Silver Oxide Mediated Novel SET Oxidative Cyclization: Stereoselective Synthesis of 3-Azabicyclo[n.1.0]alkanes

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Supporting Information

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1.General Information :

General Methods: All the solvents were distilled prior to use. Dry solvents were prepared according to the standard procedures. All other reagents were used as received from either Aldrich or Lancaster chemical companies. Reactions requiring inert atmosphere were carried out under argon atmosphere. Infrared (IR) spectra were recorded on a JASCO 4100 FT-IR spectrometer. ^{1}H NMR spectra were measured on Bruker AVANCE 400 MHz and 500 MHz spectrometers. Chemical shifts were reported in ppm relative to solvent signals. ^{13}C NMR spectra were recorded on Bruker 100 MHz and 125 MHz spectrometers with complete proton decoupling. Chemical shifts were reported in ppm from the residual solvent as an internal standard. The high-resolution mass spectra (HRMS) were performed on Micromass QTOF micro mass spectrometer equipped with a Harvard apparatus syringe pump. X-ray crystallographic data were recorded using Bruker-AXS Kappa CCD-Diffractometer with graphite monochromator $Mo_{K\alpha}$ radiation (λ=0.7107 A). The structures were solved by direct methods (SHELXS-97) and refined by full-matrix least squares techniques against *F2* (SHELXL-97). Hydrogen atoms were inserted from geometry consideration using the HFIX option of the program. For thin layer chromatography (TLC) analysis throughout this work, E-merck precoated TLC plates (silica gel 60 F254 grade, 0.25 mm) were used. Acme (India) silica gel (100-200 mesh) was used for column chromatography.

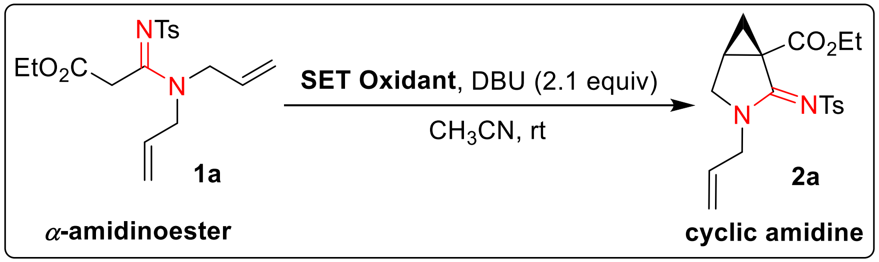
2. Optimization of reaction conditions:

2A. General procedure: To a stirred solution of α-amidinoester **1a** (1 equiv) in dry acetonitrile (3 mL/ mmol), were added DBU, I_2, SET oxidant and co-oxidant and reaction mixture was stirred at room temperature until the completion of reaction as indicated by TLC. The reaction mixture was diluted with saturated $Na_2S_2O_3$ (20 mL/ mmol) and extracted with DCM (2 X 30 mL/ mmol). The combined organic solvent was washed successively with water (2 X 20 mL) and brine solution (30 mL). The organic layers were collected, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product using column chromatography yielded the cyclic amidine **2a**.

2B. Screening of SET oxidants

The screening of SET oxidants were performed using general procedure **2A** and the results are summarized in Table **1**.

Table 1. Optimization of SET oxidant for synthesis of cyclic amidine



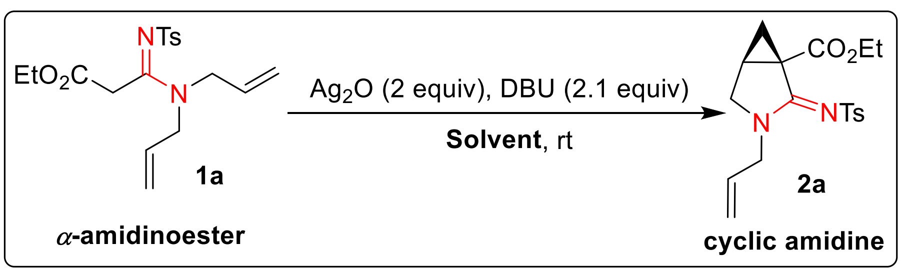
Entry	SET Oxidant (equiv)	Time (h)	Yield (%)[a]
1	**Ag_2O (2)**	**24**	**48**
2	CAN (2)	24	-
3	$Mn(OAc)_3$ (2)	24	5
4	$FeCl_3$ (2)	24	-
5	$Hg(OAc)_2$ (2)	24	5
6	$AgNO_3$ (2)	24	-
7	Ag_2CO_3 (2)	24	-
8	AgOAc (2)	24	-
9	$AgBF_4$ (2)	24	-
10	Ag_2O (3)	24	54

[a]Isolated yields.

2C. Screening of solvents

The screening of solvents were performed using general procedure **2A** and the results are summarized in Table **2**.

Table 2. Optimization of solvent system for synthesis of cyclic amidine



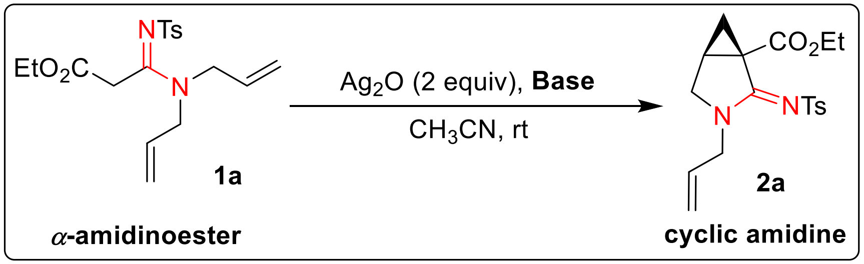
Entry	Solvent	Time (h)	Yield (%)[a]
1	THF	24	37
2	DCM	24	5
3	DCE	24	10
4	Et_2O	24	6
5	1,4-dioxane	24	5
6	toluene	24	-
7	DMSO	24	30
8	DMF	24	25
9	**CH_3CN**	**24**	**48**
10	CH_3CN : H_2O (1:1)	24	10
11	CH_3CN : DMF (1:1)	24	8
12	CH_3CN: DMSO (1:1)	24	35

[a]Isolated yields.

2D. Screening of base

The screening of base was performed using general procedure **2A** and the results are summarized in Table **3**.

Table 3. Optimization of base for synthesis of cyclic amidine



Entry	Base (equiv)	Time (h)	Yield (%)[a]
1	potassium carbonate (2.1)	24	35
2	2,2ˡ-bipyridine (2.1)	24	20
3	pyridine (2.1)	24	16
4	DABCO (2.1)	24	10
5	DMAP (2.1)	24	5
6	ethylenediamine (2.1)	24	21
7	2,6-lutidine (2.1)	24	-
8	N^1,N^1,N^2,N^2-tetramethylethane-1,2-diamine (2.1)	24	30
9	4,4ˡ-bipyridine (2.1)	24	20
10	triethylamine (2.1)	24	-
11	DBN (2.1)	24	28
12	DBU (2.1)	24	48
13	DBU (3)	24	57
14	**DBU (4)**	**24**	**69**

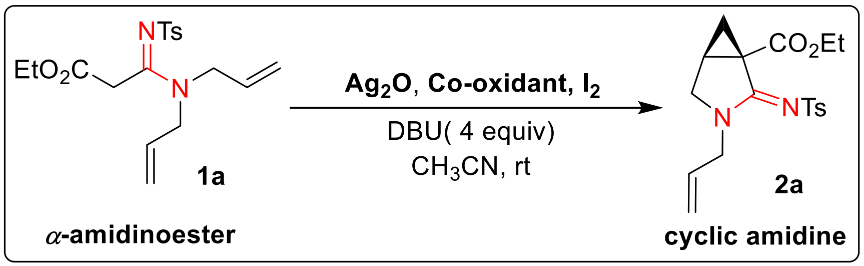
15	DBU (5)	24	58

[a]Isolated yields.

2E. Screening of SET oxidant, Co-oxidant and additive

The screening of equivalents of Ag_2O, co-oxidant and I_2 were performed using general procedure **2A** and the results are summarized in Table **4**.

Table 4. Optimization of equivalents of Ag_2O and co-oxidant for synthesis of cyclic amidine



Entry	Ag_2O (equiv)	Co-oxidant (equiv)	I_2 (equiv)	Time (h)	Yield (%)[a]
1	0.1	-	-	24	trace
2	0.1	$K_2S_2O_8$ (2.0)	-	24	14
3	0.1	$K_2S_2O_8$ (4.0)	-	24	34
4	0.1	$Na_2S_2O_8$ (4.0)	-	24	16
5	0.1	$(NH_4)_2S_2O_8$(4.0)	-	24	11
6	0.1	O_2	-	24	trace
7	0.2	$K_2S_2O_8$ (4.0)	-	24	58

8	0.3	$K_2S_2O_8$ (4.0)	-	24	72
9	0.4	$K_2S_2O_8$ (4.0)	-	24	67
10	0.3	$K_2S_2O_8$ (3.5)	-	24	61
11	0.3	$K_2S_2O_8$ (4.5)	-	24	68
12	0.3	$K_2S_2O_8$ (4.0)	0.6	18	75
13	**0.3**	**$K_2S_2O_8$ (4.0)**	**0.9**	**12**	**88**
14	0.3	$K_2S_2O_8$ (4.0)	1.2	18	78

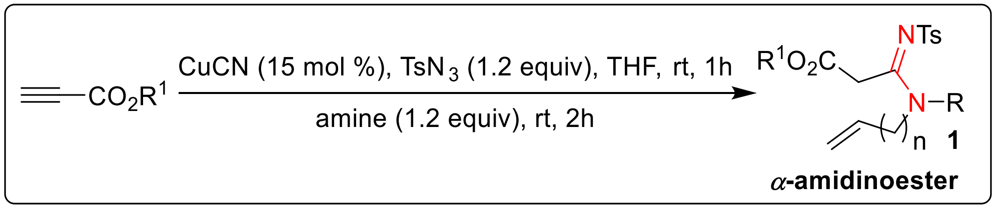
[a]Isolated yields.

3. Experimental procedures and spectral data of all compounds

3A. Preparation of starting materials

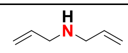
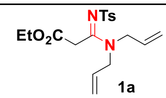
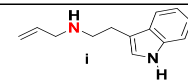
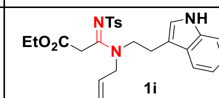
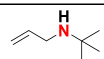
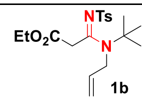
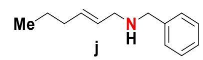
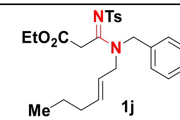
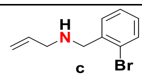
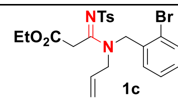
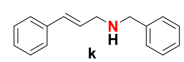
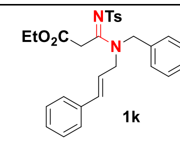
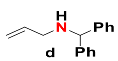
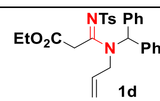
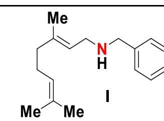
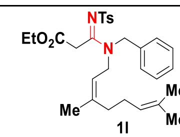
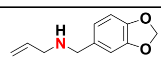
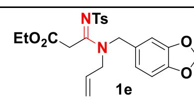
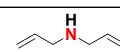
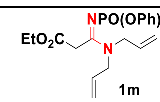
The amine derivatives **b**[1], **c**[2], **d**[2], **e**[2], **f**[3], **g**[4], **h**[5], **i**[6], **j**[7], **k**[8], **l**[9], **n**[10], **o**[10] and **p**[2] were prepared according to literature report (Table 5). The sulfonyl and phosphoryl azides were prepared using the reported procedure.[11]

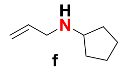
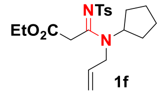
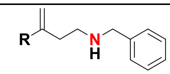
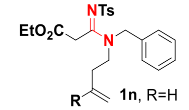
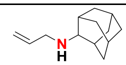
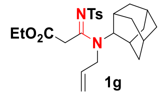
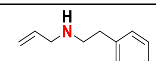
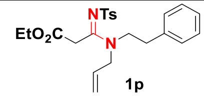
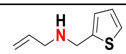
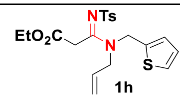
3B. General procedure for the preparation of *α*-amidinoester 1:

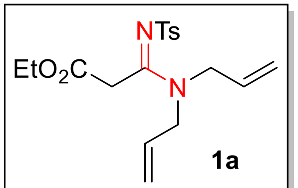


To a stirred solution of ethyl propiolate (1 equiv) in dry THF (3 mL/ mmol), was added CuCN (15 mol %) followed by TsN_3 (1.2 equiv) and the mixture was vigorously stirred at room temperature for 1h under N_2 atmosphere. To this reaction mixture, amine derivative (1.2 equiv) was added and the resultant mixture was stirred at room temperature until the completion of reaction as indicated by TLC. The reaction mixture was diluted with saturated NH_4Cl (20 mL) and extracted with dichloromethane (2 X 30 mL). The combined organic solvent was washed successively with water (2 X 20 mL) and brine solution (30 mL). The organic layers were collected, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product using column chromatography yielded the *α*-amidinoester **1** in quantitative yields.

Table 5. Preparation of *α*-amidinoesters:

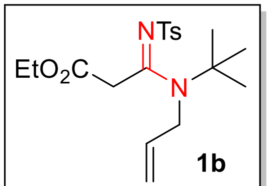
Entry	Amine	Time (h)	α-amidinoester	Isolated Yield (%)	Entry	Amine	Time (h)	α-amidinoester	Isolated Yield (%)
1	 a	2	 1a	94	9	 i	2	 1i	72
2	 b	2	 1b	81	10	 j	2	 1j	80
3	 c	2	 1c	80	11	 k	2	 1k	81
4	 d	2	 1d	81	12	 l	3	 1l	77
5	 e	2	 1e	82	13	 a	3	 1m	72

6	 f	2	 1f	86	14	 **n**, R=H **o**, R=CH_3	2	 **1n**, R=H **1o**, R=CH_3	76 80
7	 g	3	 1g	76	15	 p	2	 1p	81
8	 h	2	 1h	79					



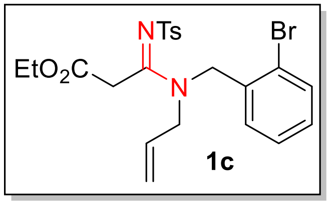
1a

Preparation of Compound 1a: The coupling reaction of ethyl propiolate (1 g, 10.19 mmol), tosyl azide (2.4 g, 12.23 mmol) and amine **a** (1.18 g, 12.23 mmol) was carried out using general procedure **3B**, the product **1a** obtained in 94% yield (3.48 g) as a colourless crystals; m.p 57-59 ^{o}C; **IR (neat):** 3073, 2982, 2934, 1737, 1599, 1564, 1471, 1425, 1328, 1148, 1092, 1035, 934, 829 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.76(d, *J* = 8.4 Hz, 2.01H), 7.21(d, *J* = 8.0 Hz, 2.03H), 5.79-5.67(m, 2.09H), 5.27-5.14(m, 4.26H), 4.15-4.09(m, 4.24H), 4.07(s, 2.12H), 3.91-3.89(m, 2.08H), 2.37(s, 3.04H), 1.23(t, *J* = 7.2 Hz, 3.07H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.7, 160.8, 142.1, 140.8, 131.4, 130.9, 129.1, 126.4, 118.2, 118.1, 62.0, 51.2, 50.7, 36.3, 21.5, 14.1**; HRMS(ESI):** m/z calcd for $C_{18}H_{25}N_2O_4S$ $[M+H]^+$: 365.1530, found: 365.1521.



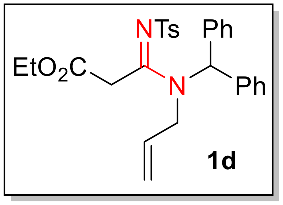
1b

Preparation of Compound 1b: The coupling reaction of ethyl propiolate (500 mg, 5.09 mmol), tosyl azide (1.2 g, 6.11 mmol) and amine **b** (691 mg, 6.11 mmol) was carried out using general procedure **3B**, the product **1b** obtained in 81% yield (1.56 g) as a yellow oil; **IR (neat):** 2969, 2924, 2857, 2361, 1732, 1642, 1577, 1457, 1277, 1157, 1086, 1020, 890 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.77(d, *J* = 8.0 Hz, 2.02H), 7.22(d, *J* = 8.0 Hz, 2.03H), 5.87-5.78(m, 1.04H), 5.27-5.15(m, 2.12H), 4.14(q, *J* = 7.2 Hz, 2.16H), 4.01-3.98(m, 3.90H), 2.36(s, 3.00H), 1.43(s, 9.07H), 1.24(t, J = 7.2 Hz, 3.28H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 167.5, 160.5, 141.9, 140.7, 134.4, 129.1, 126.2, 116.9, 61.7, 60.9, 48.4, 38.9, 28.4, 21.5, 14.0**; HRMS(ESI):** m/z calcd for $C_{19}H_{28}N_2O_4NaS$ $[M+Na]^+$: 403.1662, found: 403.1652.



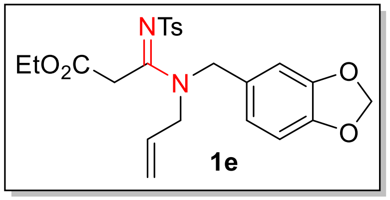
1c

Preparation of Compound 1c: The coupling reaction of ethyl propiolate (615 mg, 6.27 mmol), tosyl azide (1.48 g, 7.52 mmol) and amine **c** (1.7 g, 7.52 mmol) was carried out using general procedure **3B**, the product **1c** obtained in 80% yield (2.47 g) as a pale yellow semi solid; **IR (neat):** 3059, 2985, 2930, 1736, 1602, 1552, 1421, 1269, 1191, 1147, 1090, 1026, 959, 847 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.79-7.71(m, 0.41H), 7.59-7.54(m, 2.57H), 7.48-7.46(m, 1.10H), 7.34-7.05(m, 8.3H), 5.80-5.68(m, 1.53H), 5.28-5.24(m, 1.06H), 5.22-5.09(m, 2.27H), 4.79(s, 1.93H), 4.73(s, 0.22H), 4.53(s, 1.10H), 4.18-4.07(m, 6.40H), 4.02(s, 0.88H), 3.91-3.90(m, 2.18H), 3.84-3.82(m, 0.23H), 2.36(s, 1.98H), 2.31(s, 3.00H), 1.26-1.18(m, 4.46H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 166.4, 161.3, 161.2, 159.6, 142.1, 142.0, 140.5, 140.3, 134.4, 133.8, 133.6, 133.3, 132.6, 131.2, 130.9, 130.4, 130.3, 129.8, 129.7, 129.3, 129.0, 128.9, 128.9, 128.8, 128.8, 128.2, 128.1, 127.9, 127.7, 127.1, 126.5, 126.4, 126.3, 126.2, 123.0, 122.5, 118.4, 118.3, 62.0, 61.9, 52.0, 51.9, 51.6, 51.2, 36.4, 36.2, 21.4, 21.3, 14.0, 13.9**; HRMS(ESI):** m/z calcd for $C_{22}H_{26}BrN_2O_4S$ $[M+H]^+$: 493.0797, found: 493.0773.

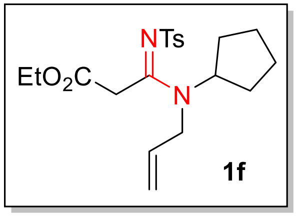


1d

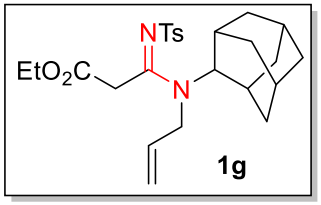
Preparation of Compound 1d: The coupling reaction of ethyl propiolate (1.03 g, 10.49 mmol), tosyl azide (2.4 g, 12.28 mmol) and amine **d** (2.74 g, 12.28 mmol) was carried out using general procedure **3B**, the product **1d** obtained in 81% yield (4.17 g) as a pale yellow semi solid; **IR (neat):** 3059, 2986, 2873, 2360, 2338, 1961, 1909, 1736, 1598, 1539, 1450, 1419, 1327, 1271, 1150, 1088, 1028, 965, 860 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.72-7.70(m, 0.34H), 7.52-7.46(m, 2.60H), 7.41-7.39(m, 1.09H), 7.24-7.229(m, 1.71H), 7.226-7.08(m, 3.84H), 5.73-5.58(m, 1.58H), 5.21-5.06(m, 3.44H), 4.72(s, 1.99H), 4.66(s, 0.168H), 4.47-4.45(m, 1.05H), 4.13-4.00(m, 6.16H), 3.95(s, 0.87H), 3.85-3.84(m, 2.17H), 3.77-3.75(m, 0.16H), 2.29(s, 1.86H), 2.24(s, 3.00H), 1.19-1.11(m, 4.76H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 167.5, 167.0, 162.0, 160.7, 159.1, 142.0, 141.8, 140.6, 137.8, 137.8, 137.6, 137.1, 132.7, 131.3, 130.9, 129.2, 129.2, 129.0, 129.0, 128.9, 128.8, 128.6, 128.5, 128.5, 127.9, 126.4, 126.2, 117.8, 117.1, 65.9, 64.4, 62.0, 61.9, 60.3, 50.1, 50.0, 49.0, 37.2, 36.8, 21.4, 21.4, 21.0, 14.2, 14.1**; HRMS(ESI):** m/z calcd for $C_{28}H_{31}N_2O_4S$ $[M+H]^+$: 491.2005, found: 491.2026.



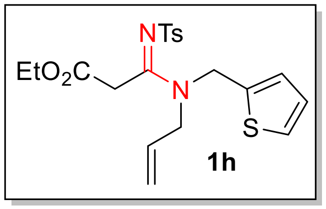
Preparation of Compound 1e: The coupling reaction of ethyl propiolate (630 mg, 6.42 mmol), tosyl azide (1.52 g, 7.71 mmol) and amine **e** (1.47 g, 7.71 mmol) was carried out using general procedure **3B**, the product **1e** obtained in 82% yield (2.41 g) as a yellow semi solid; **IR (neat):** 3059, 2984, 2928, 2362, 1736, 1642, 1601, 1551, 1493, 1444, 1370, 1327, 1278, 1145, 1090, 1036, 930, 842 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.79-7.71(m, 2.29H), 7.23-7.18(m, 2.062H), 6.76-6.71(m, 1.04H), 6.66-6.59(m, 2.23H), 5.92-5.88(m, 2.17H), 5.77-5.70(m, 1.06H), 5.47(s, 0.11H), 5.27-5.13(m, 2.19H), 4.66(s, 1.32H), 4.51-4.36(m, 0.79H), 4.13-4.08(m, 4.47H), 3.94-3.82(m, 1.32H), 2.36(s, 3.37H), 1.22-1.18(m, 3.00H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.2, 166.1, 160,8, 160.6, 148.1, 147.6, 147.3, 146.8, 141.8, 140.4, 140.3, 130.9, 130.3, 129.1, 129.0, 129.0, 128.7, 128.1, 125.9, 120.9, 119.6, 117.8, 117.7, 108.3, 107.9, 107.7, 106.7, 101.1, 100.7, 61.6, 51.0, 50.8, 50.6, 50.1, 36.1, 35.8, 21.1, 13.6**; HRMS(ESI):** m/z calcd for $C_{23}H_{27}N_2O_6S$ $[M+H]^+$: 459.1590, found: 459.1565.



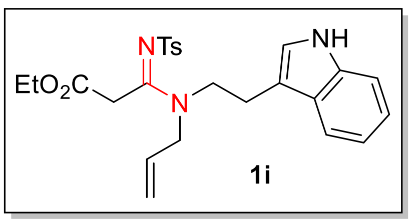
Preparation of Compound 1f: The coupling reaction of ethyl propiolate (1.3 g, 13.33 mmol), tosyl azide (3.13 g, 15.9 mmol) and amine **f** (2 g, 15.9 mmol) was carried out using general procedure **3B**, the product **1f** obtained in 86% yield (4.46 g) as a greenish yellow oil; **IR (neat):** 2962, 2918, 2868, 1737, 1643, 1539, 1455, 1423, 1323, 1275, 1197, 1145, 1090, 1024, 974, 813 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.73-7.67(m, 2.10H), 7.17-7.13(m, 2.01H), 5.77-5.67(m, 1.04H), 5.18-4.80(m, 2.34H), 4.16-4.06(m, 0.96H), 4.06-3.97(m, 2.80H), 3.95-3.94(m, 2.13H), 3.798-3.795(m, 0.98H), 2.31-2.29(m, 3.25H), 1.78-1.76(m, 2.08H), 1.57-1.42(m, 6.32H), 1.19-1.11(m, 3.12H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.8, 166.7, 161.5, 159.6, 141.9, 141.8, 140.9, 140.8, 133.2, 132.7, 129.0, 128.9, 126.3, 126.2, 117.2, 116.4, 61.8, 61.7, 59.9, 58.8, 46.9, 46.7, 37.0, 36.4, 29.8, 28.8, 23.9, 23.9, 21.4, 14.0, 13.9**; HRMS(ESI):** m/z calcd for $C_{20}H_{29}N_2O_4S$ $[M+H]^+$: 393.1848, found: 393.1863.



Preparation of Compound 1g: The coupling reaction of ethyl propiolate (623 mg, 6.35 mmol), tosyl azide (1.5 g, 7.62 mmol) and amine **g** (1.45 g, 7.62 mmol) was carried out using general procedure **3B**, the product **1g** obtained in 76% yield (2.21 g) as a pale yellow semi solid; **IR (neat):** 3059, 2980, 2911, 2856, 2661, 1738, 1643, 1600, 1536, 1452, 1415, 1323, 1278, 1145, 1090, 1029, 966, 916, 845, 814 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.63(d, *J* = 8.0 Hz, 2.0H), 7.07(d, *J* = 8.0 Hz, 2.03H), 5.76-5.69(m, 0.88H), 5.08(d, *J* = 10.4 Hz, 0.82H), 4.98(d, *J* = 17.2 Hz, 1.09H), 4.26(s, 1.11H), 4.07-3.96(m, 5.86H), 2.21(s, 3.07H), 2.0-1.91(m, 2.23H), 1.72-1.68(m, 4.06H), 1.62-1.44(m, 8.16H), 1.08(t, *J* = 7.2 Hz, 3.06H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.5, 160.7, 141.4, 140.4, 134.0, 128.4, 125.7, 116.4, 62.4, 61.2, 46.8, 38.2, 37.2, 36.8, 32.0, 30.0, 27.0, 26.2, 20.9, 13.5**; HRMS(ESI):** m/z calcd for $C_{25}H_{35}N_2O_4S$ $[M+H]^+$: 459.2318, found: 459.2315.

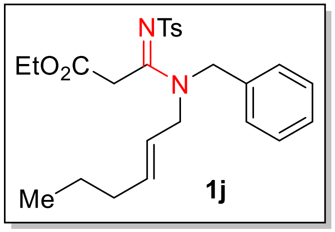


Preparation of Compound 1h: The coupling reaction of ethyl propiolate (842 mg, 8.58 mmol), tosyl azide (2.03 g, 10.3 mmol) and amine **h** (1.5 g, 10.3 mmol) was carried out using general procedure **3B**, the product **1h** obtained in 79% yield (2.85 mg) as a brown semi solid; **IR (neat):** 3065, 2983, 2927, 2873, 2361, 2337, 1737, 1600, 1551, 1457, 1425, 1327, 1278, 1184, 1145, 1088, 1026, 969, 844 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.82-7.76(m, 2.75H), 7.23-7.17(m, 4.15H), 6.94(s, 1.66H), 6.85(s, 1.01H), 5.78-5.71(m, 1.35H), 5.25-5.14(m, 2.69H), 4.82(s, 1.81H), 4.73-4.62(m, 0.64H), 4.21-4.14(m, 1.37H), 4.12-4.05(m, 4.57H), 3.94(s, 1.98H), 2.36(s, 4.14H), 1.21(t, *J* = 6.8 Hz, 0.97H), 1.16(t, *J* = 6.8 Hz, 3.00H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 165.9, 165.8, 160.2, 160.1, 141.7, 140.2, 140.1, 137.1, 136.8, 130.9, 130.1, 128.6, 127.1, 126.8, 126.2, 126.0, 125.9, 125.8, 125.7, 125.6, 117.8, 117.7, 61.4, 61.3, 50.3, 50.1, 46.6, 46.1, 35.9, 35.7, 20.9, 13.5, 13.5**; HRMS(ESI):** m/z calcd for $C_{20}H_{25}N_2O_4S_2$ $[M+H]^+$: 421.1256, found: 421.1259.



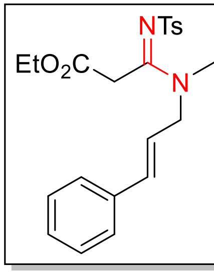
Preparation of Compound 1i: The coupling reaction of ethyl propiolate (244 mg, 2.49 mmol), tosyl azide (589 mg, 2.98 mmol) and amine **i** (598 mg, 2.98 mmol) was carried out using general procedure **3B**, the product **1i** obtained in 72% yield (823 mg) as a brown semi solid; **IR (neat):**

3369, 2921, 2856, 2362, 2339, 1734, 1599, 1551, 1457, 1427, 1328, 1270, 1192, 1141, 1087, 1021, 849, 813, 747 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 8.42(s, 0.56H), 8.32(s, 0.97H), 7.73(d, *J* = 8.0 Hz, 2.00H), 7.67(d, *J* = 8.4 Hz, 1.15H), 7.37(d, *J* = 7.6 Hz, 0.63H), 7.28-7.23(m, 2.68H), 7.16-7.10(m, 3.45H), 7.08-6.99(m, 2.48H), 6.89-6.83(m, 2.60H), 5.70-5.52(m, 1.62H), 5.13-5.04(m, 1.97H), 5.00-4.96(m, 1.32H), 4.10-4.04(m, 3.26H), 4.00(s, 1.69H), 3.99-3.93(m, 1.56H), 3.75(s, 1.16H), 3.69(d, *J* = 4.8 Hz, 2.03H), 3.59(t, *J* = 7.2 Hz, 2.07H), 3.46(t, *J* = 7.2 Hz, 1.16H), 2.93-2.88(m, 3.20H), 2.296-2.29(m, 4.89H), 1.17(t, *J* = 6.8 Hz, 3.11H), 1.08(t, *J* = 7.2 Hz, 1.67H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.7, 160.5, 160.3, 142.2, 142.1, 140.8, 140.7, 136.3, 136.3, 131.3, 131.0, 129.2, 129.1, 127.1, 126.6, 126.4, 126.3, 122.8, 122.7, 122.3, 121.9, 119.6, 119.2, 118.6, 118.0, 117.9, 117.8, 111.9, 111.8, 111.3, 110.6, 61.9, 61.8, 52.3, 51.2, 50.7, 49.2, 36.5, 35.8, 24.4, 22.4, 21.5, 21.5, 14.1, 13.9. **HRMS(ESI):** m/z calcd for $C_{25}H_{30}N_3O_4S$ $[M+H]^+$: 468.1957, found: 468.1958.



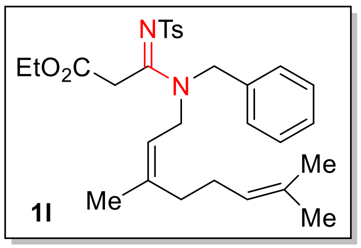
1j

Preparation of Compound 1j: The coupling reaction of ethyl propiolate (774 mg, 7.9 mmol), tosyl azide (1.86 g, 9.48 mmol) and amine **j** (1.79 g, 9.48 mmol) was carried out using general procedure **3B**, the product **1j** obtained in 80% yield (2.9 g) as a pale yellow semi solid; **IR (neat):** 3058, 2959, 2927, 2871, 2363, 2342, 1739, 1642, 1634, 1604, 1550, 1493, 1454, 1425, 1365, 1326, 1276, 1195, 1144, 1089, 1024, 971, 848 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.84(d, *J* = 8.4 Hz, 0.79H), 7.70(d, *J* = 8.4 Hz, 1.91H), 7.36-7.30(m, 1.39H), 7.30-7.25(m, 5.97H), 7.17(d, *J* = 8.0 Hz, 2.93H), 5.63-5.53(m, 1.34H), 5.41-5.33(m, 1.34H), 4.78(s, 1.92H), 4.57(s, 0.79H), 4.21(s, 1.94H), 4.16-4.11(m, 4.61H), 3.87(d, *J* = 4.8 Hz, 1.83H), 2.39(s, 1.35H), 2.35(s, 3.0H), 2.05-2.00(m, 2.16H), 1.95(q, *J* = 6.8 Hz, 0.81H), 1.44-1.29(m, 3.05), 1.27-1.20(m, 4.57H), 0.92-0.85(m, 4.43H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.1, 166.1, 160.7, 160.4, 141.6, 141.5, 140.5, 140.3, 135.3, 134.9, 134.8, 134.5, 128.7, 128.6, 128.6, 128.1, 127.7, 127.2, 127.0, 126.0, 125.9, 125.9, 122.4, 122.0, 61.4, 61.4, 50.9, 50.8, 50.5, 50.0, 36.1, 35.8, 33.8, 33.7, 21.7, 21.6, 21.0, 21.0, 13.6, 13.3**;** **HRMS(ESI):** m/z calcd for $C_{25}H_{32}N_2O_4NaS$ $[M+Na]^+$: 479.1980, found: 479.1993.



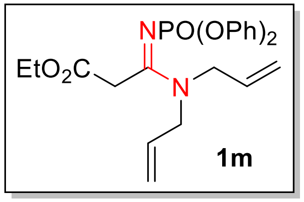
1k

Preparation of Compound 1k: The coupling reaction of ethyl propiolate (765 mg, 7.8 mmol), tosyl azide (1.84 g, 9.36 mmol) and amine **k** (2.08 g, 9.36 mmol) was carried out using general procedure **3B**, the product **1k** obtained in 81% yield (3.1 g) as a yellow semi solid; **IR (neat):** 3056, 2986, 2932, 2685, 2522, 2411, 2362, 2306, 1736, 1644, 1551, 1493, 1451, 1425, 1365, 1327, 1267, 1144, 1090, 1024, 970 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.76(d, J = 8.0 Hz, 1.30H), 7.66(d, J = 8.4 Hz, 2.11H), 7.32-7.07(m, 21.53H), 6.39(s, 0.73H), 6.359-6.356(m, 0.90H), 6.02-5.98(m, 0.92H), 5.98-5.95(m, 0.77H), 4.77(s, 1.99H), 4.53(s, 1.21H), 4.21-4.18(m, 3.27H), 4.11(s, 1.24H), 4.08-4.0(m, 5.60H), 2.27(s, 3.0H), 2.26(s, 1.90H), 1.16-1.11(m, 5.16H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.5, 160.9, 160.6, 141.8, 141.7, 140.4, 140.3, 136.0, 135.3, 134.4, 133.0, 132.8, 128.9, 128.8, 128.7, 128.4, 128.4, 128.3, 128.2, 128.0, 127.9, 127.5, 127.4, 127.3, 126.2, 126.2, 126.1, 126.0, 122.0, 121.8, 61.6, 61.6, 51.5, 51.2, 50.7, 50.3, 36.1, 36.0, 21.1, 13.7, 13.7**; HRMS(ESI):** m/z calcd for $C_{28}H_{31}N_2O_4S$ $[M+H]^+$: 491.2005, found: 491.1988.



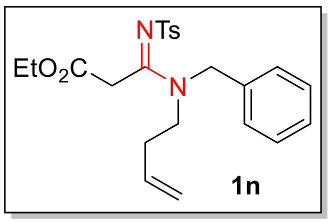
1l

Preparation of Compound 1l: The coupling reaction of ethyl propiolate (100 mg, 1.1 mmol), tosyl azide (241 mg, 1.22 mmol) and amine **l** (297 mg, 1.22 mmol) was carried out using general procedure **3B**, the product **1l** obtained in 77% yield (403 mg) as a pale yellow semi solid; **IR (neat):** 2922, 2850, 2798, 2367, 2339, 1735, 1648, 1547, 1491, 1453, 1428, 1364, 1276, 1145, 1090, 1023, 855, 813 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.83(d, J = 8.0 Hz, 0.765H), 7.72(d, J = 8.4 Hz, 2.062H), 7.38-7.29(m, 1.236H), 7.27-7.21(m, 6.315H), 7.18-7.14(m, 2.955H), 5.13(t, J = 6.8 Hz, 0.398H), 5.07-5.04(m, 2.471H), 4.76(s, 1.927H), 4.52(s, 0.738H), 4.20(s, 1.916H), 4.18-4.08(m, 4.541H), 3.86(d, J = 6.0 Hz, 1.950H), 2.38(s, 1.315H), 2.35(s, 3.0H), 2.08-1.95(m, 6.353H), 1.69-1.65 (m, 4.207H), 1.61-1.59 (m, 4.773H), 1.55-1.52(m, 2.925H), 1.45(s, 1.197H), 1.25-1.20(m, 4.267H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.4, 160.7, 160.5, 141.8, 141.8, 141.3, 141.0, 140.8, 140.6, 135.5, 134.8, 131.9, 131.5, 128.9, 128.9, 128.8, 128.4, 128.0, 127.6, 127.4, 126.3, 126.2, 126.2, 123.7, 123.3, 117.7, 117.4, 61.7, 61.6, 51.2, 51.2, 46.6, 46.5, 39.3, 39.2, 36.4, 36.1, 26.1, 25.9, 25.6, 25.6, 21.3, 17.6, 17.6, 16.1, 13.9, 13.8**; HRMS(ESI):** m/z calcd for $C_{29}H_{39}N_2O_4S$ $[M+H]^+$: 511.2631, found: 511.2642.



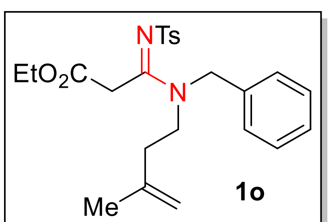
1m

Preparation of Compound 1m: The coupling reaction of ethyl propiolate (300 mg, 3.05 mmol), phosphoryl azide (721 mg, 3.66 mmol) and amine **a** (355 mg, 3.66 mmol) was carried out using general procedure **3B**, the product **1m** obtained in 72% yield (973 mg) as a yellow semi solid; **IR (neat):** 3057, 2984, 2933, 2363, 2313, 1735, 1581, 1488, 1421, 1327, 1259, 1201, 1060, 997, 929, 740 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.28-7.19(m, 8.24H), 7.10-7.06(m, 1.95H), 5.75-5.66(m, 1.02H), 5.59-5.49(m, 1.00H), 5.20(dd, *J* = 10.4 Hz, *J* = 0.8 Hz, 1.01H), 5.12-5.03(m, 3.08H), 4.10(q, *J* = 7.2 Hz, 2.12H), 4.02(s, 2.00H), 3.95(d, *J* = 5.2 Hz, 1.99H), 3.87-3.85(m, 1.99H), 1.17(t, *J* = 7.2 Hz, 3.04H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 167.1, 162.5, 162.4, 151.6, 151.6, 131.4, 131.0, 129.2, 124.2, 120.6, 120.6, 117.6, 117.5, 61.7, 50.5, 50.4, 38.5, 38.4, 13.9**; HRMS(ESI):** m/z calcd for $C_{23}H_{28}N_2O_5P$ [M+H]$^+$: 443.1730, found: 443.1725.



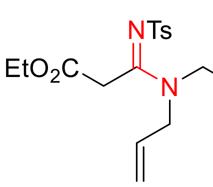
1n

Preparation of Compound 1n: The coupling reaction of ethyl propiolate (1.26 g, 12.91 mmol), tosyl azide (3.06 g, 15.46 mmol) and amine **n** (2.5 g, 15.5 mmol) was carried out using general procedure **3B**, the product **1n** obtained in 76% yield (4.1 g) as a pale yellow oil; **IR (neat):** 3056, 2982, 1736, 1558, 1448, 1282, 1158, 1089, 1027, 1158, 1089, 1027, 961, 855 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.70-7.58(m, 1.16H), 7.52(d, *J* = 8.0 Hz, 1.04H), 7.24-7.17(m, 1.36H), 7.11-7.06(m, 4.18H), 7.01(d, *J* = 7.6 Hz, 2.07H), 5.62-5.44(m, 1.00H), 4.98-4.92(m, 1.00H), 4.87-4.76(m, 1.06H), 4.66(s, 1.00H), 4.50-4.40(m, 1.08H), 4.07(s, 1.00H), 4.02-3.95(m, 3.01H), 3.42(t, *J* = 7.2 Hz, 0.87H), 3.28-3.16(m, 1.14H), 2.29-2.10(m, 5.13H), 1.08(t, *J* = 7.2 Hz, 3.03H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 166.2, 160.4, 160.3, 141.8, 141.6, 140.5, 140.3, 135.4, 134.5, 134.2, 133.0, 128.8, 128.8, 128.6, 128.3, 127.9, 127.2, 127.1, 126.1, 125.9, 118.2, 117.0, 61.6, 61.5, 52.6, 51.0, 49.0, 47.8, 36.1, 35.9, 32.1, 30.6, 21.1, 21.1, 13.7**; HRMS(ESI):** m/z calcd for $C_{23}H_{29}N_2O_4S$ [M+H]$^+$: 429.1848, found: 429.1849.



1o

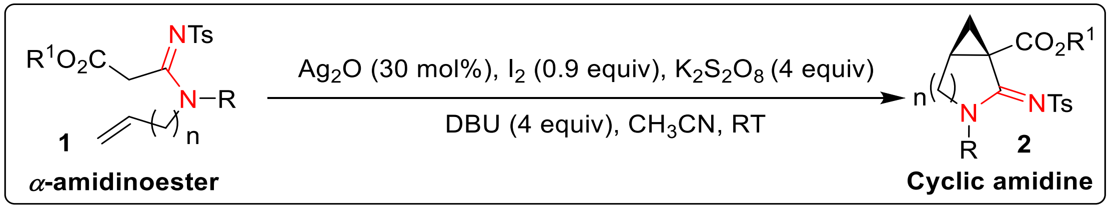
Preparation of Compound 1o: The coupling reaction of ethyl propiolate (864 mg, 8.8 mmol), tosyl azide (2.08 g, 10.56 mmol) and amine **o** (1.85 g, 10.56 mmol) was carried out using general procedure **3B**, the product **1o** obtained in 80% yield (3.11 g) as a colourless semi solid; **IR (neat):** 3059, 2983, 2935, 2362, 2308, 1736, 1648, 1601, 1553, 1487, 1450, 1367, 1326, 1269, 1148, 1089, 1027, 962, 865, 816, 737 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.72(d, *J* = 8.0 Hz, 1.05H), 7.55(d, *J* = 8.0 Hz, 0.98H), 7.26-7.19(m, 1.73H), 7.137-7.13(m, 3.72H), 7.04(brs, 2.11H), 4.69-4.68(m, 1.48H), 4.58(d, *J* = 6.8 Hz, 1.03H), 4.48-4.45(m, 1.59H), 4.08-4.00(m, 4.12H), 3.46(t, *J* = 7.6 Hz, 1.04H), 3.27(t, *J* = 7.6 Hz, 1.00H), 2.26-2.23(m, 3.23H), 2.17-2.11(m, 2.14H), 1.59(s, 1.47H), 1.47(s, 1.62H), 1.14-1.09(m, 3.16H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.2, 166.2, 160.3, 160.0, 141.8, 141.8, 141.6, 140.7, 140.5, 140.3, 135.4, 134.5, 128.8, 128.7, 128.7, 128.3, 127.9, 127.2, 126.1, 126.0, 112.9, 112.0, 61.6, 61.5, 52.3, 51.1, 48.2, 47.0, 36.2, 35.8, 35.8, 34.0, 22.2, 21.9, 21.1, 21.1, 13.7**; HRMS(ESI):** m/z calcd for $C_{24}H_{31}N_2O_4S$ $[M+H]^+$: 443.1999, found: 443.1988.



1p

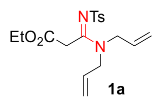
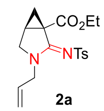
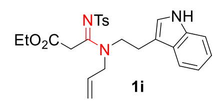
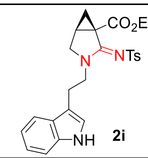
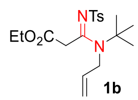
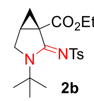
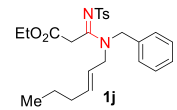
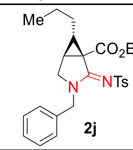
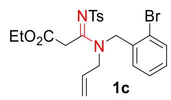
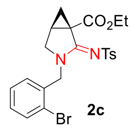
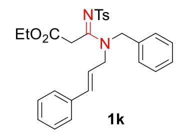
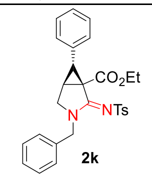
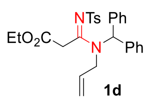
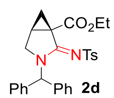
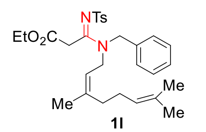
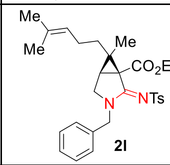
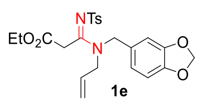
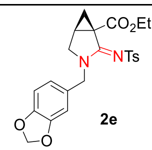
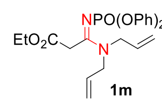
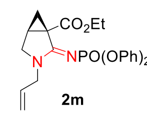
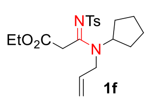
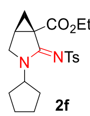
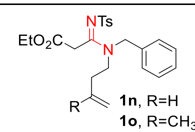
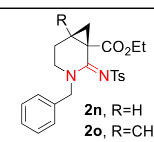
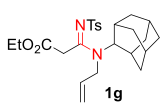
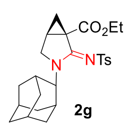
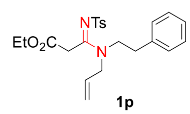
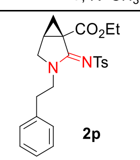
Preparation of Compound 1p: The coupling reaction of ethyl propiolate (754 mg, 7.69 mmol), tosyl azide (1.81 g, 9.22 mmol) and amine **p** (1.48 g, 9.22 mmol) was carried out using general procedure **3B**, the product **1p** obtained in 81% yield (2.66 g) as a yellow semi solid; **IR (neat):** 3056, 2986, 2935, 2362, 2315, 1736, 1638, 1608, 1553, 1487, 1427, 1324, 1267, 1191, 1149, 1090, 1025, 964, 890, 817, 741 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.82(d, *J* = 8.0 Hz, 1.91H), 7.70(d, *J* = 8.0 Hz, 1.01H), 7.21-7.12(m, 7.63H), 7.06(d, *J* = 7.2 Hz, 1.13H), 7.01(d, *J* = 7.2 Hz, 2.14H), 5.73-5.60(m, 1.46H), 5.20-5.03(m, 3.01H), 4.13-4.08(m, 3.17H), 4.05-4.00(m, 2.76H), 3.76-3.75(m, 2.76H), 3.56(t, *J* = 7.2 Hz, 1.96H), 3.45(t, *J* = 7.2 Hz, 0.96H), 2.81-2.76(m, 2.91H), 2.32-2.30(m, 4.40H), 1.20(t, *J* = 7.2 Hz, 3.0H), 1.14(t, *J* = 7.2 Hz, 1.59H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.2, 166.1, 160.1, 159.8, 141.7, 141.6, 140.5, 140.4, 138.0, 136.9, 131.1, 130.6, 128.7, 128.6, 128.5, 128.4, 128.3, 128.1, 126.6, 126.1, 125.9, 117.4, 117.4, 61.4, 51.9, 51.3, 50.6, 49.8, 35.9, 35.2, 34.1, 32.4, 21.0, 21.0, 13.6, 13.5**; HRMS(ESI):** m/z calcd for $C_{23}H_{29}N_2O_4S$ $[M+H]^+$: 429.1848, found: 429.1859.

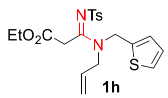
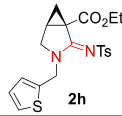
3C. General procedure for the preparation of cyclic amidine 2 from α-amidinoester 1:



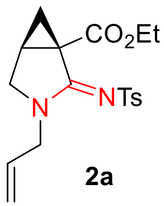
To a stirred solution of *α*-amidinoester **1** (1 equiv) in dry acetonitrile (3 mL/ mmol), were added DBU (4.0 equiv), Ag_2O (30 mol%), I_2 (0.9 equiv) and $K_2S_2O_8$ (4 equiv) and reaction mixture was stirred at room temperature until the completion of reaction as indicated by TLC. The reaction mixture was diluted with saturated $Na_2S_2O_3$ (20 mL/ mmol) and extracted with DCM (2 X 30 mL/ mmol). The combined organic solvent was washed successively with water (2 X 20 mL) and brine solution (30 mL). The organic layers were collected, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product using column chromatography yielded the cyclic amidine **2**.

Table S1. Substrate scope for silver(I)-catalyzed synthesis of cyclic amidines

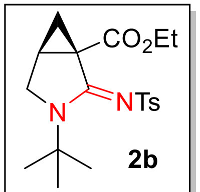
Entry	α-Amidinoester	Time (h)	Product	Yield (%)[a]	Entry	α-Amidinoester	Time (h)	Product	Yield (%)[a]
1	 1a	12	 2a	88	9	 1i	12	 2i	80
2	 1b	12	 2b	76	10	 1j	12	 2j	74
3	 1c	12	 2c	88	11	 1k	13	 2k	84
4	 1d	12	 2d	83	12	 1l	12	 2l	63
5	 1e	14	 2e	82	13	 1m	12	 2m	54
6	 1f	12	 2f	88	14	 1n, R=H 1o, R=CH_3	13 13	 2n, R=H 2o, R=CH_3	82[b] 73[b]
7	 1g	14	 2g	87	15	 1p	14	 2p	84

8	 1h	14	 2h	76					

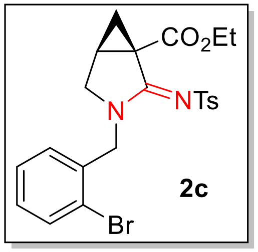
[a]Isolated Yield. [b]Yield based on recovered starting material.


2a

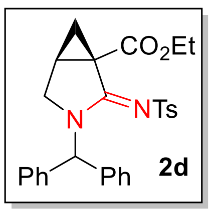
Preparation of Compound 2a: The reaction of *α*-amidinoester **1a** (128 mg, 0.35 mmol), DBU (213 mg, 1.4 mmol), I_2 (80 mg, 0.31 mmol), Ag_2O (24 mg, 0.1 mmol) and $K_2S_2O_8$ (378 mg, 1.4 mmol) was carried out using general procedure **3C**, the product **2a** obtained in 88% yield (111 mg) as a pale yellow crystals; m.p 62-64 ^{o}C; **IR (neat):** 3057, 2976, 2931, 2870, 1728, 1571, 1485, 1294, 1192, 1147, 1081 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.75(d, *J* = 8.0 Hz, 2H), 7.20(d, *J* = 8.0 Hz, 2H), 5.60-5.50(m, 1H), 5.13-5.03(m, 2H), 4.29-4.14(m, 2H), 3.99-3.94(m, 1H), 3.85-3.79(m, 1H), 3.70(dd, *J* = 11.6 Hz, 4.4 Hz, 1H), 3.29(d, *J* = 11.6 Hz, 1H), 2.36(s, 3H), 2.23(brs, 2H), 1.27(t, *J* = 7.2 Hz, 3H), 0.91(t, *J* = 10 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.7, 164.2, 141.8, 141.2, 130.7, 129.0, 126.1, 119.4, 62.1, 49.6, 47.4, 34.9, 24.5, 21.5, 19.0, 13.9. **HRMS(ESI):** m/z calcd for $C_{18}H_{22}N_2O_4NaS$ $[M+Na]^+$: 385.1198, found: 385.1193.


2b

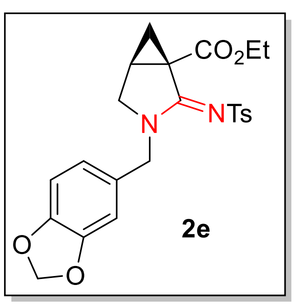
Preparation of Compound 2b: The reaction of *α*-amidinoester **1b** (600 mg, 1.57 mmol), DBU (957 mg, 6.28 mmol), I_2 (358 mg, 1.41 mmol), Ag_2O (109 mg, 0.47 mmol) and $K_2S_2O_8$ (1.69 g, 6.28 mmol) was carried out using general procedure **3C**, the product **2b** obtained in 76% yield (454 mg) as a pale yellow crystals; m.p 106-108 ^{o}C; **IR (neat):** 2978, 2926, 1730, 1565, 1459, 1381, 1286, 1179, 1149, 1088, 1017, 965, 910, 860 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.71(d, *J* = 8.0 Hz, 2H), 7.18(d, *J* = 7.6 Hz, 2H), 4.25-4.09(m, 2H), 3.77(dd, *J* = 12.0 Hz, 6.0 Hz, 1H), 3.44(d, *J* = 12.0 Hz, 1H), 2.33(s, 3H), 2.17-2.08(m, 2H), 1.26(s, 9H), 1.24(t, *J* = 7.2 Hz, 3H), 0.79(t, *J* = 4.4 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.9, 163.5, 141.5, 141.3, 129.0, 125.9, 61.8, 56.7, 48.7, 35.8, 27.4, 23.5, 21.4, 18.2, 13.8; **HRMS(ESI):** m/z calcd for $C_{19}H_{26}N_2O_4NaS$ $[M+Na]^+$: 401.1511, found: 401.1500.



Preparation of Compound 2c: The reaction of *α*-amidinoester **1c** (520 mg, 1.05 mmol), DBU (639 mg, 4.2 mmol), I_2 (240 mg, 0.94 mmol), Ag_2O (73 mg, 0.31 mmol) and $K_2S_2O_8$ (1.13 g, 4.2 mmol) was carried out using general procedure **3C**, the product **2c** obtained in 88% yield (457 mg) as a pale yellow semisolid; **IR (neat):** 3060, 2982, 2930, 2875, 2362, 2338, 1732, 1488, 1442, 1383, 1289, 1184, 1147, 1090, 1025, 903, 855 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.76(d, *J* = 8.0 Hz, 2H), 7.45-7.42(m, 1H), 7.19(d, *J* = 8.0 Hz, 2H), 7.10-7.04(m, 2H), 6.98-6.96(m, 1H), 4.84(d, *J* = 14.8 Hz, 1H), 4.33(d, *J* = 14.8 Hz, 1H), 4.29-4.16(m, 2H), 3.63-3.59(m, 1H), 3.14(d, *J* = 11.6 Hz, 1H), 2.36(s, 3H), 2.21-2.17(m, 2H), 1.28(t, *J* = 7.2 Hz, 3H), 0.94(t, *J* = 3.6 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.6, 164.3, 141.9, 141.1, 134.2, 133.0, 130.5, 129.8, 129.0, 127.8, 126.2, 123.8, 62.0, 49.4, 48.2, 34.7, 24.6, 21.4, 18.7, 13.8; **HRMS(ESI):** m/z calcd for $C_{22}H_{24}BrN_2O_4S$ $[M+H]^+$: 491.0640, found: 491.0642.

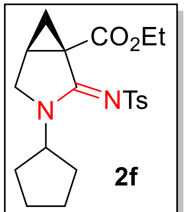


Preparation of Compound 2d: The reaction of *α*-amidinoester **1d** (500 mg, 1 mmol), DBU (620 mg, 4.07 mmol), I_2 (232 mg, 0.91 mmol), Ag_2O (71 mg, 0.3 mmol) and $K_2S_2O_8$ (1.1 g, 4 mmol) was carried out using general procedure **3C**, the product **2d** obtained in 83% yield (416 mg) as a colourless semisolid; **IR (neat):** 3060, 2979, 2927, 2360, 1732, 1637, 1563, 1454, 1391, 1290, 1153, 1089, 1021, 907, 851 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.52(d, *J* = 8.0 Hz, 2H), 7.35-7.30(m, 3H), 7.23-7.19(m, 1H), 7.17-7.14(m, 4H), 7.06(d, *J* = 8.0 Hz, 2H), 6.85(d, *J* = 6.8 Hz, 2H), 6.60(s, 1H), 4.30-4.16(m, 2H), 3.51(dd, *J* = 12.0 Hz, 4.8 Hz, 1H), 3.22(d, *J* = 11.6 Hz, 1H), 2.34(s, 3H), 2.22-2.21(m, 2H), 1.30(t, *J* = 7.2 Hz, 3H), 0.93(t, *J* = 10.4 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.6, 164.6, 141.5, 141.1, 138.0, 136.5, 128.9, 128.8, 128.7, 128.6, 128.0, 127.8, 127.7, 125.8, 62.0, 61.1, 47.9, 34.9, 24.6, 21.3, 18.3, 13.8; **HRMS(ESI):** m/z calcd for $C_{28}H_{29}N_2O_4S$ $[M+H]^+$: 489.1848, found: 489.1839.



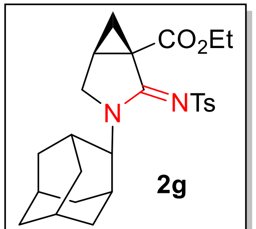
Preparation of Compound 2e: The reaction of *α*-amidinoester **1e** (944 mg, 2.05 mmol), DBU (1.25 g, 8.23 mmol), I_2 (470 mg, 1.85 mmol), Ag_2O (143 mg, 0.61 mmol) and $K_2S_2O_8$ (2.2 g, 8.23 mmol) was carried out using general procedure **3C**, the product **2e** obtained in 82% yield (776 mg) as a colorless crystalline solid;

m.p 95.5-97 °C **IR (neat):** 3052, 2983, 2689, 2304, 1731, 1576, 1443, 1267, 1181, 1149, 1084, 897cm^{-1};**^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.73(d, J = 8.0 Hz, 2H), 7.18(d, J = 8.0 Hz, 2H), 6.51(d, J = 8.0 Hz, 1H), 6.38(dd, J = 8.0 Hz, 1.6 Hz, 1H), 6.27(d, J = 1.6 Hz, 1H), 5.83(q, J = 1.6 Hz, 2H), 4.60(d, J = 14.4 Hz, 1H), 4.241-4.11(m, 2H), 3.99(d, J = 14.4 Hz, 1H), 3.59(dd, J = 11.6 Hz, 5.6 Hz, 1H), 3.18(d, J = 11.6 Hz, 1H), 2.33(s, 3H), 2.18-2.10(m, 2H), 1.25(t, J = 7.2 Hz, 3H), 0.75(t, J = 4.4 Hz, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ**ppm 167.5, 163.9, 147.9, 147.2, 141.9, 140.9, 129.0, 128.4, 125.9, 121.7, 108.2, 108.0, 101.0, 61.8, 49.0, 48.0, 34.6, 24.3, 21.3, 18.3, 13.7; **HRMS(ESI):** m/z calcd for $C_{23}H_{24}N_2O_6NaS$ $[M+Na]^+$: 479.1253, found: 479.1252.



2f

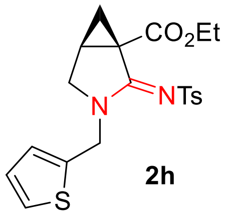
Preparation of Compound 2f: The reaction of α-amidinoester **1f** (400 mg, 1.01 mmol), DBU (620 mg, 4.07 mmol), I_2 (232 mg, 0.91 mmol), Ag_2O (71 mg, 0.3 mmol) and $K_2S_2O_8$ (1.1 g, 4.07 mmol) was carried out using general procedure **3C**, the product **2f** obtained in 88% yield (352 mg) as a brown semi solid; **IR (neat):** 2960, 2851, 2824, 2362, 1733, 1649, 1562, 1458, 1398, 1284, 1180, 1146, 1089, 1015, 910, 853, 752 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.75(d, J = 8.0 Hz, 2H), 7.20(d, J = 8.0 Hz, 2H), 4.49-4.45(m, 1H), 4.26-4.14(m, 2H), 3.72-3.68(m, 1H), 3.30(d, J = 11.6 Hz, 1H), 2.36(s, 3H), 2.24-2.18(m, 2H), 1.91-1.85(m, 1H), 1.68-1.47(m, 6H), 1.29-1.25(m, 3H), 1.20-1.07(m, 1H), 0.84-0.79(m, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 167.8, 164.4, 141.7, 141.5, 129.0, 126.0, 62.0, 55.1, 46.3, 35.2, 29.6, 28.2, 24.1, 24.1, 23.8, 21.5, 18.6, 13.9; **HRMS(ESI):** m/z calcd for $C_{20}H_{27}N_2O_4S$ $[M+H]^+$: 391.1692, found: 391.1689.



2g

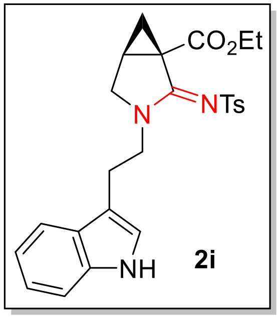
Preparation of Compound 2g: The reaction of α-amidinoester **1g** (667 mg, 1.45 mmol), DBU (882 mg, 5.8 mmol), I_2 (331 mg, 1.30 mmol), Ag_2O (101 mg, 0.43 mmol) and $K_2S_2O_8$ (1.56 g, 5.8 mmol) was carried out using general procedure **3C**, the product **2g** obtained in 87% yield (576 mg) as a pale yellow semi solid; **IR (neat):** 3056, 2984, 2918, 2857, 1730, 1563, 1453, 1424, 1267, 1180, 1148, 1090, 1017, 913, 862, 738 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.52(d, J = 8.4 Hz, 2H), 6.96(d, J = 8.4 Hz, 2H), 4.05-3.90(m, 2H), 3.86(brs, 1H), 3.71(dd, J = 11.6 Hz, 6.0 Hz, 1H), 3.55(d, J = 11.2 Hz, 1H), 2.12(s, 3H), 2.07-2.02(m, 2H), 1.94-1.91(m, 1H), 1.66-1.59(brm, 5H) 1.48-1.43(brm, 7H), 1.28(d, J = 12.4 Hz, 1H), 1.05(t, J = 7.2 Hz, 3H), 0.59(t, J = 5.2 Hz, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ**

ppm 167.6, 163.9, 141.3, 141.2, 128.5, 125.4, 61.4, 59.4, 49.7, 38.0, 37.6, 37.2, 34.0, 32.1, 31.8, 30.9, 30.1, 27.0, 26.5, 24.6, 21.0, 18.3, 13.5; **HRMS(ESI):** m/z calcd for $C_{25}H_{33}N_2O_4S$ $[M+H]^+$: 457.2161, found: 457.2189.



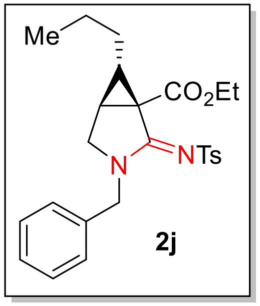
2h

Preparation of Compound 2h: The reaction of *α*-amidinoester **1h** (943 mg, 2.24 mmol), DBU (1.36 g, 8.96 mmol), I_2 (511 mg, 2 mmol), Ag_2O (155 mg, 0.67 mmol) and $K_2S_2O_8$ (2.42 g, 8.96 mmol) was carried out using general procedure **3C**, the product **2h** obtained in 76% yield (714 mg) as a orange-yellow oil; **IR (neat):** 3054, 2989, 2924, 2689, 2416, 2304, 1732, 1582, 1577, 1491, 1427, 1268, 1148, 1089, 902 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.77(d, *J* = 8.0 Hz, 2H), 7.20(d, *J* = 8.4 Hz, 2H), 7.09(dd, *J* = 4.8 Hz, 0.8 Hz, 1H), 6.77(dd, *J* = 5.2 Hz, 3.6 Hz, 1H), 6.69(d, *J* = 2.8 Hz, 1H), 4.93(d, *J* = 14.8 Hz, 1H), 4.28-4.13(m, 3H), 3.68(dd, *J* = 11.2 Hz, 5.6 Hz, 1H), 3.29(d, *J* = 11.2 Hz, 1H), 2.36(s, 3H), 2.22-2.14(m, 2H), 1.28(t, *J* = 6.8 Hz, 3H), 0.81(t, *J* = 4.4 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.5, 163.7, 141.9, 141.0, 136.6, 129.0, 127.4, 126.8, 126.3, 126.0, 62.0, 48.9, 42.7, 34.6, 24.3, 21.4, 18.2, 13.8; **HRMS(ESI):** m/z calcd for $C_{20}H_{23}N_2O_4S_2$ $[M+H]^+$: 419.1099, found: 419.1086.

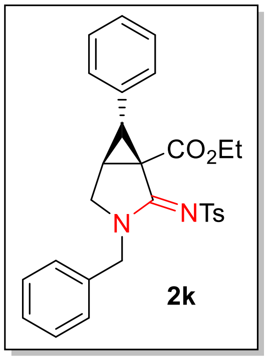


2i

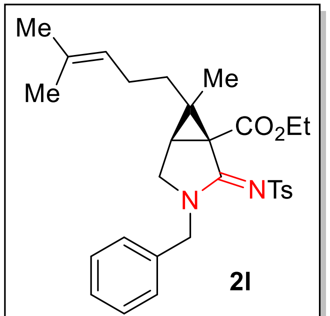
Preparation of Compound 2i: The reaction of *α*-amidinoester **1i** (350 mg, 0.74 mmol), DBU (455 mg, 2.99 mmol), I_2 (108 mg, 0.67 mmol), Ag_2O (52 mg, 0.22 mmol) and $K_2S_2O_8$ (808 mg, 2.99 mmol) was carried out using general procedure **3C**, the product **2i** obtained in 80% yield (277 mg) as a pale yellow semi solid; **IR (neat):** 3410, 3056, 2925, 2856, 2361, 1729, 1642, 1577, 1457, 1276, 1144, 1088, 1018, 910, 746 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 8.40(s, 1H), 7.87(d, *J* = 8.4 Hz, 2H), 7.34(dd, *J* = 3.6 Hz, 7.6 Hz, 2H), 7.26(d, *J* = 8.0 Hz, 2H), 7.15(t, *J* = 7.2 Hz, 1H), 7.03(t, *J* = 7.2 Hz, 1H), 6.75(d, *J* = 1.6 Hz, 1H), 4.31-4.09(m, 2H), 3.80-3.73(m, 1H), 3.49(dd, *J* = 11.6 Hz, 4.8 Hz, 1H), 3.40(dt, *J* = 13.6 Hz, 7.2 Hz, 1H), 3.01(d, *J* = 11.6 Hz, 1H), 2.83(t, *J* = 7.2 Hz, 2H), 2.37(s, 3H), 2.06(s, 2H), 1.28(t, *J* = 7.2 Hz, 3H), 0.61(t, *J* = 10.0 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.9, 164.2, 142.1, 141.3, 136.2, 129.2, 127.0, 126.2, 122.5, 122.1, 119.4, 118.4, 111.5, 111.4, 62.1, 50.9, 45.2, 35.0, 24.6, 22.6, 21.5, 18.7, 13.9; **HRMS(ESI):** m/z calcd for $C_{25}H_{28}N_3O_4S$ $[M+H]^+$: 466.1801, found: 466.1797.



Preparation of Compound 2j: The reaction of α-amidinoester **1j** (743 mg, 1.62 mmol), DBU (990 mg, 6.5 mmol), I_2 (372 mg, 1.46 mmol), Ag_2O (113 mg, 0.48 mmol) and $K_2S_2O_8$ (1.76 g, 6.5 mmol) was carried out using general procedure **3C**, the product **2j** obtained in 74% yield (551 mg) as a pale yellow crystal; m.p 108-110 ^oC; **IR (neat):** 3058, 2962, 2871, 2304, 1742, 1574, 1570, 1567, 1485, 1454, 1293, 1181, 1149, 1084, 891 cm^{-1}. **^1H NMR (400 MHz, $CDCl_3$): δ** ppm 7.78(d, J = 7.6 Hz, 2H), 7.24-7.20(m, 3H), 7.17-7.13(m, 2H), 6.93(d, J = 7.6 Hz, 2H), 4.72(d, J = 14.4 Hz, 1H), 4.28-4.11(m, 3H), 3.63-3.59(m, 1H), 3.21(d, J = 11.6 Hz, 1H), 2.39(s, 3H), 2.06-2.02(m, 2H), 1.83-1.74(m, 1H), 1.71-1.64(m, 1H), 1.51-1.44(m, 1H), 1.29-1.26(m, 3H), 1.05(q, J = 6.0 Hz, 1H), 0.93(t, J = 7.6 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.8, 165.4, 141.8, 141.4, 135.1, 129.1, 128.8, 128.2, 128.0, 126.2, 61.4, 49.6, 48.4, 37.7, 34.3, 29.5, 29.2, 22.3, 21.5, 14.0, 13.9; **HRMS(ESI):** m/z calcd for $C_{25}H_{31}N_2O_4S$ $[M+H]^+$: 455.2005, found: 455.2027.

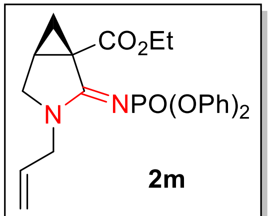


Preparation of Compound 2k: The reaction of α-amidinoester **1k** (341 mg, 0.69 mmol), DBU (423 mg, 2.78 mmol), I_2 (158 mg, 0.62 mmol), Ag_2O (48 mg, 0.2 mmol) and $K_2S_2O_8$ (751 mg, 2.78 mmol) was carried out using general procedure **3C**, the product **2k** obtained in 84% yield (286 mg) as a colorless crystals; m.p 126-128 ^oC; IR **(neat):** 3065, 2928, 2857, 1737, 1572, 1487, 1453, 1291, 1245, 1144, 1087, 916, 873 cm^{-1}. **^1H NMR (400 MHz, $CDCl_3$): δ** ppm 7.89(d, J = 8.0 Hz, 2H), 7.49(d, J = 7.6 Hz, 2H), 7.35-7.31(m, 2H), 7.28-7.26(m, 3H), 7.22(d, J = 7.2 Hz, 1H), 7.19-7.15(m, 2H), 6.98(d, J = 7.2 Hz, 2H), 4.86(d, J = 14.4 Hz, 1H), 4.20(d, J = 14.8 Hz, 1H), 4.14-4.06(m, 1H), 4.03-3.95(m, 1H), 3.83-3.78(m, 1H), 2.74(t, J = 6.0 Hz, 1H), 2.46(d, J = 6.0 Hz, 1H), 2.42(s, 3H), 1.09(t, J = 7.2 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 166.5, 164.6, 141.9, 141.2, 134.9, 133.2, 129.5, 129.2, 128.8, 128.8, 128.2, 128.1, 127.4, 126.2, 61.3, 49.3, 48.5, 39.5, 37.0, 27.6, 21.5, 13.6; **HRMS(ESI):** m/z calcd for $C_{28}H_{28}N_2O_4NaS$ $[M+Na]^+$: 511.1669, found: 511.1667.



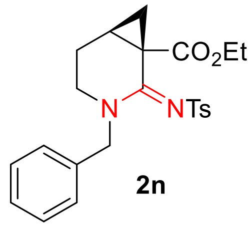
2l

Preparation of Compound 2l: The reaction of α-amidinoester **1l** (477 mg, 0.93 mmol), DBU (568 mg, 3.73 mmol), I_2 (213 mg, 0.84 mmol), Ag_2O (64 mg, 0.28 mmol) and $K_2S_2O_8$ (1 g, 3.73 mmol) was carried out using general procedure **3C**, the product **2l** obtained in 63% yield (296 mg) as a brown semi solid; **IR (neat):** 3255, 3059, 2959, 2930, 2871, 1729, 1574, 1490, 1455, 1287, 1148, 1088, 1016, 942, 882, 813 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.80(d, J = 8 Hz, 2H), 7.23(d, J = 8 Hz, 3H), 7.16(t, J = 7.6 Hz, 2H) 7.09(d, J = 7.2 Hz, 2H), 4.70(d, J = 14.4 Hz, 1H), 4.44 (t, J = 6.8 Hz, 1H), 4.30(d, J = 14.4 Hz, 1H), 4.26-4.18(m, 1H), 4.11-4.05(m,1H), 3.64-3.61(m, 1H), 3.15(d, J = 11.6 Hz, 1H), 2.40(s, 3H), 2.05(d, J = 6 Hz, 2H), 1.88-1.79 (m, 1H), 1.60(s, 3H), 1.56(s, 3H), 1.45(s, 3H), 1.23(t, J = 6.8 Hz, 3H), 1.18-1.13(m, 1H), 0.73-0.65(m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 168.3, 163.6, 141.8, 134.5, 131.8, 129.8, 129.1, 128.8, 128.2, 126.5, 126.5, 123.5, 61.6, 48.8, 47.1, 43.8, 35.6, 35.0, 30.0, 25.6, 24.4, 21.6, 19.3, 17.7, 13.8. **HRMS(ESI):** m/z calcd for $C_{29}H_{37}N_2O_4S$ $[M+H]^+$: 509.2474, found: 509.2458.



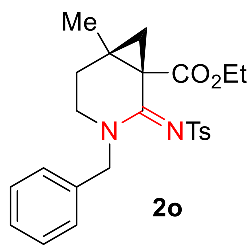
2m

Preparation of Compound 2m: The reaction of α-amidinoester **1m** (422 mg, 0.95 mmol), DBU (581 mg, 3.82 mmol), I_2 (218 mg, 0.85 mmol), Ag_2O (66 mg, 0.28 mmol) and $K_2S_2O_8$ (1 g, 3.82 mmol) was carried out using general procedure **3C**, the product **2m** obtained in 54% yield (226 mg) as a pale yellow oil; **IR (neat):** 3069, 2983, 2930, 2363, 2250, 1731, 1619, 1587, 1491, 1255, 1196, 1009, 929 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.26-7.16(m, 8H), 7.15-7.01(m, 2H), 5.43-5.32(m, 1H), 5.07(dd, J = 10.4 Hz, 1.2 Hz, 1H), 5.02-4.97(m, 1H), 4.26-4.18(m, 1H), 4.13-4.05(m, 1H), 3.92(dd, J = 15.2 Hz, 6.0 Hz, 1H), 3.67-3.58(m, 2H), 3.22(d, J = 11.2 Hz, 1H), 2.19-2.11(m, 2H), 1.19(t, J = 7.2 Hz, 3H), 0.80(t, J = 4.8 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.8, 166.2, 152.0 151.9, 151.7, 151.6, 130.9, 129.2, 129.2, 124.1, 124.0, 120.6, 120.6, 120.4, 120.4, 118.9, 61.9, 49.2, 46.7, 35.0, 24.3, 19.5, 13.9; **HRMS (ESI):** m/z calcd for $C_{23}H_{26}N_2O_5P$ $[M+H]^+$: 441.1579, found: 441.1580.



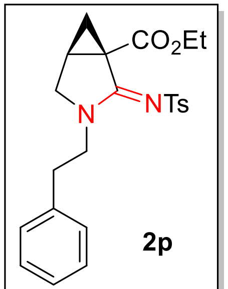
2n

Preparation of Compound 2n: The reaction of *α*-amidinoester **1n** (474 mg, 1.1 mmol), DBU (674 mg, 4.42 mmol), I_2 (253 mg, 0.99 mmol), Ag_2O (77 mg, 0.33 mmol) and $K_2S_2O_8$ (1.08 g, 4.42 mmol) was carried out using general procedure **3C**, the product **2n** obtained in 72% yield (334 mg) as a pale yellow oil and 10% recovered starting material **27**; **IR (neat):** 2930, 2861, 1731, 1547, 1492, 1448, 1282, 1149, 1089, 1022, 941, 820 cm^{-1};**^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.67(d, *J* = 8.0 Hz, 2H), 7.18-7.17(m, 3H), 7.12-7.10(m, 4H), 4.97(d, *J* = 14.4 Hz, 1H), 4.49(d, *J* = 14.8 Hz, 1H), 4.17-4.06(m, 2H), 3.42(t, *J* = 12.8 Hz, 1H), 2.98(d, *J* = 12.8 Hz, 1H), 2.30(s, 3H), 2.24-2.18(m, 1H), 2.11-2.08(m, 1H) 1.87-1.80(m, 1H), 1.23-1.18(m, 1H), 1.13(t, *J* = 7.2 Hz, 3H), 1.04(t, *J* = 6.0 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 170.0, 161.3, 141.7, 141.2, 135.6, 129.0, 128.7, 127.8, 127.7, 126.3, 61.8, 53.5, 48.4, 27.7, 26.0, 25.8, 25.6, 21.4, 13.9; **HRMS (ESI):** m/z calcd for $C_{23}H_{26}N_2O_4NaS$ $[M+Na]^+$: 449.1511, found: 449.1511.



2o

Preparation of Compound 2o: The reaction of *α*-amidinoester **1o** (398 mg, 0.9 mmol), DBU (547 mg, 3.6 mmol), I_2 (205 mg, 0.81 mmol), Ag_2O (62 mg, 0.27 mmol) and $K_2S_2O_8$ (973 mg, 3.6 mmol) was carried out using general procedure **3C**, the product **2o** obtained in 65% yield (260 mg) as a pale yellow oil and 8% recovered starting material **28**; **IR (neat):** 3058, 2983, 2935, 2865, 2304, 1731, 1544, 1485, 1427, 1267, 1154, 1084, 891,753 cm^{-1};**^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.67(d, *J* = 8.0 Hz, 2H), 7.21-7.19(m, 3H), 7.16-7.13(m, 2H), 7.11(d, *J* = 8.0 Hz, 2H), 5.11(d, *J* = 14.8 Hz, 1H), 4.37(d, *J* = 14.8 Hz, 1H), 4.17-4.03(m, 2H), 3.44(td, *J* = 12.8 Hz, 2.0 Hz, 1H), 2.97(dt, *J* = 12.8 Hz, 2.8 Hz, 1H), 2.30(s, 3H), 1.96(d, *J* = 5.6 Hz, 1H), 1.94-1.90(m, 1H), 1.39-1.32(m, 1H), 1.20-1.18(m, 3H), 1.14(t, *J* = 7.2 Hz, 3H), 0.80(t, *J* = 6.8 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.5, 162.4, 141.7, 141.2, 135.7, 129.0, 128.7, 127.8, 127.8, 126.3, 61.7, 53.8, 47.4, 36.4, 32.0, 31.2, 29.8, 21.5, 18.7, 14.1; **HRMS (ESI):** m/z calcd for $C_{24}H_{29}N_2O_4S$ $[M+H]^+$: 441.1848, found: 441.1866.

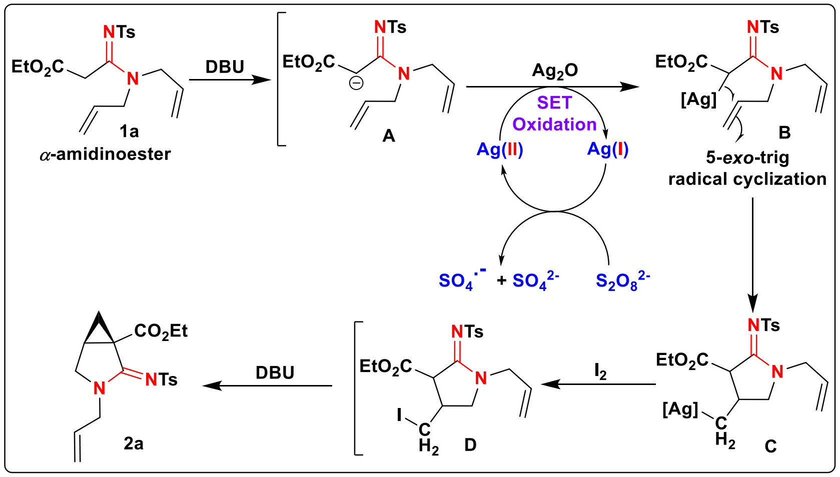


2p

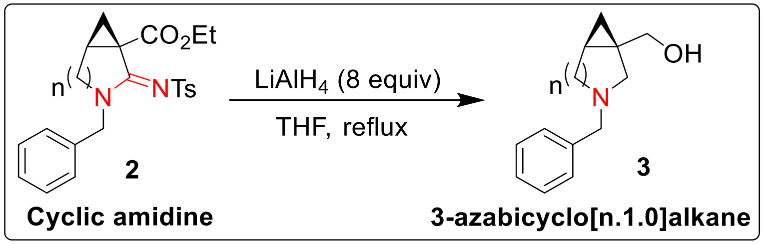
Preparation of Compound 2p: The reaction of *α*-amidinoester **1p** (9.16 g, 21.3 mmol), DBU (13 g, 85 mmol), I_2 (4.88 g, 19.2 mmol), Ag_2O (1.48 g, 6.4 mmol) and $K_2S_2O_8$ (23.1 g, 85 mmol) was carried out using general procedure **3C**, the product **2p** obtained in 84% yield (7.62 g) as a colourless semi solid; **IR (neat):** 3057, 2984, 2930, 2874, 1731, 1577, 1490, 1455, 1271, 1184, 1148, 1090, 1018, 907, 854 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.82(d, J = 8.0 Hz, 2H), 7.25(d, J = 7.6 Hz, 2H), 7.16(brs, 3H), 6.91(brs, 2H), 4.29-4.12(m, 2H), 3.77-3.71(m, 1H), 3.48(dd, J = 11.2 Hz, 5.2 Hz, 1H), 3.36-3.29(m, 1H), 3.05(d, J = 11.6 Hz, 1H), 2.68(t, J = 6.8 Hz, 2H), 2.37(s, 3H), 2.09-2.04(m, 2H), 1.28(t, J = 7.2 Hz, 3H), 0.58(t, J = 3.6 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 167.6, 164.1, 141.8, 141.3, 137.4, 129.0, 128.5, 128.4, 126.6, 126.0, 61.7, 50.6, 45.6, 34.7, 32.7, 24.4, 21.3, 18.4, 13.7; **HRMS(ESI):** m/z calcd for $C_{23}H_{26}N_2O_4NaS$ $[M+Na]^+$: 449.1505, found: 449.1493.

3D. Plausible mechanism for the formation of cyclic amidine 2a from α-amidinoester 1a

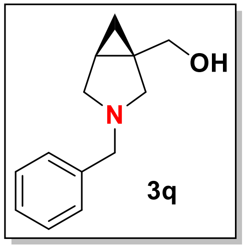
A plausible mechanism for the formation of cyclic amidine **2a** from α-amidinoester **1a** is shown in below scheme. The key precursor **1a** was derived from coupling reaction of alkyne, azide and amine.[12] Treatment of α-amidinoester **1a** with DBU would generate carbanion **A**, which on exposed with SET oxidant Ag_2O would lead to the formation of amidyl-radical **B**. Subsequent *5-exo-trig* radical cyclization of amidyl-radical **B** would lead to the corresponding cyclic amidyl-radical **C**. Notably, potassium persulfate would readily oxidize Ag(I) to Ag(II) and promotes the catalytic process. The intermediate **C** would then undergo iodination followed by carbanion cyclization furnish the cyclic amidine **2a**.



3E. Procedure for an efficient reduction of cyclic amidine to 3-azabicyclo[n.1.0]alkanes:

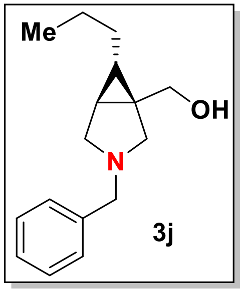


A round bottomed flask charged with dry THF and lithium aluminium hydride was allowed to reflux for 15 minutes. To this reaction mixture, was added cyclic amidine **2** in dry THF (3 mL) over five minutes and the reaction mixture was stirred at reflux until the completion of reaction as indicated by TLC. The reaction mixture was quenched by addition of moist Na_2SO_4 and extracted with EtOAc (2 X 30 mL). The combined EtOAc solvent was washed successively with water (2 X 20 mL) and brine solution (30 mL). The organic layers were collected, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product using column chromatography yielded the 3-azabicyclo[n.1.0]alkanes **3**.



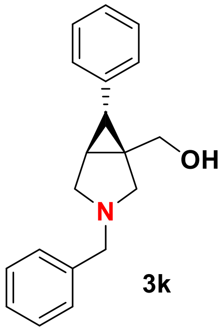
3q

Preparation of Compound 3q: The reaction of cyclic amidine **2q** (4.43 g, 10.75 mmol) with $LiAlH_4$ (3.17 g, 86 mmol), was carried out using general procedure **3E**, the product **3q** obtained in 78% yield (1.69 g) as a colourless oil; **IR (neat):** 3398, 3055, 2904, 2792, 1724, 1608, 1454, 1373, 1265, 1149, 1030, 891, 775, 702 cm^{-1}; **^1H NMR (400 MHz, $CDCl_3$): δ** ppm 7.33-7.24(m, 5H), 3.74-3.68(m, 1H), 3.64-3.59(m, 3H), 3.03(d, J = 8.4 Hz, 1H), 2.96(d, J = 8.8 Hz, 1H), 2.44(d, J = 8.4 Hz, 2H), 1.70(brs, 1H), 1.28-1.26(m, 1H), 1.13(t, J = 4.4 Hz, 1H), 0.47(dd, J = 4 Hz, 7.6 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 139.1, 128.6, 128.1, 126.8, 66.1, 59.2, 56.6, 54.9, 29.8, 20.3, 12.5. **HRMS(ESI):** m/z calcd for $C_{13}H_{18}NO$ $[M+H]^+$: 204.1310, found: 204.1314.



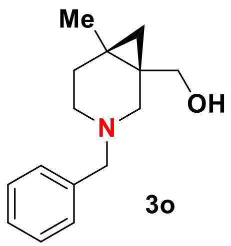
3j

Preparation of Compound 3j: The reaction of cyclic amidine **2j** (1.93 g, 4.24 mmol) with $LiAlH_4$ (1.25 g, 34 mmol), was carried out using general procedure **3E**, the product **3j** obtained in 74% yield (770 mg) as a colourless oil; **IR (neat):** 3418, 3081, 3029, 2955, 2928, 2859, 2787, 1740, 1652, 1494, 1456, 1379, 1289, 1249, 1156, 1027, 783 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.26-7.17(m, 5H), 3.70(s, 2H), 3.55(q, *J* = 13.2 Hz, 2H), 2.97(d, *J* = 8.8 Hz, 1H), 2.89(d, *J* = 8.8 Hz, 1H), 2.40-2.35(m, 2H), 1.43-1.34(m, 4H), 1.25-1.14(m, 2H), 0.94(s, 1H), 0.87(t, *J* = 7.2 Hz, 3H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 139.4, 129.8, 128.7, 128.2, 126.9, 126.5, 63.4, 59.3, 58.5, 55.5, 33.6, 30.3, 27.3, 24.7, 23.2, 14.2. **HRMS(ESI):** m/z calcd for $C_{16}H_{24}NO$ [M+H]$^+$: 246.1852, found: 246.1854.



3k

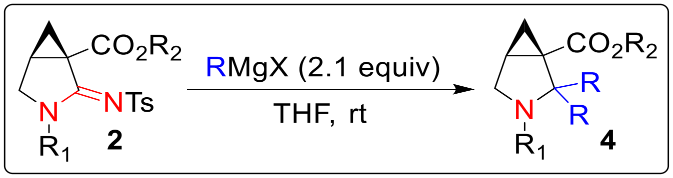
Preparation of Compound 3k: The reaction of cyclic amidine **2k** (708 mg, 1.45 mmol) with $LiAlH_4$ (428 mg, 11.6 mmol), was carried out using general procedure **3E**, the product **3k** obtained in 81% yield (327 mg) as a colourless oil; **IR (neat):** 3421, 3086, 3033, 2956, 2921, 2869, 2789, 1738, 1651, 1499, 1451, 1370, 1279, 1254, 1159, 1031, 782 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.31-7.28(m, 4H), 7.26-7.24(m, 3H), 7.19-7.15(m, 3H), 3.67(s, 2H), 3.54(q, *J* = 12 Hz, 2H), 3.25(d, *J* = 8.8 Hz, 1H), 3.10(d, *J* = 8.8 Hz, 1H), 2.81(d, *J* = 4 Hz, 1H), 2.56-2.51(m, 2H), 1.87(t, *J* = 3.6 Hz, 1H), 1.17(brs, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 139.4, 138.3, 128.7, 128.6, 128.4, 128.3, 127.0, 126.1, 62.4, 59.0, 58.4, 55.1, 37.2, 28.6, 25.4. **HRMS(ESI):** m/z calcd for $C_{19}H_{22}NO$ [M+H]$^+$: 280.1696, found: 280.1696.



3o

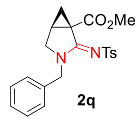
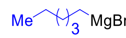
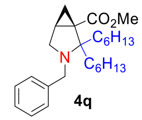
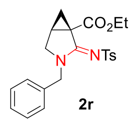
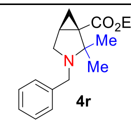
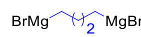
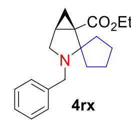
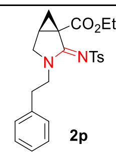
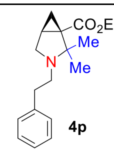
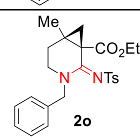
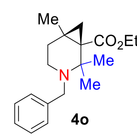
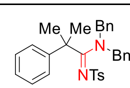
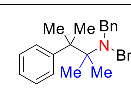
Preparation of Compound 3o: The reaction of cyclic amidine **2o** (1.2 g, 2.72 mmol) with $LiAlH_4$ (805 mg, 21.8 mmol), was carried out using general procedure **3E**, the product **3o** obtained in 77% yield (485 mg) as a colourless oil; **IR (neat):** 3392, 3061, 3030, 2977, 2924, 2873, 2810, 2769, 1653, 1605, 1493, 1451, 1362, 1286, 1251, 1159, 1125, 1078, 1030 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.33-7.21(m, 5H), 3.63(d, *J* = 8.4 Hz, 1H), 3.60(d, *J* = 10.4 Hz, 1H), 3.48(d, *J* = 4.4 Hz, 1H), 3.45(d, *J* = 2.8 Hz, 1H), 3.00(d, *J* = 11.2 Hz, 1H), 2.62(d, *J* = 11.6 Hz, 1H), 2.42-2.36(m, 1H), 2.15-2.09(m, 1H), 1.86-1.77(m, 2H), 1.20(s, 3H), 0.68(d, *J* = 4.4 Hz, 1H), 0.31(d, *J* = 4 Hz, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 136.9, 129.4, 128.3, 127.4, 66.7, 62.1, 56.4, 49.0, 31.2, 27.1, 22.1, 21.8, 19.4. **HRMS(ESI):** m/z calcd for $C_{15}H_{22}NO$ [M+H]$^+$: 232.1701, found: 232.1697.

3F. Procedure for unusual dialkylation of amidine using Grignard reagent:

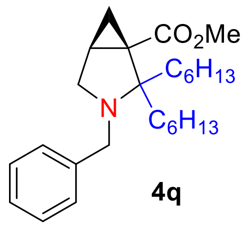


To a stirred solution of cyclic amidine **2** (1 equiv) in dry THF (3 mL/ mmol) at room temperature under N_2 atmosphere was added MeMgBr (2.1 equiv). The reaction mixture was stirred at room temperature until the completion of reaction as indicated by TLC. Then reaction mixture was cooled to 0 ^{o}C, diluted with saturated Na_2SO_4 (20 mL/ mmol) and extracted with EtOAc (2 X 30 mL/ mmol). The combined EtOAc solvent was washed successively with water (2 X 20 mL) and brine solution (30 mL). The organic layers were collected, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product using column chromatography yielded the dialkylated 3-azabicyclo[n.1.0]alkane **4**.

Table S2. Substrate scope for nucleophilic addition of Grignard reagent to amidine

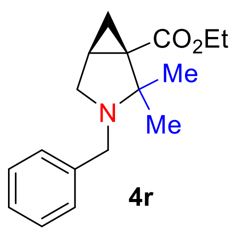
Entry	Amidine	Grignard Reagent	T (h)	Product	Yield (%)[a]
1	 2q		2	 4q	58
2	 2r	MeMgBr	1	 4r	47
			2	 4rx	41
3	 2p	MeMgBr	2	 4p	48
4	 2o	MeMgBr	2	 4o	43
5	 2s	MeMgBr	18	 4s	-

[a]Isolated yield.



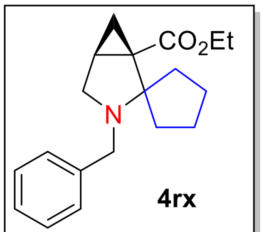
4q

Preparation of Compound 4q: The reaction of cyclic amidine **2q** (610 mg, 1.53 mmol) with Grignard reagent generated *insitu* from $C_6H_{13}Br$ (531 mg, 3.21 mmol) and Mg (78 mg, 3.21 mmol) was carried out using general procedure **3F**, the product **4q** obtained in 58% yield (358 mg) as a colourless oil; **IR (neat):** 3066, 3026, 2929, 2859, 2701, 1722, 1600, 1453, 1363, 1298, 1198, 1159, 1116, 1039, 955, 727 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.29-7.18(m, 5H), 3.93(d, J = 13.6 Hz, 1H), 3.63(s, 3H), 3.33(d, J = 13.6 Hz, 1H), 2.70(s, 2H), 2.11-2.05(m, 1H), 1.99(brs, 1H), 1.88-1.80(m, 1H), 1.64-1.60(m, 1H), 1.53-1.44(m, 4H), 1.27(brs, 14H), 1.13(dd, J = 3.2 Hz, 8 Hz, 1H), 0.91-0.85(m, 6H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 173.4, 140.8, 128.2, 128.1, 126.6, 64.4, 52.1, 51.4, 51.2, 38.2, 35.9, 34.8, 32.1, 31.8, 30.6, 30.5, 29.8, 25.7, 25.1, 24.4, 22.8, 22.8, 18.7, 14.2. **HRMS(ESI):** m/z calcd for $C_{26}H_{42}NO_2$ $[M+H]^+$: 400.3216, found: 400.3217.



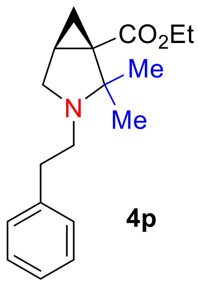
4r

Preparation of Compound 4r: The reaction of cyclic amidine **2r** (723 mg, 1.69 mmol) with MeMgBr (1.18 mL, 3.56 mmol), was carried out using general procedure **3F**, the product **4r** obtained in 47% yield (463 mg) as a colourless oil; **IR (neat):** 3057, 2982, 2931, 2903, 2799, 2684, 1713, 1603, 1490, 1454, 1426, 1374, 1314, 1263, 1205, 1166, 1093, 1030, 897, 732 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.29-7.17(m, 5H), 4.16-4.04(m, 2H), 3.82(d, J = 13.6 Hz, 1H), 3.11(d, J = 13.6 Hz, 1H), 2.68(d, J = 8.8 Hz, 1H), 2.41(dd, J = 3.2 Hz, 8.8 Hz, 1H), 1.97-1.93(m, 1H), 1.47-1.45(m, 1H), 1.33(s, 3H), 1.24(t, J = 6.8 Hz, 3H), 1.18(s, 3H), 0.94(dd, J = 3.6 Hz, 8.4 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 173.0, 140.8, 128.2, 128.2, 126.7, 60.1, 59.6, 51.0, 49.9, 37.9, 23.6, 22.7, 16.8, 16.3, 14.3. **HRMS(ESI):** m/z calcd for $C_{17}H_{24}NO_2$ $[M+H]^+$: 274.1802, found: 274.1803.



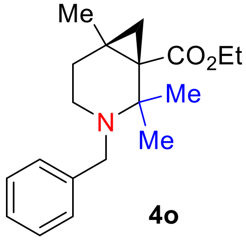
4rx

Preparation of Compound 4rx: The reaction of cyclic amidine **2r** (595 mg, 1.44 mmol) with Grignard reagent generated *insitu* from 1,4-dibromobutane (654 mg, 3.03 mmol) and Mg (147 mg, 6.06 mmol) was carried out using general procedure **3F**, the product **4rx** obtained in 41% yield (169 mg) as a colourless oil; **IR (neat):** 3057, 2953, 2930, 2856, 2792, 1723, 1635, 1625, 1452, 1440, 1365, 1264, 1199, 1165, 1106, 1039, 891, 717 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.22-7.12(m, 5H), 4.09-3.98(m, 2H), 3.79(d, *J* = 13.2 Hz, 1H), 3.08(d, *J* = 13.6 Hz, 1H), 2.56(d, *J* = 8.8 Hz, 1H), 2.27-2.19(m, 2H), 1.85-1.82(m, 2H), 1.64-1.61(m, 1H), 1.58-1.49(m, 2H), 1.21-1.15(m, 5H), 0.91-0.88(m, 1H), 0.82-0.79(m, 2H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 173.3, 140.6, 128.2, 128.2, 126.7, 71.3, 60.1, 51.3, 50.5, 38.7, 34.8, 27.9, 27.8, 26.4, 23.9, 18.2, 14.3. **HRMS(ESI):** m/z calcd for $C_{19}H_{26}NO_2$ [M+H]$^+$: 300.1807, found: 300.1815.



4p

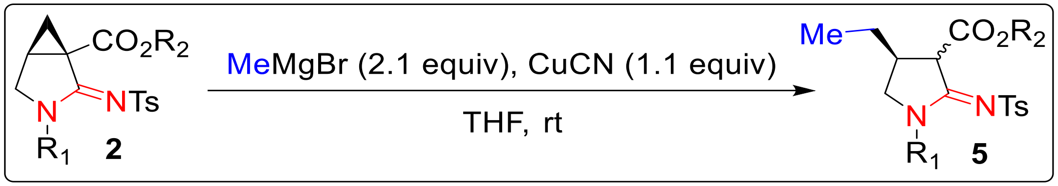
Preparation of Compound 4p: The reaction of cyclic amidine **2p** (342 mg, 0.8 mmol) with MeMgBr (0.8 mL, 2.4 mmol), was carried out using general procedure **3F**, the product **4p** obtained in 48% yield (108 mg) as a pale yellow oil; **IR (neat):** 3061, 3028, 2968, 2931, 2859, 2800, 1715, 1605, 1493, 1459, 1372, 1316, 1265, 1172, 1101, 1039, 730, 724 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.40-7.36(m, 2H), 7.31-7.27(m, 3H), 4.28-4.14(m, 2H), 3.17(d, *J* = 8.4 Hz, 1H), 2.86-2.79(m, 2H), 2.74-2.65(m, 1H), 2.61(dd, *J* = 2.8 Hz, 8.4 Hz, 1H), 2.53-2.43(m, 1H), 2.12-2.08(m, 1H), 1.42-1.40(m, 1H), 1.34(t, *J* = 7.2 Hz, 3H), 1.21(s, 3H), 1.15(s, 3H), 1.02-1.00(m, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 172.9, 141.0, 128.8, 128.2, 125.9, 60.0, 59.6, 50.0, 48.6, 37.9, 35.9, 23.5, 22.5, 16.7, 15.9, 14.2. **HRMS(ESI):** m/z calcd for $C_{18}H_{26}NO_2$ [M+H]$^+$: 288.2005, found: 288.2009.



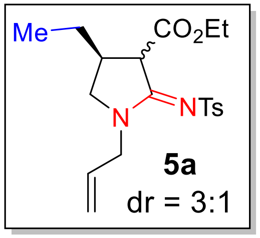
4o

Preparation of Compound 4o: The reaction of cyclic amidine **2o** (702 mg, 1.59 mmol) with MeMgBr (1.1 mL, 3.34 mmol), was carried out using general procedure **3F**, the product **4o** obtained in 43% yield (206 mg) as a colourless oil; **IR (neat):** 3060, 2979, 2927, 2866, 2829, 2800, 1712, 1602, 1497, 1451, 1365, 1296, 1255, 1174, 1138, 1103, 1022, 769, 704 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.31-7.25(m, 4H), 7.21-7.18(m, 1H), 4.14(q, *J* = 6.8 Hz, 2H), 3.92(d, *J* = 14.4 Hz, 1H), 3.03(d, *J* = 14 Hz, 1H), 2.45-2.38(m, 1H), 2.25-2.19(m, 1H), 1.78-1.70(m, 1H), 1.54-1.49(m, 1H), 1.37(d, *J* = 3.6 Hz, 1H), 1.29(s, 6H), 1.27(s, 3H), 1.04(s, 3H), 0.81(d, *J* = 4 Hz, 1H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 172.6, 141.7, 128.2, 128.0, 126.6, 60.3, 53.6, 52.7, 42.4, 42.1, 29.5, 26.9, 25.0, 22.1, 20.4, 18.0, 14.4. **HRMS(ESI):** m/z calcd for $C_{19}H_{28}NO_2$ [M+H]$^+$: 302.2115, found: 302.2110.

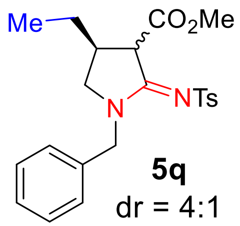
3G. Procedure for regioselective ring opening of cyclopropane using organocopper reagent:



To a stirred solution of MeMgBr (2.1 equiv) and CuCN (1.1 equiv) in dry THF at room temperature for about 30 minutes under N_2 atmosphere was added cyclic amidine **2** (1 equiv) in dry THF (3 mL/ mmol). The reaction mixture was stirred at room temperature until the completion of reaction as indicated by TLC. Then reaction mixture was cooled to 0 °C, diluted with saturated Na_2SO_4 (20 mL/ mmol) and extracted with EtOAc (2 X 30 mL/ mmol). The combined EtOAc solvent was washed successively with water (2 X 20 mL) and brine solution (30 mL). The organic layer was collected, dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. Purification of the crude product using column chromatography yielded the substituted 2-iminopyrrolidine **5**.

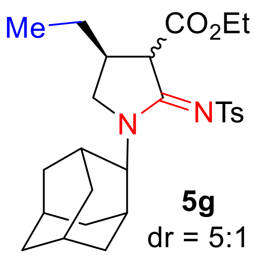


Preparation of Compound 5a: The reaction of cyclic amidine **2a** (755 mg, 1.83 mmol), MeMgBr (1.28 mL, 3.84 mmol) and CuCN (180 mg, 2 mmol) was carried out using general procedure **3G**, the product **5a** obtained in 83% yield (574 mg) (dr = 3:1) as a pale yellow oil; **IR (neat):** 3061, 2975, 2933, 2875, 1733, 1592, 1487, 1428, 1370, 1337, 1264, 1184, 1149, 1093, 1024, 993, 889, 816 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.79(d, J = 8.0 Hz, 0.67H), 7.75(d, J = 8.0 Hz, 2.13H), 7.28(d, J = 8.0 Hz, 0.67H), 7.21(d, J = 8.0 Hz, 2.15H) 5.74-5.64(m, 1.07H), 5.27-5.19(m, 2.19H), 4.95-4.93(brm, 0.58H), 4.41(d, J = 8.8 Hz, 0.44H), 4.21-4.06(m, 4.02H), 3.99-3.90(m, 1.15H), 3.67(dd, J = 10.4 Hz, 7.2 Hz, 0.65H), 3.40(t, J = 10 Hz, 0.45H), 3.24(t, J = 10.4 Hz, 0.46H), 3.05(d, J = 10.4 Hz, 0.65H), 2.53-2.47(m, 0.49H), 2.41(s, 1.04H), 2.37(s, 3.21H), 2.34-2.31(m, 1.01H), 1.59-1.42(m, 1.81H), 1.31-1.27(m, 0.44H), 1.26-1.22(m, 3.43H), 0.96(t, J = 7.6 Hz, 1.36H), 0.91(t, J = 7.6 Hz, 2.01H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 169.7, 168.0, 165.6, 164.2, 142.1, 142.1, 140.5, 140.4, 130.6, 130.5, 129.7, 129.7, 129.1, 129.1, 126.5, 126.4, 119.2, 118.9, 61.7, 61.5, 54.6, 52.9, 52.8, 52.5, 47.9, 47.8, 40.5, 40.4, 27.8, 22.2, 21.6, 21.5, 14.2, 14.1, 12.3, 11.1. **HRMS(ESI):** m/z calcd for $C_{19}H_{27}N_2O_4S$ $[M+H]^+$: 379.1686, found: 379.1696.



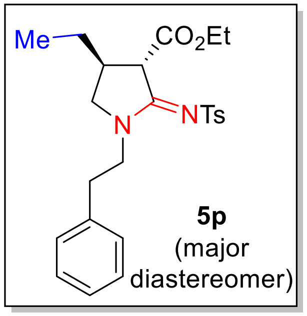
5q
dr = 4:1

Preparation of Compound 5q: The reaction of cyclic amidine **2q** (684 mg, 1.71 mmol), MeMgBr (1.2 mL, 3.6 mmol) and CuCN (169 mg, 1.89 mmol) was carried out using general procedure **3G**, the product **5q** obtained in 87% yield (618 mg) (dr = 4:1) as a pale yellow oil; **IR (neat):** 3061, 2962, 2934, 2875, 1740, 1579, 1489, 1457, 1439, 1336, 1295, 1169, 1093, 1024, 999, 892, 817, 722 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.78(d, J = 8.0 Hz, 2.46H), 7.29-7.27(m, 3.63H), 7.24-7.19(m, 5.04H), 4.84(d, J = 14.4 Hz, 0.23H) 4.75(d, J = 14.8 Hz, 1.02H), 4.52(d, J = 14.8 Hz, 1.15H), 4.46(d, J = 14.4 Hz, 0.36H), 4.18(d, J = 2 Hz, 1.00H), 3.70(s, 3.00H), 3.68(s, 0.74H), 3.58(dd, J = 10.8 Hz, 7.2 Hz, 1.04H), 3.35-3.31(m, 0.23H), 3.14(t, J = 10.4 Hz, 0.24H), 2.98-2.95(m, 1.04H), 2.39(s, 3.73H), 2.34-2.29(m, 1.05H), 1.53-1.30(m, 2.15H), 1.25-1.18(m, 0.42H), 0.91(t, J = 7.2 Hz, 0.70H), 0.85(t, J = 7.6 Hz, 3.17H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 170.2, 164.3, 142.2, 140.5, 134.7, 129.2, 128.9, 128.3, 128.1, 126.5, 54.3, 52.7, 49.1, 40.2, 27.8, 21.6, 12.2, 11.0. **HRMS(ESI):** m/z calcd for $C_{22}H_{27}N_2O_4S$ $[M+H]^+$: 415.1692, found: 415.1685.



5g
dr = 5:1

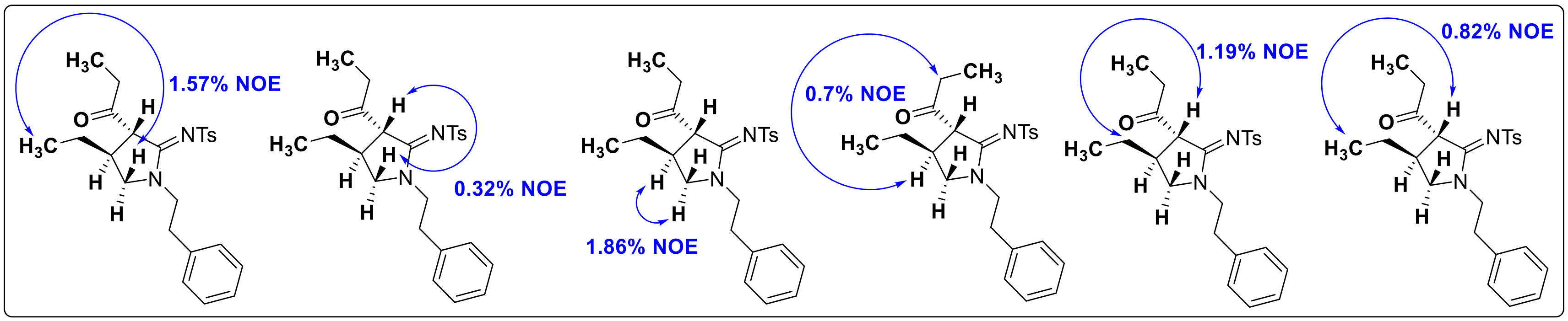
Preparation of Compound 5g: The reaction of cyclic amidine **2g** (304 mg, 0.66 mmol), MeMgBr (0.46 mL, 1.4 mmol) and CuCN (65 mg, 0.73 mmol) was carried out using general procedure **3G**, the product **5g** obtained in 84% yield (264 mg) (dr = 5:1) as a pale yellow oil; **IR (neat):** 3056, 2983, 2967, 2916, 2856, 1736, 1578, 1479, 1456, 1371, 1274, 1255, 1179, 1147, 1092, 1023, 916, 891 cm^{-1}; **^{1}H NMR (400 MHz, $CDCl_3$): δ** ppm 7.74(d, J = 8.0 Hz, 2.35H), 7.20(d, J = 8.0 Hz, 2.42H), 5.29(s, 1.59H), 4.41(d, J = 8.4 Hz, 0.20H), 4.23(s, 0.99H), 4.20-4.03(m, 4.31H), 3.96-3.92(m, 1.01H), 3.81(t, J = 8.4 Hz, 0.21H), 3.48(d, J = 10 Hz, 0.17H), 3.44(d, J = 10.4 Hz, 1.04H), 2.37(s, 3.66H), 2.35-2.31(m, 0.89H), 2.26(s, 1.12H), 2.10(s, 1.18H), 2.03(s, 0.92H), 1.98-1.61(m, 16.90H), 1.51-1.42(m, 1.99H), 1.24(t, J = 7.2 Hz, 1.37H), 1.19(t, J = 7.2 Hz, 3.49H), 0.99(t, J = 7.6 Hz, 0.69H), 0.92(t, J = 7.6 Hz, 3.00H); **^{13}C NMR (100 MHz, $CDCl_3$): δ** ppm 169.7, 164.1, 141.8, 140.9, 129.0, 126.2, 61.6, 61.3, 60.5, 60.3, 60.3, 54.1, 53.5, 53.3, 52.2, 41.2, 40.7, 38.6, 38.5, 37.8, 37.7, 33.1, 32.5, 30.8, 30.7, 30.7, 30.6, 27.6, 27.6, 27.1, 22.4, 21.5, 14.4, 14.2, 12.5, 11.3. **HRMS(ESI):** m/z calcd for $C_{26}H_{37}N_2O_4S$ [M+H]$^+$: 473.2469, found: 473.2465.



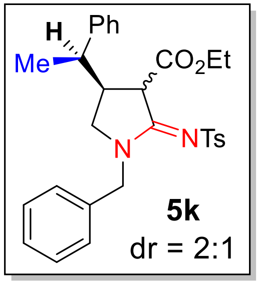
5p
(major diastereomer)

Preparation of Compound 5p (data of major diastereomer): The reaction of cyclic amidine **2p** (542 mg, 1.27 mmol), MeMgBr (0.9 mL, 2.67 mmol) and CuCN (125 mg, 1.39 mmol) was carried out using general procedure **3G**, the product **5p** obtained in 85% yield (477 mg) (dr = 4:1) as a pale yellow oil; **IR (neat):** 3063, 3030, 2969, 2935, 2873, 1734, 1584, 1575, 1488, 1460, 1371, 1295, 1282, 1261, 1222, 1183, 1148, 1092, 1026, 901 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.79(d, *J* = 8.4 Hz, 2H), 7.26-7.19(m, 5H), 7.13(d, *J* = 7.6 Hz, 2H), 4.21-4.07(m, 2H), 4.04(d, *J* = 1.6 Hz, 1H), 3.74-3.61(m, 2H), 3.51(dd, *J* = 7.2 Hz, 10.4 Hz, 1H), 2.91-2.81(m, 3H), 2.39(s, 3H), 2.25-2.20(m, 1H), 1.44-1.33(m, 1H), 1.30-1.27(m, 1H), 1.24(t, *J* = 7.2 Hz, 3H), 0.82(t, *J* = 7.2 Hz, 3H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 169.6, 164.1, 142.0, 140.8, 138.2, 129.1, 128.8, 128.7, 126.7, 126.4, 61.6, 54.6, 54.1, 46.9, 40.5, 32.9, 27.7, 21.5, 14.1, 11.2; **HRMS(ESI):** m/z calcd for $C_{24}H_{31}N_2O_4S$ [M+H]$^+$: 443.1999, found: 443.2010;

1D NOESY data (500 MHz, CDCl$_3$) of major diastereomer of 5p:



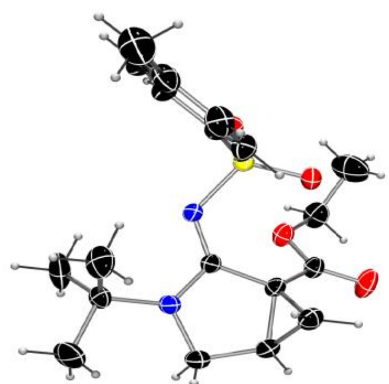
Preparation of Compound 5k: The reaction of cyclic amidine **2k** (1.1 g, 2.25 mmol), MeMgBr (1.57 mL, 4.73 mmol) and CuCN (221 mg, 2.47 mmol) was carried out using general procedure **3G**, the product **5k** obtained in 81% yield (915 mg) (dr = 2:1) as a pale



yellow oil; **IR (neat):** 3057, 2985, 2926, 2854, 1729, 1589, 1491, 1452, 1370, 1271, 1186, 1147, 1092, 1027, 896, 815, 764, 719 cm^{-1}; **^{1}H NMR (400 MHz, CDCl$_3$): δ** ppm 7.74-7.70(m, 3.02H), 7.35-7.25(m, 8.45H), 7.23-7.17(m, 7.47H), 7.09(d, *J* = 7.2 Hz, 1.16H), 7.02(d, *J* = 6.8 Hz, 1.96H), 4.86(d, *J* = 14.8 Hz, 0.55H) 4.78(d, *J* = 14.4 Hz, 0.95H), 4.49(d, *J* = 14.4 Hz, 0.55H), 4.32(d, *J* = 8.0 Hz, 0.57H), 4.26(d, *J* = 14.8 Hz, 0.98H), 4.20(s, 0.98H), 4.15-4.01(m, 2.56H), 3.89-3.84(m, 0.57H), 3.54-3.50(m, 1.00H), 3.46(d, *J* = 3.6 Hz, 0.48H), 3.43(s, 0.58H), 3.14(d, *J* = 11.2 Hz, 0.93H), 2.99-2.90(m, 0.56H), 2.73-2.62(m, 2.51H), 2.39(s, 3.00), 2.36(s, 1.75H), 1.17(t, *J* = 6.8 Hz, 3.05H), 1.14-1.05(m, 6.37H); **^{13}C NMR (100 MHz, CDCl$_3$): δ** ppm 169.4, 168.0, 165.7, 164.4, 144.0, 142.3, 142.1, 142.0, 140.5, 140.4, 134.7, 134.5, 129.1, 129.0, 128.8, 128.8, 128.7, 128.2, 128.2, 128.0, 127.4, 127.1, 126.8, 126.6, 126.4, 126.3, 61.7, 61.3, 52.9, 51.9, 51.5, 50.4, 49.1, 48.8, 44.8, 44.2, 42.5, 39.8, 22.6, 21.5, 21.4, 17.8, 13.9, 13.7. **HRMS(ESI):** m/z calcd for $C_{29}H_{33}N_2O_4S$ [M+H]$^+$: 505.2156, found: 505.2149.

4. Crystal data and structure refinement for compound 2b

Single crystal X-ray analysis of ethyl (*Z*)-3-(*tert*-butyl)-2-(tosylimino)-3-azabicyclo[3.1.0]hexane-1-carboxylate (2b)



ORTEP diagram of compound 2b with ellipsoids adjusted to 30% probability

Table S6. Crystal data and structure refinement for compound 2b.

