Diversity-Oriented Synthesis of Chromone Inden-1-one fused Cyclopentadienylides and C-acylated Chromone Adducts *via* Allylic Phosphorus Ylides

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Contents

I. General Information

a) Materials and reagents

All reactions were carried out under argon atmosphere in oven-dried glassware with magnetic stirring. All solvents and reagents were used as purchased from commercial suppliers without further purification. Triethylamine (Et_3N) was freshly distilled from calcium hydride under argon atmosphere and stored over 4 Å molecular sieves. Starting materials which were not commercially available were synthesized according to the previously reported methods.

b) Instrumentation

Thin layer chromatography (TLC): TLC analyses were performed on precoated aluminum-backed silica gel plate (Merck 60 F254, 0.2 mm thickness) which was visualized by florescence quenching.

Flash Column Chromatography: The crude products were purified on silica gel (Merck Kieselgel 60 230-400 mesh).

NMR Spectroscopy: ^{1}H, $^{13}C\{^{1}H\}$, $^{19}F\{^{1}H\}$, and $^{31}P\{^{1}H\}$-NMR spectra were recorded on an Oxford JEOL 400 MHz spectrometer, a Bruker Ascend 400 MHz spectrometer (400 MHz for ^{1}H, 100 MHz for ^{13}C, 376 MHz for ^{19}F, and 162 MHz for ^{31}P). All NMR spectra were recorded at 299 K unless otherwise noted. Chemical shifts are reported in δ ppm referenced to an internal standard, such as TMS for ^{1}H-NMR (δ = 0.0 ppm), $CDCl_3$ for ^{13}C-NMR (δ = 77.0 ppm), CD_2Cl_2 for ^{13}C-NMR (δ = 53.5 ppm), The following abbreviations were used to explain the multiplicities: s (singlet), d (doublet), t (triplet), q (quartet), sep (septet), m (multiplet), brs (broad singlet), dd (doublet of doublet), td (triplet of doublet), dtd (doublet of triplet of doublet) and p (pseudo). Coupling constants (J) are reported in Hertz (Hz).

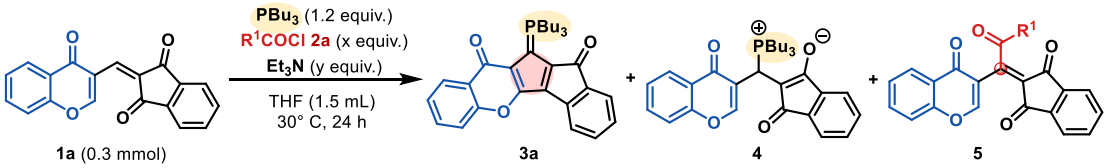
Single Crystal X-Ray Diffraction: The X-ray diffraction measurements were carried out at 200 K or 224 K on either a Bruker D8 Venture or a Bruker KAPPA APEX II CCD area detector system equipped with a graphite monochromator, a Mo-Kα fine-focus sealed tube (k = 0.71073 Å) or a Cu-Kα fine-focus sealed tube (k = 1.54178 Å).

Melting Point: Melting points were measured on a hot stage melting point apparatus and were uncorrected.

High-Resolution Mass Spectrometry (HRMS): HRMS were recorded on Waters XeVo G2-S QTof using ESI (TOF analyzer) or JEOL JMS-700 using EI (double-focusing magnetic sector). UltrafleXtreme MALDI-TOF/TOF using MALDI (Bruker

Daltonik, Bremen, Germany).

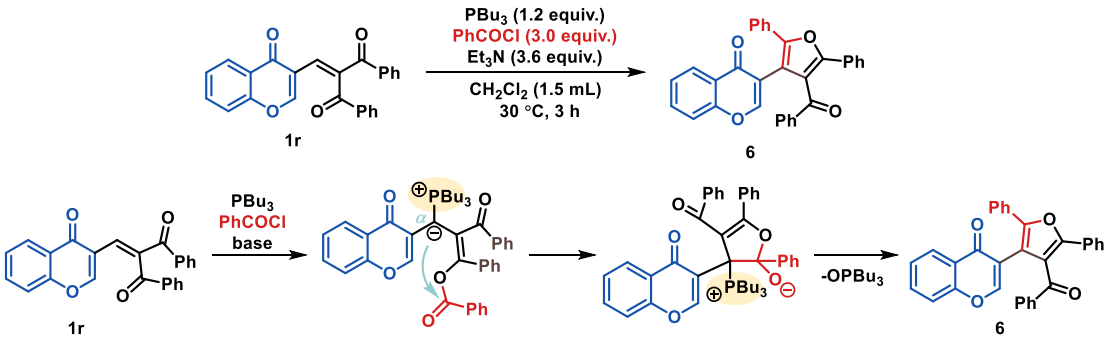
II. Preliminary studies



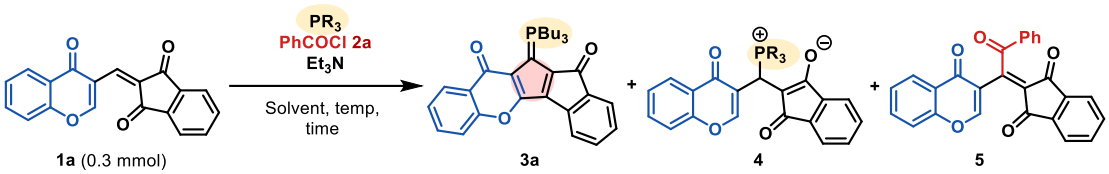
entry	R^1COCl (x equiv.)	Et_3N (y equiv.)	t (h)	3a (%)[a]	5/4 (%)[a]
1	PhCOCl (1.5)	1.8	24	37	5/42
2	4-Me-BzCl (1.5)	1.8	24	29	2/55
3	4-OMePhCl (1.5)	1.8	24	32	3/57
4	4-NO_2PhCl (1.5)	1.8	24	20	7/45
5	$(Boc)_2O$ (1.5)	1.8	24	0	0/93
6[c]	PhCOCl (1.5)	1.8	24	27	4/60
7	PhCOCl (2.5)	2.8	22	50	20/15
8	PhCOCl (3.0)	3.6	24	57	13/0

[a]Yield of the products **3a, 4 & 5** were determined by ^1H NMR analysis of the crude reaction mixture using triphenyl methane as an internal standard. [b]Reaction carried out at 60 °C.

III. Reaction conditions and plausible reaction mechanism for compound 6.



IV. Detailed optimization of compound 5aa.[a]

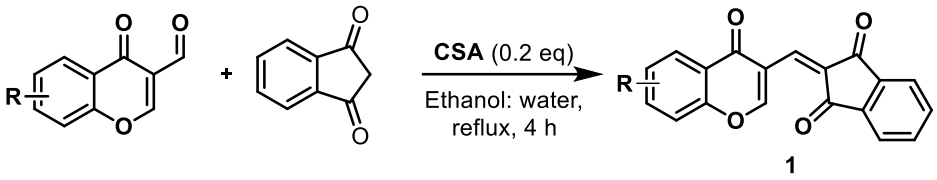


entry	PR_3 (mol%)	PhCOCl (eqiuv.)	Base (eqiuv.)	Solvent (mL)	t (h)	5aa (%)[b]	1a/4 (%)[b]
1	$MePPh_2$(120)	3.0	Et_3N (3.6)	THF	5	81	0
2	$MePPh_2$(20)	3.0	Et_3N (3.6)	THF	0.5	99	0
3	$MePPh_2$(20)	1.2	Et_3N (1.3)	THF	3	71	18
4	Me_2PPh (20)	1.2	Et_3N (1.3)	THF	0.5	88	0(6)
5	Et_2PPh (20)	1.2	Et_3N (1.3)	THF	3	39	38
6	$EtPPh_2$ (20)	1.2	Et_3N (1.3)	THF	3	36	49
7	PBu_3(20)	1.2	Et_3N (1.3)	THF	4	36	32(4)
8	PPh_3(20)	1.2	Et_3N (1.3)	THF	24	0	86
9	Me_2PPh (20)	1.2	Et_3N (1.3)	Et_2O	0.5	0	24(0)
10	Me_2PPh (20)	1.2	Et_3N (1.3)	CH_3CN	3	28	40(13
11	Me_2PPh (20)	1.2	Et_3N (1.3)	toluene	18	47	34(18
12	Me_2PPh (20)	1.2	Et_3N (1.3)	DCM	3	53	22(8)
13	Me_2PPh (20)	1.2	Et_3N (1.3)	DCE	3	57	17(10
14	Me_2PPh (20)	1.2	Et_3N (1.3)	EtOAc	18	53	30(17)
15	Me_2PPh (20)	1.2	DIPEA (1.3)	THF	0.5	87	0
16	Me_2PPh (20)	1.2	DBU (1.3)	THF	5	11	3(8)
17	Me_2PPh (20)	1.2	DMAP (1.3)	THF	0.5	0	35(13)
18	Me_2PPh (20)	1.2	Et_3N (1.5)	THF	2	87	(10)
19	Me_2PPh (20)	1.3	Et_3N (1.5)	THF	0.5	88	(5)
20	Me_2PPh (20)	1.2	Et_3N (1.3)	THF (0.75)	5	87	(6)
21	Me_2PPh (10)	1.2	Et_3N (1.3)	THF	2	74	16(4)
22[c]	Me_2PPh (20)	1.2	Et_3N (1.3)	THF	2	89	0

[a]Unless otherwise specified, all reactions were carried out with **1a** (0.3 mmol), PhCOCl **2a**, **Base** and **PR_3**, in the given anhydrous solvent (1.5 mL) under argon atmosphere at 30 °C. [b]Yield of the products **5aa & 4, 1a**

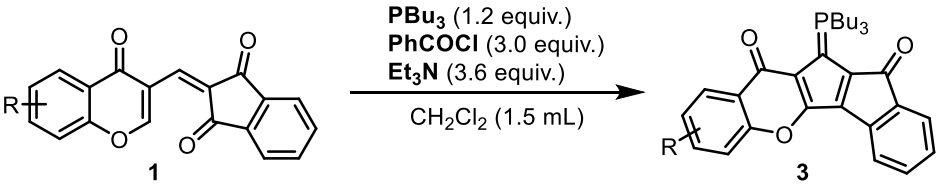
were determined by ^{1}H NMR analysis of the crude reaction mixture using triphenyl methane as an internal standard. [c]Reaction carried out at 60 °C.

V. a) Typical Procedure for the Preparation of compound 1 (TP-A)



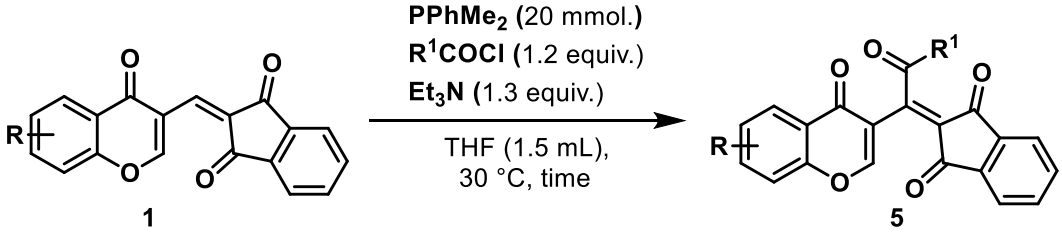
Following the reported procedure[1], a round-bottomed flask equipped with a magnetic stir bar was charged with 3-Formylchromone[2] (5.0 mmol.), 1,3-indanedione (1.0 equiv.), and (±)-Camphor-10-Sulfonic Acid (CSA) (0.2 equiv.) in water: EtOH (1:1) at 80 °C in an oil bath for 4 h. After that, the resulting mixture was filtered under a vacuum and the residue was washed with methanol (2 times) then ethyl ether (2 times) to obtain product **1**.

b) Typical Procedure for the Preparation of compound 3 (TP-B).



A dry and argon-flushed 10 mL Schlenk flask equipped with a magnetic stir bar was charged with **1** (0.3 mmol.), PBu_3 (1.2 equiv.), PhCOCl **2a** (3.0 equiv.), and Et_3N (3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C. After completion of the reaction, the reaction mixture was diluted with CH_2Cl_2 (4 mL), and the organic phase was washed with sodium bicarbonate solution. The resulted organic layer was dried over sodium sulfate and filtered through filter paper then the organic solution was concentrated under vacuum. Further, the crude reaction mixture was purified by flash column chromatography on silica gel to obtain the desired products **3**.

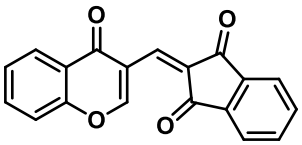
c) Typical Procedure for the Preparation of compound 5 (TP-C).



A dry and argon-flushed 10 mL Schlenk flask equipped with a magnetic stir bar was charged with compound **1** (0.3 mmol.), $PPhMe_2$ (0.2 equiv.), R^1COCl (1.2 equiv.), and Et_3N (1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C. After completion of the reaction, the solvent was removed under vacuum and the crude residue was subjected to flash column chromatography on silica gel to obtain the desired products **5.**

VI. Characterization of all Compounds

2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1a.



1a

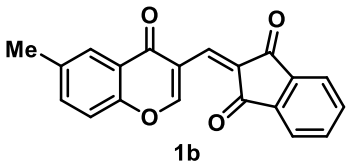
Following the **TP-A**, **1a** was obtained from 4-oxo-4H-chromene-3-carbaldehyde (0.87 g, 5.0 mmol), 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), and CSA (0.23 g, 0.2 equiv.). The residue was filtered under vacuum and obtain **1a** as a pale yellow solid (1.2 g, 80% yield). R_f = 0.50 (Hexanes:EtOAc = 7:3) : mp.: 277.3-278.5 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.40 (s, 1H), 8.44 (s, 1H), 8.32 (dd, *J* = 8.1, 1.6 Hz, 1H), 8.08-7.98 (m, 2H), 7.89-7.80 (m, 2H), 7.75 (dtd, *J* = 8.7, 7.2, 1.7 Hz, 1H), 7.57 (dd, *J* = 8.4, 0.5 Hz, 1H), 7.50 (dtd, *J* = 9.1, 7.2, 0.9 Hz, 1H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.2, 189.0, 175.3, 163.4, 156.1, 142.1, 140.4, 136.5, 135.6, 135.4, 134.5, 129.4, 126.7, 126.4, 124.0, 123.6, 123.4, 118.6, 118.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_{11}O_4$: 302.0579 found: 302.0600.

2-(5-methyl-2-phenylbenzofuran-3-yl)-1-oxo-1H-inden-3-yl pivalate 1b.



1b

Following the **TP-A**, **1b** was obtained from 6-methyl-4-oxo-4H-chromene-3-carbaldehyde (0.94 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1b** as a pale green solid (1.1 g, 70%). R_f = 0.50 (Hexanes:EtOAc = 8:2) ; mp.: 228.2-229.4 °C.

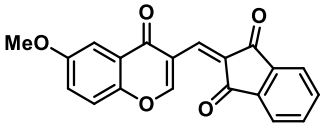
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.37 (s, 1H), 8.43 (pd, *J* = 0.6 Hz, 1H), 8.09 (pd, *J* = 1.1 Hz, 1H), 8.06-7.97 (m, 2H), 7.87-7.79 (d, 2H), 7.54 (d, *J* = 8.7, 2.2 Hz, 1H), 7.45 (pd, *J* = 8.5 Hz, 1H), 2.49 (s, 3H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.2, 189.1, 175.3, 163.4, 154.3, 142.1, 140.3, 136.8, 136.6, 135.6, 135.5, 135.3, 129.1, 126.0, 123.6, 123.5, 123.3, 118.4, 118.3,

20.9.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{20}H_{12}O_4$: 316.0736 found: 316.0737.

2-(5-methoxy-2-phenylbenzofuran-3-yl)-1-oxo-1H-inden-3-yl pivalate 1c.



1c

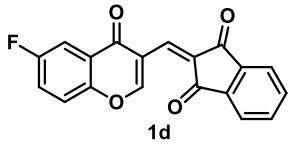
Following the **TP-A**, **1c** was obtained from 6-methoxy-4-oxo-4H-chromene-3-carbaldehyde (1.02 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1c** as a pale green solid (1.2 g, 72%). R_f = 0.38 (Hexanes:EtOAc = 7:3) ; mp.: 266.7-267.7 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.37 (s, 1H), 8.46 (s, 1H), 8.08-7.96 (m, 2H), 7.89-7.89 (m, 2H), 7.68 (d, *J* = 3.1 Hz, 1H), 7.49 (pd, *J* = 9.1 Hz, 1H), 7.32 (dd, *J* = 9.1, 3.1 Hz, 1H), 3.93 (s, 3H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.2, 189.2, 175.2, 163.1, 157.8, 150.8, 142.1, 140.3, 136.9, 135.5, 135.3, 129.1, 124.8, 124.3, 123.5, 123.4, 120.0, 117.8, 105.9, 50.1.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{20}H_{12}O_5$: 332.0685 found: 332.0677.

2-((6-fluoro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1d.



1d

Following the **TP-A**, **1d** was obtained from 6-fluoro-4-oxo-4H-chromene-3-carbaldehyde (0.96 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1d** as a half-white solid (1.1 g, 68%). R_f = 0.40 (Hexanes:EtOAc = 8:2) ; mp.: 265.8-266.9 °C

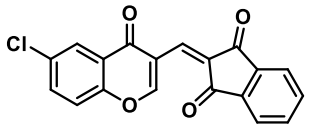
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 10.39 (d, *J* = 0.6 Hz, 1H), 8.39 (s, 1H), 8.06-8.00 (m, 2H), 7.96 (dd, *J* = 8.6, 3.1 Hz, 1H), 7.88-7.80 (m, 2H), 7.60 (dd, *J* = 9.1, 4.1 Hz, 1H), 7.51-7.43 (m, 1H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.9, 174.1, 163.2, 154.8, 142.2, 140.4, 137.5, 135.7, 135.5, 129.8, 129.3, 125.2, 123.6, 123.5, 120.5, 119.9, 118.7.

^{19}**F NMR** (376 MHz, $CDCl_3$) δ/ppm: -112.9.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9FO_4$:320.0485 found: 320.0466.

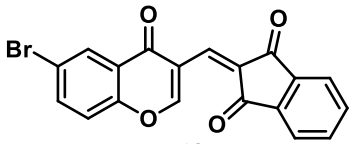
2-((6-chloro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1e.



1e

Following the **TP-A**, **1e** was obtained from 6-chloro-4-oxo-4H-chromene-3-carbaldehyde (1.04 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1e** as a half-white solid (1.0 g, 60%). R_f = 0.40 (Hexanes:EtOAc = 8:2) ; mp.: 271.2-272.3 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.37 (s, 1H), 8.38 (s, 1H), 8.28 (d, *J* = 2.6 Hz, 1H), 8.06-7.99 (m, 2H), 7.89-7.82 (m, 2H), 7.69 (dd, *J* = 8.7, 2.6 Hz, 1H), 7.53 (d, *J* = 8.9 Hz, 1H).
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.9, 174.1, 163.2, 154.8, 142.2, 140.4, 137.5, 135.7, 135.5, 129.8, 129.3, 125.2, 123.6, 123.5, 120.5, 119.9, 118.7.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9{}^{35}ClO_4$: 336.0189 found: 336.0197.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9{}^{37}ClO_4$: 338.0160 found: 338.0156.

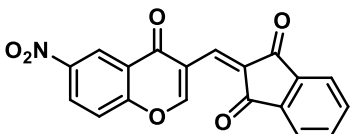
2-((6-bromo-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1f.



1f

Following the **TP-A**, **1f** was obtained from 6-bromo-4-oxo-4H-chromene-3-carbaldehyde (1.25 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1f** as a pale green solid (1.0 g, 52%). R_f = 0.38 (Hexanes:EtOAc = 9:1); mp.: 264.4-265.6 °C
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.37 (s, 1H), 8.45 (d, *J* = 2.4 Hz, 1H), 8.37 (s, 1H), 8.07-7.97 (m, 2H), 7.90-7.80 (m, 3H), 7.47 (d, *J* =8.9 Hz, 1H).
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.9, 174.1, 163.2, 154.8, 142.2, 140.4, 137.5, 135.7, 135.5, 129.8, 129.3, 125.2, 123.6, 123.5, 120.5, 119.9, 118.7.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9{}^{79}BrO_4$: 379.9684 found: 379.9700.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9{}^{81}BrO_4$: 381.9664 found: 381.9627.

2-((6-nitro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1g.

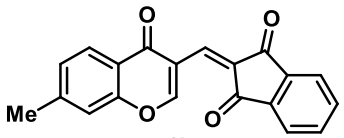


1g

Following the **TP-A**, **1g** was obtained from 6-nitro-4-oxo-4H-chromene-3-

carbaldehyde (1.09 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1g** as a pale yellow solid (1.3 g, 76%). R_f = 0.45 (Hexanes:EtOAc = 6:4) ; mp.: 309.2-310.5 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.39 (s, 1H), 9.19 (d, *J* = 2.7 Hz, 1H), 8.58 (dd, *J* = 9.7, 2.8 Hz, 1H), 8.34 (s, 1H), 8.08-8.02 (m, 2H), 7.90-7.84 (m, 2H), 7.74 (d, *J* = 9.1 Hz, 1H).
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.5, 174.0, 162.8, 158.8, 145.5, 142.2, 140.5, 135.9, 135.6, 134.4, 130.8, 128.7, 123.1, 123.8, 123.6, 123.3, 120., 119.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9NO_6$: 347.0430 found: 347.0425.

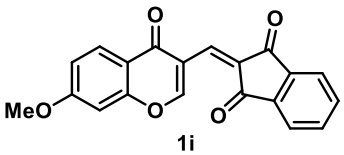
2-((7-methyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1h.



1h

Following the **TP-B**, **1h** was obtained from 7-methyl-4-oxo-4H-chromene-3-carbaldehyde (0.94 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1h** as a half-white solid (1.25 g, 80%). R_f = 0.45 (Hexanes:EtOAc = 8:2) ; mp.: 224.4-225.6 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.34 (s, 1H), 8.40 (s, 1H), 8.17 (d, *J* = 8.2 Hz, 1H), 8.06-7.94 (m, 2H), 7.87-7.78 (m, 2H), 7.33 (s, 1H), 7.28 (d, *J* = 8.0 Hz, 1H), 2.51 (s, 3H).
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.1, 189.1, 175.1, 163.3, 156.1, 146.1, 142.0, 136.6, 135.5, 135.3, 129.0, 127.8, 126.3, 123.4, 123.3, 121.6, 118.4, 118.3, 21.8.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{20}H_{12}O_4$: 316.0736 found: 316.0752.

2-((7-methoxy-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1i.



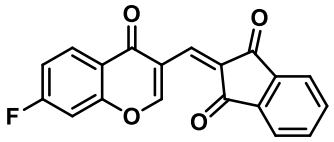
1i

Following the **TP-B**, **1i** was obtained from 7-methoxy-4-oxo-4H-chromene-3-carbaldehyde (1.02 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1i** as a half-white solid (1.1 g, 68%). R_f = 0.45 (Hexanes:EtOAc =7:2) ; mp.: 268.8-269.3 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.34 (s, 1H), 8.44 (s, 1H), 8.22 (d, *J* = 8.8 Hz, 1H) 8.09-7.97 (m, 2H), 7.89-7.77 (m, 2H), 7.04 (dd, *J* = 9.2, 2.5 Hz, 1H), 6.94 (d, *J* = 2.3 Hz, 1H), 3.64 (s, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.3, 189.1, 174.5, 164.7, 163.1, 157.8, 142.1, 140.4, 136.8, 135.5, 135.3, 129.2, 128.1, 123.5, 123.3, 118.6, 117.7, 115.4, 101.0, 55.9.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{20}H_{12}O_5$: 332.0685 found: 332.0668.

2-((7-fluoro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1j.



1j

Following the **TP-A**, **1j** was obtained from 7-fluoro-4-oxo-4H-chromene-3-carbaldehyde (0.96 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1j** as a half-white solid (1.1 g, 76%). R_f = 0.48 (Hexanes:EtOAc =8:2) ; mp.: 284.3-285.5 °C.

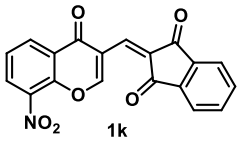
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 10.36 (s, 1H), 8.39 (s, 1H), 8.34 (dd, J = 10, 6.2 Hz, 1H), 8.08-7.99 (m, 2H), 7.87-7.82 (m, 2H), 7.33-7.16 (m, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.9, 174.3, 167.3, 164.8, 163.2, 157.1 (d, $J_{C\text{-}F}$ = 13.3 Hz) 142.2, 140.4, 135.8, 135.7, 135.5, 129.8, 129.1, 123.6, 123.4, 120.8, 118.7, 115.1 (d, $J_{C\text{-}F}$ = 22.8 Hz), 105.4 (d, $J_{C\text{-}F}$ = 24.5 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ/ppm: -100.9.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9FO_4$:320.0485 found: 320.0464.

2-((8-nitro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1k.



1k

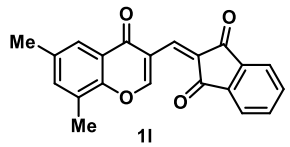
Following the **TP-A**, **1k** was obtained from 8-nitro-4-oxo-4H-chromene-3-carbaldehyde (1.1 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1k** as a brown solid (1.3 g, 76%). R_f = 0.50 (Hexanes:EtOAc =7:3) ; mp.: 249.3-250.8 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 10.40 (s, 1H), 7.54 (d, J = 8.1, 1.7 Hz, 1H), 7.54 (d, J = 8.2, 1.6 Hz, 1H), 8.31 (s, 1H), 8.08-8.01 (m, 2H), 7.92-7.82 (d, 2H), 7.62 (t, J = 7.9 Hz, 1H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.7, 188.6, 173.5, 162.3, 148.3, 142.2, 140.5, 139.2, 135.9, 135.7, 133.9, 132.3, 130.9, 130.3, 125.6, 125.5, 123.7, 123.6, 119.3.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_9NO_6$:347.0430 found: 347.0423.

2-((6,8-dimethyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1l.



1l

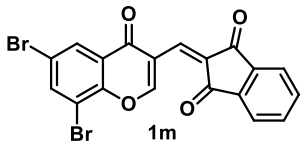
Following the **TP-A**, **1l** was obtained from 6,8-dimethyl-4-oxo-4H-chromene-3-carbaldehyde (1.0 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1l** as a pale green solid (1.05 g, 64%). R_f = 0.45 (Hexanes:EtOAc = 7:3) ; mp.: 296.6-297.8 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 10.41 (s, 1H), 8.46 (s, 1H), 8.06-7.98 (m, 2H), 7.94 (pd, *J* = 0.8 Hz, 1H), 7.87-7.79 (m, 2H), 7.39 (pd, *J* = 0.9 Hz, 1H), 2.51 (s, 3H), 2.44 (s, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.3, 189.2, 175.7, 163.1, 152.9, 142.1, 140.3, 137.1, 136.8, 135.9, 135.5, 135.3, 128.9, 127.8, 127.6, 123.6, 123.5, 123.3, 118.2, 20.9, 15.3.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{21}H_{14}O_4$:330.0892 found: 330.0864.

2-((6,8-dibromo-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1m.



1m

Following the **TP-A**, **1m** was obtained from 6,8-dibromo-4-oxo-4H-chromene-3-carbaldehyde (1.65 mg, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1m** as a pale green solid (1.2 g, 55%). R_f = 0.50 (Hexanes/EtOAc = 7: 3) ; mp: 302.5-303.6 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 10.41 (s, 1H), 8.39 (d, *J* = 2.5 Hz, 1H, 1H), 8.33 (s, 1H), 8.09 (d, *J* = 2.2 Hz, 1H), 8.07-8.00 (m, 2H), 7.90-7.82 (m, 2H).

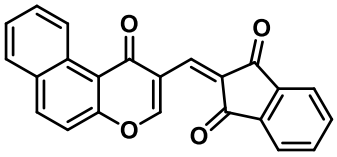
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.9, 188.7, 173.7, 162.8, 151.9, 142.2, 140.4, 140.2, 135.8, 135.6, 134.6, 130.4, 128.6, 128.6, 125.9, 123.7, 123.6, 119.8, 118.7, 133.4.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_8{}^{79}Br{}^{79}Br\ O_4$: 457.8789 found: 457.8772.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_8{}^{79}Br\ {}^{81}BrO_4$: 459.8769 found: 459.8758.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{19}H_8{}^{81}Br{}^{81}Br\ O_4$: 461.8748 found: 461.8722.

2-((1-oxo-1H-benzo[f]chromen-2-yl)methylene)-1H-indene-1,3(2H)-dione 1n.



1n

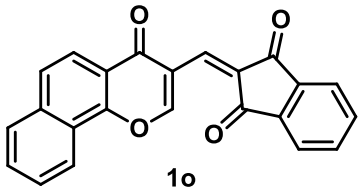
Following the **TP-A**, **1n** was obtained from 1-oxo-1H-benzo[f]chromene-2-carbaldehyde (1.1 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1n** as a half-white solid (1.3 g, 76%). R_f = 0.38 (Hexanes:EtOAc = 8:2) ; mp.: 297.4-298.5 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.56 (s, 1H), 8.61-8.53 (m, 1H), 8.49 (s, 1H), 8.24 (d, *J* = 8.7 Hz, 1H), 8.09-8.01 (m, 2H), 8.00-7.93 (m, 1H), 7.89-7.82 (m, 3H), 7.78-7.69 (m, 2H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.2, 189.1, 176.7, 160.9, 157.4, 142.2, 140.4, 136.9, 136.4, 135.6, 135.4, 131.1, 130.6, 129.8, 129.6, 127.3, 127.2, 123.6, 123.4, 120.7, 117.5.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{23}H_{12}O_4$: 352.0736 found: 352.0741.

2-((4-oxo-4H-benzo[h]chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1o.



1o

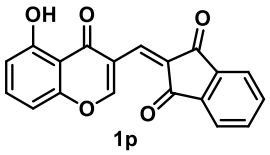
Following the **TP-A**, **1o** was obtained from 4-oxo-4H-benzo[h]chromene-3-carbaldehyde (1.1 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1o** as a yellow solid (1.4 g, 80%). R_f = 0.47 (Hexanes/EtOAc = 8:2) ; mp.: 287.3-288.2 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.56 (s, 1H), 8.61-8.53 (m, 1H), 8.58 (s, 1H), 8.25 (d, *J* = 8.7 Hz, 1H), 8.81-8.01 (m, 2H), 7.99-7.93 (m, 1H), 7.87-7.82 (m, 3H), 7.79-7.69 (m, 2H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.2, 188.9, 175.1, 162.3, 153.6, 142.2, 140.4, 136.3, 136.2, 135.6, 135.4, 129.8, 129.7, 128.2, 127.6, 126.4, 123.9, 123.6, 123.4, 122.3, 121.3, 120.4, 119.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{23}H_{12}O_4$: 352.0736 found: 352.0719.

2-((5-hydroxy-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1p.



1p

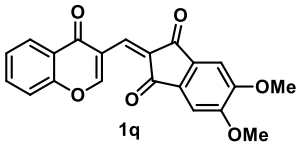
Following the **TP-A**, **1p** was obtained from 5-hydroxy-4-oxo-4H-chromene-3-carbaldehyde (0.95 g, 5.0 mmol), and 1H-indene-1,3(2H)-dione (0.73 g, 1.0 equiv.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1p** as a yellow solid (1.2 g, 75%). R_f = 0.43 (Hexanes:EtOAc =7:3) ; mp.: 249.1-250.2 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 12.31 (s, 1H), 10.38 (s, 1H), 8.31 (s, 1H), 8.13-7.97 (m, 2H) 7.90-7.77 (m, 2H), 7.60 (t, *J* = 8.3 Hz, 1H), 7.01 (pd, *J* = 8.4, 0.6 Hz, 1H), 6.89 (pd, *J* = 8.4, 0.6 Hz, 1H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.8, 180.6, 164.2, 161.5, 156.1, 142.1, 140.4, 136.4, 135.7, 135.5, 134.3, 129.6, 123.6, 123.5, 117.3, 112.9, 110.7, 107.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{21}H_{10}O_5$: 318.0528 found: 318.0517.

5,6-dimethoxy-2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione 1q.



1q

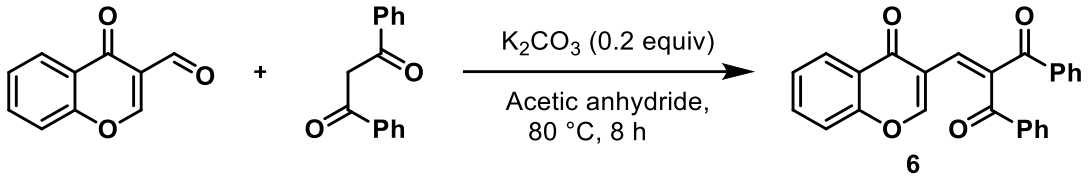
Following the **TP-A**, **1q** was obtained from 4-oxo-4H-chromene-3-carbaldehyde (0.87 g, 5.0 mmol), and 5,6-dimethoxy-1H-indene-1,3(2H)-dione (1.03 g, 5.0 mmol.), CSA (0.23 g, 0.2 equiv.). The residue was filtered under a vacuum and obtain **1q** as a yellow solid (1.2 g, 68%). R_f = 0.49 (Hexanes:EtOAc = 5:5); mp.: 271.7-272.8 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.28 (s, 1H), 8.33 (d, *J* = 7.8 Hz, 1H), 8.26 (s, 1H), 7.74 (t, *J* = 8.3 Hz, 1H), 7.56 (d, *J* = 8.5 Hz, 1H), 7.48 (t, *J* = 7.8 Hz, 1H), 7.04 (d, *J* = 11.4 Hz, 1H), 7.33 (s, 2H), 4.03 (s, 6H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 196.6, 162.7, 155.9, 138.4, 134.3, 133.1, 126.6, 126.2, 118.6, 118.5, 103.9, 103.8, 103.2, 56.7, 44.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{21}H_{14}O_6$: 362.0790 found: 362.0775.

2-((4-oxo-4H-chromen-3-yl)methylene)-1,3-diphenylpropane-1,3-dione 6.



6

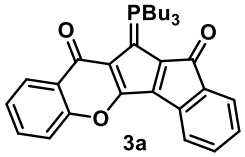
Following the reported procedure,[3] A 50 mL round-bottomed flask equipped with a magnetic stir bar was charged with 4-oxo-4H-chromene-3-carbaldehyde (0.87 g, 5.0 mmol.), 1,3-diphenylpropane-1,3-dione (1.6 g, 1.5 equiv.), K_3CO_3 (0.69 g, 0.2 equiv.) and acetic anhydride (30.0 mL). The reaction mixture was stirred for 8 h at 80 °C. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 65:35) to give **6** as a half-white solid (1.45 g, 76%). R_f = 0.45 (Hexanes:EtOAc = 7:3); mp.: 177.0-178.1 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.26 (d, *J* = 0.7 Hz, 1H), 8.17 (d, *J* = 8.2, 1.8 Hz, 1H), 8.00-7.91 (m, 4H), 7.68 (d, *J* = 0.9 Hz, 1H), 7.67-7.56 (m, 2H), 7.55-7.47 (m, 3H), 7.45-7.36 (m, 4H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 190.1, 188.8, 180.6, 164.2, 161.5, 156.1, 142.1, 140.4, 136.4, 135.7, 135.5, 134.3, 129.6, 123.6, 123.5, 117.3, 112.9, 110.7, 107.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{25}H_{16}O_4$: 380.1049 found: 380.1068.

11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3a.



3a

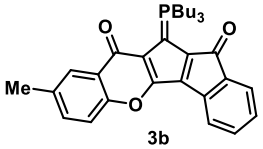
ollowing the **TP-B**, **3a** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.) and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 8 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3a** as a dark red solid (135.0 mg, 92%). R_f = 0.30 (Hexanes:EtOAc = 9:1); mp.: 184.2-185.1 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.23 (dd, *J* = 7.9, 1.9 Hz 1H), 7.57 (dtd, *J* = 9.0, 7.0, 1.7,Hz 1H), 7.46-7.44 (m, 1H), 7.33 (d, *J* = 7.2 Hz 1H), 7.29-7.25 (m, 1H), 6.94-6.88 (m, 1H), 2.73-2.54 (m, 6H), 1.48-1.44 (m, 12H), 0.93-0.89 (t, *J* = 8.0 Hz, 9H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 189.7, 174.2, 156.3, 146.1 (d, $^2J_{C\text{-}P}$ = 12.4 Hz), 141.3, 139.3, 134.4, (d, $^3J_{C\text{-}P}$ = 9.4 Hz), 133.8, 132.3, 126.1, 124.7, 123.3, 122.8, 122.6 (d, $^2J_{C\text{-}P}$ = 10.5 Hz), 122.5, 122.3, (d, $^3J_{C\text{-}P}$ = 12.7 Hz), 118.9, 117.5, 82.8, (d, $^1J_{C\text{-}P}$ = 102.9 Hz), 24.1, (d, $^3J_{C\text{-}P}$ = 4.0 Hz), 23.8, (d, $^2J_{C\text{-}P}$ = 16.0 Hz), 21.3, (d, $^1J_{C\text{-}P}$ = 52.3

Hz), 13.5.
^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.0.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{35}O_3P$: 486.2324 found: 486.2310.

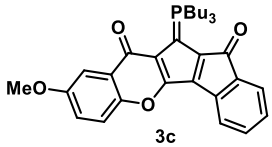
8-methyl-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3b.



3b

Following the **TP-B**, **3b** was obtained from 2-((6-methyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1b** (94.89 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 48 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3b** as a dark red solid (138.0 mg, 90%). R_f = 0.45 (Hexanes:EtOAc = 8:2); mp.: 179.9-181.1 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.03 (s, 1H), 7.40-7.30 (m, 3H), 7.28-7.20 (m, 2H), 6.95-6.85 (m, 1H), 2.70-2.58 (m, 6H), 2.43 (s, 3H), 1.53-1.39 (m, 12H), 0.92 (t, *J* = 6.7 Hz, 9H).
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 189.6, 174.3, 154.5, 146.3 (d, $^2J_{C\text{-}P}$ = 11.9 Hz), 141.3, 139.2, 139.1, 135.4 (d, $^3J_{C\text{-}P}$ = 9.7 Hz), 133.8, 133.4, 132.0, 125.6, 124.5, 123.2, 122.4 (d, $^3J_{C\text{-}P}$ = 10.6 Hz), 122.3 (d, $^2J_{C\text{-}P}$ = 11.2 Hz), 121.2, 118.9, 117.2, 82.0 (d, $^1J_{C\text{-}P}$ = 104.2 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 3.9 Hz), 23.7 (d, $^2J_{C\text{-}P}$ = 15.7 Hz), 21.5 (d, $^1J_{C\text{-}P}$ = 52.7 Hz), 20.7, 13.5.
^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.0.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{32}H_{37}O_3P$: 500.2480 found: 500.2462.

8-methoxy-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3c.

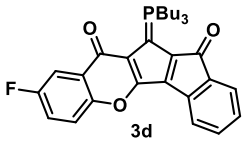


3c

Following the **TP-B**, **3c** was obtained from 2-((6-methoxy-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1c** (99.69 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 24 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3c** as a dark red

solid (114.5 mg, 73%). R_f = 0.45 (Hexanes:EtOAc = 8:2); mp.: 115.3-116.2 °C.
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 7.65 (d, *J* = 3.2 Hz, 1H), 7.38 (d, *J* = 9.1, 1H), 7.31 (d, *J* = 7.3 Hz, 1H), 7.28-7.21 (m, 1H), 7.18 (dd, *J* = 9.1, 3.2 Hz, 1H), 6.94-6.86 (m, 1H), 2.75-2.53 (m, 6H), 1.55-1.37 (m, 12H), 0.91 (t, *J* = 6.7 Hz, 9H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.7, 173.9, 155.2, 151.1, 146.5 (d, $^2J_{C\text{-}P}$ = 12.1 Hz), 141.4, 139.2, 134.6 (d, $^3J_{C\text{-}P}$ = 9.9 Hz), 133.8, 124.6, 123.2, 122.9, 122.4 (d, $^3J_{C\text{-}P}$ = 10.4 Hz), 122.1 (d, $^2J_{C\text{-}P}$ = 12.3 Hz), 121.9, 118.9, 118.7, 105.9, 81.6 (d, $^1J_{C\text{-}P}$ = 103.3 Hz), 55.8, 24.2 (d, $^3J_{C\text{-}P}$ = 3.8 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.8 Hz), 21.5 (d, $^1J_{C\text{-}P}$ = 52.8 Hz), 13.5.
^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 21.9.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{32}H_{37}O_4P$: 516.2429 found:. 516.2454.

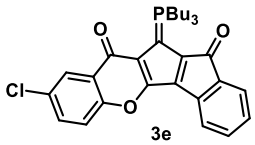
8-fluoro-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3d.



3d

Following the **TP-B**, **3d** was obtained from 2-((6-fluoro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1d** (96.01 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 8 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3d** as a dark red solid (135.0 mg, 89%). R_f= 0.46 (Hexanes:EtOAc = 9:1); mp.: 169.7-170.5 °C
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 7.87 (dd, *J* = 9.0, 3.1 Hz, 1H), 7.43 (dd, *J* = 9.1, 4.3 Hz, 1H), 7.34 (d, *J* = 7.4 Hz, 1H), 7.3-7.28 (m, 1H), 7.3-7.2 (m, 1H), 6.94-6.90 (td, *J* = 6.9, 2.0 Hz, 1H), 2.80-2.52 (m, 6H), 1.55-1.37 (m, 12H), 0.92 (t, *J* = 6.9 Hz, 9H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.7, 173.2, 159.5, 157.1, 152.4, 146.2, , (d, $^2J_{C\text{-}P}$ = 12.0 Hz), 141.2, 139.1, 134.9, (d, $^3J_{C\text{-}P}$ = 9.6 Hz), 133.9, 124.8, 123.7, (d, $J_{C\text{-}F}$ = 6.7 Hz), 123.4, 122.3, (d, $^3J_{C\text{-}P}$ = 10.6 Hz), 121.5, (d, $^2J_{C\text{-}P}$ = 12.2 Hz), 120.0 (d, $J_{C\text{-}F}$ = 25.2 Hz), 119.8, 119.0, 118.9, 111.0 (d, $J_{C\text{-}F}$ = 23.7 Hz), 81.1 (d, $^1J_{C\text{-}P}$ = 103.0 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 3.9 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.8 Hz), 21.4 , (d, $^1J_{C\text{-}P}$ = 52.5 Hz), 13.5.
^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 22.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ/ppm: -119.9.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}O_3PF$: 504.2230 found: 504.2198.

8-chloro-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3e.



3e

Following the **TP-B**, **3e** was obtained from 2-((6-chloro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1e** (101.02 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 8 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3e** as a dark red solid (141.2 mg, 90%). R_f = 0.55 (Hexanes:EtOAc = 9:1); mp.: 161.7-162.8 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.20 (d, *J* = 2.6 Hz, 1H), 7.50 (dd, *J* = 8.9, 2.6 Hz, 1H), 7.4 (d, *J* = 8.8 Hz, 1H), 7.33 (d, *J* = 7.2 Hz, 1H), 6.90 (td, *J* = 7.2, 1.7 Hz, 1H), 2.70-2.55 (m, 6H), 1.54-1.37 (m, 12H), 0.92 (t, *J* = 6.9 Hz, 9H).

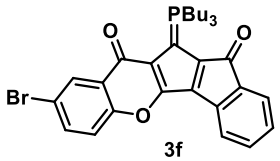
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 189.6, 172.8, 154.6, 146.1 (d, $^2J_{C\text{-}P}$ = 12.7 Hz), 141.2, 139.1, 135.0 (d, $^3J_{C\text{-}P}$ = 9.6 Hz), 133.9, 132.1, 128.1, 125.7, 124.8, 123.9, 123.4, 122.4 (d, $^3J_{C\text{-}P}$ = 10.8 Hz), 121.7 (d, $^2J_{C\text{-}P}$ = 12.3 Hz), 119.1, 119.0, 82.5 (d, $^1J_{C\text{-}P}$ = 102.7 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 4.1 Hz), 23.7 (d, $^2J_{C\text{-}P}$ = 15.7 Hz), 21.7(d, $^1J_{C\text{-}P}$ = 52.8 Hz), 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.2.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}O_3P^{35}Cl$: 520.1934 found: 520.1919.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}O_3P^{37}Cl$: 522.1905 found: 522.1904.

8-bromo-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3f.



3f

Following the **TP-B**, **3f** was obtained from 2-((6-bromo-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1f** (114.4 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 8 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3f** as a dark red solid (148.2 mg, 87%). R_f = 0.50 (Hexanes:EtOAc = 8:2); mp.: 170.3-171.2 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.36 (d, *J* = 2.5 Hz, 1H), 7.63 (dd, *J* = 8.8, 2.6 Hz, 1H), 7.35-7.34 (m, 1H), 7.33 (s, 1H), 6.94-6.90 (td, *J* = 14.1, 7.1 Hz, 1H), 2.71-2.53 (m,

6H), 1.54-1.36 (m, 12H), 0.92 (t, J = 6.9 Hz, 9H).

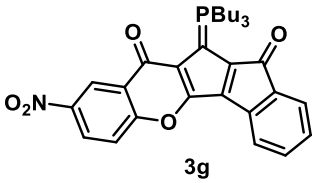
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.6, 172.7, 155.0, 145.9 (d, $^{2}J_{C\text{-}P}$ = 11.6 Hz), 141.1, 139.1, 135.0 (d, $^{3}J_{C\text{-}P}$ = 9.4 Hz), 134.9, 133.9, 128.8, 124.3, 124.3, 123.4, 122.4 (d, $^{2}J_{C\text{-}P}$ = 10.5 Hz), 121.6 (d, $^{3}J_{C\text{-}P}$ = 11.93 Hz), 119.3, 119.1, 115.5, 83.1 (d, $^{1}J_{C\text{-}P}$ = 101.8 Hz), 24.1(d, $^{3}J_{C\text{-}P}$ = 3.8 Hz), 23.8 (d, $^{2}J_{C\text{-}P}$ = 15.4 Hz), 21.4 (d, $^{1}J_{C\text{-}P}$ = 52.7 Hz), 13.5.

^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 22.2.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}O_3P^{79}Br$: 564.1429 found: 564.1411.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}O_3P^{81}Br$: 566.1408 found: 566.1397.

8-nitro-11-(tributyl-λ^5-phosphanylidene)-4c,10a,11,11a-tetrahydro-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(4bH)-dione 3g.



3g

Following the **TP-B**, **3g** was obtained from 2-((6-nitro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1g** (104.18 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride 2a (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 8 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes: EtOAc = 70:30) to give **3g** as a dark red solid (128.0 mg, 80%). R_f = 0.50 (Hexanes: EtOAc = 8:2); mp.: 212.5-213.6 °C.

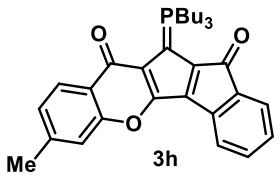
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 9.15 (d, J = 2.8 Hz, 1H), 8.40 (dd, J = 9.1 2.9 Hz, 1H), 7.54 (d, J = 9.2 Hz, 1H), 7.36 (d, J = 7.4 Hz, 1H), 7.34-7.24 (m, 1H), 6.97 (td, J = 7.3, 1.2 Hz, 1H), 2.76-2.56 (m, 6H), 1.57-1.39 (m, 12H), 0.93 (t, J = 6.8 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.5, 172.0, 159.4, 146.3 (d, $^{2}J_{C\text{-}P}$ = 11.7 Hz), 143.1, 140.7, 139.1, 135.3 (d, $^{3}J_{C\text{-}P}$ = 9.4 Hz), 134.1, 126.6, 125.2, 123.6, 123.3, 122.9, 122.7 (d, $^{3}J_{C\text{-}P}$ = 10.4 Hz), 121.2 (d, $^{2}J_{C\text{-}P}$ = 12.3 Hz), 119.3, 118.6, 83.5 (d, $^{1}J_{C\text{-}P}$ = 102.2 Hz), 24.1 (d, $^{3}J_{C\text{-}P}$ = 4.0 Hz), 23.3 (d, $^{2}J_{C\text{-}P}$ = 15.8 Hz), 21.7 (d, $^{3}J_{C\text{-}P}$ = 52.3 Hz), 13.5.

^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 22.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}NO_5P$: 531.2175 found: 531.2171.

7-methyl-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3h.



3h

Following the **TP-B**, **3h** was obtained from 2-((7-methyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1h** (94.89 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 48 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3h** as a dark red solid (113.5 mg, 75%). R_f = 0.48 (Hexanes:EtOAc =8:2); mp.: 157.2-158.2 °C.

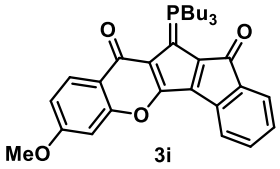
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.11 (d, *J* = 8.1 Hz, 1H), 7.32 (d, *J* = 7.2 Hz 1H), 7.28-7.20 (m, 3H), 7.09 (d, *J* = 8.1 Hz, 1H), 6.96-6.85 (m, 1H), 2.74-2.55 (m, 6H), 2.47 (s, 3H), 1.55-1.36 (m, 12H), 0.91 (t, *J* = 6.8 Hz, 9H).

^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 189.6, 174.3, 156.4, 146.1 (d, $^3J_{C\text{-}P}$ = 12.2 Hz), 143.3, 141.4, 141.3, 139.3, 134.0 (d, $^2J_{C\text{-}P}$ = 9.9 Hz), 133.7, 125.8, 124.6, 123.9, 123.2, 122.6 (d, $^2J_{C\text{-}P}$ = 10.3 Hz), 122.3 (d, $^3J_{C\text{-}P}$ = 12.2 Hz), 120.4 118.9, 117.4, 82.2 (d, $^1J_{C\text{-}P}$ = 103.7 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 3.8 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.6 Hz), 21.7 (d, $^1J_{C\text{-}P}$ = 52.9 Hz), 21.2, 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 21.9.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{32}H_{37}O_3P$: 500.2480 found: 500.2492.

7-methoxy-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3i.



3i

Following the **TP-B**, **3i** was obtained from 2-((7-methoxy-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1i** (99.69 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 24 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 75:25) to give **3i** as a dark red solid (109.0 mg, 70%). R_f = 0.38 (Hexanes:EtOAc =8:2); mp.: 152.9-153.8 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.13 (d, *J* = 8.8 Hz, 1H), 7.32 (d, *J* = 7.1 Hz 1H), 7.26-7.21 (m, 3H), 6.96-6.80 (m, 3H), 3.91 (s, 3H), 2.7-2.55 (m, 6H), 1.53-1.37 (m, 12H), 0.91 (t, *J* = 6.7 Hz, 9H).

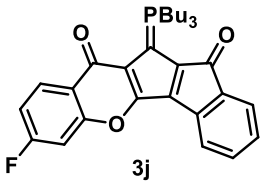
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 189.5, 174.1, 163.3, 158.0, 146.1 (d, $^3J_{C\text{-}P}$ = 12.1 Hz), 141.3, 139.4, 133.6, 133.4 (d, $^2J_{C\text{-}P}$ = 9.8 Hz), 127.4, 124.6, 123.2, 122.6 (d,

$^{2}J_{C\text{-}P}$ = 10.5 Hz), 122.2 (d, $^{3}J_{C\text{-}P}$ = 12.1 Hz), 118.9, 116.6, 111.5, 100.2, 82.2 (d, $^{1}J_{C\text{-}P}$ = 103.3 Hz), 55.7, 24.2 (d, $^{3}J_{C\text{-}P}$ = 3.4 Hz), 23.8 (d, $^{2}J_{C\text{-}P}$ = 15.8 Hz), 21.5 (d, $^{1}J_{C\text{-}P}$ = 53.1 Hz).

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.0.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{32}H_{37}O_4P$: 516.2429 found: 516.2416.

7-fluoro-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3j.



3j

Following the **TP-B**, **3j** was obtained from 2-((7-fluoro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1j** (96.08 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 24 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3j** as a dark red solid (132.1 mg, 87%). R_f = 0.50 (Hexanes:EtOAc = 8:2); mp.: 150.9-151.8 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.23 (dd, *J* = 8.9, 6.6 Hz, 1H), 7.33 (d, *J* = 7.3 Hz 1H), 7.30-7.20 (m, 2H), 6.96 (dd, *J* = 9.6, 2.4 Hz, 1H), 7.99 (td, *J* = 8.2, 2.4 Hz, 1H), 6.92 (td, *J* = 7.1, 1.6 Hz, 1H), 2.76-2.53 (m, 6H), 1.58-1.36 (m, 12H), 0.92 (t, *J* = 6.8 Hz, 9H).

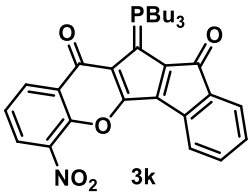
^{13}**C{^{1}H}-NMR** (100 MHz, $CDCl_3$) δ/ppm: 189.5, 173.4, 166.3, 163.8, 157.3 (d, $J_{C\text{-}F}$ = 13.2 Hz), 146.1 (d, $^{3}J_{C\text{-}P}$ = 11.8 Hz) 141.1, 139.2, 134.2 (d, $^{2}J_{C\text{-}P}$ = 9.7 Hz), 133.8, 128.3 (d, $J_{C\text{-}F}$ = 10.6 Hz), 124.8, 123.3, 122.5 (d, $^{2}J_{C\text{-}P}$ = 10.8 Hz) 121.7 (d, $^{3}J_{C\text{-}P}$ = 12.2 Hz) 119.6, 119.0, 110.9 (d, $^{2}J_{C\text{-}P}$ = 22.2 Hz), 103.9 (d, $^{2}J_{C\text{-}P}$ = 25.2 Hz), 82.5 (d, $^{1}J_{C\text{-}P}$ = 103.2 Hz), 24.1 (d, $^{3}J_{C\text{-}P}$ = 3.8 Hz), 23.8 (d, $^{2}J_{C\text{-}P}$ = 15.7 Hz), 21.4 (d, $^{1}J_{C\text{-}P}$ = 52.6 Hz), 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.3.

^{19}**F NMR** (376 MHz, $CDCl_3$) δ/ppm: -106.4.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}O_3PF$: 504.2230 found: 504.2215.

6-nitro-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3k.



3k

Following the **TP-B**, **3k** was obtained from 2-((8-nitro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1k** (104.18 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 3 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 70:30) to give **3k** as a dark red solid (138.0 mg, 86%). R_f = 0.33 (Hexanes:EtOAc = 8:2); mp.:179.7-180.8 °C.

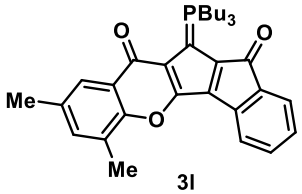
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.53 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.38 (dd, *J* = 7.9, 1.7 1H), 7.38-7.28 (m, 4H), 6.96 (td, *J* = 7.2, 2.1 Hz, 1H), 2.71-2.56 (m, 6H), 1.55-1.39 (m, 12H), 0.92 (t, *J* = 6.6 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.6, 171.7, 148.8, 144.5 (d, $^3J_{C\text{-}P}$ = 11.8 Hz), 140.6, 138.9, 138.5, 135.6 (d, $^2J_{C\text{-}P}$ = 9.6 Hz), 134.3, 132.1, 128.4, 125.3, 125.2, 123.4, 123.1 (d, $^3J_{C\text{-}P}$ = 10.5 Hz), 121.3, 120.8 (d, $^2J_{C\text{-}P}$ = 12.4 Hz), 119.6, 81.1 (d, $^1J_{C\text{-}P}$ = 102.6 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 3.9 Hz), 23.5 (d, $^2J_{C\text{-}P}$ = 15.8 Hz), 21.2 (d, $^1J_{C\text{-}P}$ = 52.6 Hz), 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.6.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{34}NO_5P$: 531.2175 found: 531.2159.

6,8-dimethyl-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3l.



3l

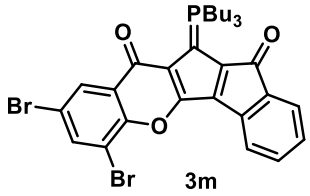
Following the **TP-B**, **3l** was obtained from 2-((6,8-dimethyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1l** (330.3 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.) and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 24 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 70:30) to give **3l** as a dark red solid (116.0 mg, 75%). R_f = 0.50 (Hexanes:EtOAc = 8:2); mp.: 211.1-212.3 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 7.88 (d, *J* = 1.4 Hz, 1H), 7.32 (d, *J* = 7.3 Hz, 1H), 7.28-7.21 (m, 2H), 7.18 (d, *J* = 7.2 Hz, 1H), 6.90 (dd, *J* = 7.3, 0.82 Hz, 1H), 2.73-2.58 (m, 6H), 2.53(s, 3H), 2.40 (s, 3H), 1.57-1.36 (m, 12H), 0.91 (t, *J* = 6.8 Hz 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.7, 174.7, 152.8, 146.3 (d, $^2J_{C\text{-}P}$ = 12.1 Hz), 141.4, 139.3, 134.6, 134.1 (d, $^3J_{C\text{-}P}$ = 9.8 Hz), 133.7, 131.4, 126.2, 124.5, 123.2, 122.6 (d, $^3J_{C\text{-}P}$ = 10.9 Hz), 122.1 (d, $^2J_{C\text{-}P}$ = 12.2 Hz), 122.0, 118.8, 82.3 (d, $^1J_{C\text{-}P}$ = 103.7 Hz), 24.2 (d, $^3J_{C\text{-}P}$ = 3.7 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.7 Hz), 21.5 (d, $^1J_{C\text{-}P}$ = 53.7 Hz), 20.7, 15.7, 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 21.9.
HRMS (EI) m/z: $[M]^+$ calcd for**.** $C_{33}H_{39}O_3P$: 514.2637 found: 514.2618.

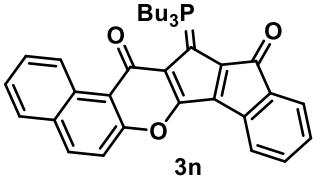
6,8-dibromo-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3m.



3m

Following the **TP-B**, **3m** was obtained from 2-((6,8-dibromo-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1m** (138.02 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.). in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 8 h. After workup, the residue was purified by column chromatography (SiO_2, Hexane:EtOAc = 75:25) to give **3m** as a dark red solid (165.0 mg, 85%). R_f = 0.40 (Hexanes:EtOAc = 9:1) ; mp.: 214.2-215.5 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.30 (d, J = 8.3 Hz, 1H), 7.91 (d, J = 2.3 Hz, 1H), 7.35 (d, J = 7.4 Hz, 1H), 7.32-7.27 (m, 2H), 6.99-6.90 (m, 1H), 2.73-2.49 (m, 6H), 1.58-1.35 (m, 12H), 0.91 (t, J = 6.7 Hz, 9H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.7, 171.8, 151.6, 145.3 (d, $^2J_{C\text{-}P}$ = 11.8 Hz), 140.9, 140.8, 139.0, 137.5, 135.4 (d, $^3J_{C\text{-}P}$ = 9.6 Hz), 134.1, 128.3, 125.1, 125.0, 123.5, 122.8 (d, $^3J_{C\text{-}P}$ = 10.5 Hz), 120.8 (d, $^2J_{C\text{-}P}$ = 12.4 Hz), 119.4, 115.1, 112.0, 82.8 (d, $^1J_{C\text{-}P}$ = 102.8 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 4.1 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.8 Hz), 21.3 (d, $^1J_{C\text{-}P}$ = 52.8 Hz), 13.5.
^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 22.4.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{33}{}^{79}Br{}^{79}Br\,O_3P$: 642.0534 found: 642.0519.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{33}{}^{79}Br\,{}^{81}BrO_4P$: 644.0514 found: 644.0522.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{31}H_{33}{}^{81}Br{}^{81}Br\,O_4P$: 646.0493 found: 646.0487.

13-(tributyl-λ^5-phosphanylidene)-12H-benzo[f]benzo[5,6]pentaleno[1,2-b]chromene-12,14(13H)-dione 3n.



3n

Following the **TP-B**, **3n** was obtained from 2-((1-oxo-1H-benzo[f]chromen-2-yl)methylene)-1H-indene-1,3(2H)-dione **1n** (105.7 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in

anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 48 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **3n** as a dark red solid (85.1 mg, 52%). R_f = 0.53 (Hexanes:EtOAc = 7:3); mp.: 189.4-190.3 °C.

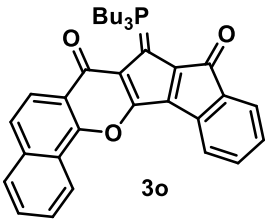
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 10.17 (d, *J* = 8.7 Hz, 1H), 7.98 (d, *J* = 9.1 Hz 1H), 7.87 (d, *J* = 8.0 Hz, 1H), 7.69 (t, *J* = 7.9 Hz, 1H), 7.57 (d, *J* = 9.1 Hz, 1H), 7.52 (t, *J* = 7.5 Hz, 1H), 7.32 (d, *J* = 7.3 Hz, 1H), 7.29-7.20 (m, 2H), 6.95-6.85 (m, 1H), 2.79-2.59 (m, 6H), 1.55-1.40 (m, 12H), 0.92 (t, *J* = 6.7 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.6, 177.2, 157.3, 144.7 (d, $^3J_{C\text{-}P}$ = 12.0 Hz), 141.3, 141.2, 139.4, 133.8, 133.7, 133.4 (d, $^2J_{C\text{-}P}$ = 10.0 Hz), 132.2, 130.2, 128.1, 126.9, 125.2 (d, $^2J_{C\text{-}P}$ = 11.4 Hz), 124.9, 124.6, 123.2, 122.7, (d, $^3J_{C\text{-}P}$ = 10.6 Hz), 118.7, 118.6, 114.7, 81.2 (d, $^1J_{C\text{-}P}$ = 104.5 Hz), 24.3 (d, $^3J_{C\text{-}P}$ = 3.9 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.7 Hz), 21.8 (d, $^1J_{C\text{-}P}$ = 53.7 Hz), 13.6.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 21.9.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{35}H_{37}O_3P$: 536.2480 found: 536.2464.

8-(tributyl-λ^5-phosphanylidene)-7H-benzo[h]benzo[5,6]pentaleno[1,2-b]chromene-7,9(8H)-dione 3o.



3o

Following the **TP-B**, **3o** was obtained from 2-((4-oxo-4H-benzo[h]chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1o** (105.72 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.), and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 24 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =75:25) to give **3o** as a dark red solid (118.0 mg, 73%). R_f = 0.50 (Hexanes:EtOAc = 8:2); mp.: 191.3-192.1 °C.

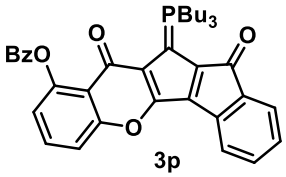
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.69-8.61 (m, 1H), 8.23 (d, *J* = 8.7 Hz, 1H), 7.94-7.84 (m, 1H), 7.73-7.60 (m, 3H), 7.42-7.29 (m, 3H), 6.94 (td, *J* = 7.4, 1.0 Hz, 1H), 2.79-2.56 (m, 6H), 1.62-1.37 (m, 12H), 0.91 (t, *J* = 6.9 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.7, 174.4, 153.1, 145.9 (d, $^3J_{C\text{-}P}$ = 12.2 Hz), 141.3, 139.6, 135.6, 133.9 (d, $^2J_{C\text{-}P}$ = 9.9 Hz), 133.8, 128.3, 127.8, 126.3, 124.8, 124.4, 123.3, 123.1 (d, $^2J_{C\text{-}P}$ = 10.3 Hz), 122.9 (d, $^3J_{C\text{-}P}$ = 12.3 Hz), 122.7, 122.4, 121.9, 118.9, 117.9, 81.7 (d, $^1J_{C\text{-}P}$ = 104.0 Hz), 24.2 (d, $^3J_{C\text{-}P}$ = 3.9 Hz), 23.8 (d, $^3J_{C\text{-}P}$ = 15.7 Hz), 21.6 (d, $^3J_{C\text{-}P}$ = 53.3 Hz), 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.1.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{35}H_{37}O_3P$: 536.2480 found: 536.2489.

10,12-dioxo-11-(tributyl-λ^5-phosphanylidene)-11,12-dihydro-10H-benzo[5,6]pentaleno[1,2-b]chromen-9-yl benzoate 3p.



3p

Following the **TP-B**, **3p** was obtained from 2-((5-hydroxy-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1p** (95.40 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (156.83 µL, 4.5 equiv.) and Et_3N (192.30 µL, 4.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 24 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 80:20) to give **3p** as a dark red solid (128.0 mg, 70%). R_f = 0.40 (Hexanes:EtOAc = 9:1); mp.: 190.8-191.5 °C.

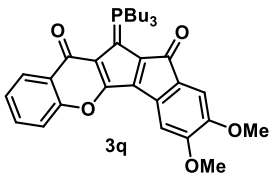
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.26 (d, *J* = 7.3 Hz, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.57-7.47 (m, 3H), 7.39 (d, *J* = 8.5 Hz, 1H), 7.30 (d, *J* = 7.3 Hz, 1H), 7.27-7.28 (m, 2H), 6.98 (d, *J* = 7.6 Hz, 1H), 7.39 (dd, *J* = 7.1, 1.6 Hz, 1H), 2.51-2.34 (m, 6H), 1.58-1.28 (m, 12H), 0.86 (t, *J* = 6.8 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.5, 173.4, 165.4, 157.7, 150.2, 144.9 (d, $^2J_{C\text{-}P}$ = 11.8 Hz), 141.3, 141.2, 139.3, 133.8 (d, $^3J_{C\text{-}P}$ = 11.8 Hz), 133.7, 132.8, 131.6, 130.8, 130.3, 128.2, 124.6, 123.3 (d, $^3J_{C\text{-}P}$ = 12.3 Hz), 123.2, 122.3 (d, $^2J_{C\text{-}P}$ = 12.2 Hz), 118.9, 116.9, 115.9, 82.4 (d, $^1J_{C\text{-}P}$ = 103.5 Hz), 24.1 (d, $^3J_{C\text{-}P}$ = 3.9 Hz), 23.8 (d, $^2J_{C\text{-}P}$ = 15.9 Hz), 21.5 (d, $^1J_{C\text{-}P}$ = 53.0 Hz), 13.5.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 21.6.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{38}H_{39}O_5P$: 606.2535 found: 606.2524.

2,3-dimethoxy-11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione 3q.



3q

Following the **TP-B**, **3q** was obtained 5,6-dimethoxy-2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1q** (108.7 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.), benzoyl chloride **2a** (104.5 µL, 3.0 equiv.) and Et_3N (150.5 µL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 3 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =72:25) to give **3q** as a reddish brown solid (90.0 mg, 55%). R_f = 0.38 (Hexanes/EtOAc = 8:2); mp.: 160.7-161.7 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.23 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.56 (dtd, *J* = 8.9,

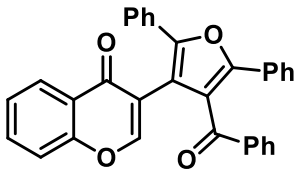
7.5, 1.7 Hz, 1H), 7.27 (dd, J = 7.5, 0.7 Hz, 1H), 6.98 (s, 1H), 6.83 (s, 1H), 4.03 (s, 3H), 3.86 (s, 3H), 2.71-2.55 (m, 6H), 1.57-1.38 (m, 12H), 0.92 (t, J = 6.7 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.2, 173.6, 156.2, 153.9, 146.4, 145.6 (d, $^{2}J_{C\text{-}P}$ = 11.9 Hz), 136.7, 135.3 (d, $^{3}J_{C\text{-}P}$ = 9.6 Hz), 132.0, 131.2, 126.1, 122.8, 122.5, 121.4 (d, $^{2}J_{C\text{-}P}$ = 12.1 Hz), 120.5 (d, $^{3}J_{C\text{-}P}$ = 10.7 Hz), 117.3, 107.9, 103.4, 82.9 (d, $^{1}J_{C\text{-}P}$ = 103.2 Hz), 56.3, 56.2, 24.2 (d, $^{3}J_{C\text{-}P}$ = 3.8 Hz), 23.8 (d, $^{2}J_{C\text{-}P}$ = 15.7 Hz), 21.4 (d, $^{1}J_{C\text{-}P}$ = 52.8 Hz), 13.5.

^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 22.0.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{33}H_{39}O_5P$: 546.2535. found: 546.2538.

3-(4-benzoyl-2,5-diphenylfuran-3-yl)-4H-chromen-4-one 6.



