Supporting Information

Pd(II)-Catalyzed Regionselective Ring Opening/[3+2] Annulation Reaction of Enaminones with Cyclopropenones: Divergent Synthesis of *γ*-Butenolides and *γ*-Lactams

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1. General information.

All compounds were fully characterized by spectroscopic data. The NMR spectra were recorded on a DRX600 (^{1}H: 500 MHz and 600 MHz, ^{13}C: 125 MHz and 150 MHz), chemical shifts (*δ*) are expressed in ppm, and *J* values are given in Hz, and deuterated $CDCl_3$ and DMSO-d_6 were used as solvent. The reactions were monitored by thin layer chromatography (TLC) using silica gel GF_{254}. The melting points were determined on XT-4A melting point apparatus and are uncorrected. HRMs were performed on an Agilent LC/MS TOF instrument.

All chemicals and solvents were used as received without further purification unless otherwise stated. Column chromatography was performed on silica gel (200–300 mesh).

Enaminones **1** were prepared according to the literature[1], cyclopropenones **2** were prepared according to the literature[2], other reagents were purchased from Energy Chemical and Adamas-beta®.

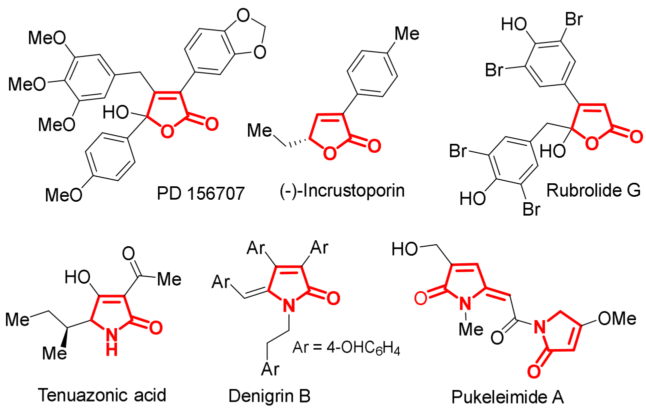
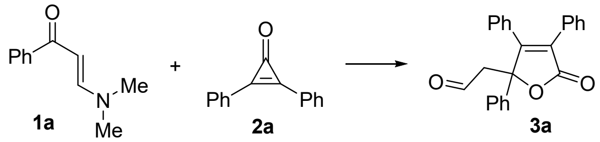


Figure S1. Representative natural *γ*-butenolides and *γ*-lactams**.**

2. Optimization of reaction conditions.

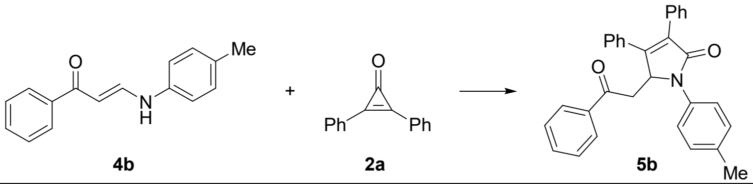
Table S1. Optimization of the reaction conditions for the γ-butenolides synthesis.[a,b]



entry	Catalyst (eq.)	Additive (eq.)	Co-catalyst (eq.)	Solvent	T (°C)	Time (h)	Yield (%)
1	$PdCl_2$ (0.5)	/	/	$MeNO_2$	50	12	47
2	$Pd(OAc)_2$ (0.5)	/	/	$MeNO_2$	50	12	n.d.
3	$PdCl_2(PPh_3)_2$ (0.5)	/	/	$MeNO_2$	50	12	n.d.
4	PdTFA (0.5)	/	/	$MeNO_2$	50	12	n.d.
5	PdO (0.5)	/	/	$MeNO_2$	50	12	n.d.
6	$FeCl_3$ (0.5)	/	/	$MeNO_2$	50	12	n.r.
7	$FeCl_2$ (0.5)	/	/	$MeNO_2$	50	12	n.d.
8	$FeBr_2$ (0.5)	/	/	$MeNO_2$	50	12	n.d.
9	$NiCl_2$ (0.5)	/	/	$MeNO_2$	50	12	n.r.
10	$CoCl_2$ (0.5)	/	/	$MeNO_2$	50	12	20
11	$CuCl_2$ (0.5)	/	/	$MeNO_2$	50	12	26
12	CuCl (0.5)	/	/	$MeNO_2$	50	12	n.d.
13	CuI (0.5)	/	/	$MeNO_2$	50	12	n.d.
14	$Cu(OAc)_2$ (0.5)	/	/	$MeNO_2$	50	12	n.d.
15	$Cu(OTf)_2$ (0.5)	/	/	$MeNO_2$	50	12	n.d.
16	$Bi(OTf)_3$ (0.5)	/	/	$MeNO_2$	50	12	trace
17	PPh_3 (0.5)	/	/	$MeNO_2$	50	12	n.d.
18	$PdCl_2$ (0.5)	AcOH (1)	/	$MeNO_2$	50	12	38
19	$PdCl_2$ (0.5)	*p*-TSA (1)	/	$MeNO_2$	50	12	34
20	$PdCl_2$ (0.5)	$MeSO_3H$ (1)	/	$MeNO_2$	50	12	30
21	$PdCl_2$ (0.5)	Ac_2O (1)	/	$MeNO_2$	50	12	59
22	$PdCl_2$ (0.5)	Adipic acid (1)	/	$MeNO_2$	50	12	41
23	$PdCl_2$ (0.5)	Benzoic anhydride (1)	/	$MeNO_2$	50	12	43
24	$PdCl_2$ (0.5)	TFAA (1)	/	$MeNO_2$	50	12	30
25	$PdCl_2$ (0.5)	Succinic anhydride (1)	/	$MeNO_2$	50	12	49
26	$PdCl_2$ (0.5)	Pivalic anhydride (1)	/	$MeNO_2$	50	12	46
27	$PdCl_2$ (0.5)	Isobutyric anhydride (1)	/	$MeNO_2$	50	12	42
28	$PdCl_2$ (0.5)	Ac_2O (2)	/	$MeNO_2$	50	12	73
29	$PdCl_2$ (0.5)	Ac_2O (3)	/	$MeNO_2$	50	12	82
30	$PdCl_2$ (0.5)	Ac_2O (4)	/	$MeNO_2$	50	12	81
31	$PdCl_2$ (0.5)	Ac_2O (3)	/	DCM	50	12	67
32	$PdCl_2$ (0.5)	Ac_2O (3)	/	DCE	50	12	53
33	$PdCl_2$ (0.5)	Ac_2O (3)	/	THF	50	12	n.d.
34	$PdCl_2$ (0.5)	Ac_2O (3)	/	$CHCl_3$	50	12	35
35	$PdCl_2$ (0.5)	Ac_2O (3)	/	MeOH	50	12	n.d.
36	$PdCl_2$ (0.5)	Ac_2O (3)	/	DMF	50	12	n.d.
37	$PdCl_2$ (0.5)	Ac_2O (3)	/	1,4-Dioxane	50	12	31
38	$PdCl_2$ (0.5)	Ac_2O (3)	/	MeCN	50	12	28
39	$PdCl_2$ (0.5)	Ac_2O (3)	/	$MeNO_2$	60	12	92
40	$PdCl_2$ (0.5)	Ac_2O (3)	/	$MeNO_2$	70	12	91
41	$PdCl_2$ (0.5)	Ac_2O (3)	/	$MeNO_2$	60	6	92
42	$PdCl_2$ (0.5)	Ac_2O (3)	/	$MeNO_2$	60	4	85
43	$PdCl_2$ (0.1)	Ac_2O (3)	/	$MeNO_2$	60	6	58
44	$PdCl_2$ (0.3)	Ac_2O (3)	/	$MeNO_2$	60	6	70
45	$PdCl_2$ (0.1)	Ac_2O (3)	$CuCl_2$ (0.5)	$MeNO_2$	60	6	73
46	$PdCl_2$ (0.1)	Ac_2O (3)	AgCl (0.5)	$MeNO_2$	60	6	40
47	$PdCl_2$ (0.1)	Ac_2O (3)	CuCl (0.5)	$MeNO_2$	60	6	90
48	$PdCl_2$ (0.1)	Ac_2O (3)	$CoCl_2$ (0.5)	$MeNO_2$	60	6	63
49	$PdCl_2$ (0.1)	Ac_2O (3)	$NiCl_2$ (0.5)	$MeNO_2$	60	6	65
50	**$PdCl_2$ (0.1)**	**Ac_2O (3)**	**CuCl (0.25)**	**$MeNO_2$**	**60**	**6**	**92**
51	$PdCl_2$ (0.1)	Ac_2O (3)	CuCl (0.1)	$MeNO_2$	60	6	80
52	$PdCl_2$ (0.05)	Ac_2O (3)	CuCl (0.25)	$MeNO_2$	60	6	82
53	$PdCl_2$ (0.1)	Ac_2O (2)	CuCl (0.25)	$MeNO_2$	60	6	86
54	$PdCl_2$ (0.1)	Ac_2O (4)	CuCl (0.25)	$MeNO_2$	60	6	92

[a]Rseaction conditions: **1a** (0.1 mmol), **2a** (0.12 mmol) and catalyst in 1.0 mL solvent for 6.0 h-12.0 h. [b]Isolated yields.

Table S2. Optimization of the reaction conditions for the *γ*-lactams synthesis.[a,b]



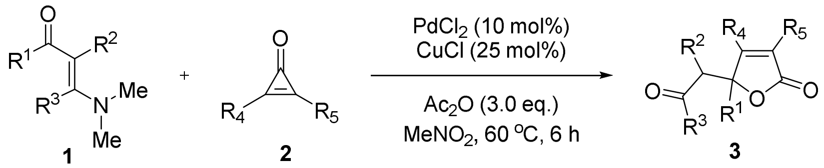
4b 2a 5b

Entry	Catalyst (eq.)	Additive (eq.)	Solvent	T (°C)	Time (h)	Yield (%)
1	$PdCl_2$ (1)	/	$MeNO_2$	50	12	45
2	$PdCl_2$ (1)	/	DCM	50	12	n.d.
3	$PdCl_2$ (1)	/	1,4-Dioxane	50	12	n.d.
4	$PdCl_2$ (1)	/	TFE	50	12	n.d.
5	$PdCl_2$ (1)	/	MeCN	50	12	n.d.
6	$PdCl_2$ (1)	/	HFIP	50	12	n.d.
7	$PdCl_2$ (1)	/	DCE	50	12	n.d.
8	$PdCl_2$ (1)	/	$CHCl_3$	50	12	n.d.
9	$PdCl_2$ (1)	/	DMSO	50	12	n.d.
10	$PdCl_2$ (1)	/	PhCl	50	12	n.d.
11	$PdCl_2$ (1)	/	DMF	50	12	n.d.
12	$PdCl_2$ (1)	/	Toluene	50	12	n.d.
13	$PdCl_2$ (0.5)	/	$MeNO_2$	50	12	44
14	$PdCl_2$ (0.25)	/	$MeNO_2$	50	12	27
15	$FeCl_3$ (0.5)	/	$MeNO_2$	50	12	n.r.
16	$FeCl_2$ (0.5)	/	$MeNO_2$	50	12	n.d.
17	$CuCl_2$ (0.5)	/	$MeNO_2$	50	12	n.d.
18	$ZnCl_2$ (0.5)	/	$MeNO_2$	50	12	n.r.
19	$BiCl_3$ (0.5)	/	$MeNO_2$	50	12	n.d.
20	$PdCl_2$ (0.5)	NaOAc (1)	$MeNO_2$	50	12	n.d.
21	$PdCl_2$ (0.5)	Cs_2CO_3 (1)	$MeNO_2$	50	12	n.r.
22	$PdCl_2$ (0.5)	$NaBF_4$ (1)	$MeNO_2$	50	12	trace
23	$PdCl_2$ (0.5)	$BiCl_3$ (1)	$MeNO_2$	50	12	30
24	$PdCl_2$ (0.5)	AgCl (1)	$MeNO_2$	50	12	trace
25	$PdCl_2$ (0.5)	$CuCl_2$ (1)	$MeNO_2$	50	12	n.d.
26	$PdCl_2$ (0.5)	$FeCl_2$ (1)	$MeNO_2$	50	12	n.d.
27	$PdCl_2$ (0.5)	$NiCl_2$ (1)	$MeNO_2$	50	12	trace
28	$PdCl_2$ (0.5)	$CoCl_2$ (1)	$MeNO_2$	50	12	trace
29	$PdCl_2$ (0.5)	$ZnCl_2$ (1)	$MeNO_2$	50	12	n.d.
30	$PdCl_2$ (0.5)	TMSCl (1)	$MeNO_2$	50	12	24
31	$PdCl_2$ (0.5)	TBPB (1)	$MeNO_2$	50	12	trace
32	$PdCl_2$ (0.5)	PIDA (1)	$MeNO_2$	50	12	n.d.
33	$PdCl_2$ (0.5)	HCl (1)	$MeNO_2$	50	12	n.d.
34	$PdCl_2$ (0.5)	$MeSO_3H$ (1)	$MeNO_2$	50	12	n.d.
35	$PdCl_2$ (0.5)	Ac_2O (1)	$MeNO_2$	50	12	50
36	$PdCl_2$ (0.5)	Benzoic anhydride (1)	$MeNO_2$	50	12	n.d.
37	$PdCl_2$ (0.5)	TFAA (1)	$MeNO_2$	50	12	trace
38	$PdCl_2$ (0.5)	Succinic anhydride (1)	$MeNO_2$	50	12	trace
39	$PdCl_2$ (0.5)	Hexanoic anhydride (1)	$MeNO_2$	50	12	trace
40	$PdCl_2$ (0.5)	Trimethylacetic anhydride (1)	$MeNO_2$	50	12	41
41	$PdCl_2$ (0.5)	Isobutyric anhydride (1)	$MeNO_2$	50	12	26
42	$PdCl_2$ (0.5)	Ac_2O (2)	$MeNO_2$	50	12	57
43	**$PdCl_2$ (0.5)**	**Ac_2O (3)**	**$MeNO_2$**	**50**	**12**	**65**
44	$PdCl_2$ (0.5)	Ac_2O (4)	$MeNO_2$	50	12	65
45	$PdCl_2$ (0.5)	AcOH (3)	$MeNO_2$	50	12	23
46	$PdCl_2$ (0.5)	Ac_2O (3)	$MeNO_2$	50	6	36
47	$PdCl_2$ (0.5)	Ac_2O (3)	$MeNO_2$	50	9	48
48	$PdCl_2$ (0.5)	Ac_2O (3)	$MeNO_2$	50	15	64
49	/	Ac_2O (3)	$MeNO_2$	50	12	n.r.
50	$PdCl_2$ (0.5)	Ac_2O (3)	$MeNO_2$	40	12	45
51	$PdCl_2$ (0.5)	Ac_2O (3)	$MeNO_2$	60	12	53

[a]Reaction conditions: **4b** (0.1 mmol), **2a** (0.12 mmol) and catalyst in 1.0 mL solvent for 6.0-12.0 h. [b]Isolated yields.

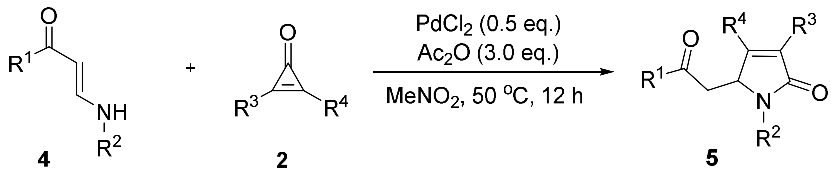
3. General procedure.

3.1 Synthesis of γ-butenolides 3.



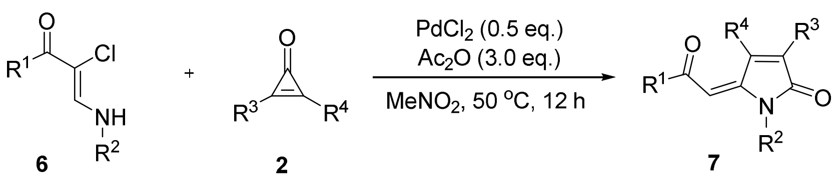
N,*N*-Dimethyl enaminones **1** (0.2 mmol), cyclopropenone **2** (0.24 mmol, 1.2 eq.), $PdCl_2$ (10 mol%), CuCl (25 mol%), Ac_2O (0.6 mmol, 3.0 eq.), and $MeNO_2$ (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 60 °C (metal bath) for 6.0 h until **1** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (15 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford *γ*-butenolides **3.**

3.2 Synthesis of γ-lactams 5.



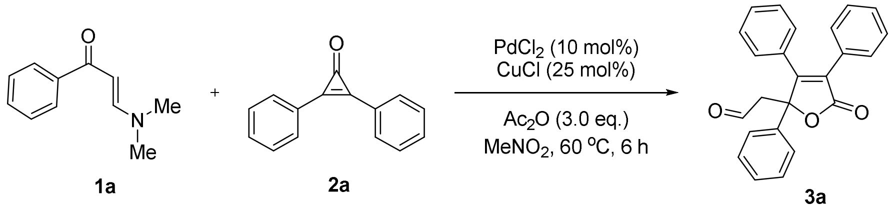
Enaminones **4** (0.2 mmol), cyclopropenone **2** (0.24 mmol, 1.2 eq.), $PdCl_2$ (0.5 eq.), Ac_2O (0.6 mmol, 3.0 eq.), and $MeNO_2$ (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 50 °C (metal bath) for 12.0 h until **4** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (15 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford 2*H*-pyrrol-2-ones **5.**

3.3 Synthesis of butenolide 7.



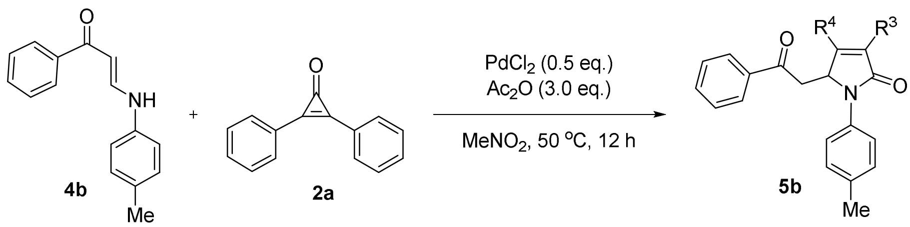
α-Chlorinated enaminones **6** (0.2 mmol), cyclopropenone **2** (0.24 mmol, 1.2 eq.), $PdCl_2$ (0.5 eq.), Ac_2O (0.6 mmol, 3.0 eq.), and $MeNO_2$ (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 50 °C (metal bath) for 12.0 h until **6** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (15 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford 2*H*-pyrrol-2-ones **7.**

3.4 Gram-scale synthesis of butenolide 3a.



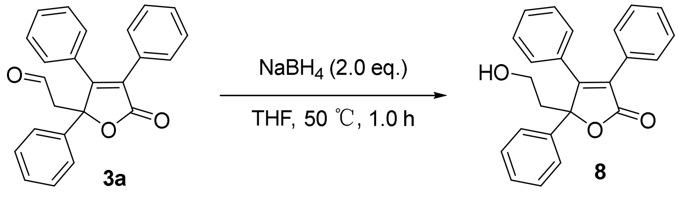
N,*N*-Dimethyl enaminones **1a** (3.0 mmol), cyclopropenone **2a** (3.6 mmol, 1.2 eq.), $PdCl_2$ (10 mol%), CuCl (25 mol%), Ac_2O (9.0 mmol, 3.0 eq.), and $MeNO_2$ (15 mL) were charged into a 75 mL Ace Glass pressure tubes, and the mixture was stirred at 60 °C (metal bath) for 6.0 h until **1a** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (30 mL × 2) were added. The organic phase was washed with water (20 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford *γ*-butenolide **3a** in 82% yield (0.87 g).

3.5 Gram-scale synthesis of butenolide 5b.

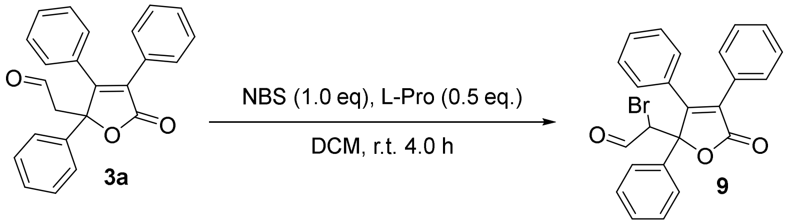


Enaminones **4b** (3.0 mmol), cyclopropenone **2a** (3.6 mmol, 1.2 eq.), $PdCl_2$ (0.5 eq.), Ac_2O (9.0 mmol, 3.0 eq.), and $MeNO_2$ (15 mL) were charged into a 75 mL Ace Glass pressure tubes, and the mixture was stirred at 50 °C (metal bath) for 12.0 h until **4b** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (30 mL × 2) were added. The organic phase was washed with water (20 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford 2*H*-pyrrol-2-ones **5b** in 42% yield (0.56 g).

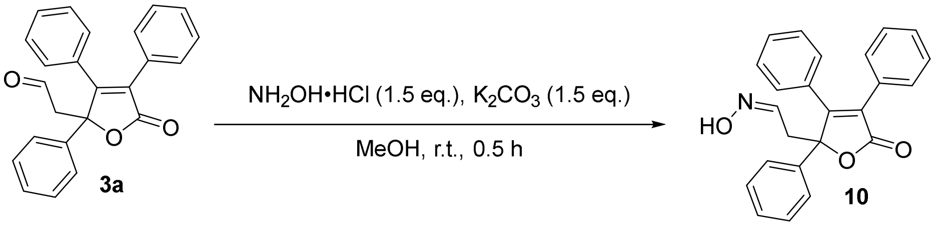
3.6 The Synthetic Applications.



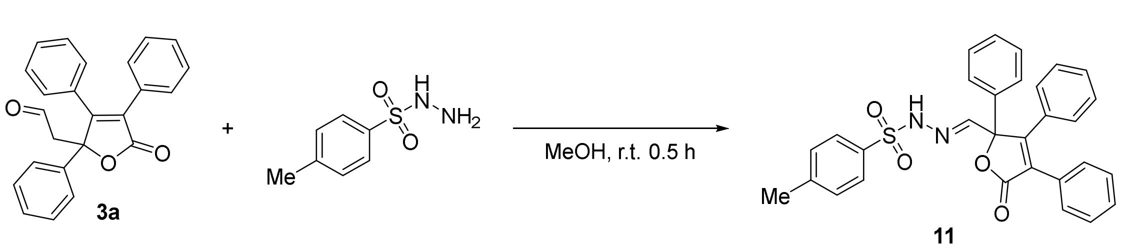
γ-Butenolide **3a** (0.2 mmol), $NaBH_4$ (0.4 mmol, 2.0 eq.), and THF (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 50 °C (metal bath) for 1.0 h until **3a** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford **8**.



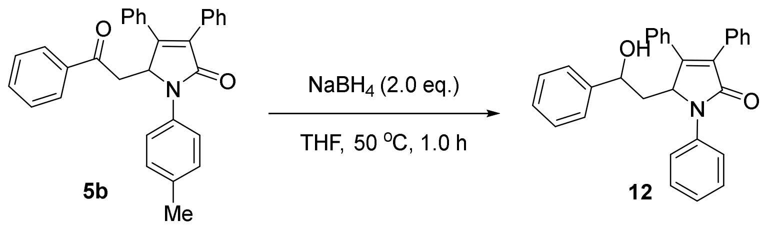
γ-Butenolide **3a** (0.2 mmol), NBS (0.2 mmol, 1.0 eq.), L-Pro (0.1 mmol, 0.5 eq.), and DCM (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at room temperature for 4.0 h until **3a** were completely consumed. And then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford **9**.



γ-Butenolide **3a** (0.2 mmol), NH_2OH•HCl (0.3 mmol, 1.5 eq.), K_2CO_3 (0.3 mmol, 1.5 eq.), and MeOH (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at room temperature for 0.5 h until **3a** were completely consumed. And then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford **10**.

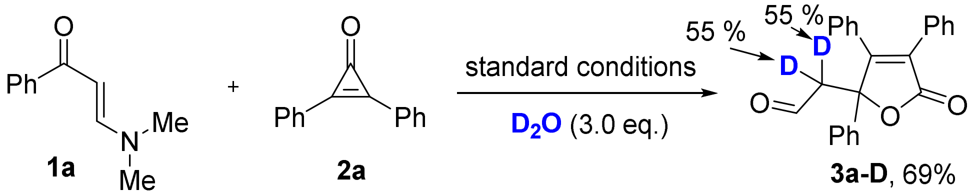


γ-Butenolide **3a** (0.2 mmol), 4-methylbenzenesulfonhydrazide (0.24 mmol, 1.2 eq.), and MeOH (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at room temperature for 0.5 h until **3a** were completely consumed. And then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford **11**.

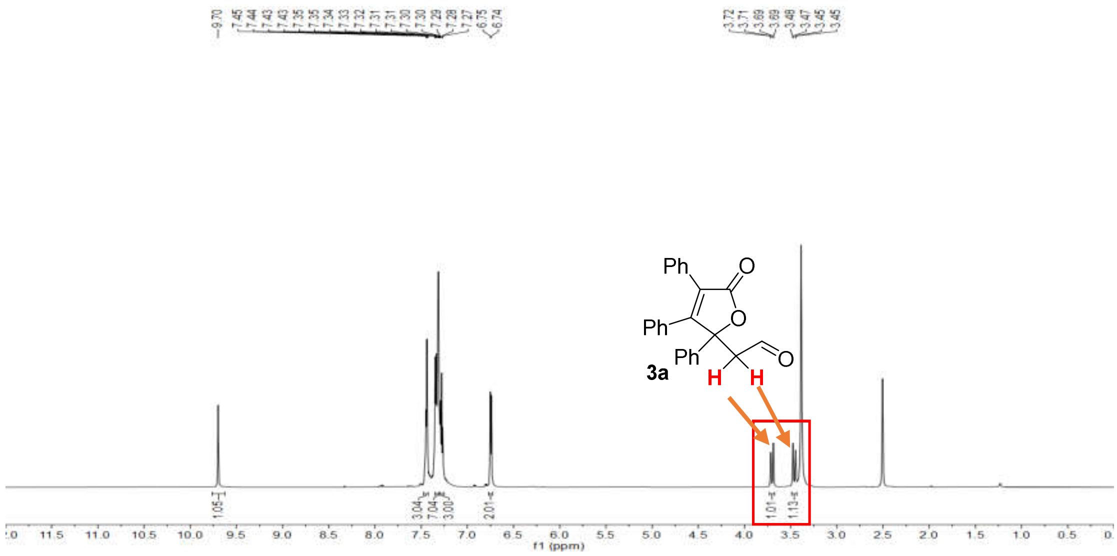


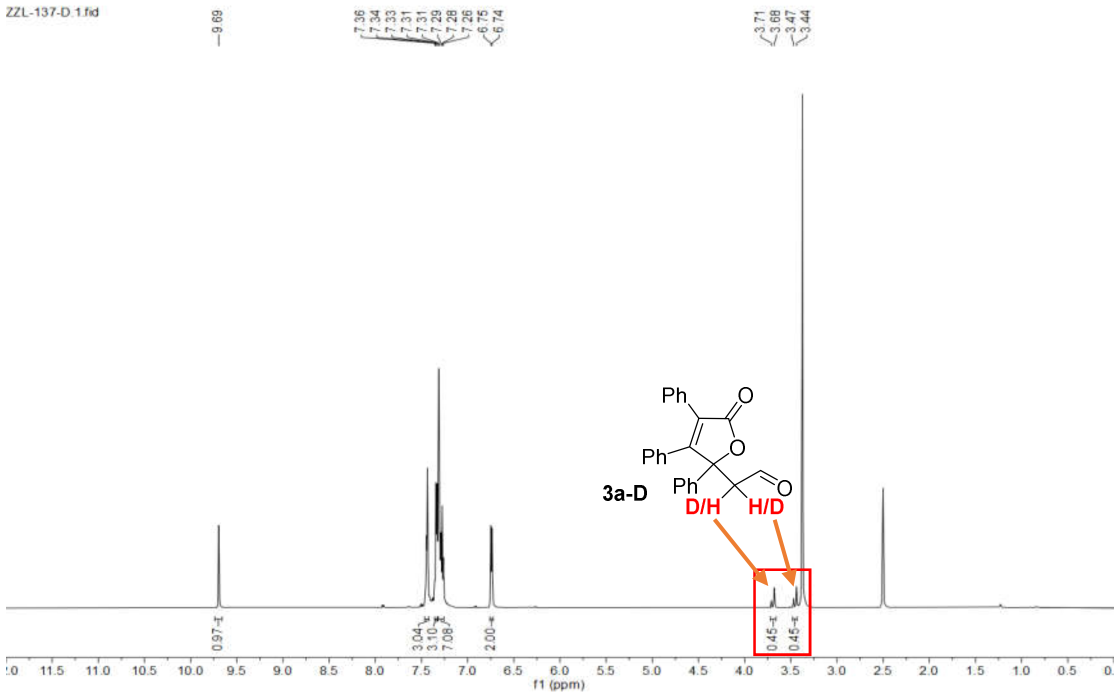
2*H*-Pyrrol-2-ones **5b** (0.2 mmol), $NaBH_4$ (0.4 mmol, 2.0 eq.), and THF (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 50 °C (metal bath) for 1.0 h until **5b** were completely consumed. The mixture was cooled to room temperature, and then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford **12**.

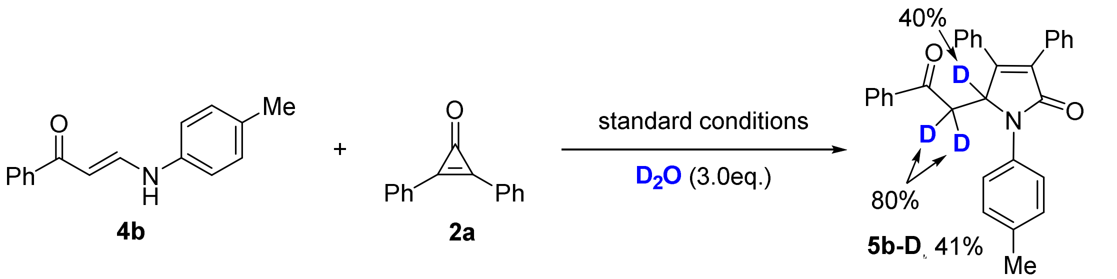
3.7 H/D Exchange experiment.



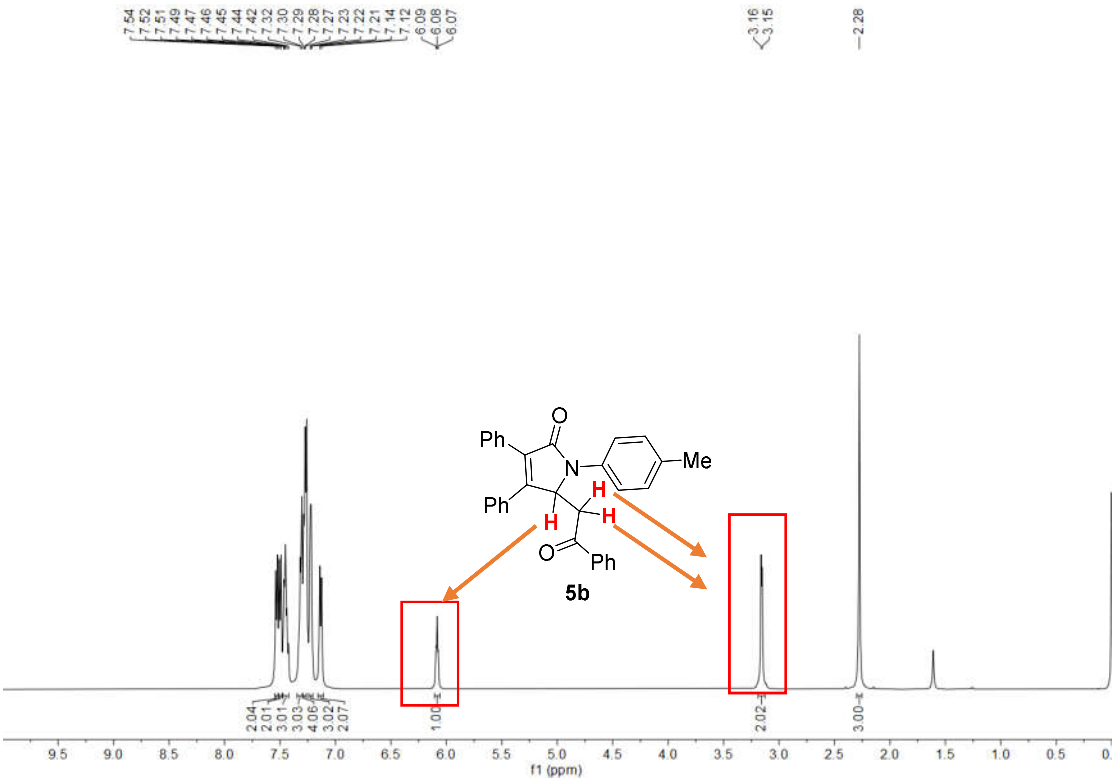
N,*N*-Dimethyl enaminones **1a** (0.2 mmol), cyclopropenone **2a** (0.24 mmol, 1.2 eq.), $PdCl_2$ (10 mol%), CuCl (25 mol%), D_2O, (0.6 mmol, 3.0 eq.), Ac_2O (0.6 mmol, 3.0 eq.), and $MeNO_2$ (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 60 °C (metal bath) for 6.0 h until **1a** were completely consumed, and then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford *γ*-butenolide **3a-D**. The deuterium content in the structure was identified by ^{1}H NMR.

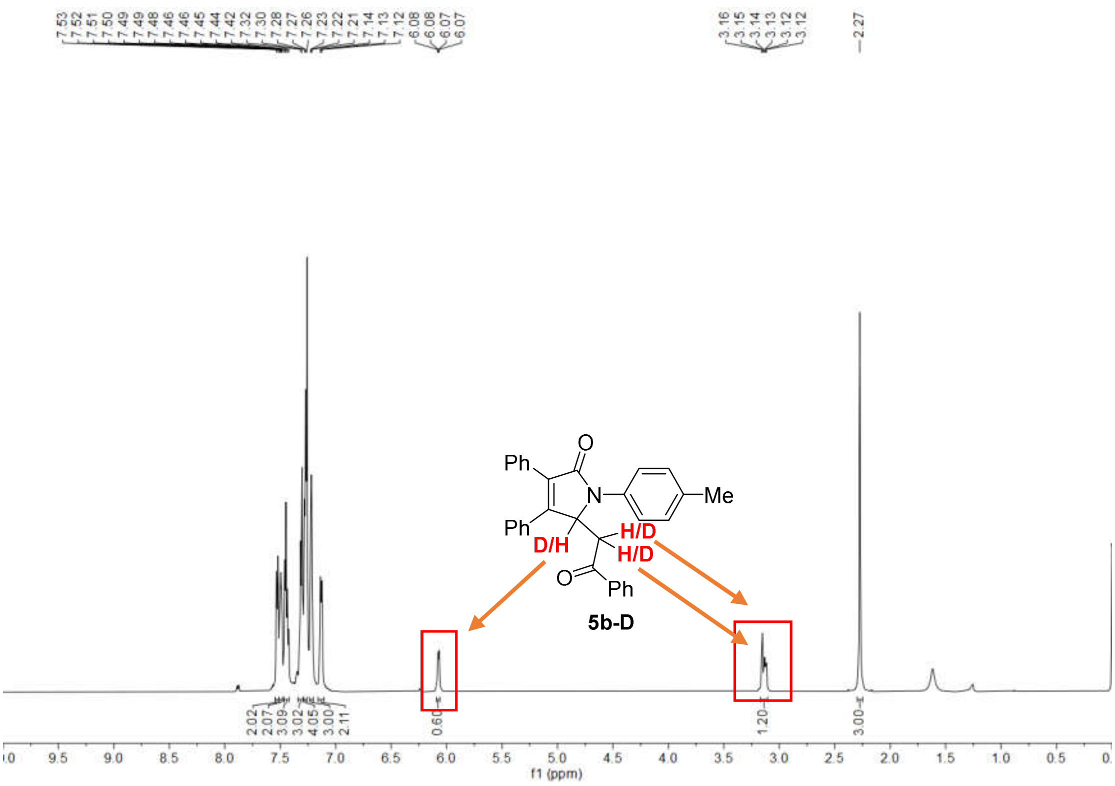




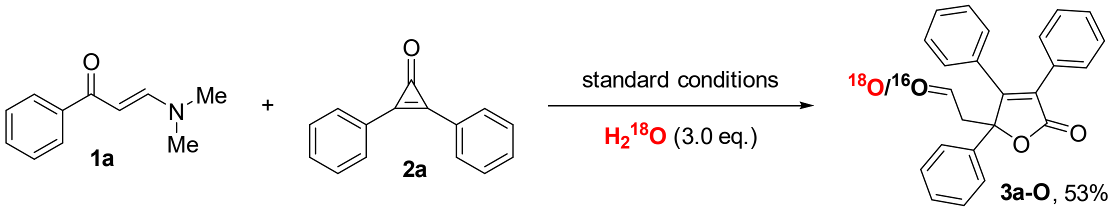


Enaminones **4b** (0.2 mmol), cyclopropenone **2a** (0.24 mmol, 1.2 eq.), $PdCl_2$ (0.5 eq.), D_2O, (0.6 mmol, 3.0 eq.), Ac_2O (0.6 mmol, 3.0 eq.), and $MeNO_2$ (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 50 °C (metal bath) for 12.0 h until **4b** were completely consumed, and then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford 2*H*-pyrrol-2-ones **5b-D**. The deuterium content in the structure was identified by [1]H NMR.



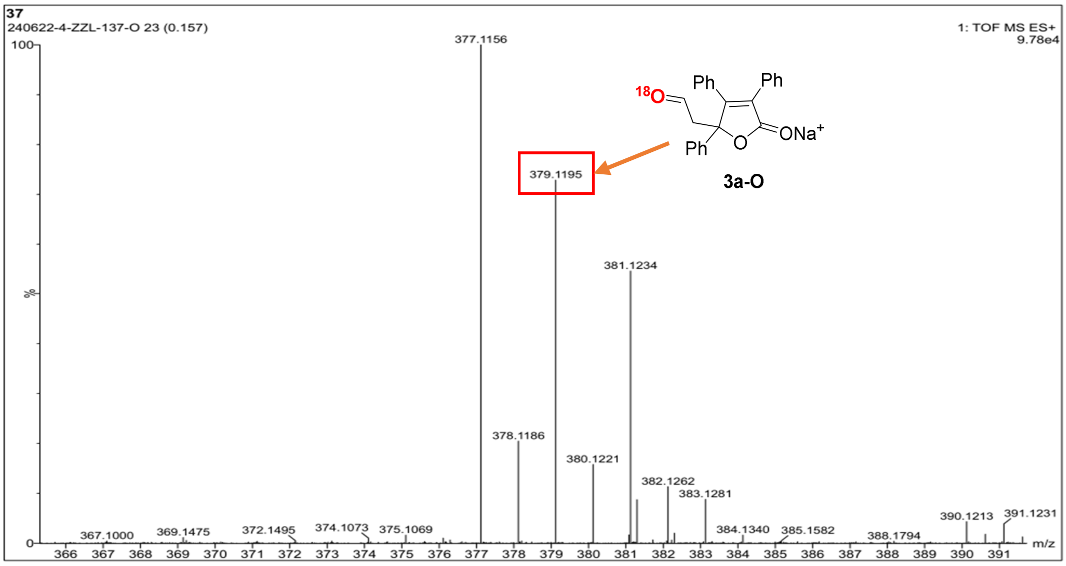


3.8 ^{18}O labeling experiment.



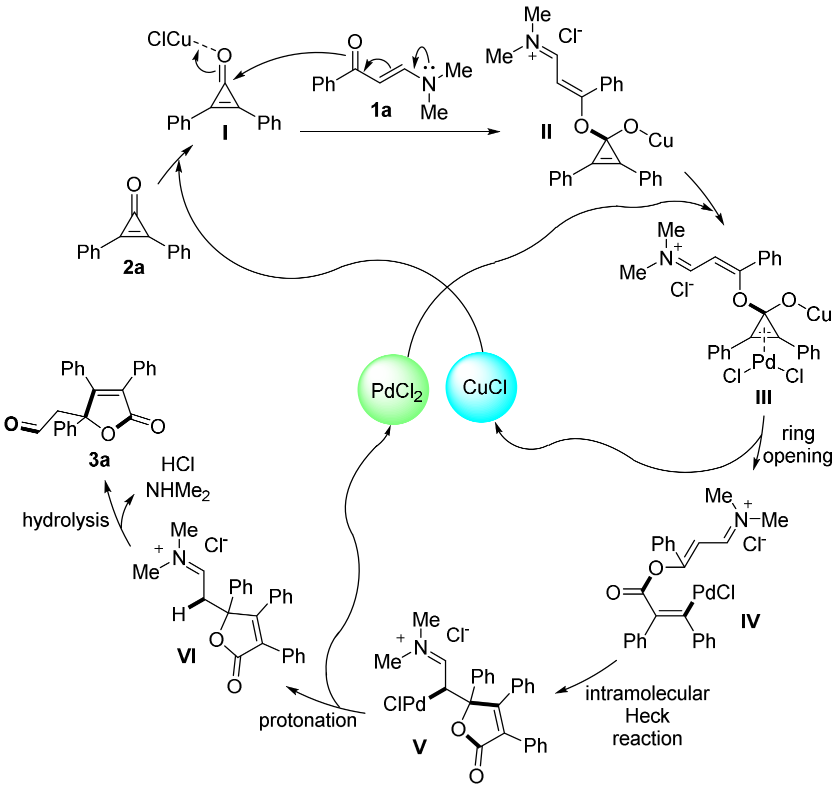
N,*N*-dimethyl enaminones **1a** (0.2 mmol), cyclopropenone **2a** (0.24 mmol, 1.2 eq.), $PdCl_2$ (10 mol%), CuCl (25 mol%), $H_2{}^{18}O$, (0.6 mmol, 3.0 eq.)Ac_2O (0.6 mmol, 3.0 eq.), and $MeNO_2$ (2 mL) were charged into a 15 mL Ace Glass pressure tubes, and the mixture was stirred at 60 °C (metal bath) for 6.0 h until **1a** were completely consumed, and then EtOAc (10 mL × 2) were added. The organic phase was washed with water (10 mL), dried over Na_2SO_4, concentrated and purified by flash column chromatography to afford γ-butenolide **3a-O**. The ^{18}O content in the structure was identified by HRMS.

HRMS (TOF ES+): m/z calcd for $C_{24}H_{18}NaO_2{}^{18}O$ [$(M+Na)^+$], 379.1191, found, 379.1195.



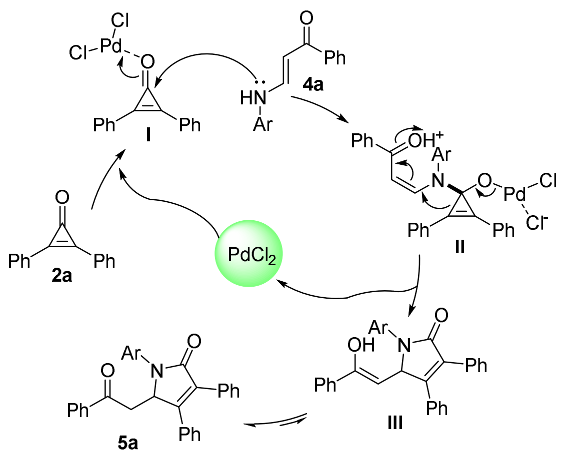
3.9 Proposed reaction mechanism

Based on the above experimental results and previous reports,[3] we proposed a possible mechanism for this Pd(II)-catalyzed [3+2] annulation process between *N*,*N*-dimethyl enaminone **1a** and cyclopropenone **2a**. Initially, cyclopropenone **2a** is complexed with CuCl to generate copper complex species **I**, which is attacked by enaminone **1a** through nucleophilic addition to generate intermediate **II**. Subsequently, $PdCl_2$ is coordinated with the C=C bond of intermediate **II** to form intermediate **III**. Then the ring opening of **III** *via* C-C bond activation generates intermediates **IV** along with regeneration of the co-catalyst CuCl. **VI** undergoes an intramolecular Heck reaction to give intermediate **V**, which is easily converted to intermediate **VI** *via* protonation and the released $PdCl_2$ is regenerated for the next catalytic cycle. Finally, product **3a** is formed through the hydrolysis of **VI**.



Scheme S1. Proposed reaction mechanism of γ-butenolides construction.

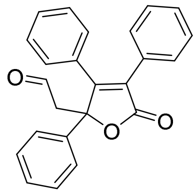
Based on the above experimental results and literature reports,[4] we proposed a possible mechanism to describe this Pd(II)-catalyzed [3+2] annulation process between *NH*-substituted enaminone **4a** and cyclopropenone **2a**. Firstly, cyclopropenone **2a** is complexed with $PdCl_2$ to generate intermediate **I**, which subsequently reacts with *NH*-substituted enaminone **4a** to form intermediate **II**. The intermediate **II** undergoes intramolecular ring-opening/cyclization process to give intermediate **III** and leave a molecule of $PdCl_2$. Finally, a keto-enol tautomerism occurr to produce the desire product **5a**.



Scheme S2. Proposed reaction mechanism of γ-lactams construction.

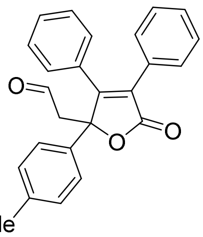
4. Spectroscopic data.

2-(5-Oxo-2,3,4-triphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3a)



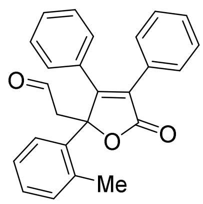
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 65 mg (92%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.70 (s, 1H), 7.45–7.43 (m, 3H), 7.36–7.30 (m, 7H), 7.29–7.27 (m, 3H), 6.75 (d, J = 7.5 Hz, 2H), 3.70 (dd, J = 17.0, 1.9 Hz, 1H), 3.46 (dd, J = 17.1, 1.9 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.4, 163.9, 136.5, 131.3, 130.0, 129.8, 129.5, 129.5, 129.5, 129.5, 129.5, 129.2, 129.2, 129.2, 128.7, 128.7, 128.5, 128.5, 126.9, 126.4, 126.4, 87.5, 46.7; HRMS (TOF ES+): m/z calcd for $C_{24}H_{19}O_3$ [$(M+H)^+$], 355.1329, found, 355.1338.

2-(5-Oxo-3,4-diphenyl-2-(*p*-tolyl)-2,5-dihydrofuran-2-yl)acetaldehyde (3b)



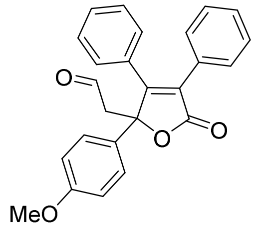
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 70 mg (89%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.68 (s, 1H), 7.36–7.33 (m, 1H), 7.32–7.22 (m, 11H), 6.76 (d, J = 7.0 Hz, 2H), 3.66 (dd, J = 17.0, 2.0 Hz, 1H), 3.41 (dd, J = 17.2, 2.0 Hz, 1H), 2.33 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.4, 163.9, 139.0, 133.5, 131.3, 130.0, 130.0, 130.0, 129.9, 129.5, 129.5, 129.2, 129.2, 129.2, 128.7, 128.7, 128.6, 128.6, 126.8, 126.3, 126.3, 87.5, 46.8, 21.1; HRMS (TOF ES+): m/z calcd for $C_{25}H_{20}NaO_3$ [$(M+Na)^+$], 391.1305, found, 391.1310.

2-(5-Oxo-3,4-diphenyl-2-(*o*-tolyl)-2,5-dihydrofuran-2-yl)acetaldehyde (3c)



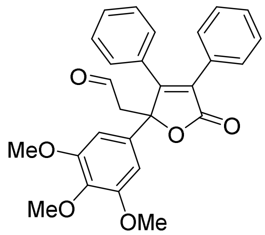
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 51 mg (65%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.73 (s, 1H), 7.37–7.31 (m, 8H), 7.26–7.22 (m, 4H), 6.70–6.66 (m, 2H), 3.73 (dd, J = 17.0, 2.3 Hz, 1H), 3.32 (dd, J = 17.0, 1.9 Hz, 1H), 2.33 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.9, 171.6, 161.7, 137.2, 133.8, 132.7, 131.2, 130.0, 129.9, 129.6, 129.4, 129.4, 129.3, 129.3, 129.2, 129.2, 128.8, 128.8, 128.4, 128.4, 128.4, 127.0, 89.3, 49.7, 21.1; HRMS (TOF ES+): m/z calcd for $C_{25}H_{20}NaO_3$ [$(M+Na)^+$], 391.1305, found, 391.1306.

2-(2-(4-Hydroxyphenyl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3d)



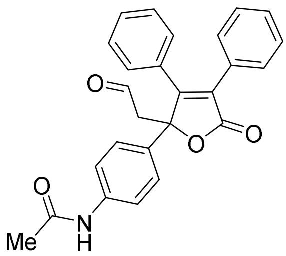
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.2; Yellow oil: 71 mg (93%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.69 (s, 1H), 7.37–7.31 (m, 6H), 7.30–7.27 (m, 4H), 7.00 (d, J = 8.5 Hz, 2H), 6.76 (d, J = 7.6 Hz, 2H), 3.78 (s, 3H), 3.67–3.62 (m, 1H), 3.41–3.39 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.9, 171.4, 163.8, 160.0, 131.3, 130.0, 129.9, 129.5, 129.5, 129.2, 129.2, 128.7, 128.7, 128.7, 128.6, 128.6, 128.1, 127.9, 127.9, 126.7, 114.8, 114.8, 87.4, 55.7, 46.8; HRMS (TOF ES+): m/z calcd for $C_{25}H_{21}O_4$ [(M+H)$^+$], 385.1434, found, 385.1444.

2-(5-Oxo-3,4-diphenyl-2-(3,4,5-trimethoxyphenyl)-2,5-dihydrofuran-2-yl)acetaldehyde (3e)



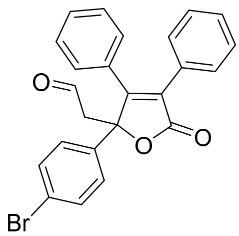
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 2:1, R_f = 0.3; Yellow oil: 80 mg (90%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.68 (s, 1H), 7.40–7.37 (m, 1H), 7.36–7.30 (m, 7H), 6.86 (d, J = 7.5 Hz, 2H), 6.52 (s, 2H), 3.72 (d, J = 17.1 Hz, 1H), 3.68 (s, 3H), 3.67 (s, 6H), 3.43 (d, J = 17.3 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.6, 170.7, 163.3, 153.0, 153.0, 137.8, 131.7, 131.0, 129.6, 129.5, 129.2, 129.2, 128.8, 128.7, 128.7, 128.4, 128.4, 128.3, 128.3, 126.4, 103.4, 103.4, 87.2, 60.2, 56.0, 56.0, 47.1; HRMS (TOF ES+): m/z calcd for $C_{27}H_{24}NaO_6$ [(M+Na)$^+$], 467.1465, found, 467.1474.

***N*-(4-(5-Oxo-2-(2-oxoethyl)-3,4-diphenyl-2,5-dihydrofuran-2-yl)phenyl)acetamide (3f)**



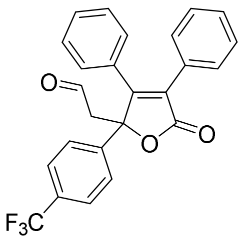
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 1:1, R_f = 0.3; Yellow oil: 63 mg (73%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 10.14 (s, 1H), 9.69 (s, 1H), 7.65 (d, J = 8.5 Hz, 2H), 7.34–7.28 (m, 10H), 6.76 (d, J = 7.2 Hz, 2H), 3.64 (d, J = 17.0 Hz, 1H), 3.38–3.37 (m, 1H), 2.06 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.9, 171.4, 169.1, 163.7, 140.4, 131.3, 130.4, 130.0, 129.9, 129.6, 129.5, 129.5, 129.4, 129.2, 129.2, 128.9, 128.7, 128.7, 128.6, 128.6, 127.1, 126.8, 119.5, 87.4, 46.6, 24.5; HRMS (TOF ES+): m/z calcd for $C_{26}H_{21}NNaO_4$ [(M+Na)$^+$], 434.1363, found, 434.1370.

2-(2-(4-Bromophenyl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3g)



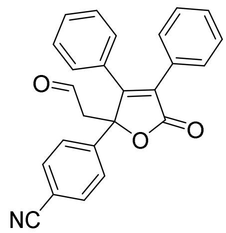
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; colorless oil: 77 mg (89%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.67 (s, 1H), 7.63 (d, J = 8.2 Hz, 2H), 7.36 (t, J = 7.4 Hz, 1H), 7.33–7.27 (m, 9H), 6.79 (d, J = 7.2 Hz, 2H), 3.72 (d, J = 17.4 Hz, 1H), 3.49 (d, J = 17.3 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.1, 170.8, 163.2, 135.7, 131.9, 131.9, 130.7, 129.6, 129.3, 129.1, 129.1, 129.1, 128.9, 128.9, 128.9, 128.3, 128.2, 128.2, 128.2, 128.2, 126.6, 122.4, 86.7, 46.3; HRMS (TOF ES+): m/z calcd for $C_{24}H_{18}BrO_3$ [(M+H)$^+$], 433.0434, found, 433.0441.

2-(5-Oxo-3,4-diphenyl-2-(4-(trifluoromethyl)phenyl)-2,5-dihydrofuran-2-yl)acetaldehyde (3h)



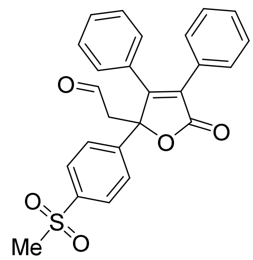
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.2; Yellow oil: 73 mg (87%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.68 (s, 1H), 7.79 (d, J = 8.2 Hz, 2H), 7.55 (d, J = 8.2 Hz, 2H), 7.37 (t, J = 7.5 Hz, 1H), 7.33–7.30 (m, 7H), 6.78 (d, J = 7.6 Hz, 2H), 3.81 (d, J = 18.0 Hz, 1H), 3.62–3.57 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.4, 171.2, 163.5, 141.4, 131.0, 130.1, 129.6, 129.6, 129.5, 129.5, 129.3, 129.3, 129.3 (d, J = 34.5 Hz), 128.7, 128.7, 128.7, 128.6, 128.6, 127.3, 127.3, 126.3 (q, J = 3.0 Hz), 124.4 (d, J = 270 Hz), 87.1, 46.9; ^{19}F NMR (470 MHz, DMSO-d_6) δ = -61.13; HRMS (TOF ES+): m/z calcd for $C_{25}H_{17}F_3NaO_3$ [(M+Na)$^+$], 445.1022, found, 445.1029.

4-(5-Oxo-2-(2-oxoethyl)-3,4-diphenyl-2,5-dihydrofuran-2-yl)benzonitrile (3i)



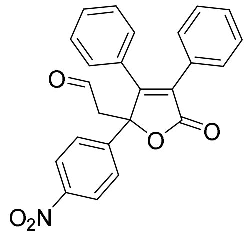
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.2; Yellow oil: 67 mg (88%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.66 (s, 1H), 7.90 (d, *J* = 8.2 Hz, 2H), 7.51 (d, *J* = 8.3 Hz, 2H), 7.38 (t, *J* = 7.4 Hz, 1H), 7.33–7.29 (m, 7H), 6.77 (d, *J* = 7.1 Hz, 2H), 3.81 (d, *J* = d, *J* = 17.6 Hz, 1H), 3.59 (dd, *J* = 17.6 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 198.8, 170.7, 163.0, 141.7, 132.8, 132.8, 130.5, 129.7, 129.1, 129.1, 129.1, 128.9, 128.9, 128.9, 128.3, 128.3, 128.2, 128.2, 127.0, 127.0, 126.9, 118.4, 111.7, 86.7, 46.3; HRMS (TOF ES+): m/z calcd for $C_{25}H_{18}NO_3$ [(M+H)$^+$], 380.1281, found, 380.1286.

2-(2-(4-(Methylsulfonyl)phenyl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3j)



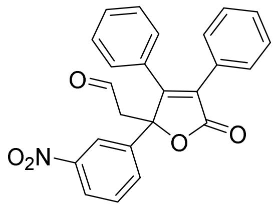
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 1:1, R_f = 0.1; Yellow oil: 74 mg (86%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.68 (s, 1H), 7.96 (d, *J* = 8.3 Hz, 2H), 7.60 (d, *J* = 8.3 Hz, 2H), 7.38 (t, *J* = 7.4 Hz, 1H), 7.33–7.30 (m, 7H), 6.78 (d, *J* = 7.1 Hz, 2H), 3.82 (d, *J* = 16.2 Hz, 1H), 3.60 (d, *J* = 17.6 Hz, 1H), 3.26 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 198.9, 170.8, 163.0, 142.0, 141.1, 130.5, 129.7, 129.2, 129.2, 129.2, 128.9, 128.9, 128.9, 128.3, 128.3, 128.2, 128.2, 127.6, 127.6, 127.0, 127.0, 127.0, 86.7, 46.5, 43.4; HRMS (TOF ES+): m/z calcd for $C_{25}H_{21}O_5S$ [(M+H)$^+$], 433.1104, found, 433.1112.

2-(2-(4-Nitrophenyl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3k)



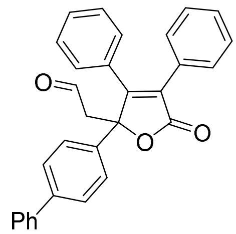
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 2:1, R_f = 0.2; Yellow oil: 66 mg (83%); ^{1}H NMR (500 MHz, $CDCl_3$) δ = 9.78 (s, 1H), 8.22 (d, *J* = 8.4 Hz, 2H), 7.43–7.35 (m, 4H), 7.29 (d, *J* = 26.8 Hz, 6H), 6.83–6.71 (m, 2H), 3.49 (d, *J* = 16.2 Hz, 1H), 3.19 (d, *J* = 16.3 Hz, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 197.0, 170.5, 162.3, 148.2, 143.4, 130.6, 130.0, 129.4, 129.3, 129.3, 129.1, 129.1, 128.4, 128.4, 128.4, 128.2, 128.2, 127.6, 126.9, 126.9, 124.1, 124.1, 86.4, 48.1; HRMS (TOF ES+): m/z calcd for $C_{24}H_{18}NO_5$ [(M+H)$^+$], 400.1179, found, 400.1184.

2-(2-(3-Nitrophenyl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3l)



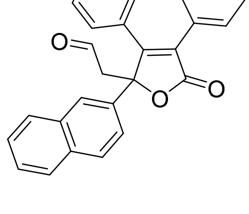
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 75 mg (94%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.67 (s, 1H), 8.27–8.25 (m, 1H), 8.05 (s, 1H), 7.73–7.68 (m, 2H), 7.38 (t, J = 7.5 Hz, 1H), 7.34–7.29 (m, 7H), 6.82 (d, J = 7.2 Hz, 2H), 3.87 (d, J = 17.7 Hz, 1H), 3.66 (d, J = 17.7 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.3, 171.1, 163.4, 148.5, 139.0, 132.9, 130.9, 130.9, 130.1, 129.5, 129.5, 129.5, 129.4, 129.3, 129.3, 128.7, 128.7, 128.7, 128.7, 127.3, 124.3, 120.8, 86.9, 47.0; HRMS (TOF ES+): m/z calcd for $C_{24}H_{18}NO_5$ [(M+H)$^+$], 400.1179, found, 400.1187.

2-(2-([1,1'-Biphenyl]-4-yl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3m)



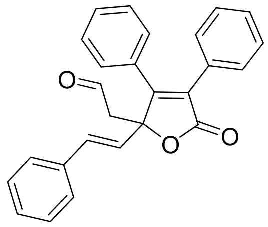
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 80 mg (93%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.73 (s, 1H), 7.77 (d, J = 8.2 Hz, 2H), 7.72 (d, J = 7.9 Hz, 2H), 7.49 (t, J = 7.7 Hz, 2H), 7.44 (d, J = 8.1 Hz, 2H), 7.41–7.38 (m, 2H), 7.35 (d, J = 7.1 Hz, 2H), 7.33–7.31 (m, 3H), 7.29 (d, J = 7.4 Hz, 2H), 6.82 (d, J = 7.6 Hz, 2H), 3.75 (d, J = 17.6 Hz, 1H), 3.50 (d, J = 17.0 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.4, 163.7, 141.0, 139.4, 135.7, 131.3, 130.0, 129.8, 129.6, 129.5, 129.5, 129.5, 129.4, 129.2, 129.2, 128.7, 128.7, 128.7, 128.6, 128.4, 127.6, 127.5, 127.4, 127.2, 127.0, 127.0, 127.0, 87.4, 46.8; HRMS (TOF ES+): m/z calcd for $C_{30}H_{23}O_3$ [(M+H)$^+$], 431.1642, found, 431.1650.

2-(2-(Naphthalen-2-yl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3n)



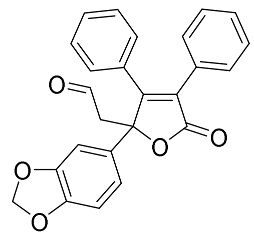
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 65 mg (81%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.76 (s, 1H), 8.01–7.98 (m, 2H), 7.97–7.94 (m, 2H), 7.61–7.56 (m, 2H), 7.41–7.39 (m, 1H), 7.37–7.36 (m, 2H), 7.33–7.31 (m, 4H), 7.25–7.23 (m, 2H), 6.75 (d, J = 7.3 Hz, 2H), 3.85 (dd, J = 17.1, 1.9 Hz, 1H), 3.56 (dd, J = 17.1, 2.1 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.4, 163.7, 133.8, 133.2, 133.0, 131.3, 130.0, 129.8, 129.6, 129.6, 129.5, 129.3, 129.2, 129.2, 128.9, 128.7, 128.7, 128.5, 128.5, 128.0, 127.6, 127.3, 127.3, 126.1, 123.5, 87.7, 46.8; HRMS (TOF ES+): m/z calcd for $C_{28}H_{21}O_3$ [$(M+H)^+$], 405.1485, found, 405.1492.

2-(5-Oxo-3,4-diphenyl-2-styryl-2,5-dihydrofuran-2-yl)acetaldehyde (3o)



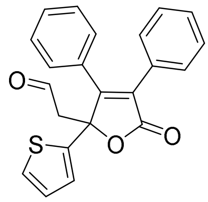
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 62 mg (82%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.71 (s, 1H), 7.55 (d, J = 7.6 Hz, 2H), 7.41–7.36 (m, 5H), 7.34–7.30 (m, 6H), 7.25 (dd, J = 6.5, 2.8 Hz, 2H), 6.79 (d, J = 16.3 Hz, 1H), 6.59 (d, J = 16.2 Hz, 1H), 3.35–3.32 (m, 1H), 3.15 (dd, J = 16.8, 2.3 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 200.0, 171.0, 162.8, 135.9, 132.6, 131.5, 130.0, 130.0, 129.6, 129.6, 129.3, 129.3, 129.2, 129.2, 129.1, 129.0, 128.8, 128.8, 128.7, 128.7, 127.5, 127.5, 127.2, 126.5, 86.8, 46.8; HRMS (TOF ES+): m/z calcd for $C_{26}H_{20}NaO_3$ [$(M+Na)^+$], 403.1305, found, 403.1312.

2-(2-(Benzo[*d*][1,3]dioxol-5-yl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3p)



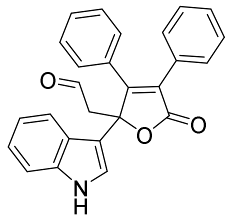
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.2; Yellow oil: 68 mg (86%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.67 (s, 1H), 7.35 (d, J = 7.3 Hz, 1H), 7.33–7.29 (m, 7H), 6.97 (d, J = 8.2 Hz, 1H), 6.91 (s, 1H), 6.85–6.80 (m, 3H), 6.08 (d, J = 10.8 Hz, 2H), 3.65 (d, J = 17.0 Hz, 1H), 3.37–3.34 (m, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.3, 163.7, 148.4, 148.2, 131.3, 130.1, 130.0, 129.9, 129.6, 129.6, 129.2, 129.2, 128.7, 128.7, 128.7, 128.6, 128.6, 126.8, 120.5, 108.9, 106.8, 102.1, 87.5, 47.0; HRMS (TOF ES+): m/z calcd for $C_{25}H_{18}NaO_5$ [$(M+Na)^+$], 421.1046, found, 421.1053.

2-(5-Oxo-3,4-diphenyl-2-(thiophen-2-yl)-2,5-dihydrofuran-2-yl)acetaldehyde (3q)



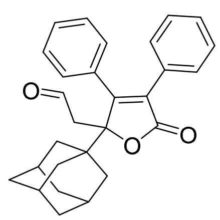
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 54 mg (75%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.69 (s, 1H), 7.74 (d, *J* = 5.1 Hz, 1H), 7.37 (d, *J* = 7.5 Hz, 1H), 7.35–7.30 (m, 7H), 7.23 (d, *J* = 3.6 Hz, 1H), 7.13–7.09 (m, 1H), 6.85 (d, *J* = 7.6 Hz, 2H), 3.72 (d, *J* = 17.2 Hz, 1H), 3.46 (d, *J* = 17.3 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.3, 170.6, 162.6, 141.1, 130.9, 130.3, 129.8, 129.5, 129.5, 129.4, 129.3, 129.3, 128.9, 128.9, 128.8, 128.6, 128.6, 128.2, 128.2, 126.6, 85.5, 47.2; HRMS (TOF ES+): m/z calcd for $C_{22}H_{16}NaO_3S$ [(M+Na)$^+$], 383.0712, found, 383.0722.

2-(2-(*1H*-Indol-3-yl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3r)



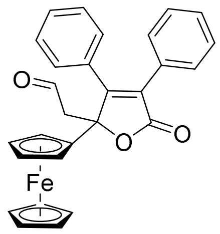
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 1:1, R_f = 0.2; Yellow solid: 25 mg (32%); mp = 222–223 ºC; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 8.96 (s, 1H), 8.37 (d, *J* = 7.6 Hz, 1H), 7.75 (s, 1H), 7.45–7.41 (m, 2H), 7.39–7.33 (m, 9H), 7.29–7.28 (m, 2H), 6.27 (d, *J* = 9.0 Hz, 1H), 3.14 (dd, *J* = 15.9, 9.1 Hz, 1H), 3.04 (dd, *J* = 16.1, 2.7 Hz, 1H);^{13}C NMR (150 MHz, $CDCl_3$) δ = 190.7, 172.6, 160.6, 136.5, 132.4, 130.7, 130.5, 129.9, 129.5, 129.5, 129.3, 129.3, 128.9, 128.7, 128.7, 128.4, 128.4, 126.8, 125.5, 124.1, 123.1, 122.4, 117.9, 111.7, 78.3, 43.0; HRMS (TOF ES+): m/z calcd for $C_{26}H_{20}NO_3$ [(M+H)$^+$], 394.1438, found, 394.1439.

2-(2-((3r,5r,7r)-Adamantan-1-yl)-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3s)



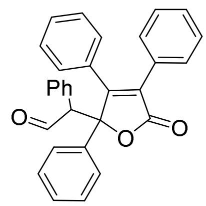
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.4; Yellow oil: 59 mg (71%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 7.42–7.35 (m, 6H), 7.31–7.28 (m, 4H), 6.07 (dd, *J* = 8.8, 2.9 Hz, 1H), 2.99 (dd, *J* = 17.8, 8.8 Hz, 1H), 2.63 (dd, *J* = 17.8, 3.0 Hz, 1H), 1.94–1.90 (m, 3H), 1.68–1.57 (m, 12H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 211.0, 172.1, 161.5, 131.0, 130.6, 130.5, 129.5, 129.5, 129.4, 129.4, 129.0, 128.9, 128.9, 128.7, 128.7, 126.1, 78.1, 46.3, 38.8, 37.3, 37.3, 37.3, 36.3, 36.3, 27.6, 27.6, 27.6, 27.6; HRMS (TOF ES+): m/z calcd for $C_{28}H_{28}NaO_3$ [(M+Na)$^+$], 435.1931, found, 435.1939.

2-(2-Ferrocenyl-5-oxo-3,4-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3t)



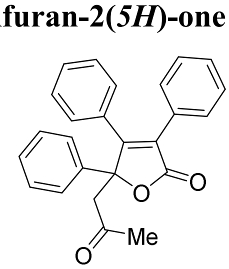
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 53 mg (57%); ^1H NMR (600 MHz, DMSO-d_6) δ = 9.83 (s, 1H), 7.36–7.32 (m, 1H), 7.30–7.27 (m, 5H), 7.25–7.24 (m, 2H), 6.81 (d, J = 7.0 Hz, 2H), 4.38–4.37 (m, 1H), 4.28 (s, 6H), 4.25–4.22 (m, 1H), 4.13–4.09 (m, 1H), 3.60 (d, J = 16.8 Hz, 1H), 3.24 (d, J = 15.1 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 200.2, 171.1, 163.6, 131.6, 130.0, 129.9, 129.5, 129.5, 129.1, 129.1, 129.0, 128.7, 128.7, 128.5, 128.5, 126.2, 88.5, 86.2, 69.7, 69.6, 69.6, 69.6, 69.6, 69.6, 68.7, 68.6, 64.8, 47.4; HRMS (TOF ES+): m/z calcd for $C_{28}H_{23}FeO_3$ [$(M+H)^+$], 463.0991, found, 463.0967.

2-(5-Oxo-2,3,4-triphenyl-2,5-dihydrofuran-2-yl)-2-phenylacetaldehyde (3u)



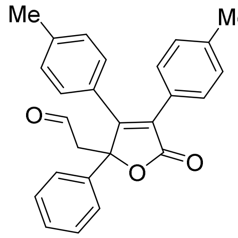
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 8:1, R_f = 0.3; White solid: 43 mg (50%); mp = 200–201 ºC; ^1H NMR (600 MHz, DMSO-d_6) δ = 7.89 (d, J = 7.9 Hz, 2H), 7.55 (t, J = 7.3 Hz, 1H), 7.43–7.40 (m, 2H), 7.35–7.31 (m, 3H), 7.28–7.23 (m, 4H), 7.14–7.11 (m, 1H), 7.06–7.01 (m, 7H), 6.47 (d, J = 7.8 Hz, 1H), 5.21 (d, J = 7.8 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 196.2, 171.5, 161.0, 135.6, 133.7, 133.4, 131.1, 130.0, 129.6, 129.6, 129.2, 129.2, 129.2, 128.9, 128.9, 128.6, 128.6, 128.5, 128.4, 128.4, 128.4, 128.4, 128.3, 128.3, 128.1, 128.1, 127.5, 127.0, 82.2, 54.7; HRMS (TOF ES+): m/z calcd for $C_{30}H_{23}O_3$ [$(M+H)^+$], 431.1642, found, 431.1646.

5-(2-Oxopropyl)-3,4,5-triphenylfuran-2(*5H*)-one (3v)



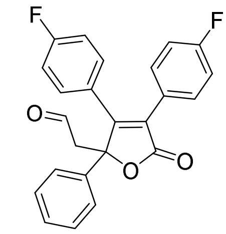
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 42 mg (54%); mp = 155–156 ºC; ^1H NMR (600 MHz, DMSO-d_6) δ = 7.43–7.39 (m, 3H), 7.34–7.25 (m, 10H), 6.73–6.66 (m, 2H), 3.75 (d, J = 17.1 Hz, 1H), 3.55 (d, J = 17.2 Hz, 1H), 2.15 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 204.6, 171.9, 164.1, 137.4, 131.6, 130.1, 129.8, 129.4, 129.4, 129.2, 129.2, 129.1, 129.1, 129.0, 129.0, 128.7, 128.7, 128.6, 128.6, 126.7, 126.1, 126.1, 87.7, 45.8, 31.9; HRMS (TOF ES+): m/z calcd for $C_{25}H_{20}NaO_3$ [$(M+H)^+$], 391.1305, found, 391.1312.

2-(5-Oxo-2-phenyl-3,4-di-*p*-tolyl-2,5-dihydrofuran-2-yl)acetaldehyde (3w)



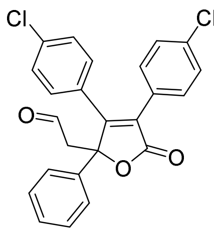
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 68 mg (89%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.68 (s, 1H), 7.46–7.42 (m, 3H), 7.34 (d, J = 6.7 Hz, 2H), 7.22 (d, J = 7.9 Hz, 2H), 7.12 (d, J = 7.9 Hz, 2H), 7.08 (d, J = 7.9 Hz, 2H), 6.64 (d, J = 7.9 Hz, 2H), 3.68 (dd, J = 17.0, 2.0 Hz, 1H), 3.41 (dd, J = 17.3, 2.1 Hz, 1H), 2.26 (s, 3H), 2.24 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.6, 163.3, 139.6, 138.7, 136.8, 129.8, 129.8, 129.5, 129.5, 129.4, 129.4, 129.4, 129.4, 129.3, 129.3, 128.5, 128.4, 127.1, 126.5, 126.3, 126.3, 87.4, 46.8, 21.3, 21.3; HRMS (TOF ES+): m/z calcd for $C_{26}H_{22}NaO_3$ [$(M+Na)^+$], 405.1461, found, 405.1465.

2-(3,4-Bis(4-fluorophenyl)-5-oxo-2-phenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3x)



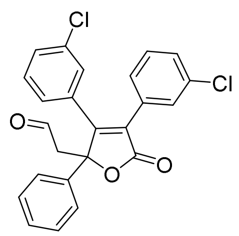
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 60 mg (77%); ^{1}H NMR (500 MHz, DMSO-d_6) δ = 9.69 (s, 1H), 7.46–7.44 (m, 3H), 7.39–7.35 (m, 4H), 7.21–7.15 (m, 4H), 6.82–6.77 (m, 2H), 3.71 (dd, J = 17.1, 1.9 Hz, 1H), 3.47 (dd, J = 17.1, 2.0 Hz, 1H); ^{13}C NMR (125 MHz, DMSO-d_6) δ = 199.8, 171.2, 163.0 (d, J = 246.3 Hz), 162.8, 162.6 (d, J = 246.3 Hz), 136.3, 131.8 (d, J = 8.4 Hz), 131.8 (d, J = 8.4 Hz), 131.0 (d, J = 8.6 Hz), 131.0 (d, J = 8.6 Hz), 129.6, 129.6, 129.5, 127.4 (d, J = 3.3 Hz), 126.4, 126.4, 126.4, 126.1 (d, J = 3.3 Hz), 116.5 (d, J = 21.9 Hz), 116.5 (d, J = 21.9 Hz), 115.9 (d, J = 21.6 Hz), 115.9 (d, J = 21.6 Hz), 87.6, 46.6; ^{19}F NMR (470 MHz, DMSO-d_6) δ = -111.01, -111.87; HRMS (TOF ES+): m/z calcd for $C_{24}H_{17}F_2O_3$ [$(M+H)^+$], 391.1140, found, 391.1146.

2-(3,4-Bis(4-chlorophenyl)-5-oxo-2-phenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3y)



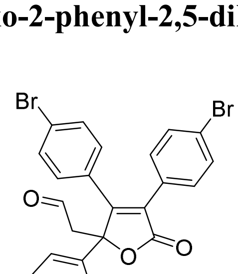
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 63 mg (75%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.68 (s, 1H), 7.45–7.42 (m, 5H), 7.40 (d, J = 8.3 Hz, 2H), 7.36–7.33 (m, 4H), 6.75 (d, J = 8.2 Hz, 2H), 3.72 (d, J = 17.7 Hz, 1H), 3.49 (d, J = 17.5 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 171.0, 163.0, 136.1, 135.0, 134.2, 131.4, 131.4, 130.4, 130.4, 129.8, 129.7, 129.5, 129.5, 129.5, 129.5, 129.0, 129.0, 129.0, 128.4, 126.4, 126.4, 87.6, 46.5; HRMS (TOF ES+): m/z calcd for $C_{24}H_{17}Cl_2O_3$ [$(M+H)^+$], 423.0549, found, 423.0556.

2-(3,4-Bis(3-chlorophenyl)-5-oxo-2-phenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3z)



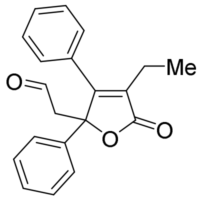
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 62 mg (74%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.69 (s, 1H), 7.47–7.45 (m, 4H), 7.42 (dd, J = 8.1, 2.2 Hz, 1H), 7.38–7.33 (m, 5H), 7.20 (d, J = 7.8 Hz, 1H), 6.75 (s, 1H), 6.69 (d, J = 7.8 Hz, 1H), 3.72 (d, J = 1.9 Hz, 1H), 3.50 (d, J = 17.3 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 170.8, 163.2, 135.7, 133.8, 133.4, 132.8, 131.5, 131.2, 130.7, 130.1, 129.7, 129.5, 129.5, 129.3, 129.3, 128.2, 128.1, 127.4, 126.5, 126.5, 126.5, 87.8, 46.5; HRMS (TOF ES+): m/z calcd for $C_{24}H_{17}Cl_2O_3$ [$(M+Na)^+$], 423.0549, found, 423.0556.

2-(3,4-Bis(4-bromophenyl)-5-oxo-2-phenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3a')



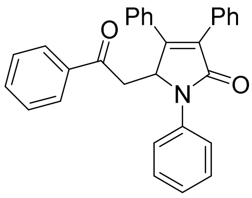
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 63 mg (62%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.67 (s, 1H), 7.56 (d, J = 8.2 Hz, 2H), 7.53 (d, J = 8.1 Hz, 2H), 7.46–7.44 (m, 3H), 7.35 (d, J = 8.1 Hz, 2H), 7.27 (d, J = 8.2 Hz, 2H), 6.67 (d, J = 8.2 Hz, 2H), 3.72 (d, J = 17.2 Hz, 1H), 3.48 (d, J = 16.2 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 199.8, 170.9, 163.1, 136.1, 132.4, 132.4, 131.9, 131.9, 131.6, 131.6, 130.6, 130.6, 130.2, 129.7, 129.5, 129.5, 128.8, 126.5, 126.4, 126.4, 123.9, 123.0, 87.6, 46.5; HRMS (TOF ES+): m/z calcd for $C_{24}H_{17}Br_2O_3$ [$(M+H)^+$], 510.9539, found, 510.9542.

2-(4-Ethyl-5-oxo-2,3-diphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (3b')



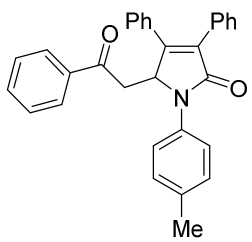
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; Yellow oil: 50 mg (82%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.65 (s, 1H), 7.51–4.46 (m, 8H), 7.44–7.41 (m, 2H), 3.84 (dd, *J* = 16.9, 2.4 Hz, 1H), 3.45 (dd, *J* = 16.9, 1.9 Hz, 1H), 2.44–2.36 (m, 2H), 0.60 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 200.1, 172.0, 169.2, 137.3, 130.4, 129.5, 129.5, 129.3, 129.2, 129.2, 129.1, 128.9, 128.9, 126.0, 126.0, 125.8, 87.7, 46.9, 19.5, 12.3; HRMS (TOF ES+): m/z calcd for $C_{20}H_{18}NaO_3$ [$(M+Na)^+$], 329.1148, found, 329.1153.

5-(2-Oxo-2-phenylethyl)-1,3,4-triphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5a)



$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; White solid: 55 mg (64%); mp = 196–197 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.65 (d, *J* = 7.9 Hz, 2H), 7.55–7.51 (m, 2H), 7.47–7.41 (m, 3H), 7.36–7.26 (m, 9H), 7.24–7.19 (m, 3H), 7.11 (t, *J* = 7.4 Hz, 1H), 6.12 (t, *J* = 4.9 Hz, 1H), 3.20–3.14 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 197.2, 168.6, 153.1, 137.0, 136.6, 133.3, 132.5, 132.0, 131.3, 130.0, 130.0, 129.4, 129.2, 129.2, 129.1, 129.1, 128.9, 128.9, 128.5, 128.5, 128.4, 128.4, 128.3, 127.9, 127.9, 125.3, 122.9, 122.9, 58.6, 40.1; HRMS (TOF ES+): m/z calcd for $C_{30}H_{23}NNaO_2$ [$(M+Na)^+$], 452.1621, found, 452.1626.

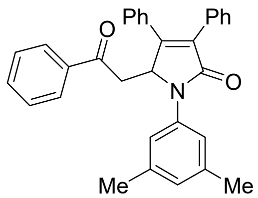
5-(2-Oxo-2-phenylethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5b)



$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; Yellow solid: 58 mg (65%); mp = 200–201 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.53 (d, *J* = 7.8 Hz, 2H), 7.50 (d, *J* = 8.0 Hz, 2H), 7.47–7.42 (m, 3H), 7.32–7.30 (m, 3H), 7.29–7.26 (m, 4H), 7.24–7.20 (m, 3H), 7.13 (d, *J* = 8.0 Hz, 2H), 6.08 (t, *J* = 4.9 Hz, 1H), 3.16 (d, *J* = 5.0 Hz, 2H), 2.28 (s, 3H); ^{13}C

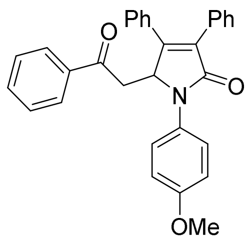
NMR (125 MHz, $CDCl_3$) δ = 197.1, 168.4, 152.8, 136.5, 135.0, 134.1, 133.1, 132.4, 131.9, 131.2, 129.8, 129.8, 129.7, 129.7, 129.2, 128.9, 128.9, 128.7, 128.7, 128.3, 128.3, 128.2, 128.2, 128.1, 127.8, 127.8, 123.0, 123.0, 58.6, 40.0, 20.9; HRMS (TOF ES+): m/z calcd for $C_{31}H_{25}NNaO_2$ [$(M+Na)^+$], 466.1778, found, 466.1782.

1-(3,5-Dimethylphenyl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5c)



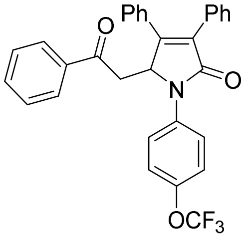
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 44 mg (48%); mp = 158–159 °C; ^1H NMR (500 MHz, $CDCl_3$) δ = 7.53 (d, J = 7.2 Hz, 2H), 7.47–7.41 (m, 3H), 7.33–7.28 (m, 7H), 7.25–7.20 (m, 5H), 6.73 (s, 1H), 6.04 (t, J = 5.0 Hz, 1H), 3.17 (dd, J = 16.8, 4.7 Hz, 1H), 3.12 (dd, J = 16.8, 5.3 Hz, 1H), 2.25 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 197.3, 168.6, 152.9, 138.8, 138.8, 136.7, 133.2, 133.2, 132.6, 132.2, 131.4, 130.0, 130.0, 129.3, 129.1, 129.1, 128.9, 128.9, 128.4, 128.4, 128.3, 128.3, 128.2, 127.9, 127.9, 127.3, 121.2, 121.2, 59.2, 40.1, 21.5, 21.5; HRMS (TOF ES+): m/z calcd for $C_{32}H_{27}NNaO_2$ [$(M+Na)^+$], 480.1934, found, 480.1940.

1-(4-Methoxyphenyl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5d)



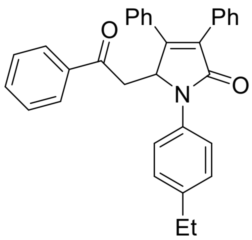
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 61 mg (66%); mp = 177–178 °C; ^1H NMR (600 MHz, $CDCl_3$) δ = 7.54 (d, J = 7.8 Hz, 2H), 7.48–7.42 (m, 5H), 7.33–7.23 (m, 7H), 7.25–7.22 (m, 3H), 6.84 (d, J = 8.5 Hz, 2H), 6.04 (t, J = 5.0 Hz, 1H), 3.75 (s, 3H), 3.18–3.08 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 197.1, 168.5, 157.3, 152.6, 136.5, 133.2, 132.4, 132.0, 131.3, 129.8, 129.8, 129.6, 129.2, 128.9, 128.9, 128.8, 128.8, 128.4, 128.4, 128.3, 128.3, 128.1, 127.8, 127.8, 125.2, 125.2, 114.3, 114.3, 59.1, 55.4, 40.1; HRMS (TOF ES+): m/z calcd for $C_{31}H_{25}NNaO_3$ [$(M+Na)^+$], 482.1727, found, 482.1727.

5-(2-Oxo-2-phenylethyl)-3,4-diphenyl-1-(4-(trifluoromethoxy)phenyl)-1,5-dihydro-2*H*-pyrrol-2-one (5e)



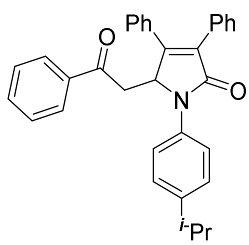
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 64 mg (62%); mp = 172–173 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.68 (d, J = 8.6 Hz, 2H), 7.54 (d, J = 7.8 Hz, 2H), 7.47–7.44 (m, 3H), 7.35–7.32 (m, 3H), 7.30–7.27 (m, 4H), 7.25–7.22 (m, 3H), 7.18 (d, J = 8.6 Hz, 2H), 6.10 (t, J = 5.0 Hz, 1H), 3.22–3.12 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 197.1, 168.6, 153.2, 146.0, 136.3, 135.4, 133.5, 133.5, 132.2, 131.6, 130.9, 129.8, 129.8, 129.5, 128.9, 128.9, 128.9, 128.9, 128.5, 128.5, 128.3, 128.3, 128.3, 127.8, 127.8, 123.9, 123.9, 121.8, 121.8, 58.5, 40.0; ^{19}F NMR (470 MHz, $CDCl_3$) δ = -57.99; HRMS (TOF ES+): m/z calcd for $C_{31}H_{22}F_3NNaO_3$ [(M+Na)$^+$], 536.1444, found, 536.1453.

1-(4-Ethylphenyl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5f)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 65 mg (71%); mp = 195–196 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.53–7.50 (m, 4H), 7.47–7.41 (m, 3H), 7.33–7.31 (m, 3H), 7.29–7.27 (m, 3H), 7.26–7.21 (m, 4H), 7.15 (d, J = 8.1 Hz, 2H), 6.08 (t, J = 5.0 Hz, 1H), 3.19–3.11 (m, 2H), 2.57 (q, J = 7.6 Hz, 2H), 1.17 (t, J = 7.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 197.3, 168.5, 152.9, 141.5, 136.6, 134.4, 133.3, 132.5, 132.1, 131.3, 129.9, 129.9, 129.3, 129.0, 129.0, 128.8, 128.8, 128.6, 128.6, 128.4, 128.4, 128.3, 128.3, 128.2, 127.9, 127.9, 123.2, 123.2, 58.9, 40.1, 28.4, 15.6; HRMS (TOF ES+): m/z calcd for $C_{32}H_{27}NNaO_2$ [(M+Na)$^+$], 480.1934, found, 480.1934.

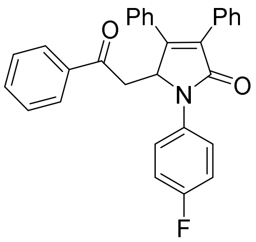
1-(4-Isopropylphenyl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5g)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 63 mg (67%); mp = 194–195 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.53–7.48 (m, 4H), 7.48–7.45 (m, 2H), 7.44–7.40 (m, 1H), 7.33–7.27 (m, 6H), 7.25–7.21 (m, 4H), 7.17 (d, J = 8.4 Hz, 2H), 6.07 (t, J = 5.0

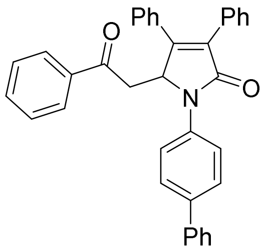
Hz, 1H), 3.19–3.10 (m, 2H), 2.86–2.80 (m, 1H), 1.2 (d, *J* = 7.0 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) *δ* = 197.4, 168.5, 152.9, 146.1, 136.8, 134.5, 133.2, 132.6, 132.2, 131.4, 130.0, 130.0, 129.3, 129.1, 129.1, 128.9, 128.9, 128.4, 128.4, 128.3, 128.3, 128.2, 127.9, 127.9, 127.2, 127.2, 123.3, 123.3, 59.2, 40.2, 33.8, 24.1, 24.0; HRMS (TOF ES+): m/z calcd for $C_{33}H_{29}NNaO_2$ [$(M+Na)^+$], 494.2091, found, 494.2097.

1-(4-Fluorophenyl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5h)



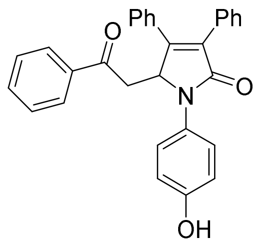
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 51 mg (57%); mp = 173–174 °C; ^{1}H NMR (500 MHz, $CDCl_3$) *δ* = 7.59–7.53 (m, 4H), 7.48–7.44 (m, 3H), 7.33–7.30 (m, 3H), 7.29–7.27 (m, 3H), 7.26–7.23 (m, 4H), 7.05–6.98 (m, 2H), 6.07 (t, *J* = 5.0 Hz, 1H), 3.15 (d, *J* = 5.0 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) *δ* = 197.0, 168.5, 160.1 (*J* = 243.8 Hz), 152.9, 136.4, 133.4, 132.8 (d, *J* = 2.5 Hz), 132.3, 131.8, 131.0, 129.8, 129.8, 129.4, 128.8, 128.8, 128.8, 128.8, 128.4, 128.4, 128.3, 128.3, 128.3, 128.3, 127.8, 125.1 (d, *J* = 8.8 Hz), 125.1 (d, *J* = 8.8 Hz), 115.8 (d, *J* = 22.5 Hz), 115.8 (d, *J* = 22.5 Hz), 58.8, 40.0; ^{19}F NMR (470 MHz, $CDCl_3$) *δ* = -116.6; HRMS (TOF ES+): m/z calcd for $C_{30}H_{22}FNNaO_2$ [$(M+Na)^+$], 470.1527, found, 470.1530.