CCDC	1822350
Empirical formula	$C_{19}H_{26}N_2O_4S$
Formula weight	378.48 g/mol
Temperature	296(2) K
Wavelength	1.54178 Å
Crystal system, space group	Monoclinic, $P2_{1/c}$
Unit cell dimensions	a = 11.0612(3) Å alpha = 90 deg.
	b = 16.9769(5) Å beta = 114.2130(10) deg.
	c = 11.5356(3) Å gamma = 90 deg.
Volume	1975.64(10) Å^3
Z, Calculated density	4, 1.272 g/cm^3
Absorption coefficient	1.672 mm^-1
F(000)	808
Crystal size	0.150 x 0.150 x 0.100 mm^3
Theta range for data collection	4.945 to 72.401 deg.
Limiting indices	-13<=h<=13, -20<=k<=20, -13<=l<=14
Reflections collected / unique	31952 / 3887 [R(int) = 0.0628]
Completeness to theta =25.00	99.5 %

Absorption correction	Semi-empirical from equivalents
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	3887 / 0 / 235
Goodness-of-fit on F^2	1.063
Final R indices [I>2sigma(I)]	R1 = 0.0439, wR2 = 0.1073
R indices (all data)	R1 = 0.0529, wR2 = 0.1132
Absolute structure parameter	0.04
Extinction coefficient	n/a
Largest diff. peak and hole	0.232 and -0.330 eÅ^-3

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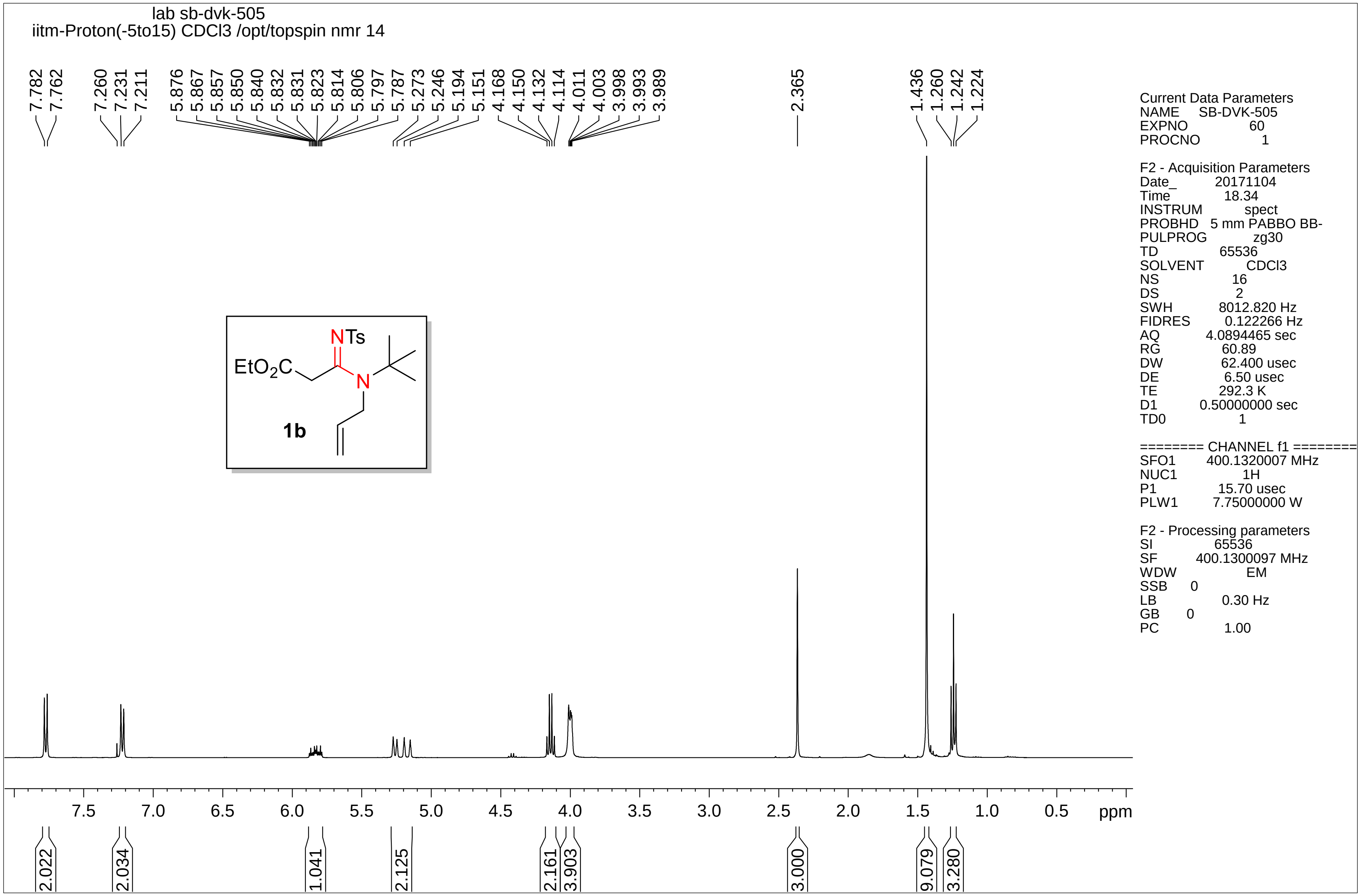
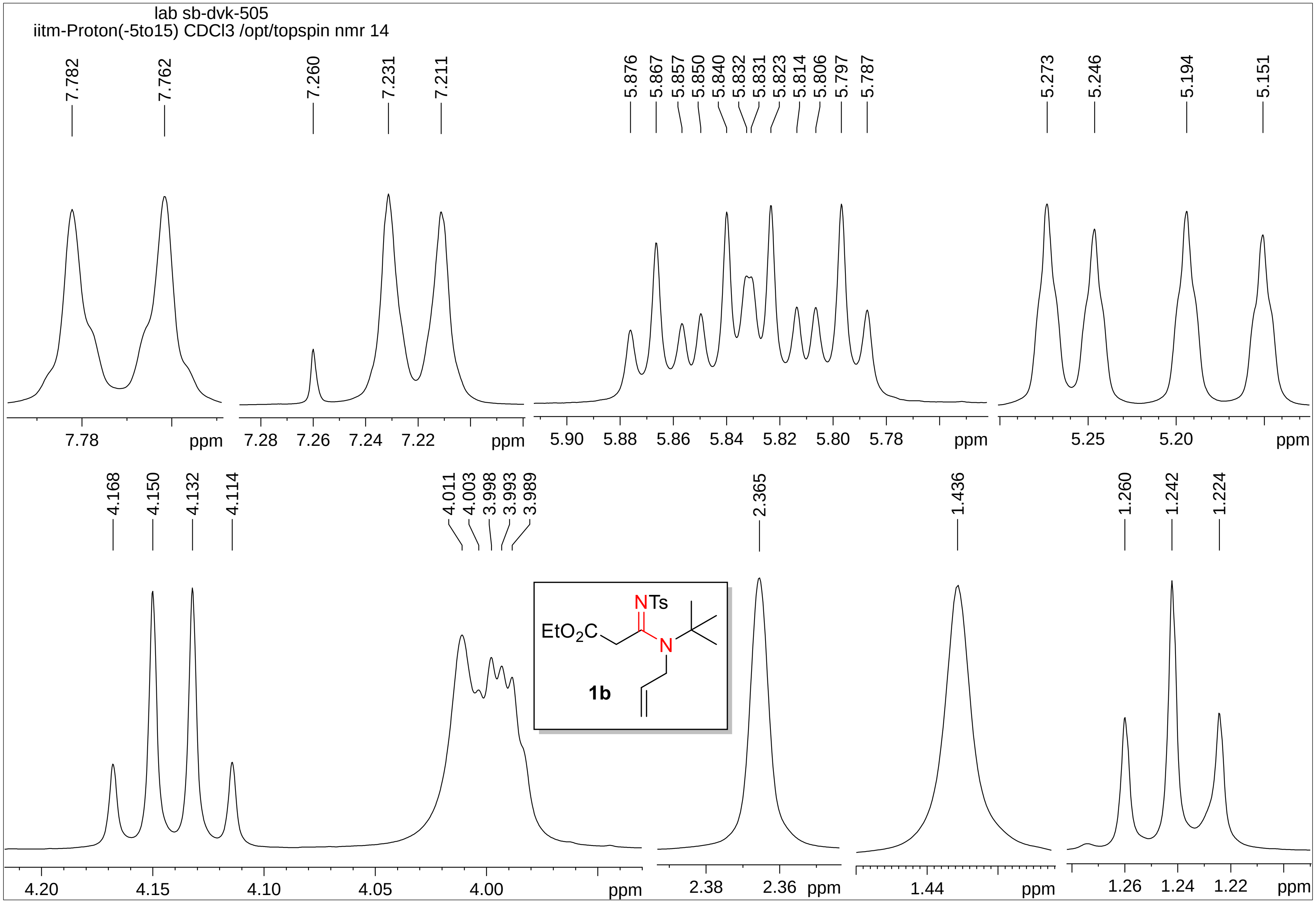
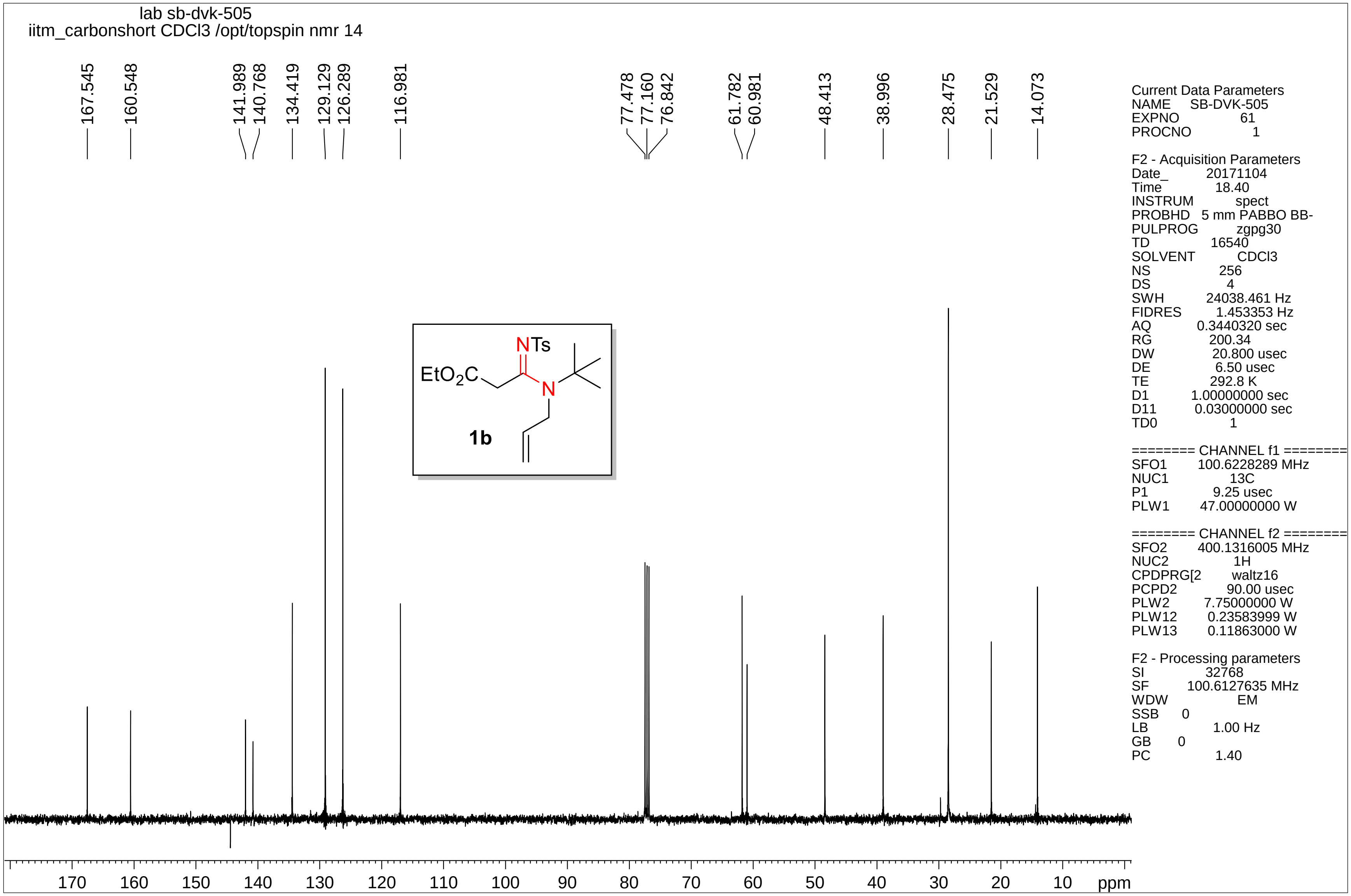


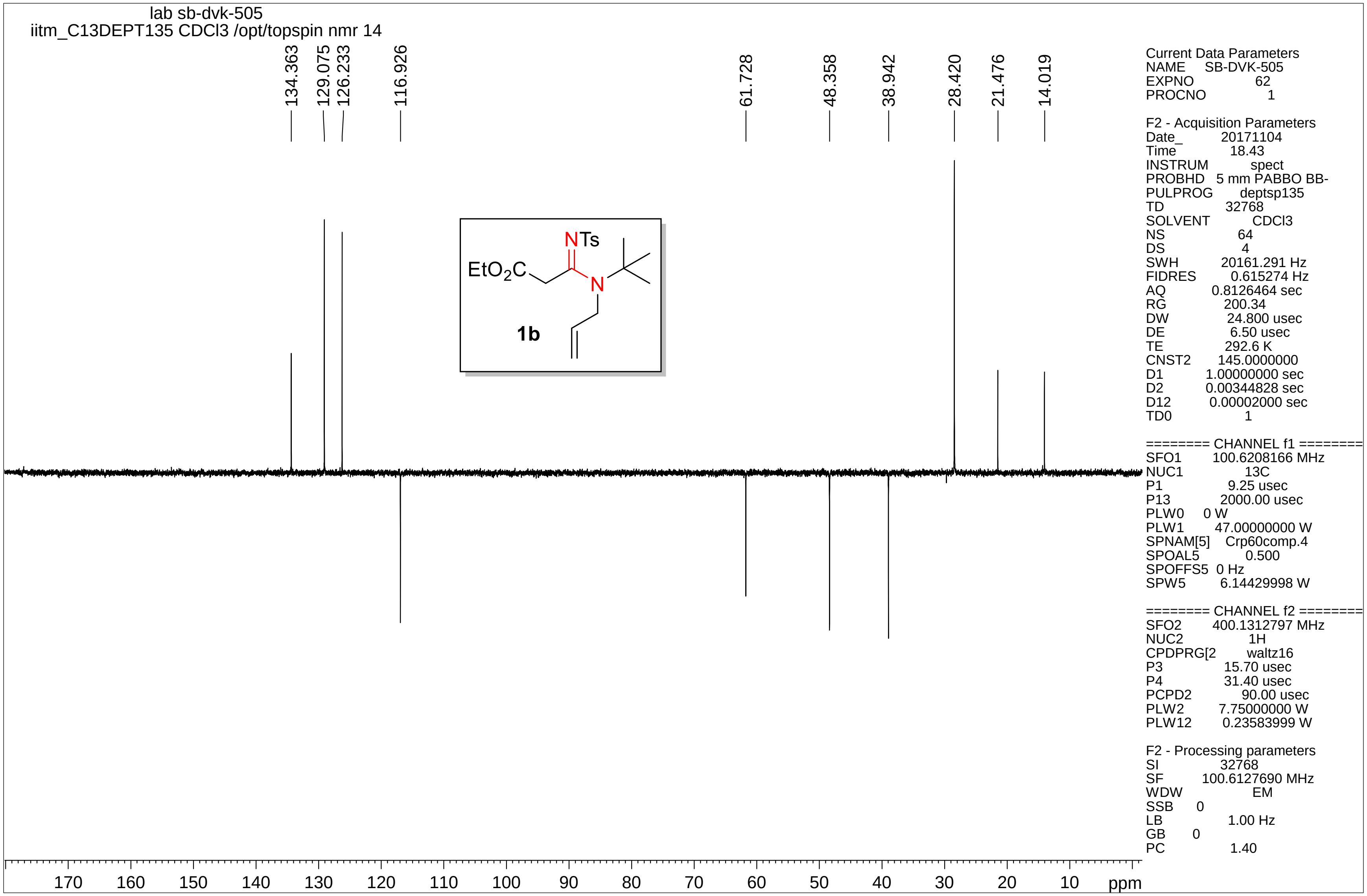
[1]H NMR spectrum of compound 1b



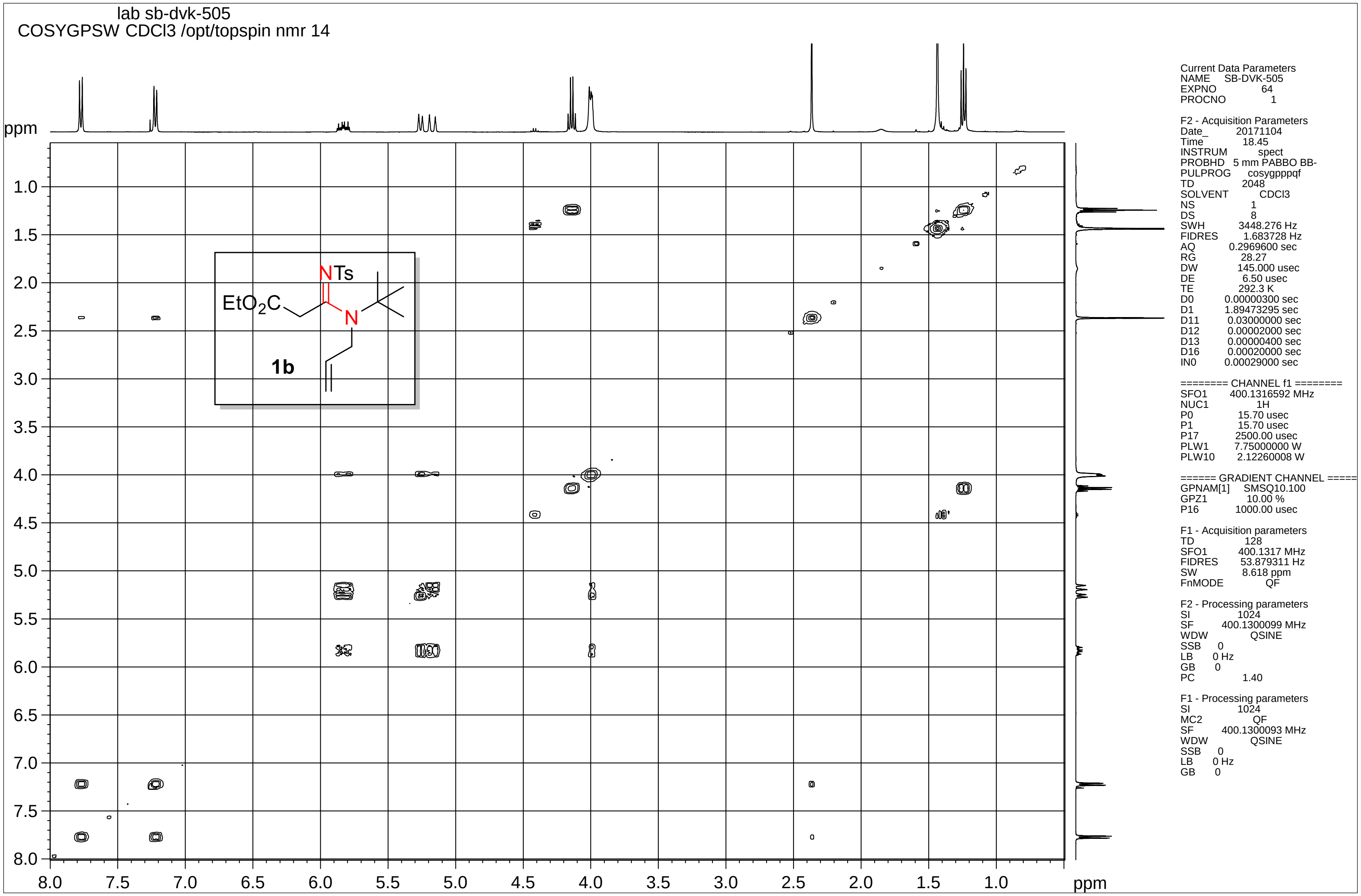
^{1}H NMR spectrum of compound 1b



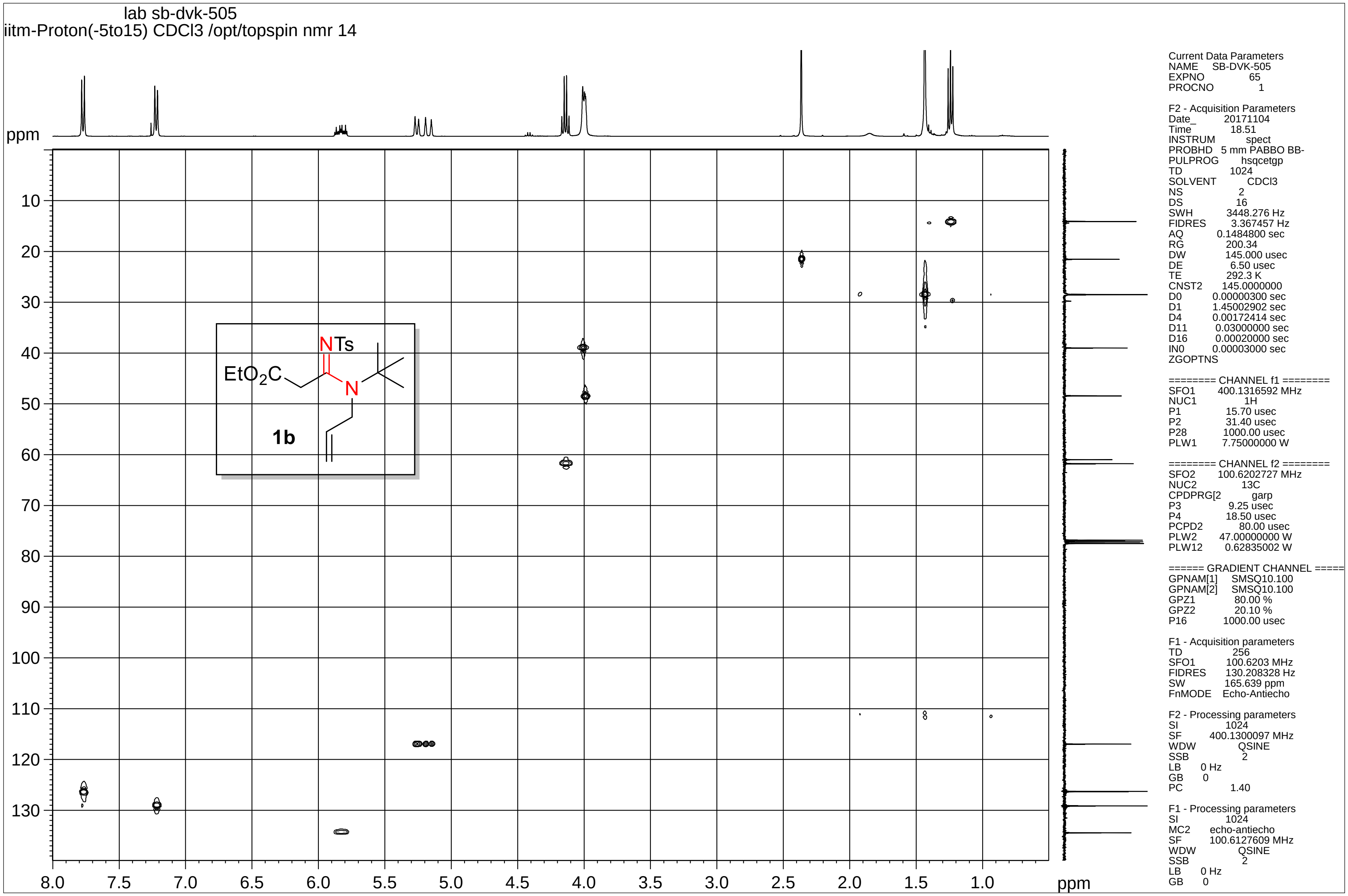
^{13}C NMR spectrum of compound 1b



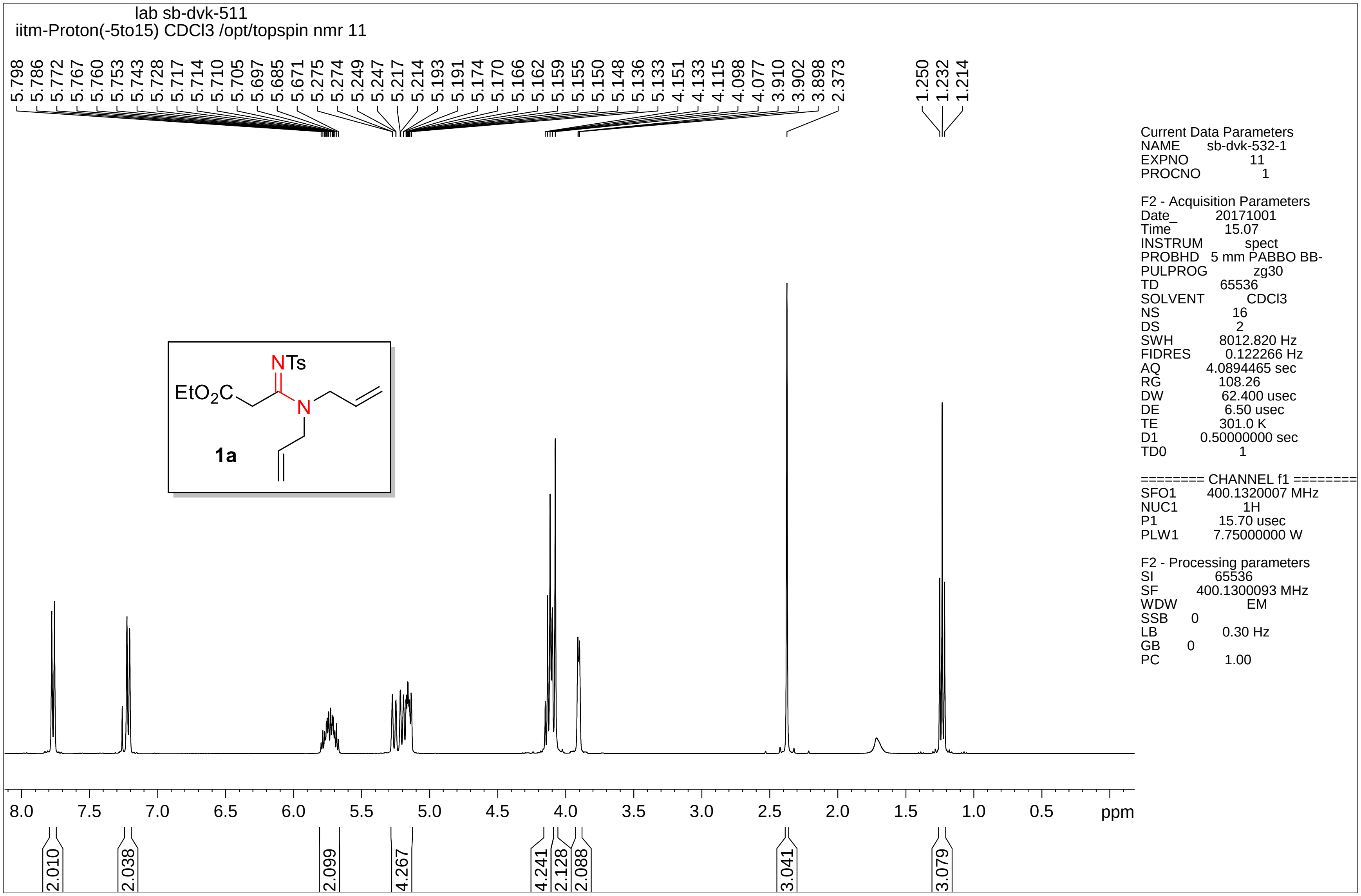
DEPT-135 NMR spectrum of compound 1b



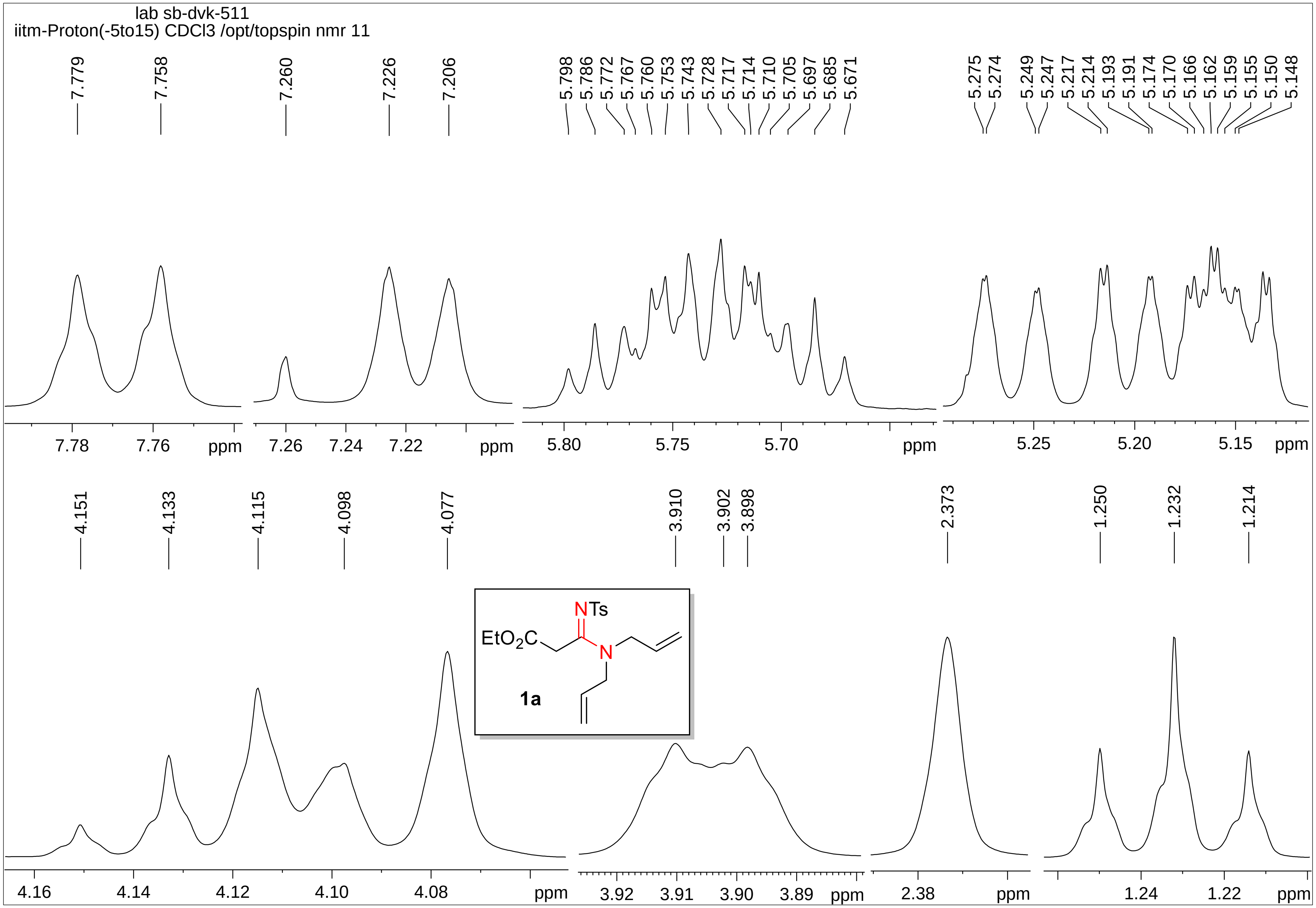
^{1}H-^{1}H COSY NMR spectrum of compound 1b



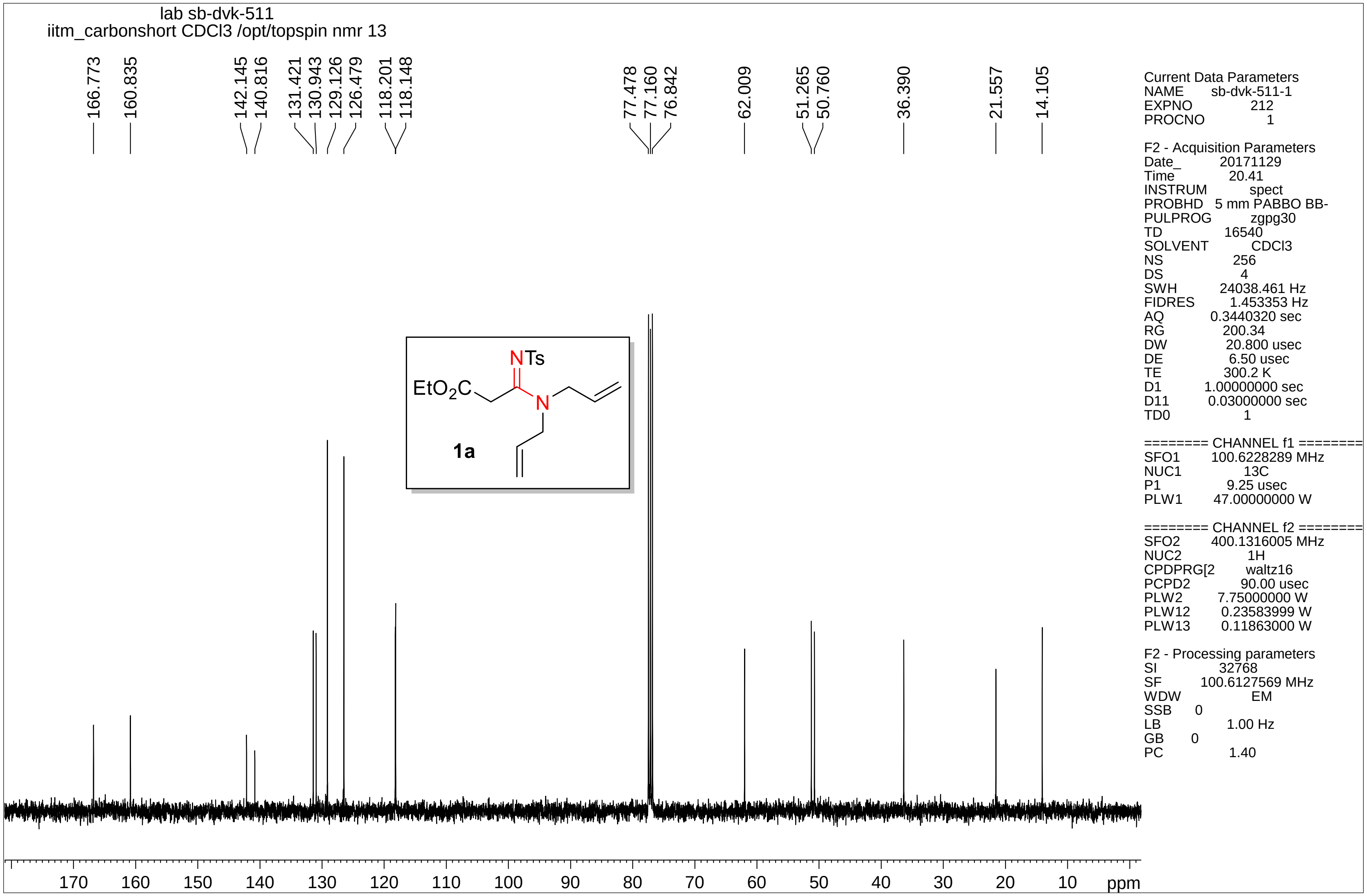
^{1}H-^{13}C HSQC NMR spectrum of compound 1b



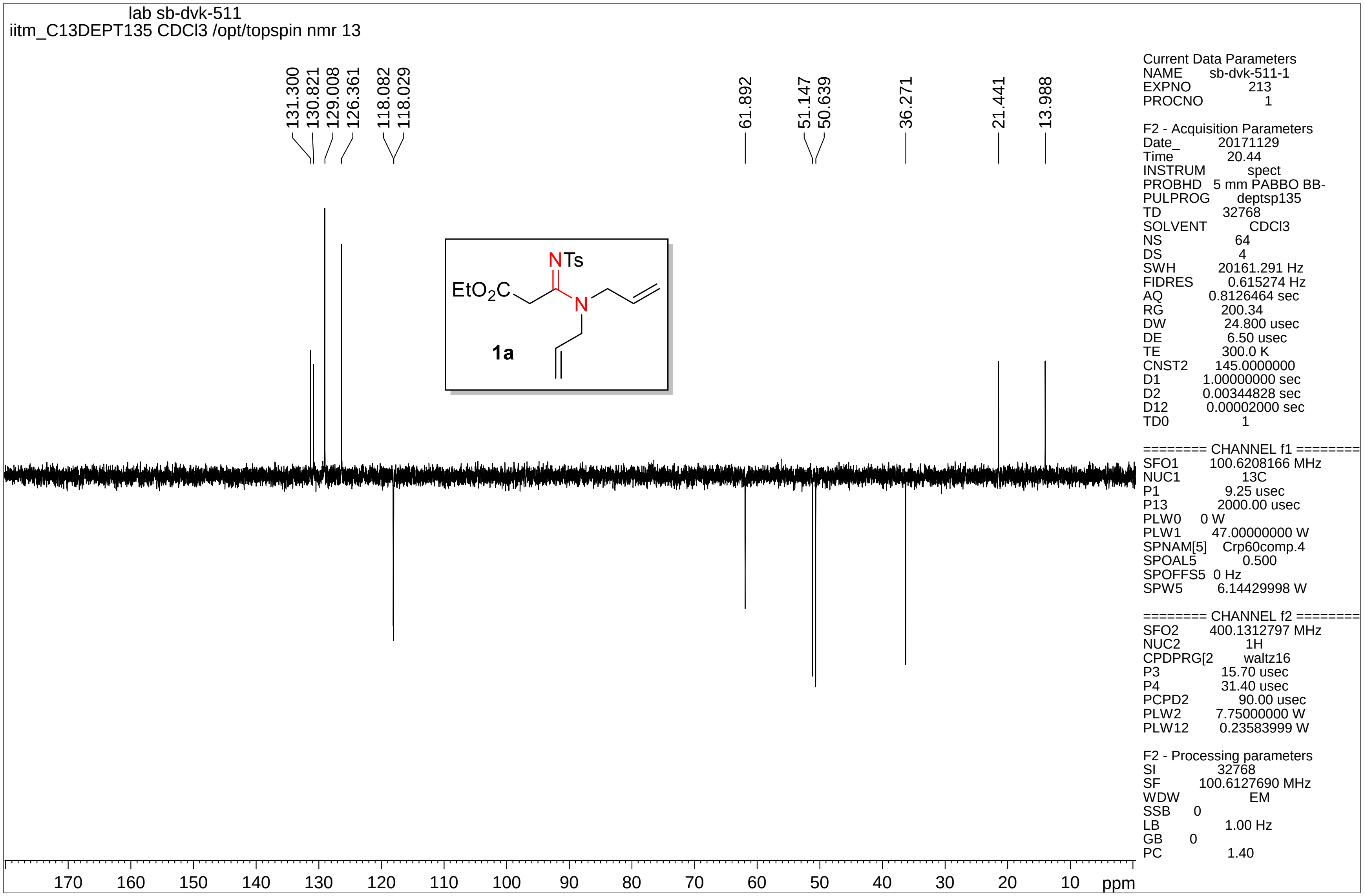
^{1}H NMR spectrum of compound 1a



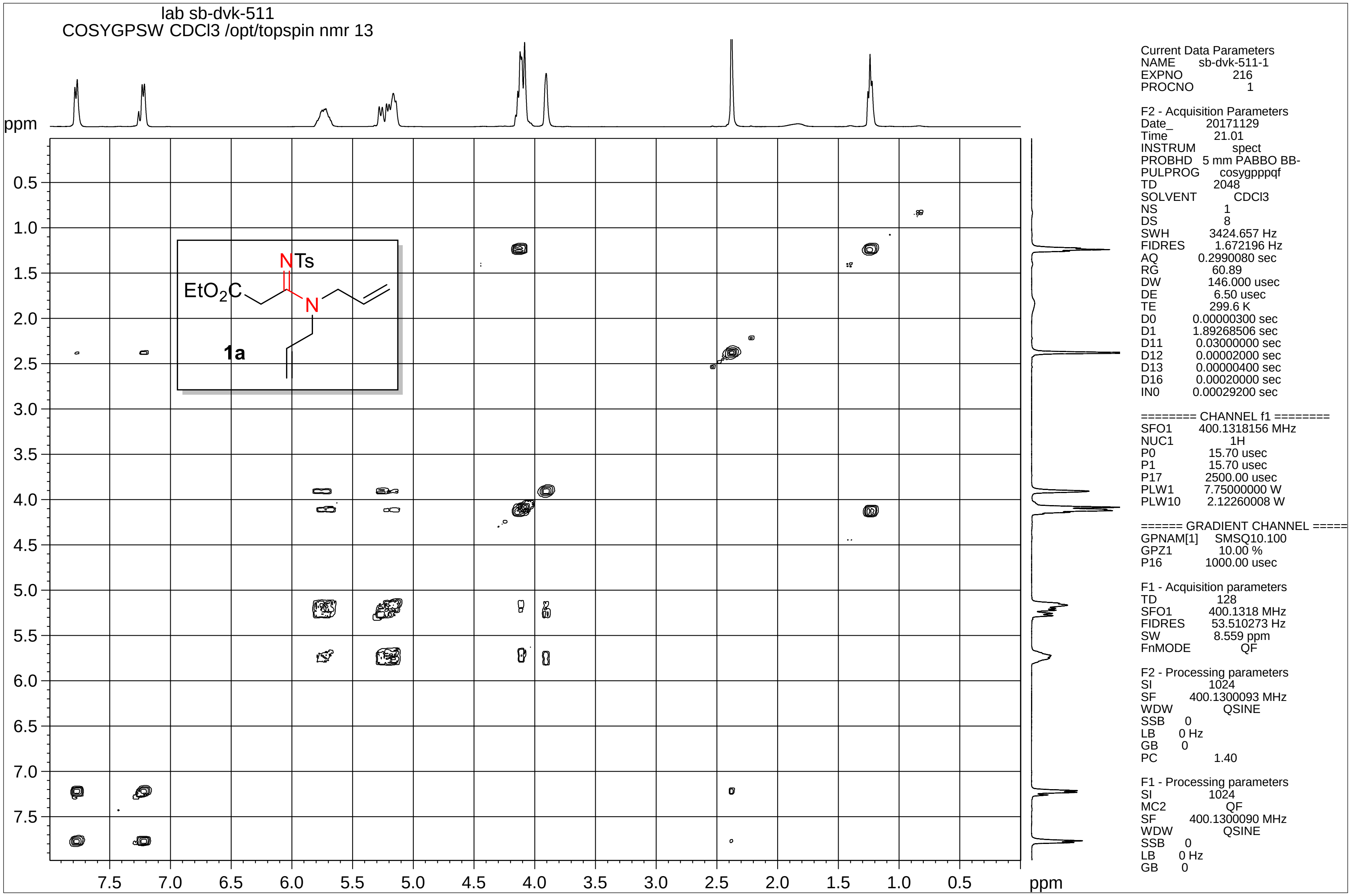
^{1}H NMR spectrum of compound 1a



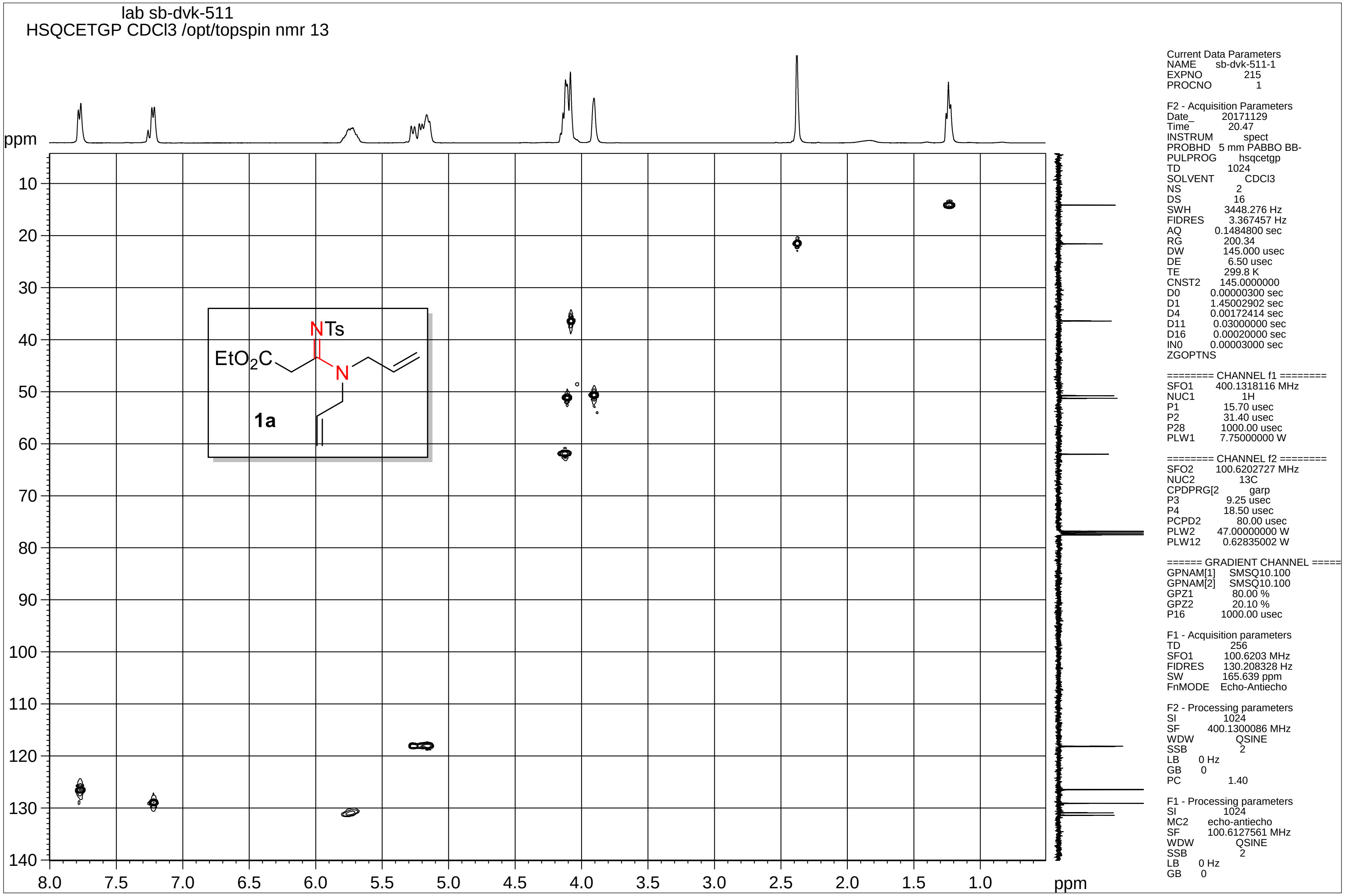
^{13}C NMR spectrum of compound 1a



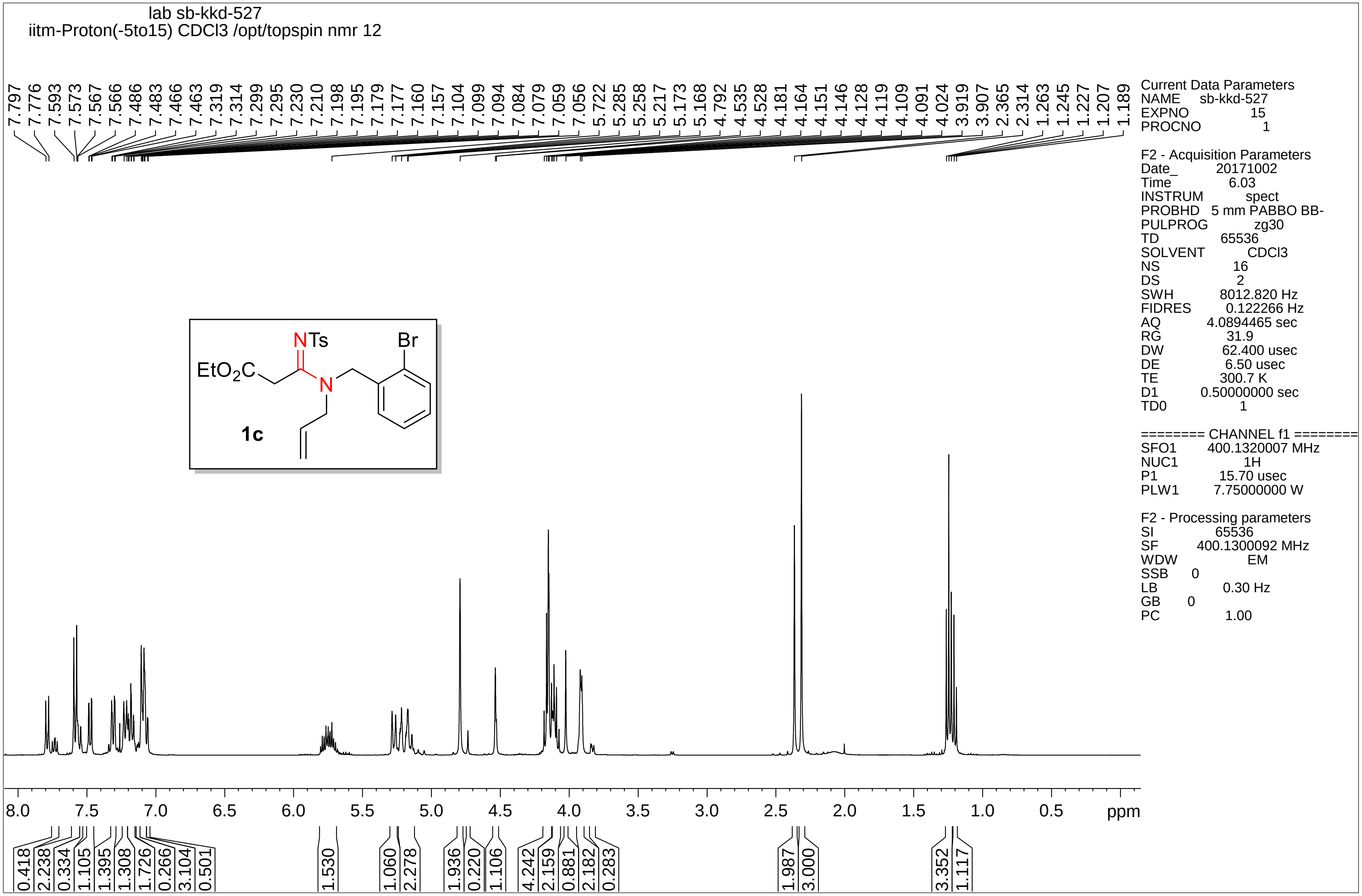
DEPT-135 NMR spectrum of compound 1a



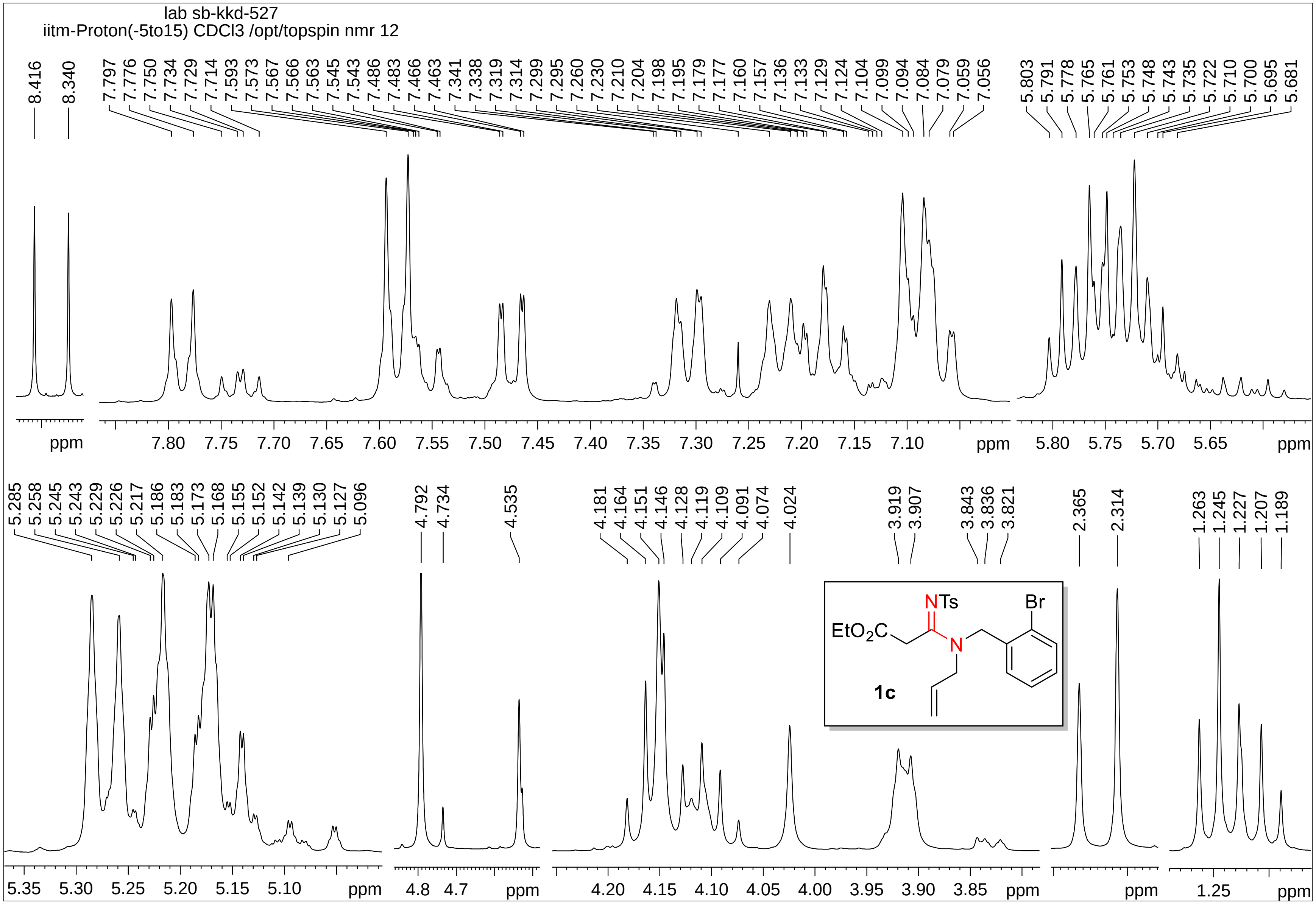
^{1}H-^{1}H COSY NMR spectrum of compound 1a



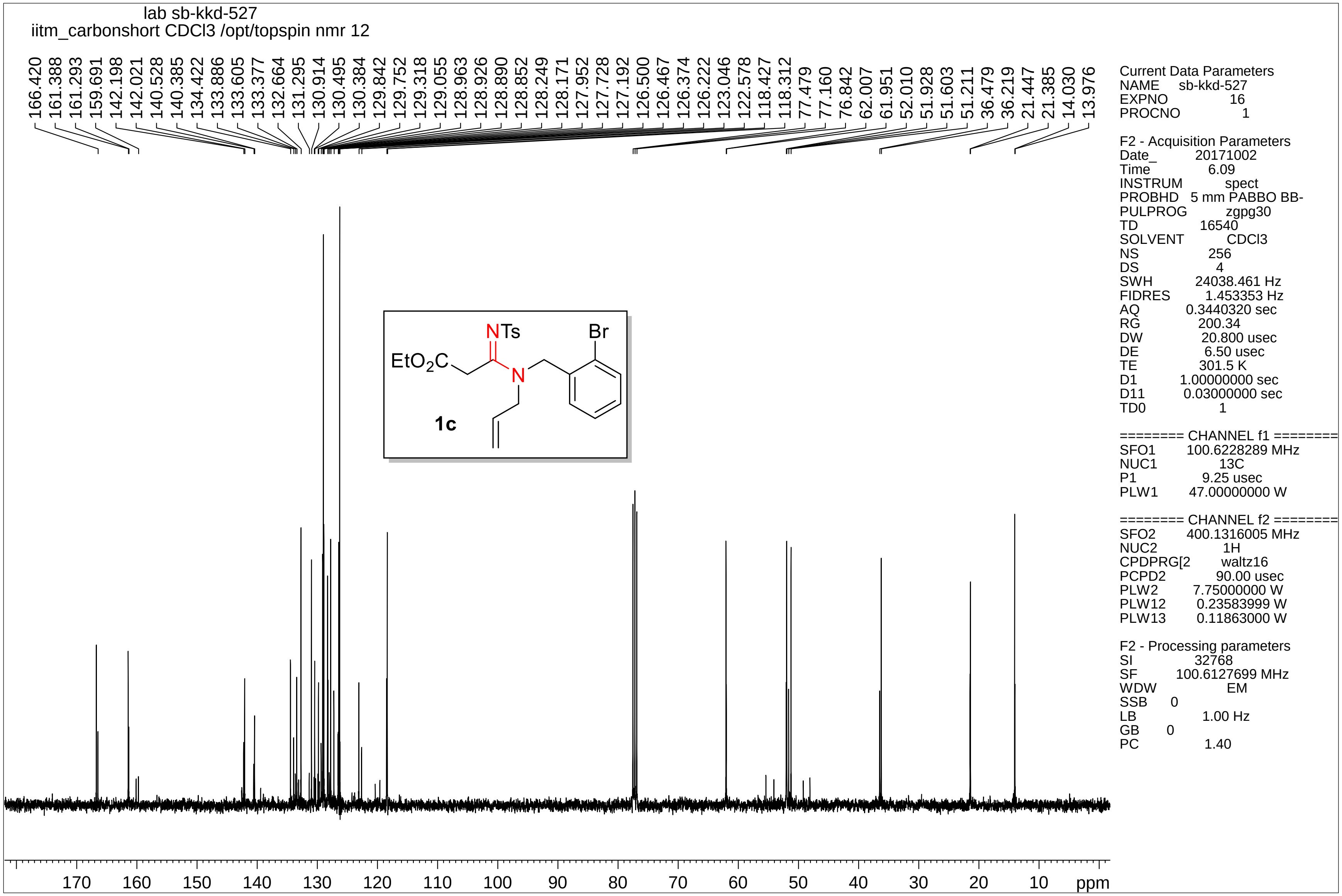
^{1}H-^{13}C HSQC NMR spectrum of compound 1a



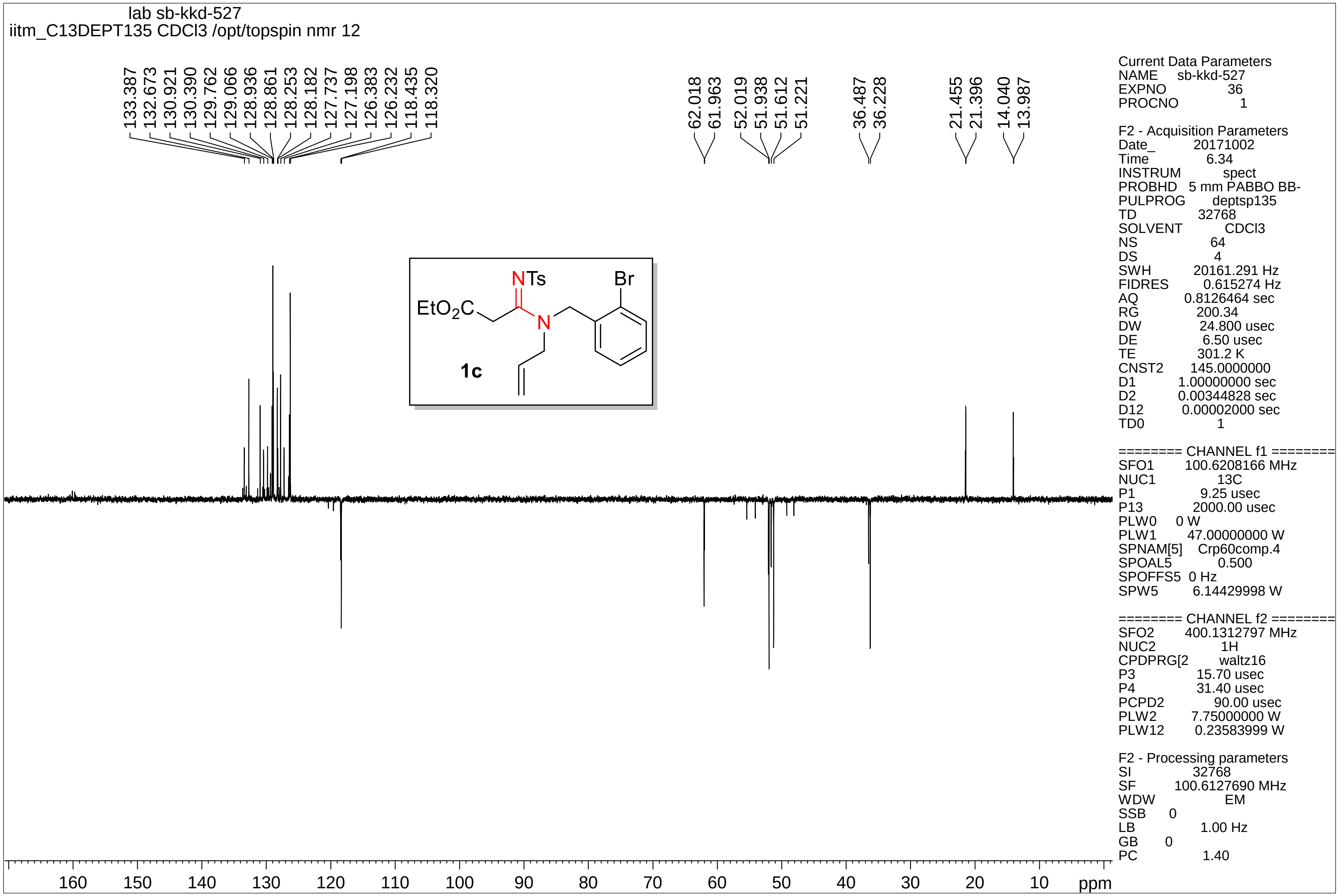
¹H NMR spectrum of compound 1c



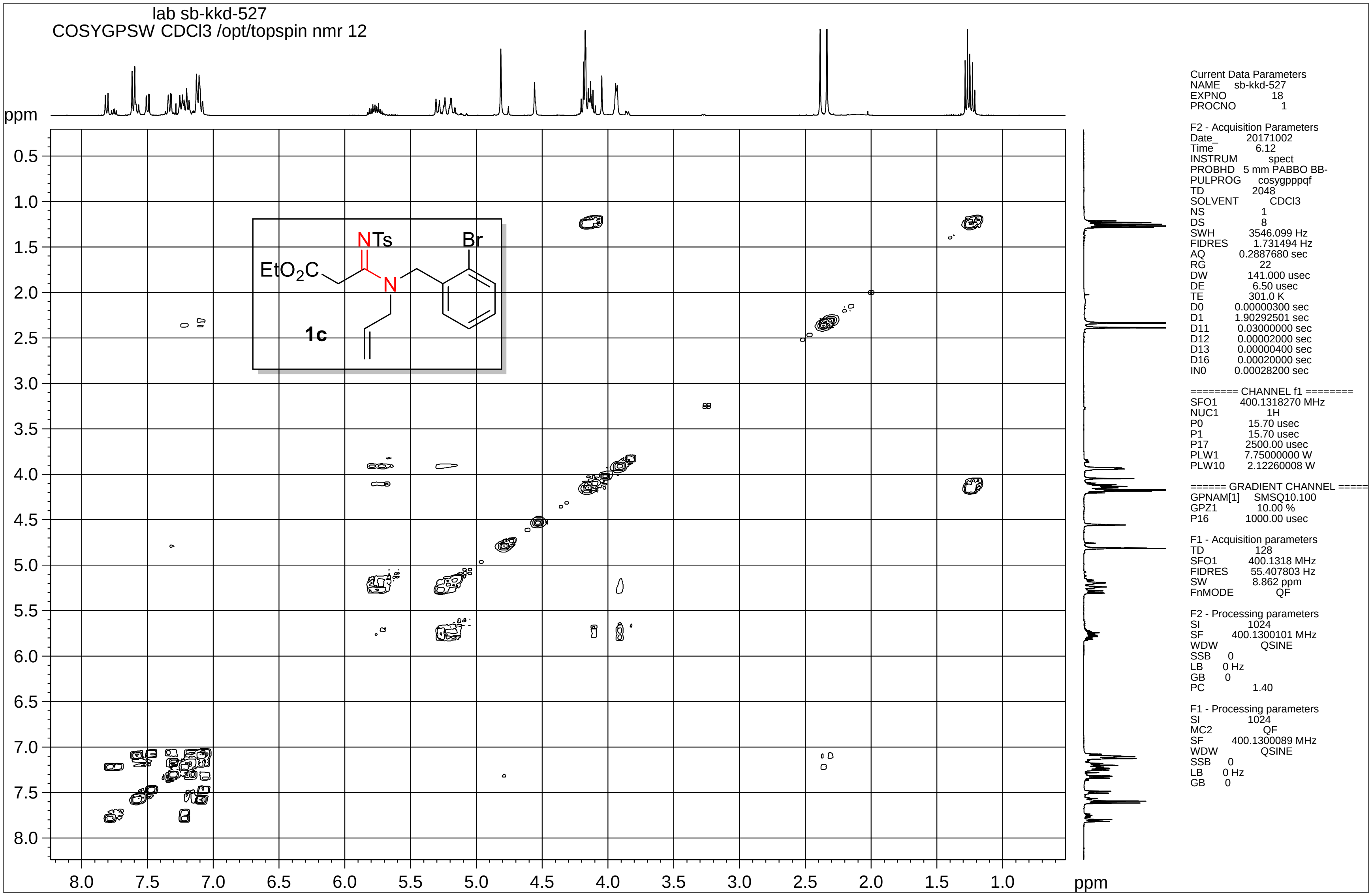
[1]H NMR spectrum of compound 1c



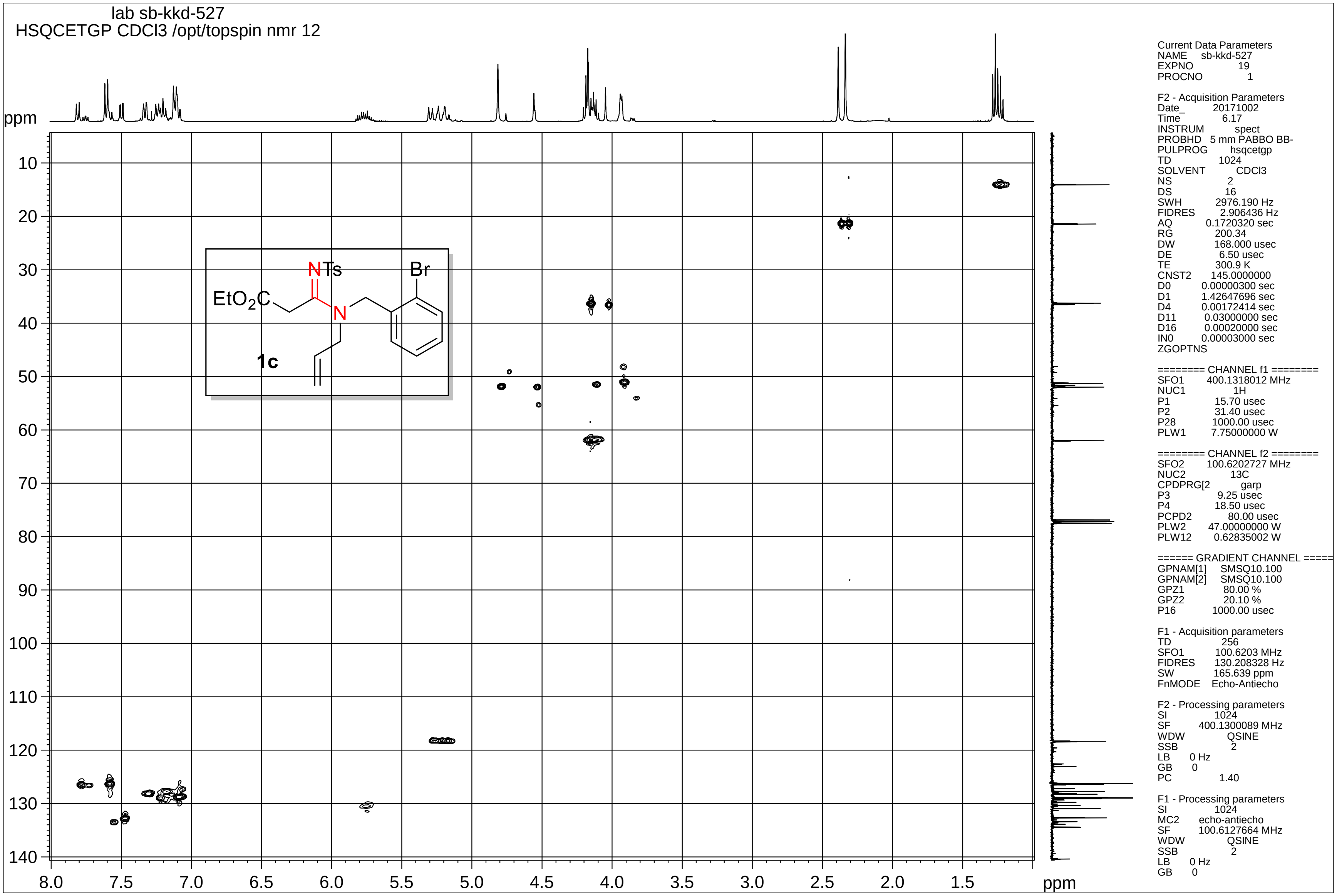
^{13}C NMR spectrum of compound 1c



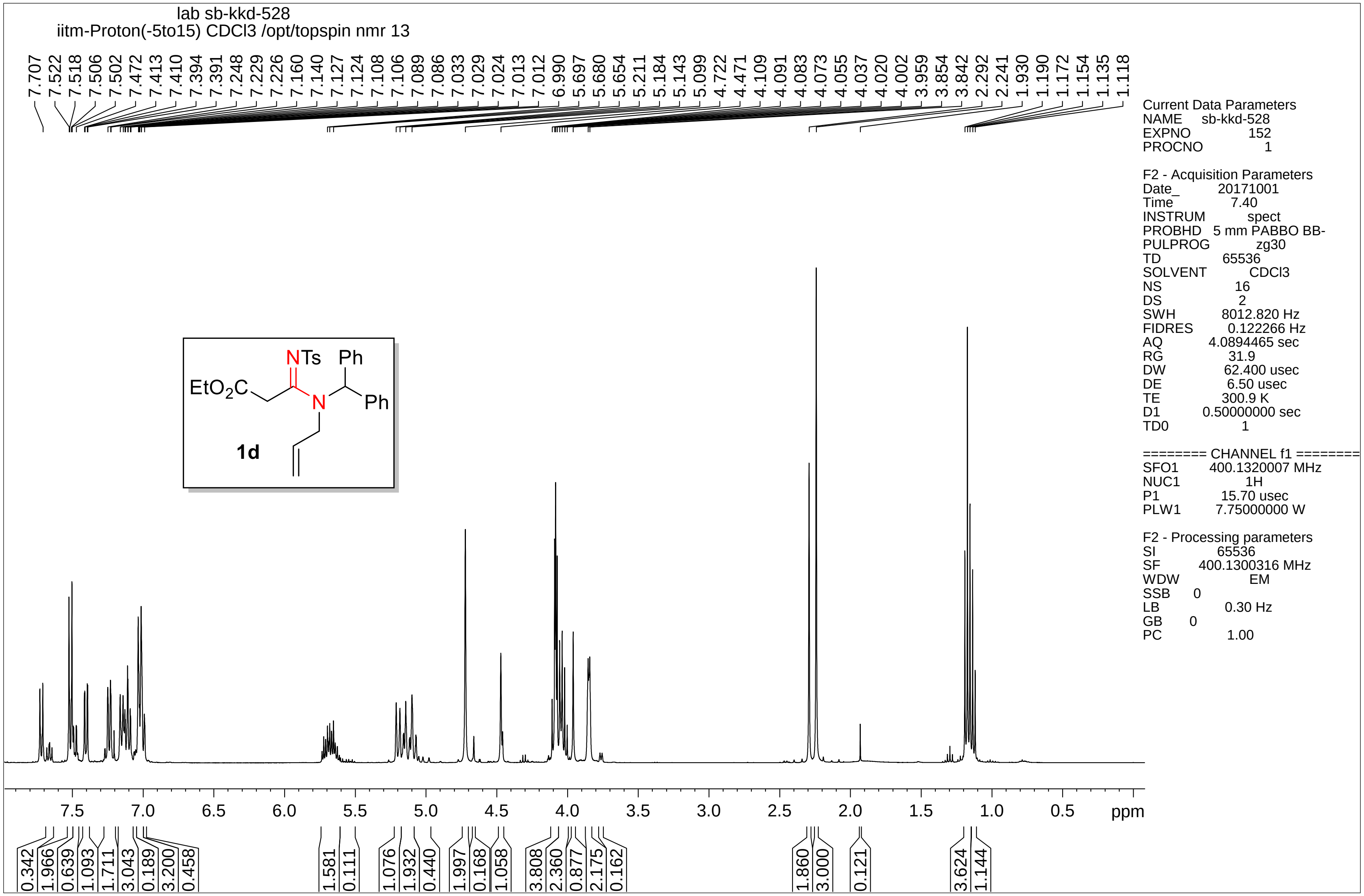
DEPT-135 NMR spectrum of compound 1c



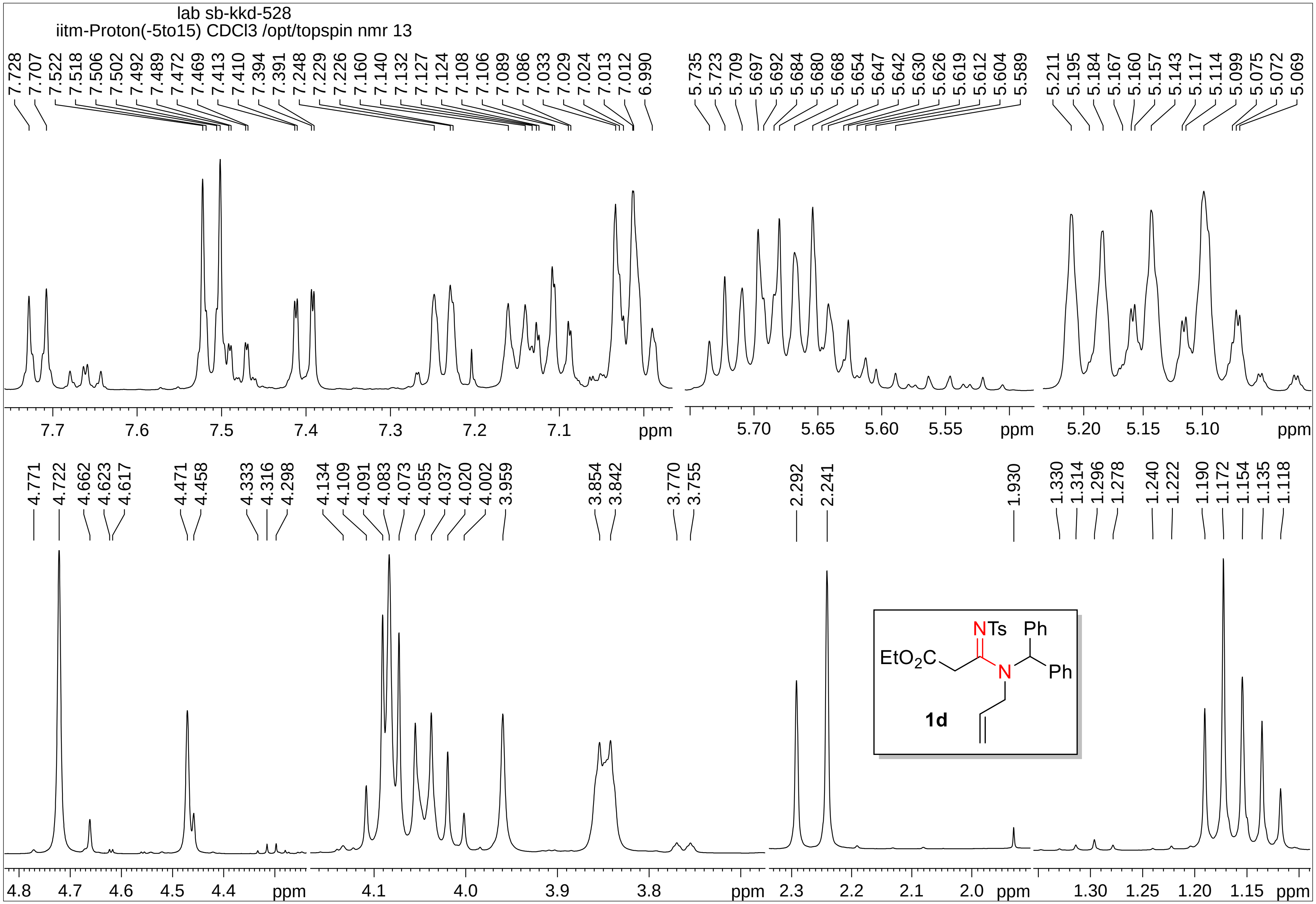
^{1}H-^{1}H COSY NMR spectrum of compound 1c



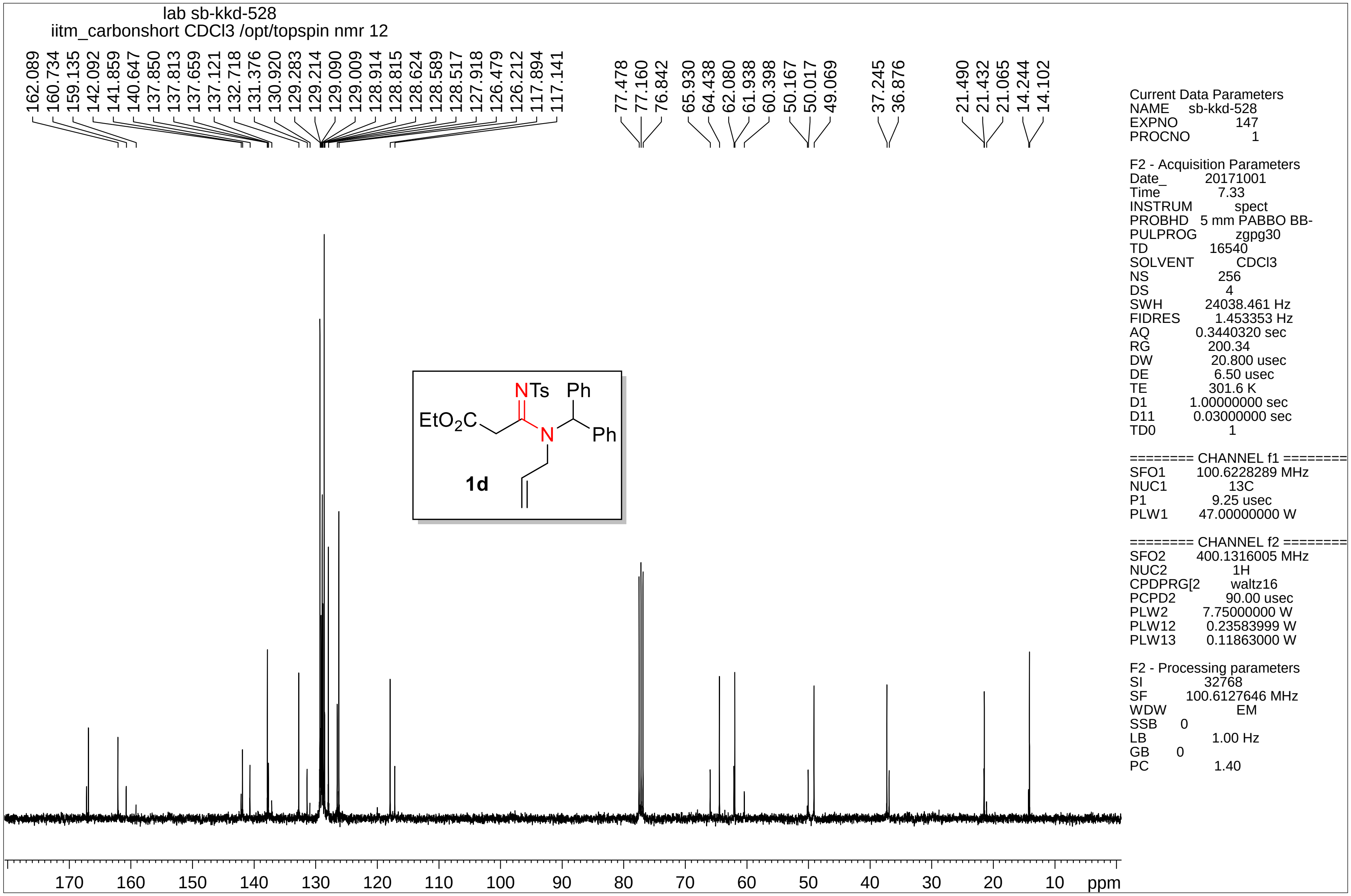
^{1}H-^{13}C HSQC NMR spectrum of compound 1c



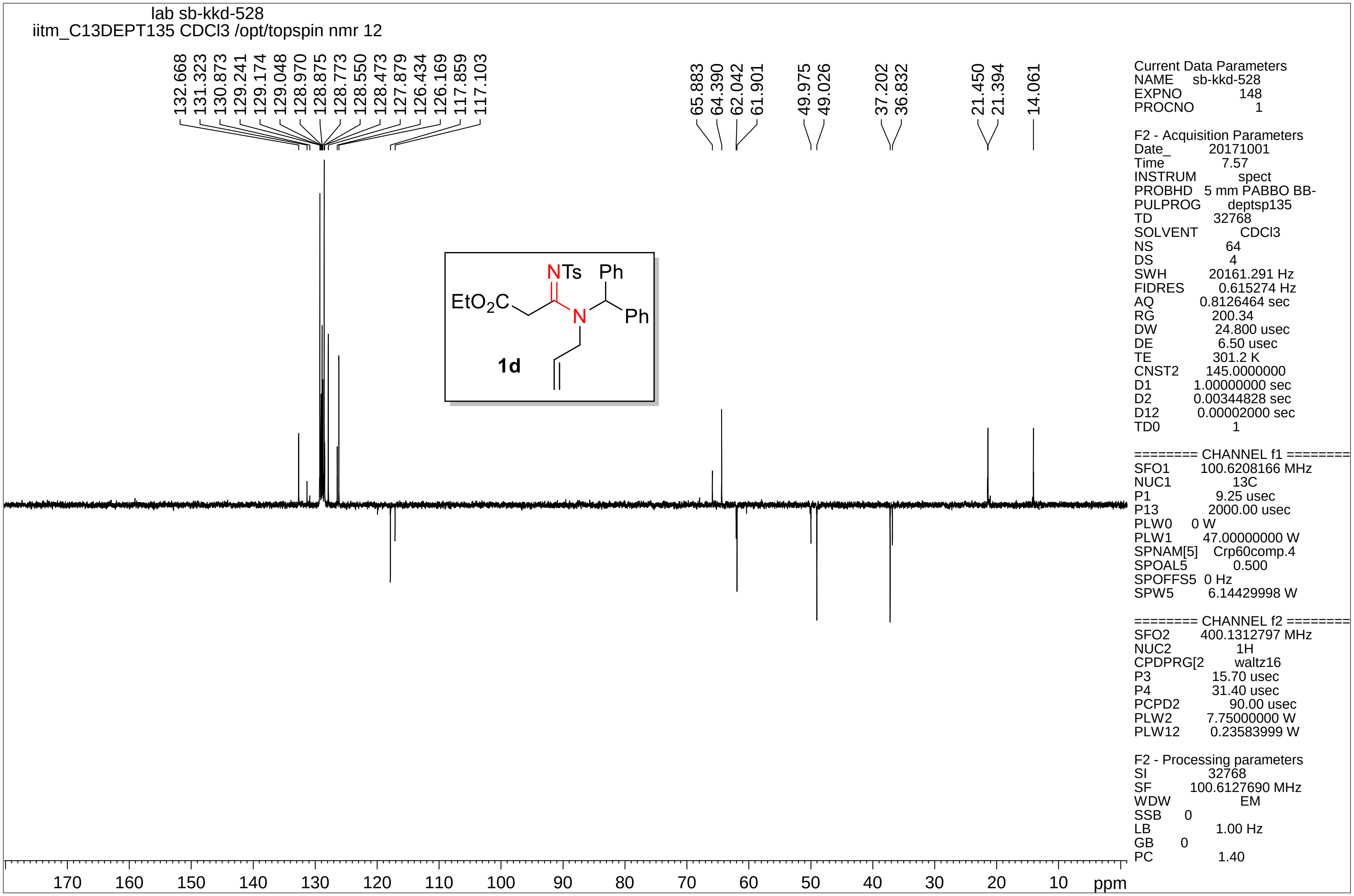
^{1}H NMR spectrum of compound 1d



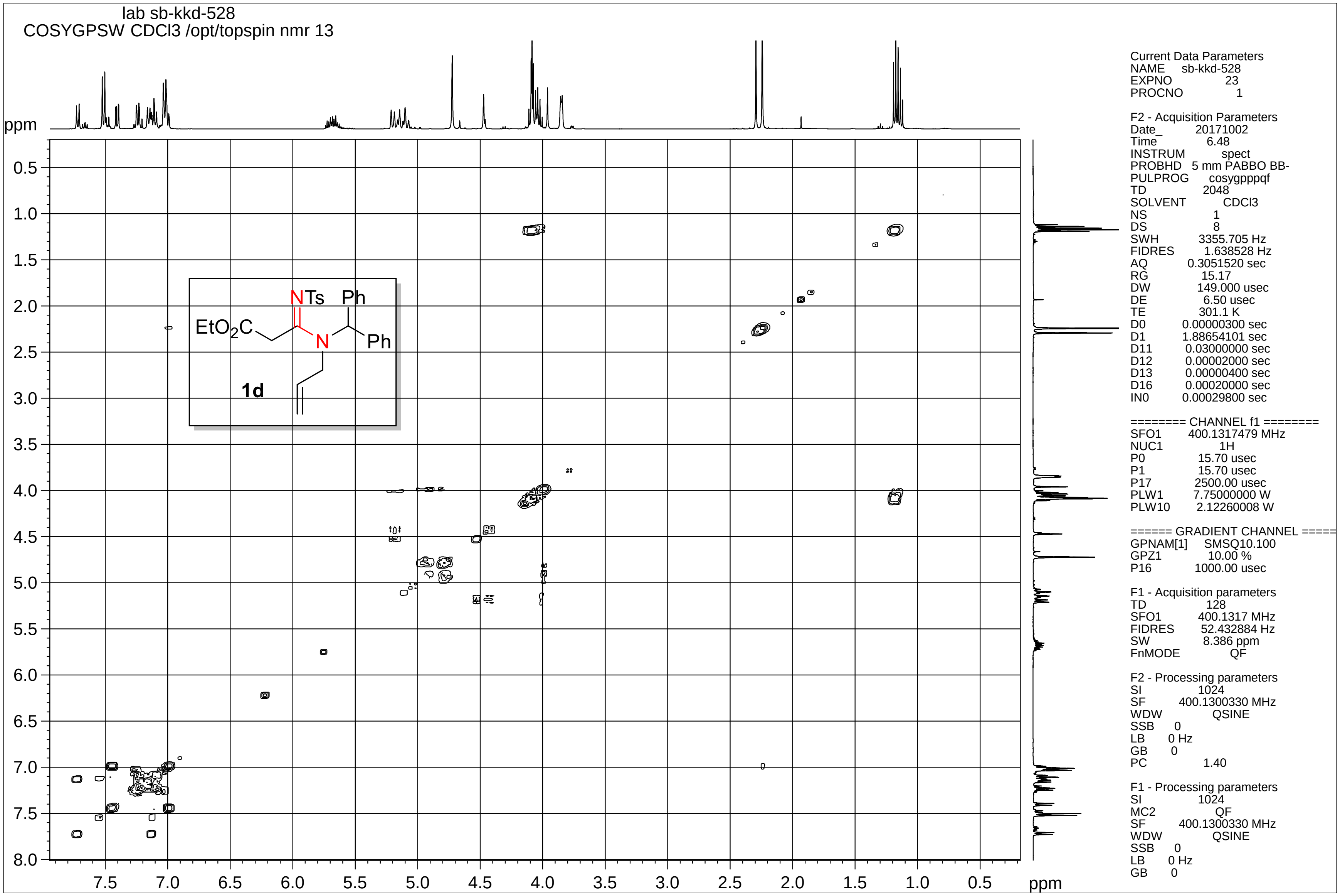
^{1}H NMR spectrum of compound 1d



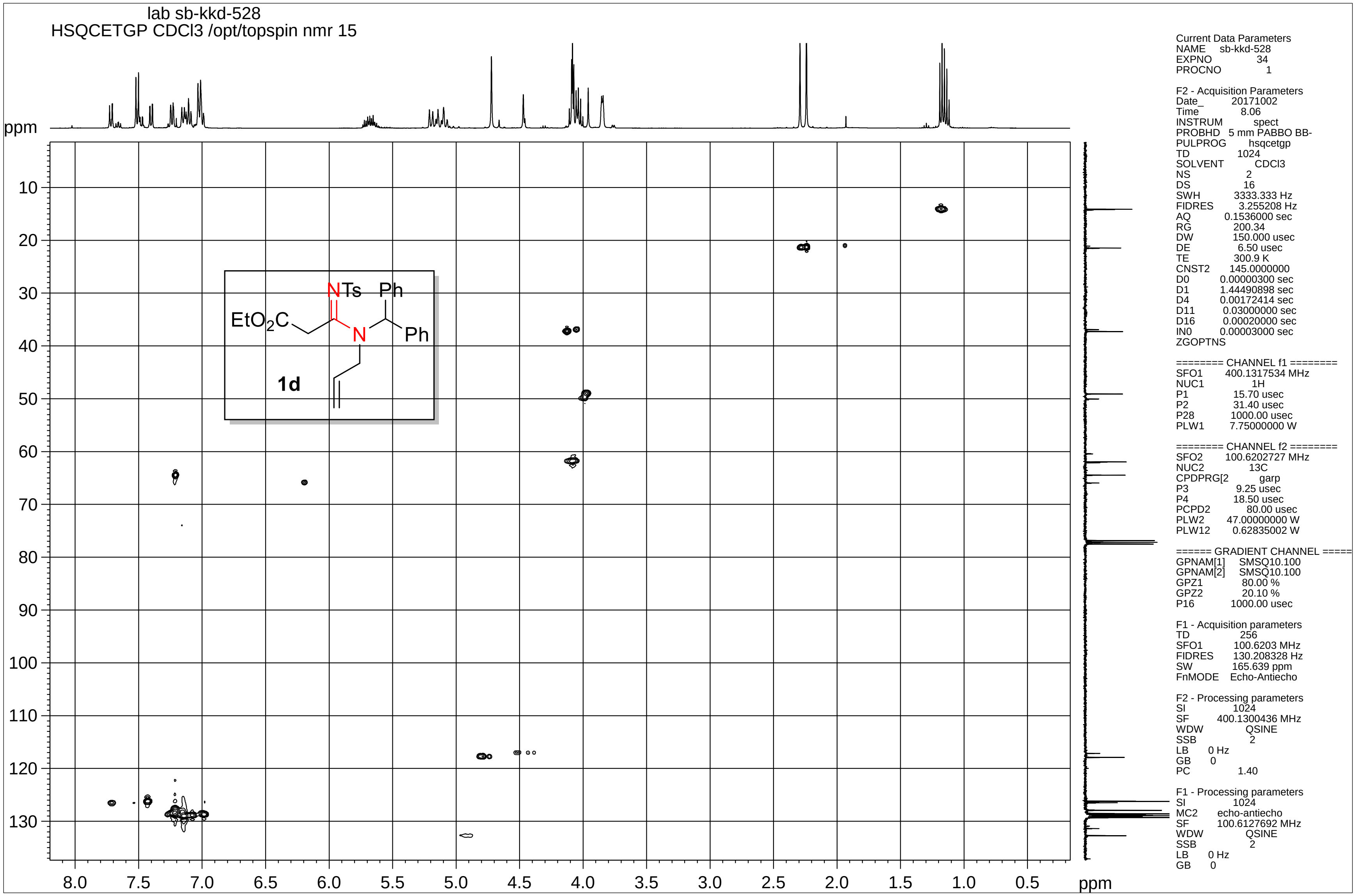
^{13}C NMR spectrum of compound 1d



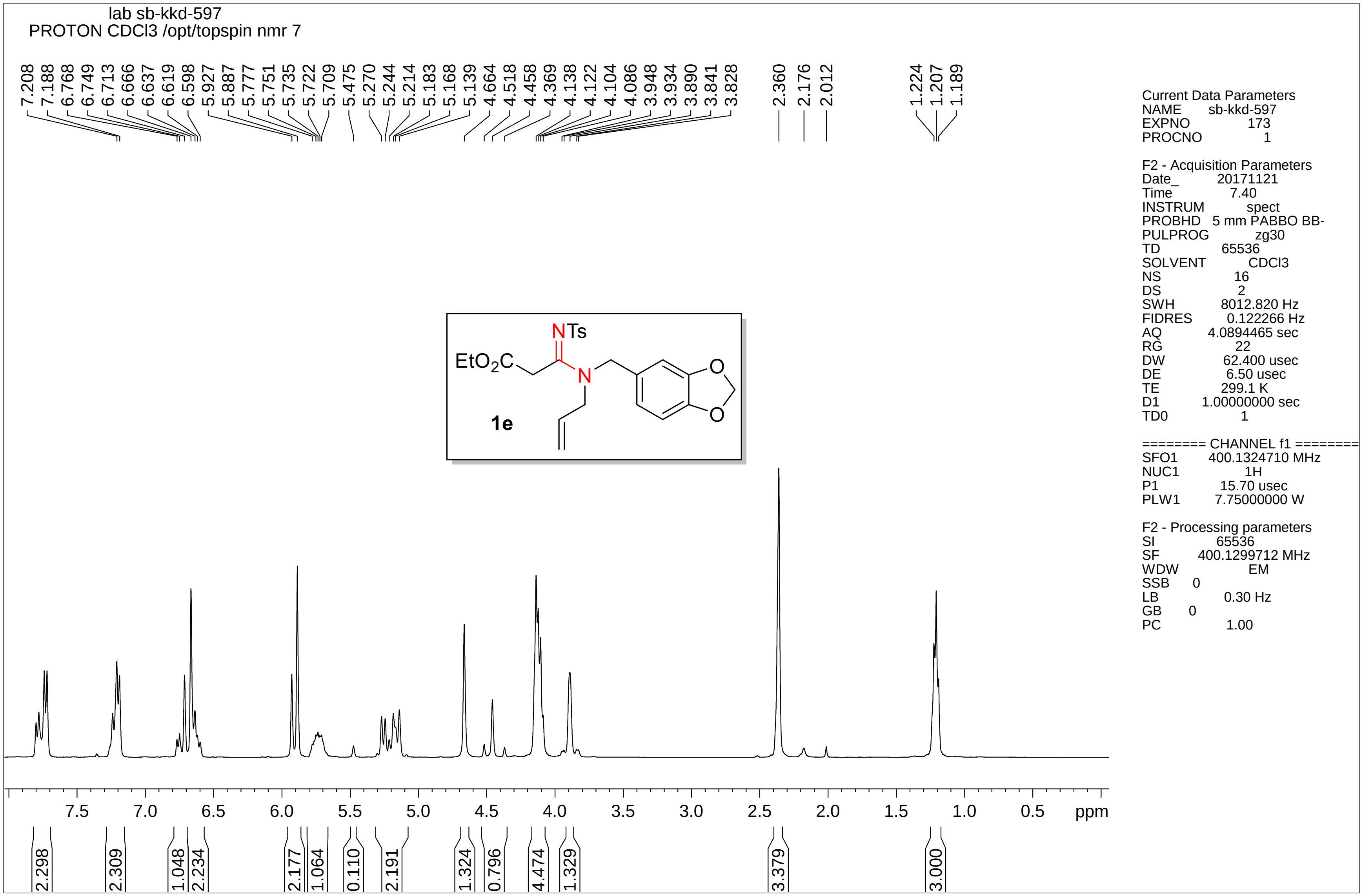
DEPT-135 NMR spectrum of compound 1d



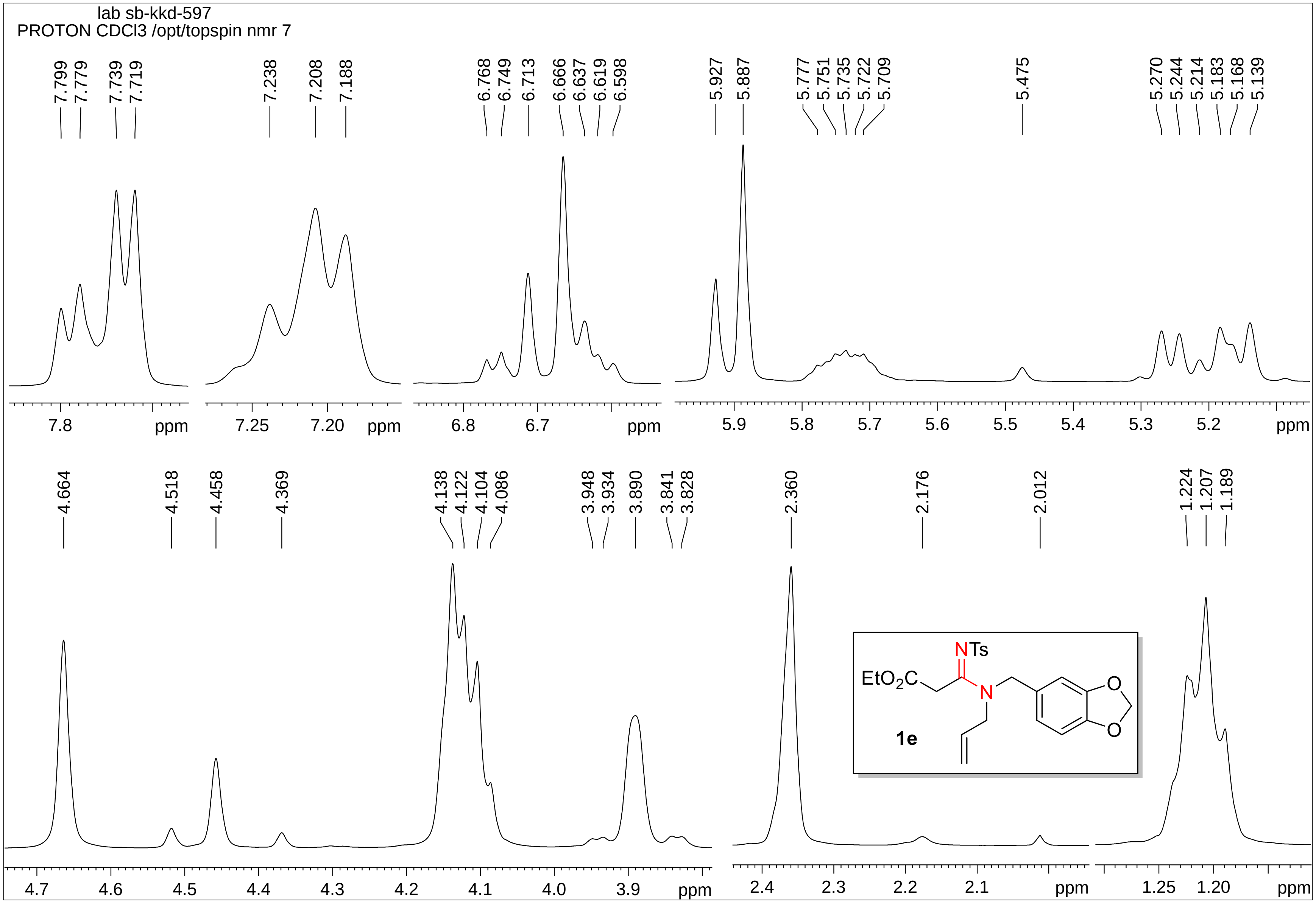
^{1}H-^{1}H COSY NMR spectrum of compound 1d



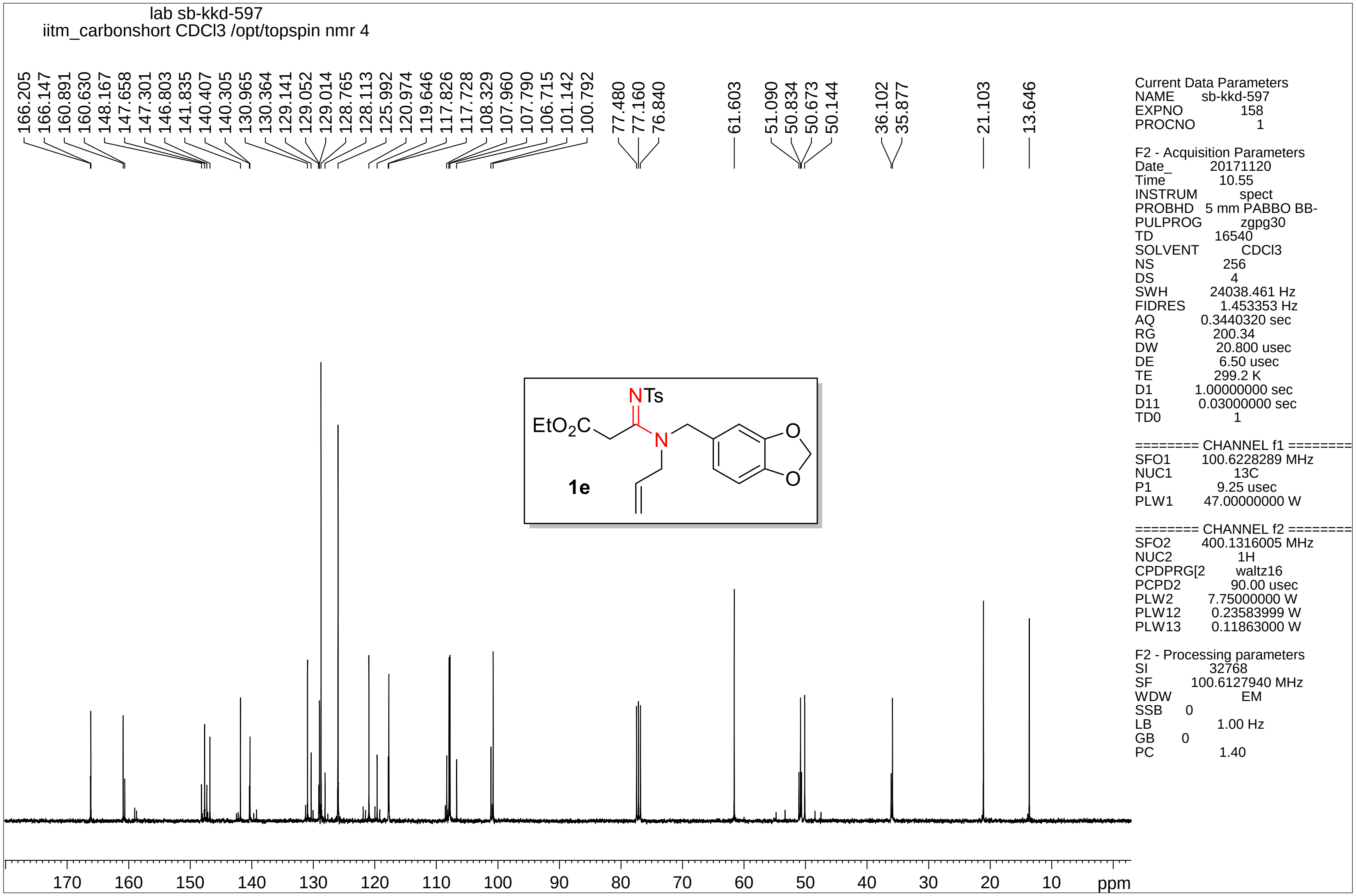
^{1}H-^{13}C HSQC NMR spectrum of compound 1d



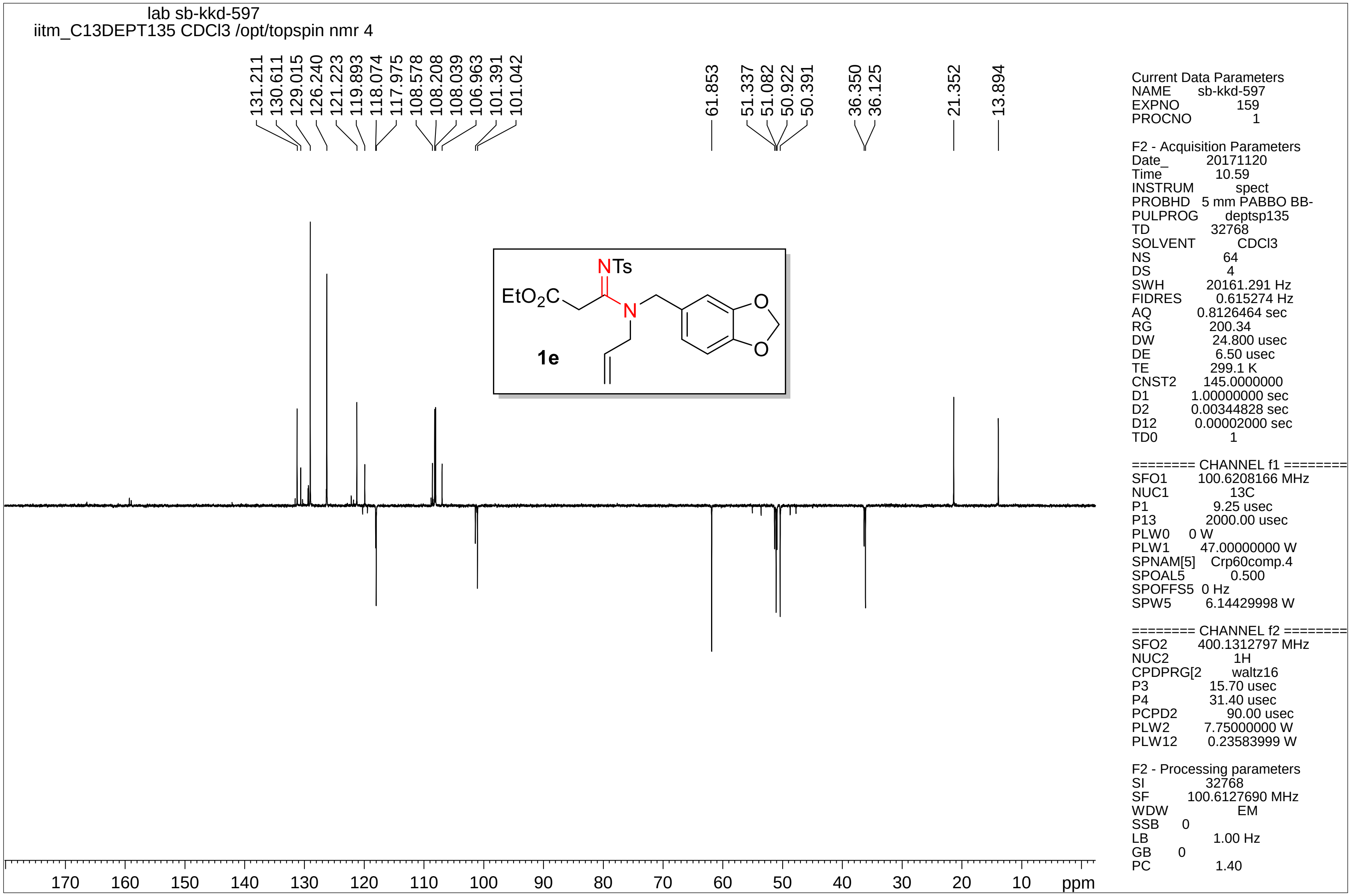
[1]H NMR spectrum of compound 1e



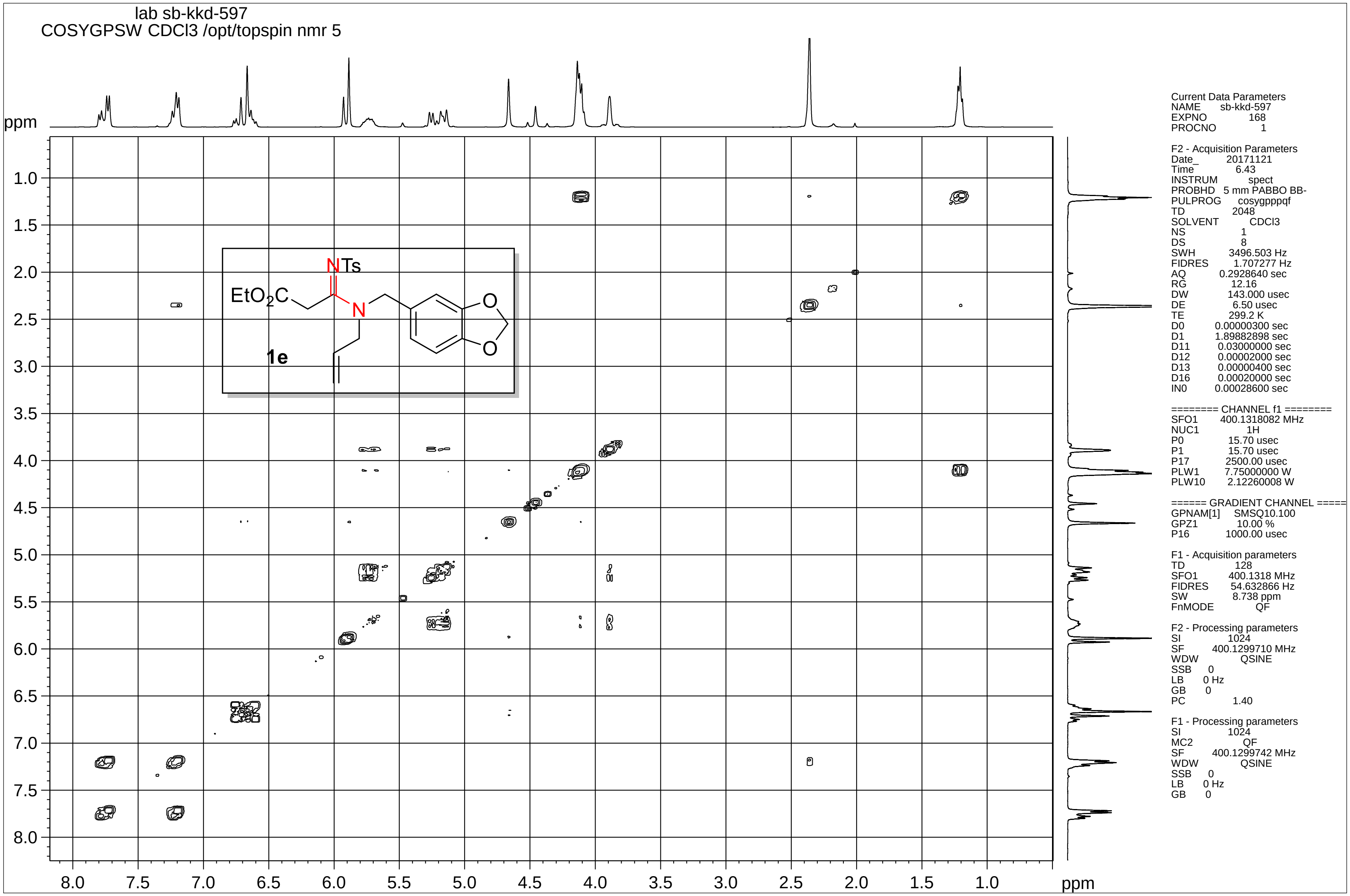
^{1}H NMR spectrum of compound 1e



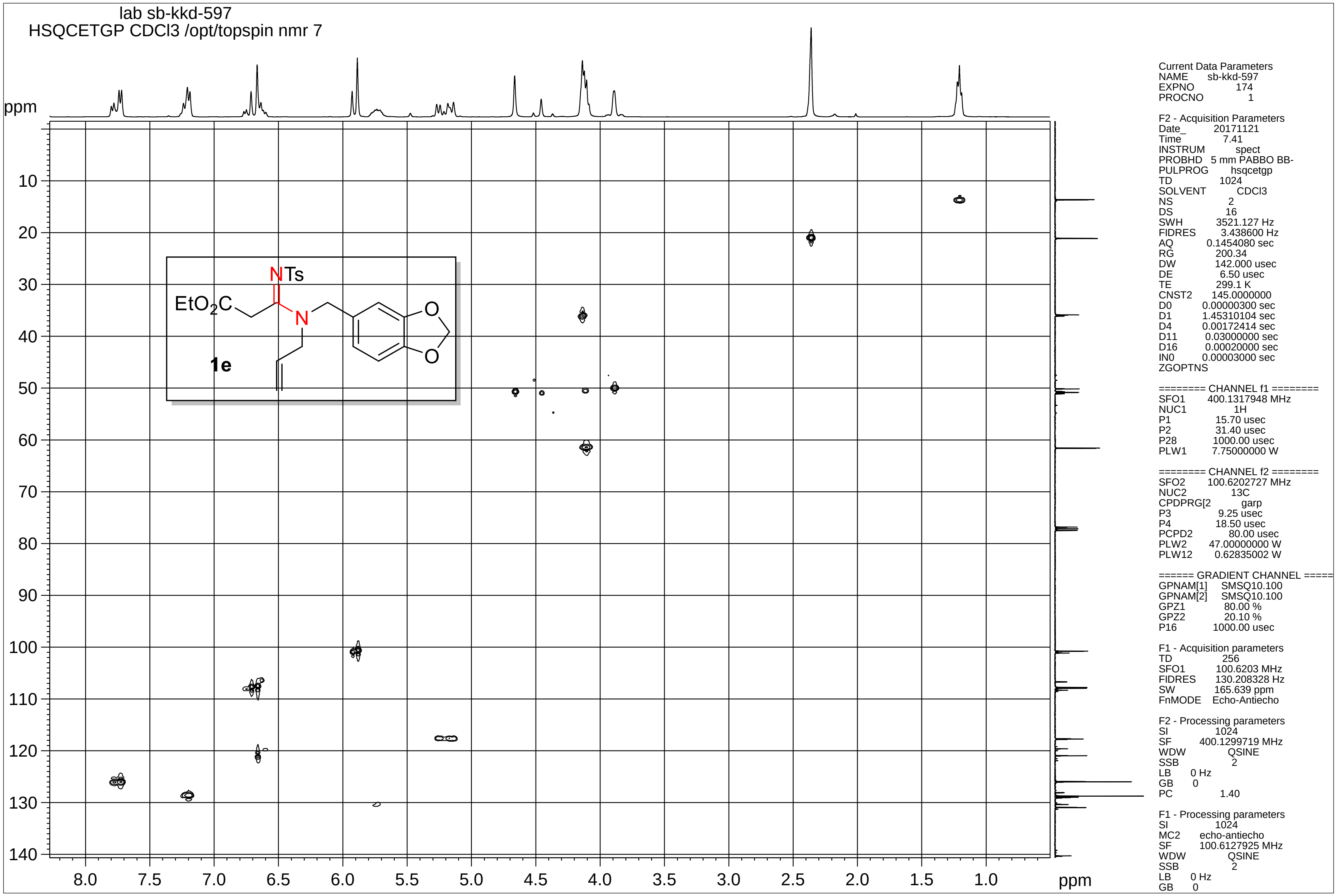
^{13}C NMR spectrum of compound 1e



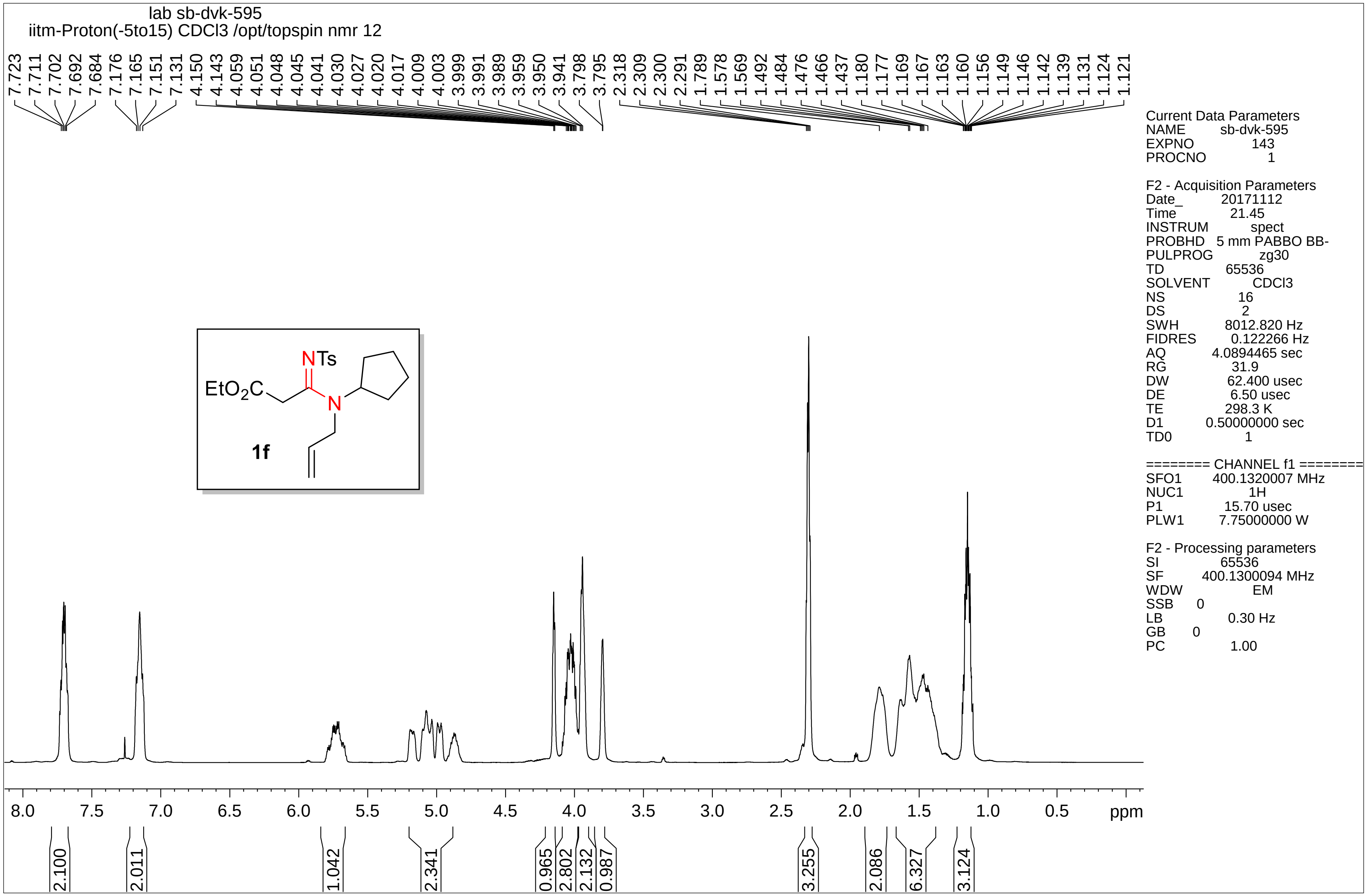
DEPT-135 NMR spectrum of compound 1e



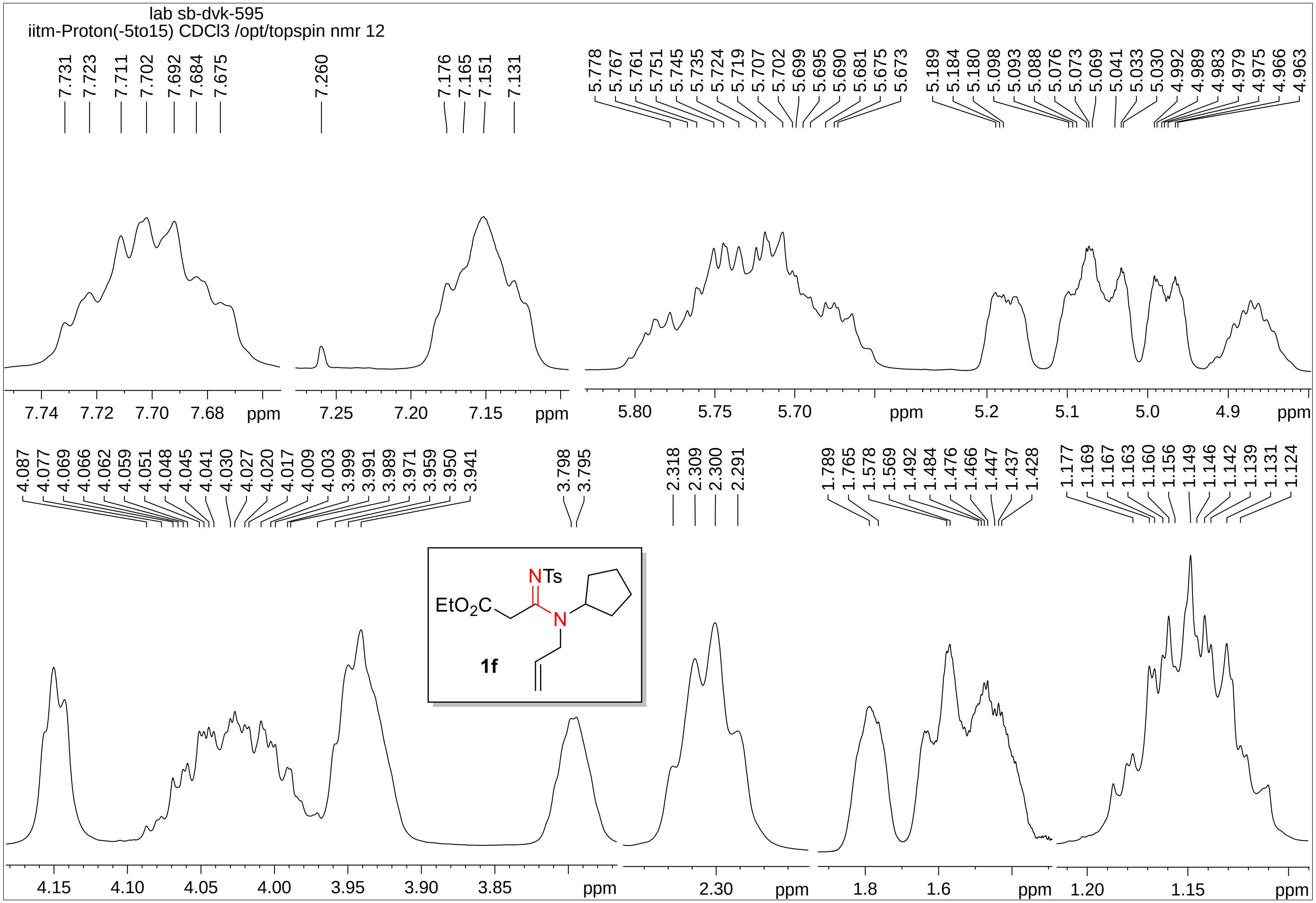
^{1}H-^{1}H COSY NMR spectrum of compound 1e



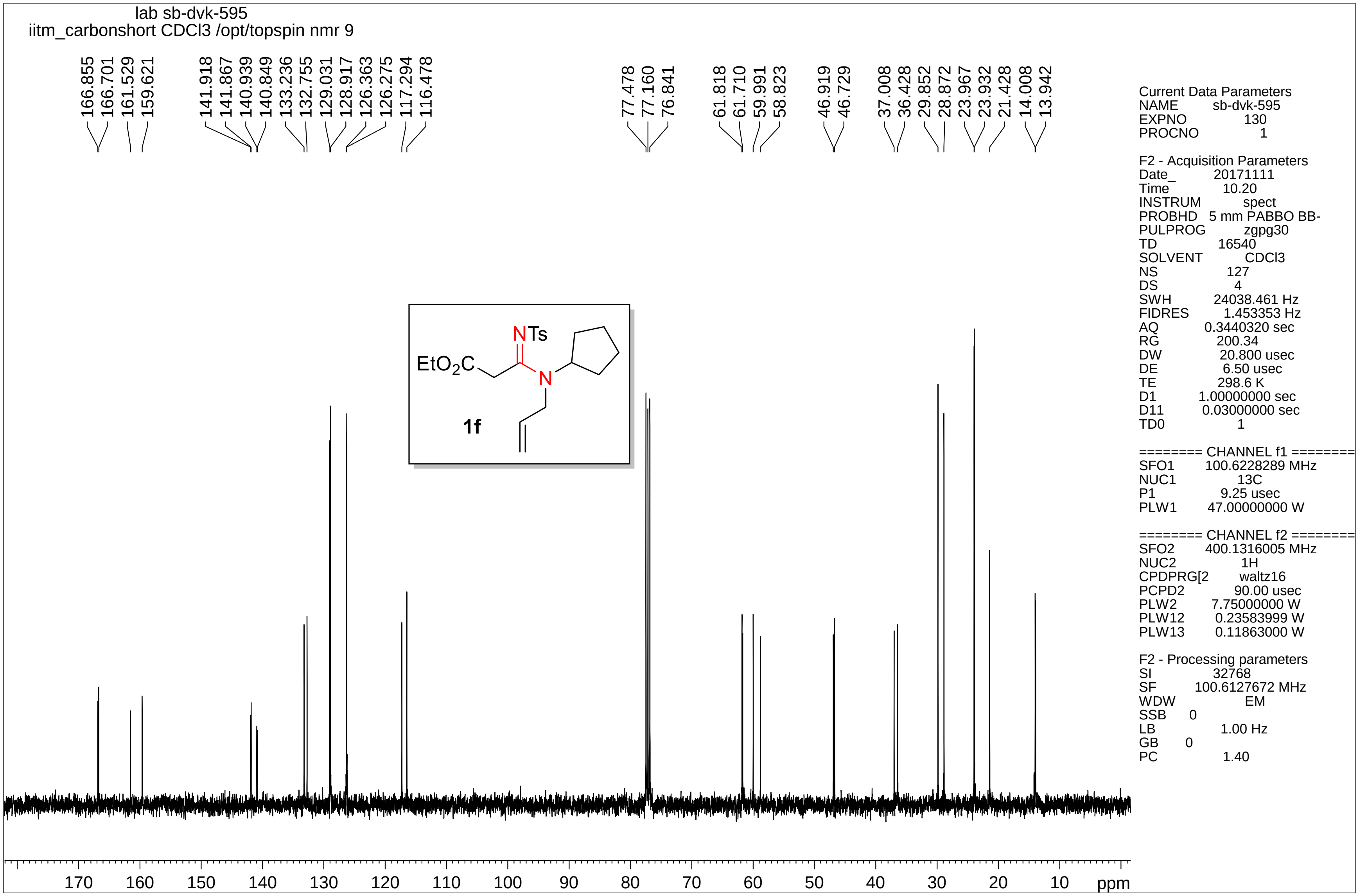
^1H-^{13}C HSQC NMR spectrum of compound 1e



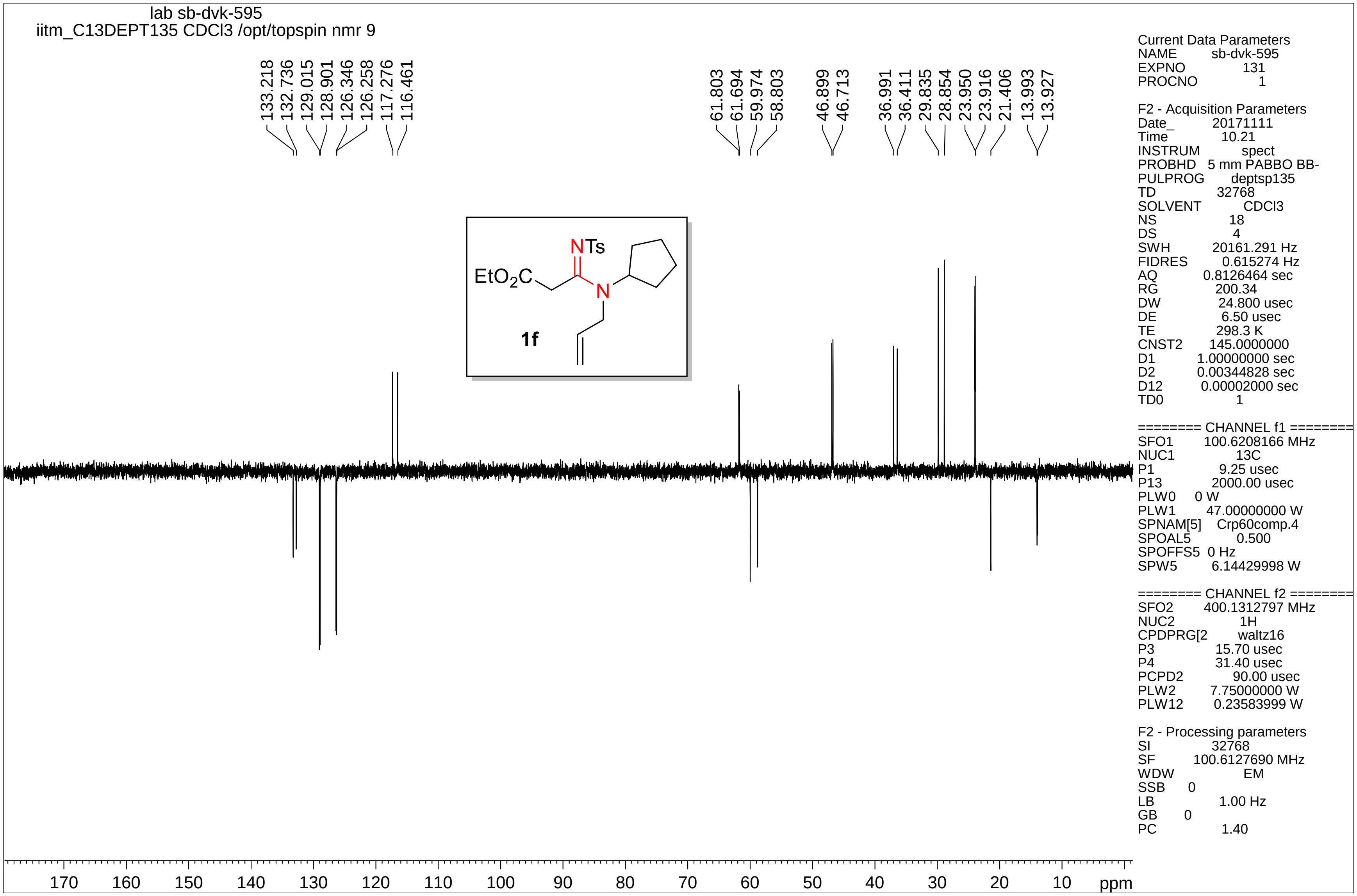
^{1}H NMR spectrum of compound 1f



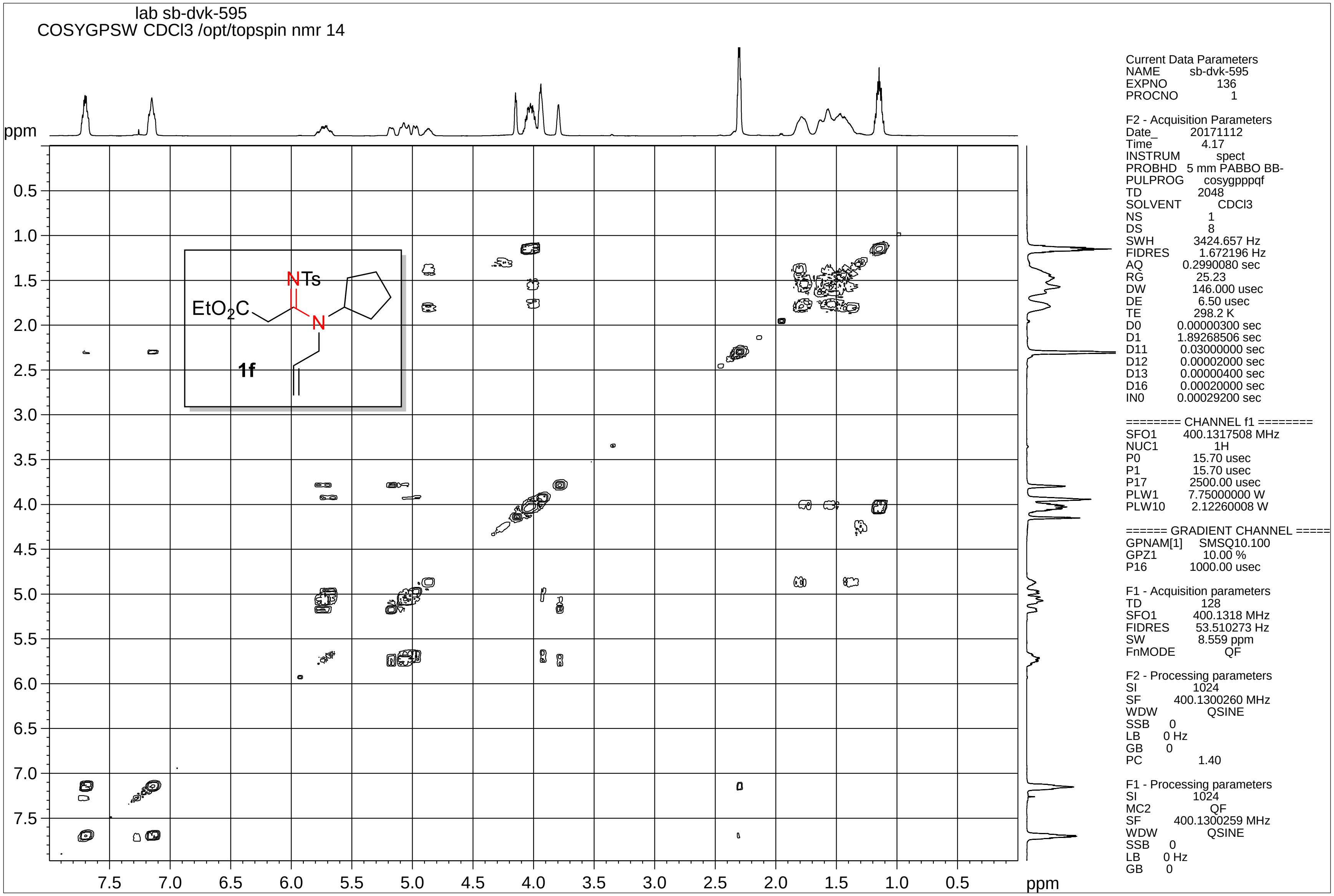
^{1}H NMR spectrum of compound 1f



^{13}C NMR spectrum of compound 1f



DEPT-135 NMR spectrum of compound 1f



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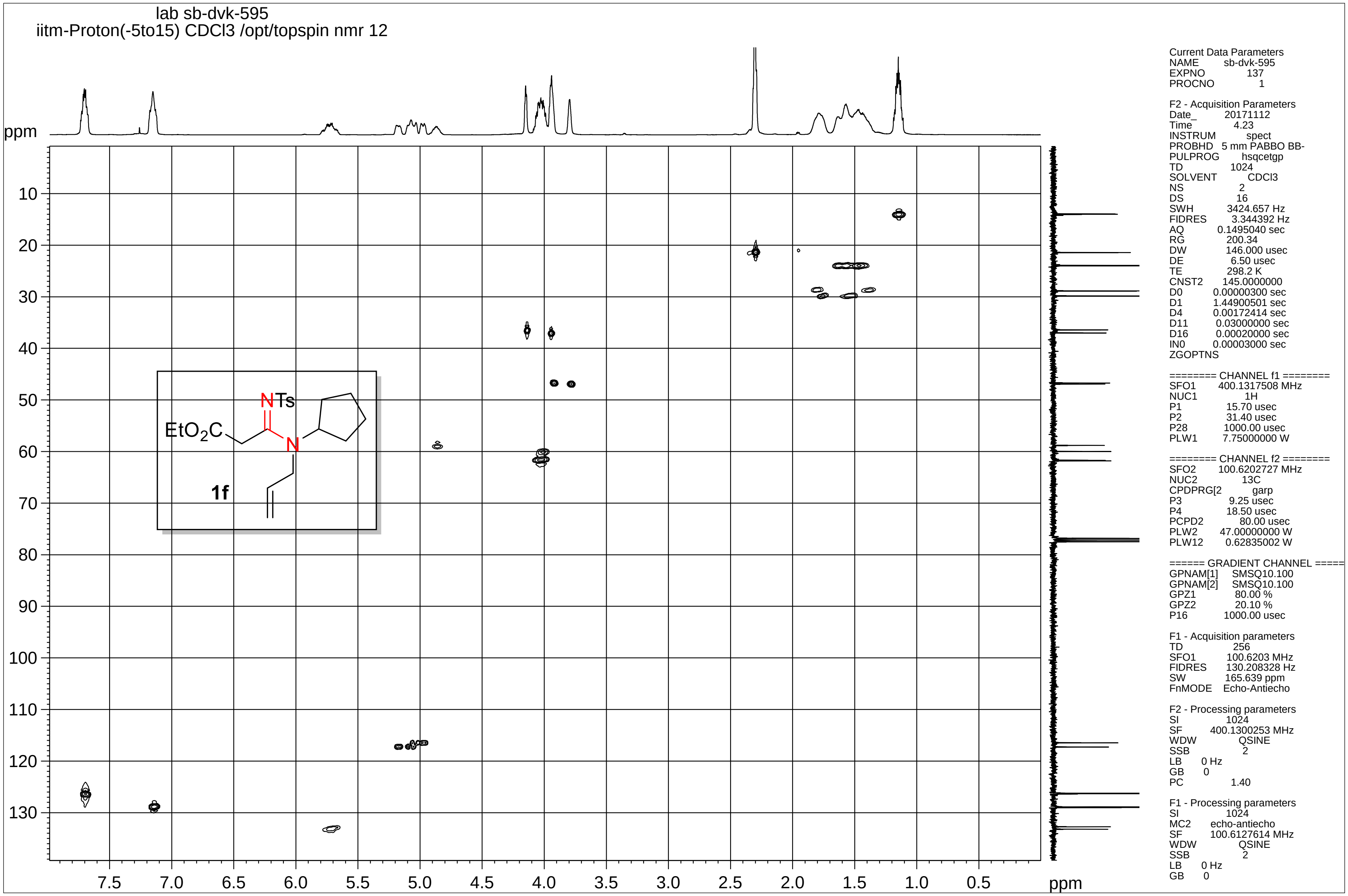