6

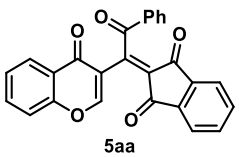
Following the **TP-B**, **6** was obtained 2-((4-oxo-4H-chromen-3-yl)methylene)-1,3-diphenylpropane-1,3-dione **1r** (114.1 mg, 0.3 mmol), PBu_3 (88.8μL, 1.2 equiv.), benzoyl chloride **2a** (104.5 μL, 3.0 equiv.) and Et_3N (150.5 μL, 3.6 equiv.) in anhydrous CH_2Cl_2 (1.5 mL) at 30 °C for 3 h. After workup, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =70:30) to give **6** as a half-white solid (99.0 mg, 75%). R_f = 0.38 (Hexanes/EtOAc = 8:2); mp.: 115.8-116.8 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.16 (dd, J = 7.9, 1.6 Hz, 1H), 8.02 (s, 1H), 7.86 (dd, J = 8.3, 1.4 Hz, 1H), 7.73-7.62 (m, 3H), 7.55-7.48 (m, 2H), 7.44 (d, J = 8.4, Hz, 1H), 7.40-7.28 (m, 5H), 7.27-7.18 (m, 5H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 192.4, 175.6, 156.2, 154.9, 152.6, 150.5, 137.2, 133.6, 132.9, 129.8, 129.7, 129.2, 128.6, 128.6, 128.2, 128.1, 127.1, 126.2, 126.1, 125.1, 123.8, 123.8, 118.0, 117.4, 113.8.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{32}H_{20}O_4P$: 468.1362. found: 468.1352.

2-(2-oxo-1-(4-oxo-4H-chromen-3-yl)-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5aa.



5aa

Following the **TP-C**, **5aa** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54μL, 0.2 equiv.),

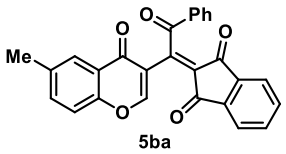
benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 70:30) to give **5aa** as a pale yellow solid (110.0 mg, 90%). R_f = 0.41 (Hexanes:EtOAc = 7:3); mp.: 248.2-248.5 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.30 (s, 1H), 8.29 (dd, *J* = 7.9, 1.5 Hz 1H), 8.11 (dd, *J* = 7.3, 1.2,Hz 1H), 7.96-7.92 (m, 1H), 7.89-7.84 (m, 1H), 7.84-7.74 (m, 2H), 7.70 (dtd, *J* = 9.0 7.3, 1.6,Hz, 1H), 7.57 (t, *J* = 7.4 Hz 1H), 7.50-7.41 (m, 4H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.4, 187.6, 187.3, 173.0, 155.9, 155.4, 146.2, 142.6, 140.7, 135.8, 132.7, 134.9, 134.3, 134.2, 131.6, 129.0, 128.9, 126.6, 126.0, 123.7, 123.6, 123.5, 118.4, 118.2.

HRMS (ESI) m/z: $[M+H]^+$ calcd for**.** $C_{26}H_{14}O_5$: 407.0919 found: 407.0916.

2-(1-(6-methyl-4-oxo-4H-chromen-3-yl)-2-oxo-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5ba.



5ba

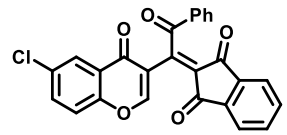
Following the **TP-C**, **5ba** was obtained from 2-((6-methyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1b** (94.89 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 3 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =70:30) to give **5ba** as a pale yellow solid (101.0 mg, 80%). R_f = 0.45 (Hexanes:EtOAc = 7:3); mp.: 290.3-291.2 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.27 (s, 1H), 8.14-8.07 (m, 3H), 7.95 (dd, *J* = 6.1, 1.5 Hz, 1H), 7.90-7.85 (m, 1H), 7.83-7.75 (m, 2H), 7.56 (t, *J* = 7.5 Hz, 1H), 7.52 (dd, *J* = 8.6, 2.1 Hz, 1H), 7.46 (t, *J* = 7.8 Hz, 2H), 7.38 (d, *J* = 8.6 Hz, 1H), 2.50 (s, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.4, 187.8, 187.4, 173.1, 155.3, 154.2, 146.5, 142.7, 140.8, 136.2, 135.8, 135.6, 135.5, 135.1, 134.2, 131.5, 129.1, 128.9, 126.0, 123.7, 123.6, 123.4, 118.2, 117.9, 20.9.

HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{27}H_{16}O_5$: 420.0998 found: 420.0989.

2-(1-(6-chloro-4-oxo-4H-chromen-3-yl)-2-oxo-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5ea.



5ea

Following the **TP-C**, **5ea** was obtained from 2-((6-chloro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1e** (101.02 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 70:30) to give **5ea** as a pale yellow solid (95.0 mg, 72%). R_f = 0.45 (Hexanes:EtOAc = 7:3); mp.: 270.1-271.2 °C.

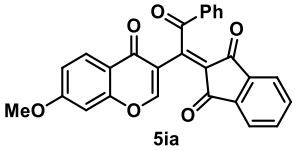
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.29 (s, 1H), 8.27 (dd, *J* = 2.6 Hz, 1H), 8.12-8.07 (m, 2H), 7.99-7.95 (m, 1H), 7.91-7.87 (m, 1H), 7.85-7.77 (m, 2H), 7.70 (dd, *J* = 9.4, 2.7 Hz, 1H), 7.62-7.56 (m, 1H), 7.51-7.43 (m, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.3, 187.6, 187.3, 171.9, 155.2, 154.3, 145.4, 142.6, 140.8, 135.9, 135.7, 134.9, 134.5, 134.4, 132.1, 131.8, 129.1, 128.9, 126.1, 124.6, 123.7, 123.6, 119.9, 118.4.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{35}Cl\ O_5$: 440.0452 found: 440.0434.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{37}Cl\ O_5$: 442.0422 found: 442.0436.

2-(1-(7-methoxy-4-oxo-4H-chromen-3-yl)-2-oxo-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5ia.



5ia

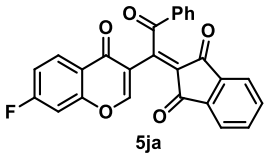
Following the **TP-C**, **5ia** was obtained from 2-((7-methoxy-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1i** (99.69 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 2 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 70:30) to give **5ia** as a pale yellow solid (82.0 mg, 62%). R_f = 0.40 (Hexanes:EtOAc = 7:3) ; mp.: 268.8-269.3 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.23 (s, 1H), 8.19 (d, *J* = 8.9 Hz, 1H), 8.14-8.07 (m, 2H), 7.99-7.95 (m, 1H), 7.90-7.86 (m, 1H), 7.85-7.74 (m, 2H), 7.62-7.54 (m, 1H), 7.50-7.43 (m, 2H), 7.02 (dd, *J* = 9.1, 2.3 Hz, 1H), 6.87 (d, *J* = 2.4 Hz, 1H), 3.91 (s, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.5, 187.8, 187.4, 172.3, 164.6, 157.7, 155.1, 146.6, 142.7, 140.8, 135.8, 135.6, 135.1, 134.1, 131.6, 129.1, 128.9, 128.1, 123.7,

123.6, 118.5, 117.6, 115.2, 100.5, 55.9.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{27}H_{16}O_6$: 436.0947 found: 436.0966.

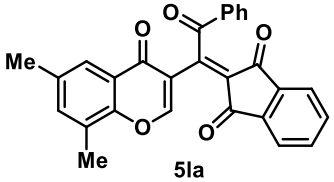
2-(1-(7-fluoro-4-oxo-4H-chromen-3-yl)-2-oxo-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5ja.



5ja

Following the **TP-C**, **5ja** was obtained from 2-((7-fluoro-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1j** (96.08 mg, 0.3 mmol), Me_2PhP (8.54μL, 0.2 equiv.), benzoyl chloride **2a** (41.82 μL, 1.2 equiv.), and Et_3N (54.36 μL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =70:30) to give **5ja** as a pale yellow solid (95.4 mg, 75%). R_f = 0.43 (Hexanes:EtOAc = 7:3); mp.: 223.5-224.5 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.3 (dd, *J* = 8.7, 6.3 Hz, 1H), 8.29 (s, 1H), 8.11 (d, *J* = 7.8 Hz, 2H), 7.96 (dd, *J* = 6.4, 1.3 Hz, 1H), 7.93-7.85 (m, 1H), 7.85-7.75 (m, 2H), 7.58 (t, *J* = 7.5 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.24-7.15 (m, 2H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.3, 187.7, 187.3, 172.2, 167.2, 164.6, 157.9 (d, $J_{C\text{-}F}$ = 13.3 Hz), 155.2, 145.6, 142.6, 140.8, 135.9, 135.8, 134.9, 134.3, 131.8, 129.1 (d, $J_{C\text{-}F}$ = 10.9 Hz), 129.1, 128.9, 123.8, 123.7, 120.7, 120.6, 118.7, 114.8 (d, $J_{C\text{-}F}$ = 22.8 Hz), 105.0 (d, $J_{C\text{-}F}$ = 25.6 Hz).
^{19}**F NMR** (376 MHz, $CDCl_3$) δ/ppm: -101.3.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}O_5F$: 424.0747 found: 424.0745.

2-(1-(6,8-dimethyl-4-oxo-4H-chromen-3-yl)-2-oxo-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5la.



5la

Following the **TP-C**, **5la** was obtained from2-((6,8-dimethyl-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1l** (99.10 mg, 0.3 mmol), Me_2PhP (8.54μL, 0.2 equiv.), benzoyl chloride **2a** (41.82 μL, 1.2 equiv.), and Et_3N (54.36 μL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc= 70:30) to give **5la** as a pale yellow solid (105.1 mg, 80%). R_f = 0.53 (Hexanes:EtOAc = 7:3); mp.:

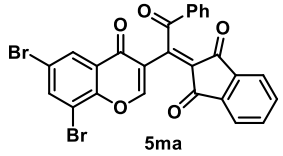
304.1-305.2 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.32 (s, 1H), 8.10 (dd, *J* = 7.3, 1.4 Hz, 1H), 7.99-7.93 (m, 1H), 7.92 (d, *J* = 0.8 Hz, 1H), 7.89-7.85 (m, 1H), 7.83-7.75 (m, 2H), 7.60-7.53 (m, 1H), 7.50-7.42 (m, 2H), 7.36 (s, 1H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.4, 187.9, 187.4, 173.4, 155.2, 152.8, 146.8, 142.7, 140.8, 136.5, 135.8, 135.6, 135.5, 135.1, 134.1, 131.4, 129.1, 128.9, 127.4, 123.7, 123.6, 123.5, 123.4, 117.9, 20.9, 15.3.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{28}H_{18}O_5$: 434.1154 found: 434.1163.

2-(1-(6,8-dibromo-4-oxo-4H-chromen-3-yl)-2-oxo-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5ma.



5ma

Following the **TP-C**, **5ma** was obtained from 2-((6,8-dibromo-4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1m** (138.04 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5ma** as a pale yellow solid (85.0 mg, 50%). R_f = 0.30 (Hexanes:EtOAc = 7:3); mp.: 269.1-270.5 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.41-8.34 (m, 2H), 8.12-8.04 (m, 3H), 7.98-7.94 (m, 1H), 7.92-7.87 (m, 1Hz), 7.86-7.77 (m, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.8 Hz, 2H).

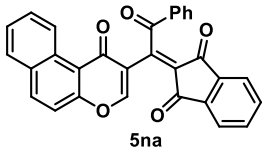
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 194.9, 187.4, 187.3, 171.4, 154.8, 151.6, 144.6, 142.6, 140.9, 140.0, 136.0, 135.9, 134.8, 134.4, 132.1, 129.1, 129.0, 128.7, 125.7, 123.8, 119.4, 118.6, 113.1.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{12}{}^{79}Br{}^{79}BrO_5$: 561.9051 found: 561.9042.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{12}{}^{79}Br{}^{81}BrO_5$: 563.9031 found: 563.9021.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{12}{}^{81}Br{}^{81}Br\ O_5$: 565.9011 found: 565.9024.

2-(2-oxo-1-(1-oxo-1H-benzo[f]chromen-2-yl)-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5na.



5na

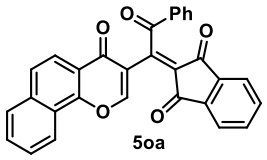
Following the **TP-C**, **5na** was obtained from 2-((1-oxo-1H-benzo[f]chromen-2-yl)methylene)-1H-indene-1,3(2H)-dione **1n** (105.70 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 2 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 65:35) to give **5na** as a pale yellow solid (97.0 mg, 74%). R_f = 0.45 (Hexanes:EtOAc = 7:3); mp.: 264.5-265.6 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 9.94 (d, *J* = 8.7 Hz, 1H), 8.32 (s, 1H), 8.23-8.20 (m, 2H), 8.12 (d, *J* = 9.1 Hz, 1H), 7.97-7.94 (m, 1H), 7.92 (d, *J* = 7.4 Hz, 1H), 7.90-7.86 (m, 1H), 7.84.7.72 (m, 3H), 7.63 (dtd, *J* = 8.78, 7.2, 1.2 Hz, 1H), 7.60-7.55 (m, 1H), 7.53-7.44 (m, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.5, 187.9, 187.3, 174.7, 157.2, 152.9, 146.8, 142.7, 140.8, 136.1, 135.8, 135.6, 135.2, 134.2, 134.3, 131.6, 131.0, 130.6, 129.6, 129.2, 128.9, 128.3, 127.2, 126.9, 123.7, 123.6, 120.9, 117.4, 117.3.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{30}H_{16}O_5$: 456.0998 found: 456.1010.

2-(2-oxo-1-(4-oxo-4H-benzo[h]chromen-3-yl)-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5oa.



5oa

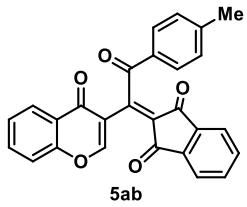
Following the **TP-C**, **5oa** was obtained from 2-((1-oxo-1H-benzo[f]chromen-2-yl)methylene)-1H-indene-1,3(2H)-dione **1o** (105.70 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), benzoyl chloride **2a** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 75:25) to give **5oa** as a pale yellow solid (98.0 mg, 75%). R_f = 0.40 (Hexanes:EtOAc = 7:3); mp.: 180.2-181.5 °C.

^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.50 (s, 1H), 8.45 (d, *J* = 8.2 Hz, 1H), 8.21 (d, *J* = 8.7 Hz, 1H), 8.18-8.12 (m, 2H), 8.0-7.95 (m, 1H), 7.93 (d, *J* = 7.7 Hz, 1H), 7.91-7.87 (m, 1H), 7.85-7.76 (m, 3H), 7.75-7.64 (m, 2H), 7.80 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.8 Hz, 2H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 195.5, 187.8, 187.3, 172.8, 154.4, 153.5, 146.2, 142.7, 140.8, 136.0, 135.8, 135.7, 135.0, 134.2, 131.8, 129.7, 129.1, 128.9, 128.1, 127.1, 127.5, 126.1, 123.8, 123.7, 123.7, 122.2, 121.1, 120.2, 119.7.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{30}H_{16}O_5$: 456.0998 found: 456.0983.

2-(2-oxo-1-(4-oxo-4H-chromen-3-yl)-2-(p-tolyl)ethylidene)-1H-indene-1,3(2H)-dione 5ab.



5ab

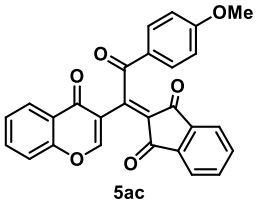
Following the **TP-C**, **5ab** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 1.2 equiv.), 4-methylbenzoyl chloride **2b** (52.35 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =80:20) to give **5ab** as a pale yellow solid (109.0 mg, 86%). R_f = 0.40 (Hexanes:EtOAc = 90:10); mp.: 284.1-285.0 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.35-8.25 (m, 2H), 8.00 (d, *J* = 8.2 Hz, 2H), 7.96 (d, *J* = 6.6 Hz, 1H), 7.91-7.85 (m, 1H), 7.84-7.75 (m, 2H), 7.71 (td, *J* = 6.7, 1.0 Hz, 1H), 7.54-7.41 (m, 2H), 7.30-7.22 (m, 2H), 2.37 (s, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 194.9 187.8, 187.4, 172.9, 155.9, 155.2, 146.4, 145.3, 142.6, 140.8, 135.8, 135.6, 134.2, 132.6, 131.4, 129.7, 129.2, 126.7, 125.9, 123.8, 123.7, 123.6, 118.6, 118.2, 21.8.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{27}H_{16}O_5$: 420.0998 found: 420.0989.

2-(2-(4-methoxyphenyl)-2-oxo-1-(4-oxo-4H-chromen-3-yl)ethylidene)-1H-indene-1,3(2H)-dione 5ac.



5ac

Following the **TP-C**, **5ac** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), 4-methoxy benzoyl chloride **2c** (52.8 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 3 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5ac** as a pale yellow solid (115.0 mg, 88%). R_f = 0.36 (Hexanes:EtOAc = 7:3); mp.: 251.9-252.8 °C.

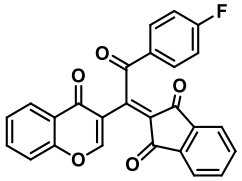
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.33-8.27 (m, 1H), 8.16-8.05 (m, 2H), 7.99-7.93 (m, 1H), 7.92-7.87 (m, 1H), 7.84-7.77 (m, 2H), 7.71 (dtd, *J* = 9.4, 7.7, 1.7 Hz, 1H),

7.51-7.43 (m, 2H), 6.97-6.88 (m, 2H), 3.83 (s, 3H).

$^{13}C\{^{1}H\}$-NMR (100 MHz, $CDCl_3$) δ/ppm: 193.8, 187.8, 187.5, 173.0, 164.5, 156.0, 154.9, 146.4, 142.6, 140.9, 135.8, 135.6, 134.2, 131.6, 131.3, 128.2, 126.7, 125.9, 123.8, 123.7, 123.6, 118.8, 118.2, 114.4, 55.5.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{27}H_{16}O_6$: 436.0947 found: 436.0945.

2-(2-oxo-1-(4-oxo-4H-benzo[h]chromen-3-yl)-2-phenylethylidene)-1H-indene-1,3(2H)-dione 5ad.



5ad

Following the **TP-C**, **5ad** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54μL, 0.2 equiv.), 4-fluorobenzoyl chloride **2d** (42.59 μL, 1.2 equiv.), and Et_3N (54.36 μL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5ad** as a pale yellow solid (110.0 mg, 86%). R_f = 0.45 (Hexanes:EtOAc = 7:3); mp.: 267.4-268.5 °C.

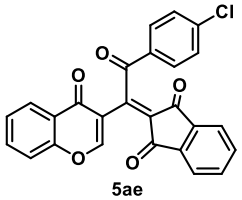
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.30 (s, 1H), 8.29 (dd, J = 8.0, 1.6 Hz, 1H), 8.18-8.11 (m, 2H), 7.99-7.94 (m, 1H), 7.86-7.78 (m, 2H), 7.73 (dtd, J = 9.5, 6.9, 1.7 Hz, 1H), 7.58 (t, J = 7.5 Hz, 1H), 7.75-7.45 (m, 2H), 7.19-7.10 (m, 2H).

$^{13}C\{^{1}H\}$-NMR (100 MHz, $CDCl_3$) δ/ppm: 193.8, 187.8, 187.2, 173.3, 167.6, 167.6, 165.1, 155.9, 155.5, 145.9, 142.6, 140.7, 135.9 (d, $J_{C\text{-}F}$ = 17.2 Hz), 134.3, 131.8, 131.7, 131.6, 126.6, 126.1, 123.7, 123.6, 118.3, 118.3, 116.2 (d, $J_{C\text{-}F}$ = 23.2 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ/ppm: -102.8.

HRMS (EI) m/z: $[M]^+$ calcd for**.** $C_{26}H_{13}O_5F$: 424.0747 found: 424.0764.

2-(2-(4-chlorophenyl)-2-oxo-1-(4-oxo-4H-chromen-3-yl)ethylidene)-1H-indene-1,3(2H)-dione 5ae.



5ae

Following the **TP-C**, **5ae** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54μL, 0.2 equiv.), 4-

chlorobenzoyl chloride **2e** (41.82 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 2 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5ae** as a pale yellow solid (121.1 mg, 92%). R_f = 0.53 (Hexanes:EtOAc = 7:3); mp.: 196.4-197.5 °C.

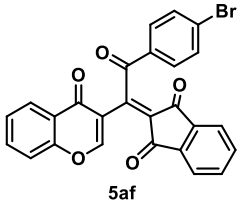
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.32 (s, 1H), 8.27 (dd, *J* = 8.1, 1.5 Hz, 1H), 8.17-8.03 (m, 2H), 7.97-7.95 (m, 1H), 7.91-7.87 (m, 1H), 7.87-7.78 (m, 2H), 7.76-7.69 (m, 1H), 7.49 (t, *J* = 8.6 Hz, 2H), 7.46-7.41 (m, 2H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 194.3, 187.8, 187.2, 173.3, 155.9, 155.8, 145.9, 142.6, 140.7, 140.6, 135.9, 135.8, 134.4, 133.6, 131.6, 131.5, 130.3, 129.3, 128.8, 126.6, 126.1, 123.8, 123.7, 123.6, 118.3, 118.2.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{35}ClO_5$: 440.0452 found: 440.0431.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{37}ClO_5$: 442.0422 found: 442.0396.

2-(2-(4-bromophenyl)-2-oxo-1-(4-oxo-4H-chromen-3-yl)ethylidene)-1H-indene-1,3(2H)-dione 5af.



5af

Following the **TP-C**, **5af** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), 4-bromobenzoyl chloride **2f** (49.09 mg, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5af** as a pale yellow solid (110.0 mg, 75%). R_f = 0.50 (Hexanes:EtOAc = 65: 35); mp.: 236.5-237.8 °C.

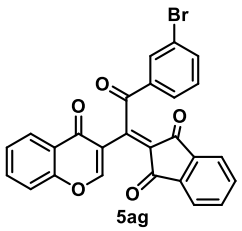
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.32 (s, 1H), 8.28 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.97 (d, *J* = 8.6 Hz, 3H), 7.92-7.76 (m, 1H), 7.86-7.77 (m, 2H), 7.73 (dtd, *J* = 8.7, 6.7, 1.5 Hz, 1H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.53-7.44 (m, 2H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 194.5, 187.8, 187.2, 173.3, 155.9, 155.9, 145.9, 142.7, 140.7, 135.9, 135.8, 134.4, 134.1, 132.3, 131.7, 130.4, 129.5, 126.6, 126.1, 123.8, 123.6, 123.7, 118.3, 118.2.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{79}BrO_5$: 483.9946 found: 483.9971.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{81}BrO_5$: 485.9926 found: 485.9979.

2-(2-(3-bromophenyl)-2-oxo-1-(4-oxo-4H-chromen-3-yl)ethylidene)-1H-indene-1,3(2H)-dione 5ag.



5ag

Following the **TP-C**, **5ag** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), 3-bromobenzoyl chloride **2g** (47.53 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5ag** as a pale yellow solid (120.0 mg, 82%). R_f = 0.48 (Hexanes:EtOAc = 7:3); mp.: 250.1-251.3 °C.

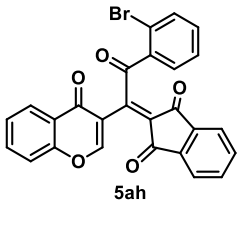
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.32 (s, 1H), 8.31-8.34 (m, 2H), 8.01-7.95 (m, 2H), 7.98-7.86 (m, 1H), 7.85-7.77 (m, 2H), 7.72 (dtd, *J* = 9.2, 7.7, 1.7 Hz, 1H), 7.78-7.66 (m, 1H), 7.50 (d, *J* = 8.5 Hz, 1H), 7.56-7.44 (m, 1H), 7.32 (t, *J* = 7.9 Hz, 1H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 194.2, 187.8, 187.1, 173.3, 156.2, 155.9, 145.9, 142.7, 140.6, 136.9, 136.8, 135.9, 135.8, 134.4, 131.7, 131.3, 130.4, 127.9, 126.6, 126.1, 123.8, 123.7, 123.2, 118.3, 118.1.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{79}BrO_5$: 483.9946 found: 483.9931.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{81}BrO_5$: 485.9926 found: 485.9912.

2-(2-(2-bromophenyl)-2-oxo-1-(4-oxo-4H-chromen-3-yl)ethylidene)-1H-indene-1,3(2H)-dione 5ah.



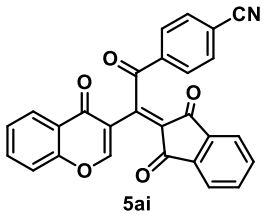
5ah

Following the **TP-C**, **5ah** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), 2-bromobenzoyl chloride **2h** (59.49 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 2 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 70:30) to give **5ah** as a pale yellow solid (113.0 mg, 77%). R_f = 0.38 (Hexanes:EtOAc = 7:3); mp.: 242.2-243.3 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.48 (s, 1H), 8.26 (dd, *J* = 8.0, 1.4 Hz, 1H), 8.08

(dd, J = 7.5, 1.9 Hz, 1H), 7.99-7.92 (m, 1H), 7.91-7.86 (m, 1H), 7.85-7.78 (m, 2H), 7.75-7.70 (m, 1H), 7.53 (d, J = 8.3 Hz, 1H), 7.47 (t, J = 7.9 Hz, 1H), 7.42-7.31 (m, 2H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 193.7, 188.0, 187.5, 173.6, 157.2, 155.9, 147.0, 142.5, 140.5, 135.8, 135.7, 135.4, 134.8, 134.4, 133.6, 133.3, 130.8, 127.4, 126.6, 126.1, 123.8, 123.7 122.2, 118.4, 118.3.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{79}BrO_5$: 483.9946 found: 483.9935.
HRMS (EI) m/z: $[M]^+$ calcd for $C_{26}H_{13}{}^{81}BrO_5$: 485.9926 found: 485.9921.

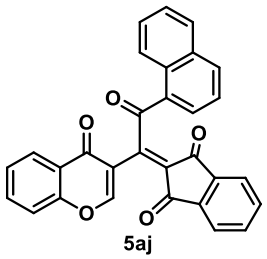
4-(2-(1,3-dioxo-1,3-dihydro-2H-inden-2-ylidene)-2-(4-oxo-4H-chromen-3-yl)acetyl)benzonitrile 5ai.



5ai

Following the **TP-C**, **5ai** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54μL, 0.2 equiv.), 4-cyanobenzoyl chloride **2i** (59.0 mg, 1.2 equiv.), and Et_3N (54.36 μL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 2 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 65:35) to give **5ai** as a yellow solid (84.0 mg, 65%). R_f = 0.50 (Hexanes:EtOAc = 5:5); mp.: 265.1-266.1 °C.
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.42 (s, 1H), 8.27-8.16 (m, 3H), 7.99 (d, J = 7.1 Hz, 1H), 7.90-7.80 (m, 3H), 7.79-7.71 (m, 3H), 7.54 (d, J = 8.5 Hz, 1H), 7.47 (t, J = 7.6 Hz, 1H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 194.3, 187.9, 187.0, 173.9, 157.4, 155.9, 146.1, 142.6, 140.4, 138.6, 136.2, 136.0, 134.6, 132.6, 131.7, 129.1, 126.5, 126.3, 126.5, 126.3, 123.9, 123.7, 123.6, 118.3, 117.9, 116.7.
HRMS (MALDI) m/z: $[M+H]^+$ calcd for $C_{27}H_{14}NO_5$: 432.0872 found: 432.0867.

2-(2-(naphthalen-1-yl)-2-oxo-1-(4-oxo-4H-chromen-3-yl)ethylidene)-1H-indene-1,3(2H)-dione 5aj.



5aj

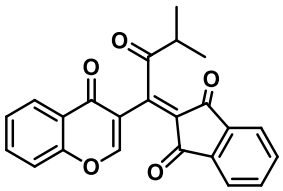
Following the **TP-C**, **5aj** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), 1-naphthoyl chloride **2j** (54.24 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 2 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 75:25) to give **5aj** as a pale yellow solid (117.0 mg, 85%). R_f = 0.43 (Hexanes:EtOAc = 7:3); mp.: 190.3-191.5 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 9.43 (d, *J* = 6.8 Hz, 1H), 8.41 (s, 1H), 8.34 (dd, *J* = 8.5, 1.1 Hz, 1H), 8.26 (d, *J* = 7.1 Hz, 1H), 8.03 (d, *J* = 8.2 Hz, 1H), 7.94 (d, *J* = 7.4 Hz, 1H), 7.89 (d, *J* = 7.9 Hz, 1H), 7.85-7.67 (m, 5H), 7.60 (t, *J* = 7.8 Hz, 1H), 7.51-7.41 (m, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 197.1, 188.1, 187.7, 173.1, 156.0, 154.7, 146.9, 142.7, 140.8, 135.7, 135.6, 135.2, 134.2, 134.0, 133.7, 131.0, 130.9, 130.7, 129.2, 128.6, 126.8, 126.7, 126.2, 125.9, 124.7, 123.8, 123.7, 123.6, 119.2, 118.2.

HRMS (EI) m/z: $[M]^+$ calcd for $C_{27}H_{16}O_5$: 456.0998 found: 456.0984.

2-(3-methyl-2-oxo-1-(4-oxo-4H-chromen-3-yl)butylidene)-1H-indene-1,3(2H)-dione 5ak.



5ak

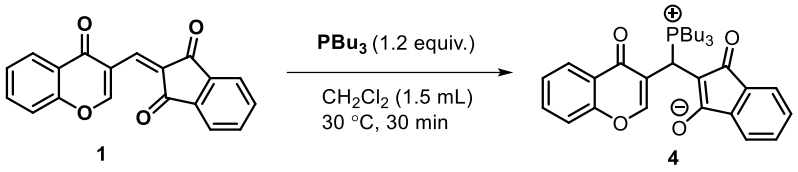
Following the **TP-C**, **5ak** was obtained from 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), Me_2PhP (8.54µL, 0.2 equiv.), isobutyryl chloride **2k** (37.7 µL, 1.2 equiv.), and Et_3N (54.36 µL, 1.3 equiv.) in anhydrous THF (1.5 mL) at 30 °C for 0.5 h. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc =70:30) to give **5ak** as a pale yellow solid (62.0 mg, 55%). R_f = 0.48 (Hexanes:EtOAc = 7:3); mp.: 200.1-201.2 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.30 (dd, *J* = 8.0, 1.5 Hz, 1H), 8.17 (s, 1H), 7.99-7.95 (m, 1H), 7.93-7.89 (m, 1H), 7.85-7.78 (m, 2H), 7.85-7.75 (m, 2H), 7.73 (td, *J* = 8.8, 7.4, 1.6 Hz, 1H), 7.53-7.45 (m, 2H), 3.13 (sep, *J* = 7.01 Hz, 1H), 1.26 (brs, 3H), 1.24 (brs, 3H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 209.8, 188.5, 187.3, 173.1, 155.9, 154.4, 147.8, 142.5, 140.7, 135.9, 135.7, 134.2, 130.4, 126.7, 126.0, 123.7, 123.6, 123.5, 118.6, 118.2, 41.1, 17.6.

HRMS (EI) m/z: $[M]^+$ calcd for**.** $C_{23}H_{16}O_5$: 372.0998 found: 372.0981.

1-oxo-2-((4-oxo-4H-chromen-3-yl)(tributylphosphonio)methyl)-1H-inden-3-olate 4



A 50 mL round-bottomed flask equipped with a magnetic stir was bar charged with 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **1a** (90.75 mg, 0.3 mmol), PBu_3 (88.8µL, 1.2 equiv.) in anhydrous CH_2Cl_2 (15 mL). The reaction mixture was stirred for 30 minutes at 30 °C. After completion of the reaction, the residue was purified by column chromatography (SiO_2, DCM:MeOH = 90:10) to give **4** as a pale yellow solid (138.0 mg, 92%). R_f = 0.45 (DCM:MeOH = 9.5:0.5); mp.: 227.1-228.4 °C.

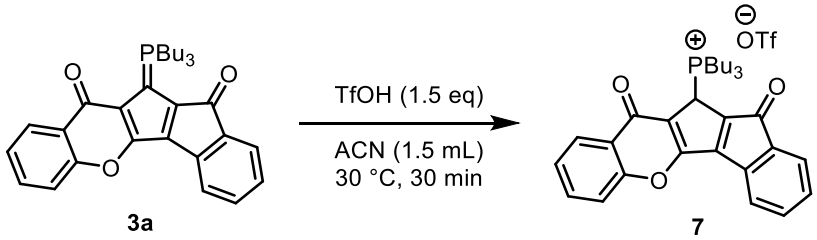
^{1}H NMR (400 MHz, $CDCl_3$) δ/ppm: 8.86 (d, *J* = 3.8 Hz, 1H), 8.21 (dtd, *J* = 8.6, 7.0, 1.6 Hz, 1H), 7.47 (d, *J* = 8.4 Hz, 1H), 7.43 (t, *J* = 7.4 Hz, 1H), 7.40-7.36 (m, 2H), 7.35-7.23 (m, 2H), 5.35 (d, *J* = 18.5 Hz, 1H), 2.38-2.13 (m, 6H), 1.66-1.34 (m, 12H), 0.87 (t, *J* = 7.3 Hz, 9H).

^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 190.7, 190.6, 177.0, 159.2 (d, $^2J_{C\text{-}P}$ = 6.2 Hz), 156.2, 139.3, 133.9, 130.0, 125.7 (d, $^2J_{C\text{-}P}$ = 29.7 Hz), 123.1, 120.4, 118.3, 118.1, 96.5(d, $^3J_{C\text{-}P}$ = 3.3 Hz), 27.6 (d, $^1J_{C\text{-}P}$ = 64.7 Hz), 25.2 (d, $^2J_{C\text{-}P}$ = 46.9 Hz), 24.8, 24.1, 23.9, 20.4 (d, $^3J_{C\text{-}P}$ = 43.9 Hz), 13.3.

^{31}P NMR (162 MHz, $CDCl_3$) δ/ppm: 36.9.

HRMS (MALDI) m/z: $[M]^+$ calcd for**.** $C_{31}H_{37}O_4P$: 504.2429 found: 504.2424.

tributyl(10,12-dioxo-11,12-dihydro-10H-benzo[5,6]pentaleno[1,2-b]chromen-11-yl)phosphonium trifluoromethanesulfonate 7.



A 50 mL round-bottomed flask equipped with a magnetic stir bar was charged with 11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione **3a** (90.75 mg, 0.15 mmol), Trifluoromethanesulfonic acid (1.2 equiv.) in acetonitrile (1.5 mL). The reaction mixture was stirred for 30 minutes at 30 °C and monitored by TLC. After completion of the reaction, the solvent was removed in *vacuo*

and the crude compound was without purification to give **7** as a purple solid (85.0 mg, 90%). R_f = 0.35 (Hexanes:EtOAc = 9:1); mp.: 170.9-171.8 °C.

^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.61 (d, *J* = 8.1 Hz, 1H), 7.86 (d, *J* = 7.6 Hz, 1H), 7.69 (d, *J* = 8.3 Hz, 1H), 7.65-7.43 (m, 4H), 7.22-7.09 (m, 1H), 2.87-2.54 (m, 6H), 1.71-1.35 (m, 12H), 0.94 (t, *J* = 6.8 Hz, 9H).

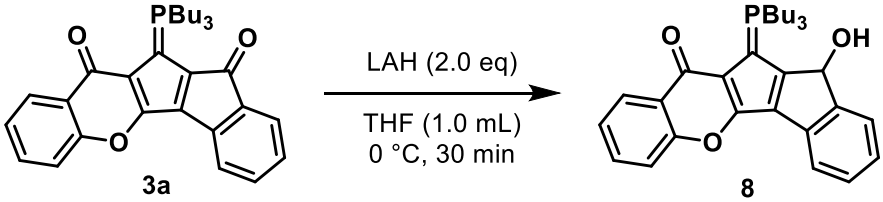
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 189.0, 164.2, 155.8, 147.8(d, $^3J_{C\text{-}P}$ = 7.6 Hz), 146.8(d, $^3J_{C\text{-}P}$ = 8.5 Hz), 140.1, 138.4, 135.7, 135.3, 126.6, 125.9, 125.3, 125.1, 124.9, 120.9, 120.3 (q, $J_{C\text{-}F}$ = 320.3 Hz) 119.6 (d, $^2J_{C\text{-}P}$ = 9.9 Hz), 118.4 (d, $^2J_{C\text{-}P}$ = 12.1 Hz), 117.9, 114.9, 86.5 (d, $^1J_{C\text{-}P}$ = 98.2 Hz), 24.2 (d, $^3J_{C\text{-}P}$ = 4.2 Hz), 23.6 (d, $^2J_{C\text{-}P}$ = 15.9 Hz), 21.5, (d, $^1J_{C\text{-}P}$ = 51.3 Hz), 13.4.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 24.9.

^{19}**F NMR** (376 MHz, $CDCl_3$) δ/ppm: -78.2.

HRMS (MALDI) m/z: $[M+Na]^+$ calcd for $C_{32}H_{36}F_3O_6PSNa$: 659.1820 found: 659.1814.

12-hydroxy-11-(tributyl-λ^5-phosphanylidene)-11,12-dihydro-10H-benzo[5,6]pentaleno[1,2-b]chromen-10-one8.



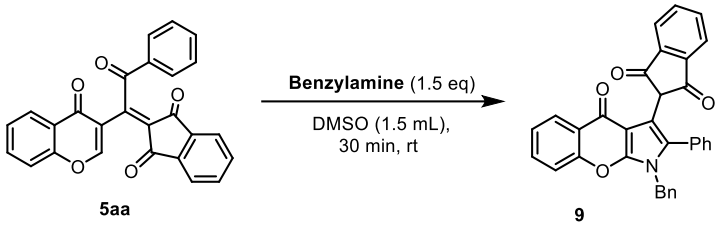
A 50 mL round-bottomed flask equipped with a magnetic stir bar was charged with LAH (11.0 mg, 2.0 equiv.) in anhydrous THF (0.5 mL) at 0 °C and 11-(tributyl-λ^5-phosphanylidene)-10H-benzo[5,6]pentaleno[1,2-b]chromene-10,12(11H)-dione **3a** (73.0 mg, 0.15 mmol) dissolved in anhydrous THF (0.5 mL) adding to reaction mixture. The reaction mixture was stirred for 30 minutes at 0 °C and monitored by TLC. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 80:20) to give **8** as a yellow solid (59.0 mg, 80%). R_f = 0.38 (Hexanes:EtOAc =7:3); mp.: 172.9-173.8 °C.

^{1}**H NMR** (400 MHz, DMSO) δ/ppm: 8.18 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.65-7.59 (m, 1H), 7.58-7.54 (m, 1H), 7.43-7.36 (m, 2H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.23 (t, *J* = 7.4 Hz, 1H), 6.98 (t, *J* = 7.4 Hz, 1H), 5.60 (d, *J* = 8.8 Hz, 1H), 5.38 (d, *J* = 8.8 Hz, 1H), 2.68-2.50 (m, 6H), 1.54-1.26 (m, 12H), 0.84 (t, *J* = 6.9 Hz, 1H).

^{13}C{^{1}H}-NMR (100 MHz, DMSO) δ/ppm: 169.7, 154.8, 148.8, 148.6 (d, $^3J_{C\text{-}P}$ = 9.6 Hz), 144.8 (d, $^2J_{C\text{-}P}$ = 11.5 Hz), 137.8, 131.1, 128.1, 125.6, 124.7, 122.9, 122.6, 122.2, 117.4, 117.0, 116.4 (d, $^2J_{C\text{-}P}$ = 13.4 Hz), 115.7 (d, $^3J_{C\text{-}P}$ = 12.5 Hz), 74.8 (d, $^1J_{C\text{-}P}$ = 107.4 Hz), 70.6, 23.3 (d, $^3J_{C\text{-}P}$ = 4.4 Hz), 23.2 (d, $^2J_{C\text{-}P}$ = 7.6 Hz), 19.7 (d, $^1J_{C\text{-}P}$ = 53.4 Hz), 13.3.

^{31}**P NMR** (162 MHz, $CDCl_3$) δ/ppm: 22.1.
HRMS (MALDI) m/z: $[M]^+$ calcd for**.** $C_{31}H_{37}O_3P$: 488.2480 found: 488.2475.

2-(1-benzyl-4-oxo-2-phenyl-1,4-dihydrochromeno[2,3-b]pyrrol-3-yl)-1H-indene-1,3(2H)-dione 9.



5aa **9**

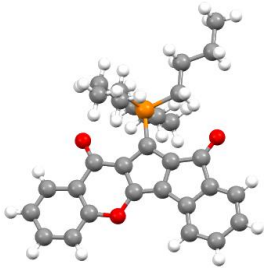
A 50 mL round-bottomed flask equipped with a magnetic stir bar was charged with 2-((4-oxo-4H-chromen-3-yl)methylene)-1H-indene-1,3(2H)-dione **5aa** (61.0 mg, 0.15 mmol), and benzylamine (25.0 μL, 1.5 equiv.) in DMSO (0.75 mL). The reaction mixture was stirred for 30 minutes at 30 °C. After completion of the reaction, the residue was purified by column chromatography (SiO_2, Hexanes:EtOAc = 65:35) to give **9** as an Off-white solid (56.0 mg, 75%). R_f = 0.40 (Hexanes:EtOAc = 7:3); mp.: 211.0-212.2 °C.
^{1}**H NMR** (400 MHz, $CDCl_3$) δ/ppm: 8.11 (dd, *J* = 8.0, 1.5 Hz, 1H), 8.09-8.03 (m, 2H), 7.98-7.83 (m, 2H), 7.55 (td, *J* = 8.9, 6.8, 1.5 Hz, 1H), 7.52-7.46 (m, 2H), 7.45-7.37 (m, 4H), 7.34-7.24 (m, 4H), 7.07 (d, *J* = 6.8 Hz, 1H), 5.26 (s, 2H), 4.28 (s, 1H).
^{13}C{^{1}H}-NMR (100 MHz, $CDCl_3$) δ/ppm: 198.1, 172.9, 154.2, 149.8, 142.3, 136.1, 135.2, 133.5, 132.4, 131.3, 129.2, 128.9, 128.8, 128.6, 127.9, 126.8, 126.7, 124.2, 123.3, 123.2, 117.2, 107.1, 104.3, 53.8, 46.8.
HRMS (EI) m/z: $[M]^+$ calcd for**.** $C_{33}H_{21}NO_4$: 495.1471 found: 495.1457.

References

1. D. Kumbhar, R. Patil, D. Patil, A. Patravale, D. Chandam, S. Jadhav, M. Deshmukh, *Synth. Commun.*, 2016, **46**, 85-92.
2. L. Pellegatti, S. L. Buchwald, *Org. Process Res. Dev.*, 2012, **16**, 1442-1448.
3. T. Lepitre, C. Denhez, M. Sanselme, M. Othman, A. M. Lawson, A Daich,. *J. Org. Chem.*, 2016, **18**, 8837-8849.

VII. X-ray crystallographic data for selected compounds

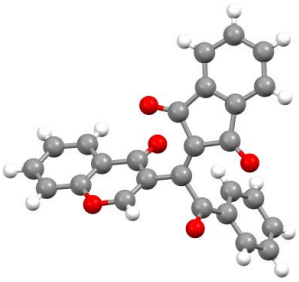
a) Crystal Data and Structure Refinement for compound **3a** (CCDC no. 2360174):



The purified compound **3a** was dissolved in a minimal amount of CH_2Cl_2 in a glass vial. Hexanes were then added until the solution became turbid. The solution was allowed to slowly evaporate. After a few days, a dark red color crystals were obtained.

Empirical formula	$C_{31}H_{35}O_3P$	
Formula weight	486.56	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/c	
Unit cell dimensions	a = 12.4838(16) Å	α= 90°.
	b = 21.180(2) Å	β= 96.690(4)°.
	c = 10.3247(11) Å	γ = 90°.
Volume	2711.4(5) $Å^3$	
Z	4	
Density (calculated)	1.192 Mg/m^3	
Absorption coefficient	0.131 mm^{-1}	
F(000)	1040	
Crystal size	0.24 x 0.21 x 0.02 mm^3	
Theta range for data collection	2.53 to 25.06°.	
Index ranges	-14<=h<=14, -25<=k<=25, -12<=l<=12	
Reflections collected	25869	
Independent reflections	4800 [R(int) = 0.0956]	
Completeness to theta = 25.06°	99.8 % Absorption correction	multi-scan
Max. and min. transmission	0.9974 and 0.9693	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	4800 / 0 / 319	
Goodness-of-fit on F^2	1.017	
Final R indices [I>2sigma(I)]	R1 = 0.0534, wR2 = 0.1240	
R indices (all data)	R1 = 0.0872, wR2 = 0.1428	
Largest diff. peak and hole	0.214 and -0.345 $e.Å^{-3}$	

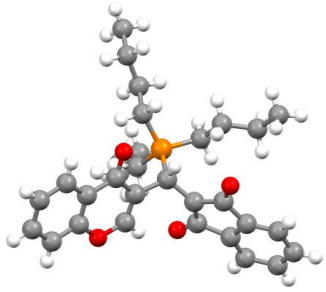
b) Crystal Data and Structure Refinement for compound **5aa** (CCDC no. 2360188):



The purified compound **5aa** was dissolved in a minimal amount of CH_2Cl_2 in a glass vial. Hexanes were then added until the solution became turbid. The solution was allowed to slowly evaporate. After a few days, a pale yellow color crystals were obtained.

Empirical formula	$C_{26}H_{14}O_5$	
Formula weight	406.37	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/c	
Unit cell dimensions	a = 19.4485(7) Å	α= 90°.
	b = 6.3637(2) Å	β= 105.2800(10)°.
	c = 15.7718(5) Å	γ = 90°.
Volume	1882.98(11) $Å^3$	
Z	4	
Density (calculated)	1.433 Mg/m^3	
Absorption coefficient	0.100 mm^{-1}	
F(000)	840	
Crystal size	0.41 x 0.20 x 0.04 mm^3	
Theta range for data collection	2.68 to 25.10°.	
Index ranges	-23<=h<=23, -7<=k<=7, -18<=l<=18	
Reflections collected	19261	
Independent reflections	3344 [R(int) = 0.0838]	
Completeness to theta = 25.10°	99.3 %	
Absorption correction	multi-scan	
Max. and min. transmission	0.9960 and 0.9602	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3344 / 0 / 280	
Goodness-of-fit on F^2	1.023	
Final R indices [I>2sigma(I)]	R1 = 0.0443, wR2 = 0.1107	
R indices (all data)	R1 = 0.0584, wR2 = 0.1239	
Largest diff. peak and hole	0.219 and -0.184 e.$Å^{-3}$	

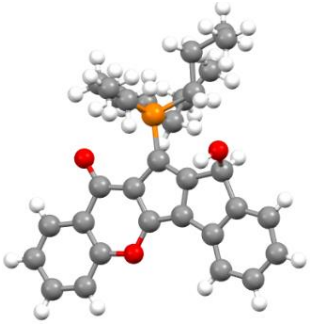
c) Crystal Data and Structure Refinement for compound **4** (CCDC no. 2360233):



The purified compound **4** was dissolved in a minimal amount of CH_2Cl_2 in a glass vial. Hexanes were then added until the solution became turbid. The solution was allowed to slowly evaporate. After a few days, a pale yellow color crystals were obtained.

Empirical formula	$C_{31}H_{36}O_4P$	
Formula weight	503.57	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/n	
Unit cell dimensions	a = 9.6734(4) Å	α= 90°.
	b = 14.6130(6) Å	β= 101.356(2)°.
	c = 19.9002(9) Å	γ = 90°.
Volume	2758.0(2) $Å^3$	
Z	4	
Density (calculated)	1.213 Mg/m^3	
Absorption coefficient	0.133 mm^{-1}	
F(000)	1076	
Crystal size	0.13 x 0.10 x 0.03 mm^3	
Theta range for data collection	2.20 to 25.38°.	
Index ranges	-11<=h<=11, -17<=k<=17, -23<=l<=23	
Reflections collected	31956	
Independent reflections	5064 [R(int) = 0.0799]	
Completeness to theta = 25.38°	99.8 %	
Absorption correction	multi-scan	
Max. and min. transmission	0.9960 and 0.9829	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	5064 / 0 / 327	
Goodness-of-fit on F^2	1.054	
Final R indices [I>2sigma(I)]	R1 = 0.0684, wR2 = 0.1967	
R indices (all data)	R1 = 0.1036, wR2 = 0.2344	
Largest diff. peak and hole	1.277 and -0.440 e.$Å^{-3}$	

d) Crystal Data and Structure Refinement for compound **8** (CCDC no. 2363295):

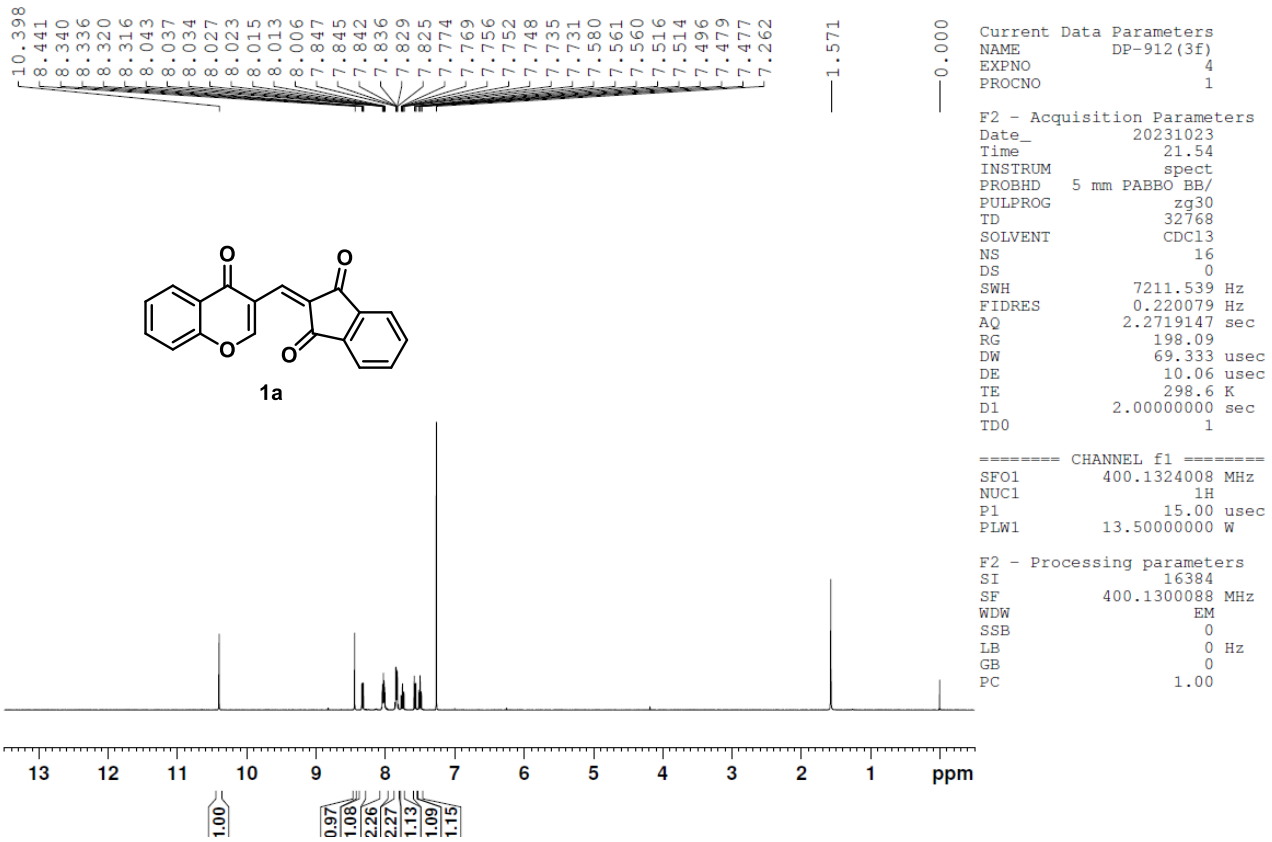


The purified compound **4** was dissolved in a minimal amount of CH_2Cl_2 in a glass vial. Hexanes were then added until the solution became turbid. The solution was allowed to slowly evaporate. After a few days, a pale yellow color crystals were obtained.

Empirical formula	$C_{31}H_{37}O_3P$	
Formula weight	488.58	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/n	
Unit cell dimensions	a = 11.3575(5) Å	α= 90°.
	b = 11.1326(5) Å	β= 97.976(2)°.
	c = 21.2159(11) Å	γ = 90°.
Volume	2656.6(2) $Å^3$	
Z	4	
Density (calculated)	1.222 Mg/m^3	
Absorption coefficient	0.134 mm^{-1}	
F(000)	1048	
Crystal size	0.22 x 0.09 x 0.03 mm^3	
Theta range for data collection	2.07 to 25.05°.	
Index ranges	-13<=h<=13, -13<=k<=13, -25<=l<=23	
Reflections collected	24725	
Independent reflections	4697 [R(int) = 0.0721]	
Completeness to theta = 25.05°	99.9 %	
Absorption correction	None	
Max. and min. transmission	0.9960 and 0.9712	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	4697 / 0 / 319	
Goodness-of-fit on F^2	1.029	
Final R indices [I>2sigma(I)]	R1 = 0.0442, wR2 = 0.1230	
R indices (all data)	R1 = 0.0590, wR2 = 0.1386	
Largest diff. peak and hole	0.199 and -0.331 $e.Å^{-3}$	

VIII. ^{1}H, ^{13}C NMR, ^{19}F NMR and ^{31}P NMR spectra for all compounds

^{1}H NMR spectrum of compound **1a** ($CDCl_3$, 400 MHz)

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PROCNO                 1

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PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                298.6 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
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NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300088 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
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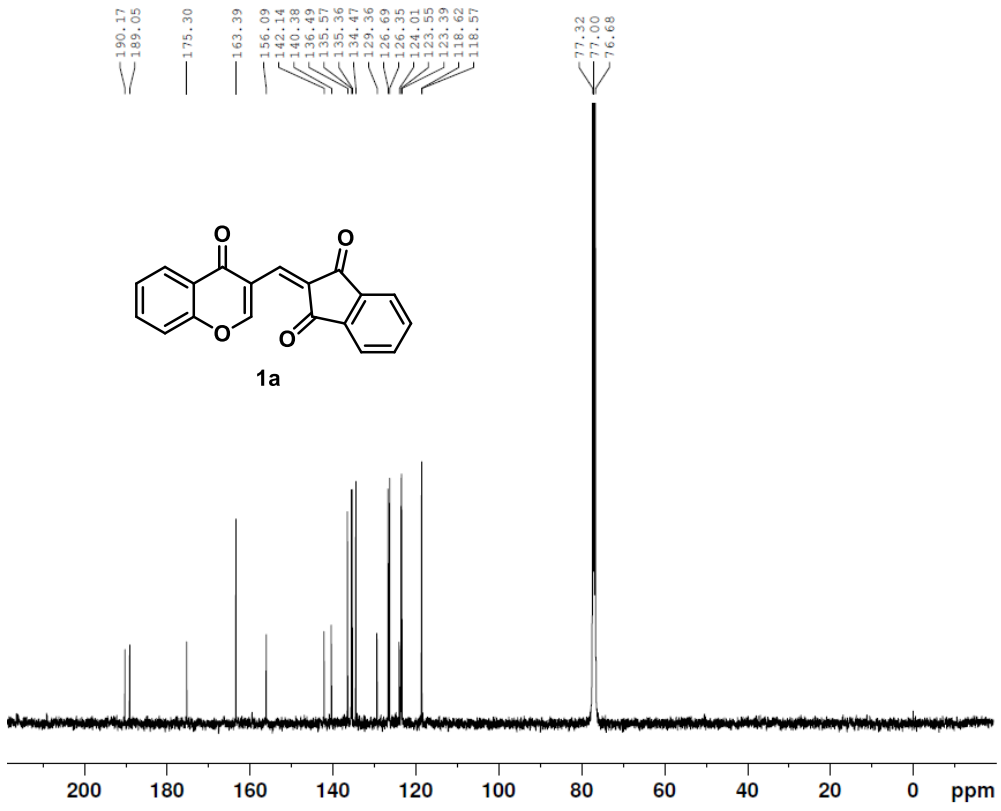
^{13}C NMR spectrum of compound **1a** ($CDCl_3$, 100 MHz)

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PROCNO                 1

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DS                     0
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AQ              0.6815744 sec
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TE                298.7 K
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NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF          100.6127684 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
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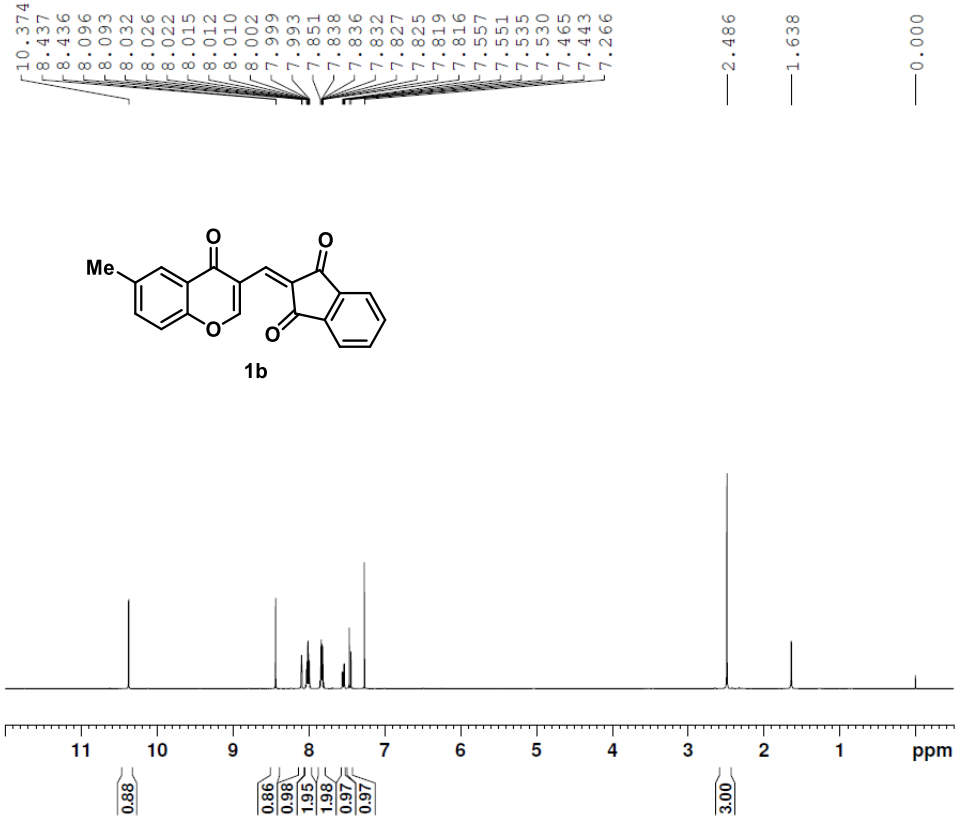
^{1}H NMR spectrum of compound **1b** ($CDCl_3$, 400 MHz)

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PROCNO                 1

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PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                144.49
DW                69.333 usec
DE                10.06 usec
TE                298.5 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
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NUC1                  1H
P1                 15.00 usec
PLW1          13.50000000 W

F2 - Processing parameters
SI                 16384
SF            400.1300074 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
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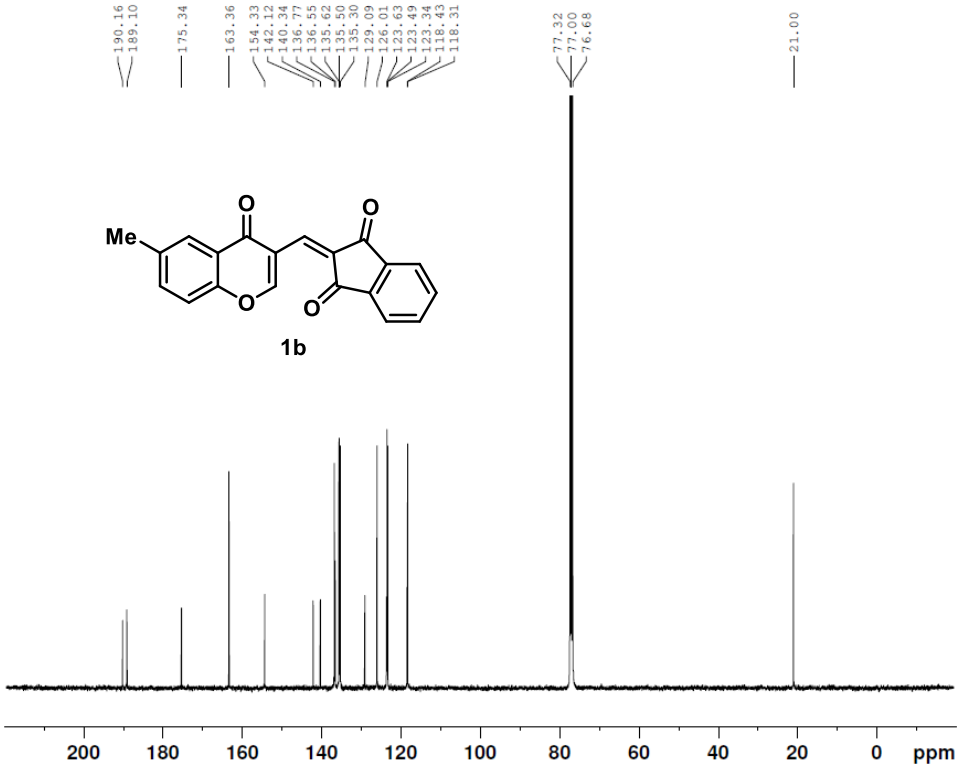
^{13}C NMR spectrum of compound **1b** ($CDCl_3$, 100 MHz)

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PROCNO                 1

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PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
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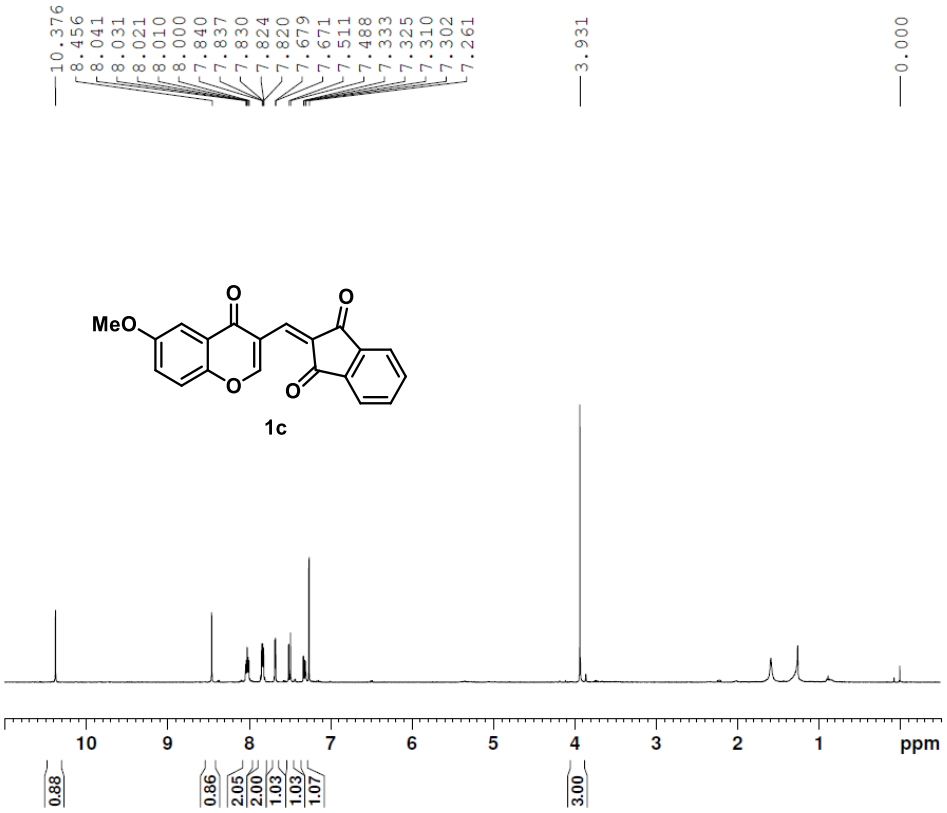
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                299.1 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          49.50000000 W

======== CHANNEL f2 ========
SFO2          400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2          12.50000000 W
PLW12          0.34722000 W
PLW13          0.28125000 W

F2 - Processing parameters
SI                 32768
SF            100.6127694 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1c** ($CDCl_3$, 400 MHz)



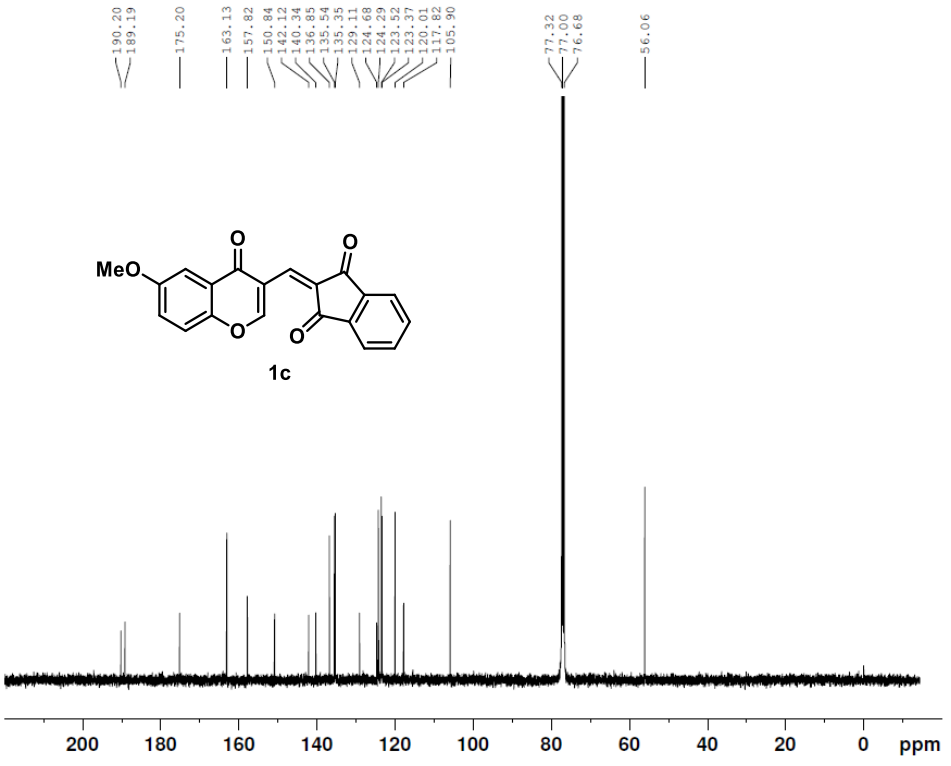

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20240615
Time               11.00
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                177.16
DW                69.333 usec
DE                 10.06 usec
TE                 300.1 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                  15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300094 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1c** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME              DP-697
EXPNO                  4
PROCNO                 1

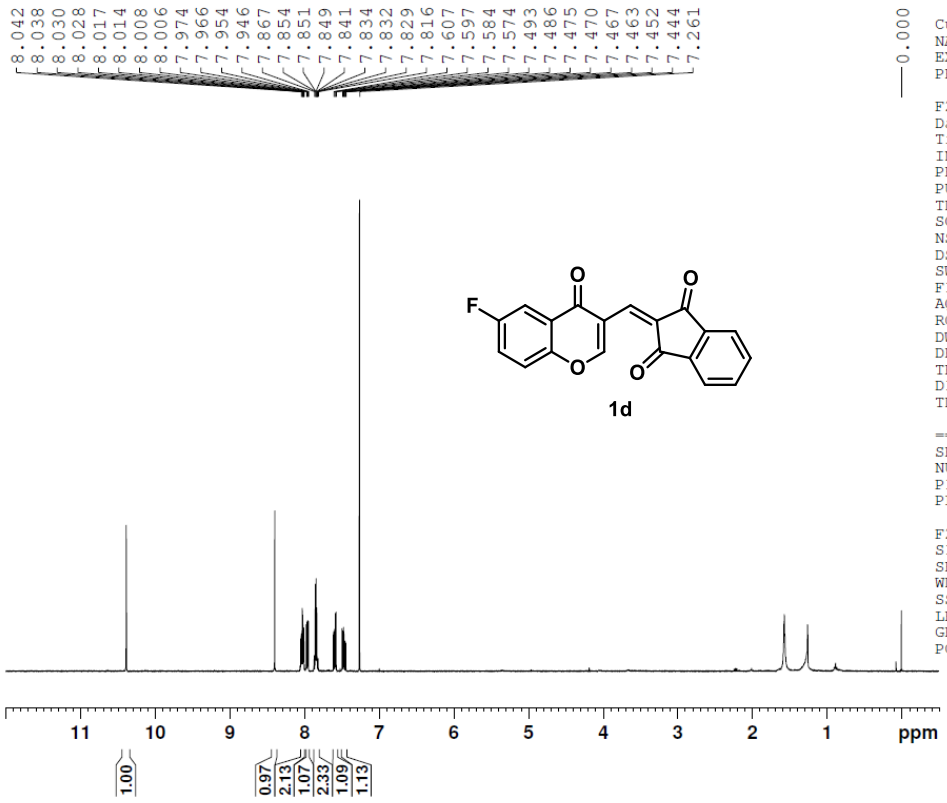
F2 - Acquisition Parameters
Date_           20231028
Time               22.06
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 19501
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                  4096
DW                20.800 usec
DE                 6.50 usec
TE                296.3 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  13C
P1                 10.00 usec
PL1                 4.20 dB
SFO1         100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2         waltz16
NUC2                   1H
PCPD2              90.00 usec
PL2                10.20 dB
PL12               26.00 dB
PL13               29.00 dB
SFO2         400.1316005 MHz

