Supporting Information for

Rh(III)-Catalyzed Substrate-Dependent Oxidative (Spiro)annulation of Isoquinolones with Diazonaphthoquinones: Selective Access to New Spirocyclic and Oxepine-Fused Polycyclic Compounds

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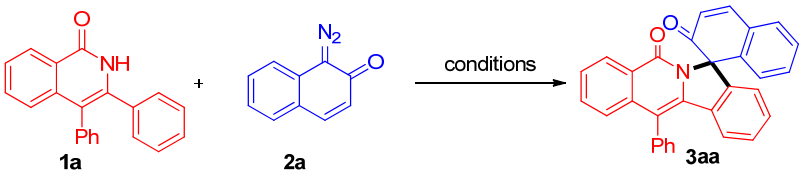
1. General Information

Isoquinolones (**1**),[1] diazo compounds (**2**),[2] and $[Cp^*RhCl_2]_2$[3] were prepared according to the reported procedures. Unless noted, other commercial reagents and solvents were used without further purification. Melting points were recorded with a micro melting point apparatus and uncorrected. The ^1H NMR spectra were recorded at 400 or 600 MHz. The ^{13}C NMR spectra were recorded at 100 or 150 MHz. High-resolution mass spectra (HRMS) were collected in ESI mode by using a MicrOTOF mass spectrometer. All reactions were monitored by thin-layer chromatography (TLC) using silica gel plates (silica gel 60 F254 0.25 mm), and components were visualized by observation under UV light (254 and 365 nm).

2. Table S1. Detailed Optimization Table for Synthesis of Spirocyclic Product 3aa[a]

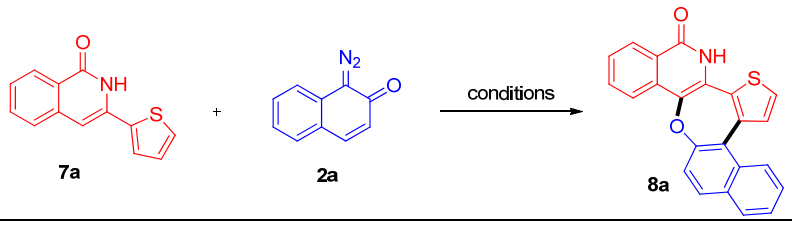


entry	catalyst	oxidant	additive	solvent	yield (%)[b]
1	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	1,4-dioxane	27
2	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	DCE	32
3	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	DCM	23
4	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	$CHCl_3$	24
5	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	$PhCH_3$	0
6	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	$PhCF_3$	0
7	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	PhCl	27
8	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	CH_3CN	48
9	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	THF	28
10	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	acetone	21
11	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	EA	10
12	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	MeOH	35
13	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	EtOH	26
14	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	^{i}PrOH	0
15	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	DMSO	0
16	$[Cp^*RhCl_2]_2$	AgOAc	PivOH	DMF	58
17	$[Cp^*RhCl_2]_2$	AgOAc	HOAc	DMF	40
18	$[Cp^*RhCl_2]_2$	AgOAc	$PhCO_2H$	DMF	38
19	$[Cp^*RhCl_2]_2$	AgOAc	$MesCO_2H$	DMF	40
20	$[Cp^*RhCl_2]_2$	AgOAc	1-$AdCO_2H$	DMF	52
21	$[Cp^*RhCl_2]_2$	AgOAc	TfOH	DMF	10
22	$[Cp^*RhCl_2]_2$	AgOAc	TFA	DMF	0
23	$[Cp^*RhCl_2]_2$	AgF	PivOH	DMF	55
24	$[Cp^*RhCl_2]_2$	Ag_2CO_3	PivOH	DMF	33

25	**$[Cp^*RhCl_2]_2$**	**Ag_2O**	**PivOH**	**DMF**	**75**
26	$[Cp^*RhCl_2]_2$	$K_2S_2O_8$	PivOH	DMF	0
27	$[Cp^*RhCl_2]_2$	$Cu(OAc)_2$	PivOH	DMF	0
28	$[Cp^*IrCl_2]_2$	Ag_2O	PivOH	DMF	66
29	$[Cp^*Co(CO)I_2]$	Ag_2O	PivOH	DMF	0
30	$[Cp^*Rh(CH_3CN)_3](SbF_6)_2$	Ag_2O	PivOH	DMF	41
31	$RhCl_3 \cdot 3H_2O$	Ag_2O	PivOH	DMF	0
32	$[RuCl_2(p\text{-cymene})]_2$	Ag_2O	PivOH	DMF	0
33	$Pd(OAc)_2$	Ag_2O	PivOH	DMF	0
34		Ag_2O	PivOH	DMF	0
35	$[Cp^*RhCl_2]_2$		PivOH	DMF	0
36	$[Cp^*RhCl_2]_2$	Ag_2O		DMF	46
37[c]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	0
38[d]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	25
39[e]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	12
40[f]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	38
41[g]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	29
42[h]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	62
43[i]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	48
44[j]	$[Cp^*RhCl_2]_2$	Ag_2O	PivOH	DMF	44

[a]The reactions were run with: **1a** (0.2 mmol), **2a** (0.4 mmol), catalyst (0.005 mmol), oxidant (0.4 mmol), additive (0.4 mmol), solvent (2 mL), air, 100 °C, 3 h. [b]Isolated yields. [c]The reaction was run at 80 °C for 12 h. [d]The reaction was run at 120 °C. [e]The reaction was run at 140 °C. [f]**1a**:**2a** = 1:1.5. [g]**1a**:**2a** = 1:3.0. [h]Ag_2O (0.2 mmol) was used. [i]PivOH (0.2 mmol) was used. [j]Ag_2O (0.2 mmol) and PivOH (0.2 mmol) was used.

3. Table S2. Optimization of Reaction Conditions for the Synthesis of 8a[a]

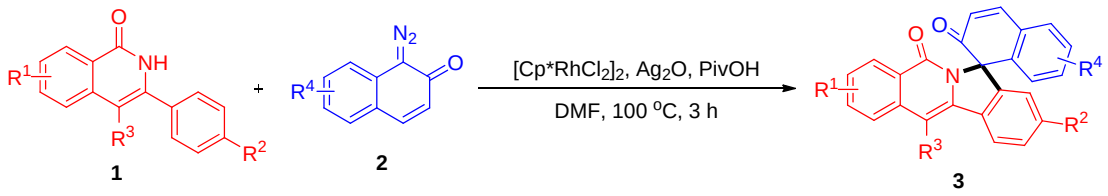


entry	catalyst	oxidant	solvent	T (°C)	yield (%)[b]
1[c]	$[Cp^*RhCl_2]_2$	Ag_2O	DMF	100	38
2	**$[Cp^*RhCl_2]_2$**	**Ag_2O**	**DMF**	**100**	**43**
3[d]	$[Cp^*RhCl_2]_2$	Ag_2O	DMF	100	38
4[e]	$[Cp^*RhCl_2]_2$	Ag_2O	DMF	100	29
5	$[Cp^*RhCl_2]_2$	AgOAc	DMF	100	26
6	$[Cp^*RhCl_2]_2$	AgF	DMF	100	13
7	$[Cp^*RhCl_2]_2$	Ag_2CO_3	DMF	100	18
8	$[Cp^*RhCl_2]_2$	$AgSbF_6$	DMF	100	0
9	$[Cp^*RhCl_2]_2$	AgOTf	DMF	100	0
10	$[Cp^*RhCl_2]_2$	Ag_2O	DCE	100	15
11	$[Cp^*RhCl_2]_2$	Ag_2O	1,4-dioxane	100	37
12	$[Cp^*RhCl_2]_2$	Ag_2O	toluene	100	23
13	$[Cp^*RhCl_2]_2$	Ag_2O	MeCN	100	messy
14	$[Cp^*RhCl_2]_2$	Ag_2O	THF	100	messy
15	$[Cp^*RhCl_2]_2$	Ag_2O	DMSO	100	0
16	$[Cp^*RhCl_2]_2$	Ag_2O	DMA	100	37
17	$[Cp^*RhCl_2]_2$	Ag_2O	NMP	100	39
18	$[Cp^*IrCl_2]_2$	Ag_2O	DMF	100	37
19	$[Cp^*RhCl_2]_2$	Ag_2O	DMF	80	25
20	$[Cp^*RhCl_2]_2$	Ag_2O	DMF	120	19

[a]The reactions were run with: **7a** (0.2 mmol), **2a** (0.4 mmol), catalyst (0.005 mmol), oxidant (0.4 mmol), solvent (2 mL), air, 100 °C, 3 h. [b]Isolated yields. [c]PivOH (0.4 mmol) was used as an additive. [d]$[Cp^*RhCl_2]_2$ (0.01 mmol) was used. [e]$[Cp^*RhCl_2]_2$ (0.002 mmol) was used.

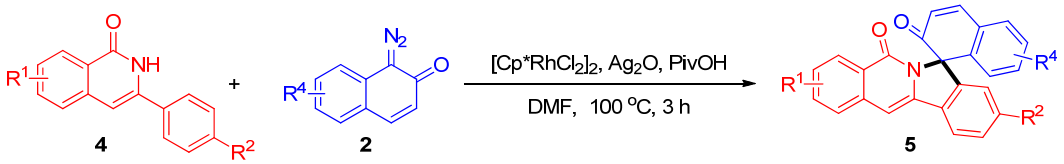
4. General Procedure for the Preparation of 3, 5, 8 and 11-14

4.1 General Procedure for the Preparation of Compounds 3



To a reaction tube (15 mL) equipped with a stirring bar were charged with 3,4-disubstituted isoquinolone **1** (0.2 mmol), 1-diazonaphthalen-2(1*H*)-one **2** (0.4 mmol), DMF (2 mL), $[Cp^*RhCl_2]_2$ (3.1 mg, 0.005 mmol), Ag_2O (93 mg, 0.4 mmol), and PivOH (41 mg, 0.4 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 °C under air for 3 h until isoquinolone **1** was consumed completely. Next, the reaction was quenched with $NaHCO_3$ and extracted with dichloromethane. The organic layer was washed with water and brine and then dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography using dichloromethane/ethyl acetate as eluent to give the corresponding product **3**.

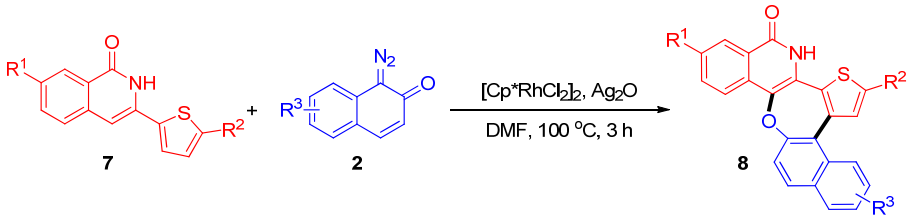
4.2 General Procedure for the Preparation of Compounds 5



To a reaction tube (15 mL) equipped with a stirring bar were charged with 4-unsubstituted isoquinolone **4** (0.2 mmol), 1-diazonaphthalen-2(1*H*)-one **2** (0.4 mmol), DMF (2 mL), $[Cp^*RhCl_2]_2$ (3.1 mg, 0.005 mmol), Ag_2O (93 mg, 0.4 mmol), and PivOH (41 mg, 0.4 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 °C under air for 3 h

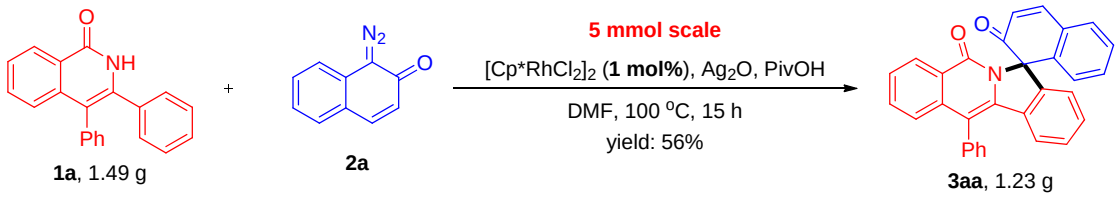
until isoquinolone **4** was consumed completely. Next, the reaction was quenched with $NaHCO_3$ and extracted with dichloromethane. The organic layer was washed with water and brine and then dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography using dichloromethane/ethyl acetate as eluent to give the corresponding product **5**.

4.3 General Procedure for the Preparation of Compounds 8



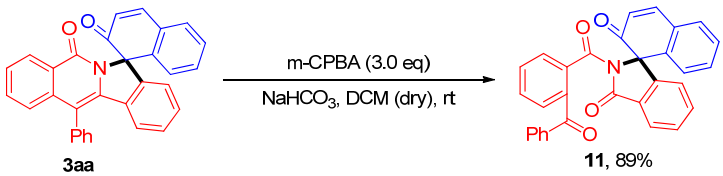
To a reaction tube (15 mL) equipped with a stirring bar were charged with 3-heteroaryl substituted isoquinolone **7** (0.2 mmol), 1-diazonaphthalen-2(1*H*)-one **2** (0.4 mmol), DMF (2 mL), $[Cp^*RhCl_2]_2$ (3.1 mg, 0.005 mmol), and Ag_2O (93 mg, 0.4 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 °C under air for 3 h until isoquinolone **7** was consumed completely. Next, the reaction was quenched with H_2O and extracted with dichloromethane. The organic layer was washed with water and brine and then dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography using petroleum ether /ethyl acetate as eluent to give the corresponding product **8**.

4.4 Gram-Scale Synthesis of 3aa



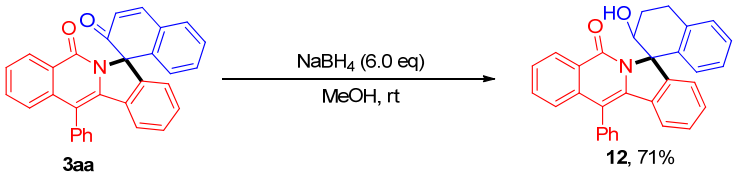
To a reaction tube (100 mL) equipped with a stirring bar were charged with **1a** (1.49 g, 5.0 mmol), **2a** (1.7 g, 10 mmol), DMF (50 mL), $[Cp^*RhCl_2]_2$ (31 mg, 0.05 mmol), Ag_2O (2.3 g, 10 mmol), and PivOH (1.0 g, 10 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 °C (oil bath) under air for 15 h until **1a** was consumed completely. Next, the reaction was quenched with $NaHCO_3$ and extracted with dichloromethane. The organic layer was washed with water and brine and then dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography using dichloromethane/ethyl acetate (30:1) as eluent to afford **3aa** (1.23 g) as brown solid in 56% yield.

4.5 Synthesis of Compound 11[4]



To a stirred suspension of $NaHCO_3$ (134 mg, 1.6 mmol) in dry dichloromethane (5 mL) was added *m*-CPBA (85% purity, 122 mg, 0.6 mmol) and then the mixture was stirred at room temperature for 15 minutes. Next, **3aa** (88 mg, 0.2 mmol) was added and the resulting mixture was stirred at room temperature for 30 h. The reaction was diluted with dichloromethane and washed with saturated $NaHCO_3$ and brine. After being dried over anhydrous Na_2SO_4, the solvent was removed under vacuum and the residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (3:1) as eluent to afford **11** (84 mg) as white solid in 89% yield.

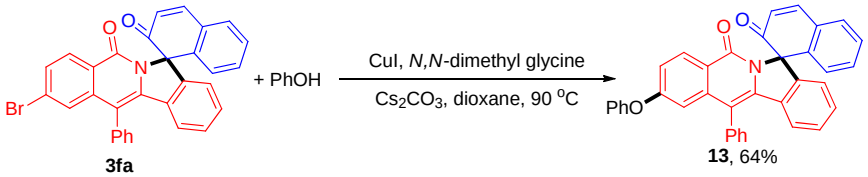
4.6 Synthesis of Compound 12[5]



3aa **12**, 71%

To a solution of **3aa** (88 mg, 0.2 mmol) in methanol (2 mL) was added $NaBH_4$ (45 mg, 1.2 mmol) at room temperature. Then the reaction mixture was stirred at the same temperature for 24 h until the complete consumption of **3aa**. Next, the reaction was quenched with water and extracted with EtOAc three times, and the combined organic layer was washed with brine and dried over anhydrous Na_2SO_4. Then, the solvent was removed under reduced pressure and the residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (5:1) as eluent to afford **12** (63 mg) as white solid in 71% yield.

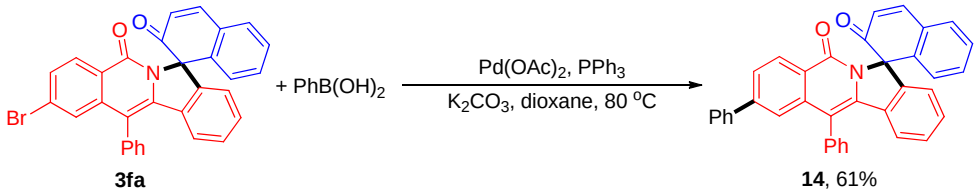
4.7 Synthesis of Compound 13[6]



3fa **13**, 64%

To a reaction tube (15 mL) equipped with a stirring bar were added **3fa** (51.6 mg, 0.1 mmol), phenol (28.2 mg, 0.3 mmol), *N,N*-dimethyl glycine hydrochloride (4.2 mg, 0.03 mmol), Cs_2CO_3 (65.2 mg, 0.2 mmol), CuI (1.9 mg, 0.01 mmol) and dioxane (1 mL). Then the resulting mixture was stirred at 90 °C for 24 h under argon atmosphere. Upon completion, it was diluted with ethyl acetate (20 mL) and washed with water and brine. The organic layer was dried over anhydrous Na_2SO_4 and evaporated under reduced pressure. The residue was purified by silica gel chromatography using petroleum ether/ethyl acetate (2:1) as eluent to afford **13** (34 mg) as yellow solid in 64% yield.

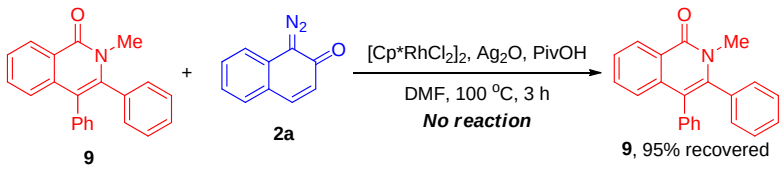
4.8 Synthesis of Compound 14[6]



To a reaction tube (15 mL) equipped with a stirring bar were added **3fa** (51.6 mg, 0.1 mmol), phenylboronic acid (36.6 mg, 0.3 mmol), PPh_3 (15.7 mg, 0.06 mmol), K_2CO_3 (55.3 mg, 0.4 mmol), $Pd(OAc)_2$ (2.2 mg, 0.01 mmol) and dioxane (1 mL). After the tube was sealed, the mixture was stirred at 80 °C (oil bath) for 24 h. Upon completion, it was diluted with ethyl acetate (10 mL) and washed with water and brine. The organic layer was dried over anhydrous Na_2SO_4 and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel with petroleum ether/ethyl acetate (2:1) as the eluent to give **14** (32 mg) as white solid in 61% yield.

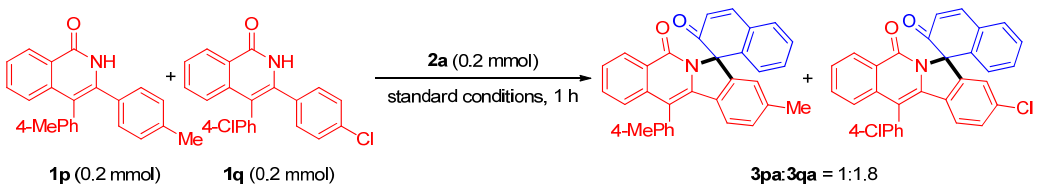
5. Mechanistic Studies

5.1 Control Experiment



To a reaction tube (15 mL) equipped with a stirring bar were charged with *N*-methyl substituted isoquinolone **9** (62 mg, 0.2 mmol), **2a** (68 mg, 0.4 mmol), DMF (2 mL), $[Cp^*RhCl_2]_2$ (3.1 mg, 0.005 mmol), Ag_2O (93 mg, 0.4 mmol), and PivOH (41 mg, 0.4 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 °C under air for 3 h. After isolation and purification, isoquinolone **9** was recovered in 95% yield, implying that the *NH* unit of isoquinolone is crucial for the ortho C(sp^2)-H bond activation.

5.2 Competitive Reaction



To a reaction tube (15 mL) equipped with a stirring bar were charged with **1p** (0.2 mmol), **1q** (0.2 mmol), **2a** (0.2 mmol), DMF (4 mL), $[Cp^*RhCl_2]_2$ (0.01 mmol), Ag_2O (0.8 mmol), and PivOH (0.8 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 °C for 1 h until **2a** was consumed completely. Next, the reaction was quenched with $NaHCO_3$ and extracted with dichloromethane. The organic layer was washed with water and brine and then dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the

residue was purified by silica gel chromatography using dichloromethane/ethyl acetate (30:1) as eluent to give a mixture of **3pa** and **3qa** (78 mg). Upon analyzing the ^{1}H NMR spectra as shown in Figure S1, the ratio of **3pa** and **3qa** was determined as 1:1.8, indicating that the ortho C-H bond cleavage might occur through a concerted metalation-deprotonation (CMD) mechanism.

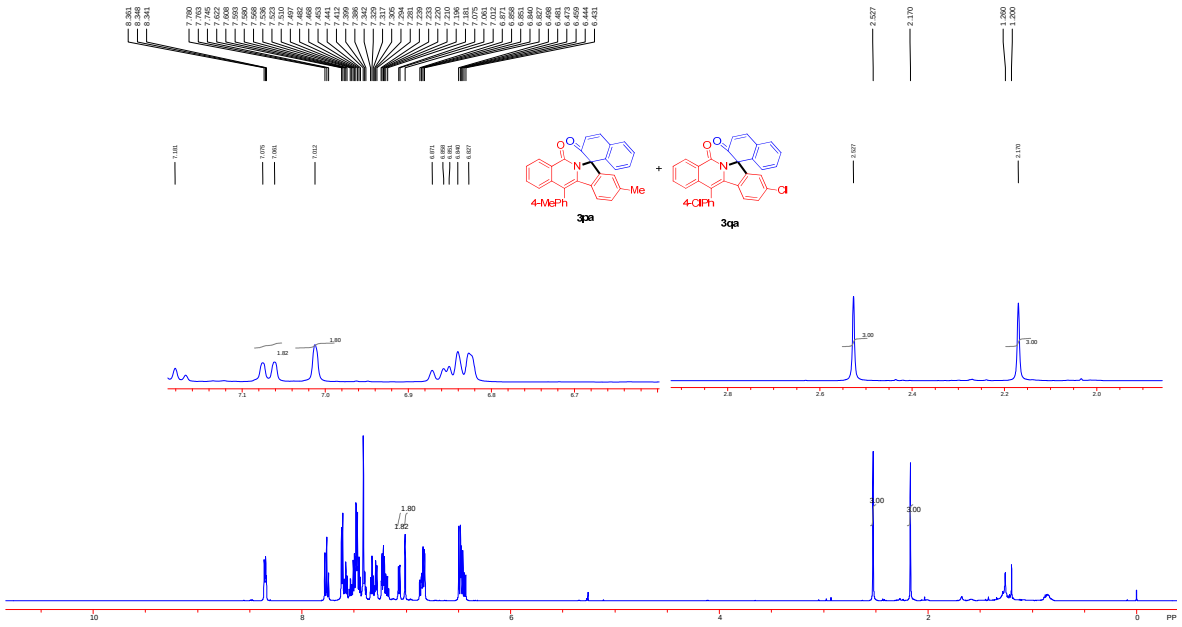
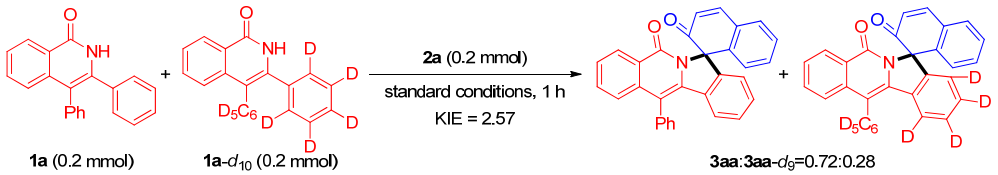


Figure S1. The ^{1}H NMR spectra of a mixture of **3pa** and **3qa**

5.3 Intermolecular KIE



To a reaction tube (15 mL) equipped with a stirring bar were charged with **1a** (0.2 mmol), **1a-*d*$_{10}$** (0.2 mmol), **2a** (0.2 mmol), DMF (4 mL), $[Cp^*RhCl_2]_2$ (0.01 mmol), Ag_2O (0.8 mmol), and PivOH (0.8 mmol). Then the tube was sealed, and the resulting mixture was stirred at 100 ^{o}C for 1 h until **2a** was consumed completely. Next, the reaction was quenched with $NaHCO_3$

and extracted with dichloromethane. The extract was washed with water and brine and then dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the residue was purified by silica gel chromatography using dichloromethane/ethyl acetate (30:1) as eluent to give a mixture of **3aa** and **3aa-*d*$_9$** (47 mg). Upon analyzing the ^{1}H NMR spectra as shown in Figure S2, the ratio of **3aa** and **3aa-*d*$_9$** was determined as 0.72:0.28. Accordingly, the KIE (kinetic isotopic effect) value was 2.57, suggesting that the C(sp^2)-H bond activation might be involved in the turnover-limiting step.

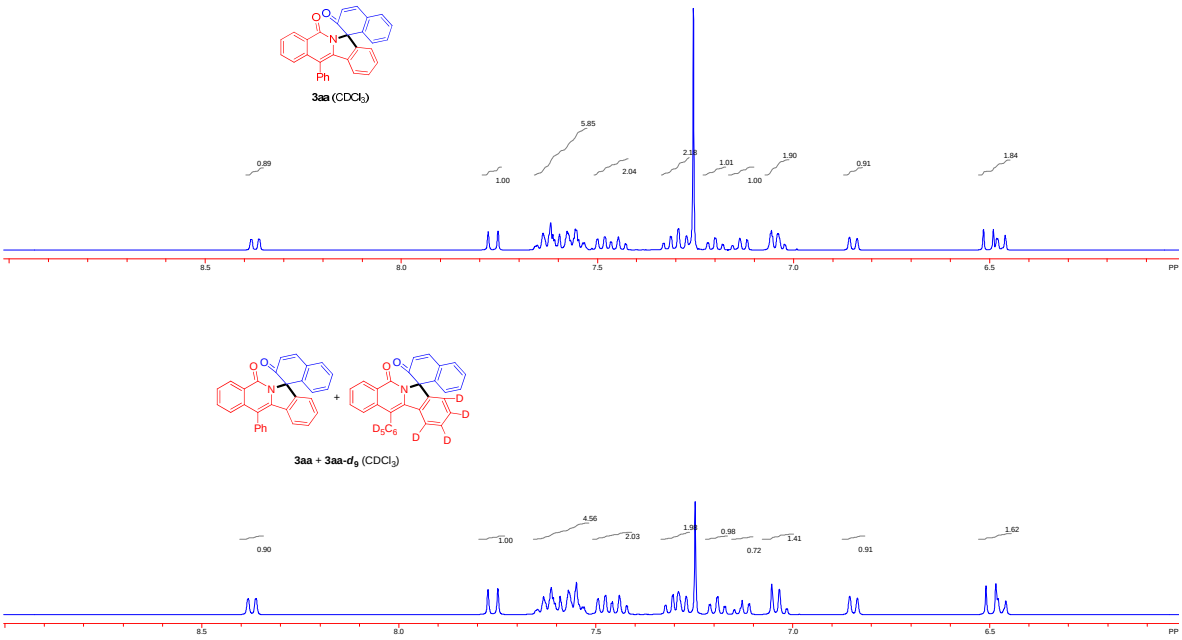
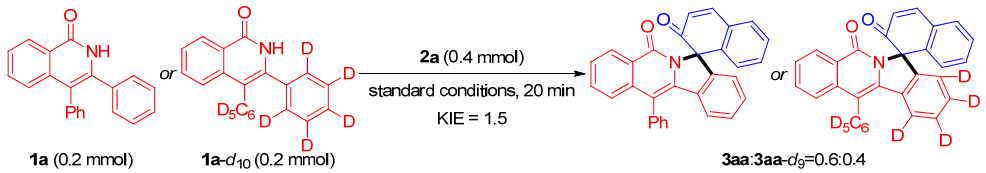


Figure S2. The ^{1}H NMR spectra of a mixture of **3aa** and **3aa-*d*$_9$**

5.4 Parallel KIE Study



Two parallel reactions with **1a** or deuterated substrate **1a-*d*$_{10}$** were performed under the standard conditions. Suspensions of **1a** (0.2 mmol) or **1a-*d*$_{10}$** (0.2 mmol), **2a** (0.4 mmol), DMF (2 mL), $[Cp^*RhCl_2]_2$ (0.05 mmol), Ag_2O (0.4 mmol), PivOH (0.4 mmol) were stirred side-by-side at 100 °C for 20 min. Both reactions were quenched with saturated $NaHCO_3$ and combined rapidly. The mixture was extracted with dichloromethane. The extract was washed with water and brine and dried over anhydrous Na_2SO_4. The solvent was removed under reduced pressure and the crude product was purified by silica gel chromatography using dichloromethane/ethyl acetate (30:1) as eluent to afford a mixture of **3aa** and **3aa-*d*$_9$** (54 mg). Upon analyzing the ^{1}H NMR spectra as shown in Figure S3, the ratio of **3aa** and **3aa-*d*$_9$** was determined as 0.6:0.4 and a value of k_H/k_D = 1.5 (parallel KIE) was calculated, suggesting that the C(sp^2)-H bond activation might be involved in the turnover-limiting step.

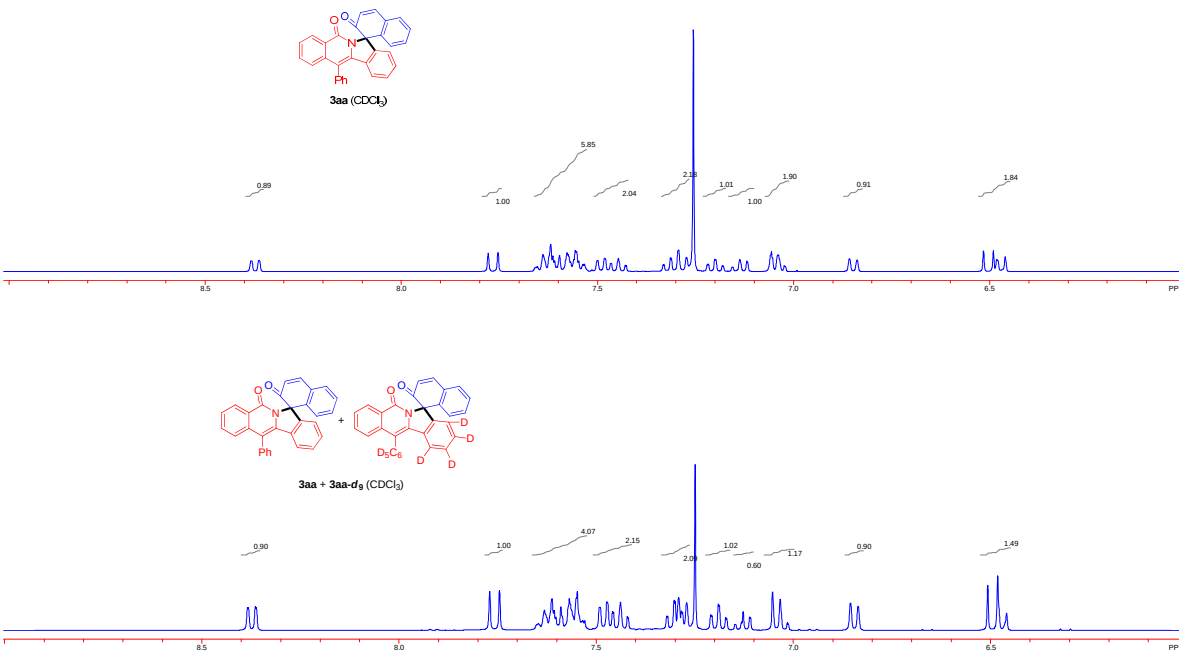


Figure S3. The ^{1}H NMR spectra of a mixture of **3aa** and **3aa-*d*$_9$**

6. X-Ray Crystal Structure and Data of 3aa, 5a, 8e, and 10

(1) Compound 3aa

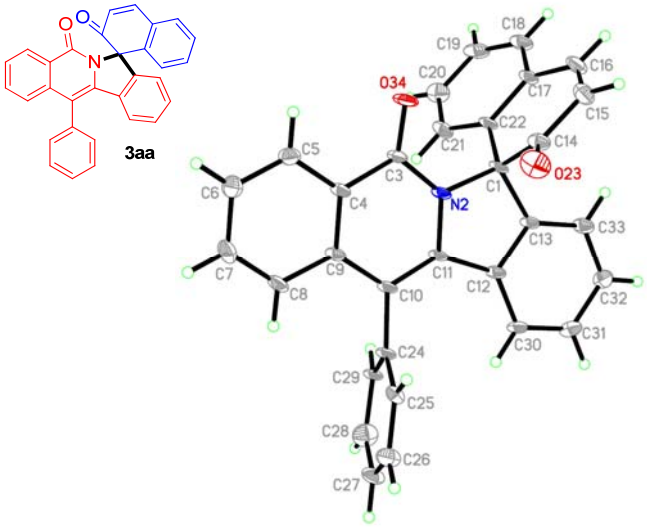


Figure S4. X-Ray Crystal Structure of **3aa** with 30% ellipsoid probability

X-ray structure determination. Single crystals suitable for X-ray diffraction were obtained by slow evaporation of the solvent from a petroleum ether/ethyl acetate (3:1) solution of **3aa**. Crystal data collection and refinement parameters of **3aa** are summarized in Table S3. Intensity data were collected at 293 K on a SuperNova Dual diffractometer using mirror-monochromated Cu Kα radiation, λ = 1.54184 Å. The data were corrected for decay, Lorentz, and polarization effects as well as absorption and beam corrections based on the multi-scan technique. Using Olex2, the structure was solved with the SHELXT structure solution program using Intrinsic Phasing Method and refined with the SHELXL refinement package using Least Squares minimisation. Nonhydrogen atoms were refined with anisotropic displacement parameters. The H-atoms were either located or calculated and subsequently treated with a riding model.

Table S3. Crystallographic Data and Structure Refinement Results of 3aa

Empirical formula	$2(C_{31}H_{19}NO_2)$
Formula weight	874.94
Temp, K	293(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a, Å	10.3989(2)
b, Å	28.6103(4)
c, Å	15.0726(2)
α (°)	90
β (°)	102.494(2)
γ (°)	90
Volume, Å^3	4378.14(12)
Z	4
d_{calc}, g cm^{-3}	1.327
λ, Å	1.54184
μ, mm^{-1}	0.654
No. of data collected	18749
No. of unique data	7566
R_{int}	0.0660
Goodness-of-fit on F^2	1.055
R_1, wR_2 ($I > 2\sigma(I)$)	0.0896, 0.2495
R_1, wR_2 (all data)	0.1104, 0.2774

(2) Compound 5a

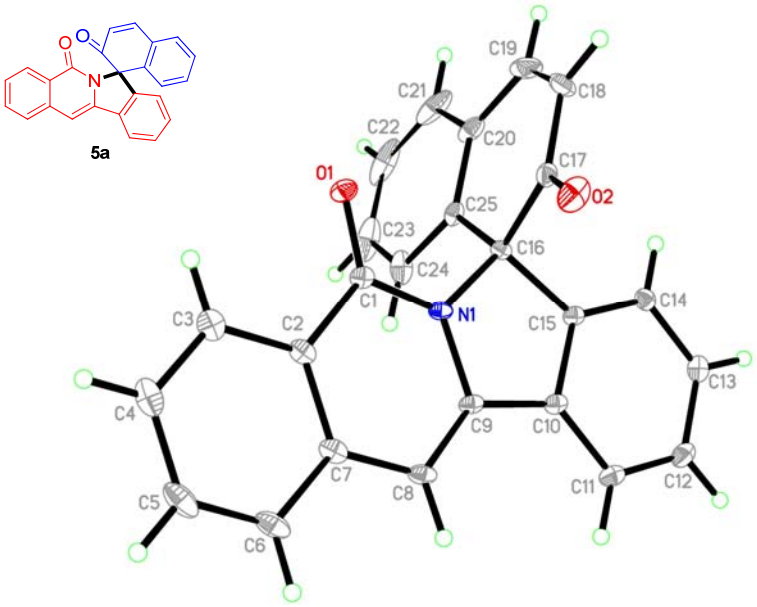


Figure S5. X-Ray Crystal Structure of **5a** with 30% ellipsoid probability

X-ray structure determination. Single crystals suitable for X-ray diffraction were obtained by slow evaporation of the solvent from a dichloromethane/ethyl acetate (30:1) solution of **5a**. Crystal data collection and refinement parameters of **5a** are summarized in Table S4. Intensity data were collected at 150 K on a SuperNova Dual diffractometer using mirror-monochromated Cu Kα radiation, λ = 1.54184 Å. The data were corrected for decay, Lorentz, and polarization effects as well as absorption and beam corrections based on the multi-scan technique. Using Olex2, the structure was solved with the SHELXT structure solution program using Intrinsic Phasing Method and refined with the SHELXL refinement package using Least Squares minimisation. Nonhydrogen atoms were refined with anisotropic displacement parameters. The H-atoms were either located or calculated and subsequently treated with a riding model.

Table S4. Crystallographic Data and Structure Refinement Results of 5a

Empirical formula	$C_{25}H_{15}NO_2$
Formula weight	361.38
Temp, K	149.99(10)
Crystal system	monoclinic
Space group	$P2_1/c$
a, Å	12.4723(3)
b, Å	13.8610(3)
c, Å	10.2625(2)
α (°)	90
β (°)	101.425(2)
γ (°)	90
Volume, Å^3	1739.01(7)
Z	4
d_{calc}, g cm^{-3}	1.380
λ, Å	1.54184
μ, mm^{-1}	0.699
No. of data collected	6920
No. of unique data	3307
R_{int}	0.0230
Goodness-of-fit on F^2	1.054
R_1, wR_2 ($I > 2\sigma(I)$)	0.0556, 0.1548
R_1, wR_2 (all data)	0.0609, 0.1608

(3) Compound 8e

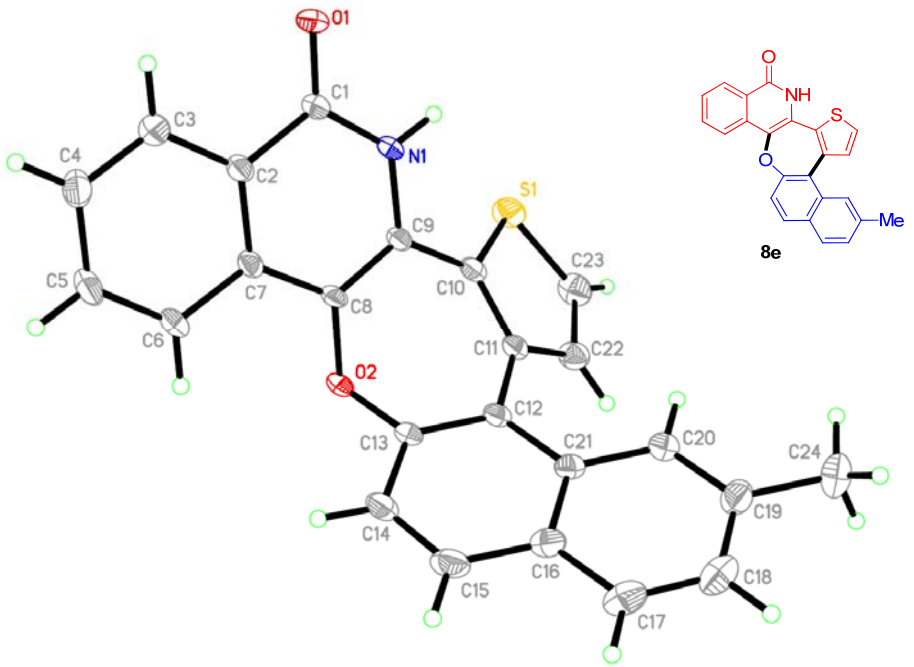


Figure S6. X-Ray Crystal Structure of **8e** with 30% ellipsoid probability

X-ray structure determination. Single crystals suitable for X-ray diffraction were obtained by slow evaporation of the solvent from a petroleum ether/ethyl acetate (3:1) solution of **8e**. Crystal data collection and refinement parameters of **8e** are summarized in Table S5. Intensity data were collected at 293 K on a SuperNova Dual diffractometer using mirror-monochromated Cu Kα radiation, λ = 1.54184 Å. The data were corrected for decay, Lorentz, and polarization effects as well as absorption and beam corrections based on the multi-scan technique. Using Olex2, the structure was solved with the SHELXT structure solution program using Intrinsic Phasing Method and refined with the SHELXL refinement package using Least Squares minimisation. Nonhydrogen atoms were refined with anisotropic displacement parameters. The H-atoms were either located or calculated and subsequently treated with a riding model.

Table S5. Crystallographic Data and Structure Refinement Results of 8e

Empirical formula	$C_{24}H_{15}NO_2S$
Formula weight	381.43
Temp, K	293(2)
Crystal system	triclinic
Space group	P-1
a, Å	8.1960(4)
b, Å	9.4755(5)
c, Å	13.0705(7)
α (°)	77.839(4)
β (°)	78.582(4)
γ (°)	76.499(4)
Volume, Å^3	952.98(9)
Z	2
d_{calc}, g cm^{-3}	1.329
λ, Å	1.54184
μ, mm^{-1}	1.662
No. of data collected	7306
No. of unique data	3622
R_{int}	0.0316
Goodness-of-fit on F^2	1.059
R_1, wR_2 ($I > 2\sigma(I)$)	0.0562, 0.1480
R_1, wR_2 (all data)	0.0636, 0.1563

(4) Compound 10

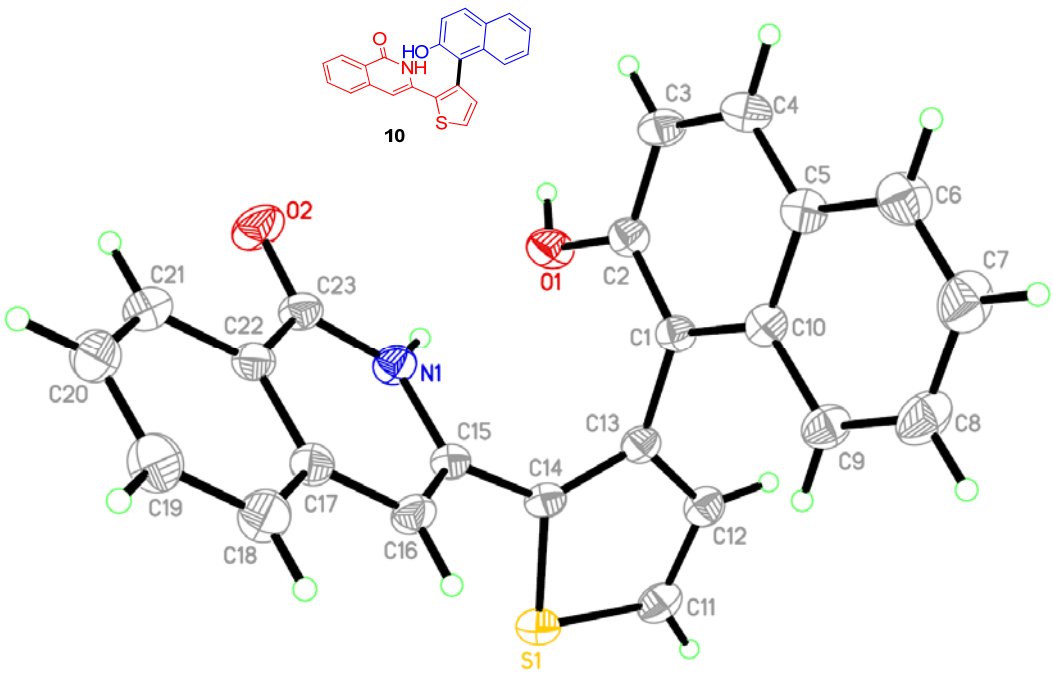


Figure S7. X-Ray Crystal Structure of **10** with 30% ellipsoid probability

X-ray structure determination. Single crystals suitable for X-ray diffraction were obtained by slow evaporation of the solvent from a petroleum ether/ethyl acetate (3:1) solution of **10**. Crystal data collection and refinement parameters of **10** are summarized in Table S6. Intensity data were collected at 293 K on a SuperNova Dual diffractometer using mirror-monochromated Cu Kα radiation, λ = 1.54184 Å. The data were corrected for decay, Lorentz, and polarization effects as well as absorption and beam corrections based on the multi-scan technique. Using Olex2, the structure was solved with the SHELXT structure solution program using Intrinsic Phasing Method and refined with the SHELXL refinement package using Least Squares minimisation. Nonhydrogen atoms were refined with anisotropic displacement parameters. The H-atoms were either located or calculated and subsequently treated with a riding model.

Table S6. Crystallographic Data and Structure Refinement Results of 10

Empirical formula	$C_{23}H_{15}NO_2S$
Formula weight	369.42
Temp, K	293(2)
Crystal system	triclinic
Space group	P-1
a, Å	8.8200(4)
b, Å	10.4849(5)
c, Å	10.5524(4)
α (°)	96.384(4)
β (°)	111.049(4)
γ (°)	90.540(4)
Volume, Å^3	903.81(7)
Z	2
d_{calc}, g cm^{-3}	1.357
λ, Å	1.54184
μ, mm^{-1}	1.732
No. of data collected	6160
No. of unique data	3422
R_{int}	0.0256
Goodness-of-fit on F^2	1.073
R_1, wR_2 ($I > 2\sigma(I)$)	0.0438, 0.1151
R_1, wR_2 (all data)	0.0504, 0.1207

7. References

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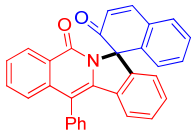
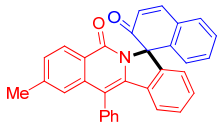
8. Characterization Data of 3aa-3sa, 3ab-3ap, 5a-5j, 8a-8n, and 10-14



3aa

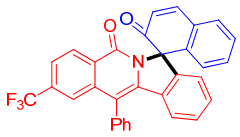
12-Phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3aa): Dichloromethane/ethyl acetate (30:1) as eluent; brown solid (65 mg, 75%), mp >300 °C. ^{1}H NMR (DMSO-d_6, 400 MHz) δ 8.17 (dd, J = 7.6, 0.8 Hz, 1H), 8.09 (d, J = 10.0 Hz, 1H), 7.76-7.65 (m, 6H), 7.58-7.50 (m, 2H), 7.41 (td, J = 7.6, 0.8 Hz, 1H), 7.29-7.15 (m, 4H), 7.10 (d, J = 7.6 Hz, 1H), 6.89 (d, J = 7.6 Hz, 1H), 6.50 (d, J = 10.0 Hz, 1H), 6.36 (d, J = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.9, 159.3, 146.4, 142.4, 140.4, 139.1, 138.9, 134.9, 133.5, 132.5, 131.4, 131.1, 130.9, 130.1, 129.8, 129.7, 129.5, 129.4, 128.9, 128.6, 128.4, 127.9, 126.6, 125.60, 125.56, 125.3, 125.2, 124.9, 121.6, 114.6, 76.1. HRMS (ESI) calcd for $C_{31}H_{19}NNaO_2$ $[M + Na]^+$ 460.1308, found 460.1301.



3ba

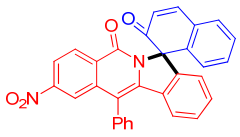
2-Methyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ba): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (56 mg, 62%), mp 201-202 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.26 (d, J = 8.0 Hz, 1H), 7.76 (d, J = 10.0 Hz, 1H), 7.67-7.60 (m, 3H), 7.57-7.52 (m, 2H), 7.48 (dd, J = 7.6, 0.8 Hz, 1H), 7.32-7.26 (m, 2H), 7.19 (td, J = 7.6, 1.2 Hz, 1H), 7.14-7.10 (m, 1H), 7.05-7.01 (m, 3H), 6.84 (d, J = 8.0 Hz, 1H), 6.49 (d, J = 10.0 Hz, 1H), 6.43-6.41 (m, 1H), 2.37 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 193.0, 159.2, 146.3, 143.1, 142.4, 140.6, 139.2, 138.9, 135.0, 133.6, 131.4, 131.1, 130.8, 130.1,

129.6, 129.5, 129.4, 128.8, 128.5, 128.3, 128.2, 127.9, 125.3, 125.23, 125.15, 124.9, 123.4, 121.5, 114.4, 76.0, 22.0 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{32}H_{21}NNaO_2$ $[M + Na]^+$ 474.1464, found 474.1443.



3ca

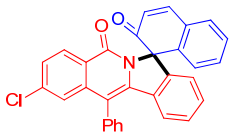
12-Phenyl-2-(trifluoromethyl)-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ca): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (76 mg, 75%), mp 193-194 °C. ^1H NMR ($CDCl_3$, 600 MHz) δ 8.48 (d, J = 8.4 Hz, 1H), 7.78 (d, J = 9.6 Hz, 1H), 7.68-7.63 (m, 4H), 7.56-7.54 (m, 3H), 7.51 (d, J = 7.2 Hz, 1H), 7.33 (td, J = 7.8, 1.2 Hz, 1H), 7.22 (td, J = 7.8, 1.2 Hz, 1H), 7.19-7.16 (m, 1H), 7.08-7.06 (m, 2H), 6.83 (d, J = 7.8 Hz, 1H), 6.51 (d, J = 10.2 Hz, 1H), 6.47 (d, J = 8.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.5, 158.5, 146.6, 142.5, 140.5, 139.8, 139.3, 134.1 (q, J = 31.8 Hz, 1C), 133.8, 132.9, 131.2, 130.99, 130.98, 130.31, 130.28, 130.0, 129.7, 129.5, 129.13, 129.06, 129.0, 128.6, 127.5, 125.2, 125.1, 123.7 (q, J = 271.2 Hz, 1C), 122.6 (q, J = 4.4 Hz, 1C), 122.5 (q, J = 3.3 Hz, 1C), 121.7, 114.1, 76.4 (one ^{13}C signal was not observed). ^{19}F NMR ($CDCl_3$, 564 MHz) δ -62.95 (s). HRMS (ESI) calcd for $C_{32}H_{18}F_3NNaO_2$ $[M + Na]^+$ 528.1182, found 528.1170.



3da

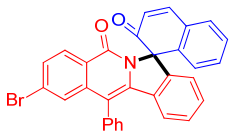
2-Nitro-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3da): Dichloromethane/ethyl acetate (30:1) as eluent; yellow solid (83 mg, 86%), mp >300 °C. ^1H NMR ($CDCl_3$, 600 MHz) δ 8.50 (d, J = 9.0 Hz, 1H), 8.17 (dd, J = 8.4, 2.4 Hz, 1H),

8.13 (d, J = 2.4 Hz, 1H), 7.80 (d, J = 9.6 Hz, 1H), 7.70-7.66 (m, 3H), 7.56-7.55 (m, 2H), 7.52 (d, J = 7.8 Hz, 1H), 7.35 (t, J = 7.2 Hz, 1H), 7.24-7.19 (m, 2H), 7.09 (t, J = 8.4 Hz, 2H), 6.84 (d, J = 7.8 Hz, 1H), 6.52-6.49 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.2, 158.1, 150.5, 146.7, 142.5, 141.4, 140.0, 139.5, 133.3, 132.6, 131.2, 131.04, 130.96, 130.7, 130.4, 130.2, 129.92, 129.90, 129.5, 129.4, 129.2, 128.9, 128.8, 125.4, 125.2, 125.0, 121.7, 120.9, 120.1, 114.0, 76.6. HRMS (ESI) calcd for $C_{31}H_{18}N_2NaO_4$ $[M + Na]^+$ 505.1159, found 505.1130.



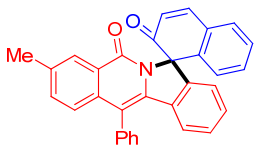
3ea

2-Chloro-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ea): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (89 mg, 94%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.28 (d, J = 8.4 Hz, 1H), 7.76 (d, J = 10.0 Hz, 1H), 7.66-7.61 (m, 3H), 7.55-7.48 (m, 3H), 7.38 (dd, J = 8.4, 1.6 Hz, 1H), 7.32 (t, J = 7.2 Hz, 1H), 7.23-7.13 (m, 3H), 7.06-7.03 (m, 2H), 6.83 (d, J = 8.0 Hz, 1H), 6.49 (d, J = 10.0 Hz, 1H), 6.45 (d, J = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.6, 158.7, 146.5, 142.6, 140.6, 140.3, 140.1, 139.3, 134.1, 133.1, 131.3, 131.0, 130.9, 130.23, 130.16, 129.9, 129.6, 129.5, 129.0, 128.5, 127.1, 125.2, 125.15, 125.08, 124.9, 123.9, 121.6, 113.6, 76.2 (two ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{31}H_{18}ClNNaO_2$ $[M + Na]^+$ 494.0918, found 494.0900.



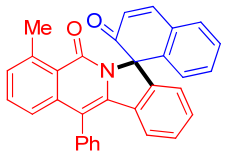
3fa

2-Bromo-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3fa): Dichloromethane/ethyl acetate (30:1) as eluent; brown solid (81 mg, 79%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.21 (d, *J* = 8.4 Hz, 1H), 7.77 (d, *J* = 10.2 Hz, 1H), 7.66-7.62 (m, 3H), 7.55-7.49 (m, 4H), 7.40 (d, *J* = 1.8 Hz, 1H), 7.32 (td, *J* = 7.2, 0.6 Hz, 1H), 7.21 (td, *J* = 7.8, 1.2 Hz, 1H), 7.17-7.14 (m, 1H), 7.06-7.04 (m, 2H), 6.83 (d, *J* = 7.2 Hz, 1H), 6.49 (d, *J* = 10.2 Hz, 1H), 6.43 (d, *J* = 7.8 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.6, 158.8, 146.5, 142.5, 140.7, 140.3, 140.0, 134.1, 133.1, 131.3, 131.0, 130.9, 130.22, 130.15, 129.9, 129.8, 129.64, 129.62, 129.5, 129.0, 128.5, 128.02, 127.97, 125.2, 125.14, 125.09, 124.2, 121.6, 113.4, 76.2 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{31}H_{18}BrNNaO_2$ $[M + Na]^+$ 538.0413, found 538.0408.



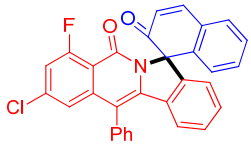
3ga

3-Methyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ga): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (52 mg, 58%), mp 196-197 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.18 (s, 1H), 7.75 (d, *J* = 10.0 Hz, 1H), 7.64-7.58 (m, 3H), 7.56-7.52 (m, 2H), 7.48 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.39 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.30 (td, *J* = 7.2, 1.2 Hz, 1H), 7.20-7.16 (m, 2H), 7.13-7.09 (m, 1H), 7.04-7.00 (m, 2H), 6.83 (d, *J* = 7.6 Hz, 1H), 6.49 (d, *J* = 10.0 Hz, 1H), 6.46 (d, *J* = 8.4 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 193.0, 159.2, 146.3, 142.3, 140.6, 138.0, 136.8, 135.0, 133.9, 133.6, 131.4, 131.1, 130.8, 130.1, 129.6, 129.5, 129.3, 128.8, 128.5, 128.3, 127.6, 125.5, 125.3, 125.2, 124.7, 121.6, 114.6, 76.0, 21.3 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{32}H_{21}NNaO_2$ $[M + Na]^+$ 474.1464, found 474.1444.



3ha

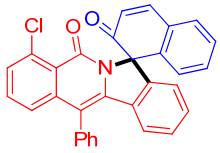
4-Methyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ha): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (35 mg, 39%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 7.75 (d, *J* = 10.0 Hz, 1H), 7.64-7.58 (m, 3H), 7.53-7.47 (m, 3H), 7.39 (t, *J* = 7.6 Hz, 1H), 7.30 (td, *J* = 7.6, 1.2 Hz, 1H), 7.21-7.18 (m, 2H), 7.12-7.08 (m, 2H), 7.03-6.99 (m, 2H), 6.87 (d, *J* = 7.6 Hz, 1H), 6.50 (d, *J* = 10.0 Hz, 1H), 6.37 (dd, *J* = 7.6, 1.2 Hz, 1H), 2.83 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 193.1, 159.9, 146.4, 142.3, 140.90, 140.87, 138.8, 135.6, 133.5, 131.5, 131.4, 131.2, 130.8, 130.2, 129.74, 129.66, 129.6, 129.4, 129.3, 128.8, 128.5, 128.2, 125.4, 125.0, 124.9, 124.2, 124.0, 121.5, 114.4, 76.3, 24.0 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{32}H_{21}NNaO_2$ [M + Na]$^+$ 474.1464, found 474.1445.



3ia

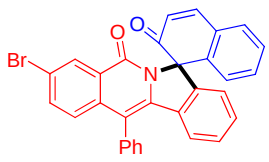
2-Chloro-4-fluoro-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ia): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (60 mg, 61%), mp 226-227 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 7.75 (d, *J* = 10.2 Hz, 1H), 7.66-7.62 (m, 3H), 7.52-7.50 (m, 2H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.33-7.30 (m, 1H), 7.23-7.20 (m, 1H), 7.17 (t, *J* = 7.8 Hz, 1H), 7.09-7.02 (m, 3H), 7.00 (s, 1H), 6.83 (d, *J* = 7.8 Hz, 1H), 6.48 (d, *J* = 10.2 Hz, 1H), 6.38 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.3, 163.0 (d, *J* = 266.9 Hz, 1C), 156.0 (d, *J* = 3.3 Hz, 1C), 146.5, 142.83, 142.80, 141.4, 139.7, 139.0 (d, *J* = 12.0 Hz, 1C),

134.0, 132.8, 131.3, 131.1, 130.9, 130.5, 130.3, 130.0, 129.7, 129.6, 129.1, 129.0, 128.5, 125.3, 125.2, 125.0, 121.7, 121.1 (d, J = 3.3 Hz, 1C), 114.3 (d, J = 24.0 Hz, 1C), 113.2 (d, J = 5.4 Hz, 1C), 112.6 (d, J = 2.3 Hz, 1C), 76.2. ^{19}F NMR ($CDCl_3$, 376 MHz) δ -107.67 (d, J = 9.4 Hz). HRMS (ESI) calcd for $C_{31}H_{17}ClFNNaO_2$ $[M + Na]^+$ 512.0824, found 512.0811.



3ja

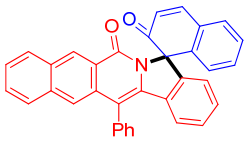
4-Chloro-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ja): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (58 mg, 61%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 7.74 (d, J = 10.2 Hz, 1H), 7.63-7.58 (m, 3H), 7.52-7.50 (m, 2H), 7.47 (d, J = 7.2 Hz, 1H), 7.42 (d, J = 6.6 Hz, 1H), 7.38 (t, J = 7.8 Hz, 1H), 7.30 (t, J = 7.2 Hz, 1H), 7.20 (t, J = 7.2 Hz, 1H), 7.17 (d, J = 7.2 Hz, 1H), 7.13 (t, J = 7.2 Hz, 1H), 7.04-7.02 (m, 2H), 6.86 (d, J = 7.8 Hz, 1H), 6.49 (d, J = 10.2 Hz, 1H), 6.36 (d, J = 8.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.5, 157.4, 146.5, 142.6, 142.3, 140.2, 140.0, 136.0, 135.0, 133.0, 131.9, 131.4, 131.2, 130.9, 130.3, 130.1, 129.8, 129.7, 129.6, 129.5, 128.9, 128.8, 128.3, 125.4, 125.1, 124.9, 124.8, 122.2, 121.6, 113.6, 76.5. HRMS (ESI) calcd for $C_{31}H_{18}ClNNaO_2$ $[M + Na]^+$ 494.0918, found 494.0914.



3ka

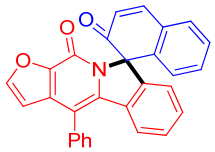
3-Bromo-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ka): Dichloromethane/ethyl acetate (45:1) as eluent; white solid (89 mg, 86%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.49 (d, J = 1.8 Hz, 1H), 7.77 (d, J = 10.2 Hz, 1H),

7.65-7.59 (m, 4H), 7.54-7.49 (m, 3H), 7.32 (td, *J* = 7.2, 0.6 Hz, 1H), 7.22-7.19 (m, 1H), 7.16-7.14 (m, 2H), 7.06-7.03 (m, 2H), 6.82 (d, *J* = 7.8 Hz, 1H), 6.49 (d, *J* = 10.2 Hz, 1H), 6.46 (d, *J* = 7.8 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.6, 158.1, 146.5, 142.4, 140.0, 139.4, 137.9, 135.5, 134.3, 133.2, 131.3, 131.0, 130.9, 130.5, 130.2, 130.0, 129.8, 129.53, 129.52, 129.0, 128.9, 128.5, 127.3, 126.8, 125.2, 125.1, 125.0, 121.7, 120.7, 114.0, 76.3. HRMS (ESI) calcd for $C_{31}H_{18}BrNNaO_2$ $[M + Na]^+$ 538.0413, found 538.0402.



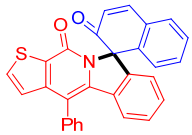
3la

14-Phenyl-2'*H*,7*H*-spiro[benzo[*g*]isoindolo[2,1-*b*]isoquinoline-5,1'-naphthalene]-2',7-dione (3la): Dichloromethane/ethyl acetate (30:1) as eluent; yellow solid (67 mg, 69%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.97 (s, 1H), 7.97 (d, *J* = 8.0 Hz, 1H), 7.78 (s, 1H), 7.76-7.75 (m, 1H), 7.69-7.60 (m, 6H), 7.53-7.44 (m, 3H), 7.31 (td, *J* = 7.6, 0.8 Hz, 1H), 7.20 (td, *J* = 8.0, 1.2 Hz, 1H), 7.15-7.11 (m, 1H), 7.06-7.02 (m, 2H), 6.92 (d, *J* = 7.6 Hz, 1H), 6.50 (d, *J* = 10.0 Hz, 1H), 6.47-6.45 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 193.4, 159.9, 146.4, 142.4, 141.0, 137.7, 135.41, 135.36, 135.2, 133.5, 131.49, 131.46, 131.2, 130.9, 130.1, 129.8, 129.7, 129.49, 129.48, 129.4, 129.3, 128.9, 128.7, 128.4, 128.2, 128.0, 126.2, 125.3, 125.2, 125.0, 124.5, 124.0, 121.6, 114.6, 75.9. HRMS (ESI) calcd for $C_{35}H_{21}NNaO_2$ $[M + Na]^+$ 510.1464, found 510.1446.



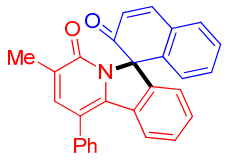
3ma

4-Phenyl-2'*H*,11*H*-spiro[furo[3',2':4,5]pyrido[2,1-*a*]isoindole-9,1'-naphthalene]-2',11-dione (3ma): Dichloromethane/ethyl acetate (7:1) as eluent; brown solid (48 mg, 56%), mp 273-274 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 7.76 (d, *J* = 10.2 Hz, 1H), 7.71 (d, *J* = 1.8 Hz, 1H), 7.63-7.58 (m, 4H), 7.56-7.53 (m, 1H), 7.49 (d, *J* = 7.2 Hz, 1H), 7.32 (td, *J* = 7.8, 1.2 Hz, 1H), 7.21 (td, *J* = 7.8, 1.2 Hz, 1H), 7.15-7.12 (m, 1H), 7.07 (t, *J* = 7.2 Hz, 2H), 6.93-6.92 (m, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 6.51-6.49 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.5, 150.1, 148.6, 146.6, 142.7, 142.5, 139.9, 139.8, 136.6, 134.4, 133.0, 130.9, 130.4, 130.20, 130.18, 129.53, 129.48, 129.4, 129.1, 128.8, 128.7, 128.4, 125.3, 124.8, 124.1, 121.6, 110.8, 107.3, 76.4. HRMS (ESI) calcd for $C_{29}H_{17}NNaO_3$ $[M + Na]^+$ 450.1101, found 450.1091.



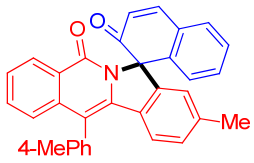
3na

4'-Phenyl-2*H*,11'*H*-spiro[naphthalene-1,9'-thieno[3',2':4,5]pyrido[2,1-*a*]isoindole]-2,11'-dione (3na): Dichloromethane/ethyl acetate (15:1) as eluent; white solid (58 mg, 65%), mp >300 °C. ^{1}H NMR (DMSO-*d*$_6$, 400 MHz) δ 8.09 (d, *J* = 5.2 Hz, 1H), 8.08 (d, *J* = 10.0 Hz, 1H), 7.73-7.64 (m, 5H), 7.57 (d, *J* = 8.4 Hz, 1H), 7.42 (td, *J* = 7.6, 0.8 Hz, 1H), 7.31-7.25 (m, 2H), 7.22-7.18 (m, 1H), 7.11 (d, *J* = 7.6 Hz, 1H), 6.94 (d, *J* = 5.2 Hz, 1H), 6.86 (d, *J* = 7.6 Hz, 1H), 6.62 (d, *J* = 7.6 Hz, 1H), 6.50 (d, *J* = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.6, 155.4, 148.3, 146.4, 142.4, 140.7, 139.9, 135.1, 133.4, 133.2, 130.9, 130.7, 130.4, 130.1, 129.7, 129.53, 129.45, 129.2, 128.9, 128.8, 128.7, 128.4, 125.3, 125.1, 124.5, 124.4, 121.7, 113.5, 76.0. HRMS (ESI) calcd for $C_{29}H_{17}NNaO_2S$ $[M + Na]^+$ 466.0872, found 466.0864.



3oa

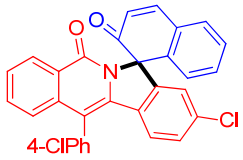
3'-Methyl-1'-phenyl-2*H*,4'*H*-spiro[naphthalene-1,6'-pyrido[2,1-*a*]isoindole]-2,4'-dione (3oa): Dichloromethane/ethyl acetate (15:1) as eluent; brown solid (39 mg, 48%), mp 236-237 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 7.74 (d, *J* = 9.6 Hz, 1H), 7.56-7.51 (m, 4H), 7.49-7.46 (m, 2H), 7.36 (s, 1H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.22 (t, *J* = 7.2 Hz, 1H), 7.15 (t, *J* = 7.2 Hz, 1H), 7.10-7.07 (m, 1H), 7.03 (t, *J* = 7.2 Hz, 2H), 6.76 (d, *J* = 7.8 Hz, 1H), 6.49 (d, *J* = 9.6 Hz, 1H), 2.16 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.1, 159.7, 146.3, 142.5, 142.1, 141.5, 139.4, 136.9, 133.3, 130.9, 130.1, 129.9, 129.7, 129.6, 128.9, 128.75, 128.73, 128.4, 128.2, 125.5, 124.8, 124.1, 121.7, 116.6, 76.6, 16.3. HRMS (ESI) calcd for $C_{28}H_{19}NNaO_2$ $[M + Na]^+$ 424.1308, found 424.1290.



3pa

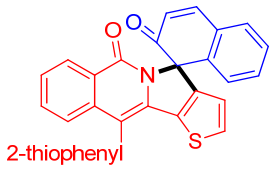
9-Methyl-12-(*p*-tolyl)-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3pa): Dichloromethane/ethyl acetate (30:1) as eluent; yellow solid (68 mg, 73%), mp 206-207 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.35 (dd, *J* = 7.8, 0.6 Hz, 1H), 7.76 (d, *J* = 10.2 Hz, 1H), 7.56-7.54 (m, 1H), 7.49 (d, *J* = 7.2 Hz, 1H), 7.42-7.40 (m, 5H), 7.32-7.28 (m, 2H), 7.19 (td, *J* = 7.8, 0.6 Hz, 1H), 6.87 (d, *J* = 8.4 Hz, 1H), 6.84 (d, *J* = 7.8 Hz, 1H), 6.82 (s, 1H), 6.50 (d, *J* = 10.2 Hz, 1H), 6.43 (d, *J* = 8.4 Hz, 1H), 2.54 (s, 3H), 2.18 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 193.1, 159.3, 146.3, 142.7, 140.6, 140.3, 139.4, 139.1, 138.2, 132.3, 131.9, 131.2,

131.0, 130.92, 130.85, 130.3, 130.1, 130.0, 129.9, 129.5, 128.3, 127.8, 126.3, 125.44, 125.42, 125.37, 125.2, 124.8, 121.8, 113.8, 75.9, 21.54, 21.52. HRMS (ESI) calcd for $C_{33}H_{23}NNaO_2$ $[M + Na]^+$ 488.1621, found 488.1601.



3qa

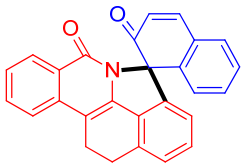
9-Chloro-12-(4-chlorophenyl)-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3qa): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (68 mg, 67%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.36 (d, *J* = 7.8 Hz, 1H), 7.78 (d, *J* = 10.2 Hz, 1H), 7.63 (d, *J* = 8.4 Hz, 2H), 7.59 (td, *J* = 8.4, 1.2 Hz, 1H), 7.52-7.45 (m, 4H), 7.35 (td, *J* = 7.2, 0.6 Hz, 1H), 7.24-7.21 (m, 2H), 7.08 (dd, *J* = 8.4, 1.8 Hz, 1H), 7.01 (d, *J* = 1.8 Hz, 1H), 6.84 (d, *J* = 7.8 Hz, 1H), 6.50 (d, *J* = 10.2 Hz, 1H), 6.47 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.2, 159.1, 146.7, 143.8, 139.5, 138.7, 138.1, 135.9, 135.0, 133.1, 132.8, 132.7, 132.5, 131.7, 131.1, 130.4, 130.1, 129.9, 129.5, 129.4, 128.8, 128.0, 127.0, 125.7, 125.6, 125.3, 125.2, 125.1, 122.1, 113.3, 75.7. HRMS (ESI) calcd for $C_{31}H_{17}Cl_2NNaO_2$ $[M + Na]^+$ 528.0529, found 528.0501.



3ra

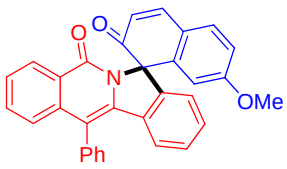
11'-(Thiophen-2-yl)-2*H*,6'*H*-spiro[naphthalene-1,4'-thieno[2',3':3,4]pyrrolo[1,2-*b*]isoquinoline]-2,6'-dione (3ra): Dichloromethane/ethyl acetate (45:1) as eluent; yellow solid (59 mg, 66%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.25 (d, *J* = 7.6 Hz, 1H), 7.64 (d, *J* = 10.0

Hz, 1H), 7.54 (m, 2H), 7.46 (d, *J* = 8.0 Hz, 1H), 7.39-7.33 (m, 2H), 7.26-7.20 (m, 3H), 7.17-7.14 (m, 2H), 6.86 (d, *J* = 7.2 Hz, 1H), 6.55 (d, *J* = 4.8 Hz, 1H), 6.40 (d, *J* = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 191.3, 159.1, 148.4, 146.2, 139.3, 139.0, 138.1, 134.9, 134.0, 132.8, 130.9, 130.2, 129.8, 129.5, 128.7, 128.1, 127.9, 126.5, 125.3, 125.13, 125.10, 118.9, 104.0, 75.6 (three ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{27}H_{15}NNaO_2S_2$ $[M + Na]^+$ 472.0436, found 472.0430.



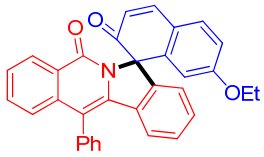
3sa

11,12-Dihydro-2'*H*,6*H*-spiro[isoindolo[7,1,2-*cde*]phenanthridine-4,1'-naphthalene]-2',6-dione (3sa): Dichloromethane/ethyl acetate (60:1) as eluent; yellow solid (38 mg, 49%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.40 (dd, *J* = 8.0, 0.4 Hz, 1H), 7.74 (d, *J* = 10.4 Hz, 1H), 7.69 (dd, *J* = 7.2, 1.2 Hz, 1H), 7.65 (d, *J* = 7.2 Hz, 1H), 7.47 (d, *J* = 7.2 Hz, 1H), 7.44-7.40 (m, 1H), 7.31 (td, *J* = 7.2, 1.2 Hz, 1H), 7.21-7.11 (m, 3H), 6.89 (t, *J* = 6.8 Hz, 2H), 6.44 (d, *J* = 10.0 Hz, 1H), 3.32-3.21 (m, 4H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.3, 159.3, 146.5, 139.4, 138.9, 138.4, 137.9, 133.5, 132.4, 130.85, 130.76, 130.5, 130.1, 129.24, 129.21, 128.6, 127.7, 127.2, 125.7, 125.6, 125.0, 122.1, 119.3, 103.4, 79.8, 25.5, 21.5. HRMS (ESI) calcd for $C_{27}H_{17}NNaO_2$ $[M + Na]^+$ 410.1151, found 410.1147.



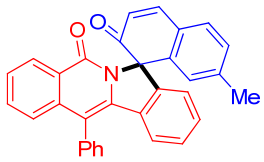
3ab

7'-Methoxy-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ab): Dichloromethane/ethyl acetate (30:1) as eluent; pink solid (82 mg, 88%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.38 (d, *J* = 7.8 Hz, 1H), 7.71 (d, *J* = 9.6 Hz, 1H), 7.64-7.53 (m, 6H), 7.46-7.43 (m, 2H), 7.28 (d, *J* = 7.8 Hz, 1H), 7.13 (t, *J* = 7.8 Hz, 1H), 7.07 (d, *J* = 7.2 Hz, 1H), 7.03 (t, *J* = 7.2 Hz, 1H), 6.81 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.46 (d, *J* = 8.4 Hz, 1H), 6.39 (d, *J* = 2.4 Hz, 1H), 6.36 (d, *J* = 10.2 Hz, 1H), 3.65 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.7, 161.8, 159.3, 146.3, 142.7, 142.5, 139.2, 138.9, 134.9, 133.3, 132.4, 131.9, 131.4, 131.1, 129.7, 129.6, 129.4, 128.8, 128.6, 127.9, 126.6, 125.6, 125.5, 124.9, 122.9, 122.7, 121.6, 114.5, 112.7, 112.0, 76.2, 55.3. HRMS (ESI) calcd for $C_{32}H_{21}NNaO_3$ $[M + Na]^+$ 490.1414, found 490.1399.



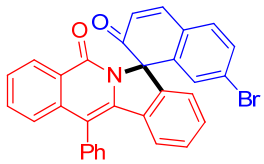
3ac

7'-Ethoxy-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ac): Dichloromethane/ethyl acetate (30:1) as eluent; pink solid (95 mg, 98%), mp 183-184 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.39 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.71 (d, *J* = 10.2 Hz, 1H), 7.65-7.55 (m, 6H), 7.46-7.42 (m, 2H), 7.28 (d, *J* = 8.4 Hz, 1H), 7.13 (t, *J* = 7.8 Hz, 1H), 7.06 (d, *J* = 7.2 Hz, 1H), 7.03 (td, *J* = 8.4, 1.2 Hz, 1H), 6.79 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.45 (d, *J* = 8.4 Hz, 1H), 6.39 (d, *J* = 2.4 Hz, 1H), 6.36 (d, *J* = 10.2 Hz, 1H), 3.92-3.86 (m, 2H), 1.28 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.8, 161.2, 159.3, 146.4, 142.6, 142.5, 139.2, 138.9, 134.9, 133.4, 132.4, 131.9, 131.4, 131.2, 129.7, 129.6, 129.4, 128.8, 128.6, 127.9, 126.5, 125.6, 125.5, 124.9, 122.7, 122.5, 121.6, 114.5, 113.2, 112.3, 76.3, 63.6, 14.6. HRMS (ESI) calcd for $C_{33}H_{23}NNaO_3$ $[M + Na]^+$ 504.1570, found 504.1549.



3ad

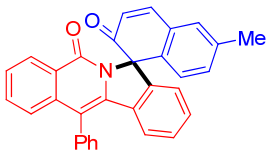
7'-Methyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ad): Dichloromethane/ethyl acetate (30:1) as eluent; yellow solid (44 mg, 49%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.39 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.74 (d, *J* = 9.6 Hz, 1H), 7.66-7.55 (m, 6H), 7.46 (td, *J* = 8.0, 1.2 Hz, 1H), 7.38 (d, *J* = 8.0 Hz, 1H), 7.30 (d, *J* = 8.0 Hz, 1H), 7.16-7.10 (m, 2H), 7.06-7.02 (m, 2H), 6.61 (s, 1H), 6.49-6.47 (m, 1H), 6.43 (d, *J* = 9.6 Hz, 1H), 2.16 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 193.0, 159.3, 146.5, 142.5, 141.5, 140.3, 139.2, 139.0, 134.9, 133.4, 132.4, 131.4, 131.1, 130.2, 129.72, 129.66, 129.4, 129.3, 128.8, 128.6, 128.0, 127.0, 126.5, 125.71, 125.67, 125.5, 124.9, 124.2, 121.6, 114.4, 76.3, 21.7. HRMS (ESI) calcd for $C_{32}H_{21}NNaO_2$ $[M + Na]^+$ 474.1464, found 474.1456.



3ae

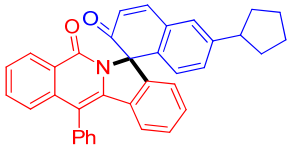
7'-Bromo-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ae): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (37 mg, 36%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.38 (d, *J* = 8.0 Hz, 1H), 7.71 (d, *J* = 10.0 Hz, 1H), 7.68-7.58 (m, 5H), 7.54 (d, *J* = 6.8 Hz, 1H), 7.50-7.44 (m, 2H), 7.36 (d, *J* = 8.0 Hz, 1H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.16 (t, *J* = 7.6 Hz, 1H), 7.07 (t, *J* = 7.6 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 1H), 6.95 (d, *J* = 1.2 Hz, 1H), 6.52-6.48 (m, 2H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.0, 159.4, 145.2, 142.3, 141.6, 139.2, 138.6, 134.7, 133.5, 132.6, 131.8, 131.31, 131.28, 131.2, 129.8,

129.7, 129.4, 129.2, 128.7, 128.5, 128.3, 127.9, 126.8, 125.69, 125.66, 125.6, 125.5, 125.1, 121.6, 114.9, 75.7. HRMS (ESI) calcd for $C_{31}H_{18}BrNNaO_2$ $[M + Na]^+$ 538.0413, found 538.0416.



3af

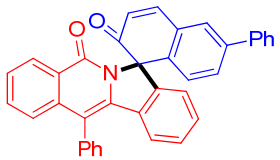
6'-Methyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3af): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (51 mg, 56%), mp 198-199 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.38 (d, J = 7.8 Hz, 1H), 7.72 (d, J = 10.2 Hz, 1H), 7.64-7.53 (m, 6H), 7.43 (t, J = 7.8 Hz, 1H), 7.29 (s, 1H), 7.28 (d, J = 7.8 Hz, 1H),, 7.13 (t, J = 7.8 Hz, 1H), 7.04-6.99 (m, 3H), 6.73 (d, J = 7.8 Hz, 1H), 6.49-6.46 (m, 2H), 2.32 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 193.2, 159.3, 146.5, 142.7, 139.1, 138.9, 138.2, 137.4, 135.0, 133.5, 132.4, 131.7, 131.4, 131.1, 130.8, 129.8, 129.7, 129.4, 128.8, 128.6, 127.9, 126.5, 125.6, 125.5, 125.3, 125.1, 124.9, 121.6, 114.5, 76.0, 21.0 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{32}H_{21}NNaO_2$ $[M + Na]^+$ 474.1464, found 474.1457.



3ag

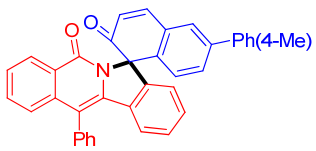
6'-Cyclopentyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ag): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (63 mg, 63%), mp 272-273 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.38 (d, J = 8.4 Hz, 1H), 7.73 (d, J = 10.2 Hz, 1H), 7.64-7.53 (m, 6H), 7.44 (t, J = 7.2 Hz, 1H), 7.33 (d, J = 1.2 Hz, 1H), 7.28 (d, J = 8.4 Hz, 1H),

7.13 (t, J = 7.2 Hz, 1H), 7.06-7.01 (m, 3H), 6.74 (d, J = 7.8 Hz, 1H), 6.48 (d, J = 10.2 Hz, 1H), 6.46 (d, J = 7.8 Hz, 1H), 2.98-2.92 (m, 1H), 2.06-2.02 (m, 2H), 1.81-1.75 (m, 2H), 1.70-1.63 (m, 2H), 1.58-1.51 (m, 2H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 193.2, 159.3, 146.8, 146.7, 142.7, 139.1, 139.0, 137.6, 135.0, 133.4, 132.4, 131.4, 131.1, 129.9, 129.7, 129.6, 129.4, 129.3, 129.0, 128.7, 128.6, 127.9, 126.5, 125.6, 125.5, 125.1, 125.0, 124.9, 121.7, 114.5, 76.0, 45.4, 34.40, 34.35, 25.4. HRMS (ESI) calcd for $C_{36}H_{27}NNaO_2$ $[M + Na]^+$ 528.1934, found 528.1904.



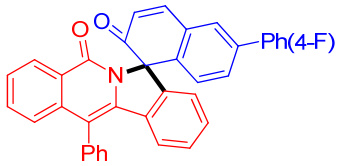
3ah

6',12-Diphenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ah): Dichloromethane/ethyl acetate (45:1) as eluent; grey solid (51 mg, 49%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.39 (d, J = 7.8 Hz, 1H), 7.83 (d, J = 9.6 Hz, 1H), 7.69 (s, 1H), 7.66-7.56 (m, 6H), 7.53 (d, J = 7.2 Hz, 2H), 7.47-7.39 (m, 4H), 7.36 (t, J = 7.2 Hz, 1H), 7.30 (d, J = 8.4 Hz, 1H), 7.16 (t, J = 7.8 Hz, 1H), 7.10 (d, J = 7.8 Hz, 1H), 7.06 (t, J = 7.8 Hz, 1H), 6.92 (d, J = 7.8 Hz, 1H), 6.55 (d, J = 10.2 Hz, 1H), 6.49 (d, J = 8.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.9, 159.3, 146.3, 142.4, 141.6, 139.9, 139.2, 139.1, 138.9, 134.9, 133.5, 132.5, 131.4, 131.1, 129.9, 129.8, 129.7, 129.6, 129.4, 128.93, 128,86, 128.7, 127.9, 127.8, 127.1, 126.7, 125.71, 125.68, 125.6, 125.0, 121.7, 114.6, 76.0. HRMS (ESI) calcd for $C_{37}H_{23}NNaO_2$ $[M + Na]^+$ 536.1621, found 536.1603.