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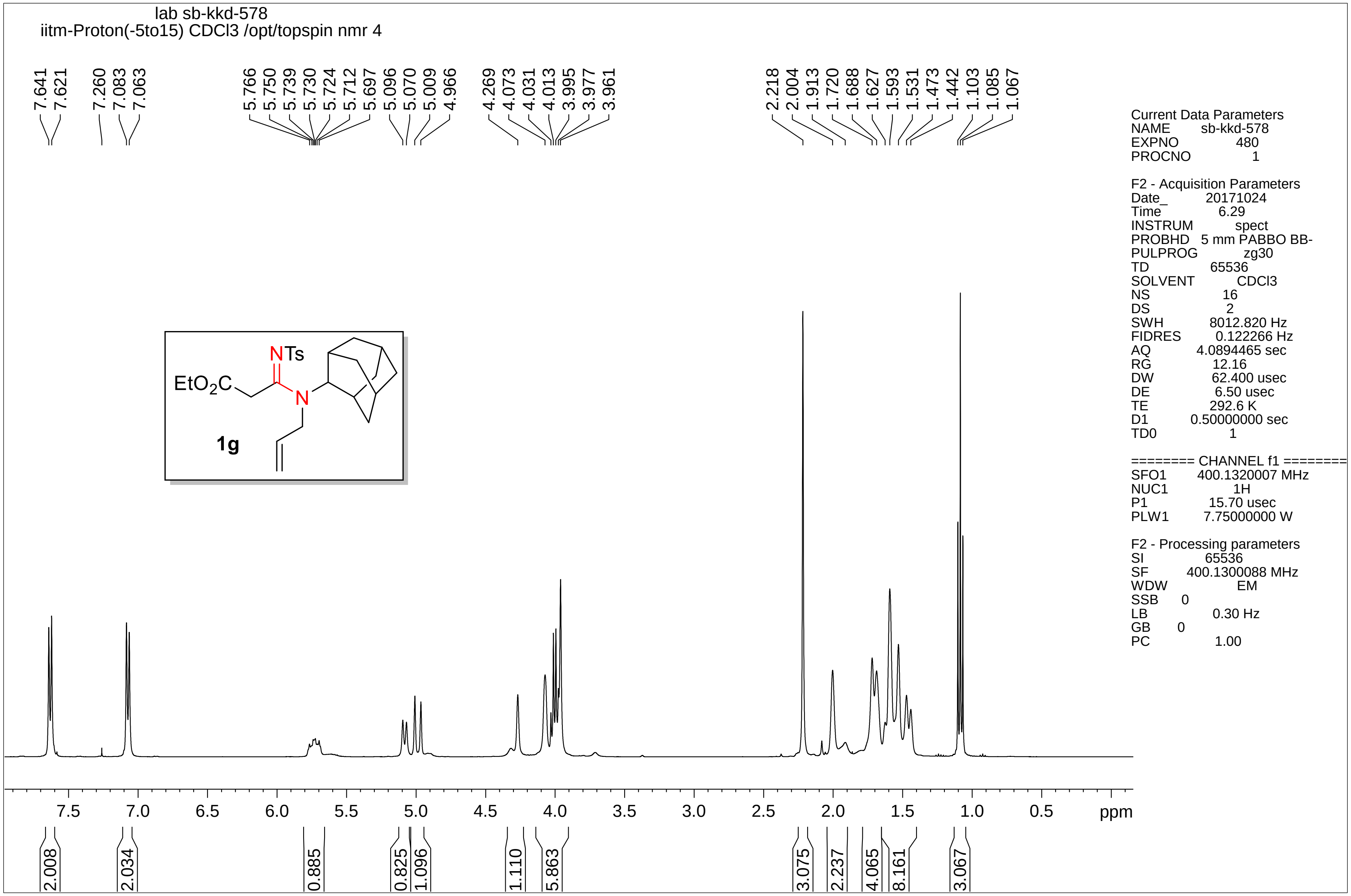
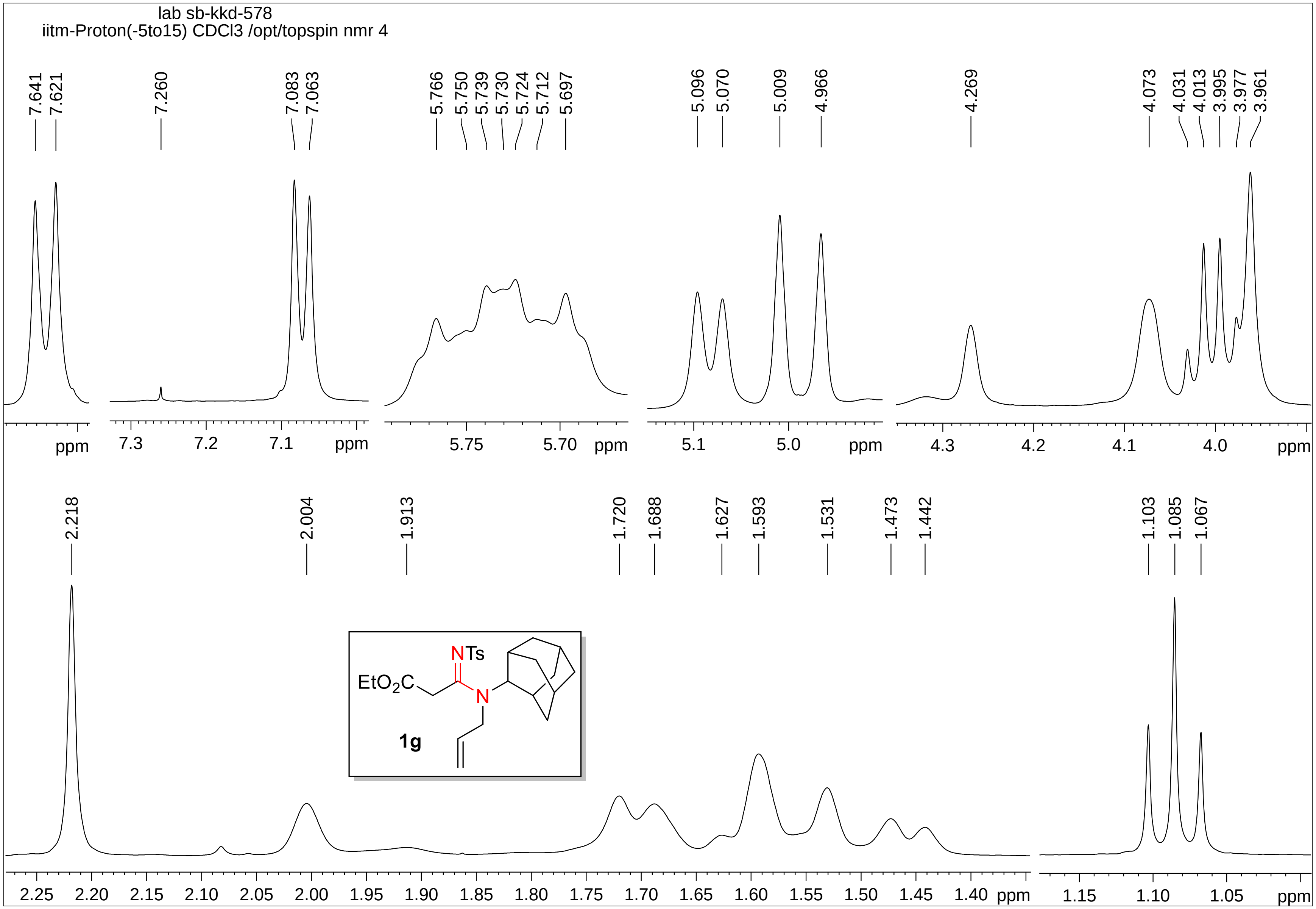
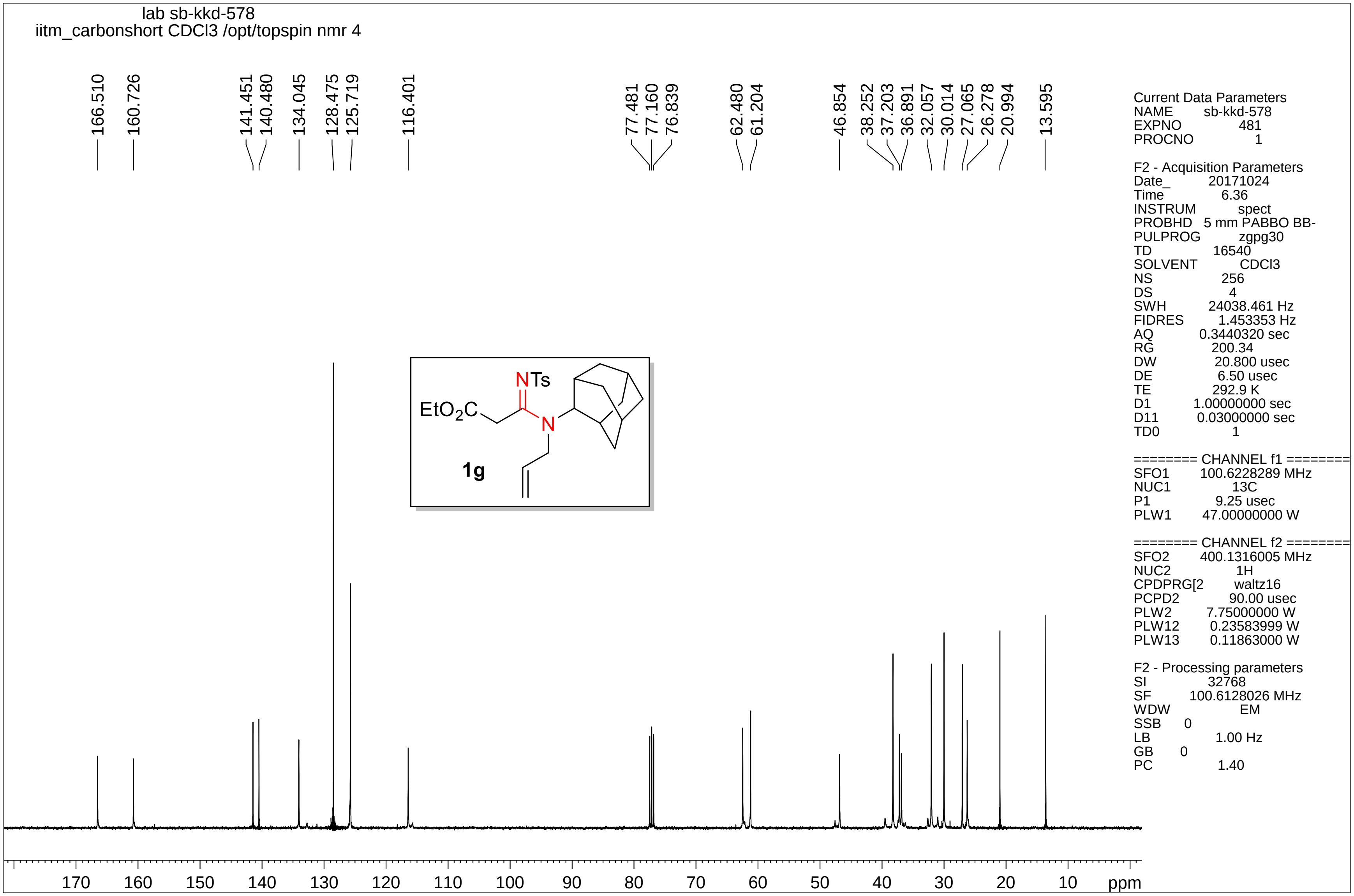


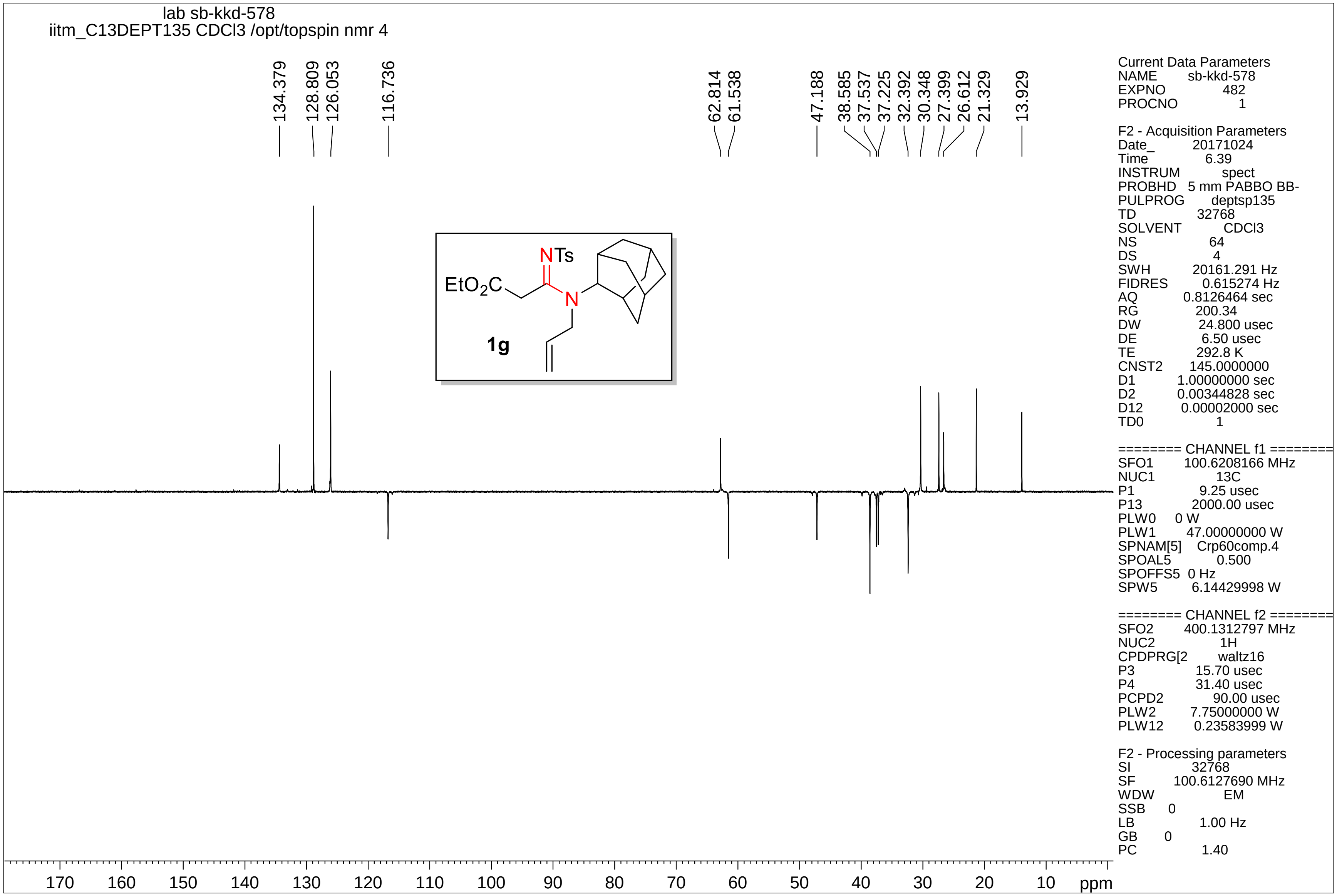
[1]H NMR spectrum of compound 1g



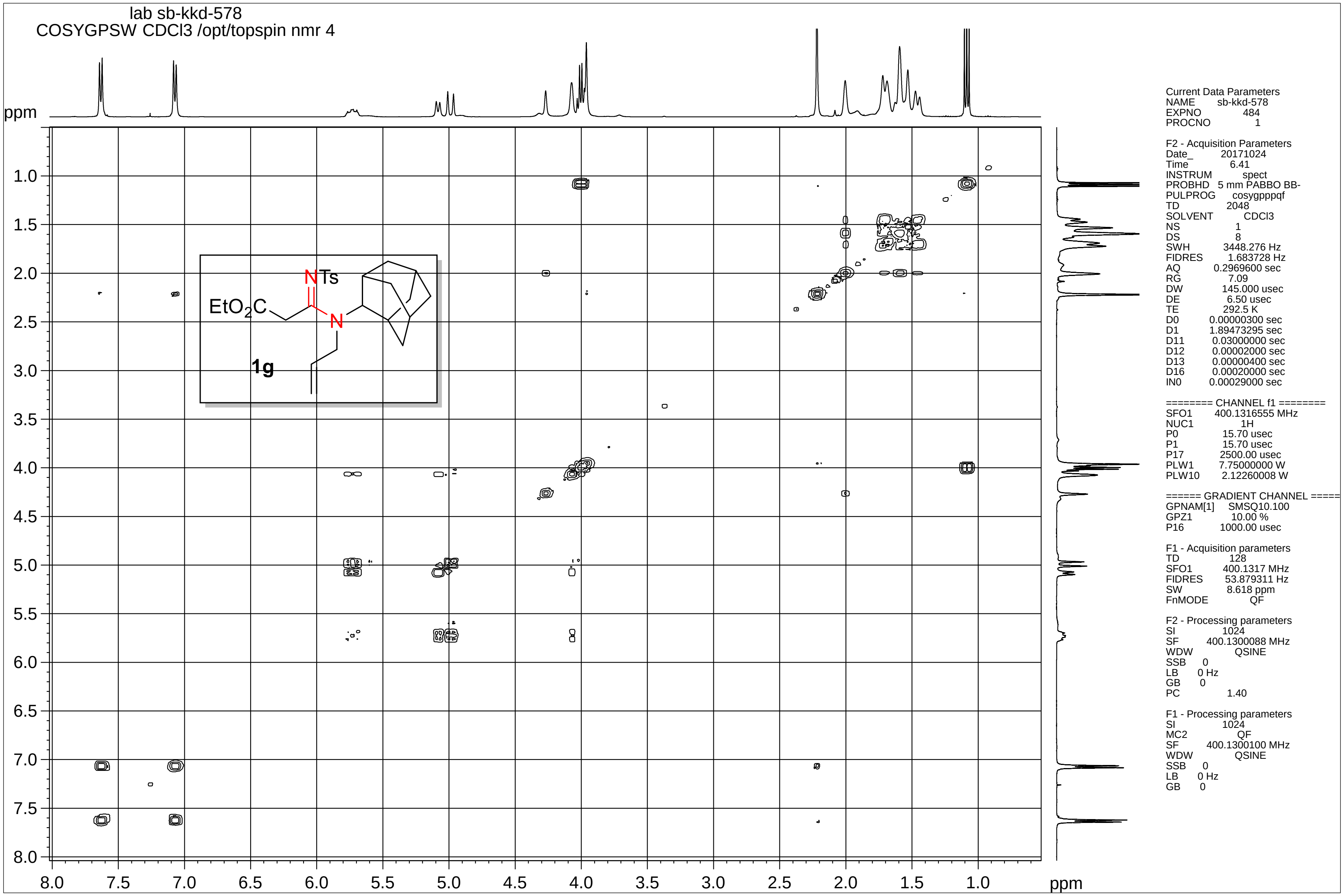
[1]H NMR spectrum of compound 1g



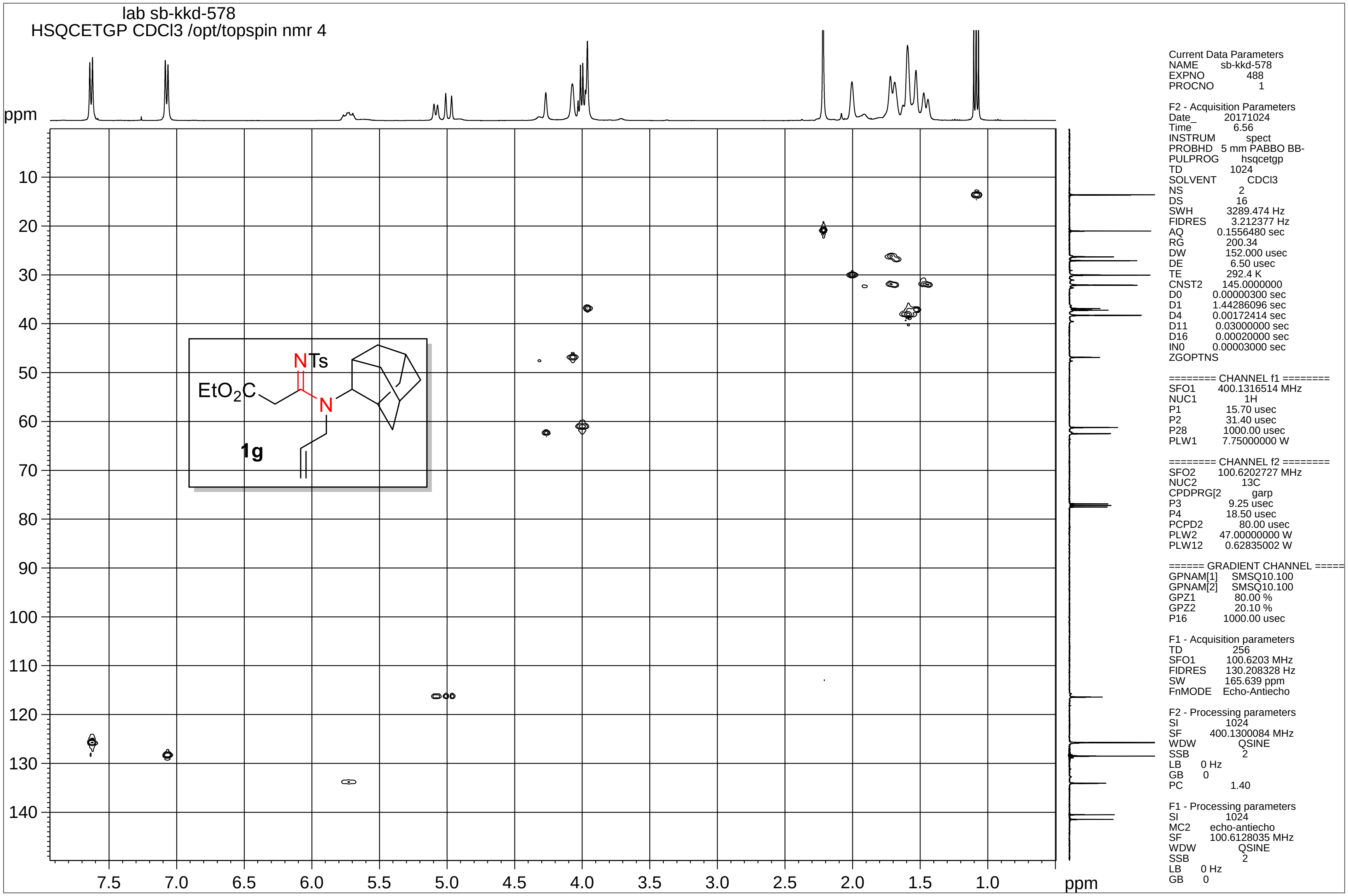
^{13}C NMR spectrum of compound 1g



DEPT-135 NMR spectrum of compound 1g



^{1}H-^{1}H COSY NMR spectrum of compound 1g



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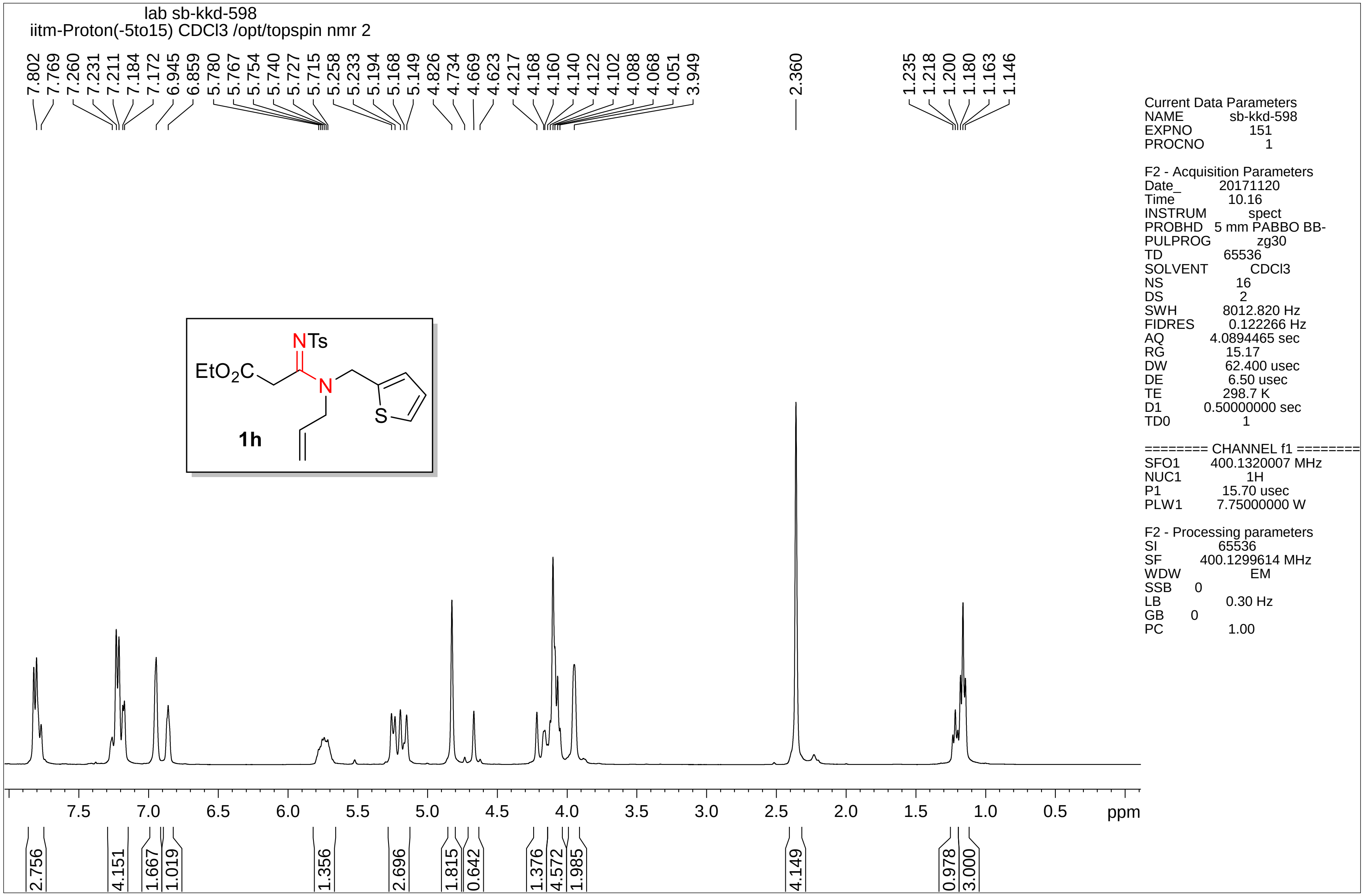
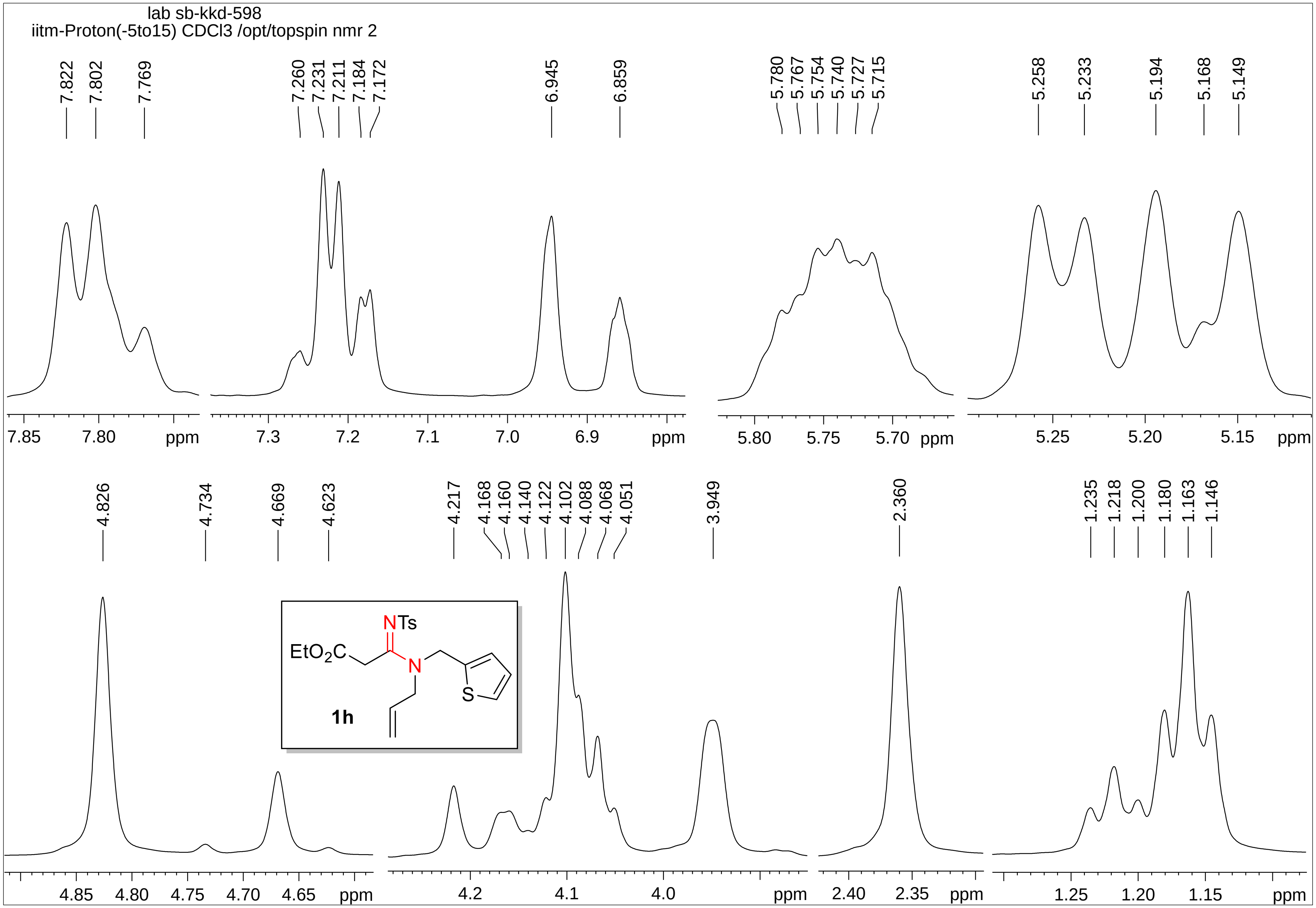
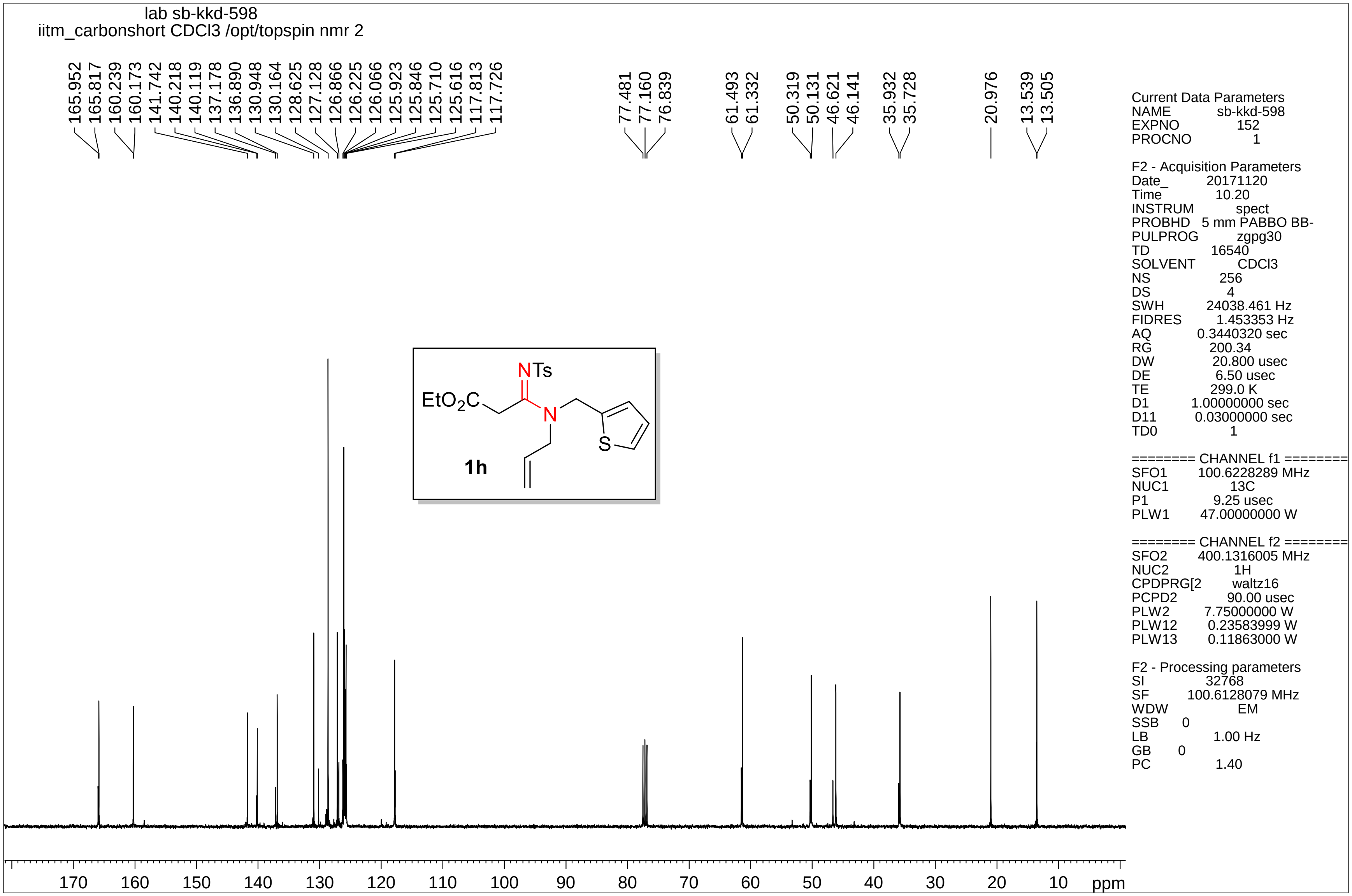


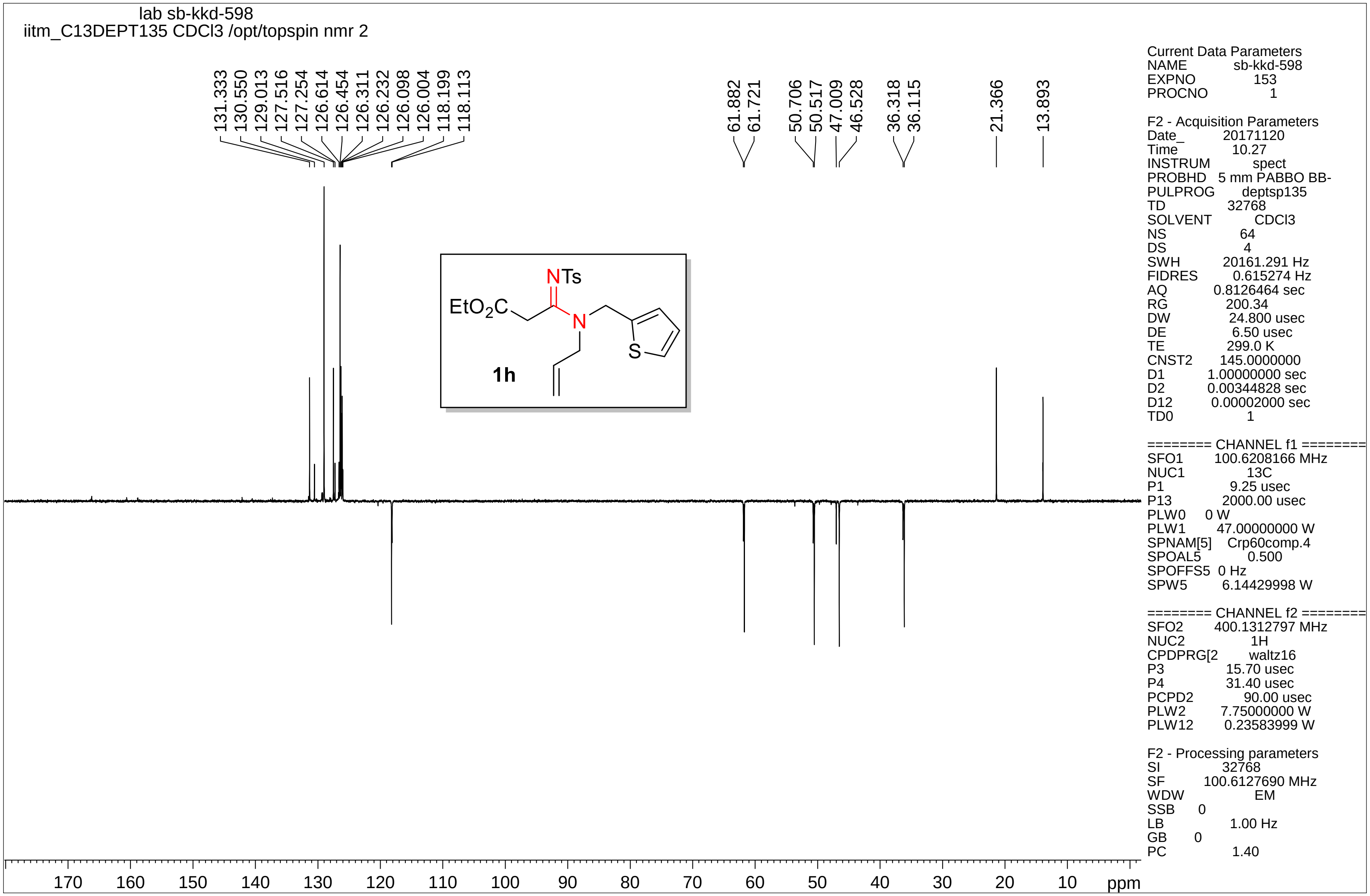
^{1}H NMR spectrum of compound 1h



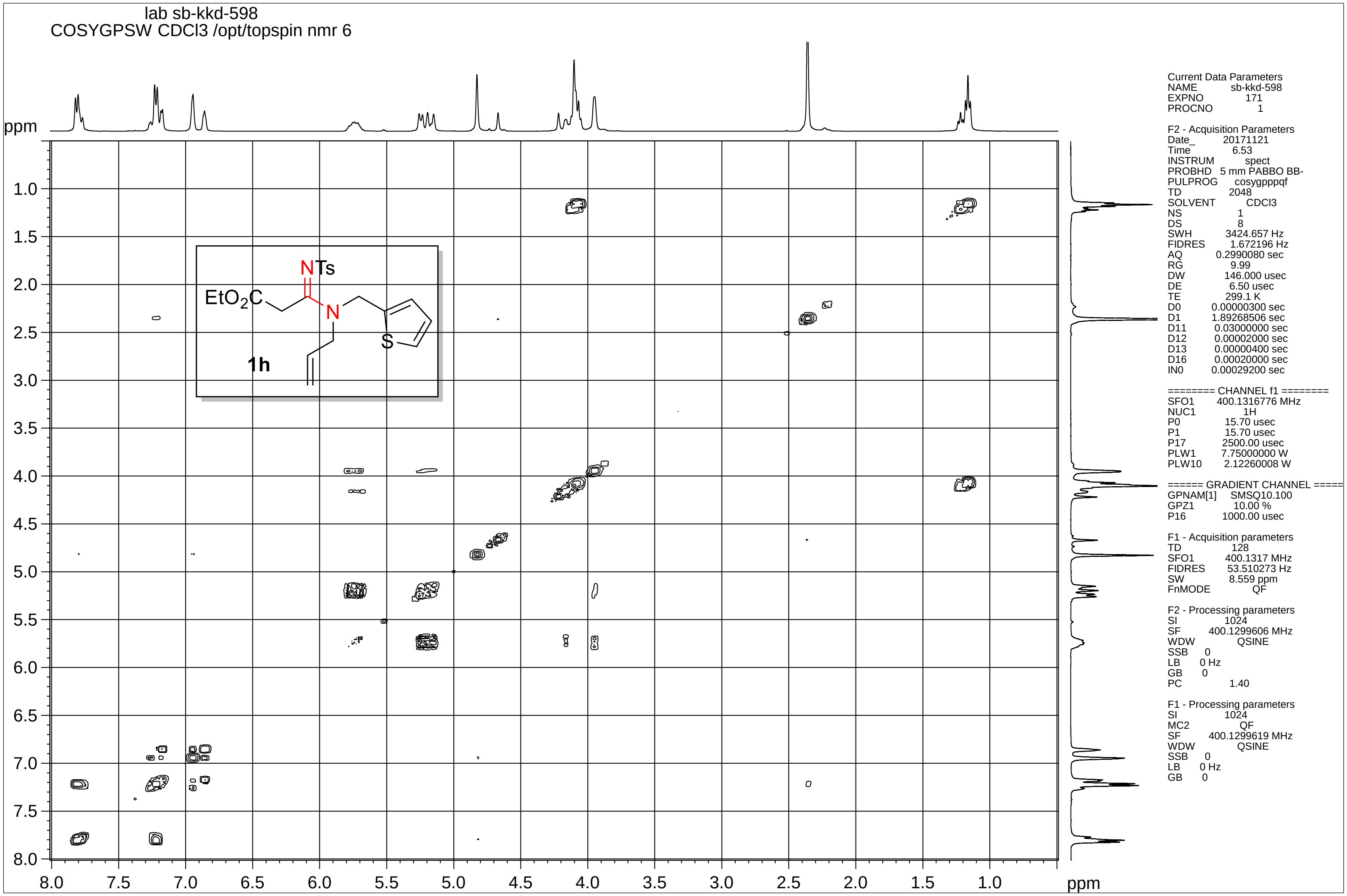
^{1}H NMR spectrum of compound 1h



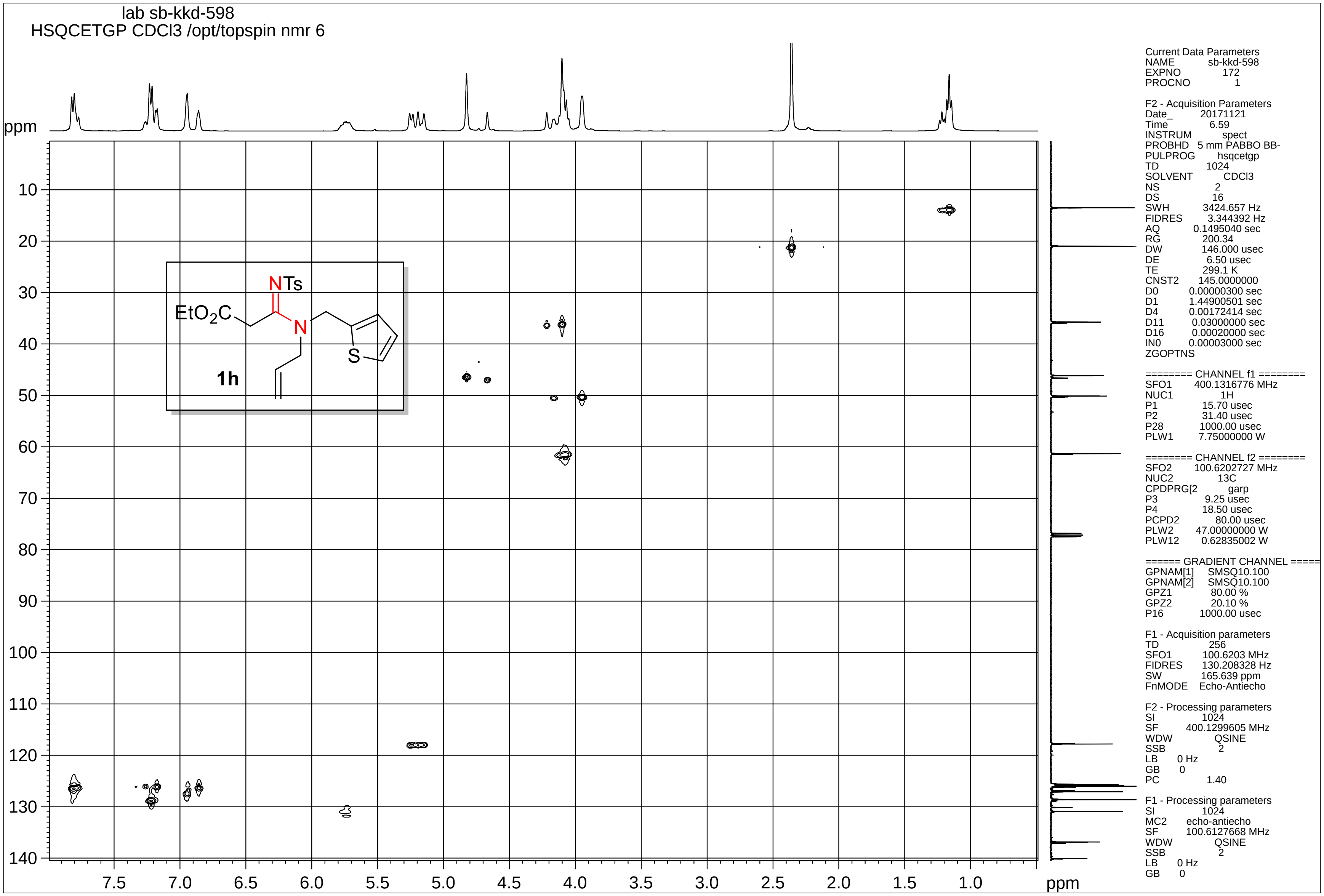
^{13}C NMR spectrum of compound 1h



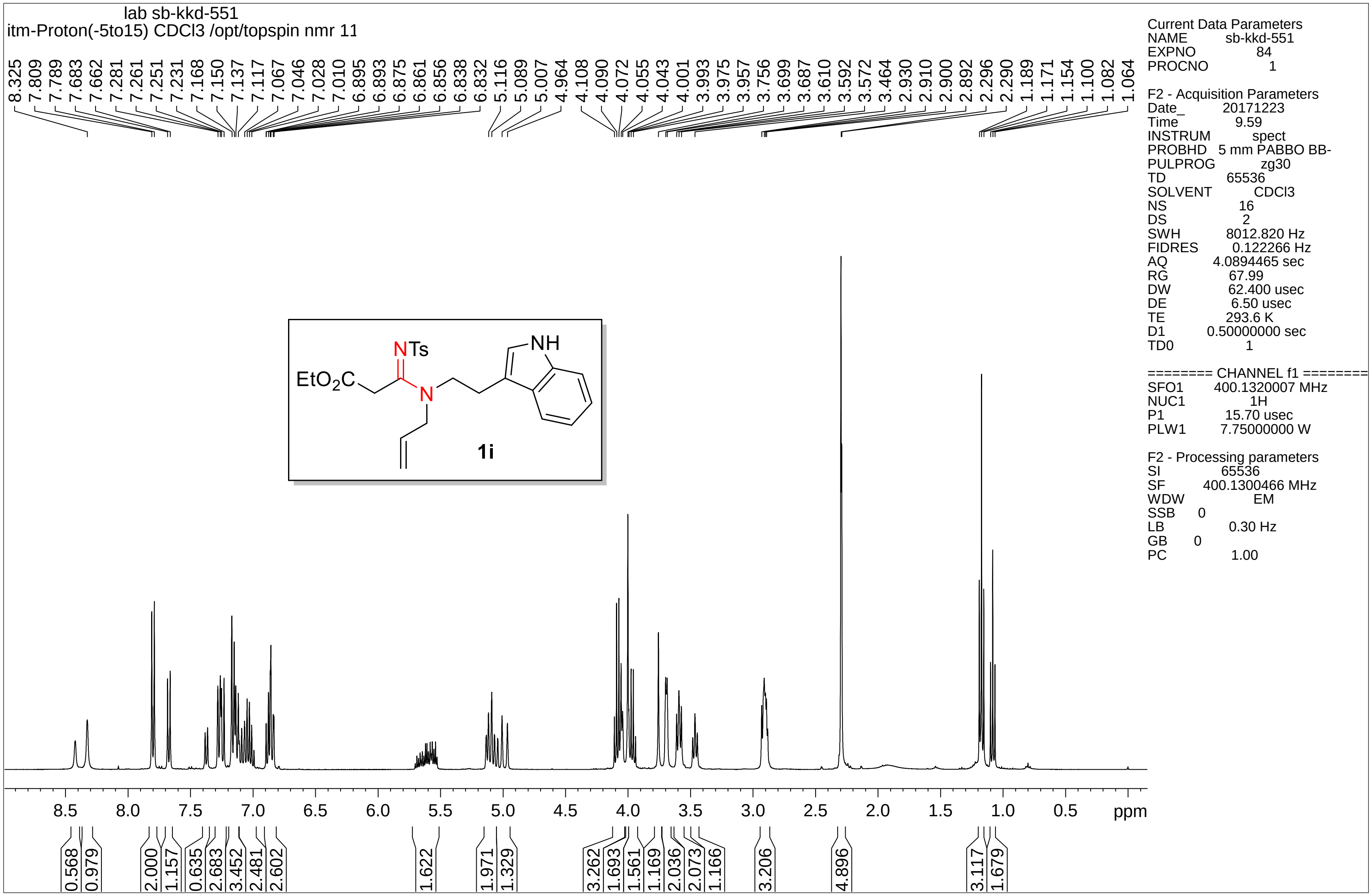
DEPT-135 NMR spectrum of compound 1h



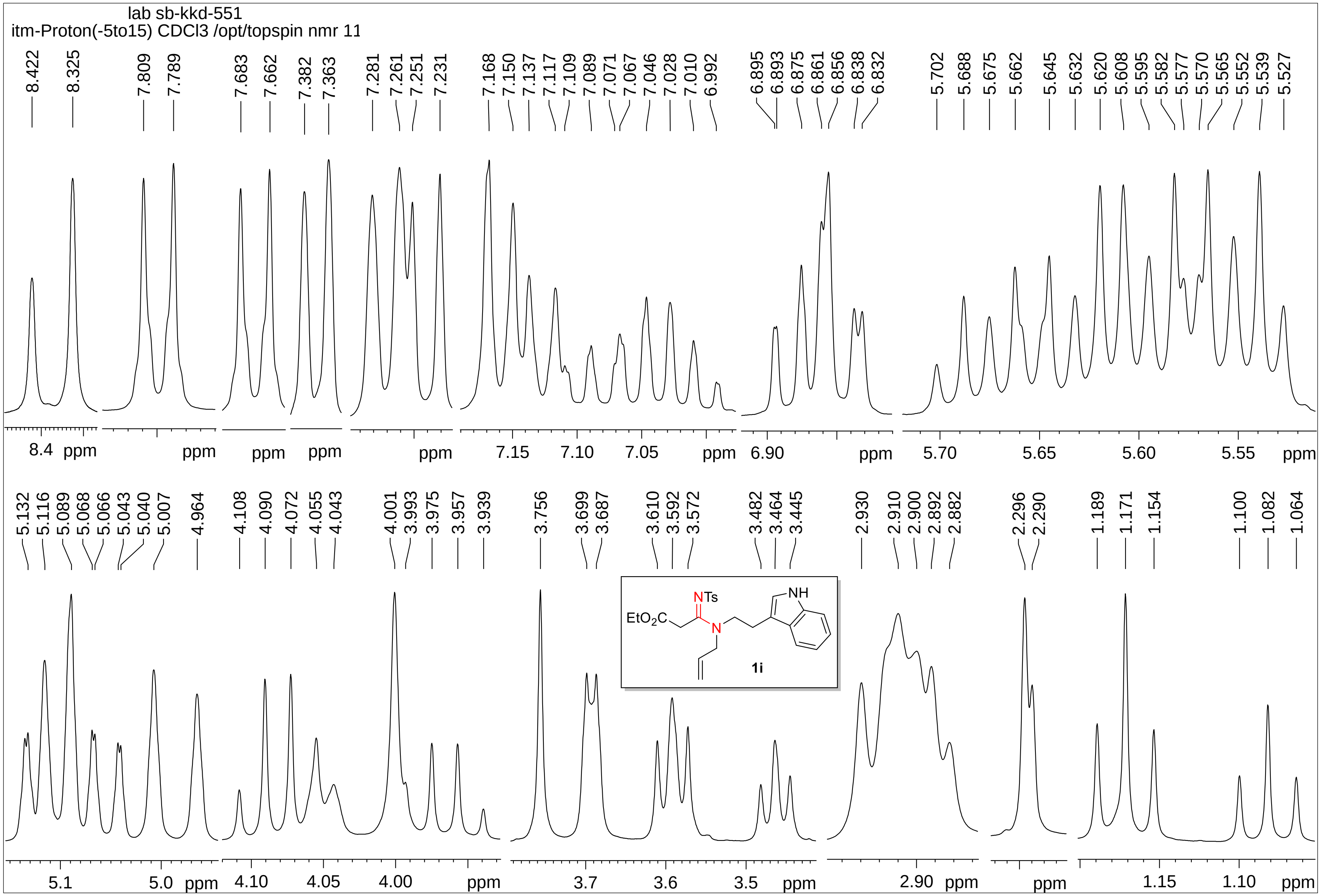
^{1}H-^{1}H COSY NMR spectrum of compound 1h



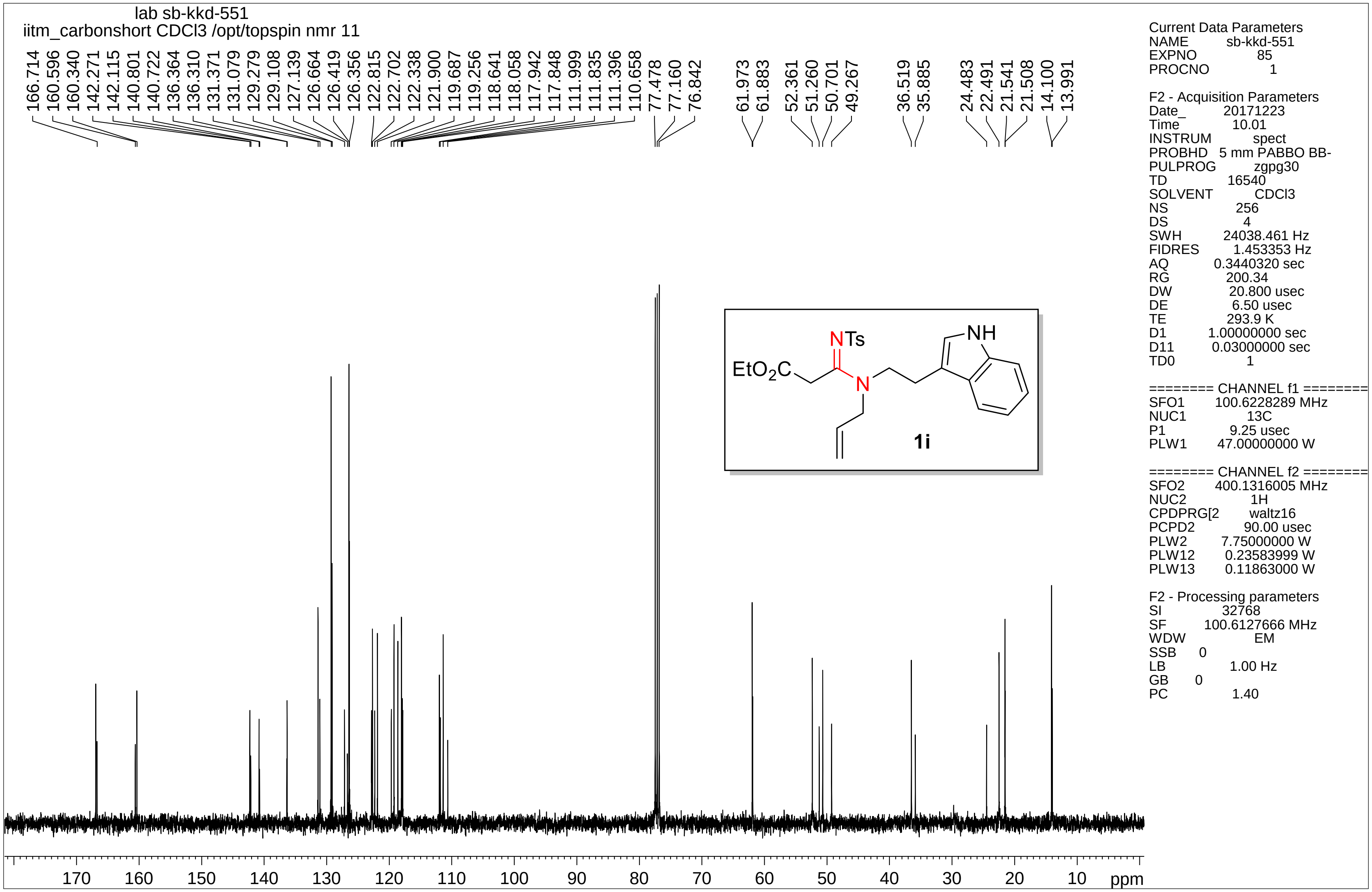
^{1}H-^{13}C HSQC NMR spectrum of compound 1h



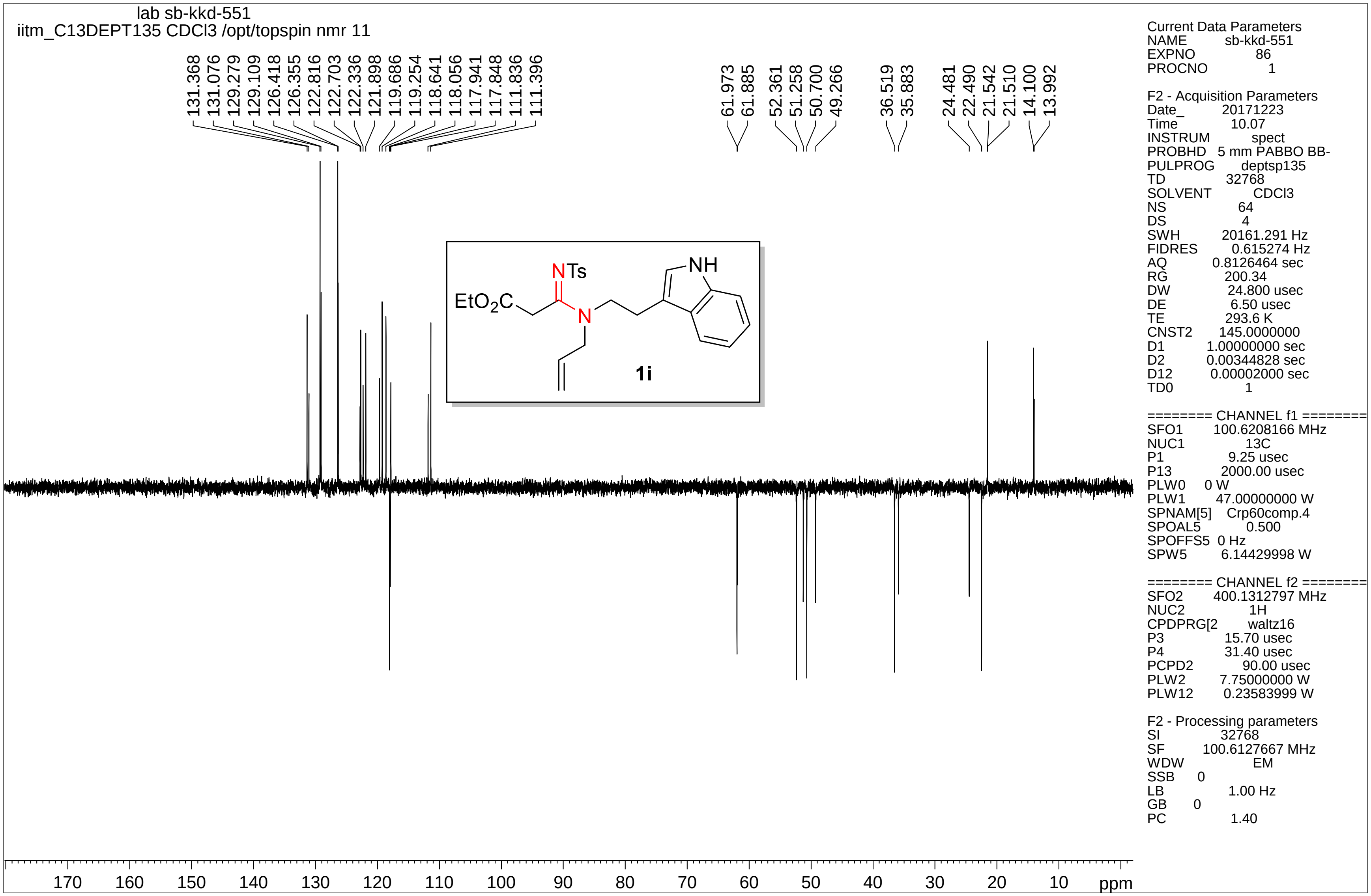
^{1}H NMR spectrum of compound 1i



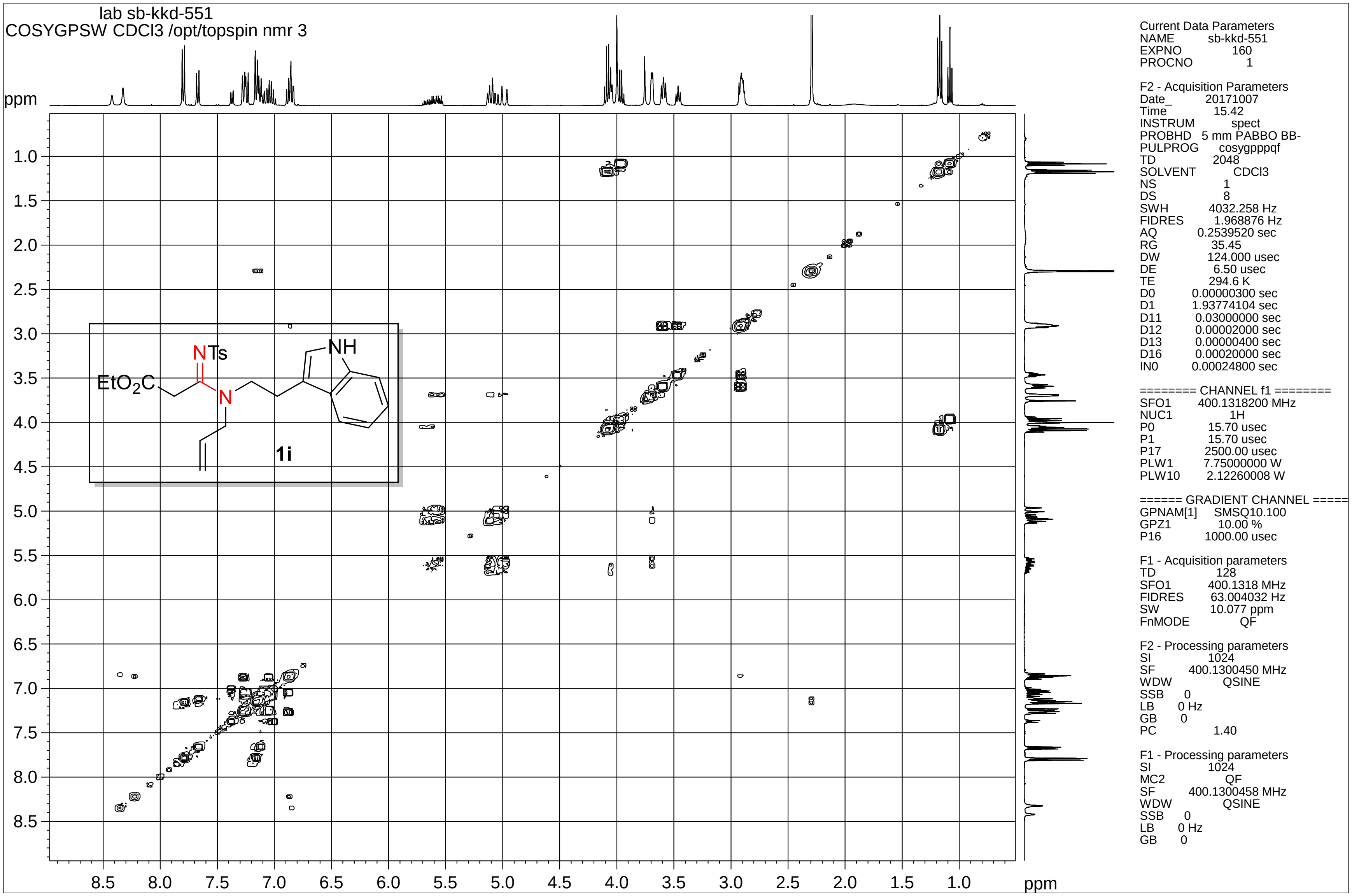
[1]H NMR spectrum of compound 1i



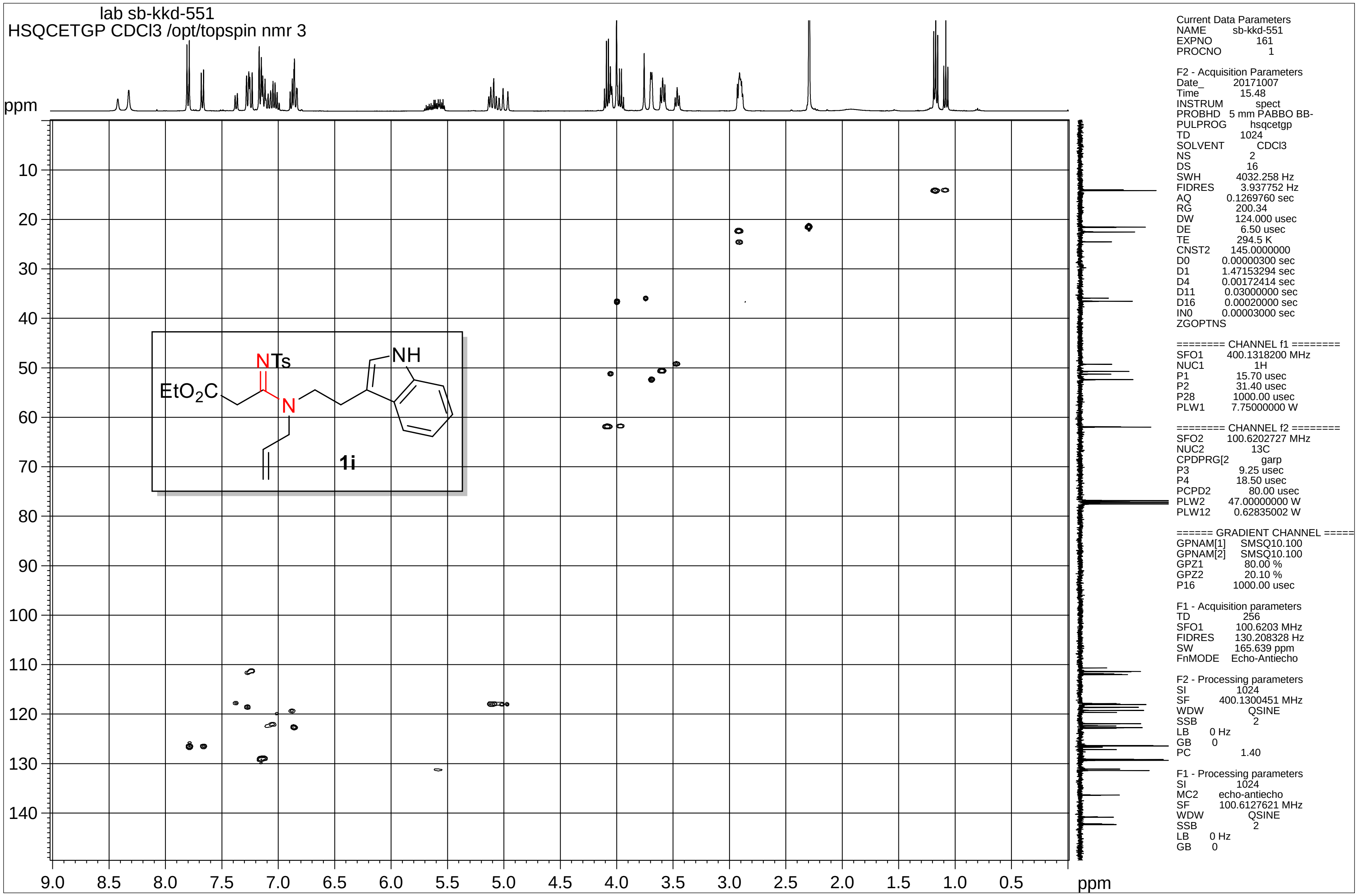
^{13}C NMR spectrum of compound 1i



DEPT-135 NMR spectrum of compound 1i



^{1}H-^{1}H COSY NMR spectrum of compound 1i



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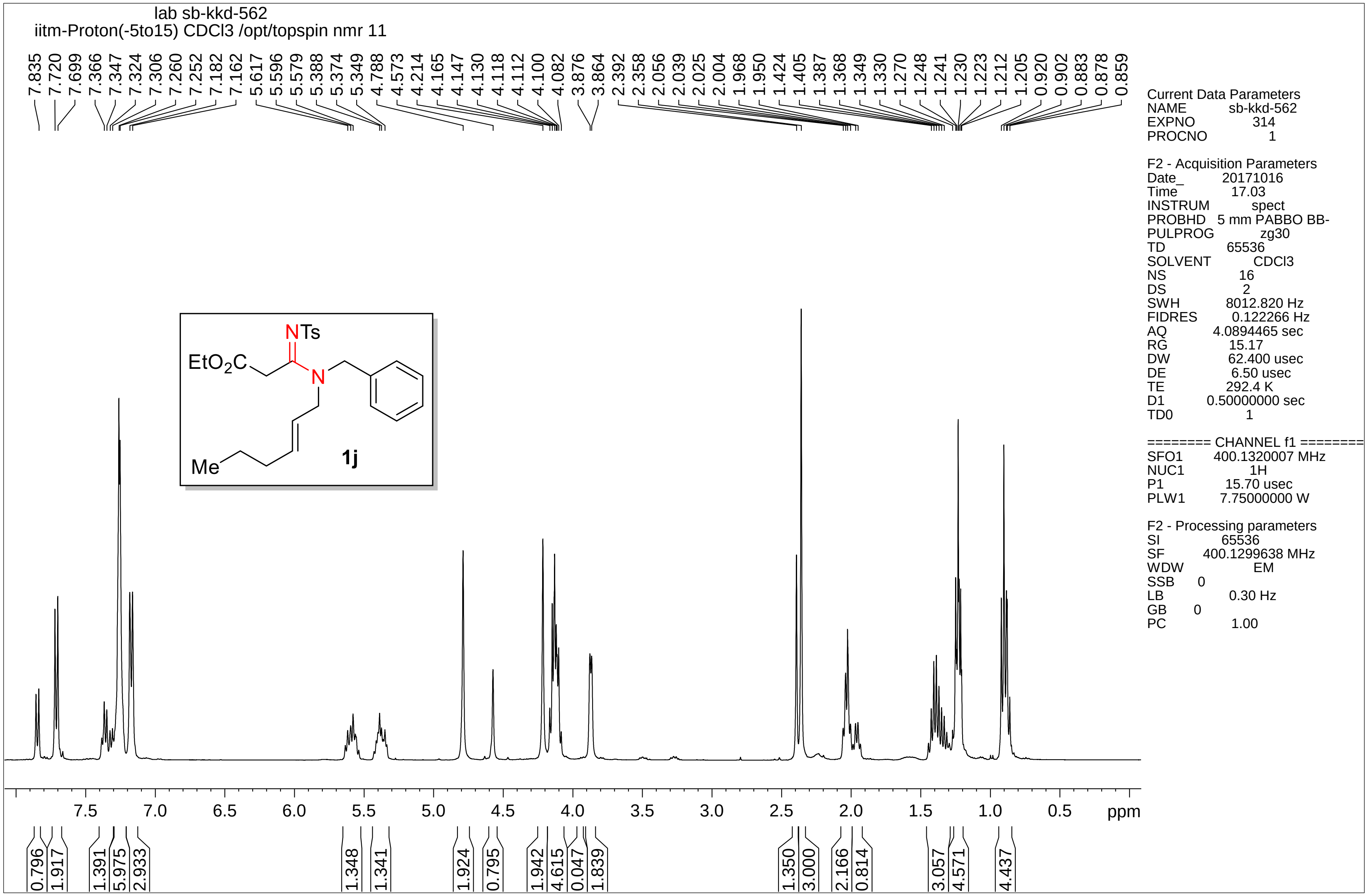

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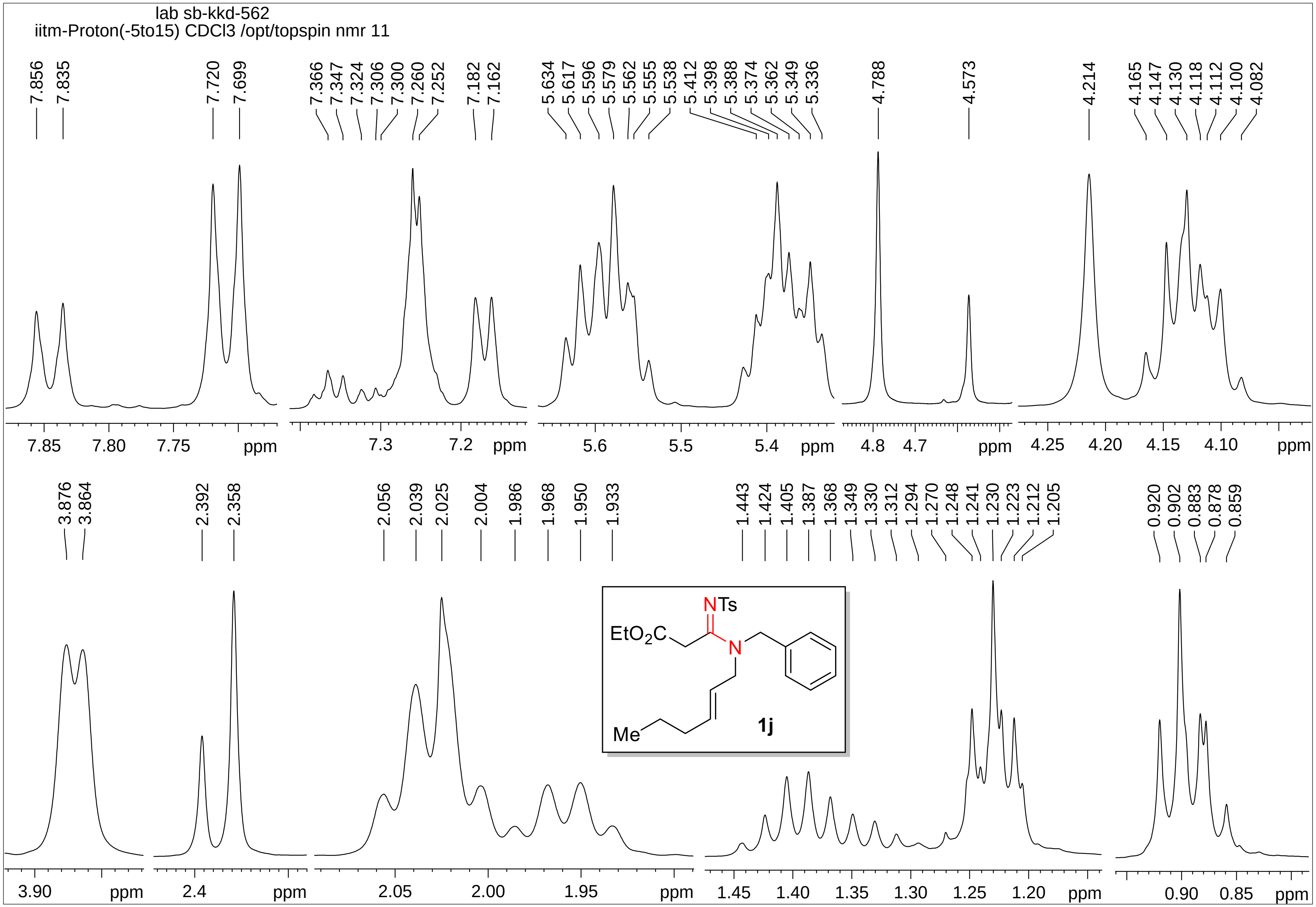
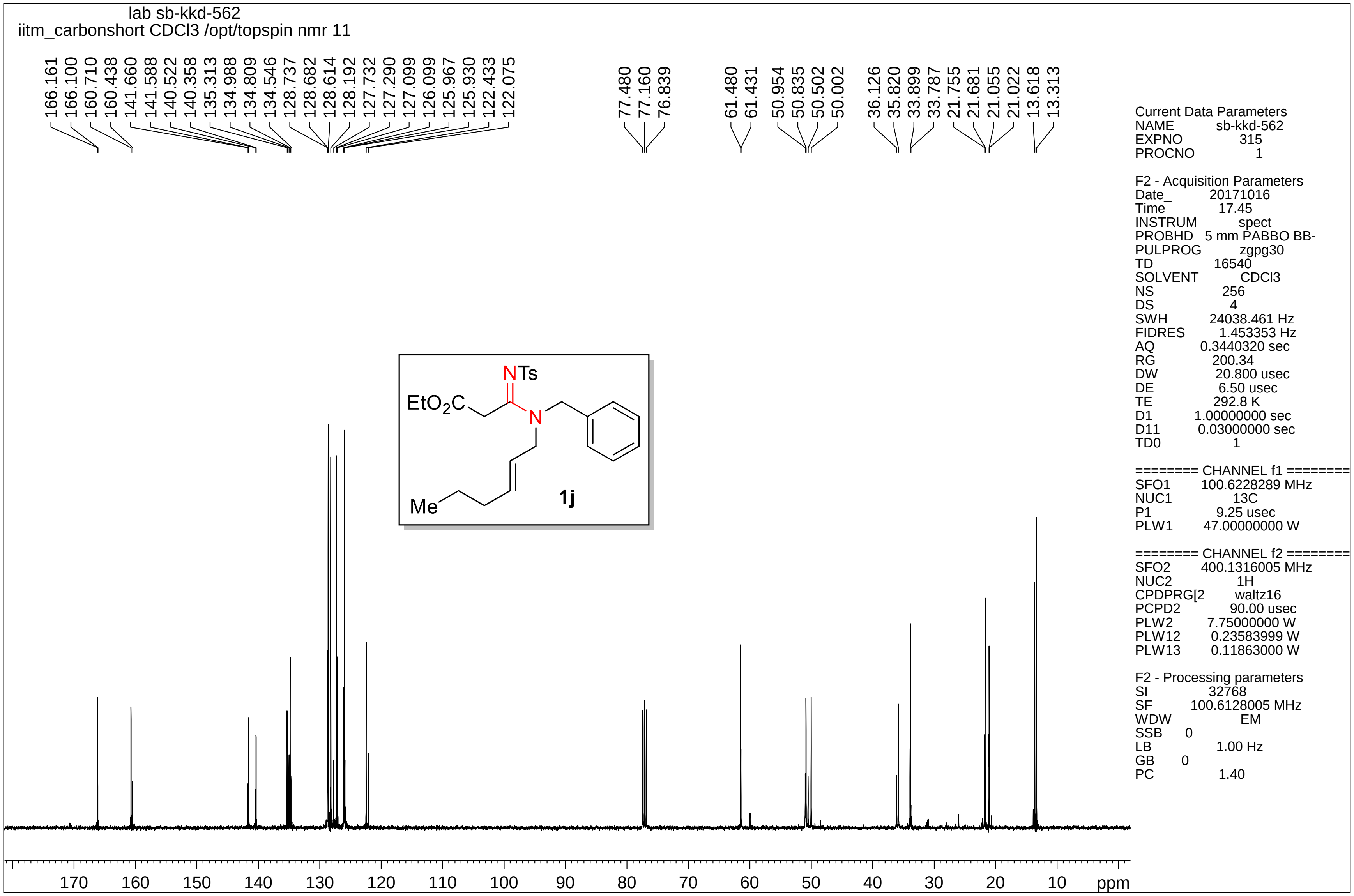
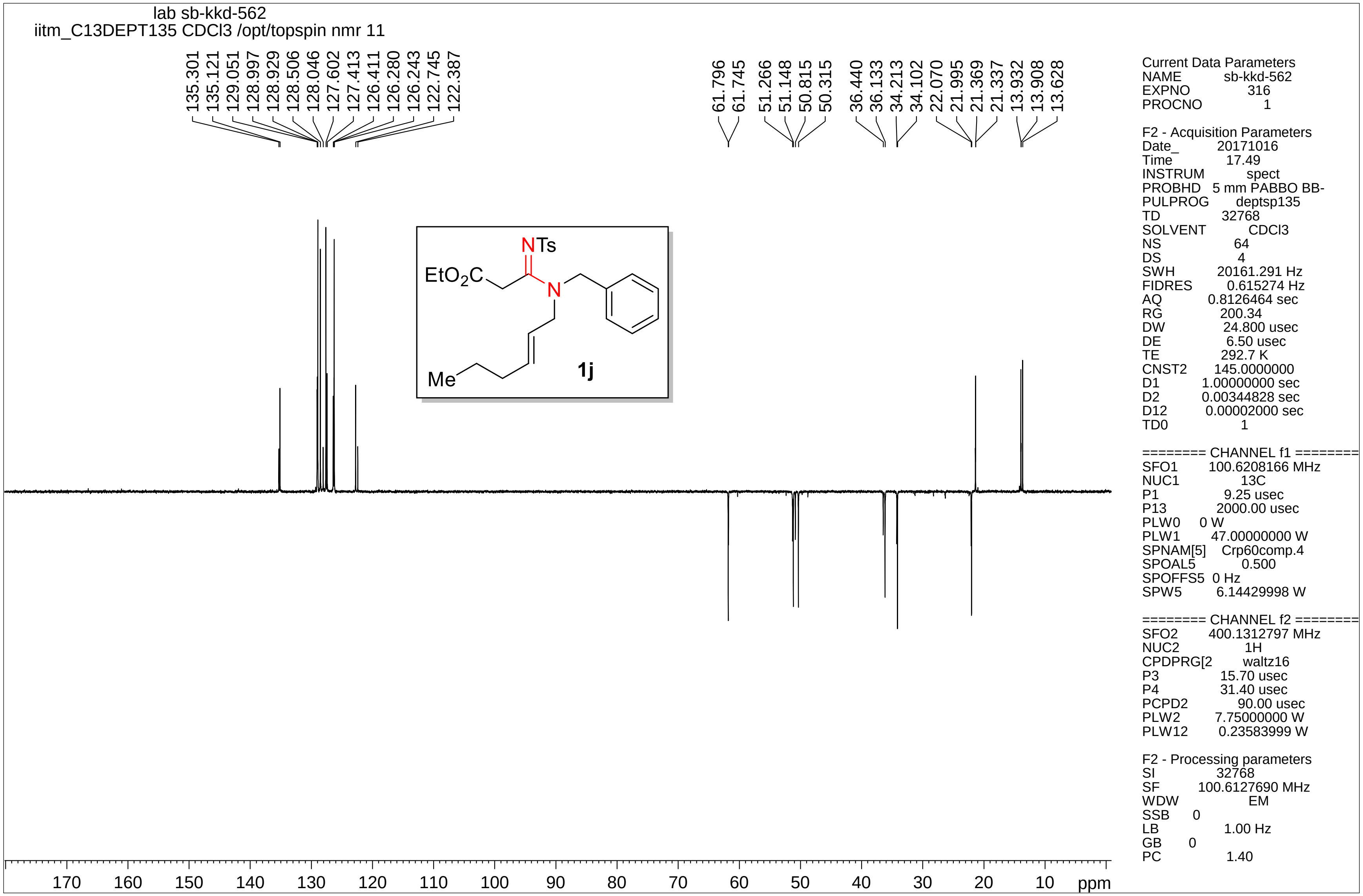


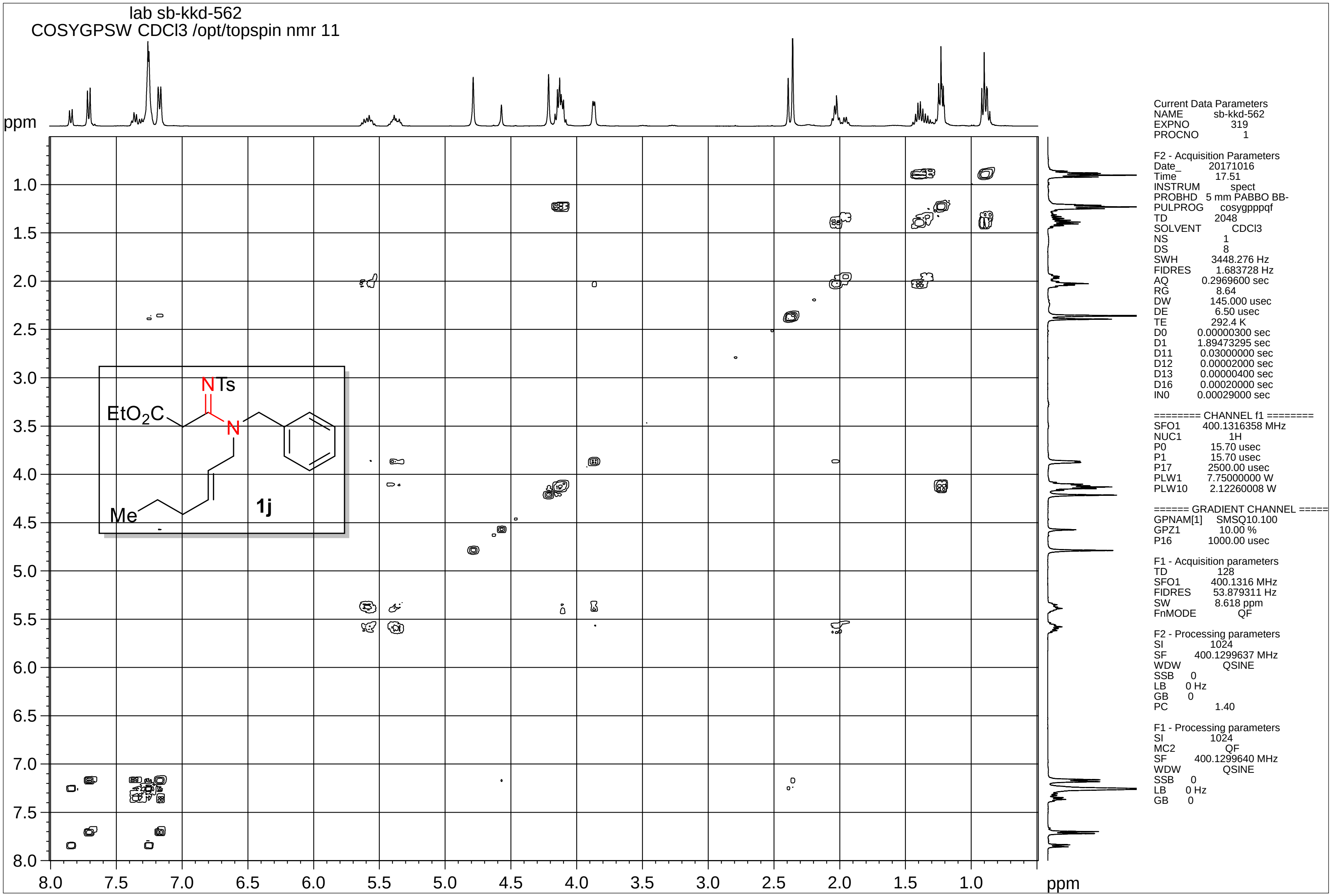
^{1}H NMR spectrum of compound 1j



^{13}C NMR spectrum of compound 1j



DEPT-135 NMR spectrum of compound 1j



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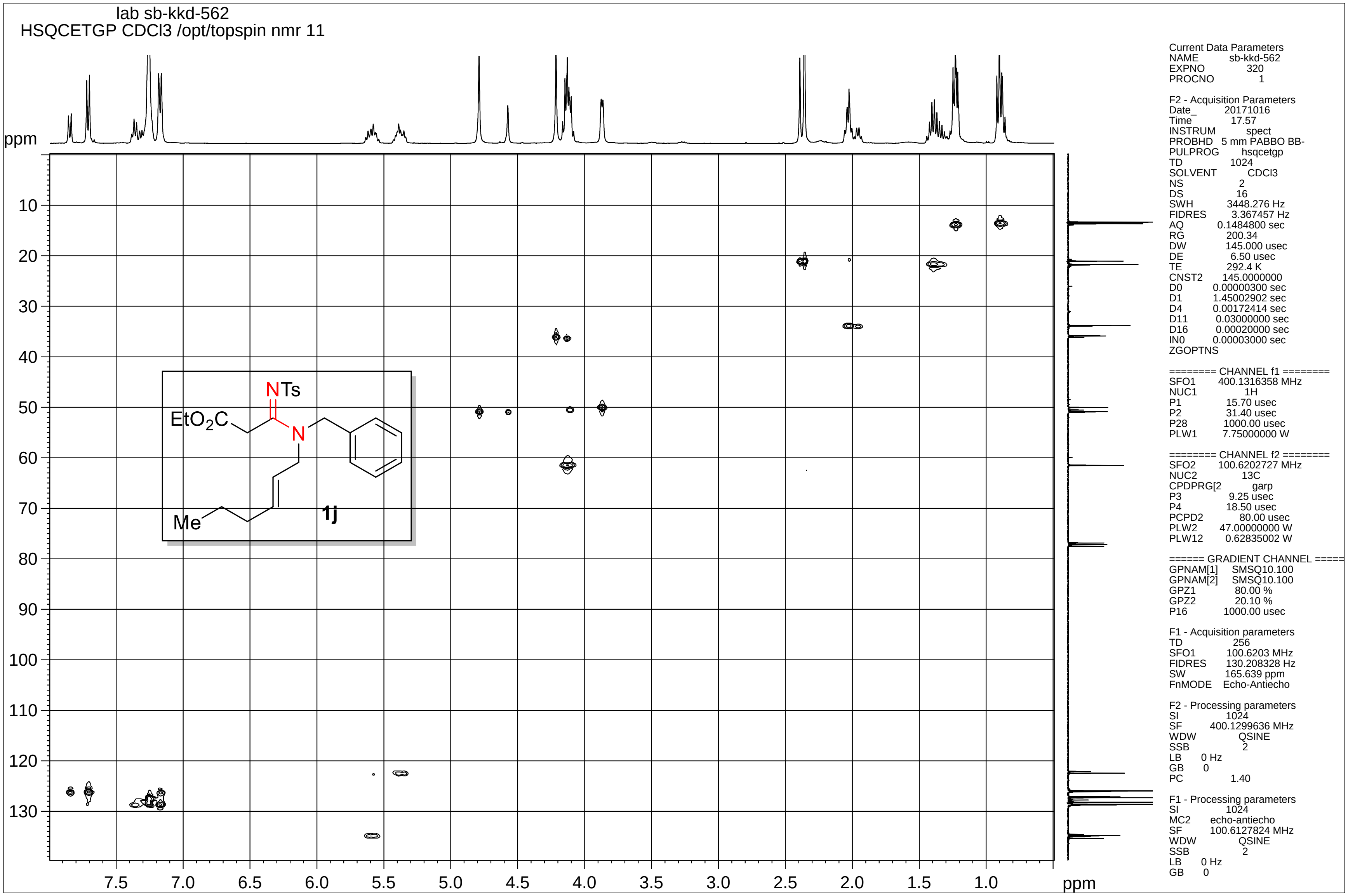
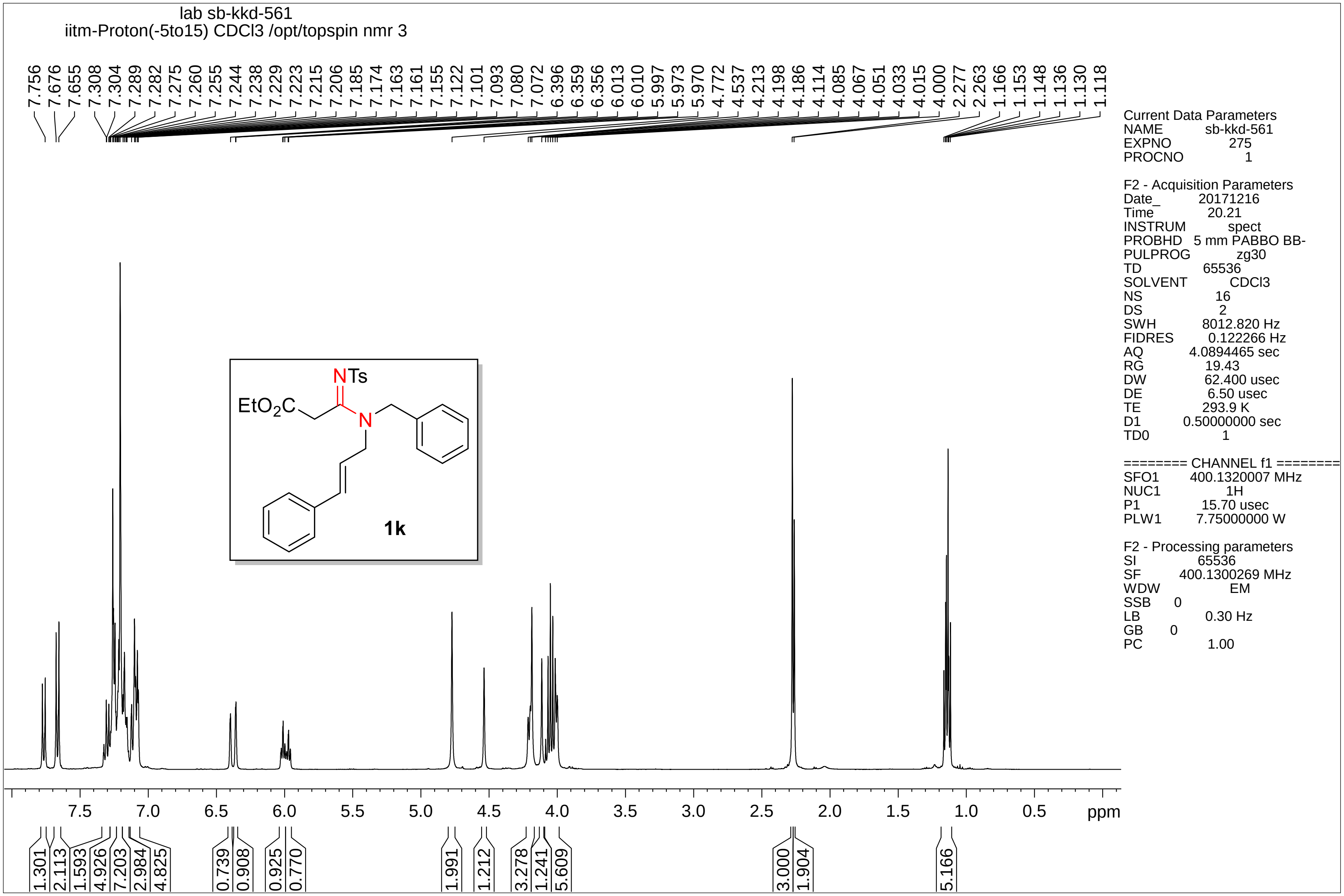
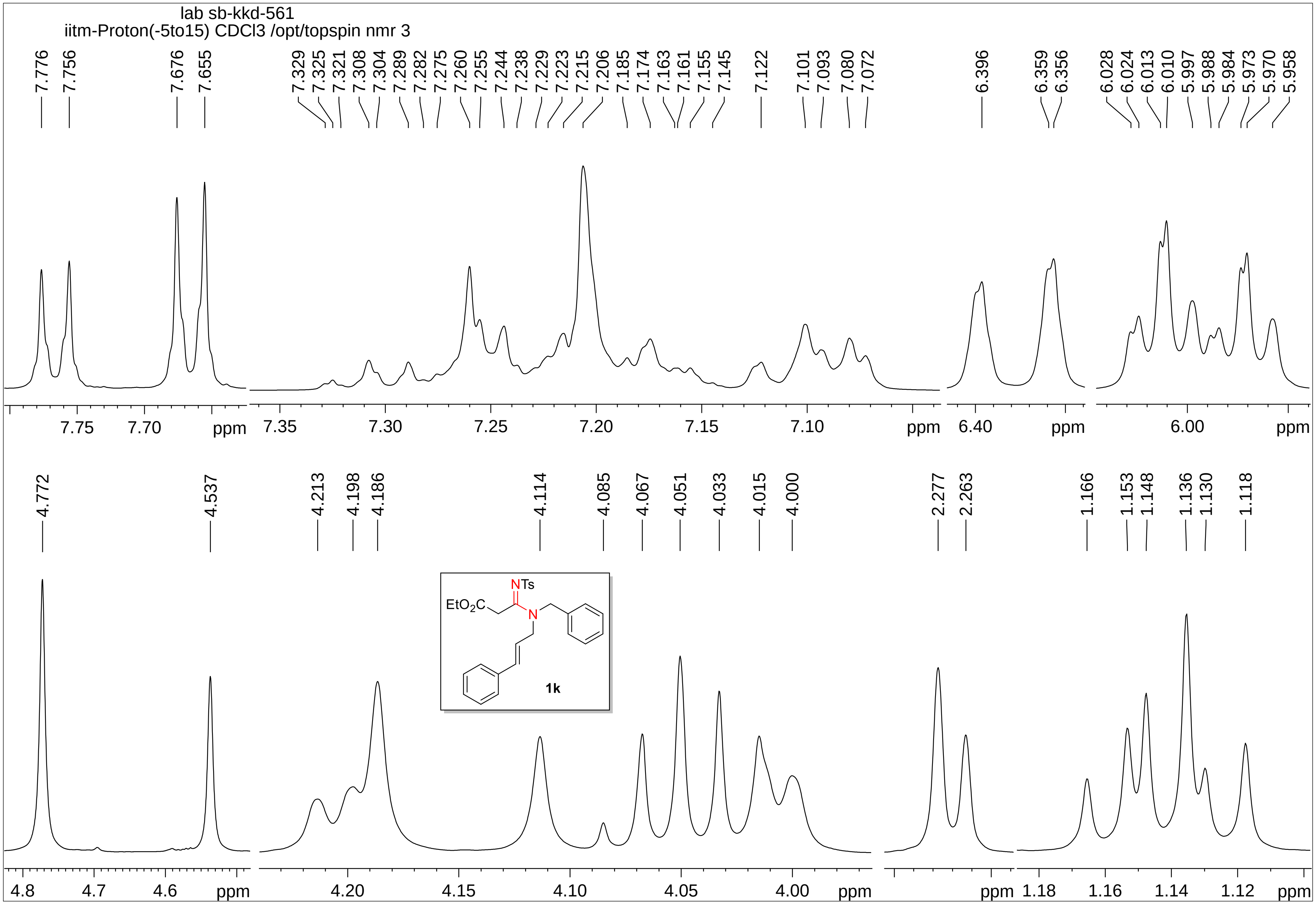


^{1}H-^{13}C HSQC NMR spectrum of compound 1j



^{1}H NMR spectrum of compound 1k



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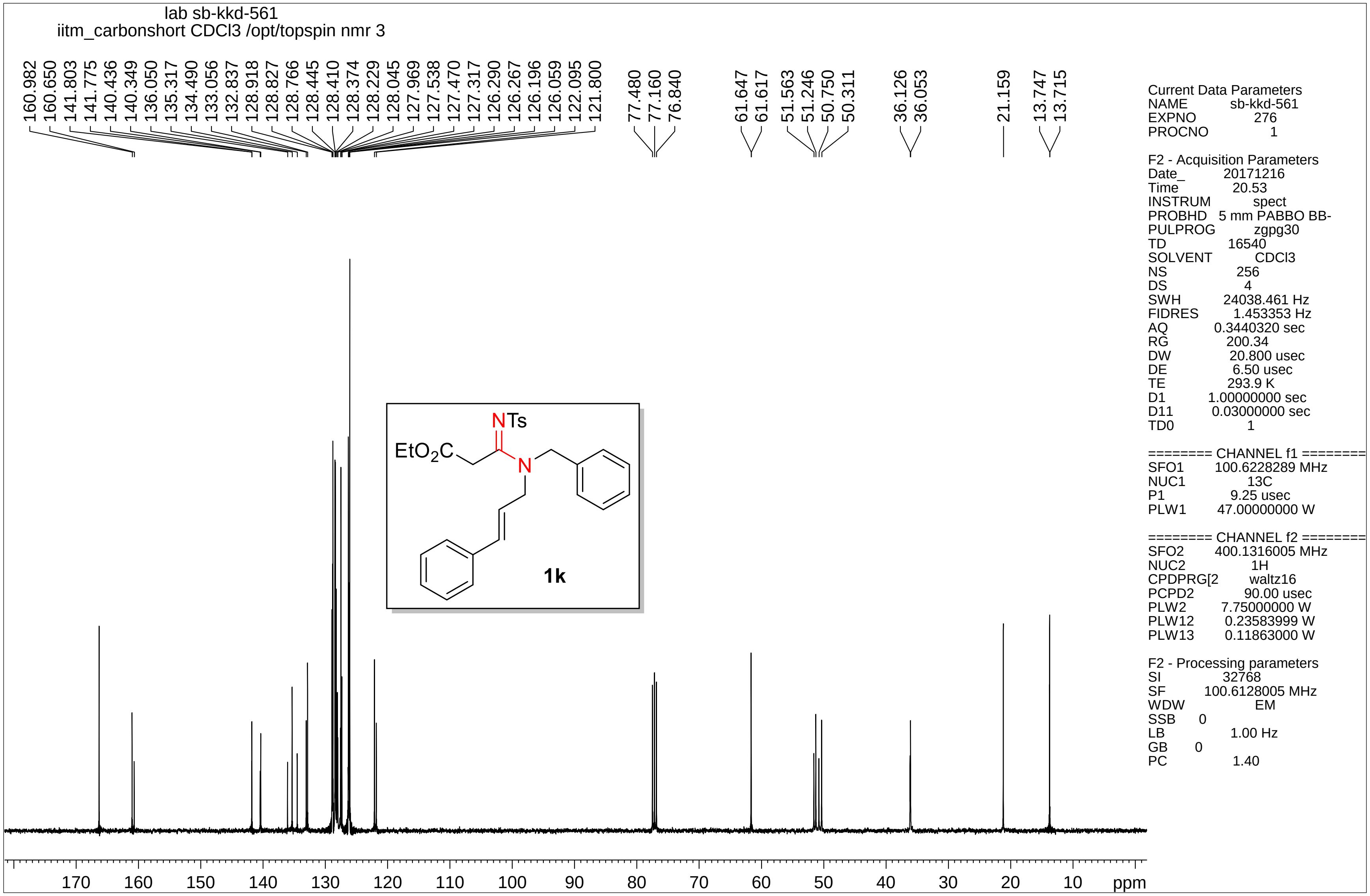
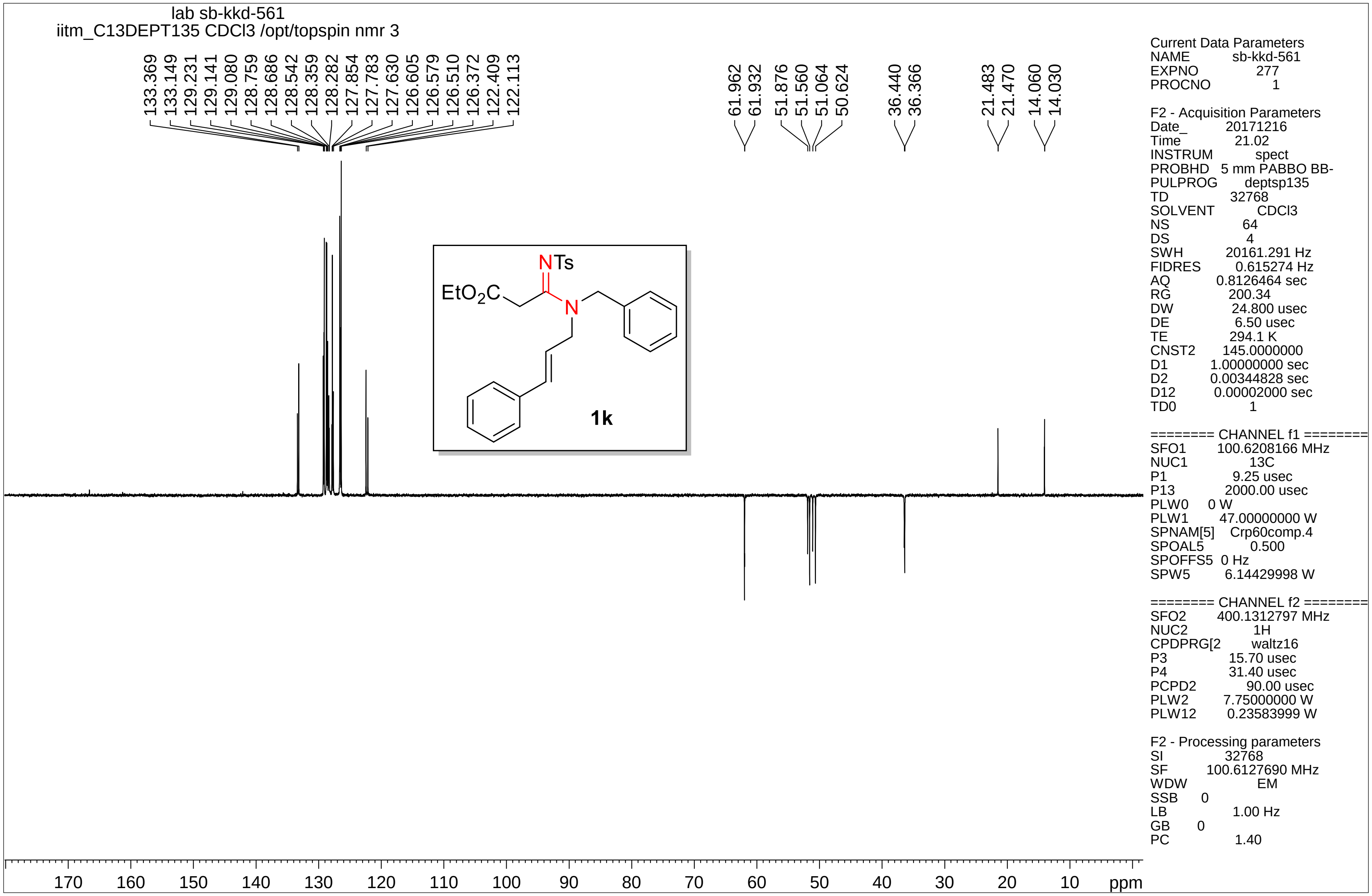


^{13}C NMR spectrum of compound 1k



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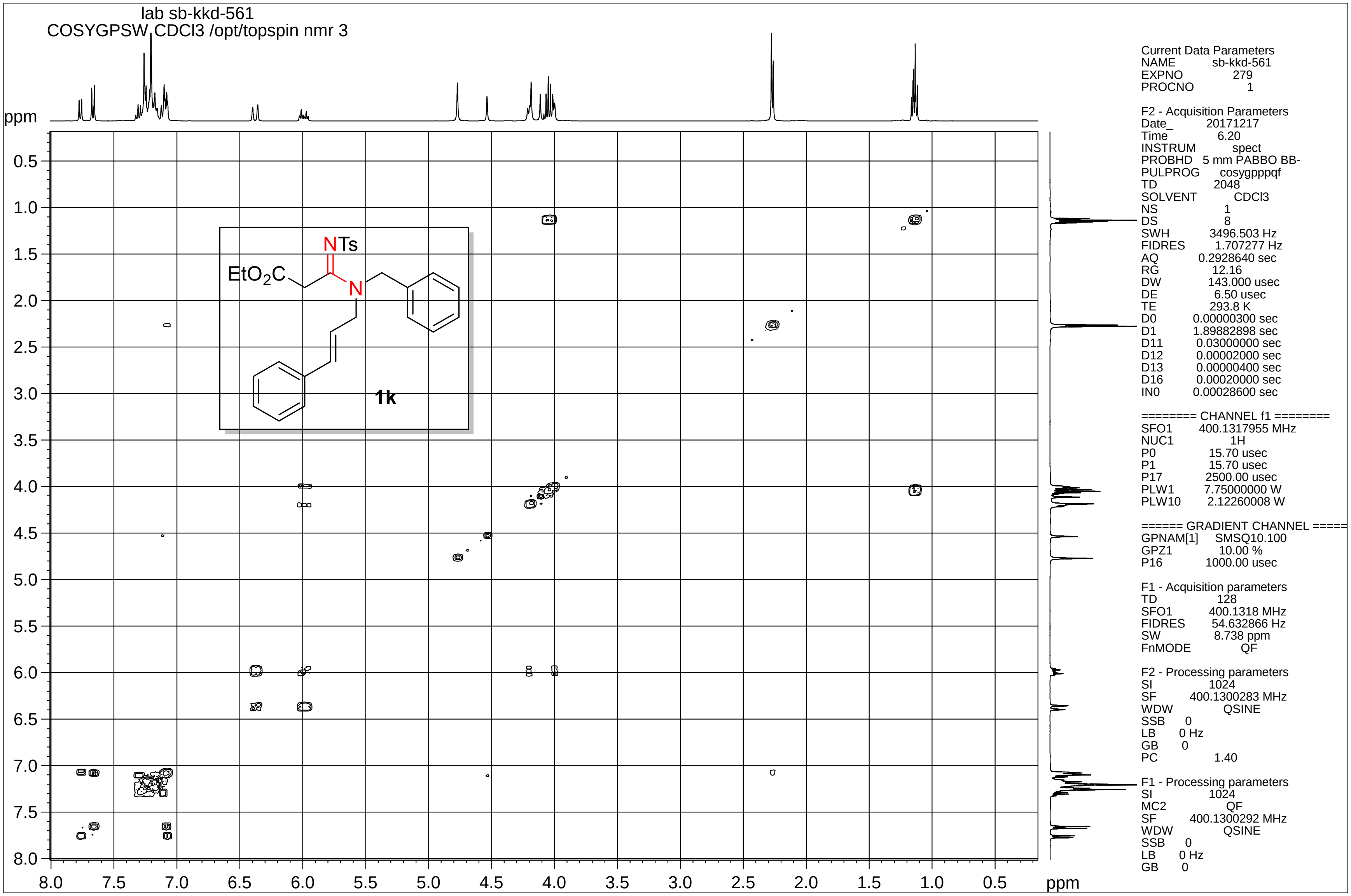

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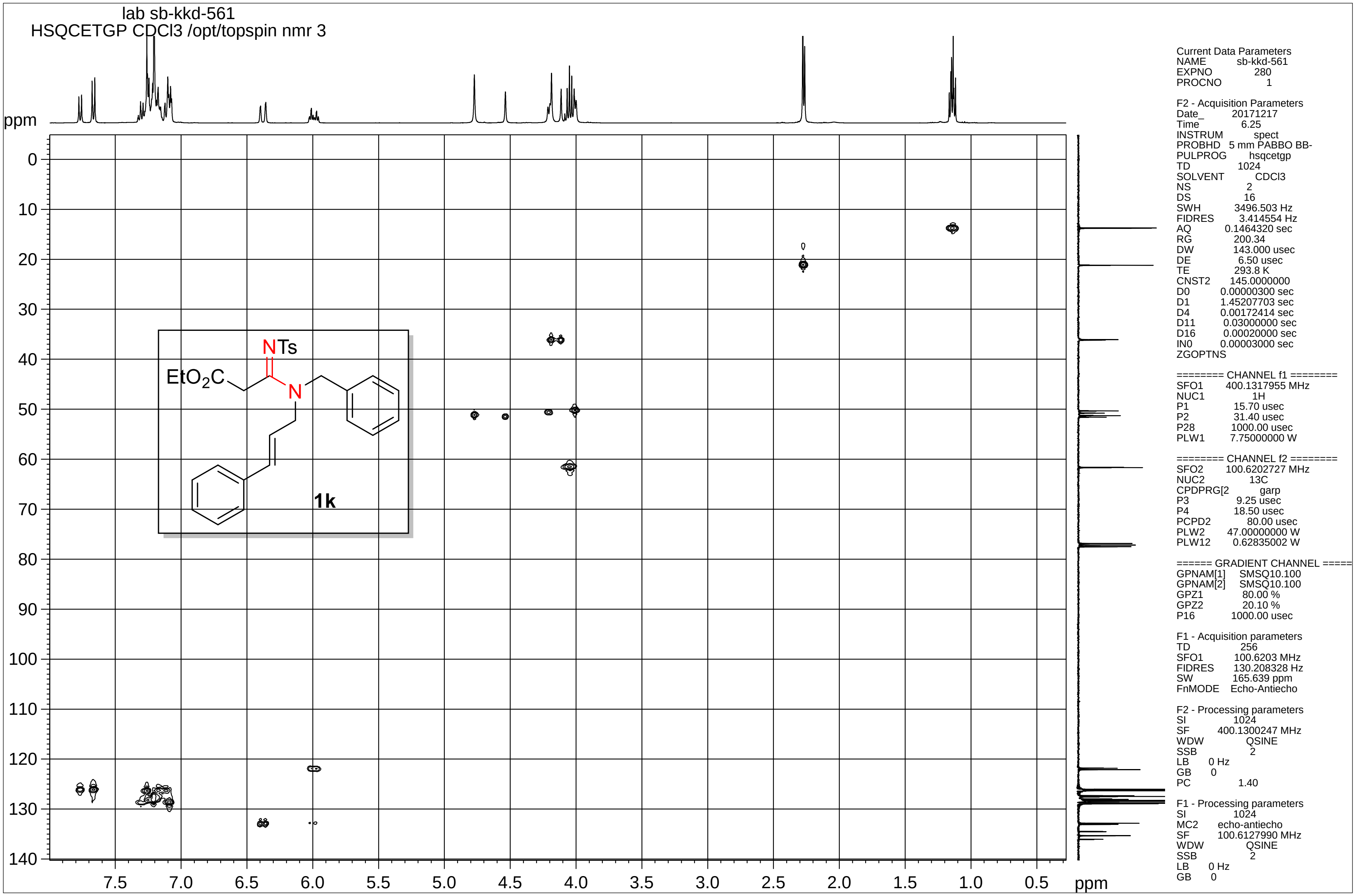

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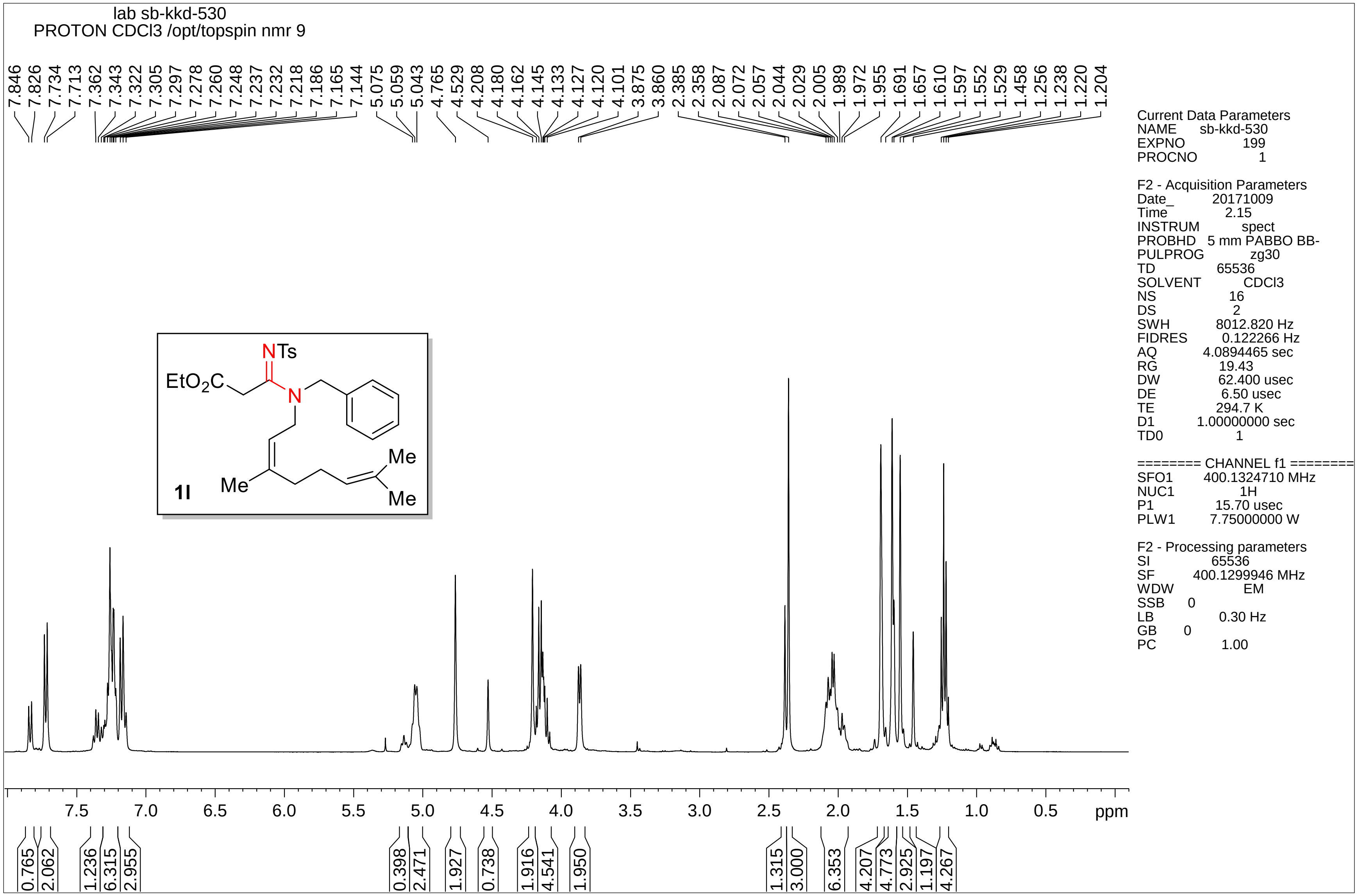
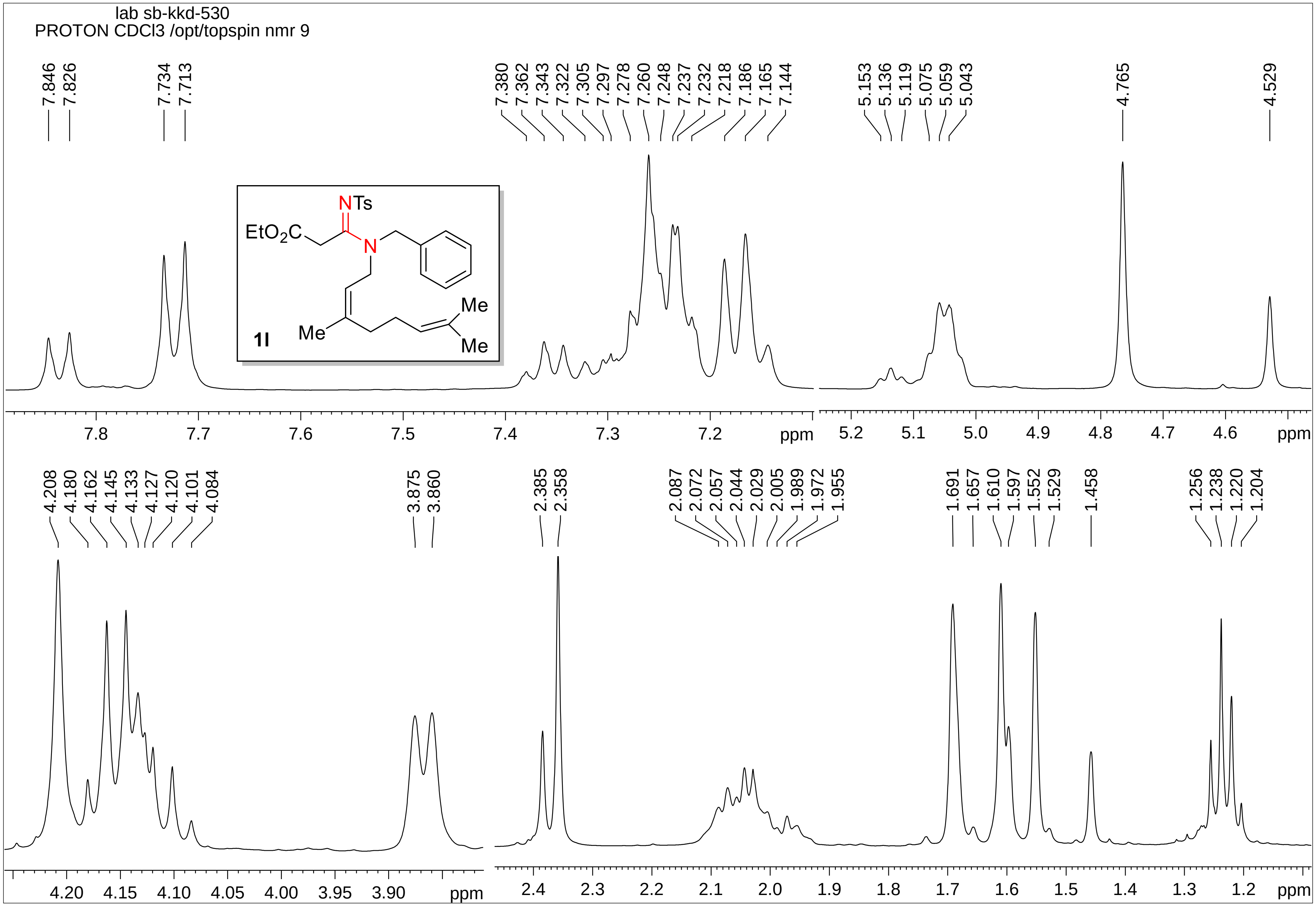
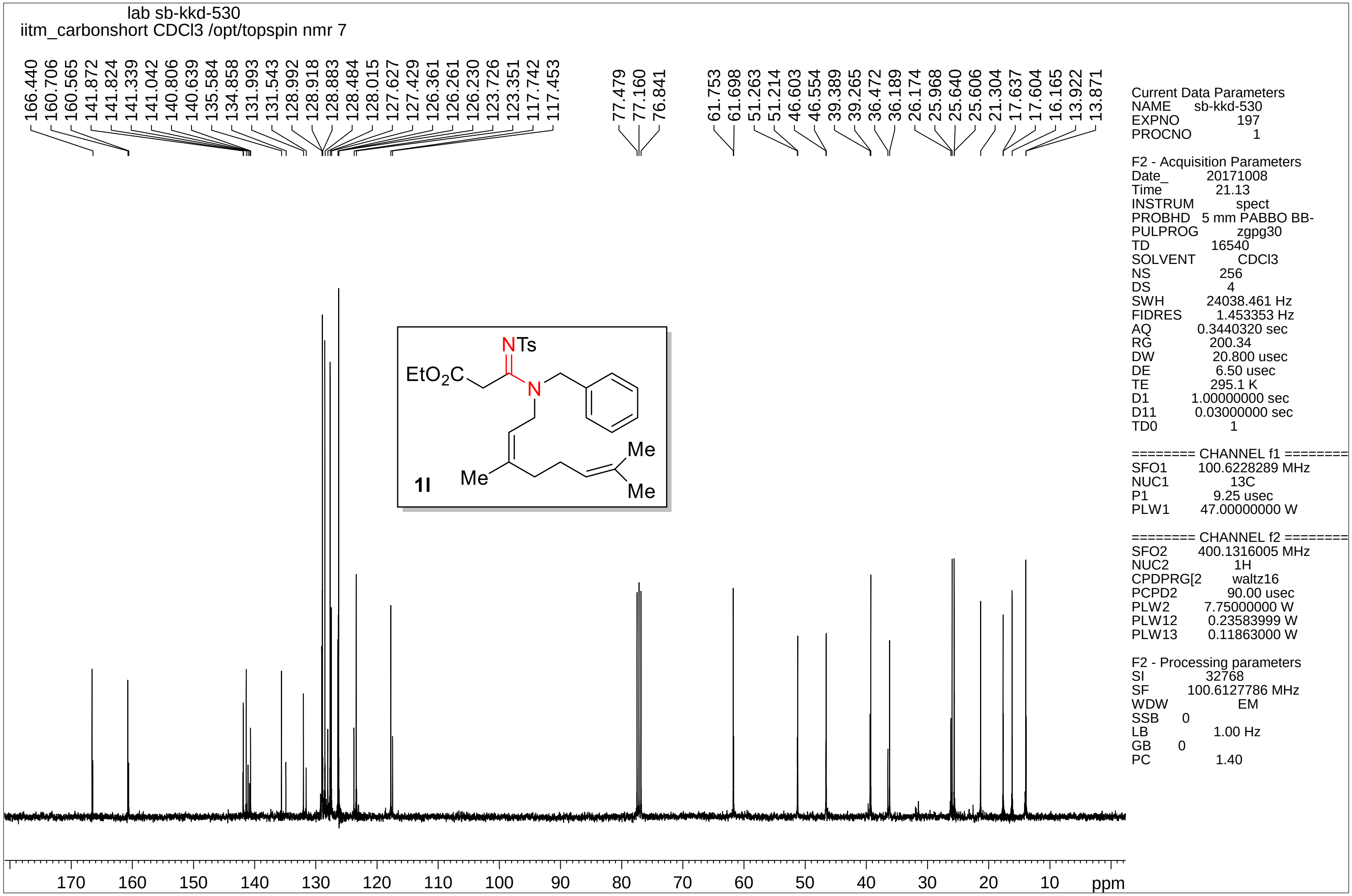