F2 - Processing parameters
SI                 32768
SF           100.6127690 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1d** ($CDCl_3$, 400 MHz)



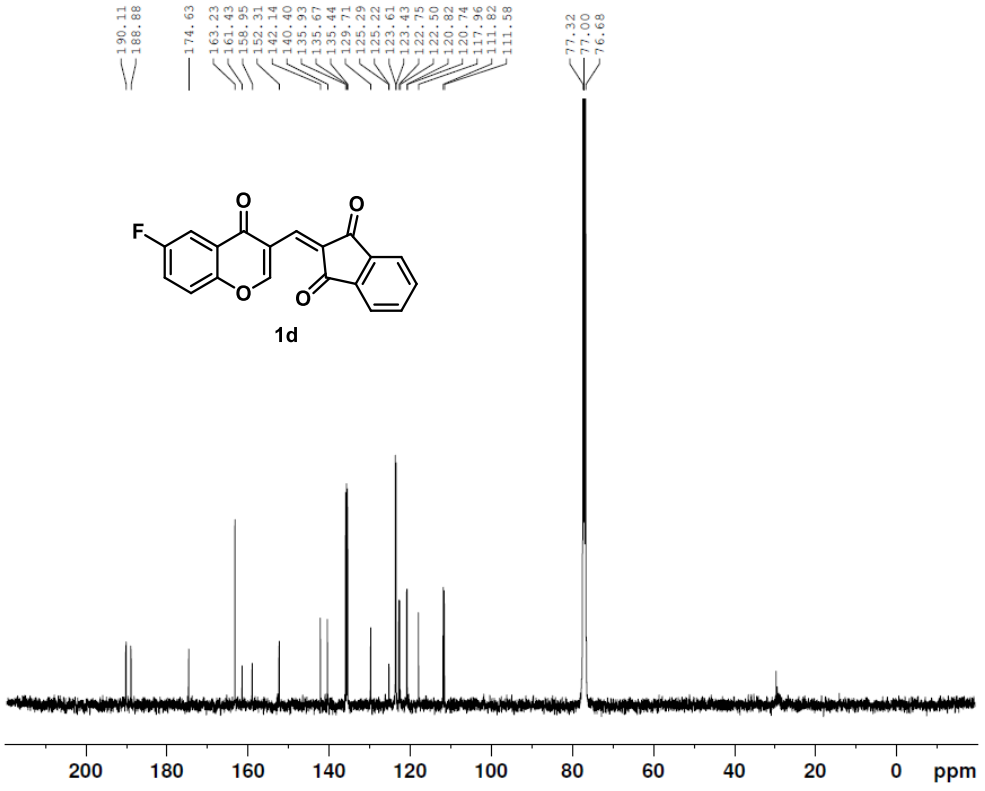

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                    2
PROCNO                   1

F2 - Acquisition Parameters
Date_           20240615
Time               11.03
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    11
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                299.9 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300092 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1d** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME      DP-820-sm (3f)
EXPNO                  7
PROCNO                 1

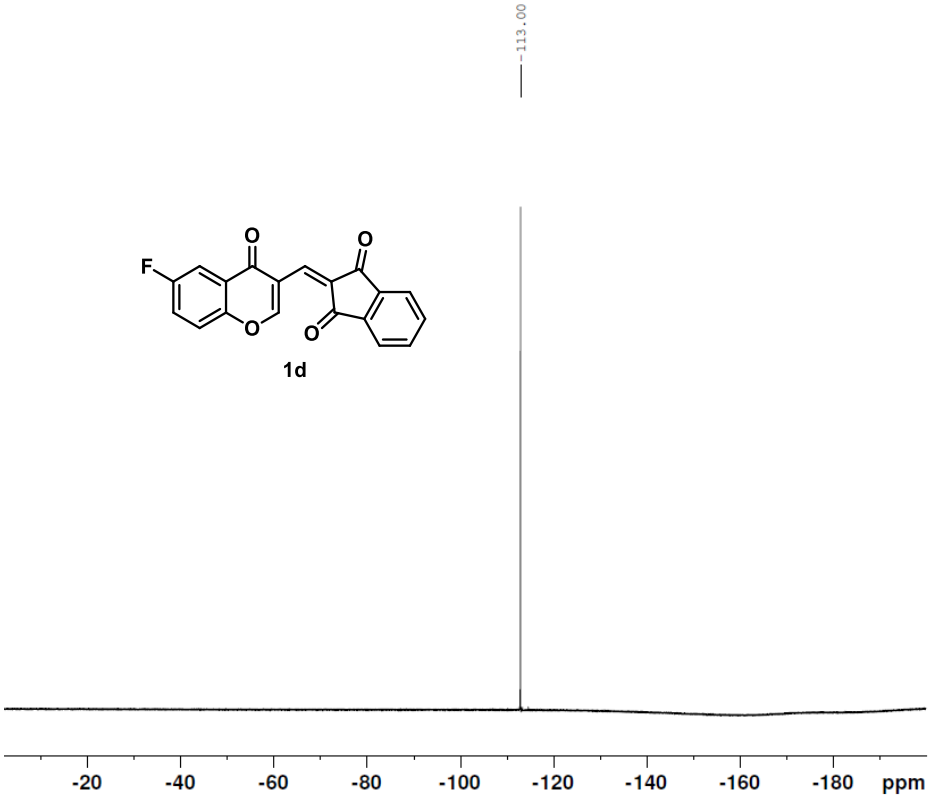
F2 - Acquisition Parameters
Date_           20240619
Time               9.27
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 14798
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                302.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127685 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{19}F NMR spectrum of compound **1d** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME      DP-14-06-2024(3f)
EXPNO                   13
PROCNO                   1

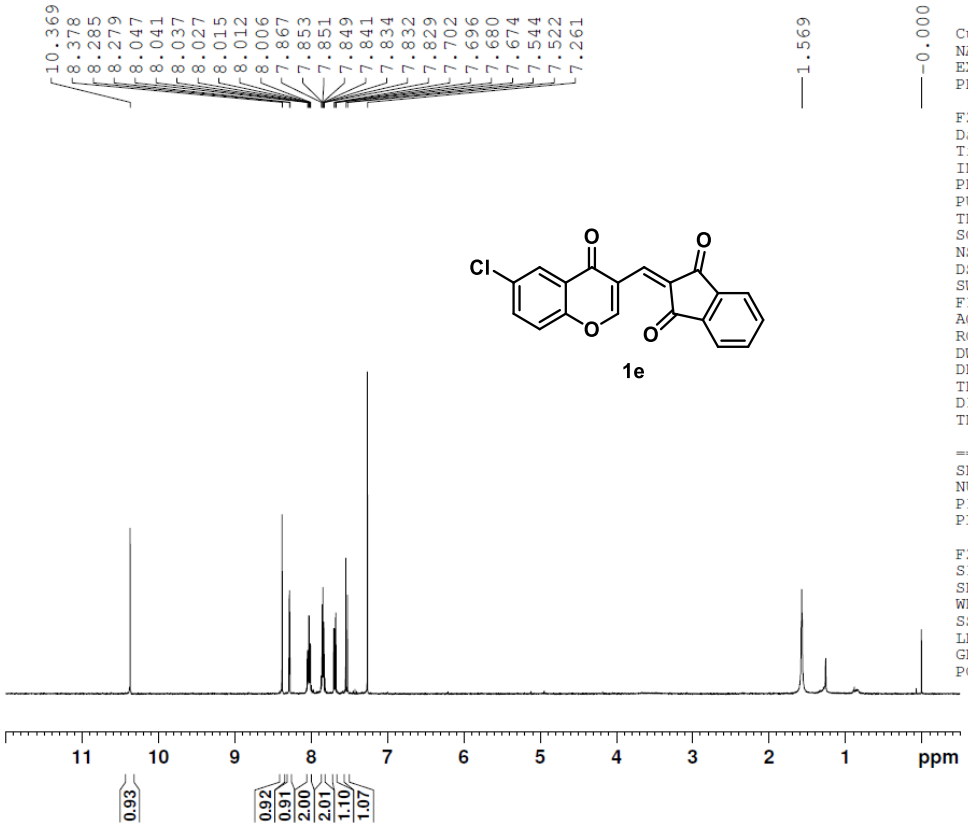
F2 - Acquisition Parameters
Date_           20240614
Time              18.10
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG           zgig
TD              131072
SOLVENT           CDCl3
NS                   16
DS                    0
SWH           89285.711 Hz
FIDRES        0.681196 Hz
AQ            0.7340032 sec
RG               198.09
DW                5.600 usec
DE                6.50 usec
TE                298.2 K
D1           1.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         376.4607168 MHz
NUC1                19F
P1                15.00 usec
PLW1         16.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W

F2 - Processing parameters
SI                  65536
SF           376.4983662 MHz
WDW                 EM
SSB                  0
LB                1.00 Hz
GB                   0
PC                1.00
```

^{1}H NMR spectrum of compound **1e** ($CDCl_3$, 400 MHz)



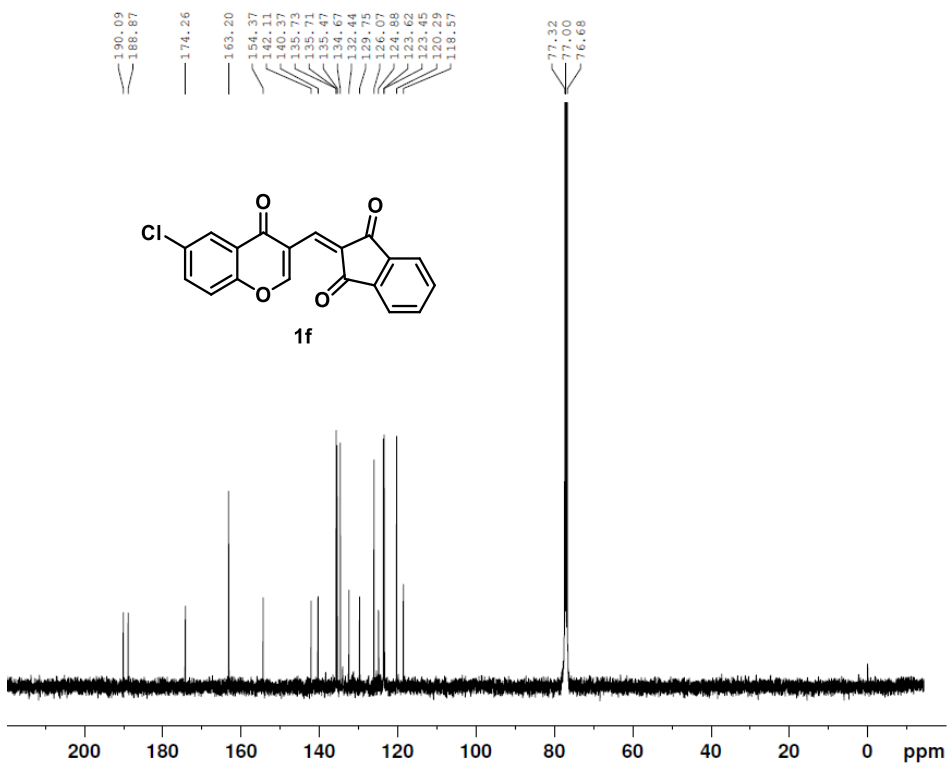

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                   10
PROCNO                   1

F2 - Acquisition Parameters
Date_           20240615
Time              15.13
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH           7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG               198.09
DW                69.333 usec
DE                10.06 usec
TE                300.7 K
D1           2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                1H
P1                15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                  16384
SF           400.1300096 MHz
WDW                 EM
SSB                  0
LB                0 Hz
GB                   0
PC                1.00
```

^{13}C NMR spectrum of compound **1e** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-907
EXPNO                      2
PROCNO                     1

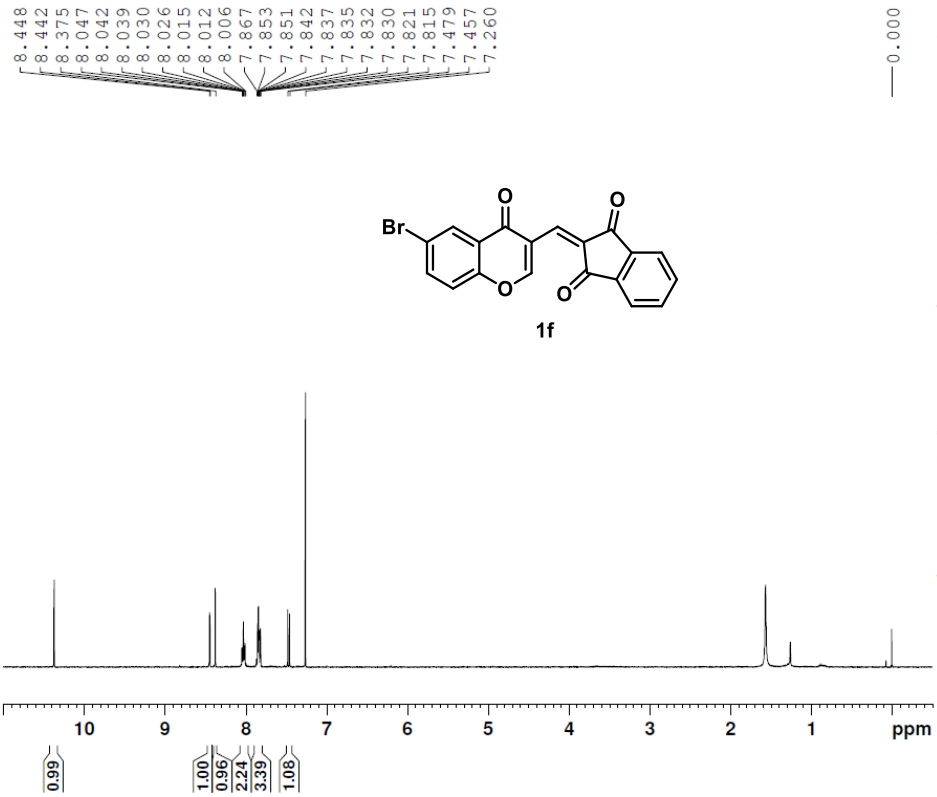
F2 - Acquisition Parameters
Date_              20240312
Time                   23.12
INSTRUM                spect
PROBHD   5 mm BBO BB-1H
PULPROG              zgpg30
TD                      32768
SOLVENT                CDCl3
NS                      16622
DS                          0
SWH                24038.461 Hz
FIDRES              0.733596 Hz
AQ                  0.6815744 sec
RG                       4096
DW                     20.800 usec
DE                      6.50 usec
TE                     295.6 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                     10.00 usec
PL1                     4.20 dB
SFO1             100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2               waltz16
NUC2                       1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2             400.1316005 MHz

F2 - Processing parameters
SI                      32768
SF               100.6127696 MHz
WDW                        EM
SSB                         0
LB                     1.00 Hz
GB                          0
PC                     1.00
```

^{1}H NMR spectrum of compound **1f** ($CDCl_3$, 400 MHz)



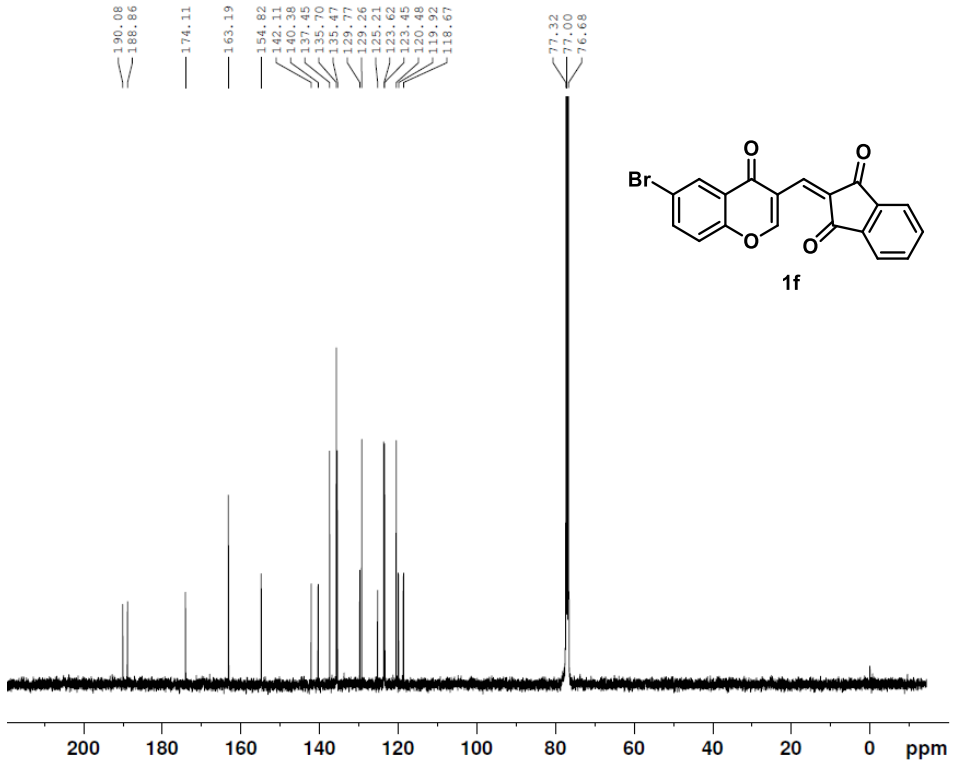

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                    9
PROCNO                   1

F2 - Acquisition Parameters
Date_              20240615
Time                   15.10
INSTRUM                spect
PROBHD   5 mm PABBO BB/
PULPROG                zg30
TD                      32768
SOLVENT                CDCl3
NS                         11
DS                          0
SWH                7211.539 Hz
FIDRES             0.220079 Hz
AQ                 2.2719147 sec
RG                    198.09
DW                    69.333 use
DE                     10.06 use
TE                     300.6 K
D1                2.00000000 sec
TD0                         1

======== CHANNEL f1 ========
SFO1             400.1324008 MHz
NUC1                       1H
P1                     15.00 use
PLW1             13.50000000 W

F2 - Processing parameters
SI                      16384
SF               400.1300099 MHz
WDW                        EM
SSB                         0
LB                      0 Hz
GB                          0
PC                     1.00
```

^{13}C NMR spectrum of compound **1f** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-906
EXPNO                      3
PROCNO                     1

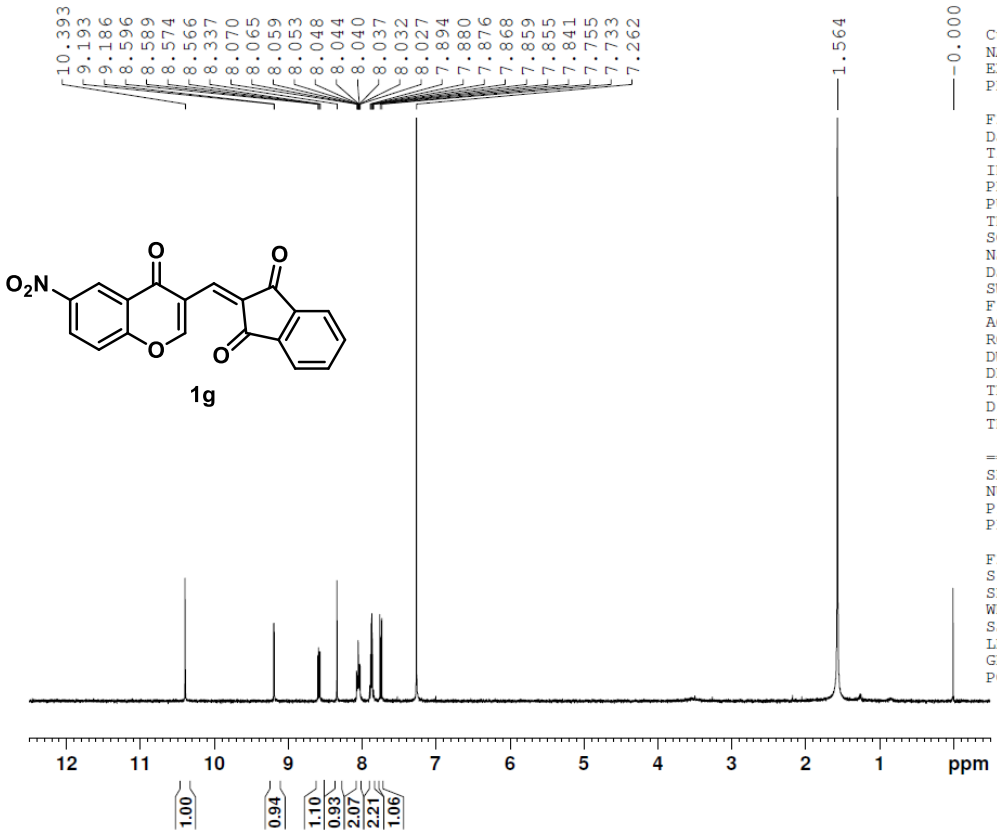
F2 - Acquisition Parameters
Date_               20231105
Time                   20.45
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG             zgpg30
TD                      32768
SOLVENT                 CDCl3
NS                      13445
DS                          0
SWH                24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                       4096
DW                     20.800 usec
DE                      6.50 usec
TE                     297.6 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                     10.00 usec
PL1                     4.20 dB
SFO1             100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2              waltz16
NUC2                      1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2             400.1316005 MHz

F2 - Processing parameters
SI                       32768
SF               100.6127694 MHz
WDW                         EM
SSB                          0
LB                      1.00 Hz
GB                           0
PC                      1.00
```

^{1}H NMR spectrum of compound **1g** ($CDCl_3$, 400 MHz)



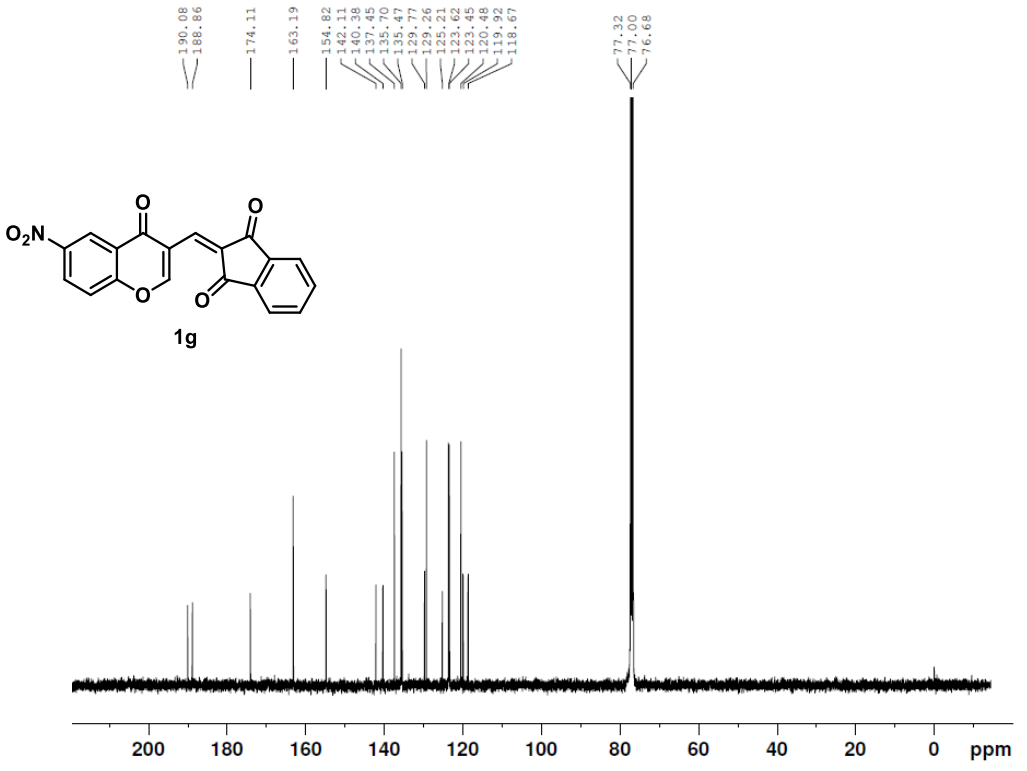

```
Current Data Parameters
NAME          JN-083(3f)
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240601
Time               14.24
INSTRUM            spect
PROBHD    5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                298.0 K
D1              2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                  15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300091 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1g** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-906
EXPNO                      3
PROCNO                     1

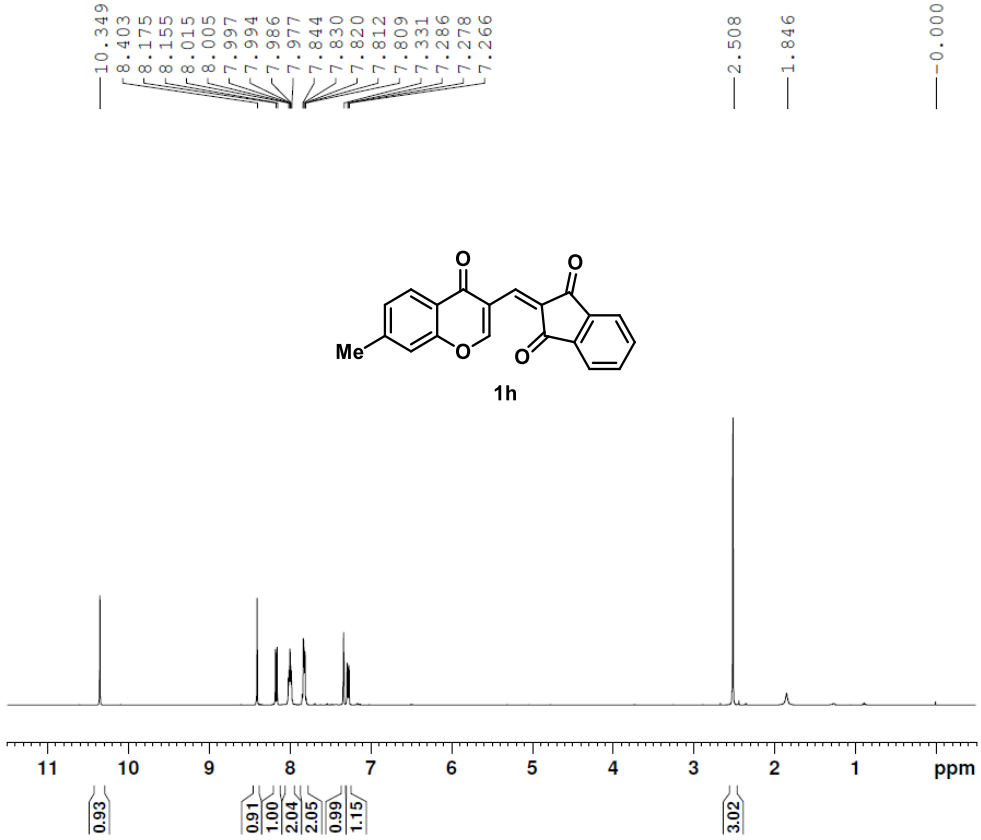
F2 - Acquisition Parameters
Date_              20231105
Time                  20.45
INSTRUM               spect
PROBHD    5 mm BBO BB-1H
PULPROG               zgpg30
TD                     32768
SOLVENT               CDCl3
NS                     13445
DS                         0
SWH               24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                      4096
DW                    20.800 usec
DE                     6.50 usec
TE                    297.6 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                     13C
P1                    10.00 usec
PL1                    4.20 dB
SFO1           100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2              waltz16
NUC2                     1H
PCPD2                 90.00 usec
PL2                   10.20 dB
PL12                  26.00 dB
PL13                  29.00 dB
SFO2           400.1316005 MHz

F2 - Processing parameters
SI                     32768
SF            100.6127694 MHz
WDW                       EM
SSB                        0
LB                     1.00 Hz
GB                         0
PC                     1.00
```

^{1}H NMR spectrum of compound **1h** ($CDCl_3$, 400 MHz)



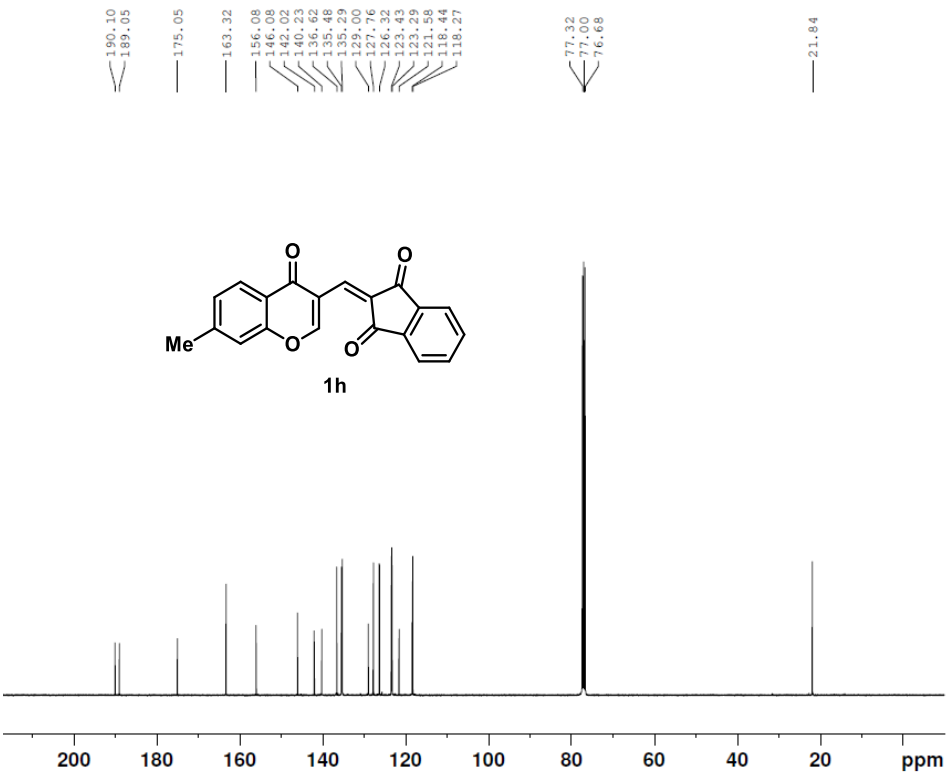

```
Current Data Parameters
NAME                  DP-1217
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_              20240419
Time                  22.05
INSTRUM               spect
PROBHD    5 mm BBO BB-1H
PULPROG                zg30
TD                     32768
SOLVENT               CDCl3
NS                        16
DS                         0
SWH                7246.377 Hz
FIDRES             0.221142 Hz
AQ                 2.2609921 sec
RG                     161.3
DW                    69.000 usec
DE                     6.50 usec
TE                    294.8 K
D1                2.00000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      1H
P1                    15.00 usec
PL1                   11.10 dB
SFO1           400.1324008 MHz

F2 - Processing parameters
SI                     16384
SF            400.1300021 MHz
WDW                       EM
SSB                        0
LB                     0 Hz
GB                         0
PC                     1.00
```

^{13}C NMR spectrum of compound **1h** ($CDCl_3$, 100 MHz)



1h

```
Current Data Parameters
NAME                  DP-1217
EXPNO                       2
PROCNO                      1

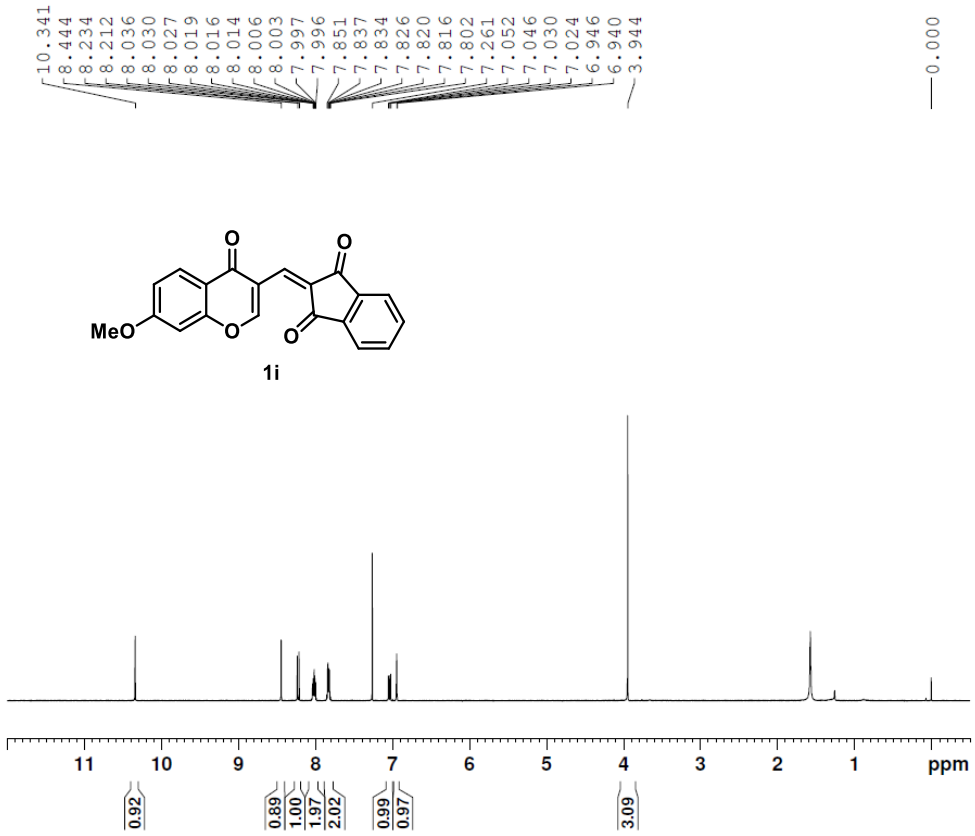
F2 - Acquisition Parameters
Date_               20240419
Time                   22.10
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG             zgpg30
TD                      32768
SOLVENT                CDCl3
NS                      15093
DS                          0
SWH                24038.461 Hz
FIDRES                 0.733596 Hz
AQ                     0.6815744 sec
RG                       4096
DW                      20.800 usec
DE                       6.50 usec
TE                      295.3 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                      10.00 usec
PL1                      4.20 dB
SFO1               100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2               waltz16
NUC2                       1H
PCPD2                   90.00 usec
PL2                     10.20 dB
PL12                    26.00 dB
PL13                    29.00 dB
SFO2               400.1316005 MHz

F2 - Processing parameters
SI                      32768
SF                 100.6127736 MHz
WDW                        EM
SSB                         0
LB                      1.00 Hz
GB                          0
PC                      1.00
```

^{1}H NMR spectrum of compound **1i** ($CDCl_3$, 400 MHz)



1i

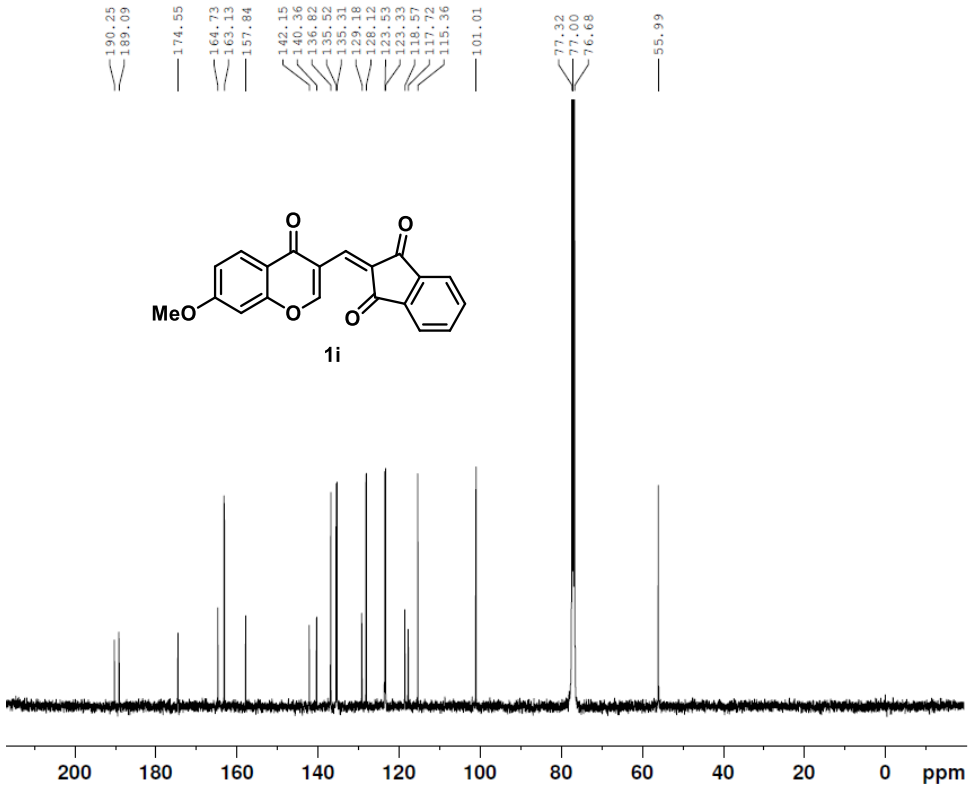
```
Current Data Parameters
NAME      DP-16-06-202(3f)
EXPNO                     4
PROCNO                    1

F2 - Acquisition Parameters
Date_               20240617
Time                   21.43
INSTRUM                spect
PROBHD    5 mm PABBO BB/
PULPROG                zg30
TD                      32768
SOLVENT                CDCl3
NS                          7
DS                          0
SWH                 7211.539 Hz
FIDRES                 0.220079 Hz
AQ                     2.2719147 sec
RG                      198.09
DW                      69.333 usec
DE                      10.06 usec
TE                      301.0 K
D1                 2.00000000 sec
TD0                         1

======== CHANNEL f1 ========
SFO1               400.1324008 MHz
NUC1                       1H
P1                      15.00 usec
PLW1               13.50000000 W

F2 - Processing parameters
SI                      16384
SF                 400.1300096 MHz
WDW                        EM
SSB                         0
LB                          0 Hz
GB                          0
PC                      1.00
```

^{13}C NMR spectrum of compound **1i** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-084(3f)
EXPNO                  3
PROCNO                 1

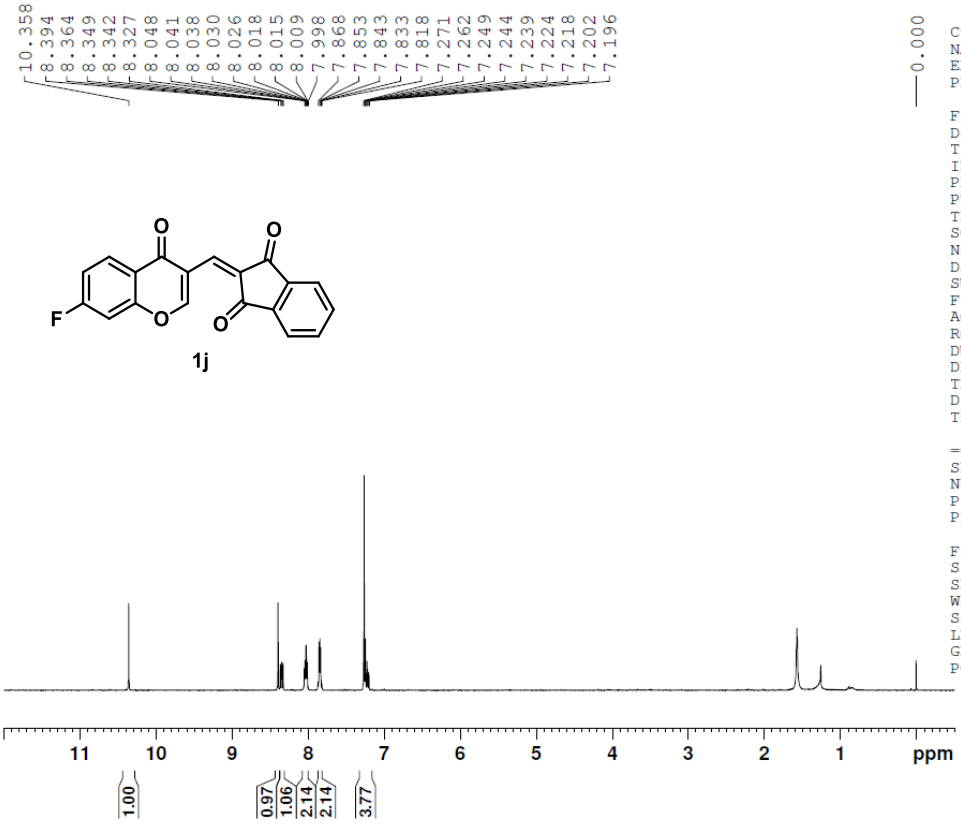
F2 - Acquisition Parameters
Date_           20240601
Time               21.16
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                19504
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.2 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127681 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1j** ($CDCl_3$, 400 MHz)



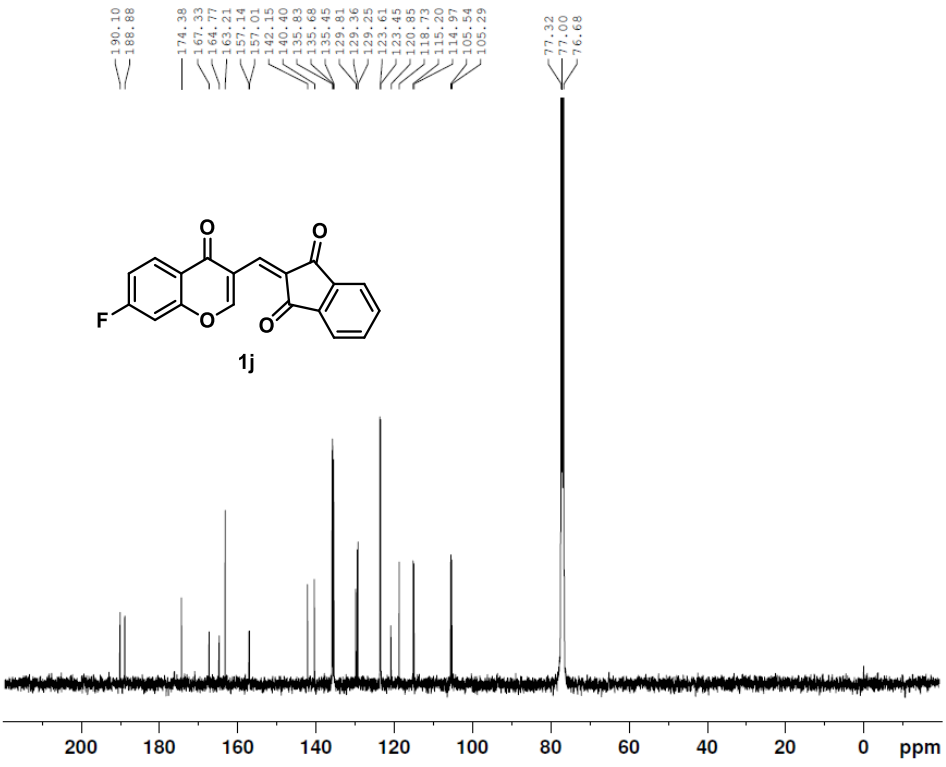

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                    8
PROCNO                   1

F2 - Acquisition Parameters
Date_           20240615
Time               11.58
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7211.539 Hz
FIDRES         0.220079 Hz
AQ             2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                298.5 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300091 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1j** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1037(3f)
EXPNO                  4
PROCNO                 1

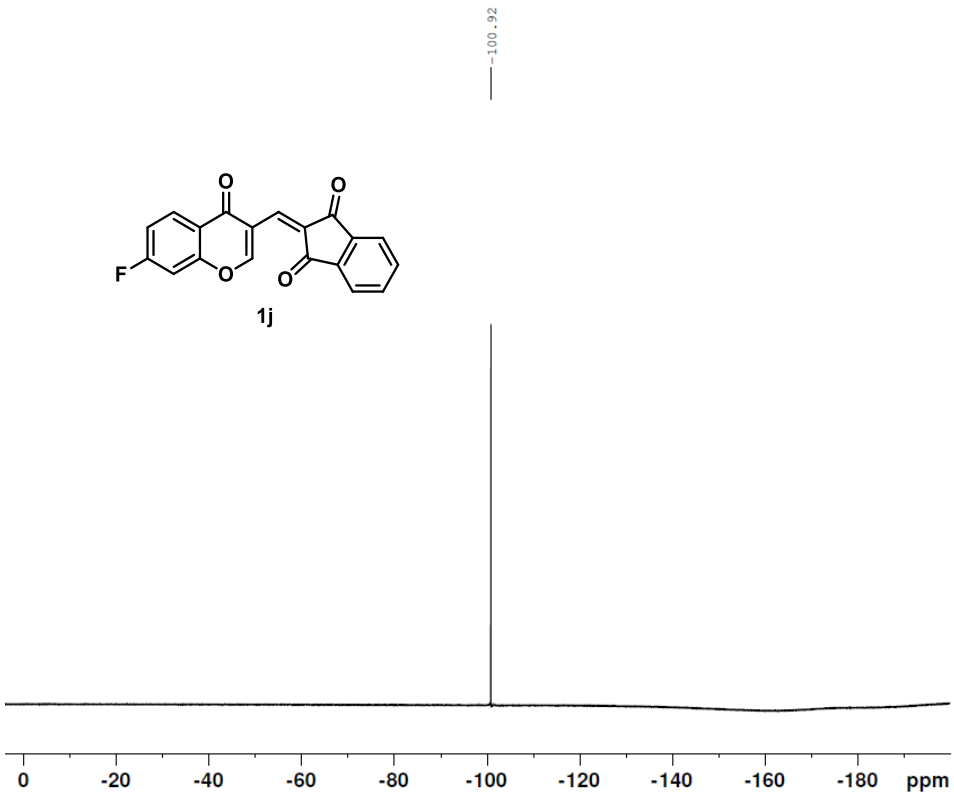
F2 - Acquisition Parameters
Date_           20240512
Time               20.42
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                16063
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                300.9 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127679 MHz
WDW                   EM
SSB                    0
LB                 2.00 Hz
GB                     0
PC                 1.00
```

^{19}F NMR spectrum of compound **1j** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME      DP-14-06-2024(3f)
EXPNO                   12
PROCNO                   1

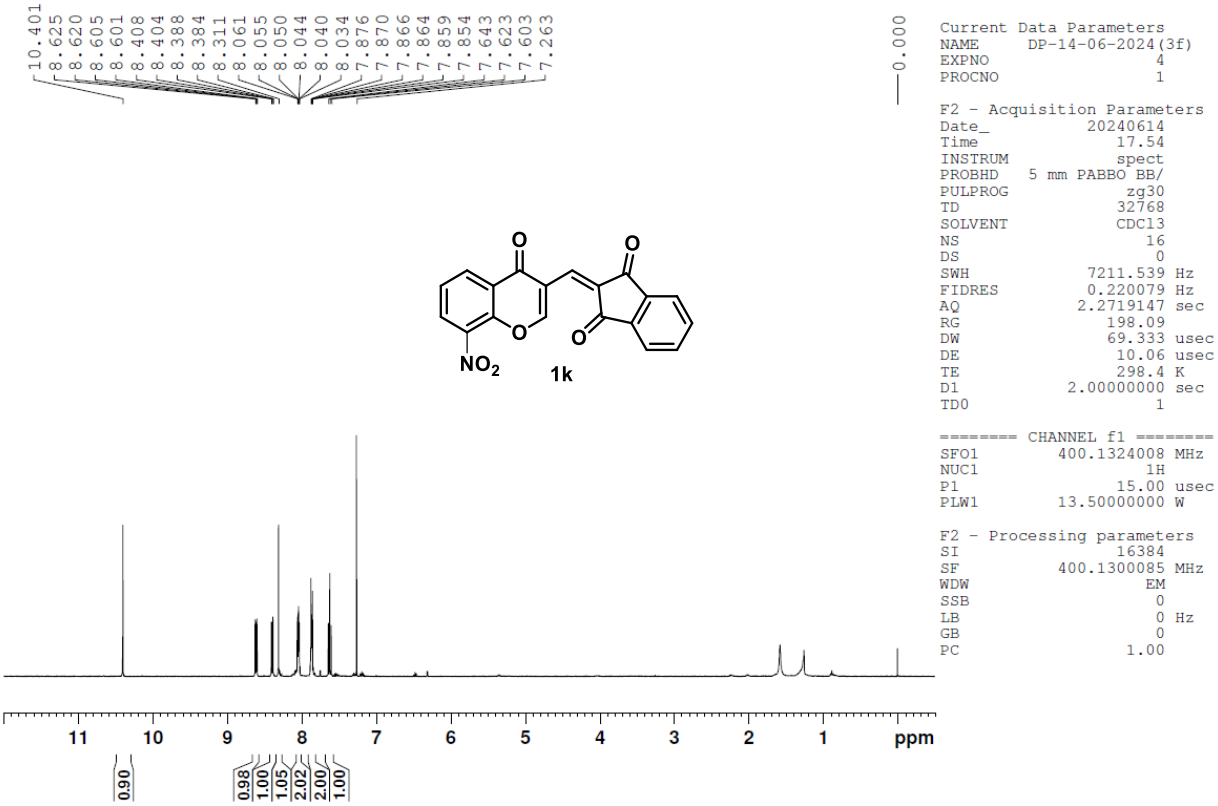
F2 - Acquisition Parameters
Date_           20240614
Time               18.04
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zgig
TD                131072
SOLVENT           CDCl3
NS                   16
DS                    0
SWH           89285.711 Hz
FIDRES         0.681196 Hz
AQ             0.7340032 sec
RG                198.09
DW                 5.600 usec
DE                 6.50 usec
TE                298.3 K
D1            1.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         376.4607168 MHz
NUC1                  19F
P1                 15.00 usec
PLW1         16.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W

F2 - Processing parameters
SI                 65536
SF           376.4983662 MHz
WDW                   EM
SSB                    0
LB                 1.00 Hz
GB                     0
PC                 1.00
```

^{1}H NMR spectrum of compound **1k** ($CDCl_3$, 400 MHz)



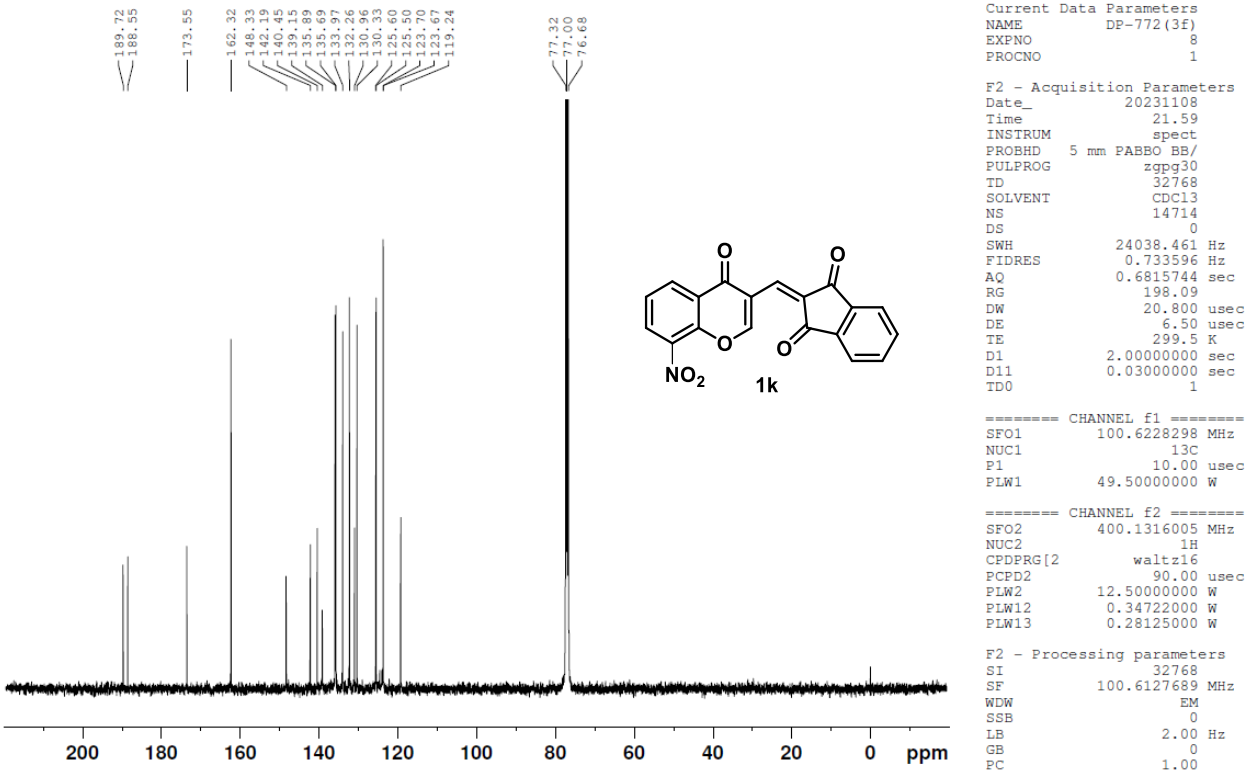

```
Current Data Parameters
NAME      DP-14-06-2024(3f)
EXPNO                    4
PROCNO                   1

F2 - Acquisition Parameters
Date_           20240614
Time              17.54
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG           zg30
TD               32768
SOLVENT          CDCl3
NS                  16
DS                   0
SWH           7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG              198.09
DW              69.333 usec
DE              10.06 usec
TE              298.4 K
D1           2.00000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                1H
P1                15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI               16384
SF          400.1300085 MHz
WDW                 EM
SSB                  0
LB                   0 Hz
GB                   0
PC                1.00
```

^{13}C NMR spectrum of compound **1k** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-772(3f)
EXPNO                  8
PROCNO                 1

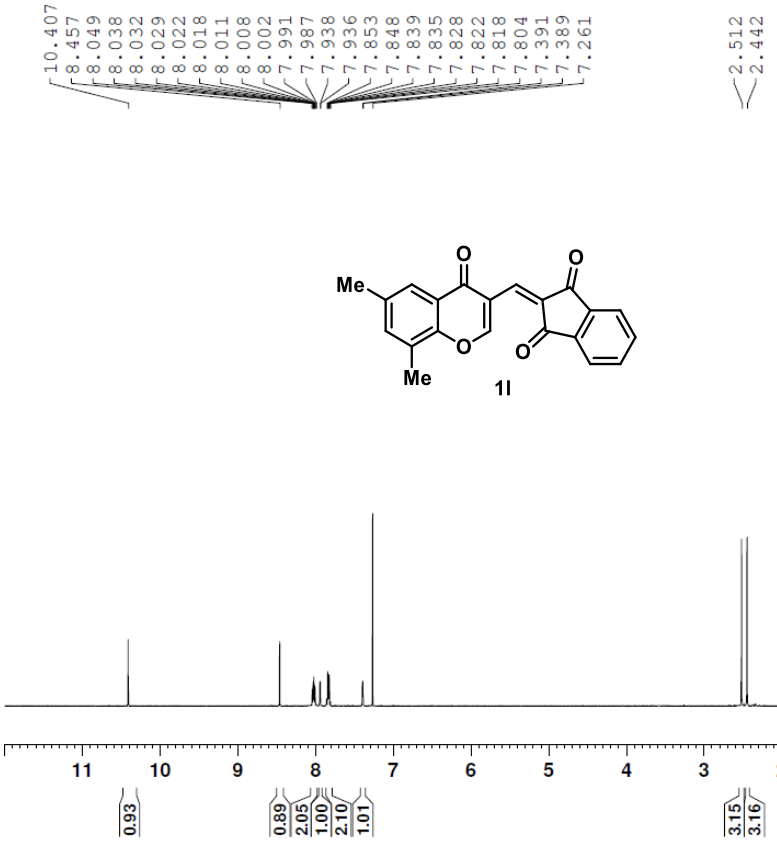
F2 - Acquisition Parameters
Date_           20231108
Time              21.59
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD               32768
SOLVENT          CDCl3
NS               14714
DS                   0
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG              198.09
DW              20.800 usec
DE               6.50 usec
TE              299.5 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI               32768
SF          100.6127689 MHz
WDW                 EM
SSB                  0
LB                2.00 Hz
GB                   0
PC                1.00
```

^{1}H NMR spectrum of compound **1l** ($CDCl_3$, 400 MHz)



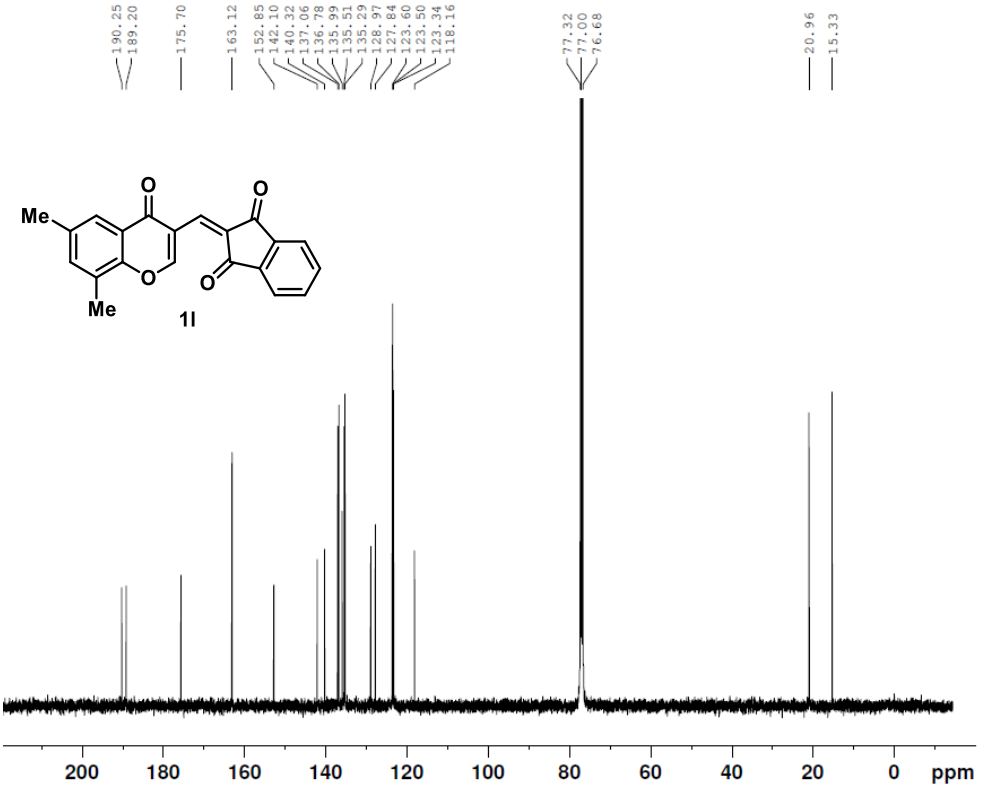

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                   6
PROCNO                  1

F2 - Acquisition Parameters
Date_           20240615
Time               11.52
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     9
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                298.6 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300092 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1l** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME             DP-1209
EXPNO                  2
PROCNO                 1

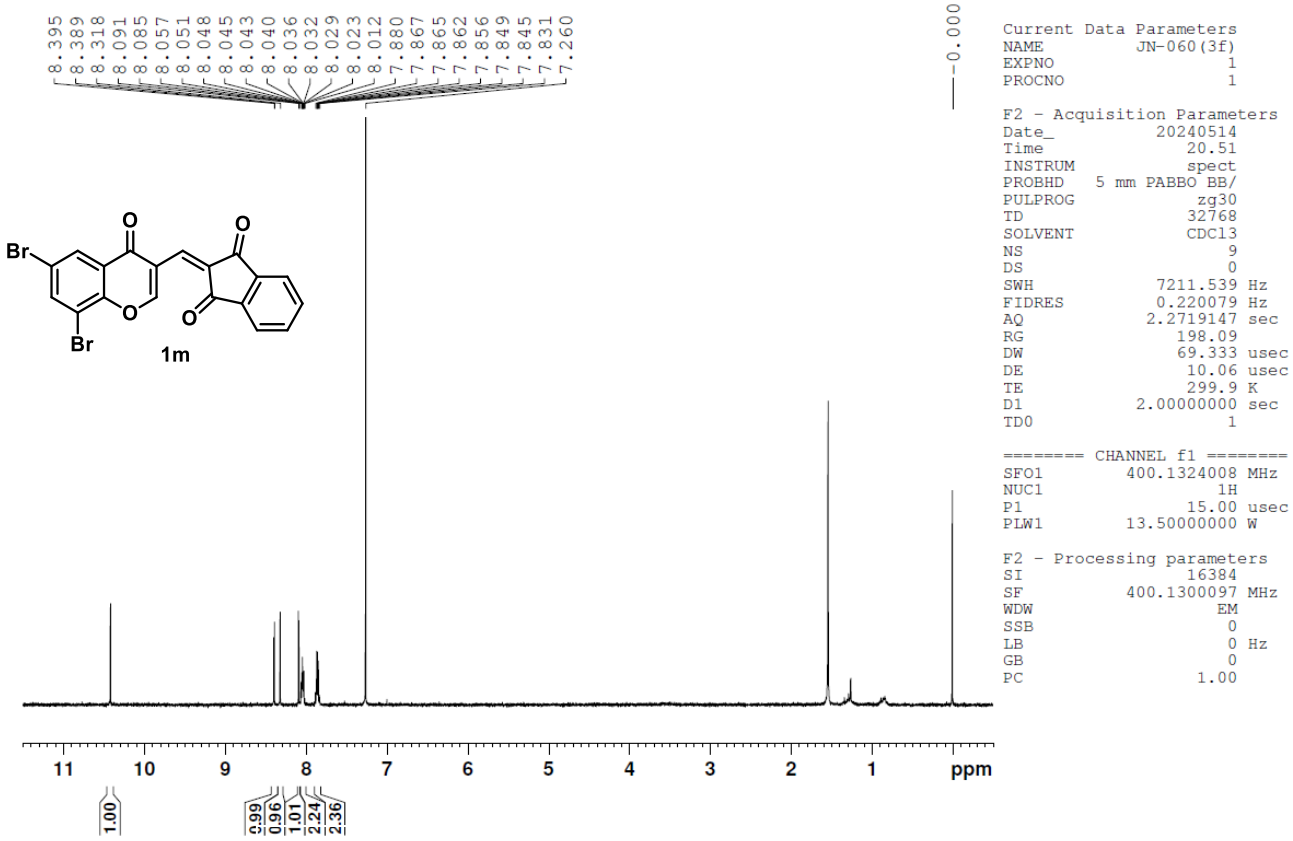
F2 - Acquisition Parameters
Date_           20240414
Time               22.10
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 15124
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                  4096
DW                20.800 usec
DE                 6.50 usec
TE                295.6 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  13C
P1                10.00 usec
PL1                4.20 dB
SFO1         100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2         waltz16
NUC2                   1H
PCPD2             90.00 usec
PL2               10.20 dB
PL12              26.00 dB
PL13              29.00 dB
SFO2         400.1316005 MHz

F2 - Processing parameters
SI                 32768
SF           100.6127695 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1m** ($CDCl_3$, 400 MHz)