3ai

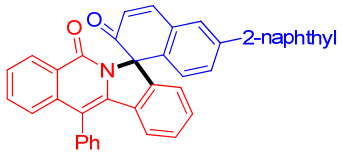
12-Phenyl-6'-(*p*-tolyl)-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ai): Dichloromethane/ethyl acetate (30:1) as eluent; yellow solid (63 mg, 60%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.39 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.81 (d, *J* = 10.0 Hz, 1H), 7.66-7.54 (m, 7H), 7.46-7.41 (m, 3H), 7.37 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 1H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.15 (td, *J* = 8.0, 0.8 Hz, 1H), 7.10-7.02 (m, 2H), 6.89 (d, *J* = 8.0 Hz, 1H), 6.53 (d, *J* = 10.0 Hz, 1H), 6.48 (d, *J* = 7.6 Hz, 1H), 2.37 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 193.0, 159.3, 146.5, 142.5, 141.5, 139.2, 138.9, 138.8, 137.7, 137.0, 134.9, 133.5, 132.5, 131.4, 131.1, 129.9, 129.8, 129.7, 129.43, 129.40, 128.9, 128.67, 128.66, 127.9, 126.9, 126.6, 125.7, 125.61, 125.58, 125.0, 121.7, 114.6, 76.0, 21.2. HRMS (ESI) calcd for $C_{38}H_{25}NNaO_2$ $[M + Na]^+$ 550.1777, found 550.1756.



3aj

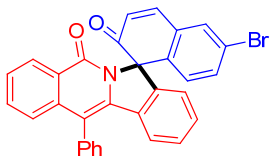
6'-(4-Fluorophenyl)-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3aj): Dichloromethane/ethyl acetate (30:1) as eluent; grey solid (54 mg, 51%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.39 (d, *J* = 7.8 Hz, 1H), 7.82 (d, *J* = 10.2 Hz, 1H), 7.66-7.55 (m, 7H), 7.50-7.45 (m, 3H), 7.34 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.30 (d, *J* = 7.8 Hz, 1H), 7.16 (t, *J* = 7.2 Hz, 1H), 7.13-7.05 (m, 4H), 6.91 (d, *J* = 7.8 Hz, 1H), 6.55 (d, *J* = 10.2 Hz, 1H), 6.49 (d, *J* = 8.4 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.8, 162.8 (d, *J* = 246.2 Hz, 1C), 159.3, 146.1, 142.3, 140.6, 139.2, 138.8, 136.0 (d, *J* = 3.3 Hz, 1C), 134.8, 133.5, 132.5, 131.4, 131.1, 129.9, 129.8, 129.7, 129.41, 129.40, 129.0, 128.75, 128.70, 128.67, 127.9, 126.7, 125.8 (d, *J* = 7.7 Hz, 2C), 125.60, 125.57, 125.0, 121.7, 115.9 (d, *J* = 20.7 Hz, 2C), 114.7, 75.9. ^{19}F

NMR ($CDCl_3$, 376 MHz) δ -114.63– -114.70 (m). HRMS (ESI) calcd for $C_{37}H_{22}FNNaO_2$ [M + Na]$^+$ 554.1527, found 554.1500.



3ak

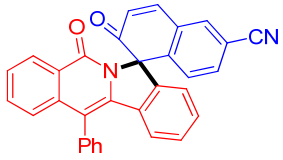
6'-(Naphthalen-2-yl)-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ak): Dichloromethane/ethyl acetate (45:1) as eluent; white solid (83 mg, 73%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.41 (d, *J* = 8.0 Hz, 1H), 7.97 (s, 1H), 7.90-7.84 (m, 4H), 7.80 (s, 1H), 7.66-7.56 (m, 7H), 7.51-7.43 (m, 4H), 7.30 (d, *J* = 8.4 Hz, 1H), 7.18-7.10 (m, 2H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.95 (d, *J* = 8.4 Hz, 1H), 6.56 (d, *J* = 10.0 Hz, 1H), 6.50 (d, *J* = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.9, 159.4, 146.4, 142.4, 141.5, 139.20, 139.18, 138.9, 137.2, 134.9, 133.6, 133.5, 132.8, 132.5, 131.4, 131.1, 130.0, 129.9, 129.8, 129.7, 129.4, 129.1, 129.0, 128.70, 128.67, 128.3, 127.9, 127.7, 126.7, 126.5, 126.3, 126.0, 125.79, 125.76, 125.6, 125.2, 125.0, 121.7, 114.7, 76.0 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{41}H_{25}NNaO_2$ [M + Na]$^+$ 586.1777, found 586.1739.



3al

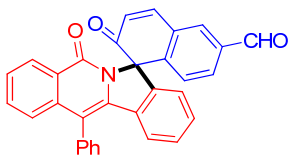
6'-Bromo-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3al): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (44 mg, 43%), mp 190-191 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.36 (d, *J* = 7.2 Hz, 1H), 7.68 (d, *J* = 10.2 Hz, 1H), 7.64-7.57 (m, 5H), 7.55-7.53 (m, 2H), 7.46 (t, *J* = 7.2 Hz, 1H), 7.31-7.28 (m, 2H), 7.15 (t, *J* =

7.8 Hz, 1H), 7.06 (t, J = 7.2 Hz, 1H), 7.03 (d, J = 7.8 Hz, 1H), 6.72 (d, J = 8.4 Hz, 1H), 6.53 (d, J = 10.2 Hz, 1H), 6.47 (d, J = 7.8 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.3, 159.3, 144.6, 141.8, 139.3, 139.1, 138.6, 134.7, 133.6, 133.5, 132.6, 131.3, 131.0, 129.9, 129.7, 129.4, 129.1, 128.7, 127.9, 126.9, 126.8, 126.5, 125.6, 125.5, 125.0, 122.2, 121.6, 114.8, 75.7. HRMS (ESI) calcd for $C_{31}H_{18}BrNNaO_2$ $[M + Na]^+$ 538.0413, found 538.0407.



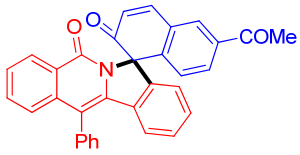
3am

2',5-Dioxo-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-6'-carbonitrile (3am): Dichloromethane/ethyl acetate (30:1) as eluent; grey solid (38 mg, 41%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.35 (d, J = 7.6 Hz, 1H), 7.80 (d, J = 1.2 Hz, 1H), 7.75 (d, J = 10.0 Hz, 1H), 7.67-7.59 (m, 4H), 7.56-7.53 (m, 2H), 7.50-7.46 (m, 2H), 7.30 (d, J = 8.4 Hz, 1H), 7.17 (t, J = 7.2 Hz, 1H), 7.09 (t, J = 7.2 Hz, 1H), 7.02 (d, J = 8.0 Hz, 1H), 6.98 (d, J = 8.0 Hz, 1H), 6.62 (d, J = 10.0 Hz, 1H), 6.50 (d, J = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 191.4, 159.3, 145.2, 143.7, 140.9, 139.1, 138.3, 134.5, 133.8, 133.7, 133.1, 132.8, 131.2, 130.9, 130.6, 130.0, 129.8, 129.5, 128.8, 127.8, 127.3, 127.0, 126.2, 125.8, 125.3, 125.2, 121.5, 117.7, 115.2, 112.7, 75.7 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{32}H_{18}N_2NaO_2$ $[M + Na]^+$ 485.1260, found 485.1233.



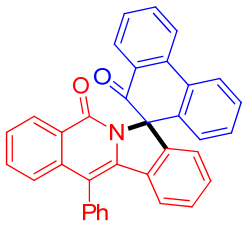
3an

2',5-Dioxo-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-6'-carbaldehyde (3an): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (35 mg, 38%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 10.00 (s, 1H), 8.36 (d, *J* = 7.8 Hz, 1H), 8.02 (d, *J* = 1.2 Hz, 1H), 7.85 (d, *J* = 10.2 Hz, 1H), 7.71 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.66-7.59 (m, 4H), 7.57-7.55 (m, 2H), 7.47 (t, *J* = 7.2 Hz, 1H), 7.31 (d, *J* = 8.4 Hz, 1H), 7.16 (t, *J* = 7.2 Hz, 1H), 7.08 (t, *J* = 7.2 Hz, 1H), 7.05 (d, *J* = 3.6 Hz, 1H), 7.04 (d, *J* = 3.6 Hz, 1H), 6.61 (d, *J* = 10.2 Hz, 1H), 6.50 (d, *J* = 7.8 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 191.8, 190.8, 159.3, 146.5, 144.9, 141.2, 139.1, 138.5, 136.3, 134.6, 133.6, 132.7, 131.7, 131.3, 131.0, 130.7, 130.3, 129.9, 129.7, 129.4, 129.3, 128.7, 127.8, 126.9, 126.6, 126.0, 125.7, 125.4, 125.1, 121.5, 115.0, 76.0. HRMS (ESI) calcd for $C_{32}H_{19}NNaO_3$ $[M + Na]^+$ 488.1257, found 488.1244.



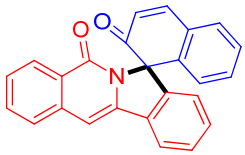
3ao

6'-Acetyl-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (3ao): Dichloromethane/ethyl acetate (30:1) as eluent; white solid (65 mg, 68%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.36 (dd, *J* = 8.0, 0.8 Hz, 1H), 8.09 (d, *J* = 1.2 Hz, 1H), 7.84 (d, *J* = 10.0 Hz, 1H), 7.77 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.67-7.54 (m, 6H), 7.47 (td, *J* = 8.0, 0.8 Hz, 1H), 7.30 (d, *J* = 8.0 Hz, 1H), 7.15 (td, *J* = 7.6, 1.2 Hz, 1H), 7.09-7.03 (m, 2H), 6.96 (d, *J* = 8.0 Hz, 1H), 6.58 (d, *J* = 10.0 Hz, 1H), 6.49 (d, *J* = 8.0 Hz, 1H), 2.58 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 196.7, 192.1, 159.3, 145.4, 145.1, 141.5, 139.1, 138.6, 137.1, 134.7, 133.6, 132.6, 131.3, 131.0, 130.5, 129.9, 129.84, 129.77, 129.7, 129.4, 129.2, 128.7, 127.9, 126.8, 126.3, 125.7, 125.6, 125.4, 125.1, 121.5, 114.9, 76.0, 26.6. HRMS (ESI) calcd for $C_{33}H_{21}NNaO_3$ $[M + Na]^+$ 502.1414, found 502.1402.



3ap

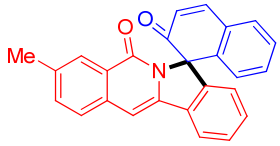
12-Phenyl-5*H*,10'*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,9'-phenanthrene]-5,10'-dione (3ap): Dichloromethane/ethyl acetate (100:1) as eluent; white solid (46 mg, 47%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.39 (d, *J* = 7.2 Hz, 1H), 8.22 (d, *J* = 8.0 Hz, 1H), 8.16-8.13 (m, 2H), 7.80 (td, *J* = 8.4, 0.8 Hz, 1H), 7.66-7.55 (m, 6H), 7.48 (d, *J* = 7.6 Hz, 1H), 7.44 (d, *J* = 6.8 Hz, 1H), 7.39 (td, *J* = 8.0, 0.8 Hz, 1H), 7.30 (d, *J* = 8.0 Hz, 1H), 7.17 (t, *J* = 7.6 Hz, 1H), 7.04-6.98 (m, 2H), 6.92 (d, *J* = 7.6 Hz, 1H), 6.84-6.82 (m, 1H), 6.47-6.45 (m, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 191.2, 159.4, 142.6, 139.2, 138.9, 137.9, 137.3, 135.5, 135.0, 133.3, 132.4, 131.4, 131.2, 129.8, 129.69, 129.67, 129.45, 129.43, 129.38, 128.92, 128.85, 128.6, 128.5, 128.0, 126.6, 125.7, 125.5, 125.3, 124.9, 124.5, 123.6, 121.9, 114.7, 76.9 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{35}H_{21}NNaO_2$ $[M + Na]^+$ 510.1464, found 510.1462.



5a

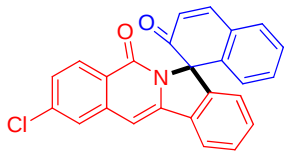
2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5a): Dichloromethane/ethyl acetate (30:1) as eluent; brown solid (50 mg, 69%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.30 (d, *J* = 8.4 Hz, 1H), 7.83 (d, *J* = 7.2 Hz, 1H), 7.76 (d, *J* = 10.2 Hz, 1H), 7.69-7.65 (m, 2H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.44 (d, *J* = 6.6 Hz, 1H), 7.42 (d, *J* = 7.2 Hz, 1H), 7.30 (t, *J* = 7.2 Hz, 1H), 7.28 (d, *J* = 7.2 Hz, 1H), 7.16 (t, *J* = 7.8 Hz, 1H),

7.10-7.09 (m, 2H), 6.77 (d, J = 7.8 Hz, 1H), 6.48 (d, J = 10.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.7, 159.6, 146.5, 142.6, 142.2, 139.9, 138.2, 133.2, 132.6, 130.9, 130.4, 130.1, 129.5, 129.3, 128.5, 128.0, 126.7, 126.6, 126.1, 125.2, 122.0, 121.9, 98.5, 76.6 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{25}H_{15}NNaO_2$ $[M + Na]^+$ 384.0995, found 384.0982.



5b

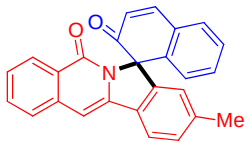
3-Methyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5b): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (41 mg, 54%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.11 (s, 1H), 7.80 (d, J = 7.8 Hz, 1H), 7.75 (d, J = 9.6 Hz, 1H), 7.59 (d, J = 7.8 Hz, 1H), 7.50-7.47 (m, 2H), 7.41 (t, J = 7.8 Hz, 1H), 7.29 (t, J = 7.2 Hz, 1H), 7.25 (t, J = 7.2 Hz, 1H), 7.16-7.14 (m, 1H), 7.09 (d, J = 7.8 Hz, 1H), 7.07 (s, 1H), 6.75 (d, J = 7.8 Hz, 1H), 6.48 (d, J = 10.2 Hz, 1H), 2.44 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.8, 159.5, 146.4, 142.1, 141.7, 140.1, 136.8, 135.8, 134.1, 133.3, 130.9, 130.10, 130.07, 129.5, 129.3, 128.4, 127.7, 126.7, 126.1, 125.2, 121.9, 121.8, 98.5, 76.5, 21.5 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{26}H_{17}NNaO_2$ $[M + Na]^+$ 398.1151, found 398.1136.



5c

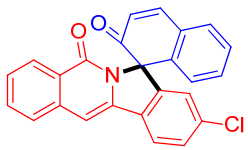
2-Chloro-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5c): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (52 mg, 65%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.21 (d, J = 8.8 Hz, 1H), 7.80 (d, J = 8.0 Hz, 1H), 7.77 (d, J =

10.0 Hz, 1H), 7.63 (d, J = 2.0 Hz, 1H), 7.49 (d, J = 7.2 Hz, 1H), 7.41 (td, J = 7.6, 0.8 Hz, 1H), 7.36 (dd, J = 8.8, 2.0 Hz, 1H), 7.33-7.26 (m, 2H), 7.17 (td, J = 7.6, 1.2 Hz, 1H), 7.10 (d, J = 7.6 Hz, 1H), 7.00 (s, 1H), 6.75 (d, J = 8.0 Hz, 1H), 6.49 (d, J = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.5, 159.0, 146.6, 144.0, 142.3, 139.6, 139.5, 139.1, 132.7, 131.0, 130.8, 130.2, 129.7, 129.4, 128.6, 127.0, 125.9, 125.1, 124.4, 122.2, 121.9, 97.4, 77.3 (two ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{25}H_{14}ClNNaO_2$ $[M + Na]^+$ 418.0605, found 418.0589.



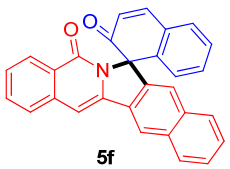
5d

9-Methyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5d): Dichloromethane/ethyl acetate (45:1) as eluent; yellow solid (55 mg, 73%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.29 (d, J = 8.0 Hz, 1H), 7.75 (d, J = 10.0 Hz, 1H), 7.70 (d, J = 8.0 Hz, 1H), 7.64-7.63 (m, 2H), 7.48 (d, J = 7.2 Hz, 1H), 7.42-7.38 (m, 1H), 7.29 (t, J = 7.6 Hz, 1H), 7.21 (d, J = 8.0 Hz, 1H), 7.16 (t, J = 7.6 Hz, 1H), 7.02 (s, 1H), 6.87 (s, 1H), 6.76 (d, J = 7.6 Hz, 1H), 6.48 (d, J = 10.0 Hz, 1H), 2.27 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.9, 159.6, 146.5, 142.8, 142.5, 141.0, 140.1, 138.3, 132.6, 130.9, 130.5, 130.4, 130.1, 129.5, 128.4, 128.0, 126.6, 126.3, 125.9, 125.3, 125.2, 122.2, 121.8, 97.9, 76.4, 21.8. HRMS (ESI) calcd for $C_{26}H_{17}NNaO_2$ $[M + Na]^+$ 398.1151, found 398.1142.



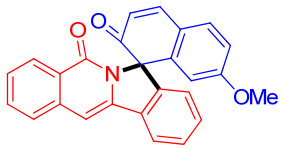
5e

9-Chloro-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5e): Dichloromethane/ethyl acetate (45:1) as eluent; yellow solid (58 mg, 73%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.30-8.28 (m, 1H), 7.78 (d, *J* = 10.0 Hz, 1H), 7.74 (d, *J* = 8.4 Hz, 1H), 7.67-7.66 (m, 2H), 7.50 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.47-7.43 (m, 1H), 7.37 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.33 (td, *J* = 7.2, 1.2 Hz, 1H), 7.19 (td, *J* = 7.6, 1.2 Hz, 1H), 7.06 (s, 1H), 7.05 (d, *J* = 2.0 Hz, 1H), 6.76 (d, *J* = 7.6 Hz, 1H), 6.49 (d, *J* = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.2, 159.5, 146.7, 143.4, 141.5, 139.2, 138.0, 136.1, 132.8, 131.7, 131.1, 130.4, 129.9, 129.4, 128.8, 128.0, 126.8, 126.1, 125.2, 125.0, 123.1, 122.4, 98.9, 76.1 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{25}H_{14}ClNNaO_2$ $[M + Na]^+$ 418.0605, found 418.0598.



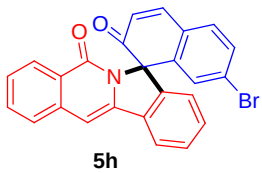
5f

2'*H*,5*H*-Spiro[benzo[5,6]isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5f): Dichloromethane/ethyl acetate (45:1) as eluent; yellow solid (43 mg, 52%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.33-8.31 (m, 2H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.83 (d, *J* = 10.0 Hz, 1H), 7.73-7.66 (m, 3H), 7.54-7.43 (m, 5H), 7.31 (td, *J* = 7.6, 1.2 Hz, 1H), 7.28 (s, 1H), 7.15 (td, *J* = 7.6, 1.2 Hz, 1H), 6.79 (d, *J* = 8.0 Hz, 1H), 6.53 (d, *J* = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.9, 159.7, 146.6, 142.2, 140.9, 139.0, 138.2, 134.2, 133.6, 132.7, 131.1, 130.9, 130.2, 129.3, 128.6, 128.42, 128.35, 128.1, 127.3, 127.1, 126.8, 126.7, 126.3, 125.3, 125.0, 121.4, 121.1, 98.9, 76.0. HRMS (ESI) calcd for $C_{29}H_{17}NNaO_2$ $[M + Na]^+$ 434.1151, found 434.1135.



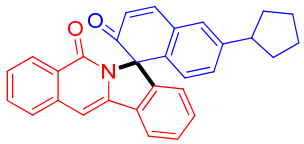
5g

7'-Methoxy-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5g): Dichloromethane/ethyl acetate (45:1) as eluent; brown solid (35 mg, 44%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.32 (d, *J* = 8.0 Hz, 1H), 7.82 (d, *J* = 7.6 Hz, 1H), 7.71 (d, *J* = 10.0 Hz, 1H), 7.69-7.67 (m, 2H), 7.46-7.40 (m, 3H), 7.30-7.26 (m, 1H), 7.12 (d, *J* = 7.6 Hz, 1H), 7.09 (s, 1H), 6.80 (dd, *J* = 8.4, 2.8 Hz, 1H), 6.35 (d, *J* = 9.6 Hz, 1H), 6.29 (d, *J* = 2.4 Hz, 1H), 3.61 (s, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.6, 161.8, 159.6, 146.5, 142.6, 142.3, 142.2, 138.2, 133.0, 132.6, 131.9, 130.3, 129.3, 128.1, 126.7, 126.6, 126.1, 122.8, 122.5, 122.0, 121.9, 112.6, 112.3, 98.5, 76.7, 55.3. HRMS (ESI) calcd for $C_{26}H_{17}NNaO_3$ $[M + Na]^+$ 414.1101, found 414.1093.



5h

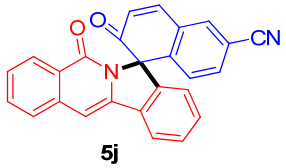
7'-Bromo-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (5h): Dichloromethane/ethyl acetate (45:1) as eluent; yellow solid (37 mg, 42%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.30 (d, *J* = 8.0 Hz, 1H), 7.84 (d, *J* = 8.0 Hz, 1H), 7.71-7.68 (m, 3H), 7.47-7.42 (m, 3H), 7.33 (d, *J* = 8.4 Hz, 1H), 7.29 (t, *J* = 8.0 Hz, 1H), 7.11 (s, 1H), 7.07 (d, *J* = 8.0 Hz, 1H), 6.87 (d, *J* = 1.2 Hz, 1H), 6.49 (d, *J* = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 191.8, 159.7, 145.3, 142.3, 141.8, 141.5, 138.2, 133.2, 132.8, 131.8, 131.3, 130.5, 129.6, 128.43, 128.39, 128.0, 126.9, 126.8, 126.0, 125.7, 125.5, 122.2, 121.9, 98.9, 76.0. HRMS (ESI) calcd for $C_{25}H_{14}BrNNaO_2$ $[M + Na]^+$ 462.0100, found 462.0104.



5i

6'-Cyclopentyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione

(5i): Dichloromethane/ethyl acetate (100:1) as eluent; brown solid (30 mg, 34%), mp 164-165 ^{o}C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.30 (d, *J* = 8.0 Hz, 1H), 7.81 (d, *J* = 7.6 Hz, 1H), 7.72 (d, *J* = 10.0 Hz, 1H), 7.68-7.63 (m, 2H), 7.44-7.38 (m, 2H), 7.32 (d, *J* = 1.2 Hz, 1H), 7.28-7.25 (m, 1H), 7.10-7.08 (m, 2H), 7.02 (dd, *J* = 8.0, 1.6 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 6.46 (d, *J* = 9.6 Hz, 1H), 2.98-2.89 (m, 1H), 2.06-2.01 (m, 2H), 1.83-1.75 (m, 2H), 1.71-1.63 (m, 2H), 1.55-1.48 (m, 2H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 193.0, 159.6, 147.0, 146.8, 142.7, 142.5, 138.2, 137.0, 133.1, 132.6, 130.3, 129.9, 129.24, 129.20, 129.0, 128.0, 126.7, 126.5, 126.1, 125.1, 125.0, 122.0, 121.9, 98.4, 76.5, 45.4, 34.4, 34.3, 25.4. HRMS (ESI) calcd for $C_{30}H_{23}NNaO_2$ $[M + Na]^+$ 452.1621, found 452.1603.

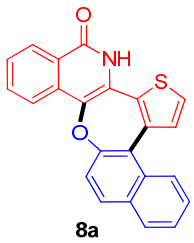


5j

2',5-Dioxo-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-6'-carbonitrile

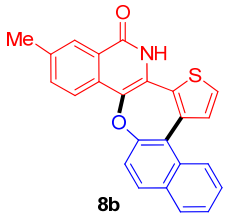
(5j): Dichloromethane/ethyl acetate (45:1) as eluent; yellow solid (27 mg, 34%), mp >300 ^{o}C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.28 (d, *J* = 8.0 Hz, 1H), 7.85 (d, *J* = 7.6 Hz, 1H), 7.78 (s, 1H), 7.74 (d, *J* = 10.4 Hz, 1H), 7.70 (d, *J* = 3.6 Hz, 2H), 7.49-7.42 (m, 3H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.13 (s, 1H), 7.07 (d, *J* = 8.0 Hz, 1H), 6.89 (d, *J* = 8.0 Hz, 1H), 6.59 (d, *J* = 10.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 191.2, 159.6, 144.7, 143.8, 142.1, 140.7, 138.1, 133.8, 133.3, 133.1, 133.0, 130.6, 130.5, 129.9, 128.0, 127.2, 126.98, 126.96, 126.2, 125.8, 122.3, 121.8,

117.7, 112.7, 99.1, 76.1. HRMS (ESI) calcd for $C_{26}H_{14}N_2NaO_2$ $[M + Na]^+$ 409.0947, found 409.0941.



8a

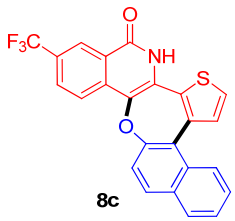
Naphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8a): Petroleum ether/ethyl acetate (3:1) as eluent; yellow solid (32 mg, 43%), mp >300 °C. ^{1}H NMR (DMSO-d_6, 600 MHz) δ 11.75 (s, 1H), 8.43 (d, J = 7.8 Hz, 1H), 8.25 (d, J = 7.2 Hz, 1H), 8.15 (d, J = 8.4 Hz, 1H), 8.08-8.06 (m, 2H), 8.02 (d, J = 7.8 Hz, 1H), 7.94-7.91 (m, 1H), 7.84 (d, J = 9.0 Hz, 1H), 7.71 (d, J = 5.4 Hz, 1H), 7.64-7.60 (m, 2H), 7.56-7.54 (m, 1H); ^{13}C NMR (DMSO-d_6, 100 MHz) δ 161.4, 158.0, 137.1, 136.6, 133.8, 133.2, 132.6, 132.0, 131.3, 131.2, 130.4, 129.1, 128.2, 128.0, 126.1, 125.8, 125.4, 123.4, 122.0, 121.3 (three ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{23}H_{13}NNaO_2S$ $[M + Na]^+$ 390.0559, found 390.0546.



8b

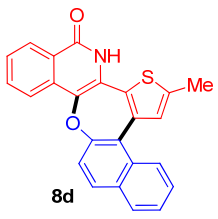
10-Methylnaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8b): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (25 mg, 33%), mp 257-258 °C. ^{1}H NMR (DMSO-d_6, 600 MHz) δ 11.66 (s, 1H), 8.32 (d, J = 8.4 Hz, 1H), 8.15 (d, J = 9.0 Hz, 1H), 8.07-8.05 (m, 3H), 8.02 (d, J = 7.8 Hz, 1H), 7.81 (d, J = 9.0 Hz, 1H), 7.74 (dd, J = 7.8, 1.2 Hz, 1H), 7.70 (d, J = 5.4 Hz, 1H), 7.62-7.59 (m, 1H), 7.56-7.53 (m, 1H), 2.49 (s, 3H); ^{13}C

NMR (DMSO-d_6, 100 MHz) δ 161.3, 158.0, 137.9, 136.8, 135.1, 132.0, 131.3, 131.1, 130.9, 130.4, 129.1, 128.00, 127.95, 127.6, 126.1, 125.4, 123.4, 122.1, 121.3, 21.5 (four ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{24}H_{15}NNaO_2S$ $[M + Na]^+$ 404.0716, found 404.0714.



8c

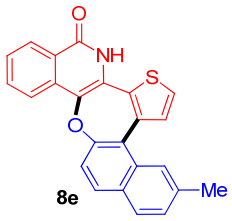
10-(Trifluoromethyl)naphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8c): Petroleum ether/ethyl acetate (5:1) as eluent; yellow solid (26 mg, 30%), mp 267-268 °C. ^1H NMR (DMSO-d_6, 600 MHz) δ 12.12 (s, 1H), 8.63 (d, J = 8.4 Hz, 1H), 8.46 (s, 1H), 8.17-8.13 (m, 3H), 8.09 (d, J = 9.0 Hz, 1H), 8.03 (d, J = 7.8 Hz, 1H), 7.85 (d, J = 9.0 Hz, 1H), 7.73 (d, J = 5.4 Hz, 1H), 7.63-7.61 (m, 1H), 7.56 (t, J = 7.2 Hz, 1H); ^{13}C NMR (DMSO-d_6, 150 MHz) δ 160.8, 157.8, 137.9, 136.0, 132.1, 131.4, 131.3, 130.6, 129.6, 129.2, 129.1, 128.1, 127.7, 127.5, 126.2, 125.4, 125.3, 125.1, 123.6, 123.5, 123.2, 121.1; ^{19}F NMR (DMSO-d_6, 564 MHz) δ -60.99 (s). HRMS (ESI) calcd for $C_{24}H_{12}F_3NNaO_2S$ $[M + Na]^+$ 458.0433, found 458.0431.



8d

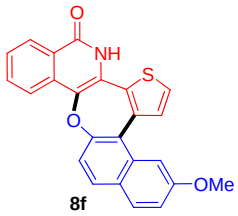
15-Methylnaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8d): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (29 mg, 38%), mp 125-126 °C. ^1H NMR ($CDCl_3$, 400 MHz) δ 8.62 (s, 1H), 8.39 (d, J = 7.6 Hz, 1H), 8.29 (d, J = 8.0 Hz, 1H),

8.21 (d, J = 8.4 Hz, 1H), 7.88-7.81 (m, 3H), 7.58-7.45 (m, 4H), 7.34 (d, J = 0.8 Hz, 1H), 2.70 (d, J = 0.8 Hz, 3H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 161.5, 157.8, 140.8, 137.8, 136.8, 133.7, 133.3, 131.9, 131.6, 130.5, 129.5, 129.3, 128.5, 128.4, 127.3, 127.1, 125.6, 125.5, 125.3, 123.5, 121.4, 120.9, 15.8 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{24}H_{15}NNaO_2S$ $[M + Na]^+$ 404.0716, found 404.0717.



8e

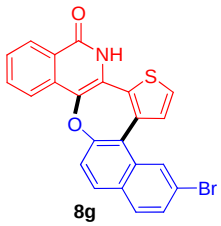
2-Methylnaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8e): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (22 mg, 29%), mp 119-120 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 9.94 (s, 1H), 8.43 (d, J = 7.6 Hz, 1H), 8.31 (d, J = 8.0 Hz, 1H), 7.97 (s, 1H), 7.86-7.81 (m, 2H), 7.75 (d, J = 8.4 Hz, 1H), 7.68 (m, 2H), 7.58-7.54 (m, 1H), 7.51 (d, J = 8.8 Hz, 1H), 7.30 (dd, J = 8.0, 0.8 Hz, 1H), 2.49 (s, 3H); ^{13}C NMR (DMSO-d_6, 150 MHz) δ 161.4, 158.2, 137.5, 137.3, 133.8, 133.2, 131.6, 130.9, 130.4, 130.2, 130.1, 129.0, 128.24, 128.21, 128.0, 124.4, 122.7, 122.0, 120.3, 22.2 (four ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{24}H_{15}NNaO_2S$ $[M + Na]^+$ 404.0716, found 404.0718.



8f

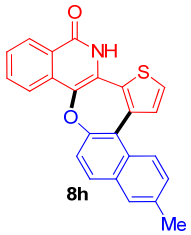
2-Methoxynaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8f): Petroleum ether/ethyl acetate (2:1) as eluent; brown solid (30 mg, 38%), mp 107-108 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 9.95 (s, 1H), 8.43 (d, J = 7.2 Hz, 1H), 8.32 (d, J = 8.0 Hz, 1H),

7.87-7.82 (m, 1H), 7.79 (d, J = 8.8 Hz, 1H), 7.75 (d, J = 8.8 Hz, 1H), 7.72 (d, J = 5.2 Hz, 1H), 7.68 (d, J = 5.2 Hz, 1H), 7.59-7.53 (m, 2H), 7.44 (d, J = 8.8 Hz, 1H), 7.13 (dd, J = 8.8, 2.4 Hz, 1H), 3.88 (s, 3H); ^{13}C NMR (DMSO-d_6, 150 MHz) δ 161.4, 158.9, 158.8, 137.4, 133.8, 133.2, 132.9, 130.9, 130.8, 129.9, 128.4, 128.0, 127.4, 122.4, 122.0, 118.7, 118.3, 104.4, 55.5 (five ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{24}H_{15}NNaO_3S$ $[M + Na]^+$ 420.0665, found 420.0657.



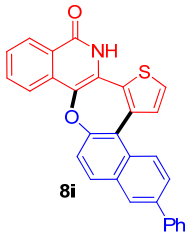
8g

2-Bromonaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8g): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (37 mg, 41%), mp 151-152 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 10.27 (s, 1H), 8.44 (d, J = 7.8 Hz, 1H), 8.35 (s, 1H), 8.29 (d, J = 8.4 Hz, 1H), 7.86-7.82 (m, 2H), 7.72-7.71 (m, 2H), 7.63 (d, J = 5.4 Hz, 1H), 7.60-7.56 (m, 2H), 7.54 (dd, J = 9.0, 1.8 Hz, 1H); ^{13}C NMR (DMSO-d_6, 150 MHz) δ 161.4, 158.7, 136.3, 133.8, 133.1, 132.6, 131.34, 131.29, 130.5, 130.0, 129.1, 128.8, 128.1, 128.0, 127.3, 122.8, 122.0, 121.7 (five ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{23}H_{12}BrNNaO_2S$ $[M + Na]^+$ 467.9664, found 467.9662.



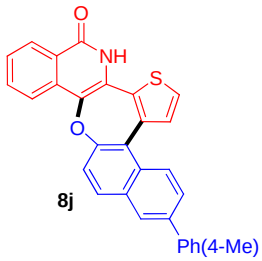
8h

3-Methylnaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8h): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (36 mg, 47%), mp 145-146 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 10.59 (s, 1H), 8.44 (d, *J* = 8.0 Hz, 1H), 8.31 (d, *J* = 8.0 Hz, 1H), 8.07 (d, *J* = 8.8 Hz, 1H), 7.83 (t, *J* = 8.0 Hz, 1H), 7.75 (d, *J* = 8.8 Hz, 1H), 7.66-7.62 (m, 2H), 7.60 (s, 1H), 7.57-7.52 (m, 2H), 7.31 (d, *J* = 8.0 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 162.4, 157.4, 137.8, 137.6, 135.1, 133.8, 133.2, 132.2, 131.9, 130.7, 129.8, 129.4, 128.3, 127.5, 127.4, 126.0, 125.63, 125.58, 125.4, 123.3, 121.5, 120.7, 21.3 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{24}H_{15}NNaO_2S$ $[M + Na]^+$ 404.0716, found 404.0712.

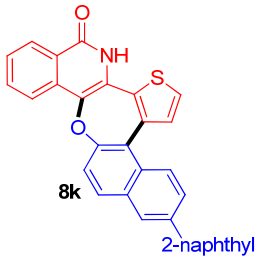


8i

3-Phenylnaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8i): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (21 mg, 23%), mp 264-265 °C. ^{1}H NMR (DMSO-d_6, 400 MHz) δ 11.75 (s, 1H), 8.44 (d, *J* = 8.0 Hz, 1H), 8.35 (d, *J* = 1.2 Hz, 1H), 8.23 (t, *J* = 8.4 Hz, 2H), 8.15 (d, *J* = 9.2 Hz, 1H), 8.09 (d, *J* = 5.2 Hz, 1H), 7.96-7.91 (m, 2H), 7.87 (d, *J* = 8.8 Hz, 1H), 7.82 (d, *J* = 7.6 Hz, 2H), 7.74 (d, *J* = 5.2 Hz, 1H), 7.63 (t, *J* = 8.0 Hz, 1H), 7.52 (t, *J* = 8.0 Hz, 2H), 7.41 (t, *J* = 7.6 Hz, 1H); ^{13}C NMR (DMSO-d_6, 100 MHz) δ 161.4, 158.0, 139.7, 137.5, 137.0, 133.9, 133.2, 132.4, 131.6, 130.5, 130.4, 129.6, 128.4, 128.3, 128.0, 127.3, 126.9, 126.4, 126.2, 123.3, 122.0, 121.8 (five ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{29}H_{17}NNaO_2S$ $[M + Na]^+$ 466.0872, found 466.0867.

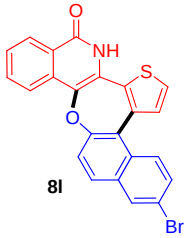


3-(P-tolyl)naphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8j): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (31 mg, 34%), mp 136-137 °C. ^{1}H NMR (DMSO-d_6, 600 MHz) δ 11.78 (s, 1H), 8.44 (d, J = 7.8 Hz, 1H), 8.30 (s, 1H), 8.27 (d, J = 7.8 Hz, 1H), 8.19 (d, J = 9.0 Hz, 1H), 8.12 (d, J = 9.0 Hz, 1H), 8.09 (d, J = 5.4 Hz, 1H), 7.95-7.90 (m, 2H), 7.85 (d, J = 9.0 Hz, 1H), 7.74 (d, J = 5.4 Hz, 1H), 7.70 (d, J = 7.8 Hz, 2H), 7.64 (t, J = 7.8 Hz, 1H), 7.31 (d, J = 7.8 Hz, 2H), 2.36 (s, 3H); ^{13}C NMR (DMSO-d_6, 150 MHz) δ 161.4, 157.9, 137.6, 137.4, 137.1, 136.8, 133.8, 133.2, 132.4, 131.5, 130.37, 130.35, 130.1, 128.3, 128.0, 127.1, 126.8, 126.2, 125.9, 123.3, 122.0, 121.7, 21.2 (five ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{30}H_{19}NNaO_2S$ $[M + Na]^+$ 480.1029, found 480.1012.



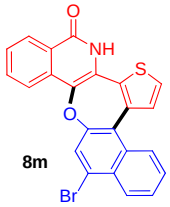
3-(Naphthalen-2-yl)naphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8k): Petroleum ether/ethyl acetate (3:1) as eluent; yellow solid (34 mg, 34%), mp 143-144 °C. ^{1}H NMR (DMSO-d_6, 600 MHz) δ 11.78 (s, 1H), 8.48 (d, J = 1.2 Hz, 1H), 8.44 (d, J = 7.8 Hz, 1H), 8.37 (s, 1H), 8.27-8.23 (m, 2H), 8.17 (d, J = 9.0 Hz, 1H), 8.10-8.07 (m, 2H), 8.03 (t, J = 8.4 Hz, 2H), 7.99 (dd, J = 8.4, 1.2 Hz, 1H), 7.96-7.92 (m, 2H), 7.87 (d, J = 9.0 Hz,

1H), 7.75 (d, *J* = 4.8 Hz, 1H), 7.63 (t, *J* = 7.8 Hz, 1H), 7.57-7.52 (m, 2H); ^{13}C NMR (DMSO-*d*$_6$, 100 MHz) δ 161.4, 158.1, 137.2, 137.04, 136.99, 133.8, 133.2, 132.9, 132.5, 131.6, 130.6, 130.4, 129.1, 128.7, 128.4, 128.0, 127.03, 127.01, 126.8, 126.7, 126.3, 126.0, 125.5, 123.4, 122.0, 121.8 (seven ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{33}H_{20}NO_2S$ $[M + H]^+$ 494.1209, found 494.1190.



8l

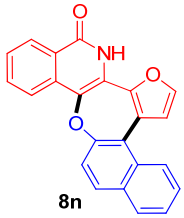
3-Bromonaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8l): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (28 mg, 32%), mp 124-125 °C. ^{1}H NMR (DMSO-*d*$_6$, 400 MHz) δ 11.75 (s, 1H), 8.42 (d, *J* = 8.4 Hz, 1H), 8.32 (d, *J* = 2.0 Hz, 1H), 8.24 (d, *J* = 8.0 Hz, 1H), 8.09-8.05 (m, 3H), 7.94-7.89 (m, 2H), 7.71 (dd, *J* = 9.2, 2.4 Hz, 1H), 7.68 (d, *J* = 5.2 Hz, 1H), 7.63 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (DMSO-*d*$_6$, 150 MHz) δ 161.4, 158.2, 136.51, 136.47, 133.8, 133.3, 133.1, 130.81, 130.79, 130.4, 130.3, 130.0, 128.5, 128.1, 128.0, 127.95, 127.89, 123.8, 122.6, 122.0, 119.3 (two ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{23}H_{12}BrNNaO_2S$ $[M + Na]^+$ 467.9664, found 467.9669.



8m

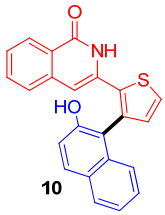
5-Bromonaphtho[1',2':6,7]thieno[2',3':4,5]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8m): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (36 mg, 40%), mp 106-107 °C. ^{1}H NMR (DMSO-*d*$_6$, 400 MHz) δ 11.80 (s, 1H), 8.51 (d, *J* = 8.0 Hz, 1H), 8.34 (s, 1H), 8.25 (d, *J*

= 7.6 Hz, 1H), 8.22-8.17 (m, 2H), 8.10 (d, *J* = 4.8 Hz, 1H), 7.96-7.92 (m, 1H), 7.72-7.68 (m, 3H), 7.66-7.62 (m, 1H); ^{13}C NMR (DMSO-*d*$_6$, 150 MHz) δ 161.4, 157.1, 136.3, 133.9, 133.0, 131.9, 130.5, 130.1, 128.9, 128.6, 128.1, 128.0, 127.9, 127.5, 126.4, 125.3, 123.9, 123.8, 122.2 (four ^{13}C signals were not observed). HRMS (ESI) calcd for $C_{23}H_{12}BrNNaO_2S$ $[M + Na]^+$ 467.9664, found 467.9669.



8n

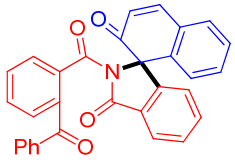
Furo[2',3':4,5]naphtho[1',2':6,7]oxepino[3,2-*c*]isoquinolin-12(13*H*)-one (8n): Petroleum ether/ethyl acetate (2:1) as eluent; yellow solid (25 mg, 35%), mp >300 °C. ^{1}H NMR (DMSO-*d*$_6$, 400 MHz) δ 11.83 (s, 1H), 8.43 (d, *J* = 8.0 Hz, 1H), 8.33-8.24 (m, 3H), 8.08 (d, *J* = 8.8 Hz, 1H), 8.03 (d, *J* = 8.4 Hz, 1H), 7.94-7.90 (m, 1H), 7.85 (d, *J* = 8.8 Hz, 1H), 7.66-7.62 (m, 2H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.42 (d, *J* = 2.0 Hz, 1H); ^{13}C NMR (DMSO-*d*$_6$, 150 MHz) δ 161.0, 155.6, 145.2, 144.4, 134.9, 133.8, 133.3, 131.9, 131.3, 131.0, 129.2, 128.2, 128.13, 128.08, 126.3, 126.2, 125.1, 122.7, 122.6, 122.1, 121.6, 120.4, 113.6. HRMS (ESI) calcd for $C_{23}H_{14}NO_3$ $[M + H]^+$ 352.0968, found 352.0970.



10

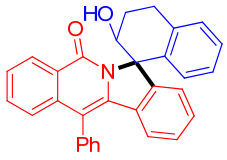
3-(3-(2-Hydroxynaphthalen-1-yl)thiophen-2-yl)isoquinolin-1(2*H*)-one (10): Petroleum ether/ethyl acetate (3:1) as eluent; brown solid (24 mg, 32%), mp 171-172 °C. ^{1}H NMR (DMSO-*d*$_6$, 600 MHz) δ 10.68 (s, 1H), 10.22 (s, 1H), 8.04 (d, *J* = 8.4 Hz, 1H), 7.86 (d, *J* = 4.8

Hz, 1H), 7.83 (d, *J* = 9.0 Hz, 1H), 7.81 (d, *J* = 7.8 Hz, 1H), 7.60-7.57 (m, 1H), 7.40-7.38 (m, 2H), 7.34-7.25 (m, 4H), 7.07 (d, *J* = 4.8 Hz, 1H), 6.48 (s, 1H); ^{13}C NMR (DMSO-*d*$_6$, 150 MHz) δ 162.1, 152.9, 137.8, 135.4, 134.7, 134.1, 133.4, 133.2, 132.4, 130.2, 128.5, 128.4, 127.11, 127.07, 127.0, 126.9, 125.0, 124.3, 123.4, 118.6, 115.3, 105.2 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{23}H_{15}NNaO_2S$ $[M + Na]^+$ 392.0716, found 392.0710.



11

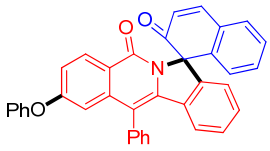
2-(2-Benzoylbenzoyl)-2'*H*-spiro[isoindoline-1,1'-naphthalene]-2',3-dione (11): Petroleum ether/ethyl acetate (3:1) as eluent; white solid (84 mg, 89%), mp 138-139 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 7.88 (d, *J* = 7.2 Hz, 2H), 7.79 (d, *J* = 7.2 Hz, 1H), 7.70 (d, *J* = 9.6 Hz, 1H), 7.65-7.62 (m, 3H), 7.56 (t, *J* = 7.2 Hz, 1H), 7.53-7.50 (m, 1H), 7.47-7.37 (m, 5H), 7.33-7.29 (m, 3H), 7.08 (d, *J* = 7.8 Hz, 1H), 6.37 (d, *J* = 9.6 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 195.5, 192.4, 168.3, 167.0, 147.1, 145.0, 139.7, 137.4, 137.2, 136.7, 134.7, 132.5, 131.5, 131.1, 130.41, 130.39, 130.3, 129.5, 129.3, 129.04, 129.01, 128.45, 128.39, 128.3, 126.3, 125.9, 124.3, 121.6, 73.5. HRMS (ESI) calcd for $C_{31}H_{19}NNaO_4$ $[M + Na]^+$ 492.1206, found 492.1195.



12

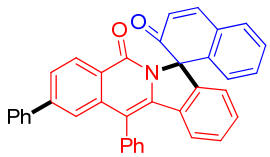
2'-Hydroxy-12-phenyl-3',4'-dihydro-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalen]-5-one (12): Petroleum ether/ethyl acetate (5:1) as eluent; white solid (63 mg, 71%), mp >300 °C. ^{1}H NMR ($CDCl_3$, 600 MHz) δ 8.41 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.66-7.61 (m, 3H),

7.59-7.56 (m, 1H), 7.53 (d, J = 7.8 Hz, 1H), 7.47-7.43 (m, 2H), 7.30 (d, J = 7.8 Hz, 1H), 7.23 (d, J = 8.4 Hz, 1H), 7.21-7.17 (m, 2H), 7.05 (d, J = 7.8 Hz, 1H), 7.03-7.01 (m, 1H), 6.97 (t, J = 7.8 Hz, 1H), 6.61 (d, J = 7.2 Hz, 1H), 6.36 (d, J = 8.4 Hz, 1H), 5.60 (d, J = 7.8 Hz, 1H), 4.30-4.28 (m, 1H), 3.54-3.49 (m, 1H), 2.98 (dt, J = 16.8, 4.8 Hz, 1H), 2.53-2.48 (m, 1H), 2.41-2.36 (m, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 163.4, 148.0, 138.7, 138.5, 137.1, 135.2, 134.3, 132.6, 131.8, 131.3, 130.8, 129.8, 129.6, 129.5, 129.1, 128.7, 128.20, 128.17, 127.6, 126.7, 126.2, 125.3, 125.2, 124.0, 123.8, 115.9, 76.7, 76.0, 28.7, 24.3 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{31}H_{23}NNaO_2$ $[M + Na]^+$ 464.1621, found 464.1605.



13

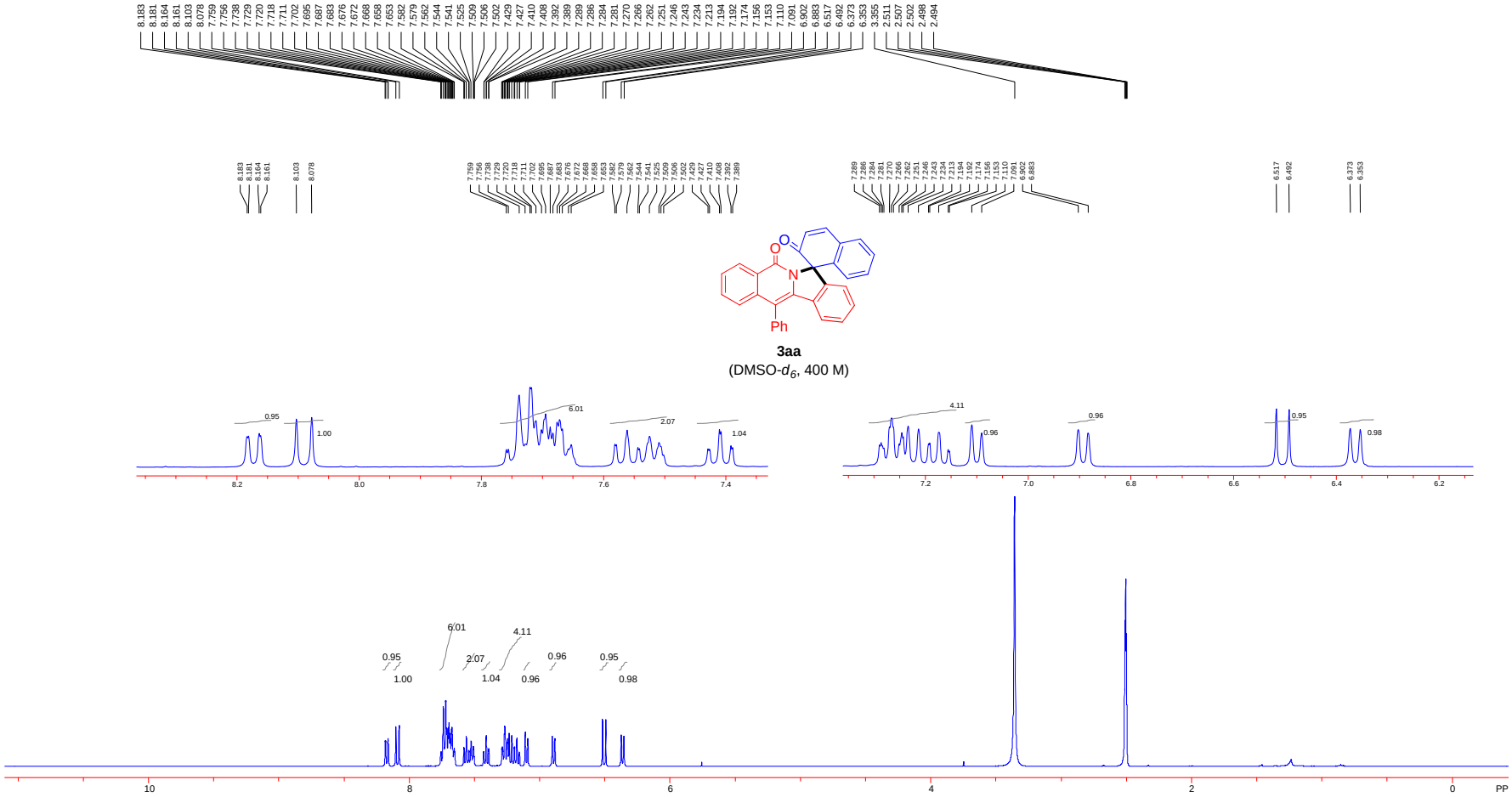
2-Phenoxy-12-phenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (13): Petroleum ether/ethyl acetate (2:1) as eluent; yellow solid (34 mg, 64%), mp 170-171 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.23 (d, J = 8.8 Hz, 1H), 7.67 (d, J = 10.0 Hz, 1H), 7.52-7.40 (m, 6H), 7.26-7.21 (m, 3H), 7.13 (td, J = 7.6, 1.2 Hz, 1H), 7.08-7.02 (m, 2H), 6.97 (d, J = 7.2 Hz, 2H), 6.94-6.90 (m, 3H), 6.79-6.78 (m, 2H), 6.43-6.40 (m, 2H); ^{13}C NMR ($CDCl_3$, 100 MHz) δ 192.9, 161.1, 158.8, 155.9, 146.3, 142.6, 141.5, 140.5, 139.7, 134.6, 133.4, 131.3, 131.0, 130.9, 130.2, 130.1, 129.90, 129.87, 129.6, 129.5, 129.4, 128.8, 128.6, 128.4, 125.3, 125.2, 125.0, 124.2, 121.6, 121.1, 119.6, 117.1, 114.1, 113.6, 76.1. HRMS (ESI) calcd for $C_{37}H_{23}NNaO_3$ $[M + Na]^+$ 552.1570, found 552.1549.

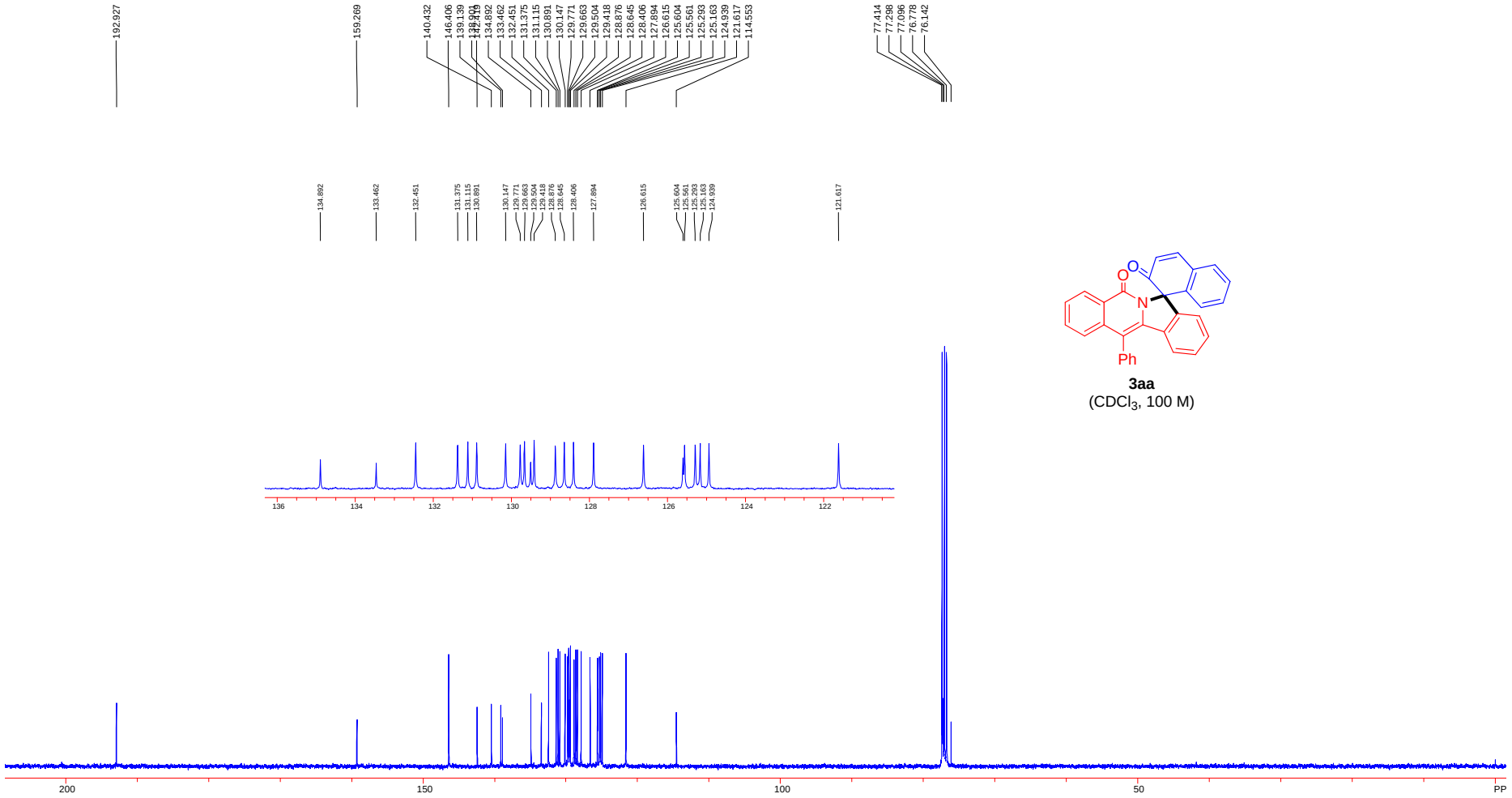


14

2,12-Diphenyl-2'*H*,5*H*-spiro[isoindolo[2,1-*b*]isoquinoline-7,1'-naphthalene]-2',5-dione (14): Petroleum ether/ethyl acetate (2:1) as eluent; white solid (32 mg, 61%), mp >300 ^{o}C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.44 (d, *J* = 8.4 Hz, 1H), 7.77 (d, *J* = 10.0 Hz, 1H), 7.69-7.57 (m, 6H), 7.52-7.49 (m, 3H), 7.46 (d, *J* = 1.2 Hz, 1H), 7.43-7.39 (m, 2H), 7.37-7.30 (m, 2H), 7.23-7.19 (m, 1H), 7.16-7.12 (m, 1H), 7.06-7.03 (m, 2H), 6.87 (d, *J* = 7.6 Hz, 1H), 6.51 (d, *J* = 10.0 Hz, 1H), 6.46 (d, *J* = 7.6 Hz, 1H); ^{13}C NMR ($CDCl_3$, 150 MHz) δ 192.9, 159.1, 146.4, 145.3, 142.5, 140.4, 139.6, 139.3, 134.8, 133.5, 131.4, 131.1, 130.9, 130.1, 129.8, 129.7, 129.51, 129.48, 128.90, 128.87, 128.7, 128.5, 128.4, 128.1, 127.6, 125.9, 125.3, 125.2, 125.0, 124.5, 123.8, 121.6, 114.7, 76.1 (one ^{13}C signal was not observed). HRMS (ESI) calcd for $C_{37}H_{23}NNaO_2$ $[M + Na]^+$ 536.1621, found 536.1604.

9. The ^{1}H, ^{13}C, and ^{19}F NMR Spectra of 3aa-3sa, 3ab-3ap, 5a-5j, 8a-8n, and 10-14

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146.406
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133.462
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131.375
131.115
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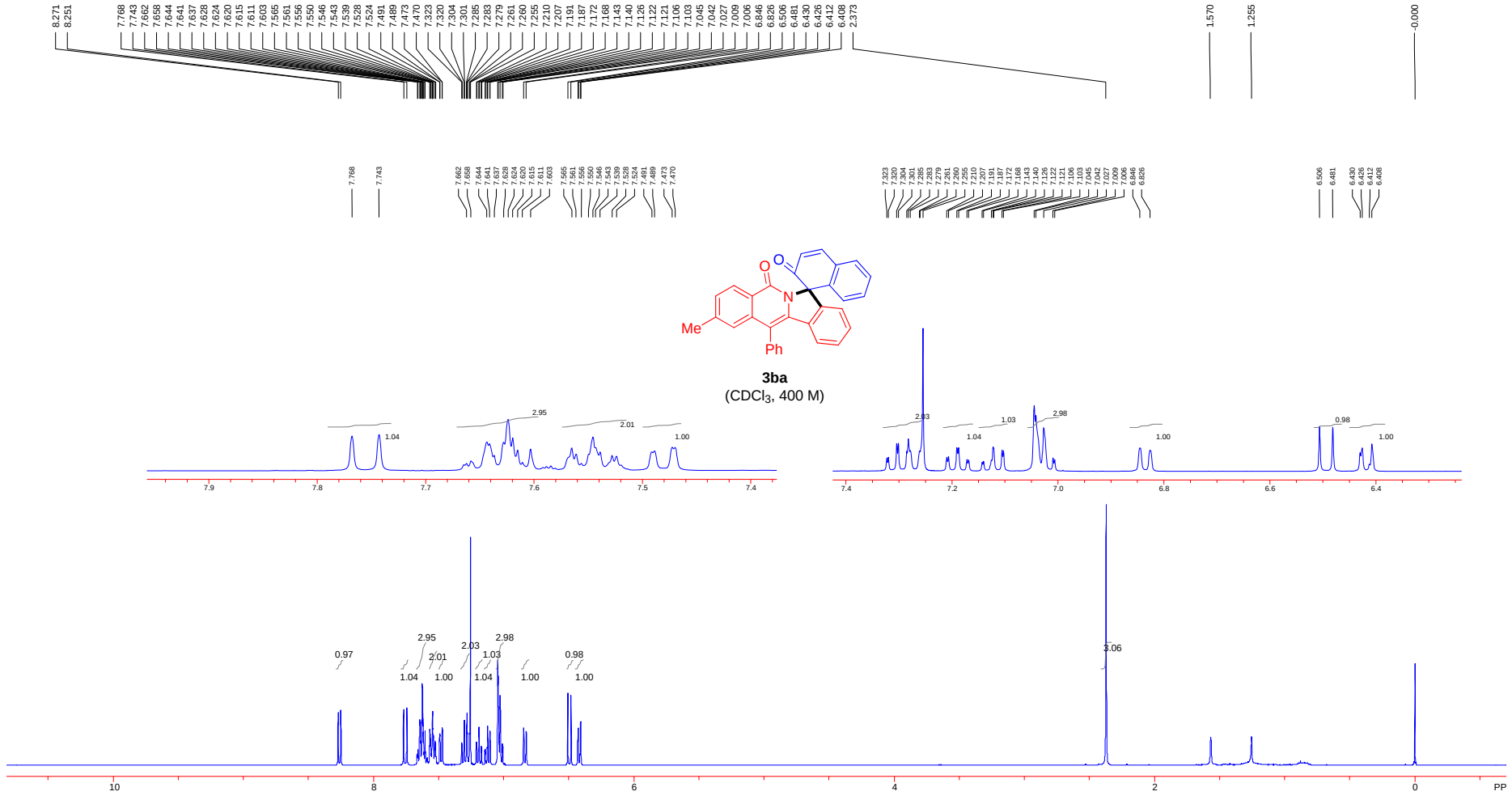
130.147
129.771
129.663
129.504
129.418
128.876
128.645
128.406
127.894
126.615
125.604
125.561
125.293
125.163
124.939
121.617
114.553
77.414
77.298
77.096
76.778
76.142
O
O
N
Ph
3aa
(CDCl3, 100 M)
200
150
100
50
PP
136
134
132
130
128
126
124
122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7.641
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7.628
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7.620
7.615
7.611
7.603
7.565
7.561
7.556
7.550
7.546
7.543
7.539
7.528
7.524
7.491
7.488
7.473
7.470
7.323
7.320
7.304
7.301
7.285
7.283
7.279
7.261
7.260
7.255
7.210
7.207
7.191
7.187
7.172
7.168
7.143
7.140
7.126
7.122
7.121
7.106
7.103
7.045
7.042
7.027
7.009
7.006
6.846
6.826
6.506
6.481
6.430
6.426
6.412
6.408
2.373
1.570
1.255
0.000
O
O
N
Me
Ph
3ba
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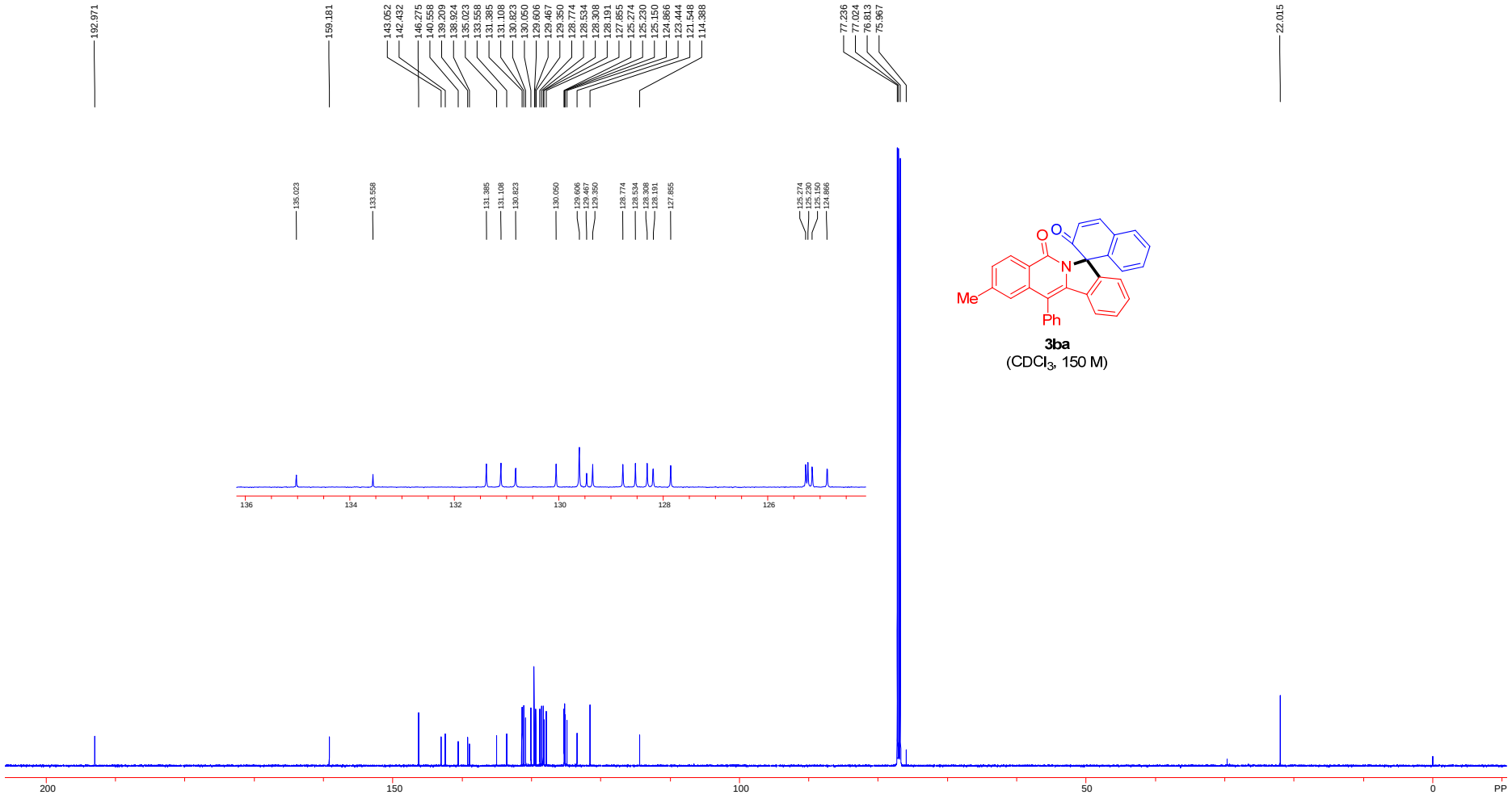
2.03
1.03
2.98
0.98
3.06
1.04
1.00
PP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140.558
139.209
138.924
135.023
133.558
131.385
131.108
130.823
130.050
129.606
129.467
129.350
128.774
128.534
128.308
128.191
127.855
125.274
125.230
125.150
124.866
123.444
121.548
114.388
77.236
77.024
76.813
75.967
22.015
138.023
133.558
131.385
131.108
130.823
130.050
129.606
129.467
129.350
128.774
128.534
128.308
128.191
127.855
125.274
125.230
125.150
124.866
O
O
N
Me
Ph
3ba
(CDCl3, 150 M)
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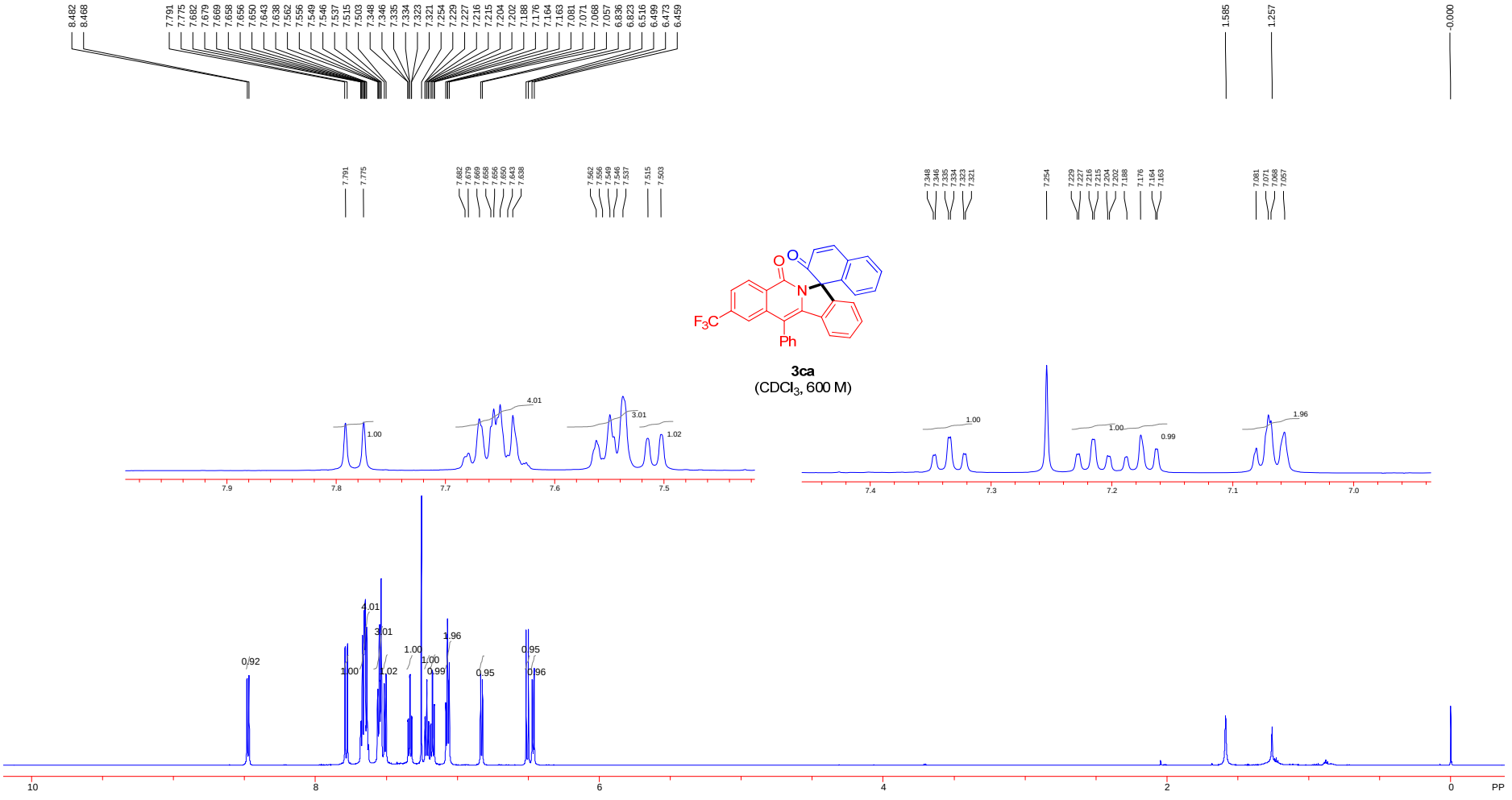
134
132
130
128
126
200
150
100
50
0
PP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7.775
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7.679
7.669
7.658
7.656
7.650
7.643
7.638
7.562
7.556
7.549
7.546
7.537
7.515
7.503
7.348
7.346
7.335
7.334
7.323
7.321
7.254
7.229
7.227
7.216
7.215
7.204
7.202
7.188
7.176
7.164
7.163
7.081
7.071
7.068
7.057
6.836
6.823
6.516
6.499
6.473
6.459
1.585
1.257
0.000
O
O
N
F3C
Ph
3ca
(CDCl3, 600 M)
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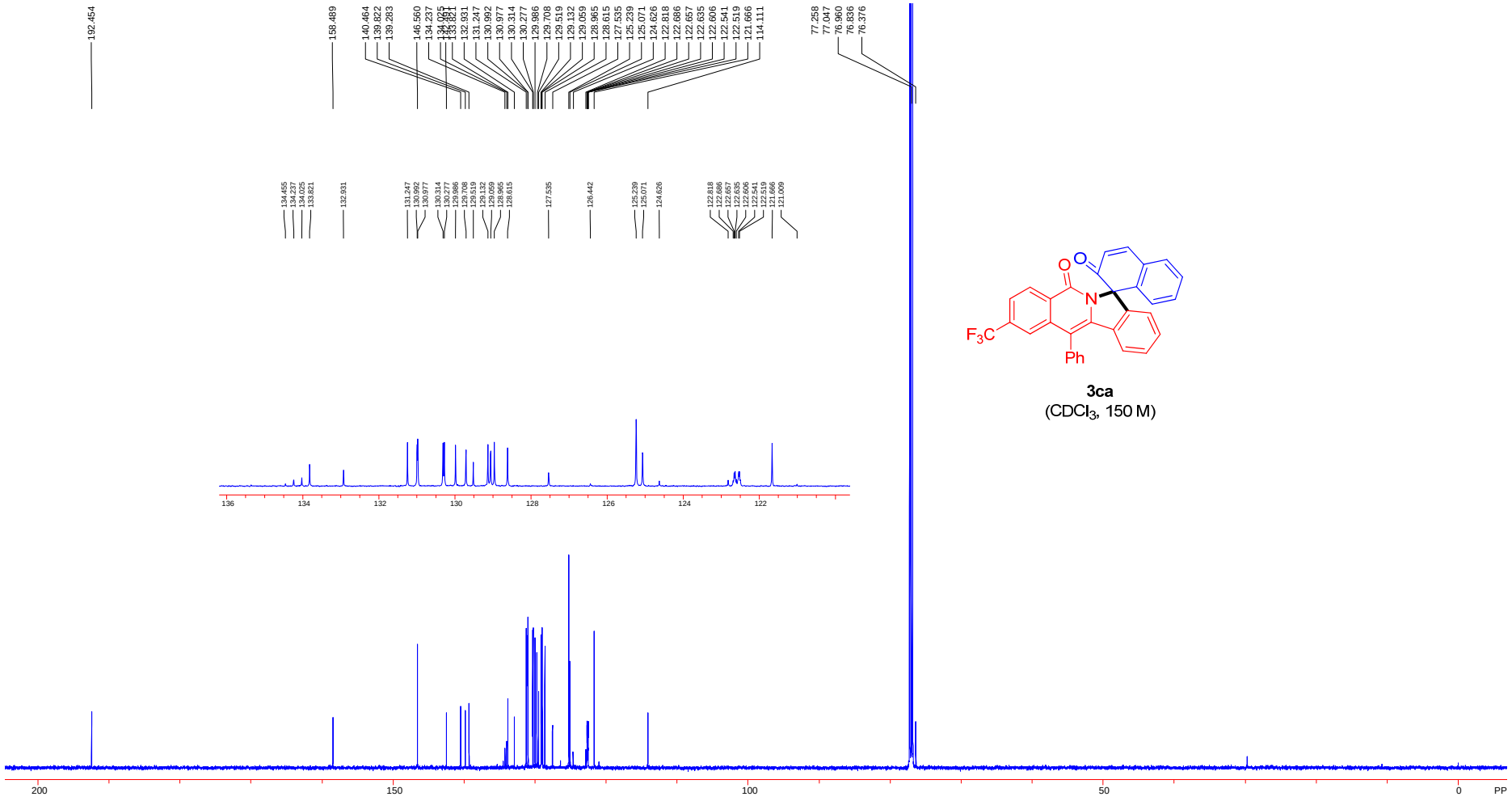
4.01
3.01
1.02
1.00
1.00
0.99
1.96
0.92
1.00
4.01
3.01
1.02
1.00
1.00
0.99
1.96
0.95
0.95
0.96
10
8
6
4
2
0
PP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133.821
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130.977
130.314
130.277
129.986
129.708
129.519
129.132
129.059
128.965
128.615
127.535
125.239
125.071
124.626
122.886
122.857
122.635
122.606
122.541
122.519
121.666
114.111
77.258
77.047
76.960
76.836
76.376
O
O
N
F3C
Ph
3ca
(CDCl3, 150 M)
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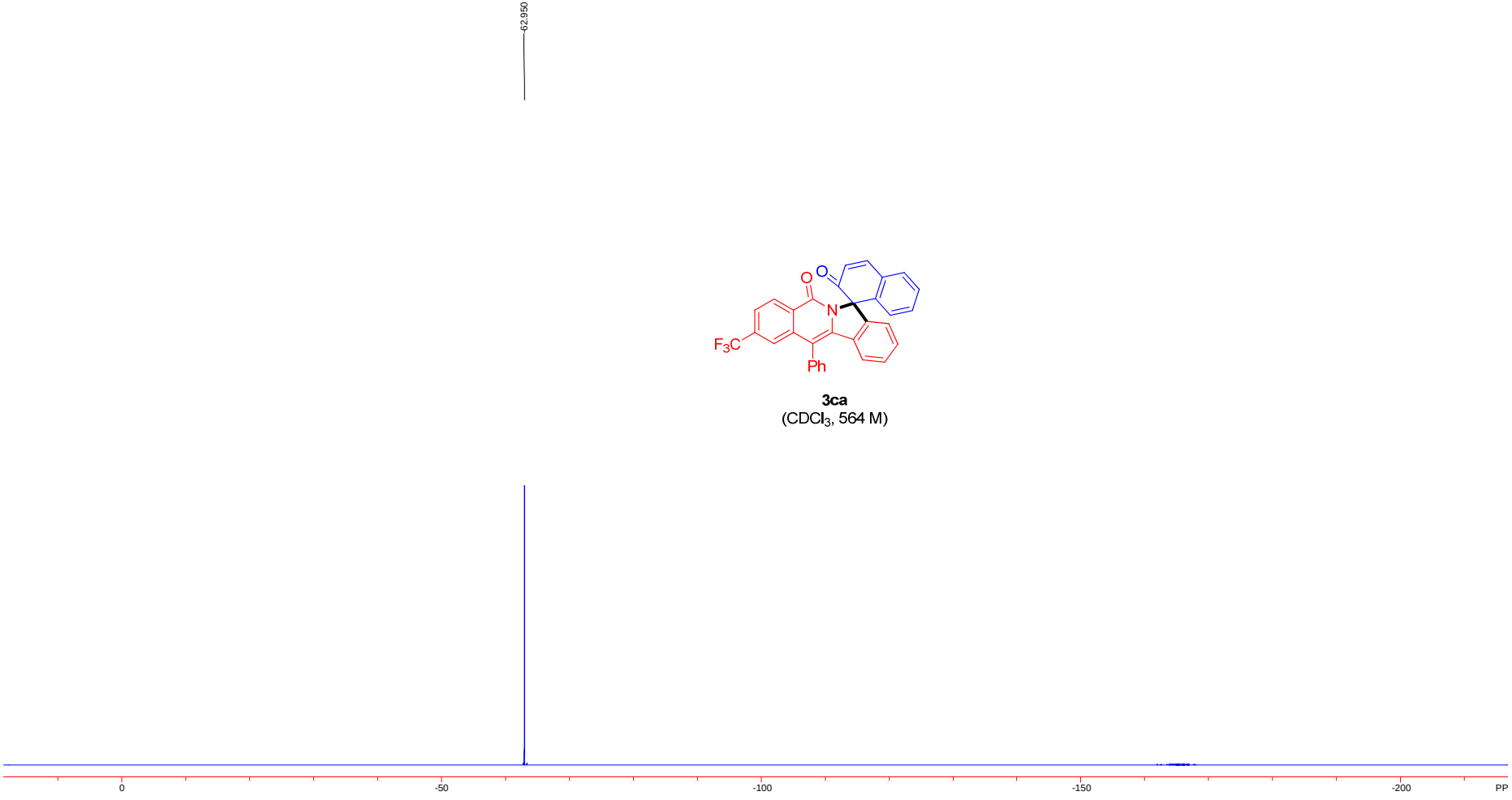
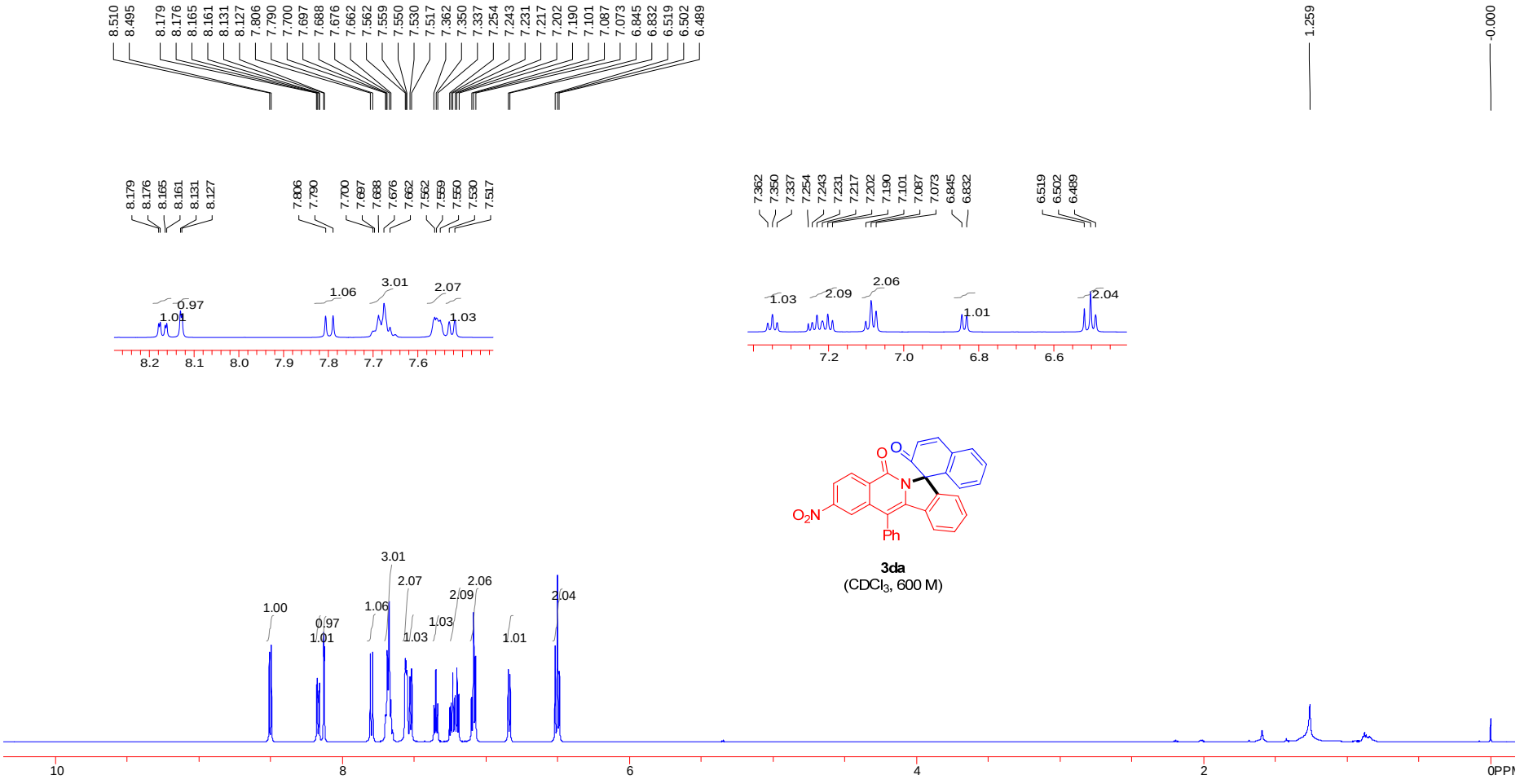
150
100
50
0
PP