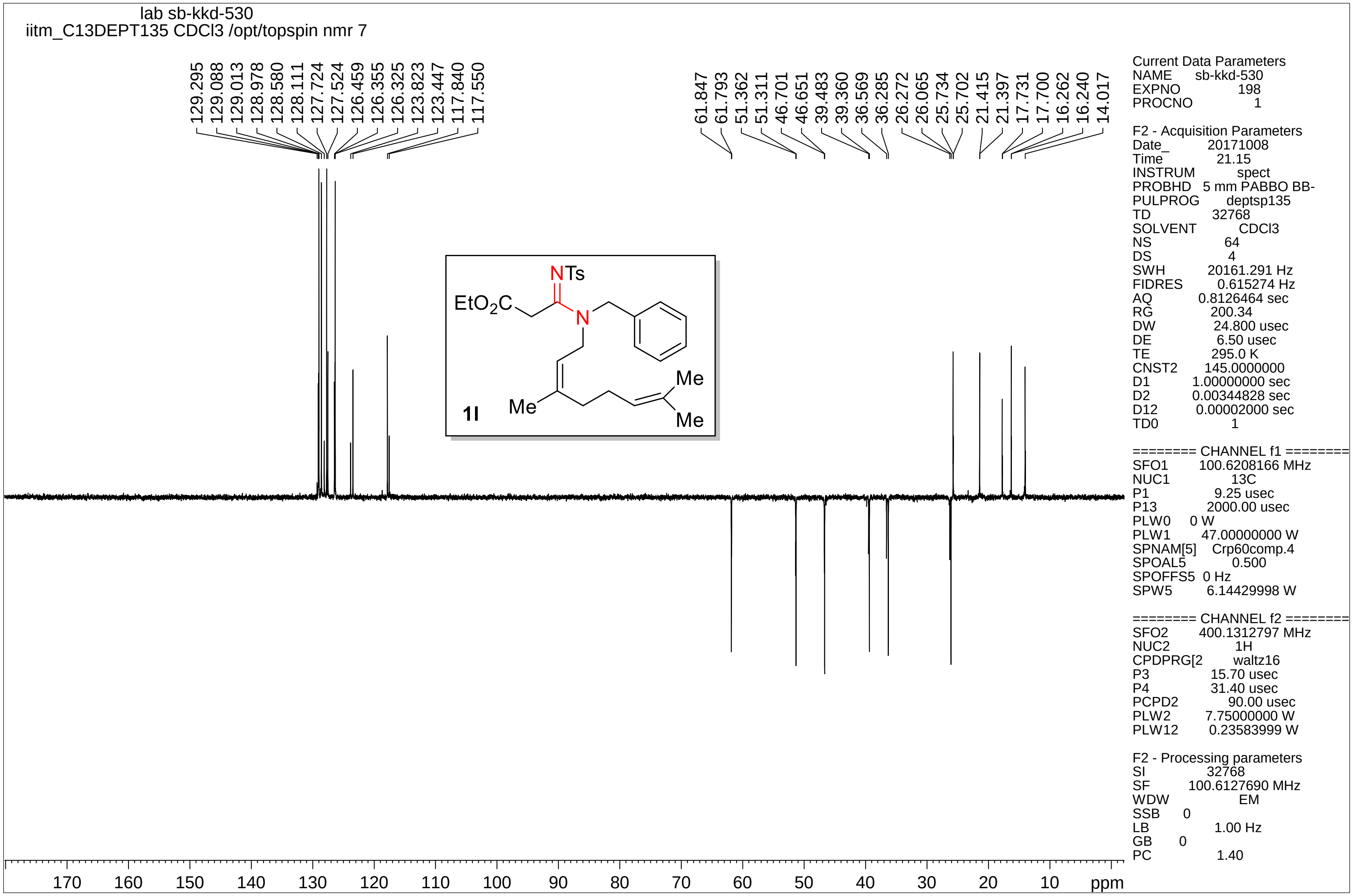
^{1}H NMR spectrum of compound 1l



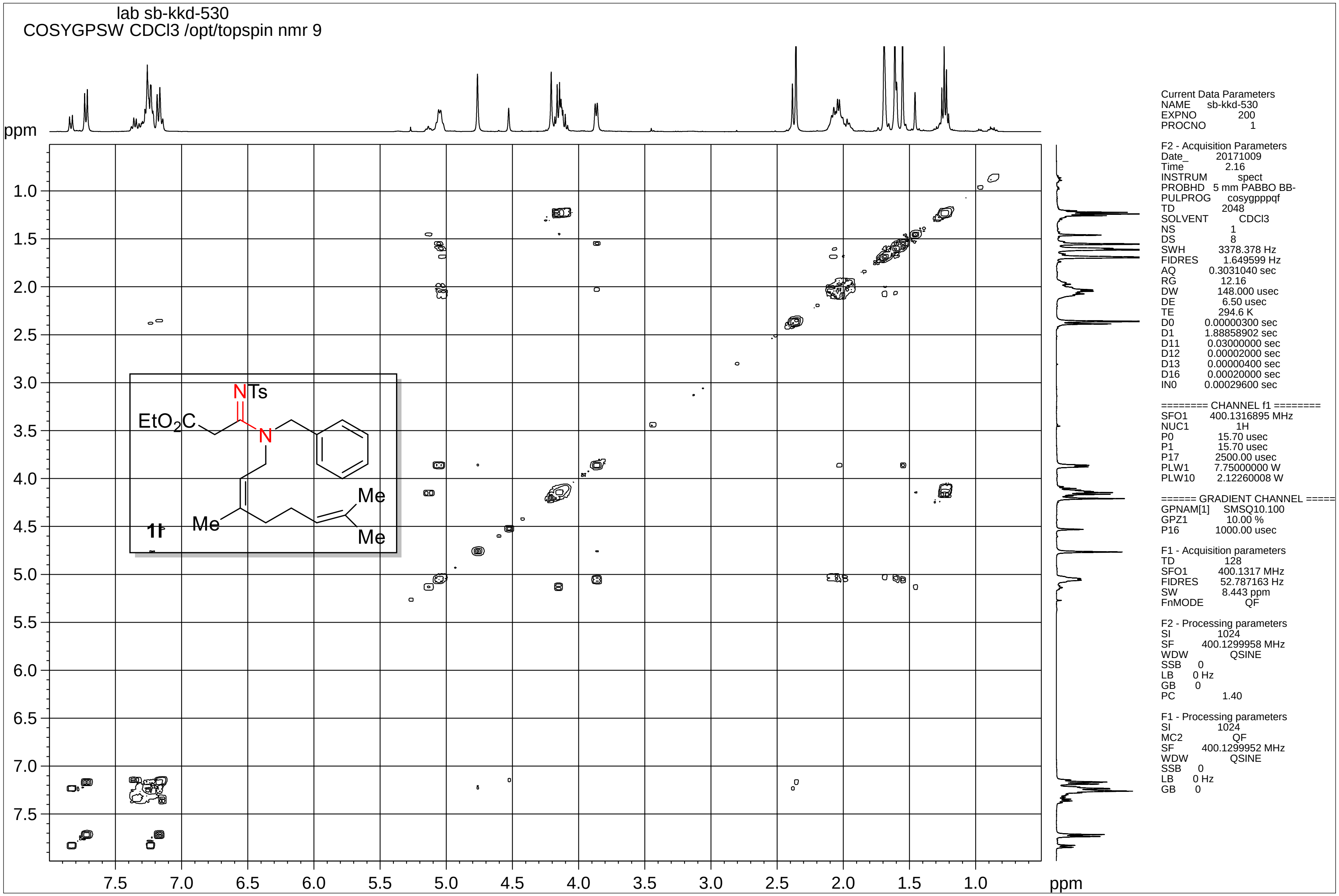
^{1}H NMR spectrum of compound 1l



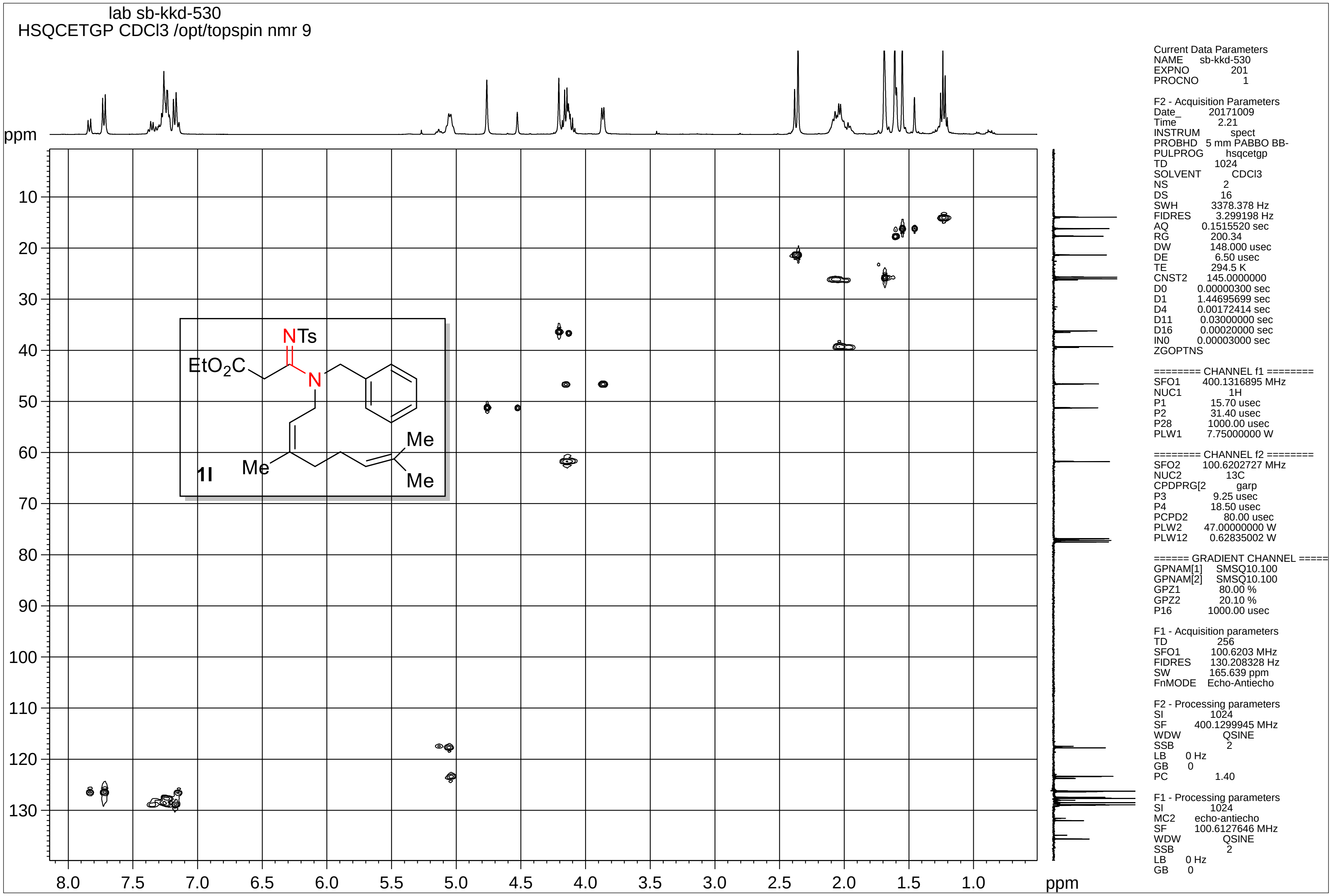
^{13}C NMR spectrum of compound 1l



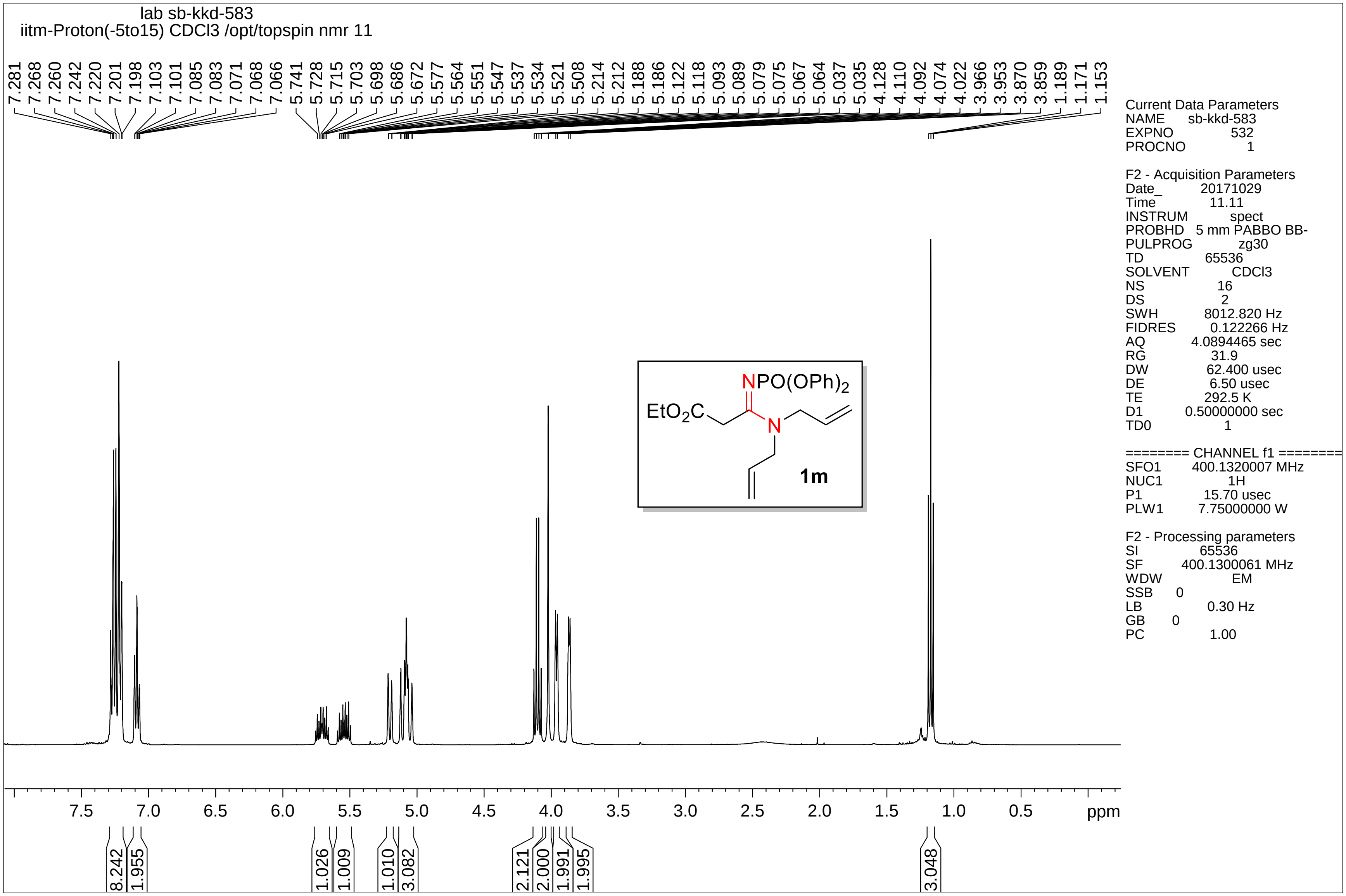
DEPT-135 NMR spectrum of compound 1l



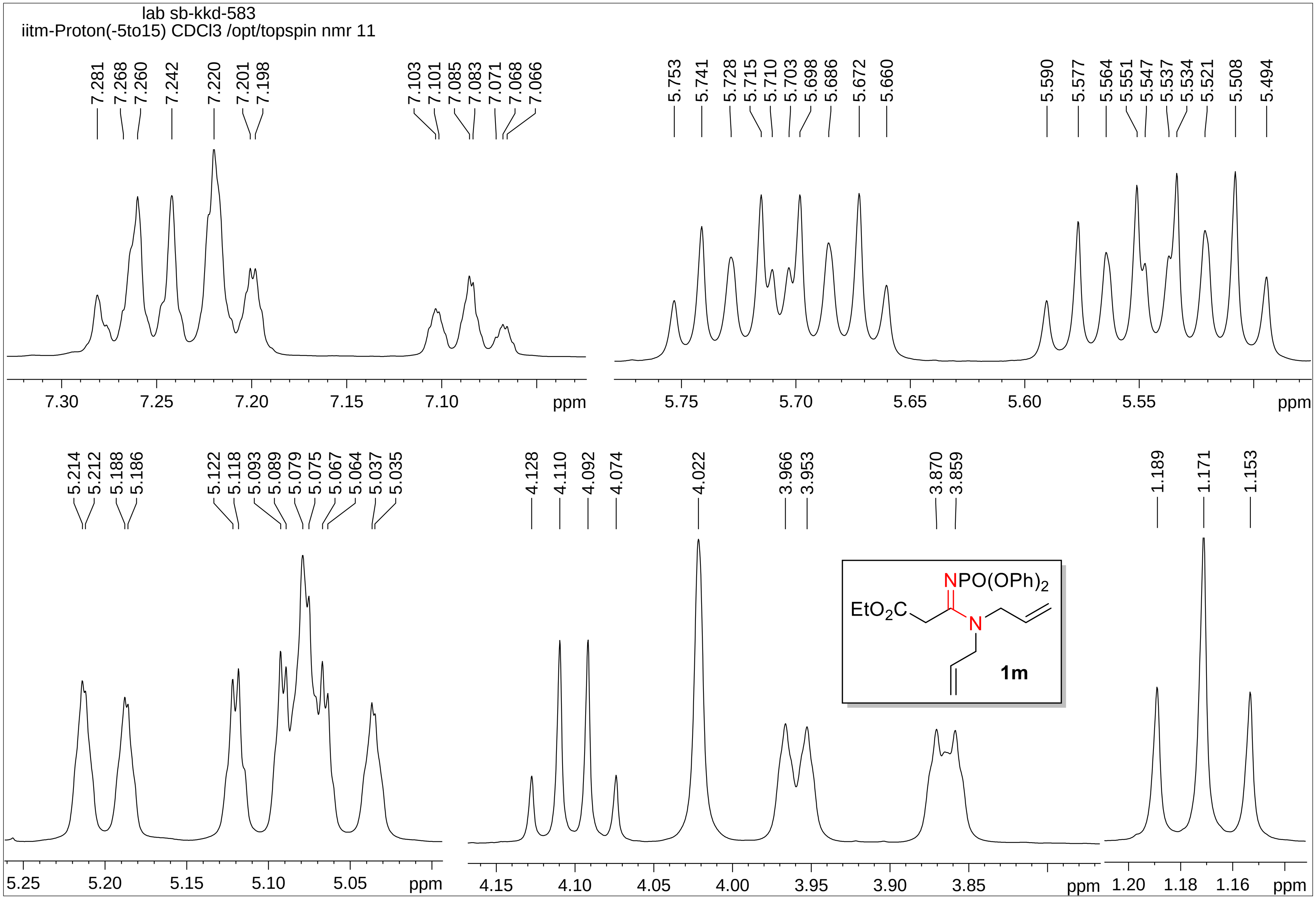
^1H-^1H COSY NMR spectrum of compound 1l



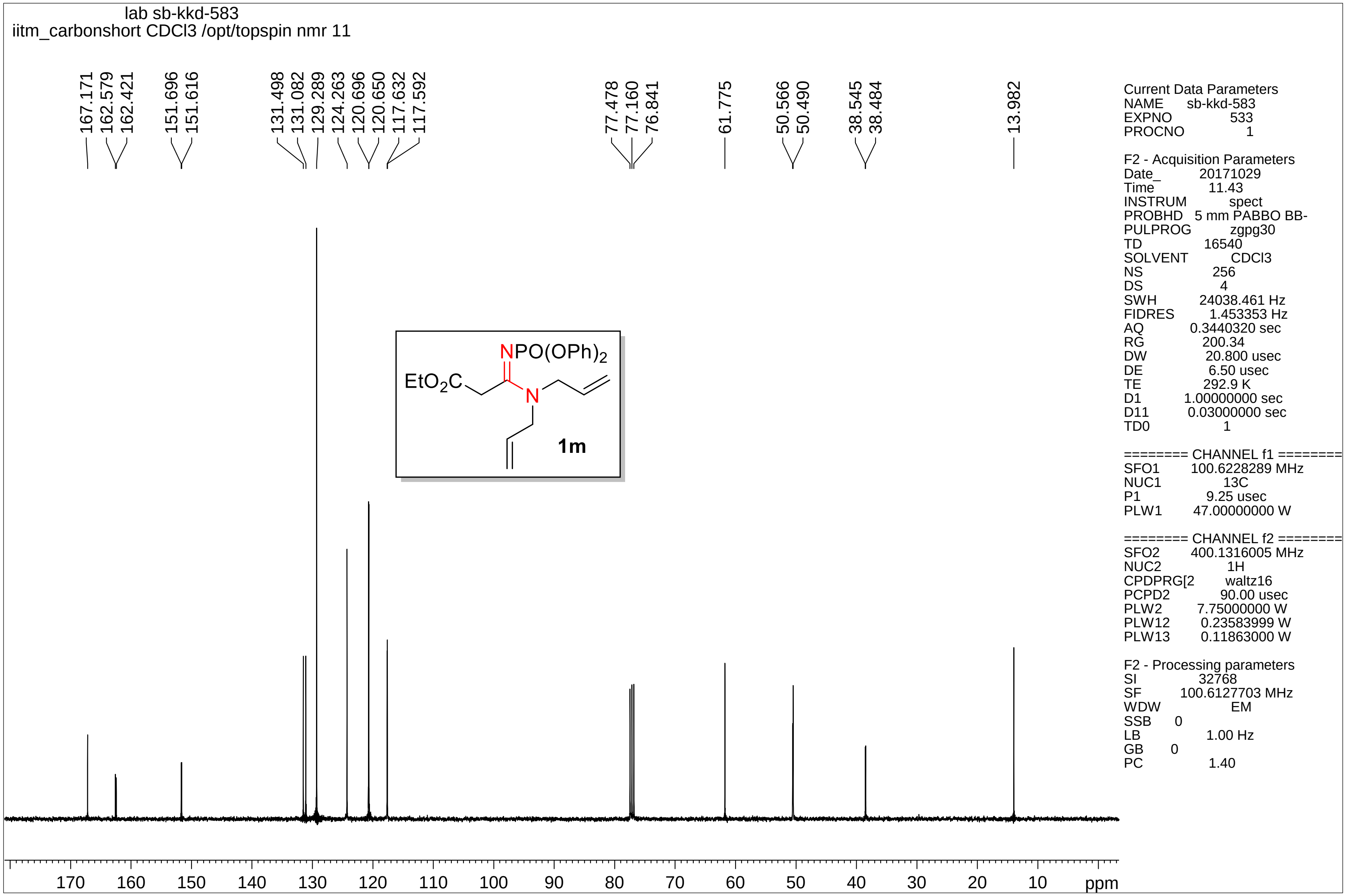
^{1}H-^{13}C HSQC NMR spectrum of compound 1l



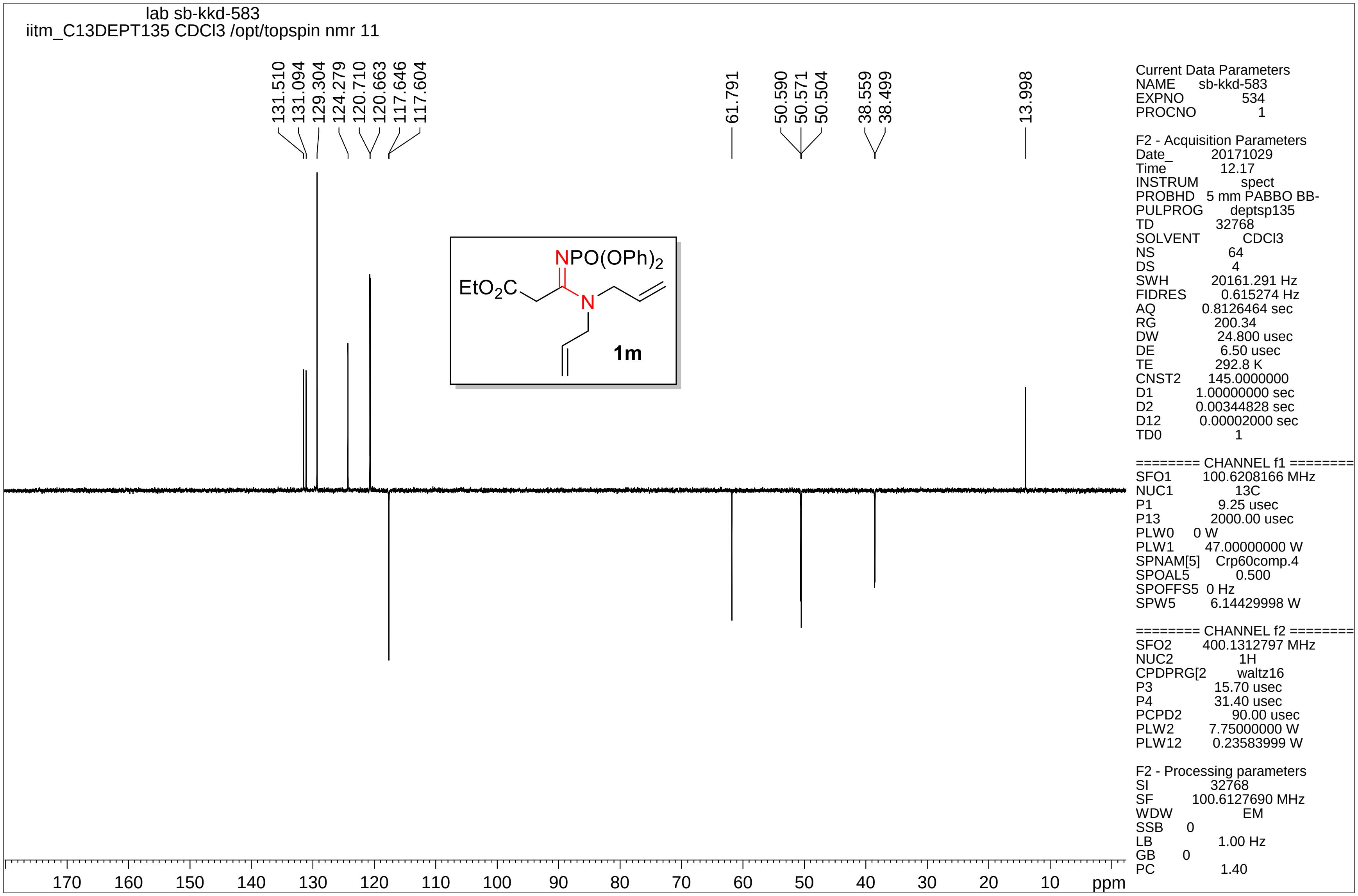
^{1}H NMR spectrum of compound 1m



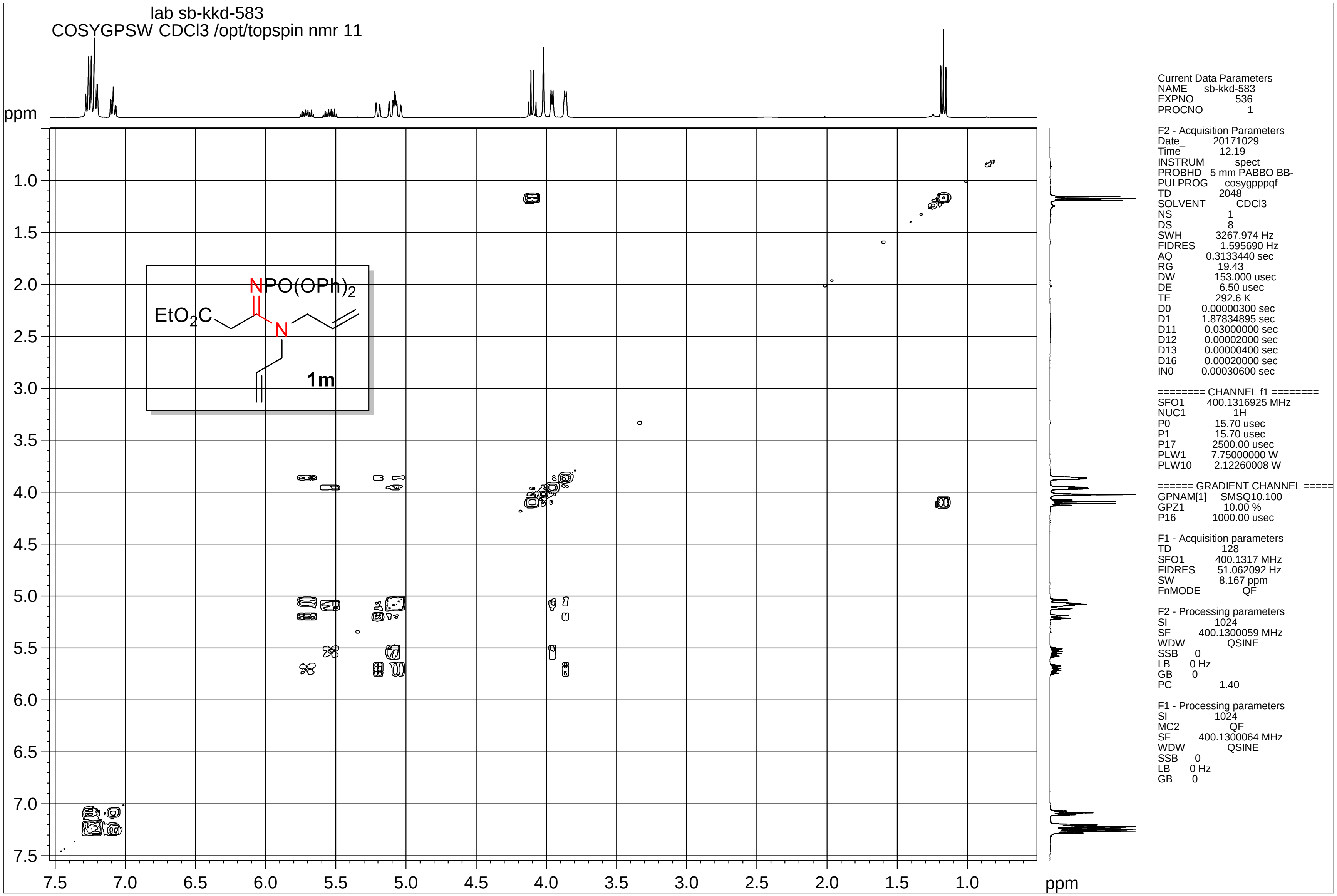
[1]H NMR spectrum of compound 1m



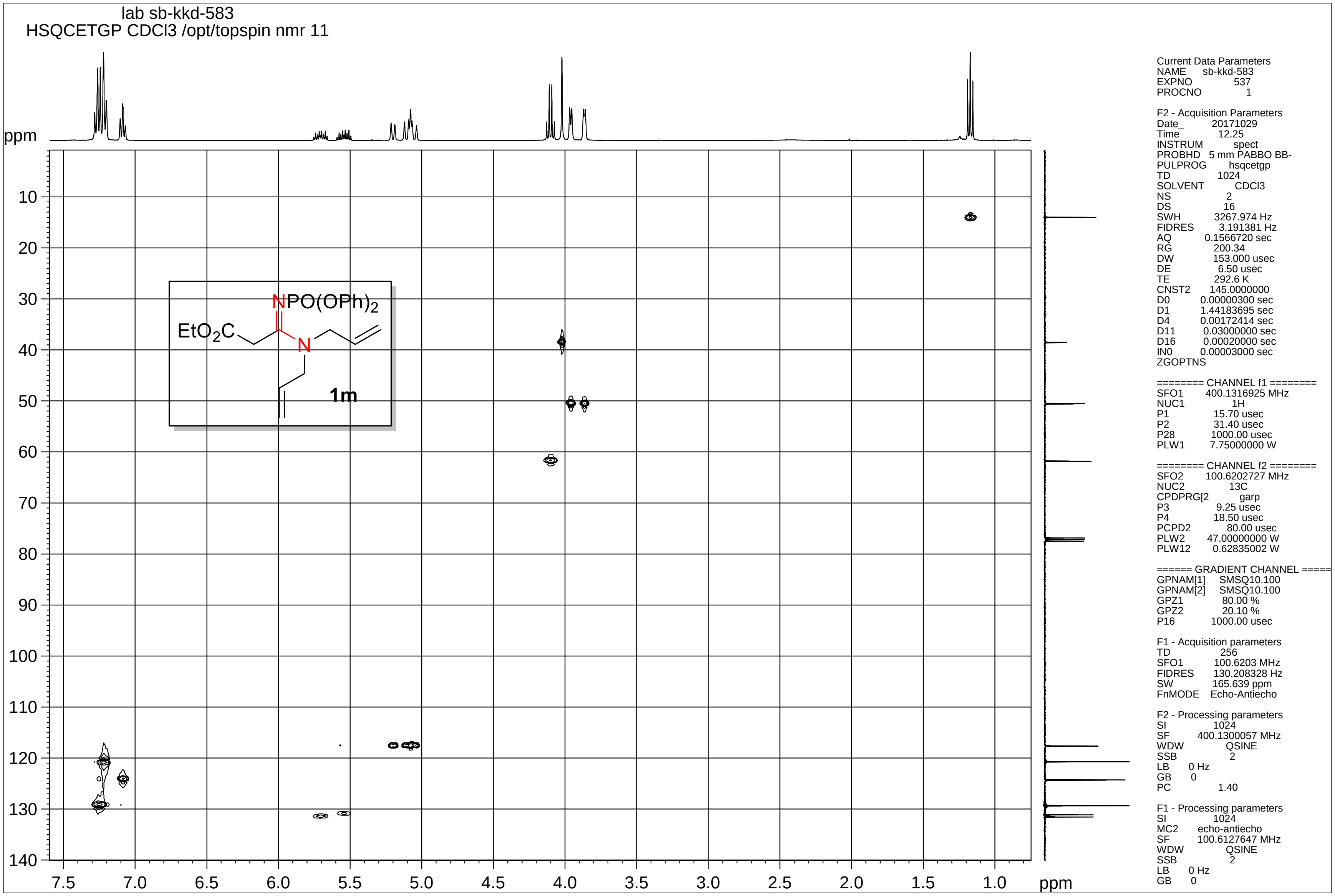
^{13}C NMR spectrum of compound 1m



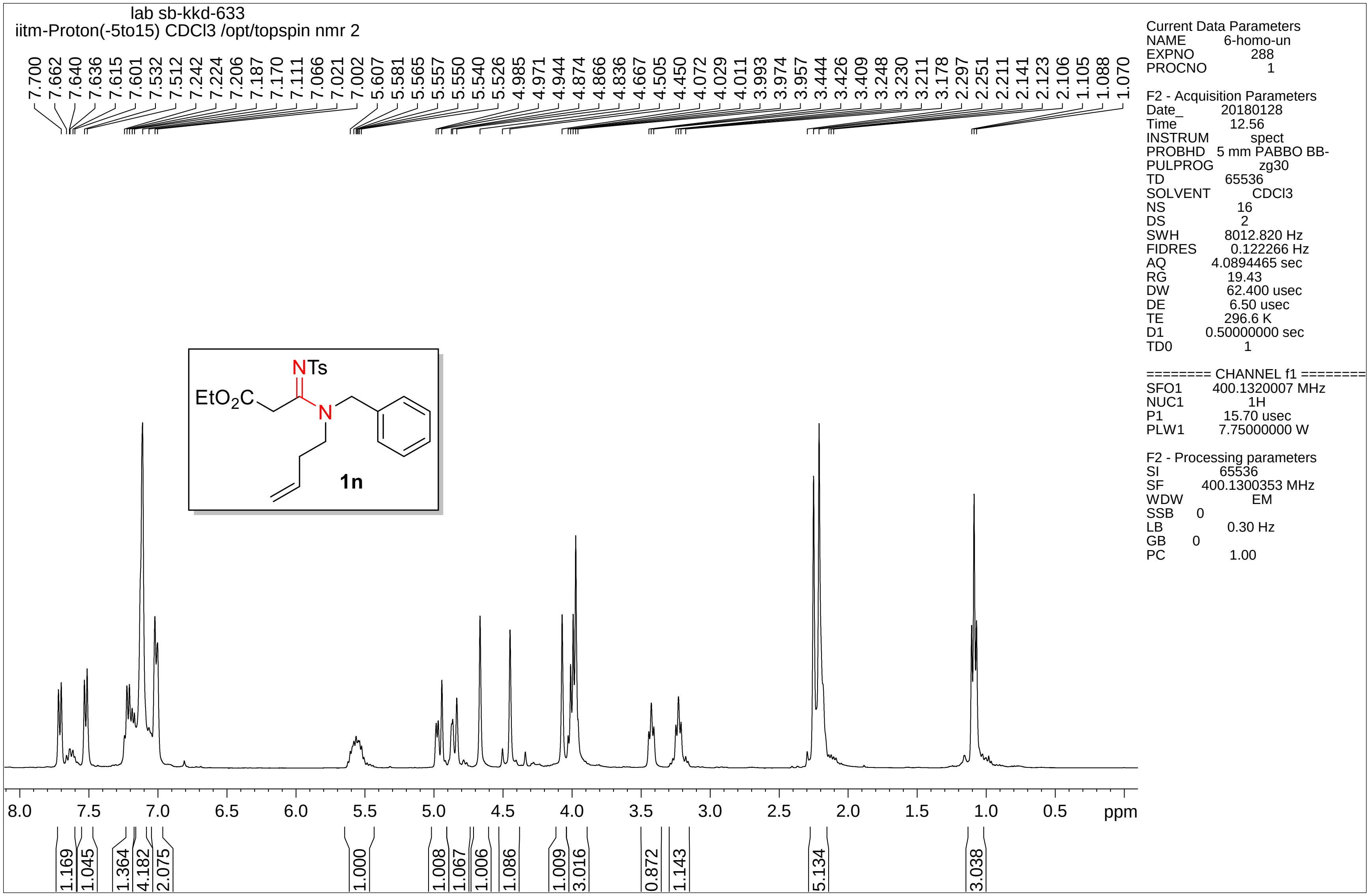
DEPT-135 NMR spectrum of compound 1m



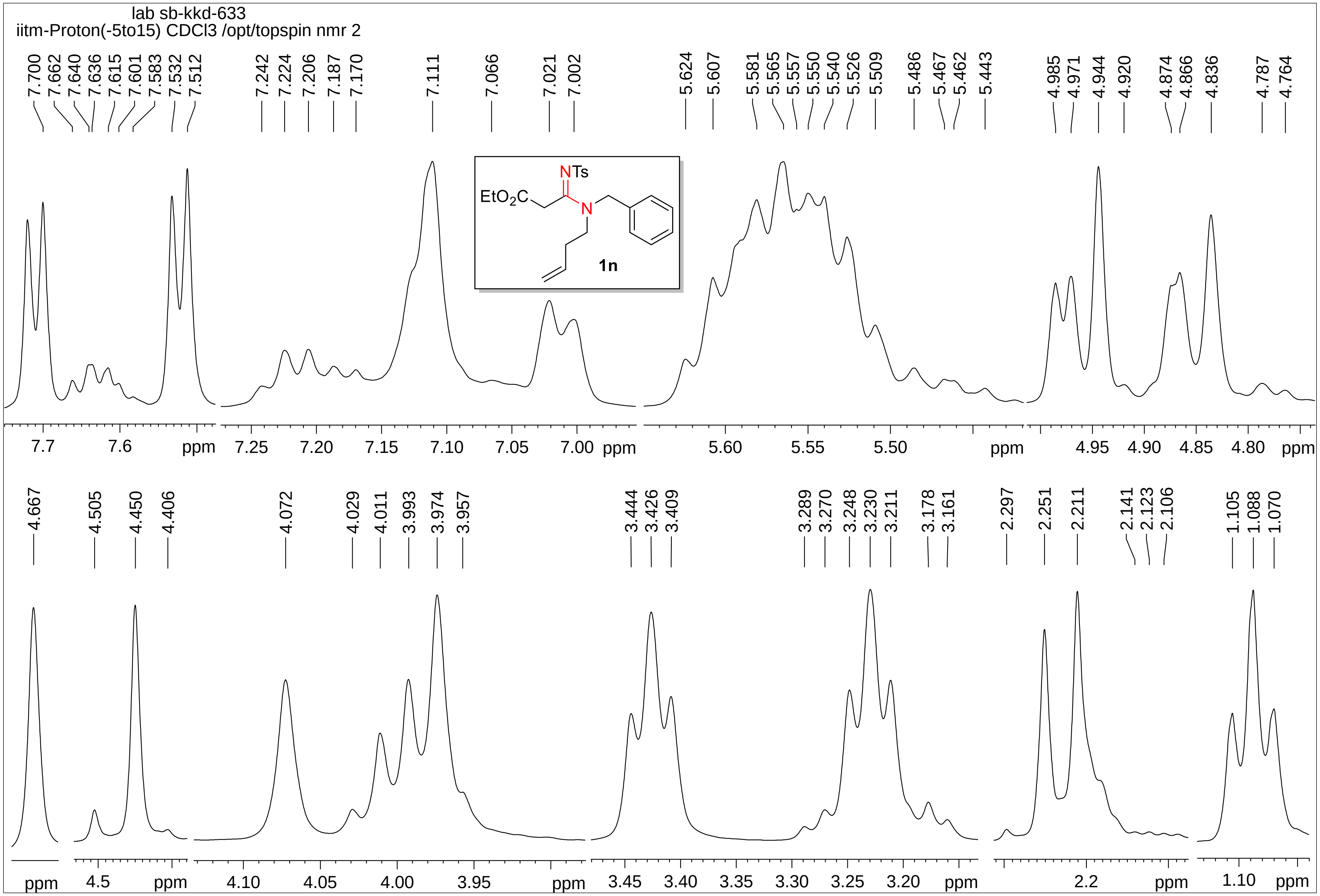
^{1}H-^{1}H COSY NMR spectrum of compound 1m



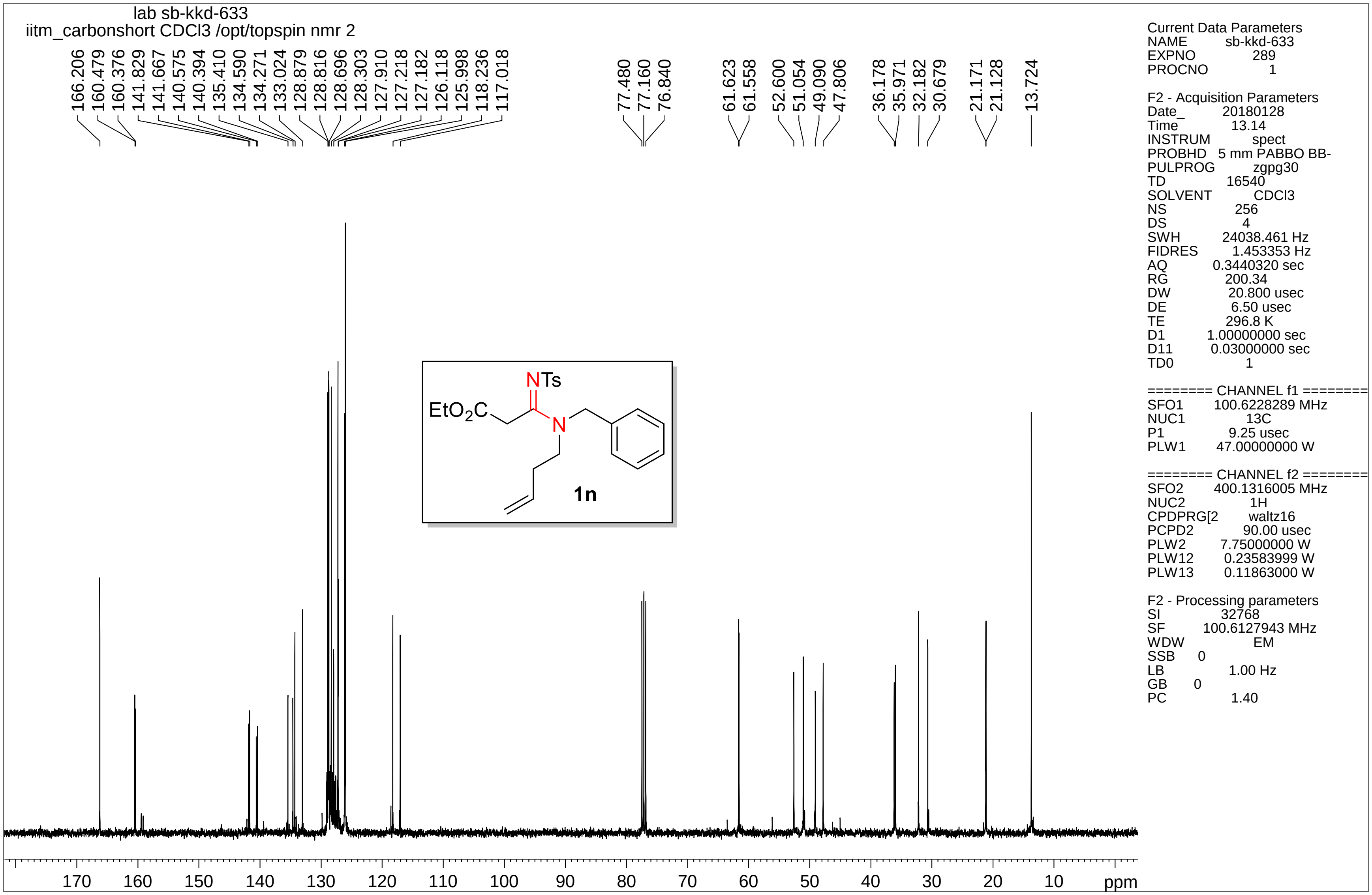
^{1}H-^{13}C HSQC NMR spectrum of compound 1m



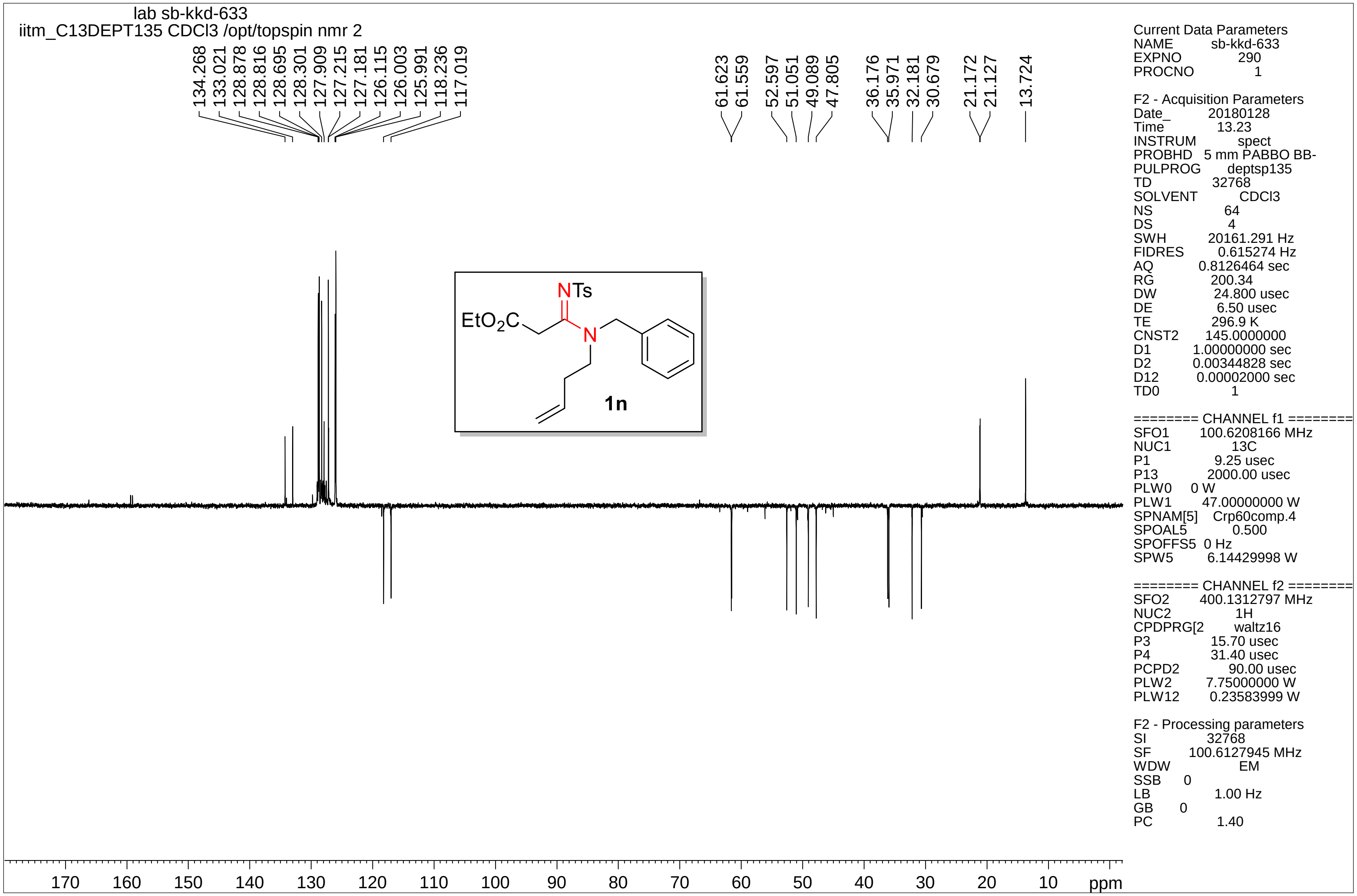
^{1}H NMR spectrum of compound 1n



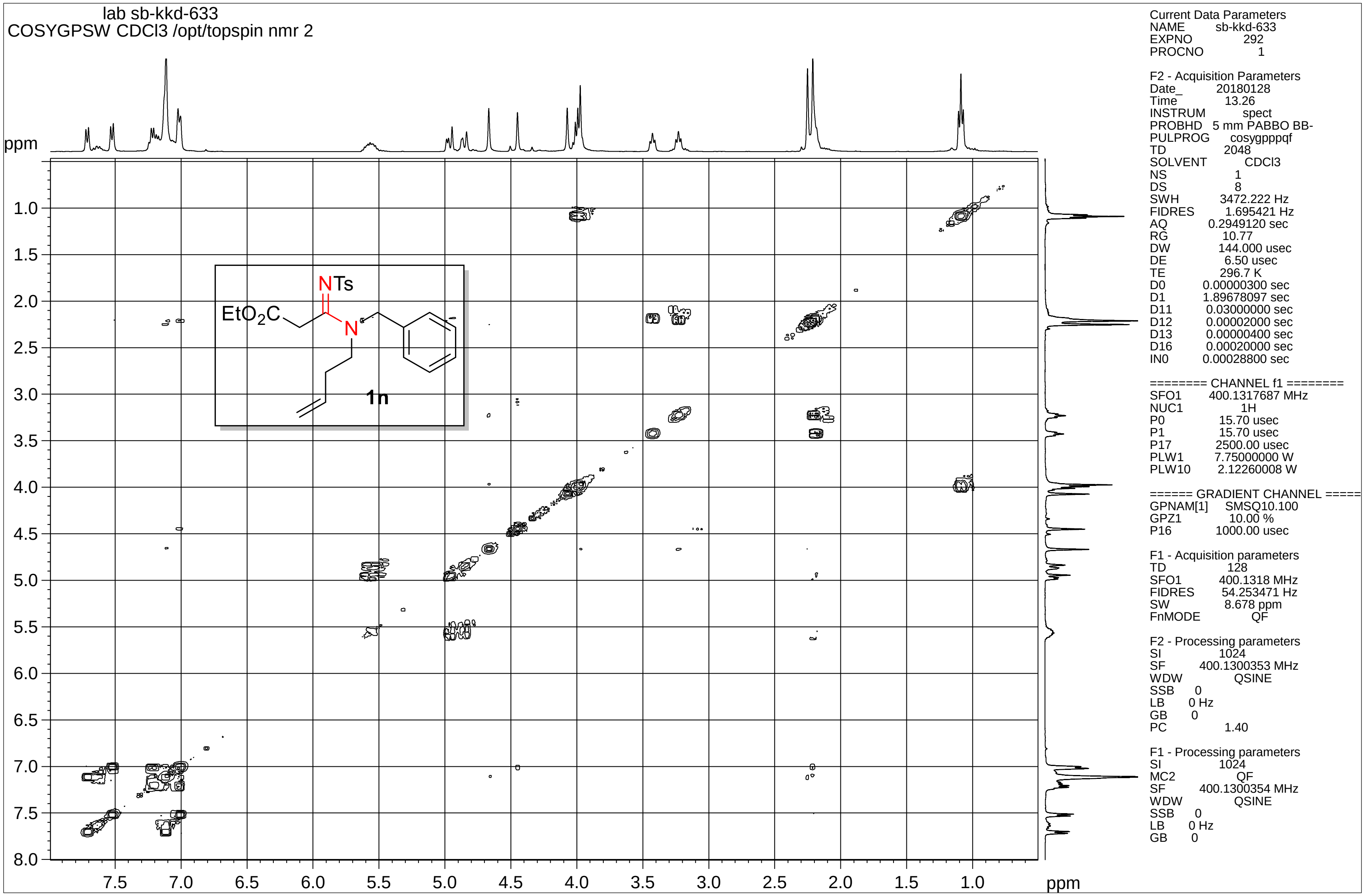
^{1}H NMR spectrum of compound 1n



^{13}C NMR spectrum of compound 1n



DEPT-135 NMR spectrum of compound 1n



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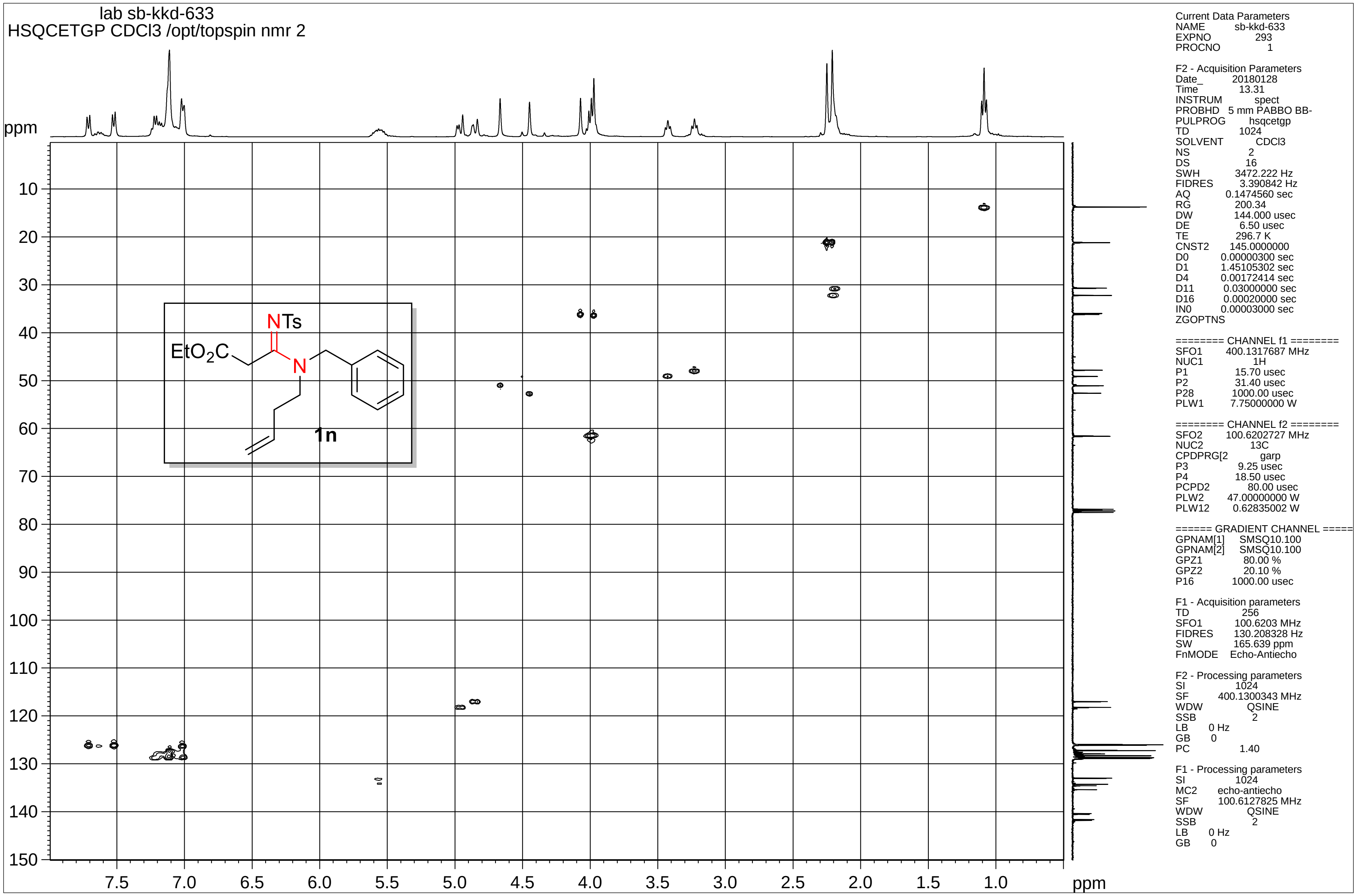

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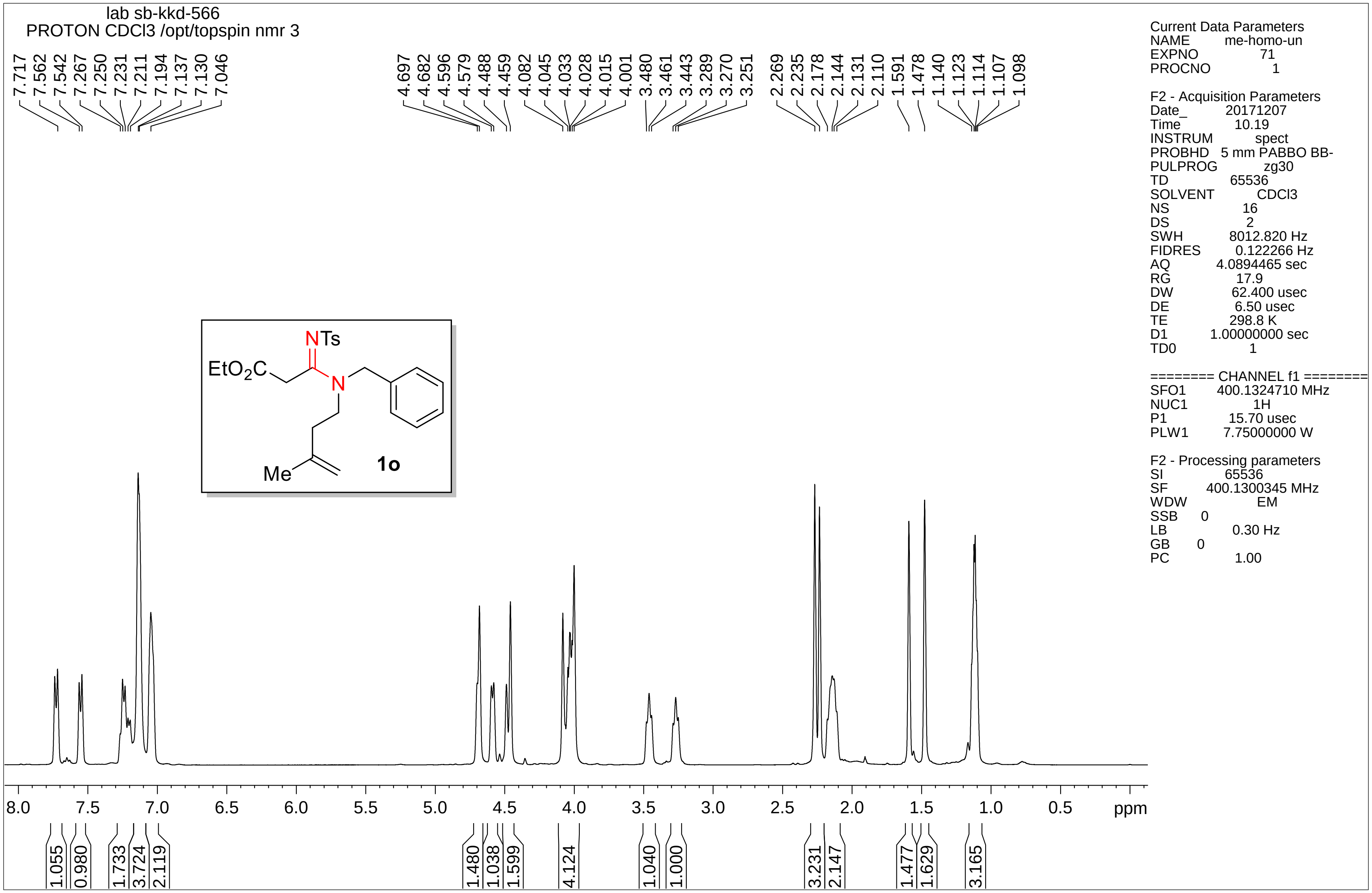
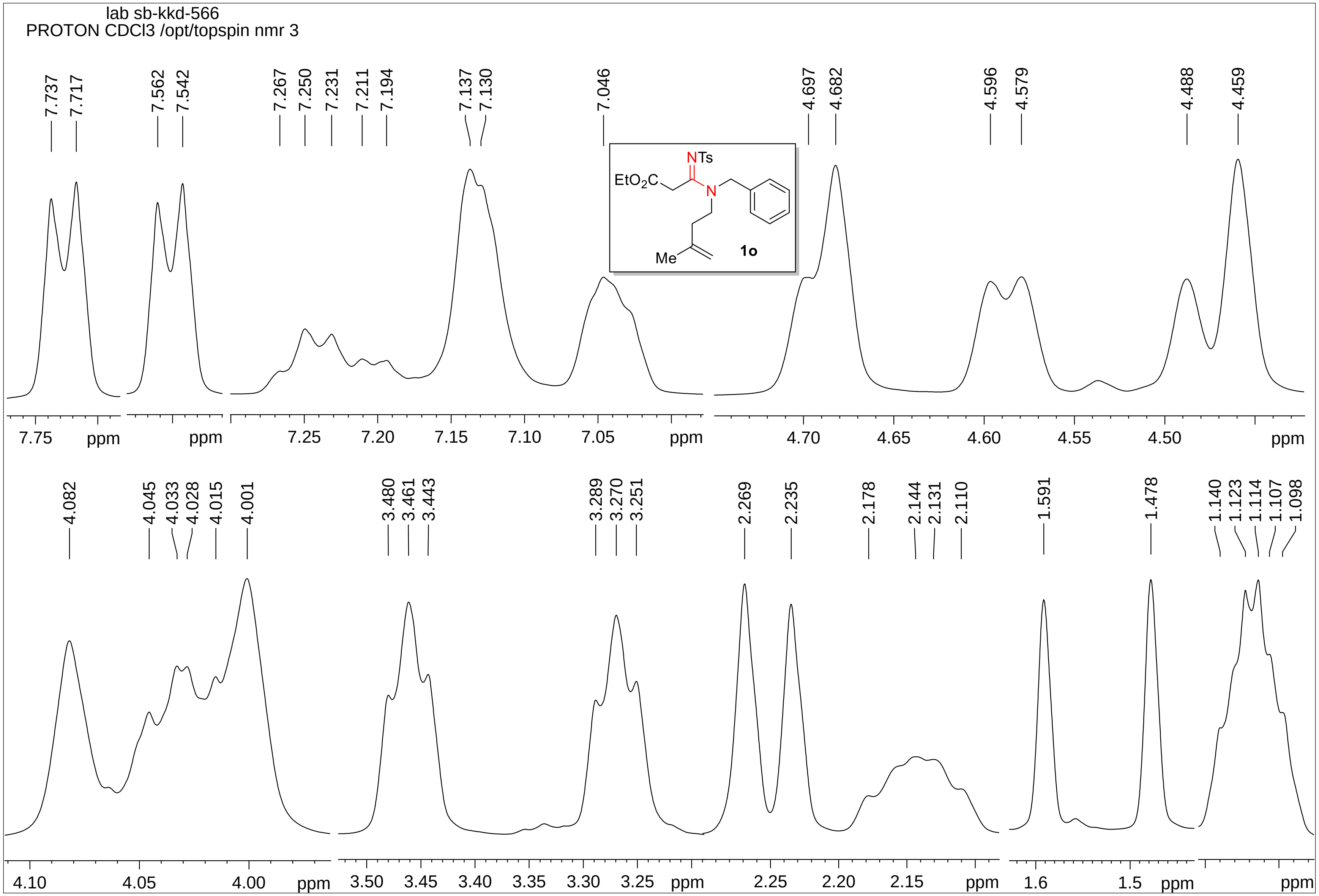
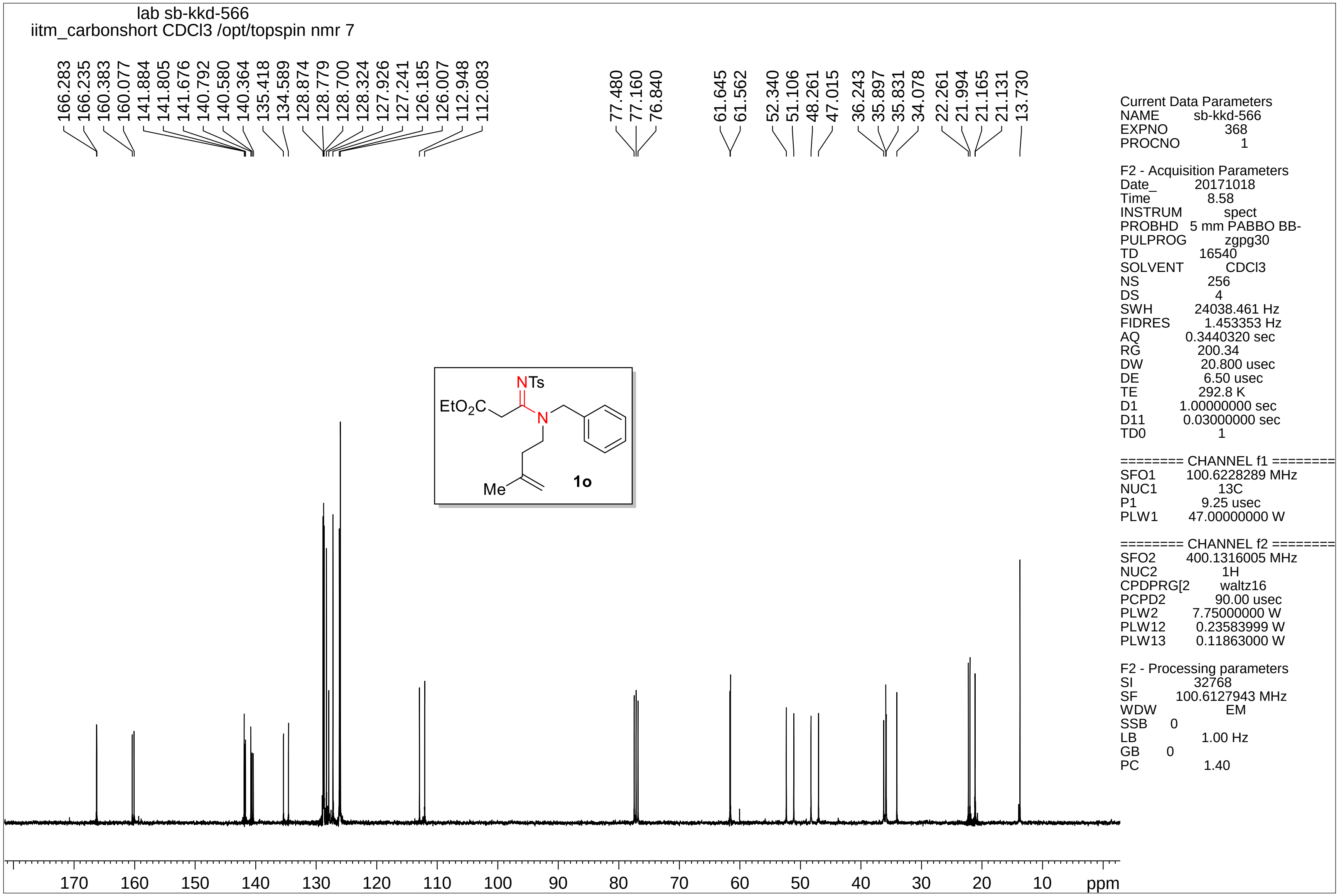


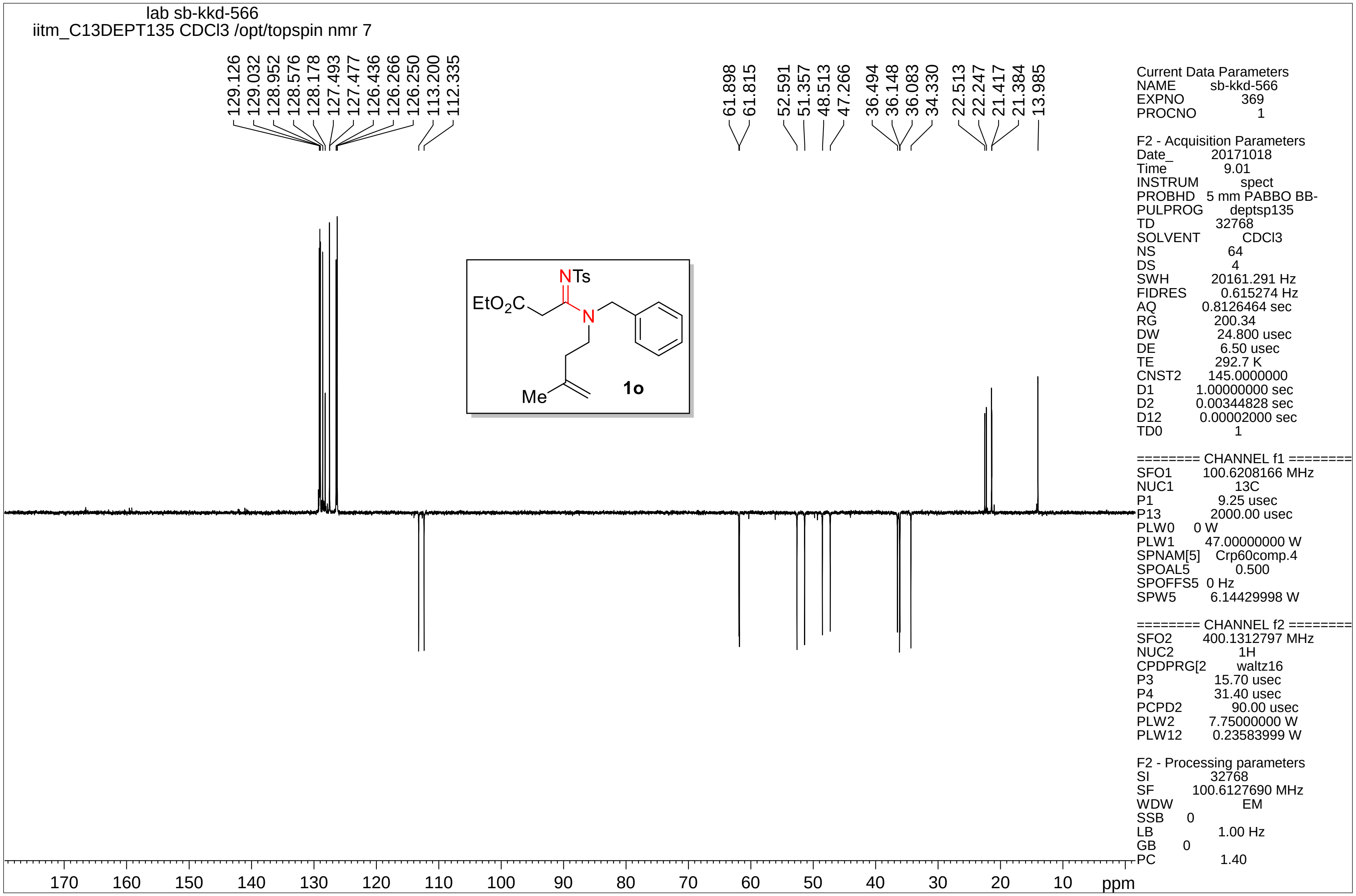
[1]H NMR spectrum of compound 1o



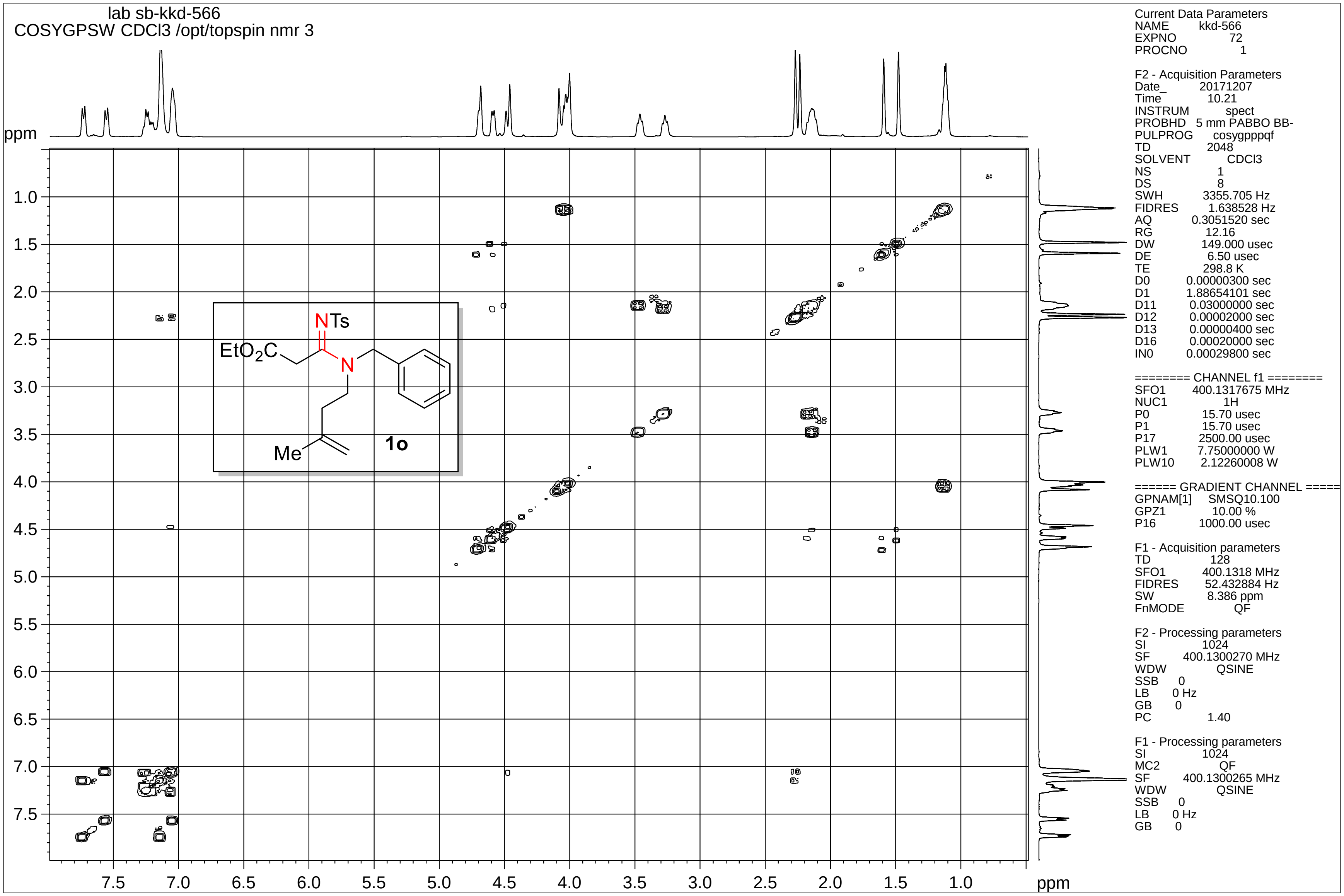
^{1}H NMR spectrum of compound 1o



^{13}C NMR spectrum of compound 1o



DEPT-135 NMR spectrum of compound 1o



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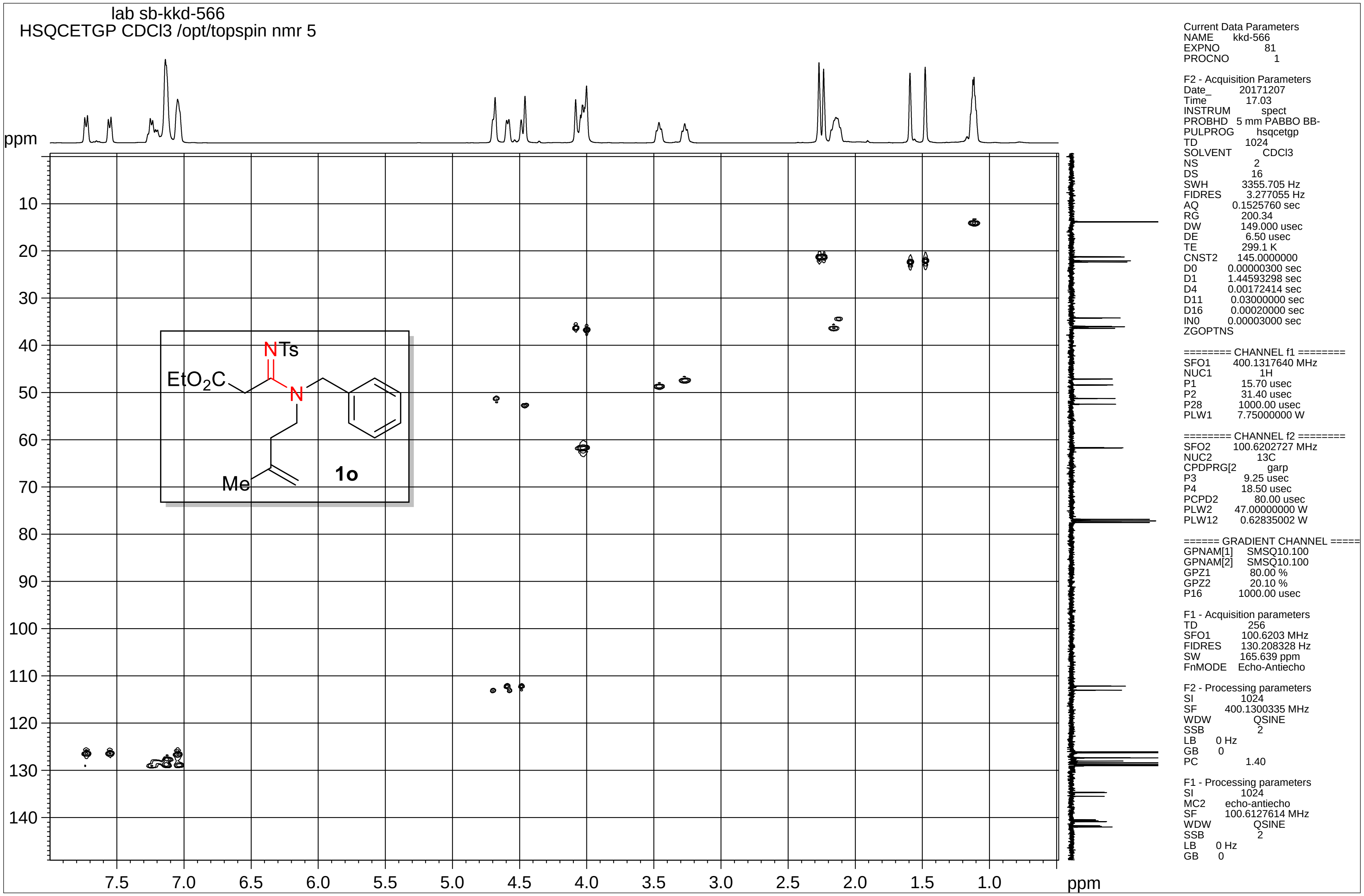

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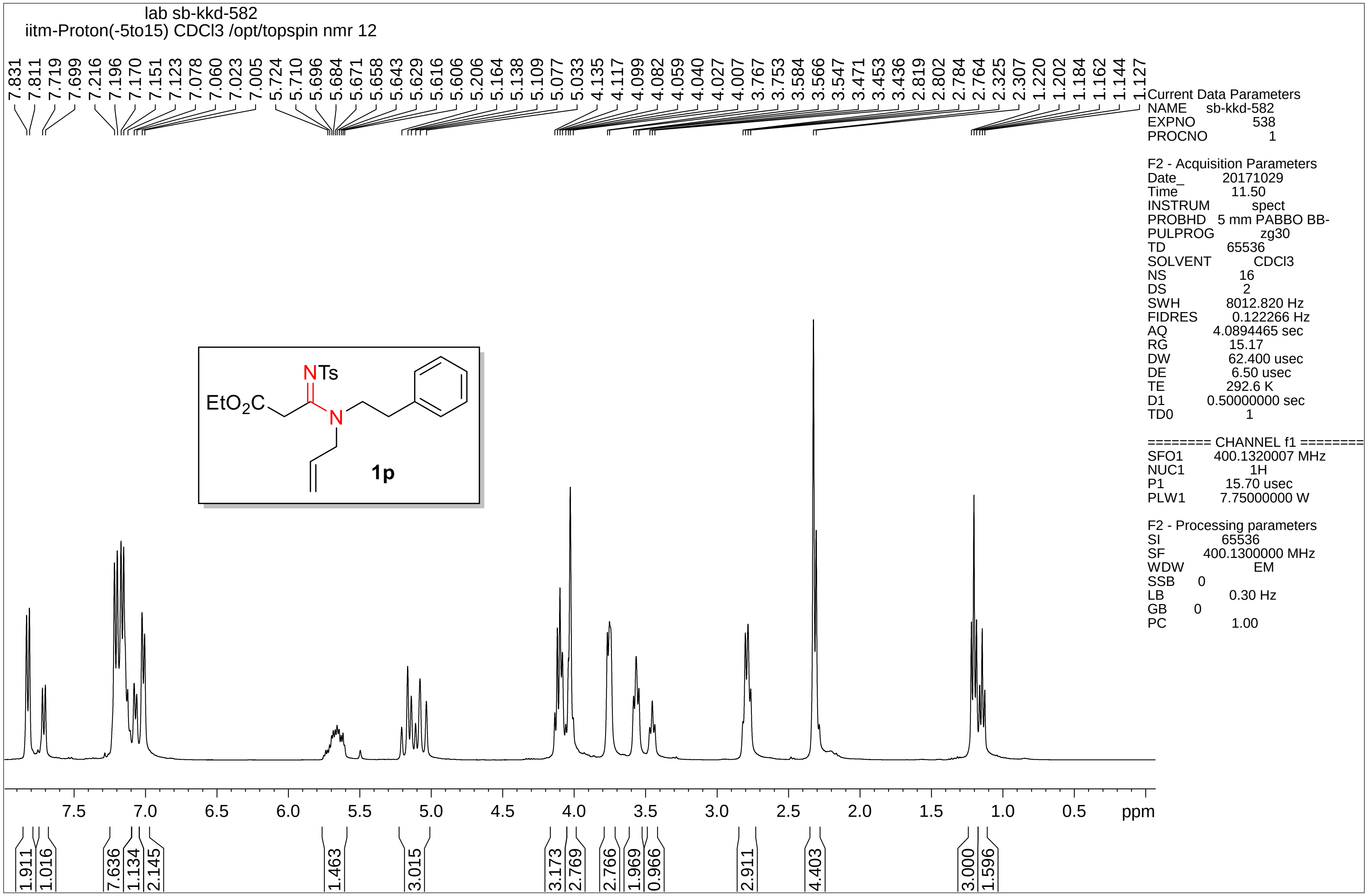
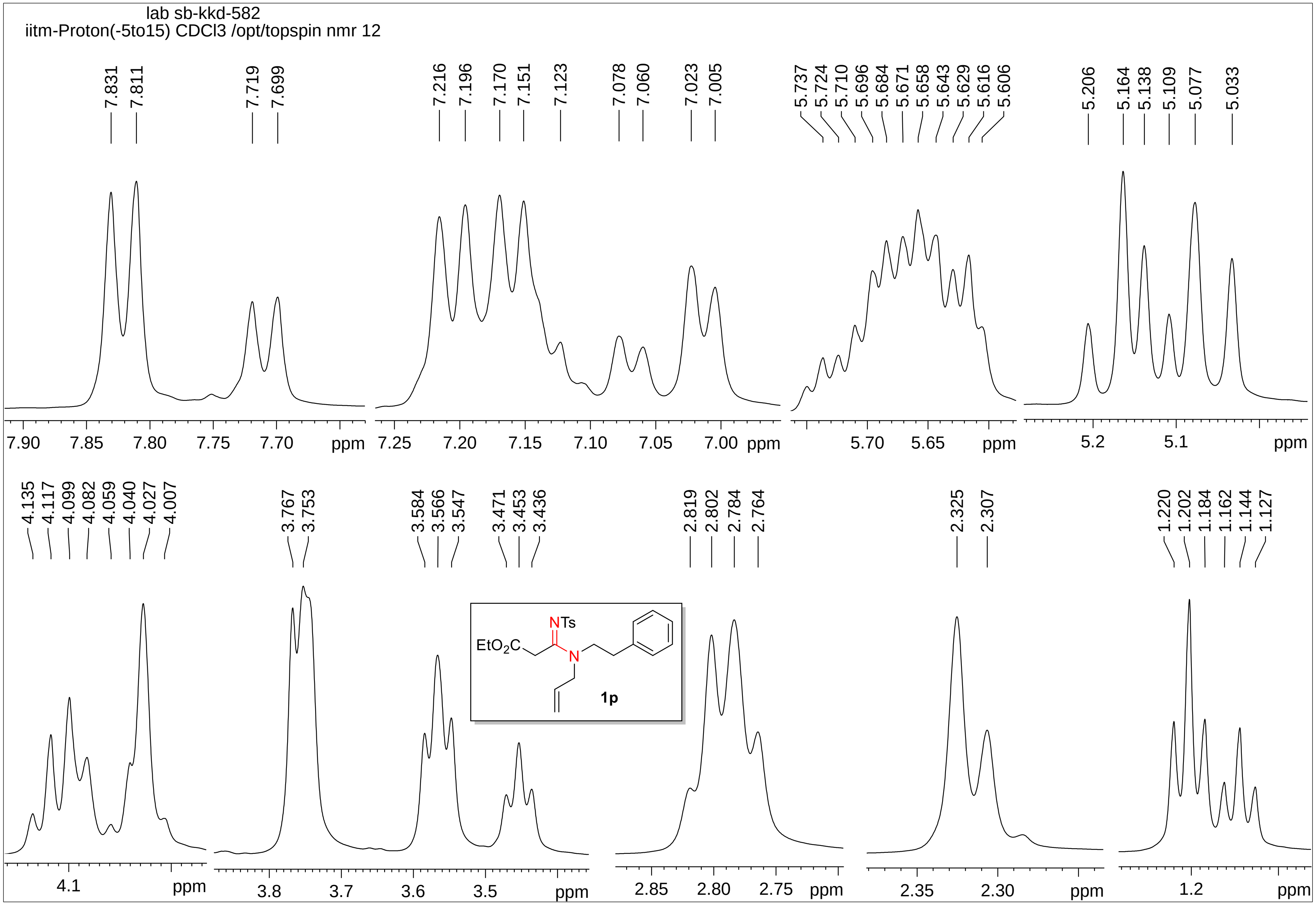
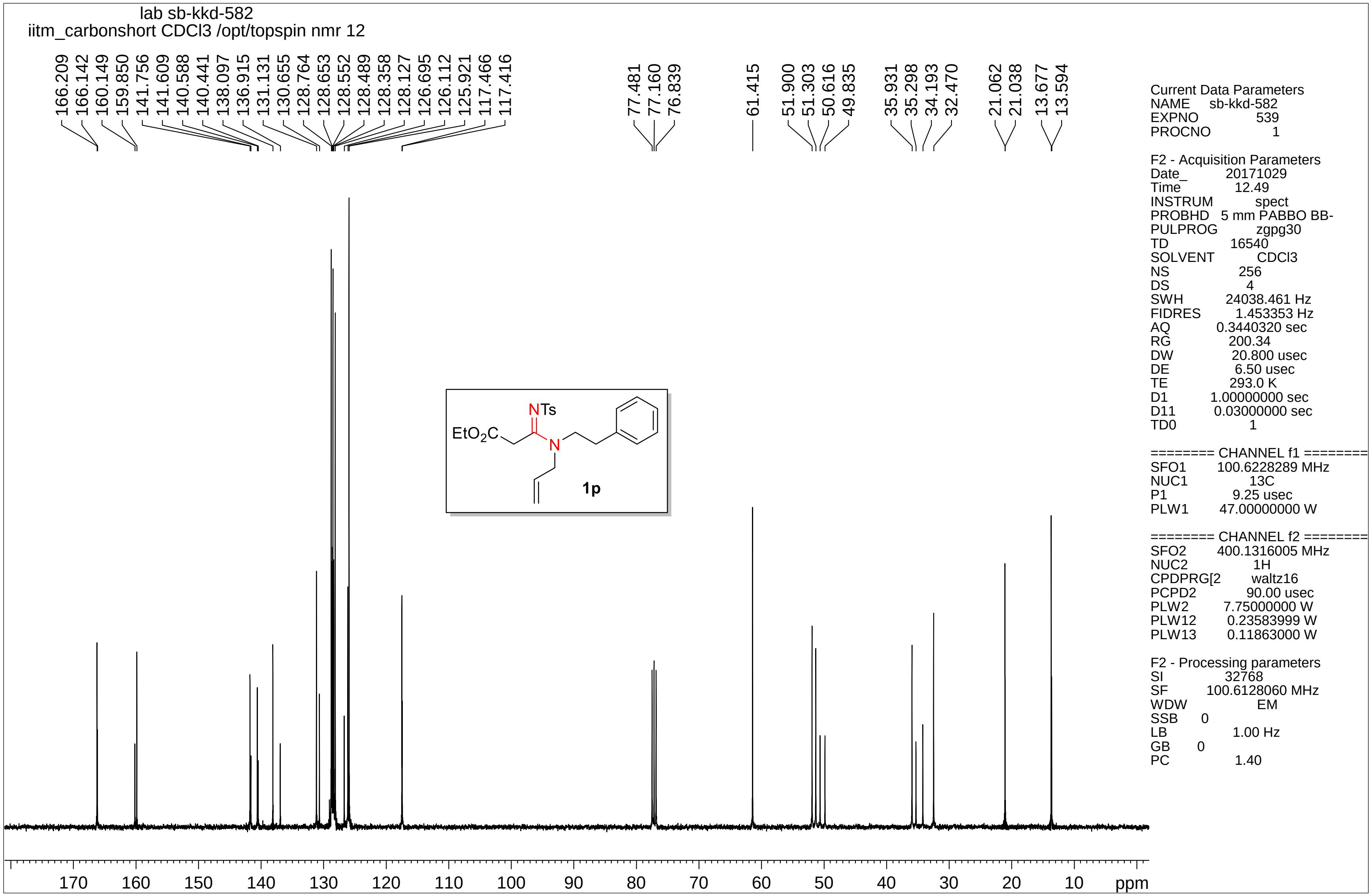


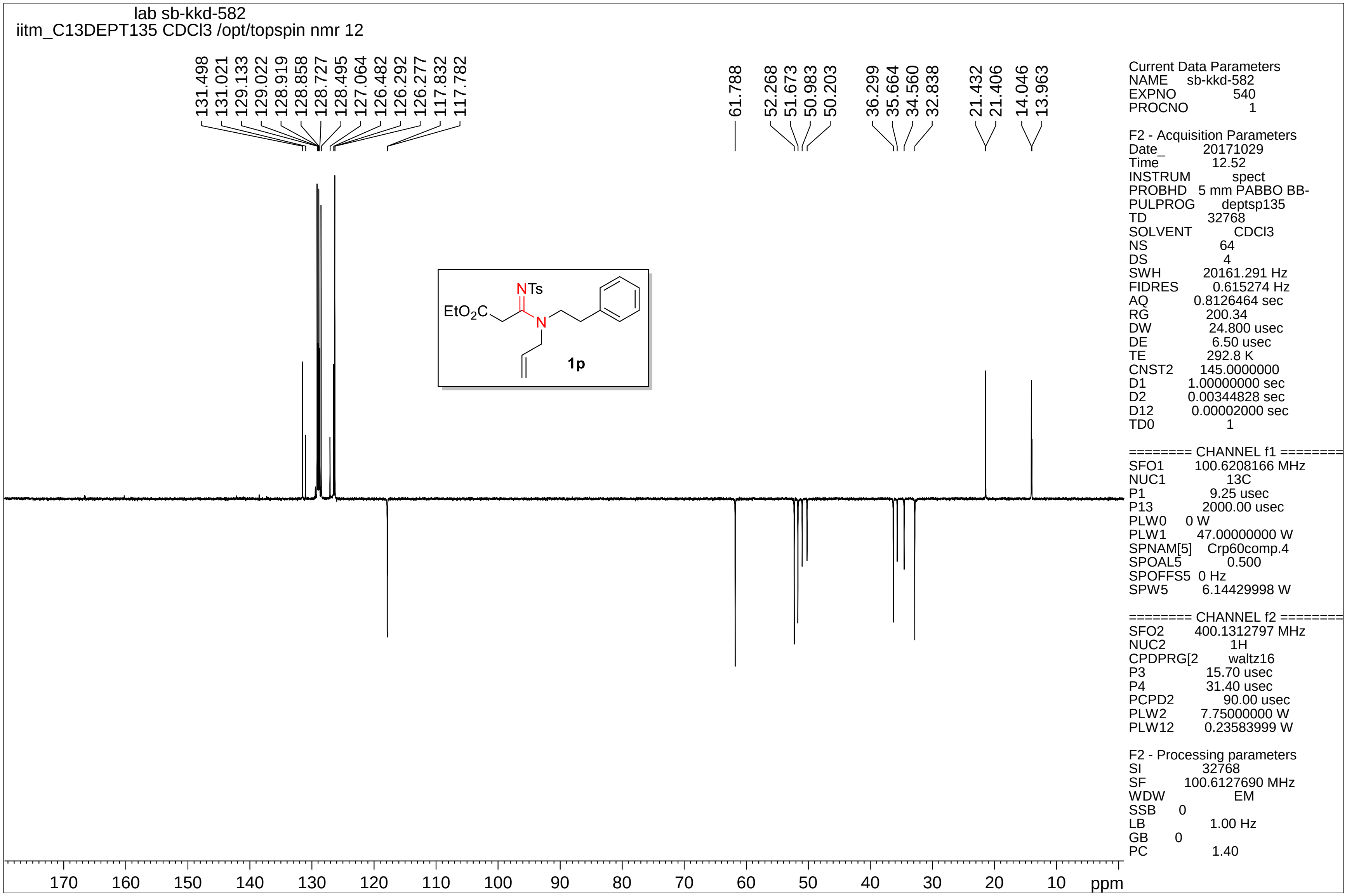
^{1}H NMR spectrum of compound 1p



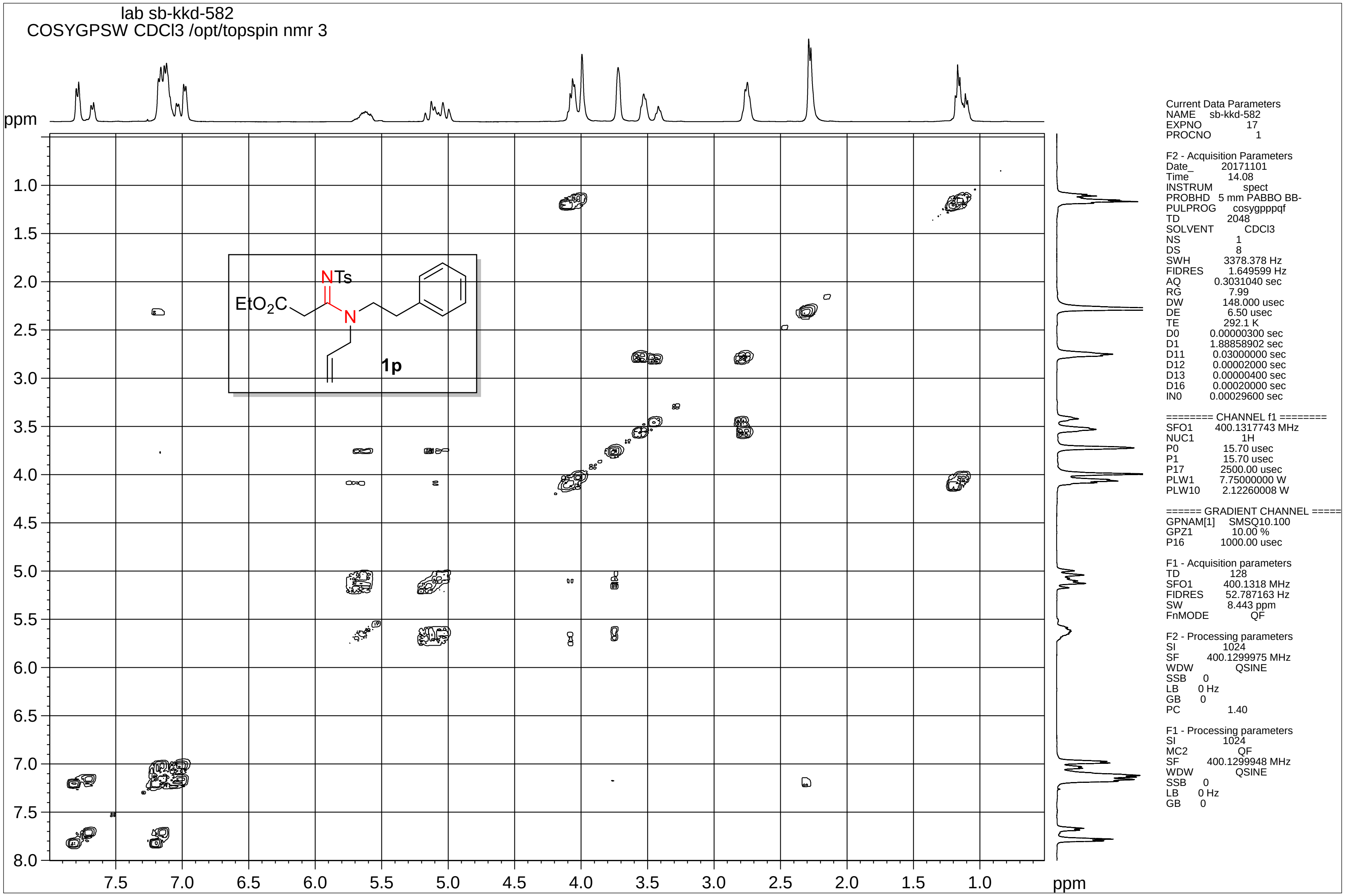
^{1}H NMR spectrum of compound 1p



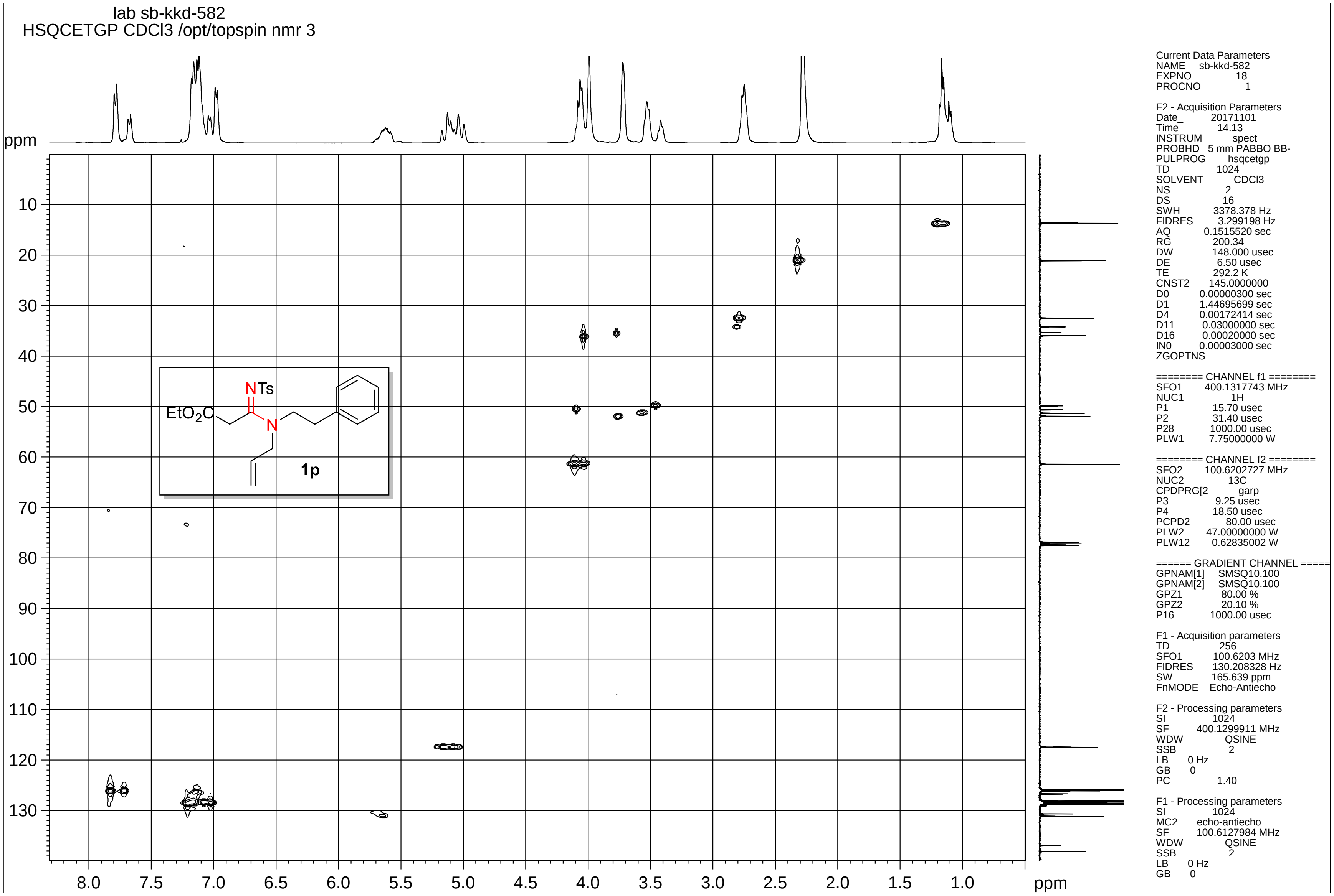
^{13}C NMR spectrum of compound 1p



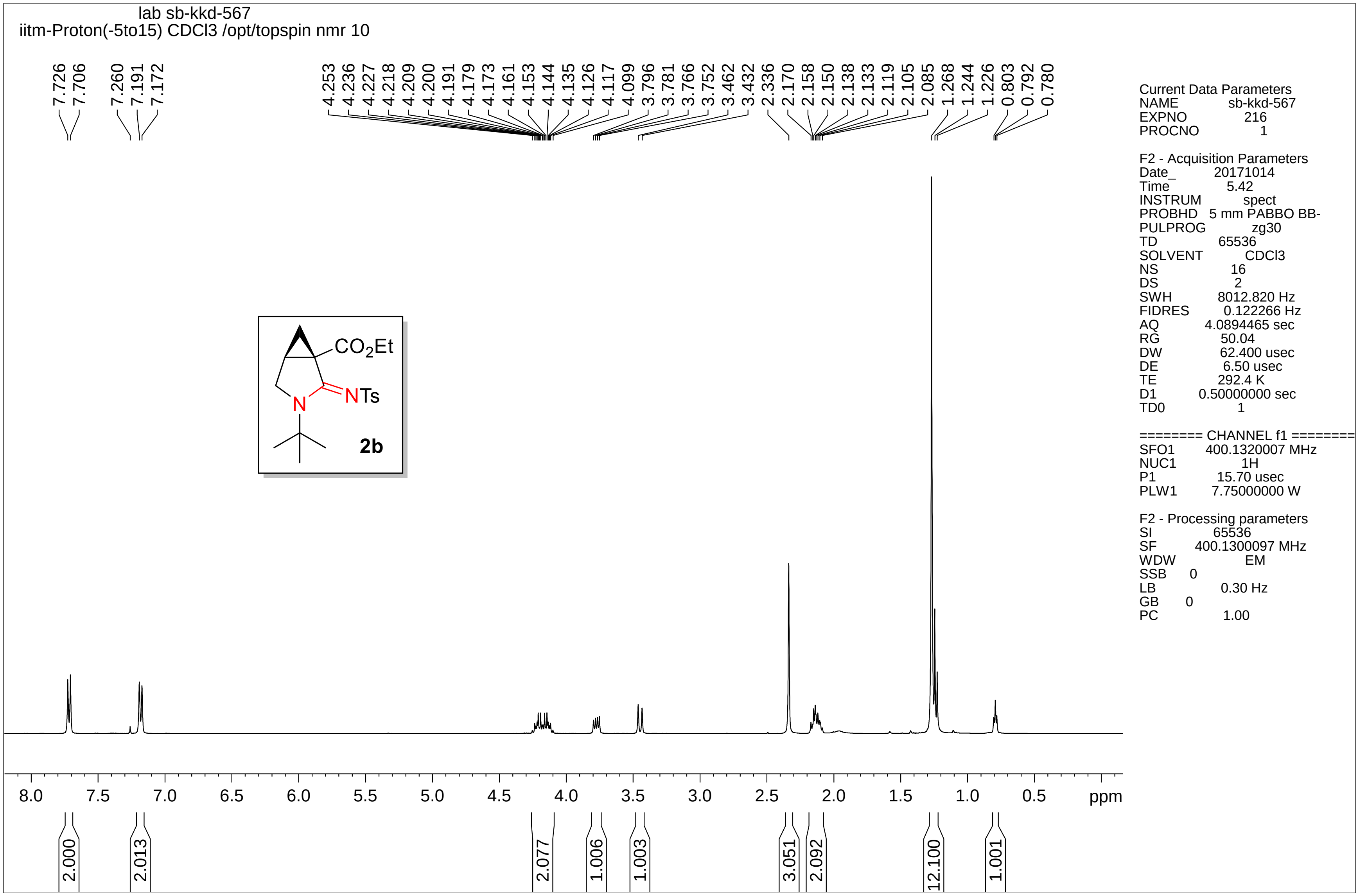
DEPT-135 NMR spectrum of compound 1p



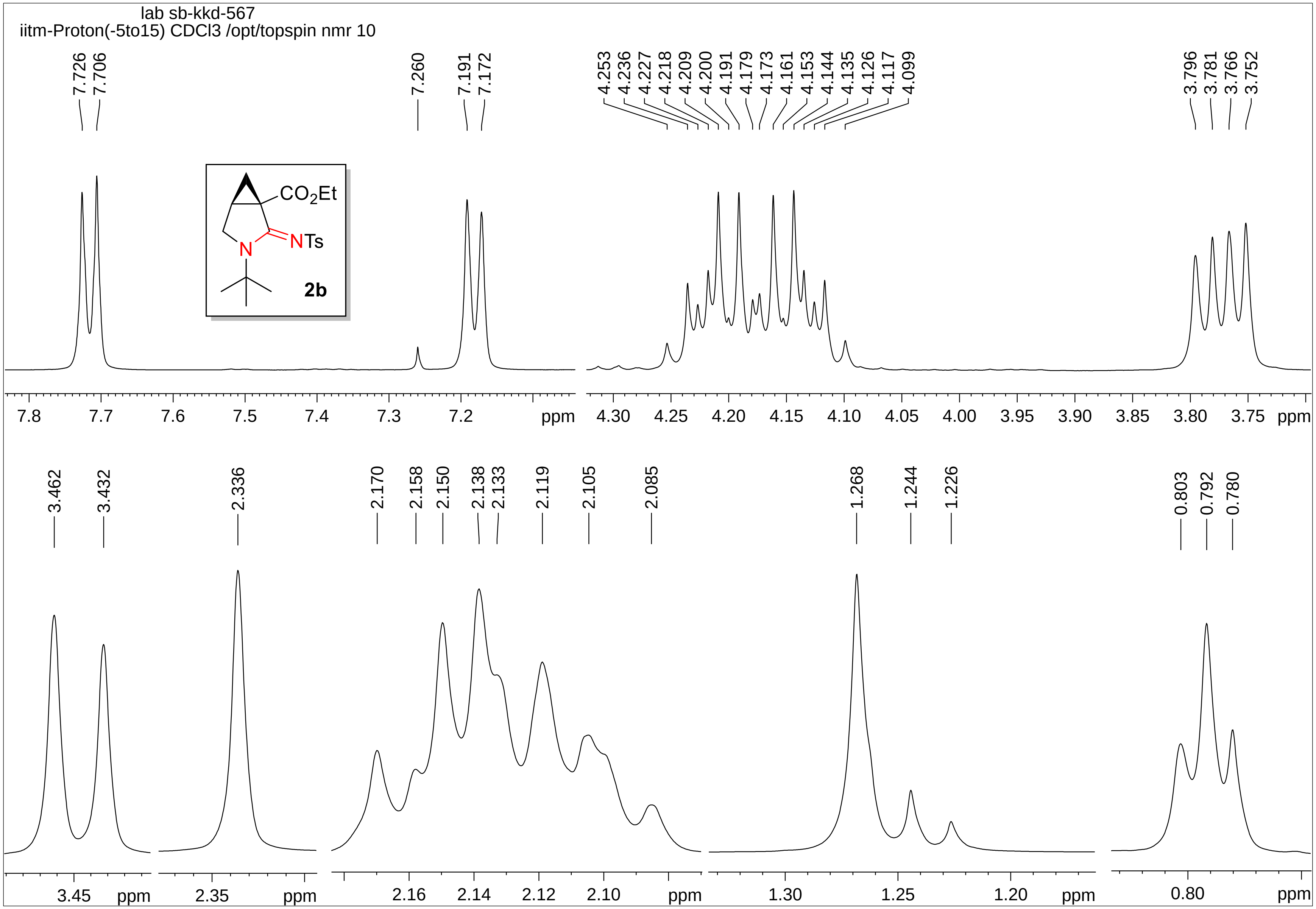
^{1}H-^{1}H COSY NMR spectrum of compound 1p



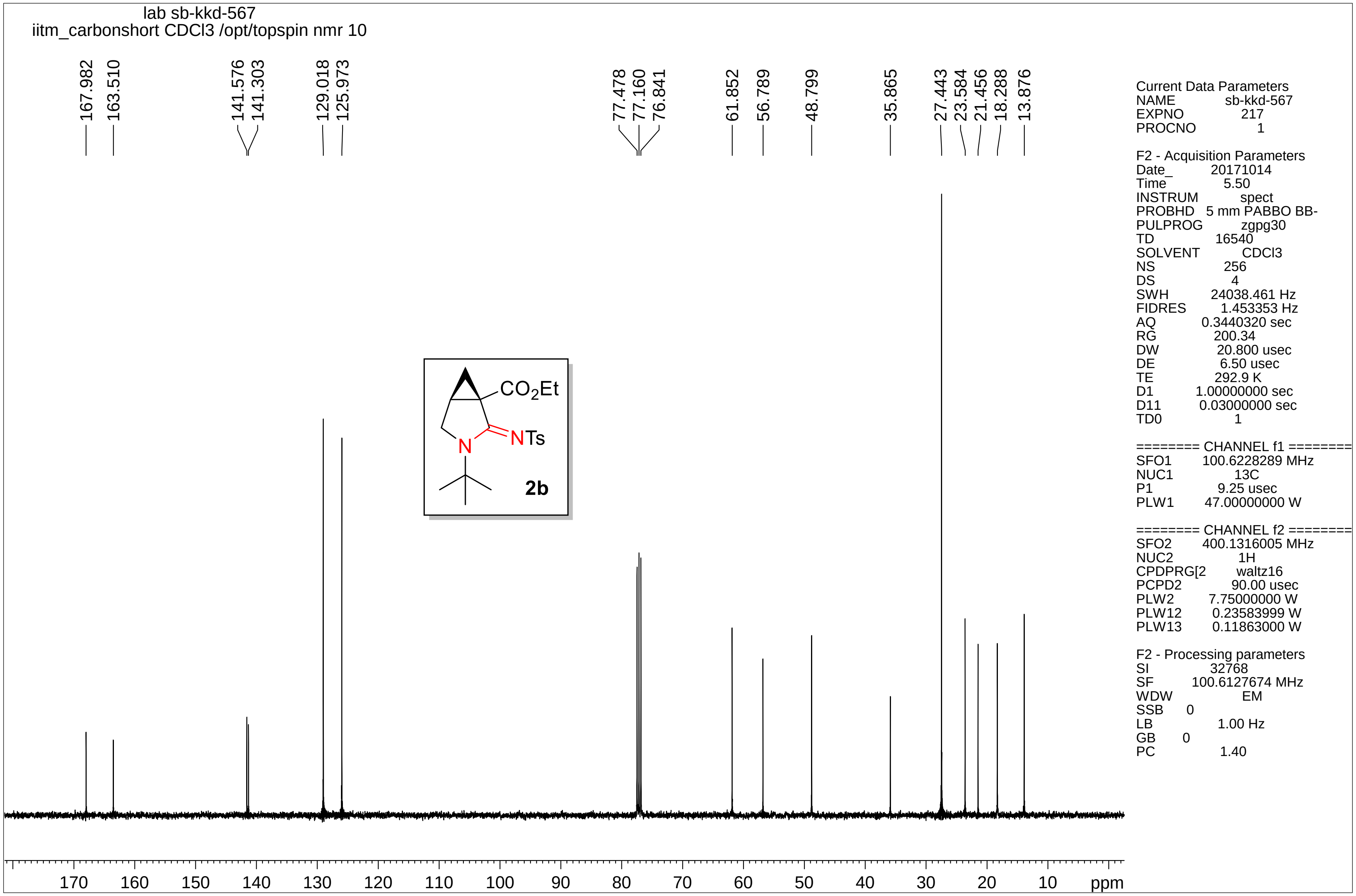
^{1}H-^{13}C HSQC NMR spectrum of compound 1p



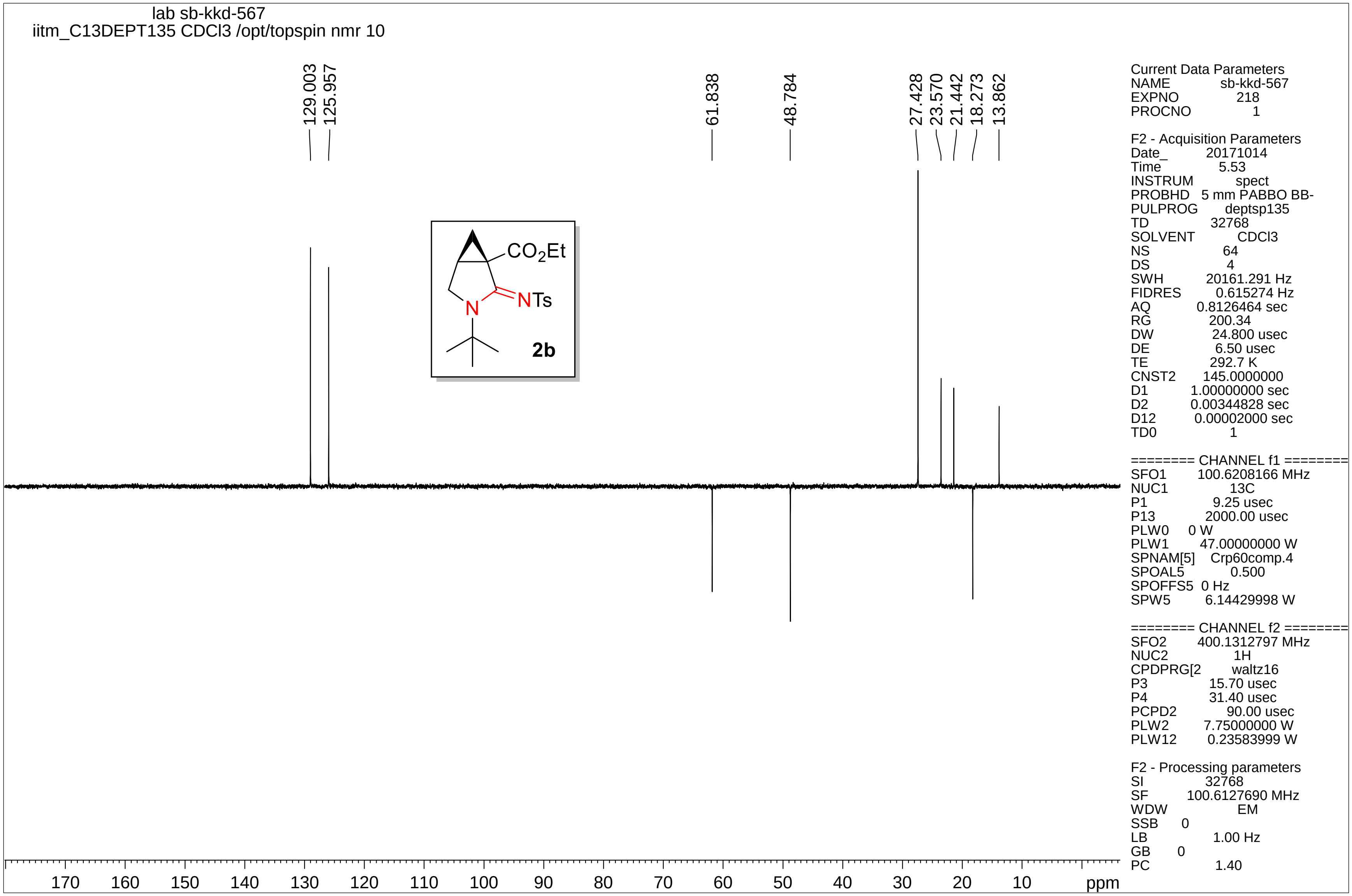
[1]H NMR spectrum of compound 2b



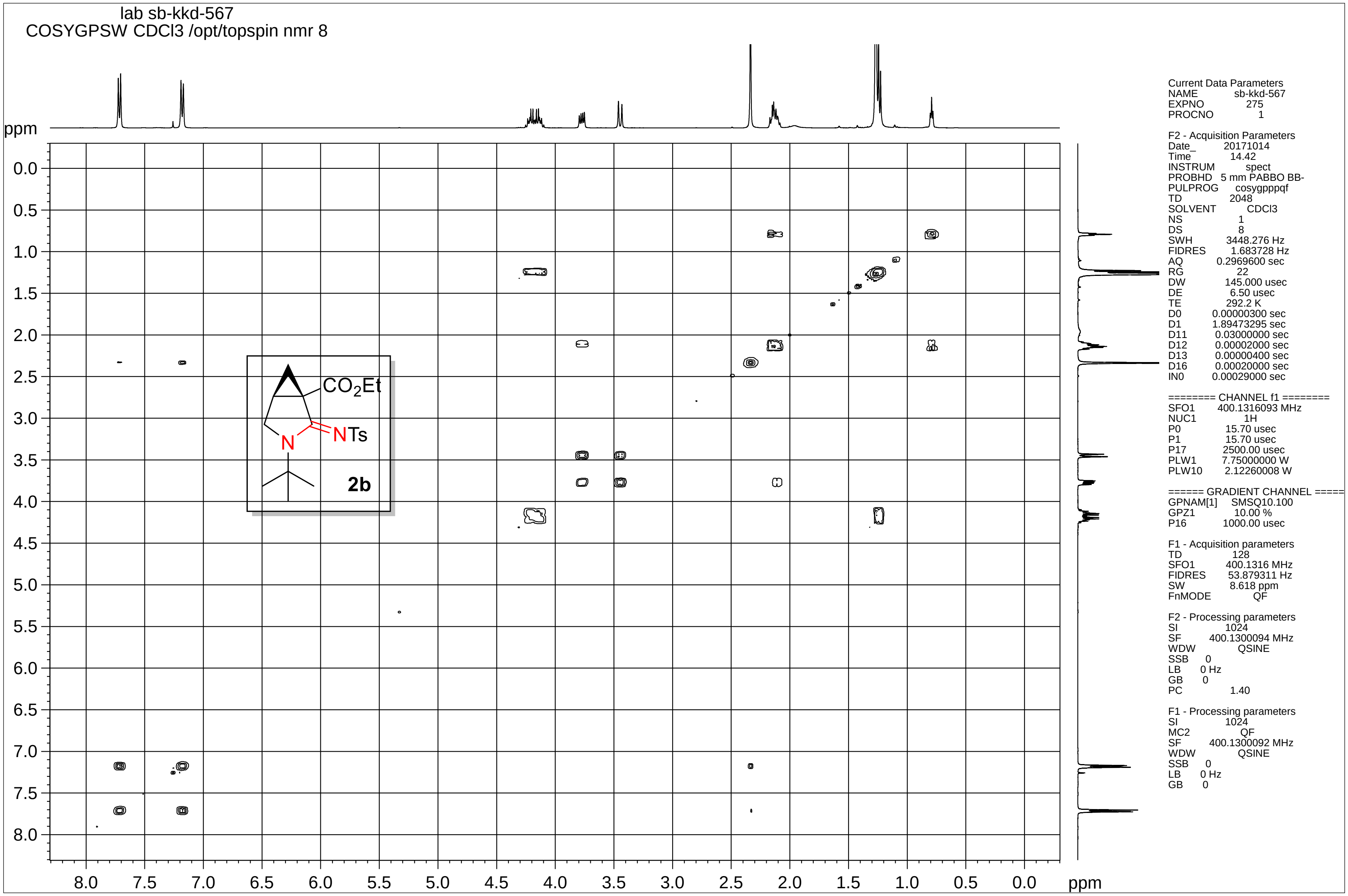
[1]H NMR spectrum of compound 2b



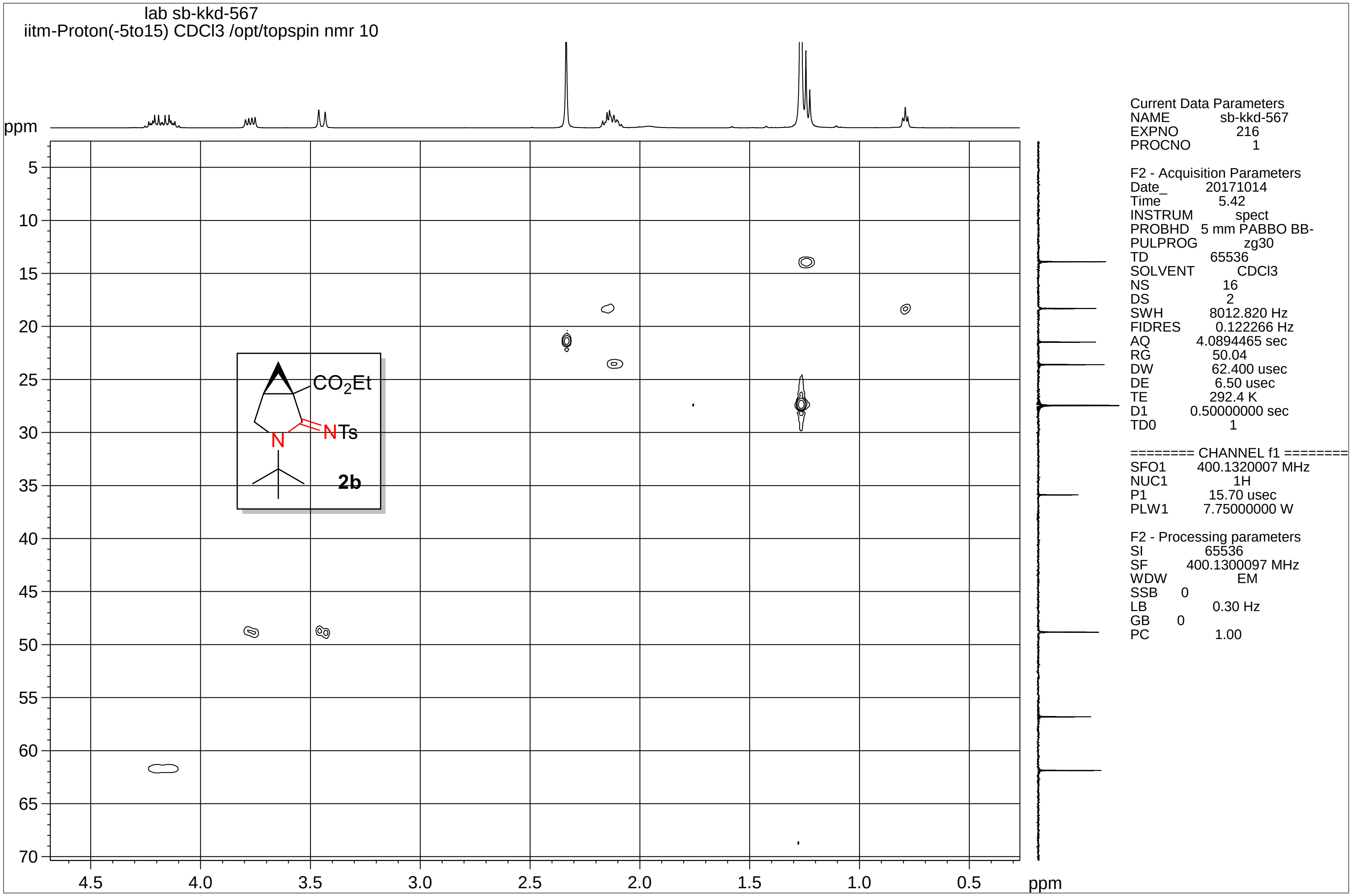
^{13}C NMR spectrum of compound 2b



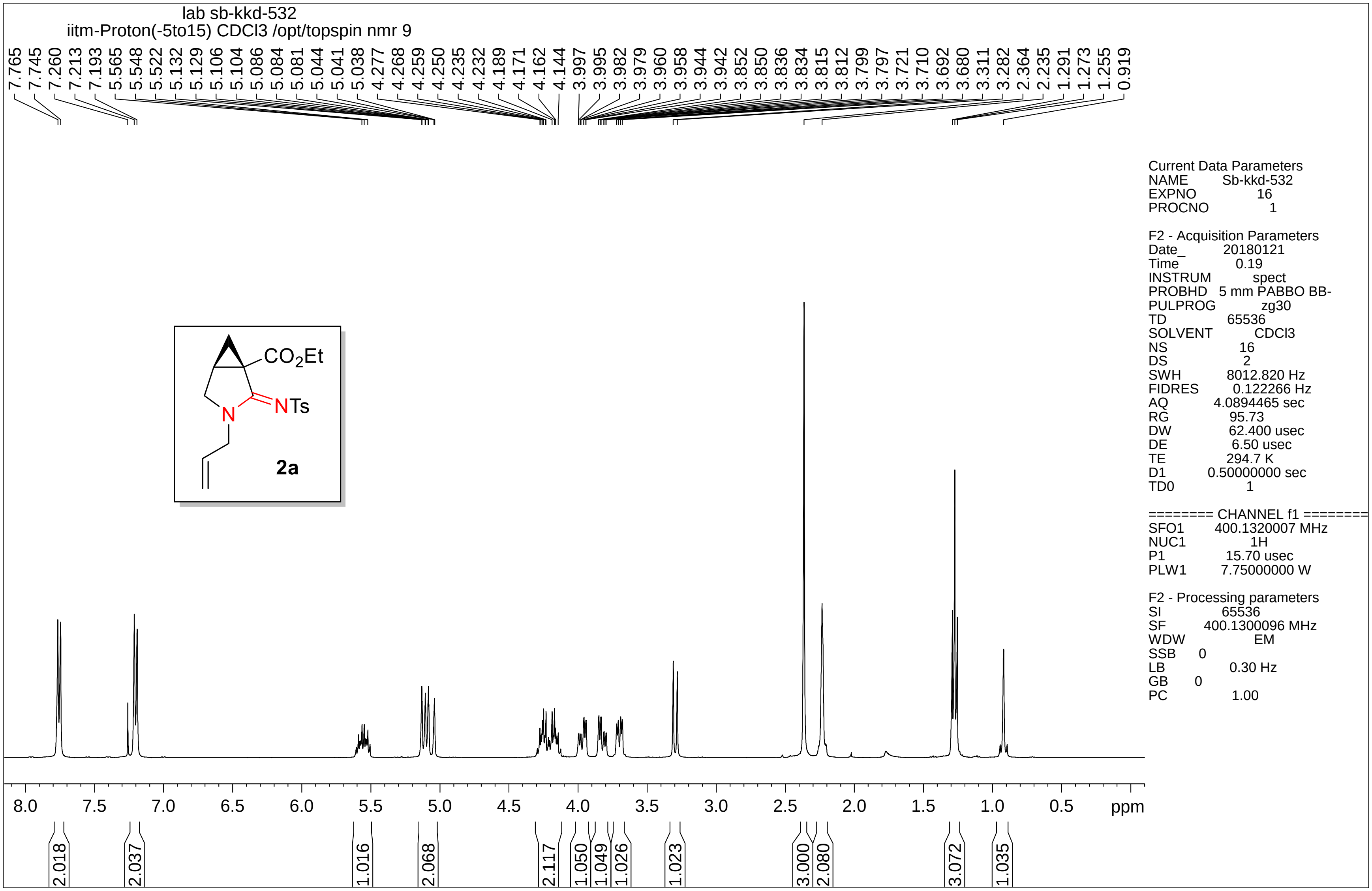
DEPT-135 NMR spectrum of compound 2b



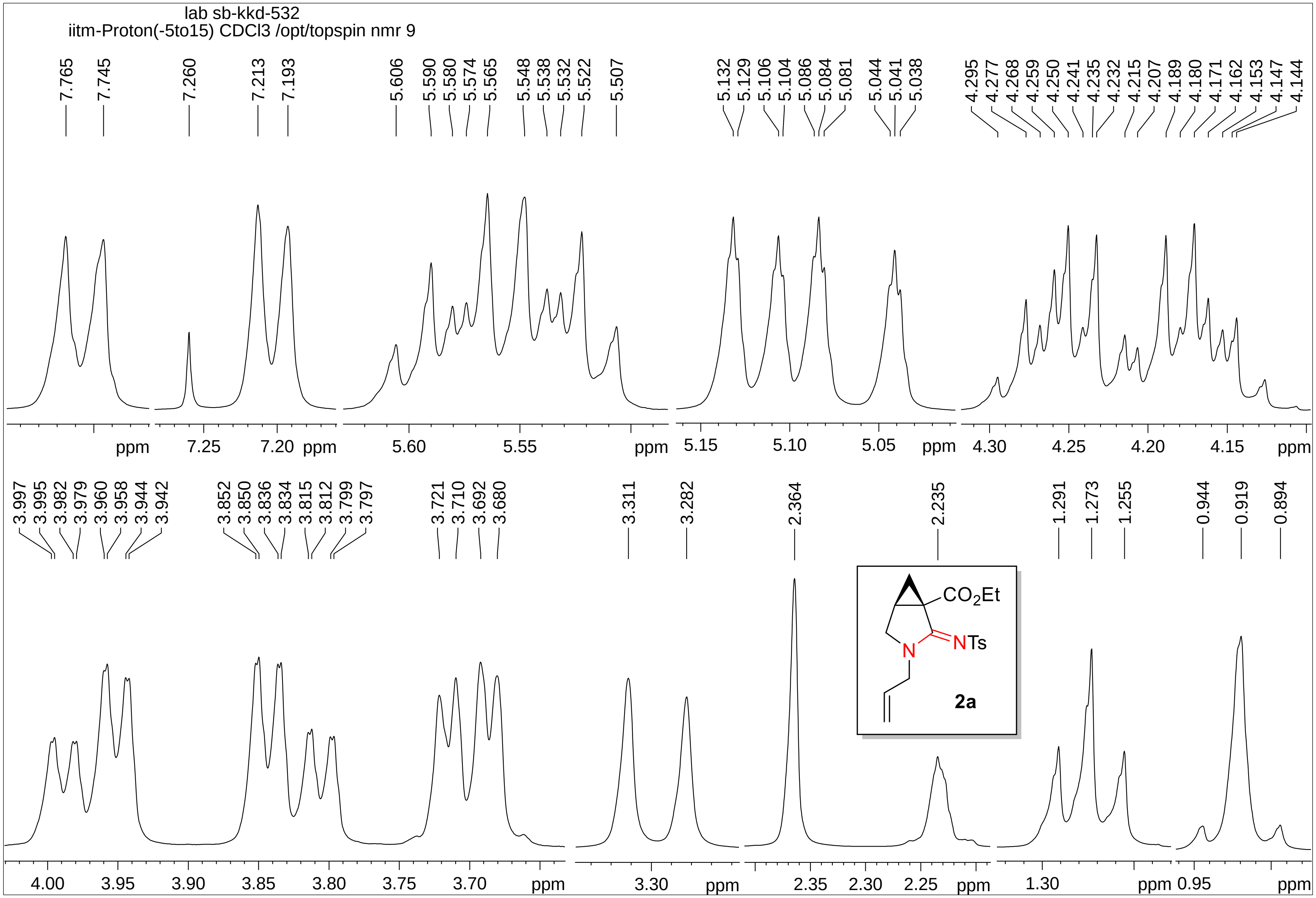
^{1}H-^{1}H COSY NMR spectrum of compound 2b



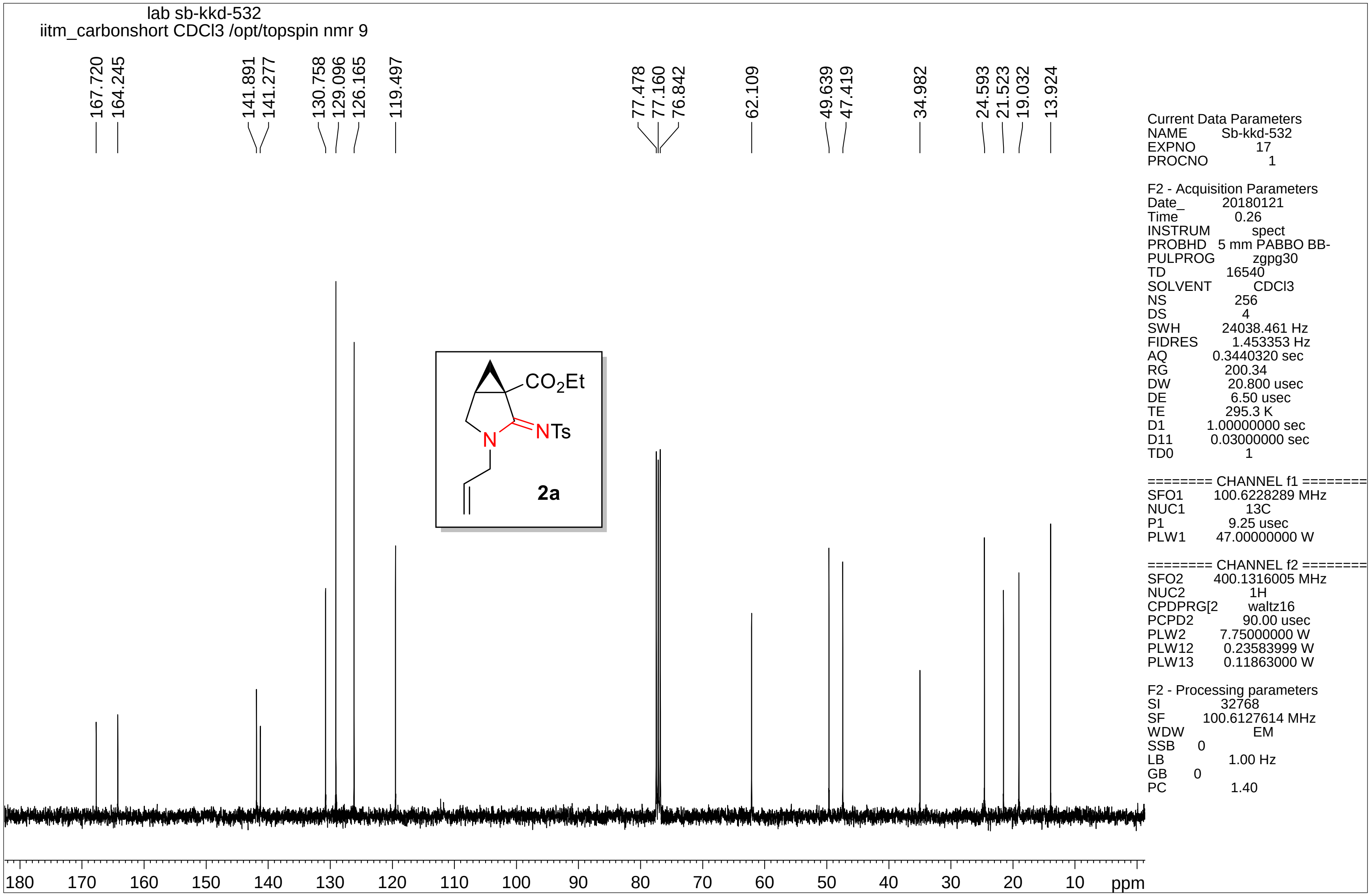
^{1}H-^{13}C HSQC NMR spectrum of compound 2b