1-([1,1'-Biphenyl]-4-yl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5i)



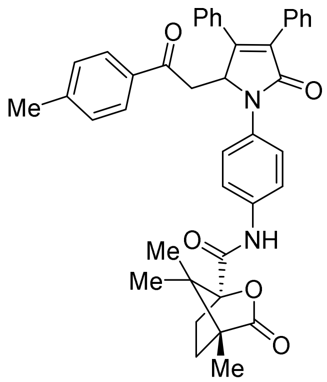
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 56 mg (55%); mp = 179–180 °C; ^{1}H NMR (500 MHz, $CDCl_3$) *δ* = 7.73 (d, *J* = 8.2 Hz, 2H), 7.59–7.52 (m, 6H), 7.47 (d, *J* = 5.4 Hz, 2H), 7.44–7.40 (m, 3H), 7.35–7.28 (m, 8H), 7.25–7.24 (m, 3H), 6.15 (t, *J* = 4.9 Hz, 1H), 3.22 (d, *J* = 4.9 Hz, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) *δ* = 197.3, 168.7, 153.2, 140.6, 138.0, 136.6, 136.2, 133.4, 132.5, 132.0, 131.3, 130.0, 130.0, 129.4, 129.1, 129.1, 128.9, 128.9, 128.9, 128.9, 128.5, 128.5, 128.4, 128.4, 128.3, 127.9, 127.9, 127.9, 127.9, 127.3, 127.1, 127.1, 123.1, 123.1, 58.7, 40.2; HRMS (TOF ES+): m/z calcd for $C_{36}H_{27}NNaO_2$ [$(M+Na)^+$], 528.1934, found, 528.1942.

1-(4-Hydroxyphenyl)-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5j)



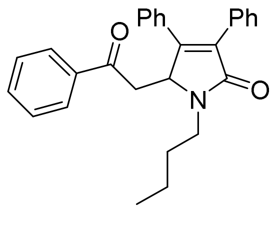
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 1:1, R_f = 0.2; Yellow solid: 42 mg (47%); mp = 206–207 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.53–7.49 (m, 2H), 7.47–7.44 (m, 2H), 7.43–7.41 (m, 1H), 7.35–7.30 (m, 3H), 7.28–7.26 (m, 3H), 7.25–7.24 (m, 5H), 7.17 (d, J = 8.6 Hz, 2H), 6.58 (d, J = 8.7 Hz, 2H), 5.94 (t, J = 5.1 Hz, 1H), 3.21–3.03 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 196.9, 169.4, 154.8, 153.1, 136.5, 133.2, 132.3, 132.0, 131.1, 129.8, 129.8, 129.2, 128.8, 128.8, 128.8, 128.8, 128.4, 128.4, 128.4, 128.3, 128.3, 128.2, 127.7, 127.7, 126.5, 126.5, 116.4, 116.4, 60.2, 39.8; HRMS (TOF ES+): m/z calcd for $C_{30}H_{23}NNaO_3$ [$(M+Na)^+$], 468.1570, found, 468.1577.

4,7,7-Trimethyl-3-oxo-*N*-(4-(2-oxo-5-(2-oxo-2-(*p*-tolyl)ethyl)-3,4-diphenyl-2,5-dihydro-1*H*-pyrrol-1-yl)phenyl)-2-oxabicyclo[2.2.1]heptane-1-carboxamide (5k)



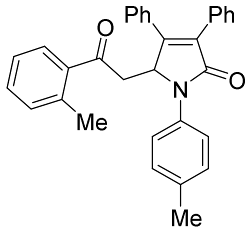
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow oil: 82 mg (64%); ^{1}H NMR (600 MHz, DMSO-d_6) δ = 9.86 (s, 1H), 7.73 (d, J = 8.6 Hz, 2H), 7.54 (dd, J = 9.0, 2.6 Hz, 2H), 7.43 (d, J = 7.9 Hz, 2H), 7.35–7.32 (m, 3H), 7.31–7.26 (m, 7H), 7.09 (d, J = 7.9 Hz, 2H), 6.15 (t, J = 4.7 Hz, 1H), 3.28–3.24 (m, 1H), 3.14 (dd, J = 17.2, 4.1 Hz, 1H), 2.49–2.47 (m, 1H), 2.26 (s, 3H), 2.03–2.00 (m, 1H), 1.93–1.88 (m, 1H), 1.61–1.59 (m, 1H), 1.05 (s, 6H), 0.91 (s, 3H); ^{13}C NMR (150 MHz, DMSO-d_6) δ = 196.6, 178.5, 168.4, 165.7, 153.7, 144.0, 135.3, 135.2, 134.5, 133.4, 132.5, 131.9, 131.9, 129.9, 129.9, 129.5, 129.4, 129.4, 129.1, 129.0, 129.0, 128.6, 128.6, 128.4, 128.2, 128.2, 123.5, 123.5, 121.8, 121.7, 92.3, 59.1, 55.0, 54.1, 38.1, 30.5, 28.9, 21.5, 17.0, 16.8, 10.1; HRMS (TOF ES+): m/z calcd for $C_{41}H_{38}N_2NaO_5$ [$(M+Na)^+$], 661.2673, found, 661.2681.

1-Butyl-5-(2-oxo-2-phenylethyl)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (5l)



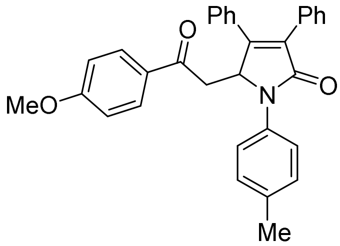
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.4; White solid: 30 mg (37%); mp = 142–143 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.8 (d, J = 7.2 Hz, 2H), 7.56 (t, J = 7.4 Hz, 1H), 7.45–7.39 (m, 4H), 7.30–7.27 (m, 6H), 7.24–7.21 (m, 2H), 5.50 (dd, J = 7.9, 2.8 Hz, 1H), 3.90–3.85 (m, 1H), 3.21–3.16 (m, 1H), 3.05–2.93 (m, 2H), 1.70–1.61 (m, 1H), 1.57–1.49 (m, 1H), 1.35–1.24 (m, 2H), 0.89 (t, J = 7.4 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 197.4, 170.0, 152.2, 136.5, 133.8, 132.6, 131.7, 129.9, 129.9, 129.2, 129.0, 129.0, 128.9, 128.9, 128.9, 128.9, 128.3, 128.3, 128.2, 128.2, 128.1, 57.3, 41.3, 41.1, 30.6, 20.3, 20.3, 13.9; HRMS (TOF ES+): m/z calcd for $C_{28}H_{27}NNaO_2$ [$(M+Na)^+$], 432.1934, found, 432.1938.

5-(2-Oxo-2-(*o*-tolyl)ethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5m)



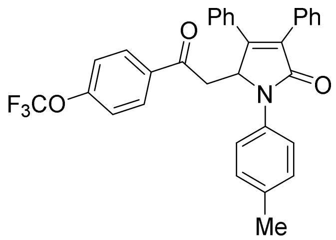
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 39 mg (43%); mp = 159–160 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.52 (d, J = 8.5 Hz, 2H), 7.47–7.42 (m, 2H), 7.34–7.27 (m, 8H), 7.24–7.22 (m, 1H), 7.18 (d, J = 8.2 Hz, 2H), 7.10 (d, J = 7.6 Hz, 1H), 7.02–6.99 (m, 1H), 6.97–6.95 (m, 1H), 6.07 (t, J = 4.8 Hz, 1H), 3.11 (dd, J = 4.8, 2.9 Hz, 2H), 2.32 (s, 3H), 2.22 (s, 3H; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 200.5, 168.6, 152.9, 138.1, 137.4, 135.2, 134.4, 132.6, 132.3, 131.8, 131.6, 131.4, 130.0, 130.0, 129.9, 129.9, 129.4, 129.0, 129.0, 128.9, 128.9, 128.4, 128.4, 128.3, 128.2, 125.6, 123.1, 123.1, 58.3, 43.1, 21.1, 20.9; HRMS (TOF ES+): m/z calcd for $C_{32}H_{27}NNaO_2$ [$(M+Na)^+$], 480.1934, found, 480.1934.

5-(2-(4-Methoxyphenyl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5n)



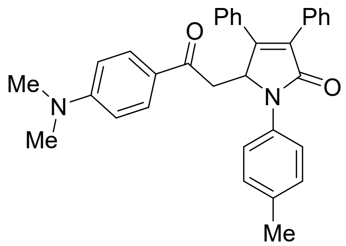
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; White solid: 57 mg (60%); mp = 180–181 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.55–7.49 (m, 4H), 7.48–7.44 (m, 2H), 7.34–7.27 (m, 5H), 7.23–7.20 (m, 3H), 7.13 (d, J = 8.0 Hz, 2H), 6.73 (d, J = 8.8 Hz, 2H), 6.07 (t, J = 5.0 Hz, 1H), 3.79 (s, 3H), 3.10 (d, J = 5.0 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 195.5, 168.6, 163.7, 153.2, 135.0, 134.4, 132.5, 132.2, 131.5, 130.3, 130.3, 130.0, 130.0, 129.8, 129.8, 129.8, 129.3, 129.1, 129.1, 128.8, 128.8, 128.3, 128.3, 128.2, 123.1, 123.1, 113.6, 113.6, 58.9, 55.6, 39.8, 21.0; HRMS (TOF ES+): m/z calcd for $C_{32}H_{27}NNaO_3$ [$(M+Na)^+$], 496.1883, found, 496.1887.

5-(2-Oxo-2-(4-(trifluoromethoxy)phenyl)ethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5o)



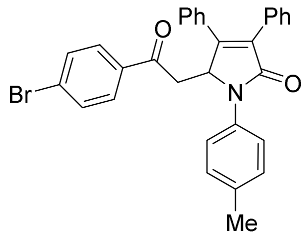
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; Yellow solid: 64 mg (61%); mp = 140–141 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.55 (d, J = 8.9 Hz, 2H), 7.47–7.44 (m, 4H), 7.33–7.29 (m, 3H), 7.27–7.26 (m, 2H), 7.24–7.20 (m, 3H), 7.12 (d, J = 8.1 Hz, 2H), 7.08 (d, J = 8.4 Hz, 2H), 6.01 (t, J = 5.1 Hz, 1H), 3.12 (d, J = 4.9 Hz, 2H), 2.27 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 195.7, 168.3, 152.4, 135.2, 134.7, 134.1, 132.6, 132.0, 131.1, 129.8, 129.8, 129.8, 129.8, 129.8, 129.8, 129.7, 129.3, 128.9, 128.9, 128.9, 128.8, 128.8, 128.2, 128.2, 128.2, 123.2, 123.2, 120.0, 120.0, 59.1, 39.8, 20.9; ^{19}F NMR (470 MHz, $CDCl_3$) δ = -57.67; HRMS (TOF ES+): m/z calcd for $C_{32}H_{24}F_3NNaO_3$ [$(M+Na)^+$], 550.1600, found, 550.1608.

5-(2-(4-(Dimethylamino)phenyl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5p)



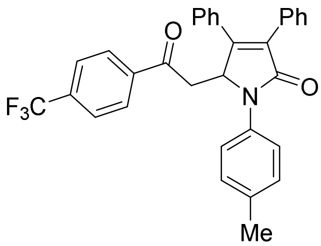
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.2; Yellow solid: 41 mg (42%); mp = 242–243 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.54 (d, J = 8.1 Hz, 2H), 7.50 (d, J = 9.1 Hz, 2H), 7.48–7.44 (m, 2H), 7.33–7.28 (m, 5H), 7.21–7.20 (m, 3H), 7.13 (d, J = 8.1 Hz, 2H), 6.46 (d, J = 9.1 Hz, 2H), 6.14 (t, J = 4.9 Hz, 1H), 3.08 (d, J = 4.9 Hz, 2H), 2.98 (s, 6H), 2.27 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 194.2, 168.5, 153.5, 153.3, 134.6, 134.4, 132.1, 132.1, 131.5, 130.1, 130.1, 129.9, 129.9, 129.6, 129.6, 129.0, 129.0, 129.0, 128.6, 128.6, 128.2, 128.2, 128.0, 124.5, 122.8, 122.8, 110.3, 110.3, 58.4, 40.0, 40.0, 39.3, 20.9; HRMS (TOF ES+): m/z calcd for $C_{33}H_{30}N_2NaO_2$ [$(M+Na)^+$], 509.2199, found, 509.2205.

5-(2-(4-Bromophenyl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5q)



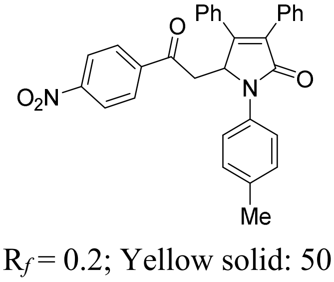
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; Yellow solid: 60 mg (58%); mp = 184–185 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.49–7.43 (m, 4H), 7.41–7.35 (m, 4H), 7.33–7.29 (m, 3H), 7.26–7.21 (m, 5H), 7.13 (d, J = 8.1 Hz, 2H), 6.01 (t, J = 5.1 Hz, 1H), 3.10 (d, J = 4.3 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 196.2, 168.3, 152.5, 135.3, 135.2, 134.1, 132.6, 132.0, 131.6, 131.6, 131.6, 131.1, 129.8, 129.8, 129.7, 129.7, 129.3, 129.3, 129.3, 128.9, 128.9, 128.8, 128.8, 128.4, 128.2, 128.2,128.2, 123.1, 123.1, 59.0, 39.8, 20.9; HRMS (TOF ES+): m/z calcd for $C_{31}H_{24}BrNNaO_2$ [$(M+Na)^+$], 544.0883, found, 544.0887.

5-(2-Oxo-2-(4-(trifluoromethyl)phenyl)ethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5r)



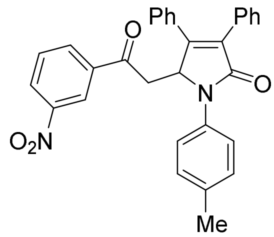
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.2; Yellow solid: 63 mg (62%); mp = 148–149 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.58 (d, J = 8.3 Hz, 2H), 7.52 (d, J = 8.2 Hz, 2H), 7.45 (d, J = 8.2 Hz, 4H), 7.33–7.26 (m, 5H), 7.25–7.21 (m, 3H), 7.12 (d, J = 8.0 Hz, 2H), 6.01 (t, J = 5.1 Hz, 1H), 3.15 (dd, J = 5.1, 1.7 Hz, 2H), 2.27 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 196.6, 168.4, 152.4, 139.3, 135.4, 134.2, 132.8, 134.5 (d, J = 31.3 Hz), 132.1, 131.2, 129.9, 129.9, 129.9, 129.9, 129.4, 129.4, 129.0, 129.0, 129.0, 129.0, 128.7 (d, J = 2.5 Hz), 128.4, 128.4, 128.2, 128.2,125.5 (q, J = 3.8 Hz), 123.6 (d, J = 270.0 Hz), 123.3, 123.3, 59.3, 40.2, 21.0; ^{19}F NMR (470 MHz, $CDCl_3$) δ = -63.23; HRMS (TOF ES+): m/z calcd for $C_{32}H_{24}F_3NNaO_2$ [$(M+Na)^+$], 534.1651, found, 534.1653.

5-(2-(4-Nitrophenyl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5s)



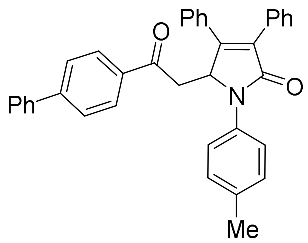
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.2; Yellow solid: 50 mg (51%); mp = 188–189 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 8.09 (d, J = 8.9 Hz, 2H), 7.60 (d, J = 8.9 Hz, 2H), 7.46–7.44 (m, 4H), 7.31–7.30 (m, 3H), 7.26–7.23 (m, 5H), 7.13 (d, J = 8.1 Hz, 2H), 5.98 (t, J = 5.1 Hz, 1H), 3.17 (d, J = 5.1 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 196.1, 168.2, 152.0, 150.1, 140.9, 135.4, 134.0, 132.8, 131.9, 130.9, 129.8, 129.8, 129.8, 129.8, 129.4, 128.9, 128.9, 128.9, 128.9, 128.7, 128.7, 128.3, 128.3, 128.3, 123.5, 123.5, 123.2, 123.2, 59.2, 40.2, 20.9; HRMS (TOF ES+): m/z calcd for $C_{31}H_{24}N_2NaO_4$ [(M+Na)$^+$], 511.1628, found, 511.1635.

5-(2-(3-Nitrophenyl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5t)



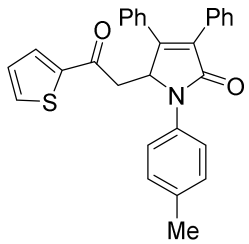
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.1; White solid: 73 mg (75%); mp = 190–191 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 8.27 (d, J = 8.0 Hz, 1H), 8.21 (s, 1H), 7.84 (d, J = 7.7 Hz, 1H), 7.50–7.43 (m, 5H), 7.33–7.27 (m, 5H), 7.24–7.22 (m, 3H), 7.12 (d, J = 8.0 Hz, 2H), 5.98 (t, J = 5.2 Hz, 1H), 3.22–3.15 (m, 2H), 2.26 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 195.4, 168.2, 152.0, 148.0, 137.8, 135.4, 134.0, 133.1, 132.9, 131.9, 130.9, 129.8, 129.8, 129.8, 129.8, 129.5, 129.3, 128.9, 128.9, 128.9, 128.9, 128.3, 128.3, 128.3, 127.3, 123.3, 123.3, 122.7, 59.4, 39.9, 20.8; HRMS (TOF ES+): m/z calcd for $C_{31}H_{24}N_2NaO_4$ [(M+Na)$^+$], 511.1628, found, 511.1630.

5-(2-([1,1'-Biphenyl]-4-yl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5u)



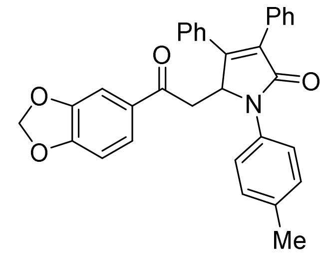
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 34 mg (33%); mp = 210–211 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.61 (d, J = 8.1 Hz, 2H), 7.56–7.52 (m, 3H), 7.50 (d, J = 4.6 Hz, 2H), 7.49–7.47 (m, 2H), 7.47–7.42 (m, 3H), 7.39–7.38 (m, 1H), 7.32–7.29 (m, 5H), 7.24–7.23 (m, 3H), 7.14 (d, J = 8.1 Hz, 2H), 6.09 (t, J = 4.9 Hz, 1H), 3.19 (dd, J = 5.0, 2.0 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 196.7, 168.6, 153.0, 146.0, 139.8, 135.3, 135.2, 134.3, 132.6, 132.2, 131.4, 130.0, 130.0, 129.8, 129.8, 129.3, 129.1, 129.1, 129.1, 129.1, 128.9, 128.9, 128.5, 128.5, 128.4, 128.4, 128.4, 128.3, 127.3, 127.3, 127.0, 127.0, 123.2, 123.2, 58.9, 40.1, 21.1; HRMS (TOF ES+): m/z calcd for $C_{37}H_{29}NNaO_2$ [(M+Na)$^+$], 542.2091, found, 542.2096.

5-(2-Oxo-2-(thiophen-2-yl)ethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5v)



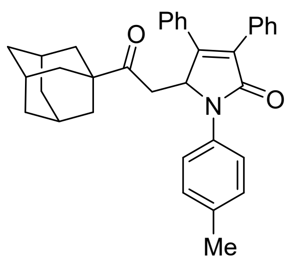
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 42 mg (47%); mp = 148–149 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.52–7.43 (m, 5H), 7.33–7.26 (m, 5H), 7.24–7.18 (m, 4H), 7.14 (d, J = 8.0 Hz, 2H), 6.90–6.88 (m, 1H), 5.98 (t, J = 5.1 Hz, 1H), 3.08 (d, J = 5.1 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 189.6, 168.5, 152.7, 143.8, 135.2, 134.3, 134.2, 132.6, 132.2, 132.1, 131.3, 130.0, 130.0, 129.8, 129.8, 129.3, 129.1, 129.1, 128.9, 128.9, 128.4, 128.4, 128.3, 127.9, 123.2, 123.2, 59.1, 40.8, 21.0; HRMS (TOF ES+): m/z calcd for $C_{29}H_{23}NNaO_2S$ [$(M+Na)^+$], 472.1342, found, 472.1346.

5-(2-(Benzo[*d*][1,3]dioxol-5-yl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5w)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.1 White solid: 40 mg (41%); mp = 195–196 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.49 (d, J = 8.2 Hz, 2H), 7.47–7.43 (m, 2H), 7.32–7.30 (m, 3H), 7.29–7.27 (m, 2H), 7.25–7.21 (m, 3H), 7.14 (d, J = 8.0 Hz, 2H), 7.10 (dd, J = 8.2, 1.8 Hz, 1H), 7.05 (d, J = 1.7 Hz, 1H), 6.63 (d, J = 8.2 Hz, 1H), 6.04 (t, J = 5.0 Hz, 1H), 5.97 (s, 2H), 3.07 (d, J = 5.0 Hz, 2H), 2.29 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 194.9, 168.4, 152.9, 151.8, 147.9, 135.0, 134.2, 132.4, 132.0, 131.4, 131.2, 129.8, 129.8, 129.6, 129.6, 129.1, 128.9, 128.9, 128.7, 128.7, 128.2, 128.2, 128.1, 124.2, 123.0, 123.0, 107.6, 107.5, 101.8, 58.8, 39.8, 20.9; HRMS (TOF ES+): m/z calcd for $C_{32}H_{25}NNaO_4$ [$(M+Na)^+$], 510.1676, found, 510.1680.

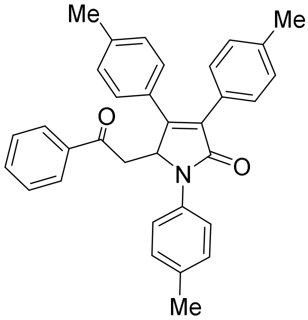
5-(2-((3r,5r,7r)-Adamantan-1-yl)-2-oxoethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5x)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.4; White solid: 49 mg (49%); mp = 222–223 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.51 (d, J = 8.5 Hz, 2H), 7.45–7.40 (m, 2H), 7.34–

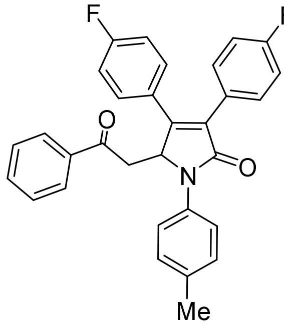
7.27 (m, 6H), 7.25–7.17 (m, 4H), 6.01 (t, J = 4.8 Hz, 1H), 2.69–2.61 (m, 2H), 2.34 (s, 3H), 1.87–1.80 (m, 3H), 1.61–1.56 (m, 3H), 1.47–1.45 (m, 3H), 1.29 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 212.1, 168.5, 153.4, 134.8, 134.4, 132.3, 132.1, 131.4, 130.0, 130.0, 129.8, 129.8, 129.3, 129.3, 129.3, 128.8, 128.8, 128.3, 128.3, 128.2, 122.7, 122.7, 57.4, 46.5, 38.3, 37.6, 37.6, 37.6, 36.4, 36.4, 36.4, 27.8, 27.8, 27.8, 21.1; HRMS (TOF ES+): m/z calcd for $C_{35}H_{35}NNaO_2$ [$(M+Na)^+$], 524.2560, found, 524.2566.

5-(2-Oxo-2-phenylethyl)-1,3,4-tri-*p*-tolyl-1,5-dihydro-2*H*-pyrrol-2-one (5y)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 64 mg (68%); mp = 116–117 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.53 (d, J = 7.9 Hz, 2H), 7.49 (d, J = 8.1 Hz, 2H), 7.44 (t, J = 7.4 Hz, 1H), 7.36 (d, J = 7.7 Hz, 2H), 7.29–7.26 (m, 3H), 7.17 (d, J = 7.8 Hz, 2H), 7.14–7.10 (m, 4H), 7.02 (d, J = 7.8 Hz, 2H), 6.04 (t, J = 5.0 Hz, 1H), 3.17–3.10 (m, 2H), 2.34 (s, 3H), 2.26 (s, 3H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 197.3, 168.7, 152.3, 139.2, 137.8, 136.5, 134.8, 134.2, 133.1, 131.6, 129.6, 129.6, 129.6, 129.6, 129.4, 129.4, 129.1, 128.9, 128.9, 128.8, 128.8, 128.4, 128.2, 128.2, 127.8, 127.8, 123.0, 123.0, 58.5, 40.3, 21.4, 21.3, 20.9; HRMS (TOF ES+): m/z calcd for $C_{33}H_{29}NNaO_2$ [$(M+Na)^+$], 494.2091, found, 494.2100.

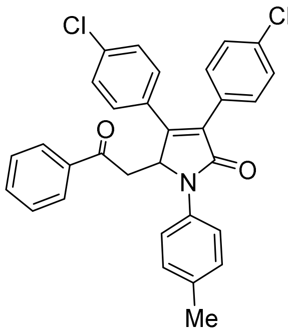
3,4-Bis(4-fluorophenyl)-5-(2-oxo-2-phenylethyl)-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5z)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 70 mg (73%); mp = 159–160 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.54 (d, J = 7.5 Hz, 2H), 7.49–7.41 (m, 5H), 7.29 (t, J = 7.9 Hz, 2H), 7.25–7.24 (m, 2H), 7.14 (d, J = 8.1 Hz, 2H), 7.02 (t, J = 8.7 Hz, 2H), 6.93 (t, J = 8.6 Hz, 2H), 6.03 (t, J = 5.0 Hz, 1H), 3.15 (d, J = 6.2 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 195.1, 166.3, 161.2 (d, J = 250.5 Hz), 160.8 (d, J = 246.0 Hz), 149.9, 134.5, 133.4, 132.1, 131.6, 129.8 (d, J = 9.0 Hz), 129.8 (d, J = 9.0 Hz), 129.7, 129.0 (d, J = 9.0 Hz), 129.0 (d, J = 9.0 Hz), 127.9, 127.9, 126.6, 126.6, 126.0, 126.0, 126.0, 125.1 (d, J = 3.0 Hz), 121.0, 121.0, 114.2 (d, J = 21.0 Hz), 114.2

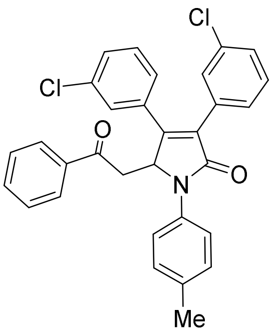
(d, J = 21.0 Hz), 113.6 (d, J = 21.0 Hz), 113.6 (d, J = 21.0 Hz), 56.8, 37.9, 19.1; ^{19}F NMR (470 MHz, $CDCl_3$) δ = -110.71, -112.80; HRMS (TOF ES+): m/z calcd for $C_{31}H_{23}F_2NNaO_2$ [$(M+Na)^+$], 502.1589, found, 502.1599.

3,4-Bis(4-chlorophenyl)-5-(2-oxo-2-phenylethyl)-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5a')



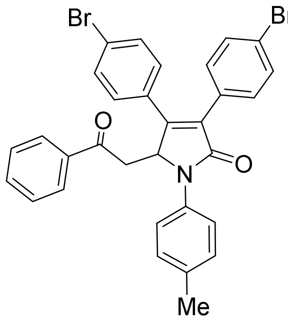
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 55 mg (54%); mp = 159–160 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.54 (d, J = 7.2 Hz, 2H), 7.48–7.45 (m, 3H), 7.39 (d, J = 8.5 Hz, 2H), 7.31–7.28 (m, 4H), 7.23–7.18 (m, 4H), 7.14 (d, J = 8.1 Hz, 2H), 6.01 (t, J = 5.0 Hz, 1H), 3.14 (dd, J = 4.9, 1.9 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ = 196.8, 167.8, 151.9, 136.3, 135.5, 135.3, 134.4, 133.9, 133.4, 131.8, 131.1, 131.1, 130.2, 130.2, 130.2, 129.8, 129.8, 129.3, 129.2, 129.2, 128.7, 128.7, 128.4, 128.4, 127.8, 127.8, 123.0, 123.0, 58.7, 39.6, 20.9; HRMS (TOF ES+): m/z calcd for $C_{31}H_{23}Cl_2NNaO_2$ [$(M+Na)^+$], 534.0998, found, 534.1006.

3,4-Bis(3-chlorophenyl)-5-(2-oxo-2-phenylethyl)-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5b')



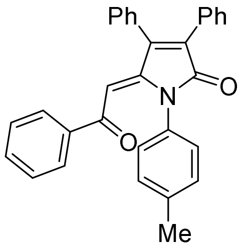
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 57 mg (56%); mp = 152–153 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.53–7.51 (m, 3H), 7.47–7.45 (m, 3H), 7.31–7.28 (m, 3H), 7.24–7.20 (m, 4H), 7.18–7.12 (m, 4H), 5.99 (t, J = 5.1 Hz, 1H), 3.19–3.12 (m, 2H), 2.29 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 196.6, 167.5, 152.1, 136.3, 135.4, 134.8, 134.3, 133.7, 133.4, 133.4, 132.4, 132.2, 130.2, 129.8, 129.8, 129.7, 129.6, 129.5, 128.7, 128.6, 128.4, 128.4, 127.9, 127.8, 127.8, 127.1, 123.0, 123.0, 58.9, 39.3, 20.9; HRMS (TOF ES+): m/z calcd for $C_{31}H_{23}Cl_2NNaO_2$ [$(M+Na)^+$], 534.0998, found, 534.1008.

3,4-Bis(4-bromophenyl)-5-(2-oxo-2-phenylethyl)-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (5c')



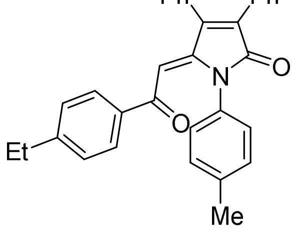
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; Yellow solid: 46 mg (38%); mp = 161–162 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.54 (d, J = 7.8 Hz, 2H), 7.46–7.44 (m, 4H), 7.37 (d, J = 8.2 Hz, 2H), 7.34–7.26 (m, 5H), 7.16–7.12 (m, 4H), 6.01 (t, J = 5.0 Hz, 1H), 3.14 (t, J = 4.6 Hz, 2H), 2.28 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 196.8, 167.7, 151.9, 136.2, 135.4, 133.7, 133.4, 132.2, 132.2, 131.8, 131.6, 131.6, 131.4, 131.4, 130.5, 130.4, 130.4, 129.8, 129.8, 129.7, 128.4, 128.4, 127.8, 127.8, 123.9, 122.9, 122.7, 122.7, 58.6, 39.6, 20.9; HRMS (TOF ES+): m/z calcd for $C_{31}H_{23}Br_2NNaO_2$ [$(M+Na)^+$], 621.9988, found, 621.9985.

(*Z*)-5-(2-Oxo-2-phenylethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7a)



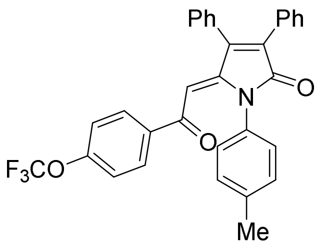
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; *Z/E* > 20/1, Yellow solid: 39 mg (44%); mp = 212–213 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.53 (d, J = 7.8 Hz, 2H), 7.48–7.44 (m, 6H), 7.43–7.40 (m, 2H), 7.33–7.30 (m, 2H), 7.27–7.26 (m, 3H), 6.94 (s, 4H), 6.00 (s, 1H), 2.26 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 192.2, 169.4, 146.6, 145.2, 137.8, 137.5, 133.2, 133.1, 131.4, 130.8, 130.1, 130.0, 130.0, 129.9, 129.9, 129.6, 129.6, 129.3, 129.1, 129.1, 128.8, 128.6, 128.6, 128.3, 128.3, 128.3, 128.3, 127.3, 127.3, 109.1, 21.3; HRMS (TOF ES+): m/z calcd for $C_{31}H_{23}NNaO_2$ [$(M+Na)^+$], 464.1621, found, 464.1623.

(*Z*)-5-(2-(4-Ethylphenyl)-2-oxoethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7b)



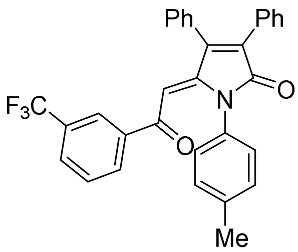
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; *Z/E* = 5/1, Yellow solid: 40 mg (43%); mp = 210–211 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.46–7.44 (m, 6H), 7.41–7.40 (m, 2H), 7.37 (s, 1H), 7.27–7.26 (m, 3H), 7.13 (d, J = 7.8 Hz, 2H), 6.95 (s, 4H), 6.00 (s, 1H), 2.66 (q, J = 7.8 Hz, 2H), 2.26 (s, 3H), 1.24 (t, J = 7.7 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 191.6, 169.3, 150.1, 146.2, 145.1, 137.2, 135.5, 133.1, 131.3, 130.5, 130.4, 129.8, 129.8, 129.8, 129.8, 129.4, 129.4, 129.1, 128.9, 128.9, 128.7, 128.7, 128.6, 128.1, 128.1, 127.7, 127.7, 127.2, 127.2, 109.3, 29.0, 21.1, 15.4; HRMS (TOF ES+): m/z calcd for $C_{33}H_{27}NNaO_2$ [(M+ Na)$^+$], 492.1934, found, 492.1942.

(*Z*)-5-(2-Oxo-2-(4-(trifluoromethoxy)phenyl)ethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7c)



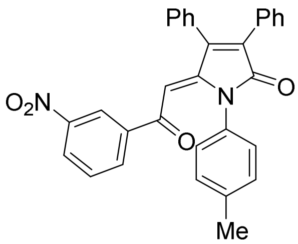
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.2; *Z/E* = 4/1, Yellow solid: 39 mg (37%); mp = 207–208 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.53 (d, J = 8.2 Hz, 2H), 7.48–7.47 (m, 2H), 7.45–7.43 (m, 2H), 7.41–7.40 (m, 2H), 7.37 (s, 1H), 7.29–7.27 (s, 3H), 7.12 (d, J = 8.3 Hz, 2H), 6.95 (d, J = 7.8 Hz, 2H), 6.89 (d, J = 8.0 Hz, 2H), 5.92 (s, 1H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 190.9, 169.1, 152.3, 146.8, 145.0, 137.6, 136.0, 133.0, 131.1, 130.8, 130.5, 130.4, 130.4, 129.8, 129.8, 129.8, 129.8, 129.5, 129.5, 129.3, 129.0, 129.0, 128.8, 128.4, 128.4, 128.2, 128.2, 127.2, 127.2, 120.1, 108.1, 21.1; ^{19}F NMR (470 MHz, $CDCl_3$) δ = -57.63; HRMS (TOF ES+): m/z calcd for $C_{32}H_{22}F_3NNaO_3$ [(M+ Na)$^+$], 548.1444, found, 548.1453.

(*Z*)-5-(2-Oxo-2-(3-(trifluoromethyl)phenyl)ethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7d)



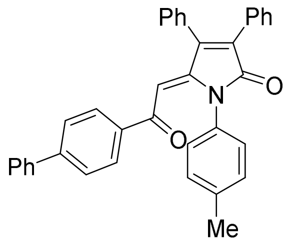
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.2; *Z/E* = 4/1, Yellow solid: 23 mg (23%); mp = 241–242 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.73–7.69 (m, 2H), 7.60 (s, 1H), 7.49–7.47 (m, 3H), 7.46–7.44 (m, 2H), 7.43–7.41 (m, 2H), 7.38 (s, 1H), 7.28-7.26 (m, 3H), 6.92 (d, J = 7.7 Hz, 2H), 6.85 (d, J = 7.9 Hz, 2H), 5.91 (s, 1H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 191.5, 169.1, 147.1, 144.9, 138.3, 137.7, 132.9, 131.8, 131.0, 130.8, 130.8 (d, J = 33.0 Hz), 130.5, 129.9, 129.9, 129.8, 129.8, 129.5, 129.5, 129.3, 129.1, 129.1, 128.9, 128.7, 128.4 (d, J = 3.0 Hz), 128.2, 128.2, 127.2, 127.2, 124.6 (q, J = 3.0 Hz), 123.6 (d, J = 271.5 Hz), 107.7, 20.9; ^{19}F NMR (470 MHz, $CDCl_3$) δ = -62.84; HRMS (TOF ES+): m/z calcd for $C_{32}H_{22}F_3NNaO_2$ [(M+ Na)$^+$], 532.1495, found, 532.1501.

(*Z*)-5-(2-(3-Nitrophenyl)-2-oxoethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7e)



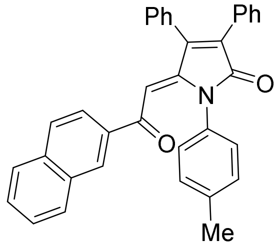
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.2; *Z/E* = 2/1, Yellow solid: 41 mg (42%); mp = 203–204 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 8.31–8.26 (m, 1H), 8.19 (s, 1H), 7.83–7.80 (m, 1H), 7.50–7.48 (m, 3H), 7.46–7.43 (m, 3H), 7.39 (s, 1H), 7.28–7.26 (m, 3H), 7.02 (t, *J* = 7.5 Hz, 1H), 6.93 (d, *J* = 8.6 Hz, 2H), 6.87 (d, *J* = 7.9 Hz, 2H), 5.93 (s, 1H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 190.4, 169.1, 148.0, 147.8, 145.0, 139.3, 138.0, 133.8, 133.0, 131.0, 130.5, 129.9, 129.9, 129.7, 129.7, 129.6, 129.6, 129.4, 129.2, 129.1, 129.1, 128.4, 128.2, 128.2, 128.1, 127.2, 127.2, 126.8, 122.8, 106.9, 21.0; HRMS (TOF ES+): m/z calcd for $C_{31}H_{22}N_2NaO_4$ [$(M+ Na)^+$], 509.1472, found, 509.1475.

(*Z*)-5-(2-([1,1'-Biphenyl]-4-yl)-2-oxoethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7f)



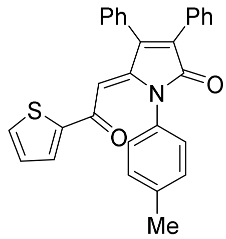
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; *Z/E* = 7/1, Yellow solid: 37 mg (36%); mp = 245–246 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.60–7.58 (m, 4H), 7.53 (d, *J* = 8.0 Hz, 2H), 7.49–7.46 (m, 6H), 7.44–7.39 (m, 4H), 7.27–7.26 (m, 3H), 6.96 (s, 4H), 6.04 (s, 1H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 191.6, 169.3, 146.5, 145.7, 145.1, 139.9, 137.4, 136.4, 133.1, 131.3, 130.6, 130.4, 129.9, 129.9, 129.8, 129.8, 129.4, 129.4, 129.2, 129.1, 129.0, 129.0, 129.0, 129.0, 129.0, 129.0, 128.7, 128.3, 128.2, 128.2, 127.2, 127.2, 127.2, 126.8, 126.8, 109.0, 21.2; HRMS (TOF ES+): m/z calcd for $C_{37}H_{27}NNaO_2$ [$(M+ Na)^+$], 540.1934, found, 540.1942.

(*Z*)-5-(2-(Naphthalen-2-yl)-2-oxoethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7g)



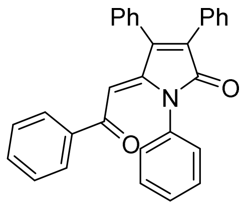
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; *Z/E* = 6/1 Yellow solid: 32 mg (33%); mp = 240–241 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 8.05 (s, 1H), 7.88 (d, *J* = 8.2 Hz, 1H), 7.83 (d, J = 8.2 Hz, 1H), 7.73 (d, J = 8.6 Hz, 1H), 7.60–7.53 (m, 3H), 7.49–7.44 (m, 6H), 7.28–7.26 (m, 4H), 6.91 (d, J = 6.5 Hz, 2H), 6.82 (d, J = 7.8 Hz, 2H), 6.12 (s, 1H), 2.18 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 192.3, 169.4, 146.6, 145.2, 137.6, 135.6, 135.2, 133.2, 132.4, 131.4, 130.8, 130.5, 130.0, 130.0, 130.0, 130.0, 130.0, 129.6, 129.5, 129.5, 129.3, 129.1, 129.1, 128.8, 128.7, 128.3, 128.3, 128.1, 127.9, 127.3, 127.3, 126.8, 124.1, 109.3, 21.2; HRMS (TOF ES+): m/z calcd for $C_{35}H_{25}NNaO_2$ [$(M+Na)^+$], 514.1778, found, 514.1787.

(*Z*)-5-(2-Oxo-2-(thiophen-2-yl)ethylidene)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (7h)



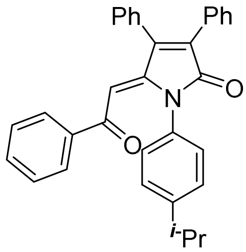
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; *Z/E* = 9/1, Yellow solid: 41 mg (46%); mp = 233–234 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.56 (d, J = 4.9 Hz, 1H), 7.47–7.46 (m, 3H), 7.45–7.42 (m, 3H), 7.40–7.38 (m, 2H), 7.27–7.26 (s, 3H), 7.07–7.02 (m, 5H), 6.02 (s, 1H), 2.31 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 183.2, 169.3, 146.6, 145.2, 145.1, 137.4, 134.2, 133.1, 132.7, 131.1, 130.7, 130.3, 129.8, 129.8, 129.7, 129.7, 129.4, 129.4, 129.2, 128.9, 128.9, 128.7, 128.1, 128.1, 127.7, 127.0, 127.0, 108.0, 21.2; HRMS (TOF ES+): m/z calcd for $C_{29}H_{21}NNaO_2S$ [$(M+ Na)^+$], 470.1185, found, 470.1193.

(*Z*)-5-(2-Oxo-2-phenylethylidene)-1,3,4-triphenyl-1,5-dihydro-2*H*-pyrrol-2-one (7i)



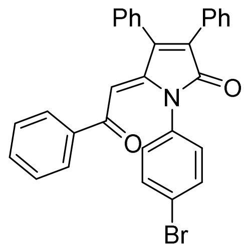
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.3; *Z/E* > 20/1, Yellow solid: 32 mg (38%); mp = 221–222 °C; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.53 (d, J = 7.7 Hz, 2H), 7.49–7.44 (m, 6H), 7.43–7.41 (m, 2H), 7.31 (t, J = 7.7 Hz, 2H), 7.28–7.26 (s, 3H), 7.18–7.17 (d, J = 5.4 Hz, 3H), 7.10–7.06 (m, 2H), 6.04 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 191.8, 169.1, 146.4, 145.2, 137.5, 135.8, 133.0, 131.1, 130.6, 129.8, 129.8, 129.8, 129.7, 129.7, 129.2, 128.9, 128.9, 128.7, 128.7, 128.7, 128.4, 128.4, 128.3, 128.3, 128.1, 128.1, 127.4, 127.3, 127.3, 108.9; HRMS (TOF ES+): m/z calcd for $C_{30}H_{21}NNaO_2$ [$(M+ Na)^+$], 450.1465, found, 450.1474.

(*Z*)-1-(4-Isopropylphenyl)-5-(2-oxo-2-phenylethylidene)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (7j)



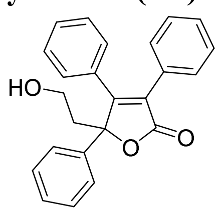
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; *Z/E* = 10/1, Yellow solid: 38 mg (41%); mp = 219–220 °C; ^{1}H NMR (600 MHz, $CDCl_3$) *δ* = 7.47–7.44 (m, 7H), 7.44–7.39 (m, 3H), 7.29–7.27 (m, 5H), 6.95 (d, *J* = 8.0 Hz, 2H), 6.90 (d, *J* = 8.0 Hz, 2H), 5.94 (s, 1H), 2.82 –2.78 (m, 1H), 1.18 (d, *J* = 6.9 Hz, 6H); ^{13}C NMR (150 MHz, $CDCl_3$) *δ* = 192.8, 169.1, 148.1, 146.0, 144.9, 137.6, 133.1, 132.9, 131.3, 130.5, 130.0, 129.8, 129.8, 129.8, 129.8, 129.2, 129.0, 129.0, 128.7, 128.4, 128.4, 128.2, 128.2, 128.1, 128.1, 127.5, 127.5, 126.8, 126.8, 109.3, 33.7, 23.9, 23.9; HRMS (TOF ES+): m/z calcd for $C_{33}H_{27}NNaO_2$ [$(M+Na)^+$], 492.1934, found, 492.1942.

(*Z*)-1-(4-Bromophenyl)-5-(2-oxo-2-phenylethylidene)-3,4-diphenyl-1,5-dihydro-2*H*-pyrrol-2-one (7k)



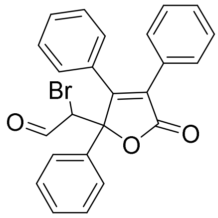
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.3; *Z/E* = 5/1, Yellow solid: 40 mg (40%); mp > 250 °C; ^{1}H NMR (500 MHz, $CDCl_3$) *δ* = 7.54 (dd, *J* = 8.2, 1.4 Hz, 2H), 7.49–7.47 (m, 3H), 7.44–7.43 (m, 2H), 7.41–7.39 (m, 2H), 7.37–7.33 (m, 2H), 7.29–7.27 (m, 6H), 6.95 (d, *J* = 8.6 Hz, 2H), 6.06 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) *δ* = 191.7, 169.0, 146.2, 145.5, 137.6, 134.9, 133.3, 133.0, 131.9, 131.9, 131.1, 130.7, 129.8, 129.8, 129.7, 129.7, 129.4, 129.1, 129.1, 128.9, 128.9, 128.9, 128.4, 128.4, 128.4, 128.4, 128.2, 128.2, 121.4, 109.0; HRMS (TOF ES+): m/z calcd for $C_{30}H_{20}BrNNaO_2$ [$(M+Na)^+$], 528.0570, found, 528.0579.

5-(2-Hydroxyethyl)-3,4,5-triphenylfuran-2(*5H*)-one (8)



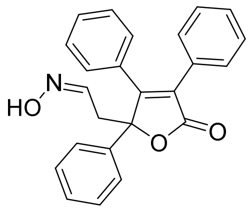
$V_{\text{Petroleum ether}}/V_{\text{Ethyl acetate}}$ = 4:1, R_f = 0.1; Yellow oil: 53 mg (75%); ^{1}H NMR (600 MHz, DMSO-d_6) *δ* = 7.43–7.39 (m, 3H), 7.36–7.30 (m, 8H), 7.29–7.25 (m, 2H), 6.84 (d, *J* = 7.7 Hz, 2H), 4.79–4.76 (m, 1H), 3.61–3.52 (m, 2H), 2.60–2.52 (m, 2H); ^{13}C NMR (150 MHz, DMSO-d_6) *δ* = 171.7, 164.8, 137.7, 131.7, 130.1, 129.9, 129.6, 129.6, 129.3, 129.3, 129.2, 129.1, 129.0, 129.0, 128.7, 128.7, 128.7, 128.7, 126.3, 126.2, 126.2, 88.9, 56.6, 37.5; HRMS (TOF ES+): m/z calcd for $C_{24}H_{20}NaO_3$ [$(M+Na)^+$], 379.1305, found, 379.1306.

2-Bromo-2-(5-oxo-2,3,4-triphenyl-2,5-dihydrofuran-2-yl)acetaldehyde (9)



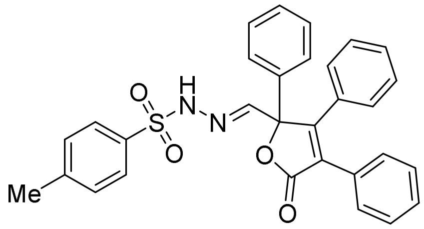
$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 5:1, R_f = 0.3; White solid: 46 mg (53%); mp = 137–138 ºC; d/r = 5:1; ^{1}H NMR (600 MHz, DMSO-*d*6) δ = 9.40 (s, 1H), 7.40–7.34 (m, 6H), 7.31–7.27 (m, 7H), 6.87 (d, *J* = 7.6 Hz, 2H), 6.08 (s, 1H); ^{13}C NMR (150 MHz, DMSO-*d*6) δ = 191.0, 170.6, 162.5, 133.8, 130.4, 130.3, 129.8, 129.6, 129.5, 129.4, 129.4, 129.4, 129.4, 129.4, 129.4, 129.4, 129.4, 129.1, 128.8, 128.8, 128.6, 128.6, 126.5, 126.5, 88.4, 57.9; HRMS (TOF ES+): m/z calcd for $C_{24}H_{17}BrNaO_3$ [$(M+Na)^+$], 455.0253, found, 455.0252.

2-(5-Oxo-2,3,4-triphenyl-2,5-dihydrofuran-2-yl)acetaldehyde oxime (10)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 3:1, R_f = 0.2; Yellow oil: 60 mg (81%); ^{1}H NMR (600 MHz, DMSO-*d*6) δ = 10.98 (s, 1H), 7.44–7.42 (m, 3H), 7.36–7.33 (m, 3H), 7.32–7.29 (m, 8H), 6.83 (d, *J* = 7.6 Hz, 2H), 3.32 (dd, *J* = 14.9, 5.9 Hz, 1H), 3.26 (dd, *J* = 14.9, 6.6 Hz, 1H); ^{13}C NMR (150 MHz, DMSO-*d*6) δ = 171.3, 164.2, 144.1, 136.8, 131.4, 130.0, 129.8, 129.5, 129.5, 129.5, 129.4, 129.4, 129.2, 129.1, 129.1, 128.8, 128.8, 128.6, 128.6, 127.3, 126.5, 126.5, 88.9, 35.1; HRMS (TOF ES+): m/z calcd for $C_{24}H_{19}NNaO_3$ [$(M+Na)^+$], 392.1257, found, 392.1262.

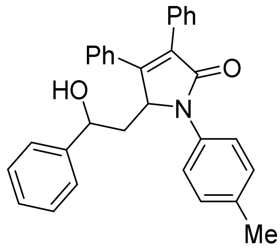
4-Methyl-*N*'-(2-(5-oxo-2,3,4-triphenyl-2,5-dihydrofuran-2-yl)ethylidene)benzenesulfonohydrazide (11)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 2:1, R_f = 0.2; Yellow oil: 90 mg (86%); ^{1}H NMR (600 MHz, DMSO-*d*6) δ = 11.39 (s, 1H), 7.65 (d, *J* = 8.0 Hz, 2H), 7.38–7.28 (m, 7H), 7.28–7.23 (m, 5H), 7.18 (d, *J* = 7.4 Hz, 2H), 7.14 (t, *J* = 7.7 Hz, 2H), 6.49 (d, *J* = 7.7 Hz, 2H), 3.32 (dd, *J* = 15.0, 4.5 Hz, 1H), 3.18 (dd, *J* = 15.0, 6.9 Hz, 1H), 2.26 (s, 3H); ^{13}C NMR

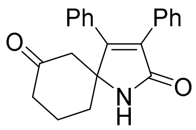
(150 MHz, DMSO-d_6) δ = 171.1, 163.9, 145.7, 143.7, 136.7, 136.6, 131.0, 130.2, 130.2, 129.7, 129.7, 129.6, 129.6, 129.6, 129.4, 129.3, 129.2, 129.2, 128.9, 128.9, 128.6, 128.6, 128.6, 128.4, 128.4, 127.5, 127.5, 127.3, 126.3, 126.3, 88.8, 37.5, 21.4; HRMS (TOF ES+): m/z calcd for $C_{31}H_{26}N_2NaO_4S$ [$(M+Na)^+$], 545.1505, found, 545.1512.

5-(2-Hydroxy-2-phenylethyl)-3,4-diphenyl-1-(*p*-tolyl)-1,5-dihydro-2*H*-pyrrol-2-one (12)



$V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 4:1, R_f = 0.1; White solid: 74 mg (83%); mp > 250 °C; d/r ＞20:1; ^{1}H NMR (600 MHz, $CDCl_3$) δ = 7.44 (d, J = 8.0 Hz, 2H), 7.42–7.40 (m, 2H), 7.39–7.37 (m, 3H), 7.36–7.34 (m, 2H), 7.31–7.28 (m, 3H), 7.24–7.20 (m, 5H), 6.93–6.89 (m, 2H), 5.43–5.41 (m, 1H), 4.33–4.31 (m, 1H), 2.37 (s, 3H), 2.23–2.18 (m, 1H), 2.07–2.03 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ = 168.4, 153.1, 143.6, 134.7, 134.3, 133.3, 132.5, 131.2, 129.8, 129.8, 129.6, 129.6, 129.1, 128.8, 128.8, 128.8, 128.8, 128.5, 128.5, 128.1, 128.1, 128.0, 127.8, 125.6, 125.6, 122.7, 122.7, 70.2, 59.7, 39.4, 21.0; HRMS (TOF ES+): m/z calcd for $C_{31}H_{27}NNaO_2$ [$(M+Na)^+$], 468.1934, found, 468.1943.

Failed examples:



5. X-ray Structure and Data.

5.1 X-ray Structure and Data[5] of 3v (CCDC 2377854).

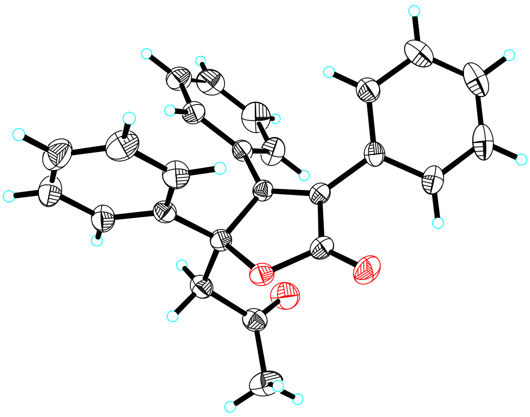


Figure S2 X-Ray crystal structure of **3v.**

Table S3 Crystal data and structure refinement for **3v.**

Empirical formula	$C_{25}H_{20}O_3$	
Formula weight	368.41	
Temperature	300.00 K	
Crystal system, space group	Monoclinic, $P2_1/c$	
Unit cell dimensions	a = 10.2274(4) A	alpha = 90 deg.
	b = 13.5230(5) A	beta = 90.829(2) deg.
	c = 14.2522(7) A	gamma = 90 deg.
Volume	1970.95(14) A^3	
Z, Calculated density	4, 1.242 Mg/m^3	
Absorption coefficient	0.081 mm^-1	
F(000)	776.0	
Theta range for data collection	3.982 to 56.604 deg.	
Limiting indices	-13<=h<=13, -18<=k<=18, -18<=l<=19	
Reflections collected / unique	53825	
Data/restraints/parameters	4901 / 0 / 254	
Goodness-of-fit on F^2	1.056	
Final R indices [I>2sigma(I)]	R1 = 0.0438, wR2 = 0.1161	
R indices (all data)	R1 = 0.0612, wR2 = 0.1303	
Largest diff. peak and hole	0.18 and -0.20 e.A^-3	

5.2 X-ray Structure and Data[6] of 5b (CCDC 2391288).

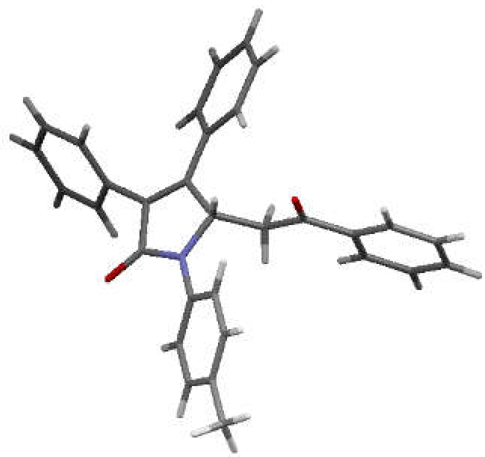


Figure S3 X-Ray crystal structure of **5b.**

Table S4 Crystal data and structure refinement for **5b.**

Empirical formula	$C_{31}H_{25}NO_2$	
Formula weight	443.52	
Temperature	296.15 K	
Crystal system, space group	Monoclinic, C2/c	
Unit cell dimensions	a = 38.980(3) A	alpha = 90 deg.
	b = 5.8496(5) A	beta = 118.940(3) deg.
	c = 25.600(3) A	gamma = 90 deg.
Volume	5108.3(8) A^3	
Z, Calculated density	8, 1.153 Mg/m^3	
Absorption coefficient	0.072 mm^-1	
F(000)	1872.0	
Theta range for data collection	2.388 to 54.994 deg.	
Limiting indices	-50<=h<=40, -7<=k<=7, -28<=l<=33	
Reflections collected / unique	14699	
Data/restraints/parameters	5794 / 0 / 308	
Goodness-of-fit on F^2	0.963	
Final R indices [I>2sigma(I)]	R1 = 0.0488, wR2 = 0.1145	
R indices (all data)	R1 = 0.0827, wR2 = 0.1328	
Largest diff. peak and hole	0.22 and -0.24 e.A^-3	

5.3 X-ray Structure and Data[7] of 7a (CCDC 2391289).

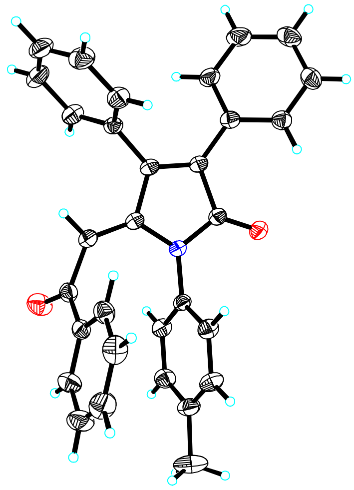


Figure S4 X-Ray crystal structure of **7a.**

Table S5 Crystal data and structure refinement for **7a.**

Empirical formula	$C_{31}H_{23}NO_2$
Formula weight	441.50
Temperature	303.00 K
Crystal system, space group	Orthorhombic, $Pca2_1$
Unit cell dimensions	a = 26.0297(16) A alpha = 90 deg.
	b = 5.9625(3) A beta = 90 deg.
	c = 15.3428(9) A gamma = 90 deg.
Volume	2381.2(2) A^3
Z, Calculated density	4, 1.232 Mg/m^3
Absorption coefficient	0.077 mm^-1
F(000)	928.0
Theta range for data collection	5.31 to 56.574 deg.
Limiting indices	-34<=h<=34, -7<=k<=7, -20<=l<=20
Reflections collected / unique	53825
Data/restraints/parameters	5846 / 1 / 309
Goodness-of-fit on F^2	1.093
Final R indices [I>2sigma(I)]	R1 = 0.0451, wR2 = 0.0929
R indices (all data)	R1 = 0.0656, wR2 = 0.1099
Largest diff. peak and hole	0.12 and -0.18 e.A^-3

6. ^{1}H NMR and ^{13}C NMR spectra for spectroscopic data.