3ca
($CDCl_3$, 564 M)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8.161
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8.127
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7.700
7.697
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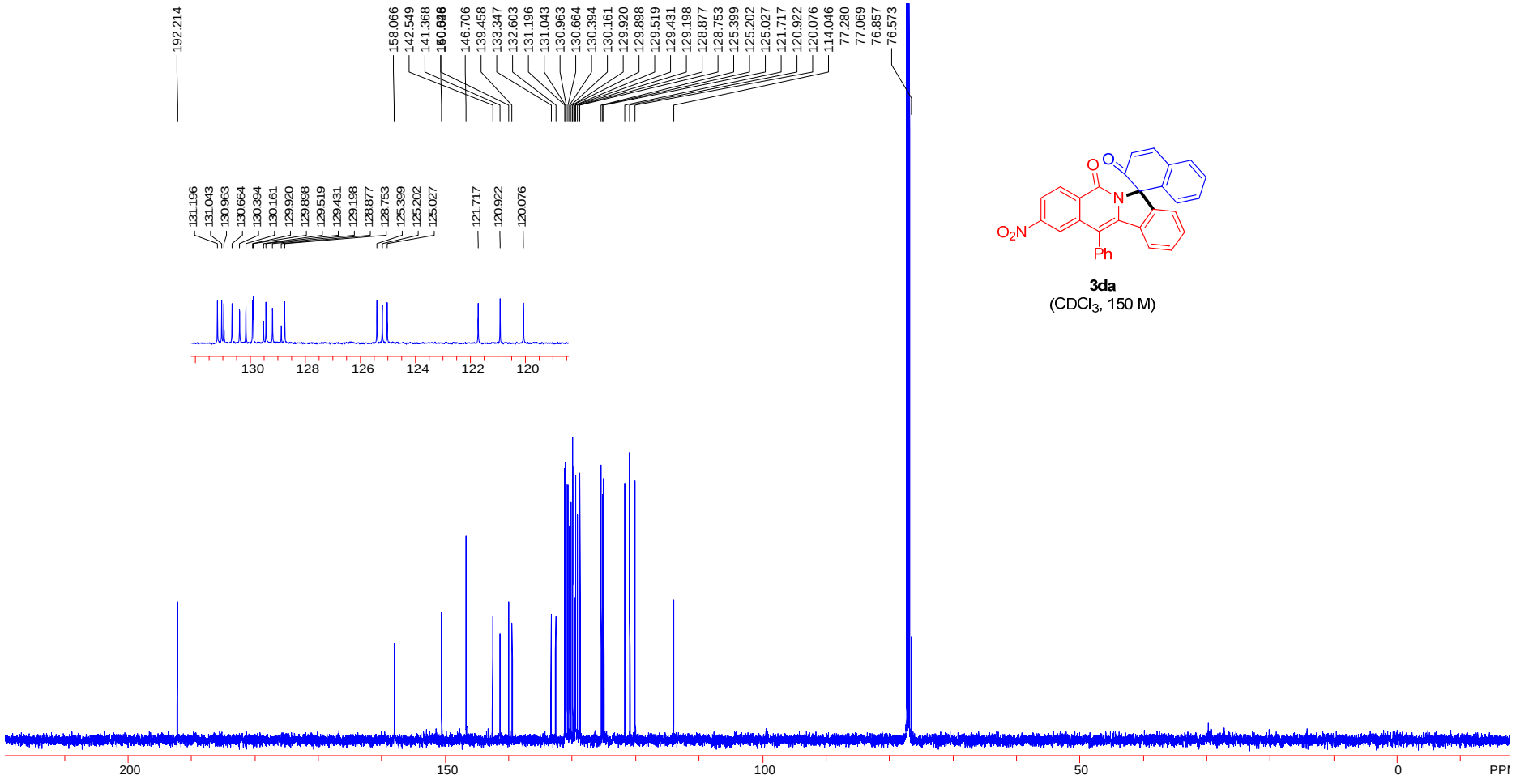
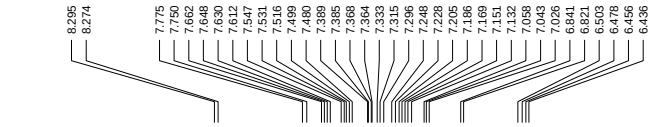
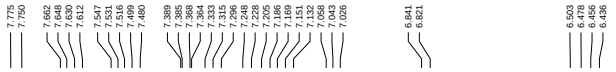
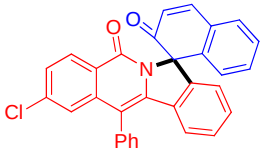
7.676
7.662
7.562
7.559
7.550
7.530
7.517
7.362
7.350
7.337
7.254
7.243
7.231
7.217
7.202
7.190
7.101
7.087
7.073
6.845
6.832
6.519
6.502
6.489
1.259
-0.000
0.97
1.01
1.06
3.01
2.07
1.03
1.03
2.09
2.06
1.01
2.04
O
O
N
O2N
Ph
3da
(CDCl3, 600 M)
1.00
0.97
1.01
1.06
3.01
2.07
1.03
1.03
2.09
2.06
1.01
2.04
10
8
6
4
2
0PPM



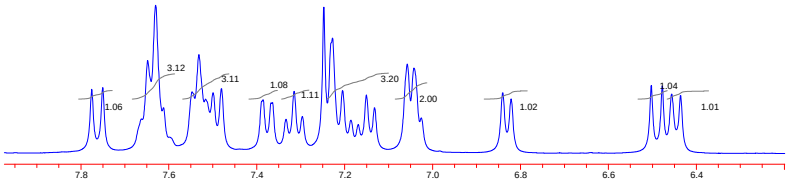
3da
($CDCl_3$, 150 M)

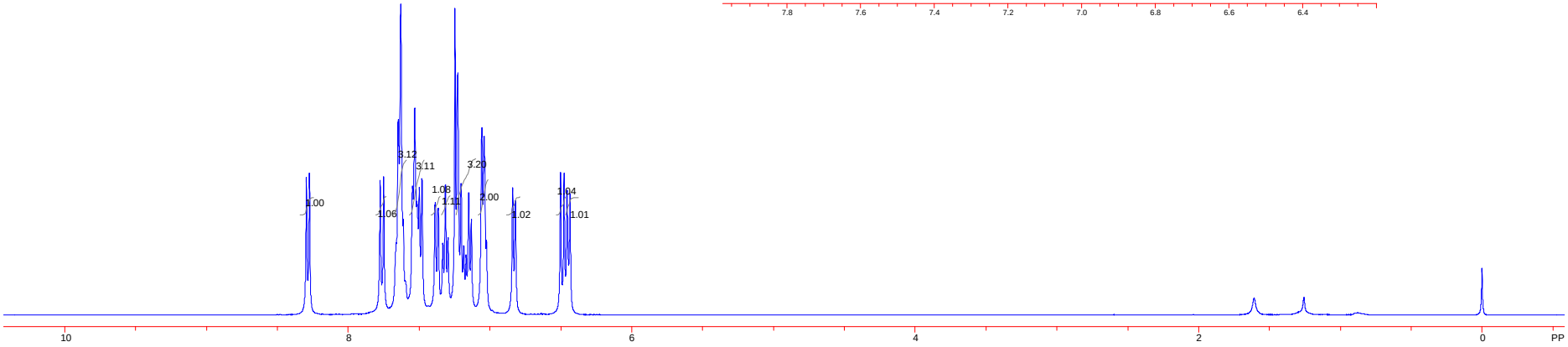


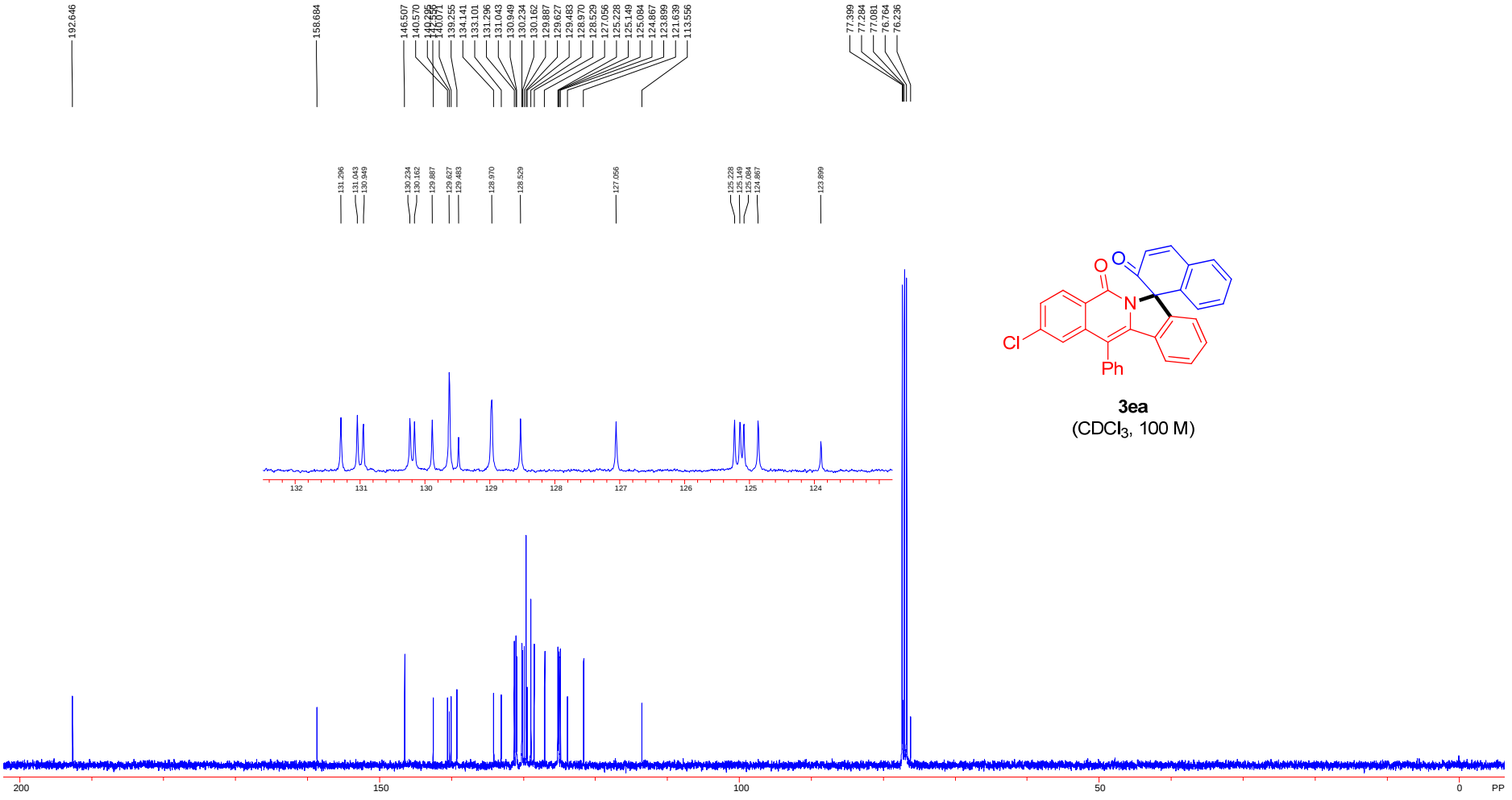




3ea
($CDCl_3$, 400 M)



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139.255
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133.101
131.296
131.043
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130.234
130.162
129.887
129.627
129.483
128.970
128.529
127.056
125.228
125.149
125.084
124.867
123.899
121.639
113.556
77.399
77.284
77.081
76.764
76.236
131.296
131.043
130.949
130.234
130.162
129.887
129.627
129.483
128.970
128.529
127.056
125.228
125.149
125.084
124.867
123.899
O
O
N
Cl
Ph
3ea
(CDCl3, 100 M)
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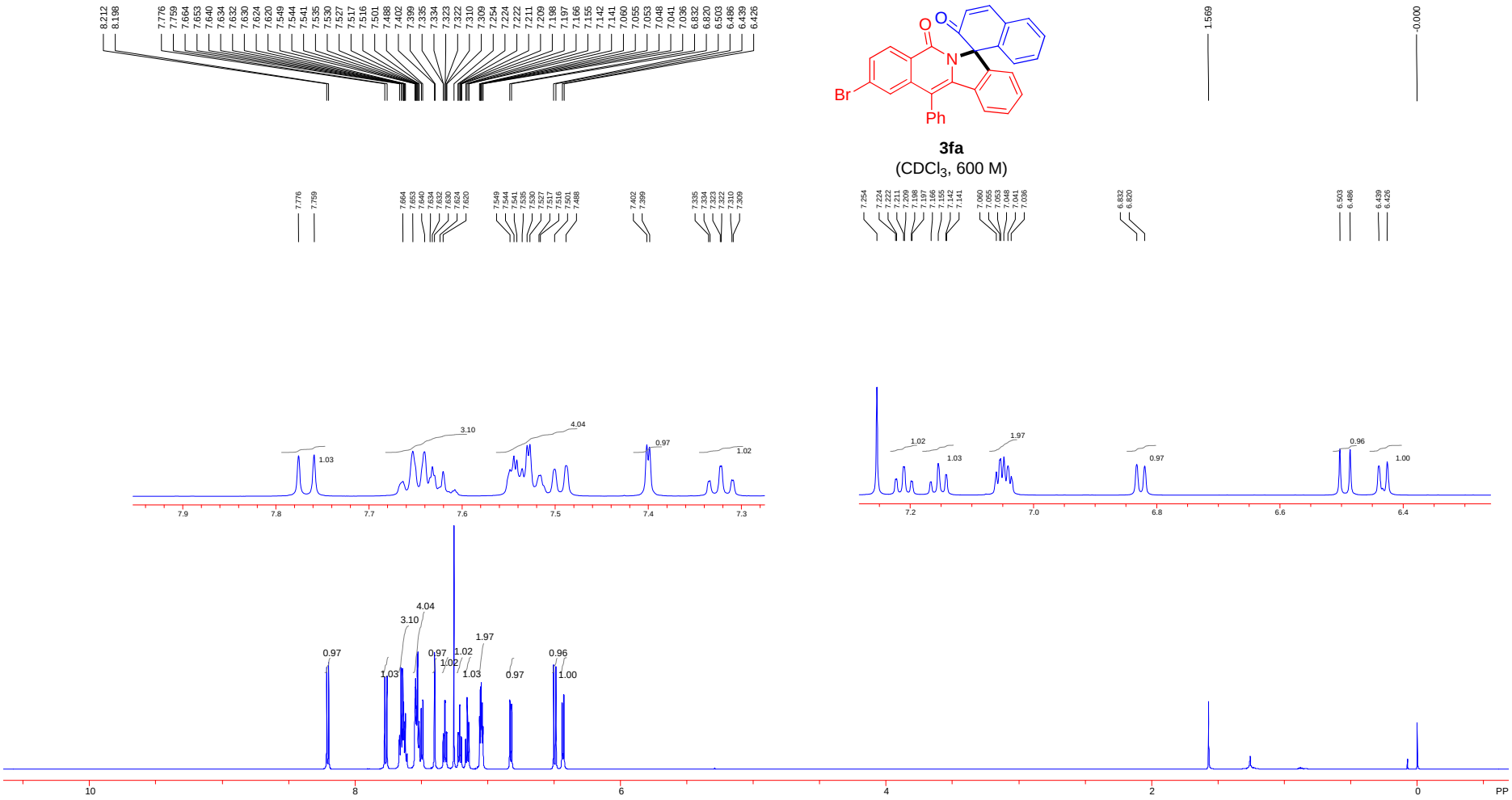
129
128
127
126
125
124
200
150
100
50
0
PP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7.653
7.640
7.634
7.632
7.630
7.624
7.620
7.549
7.544
7.541
7.535
7.530
7.527
7.517
7.516
7.501
7.488
7.402
7.399
7.335
7.334
7.323
7.322
7.310
7.309
7.254
7.224
7.222
7.211
7.209
7.198
7.197
7.166
7.155
7.142
7.141
7.060
7.055
7.053
7.048
7.041
7.036
6.832
6.820
6.503
6.486
6.439
6.426
1.569
-0.000
O
O
N
Br
Ph
3fa
(CDCl3, 600 M)
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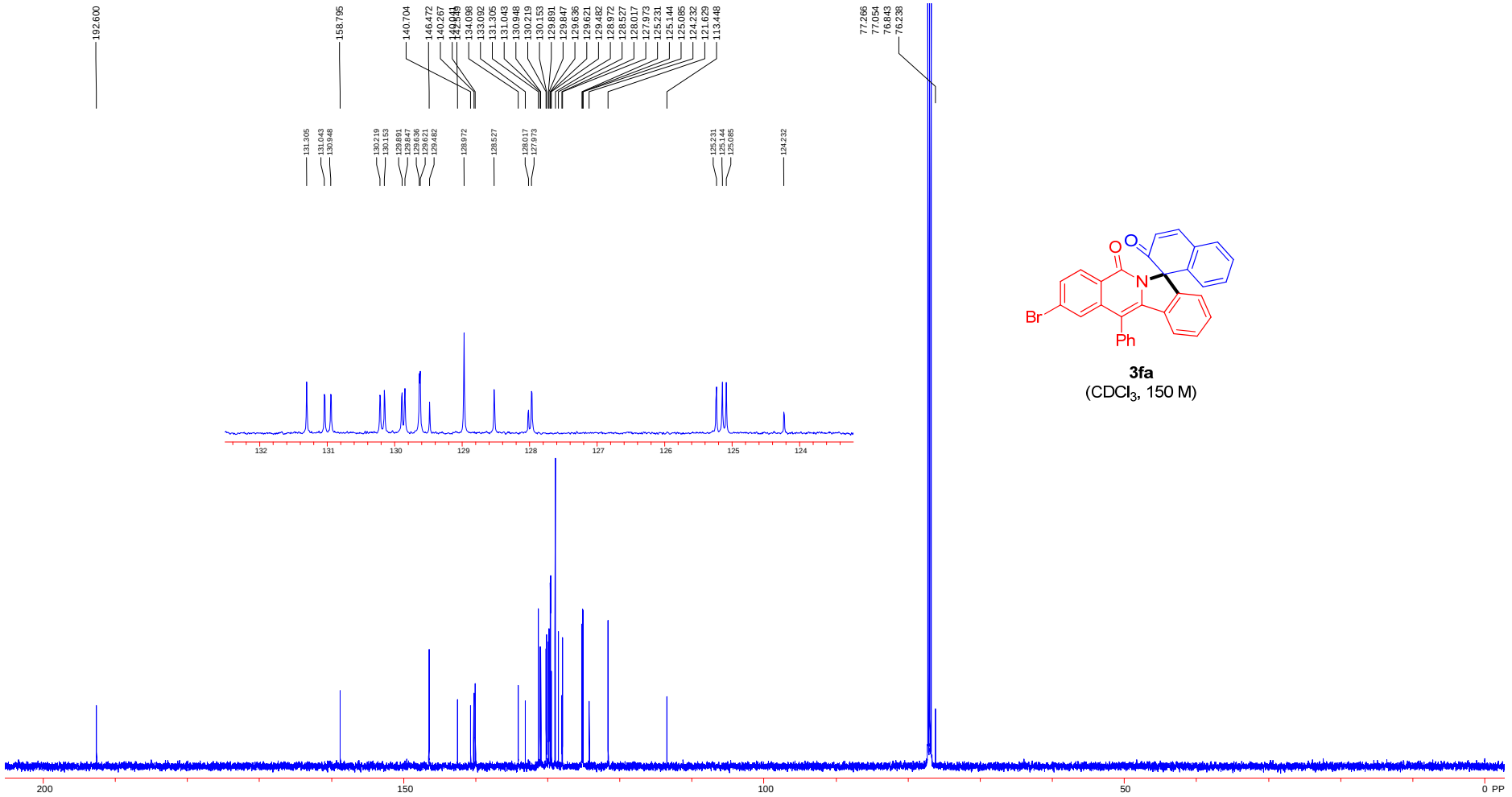
3.10
4.04
0.97
1.02
1.02
1.97
1.03
0.97
1.03
0.97
4.04
3.10
1.02
1.97
0.97
0.96
1.00
PP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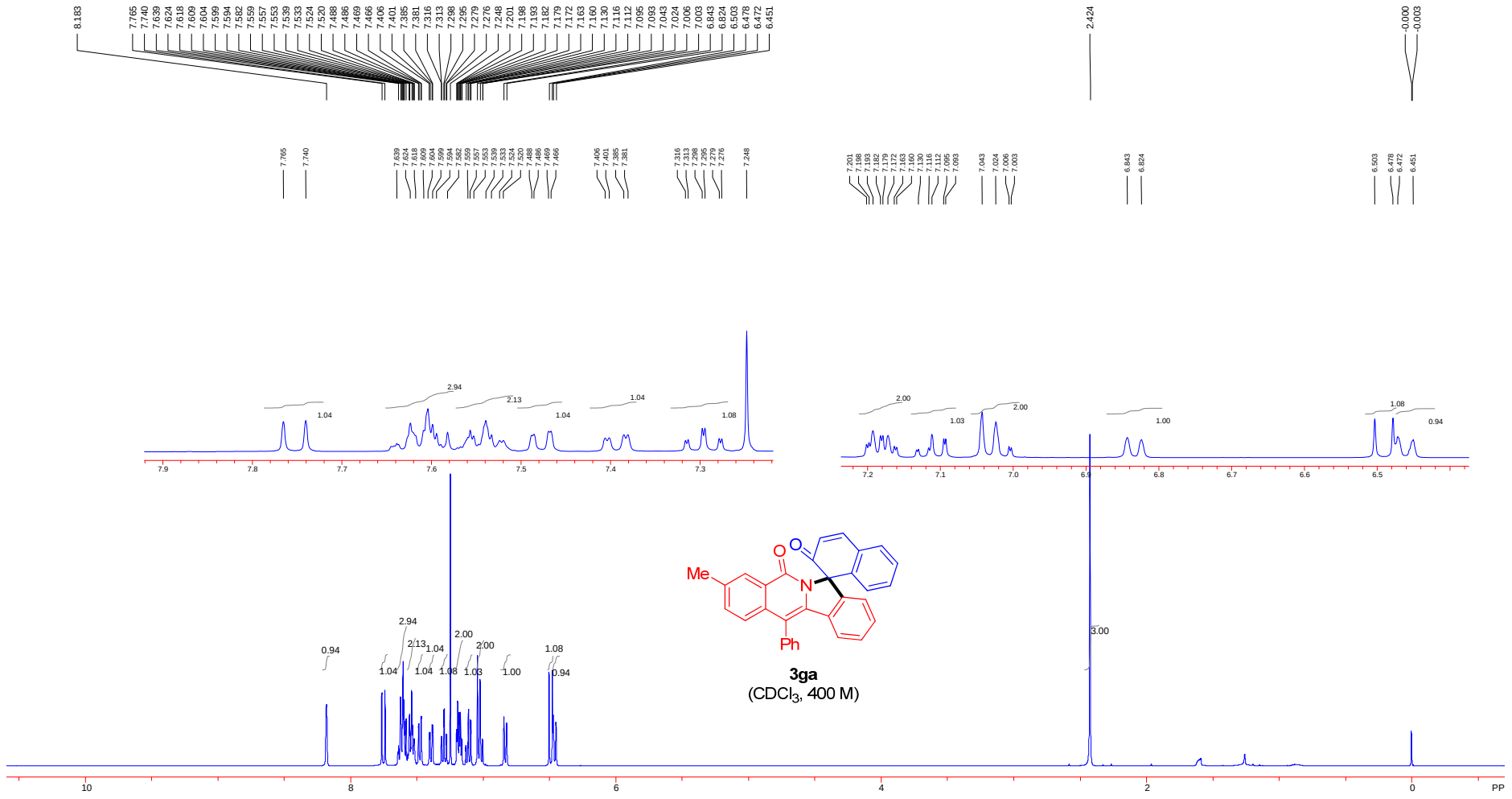
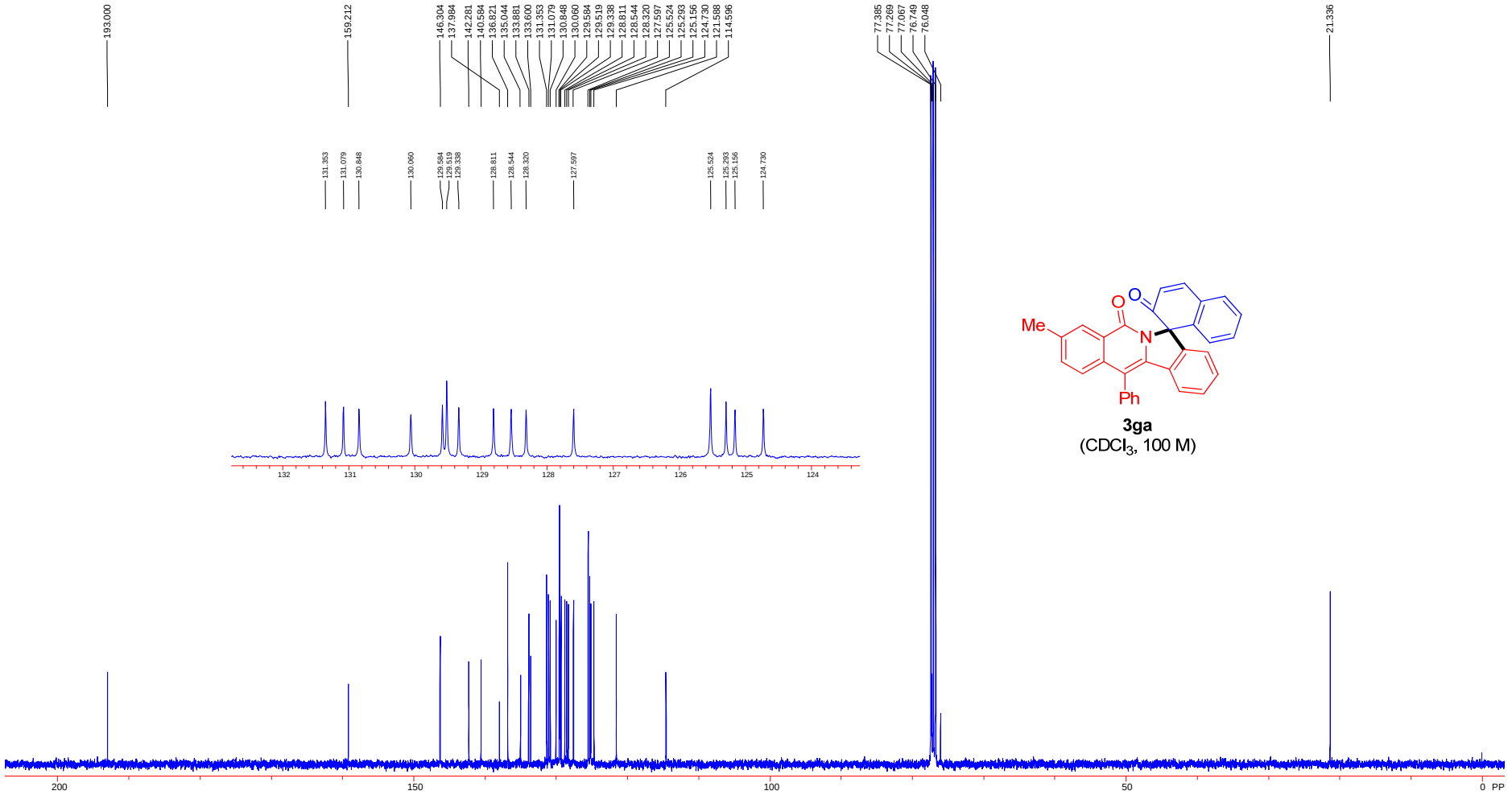
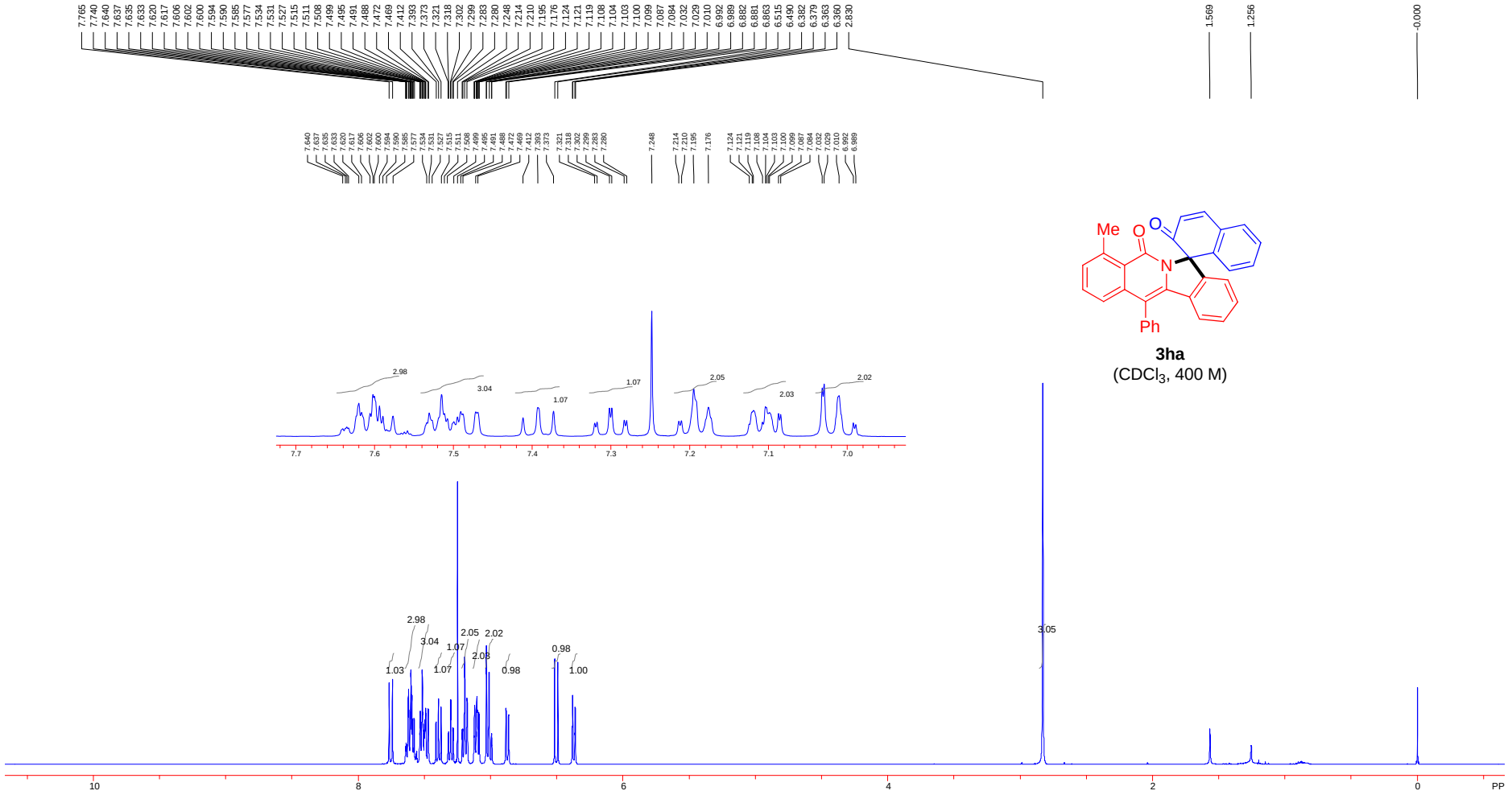
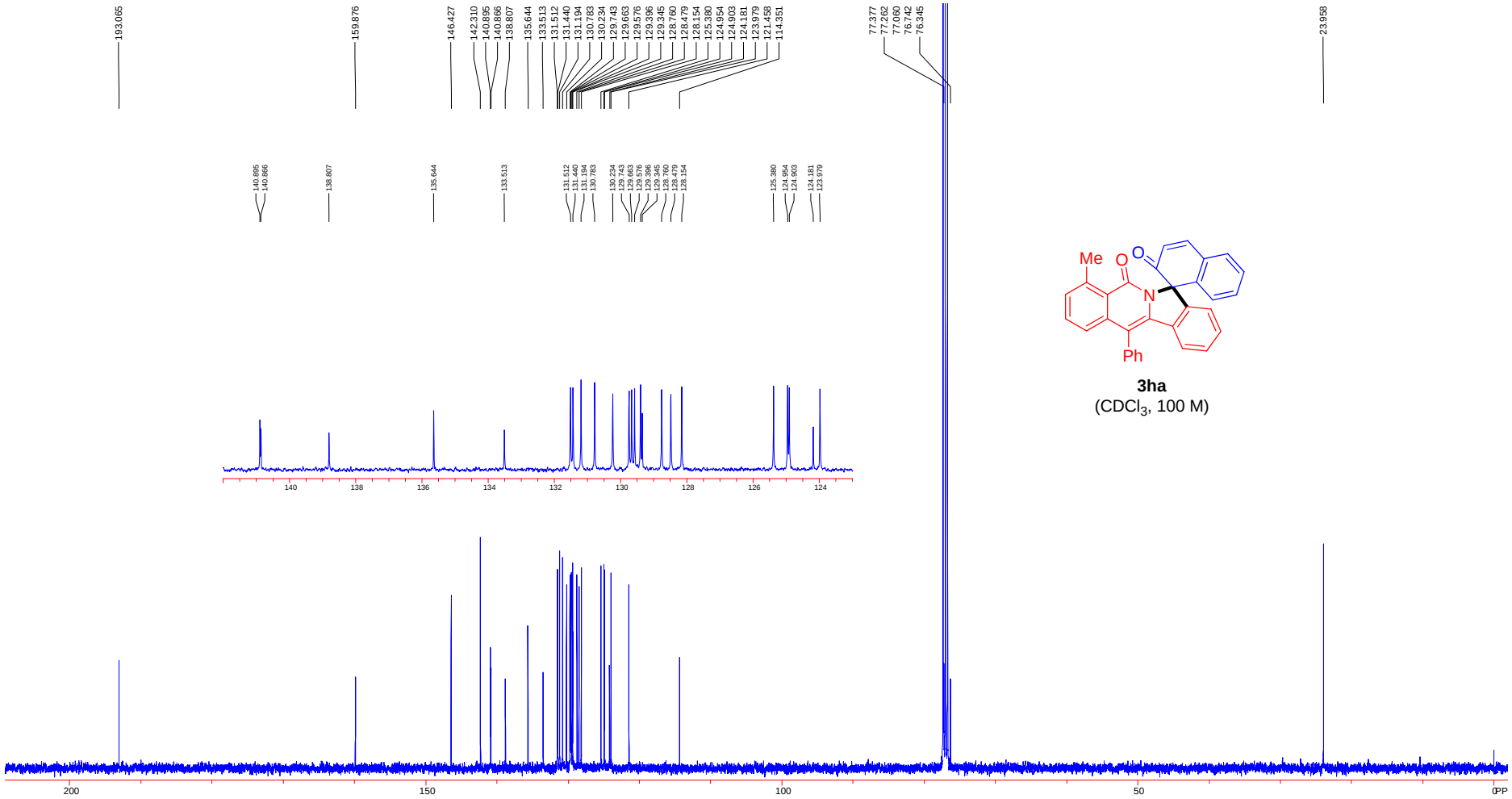
129.847
129.636
129.482
128.972
128.527
128.017
127.973
125.231
125.144
125.085
124.232
121.629
113.448
77.266
77.054
76.843
76.238
Br
O
O
N
Ph
3fa
(CDCl3, 150 M)
200
150
100
50
0 PP



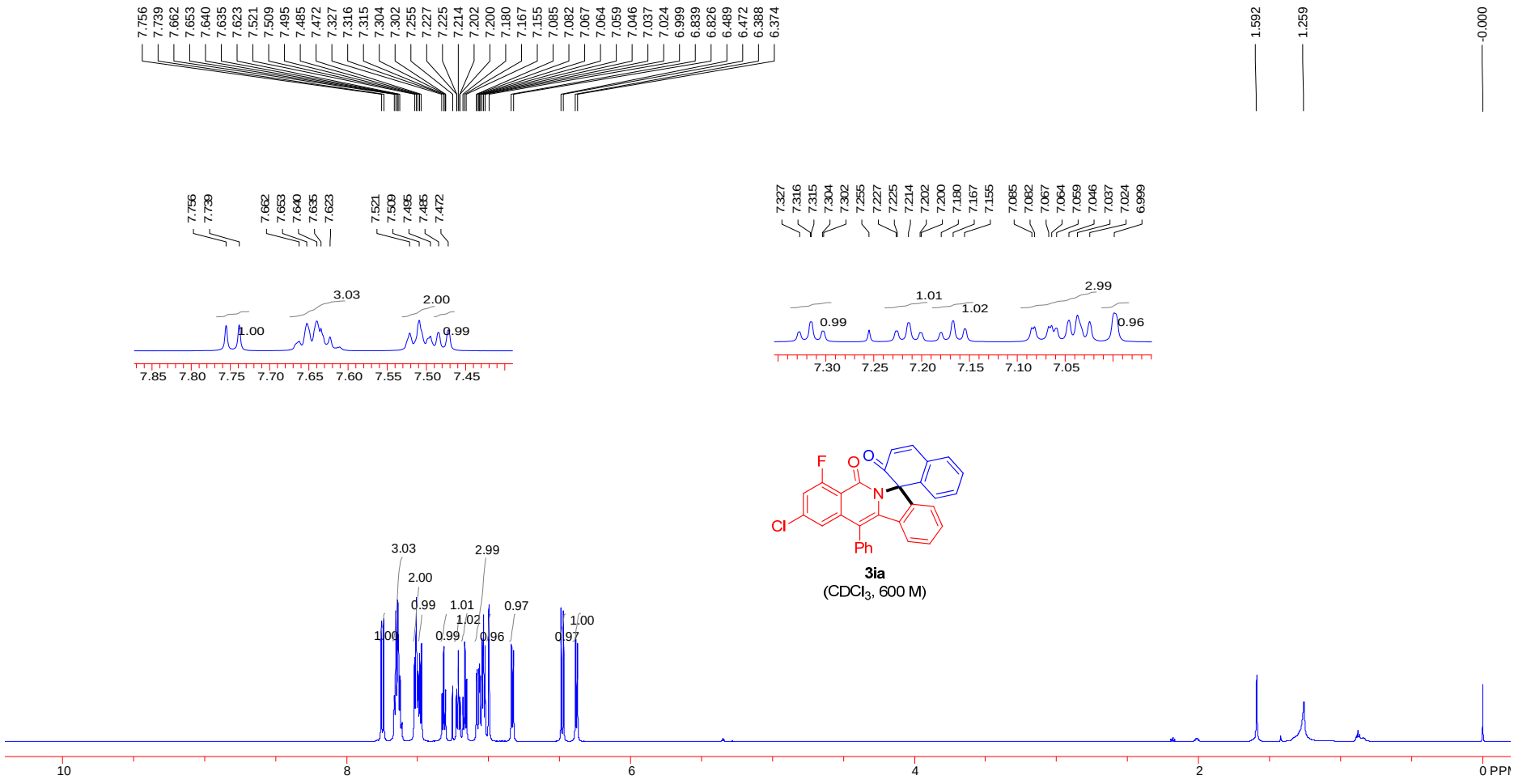
3ga
($CDCl_3$, 400 M)

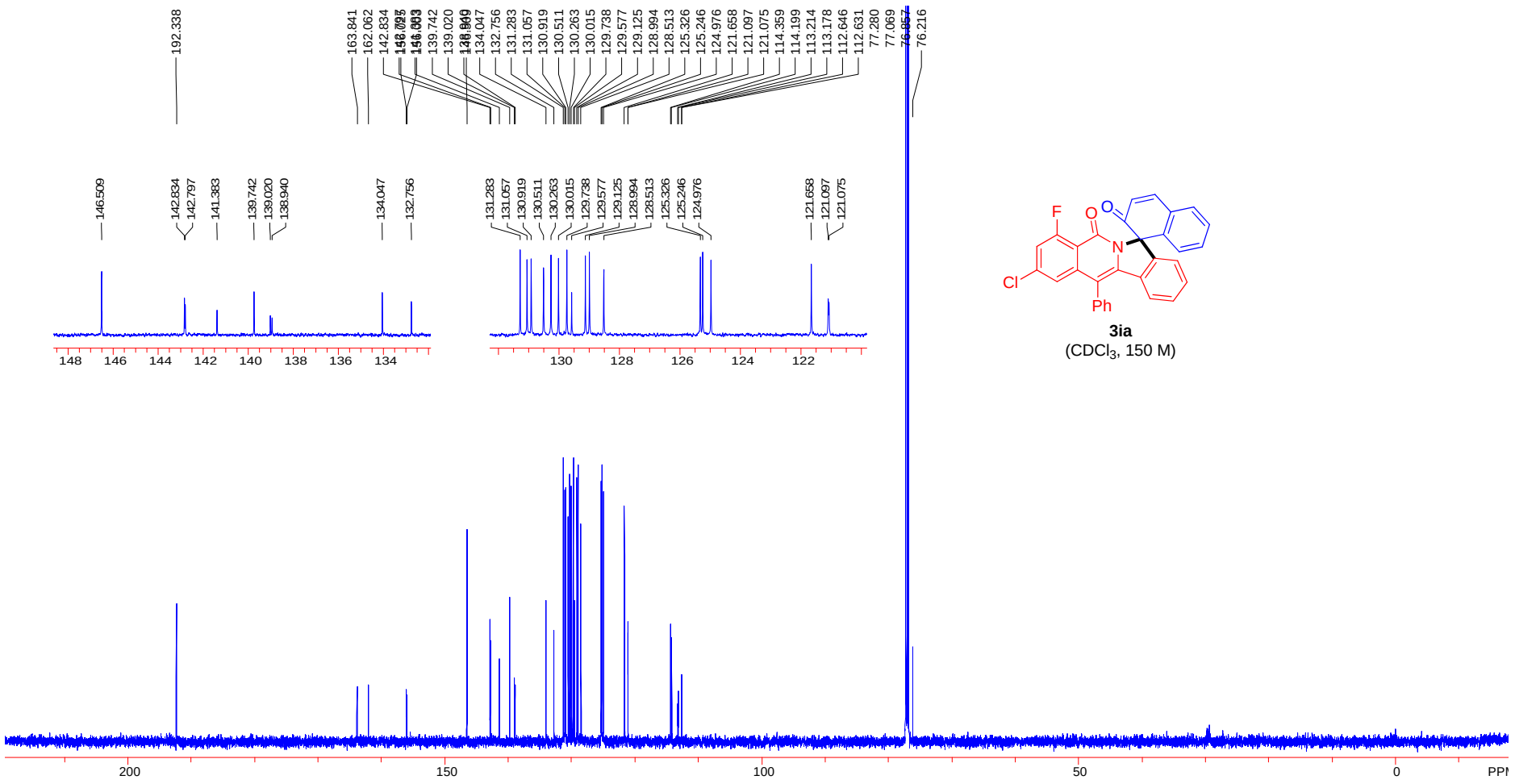

193.000
159.212
146.304
137.984
142.281
140.584
136.821
135.044
133.881
133.600
131.353
131.079
130.848
130.060
129.584
129.519
129.338
128.811
128.544
128.320
127.597
125.524
125.293
125.156
124.730
121.588
114.596
77.385
77.269
77.067
76.749
76.048
21.336
131.353
131.079
130.848
130.060
129.584
129.519
129.338
128.811
128.544
128.320
127.597
125.524
125.293
125.156
124.730
O
O
N
Me
Ph
3ga
(CDCl3, 100 M)
132
131
130
129
128
127
126
125
124
200
150
100
50
0 PP


7.765 7.740 7.640 7.637 7.635 7.633 7.620 7.617 7.606 7.602 7.600 7.594 7.590 7.585 7.577 7.534 7.531 7.527 7.515 7.511 7.508 7.499 7.495 7.491 7.488 7.472 7.469 7.412 7.393 7.373 7.321 7.318 7.302 7.299 7.283 7.280 7.248 7.214 7.210 7.195 7.176 7.124 7.121 7.119 7.108 7.104 7.103 7.100 7.099 7.087 7.084 7.032 7.029 7.010 6.992 6.989 6.882 6.881 6.863 6.515 6.490 6.382 6.379 6.363 6.360 2.830
1.569 1.256 0.000
Me O O N Ph
3ha
(CDCl3, 400 M)
2.98 3.04 1.07 1.07 2.05 2.03 2.02
2.98 3.04 1.07 2.05 2.02 2.03 1.03 1.07 0.98 0.98 1.00 3.05
10 8 6 4 2 0 PP

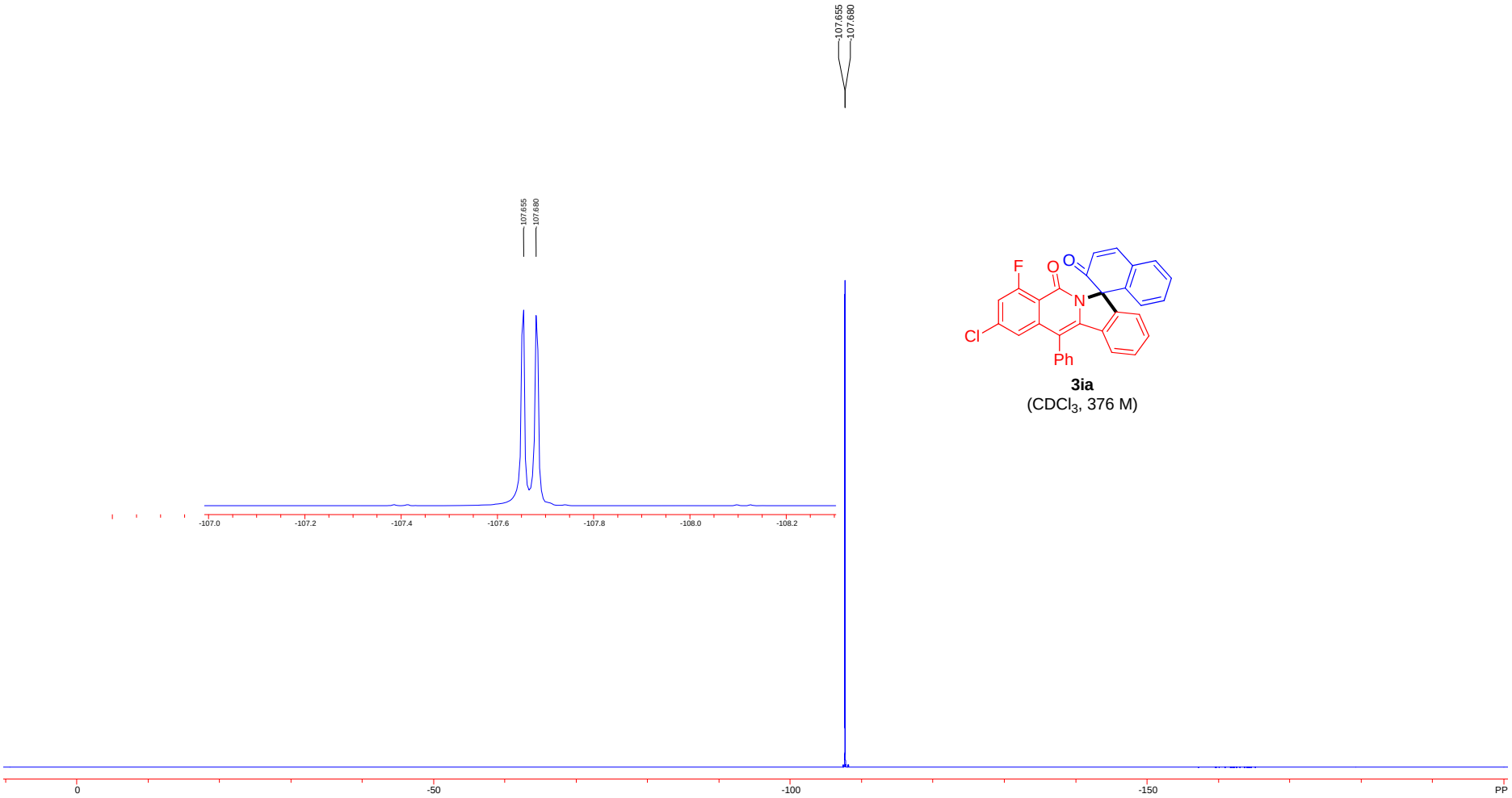


3ha
($CDCl_3$, 100 M)

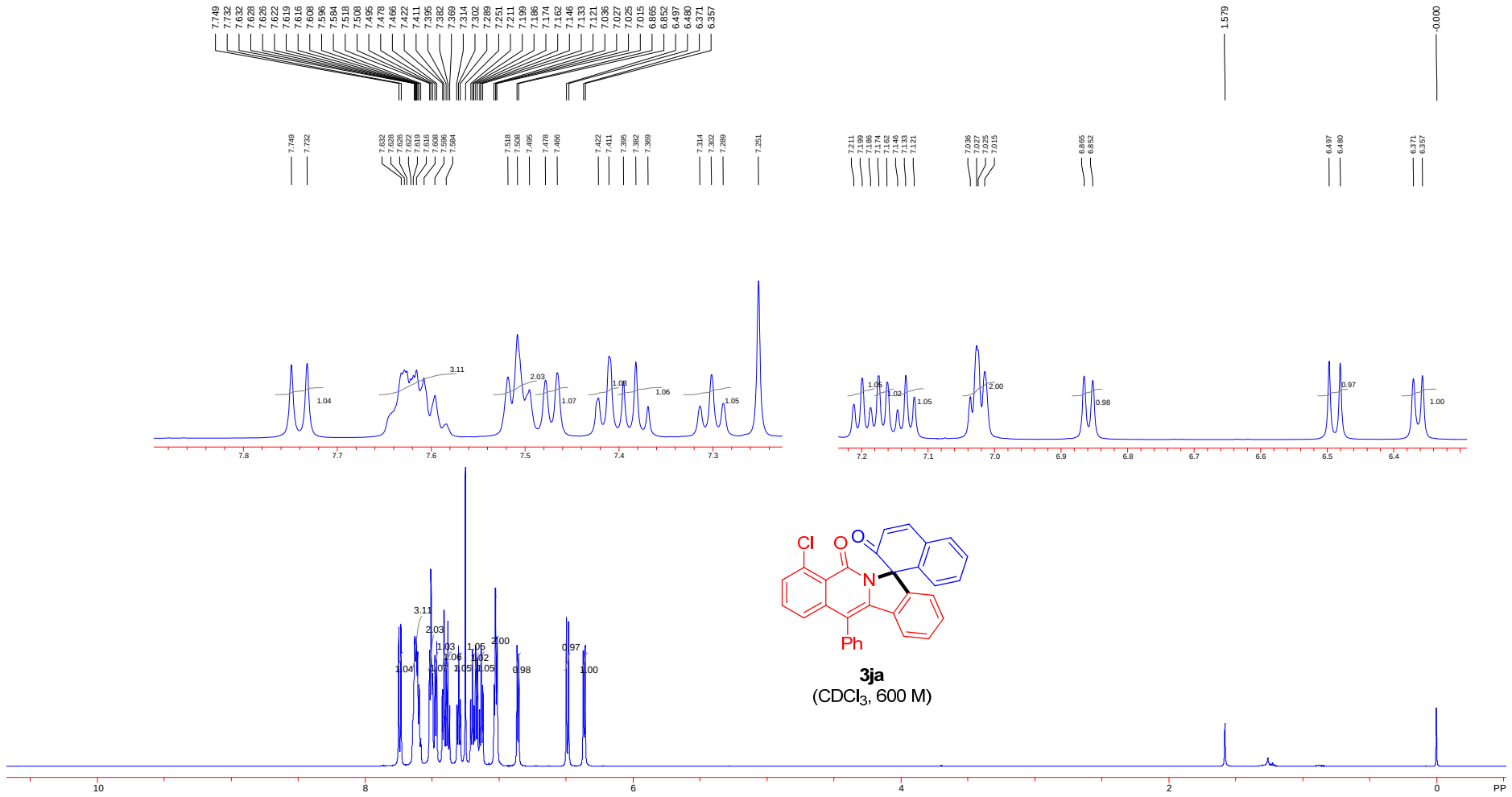

7.756
7.739
7.662
7.653
7.640
7.635
7.623
7.521
7.509
7.495
7.485
7.472
7.327
7.316
7.315
7.304
7.302
7.255
7.227
7.225
7.214
7.202
7.200
7.180
7.167
7.155
7.085
7.082
7.067
7.064
7.059
7.046
7.037
7.024
6.999
6.839
6.826
6.489
6.472
6.388
6.374
1.592
1.259
-0.000
3.03
2.00
1.00
0.99
1.01
1.02
2.99
0.96
0.97
F
O
N
Cl
Ph
3ia
(CDCl3, 600 M)
10
8
6
4
2
0 PPM



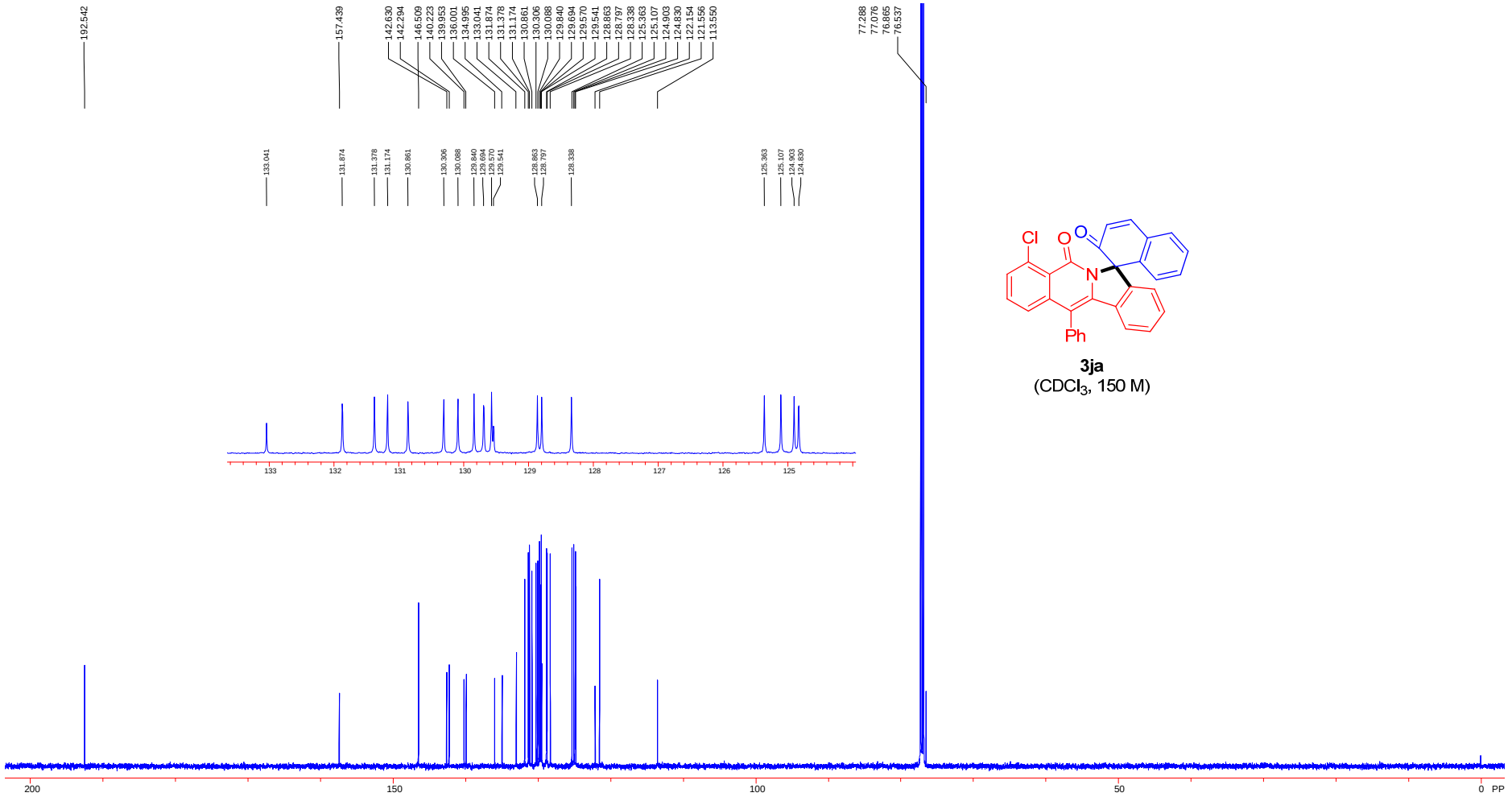
3ia
($CDCl_3$, 150 M)



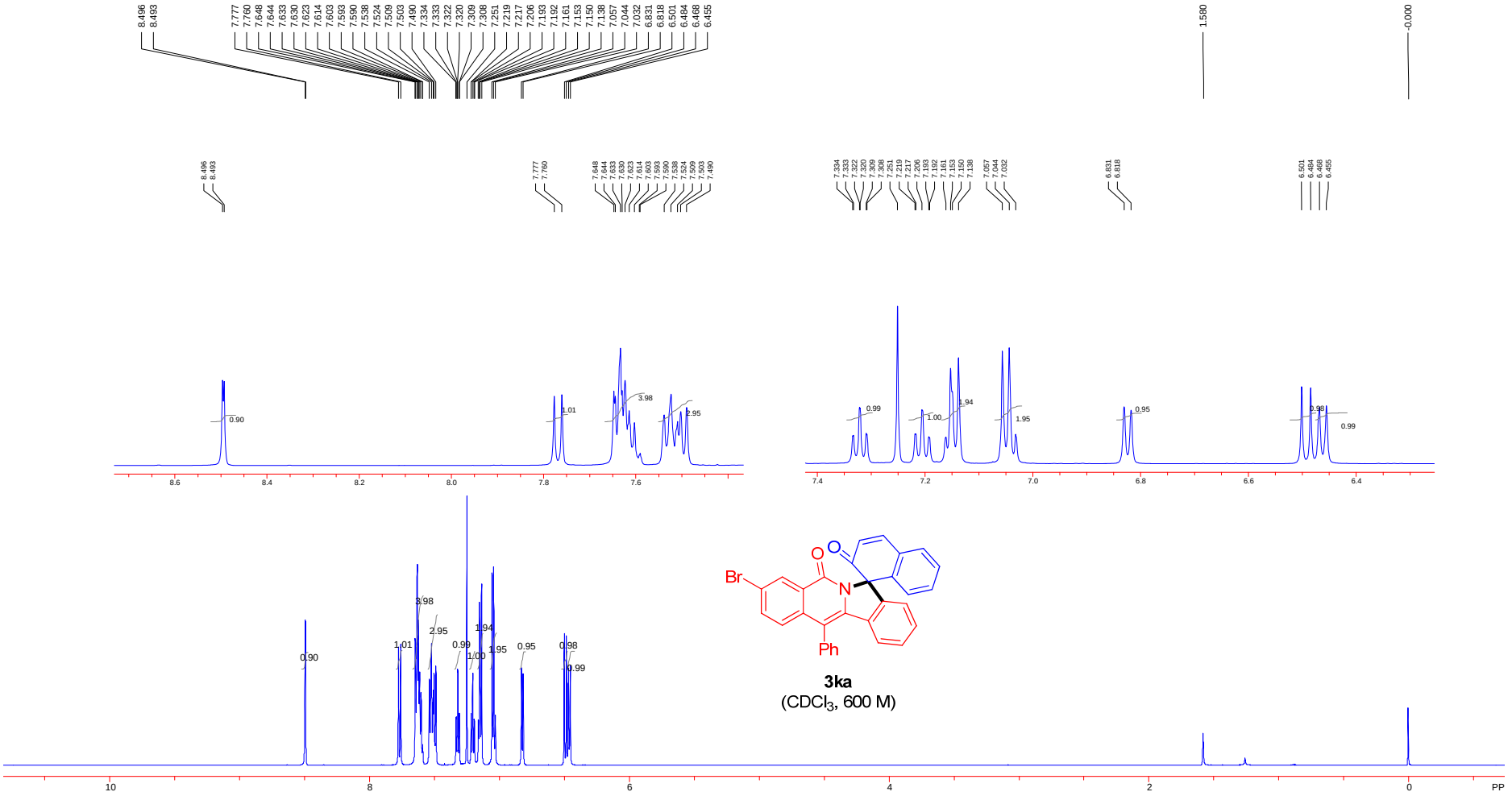
3ia
($CDCl_3$, 376 M)

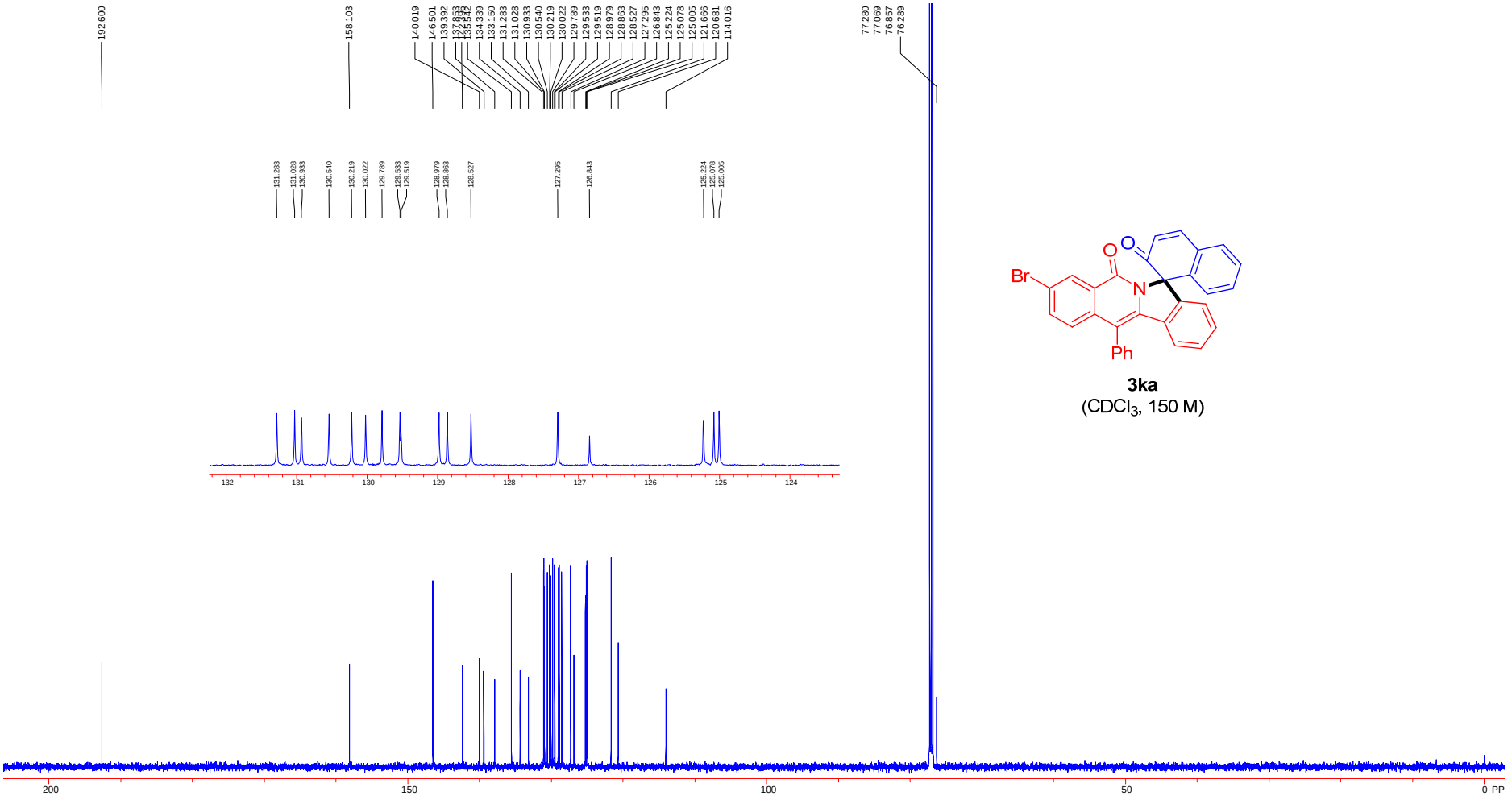


3ja
($CDCl_3$, 600 M)

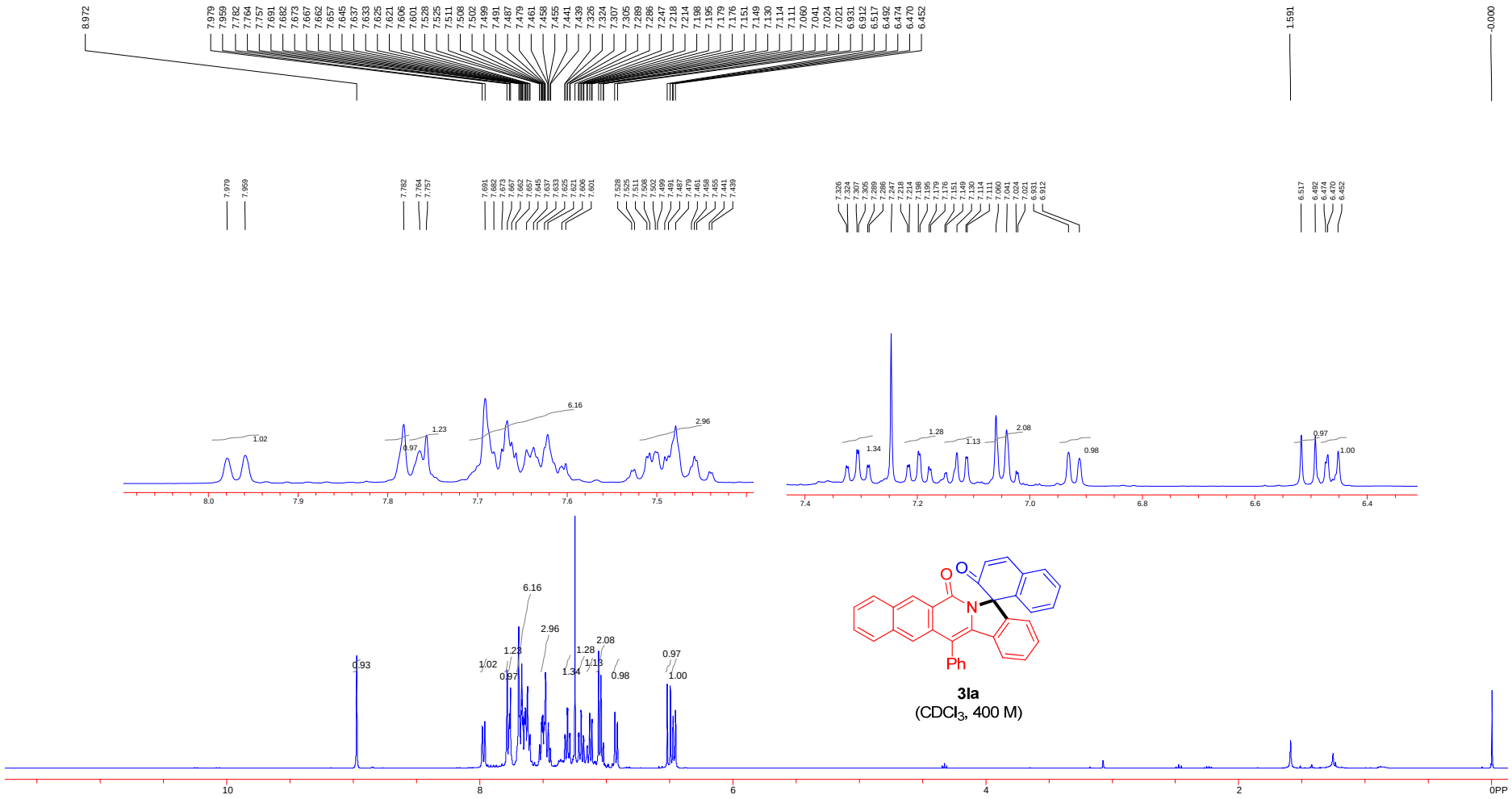


3ja
($CDCl_3$, 150 M)


8.496
8.493
7.777
7.760
7.648
7.644
7.633
7.630
7.623
7.614
7.603
7.593
7.590
7.538
7.524
7.509
7.503
7.490
7.334
7.333
7.322
7.309
7.308
7.251
7.219
7.217
7.206
7.193
7.192
7.161
7.153
7.150
7.138
7.057
7.044
7.032
6.831
6.818
6.501
6.484
6.468
6.455
1.580
-0.000
0.90
1.01
3.98
2.95
0.99
1.00
1.94
1.95
0.95
0.98
0.99
Br
O
O
N
Ph
3ka
(CDCl3, 600 M)
PP



3ka
($CDCl_3$, 150 M)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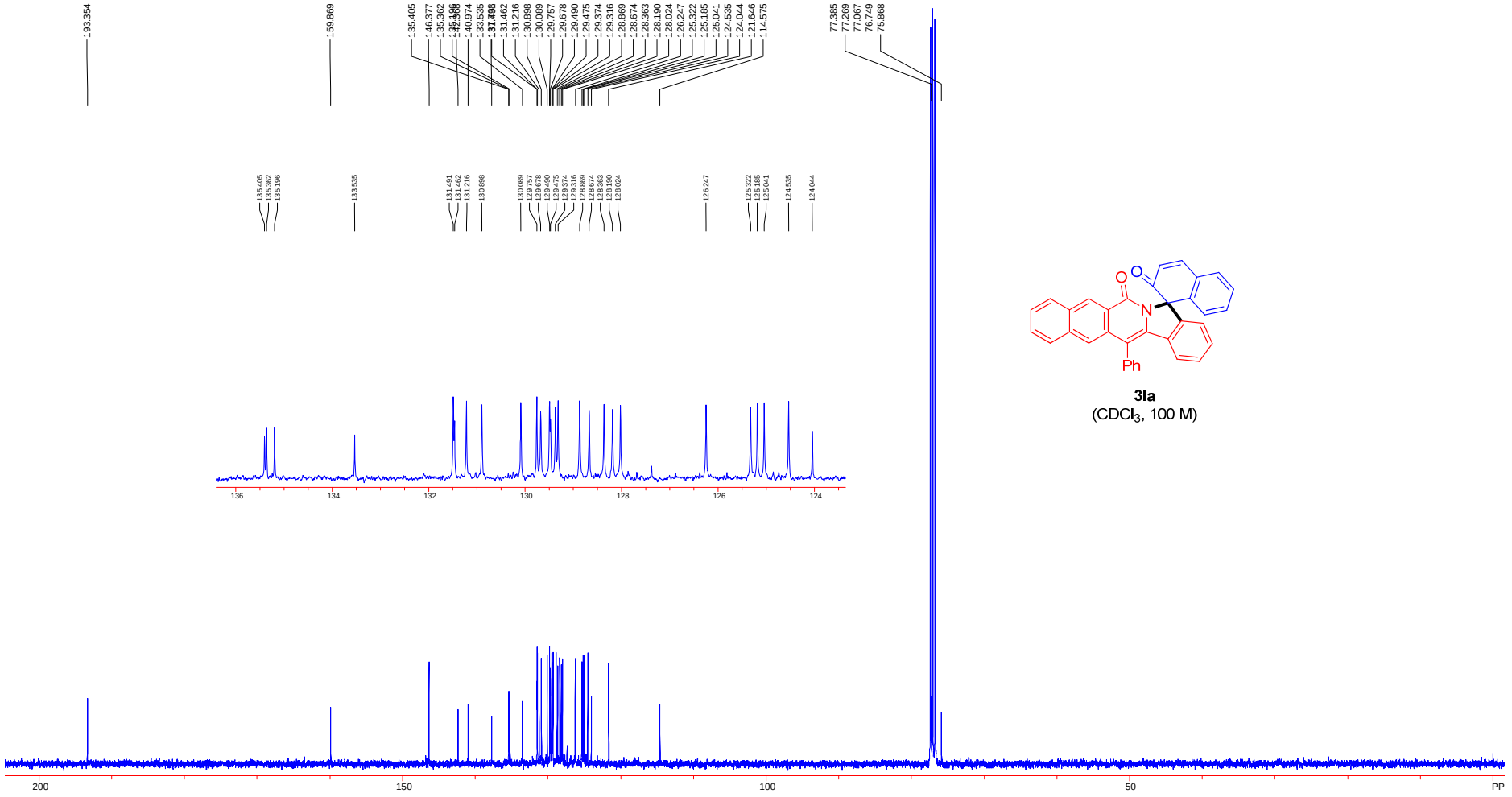
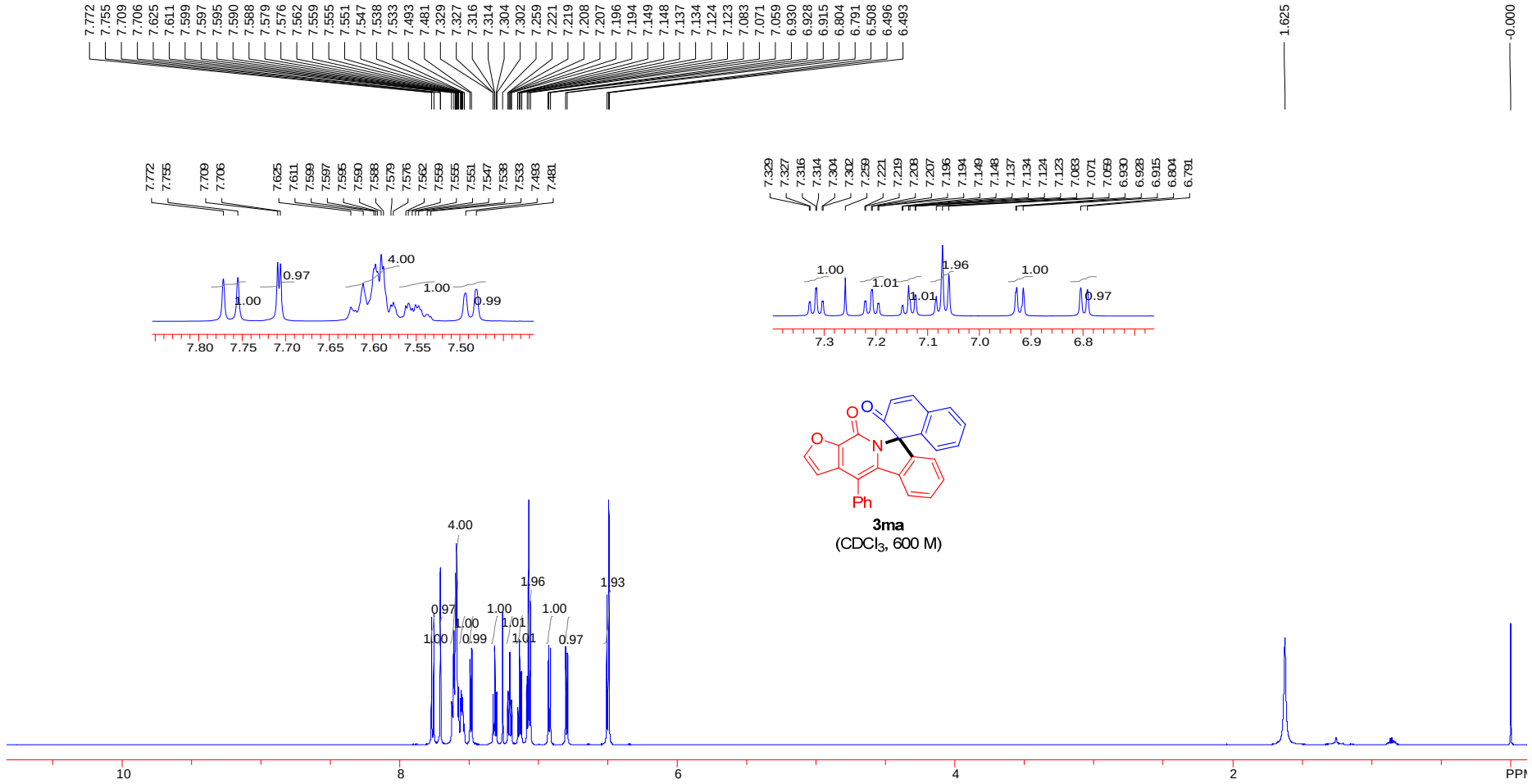
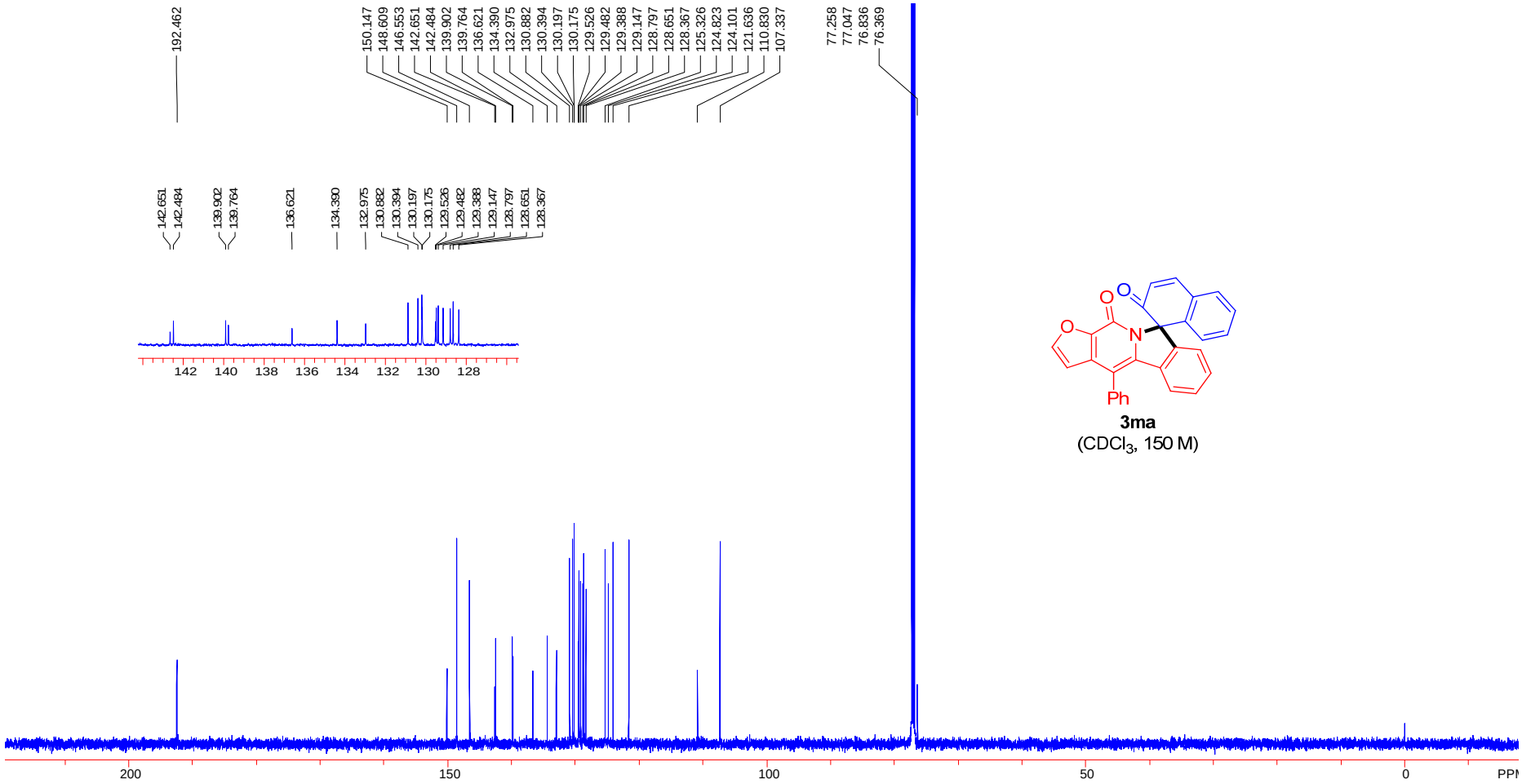
7.979
7.959
7.782
7.764
7.757
7.691
7.682
7.673
7.667
7.662
7.657
7.645
7.637
7.633
7.625
7.621
7.606
7.601
7.528
7.525
7.511
7.508
7.502
7.499
7.491
7.487
7.479
7.461
7.458
7.455
7.441
7.439
7.326
7.324
7.307
7.305
7.289
7.286
7.247
7.218
7.214
7.198
7.195
7.179
7.176
7.151
7.149
7.130
7.114
7.111
7.060
7.041
7.024
7.021
6.931
6.912
6.517
6.492
6.474
6.470
6.452
1.591
-0.000
1.02
0.97
1.23
6.16
2.96
1.34
1.28
1.13
2.08
0.98
0.97
1.00
0.93
1.02
0.97
1.23
6.16
2.96
1.34
1.28
1.13
2.08
0.98
0.97
1.00
O
O
N
Ph
3la
(CDCl3, 400 M)
10
8
6
4
2
0PP