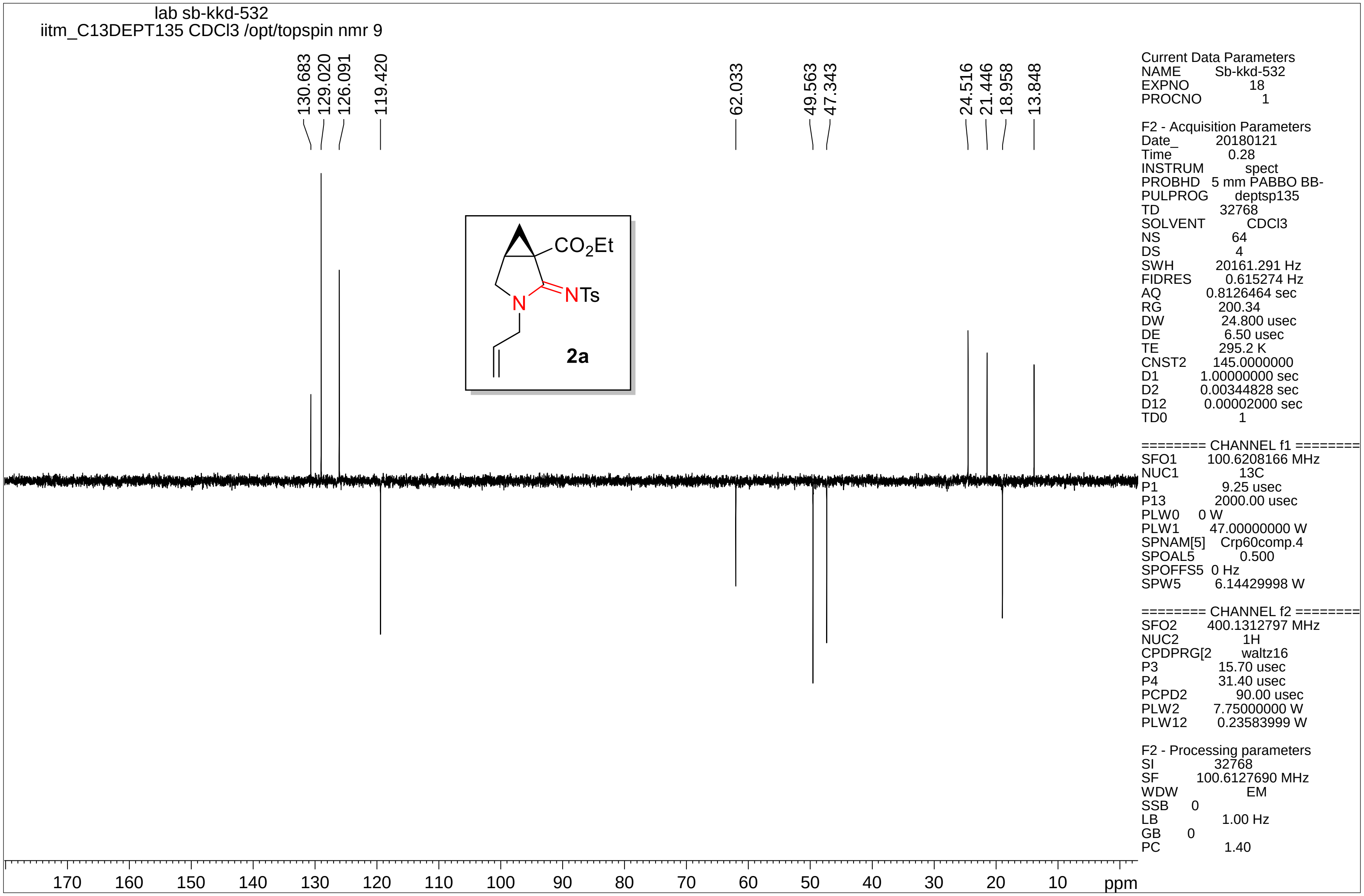
^{1}H NMR spectrum of compound 2a



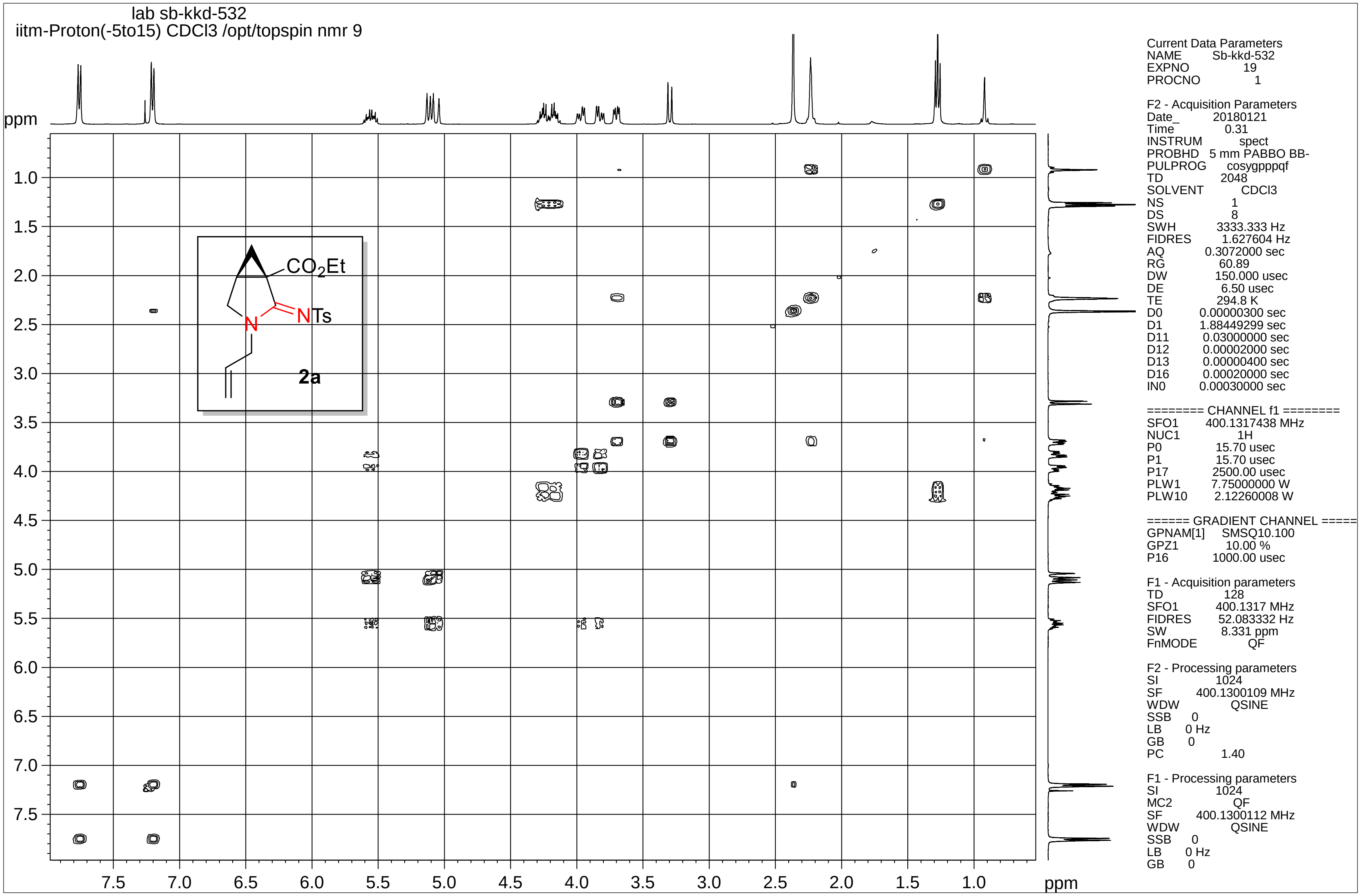
[1]H NMR spectrum of compound 2a



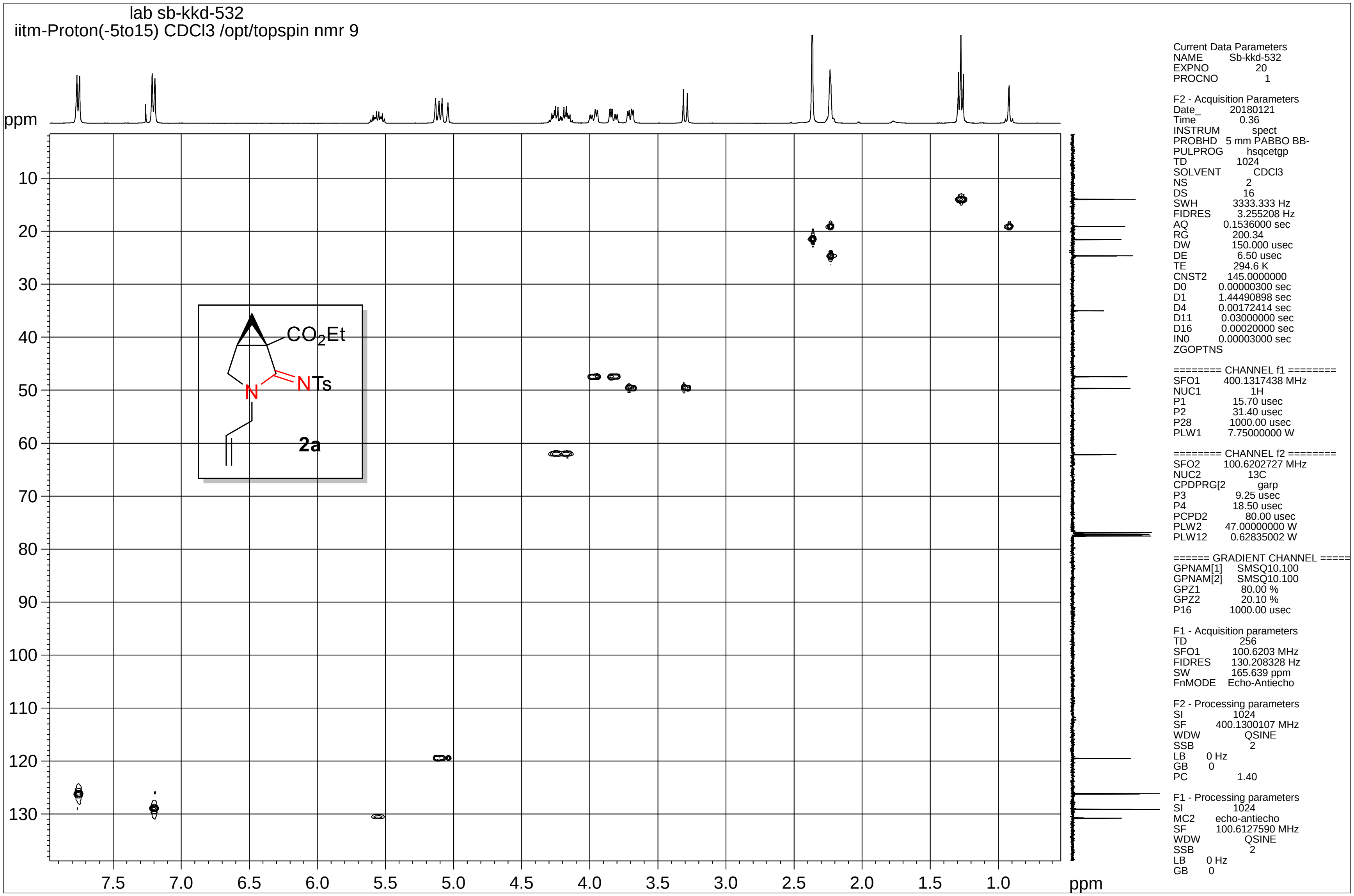
^{13}C NMR spectrum of compound 2a



DEPT-135 NMR spectrum of compound 2a



^{1}H-^{1}H COSY NMR spectrum of compound 2a



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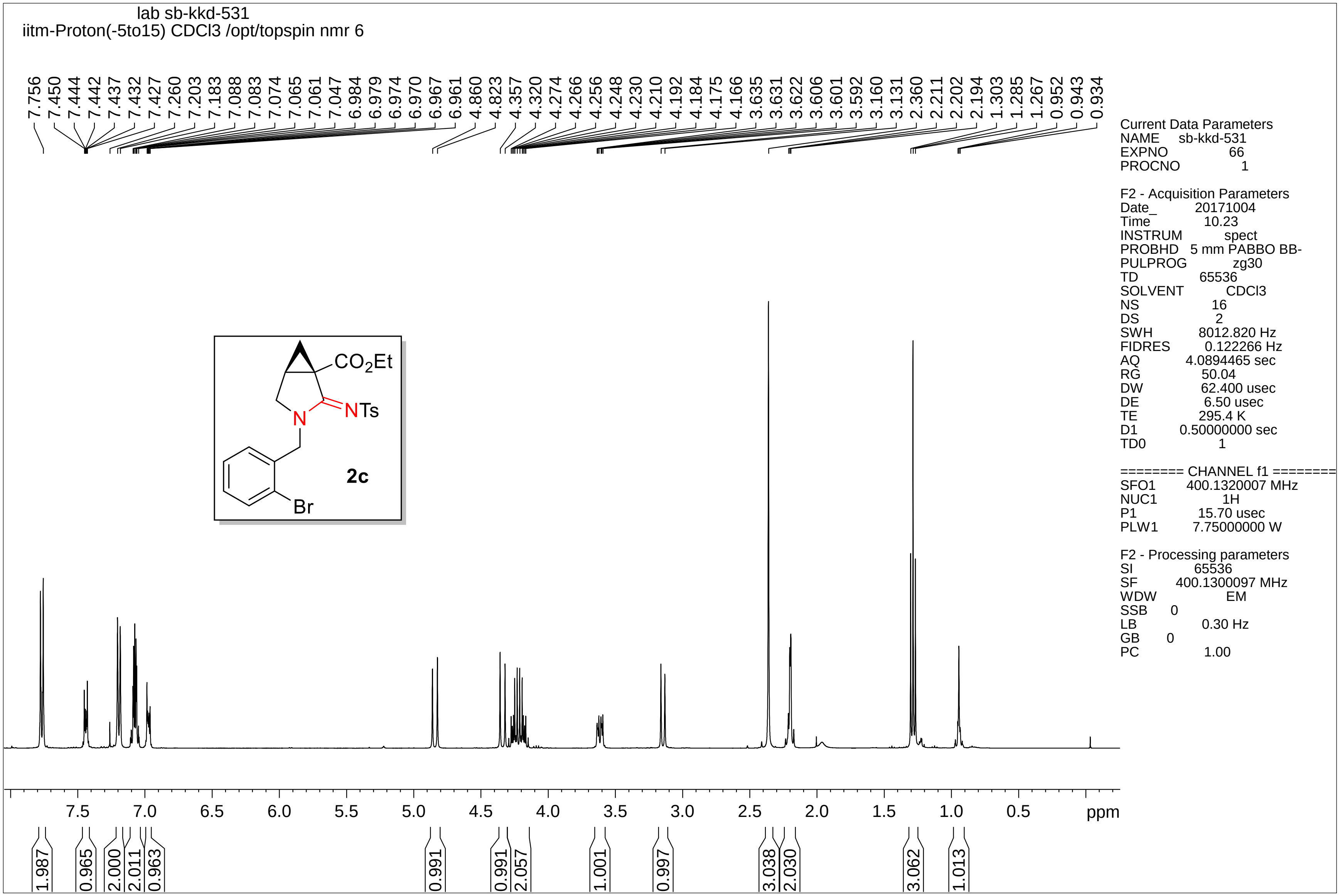
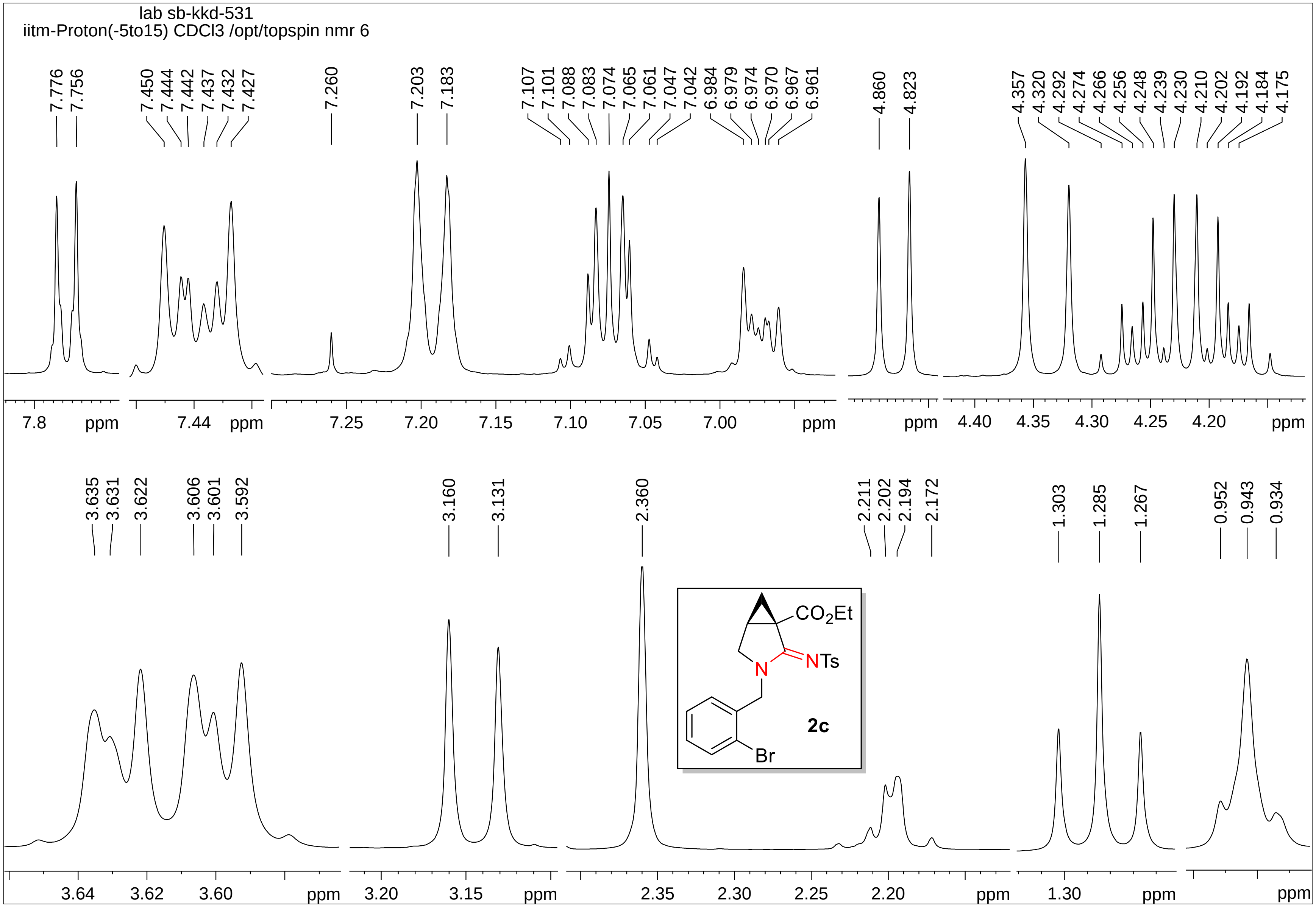
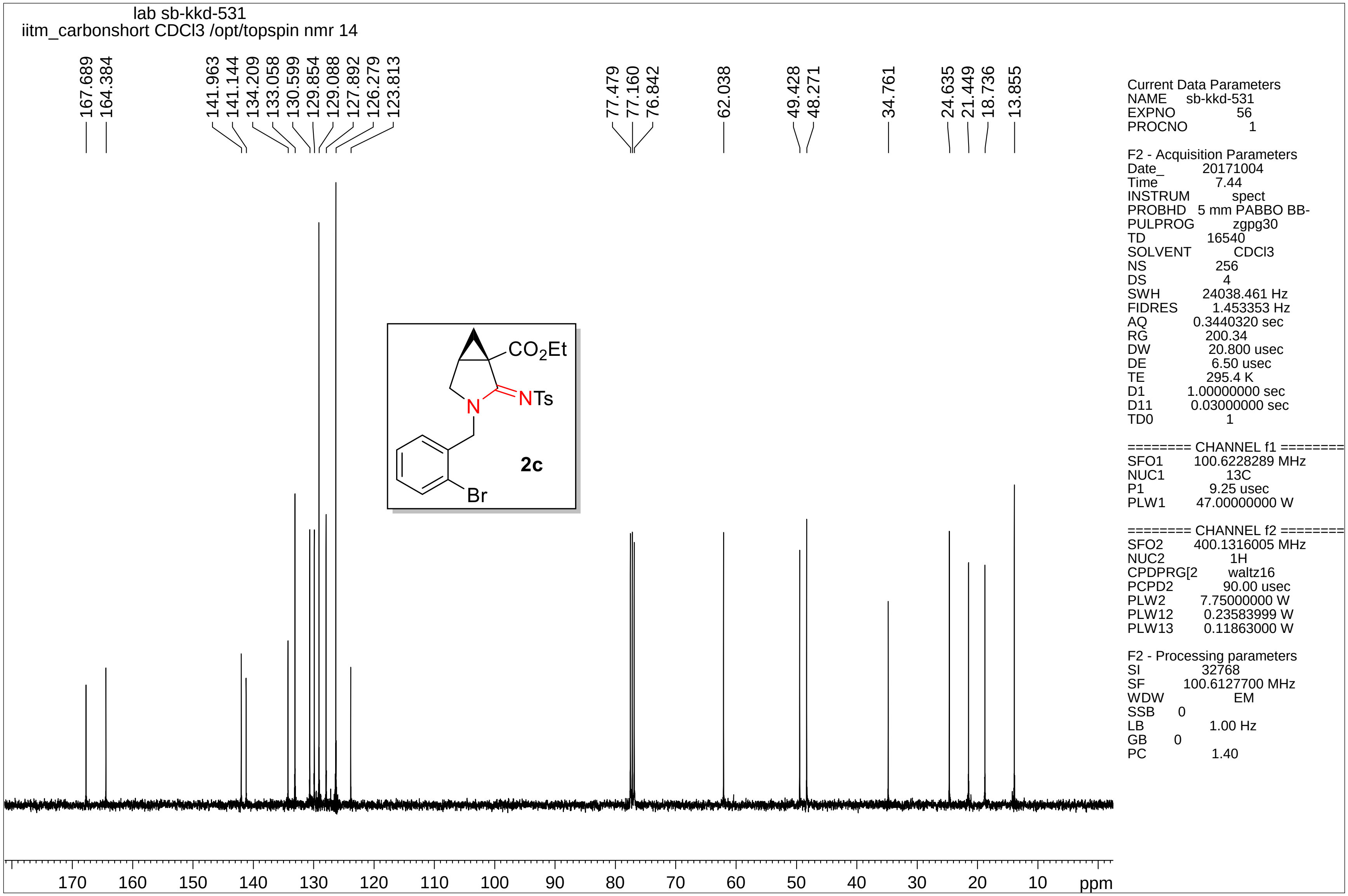


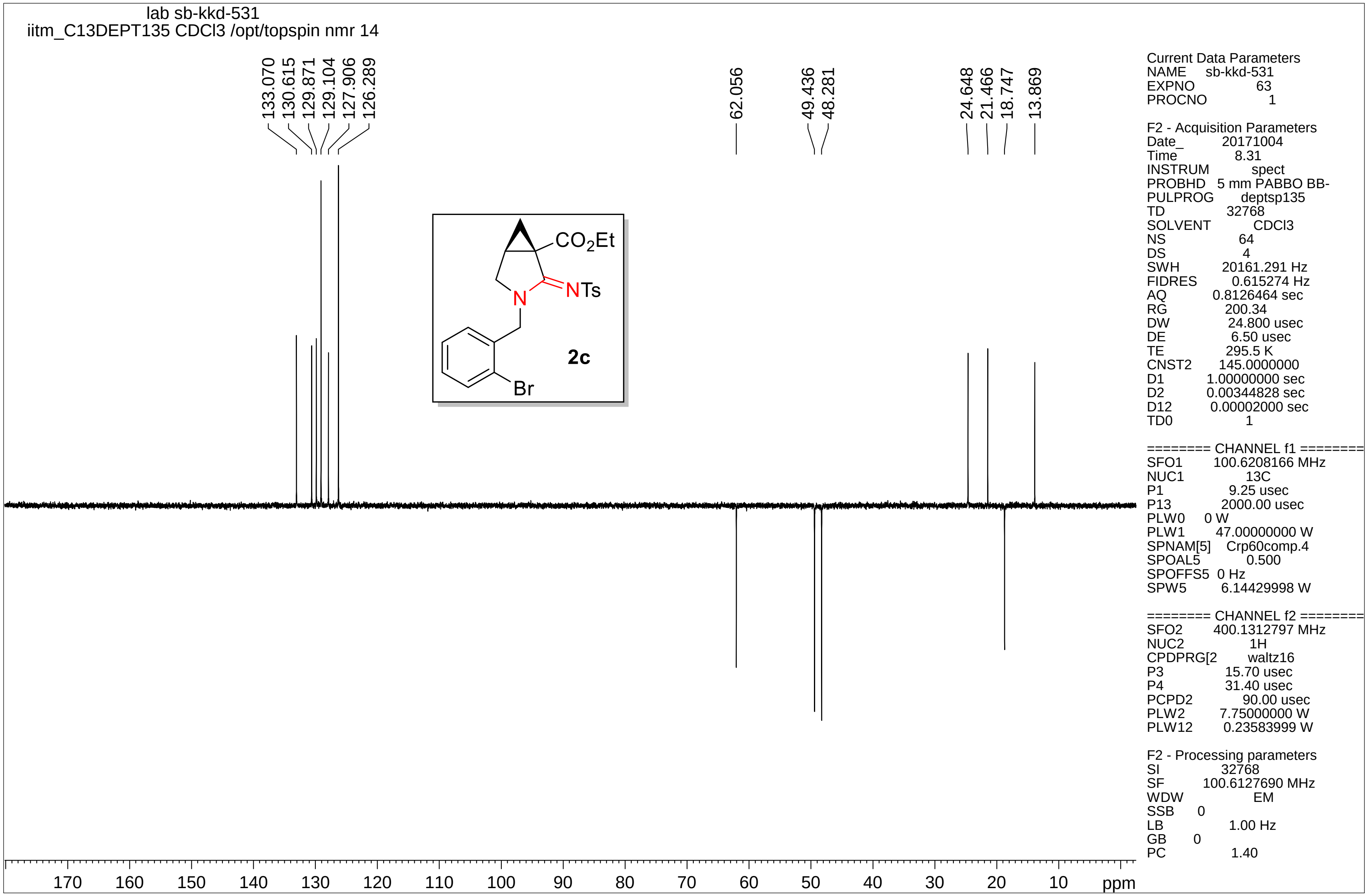
^{1}H NMR spectrum of compound 2c



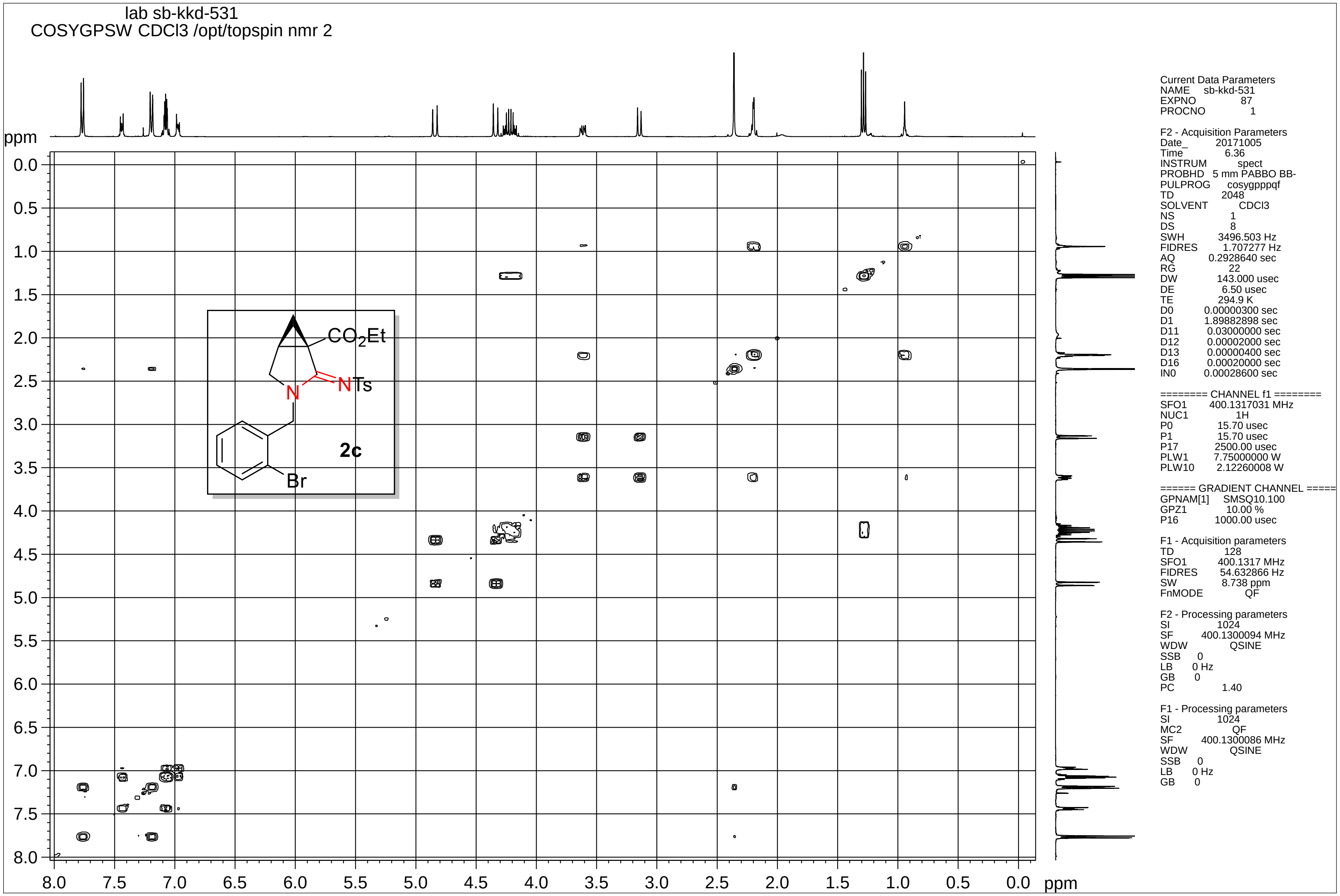
^{1}H NMR spectrum of compound 2c



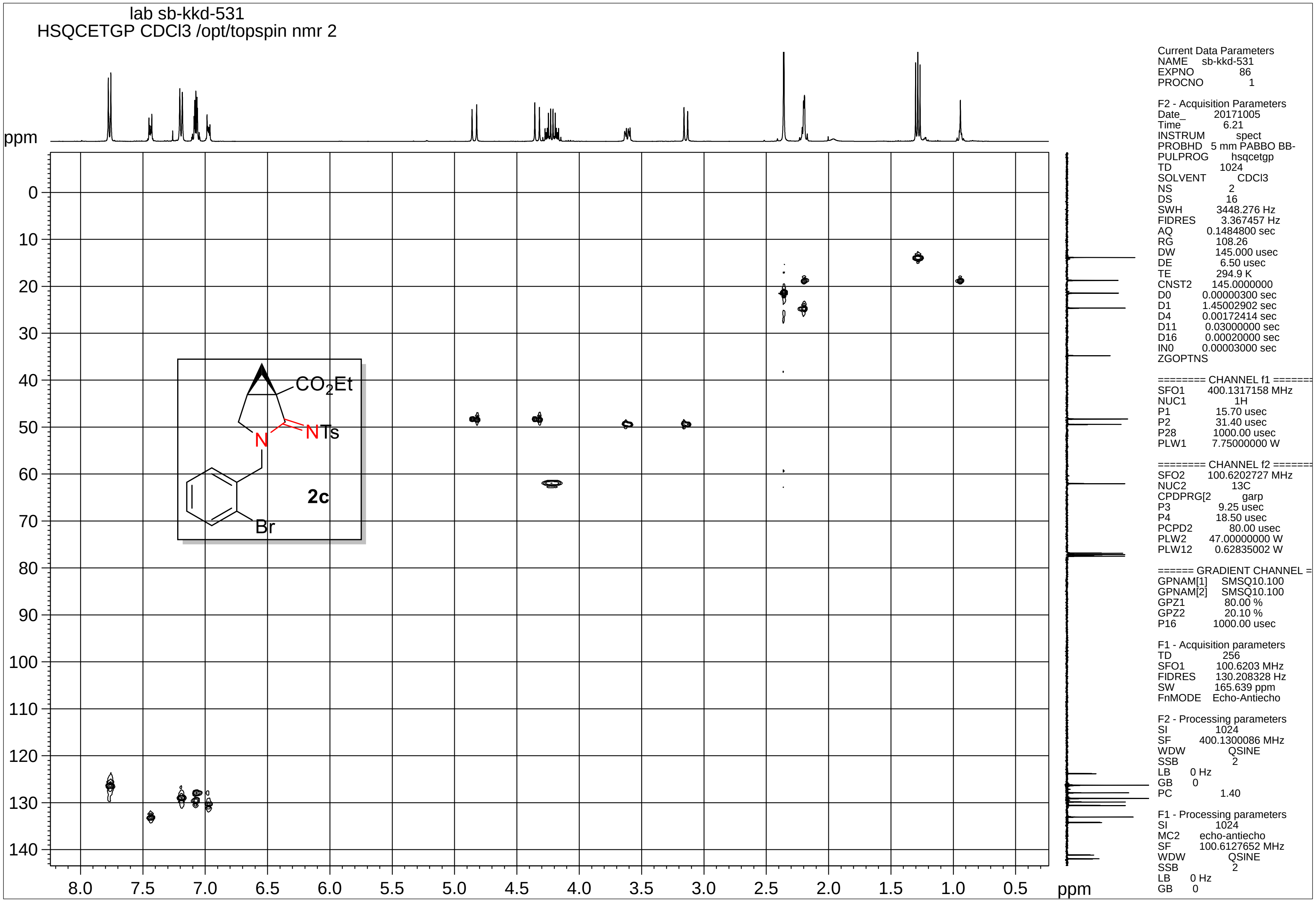
^{13}C NMR spectrum of compound 2c



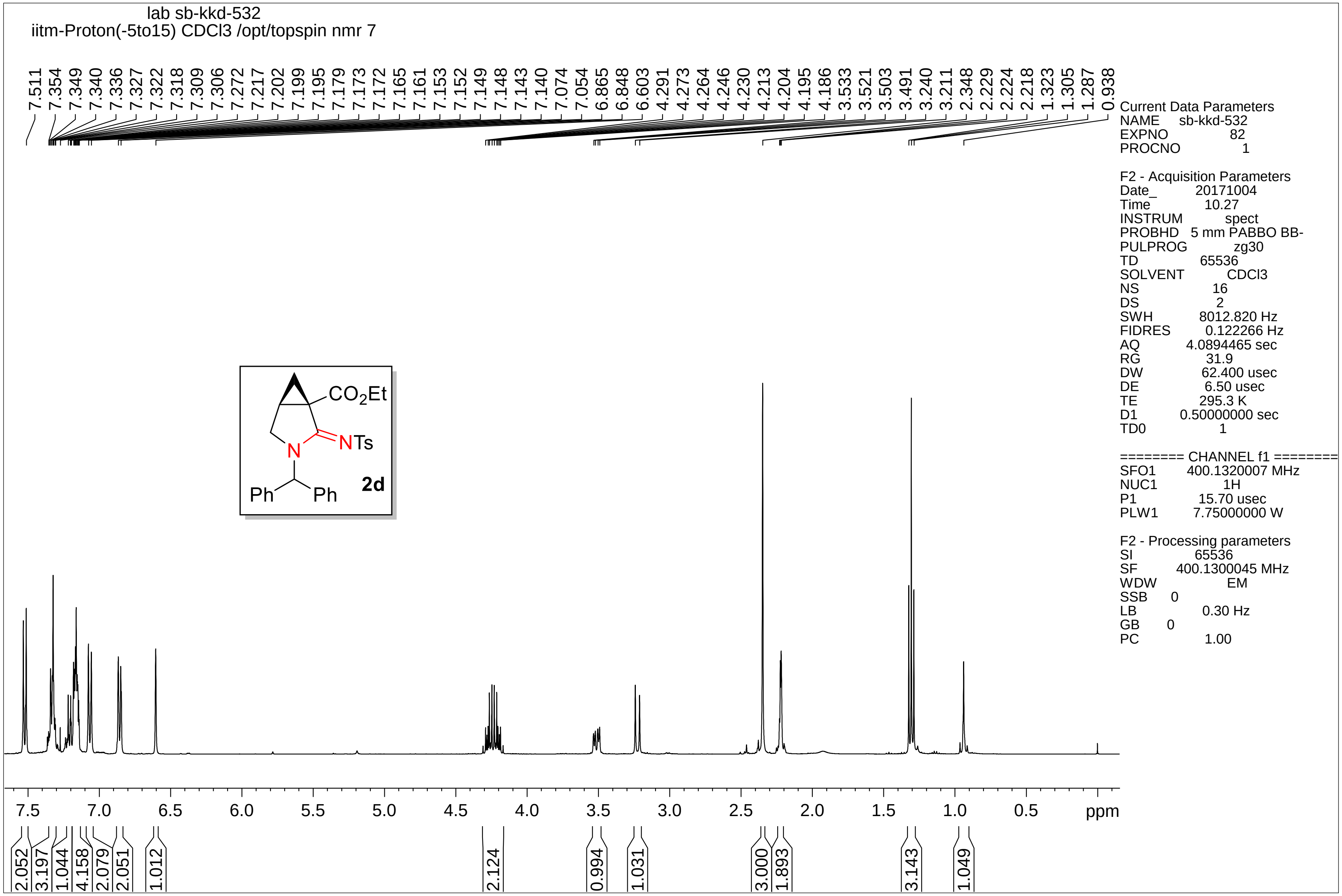
DEPT-135 NMR spectrum of compound 2c



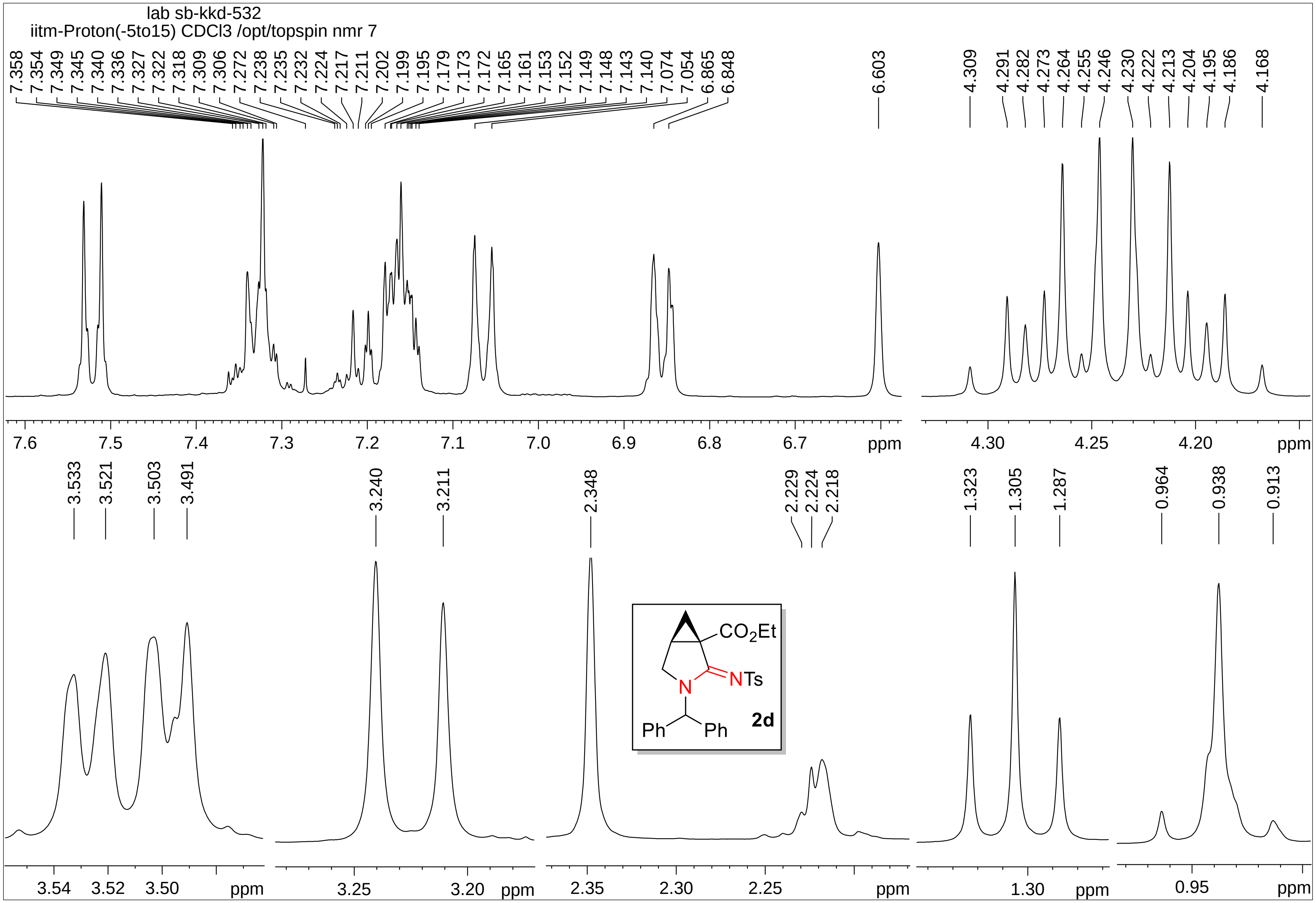
^1H-^1H COSY NMR spectrum of compound 2c



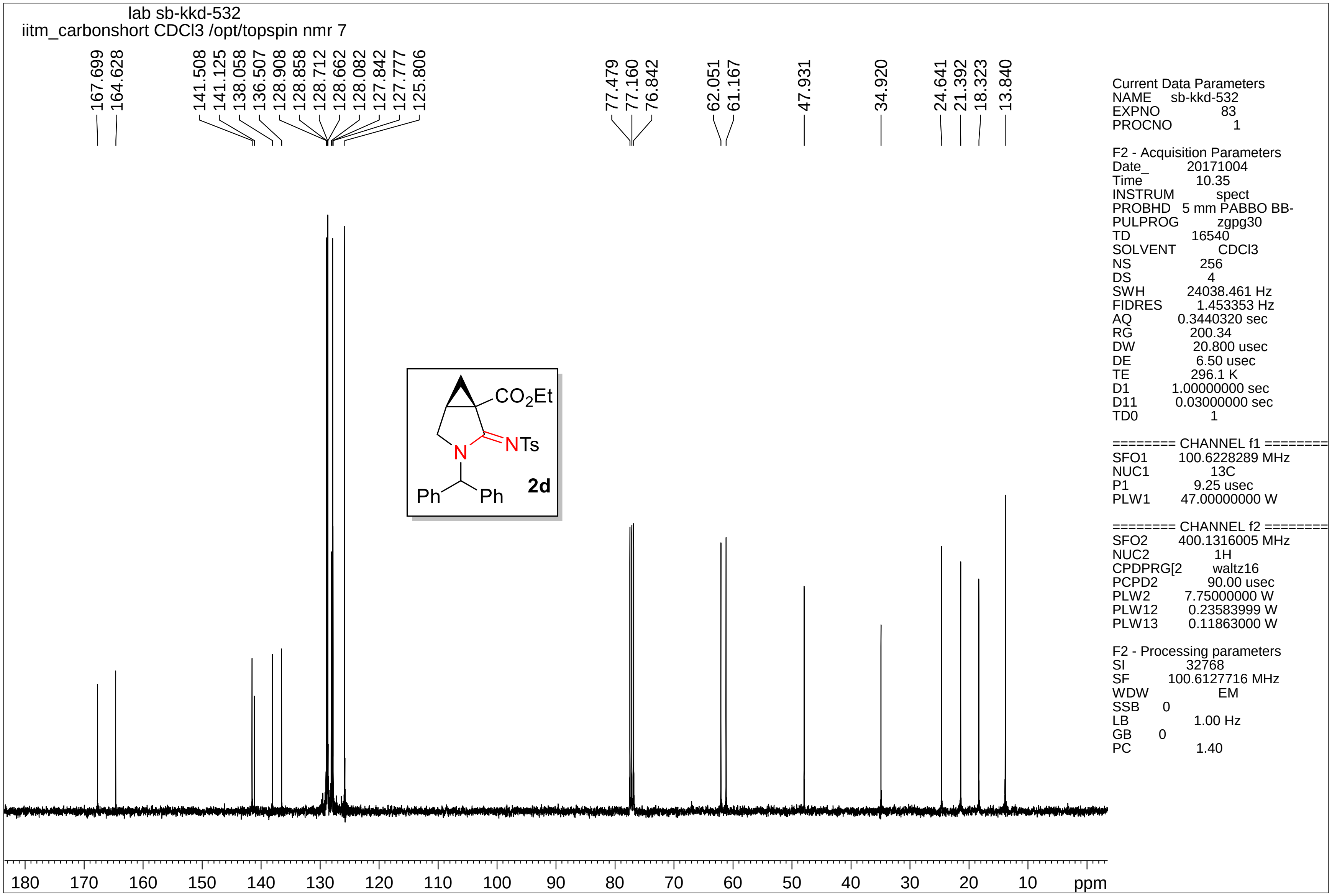
^{1}H-^{13}C HSQC NMR spectrum of compound 2c



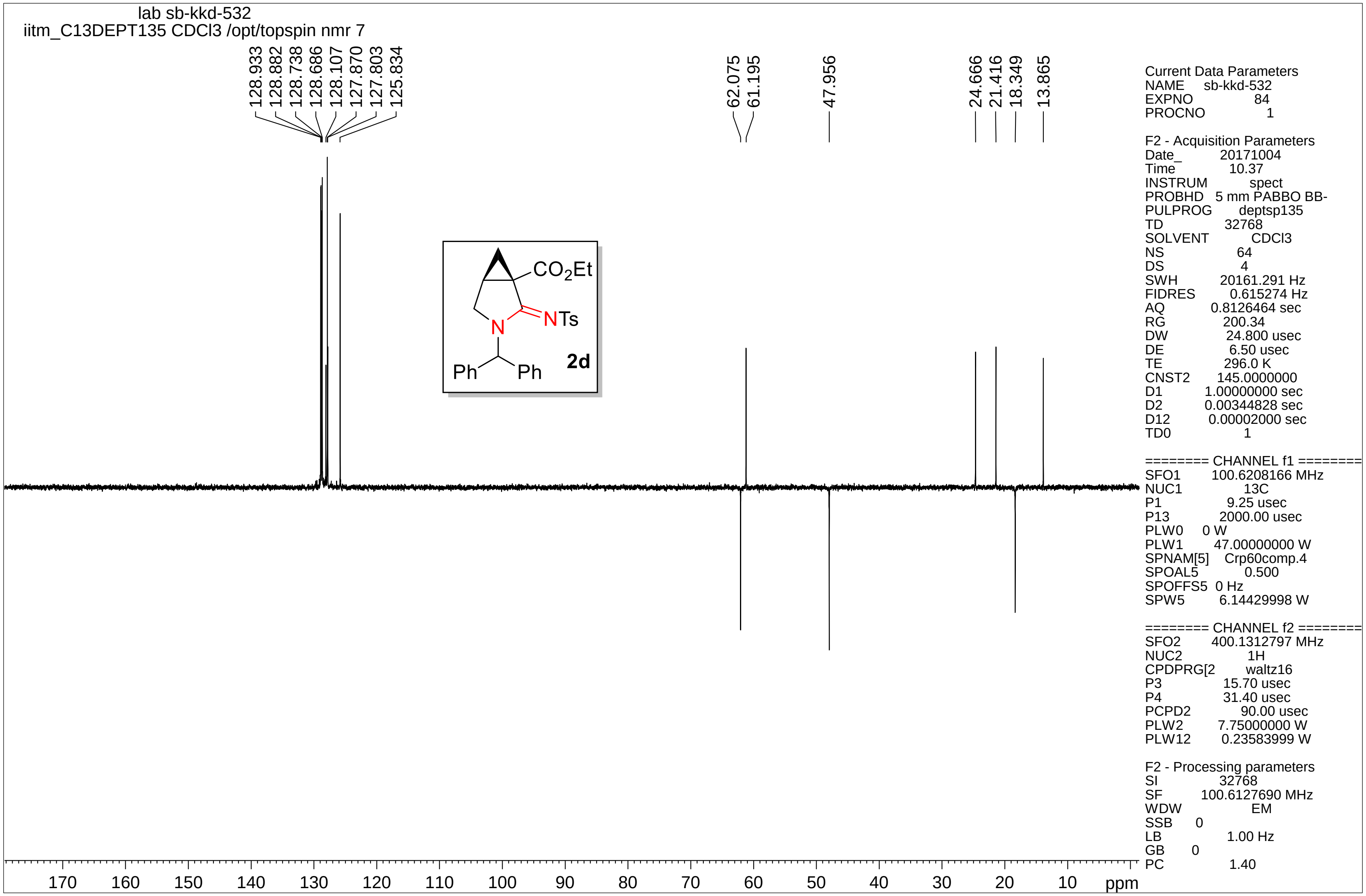
^{1}H NMR spectrum of compound 2d



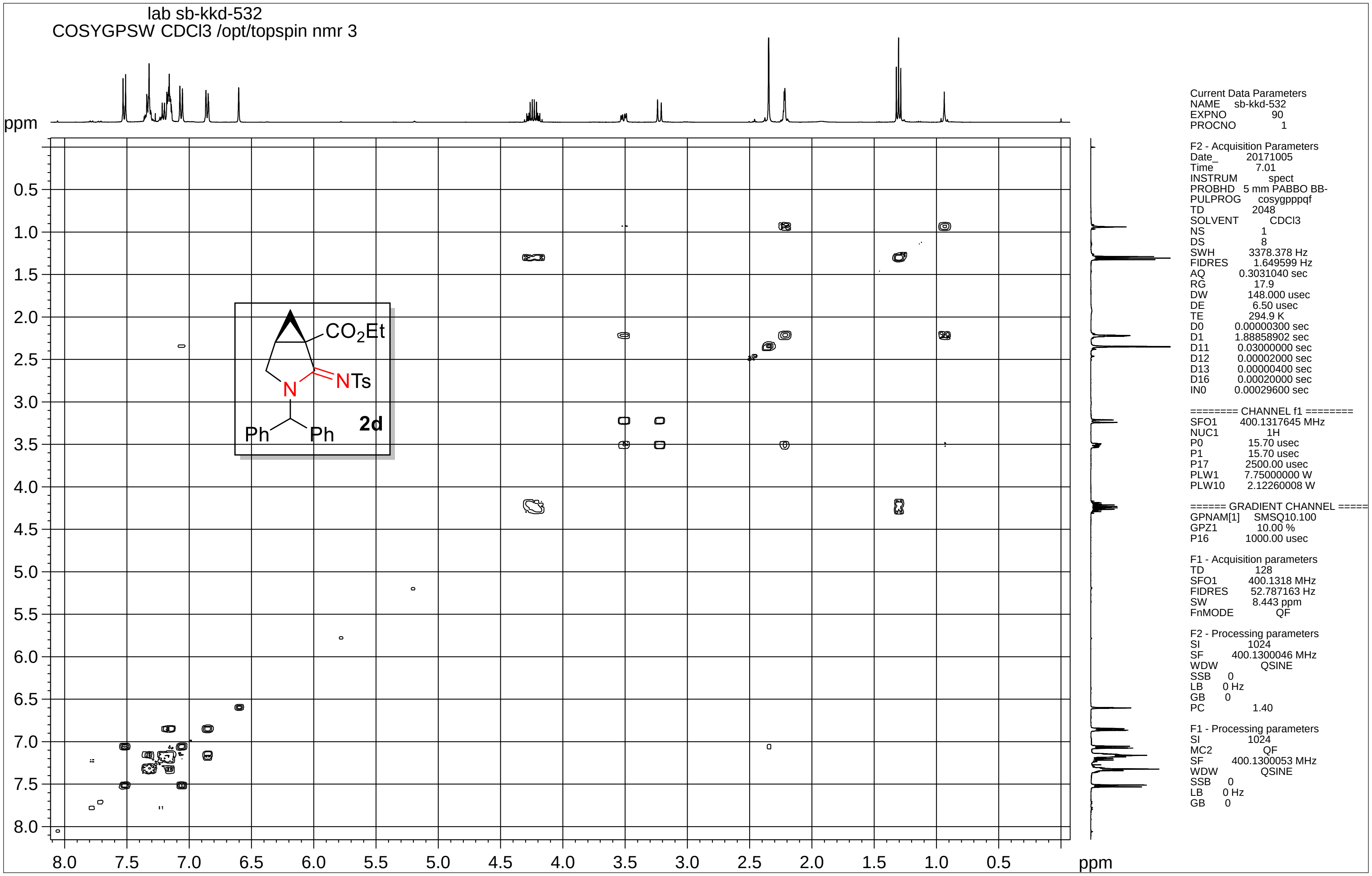
^{1}H NMR spectrum of compound 2d



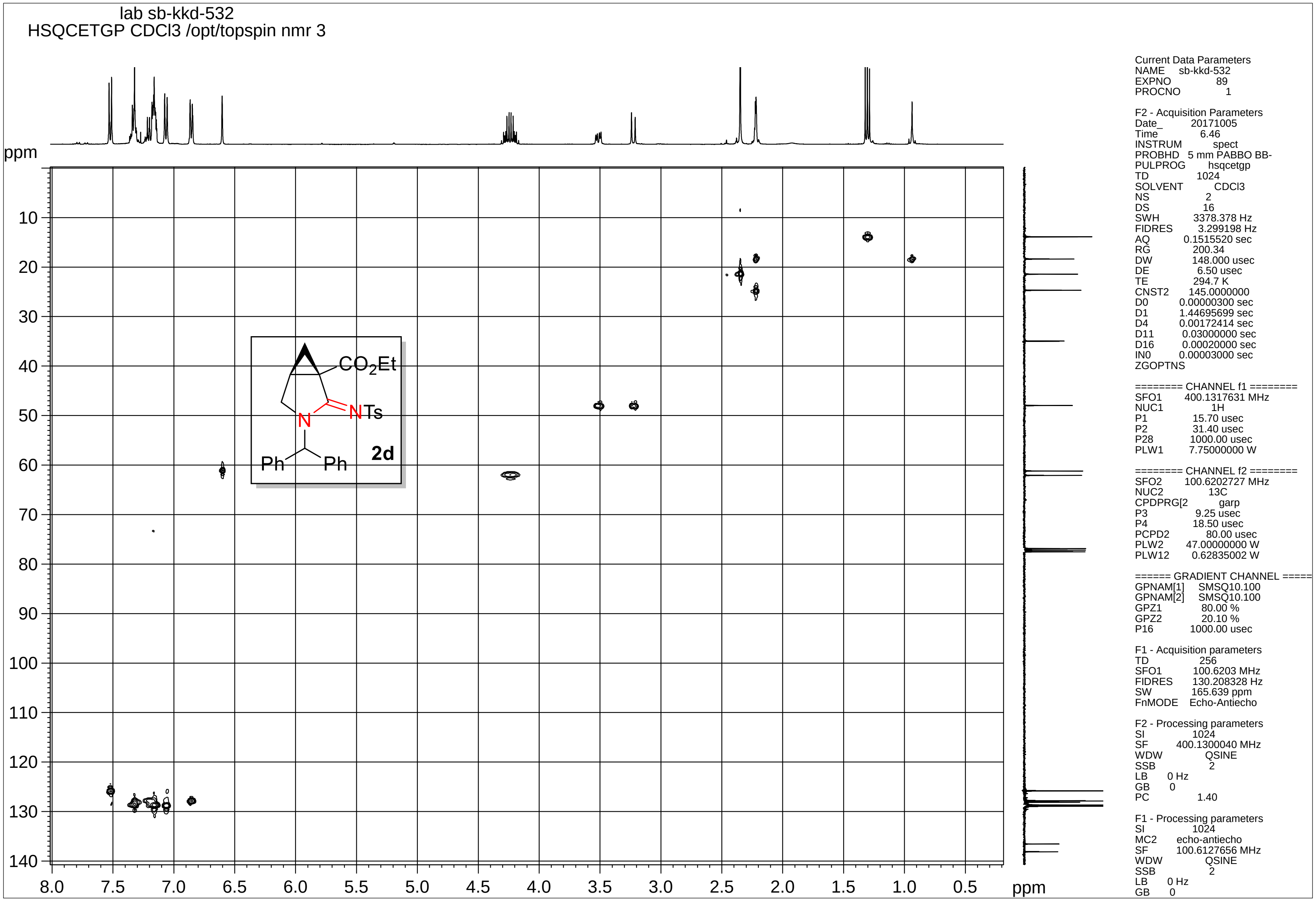
^{13}C NMR spectrum of compound 2d



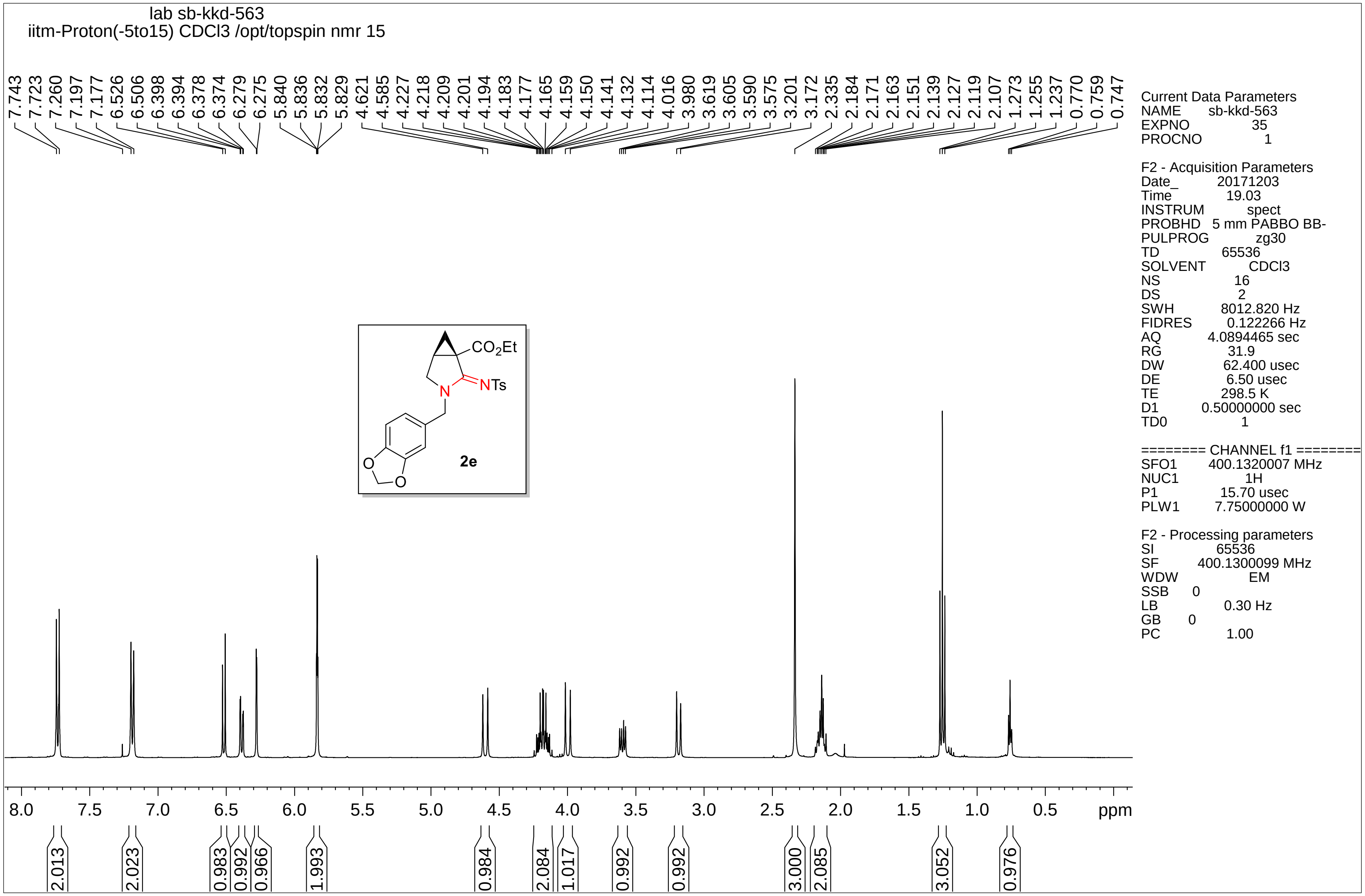
DEPT-135 NMR spectrum of compound 2d



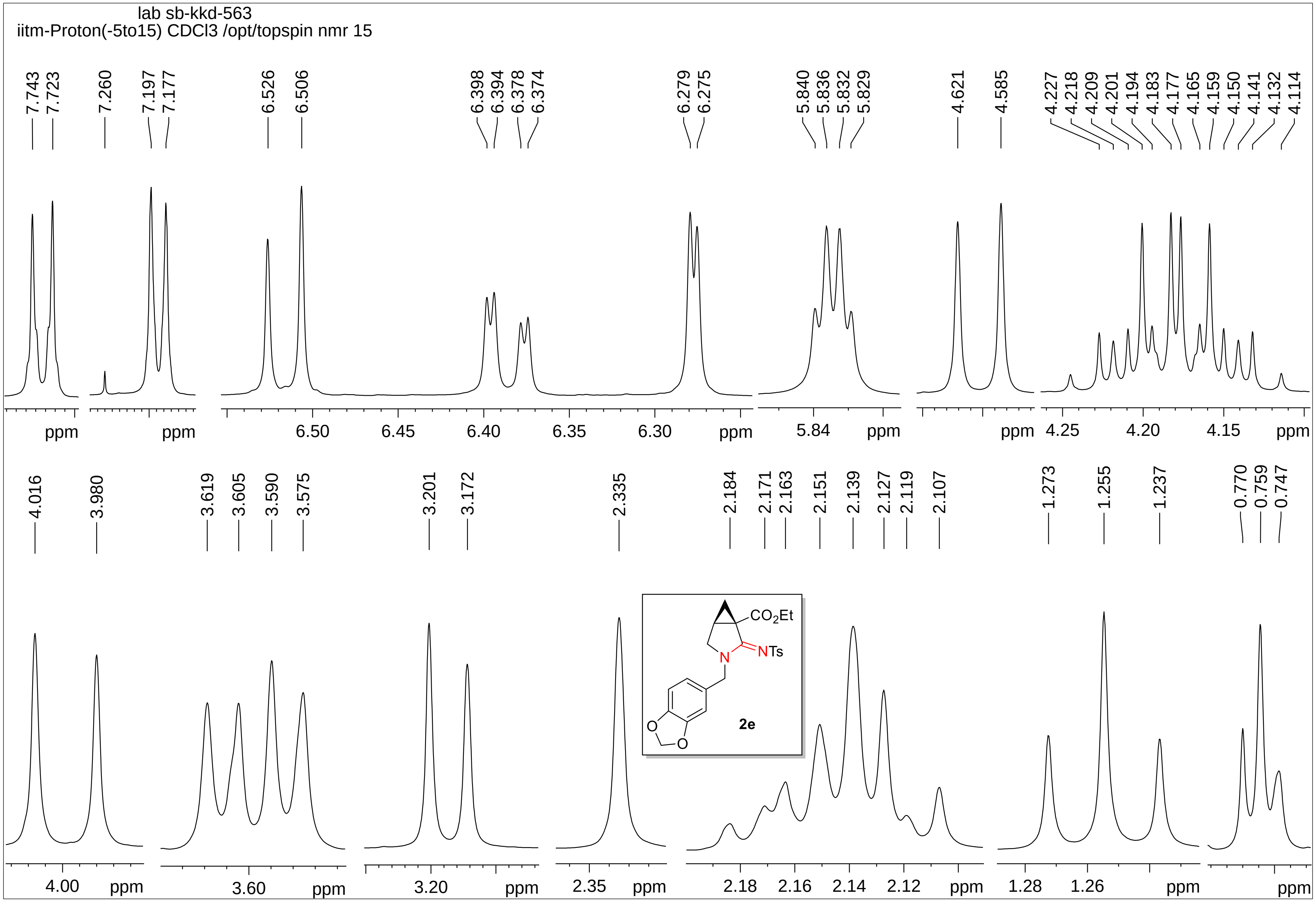
^{1}H-^{1}H COSY NMR spectrum of compound 2d



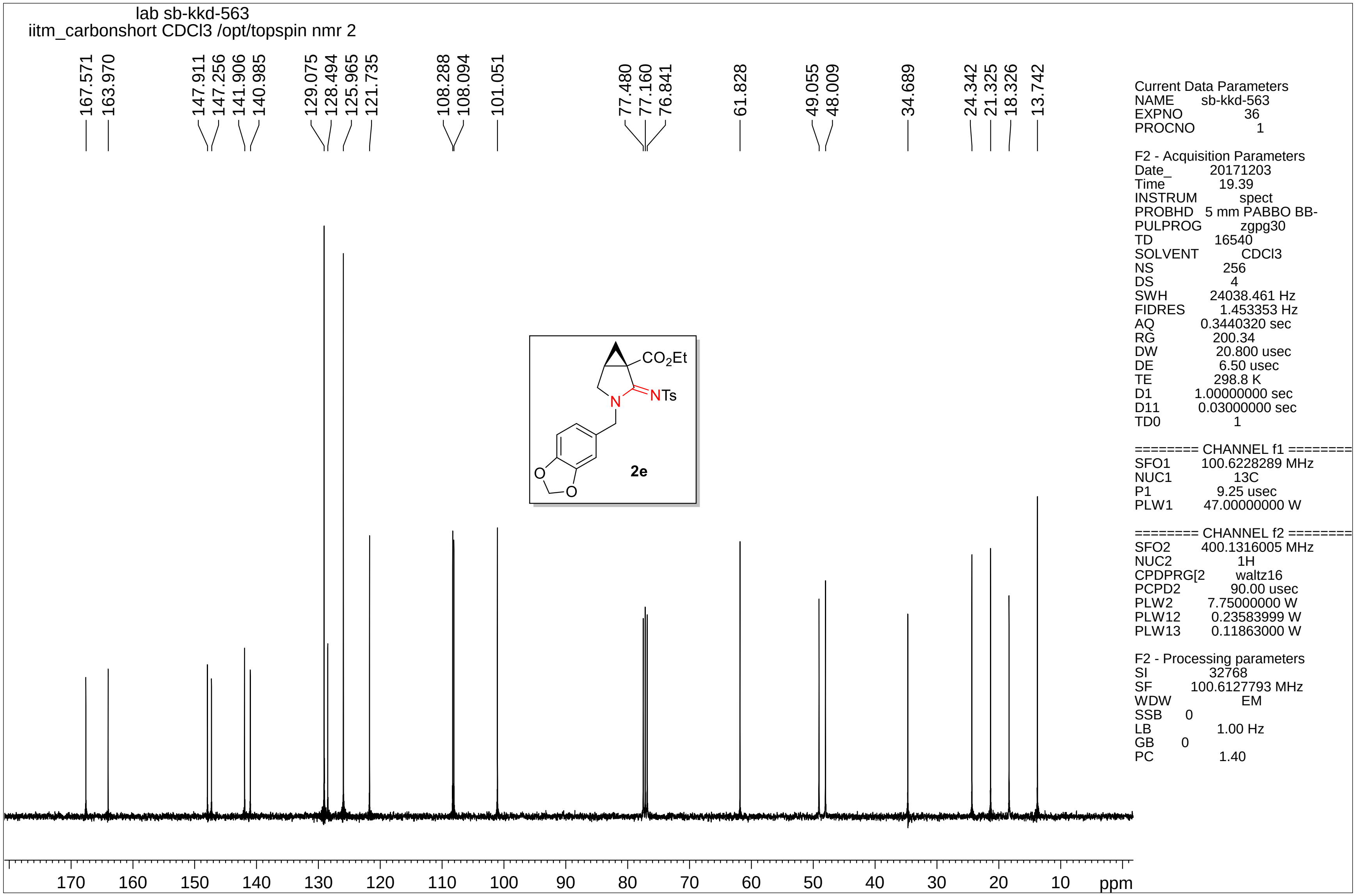
^{1}H-^{13}C HSQC NMR spectrum of compound 2d



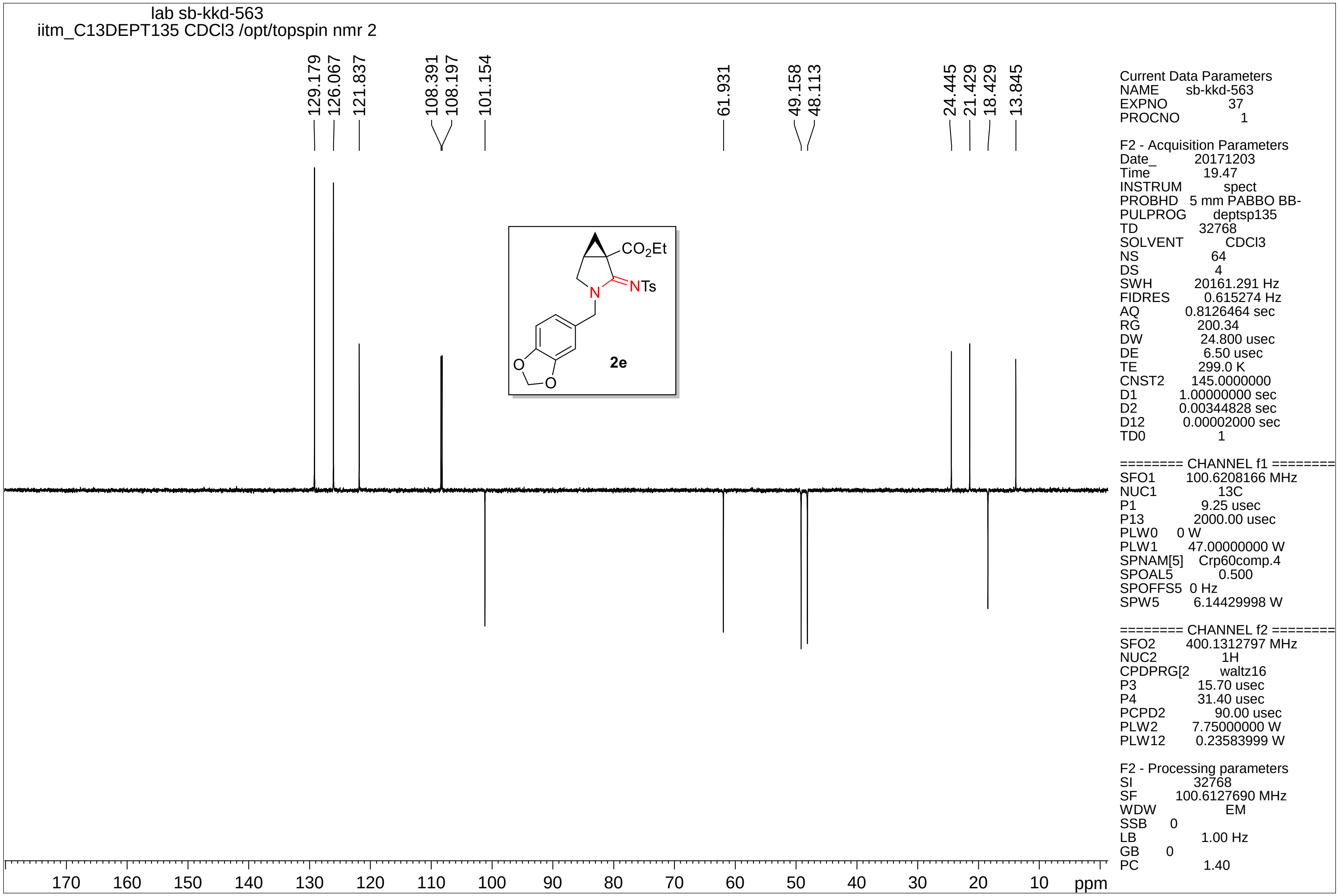
[1]H NMR spectrum of compound 2e



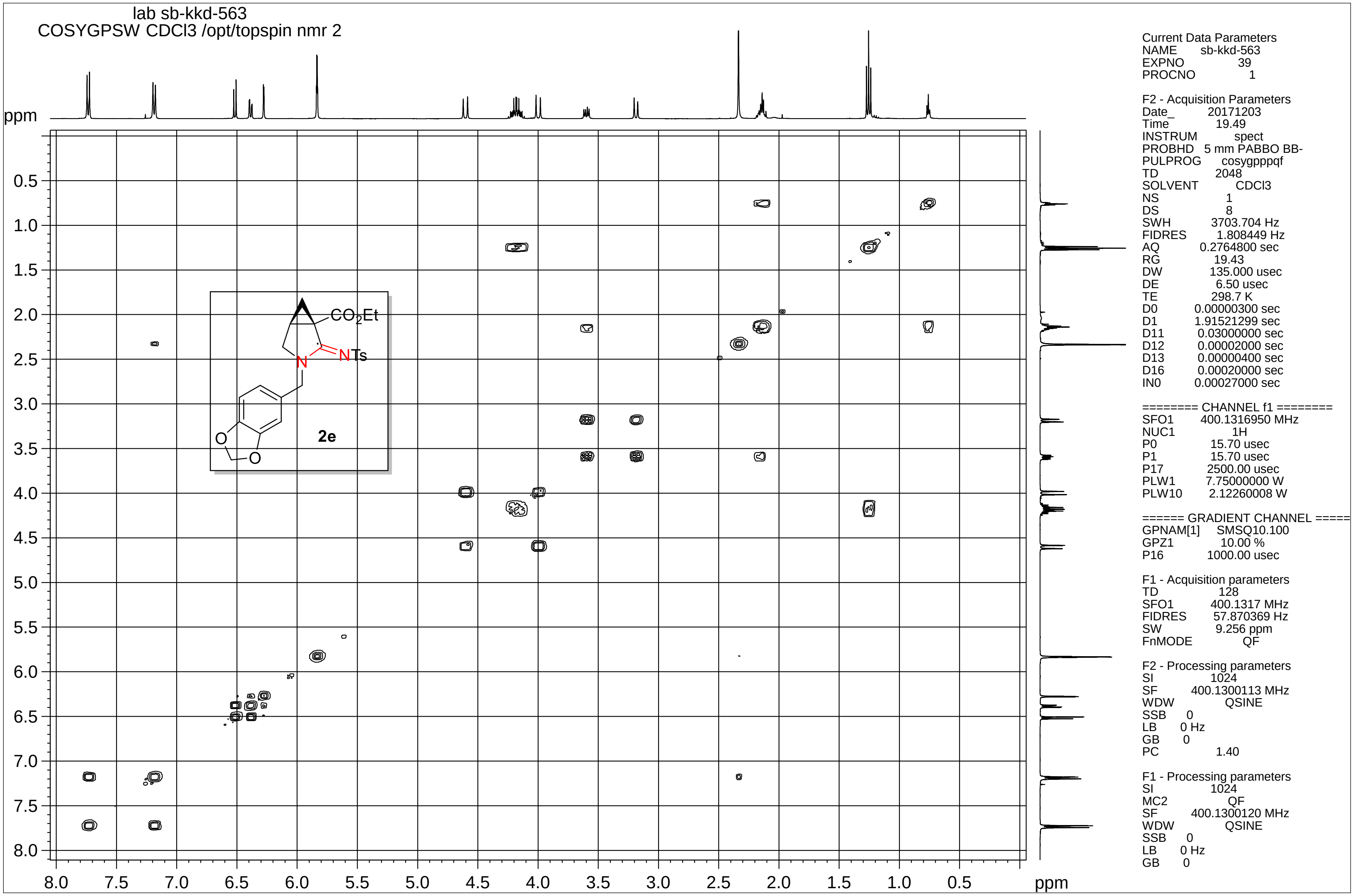
^{1}H NMR spectrum of compound 2e



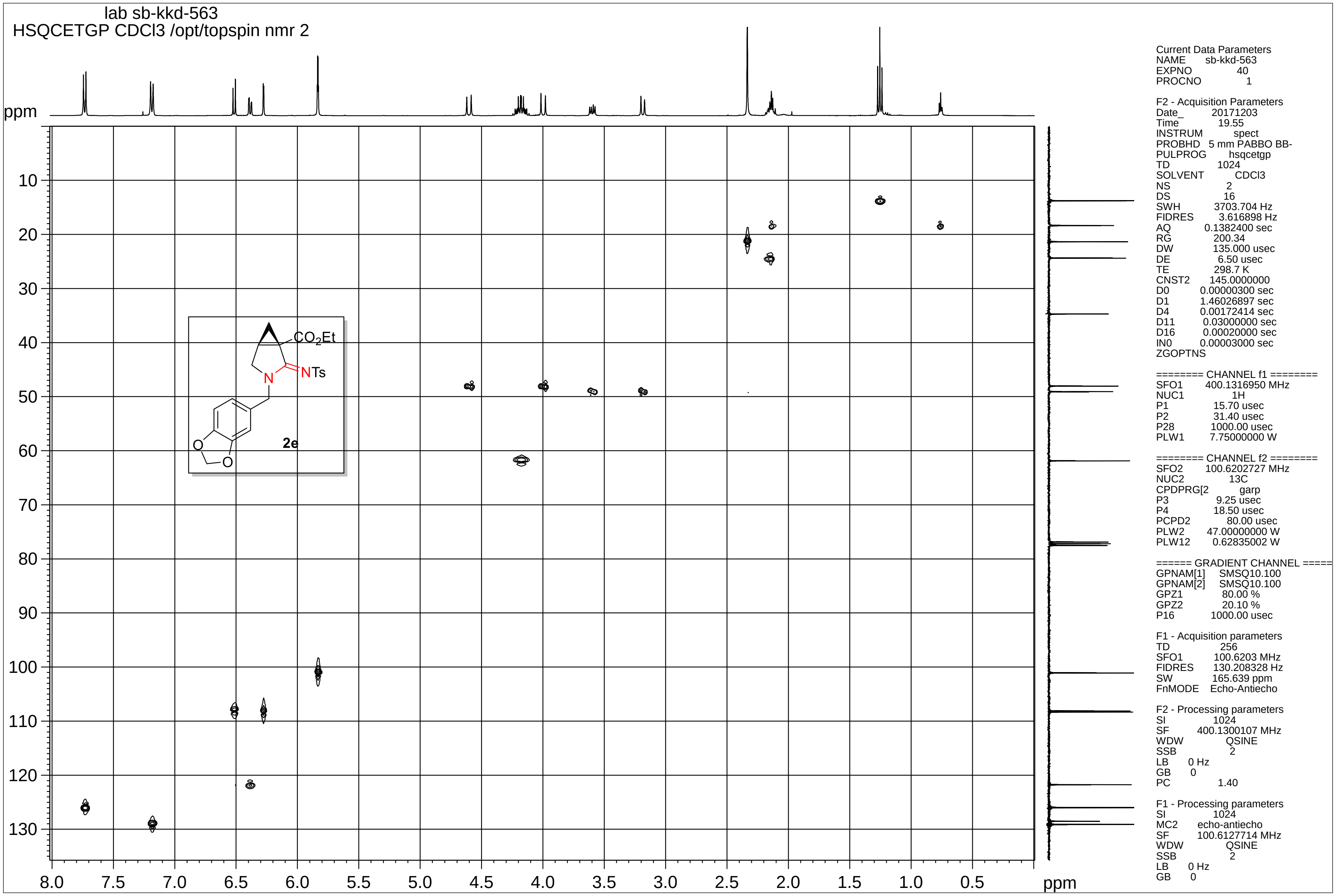
^{13}C NMR spectrum of compound 2e



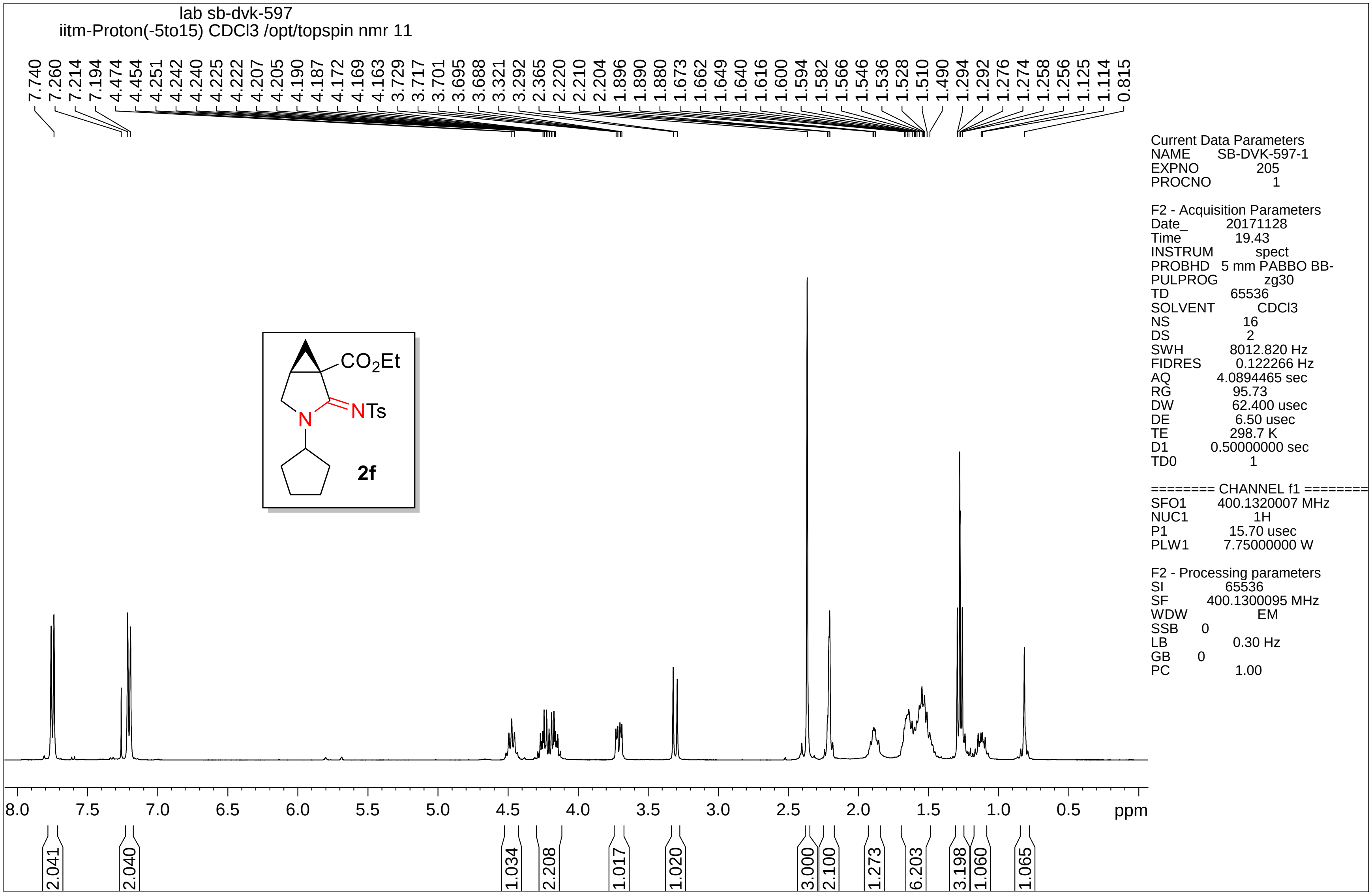
DEPT-135 NMR spectrum of compound 2e



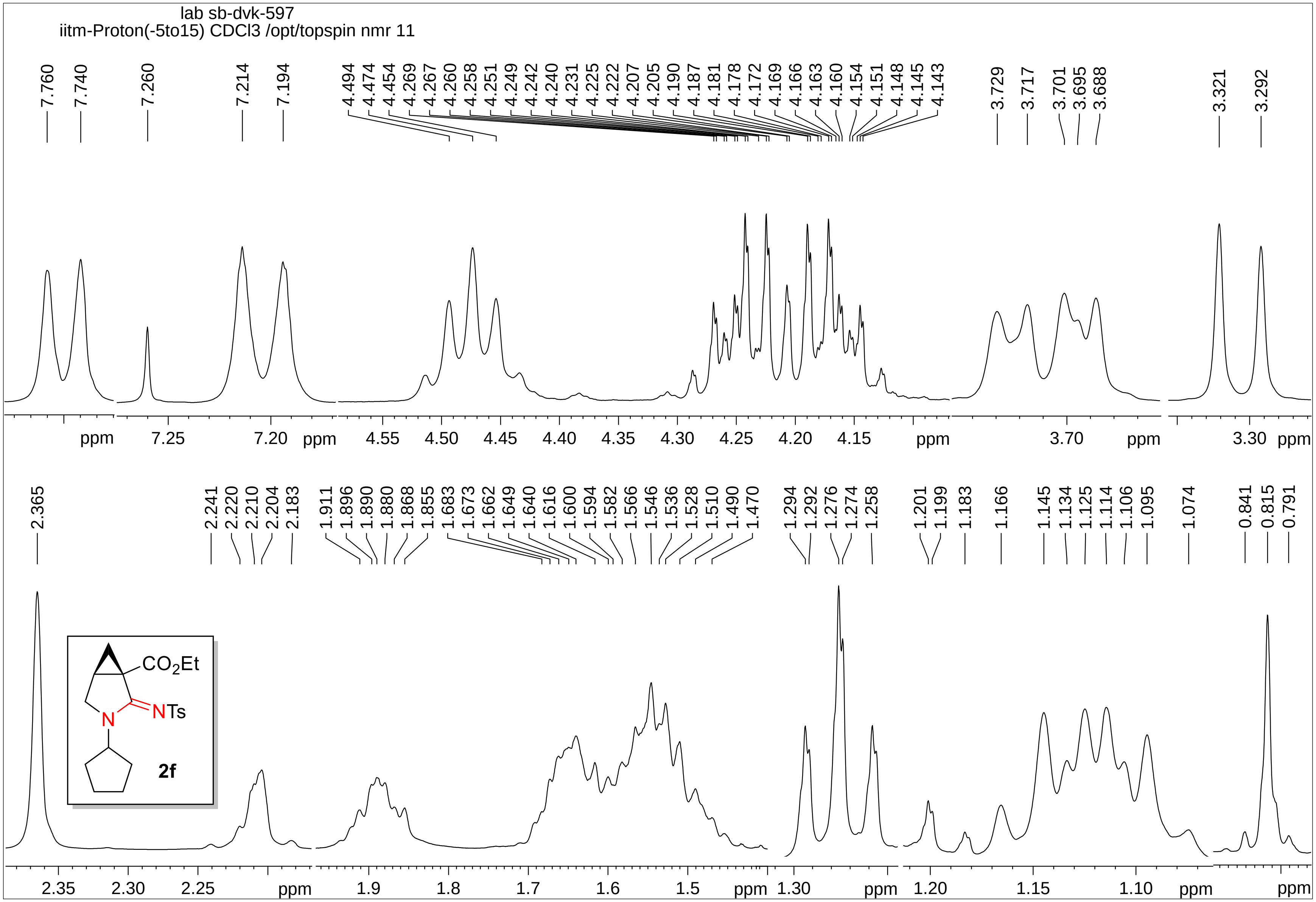
[1]H-[1]H COSY NMR spectrum of compound 2e



^1H-^{13}C HSQC NMR spectrum of compound 2e



[1]H NMR spectrum of compound 2f



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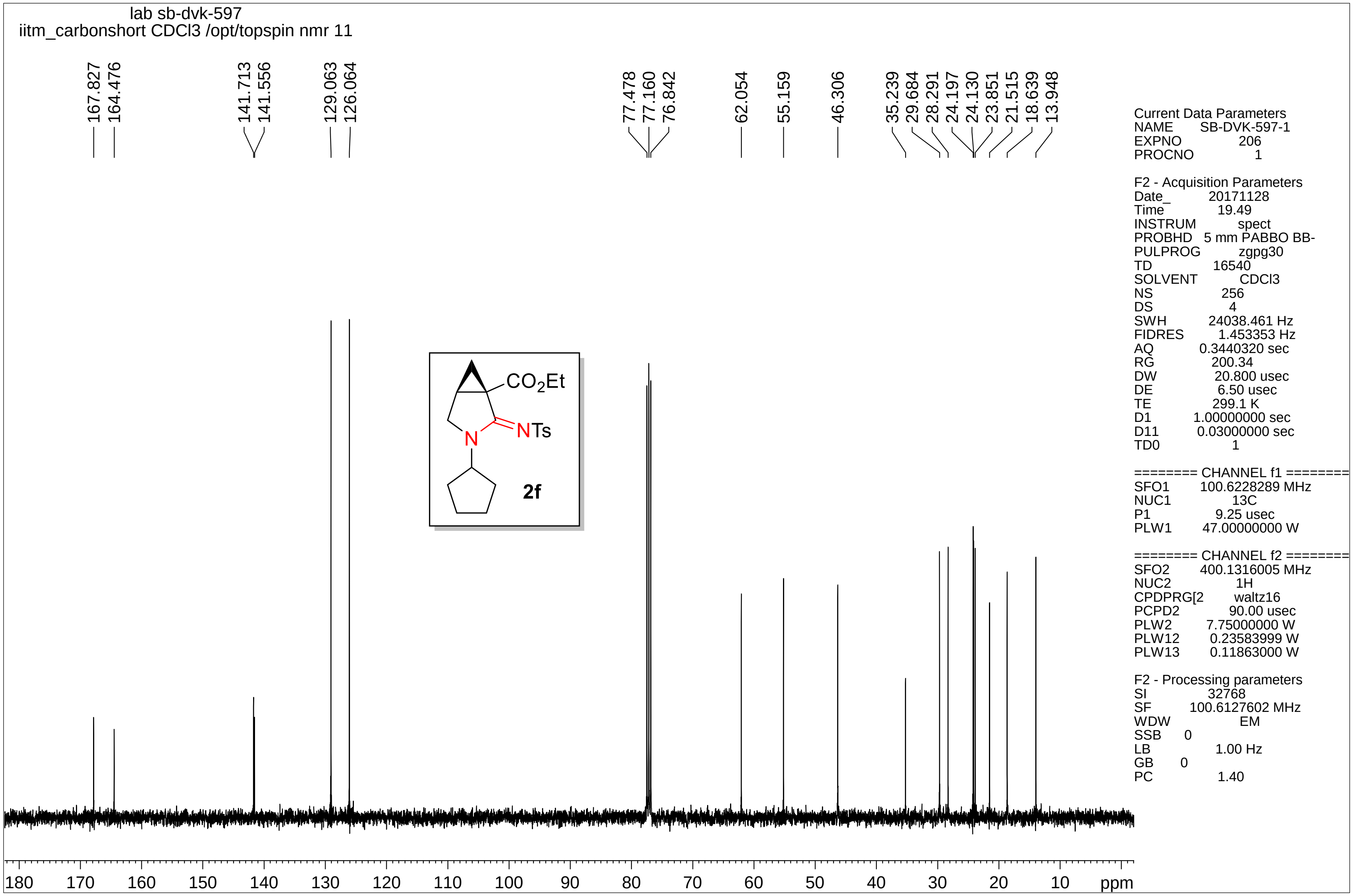
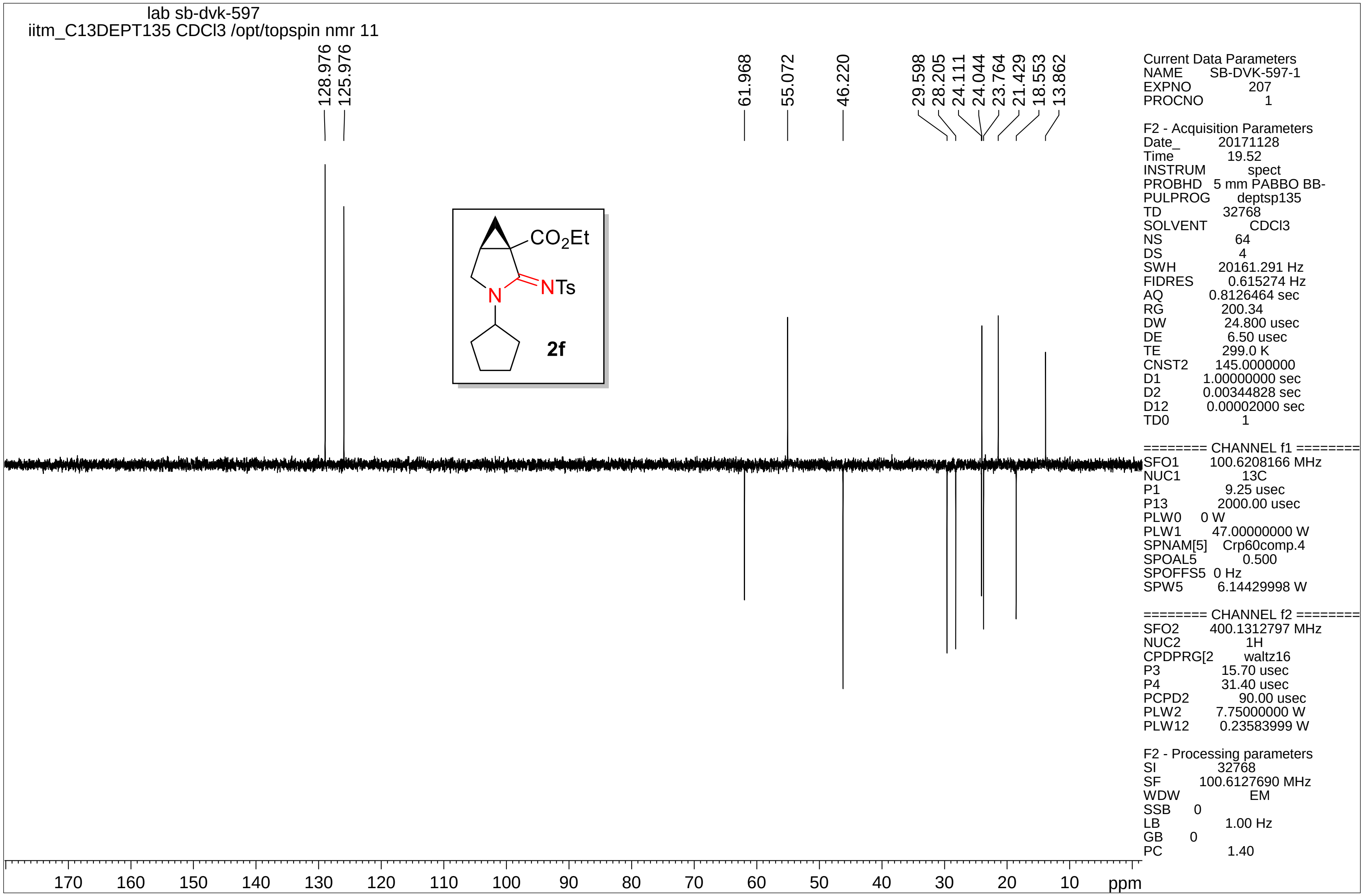
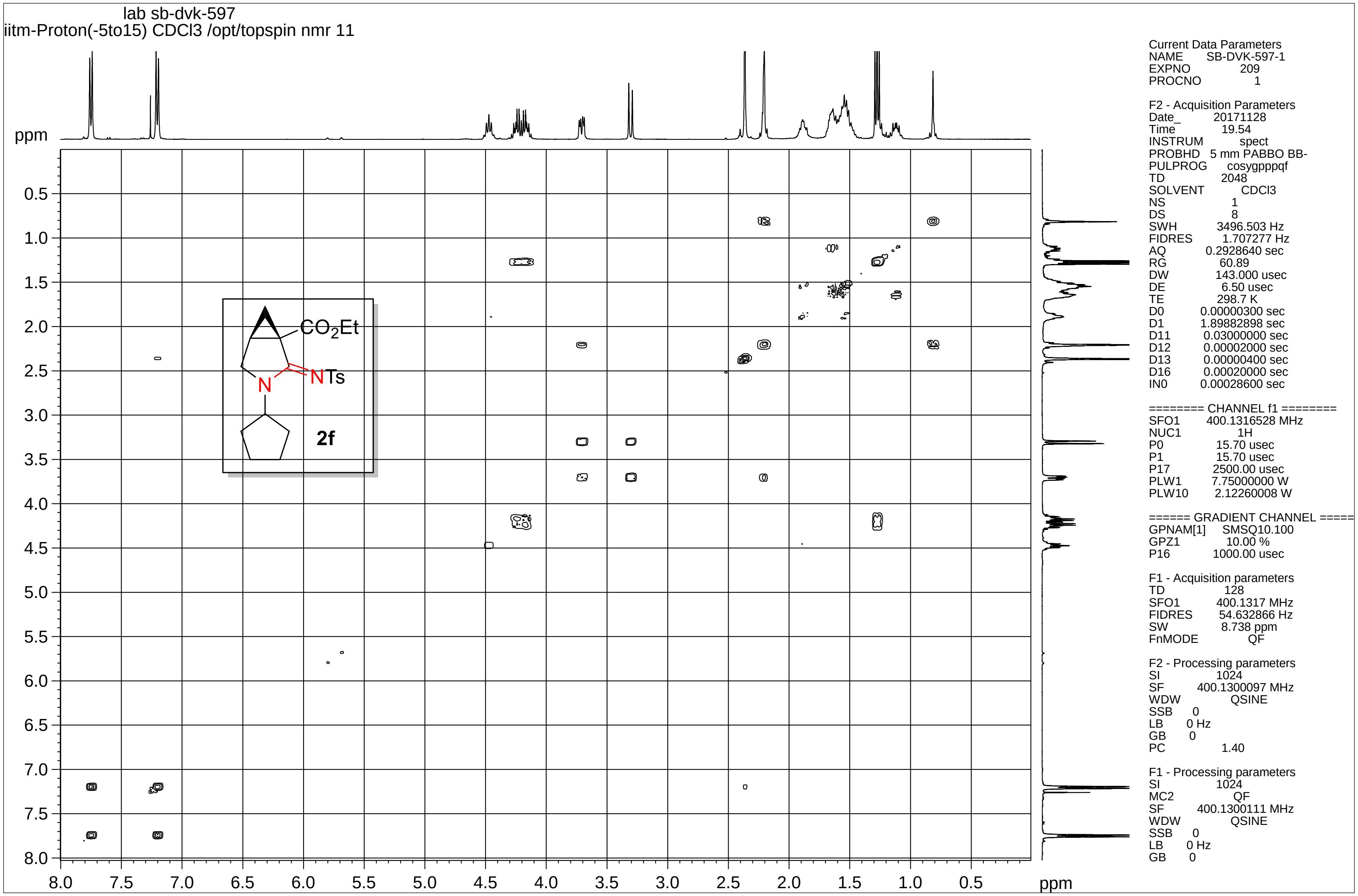


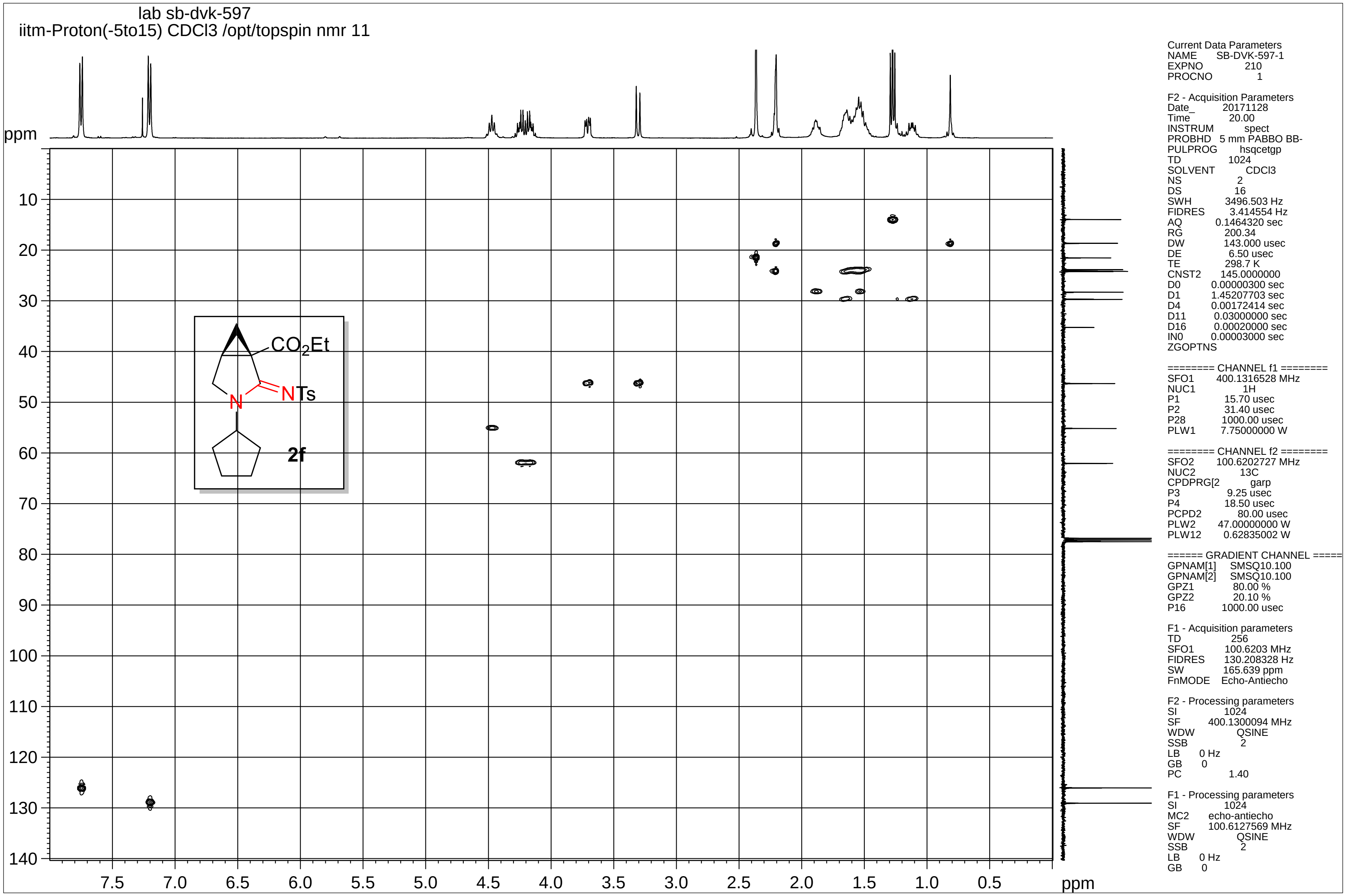
^{13}C NMR spectrum of compound 2f



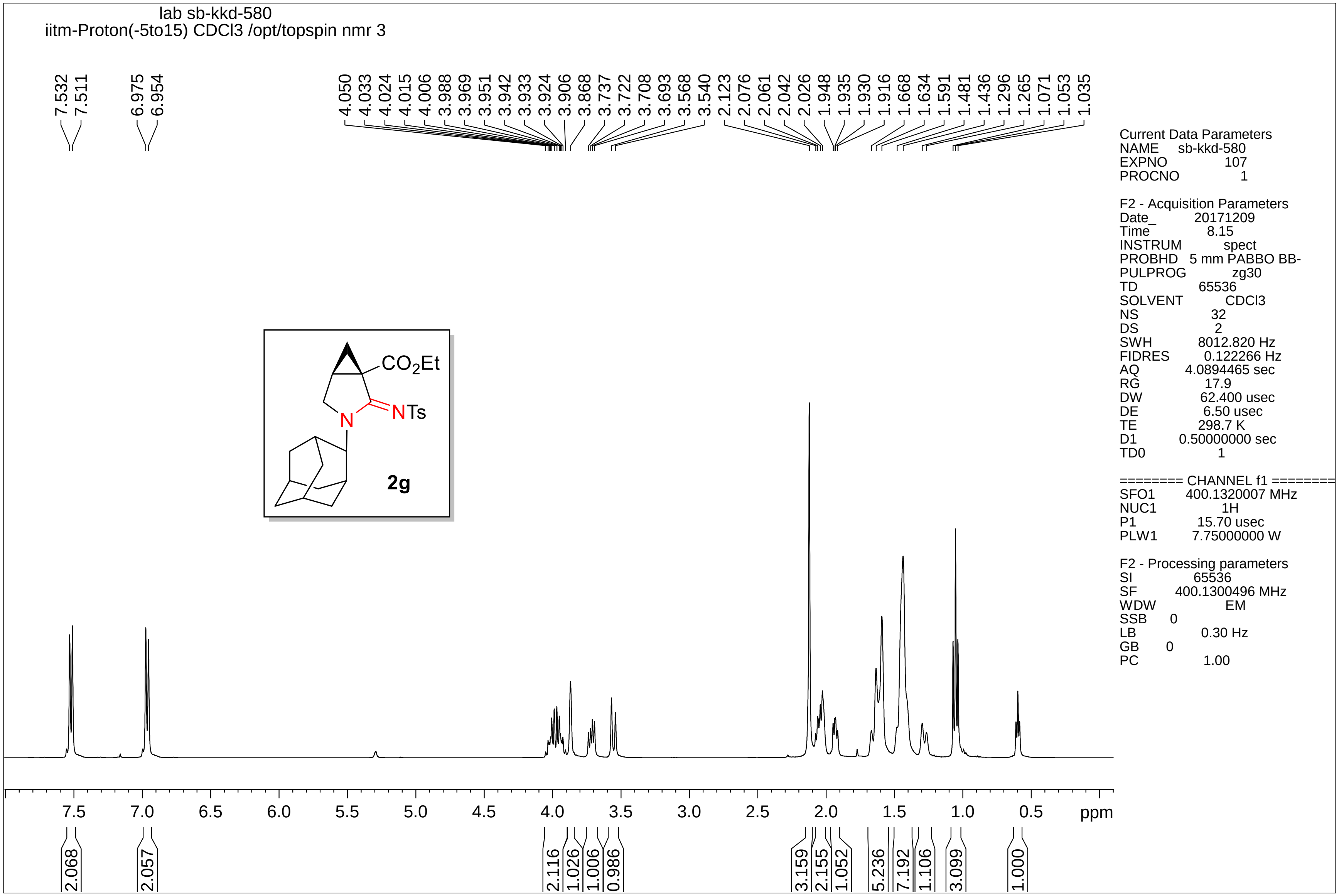
DEPT-135 NMR spectrum of compound 2f



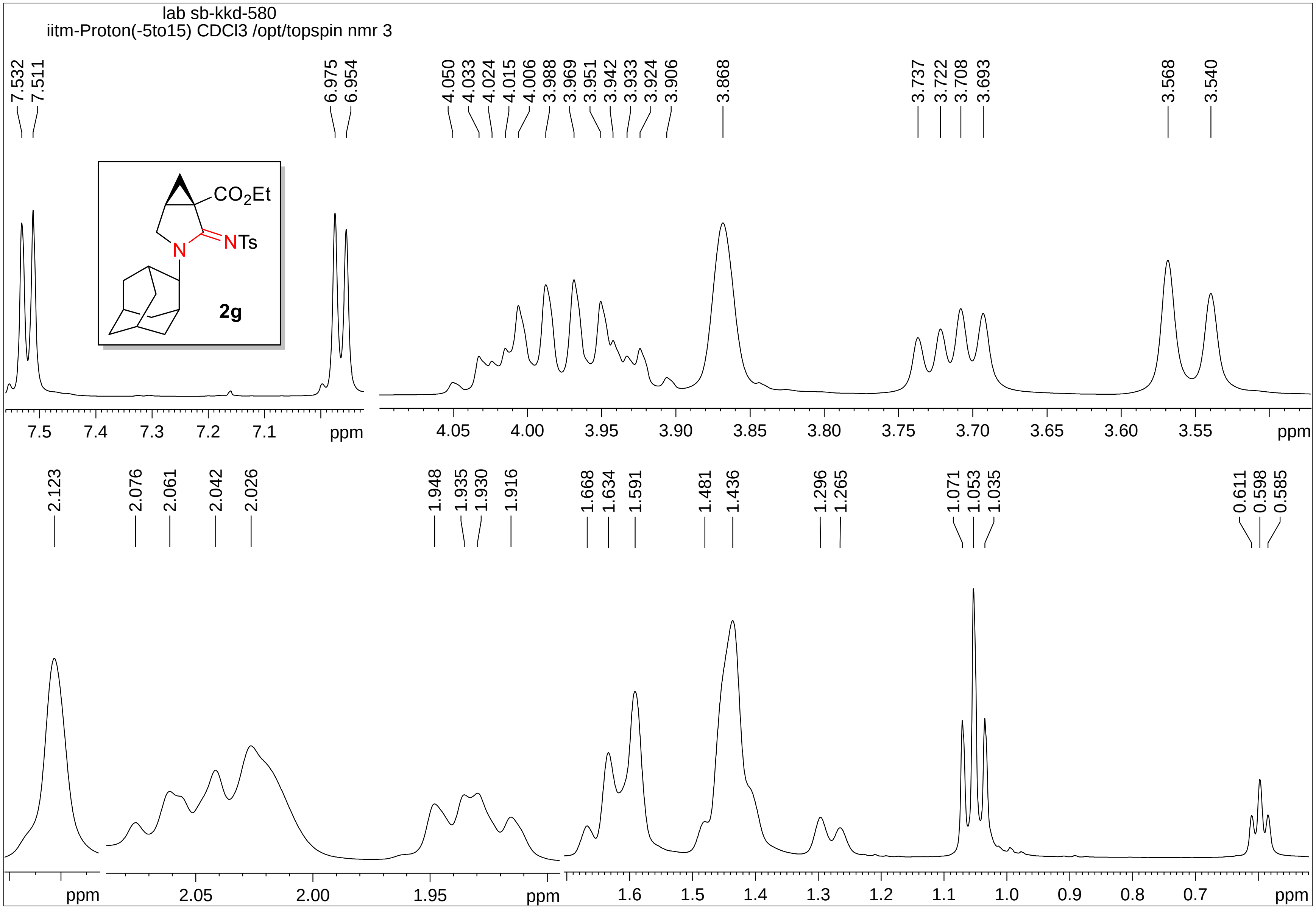
^{1}H-^{1}H COSY NMR spectrum of compound 2f



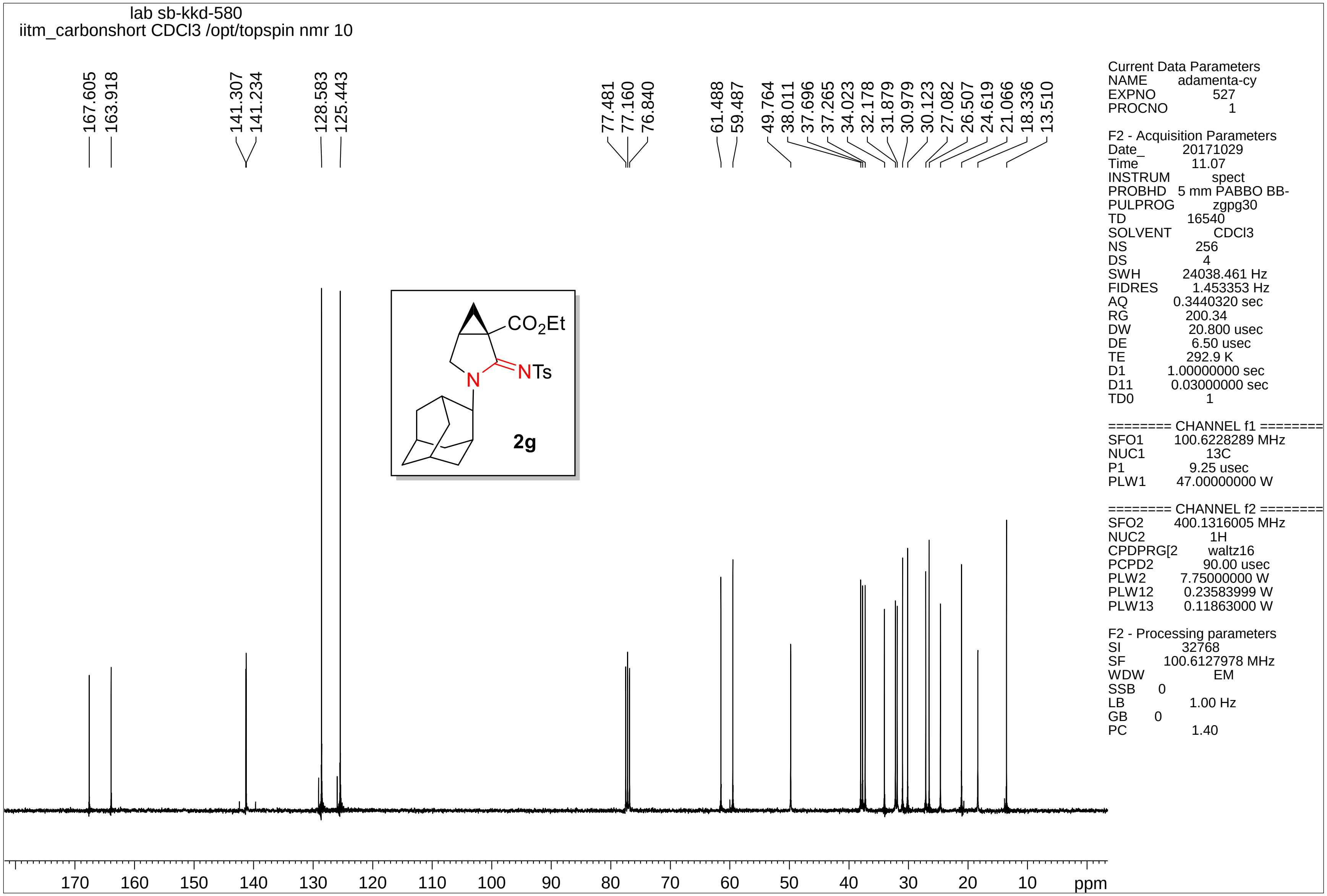
^{1}H-^{13}C HSQC NMR spectrum of compound 2f



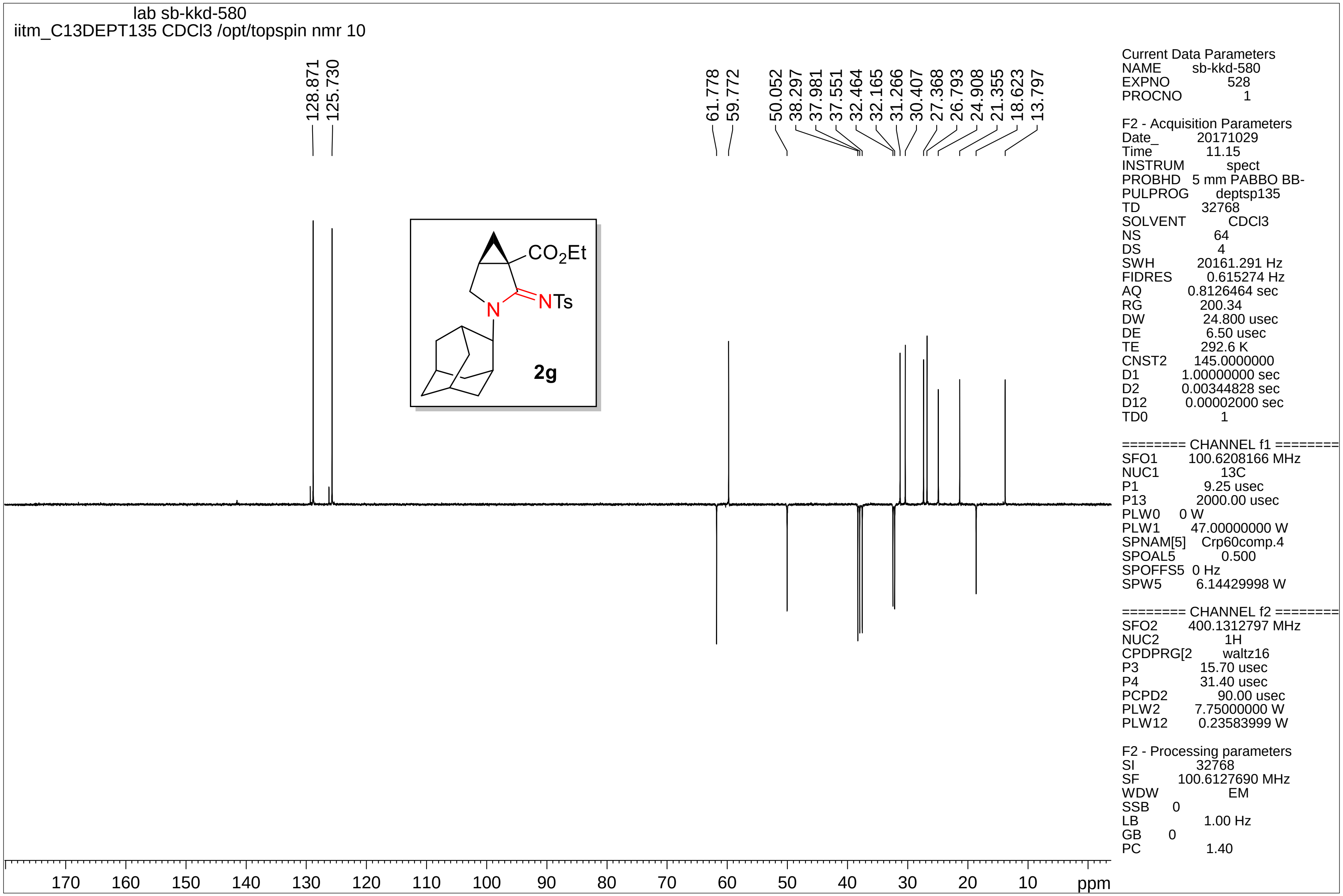
[1]H NMR spectrum of compound 2g



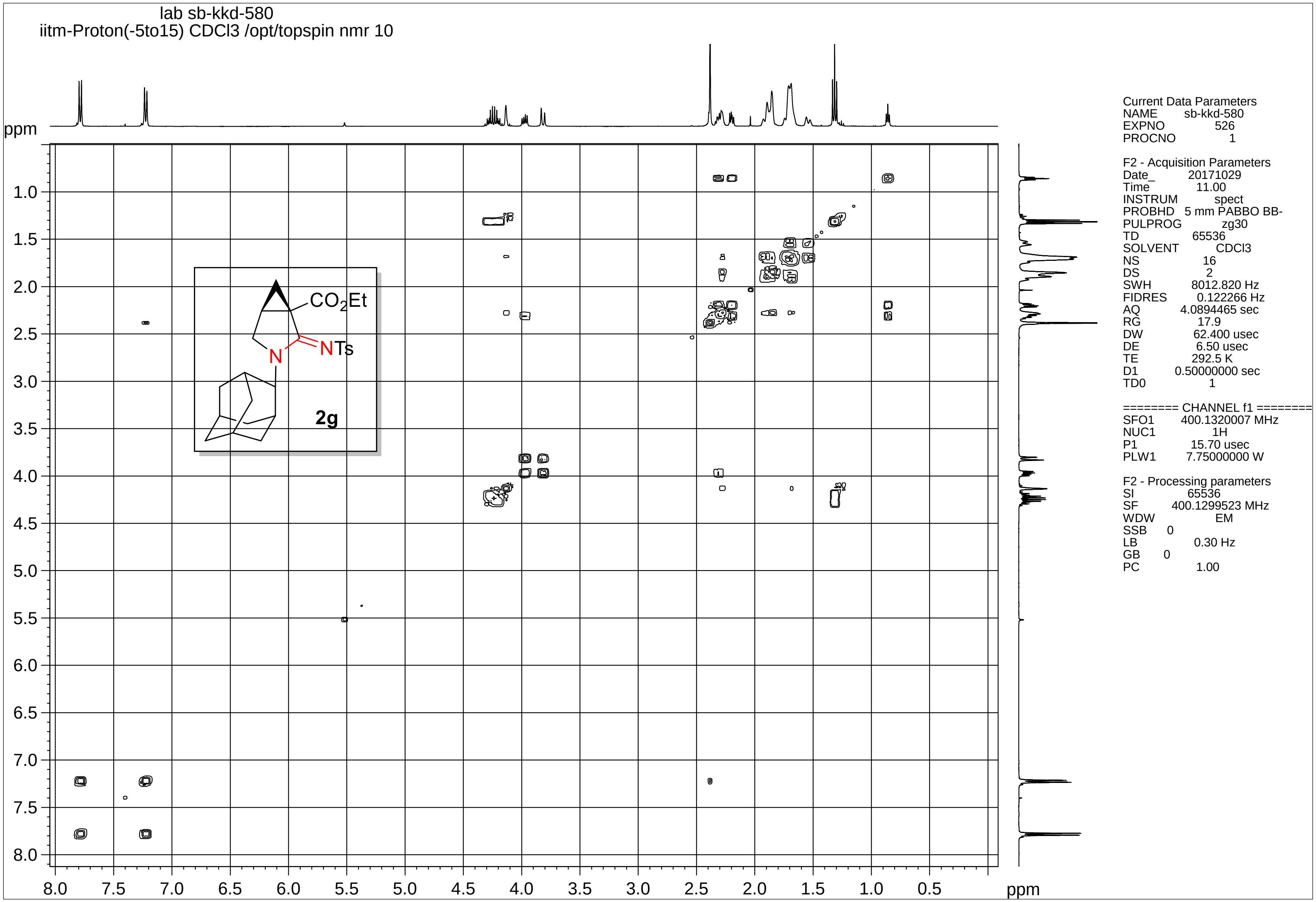
^{1}H NMR spectrum of compound 2g



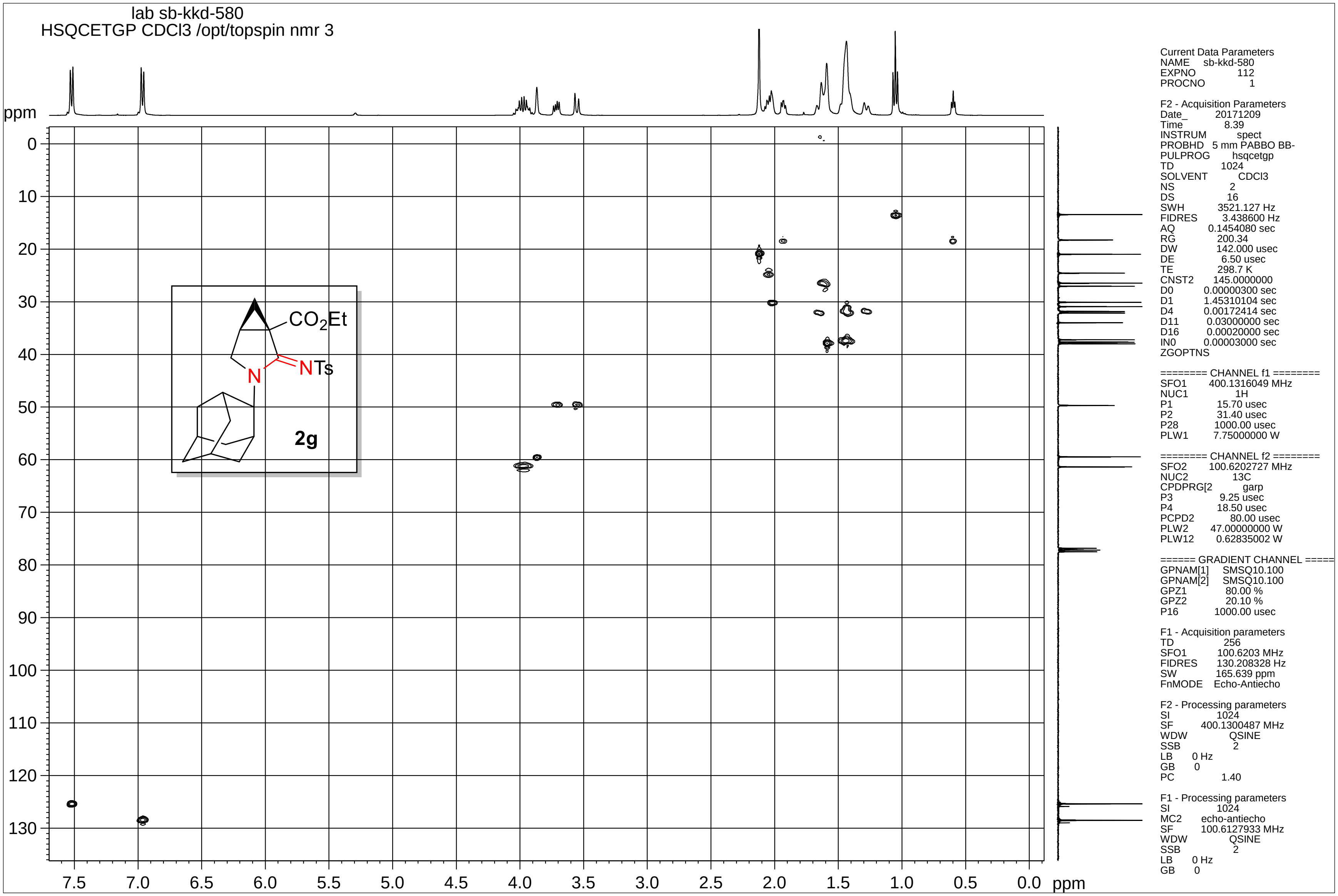
^{13}C NMR spectrum of compound 2g



DEPT-135 NMR spectrum of compound 2g



^{1}H-^{1}H COSY NMR spectrum of compound 2g



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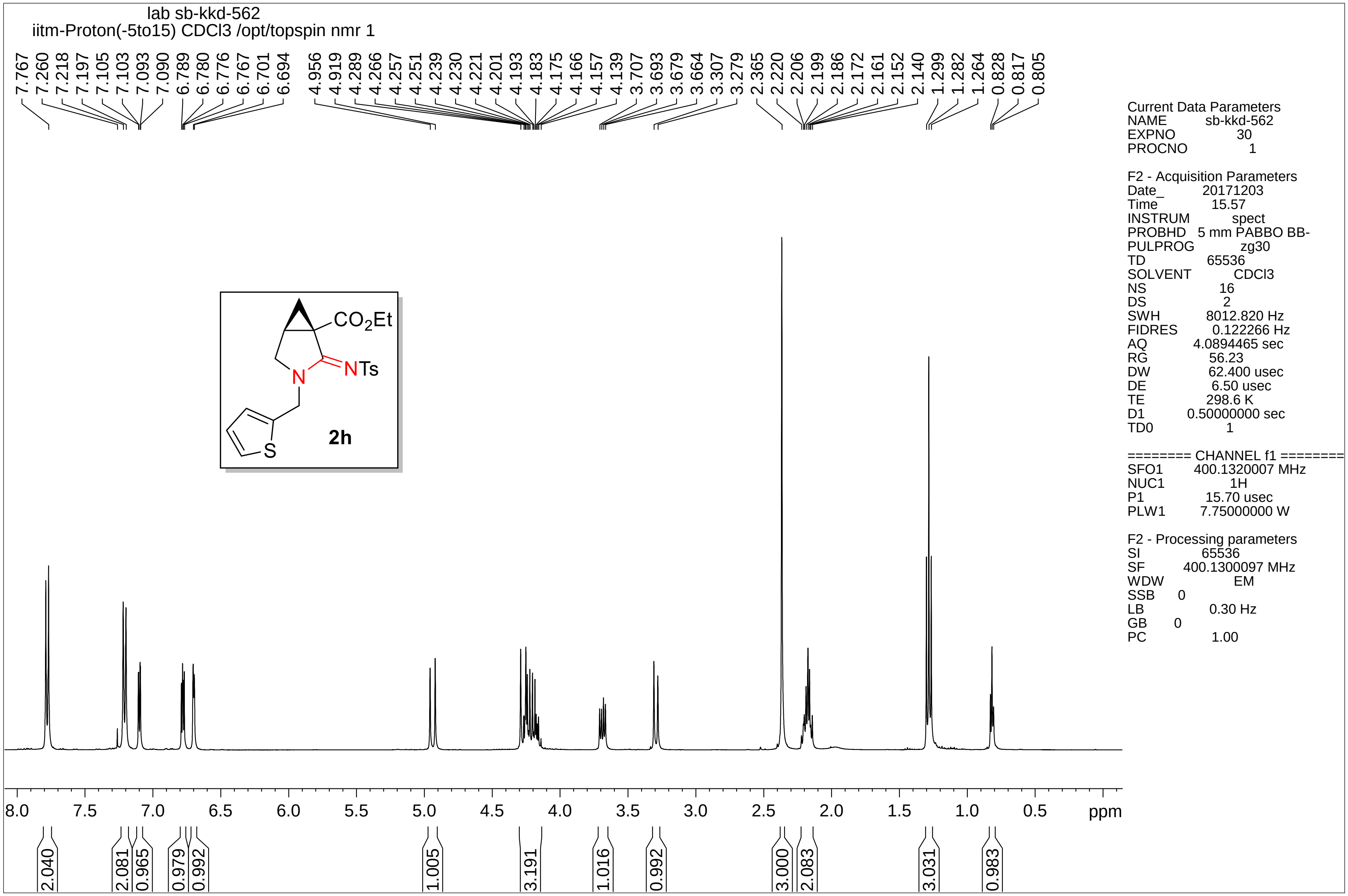
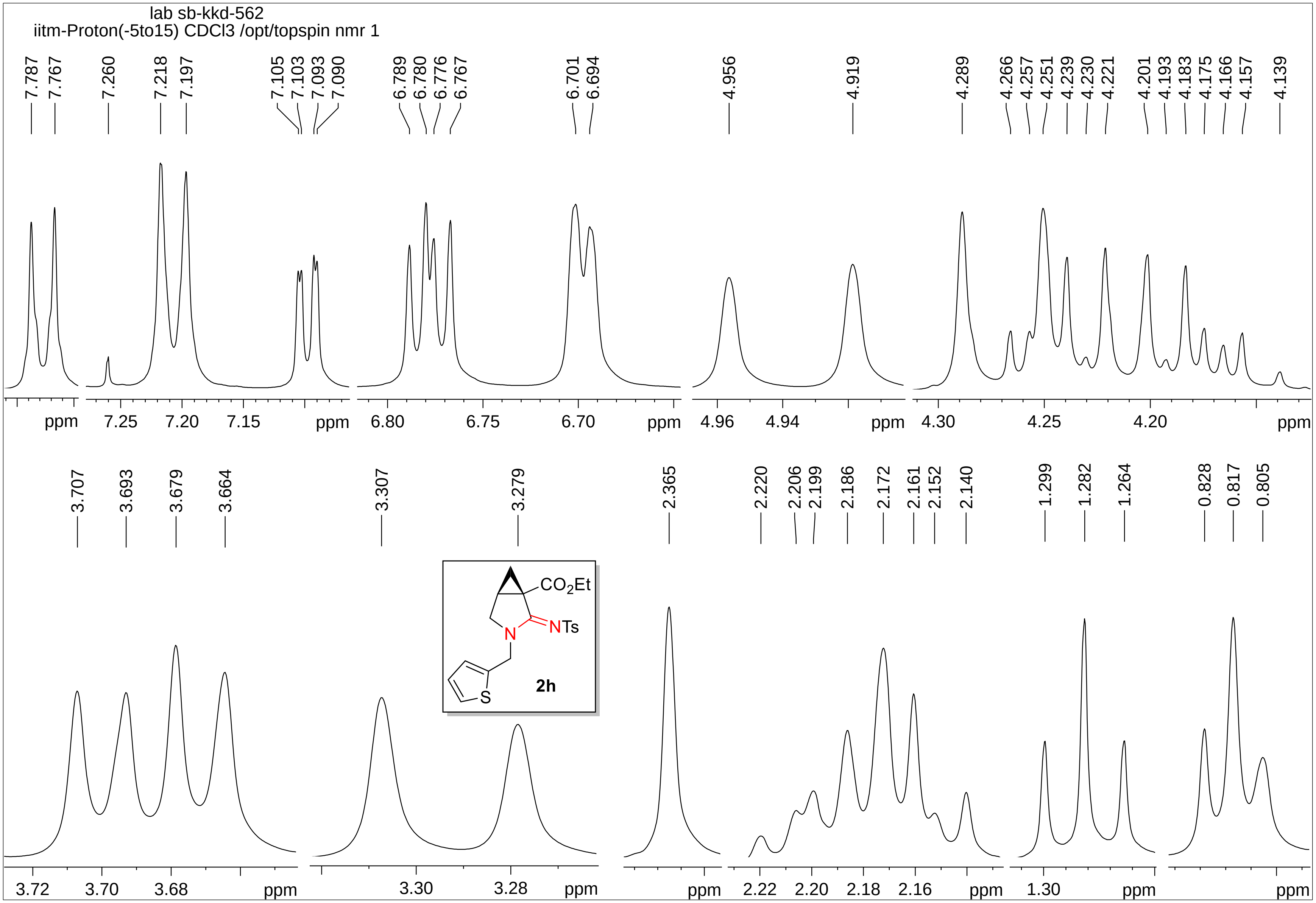
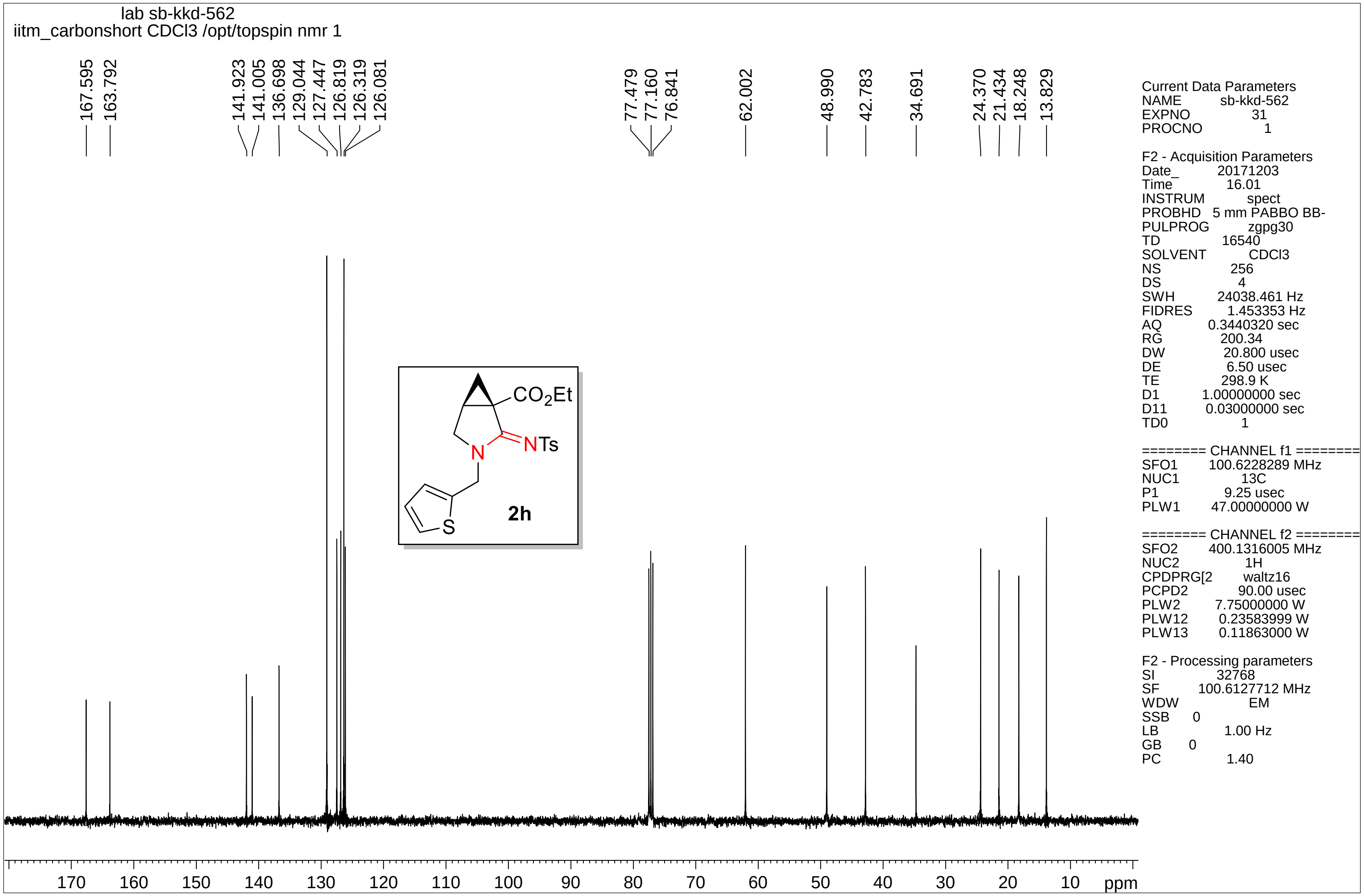


