

Supporting Information  
For

**Synthesis of indenofurans, benzofurans and spiro-lactones via Hauser-Kraus annulation involving 1,6-addition of phthalide to quinone methides**

Pallabita Basu, Nishikant Satam and Irishi N. N. Namboothiri\*

*Department of Chemistry, Indian Institute of Technology Bombay, Mumbai 400 076, INDIA*  
irishi@iitb.ac.in

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**Table of Contents**

Entry		Page
01	<b>Figure S01.</b> $^1\text{H}$ NMR Spectrum of 3a	04
02	<b>Figure S02.</b> $^{13}\text{C}$ NMR Spectrum of 3a	05
03	<b>Figure S03.</b> $^{13}\text{C}$ -APT NMR Spectrum of 3a	06
04	<b>Figure S04.</b> $^1\text{H}$ NMR Spectrum of 5a	07
05	<b>Figure S05.</b> $^{13}\text{C}$ NMR Spectrum of 5a	08
06	<b>Figure S06.</b> $^{13}\text{C}$ -APT NMR Spectrum of 5a	09
07	<b>Figure S07.</b> Inverse Gated $^{13}\text{C}$ NMR Spectrum of 5a	10
08	<b>Figure S08.</b> $^1\text{H}$ - $^{13}\text{C}$ HSQC NMR Spectrum of 5a	11
09	<b>Figure S09.</b> $^1\text{H}$ - $^{13}\text{C}$ HMBC Spectrum of 5a	12
10	<b>Figure S10.</b> $^1\text{H}$ NMR Spectrum of 5b	13
11	<b>Figure S11.</b> $^{13}\text{C}$ NMR Spectrum of 5b	14
12	<b>Figure S12.</b> $^{13}\text{C}$ -APT NMR Spectrum of 5b	15
13	<b>Figure S13.</b> Inverse-Gated $^{13}\text{C}$ NMR VSpectrum of 5b	16
14	<b>Figure S14.</b> $^1\text{H}$ NMR Spectrum of 3c	17
15	<b>Figure S15.</b> $^{13}\text{C}$ NMR Spectrum of 3c	18
16	<b>Figure S16.</b> $^{13}\text{C}$ -APT NMR Spectrum of 3c	19
17	<b>Figure S17.</b> $^1\text{H}$ NMR Spectrum of 5d	20
18	<b>Figure S18.</b> $^{13}\text{C}$ NMR Spectrum of 5d	21
19	<b>Figure S19.</b> $^{13}\text{C}$ -APT NMR Spectrum of 5d	22
20	<b>Figure S20.</b> Inverse-Gated $^{13}\text{C}$ NMR Spectrum of 5d	23

21	<b>Figure S21.</b> $^1\text{H}$ - $^1\text{H}$ COSY NMR Spectrum of 5d	24
22	<b>Figure S22.</b> $^1\text{H}$ - $^1\text{H}$ NOEY NMR Spectrum of 5d	25
23	<b>Figure S23.</b> $^1\text{H}$ NMR Spectrum of 5e	26
24	<b>Figure S24.</b> $^{13}\text{C}$ NMR Spectrum of 5e	27
25	<b>Figure S25.</b> $^{13}\text{C}$ -APT NMR Spectrum of 5e	28
26	<b>Figure S26.</b> Inverse-Gated $^{13}\text{C}$ NMR Spectrum of 5e	29
27	<b>Figure S27.</b> $^1\text{H}$ NMR Spectrum of 5f	30
28	<b>Figure S28.</b> $^{13}\text{C}$ NMR Spectrum of 5f	31
29	<b>Figure S29.</b> $^{13}\text{C}$ -APT NMR Spectrum of 5f	32
30	<b>Figure S30.</b> Inverse-Gated $^{13}\text{C}$ NMR Spectrum of 5f	33
31	<b>Figure S31.</b> $^1\text{H}$ NMR Spectrum of 3g	34
32	<b>Figure S32.</b> $^{13}\text{C}$ NMR Spectrum of 3g	35
33	<b>Figure S33.</b> $^{13}\text{C}$ -APT NMR Spectrum of 3g	36
34	<b>Figure S34.</b> $^1\text{H}$ NMR Spectrum of 3h	37
35	<b>Figure S35.</b> $^{13}\text{C}$ NMR Spectrum of 3h	38
36	<b>Figure S36.</b> $^{13}\text{C}$ -APT NMR Spectrum of 3h	39
37	<b>Figure S37.</b> $^1\text{H}$ NMR Spectrum of 4a	40
38	<b>Figure S38.</b> $^{13}\text{C}$ NMR Spectrum of 4a	41
39	<b>Figure S39.</b> $^{13}\text{C}$ -APT NMR Spectrum of 4a	42
40	<b>Figure S40.</b> $^1\text{H}$ NMR Spectrum of 4d	43
41	<b>Figure S41.</b> $^{13}\text{C}$ NMR Spectrum of 4d	44
42	<b>Figure S42.</b> $^{13}\text{C}$ -APT NMR Spectrum of 4d	45
43	<b>Figure S43.</b> $^1\text{H}$ NMR Spectrum of 4e	46
44	<b>Figure S44.</b> $^{13}\text{C}$ NMR Spectrum of 4e	47
45	<b>Figure S45.</b> $^1\text{H}$ NMR Spectrum of 4f	48
46	<b>Figure S46.</b> $^{13}\text{C}$ NMR Spectrum of 4f	49
47	<b>Figure S47.</b> $^1\text{H}$ NMR Spectrum of 4g	50
48	<b>Figure S48.</b> $^{13}\text{C}$ NMR Spectrum of 4g	51
49	<b>Figure S49.</b> $^{13}\text{C}$ -APT NMR Spectrum of 4g	52
50	<b>Figure S50.</b> $^1\text{H}$ NMR Spectrum of 4h	53
51	<b>Figure S51.</b> $^{13}\text{C}$ NMR Spectrum of 4h	54
52	<b>Figure S52.</b> $^{13}\text{C}$ -APT NMR Spectrum of 4h	55
53	<b>Figure S53.</b> $^1\text{H}$ - $^1\text{H}$ COSY NMR Spectrum of 4h	56

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54	<b>Figure S54.</b> $^1\text{H}$ NMR Spectrum of 6a	57
55	<b>Figure S55.</b> $^{13}\text{C}$ NMR Spectrum of 6a	58
56	<b>Figure S56.</b> $^{13}\text{C}$ -APT NMR Spectrum of 6a	59
57	<b>Figure S57.</b> $^1\text{H}$ - $^1\text{H}$ COSY NMR Spectrum of 6a	60
58	<b>Figure S58.</b> $^1\text{H}$ - $^1\text{H}$ NOESY NMR Spectrum of 6a	61
59	<b>Figure S59.</b> $^1\text{H}$ NMR Spectrum of 6b	62
60	<b>Figure S60.</b> $^{13}\text{C}$ NMR Spectrum of 6b	63
61	<b>Figure S61.</b> $^{13}\text{C}$ -APT NMR Spectrum of 6b	64
62	<b>Figure S62.</b> $^1\text{H}$ NMR Spectrum of 6c	65
63	<b>Figure S63.</b> $^{13}\text{C}$ NMR Spectrum of 6c	66
64	<b>Figure S64.</b> $^{13}\text{C}$ -APT NMR Spectrum of 6c	67
65	<b>Figure S65.</b> $^1\text{H}$ NMR Spectrum of 6d	68
66	<b>Figure S66.</b> $^{13}\text{C}$ NMR Spectrum of 6d	69
67	<b>Figure S67.</b> $^{13}\text{C}$ -APT NMR Spectrum of 6d	70
68	<b>Figure S68.</b> $^1\text{H}$ NMR Spectrum of 6e	71
69	<b>Figure S69.</b> $^{13}\text{C}$ NMR Spectrum of 6e	72
70	<b>Figure S70.</b> $^{13}\text{C}$ -APT NMR Spectrum of 6e	73
71	<b>Figure S71.</b> $^1\text{H}$ NMR Spectrum of 6f	74
72	<b>Figure S72.</b> $^{13}\text{C}$ NMR Spectrum of 6f	75
73	<b>Figure S73.</b> $^{13}\text{C}$ -APT NMR Spectrum of 6f	76
74	<b>Figure S74.</b> $^1\text{H}$ NMR Spectrum of 6g	77
75	<b>Figure S75.</b> $^{13}\text{C}$ NMR Spectrum of 6g	78
76	<b>Figure S76.</b> $^1\text{H}$ NMR Spectrum of 6h	79
77	<b>Figure S77.</b> $^{13}\text{C}$ NMR Spectrum of 6h	80
78	<b>Table S1.</b> Selected X-ray data for 3a	81
79	<b>Table S2.</b> Selected X-ray data for 4a	83
80	<b>Table S3.</b> Selected X-ray data for 6d	85

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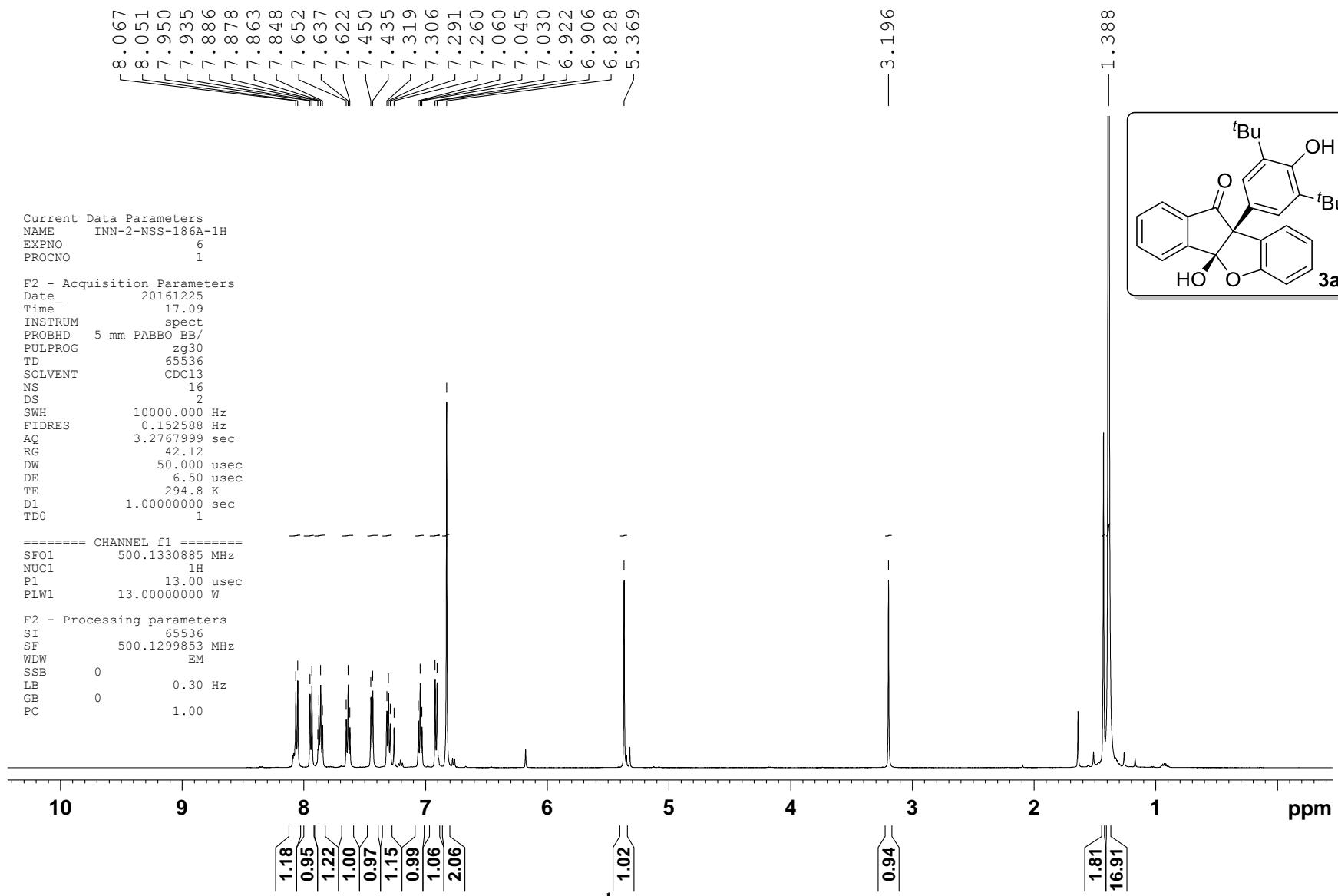
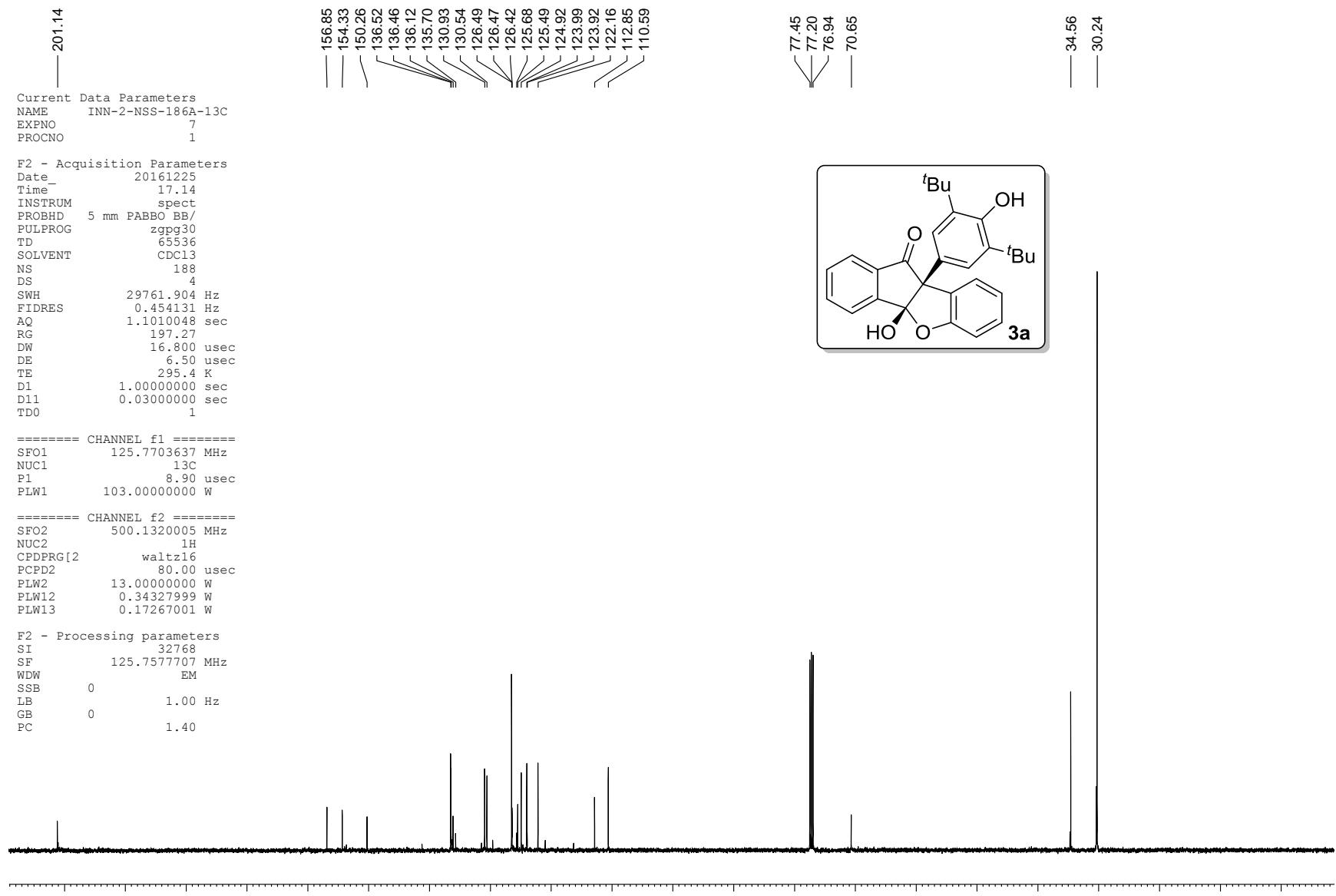
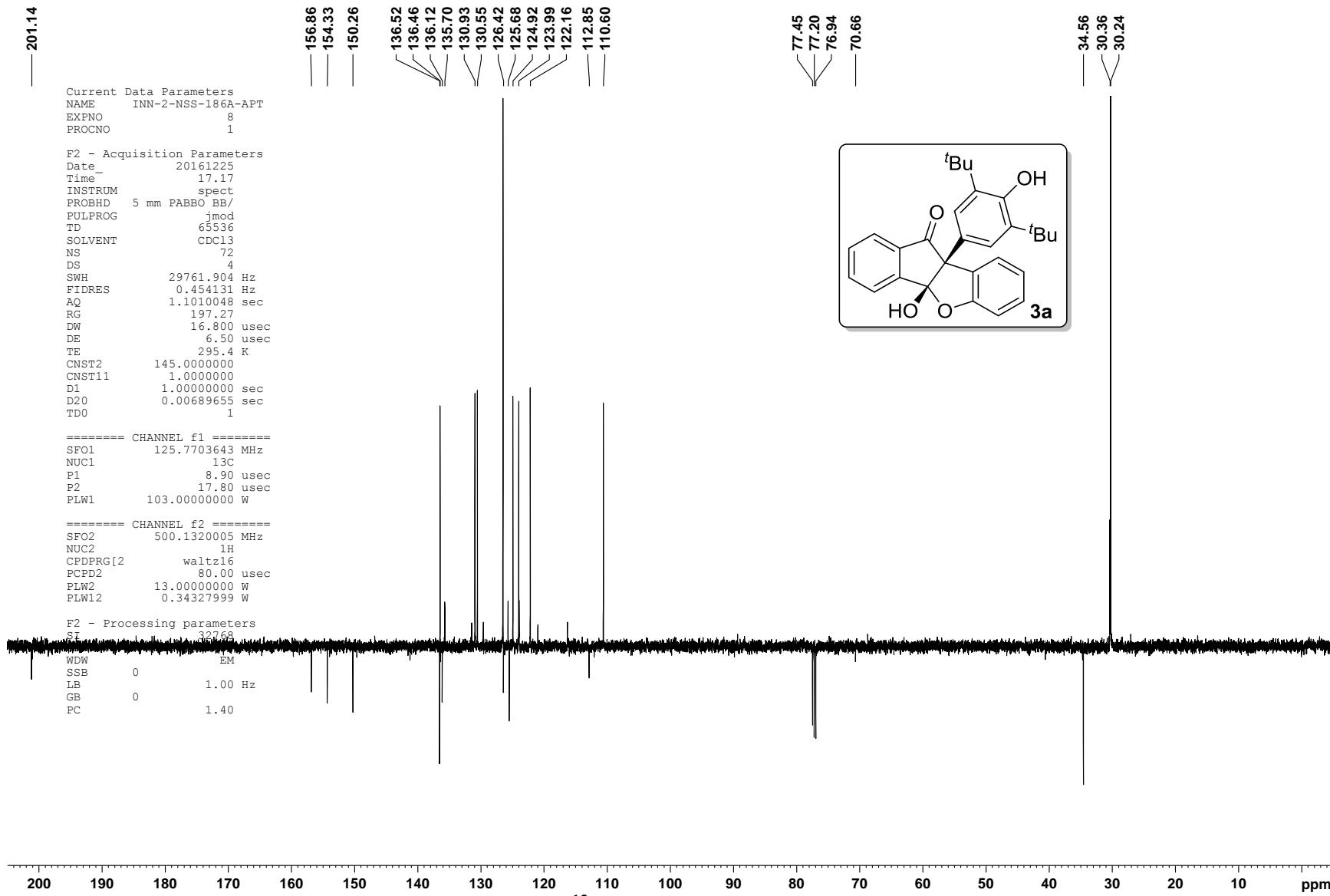


Figure S01.  $^1\text{H}$  NMR Spectrum of 3a



Figure S03.  $^{13}\text{C}$ -APT NMR Spectrum of 3a

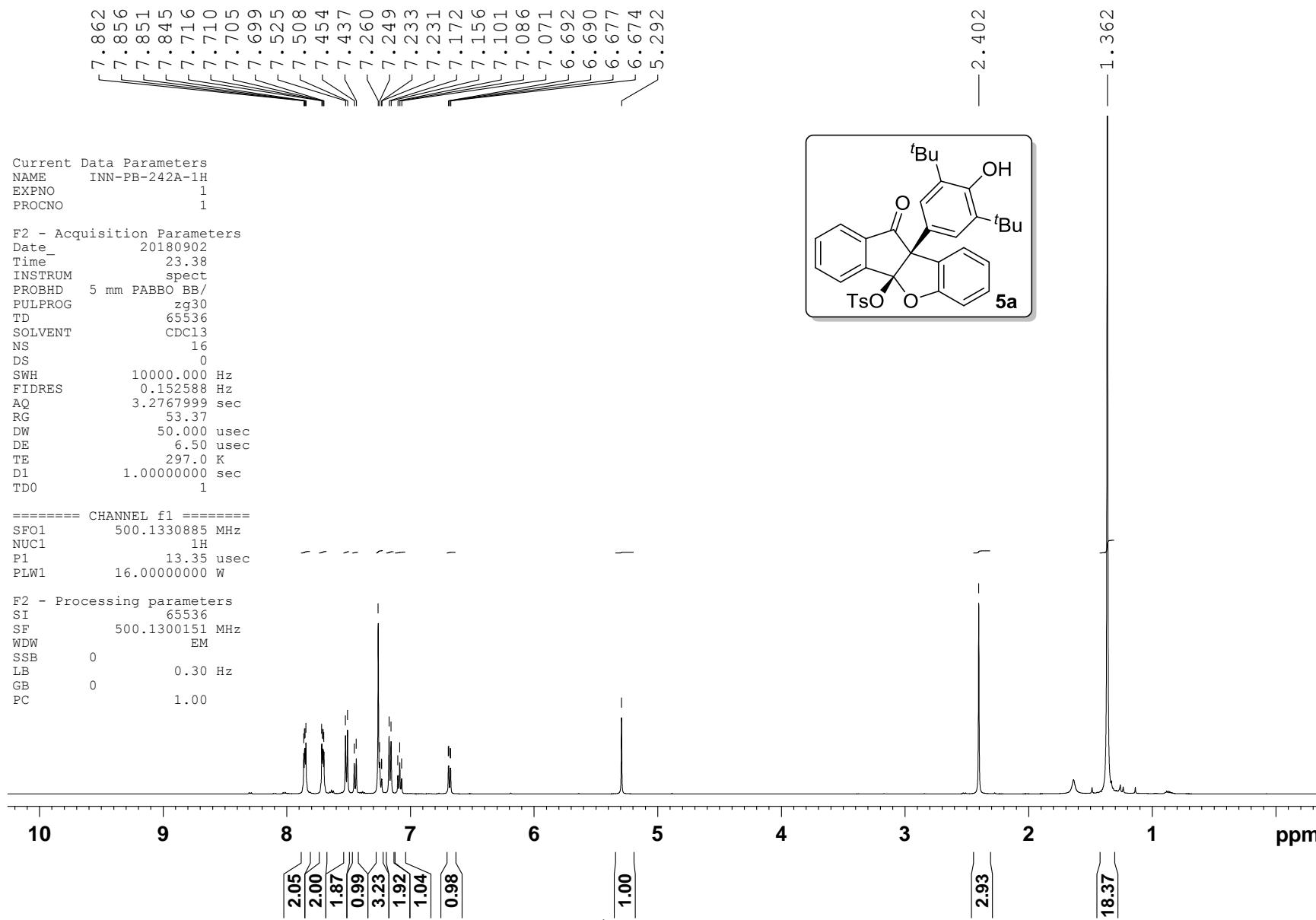
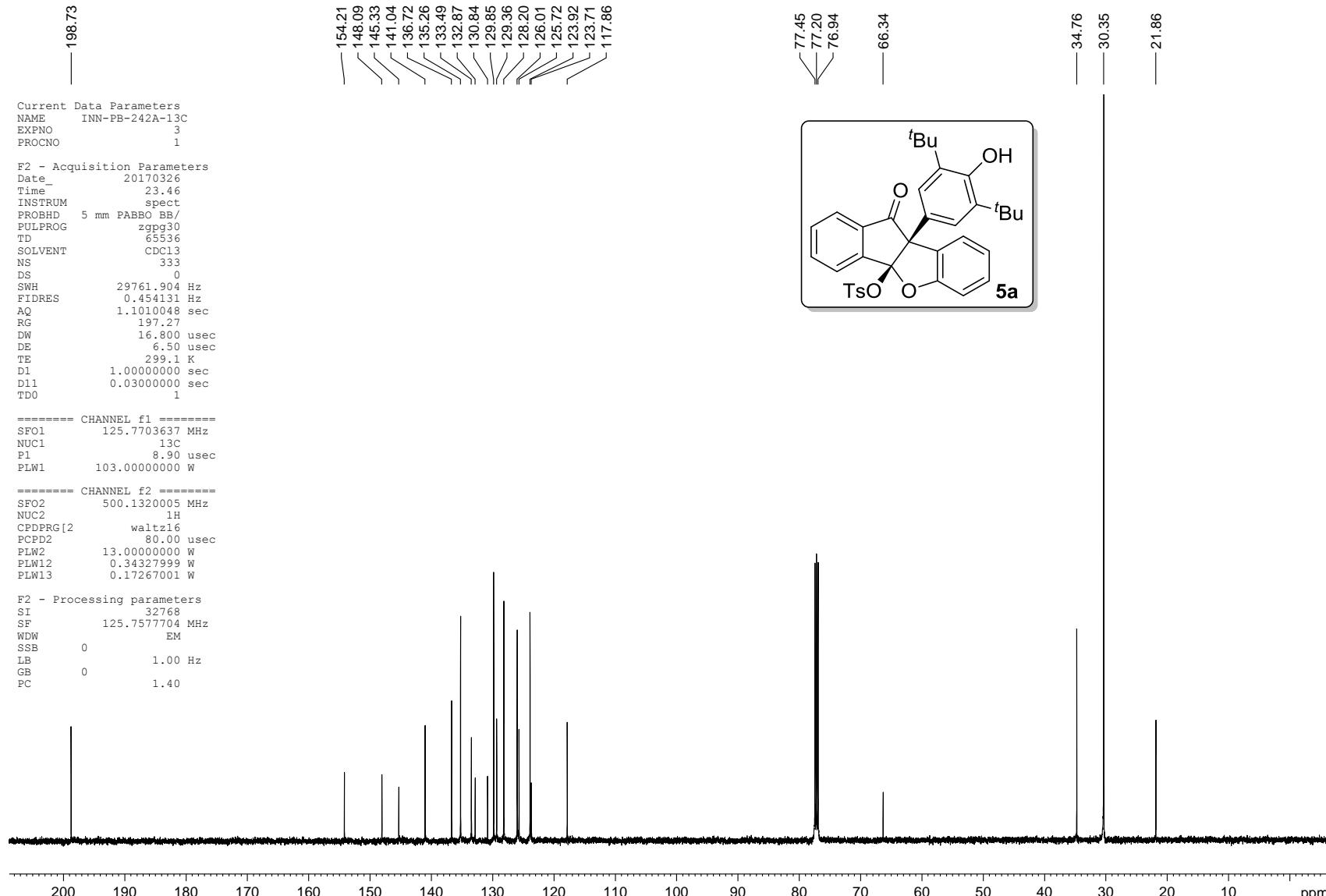
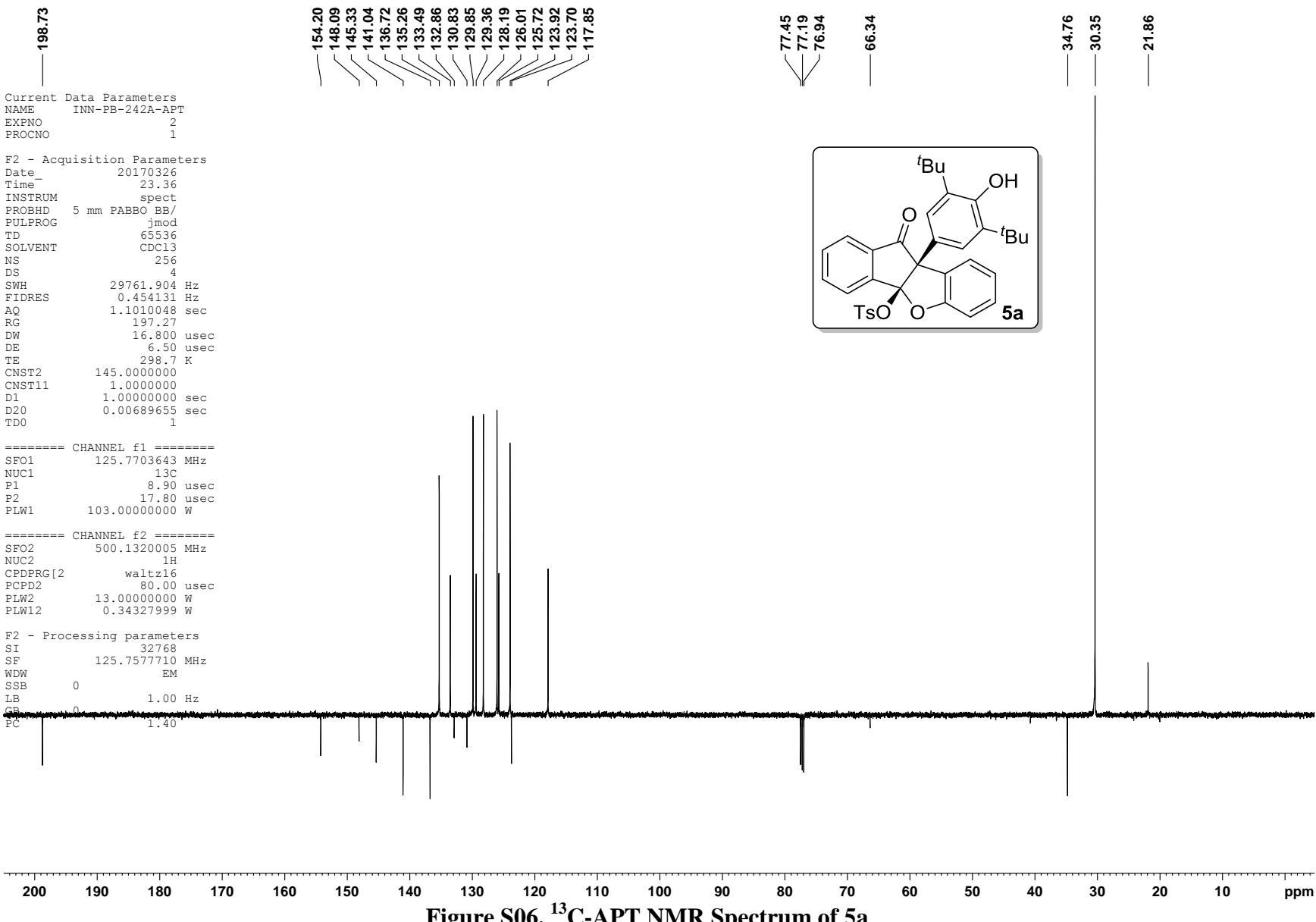
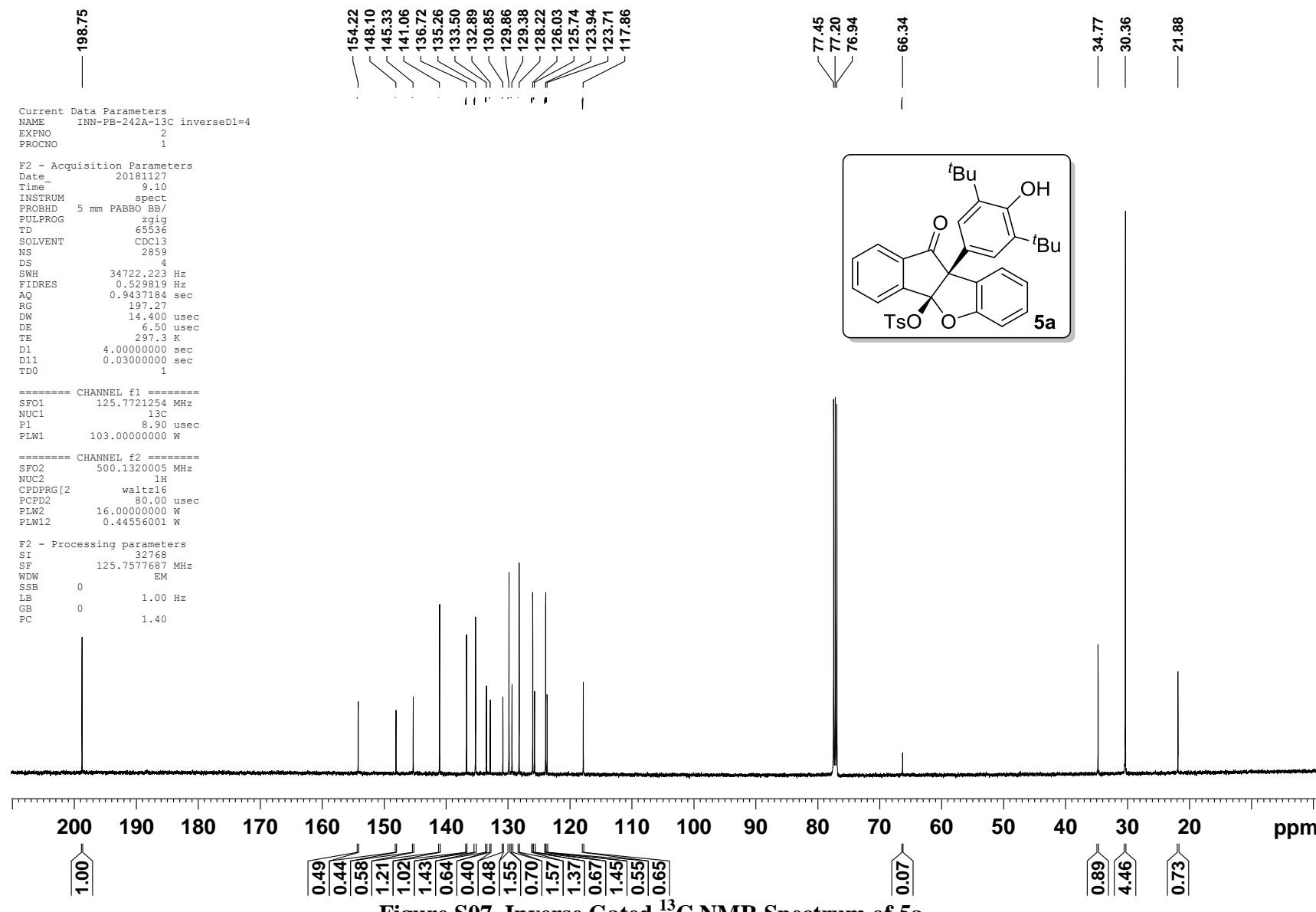