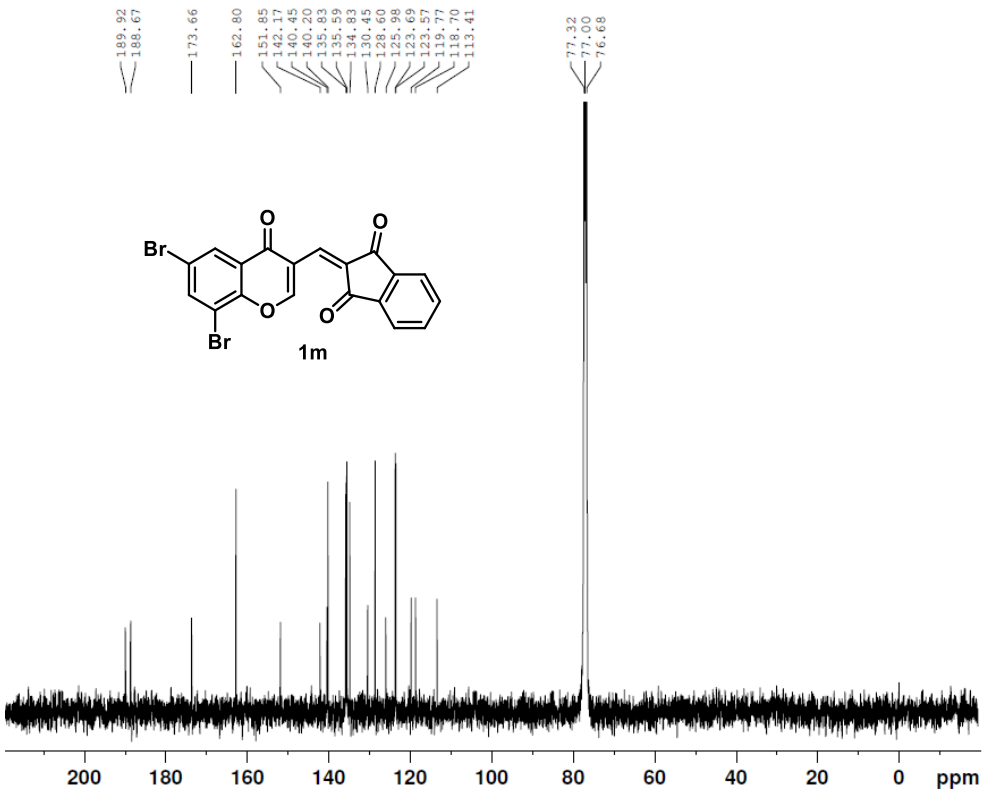

```
Current Data Parameters
NAME          JN-060(3f)
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240514
Time               20.51
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     9
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                299.9 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          400.1324008 MHz
NUC1                  1H
P1                 15.00 usec
PLW1          13.50000000 W

F2 - Processing parameters
SI                 16384
SF            400.1300097 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1m** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-060(3f)
EXPNO                  3
PROCNO                 1

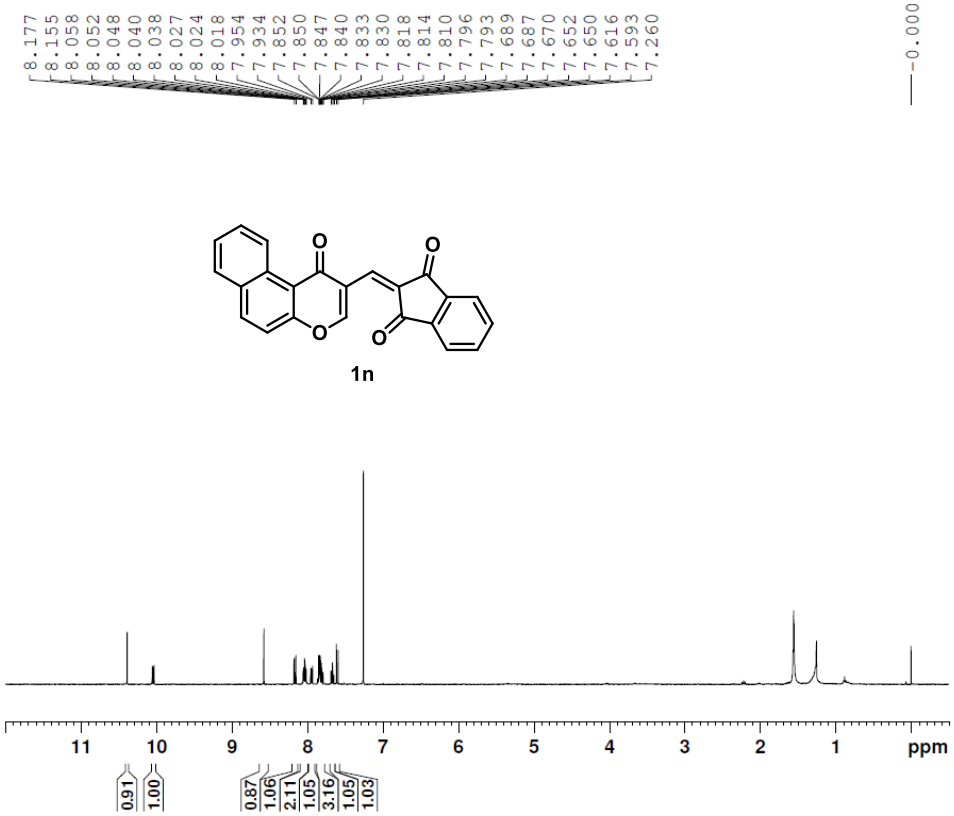
F2 - Acquisition Parameters
Date_           20240519
Time               20.40
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 17543
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.1 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          49.50000000 W

======== CHANNEL f2 ========
SFO2          400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2          12.50000000 W
PLW12          0.34722000 W
PLW13          0.28125000 W

F2 - Processing parameters
SI                 32768
SF            100.6127682 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1n** ($CDCl_3$, 400 MHz)



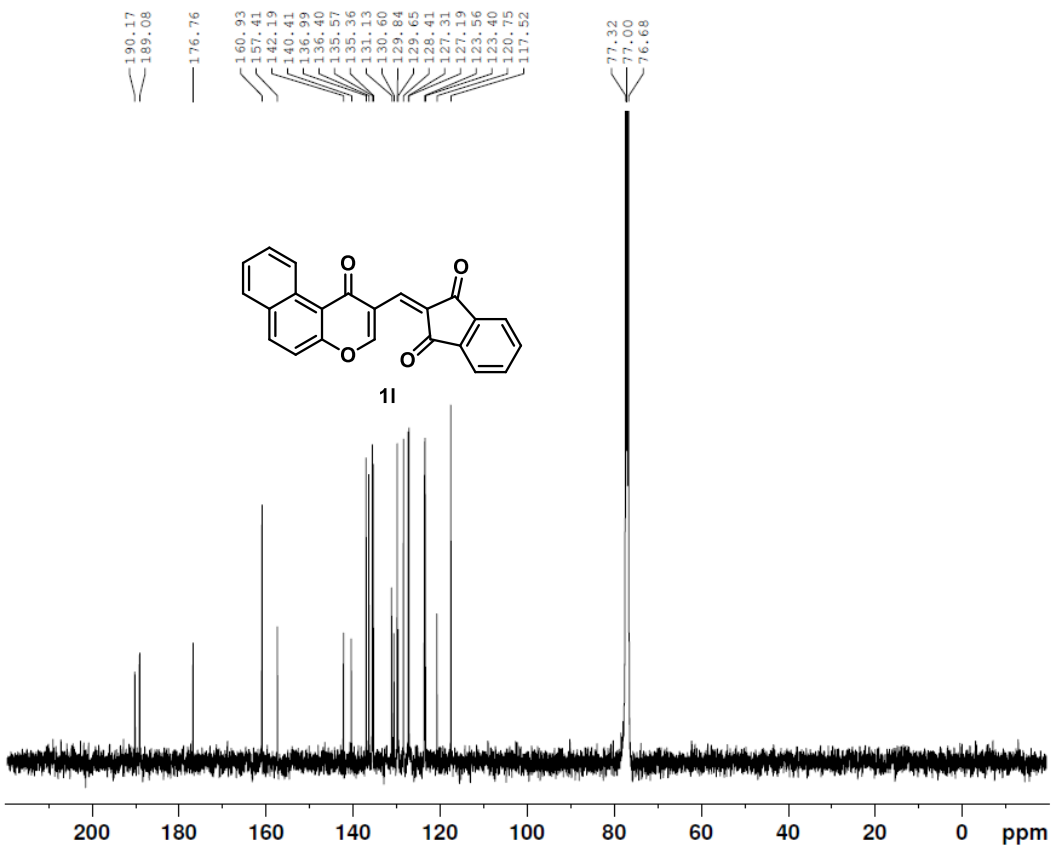

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                  12
PROCNO                  1

F2 - Acquisition Parameters
Date_           20240615
Time               15.42
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                301.2 K
D1           2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300000 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1n** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-060(3f)
EXPNO                  5
PROCNO                 1

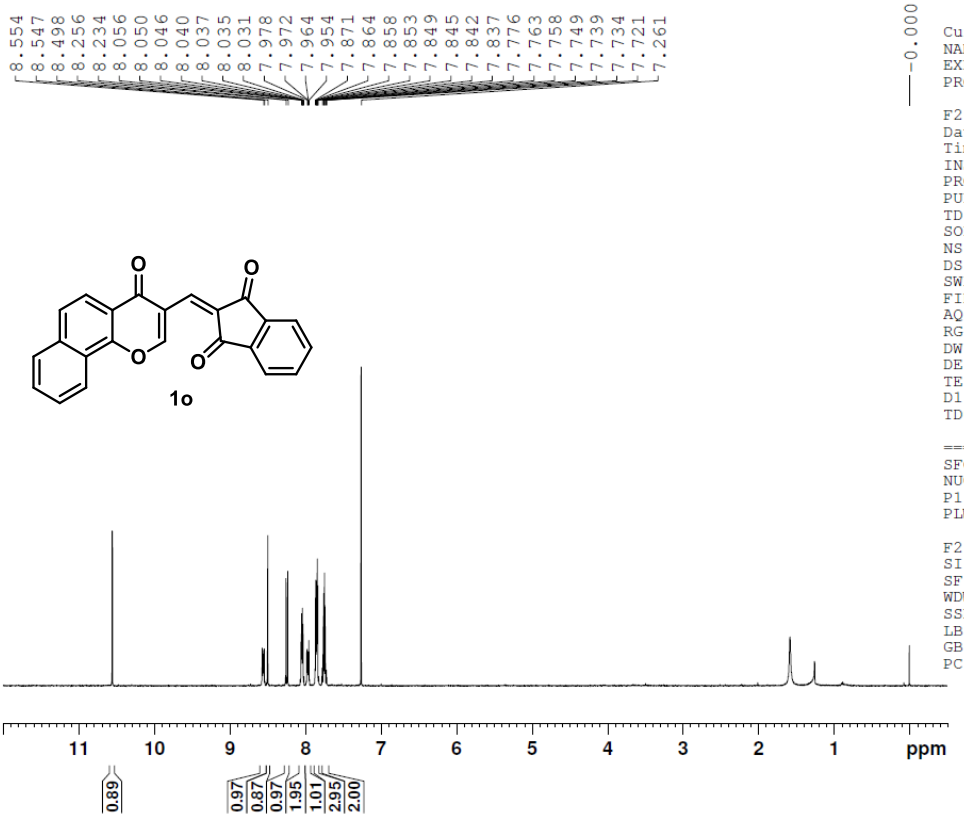
F2 - Acquisition Parameters
Date_           20240626
Time               7.58
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 11620
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                300.1 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF          100.6127685 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1o** ($CDCl_3$, 400 MHz)



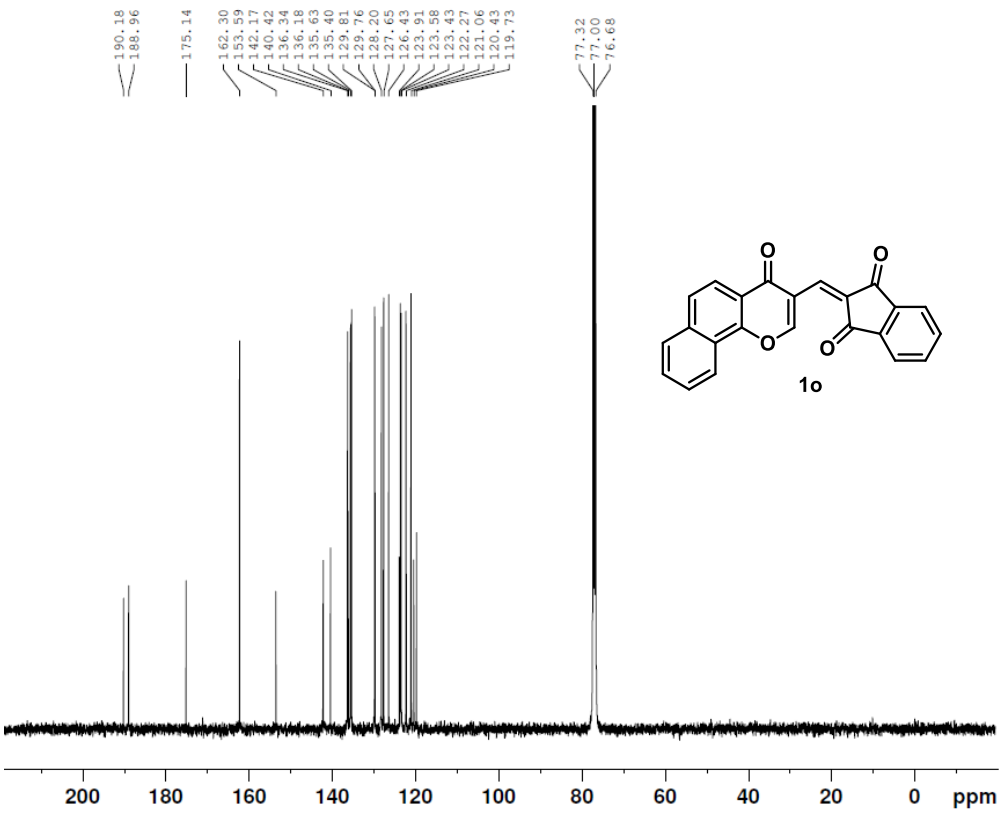

```
Current Data Parameters
NAME      DP-15-06-202(3f)
EXPNO                   7
PROCNO                  1

F2 - Acquisition Parameters
Date_           20240615
Time               11.55
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     9
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                177.16
DW                69.333 usec
DE                10.06 usec
TE                298.5 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300092 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1o** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1067(3f)
EXPNO                  9
PROCNO                 1

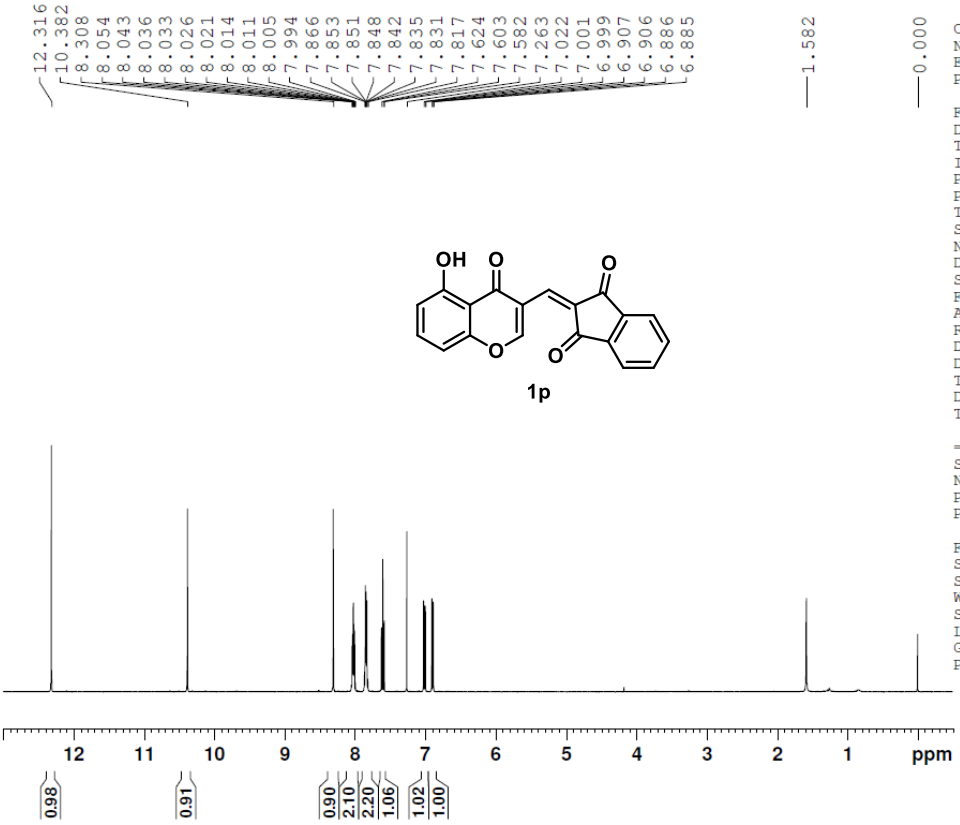
F2 - Acquisition Parameters
Date_           20240418
Time               21.58
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 15025
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.3 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127690 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1p** ($CDCl_3$, 400 MHz)



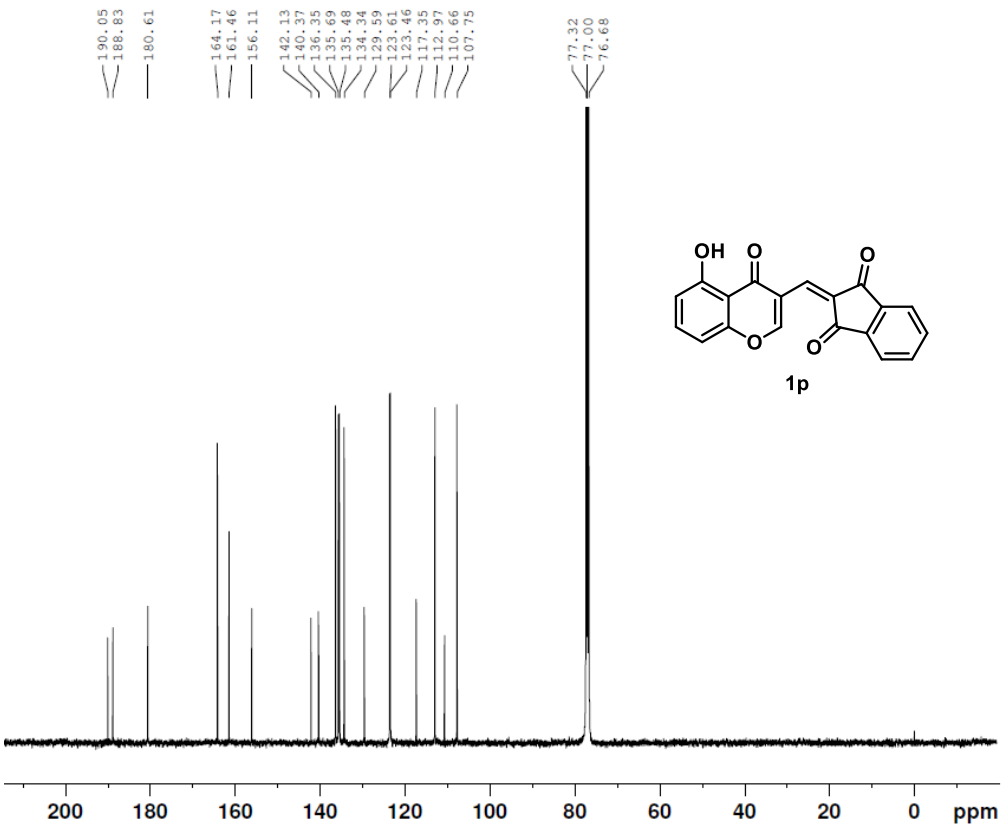

```
Current Data Parameters
NAME          JN-050(3f)
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240504
Time               22.41
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                177.16
DW                69.333 usec
DE                10.06 usec
TE                298.3 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          400.1324008 MHz
NUC1                  1H
P1                 15.00 usec
PLW1          13.50000000 W

F2 - Processing parameters
SI                 16384
SF            400.1300086 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1p** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-050(3f)
EXPNO                  2
PROCNO                 1

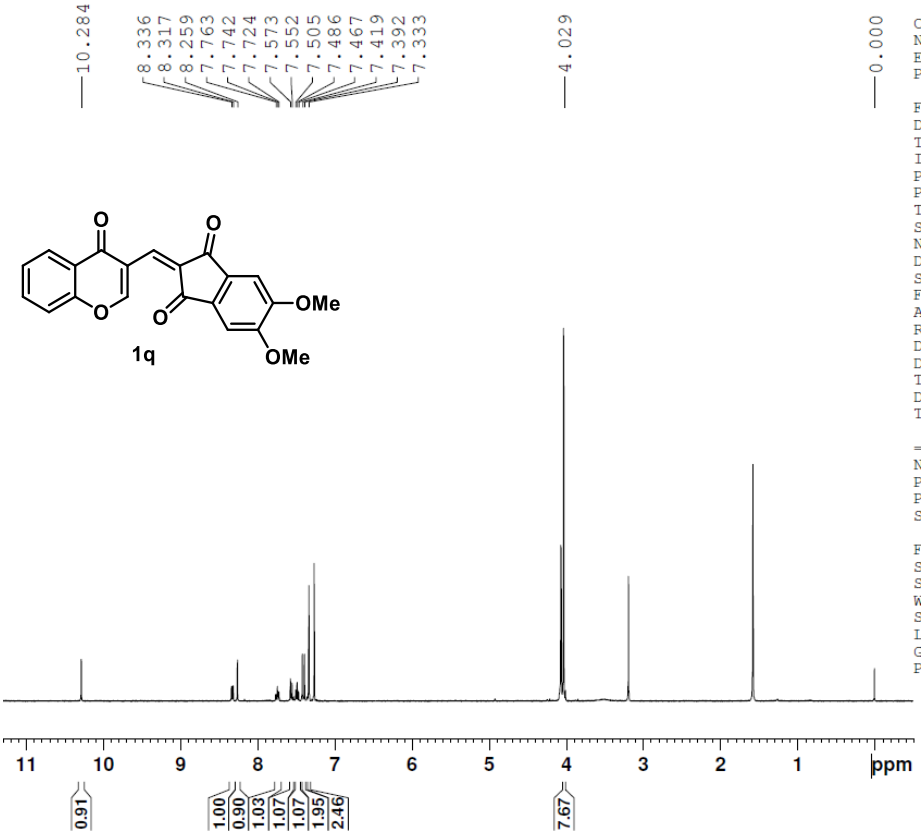
F2 - Acquisition Parameters
Date_           20240504
Time               22.43
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 18972
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.6 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          49.50000000 W

======== CHANNEL f2 ========
SFO2          400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2          12.50000000 W
PLW12          0.34722000 W
PLW13          0.28125000 W

F2 - Processing parameters
SI                 32768
SF            100.6127688 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **1q** ($CDCl_3$, 400 MHz)



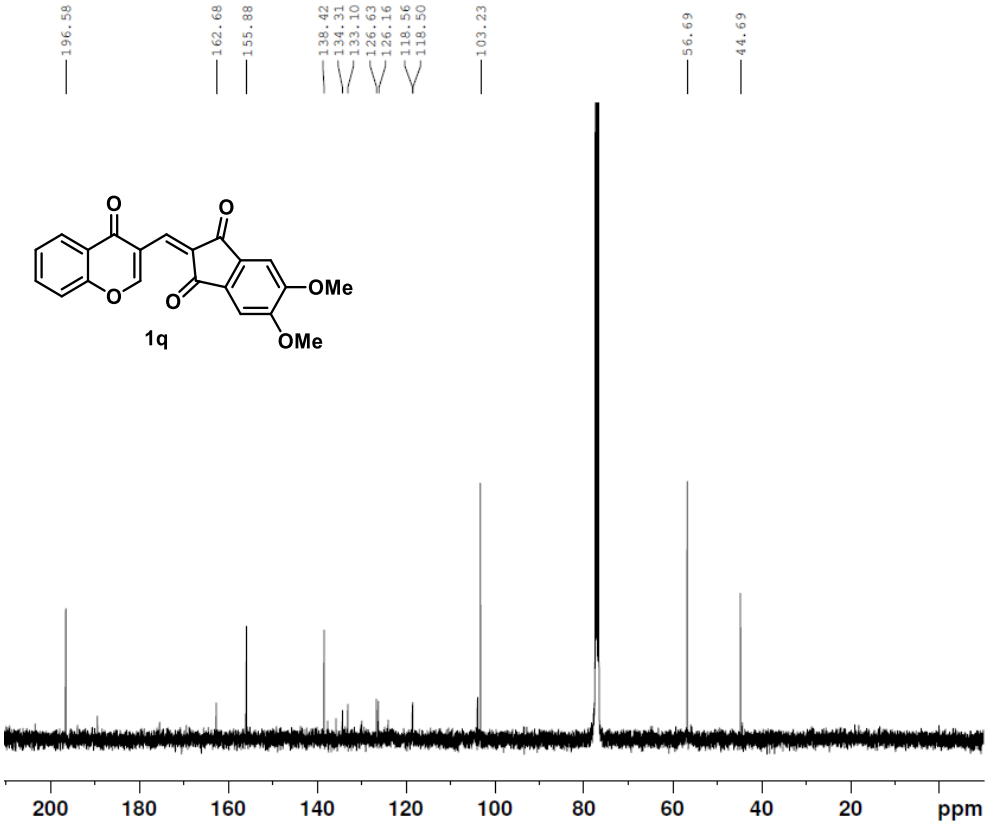

```
Current Data Parameters
NAME                  DP-985
EXPNO                      2
PROCNO                     1

F2 - Acquisition Parameters
Date_              20240519
Time                  21.38
INSTRUM               spect
PROBHD    5 mm BBO BB-1H
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                       16
DS                        0
SWH                7246.377 Hz
FIDRES            0.221142 Hz
AQ                2.2609921 sec
RG                    456.1
DW                   69.000 usec
DE                    6.50 usec
TE                   297.0 K
D1                2.00000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                     1H
P1                   15.00 usec
PL1                  11.10 dB
SFO1           400.1324008 MHz

F2 - Processing parameters
SI                    16384
SF             400.1300078 MHz
WDW                      EM
SSB                       0
LB                        0 Hz
GB                        0
PC                     1.00
```

^{13}C NMR spectrum of compound **1q** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-985
EXPNO                      3
PROCNO                     1

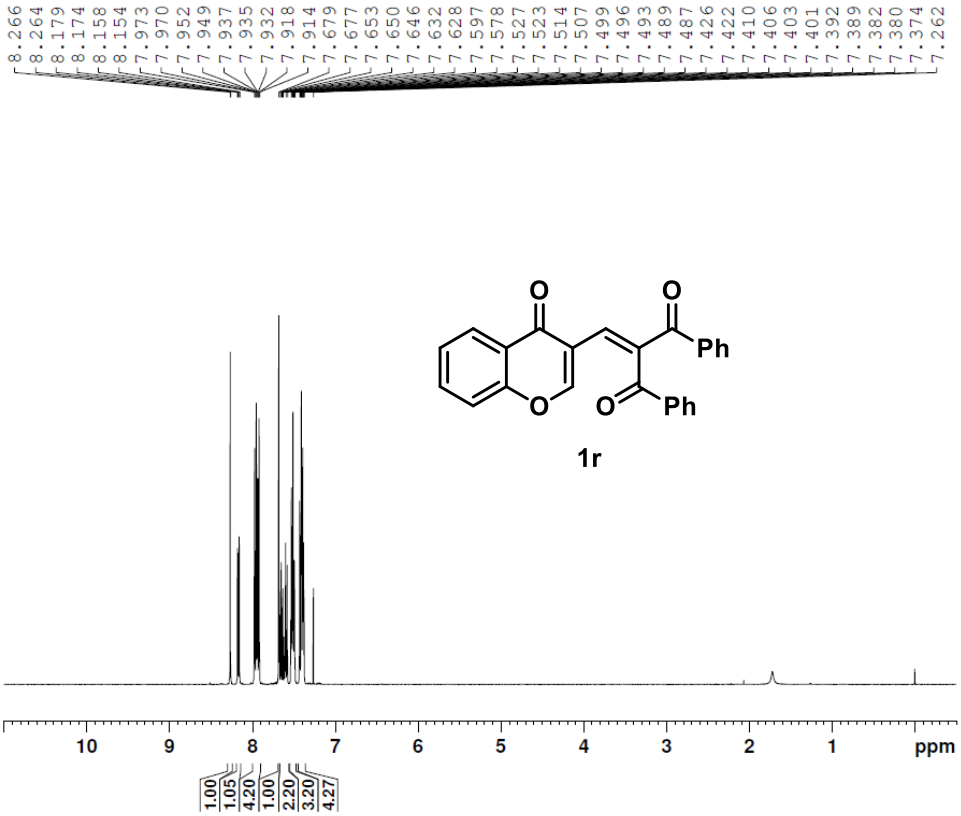
F2 - Acquisition Parameters
Date_              20240519
Time                  21.41
INSTRUM               spect
PROBHD    5 mm BBO BB-1H
PULPROG              zgpg30
TD                    32768
SOLVENT               CDCl3
NS                    16120
DS                        0
SWH               24038.461 Hz
FIDRES            0.733596 Hz
AQ                0.6815744 sec
RG                     4096
DW                   20.800 usec
DE                    6.50 usec
TE                   297.2 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                    13C
P1                   10.00 usec
PL1                   4.20 dB
SFO1           100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2          waltz16
NUC2                     1H
PCPD2                90.00 usec
PL2                  10.20 dB
PL12                 26.00 dB
PL13                 29.00 dB
SFO2           400.1316005 MHz

F2 - Processing parameters
SI                    32768
SF             100.6127690 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.00
```

^{1}H NMR spectrum of compound **1r** ($CDCl_3$, 400 MHz)



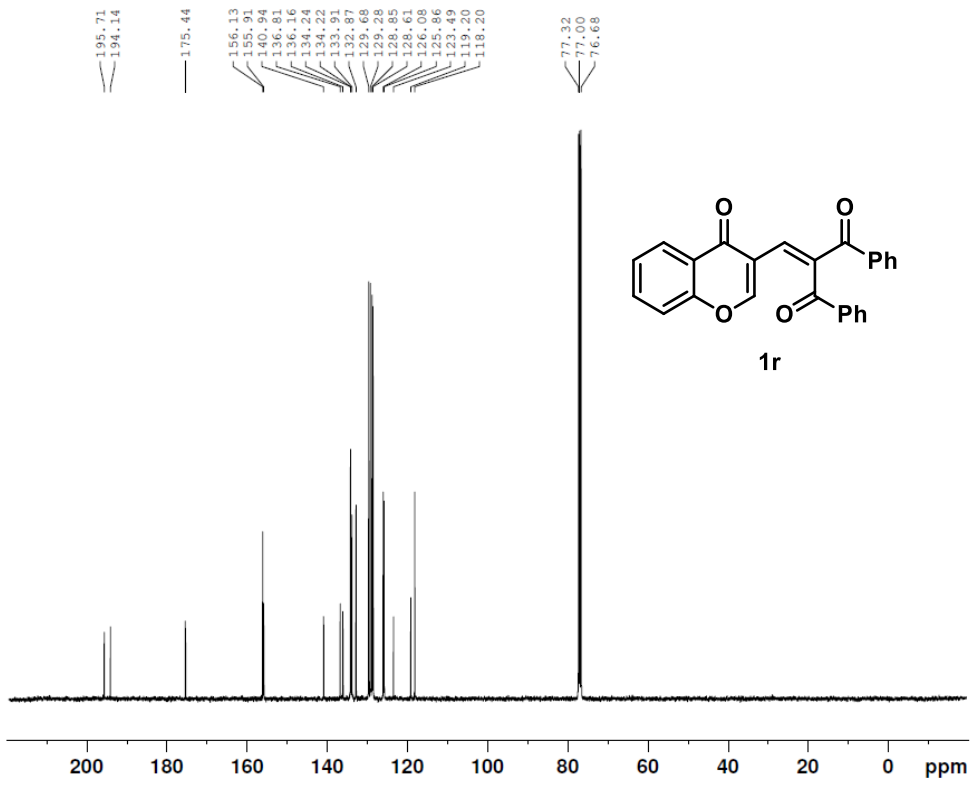

```
Current Data Parameters
NAME          JN-020(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240601
Time               19.24
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     7
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 89.08
DW                69.333 usec
DE                10.06 usec
TE                298.1 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300087 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **1r** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-020(3f)
EXPNO                  5
PROCNO                 1

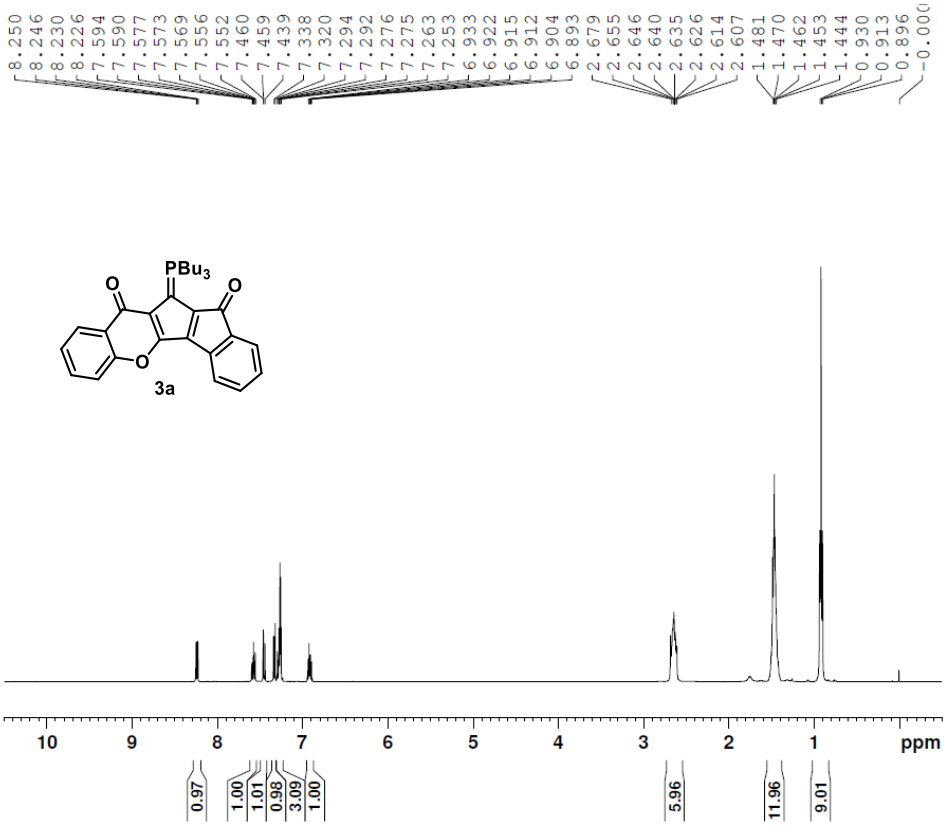
F2 - Acquisition Parameters
Date_           20240601
Time               19.26
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  1103
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.5 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127734 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **3a** ($CDCl_3$, 400 MHz)



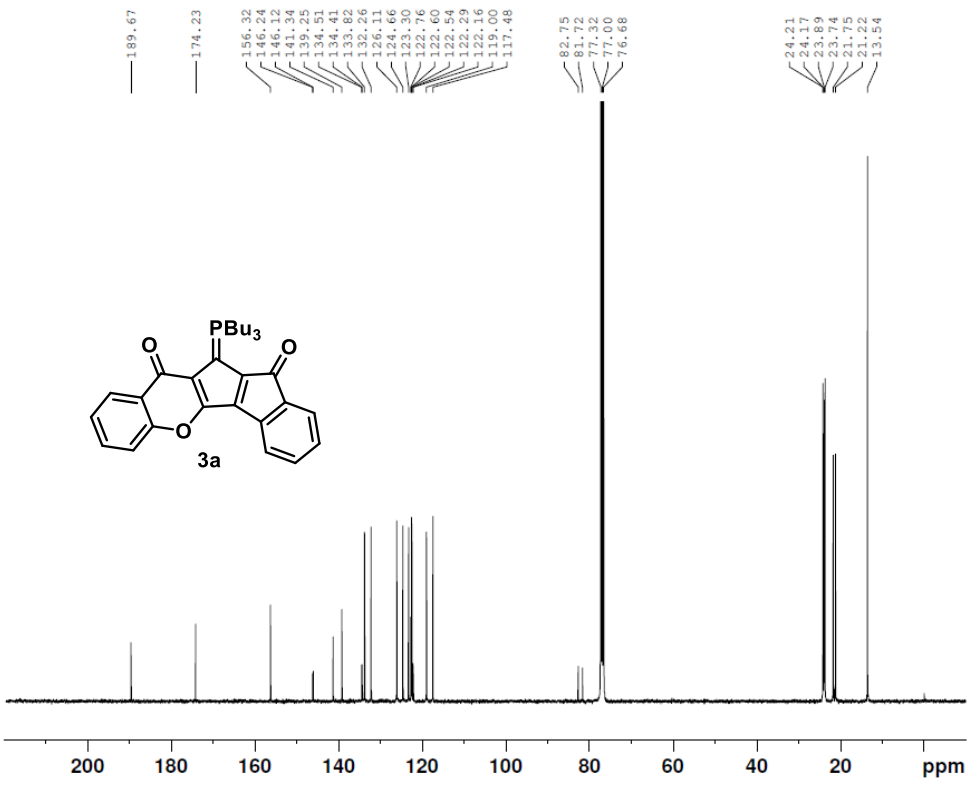

```
Current Data Parameters
NAME          DP-703(3f)
EXPNO                 14
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230624
Time                4.45
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 57.42
DW                69.333 usec
DE                 10.06 usec
TE                 298.3 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300087 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3a** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-703(3f)
EXPNO                 17
PROCNO                 1

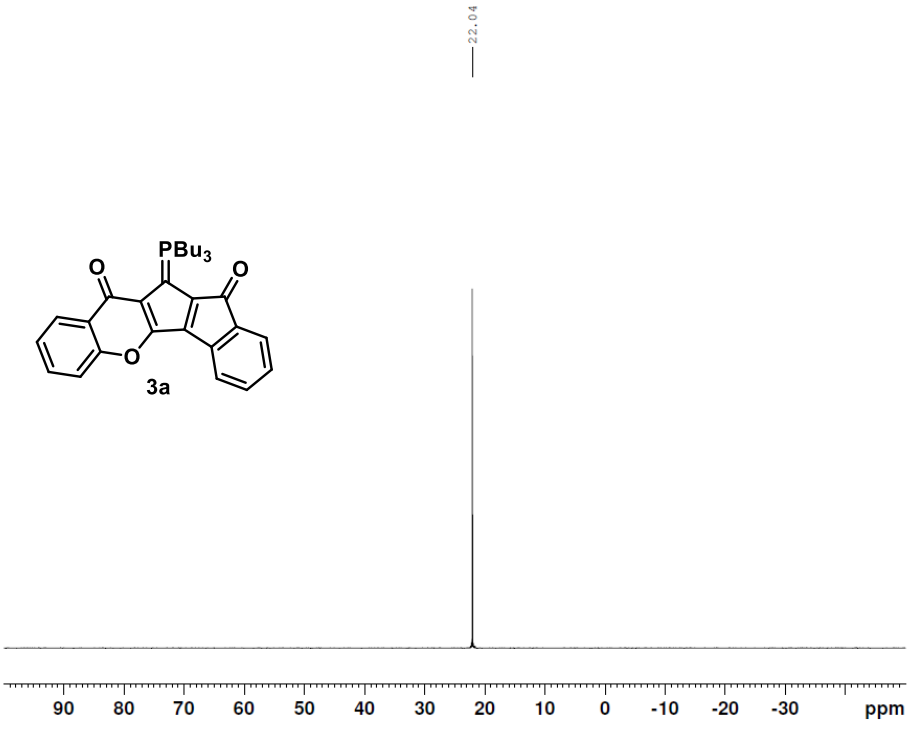
F2 - Acquisition Parameters
Date_           20230706
Time               10.09
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 13905
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                299.1 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127693 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3a** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME          DP-703(3f)
EXPNO                 11
PROCNO                 1

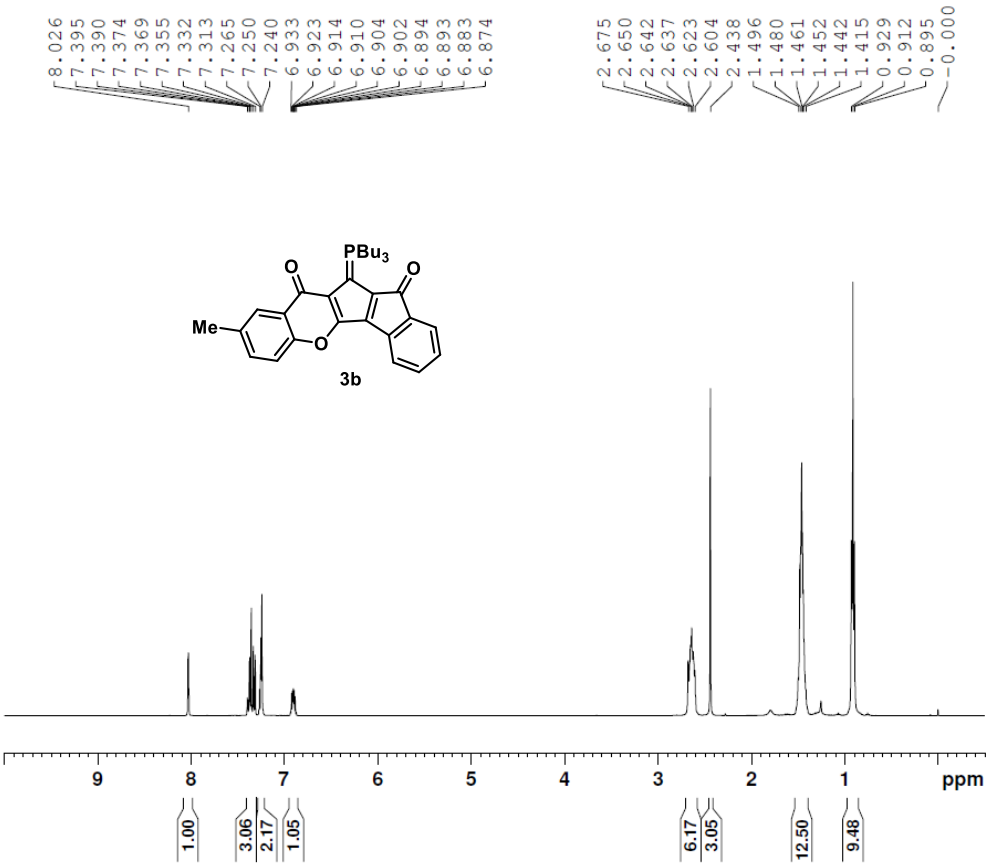
F2 - Acquisition Parameters
Date_           20230624
Time                2.45
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     4
SWH            49019.609 Hz
FIDRES         0.747980 Hz
AQ             0.6684672 sec
RG                198.09
DW                10.200 usec
DE                 6.50 usec
TE                298.9 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         161.9836917 MHz
NUC1                 31P
P1                15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                 2.00 Hz
GB                     0
PC                 1.40
```

^{1}H NMR spectrum of compound **3b** ($CDCl_3$, 400 MHz)



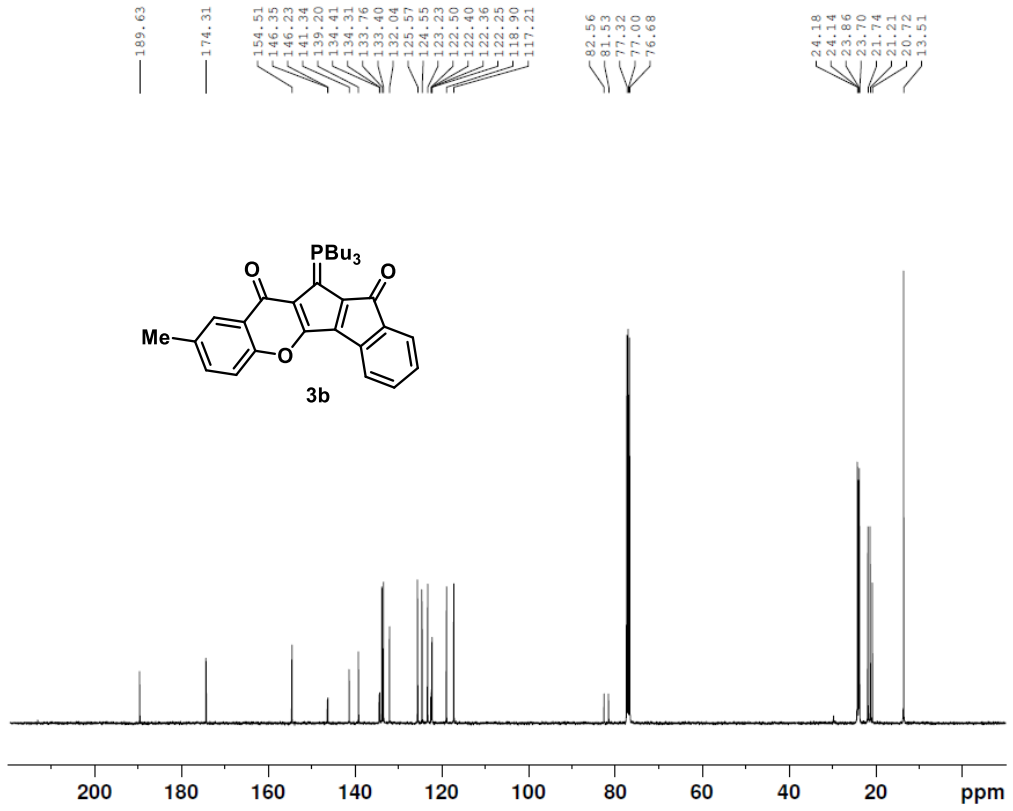

```
Current Data Parameters
NAME          DP-1173(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240305
Time               13.03
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES         0.220079 Hz
AQ             2.2719147 sec
RG                 38.89
DW                69.333 usec
DE                 10.06 usec
TE                 298.0 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                 1H
P1                15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300079 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                 1.00
```

^{13}C NMR spectrum of compound **3b** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1173(3f)
EXPNO                  5
PROCNO                 1

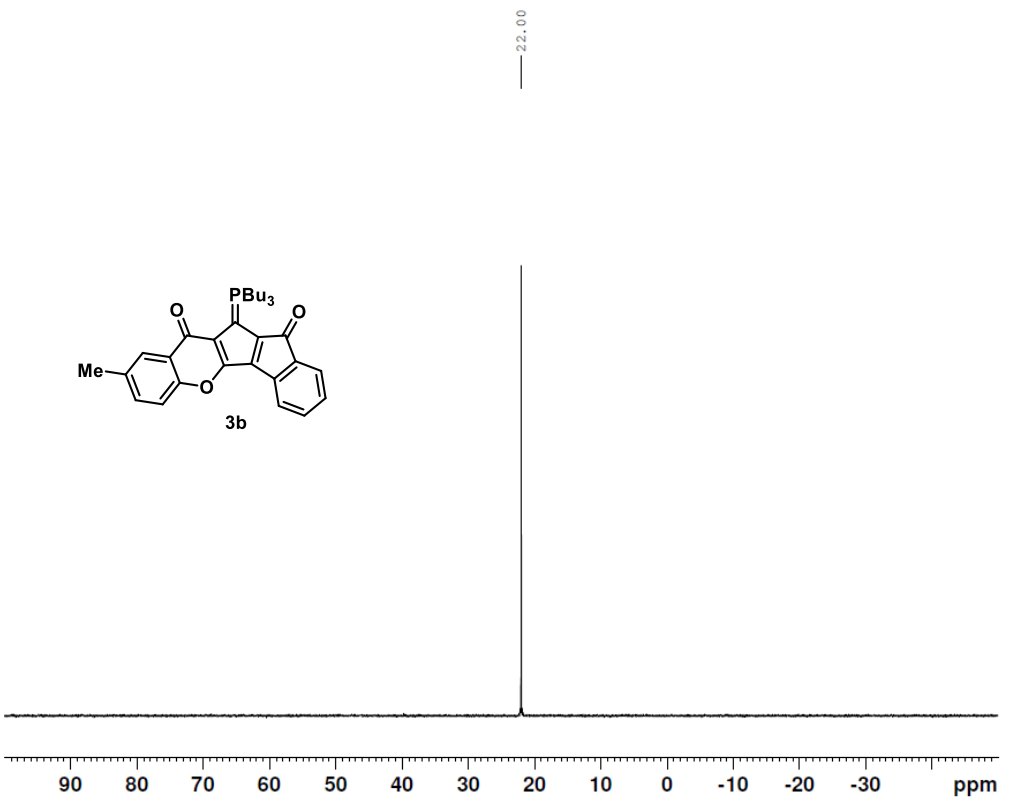
F2 - Acquisition Parameters
Date_           20240305
Time               13.05
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  1493
DS                     0
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                6.50 usec
TE                298.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          100.6127738 MHz
WDW                   EM
SSB                    0
LB                2.00 Hz
GB                     0
PC                1.00
```

^{31}P NMR spectrum of compound **3b** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1173(3f)
EXPNO                  1
PROCNO                 1

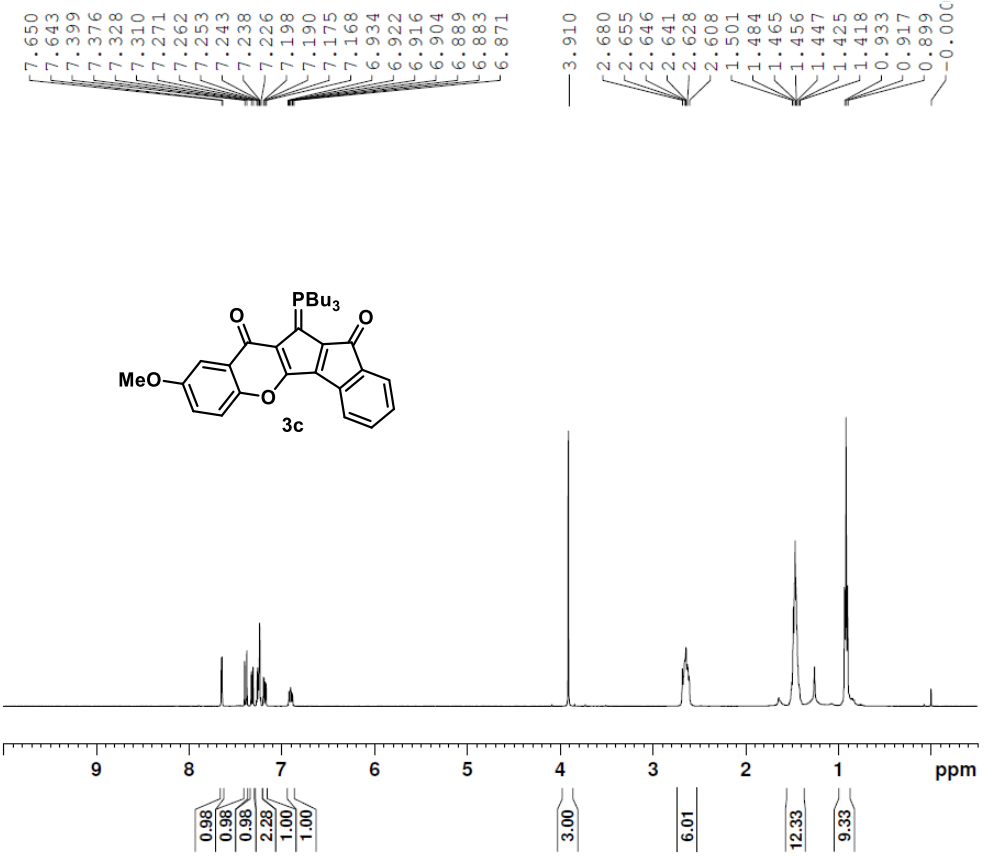
F2 - Acquisition Parameters
Date_           20240229
Time               16.09
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                     6
DS                     4
SWH          49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                   EM
SSB                    0
LB                2.00 Hz
GB                     0
PC                1.40
```

^{1}H NMR spectrum of compound **3c** ($CDCl_3$, 400 MHz)



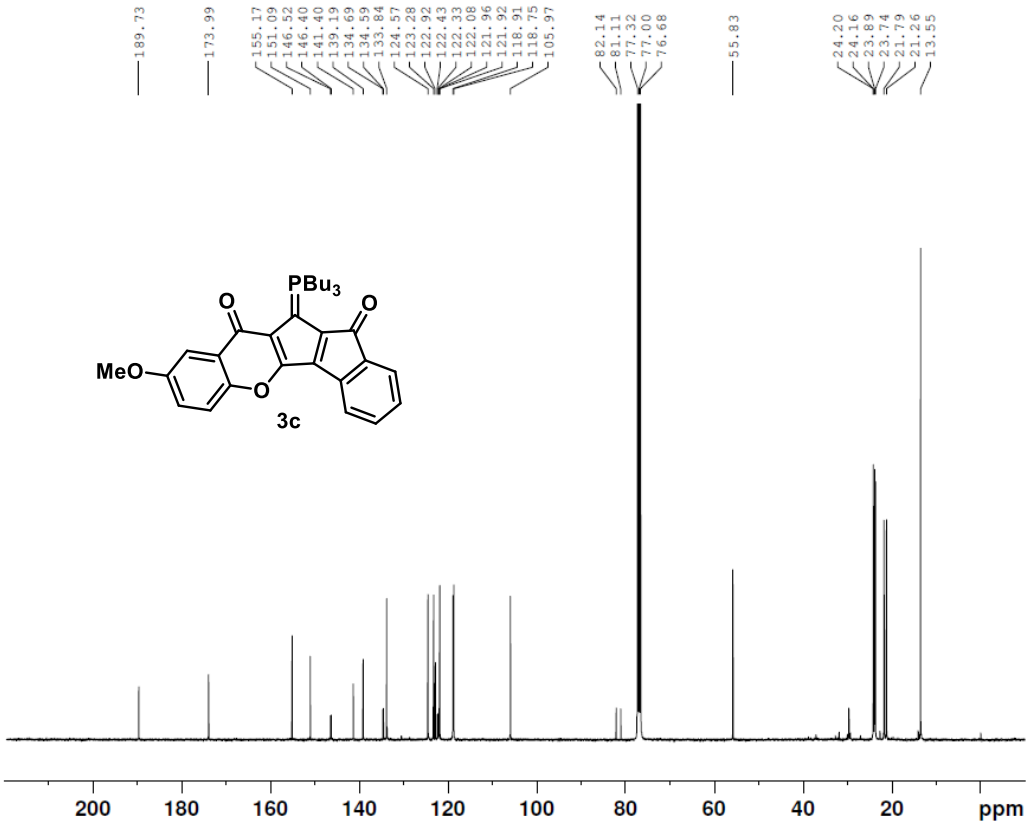

```
Current Data Parameters
NAME         DP-1169(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240309
Time               22.46
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH           7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG                 78.51
DW               69.333 usec
DE                10.06 usec
TE                298.8 K
D1           2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                 1H
P1                15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300088 MHz
WDW                  EM
SSB                   0
LB                    0 Hz
GB                    0
PC                 1.00
```

^{13}C NMR spectrum of compound **3c** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1169(3f)
EXPNO                  5
PROCNO                 1

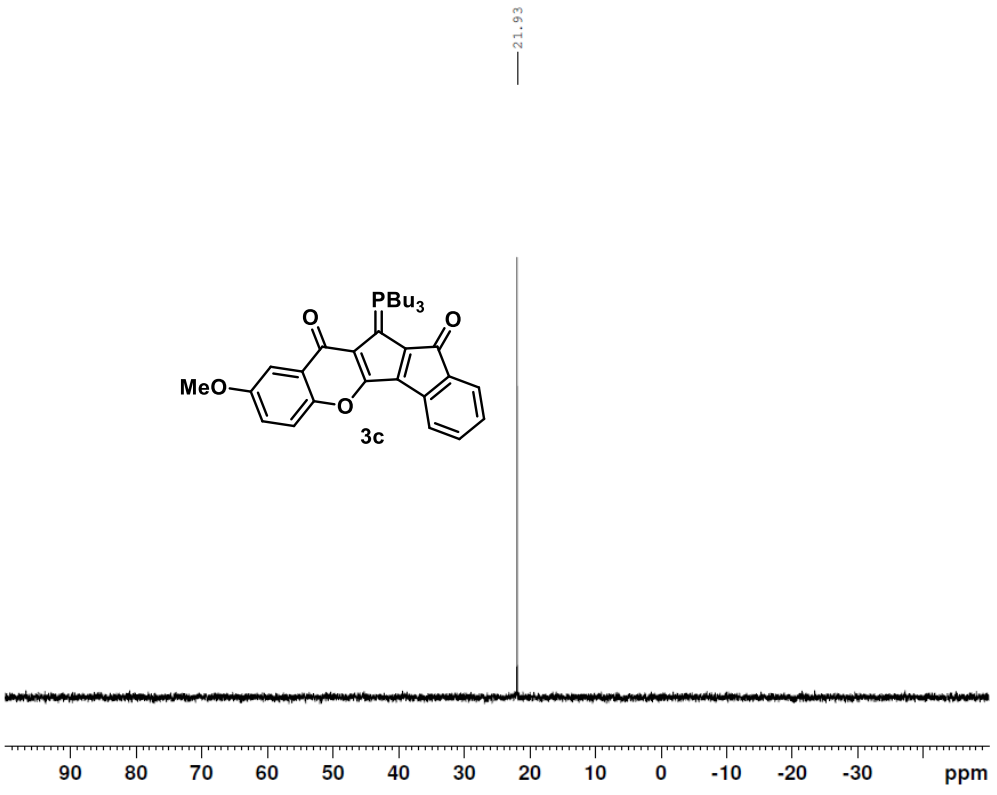
F2 - Acquisition Parameters
Date_           20240309
Time               22.48
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 16934
DS                     0
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                198.09
DW               20.800 usec
DE                 6.50 usec
TE                298.6 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127703 MHz
WDW                  EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.00
```

^{31}P NMR spectrum of compound **3c** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1169(3f)
EXPNO                  1
PROCNO                 1

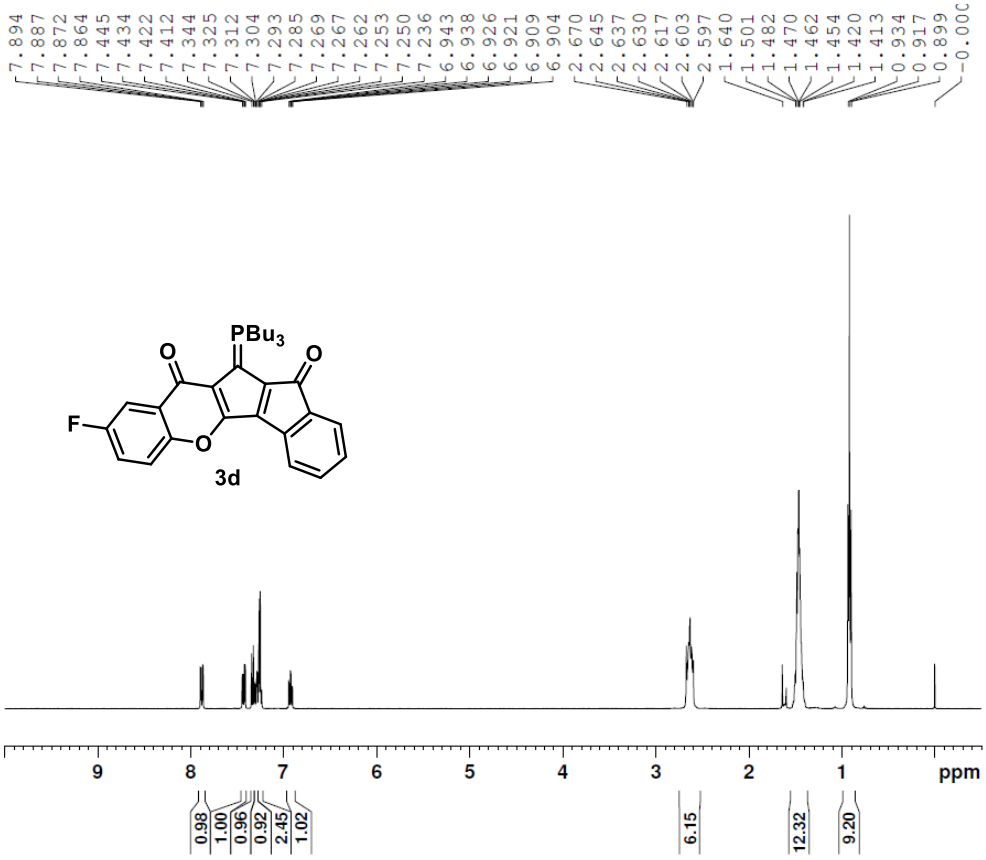
F2 - Acquisition Parameters
Date_           20240226
Time              21.12
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                65536
SOLVENT           CDCl3
NS                    7
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ             0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE               297.5 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1               31P
P1               15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2            90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                EM
SSB                 0
LB               2.00 Hz
GB                  0
PC               1.40
```

^{1}H NMR spectrum of compound **3d** ($CDCl_3$, 400 MHz)



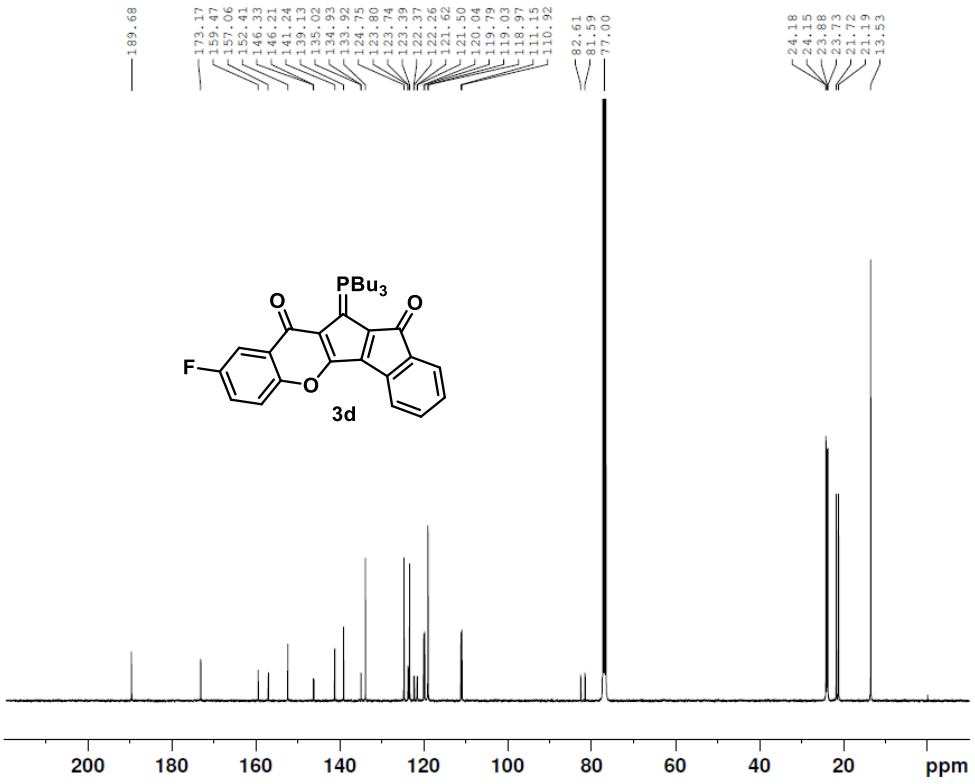

```
Current Data Parameters
NAME         DP-1184(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240308
Time              21.52
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7211.539 Hz
FIDRES         0.220079 Hz
AQ             2.2719147 sec
RG                89.08
DW               69.333 usec
DE                10.06 usec
TE               298.0 K
D1            2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1               1H
P1               15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                16384
SF          400.1300088 MHz
WDW                EM
SSB                 0
LB                  0 Hz
GB                  0
PC               1.00
```

^{13}C NMR spectrum of compound **3d** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-1184(3f)
EXPNO                   5
PROCNO                  1

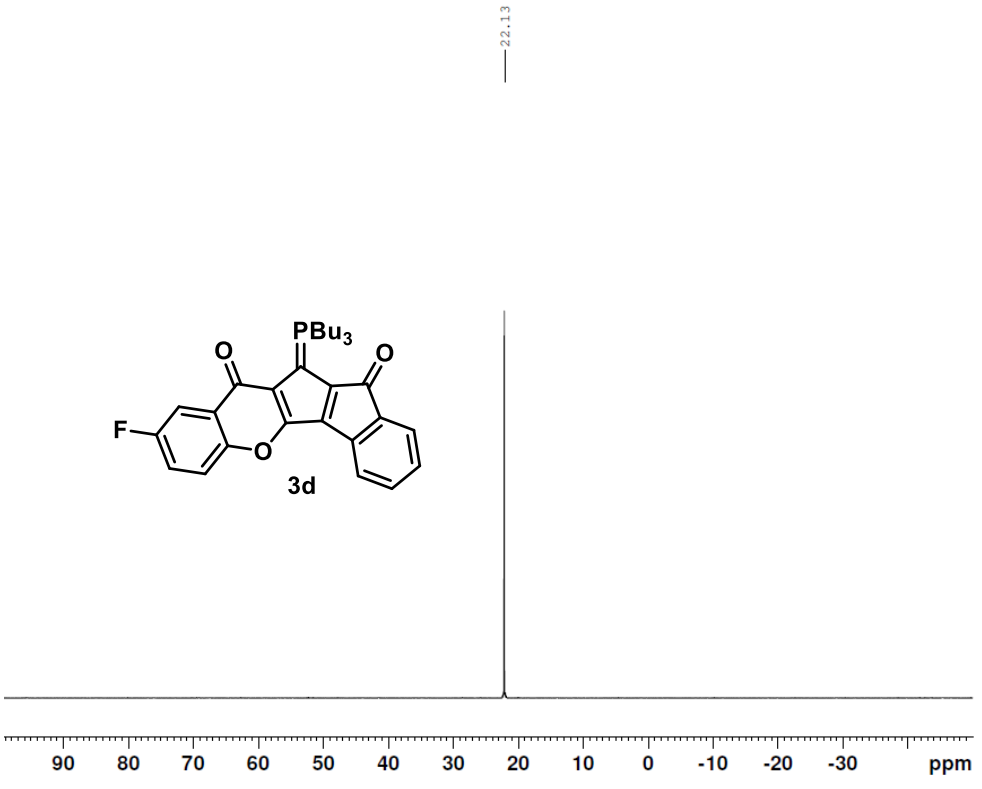
F2 - Acquisition Parameters
Date_           20240308
Time               21.54
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                14262
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                6.50 usec
TE                298.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                32768
SF          100.6127698 MHz
WDW                  EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.00
```

^{31}P NMR spectrum of compound **3d** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME          DP-1184(3f)
EXPNO                   6
PROCNO                  1

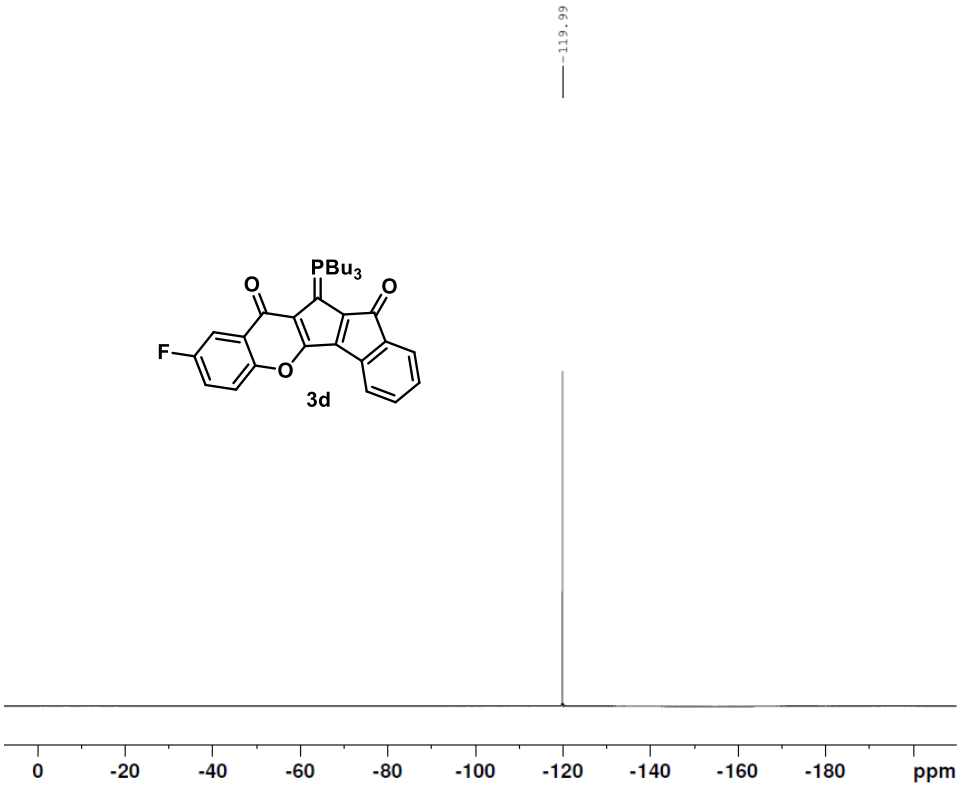
F2 - Acquisition Parameters
Date_           20240311
Time               11.24
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.5 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                  EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.40
```

^{19}F NMR spectrum of compound **3d** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME         DP-1184(3f)
EXPNO                  8
PROCNO                 1

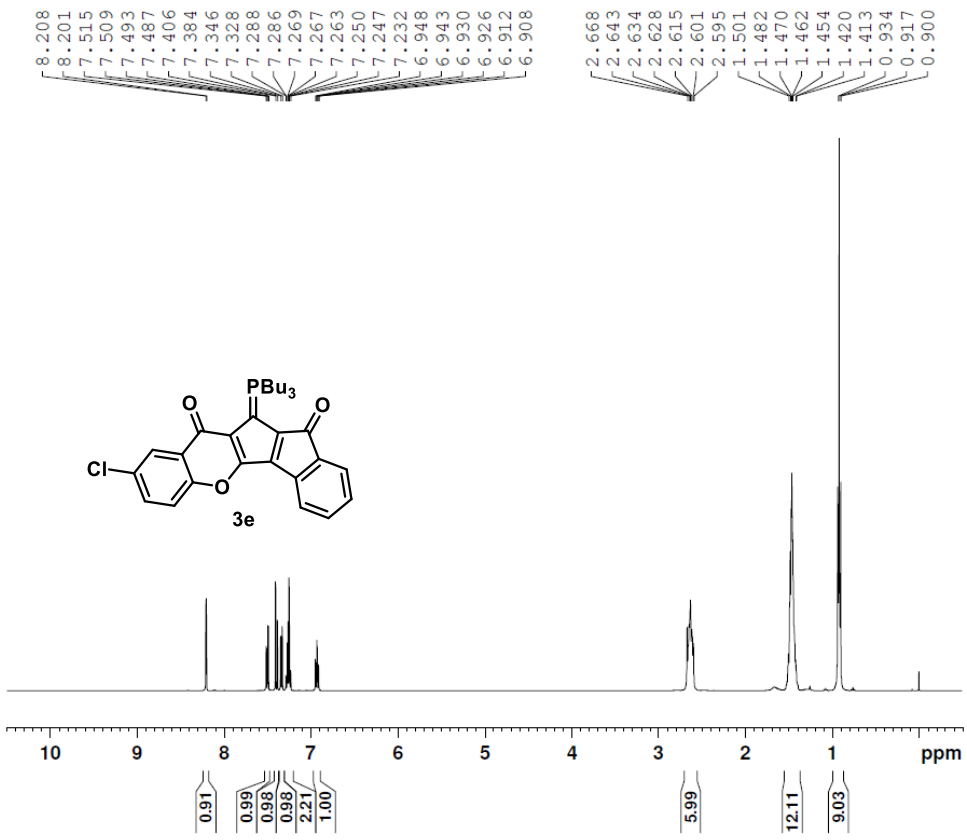
F2 - Acquisition Parameters
Date_           20240311
Time               11.27
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zgig
TD                131072
SOLVENT             CDCl3
NS                     16
DS                      0
SWH            89285.711 Hz
FIDRES         0.681196 Hz
AQ             0.7340032 sec
RG                198.09
DW                 5.600 usec
DE                 6.50 usec
TE                298.4 K
D1           1.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         376.4607168 MHz
NUC1                 19F
P1                15.00 usec
PLW1         16.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W

F2 - Processing parameters
SI                 65536
SF           376.4983662 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **3e** ($CDCl_3$, 400 MHz)



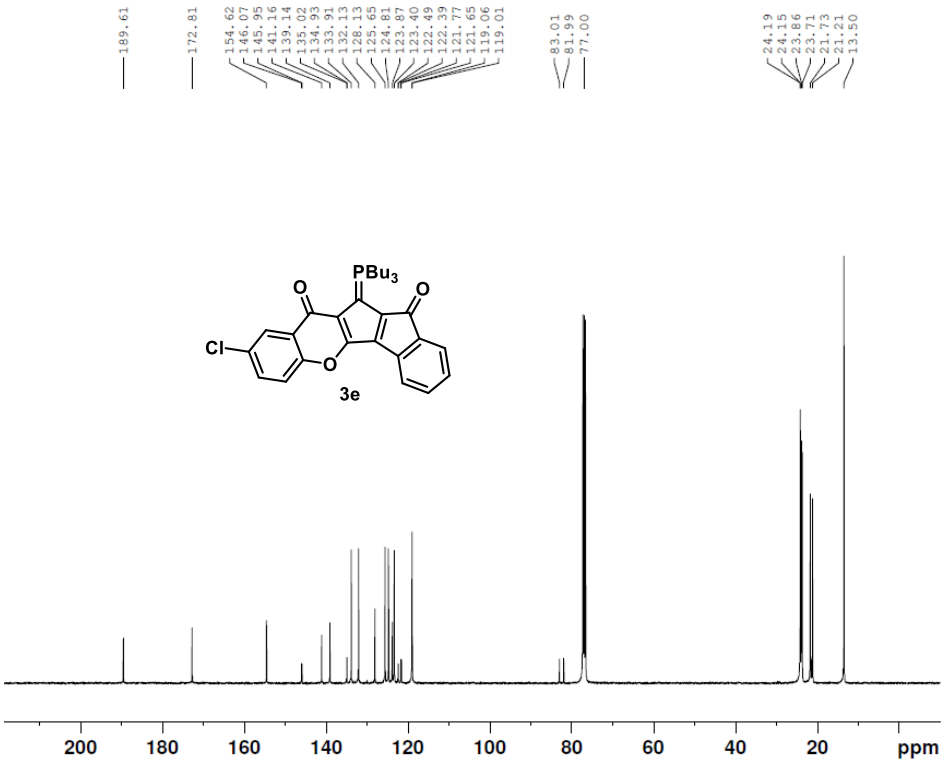