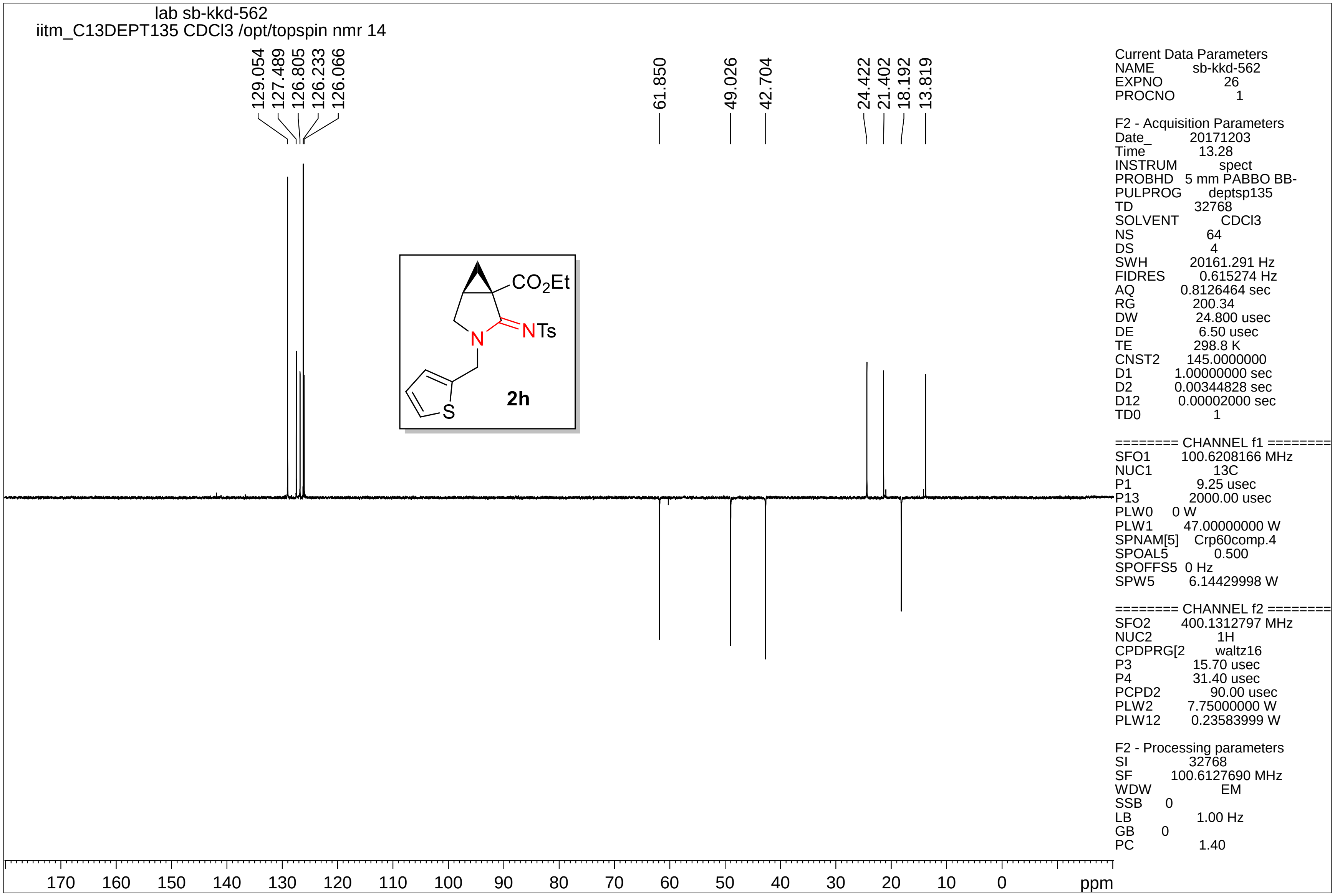
[1]H NMR spectrum of compound 2h



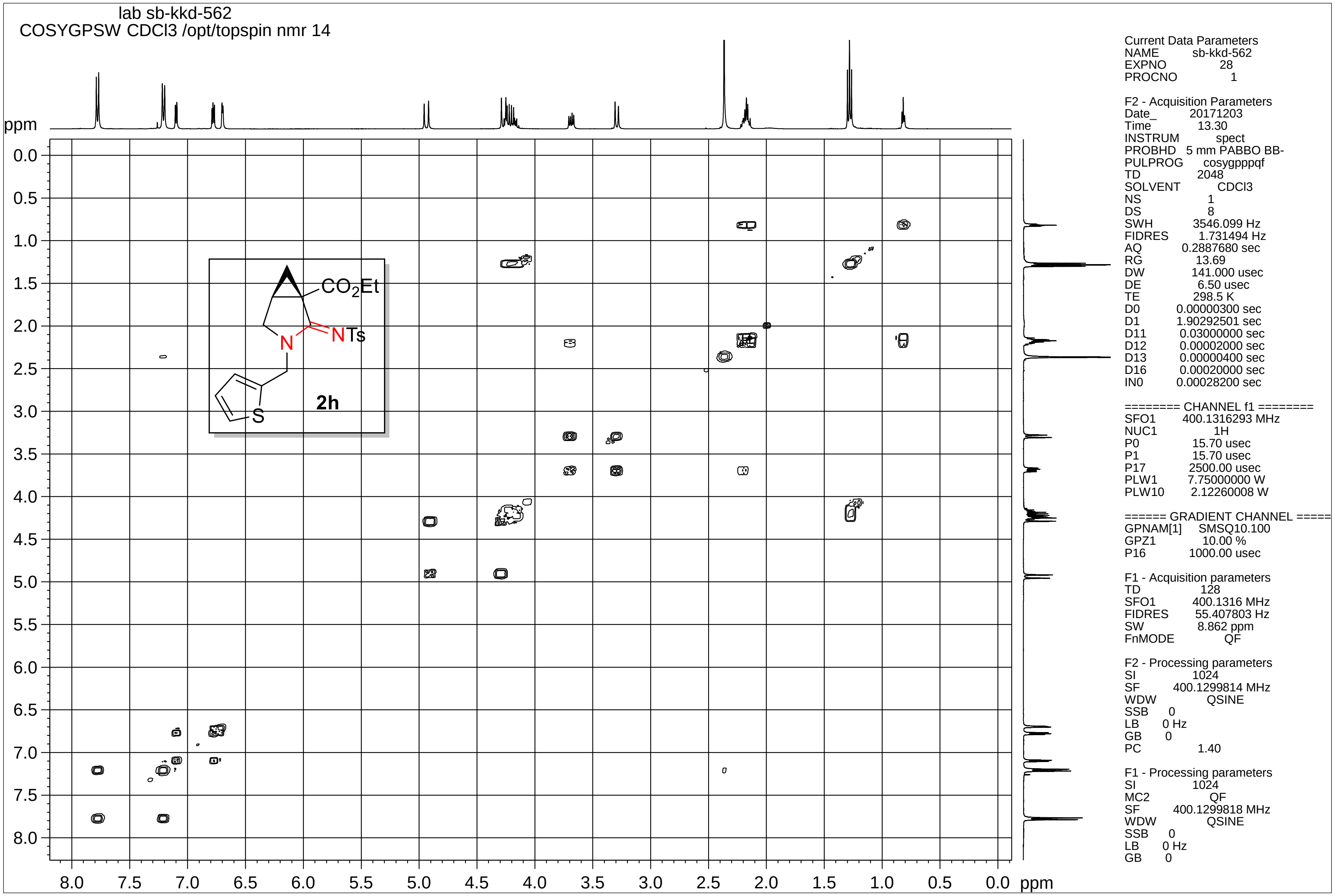
[1]H NMR spectrum of compound 2h



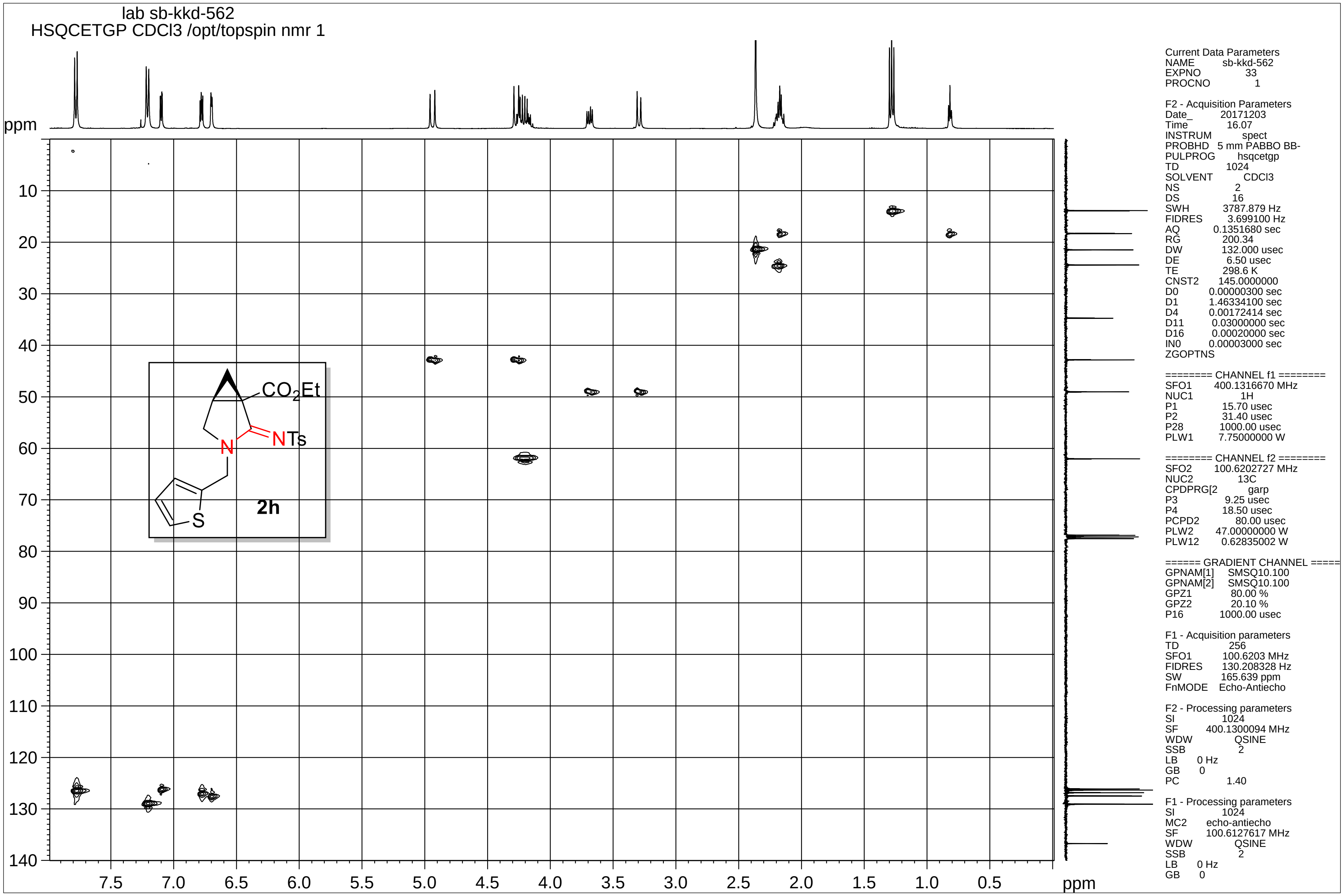
^{13}C NMR spectrum of compound 2h



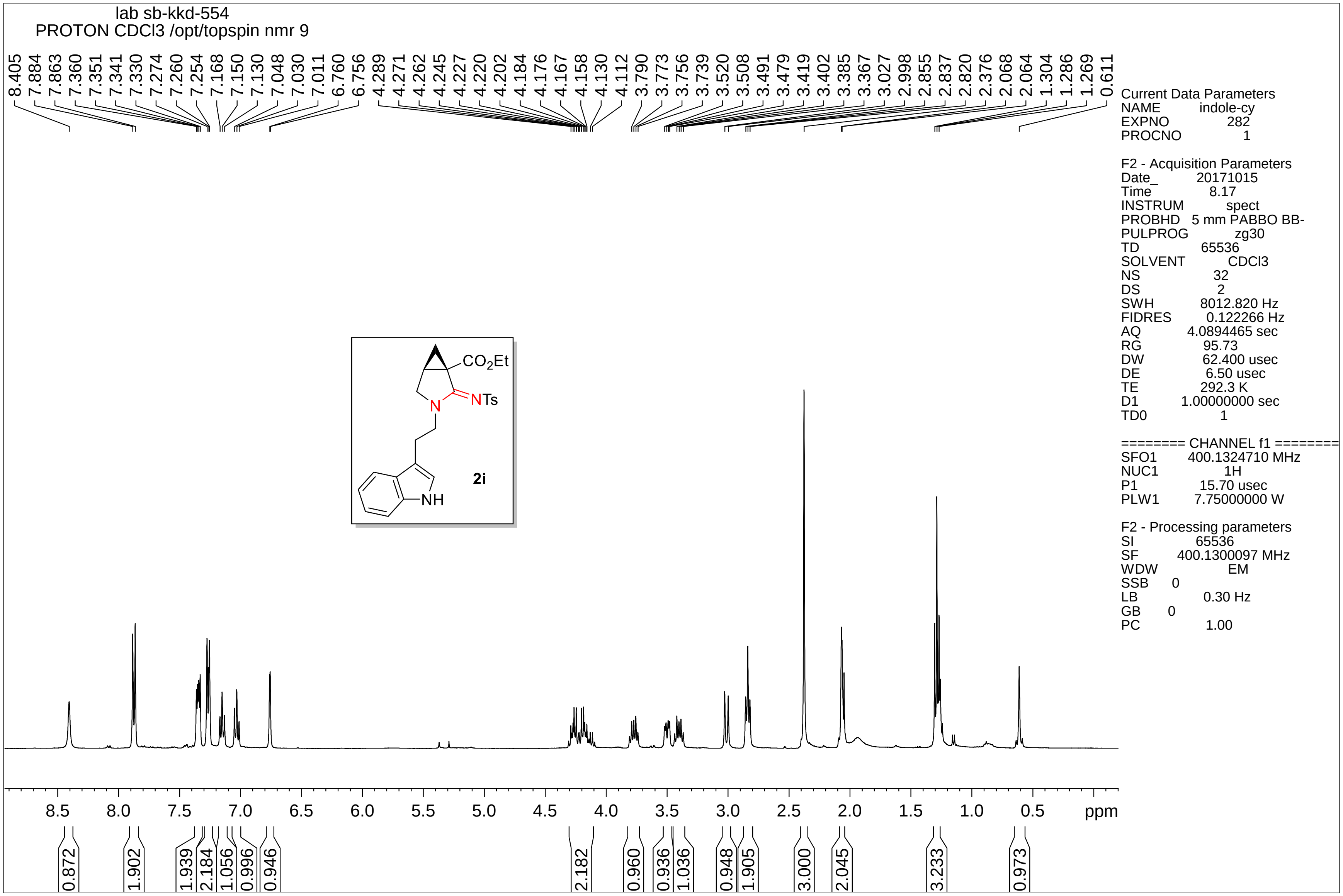
DEPT-135 NMR spectrum of compound 2h



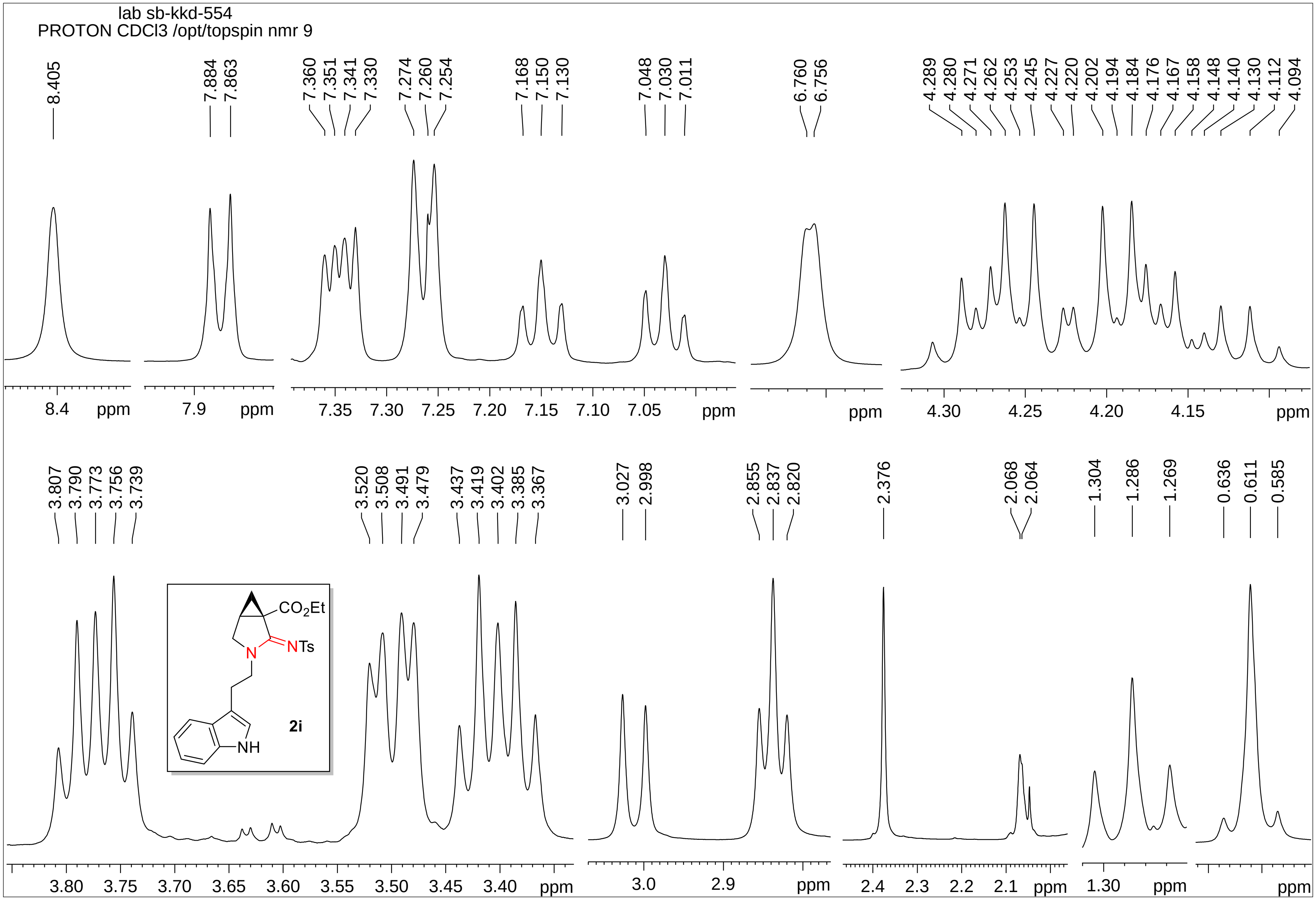
^{1}H-^{1}H COSY NMR spectrum of compound 2h



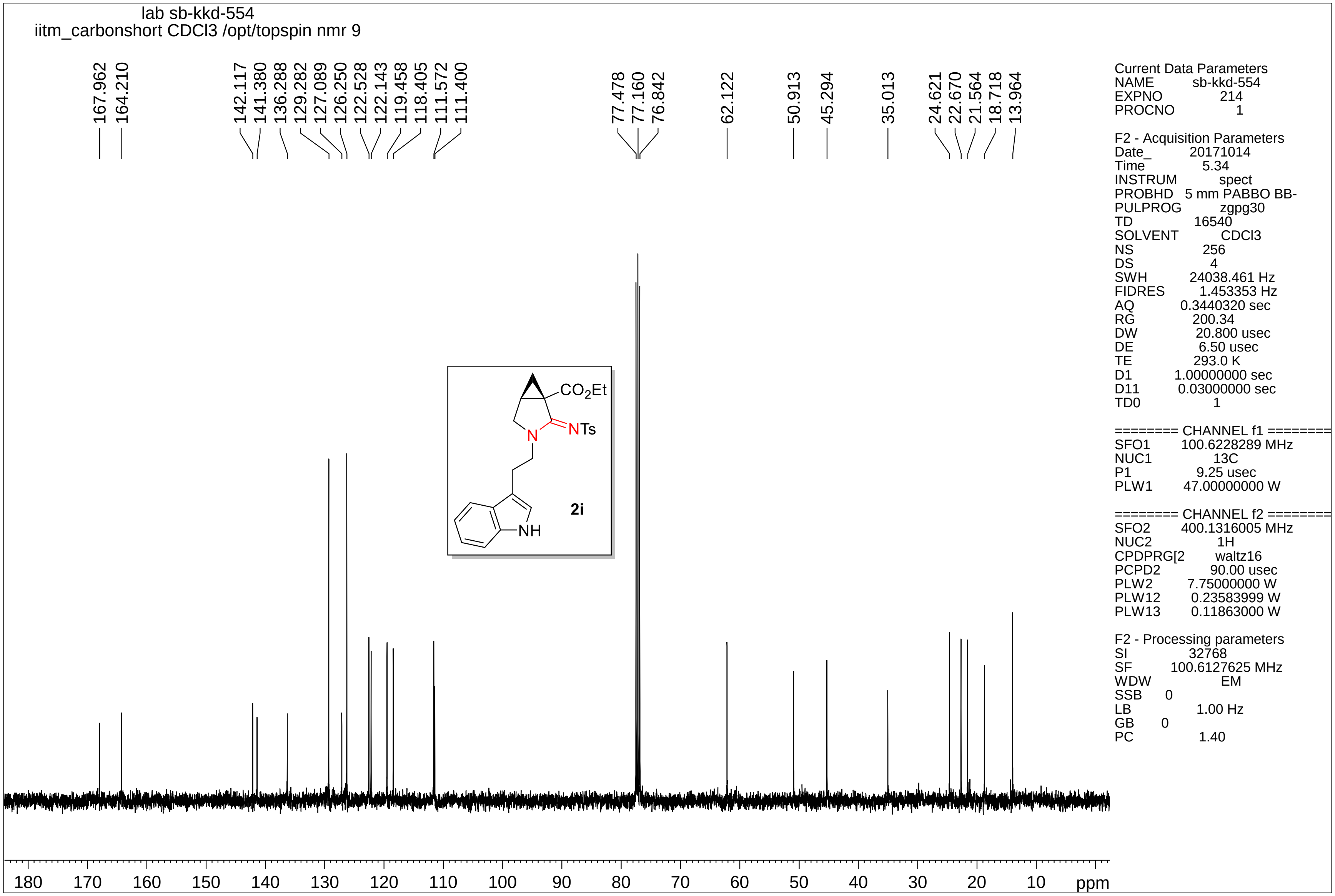
^{1}H-^{13}C HSQC NMR spectrum of compound 2h



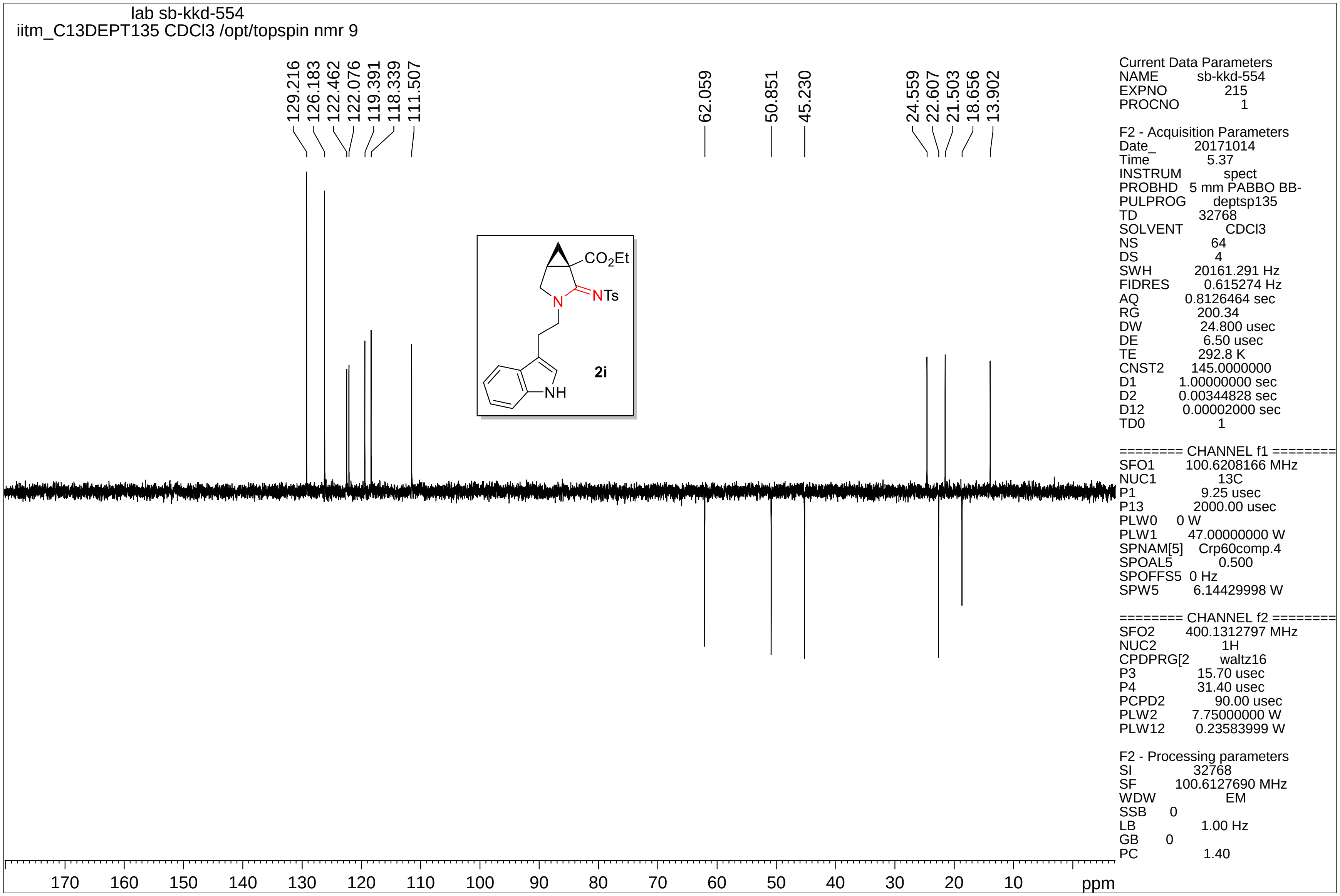
^{1}H NMR spectrum of compound 2i



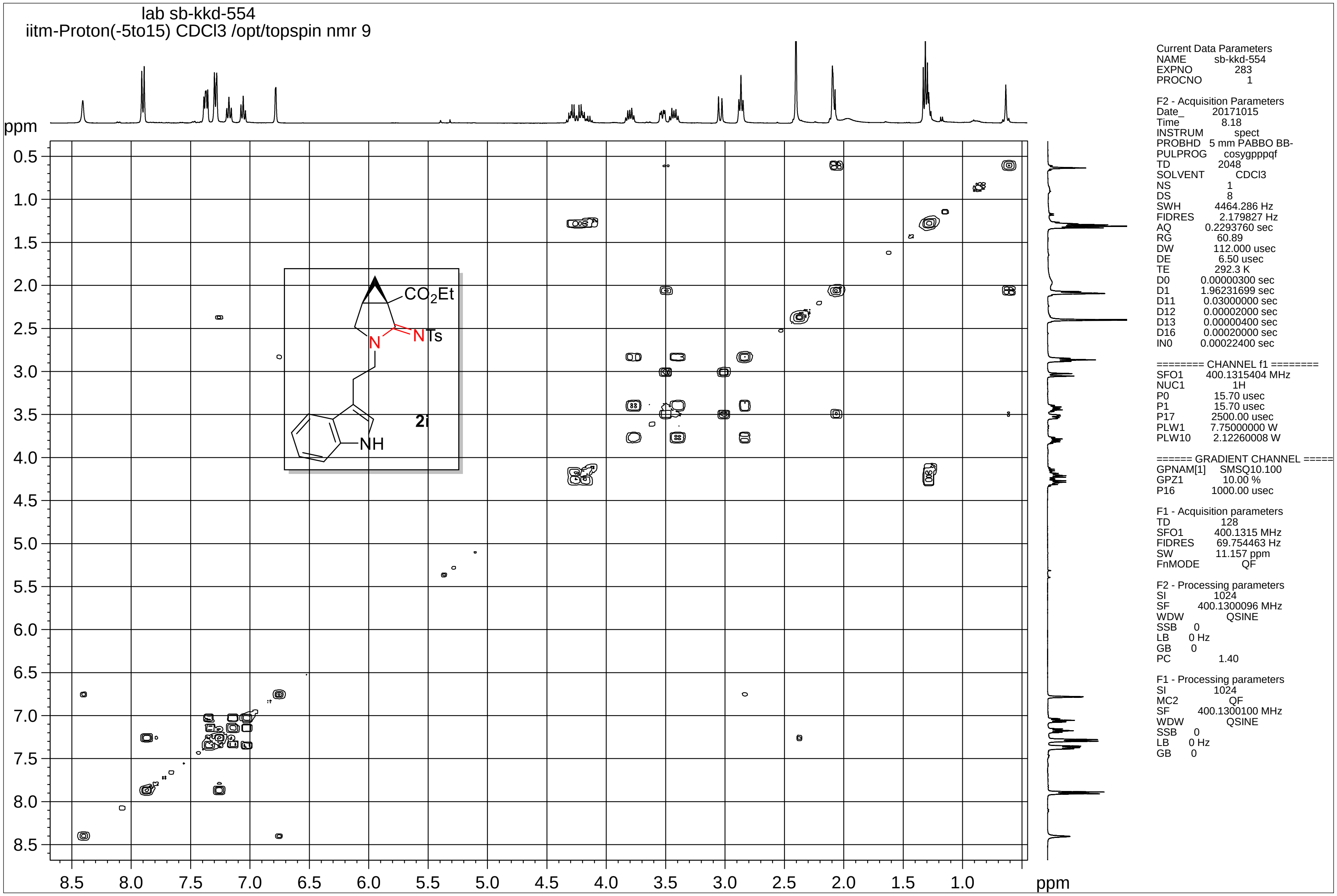
[1]H NMR spectrum of compound 2i



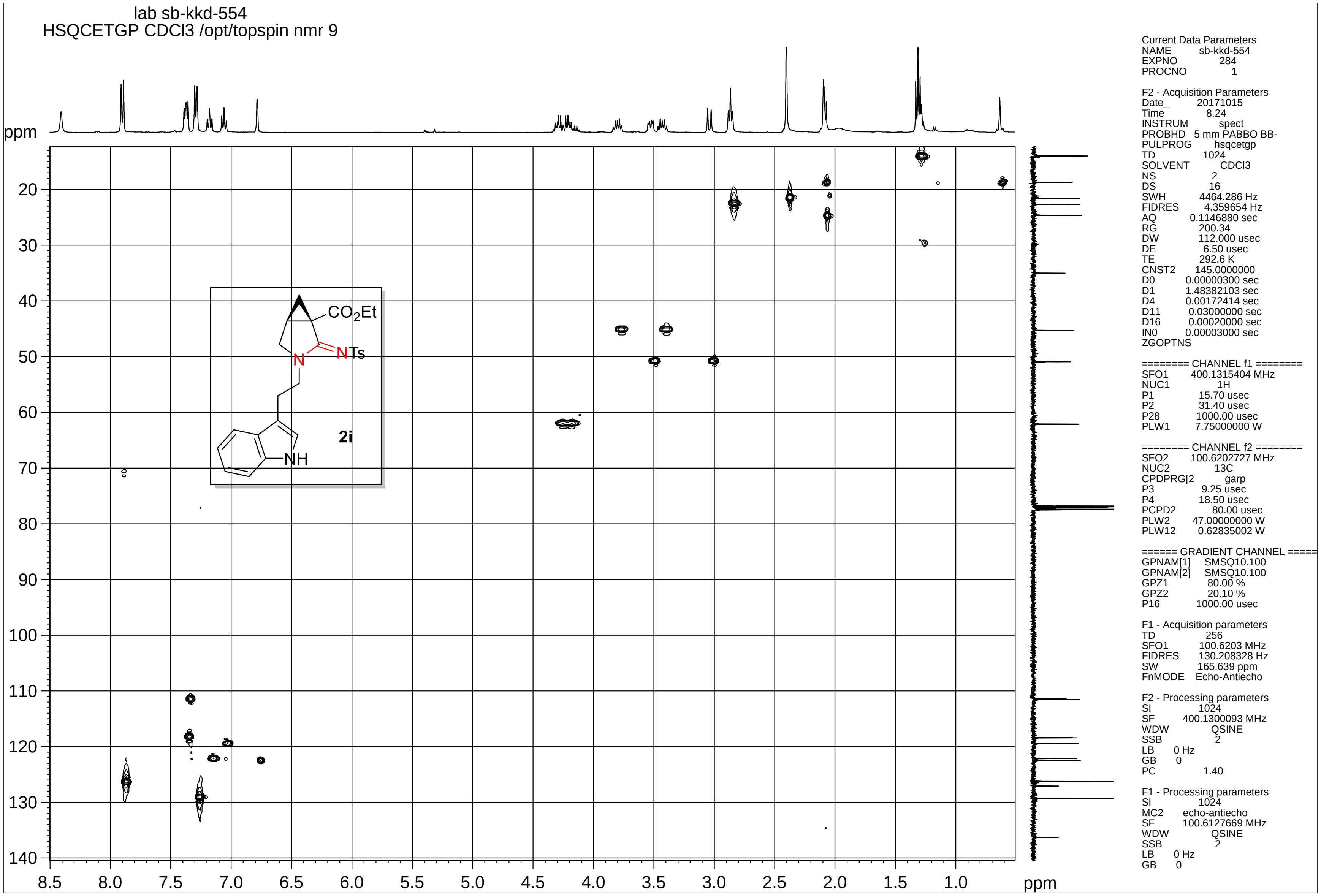
^{13}C NMR spectrum of compound 2i



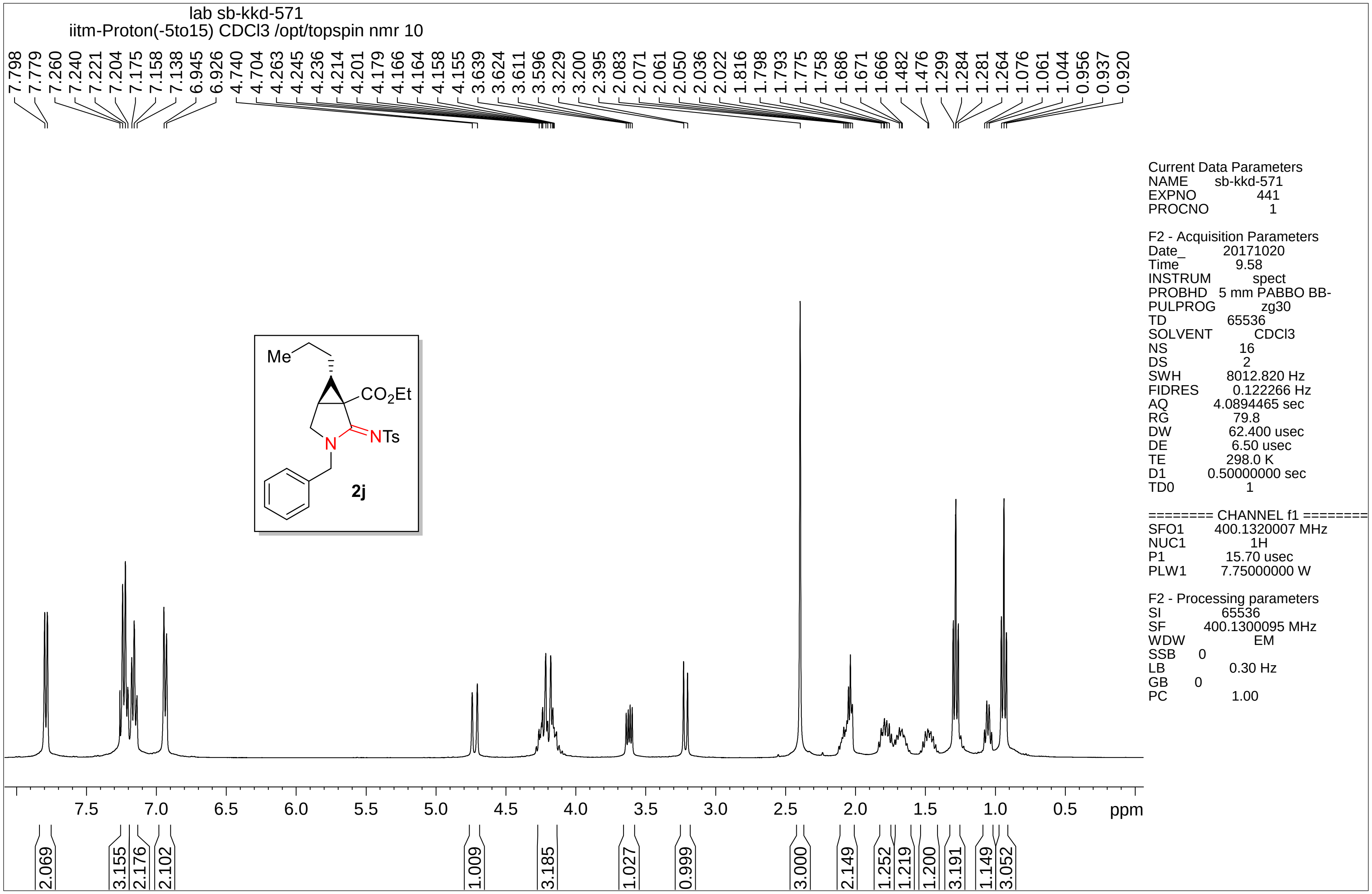
DEPT-135 NMR spectrum of compound 2i



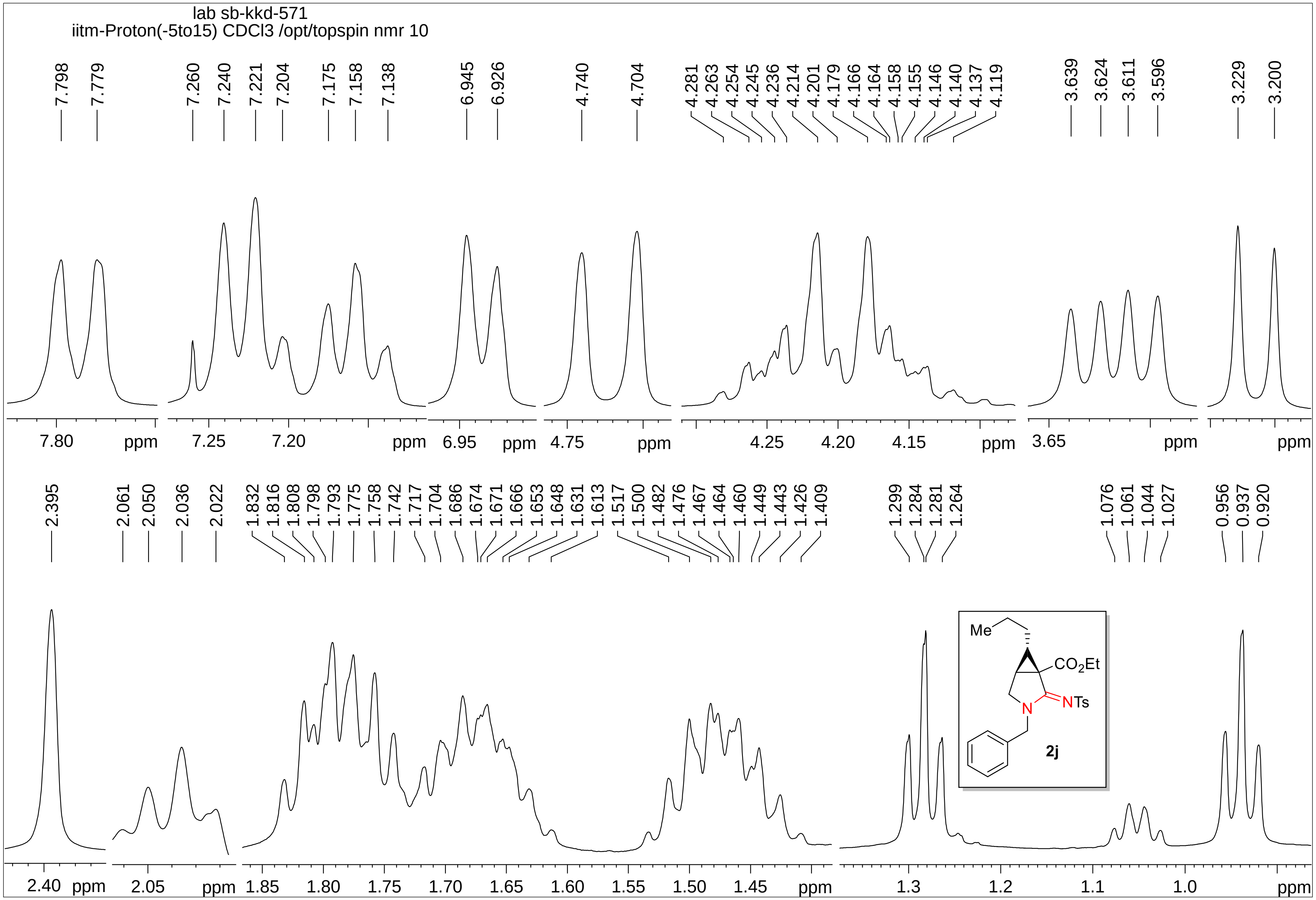
^{1}H-^{1}H COSY NMR spectrum of compound 2i



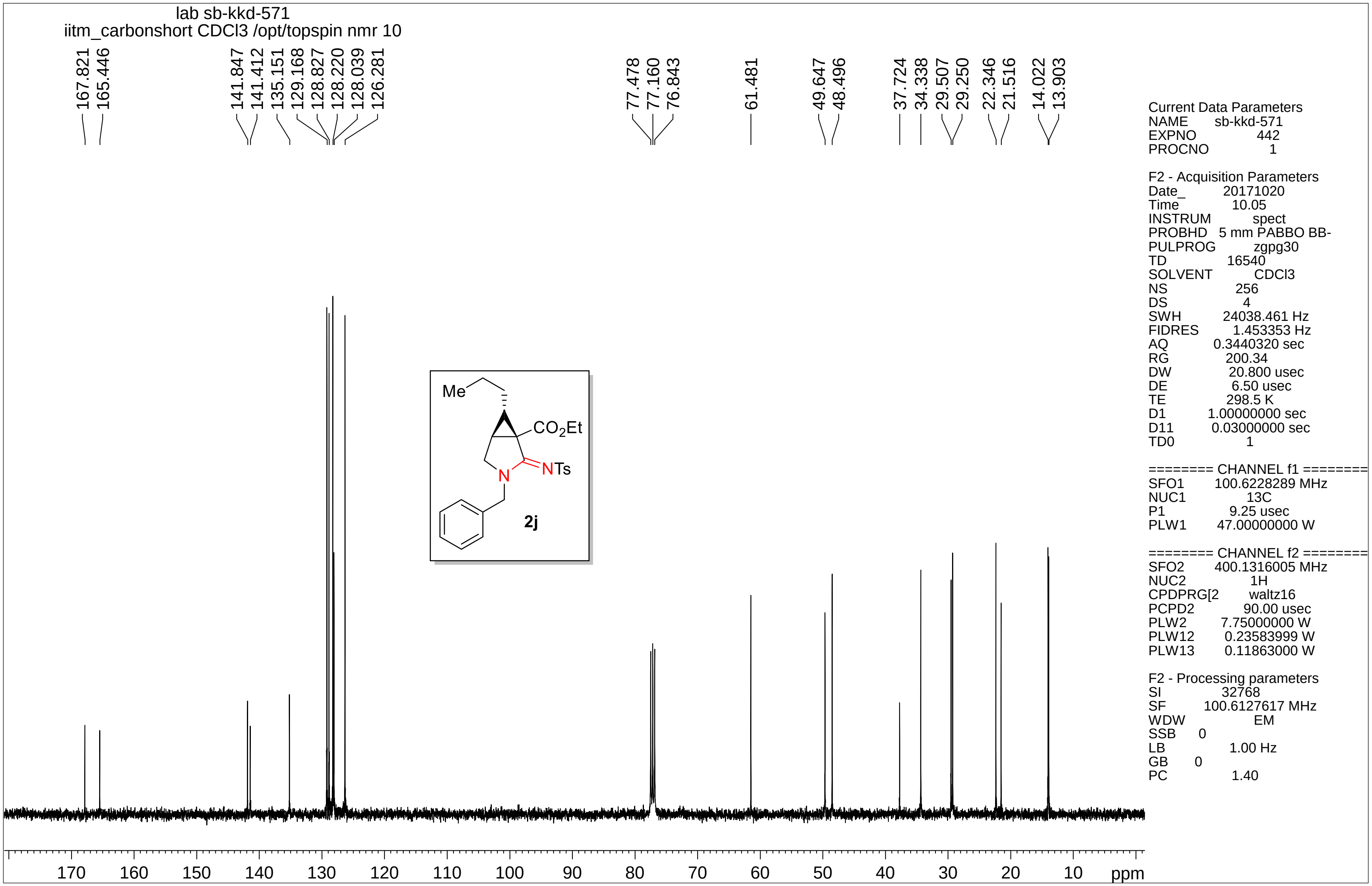
^{1}H-^{13}C HSQC NMR spectrum of compound 2i



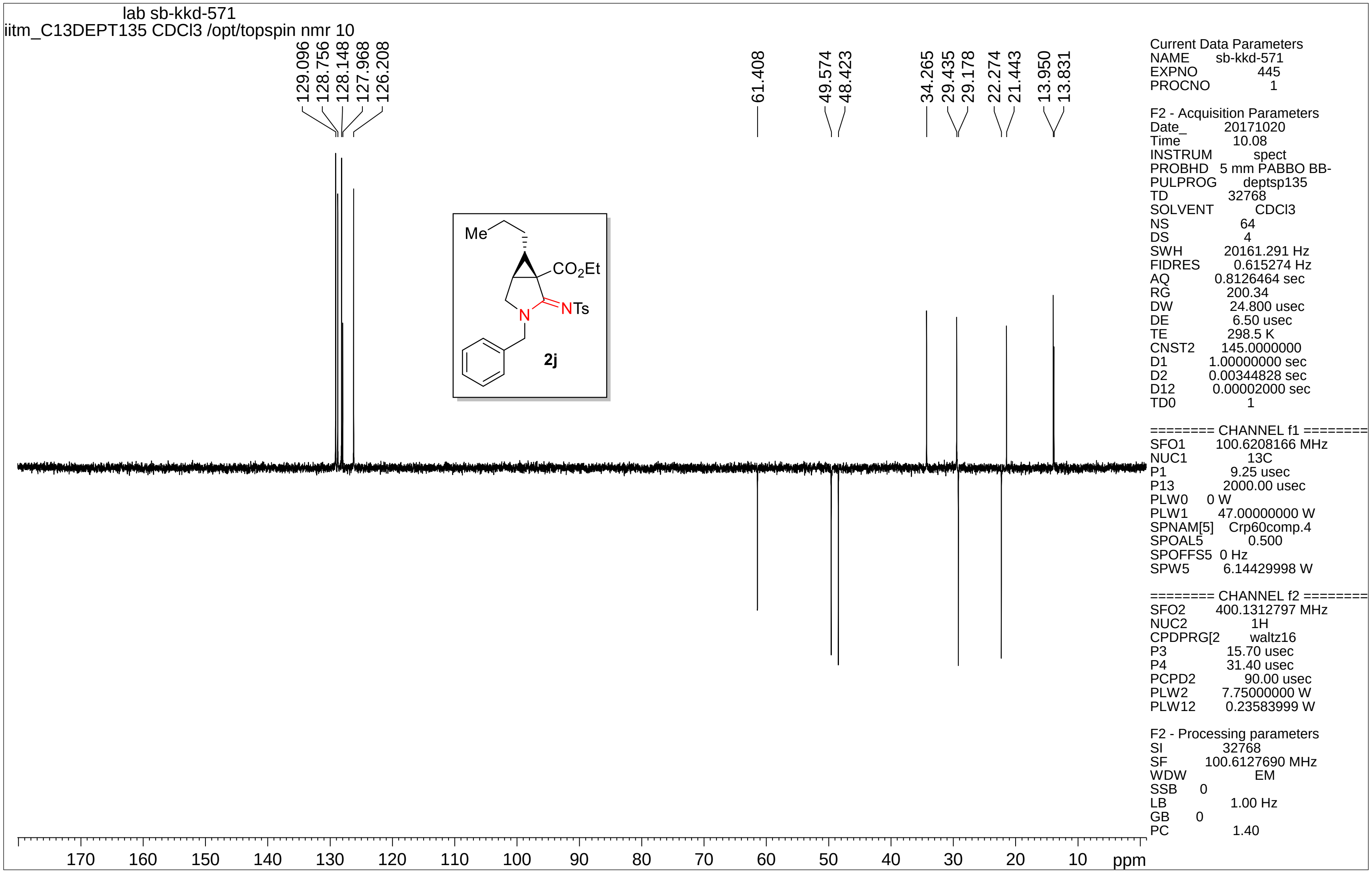
^{1}H NMR spectrum of compound 2j



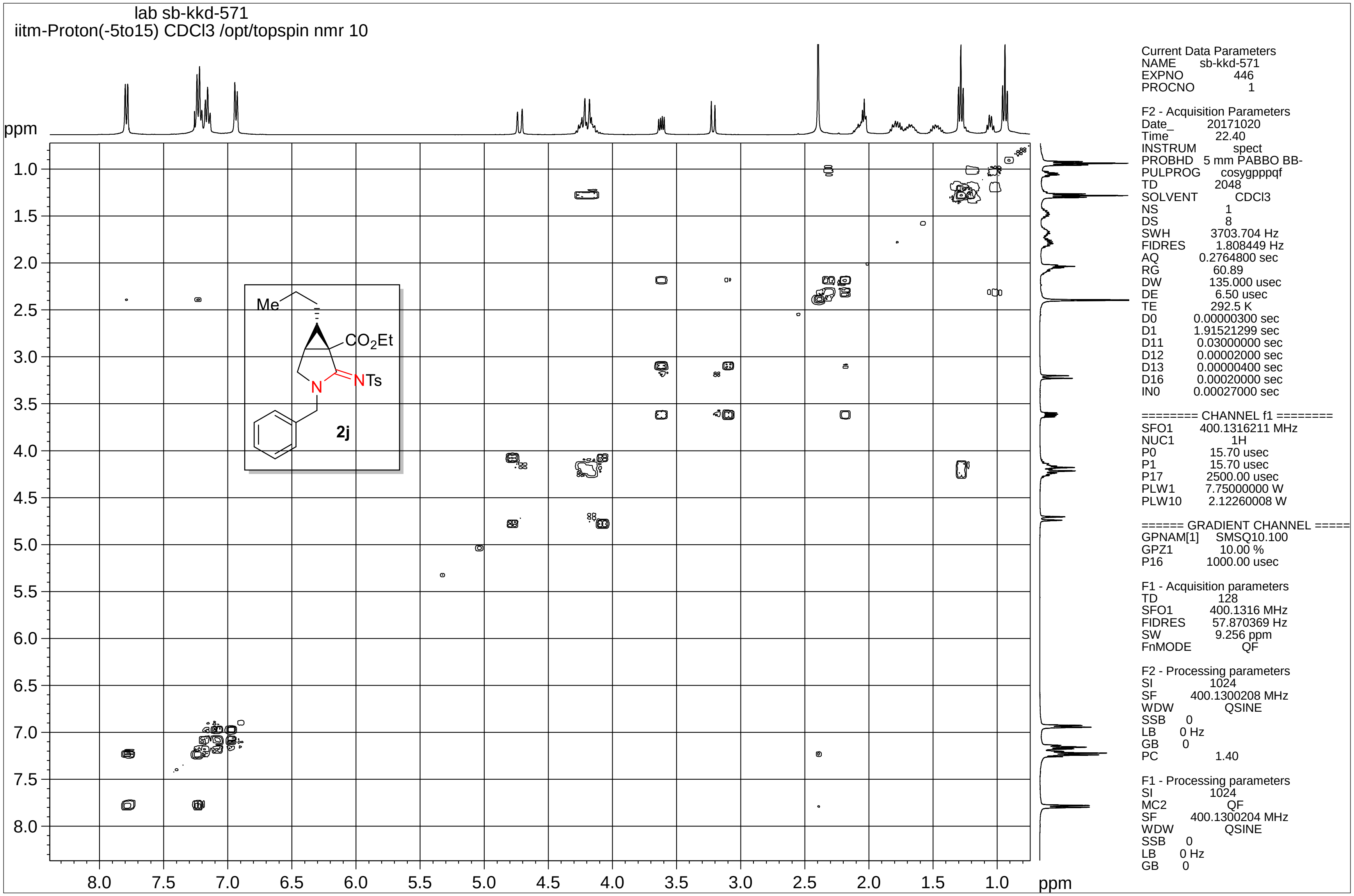
^{1}H NMR spectrum of compound 2j



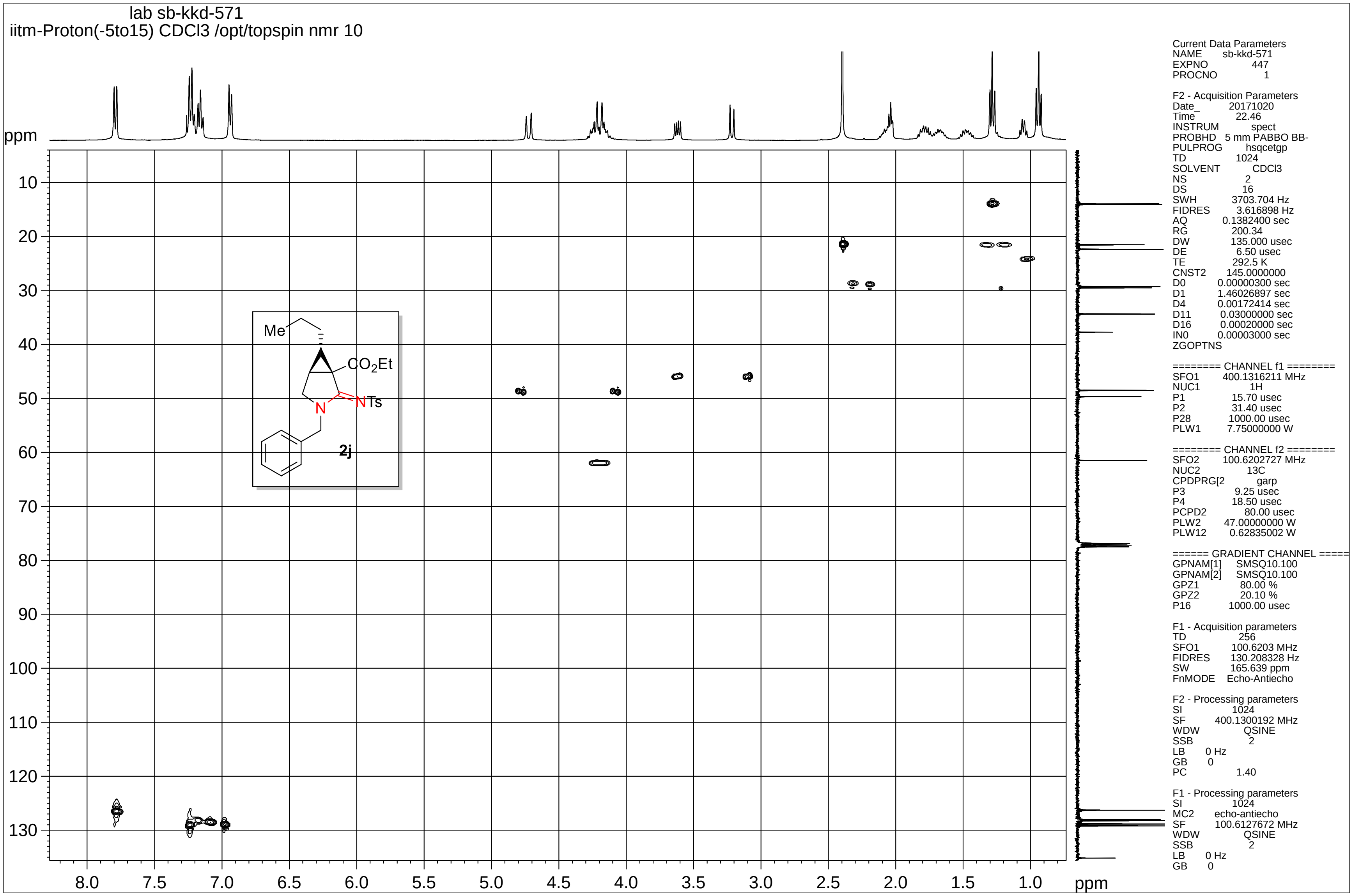
^{13}C NMR spectrum of compound 2j



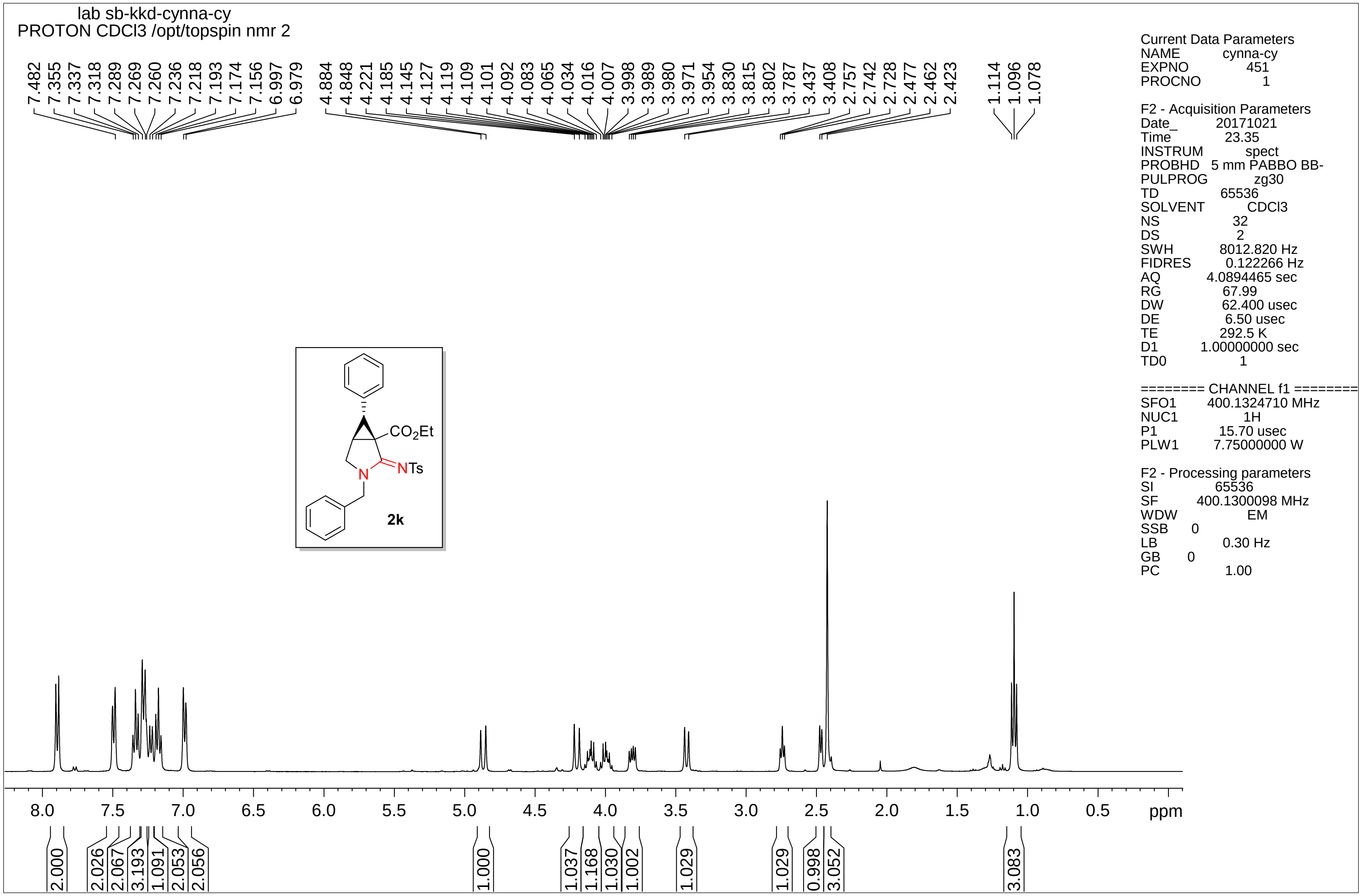
DEPT-135 NMR spectrum of compound 2j



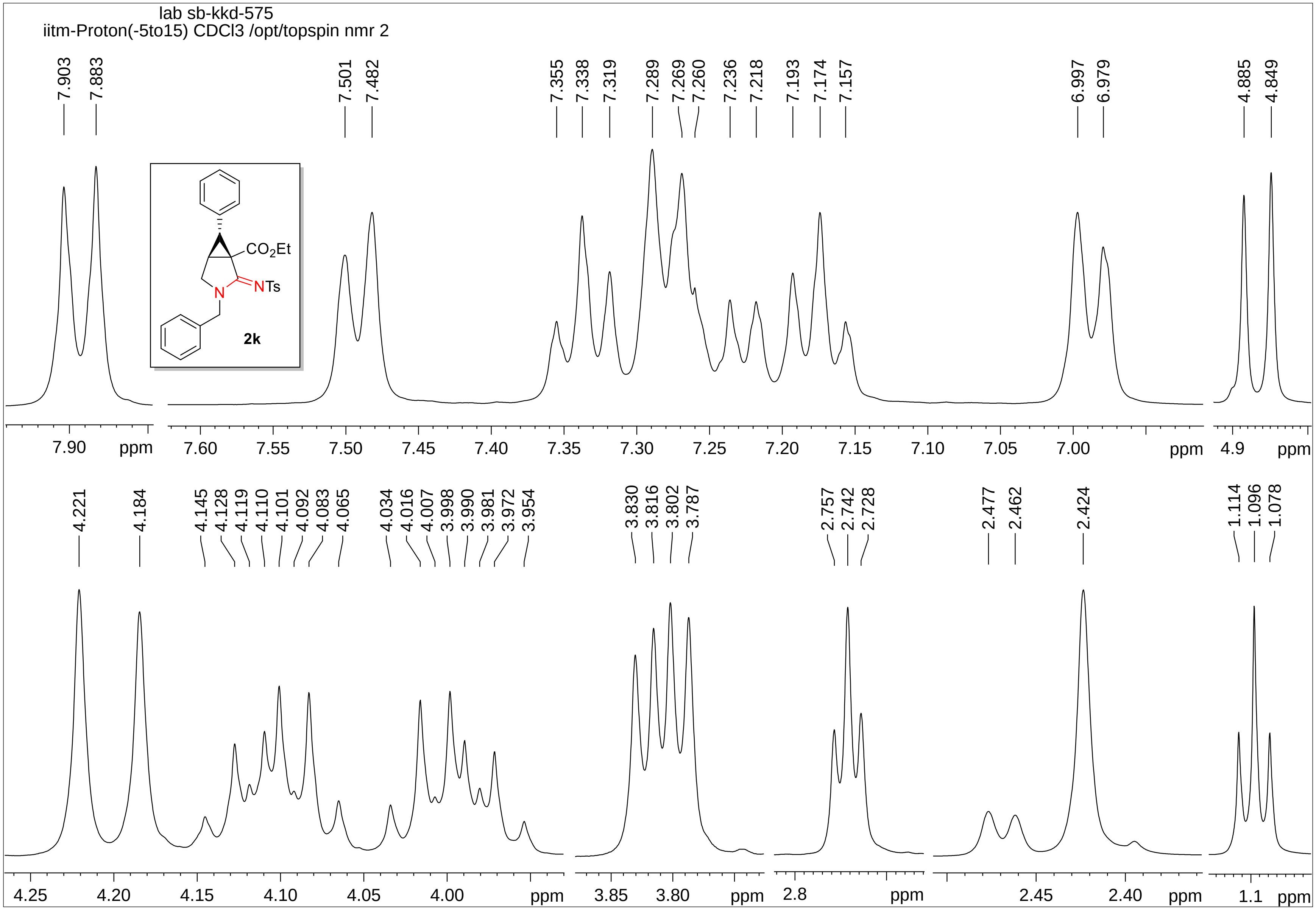
^{1}H-^{1}H COSY NMR spectrum of compound 2j



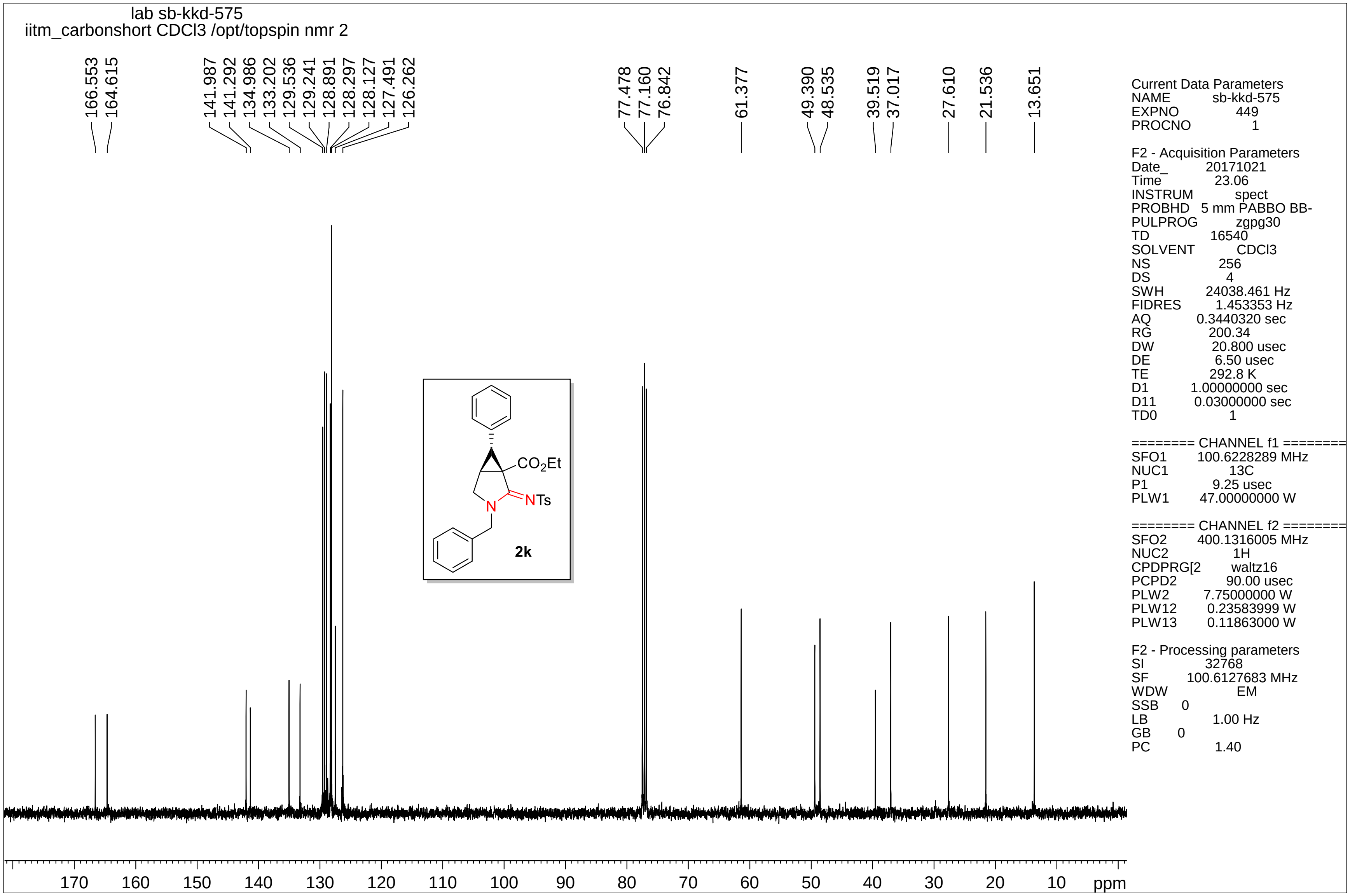
^{1}H-^{13}C HSQC NMR spectrum of compound 2j



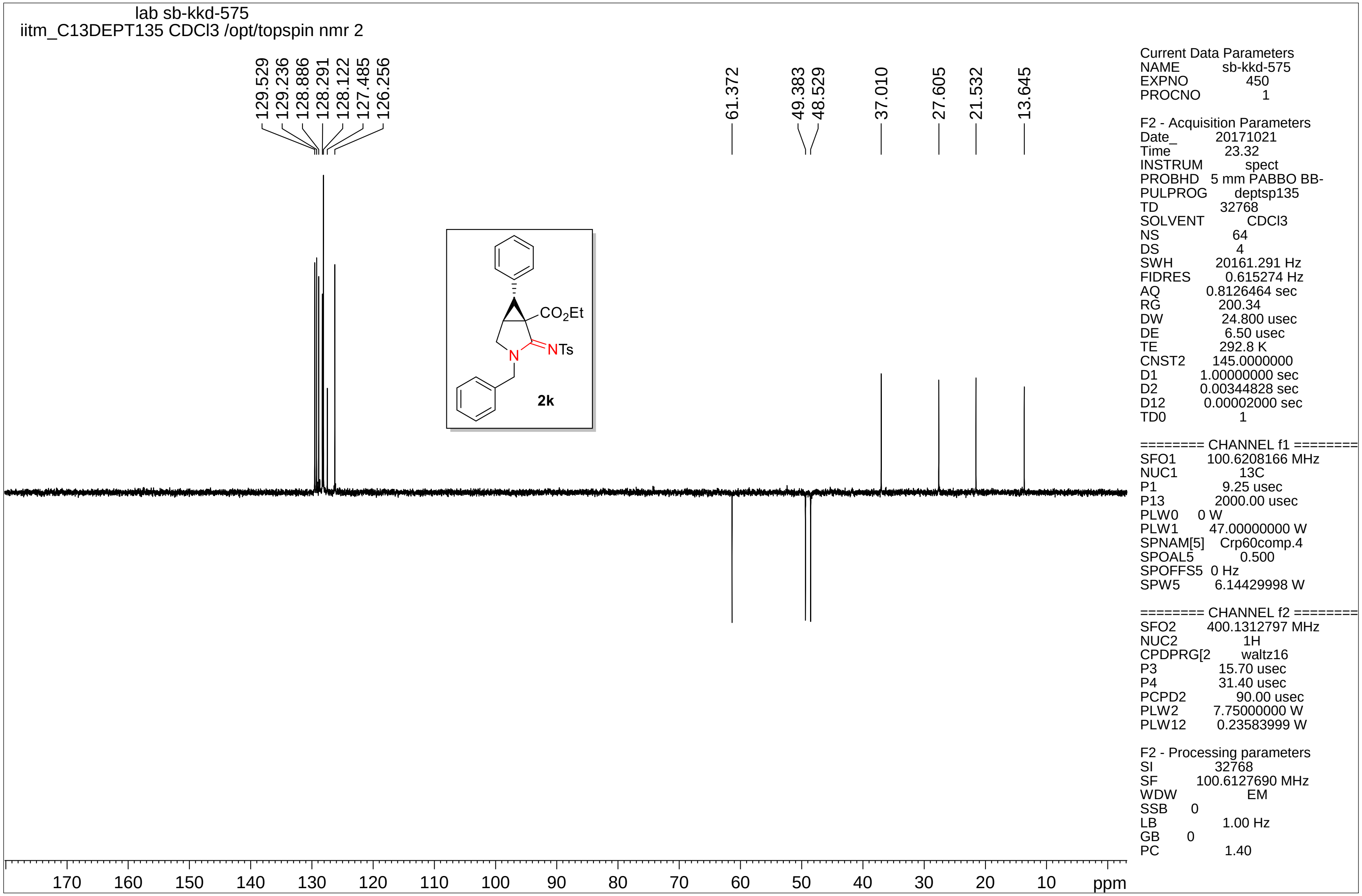
^{1}H NMR spectrum of compound 2k



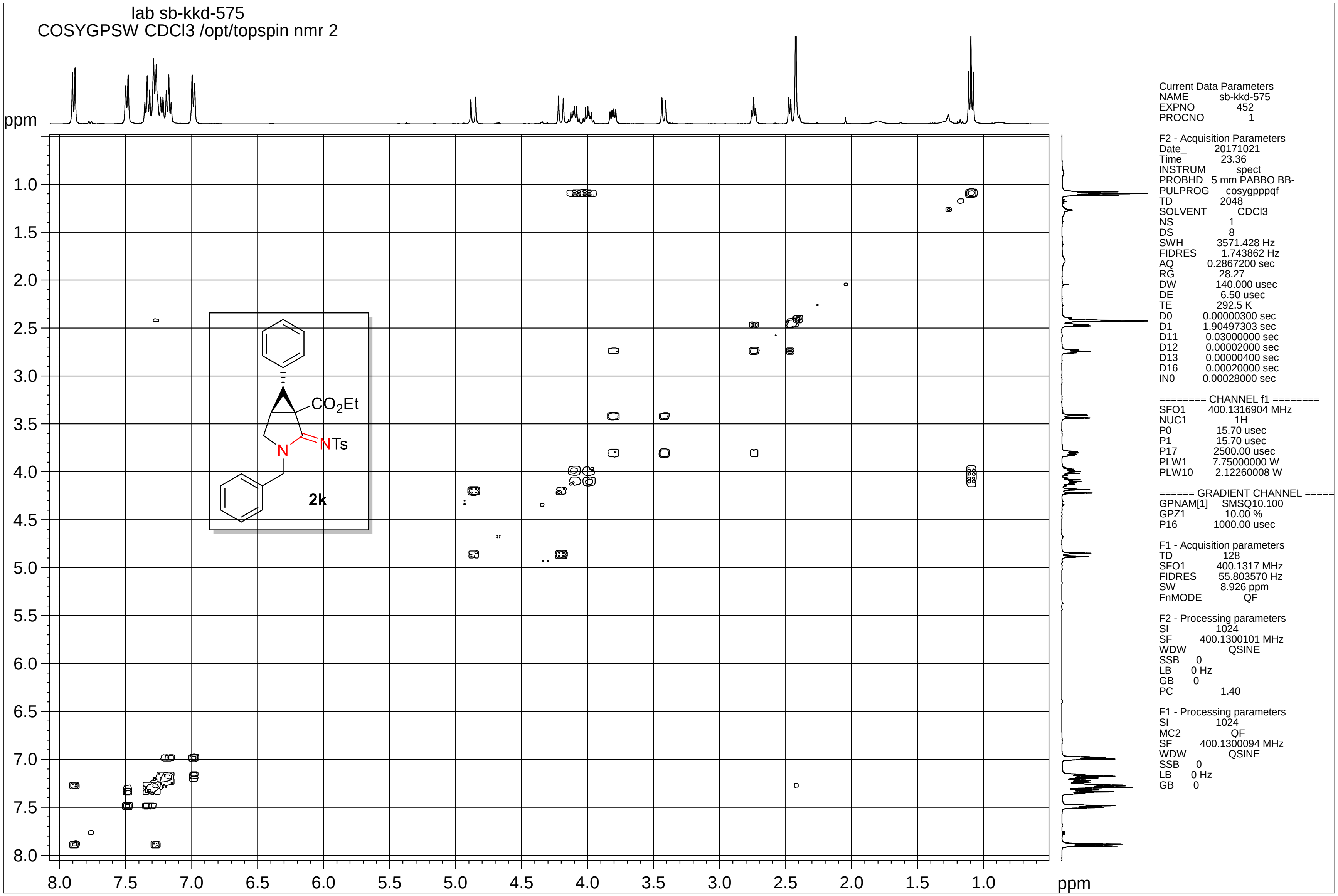
^{1}H NMR spectrum of compound 2k



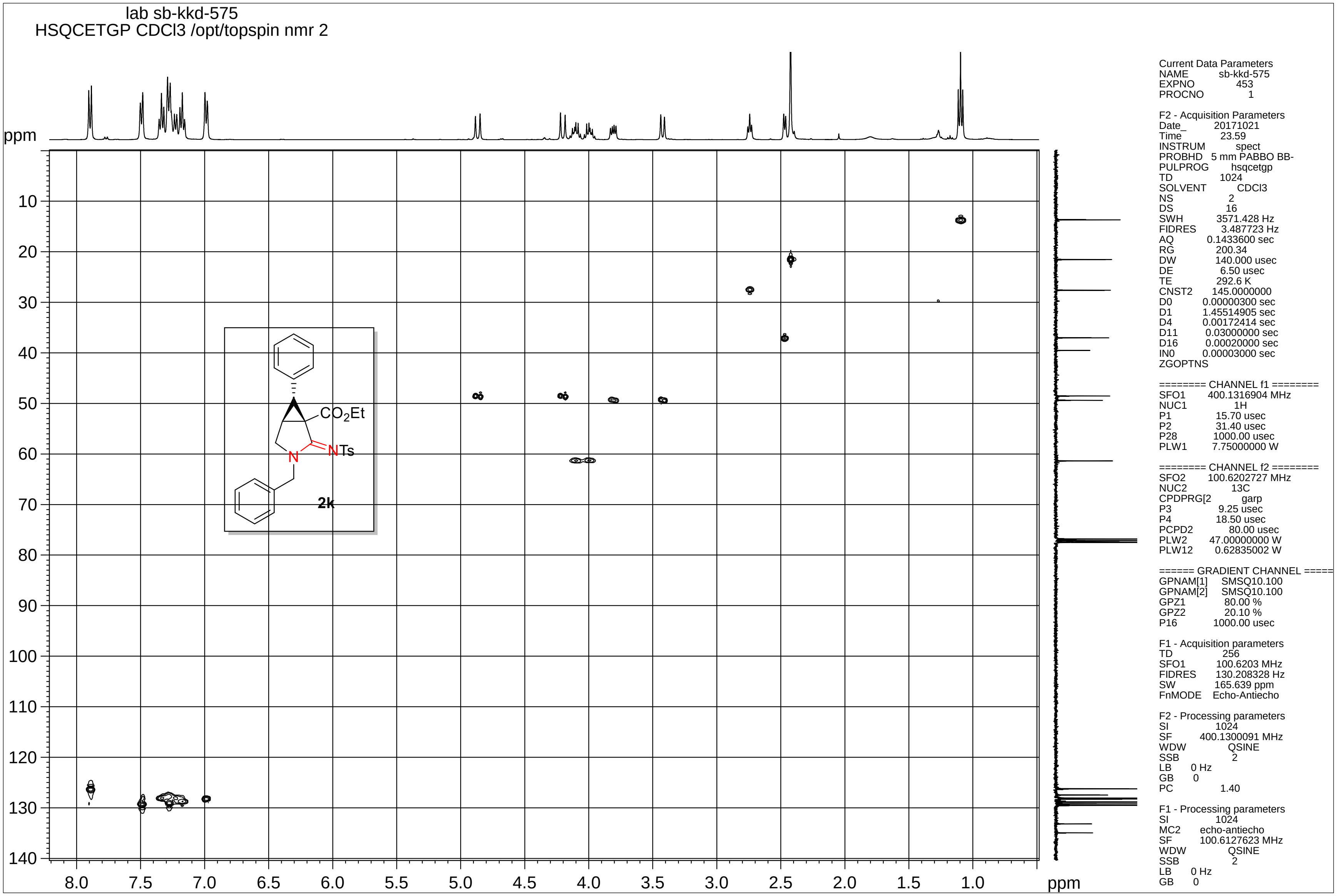
^{13}C NMR spectrum of compound 2k



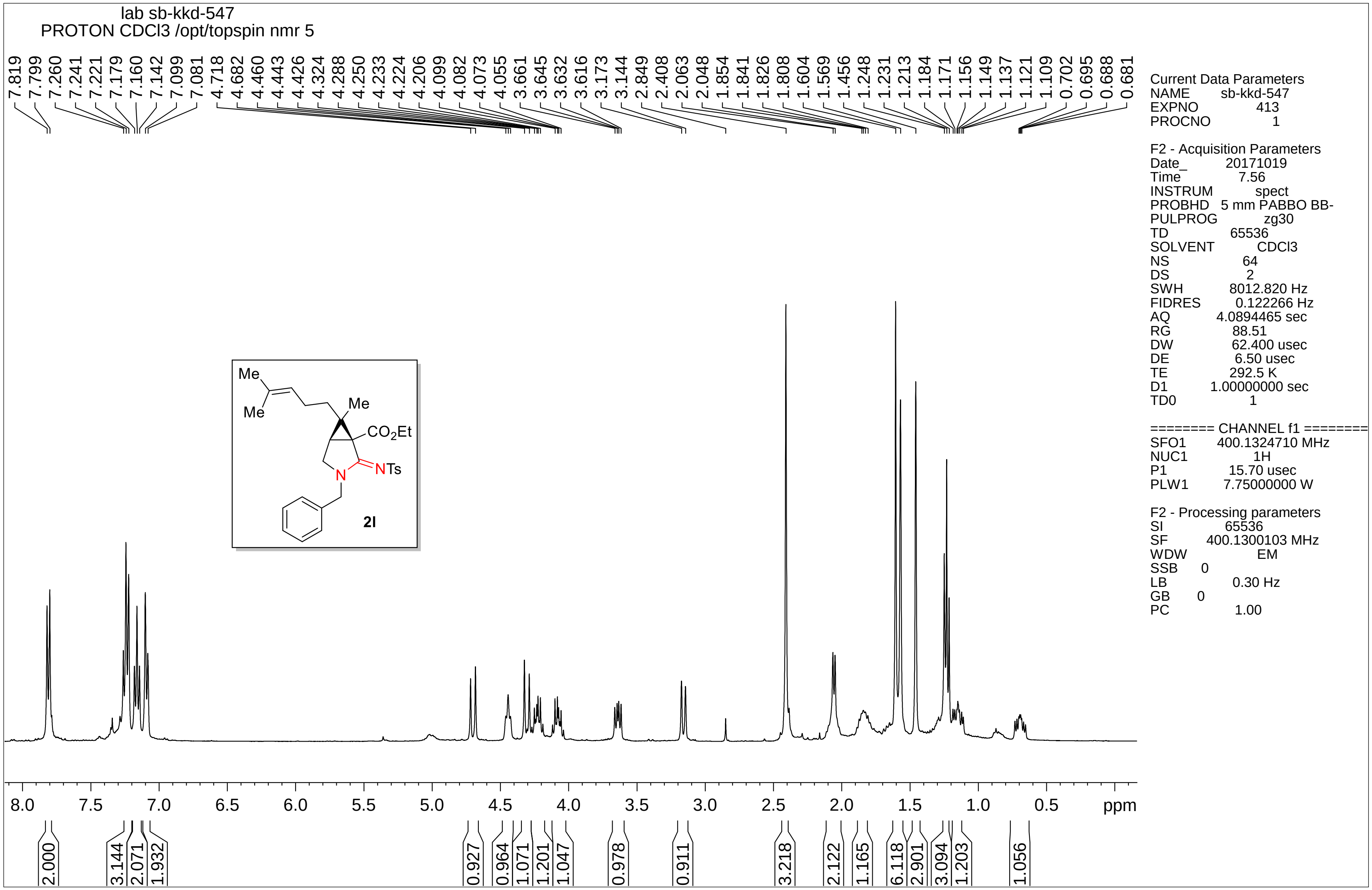
DEPT-135 NMR spectrum of compound 2k



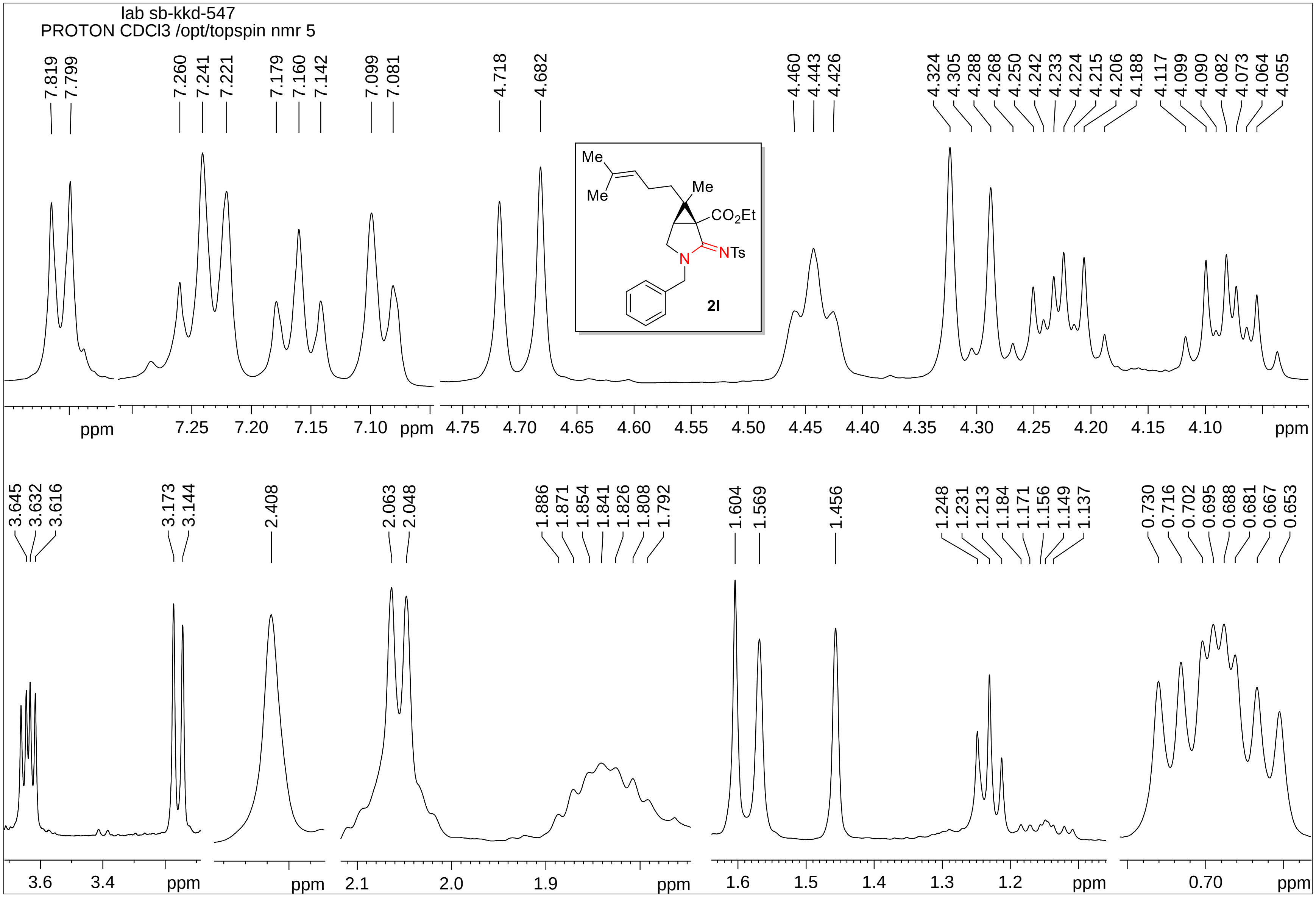
^1H-^1H COSY NMR spectrum of compound 2k



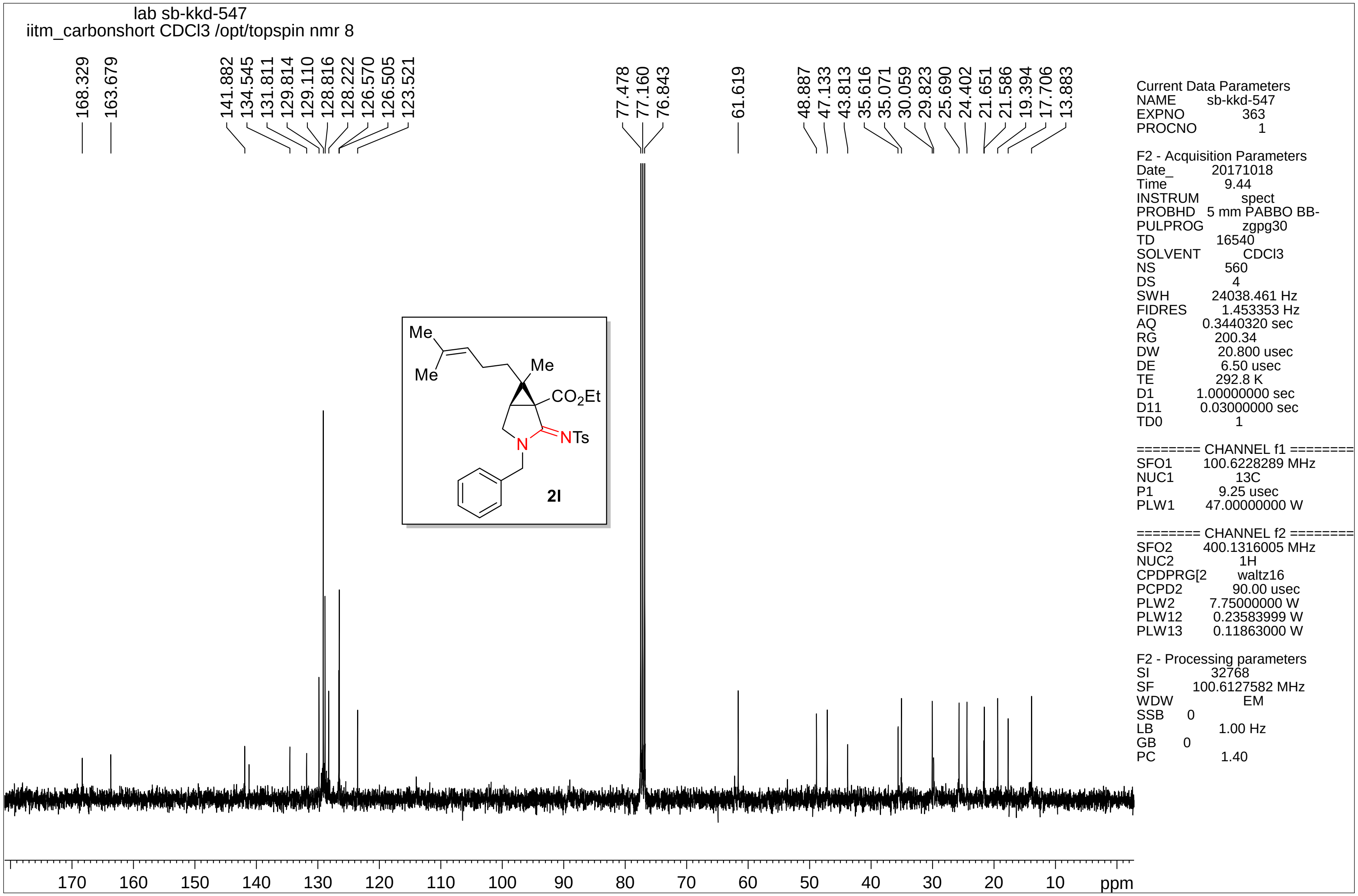
^{1}H-^{13}C HSQC NMR spectrum of compound 2k



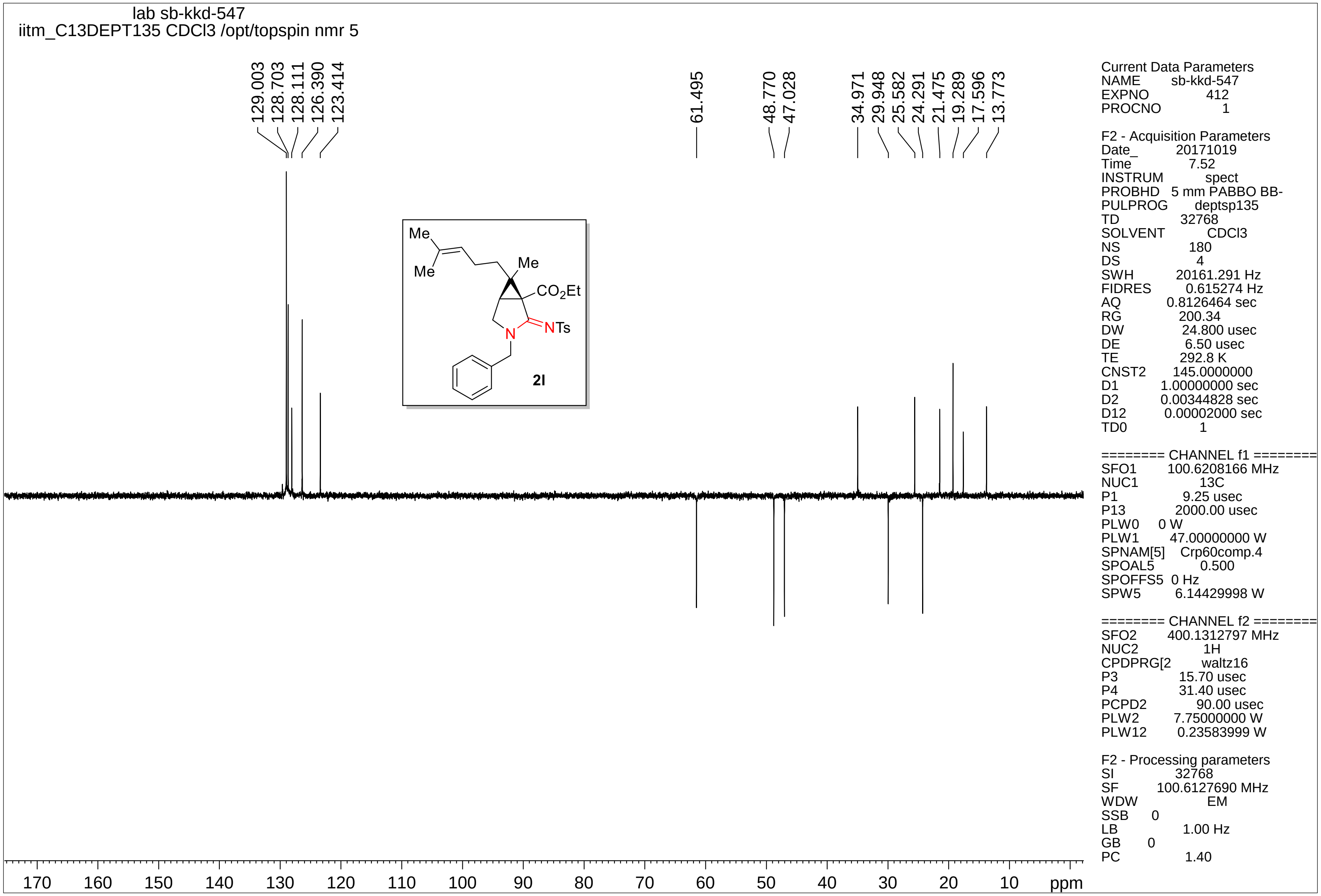
^{1}H NMR spectrum of compound 2l



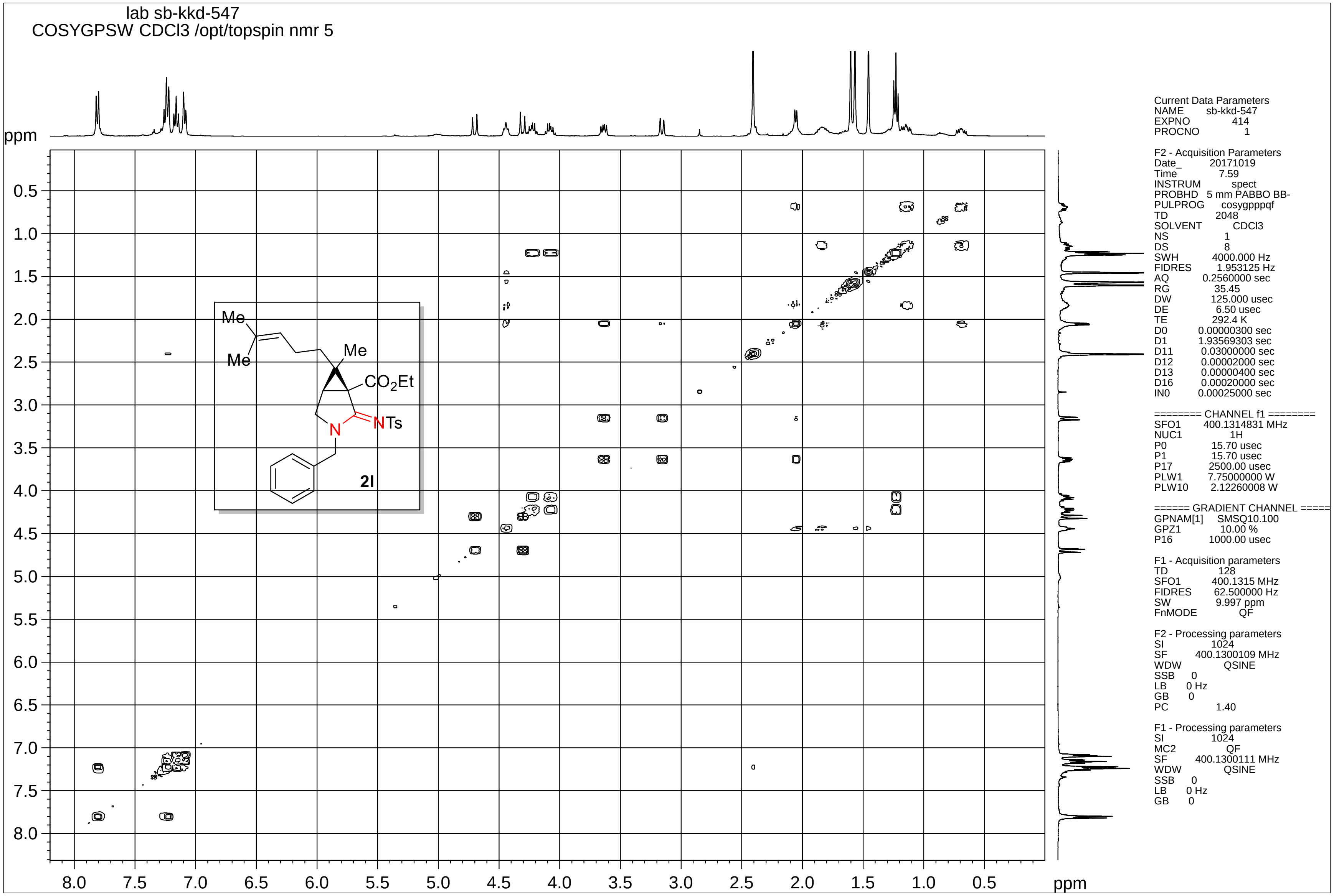
^{1}H NMR spectrum of compound 2l



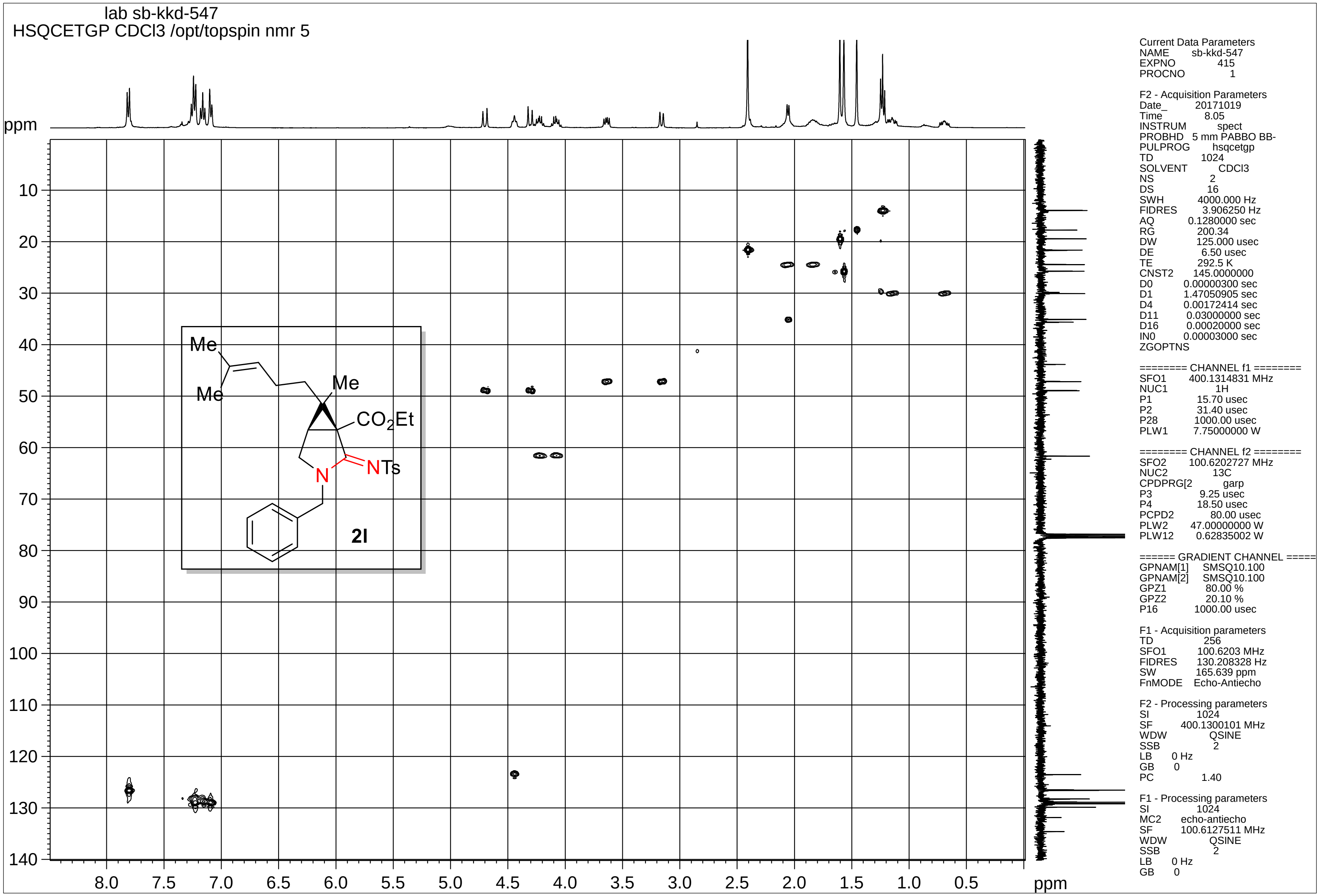
^{13}C NMR spectrum of compound 2l



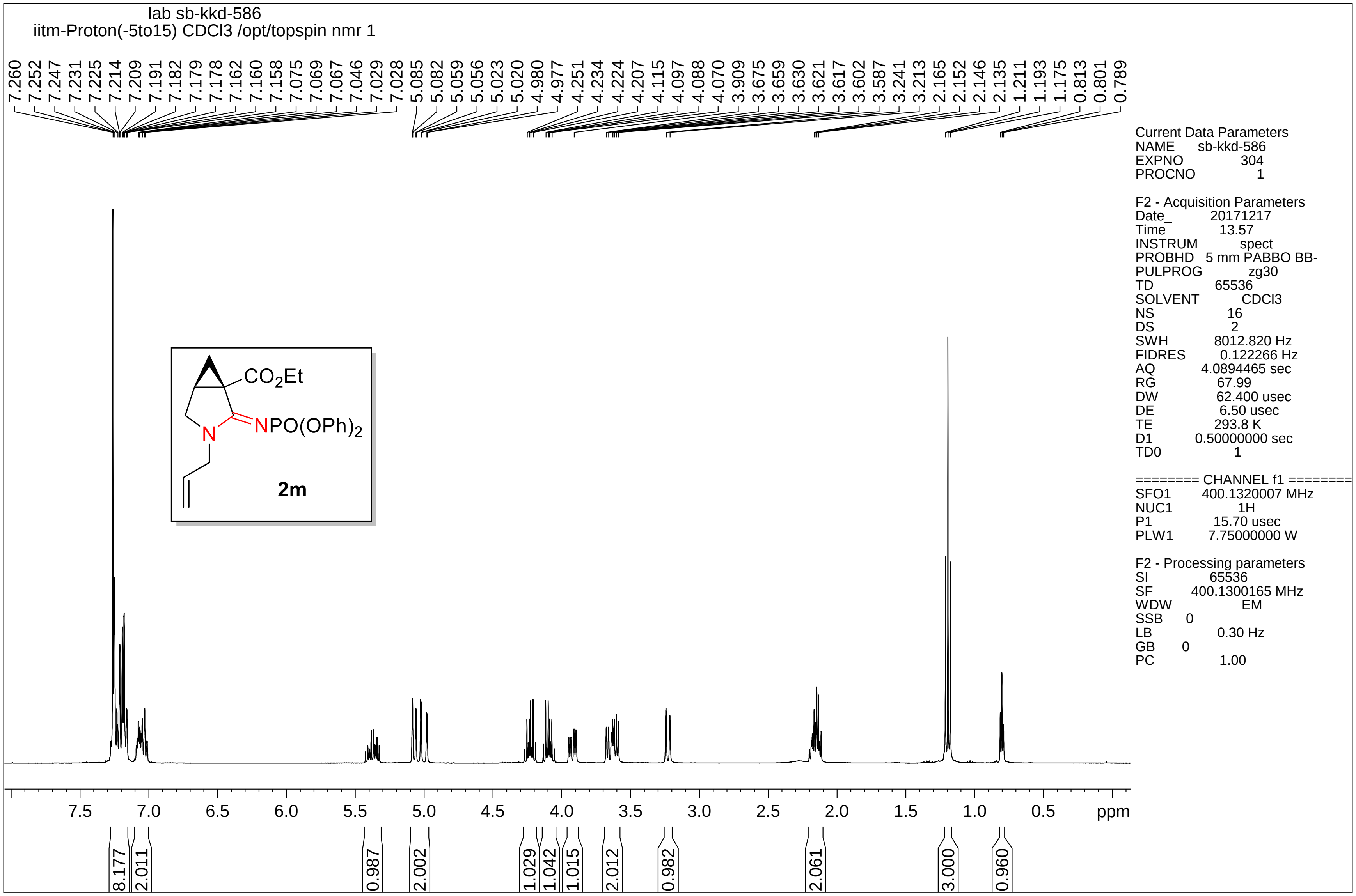
DEPT-135 NMR spectrum of compound 2l



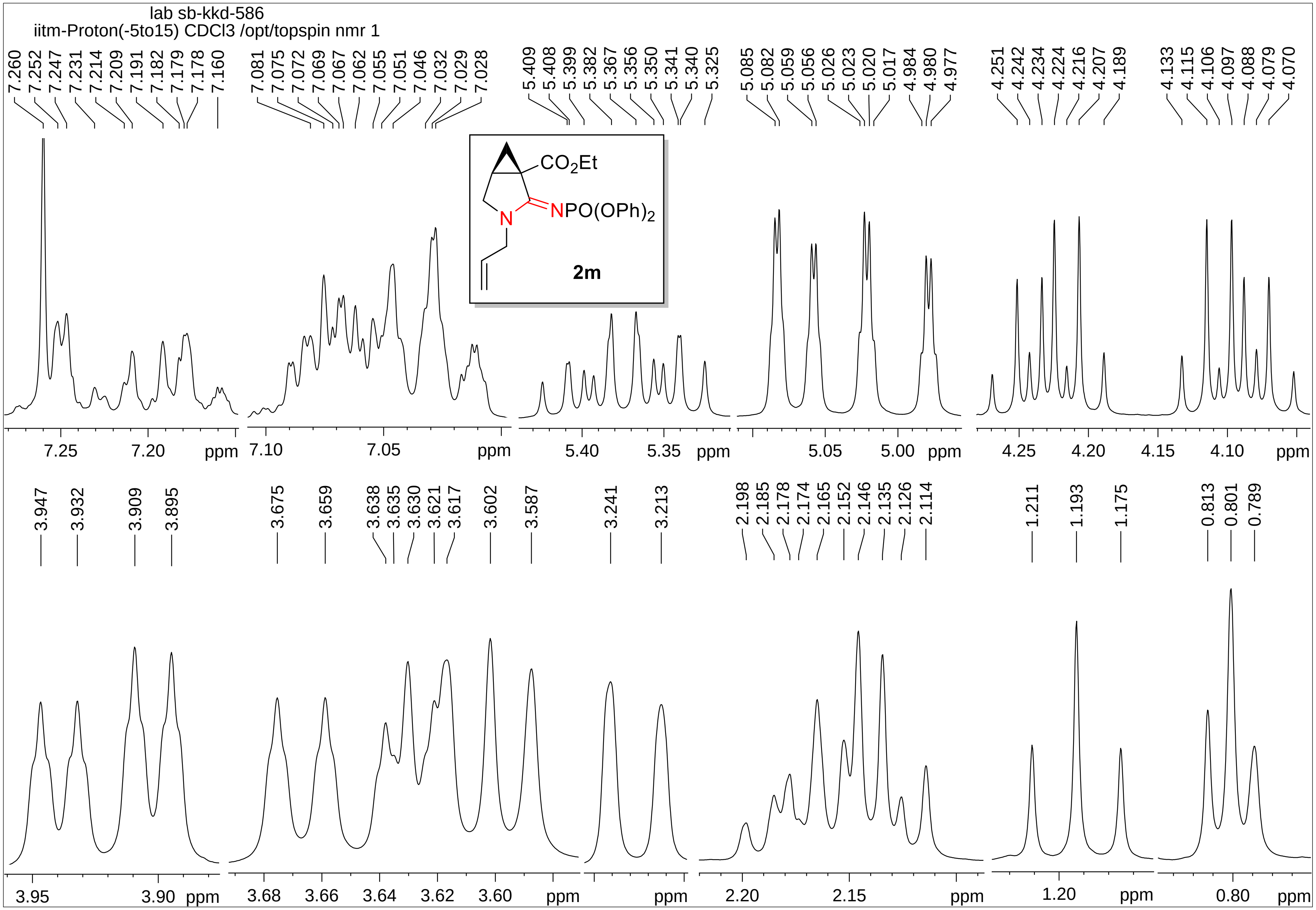
^1H-^1H **COSY NMR spectrum of compound 2l**



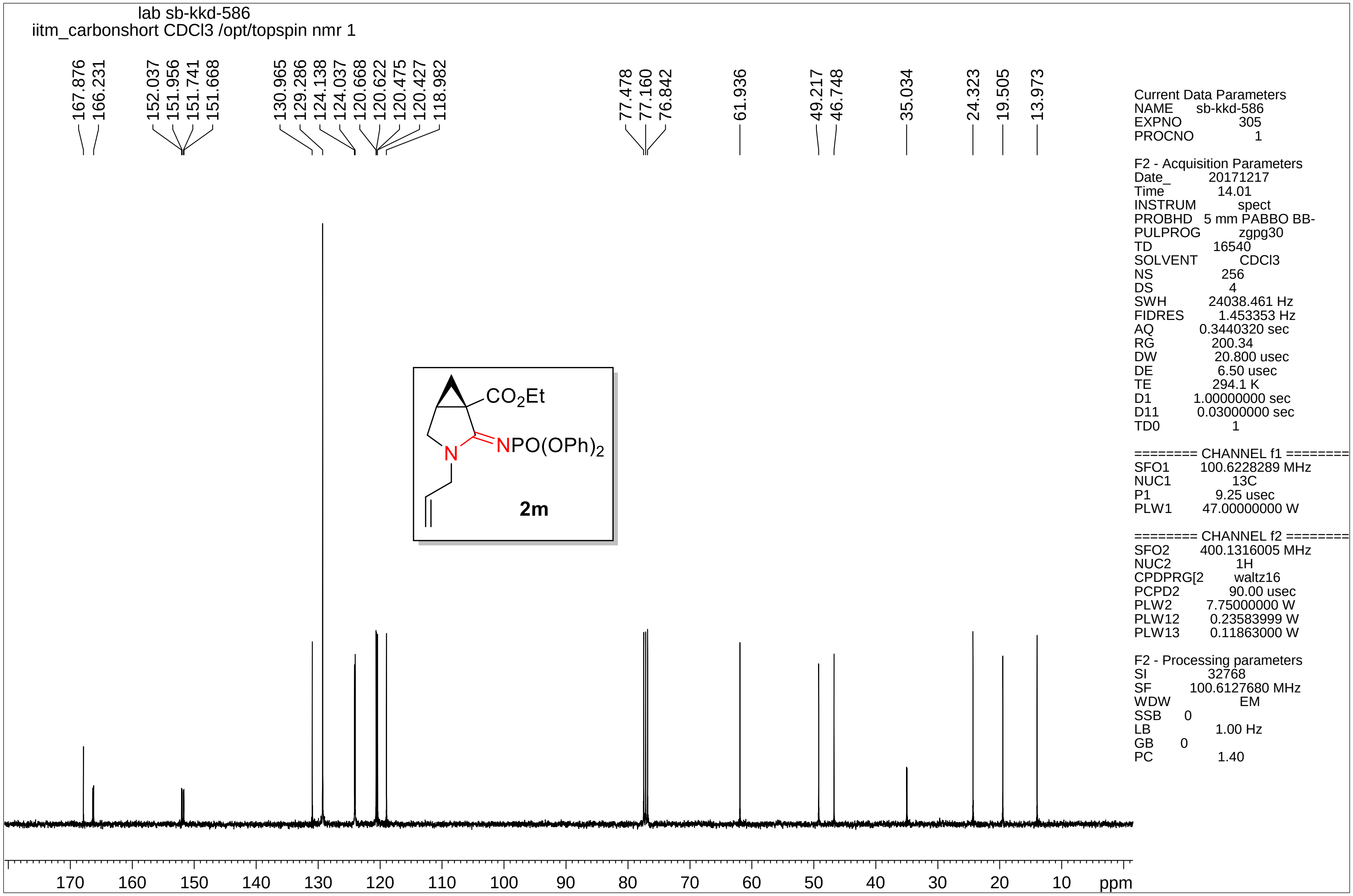
^{1}H-^{13}C HSQC NMR spectrum of compound 2l