Figure S04. <sup>1</sup>H NMR Spectrum of **5a**







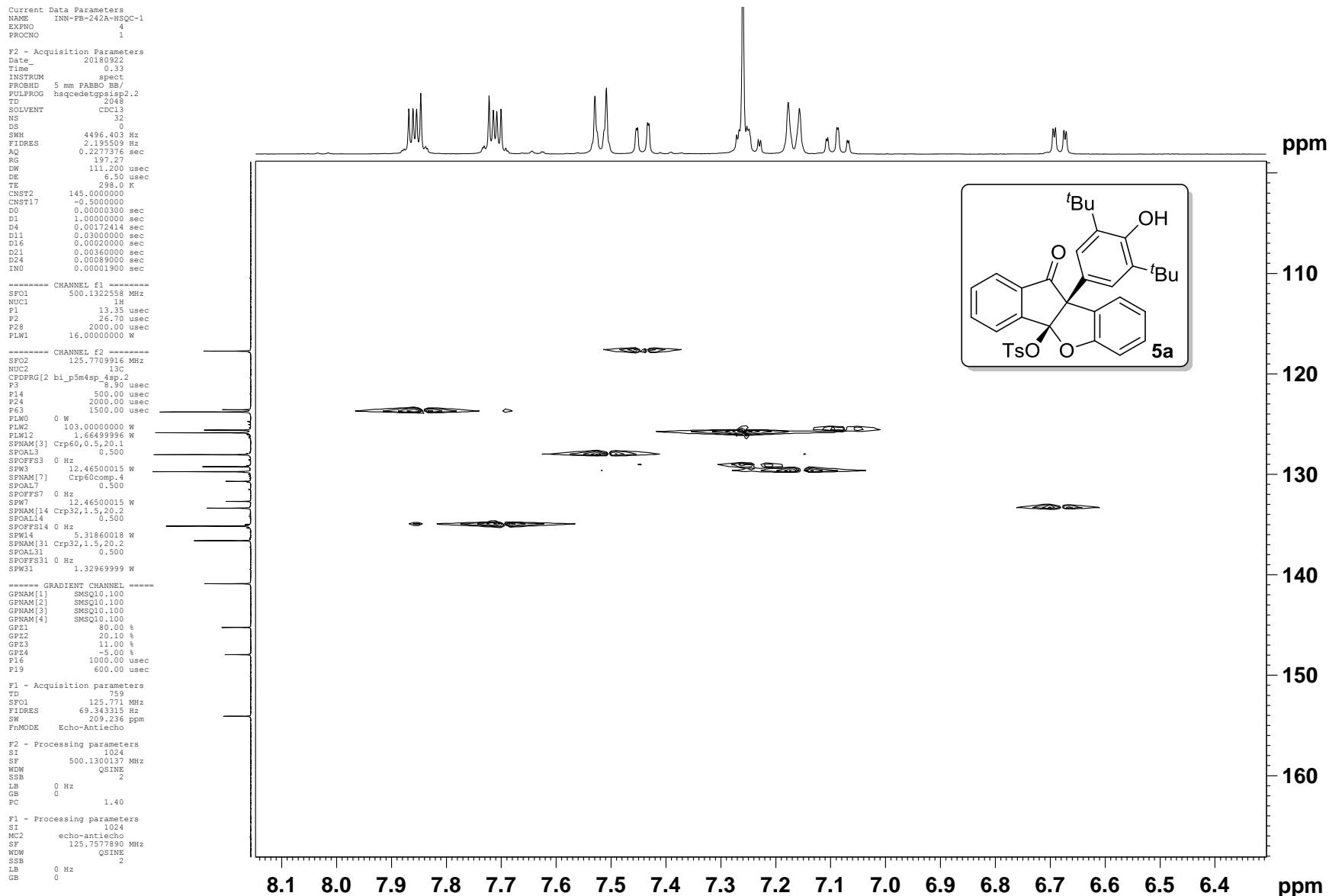


Figure S08. <sup>1</sup>H-<sup>13</sup>C HSQC NMR Spectrum of 5a

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PULPROG hmbctgpl3nd  
TD 4096  
SWL 46  
SOLVENT CDCl3  
NS 32  
DS 0  
SWH 4496.403 Hz  
FIDRES 1.097755 Hz  
AQ 0.4554752 sec  
RG 1.07  
DW 111.200 usec  
DE 6.50 usec  
TE 297.0 K  
CNST6 120.000000  
CNST7 170.000000  
CNST13 8.000000  
CNST30 0.581120  
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D1 1.0000000 sec  
D6 0.0625000 sec  
D16 0.0002000 sec  
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P2 26.70 usec  
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NUC2 13C  
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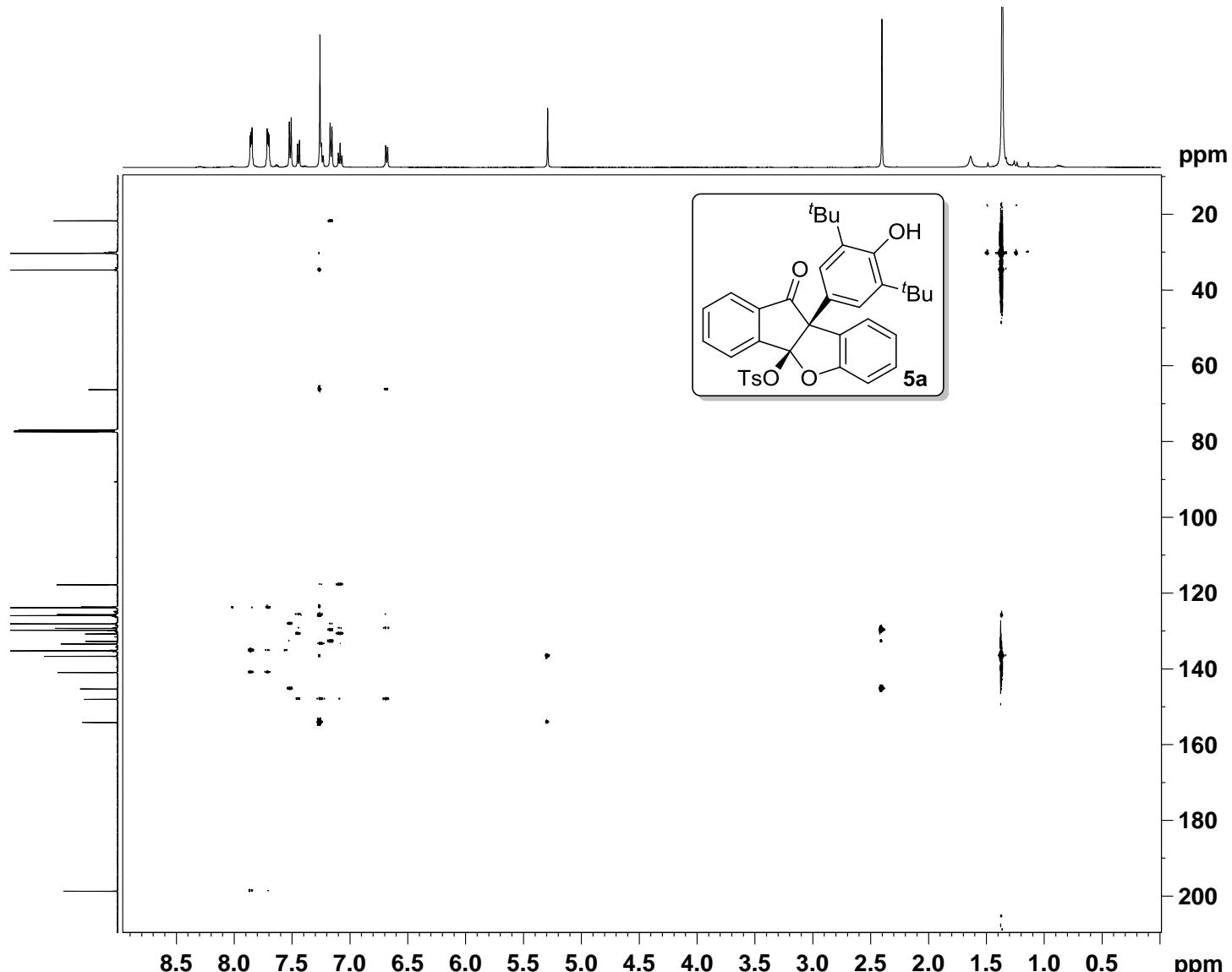
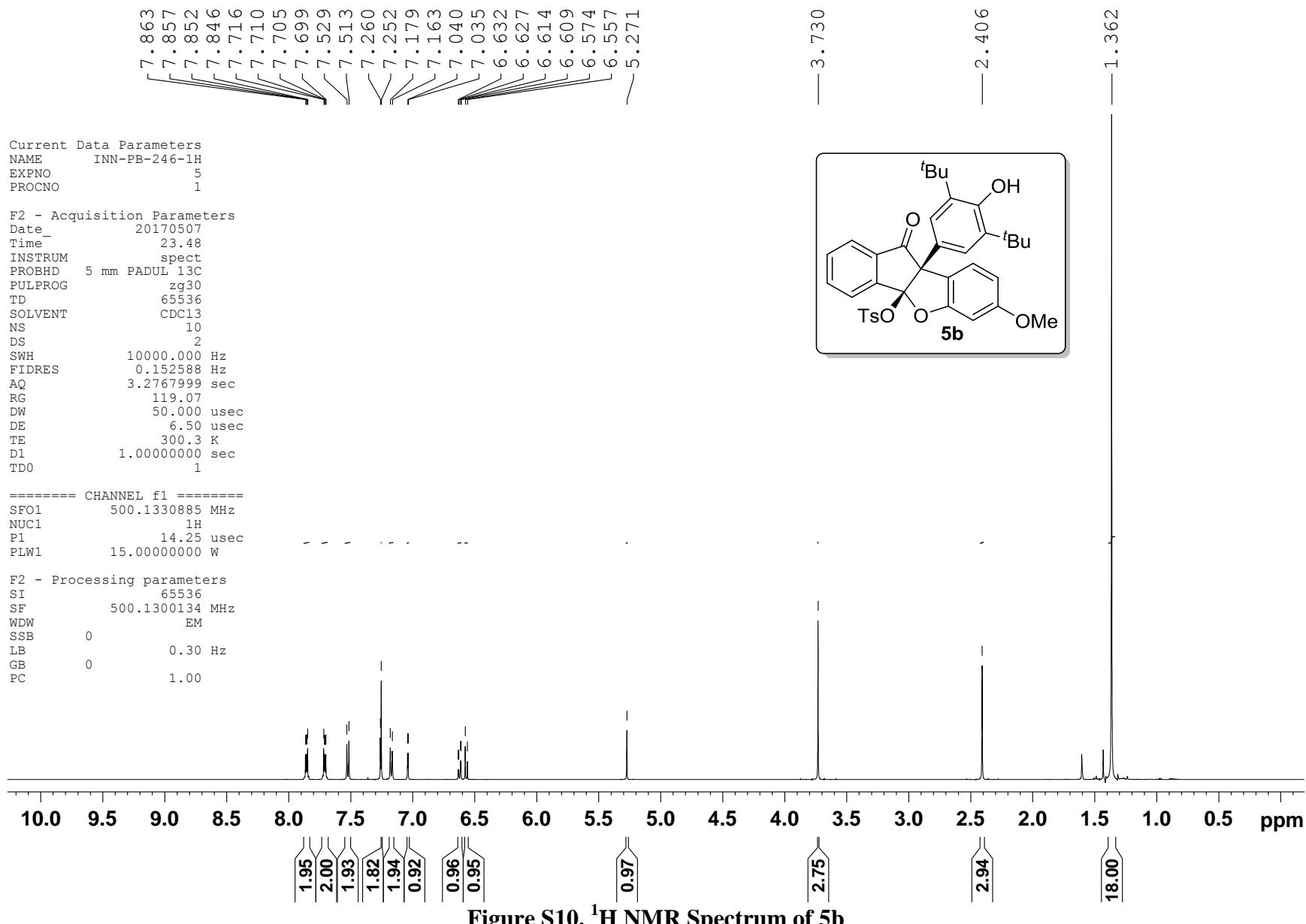
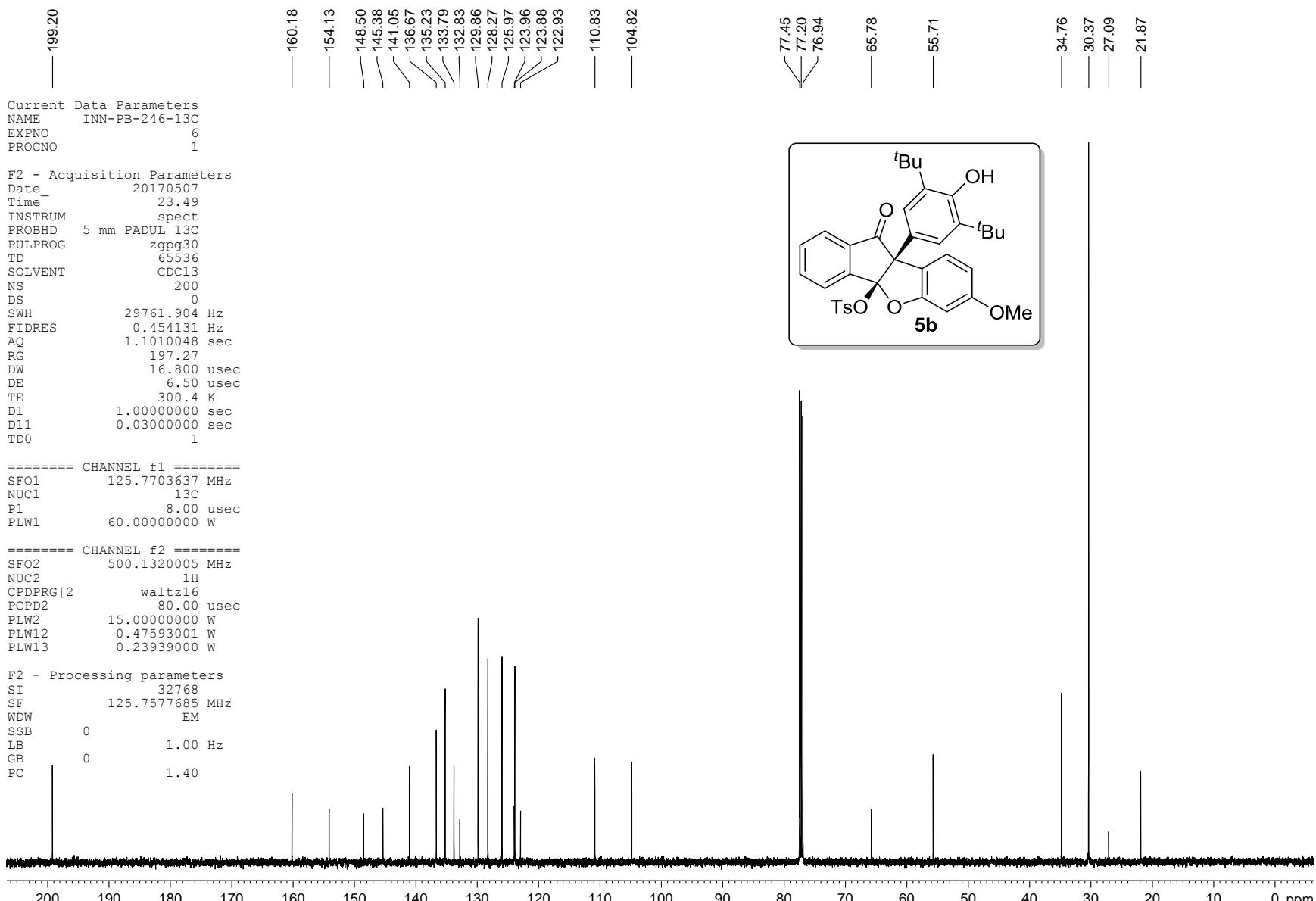


Figure S09.  $^1\text{H}$ - $^{13}\text{C}$  HMBC NMR Spectrum of 5a





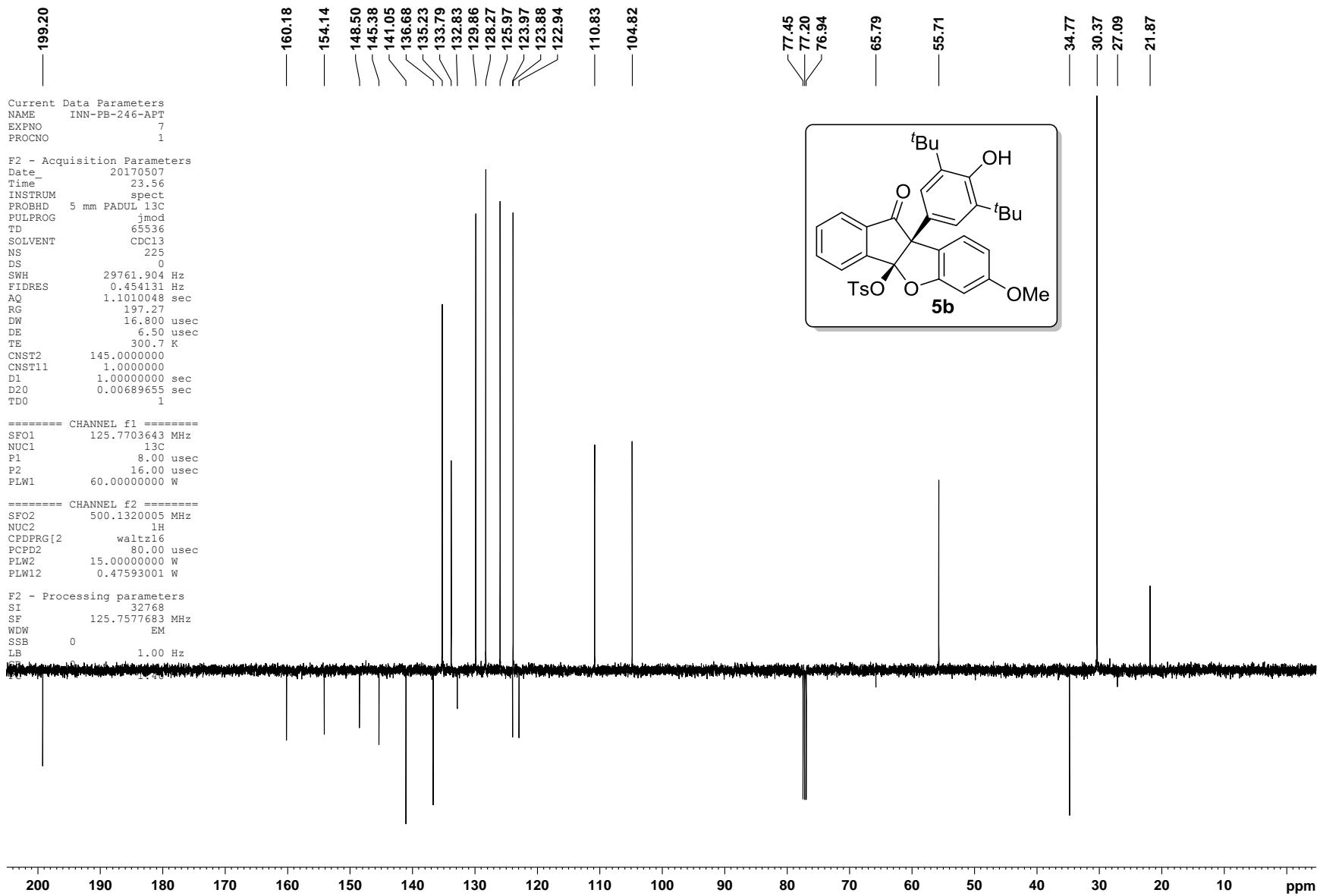


Figure S12.  $^{13}\text{C}$ -APT NMR Spectrum of 5b

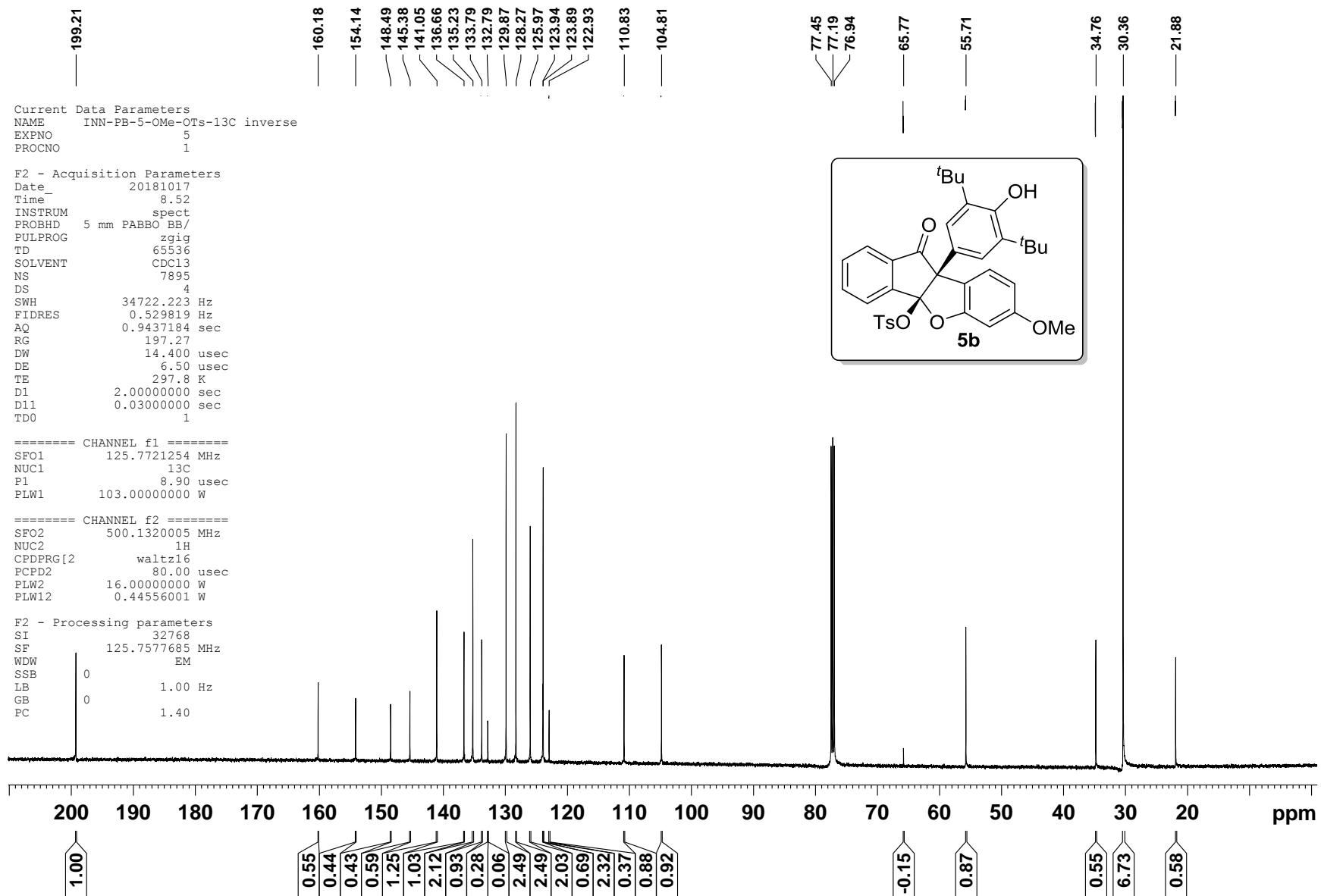
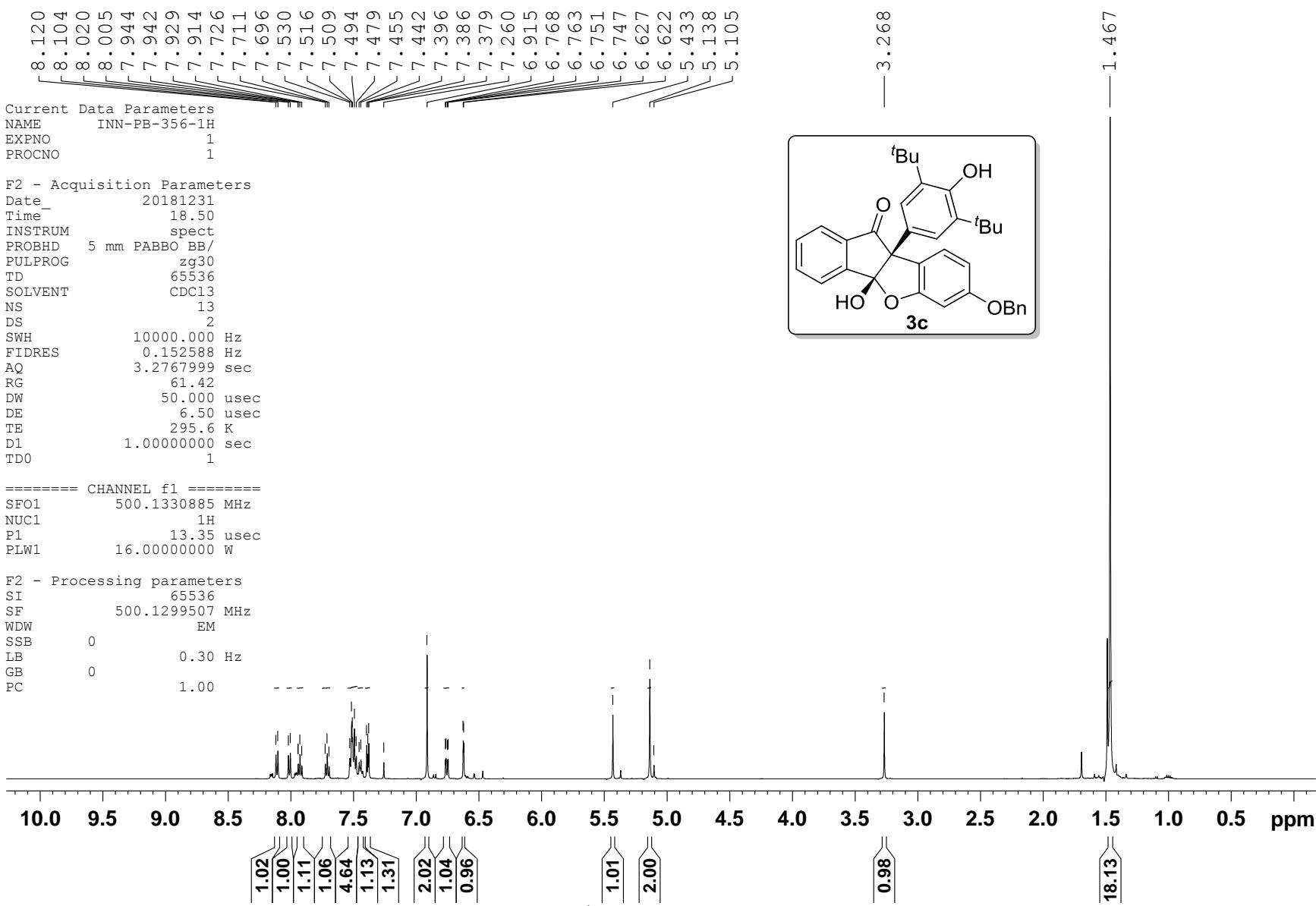
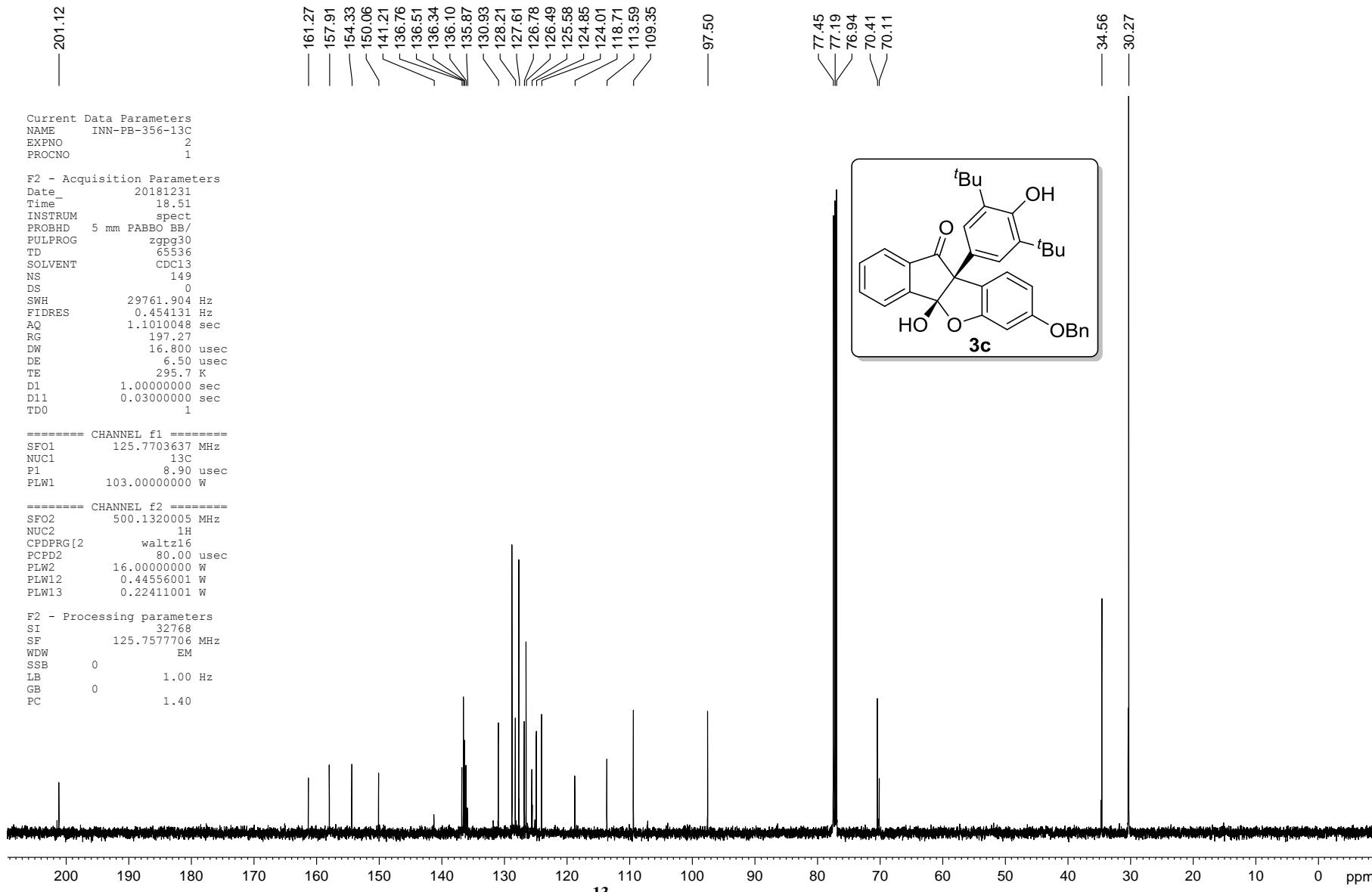
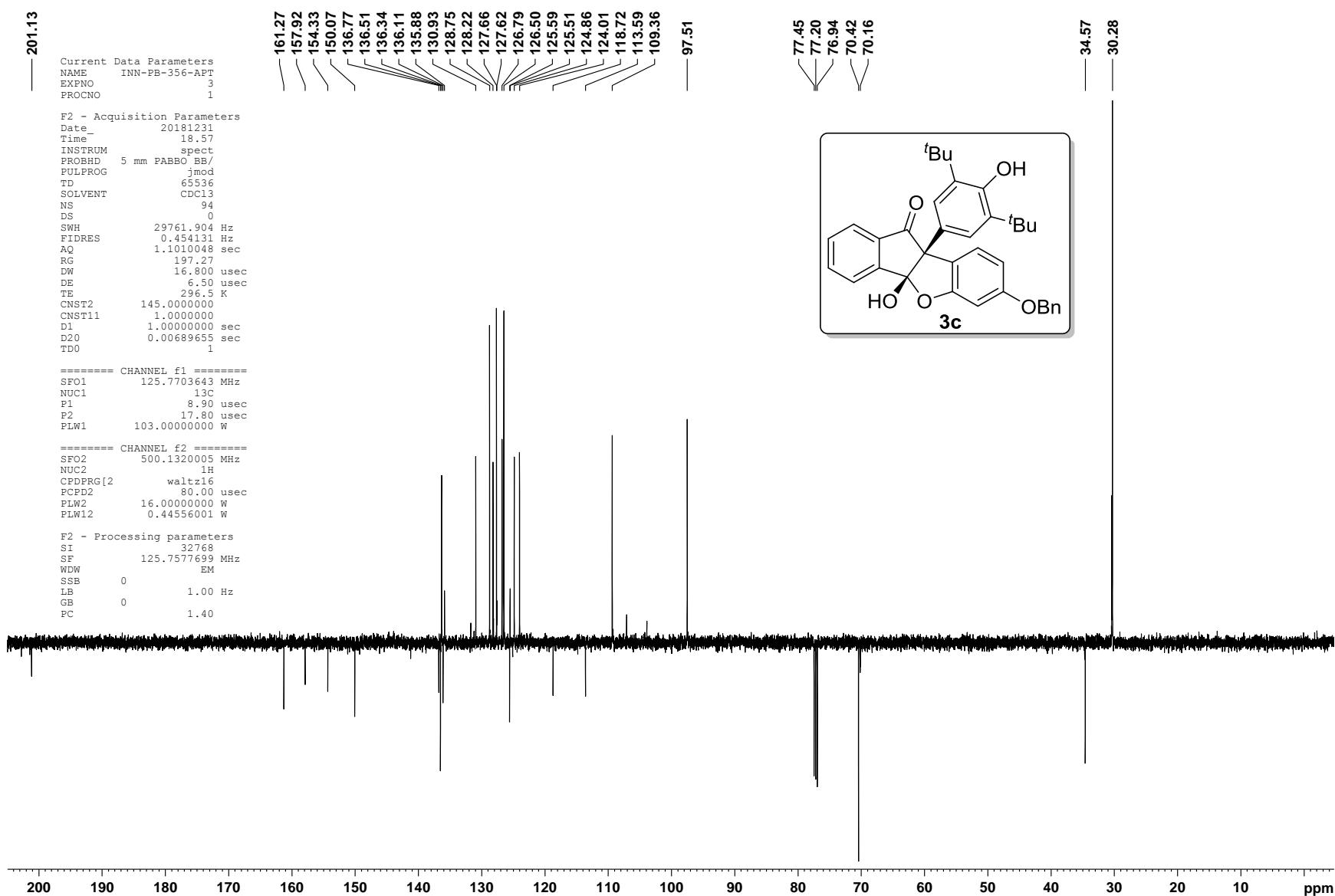


Figure S13. Inverse-Gated  $^{13}\text{C}$  NMR Spectrum of 5b







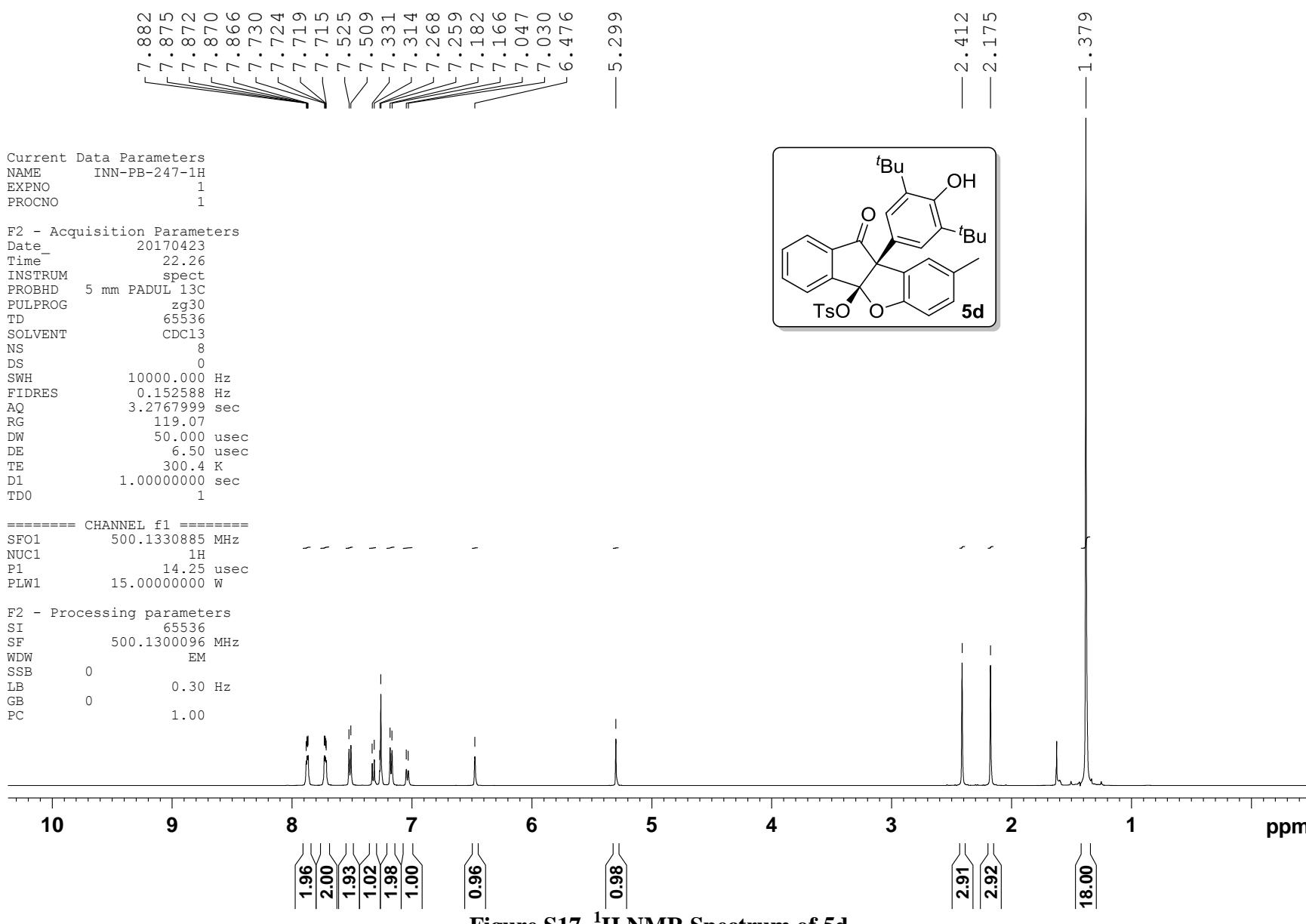
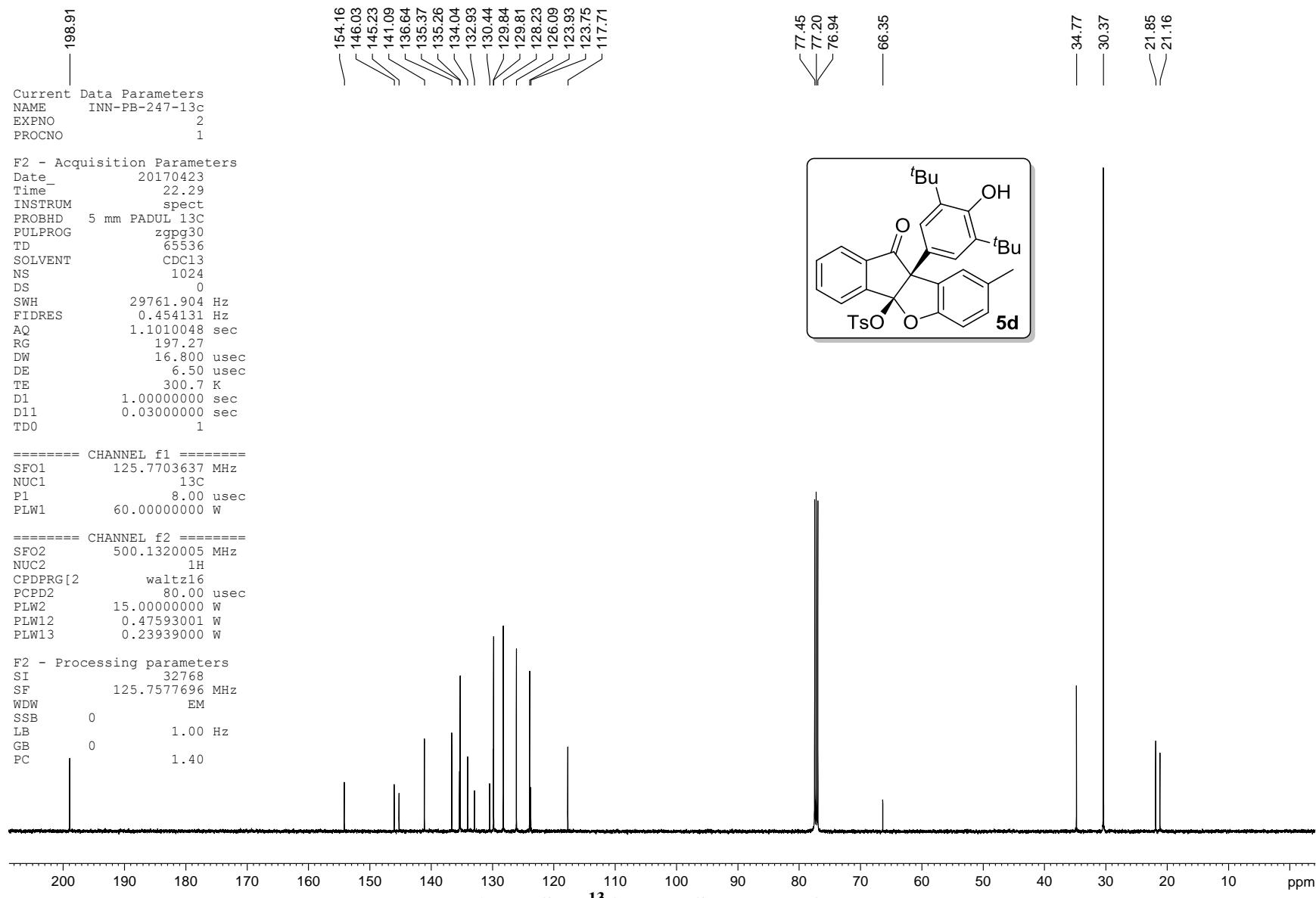