```
Current Data Parameters
NAME         DP-1150(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240217
Time               18.37
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT             CDCl3
NS                     16
DS                      0
SWH             7211.539 Hz
FIDRES         0.220079 Hz
AQ             2.2719147 sec
RG                 71.42
DW                 69.333 usec
DE                 10.06 usec
TE                298.2 K
D1           2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                 1H
P1                15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300084 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3e** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1150(3f)
EXPNO                  5
PROCNO                 1

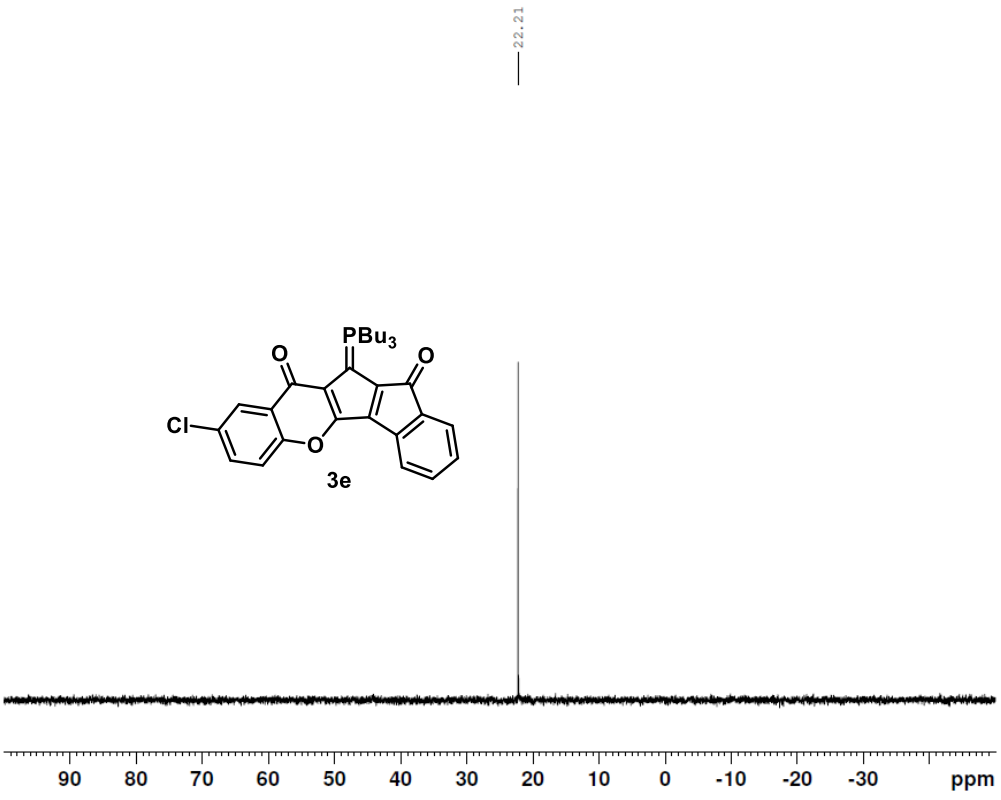
F2 - Acquisition Parameters
Date_           20240219
Time               22.13
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                32768
SOLVENT           CDCl3
NS                14958
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW              20.800 usec
DE                6.50 usec
TE               299.1 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                 13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127702 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3e** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1150(3f)
EXPNO                  1
PROCNO                 1

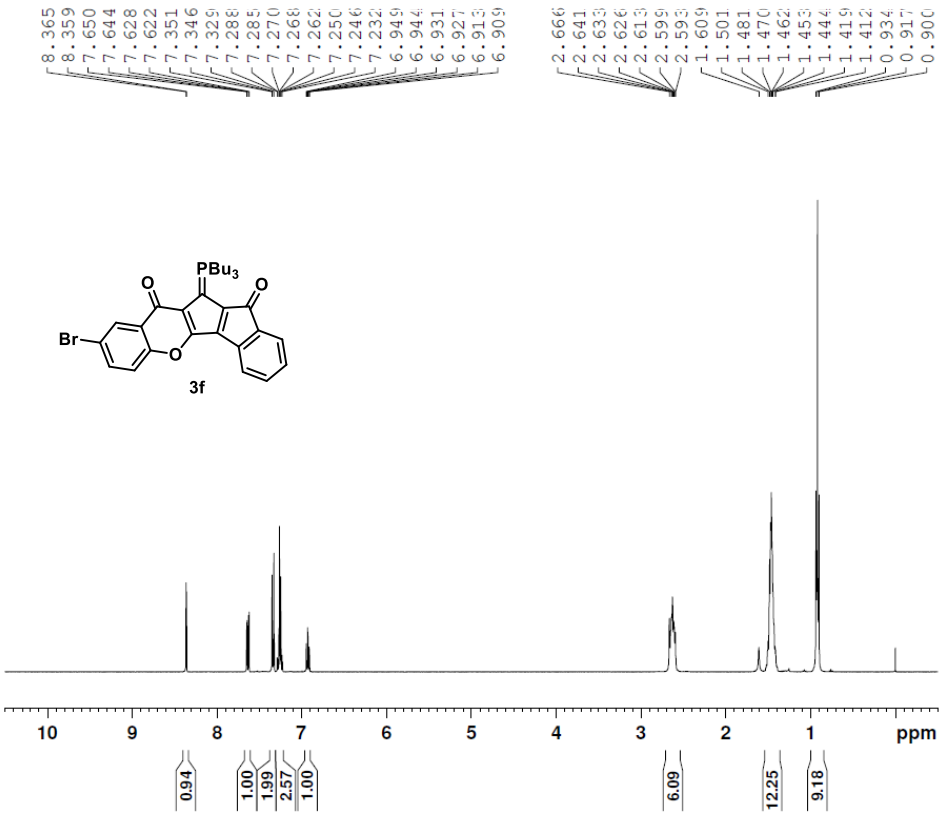
F2 - Acquisition Parameters
Date_           20240311
Time               11.15
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ             0.6684672 sec
RG                198.09
DW              10.200 usec
DE                6.50 usec
TE               298.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         161.9836917 MHz
NUC1                 31P
P1                15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.40
```

^{1}H NMR spectrum of compound **3f** ($CDCl_3$, 400 MHz)



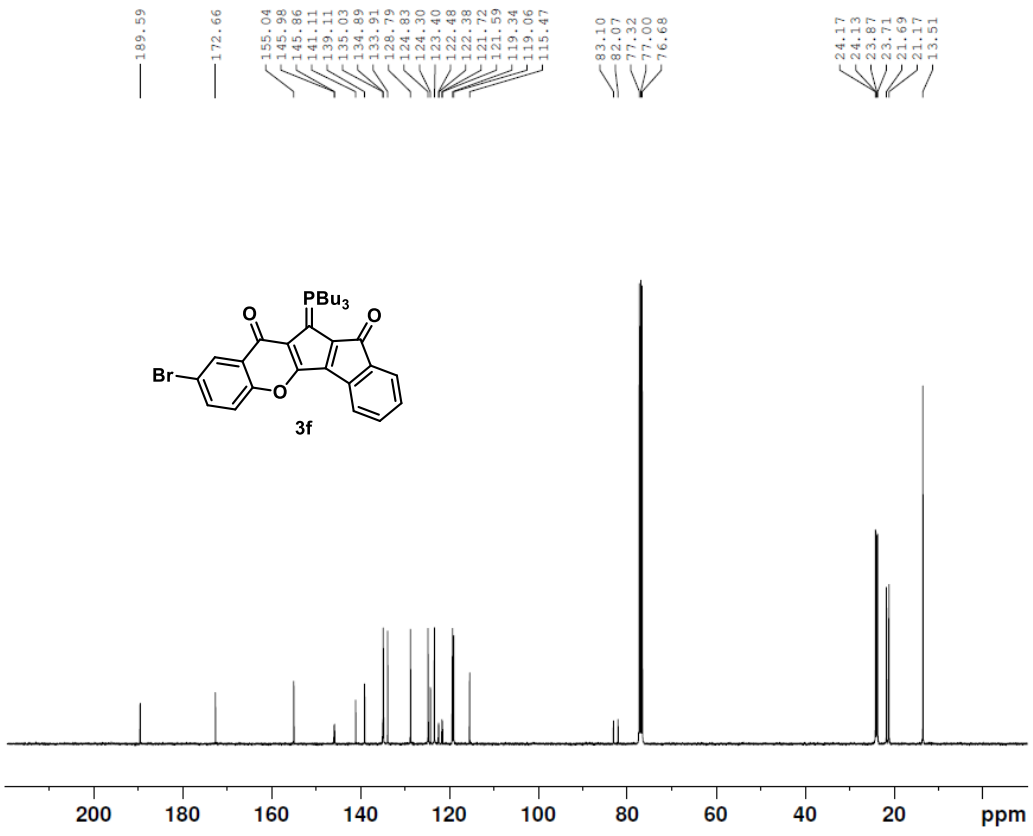

```
Current Data Parameters
NAME          DP-913(3f)
EXPNO                 15
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240222
Time               14.35
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                  4.01
DW                69.333 usec
DE                10.06 usec
TE                298.3 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300089 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3f** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-913(3f)
EXPNO                 14
PROCNO                 1

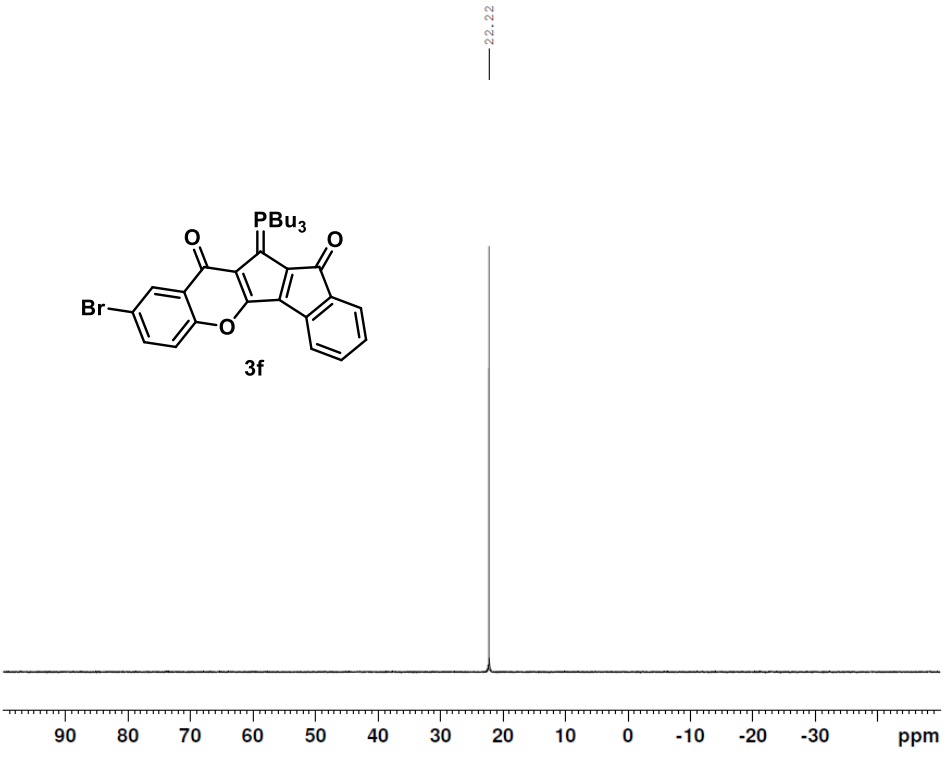
F2 - Acquisition Parameters
Date_           20230924
Time               14.52
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  2744
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.5 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127716 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3f** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME          DP-913(3f)
EXPNO                 16
PROCNO                 1

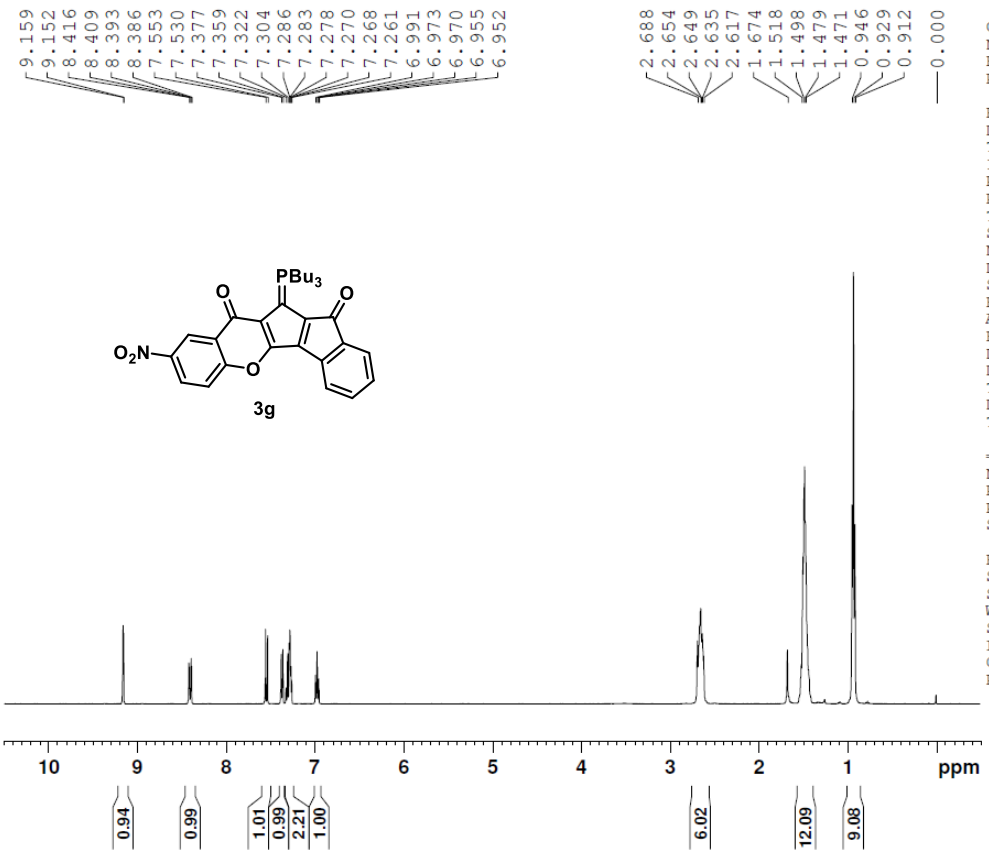
F2 - Acquisition Parameters
Date_           20240222
Time               14.34
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                65536
SOLVENT           CDCl3
NS                    9
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ             0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.3 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.40
```

^{1}H NMR spectrum of compound **3g** ($CDCl_3$, 400 MHz)



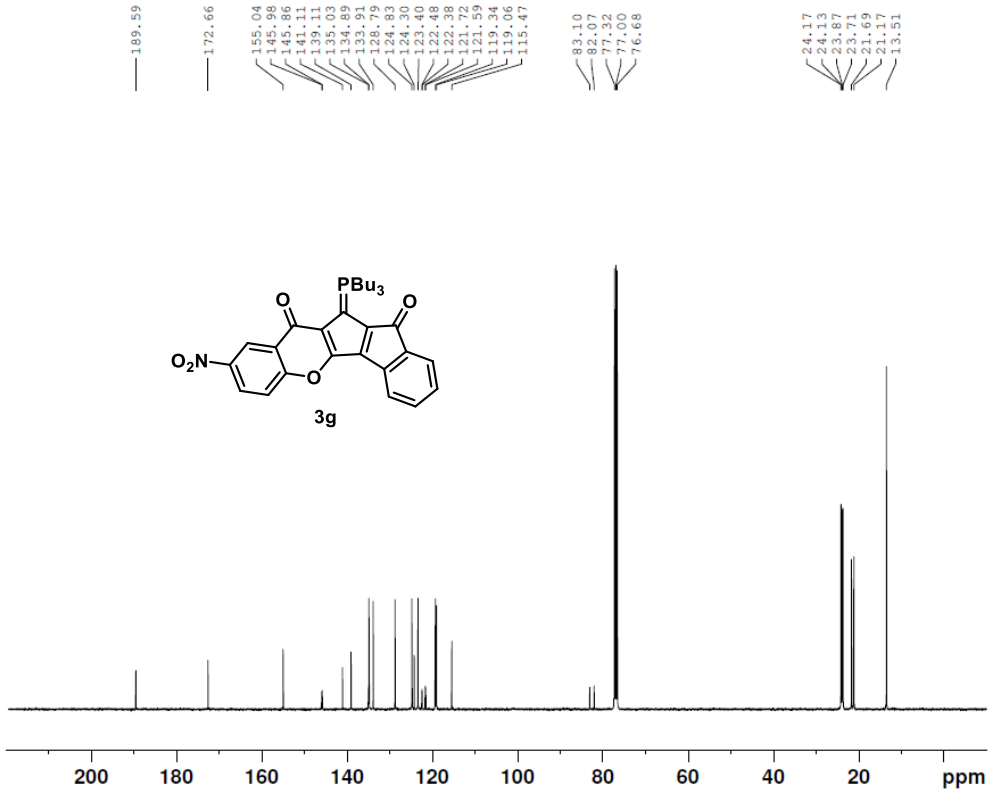

```
Current Data Parameters
NAME                DP-775
EXPNO                    2
PROCNO                   1

F2 - Acquisition Parameters
Date_            20240306
Time                22.02
INSTRUM             spect
PROBHD    5 mm BBO BB-1H
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                     16
DS                      0
SWH             7246.377 Hz
FIDRES          0.221142 Hz
AQ              2.2609921 sec
RG                    114
DW                69.000 usec
DE                 6.50 usec
TE                 299.0 K
D1             2.00000000 sec
TD0                     1

======== CHANNEL f1 ========
NUC1                   1H
P1                 15.00 usec
PL1                11.10 dB
SFO1          400.1324008 MHz

F2 - Processing parameters
SI                  16384
SF            400.1300057 MHz
WDW                    EM
SSB                     0
LB                      0 Hz
GB                      0
PC                   1.00
```

^{13}C NMR spectrum of compound **3g** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-913(3f)
EXPNO                 14
PROCNO                 1

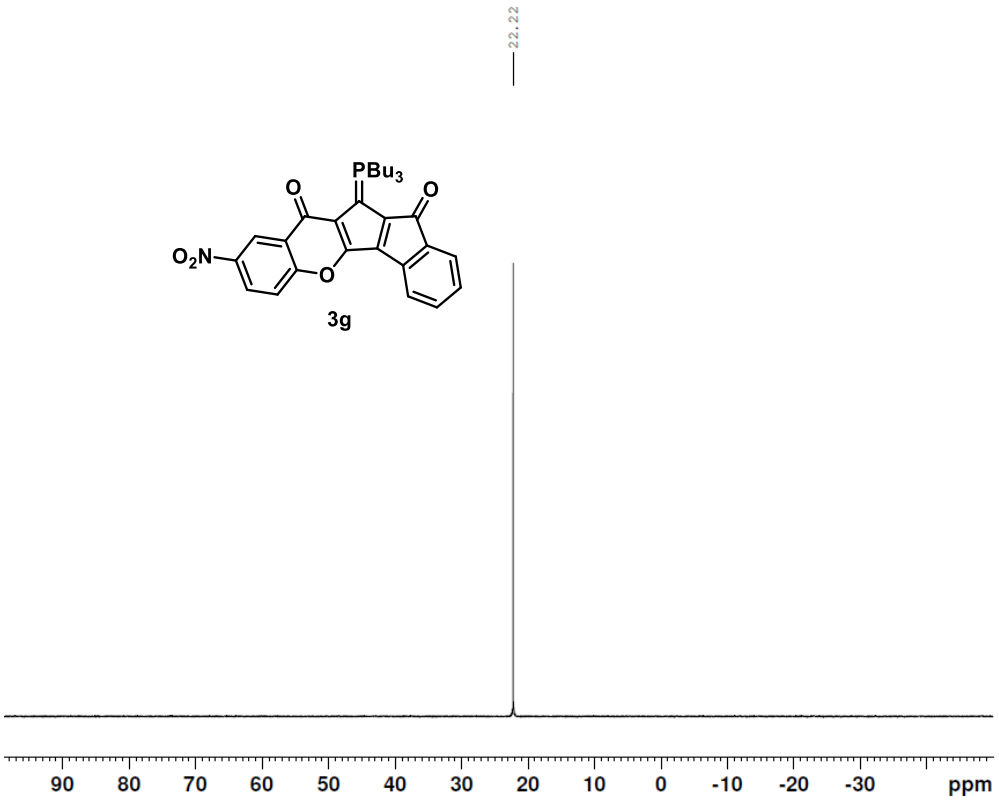
F2 - Acquisition Parameters
Date_           20230924
Time               14.52
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                 2744
DS                    0
SWH           24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                6.50 usec
TE                298.5 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          100.6127716 MHz
WDW                EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.00
```

^{31}P NMR spectrum of compound **3g** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME          DP-913(3f)
EXPNO                 16
PROCNO                 1

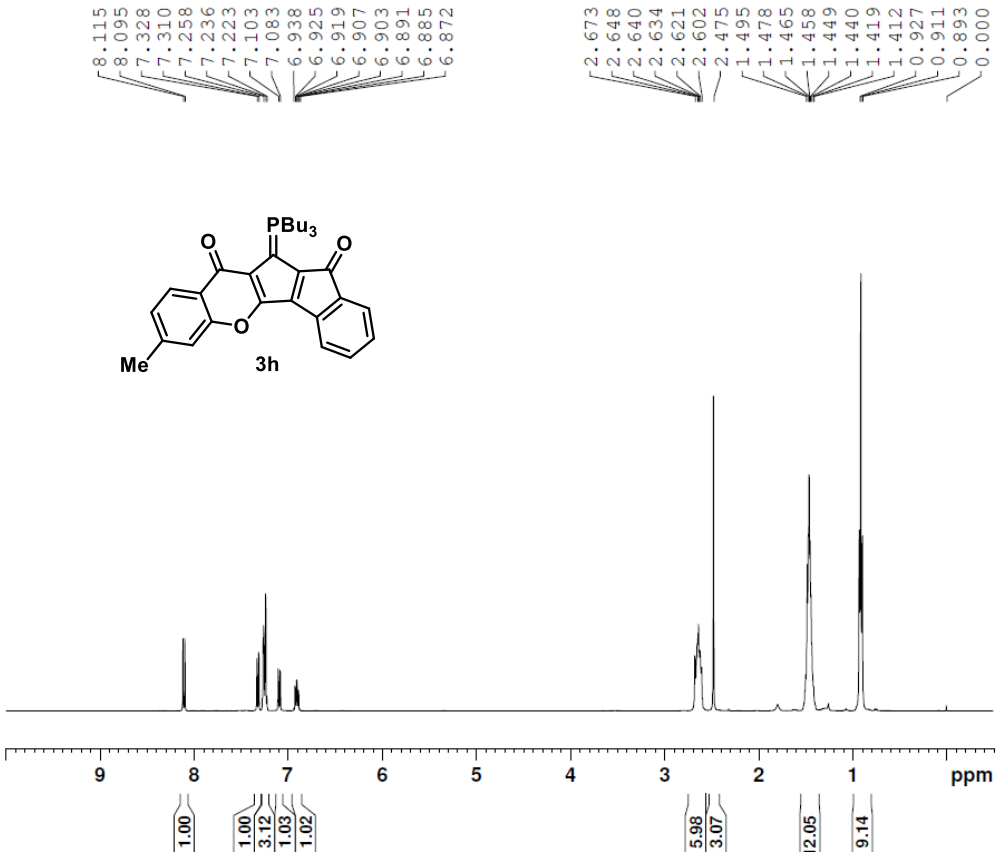
F2 - Acquisition Parameters
Date_           20240222
Time               14.34
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                    9
DS                    4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.3 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.40
```

^{1}H NMR spectrum of compound **3h** ($CDCl_3$, 400 MHz)



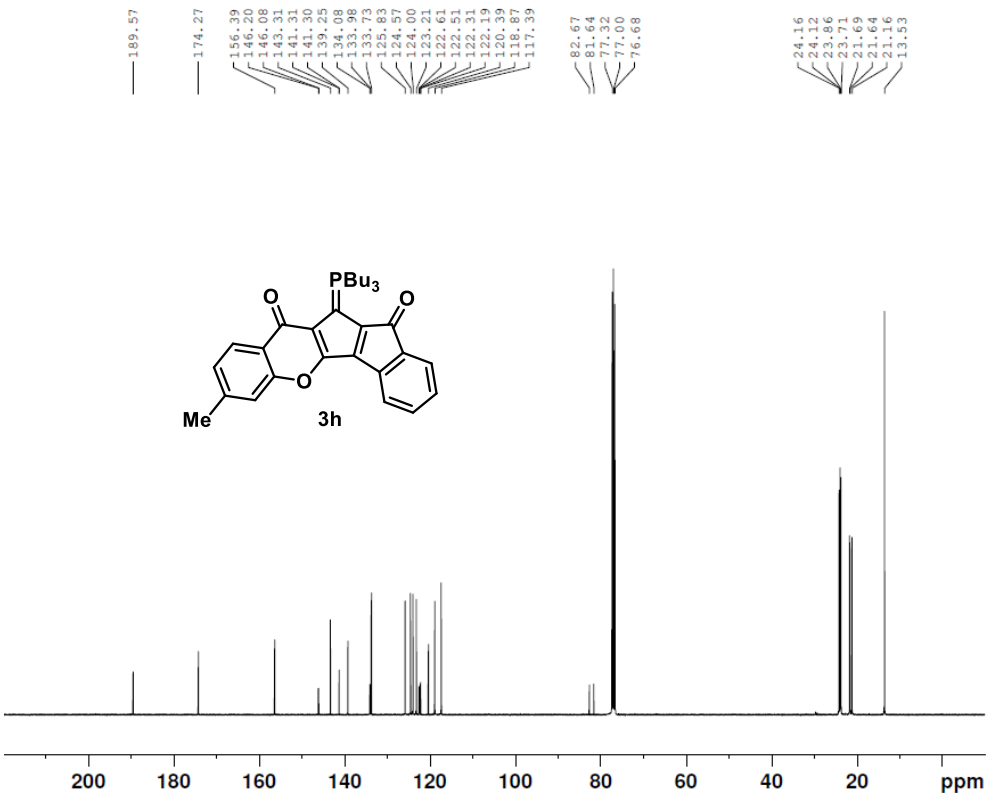

```
Current Data Parameters
NAME                  DP-1219
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_               20240415
Time                   21.56
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                       16
DS                        0
SWH                7246.377 Hz
FIDRES             0.221142 Hz
AQ                 2.2609921 sec
RG                       57
DW                    69.000 usec
DE                     6.50 usec
TE                    295.9 K
D1                 2.00000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                       1H
P1                      15.00 usec
PL1                     11.10 dB
SFO1             400.1324008 MHz

F2 - Processing parameters
SI                        16384
SF                 400.1300079 MHz
WDW                          EM
SSB                           0
LB                         0 Hz
GB                            0
PC                         1.00
```

^{13}C NMR spectrum of compound **3h** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-1219
EXPNO                       2
PROCNO                      1

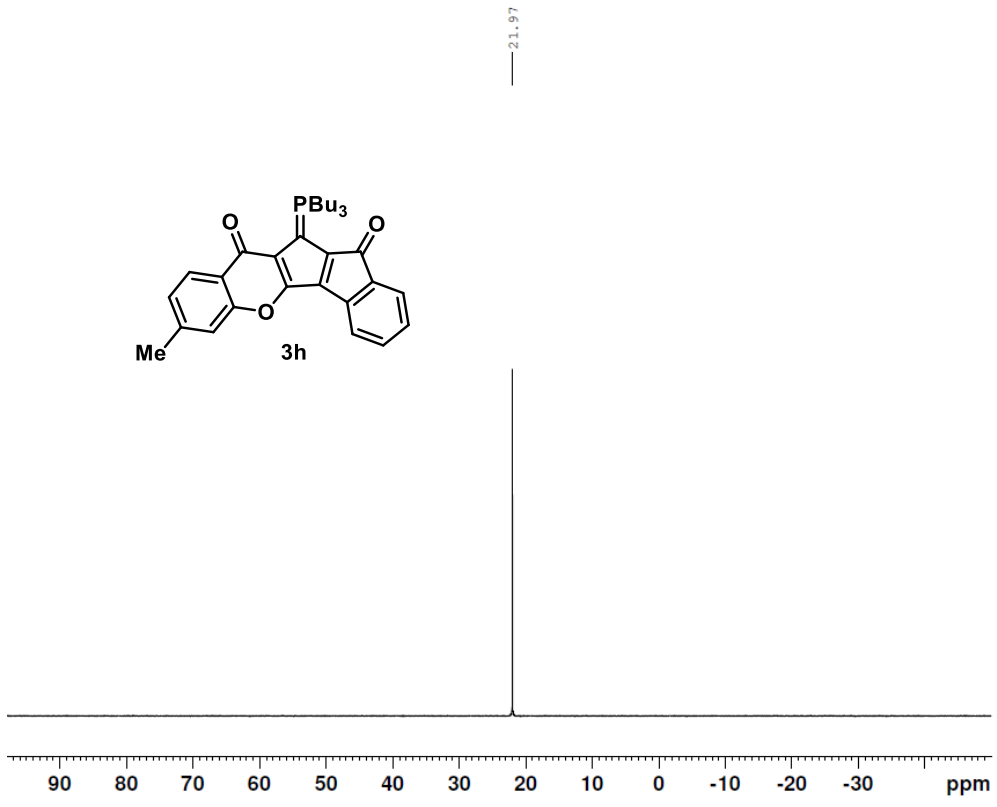
F2 - Acquisition Parameters
Date_               20240415
Time                   21.59
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG              zgpg30
TD                    32768
SOLVENT               CDCl3
NS                    15844
DS                        0
SWH               24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                     4096
DW                   20.800 usec
DE                     6.50 usec
TE                    296.1 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                      10.00 usec
PL1                      4.20 dB
SFO1             100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2             waltz16
NUC2                       1H
PCPD2                   90.00 usec
PL2                     10.20 dB
PL12                    26.00 dB
PL13                    29.00 dB
SFO2             400.1316005 MHz

F2 - Processing parameters
SI                        32768
SF                 100.6127738 MHz
WDW                          EM
SSB                           0
LB                         1.00 Hz
GB                            0
PC                         1.00
```

^{13}P NMR spectrum of compound **3h** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1255(3f)
EXPNO                  1
PROCNO                 1

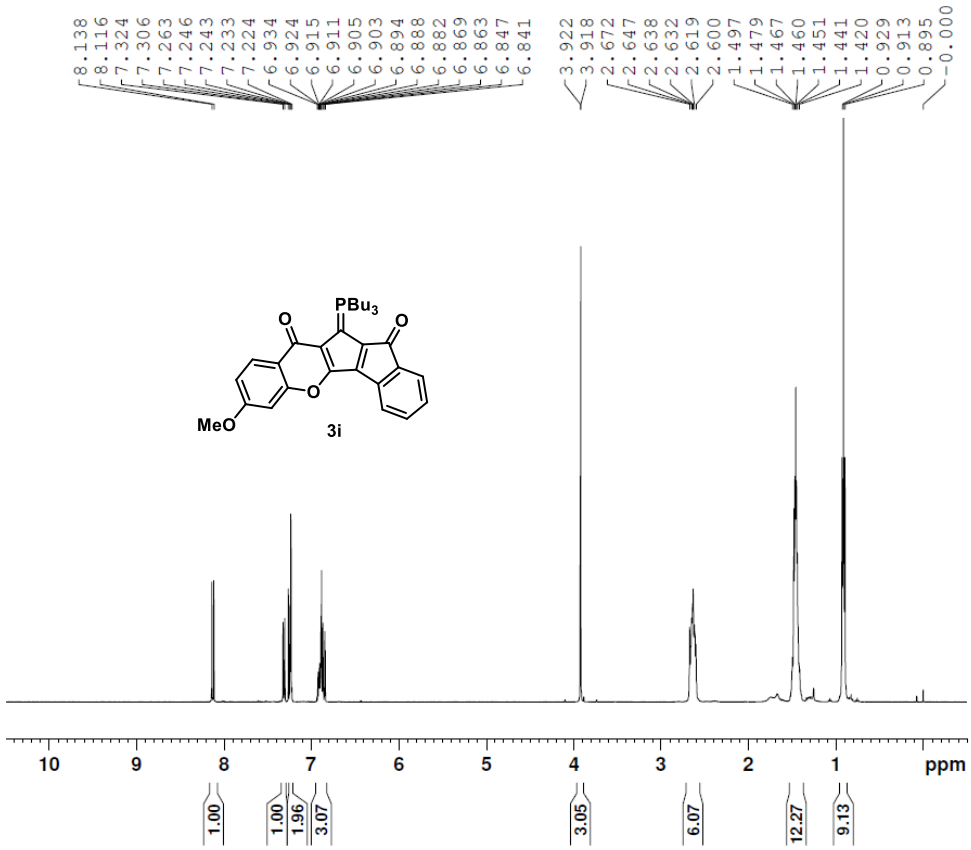
F2 - Acquisition Parameters
Date_           20240424
Time               15.30
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                65536
SOLVENT           CDCl3
NS                    8
DS                    4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.8 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                   EM
SSB                    0
LB                2.00 Hz
GB                     0
PC                1.40
```

^{1}H NMR spectrum of compound **3i** ($CDCl_3$, 400 MHz)



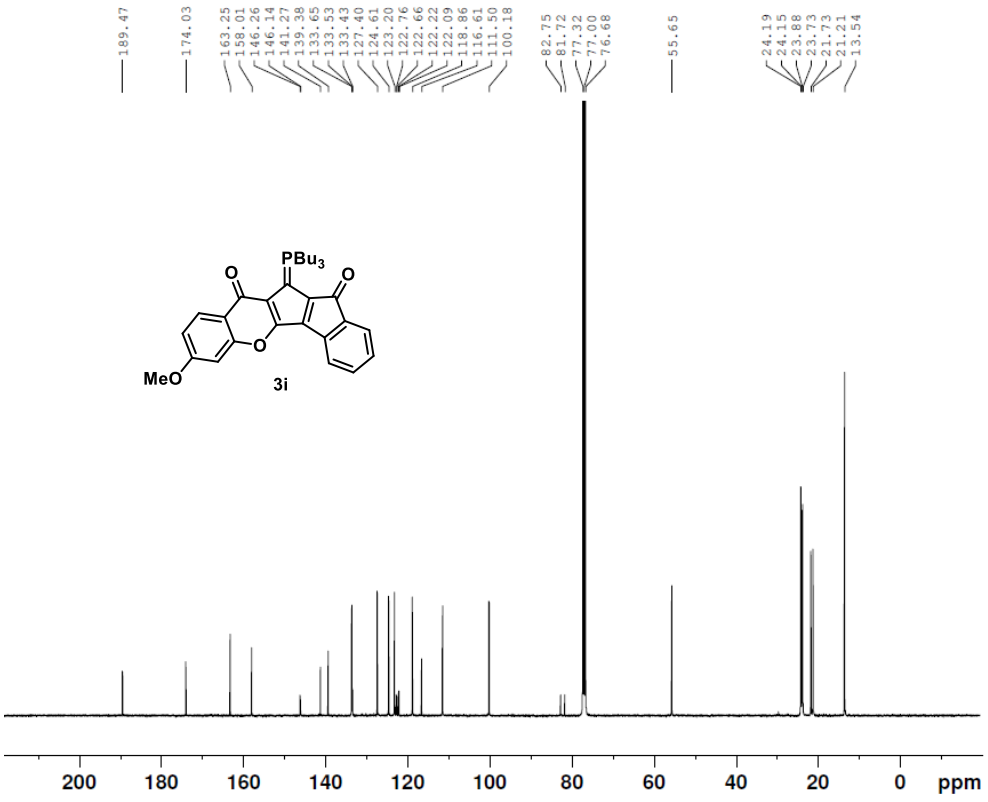

```
Current Data Parameters
NAME         DP-1296(3f)
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240604
Time               23.51
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH           7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG                89.08
DW               69.333 usec
DE                10.06 usec
TE                298.0 K
D1           2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                1H
P1                15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300085 MHz
WDW                   EM
SSB                    0
LB                 0 Hz
GB                     0
PC                1.00
```

^{13}C NMR spectrum of compound **3i** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1296(3f)
EXPNO                 13
PROCNO                 1

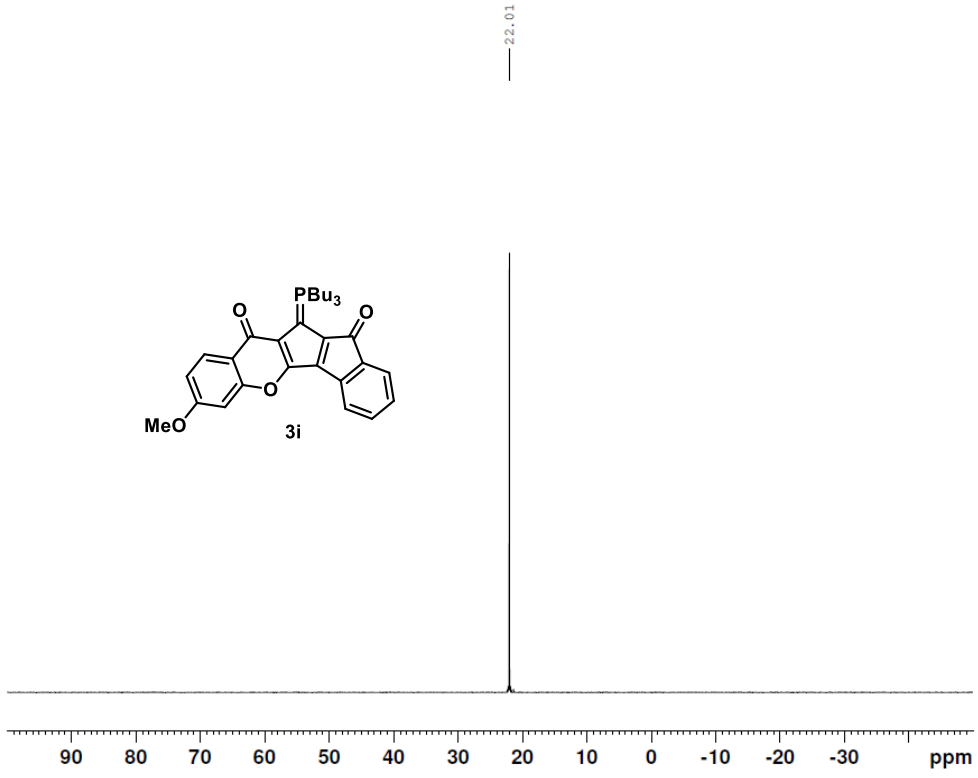
F2 - Acquisition Parameters
Date_           20240604
Time               23.55
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                12289
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                6.50 usec
TE                298.5 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                32768
SF          100.6127711 MHz
WDW                EM
SSB                 0
LB                2.00 Hz
GB                  0
PC                1.00
```

^{31}P NMR spectrum of compound **3i** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1296(3f)
EXPNO                 9
PROCNO                1

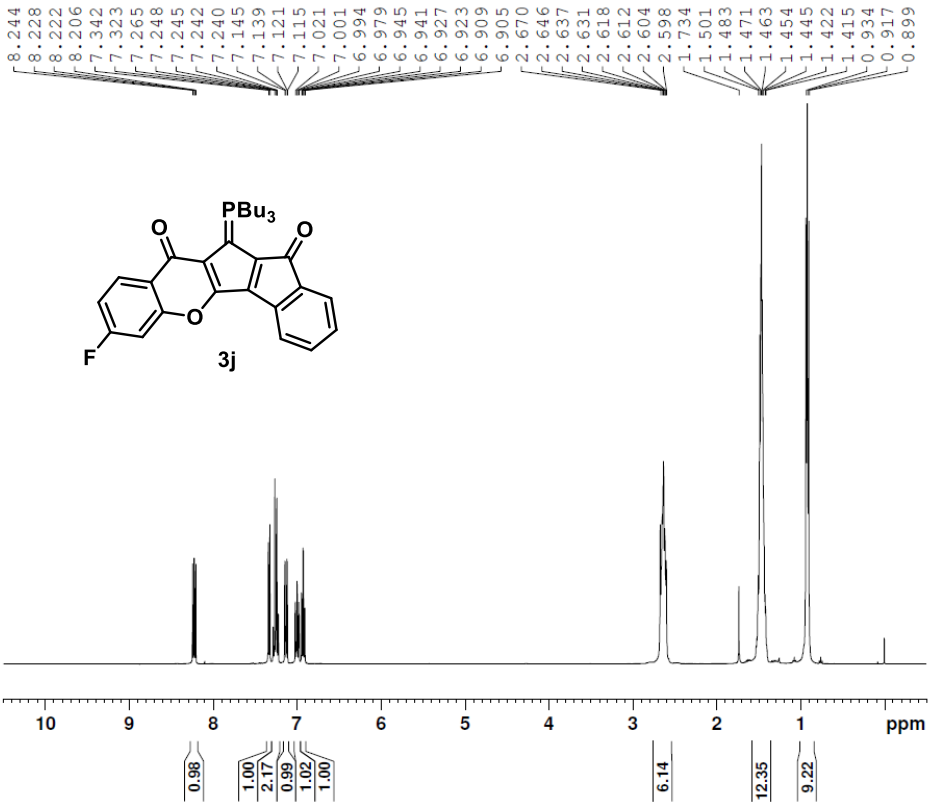
F2 - Acquisition Parameters
Date_           20240604
Time               18.16
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                    5
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                EM
SSB                 0
LB                2.00 Hz
GB                  0
PC                1.40
```

^{1}H NMR spectrum of compound **3j** ($CDCl_3$, 400 MHz)



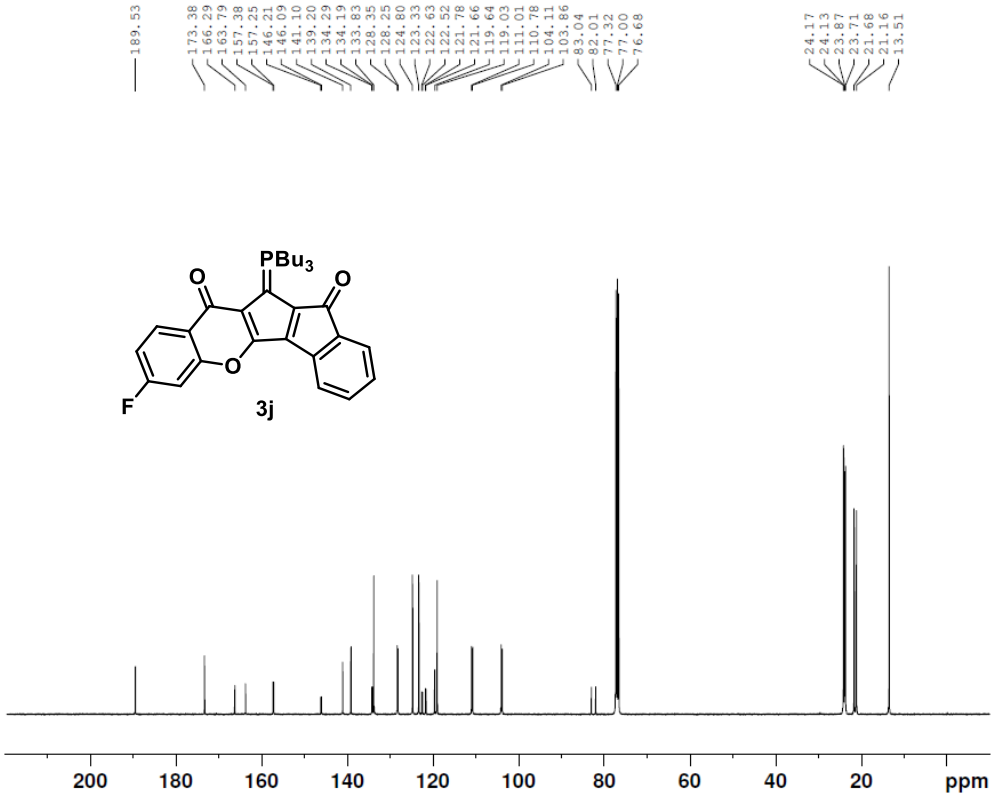

```
Current Data Parameters
NAME         DP-1170(3f)
EXPNO                  6
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240227
Time               22.03
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                 57.42
DW                69.333 usec
DE                10.06 usec
TE                297.9 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300077 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3j** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1170(3f)
EXPNO                  7
PROCNO                 1

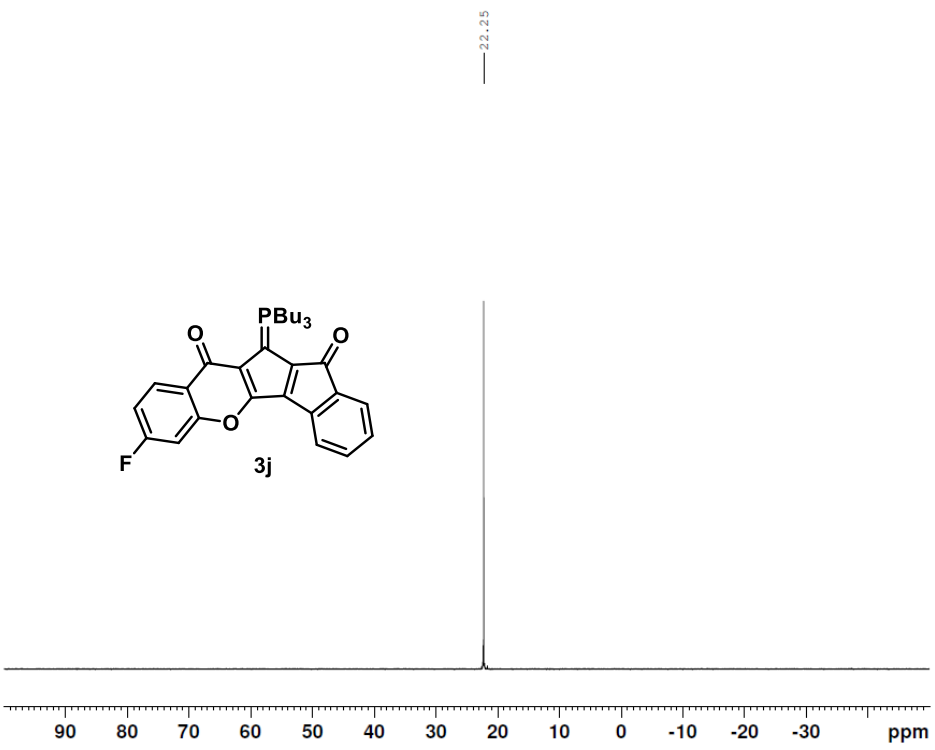
F2 - Acquisition Parameters
Date_           20240227
Time               22.05
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG            zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 14850
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.1 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127715 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3j** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1170(3f)
EXPNO                  1
PROCNO                 1

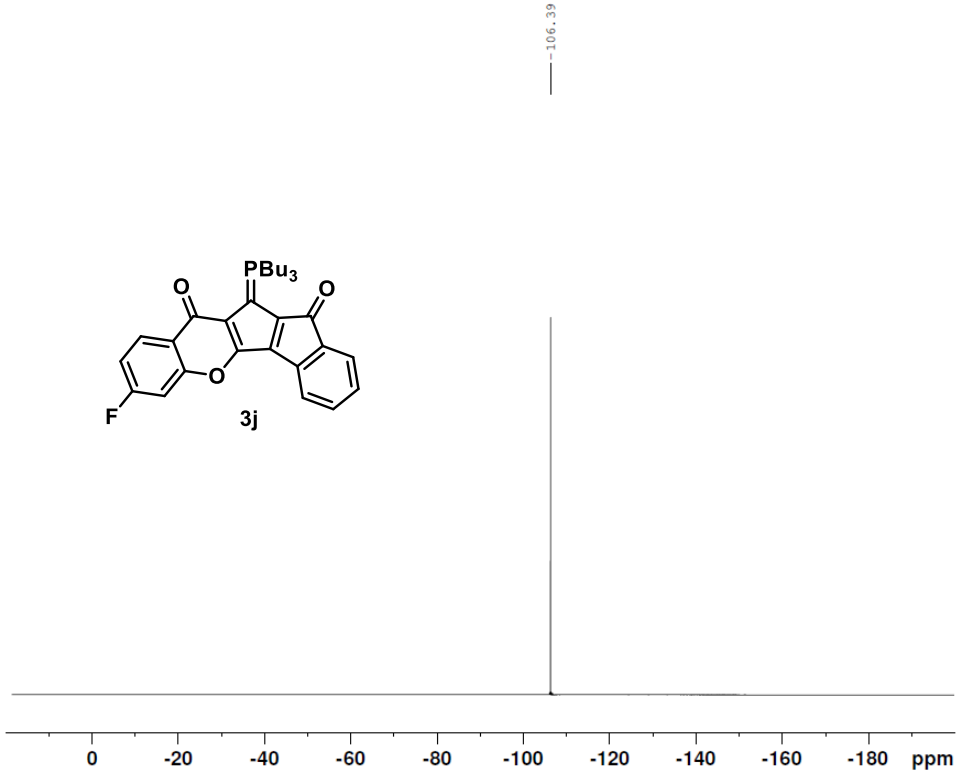
F2 - Acquisition Parameters
Date_           20240226
Time              21.17
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                    9
DS                    4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG              198.09
DW              10.200 usec
DE               6.50 usec
TE               297.6 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                   EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.40
```

^{19}F NMR spectrum of compound **3j** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME         DP-1170(3f)
EXPNO                  8
PROCNO                 1

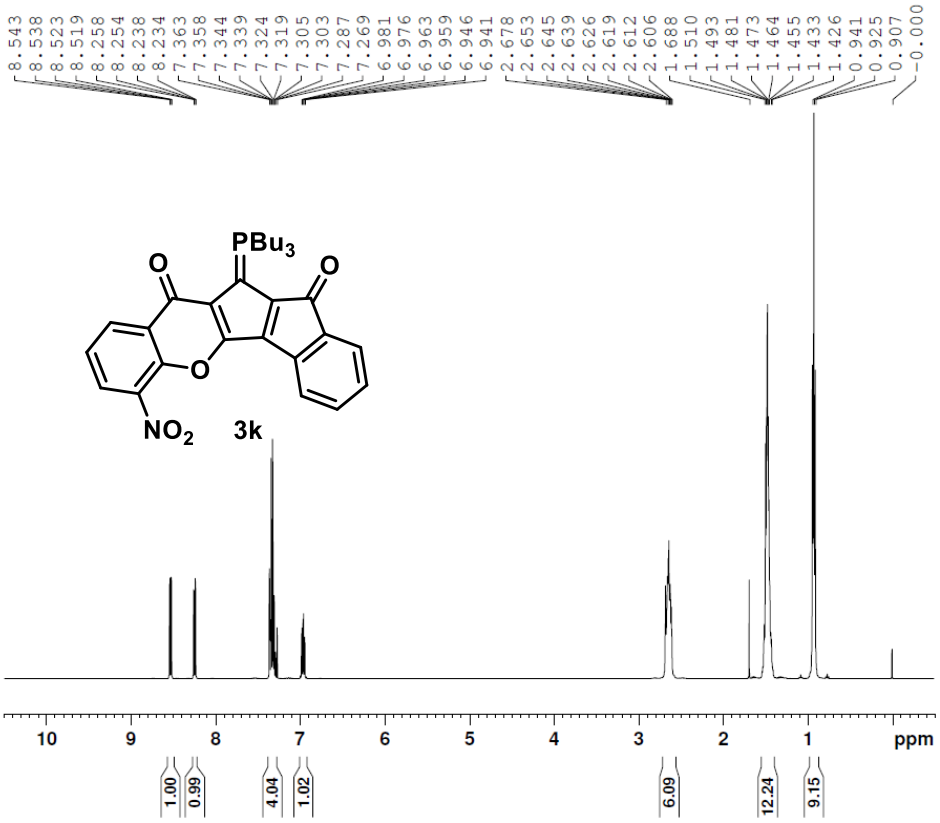
F2 - Acquisition Parameters
Date_           20240311
Time              11.31
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG             zg1g
TD                131072
SOLVENT           CDCl3
NS                   16
DS                    0
SWH           89285.711 Hz
FIDRES        0.681196 Hz
AQ            0.7340032 sec
RG              198.09
DW               5.600 usec
DE               6.50 usec
TE               298.3 K
D1           1.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        376.4607168 MHz
NUC1                19F
P1                15.00 usec
PLW1        16.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W

F2 - Processing parameters
SI                 65536
SF          376.4983662 MHz
WDW                   EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.00
```

^{1}H NMR spectrum of compound **3k** ($CDCl_3$, 400 MHz)



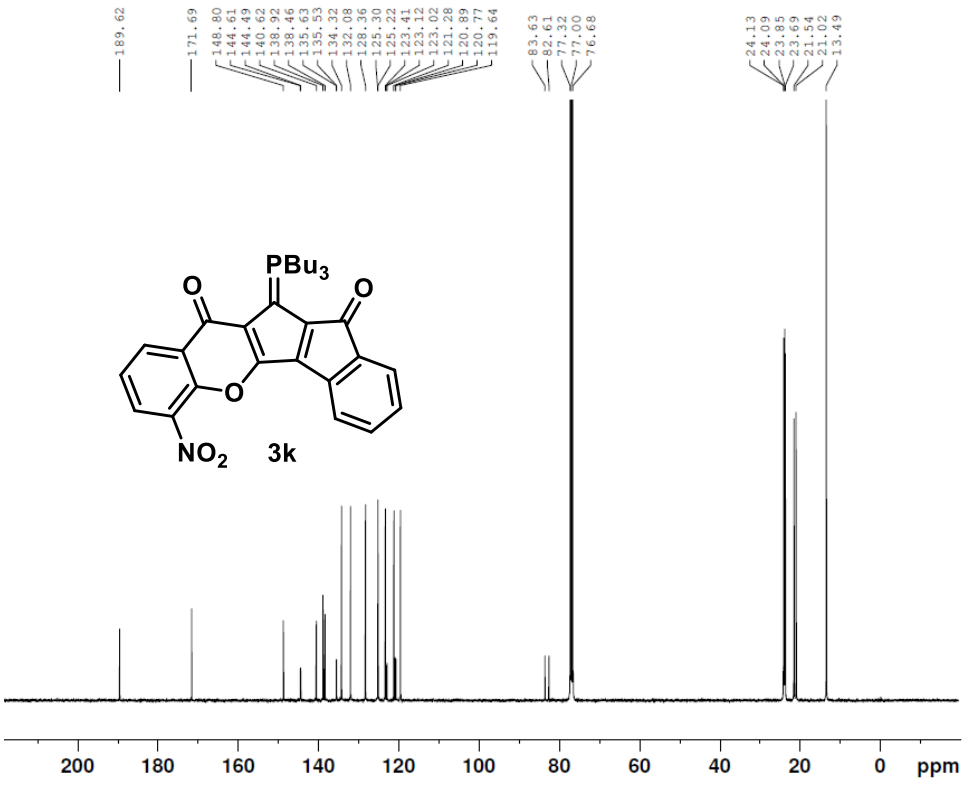

```
Current Data Parameters
NAME         DP-1182(3f)
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240309
Time               18.28
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 63.58
DW                69.333 usec
DE                10.06 usec
TE                298.1 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                  15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300058 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3k** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1182(3f)
EXPNO                 11
PROCNO                 1

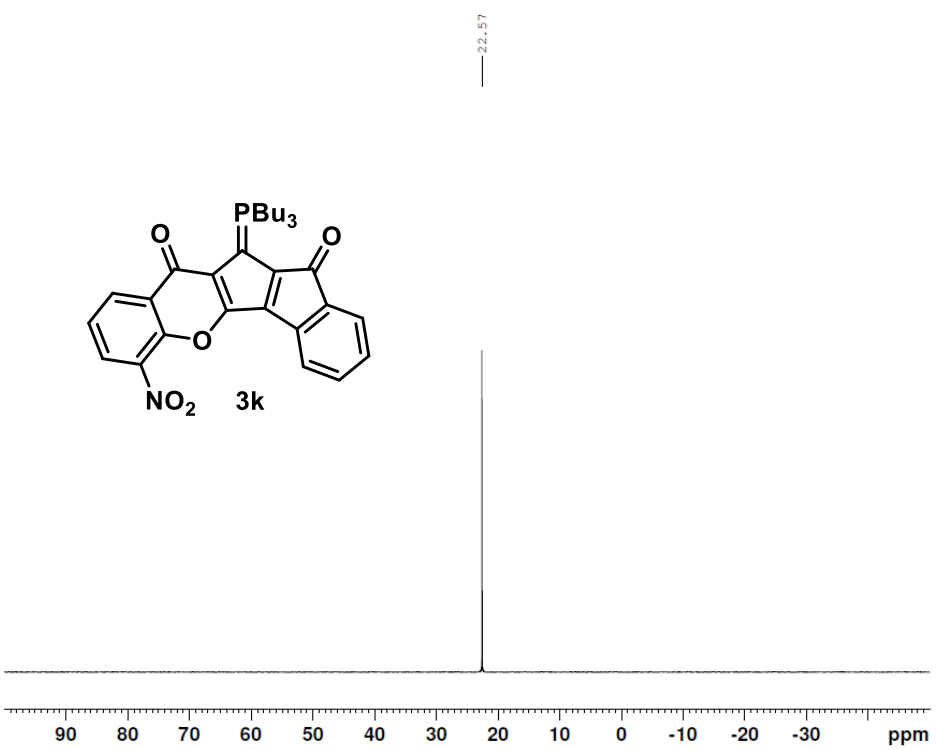
F2 - Acquisition Parameters
Date_           20240309
Time               18.31
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  5535
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                  10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2               90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF          100.6127718 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3k** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1182(3f)
EXPNO                  9
PROCNO                 1

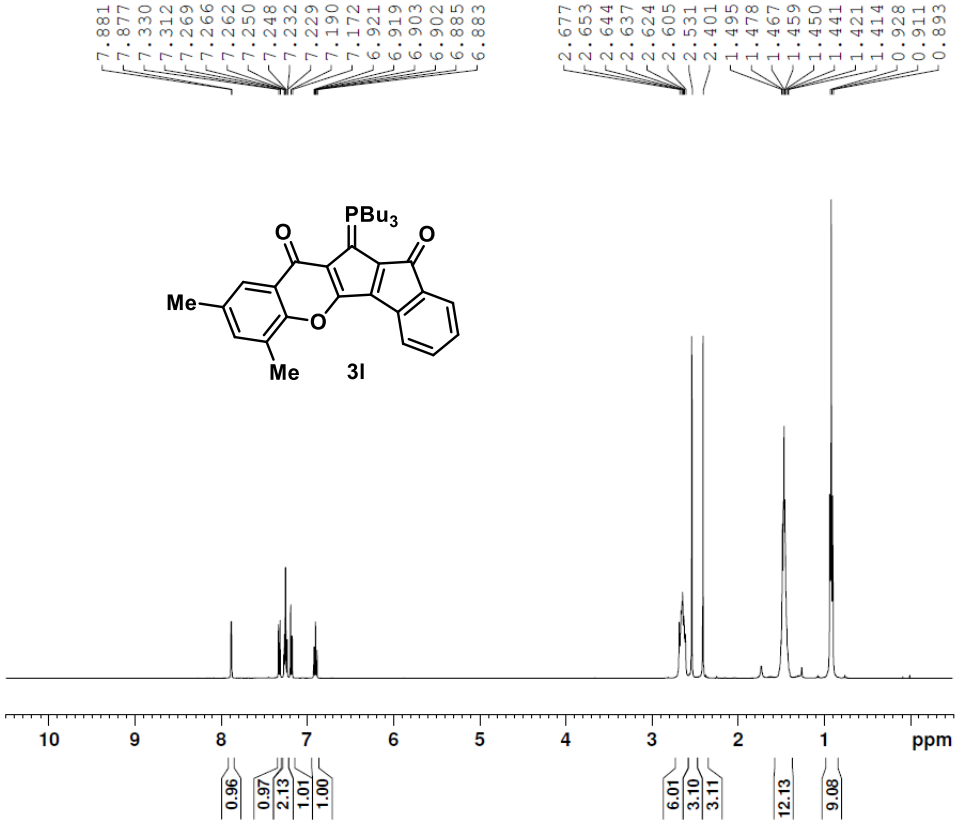
F2 - Acquisition Parameters
Date_           20240309
Time               14.30
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                 31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                  EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.40
```

^{1}H NMR spectrum of compound **3l** ($CDCl_3$, 400 MHz)



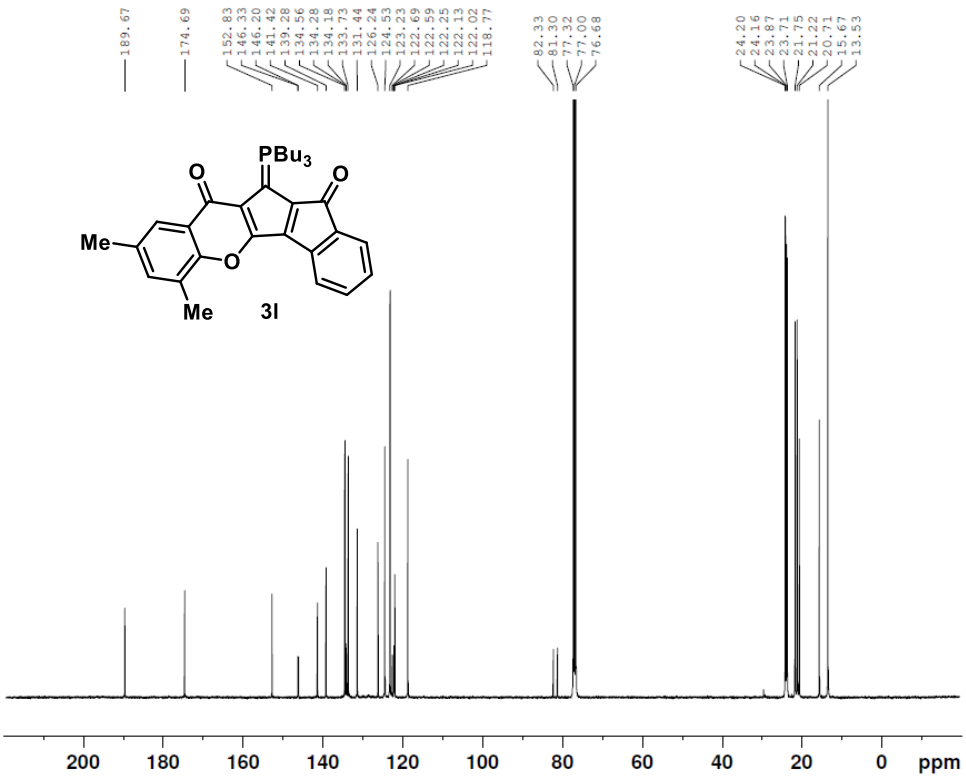

```
Current Data Parameters
NAME         DP-1211(3f)
EXPNO                 12
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240403
Time               22.07
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG                 51.8
DW               69.333 usec
DE                10.06 usec
TE                298.2 K
D1           2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                 1H
P1                15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                16384
SF          400.1300088 MHz
WDW                  EM
SSB                   0
LB                 0 Hz
GB                    0
PC                 1.00
```

^{13}C NMR spectrum of compound **3l** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1211(3f)
EXPNO                 13
PROCNO                 1

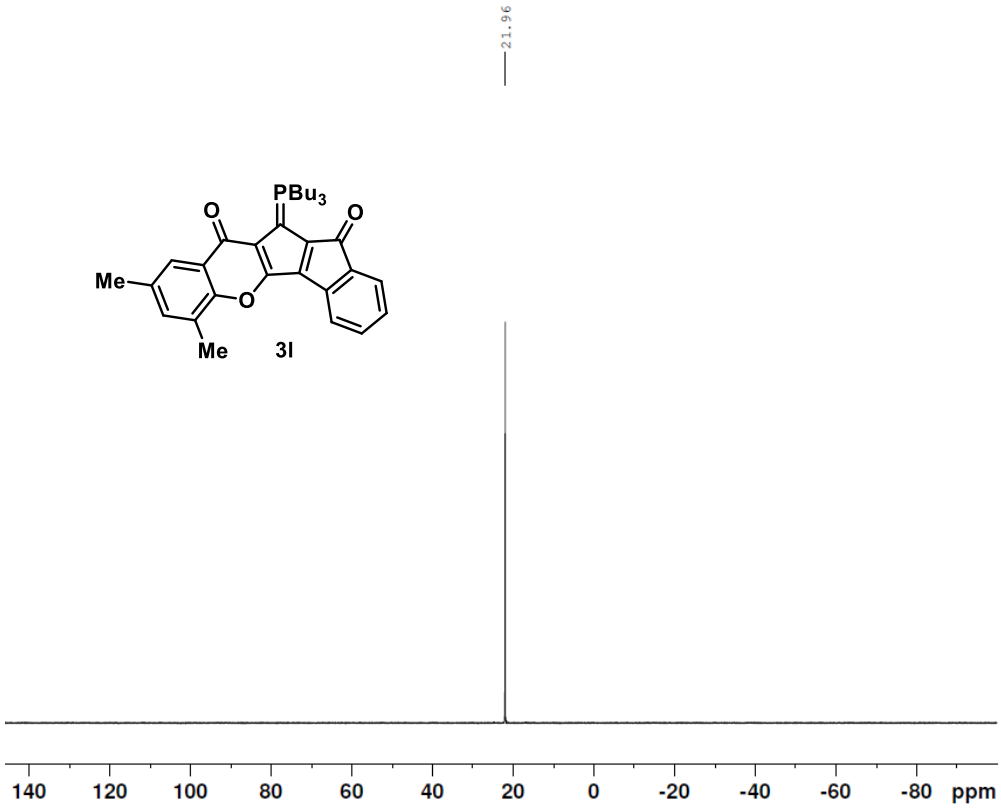
F2 - Acquisition Parameters
Date_           20240403
Time              22.09
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                13692
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                6.50 usec
TE                298.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          100.6127721 MHz
WDW                EM
SSB                   0
LB                2.00 Hz
GB                    0
PC                1.00
```

^{31}P NMR spectrum of compound **3l** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1211(3f)
EXPNO                 9
PROCNO                1

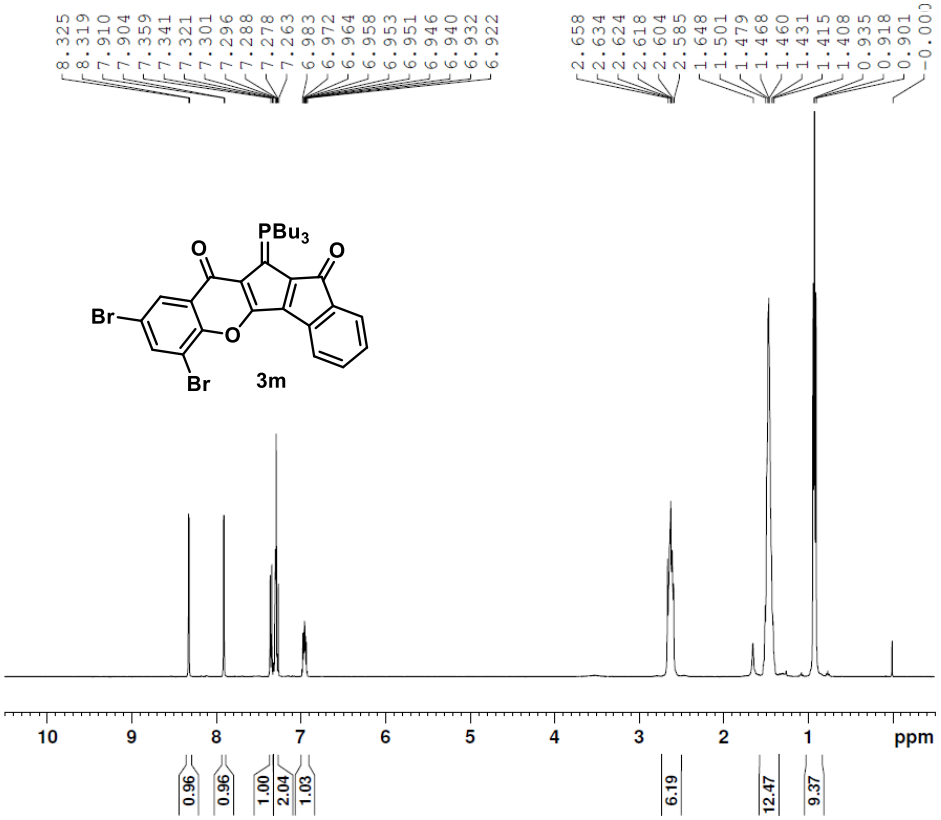
F2 - Acquisition Parameters
Date_           20240401
Time              20.07
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                    5
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.4 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                EM
SSB                   0
LB                2.00 Hz
GB                    0
PC                1.40
```