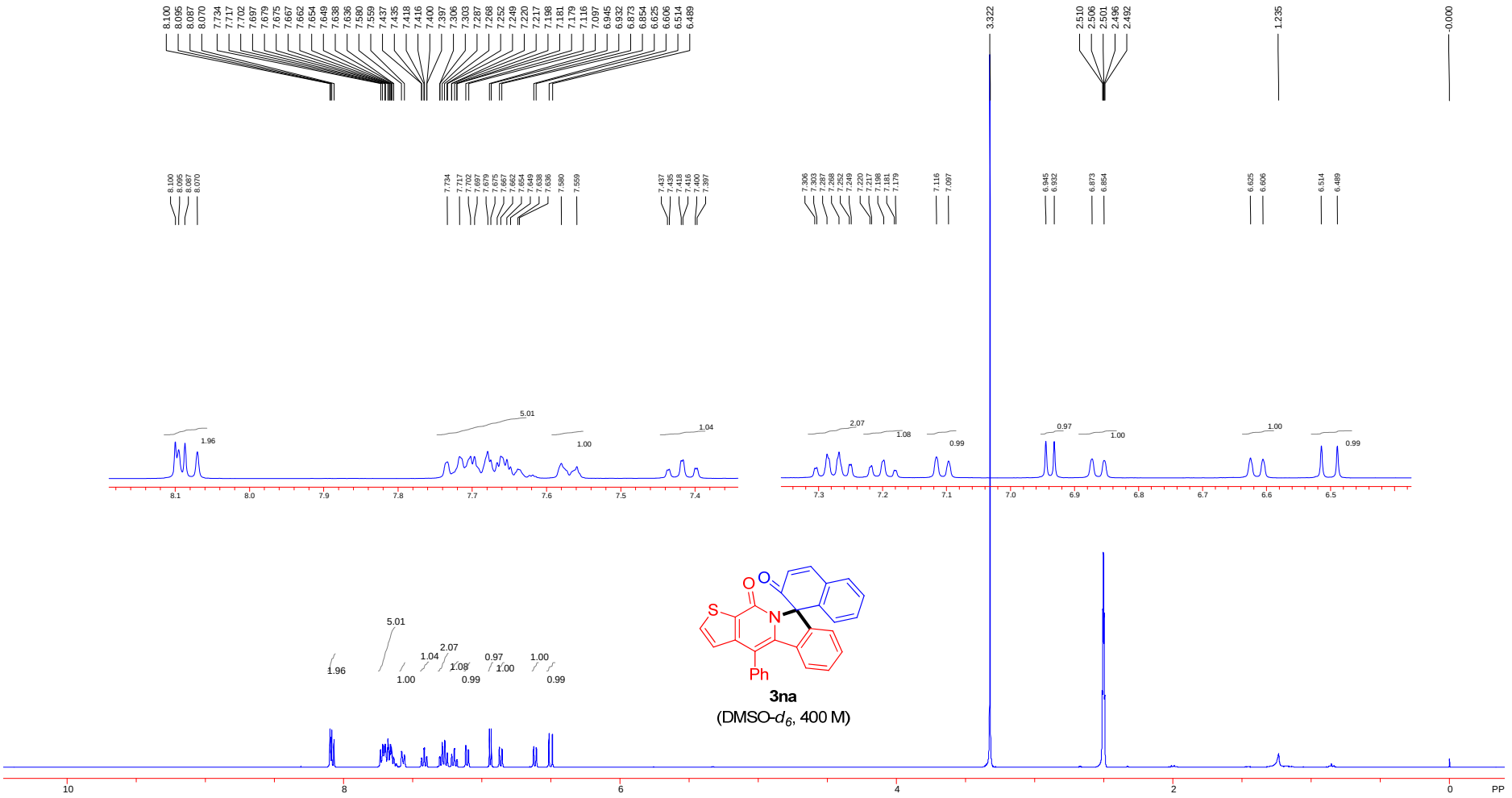


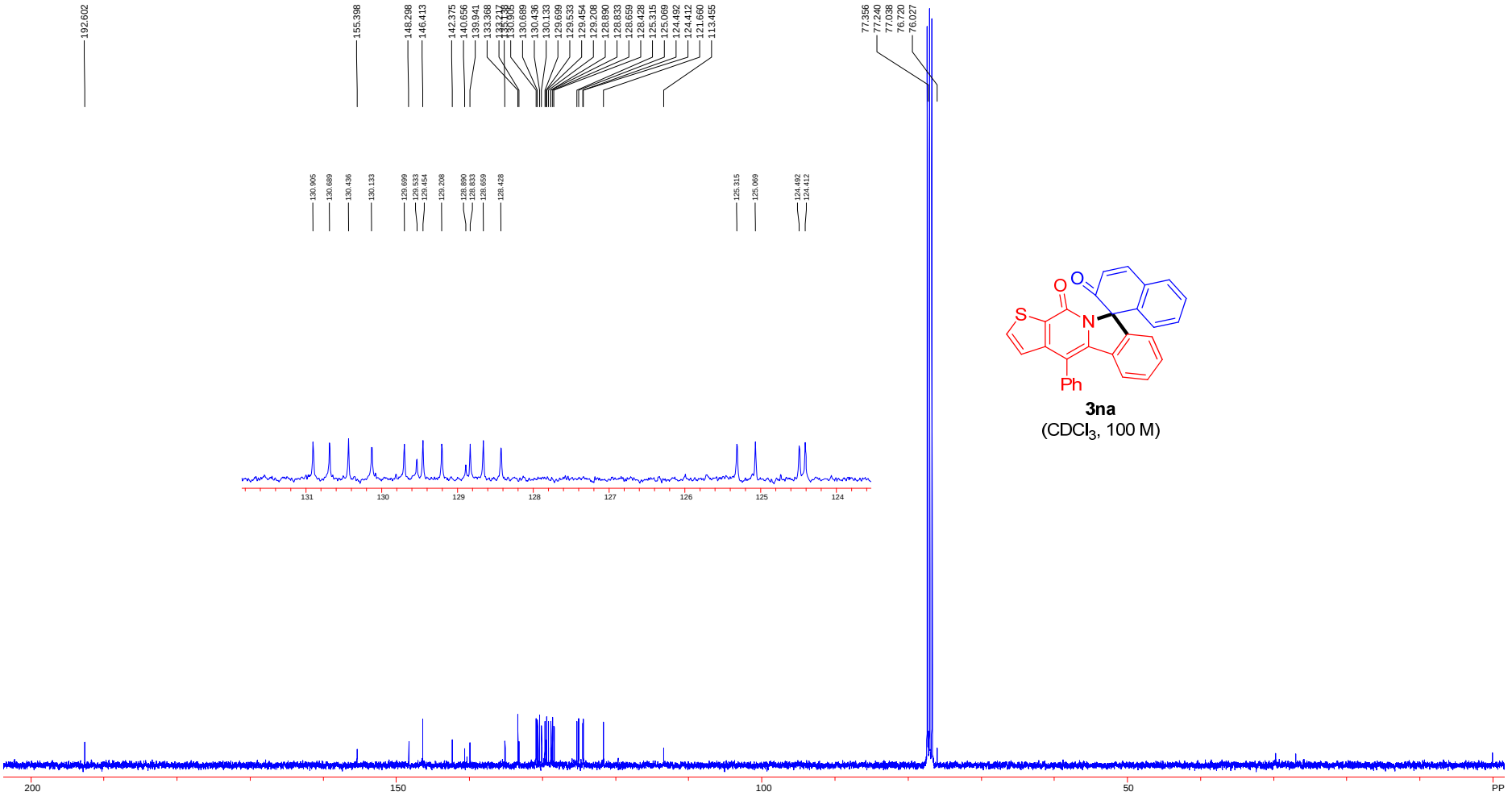
3la
($CDCl_3$, 100 M)

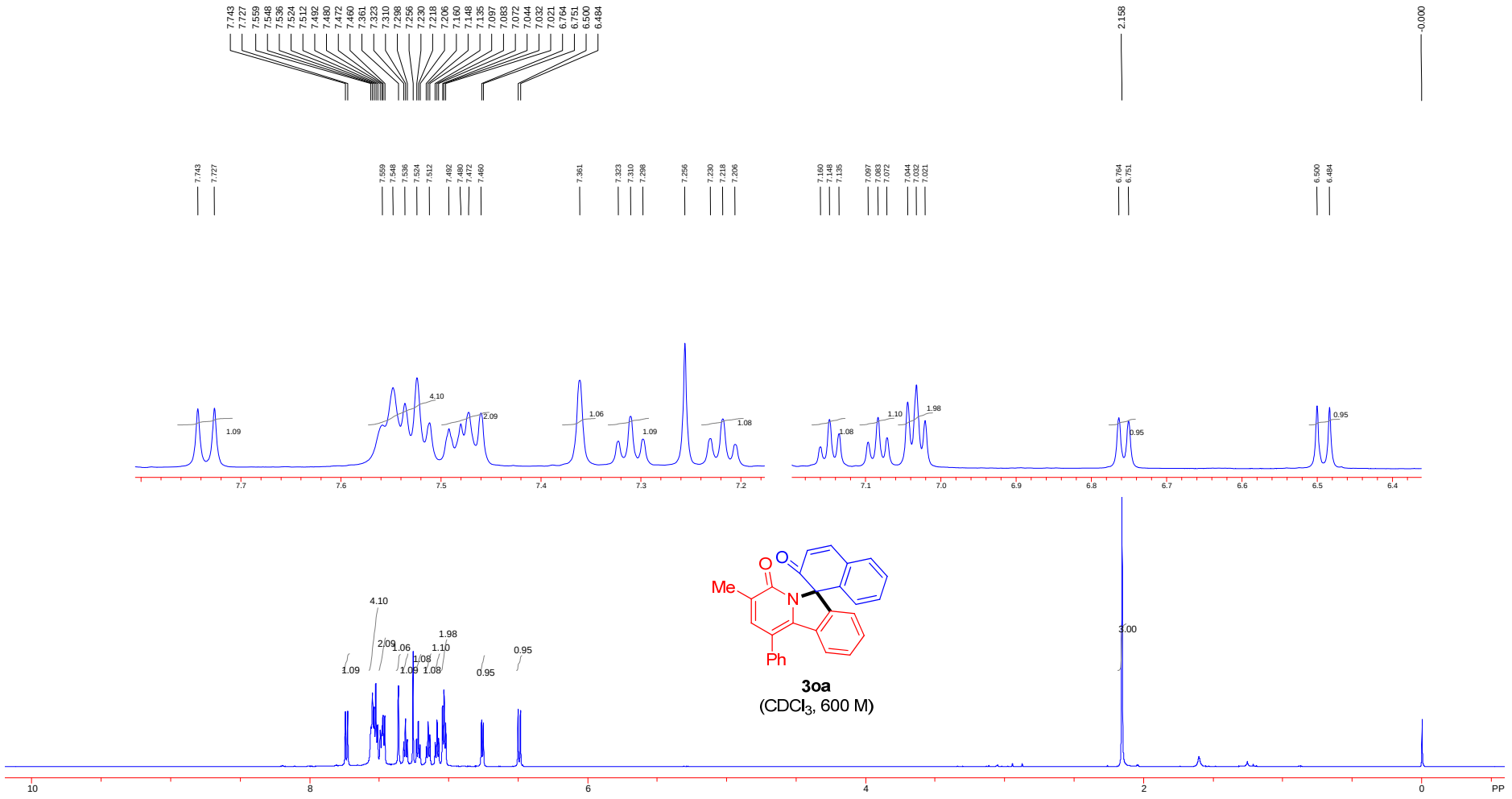

7.772 7.755 7.709 7.706 7.625 7.611 7.599 7.597 7.595 7.590 7.588 7.579 7.576 7.562 7.559 7.555 7.551 7.547 7.538 7.533 7.493 7.481 7.329 7.327 7.316 7.314 7.304 7.302 7.259 7.221 7.219 7.208 7.207 7.196 7.194 7.149 7.148 7.137 7.134 7.124 7.123 7.083 7.071 7.059 6.930 6.928 6.915 6.804 6.791 6.508 6.496 6.493
1.625
0.000
4.00
0.97
1.00
1.00
0.99
7.80 7.75 7.70 7.65 7.60 7.55 7.50
1.00
1.01
1.96
1.01
1.00
0.97
7.3 7.2 7.1 7.0 6.9 6.8
O
O
N
O
Ph
3ma
(CDCl3, 600 M)
4.00
0.97
1.00
1.00
0.99
1.96
1.00
1.01
1.01
1.00
0.97
1.93
10 8 6 4 2 PPM

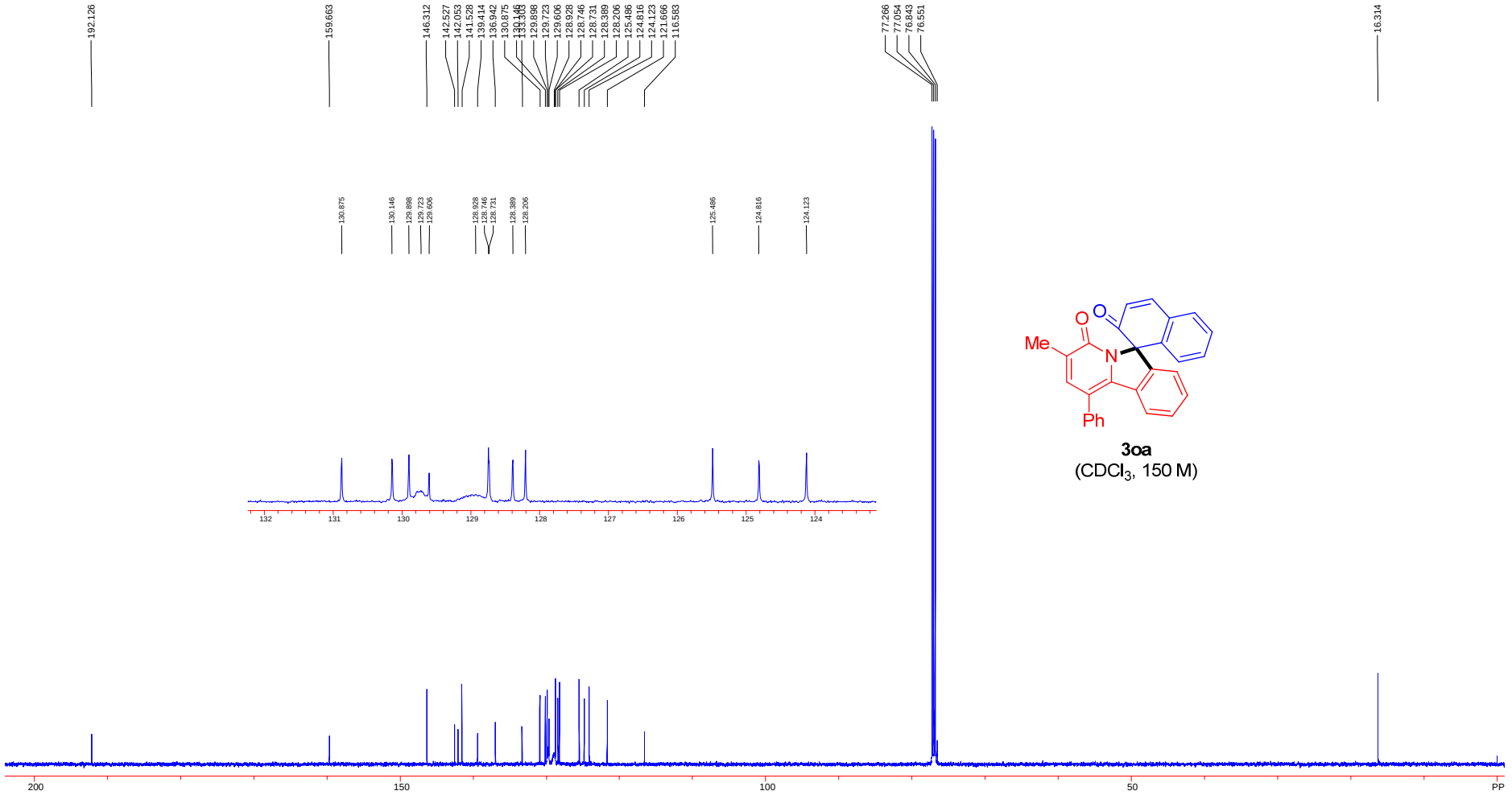


3ma
($CDCl_3$, 150 M)

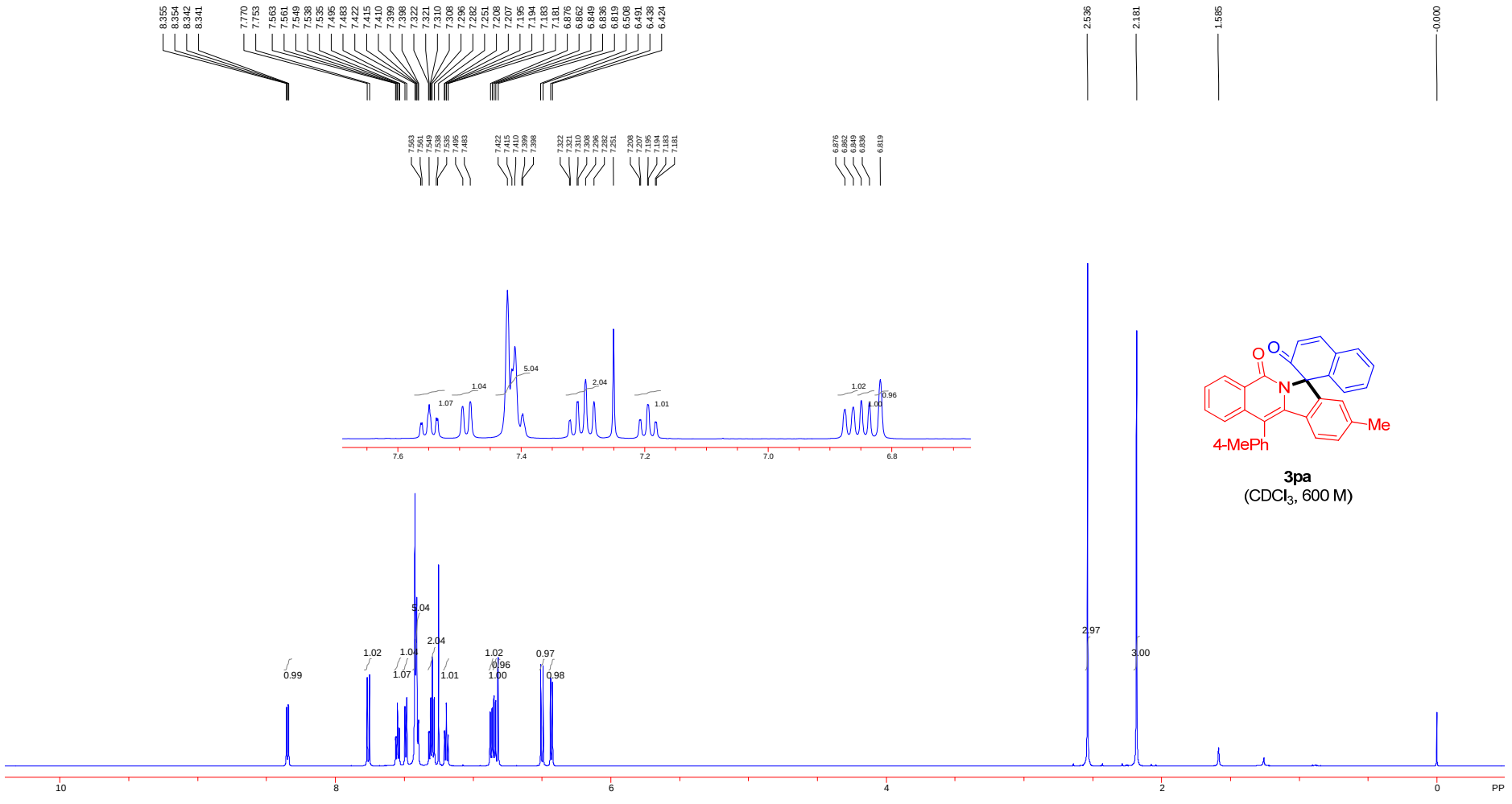

8.100 8.095 8.087 8.070 7.734 7.717 7.702 7.697 7.679 7.675 7.667 7.662 7.654 7.649 7.638 7.636 7.580 7.559 7.437 7.435 7.418 7.416 7.400 7.397 7.306 7.303 7.287 7.288 7.252 7.249 7.220 7.217 7.198 7.181 7.179 7.116 7.097 6.945 6.932 6.873 6.854 6.625 6.606 6.514 6.489
3.322
2.510 2.506 2.501 2.496 2.492
1.235
-0.000
1.96 5.01 1.00 1.04
2.07 1.08 0.99 0.97 1.00 1.00 0.99
1.96 5.01 1.00 1.04 2.07 1.08 0.99 0.97 1.00 1.00 0.99
O O S N Ph
3na
(DMSO-d_6, 400 M)
10 8 6 4 2 0 PP

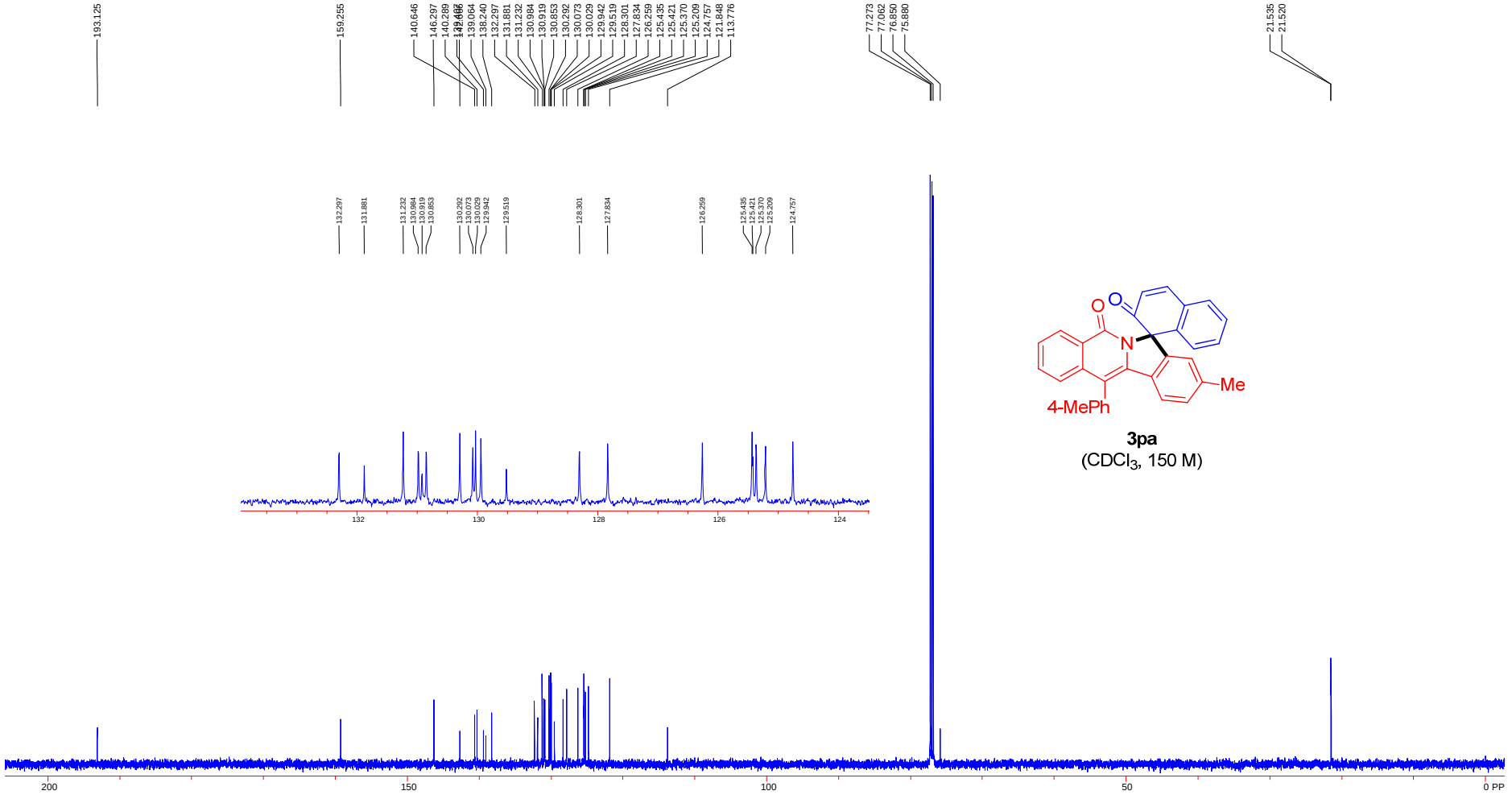

192.602
155.398
148.298
146.413
142.375
140.656
139.941
133.368
130.689
130.436
130.133
129.699
129.533
129.454
129.208
128.890
128.833
128.659
128.428
125.315
125.069
124.492
124.412
121.660
113.455
77.356
77.240
77.038
76.720
76.027
130.905
130.689
130.436
130.133
129.699
129.533
129.454
129.208
128.890
128.833
128.659
128.428
125.315
125.069
124.492
124.412
O
O
S
N
Ph
3na
(CDCl3, 100 M)
131
130
129
128
127
126
125
124
200
150
100
50
PP

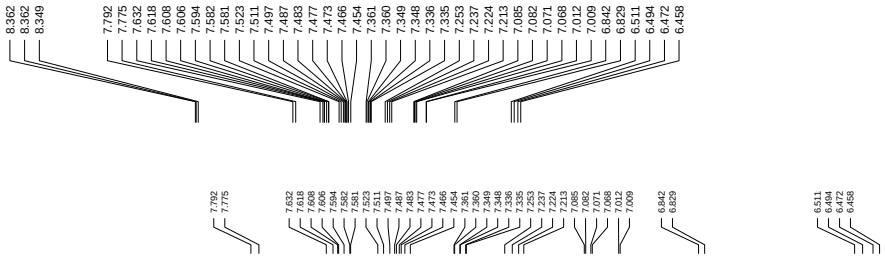

7.743
7.727
7.559
7.548
7.536
7.524
7.512
7.492
7.480
7.472
7.460
7.361
7.323
7.310
7.298
7.256
7.230
7.218
7.206
7.160
7.148
7.135
7.097
7.083
7.072
7.044
7.032
7.021
6.764
6.751
6.500
6.484
2.158
0.000
1.09
4.10
2.09
1.06
1.09
1.08
1.10
1.98
1.08
0.95
0.95
3.00
Me
N
O
O
Ph
3oa
(CDCl3, 600 M)
PP

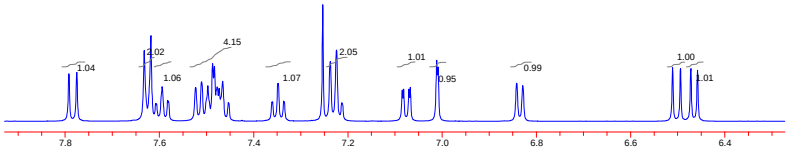


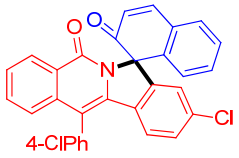
3oa
($CDCl_3$, 150 M)


8.355
8.354
8.342
8.341
7.770
7.753
7.563
7.561
7.549
7.538
7.535
7.495
7.483
7.422
7.415
7.410
7.399
7.398
7.322
7.321
7.310
7.308
7.296
7.282
7.251
7.208
7.207
7.195
7.194
7.183
7.181
6.876
6.862
6.849
6.836
6.819
6.508
6.491
6.438
6.424
2.536
2.181
1.585
-0.000
1.04
5.04
1.07
2.04
1.01
1.02
0.96
1.01
7.6
7.4
7.2
7.0
6.8
0.99
1.02
1.04
1.07
5.04
2.04
1.01
1.02
0.96
1.00
0.97
0.98
2.97
3.00
10
8
6
4
2
0
PP
O
O
N
Me
4-MePh
3pa
(CDCl3, 600 M)

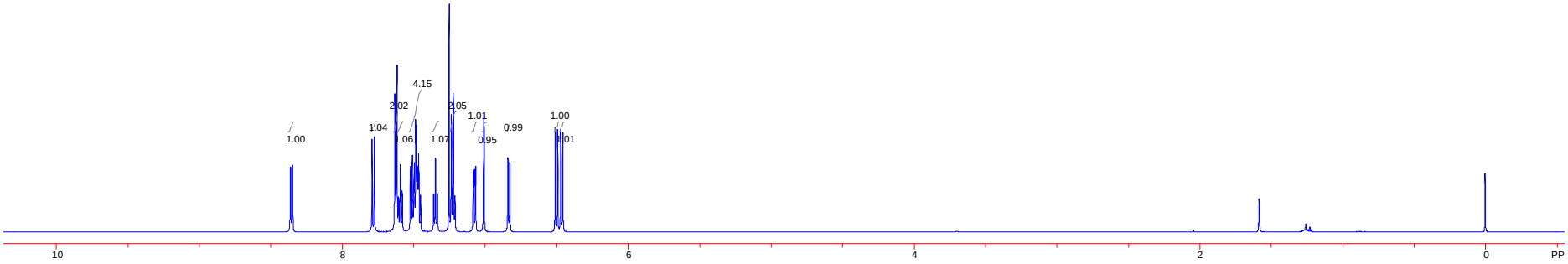

193.125
159.255
140.646
146.297
140.289
139.064
138.240
132.297
131.881
131.232
130.984
130.919
130.853
130.292
130.073
130.029
129.942
129.519
128.301
127.834
126.259
125.435
125.421
125.370
125.209
124.757
121.848
113.776
77.273
77.062
76.850
75.880
21.535
21.520
O
O
N
Me
4-MePh
3pa
(CDCl3, 150 M)
200
150
100
50
0 PP
132
130
128
126
124

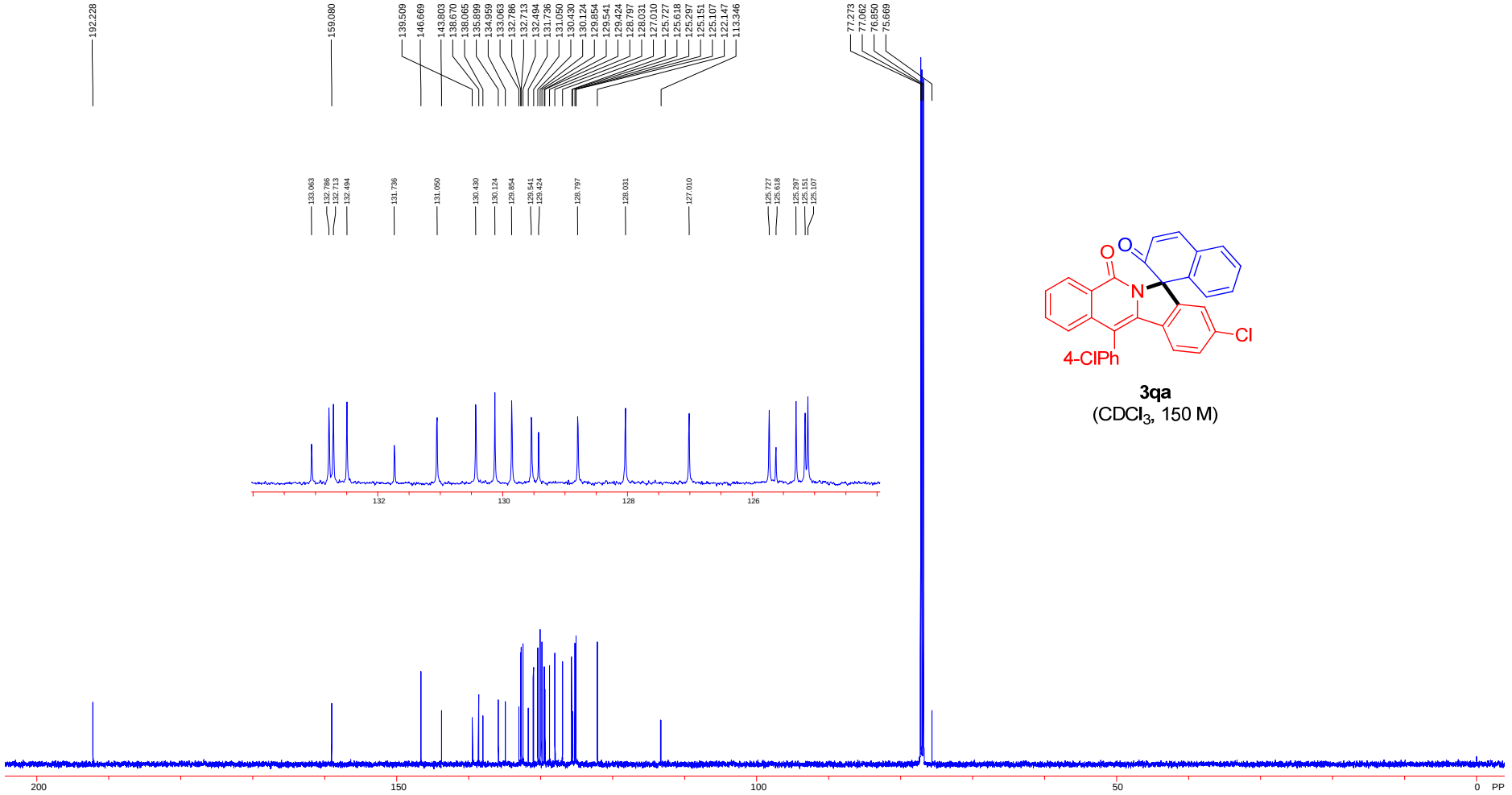






3qa
($CDCl_3$, 600 M)

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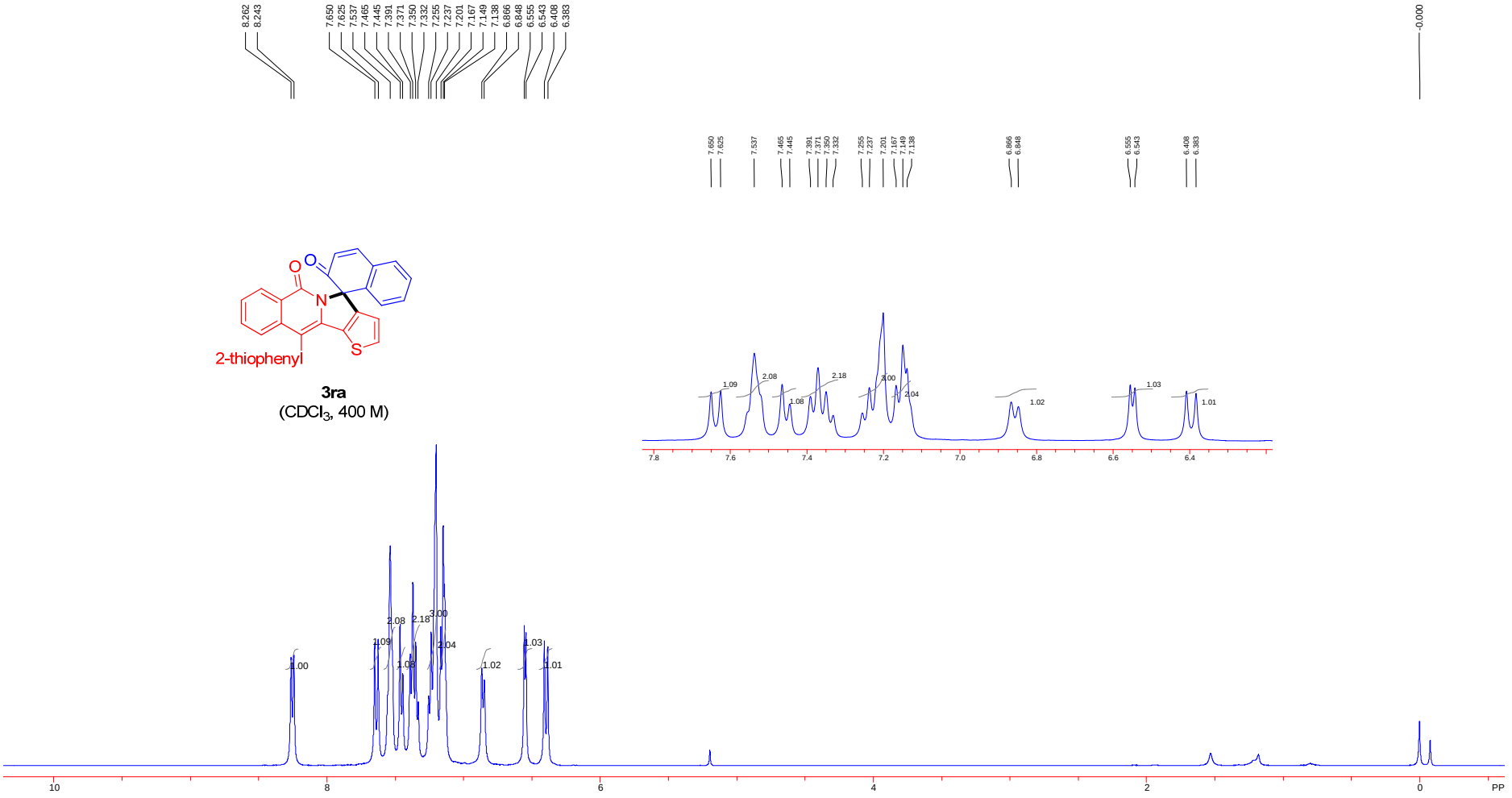
159.080
139.509
146.669
143.803
138.670
138.065
135.899
134.959
133.063
132.786
132.713
132.494
131.736
131.050
130.430
130.124
129.854
129.541
129.424
128.797
128.031
127.010
125.727
125.618
125.297
125.151
125.107
122.147
113.346
77.273
77.062
76.850
75.669
O
O
N
Cl
4-ClPh
3qa
(CDCl3, 150 M)
200
150
100
50
0
PP
132
130
128
126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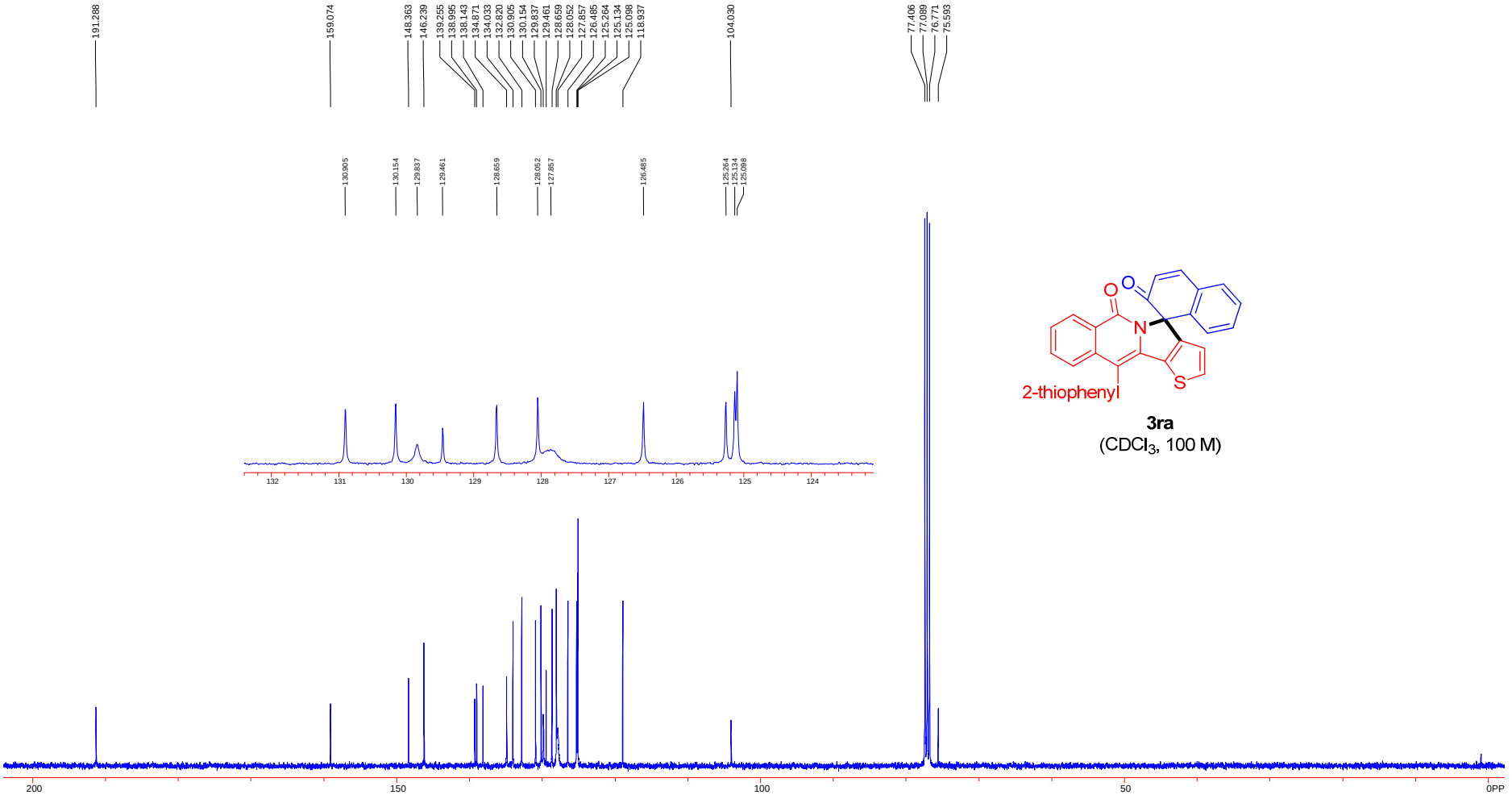
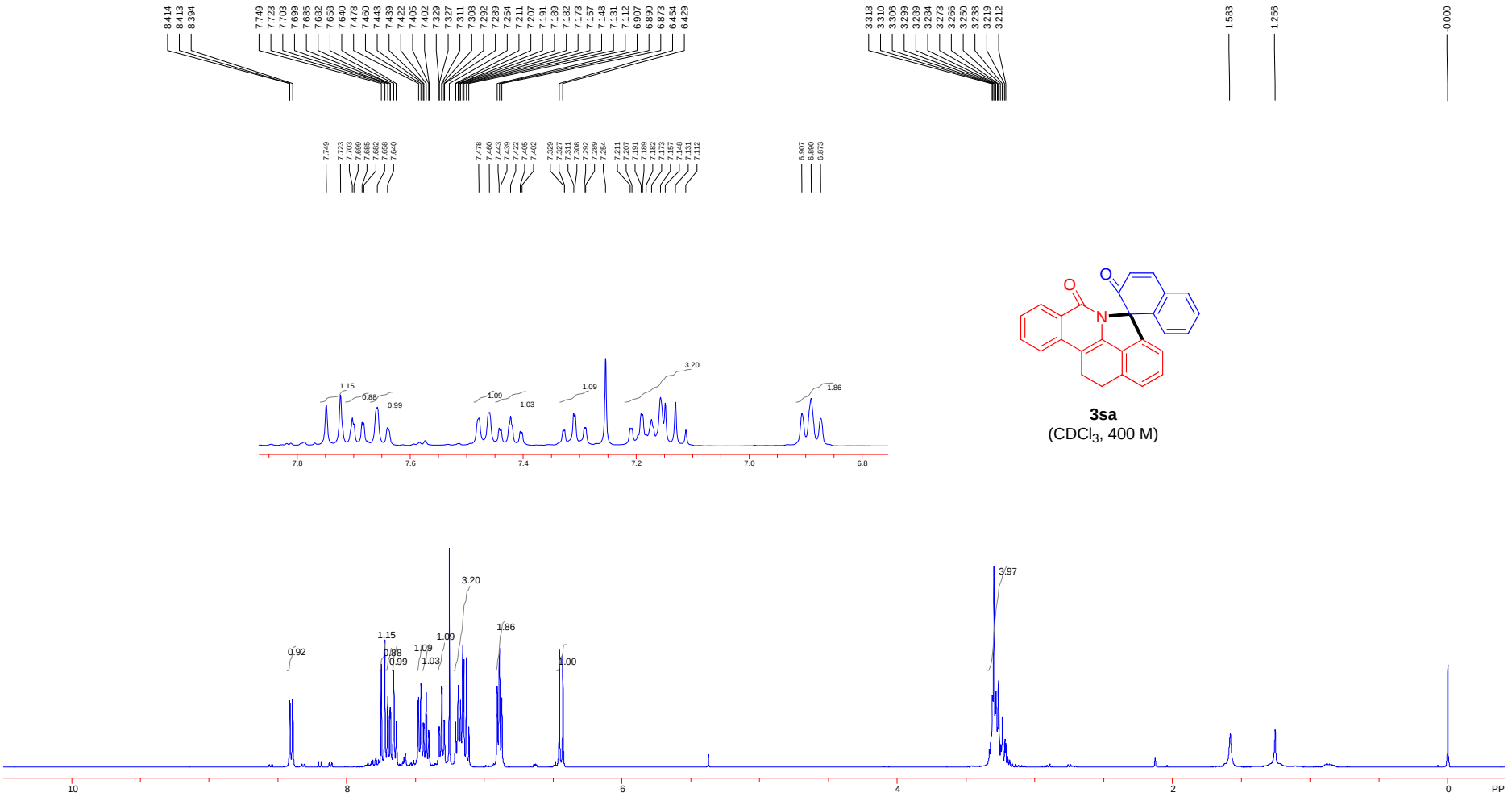
7.650
7.625
7.537
7.465
7.445
7.391
7.371
7.350
7.332
7.255
7.237
7.201
7.167
7.149
7.138
6.866
6.848
6.555
6.543
6.408
6.383
0.000
O
O
N
S
2-thiophenyl
3ra
(CDCl3, 400 M)
1.09
2.08
2.18
3.00
2.04
1.08
1.02
1.03
1.01
1.00
10
8
6
4
2
0
PP


191.288
159.074
148.363
146.239
139.255
138.995
138.143
134.871
134.033
132.820
130.905
130.154
129.837
129.461
128.659
128.052
127.857
126.485
125.264
125.134
125.098
118.937
104.030
77.406
77.089
76.771
75.593
130.905
130.154
129.837
129.461
128.659
128.052
127.857
126.485
125.264
125.134
125.098
O
O
N
S
2-thiophenyl
3ra
(CDCl3, 100 M)
200
150
100
50
0PPM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8.413
8.394
7.749
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7.682
7.658
7.640
7.478
7.460
7.443
7.439
7.422
7.405
7.402
7.329
7.327
7.311
7.308
7.292
7.289
7.254
7.211
7.207
7.191
7.189
7.182
7.173
7.157
7.148
7.131
7.112
6.907
6.890
6.873
6.454
6.429
3.318
3.310
3.306
3.299
3.289
3.284
3.273
3.266
3.250
3.238
3.219
3.212
1.583
1.256
0.000
1.15
0.88
0.99
1.09
1.03
1.09
3.20
1.86
O
O
N
3sa
(CDCl3, 400 M)
0.92
1.15
0.88
0.99
1.09
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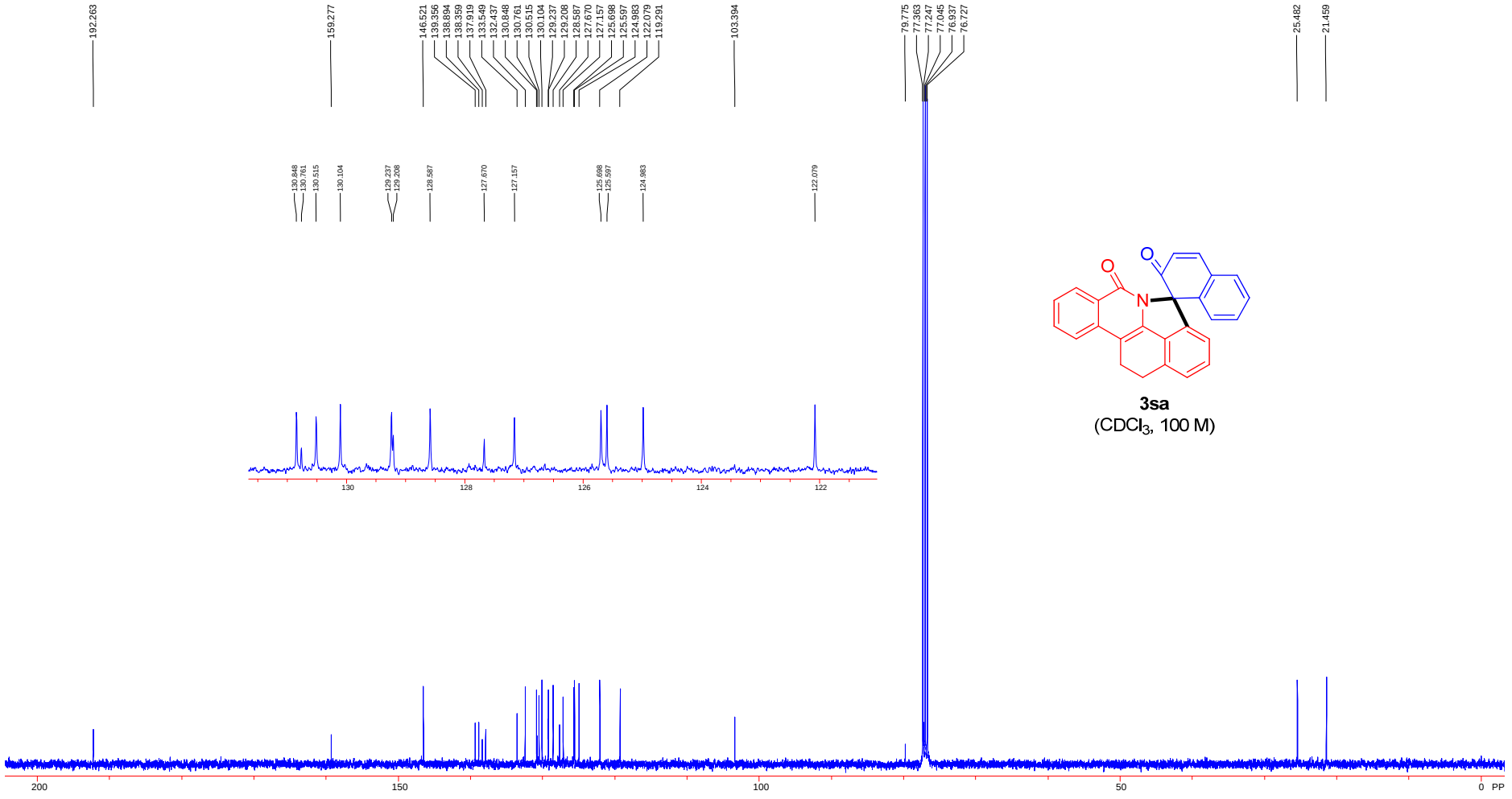
1.09
3.20
1.86
1.00
3.97
10
8
6
4
2
0
PP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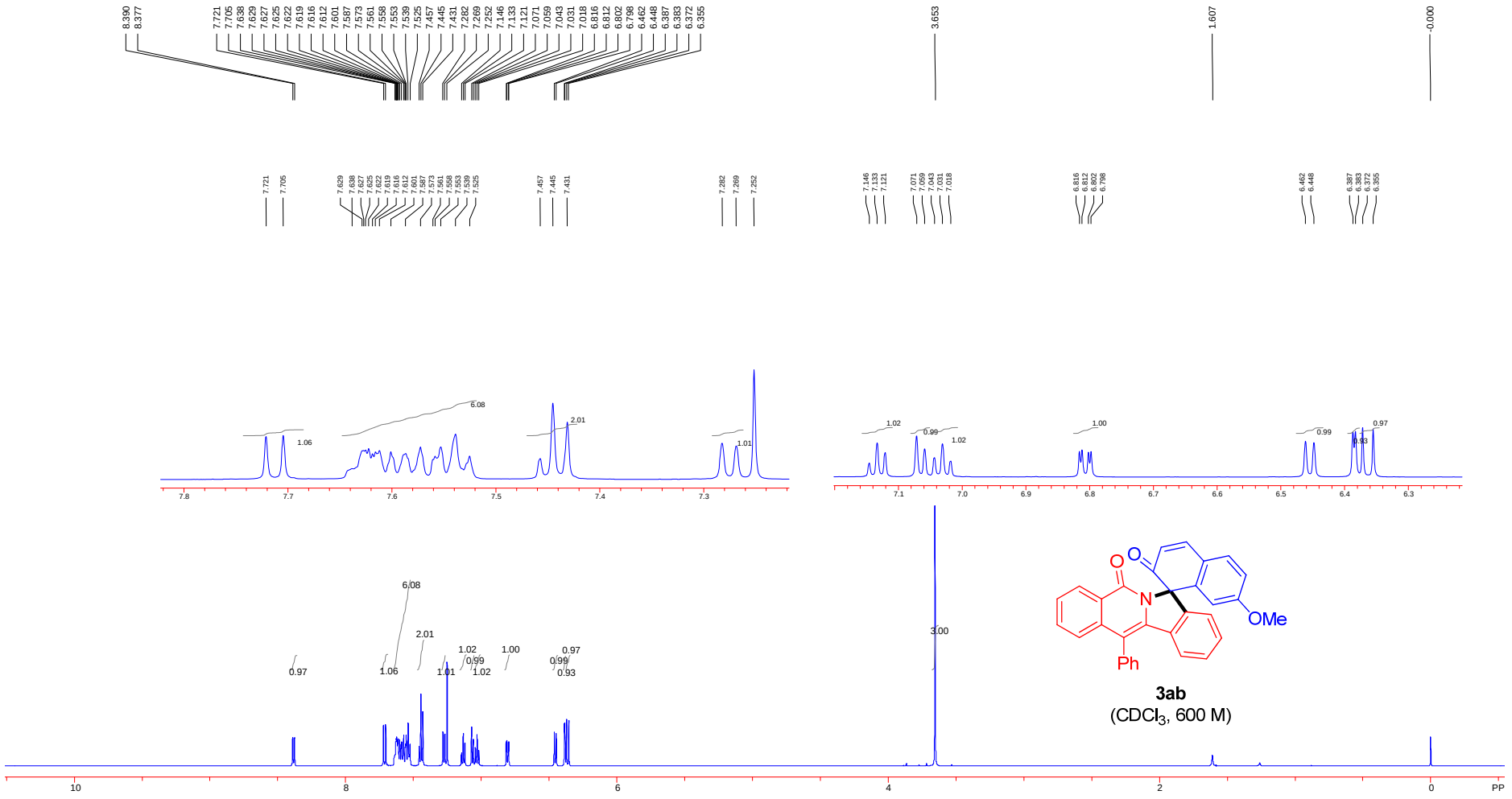
130.104
129.237
129.208
128.587
127.670
127.157
125.698
125.597
124.983
122.079
119.291
103.394
79.775
77.363
77.247
77.045
76.937
76.727
25.482
21.459
O
O
N
3sa
(CDCl3, 100 M)
200
150
100
50
0 PP
130
128
126
124
122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7.625
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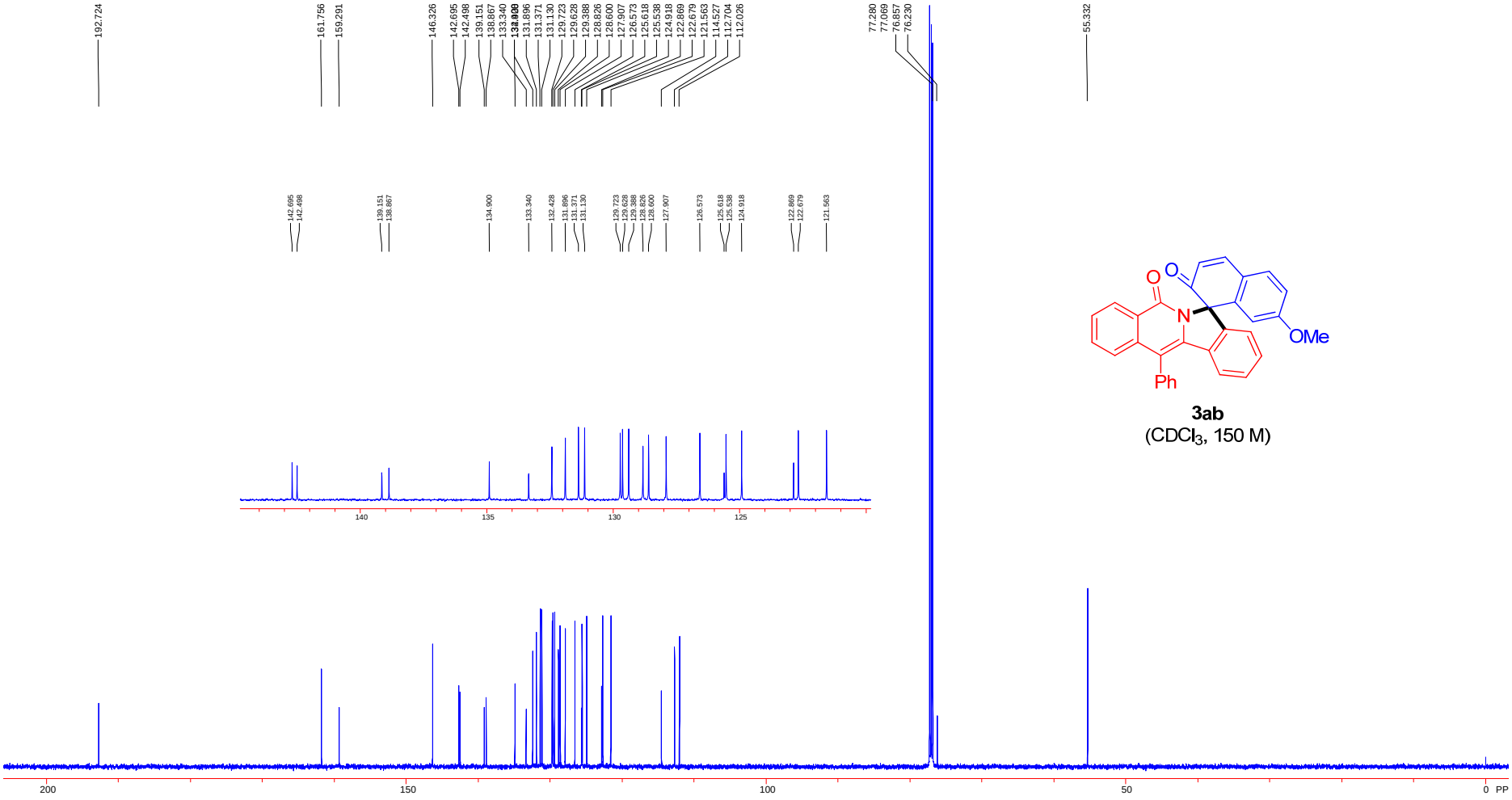
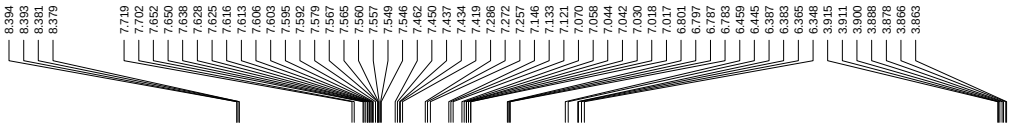
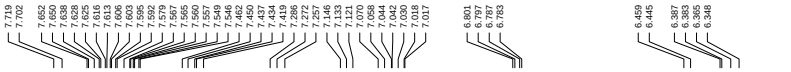
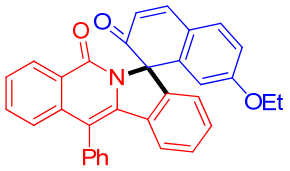
7.619
7.616
7.612
7.601
7.587
7.573
7.561
7.558
7.553
7.539
7.525
7.457
7.445
7.431
7.282
7.269
7.252
7.146
7.133
7.121
7.071
7.059
7.043
7.031
7.018
6.816
6.812
6.802
6.798
6.462
6.448
6.387
6.383
6.372
6.355
3.653
1.607
-0.000
6.08
2.01
1.06
1.01
1.02
0.99
1.00
0.97
0.93
3.00
OMe
Ph
3ab
(CDCl3, 600 M)
PP



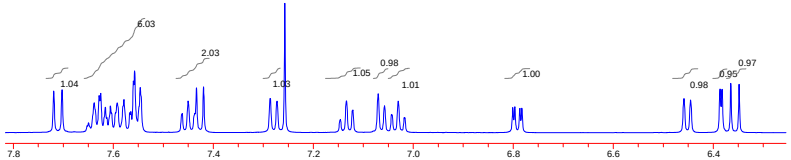
3ab
($CDCl_3$, 150 M)

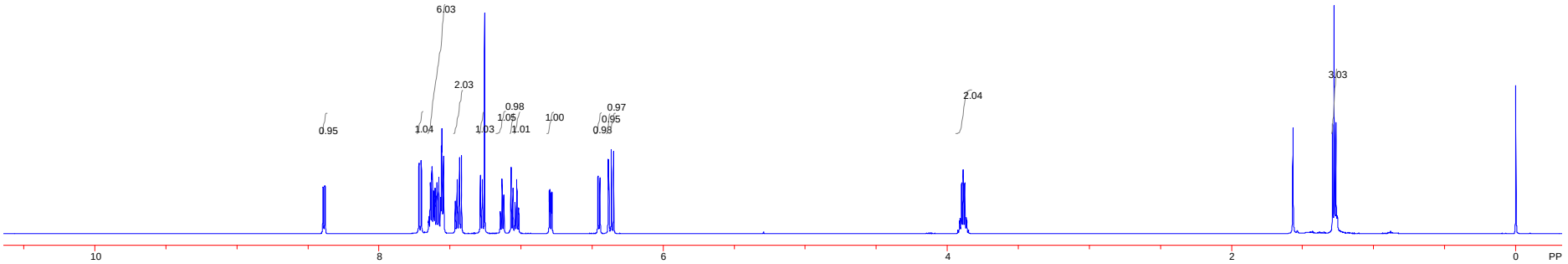


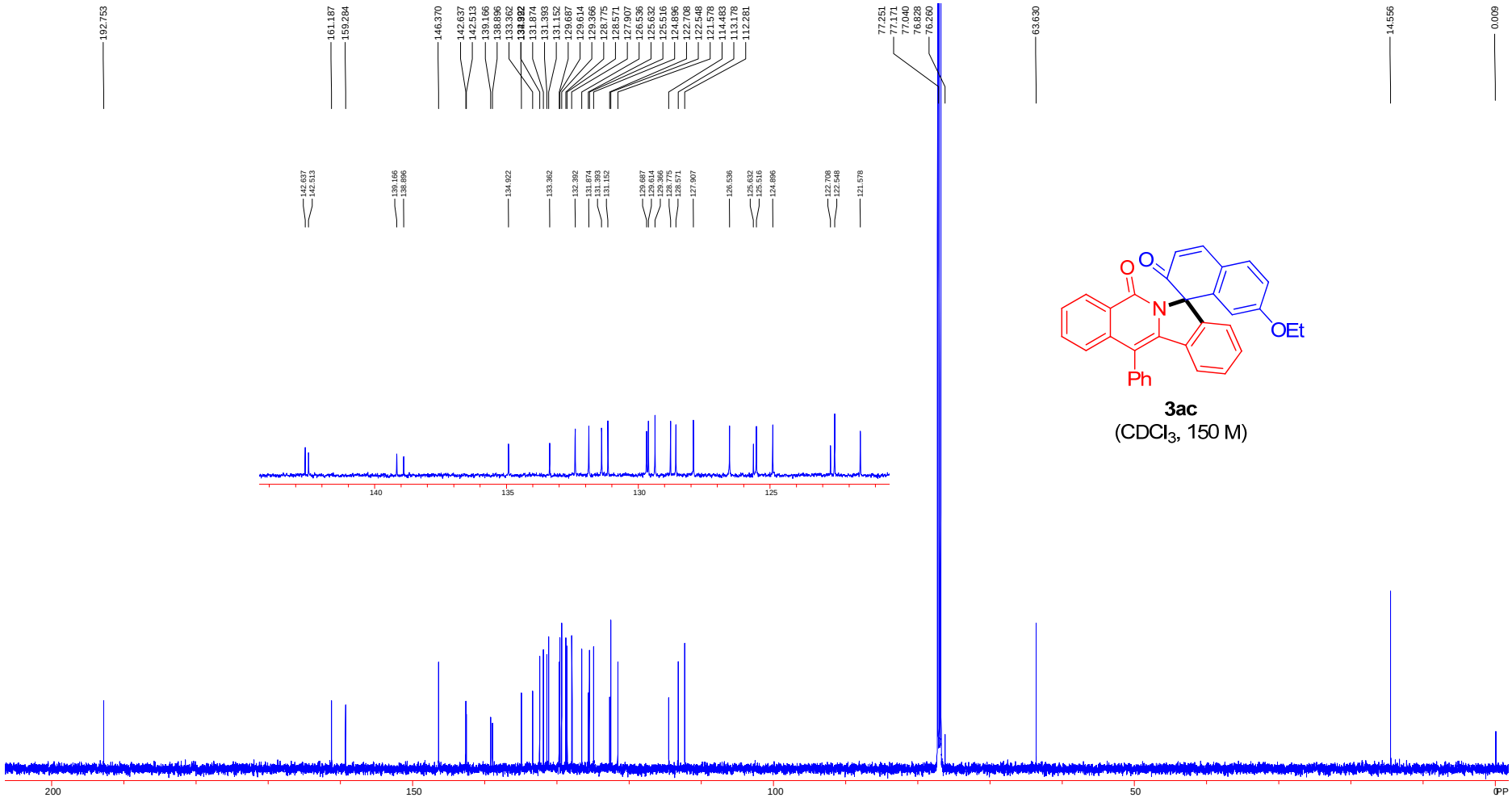




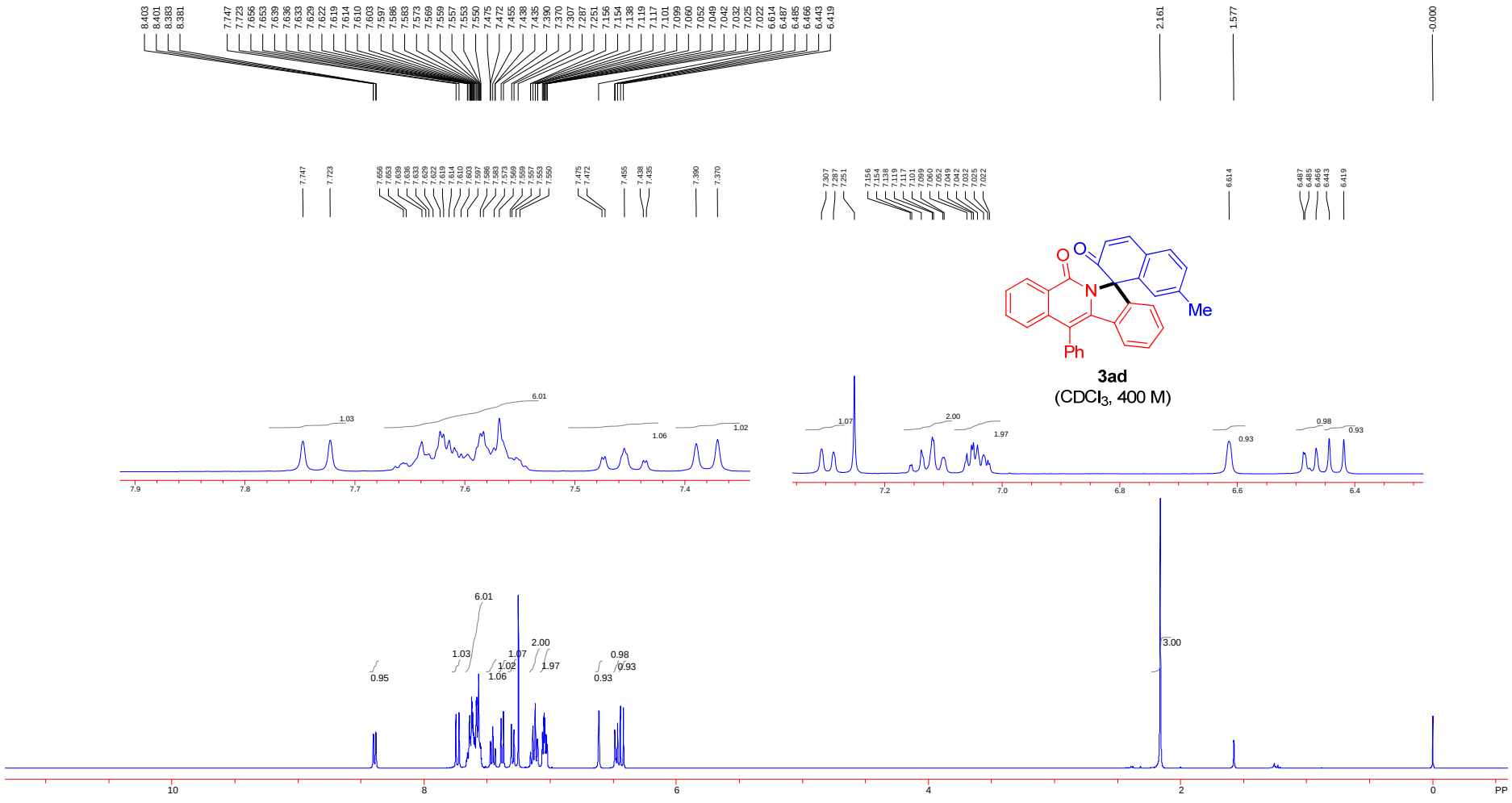
3ac
($CDCl_3$, 600 M)







3ac
($CDCl_3$, 150 M)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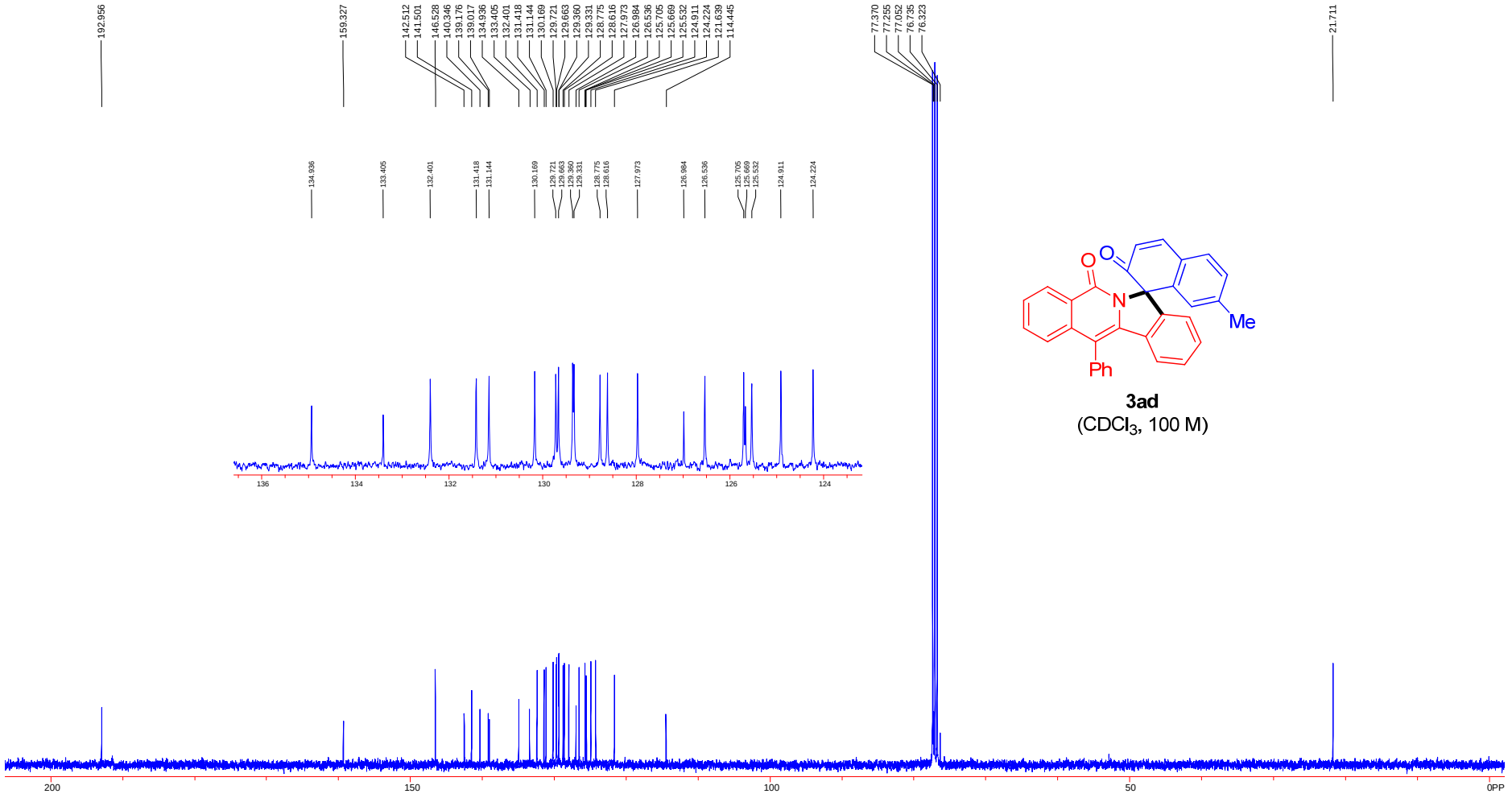
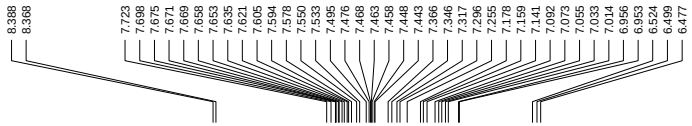
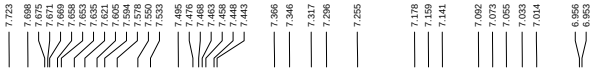
2.161 1.577 0.000
O
O
N
Me
Ph
3ad
(CDCl3, 400 M)
1.03 6.01 1.06 1.02
1.07 2.00 1.97 0.93 0.98 0.93
0.95 6.01 1.03 1.07 2.00 0.98 1.02 1.06 1.97 0.93 0.93 3.00
10 8 6 4 2 0 PP

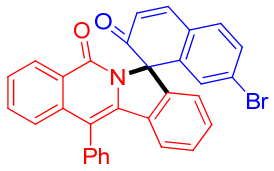


3ad

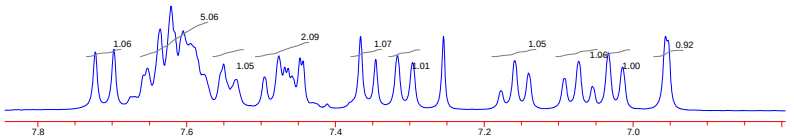
($CDCl_3$, 100 M)

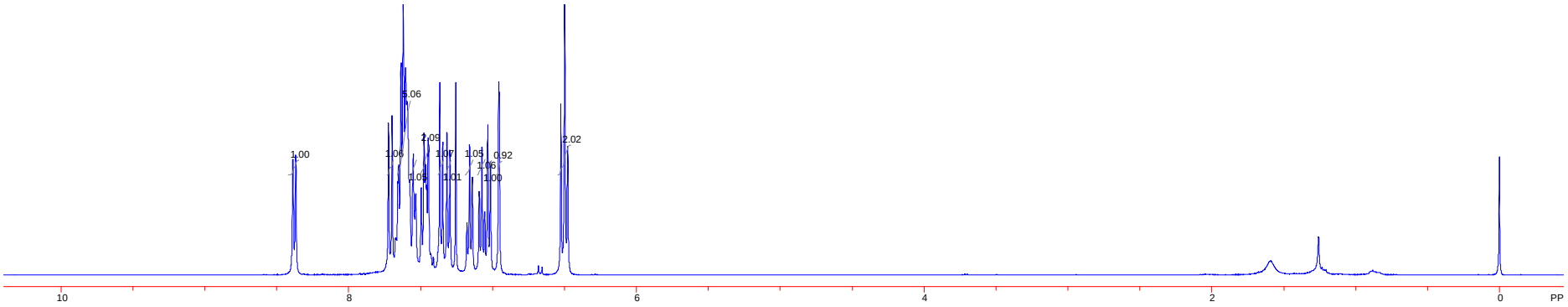


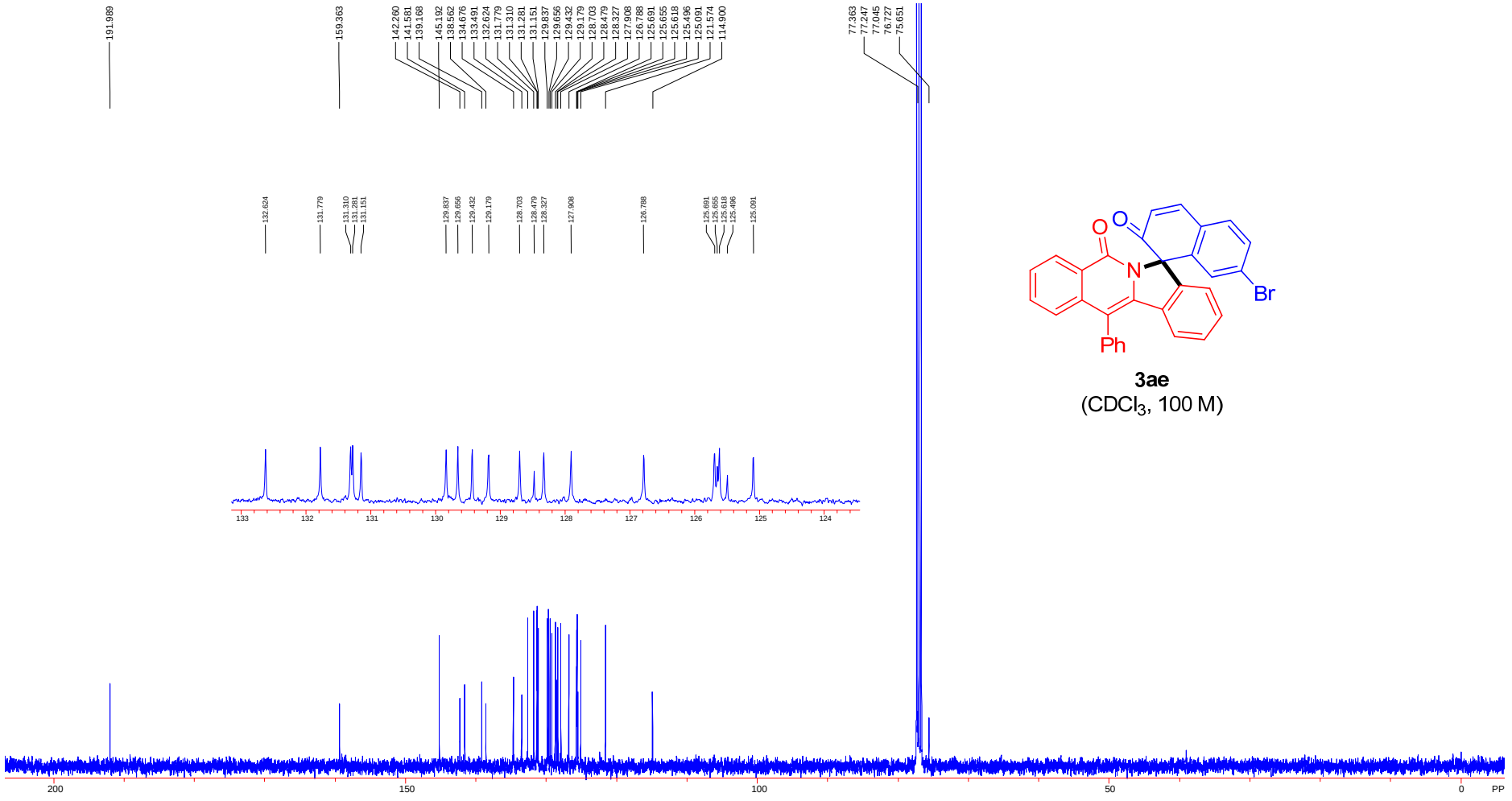




3ae
($CDCl_3$, 400 M)