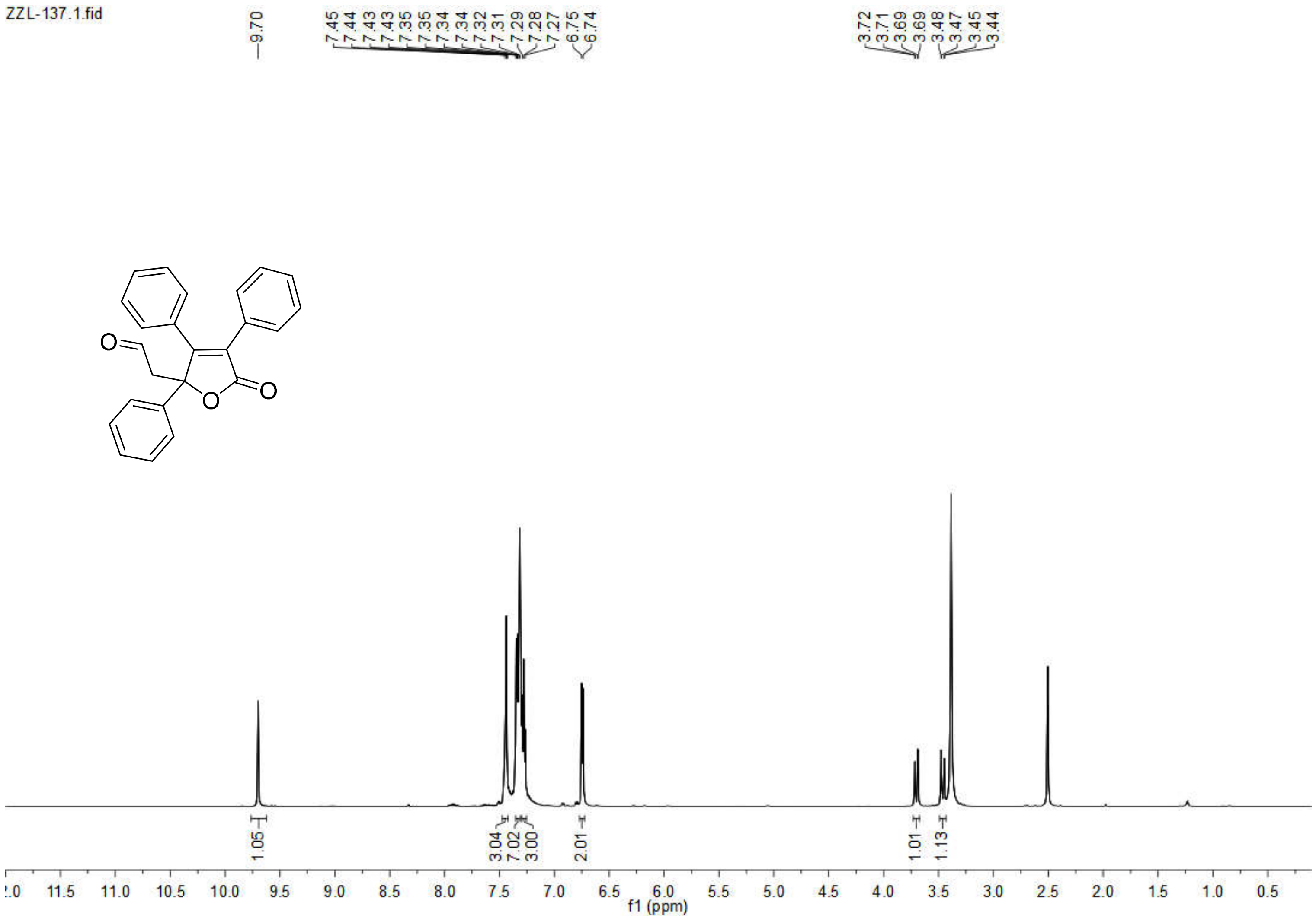


Figure S5. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3a**

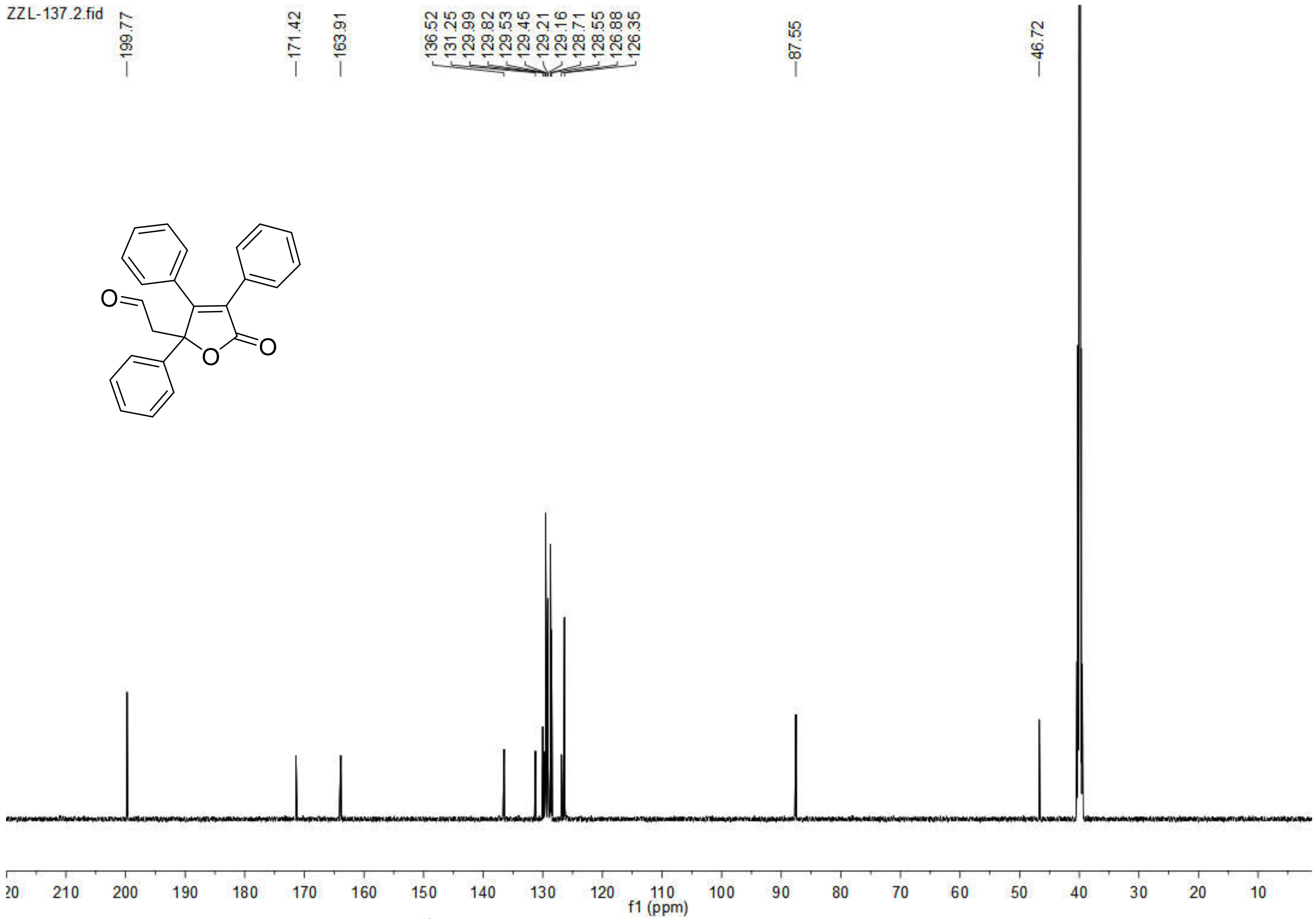


Figure S6. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3a**

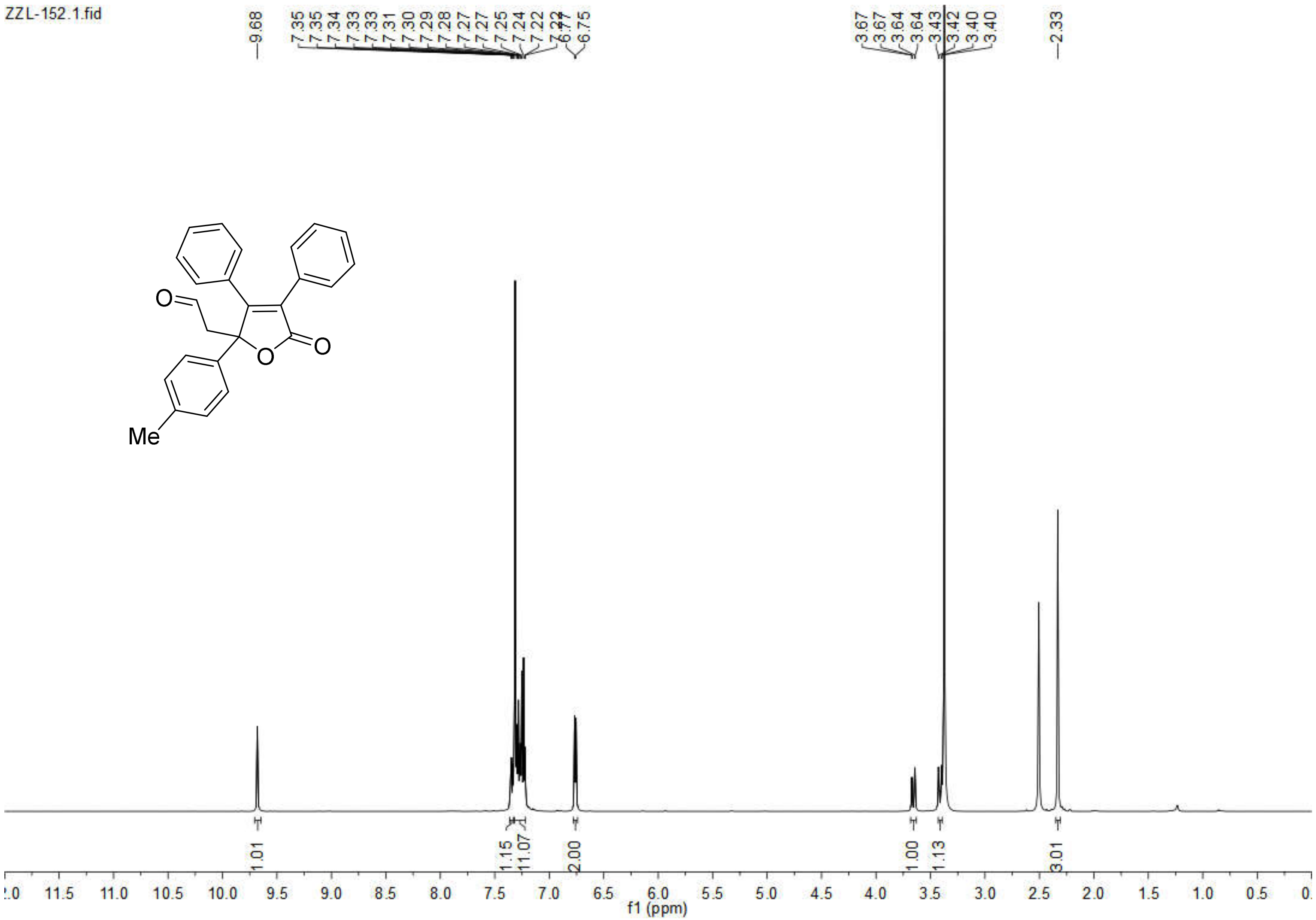


Figure S7. [1]H NMR (600 MHz, DMSO-d_6) spectra of compound **3b**

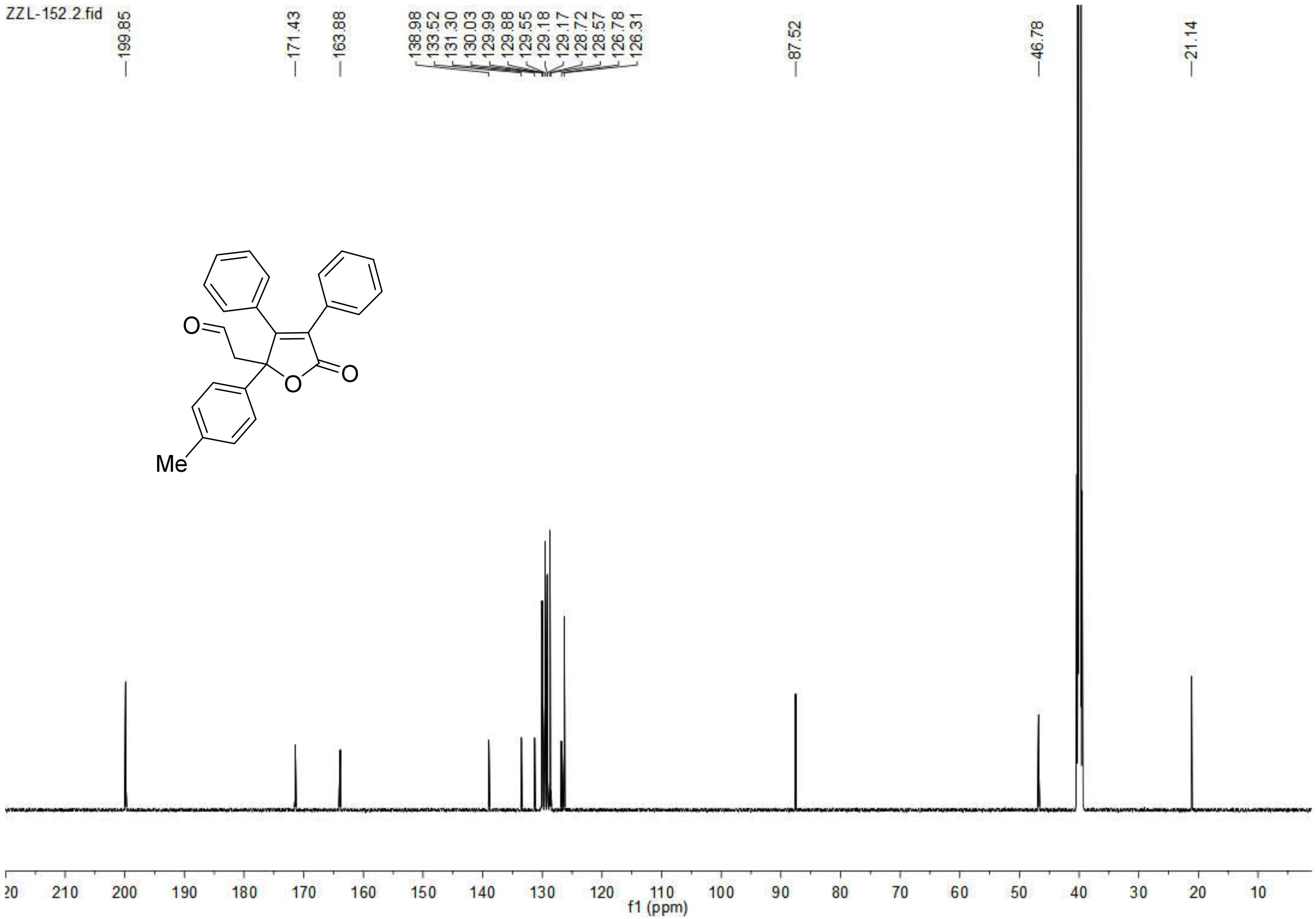


Figure S8. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3b**

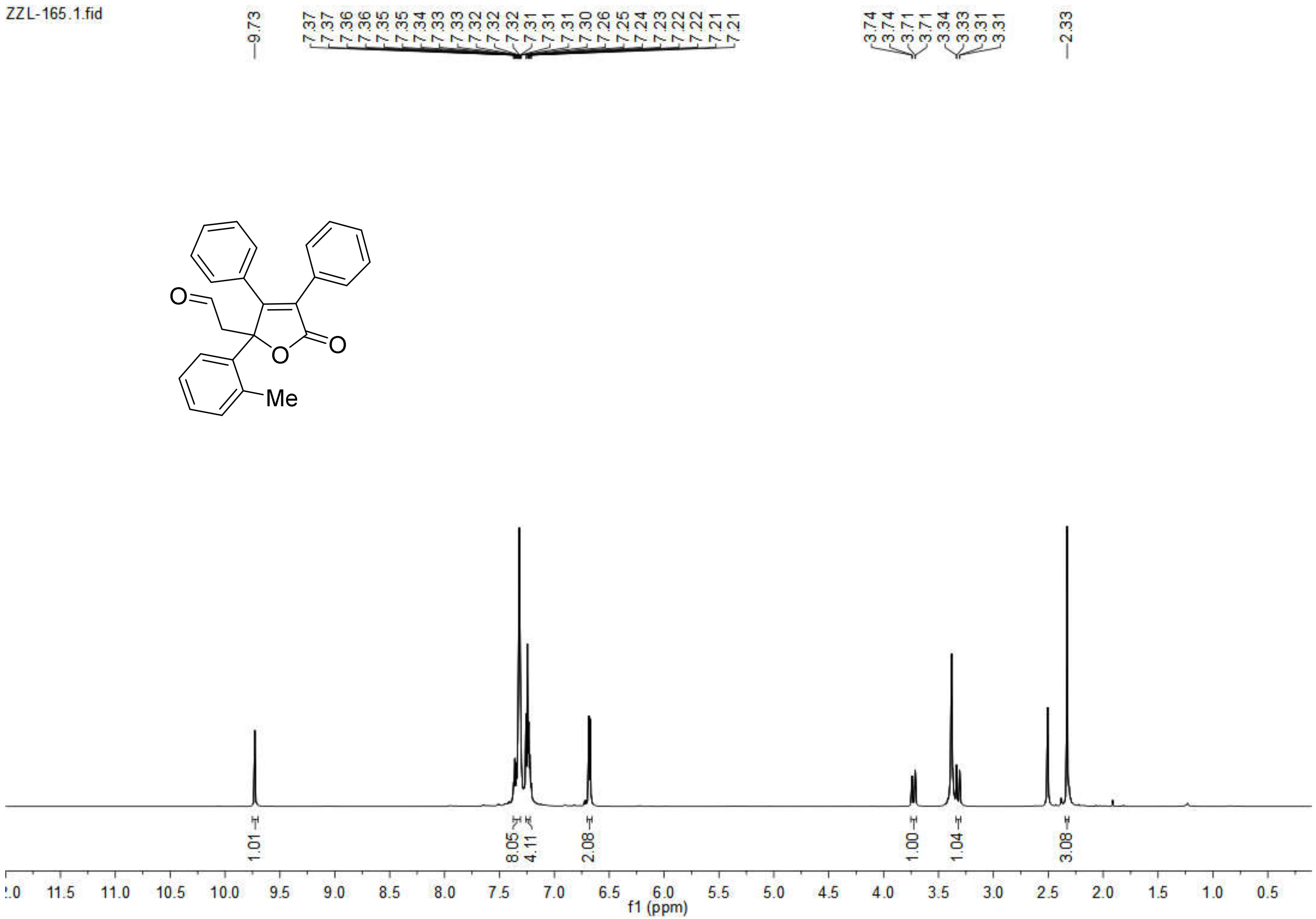


Figure S9. ¹H NMR (600 MHz, DMSO-d_6) spectra of compound **3c**

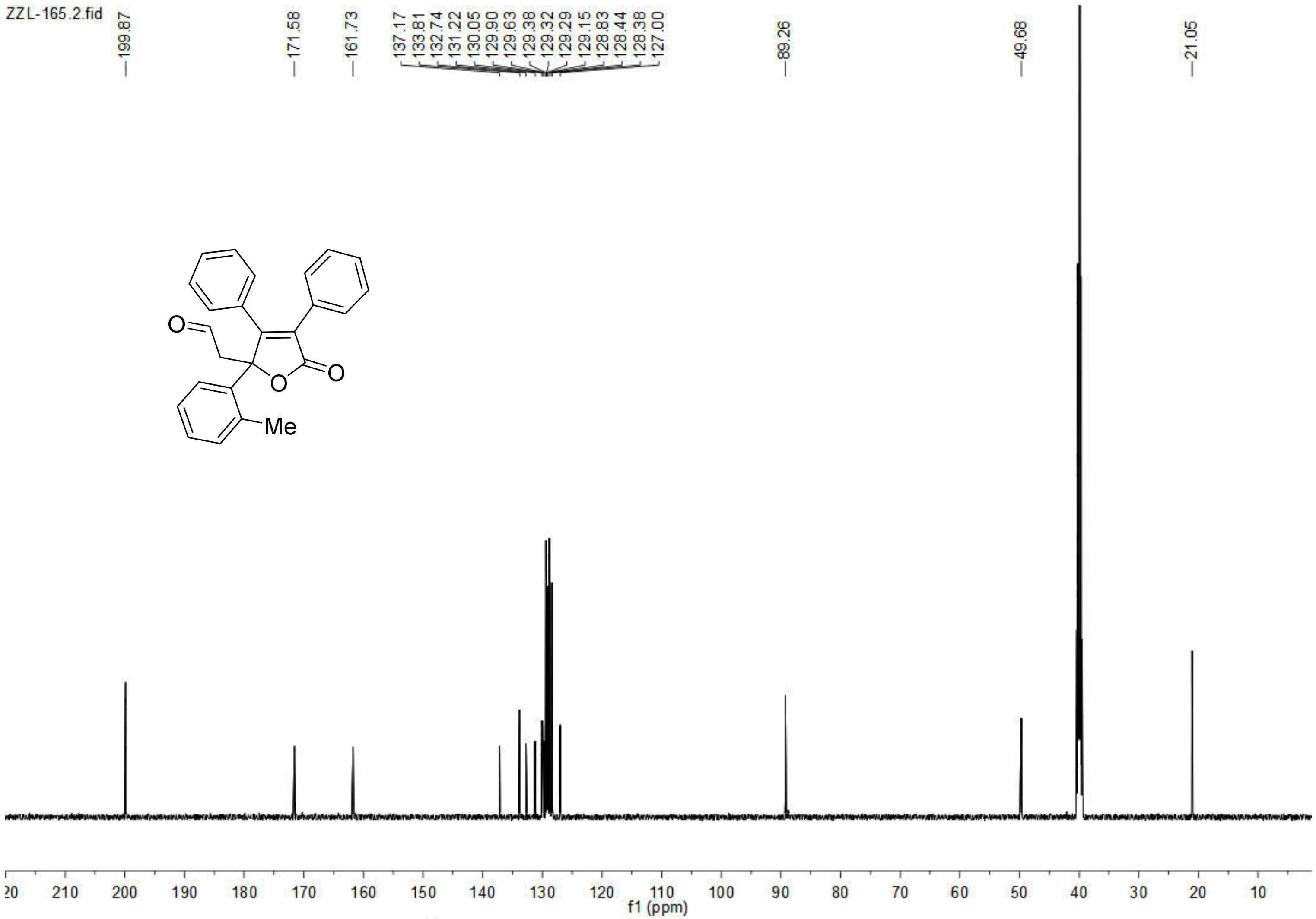


Figure S10. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3c**

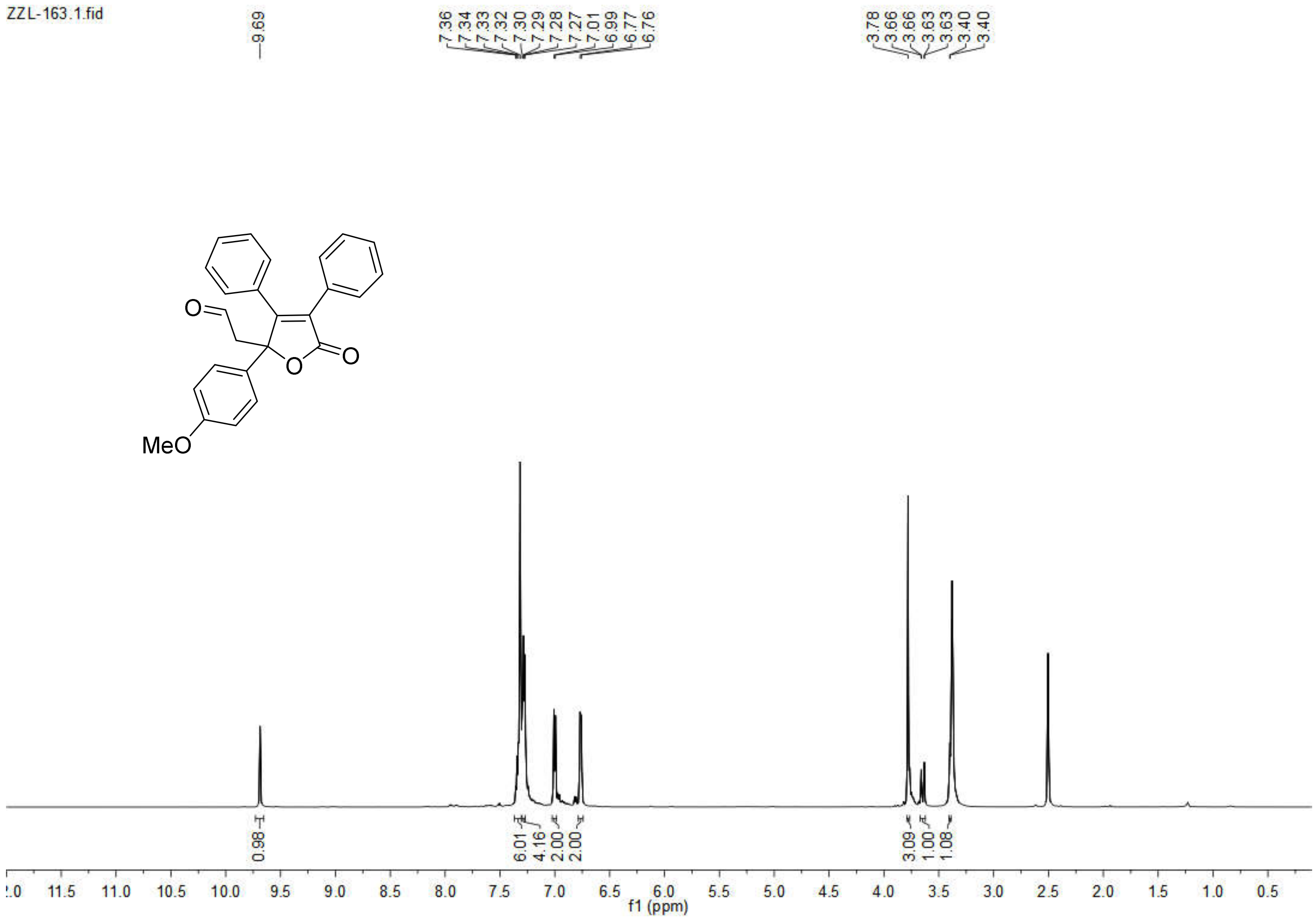


Figure S11. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3d**

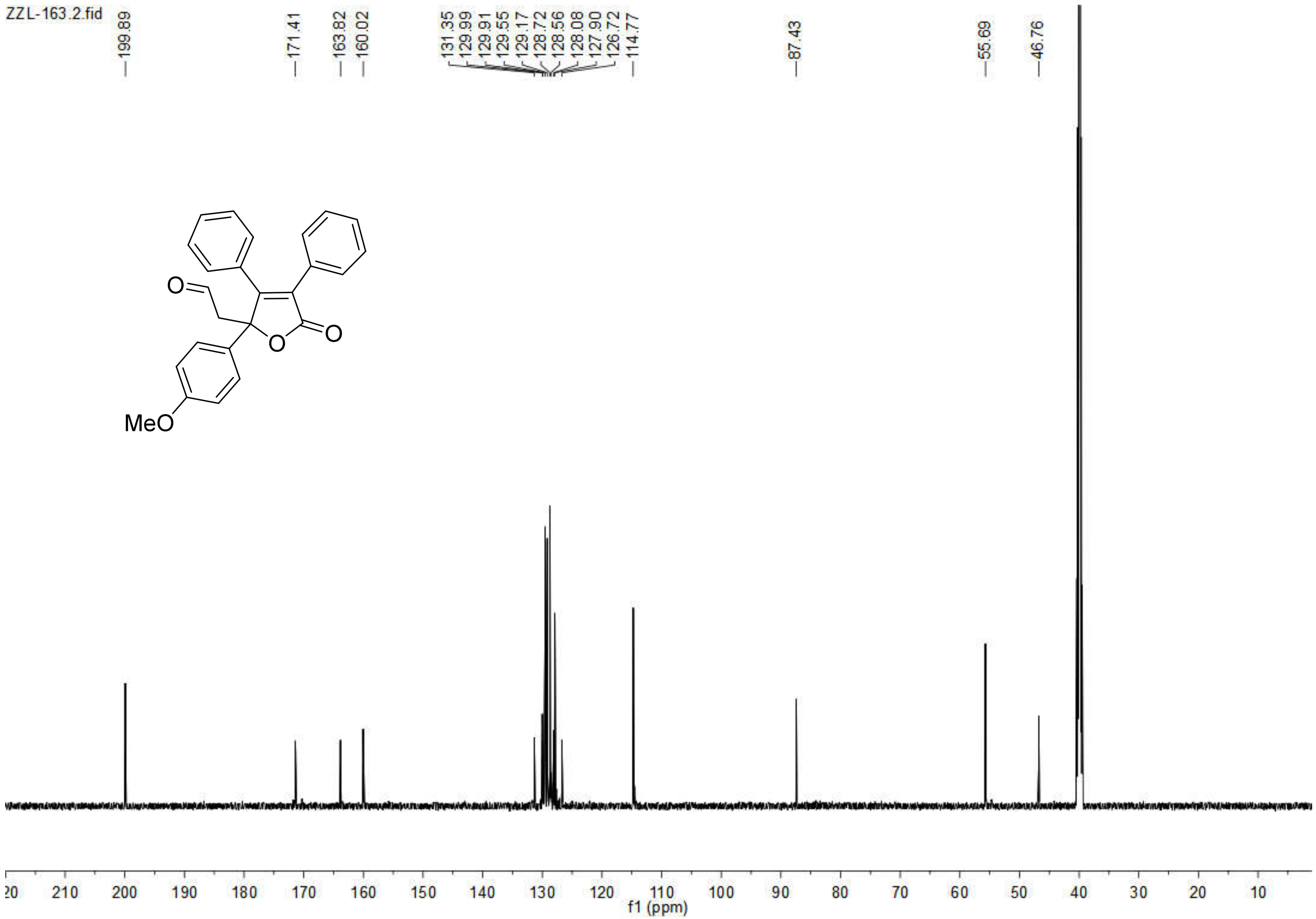


Figure S12. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3d**

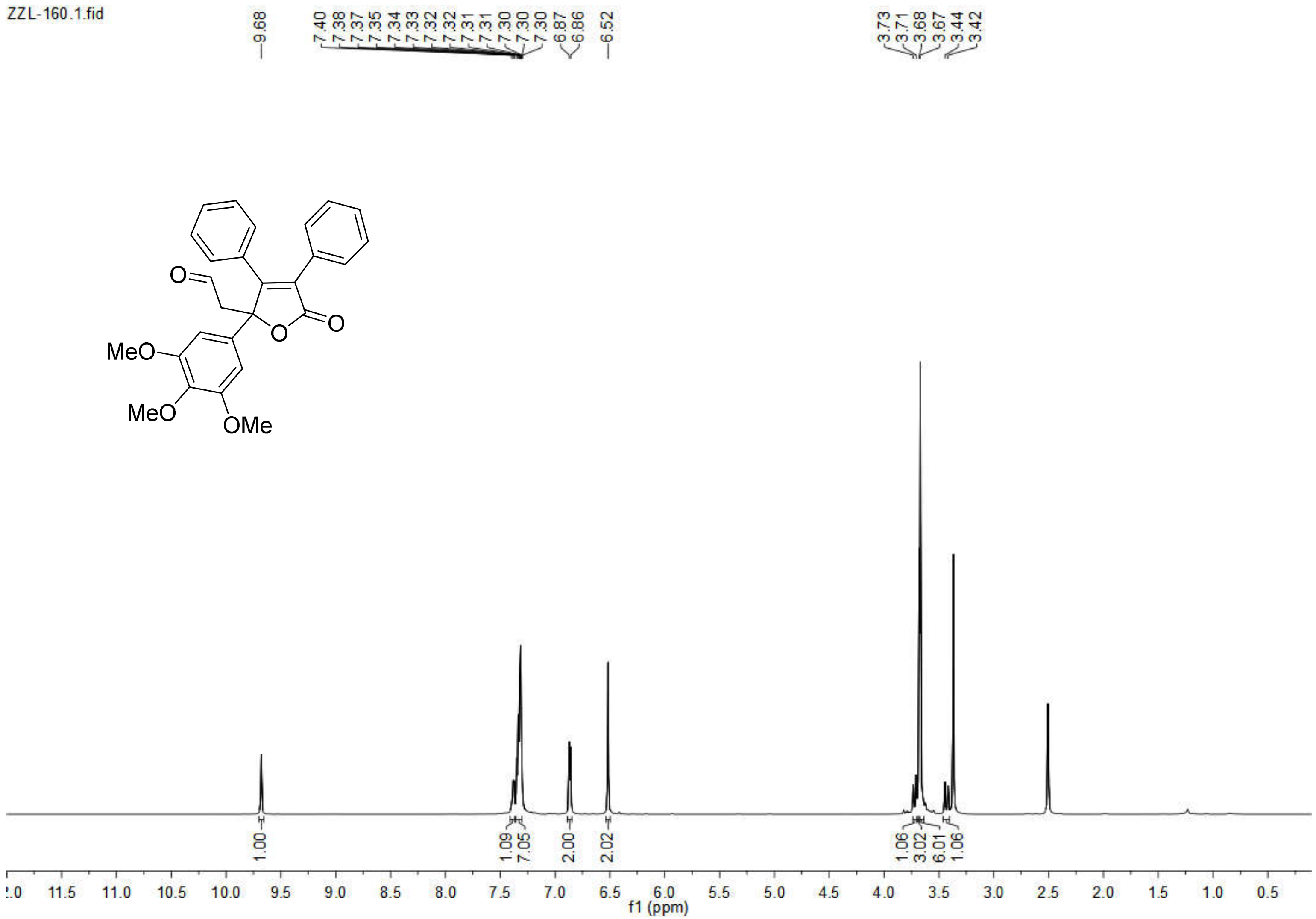


Figure S13. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3e**

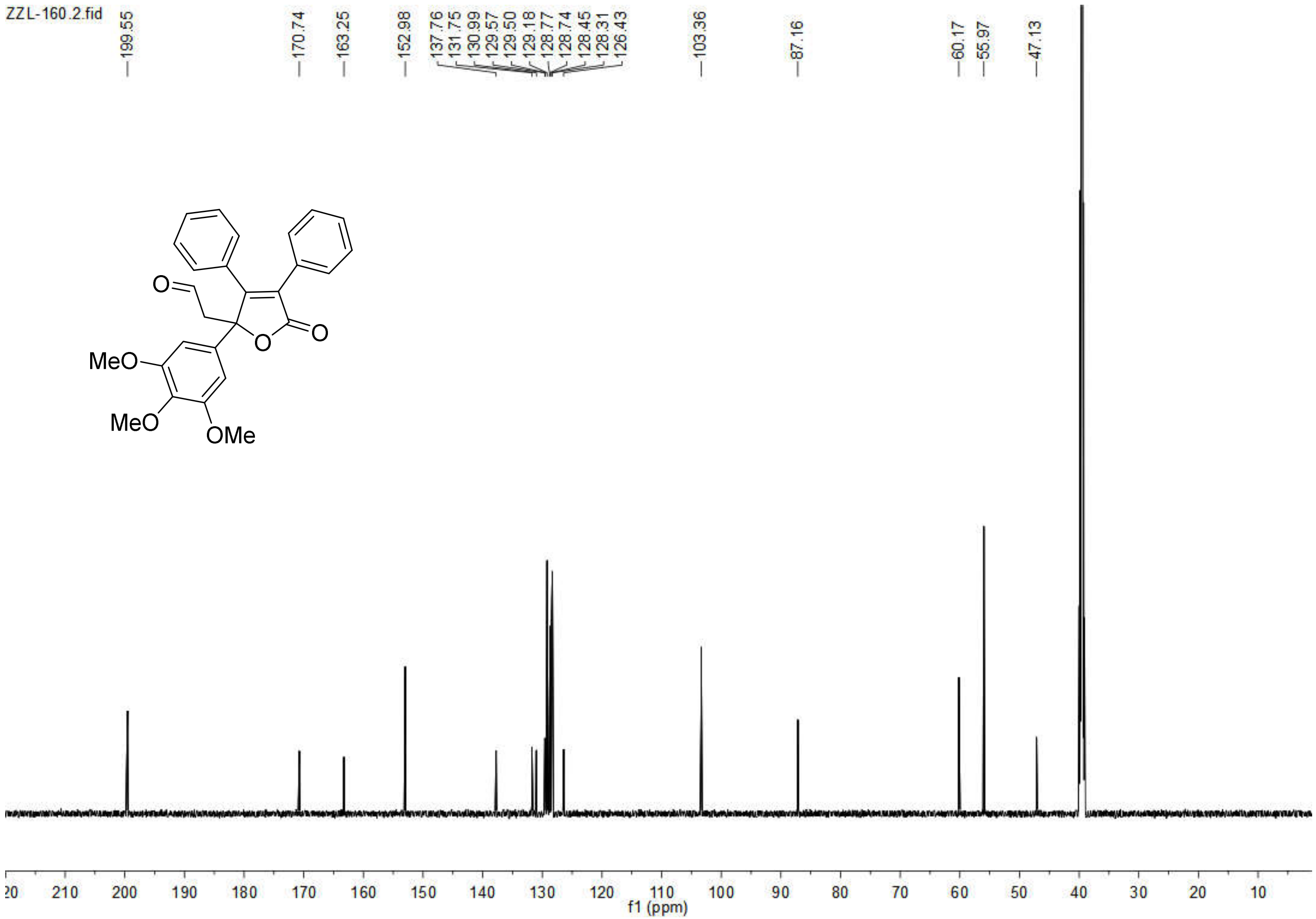


Figure S14. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3e**

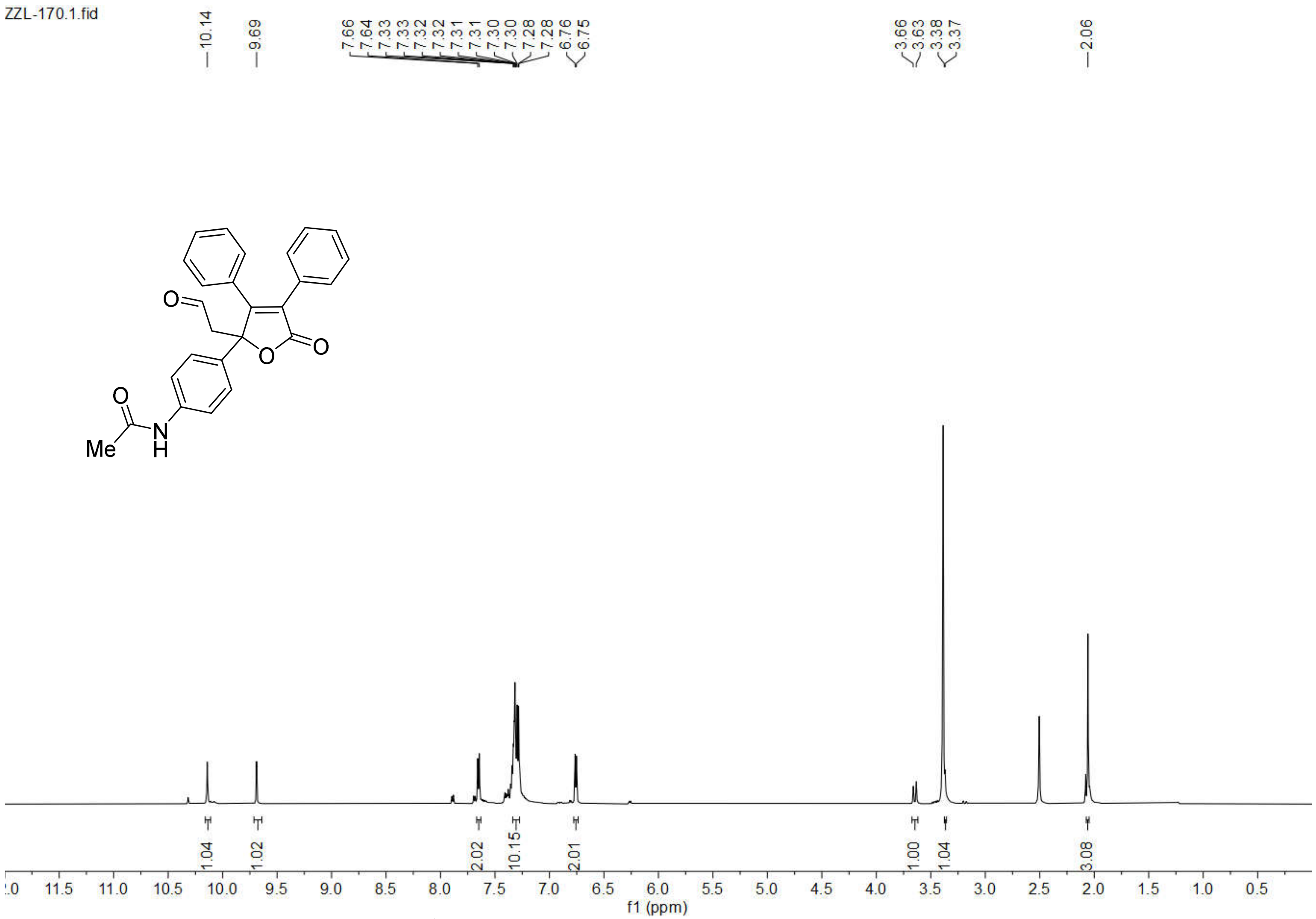


Figure S15. [1]H NMR (600 MHz, DMSO-d_6) spectra of compound **3f**

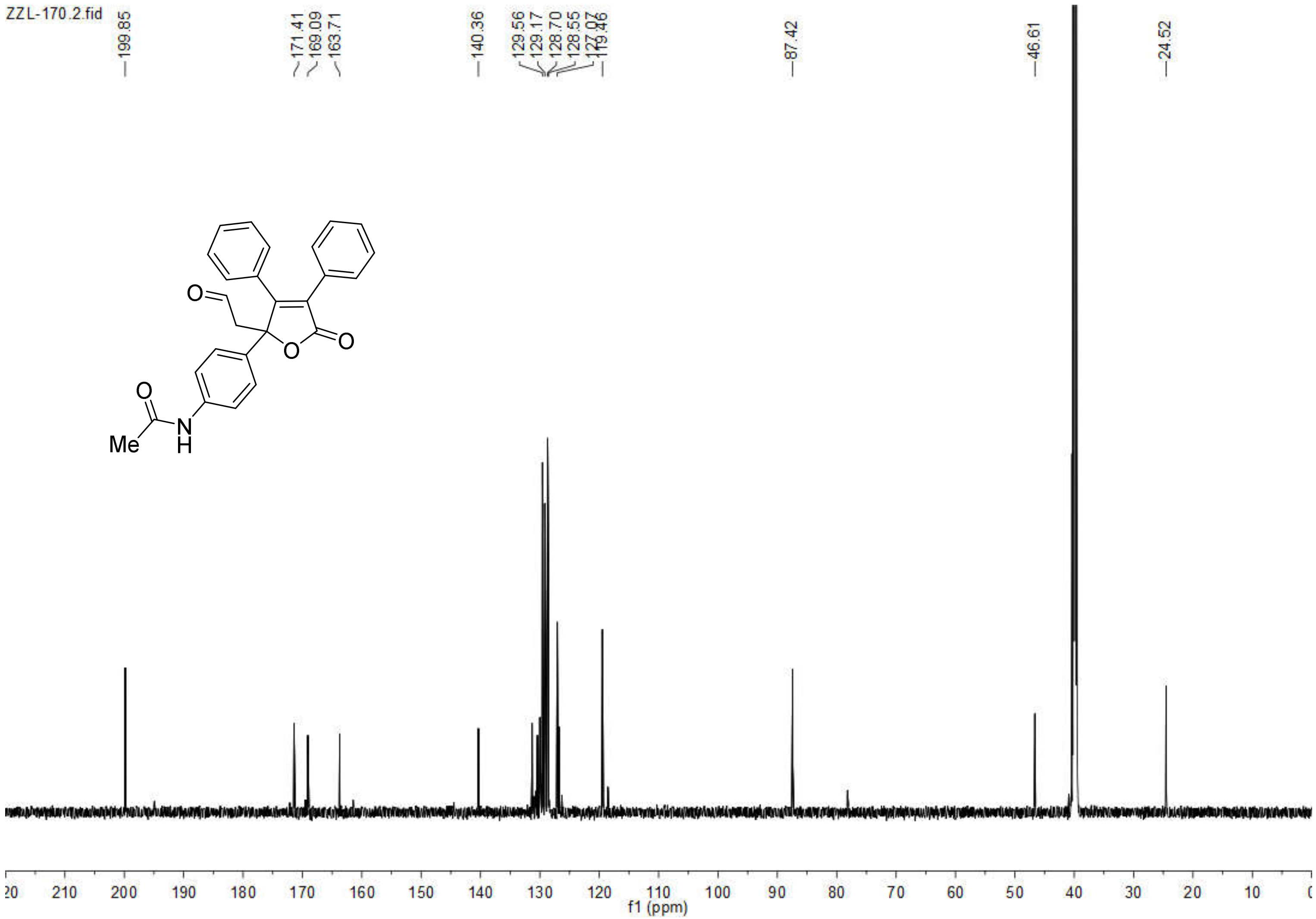


Figure S16. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3f**

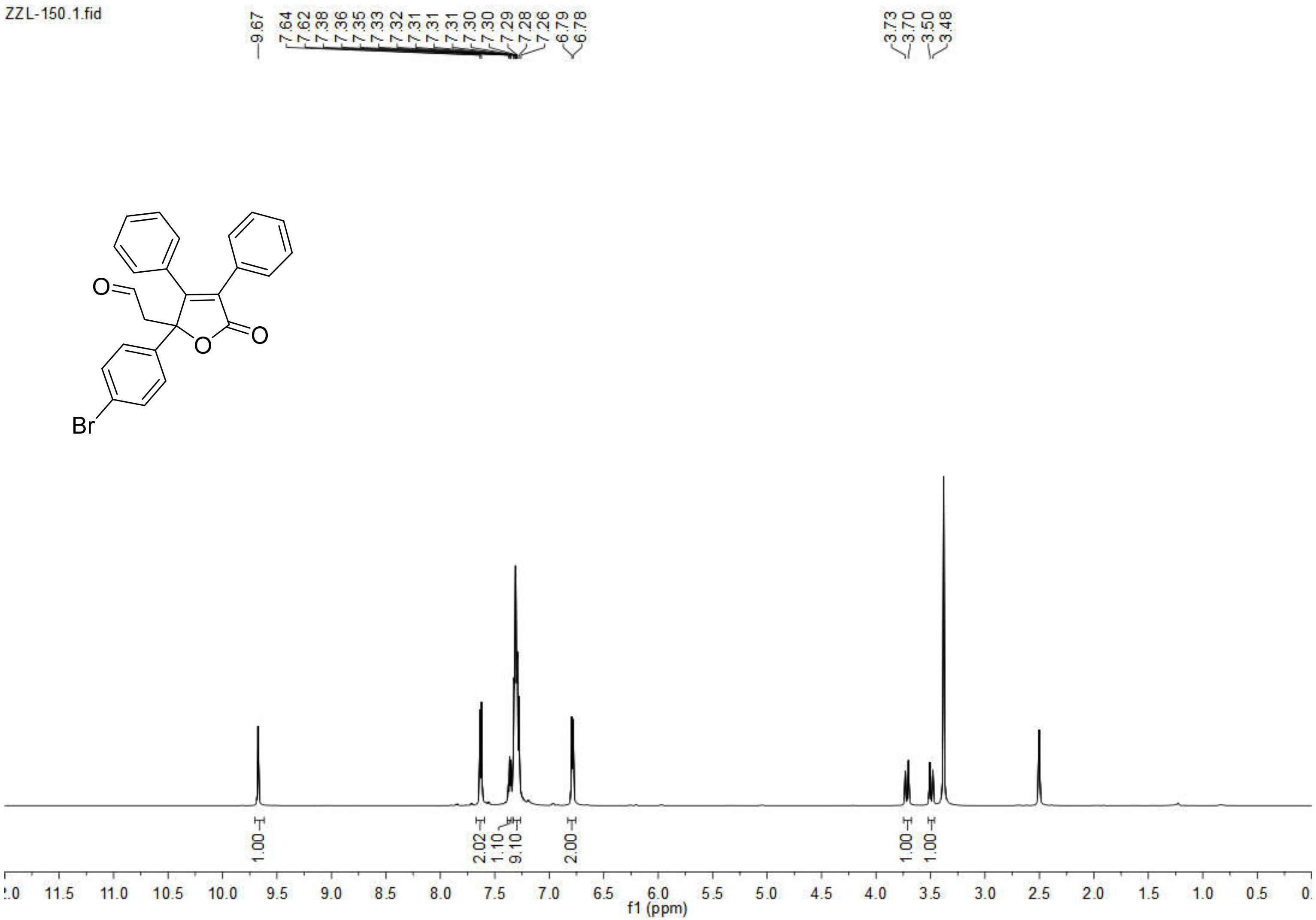


Figure S17. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3g**

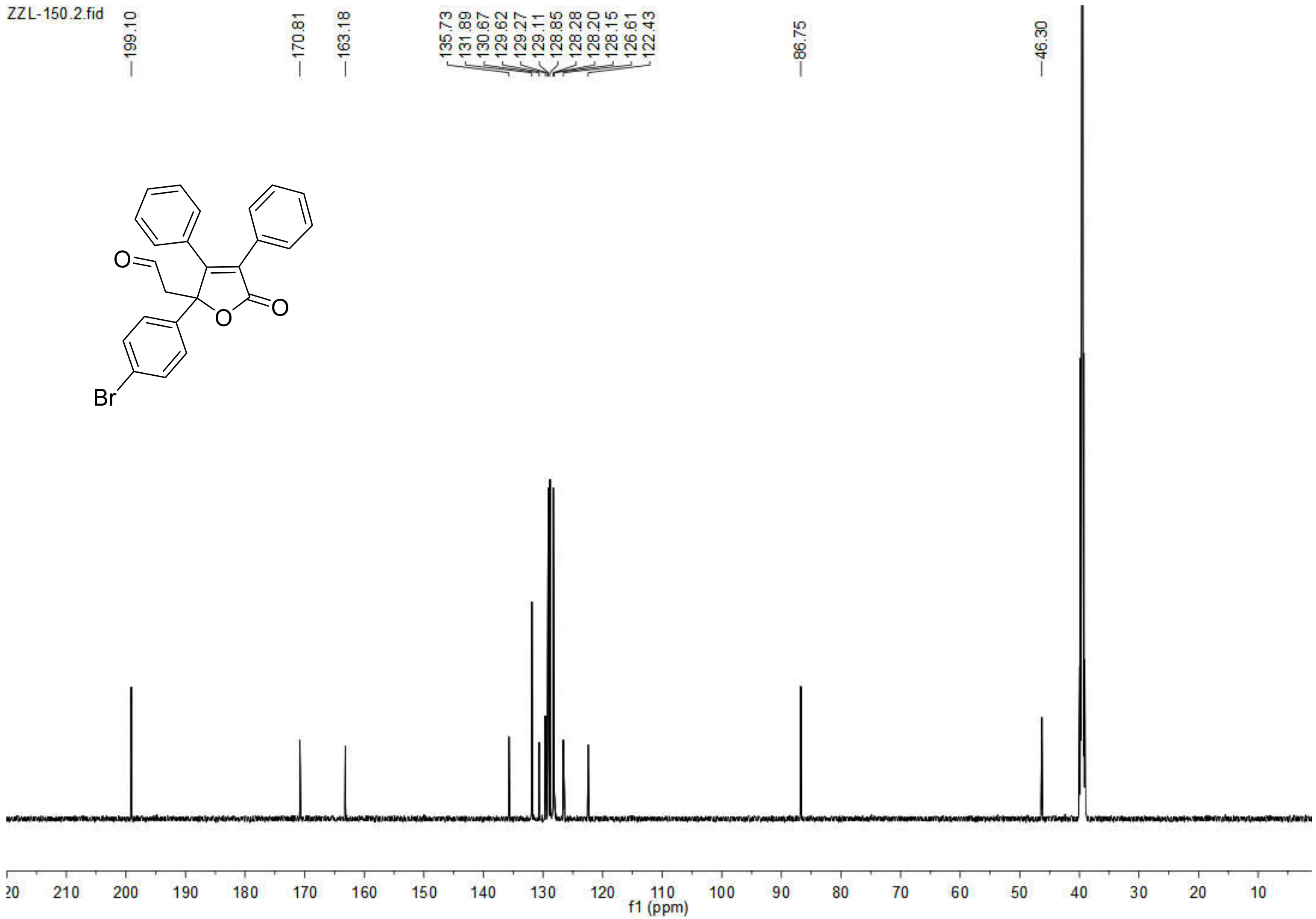


Figure S18. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3g**

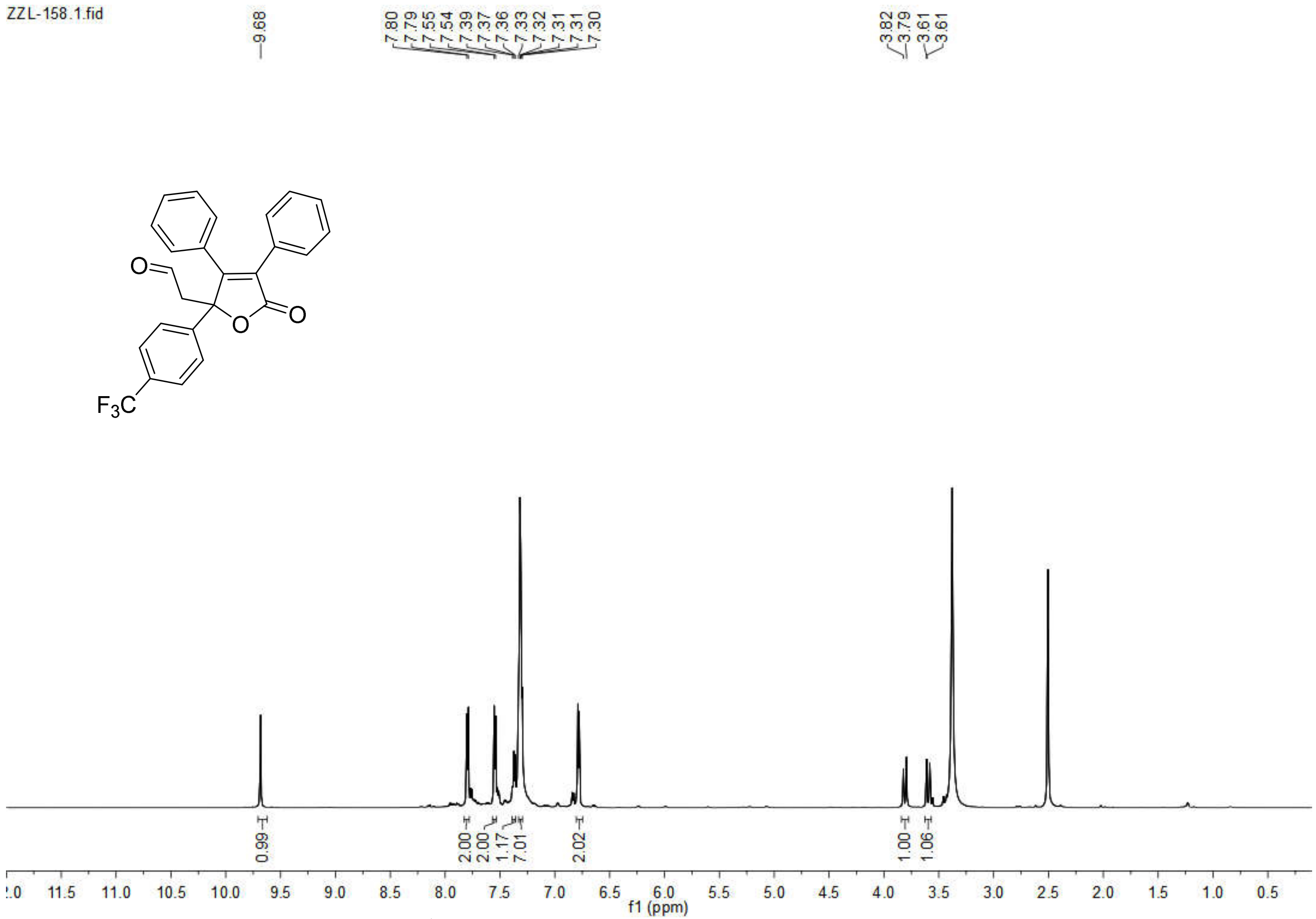


Figure S19. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3h**

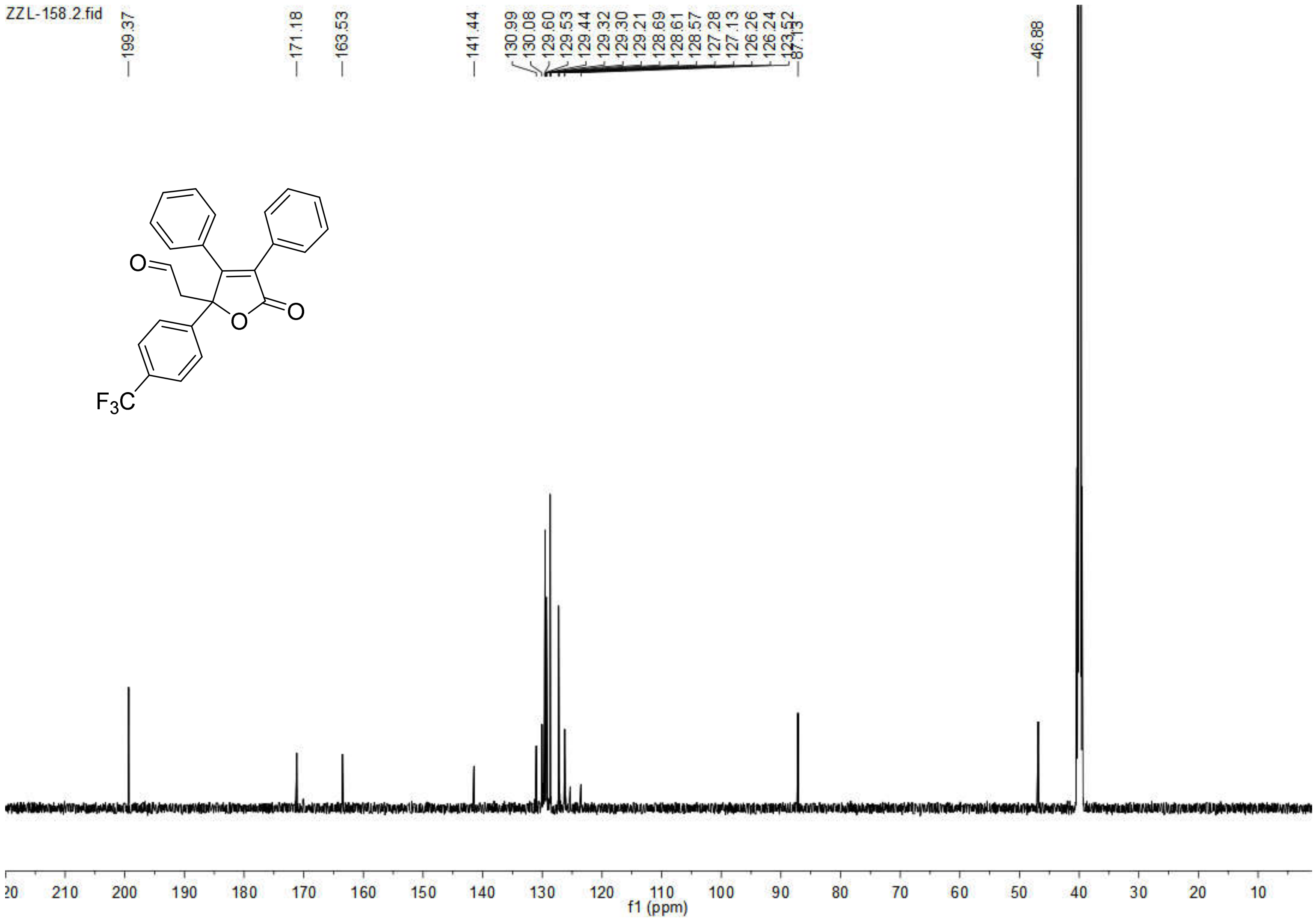


Figure S20. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3h**

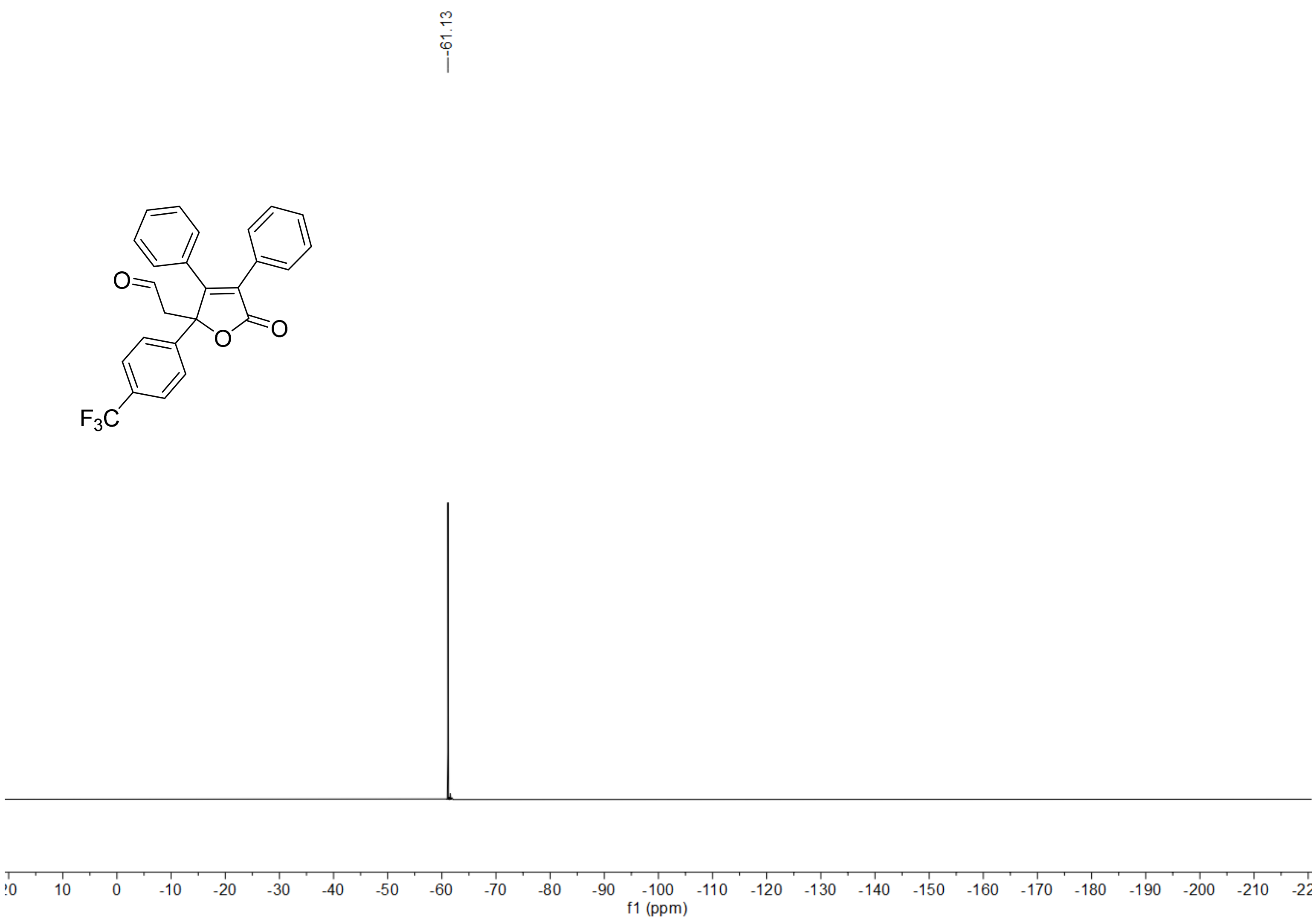


Figure S21. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3h**

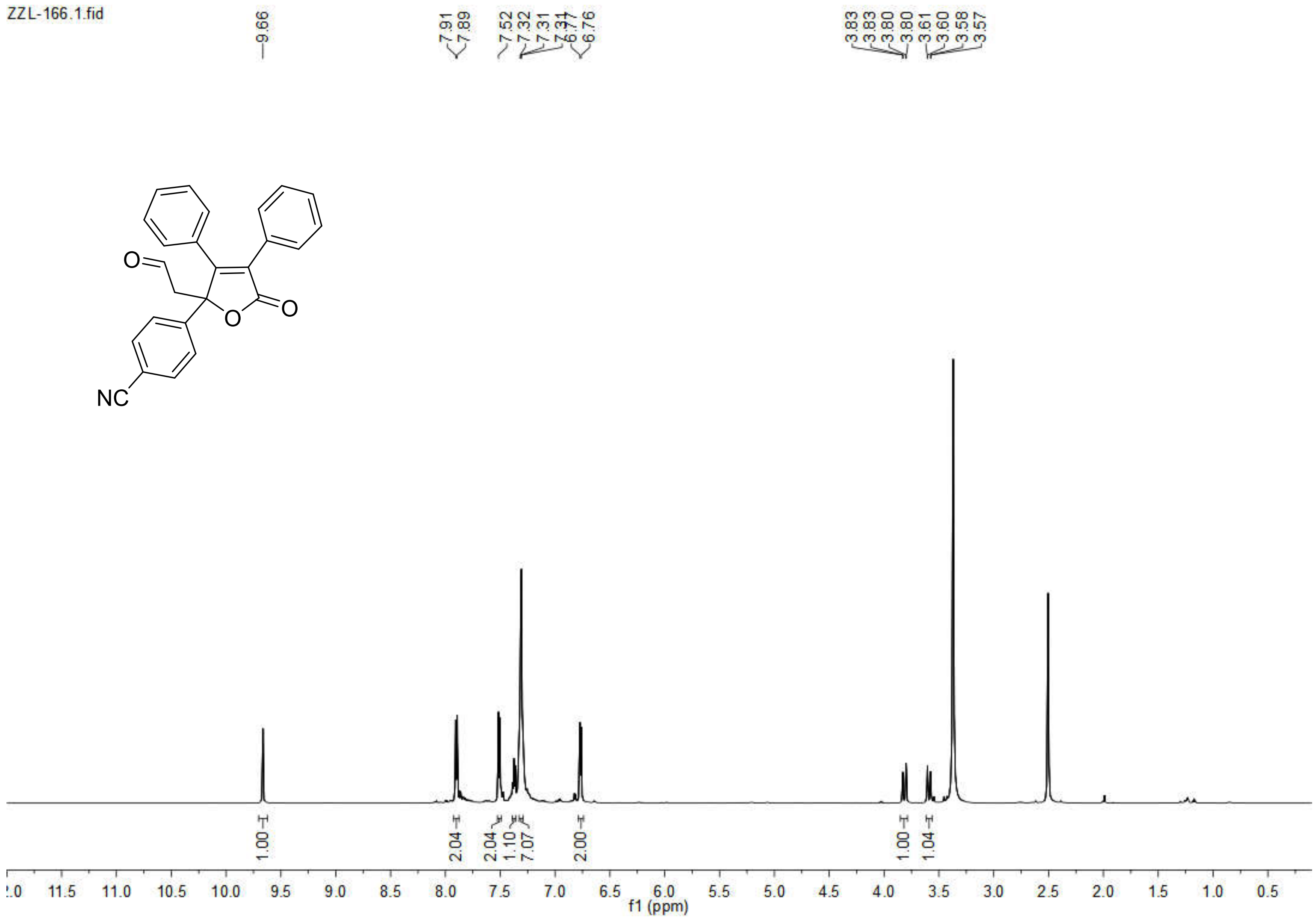


Figure S22. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3i**

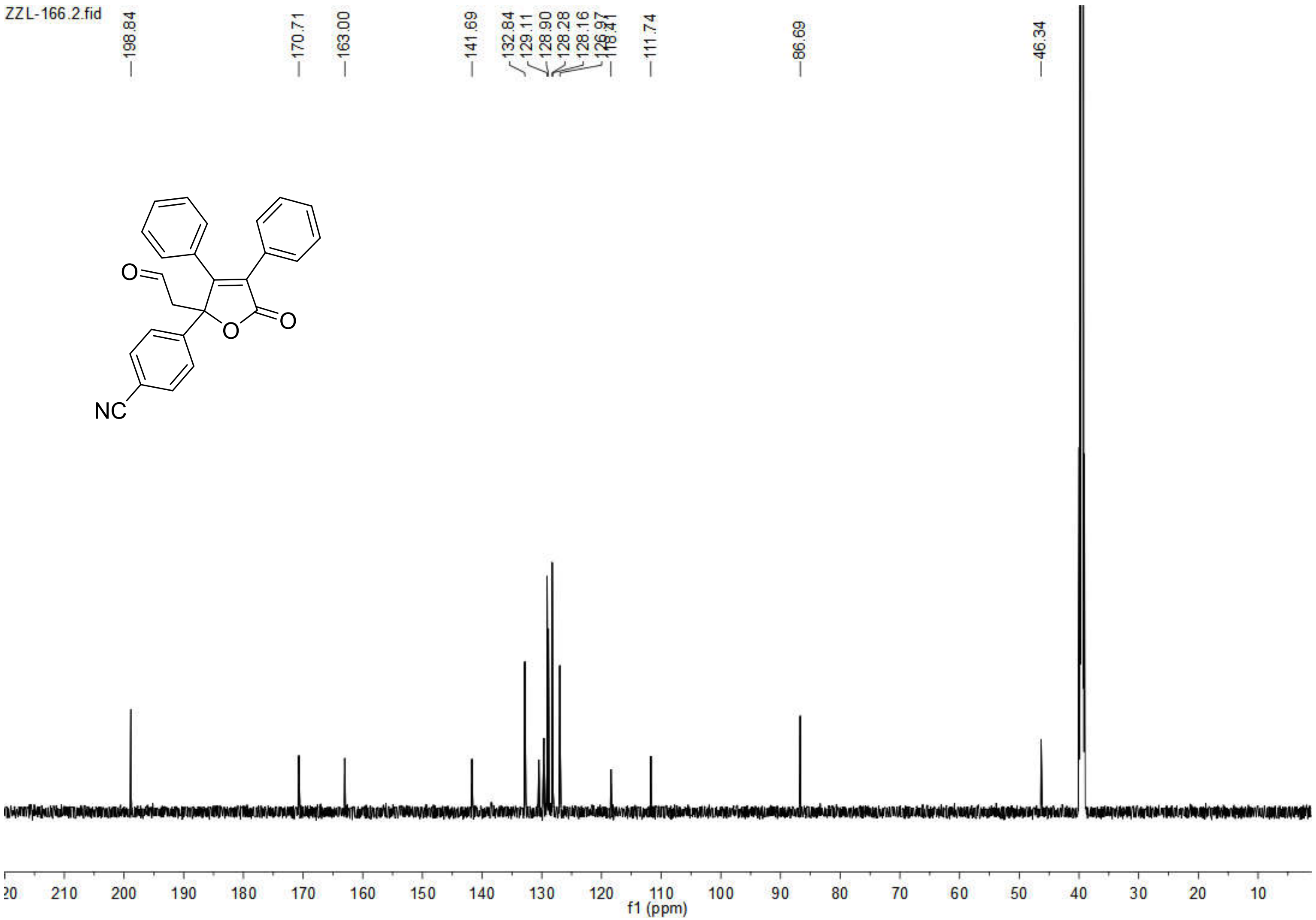


Figure S23. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3i**

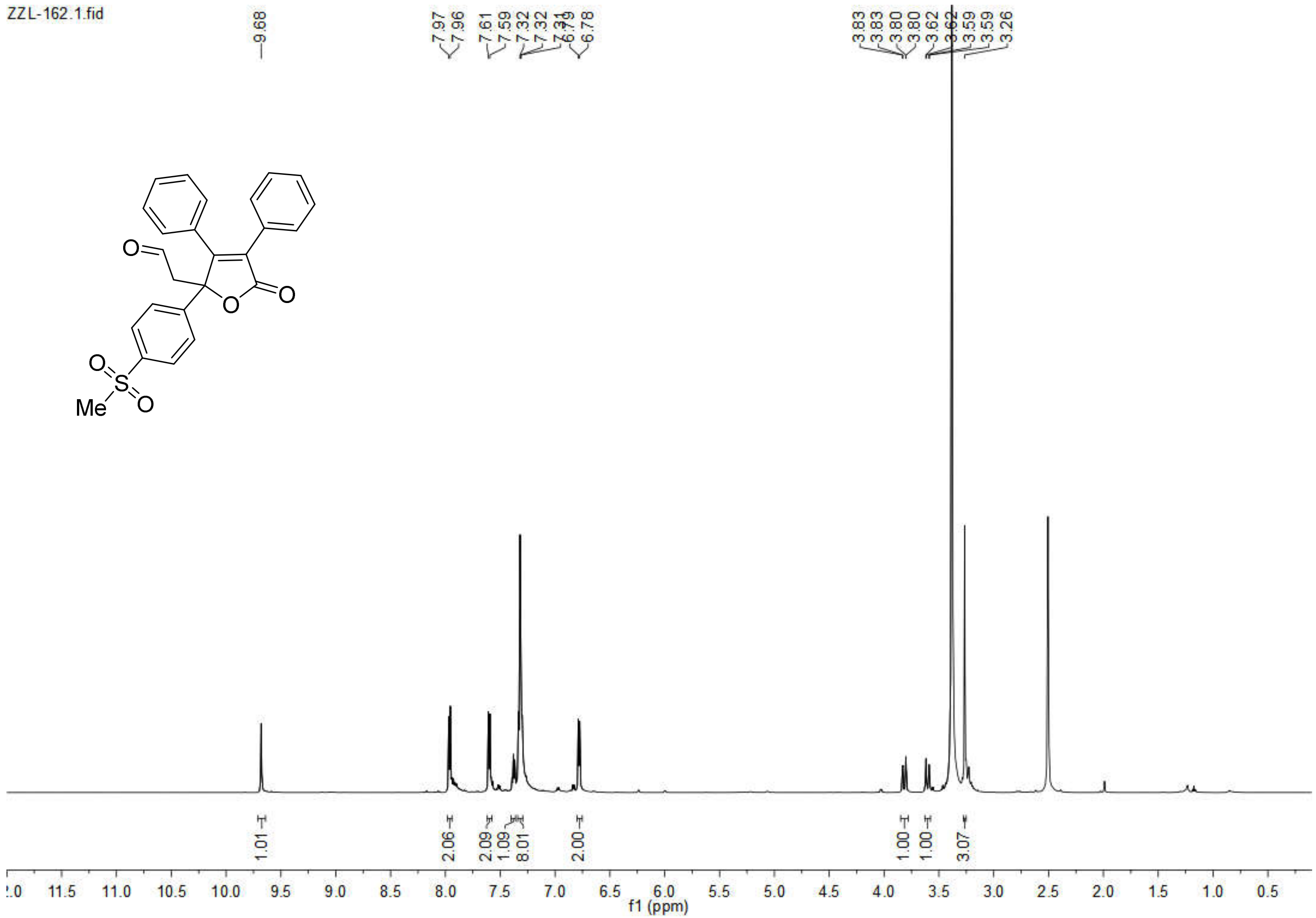


Figure S24. ¹H NMR (600 MHz, DMSO-d_6) spectra of compound **3j**

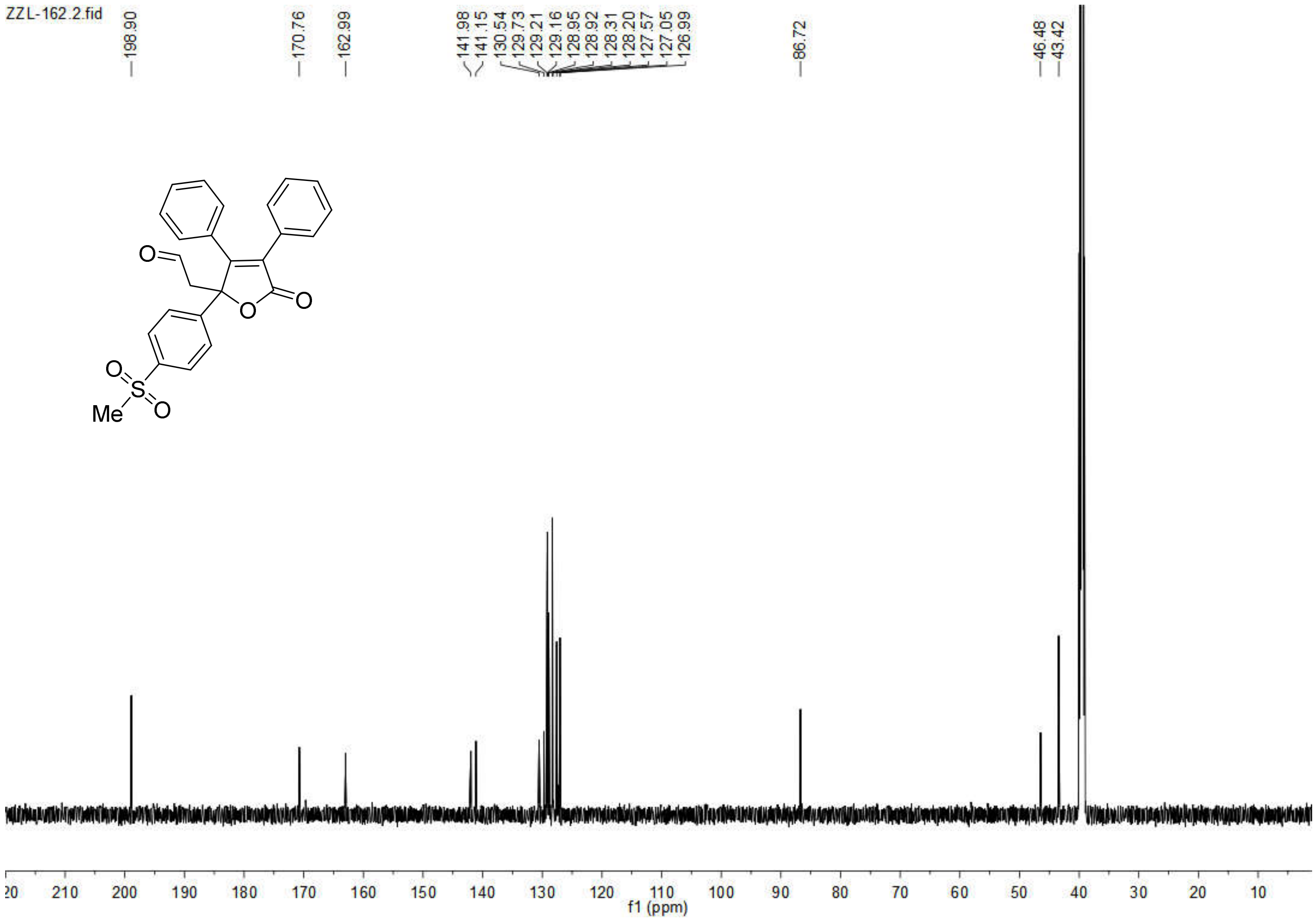


Figure S25. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3j**

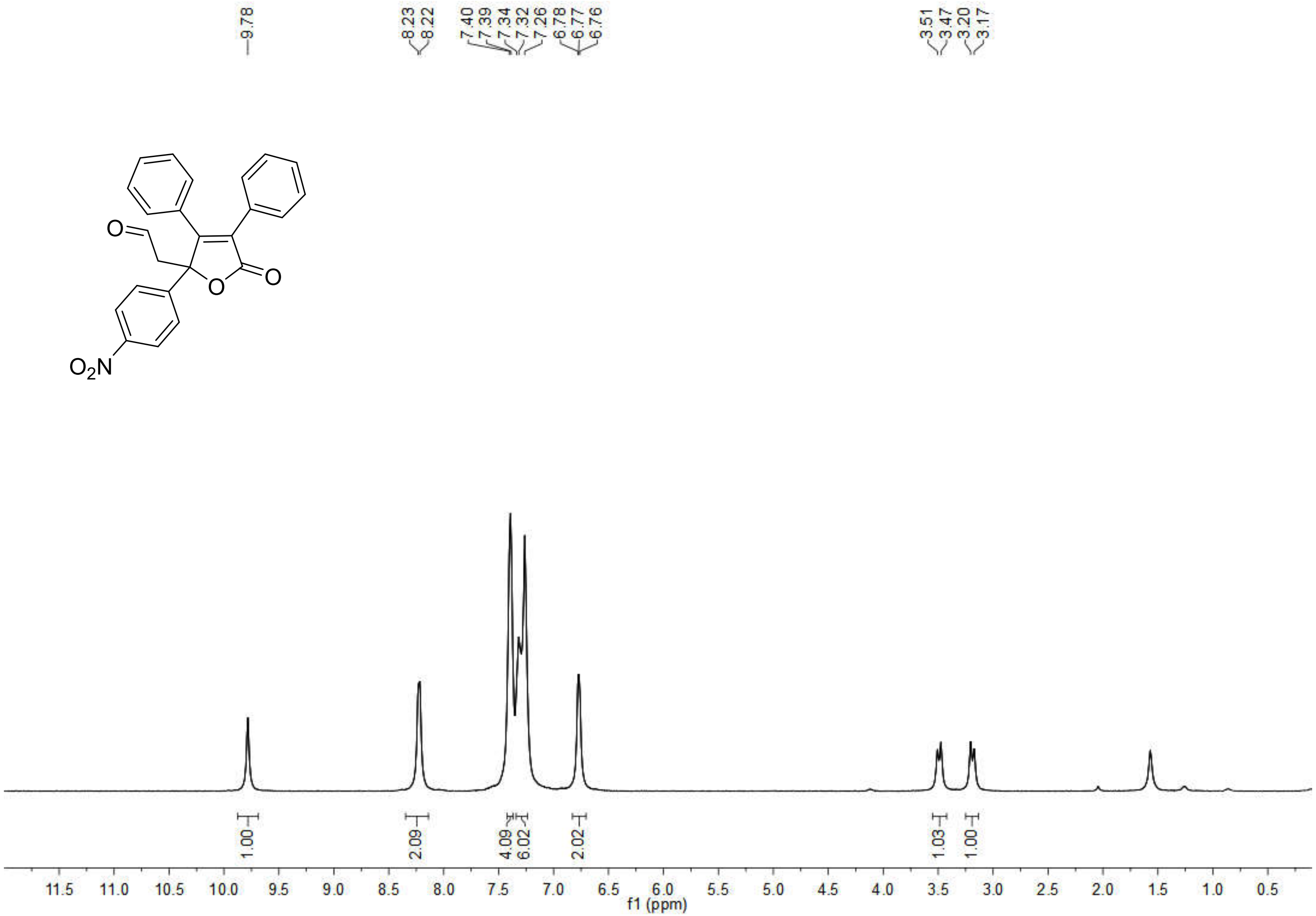


Figure S26. ^1H NMR (500 MHz, $CDCl_3$) spectra of compound **3k**

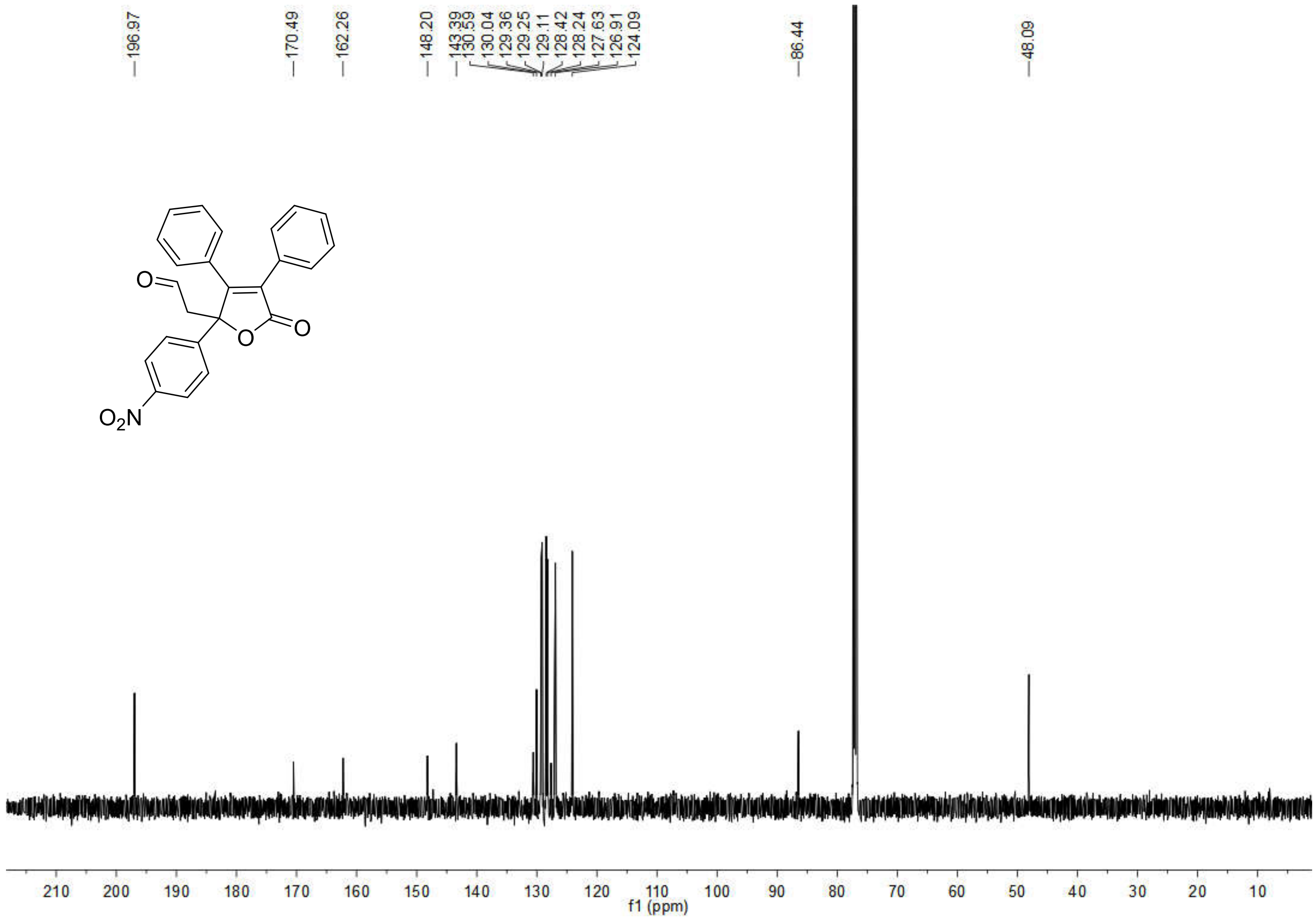


Figure S27. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **3k**

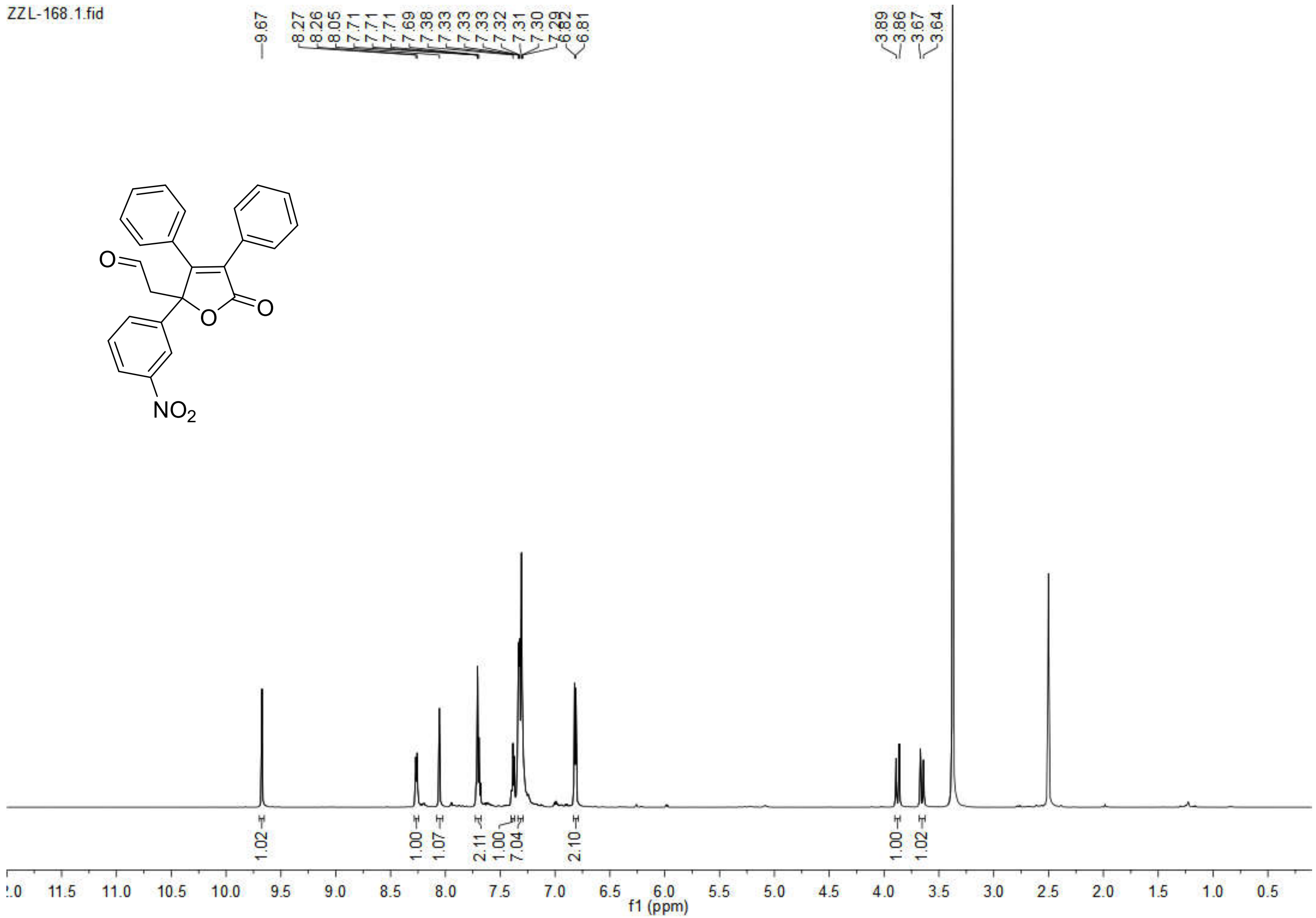


Figure S28. [1]H NMR (600 MHz, DMSO-d_6) spectra of compound **3l**

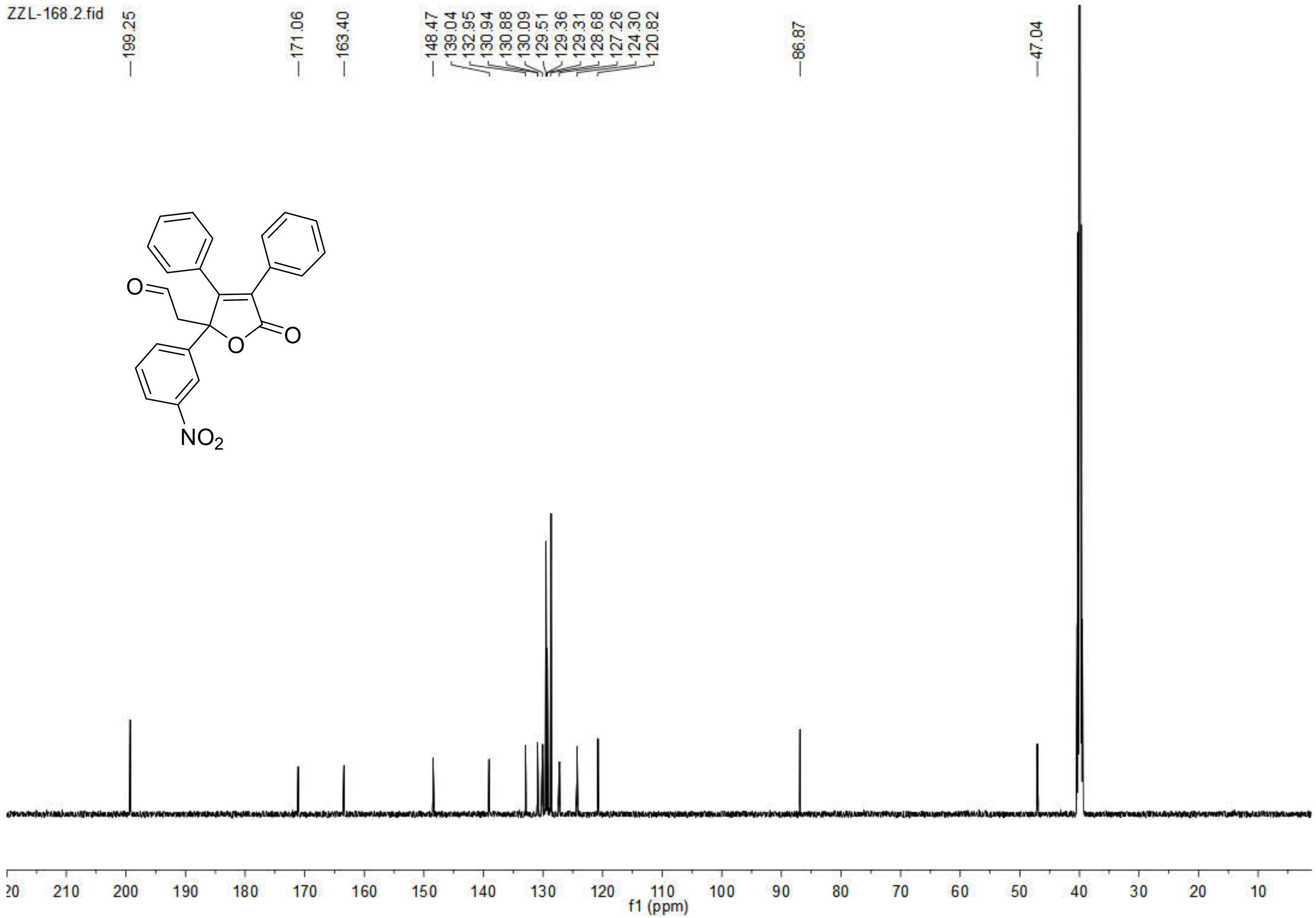


Figure S29. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3l**

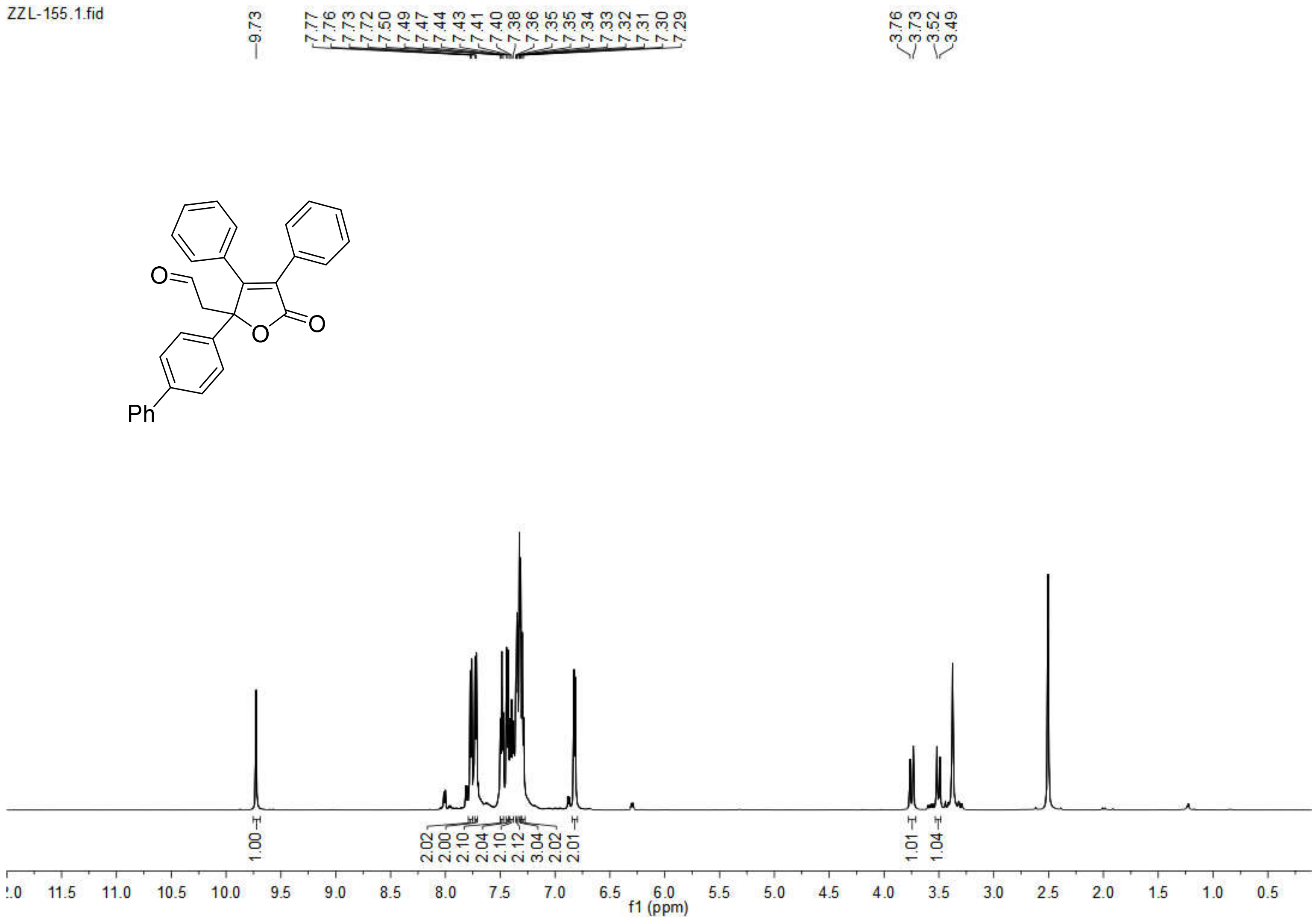


Figure S30. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3m**

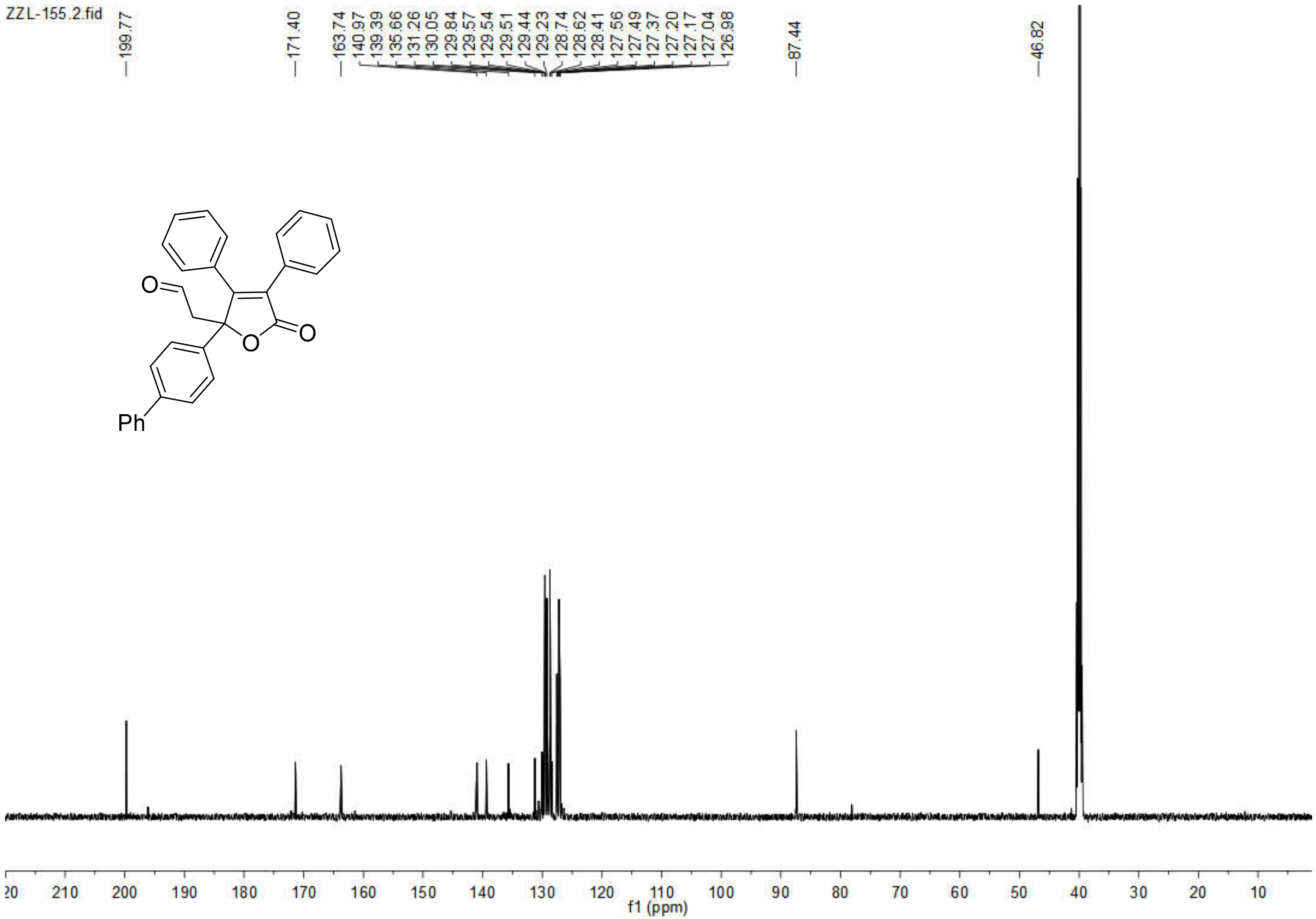


Figure S31. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3m**

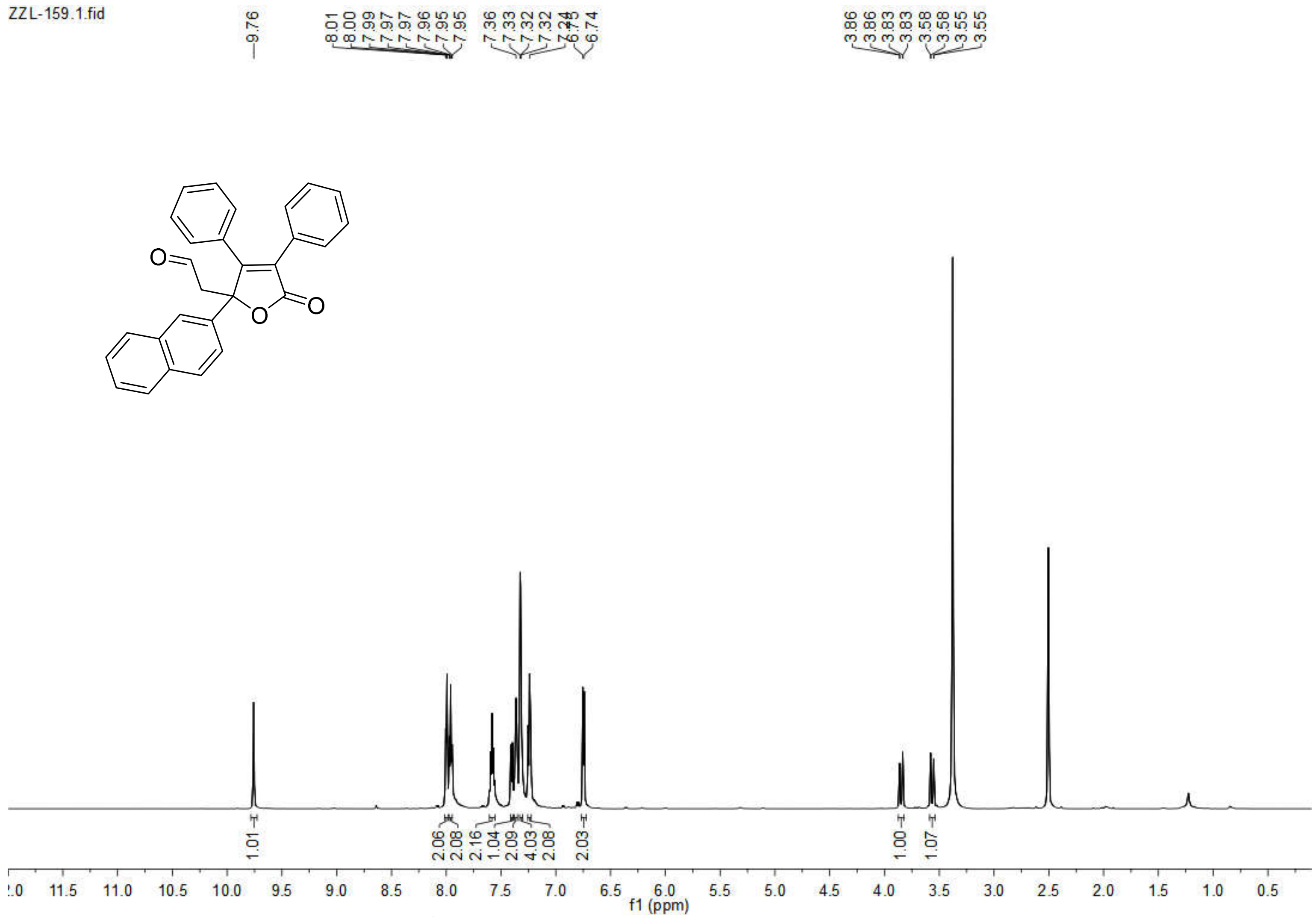