^{1}H NMR spectrum of compound **3m** ($CDCl_3$, 400 MHz)



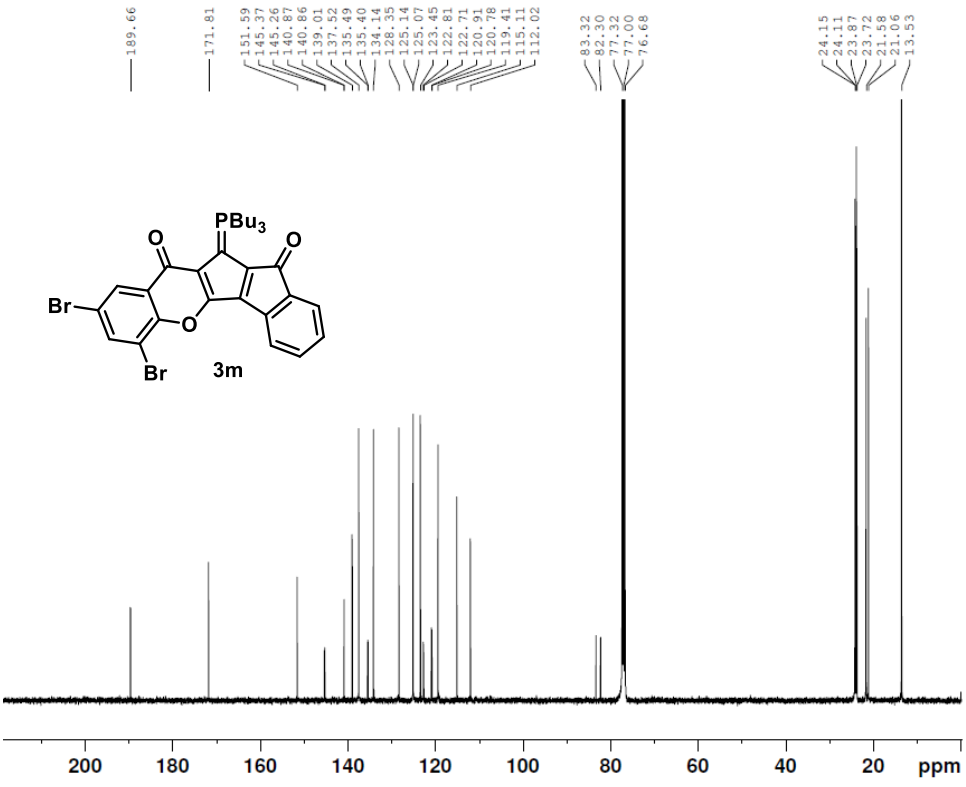

```
Current Data Parameters
NAME                  DP-1254
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_              20240428
Time                  22.13
INSTRUM               spect
PROBHD   5 mm BBO BB-1H
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                       16
DS                        0
SWH                7246.377 Hz
FIDRES            0.221142 Hz
AQ                2.2609921 sec
RG                      114
DW                   69.000 usec
DE                    6.50 usec
TE                   296.8 K
D1                2.00000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                      1H
P1                    15.00 usec
PL1                   11.10 dB
SFO1            400.1324008 MHz

F2 - Processing parameters
SI                     16384
SF                400.1300079 MHz
WDW                       EM
SSB                       0
LB                        0 Hz
GB                        0
PC                     1.00
```

^{13}C NMR spectrum of compound **3m** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-1254
EXPNO                       2
PROCNO                      1

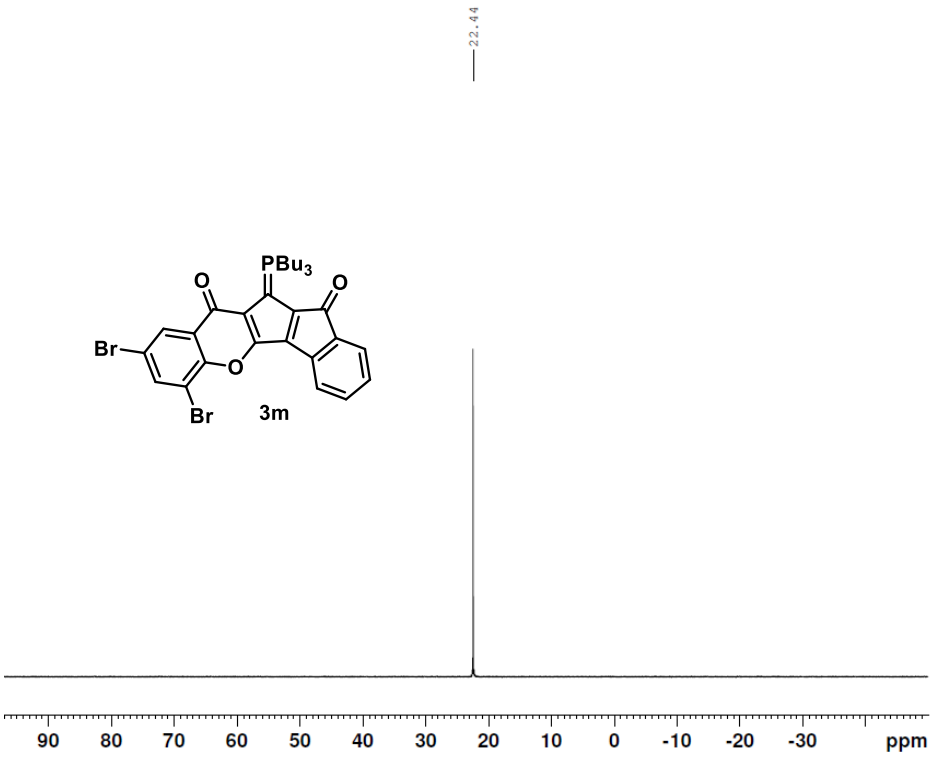
F2 - Acquisition Parameters
Date_              20240428
Time                  22.15
INSTRUM               spect
PROBHD   5 mm BBO BB-1H
PULPROG             zgpg30
TD                    32768
SOLVENT               CDCl3
NS                    16394
DS                        0
SWH               24038.461 Hz
FIDRES            0.733596 Hz
AQ                0.6815744 sec
RG                     4096
DW                   20.800 usec
DE                    6.50 usec
TE                   296.9 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                     13C
P1                    10.00 usec
PL1                    4.20 dB
SFO1            100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2             waltz16
NUC2                      1H
PCPD2                 90.00 usec
PL2                   10.20 dB
PL12                  26.00 dB
PL13                  29.00 dB
SFO2            400.1316005 MHz

F2 - Processing parameters
SI                    32768
SF               100.6127709 MHz
WDW                       EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.00
```

^{31}P NMR spectrum of compound **3m** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1254(3f)
EXPNO                  1
PROCNO                 1

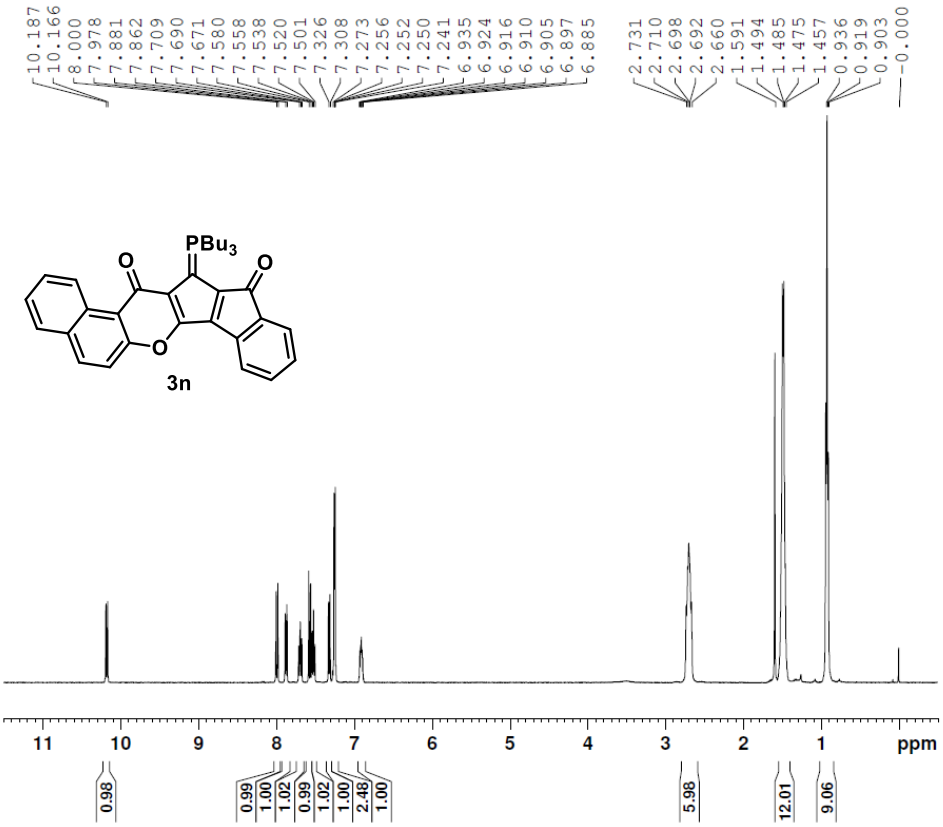
F2 - Acquisition Parameters
Date_           20240424
Time               15.26
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                    5
DS                    4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE               298.7 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.40
```

^{1}H NMR spectrum of compound **3n** ($CDCl_3$, 400 MHz)



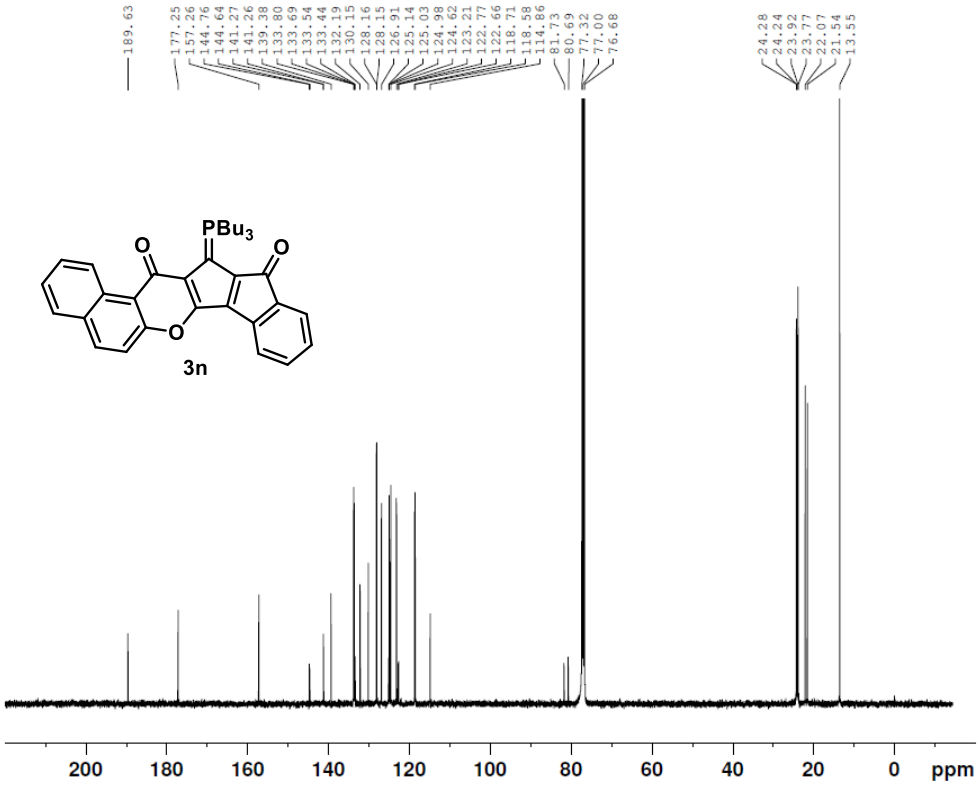

```
Current Data Parameters
NAME         DP-1174(3f)
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240305
Time               21.57
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7246.377 Hz
FIDRES        0.221142 Hz
AQ            2.2609921 sec
RG                  181
DW               69.000 usec
DE                6.50 usec
TE               298.7 K
D1            2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
NUC1                1H
P1                15.00 usec
PL1               11.10 dB
SFO1         400.1324008 MHz

F2 - Processing parameters
SI                 16384
SF           400.1300106 MHz
WDW                   EM
SSB                   0
LB                    0 Hz
GB                    0
PC                 1.00
```

^{13}C NMR spectrum of compound **3n** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1174(3f)
EXPNO                  2
PROCNO                 1

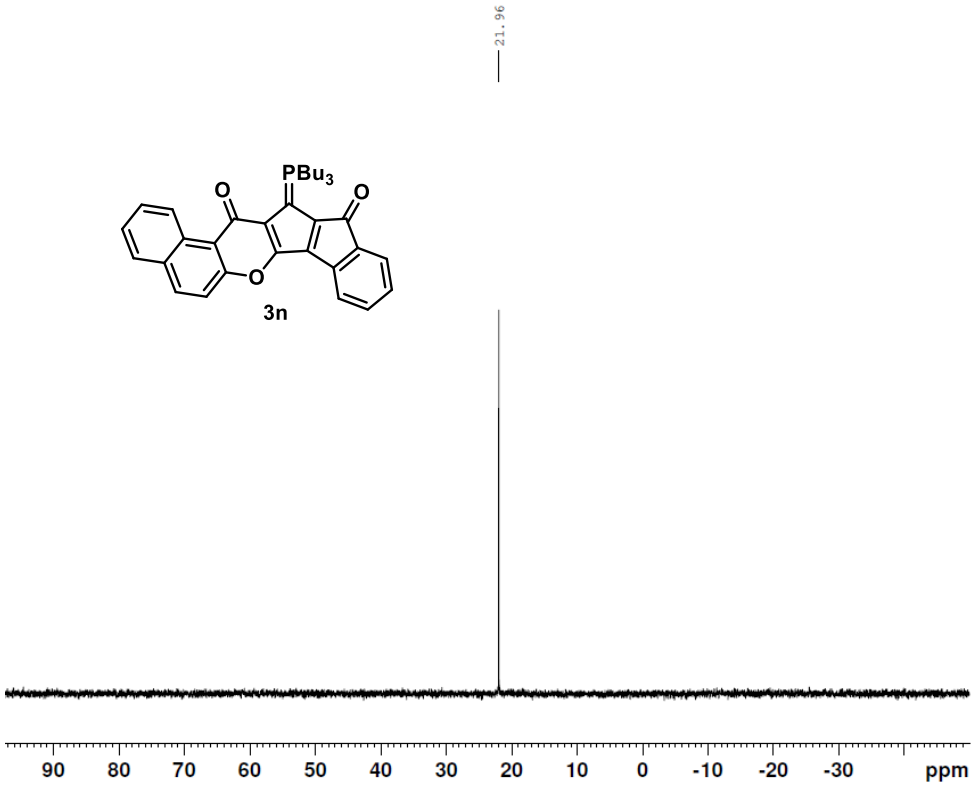
F2 - Acquisition Parameters
Date_           20240305
Time               21.59
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                17361
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ            0.6815744 sec
RG                 4096
DW               20.800 usec
DE                6.50 usec
TE                298.7 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                10.00 usec
PL1                4.20 dB
SFO1        100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2         waltz16
NUC2                 1H
PCPD2             90.00 usec
PL2               10.20 dB
PL12              26.00 dB
PL13              29.00 dB
SFO2        400.1316005 MHz

F2 - Processing parameters
SI                32768
SF          100.6127704 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.00
```

^{31}P NMR spectrum of compound **3n** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1174(3f)
EXPNO                  3
PROCNO                 1

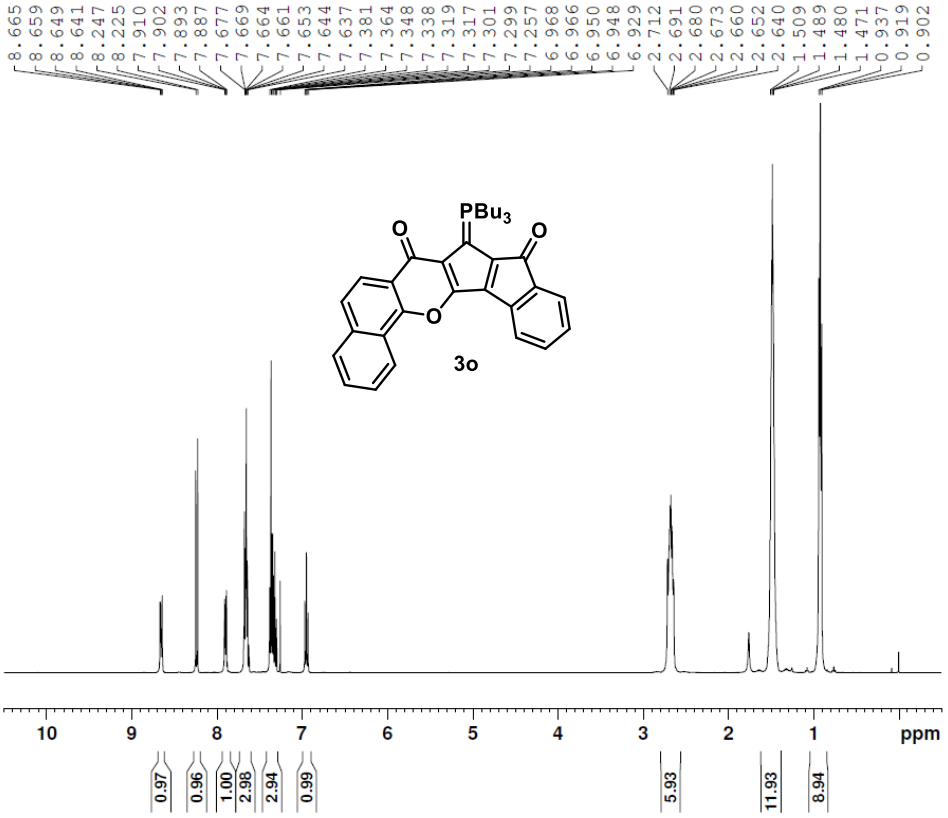
F2 - Acquisition Parameters
Date_           20240229
Time               16.13
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   14
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ            0.6684672 sec
RG                198.09
DW               10.200 usec
DE                6.50 usec
TE                298.4 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                 31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          161.9755930 MHz
WDW                  EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.40
```

^{1}H NMR spectrum of compound **3o** ($CDCl_3$, 400 MHz)



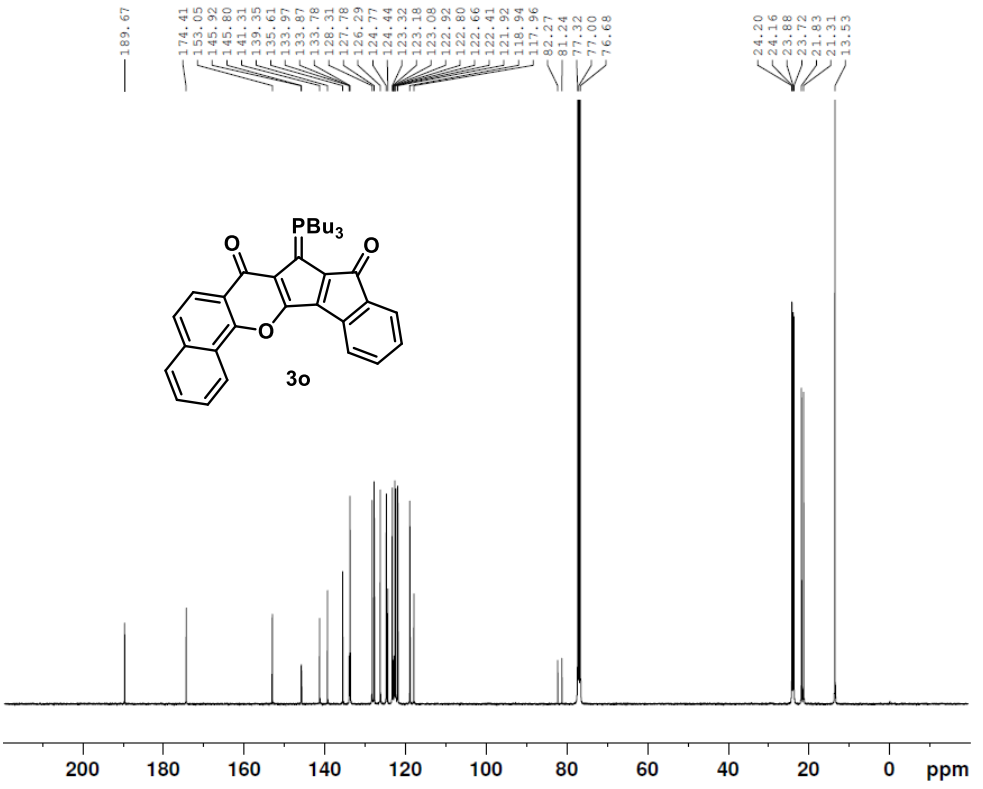

```
Current Data Parameters
NAME         DP-1244(3f)
EXPNO                  7
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240501
Time               22.00
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 57.42
DW                69.333 usec
DE                10.06 usec
TE                298.3 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300107 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3o** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1244(3f)
EXPNO                  8
PROCNO                 1

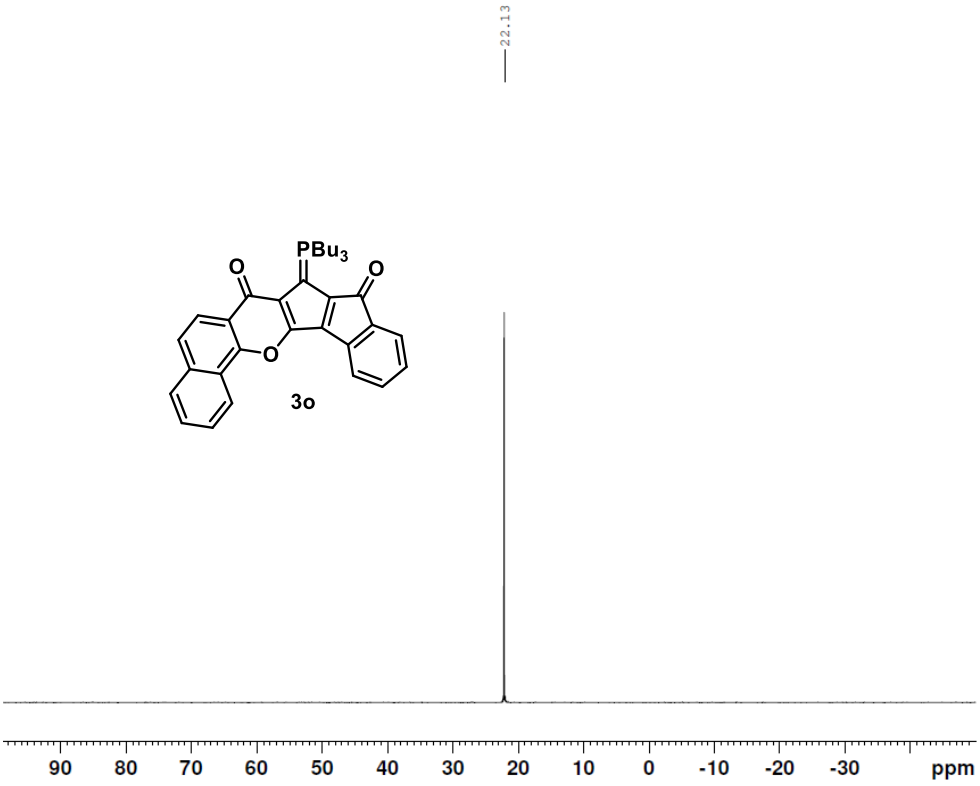
F2 - Acquisition Parameters
Date_           20240501
Time               22.01
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 15259
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.3 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127727 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3o** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME          DP-1244(3f)
EXPNO                   1
PROCNO                  1

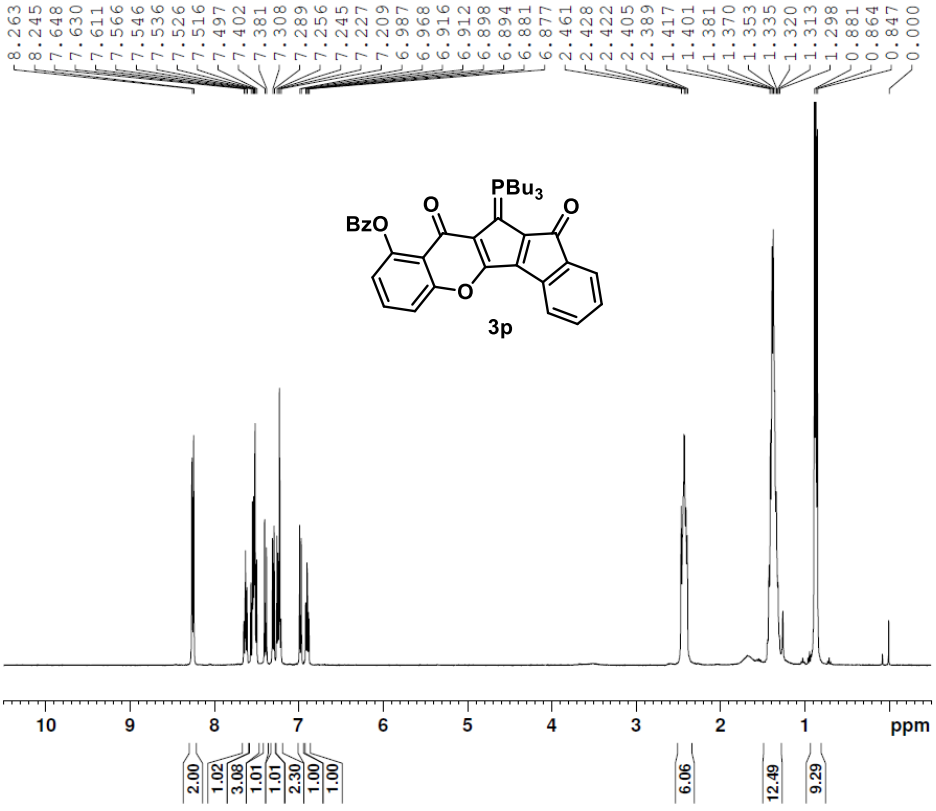
F2 - Acquisition Parameters
Date_            20240416
Time                14.25
INSTRUM             spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                    10
DS                     4
SWH            49019.609 Hz
FIDRES         0.747980 Hz
AQ             0.6684672 sec
RG                198.09
DW                10.200 usec
DE                 6.50 usec
TE                298.7 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         161.9836917 MHz
NUC1                  31P
P1                 15.00 usec
PLW1         13.19999981 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           161.9755930 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.40
```

^{1}H NMR spectrum of compound **3p** ($CDCl_3$, 400 MHz)



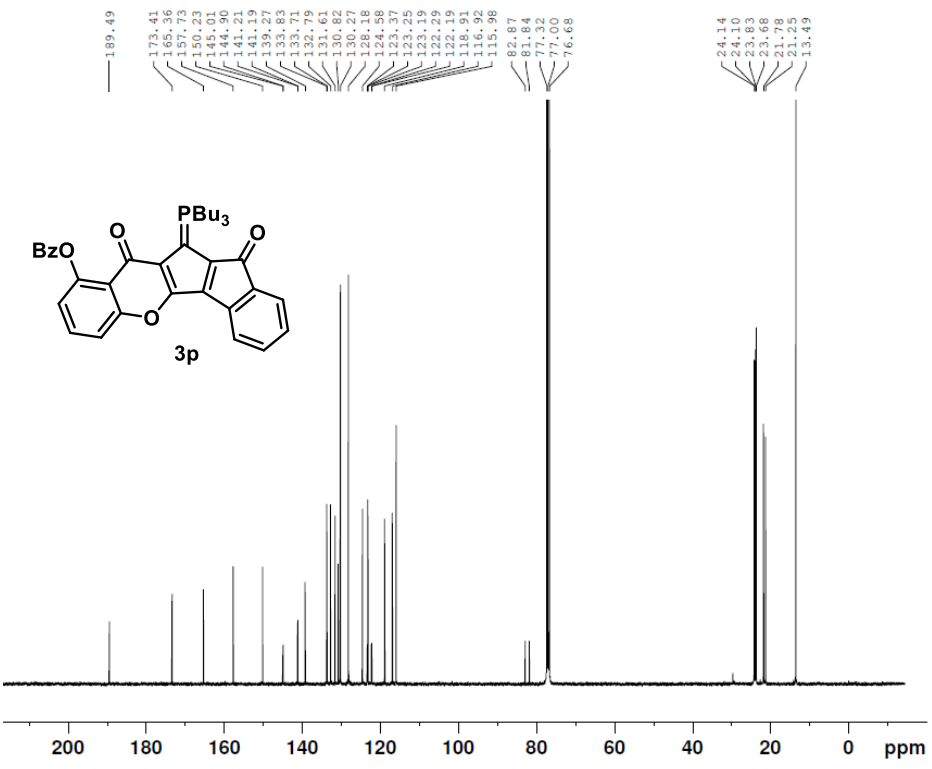

```
Current Data Parameters
NAME              DP-1274
EXPNO                   4
PROCNO                  1

F2 - Acquisition Parameters
Date_            20240507
Time                23.24
INSTRUM             spect
PROBHD   5 mm BBO BB-1H
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7246.377 Hz
FIDRES         0.221142 Hz
AQ             2.2609921 sec
RG                   114
DW                69.000 usec
DE                 6.50 usec
TE                296.0 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 15.00 usec
PL1                11.10 dB
SFO1         400.1324008 MHz

F2 - Processing parameters
SI                 16384
SF           400.1300108 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3p** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-1274
EXPNO                       5
PROCNO                      1

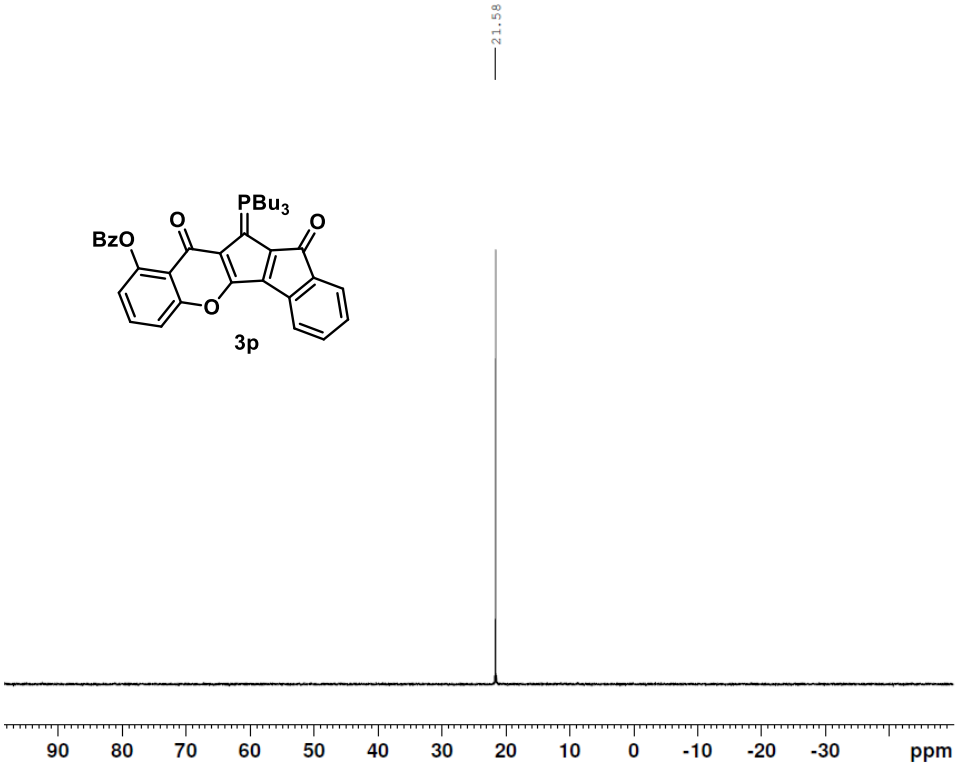
F2 - Acquisition Parameters
Date_               20240507
Time                   23.26
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG                zgpg30
TD                      32768
SOLVENT                 CDCl3
NS                      13966
DS                          0
SWH                24038.461 Hz
FIDRES              0.733596 Hz
AQ                  0.6815744 sec
RG                       4096
DW                     20.800 usec
DE                      6.50 usec
TE                     296.1 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                     10.00 usec
PL1                     4.20 dB
SFO1             100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2              waltz16
NUC2                      1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2             400.1316005 MHz

F2 - Processing parameters
SI                      32768
SF               100.6127730 MHz
WDW                        EM
SSB                         0
LB                      1.00 Hz
GB                          0
PC                      1.00
```

^{31}P NMR spectrum of compound **3p** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME                  DP-1274
EXPNO                       1
PROCNO                      1

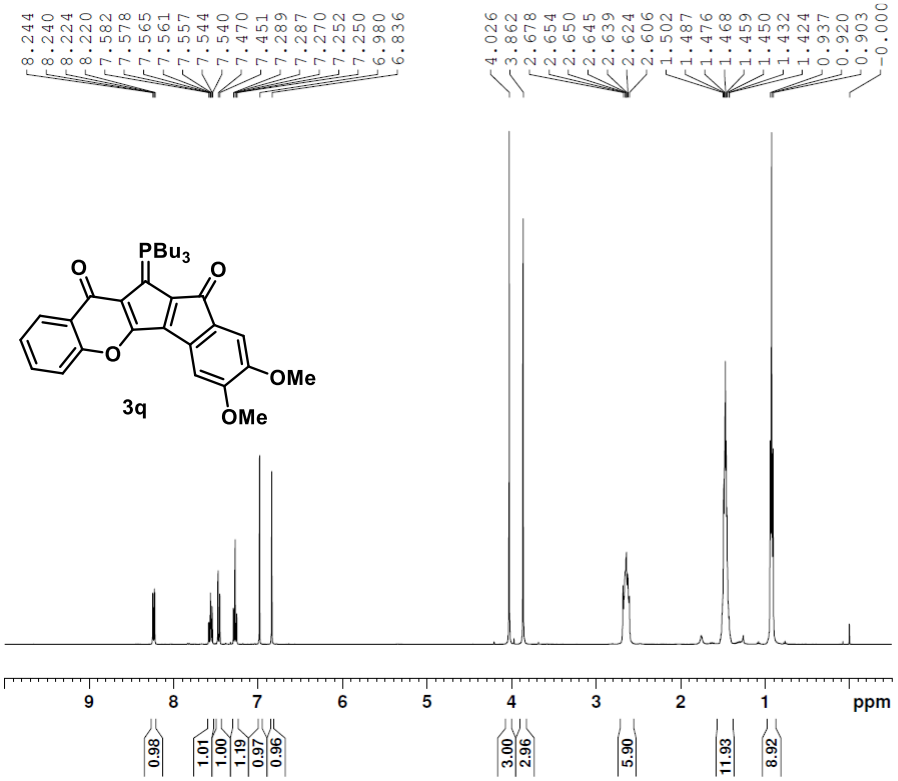
F2 - Acquisition Parameters
Date_               20240507
Time                   21.49
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG                zgpg30
TD                      65536
SOLVENT                 CDCl3
NS                         11
DS                          0
SWH                64724.918 Hz
FIDRES              0.987624 Hz
AQ                  0.5062656 sec
RG                      13004
DW                      7.725 usec
DE                      6.50 usec
TE                     296.1 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      31P
P1                     15.40 usec
PL1                    12.00 dB
SFO1             161.9674942 MHz

======== CHANNEL f2 ========
CPDPRG[2              waltz16
NUC2                      1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2             400.1316005 MHz

F2 - Processing parameters
SI                      32768
SF               161.9755930 MHz
WDW                        EM
SSB                         0
LB                      1.00 Hz
GB                          0
PC                      1.00
```

^{1}H NMR spectrum of compound **3q** ($CDCl_3$, 400 MHz)



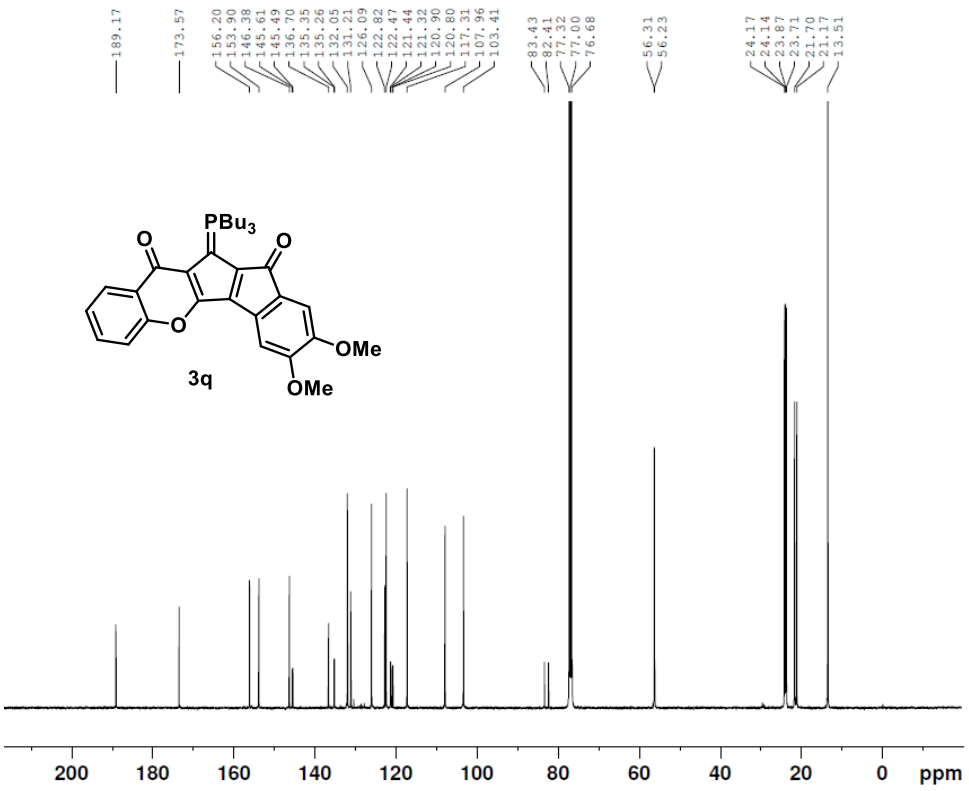

```
Current Data Parameters
NAME         DP-1265(3f)
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240427
Time               21.28
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 71.42
DW                69.333 usec
DE                 10.06 usec
TE                298.4 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          400.1324008 MHz
NUC1                  1H
P1                 15.00 usec
PLW1          13.50000000 W

F2 - Processing parameters
SI                 16384
SF            400.1300056 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **3q** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1265(3f)
EXPNO                  4
PROCNO                 1

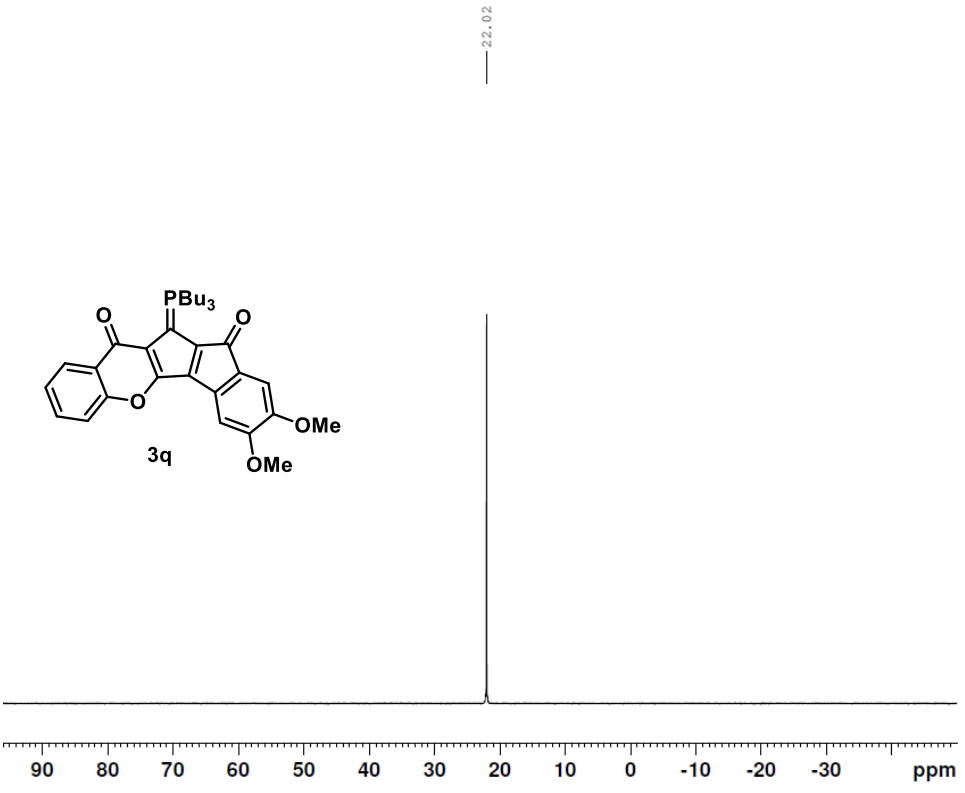
F2 - Acquisition Parameters
Date_           20240427
Time               21.31
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG            zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 21747
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.8 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          49.50000000 W

======== CHANNEL f2 ========
SFO2          400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2          12.50000000 W
PLW12          0.34722000 W
PLW13          0.28125000 W

F2 - Processing parameters
SI                 32768
SF            100.6127716 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **3q** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1265(3f)
EXPNO                  1
PROCNO                 1

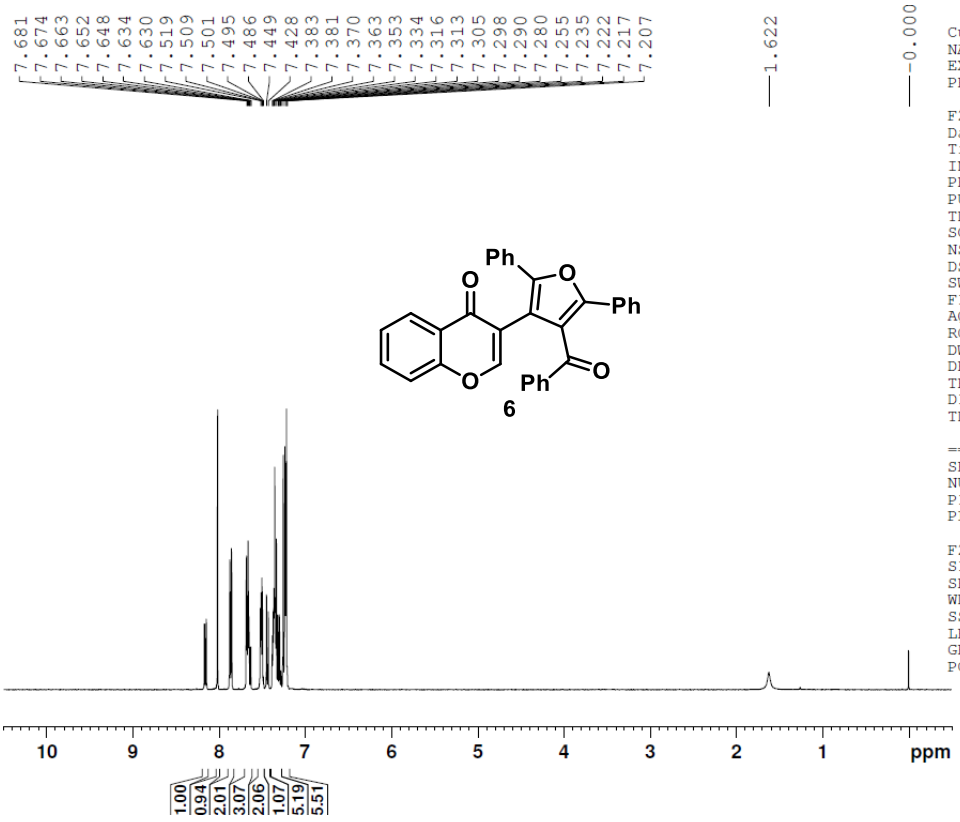
F2 - Acquisition Parameters
Date_           20240427
Time               17.52
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                65536
SOLVENT           CDCl3
NS                   11
DS                    4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG                198.09
DW               10.200 usec
DE                6.50 usec
TE                298.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.40
```

^{1}H NMR spectrum of compound **6** ($CDCl_3$, 400 MHz)



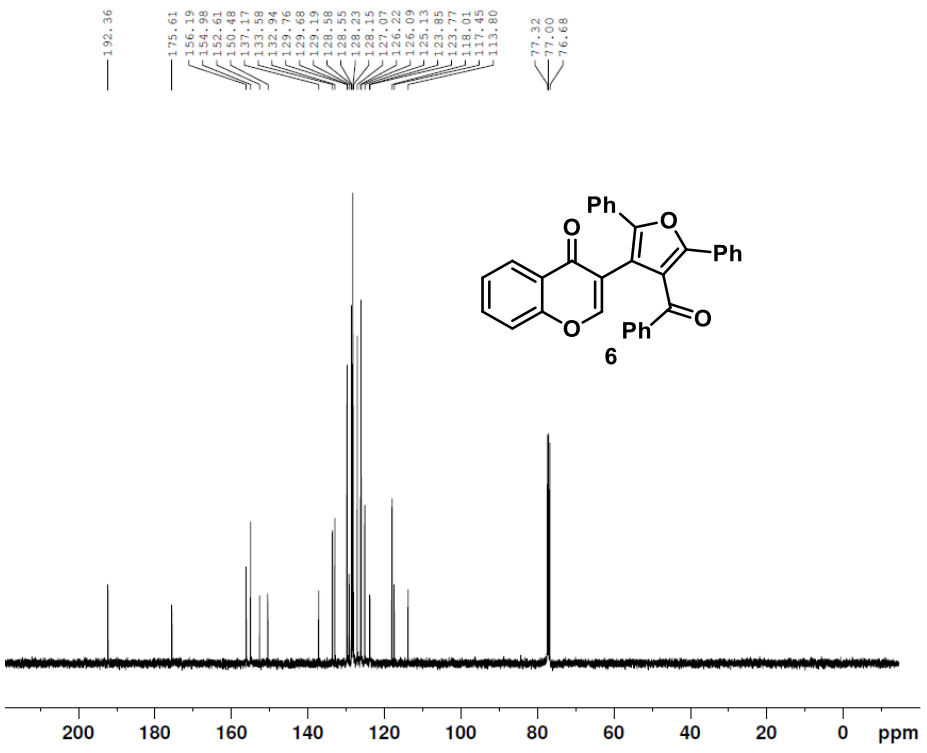

```
Current Data Parameters
NAME          JN-039(3f)
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240429
Time               19.19
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                32768
SOLVENT           CDCl3
NS                    9
DS                    0
SWH            7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG                128.9
DW               69.333 usec
DE                10.06 usec
TE                298.2 K
D1           2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                1H
P1                15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300117 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **6** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  JN-039
EXPNO                      2
PROCNO                     1

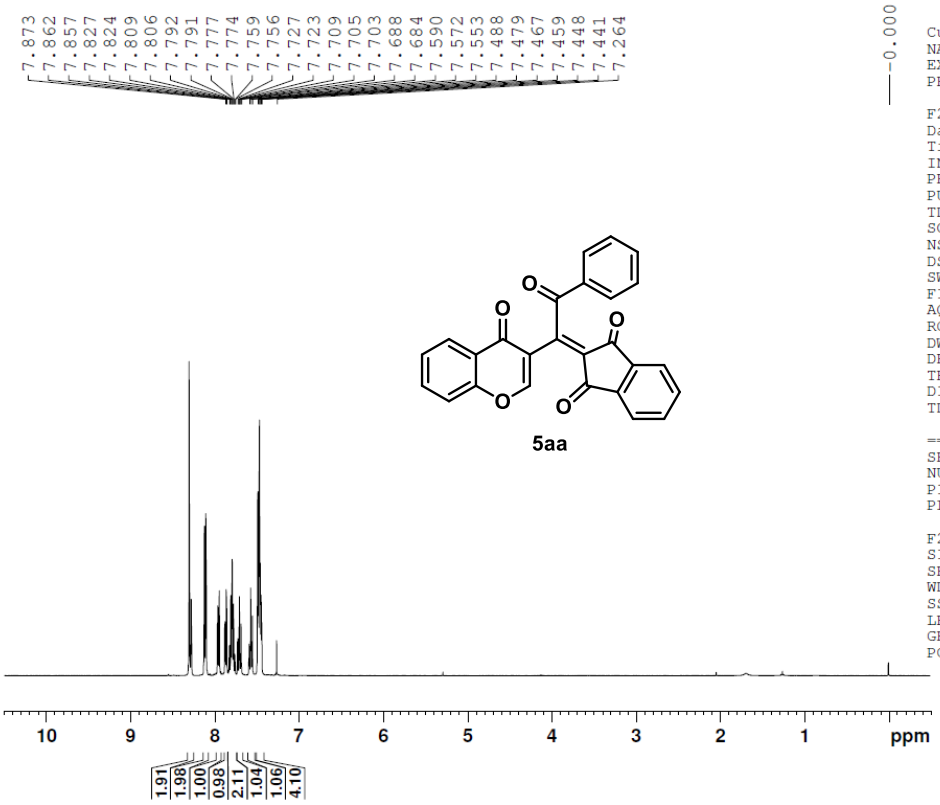
F2 - Acquisition Parameters
Date_              20240429
Time                  19.51
INSTRUM               spect
PROBHD    5 mm BBO BB-1H
PULPROG             zgpg30
TD                    32768
SOLVENT               CDCl3
NS                      101
DS                        0
SWH               24038.461 Hz
FIDRES             0.733596 Hz
AQ                0.6815744 sec
RG                     4096
DW                   20.800 usec
DE                    6.50 usec
TE                   297.1 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                    13C
P1                   10.00 usec
PL1                   4.20 dB
SFO1          100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2           waltz16
NUC2                    1H
PCPD2                90.00 usec
PL2                  10.20 dB
PL12                 26.00 dB
PL13                 29.00 dB
SFO2          400.1316005 MHz

F2 - Processing parameters
SI                    32768
SF            100.6127872 MHz
WDW                      EM
SSB                       0
LB                    1.00 Hz
GB                        0
PC                    1.00
```

^{1}H NMR spectrum of compound **5aa** ($CDCl_3$, 400 MHz)



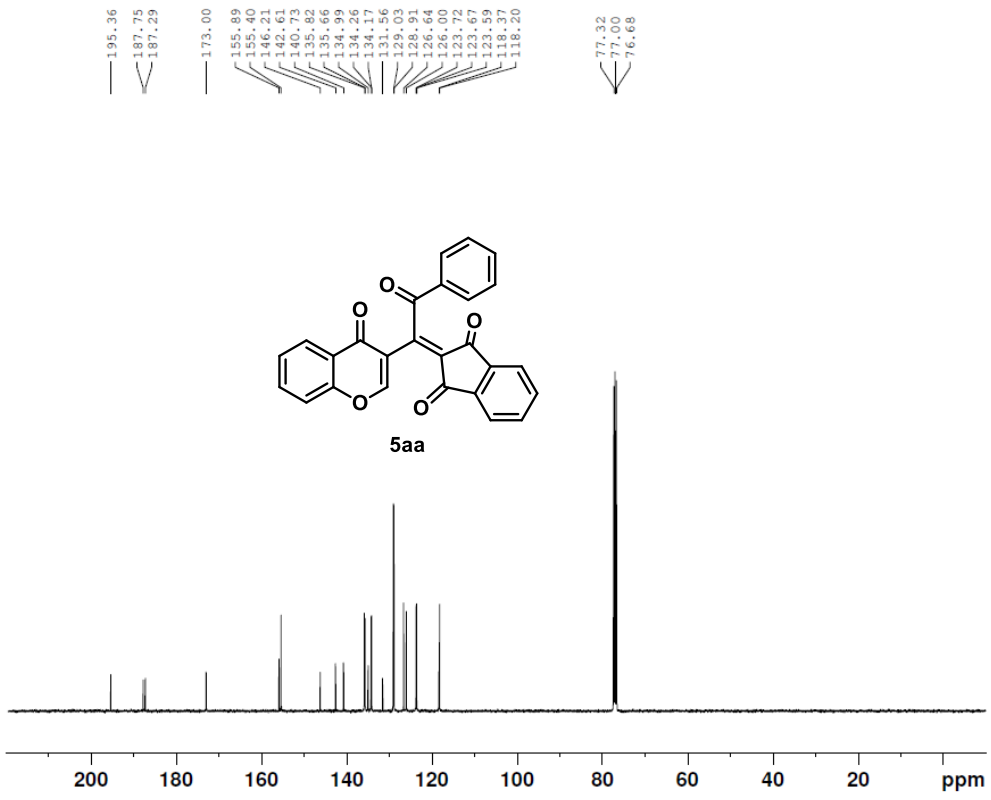

```
Current Data Parameters
NAME          DP-612(3f)
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230514
Time                4.20
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 89.08
DW                69.333 usec
DE                 10.06 usec
TE                 295.1 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300079 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5aa** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-612(3f)
EXPNO                 11
PROCNO                 1

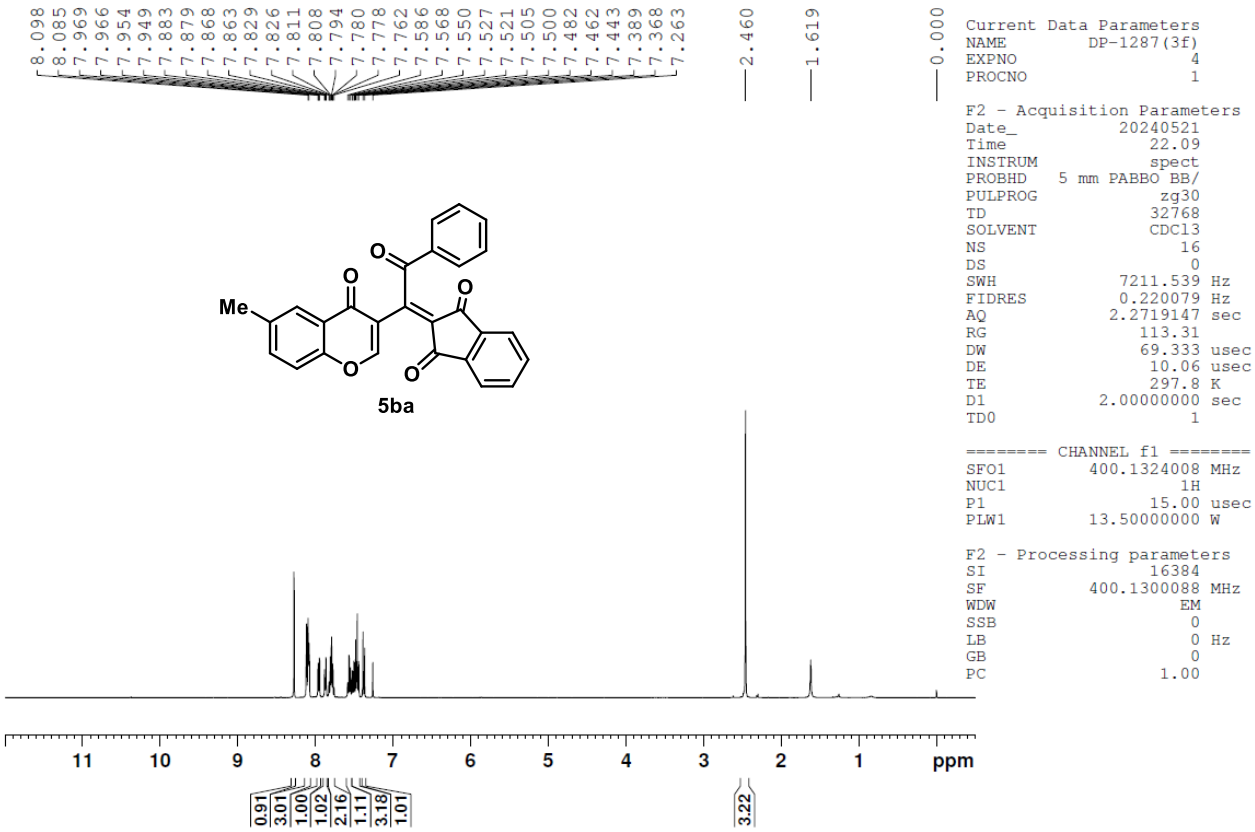
F2 - Acquisition Parameters
Date_           20230514
Time                4.21
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                   901
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                 295.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127750 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ba** ($CDCl_3$, 400 MHz)



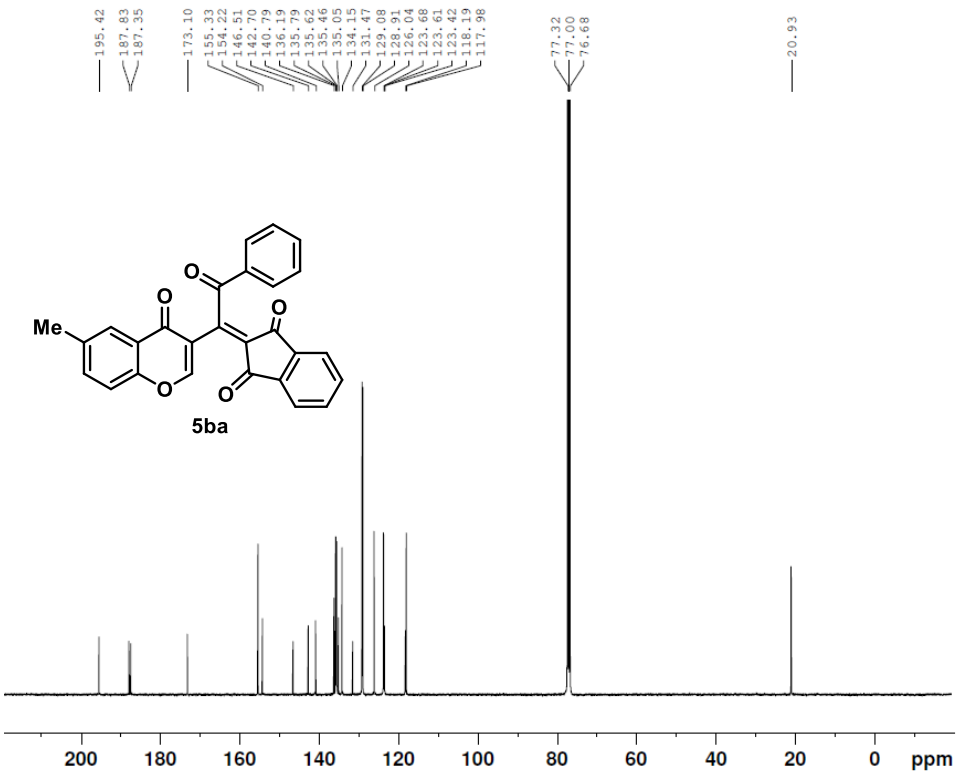

```
Current Data Parameters
NAME         DP-1287(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240521
Time               22.09
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                113.31
DW                69.333 usec
DE                10.06 usec
TE                297.8 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300088 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ba** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1287(3f)
EXPNO                  5
PROCNO                 1

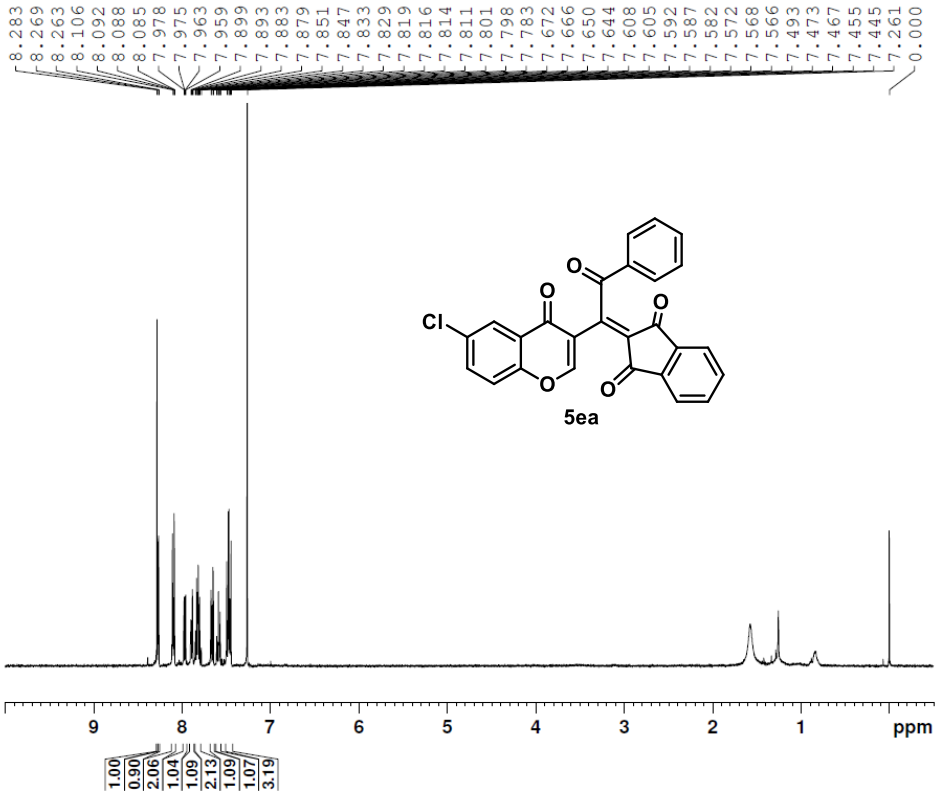
F2 - Acquisition Parameters
Date_           20240521
Time               22.11
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 13904
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                297.9 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127710 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ea** ($CDCl_3$, 400 MHz)



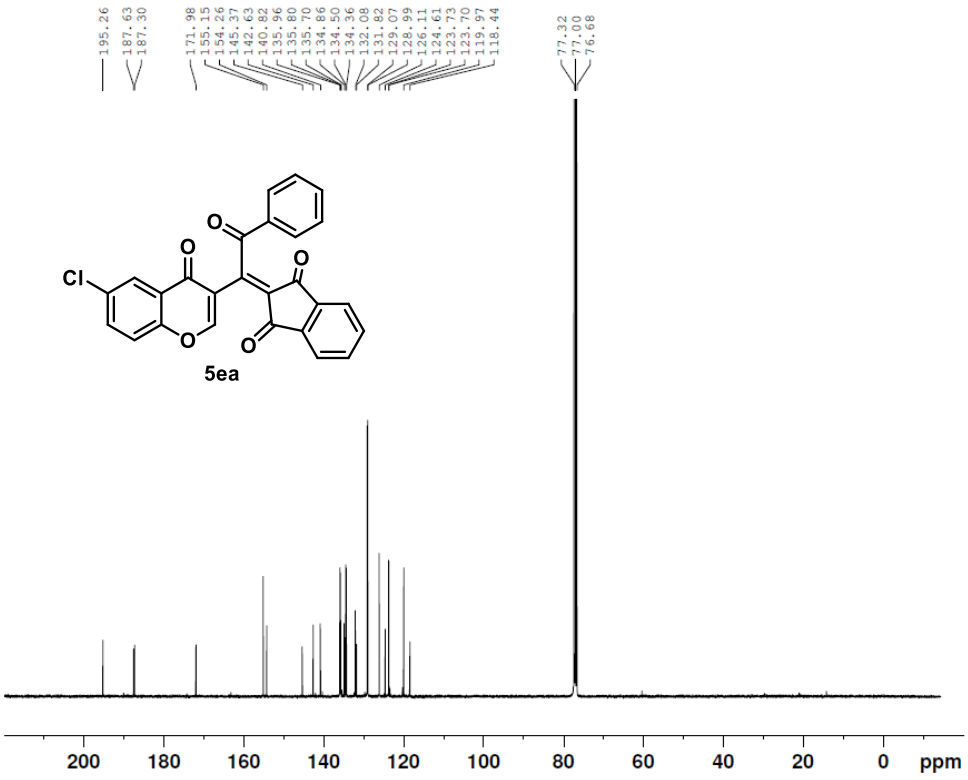

```
Current Data Parameters
NAME         DP-1281(3f)
EXPNO                  5
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240527
Time               11.03
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                297.8 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300094 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ea** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME             DP-1281
EXPNO                  2
PROCNO                 1

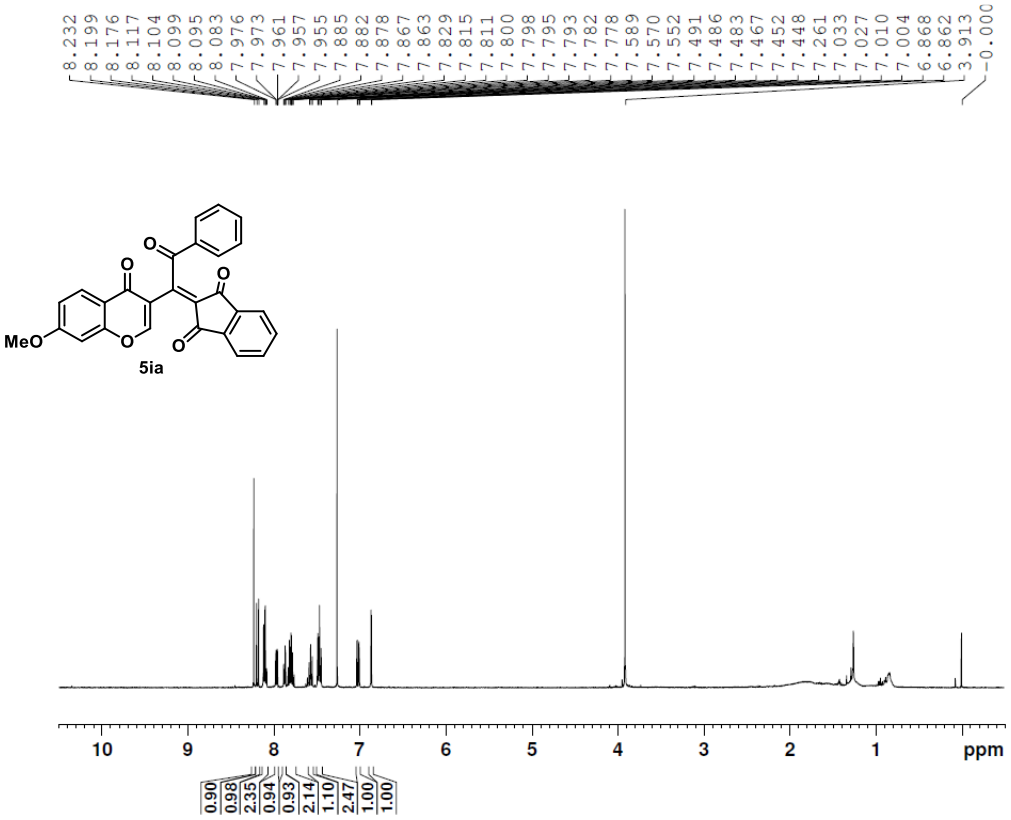
F2 - Acquisition Parameters
Date_           20240512
Time               17.56
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 12842
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                  4096
DW                20.800 usec
DE                 6.50 usec
TE                298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  13C
P1                10.00 usec
PL1                4.20 dB
SFO1         100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2         waltz16
NUC2                   1H
PCPD2             90.00 usec
PL2               10.20 dB
PL12              26.00 dB
PL13              29.00 dB
SFO2         400.1316005 MHz

F2 - Processing parameters
SI                 32768
SF           100.6127717 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ia** ($CDCl_3$, 400 MHz)