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141.581
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145.192
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134.676
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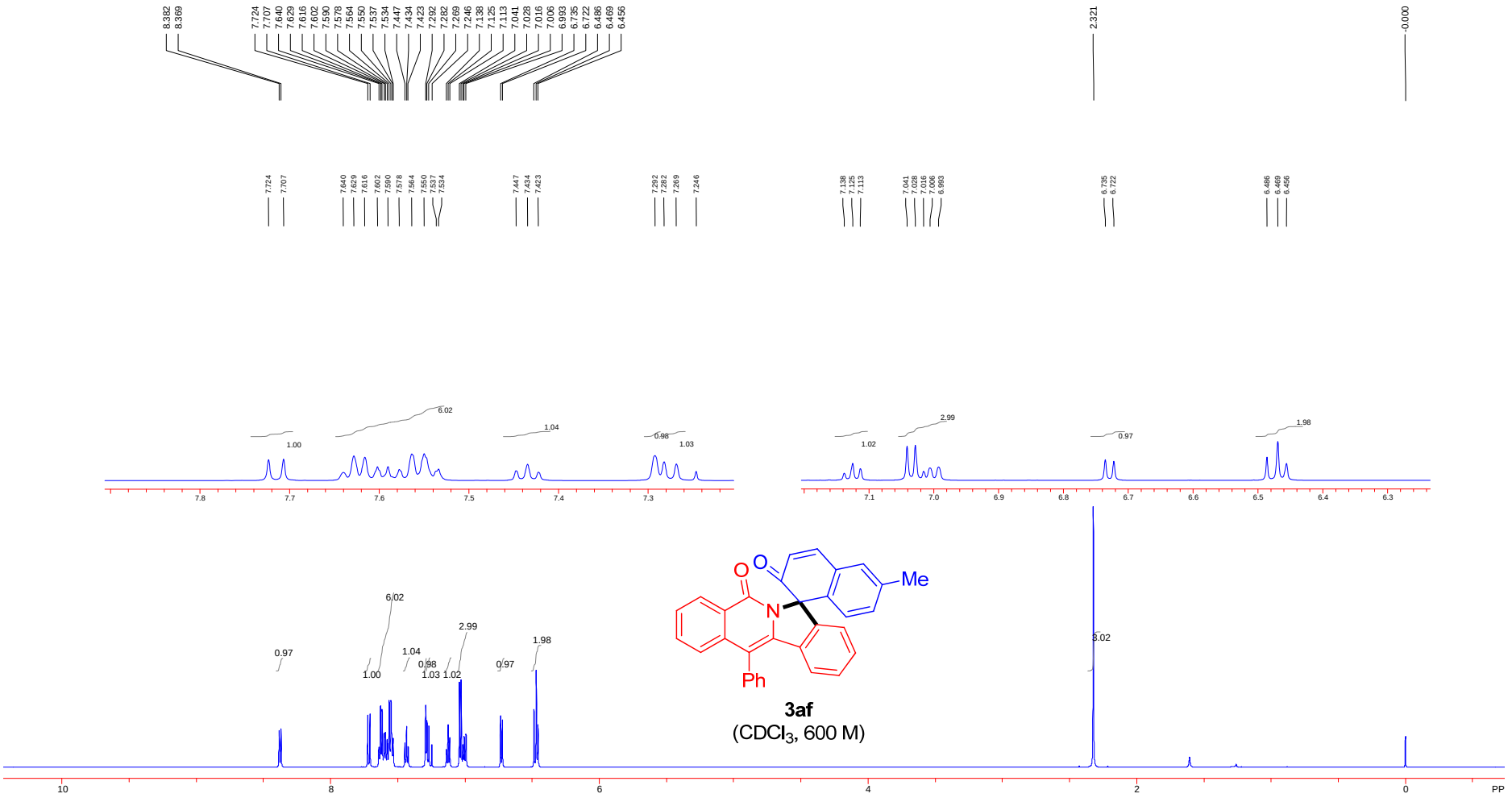
132.624
131.779
131.310
131.281
131.151
129.837
129.656
129.432
129.179
128.703
128.479
128.327
127.908
126.788
125.691
125.655
125.618
125.496
125.091
121.574
114.900
77.363
77.247
77.045
76.727
75.651
O
O
N
Br
Ph
3ae
(CDCl3, 100 M)
200
150
100
50
0
PP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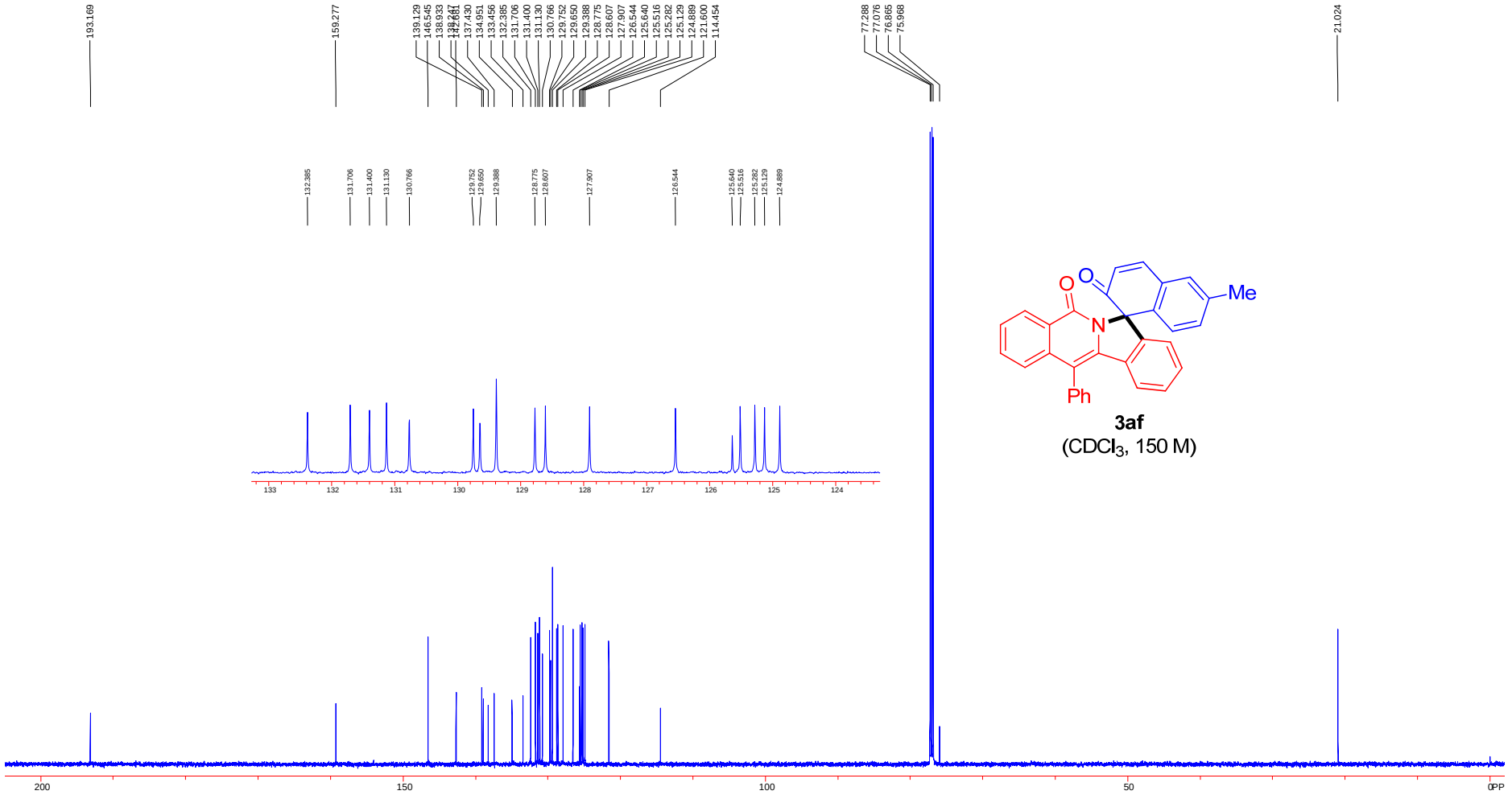
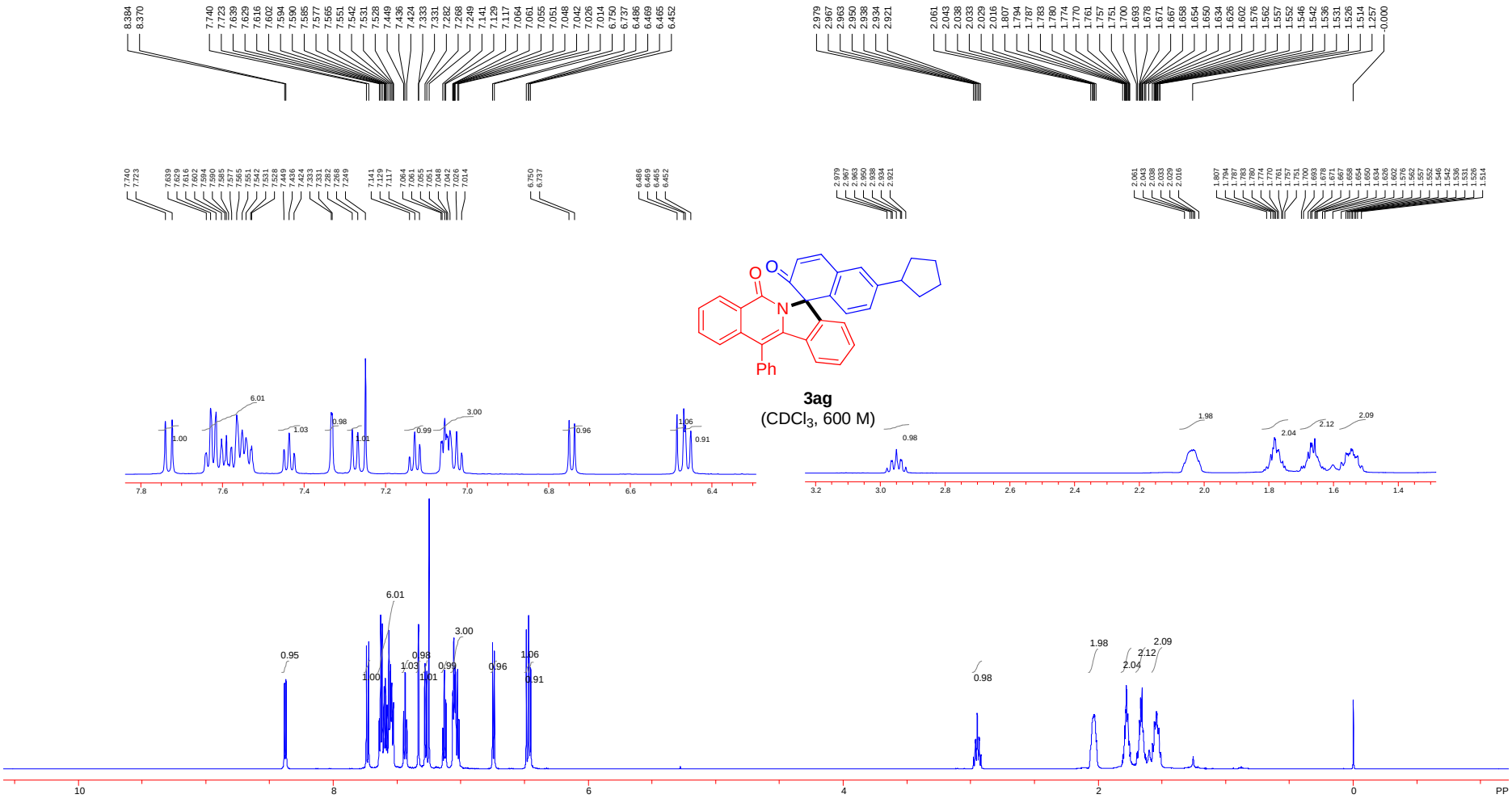
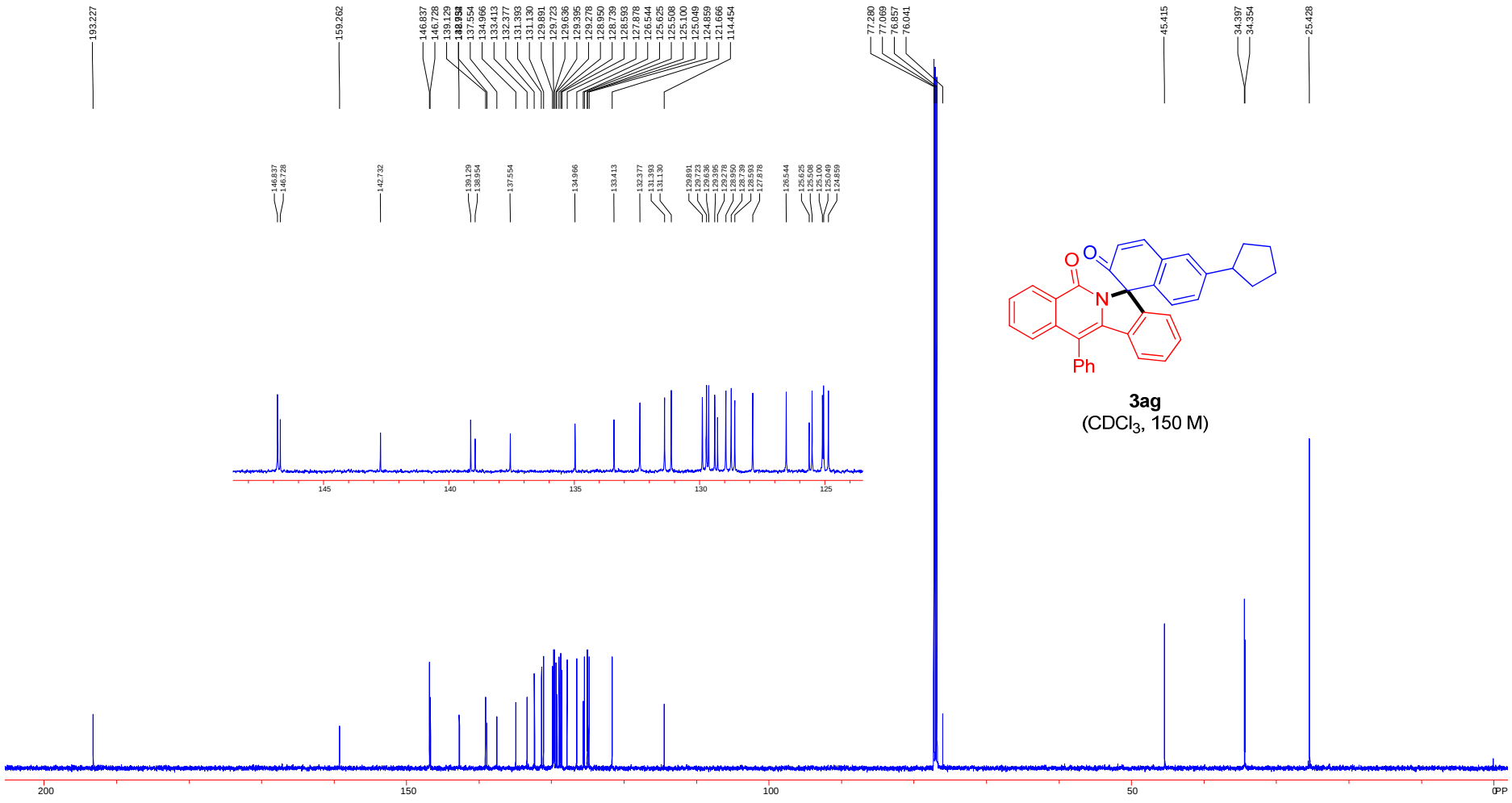
7.616
7.602
7.590
7.578
7.564
7.550
7.537
7.534
7.447
7.434
7.423
7.292
7.282
7.269
7.246
7.138
7.125
7.113
7.041
7.028
7.016
7.006
6.993
6.735
6.722
6.486
6.469
6.456
2.321
0.000
1.00
6.02
1.04
0.98
1.03
1.02
2.99
0.97
1.98
3.02
O
O
N
Me
Ph
3af
(CDCl3, 600 M)
10
8
6
4
2
0
PP



3af

($CDCl_3$, 150 M)


3ag
(CDCl3, 600 M)
Ph
O
N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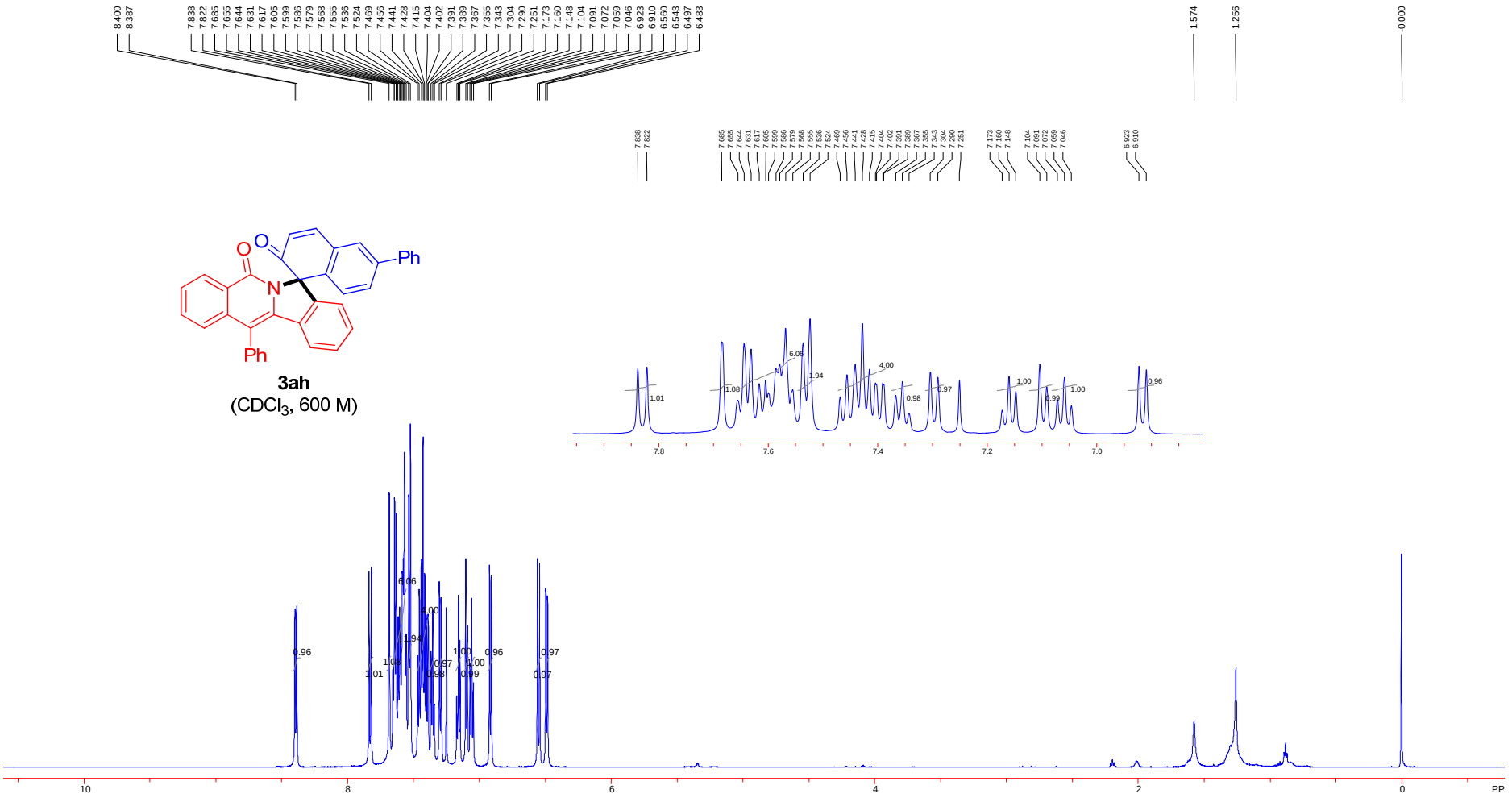
146.728
139.129
137.554
134.966
133.413
132.377
131.393
131.130
129.891
129.723
129.636
129.395
129.278
128.950
128.739
128.593
127.878
126.544
125.625
125.508
125.100
125.049
124.859
121.666
114.454
77.280
77.069
76.857
76.041
45.415
34.397
34.354
25.428
O
O
N
Ph
3ag
(CDCl3, 150 M)
200
150
100
50
0
PP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7.631
7.617
7.605
7.599
7.586
7.579
7.568
7.555
7.536
7.524
7.469
7.456
7.441
7.428
7.415
7.404
7.402
7.391
7.389
7.367
7.355
7.343
7.304
7.290
7.251
7.173
7.160
7.148
7.104
7.091
7.072
7.059
7.046
6.923
6.910
6.560
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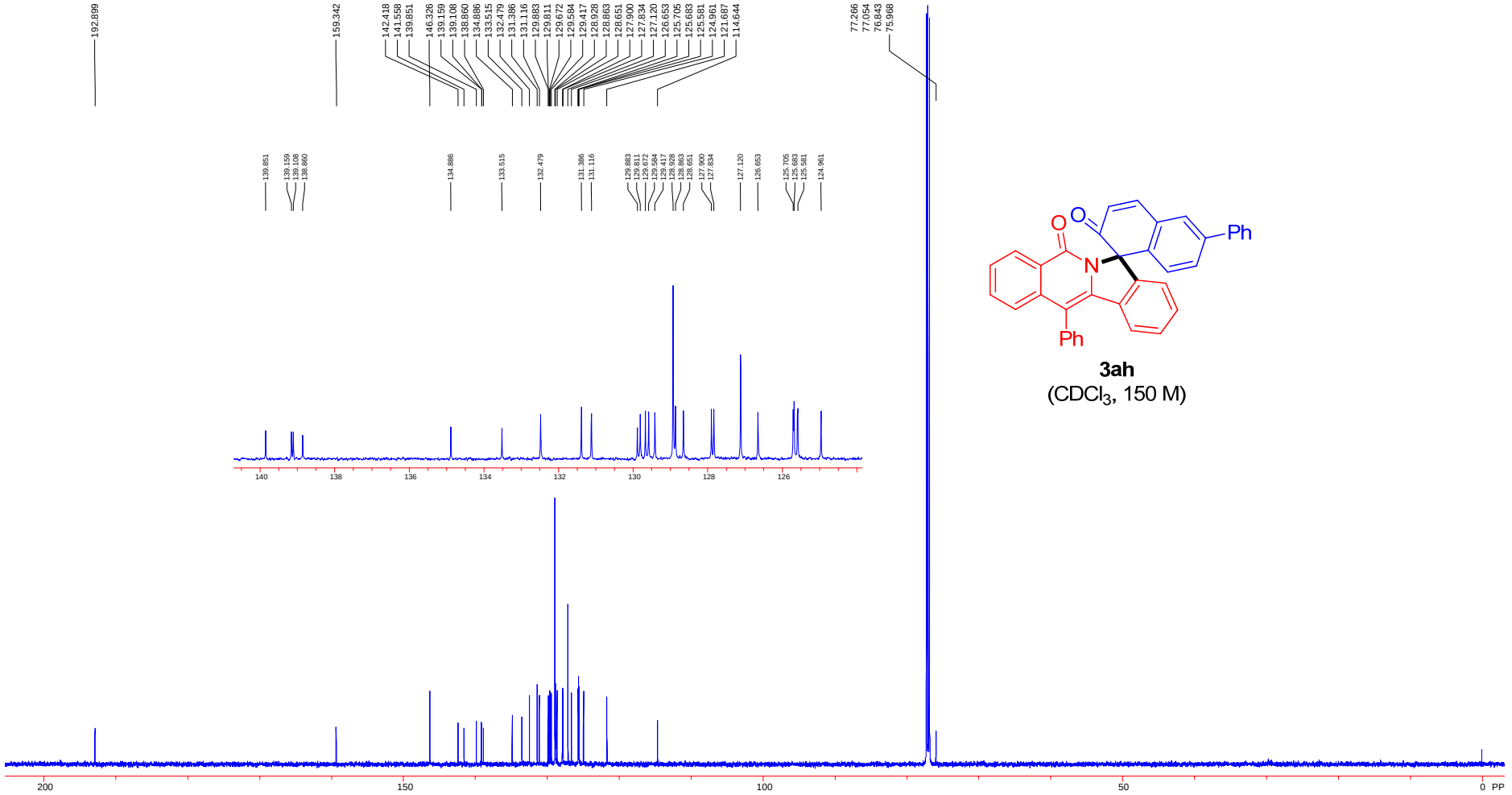
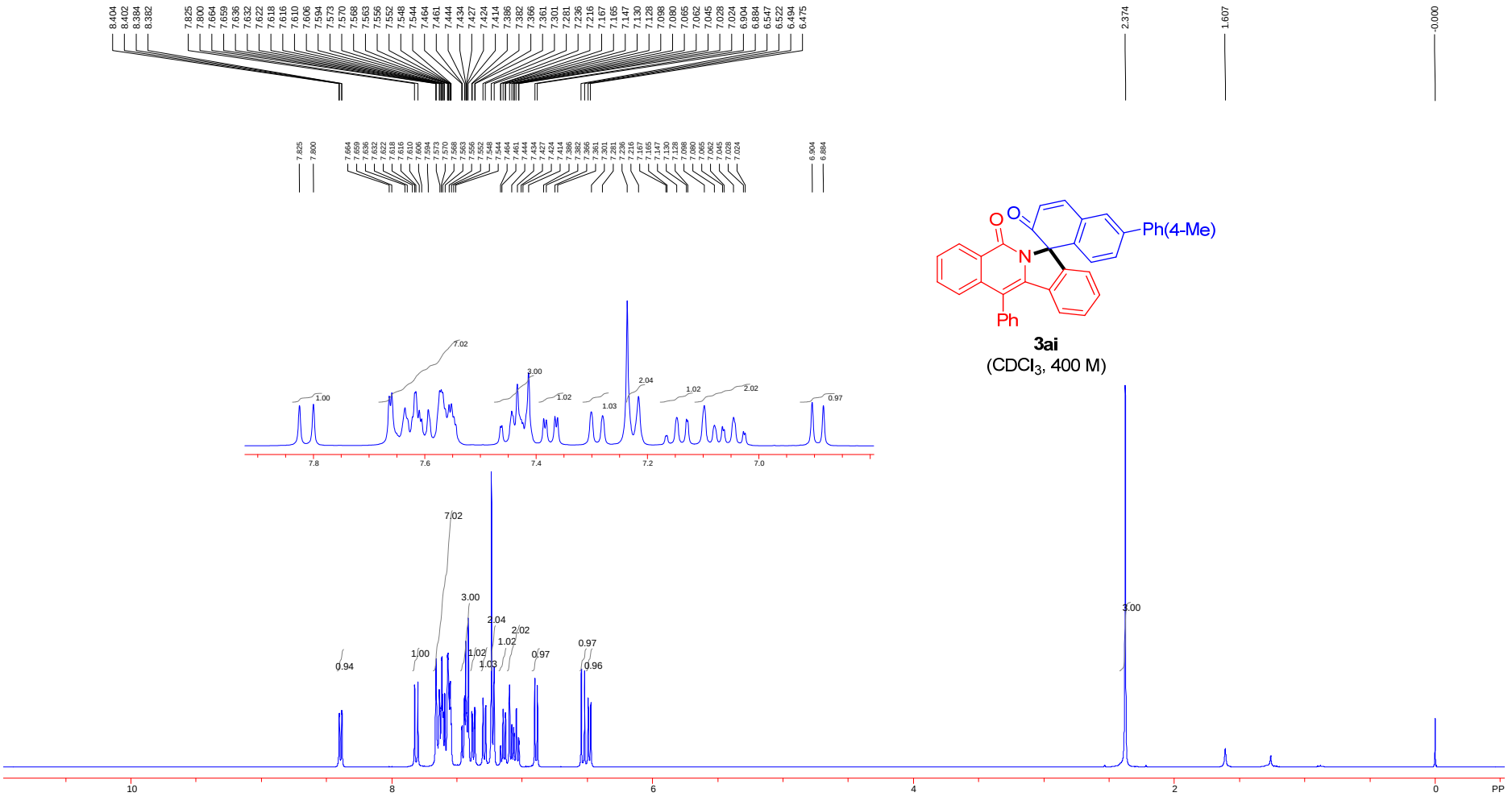
6.497
6.483
1.574
1.256
-0.000
O
O
N
Ph
Ph
3ah
(CDCl3, 600 M)
0.96
1.01
1.08
6.06
1.94
4.00
0.98
0.97
1.00
0.99
1.00
0.96
0.97
10
8
6
4
2
0
PP



3ah
($CDCl_3$, 150 M)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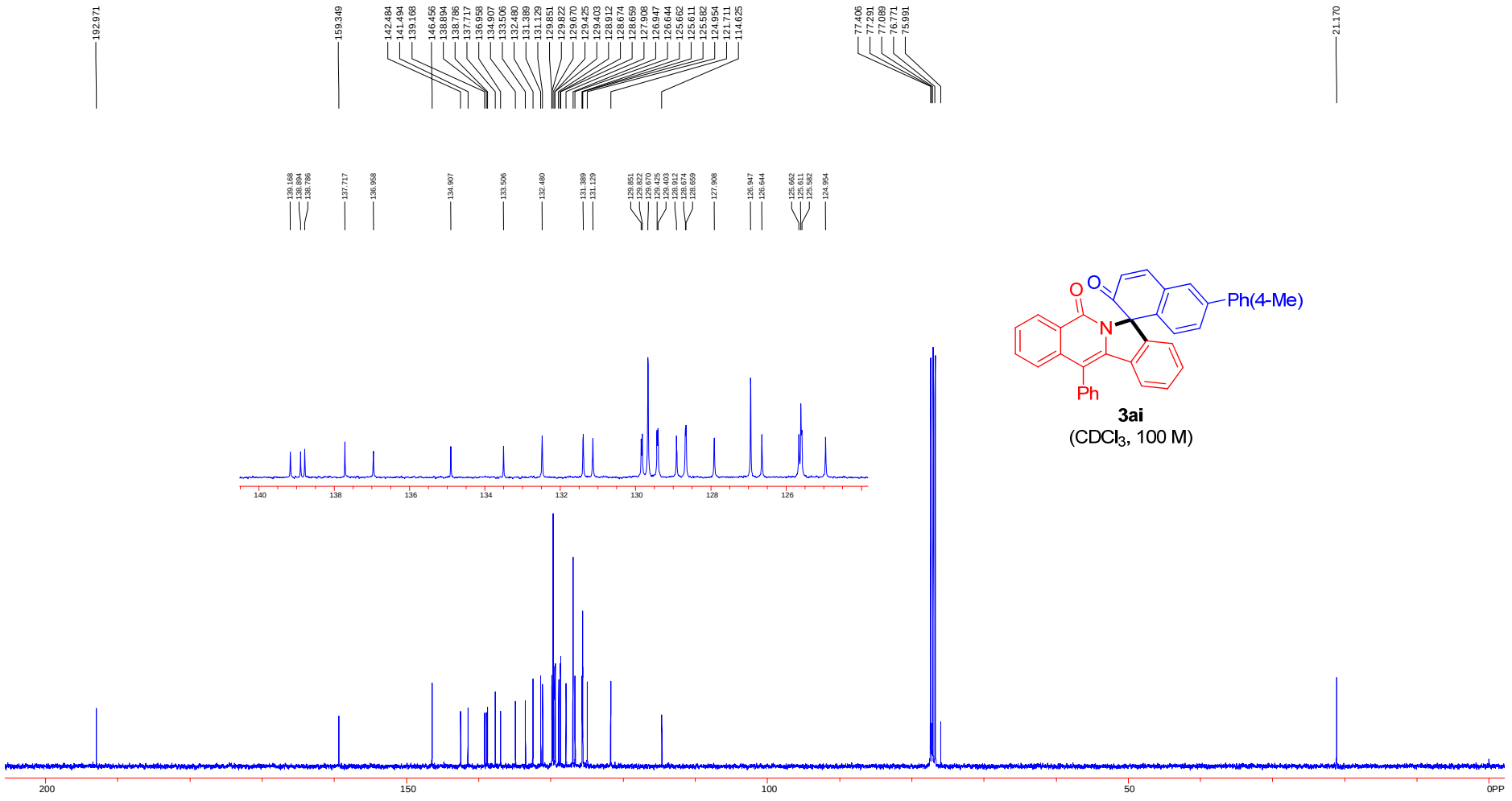
2.374 1.607 -0.000
O O N Ph(4-Me) Ph
3ai
(CDCl3, 400 M)
1.00 7.02 3.00 1.02 1.03 2.04 1.02 2.02 0.97
0.94 1.00 7.02 1.02 1.03 3.00 2.04 2.02 1.02 0.97 0.97 0.96 3.00
10 8 6 4 2 0 PP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127.908
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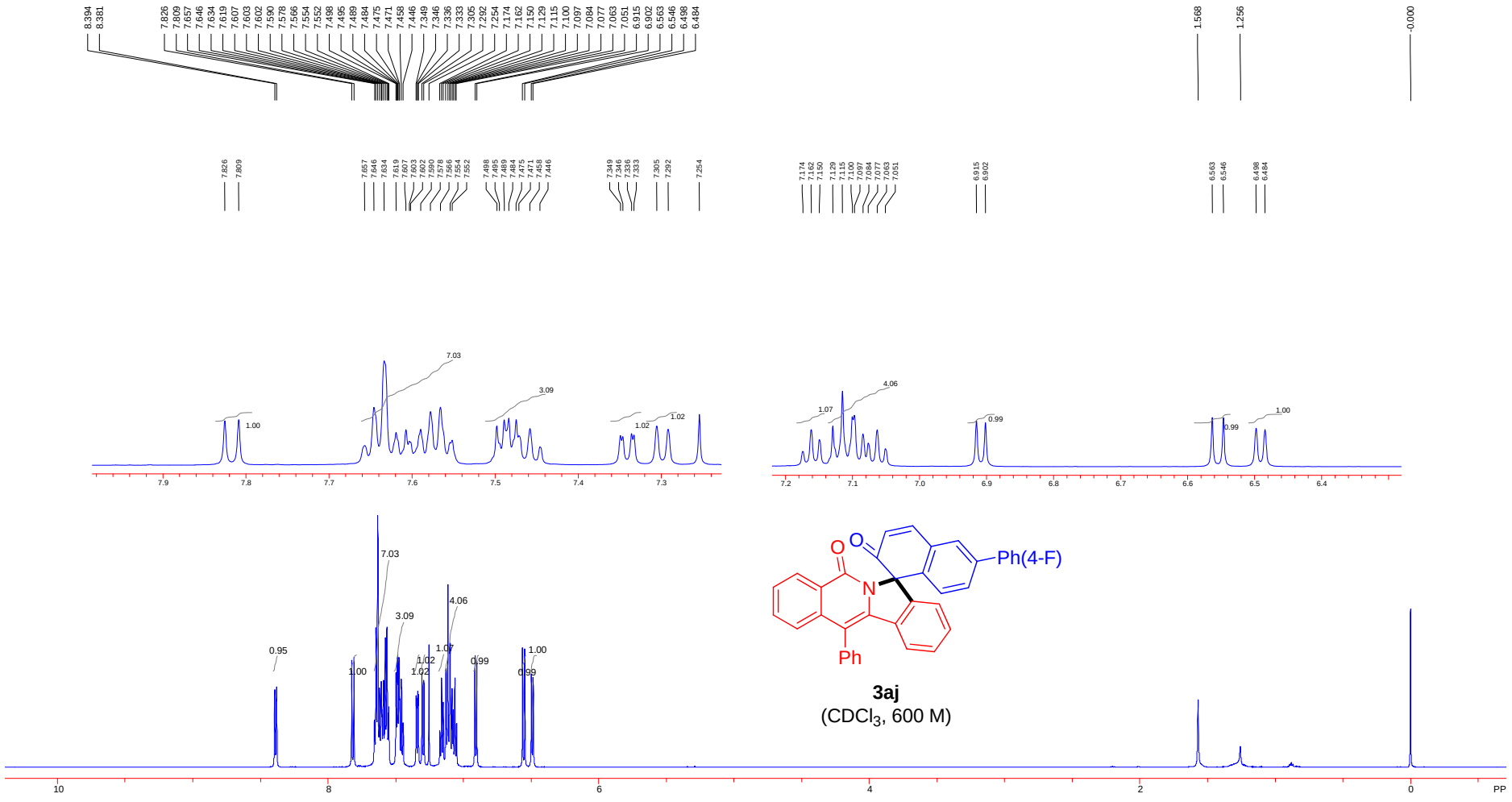
126.644
125.662
125.611
125.582
124.954
121.711
114.625
77.406
77.291
77.089
76.771
75.991
21.170
O
O
N
Ph(4-Me)
Ph
3ai
(CDCl3, 100 M)
200
150
100
50
0PP
140
138
136
134
132
130
128
126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7.602
7.590
7.578
7.566
7.554
7.552
7.498
7.495
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7.305
7.292
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7.150
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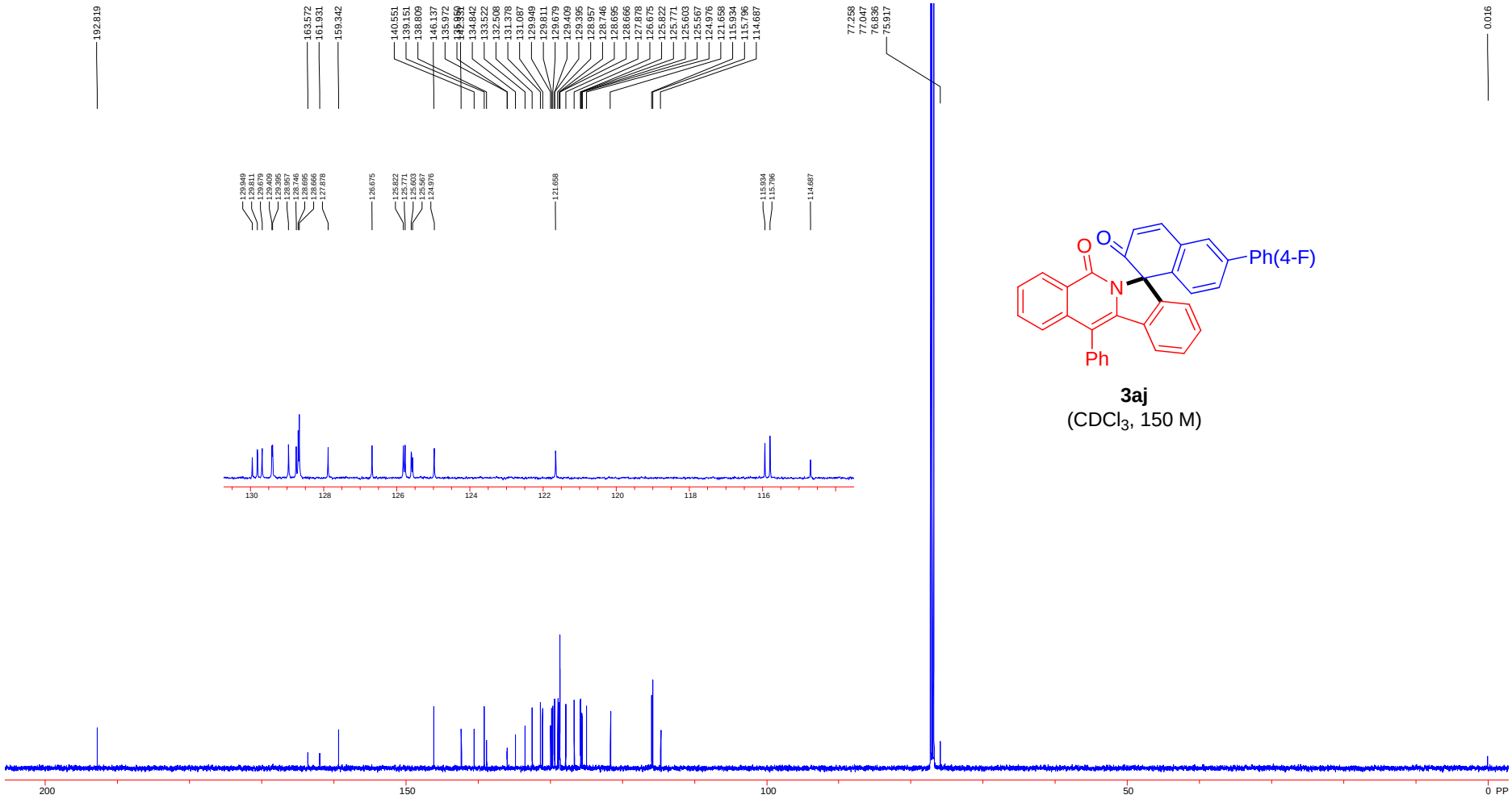
7.100
7.097
7.084
7.077
7.063
7.051
6.915
6.902
6.563
6.546
6.498
6.484
1.568
1.256
0.000
7.03
3.09
1.00
1.02
1.02
4.06
1.07
0.99
0.99
1.00
0.95
1.00
1.02
1.02
7.03
3.09
4.06
1.07
0.99
0.99
1.00
O
O
N
Ph
Ph(4-F)
3aj
(CDCl3, 600 M)
PP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132.508
131.378
131.087
129.949
129.811
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129.409
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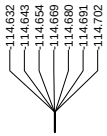
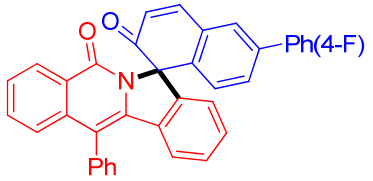
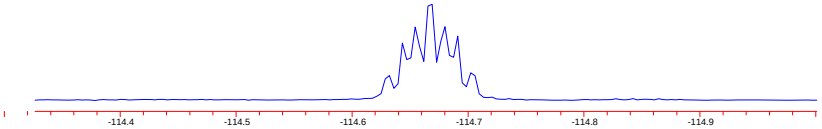
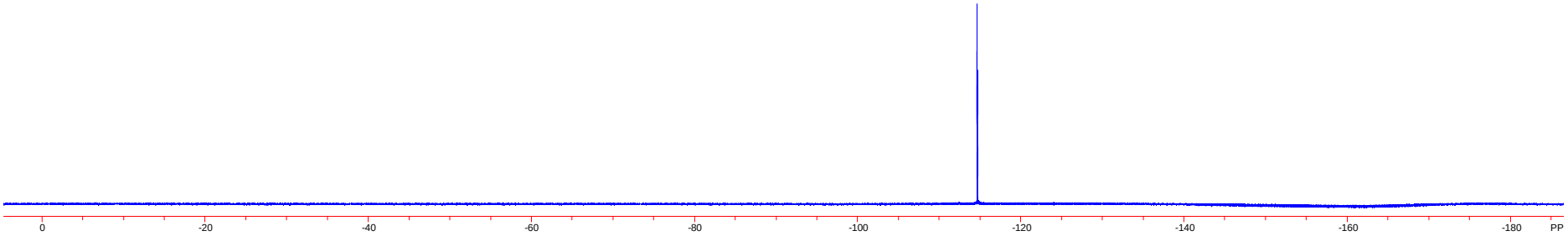
128.957
128.746
128.695
128.666
127.878
126.675
125.822
125.771
125.603
125.567
124.976
121.658
115.934
115.796
114.687
77.258
77.047
76.836
75.917
0.016
O
O
N
Ph(4-F)
Ph
3aj
(CDCl3, 150 M)
200
150
100
50
0 PP

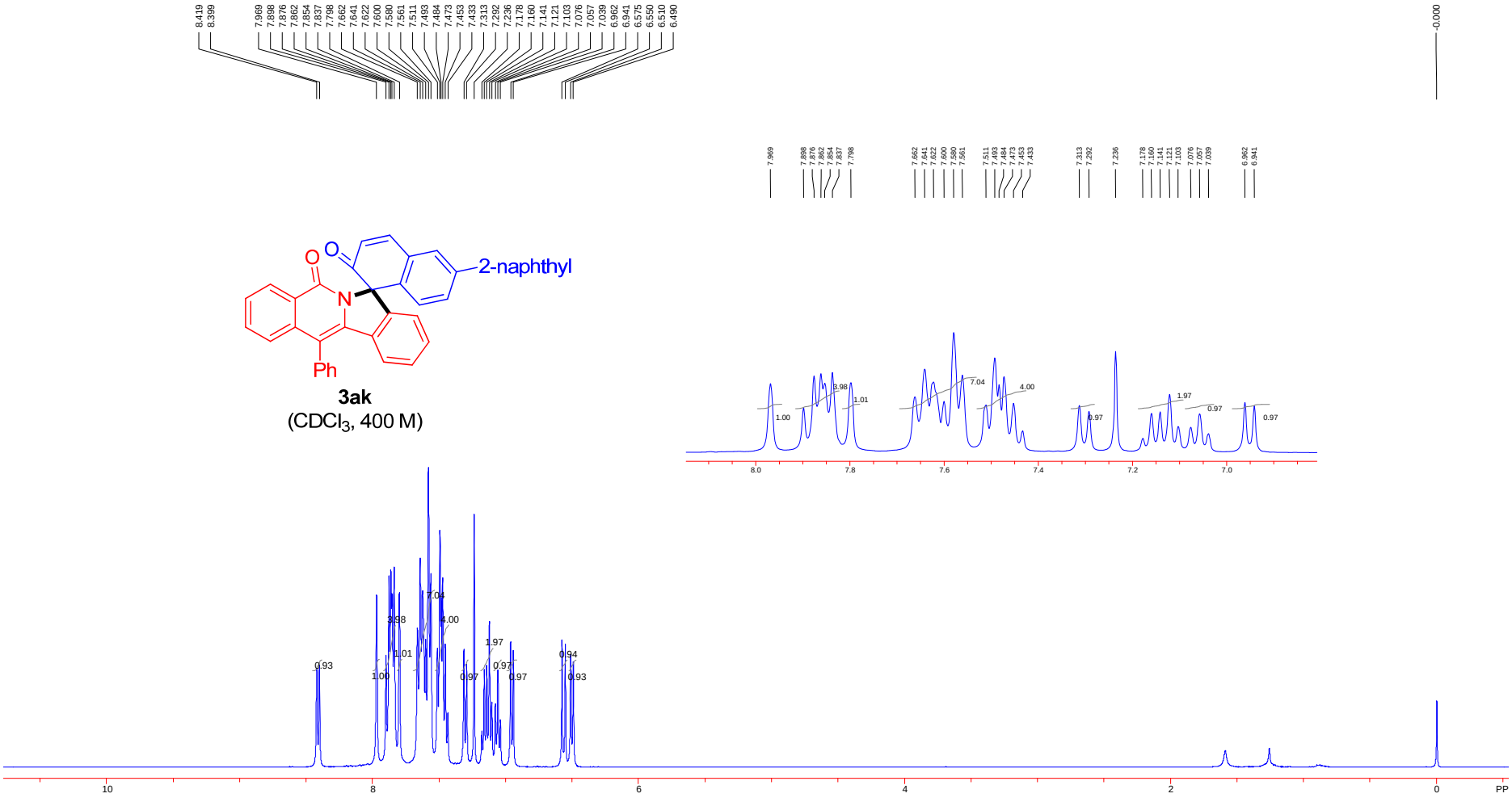




3aj
($CDCl_3$, 376 M)



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7.580
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7.433
7.313
7.292
7.236
7.178
7.160
7.141
7.121
7.103
7.076
7.057
7.039
6.962
6.941
6.575
6.550
6.510
6.490
-0.000
O
O
N
2-naphthyl
Ph
3ak
(CDCl3, 400 M)
1.00
3.98
1.01
7.04
4.00
0.97
1.97
0.97
0.97
0.93
1.00
3.98
1.01
7.04
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1.97
0.97
0.97
0.94
0.93
10
8
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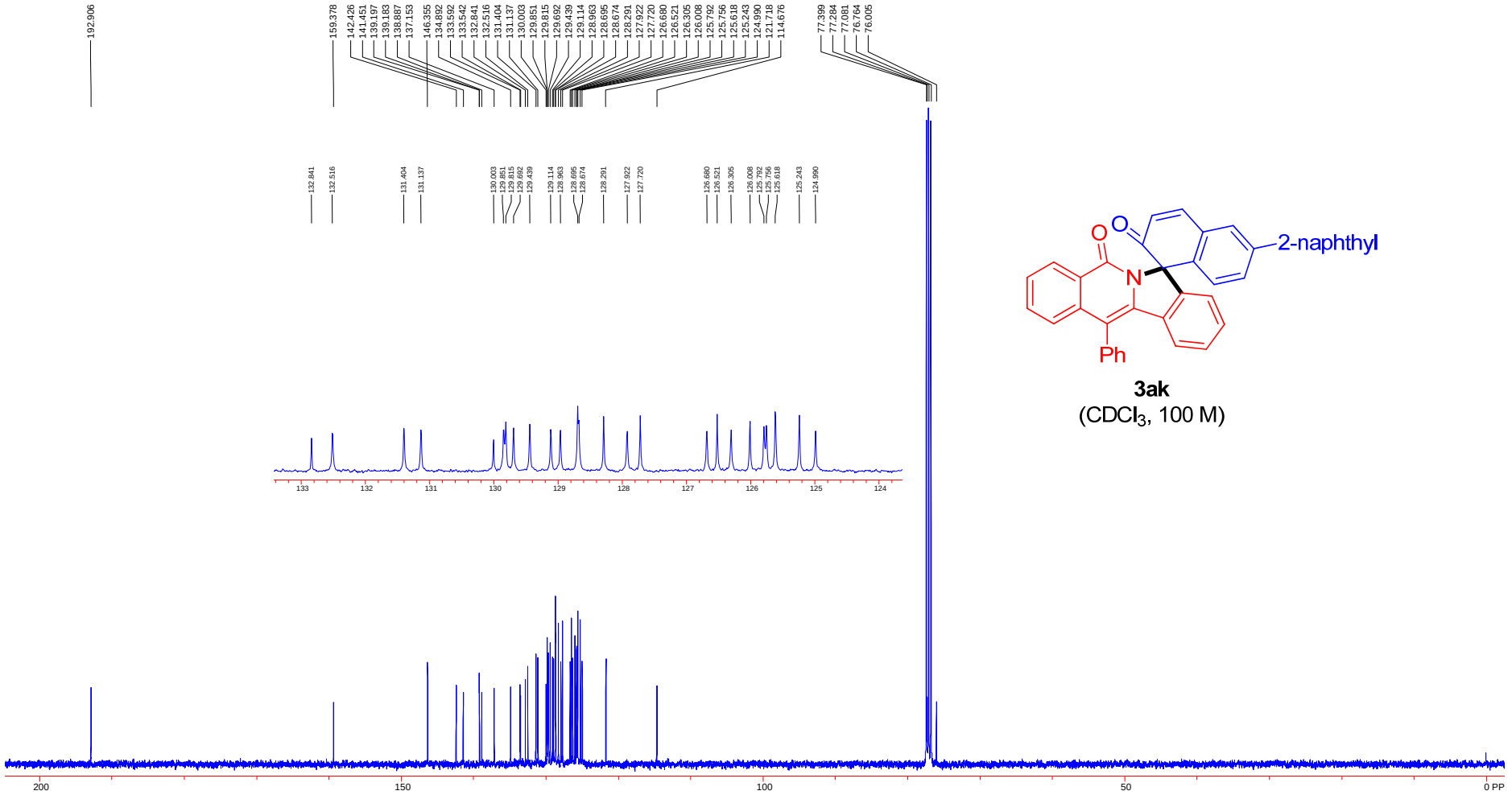
4
2
0
PP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131.404
131.137
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128.674
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126.305
126.008
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125.756
125.618
125.243
124.990
121.718
114.676
77.399
77.284
77.081
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76.005
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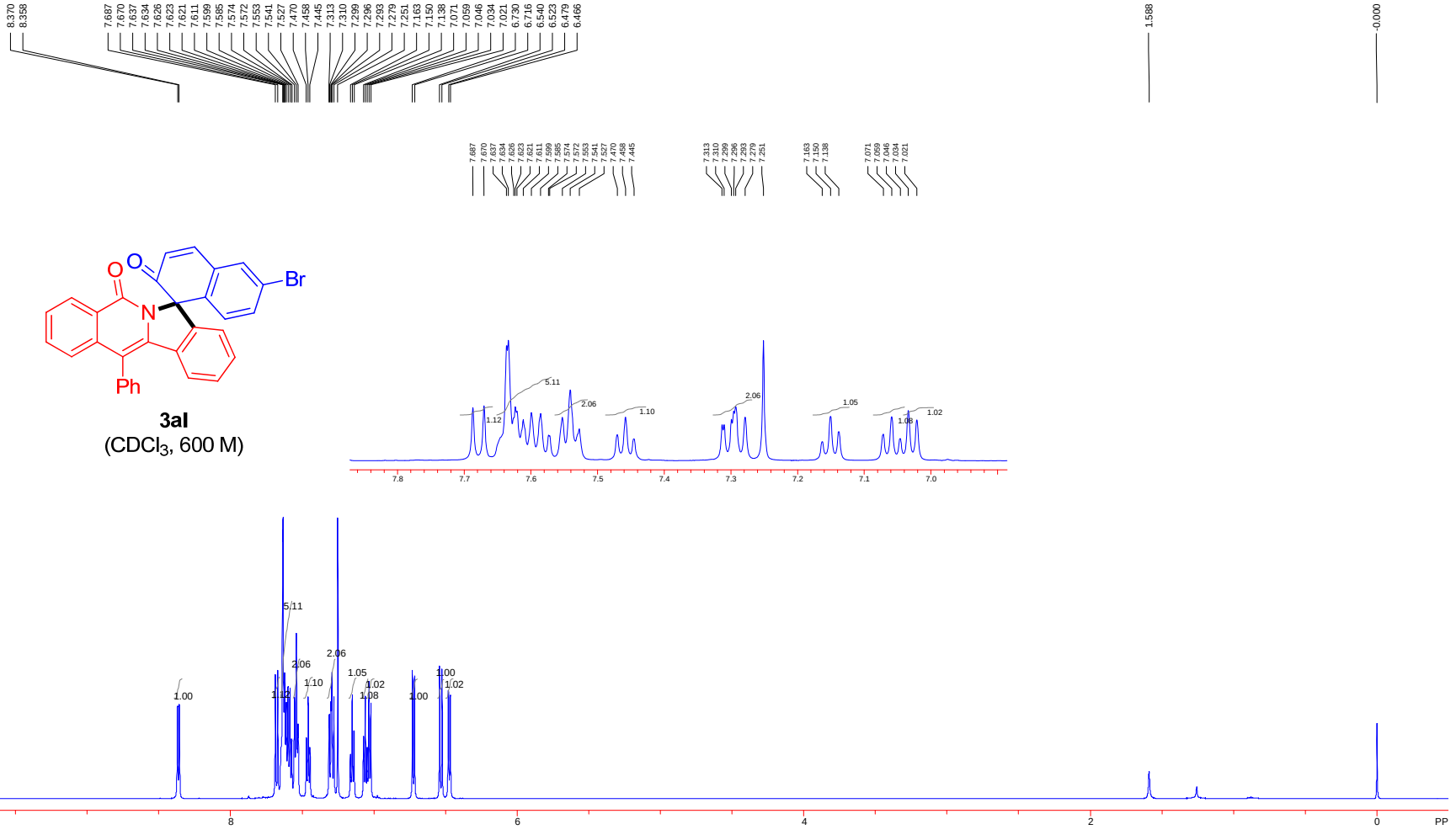
O
N
Ph
2-naphthyl
3ak
(CDCl3, 100 M)
200
150
100
50
0 PPM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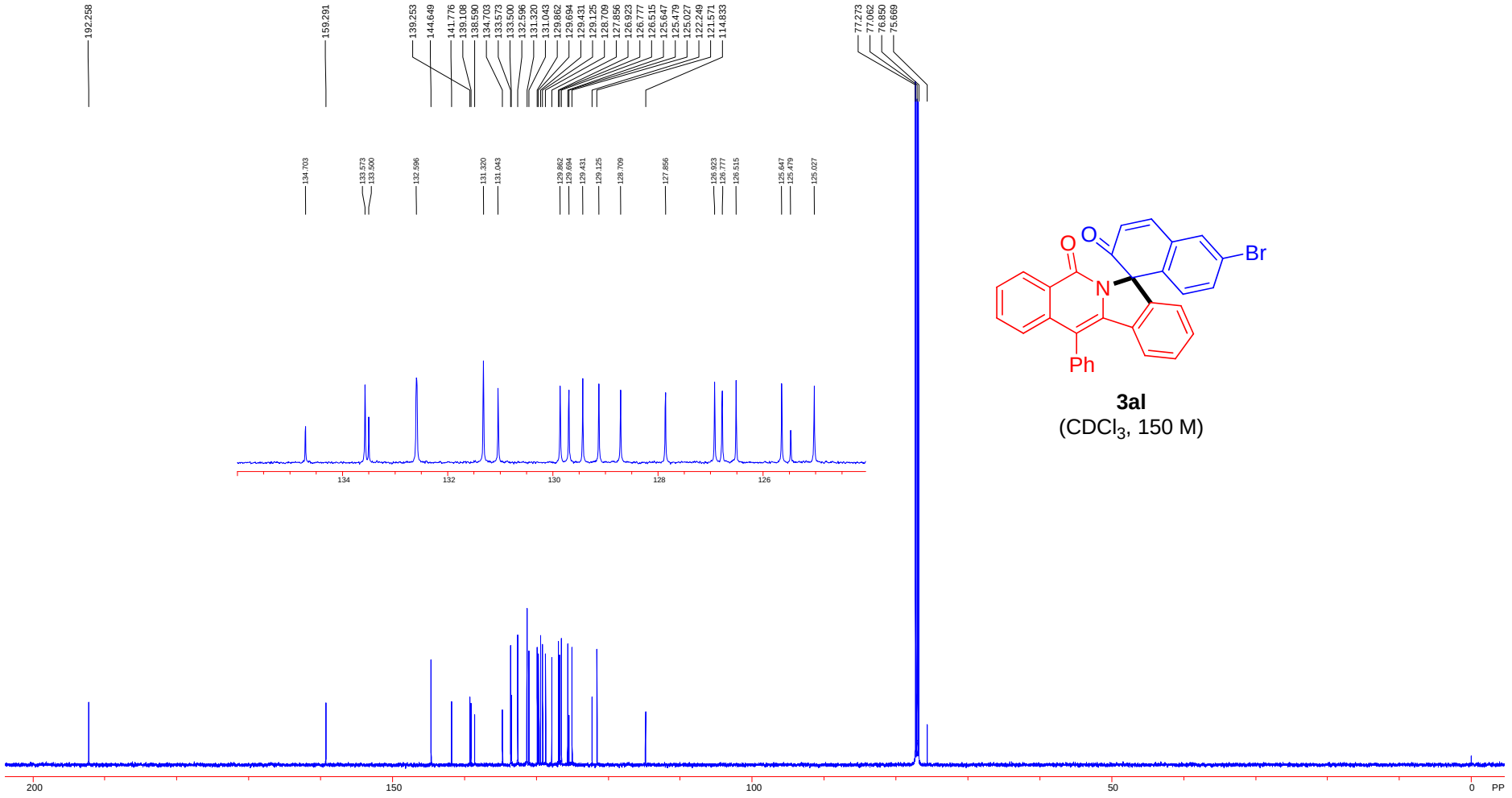
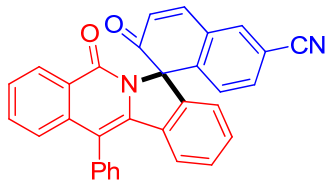
7.599
7.585
7.574
7.572
7.553
7.541
7.527
7.470
7.458
7.445
7.313
7.310
7.299
7.296
7.293
7.279
7.251
7.163
7.150
7.138
7.071
7.059
7.046
7.034
7.021
6.730
6.716
6.540
6.523
6.479
6.466
1.588
0.000
O
O
N
Br
Ph
3aI
(CDCl3, 600 M)
5.11
2.06
1.10
1.12
2.06
1.05
1.08
1.02
1.00
10
8
6
4
2
0
PP



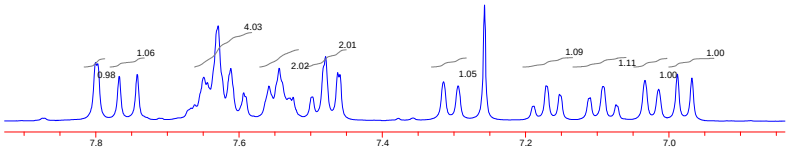
3al

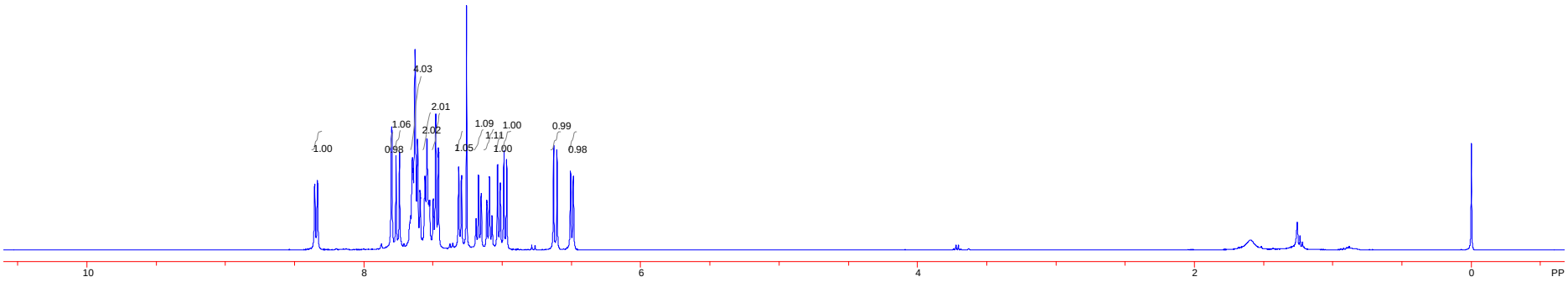
($CDCl_3$, 150 M)

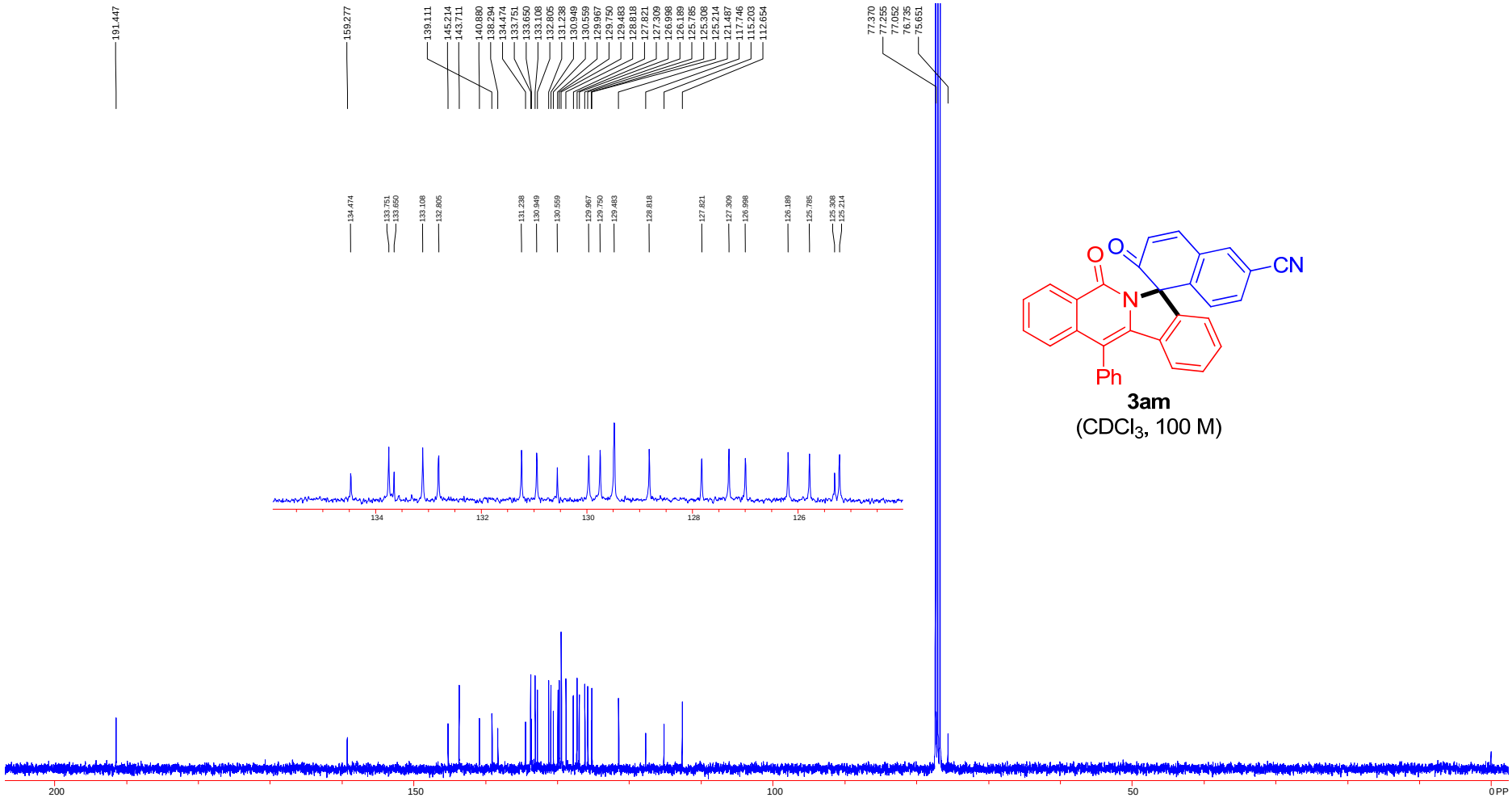


3am

($CDCl_3$, 400 M)

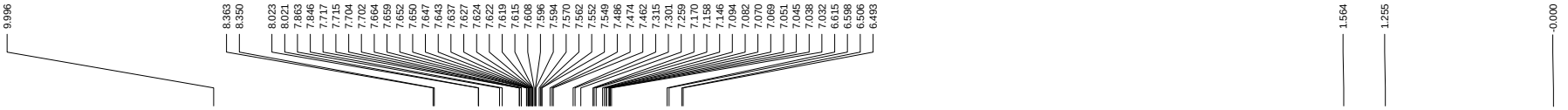


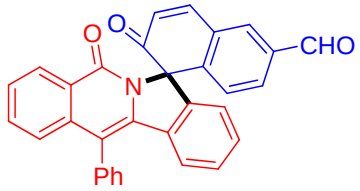




3am

($CDCl_3$, 100 M)





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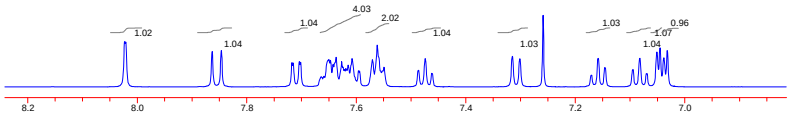
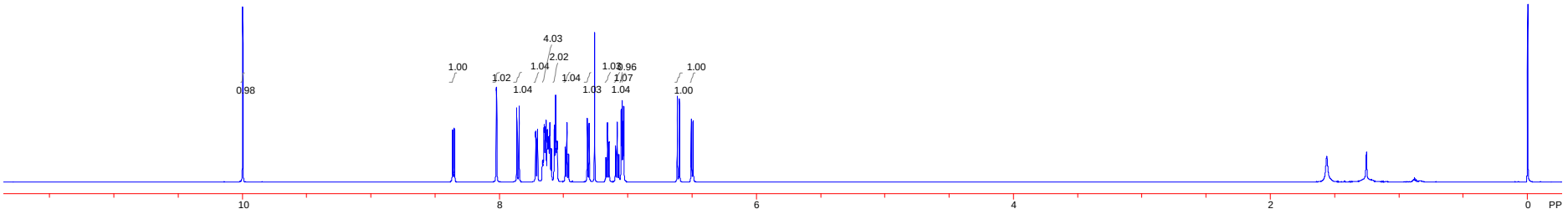
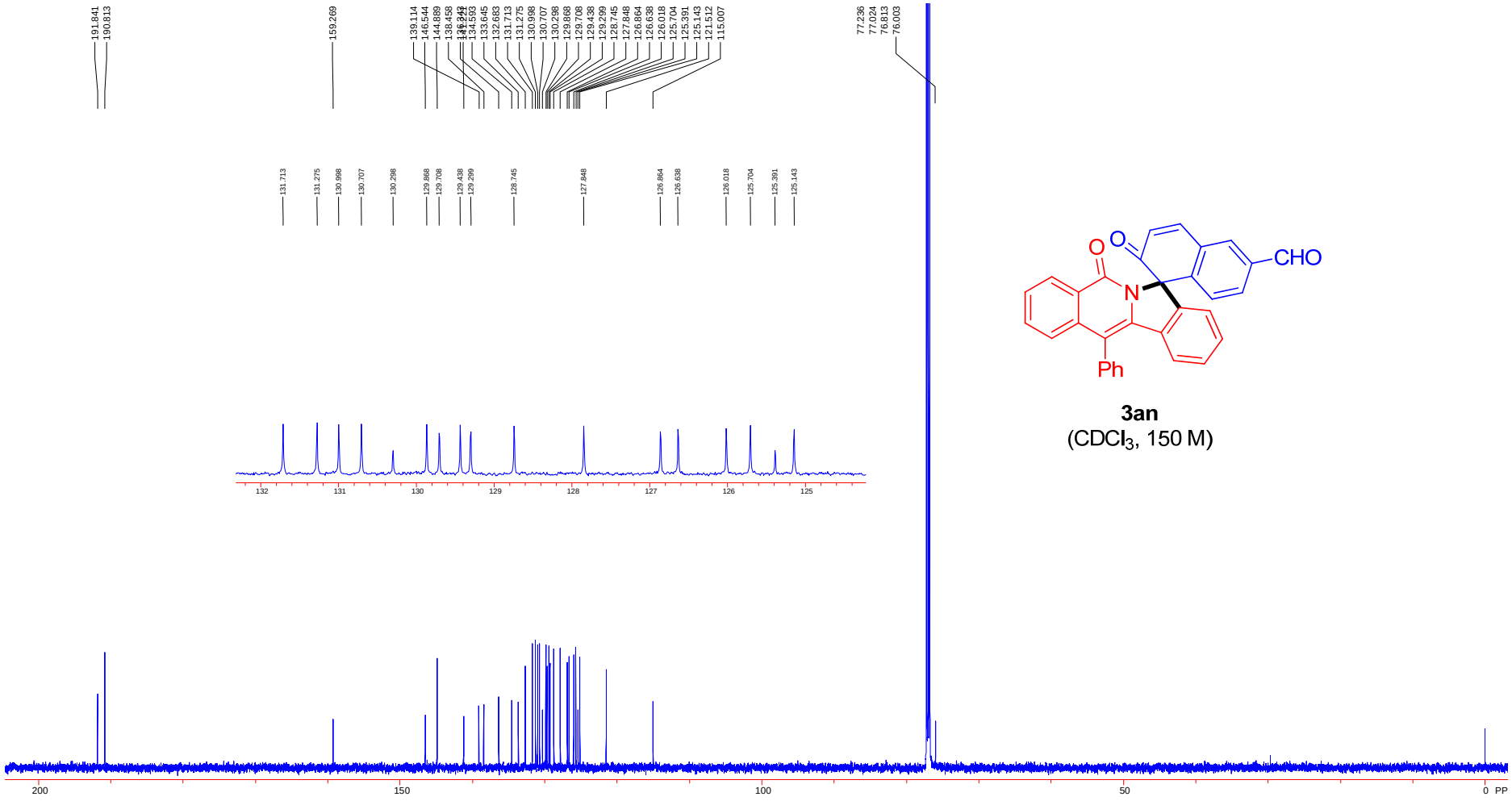
($CDCl_3$, 600 M)



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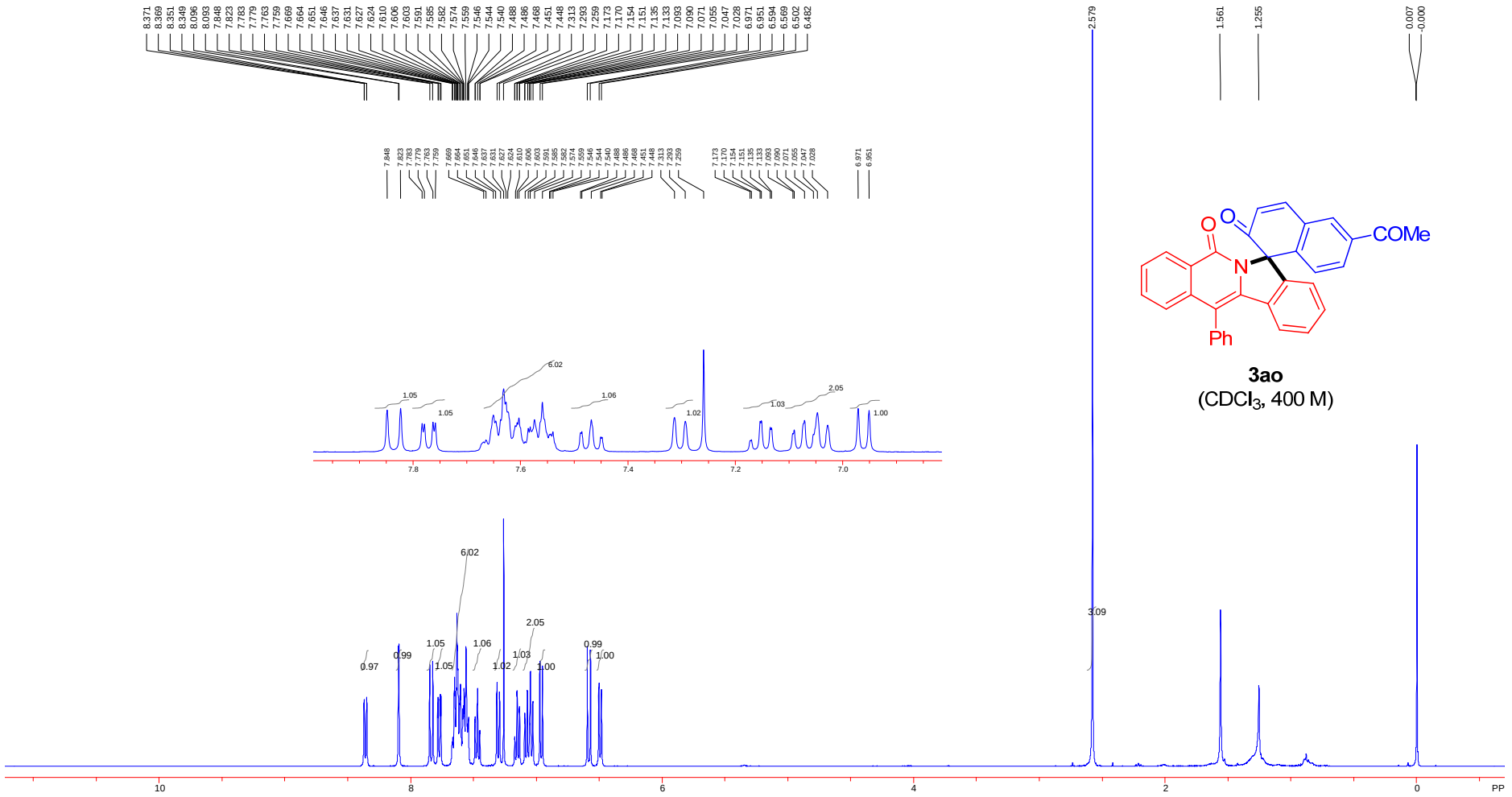
190.813
159.269
139.114
146.544
144.889
138.458
134.593
133.645
132.683
131.713
131.275
130.998
130.707
130.298
129.868
129.708
129.438
129.299
128.745
127.848
126.864
126.638
126.018
125.704
125.391
125.143
121.512
115.007
77.236
77.024
76.813
76.003
131.713
131.275
130.998
130.707
130.298
129.868
129.708
129.438
129.299
128.745
127.848
126.864
126.638
126.018
125.704
125.391
125.143
O
O
CHO
N
Ph
3an
(CDCl3, 150 M)
132
131
130
129
128
127
126
125
200
150
100
50
0 PP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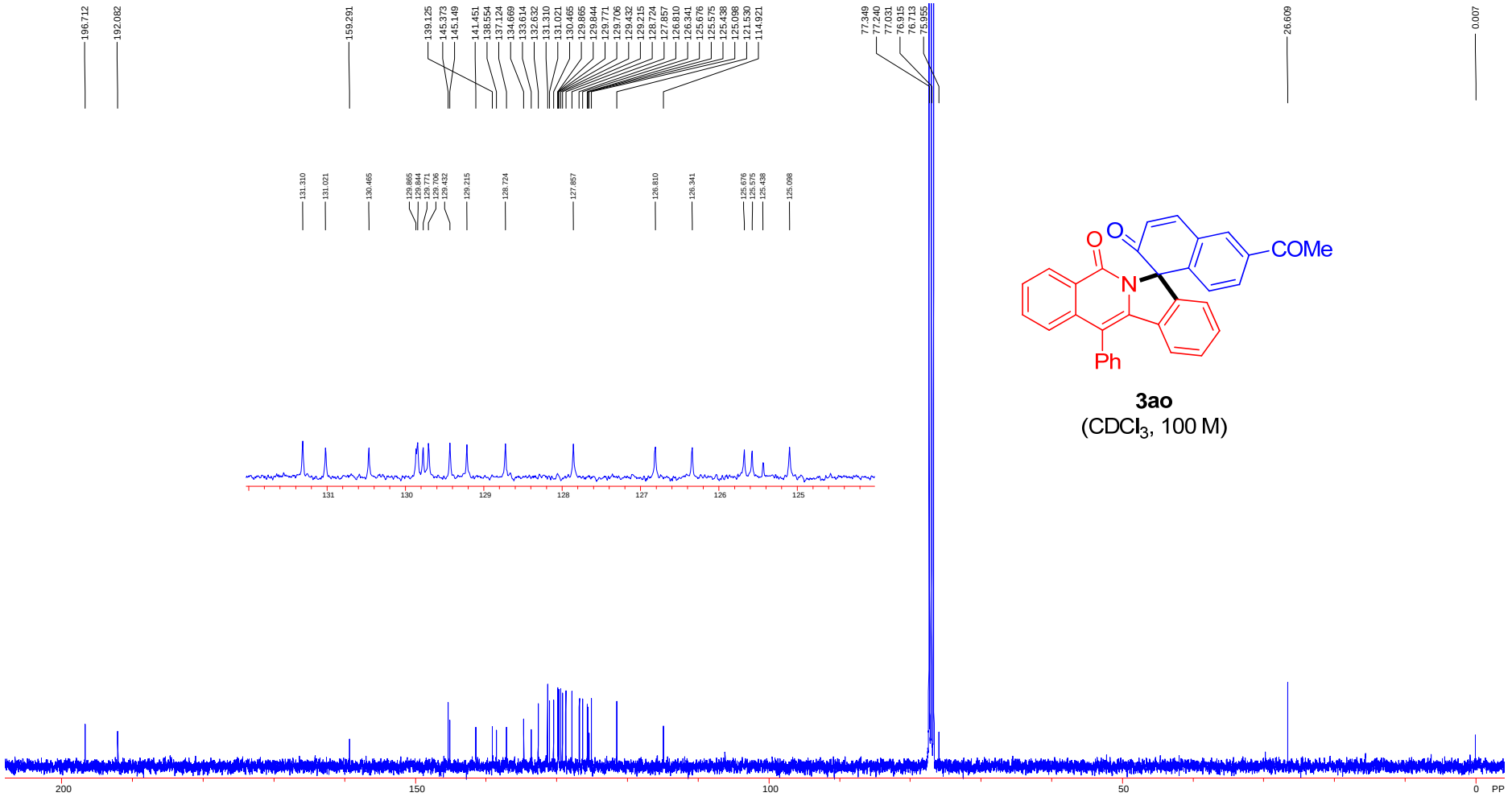
2.579
1.561
1.255
0.007
-0.000
O
O
N
COMe
Ph
3ao
(CDCl3, 400 M)
6.02
1.05
1.05
1.06
1.02
1.03
2.05
1.00
7.8
7.6
7.4
7.2
7.0
0.97
0.99
1.05
1.05
6.02
1.06
1.02
1.03
2.05
1.00
0.99
1.00
3.09
10
8
6
4
2
0
PP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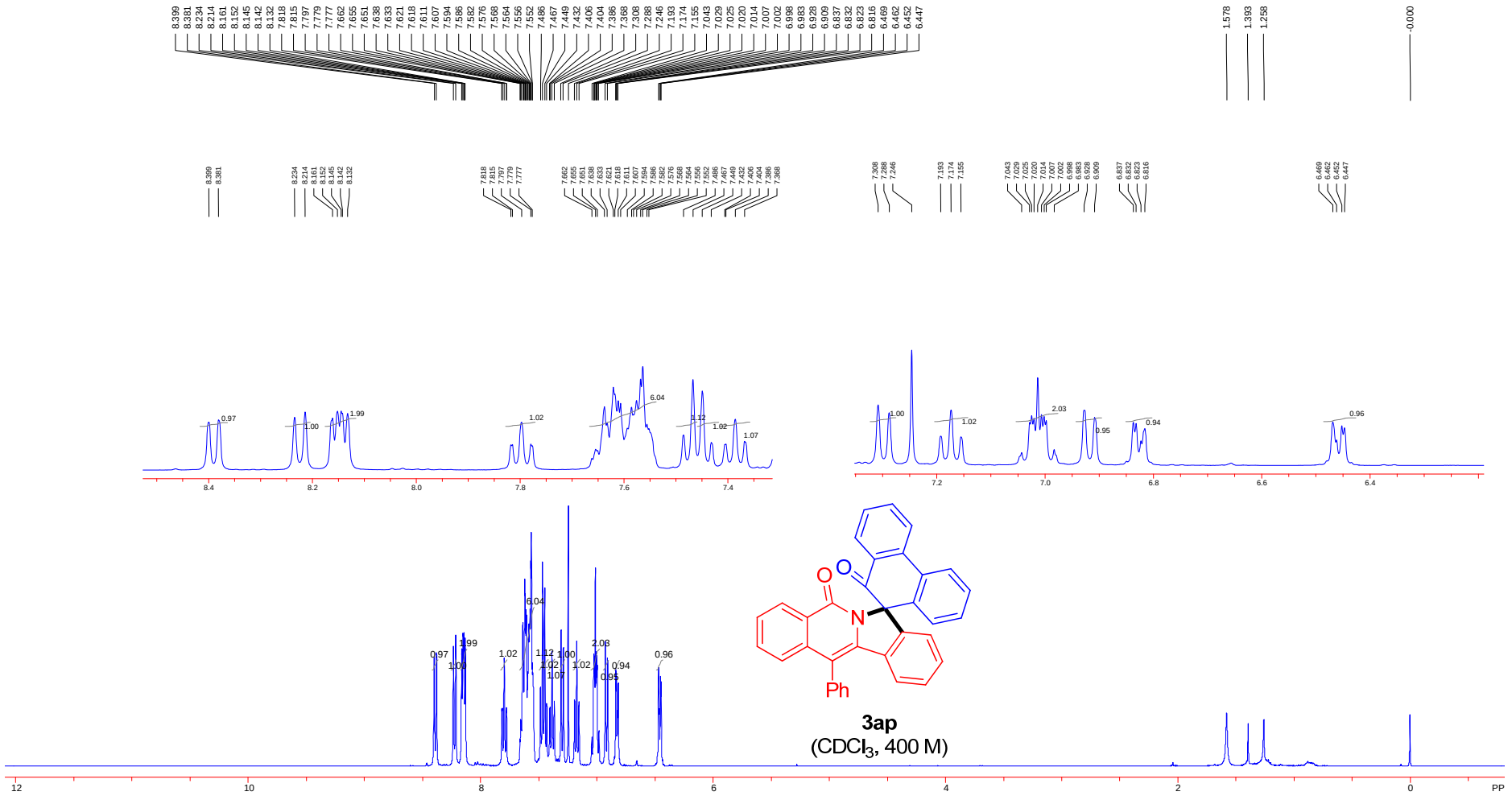
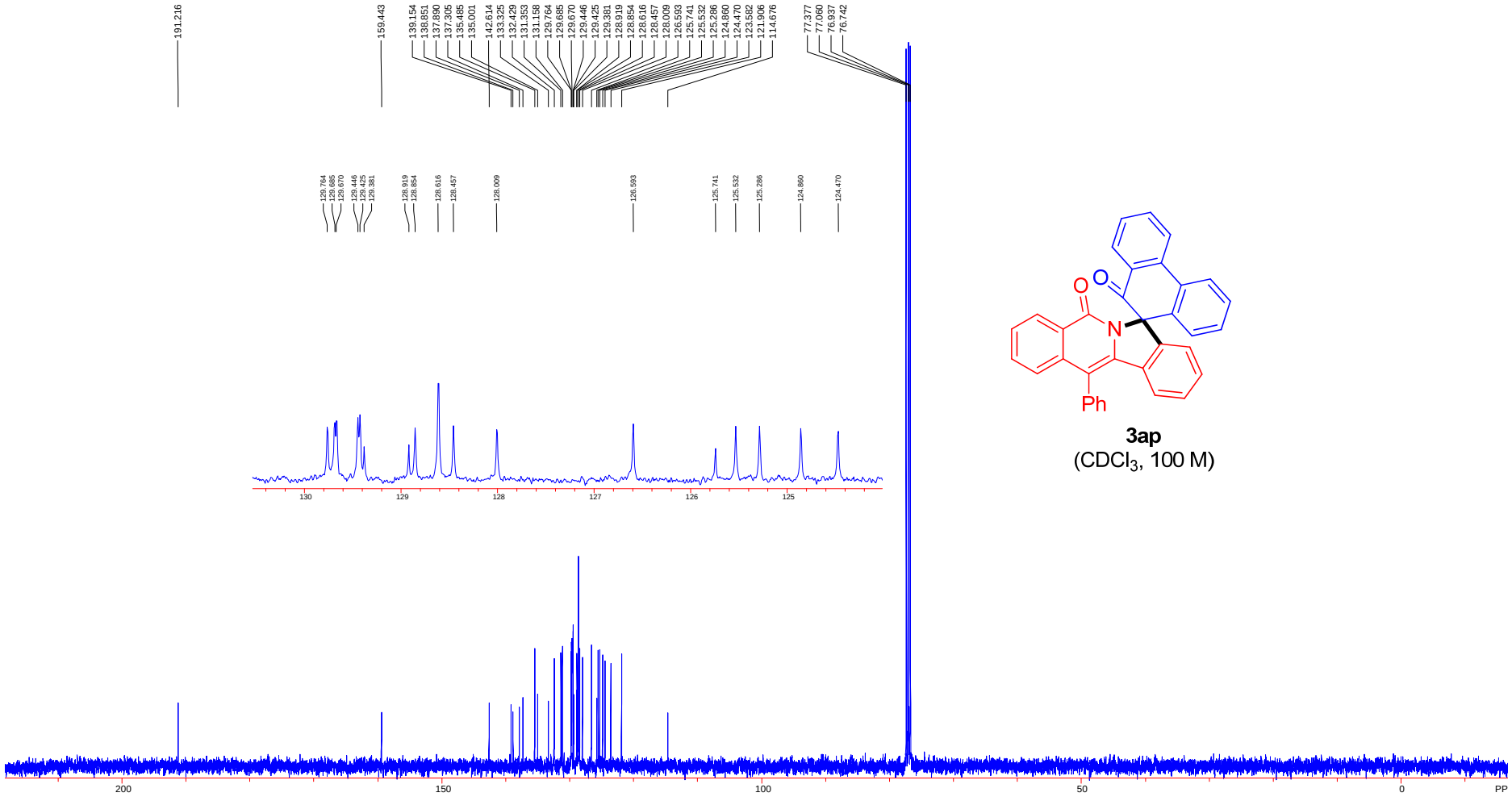
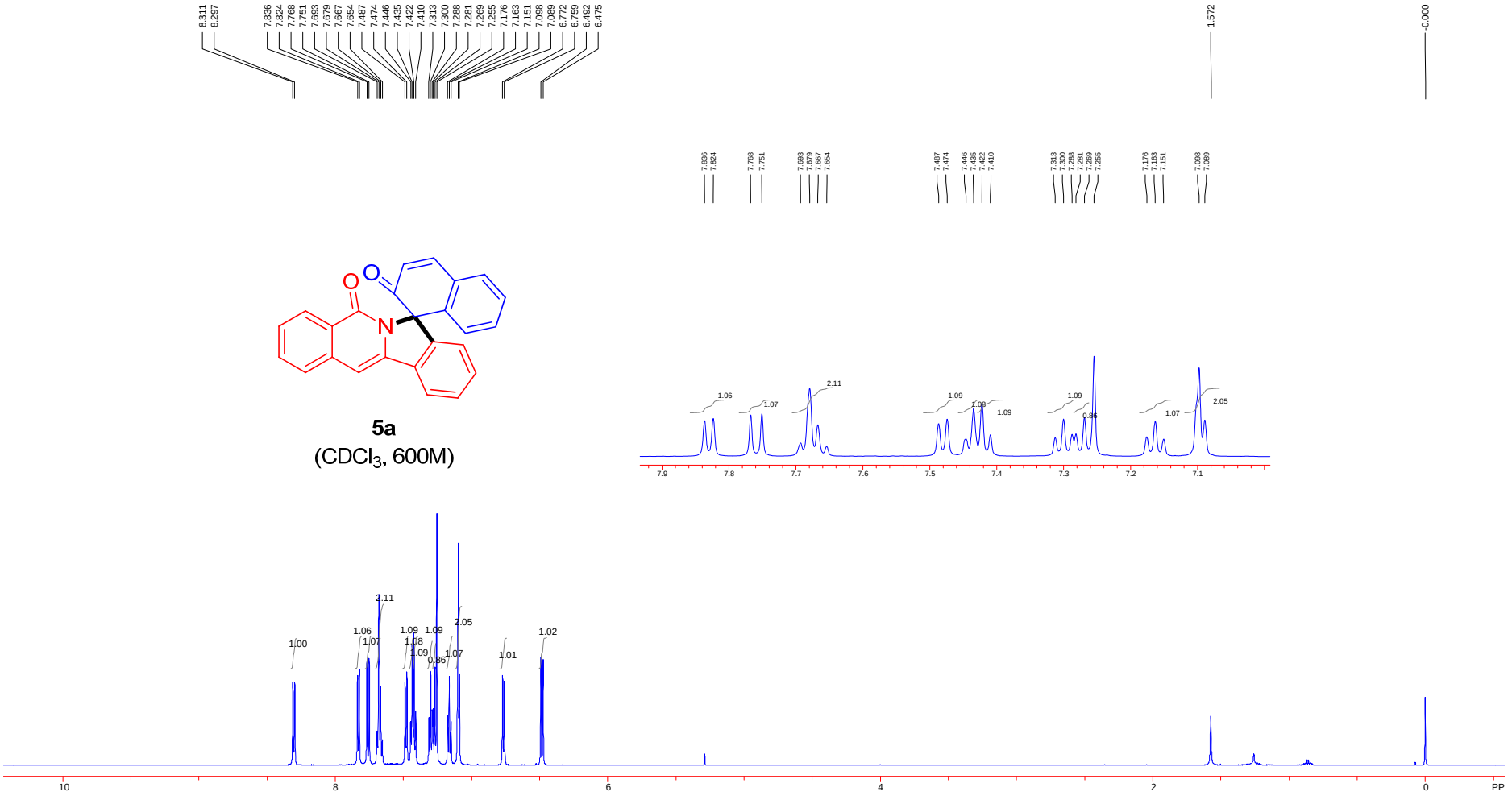
159.291
139.125
145.373
145.149
141.451
138.554
137.124
134.669
133.614
132.632
131.310
131.021
130.465
129.865
129.844
129.771
129.706
129.432
129.215
128.724
127.857
126.810
126.341
125.676
125.575
125.438
125.098
121.530
114.921
77.349
77.240
77.031
76.915
76.713
75.955
26.609
0.007
131.310
131.021
130.465
129.865
129.844
129.771
129.706
129.432
129.215
128.724
127.857
126.810
126.341
125.676
125.575
125.438
125.098
O
O
N
COMe
Ph
3ao
(CDCl3, 100 M)
131
130
129
128
127
126
125
200
150
100
50
0
PP