Figure S32. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3n**

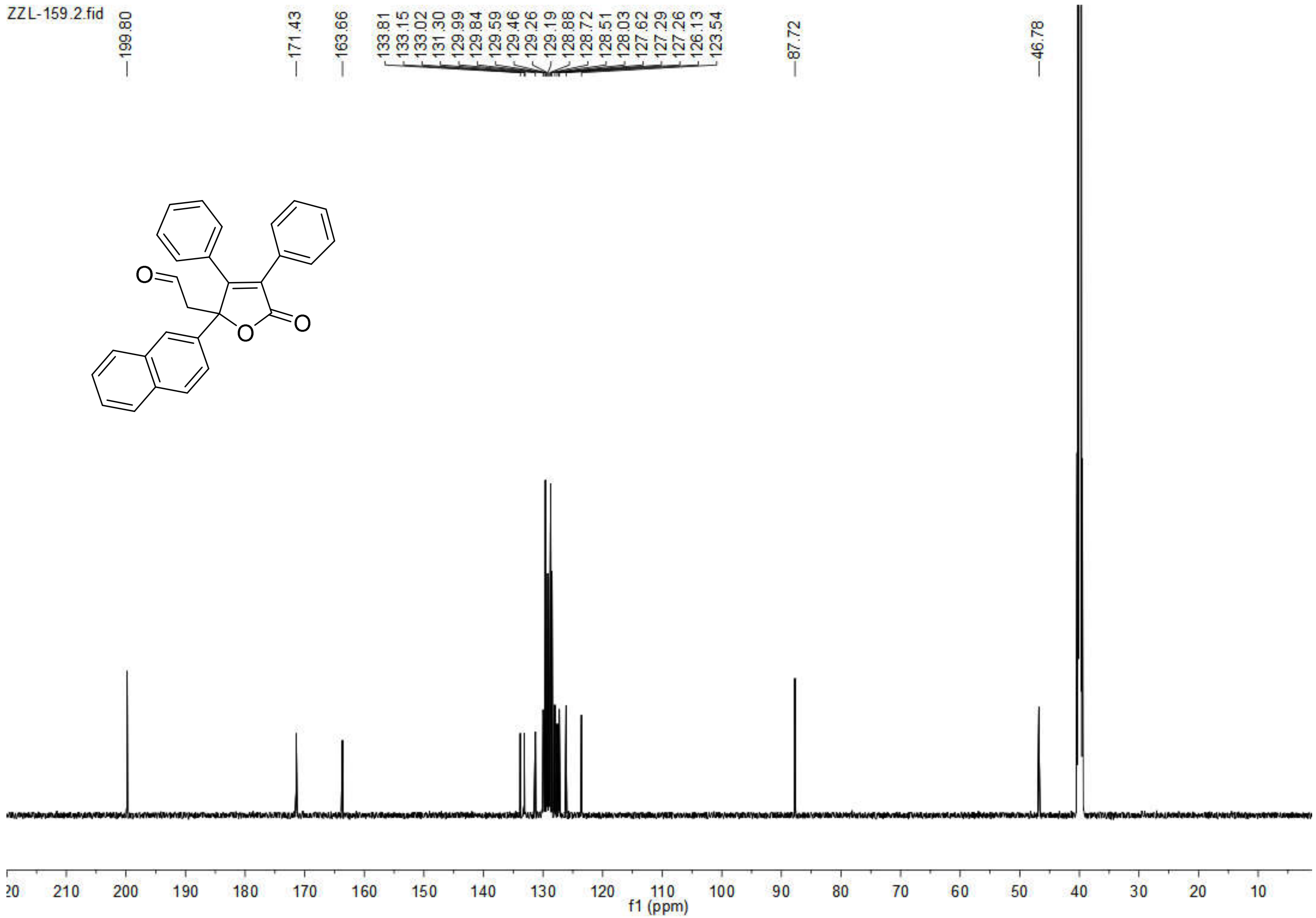


Figure S33. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3n**

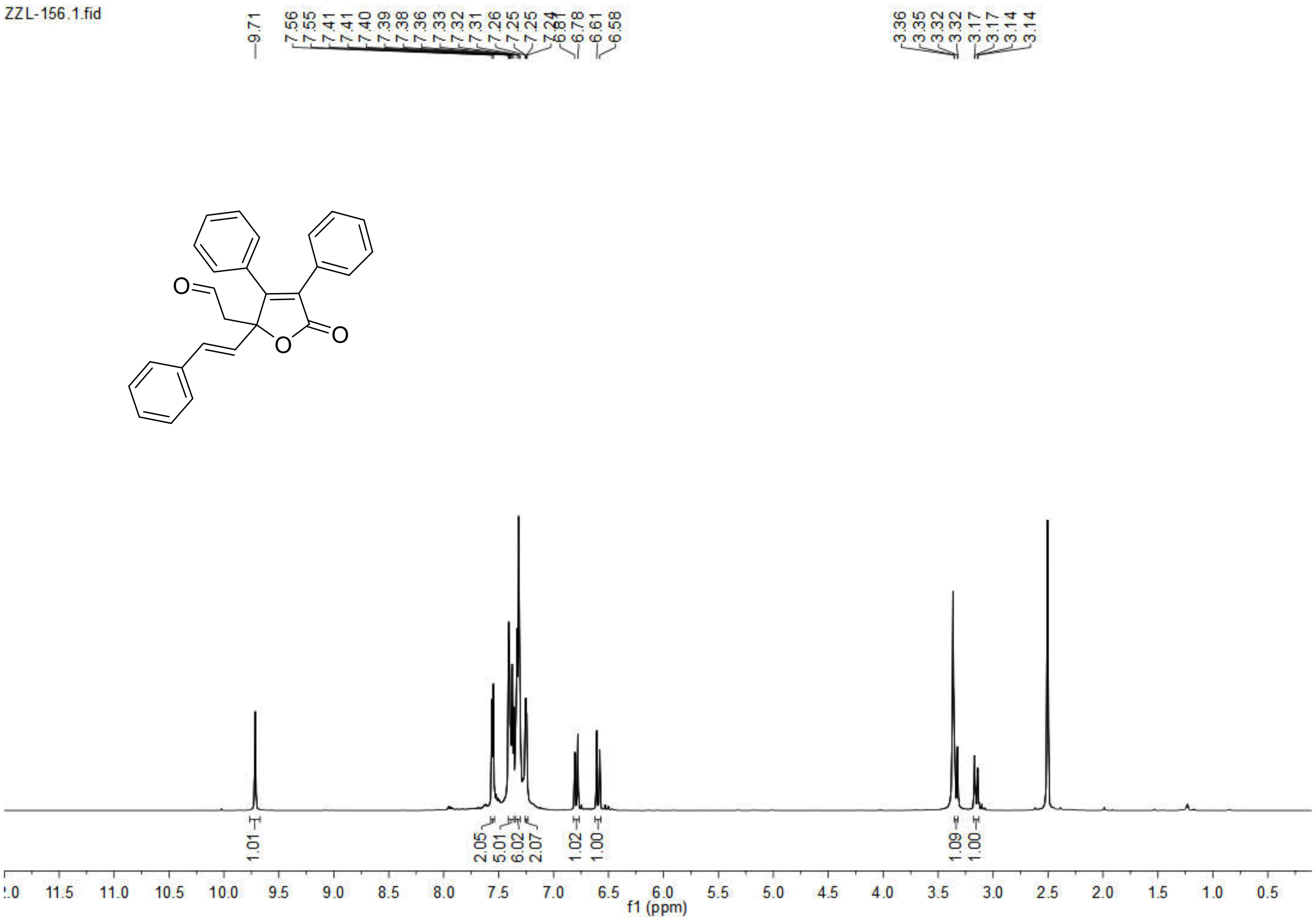


Figure S34 [1]H NMR (600 MHz, DMSO-d_6) spectra of compound **3o**

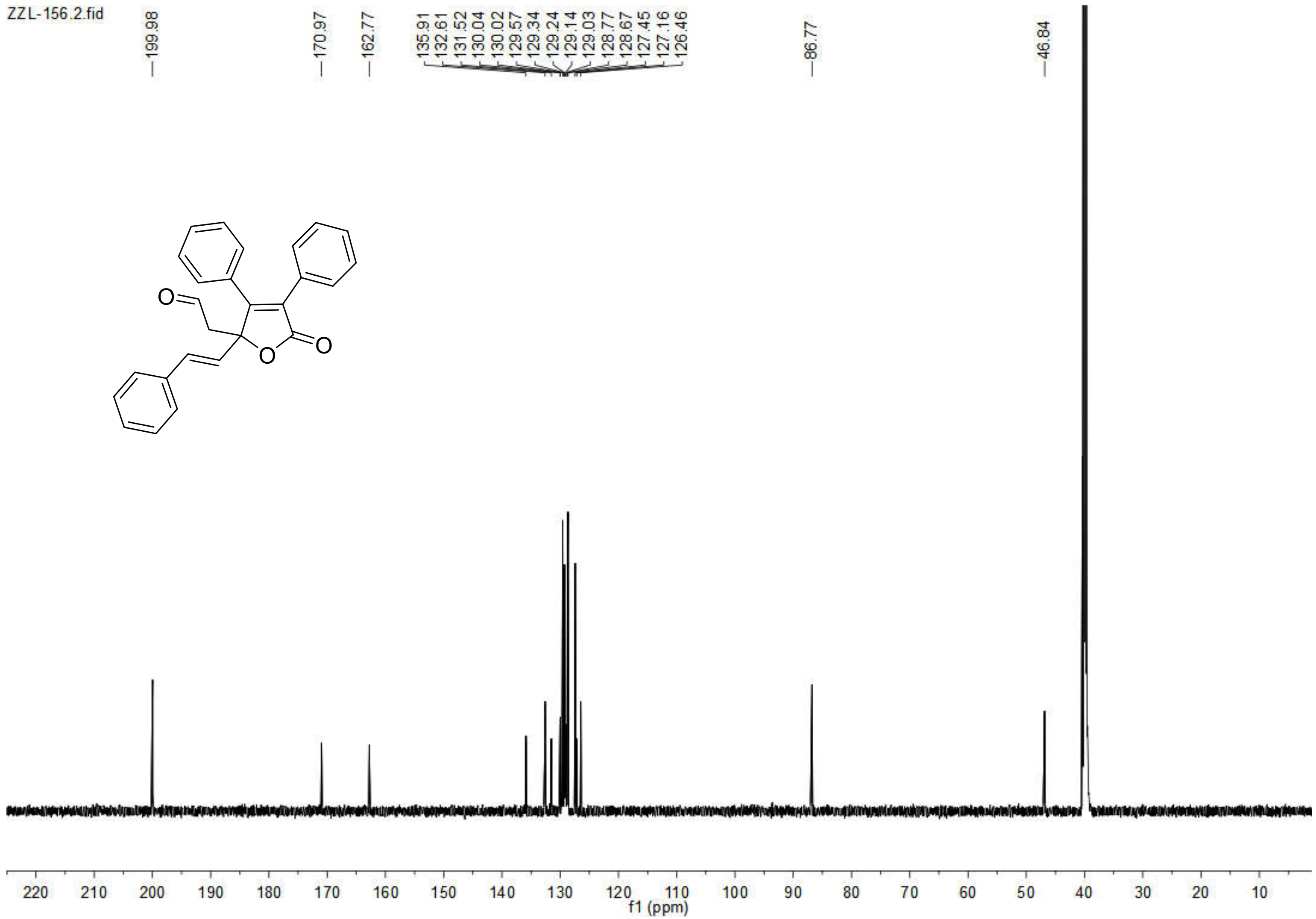


Figure S35. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3o**

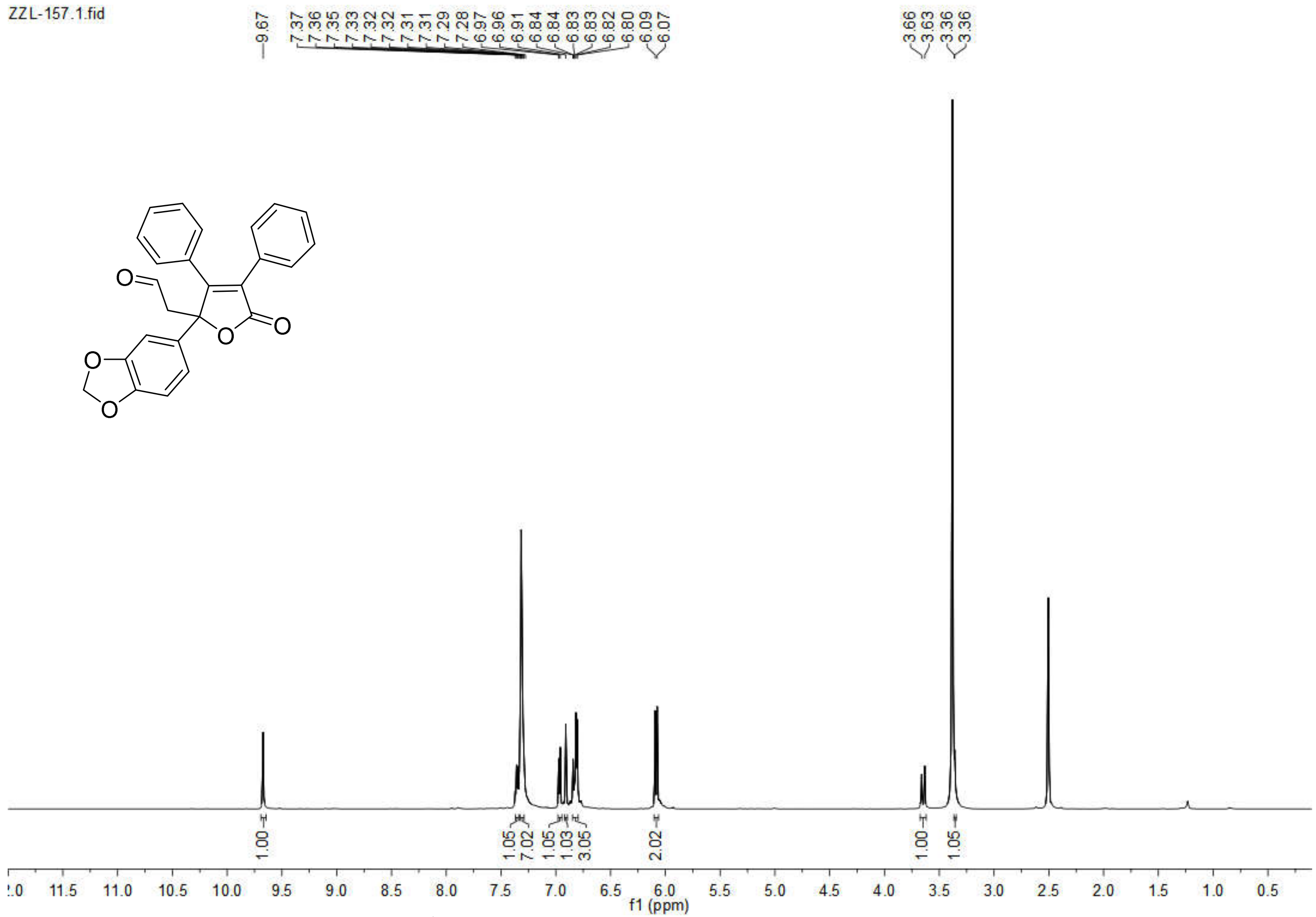


Figure S36. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3p**

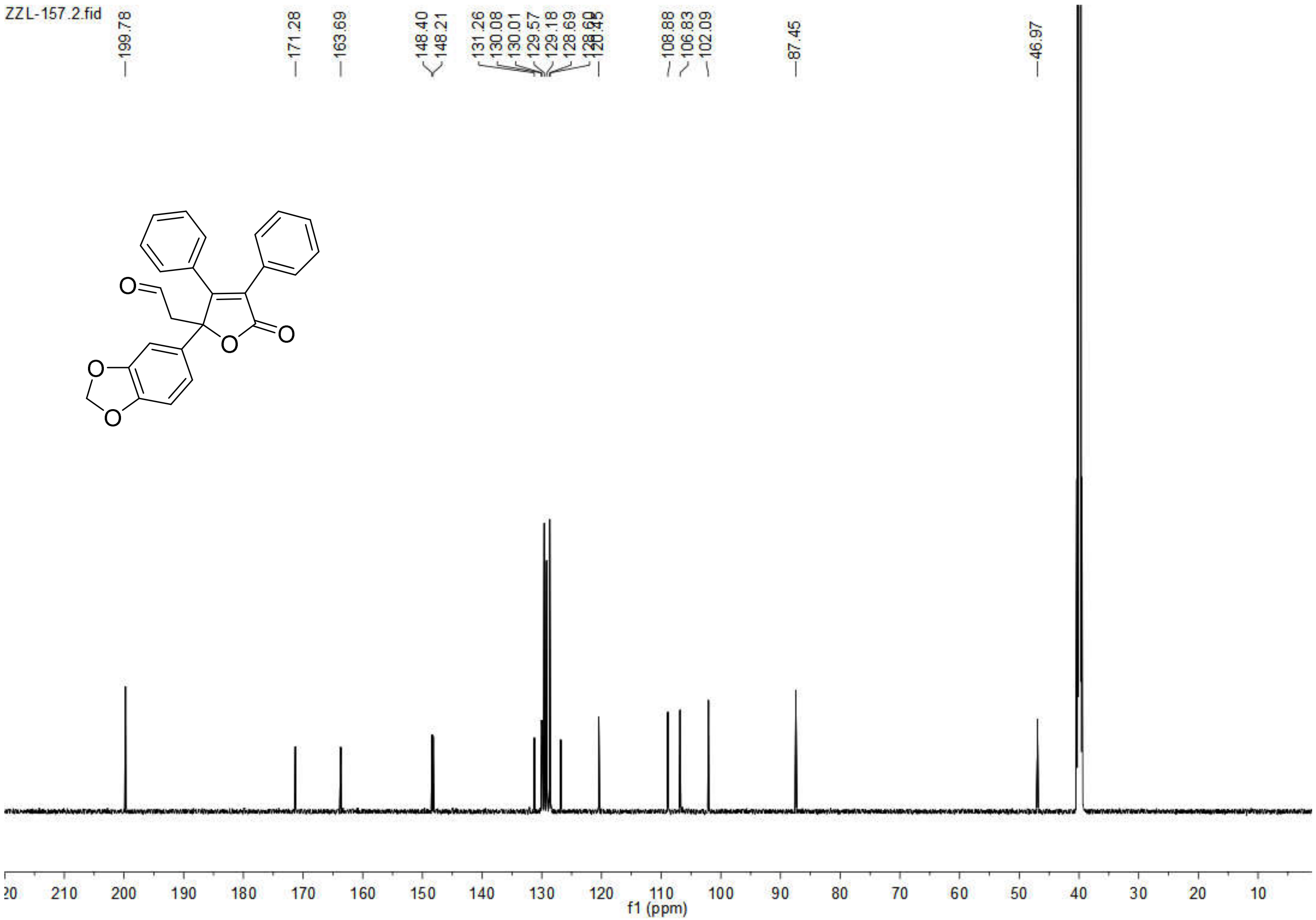


Figure S37. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3p**

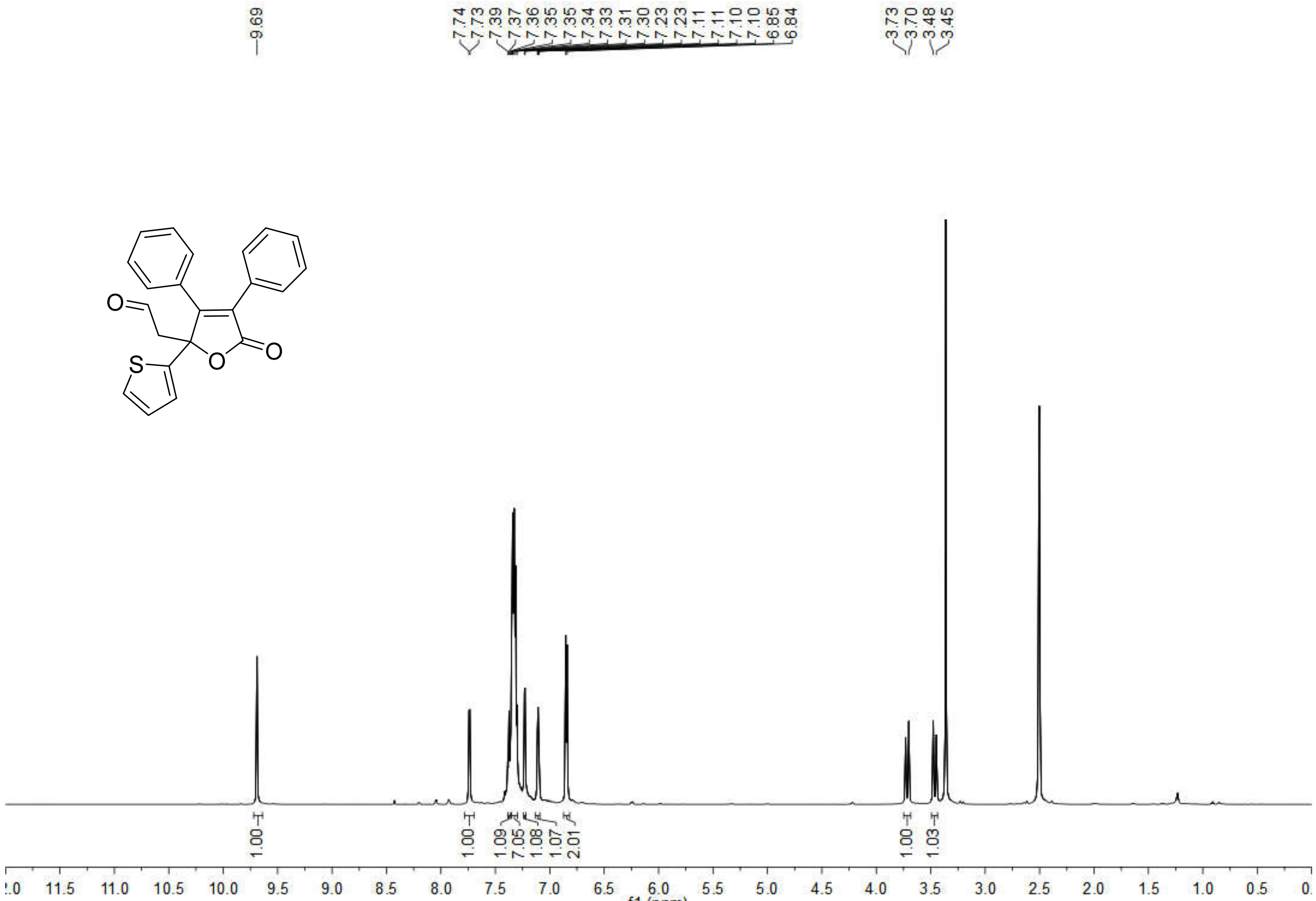


Figure S38. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3q**

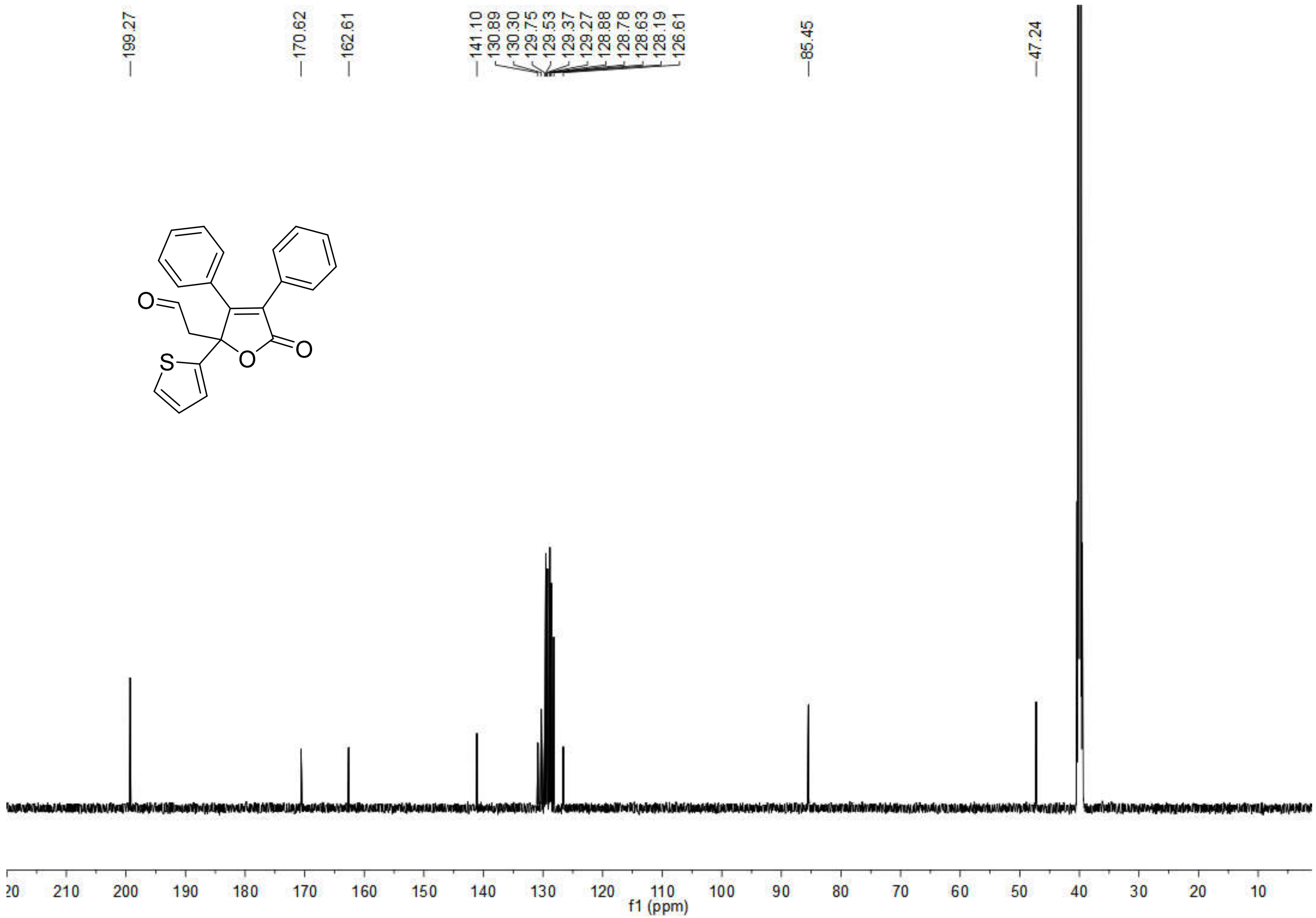


Figure S39. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3q**

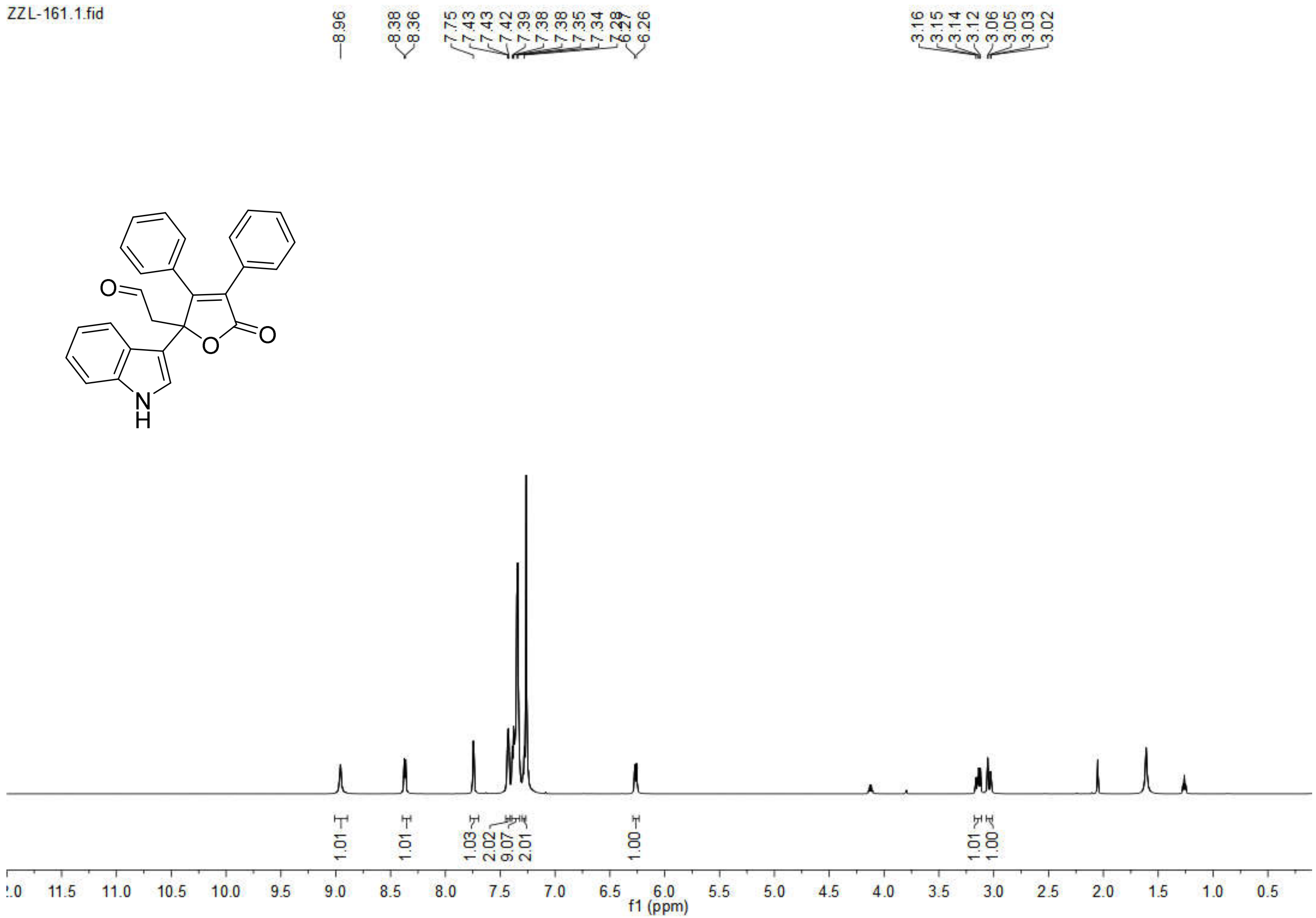


Figure S40. [1]H NMR (600 MHz, $CDCl_3$) spectra of compound **3r**

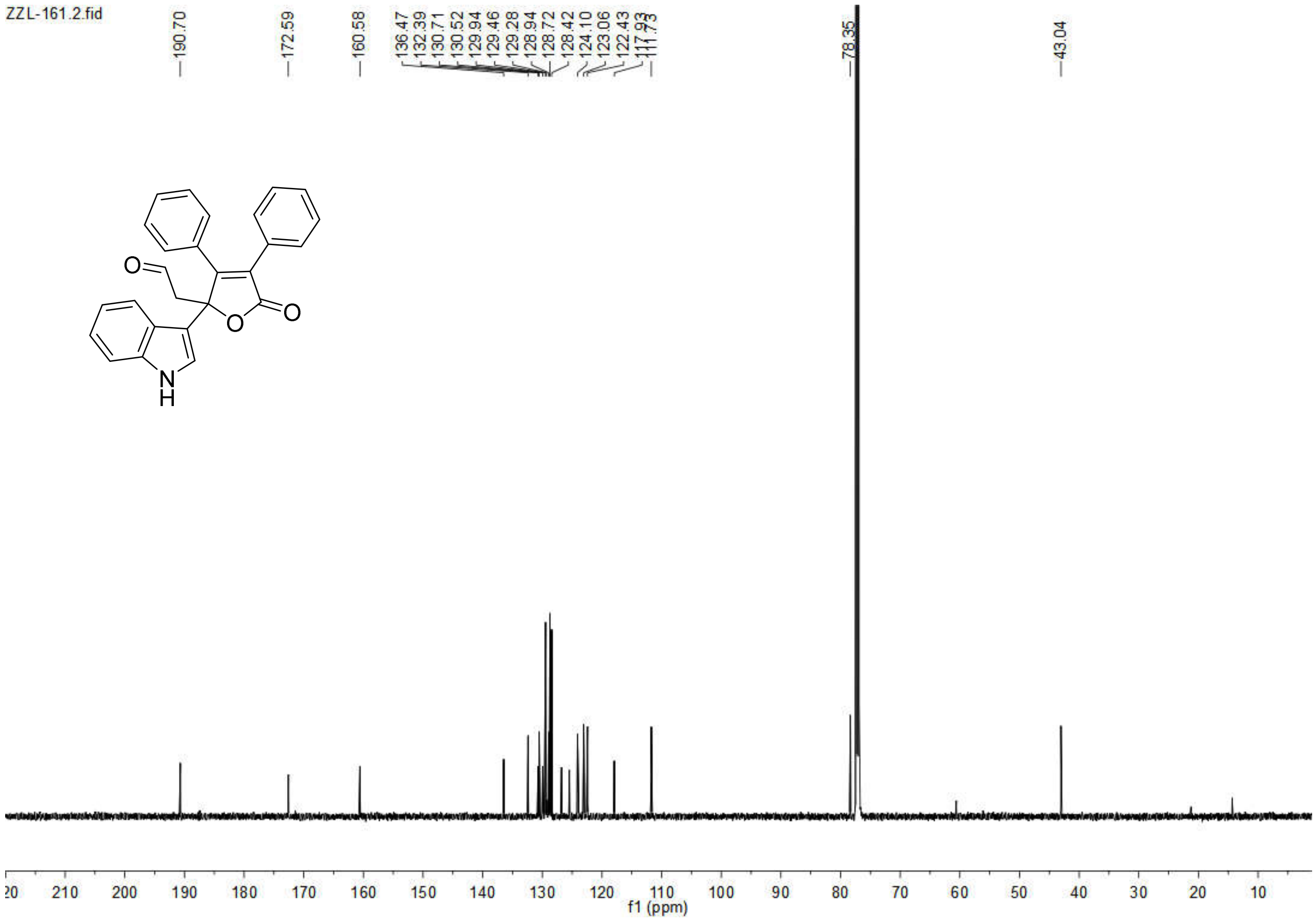


Figure S41. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **3r**

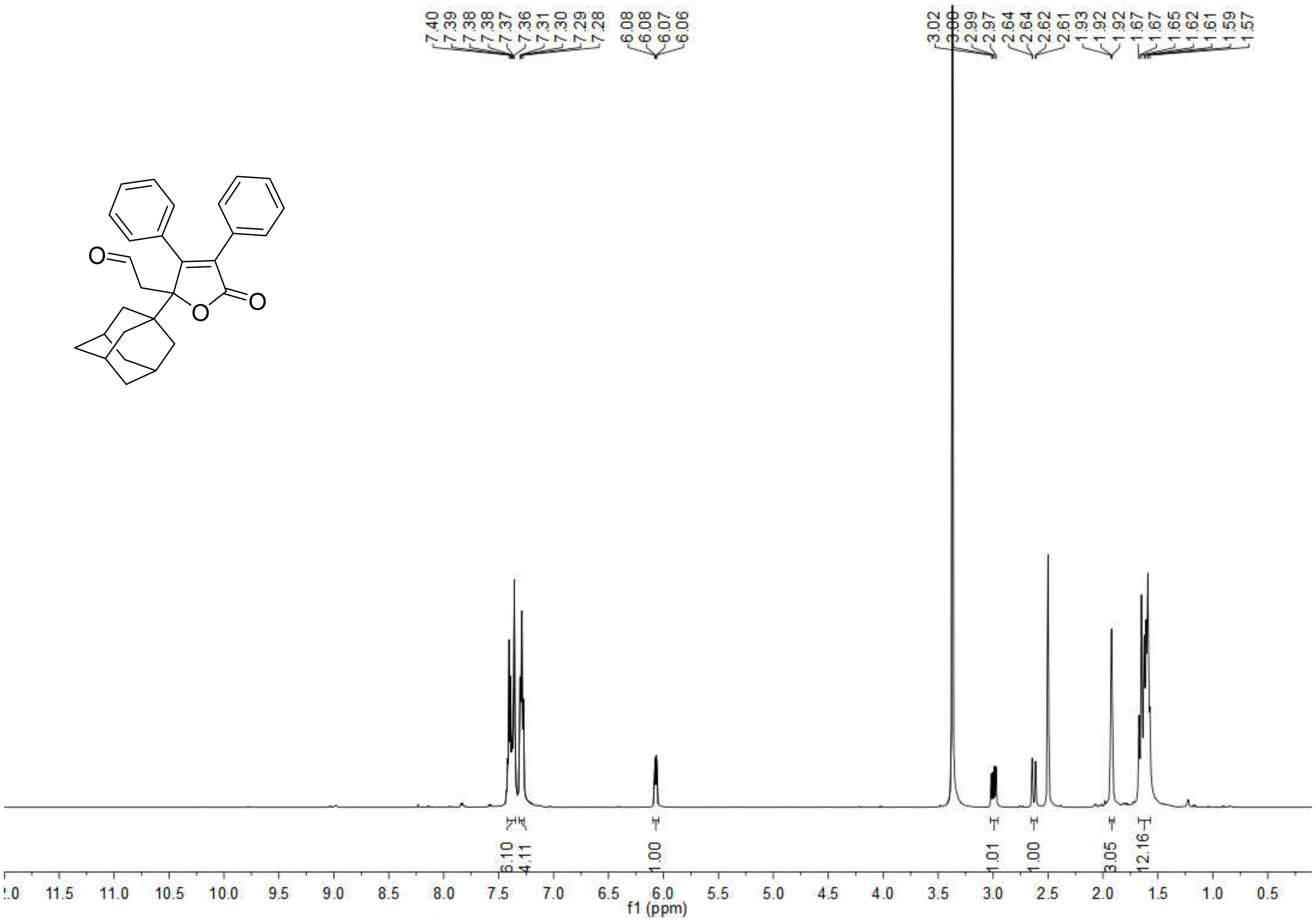


Figure S42. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3s**

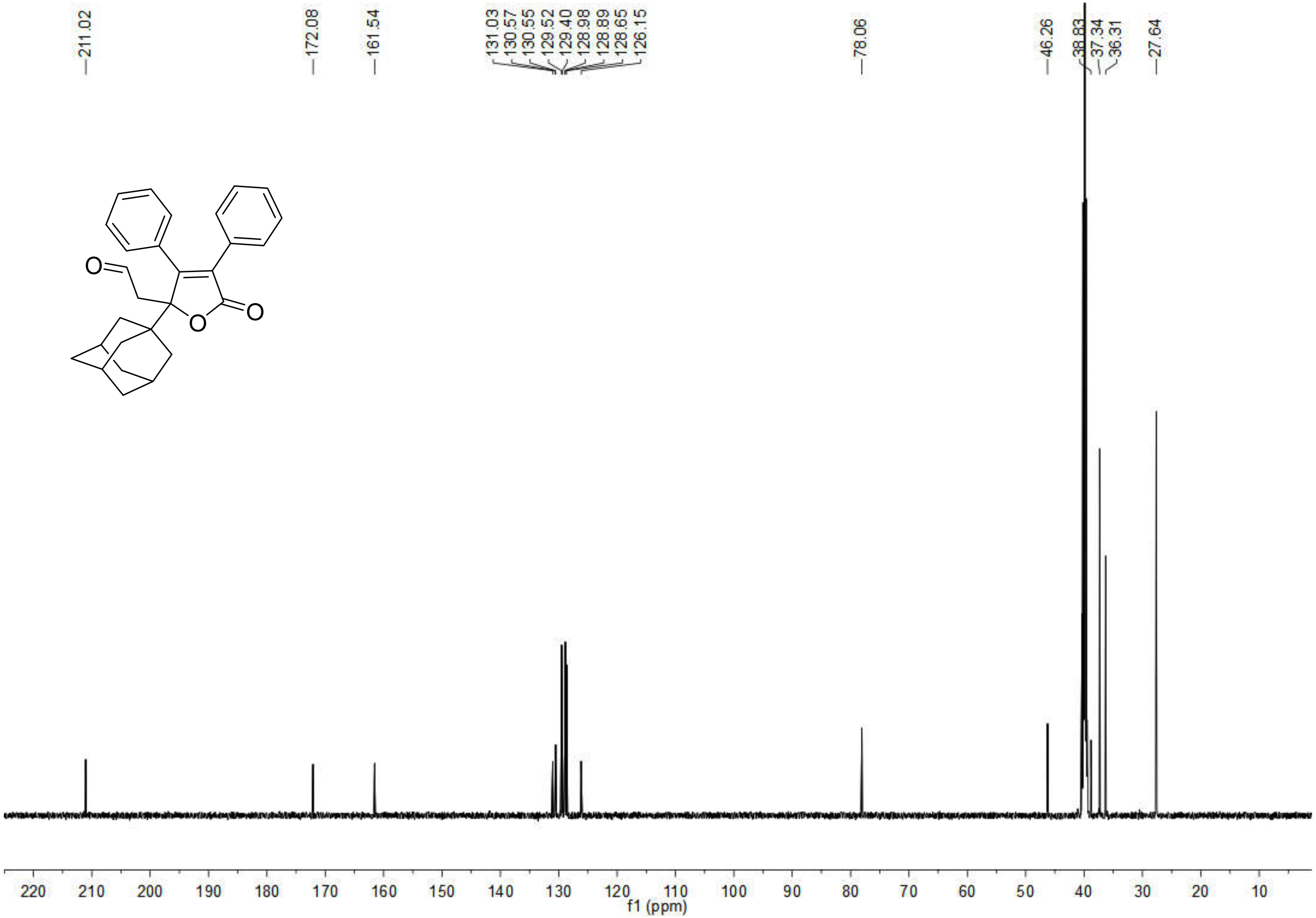


Figure S43. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3s**

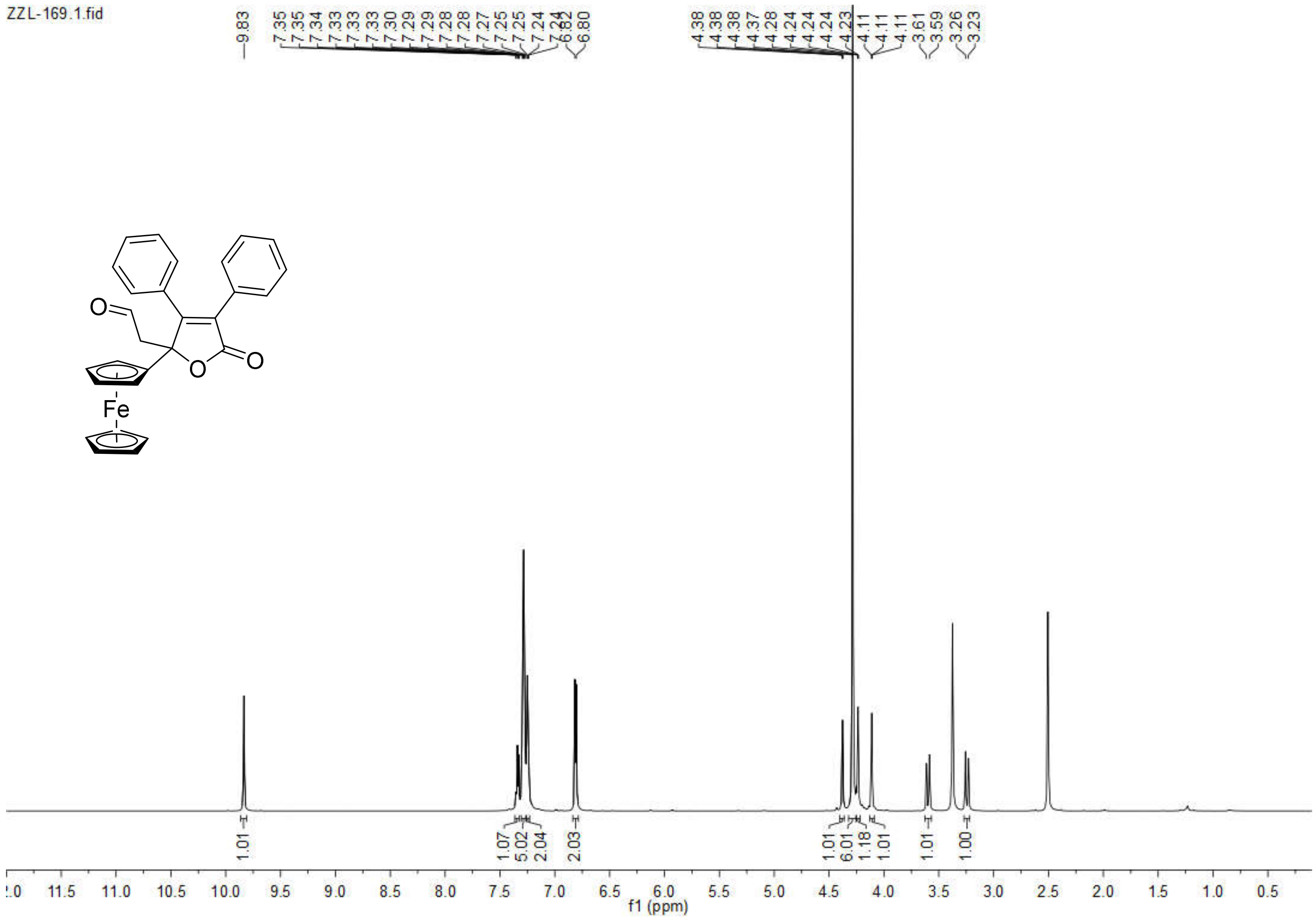


Figure S44. [1]H NMR (600 MHz, DMSO-d_6) spectra of compound **3t**

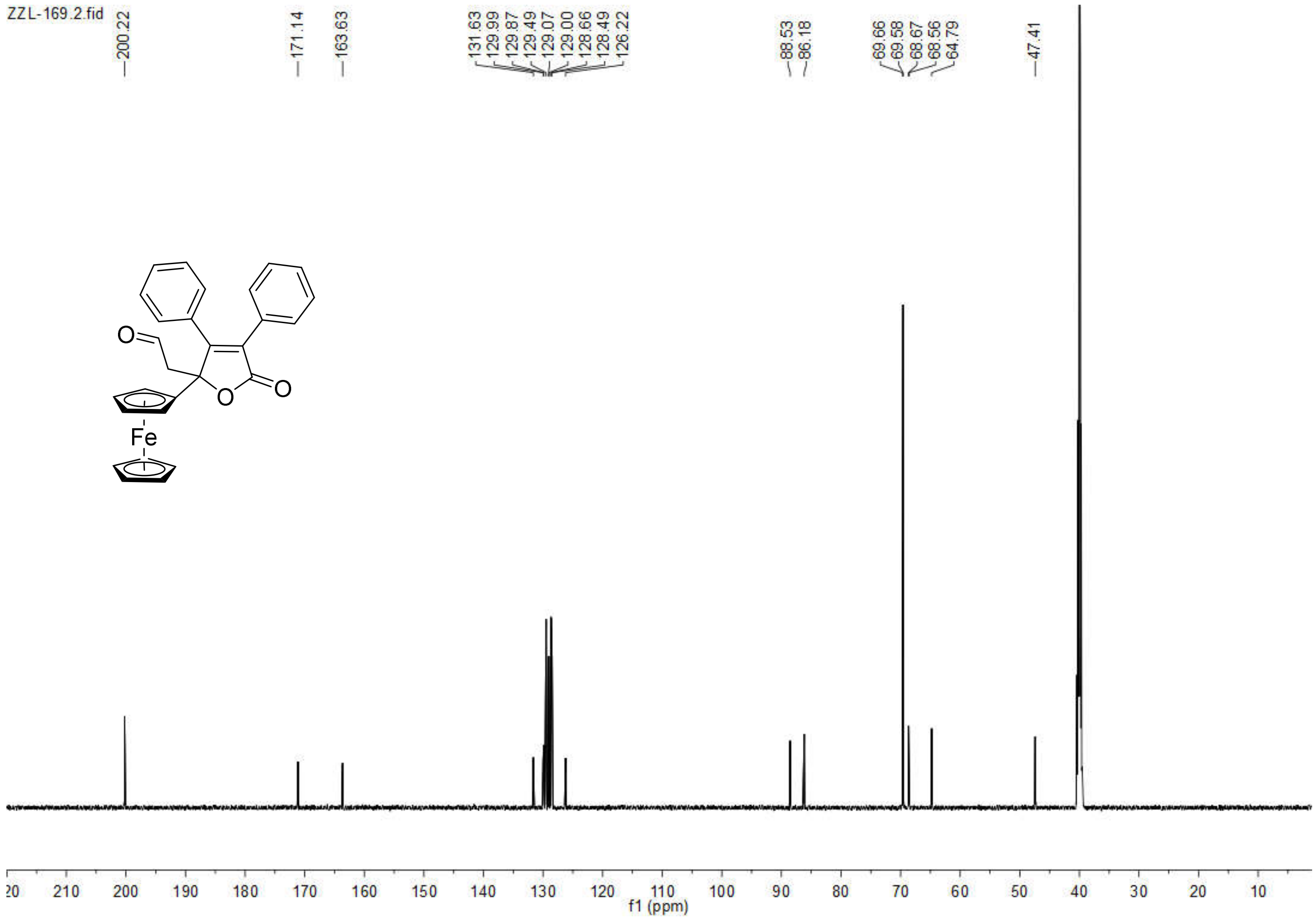


Figure S45. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3t**

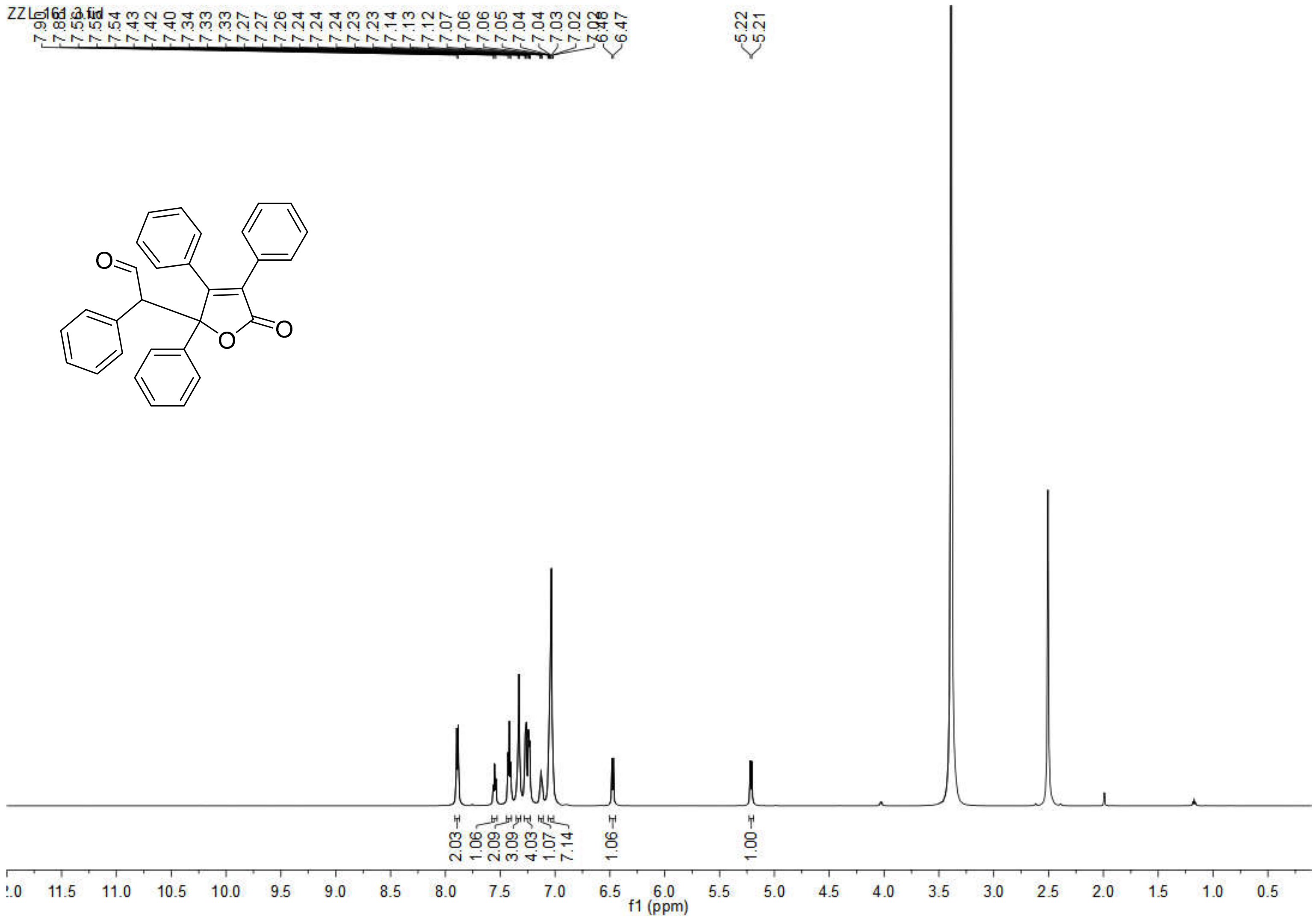


Figure S46. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3u**

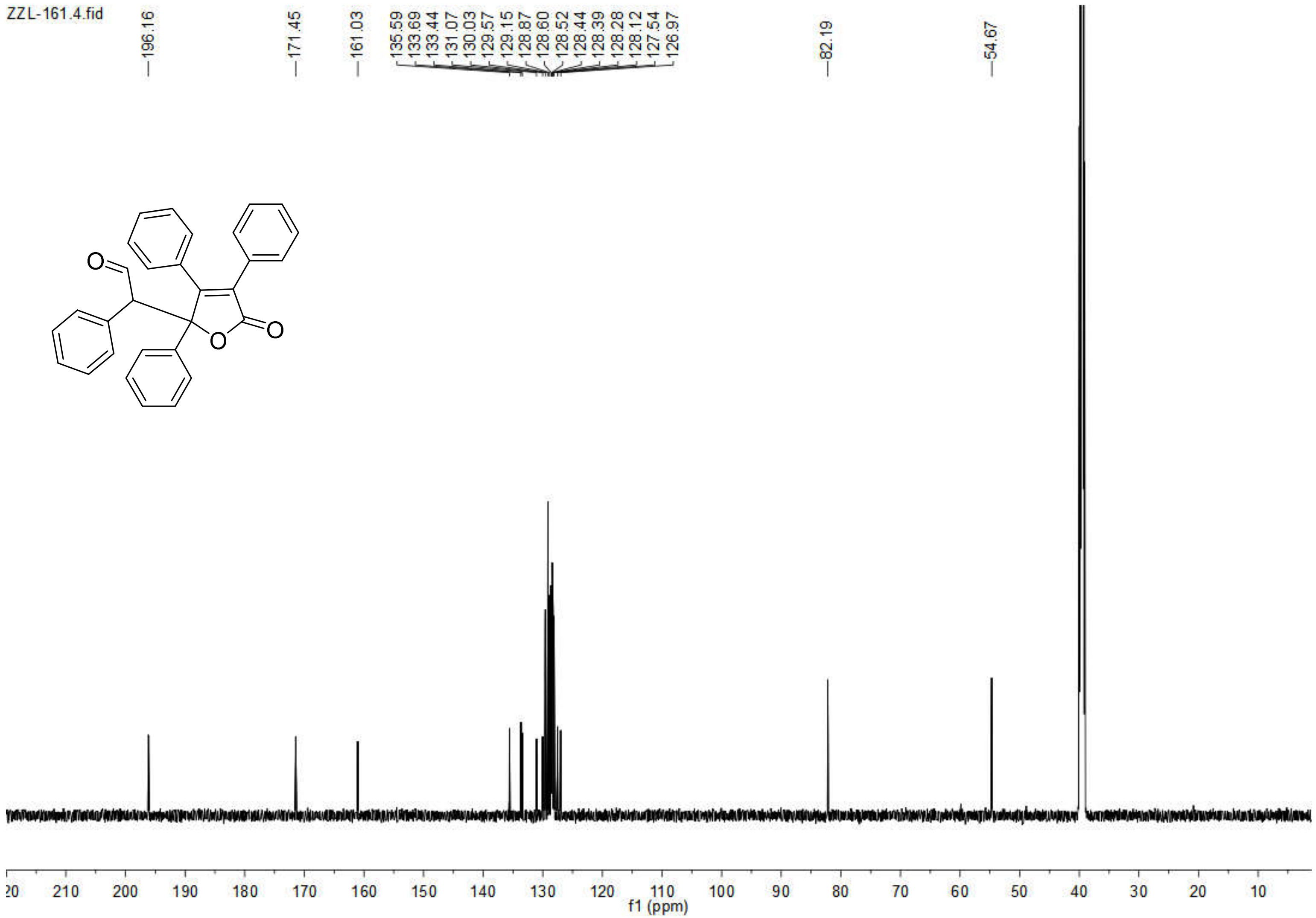


Figure S47. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3u**

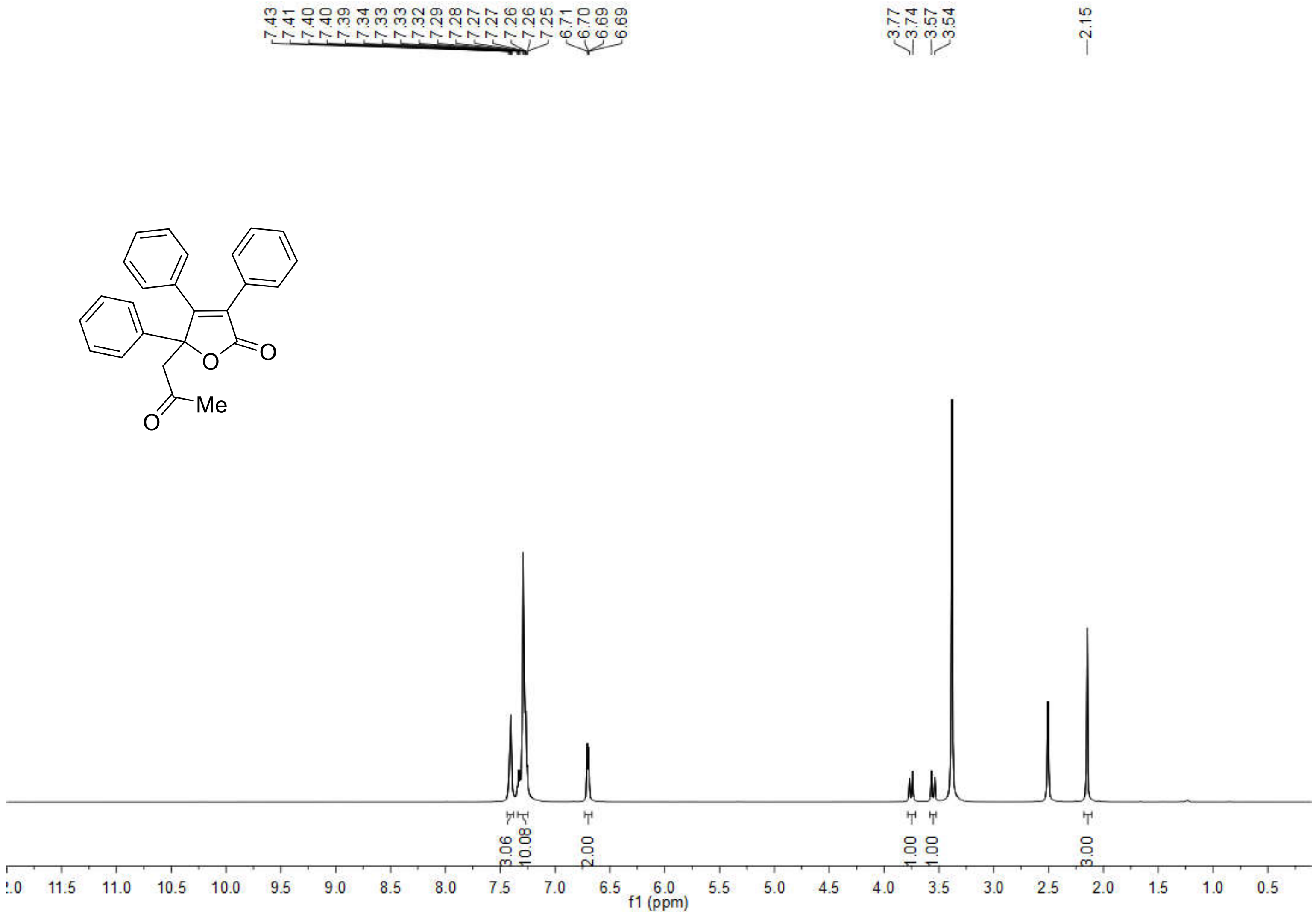


Figure S48. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3v**

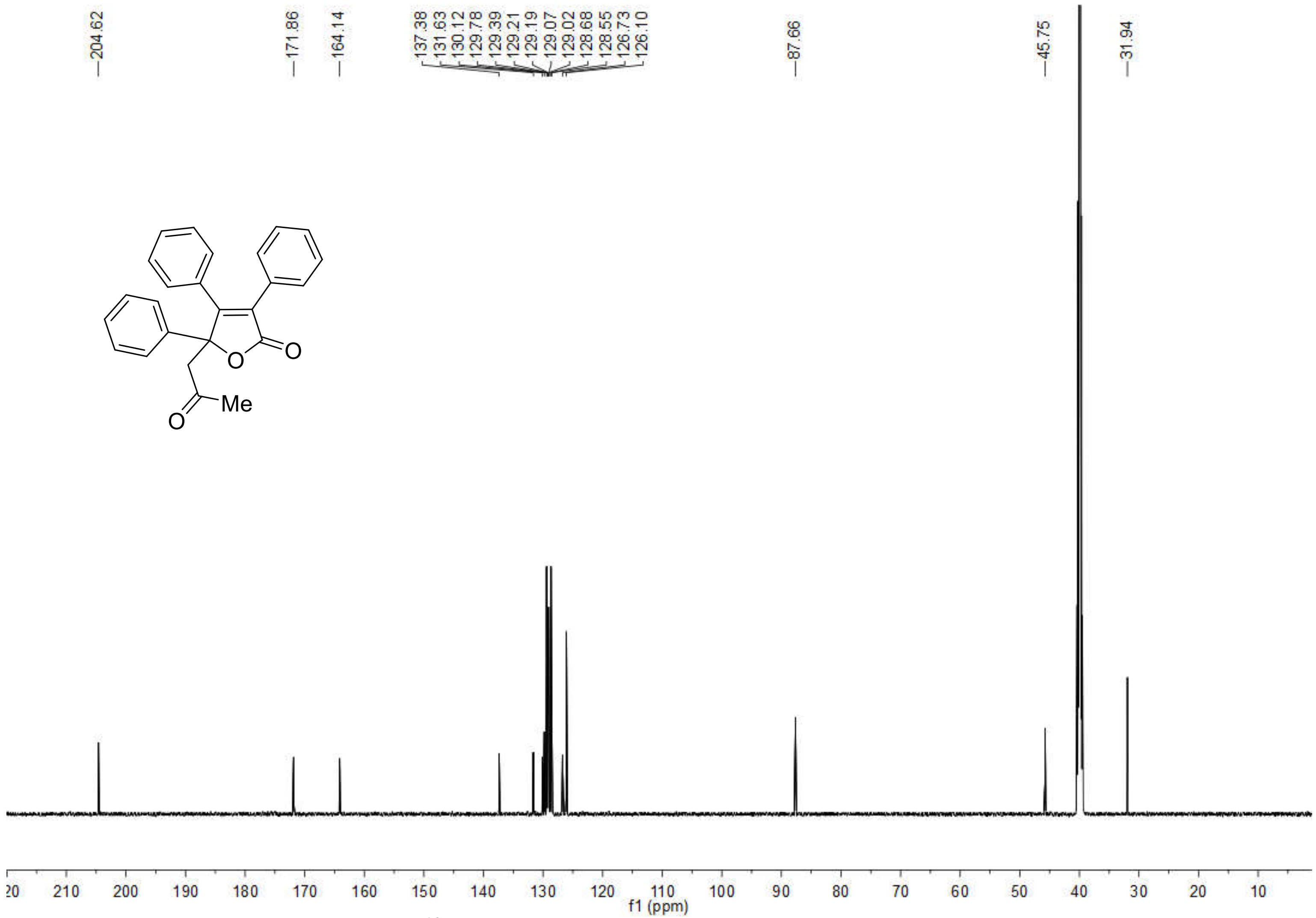


Figure S49. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3v**

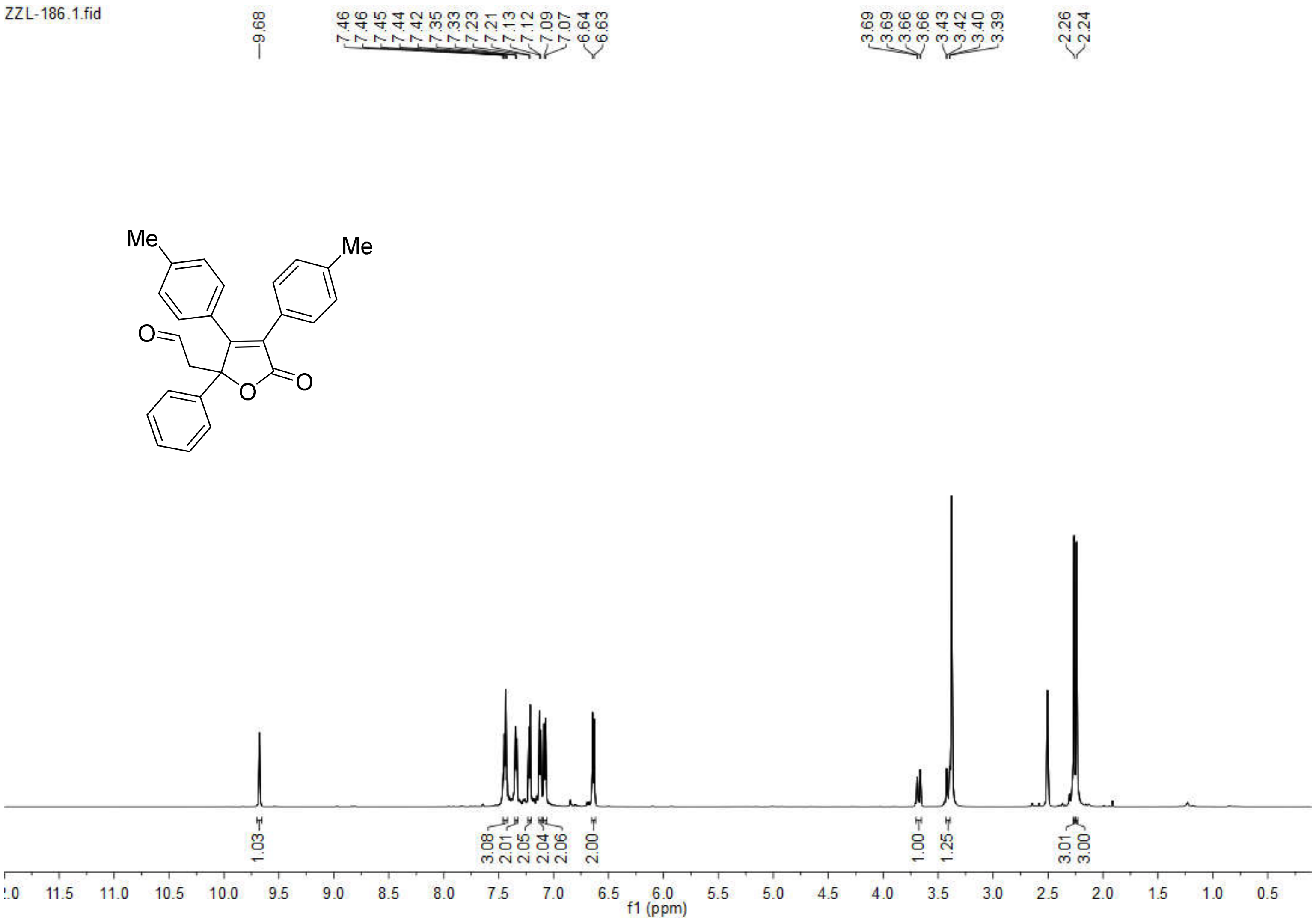


Figure S50. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3w**

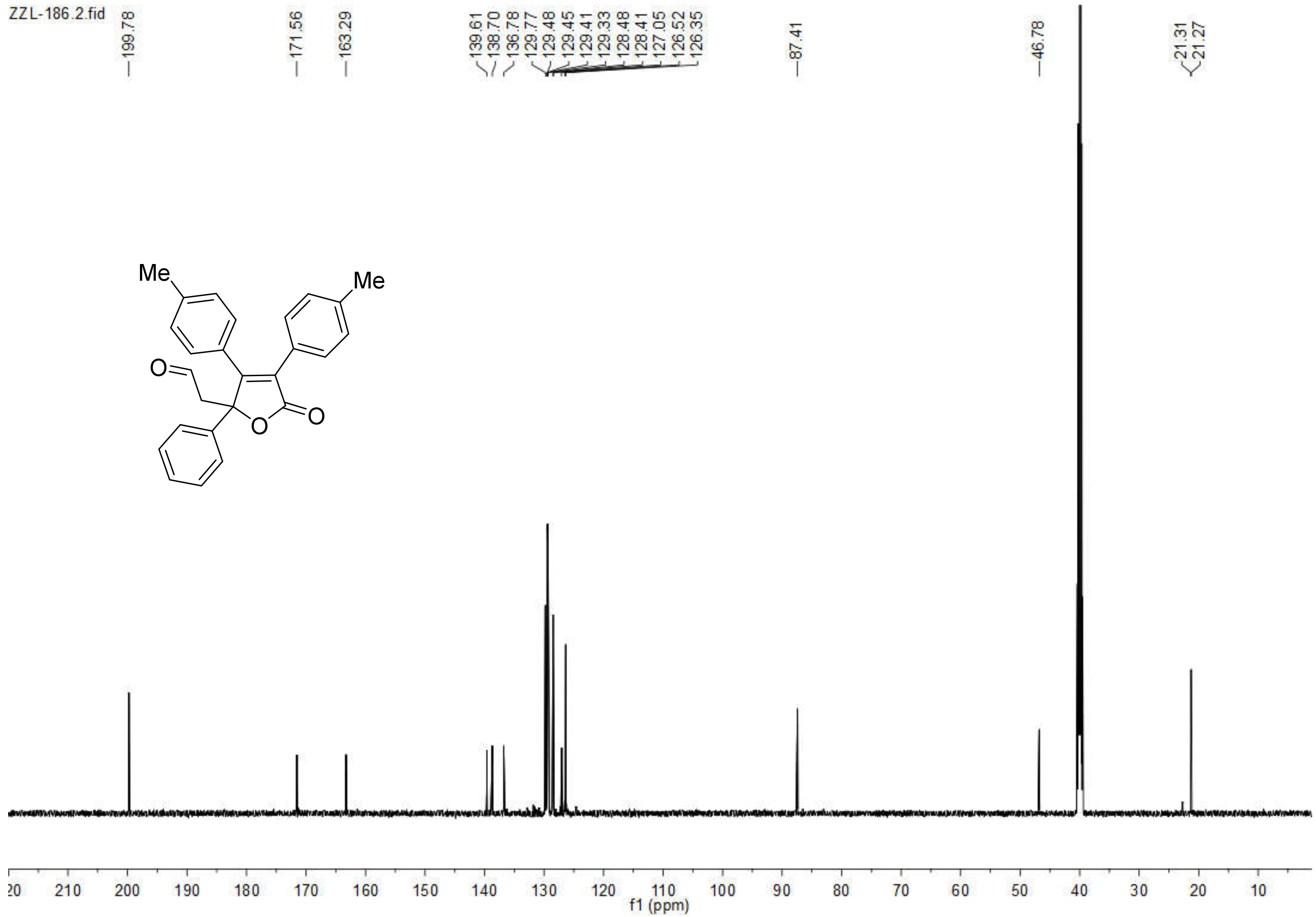


Figure S51. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3w**

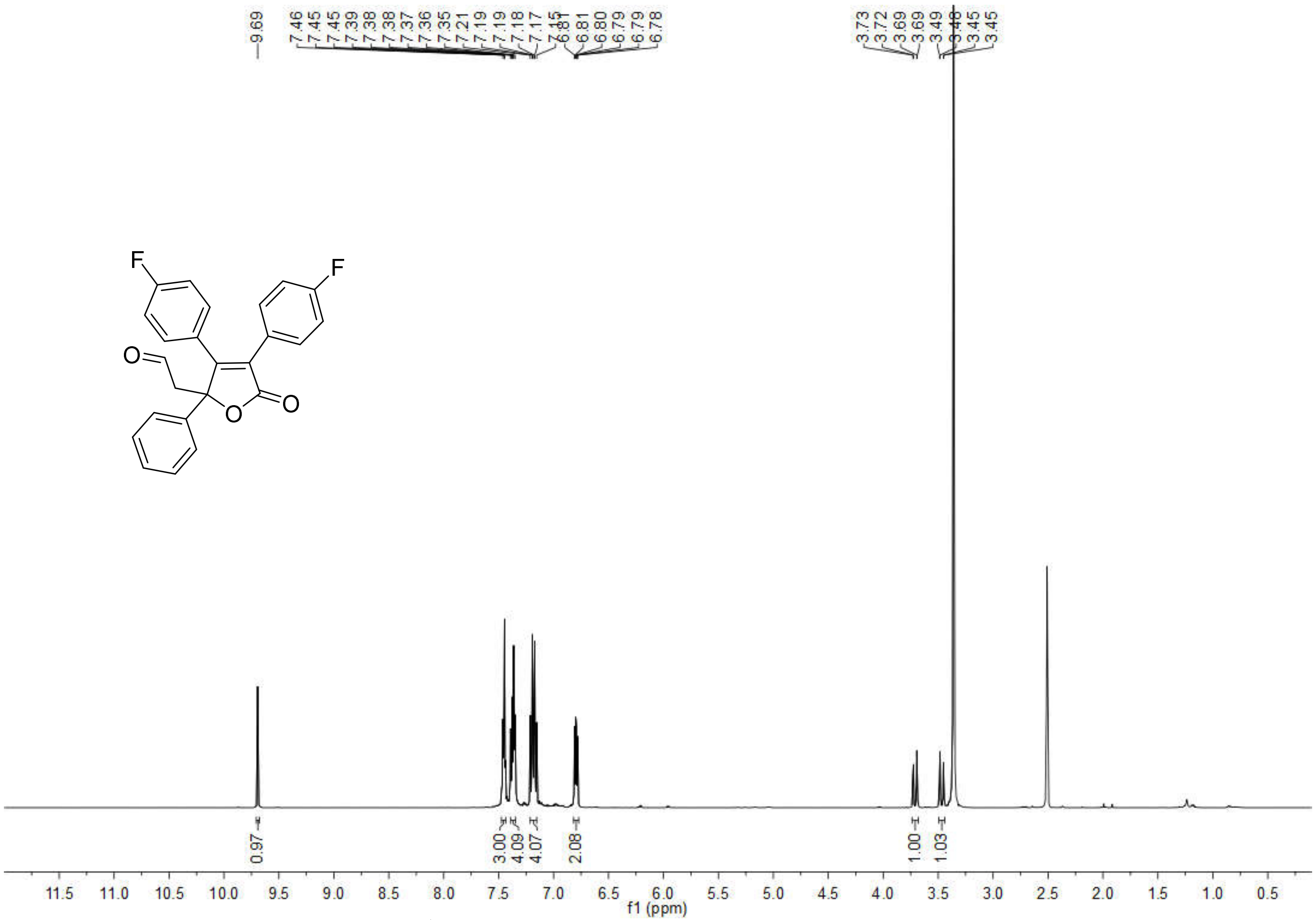


Figure S52. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3x**

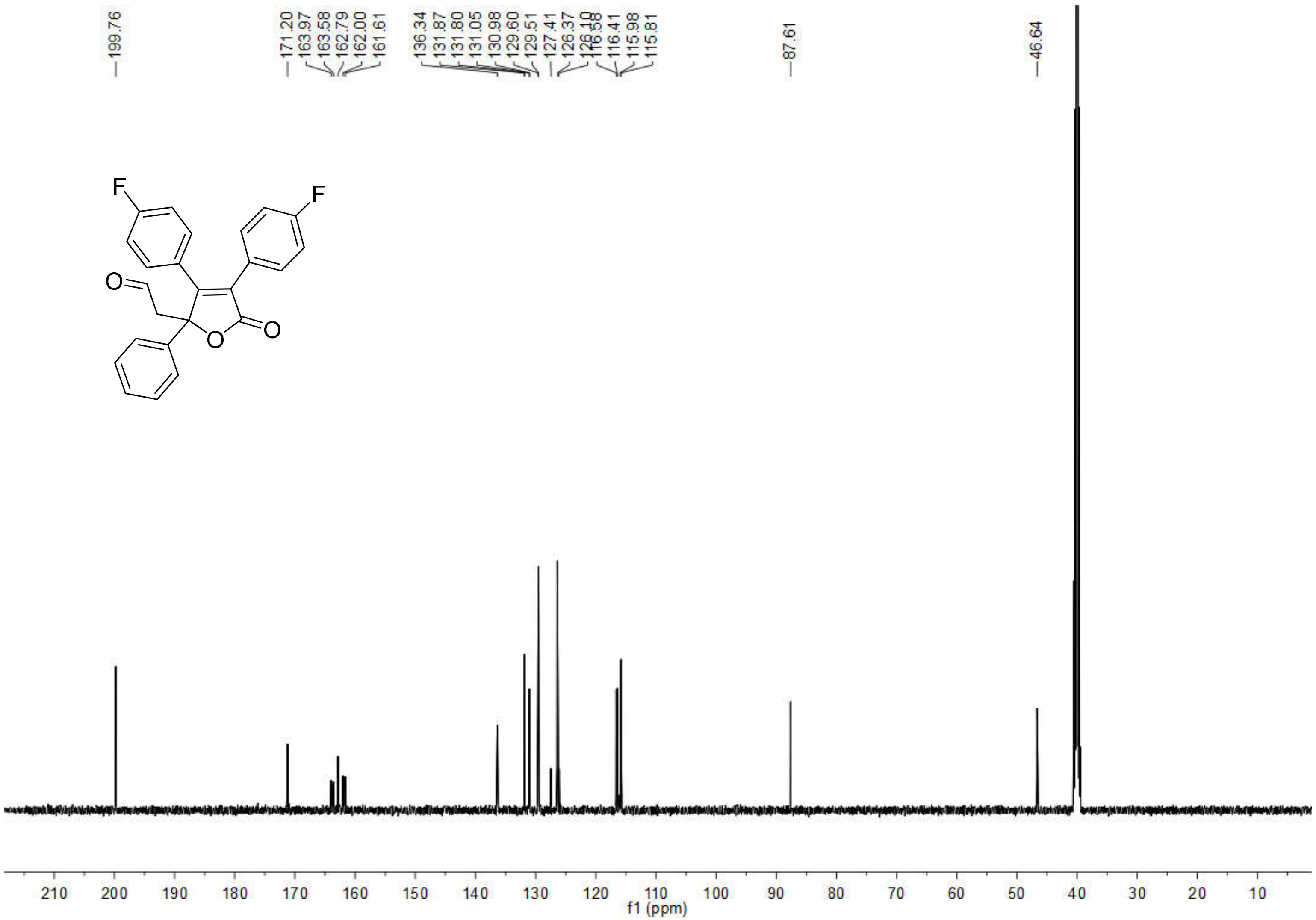


Figure S53. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3x**

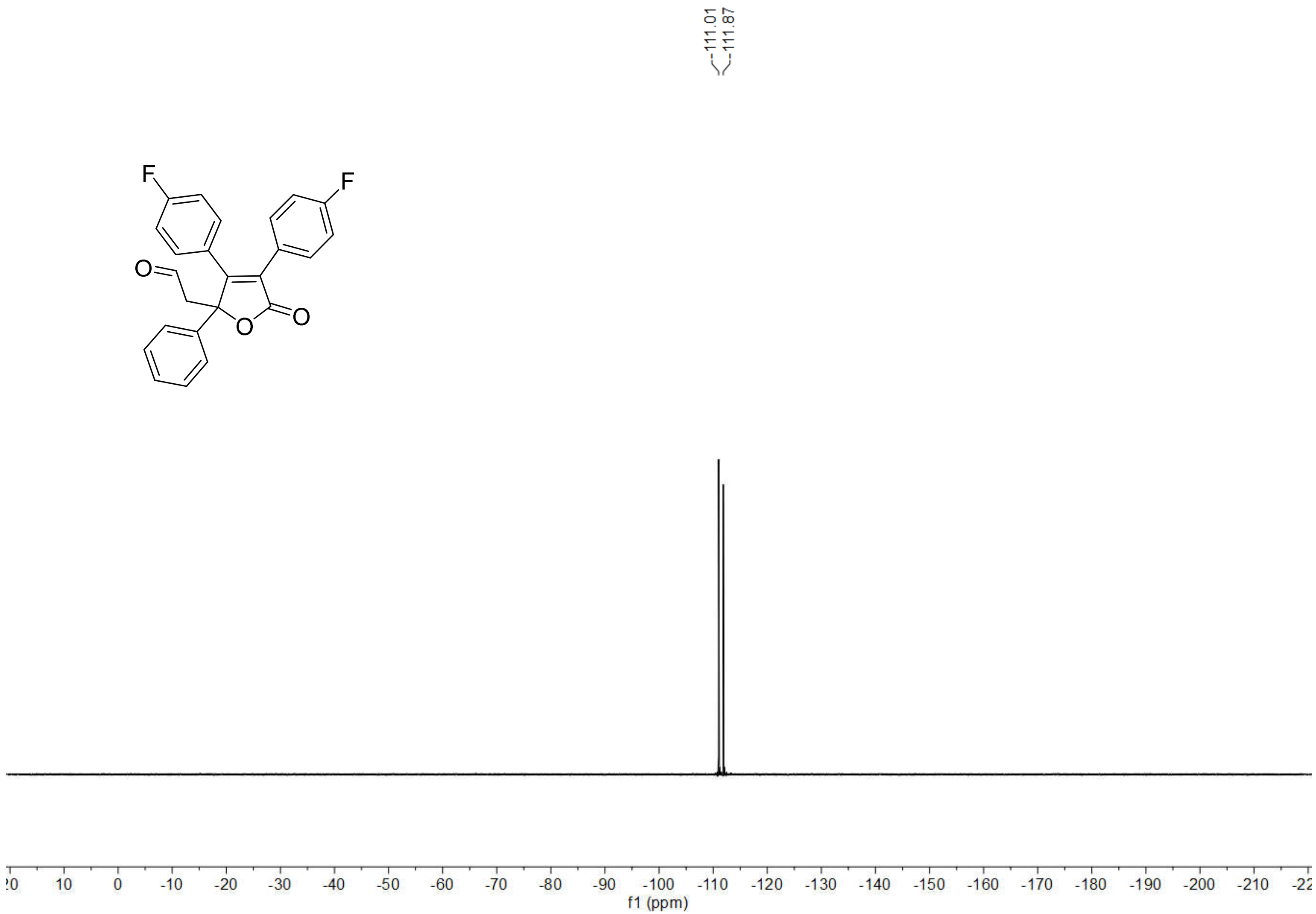


Figure S54. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3x**

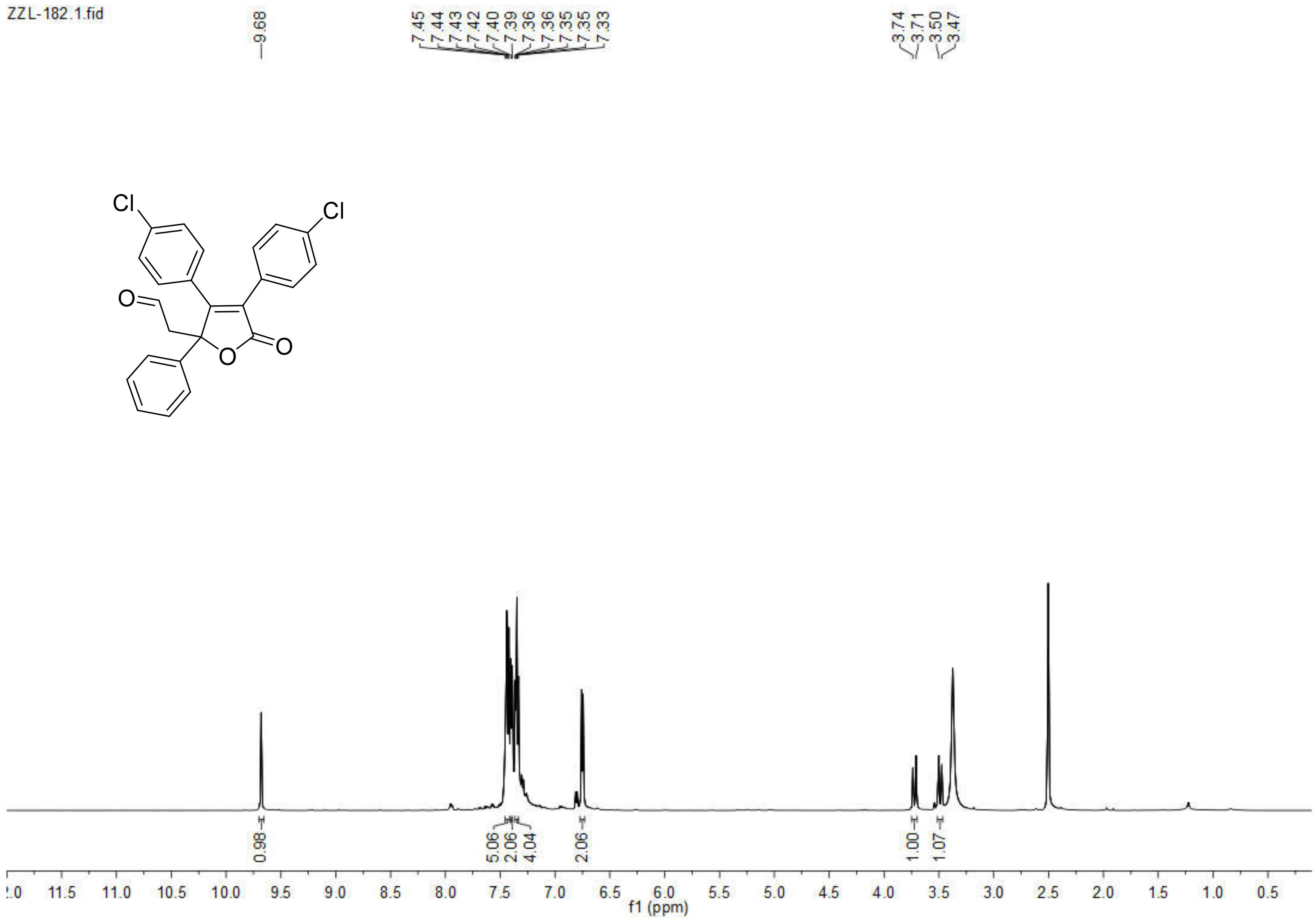


Figure S55. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3y**

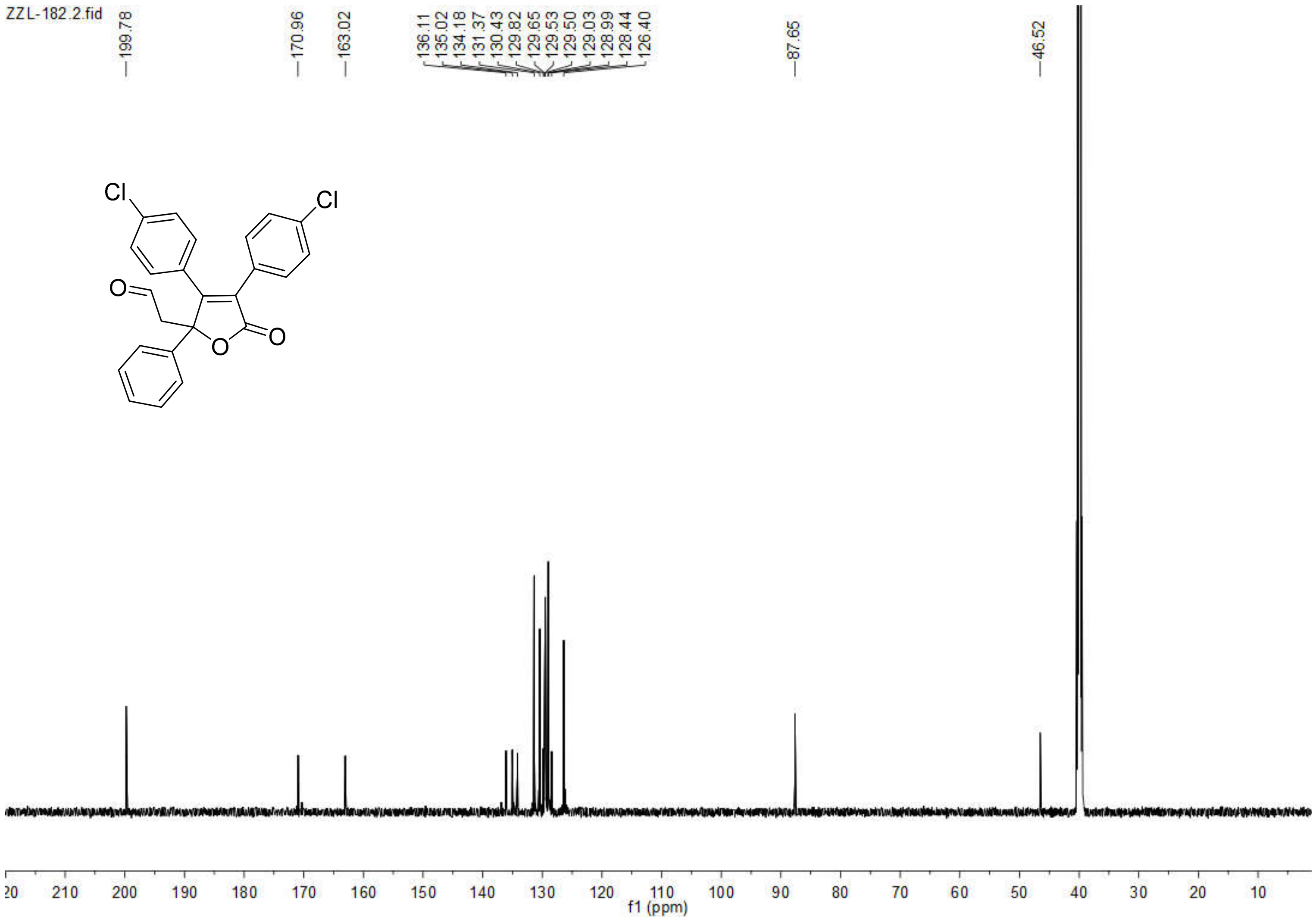


Figure S56. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3y**

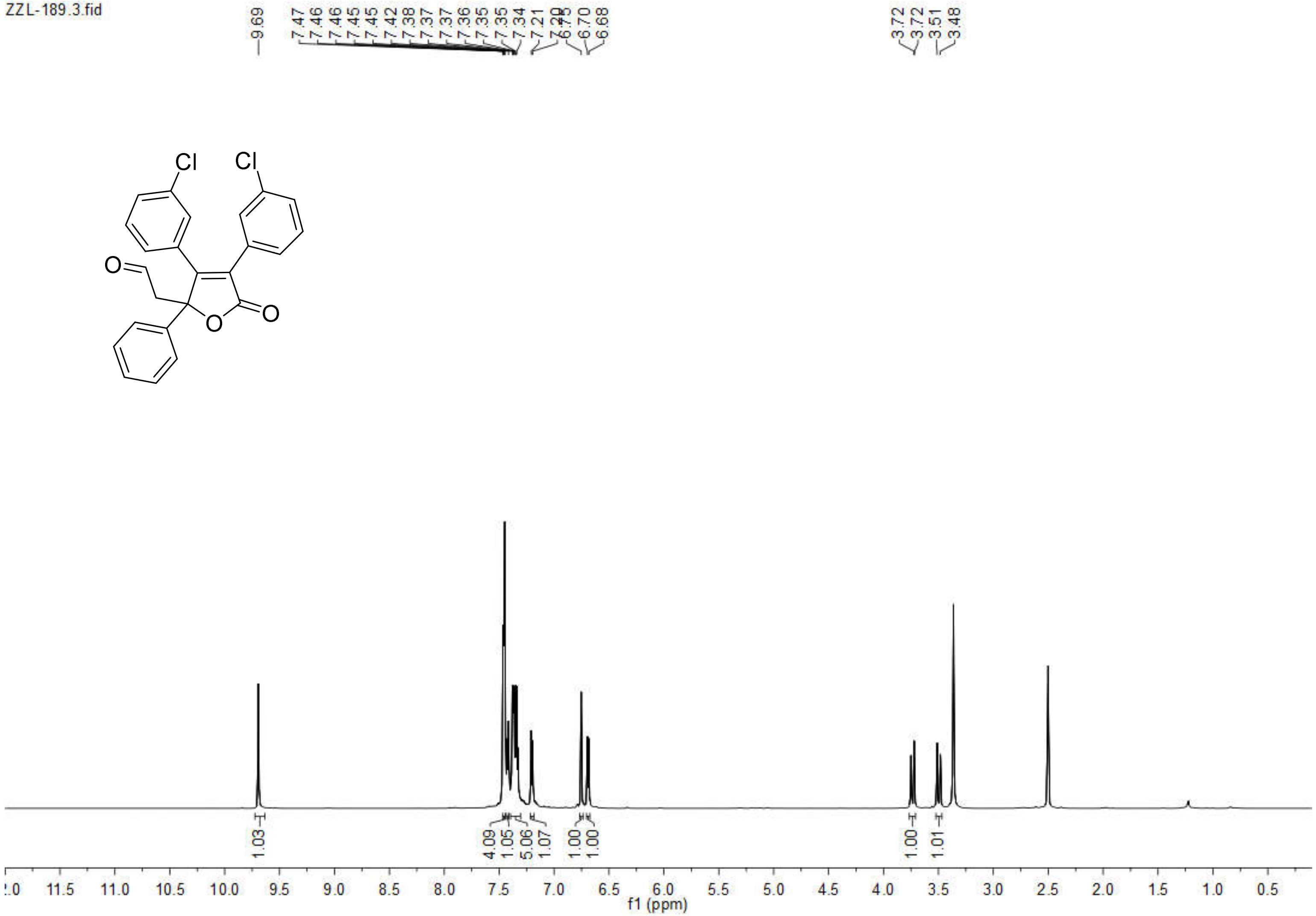


Figure S57. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3z**

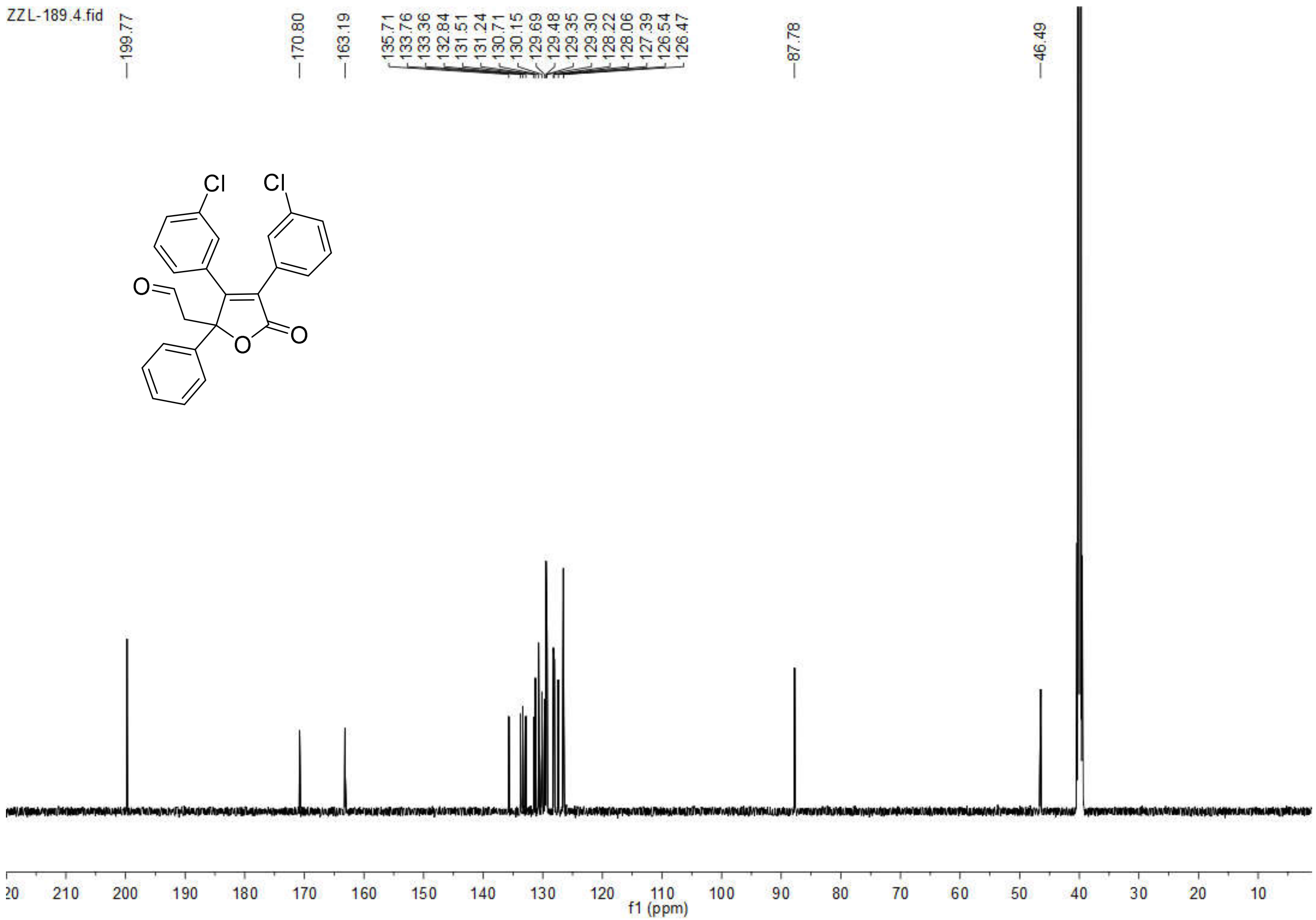


Figure S58. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3z**

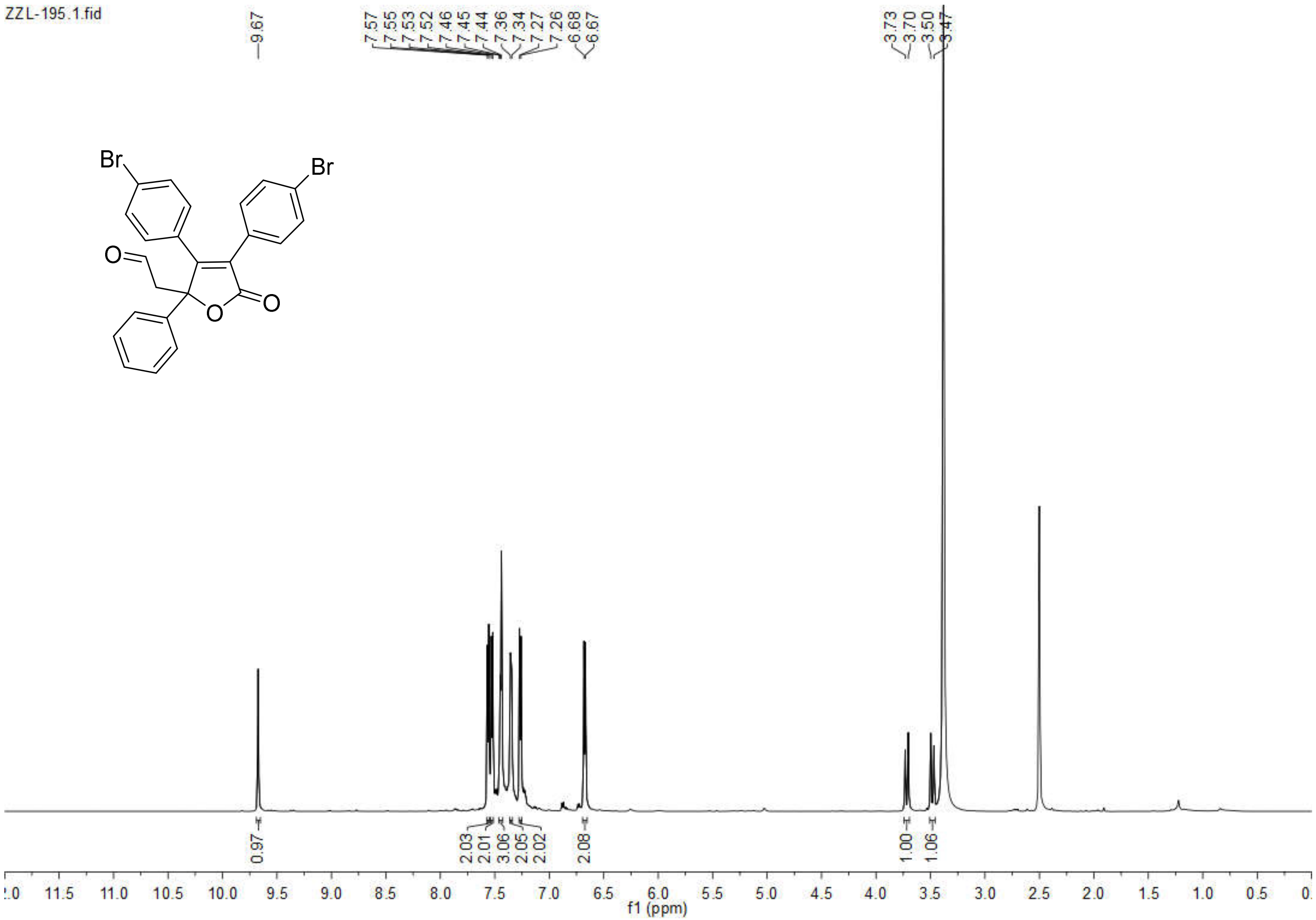