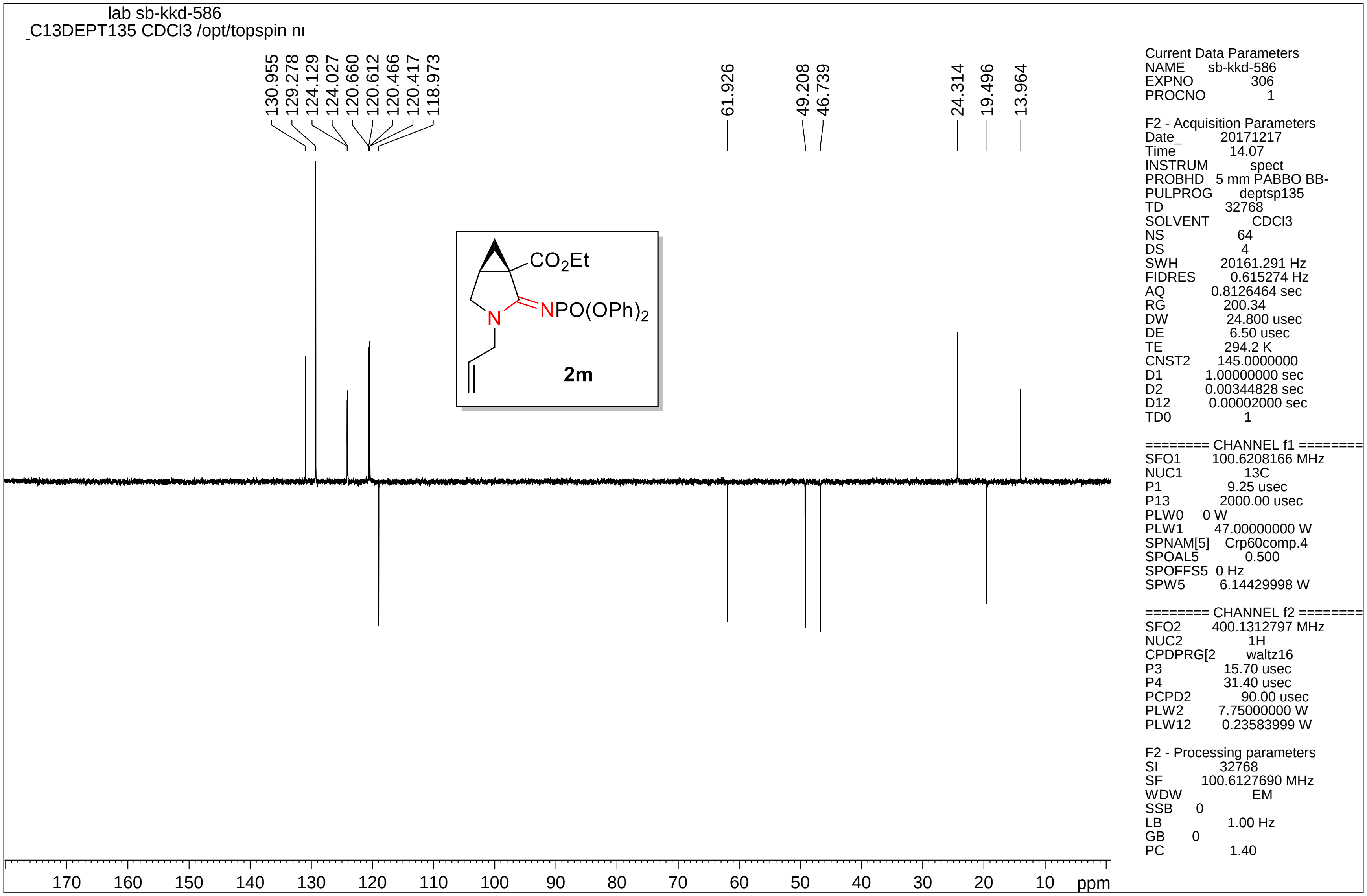
^{1}H NMR spectrum of compound 2m



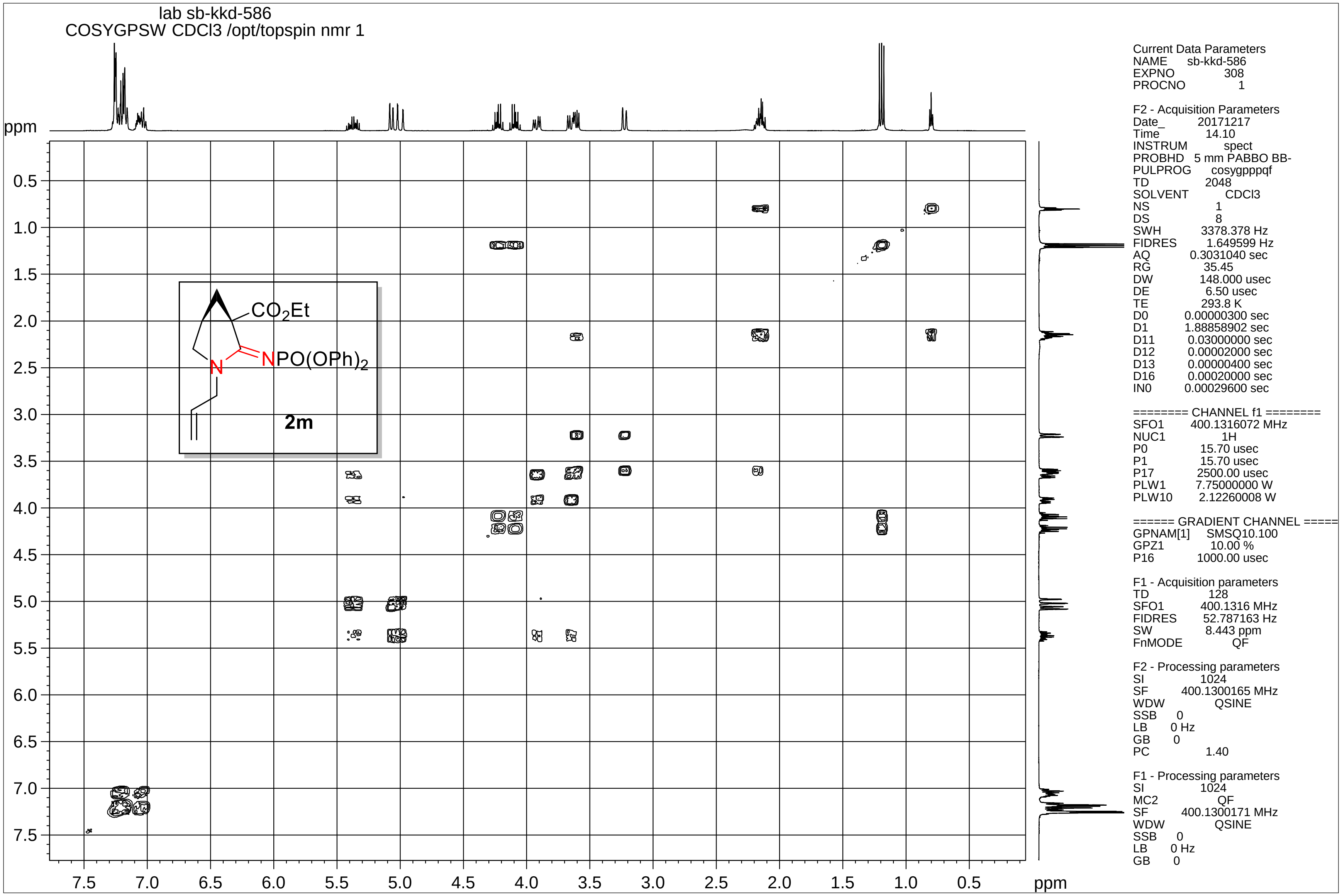
^{1}H NMR spectrum of compound 2m



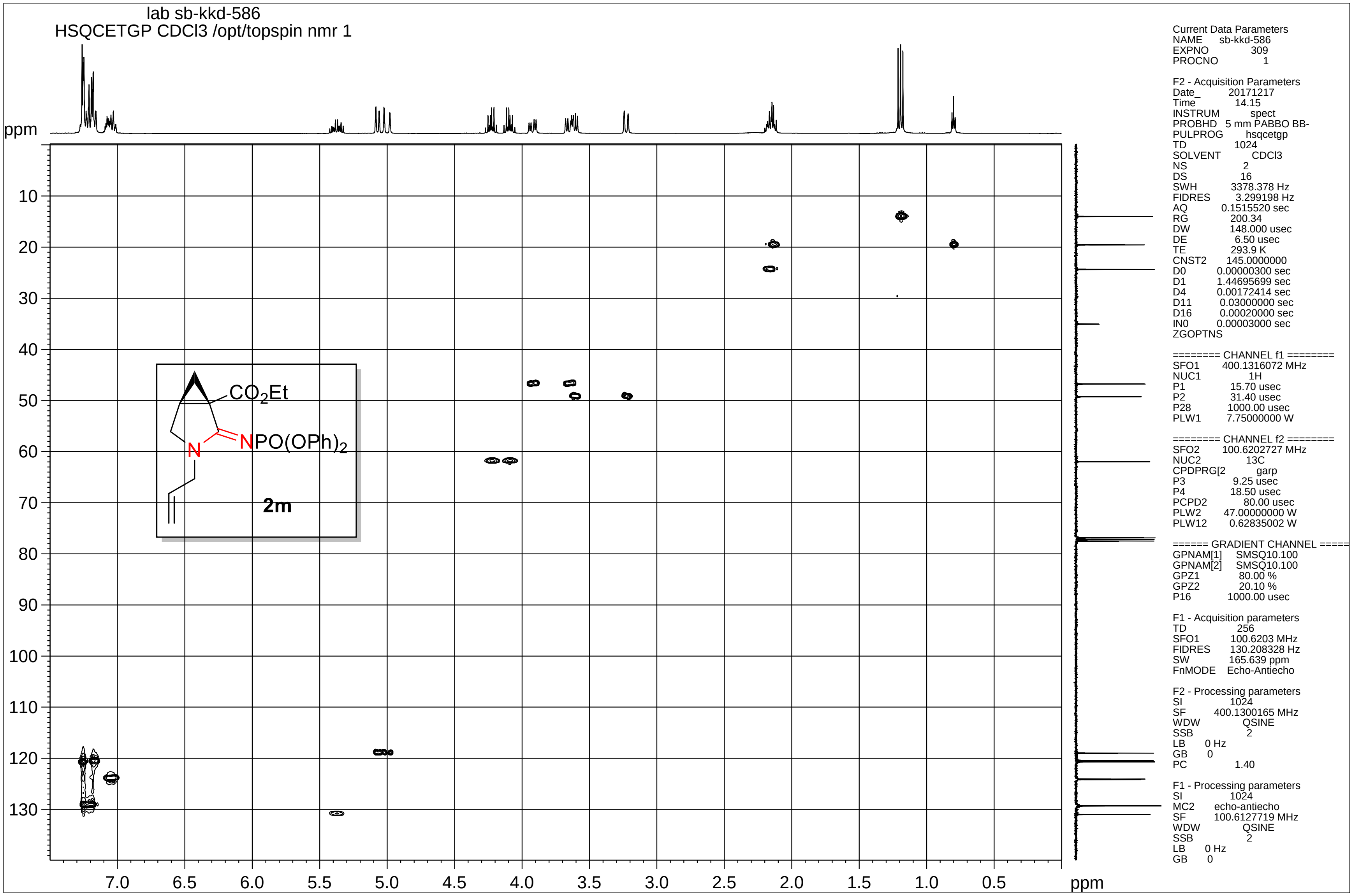
^{13}C NMR spectrum of compound 2m



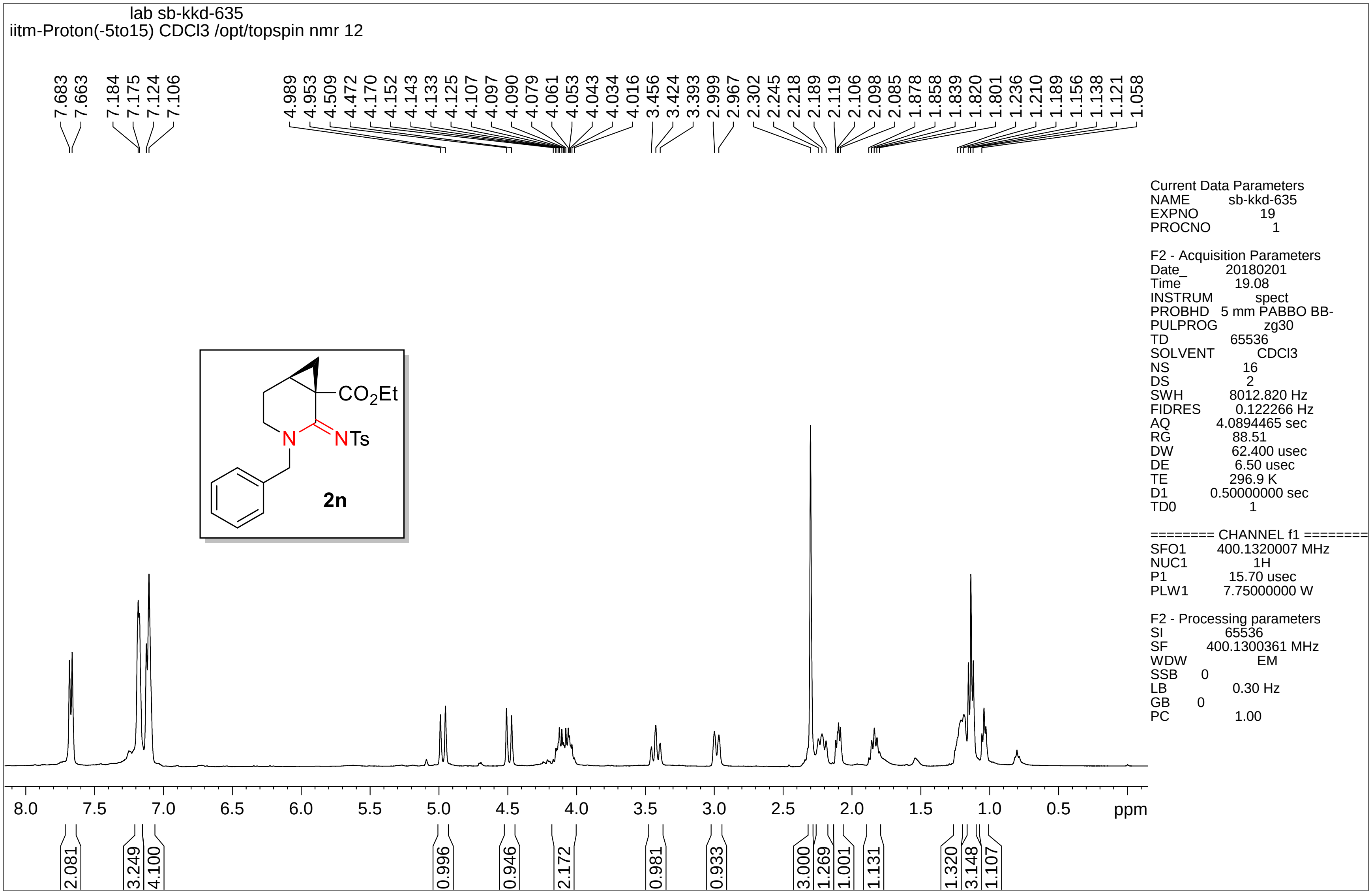
DEPT-135 NMR spectrum of compound 2m



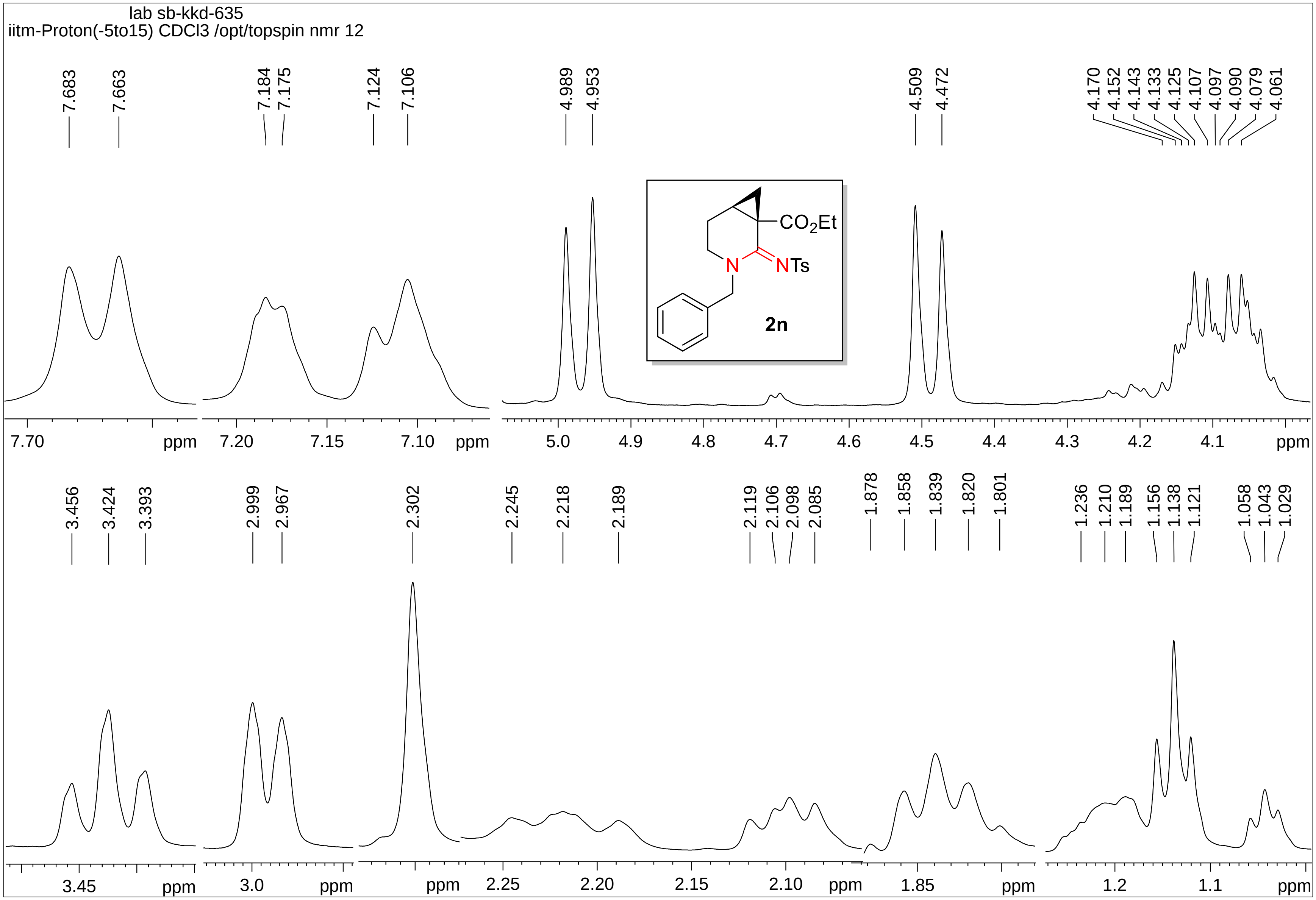
^1H-^1H COSY NMR spectrum of compound 2m



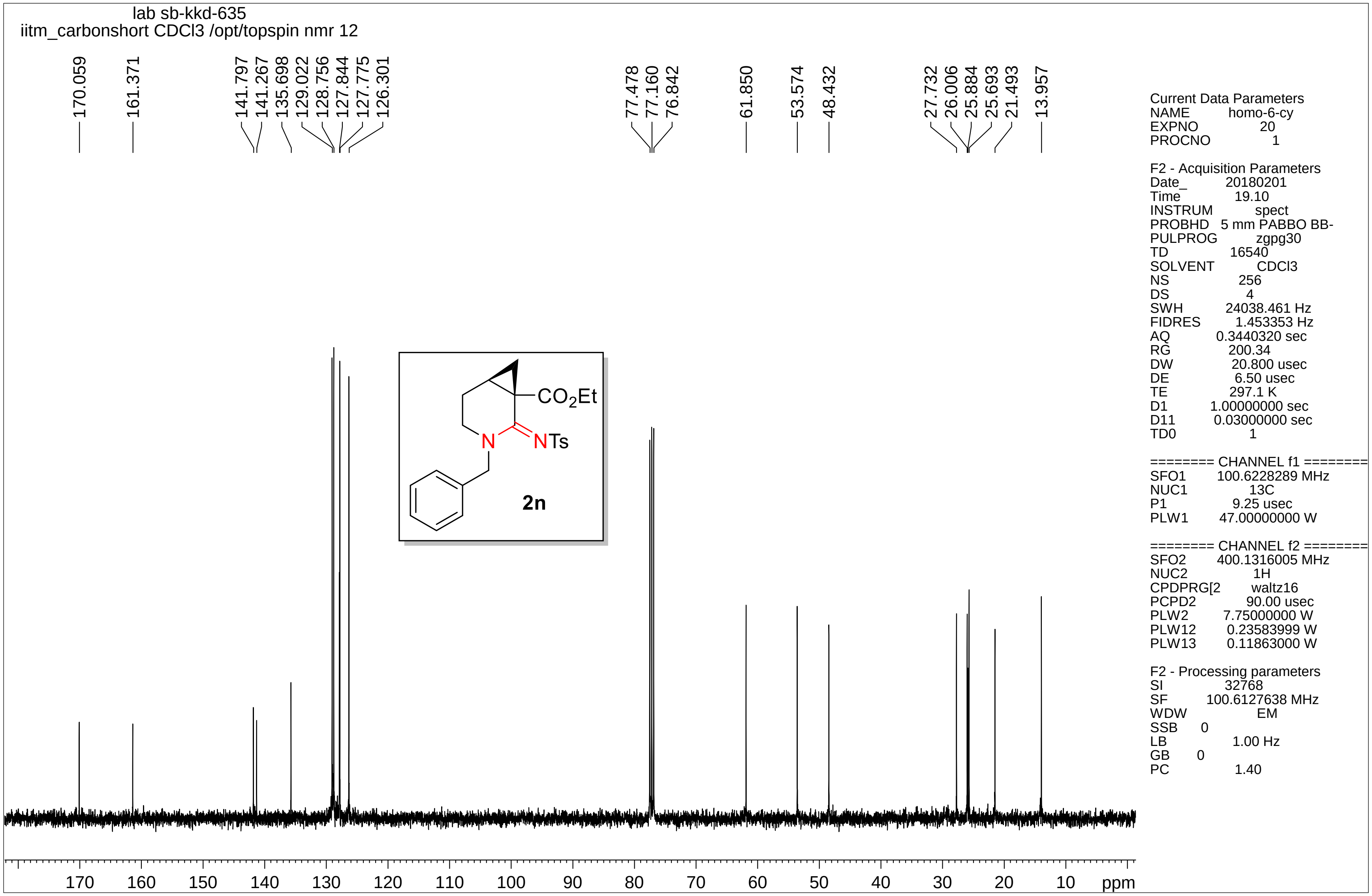
^{1}H-^{13}C HSQC NMR spectrum of compound 2m



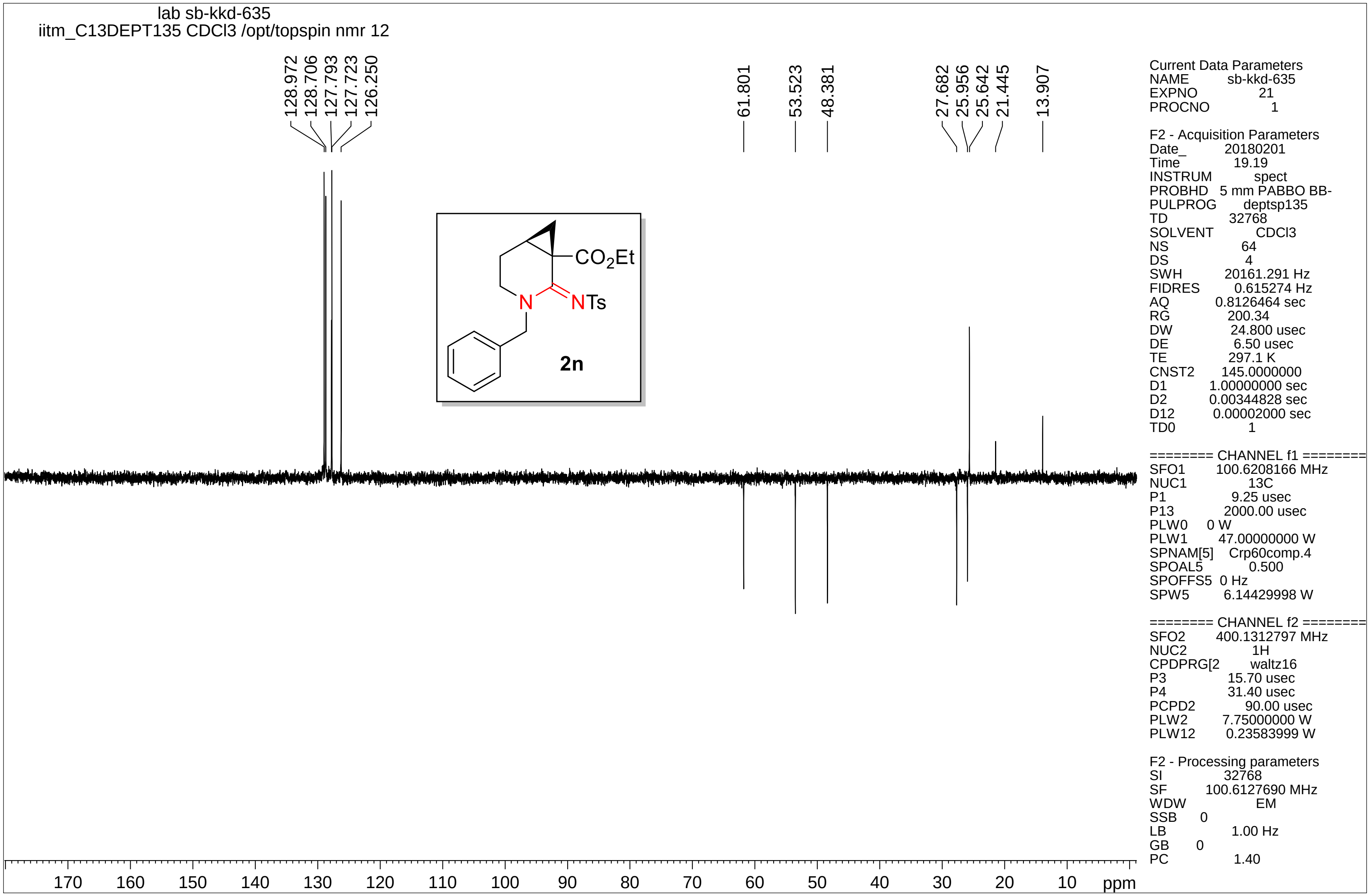
^{1}H NMR spectrum of compound 2n



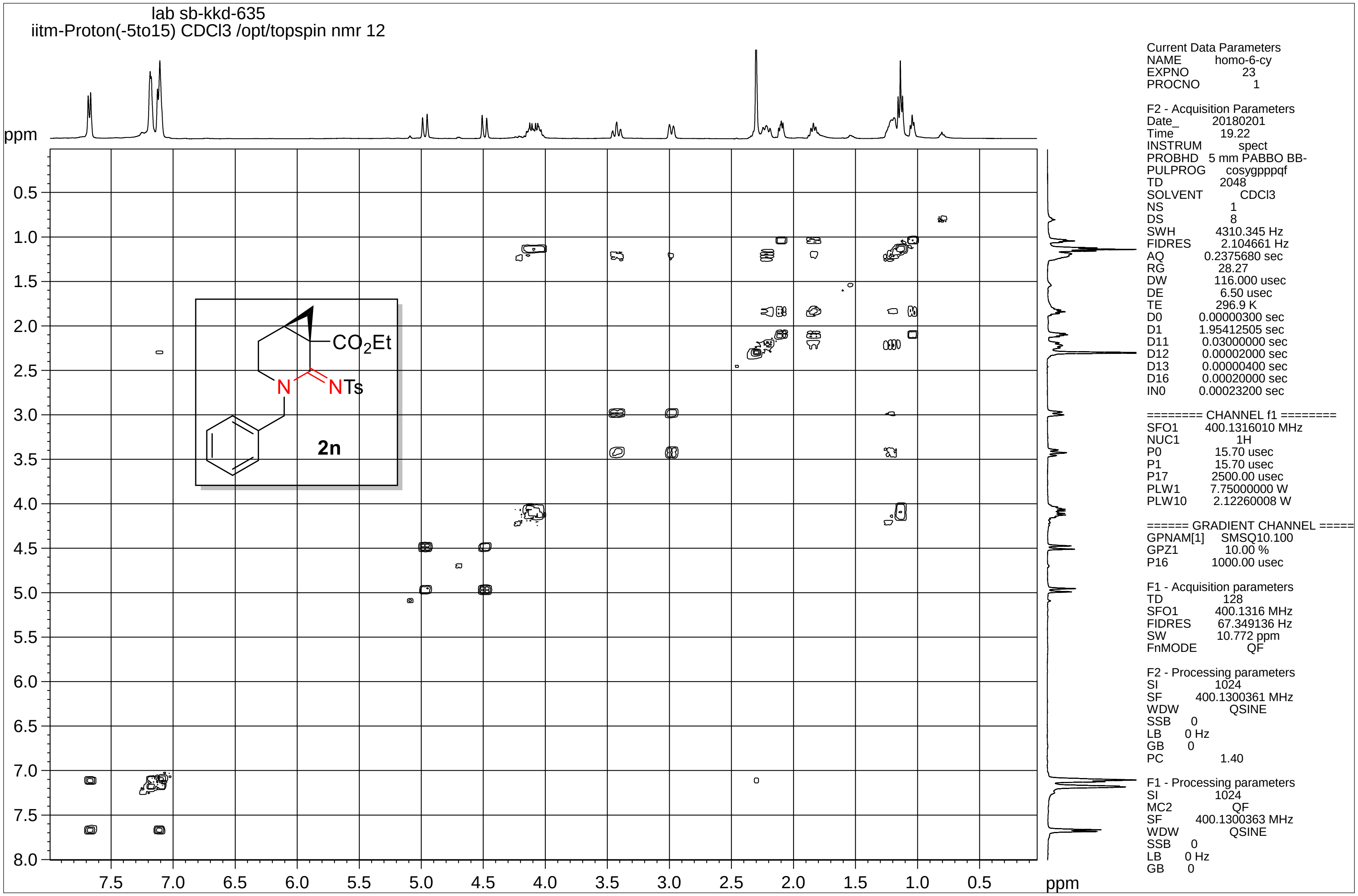
^{1}H NMR spectrum of compound 2n



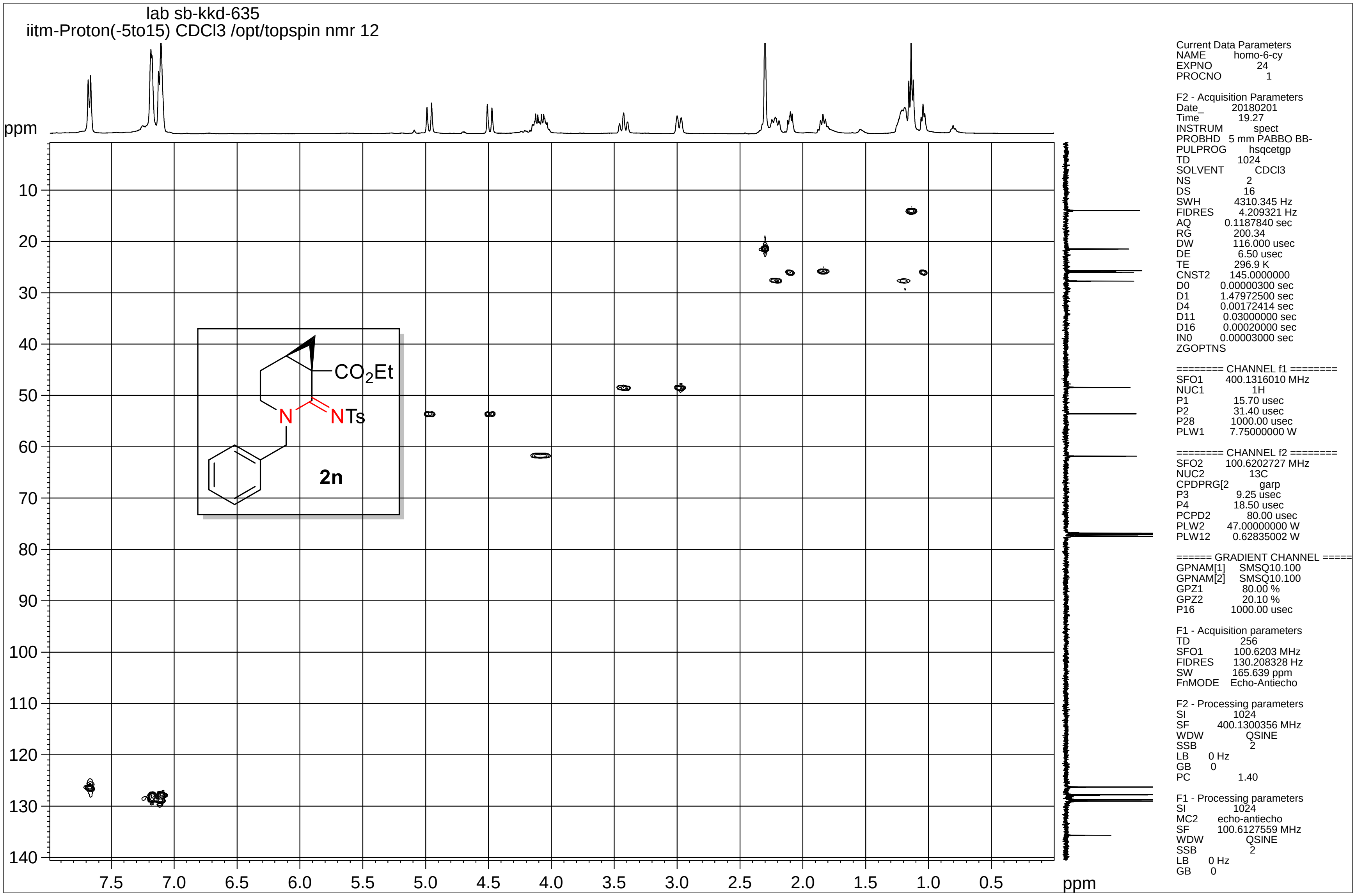
^{13}C NMR spectrum of compound 2n



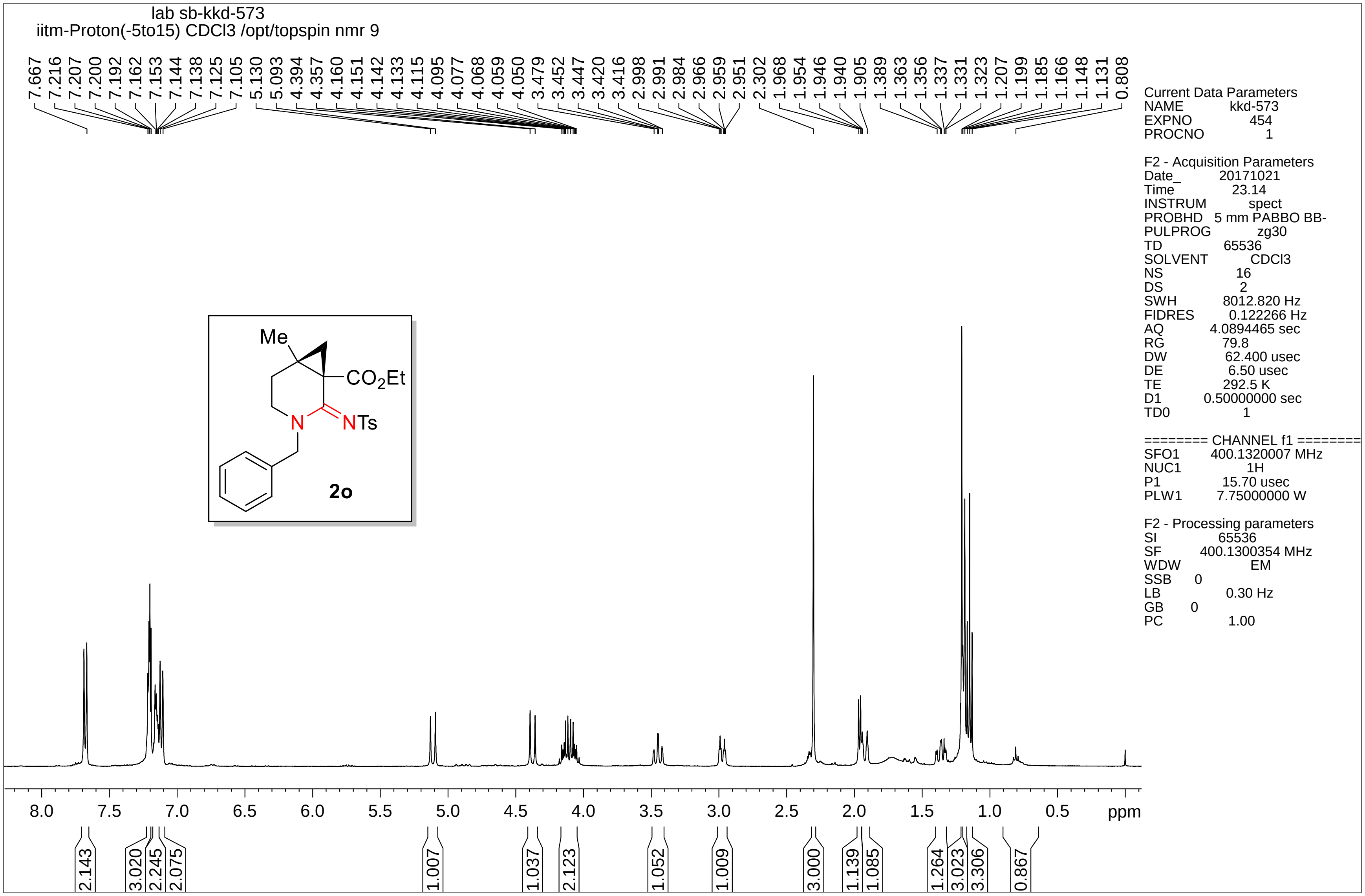
DEPT-135 NMR spectrum of compound 2n



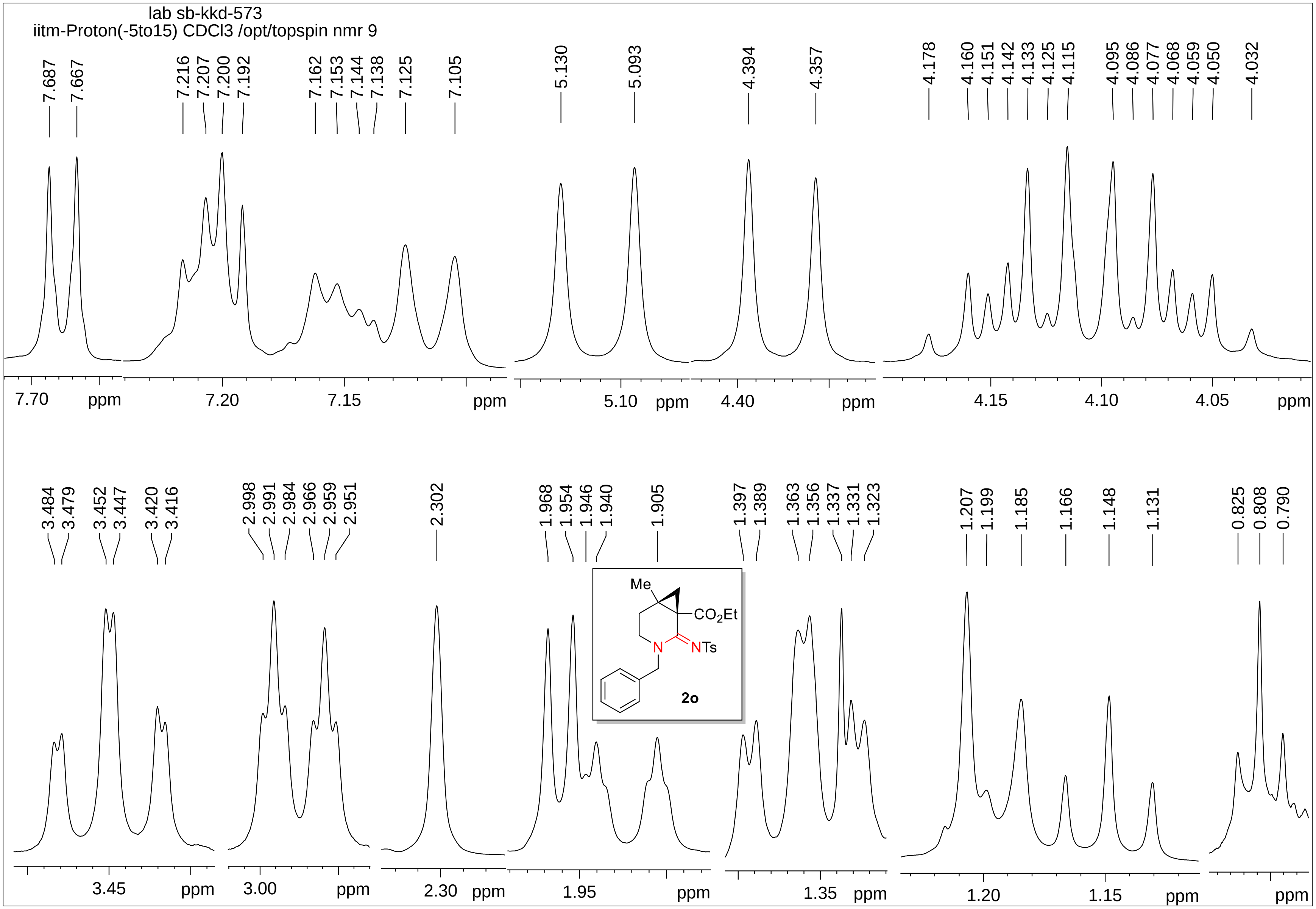
[1]H-[1]H COSY NMR spectrum of compound 2n



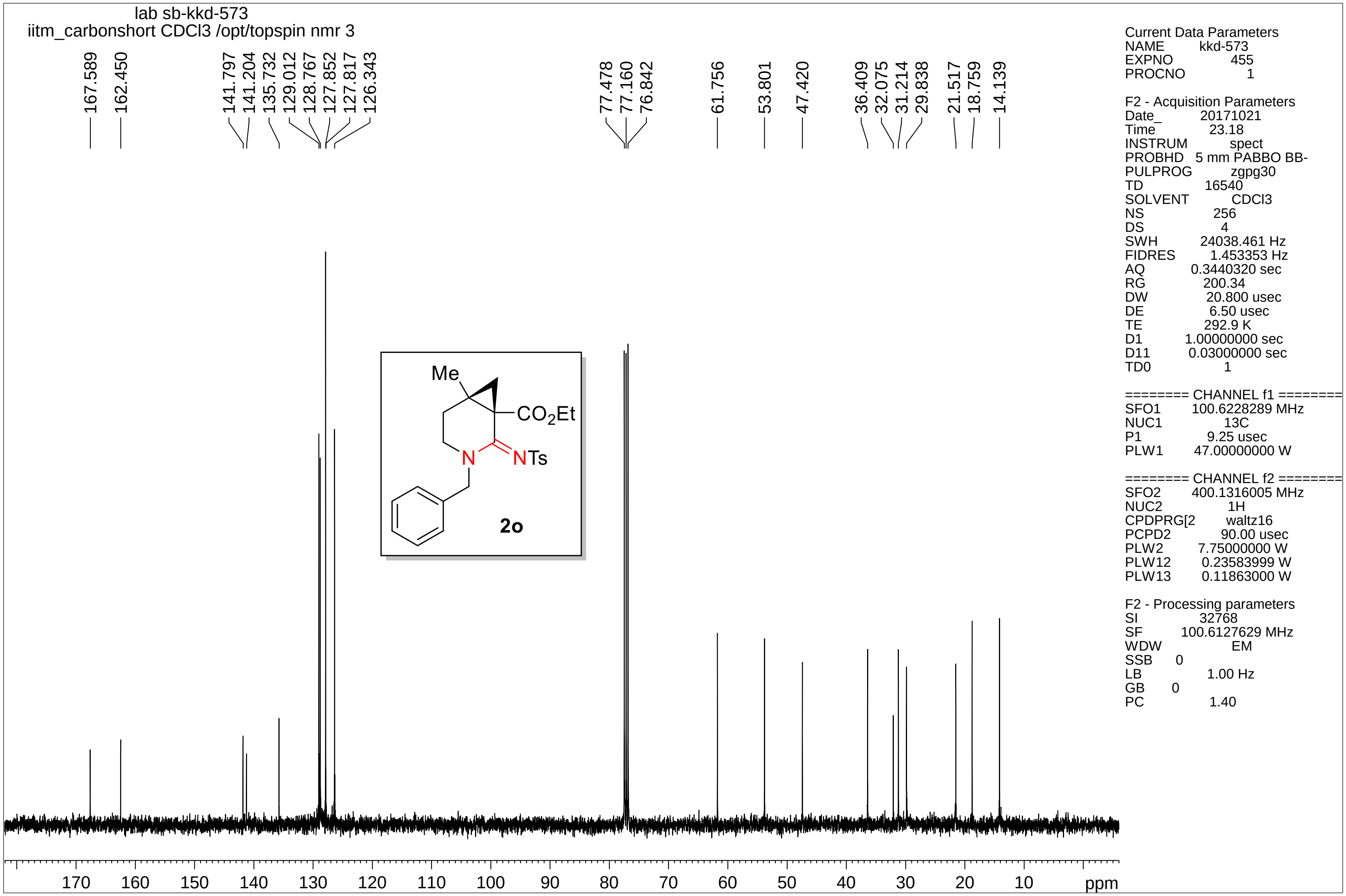
^{1}H-^{13}C HSQC NMR spectrum of compound 2n



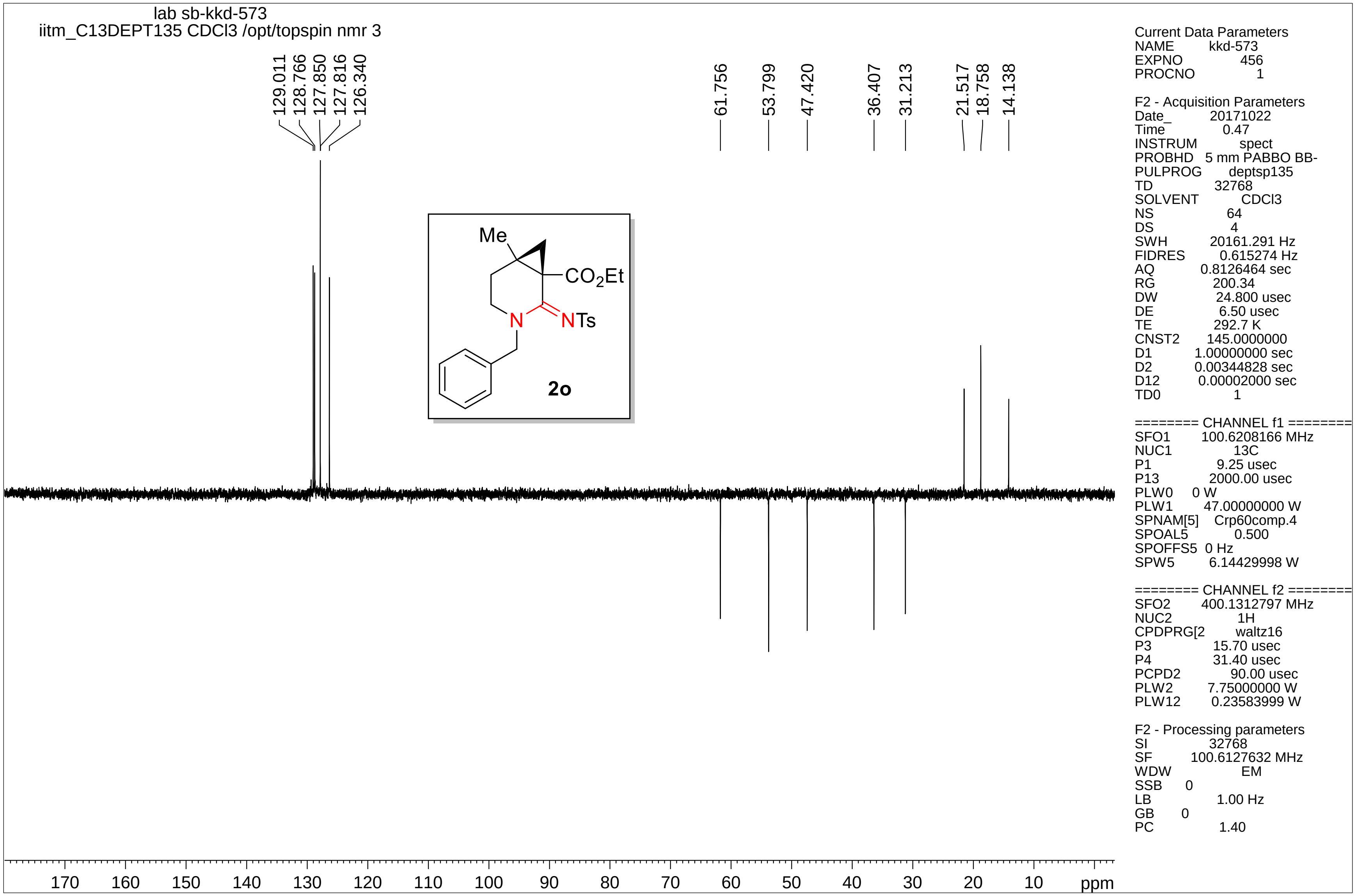
^{1}H NMR spectrum of compound 2o



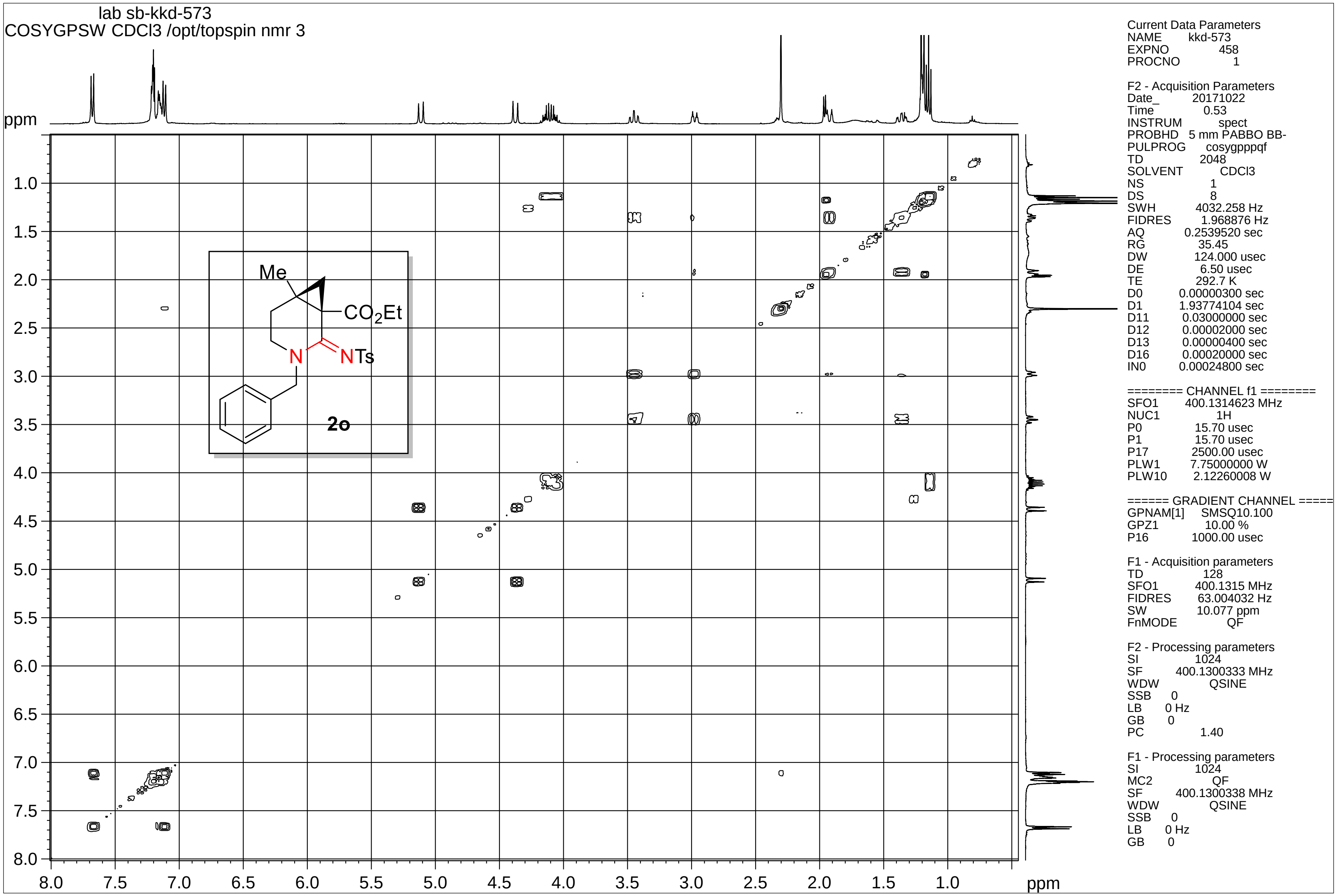
^{1}H NMR spectrum of compound 2o



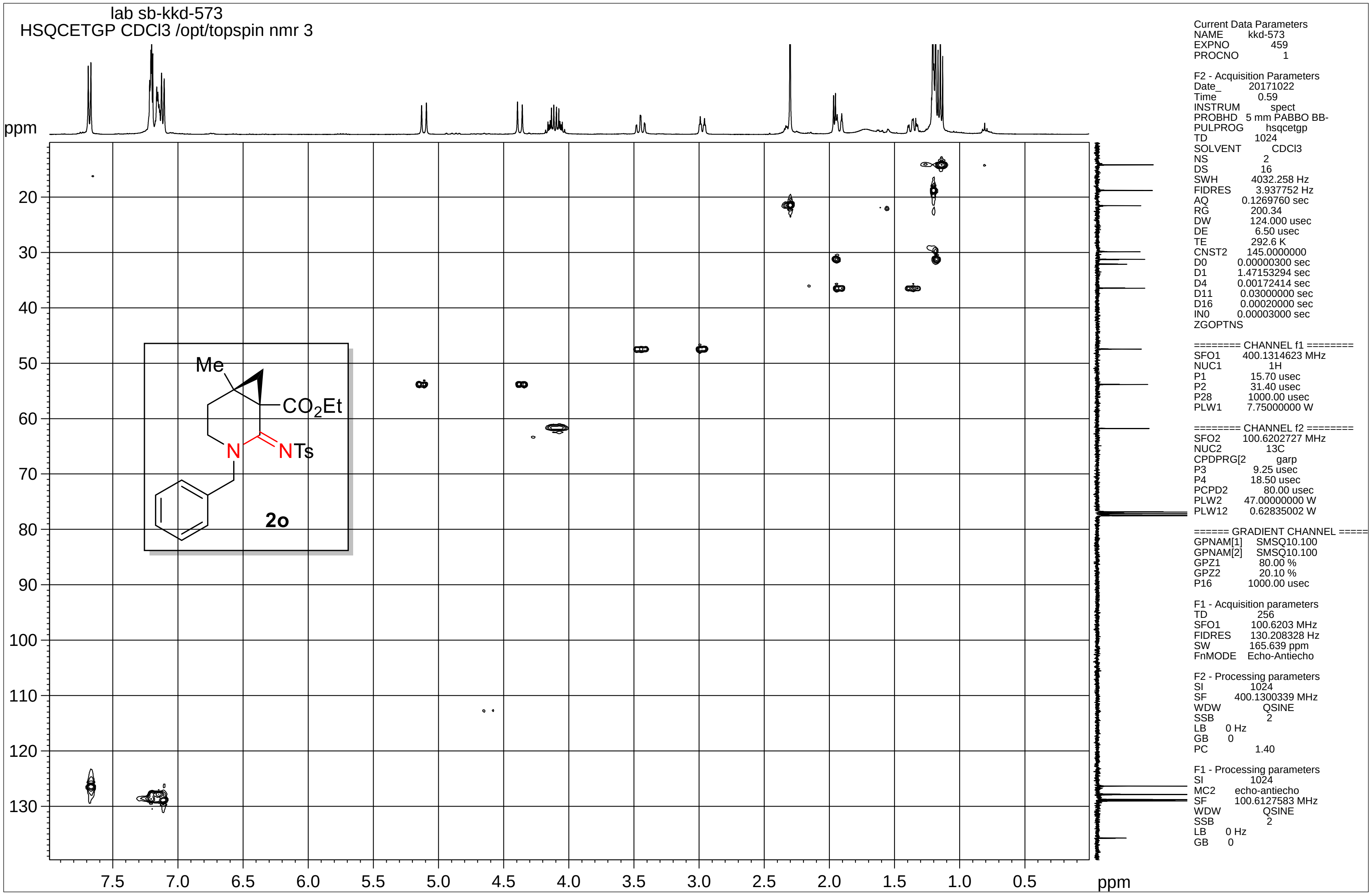
^{13}C NMR spectrum of compound 2o



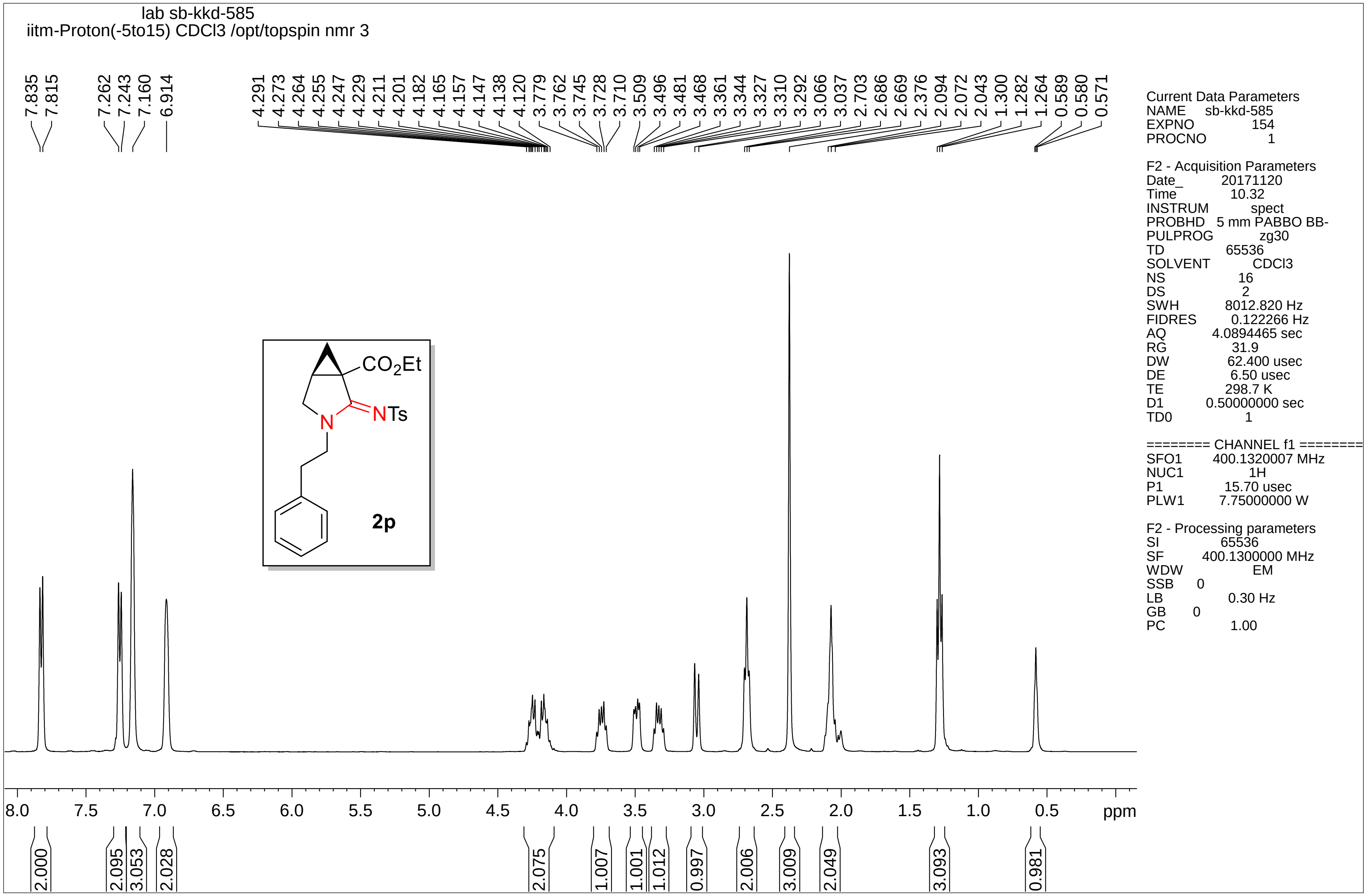
DEPT-135 NMR spectrum of compound 2o



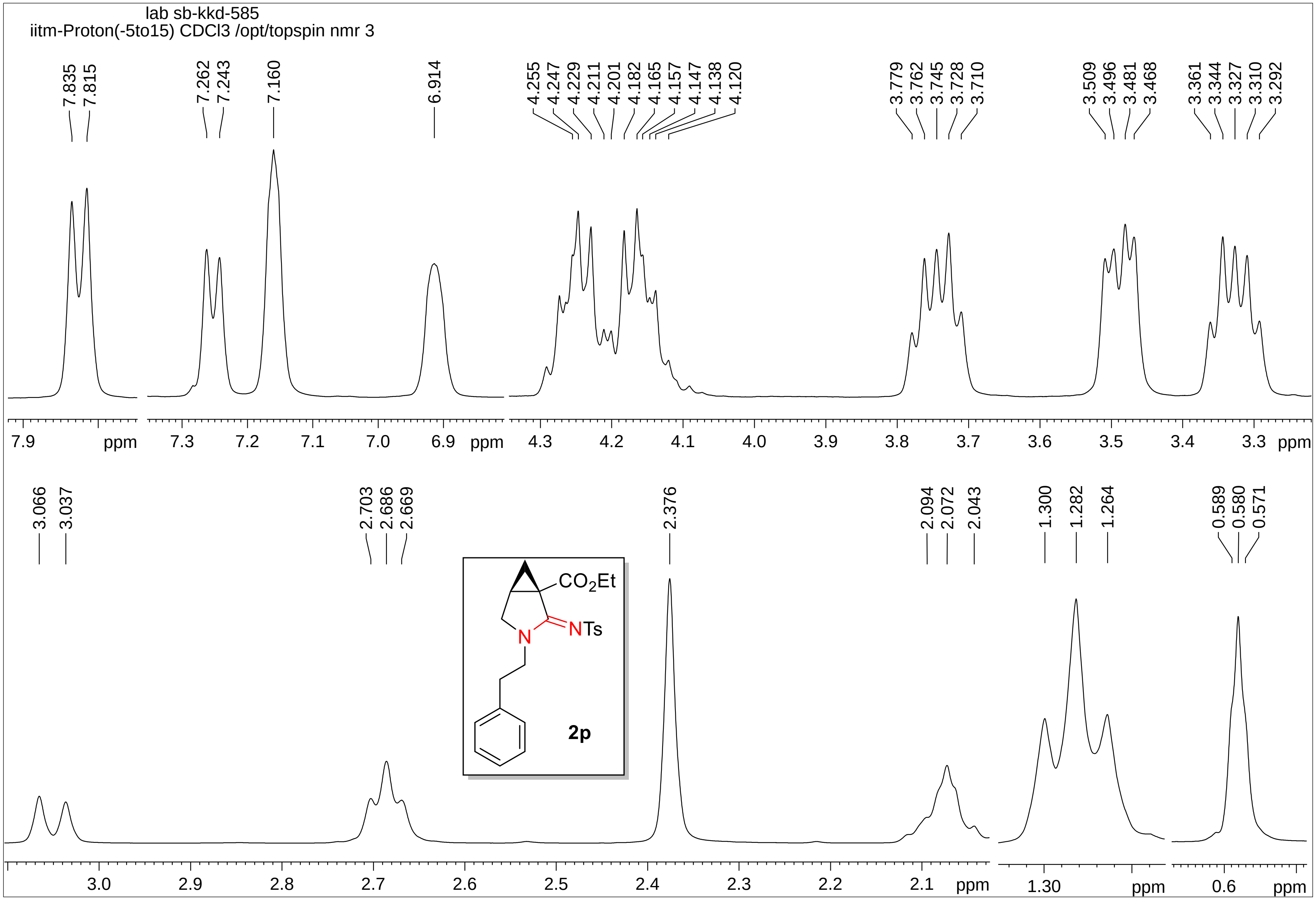
^{1}H-^{1}H COSY NMR spectrum of compound 2o



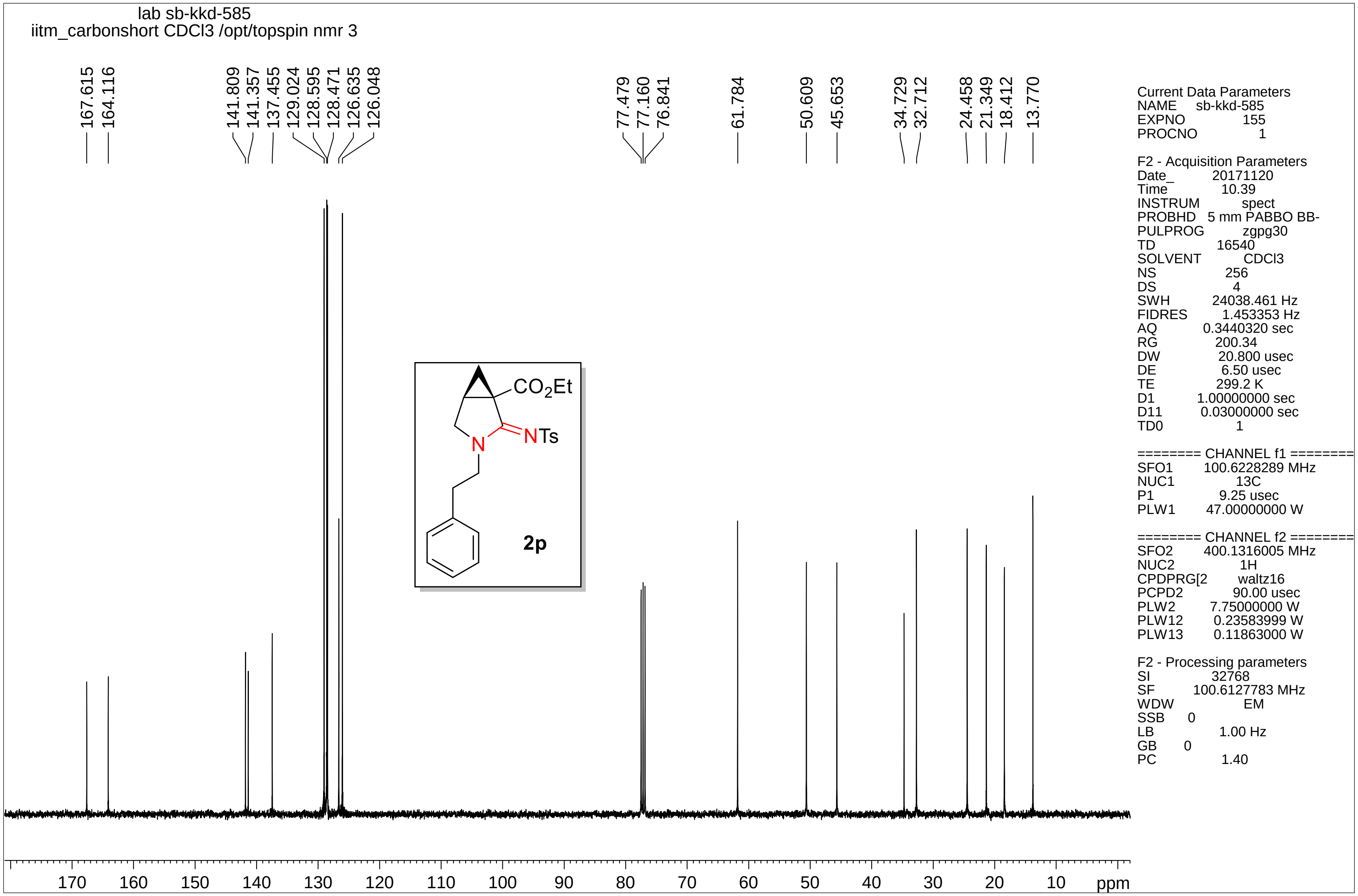
^{1}H-^{13}C HSQC NMR spectrum of compound 2o



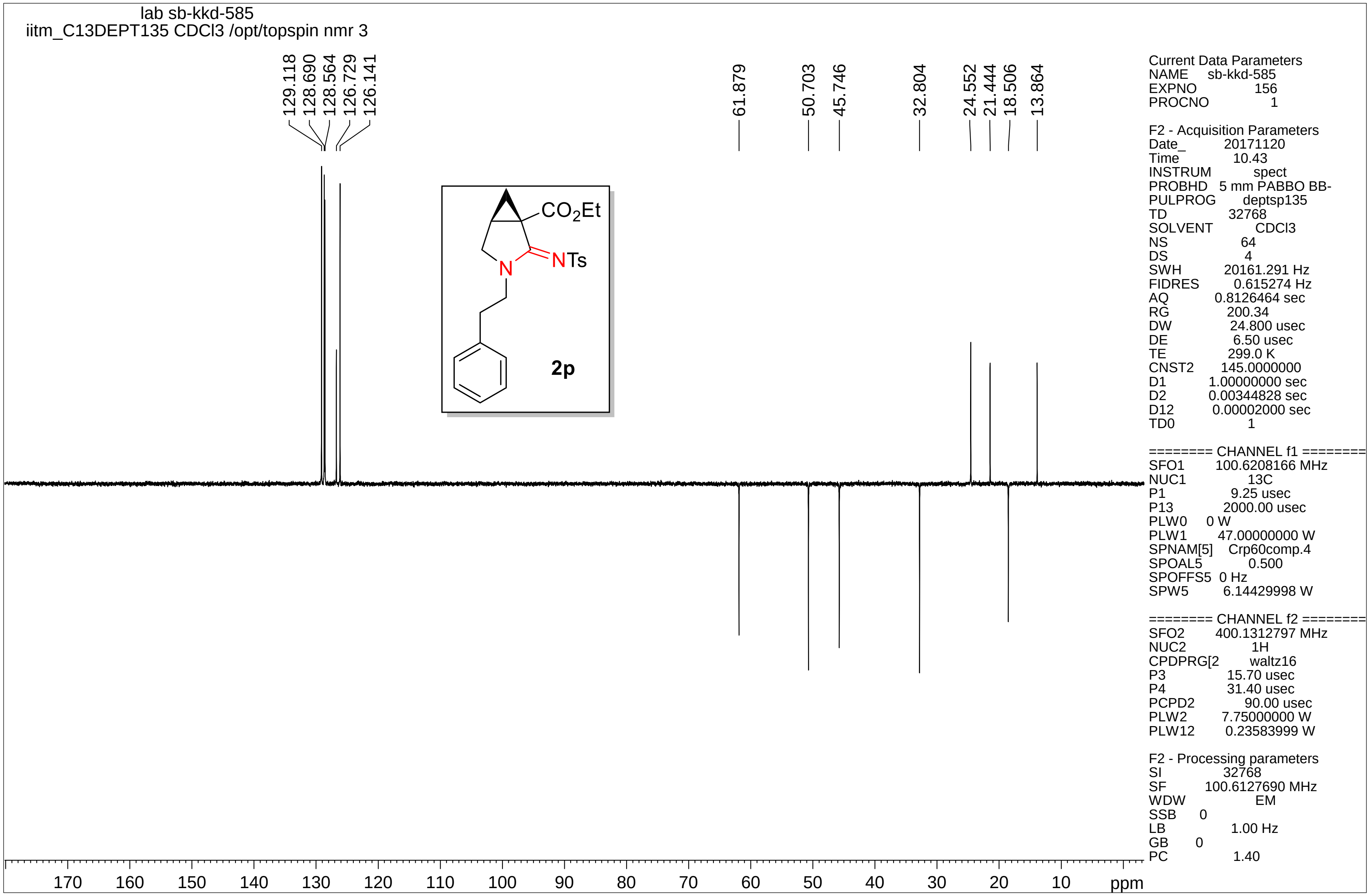
^{1}H NMR spectrum of compound 2p



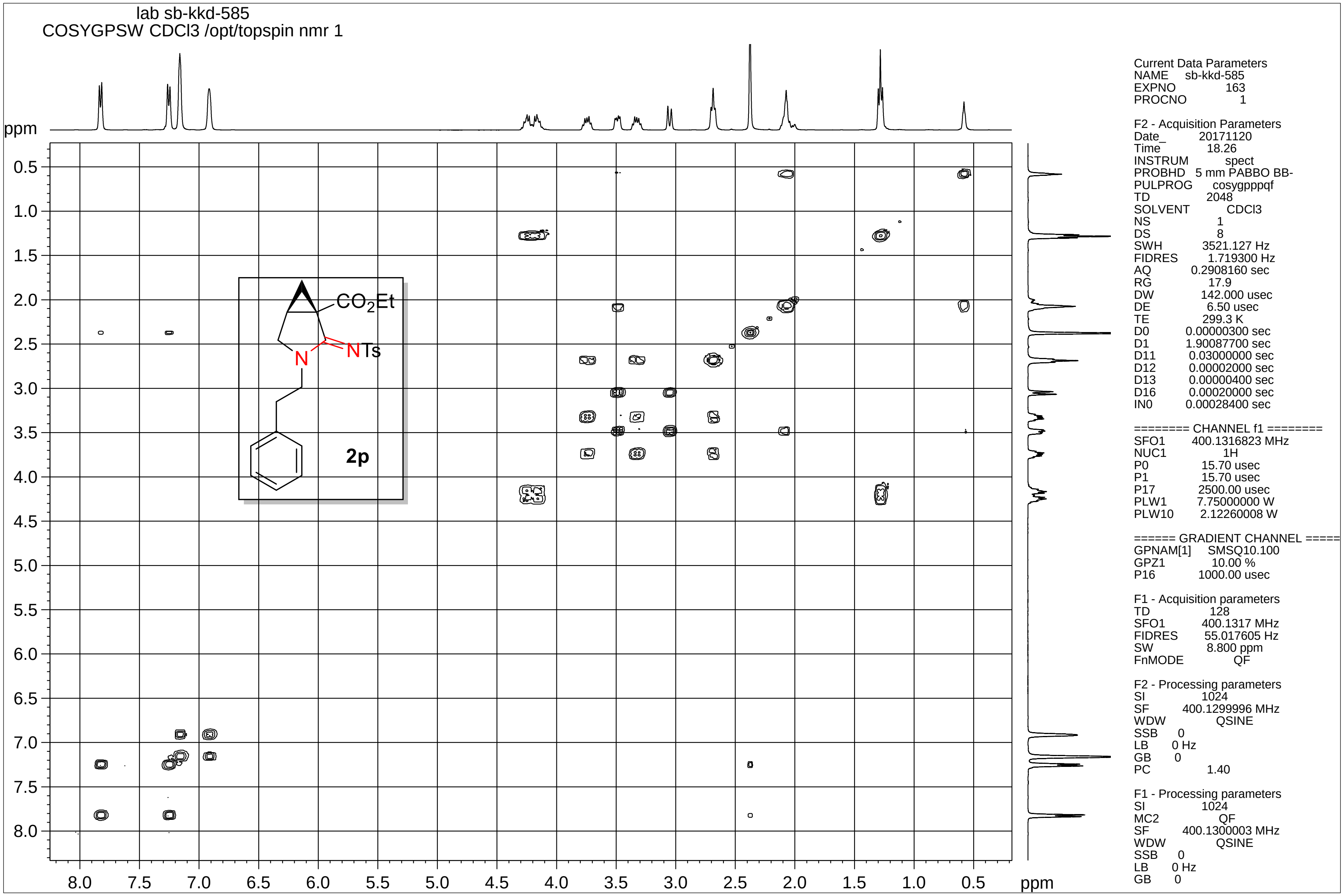
^{1}H NMR spectrum of compound 2p



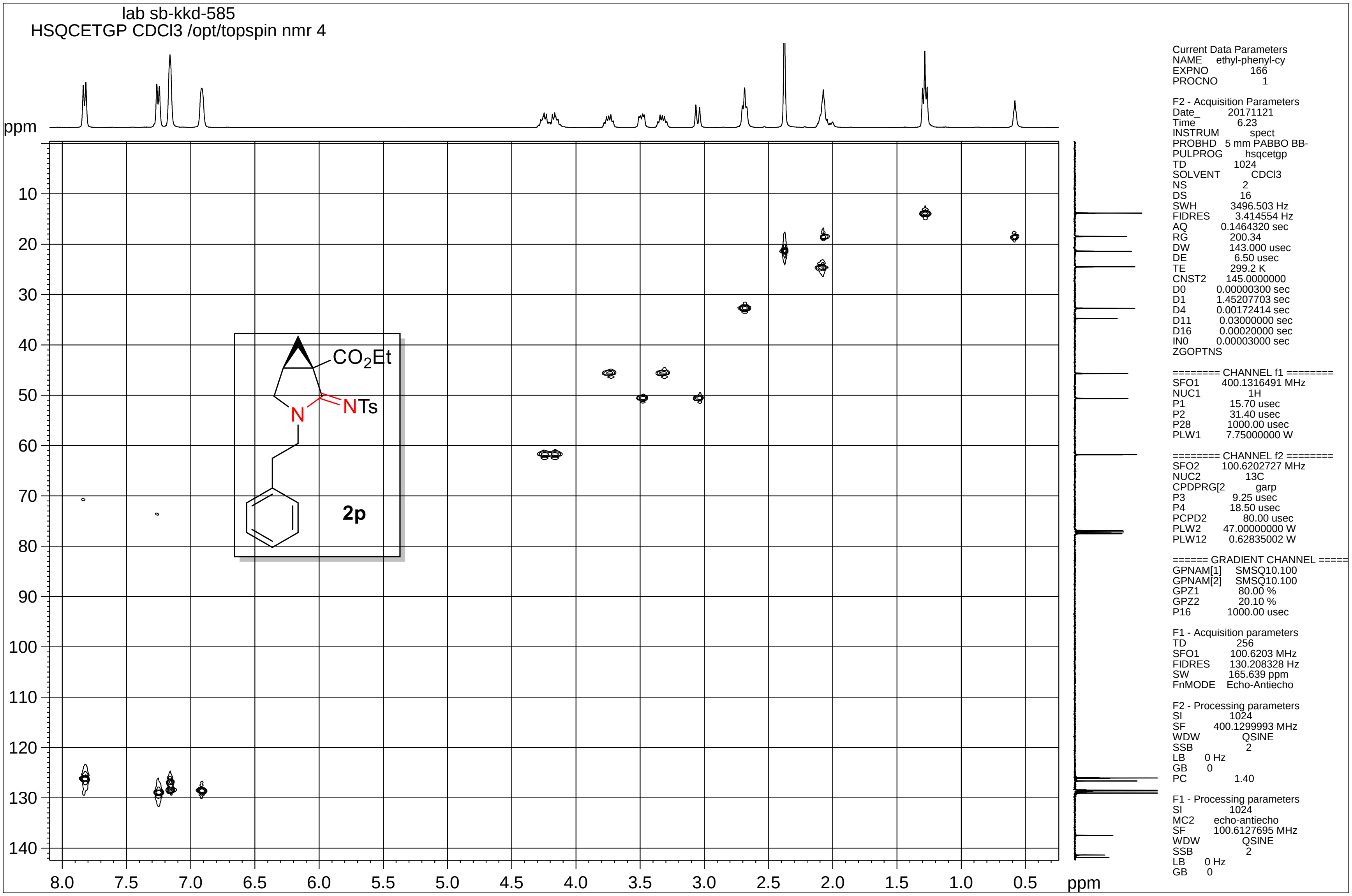
^{13}C NMR spectrum of compound 2p



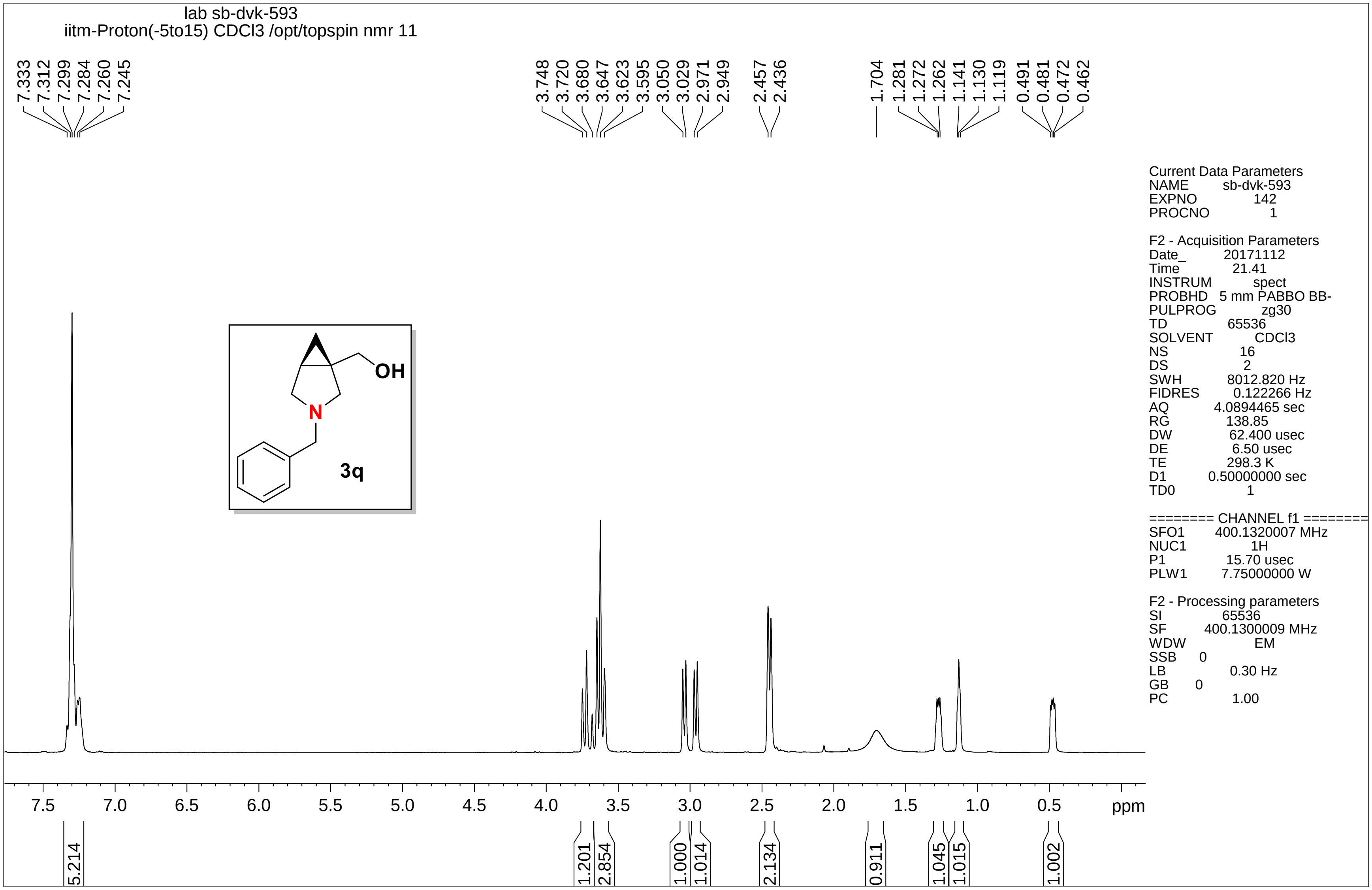
DEPT-135 NMR spectrum of compound 2p



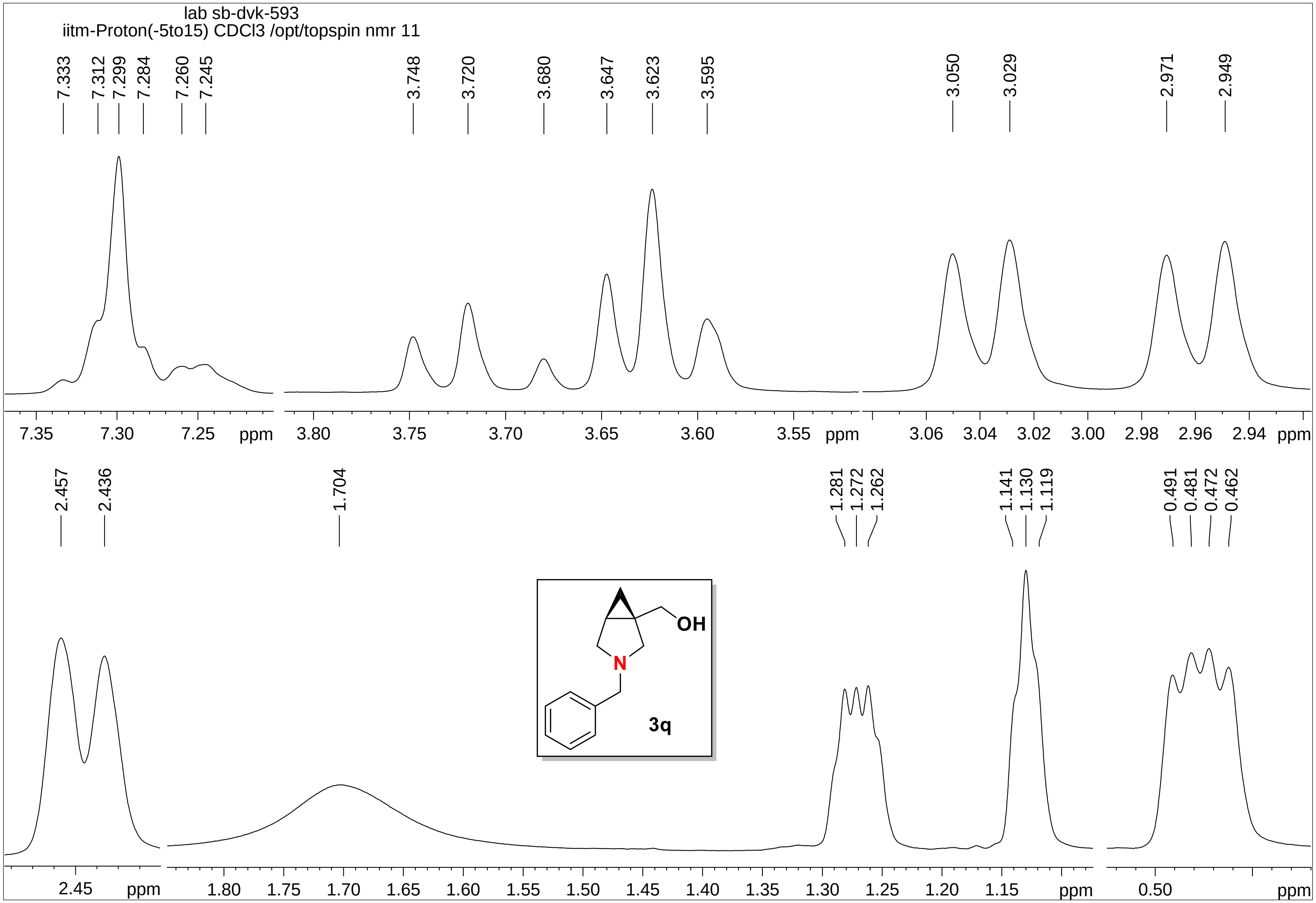
^{1}H-^{1}H COSY NMR spectrum of compound 2p



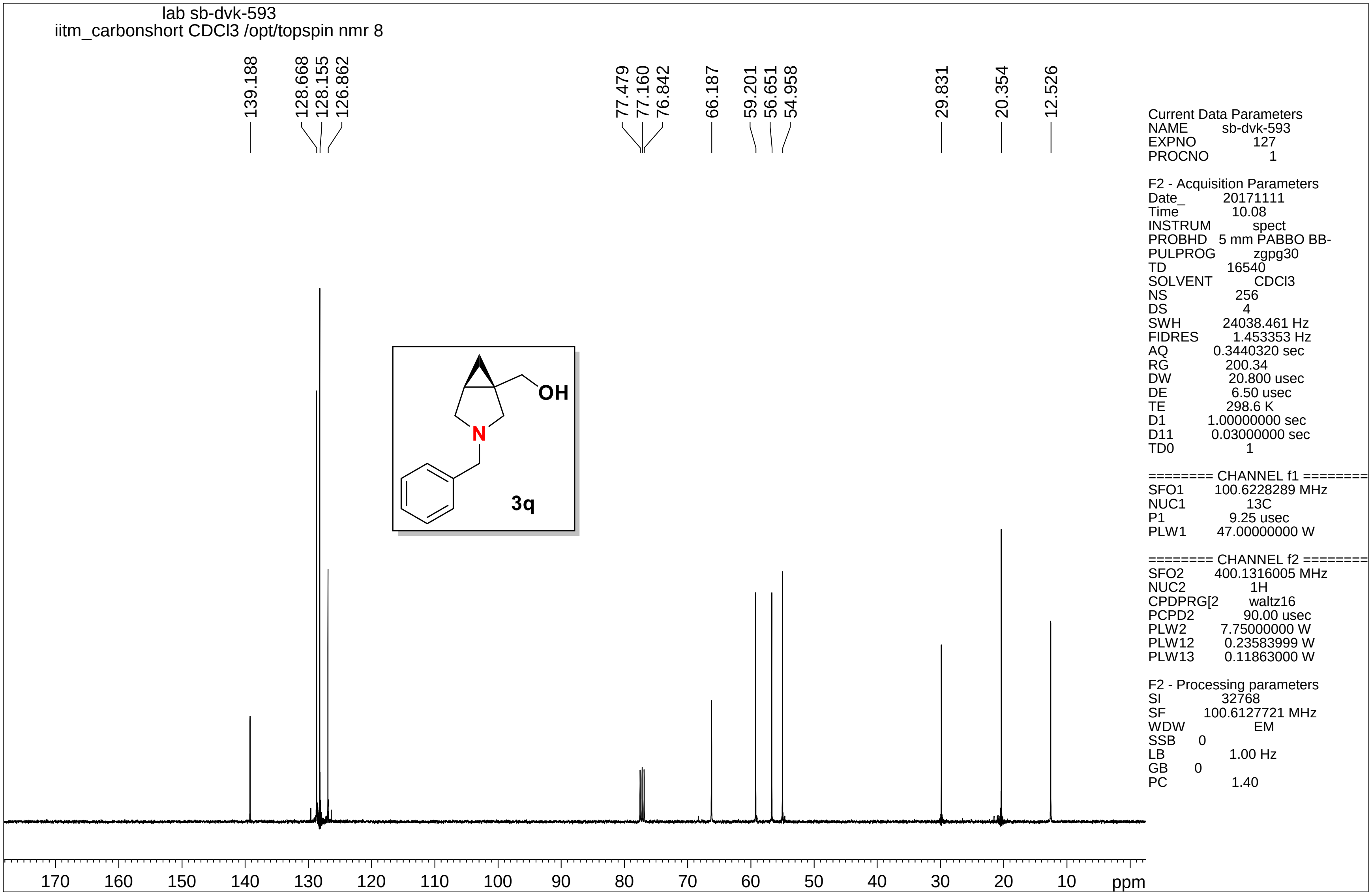
^{1}H-^{13}C HSQC NMR spectrum of compound 2p



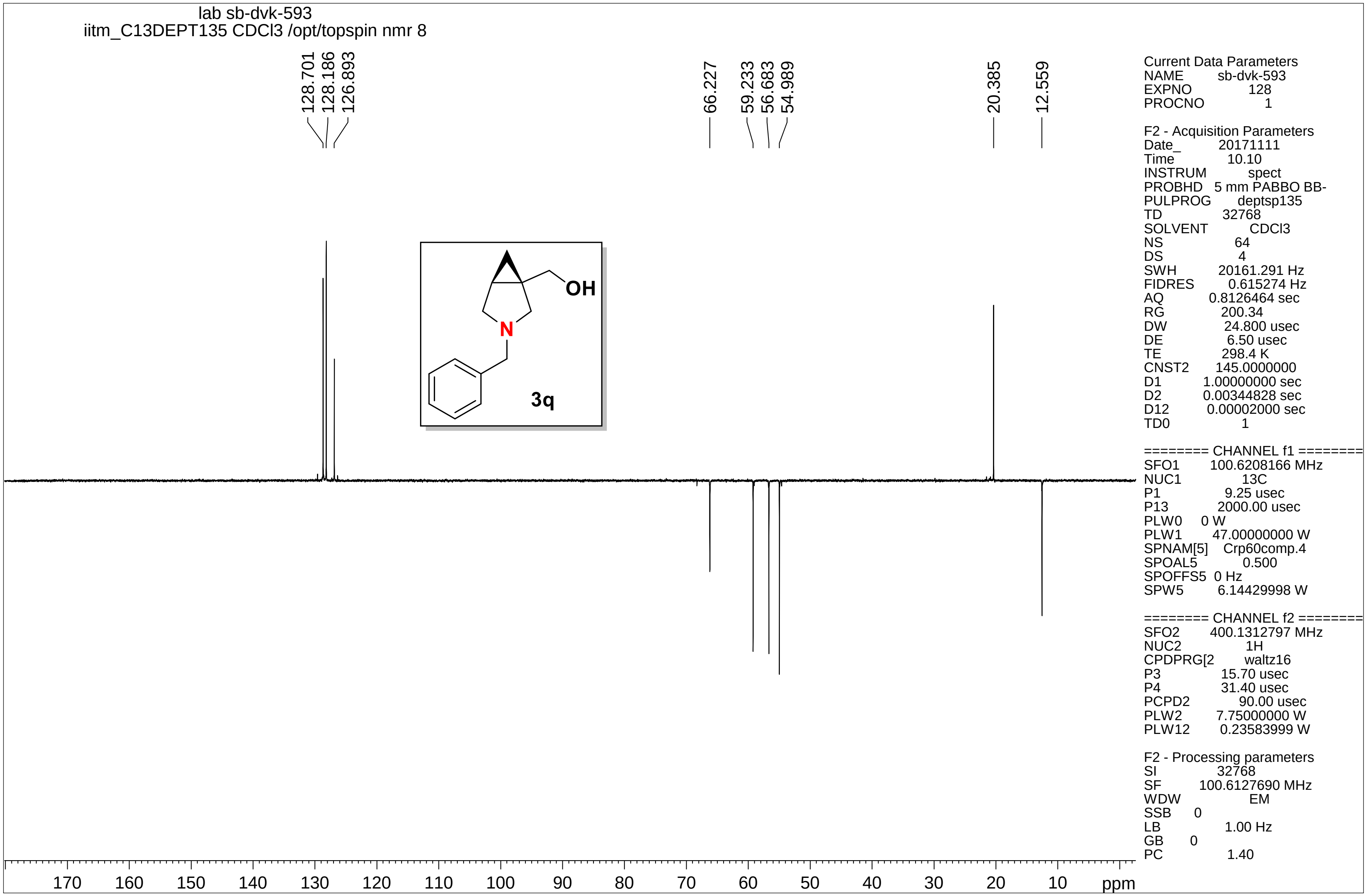
^{1}H NMR spectrum of compound 3q



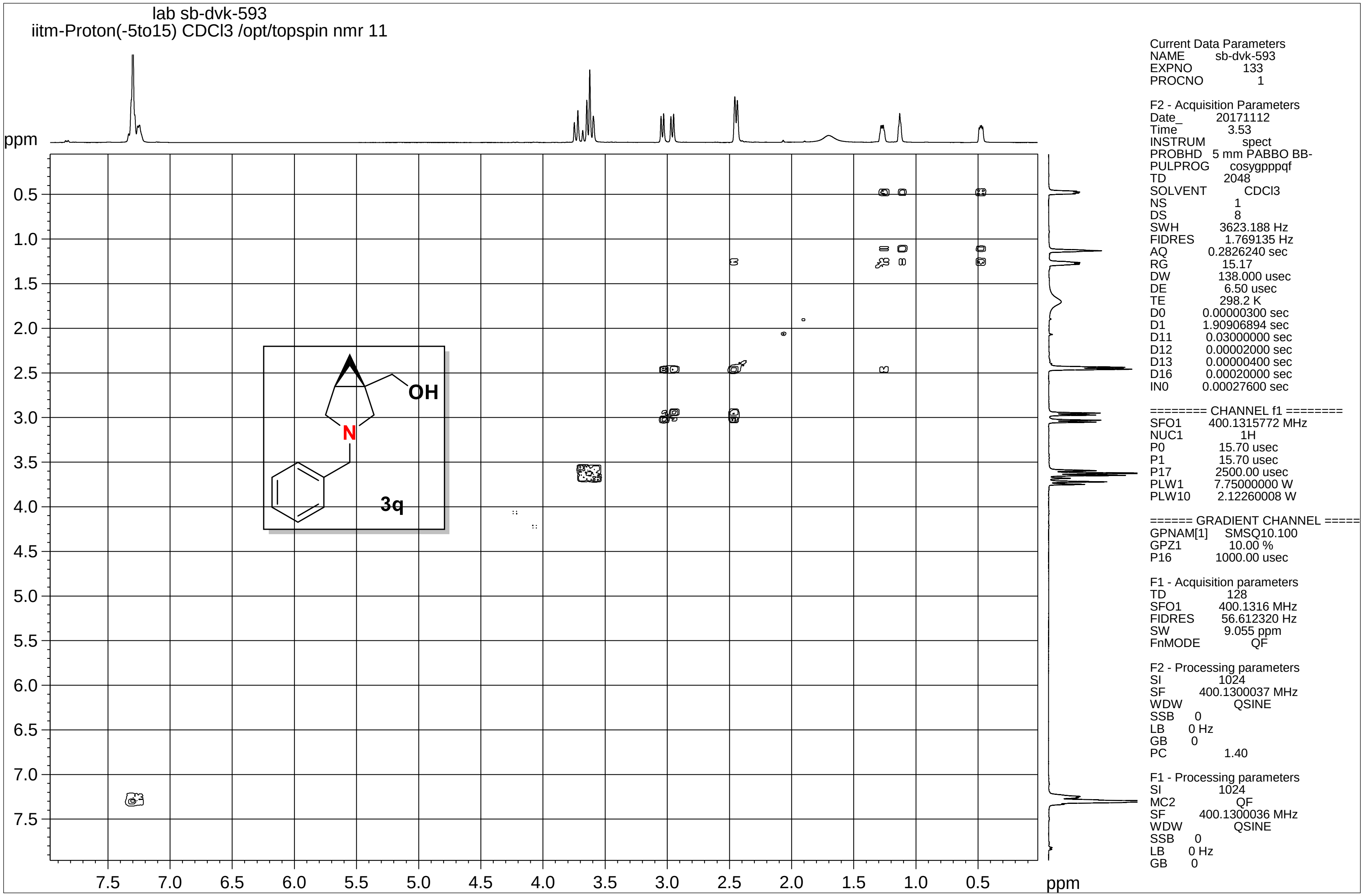
[1]H NMR spectrum of compound 3q



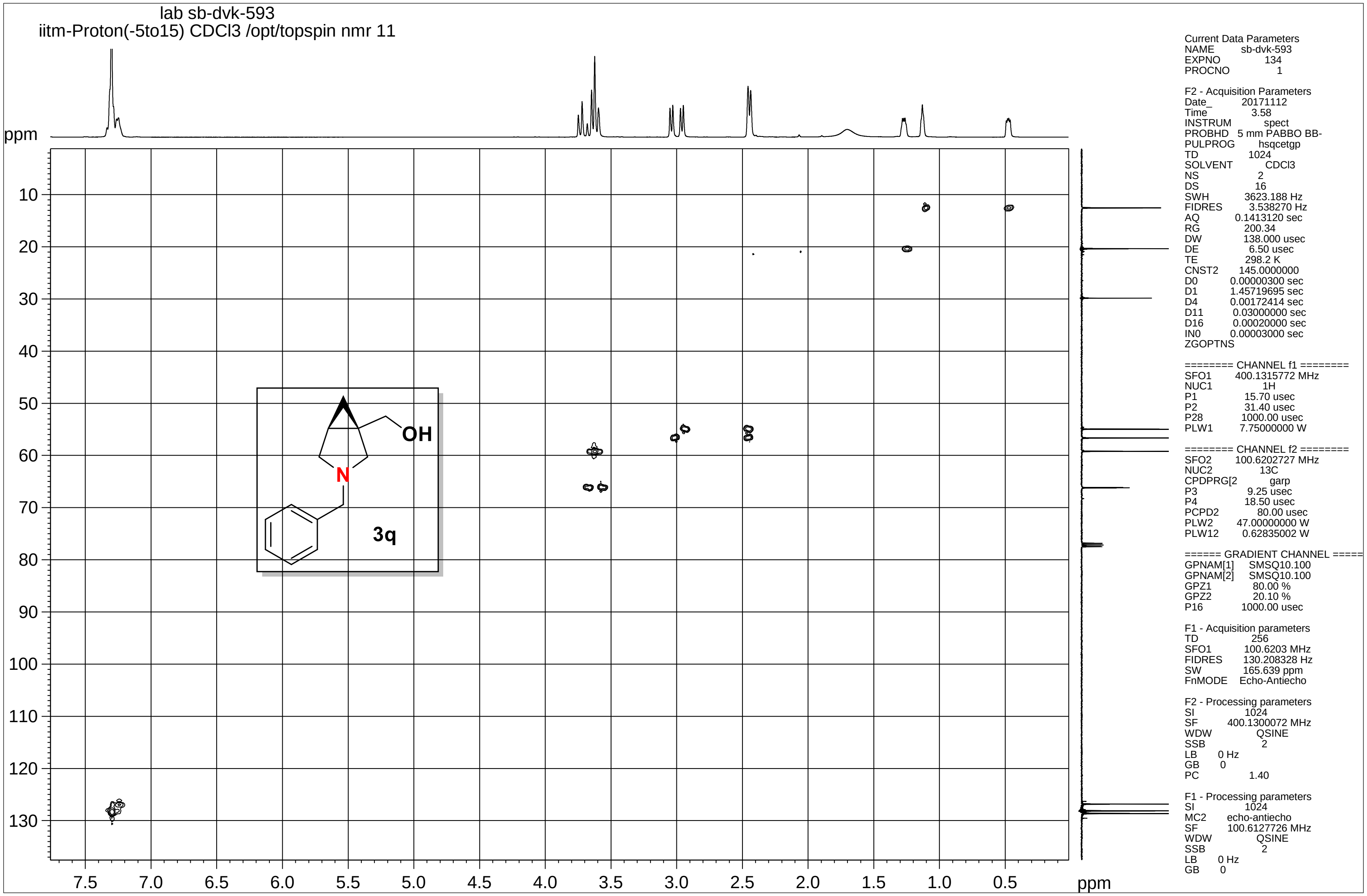
^{13}C NMR spectrum of compound 3q



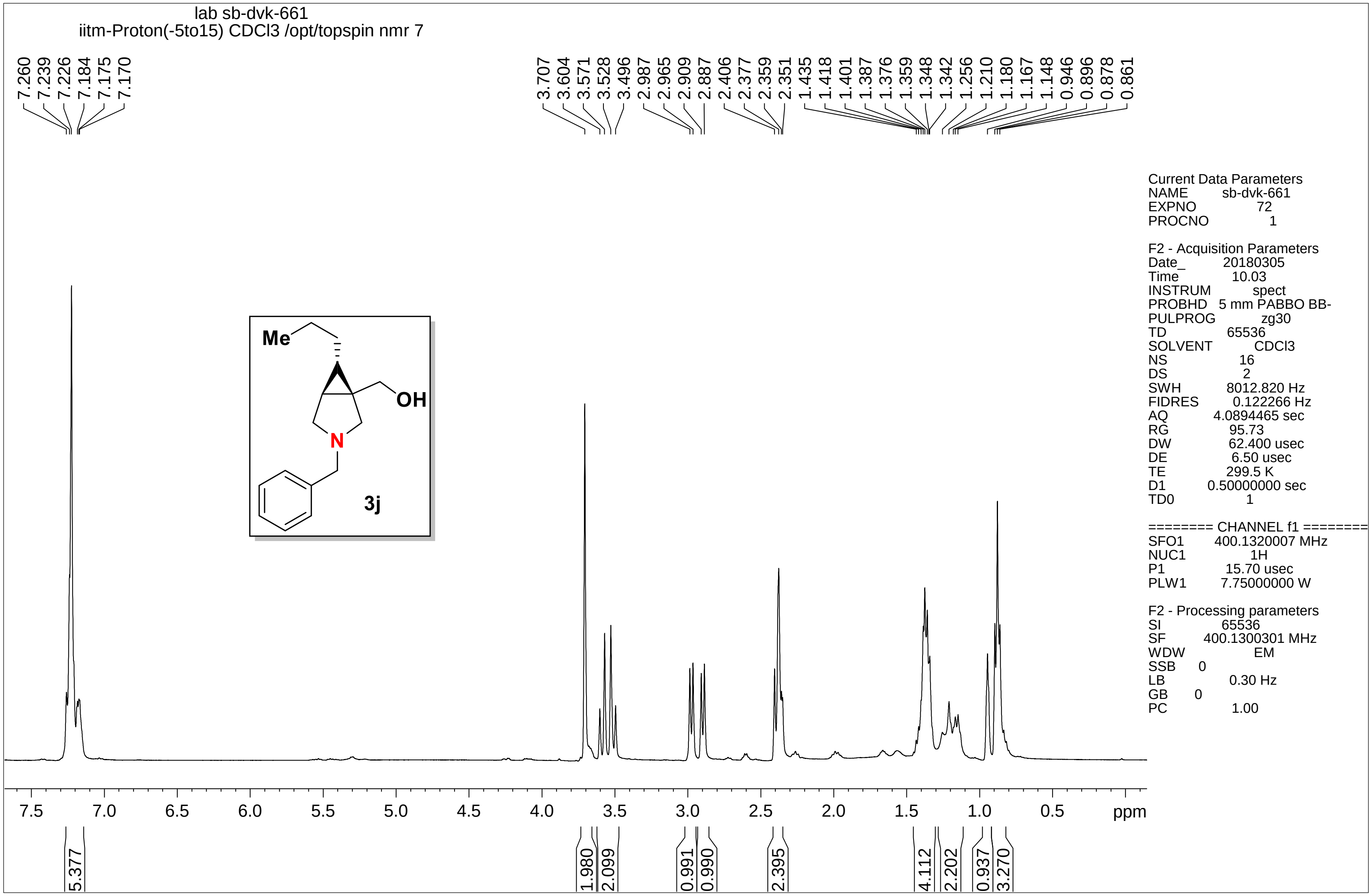
DEPT-135 NMR spectrum of compound 3q



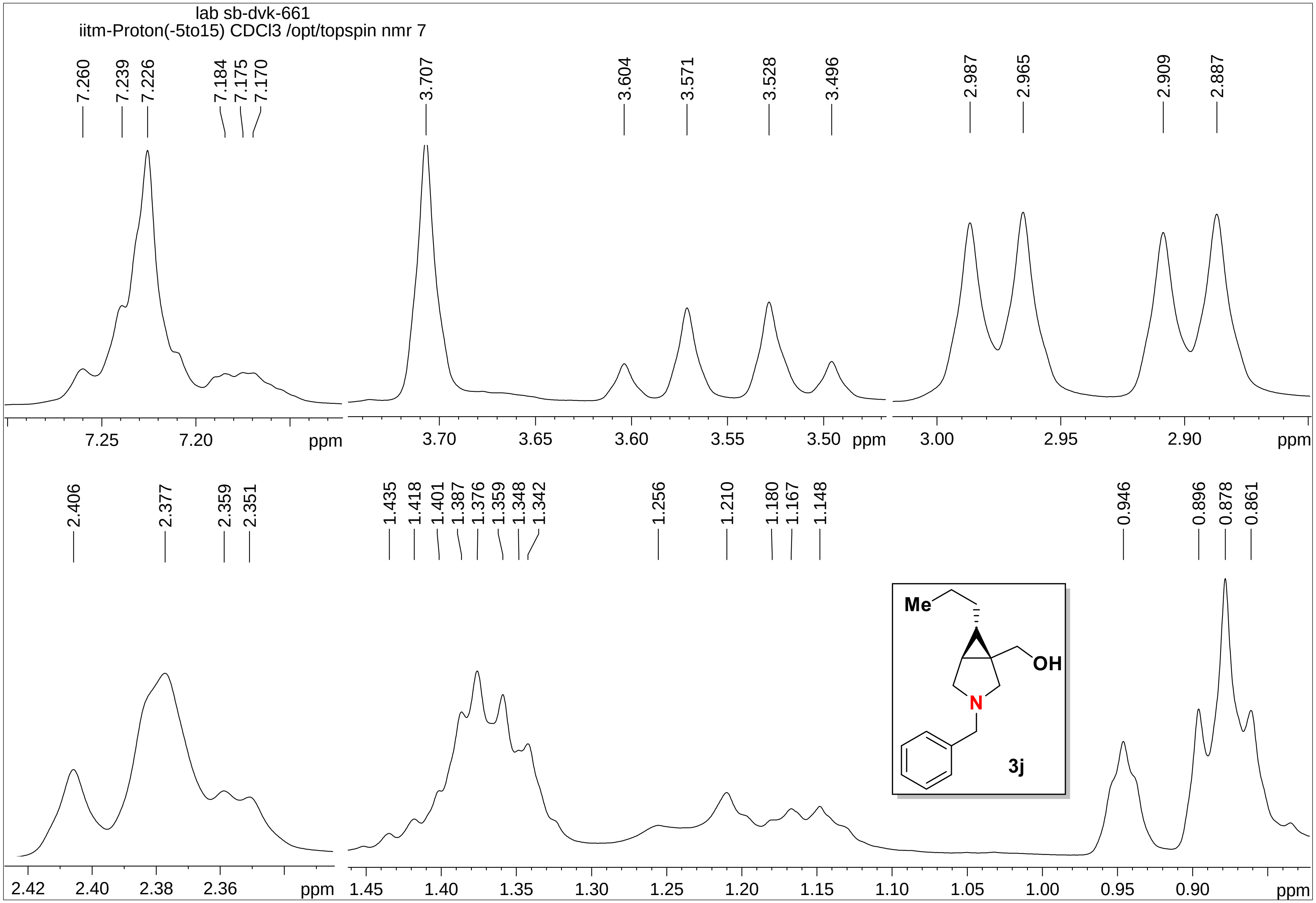
^{1}H-^{1}H COSY NMR spectrum of compound 3q



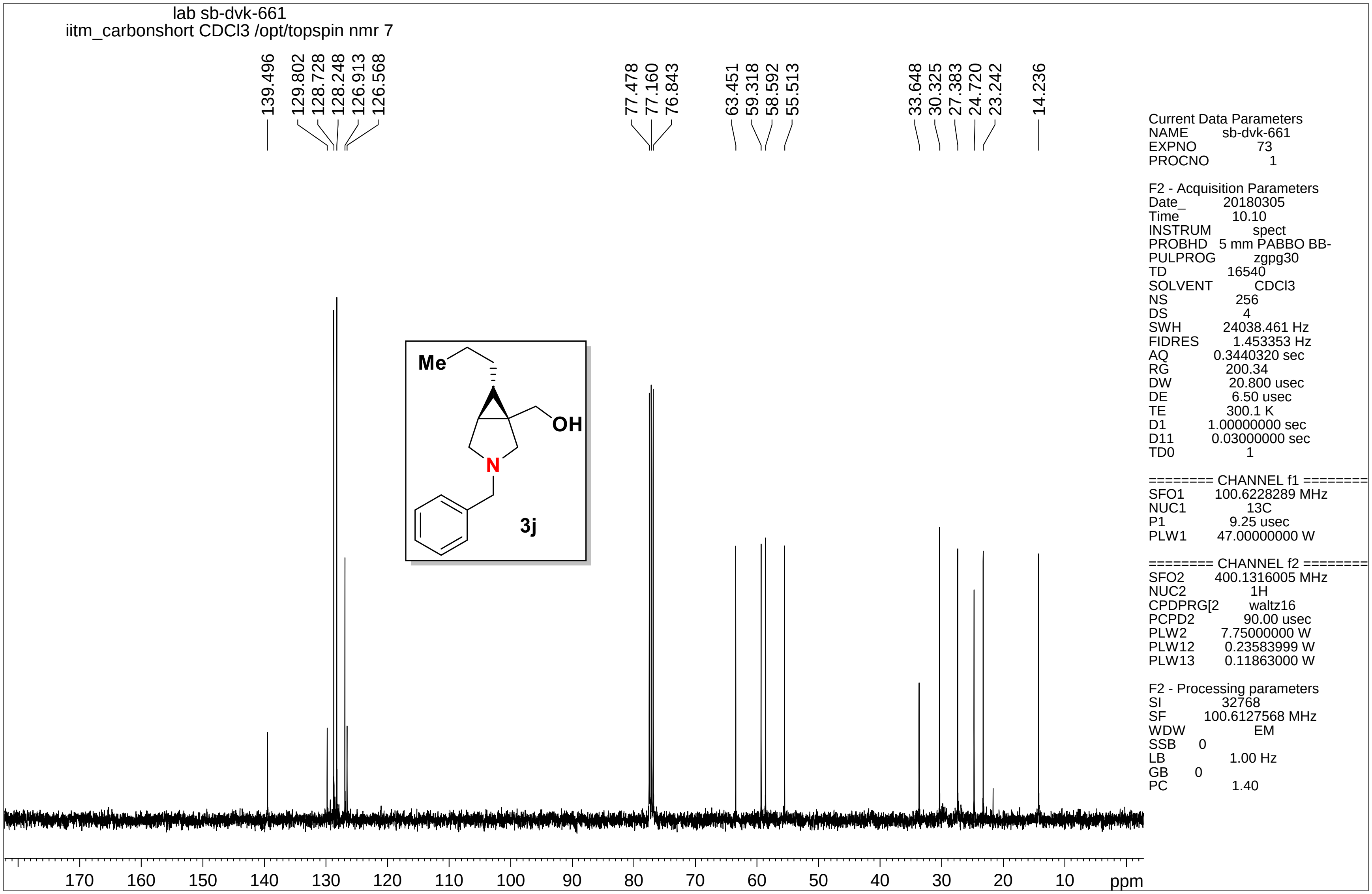
^{1}H-^{13}C HSQC NMR spectrum of compound 3q



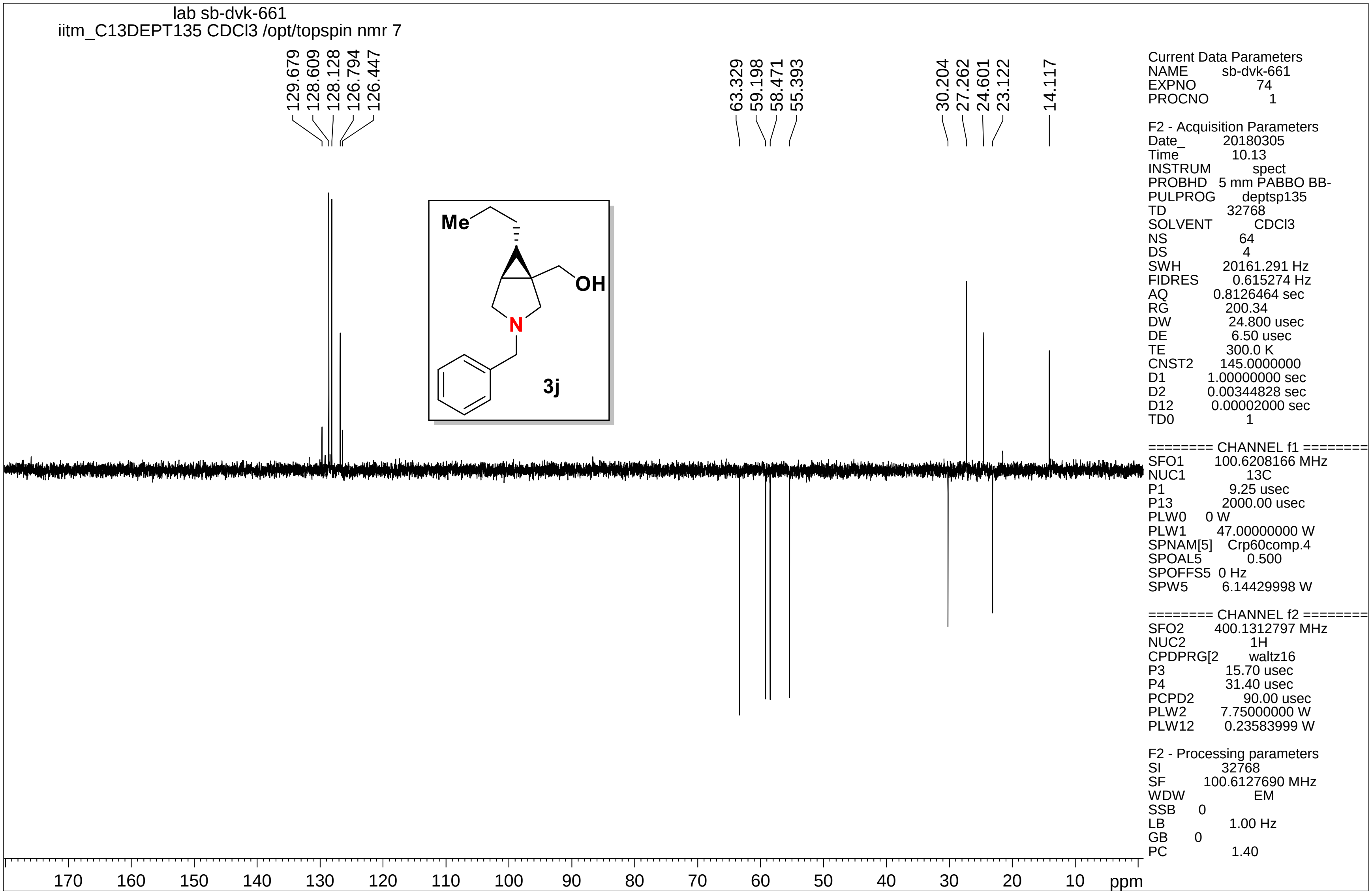
^{1}H NMR spectrum of compound 3j



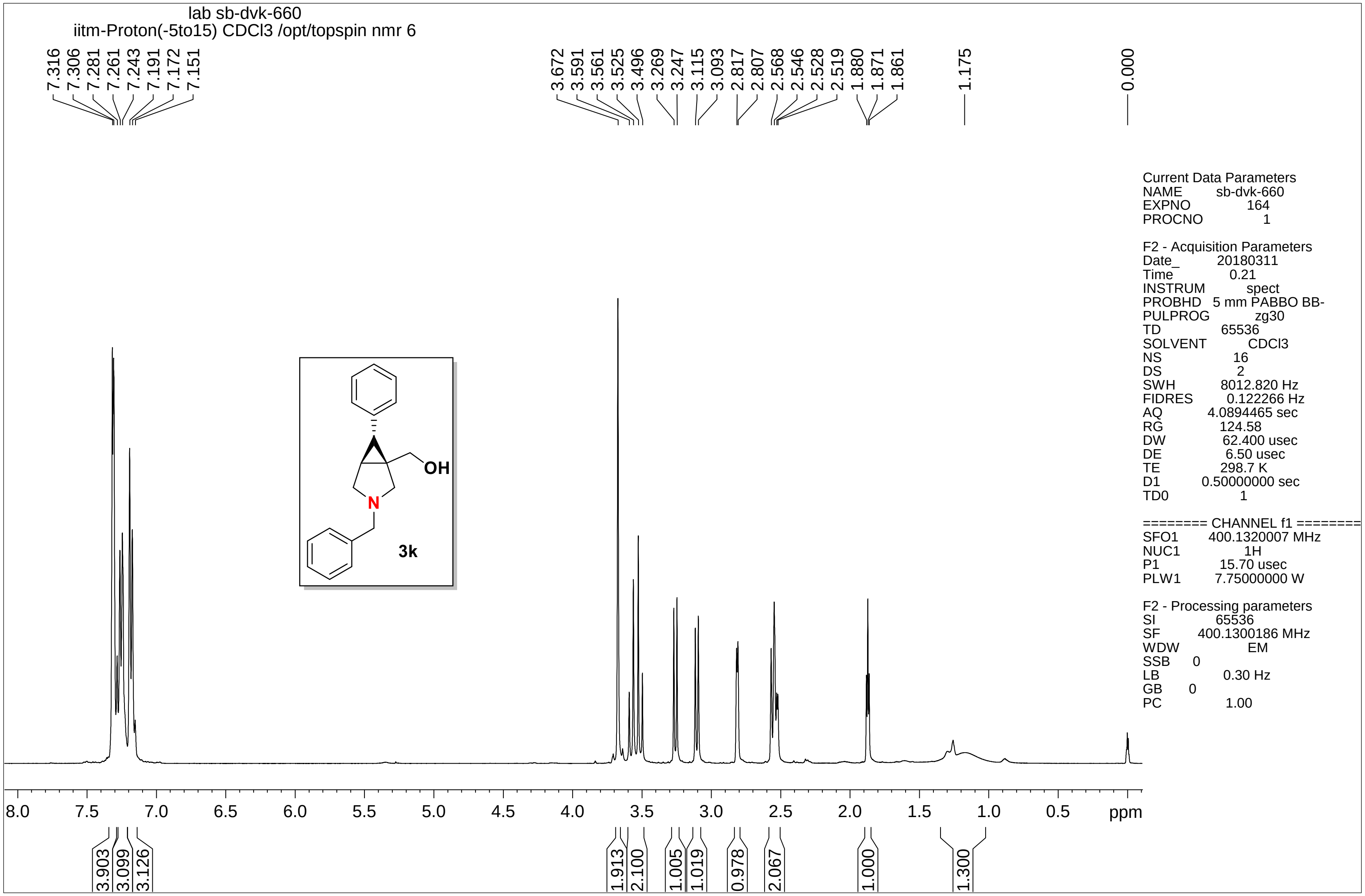
^{1}H NMR spectrum of compound 3j



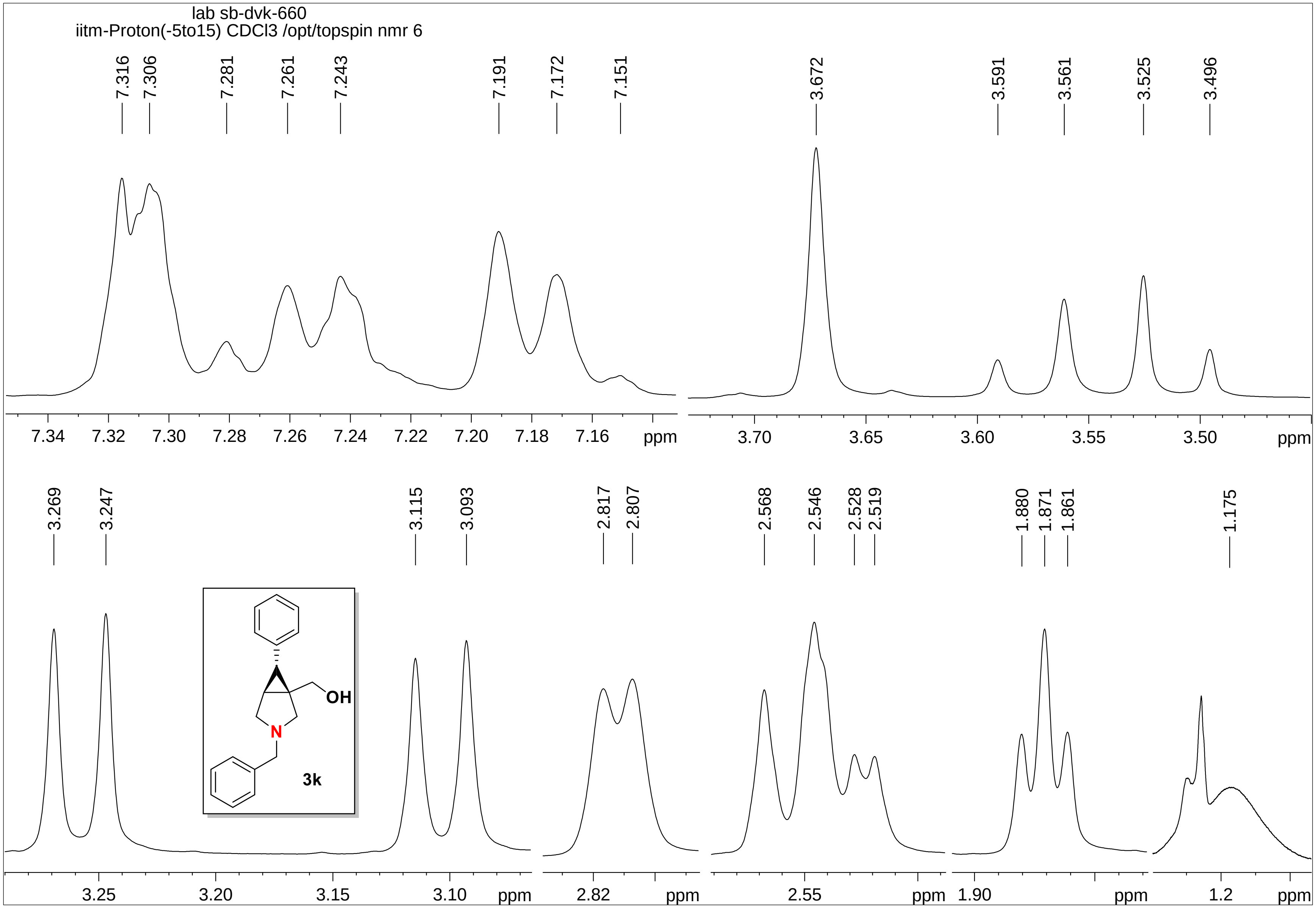
^{13}C NMR spectrum of compound 3j



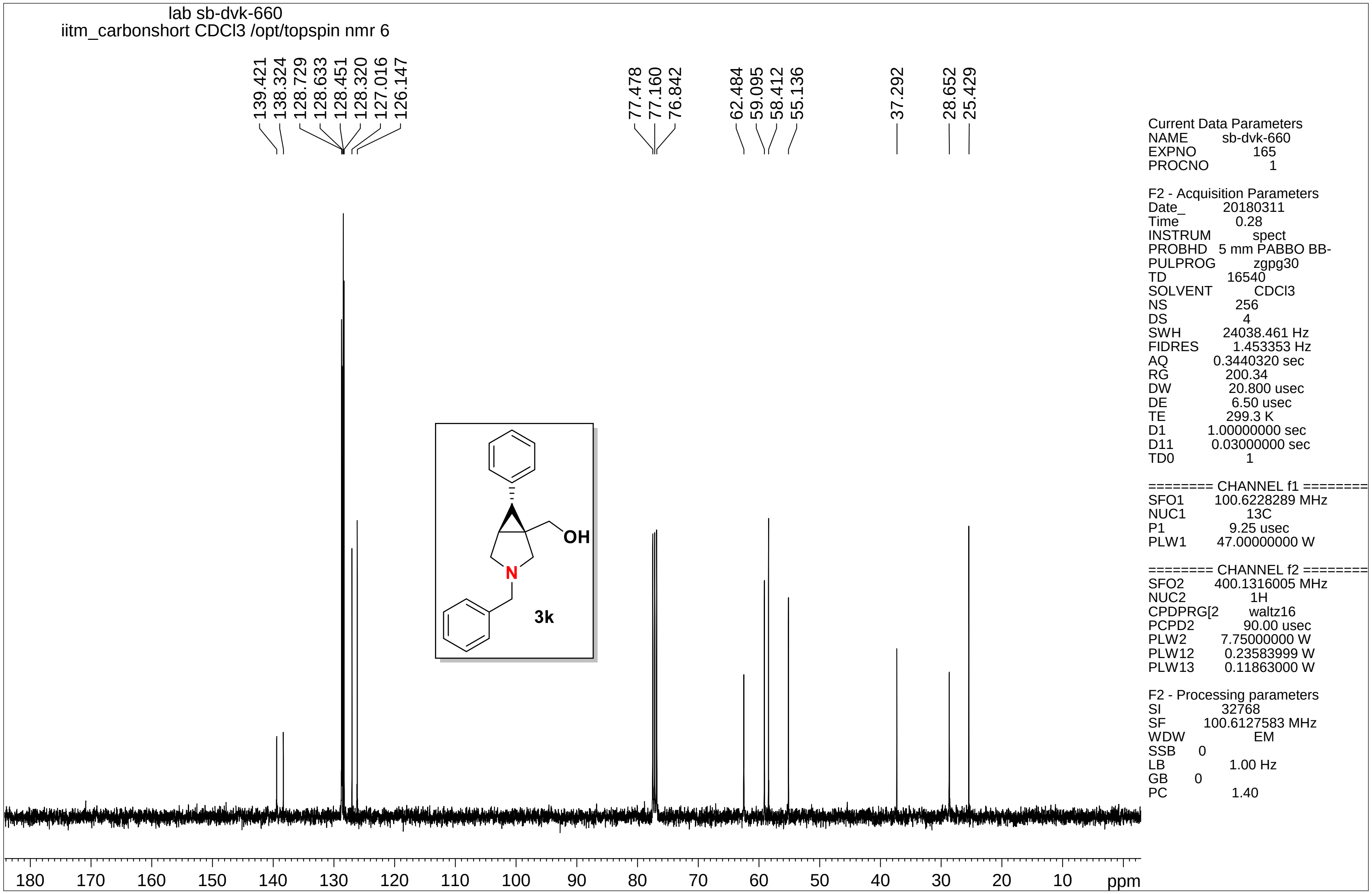
DEPT-135 NMR spectrum of compound 3j



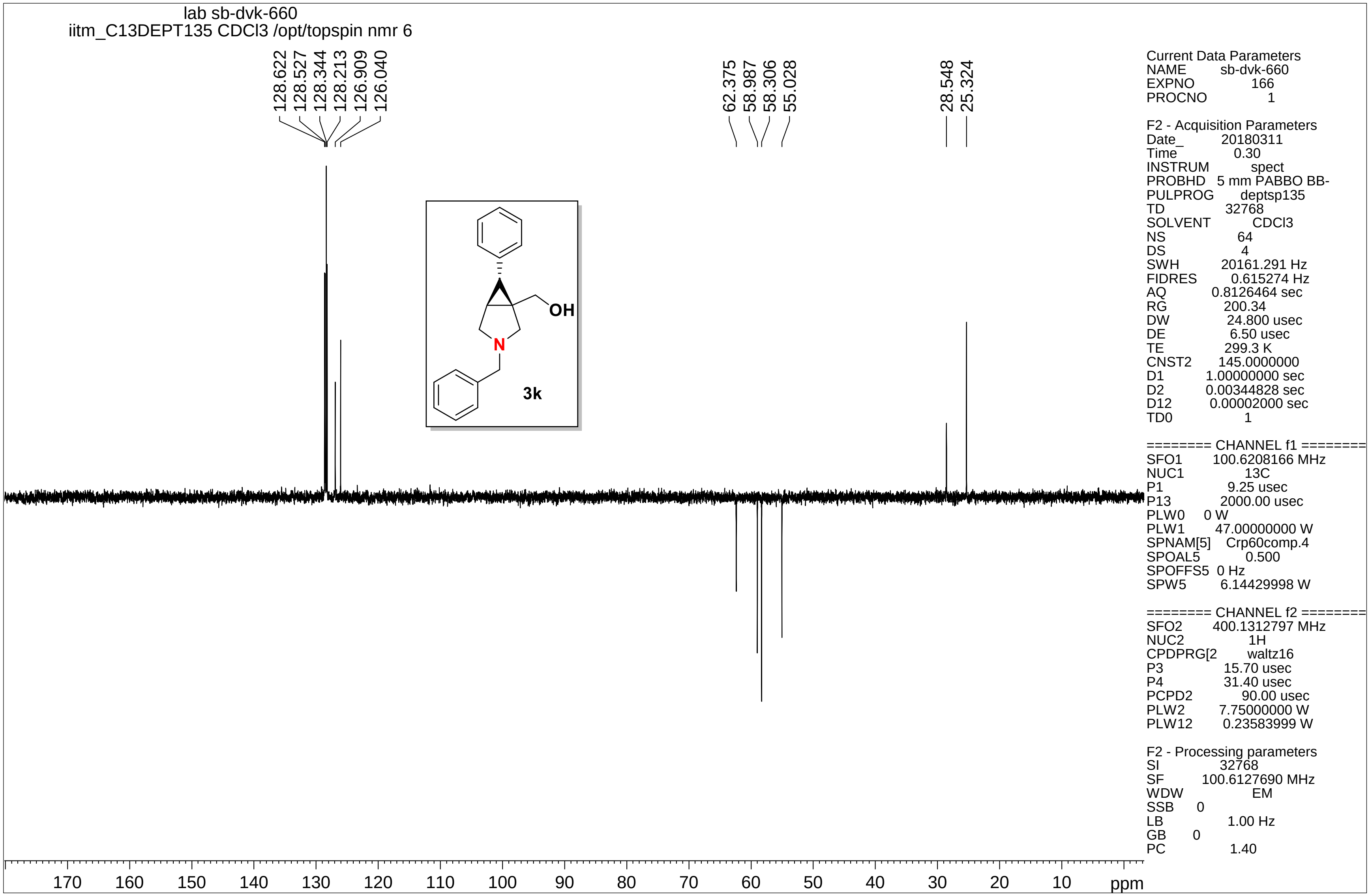
^{1}H NMR spectrum of compound 3k



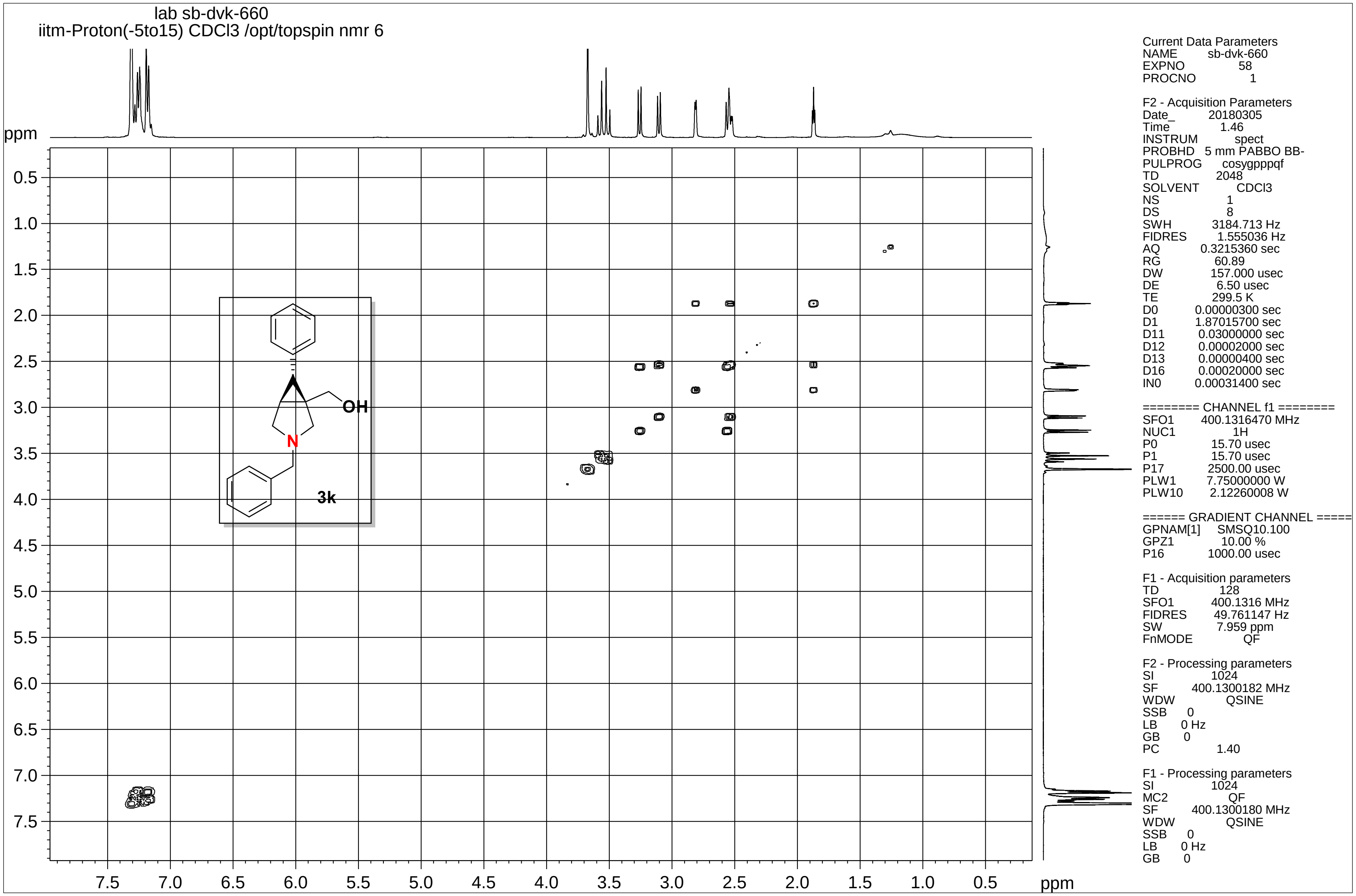
^{1}H NMR spectrum of compound 3k



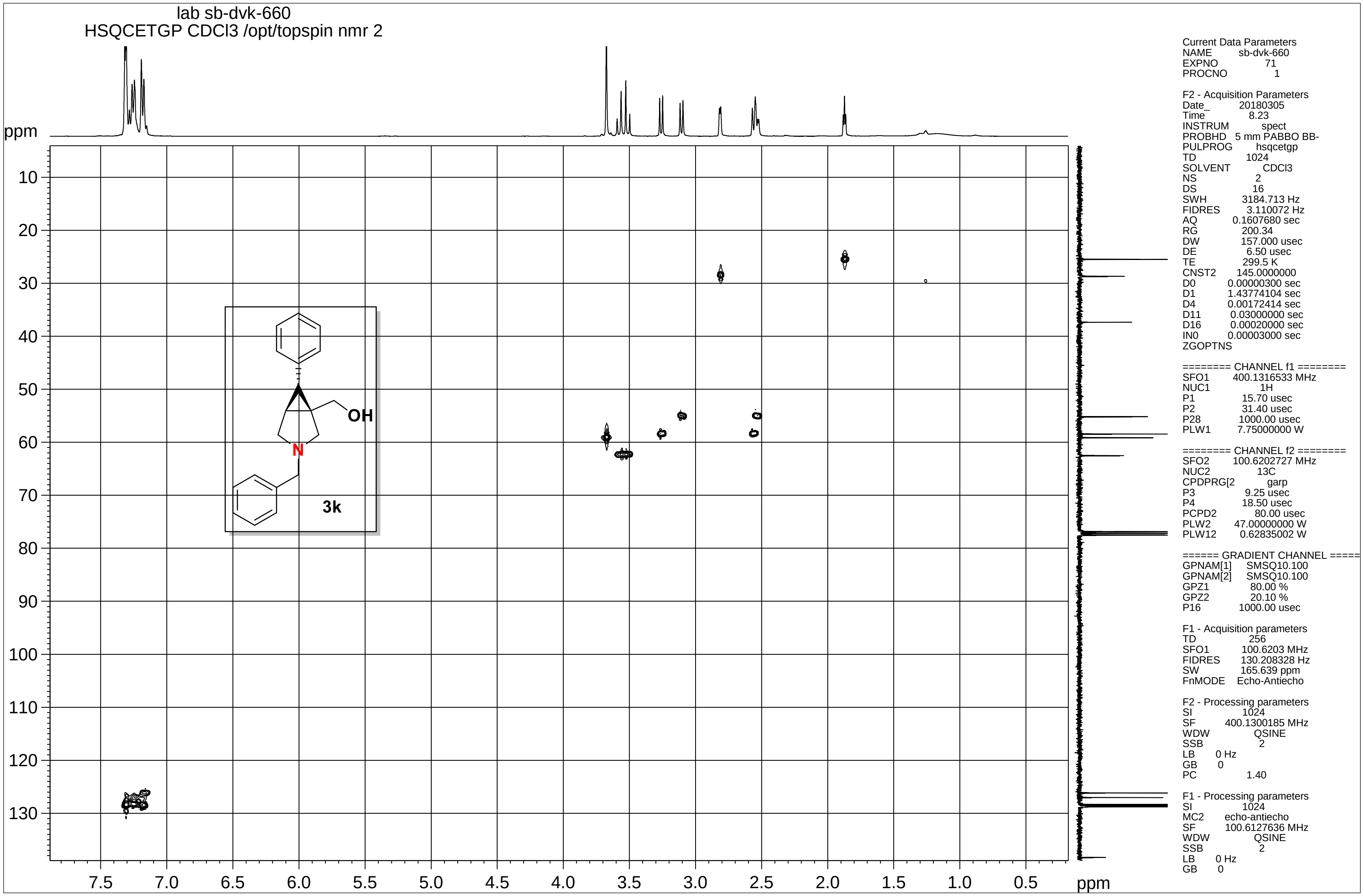
^{13}C NMR spectrum of compound 3k



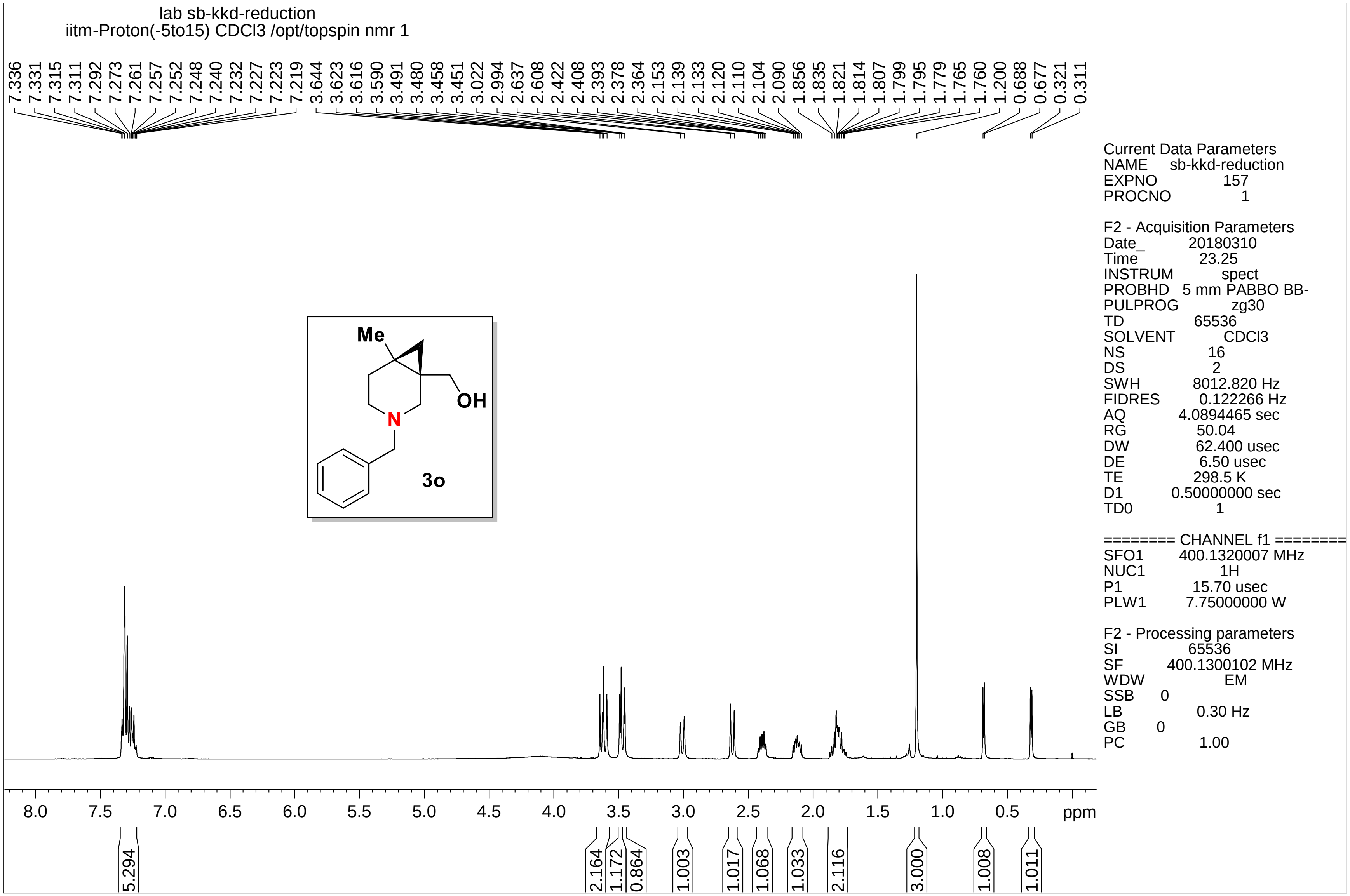
DEPT-135 NMR spectrum of compound 3k



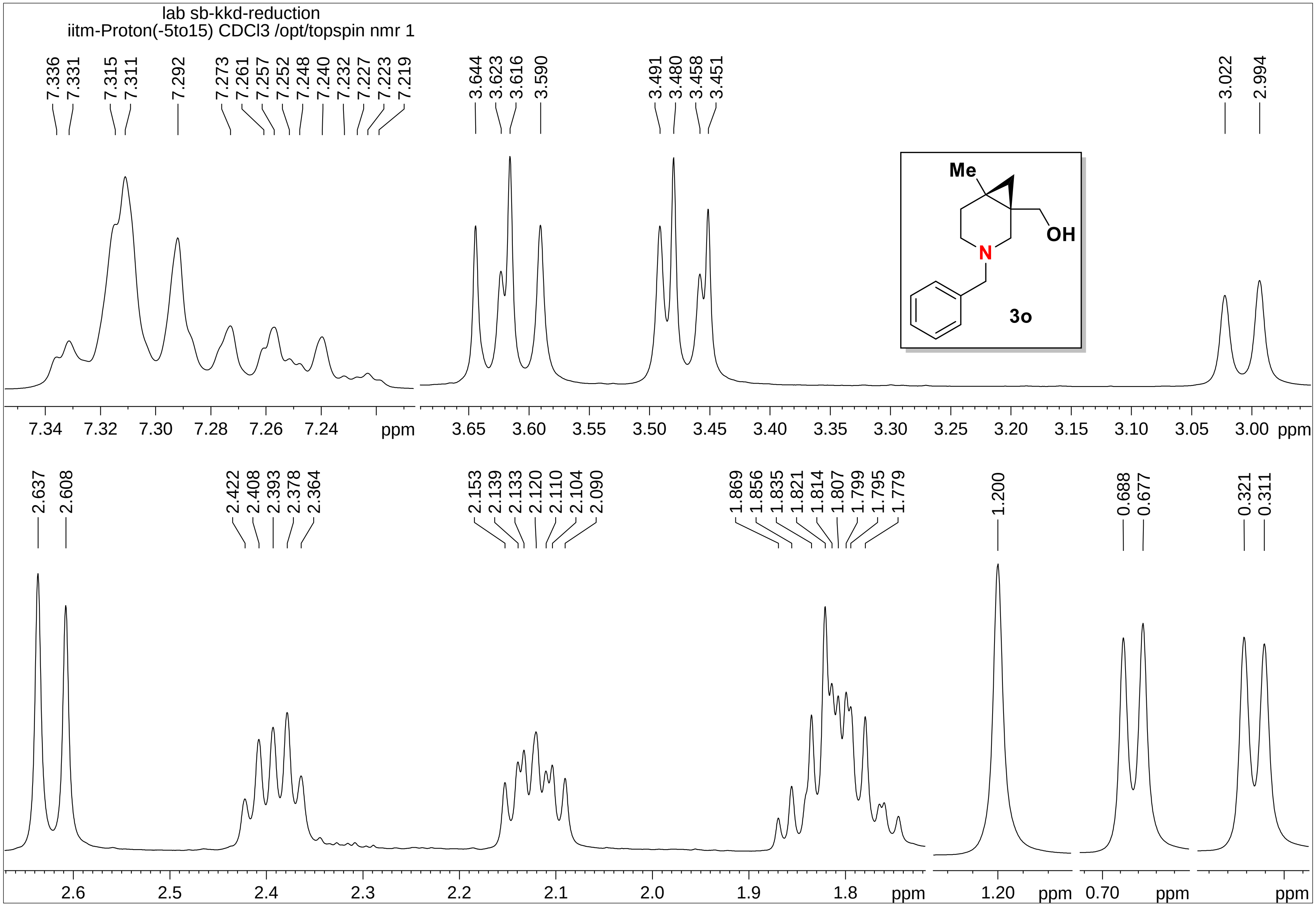
^{1}H-^{1}H COSY NMR spectrum of compound 3k