3ap
(CDCl3, 400 M)
Ph
O
O
N



3ap
($CDCl_3$, 100 M)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7.824
7.768
7.751
7.693
7.679
7.667
7.654
7.487
7.474
7.446
7.435
7.422
7.410
7.313
7.300
7.288
7.281
7.269
7.255
7.176
7.163
7.151
7.098
7.089
6.772
6.759
6.492
6.475
1.572
-0.000
O
O
N
5a
(CDCl3, 600M)
1.06
1.07
2.11
1.09
1.08
1.09
1.09
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1.07
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1.02
1.01
10
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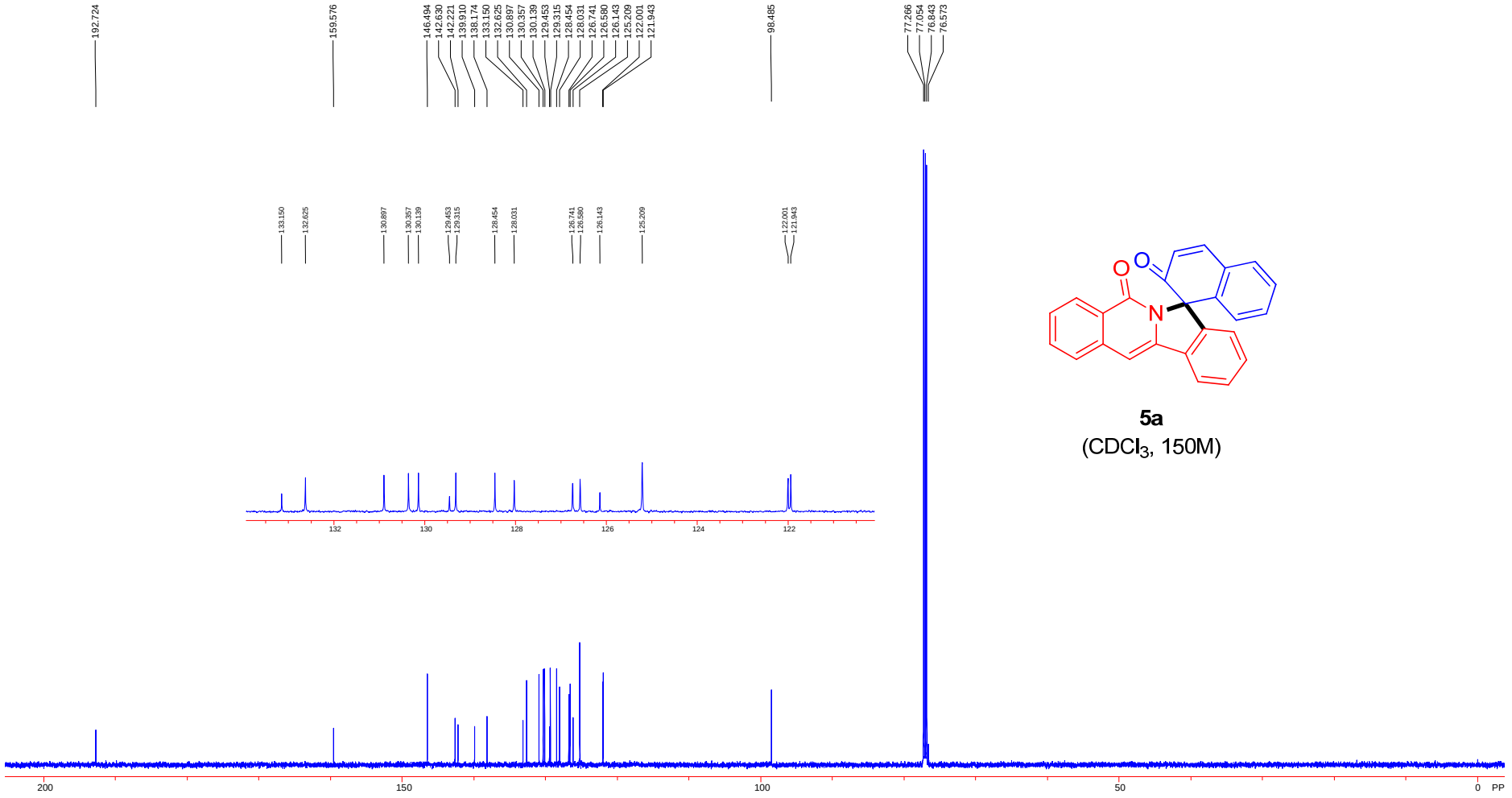
6
4
2
0
PP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132.625
130.897
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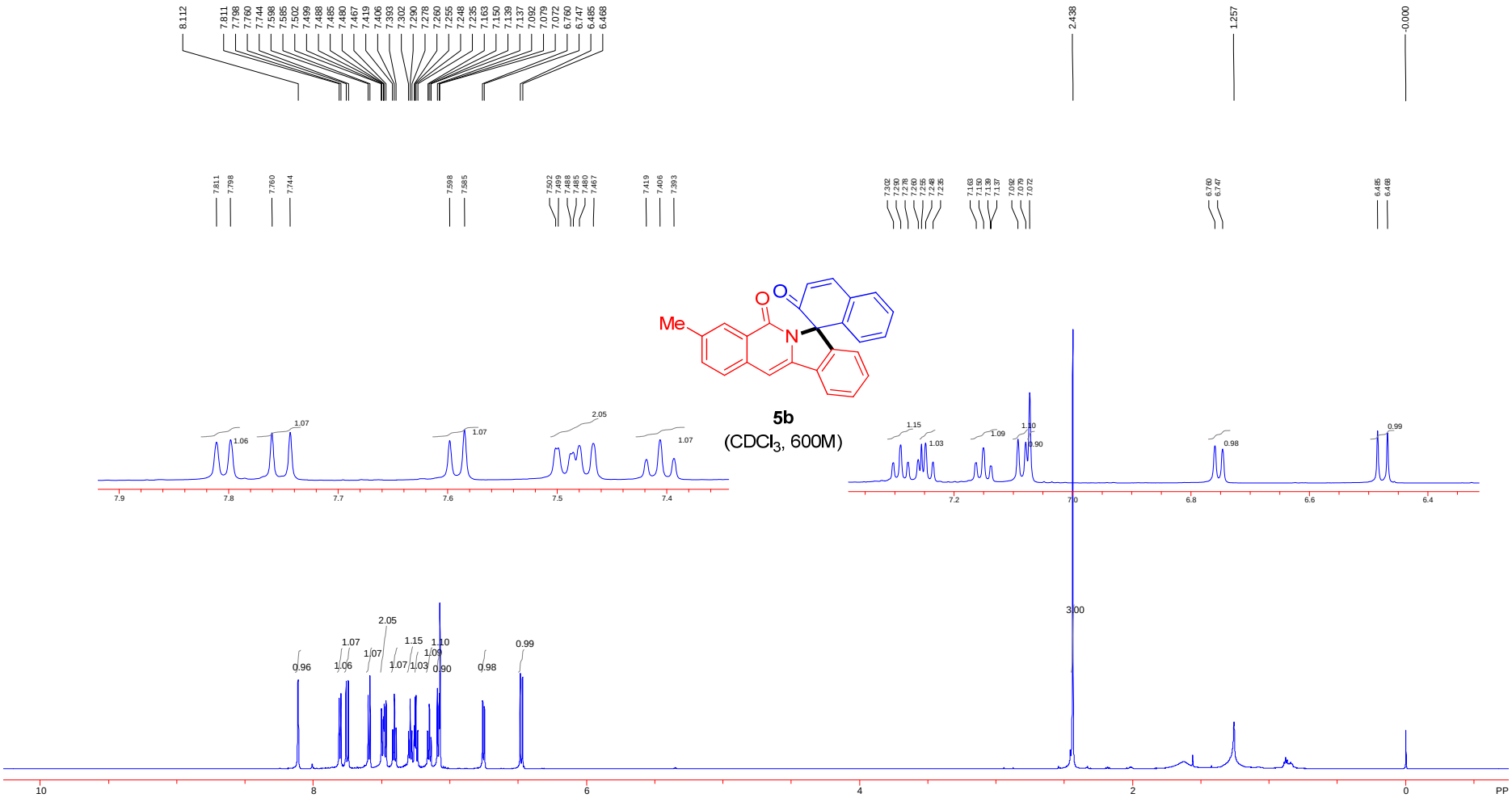
130.139
129.453
129.315
128.454
128.031
126.741
126.580
126.143
125.209
122.001
121.943
98.485
77.266
77.054
76.843
76.573
O
O
N
5a
(CDCl3, 150M)
200
150
100
50
0
PP
132
130
128
126
124
122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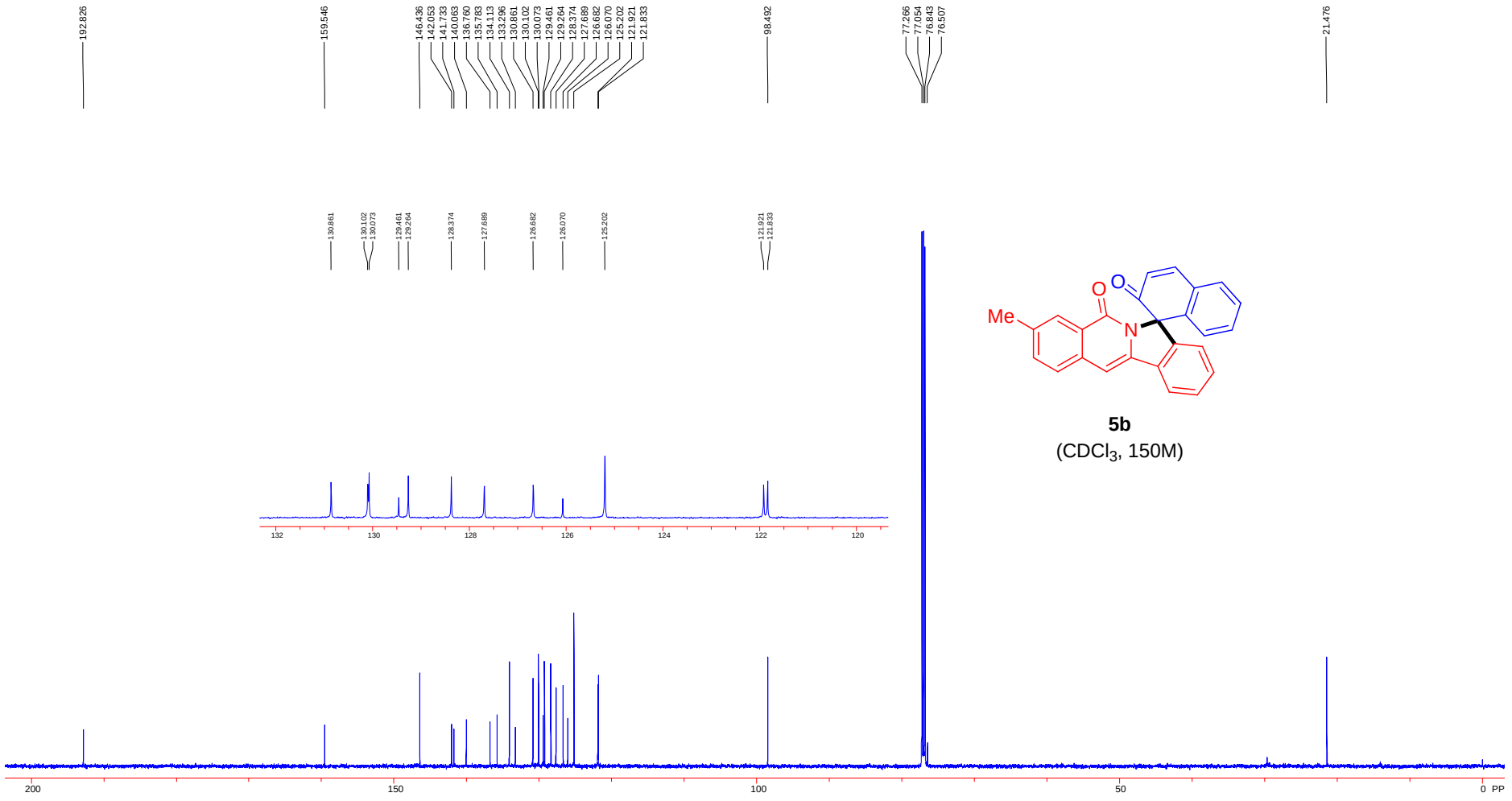
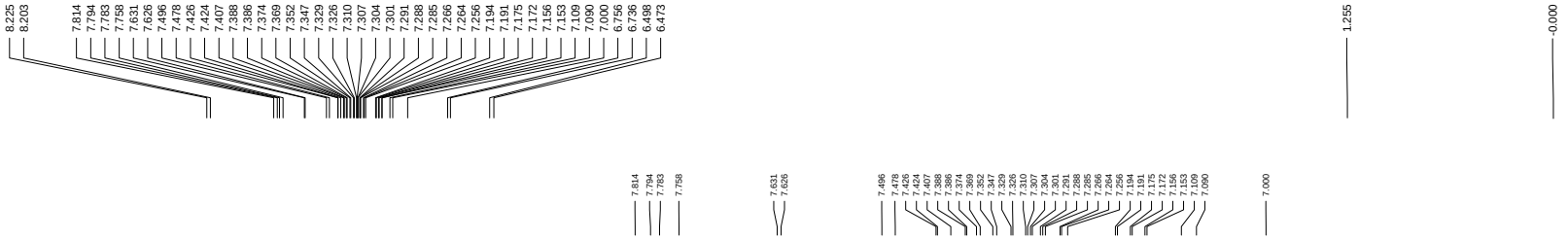
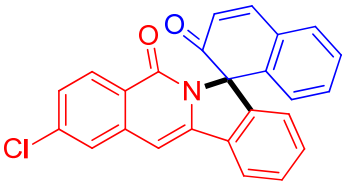
7.485
7.480
7.467
7.419
7.406
7.393
7.302
7.290
7.278
7.260
7.255
7.248
7.235
7.163
7.150
7.139
7.137
7.092
7.079
7.072
6.760
6.747
6.485
6.468
2.438
1.257
-0.000
Me
O
O
N
5b
(CDCl3, 600M)
1.06
1.07
1.07
2.05
1.07
1.15
1.09
1.10
1.03
0.90
0.98
0.99
3.00
0.96
1.06
1.07
1.07
2.05
1.07
1.03
1.15
1.09
1.10
0.90
0.98
0.99
PP



5b

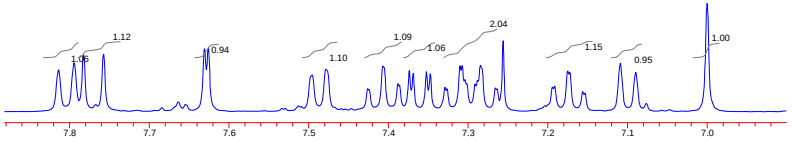
($CDCl_3$, 150M)

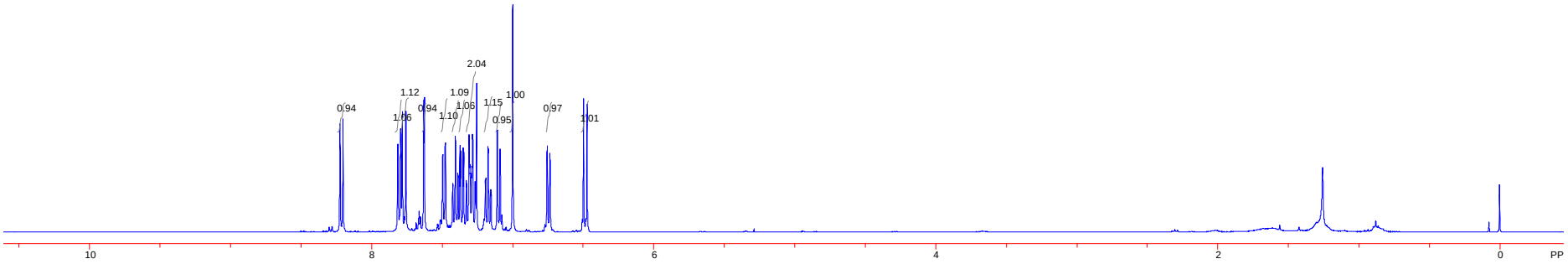


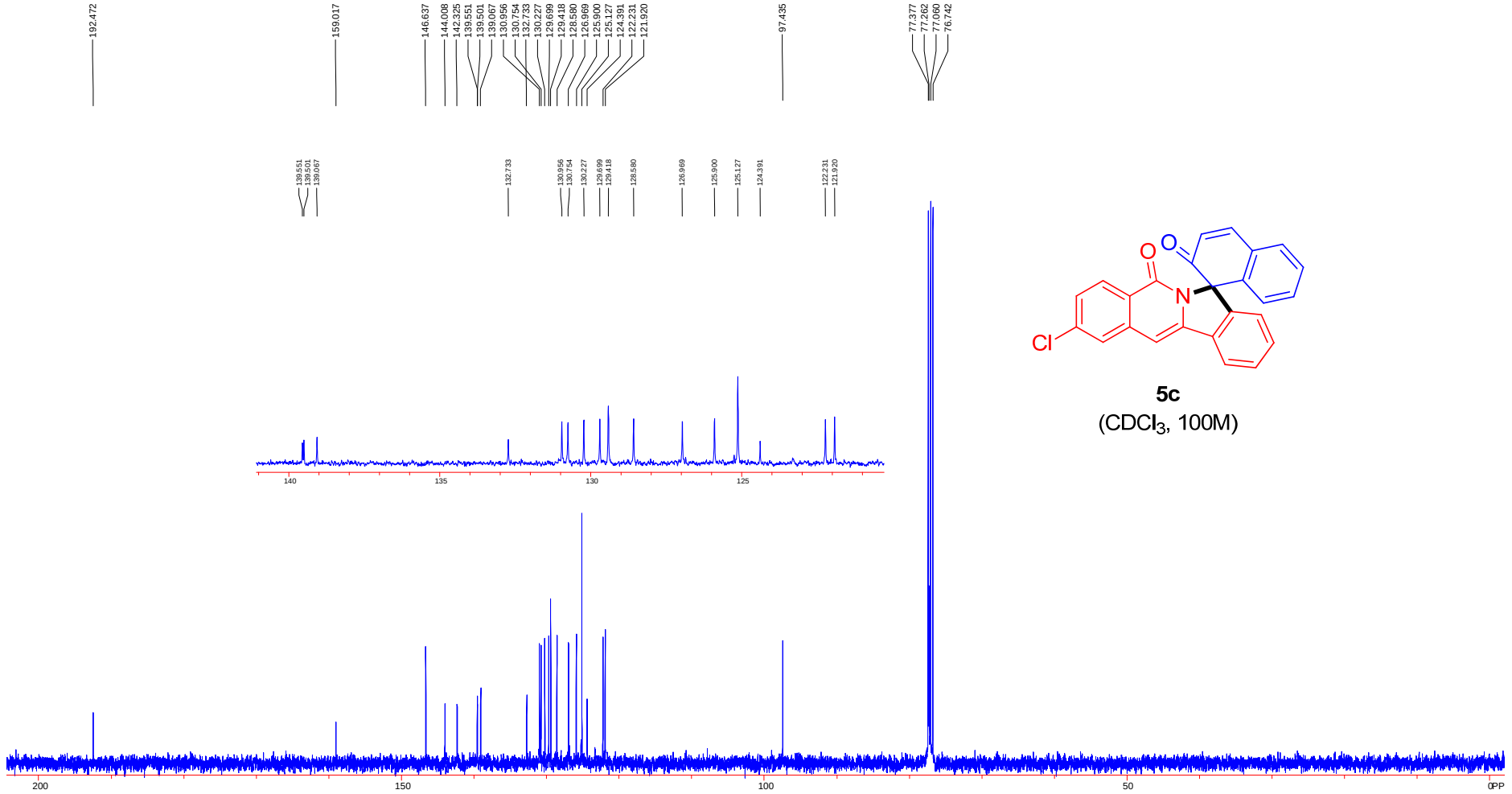


5c

($CDCl_3$, 400M)

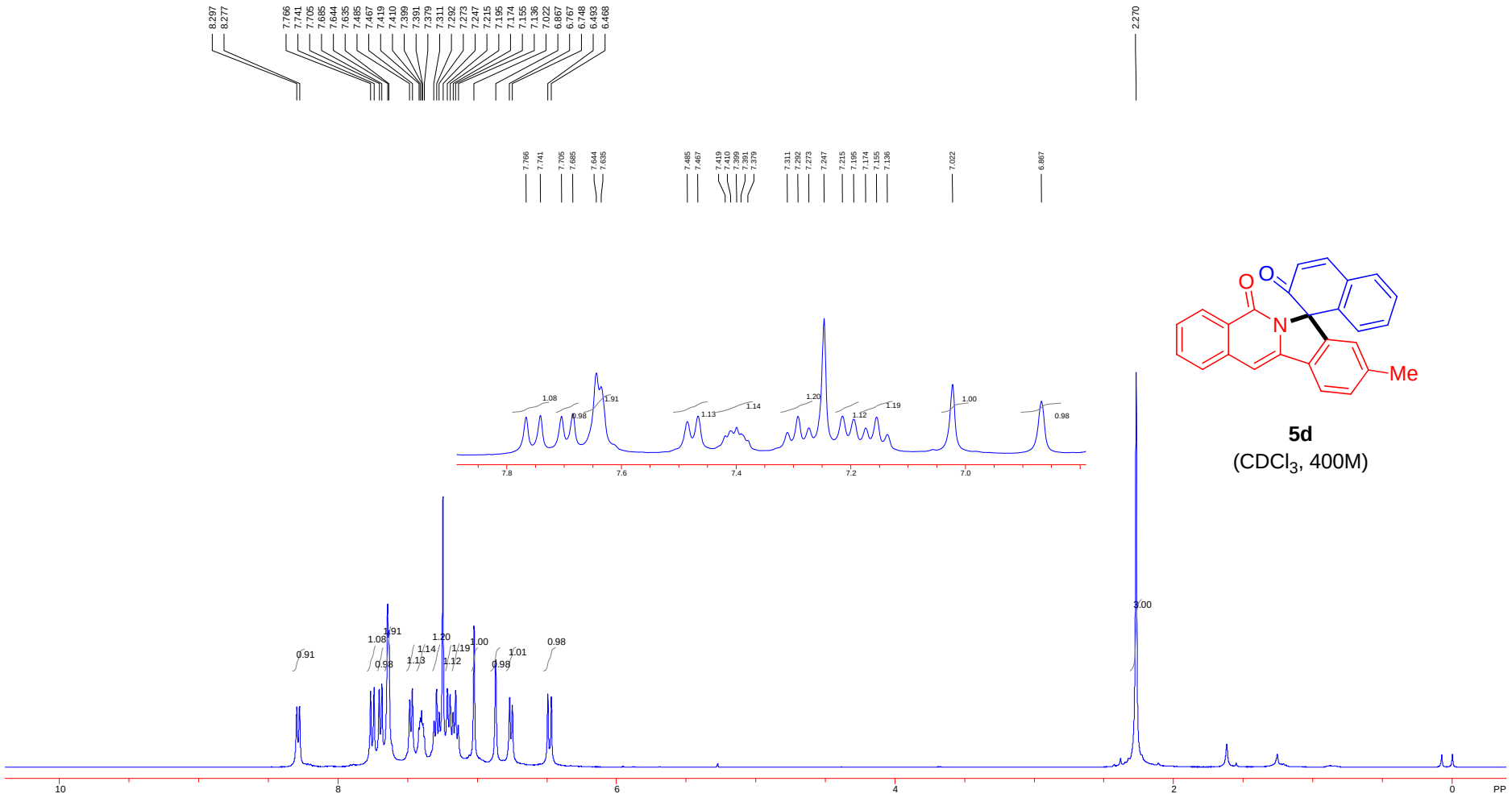






5c

($CDCl_3$, 100M)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7.399
7.391
7.379
7.311
7.292
7.273
7.247
7.215
7.195
7.174
7.155
7.136
7.022
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6.767
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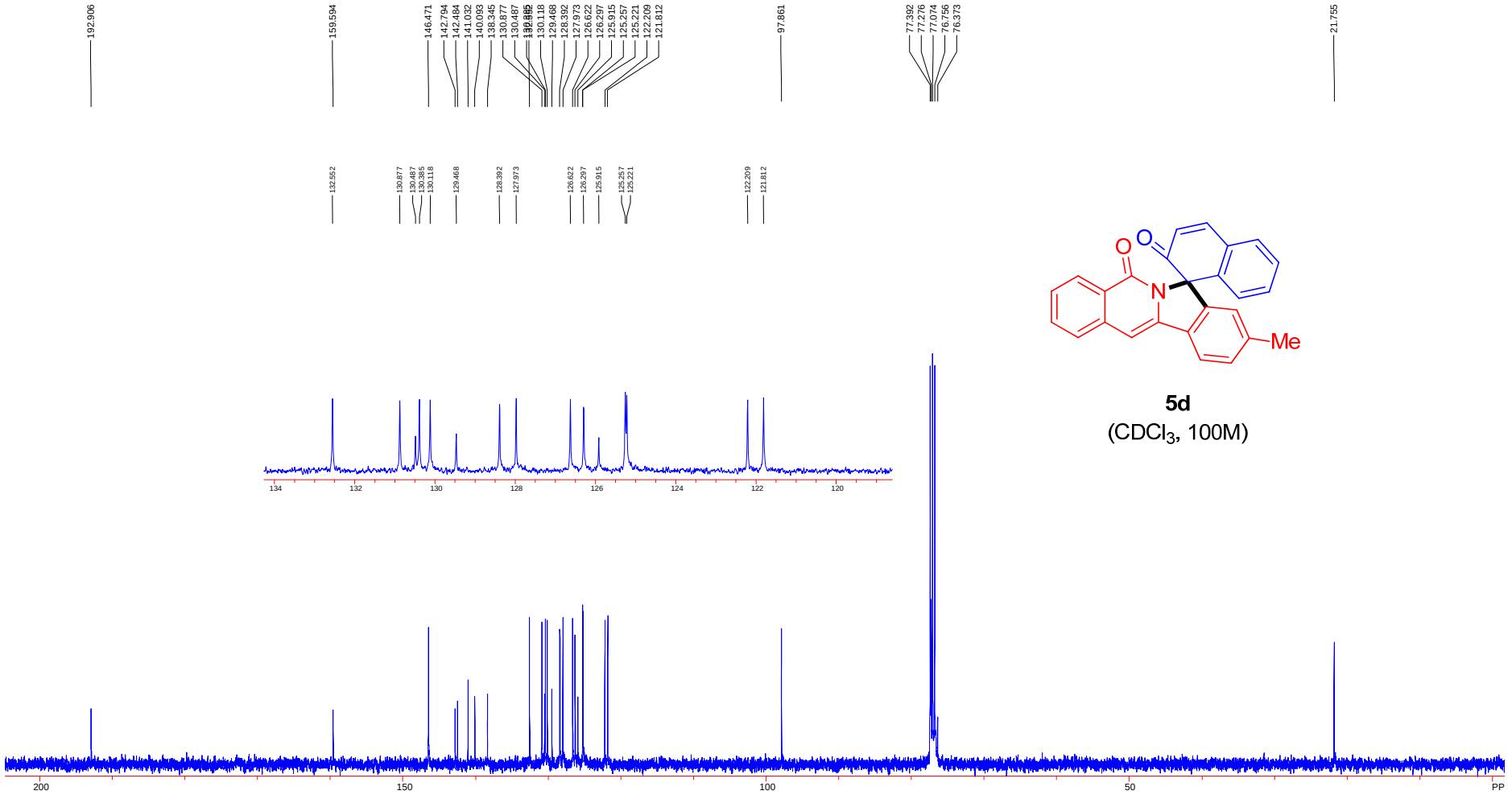
6.493
6.468
2.270
O
O
N
Me
5d
(CDCl3, 400M)
PP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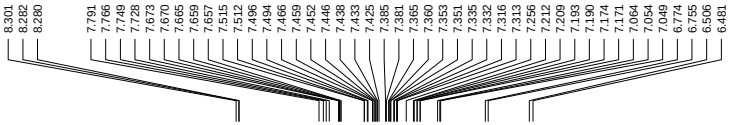
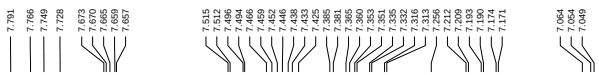
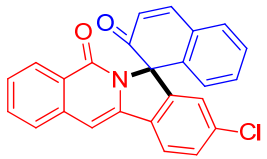
127.973
126.622
126.297
125.915
125.257
125.221
122.209
121.812
97.861
77.392
77.276
77.074
76.756
76.373
21.755
132.552
130.877
130.487
130.385
130.118
129.468
128.392
127.973
126.622
126.297
125.915
125.257
125.221
122.209
121.812
O
O
N
Me
5d
(CDCl3, 100M)
134
132
130
128
126
124
122
120
200
150
100
50
PP

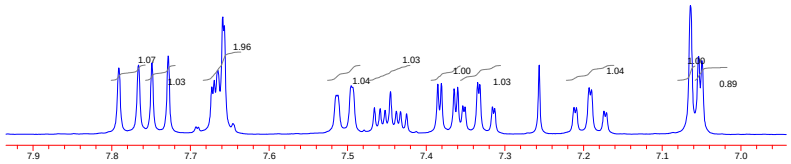


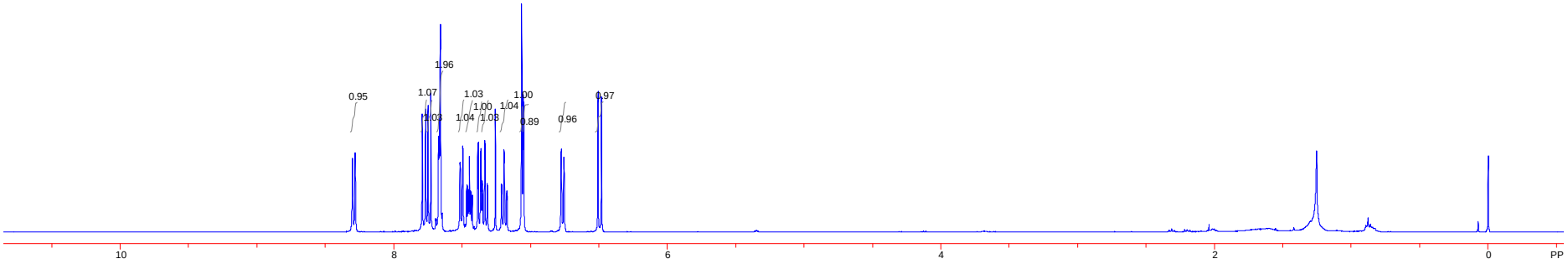


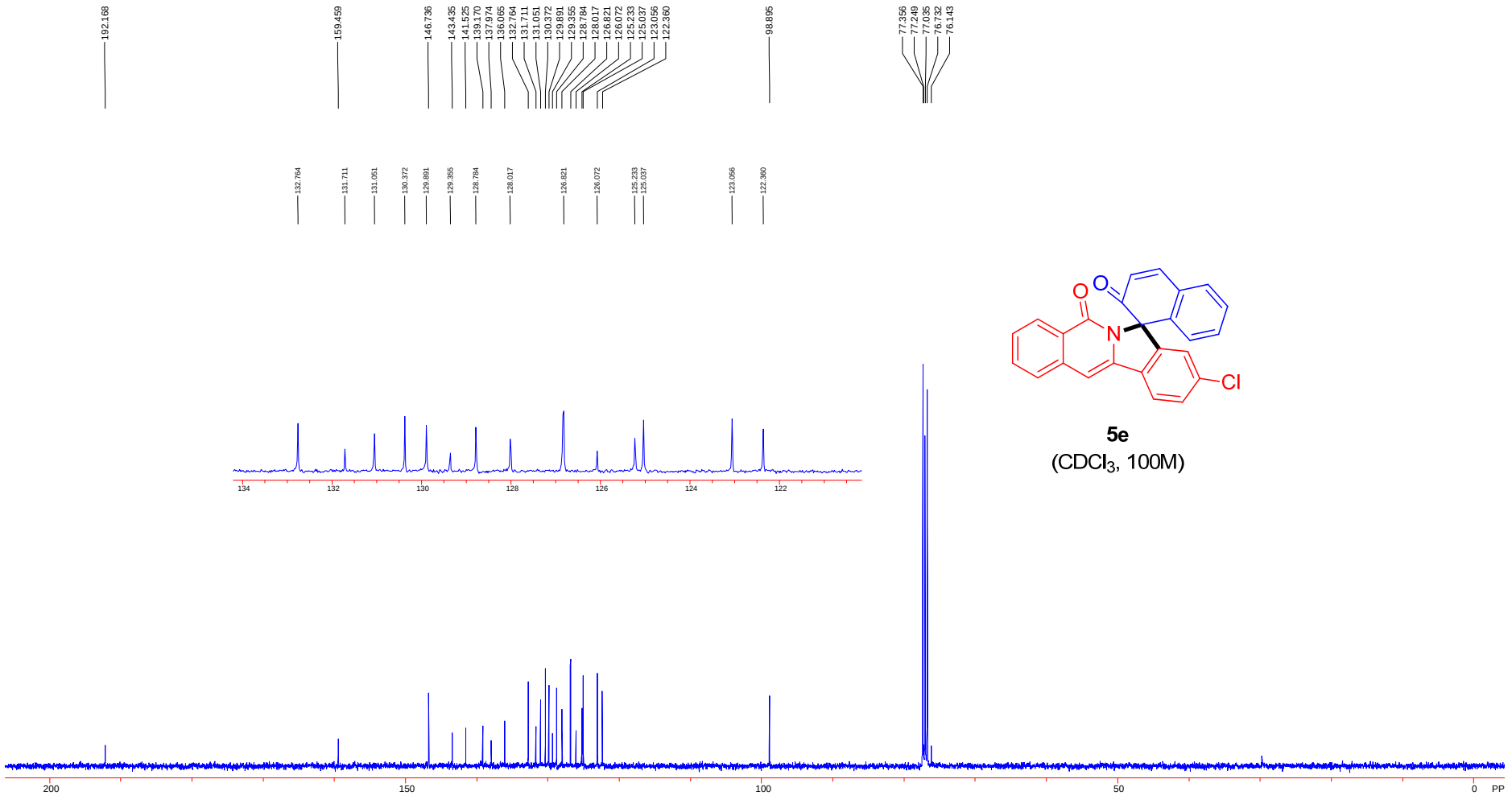


5e

($CDCl_3$, 400M)



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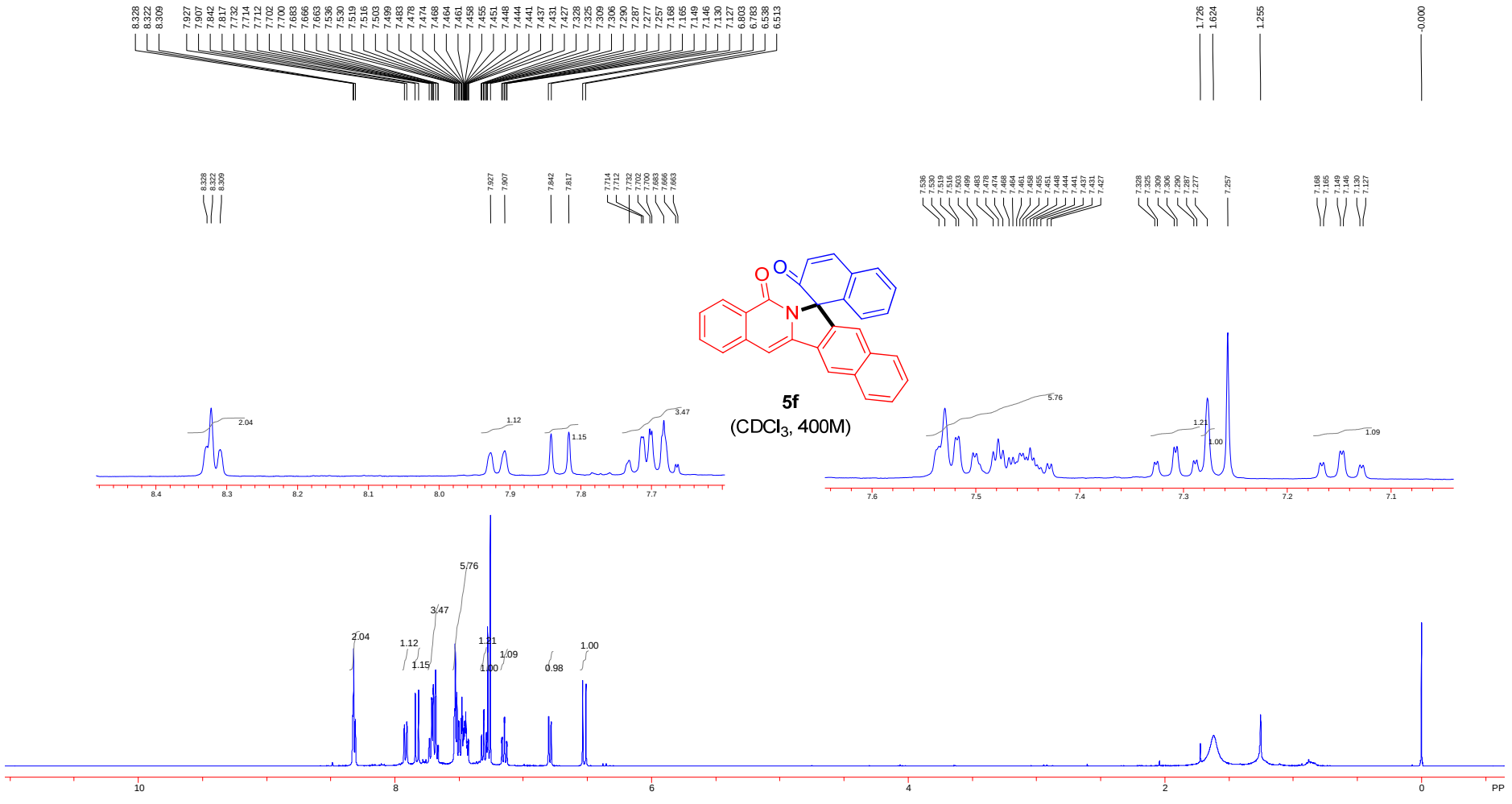
125.037
123.056
122.360
98.895
77.356
77.249
77.035
76.732
76.143
O
O
N
Cl
5e
(CDCl3, 100M)
200
150
100
50
0
PP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7.516
7.503
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7.448
7.444
7.441
7.437
7.431
7.427
7.328
7.325
7.309
7.306
7.290
7.287
7.277
7.257
7.168
7.165
7.149
7.146
7.130
7.127
6.803
6.783
6.538
6.513
1.726
1.624
1.255
-0.000
O
O
N
5f
(CDCl3, 400M)
2.04
1.12
1.15
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5.76
1.21
1.00
1.09
0.98
10
8
6
4
2
0
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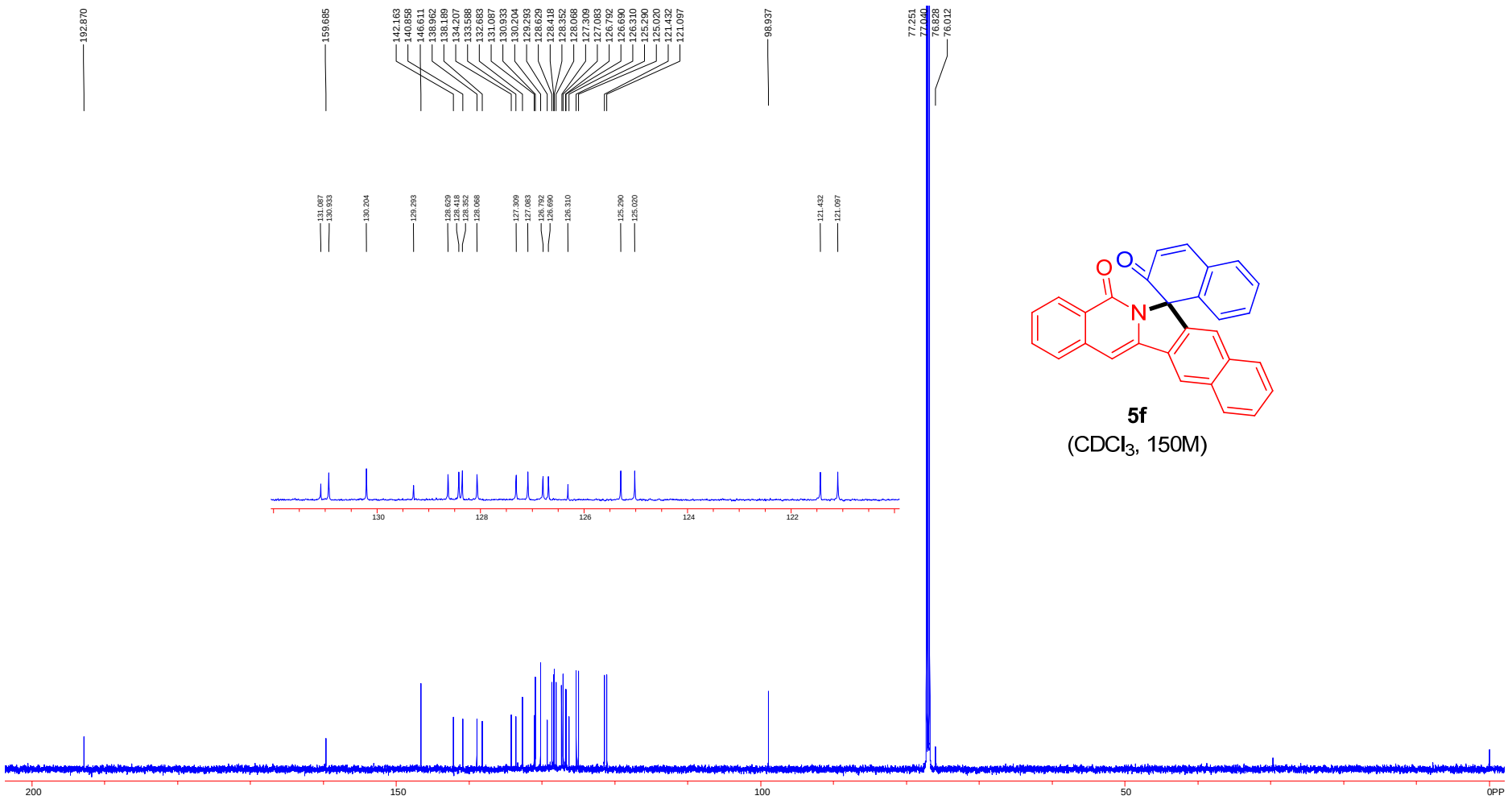
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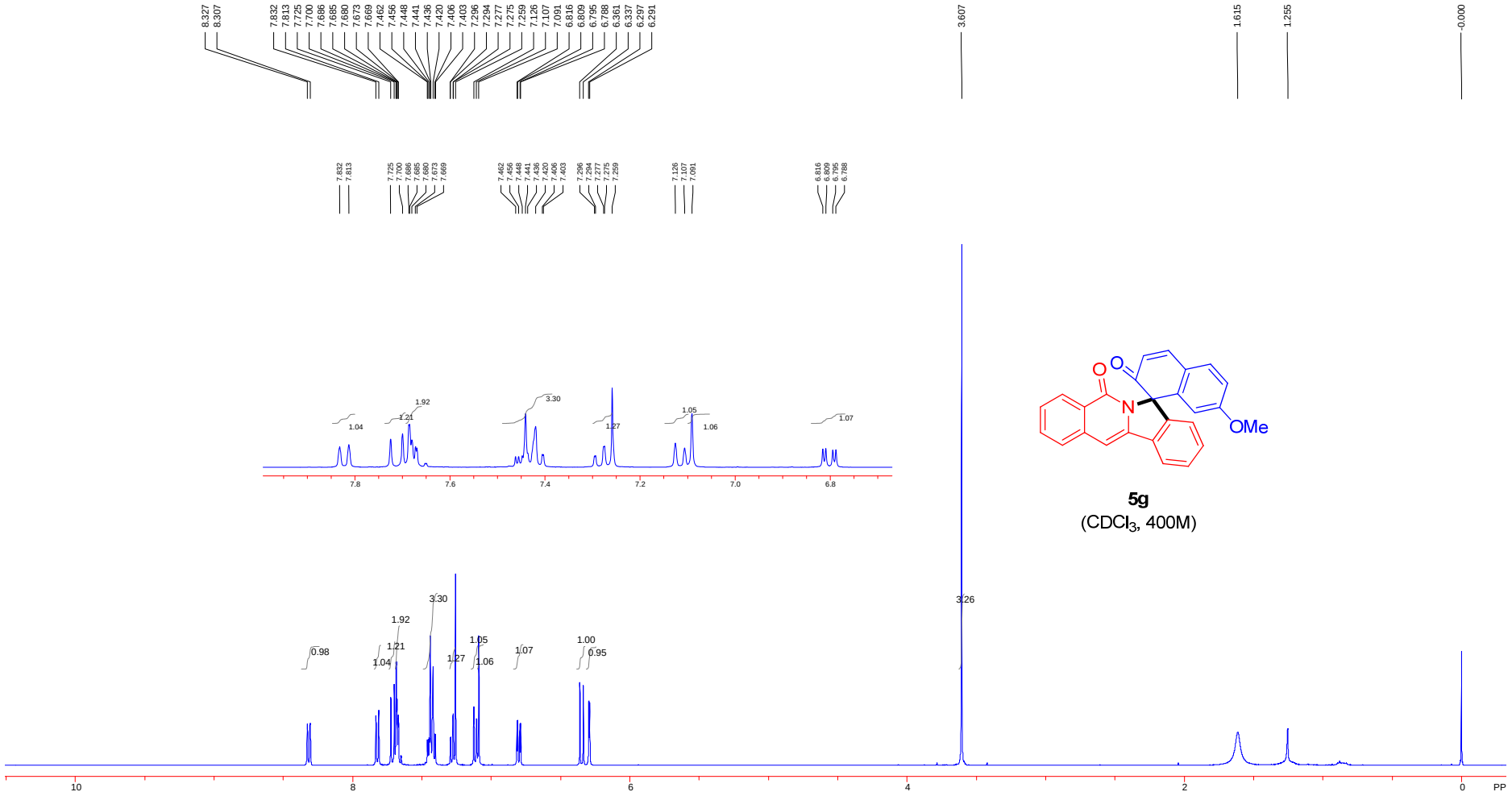
142.163
140.858
146.611
138.962
138.189
134.207
133.588
132.683
131.087
130.933
130.204
129.293
128.629
128.418
128.352
128.068
127.309
127.083
126.792
126.690
126.310
125.290
125.020
121.432
121.097
98.937
77.251
77.040
76.828
76.012
O
O
N
5f
(CDCl3, 150M)
200
150
100
50
0PP
130
128
126
124
122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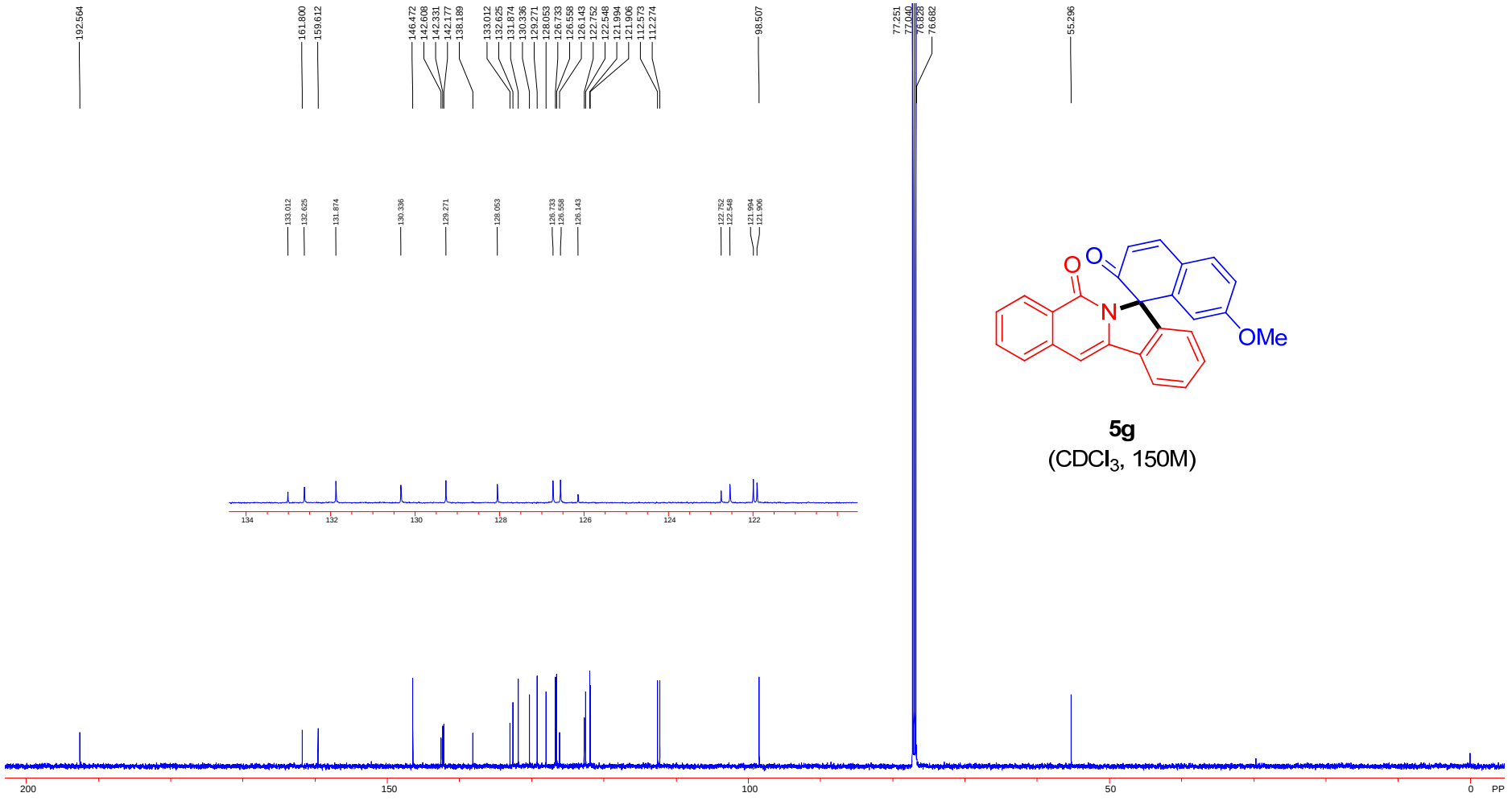
8.307
7.832
7.813
7.725
7.700
7.686
7.685
7.680
7.673
7.669
7.462
7.456
7.448
7.441
7.436
7.420
7.406
7.403
7.296
7.294
7.277
7.275
7.259
7.126
7.107
7.091
6.816
6.809
6.795
6.788
6.361
6.337
6.297
6.291
3.607
1.615
1.255
-0.000
1.04
1.92
1.21
3.30
1.27
1.05
1.06
1.07
0.98
1.00
0.95
3.26
O
N
OMe
5g
(CDCl3, 400M)
PP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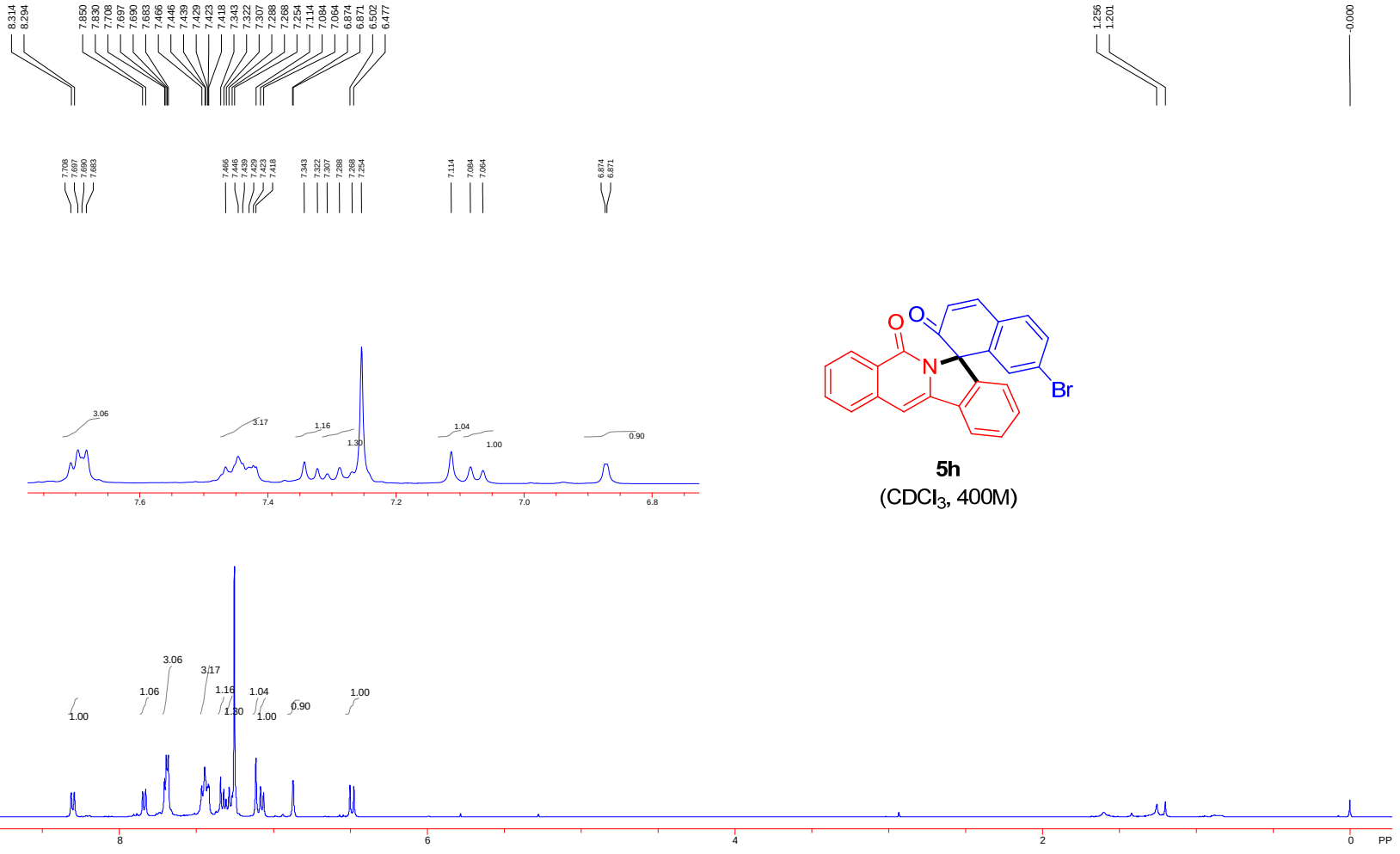
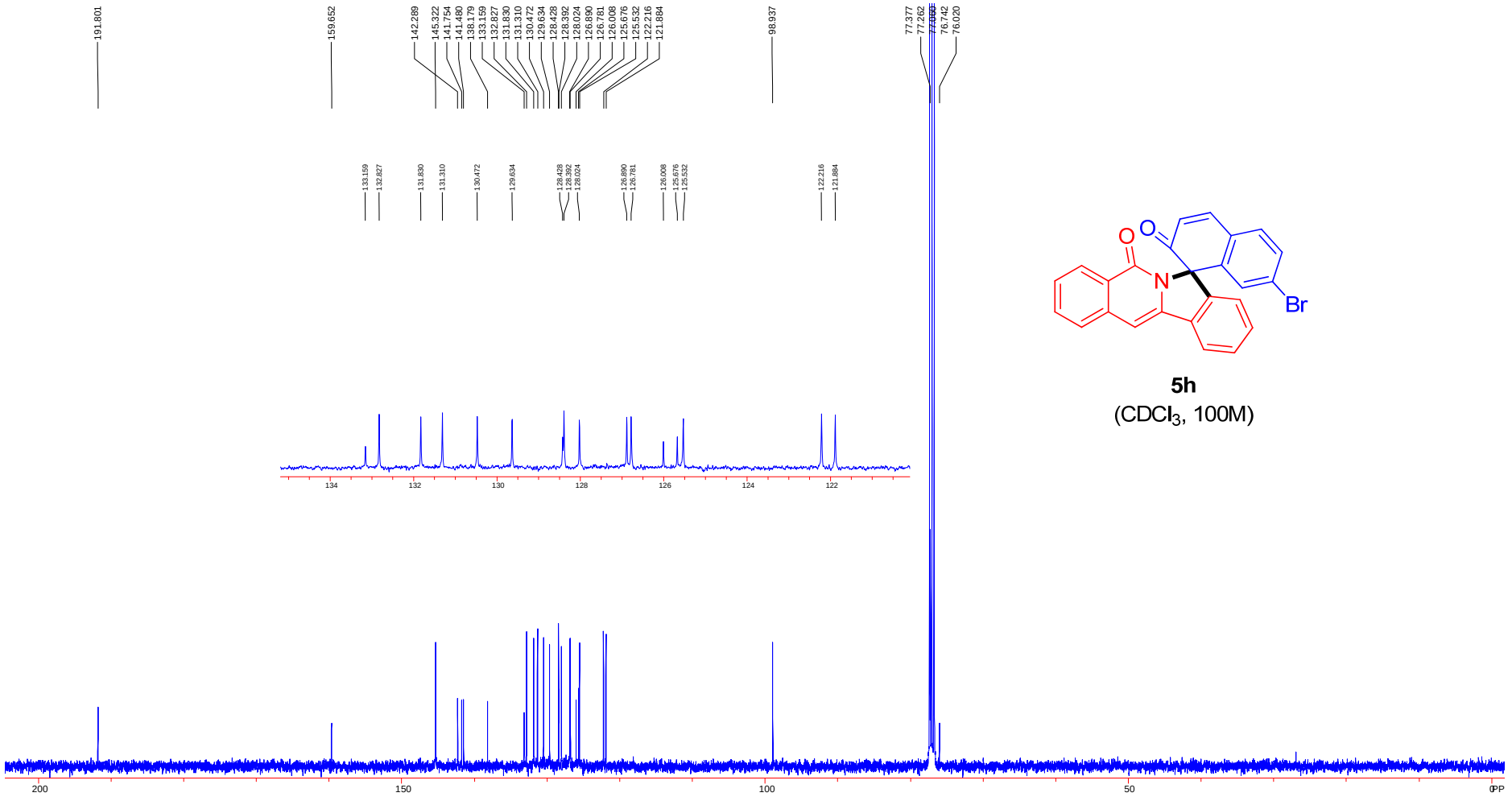
161.800
159.612
146.472
142.608
142.331
142.177
138.189
133.012
132.625
131.874
130.336
129.271
128.053
126.733
126.558
126.143
122.752
122.548
121.994
121.906
112.573
112.274
98.507
77.251
77.040
76.828
76.682
55.296
O
O
N
OMe
5g
(CDCl3, 150M)
200
150
100
50
0
PP



5h

($CDCl_3$, 400M)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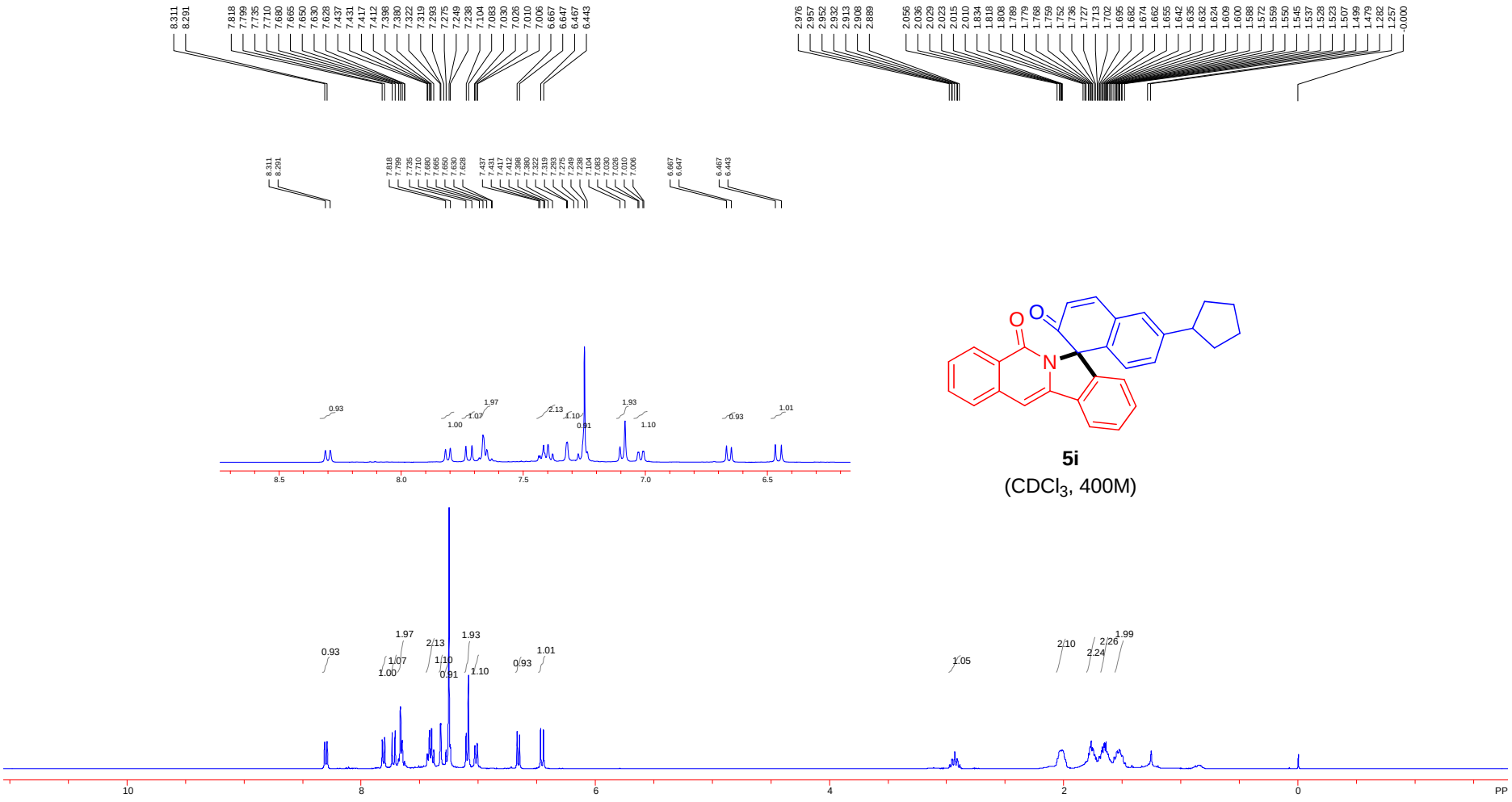
159.652
142.289
145.322
141.754
141.490
138.179
133.159
132.827
131.830
131.310
130.472
129.634
128.428
128.392
128.024
126.890
126.781
126.008
125.676
125.532
122.216
121.884
98.937
77.377
77.262
76.742
76.020
O
O
N
Br
5h
(CDCl3, 100M)
200
150
100
50
0
PP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8.291
7.818
7.799
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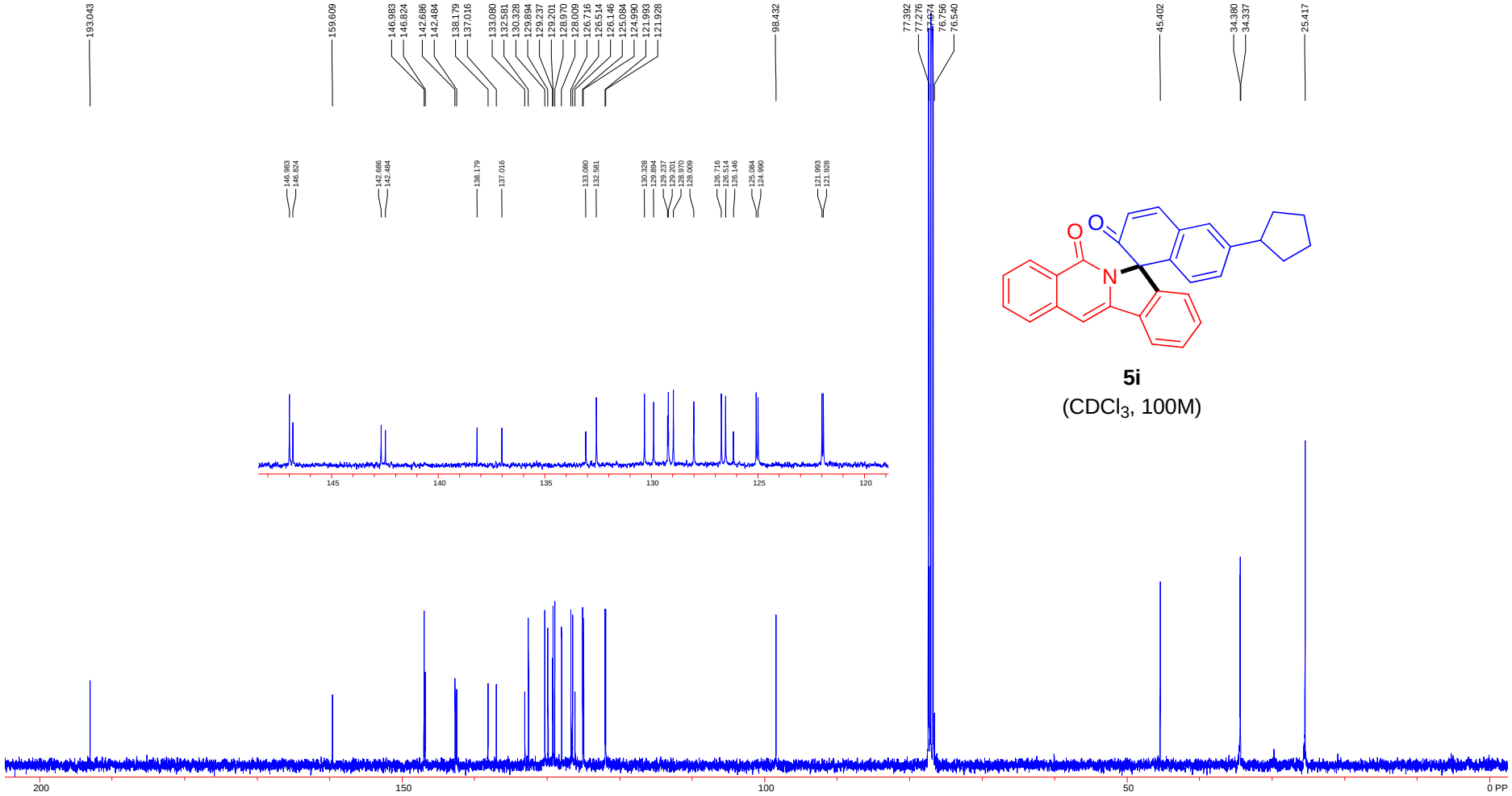
7.710
7.680
7.665
7.650
7.630
7.628
7.437
7.431
7.417
7.412
7.398
7.380
7.322
7.319
7.293
7.275
7.249
7.238
7.104
7.083
7.030
7.026
7.010
7.006
6.667
6.647
6.467
6.443
2.976
2.957
2.952
2.932
2.913
2.908
2.889
2.056
2.036
2.029
2.023
2.015
2.010
1.834
1.818
1.808
1.789
1.779
1.768
1.759
1.752
1.736
1.727
1.713
1.702
1.695
1.682
1.674
1.662
1.655
1.642
1.635
1.632
1.624
1.609
1.600
1.588
1.572
1.559
1.550
1.545
1.537
1.528
1.523
1.507
1.499
1.479
1.282
1.257
-0.000
0.93
1.00
1.07
1.97
2.13
1.10
0.91
1.93
1.10
0.93
1.01
8.5
8.0
7.5
7.0
6.5
O
O
N
5i
(CDCl3, 400M)
0.93
1.00
1.97
1.07
2.13
1.10
0.91
1.93
1.10
0.93
1.01
1.05
2.10
2.24
2.26
1.99
10
8
6
4
2
0
PP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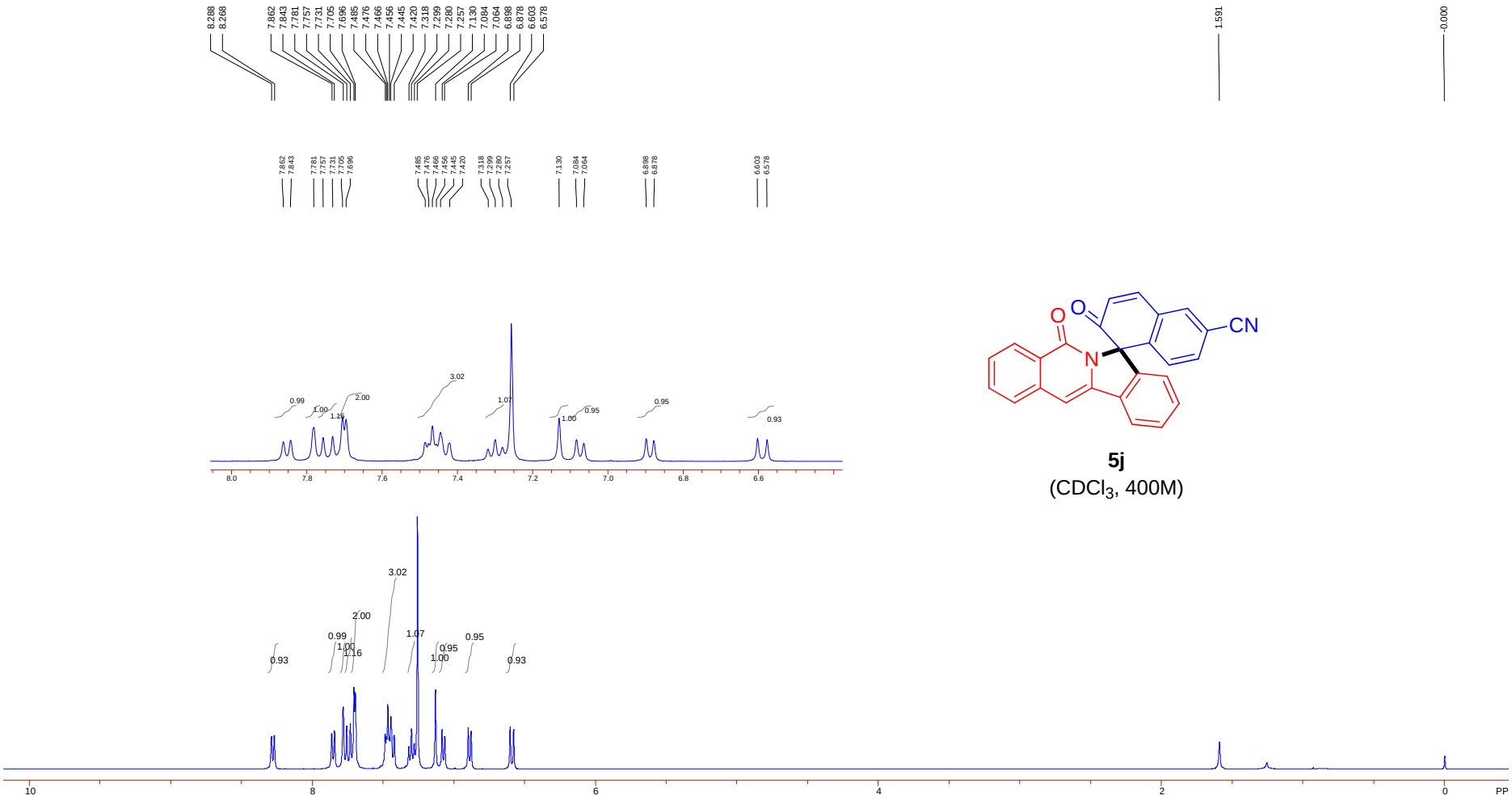
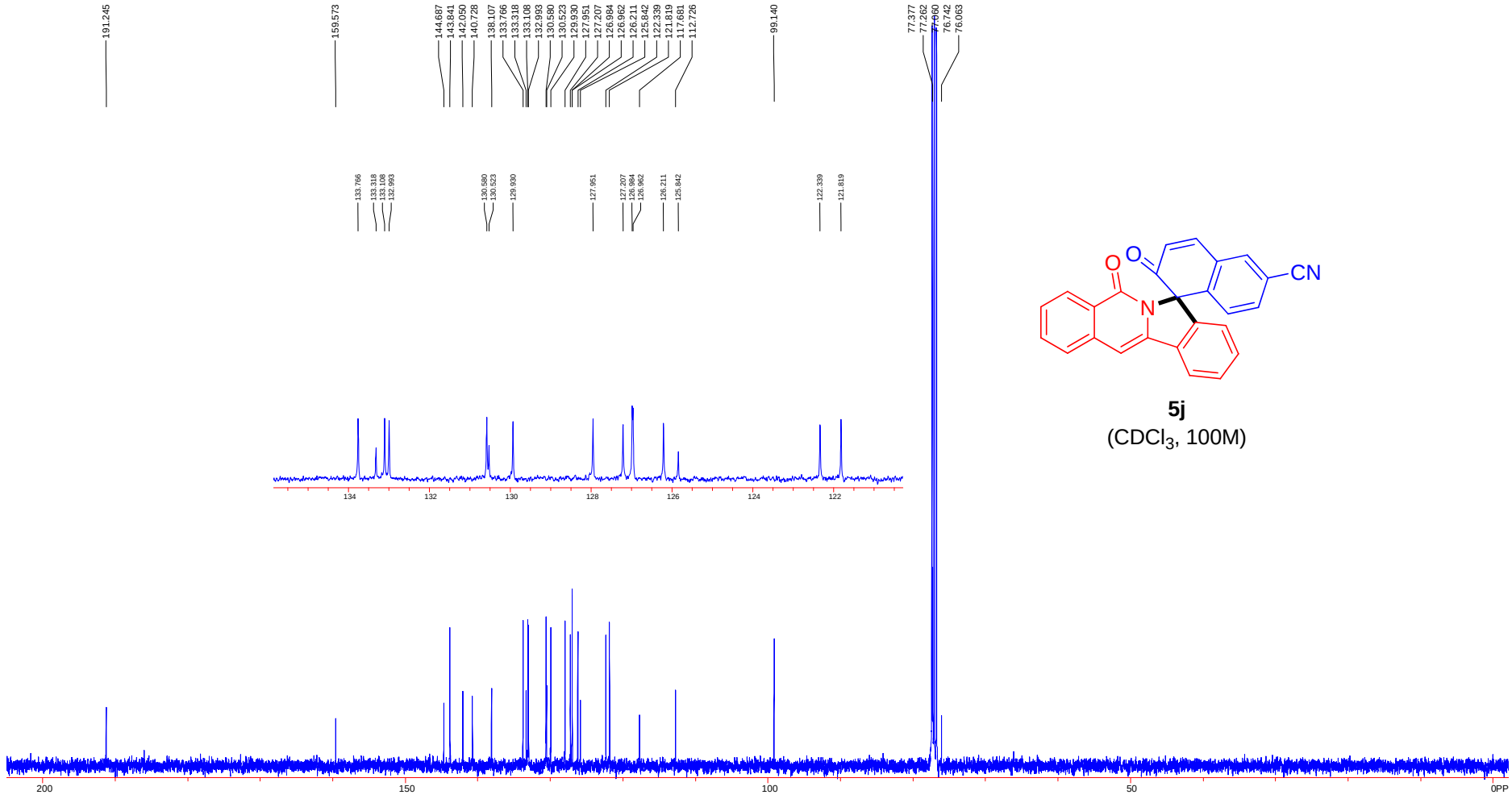
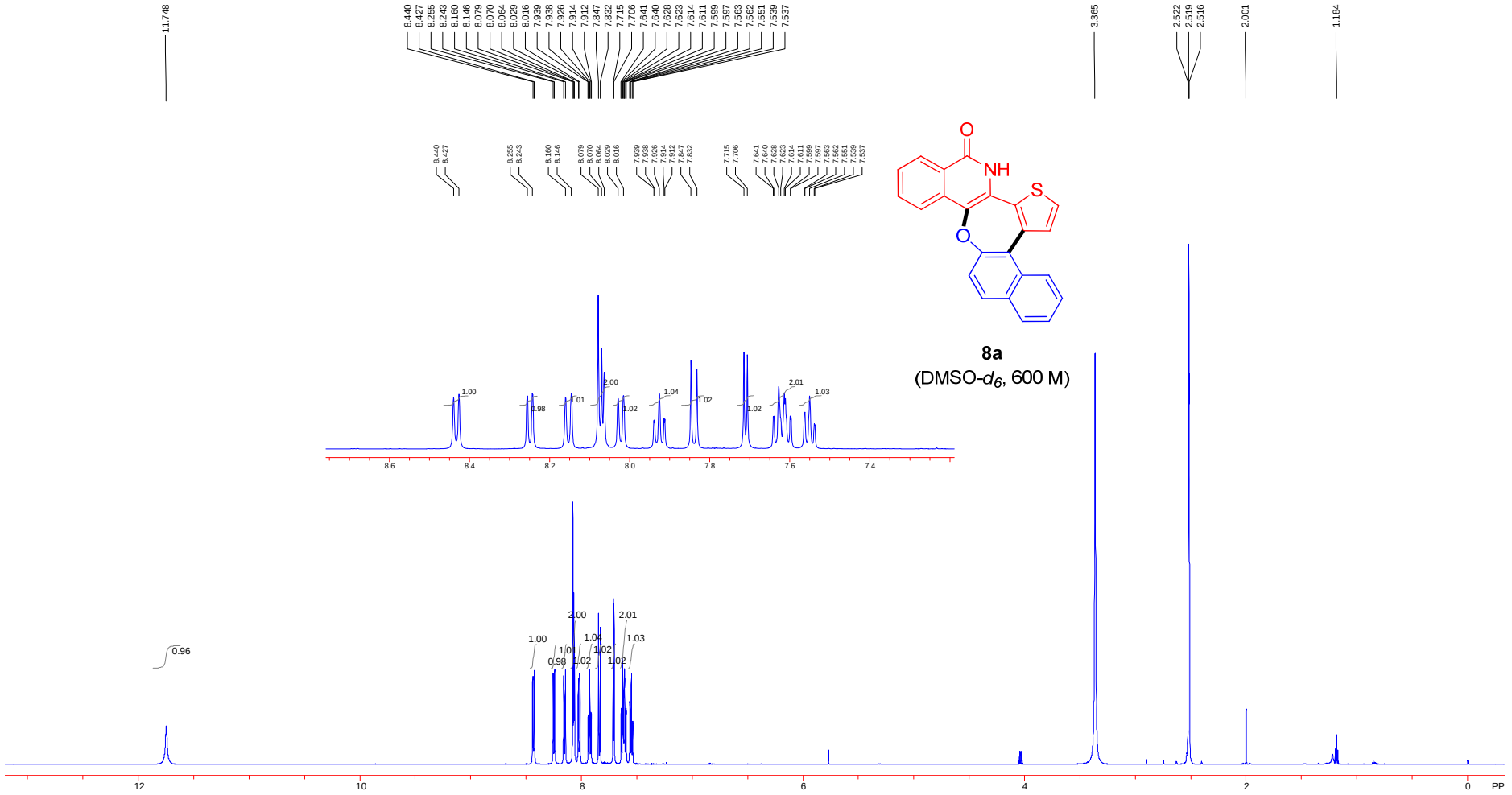
159.609
146.983
146.824
142.686
142.484
138.179
137.016
133.080
132.581
130.328
129.894
129.237
129.201
128.970
128.009
126.716
126.514
126.146
125.084
124.990
121.993
121.928
98.432
77.392
77.276
77.074
76.756
76.540
45.402
34.380
34.337
25.417
O
O
N
5i
(CDCl3, 100M)
200
150
100
50
0 PP
145
140
135
130
125
120