Figure S59. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3a'**

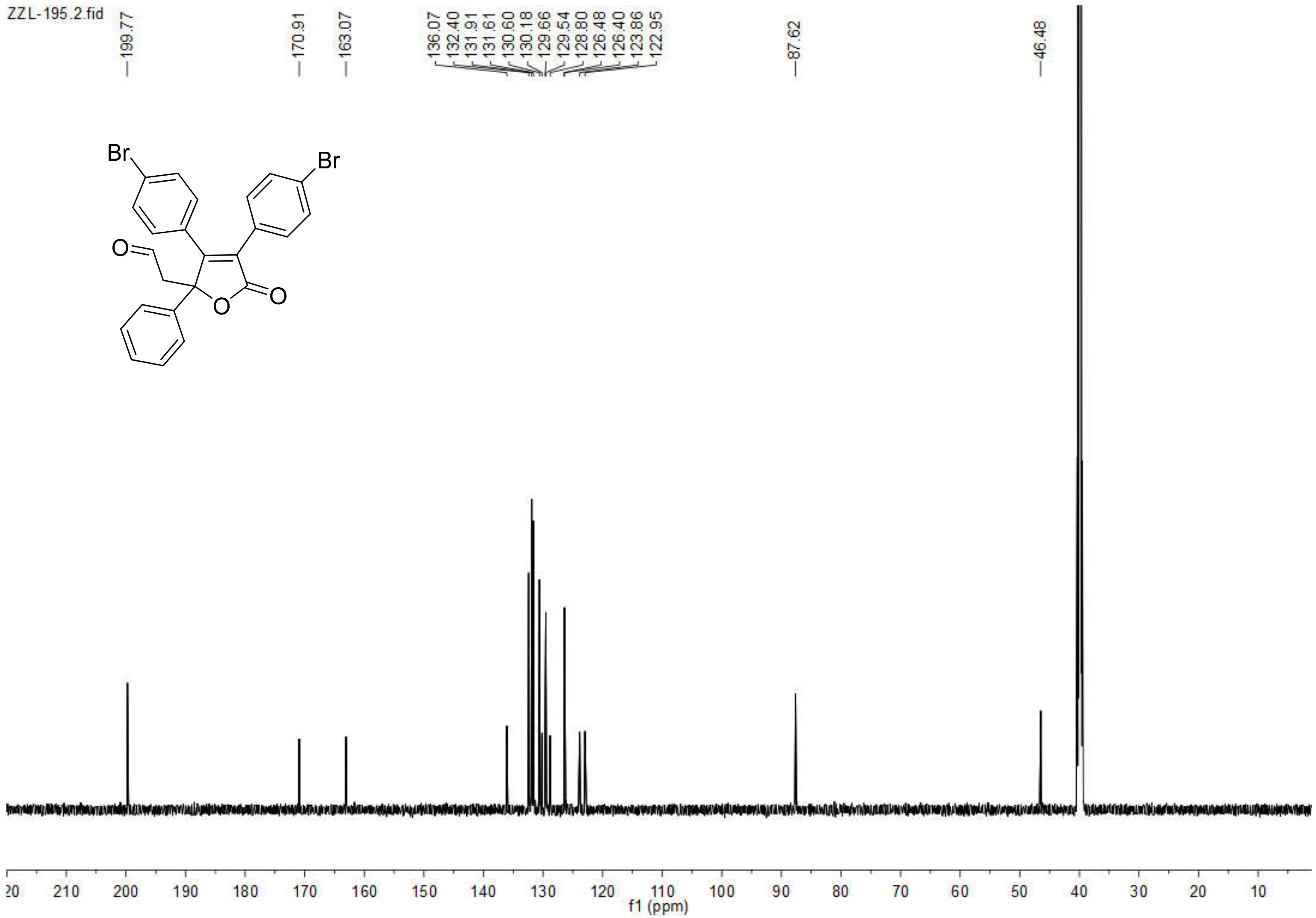


Figure S60. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3a'**

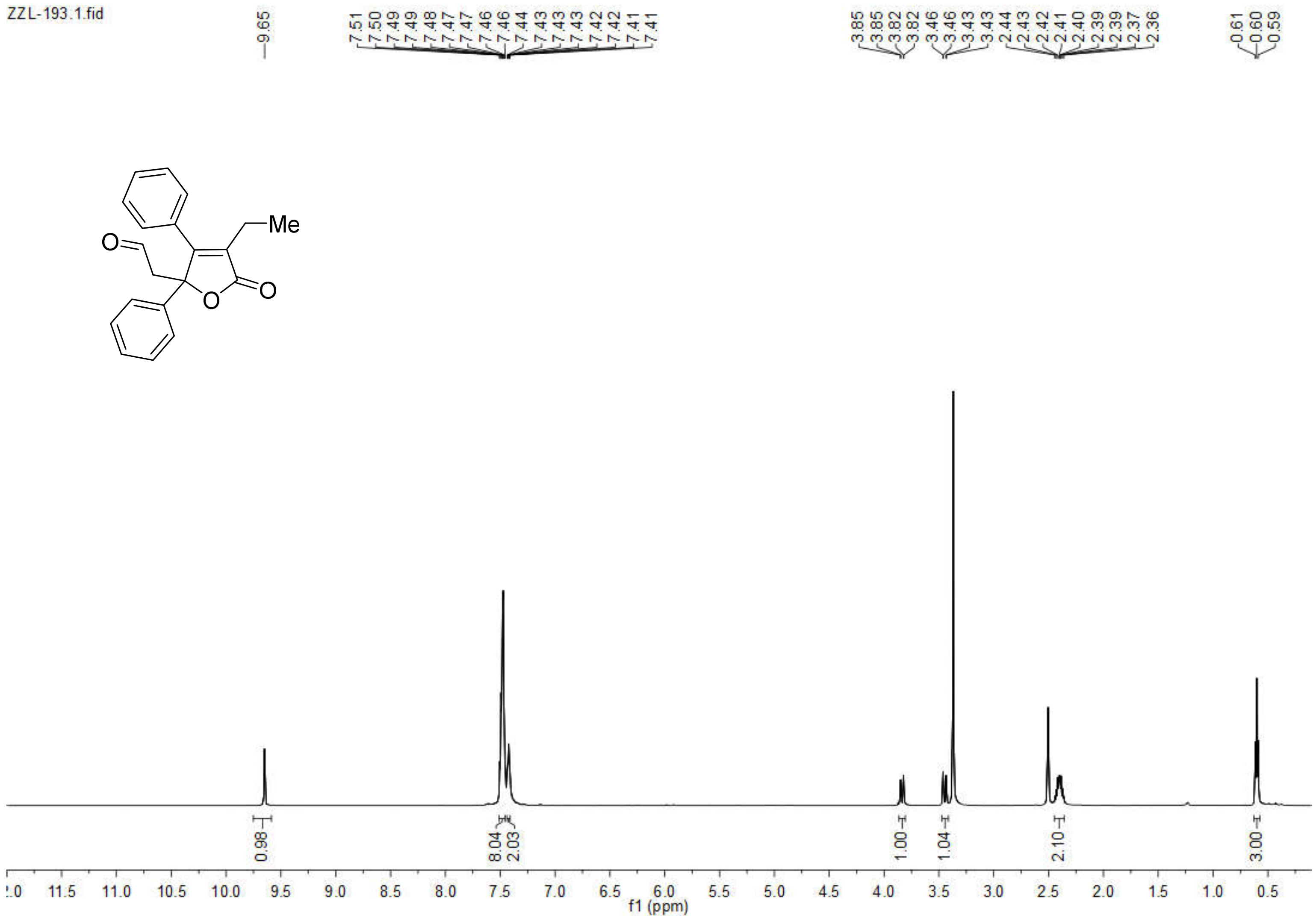


Figure S61. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3b'**

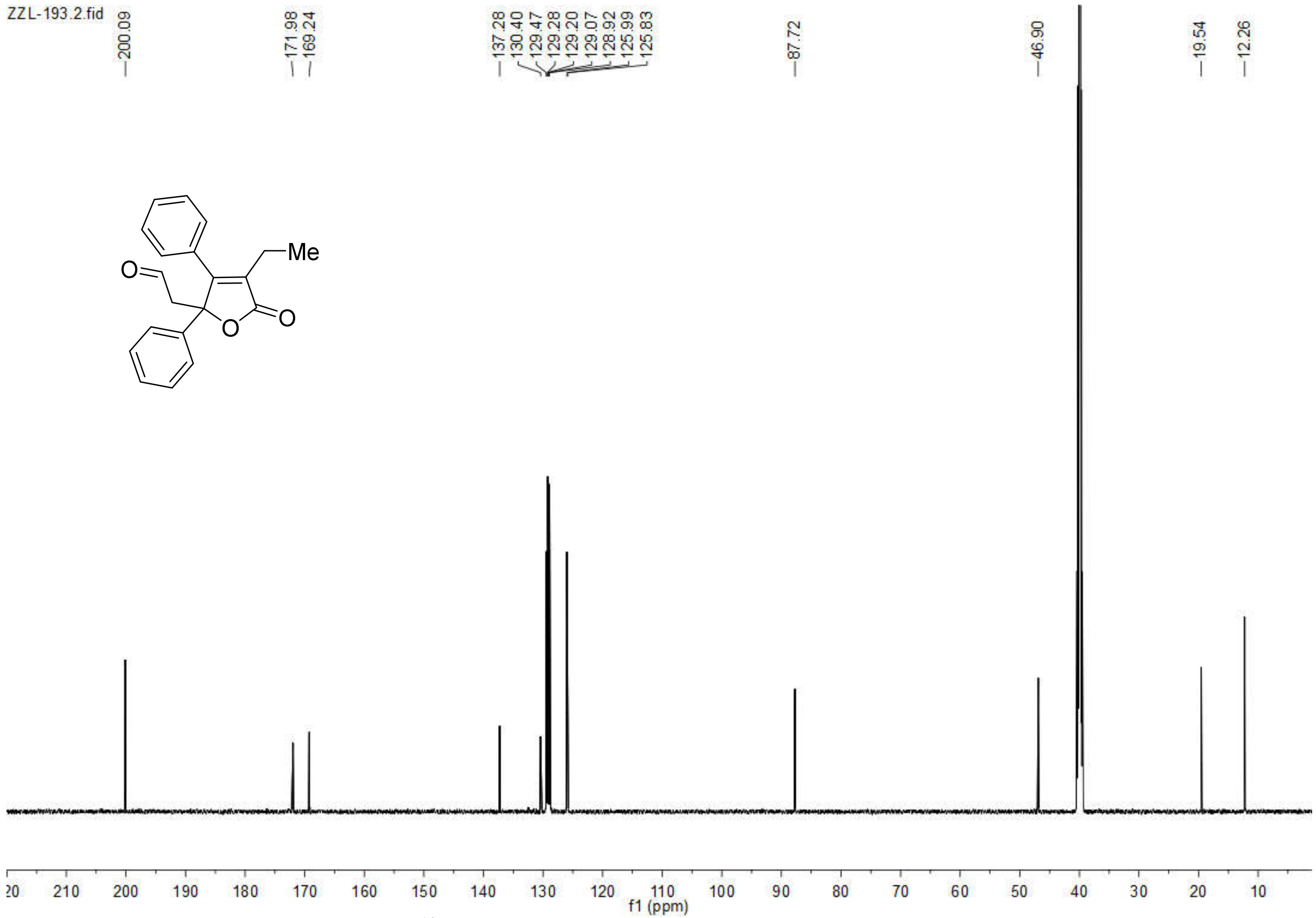


Figure S62. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3b'**

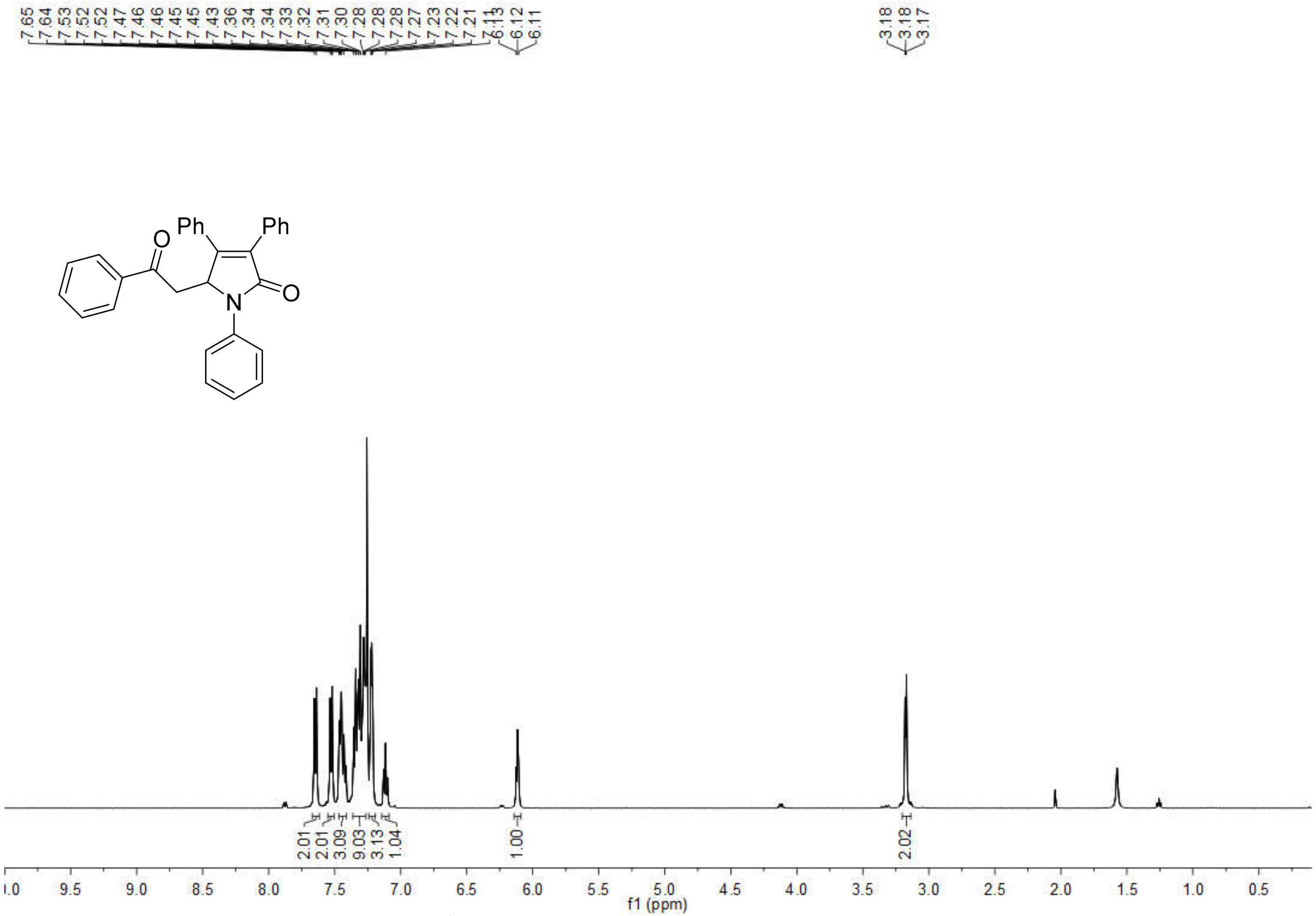


Figure S63. ¹H NMR (500 MHz, $CDCl_3$) spectra of compound **5a**

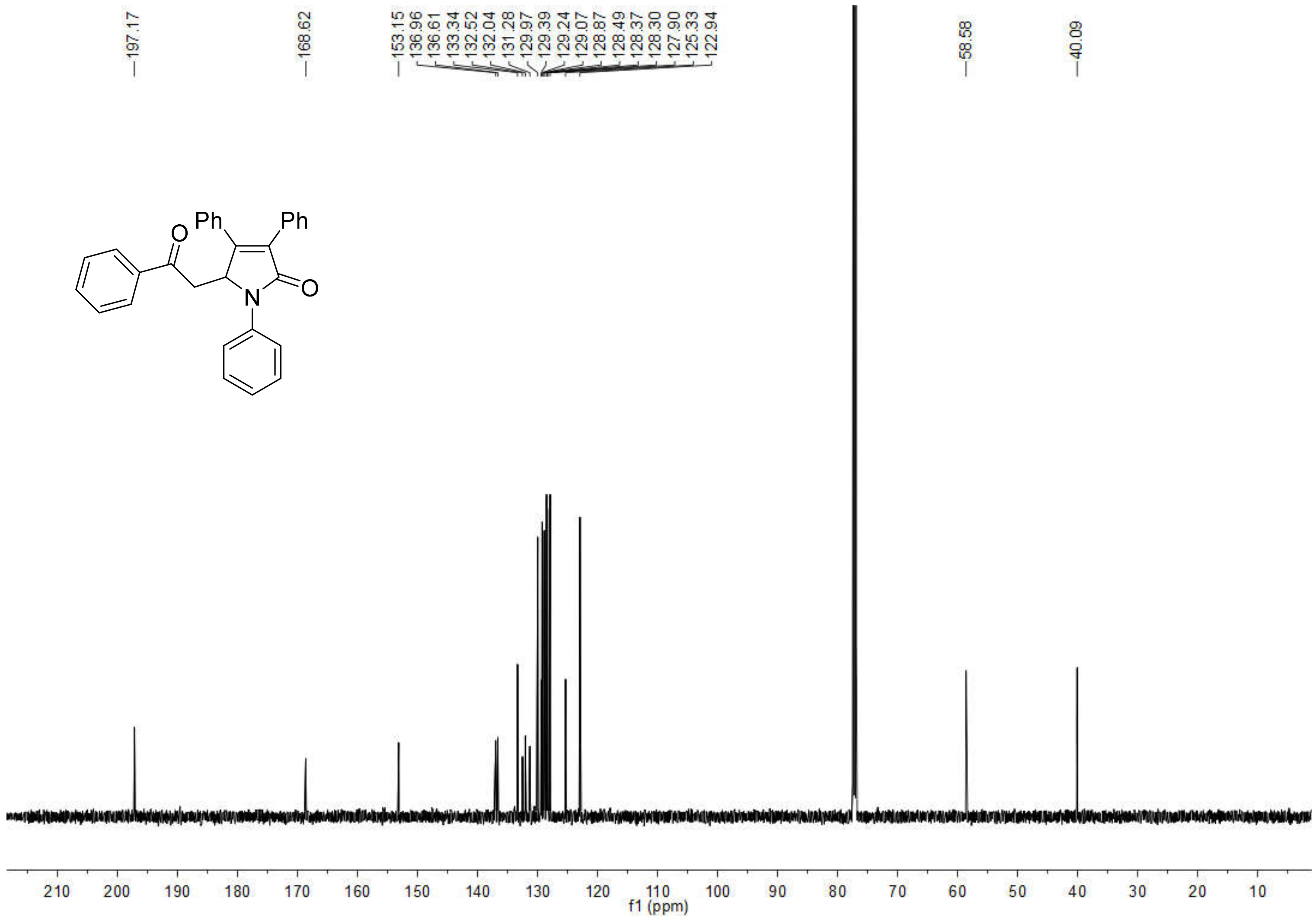


Figure S64. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5a**

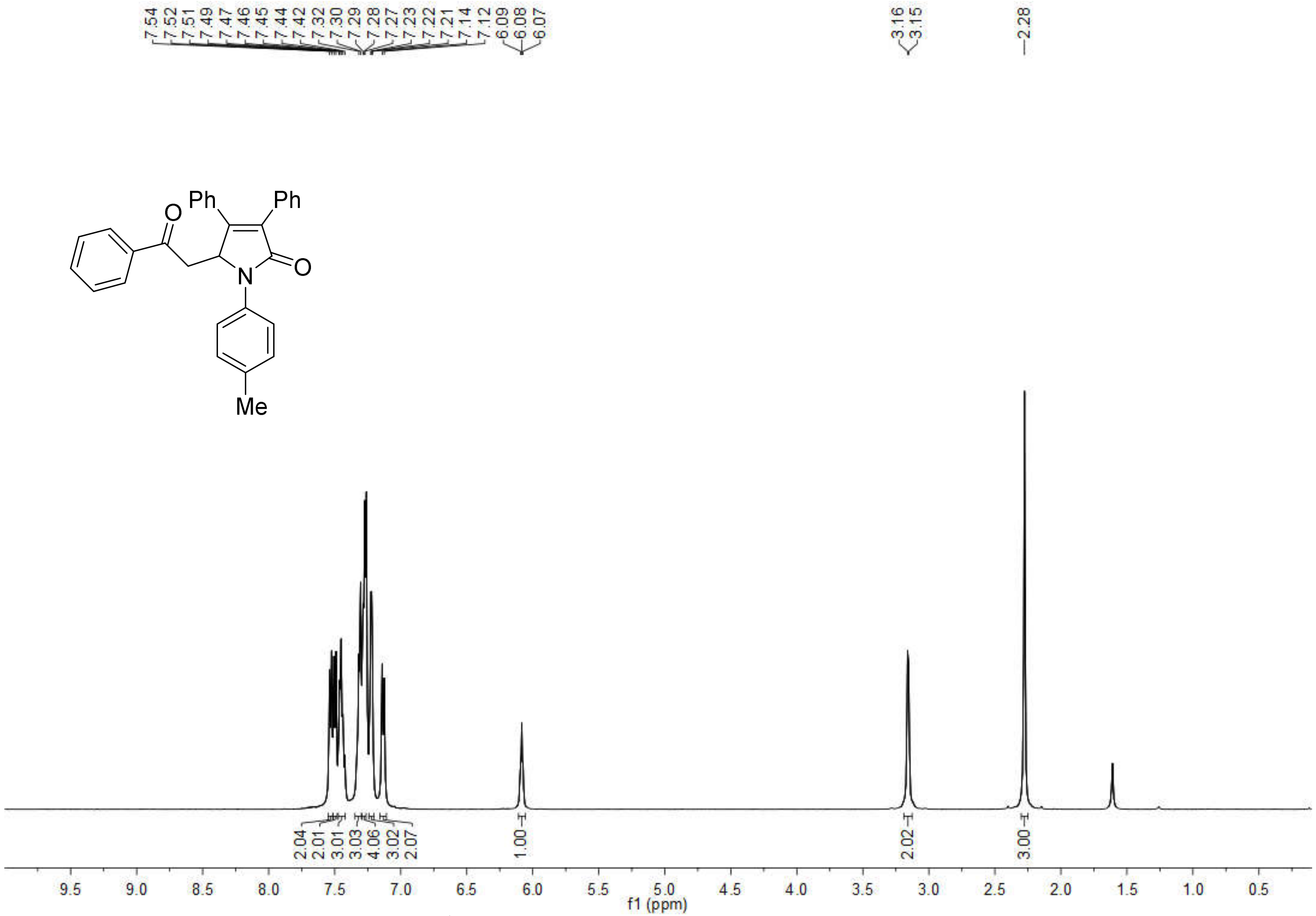


Figure S65. [1]H NMR (500 MHz, $CDCl_3$) spectra of compound **5b**

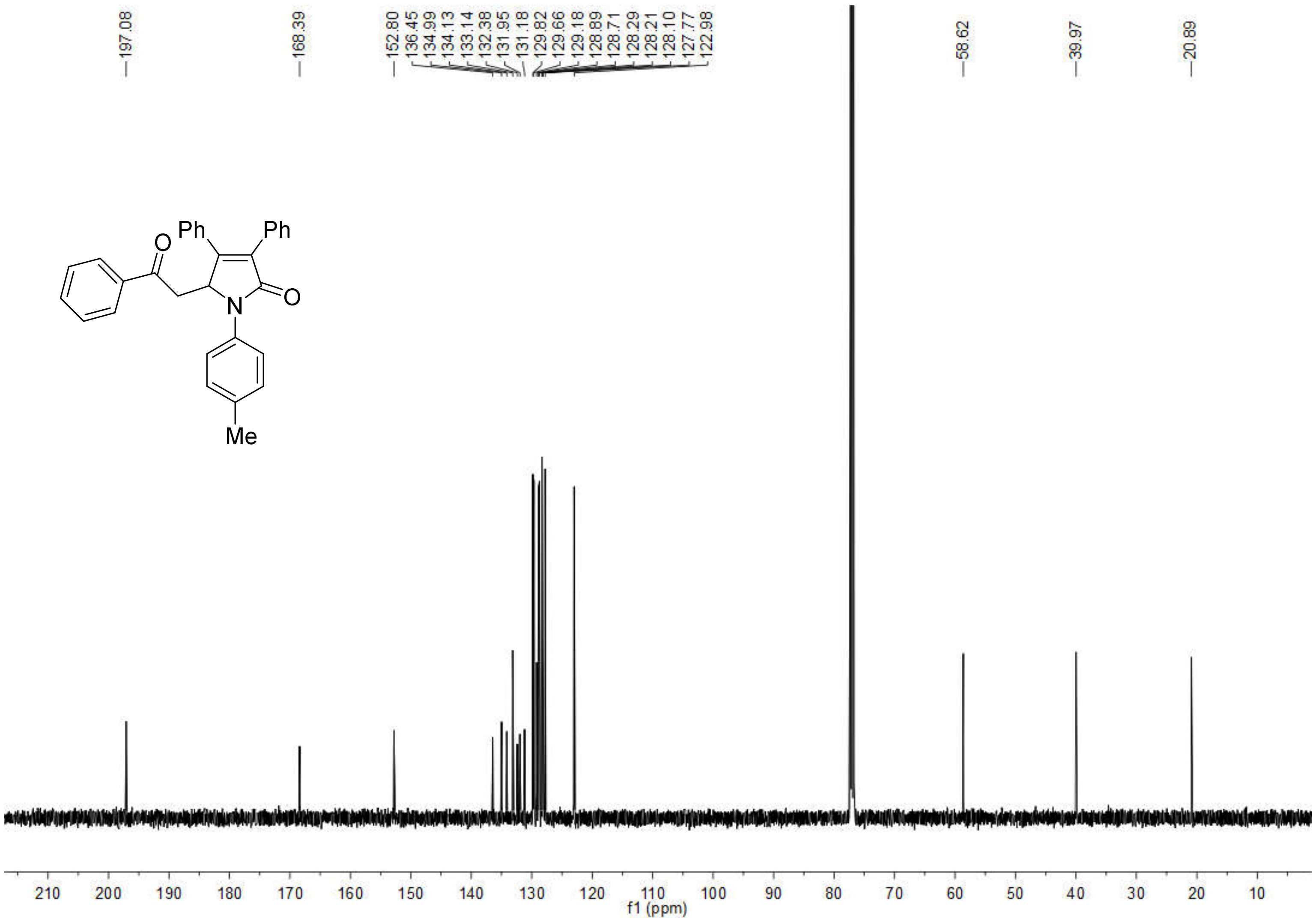


Figure S66. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5b**

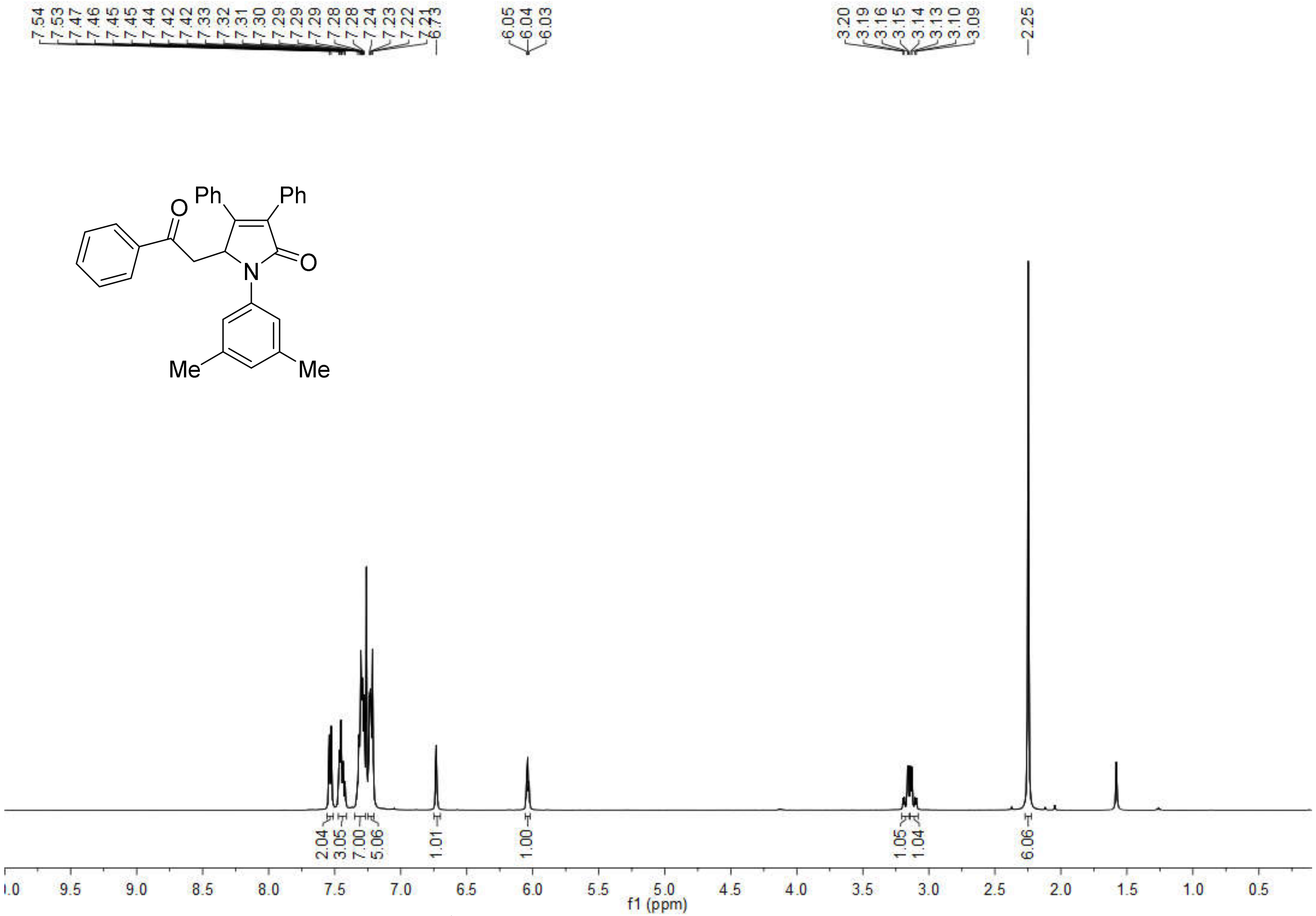


Figure S67. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5c**

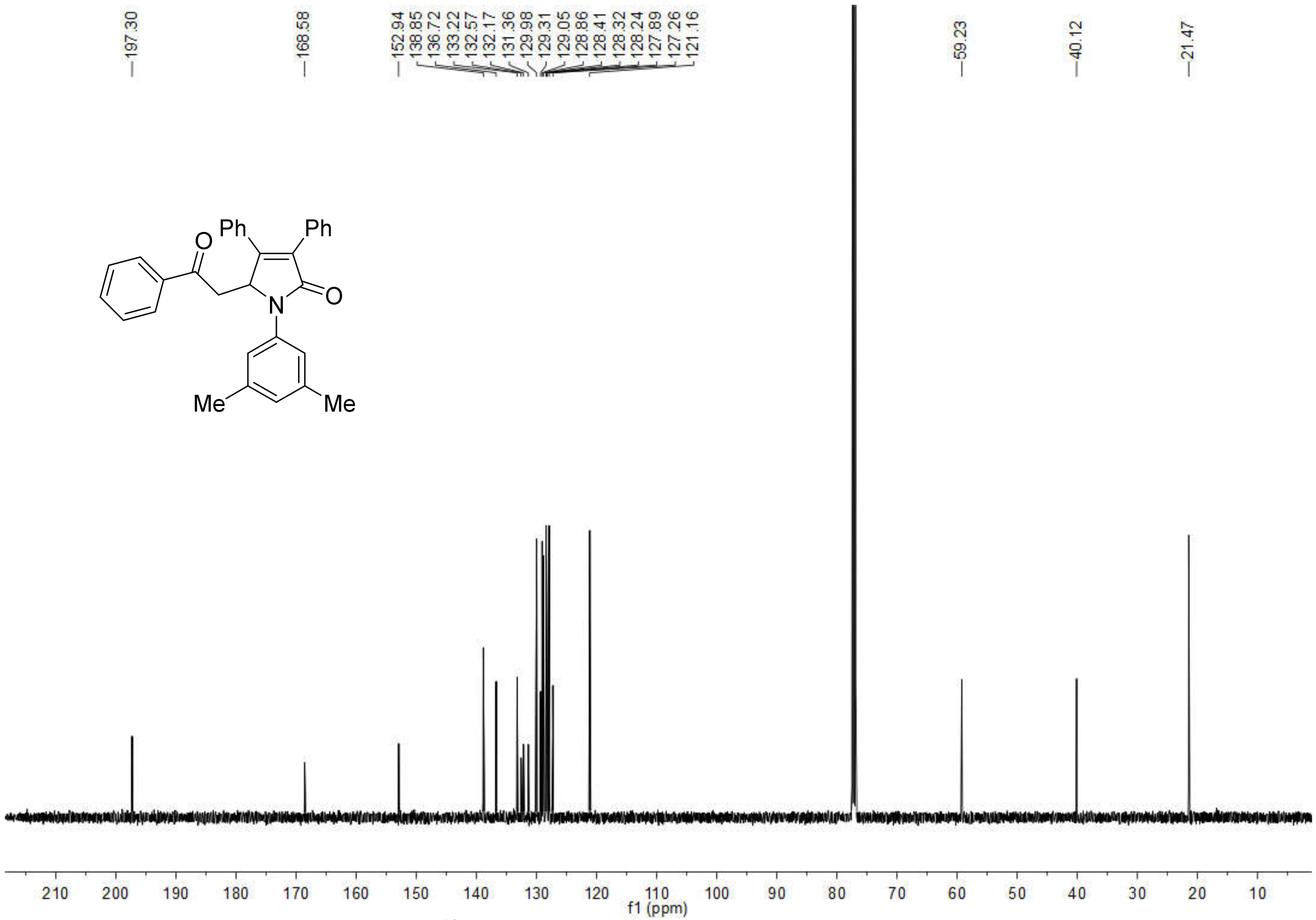


Figure S68. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5c**

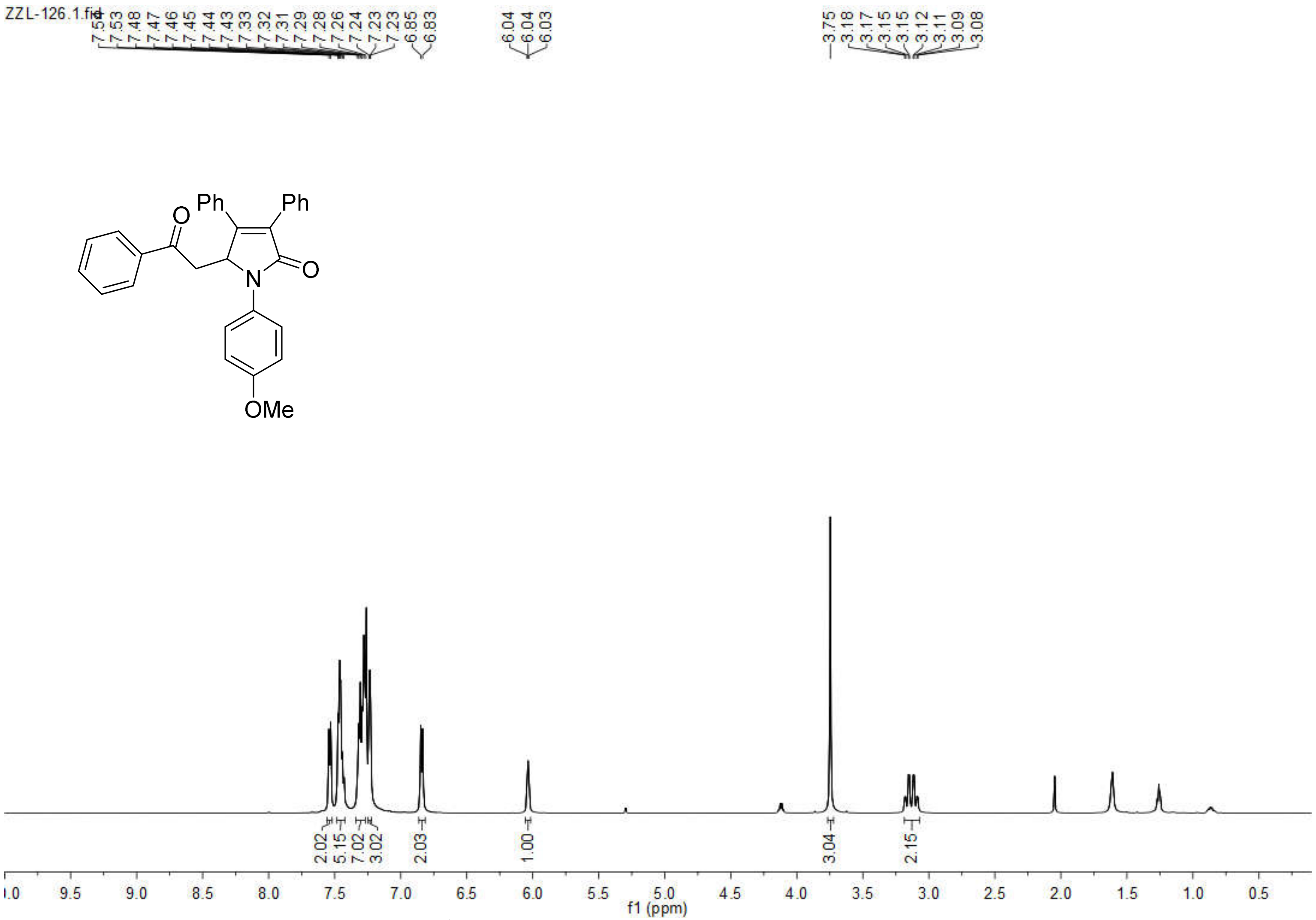


Figure S69. [1]H NMR (600 MHz, $CDCl_3$) spectra of compound **5d**

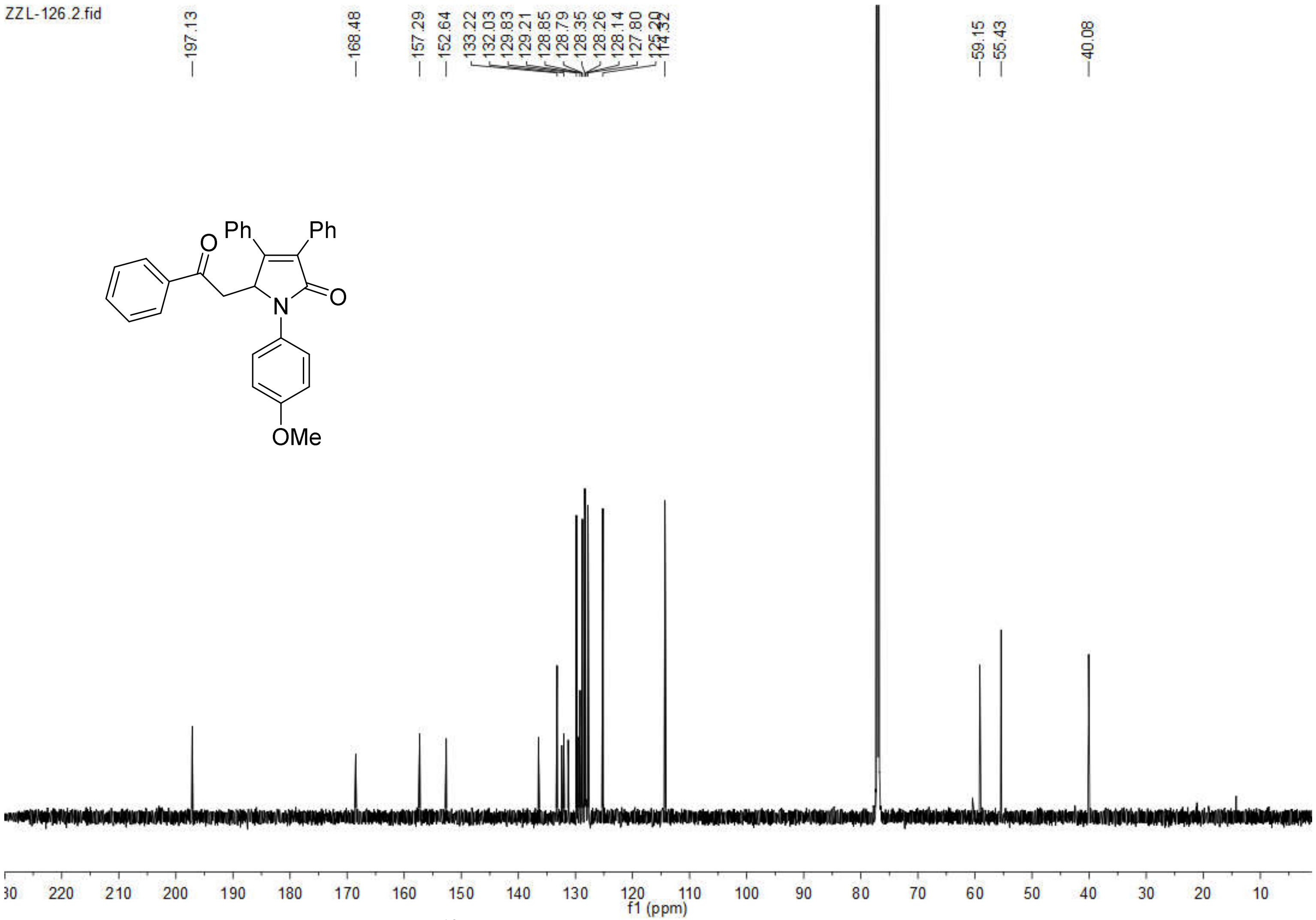


Figure S70. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5d**

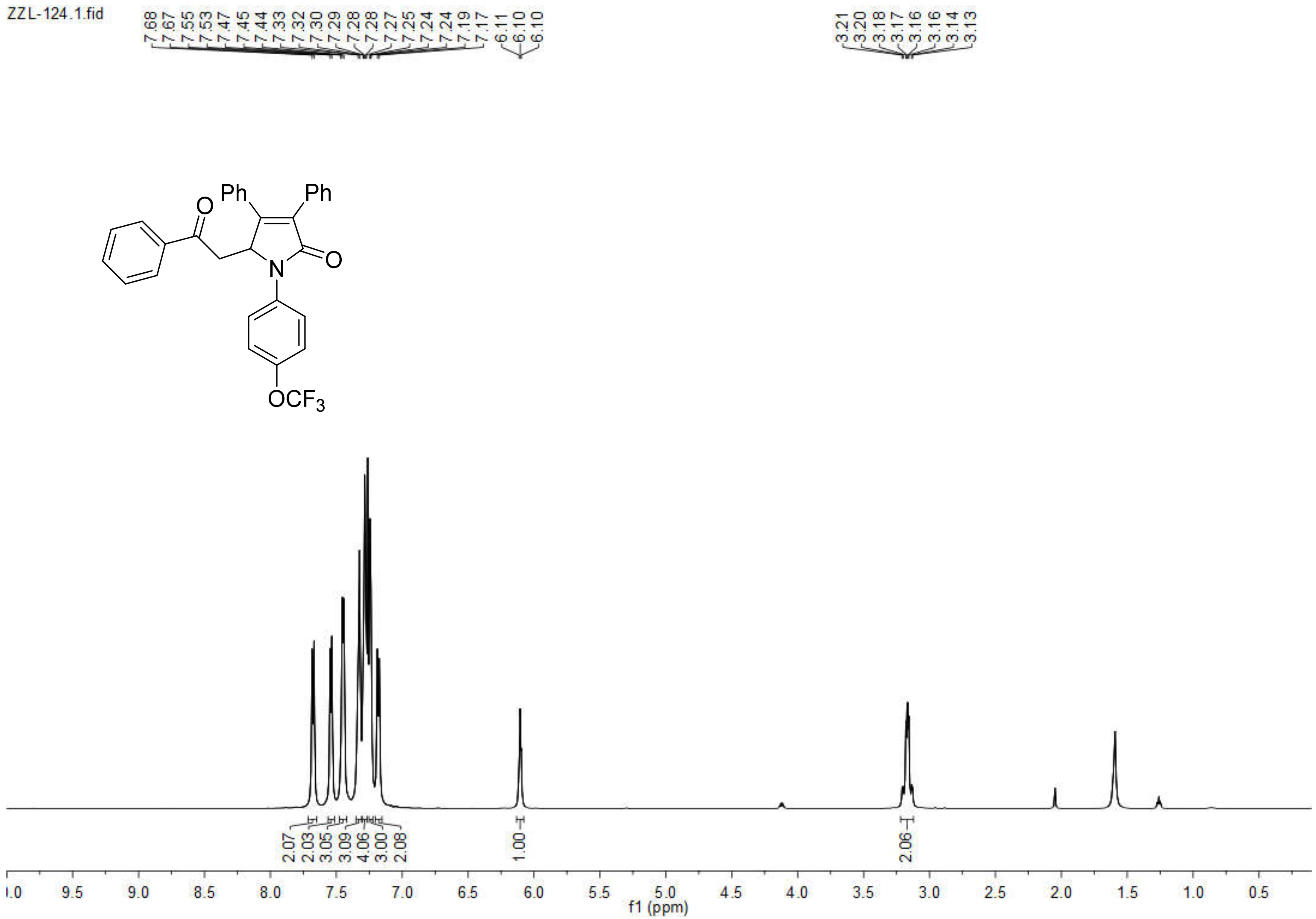


Figure S71. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **5e**

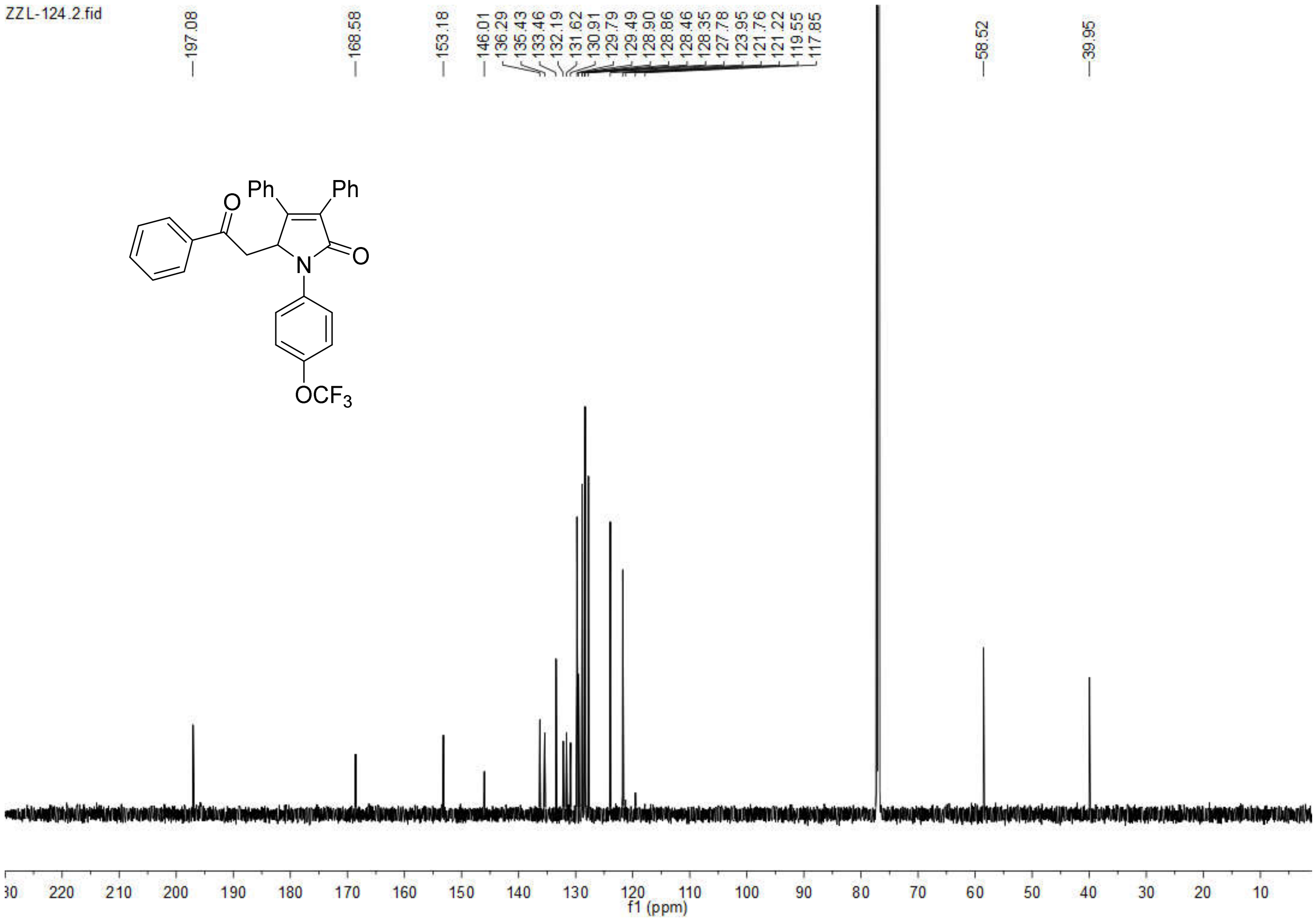


Figure S72. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5e**

Figure S73. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **5e**

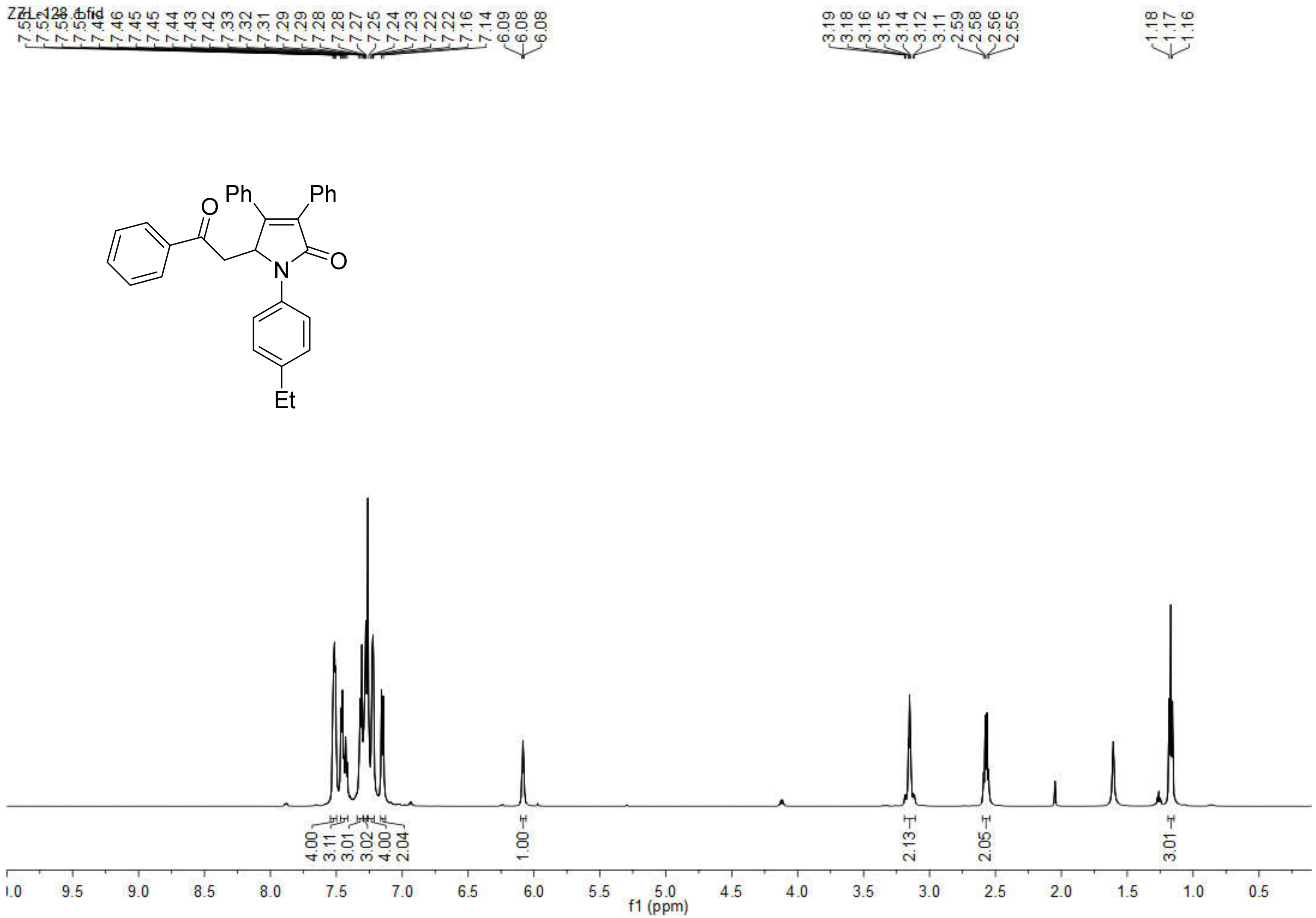


Figure S74. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **5f**

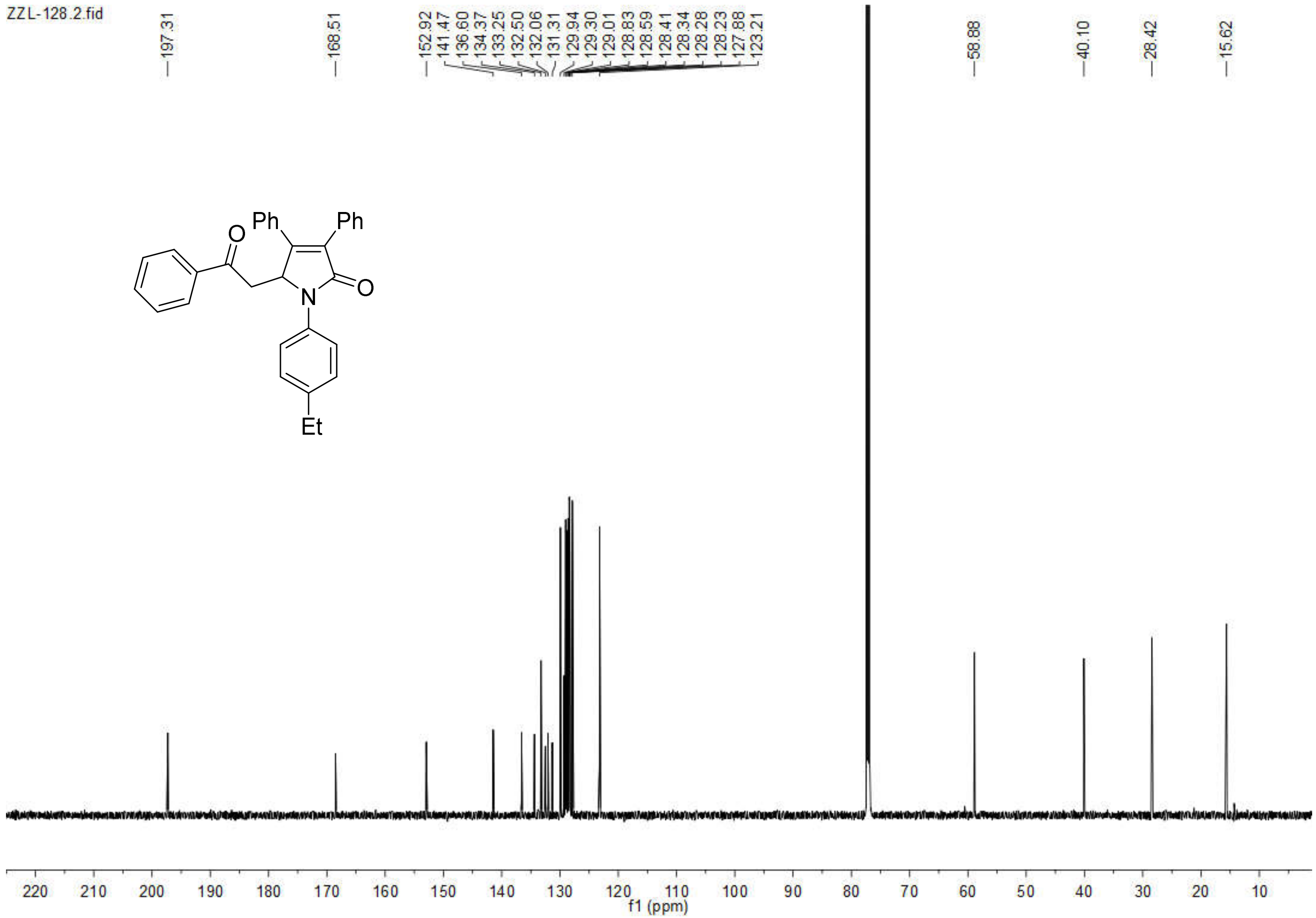


Figure S75. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5f**

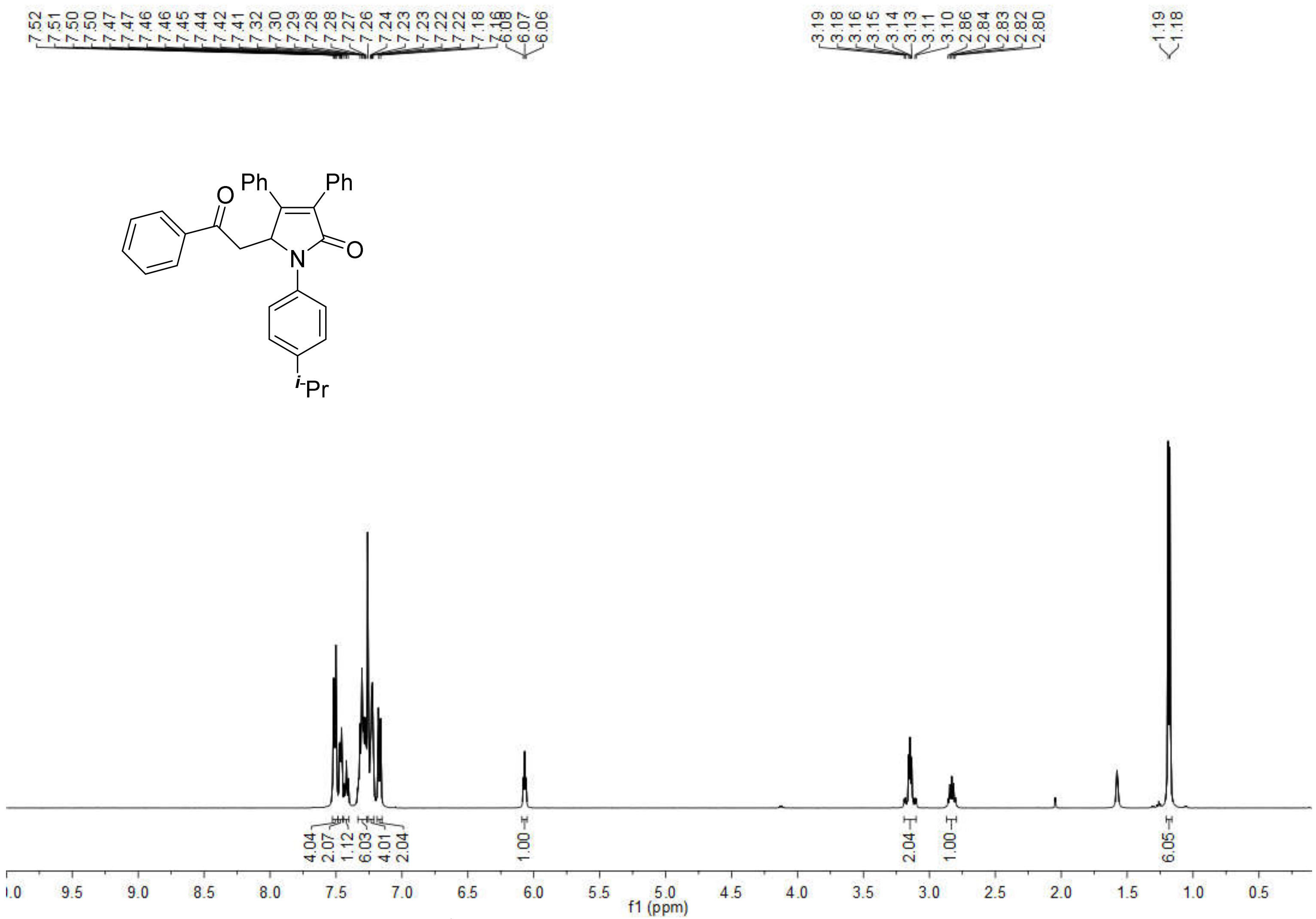


Figure S76. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5g**

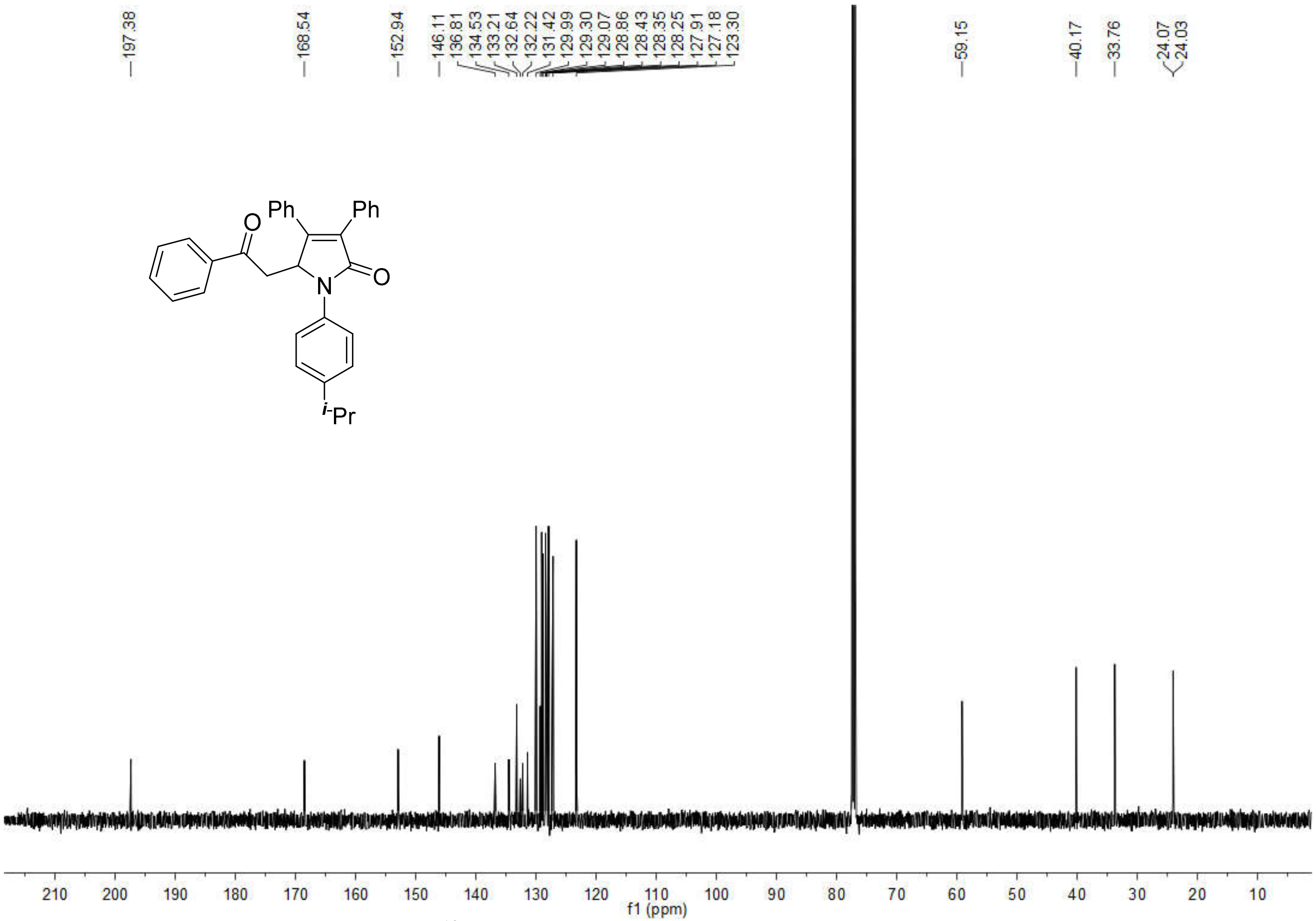


Figure S77. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5g**

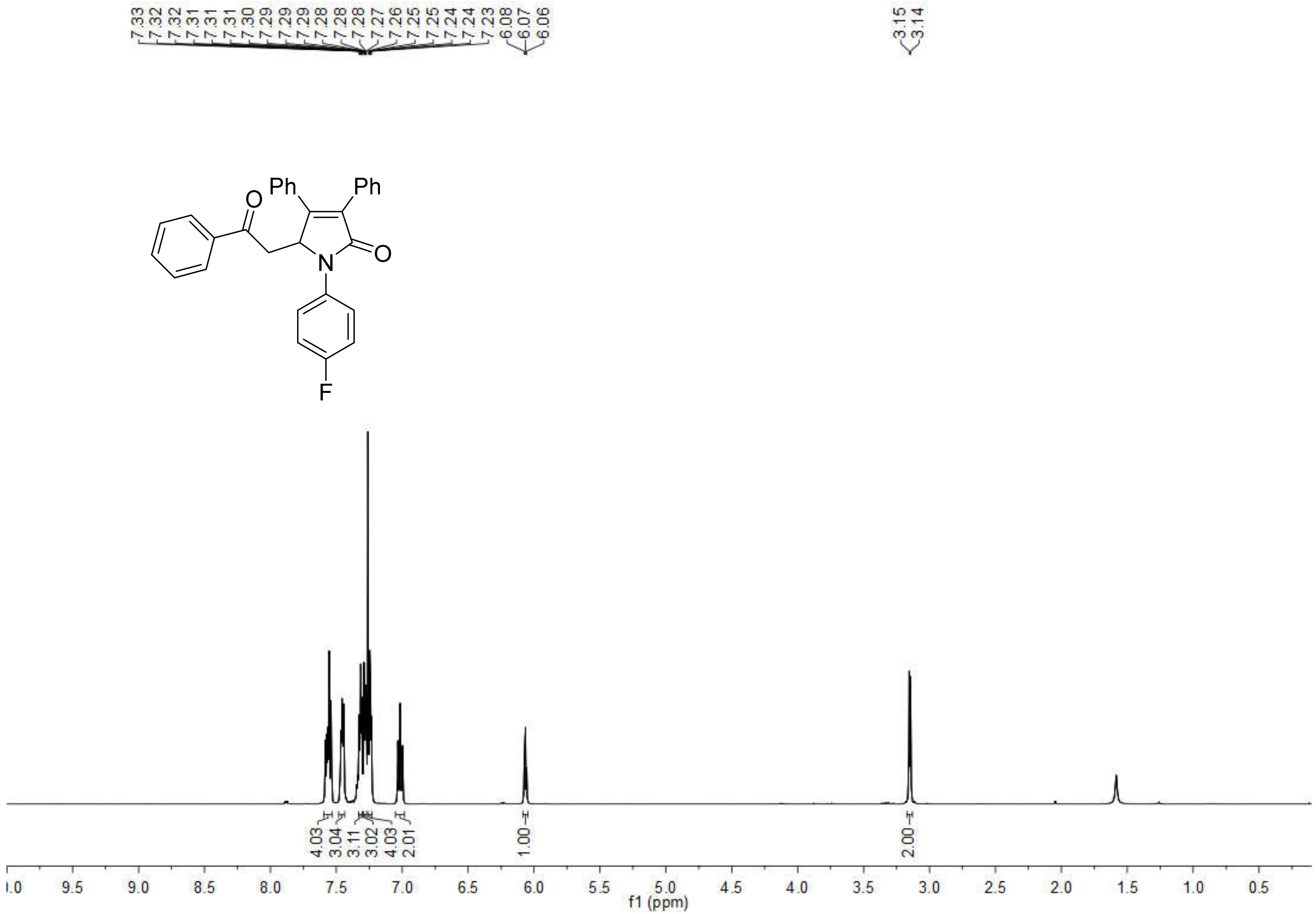


Figure S78. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5h**

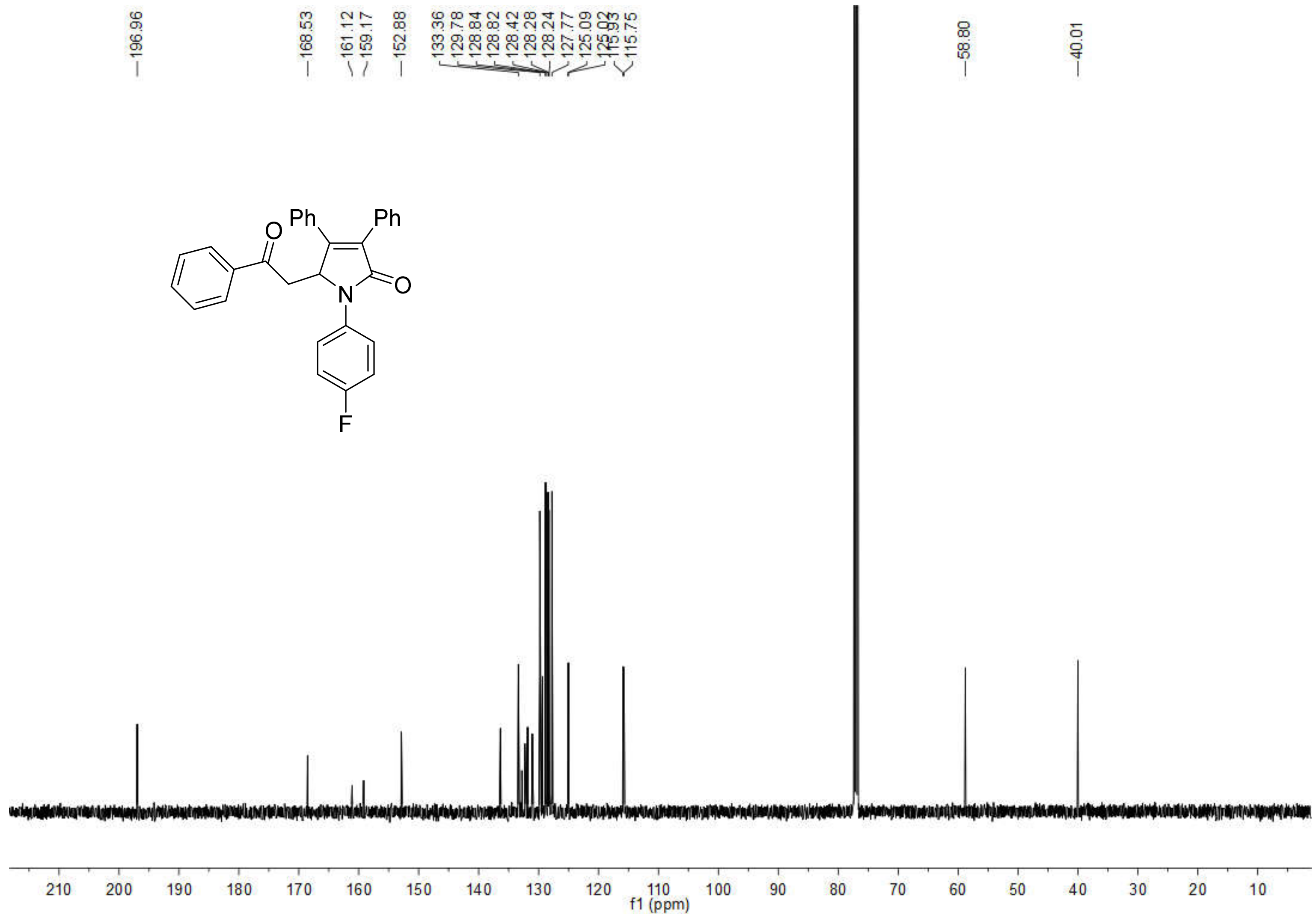


Figure S79. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5h**

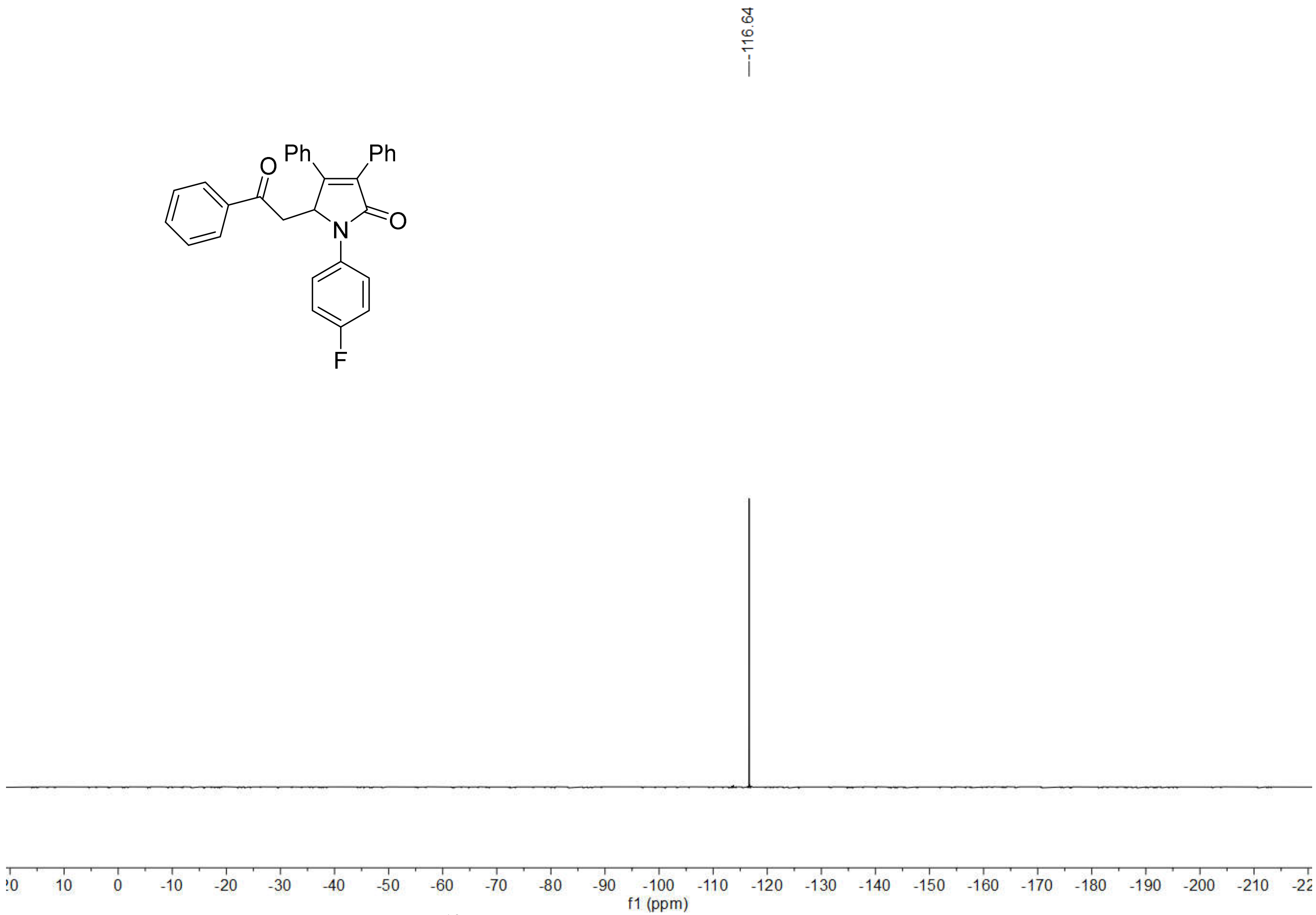


Figure S80. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **5h**

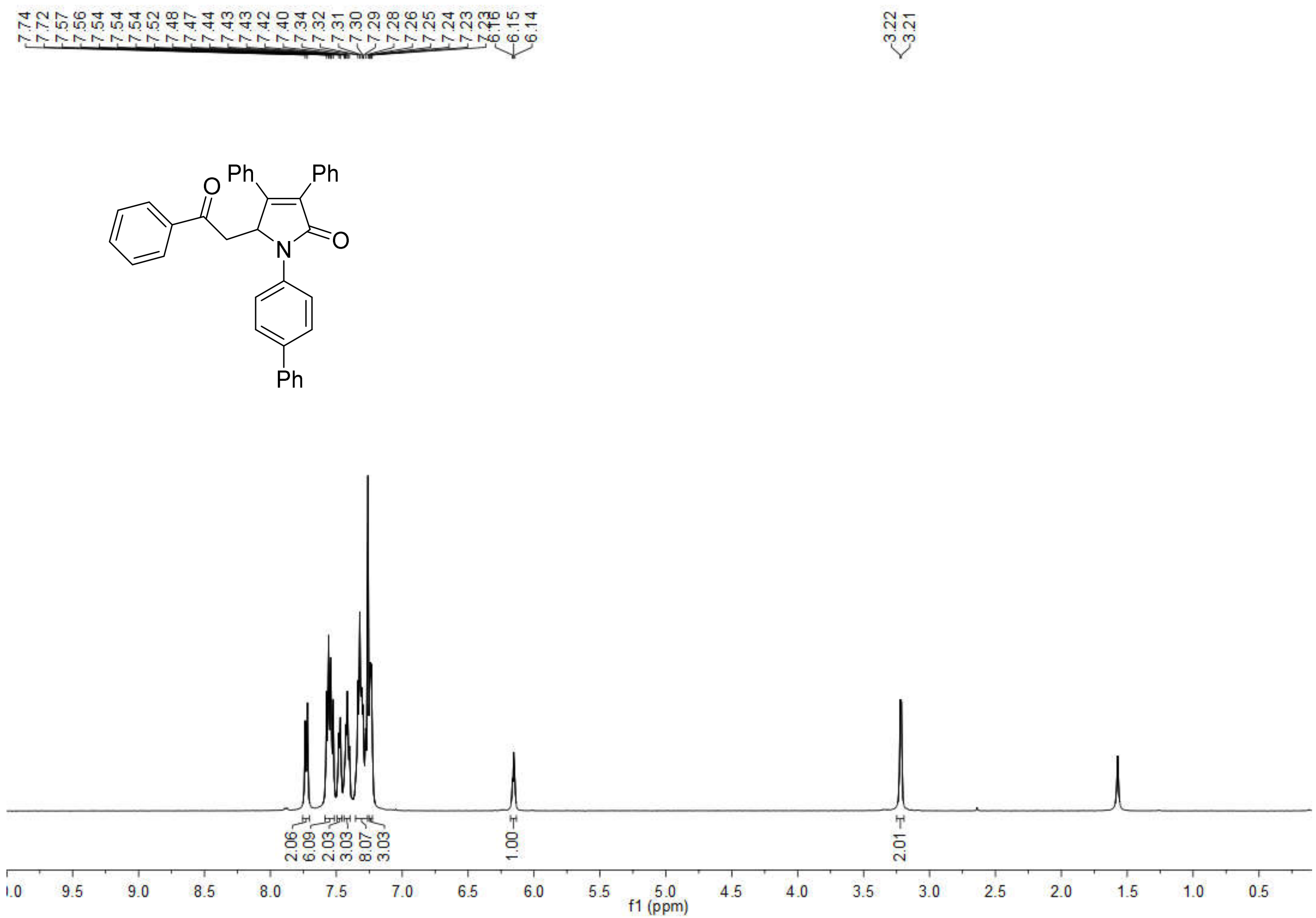


Figure S81. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5i**

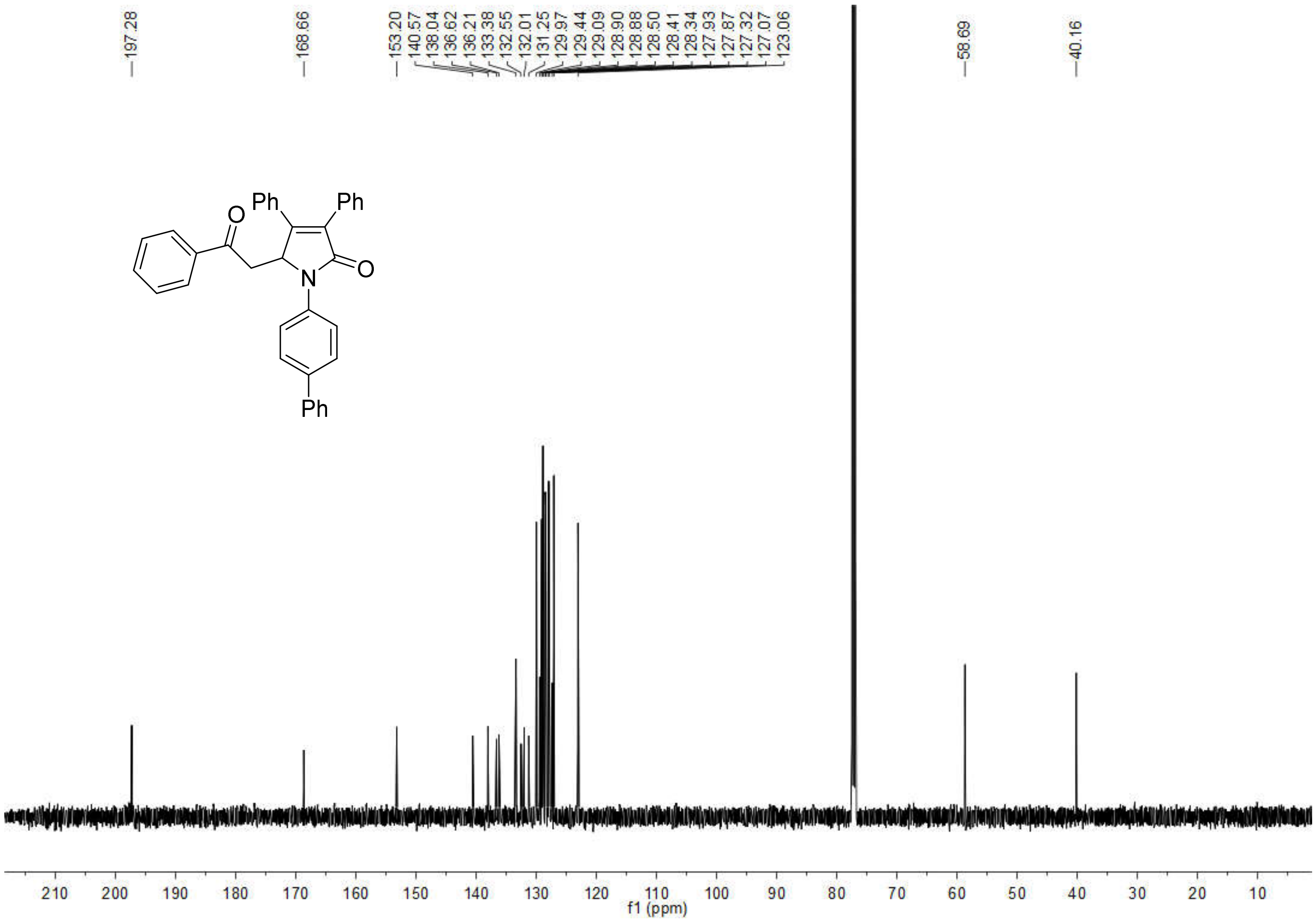


Figure S82. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5i**

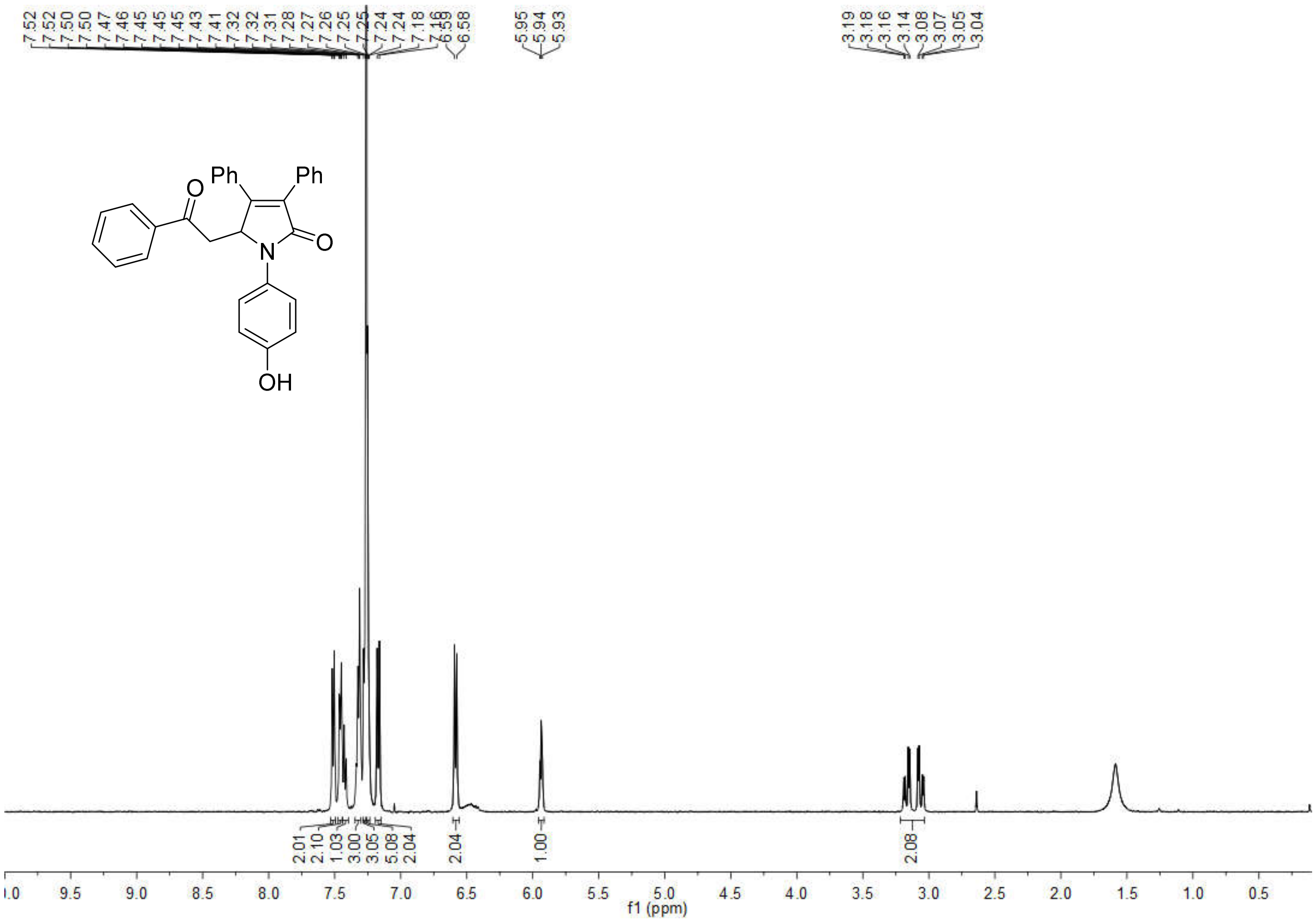


Figure S83. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5j**

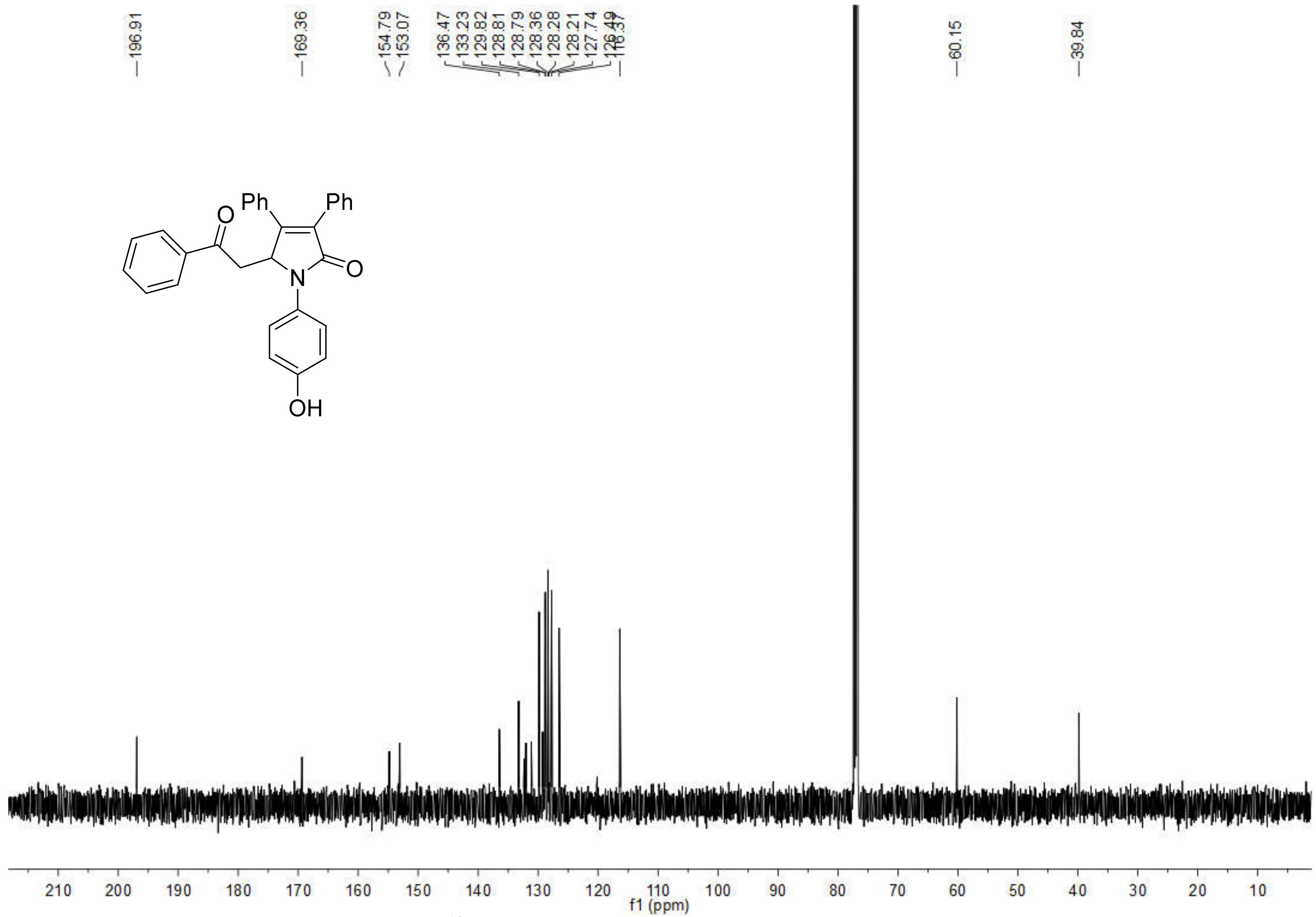


Figure S84. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5j**

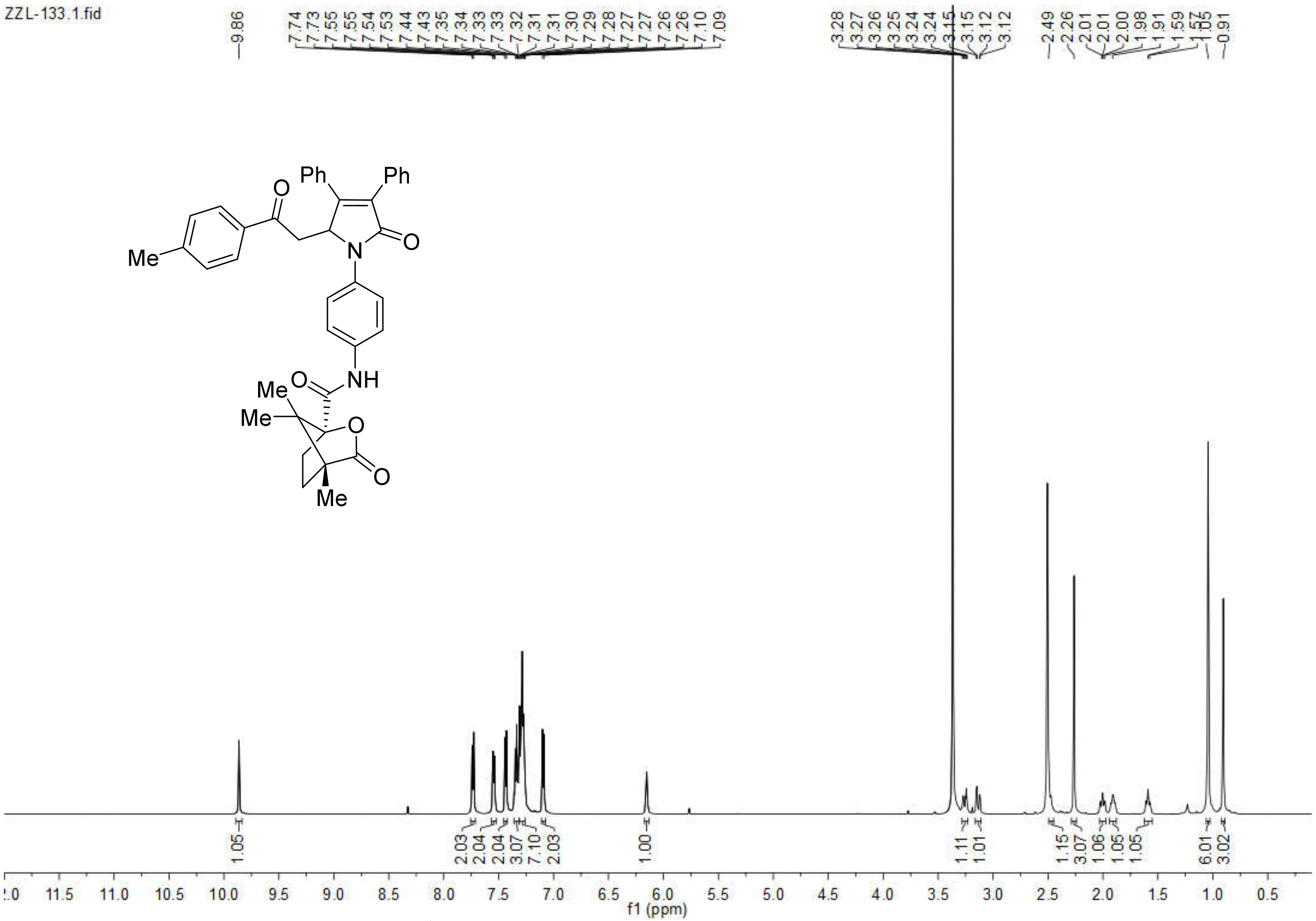


Figure S85. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **5k**

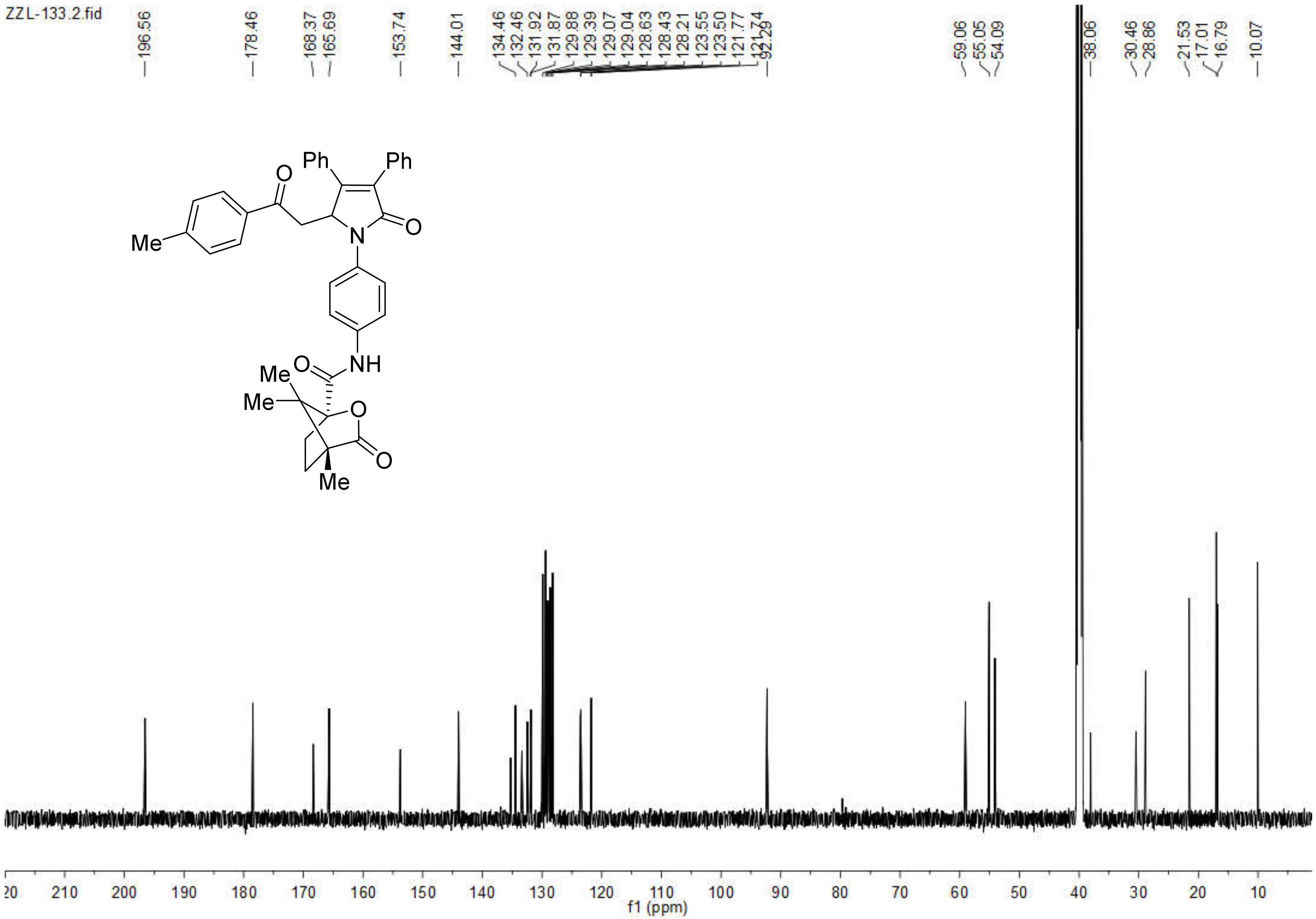
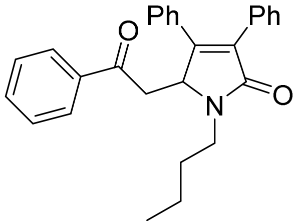
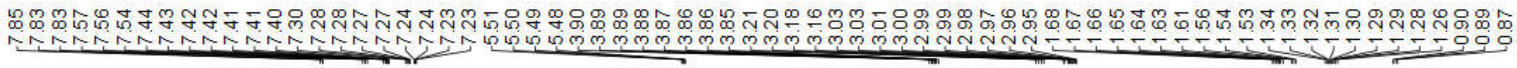