Figure S17.  $^1\text{H}$  NMR Spectrum of 5d



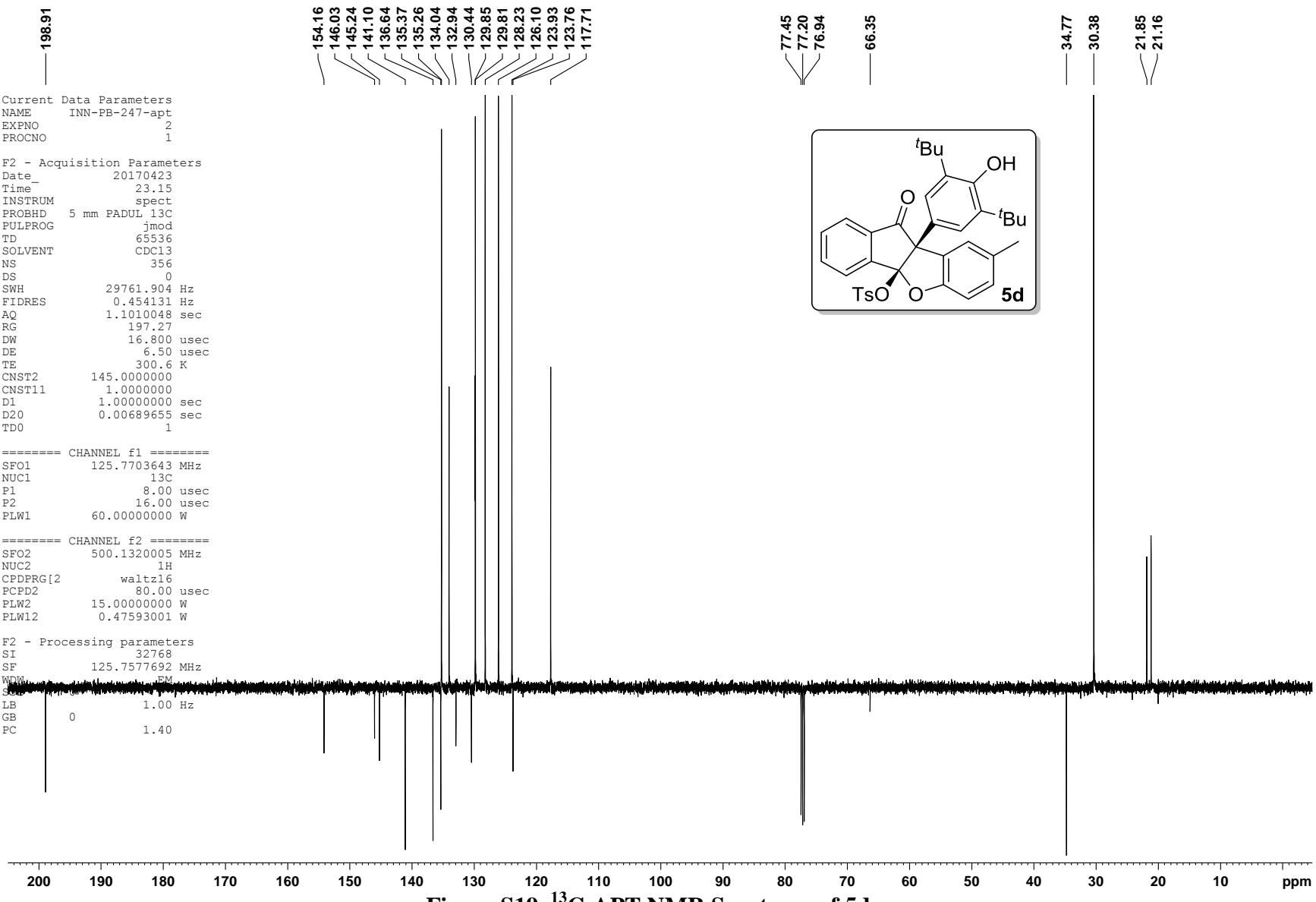
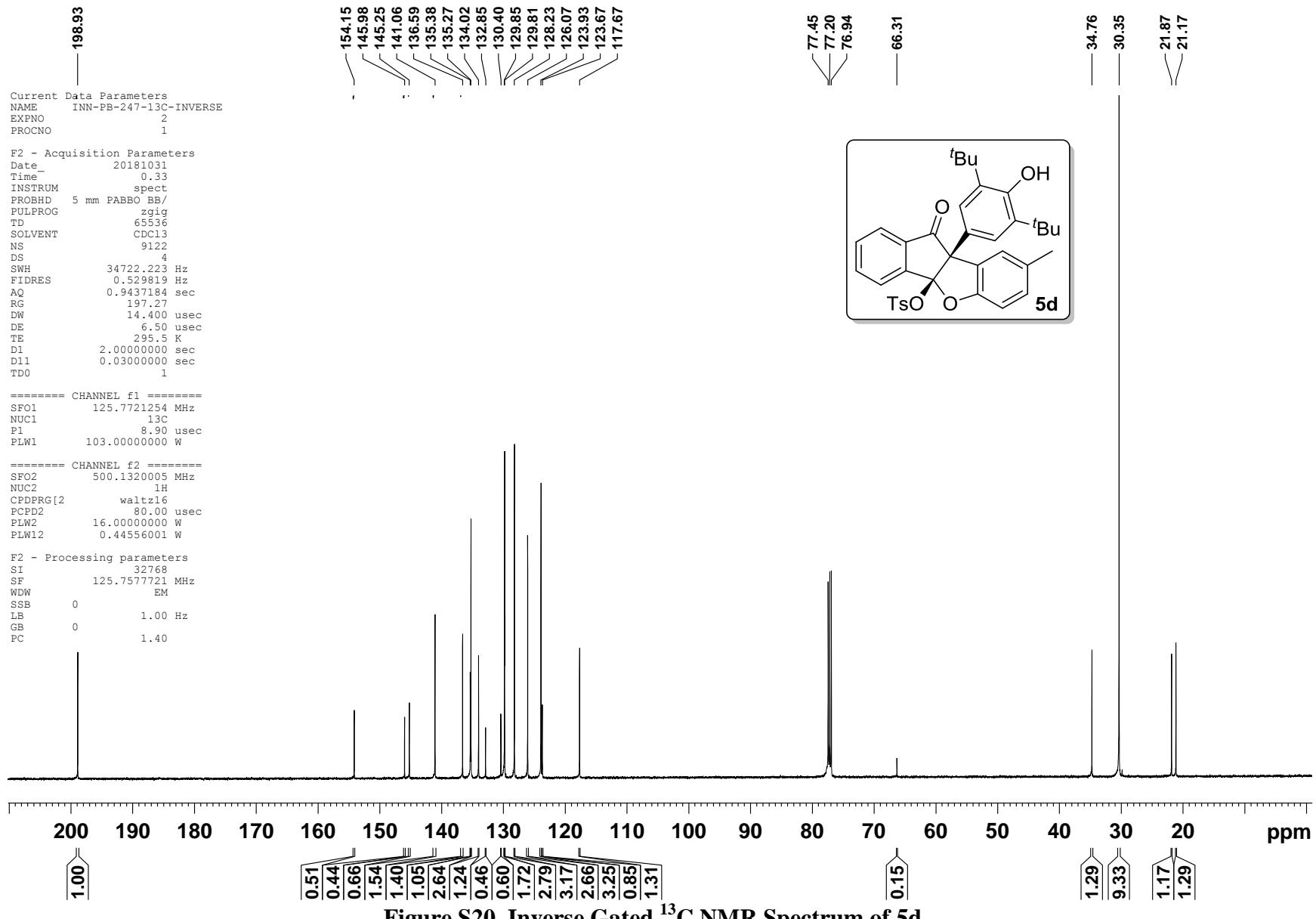


Figure S19.  $^{13}\text{C}$ -APT NMR Spectrum of 5d



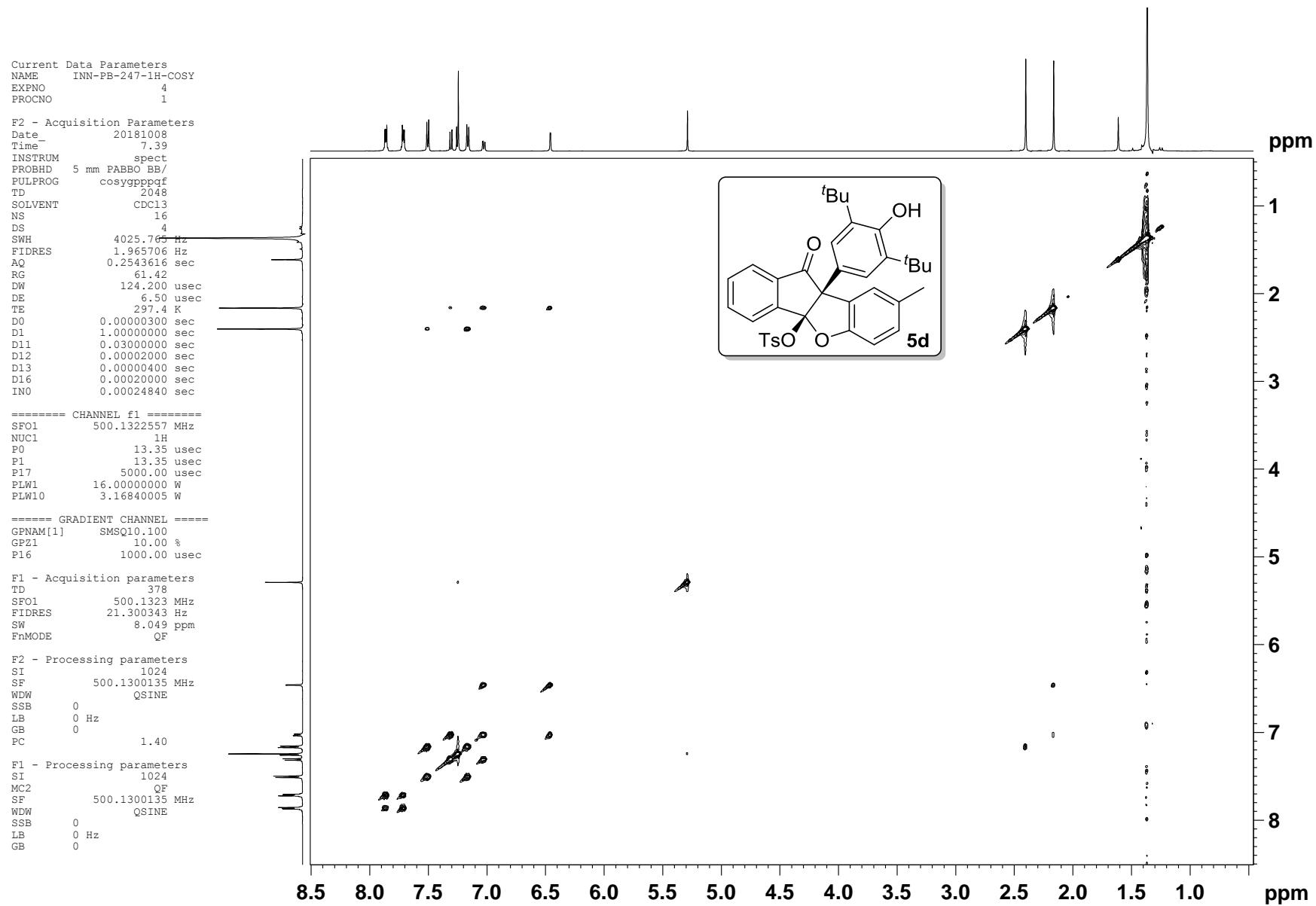


Figure S21.  $^1\text{H}$ - $^1\text{H}$  COSY NMR Spectrum of 5d

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 IN0 0.00024840 sec

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 SSB 2  
 LB 0 Hz  
 GB 0  
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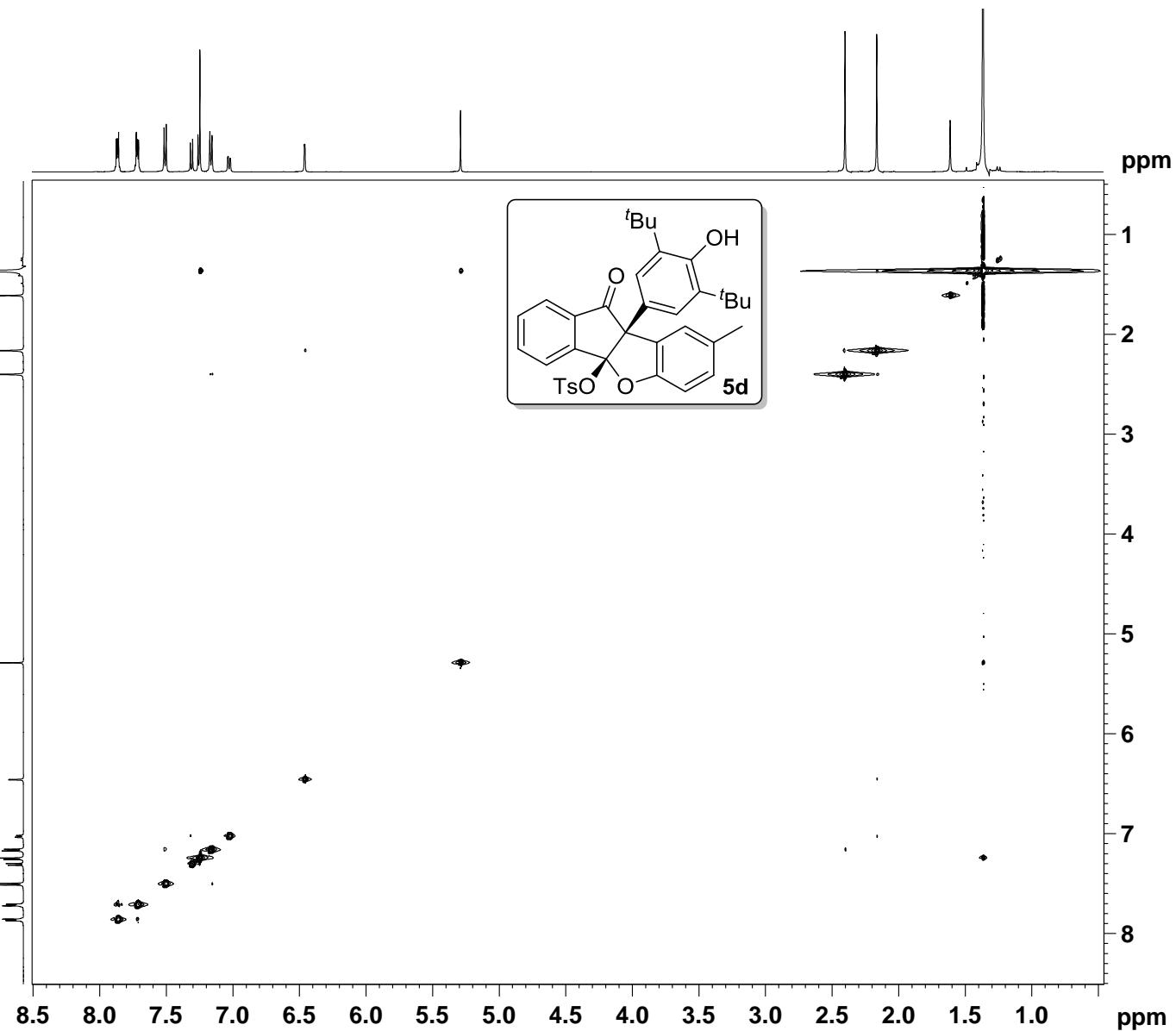
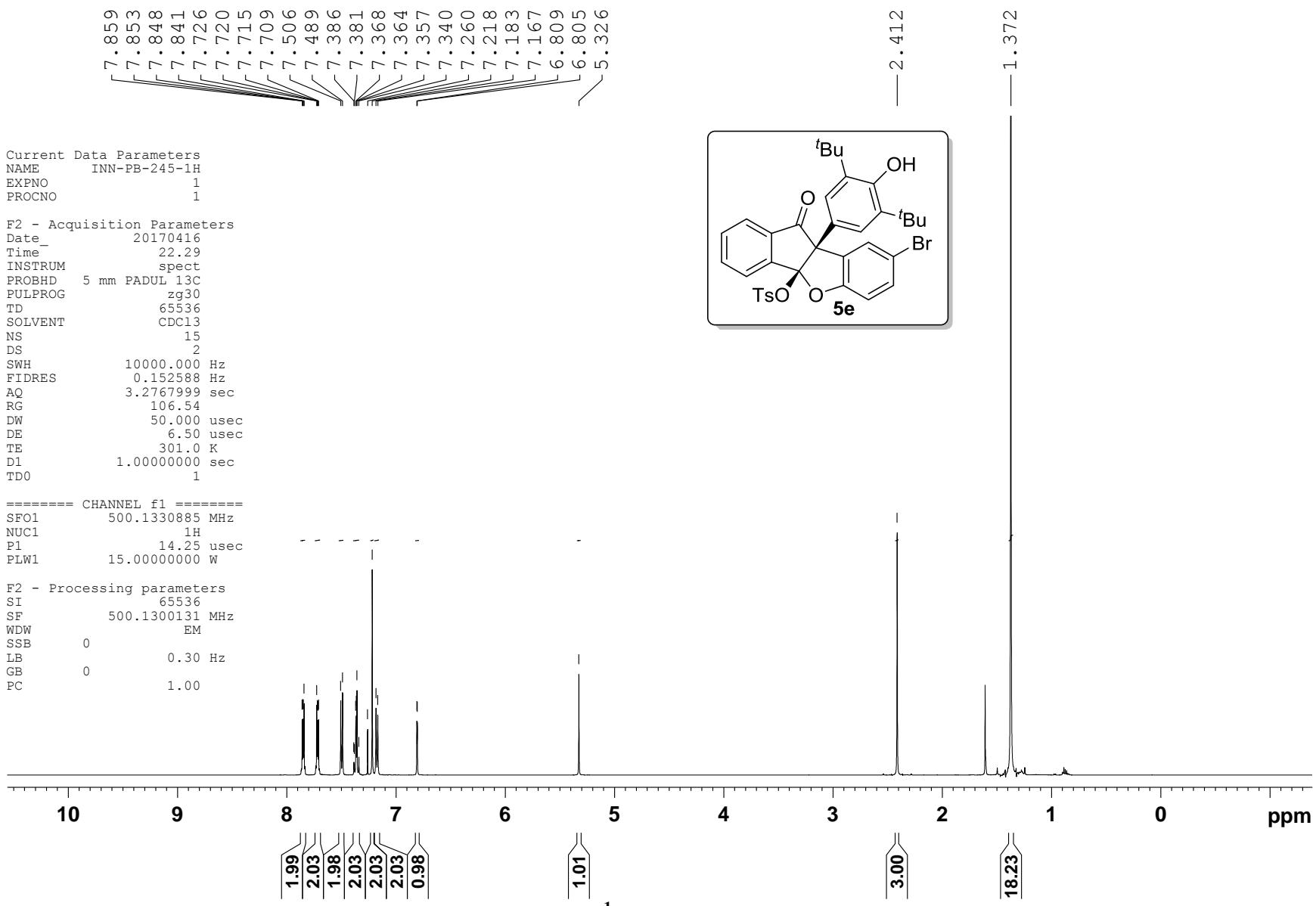
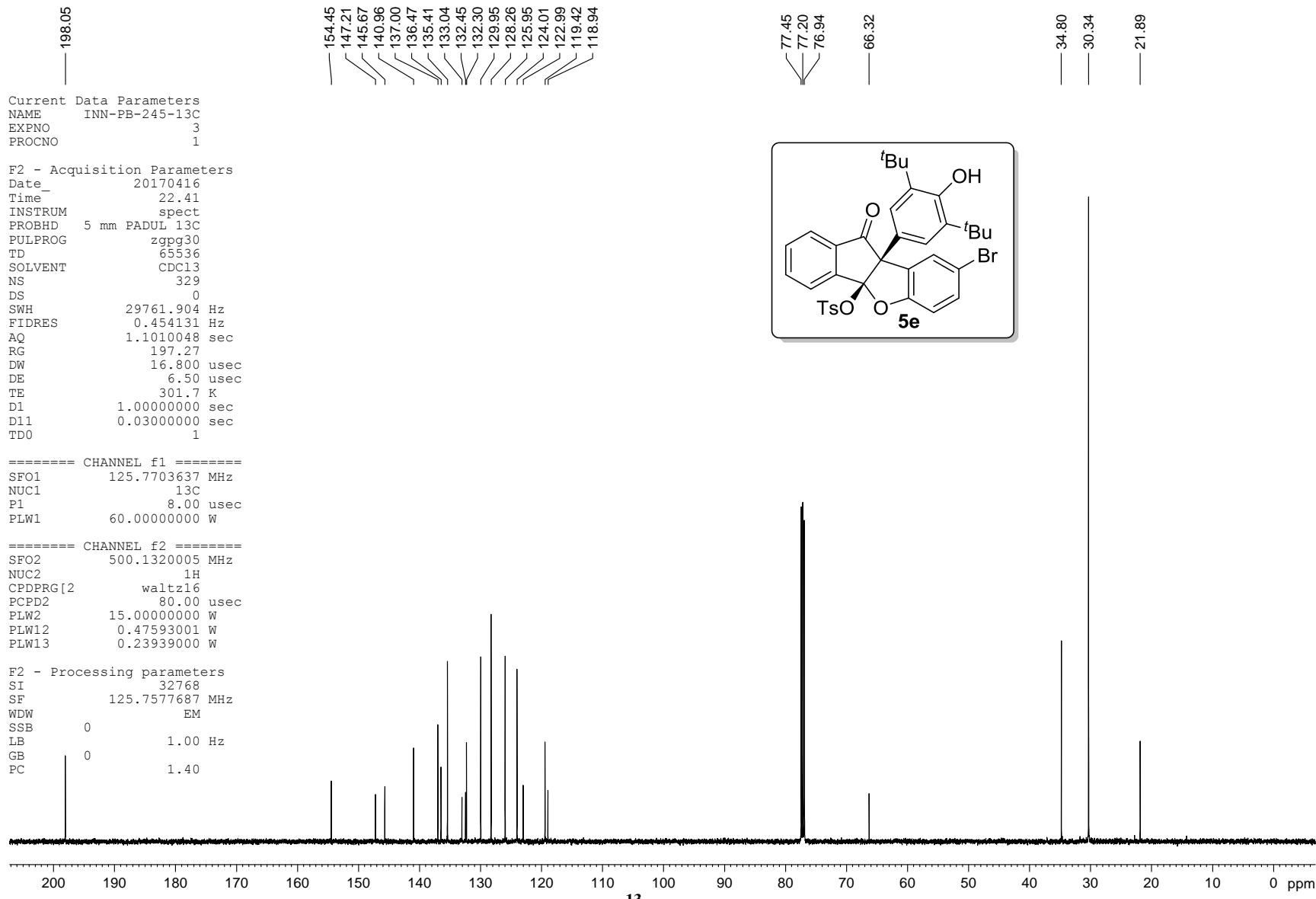
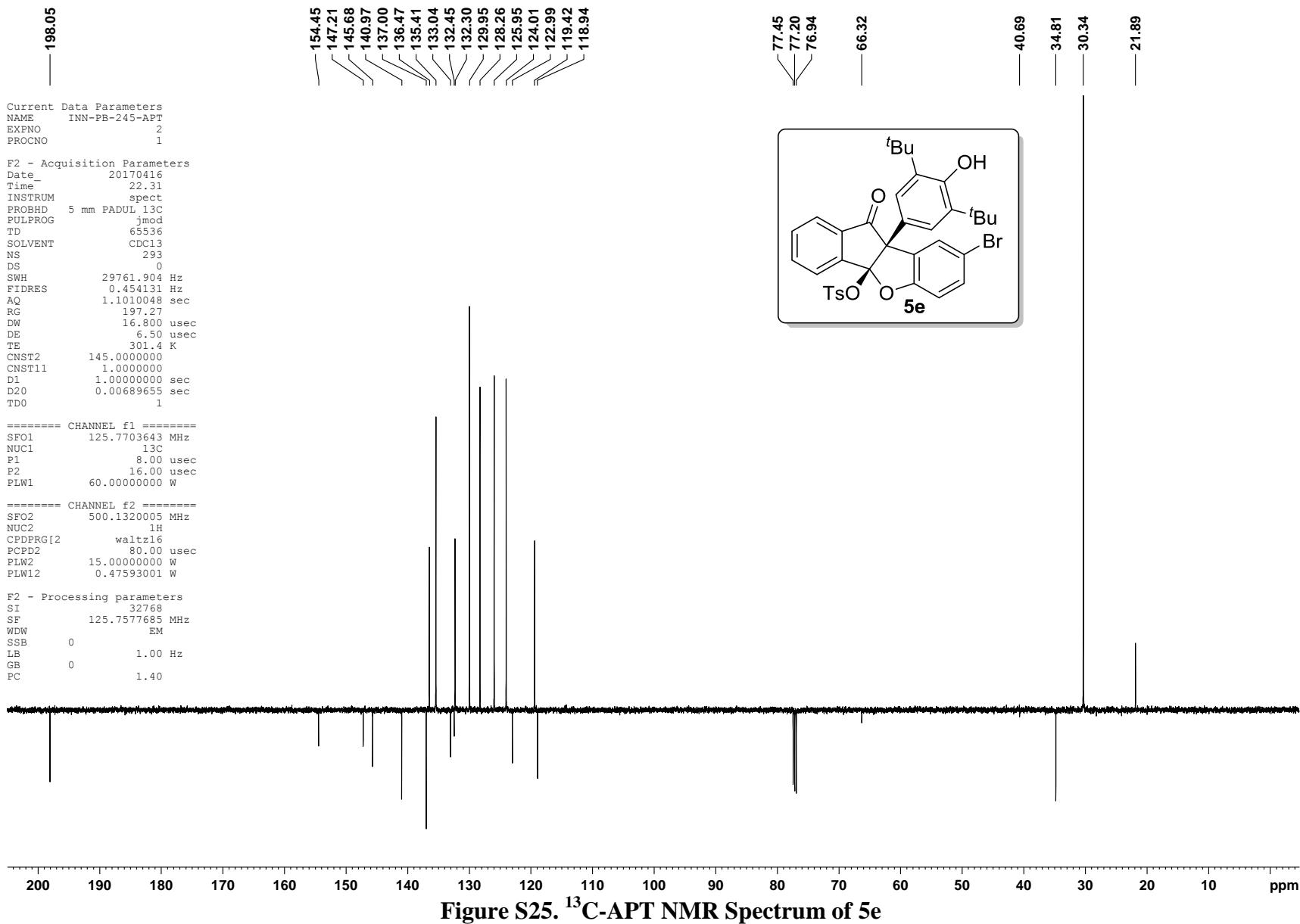
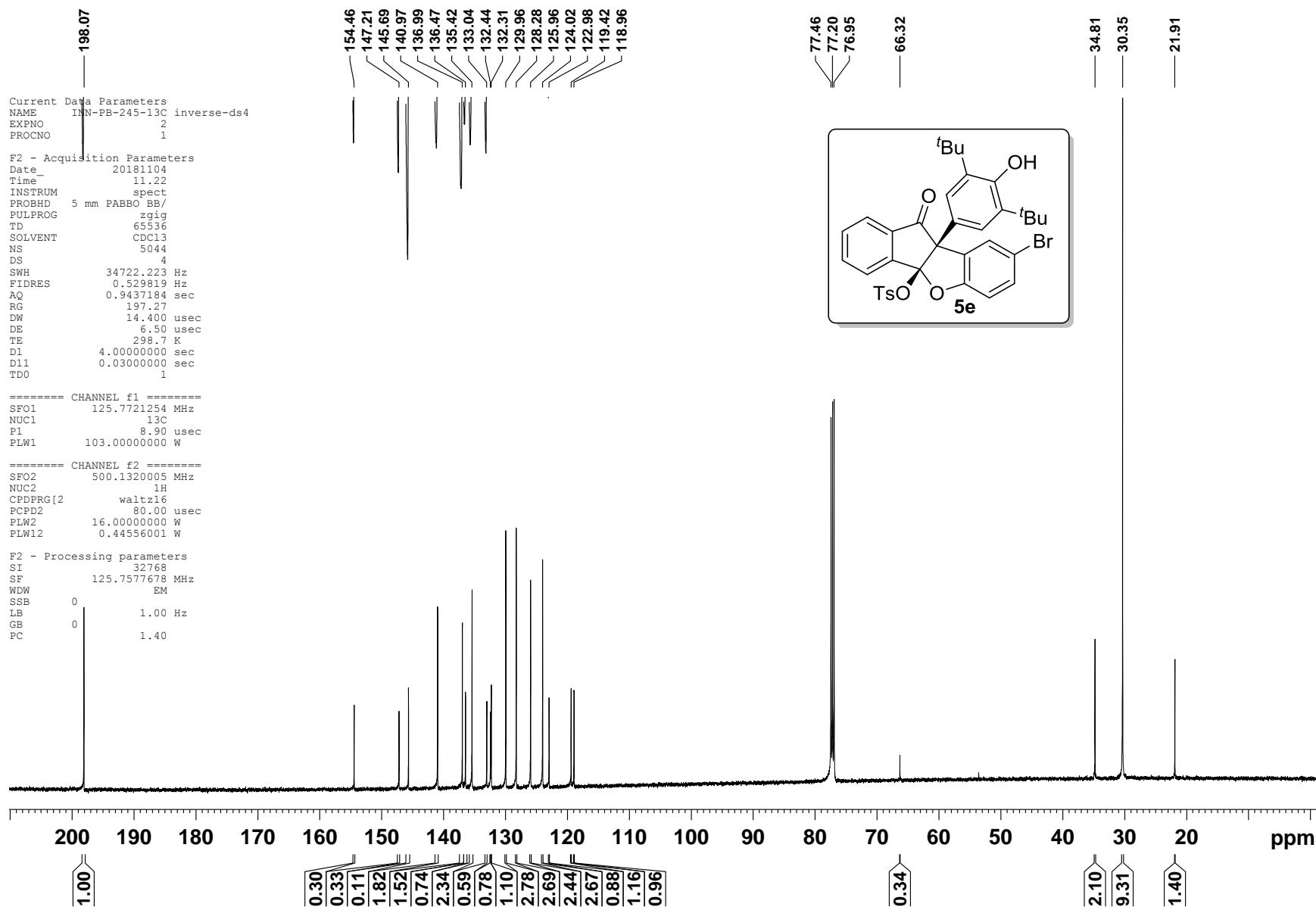


Figure S22.  $^1\text{H}$ - $^1\text{H}$  NOESY NMR Spectrum of 5d









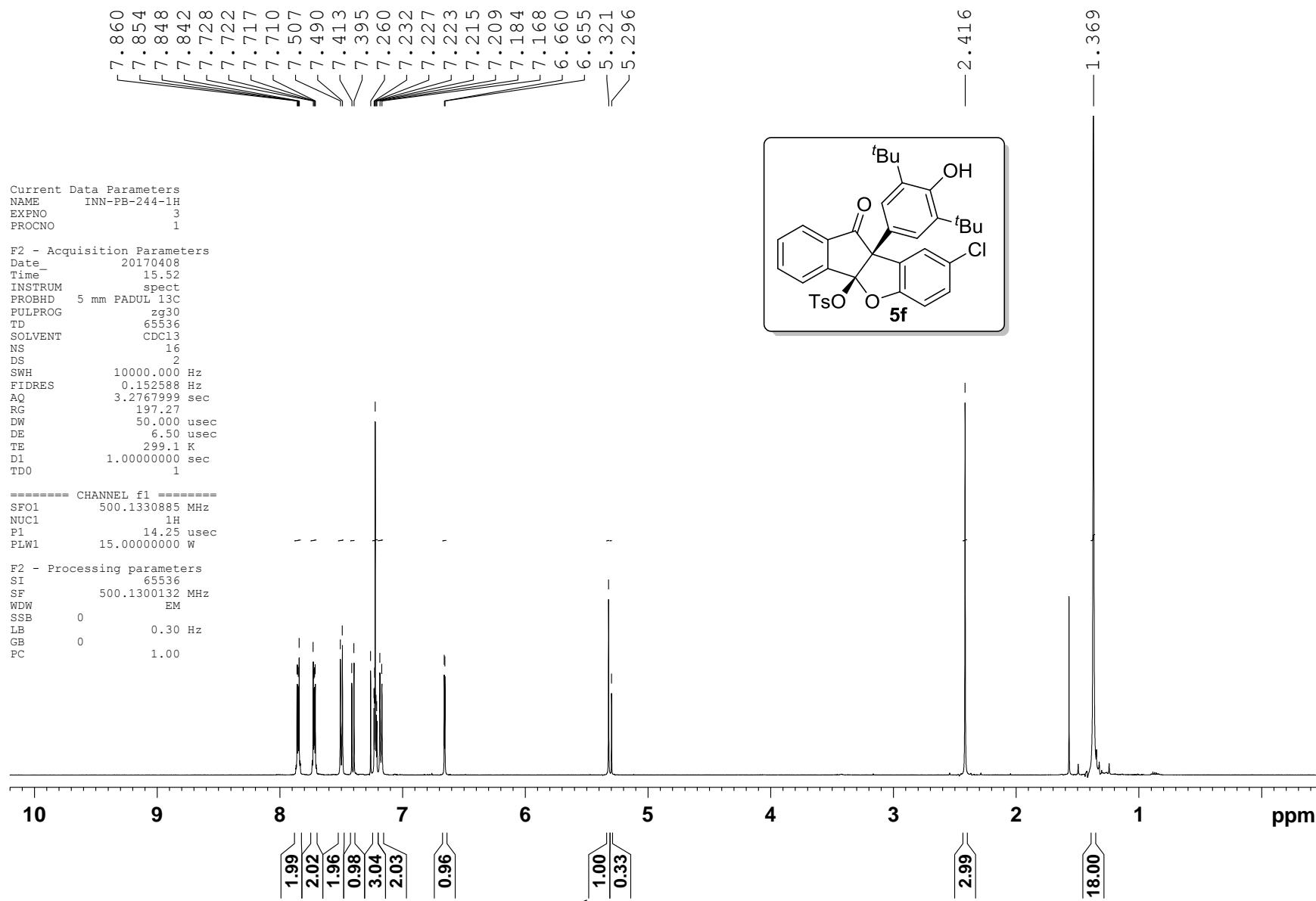
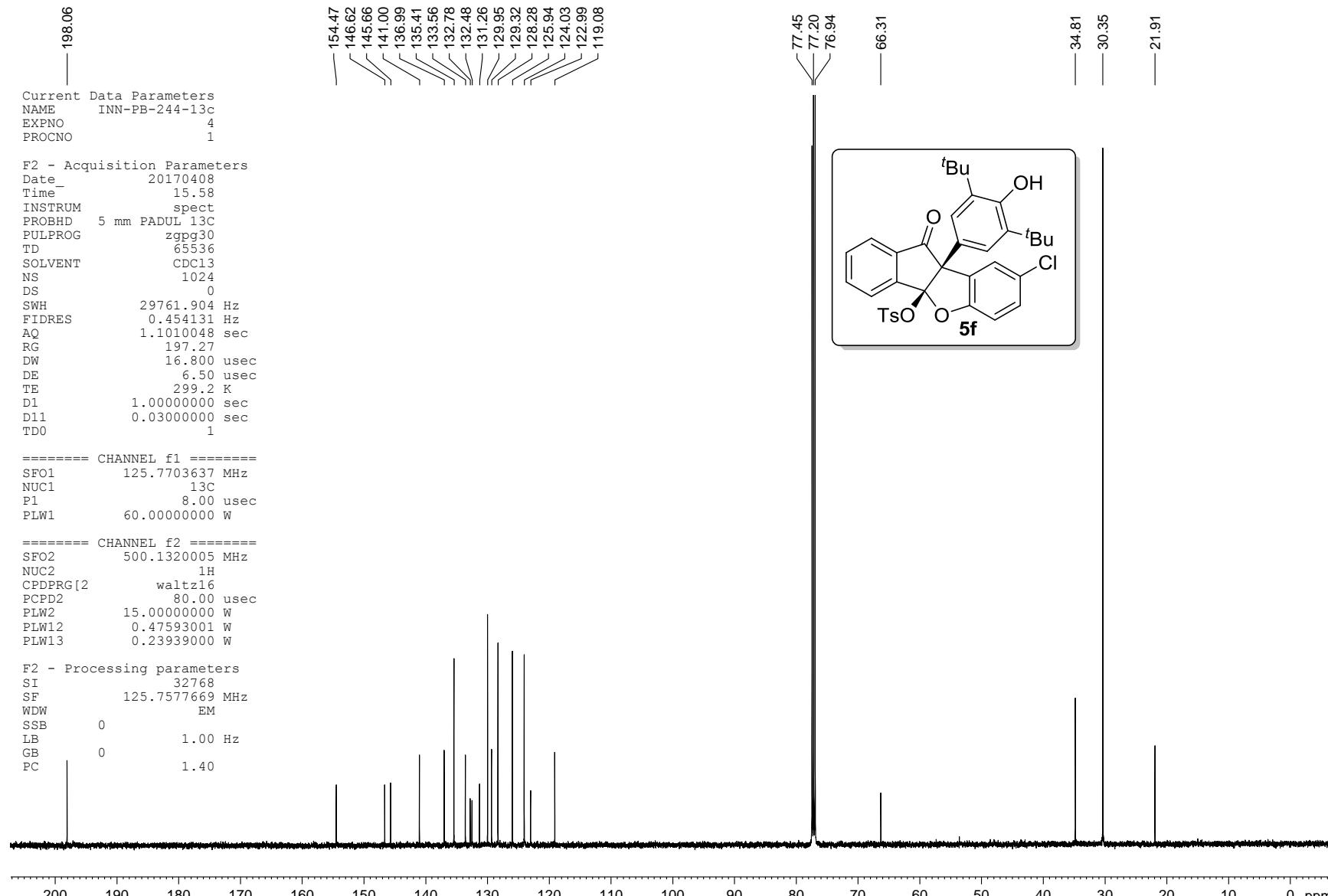
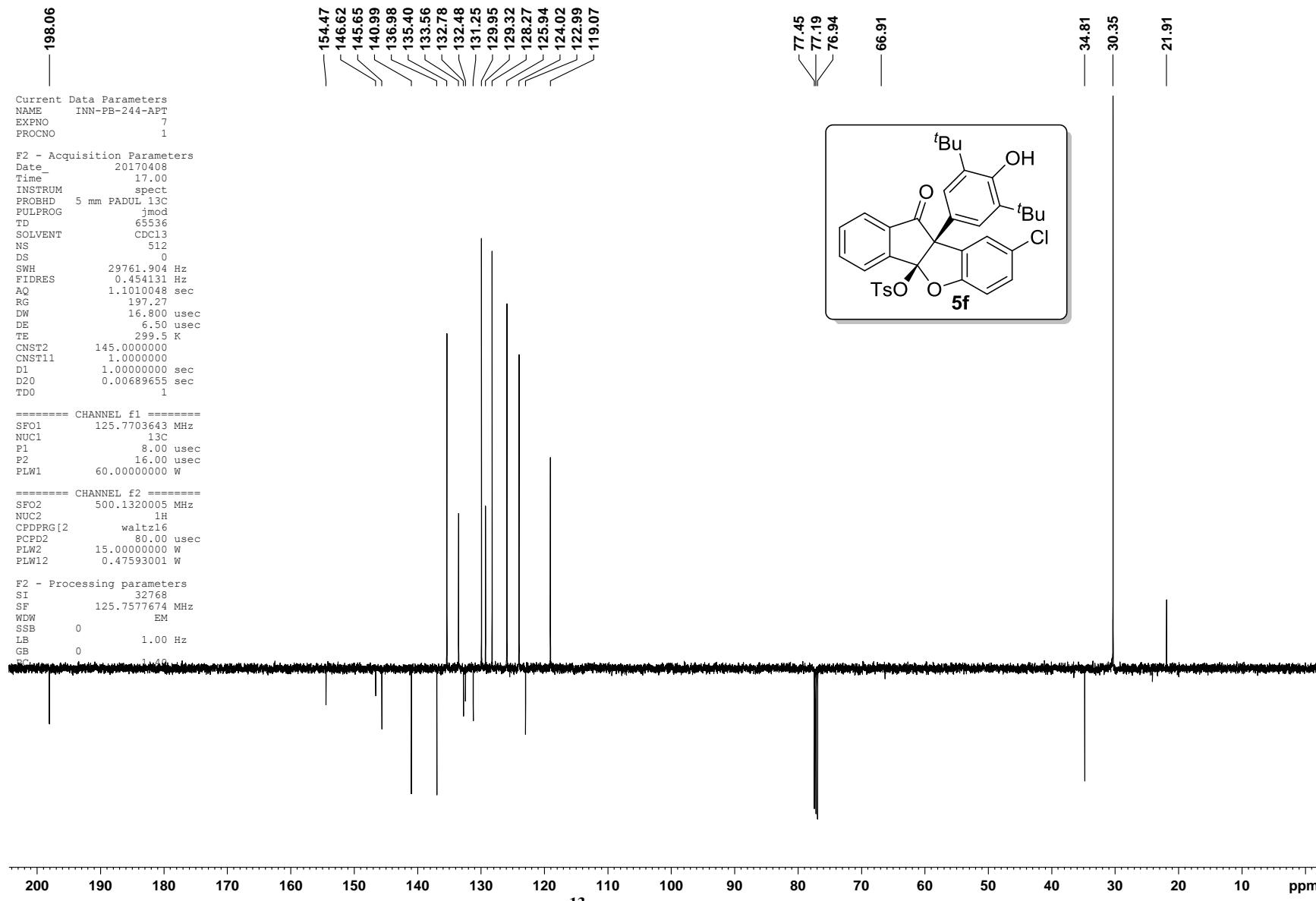