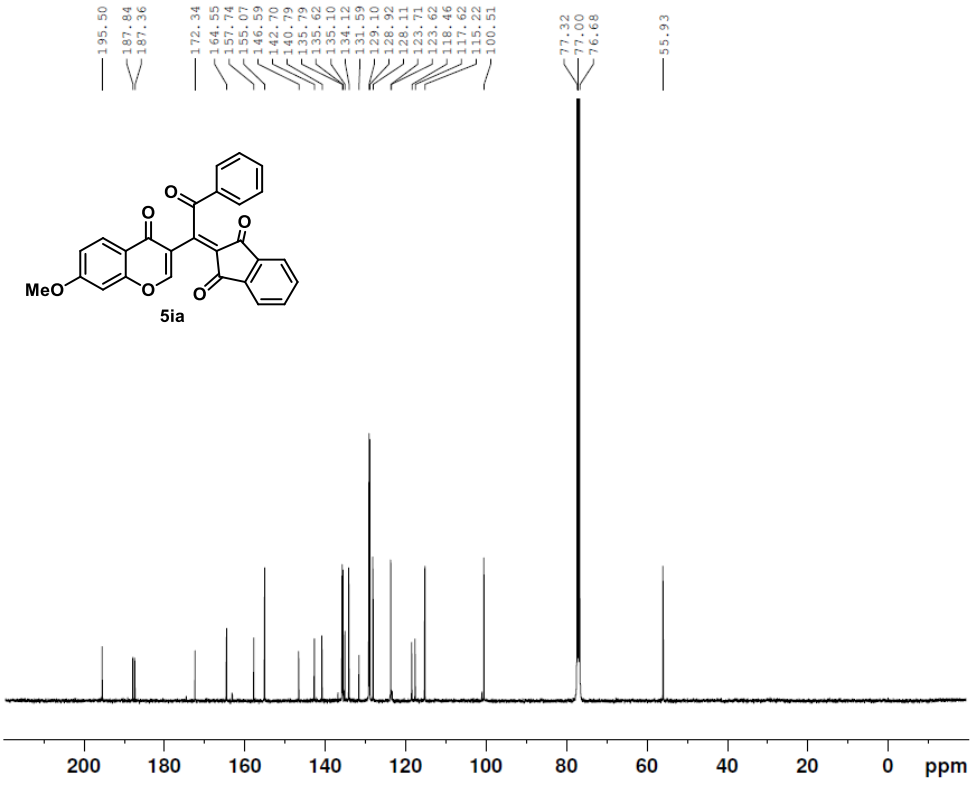

```
Current Data Parameters
NAME          JN-087(3f)
EXPNO                  5
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240605
Time               9.48
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG            zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG               177.16
DW               69.333 usec
DE                10.06 usec
TE                298.4 K
D1           2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300092 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ia** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-087(3f)
EXPNO                  4
PROCNO                 1

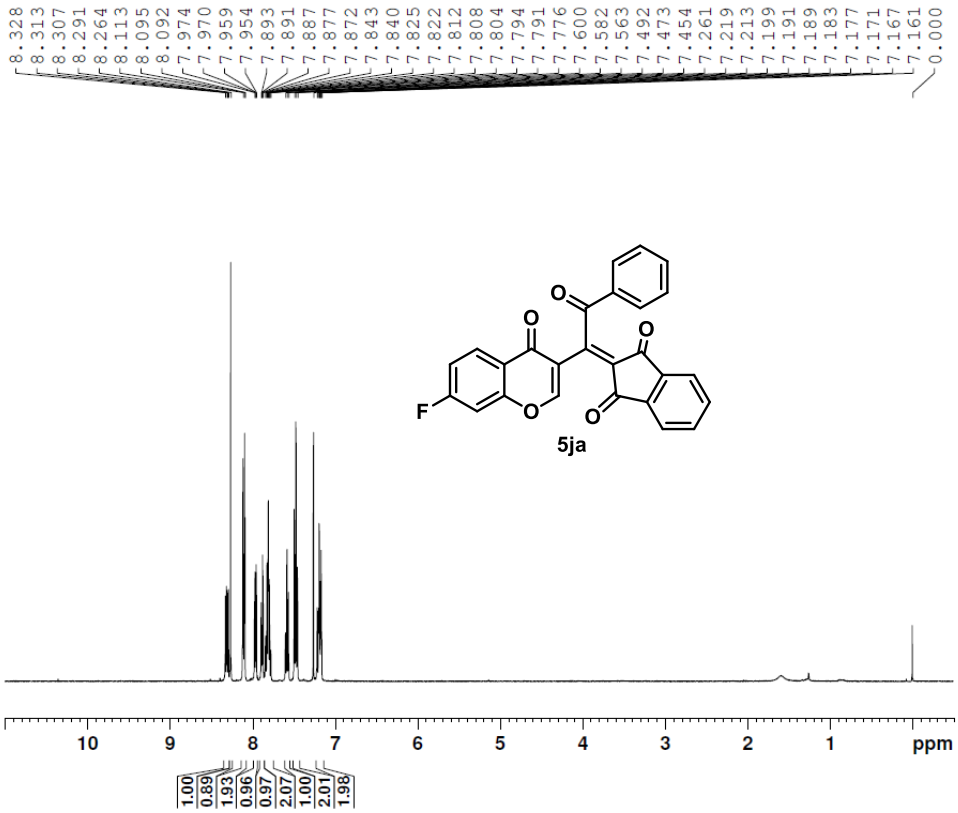
F2 - Acquisition Parameters
Date_           20240603
Time              22.16
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                14290
DS                    0
SWH           24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                 6.50 usec
TE                298.4 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127695 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ja** ($CDCl_3$, 400 MHz)



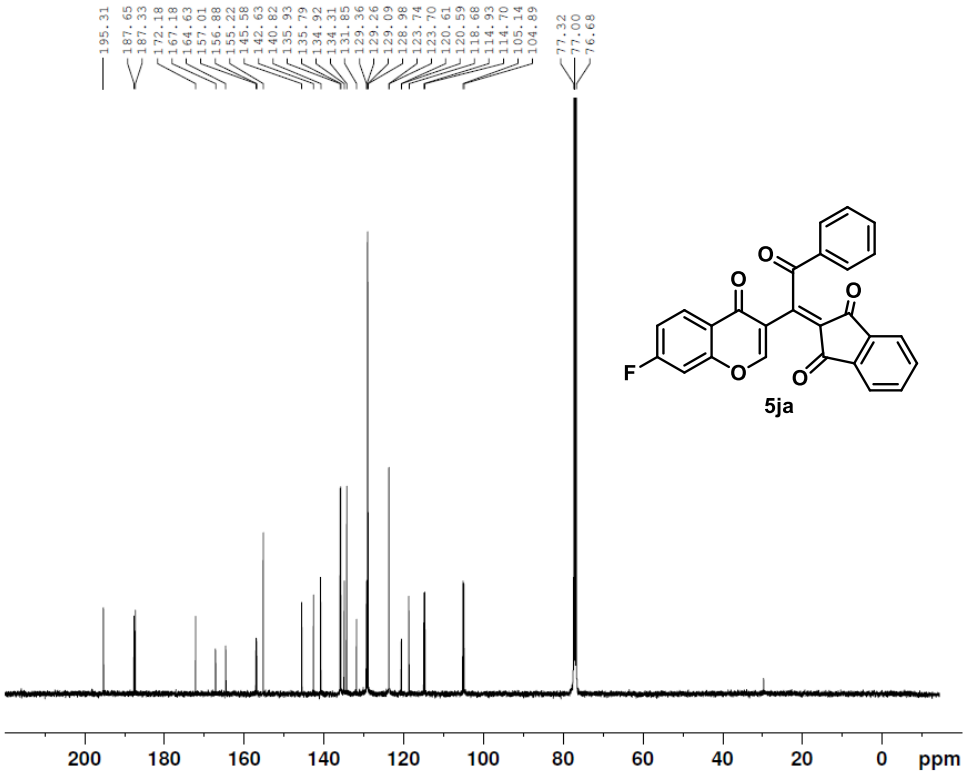

```
Current Data Parameters
NAME          DP-1282(3f)
EXPNO                   5
PROCNO                  1

F2 - Acquisition Parameters
Date_           20240514
Time               18.42
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                158.74
DW                69.333 usec
DE                10.06 usec
TE                298.6 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                1H
P1                15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300095 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ja** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME             DP-1282
EXPNO                  5
PROCNO                 1

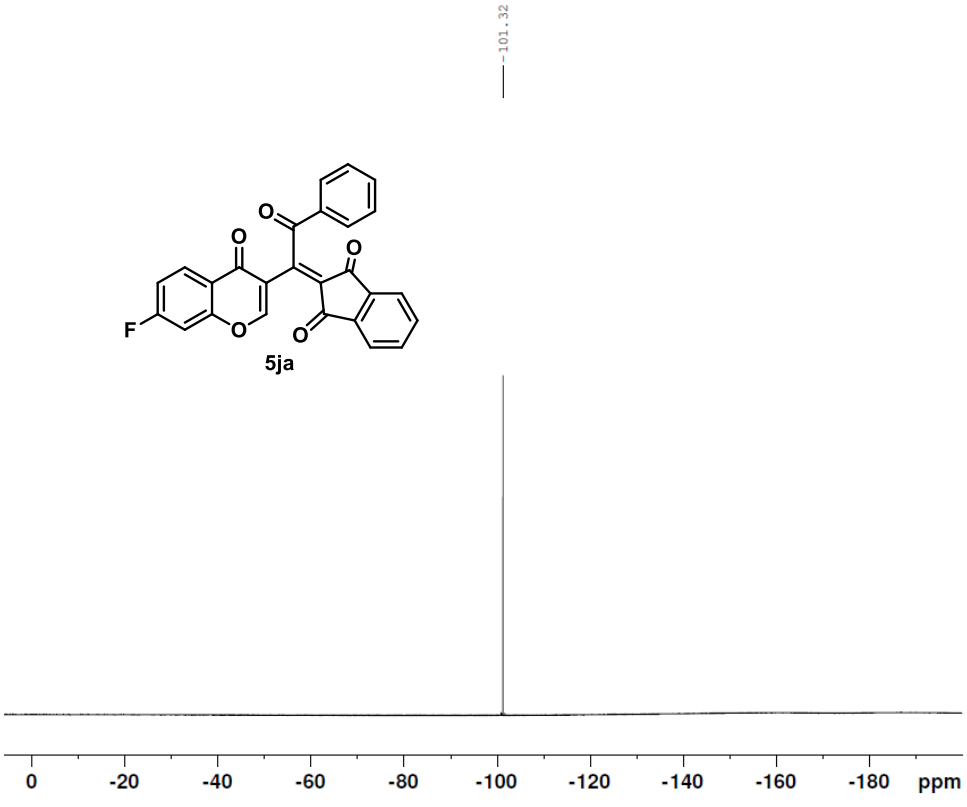
F2 - Acquisition Parameters
Date_           20240510
Time               22.08
INSTRUM            spect
PROBHD   5 mm BBO BB-1H
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 14389
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                  4096
DW                20.800 usec
DE                 6.50 usec
TE                297.1 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                13C
P1                10.00 usec
PL1                4.20 dB
SFO1         100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2         waltz16
NUC2                1H
PCPD2             90.00 usec
PL2               10.20 dB
PL12              26.00 dB
PL13              29.00 dB
SFO2         400.1316005 MHz

F2 - Processing parameters
SI                 32768
SF           100.6127711 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.00
```

^{19}F NMR spectrum of compound **5ja** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME         DP-1282(3f)
EXPNO                  7
PROCNO                 1

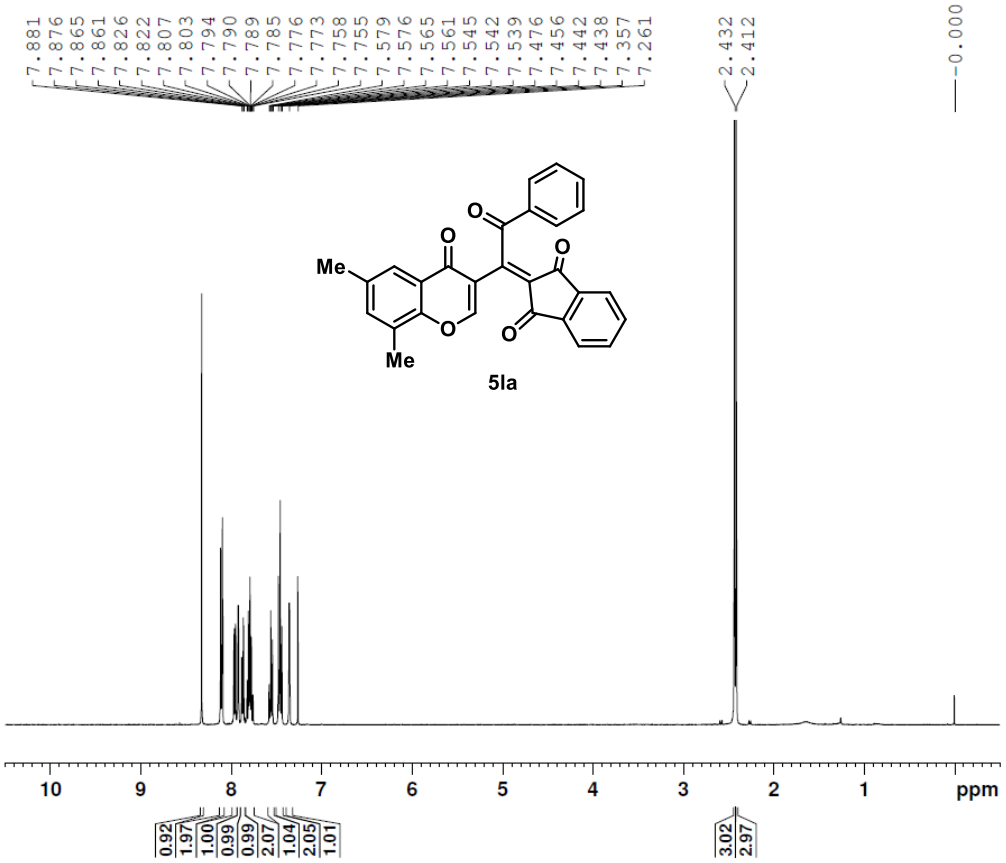
F2 - Acquisition Parameters
Date_           20240621
Time               10.53
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zgig
TD                131072
SOLVENT            CDCl3
NS                    16
DS                     0
SWH            89285.711 Hz
FIDRES         0.681196 Hz
AQ             0.7340032 sec
RG                198.09
DW                 5.600 usec
DE                 6.50 usec
TE                298.7 K
D1             1.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         376.4607168 MHz
NUC1                 19F
P1                15.00 usec
PLW1         16.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W

F2 - Processing parameters
SI                 65536
SF           376.4983662 MHz
WDW                  EM
SSB                   0
LB                 1.00 Hz
GB                    0
PC                 1.00
```

^{1}H NMR spectrum of compound **5la** ($CDCl_3$, 400 MHz)



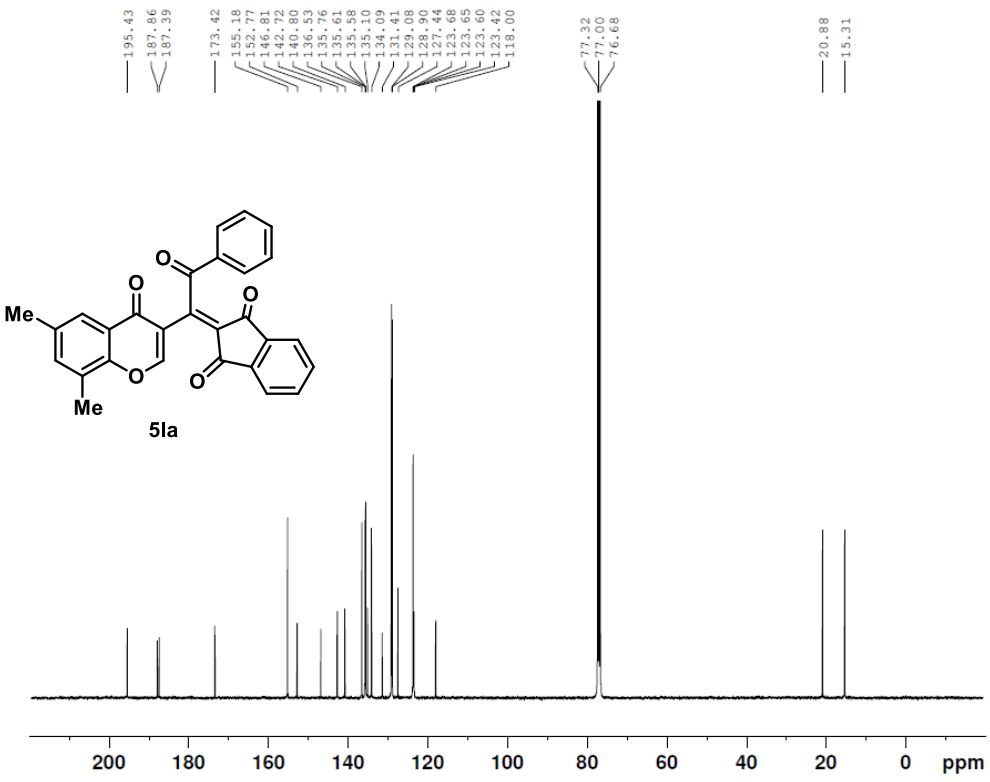

```
Current Data Parameters
NAME          JN-062(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240514
Time               22.05
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     7
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 113.31
DW                 69.333 usec
DE                  10.06 usec
TE                  299.4 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                  15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300095 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5la** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-062(3f)
EXPNO                  5
PROCNO                 1

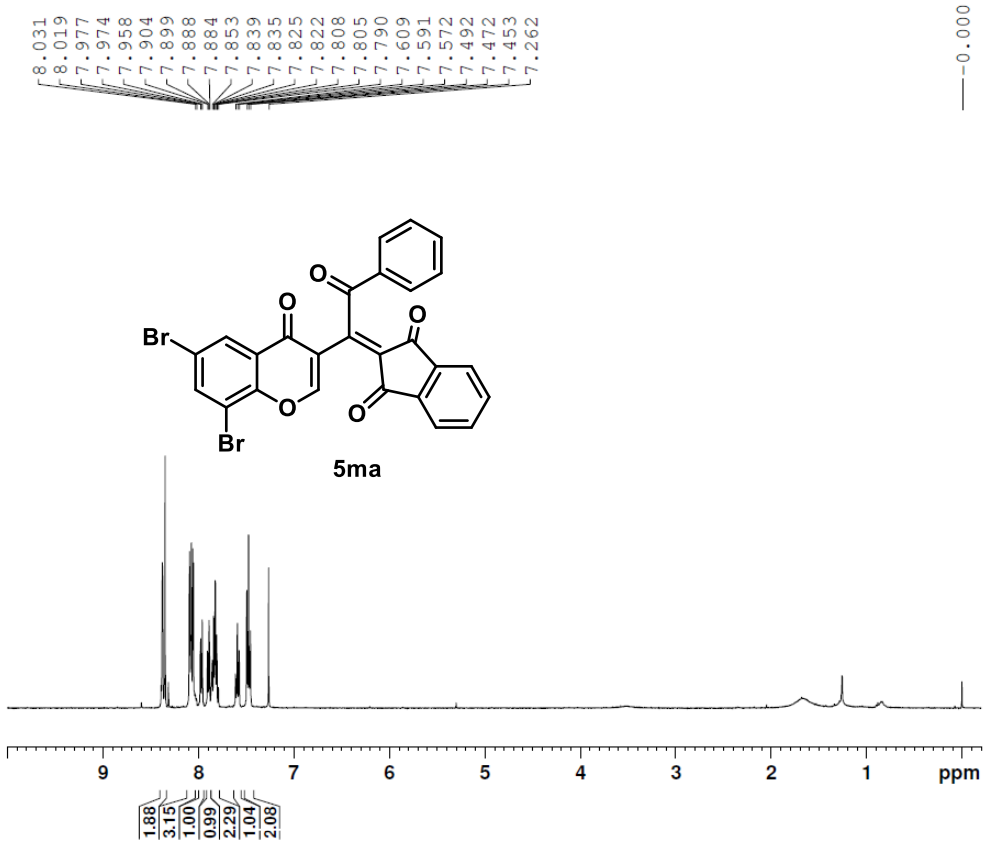
F2 - Acquisition Parameters
Date_           20240514
Time               22.20
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 16233
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                 198.09
DW                 20.800 usec
DE                  6.50 usec
TE                  299.3 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                  10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2               90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF          100.6127702 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ma** ($CDCl_3$, 400 MHz)



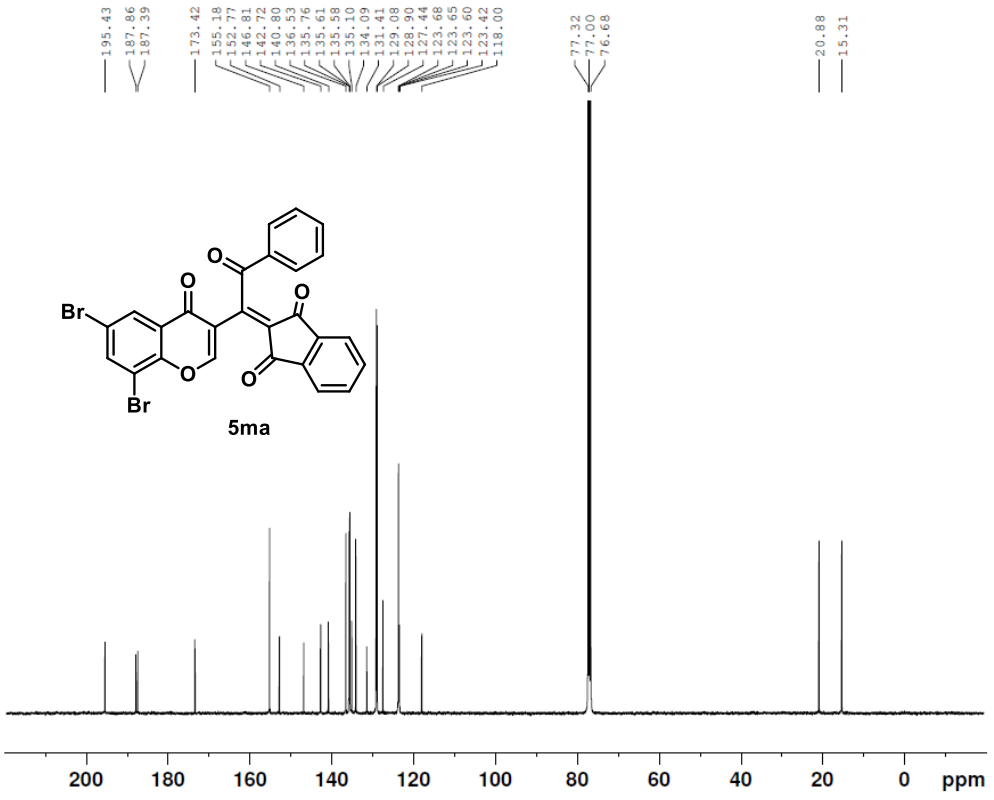

```
Current Data Parameters
NAME                  JN-061
EXPNO                      1
PROCNO                     1

F2 - Acquisition Parameters
Date_              20240530
Time                  22.32
INSTRUM               spect
PROBHD    5 mm BBO BB-1H
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                       16
DS                        0
SWH                7246.377 Hz
FIDRES            0.221142 Hz
AQ                2.2609921 sec
RG                    322.5
DW                   69.000 usec
DE                    6.50 usec
TE                   297.1 K
D1                2.00000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      1H
P1                     15.00 usec
PL1                    11.10 dB
SFO1           400.1324008 MHz

F2 - Processing parameters
SI                     16384
SF               400.1300084 MHz
WDW                       EM
SSB                        0
LB                         0 Hz
GB                         0
PC                      1.00
```

^{13}C NMR spectrum of compound **5ma** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME              JN-062(3f)
EXPNO                      5
PROCNO                     1

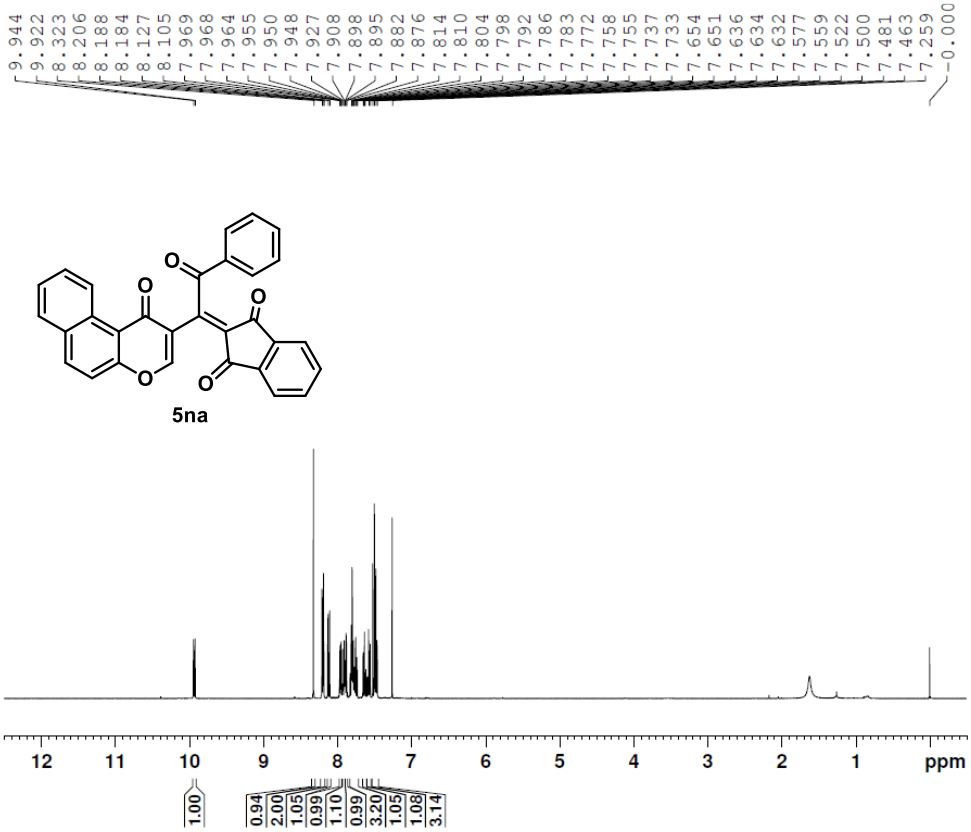
F2 - Acquisition Parameters
Date_              20240514
Time                  22.20
INSTRUM               spect
PROBHD    5 mm PABBO BB/
PULPROG              zgpg30
TD                    32768
SOLVENT               CDCl3
NS                    16233
DS                        0
SWH               24038.461 Hz
FIDRES            0.733596 Hz
AQ                0.6815744 sec
RG                   198.09
DW                   20.800 usec
DE                    6.50 usec
TE                   299.3 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1

======== CHANNEL f1 ========
SFO1           100.6228298 MHz
NUC1                      13C
P1                    10.00 usec
PLW1           49.50000000 W

======== CHANNEL f2 ========
SFO2           400.1316005 MHz
NUC2                      1H
CPDPRG[2             waltz16
PCPD2                 90.00 usec
PLW2           12.50000000 W
PLW12           0.34722000 W
PLW13           0.28125000 W

F2 - Processing parameters
SI                     32768
SF               100.6127702 MHz
WDW                       EM
SSB                        0
LB                      2.00 Hz
GB                         0
PC                      1.00
```

^{1}H NMR spectrum of compound **5na** ($CDCl_3$, 400 MHz)



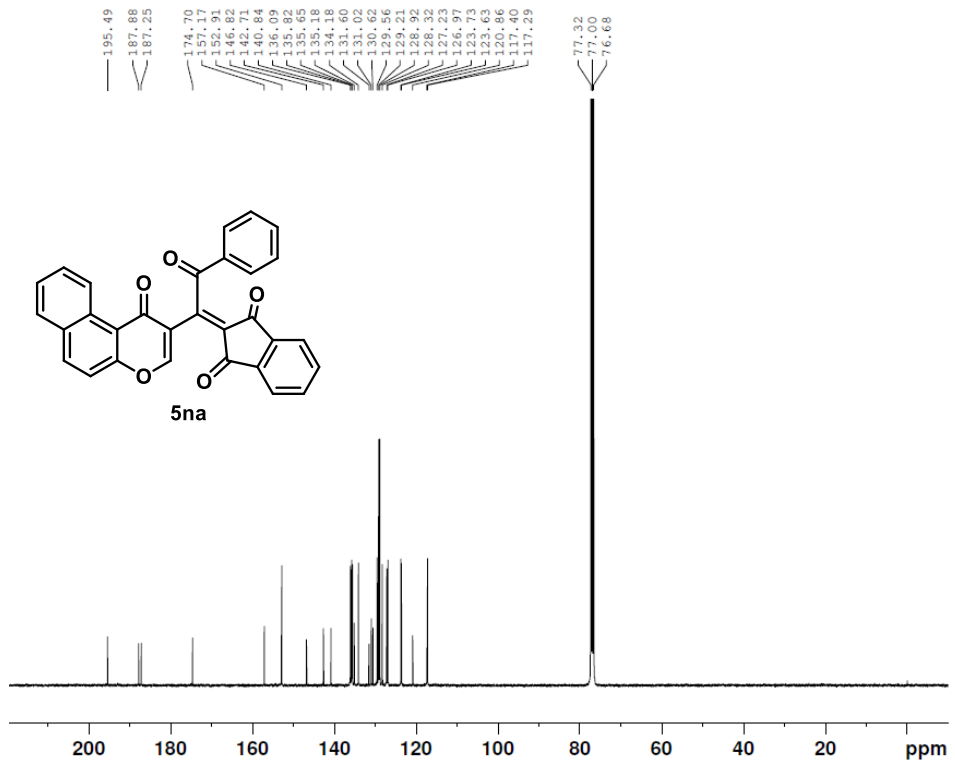

```
Current Data Parameters
NAME         DP-1153(3f)
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240302
Time              21.22
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG           zg30
TD               32768
SOLVENT          CDCl3
NS                  16
DS                   0
SWH           7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG               144.49
DW               69.333 usec
DE                10.06 usec
TE                297.5 K
D1           2.00000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                1H
P1                15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                16384
SF          400.1300100 MHz
WDW                EM
SSB                 0
LB                  0 Hz
GB                  0
PC               1.00
```

^{13}C NMR spectrum of compound **5na** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1153(3f)
EXPNO                 11
PROCNO                 1

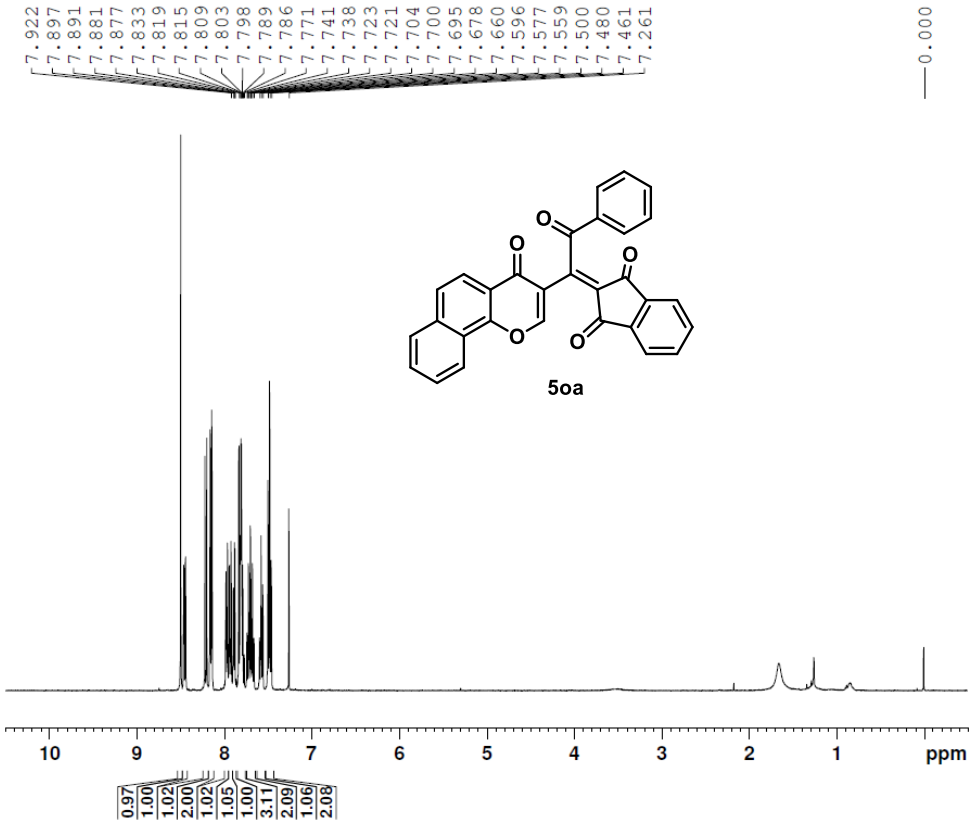
F2 - Acquisition Parameters
Date_           20240302
Time              21.24
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD               32768
SOLVENT          CDCl3
NS               18528
DS                   0
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                6.50 usec
TE                297.9 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                13C
P1                10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          100.6127702 MHz
WDW                EM
SSB                 0
LB                2.00 Hz
GB                  0
PC               1.00
```

^{1}H NMR spectrum of compound **5oa** ($CDCl_3$, 400 MHz)



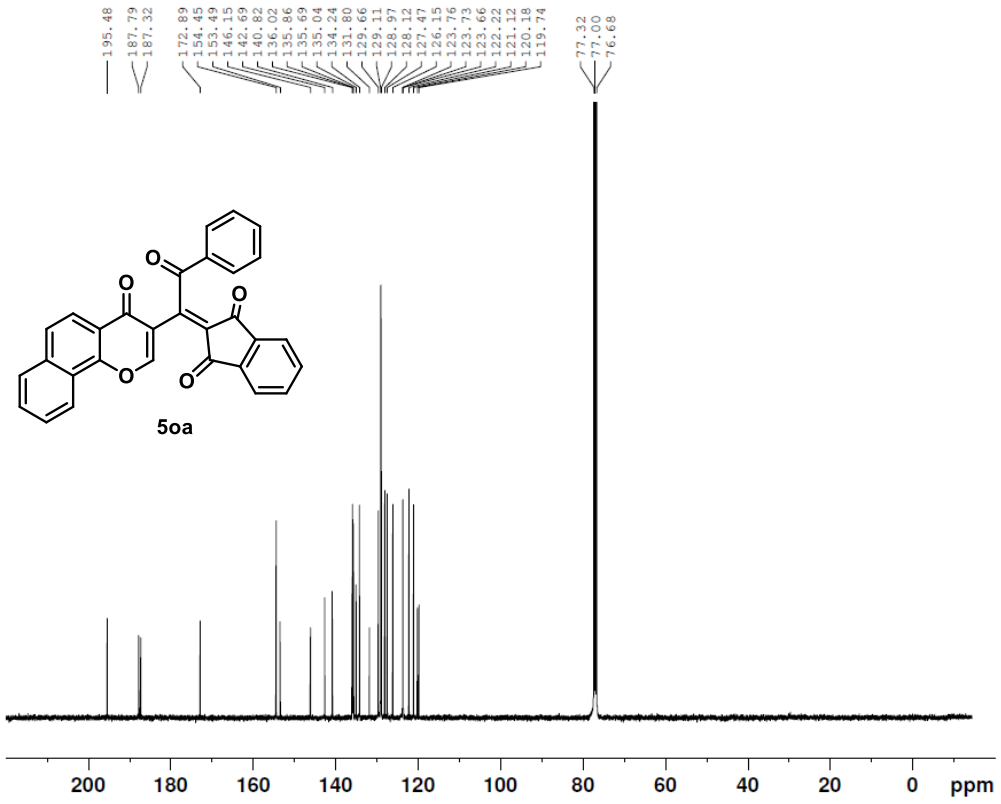

```
Current Data Parameters
NAME                  DP-1283
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_               20240517
Time                   22.12
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG                 zg30
TD                     32768
SOLVENT                CDCl3
NS                        16
DS                         0
SWH                7246.377 Hz
FIDRES             0.221142 Hz
AQ                 2.2609921 sec
RG                       181
DW                  69.000 usec
DE                    6.50 usec
TE                   295.5 K
D1                 2.00000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                       1H
P1                     15.00 usec
PL1                    11.10 dB
SFO1            400.1324008 MHz

F2 - Processing parameters
SI                      16384
SF                400.1300092 MHz
WDW                        EM
SSB                         0
LB                      0 Hz
GB                          0
PC                       1.00
```

^{13}C NMR spectrum of compound **5oa** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-1283
EXPNO                       2
PROCNO                      1

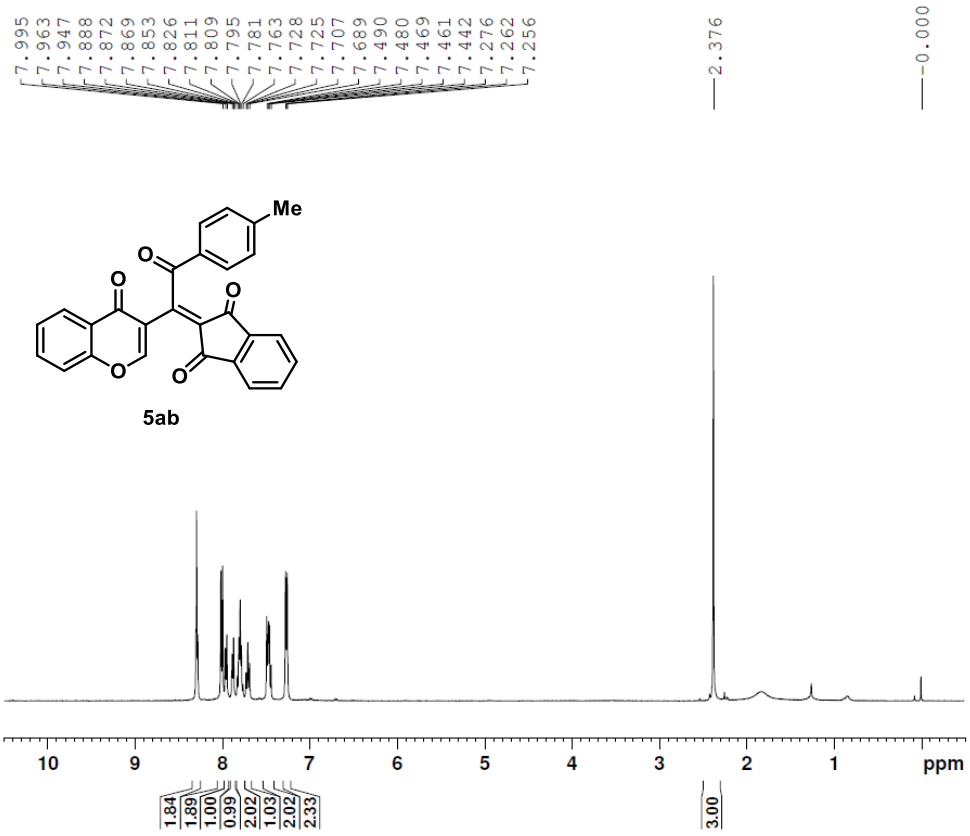
F2 - Acquisition Parameters
Date_               20240518
Time                    9.16
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG              zgpg30
TD                     32768
SOLVENT                CDCl3
NS                     14483
DS                         0
SWH               24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                      4096
DW                  20.800 usec
DE                    6.50 usec
TE                   296.8 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                     10.00 usec
PL1                     4.20 dB
SFO1            100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2             waltz16
NUC2                       1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2            400.1316005 MHz

F2 - Processing parameters
SI                      32768
SF                100.6127716 MHz
WDW                        EM
SSB                         0
LB                      1.00 Hz
GB                          0
PC                       1.00
```

^{1}H NMR spectrum of compound **5ab** ($CDCl_3$, 400 MHz)



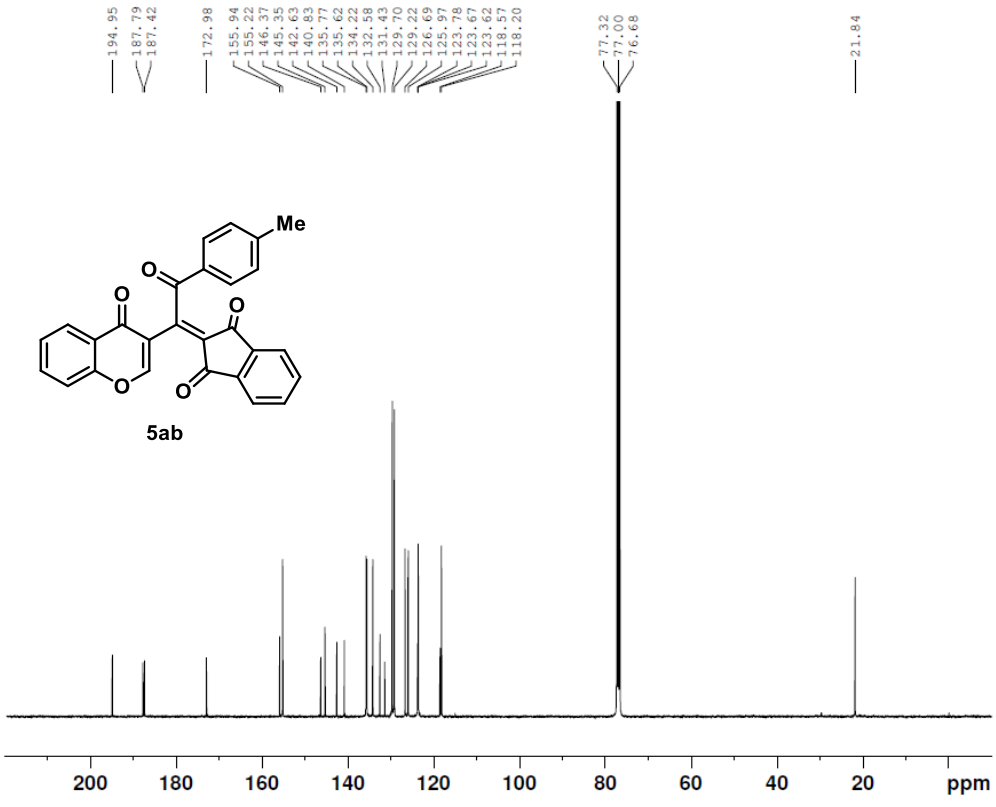

```
Current Data Parameters
NAME         DP-1174(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240303
Time               23.25
INSTRUM            spect
PROBHD    5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 128.9
DW                69.333 usec
DE                10.06 usec
TE                297.3 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300088 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ab** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1174(3f)
EXPNO                  5
PROCNO                 1

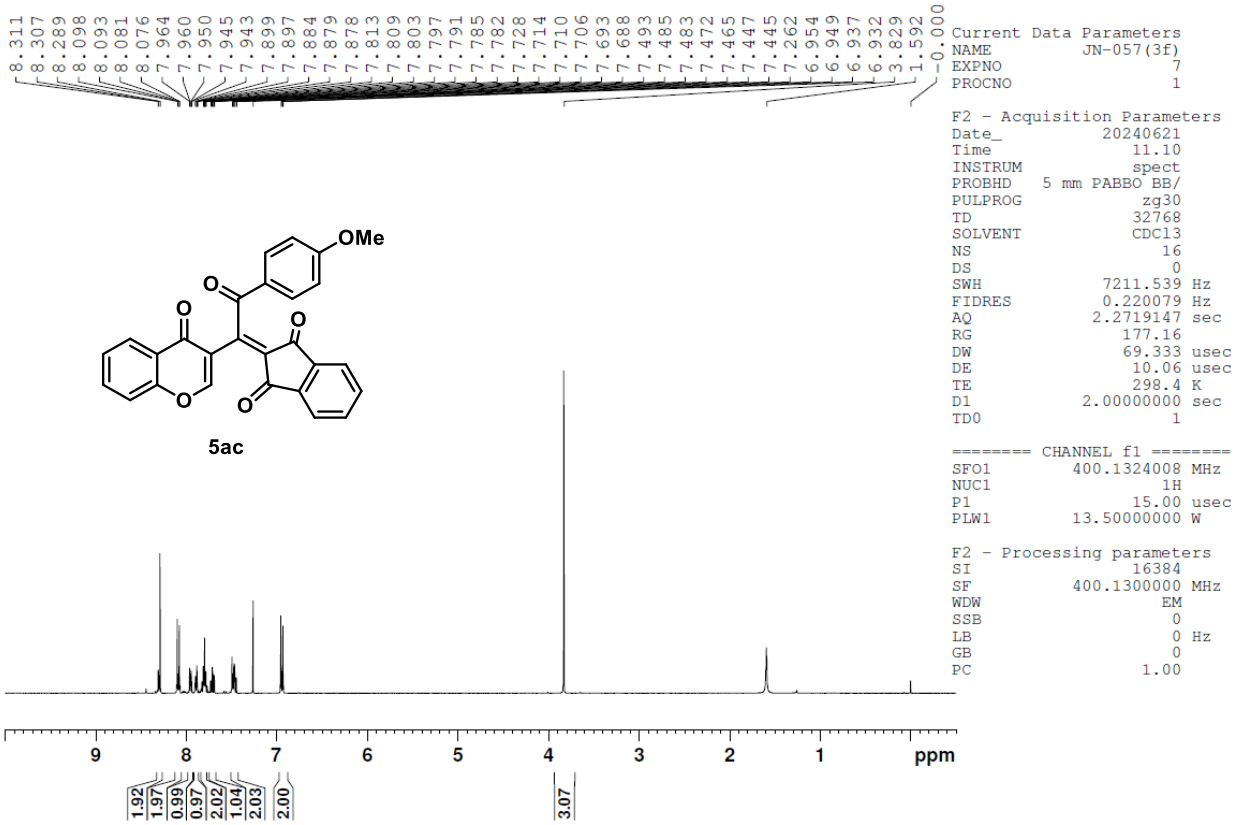
F2 - Acquisition Parameters
Date_           20240303
Time               23.35
INSTRUM            spect
PROBHD    5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 13401
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                 198.09
DW                20.800 usec
DE                 6.50 usec
TE                297.5 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127716 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ac** ($CDCl_3$, 400 MHz)



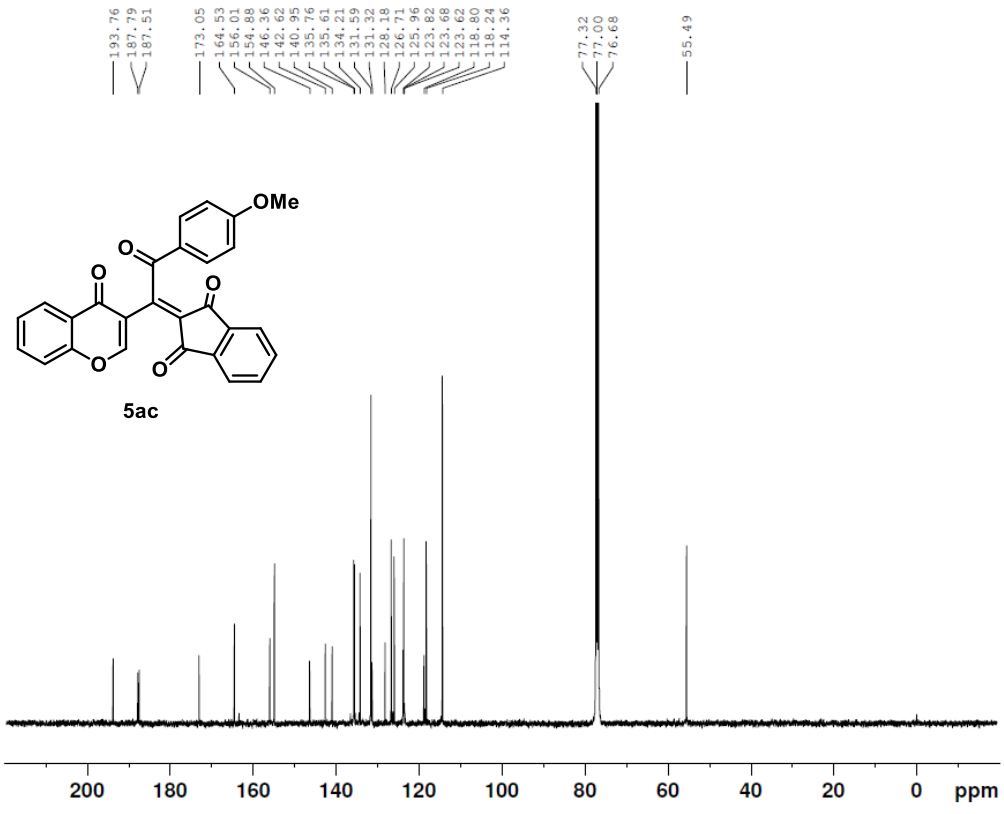

```
Current Data Parameters
NAME          JN-057(3f)
EXPNO                  7
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240621
Time               11.10
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH            7211.539 Hz
FIDRES         0.220079 Hz
AQ             2.2719147 sec
RG                177.16
DW                69.333 usec
DE                10.06 usec
TE                298.4 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300000 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ac** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-057(3f)
EXPNO                  6
PROCNO                 1

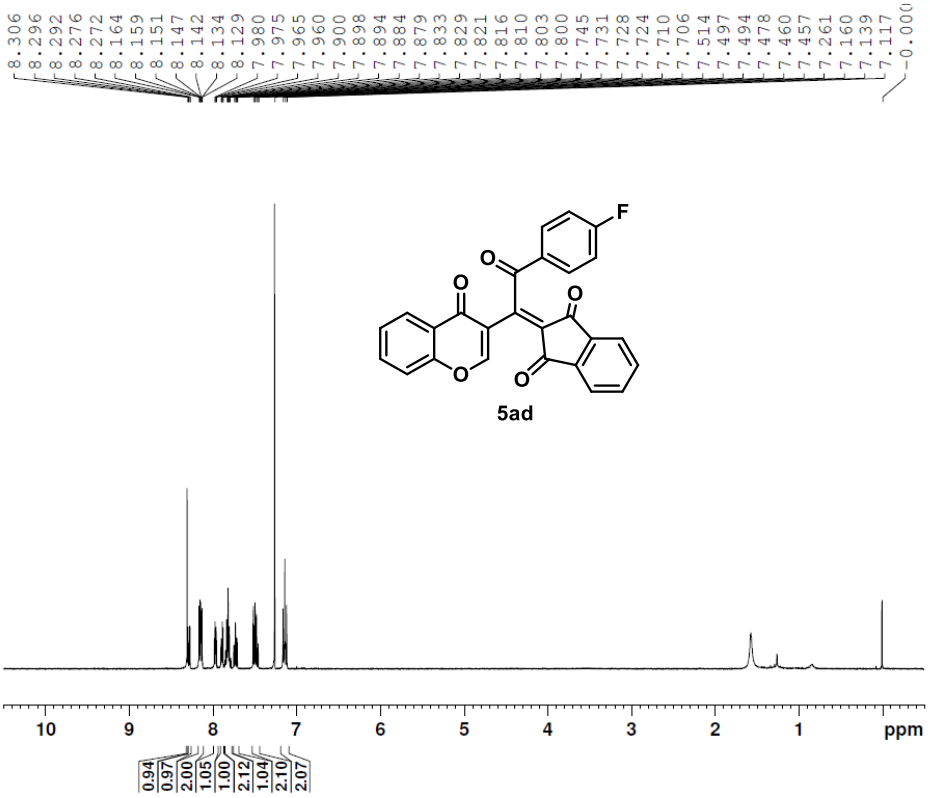
F2 - Acquisition Parameters
Date_           20240513
Time               22.15
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 16177
DS                     0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                300.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127688 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ad** ($CDCl_3$, 400 MHz)



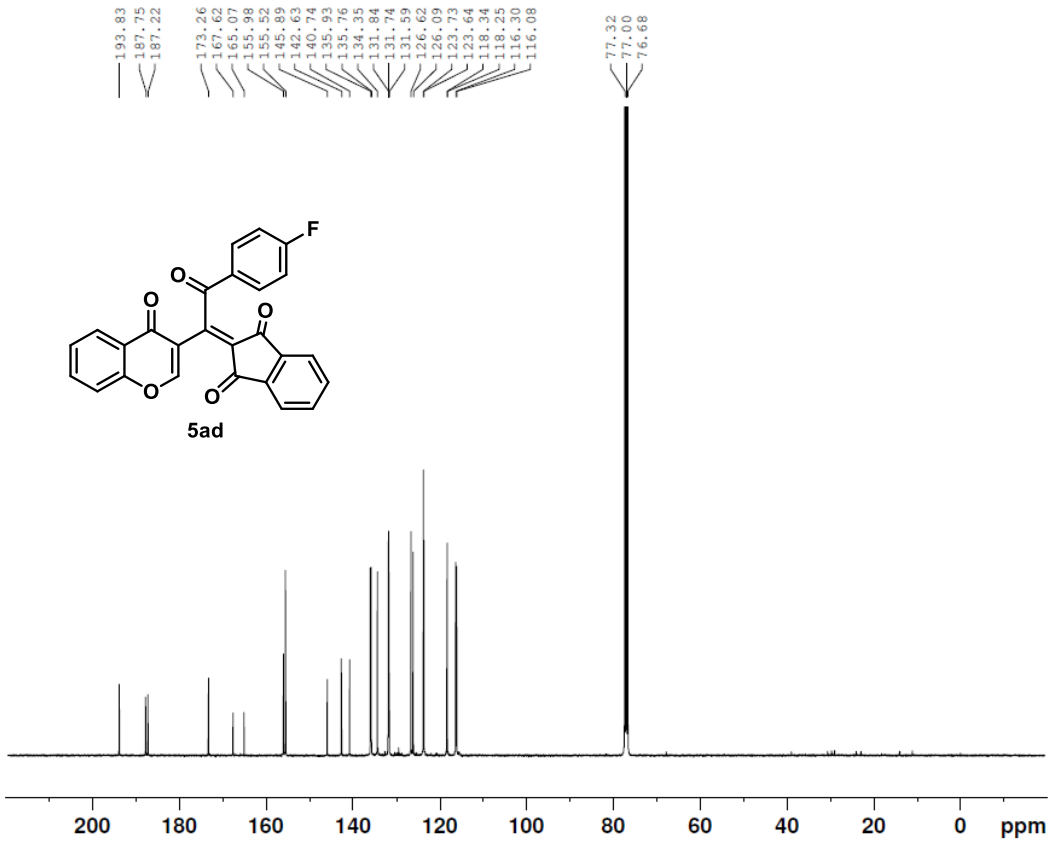

```
Current Data Parameters
NAME         DP-1161(3f)
EXPNO                  9
PROCNO                 1

F2 - Acquisition Parameters
Date_          20240527
Time              11.00
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG            zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7211.539 Hz
FIDRES         0.220079 Hz
AQ             2.2719147 sec
RG                198.09
DW                69.333 usec
DE                10.06 usec
TE                297.8 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300093 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ad** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1161(3f)
EXPNO                  7
PROCNO                 1

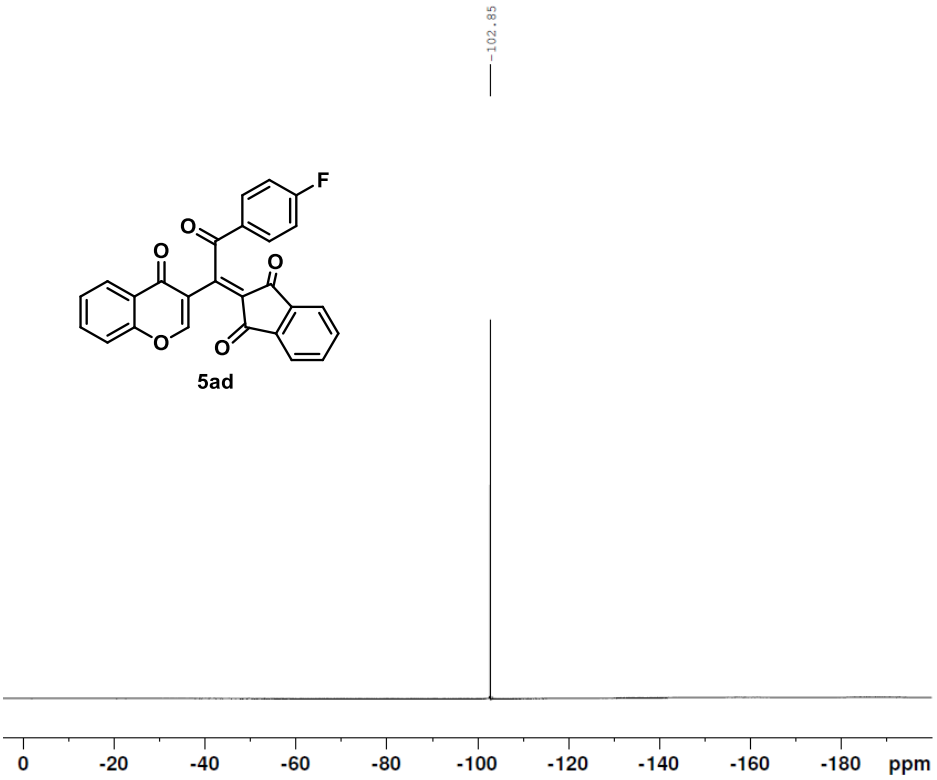
F2 - Acquisition Parameters
Date_          20240511
Time              23.52
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                20000
DS                    0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                299.3 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127715 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{19}F NMR spectrum of compound **5ad** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME         DP-1161(3f)
EXPNO                 10
PROCNO                 1

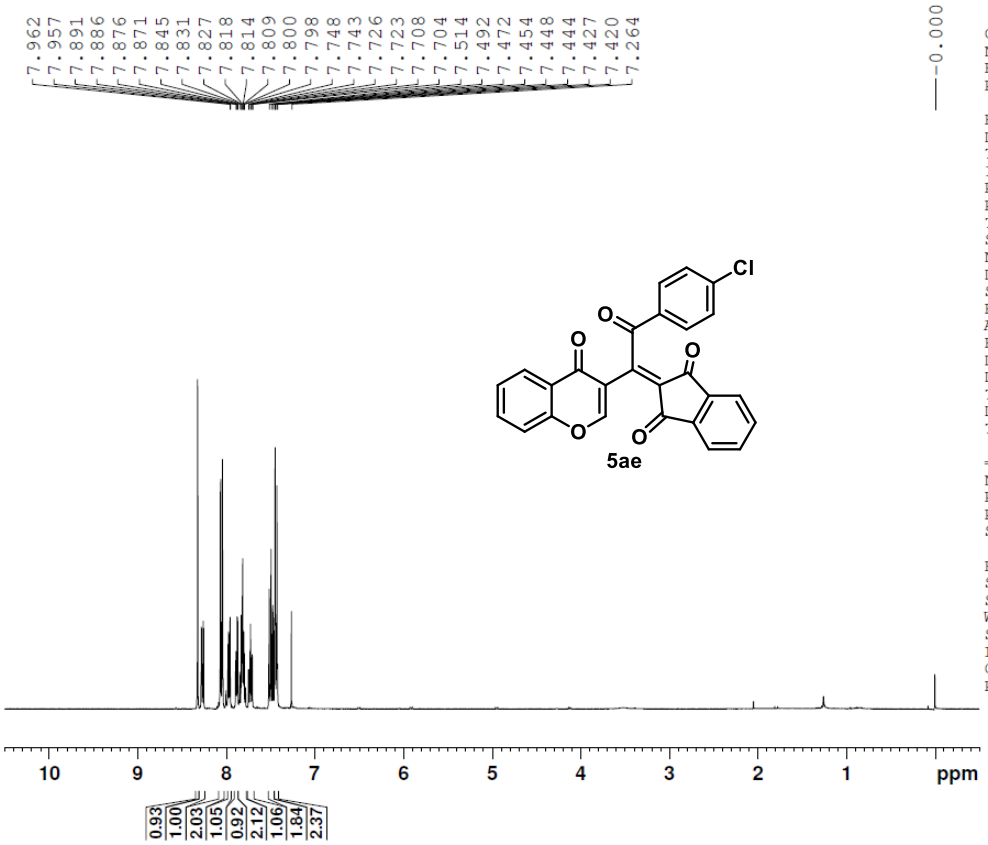
F2 - Acquisition Parameters
Date_           20240621
Time               10.50
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG            zgig
TD               131072
SOLVENT            CDCl3
NS                    16
DS                     0
SWH            89285.711 Hz
FIDRES          0.681196 Hz
AQ             0.7340032 sec
RG                198.09
DW                 5.600 usec
DE                 6.50 usec
TE                298.8 K
D1           1.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         376.4607168 MHz
NUC1                19F
P1                15.00 usec
PLW1        16.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W

F2 - Processing parameters
SI                 65536
SF           376.4983662 MHz
WDW                   EM
SSB                    0
LB                 1.00 Hz
GB                     0
PC                 1.00
```

^{1}H NMR spectrum of compound **5ae** ($CDCl_3$, 400 MHz)



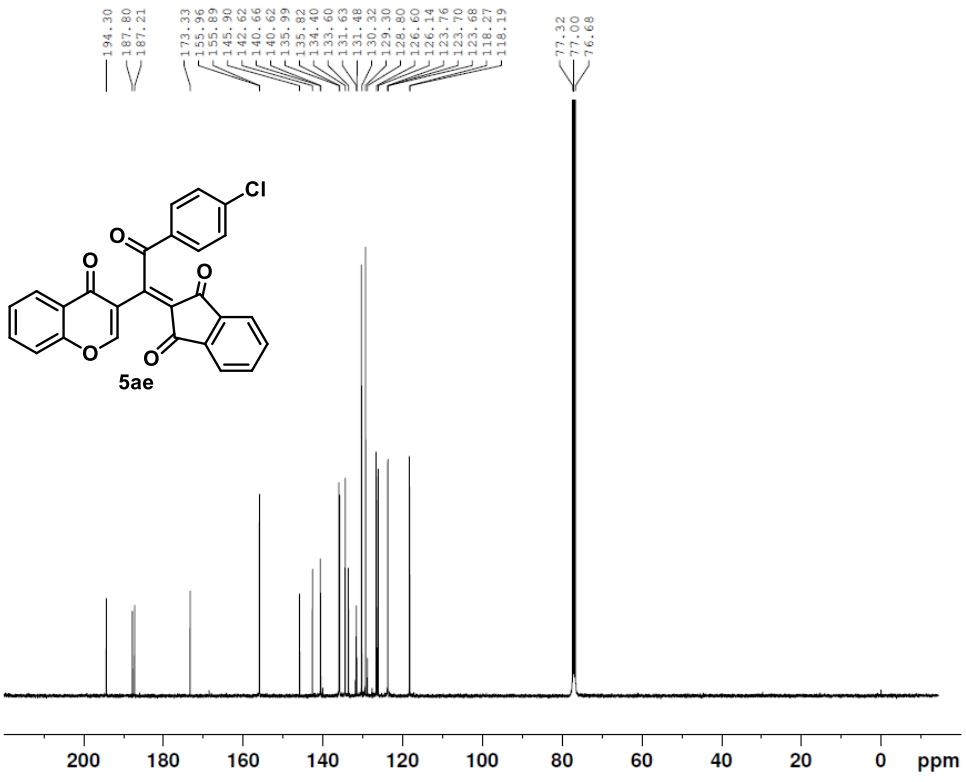

```
Current Data Parameters
NAME                  DP-1167
EXPNO                       1
PROCNO                      1

F2 - Acquisition Parameters
Date_               20240224
Time                   21.08
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                       16
DS                        0
SWH                7246.377 Hz
FIDRES             0.221142 Hz
AQ                 2.2609921 sec
RG                     228.1
DW                    69.000 usec
DE                     6.50 usec
TE                    295.4 K
D1                 2.00000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                       1H
P1                     15.00 usec
PL1                    11.10 dB
SFO1            400.1324008 MHz

F2 - Processing parameters
SI                      16384
SF                400.1300077 MHz
WDW                        EM
SSB                         0
LB                          0 Hz
GB                          0
PC                       1.00
```

^{13}C NMR spectrum of compound **5ae** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-1167
EXPNO                       2
PROCNO                      1

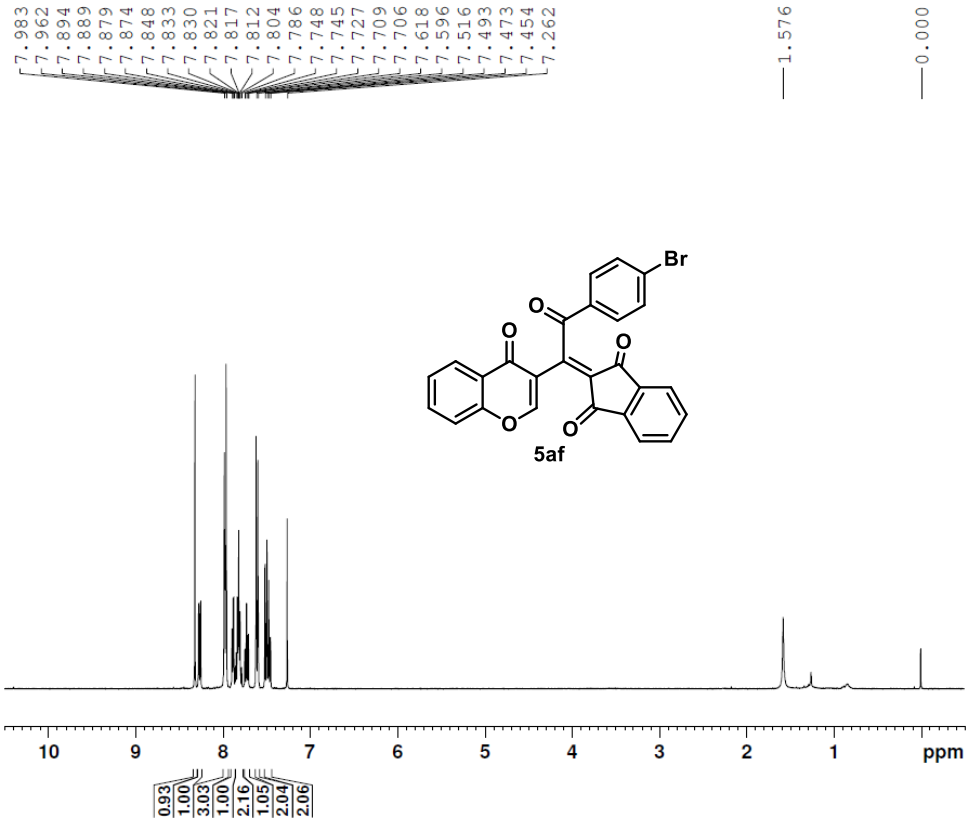
F2 - Acquisition Parameters
Date_               20240224
Time                   21.11
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG              zgpg30
TD                    32768
SOLVENT               CDCl3
NS                    20000
DS                        0
SWH               24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                     4096
DW                    20.800 usec
DE                     6.50 usec
TE                    295.8 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                     10.00 usec
PL1                     4.20 dB
SFO1            100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2             waltz16
NUC2                       1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2            400.1316005 MHz

F2 - Processing parameters
SI                      32768
SF                100.6127723 MHz
WDW                        EM
SSB                         0
LB                       1.00 Hz
GB                          0
PC                       1.00
```

^{1}H NMR spectrum of compound **5af** ($CDCl_3$, 400 MHz)



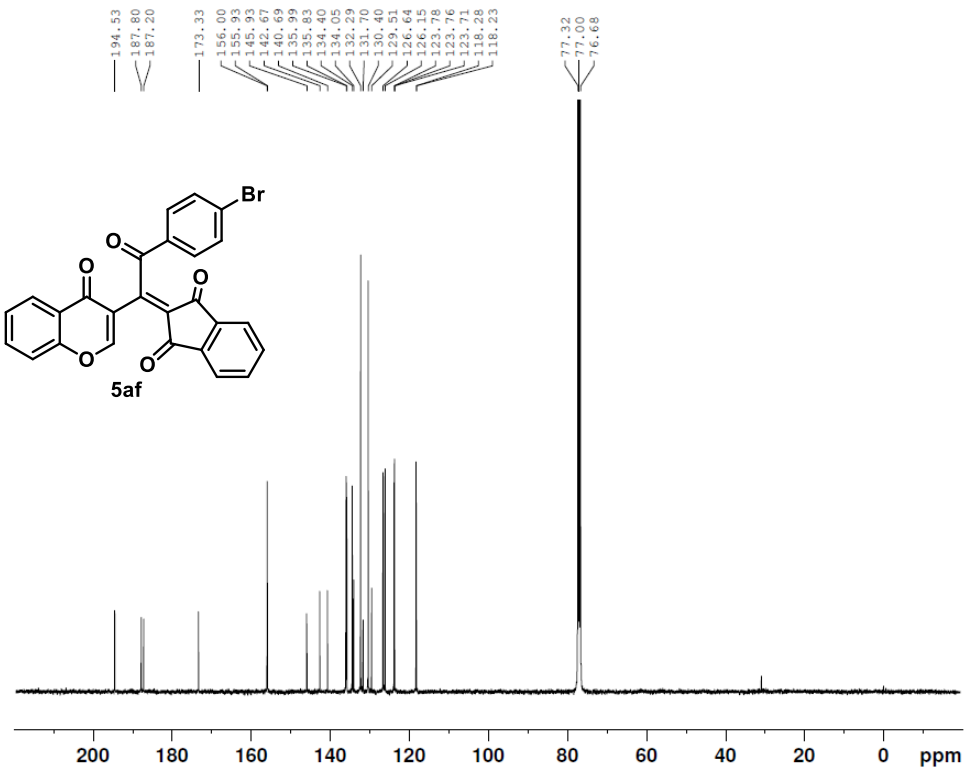