Figure S86. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **5k**





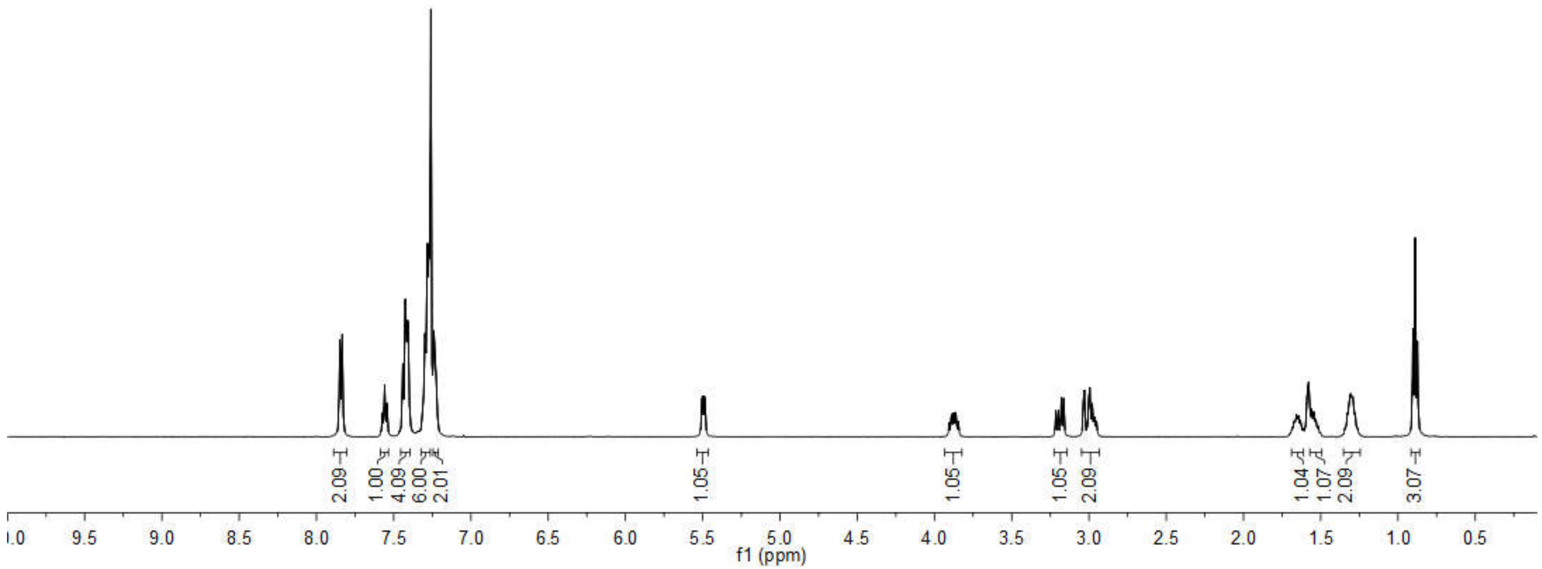


Figure S87. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5l**

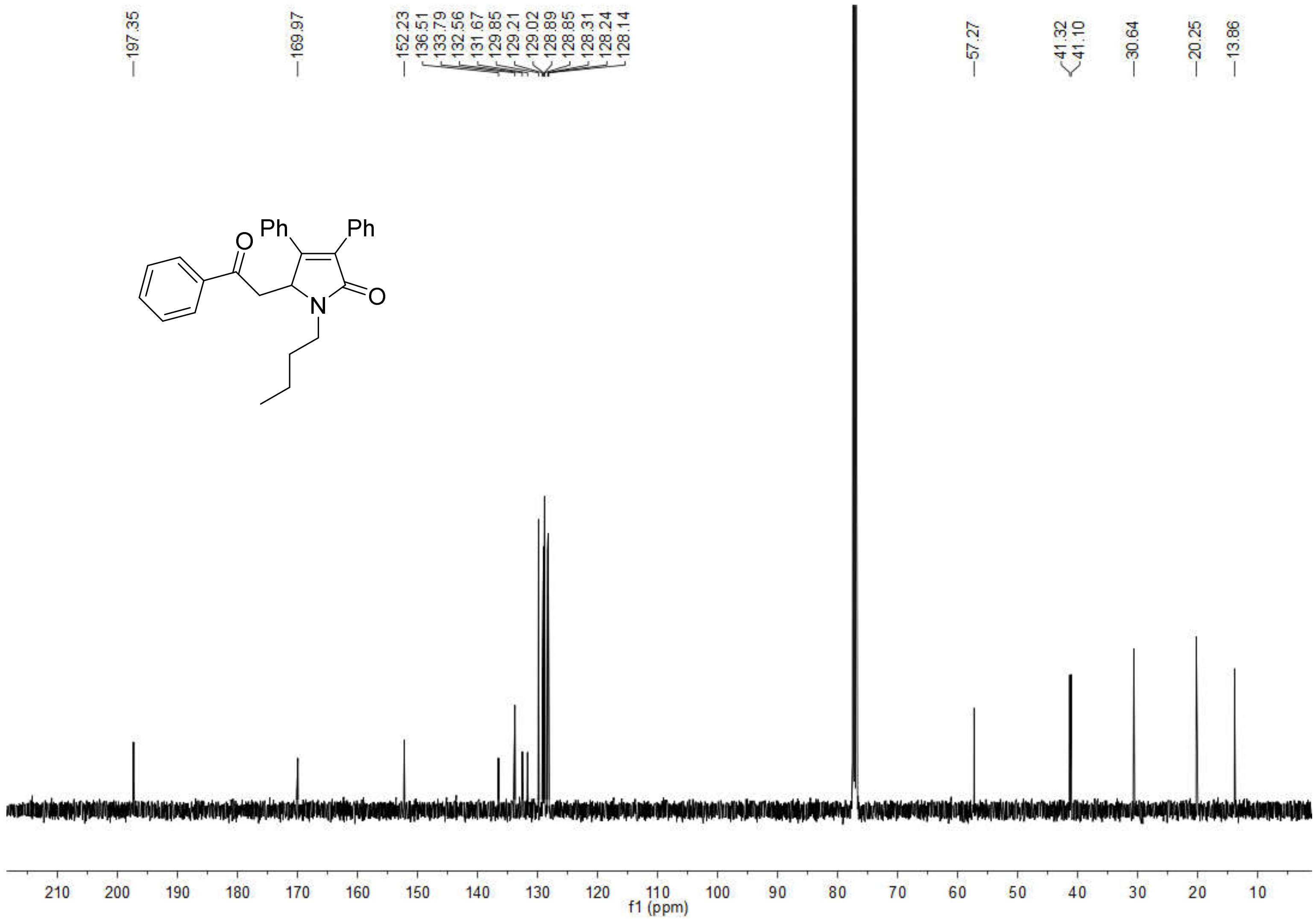


Figure S88. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5l**

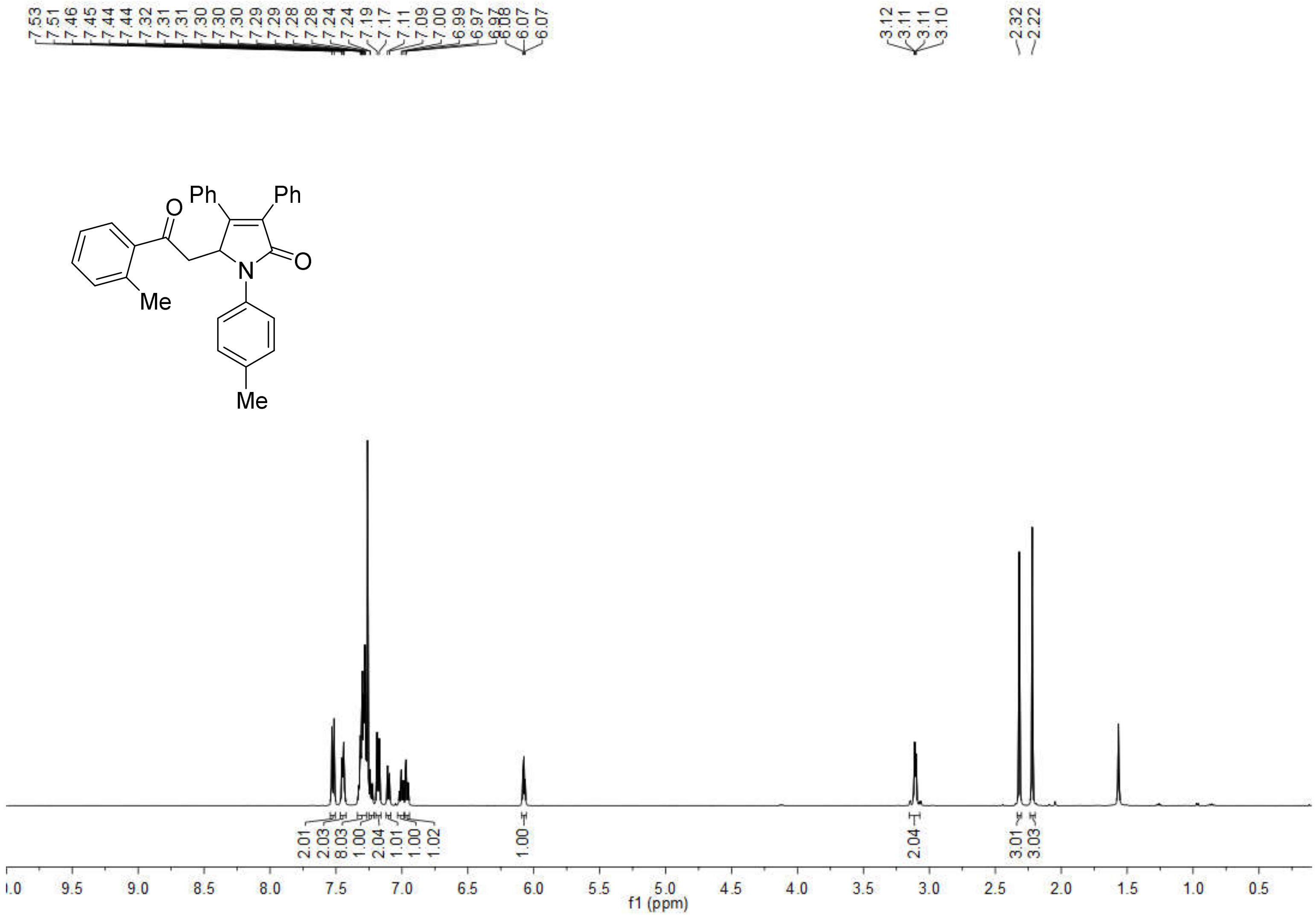


Figure S89. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5m**

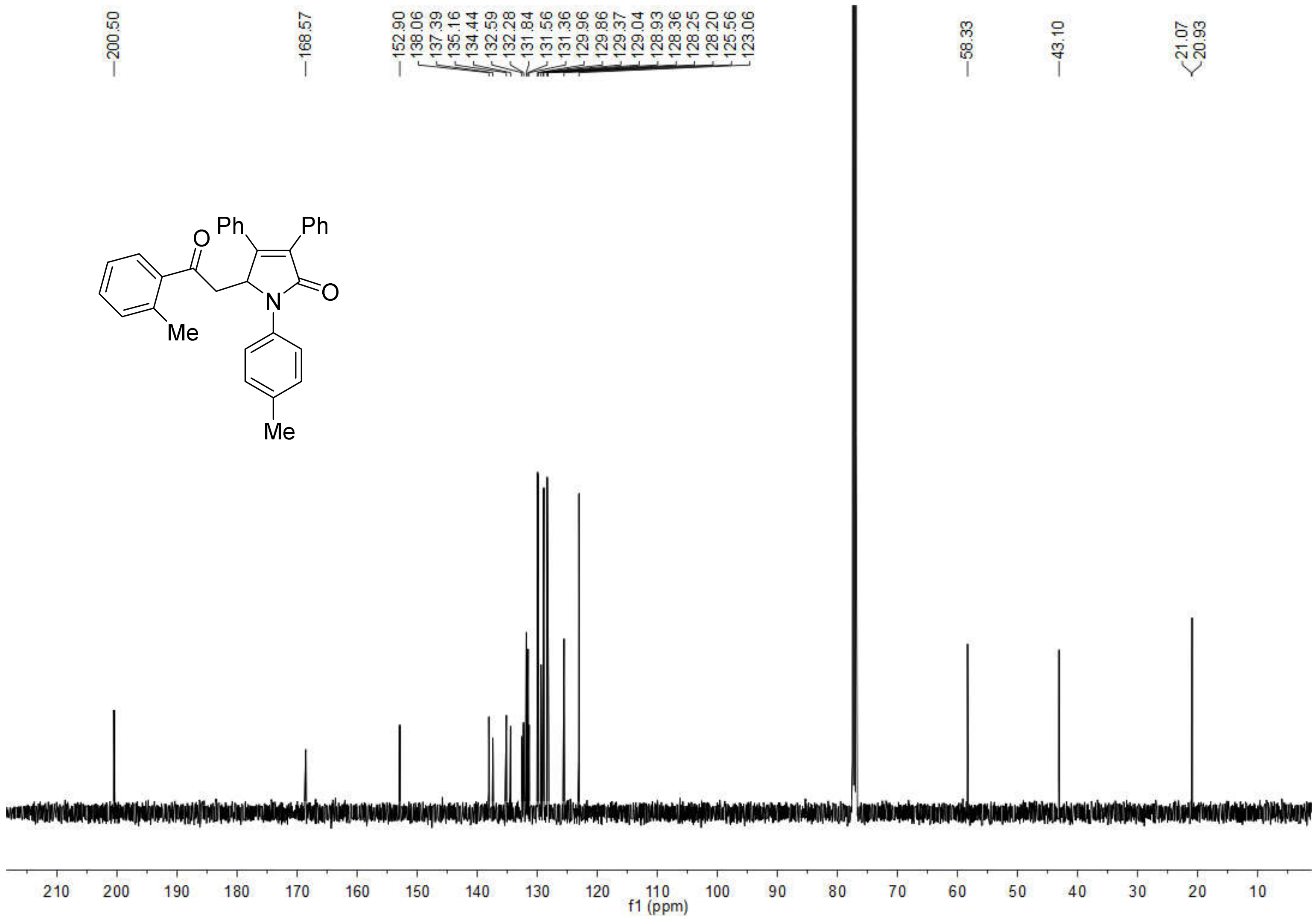


Figure S90. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5m**

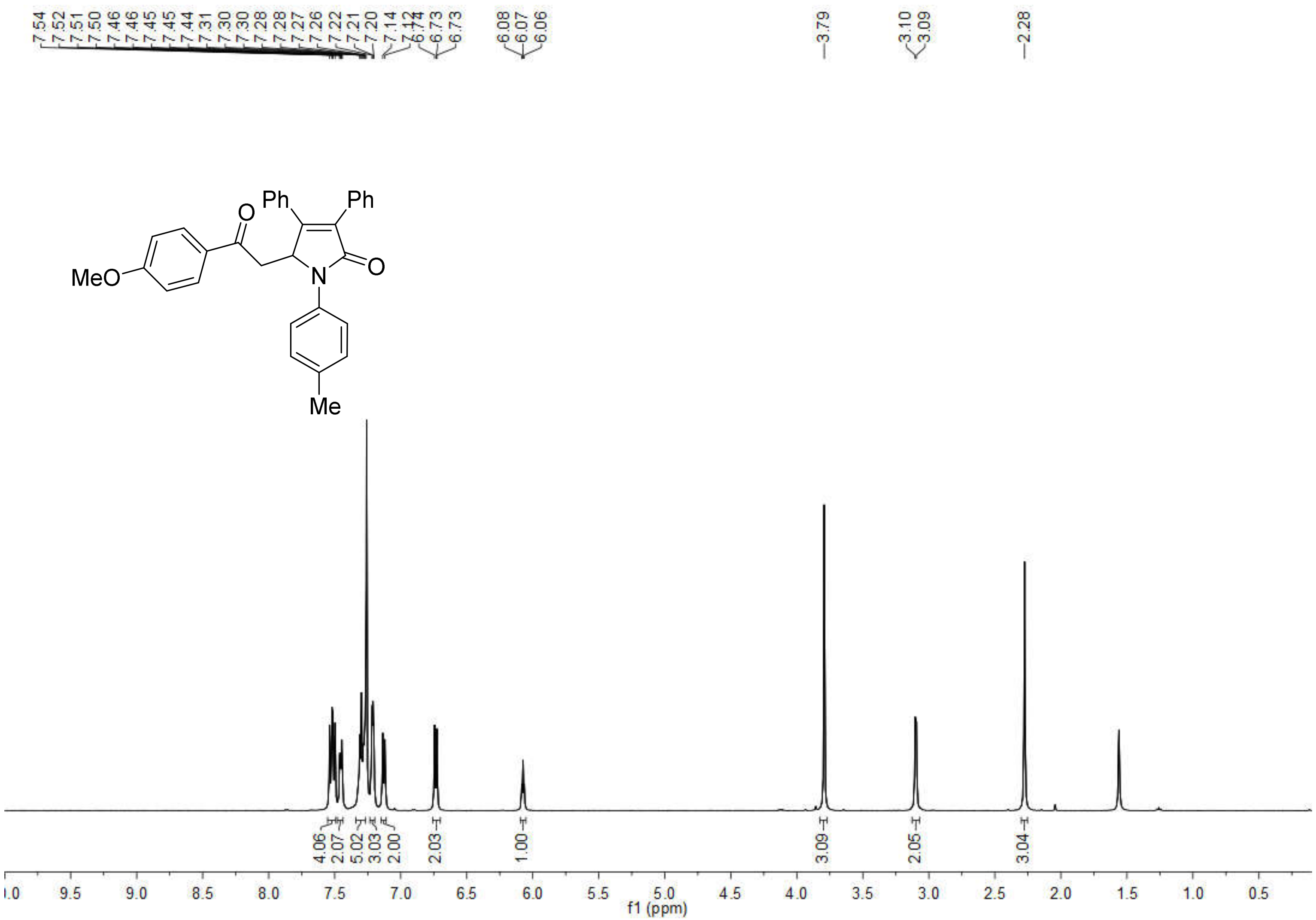


Figure S91. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5n**

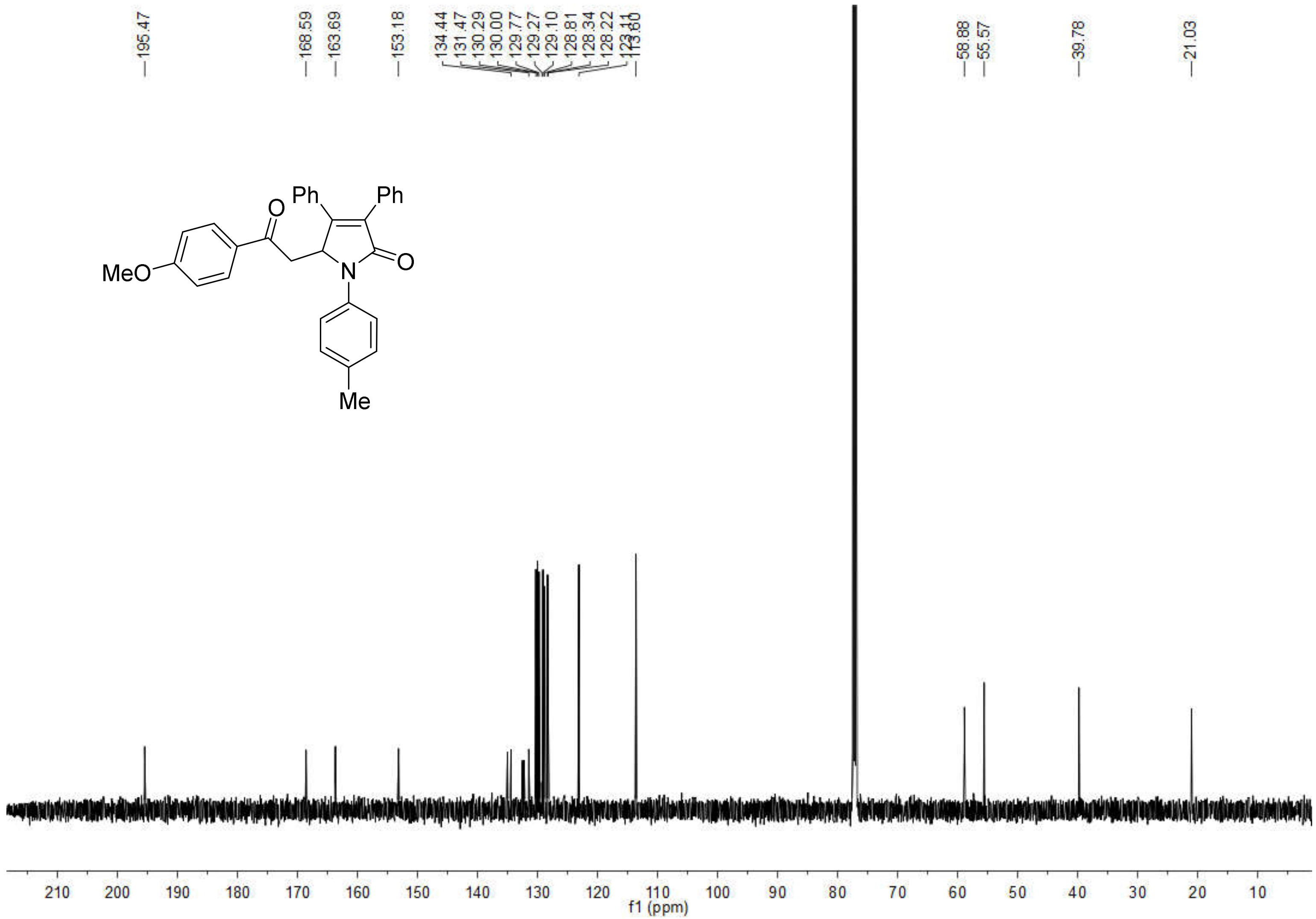


Figure S92. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5n**

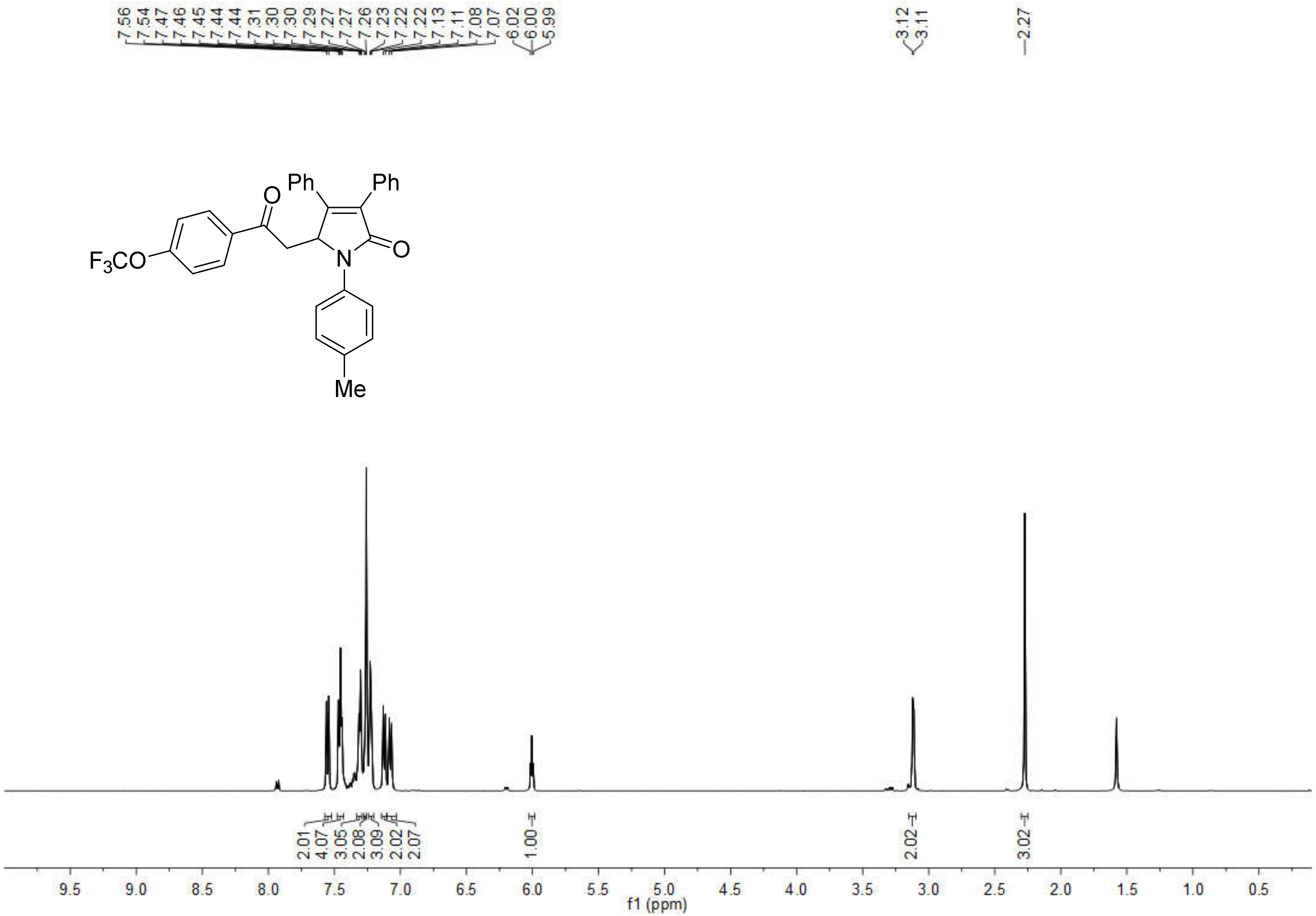


Figure S93. [1]H NMR (500 MHz, $CDCl_3$) spectra of compound **5o**

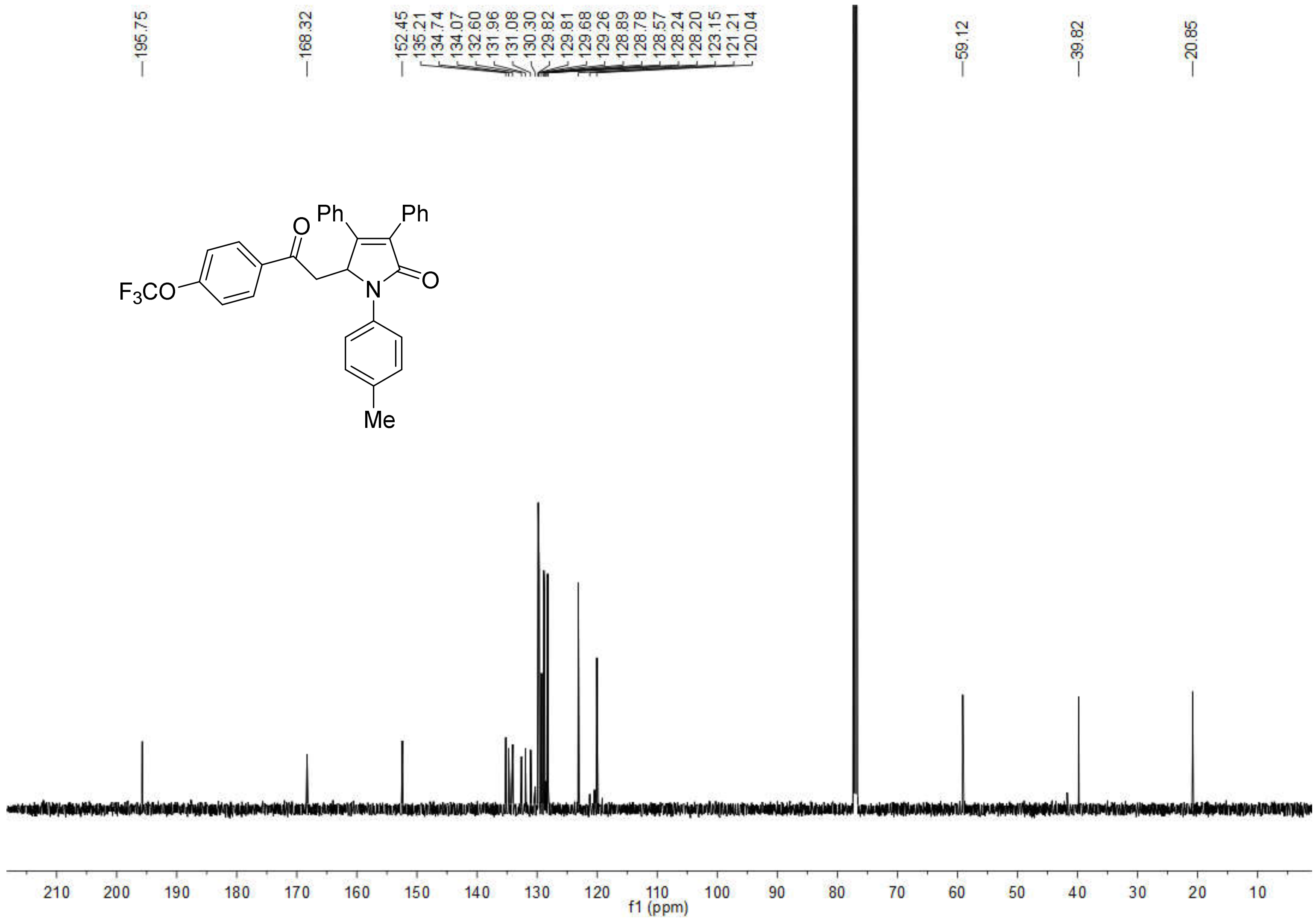


Figure S94. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5o**

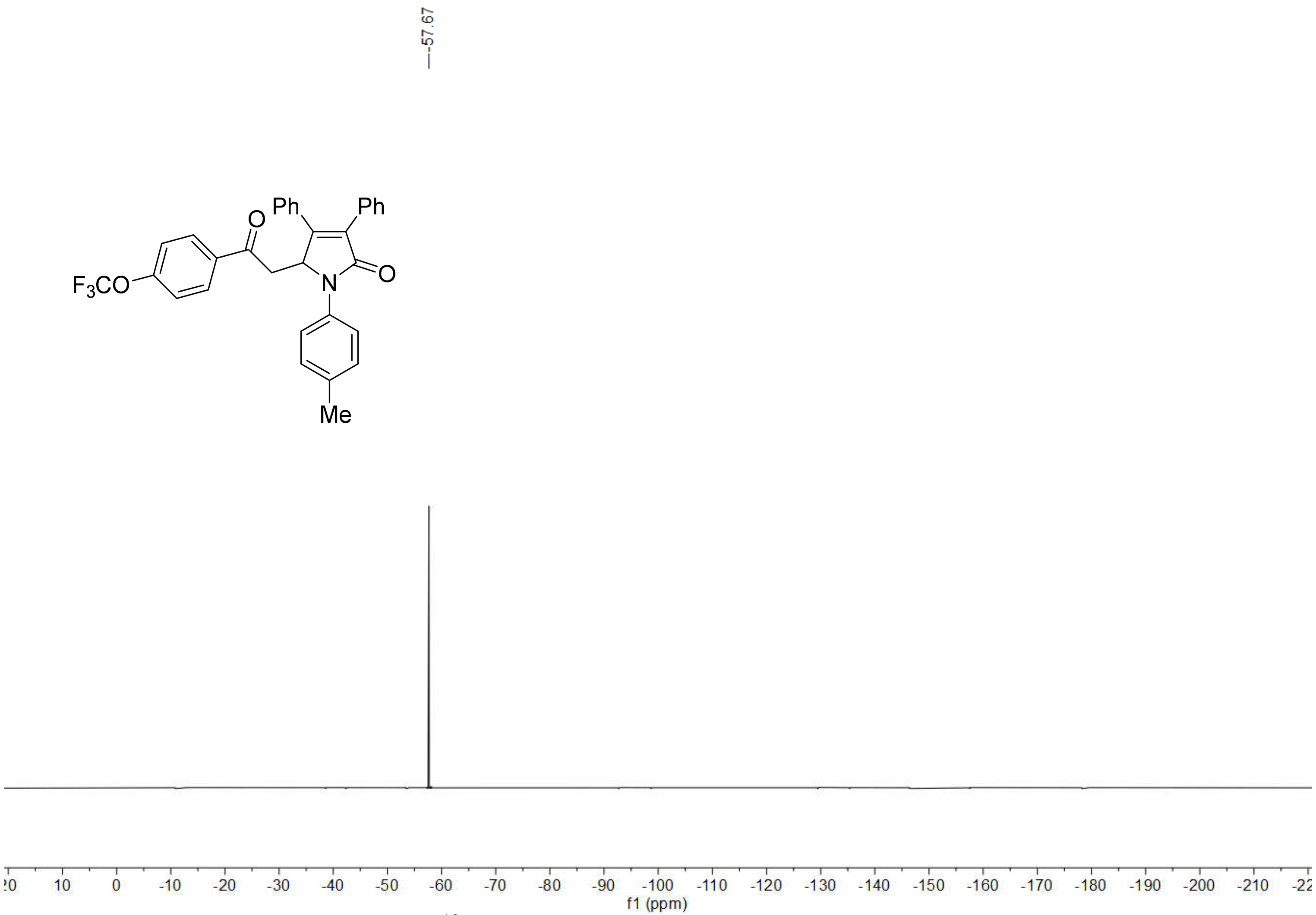


Figure S95. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **5o**

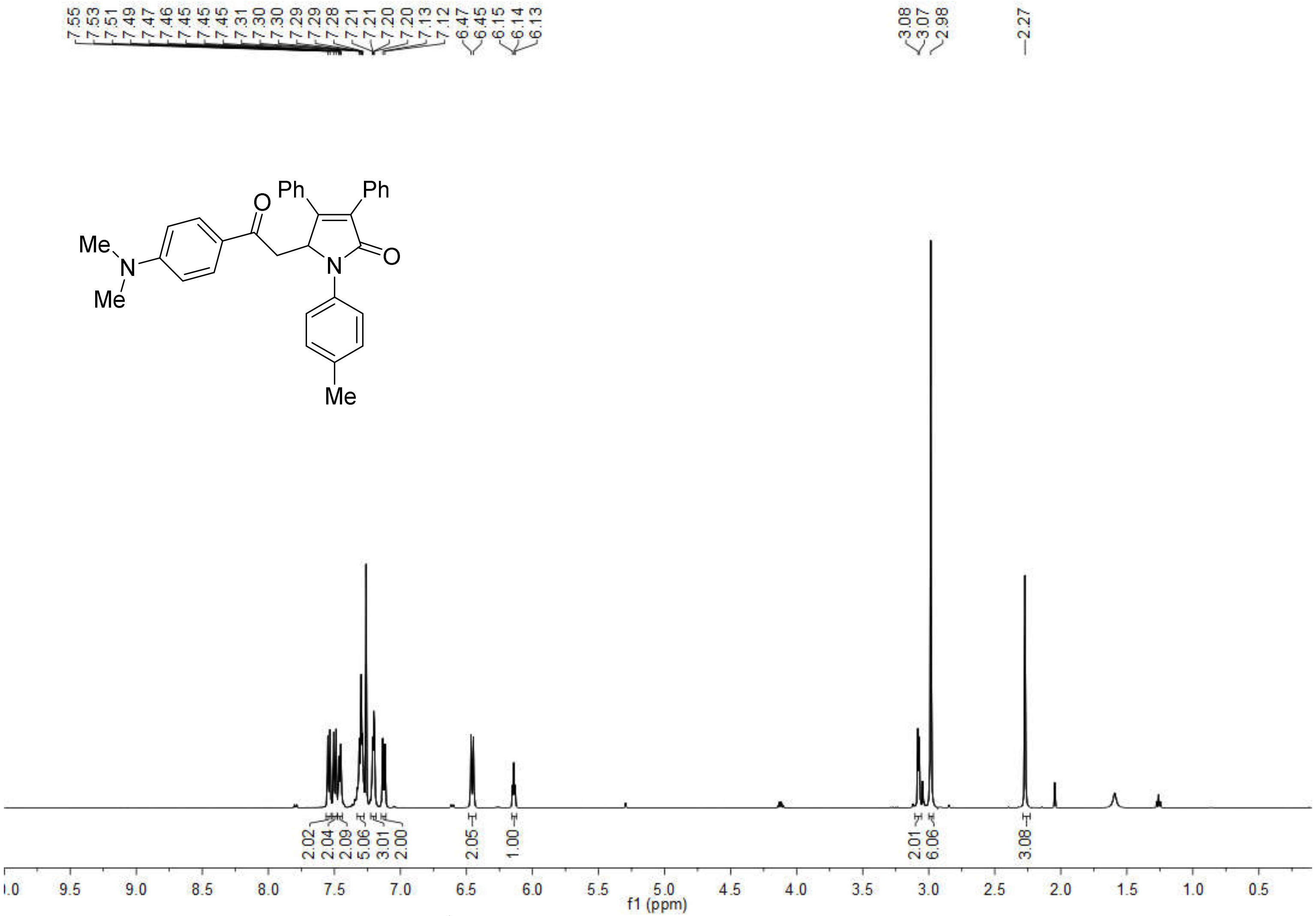


Figure S96. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5p**

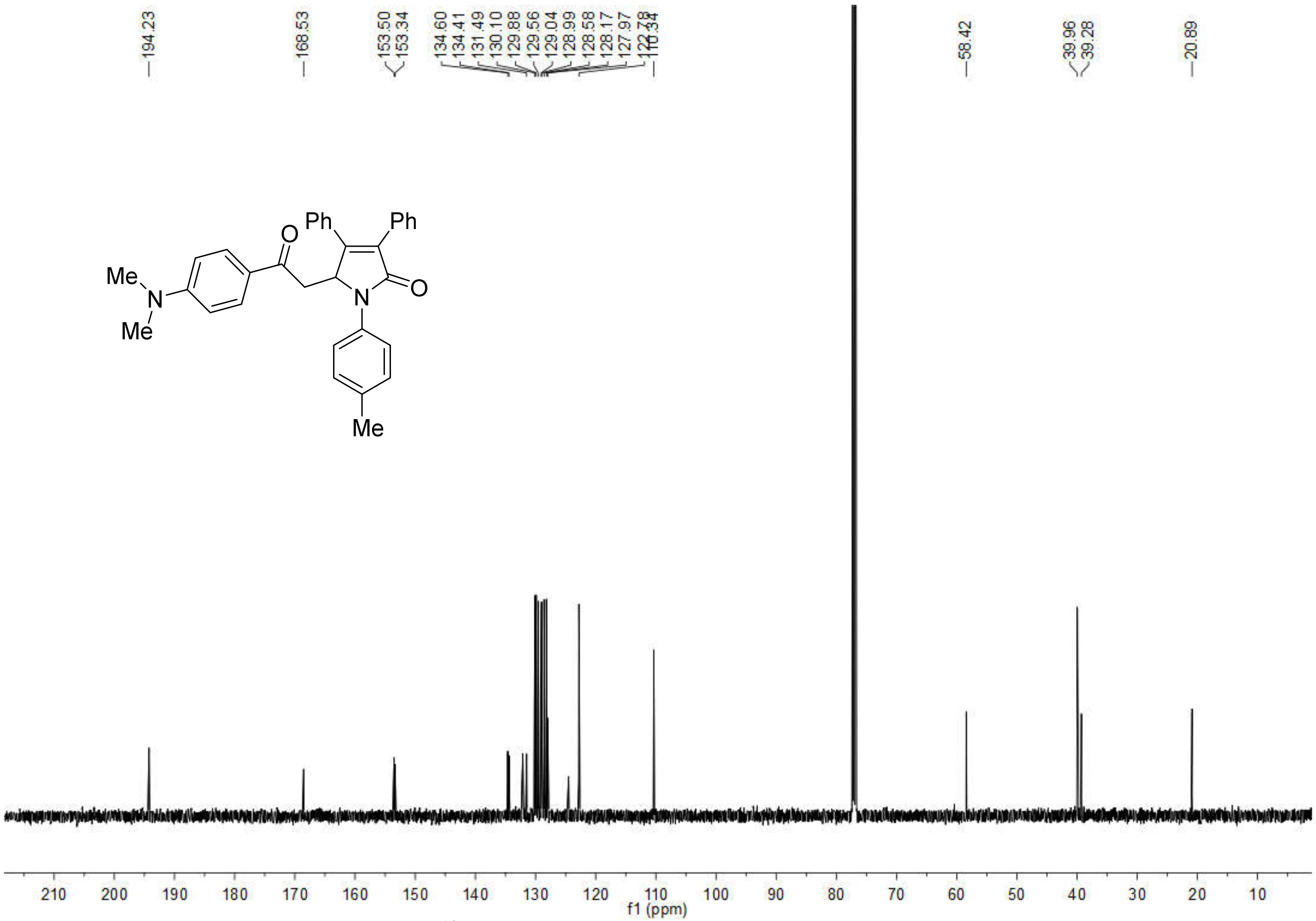


Figure S97. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5p**

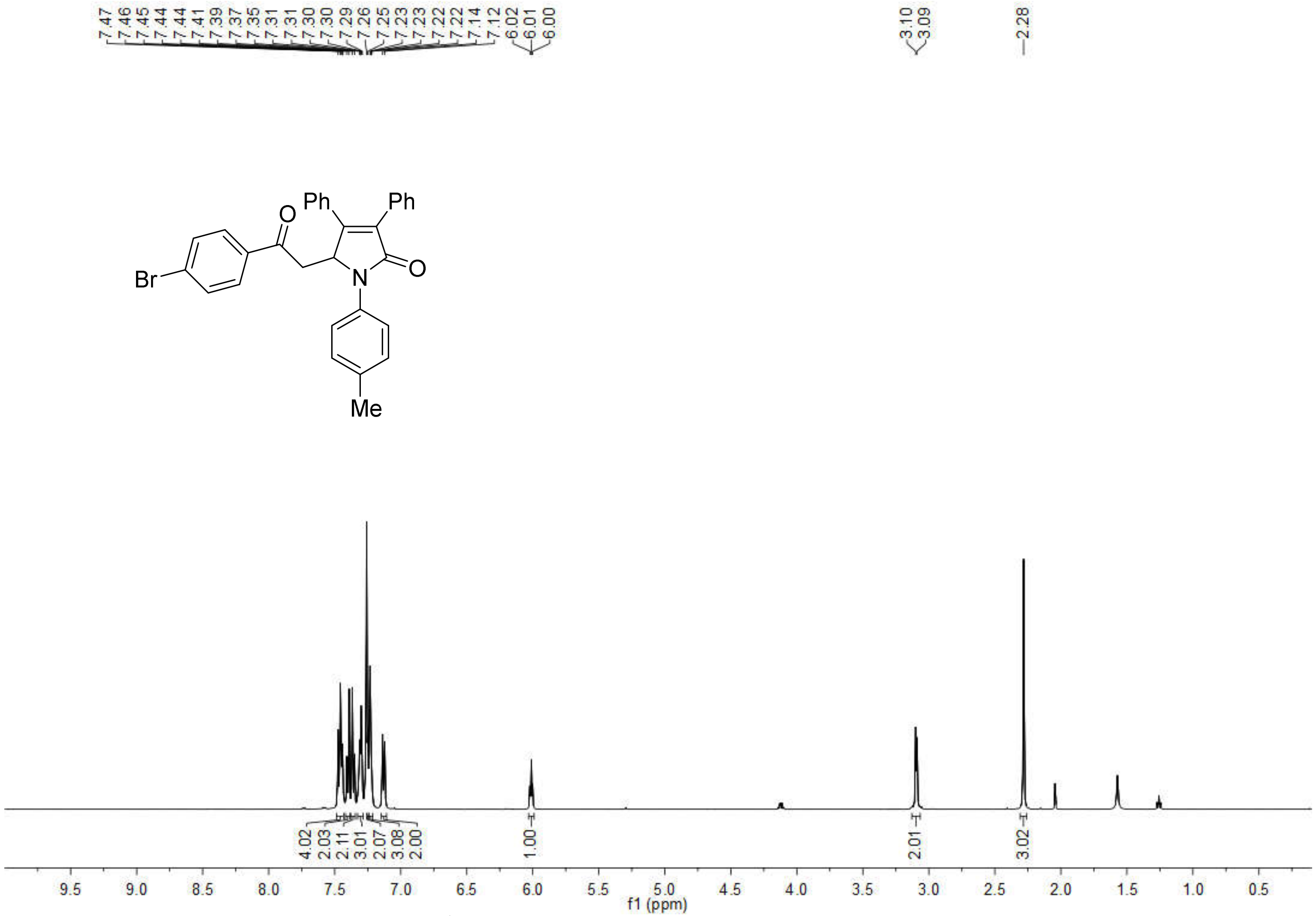


Figure S98. [1]H NMR (500 MHz, $CDCl_3$) spectra of compound **5q**

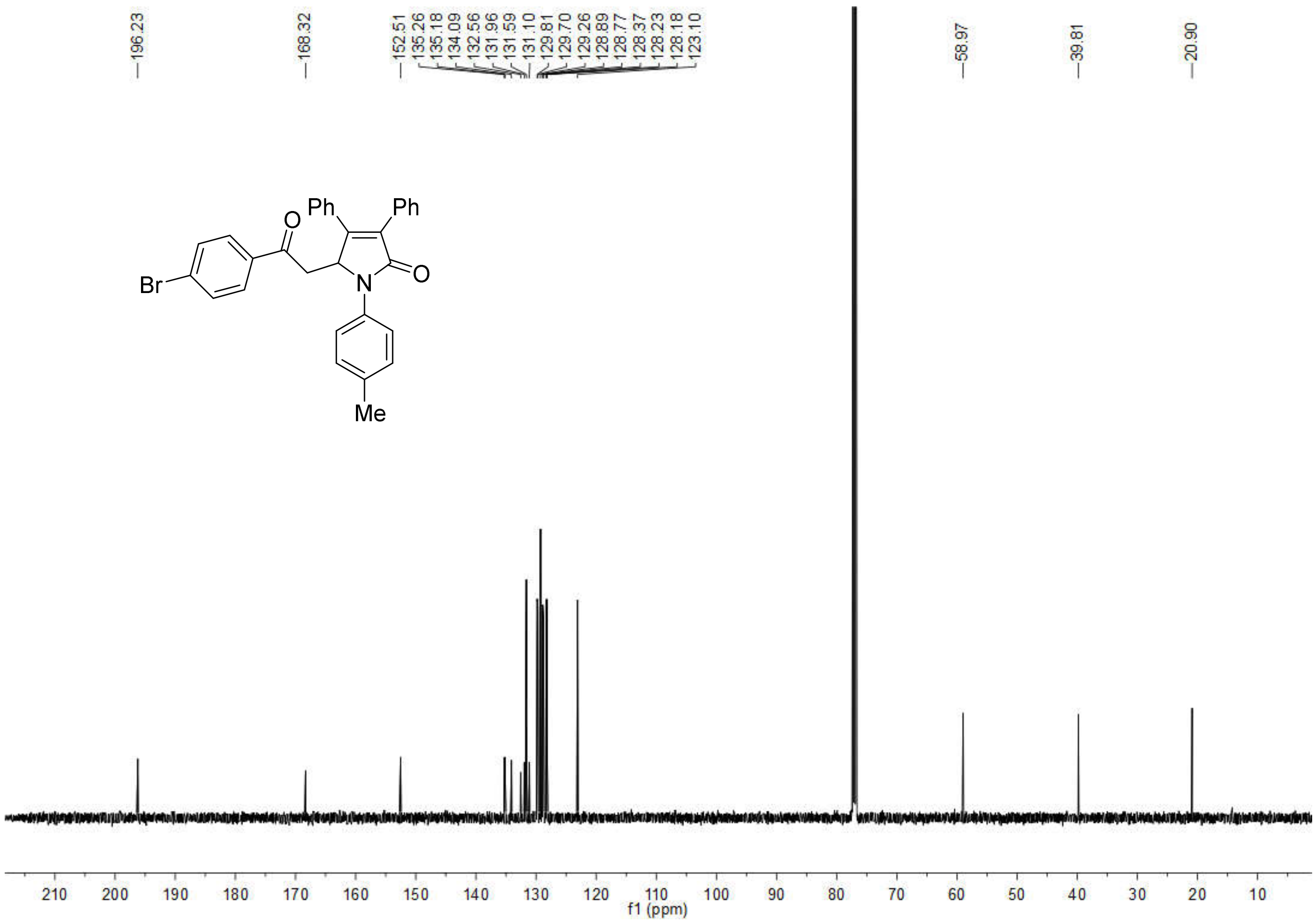


Figure S99. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5q**

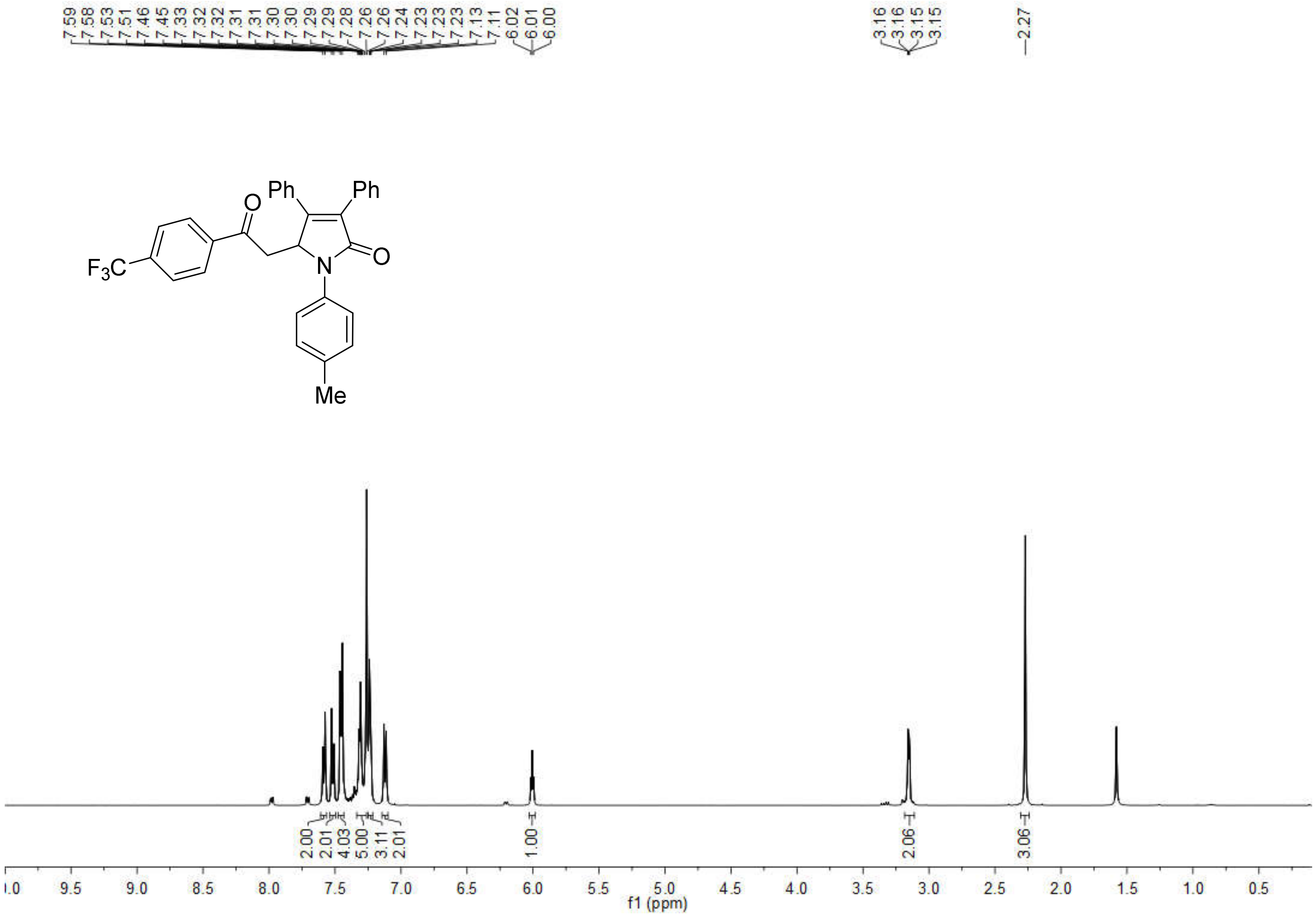


Figure S100. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5r**

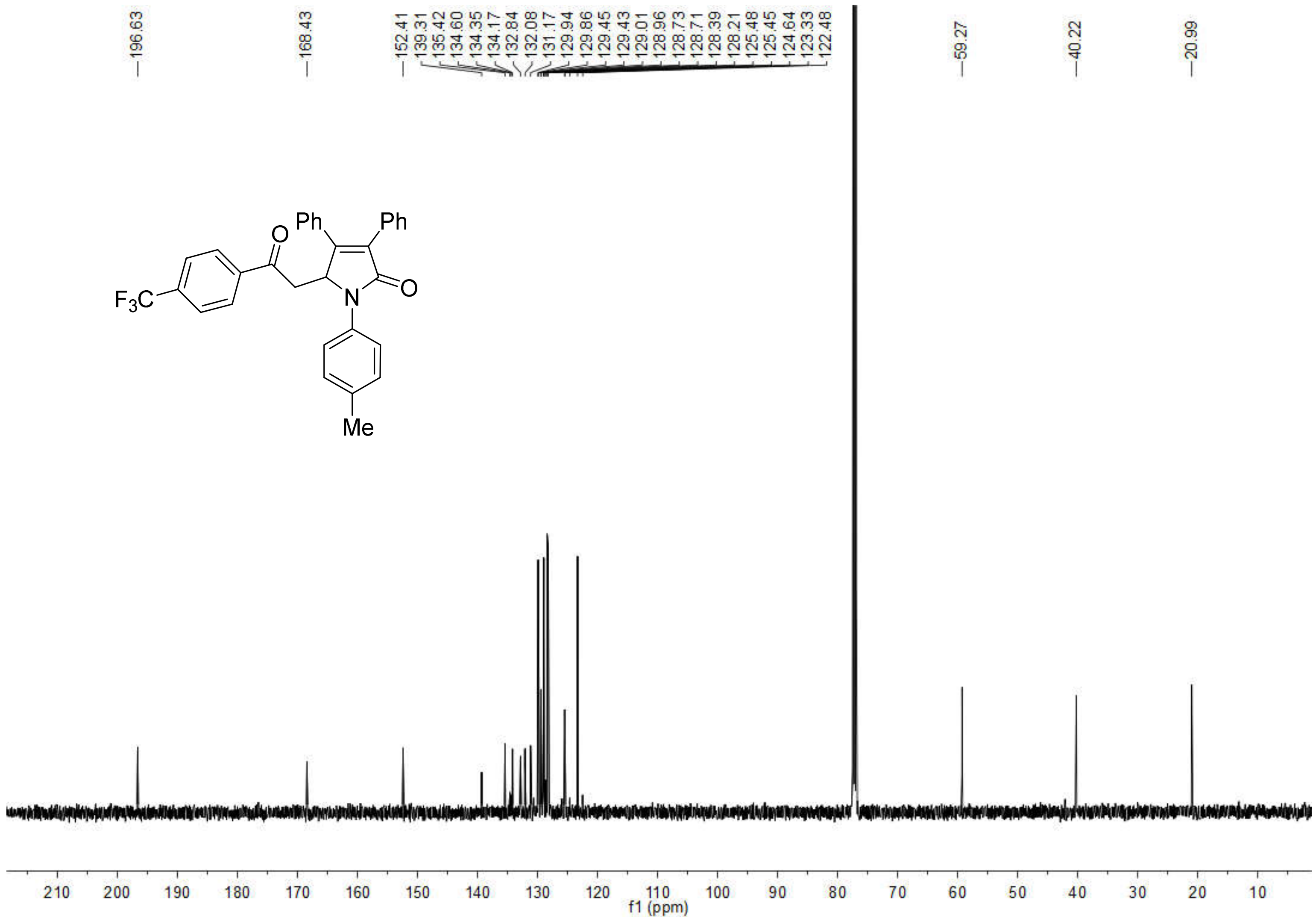


Figure S101. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5r**

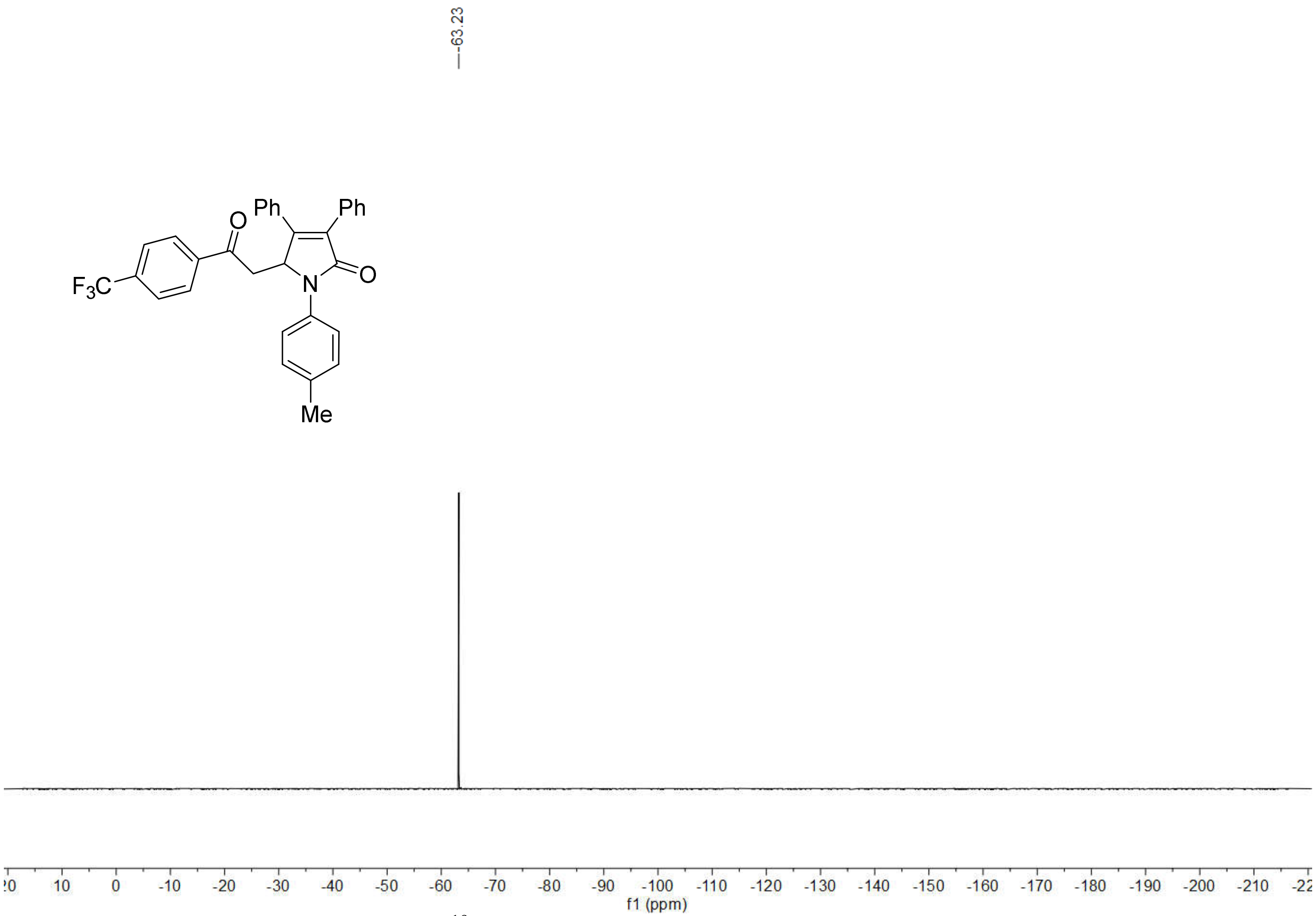


Figure S102. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **5r**

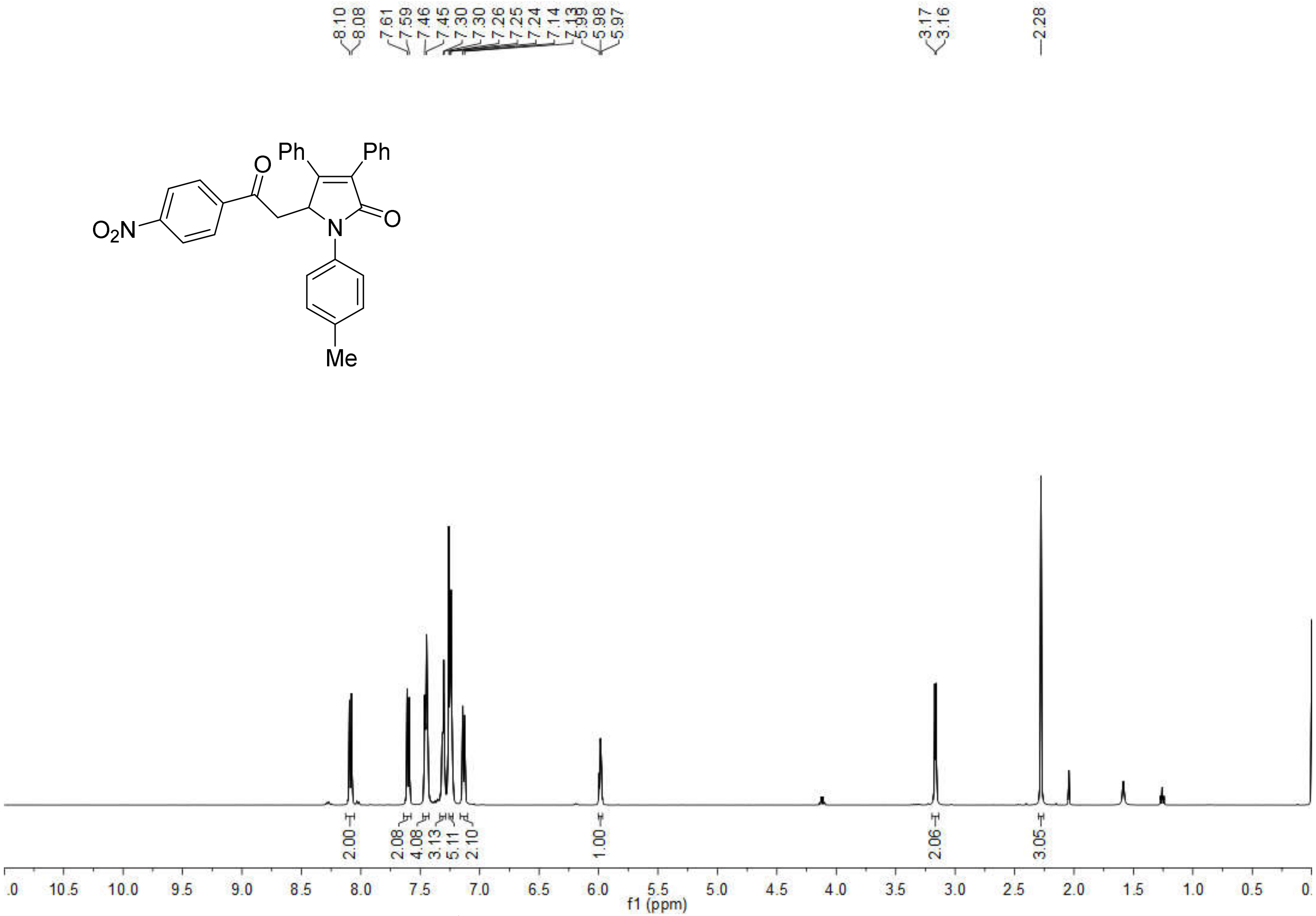


Figure S103. [1]H NMR (500 MHz, $CDCl_3$) spectra of compound **5s**

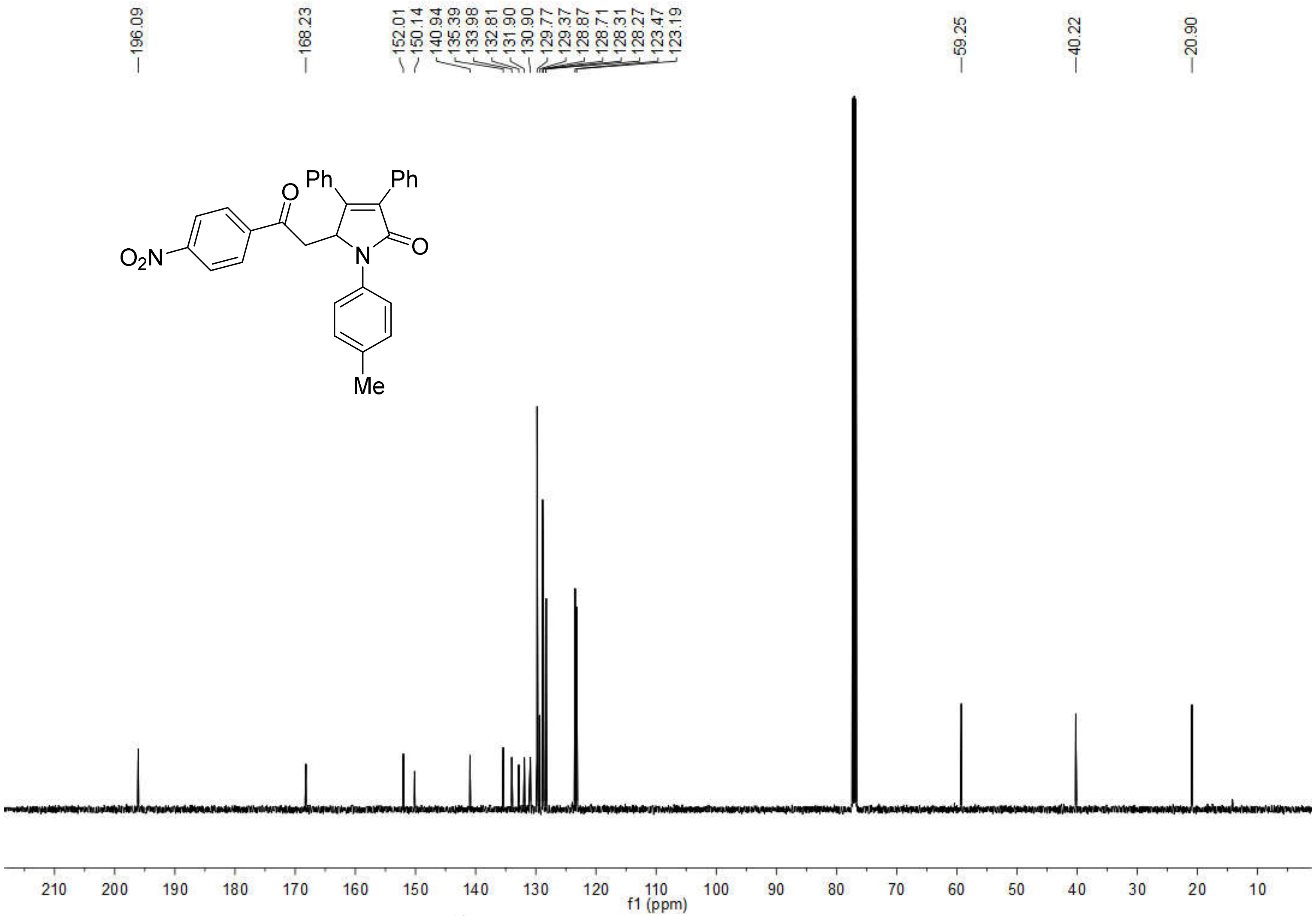


Figure S104. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5s**

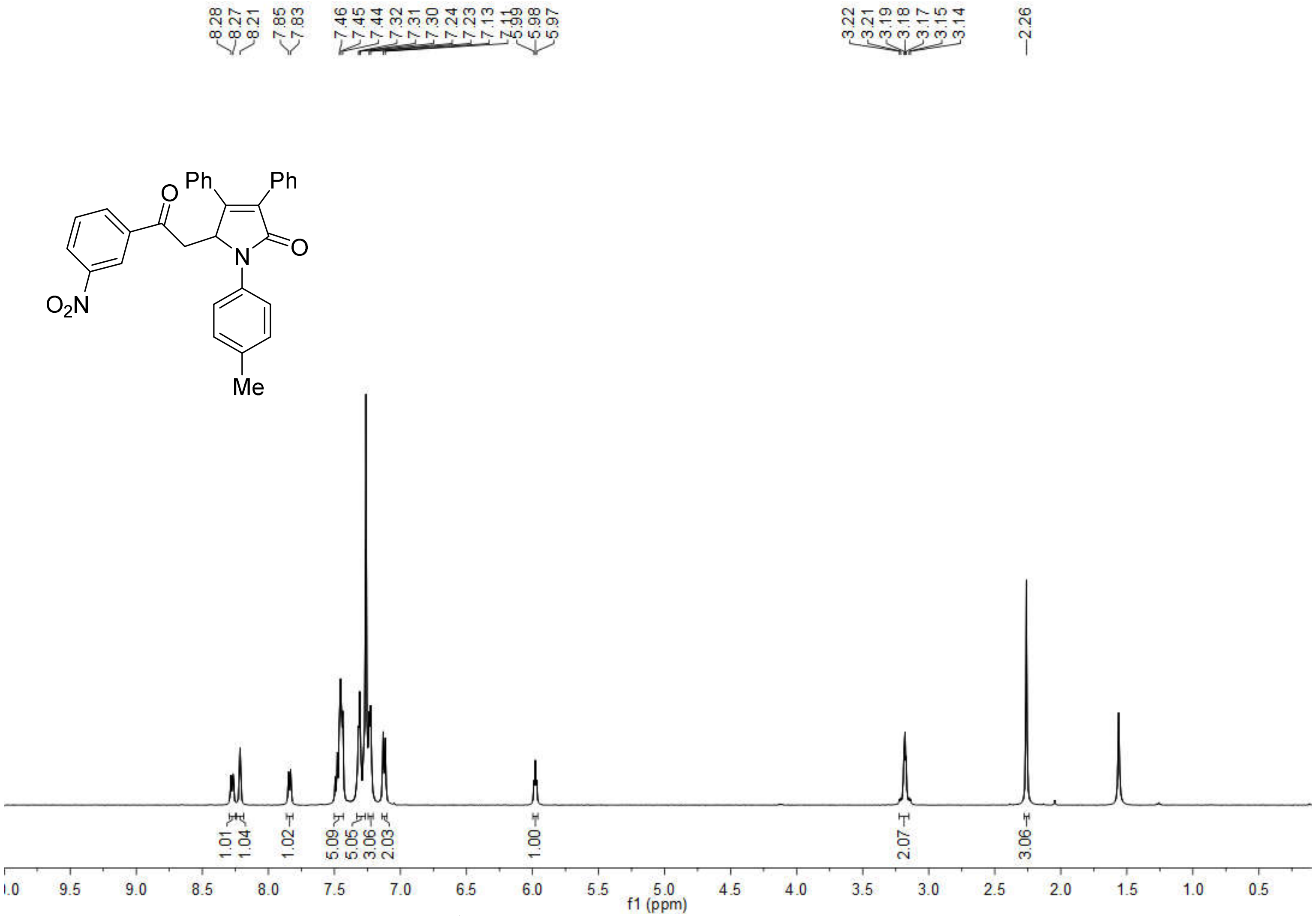


Figure S105. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5t**

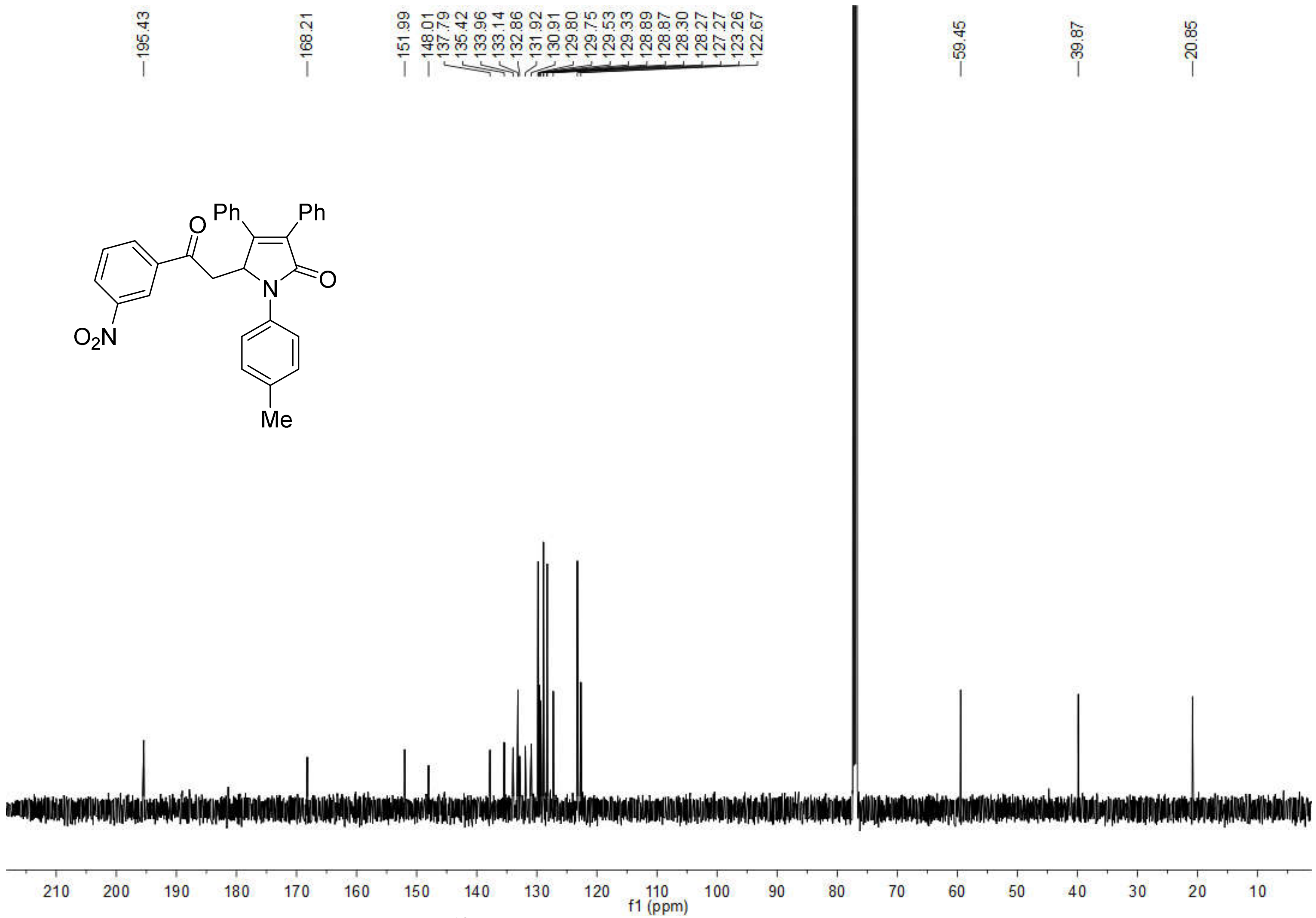


Figure S106. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5t**

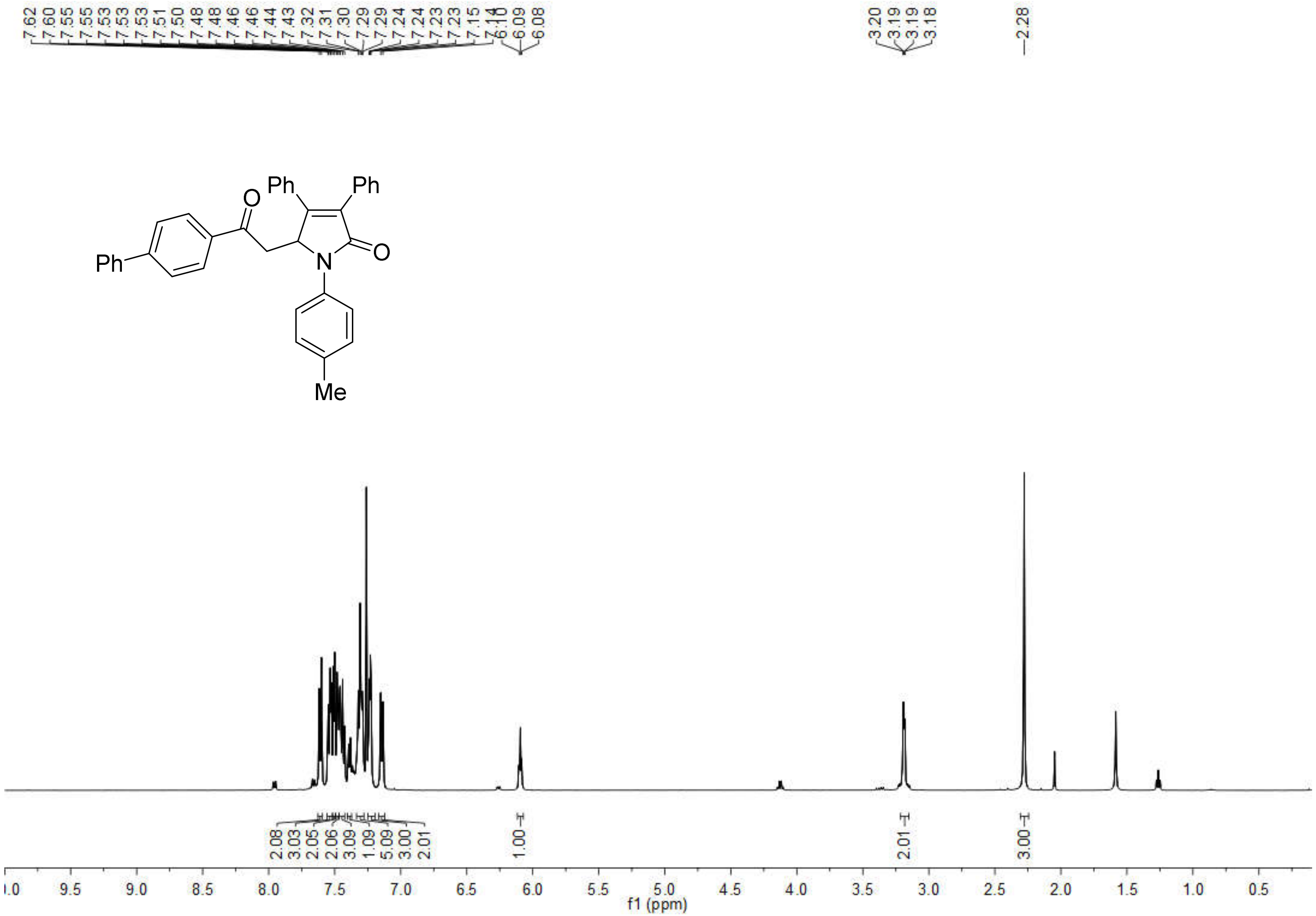


Figure S107. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5u**

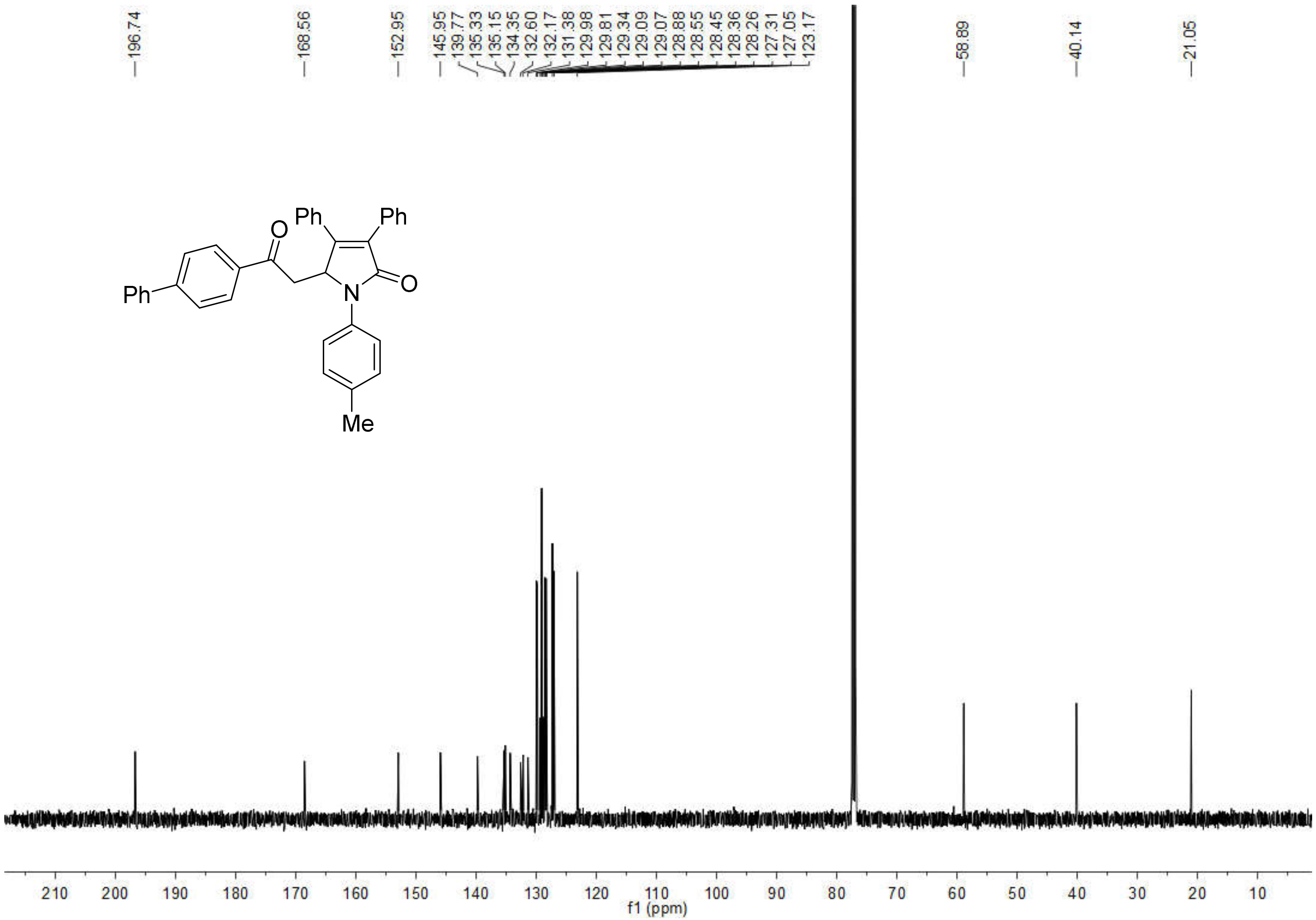


Figure S108. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5u**

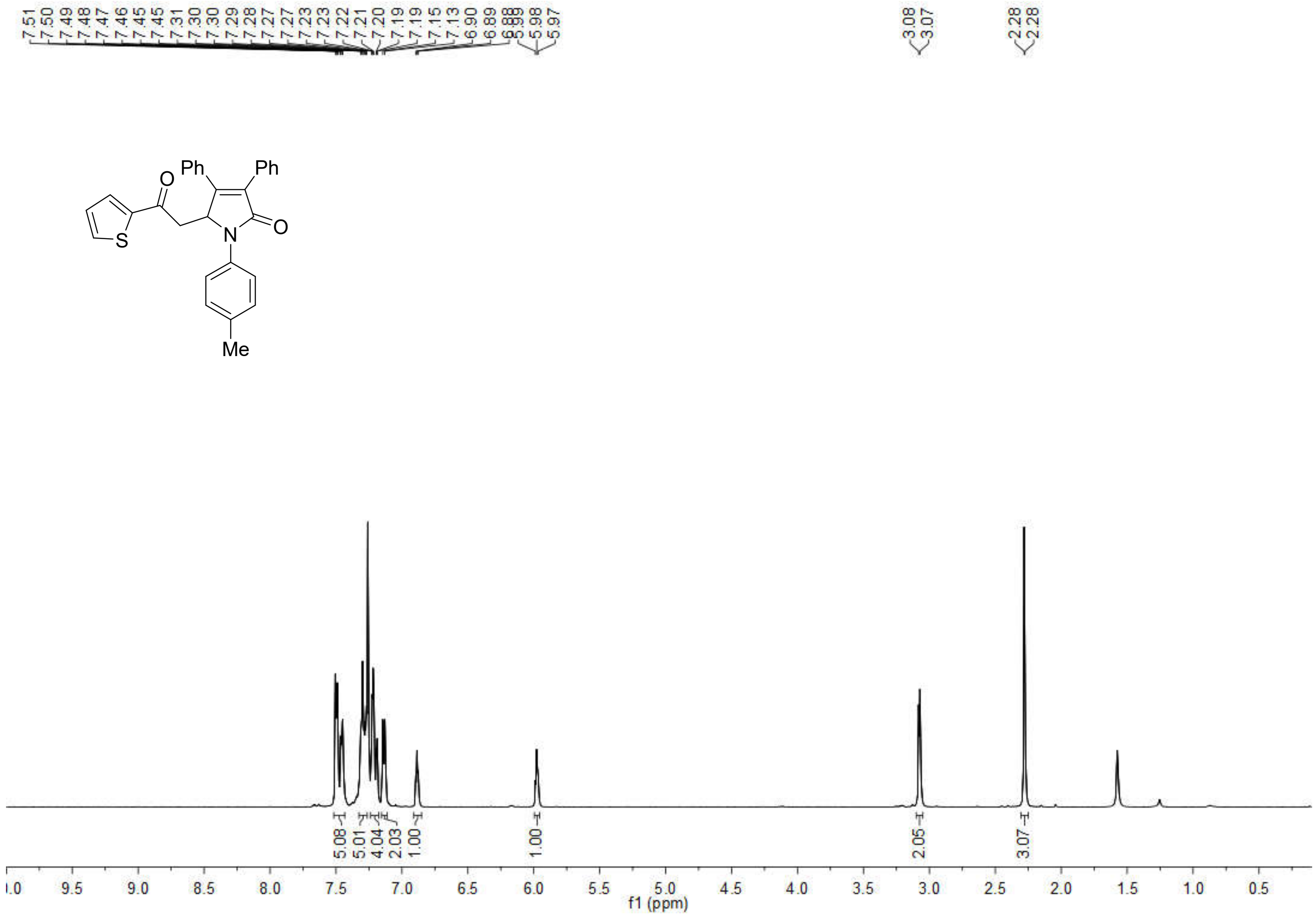


Figure S109. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5v**

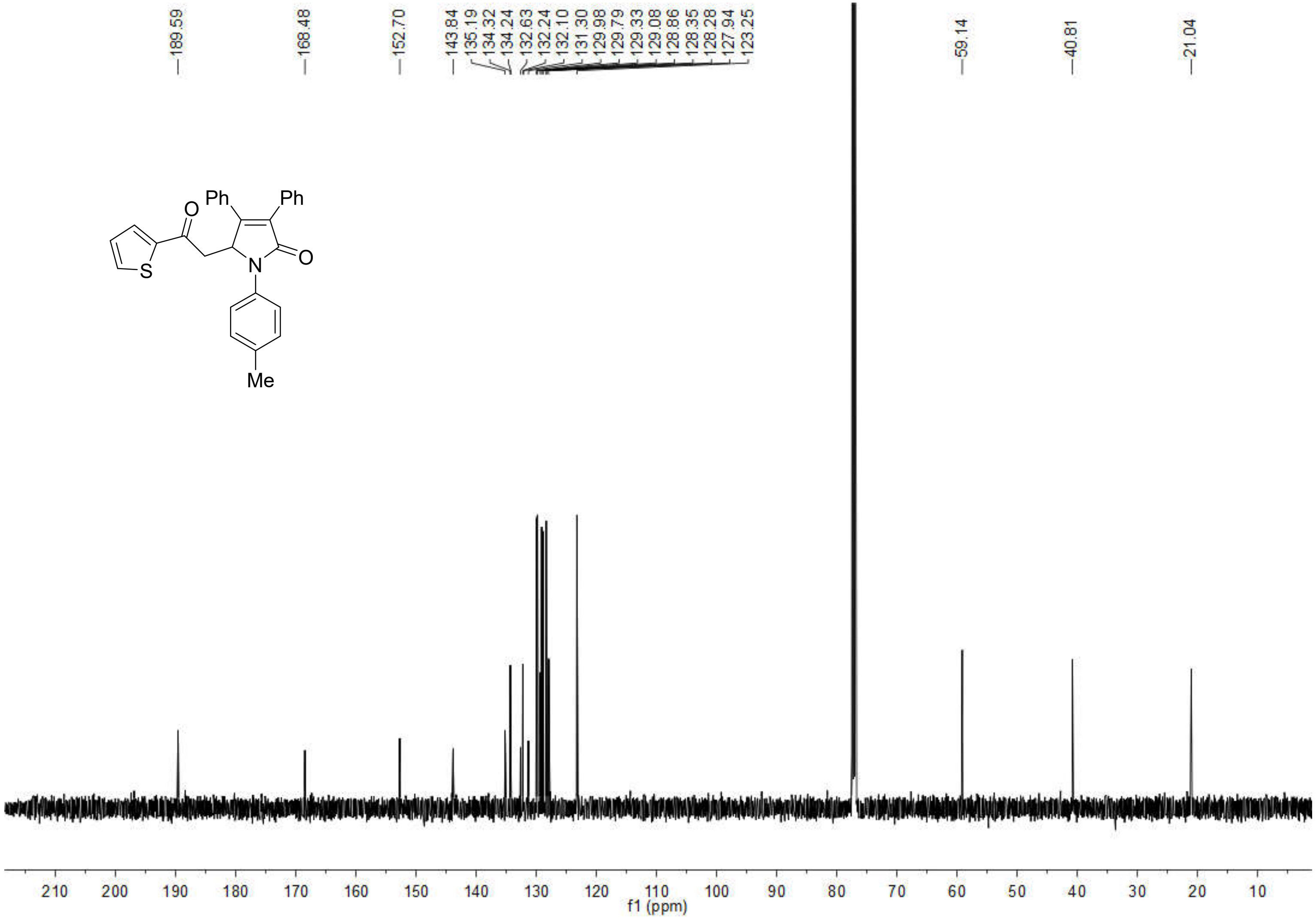


Figure S110. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5v**

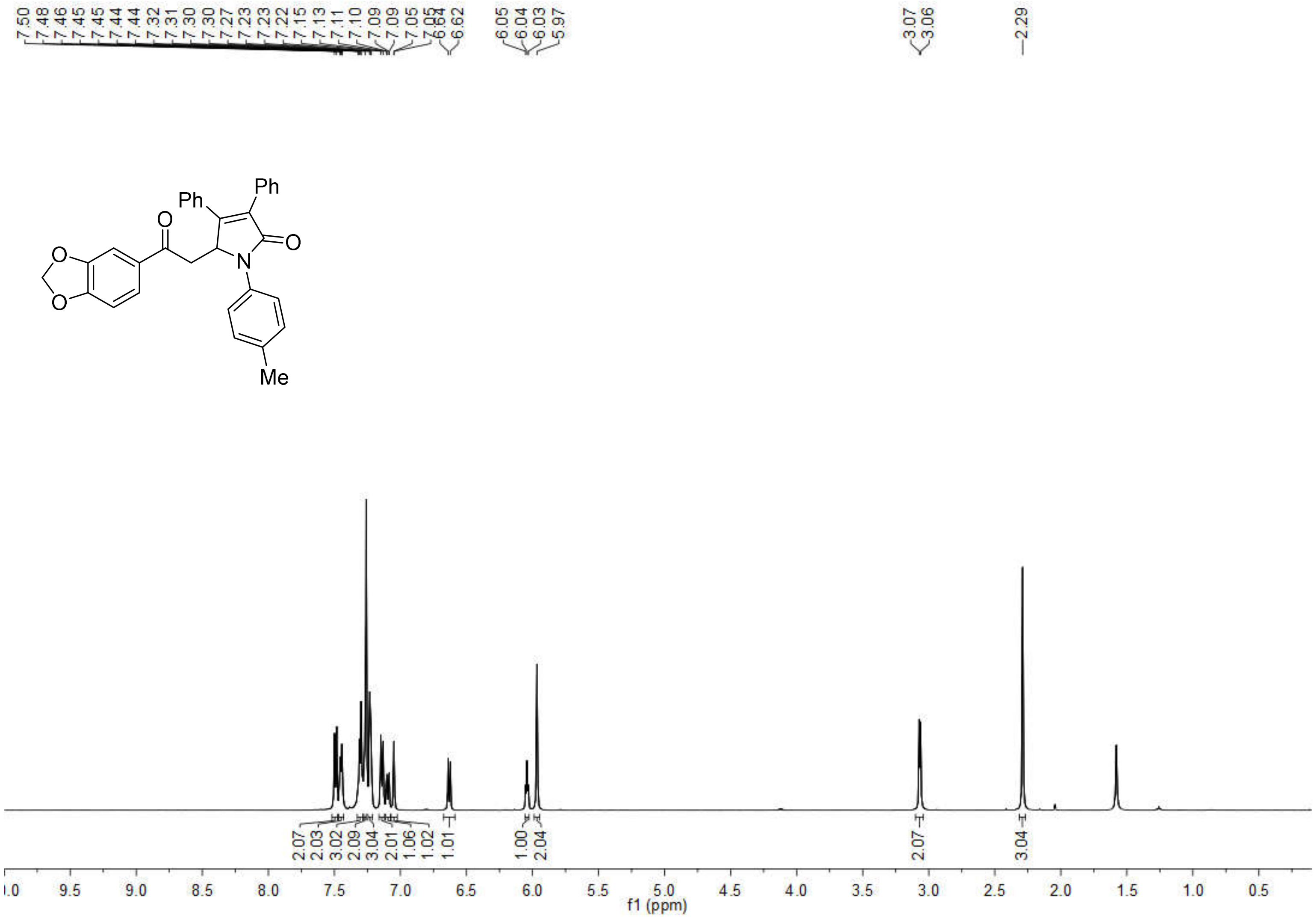


Figure S111. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5w**

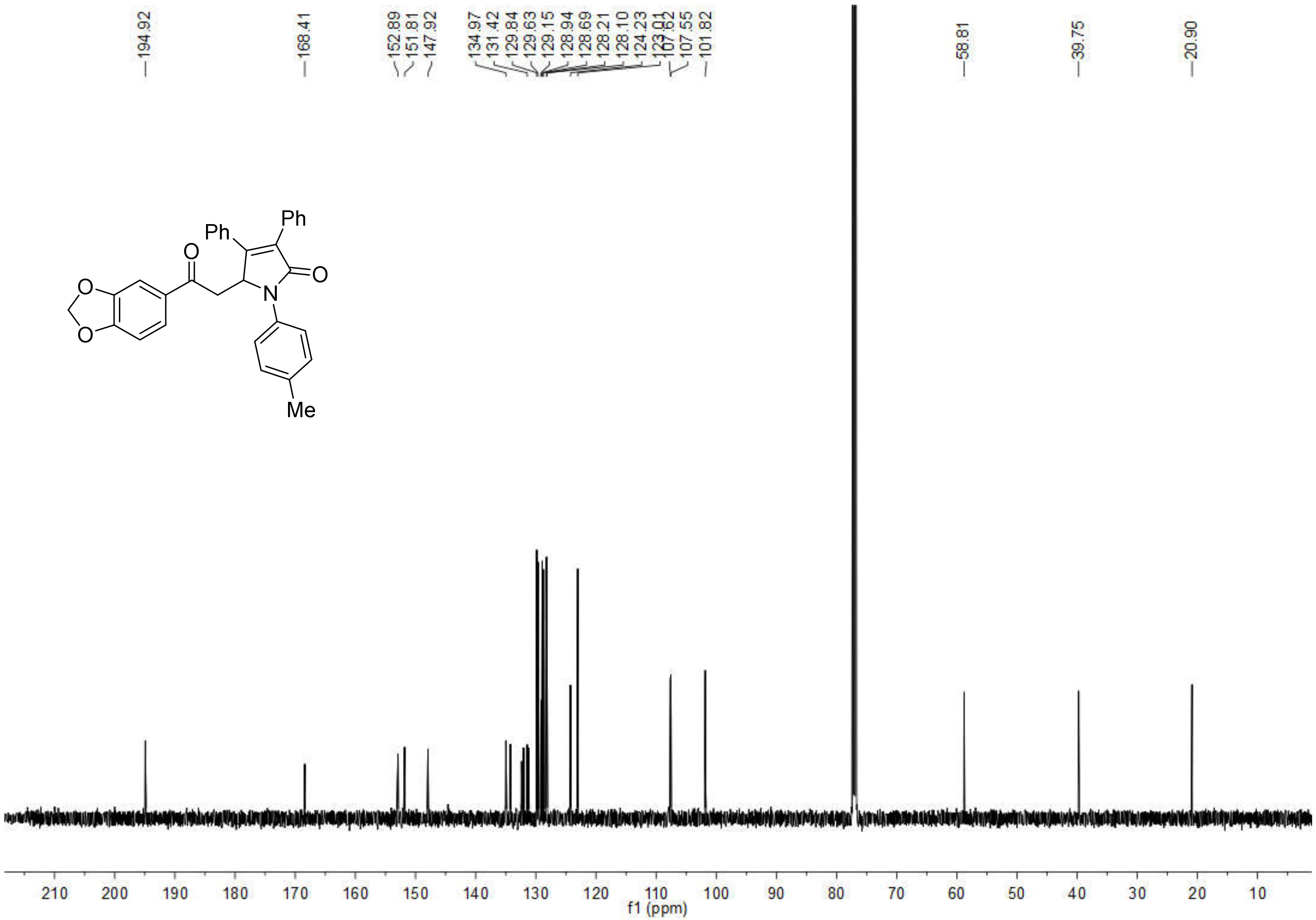


Figure S112. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5w**

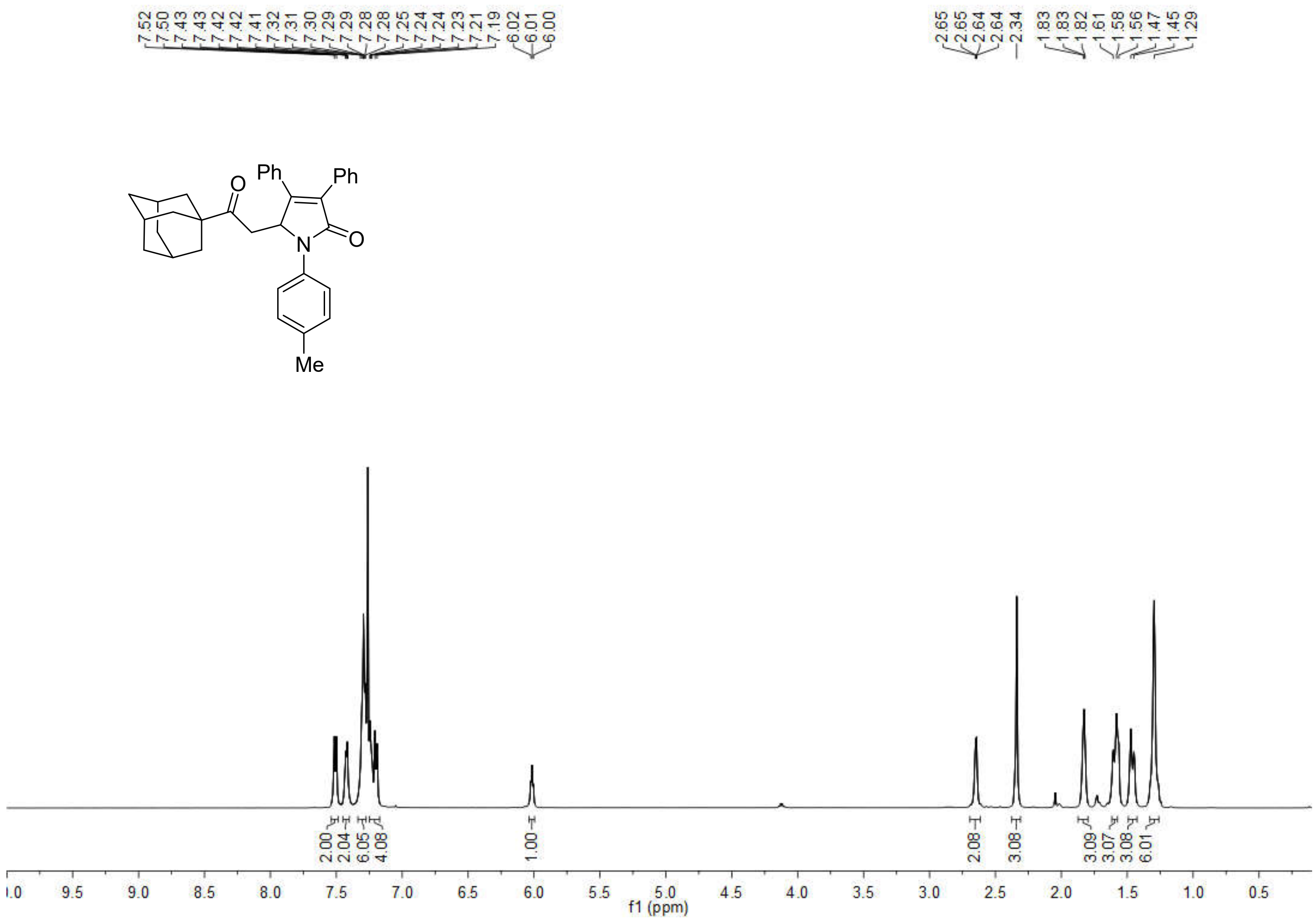


Figure S113. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5x**

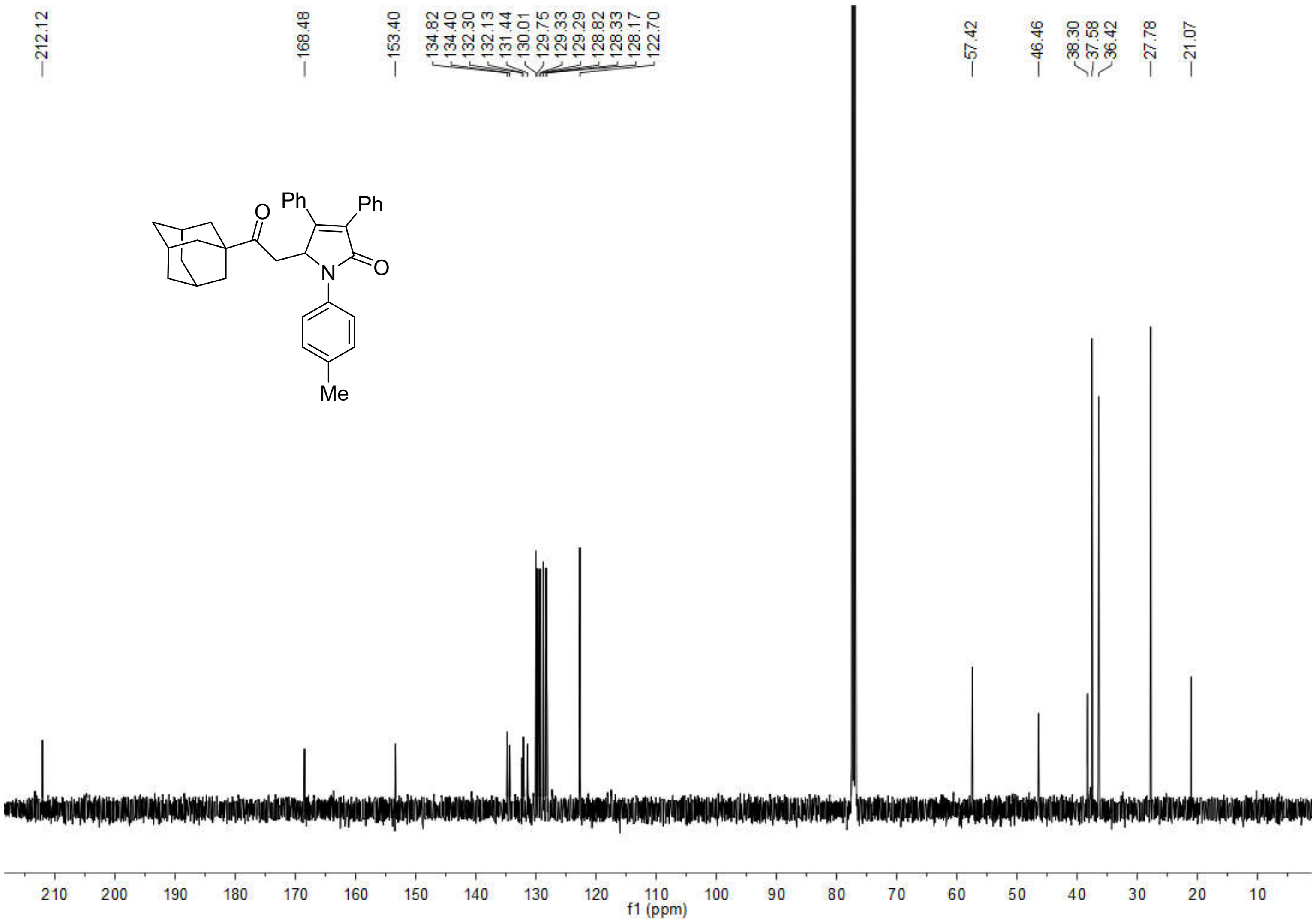


Figure S114. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5x**

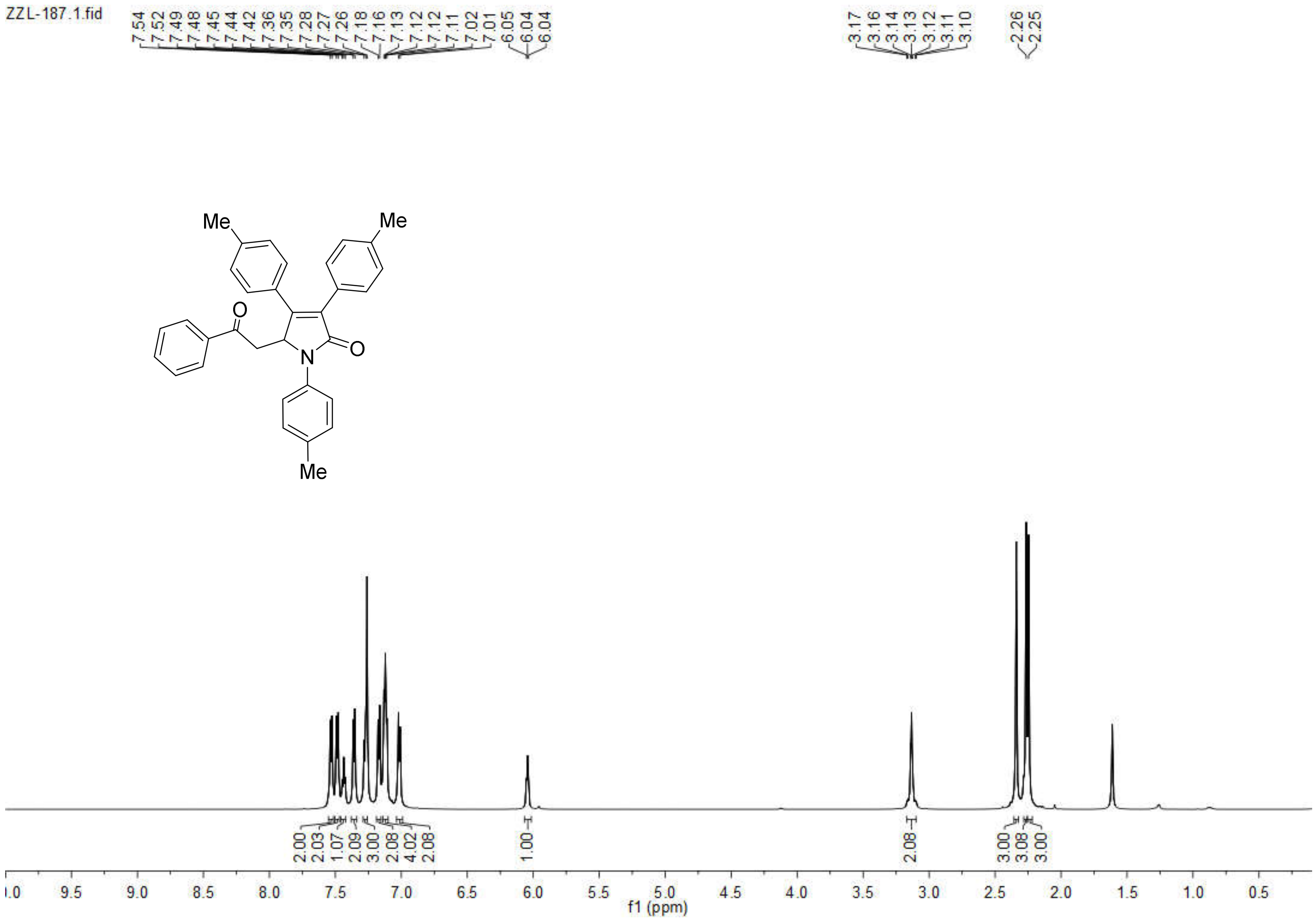


Figure S115. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **5y**

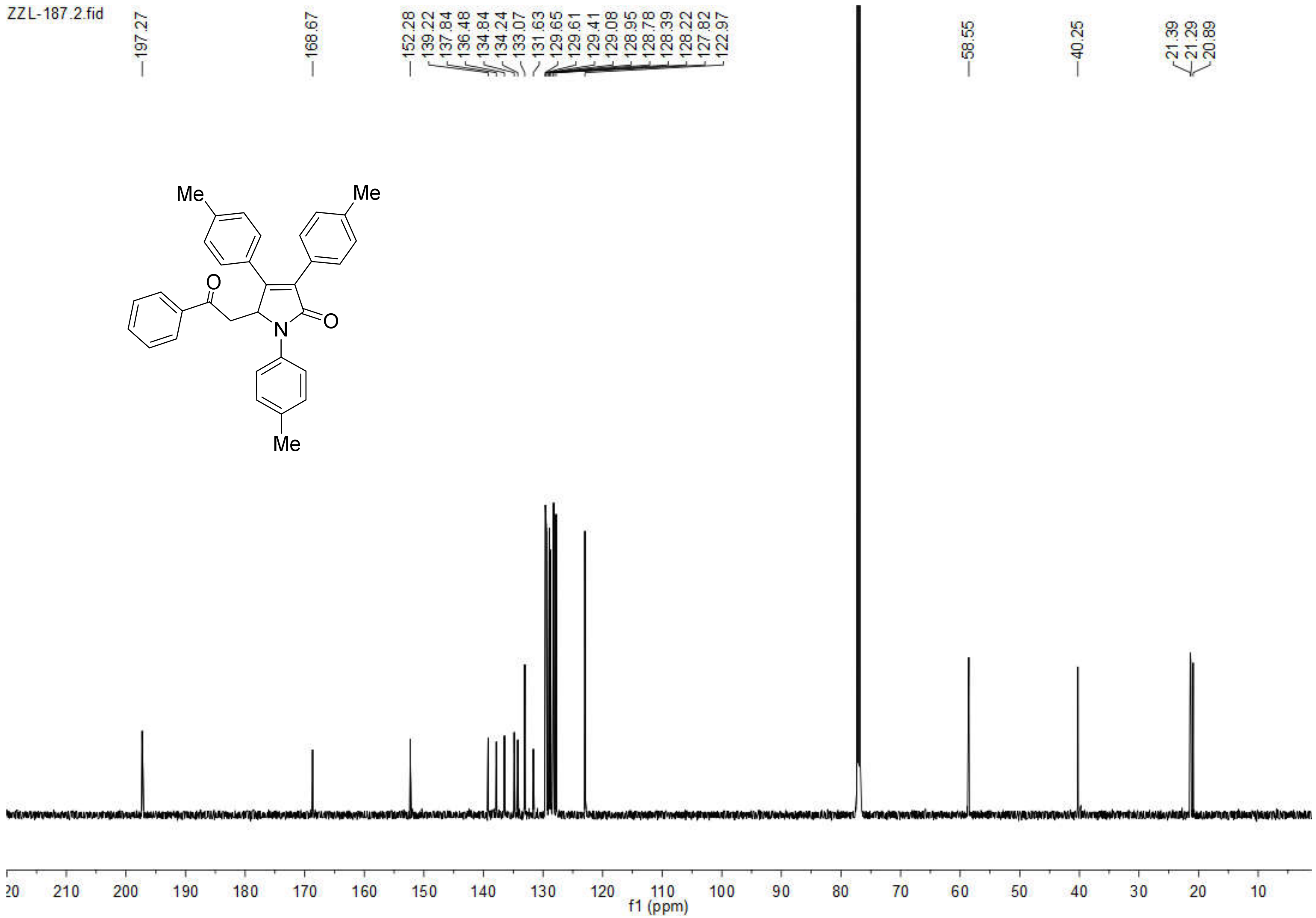