Figure S27. <sup>1</sup>H NMR Spectrum of 5f



**Figure S28.**  $^{13}\text{C}$  NMR Spectrum of **5f**



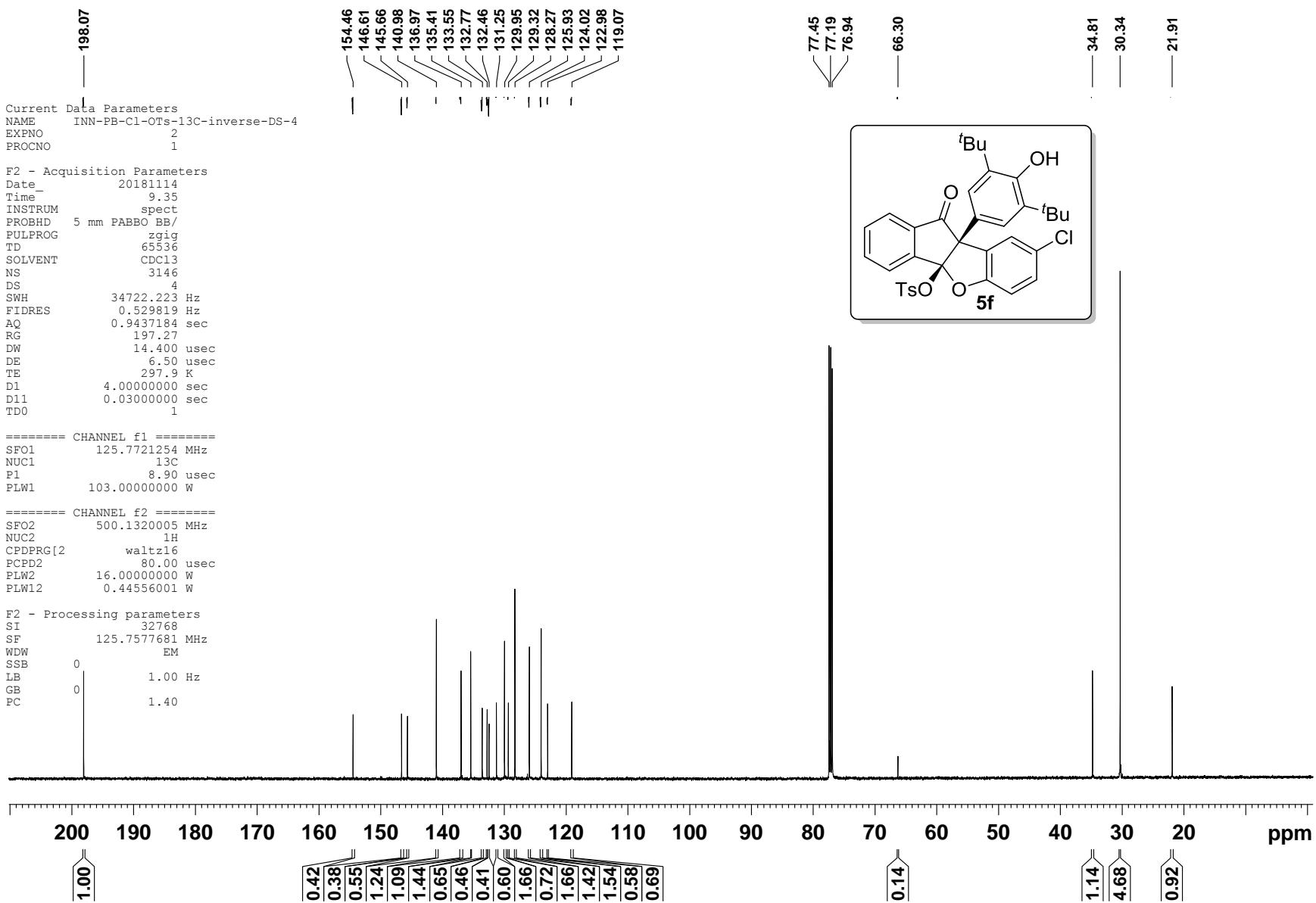


Figure S30. Inverse Gated  $^{13}\text{C}$  NMR Spectrum of 5f

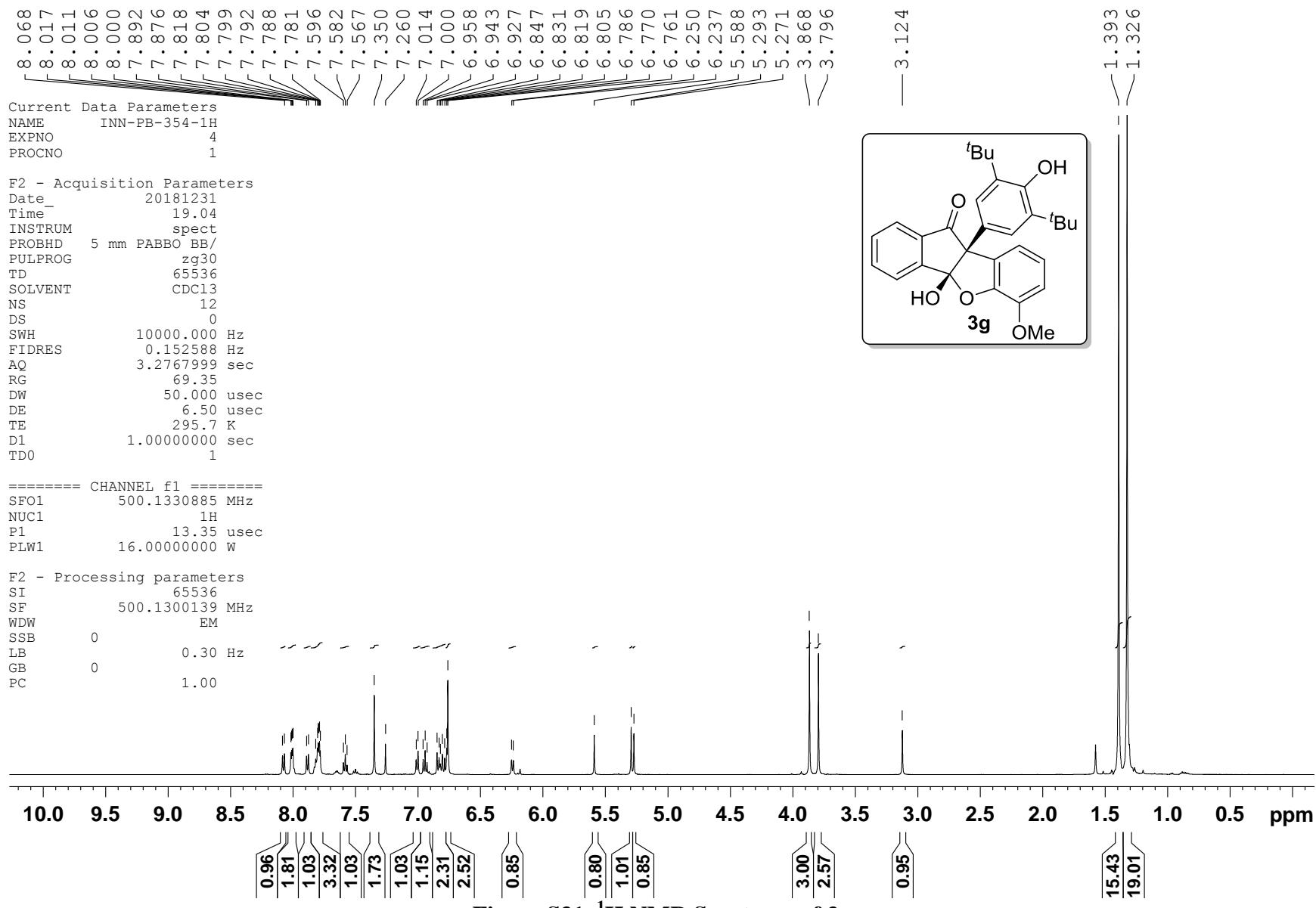


Figure S31. <sup>1</sup>H NMR Spectrum of 3g

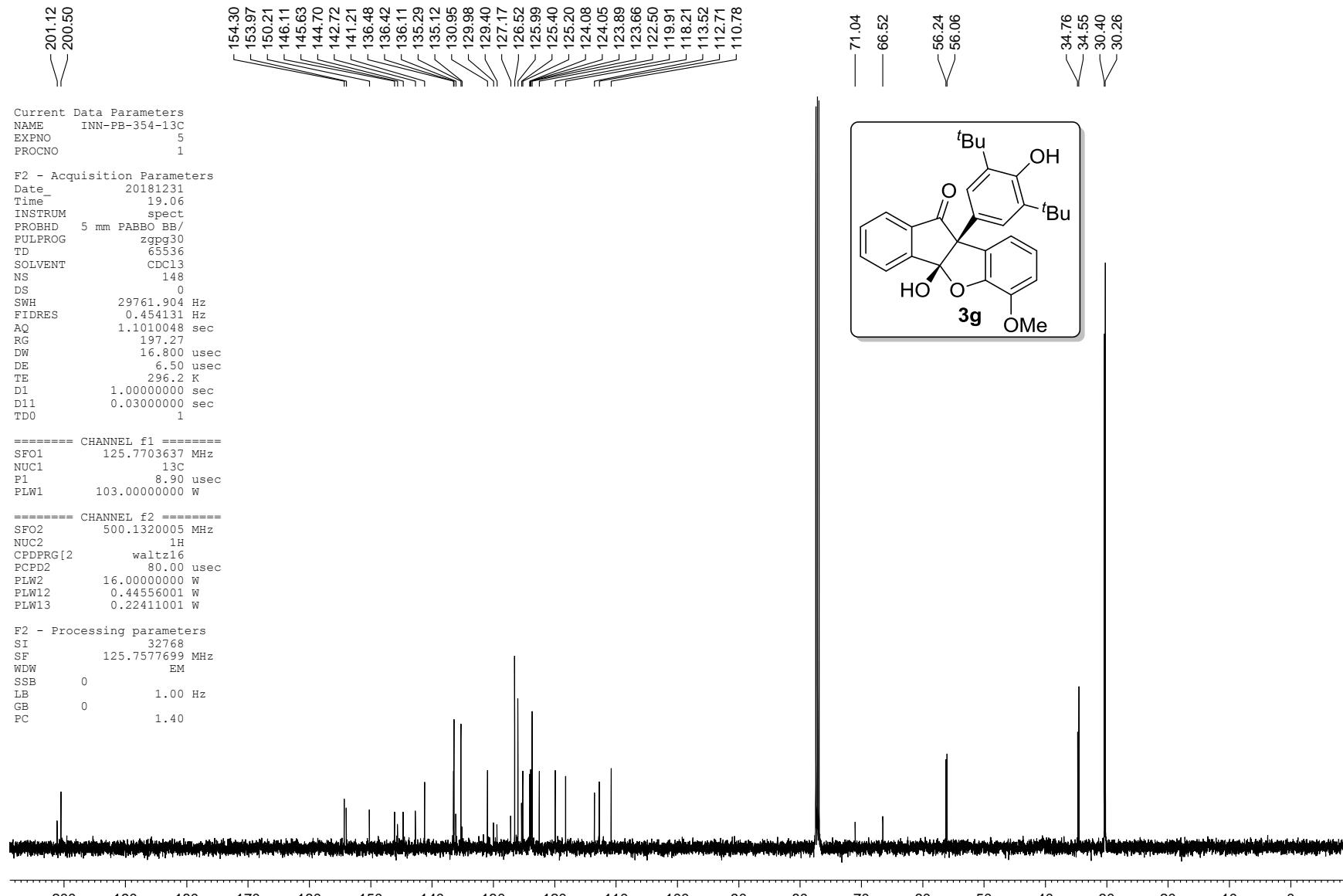
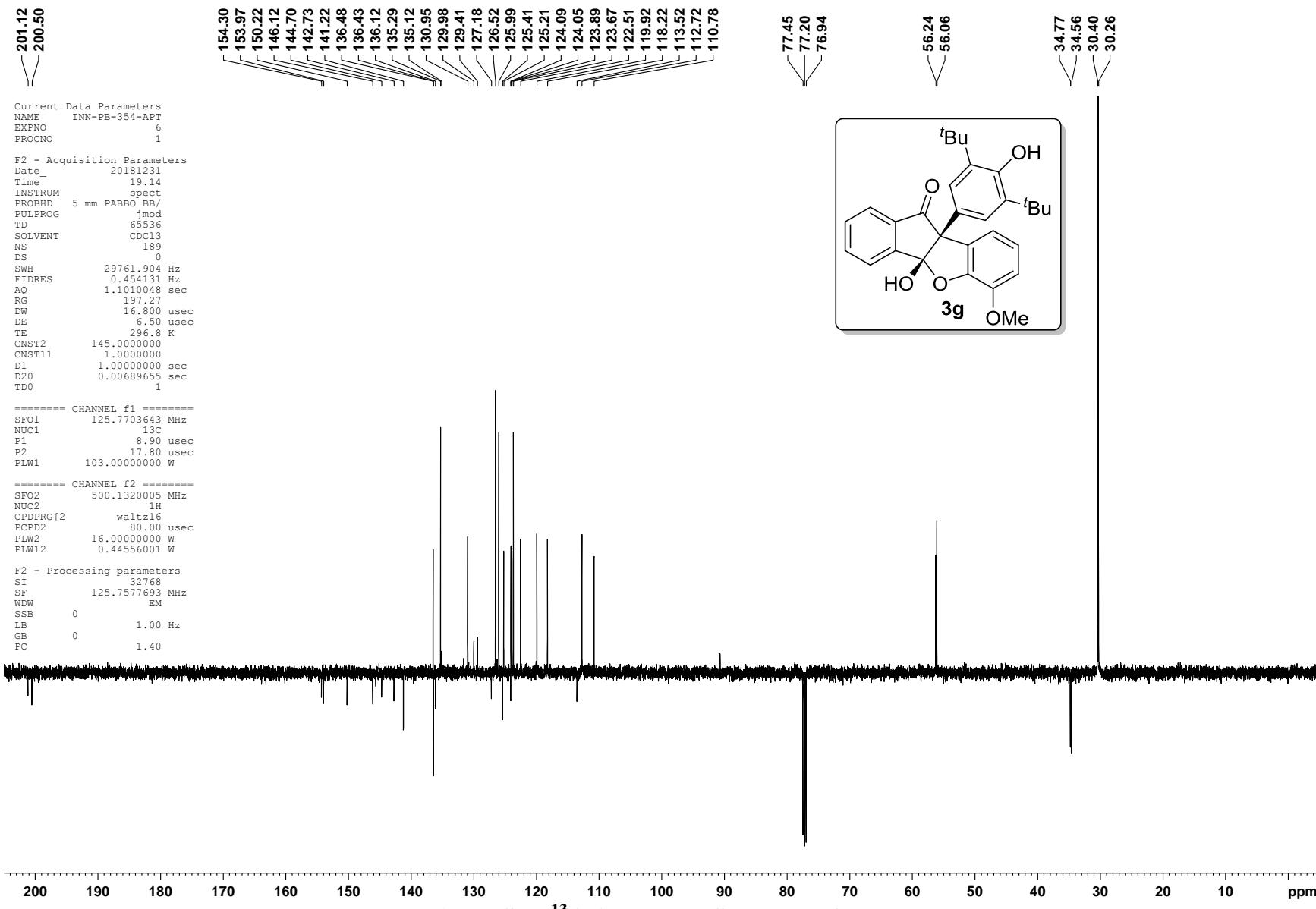


Figure S32. <sup>13</sup>C NMR Spectrum of 3g



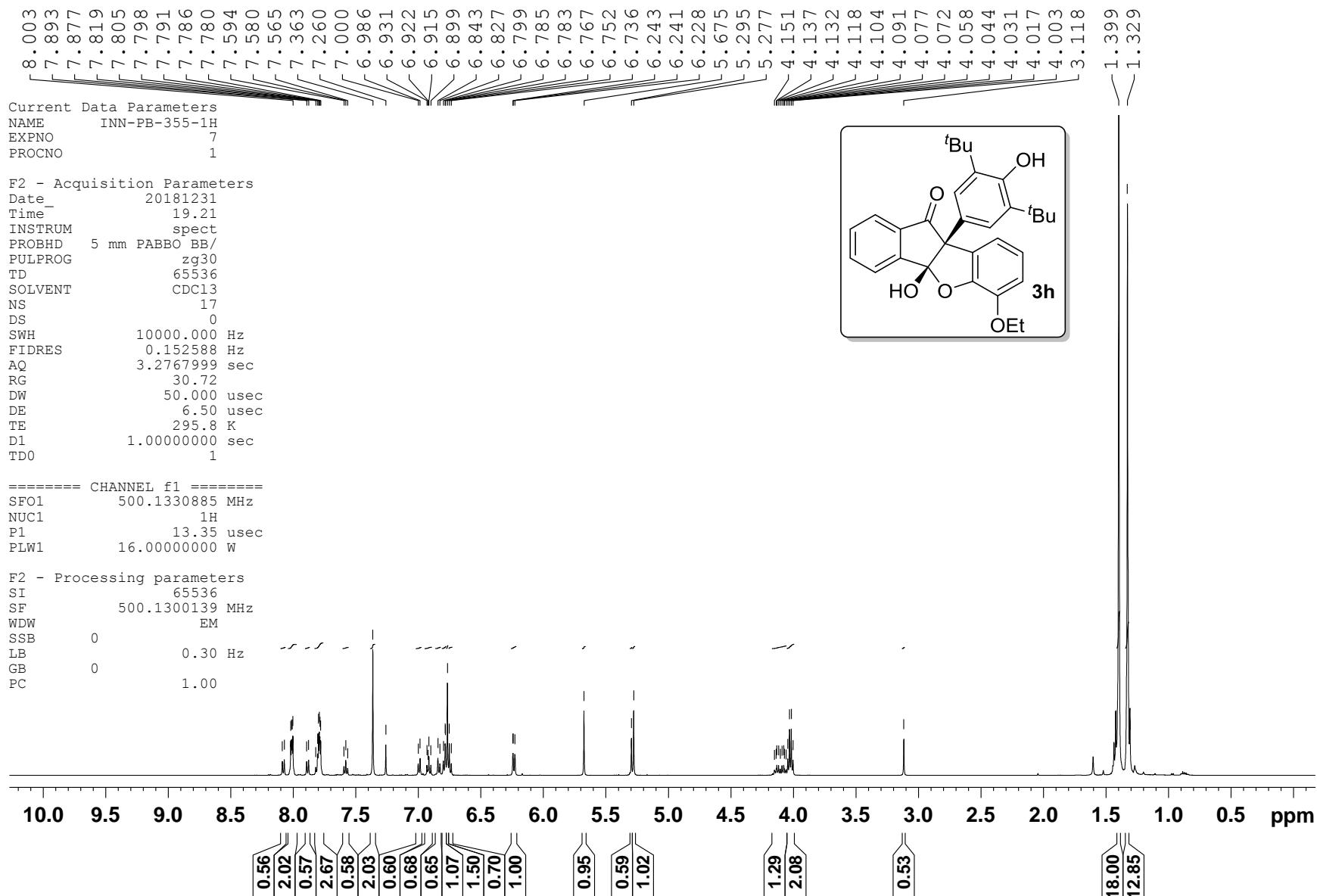
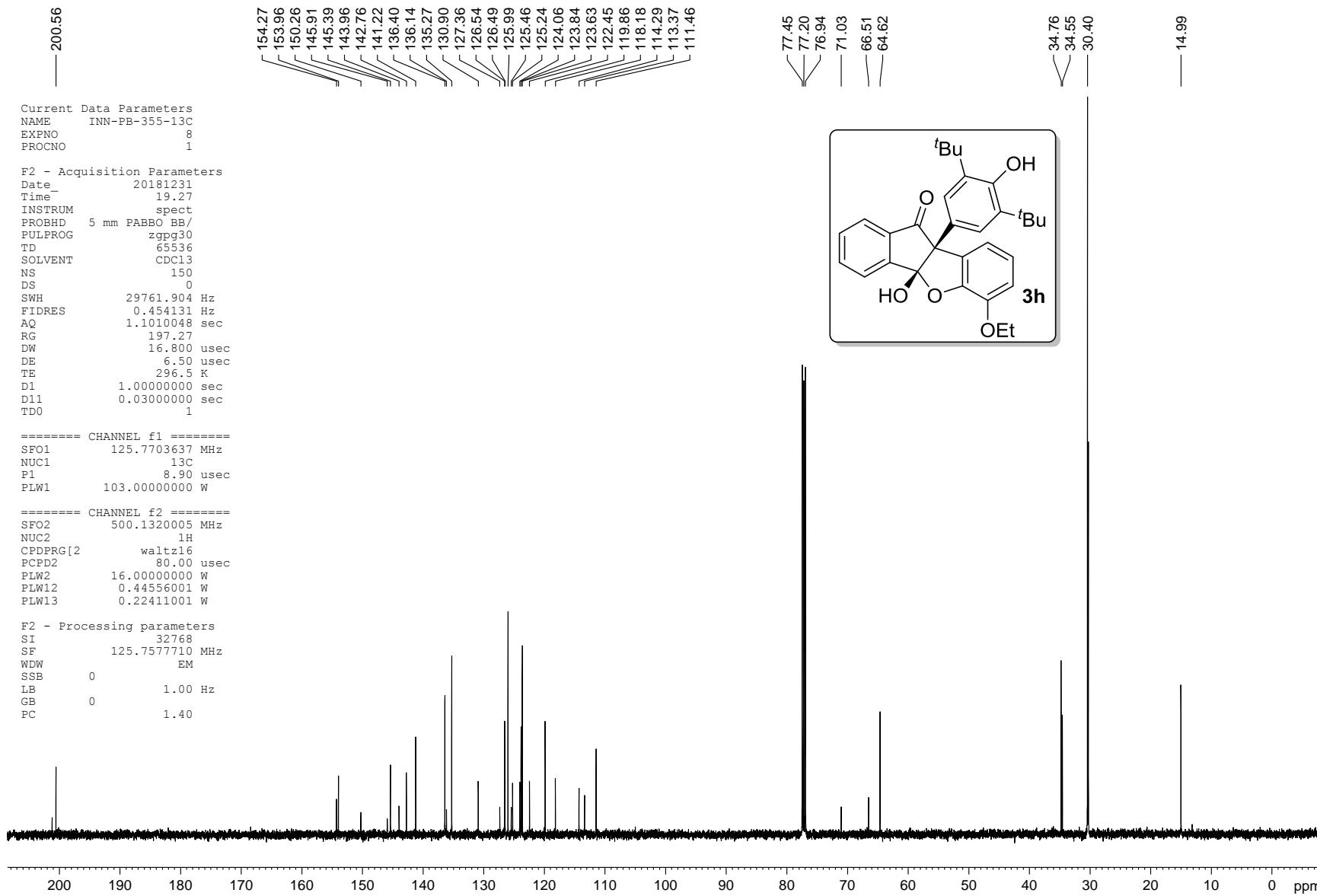
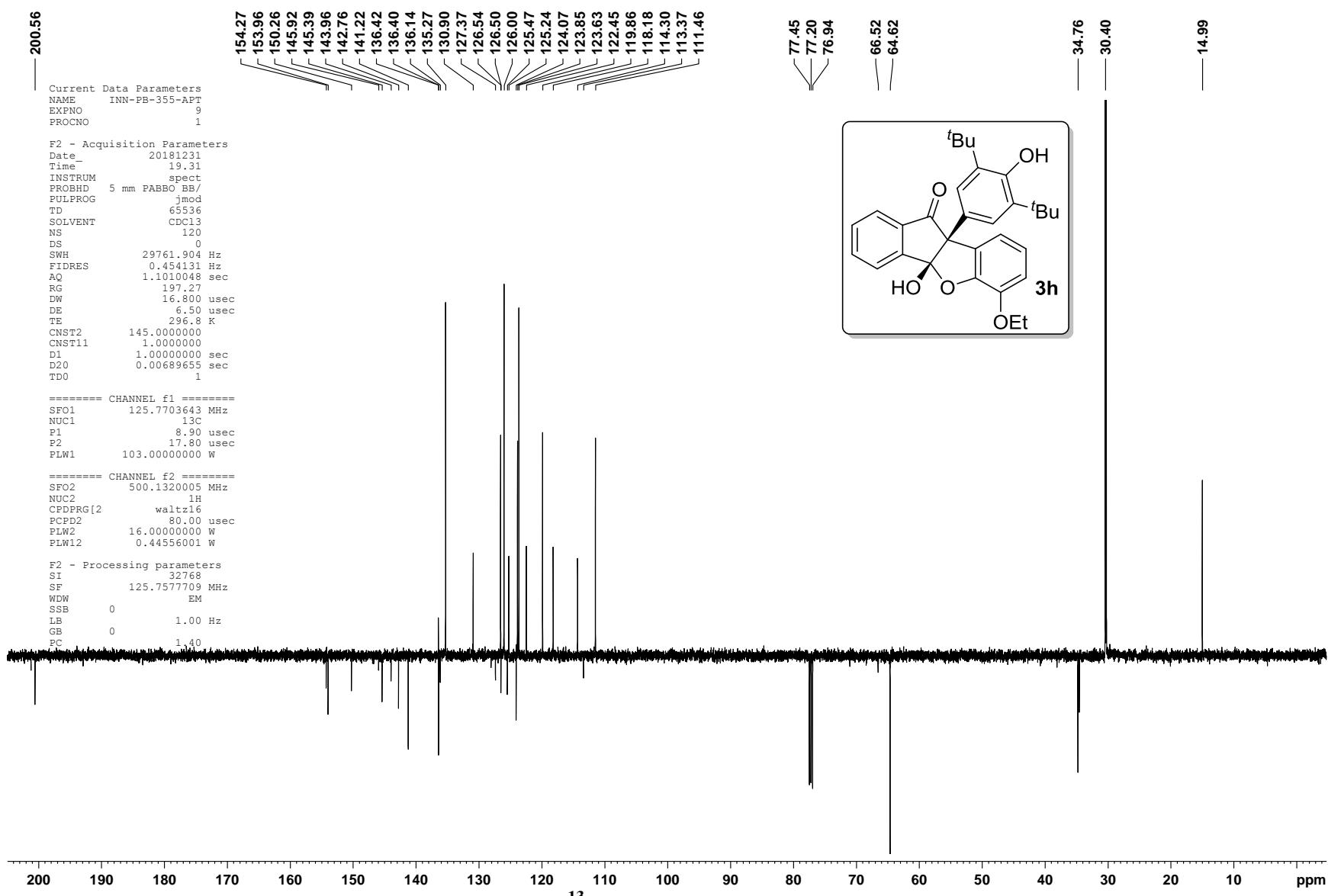


Figure S34. <sup>1</sup>H NMR Spectrum of 3h



**Figure S35.**  $^{13}\text{C}$  NMR Spectrum of **3h**

200.56



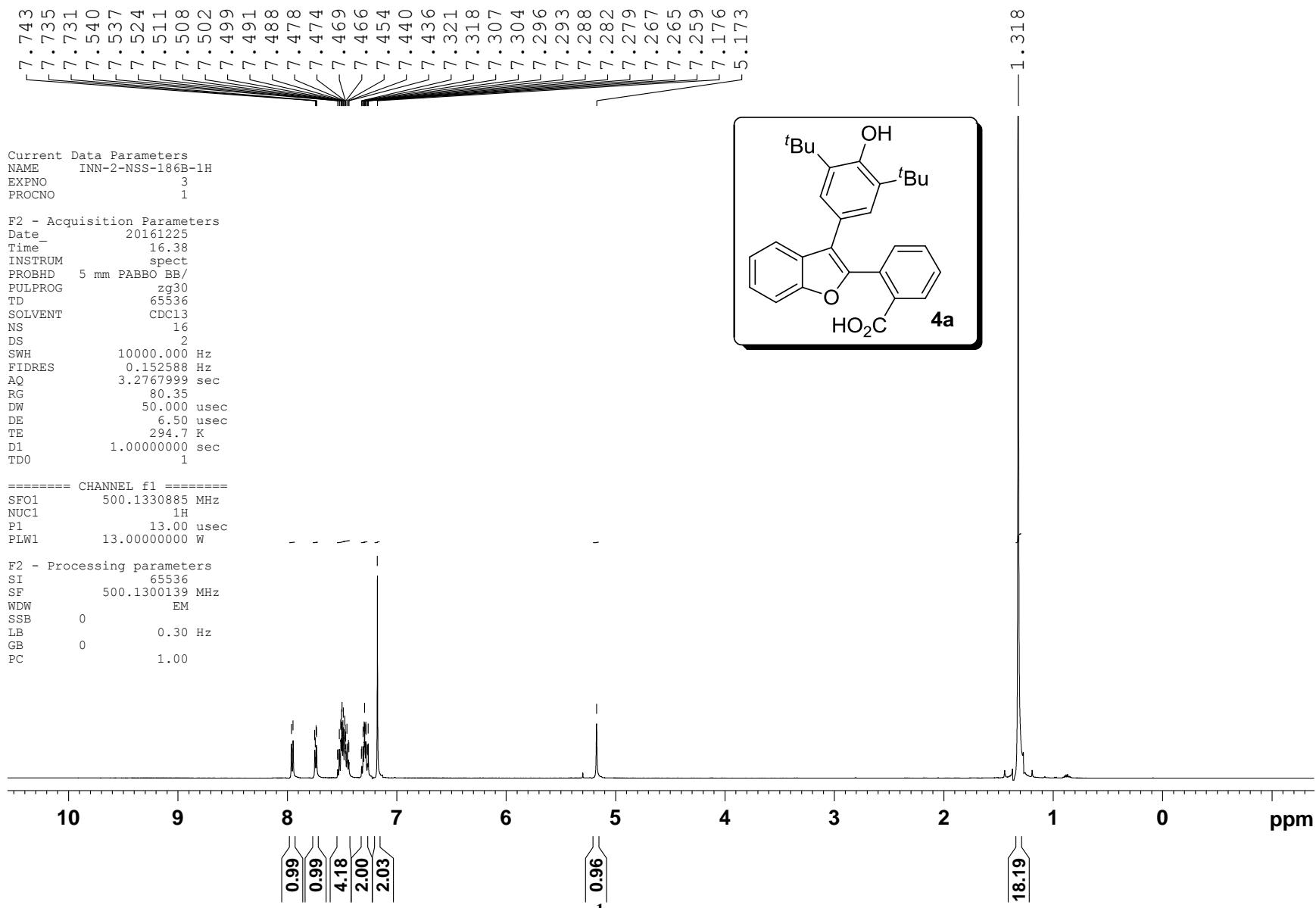
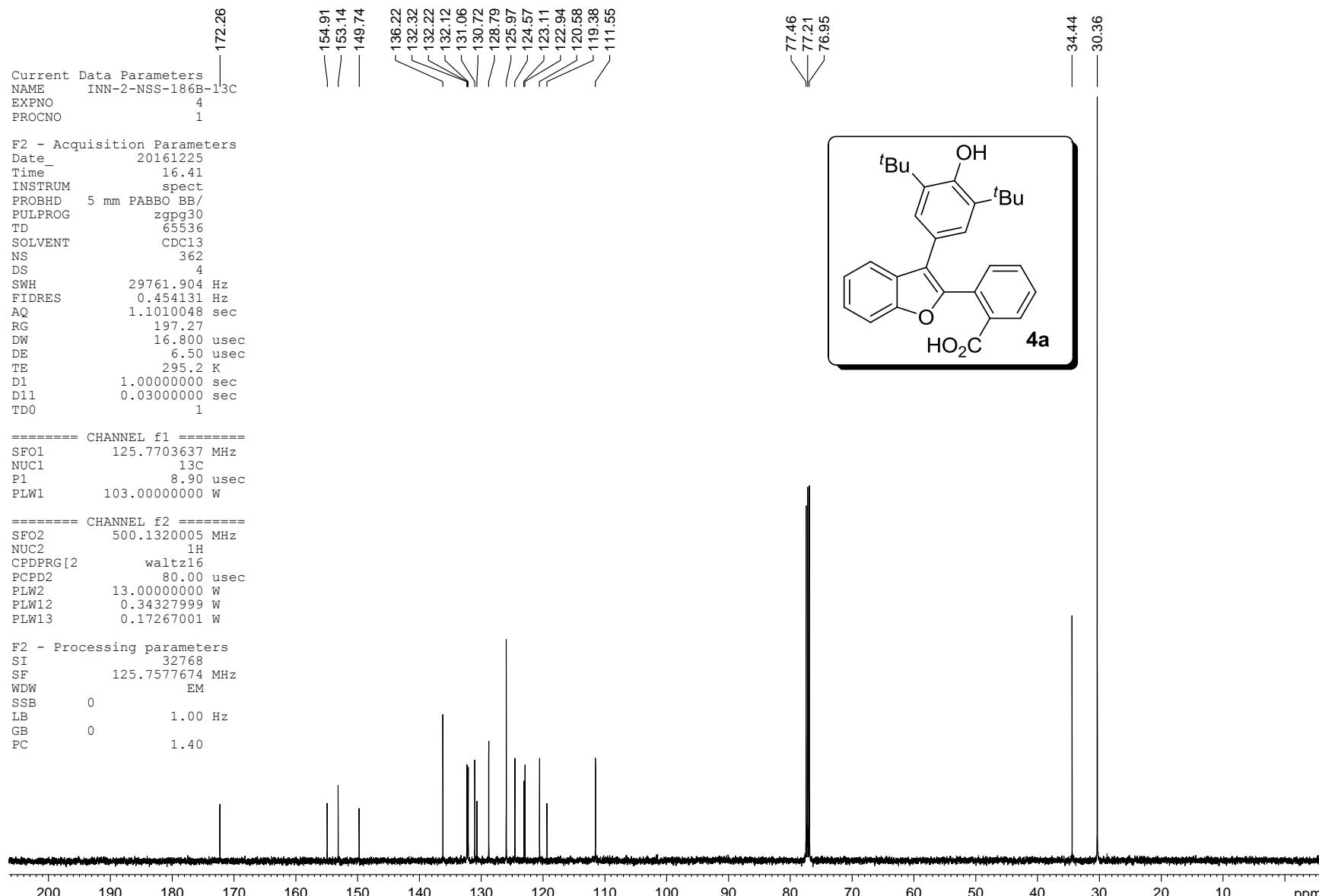
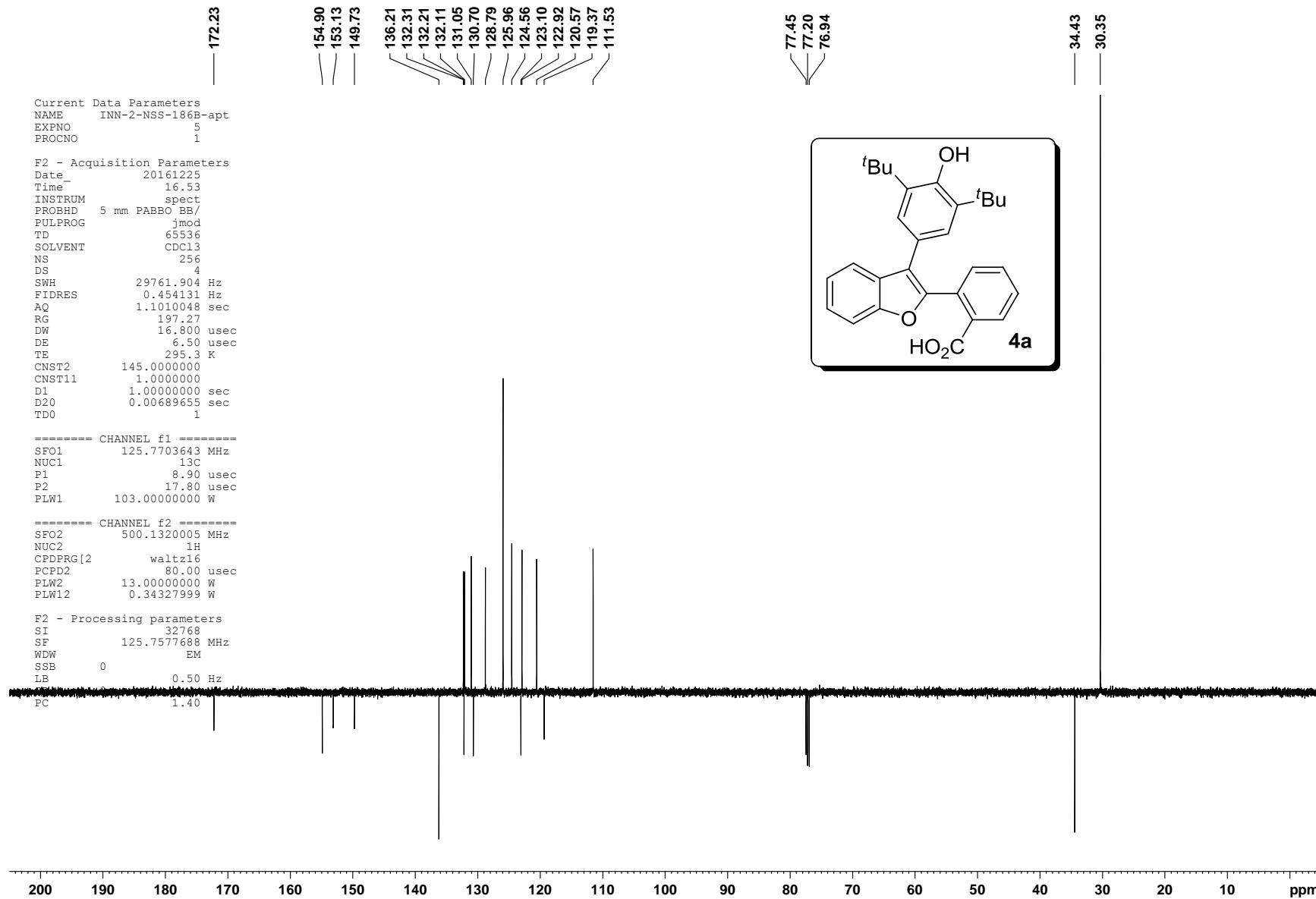