8.288
8.268
7.862
7.843
7.781
7.757
7.731
7.705
7.696
7.485
7.476
7.466
7.456
7.445
7.420
7.318
7.299
7.280
7.257
7.130
7.084
7.064
6.898
6.878
6.603
6.578
1.591
0.000
O
O
N
CN
5j
(CDCl3, 400M)
0.99
1.00
1.16
2.00
3.02
1.07
1.00
0.95
0.95
0.93
10
8
6
4
2
0
PP



5j

($CDCl_3$, 100M)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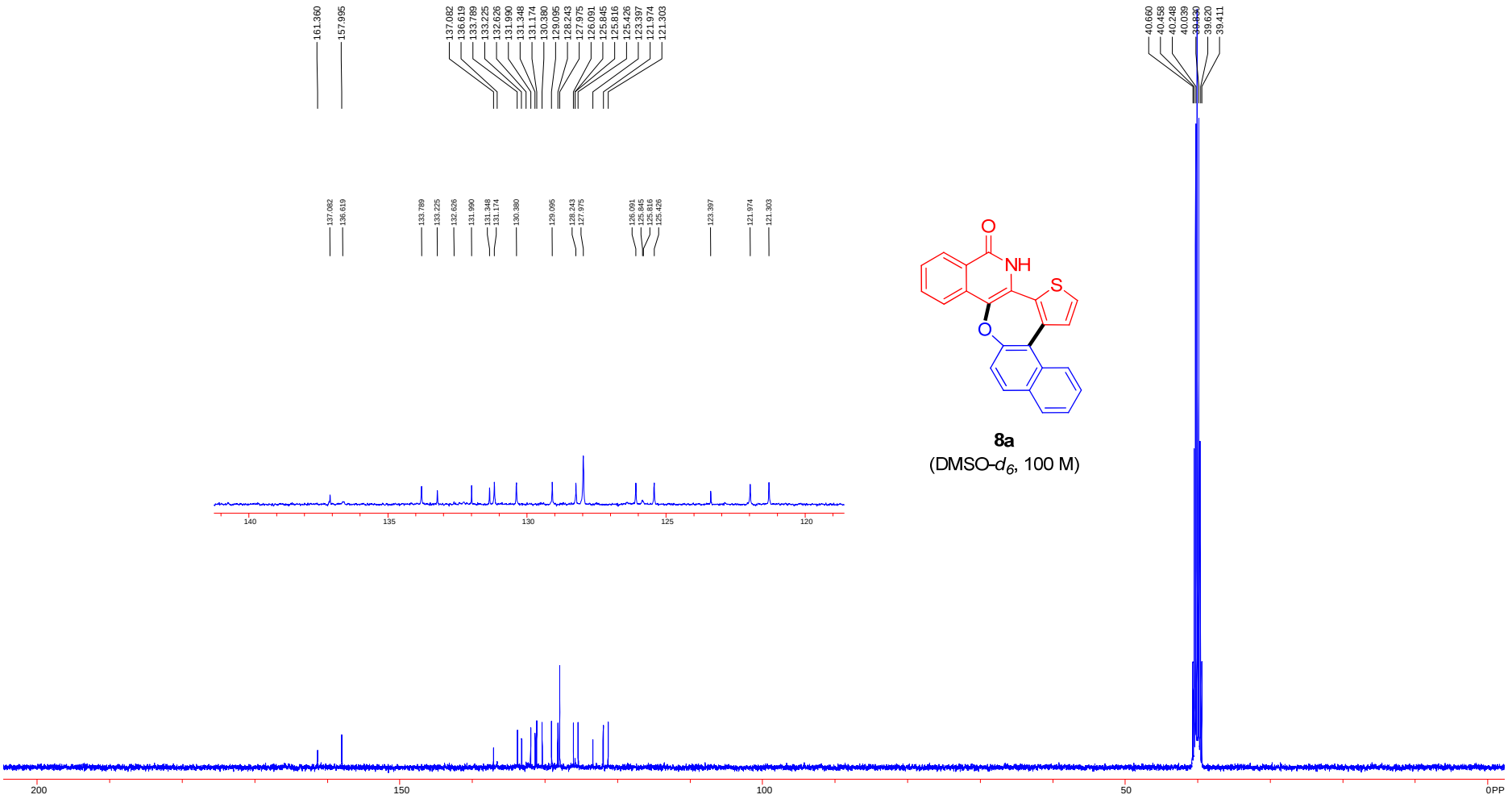
8.440
8.427
8.255
8.243
8.160
8.146
8.079
8.070
8.064
8.029
8.016
7.939
7.938
7.926
7.914
7.912
7.847
7.832
7.715
7.706
7.641
7.640
7.628
7.623
7.614
7.611
7.599
7.597
7.563
7.562
7.551
7.539
7.537
3.365
2.522
2.519
2.516
2.001
1.184
O
NH
S
O
8a
(DMSO-d6, 600 M)
0.96
1.00
0.98
1.01
2.00
1.02
1.04
1.02
1.02
2.01
1.03
12
10
8
6
4
2
0
PP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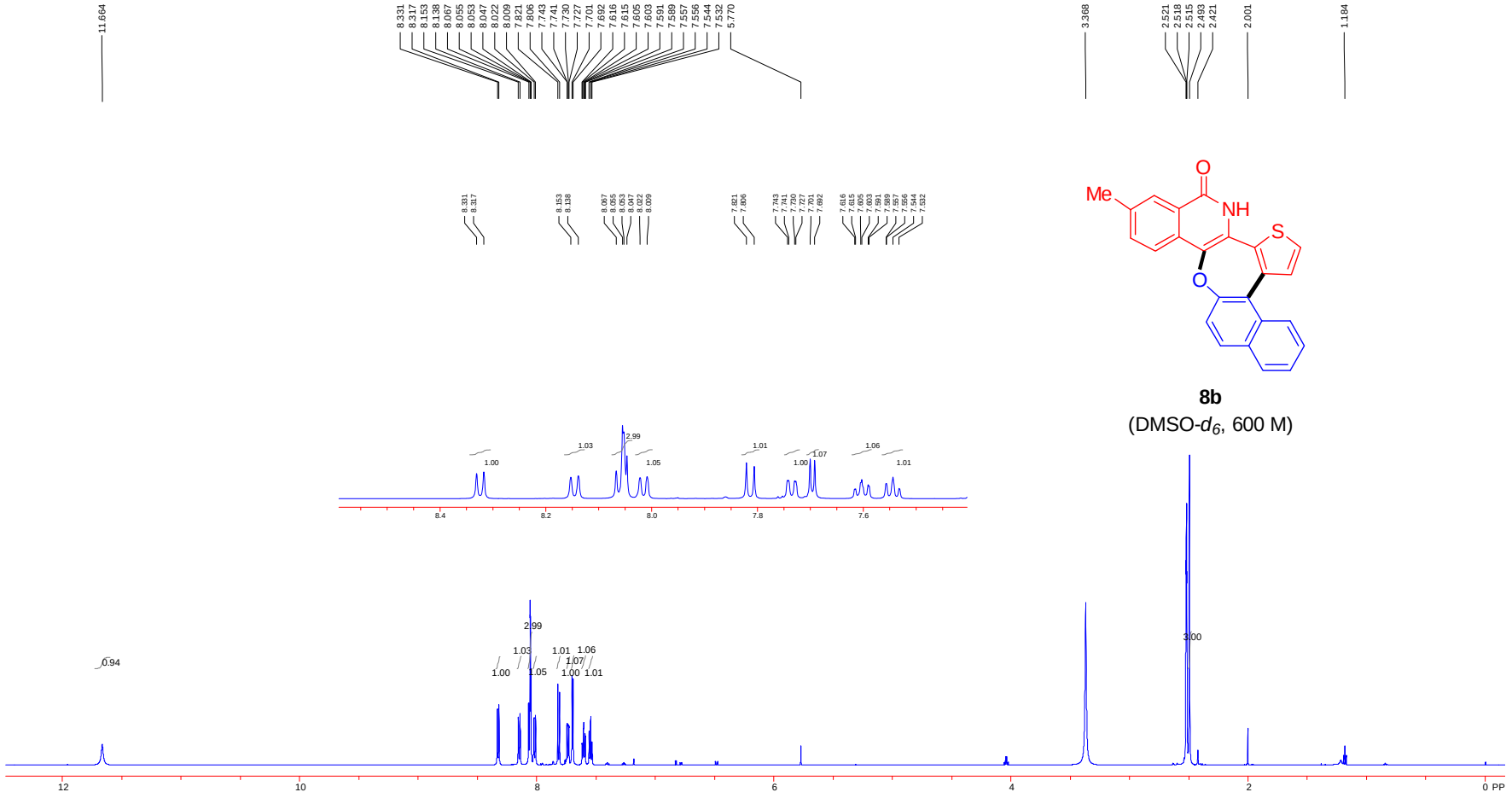
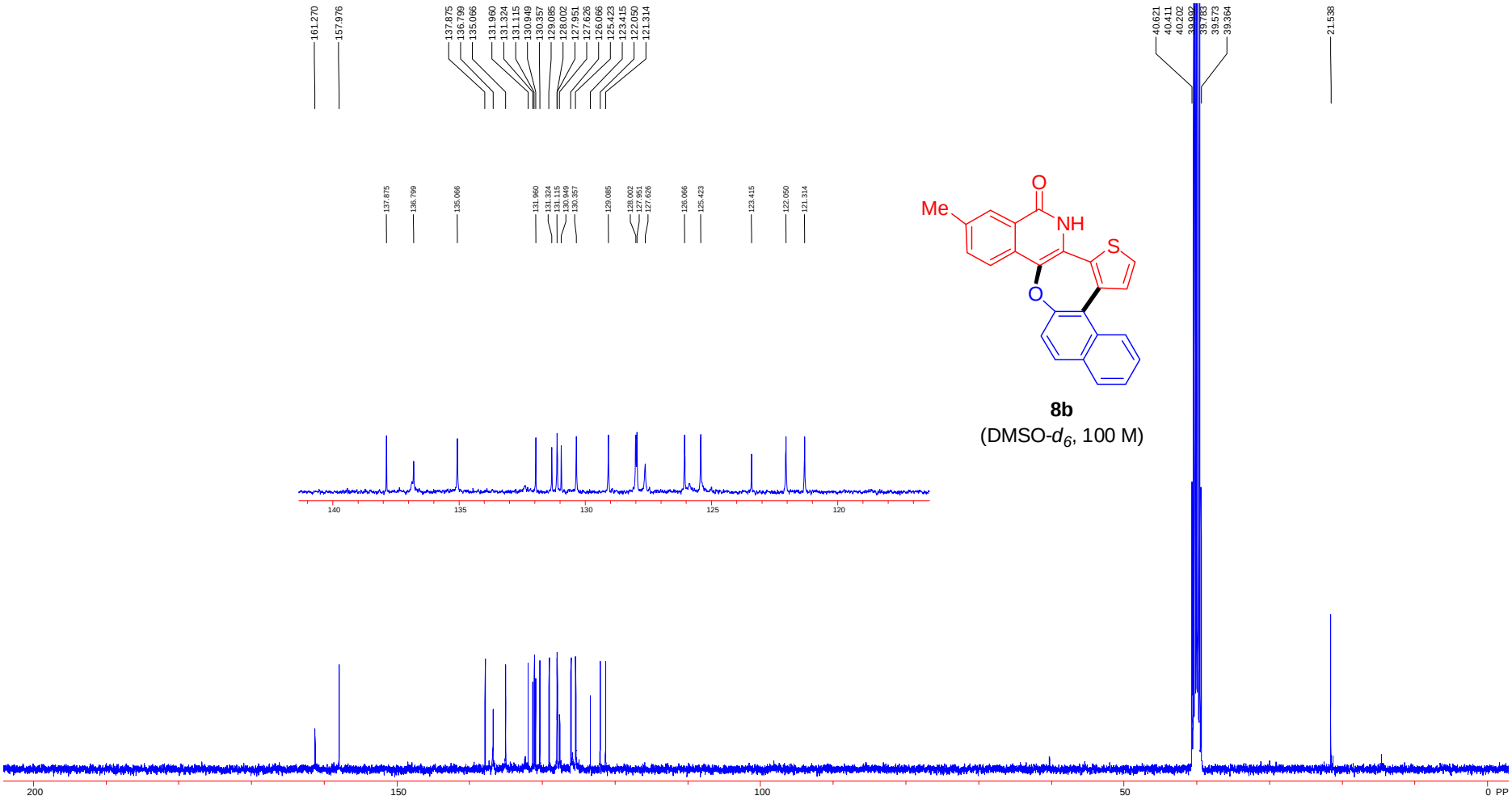
157.995
137.082
136.619
133.789
133.225
132.626
131.990
131.348
131.174
130.380
129.095
128.243
127.975
126.091
125.845
125.816
125.426
123.397
121.974
121.303
40.660
40.458
40.248
40.039
39.620
39.411
O
NH
S
O
8a
(DMSO-d_6, 100 M)
140
135
130
125
120
200
150
100
50
0PP


11.664
8.331
8.317
8.153
8.138
8.067
8.055
8.053
8.047
8.022
8.009
7.821
7.806
7.743
7.741
7.730
7.727
7.701
7.692
7.616
7.615
7.605
7.603
7.591
7.589
7.557
7.556
7.544
7.532
5.770
3.368
2.521
2.518
2.515
2.493
2.421
2.001
1.184
Me
NH
S
O
O
8b
(DMSO-d6, 600 M)
0.94
2.99
1.03
1.01
1.06
1.07
1.00
1.05
1.00
1.01
3.00
12
10
8
6
4
2
0 PP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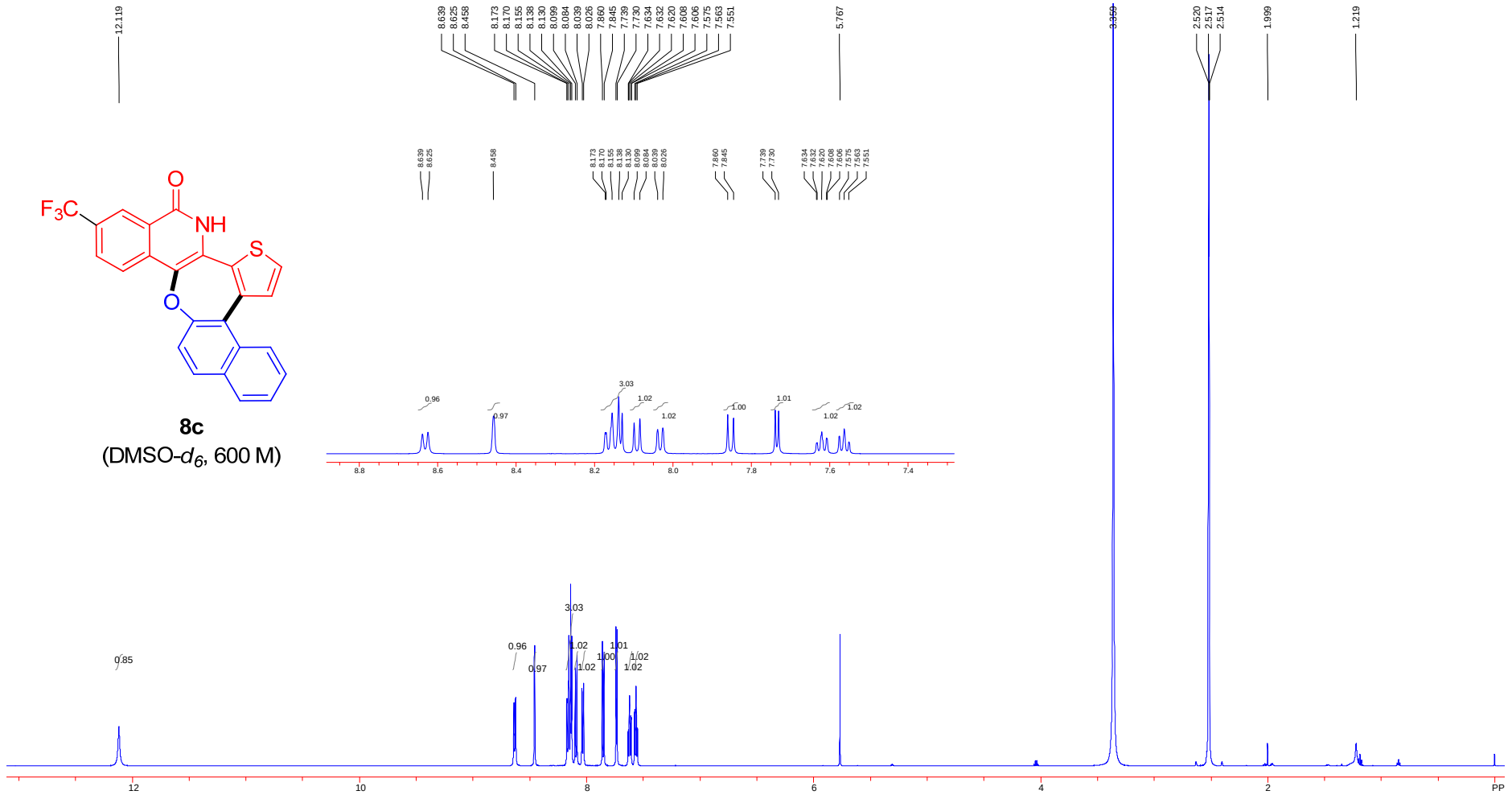
157.976
137.875
136.799
135.066
131.960
131.324
131.115
130.949
130.357
129.085
128.002
127.951
127.626
126.066
125.423
123.415
122.050
121.314
40.621
40.411
40.202
39.992
39.783
39.573
39.364
21.538
Me
O
NH
S
O
8b
(DMSO-d_6, 100 M)
200
150
100
50
0 PPM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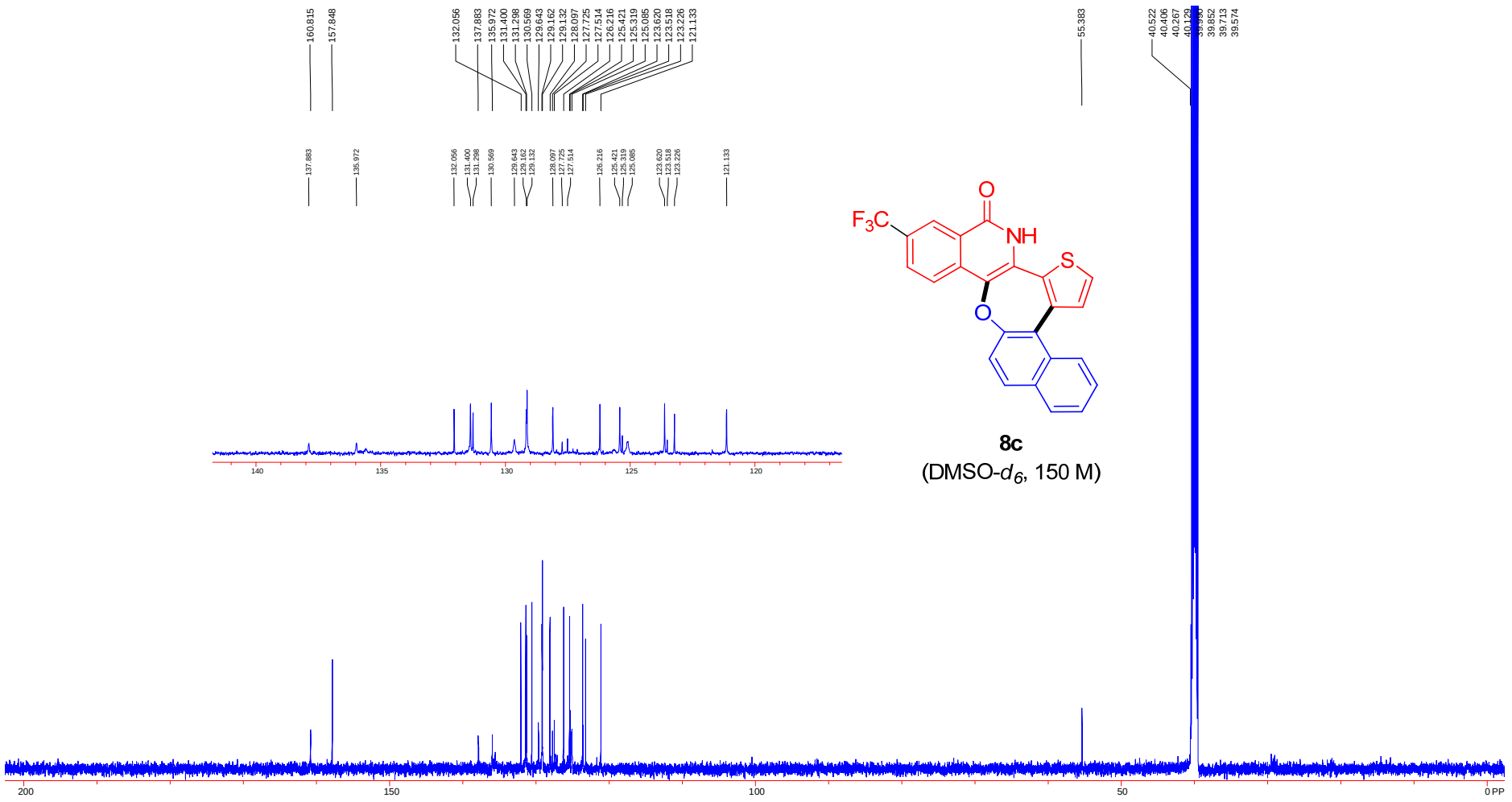
8.639
8.625
8.458
8.173
8.170
8.155
8.138
8.130
8.099
8.084
8.039
8.026
7.860
7.845
7.739
7.730
7.634
7.632
7.620
7.608
7.606
7.575
7.563
7.551
5.767
3.359
2.520
2.517
2.514
1.999
1.219
O
F3C
NH
S
O
8c
(DMSO-d6, 600 M)
0.96
0.97
3.03
1.02
1.02
1.00
1.01
1.02
1.02
0.85
12
10
8
6
4
2
PP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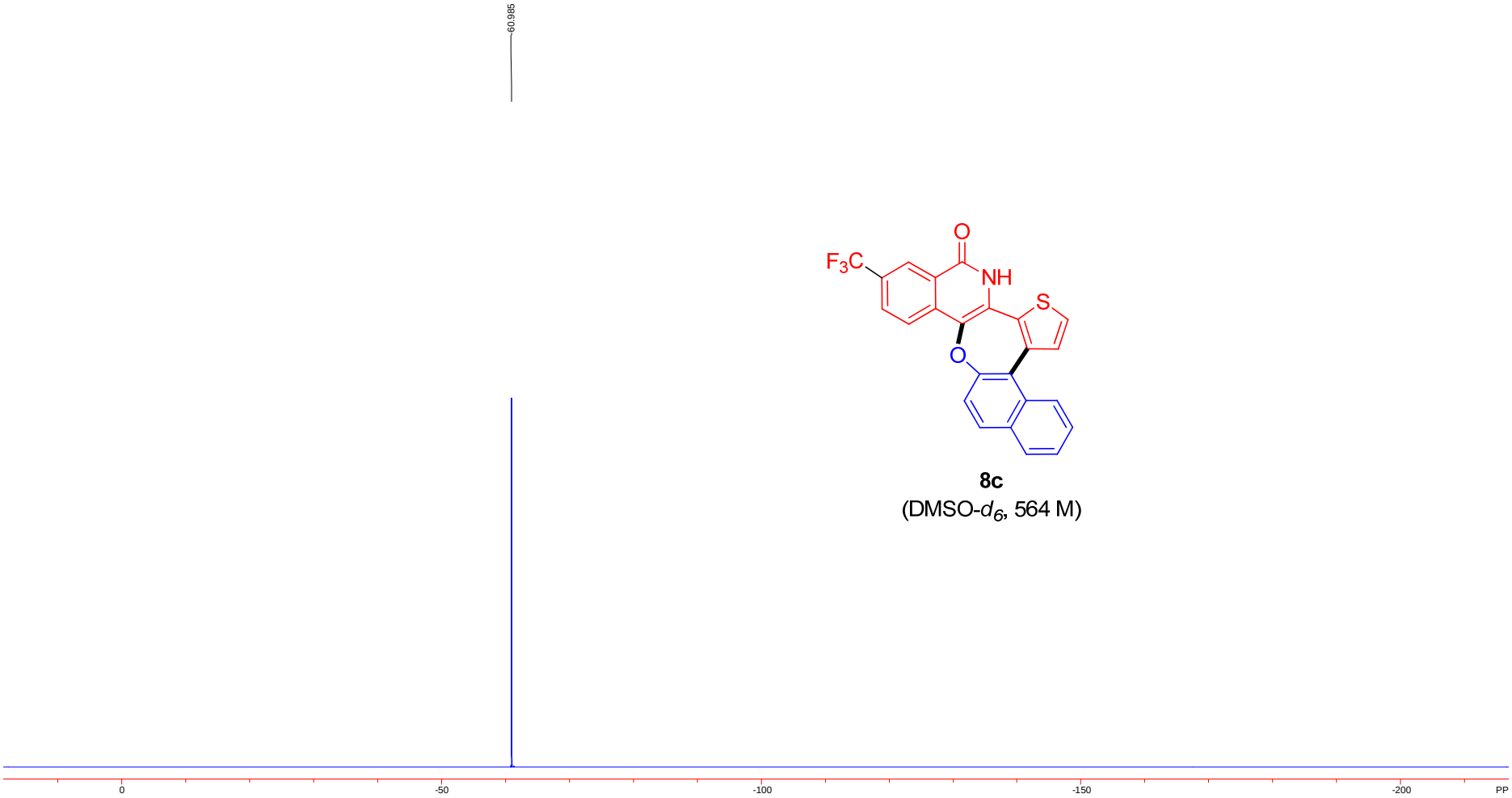
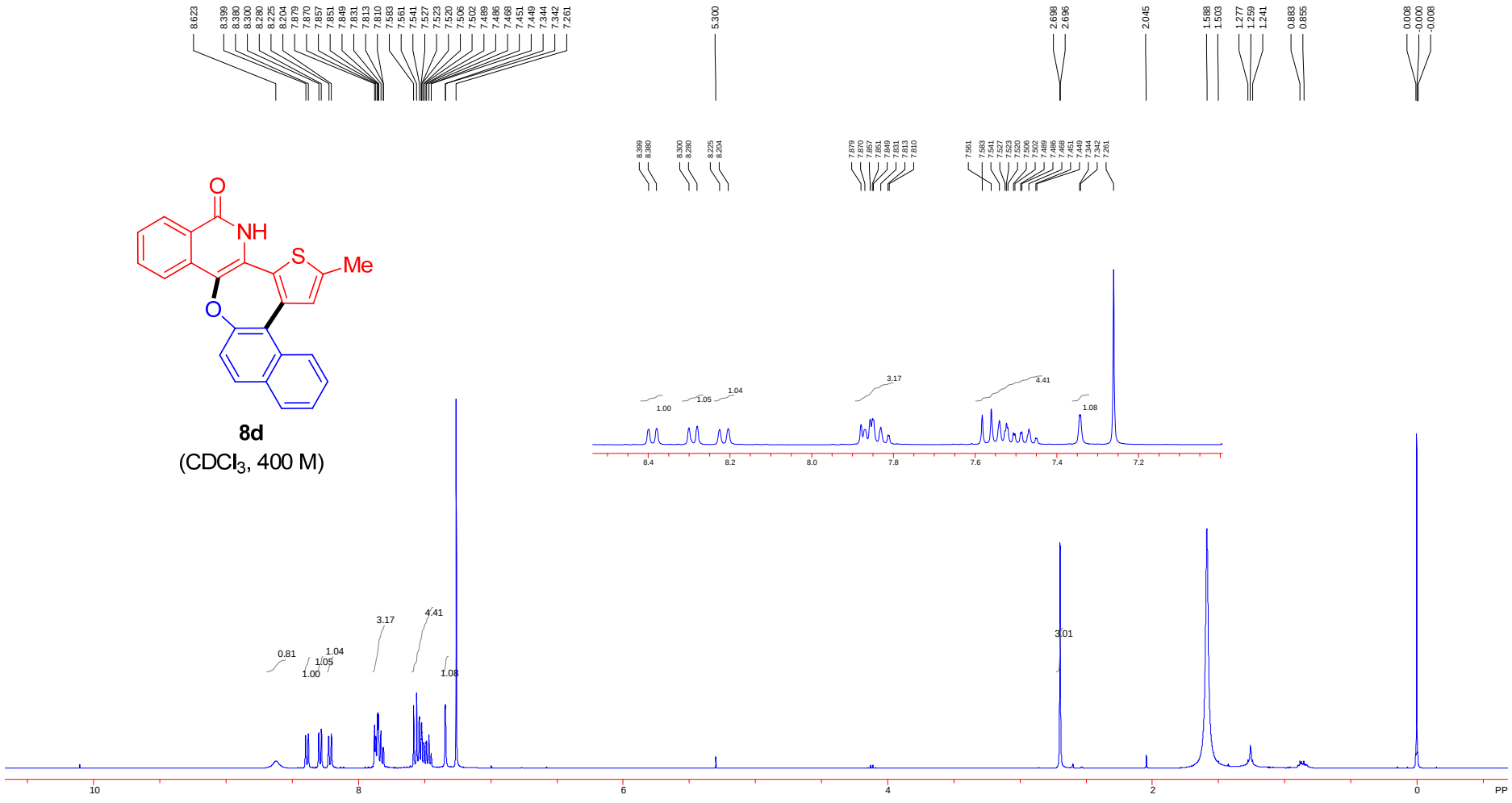
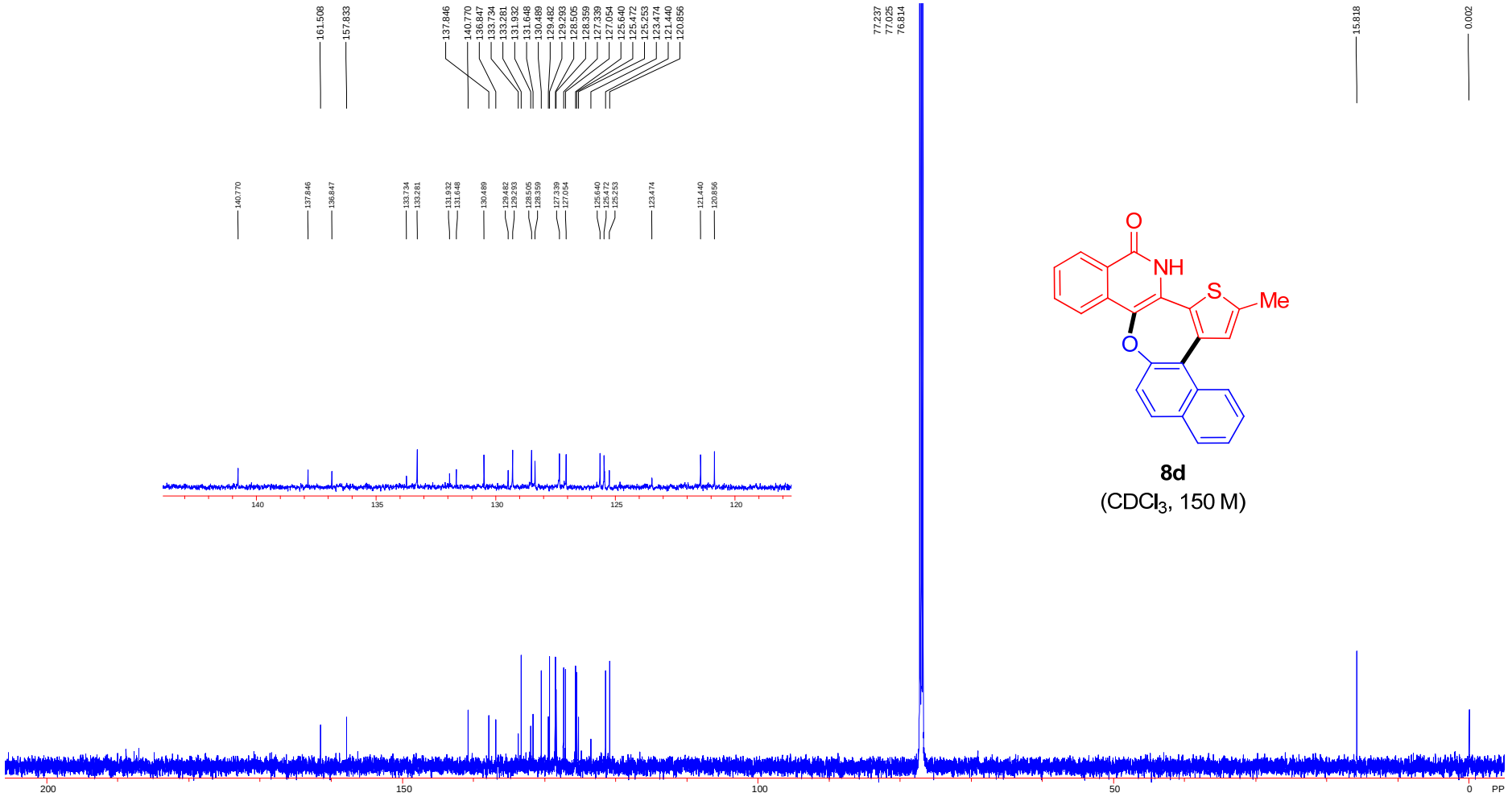
157.848
132.056
137.883
135.972
131.400
131.298
130.569
129.643
129.162
129.132
128.097
127.725
127.514
126.216
125.421
125.319
125.085
123.620
123.518
123.226
121.133
55.383
40.522
40.406
40.267
40.129
39.852
39.713
39.574
O
NH
S
O
F3C
8c
(DMSO-d6, 150 M)
200
150
100
50
0 PP

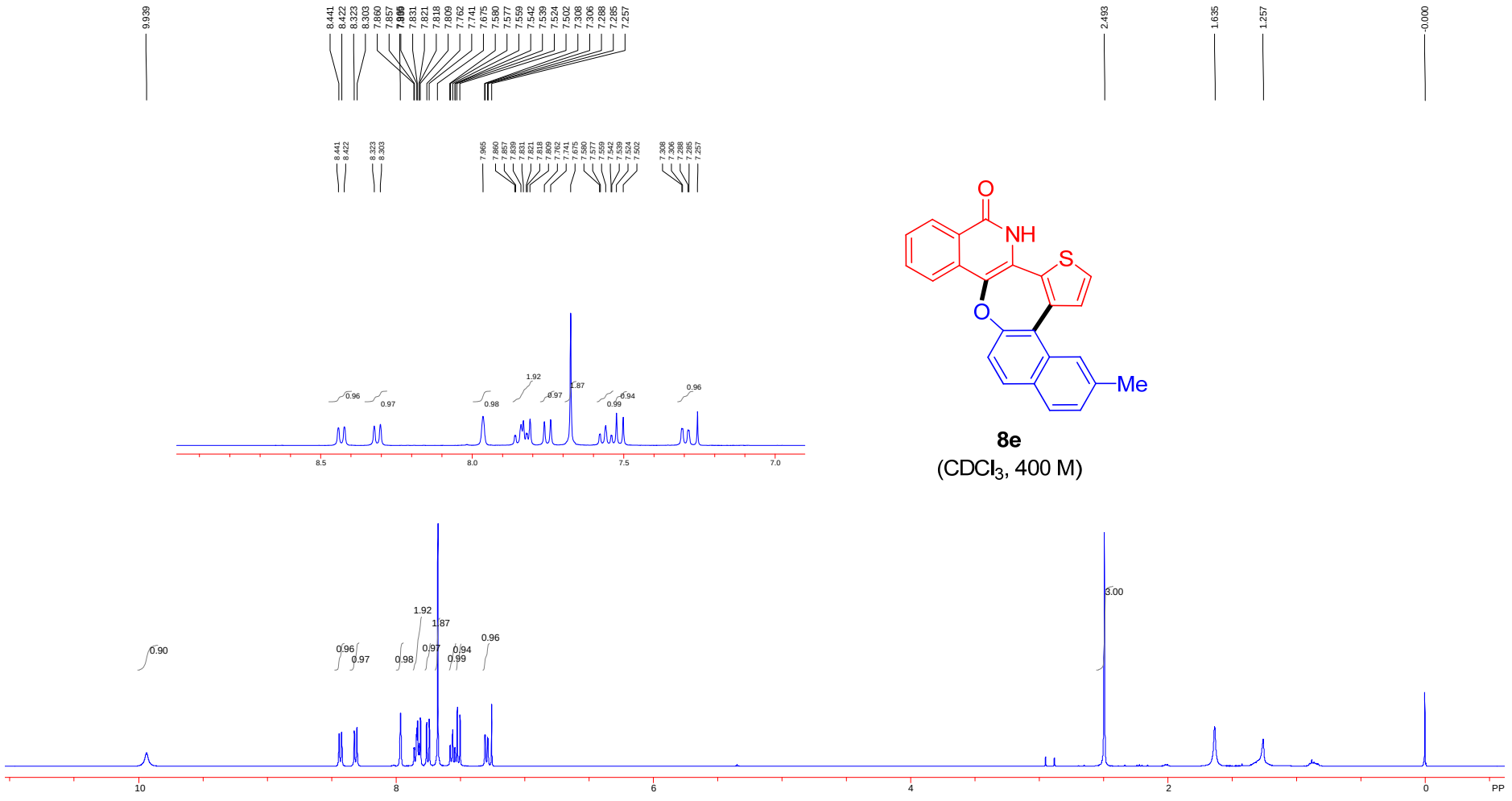


8c

(DMSO-d_6, 564 M)

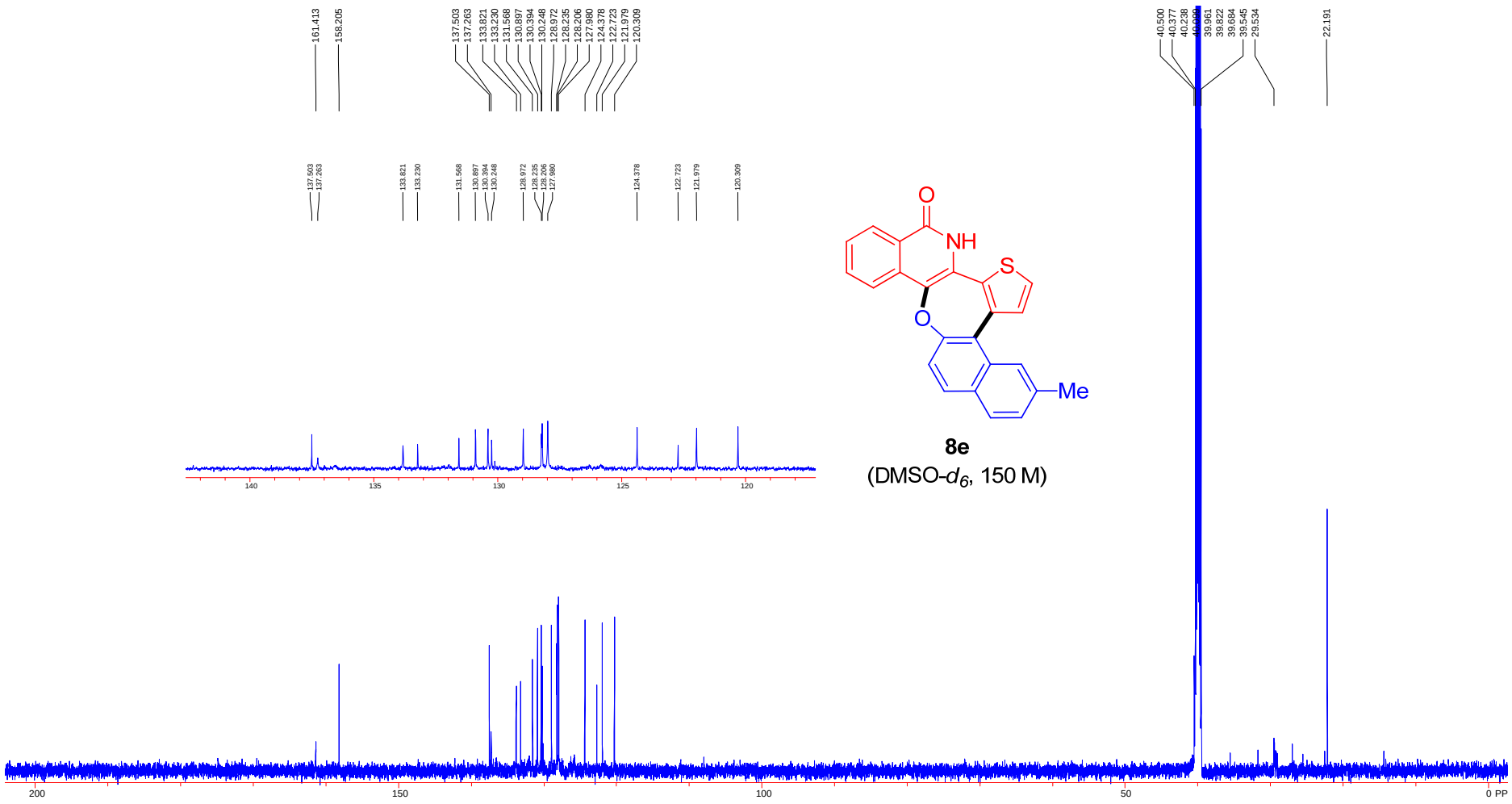

8.623
8.399
8.380
8.300
8.280
8.225
8.204
7.879
7.870
7.857
7.851
7.849
7.831
7.813
7.810
7.583
7.561
7.541
7.527
7.523
7.520
7.506
7.502
7.489
7.486
7.468
7.451
7.449
7.344
7.342
7.261
5.300
2.698
2.696
2.045
1.588
1.503
1.277
1.259
1.241
0.883
0.855
0.008
0.000
-0.008
O
NH
S
Me
O
8d
(CDCl3, 400 M)
1.00
1.05
1.04
3.17
4.41
1.08
0.81
3.01
10
8
6
4
2
0
PP


161.508
157.833
137.846
140.770
136.847
133.734
133.281
131.932
131.648
130.489
129.482
129.293
128.505
128.359
127.339
127.054
125.640
125.472
125.253
123.474
121.440
120.856
77.237
77.025
76.814
15.818
0.002
O
NH
S
Me
O
8d
(CDCl3, 150 M)
200
150
100
50
0
PP



8e

($CDCl_3$, 400 M)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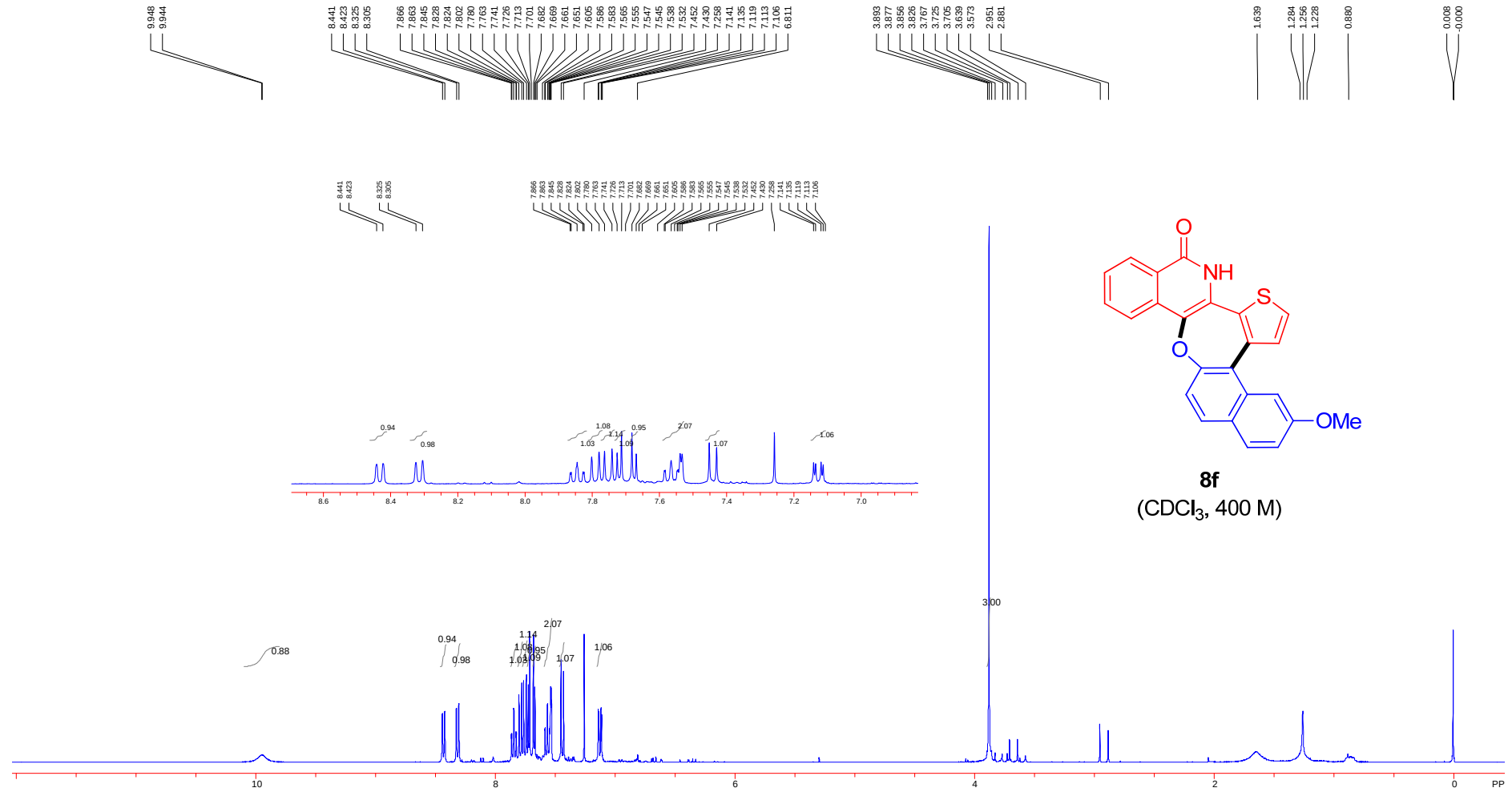
158.205
137.503
137.263
133.821
133.230
131.568
130.897
130.394
130.248
128.972
128.235
128.206
127.980
124.378
122.723
121.979
120.309
40.500
40.377
40.238
39.961
39.822
39.684
39.545
29.534
22.191
O
NH
S
O
Me
8e
(DMSO-d_6, 150 M)
200
150
100
50
0 PP
140
135
130
125
120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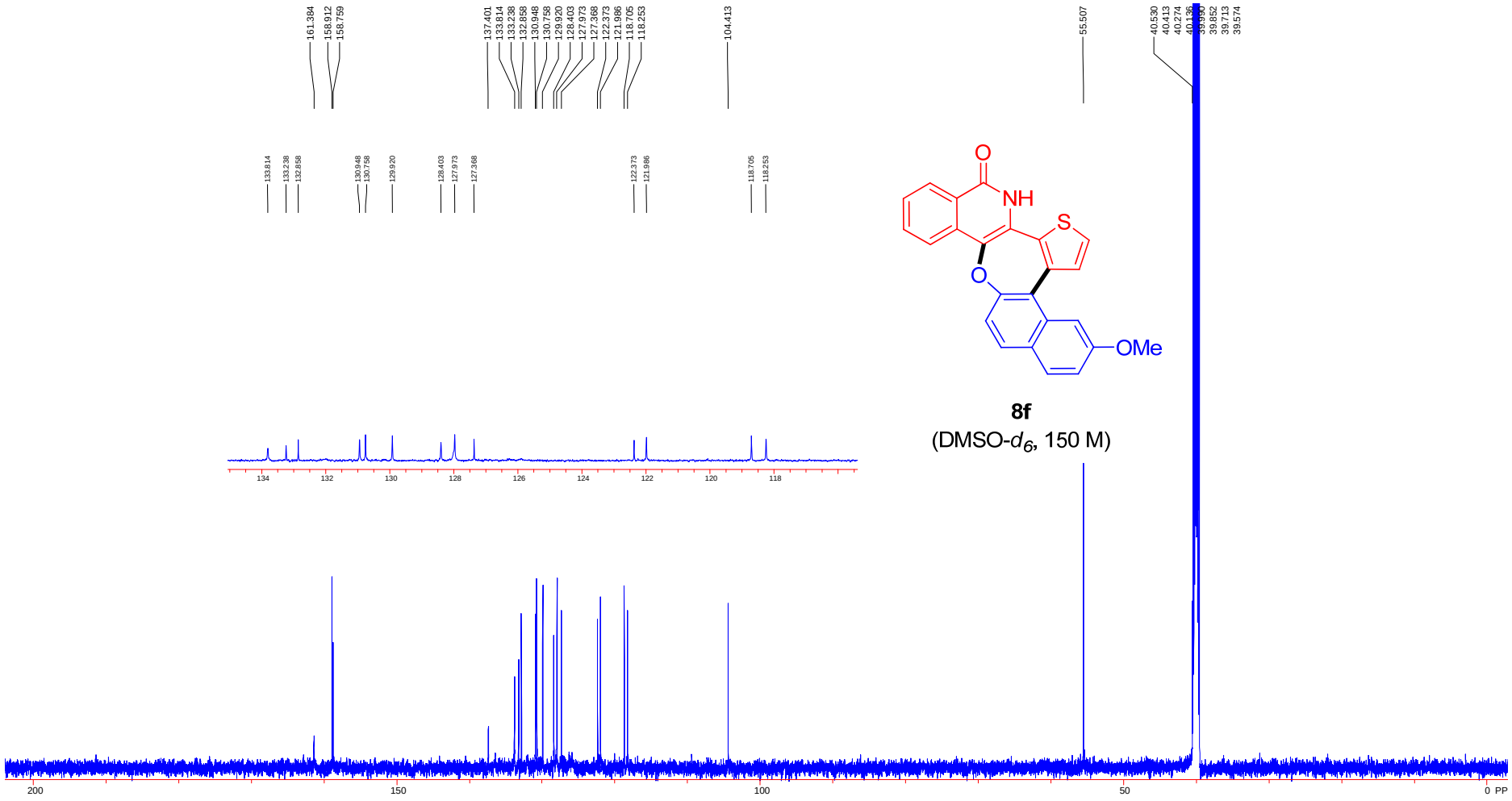
9.944
8.441
8.423
8.325
8.305
7.866
7.863
7.845
7.828
7.824
7.802
7.780
7.763
7.741
7.726
7.713
7.701
7.682
7.669
7.661
7.651
7.605
7.586
7.583
7.565
7.555
7.547
7.545
7.538
7.532
7.452
7.430
7.258
7.141
7.135
7.119
7.113
7.106
6.811
3.893
3.877
3.856
3.826
3.767
3.725
3.705
3.639
3.573
2.951
2.881
1.639
1.284
1.256
1.228
0.880
0.008
-0.000
NH
S
O
O
OMe
8f
(CDCl3, 400 M)
0.88
0.94
0.98
1.08
1.14
1.09
0.95
1.03
2.07
1.07
1.06
3.00
10
8
6
4
2
0
PP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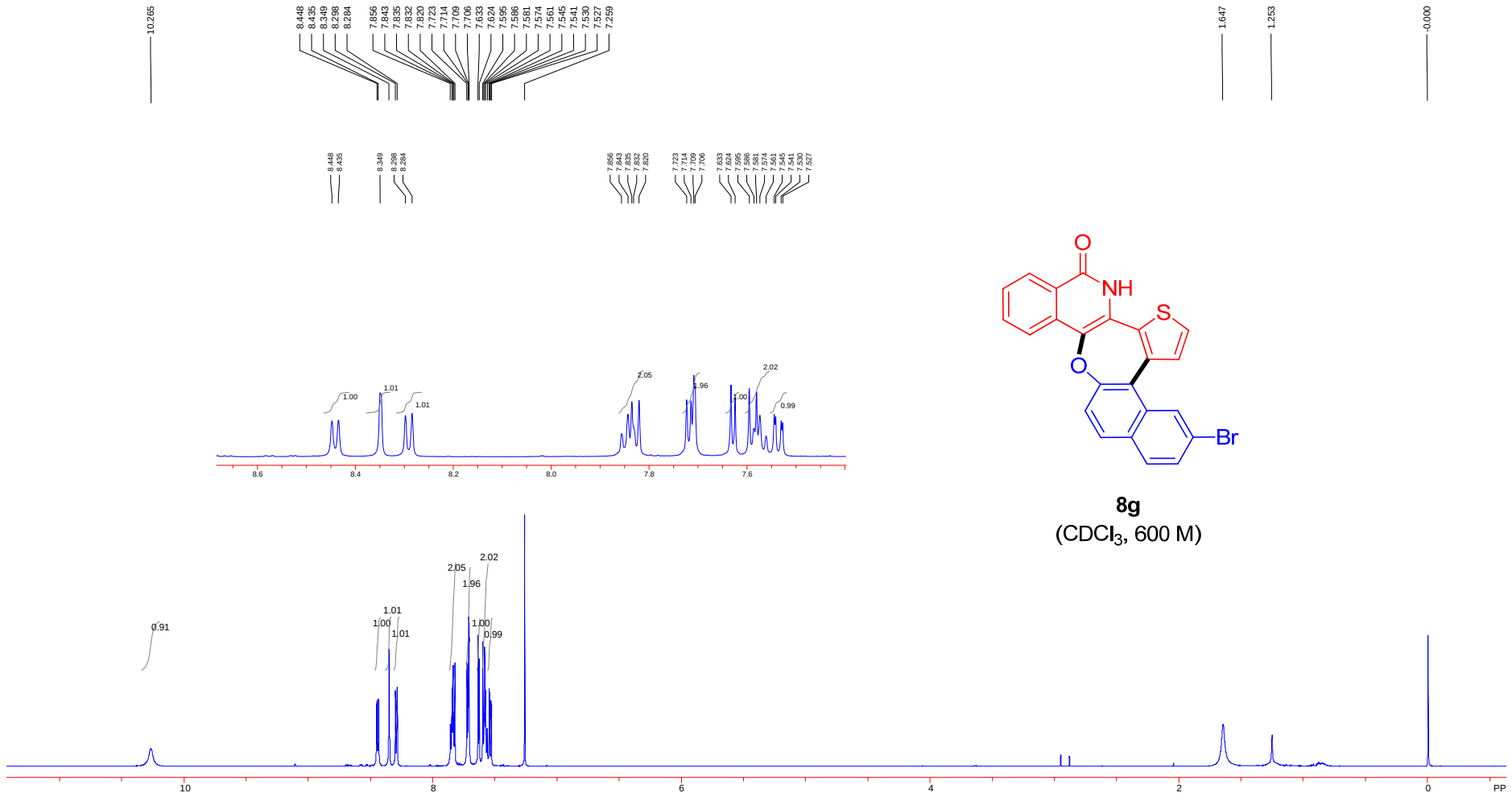
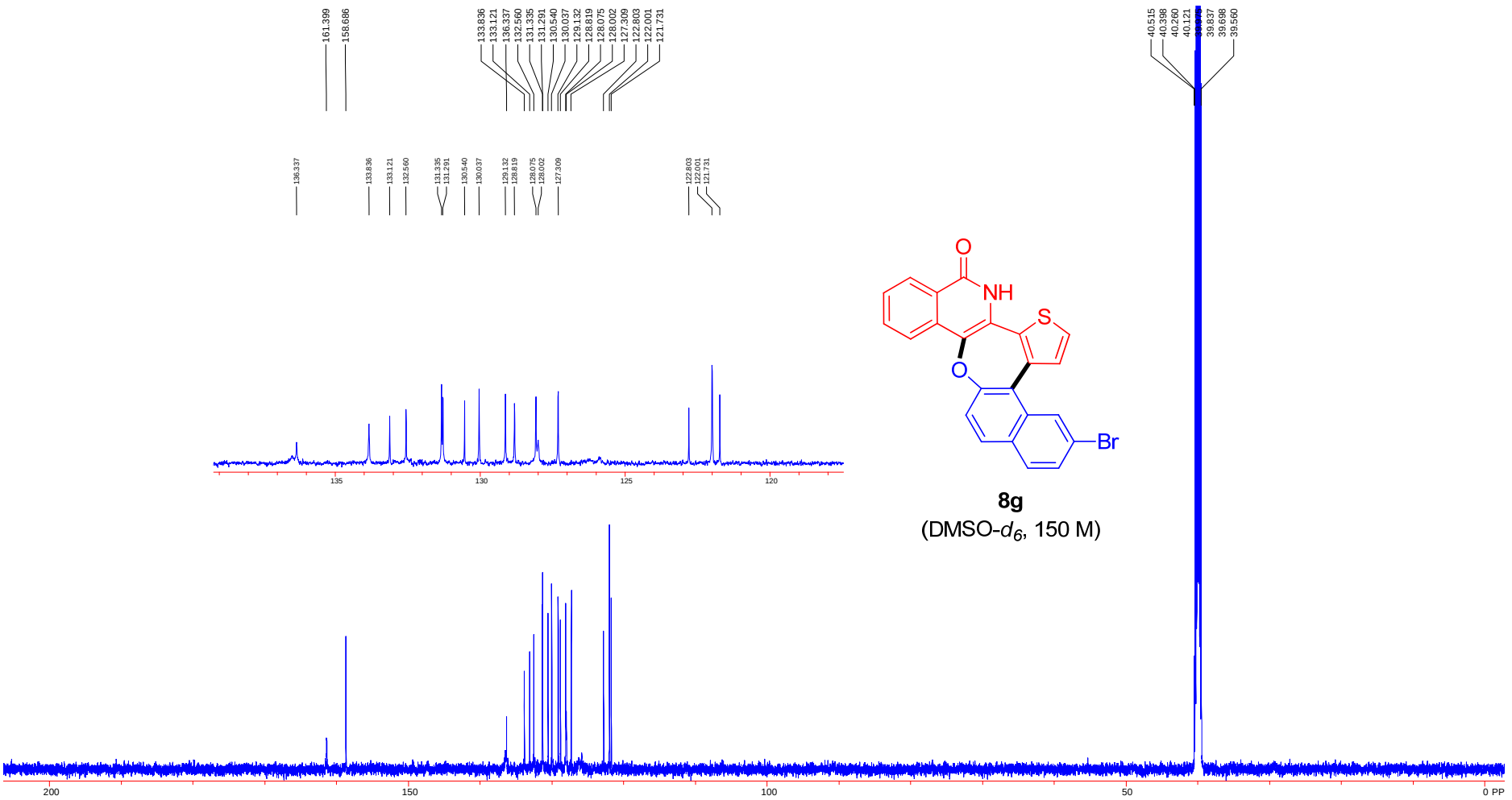
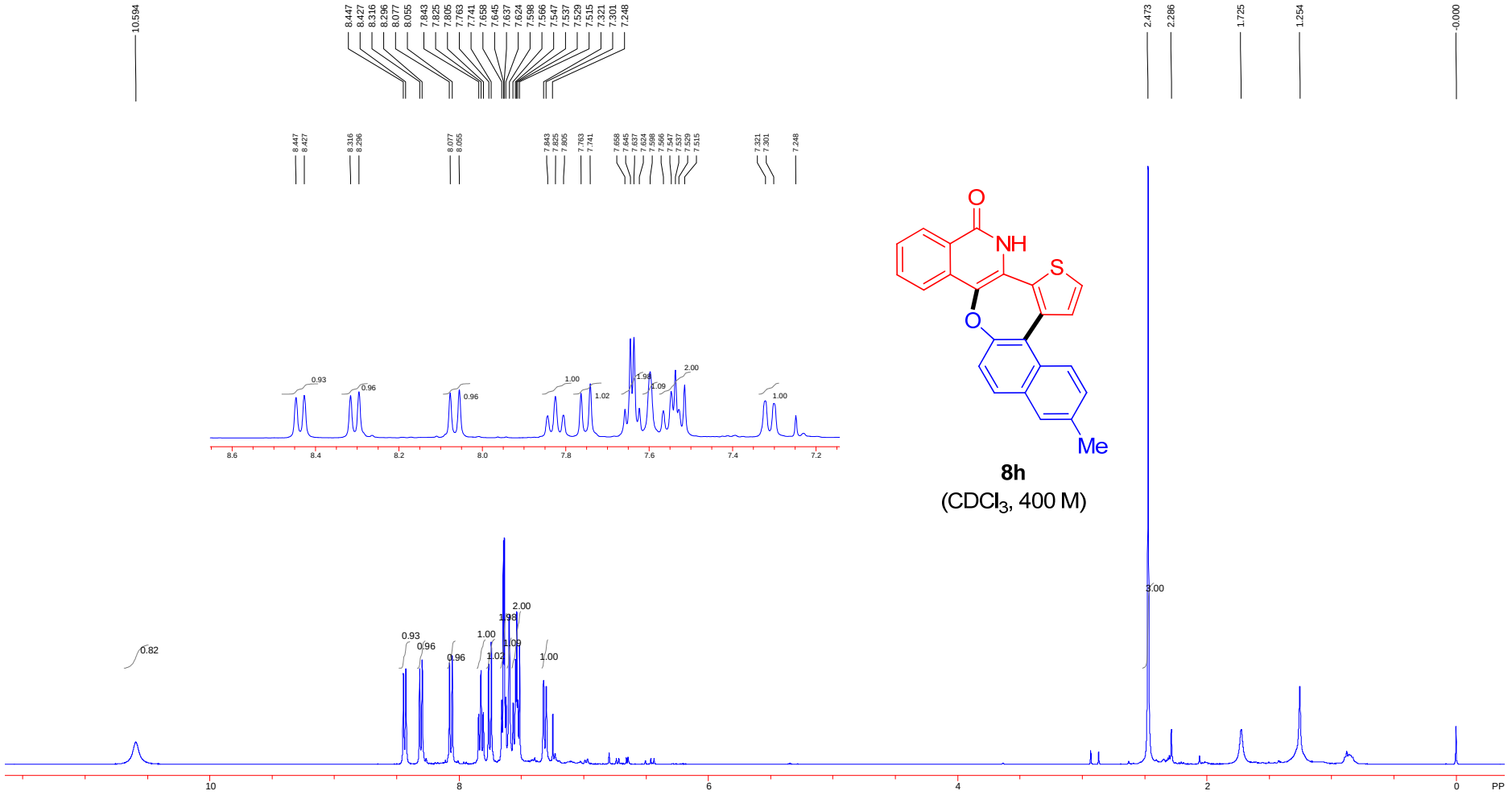
158.912
158.759
137.401
133.814
133.238
132.858
130.948
130.758
129.920
128.403
127.973
127.368
122.373
121.986
118.705
118.253
104.413
55.507
40.530
40.413
40.274
40.136
39.996
39.852
39.713
39.574
O
NH
S
O
OMe
8f
(DMSO-d6, 150 M)
200
150
100
50
0 PP


10.265
8.448
8.435
8.349
8.298
8.284
7.856
7.843
7.835
7.832
7.820
7.723
7.714
7.709
7.706
7.633
7.624
7.595
7.586
7.581
7.574
7.561
7.545
7.541
7.530
7.527
7.259
1.647
1.253
0.000
O
NH
S
O
Br
8g
(CDCl3, 600 M)
0.91
1.00
1.01
1.01
2.05
1.96
2.02
1.00
0.99
10
8
6
4
2
0
PP



8g

(DMSO-d_6, 150 M)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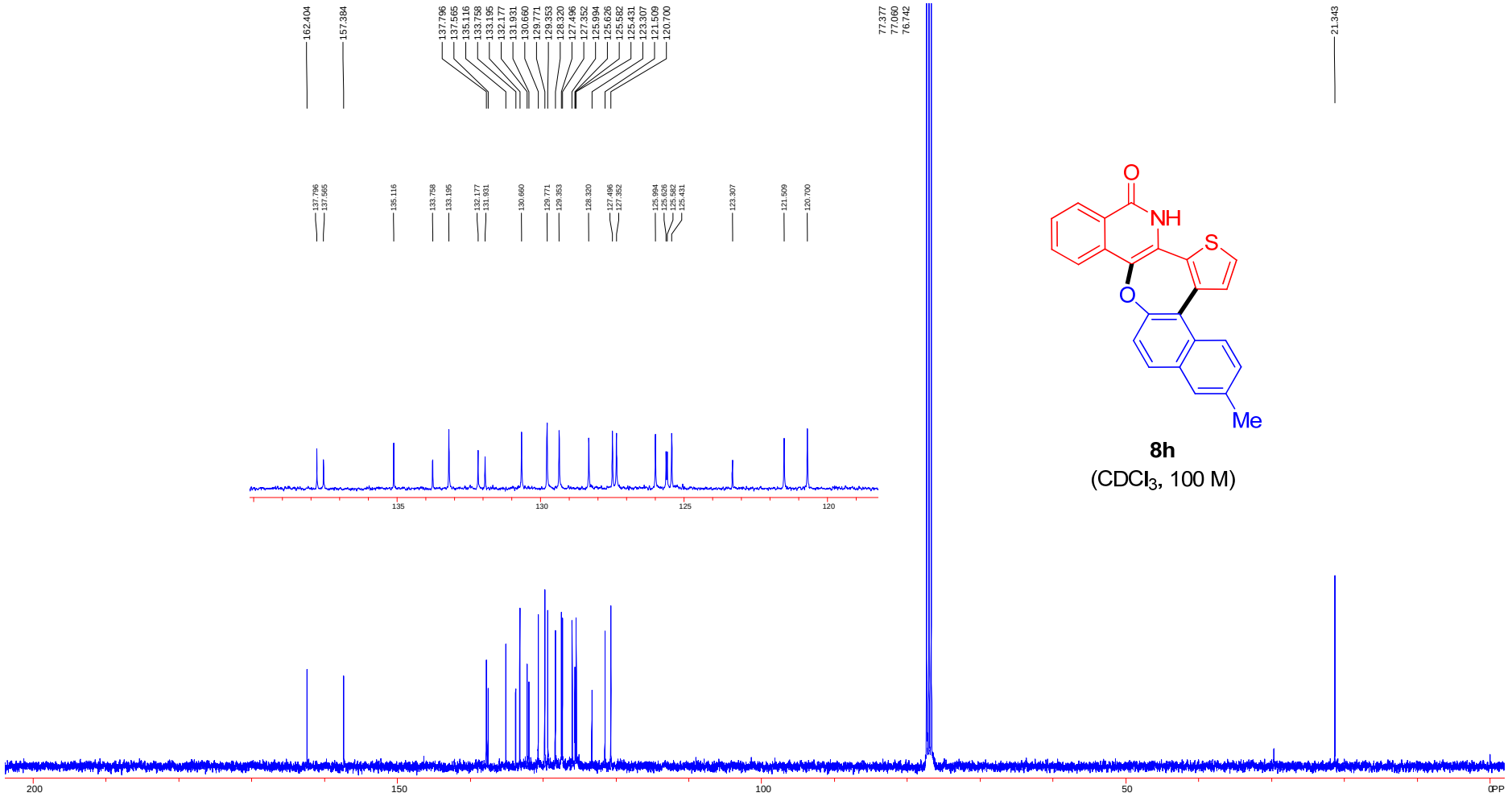
8.447
8.427
8.316
8.296
8.077
8.055
7.843
7.825
7.805
7.763
7.741
7.658
7.645
7.637
7.624
7.598
7.566
7.547
7.537
7.529
7.515
7.321
7.301
7.248
2.473
2.286
1.725
1.254
-0.000
O
NH
S
O
Me
8h
(CDCl3, 400 M)
0.82
0.93
0.96
0.96
1.00
1.02
1.98
1.09
2.00
1.00
3.00
PP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137.796
137.565
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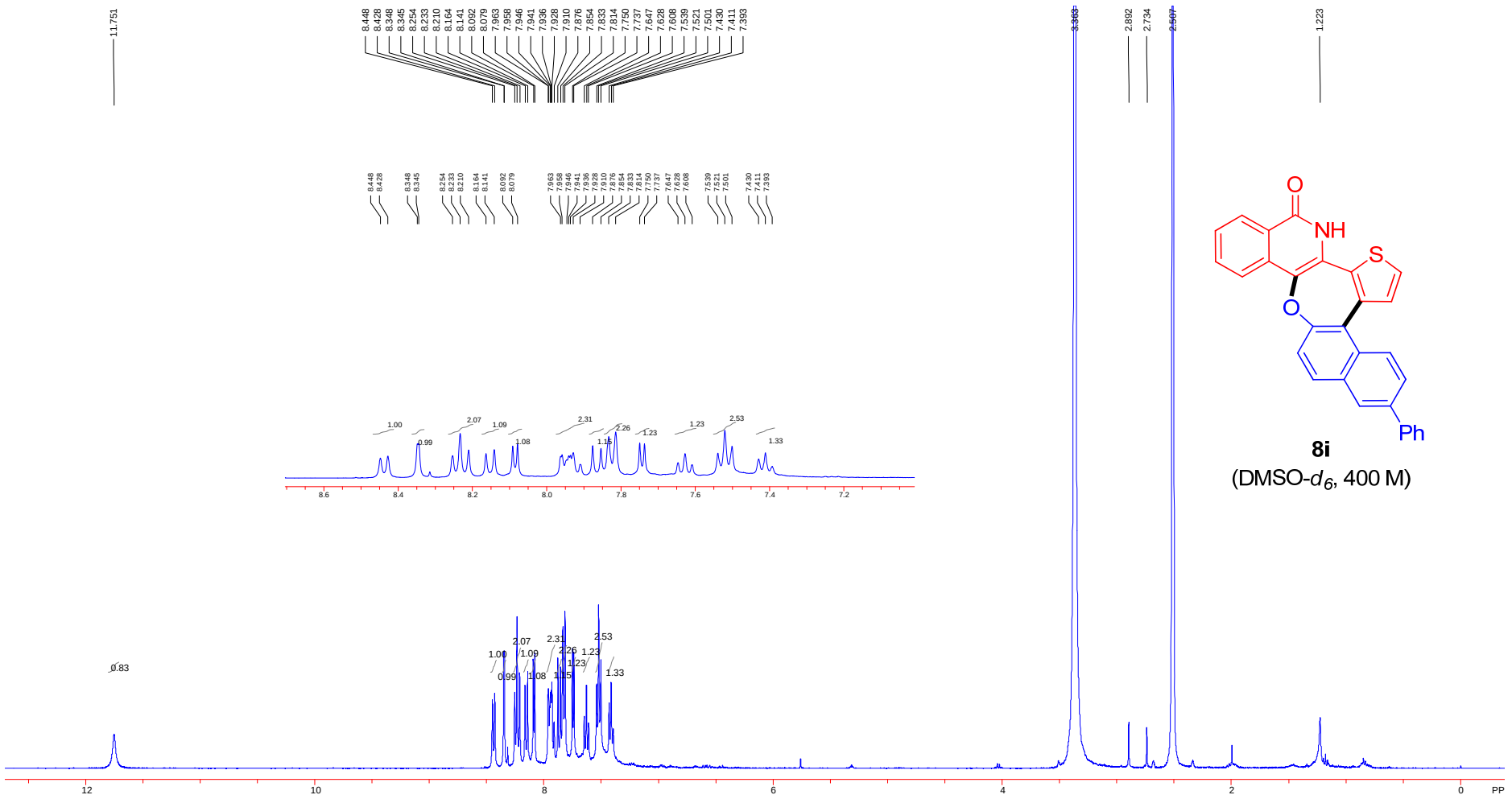
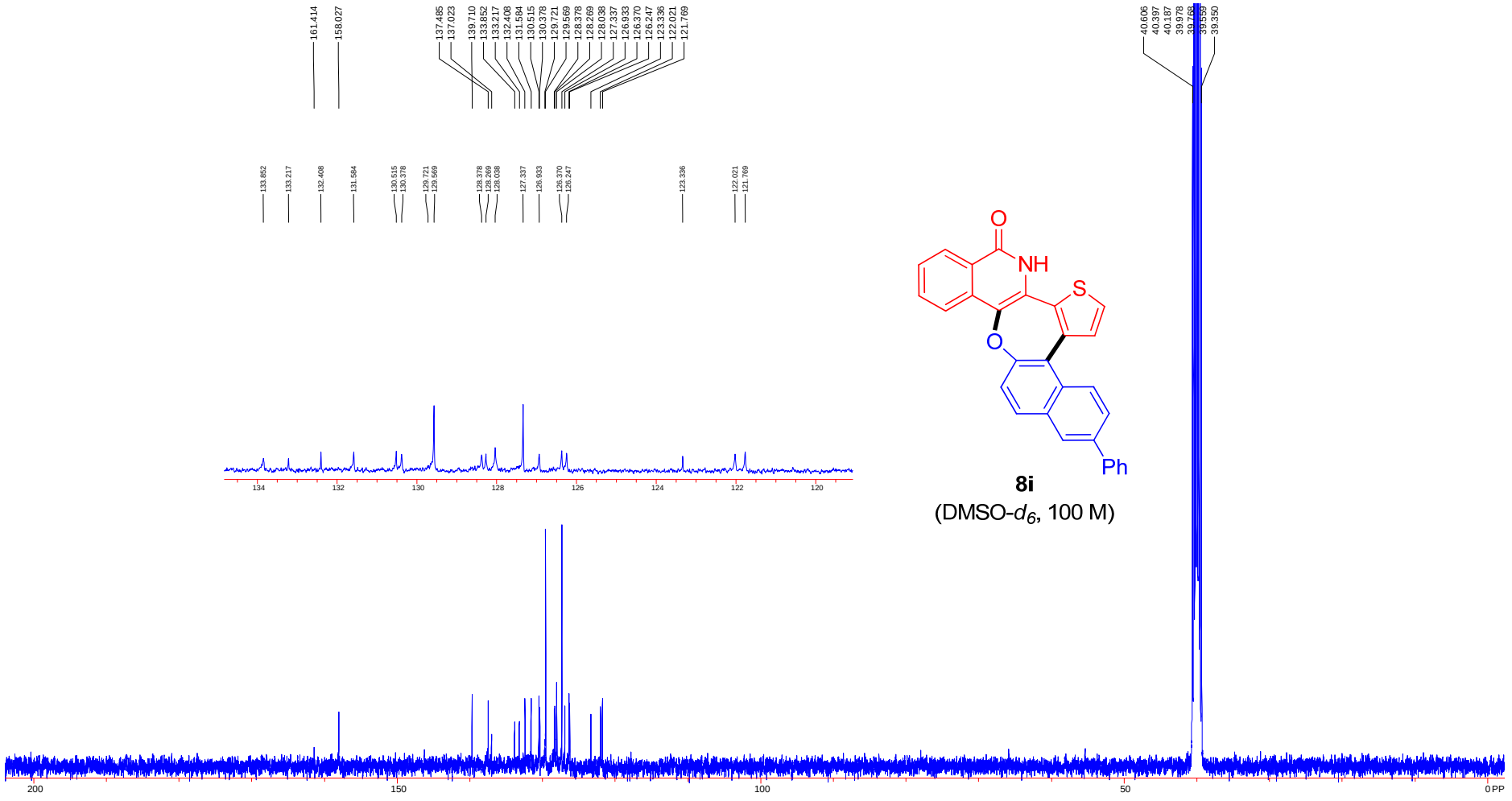
133.758
133.195
132.177
131.931
130.660
129.771
129.353
128.320
127.496
127.352
125.994
125.626
125.582
125.431
123.307
121.509
120.700
77.377
77.060
76.742
21.343
O
NH
S
O
Me
8h
(CDCl3, 100 M)
200
150
100
50
0
PPM
135
130
125
120