Figure S116. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5y**

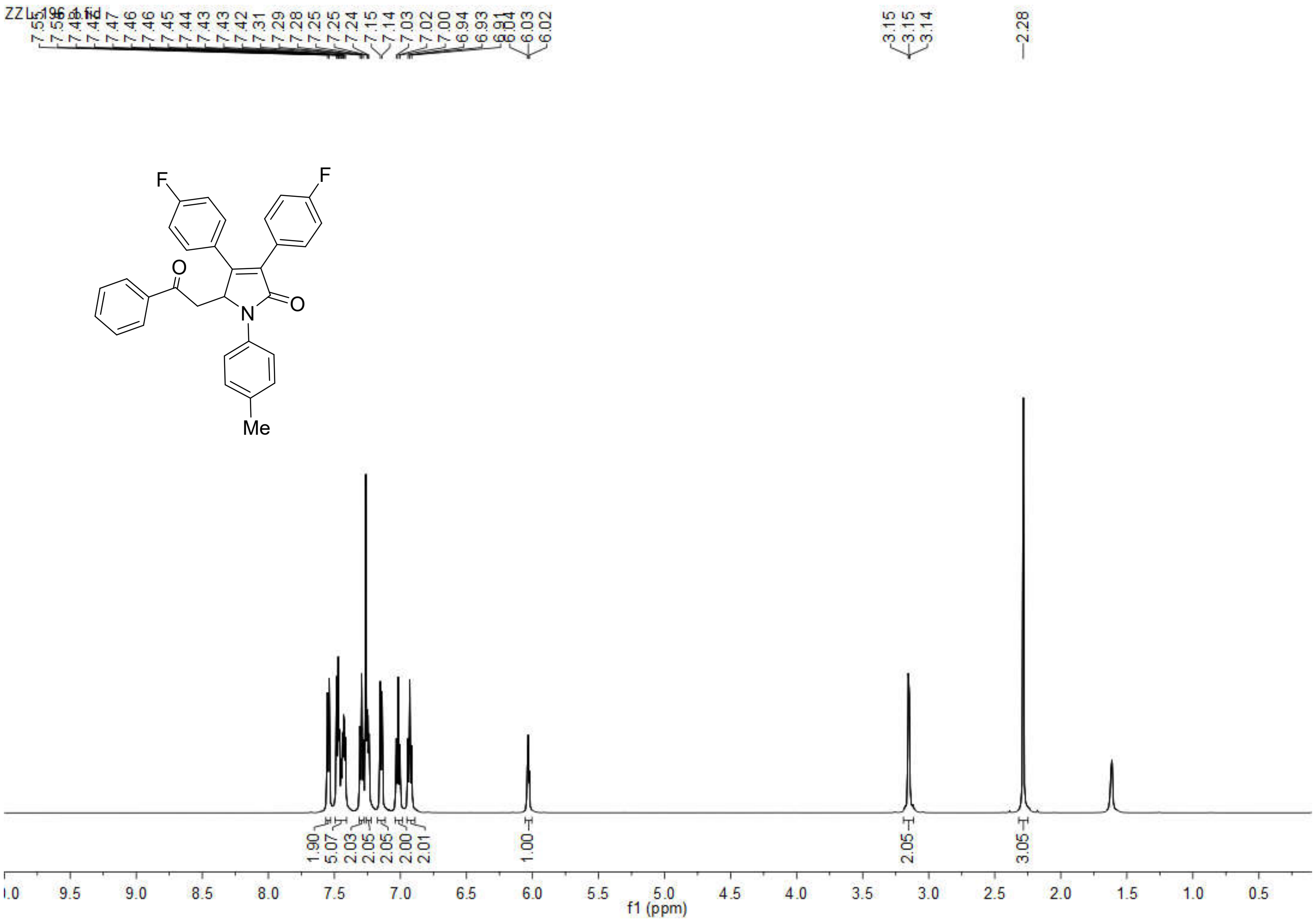


Figure S117. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **5z**

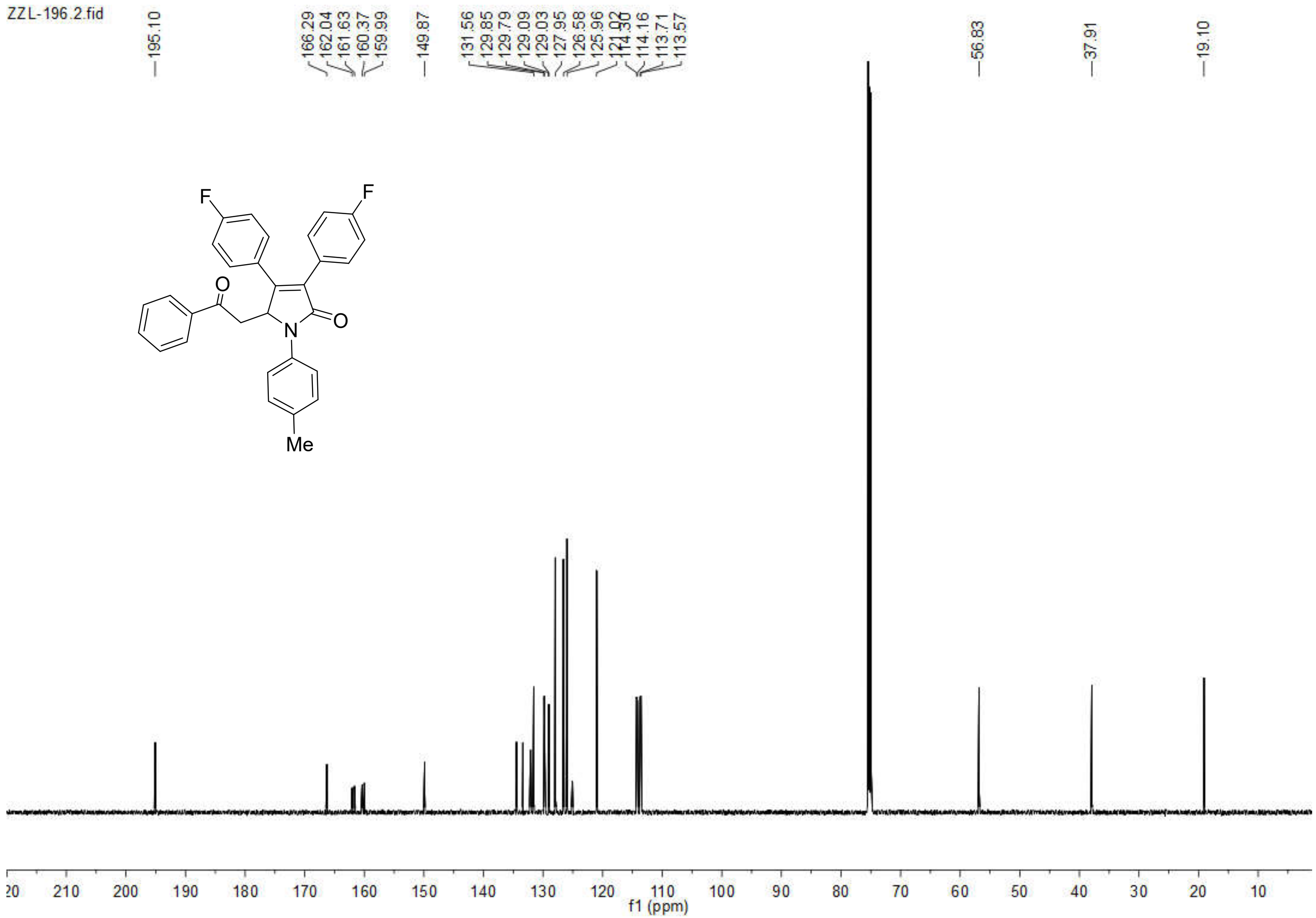


Figure S118. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5z**

Figure S119. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **5z**

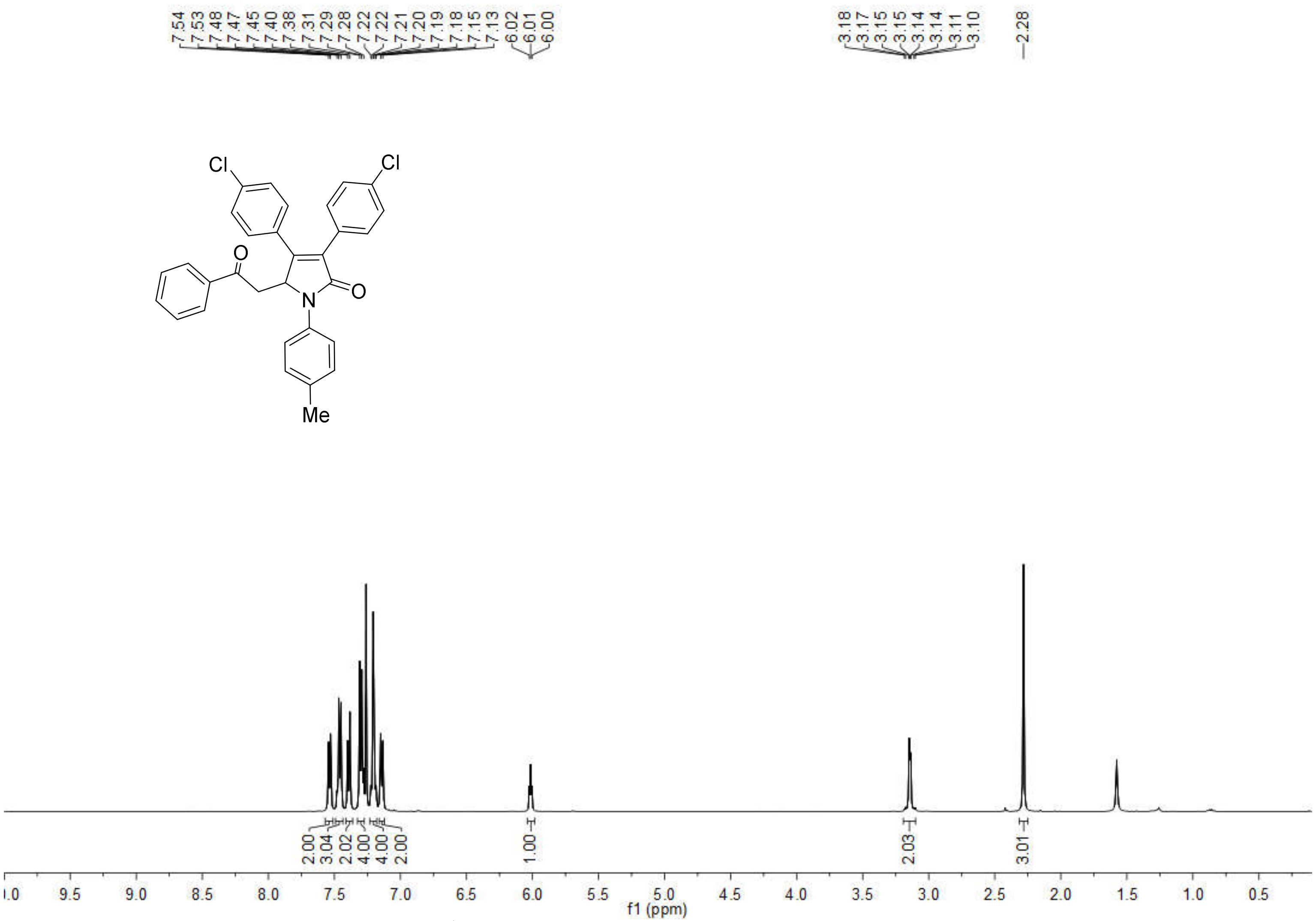


Figure S120. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **5a'**

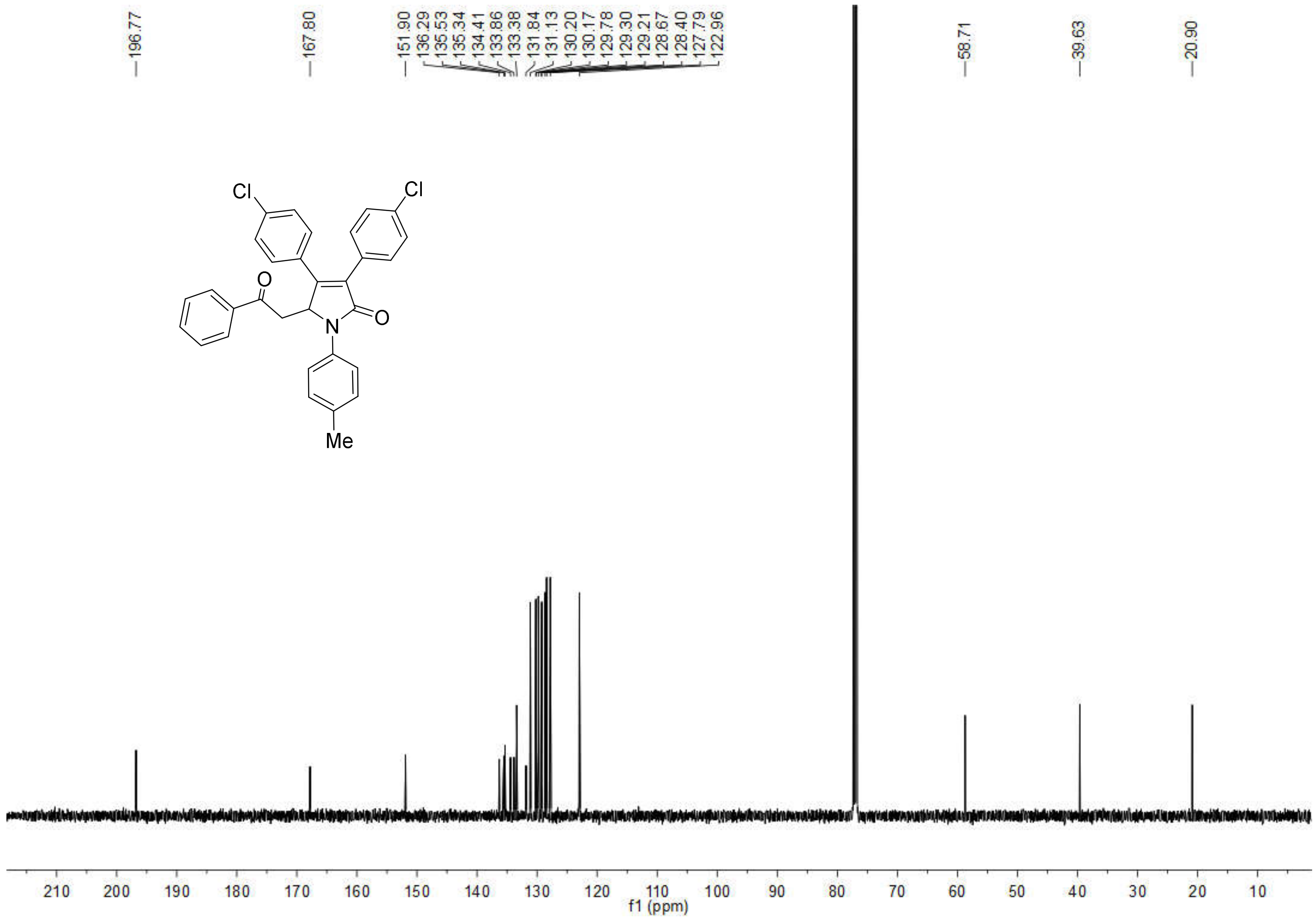


Figure S121. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **5a'**

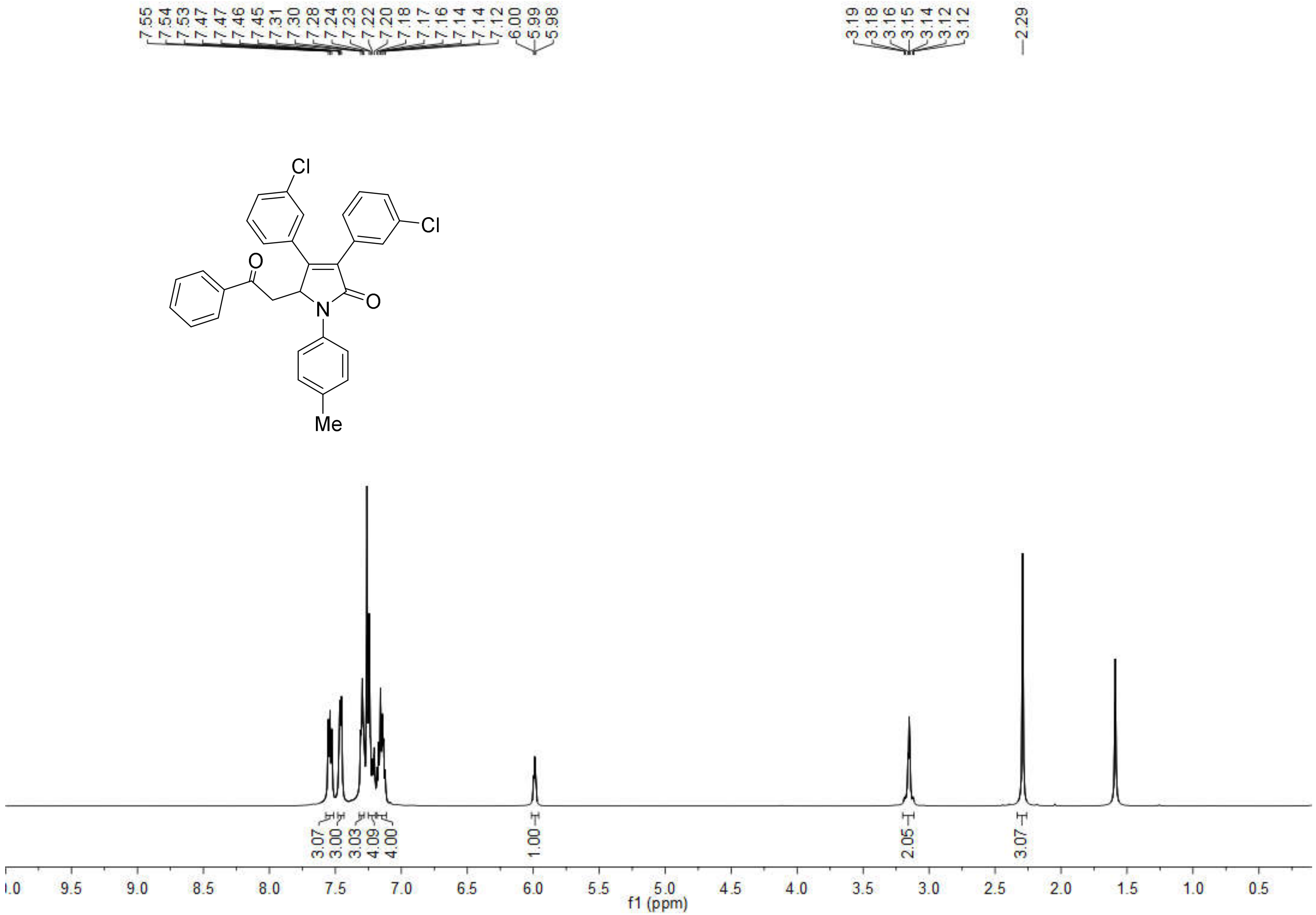


Figure S122. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **5b'**

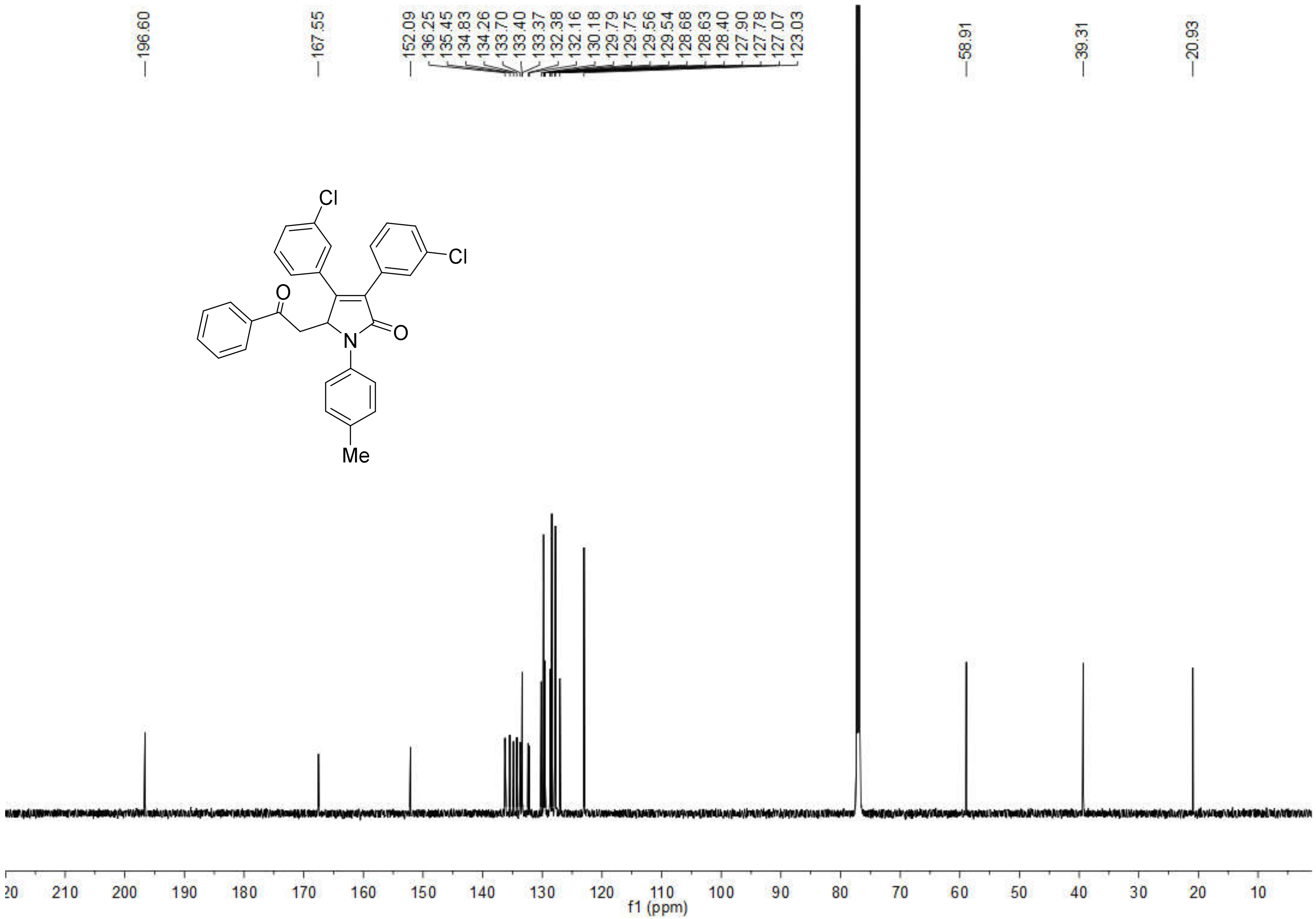


Figure S123. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5b'**

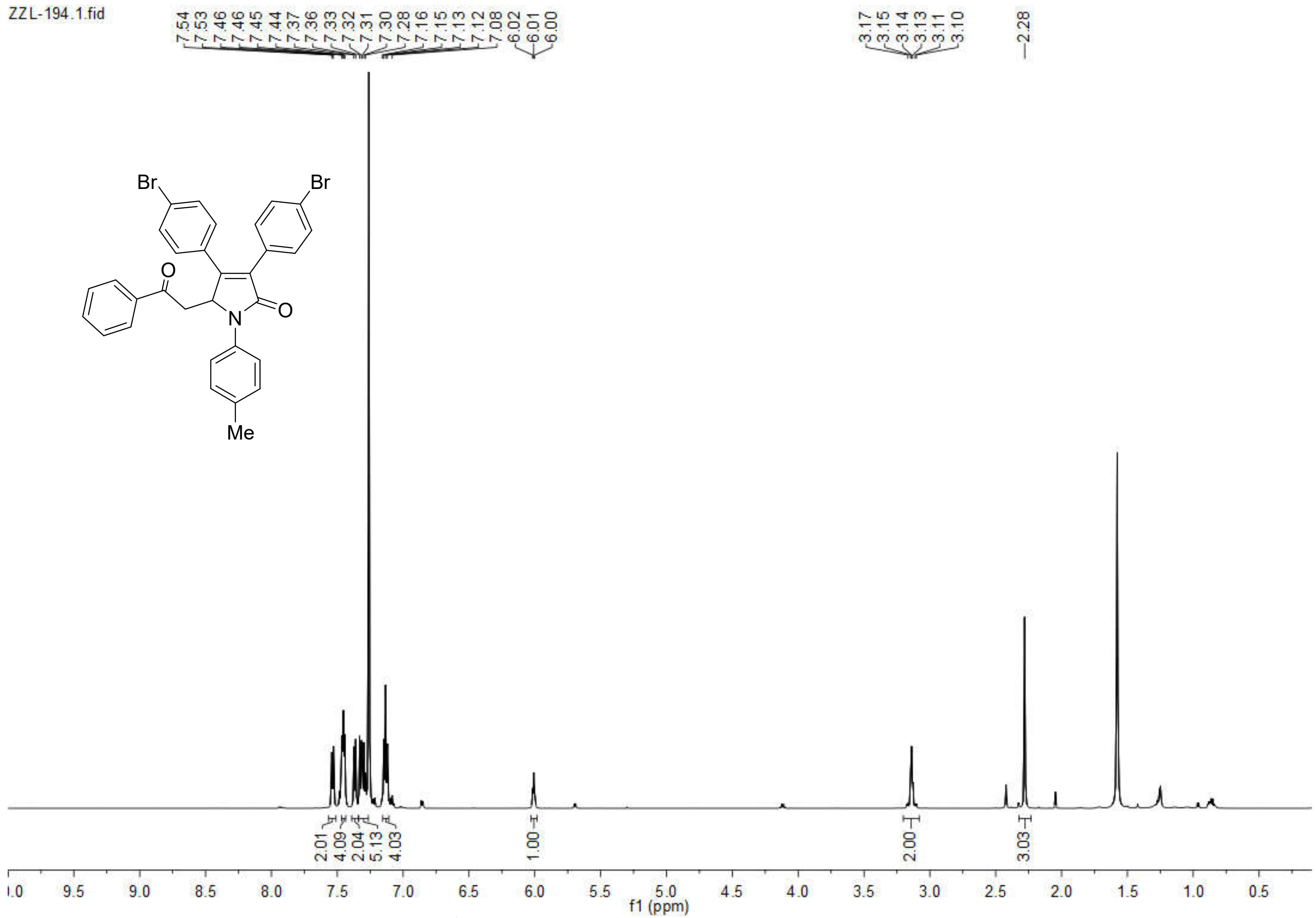


Figure S124. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **5c'**

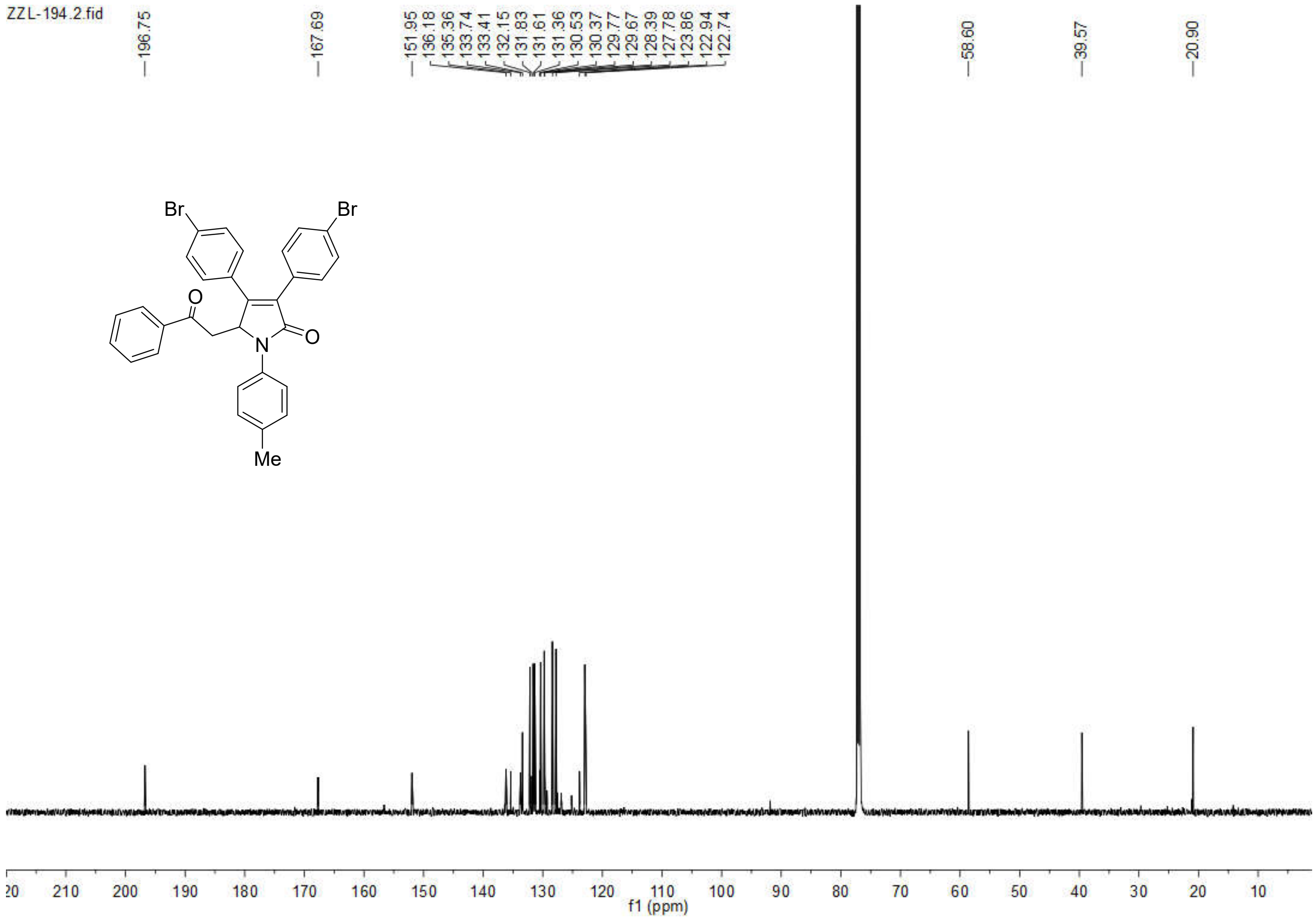


Figure S125. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **5c'**

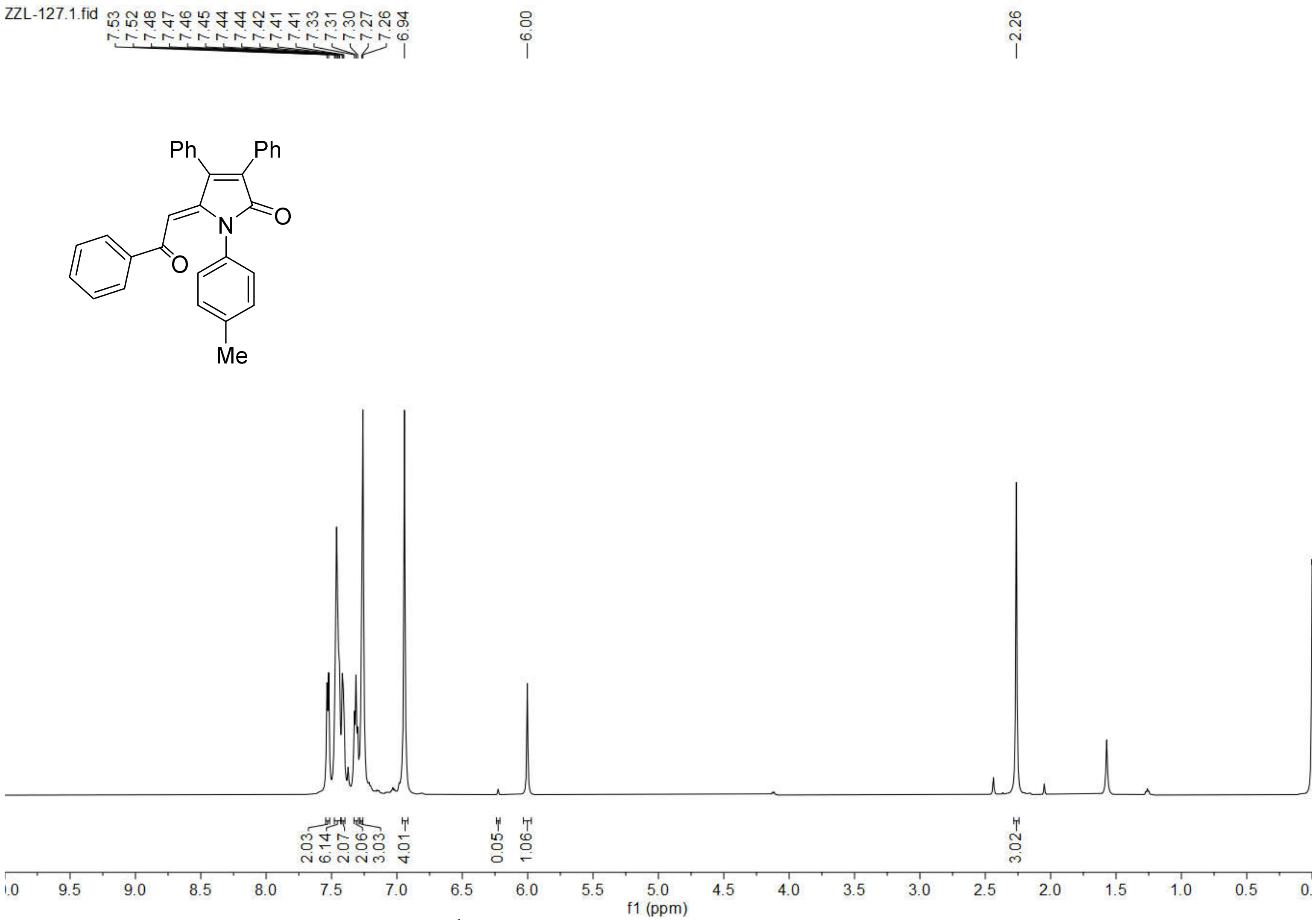


Figure S126. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7a**

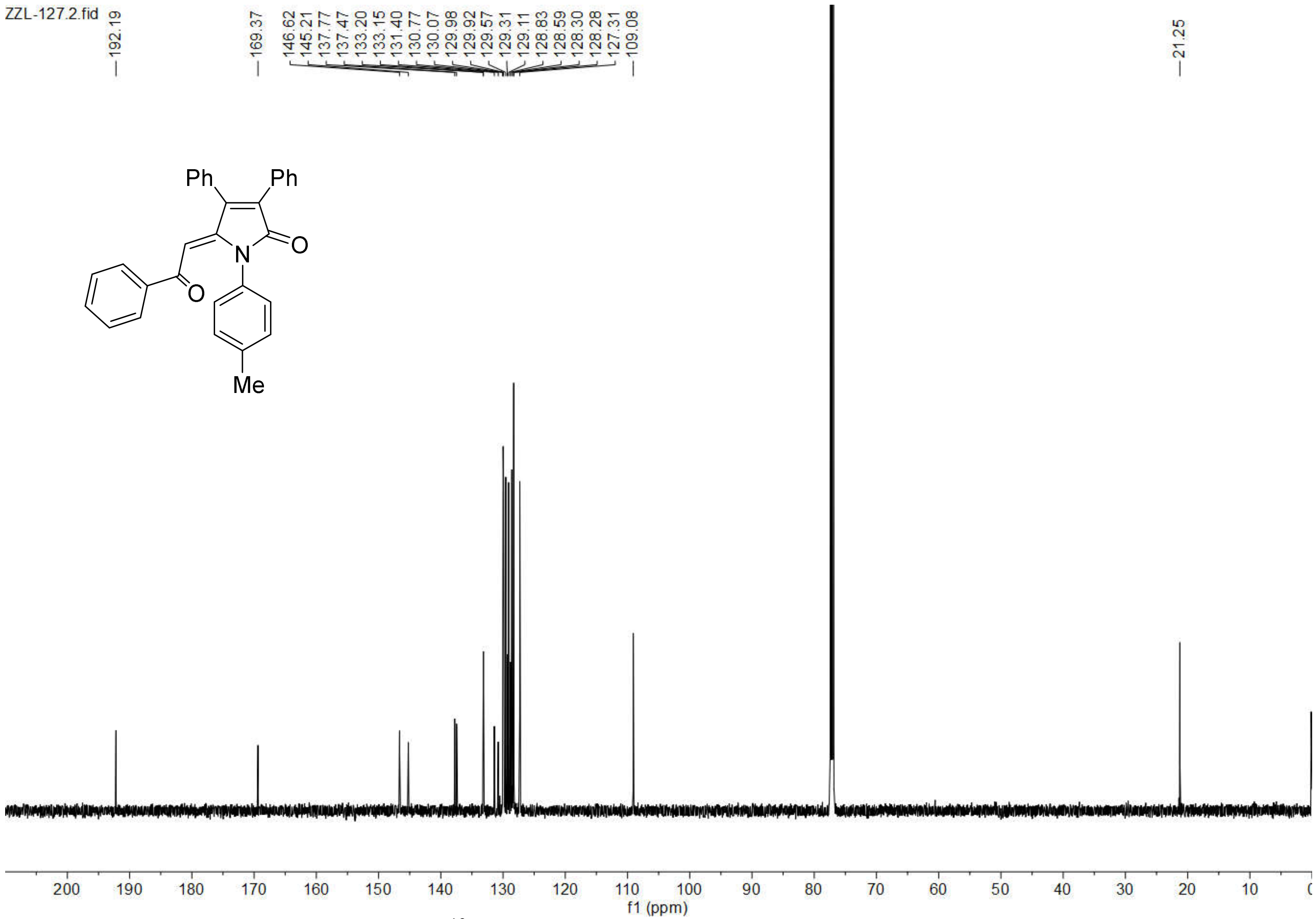


Figure S127. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7a**

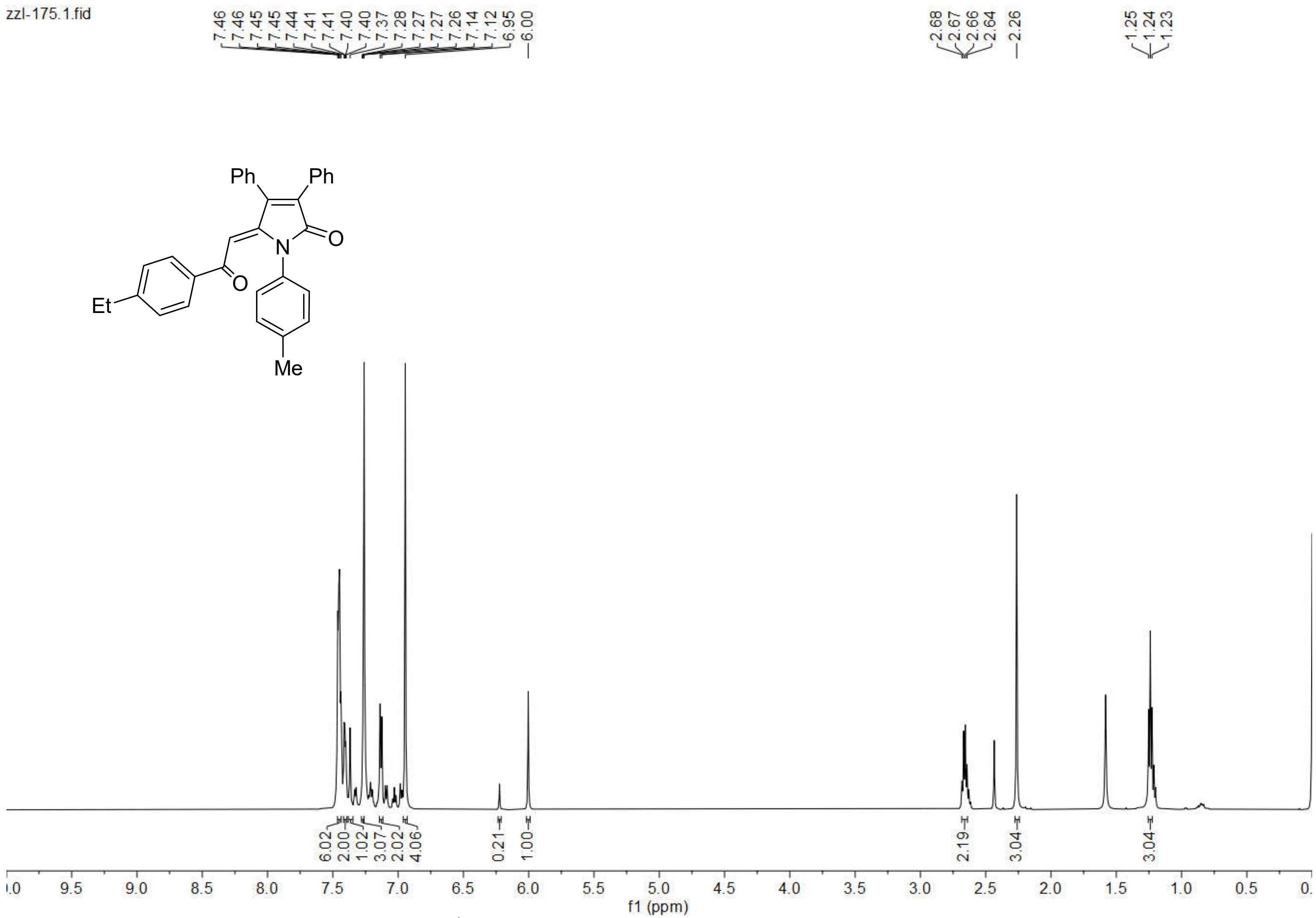


Figure S128. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7b**

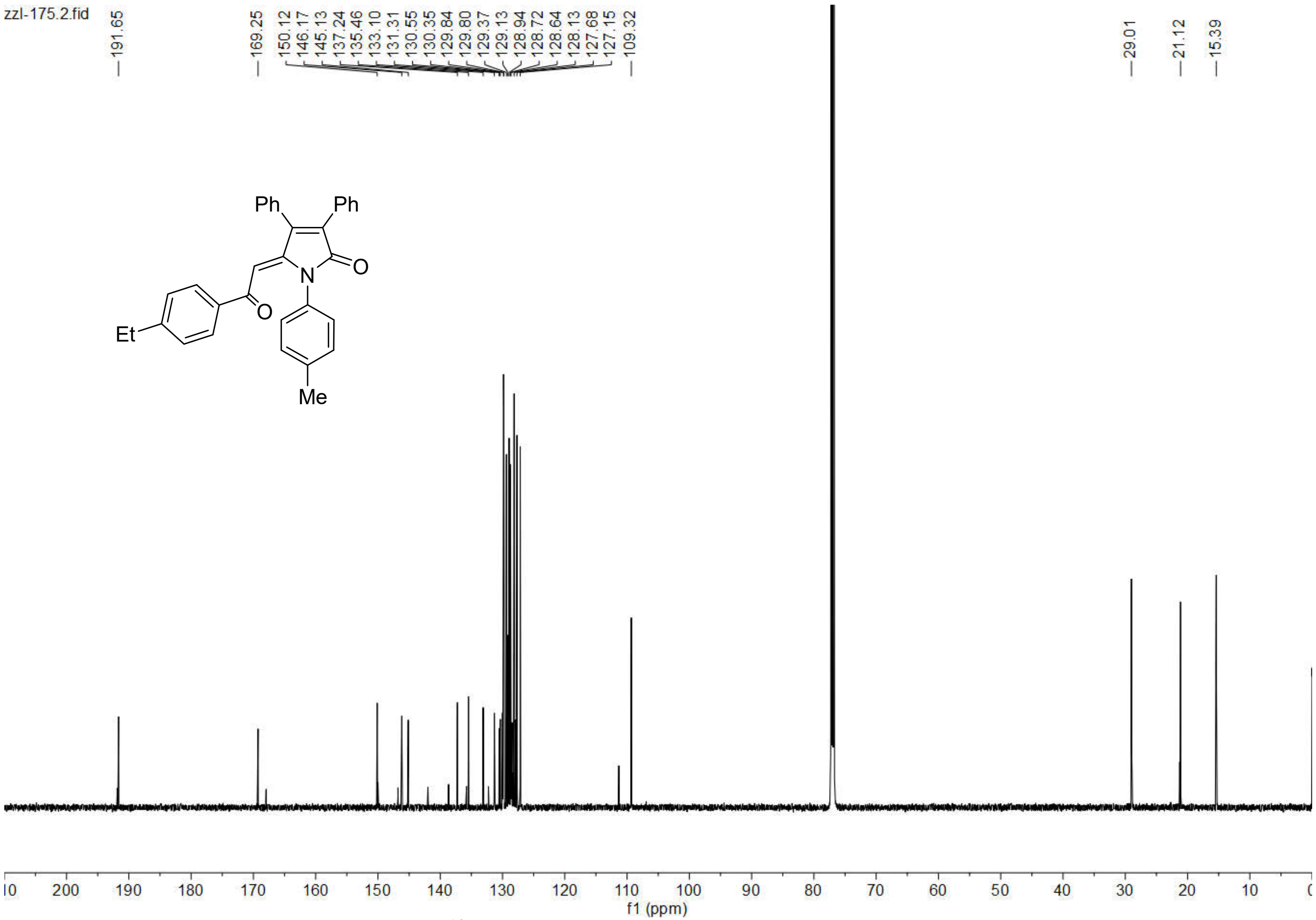


Figure S129. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7b**

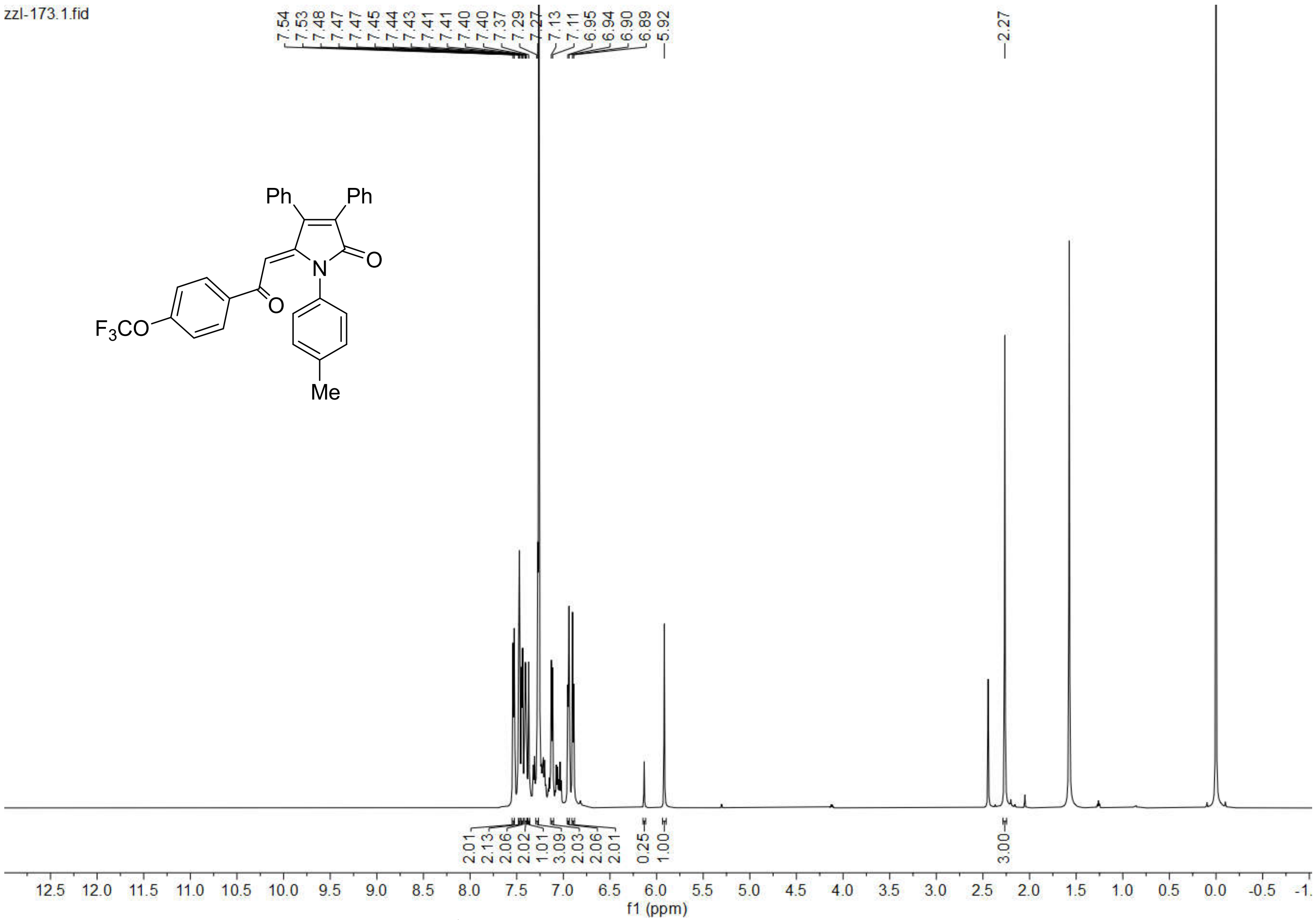


Figure S130. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7c**

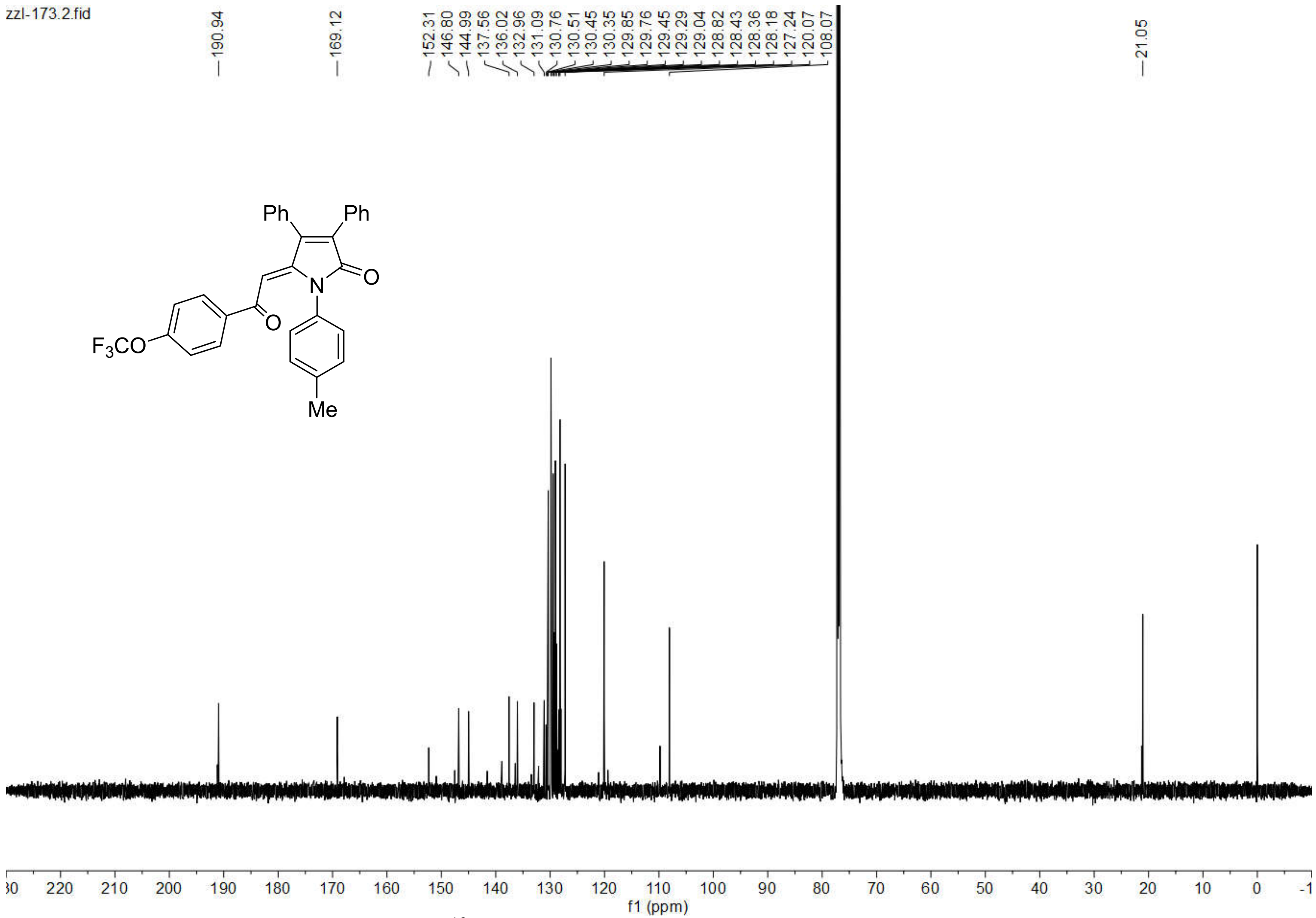


Figure S131. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7c**

Figure S132. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **7c**

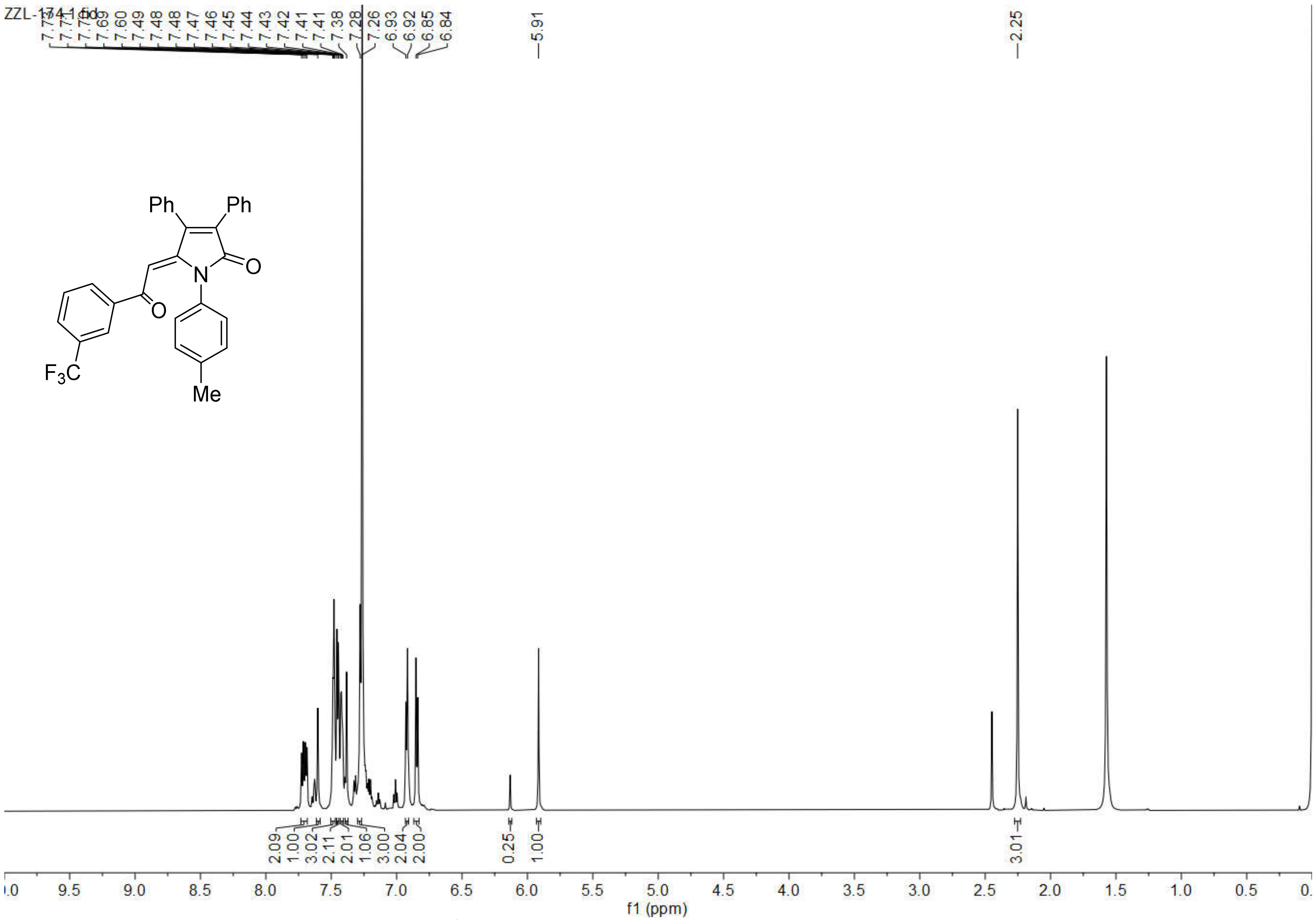


Figure S133. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7d**

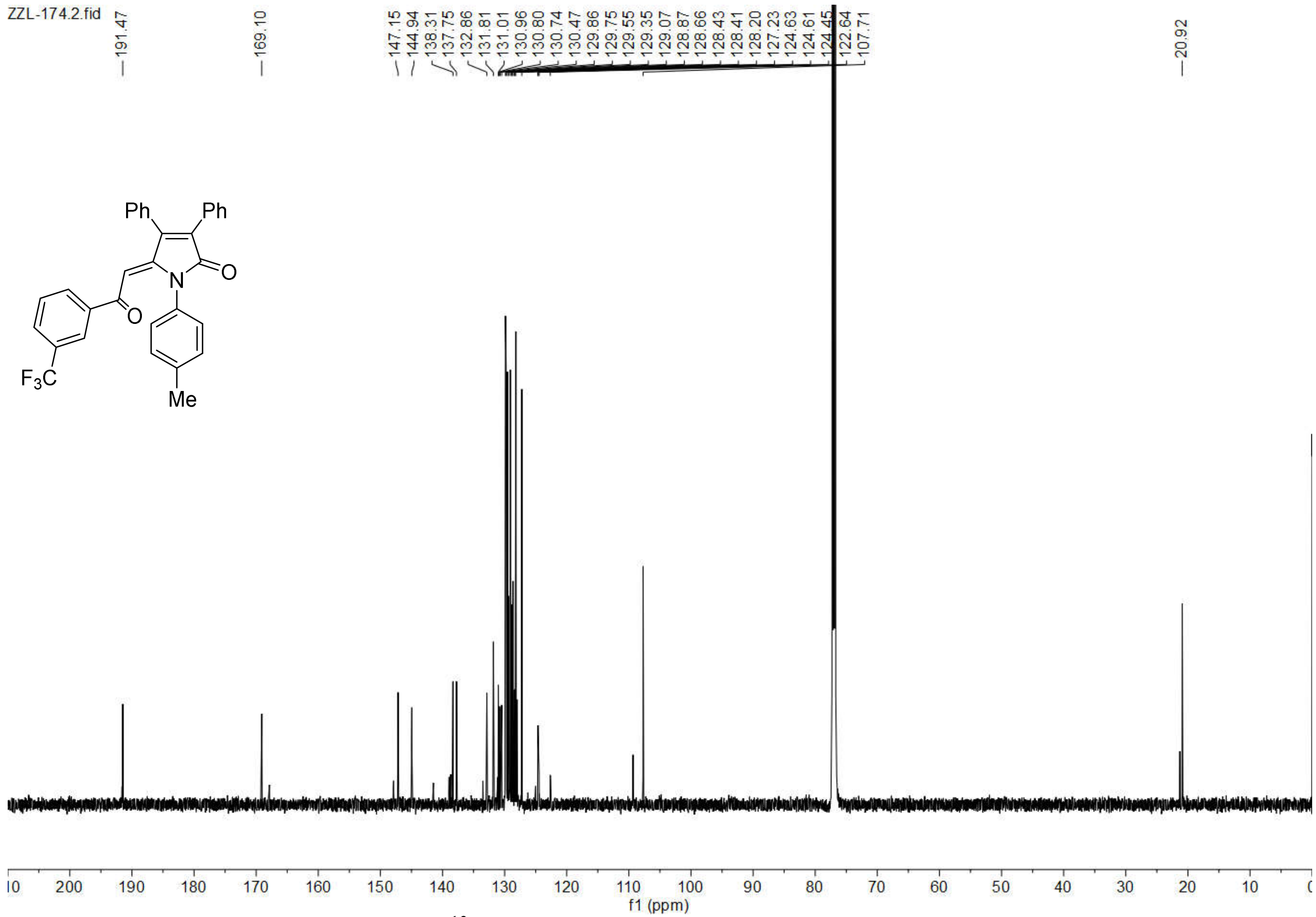


Figure S134. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7d**

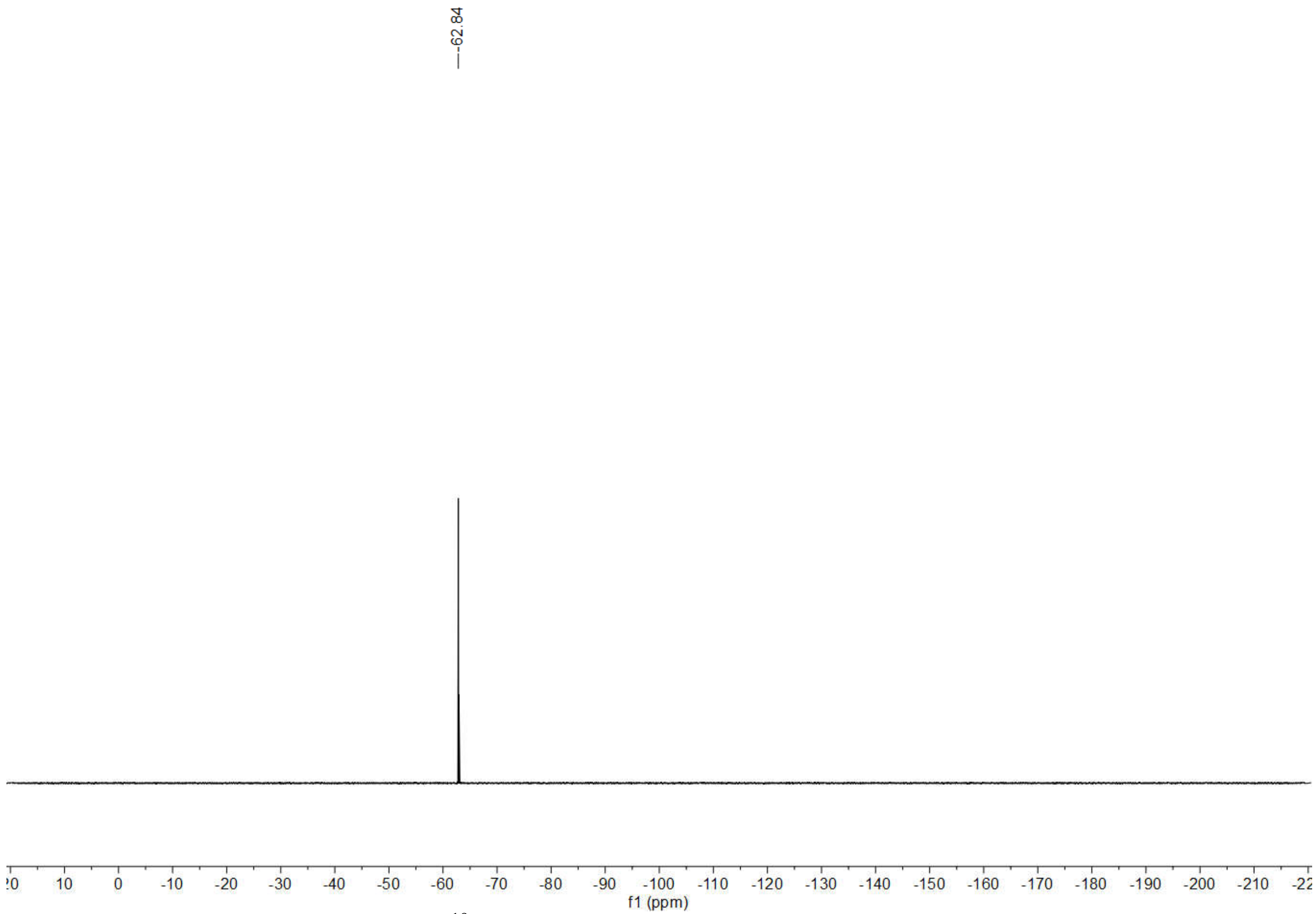


Figure S135. ^{19}F NMR (470 MHz, $CDCl_3$) spectra of compound **7d**

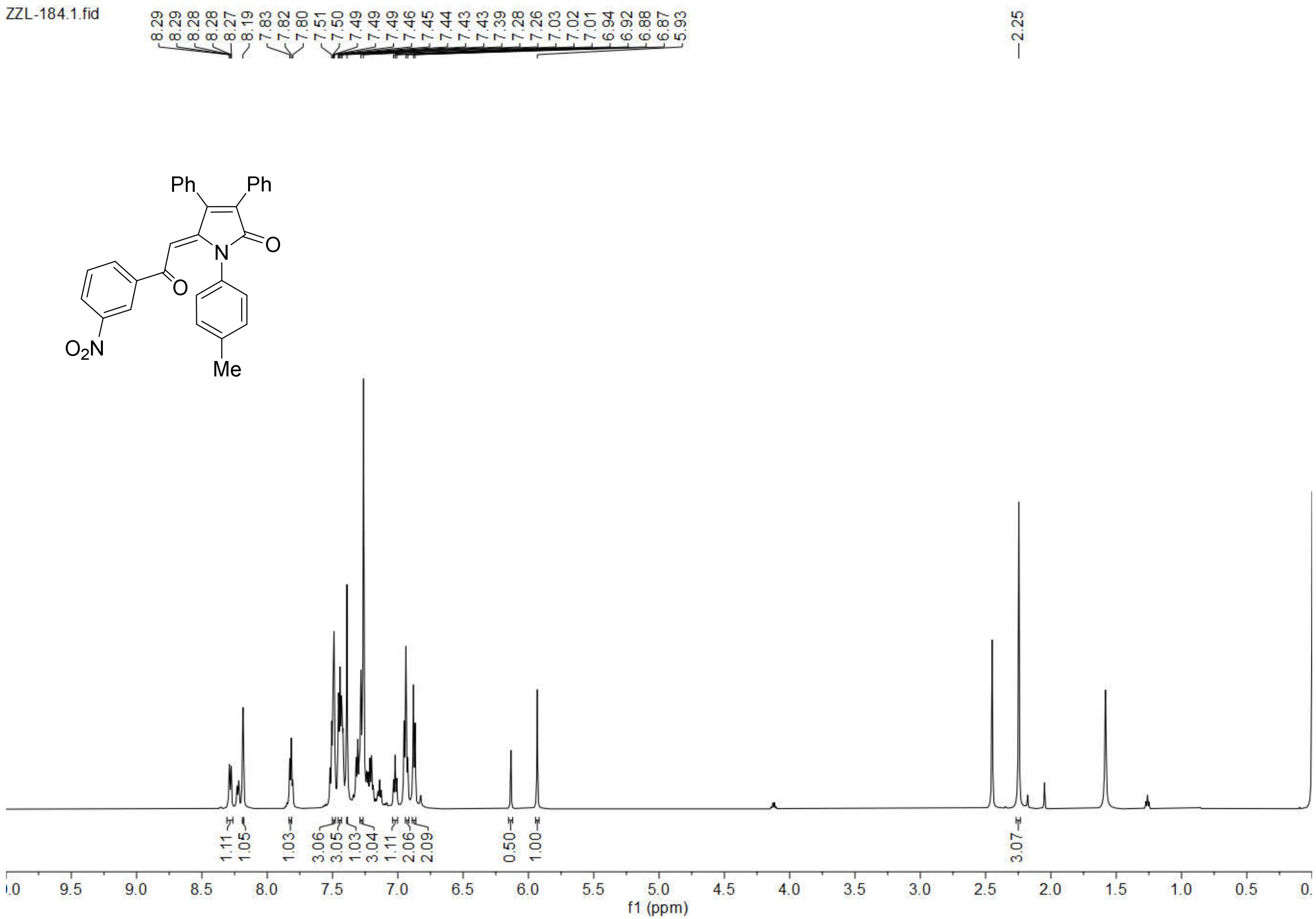


Figure S136. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7e**

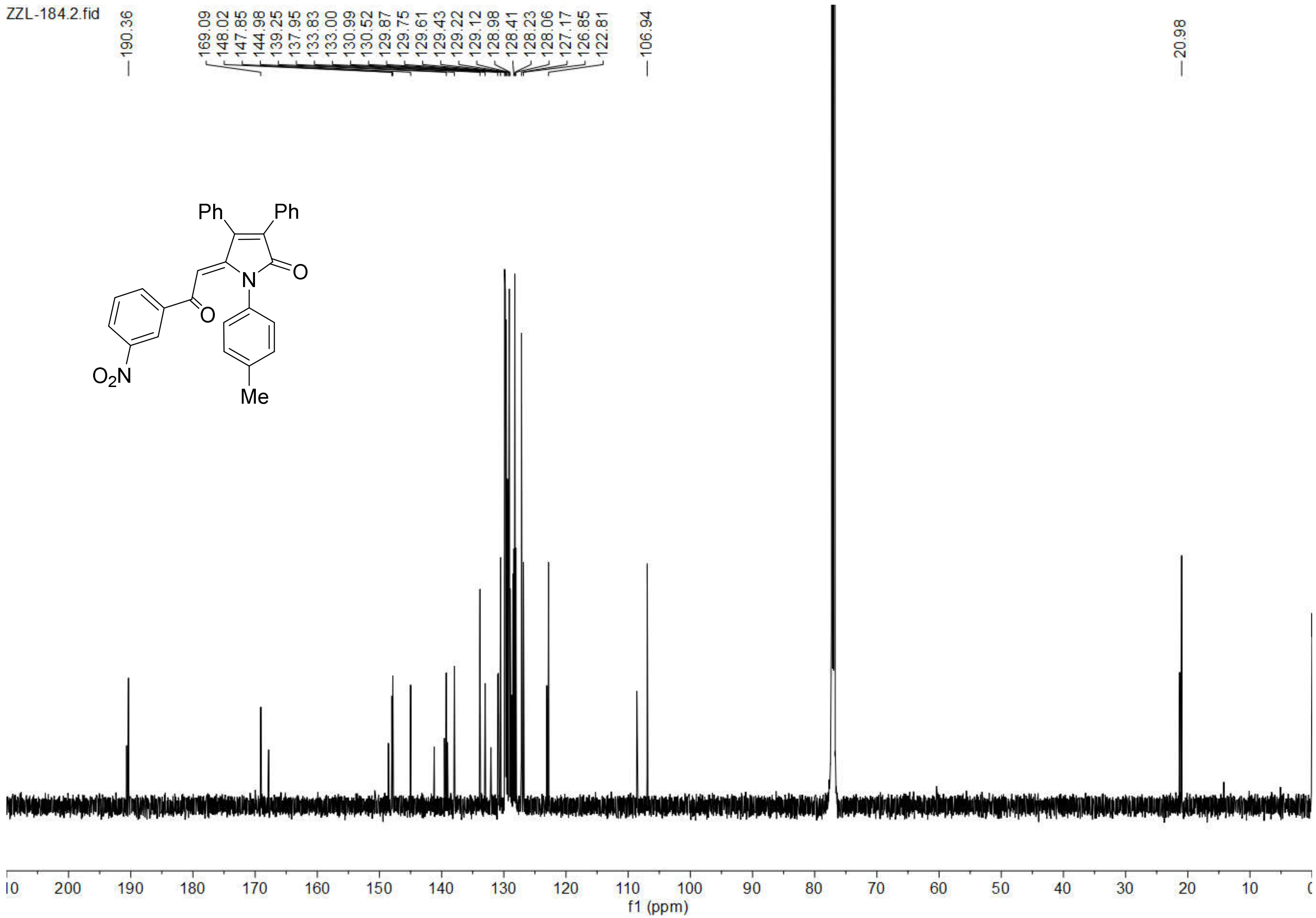


Figure S137. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7e**

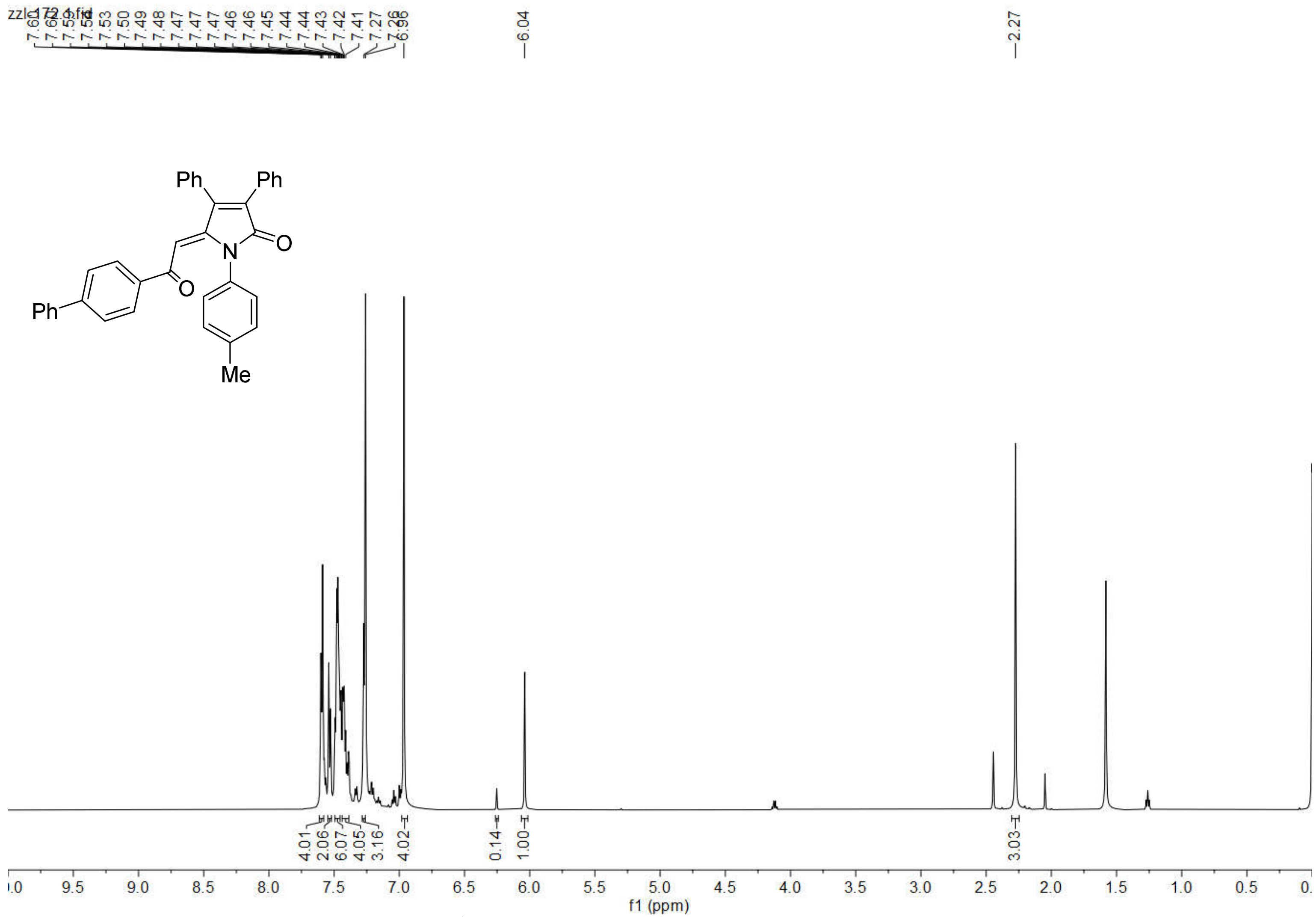


Figure S138. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7f**

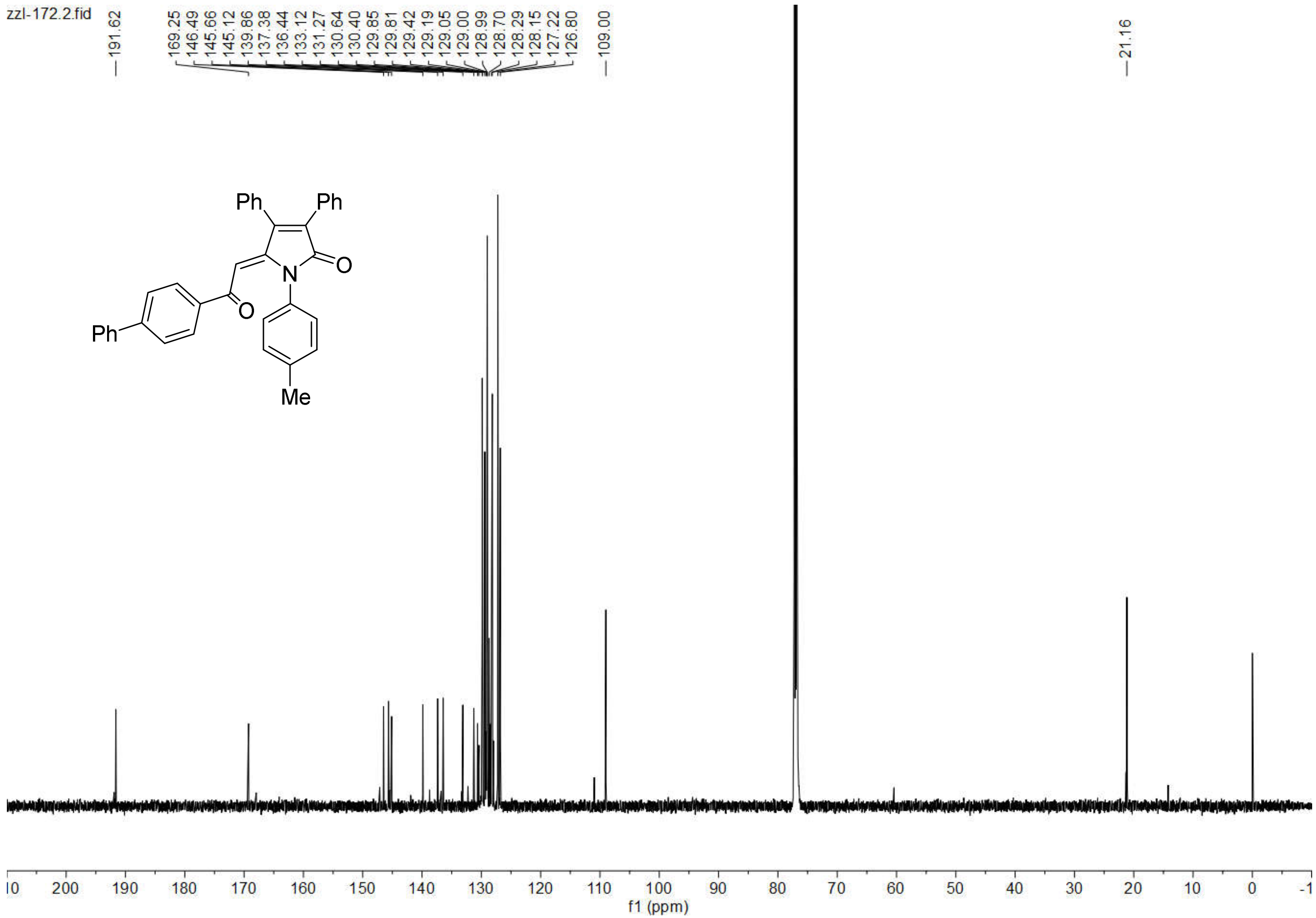


Figure S139. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7f**

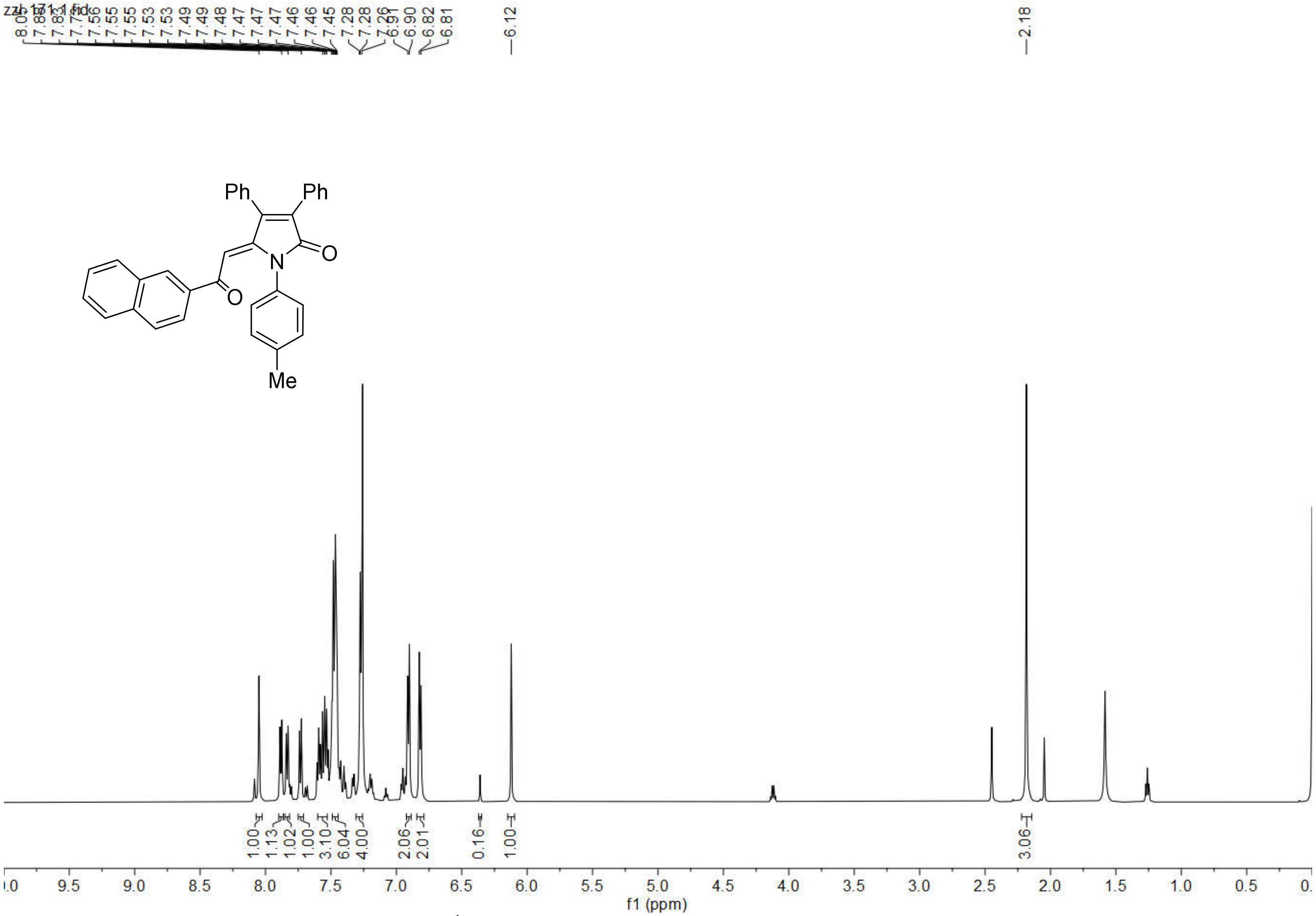


Figure S140. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7g**

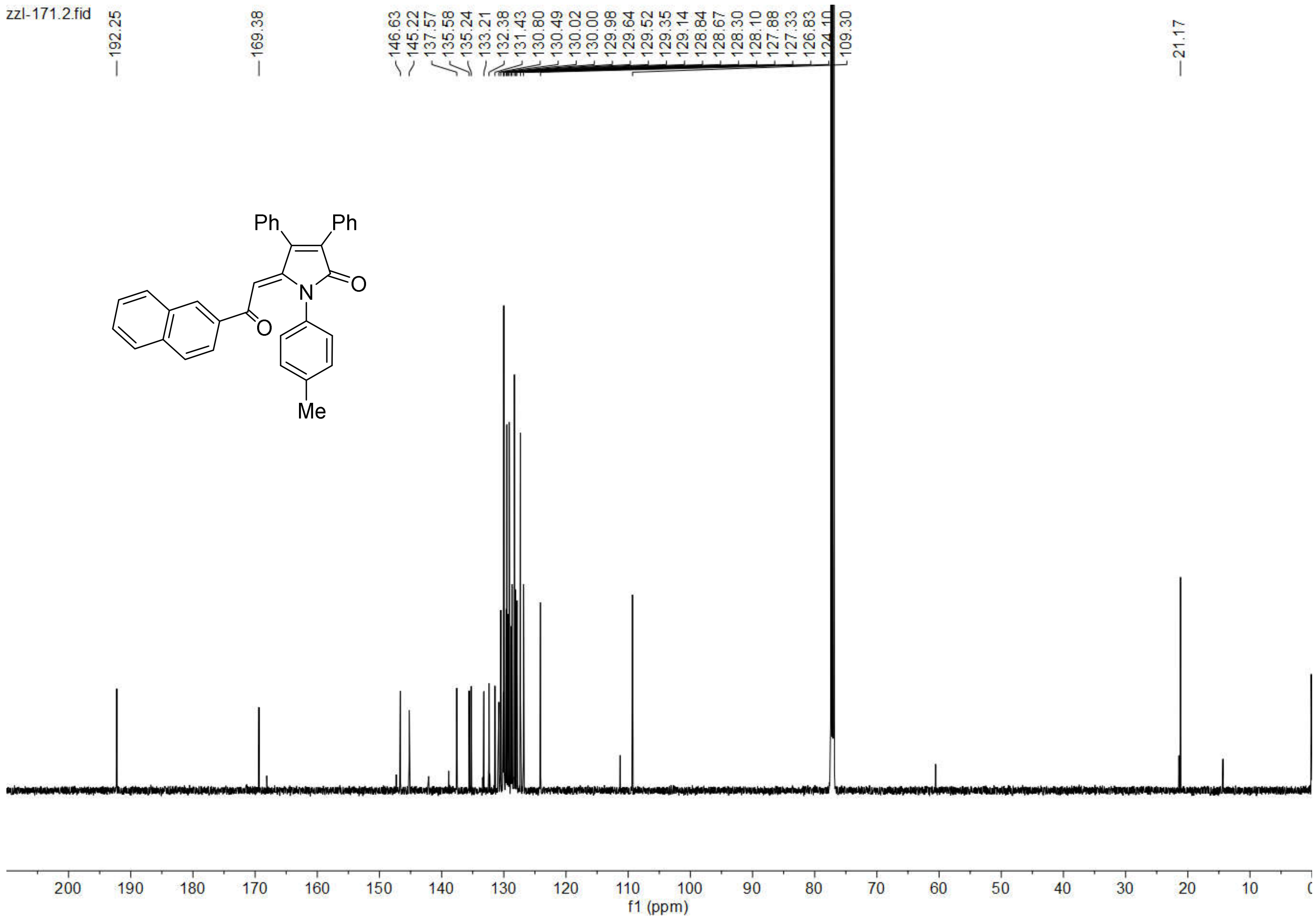


Figure S141. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7g**

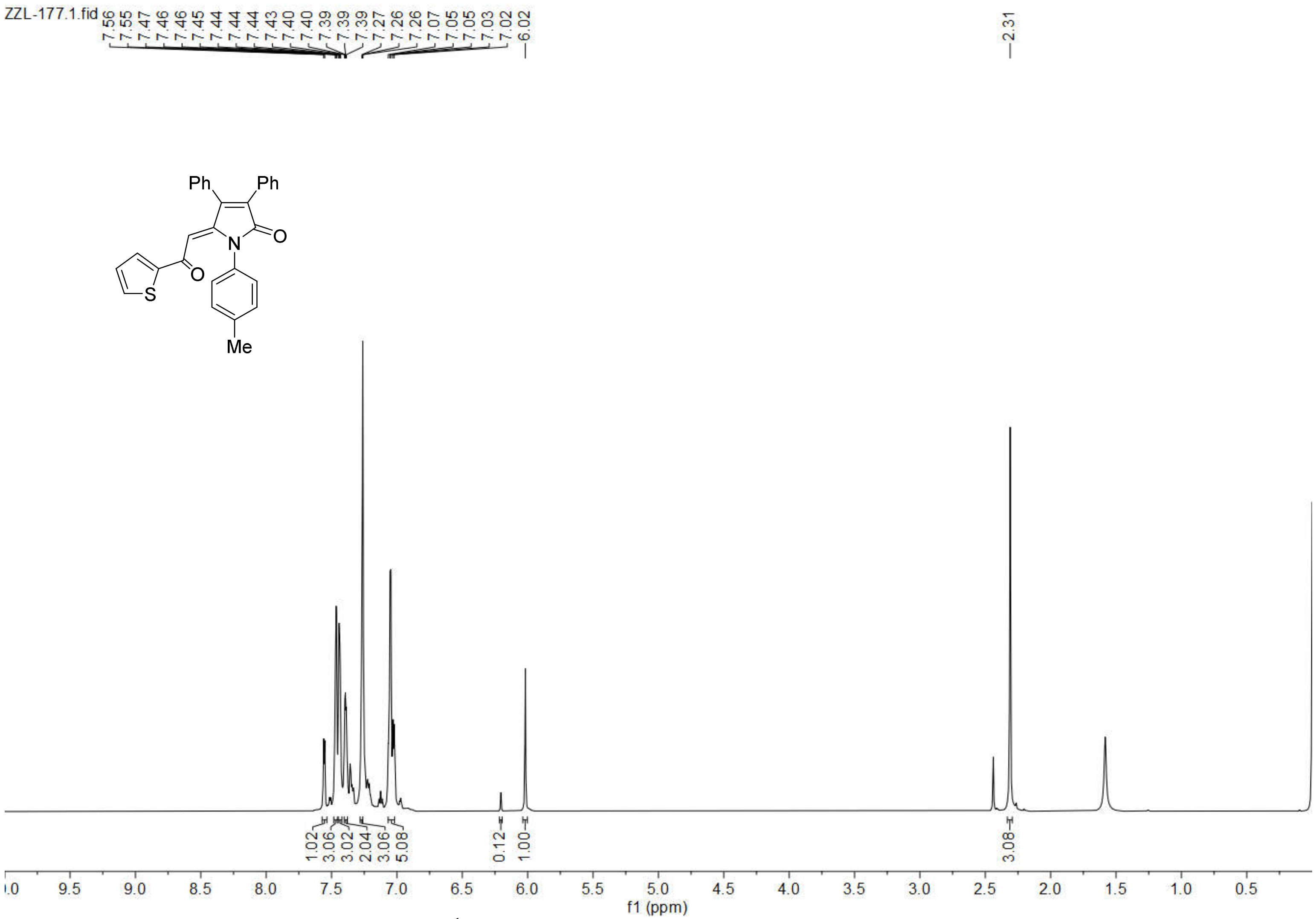


Figure S142. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7h**

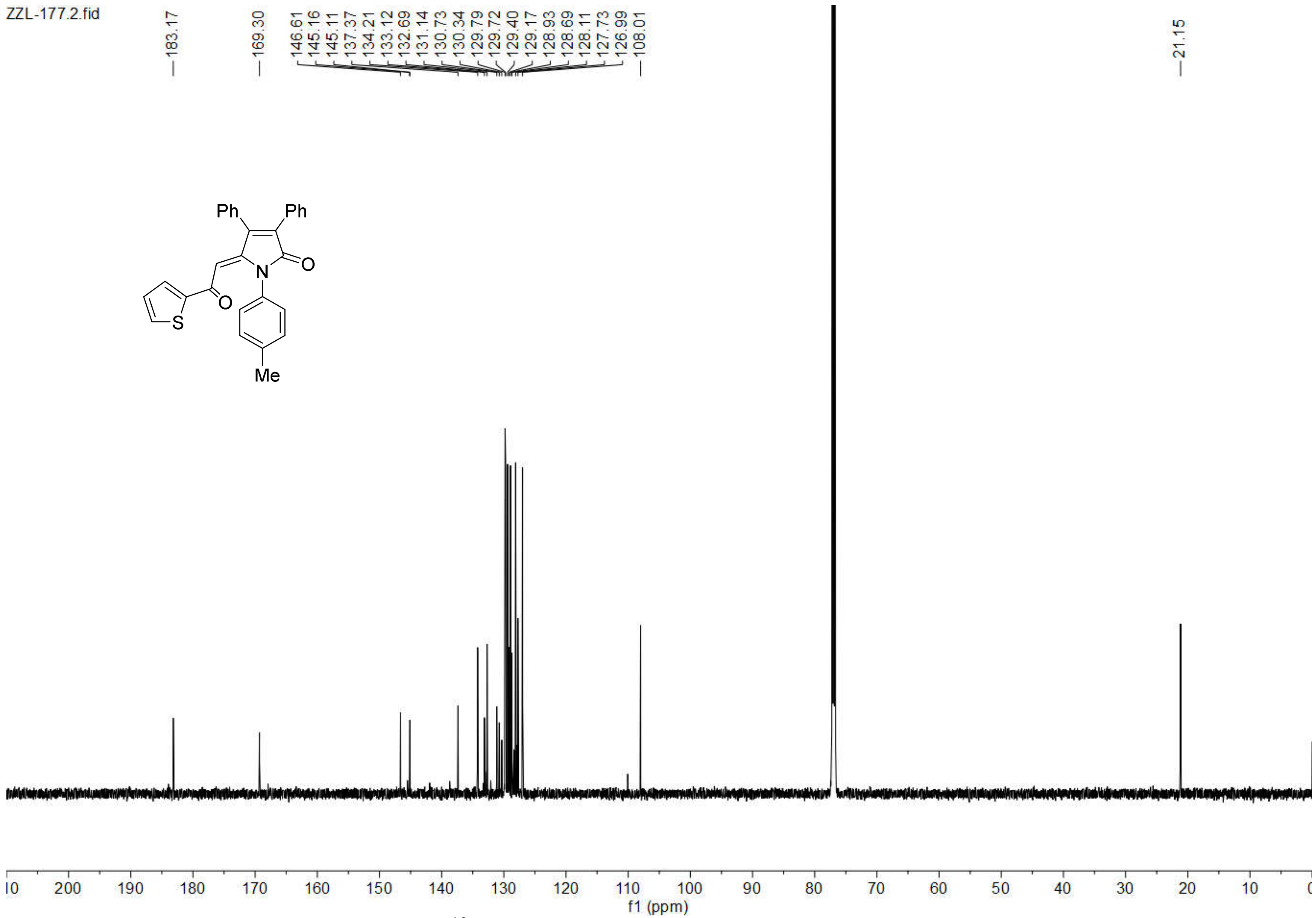


Figure S143. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7h**

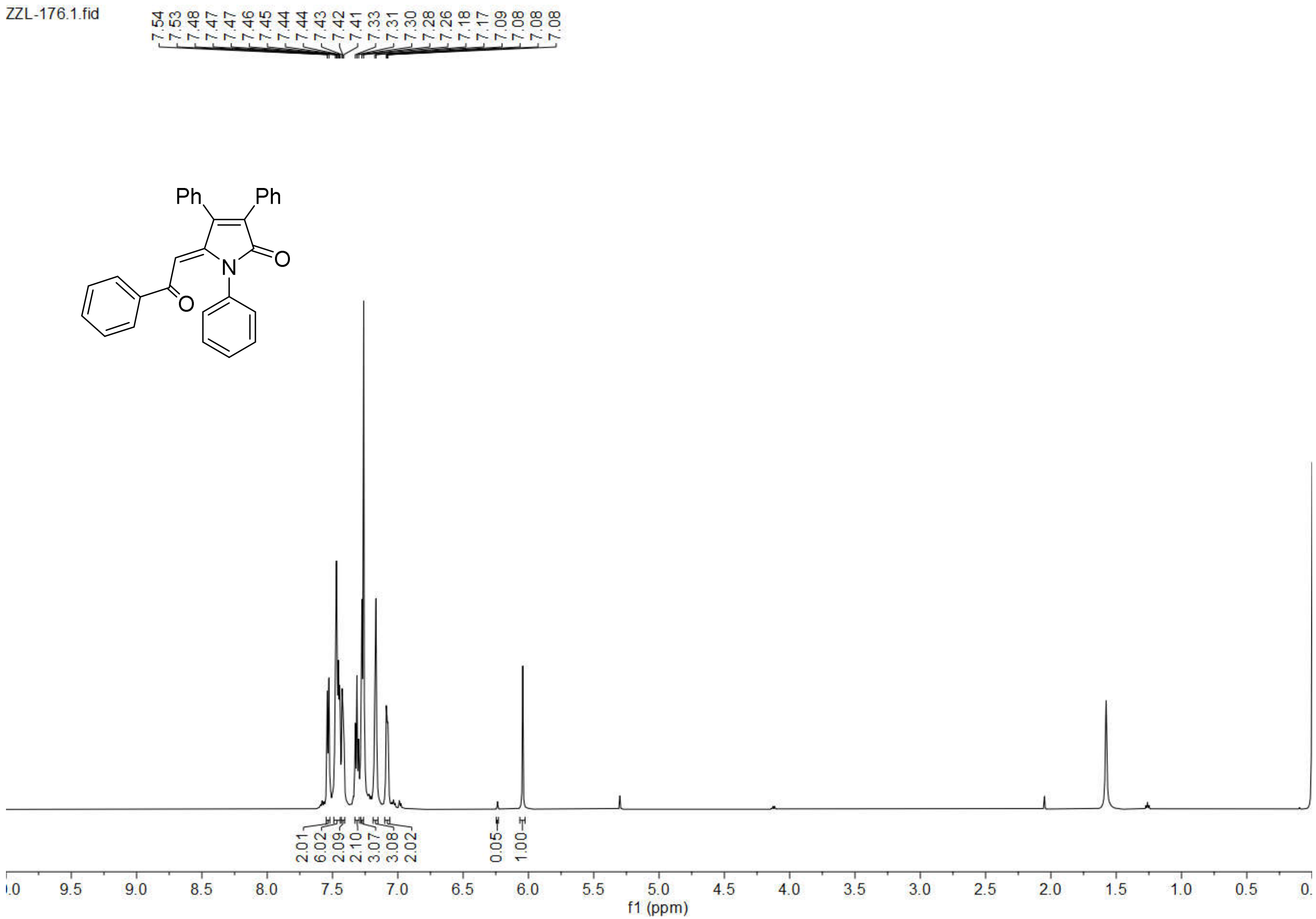


Figure S144. ^{1}H NMR (600 MHz, $CDCl_3$) spectra of compound **7i**

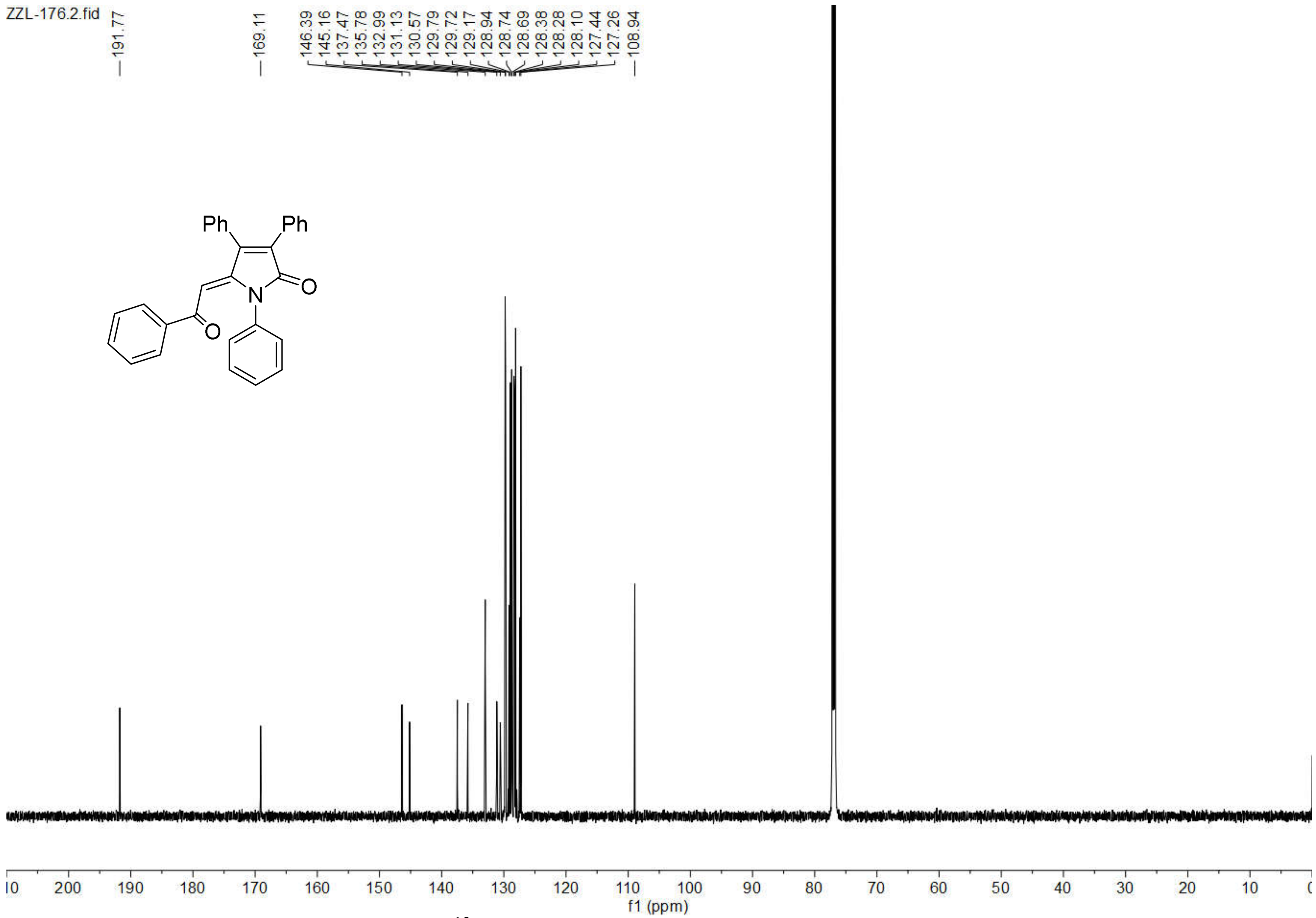


Figure S145. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7i**

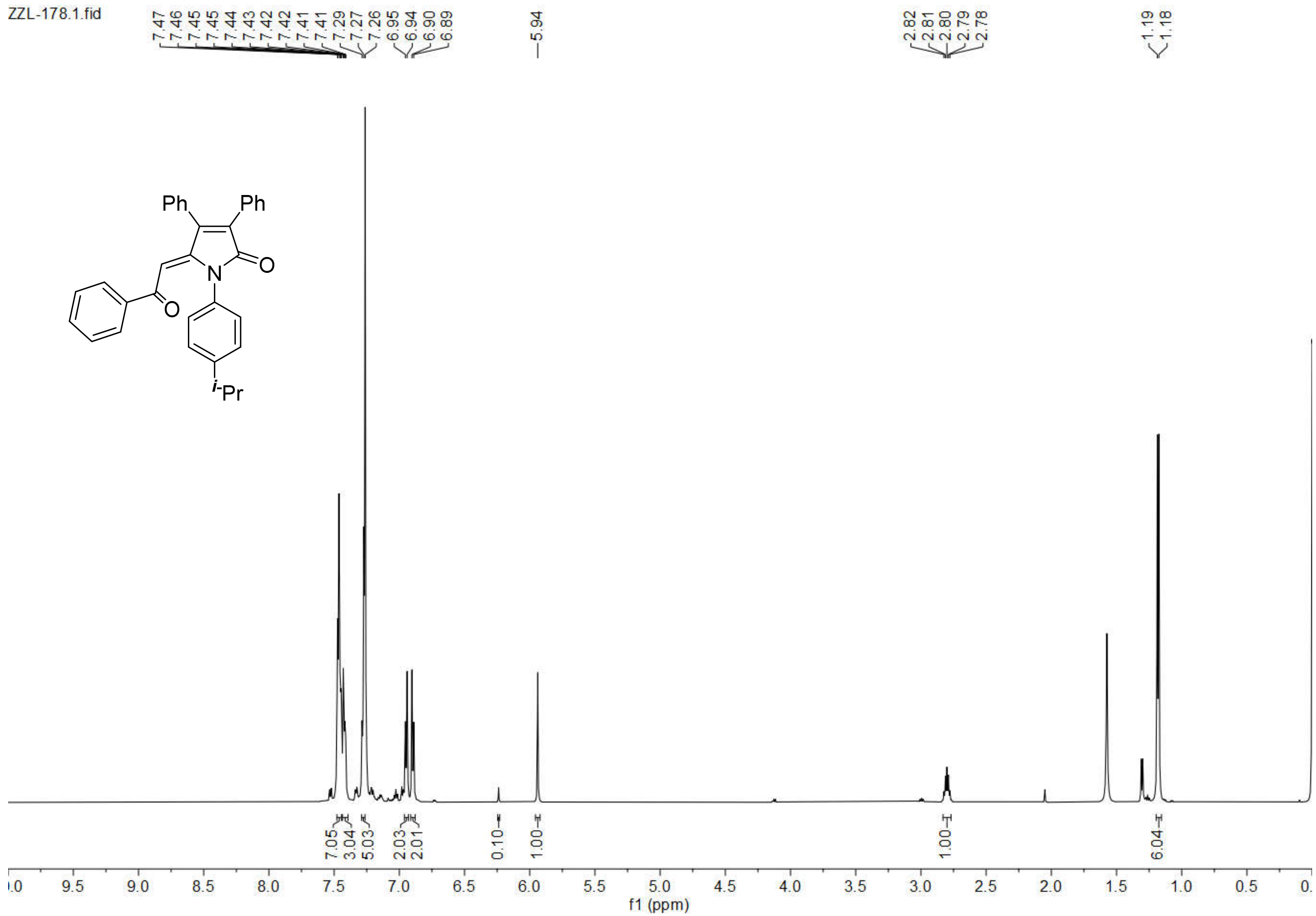


Figure S146. [1]H NMR (600 MHz, $CDCl_3$) spectra of compound **7j**