Figure S37.  $^1\text{H}$  NMR Spectrum of **4a**



**Figure S38.** <sup>13</sup>C NMR Spectrum of 4a



**Figure S39.**  $^{13}\text{C}$ -APT NMR Spectrum of **4a**

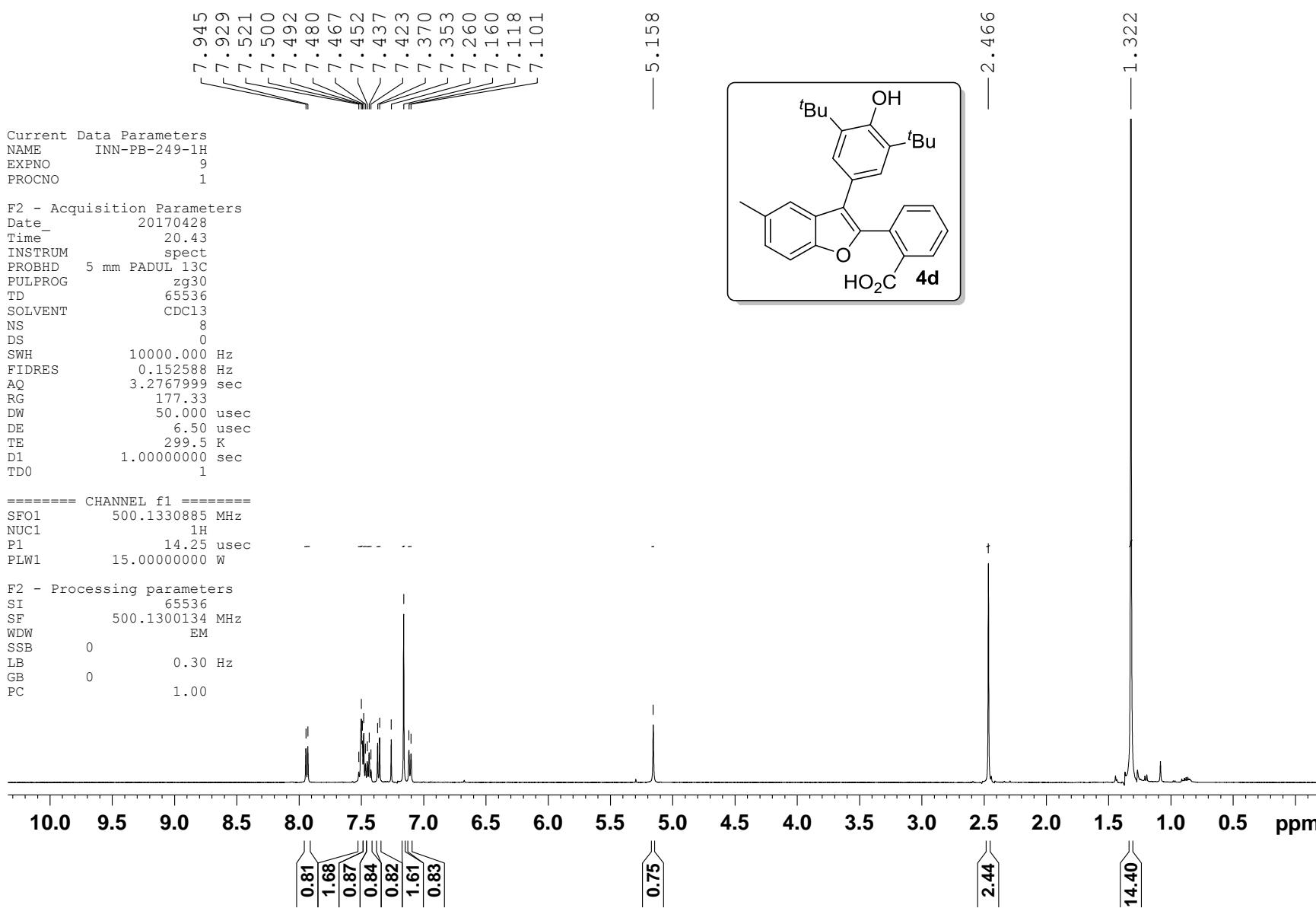


Figure S40. <sup>1</sup>H NMR Spectrum of 4d

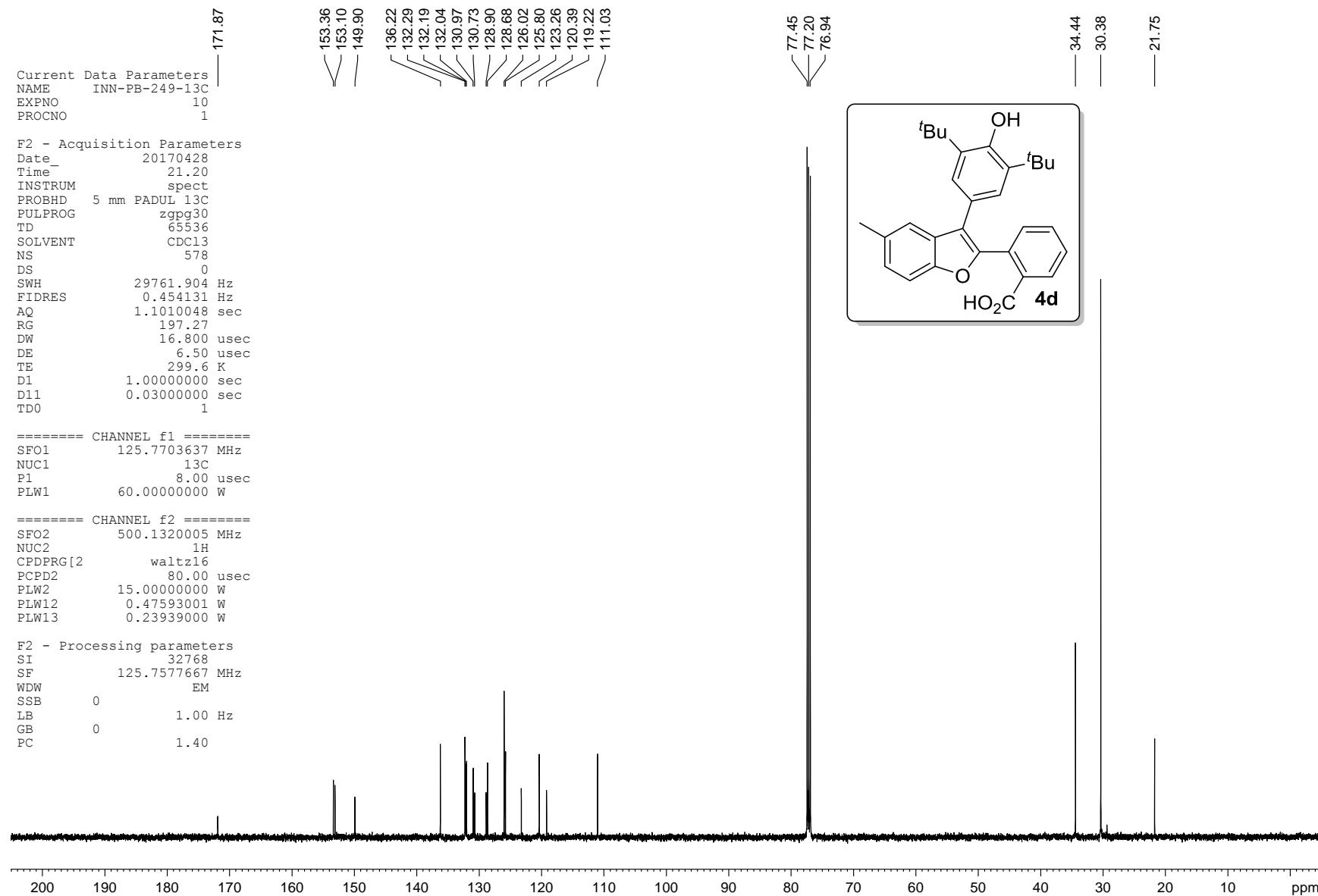
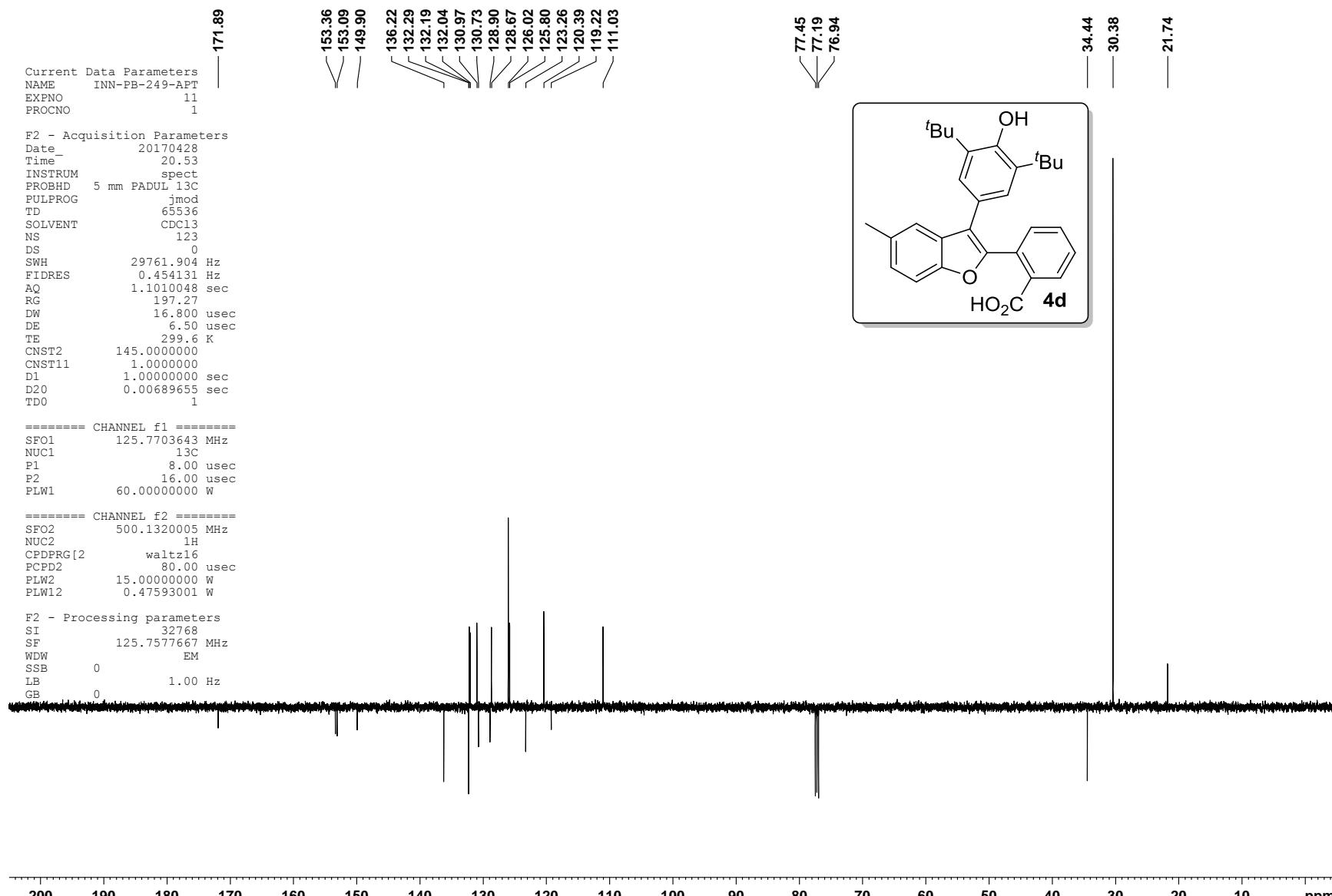
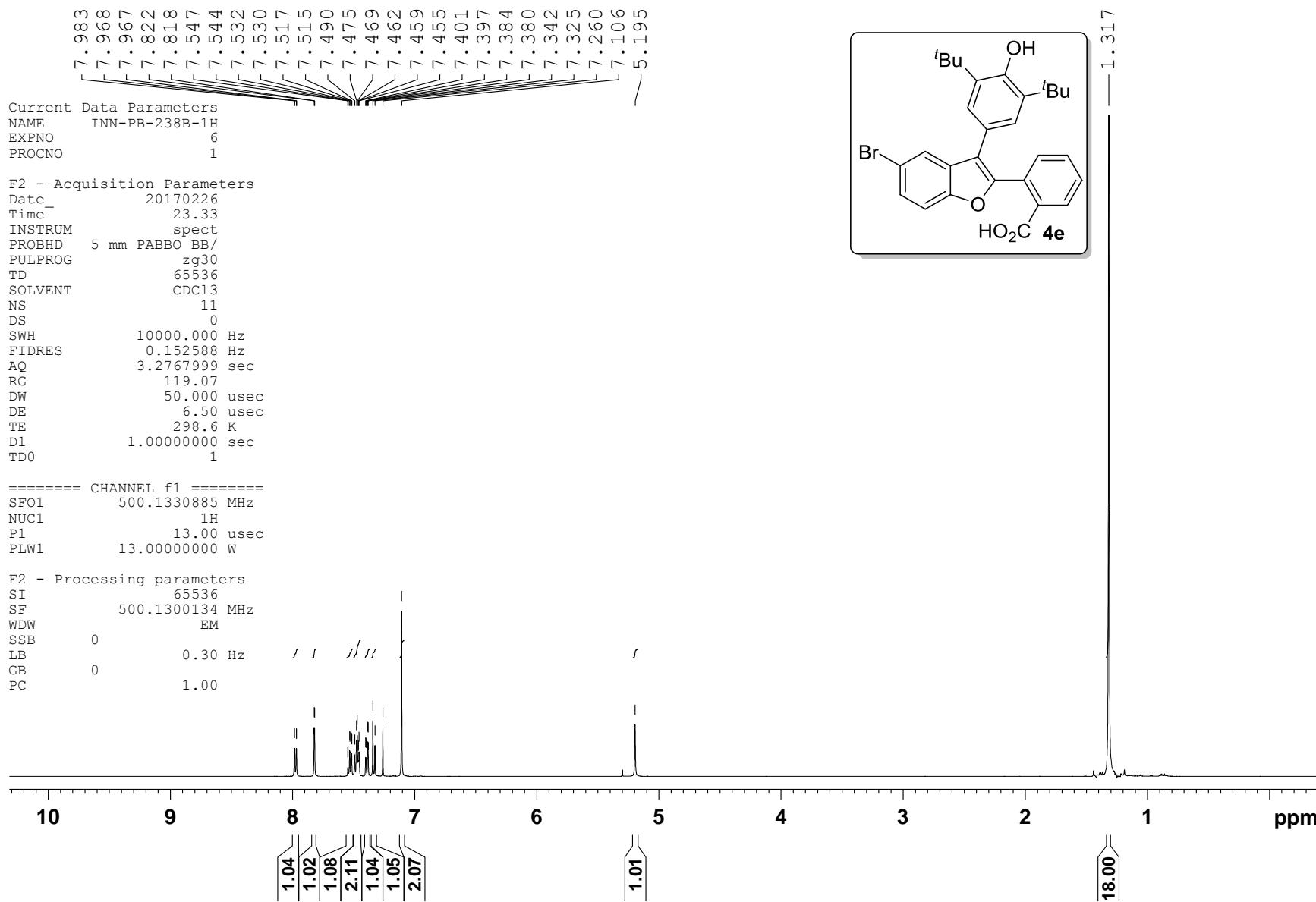


Figure S41.  $^{13}\text{C}$  NMR Spectrum of 4d





**Figure S43.**  $^1\text{H}$  NMR Spectrum of **4e**

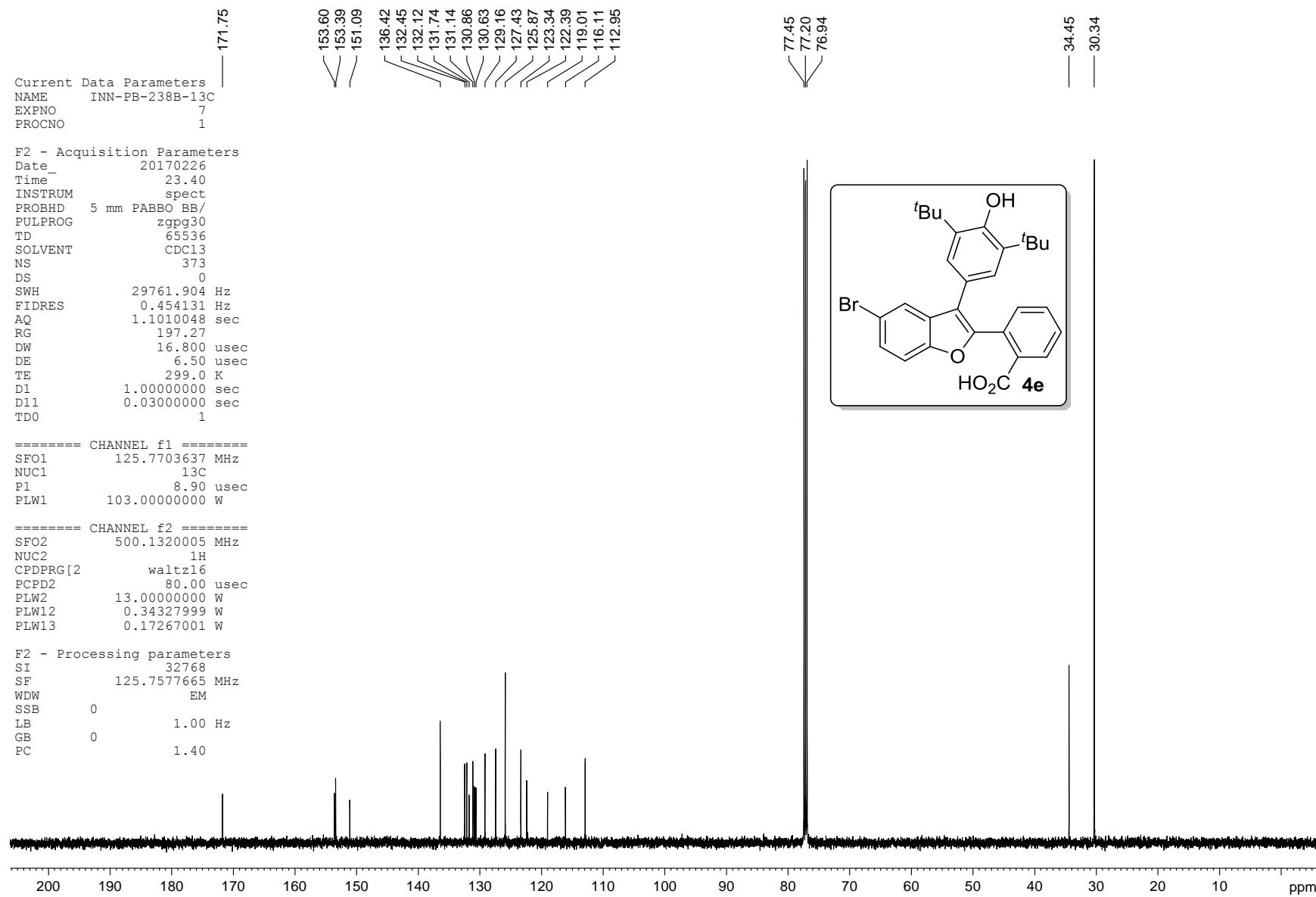
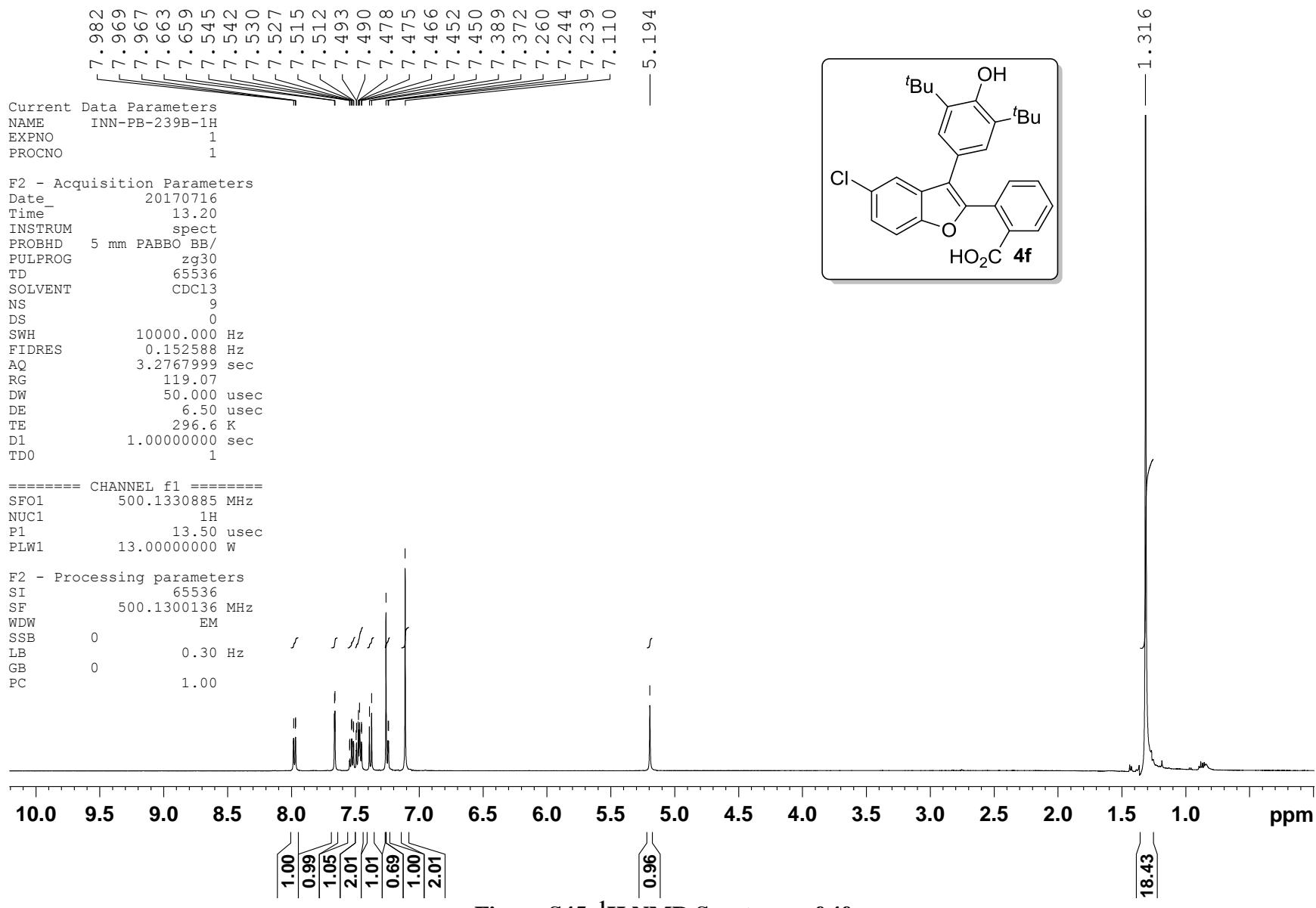


Figure S44. <sup>13</sup>C NMR Spectrum of 4e



**Figure S45.** <sup>1</sup>H NMR Spectrum of 4f

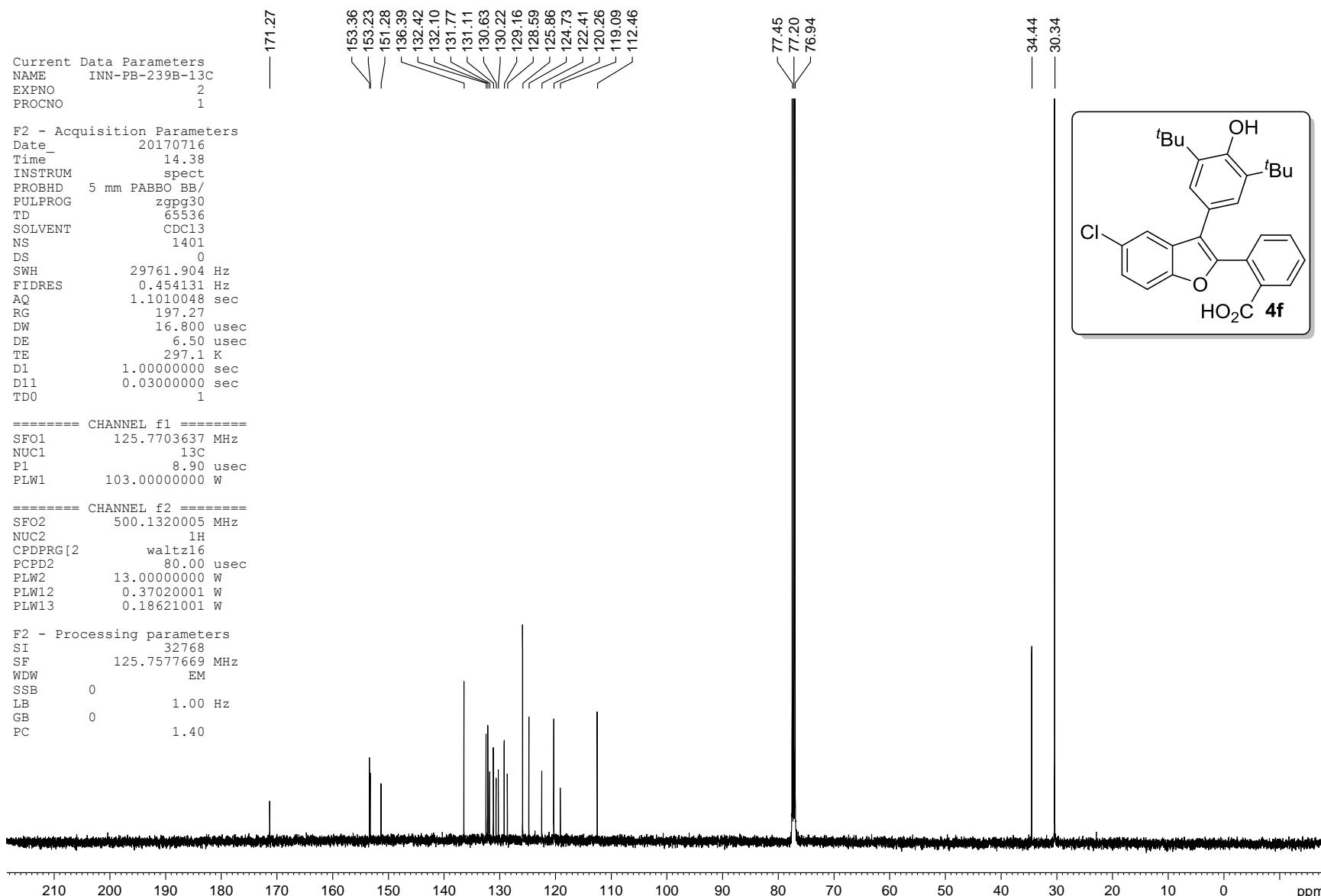
Current Data Parameters  
 NAME INN-PB-239B-13C  
 EXPNO 2  
 PROCNO 1

F2 - Acquisition Parameters  
 Date 20170716  
 Time 14.38  
 INSTRUM spect  
 PROBHD 5 mm PABBO BB/  
 PULPROG zgpg30  
 TD 65536  
 SOLVENT CDCl3  
 NS 1401  
 DS 0  
 SWH 29761.904 Hz  
 FIDRES 0.454131 Hz  
 AQ 1.1010048 sec  
 RG 197.27  
 DW 16.800 usec  
 DE 6.50 usec  
 TE 297.1 K  
 D1 1.0000000 sec  
 D11 0.0300000 sec  
 TDO 1

===== CHANNEL f1 =====  
 SFO1 125.7703637 MHz  
 NUC1 13C  
 P1 8.90 usec  
 PLW1 103.0000000 W

===== CHANNEL f2 =====  
 SFO2 500.1320005 MHz  
 NUC2 1H  
 CPDPRG[2] waltz16  
 PCPD2 80.00 usec  
 PLW2 13.0000000 W  
 PLW12 0.3702001 W  
 PLW13 0.18621001 W

F2 - Processing parameters  
 SI 32768  
 SF 125.7577669 MHz  
 WDW EM  
 SSB 0  
 LB 1.00 Hz  
 GB 0  
 PC 1.40



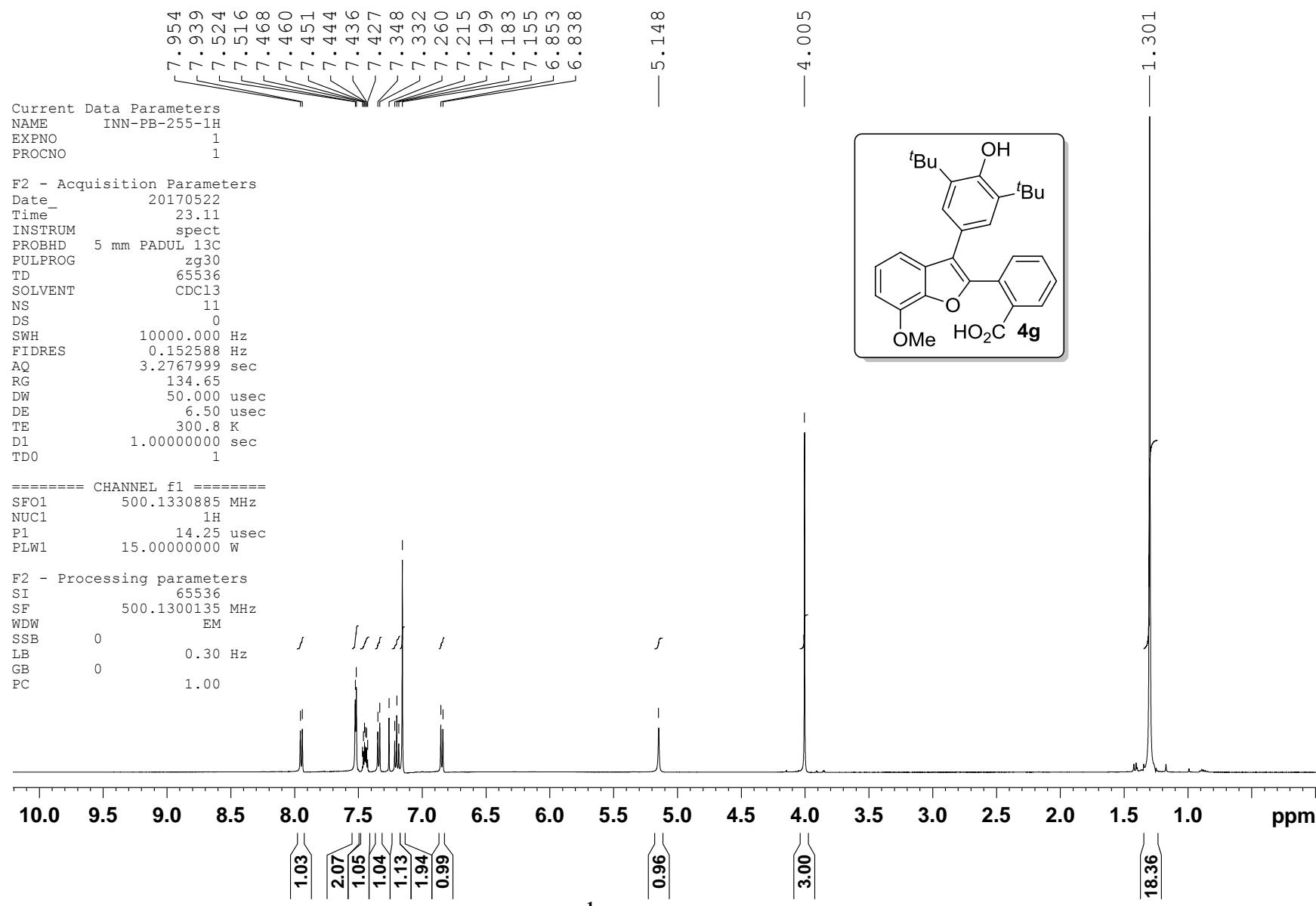
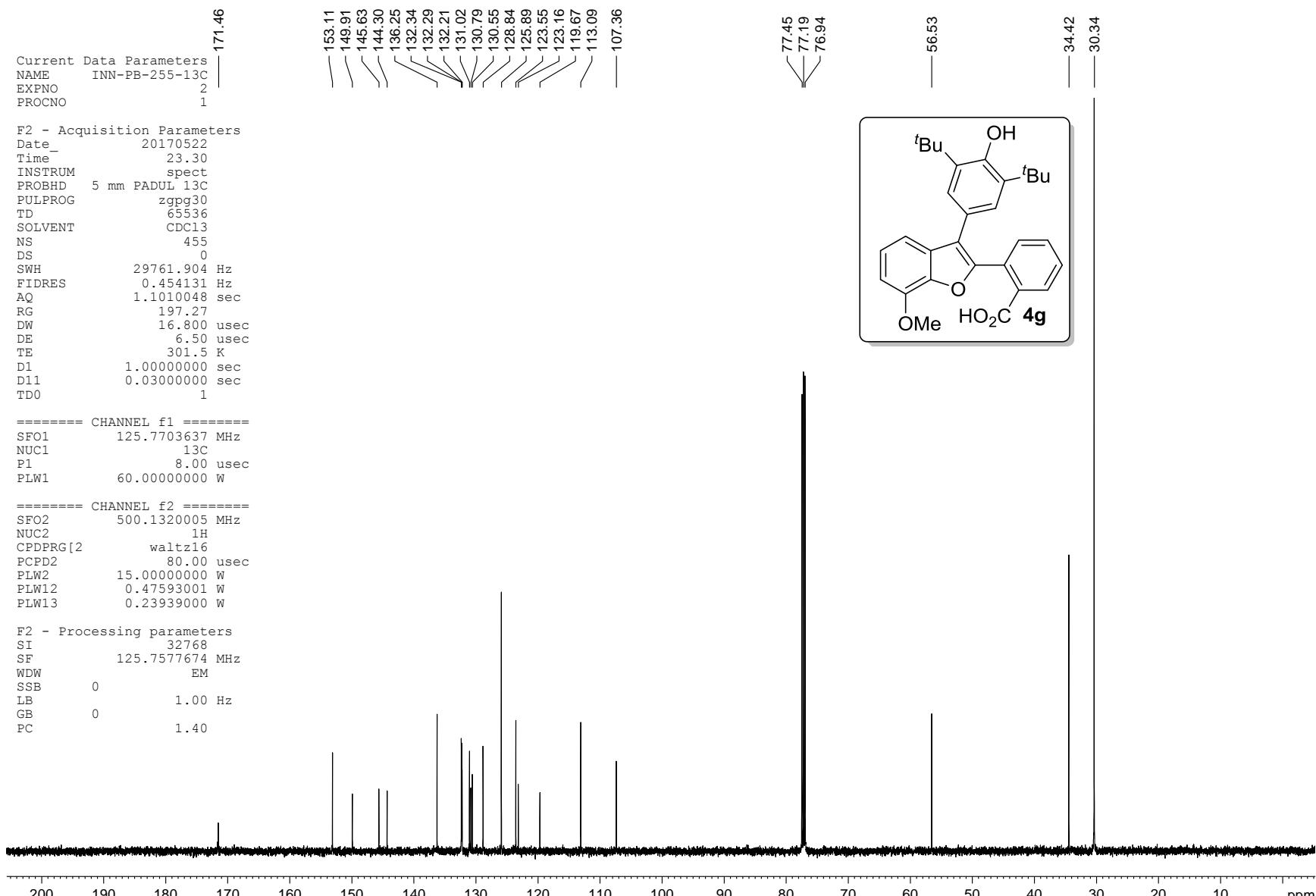