11.751
8.448 8.428 8.348 8.345 8.254 8.233 8.210 8.164 8.141 8.092 8.079 7.963 7.958 7.946 7.941 7.936 7.928 7.910 7.876 7.854 7.833 7.814 7.750 7.737 7.647 7.628 7.608 7.539 7.521 7.501 7.430 7.411 7.393
3.363
2.892
2.734
2.567
1.223
1.00 2.07 1.09 2.31 2.26 1.23 1.23 2.53 1.33 0.99 1.08 1.15
0.83
12 10 8 6 4 2 0 PP
O NH S O Ph
8i
(DMSO-d_6, 400 M)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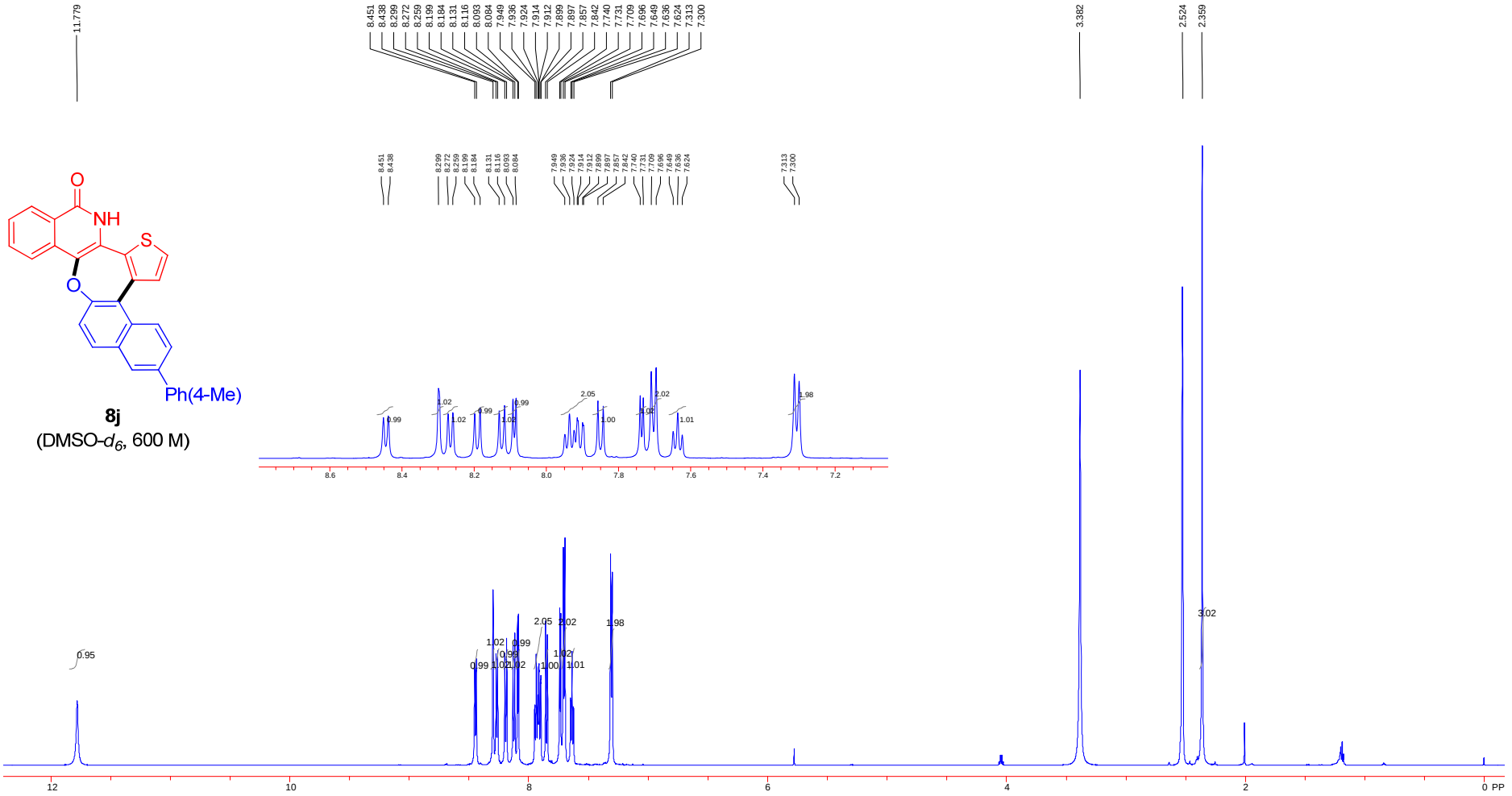
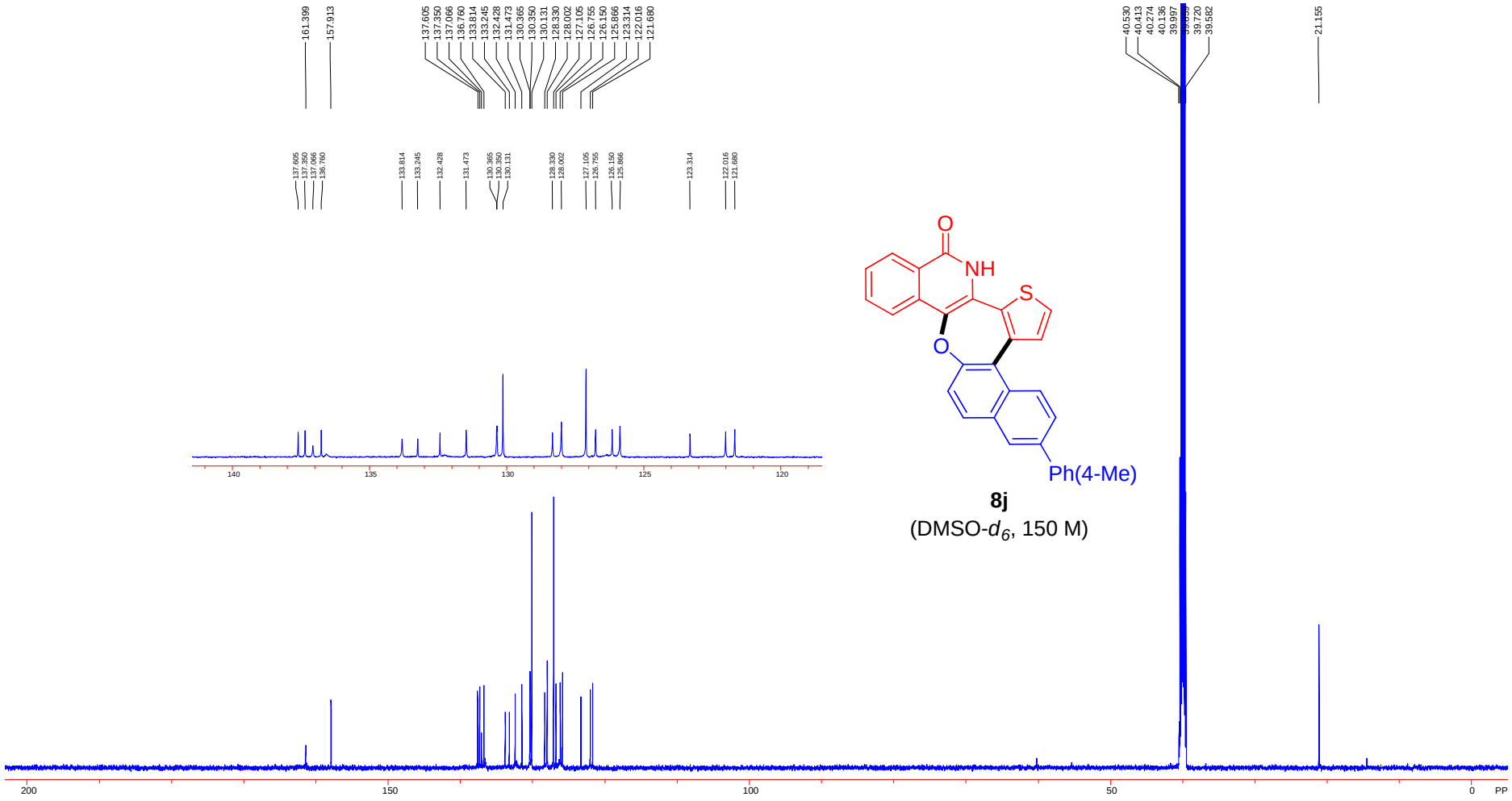
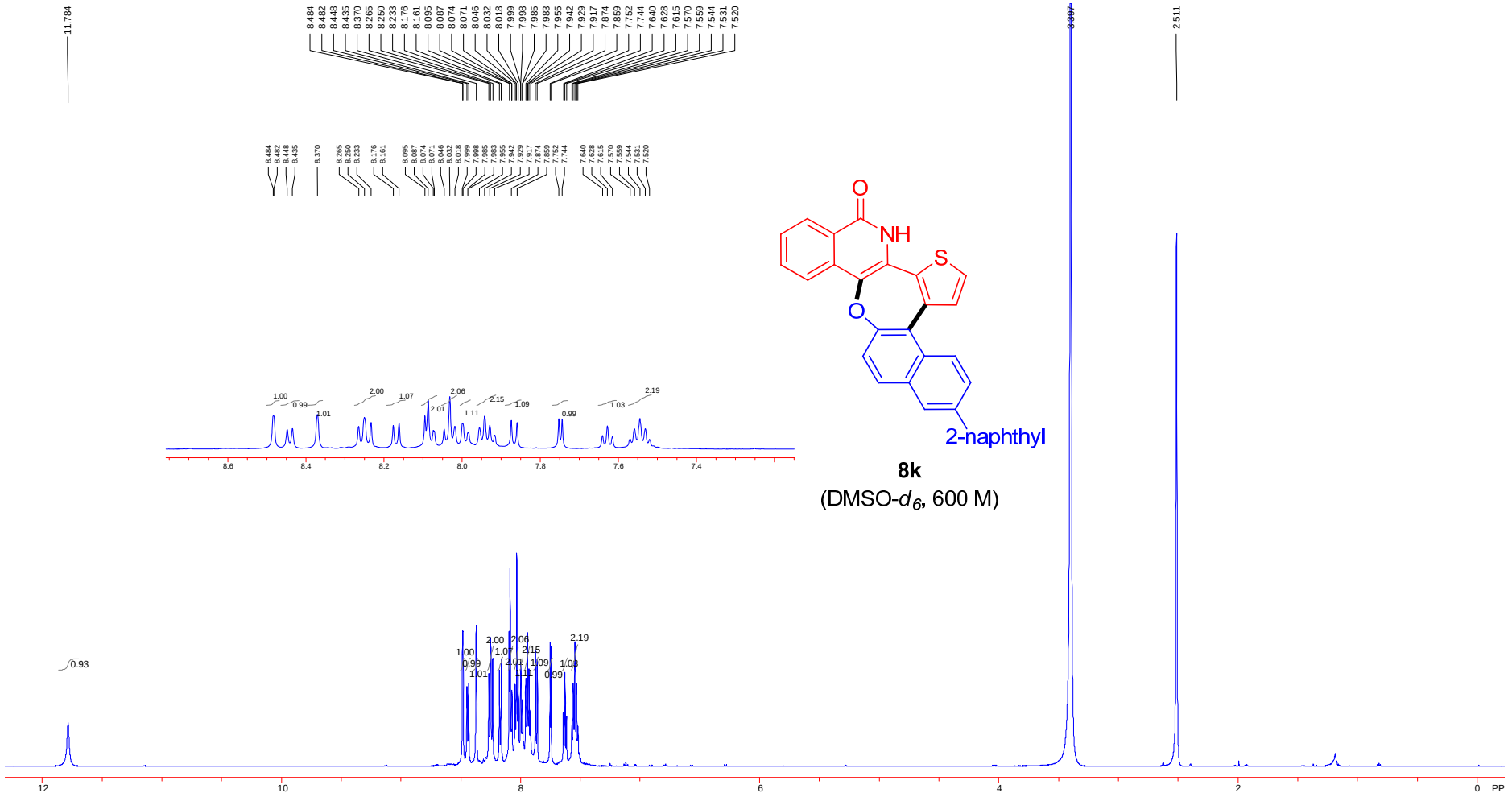
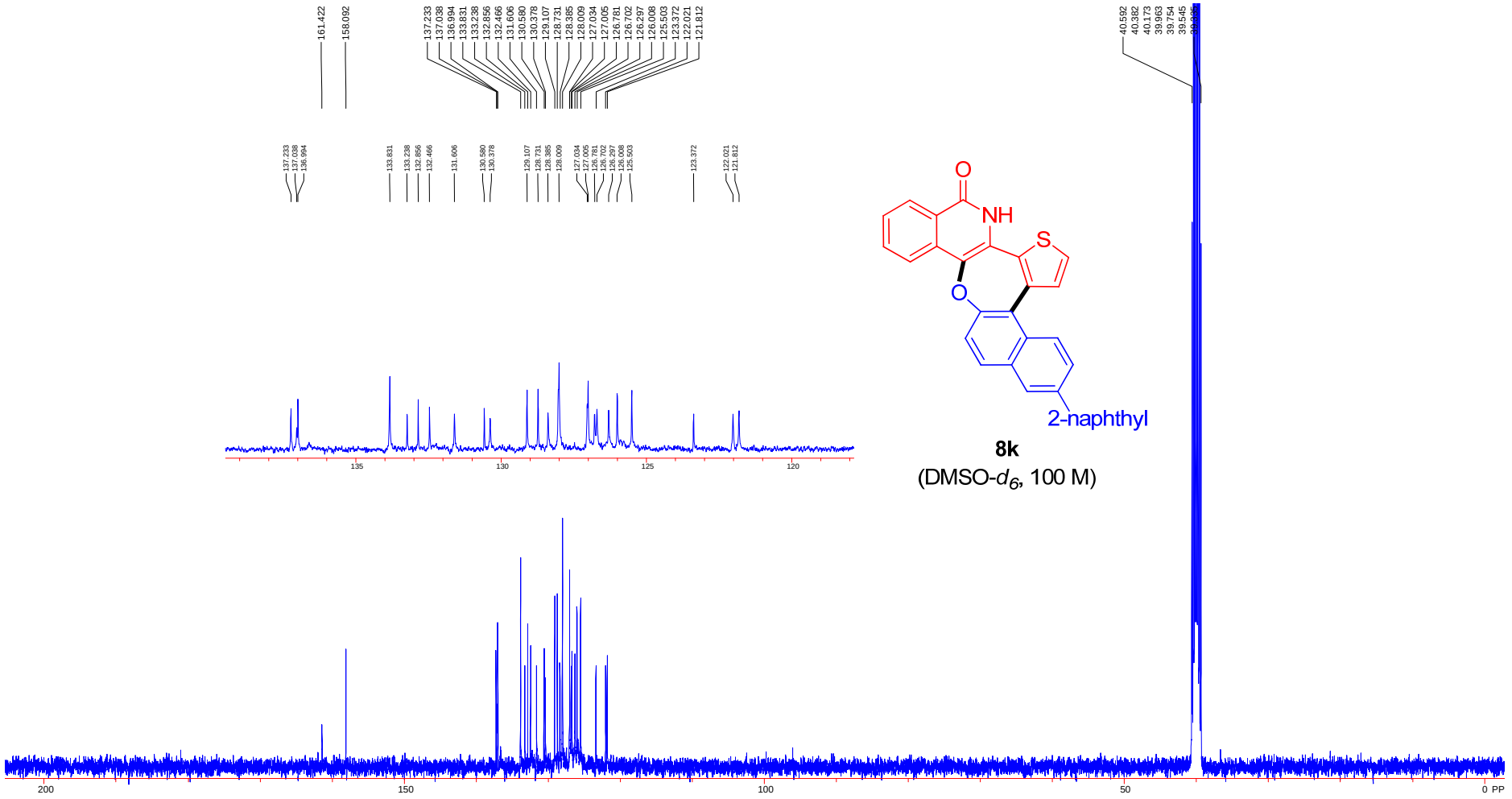
158.027
137.485
137.023
139.710
133.852
133.217
132.408
131.584
130.515
130.378
129.721
129.569
128.378
128.269
128.038
127.337
126.933
126.370
126.247
123.336
122.021
121.769
40.606
40.397
40.187
39.978
39.768
39.559
39.350
133.852
133.217
132.408
131.584
130.515
130.378
129.721
129.569
128.378
128.269
128.038
127.337
126.933
126.370
126.247
123.336
122.021
121.769
O
NH
S
O
Ph
8i
(DMSO-d_6, 100 M)
134
132
130
128
126
124
122
120
200
150
100
50
0 PPM


11.779
8.451
8.438
8.299
8.272
8.259
8.199
8.184
8.131
8.116
8.093
8.084
7.949
7.936
7.924
7.914
7.912
7.899
7.897
7.857
7.842
7.740
7.731
7.709
7.696
7.649
7.636
7.624
7.313
7.300
3.382
2.524
2.359
O
NH
S
O
Ph(4-Me)
8j
(DMSO-d_6, 600 M)
0.95
1.02
0.99
1.02
0.99
1.02
1.02
0.99
2.05
2.02
1.00
1.02
1.01
1.98
3.02
12
10
8
6
4
2
0 PP


161.399
157.913
137.605
137.350
137.066
136.760
133.814
133.245
132.428
131.473
130.365
130.350
130.131
128.330
128.002
127.105
126.755
126.150
125.866
123.314
122.016
121.680
40.530
40.413
40.274
40.136
39.997
39.859
39.720
39.582
21.155
O
NH
S
O
Ph(4-Me)
8j
(DMSO-d_6, 150 M)
140
135
130
125
120
200
150
100
50
0
PP


11.784
8.484
8.482
8.448
8.435
8.370
8.265
8.250
8.233
8.176
8.161
8.095
8.087
8.074
8.071
8.046
8.032
8.018
7.999
7.998
7.985
7.983
7.955
7.942
7.929
7.917
7.874
7.859
7.752
7.744
7.640
7.628
7.615
7.570
7.559
7.544
7.531
7.520
3.997
2.511
O
NH
S
O
2-naphthyl
8k
(DMSO-d_6, 600 M)
0.93
1.00
0.99
1.01
2.00
1.07
2.06
2.01
1.11
2.15
1.09
0.99
1.03
2.19
12
10
8
6
4
2
0
PP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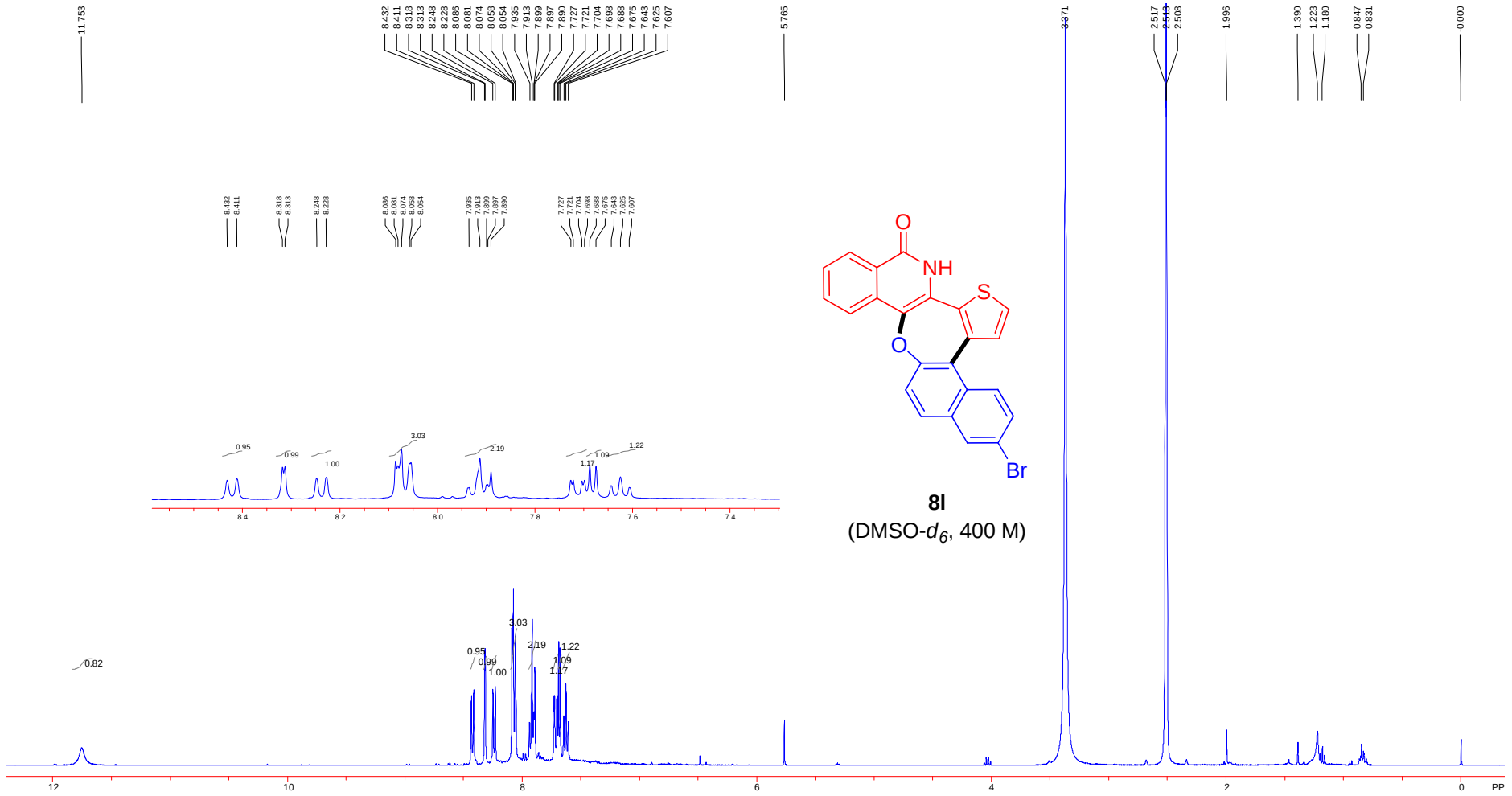
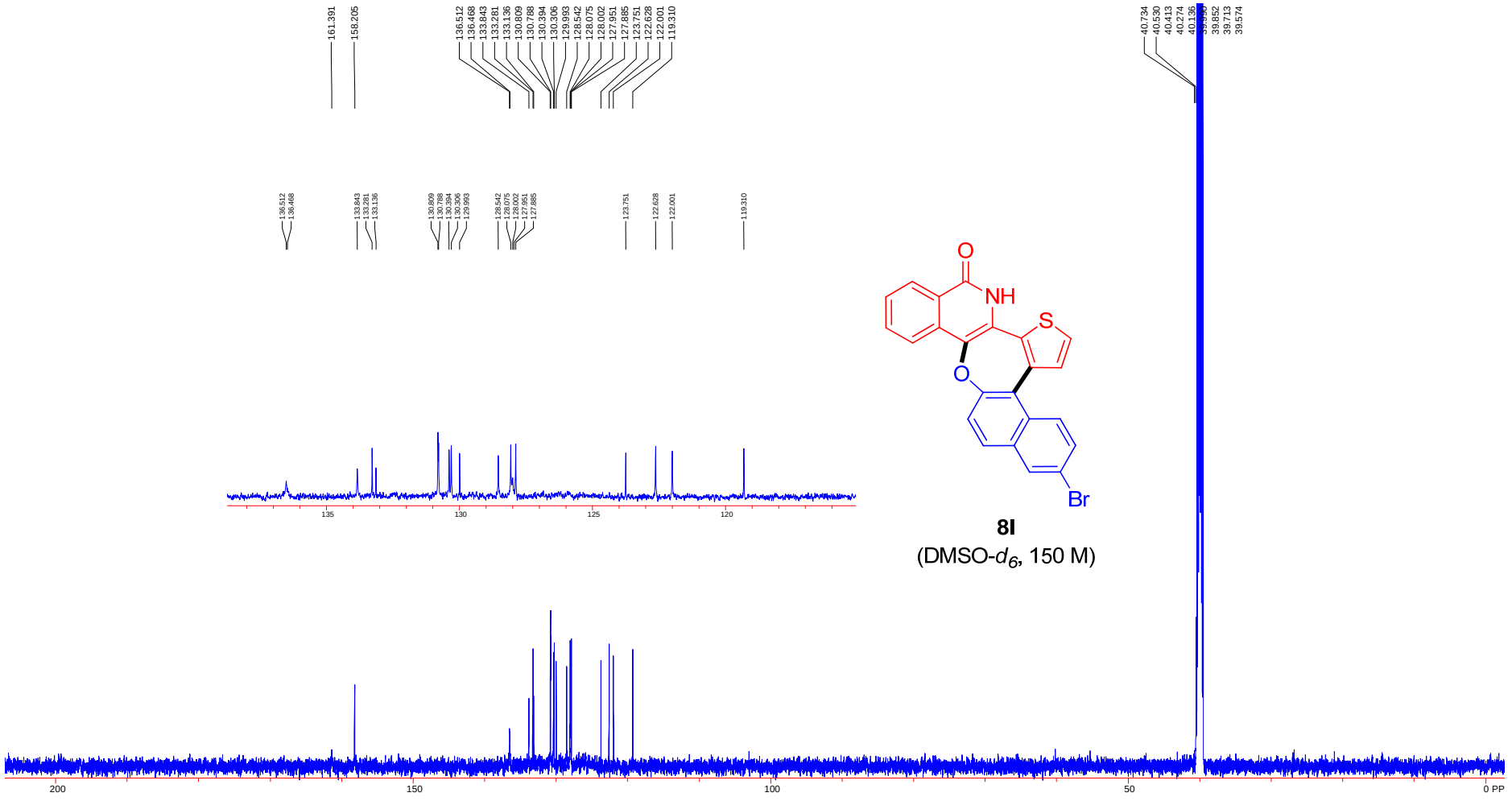
158.092
137.233
137.038
136.994
133.831
133.238
132.856
132.466
131.606
130.580
130.378
129.107
128.731
128.385
128.009
127.034
127.005
126.701
126.702
126.297
126.008
125.503
123.372
122.021
121.812
40.592
40.382
40.173
39.963
39.754
39.545
O
NH
S
O
2-naphthyl
8k
(DMSO-d_6, 100 M)
200
150
100
50
0 PP


11.753
8.432
8.411
8.318
8.313
8.248
8.228
8.086
8.081
8.074
8.058
8.054
7.935
7.913
7.899
7.897
7.890
7.727
7.721
7.704
7.698
7.688
7.675
7.643
7.625
7.607
5.765
3.371
2.517
2.513
2.508
1.996
1.390
1.223
1.180
0.847
0.831
0.000
0.95
0.99
1.00
3.03
2.19
1.09
1.17
1.22
0.82
NH
S
O
O
Br
8I
(DMSO-d_6, 400 M)
PP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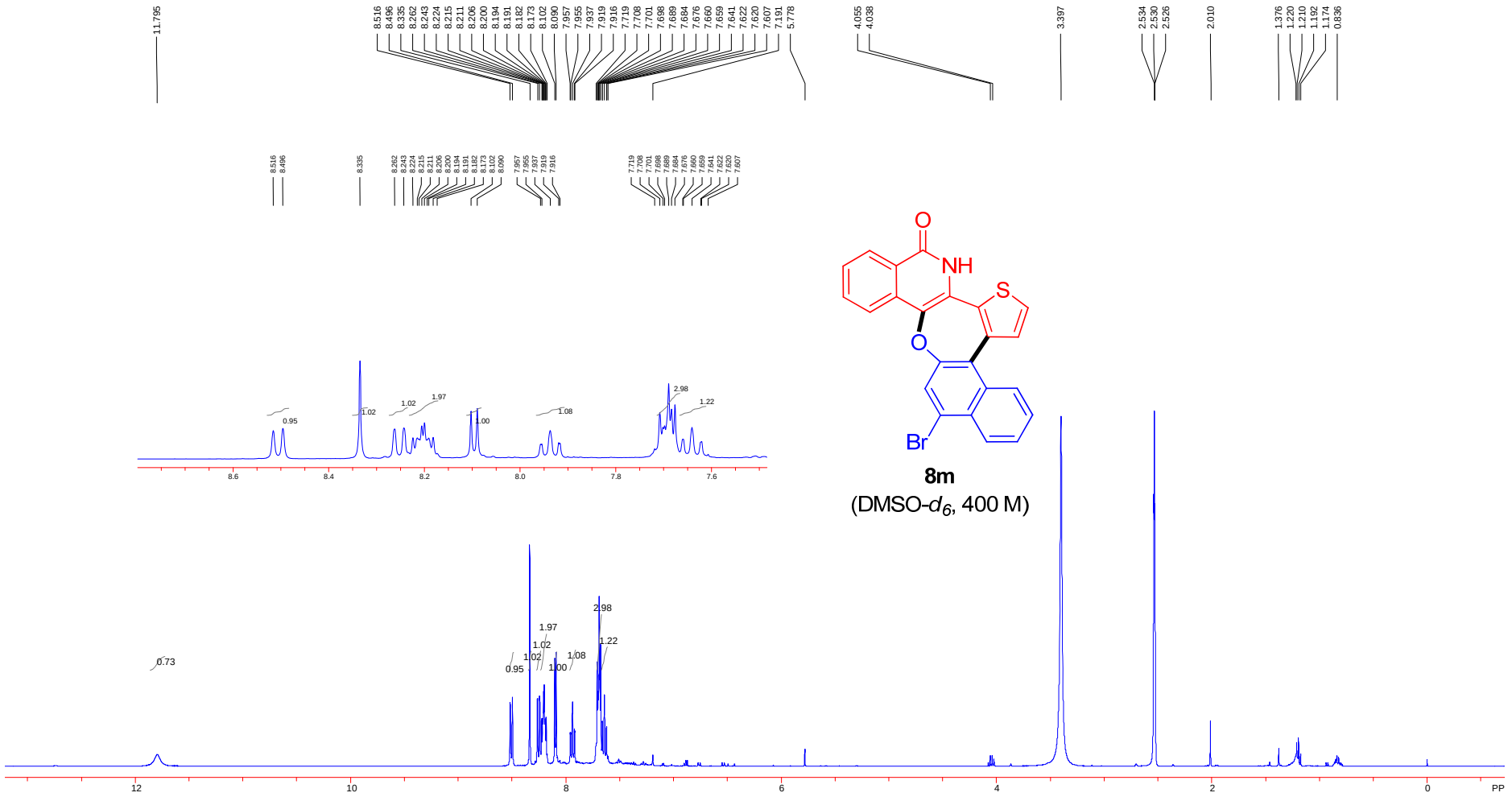
158.205
136.512
136.468
133.843
133.281
133.136
130.809
130.788
130.394
130.306
129.993
128.542
128.075
128.002
127.951
127.885
123.751
122.628
122.001
119.310
40.734
40.530
40.413
40.274
40.135
39.990
39.852
39.713
39.574
O
NH
S
O
Br
8I
(DMSO-d6, 150 M)
135
130
125
120
200
150
100
50
0 PP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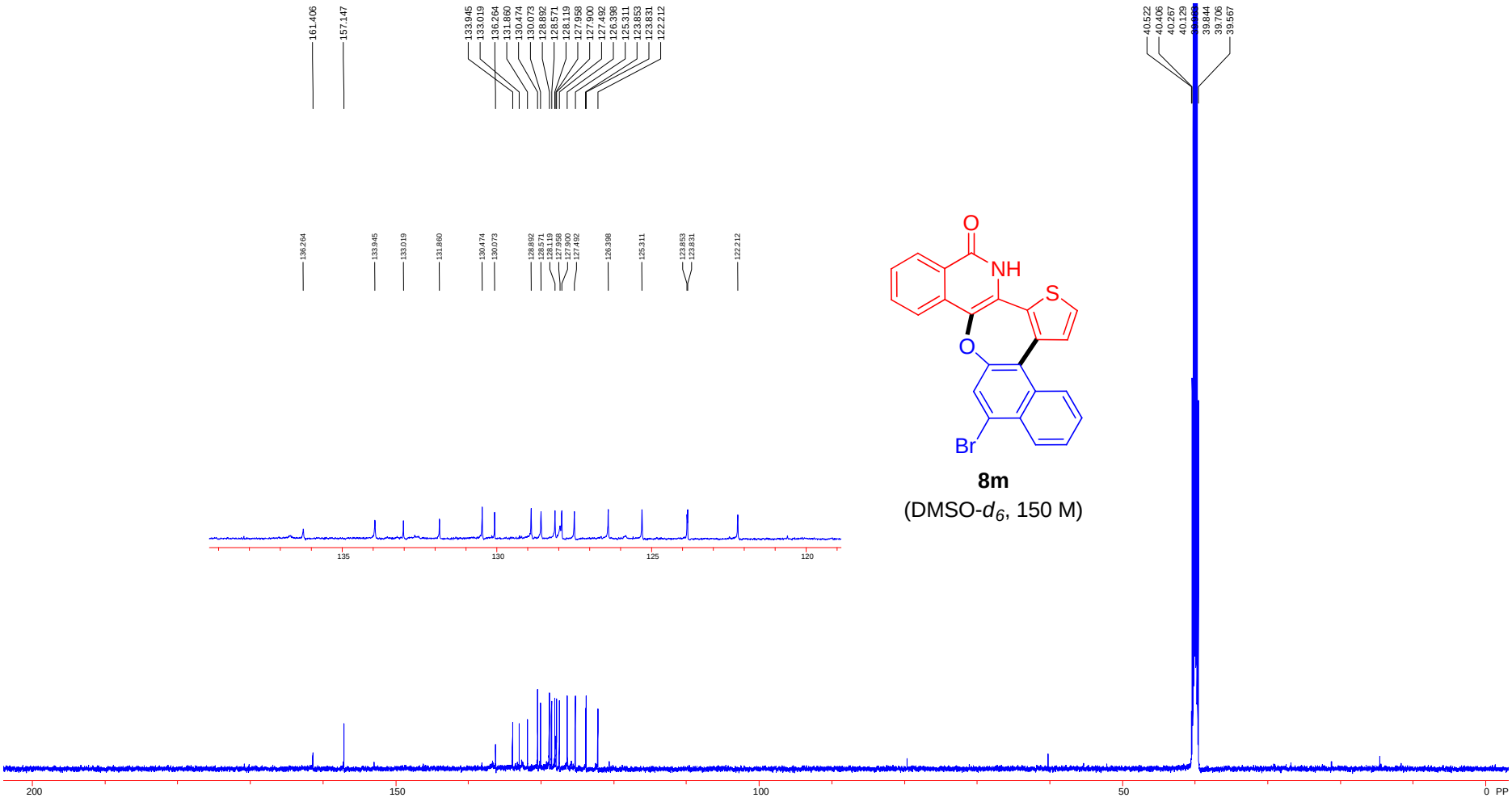
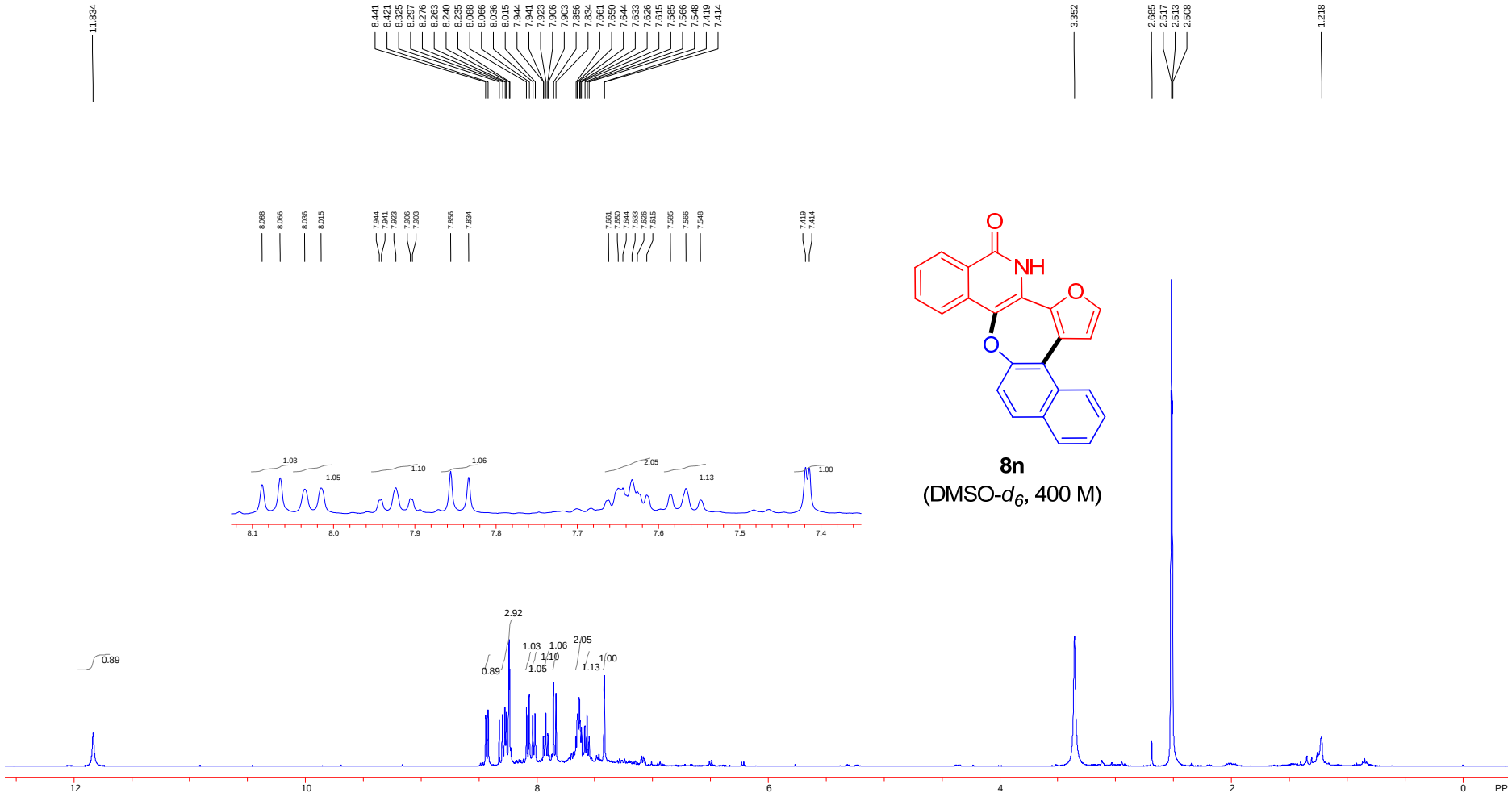
8.516
8.496
8.335
8.262
8.243
8.224
8.215
8.211
8.206
8.200
8.194
8.191
8.182
8.173
8.102
8.090
7.957
7.955
7.937
7.919
7.916
7.719
7.708
7.701
7.698
7.689
7.684
7.676
7.660
7.659
7.641
7.622
7.620
7.607
7.191
5.778
4.055
4.038
3.397
2.534
2.530
2.526
2.010
1.376
1.220
1.210
1.192
1.174
0.836
O
NH
S
O
Br
8m
(DMSO-d6, 400 M)
0.73
0.95
1.02
1.02
1.97
1.00
1.08
2.98
1.22
12
10
8
6
4
2
0
PP



8m

(DMSO-d_6, 150 M)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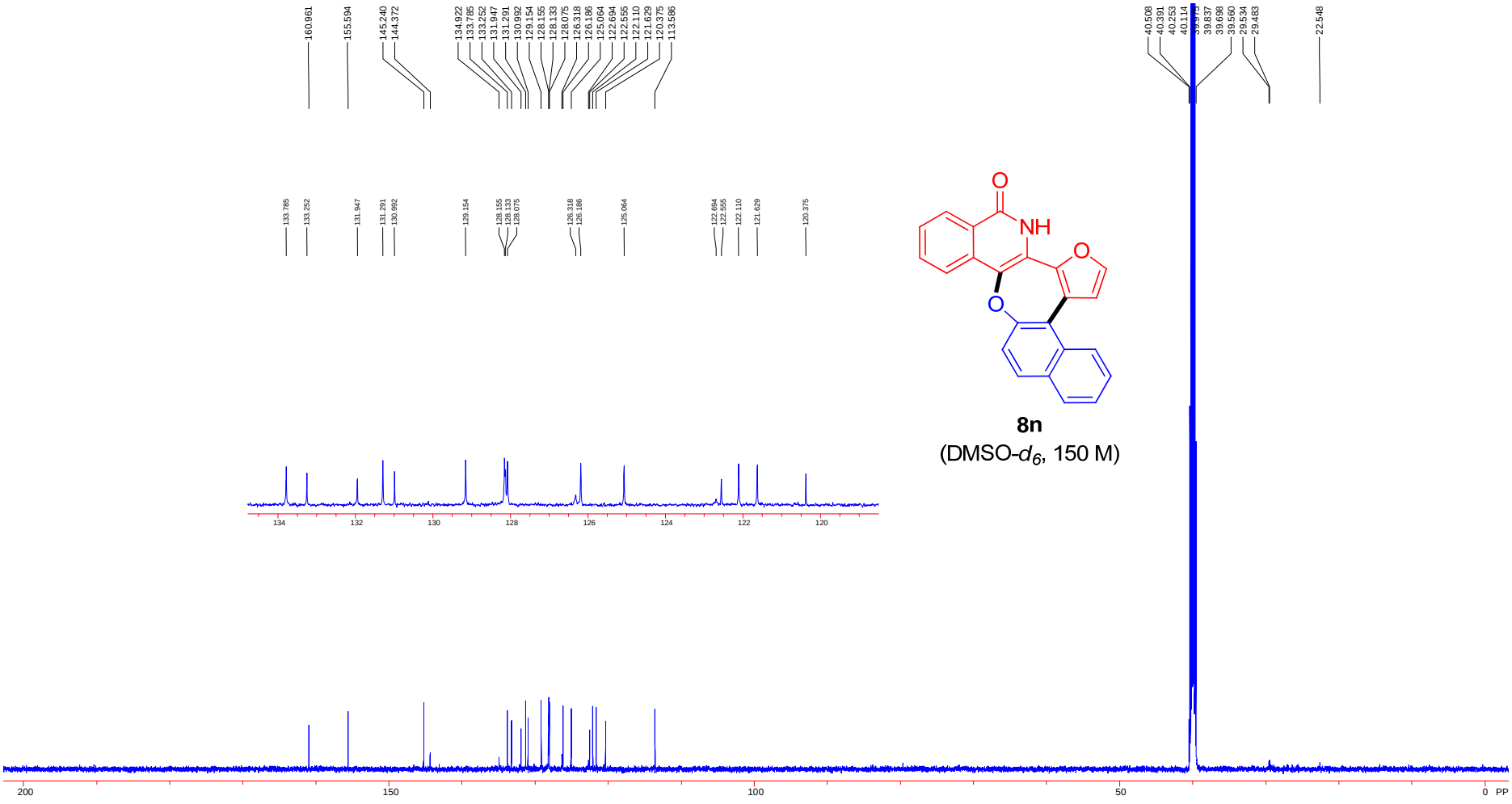
8.441
8.421
8.325
8.297
8.276
8.263
8.240
8.235
8.088
8.066
8.036
8.015
7.944
7.941
7.923
7.906
7.903
7.856
7.834
7.661
7.650
7.644
7.633
7.626
7.615
7.585
7.566
7.548
7.419
7.414
3.352
2.685
2.517
2.513
2.508
1.218
O
NH
O
O
8n
(DMSO-d6, 400 M)
0.89
2.92
1.03
1.06
2.05
1.10
1.05
1.13
1.00
12
10
8
6
4
2
0
PP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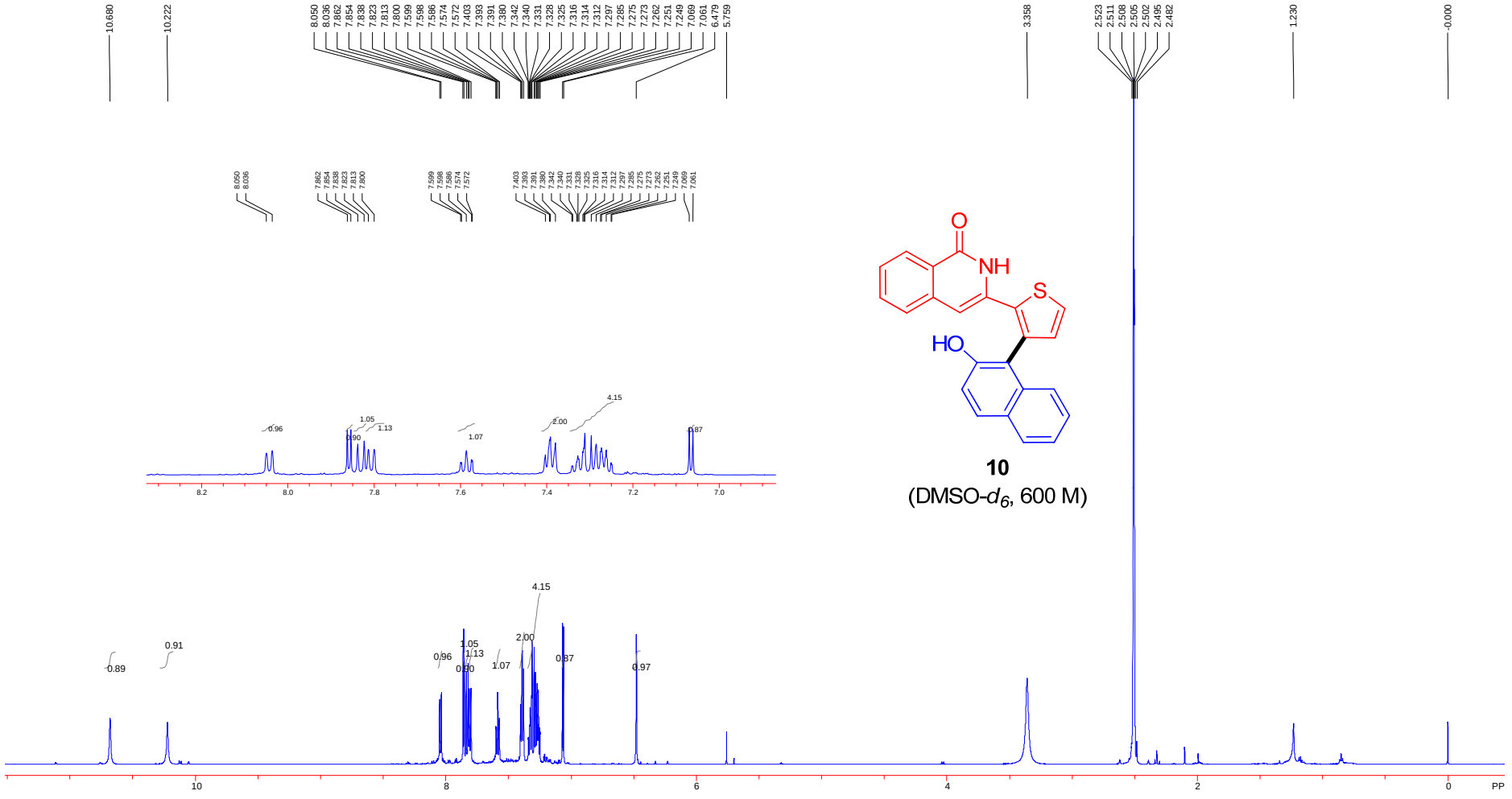
155.594
145.240
144.372
134.922
133.785
133.252
131.947
131.291
130.992
129.154
128.155
128.133
128.075
126.318
126.186
125.064
122.694
122.555
122.110
121.629
120.375
113.586
40.508
40.391
40.253
40.114
39.975
39.837
39.698
39.560
29.534
29.483
22.548
O
NH
O
O
8n
(DMSO-d6, 150 M)
200
150
100
50
0
PP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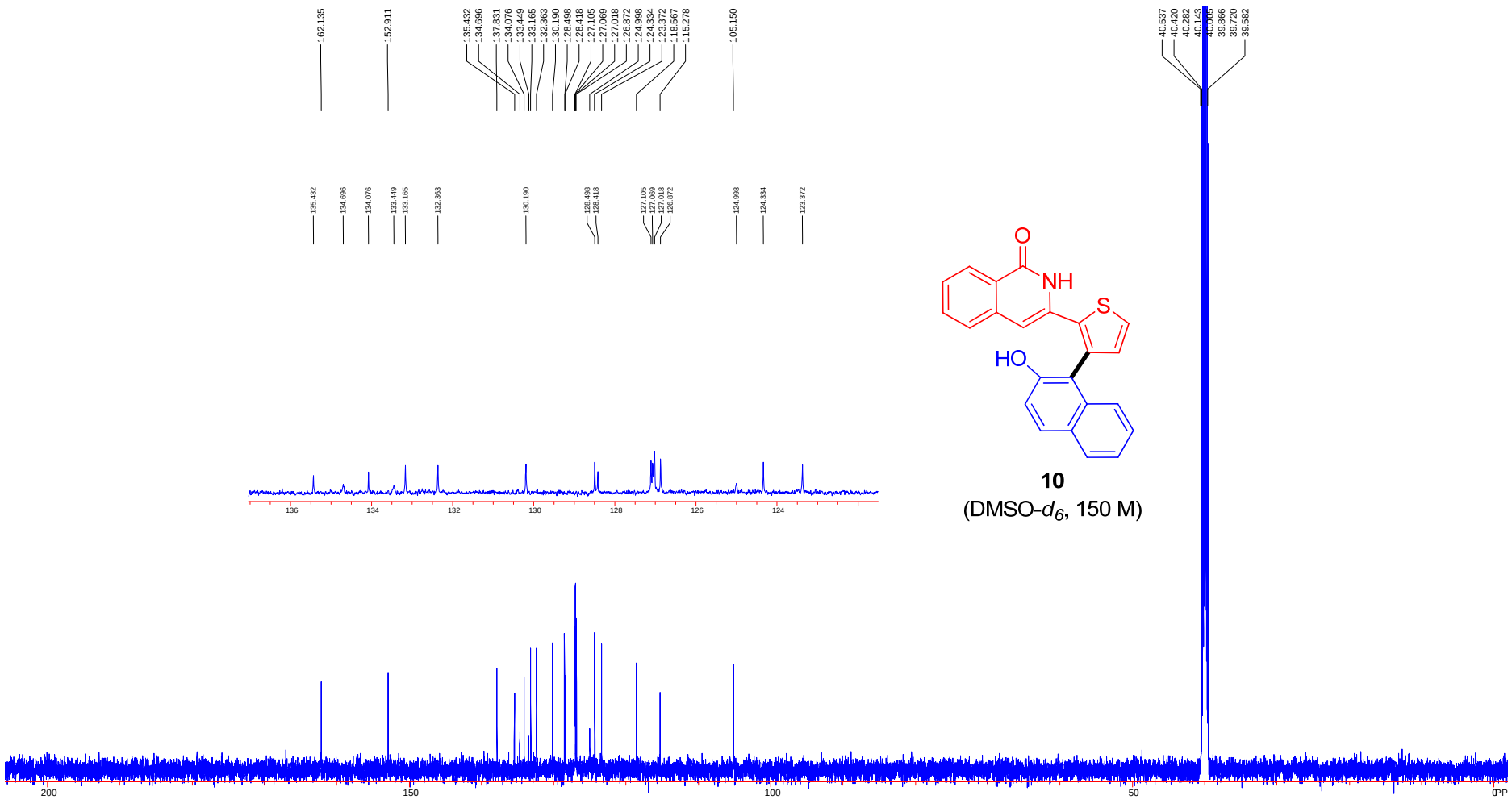
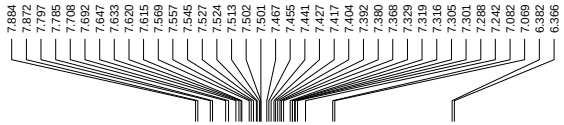
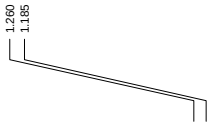
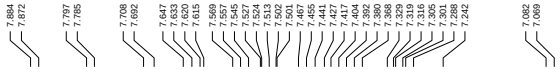
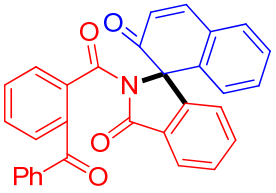
10.222
8.050
8.036
7.862
7.854
7.838
7.823
7.813
7.800
7.599
7.598
7.586
7.574
7.572
7.403
7.393
7.391
7.380
7.342
7.340
7.331
7.328
7.325
7.316
7.314
7.312
7.297
7.285
7.275
7.273
7.262
7.251
7.249
7.069
7.061
6.479
5.759
3.358
2.523
2.511
2.508
2.505
2.502
2.495
2.482
1.230
-0.000
O
NH
S
HO
10
(DMSO-d6, 600 M)
0.89
0.91
0.96
1.05
1.13
1.00
1.07
4.15
2.00
0.87
0.97
PP


162.135
152.911
135.432
134.696
137.831
134.076
133.449
133.165
132.363
130.190
128.498
128.418
127.105
127.069
127.018
126.872
124.998
124.334
123.372
118.567
115.278
105.150
40.537
40.420
40.262
40.143
40.006
39.866
39.720
39.582
O
NH
S
HO
10
(DMSO-d_6, 150 M)
200
150
100
50
0
PP



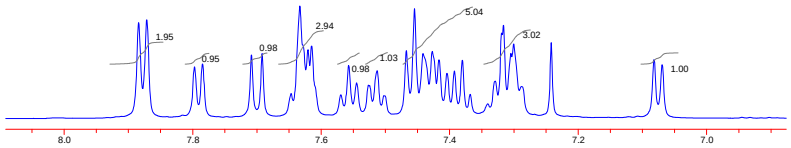


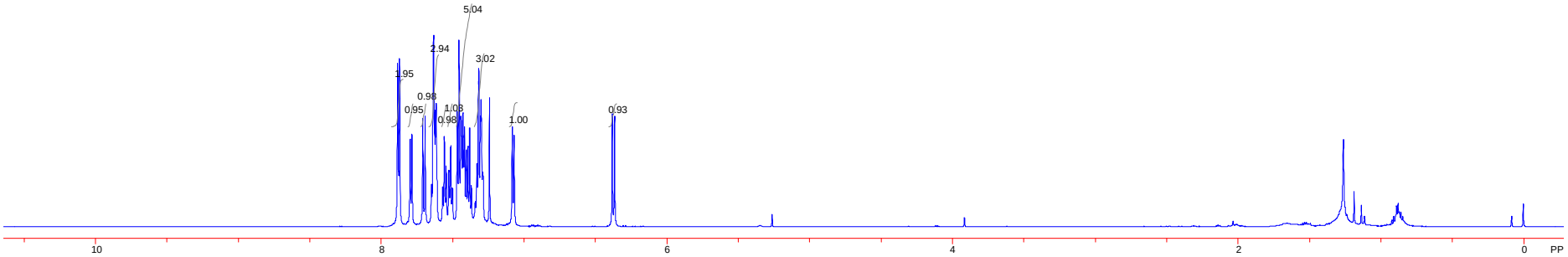


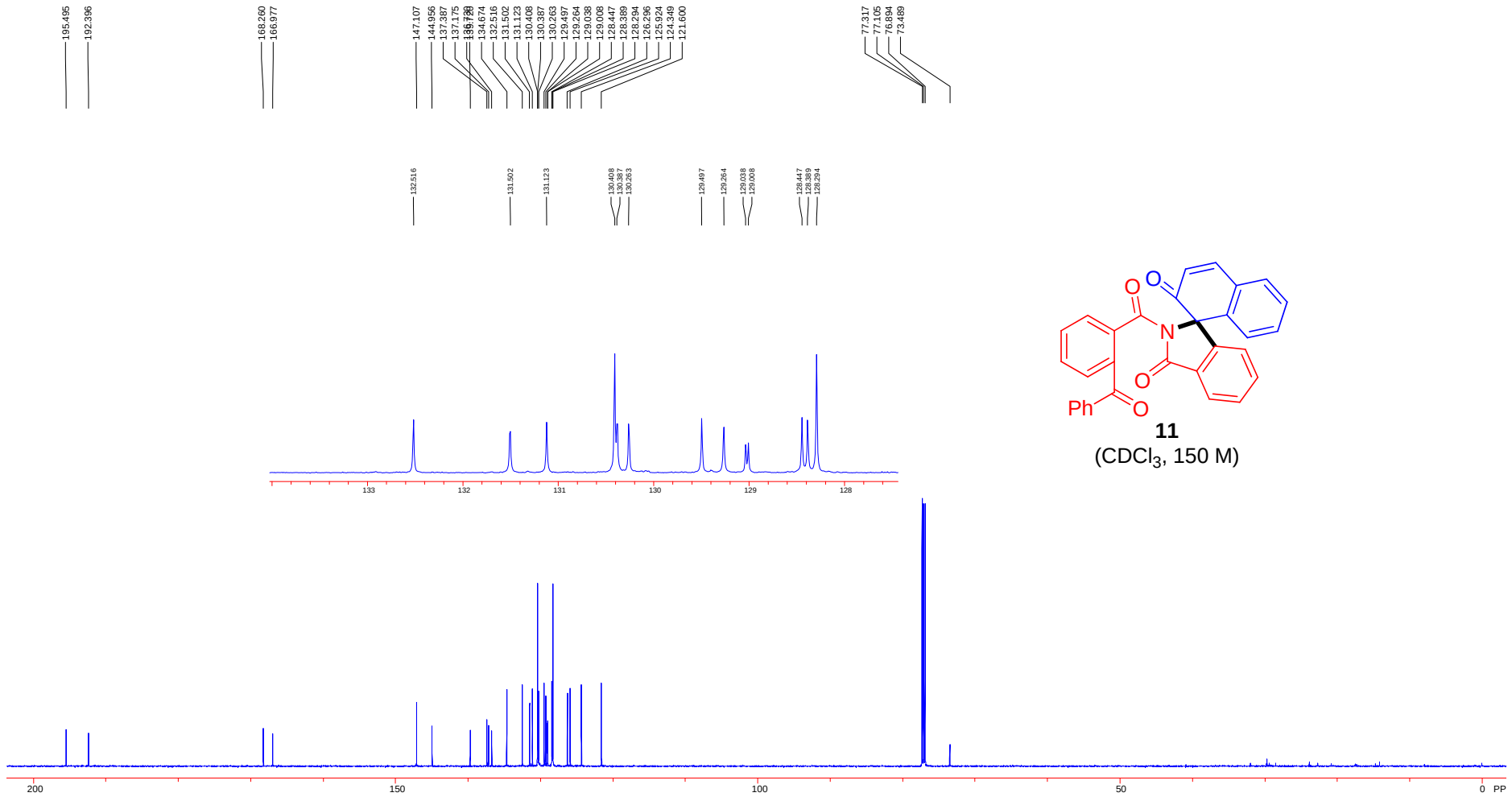


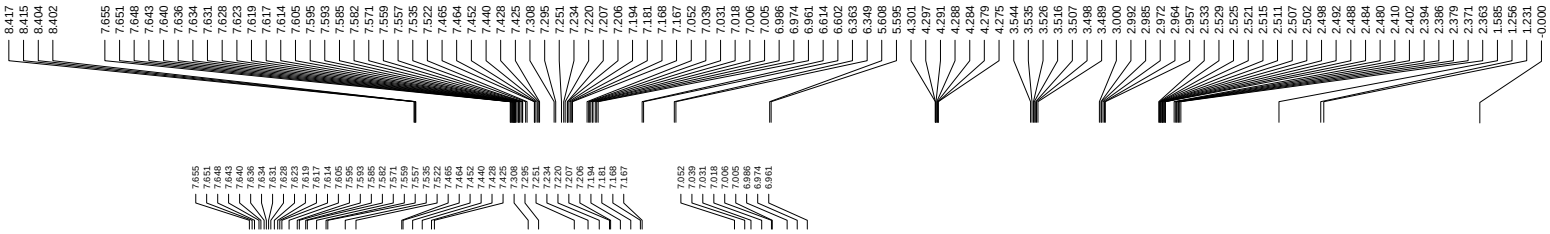
11

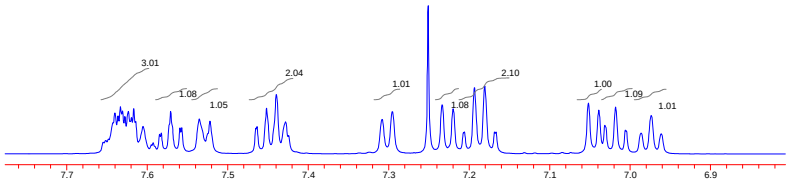
($CDCl_3$, 600 M)

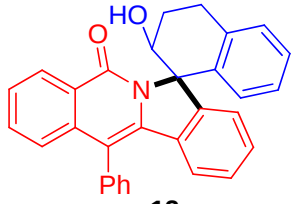





195.495
192.396
168.260
166.977
147.107
144.956
137.387
137.175
134.674
132.516
131.502
131.123
130.408
130.387
130.263
129.497
129.264
129.038
129.008
128.447
128.389
128.294
126.296
125.924
124.349
121.600
77.317
77.105
76.894
73.489
O
O
N
O
Ph
O
11
(CDCl3, 150 M)
200
150
100
50
0
PP

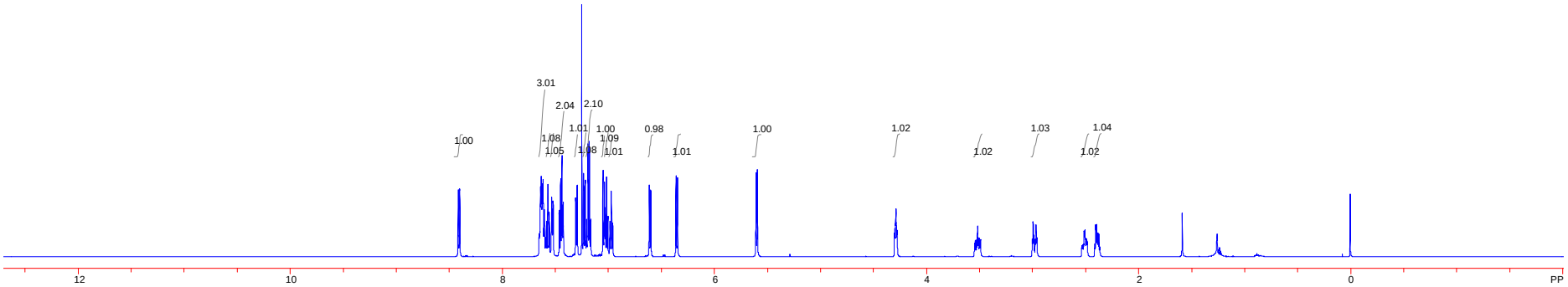


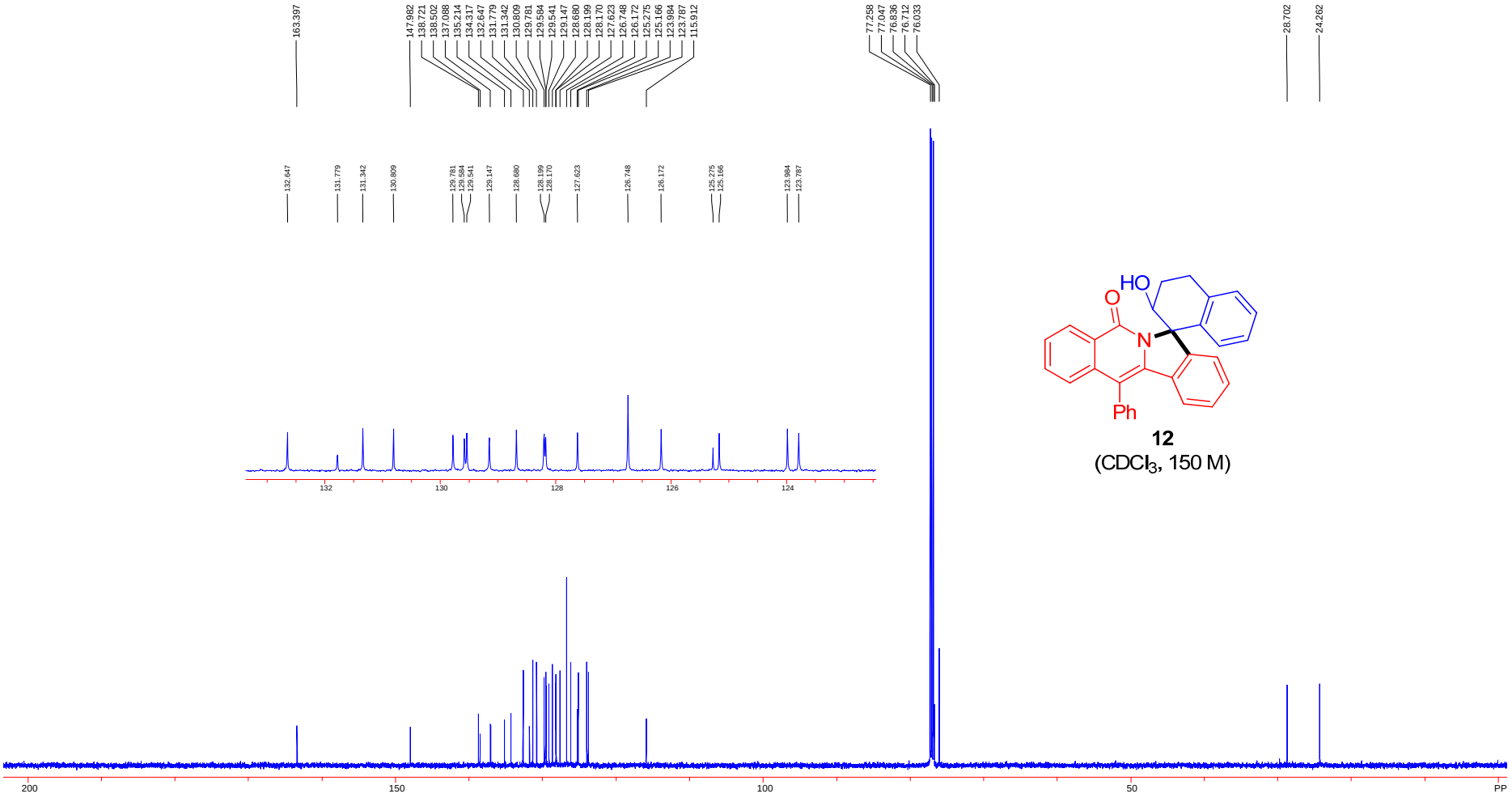


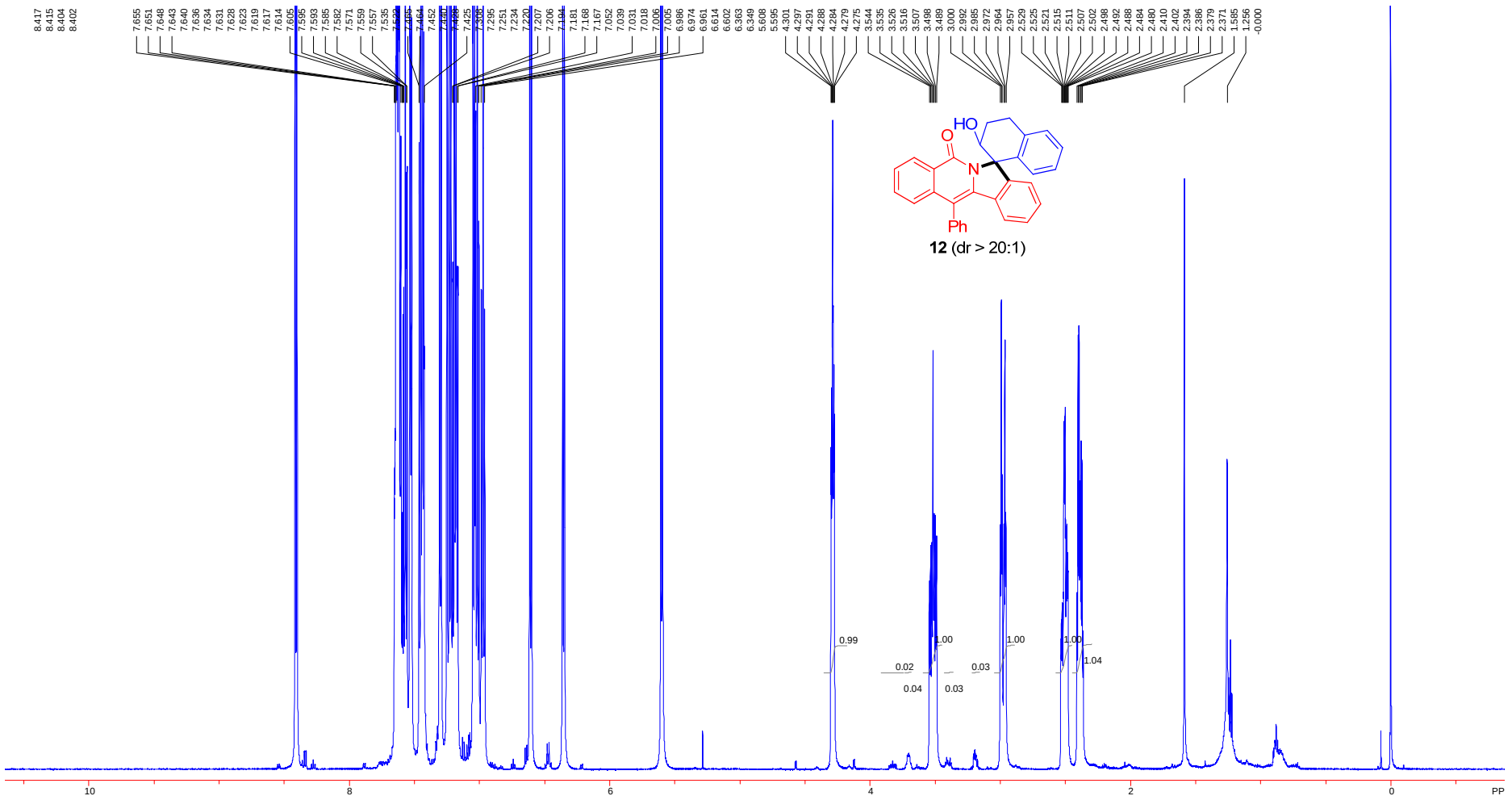


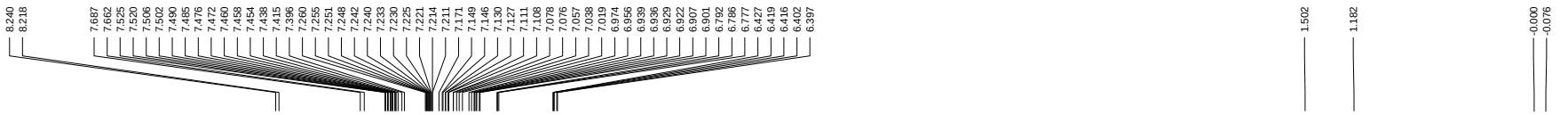
12

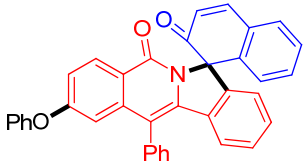
($CDCl_3$, 600 M)




163.397
147.982
138.721
138.502
137.088
135.214
134.317
132.647
131.779
131.342
130.809
129.781
129.584
129.541
129.147
128.680
128.199
128.170
127.623
126.748
126.172
125.275
125.166
123.984
123.787
115.912
77.258
77.047
76.836
76.712
76.033
28.702
24.262
HO
O
N
Ph
12
(CDCl3, 150 M)
200
150
100
50
PP

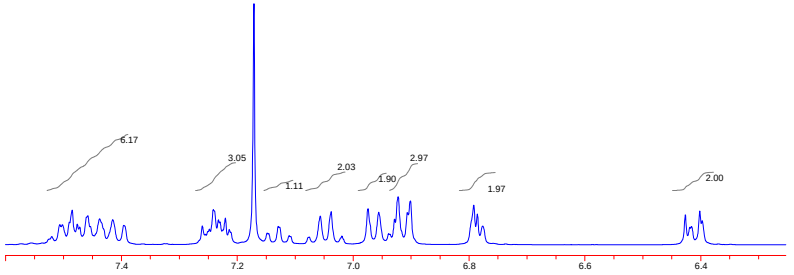

HO
O
N
Ph
12 (dr > 20:1)
0.99
0.02
0.04
1.00
0.03
0.03
1.00
1.00
1.04
10
8
6
4
2
0
PP

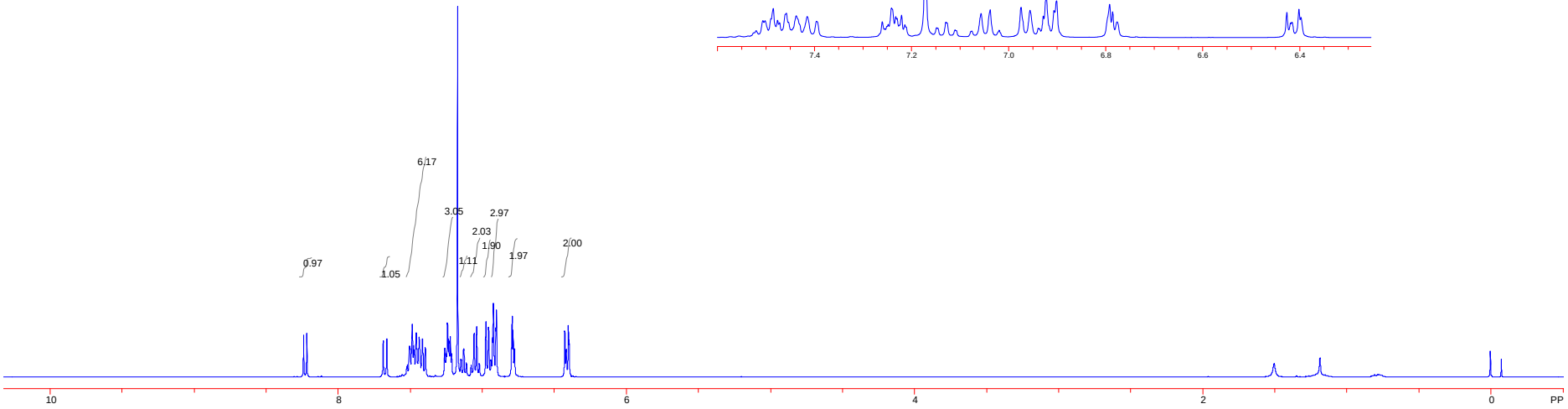


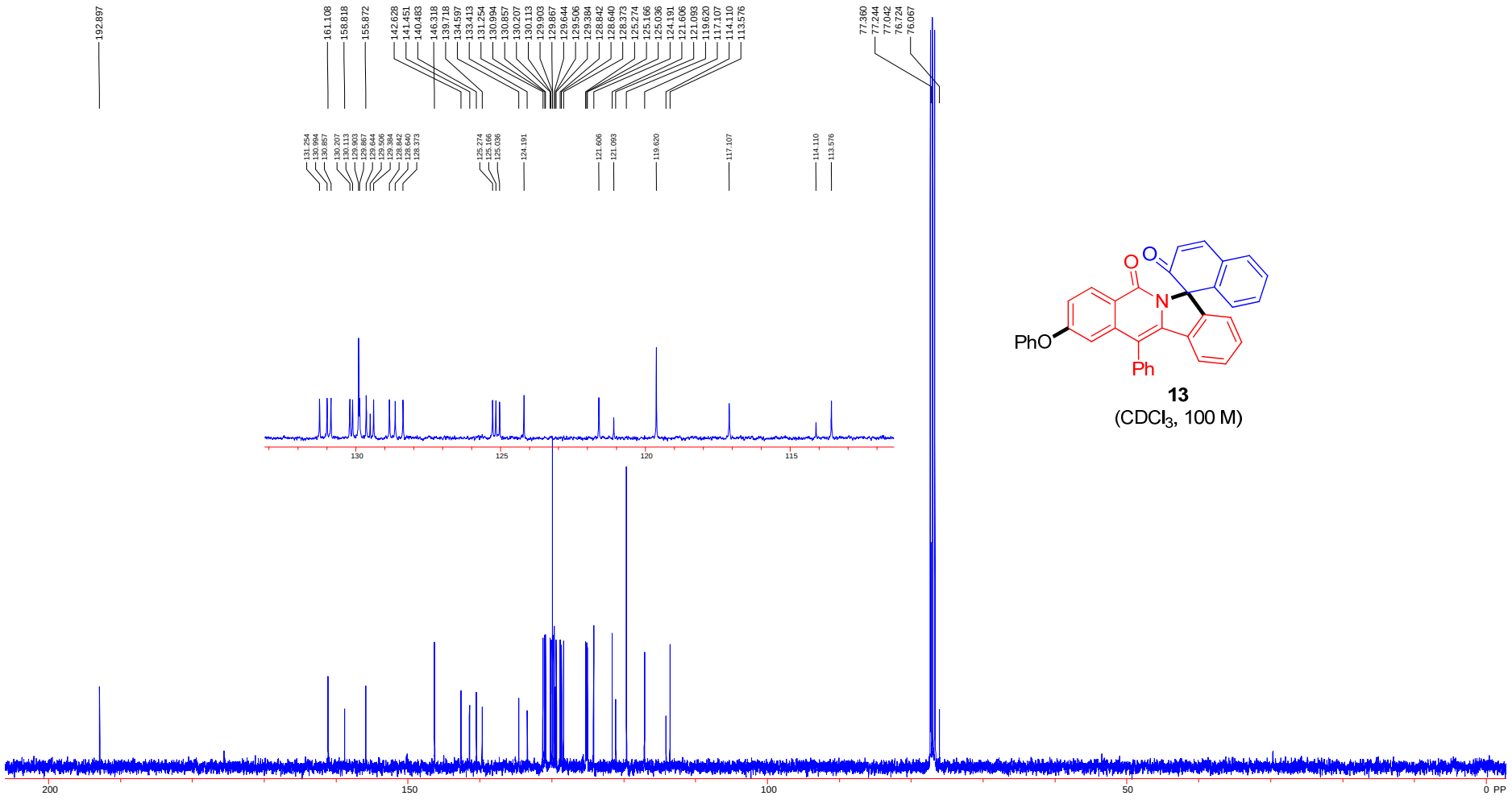


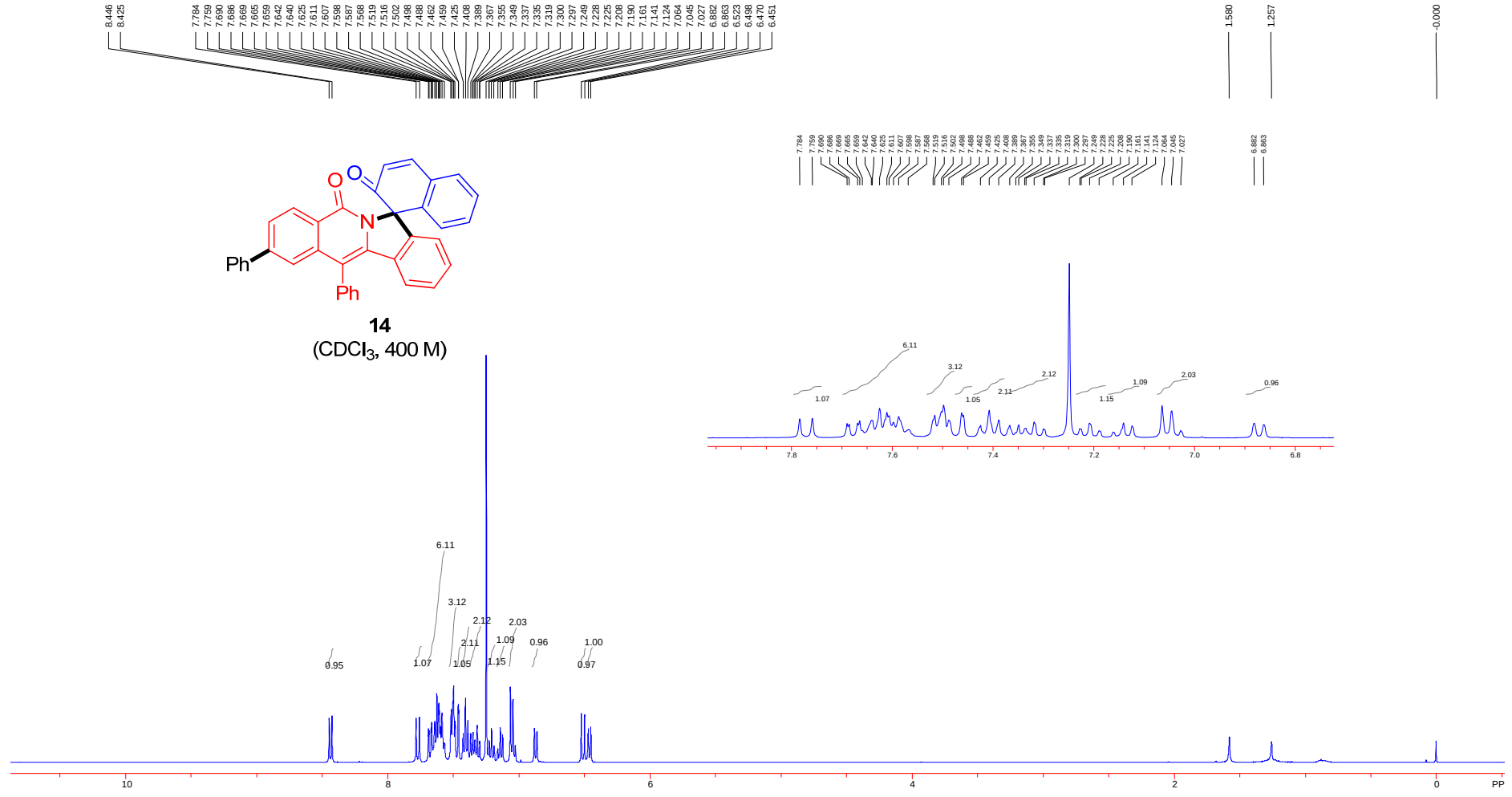
13

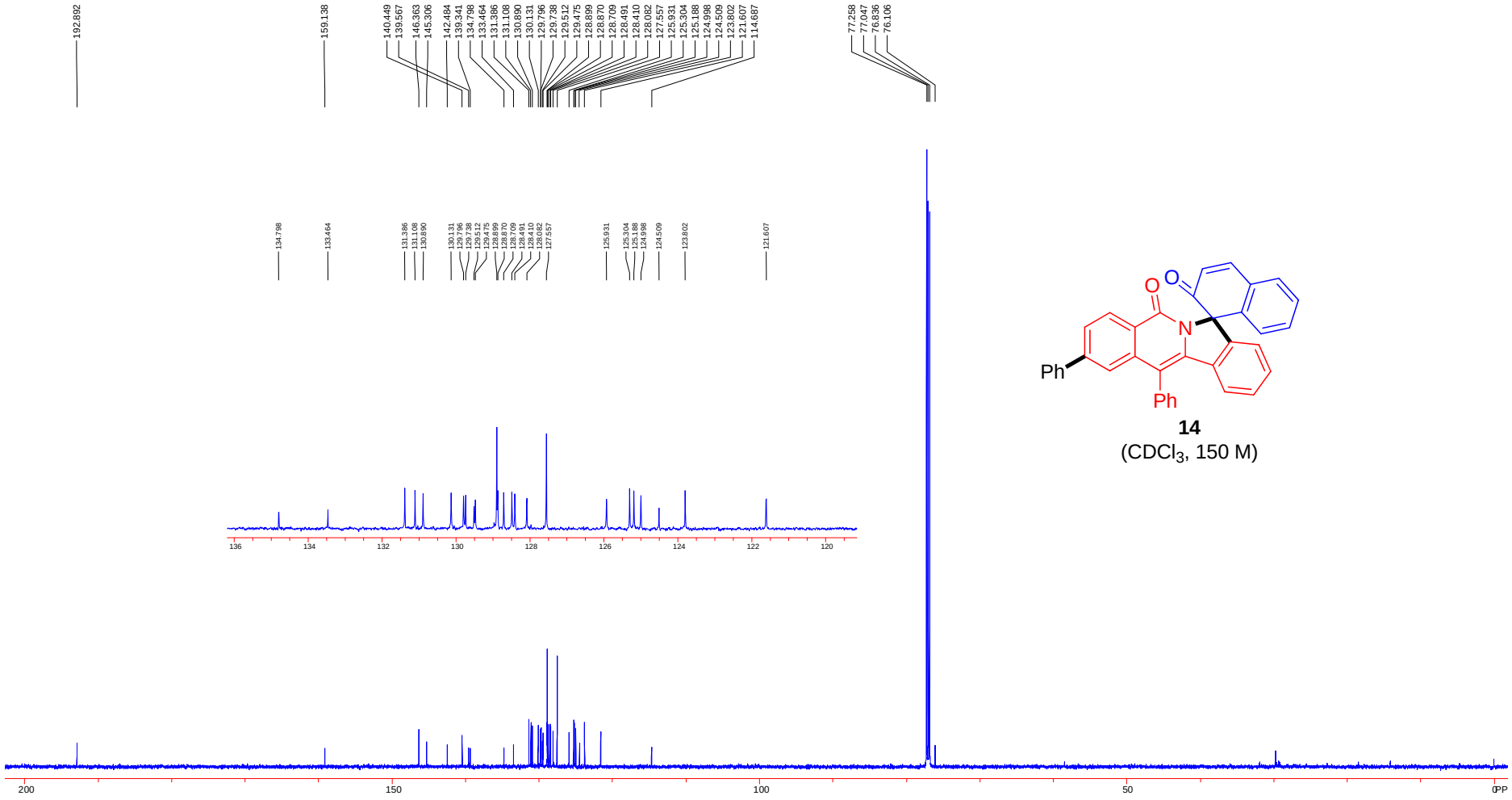
($CDCl_3$, 400 M)






192.897
161.108
158.818
155.872
142.628
141.451
140.483
146.318
139.718
134.597
133.413
131.254
130.994
130.857
130.207
130.113
129.903
129.867
129.644
129.506
129.384
128.842
128.640
128.373
125.274
125.166
125.036
124.191
121.606
121.093
119.620
117.107
114.110
113.576
77.360
77.244
77.042
76.724
76.067
PhO
Ph
13
(CDCl3, 100 M)
200
150
100
50
0 PP


8.446
8.425
7.784
7.759
7.690
7.686
7.669
7.665
7.659
7.642
7.640
7.625
7.611
7.607
7.598
7.587
7.568
7.519
7.516
7.502
7.498
7.488
7.462
7.459
7.425
7.408
7.389
7.367
7.355
7.349
7.337
7.335
7.319
7.300
7.297
7.249
7.228
7.225
7.208
7.190
7.161
7.141
7.124
7.064
7.045
7.027
6.882
6.863
6.523
6.498
6.470
6.451
1.580
1.257
-0.000
O
O
N
Ph
Ph
14
(CDCl3, 400 M)
6.11
3.12
2.12
2.03
2.11
1.09
0.96
1.00
0.95
1.07
1.05
1.15
0.97
10
8
6
4
2
0
PP
6.11
3.12
2.12
1.07
1.05
2.11
1.15
1.09
2.03
0.96
7.8
7.6
7.4
7.2
7.0
6.8



14

($CDCl_3$, 150 M)