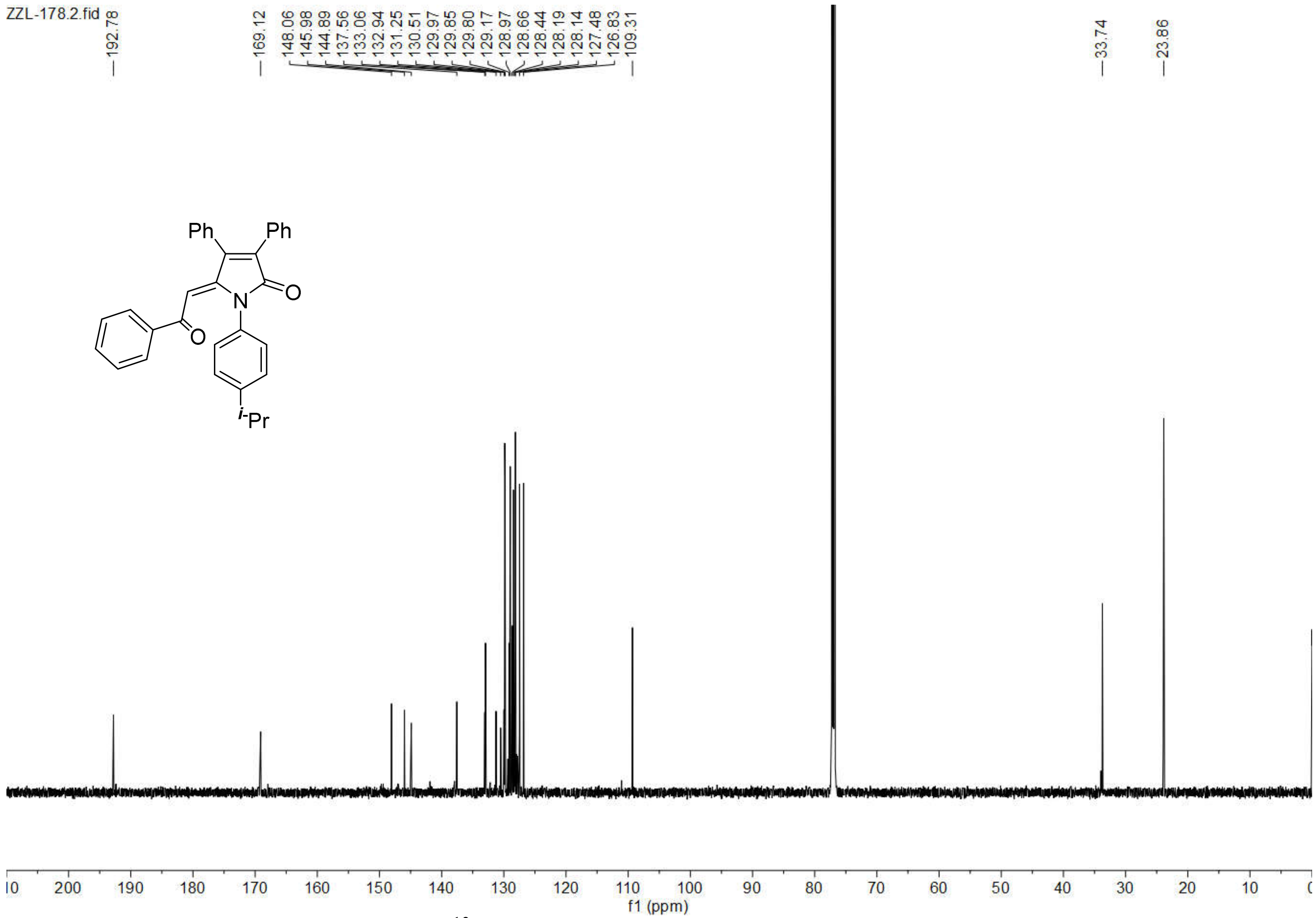


Figure S147. ^{13}C NMR (150 MHz, $CDCl_3$) spectra of compound **7j**

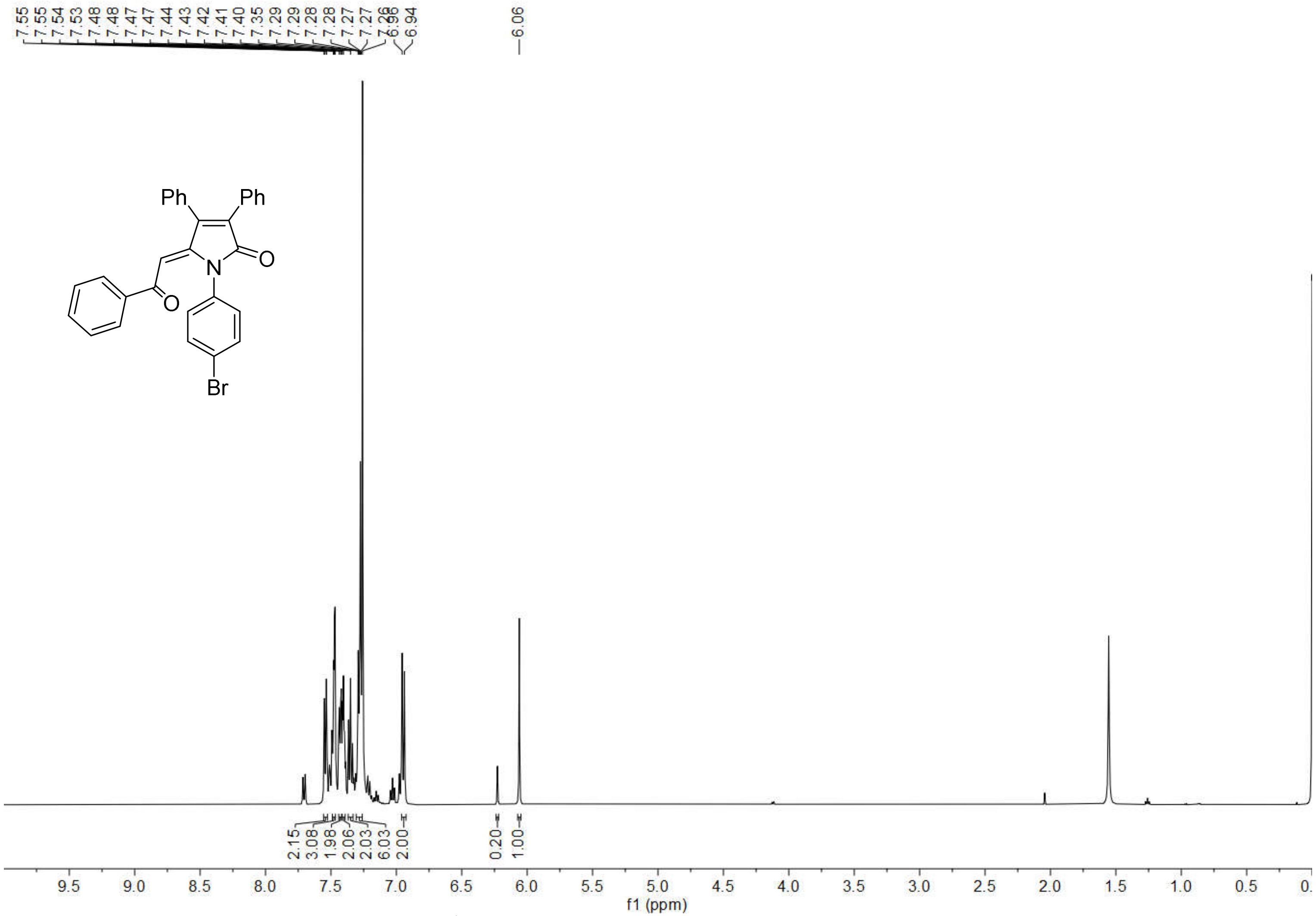


Figure S148. ^{1}H NMR (500 MHz, $CDCl_3$) spectra of compound **7k**

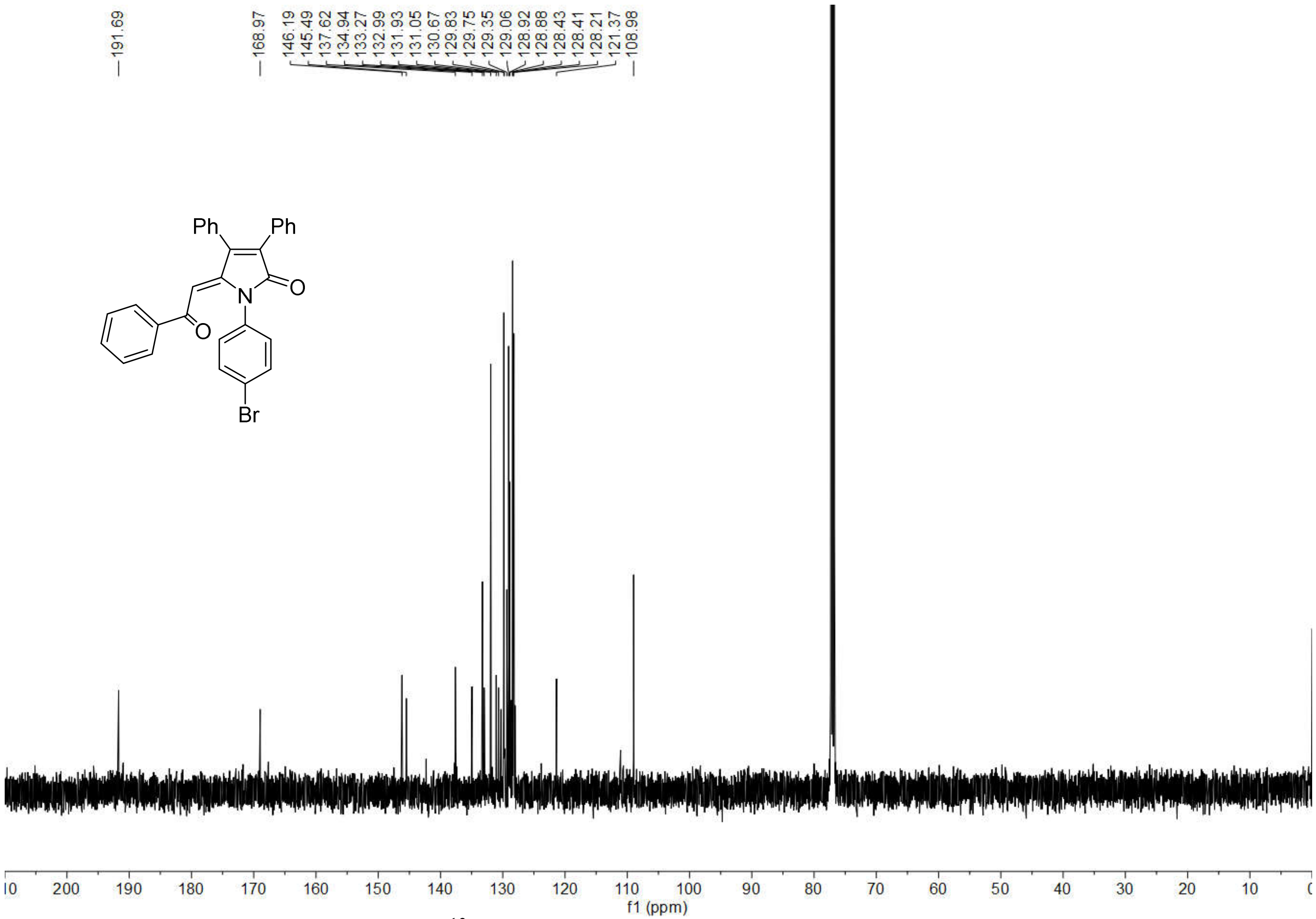


Figure S149. ^{13}C NMR (125 MHz, $CDCl_3$) spectra of compound **7k**

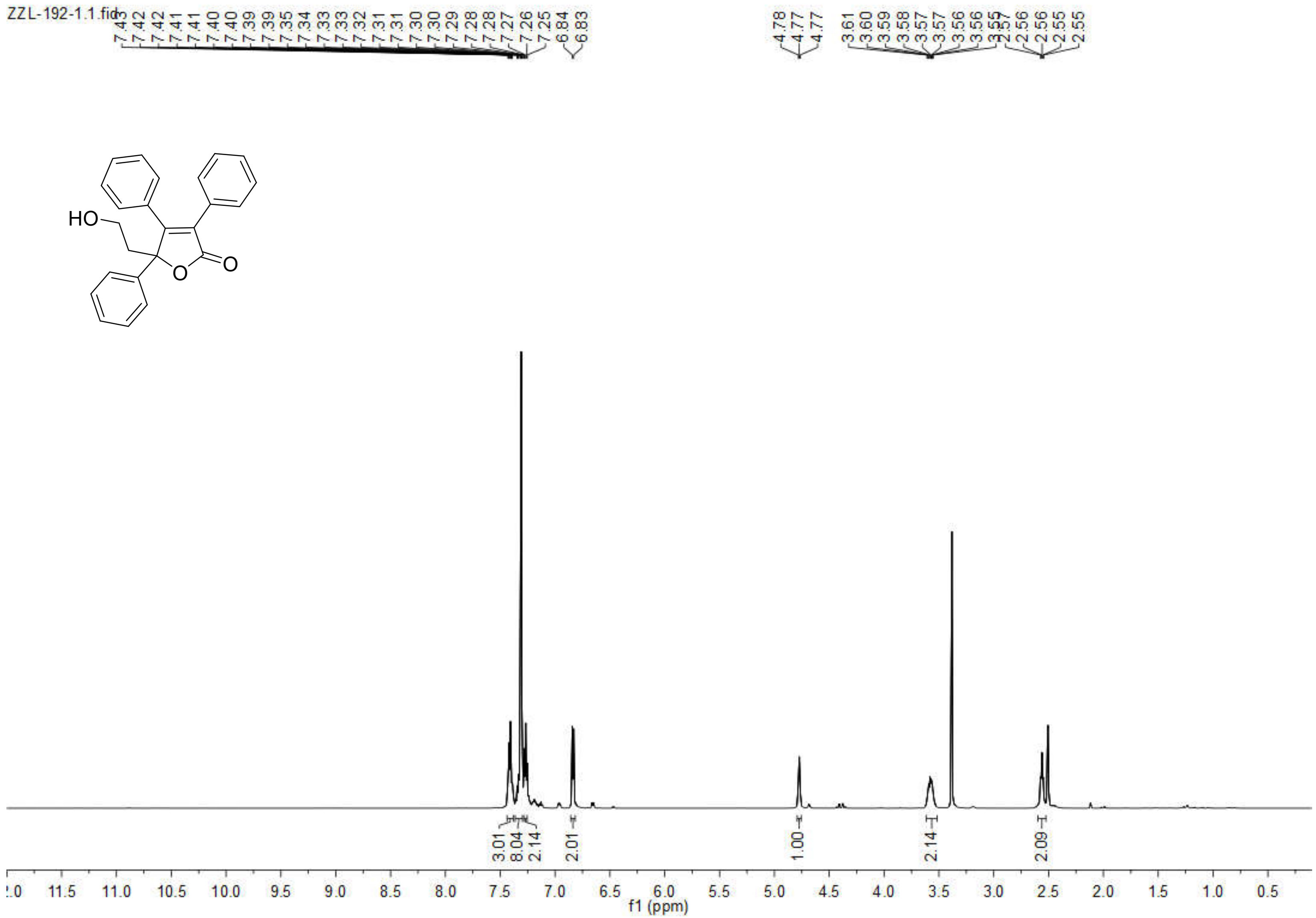


Figure S150. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **8**

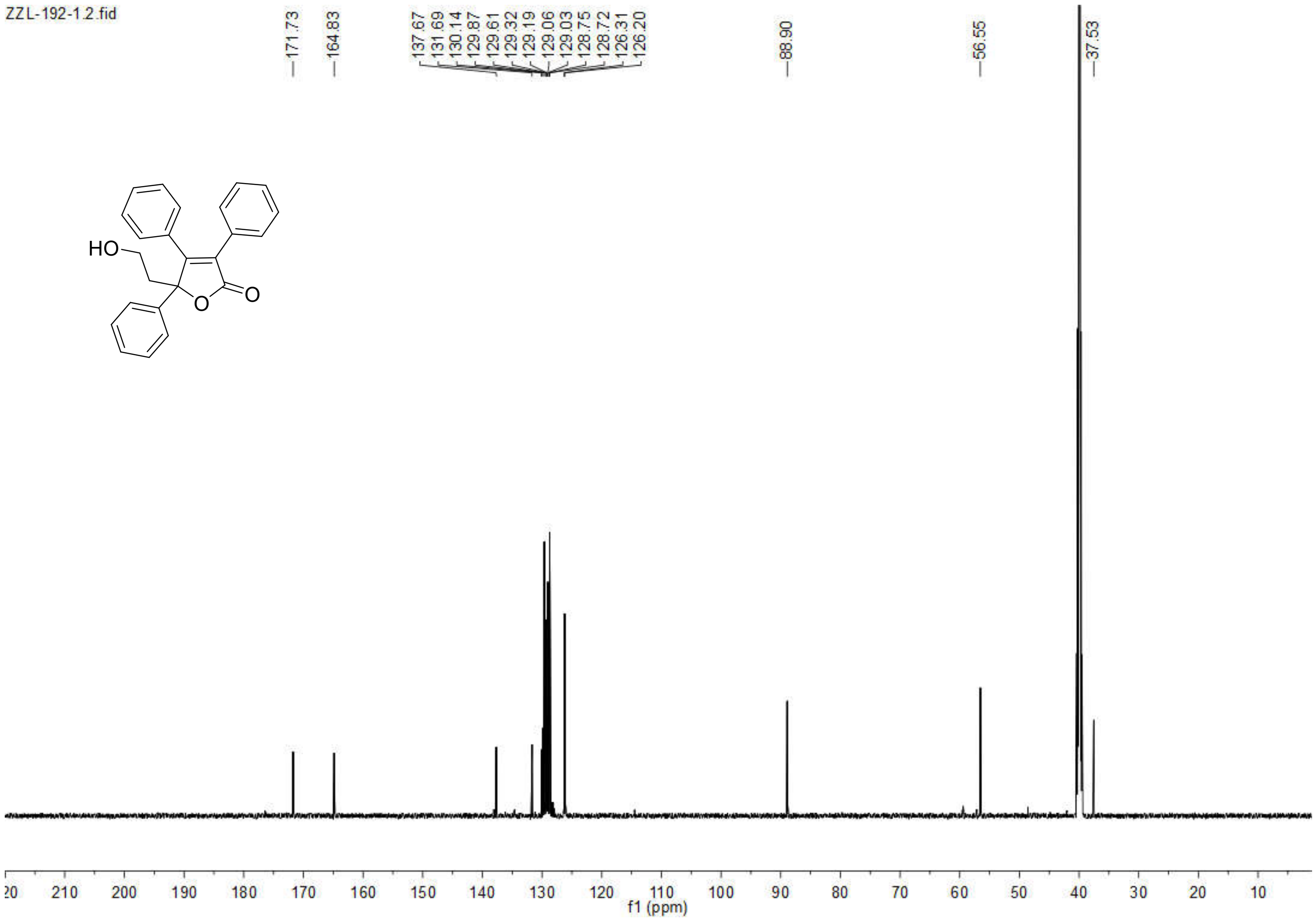


Figure S151. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **8**

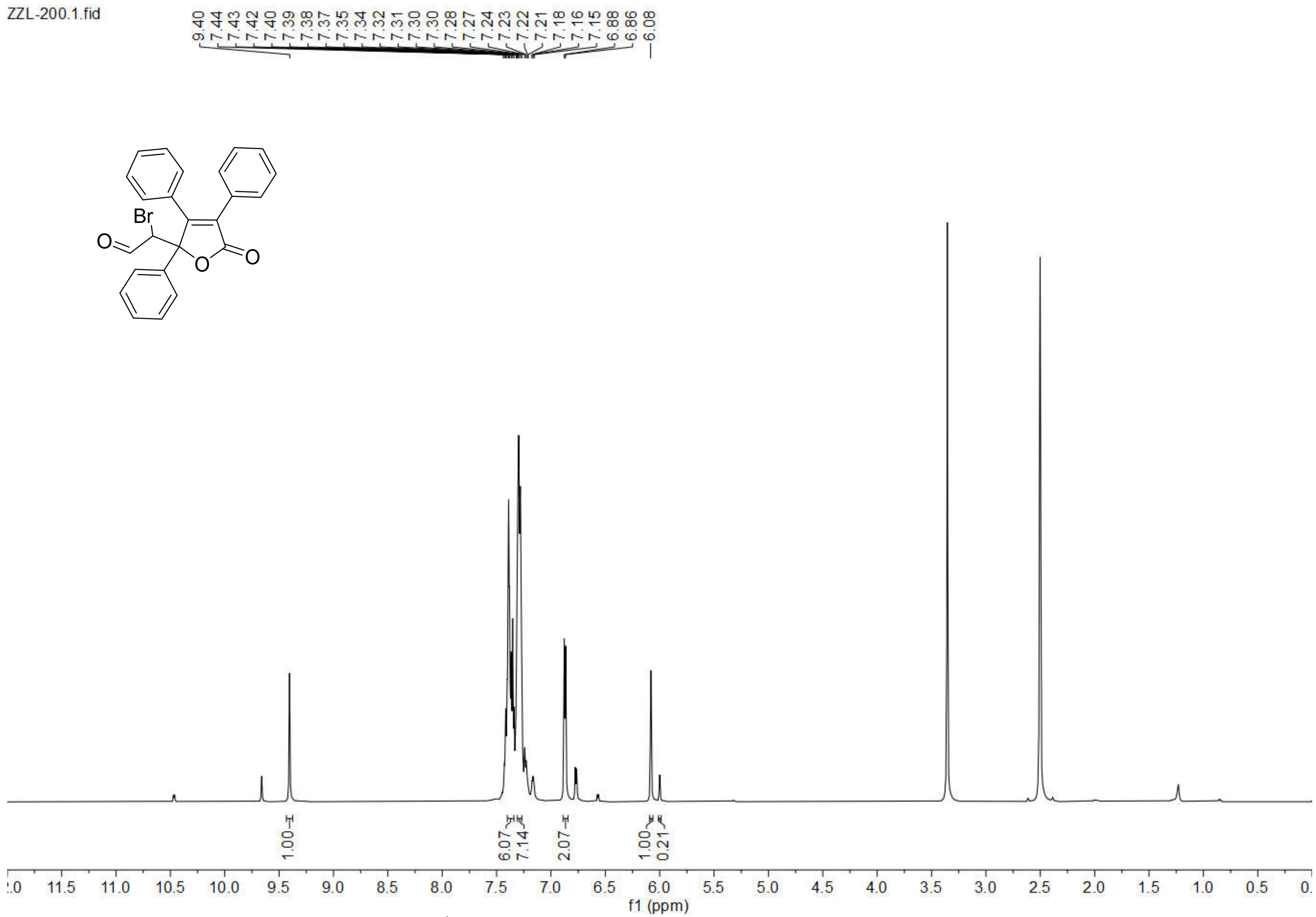


Figure S152. [1]H NMR (600 MHz, DMSO-d_6) spectra of compound **9**

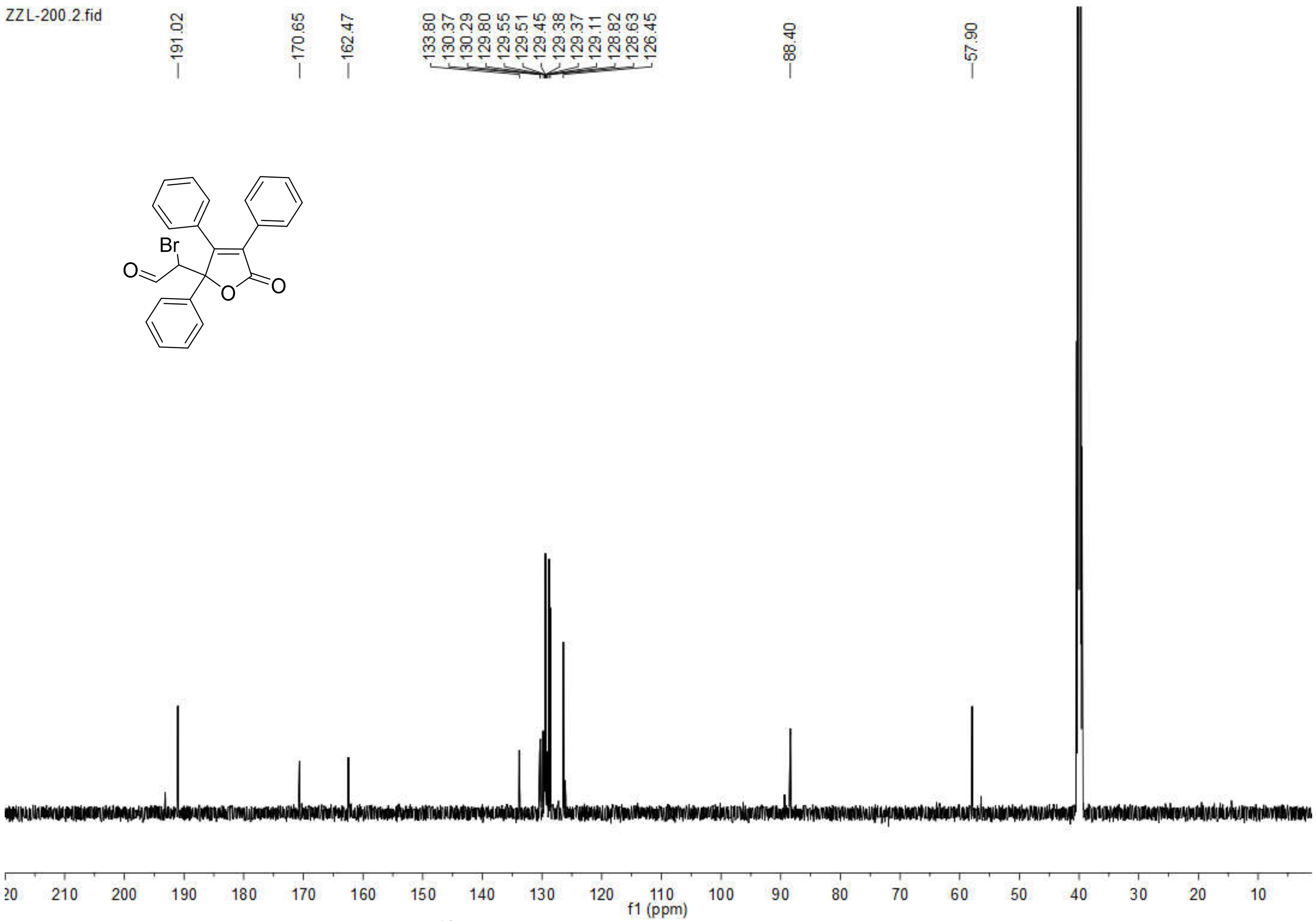


Figure S153. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **9**

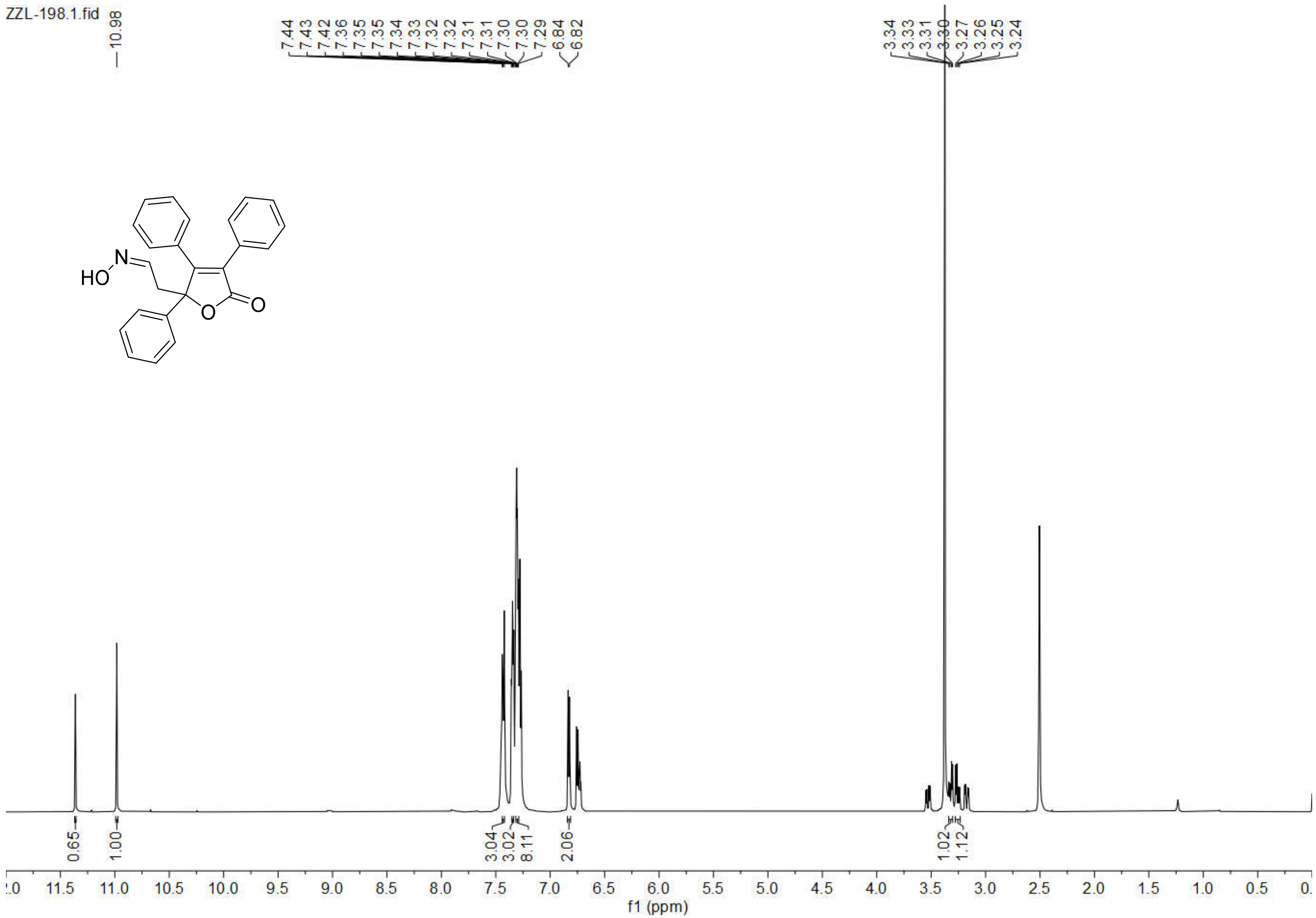


Figure S154. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **10**

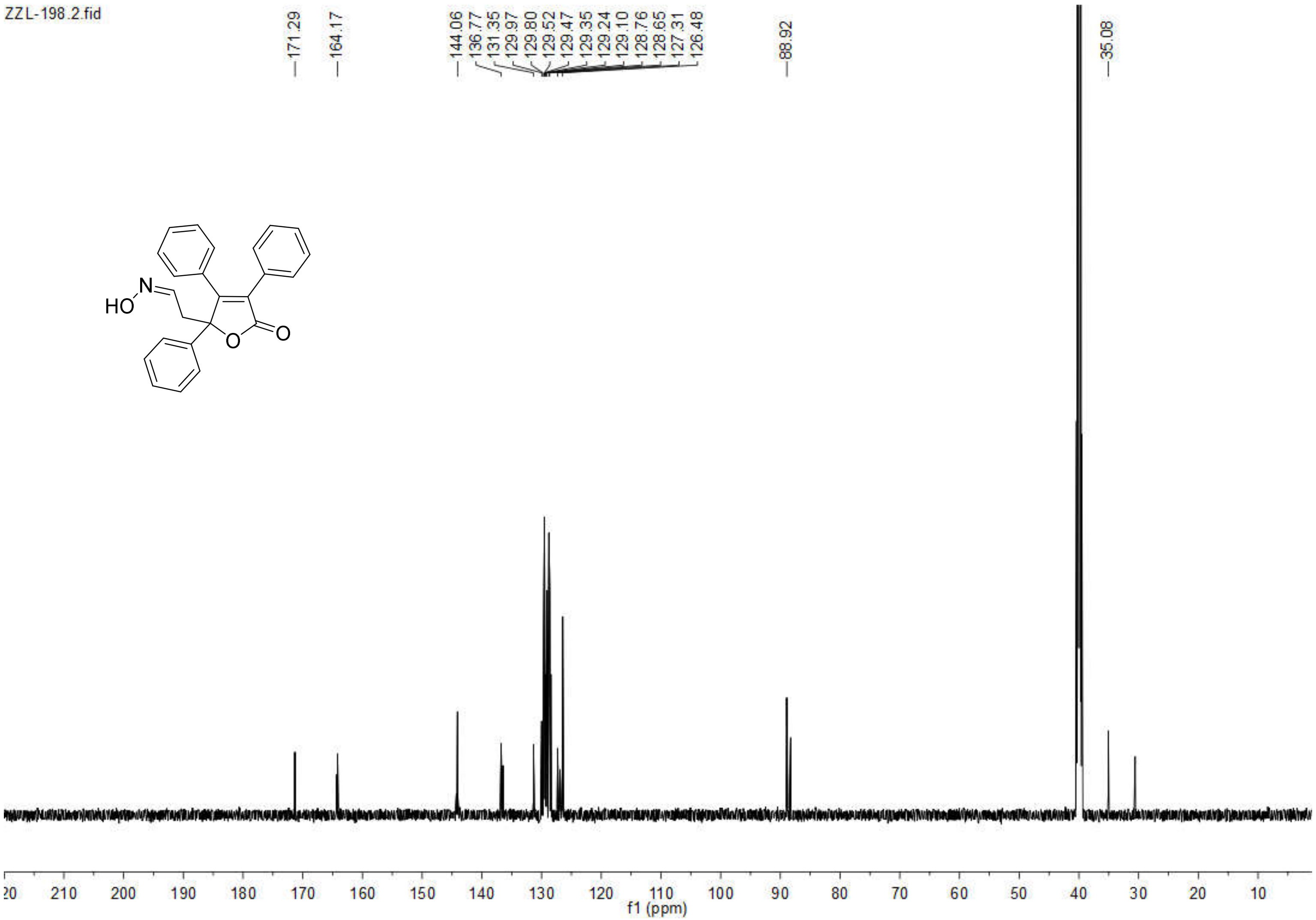


Figure S155. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **10**

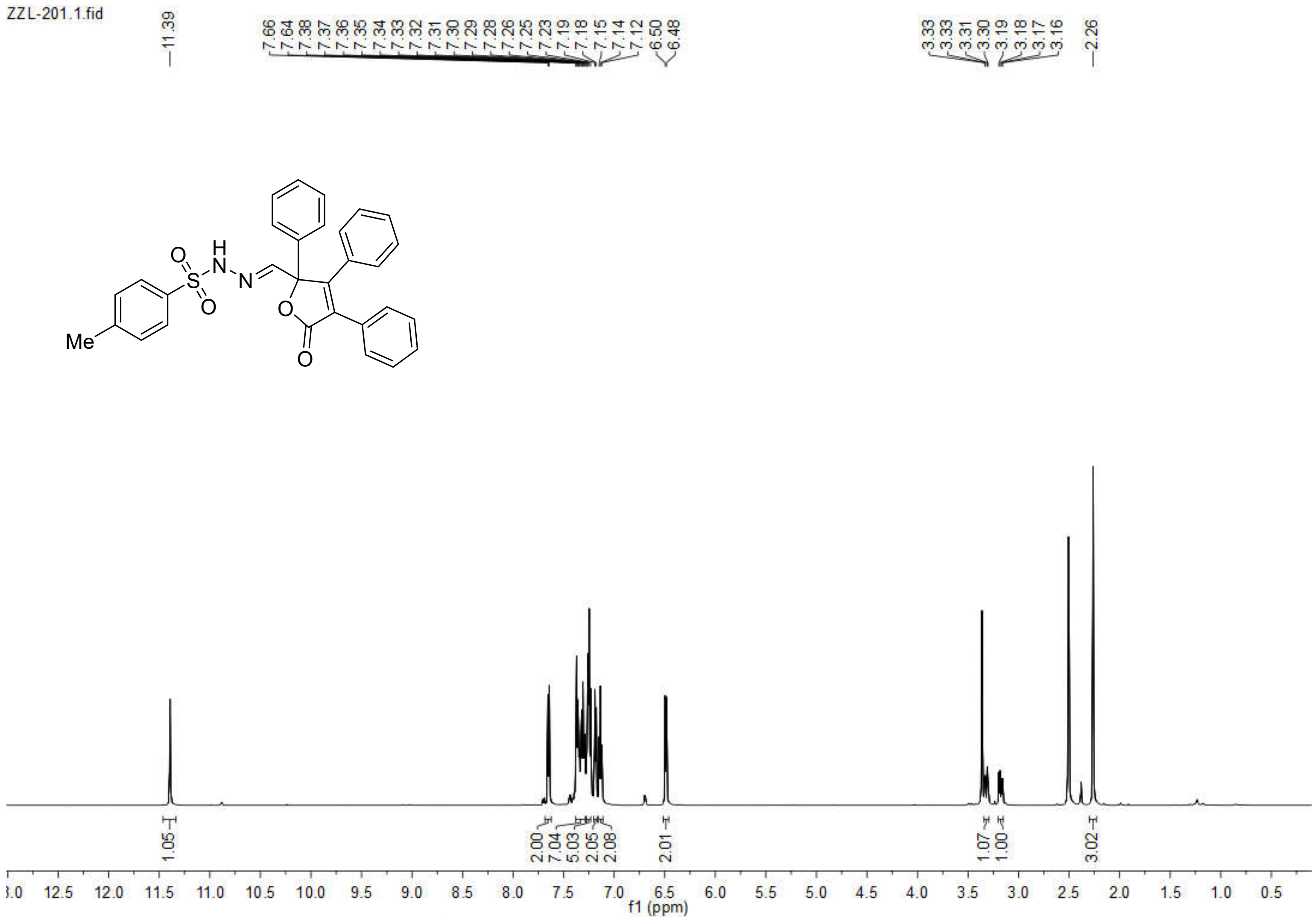


Figure S156. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **11**

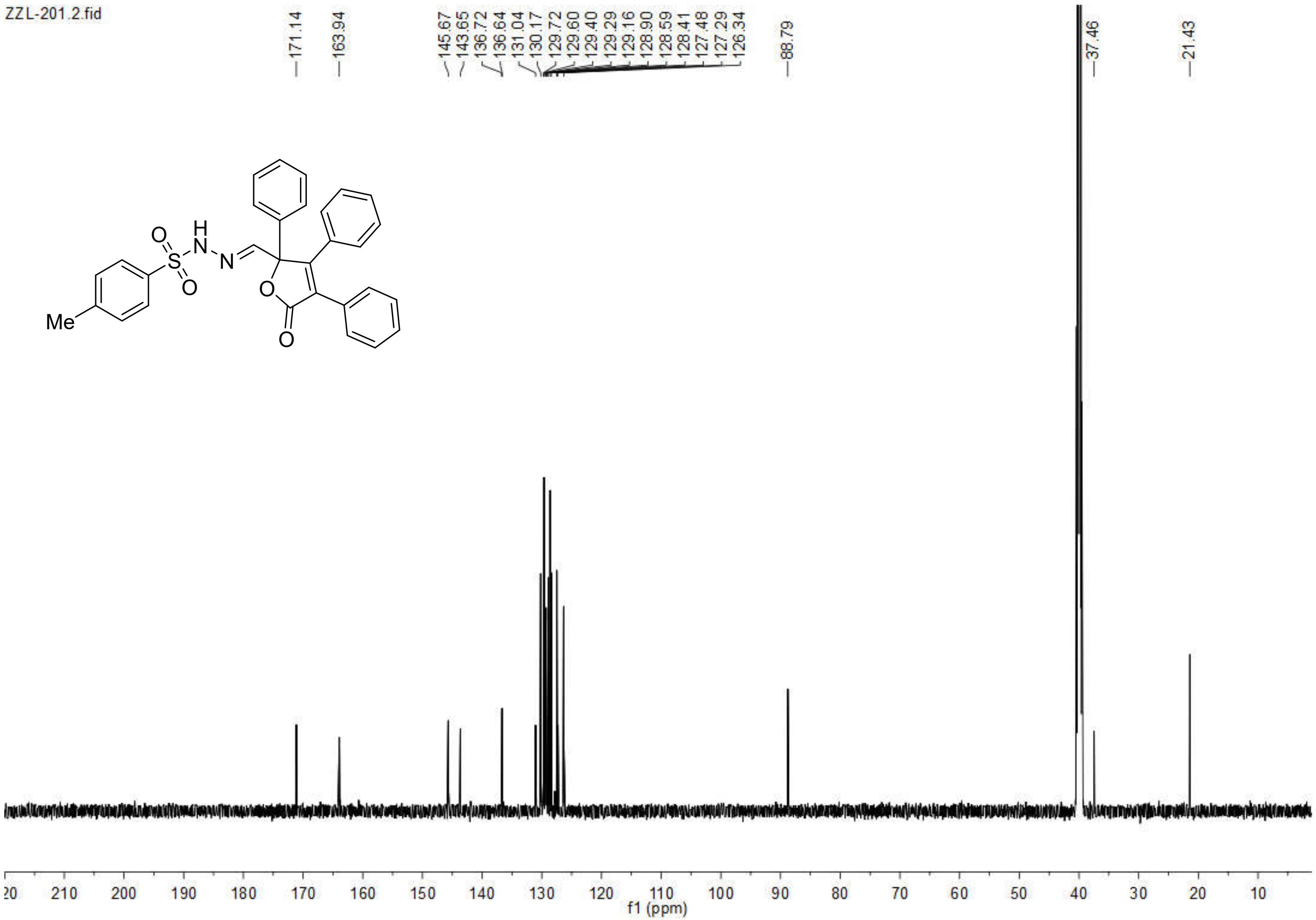


Figure S157. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **11**

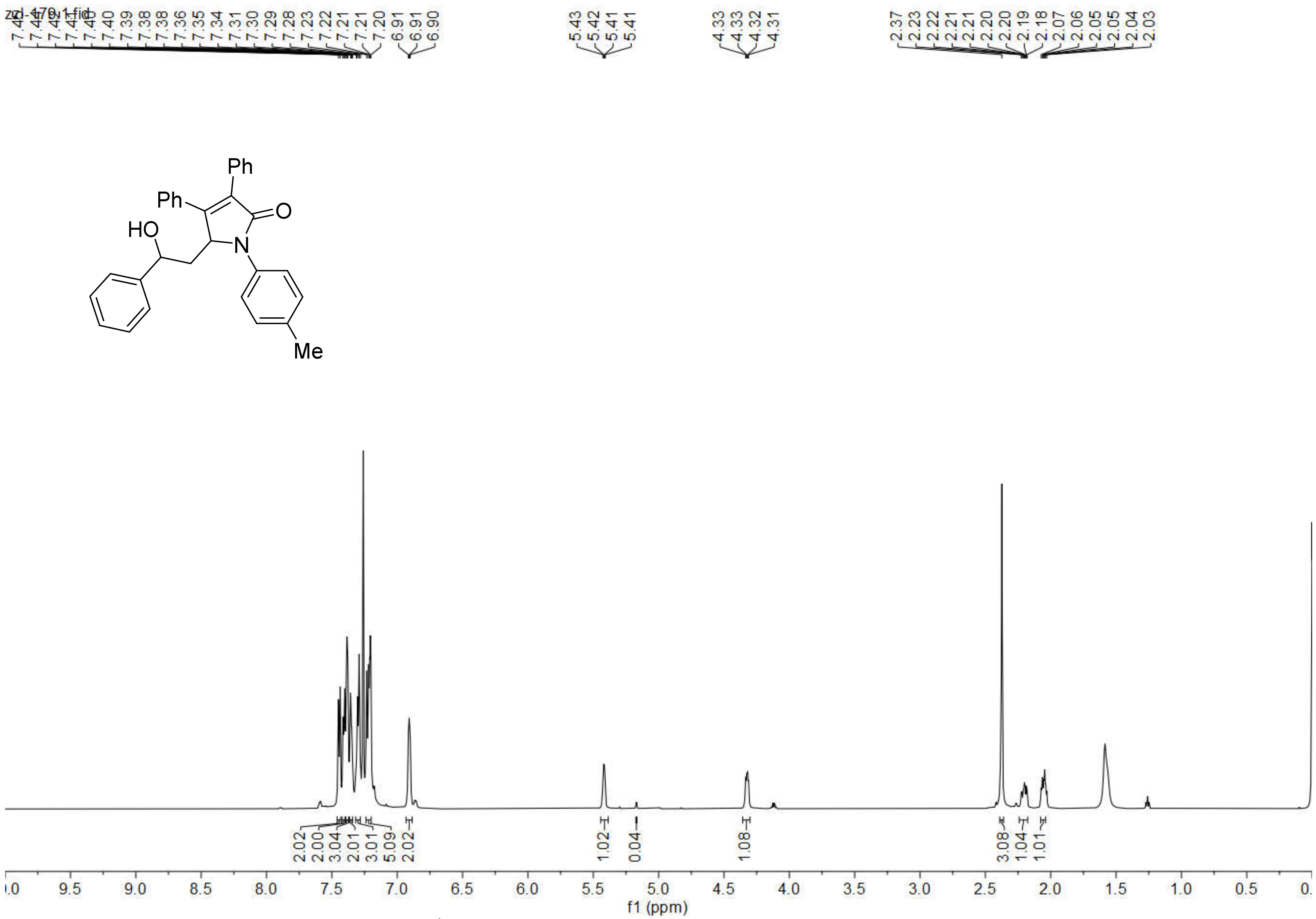


Figure S158. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **12**

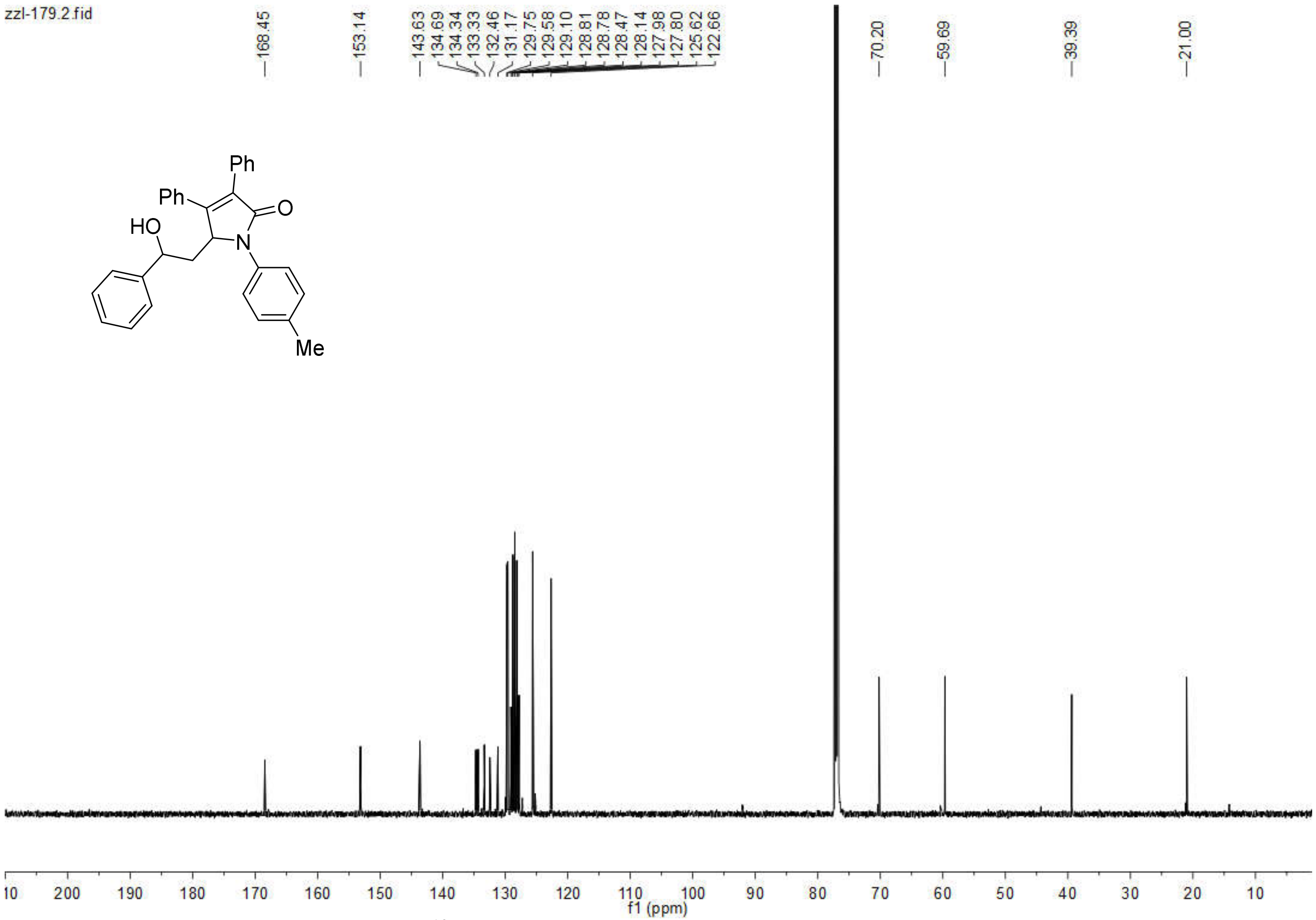


Figure S159. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **12**

7. References and notes.

1. (a) Liu, Y.; Zhou, R..; Wan, J.-P. *Synth. Commun.*, **2013**, *43*, 2475. (b) Zhou, Z.-Z.; Liu, F.-S.; Shen, D.-S.; Tan, C.; Luo, L.-Y. Inorg. *Chem. Commun.*, **2011**, *14*, 659. (c) Larina, N. A.; Lokshin, V.; Berthet, J.; Delbaere, S.; Vermeersch, G.; Khodorkovsky, V. *Tetrahedron*, **2010**, *66*, 8291. (d) Zhou, P.; Hu, B.; Rao, K.; Li, L.; Yang, J.; Gao, C.; Wang, F.; Yu, F. *Synlett*, **2018**, *29*, 519.
2. (a) Miao, W.-H.; Gao, W.-X.; Huang, X.-B.; Liu, M.-C.; Zhou, Y.-B.; Wu, H.-Y. *Org. Lett.*, **2021**, *23*, 9425. (b) Wang, H.; Yan, R. *Adv. Synth. Catal.*, **2022**, *364*, 715.
3. (a) Yuan, W.; Li, X.; Qi, Z.; Li, X. *Org. Lett.* **2021**, *23*, 9425−9430. (b) Liu, L.; Wu, H.; Huang, G. *Chin. Chem. Lett.* **2021**, *32*, 3015–3018. (c) Li, X.; Han, C.; Yao, H.; Lin, A. *Org. Lett.* **2017**, *19*, 778. (d) Bai, D.; Yu, Y.; Guo, H.; Chang, J.; Li, X. *Angew. Chem. Int. Ed.* **2020**, *59*, 2740.
4. (a) Ren, J.-T.; Wang, J.-X.; Tian, H.; Xu, J.-L.; Hu, H.; Aslam, M.; Sun, M. *Org. Lett.* **2018**, *20*, 6636. (b) Xu, J.-L.; Tian, H.; Kang, J.-H.; Kang, W.-X.; Sun, W.; Sun, R.; Li, Y.-M.; Sun, M. *Org. Lett.* **2020**, *22*, 6739. (c) Yuan, W.; Li, X.; Qi, Z.; Li, X. *Org. Lett.* **2022**, *24*, 2093.
5. CCDC 2377854 contain the supplementary crystallographic data for compound **3v**. These data can be obtained free of charge from The Cambridge Crystallographic Data Center *via* www.ccdc.cam.ac.uk/data_request/cif.
6. CCDC 2391288 contain the supplementary crystallographic data for compound **5b**. These data can be obtained free of charge from The Cambridge Crystallographic Data Center *via* www.ccdc.cam.ac.uk/data_request/cif.
7. CCDC 2391289 contain the supplementary crystallographic data for compound **7a**. These data can be obtained free of charge from The Cambridge Crystallographic Data Center *via* www.ccdc.cam.ac.uk/data_request/cif.