Figure S47. <sup>1</sup>H NMR Spectrum of 4g



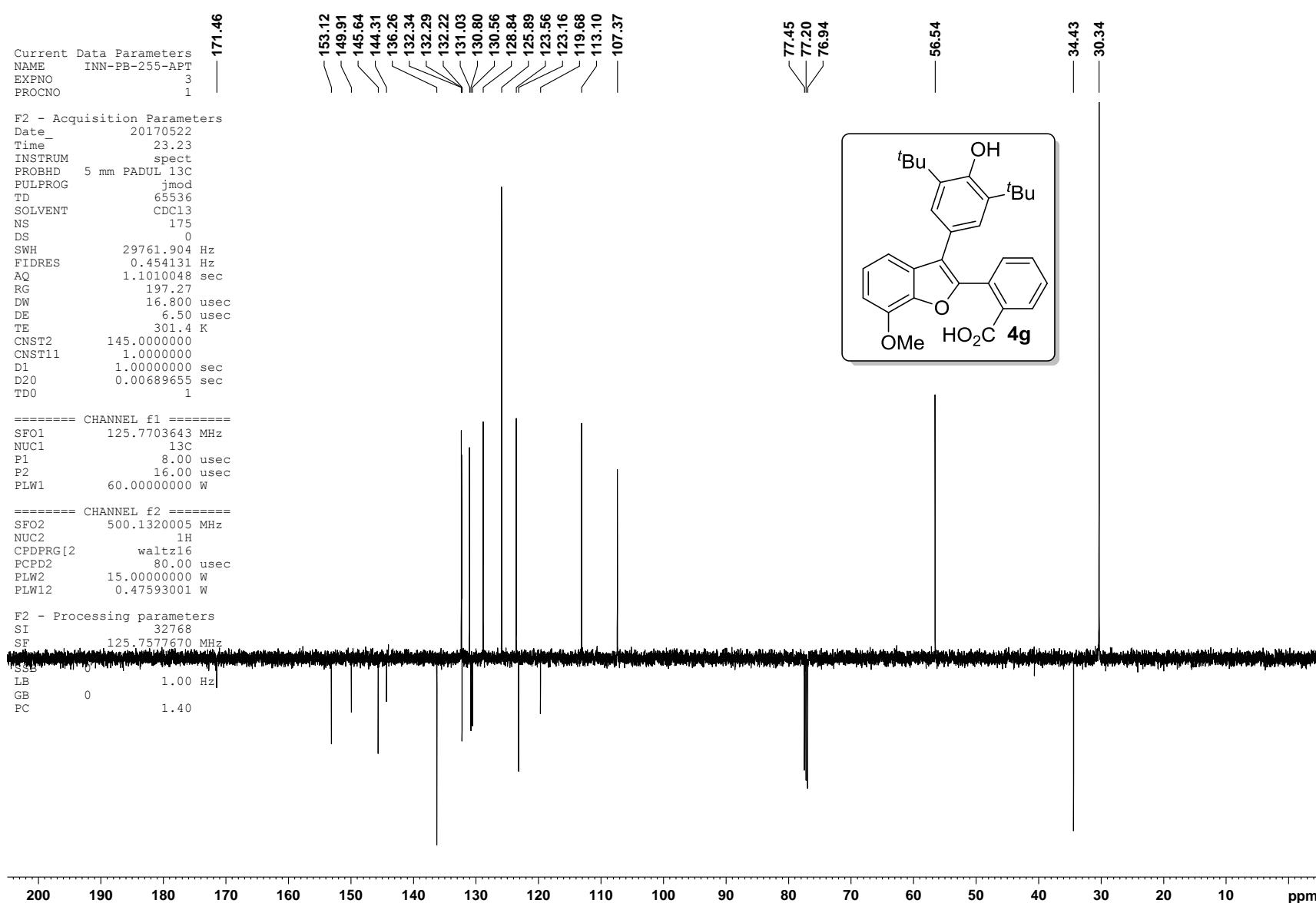


Figure S49.  $^{13}\text{C}$ -APT NMR Spectrum of 4g

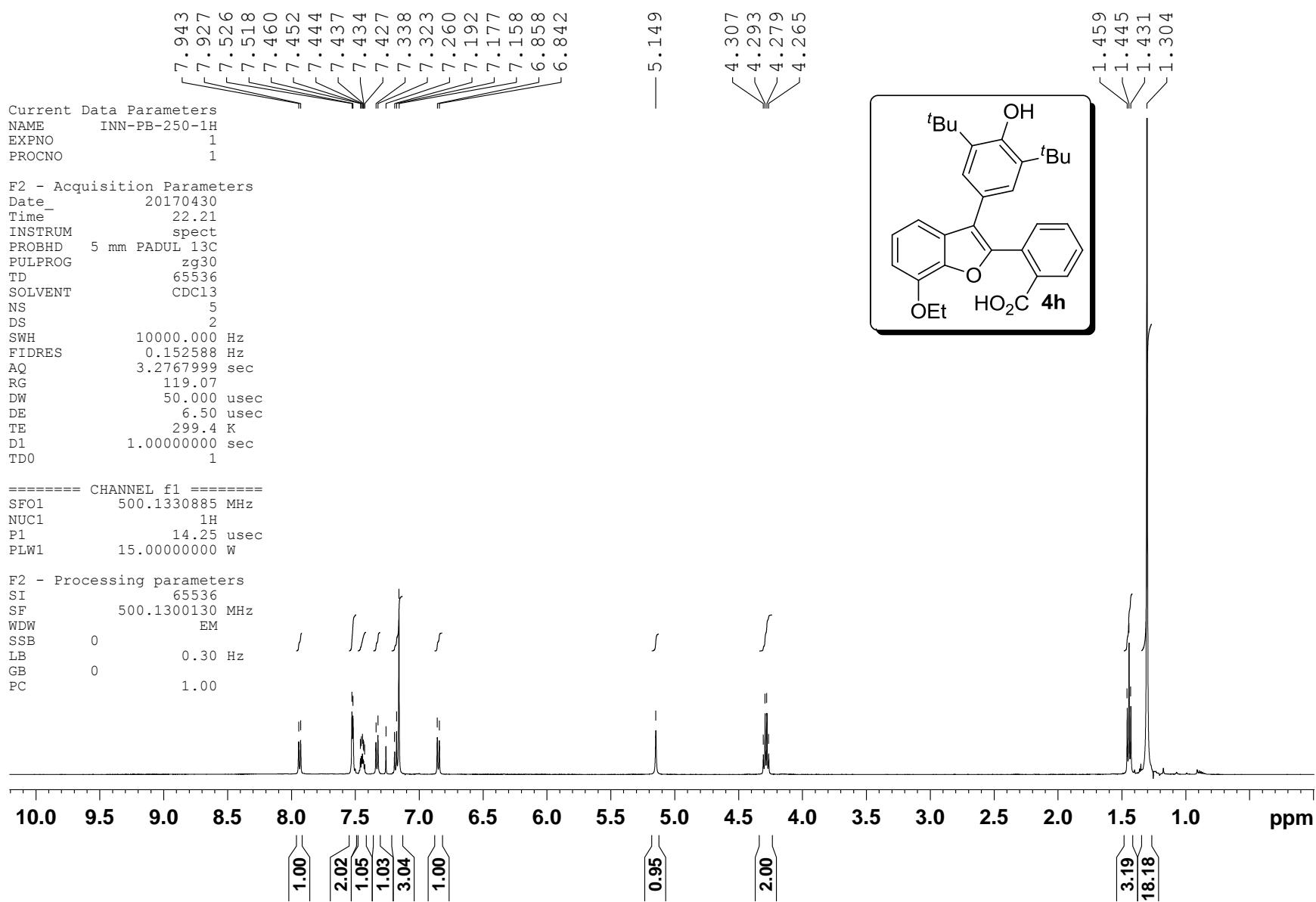


Figure S50. <sup>1</sup>H NMR Spectrum of 4h

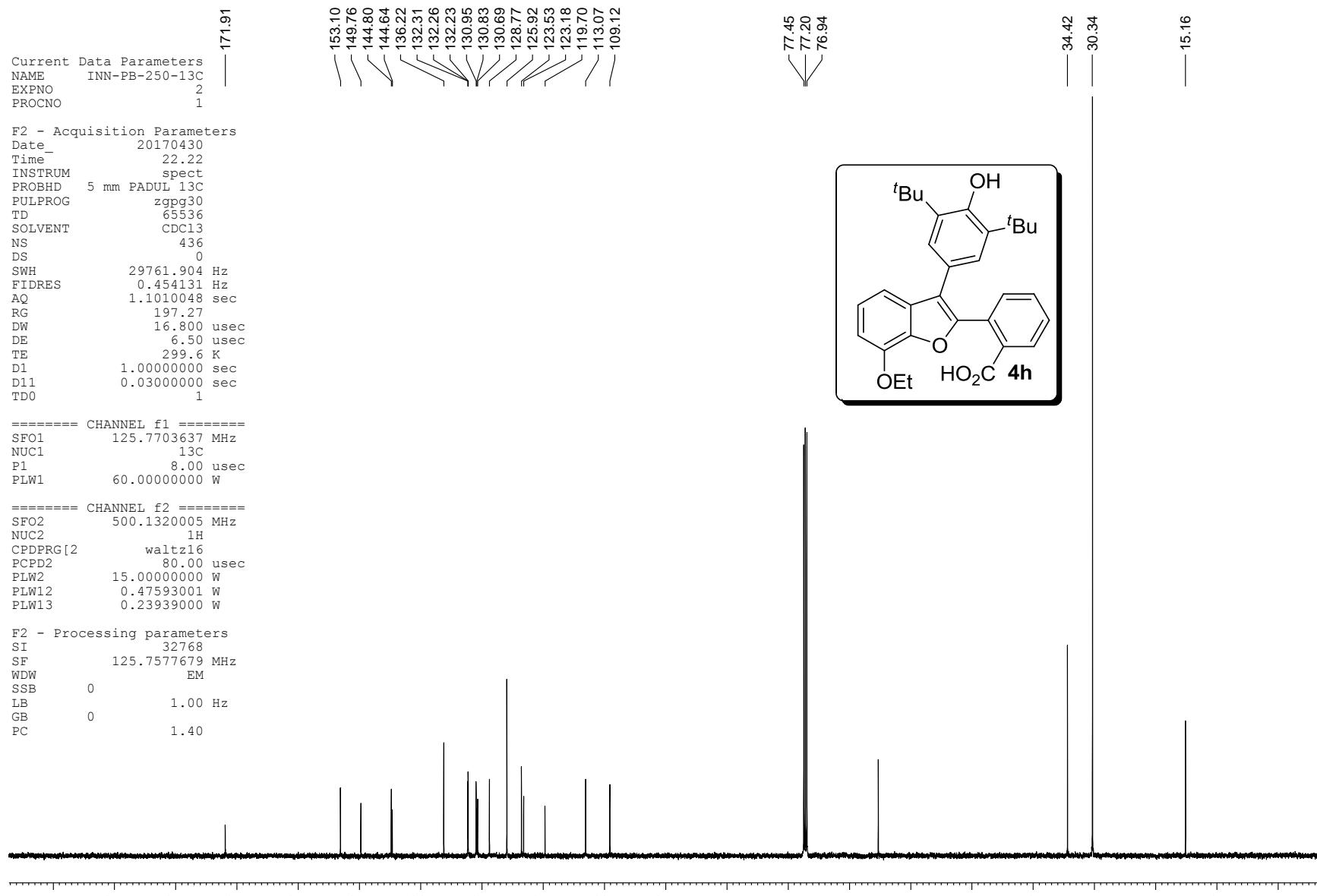


Figure S51.  $^{13}\text{C}$  NMR Spectrum of 4h

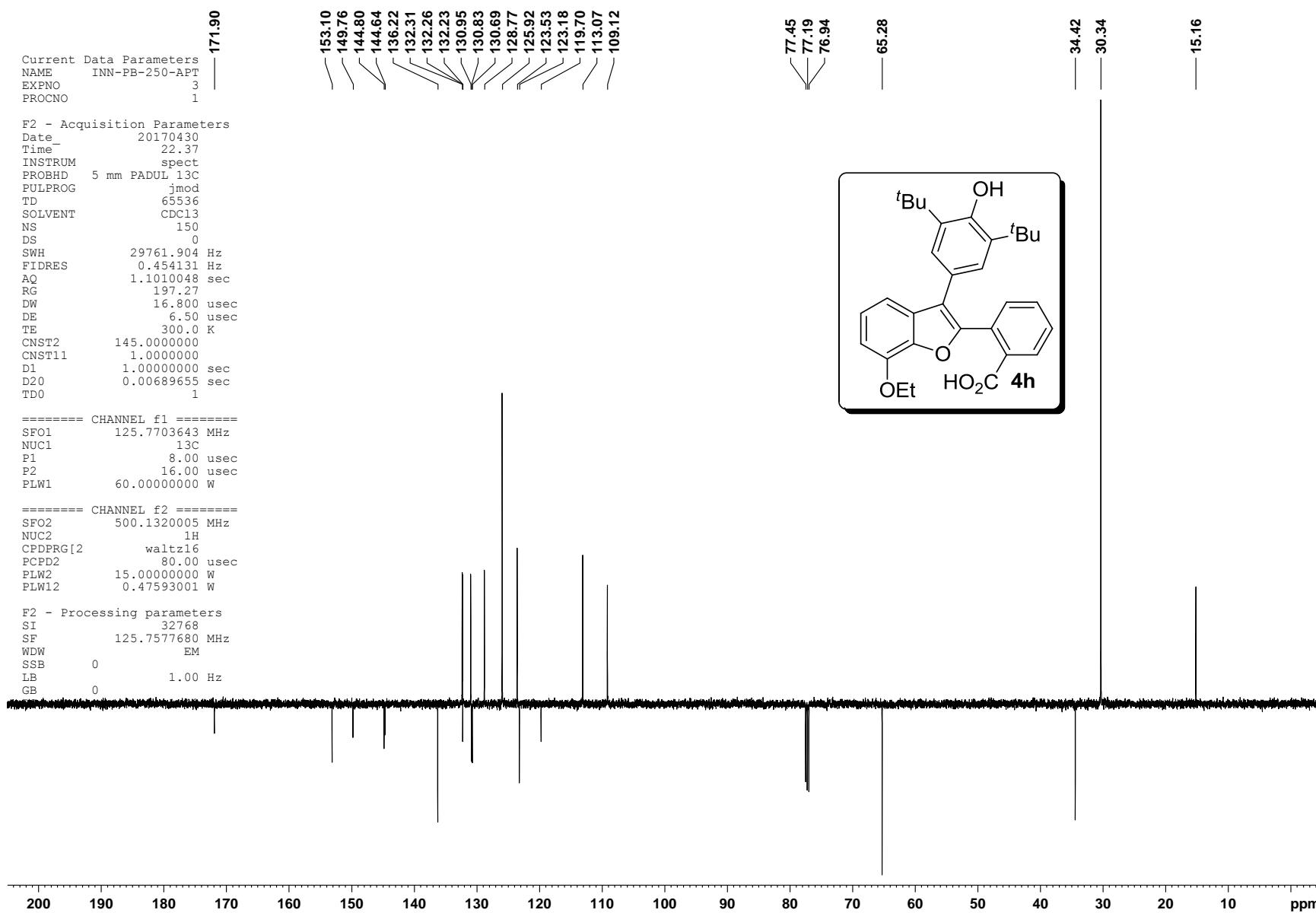


Figure S52. <sup>13</sup>C-APT NMR Spectrum of 4h

```

Current Data Parameters
NAME      INN-PB-250-COSY
EXPNO     5
PROCNO    1

F2 - Acquisition Parameters
Date_     20170430
Time      22.55
INSTRUM   spect
PROBHD   5 mm PADUL 13C
PULPROG  cosyppppgf
TD        2048
SOLVENT   CDCl3
NS       16
DS        0
SWH      2289.377 Hz
FIDRES   1.117860 Hz
AQ        0.4472832 sec
RG        177.33
DW        218.400 usec
DE        6.50 usec
TE        299.2 K
D0        0.00000300 sec
D1        1.00000000 sec
D11       0.03000000 sec
D12       0.00002000 sec
D13       0.00000400 sec
D16       0.00020000 sec
IN0       0.00043680 sec

===== CHANNEL f1 =====
SF01     500.1333547 MHz
NUC1      1H
P0        14.25 usec
P1        14.25 usec
P17       2500.00 usec
PLW1     15.0000000 W
PLW10    3.38439989 W

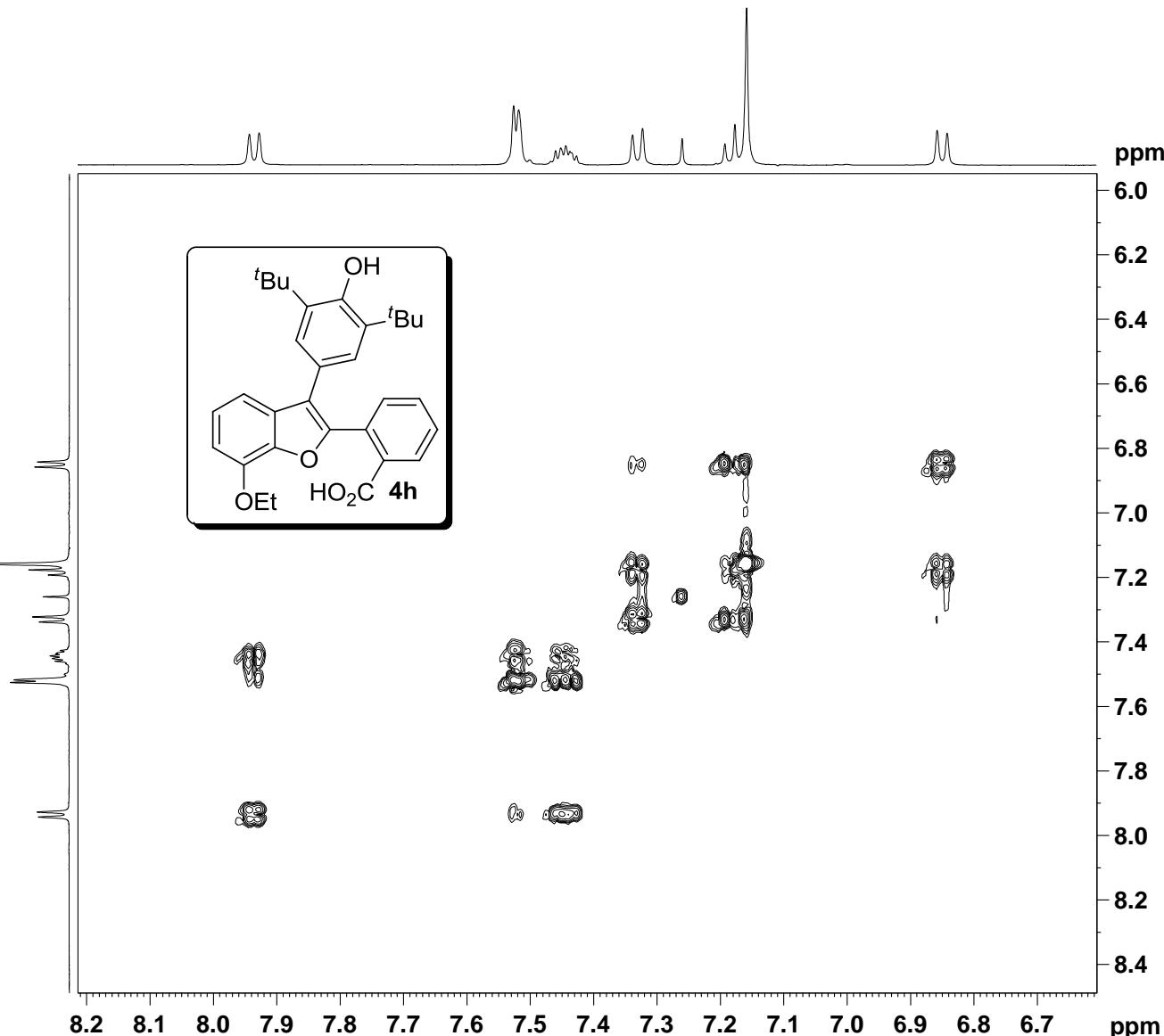
===== GRADIENT CHANNEL =====
GPNAME[1] SMSQ10.100
GP21      10.00 %
P16       1000.00 usec

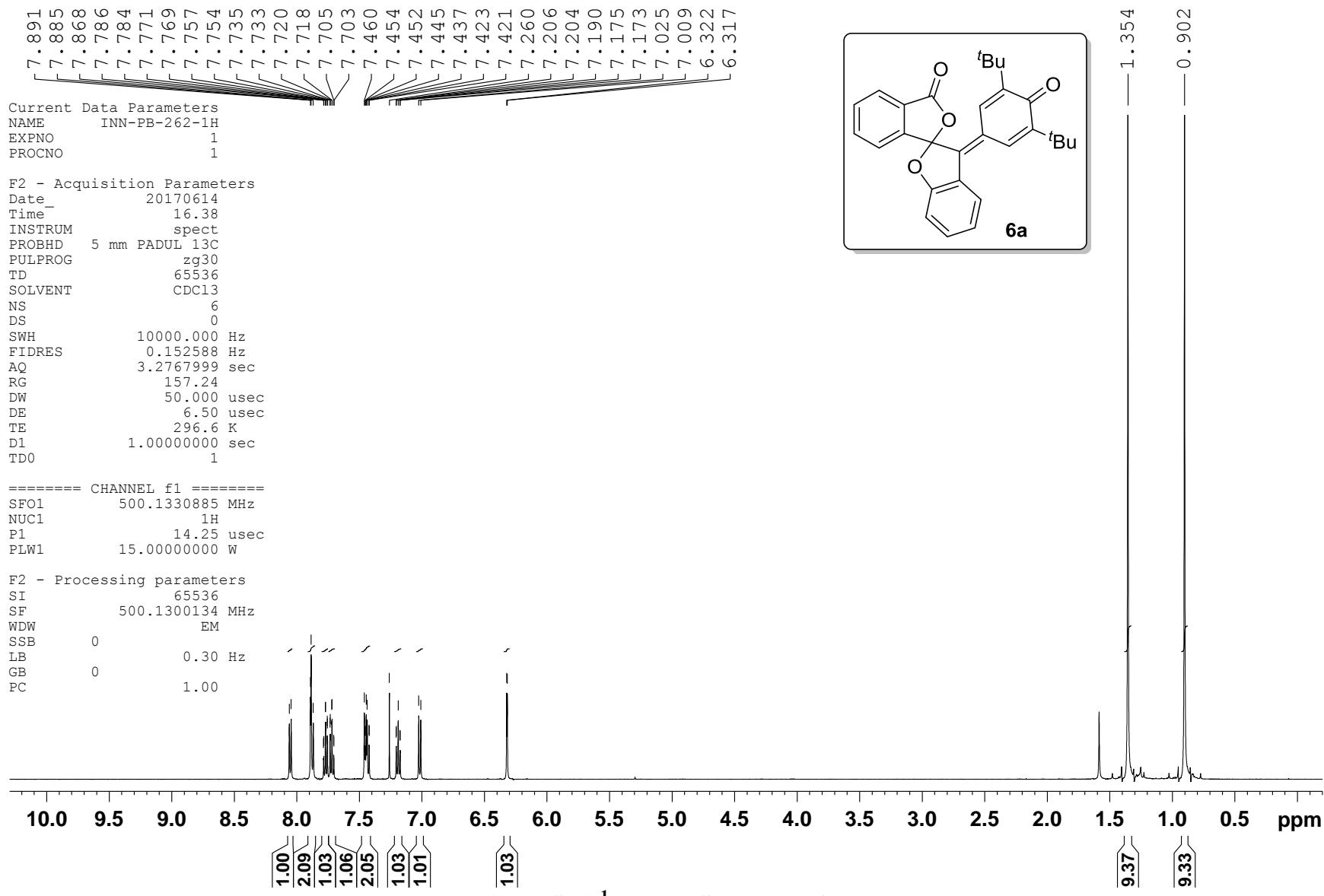
F1 - Acquisition parameters
TD        168
SF01     500.1334 MHz
FIDRES   27.254492 Hz
SW        4.578 ppm
FnMODE   QF

F2 - Processing parameters
SI        1024
SF        500.1300130 MHz
WDW      QSINE
SSB      0
LB       0 Hz
GB       0
PC        1.40

F1 - Processing parameters
SI        1024
MC2      QF
SF        500.1300130 MHz
WDW      QSINE
SSB      0
LB       0 Hz
GB       0

```





**Figure S54.**  $^1\text{H}$  NMR Spectrum of **6a**

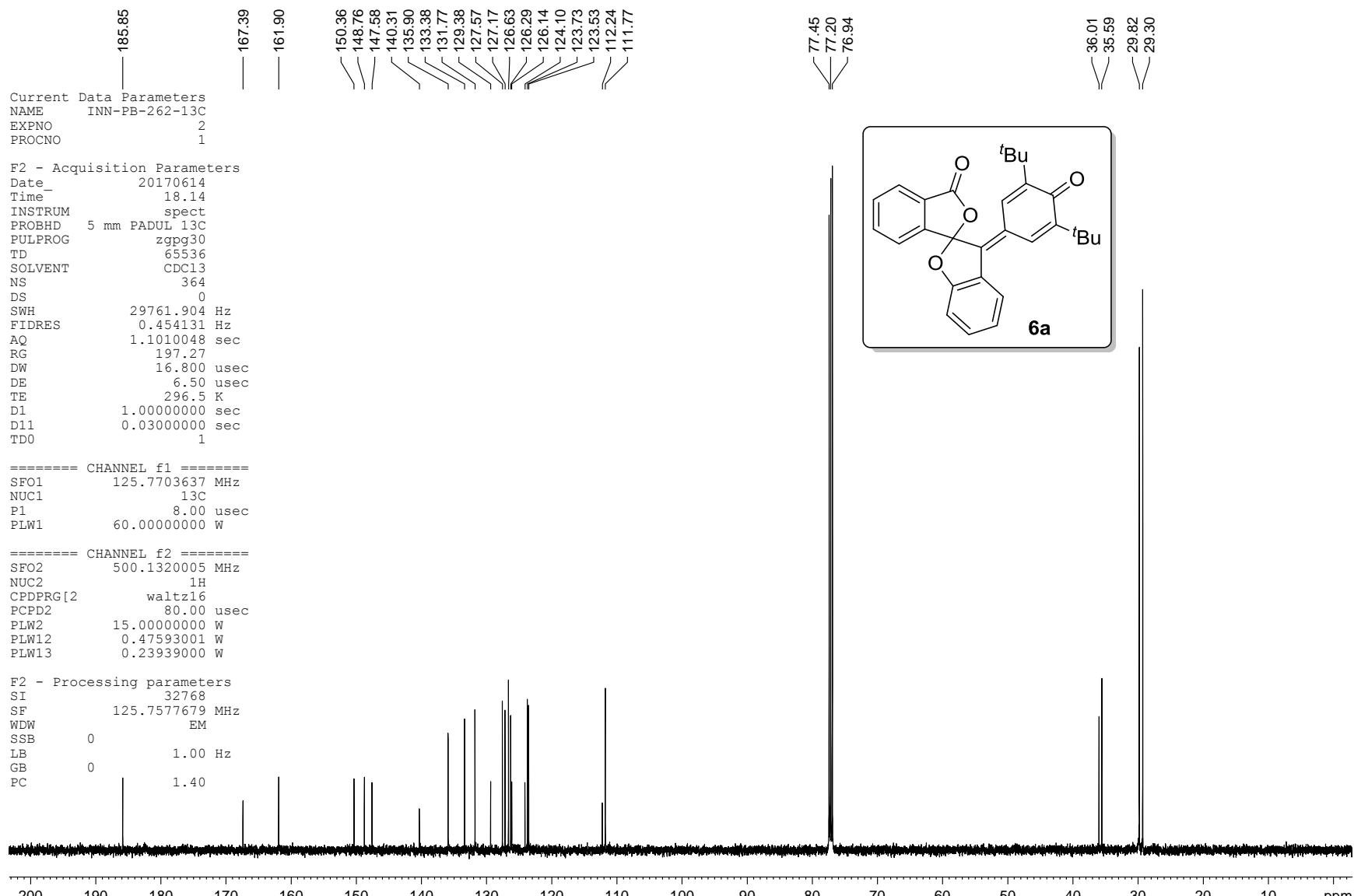


Figure S55. <sup>13</sup>C NMR Spectrum of 6a

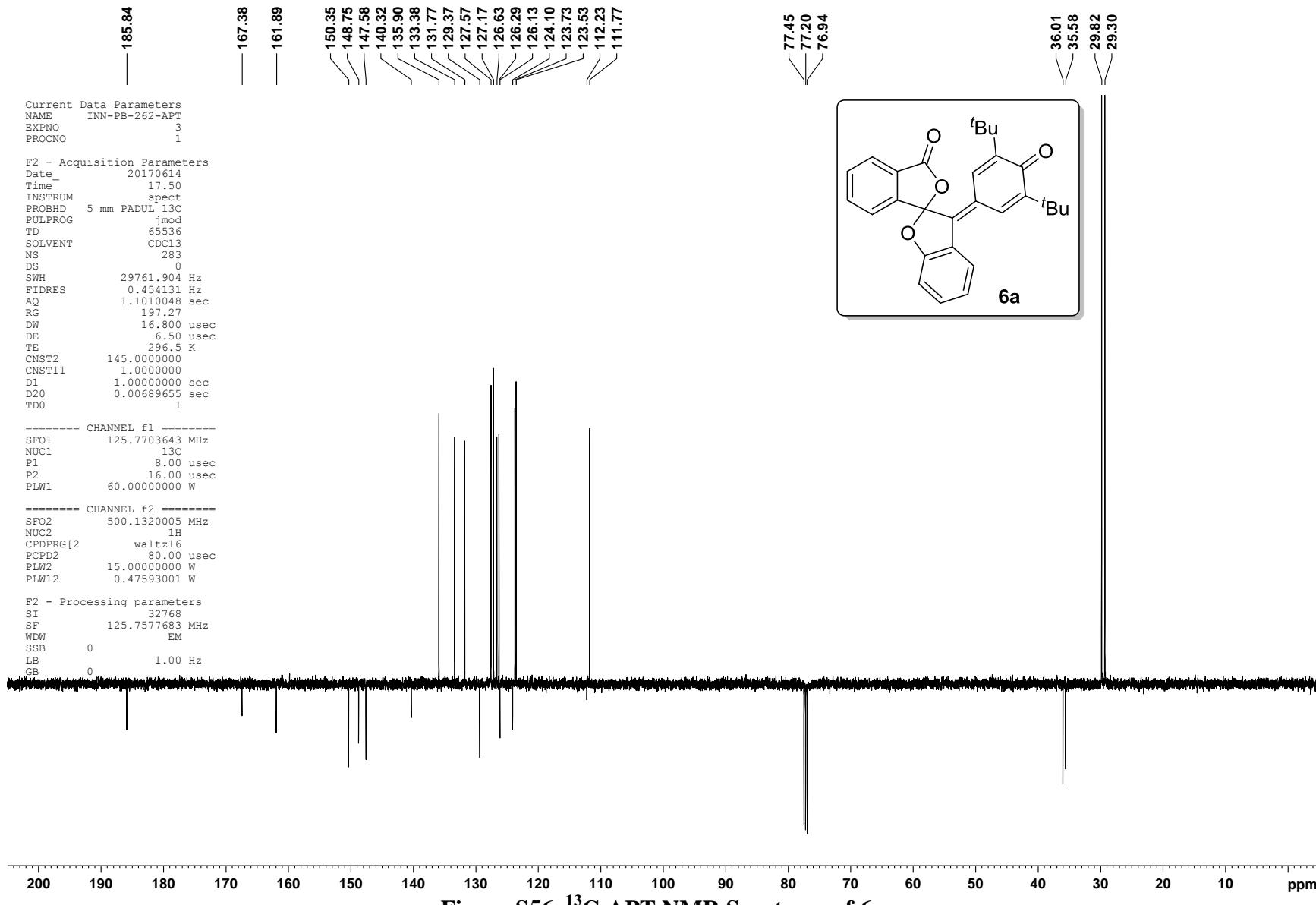
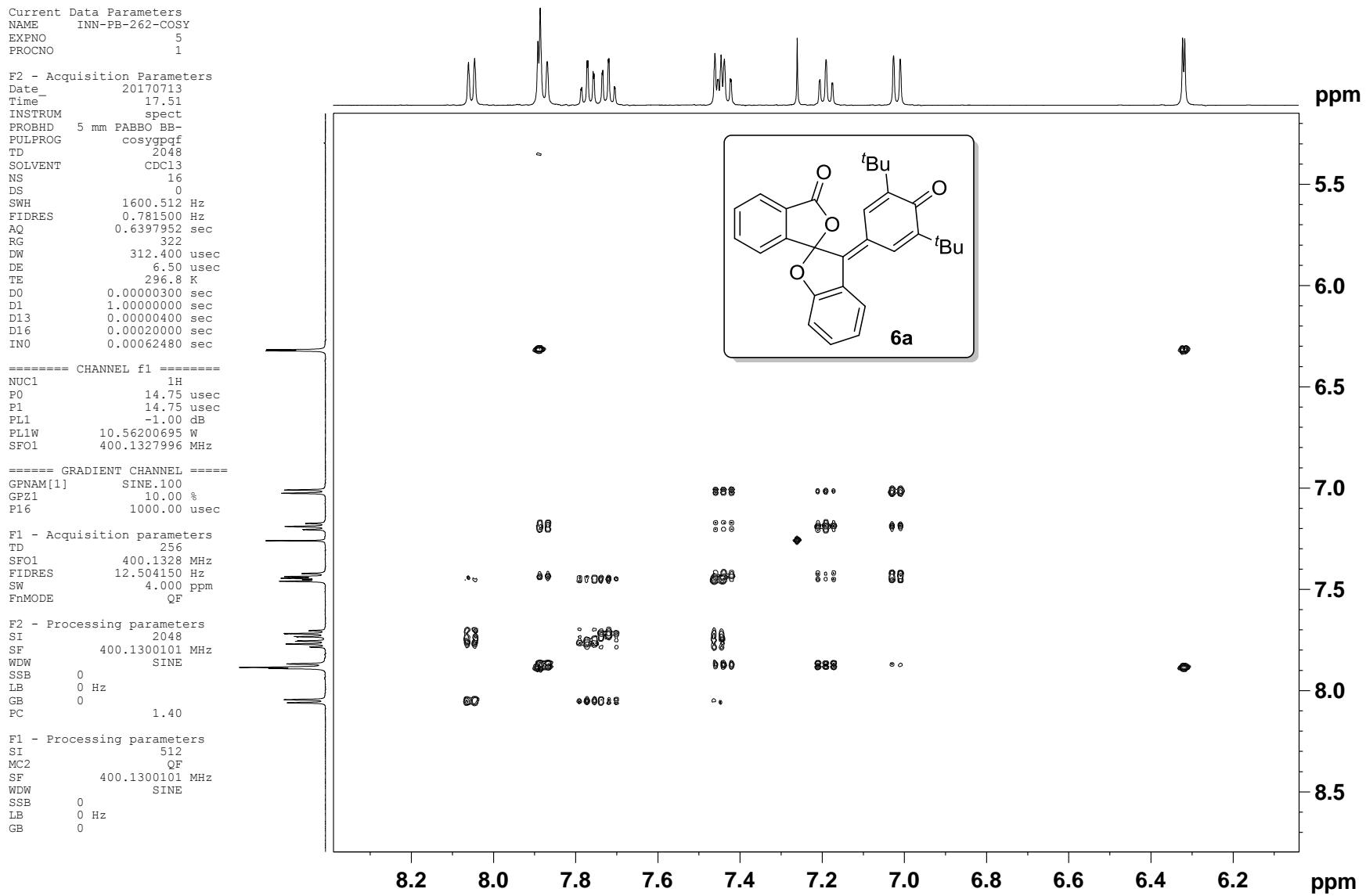


Figure S56. <sup>13</sup>C-APT NMR Spectrum of 6a



**Figure S57.  $^1\text{H}$ - $^1\text{H}$  COSY NMR Spectrum of 6a**

Current Data Parameters  
NAME 1H-1H-262-NOESY  
EXNO 6  
BLOCKNO 1

F2 - Acquisition Parameters  
Date 20170713  
Time 19:49  
INSTRUM spect  
PROBHD 5 mm PABBO BB-  
PULPROG noesygppr1  
TD 2048  
SOLVENT CDCl3  
NS 16  
DS 0  
SWH 1600.512 Hz  
ETR023 0.761500 Hz  
AQ 0.6297952 sec  
RG 2.56  
DM 312.400 usec  
DE 6.50 usec  
TE 296.2 K  
D0 0.00029362 sec  
T1 1.0000000 sec  
D2 0.6000002 sec  
DW 0.00062460 sec

===== CHANNEL F1 =====

NUC1 1H  
F1 14.75 usec  
PL1 -1.00 dB  
PL1W 10.562004695 W  
SF01 400.1327994 MHz

F1 - Acquisition parameters  
TD 512  
SF01 400.1326 MHz  
ETR023 6.252075 Hz  
SW 4.000 ppm  
PulseE States-TIPI

F1 - Processing parameters  
SI 2048  
SF 400.1300301 MHz  
WDW QSMINE  
SSB 2  
DE 0 Hz  
GZ 0  
PC 1.00

F1 - Processing parameters  
SI 512  
MC2 States-TIPI  
SF 400.1300301 MHz  
WDW QSMINE  
SSB 2  
DE 0 Hz  
GZ 0