```
Current Data Parameters
NAME          JN-066(3f)
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240518
Time              21.13
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG            zg30
TD                32768
SOLVENT           CDCl3
NS                   16
DS                    0
SWH            7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG               158.74
DW               69.333 usec
DE                10.06 usec
TE                297.7 K
D1           2.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                  1H
P1                15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                16384
SF          400.1300093 MHz
WDW                  EM
SSB                   0
LB                    0 Hz
GB                    0
PC                 1.00
```

^{13}C NMR spectrum of compound **5af** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-066(3f)
EXPNO                  3
PROCNO                 1

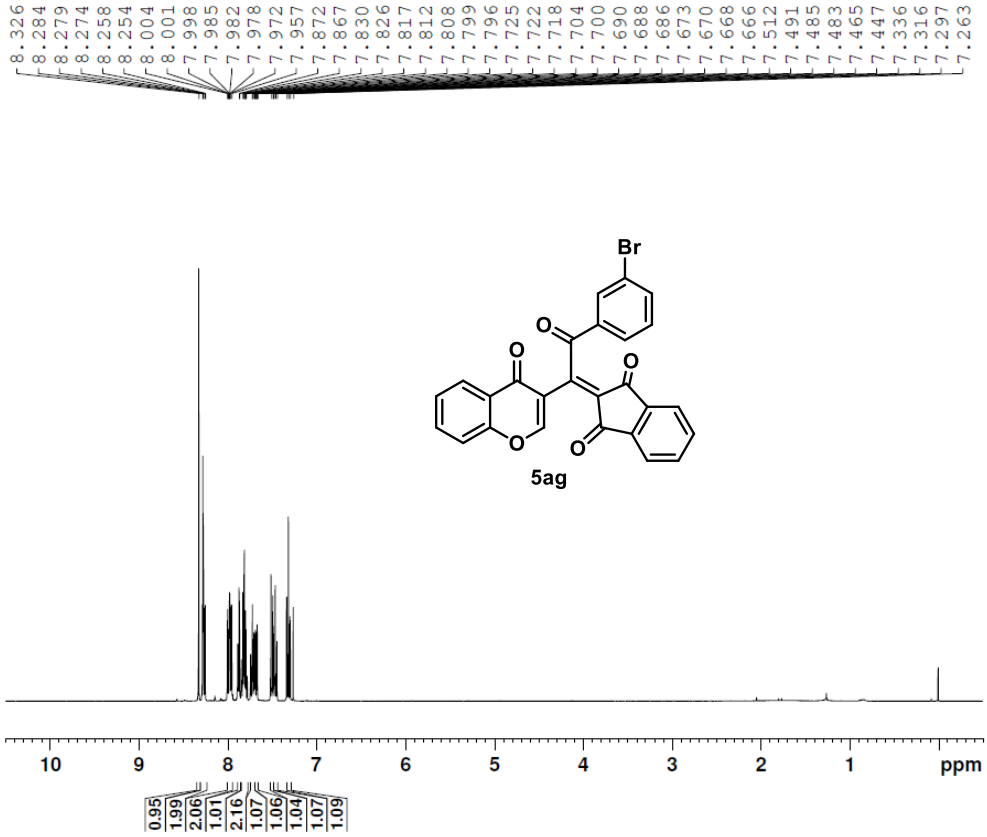
F2 - Acquisition Parameters
Date_           20240518
Time              21.15
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                24240
DS                    0
SWH           24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               198.09
DW               20.800 usec
DE                 6.50 usec
TE                297.8 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                  13C
P1                10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                  1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                32768
SF          100.6127695 MHz
WDW                  EM
SSB                   0
LB                 2.00 Hz
GB                    0
PC                 1.00
```

^{1}H NMR spectrum of compound **5ag** ($CDCl_3$, 400 MHz)



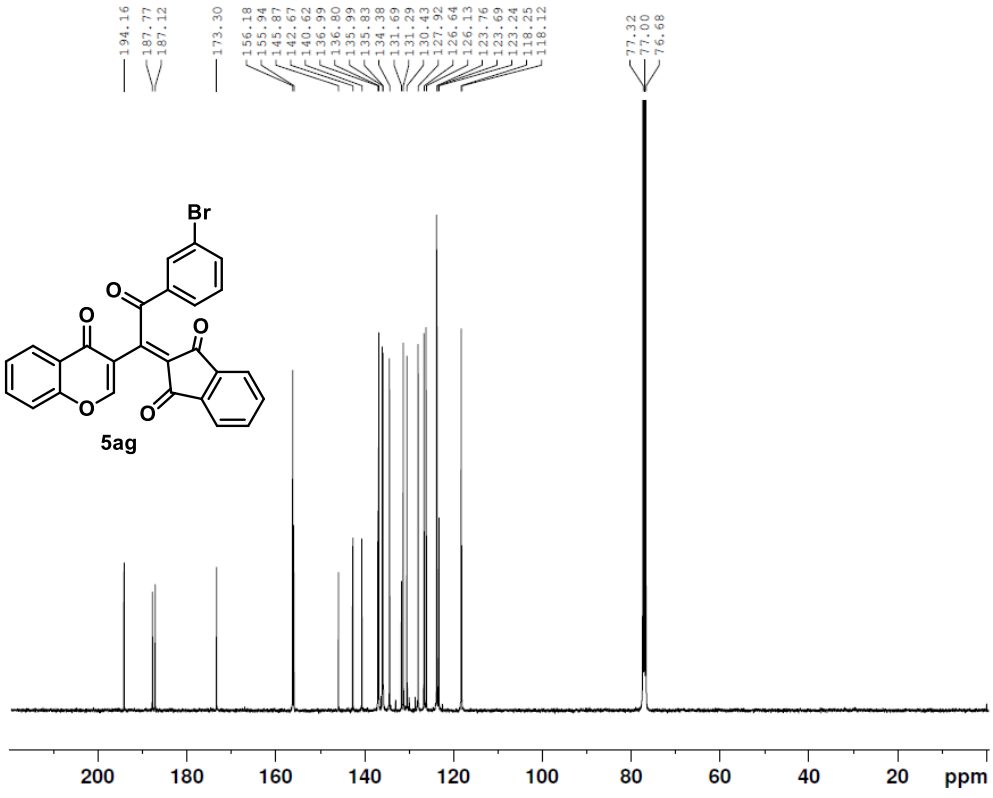

```
Current Data Parameters
NAME         DP-1164(3f)
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240223
Time               21.58
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                113.31
DW                69.333 usec
DE                10.06 usec
TE                298.3 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300084 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ag** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1164(3f)
EXPNO                  4
PROCNO                 1

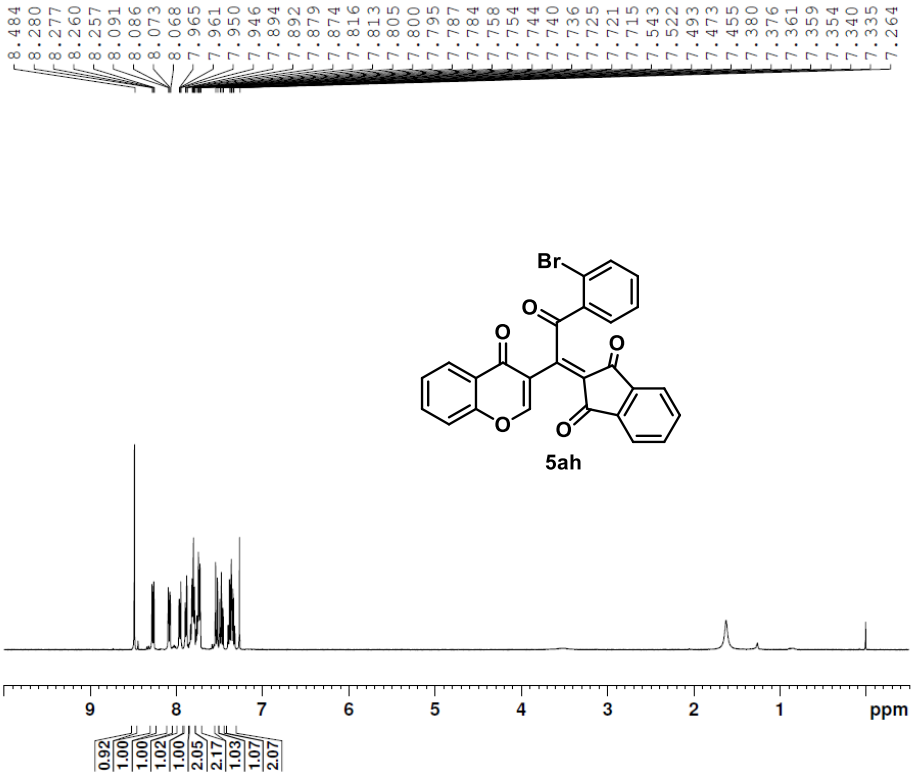
F2 - Acquisition Parameters
Date_           20240223
Time               22.00
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 13499
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.6 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127720 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ah** ($CDCl_3$, 400 MHz)



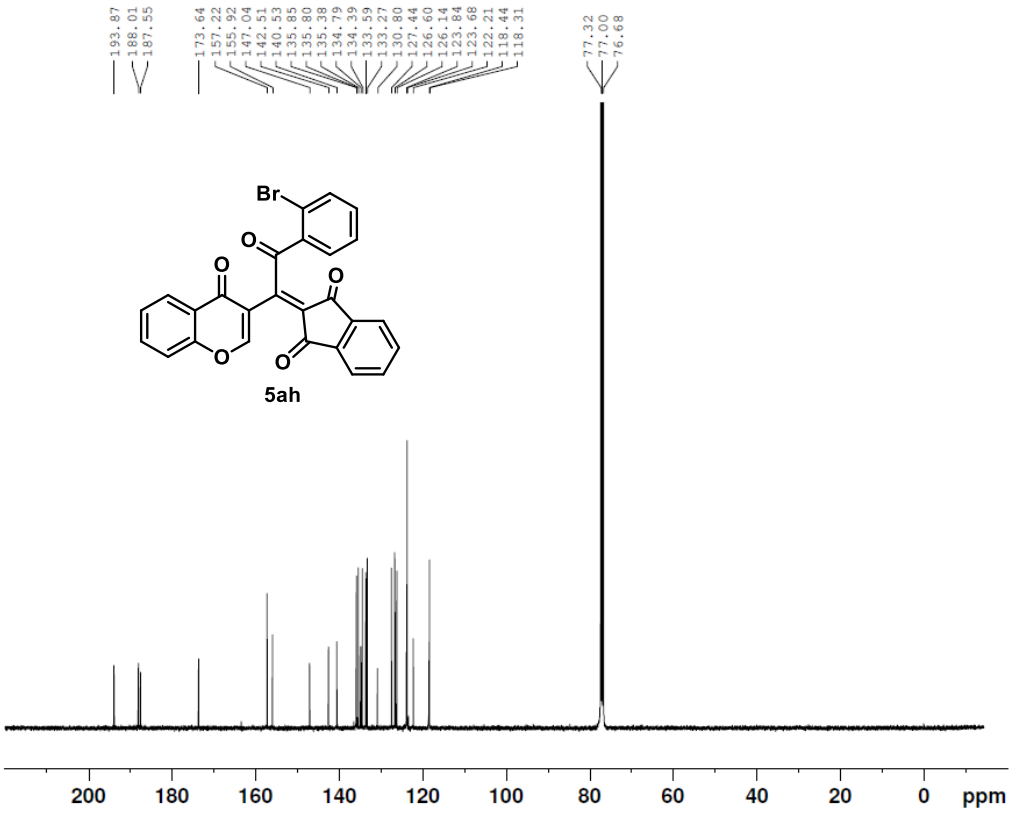

```
Current Data Parameters
NAME                  JN-056
EXPNO                      1
PROCNO                     1

F2 - Acquisition Parameters
Date_              20240513
Time                 21.55
INSTRUM              spect
PROBHD    5 mm BBO BB-1H
PULPROG              zg30
TD                  32768
SOLVENT             CDCl3
NS                     16
DS                      0
SWH             7246.377 Hz
FIDRES          0.221142 Hz
AQ              2.2609921 sec
RG                    256
DW                69.000 usec
DE                 6.50 usec
TE                295.8 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                  1H
P1                 15.00 usec
PL1                11.10 dB
SFO1         400.1324008 MHz

F2 - Processing parameters
SI                 16384
SF           400.1300075 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ah** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  JN-056
EXPNO                      2
PROCNO                     1

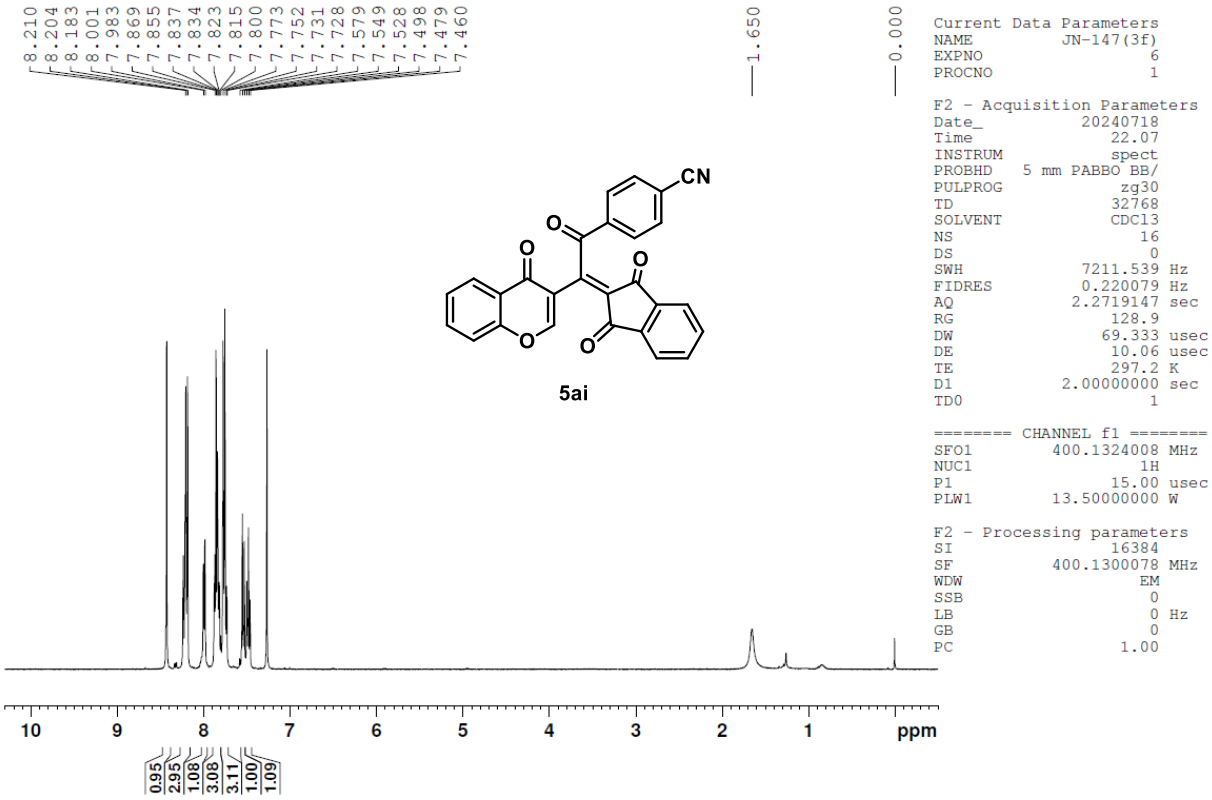
F2 - Acquisition Parameters
Date_              20240513
Time                 21.57
INSTRUM              spect
PROBHD    5 mm BBO BB-1H
PULPROG            zgpg30
TD                  32768
SOLVENT             CDCl3
NS                  17361
DS                      0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                   4096
DW                20.800 usec
DE                 6.50 usec
TE                295.9 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
NUC1                 13C
P1                 10.00 usec
PL1                 4.20 dB
SFO1         100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2         waltz16
NUC2                  1H
PCPD2              90.00 usec
PL2                10.20 dB
PL12               26.00 dB
PL13               29.00 dB
SFO2         400.1316005 MHz

F2 - Processing parameters
SI                 32768
SF           100.6127713 MHz
WDW                   EM
SSB                    0
LB                  1.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ai** ($CDCl_3$, 400 MHz)



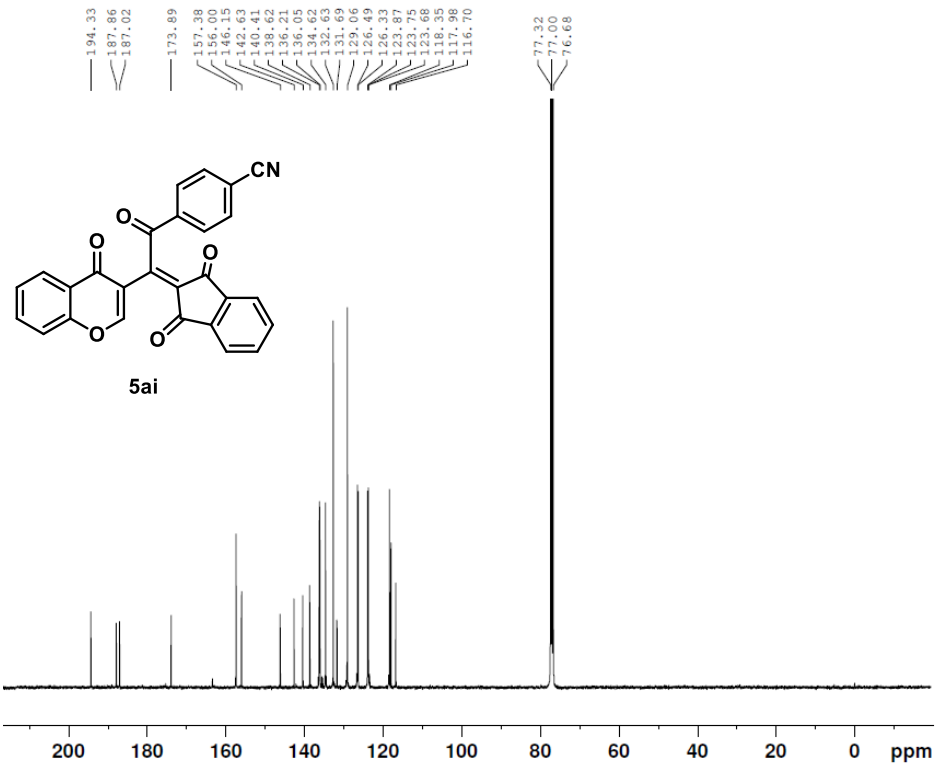

```
Current Data Parameters
NAME          JN-147(3f)
EXPNO                  6
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240718
Time               22.07
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 128.9
DW                69.333 usec
DE                 10.06 usec
TE                 297.2 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          400.1324008 MHz
NUC1                  1H
P1                 15.00 usec
PLW1          13.50000000 W

F2 - Processing parameters
SI                 16384
SF            400.1300078 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ai** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-147(3f)
EXPNO                  7
PROCNO                 1

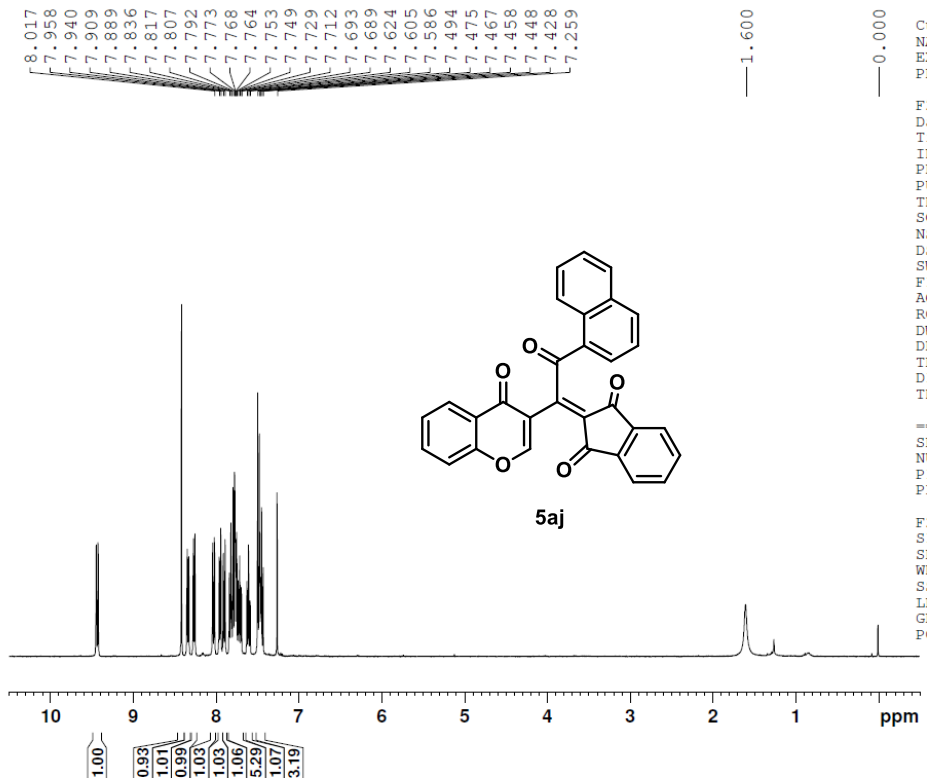
F2 - Acquisition Parameters
Date_           20240718
Time               22.09
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 15030
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                 198.09
DW                20.800 usec
DE                 6.50 usec
TE                 297.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          49.50000000 W

======== CHANNEL f2 ========
SFO2          400.1316005 MHz
NUC2                  1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2          12.50000000 W
PLW12          0.34722000 W
PLW13          0.28125000 W

F2 - Processing parameters
SI                 32768
SF            100.6127711 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5aj** ($CDCl_3$, 400 MHz)



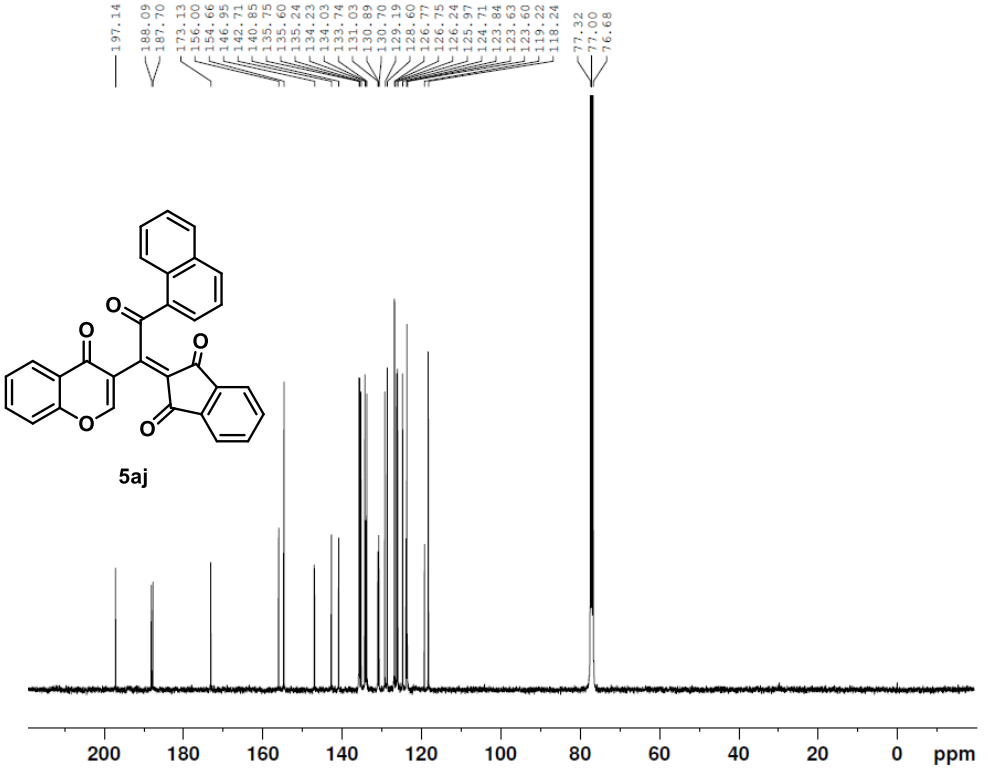

```
Current Data Parameters
NAME         DP-1259(3f)
EXPNO                  8
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240522
Time               22.04
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                144.49
DW                69.333 usec
DE                 10.06 usec
TE                 297.8 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300102 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5aj** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1259(3f)
EXPNO                  9
PROCNO                 1

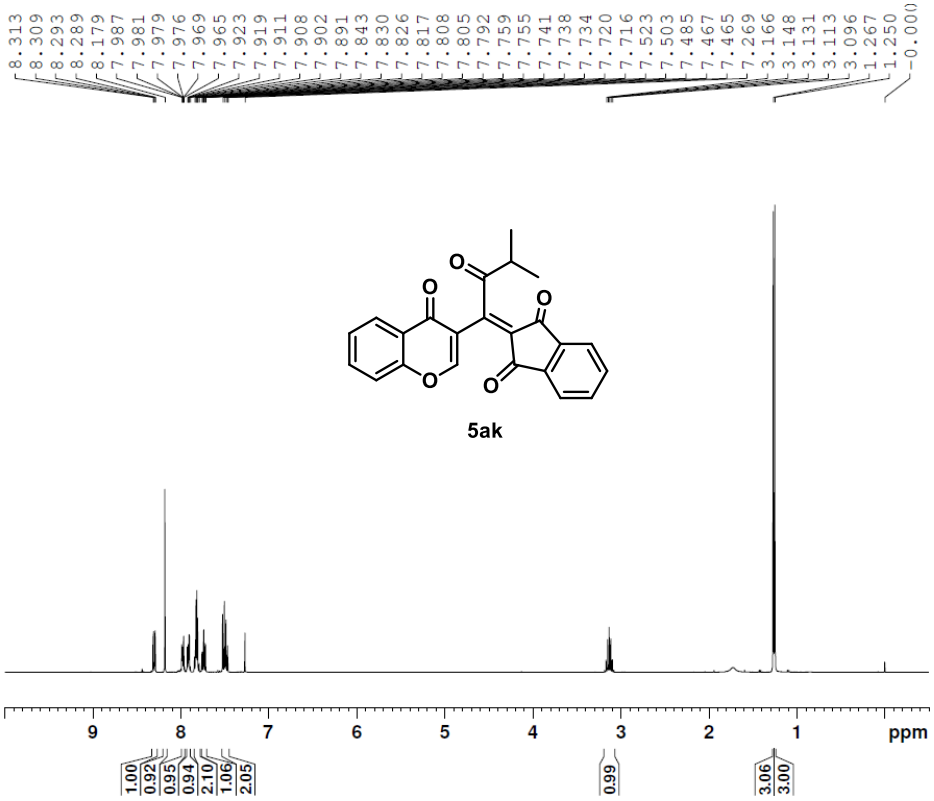
F2 - Acquisition Parameters
Date_           20240522
Time               22.07
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 15580
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                 297.8 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127701 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **5ak** ($CDCl_3$, 400 MHz)



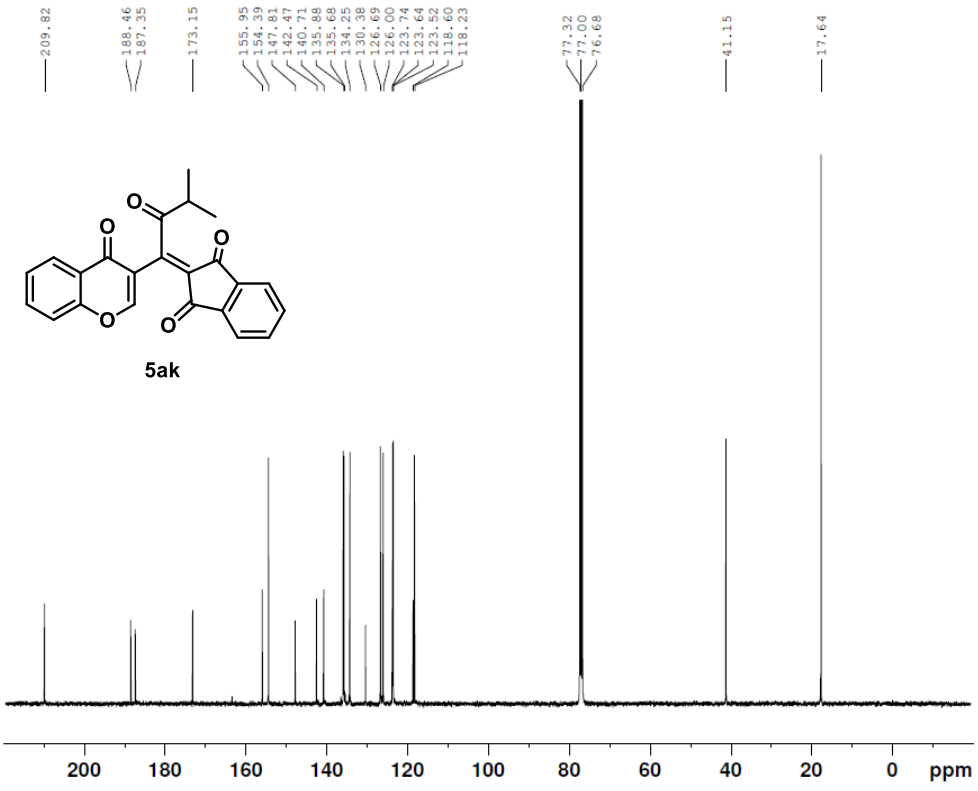

```
Current Data Parameters
NAME         DP-1166(3f)
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240511
Time               21.10
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                 99.72
DW                69.333 usec
DE                10.06 usec
TE                298.5 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          400.1324008 MHz
NUC1                  1H
P1                 15.00 usec
PLW1          13.50000000 W

F2 - Processing parameters
SI                 16384
SF            400.1300060 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **5ak** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME         DP-1166(3f)
EXPNO                  5
PROCNO                 1

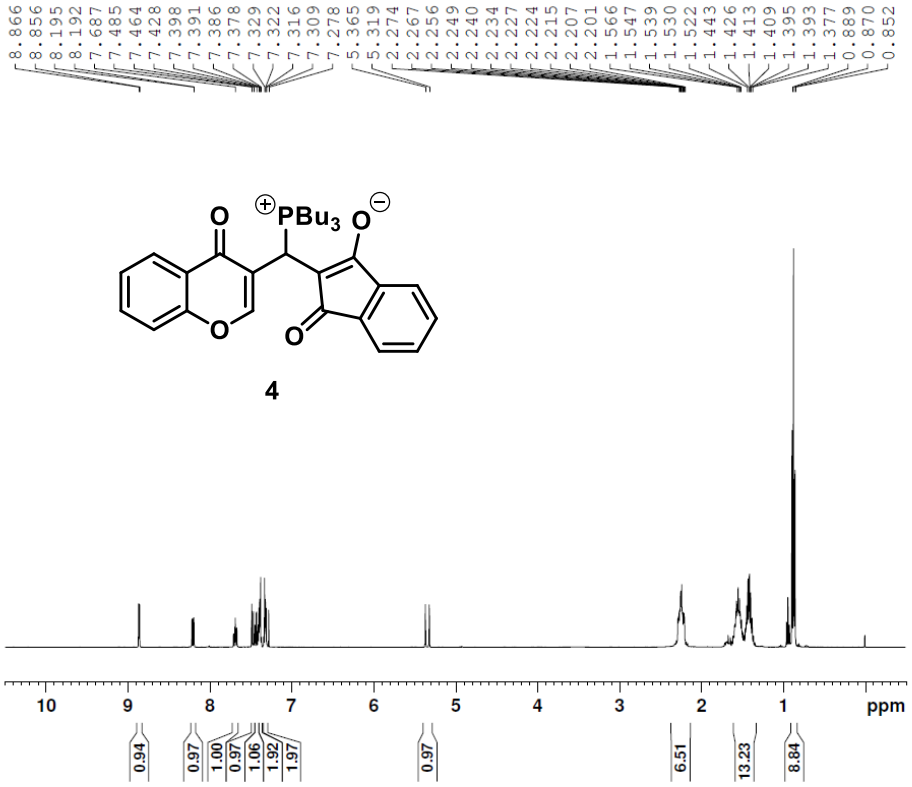
F2 - Acquisition Parameters
Date_           20240511
Time               21.12
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  3408
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.8 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1          49.50000000 W

======== CHANNEL f2 ========
SFO2          400.1316005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2          12.50000000 W
PLW12          0.34722000 W
PLW13          0.28125000 W

F2 - Processing parameters
SI                 32768
SF            100.6127709 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{1}H NMR spectrum of compound **4** ($CDCl_3$, 400 MHz)



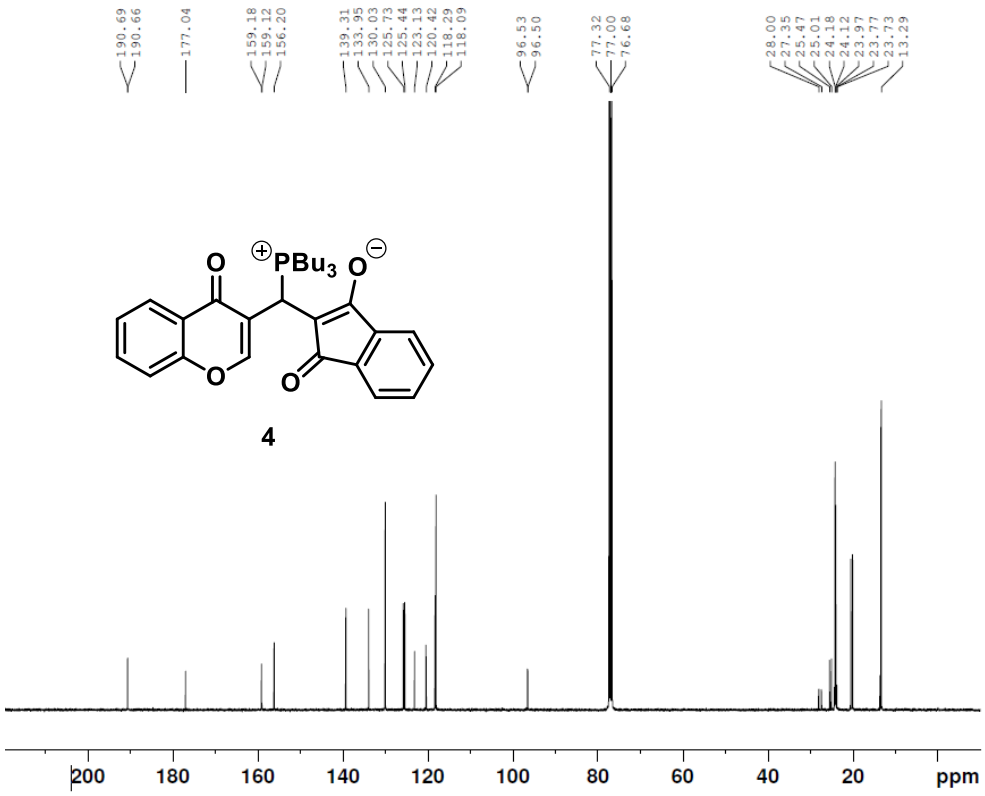

```
Current Data Parameters
NAME                  DP-1037
EXPNO                       6
PROCNO                      1

F2 - Acquisition Parameters
Date_               20240303
Time                   23.45
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG                zg30
TD                    32768
SOLVENT               CDCl3
NS                       16
DS                        0
SWH                7246.377 Hz
FIDRES             0.221142 Hz
AQ                 2.2609921 sec
RG                       114
DW                    69.000 usec
DE                     6.50 usec
TE                    298.2 K
D1                 2.00000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                      1H
P1                     15.00 usec
PL1                    11.10 dB
SFO1              400.1324008 MHz

F2 - Processing parameters
SI                     16384
SF                400.1300022 MHz
WDW                       EM
SSB                       0
LB                     0 Hz
GB                        0
PC                     1.00
```

^{13}C NMR spectrum of compound **4** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME                  DP-1037
EXPNO                       7
PROCNO                      1

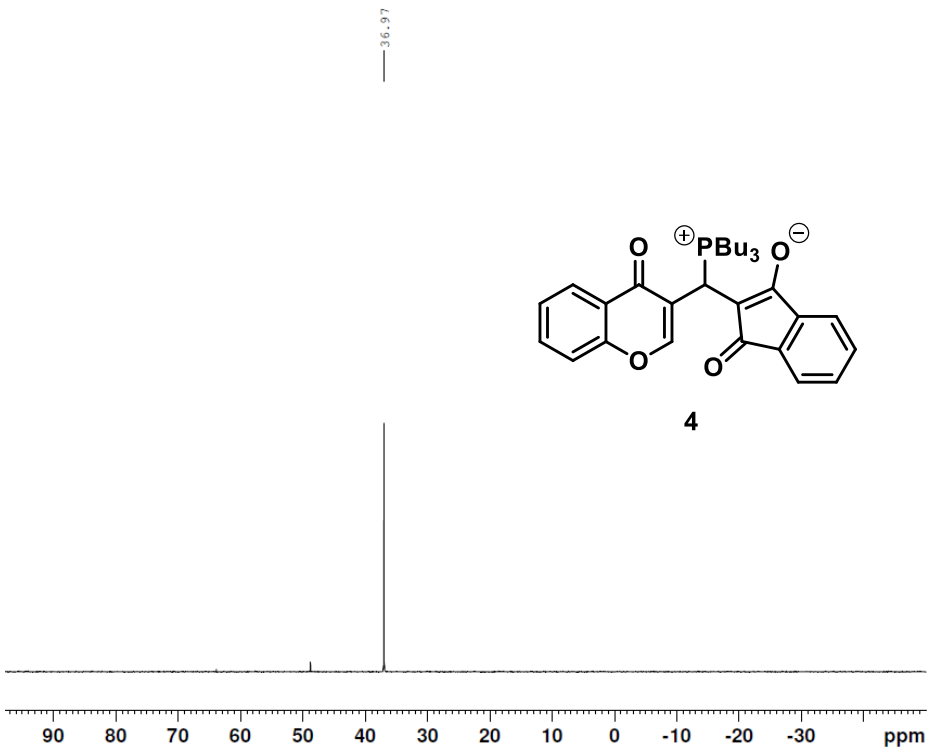
F2 - Acquisition Parameters
Date_               20240303
Time                   23.48
INSTRUM                spect
PROBHD    5 mm BBO BB-1H
PULPROG              zgpg30
TD                    32768
SOLVENT               CDCl3
NS                    13260
DS                        0
SWH               24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                     4096
DW                   20.800 usec
DE                     6.50 usec
TE                    298.3 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                       1

======== CHANNEL f1 ========
NUC1                     13C
P1                     10.00 usec
PL1                     4.20 dB
SFO1              100.6233325 MHz

======== CHANNEL f2 ========
CPDPRG[2             waltz16
NUC2                      1H
PCPD2                  90.00 usec
PL2                    10.20 dB
PL12                   26.00 dB
PL13                   29.00 dB
SFO2              400.1316005 MHz

F2 - Processing parameters
SI                     32768
SF                100.6127719 MHz
WDW                       EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.00
```

^{31}P NMR spectrum of compound **4** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1150(3f)
EXPNO                  7
PROCNO                 1

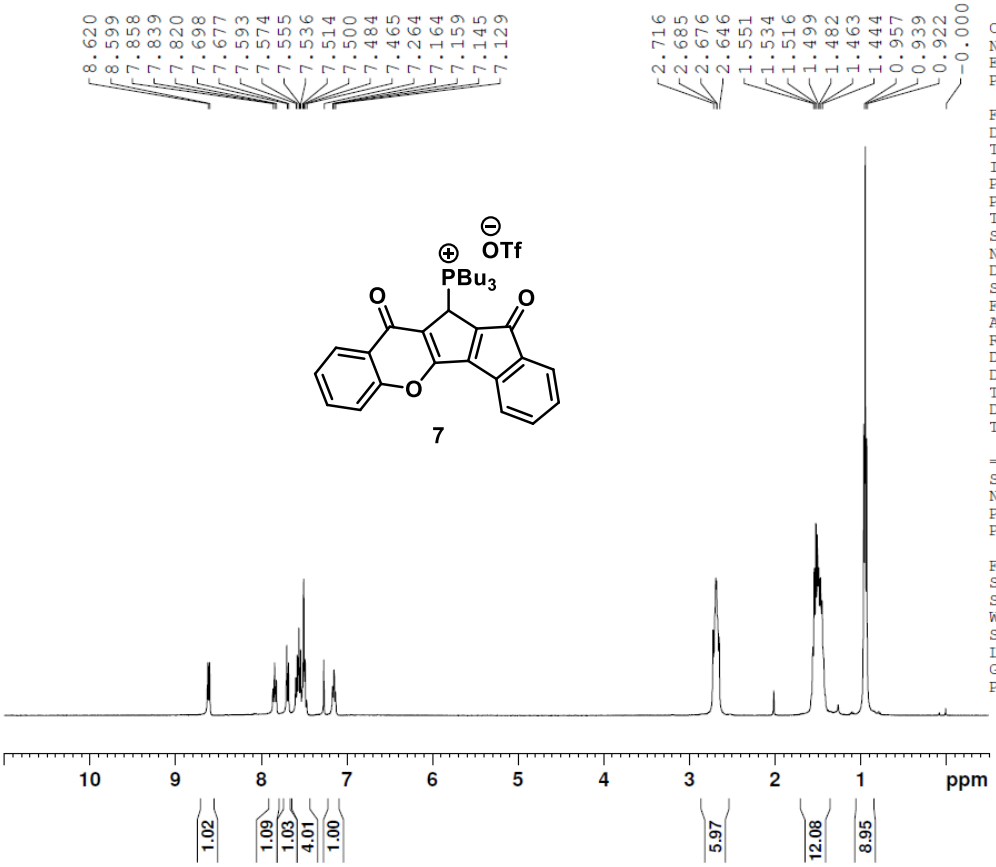
F2 - Acquisition Parameters
Date_           20240311
Time               11.20
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    4
SWH           49019.609 Hz
FIDRES         0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                298.4 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                EM
SSB                 0
LB                2.00 Hz
GB                  0
PC                1.40
```

^{1}H NMR spectrum of compound **7** ($CDCl_3$, 400 MHz)



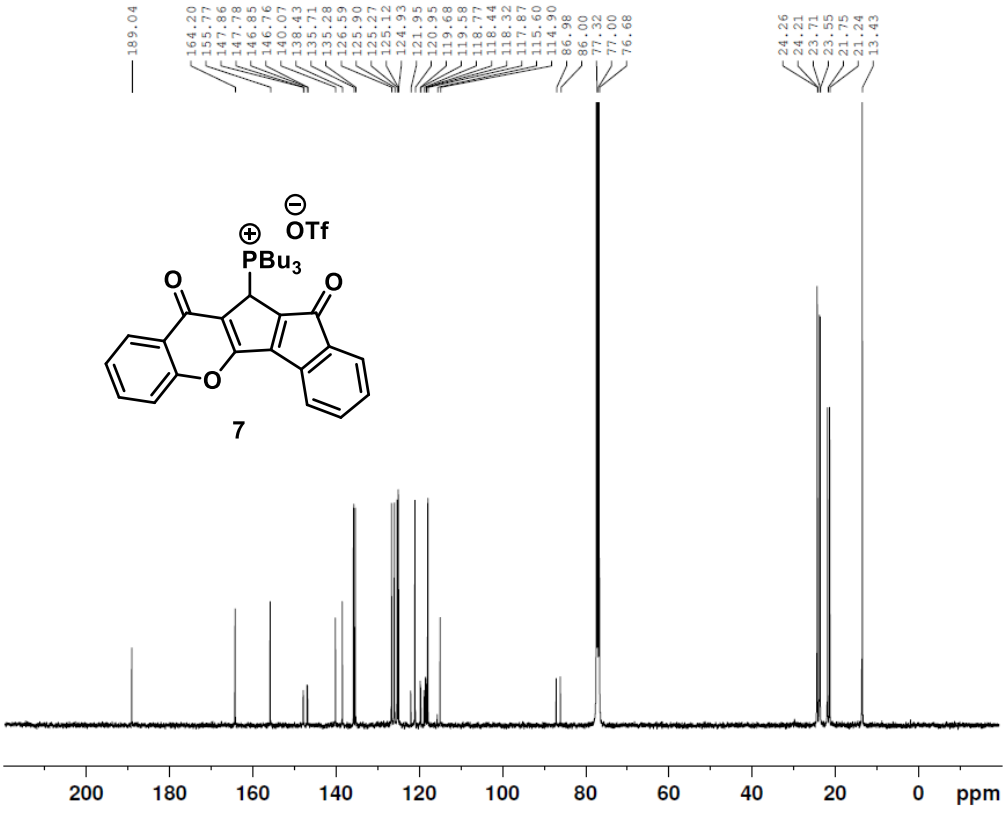

```
Current Data Parameters
NAME          DP-1300(3f)
EXPNO                   4
PROCNO                  1

F2 - Acquisition Parameters
Date_           20240611
Time               22.12
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                    16
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ             2.2719147 sec
RG                 99.72
DW                69.333 usec
DE                 10.06 usec
TE                 300.5 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300083 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **7** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          DP-1300(3f)
EXPNO                   5
PROCNO                  1

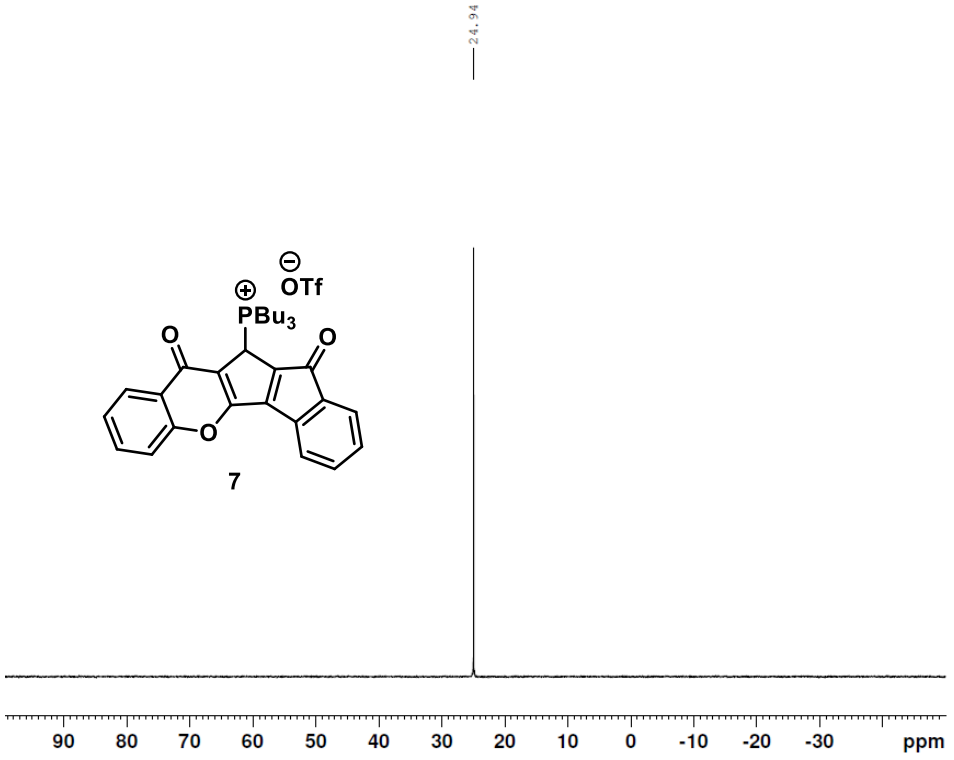
F2 - Acquisition Parameters
Date_           20240611
Time               22.14
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 15932
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                 300.5 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127698 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **7** ($CDCl_3$, 162 MHz)




```
Current Data Parameters
NAME         DP-1300(3f)
EXPNO                  1
PROCNO                 1

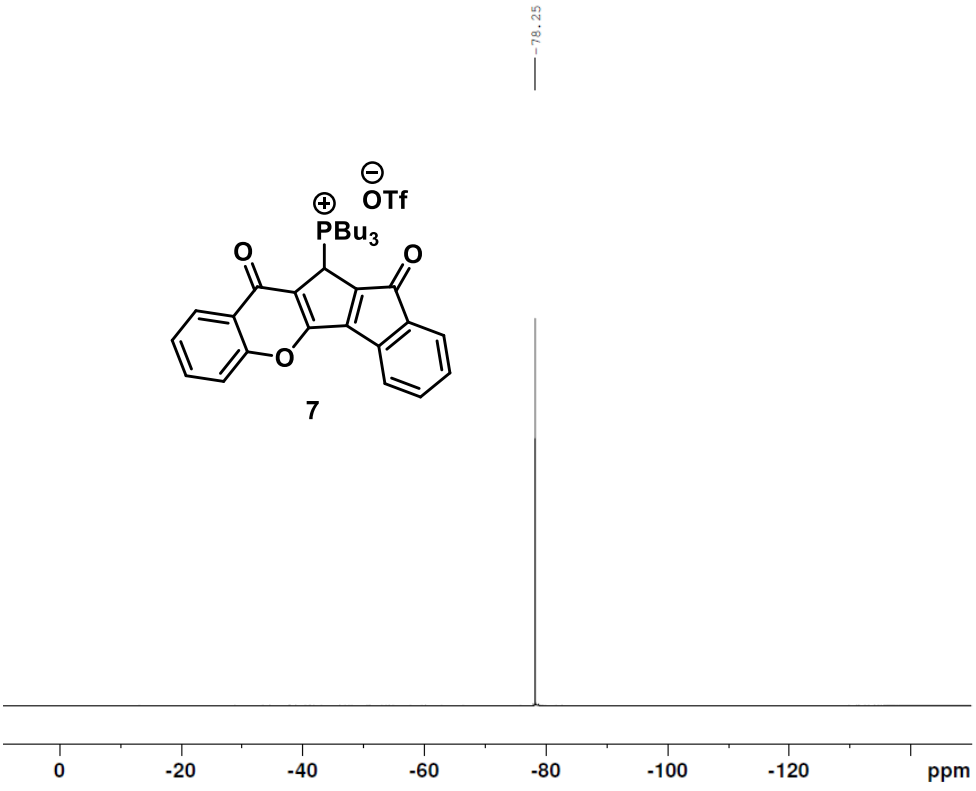
F2 - Acquisition Parameters
Date_           20240611
Time              21.41
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD               65536
SOLVENT          CDCl3
NS                   7
DS                   4
SWH          49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG              198.09
DW              10.200 usec
DE               6.50 usec
TE              300.5 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1               31P
P1               15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2            90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                EM
SSB                 0
LB               2.00 Hz
GB                  0
PC                1.40
```

^{19}F NMR spectrum of compound **7** ($CDCl_3$, 376 MHz)




```
Current Data Parameters
NAME         DP-1300(3f)
EXPNO                  3
PROCNO                 1

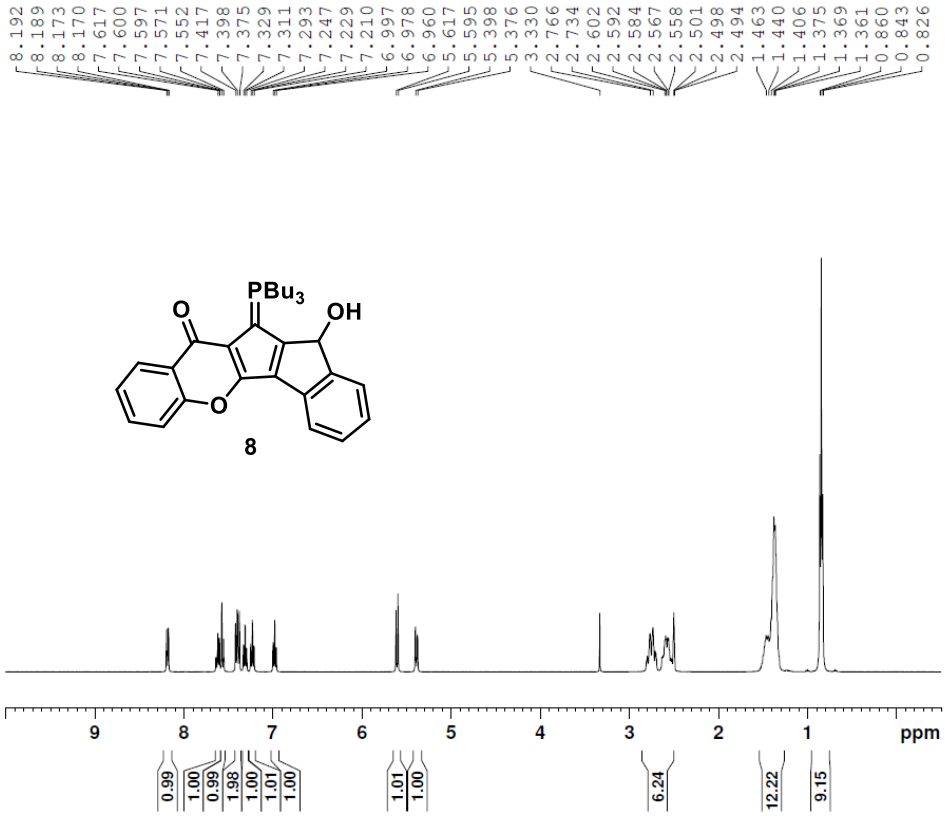
F2 - Acquisition Parameters
Date_           20240611
Time              21.45
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG            zgig
TD               131072
SOLVENT          CDCl3
NS                  16
DS                   0
SWH          89285.711 Hz
FIDRES        0.681196 Hz
AQ            0.7340032 sec
RG              198.09
DW               5.600 usec
DE               6.50 usec
TE              300.6 K
D1           1.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        376.4607168 MHz
NUC1               19F
P1               15.00 usec
PLW1        16.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2            90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W

F2 - Processing parameters
SI                 65536
SF          376.4983662 MHz
WDW                EM
SSB                 0
LB               1.00 Hz
GB                  0
PC                1.00
```

^{1}H NMR spectrum of compound **8** (DMSO, 400 MHz)



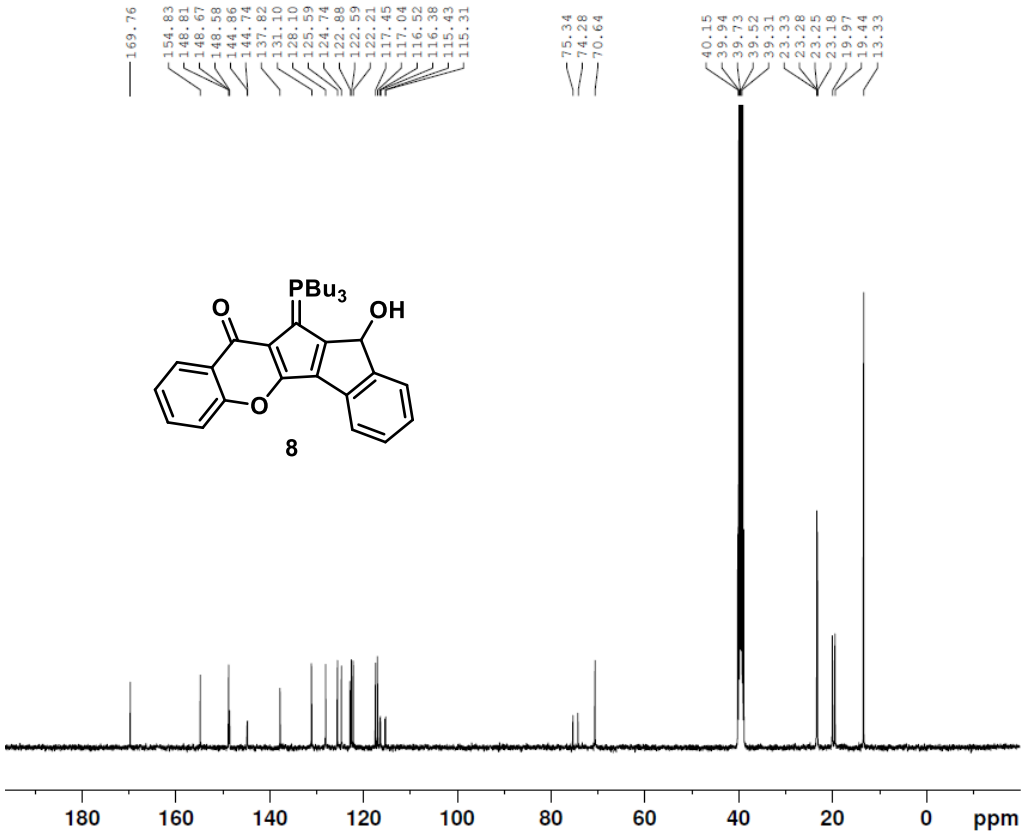

```
Current Data Parameters
NAME          JN-085(3f)
EXPNO                 19
PROCNO                 1

F2 - Acquisition Parameters
Date_          20240719
Time              17.13
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG            zg30
TD                32768
SOLVENT            DMSO
NS                    16
DS                     0
SWH            7211.539 Hz
FIDRES        0.220079 Hz
AQ            2.2719147 sec
RG                71.42
DW              69.333 usec
DE               10.06 usec
TE               296.9 K
D1            2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1        13.50000000 W

F2 - Processing parameters
SI                 16384
SF          400.1300042 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **8** (DMSO, 100 MHz)




```
Current Data Parameters
NAME          JN-085(3f)
EXPNO                 20
PROCNO                 1

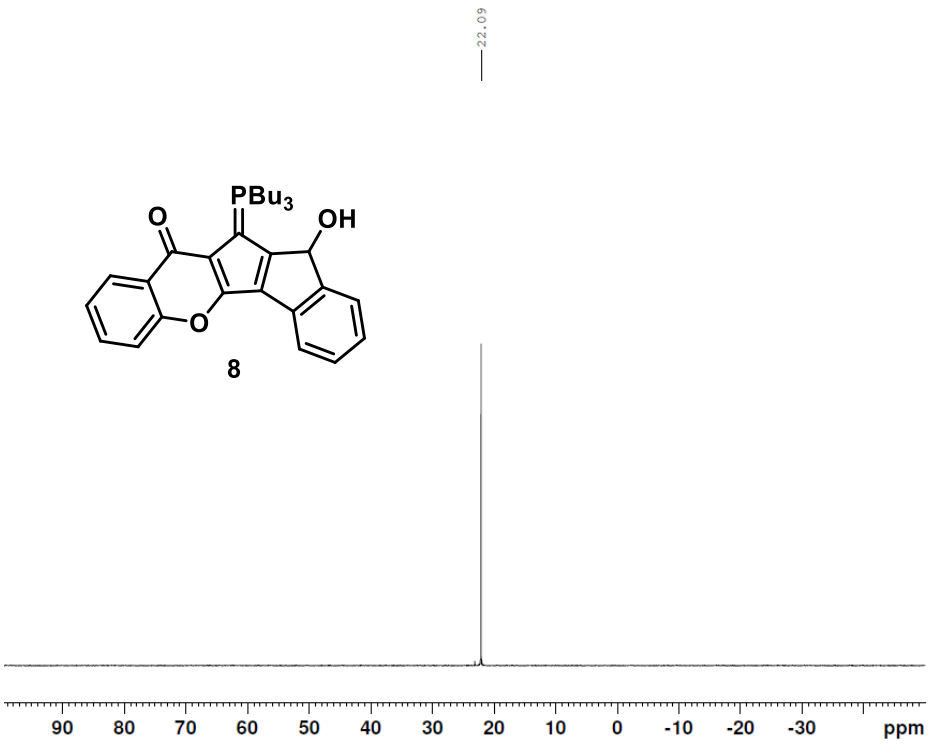
F2 - Acquisition Parameters
Date_          20240719
Time              17.16
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT            DMSO
NS                  1465
DS                     0
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ            0.6815744 sec
RG                198.09
DW              20.800 usec
DE                6.50 usec
TE               296.9 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        100.6228298 MHz
NUC1                  13C
P1                 10.00 usec
PLW1        49.50000000 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                   1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          100.6128210 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```

^{31}P NMR spectrum of compound **8** (DMSO, 162 MHz)




```
Current Data Parameters
NAME          JN-085(3f)
EXPNO                 21
PROCNO                 1

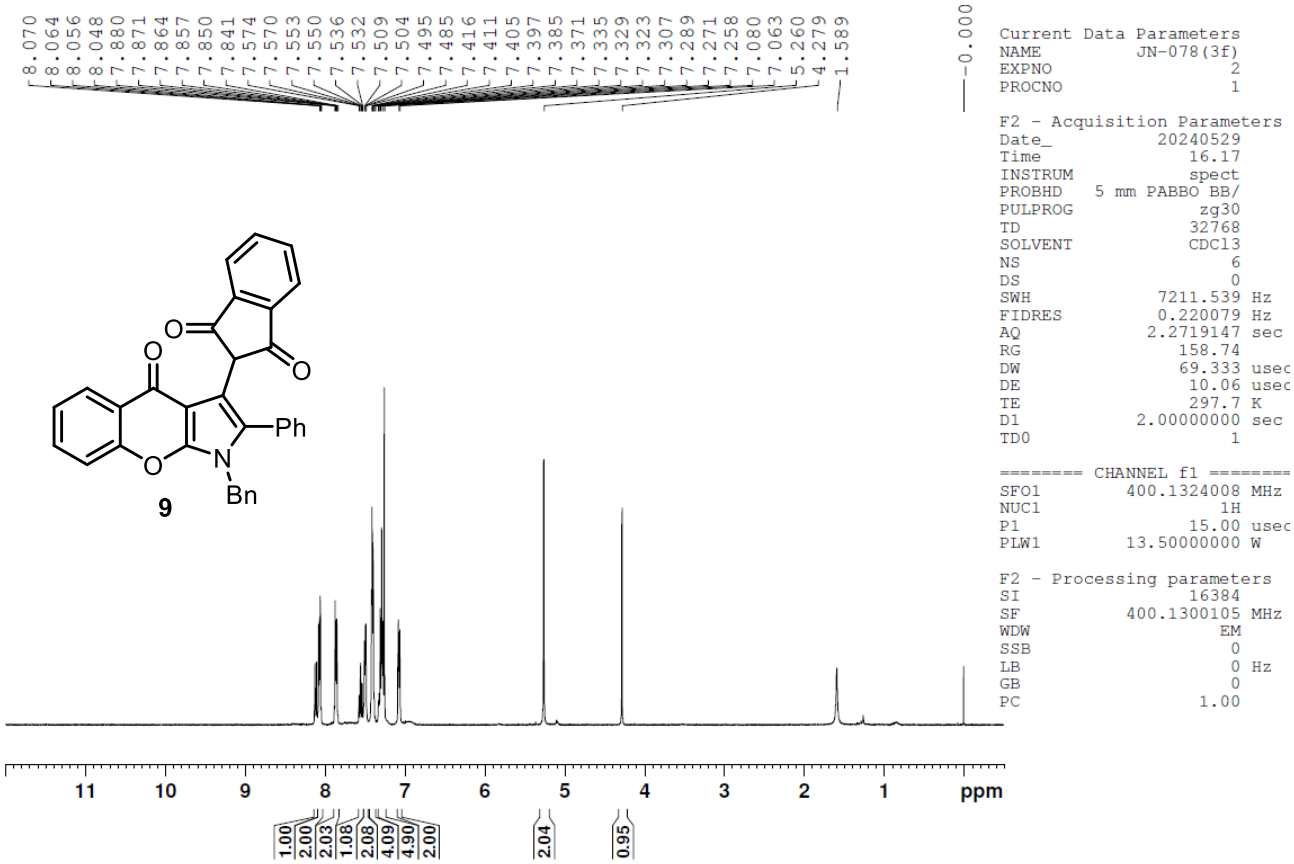
F2 - Acquisition Parameters
Date_           20240721
Time              11.31
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD                65536
SOLVENT             DMSO
NS                    16
DS                     4
SWH           49019.609 Hz
FIDRES        0.747980 Hz
AQ            0.6684672 sec
RG               198.09
DW               10.200 usec
DE                6.50 usec
TE                297.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        161.9836917 MHz
NUC1                31P
P1                15.00 usec
PLW1        13.19999981 W

======== CHANNEL f2 ========
SFO2        400.1316005 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.50000000 W
PLW12        0.34722000 W
PLW13        0.28125000 W

F2 - Processing parameters
SI                 32768
SF          161.9755930 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.40
```

^{1}H NMR spectrum of compound **9** ($CDCl_3$, 400 MHz)



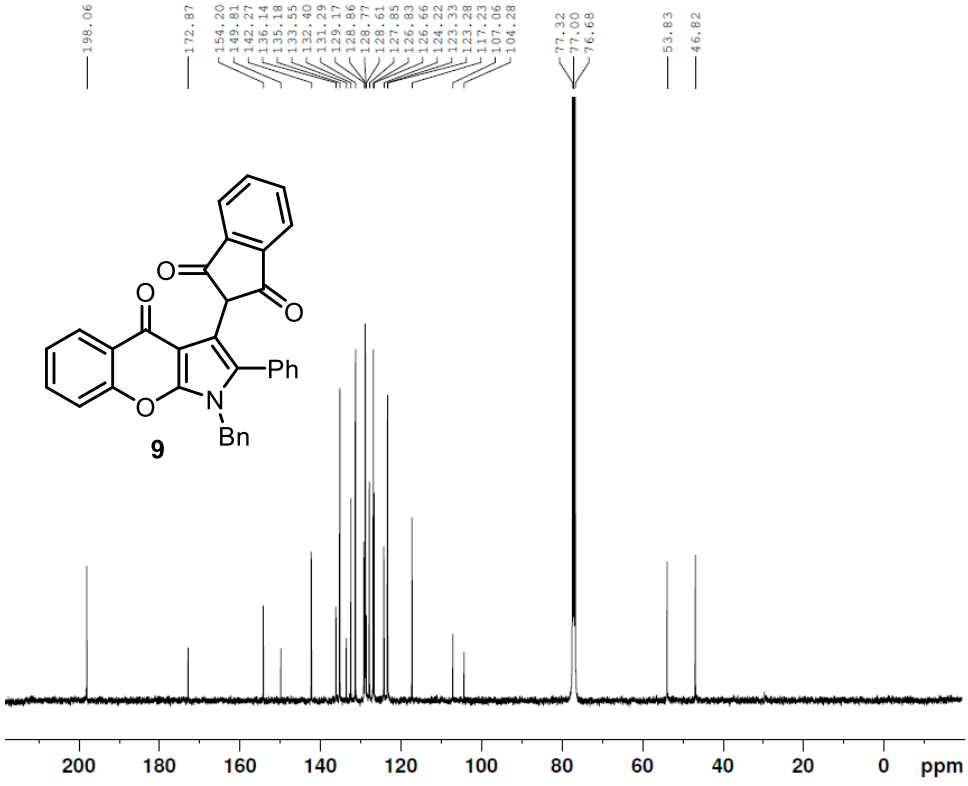

```
Current Data Parameters
NAME          JN-078(3f)
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240529
Time               16.17
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG             zg30
TD                 32768
SOLVENT            CDCl3
NS                     6
DS                     0
SWH             7211.539 Hz
FIDRES          0.220079 Hz
AQ              2.2719147 sec
RG                158.74
DW                69.333 usec
DE                10.06 usec
TE                297.7 K
D1             2.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         400.1324008 MHz
NUC1                   1H
P1                 15.00 usec
PLW1         13.50000000 W

F2 - Processing parameters
SI                 16384
SF           400.1300105 MHz
WDW                   EM
SSB                    0
LB                     0 Hz
GB                     0
PC                  1.00
```

^{13}C NMR spectrum of compound **9** ($CDCl_3$, 100 MHz)




```
Current Data Parameters
NAME          JN-078(3f)
EXPNO                  9
PROCNO                 1

F2 - Acquisition Parameters
Date_           20240530
Time               22.22
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT            CDCl3
NS                 14252
DS                     0
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                198.09
DW                20.800 usec
DE                 6.50 usec
TE                298.2 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6228298 MHz
NUC1                   13C
P1                 10.00 usec
PLW1         49.50000000 W

======== CHANNEL f2 ========
SFO2         400.1316005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         12.50000000 W
PLW12         0.34722000 W
PLW13         0.28125000 W

F2 - Processing parameters
SI                 32768
SF           100.6127696 MHz
WDW                   EM
SSB                    0
LB                  2.00 Hz
GB                     0
PC                  1.00
```