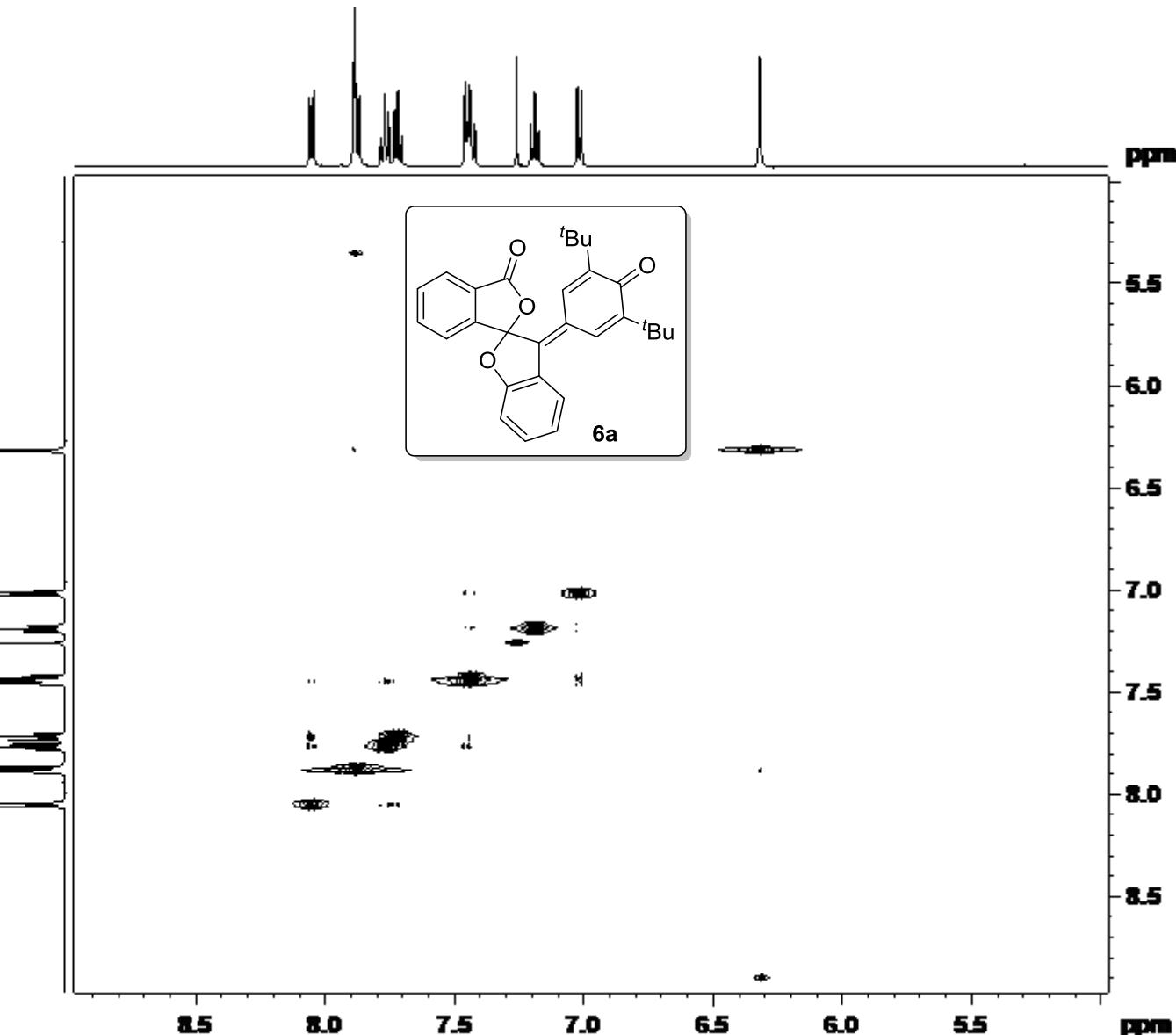


Figure S58.  $^1\text{H}$ - $^1\text{H}$  NOESY NMR Spectrum of 6a

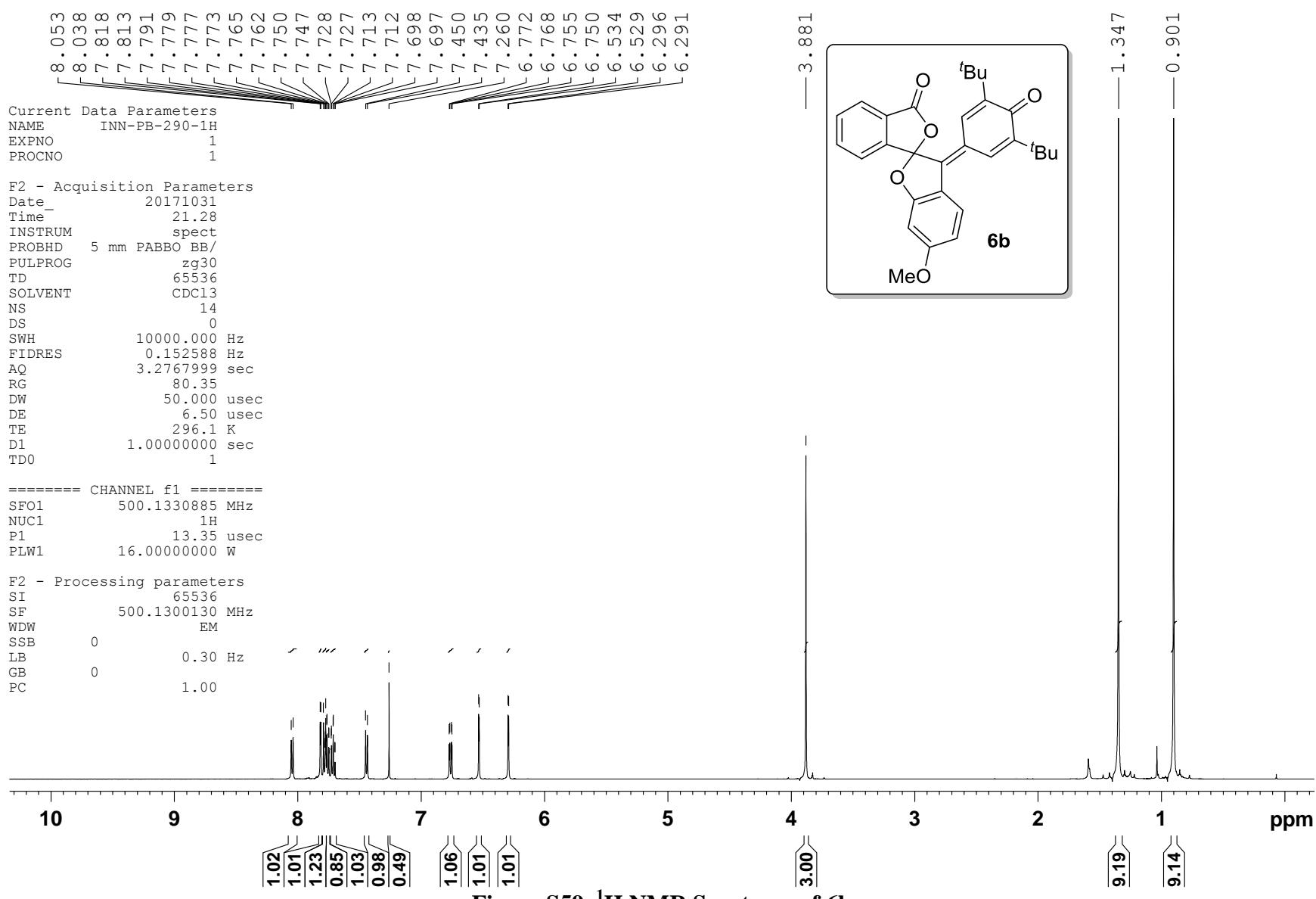
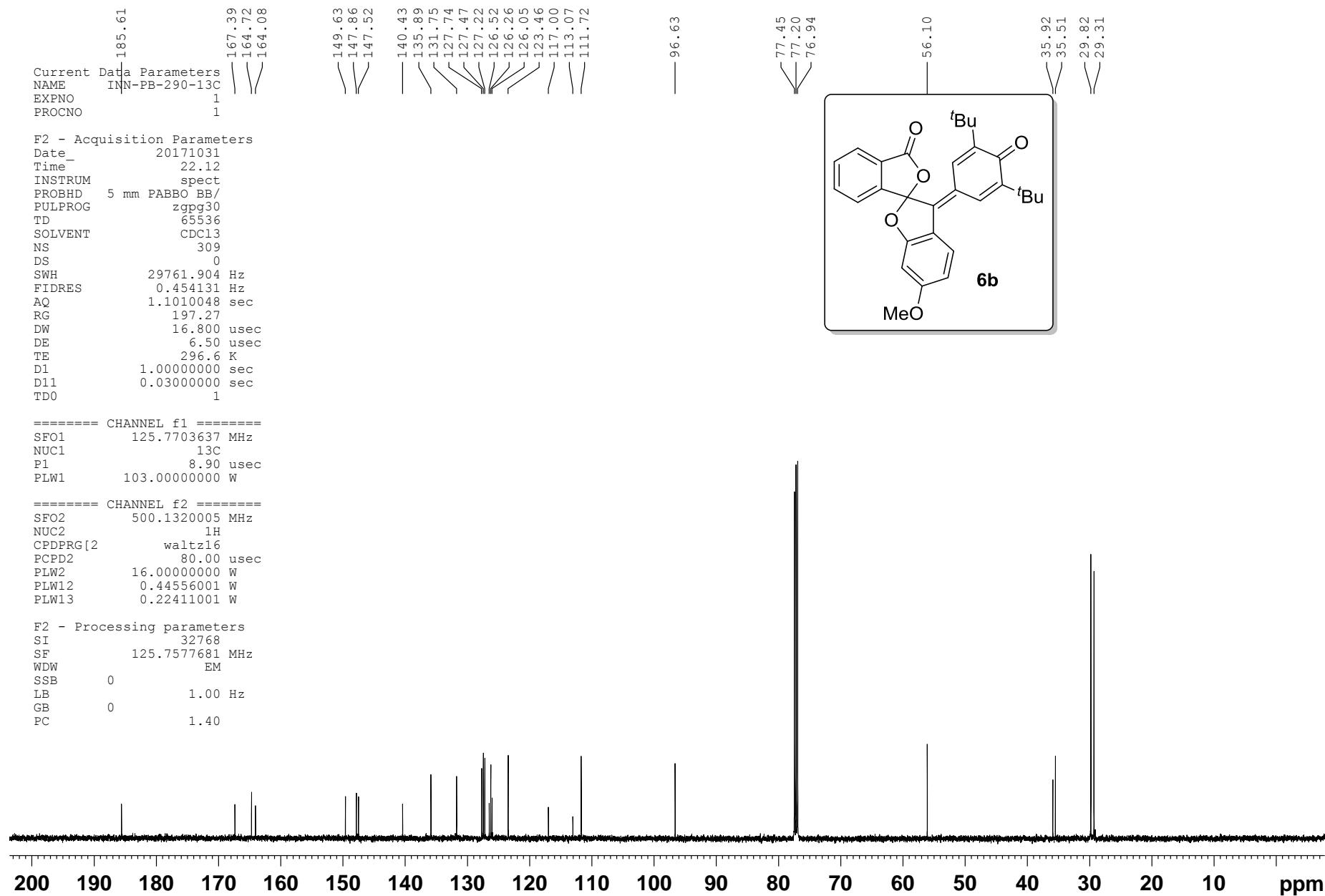
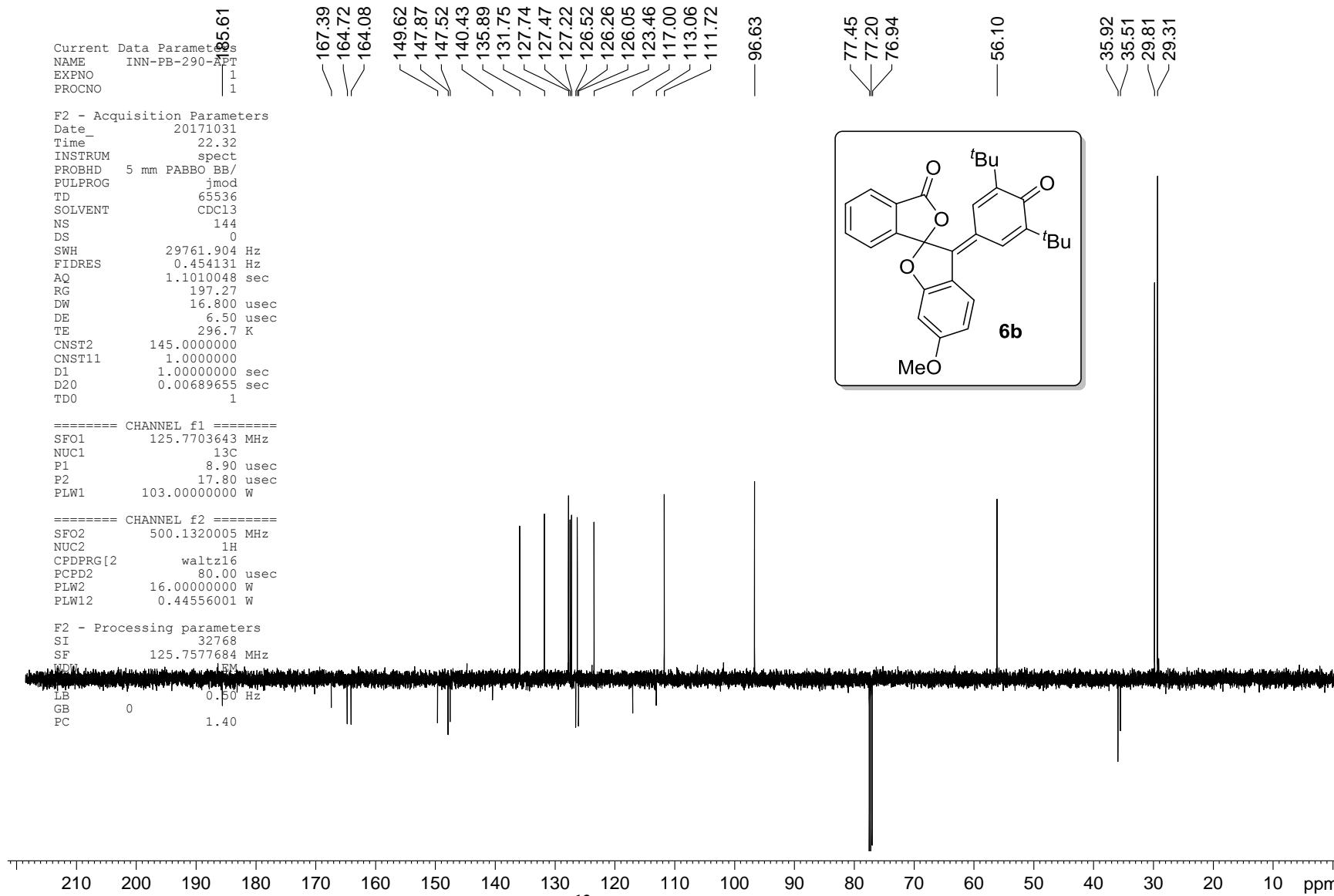


Figure S59. <sup>1</sup>H NMR Spectrum of 6b





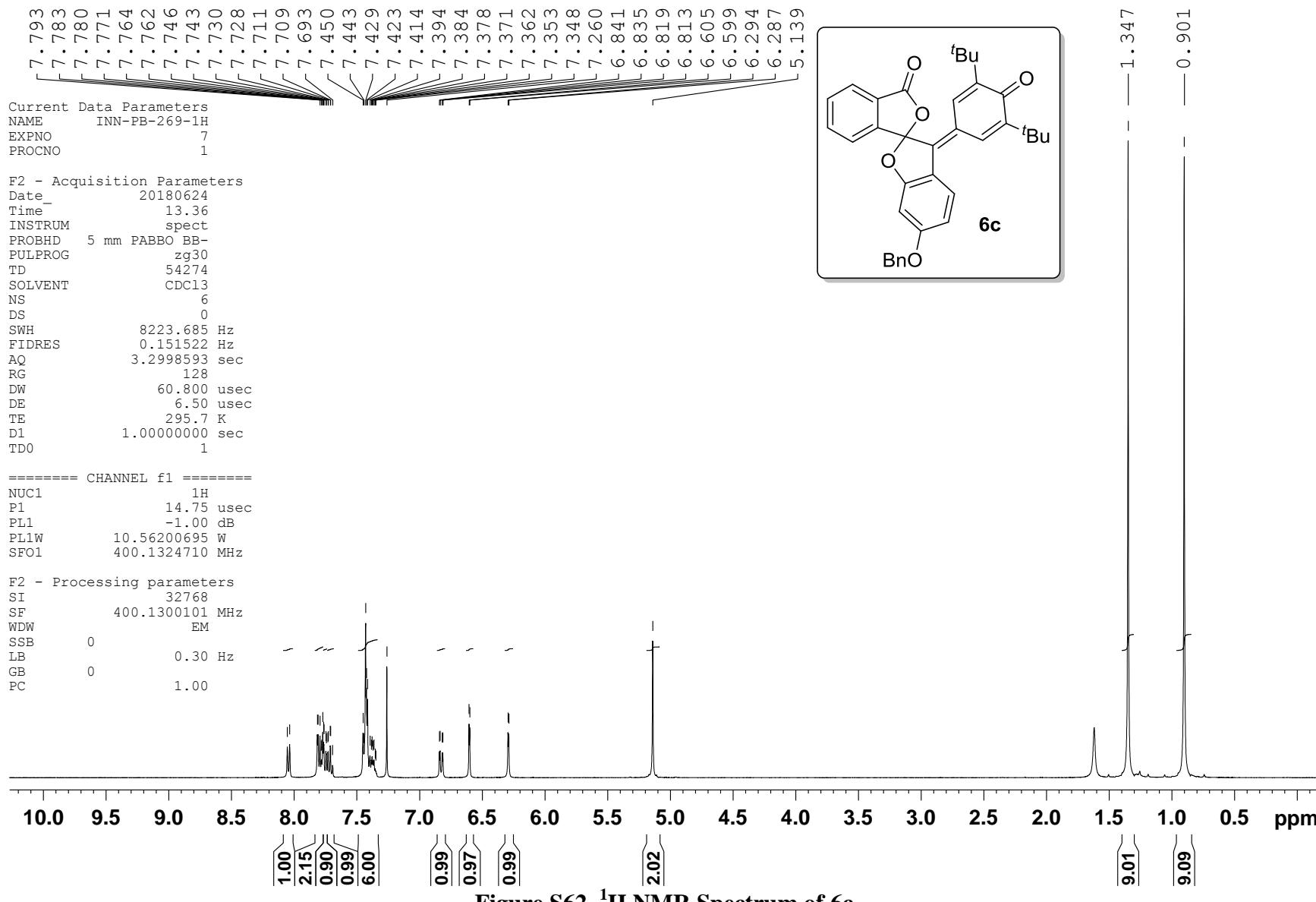
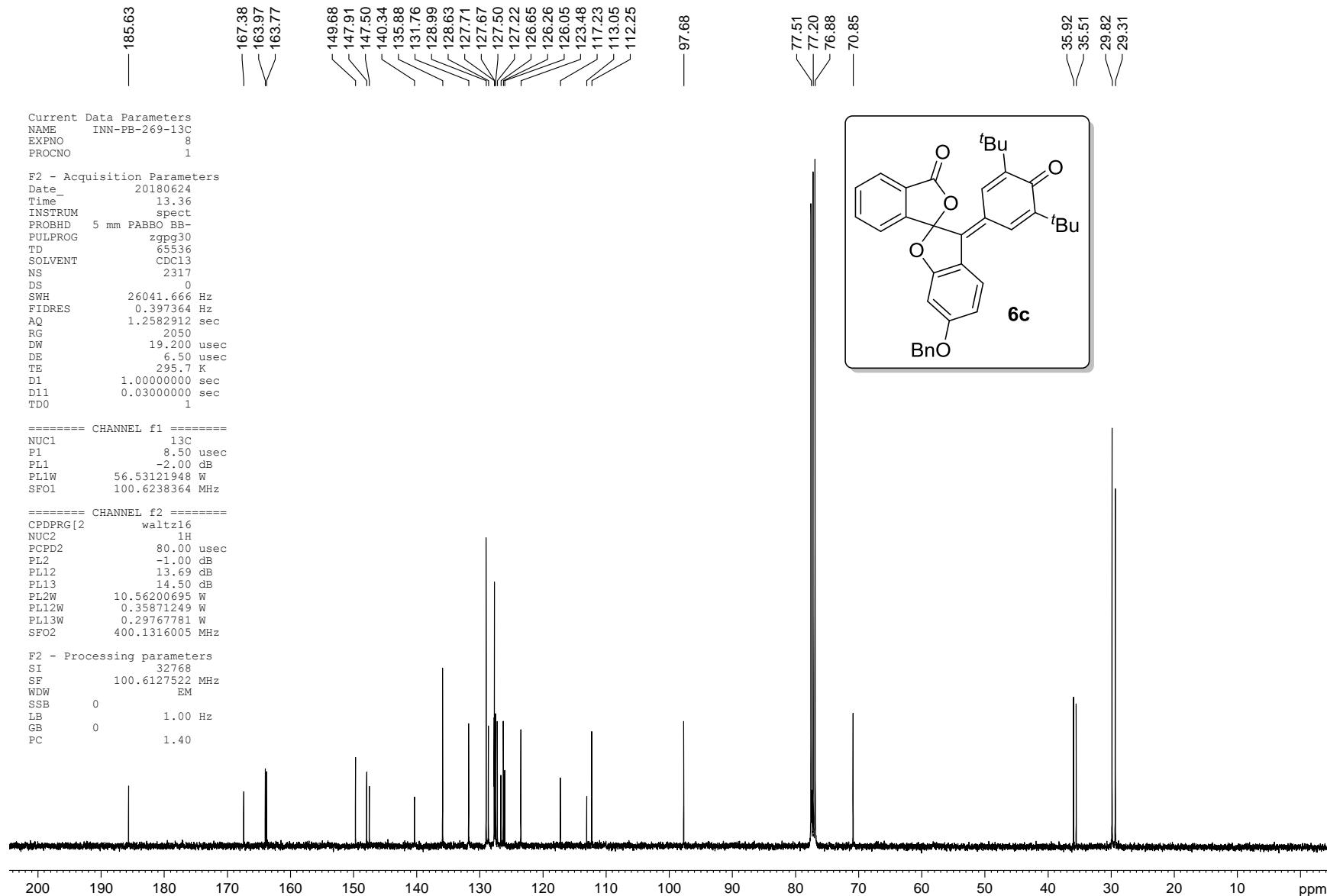
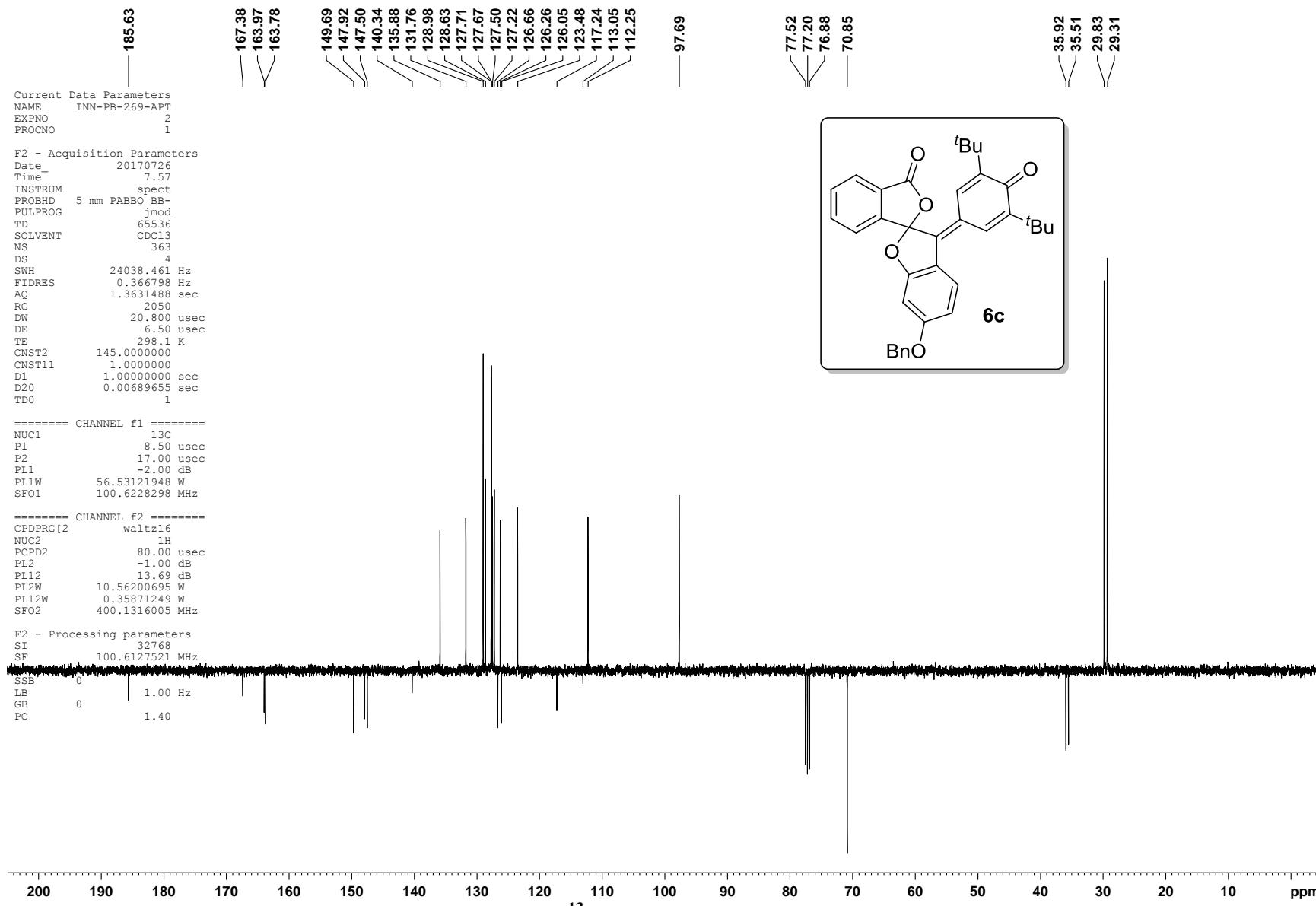


Figure S62.  $^1\text{H}$  NMR Spectrum of **6c**





**Figure S64.**  $^{13}\text{C}$ -APT NMR Spectrum of **6c**

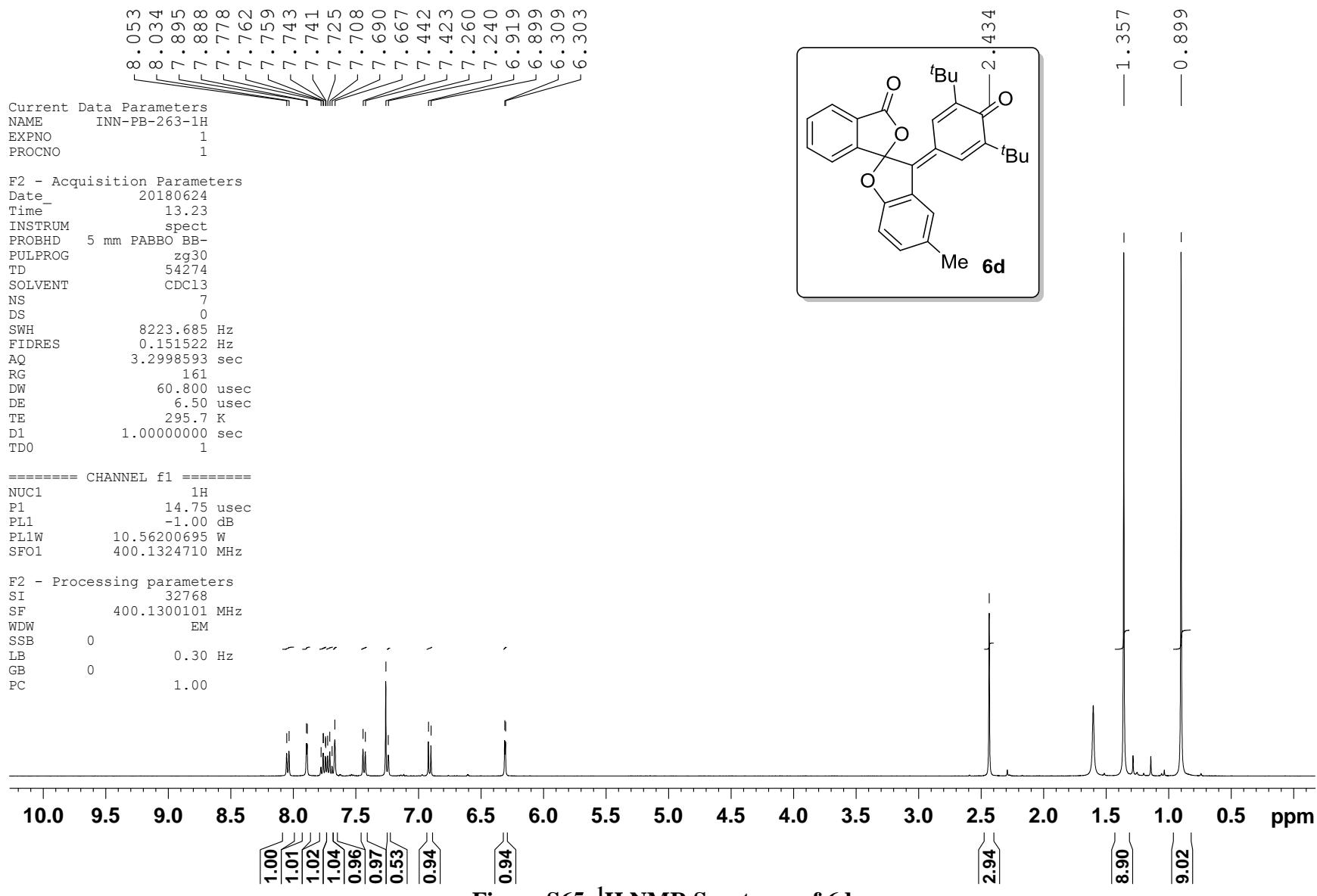
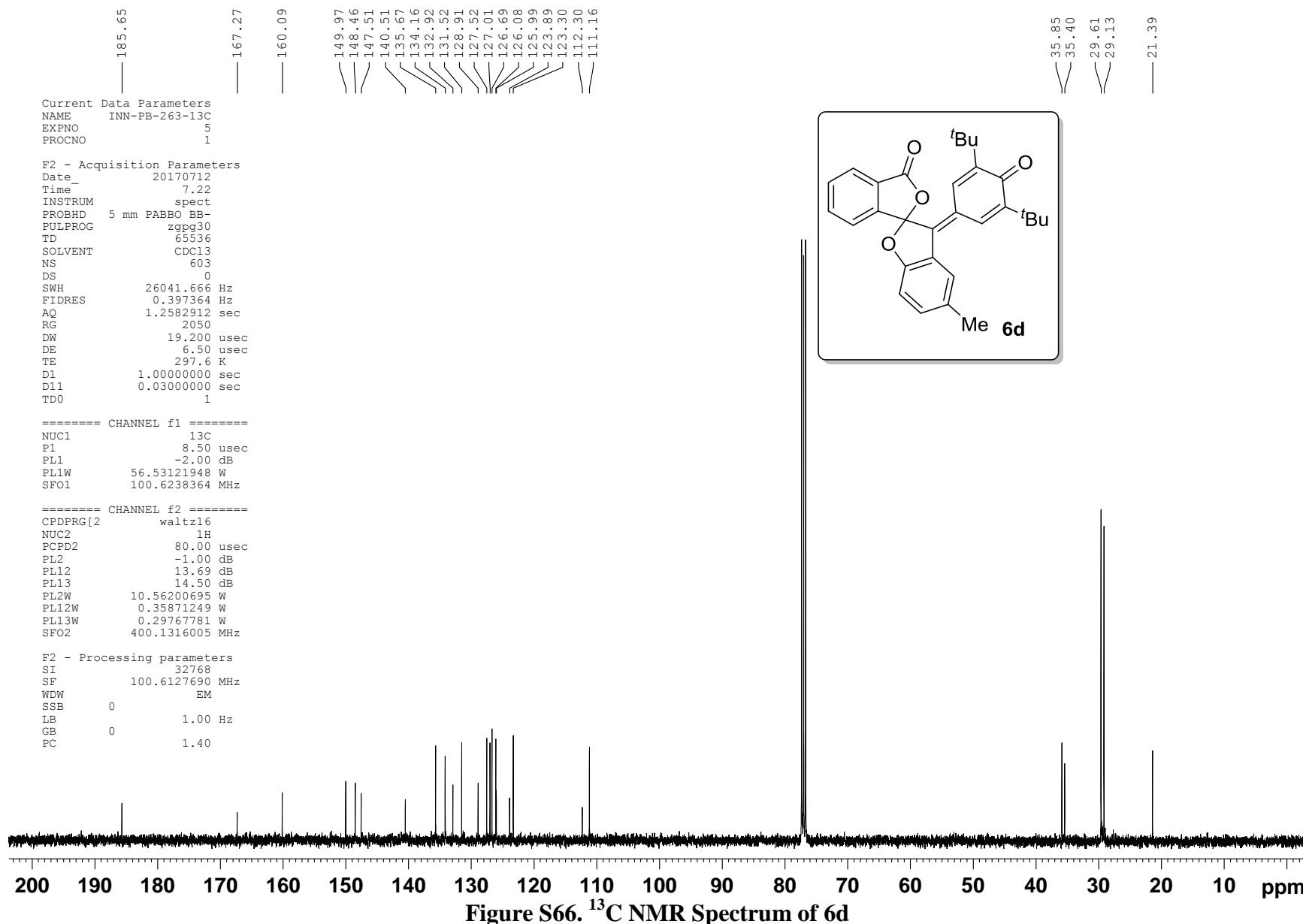


Figure S65. <sup>1</sup>H NMR Spectrum of **6d**



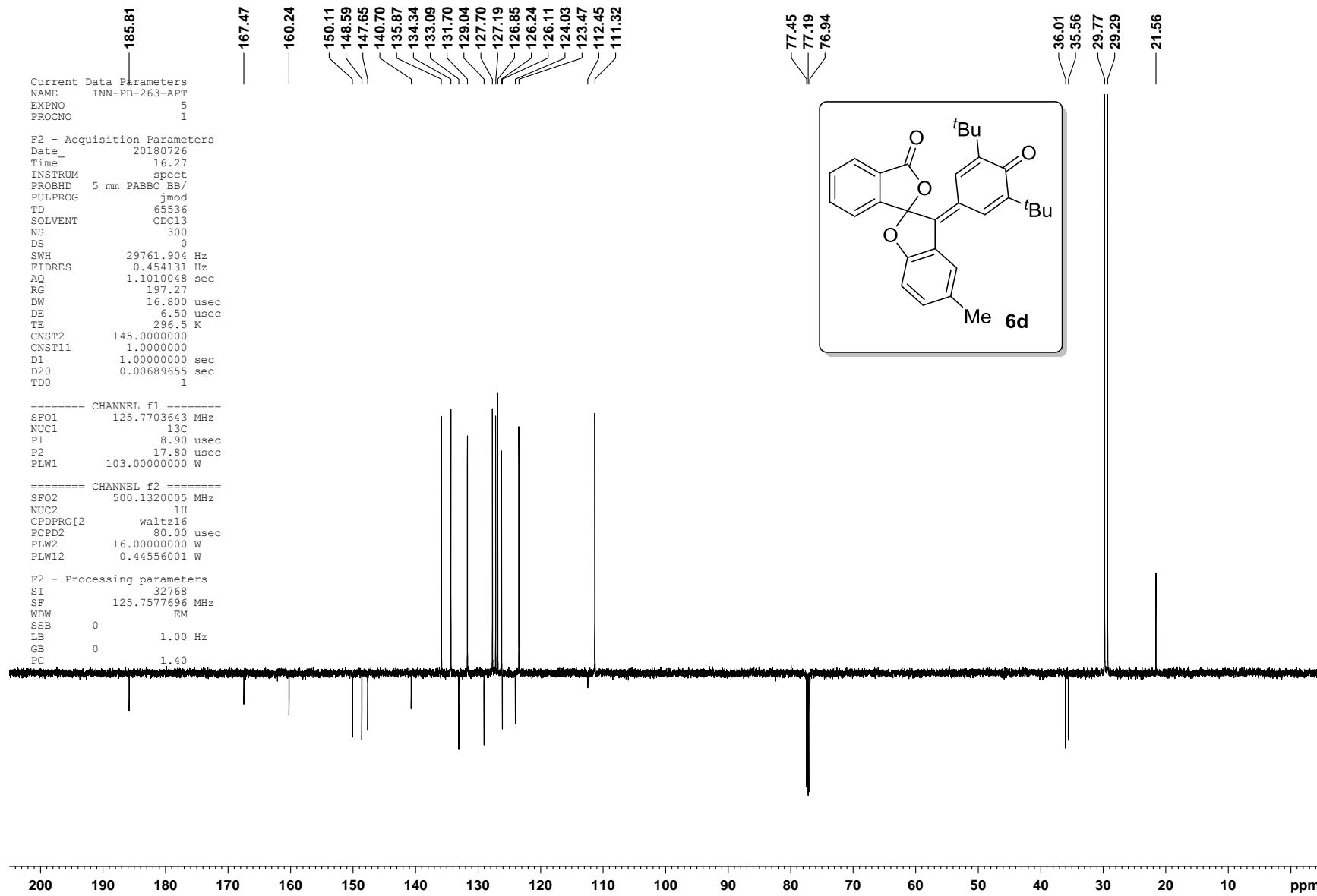
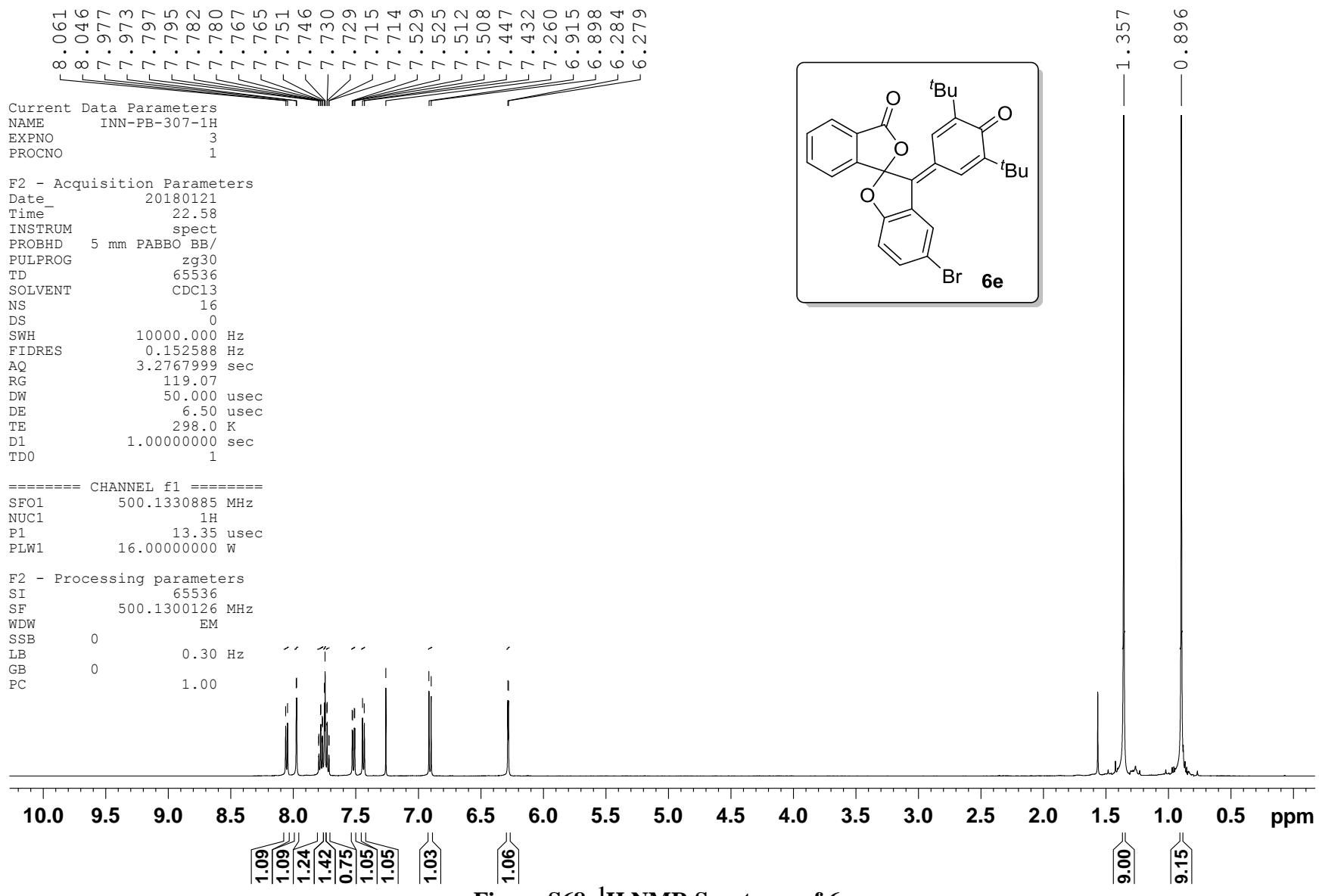


Figure S67.  $^{13}\text{C}$ -APT NMR Spectrum of 6d



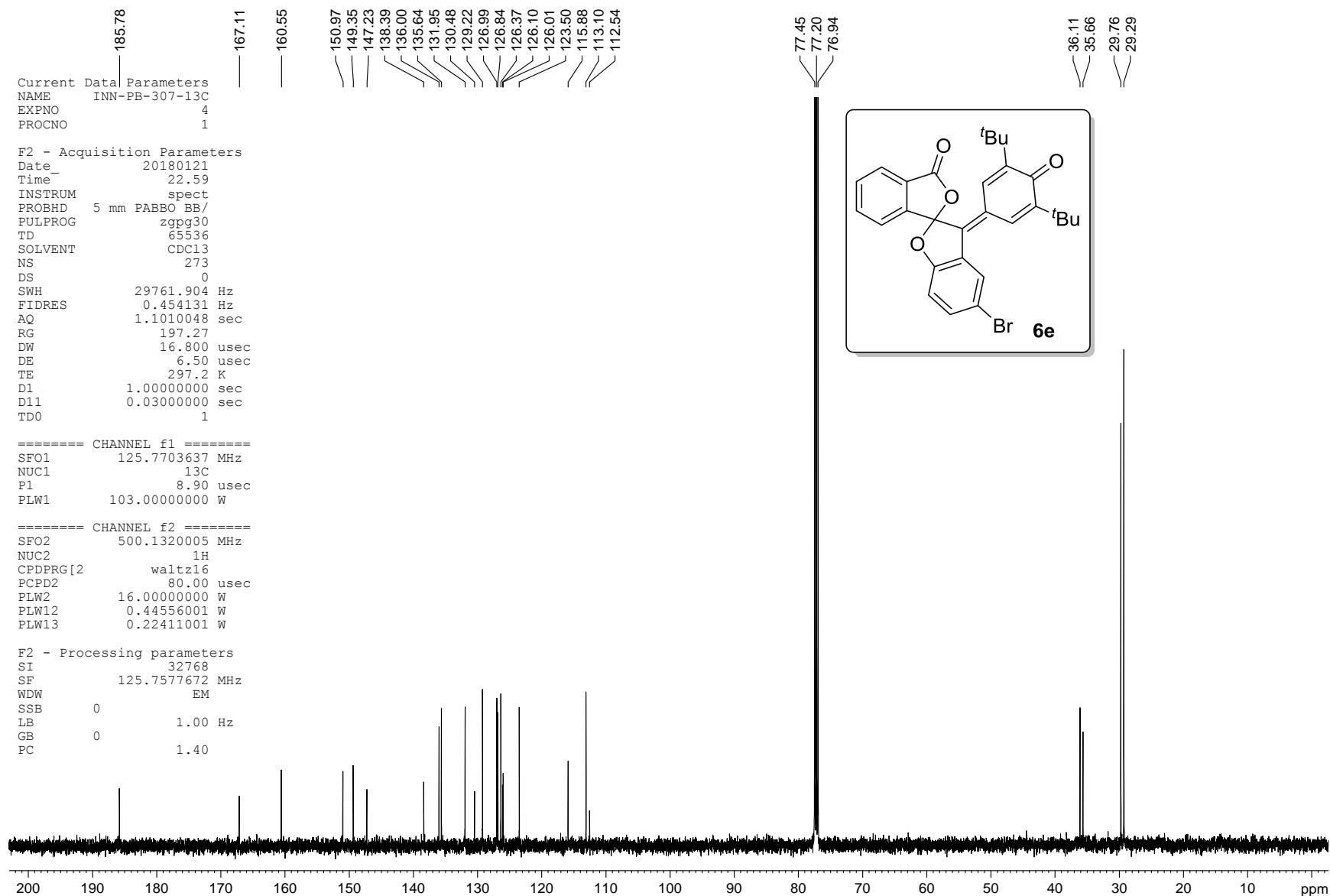


Figure S69.  $^{13}\text{C}$  NMR Spectrum of 6e

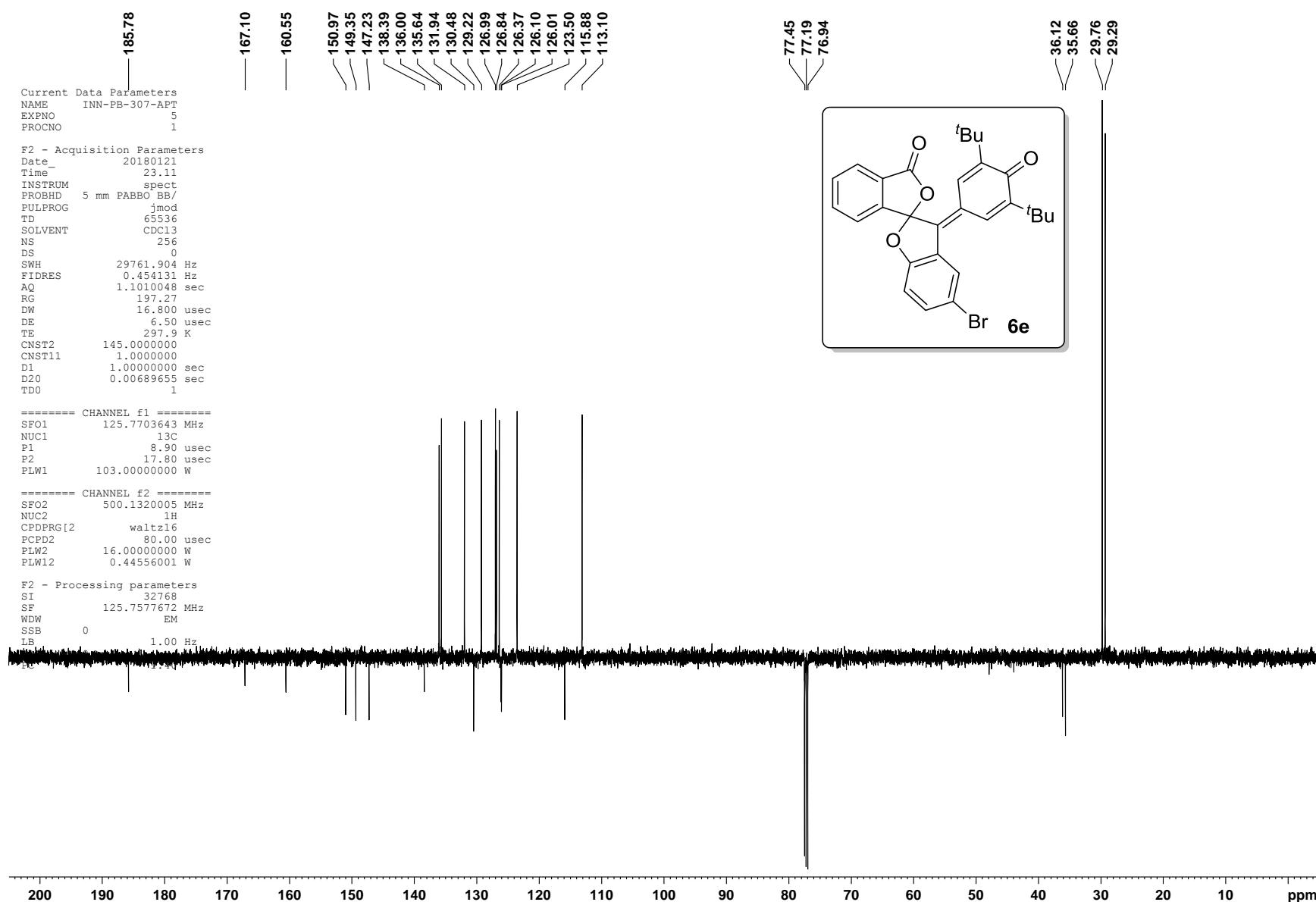


Figure S70.  $^{13}\text{C}$ -APT NMR Spectrum of 6e

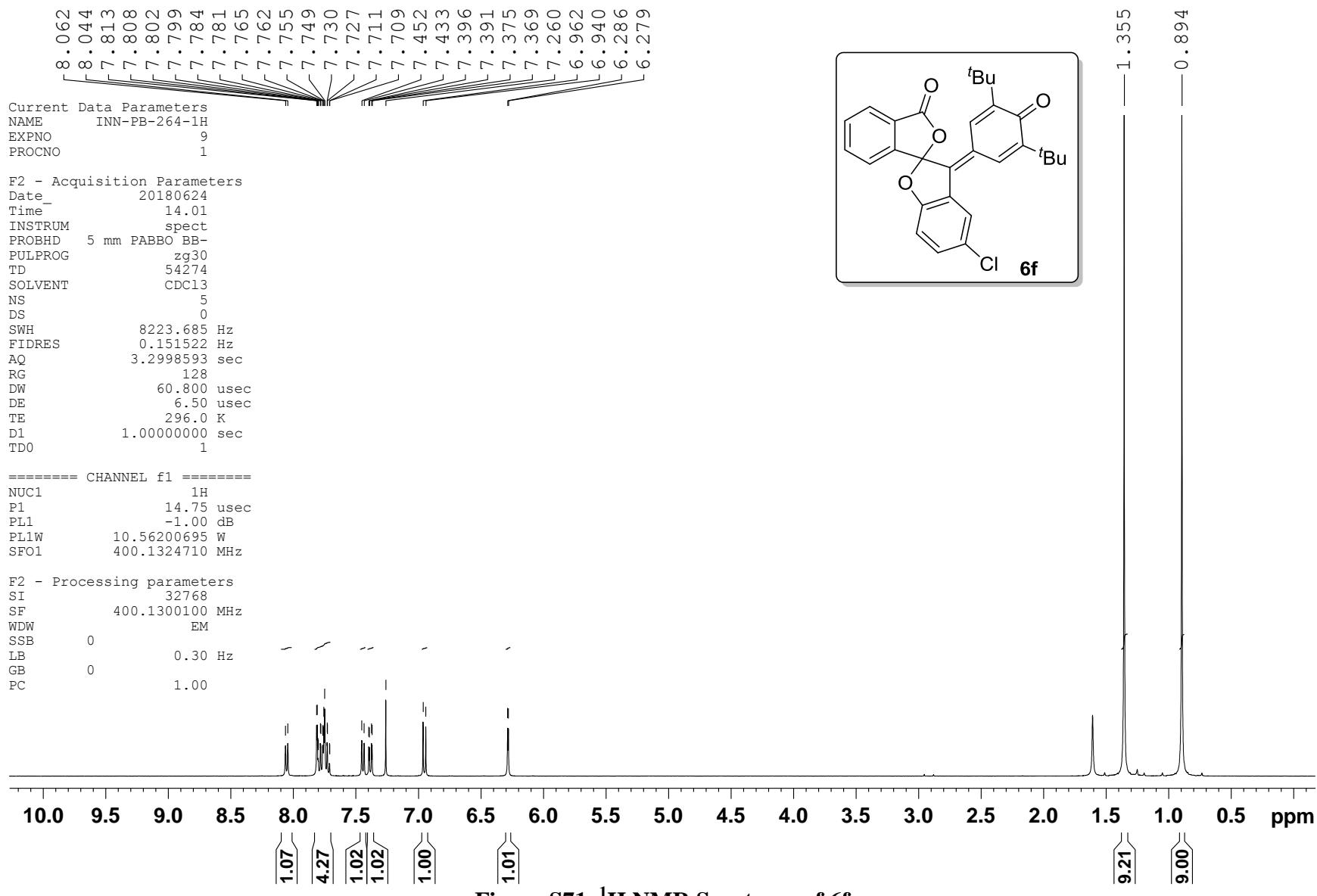
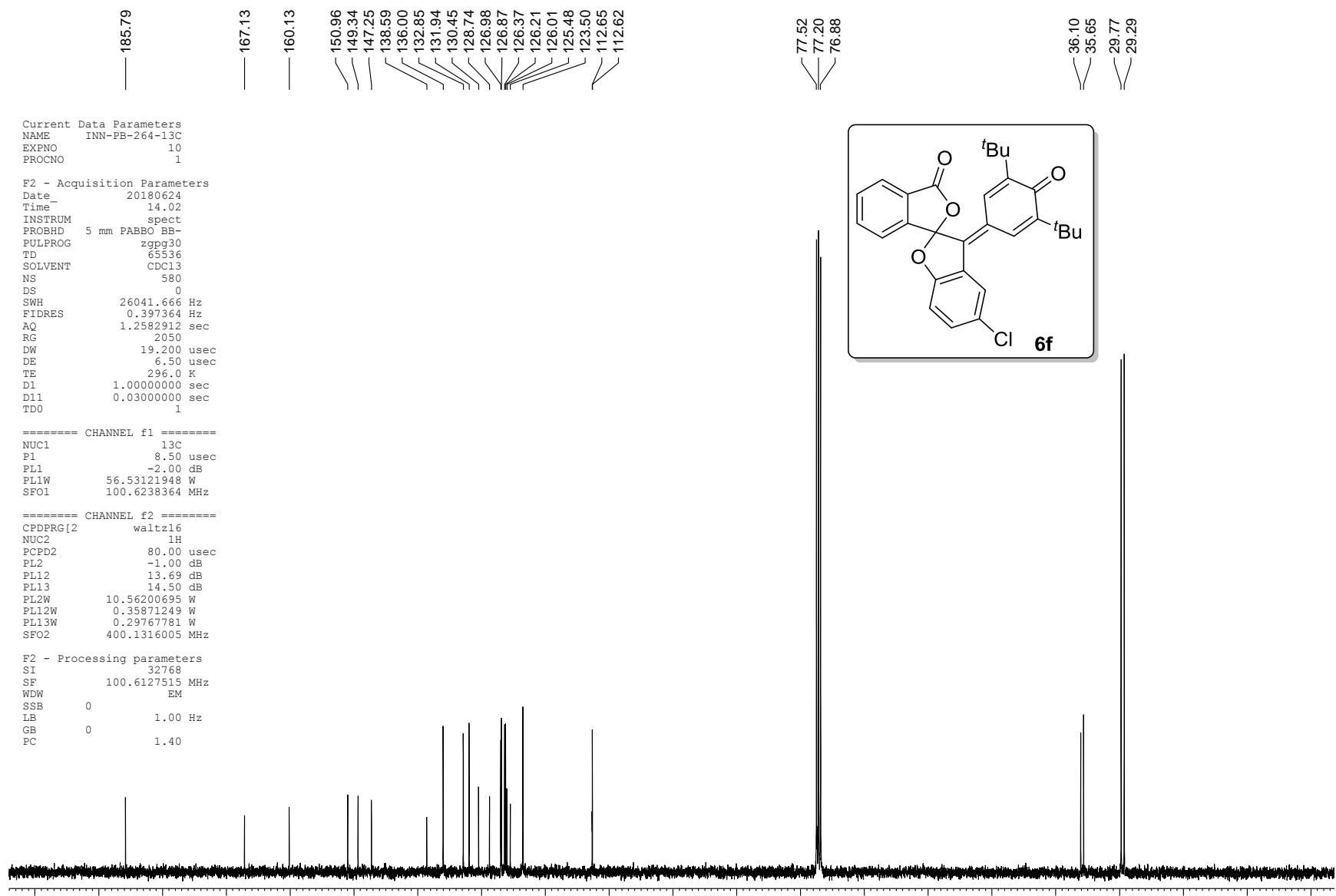
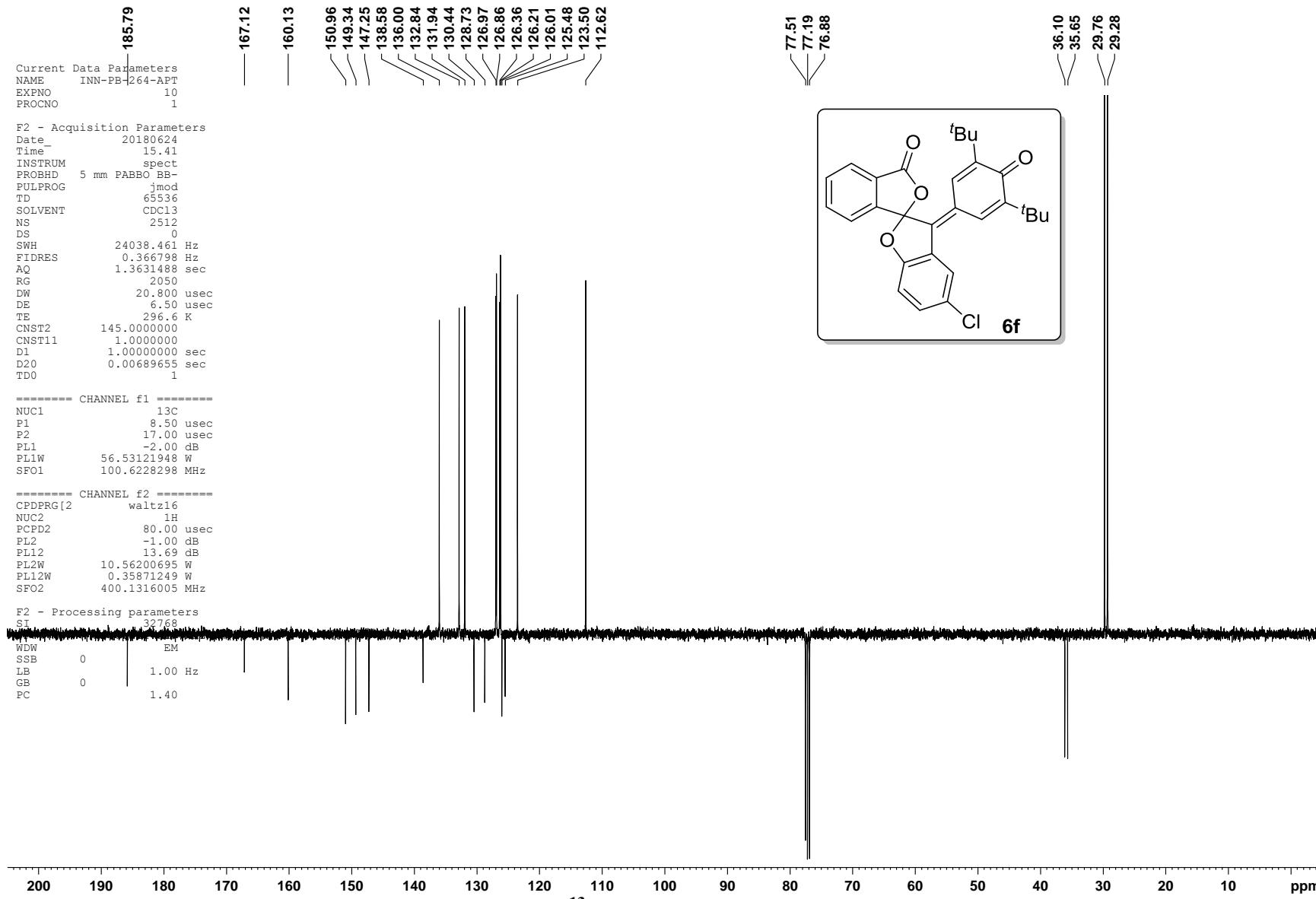
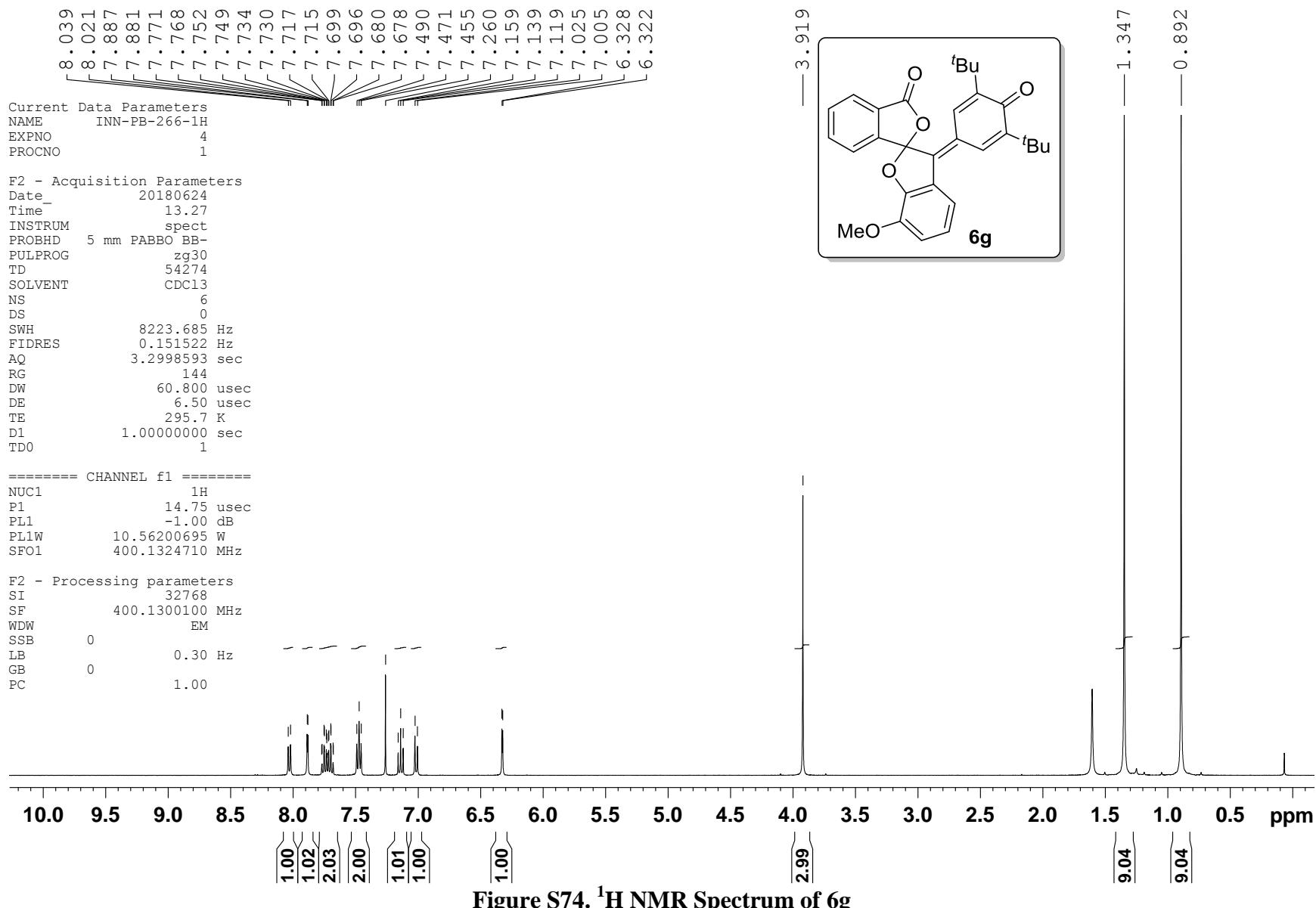


Figure S71.  $^1\text{H}$  NMR Spectrum of **6f**







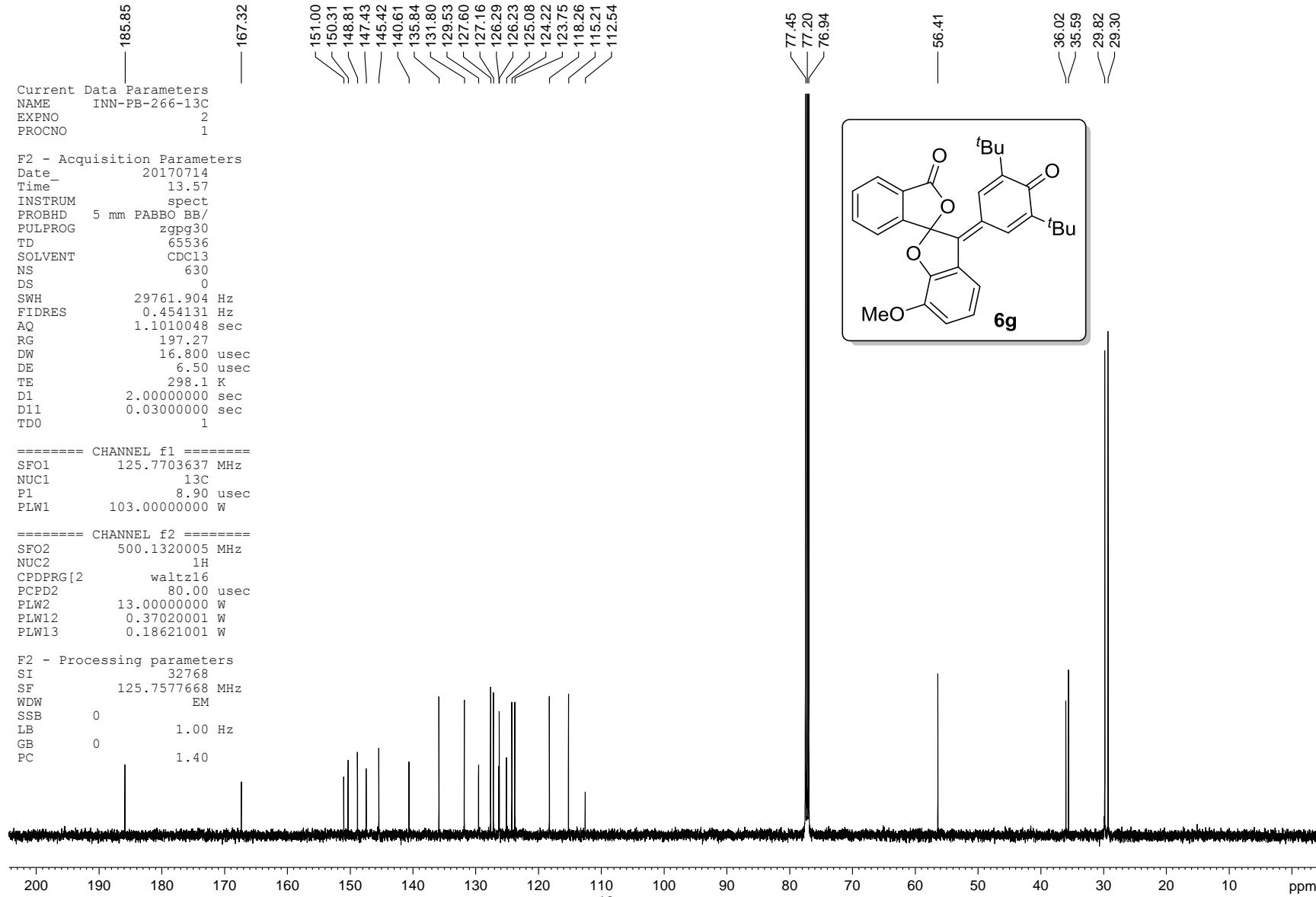


Figure S75.  $^{13}\text{C}$  NMR Spectrum of 6g

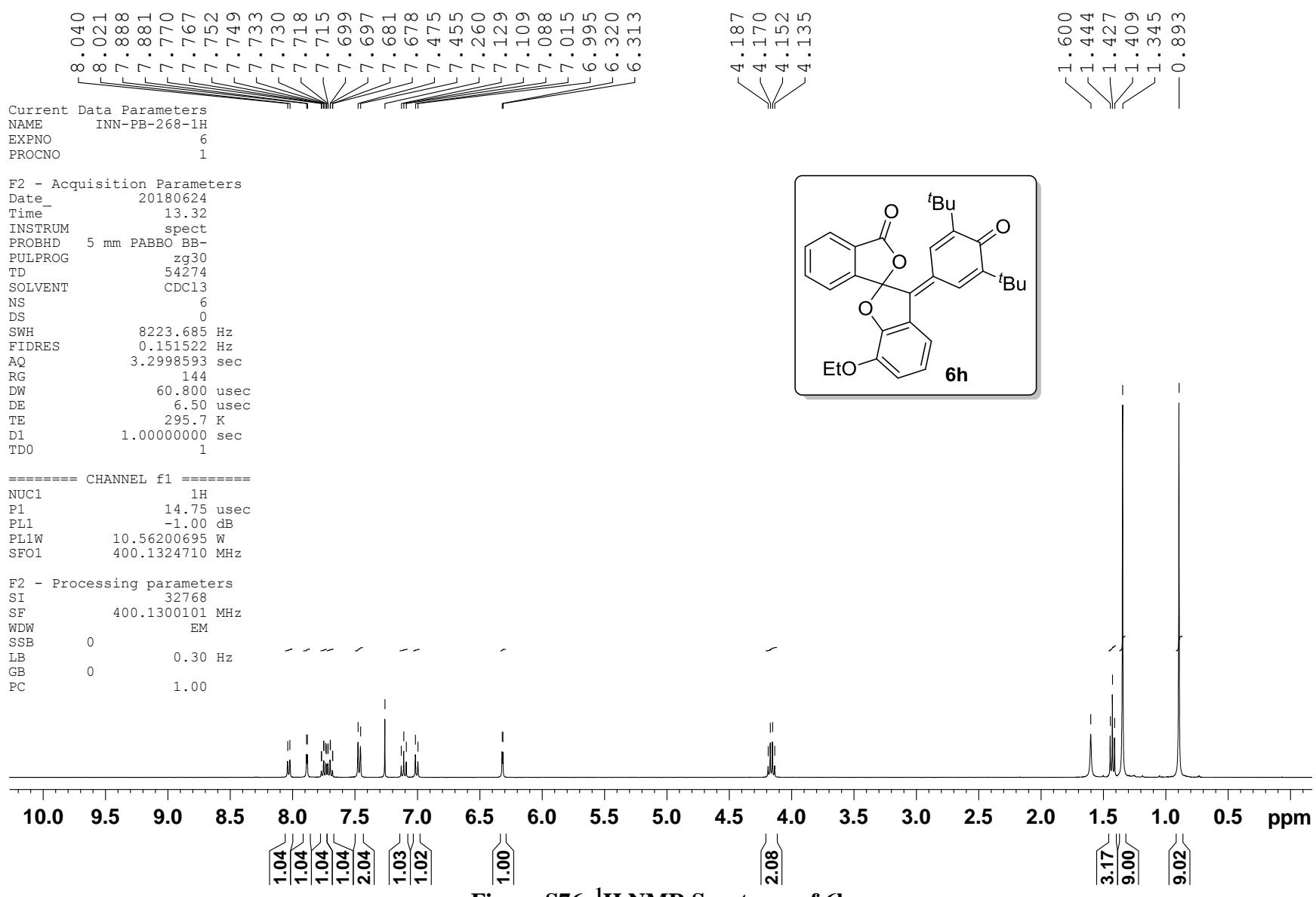


Figure S76.  $^1\text{H}$  NMR Spectrum of 6h

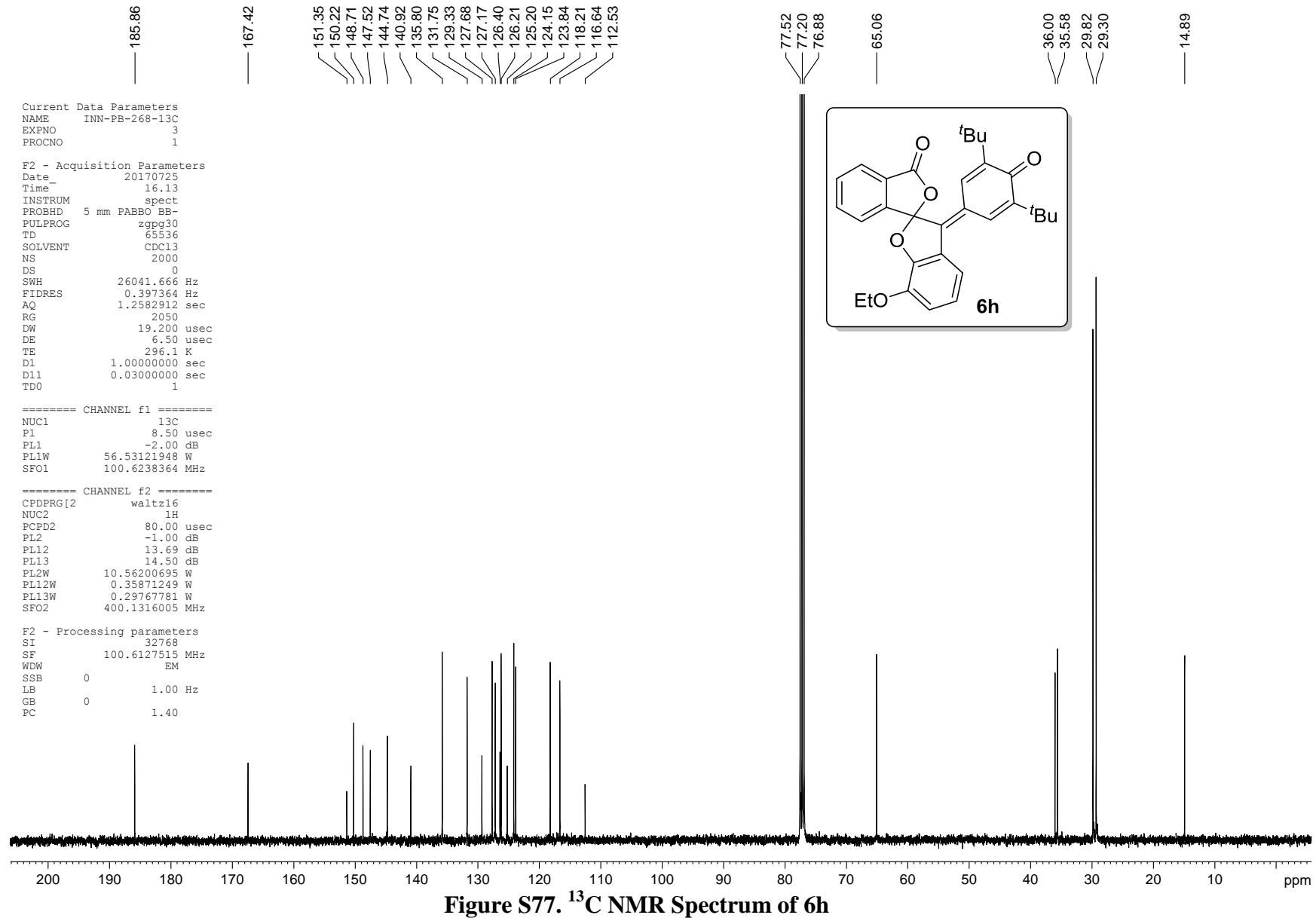
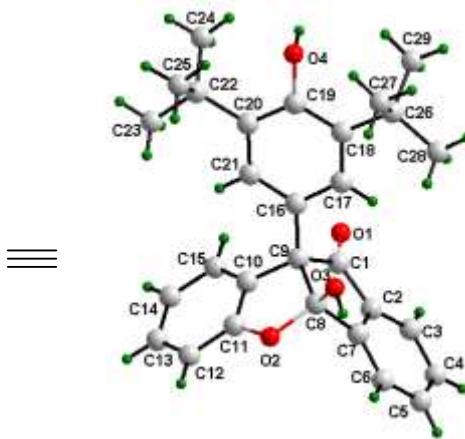
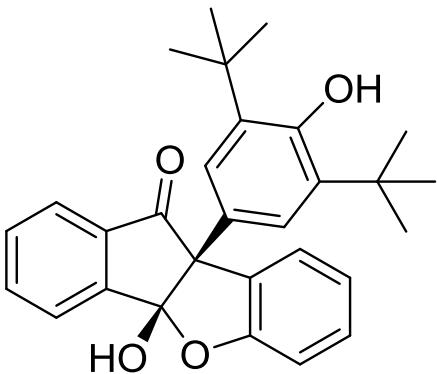


Figure S77.  $^{13}\text{C}$  NMR Spectrum of **6h**

**Table S1. Selected X-ray data of 3a**

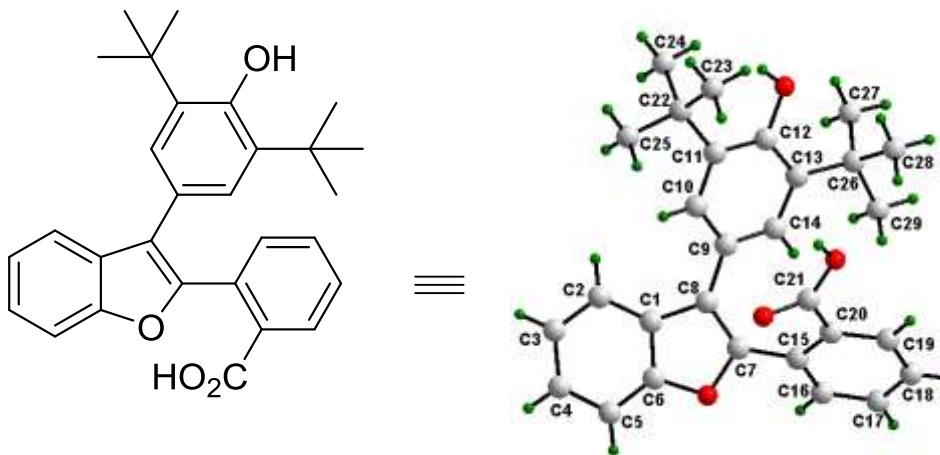


**CCDC 1994862**

Identification code	186-a_cifmo
Empirical formula	C <sub>29</sub> H <sub>30</sub> O <sub>4</sub>
Formula weight	442.53
Temperature/K	150(2)
Crystal system	monoclinic
Space group	P2 <sub>1</sub> /n
a/Å	12.1334(13)
b/Å	10.3500(11)
c/Å	18.7632(18)
α/°	90
β/°	95.327(10)
γ/°	90
Volume/Å <sup>3</sup>	2346.1(4)

Z	2
$\rho_{\text{calc}}$ g/cm <sup>3</sup>	1.253
$\mu/\text{mm}^{-1}$	0.082
F(000)	944.0
Crystal size/mm <sup>3</sup>	0.150 × 0.120 × 0.060
Radiation	MoK $\alpha$ ( $\lambda = 0.71073$ )
2 $\Theta$ range for data collection/ $^{\circ}$	4.36 to 50
Index ranges	-10 ≤ h ≤ 14, -8 ≤ k ≤ 12, -22 ≤ l ≤ 22
Reflections collected	7750
Independent reflections	4048 [ $R_{\text{int}} = 0.0894$ , $R_{\text{sigma}} = 0.1611$ ]
Data/restraints/parameters	4048/3/305
Goodness-of-fit on F <sup>2</sup>	1.006
Final R indexes [I>=2σ (I)]	$R_1 = 0.0691$ , $wR_2 = 0.1184$
Final R indexes [all data]	$R_1 = 0.1488$ , $wR_2 = 0.1630$
Largest diff. peak/hole / e Å <sup>-3</sup>	0.31/-0.34

**Table S2. Selected X-ray data of 4a**

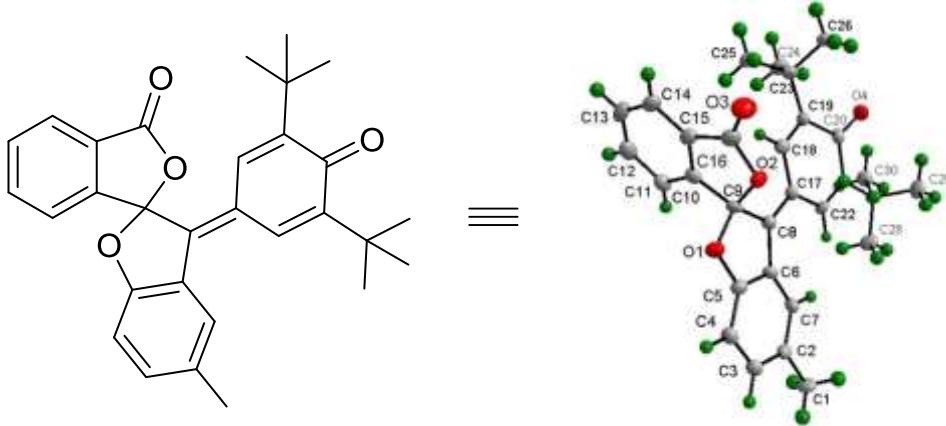


**CCDC 1994867**

Identification code	186-b_mo_cif
Empirical formula	C <sub>29</sub> H <sub>30</sub> O <sub>4</sub>
Formula weight	442.53
Temperature/K	150(2)
Crystal system	orthorhombic
Space group	Pbca
a/Å	19.9040(6)
b/Å	11.4024(4)
c/Å	21.6619(7)
α/°	90
β/°	90
γ/°	90
Volume/Å <sup>3</sup>	4916.2(3)
Z	8

$\rho_{\text{calc}}$ /cm <sup>3</sup>	1.196
$\mu/\text{mm}^{-1}$	0.078
F(000)	1888.0
Crystal size/mm <sup>3</sup>	0.200 × 0.150 × 0.120
Radiation	MoK $\alpha$ ( $\lambda = 0.71073$ )
2 $\Theta$ range for data collection/°	4.526 to 49.994
Index ranges	-23 ≤ h ≤ 23, -13 ≤ k ≤ 12, -25 ≤ l ≤ 25
Reflections collected	40196
Independent reflections	4323 [ $R_{\text{int}} = 0.0874$ , $R_{\text{sigma}} = 0.0496$ ]
Data/restraints/parameters	4323/0/305
Goodness-of-fit on F <sup>2</sup>	1.164
Final R indexes [I>=2σ (I)]	$R_1 = 0.0498$ , wR <sub>2</sub> = 0.1223
Final R indexes [all data]	$R_1 = 0.0628$ , wR <sub>2</sub> = 0.1309
Largest diff. peak/hole / e Å <sup>-3</sup>	0.37/-0.44

**Table S3. Selected X-ray data of 6d**



**CCDC 1994868**

Identification code	inn-pb-263_mo_sq
Empirical formula	C <sub>30</sub> H <sub>30</sub> O <sub>4</sub>
Formula weight	454.54
Temperature/K	150(2)
Crystal system	monoclinic
Space group	P2 <sub>1</sub> /n
a/Å	8.6480(7)
b/Å	17.1737(13)
c/Å	18.0840(17)
α/°	90
β/°	98.244(8)
γ/°	90
Volume/Å <sup>3</sup>	2658.0(4)

Z	4
$\rho_{\text{calc}}$ g/cm <sup>3</sup>	1.136
$\mu/\text{mm}^{-1}$	0.074
F(000)	968.0
Crystal size/mm <sup>3</sup>	0.200 × 0.150 × 0.120
Radiation	MoK $\alpha$ ( $\lambda = 0.71073$ )
2 $\Theta$ range for data collection/ $^{\circ}$	3.286 to 49.996
Index ranges	-7 ≤ h ≤ 10, -13 ≤ k ≤ 20, -21 ≤ l ≤ 21
Reflections collected	9515
Independent reflections	4596 [ $R_{\text{int}} = 0.0757$ , $R_{\text{sigma}} = 0.1219$ ]
Data/restraints/parameters	4596/0/314
Goodness-of-fit on F <sup>2</sup>	1.057
Final R indexes [I>=2σ (I)]	$R_1 = 0.0738$ , $wR_2 = 0.1989$
Final R indexes [all data]	$R_1 = 0.1276$ , $wR_2 = 0.2710$
Largest diff. peak/hole / e Å <sup>-3</sup>	0.39/-0.46