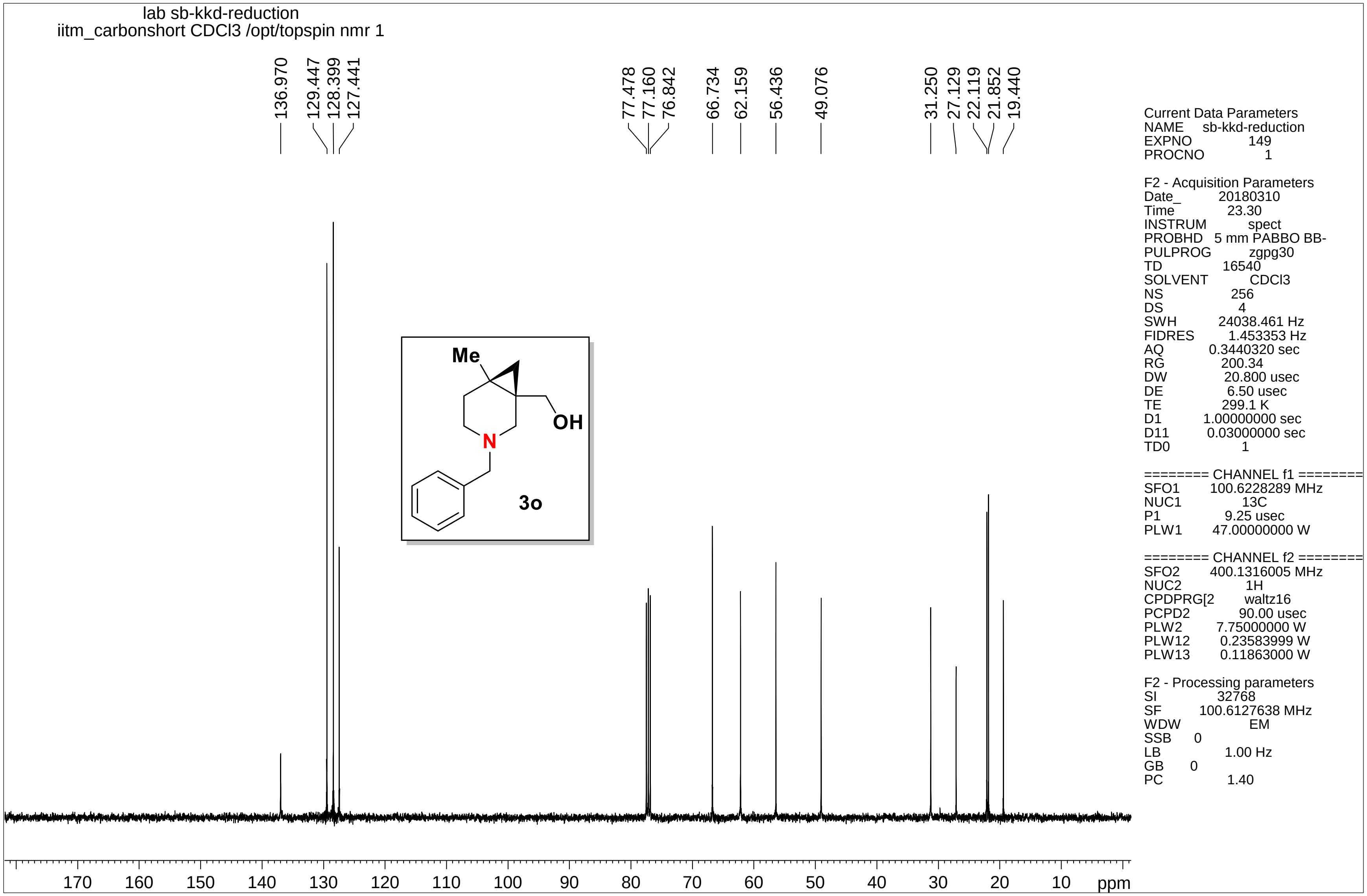
^{1}H-^{13}C HSQC NMR spectrum of compound 3k



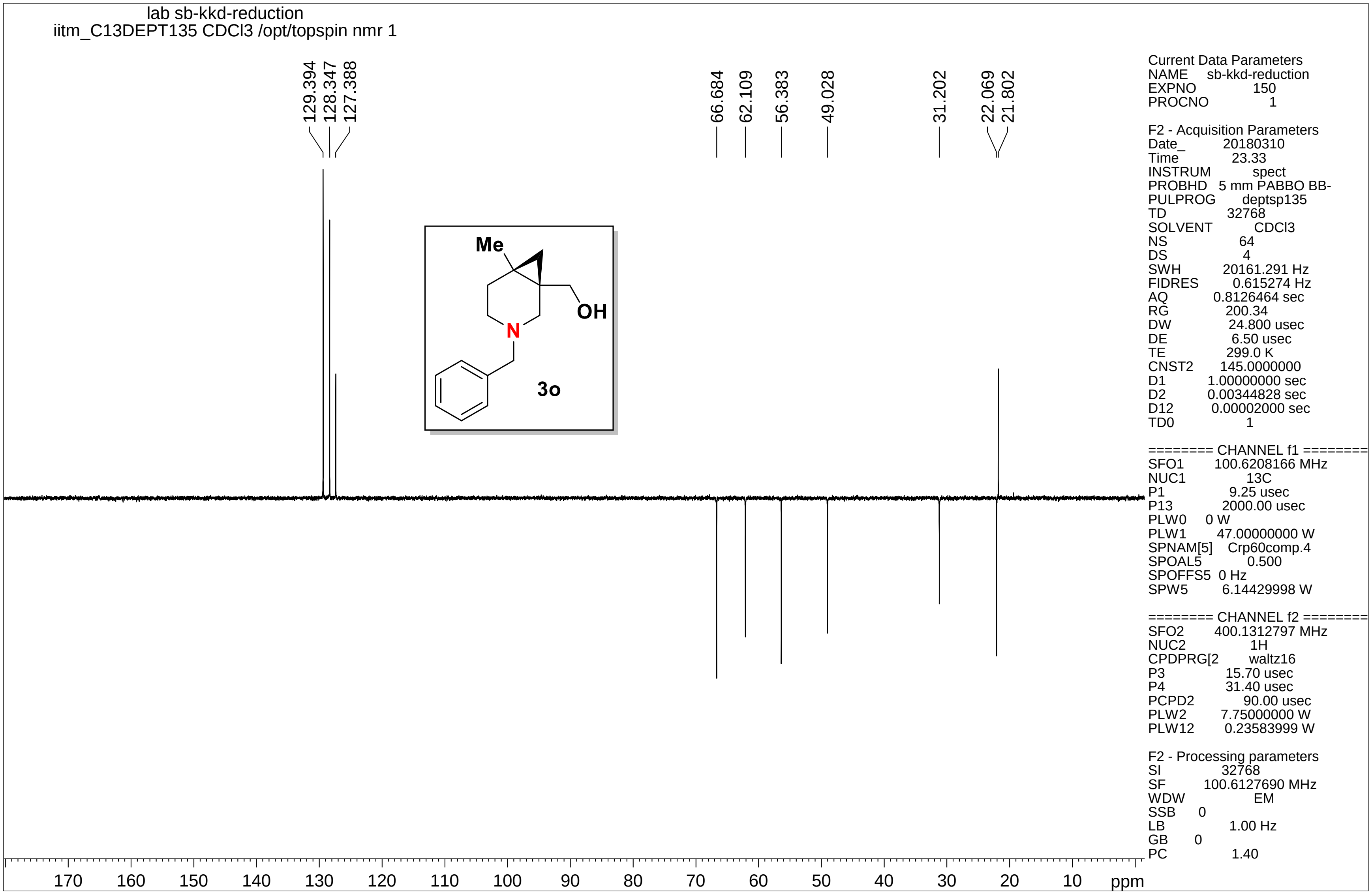
^{1}H NMR spectrum of compound 3o



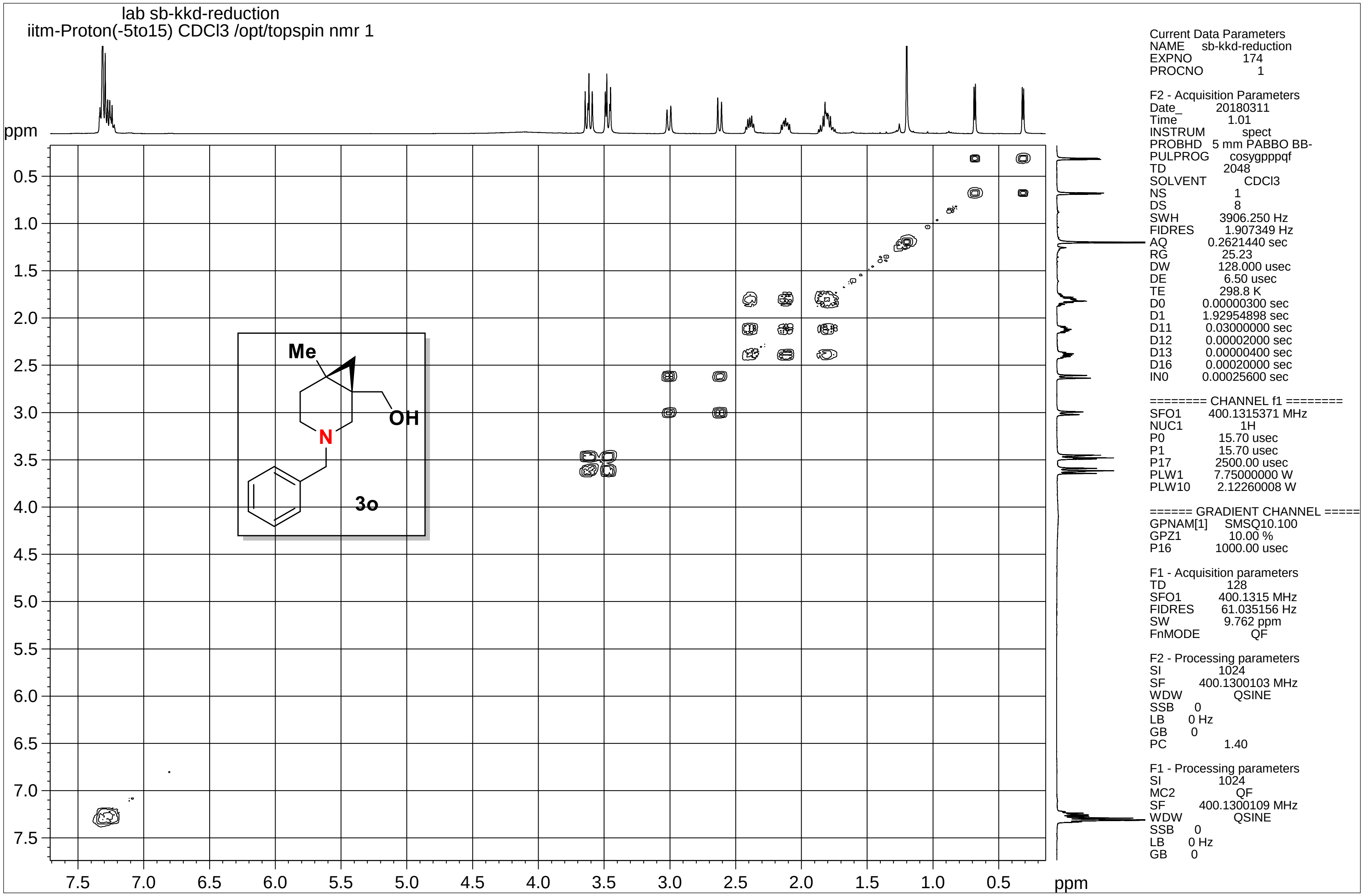
[1]H NMR spectrum of compound 3o



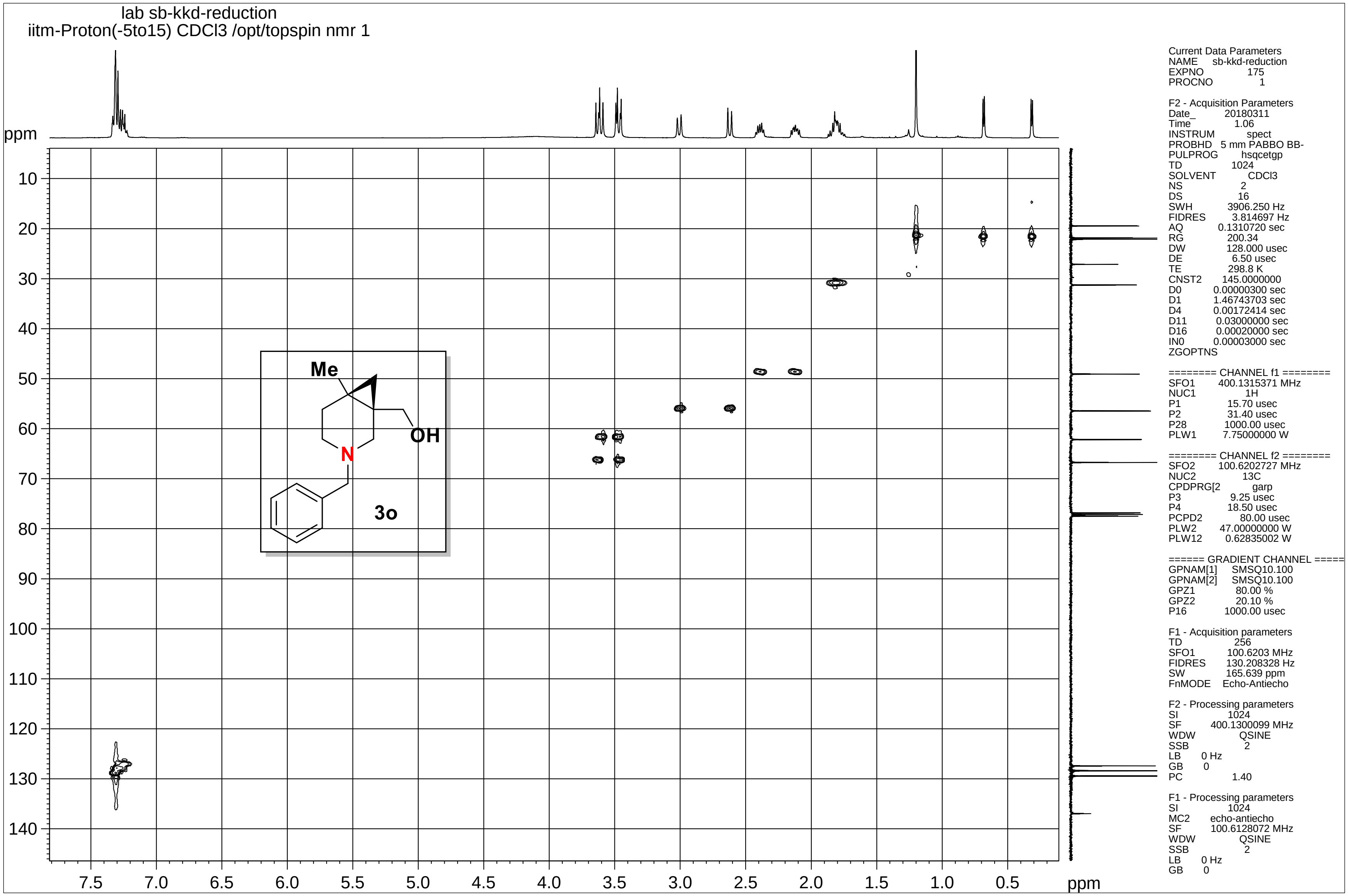
^{13}C NMR spectrum of compound 3o



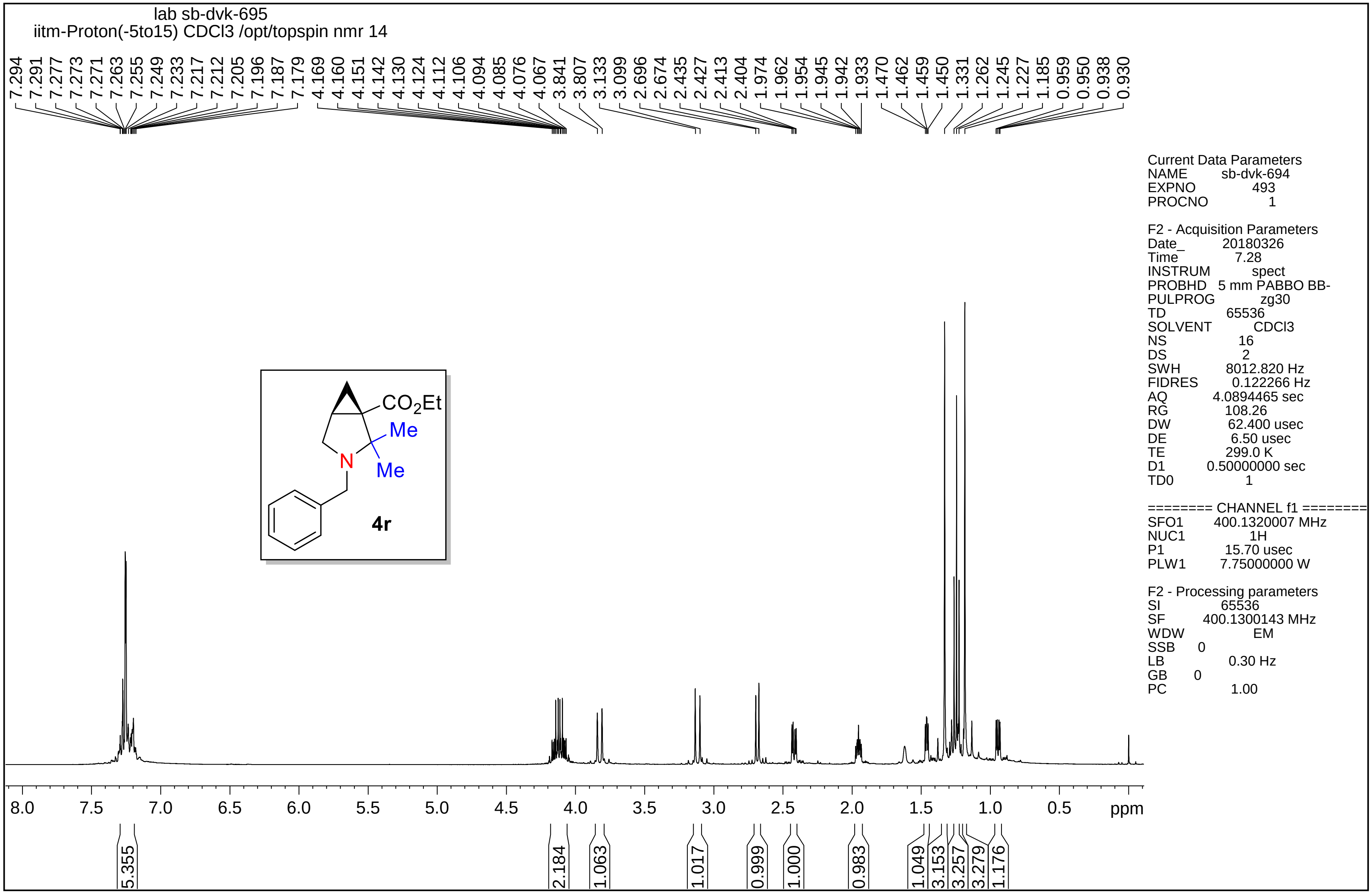
DEPT-135 NMR spectrum of compound 3o



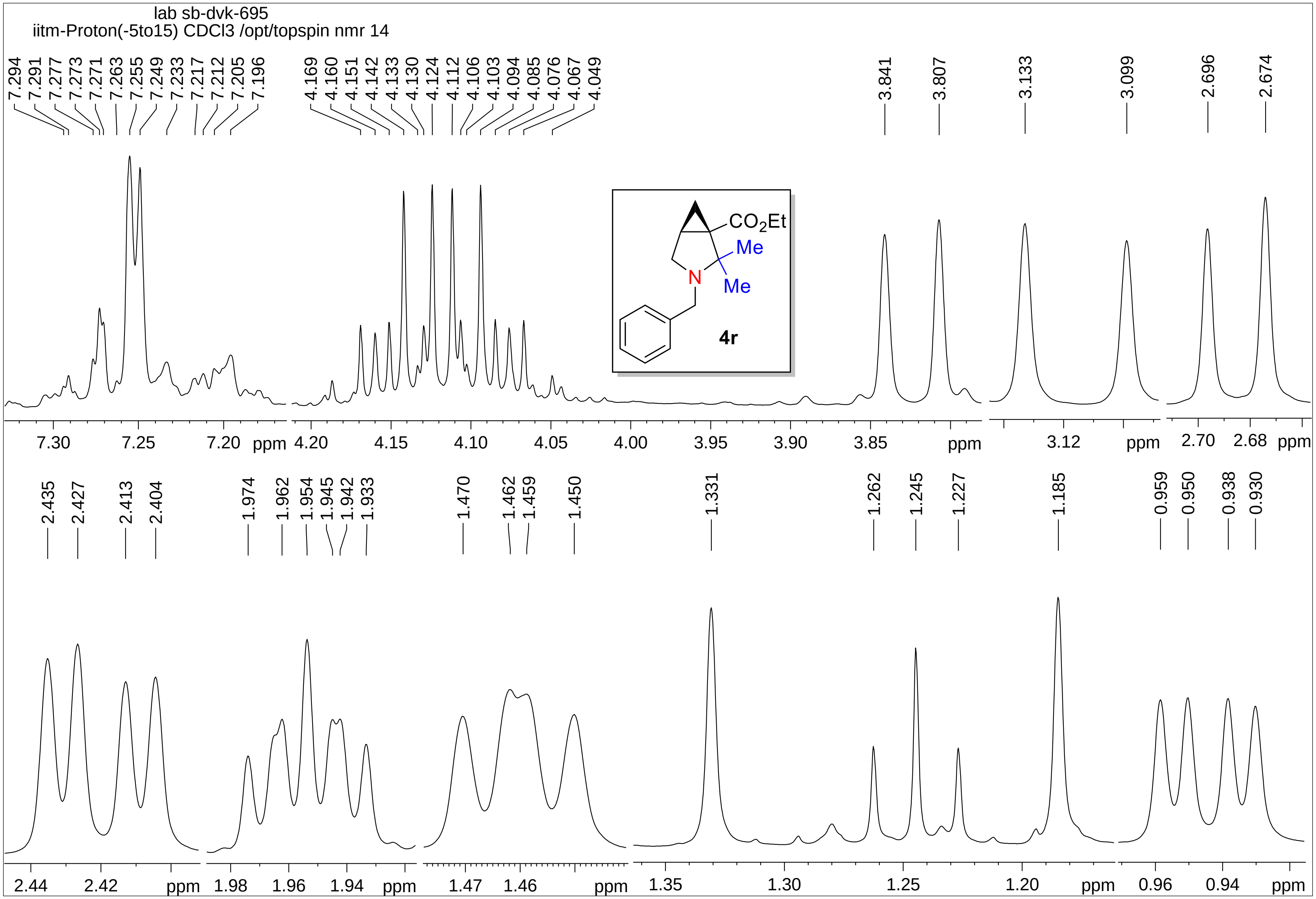
^{1}H-^{1}H COSY NMR spectrum of compound 3o



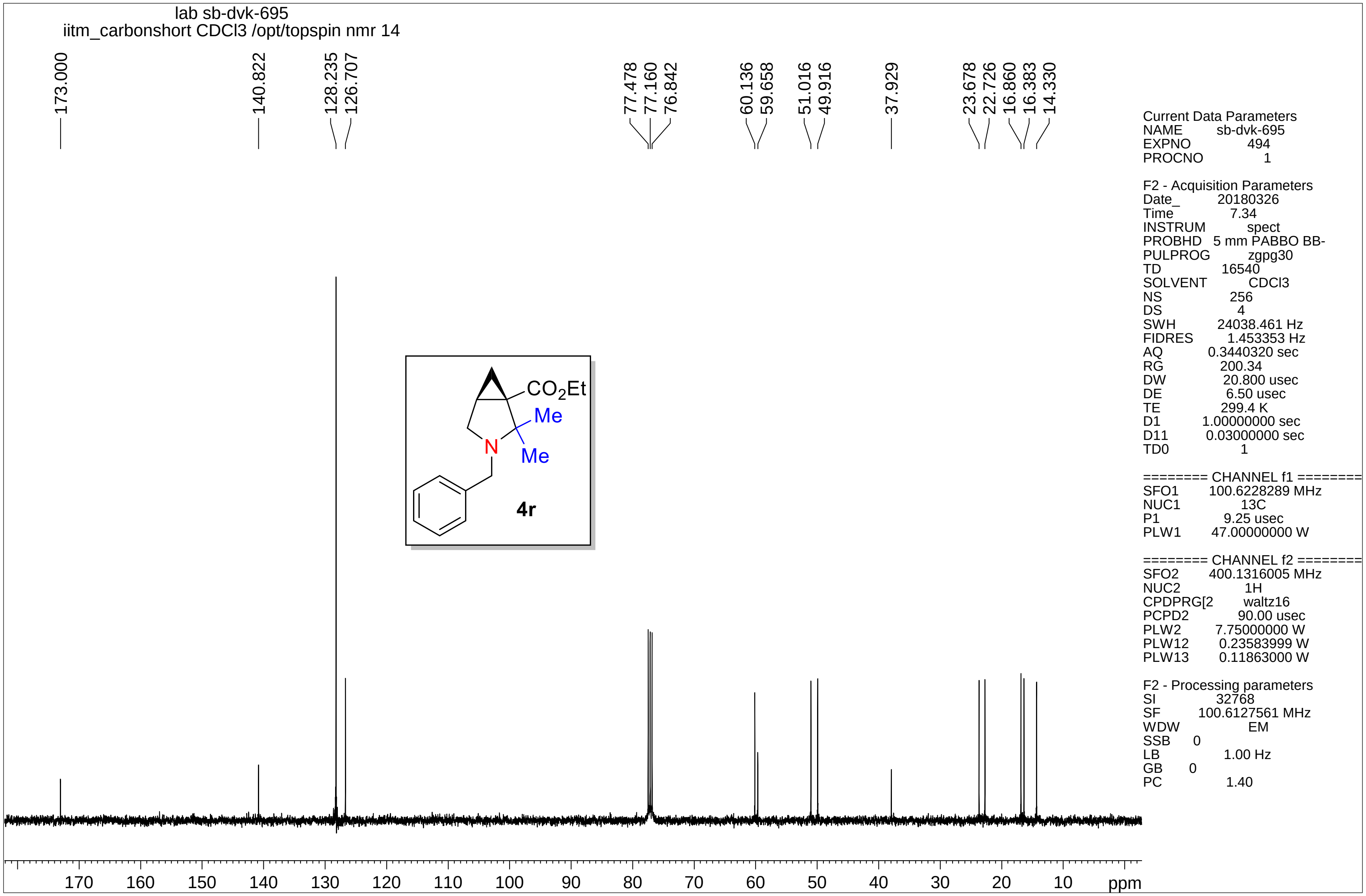
^{1}H-^{13}C HSQC NMR spectrum of compound 3o



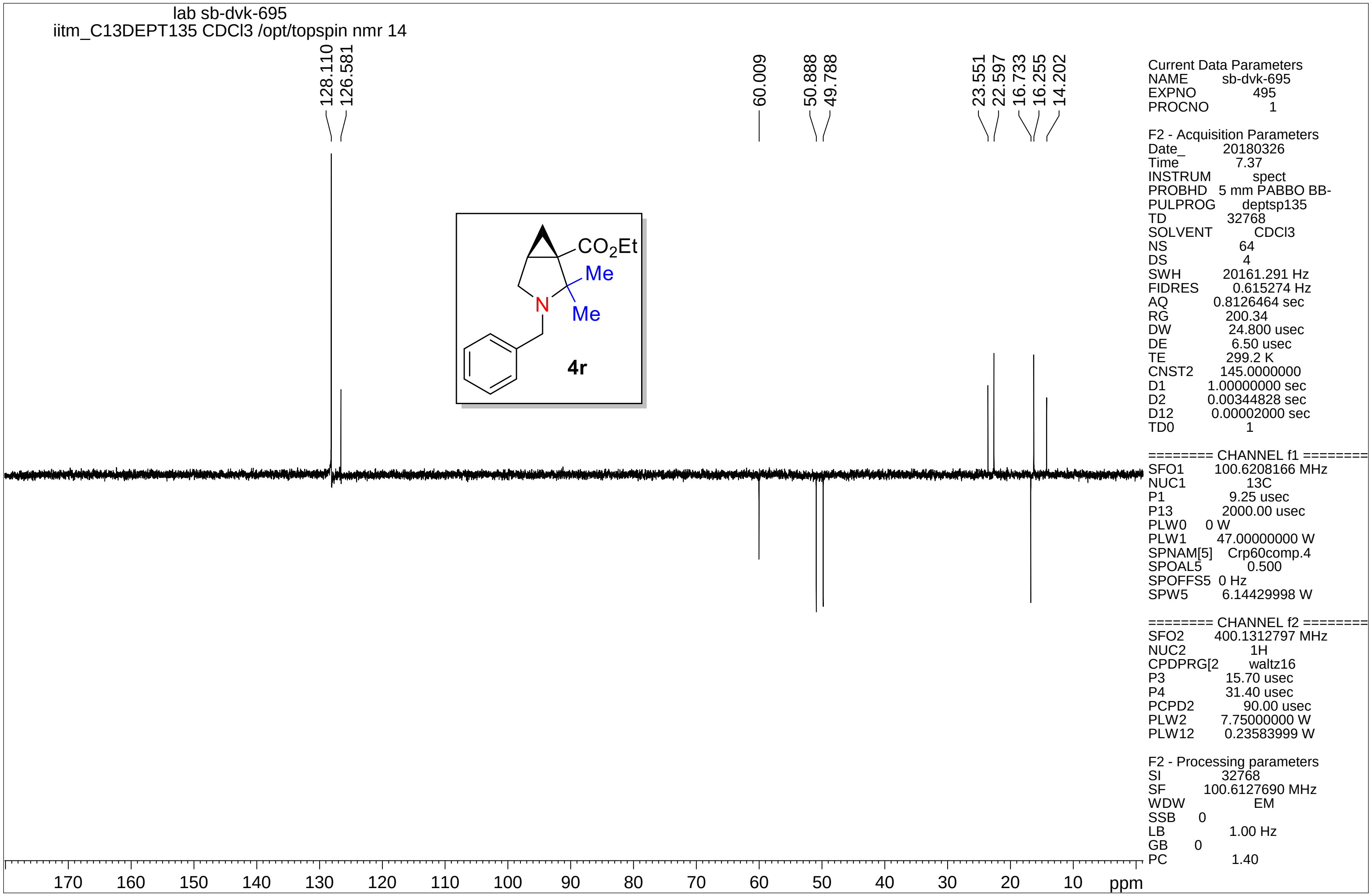
[1]H NMR spectrum of compound 4r



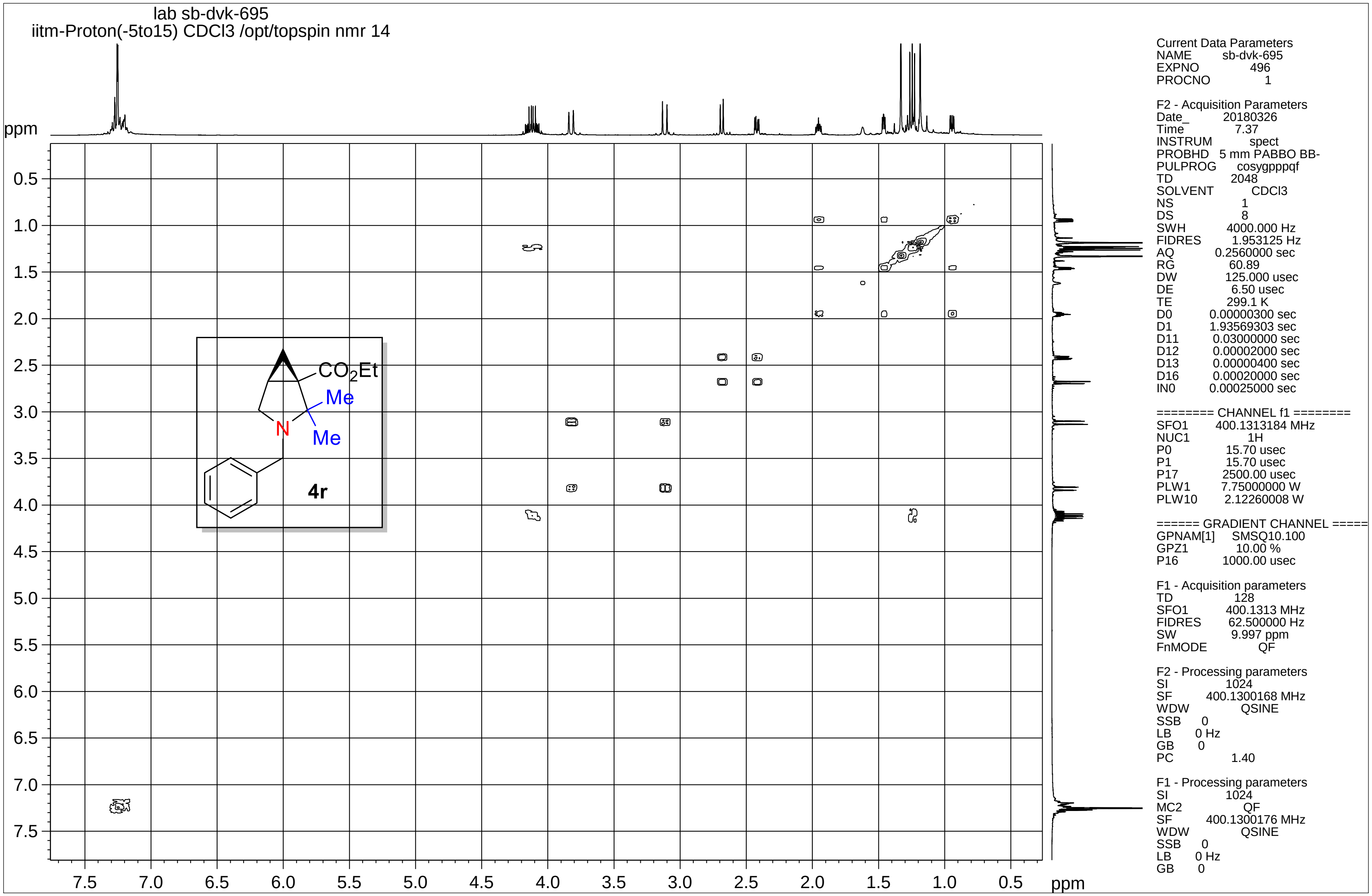
^{1}H NMR spectrum of compound 4r



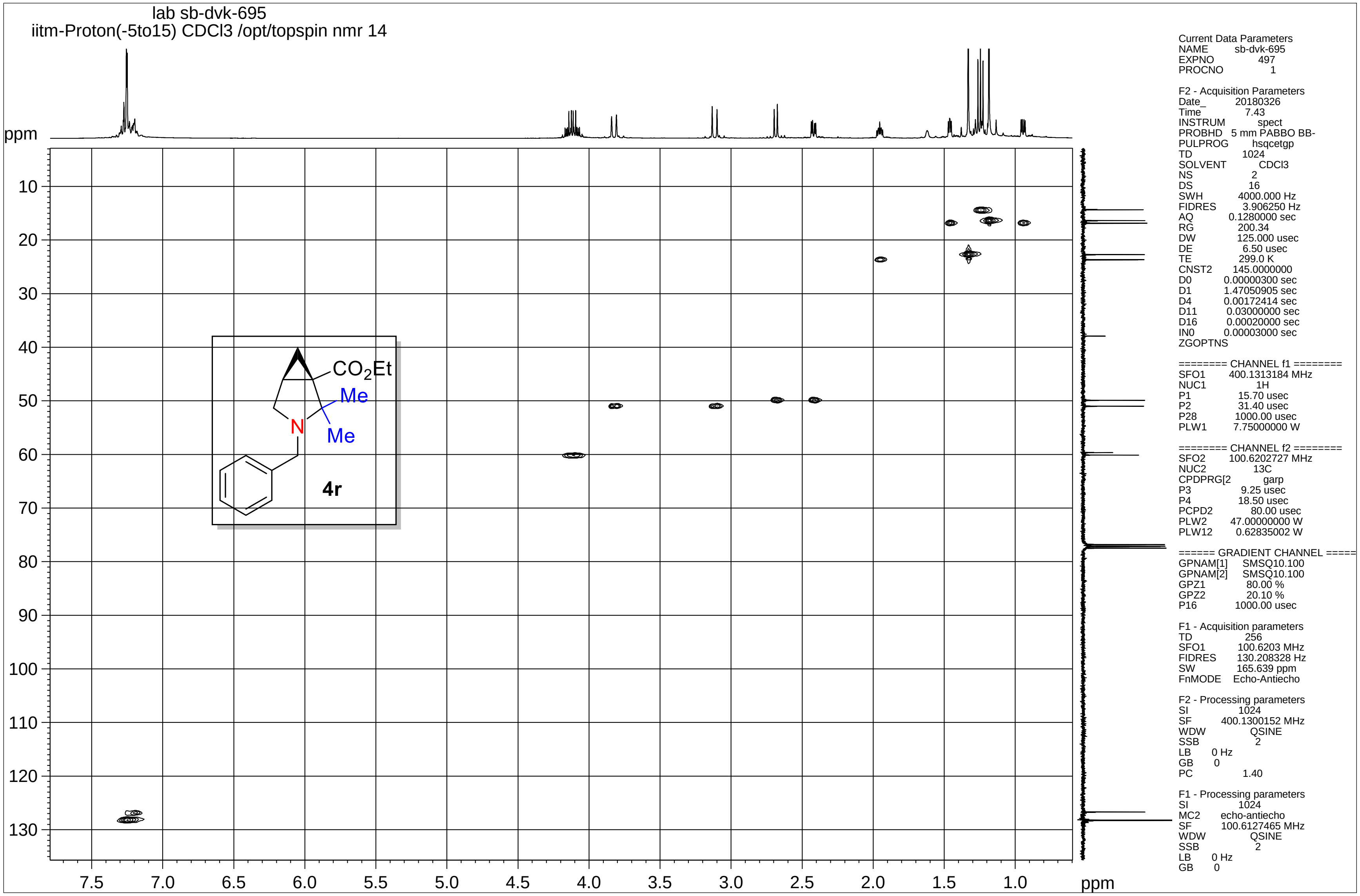
^{13}C NMR spectrum of compound 4r



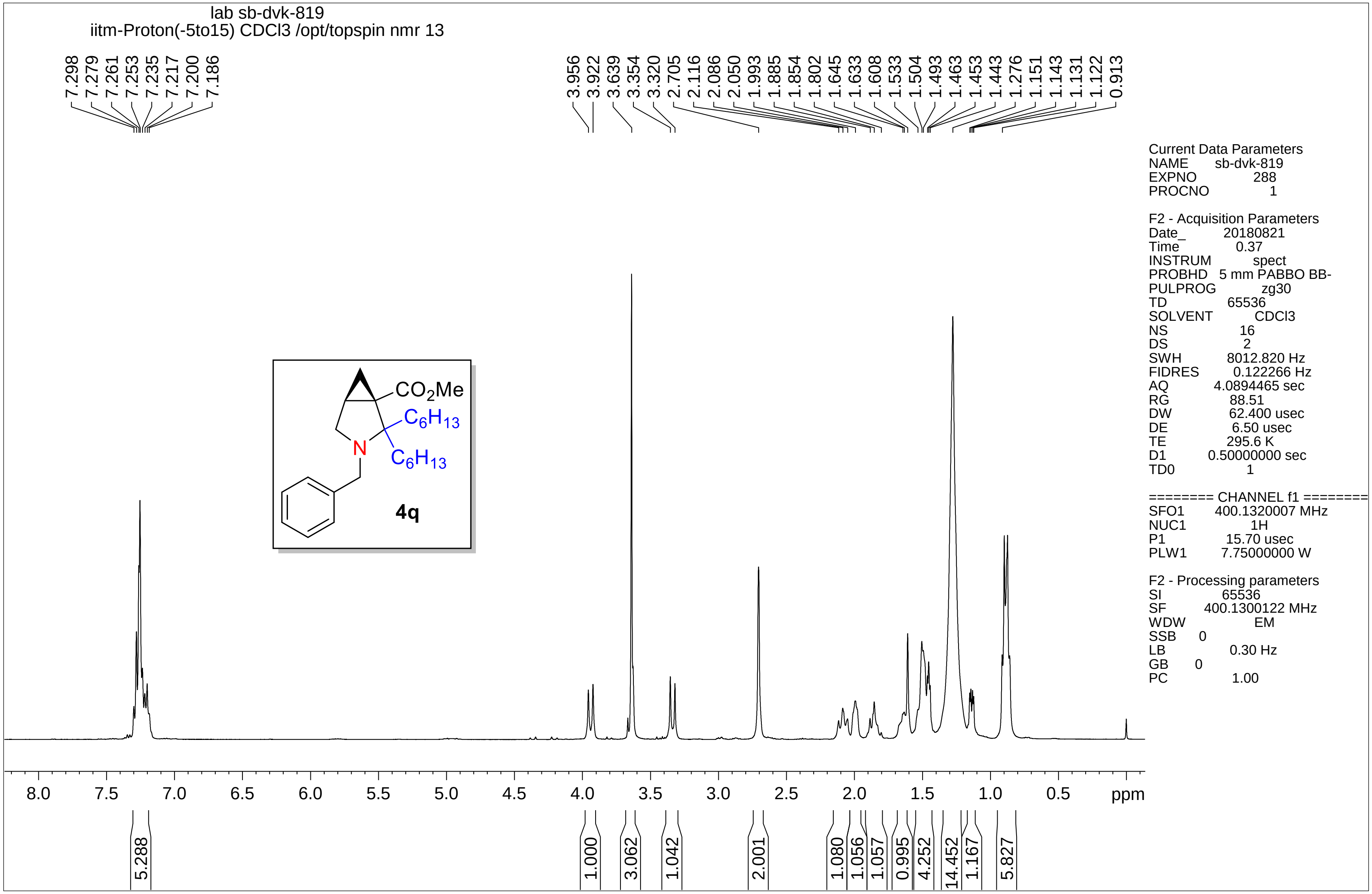
DEPT-135 NMR spectrum of compound 4r



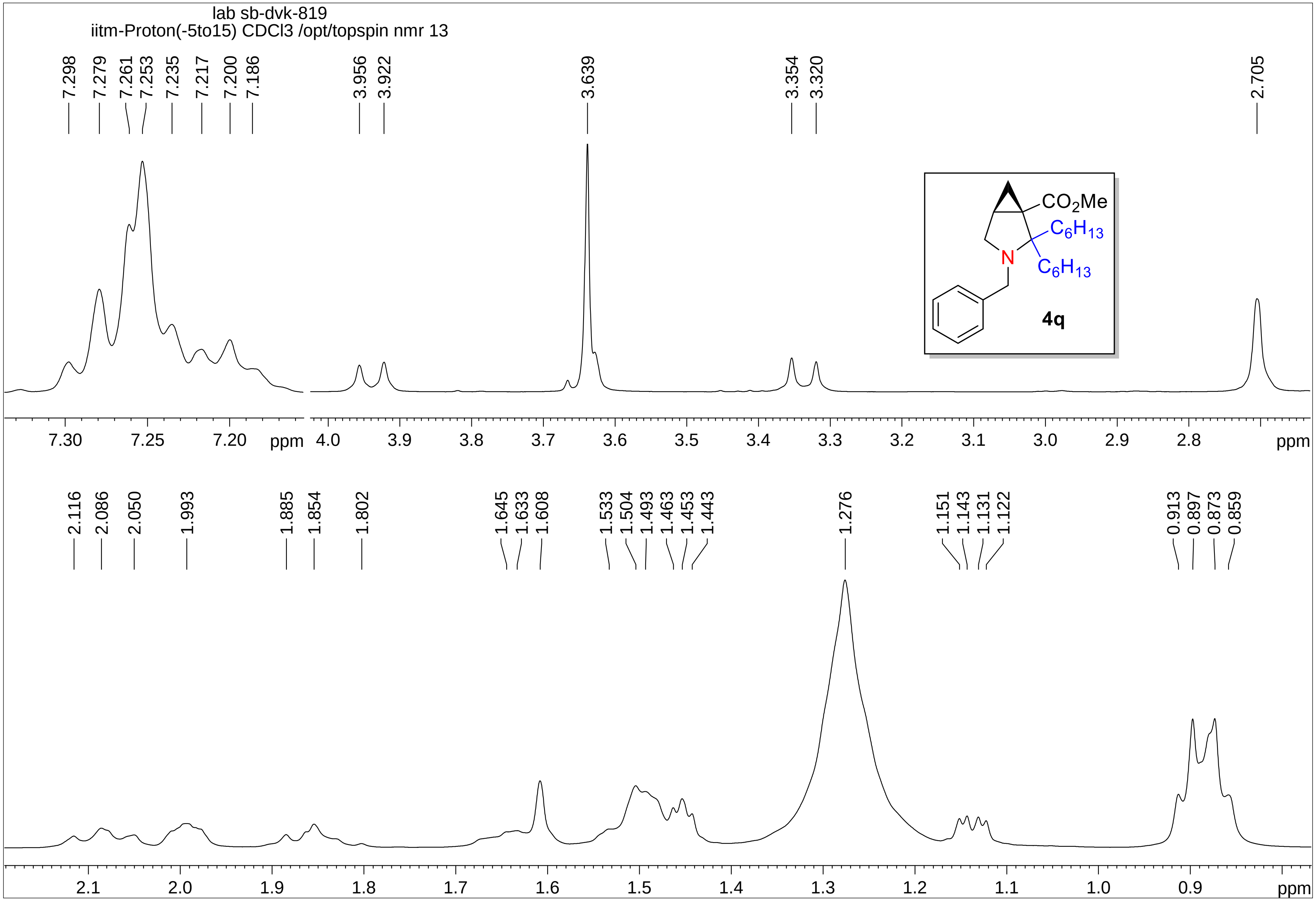
^{1}H-^{1}H COSY NMR spectrum of compound 4r



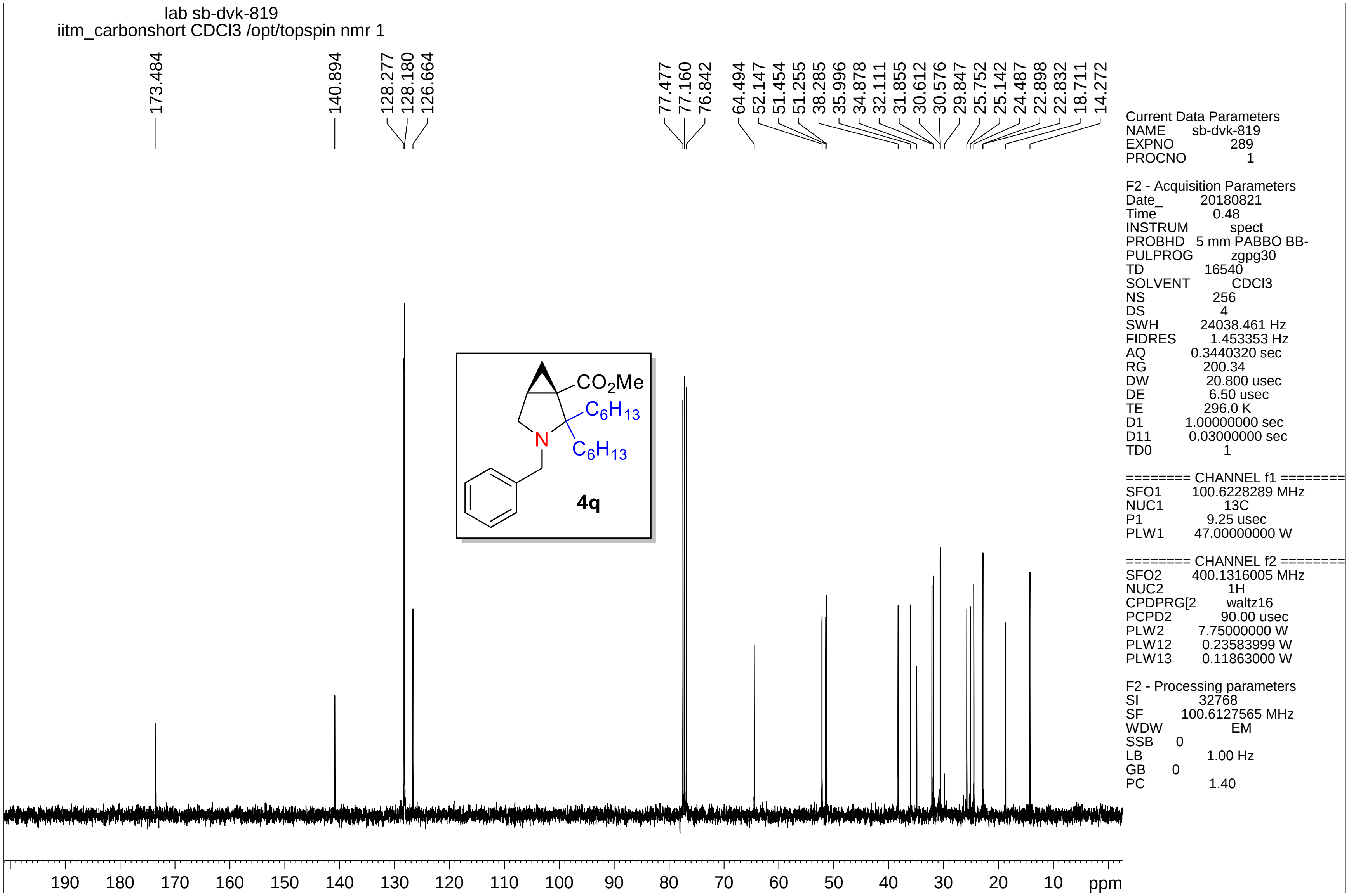
^{1}H-^{13}C HSQC NMR spectrum of compound 4r



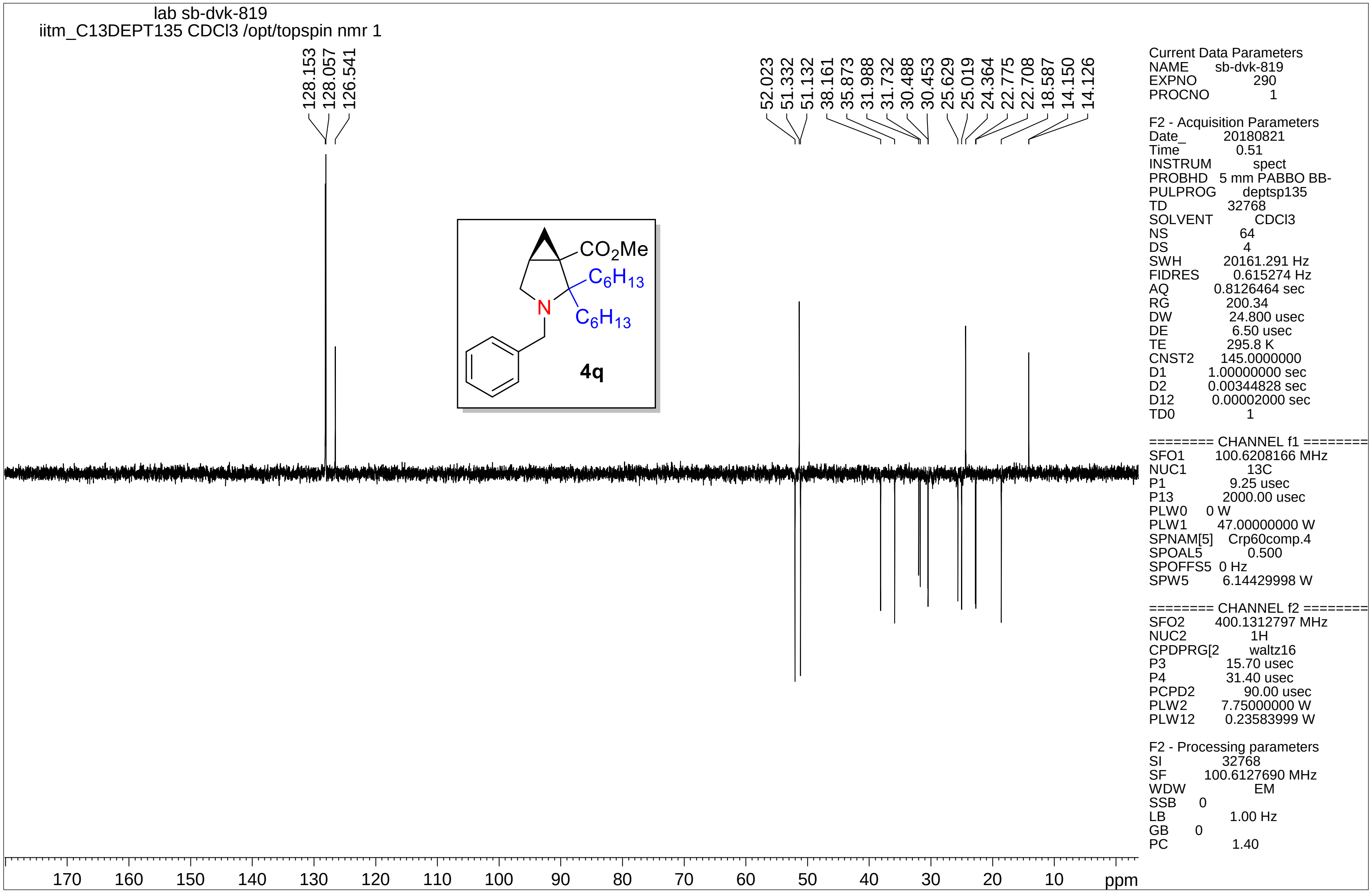
^{1}H NMR spectrum of compound 4q



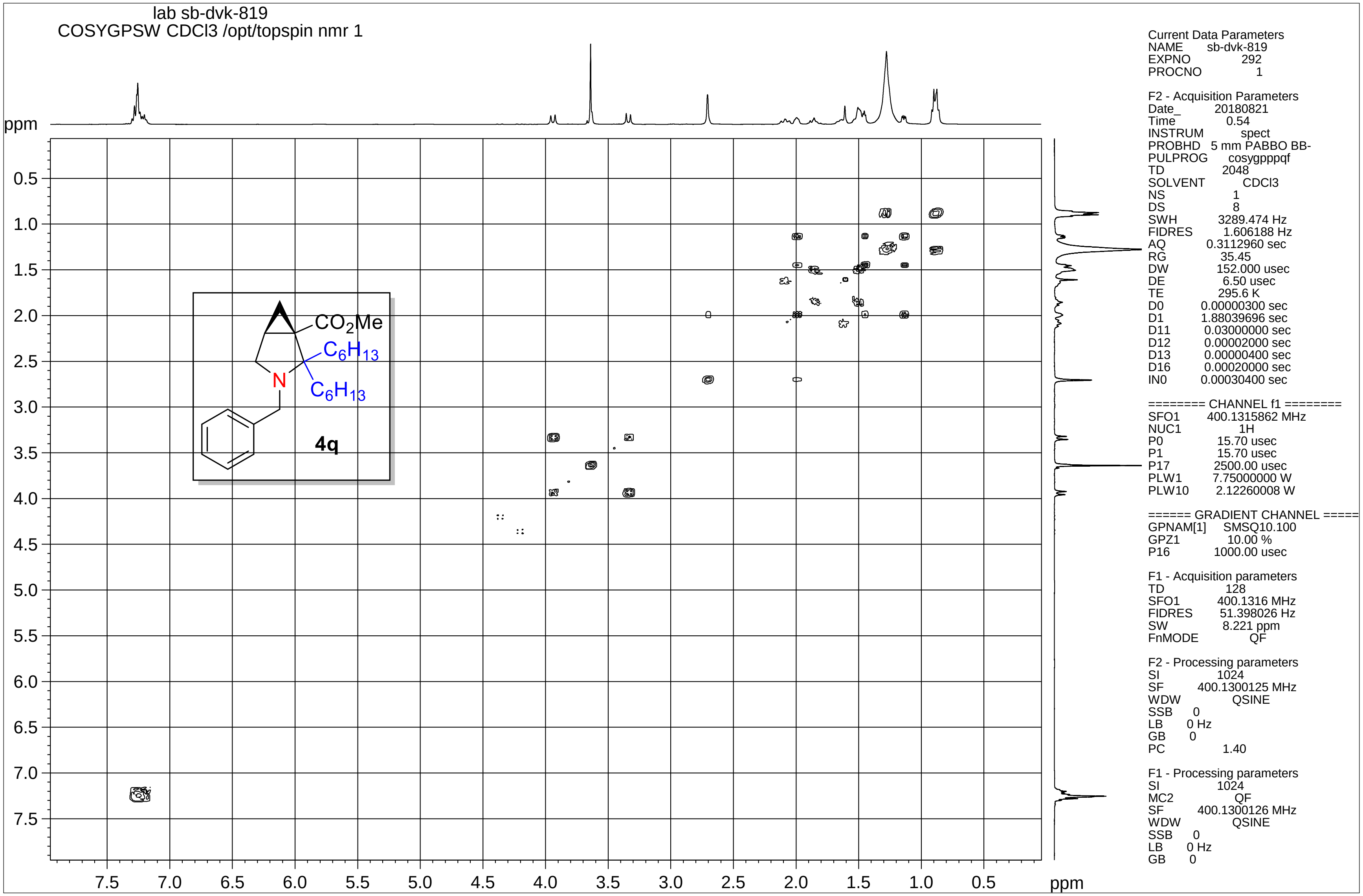
^{1}H NMR spectrum of compound 4q



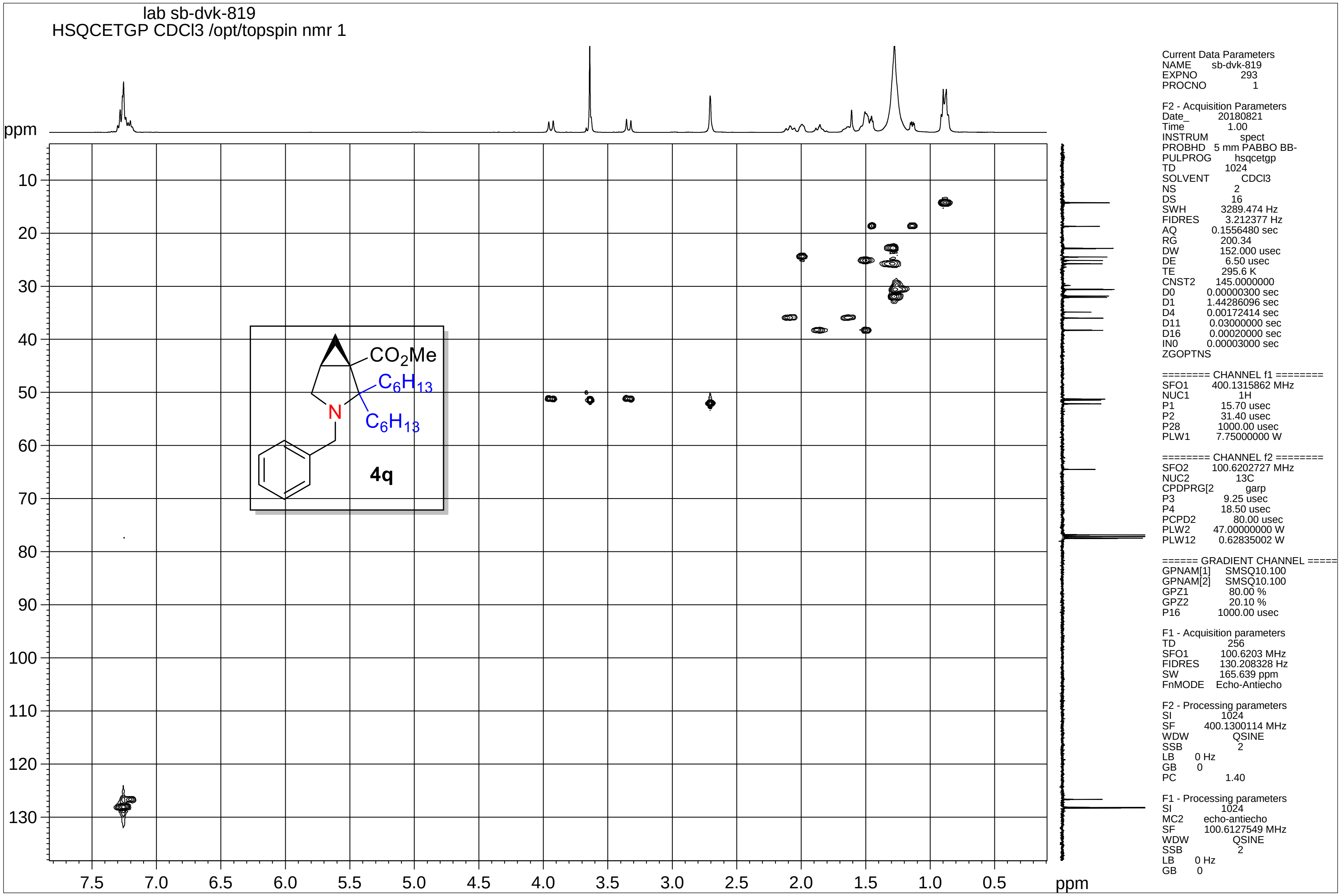
^{13}C NMR spectrum of compound 4q



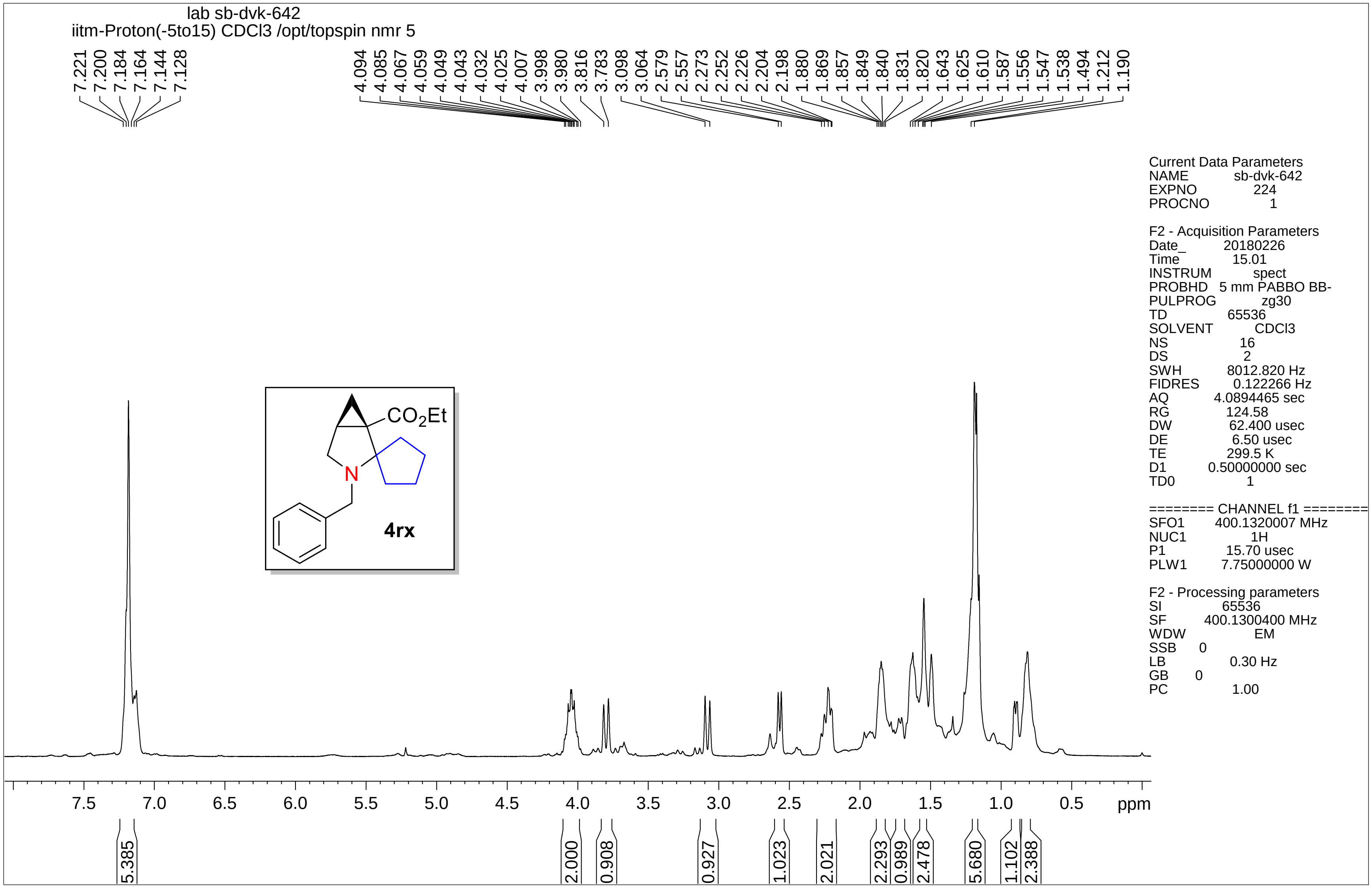
DEPT-135 NMR spectrum of compound 4q



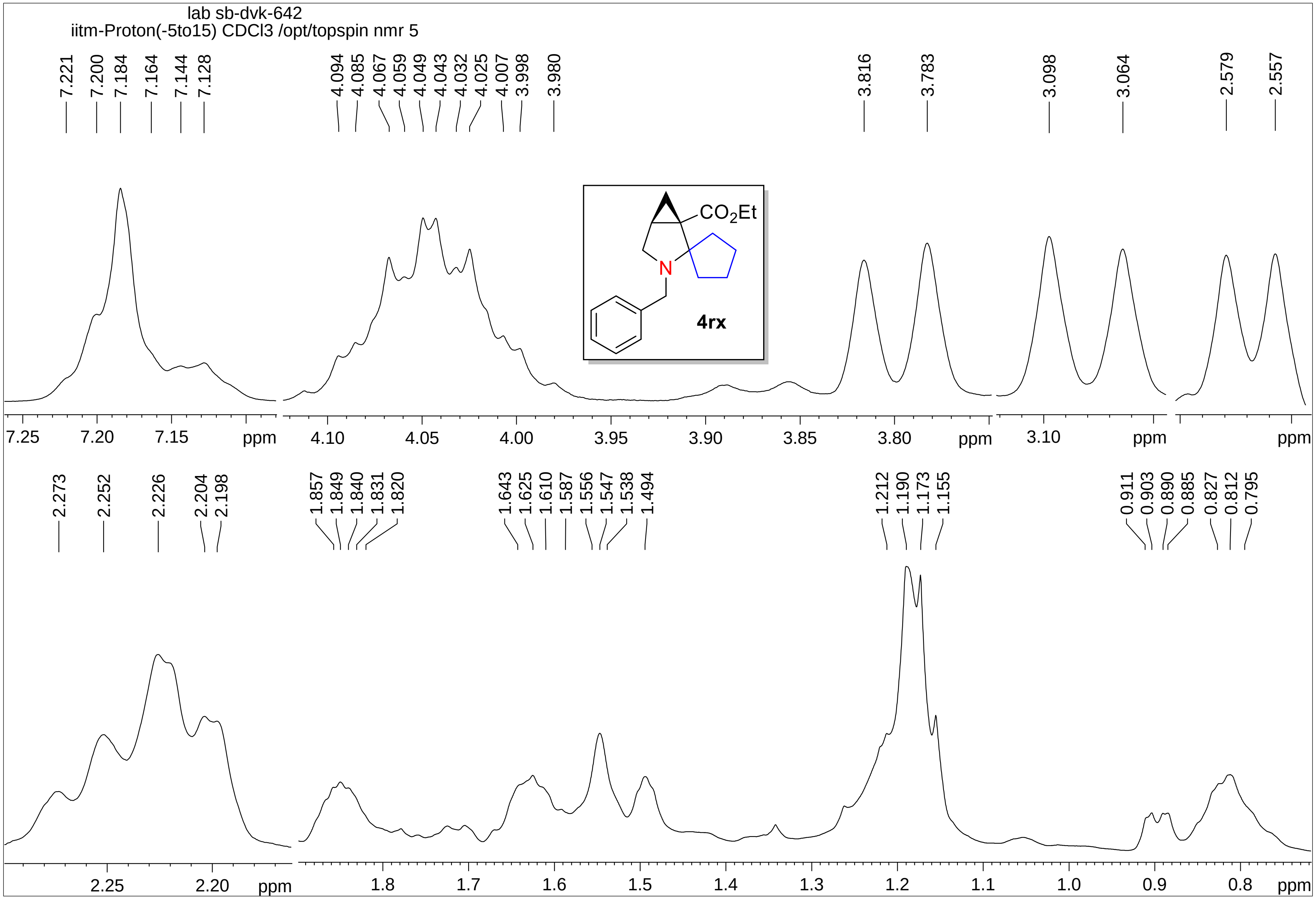
^{1}H-^{1}H COSY NMR spectrum of compound 4q



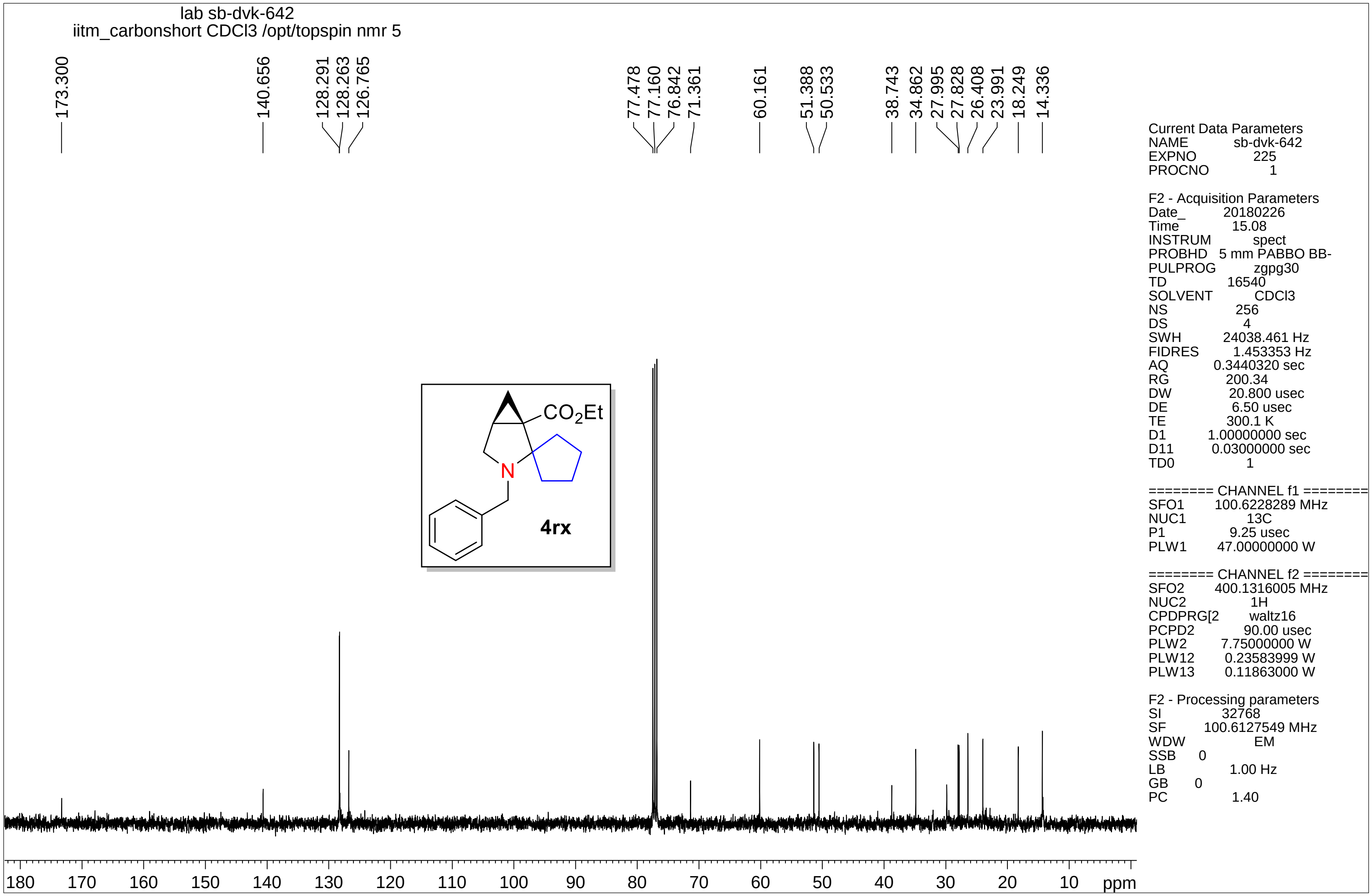
^{1}H-^{13}C HSQC NMR spectrum of compound 4q



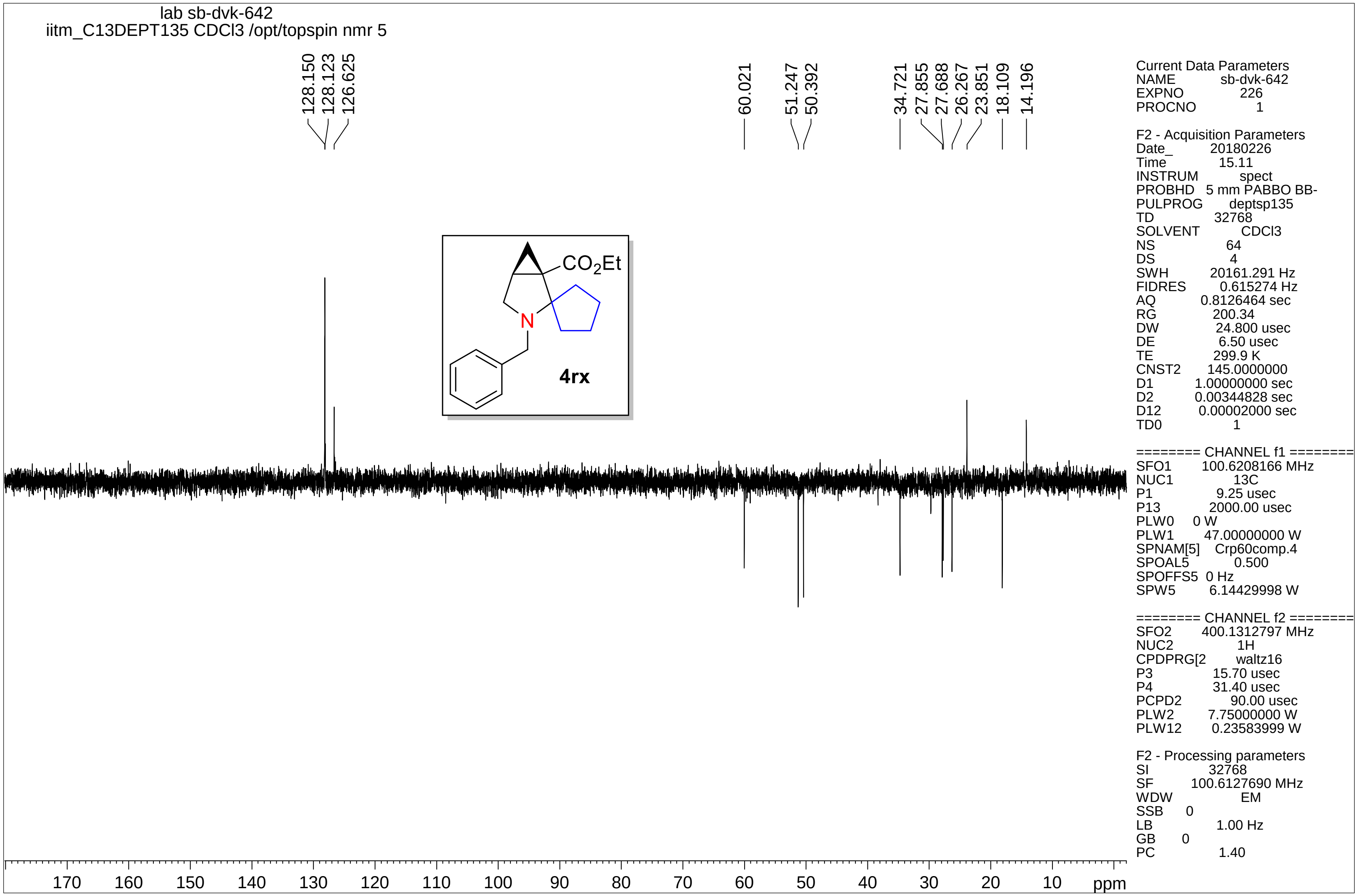
^{1}H NMR spectrum of compound 4rx



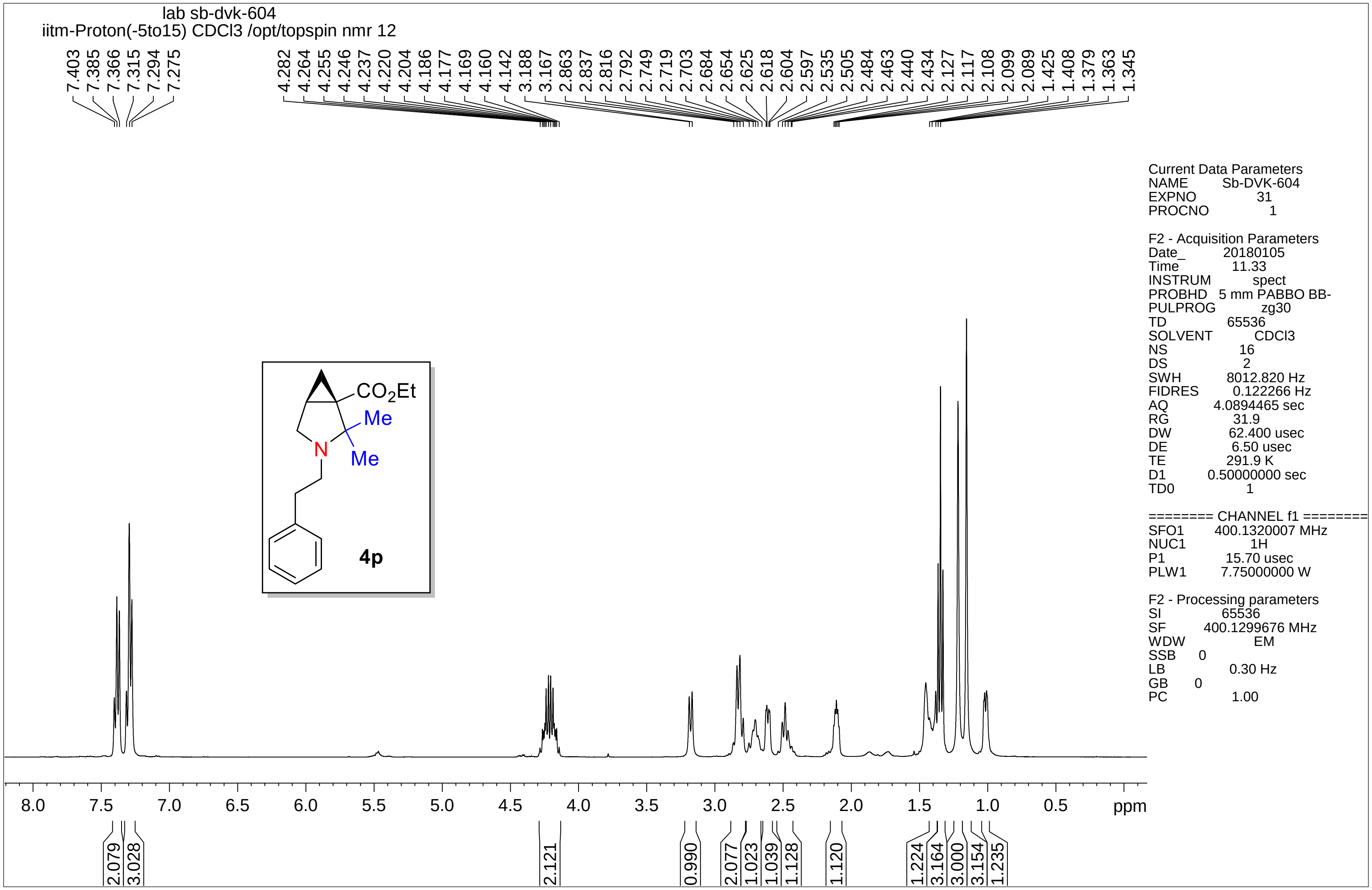
^{1}H NMR spectrum of compound 4rx



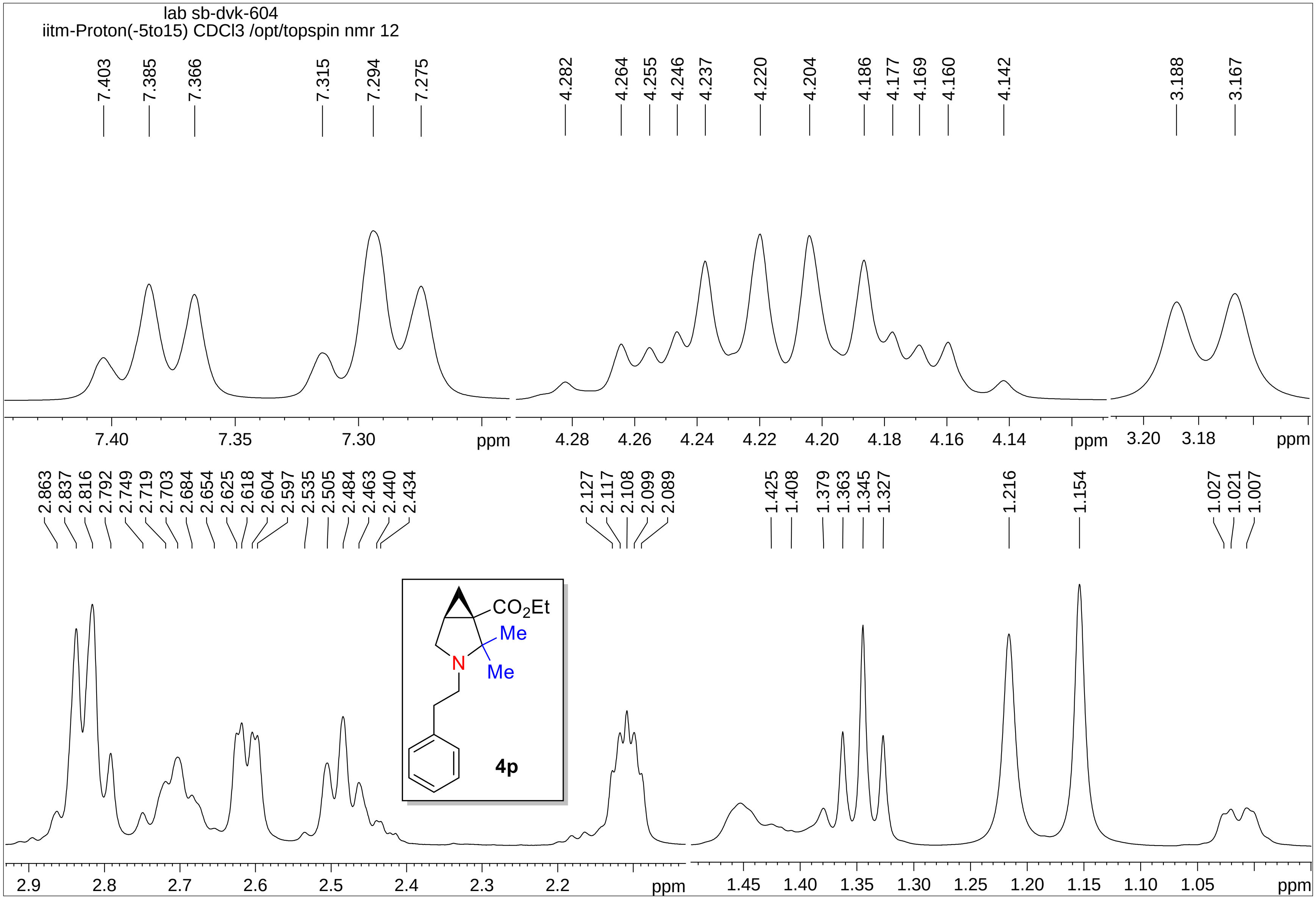
^{13}C NMR spectrum of compound 4rx



DEPT-135 NMR spectrum of compound 4rx



^{1}H NMR spectrum of compound 4p



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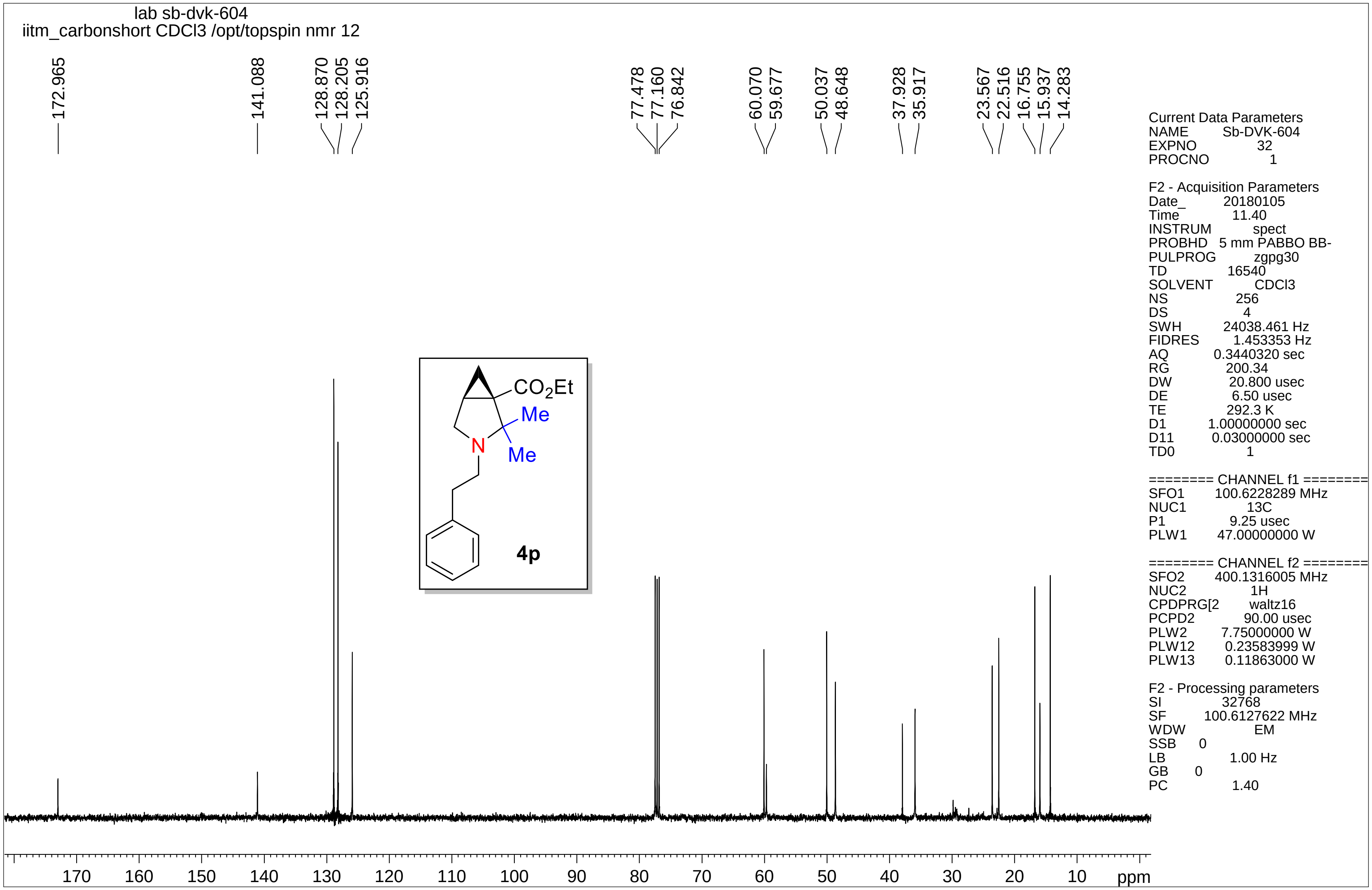

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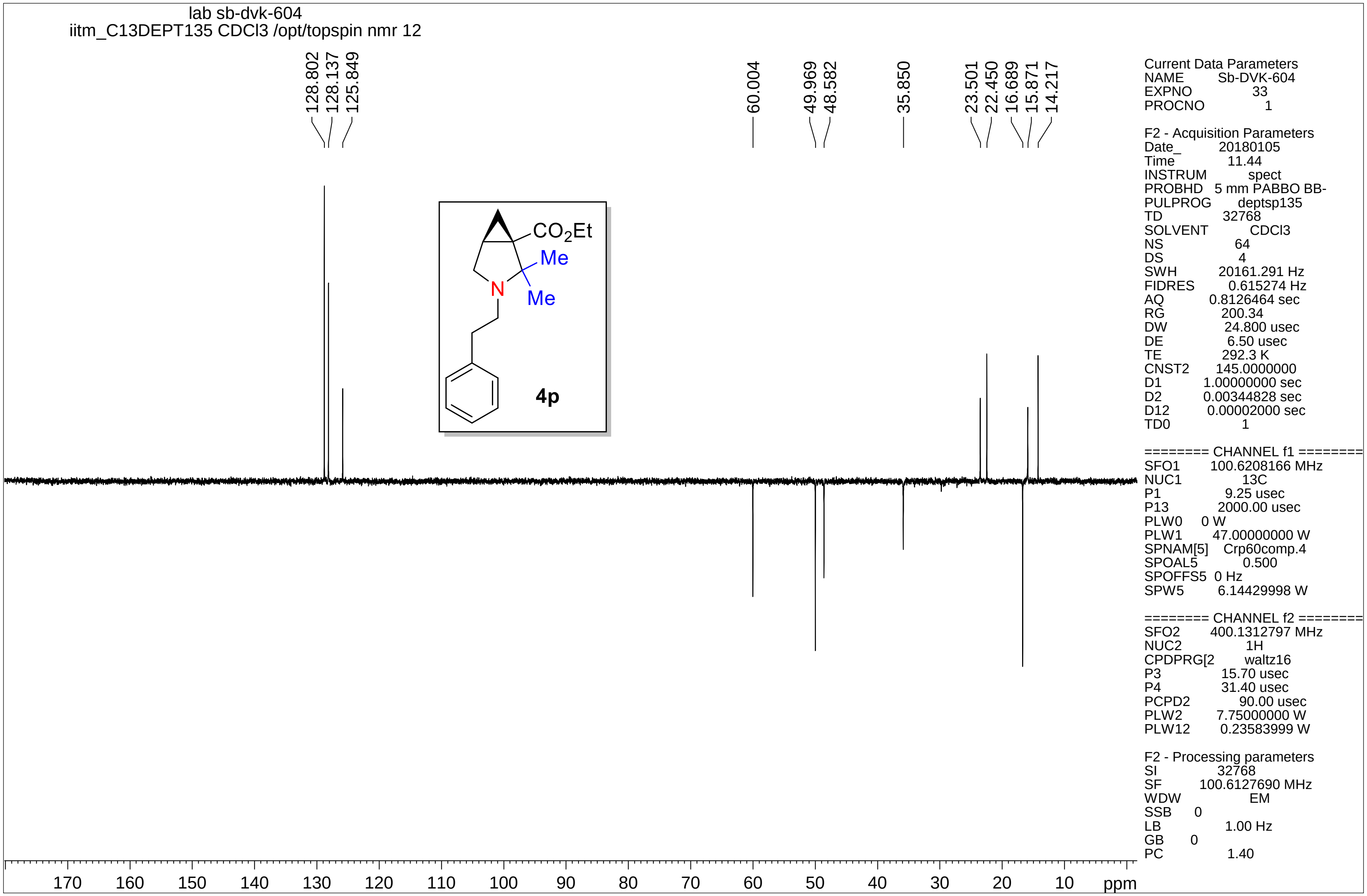
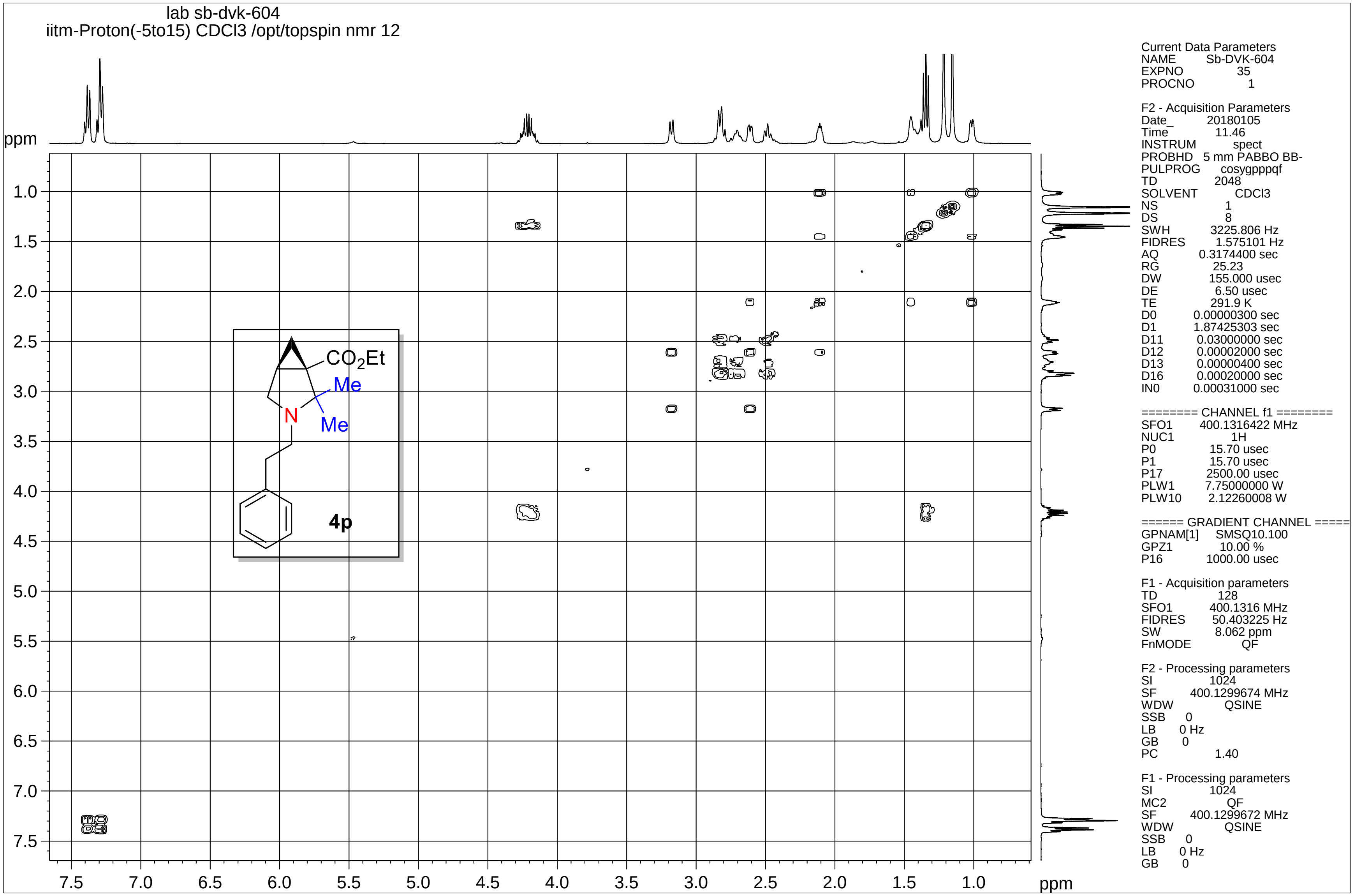
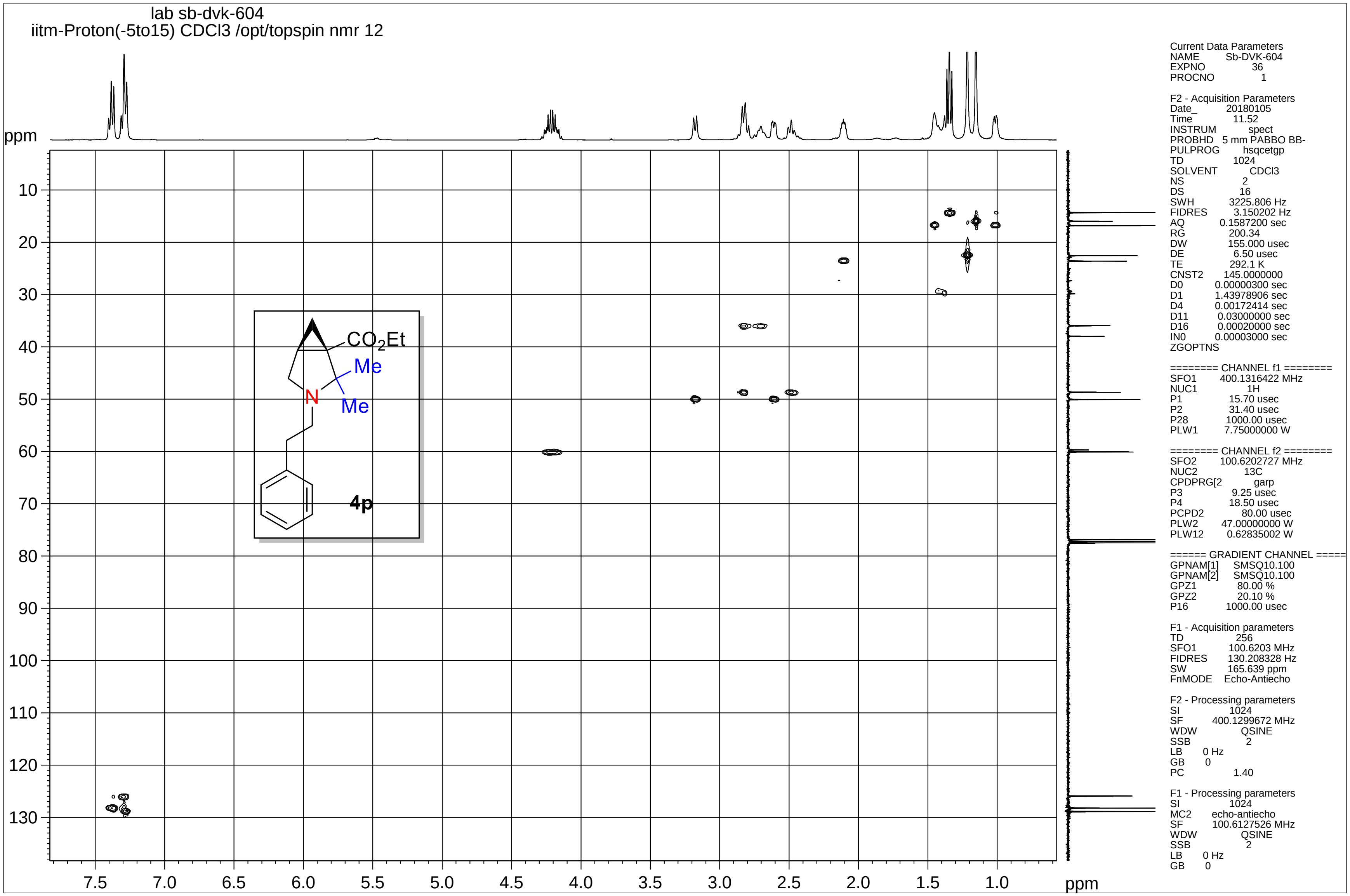


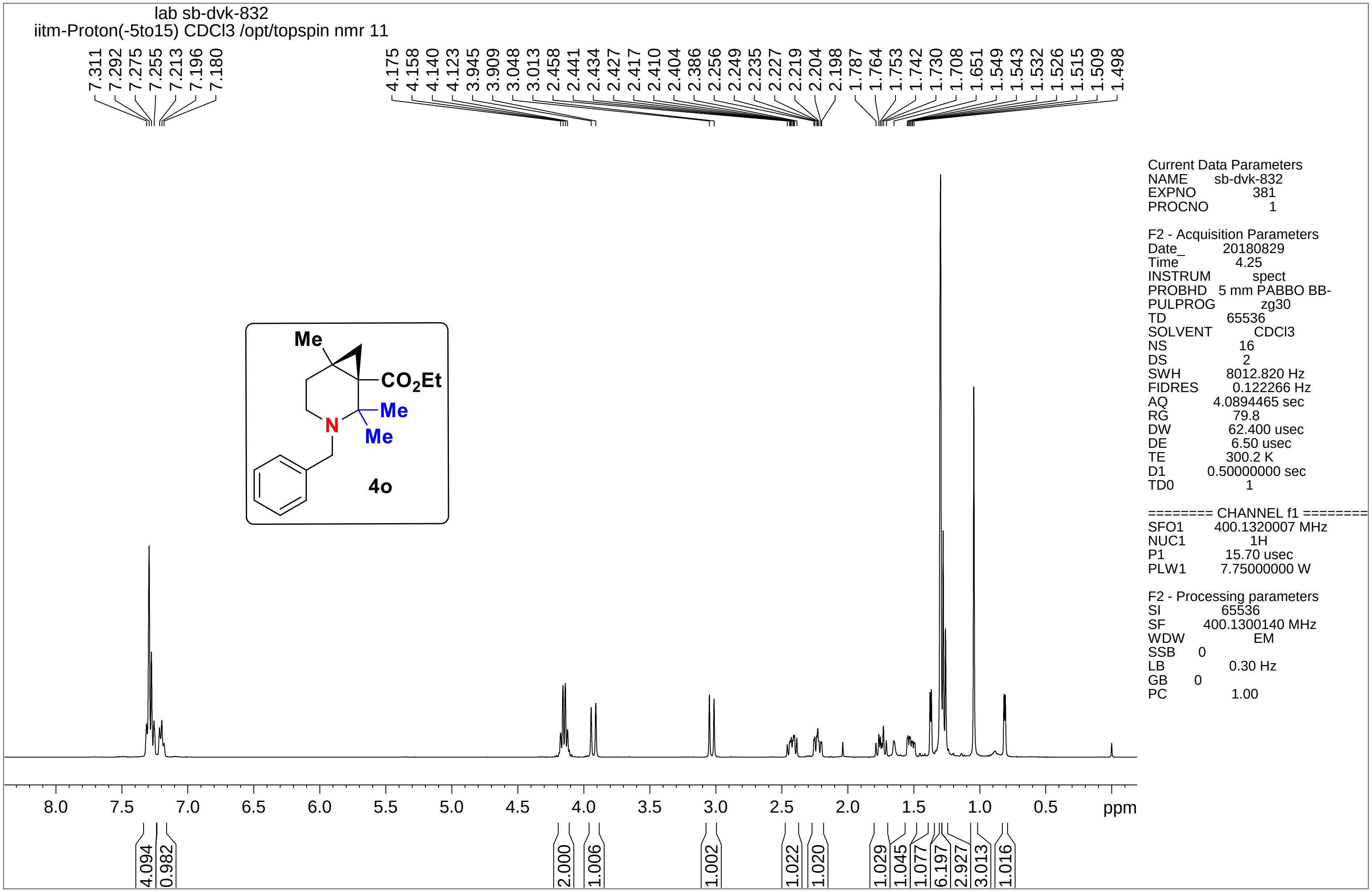
DEPT-135 NMR spectrum of compound 4p



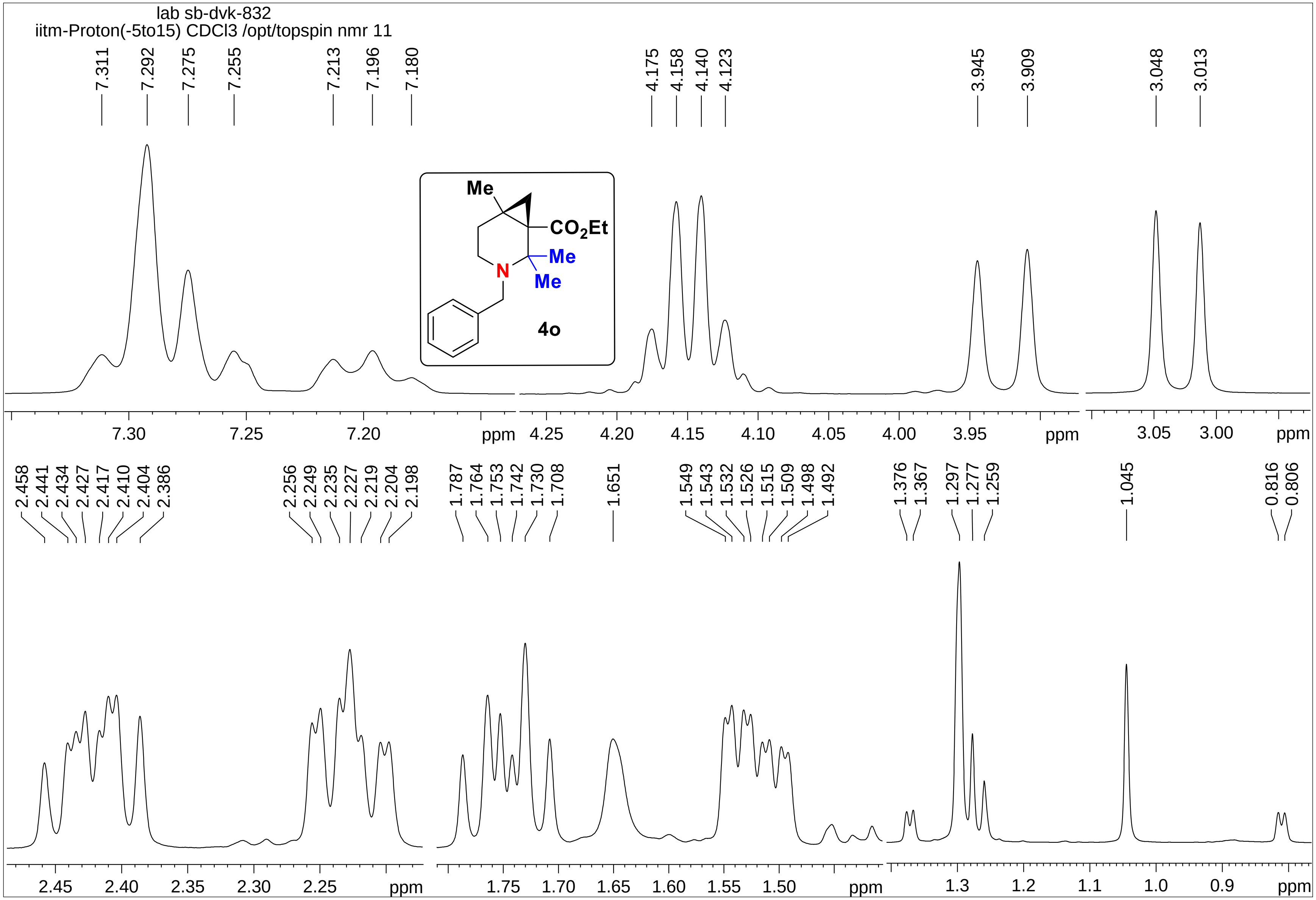
^{1}H-^{1}H COSY NMR spectrum of compound 4p



^{1}H-^{13}C HSQC NMR spectrum of compound 4p



^{1}H NMR spectrum of compound 4o



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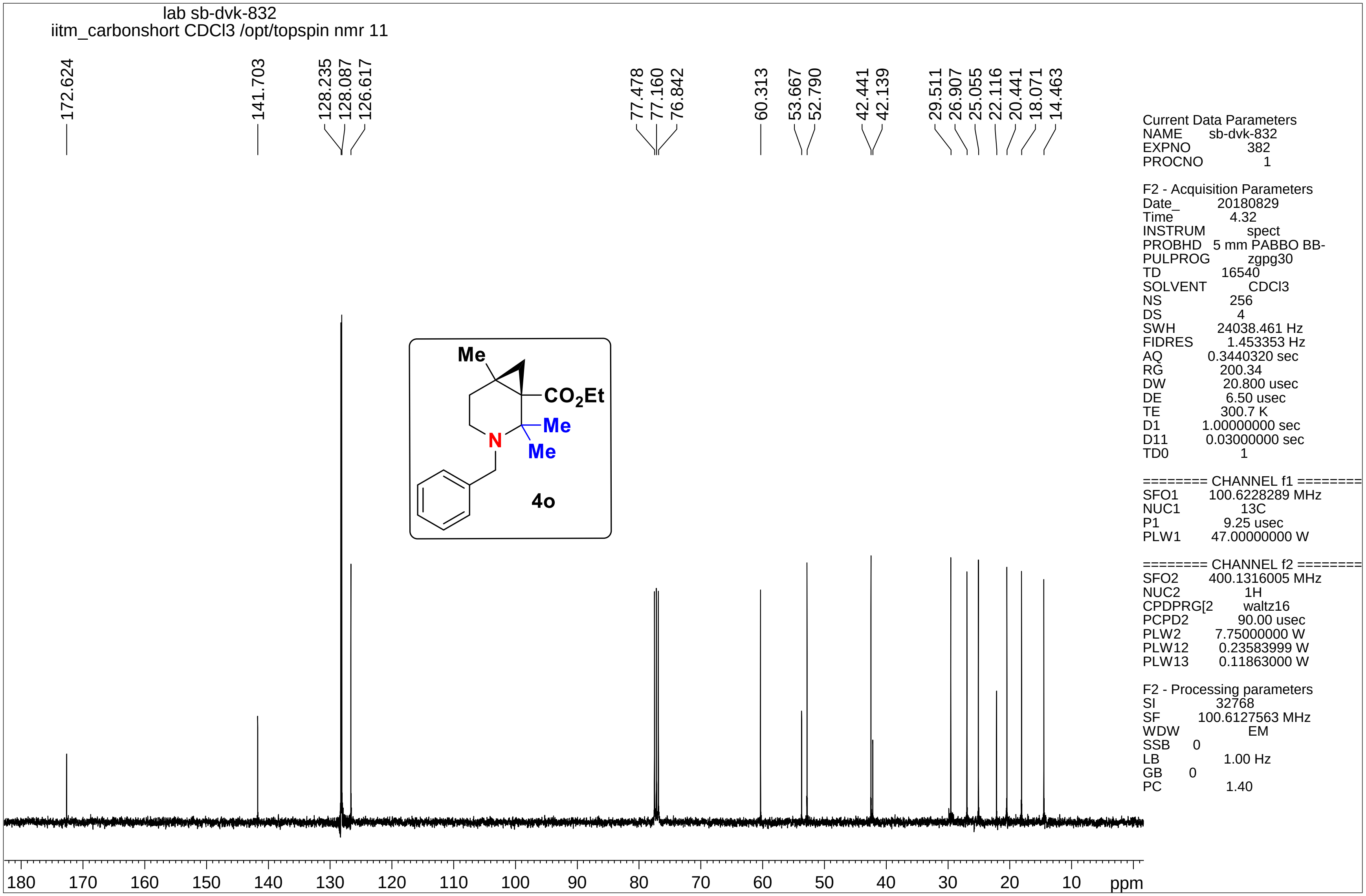
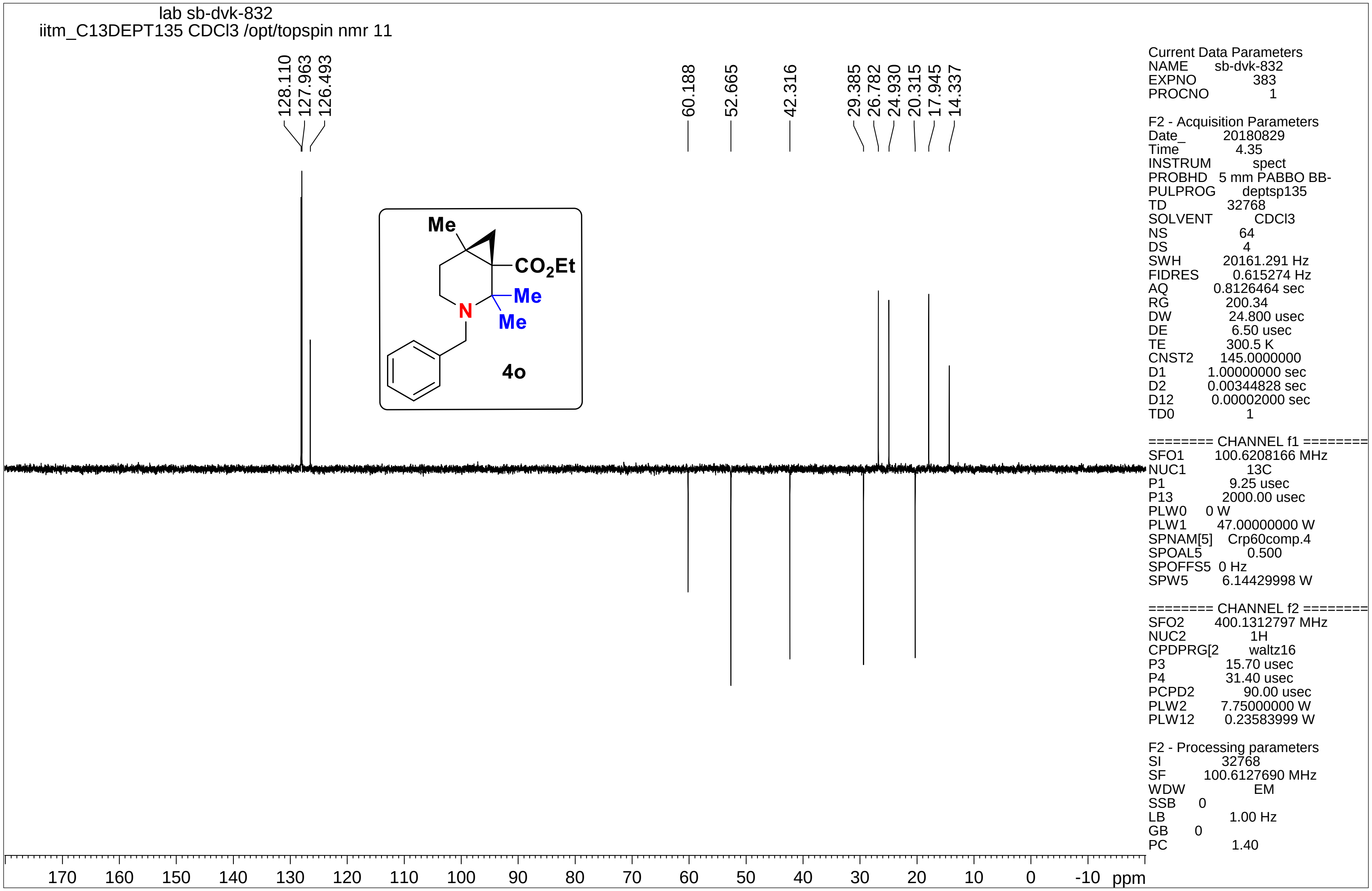
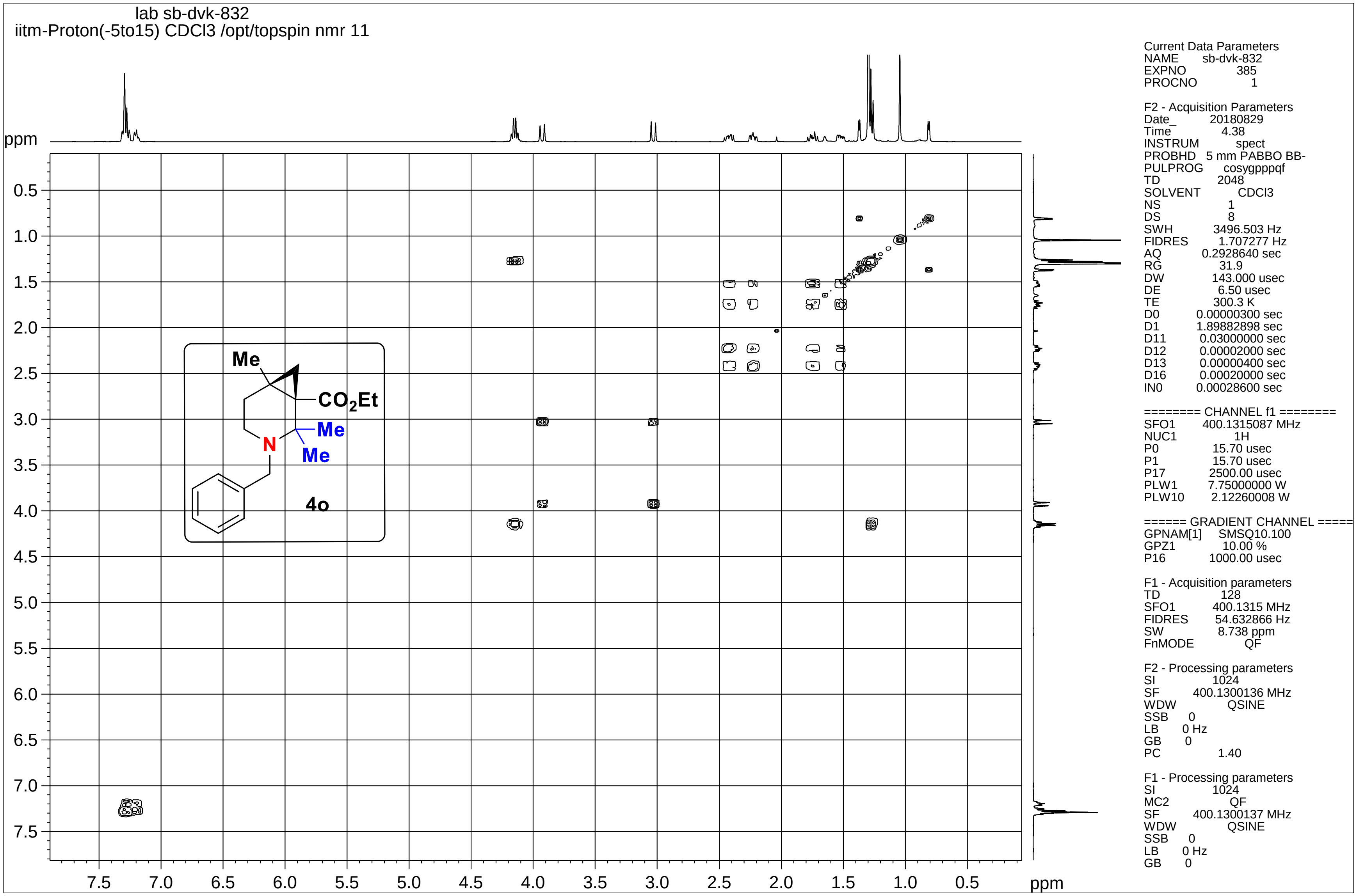


^{13}C NMR spectrum of compound 4o



DEPT-135 NMR spectrum of compound 4o



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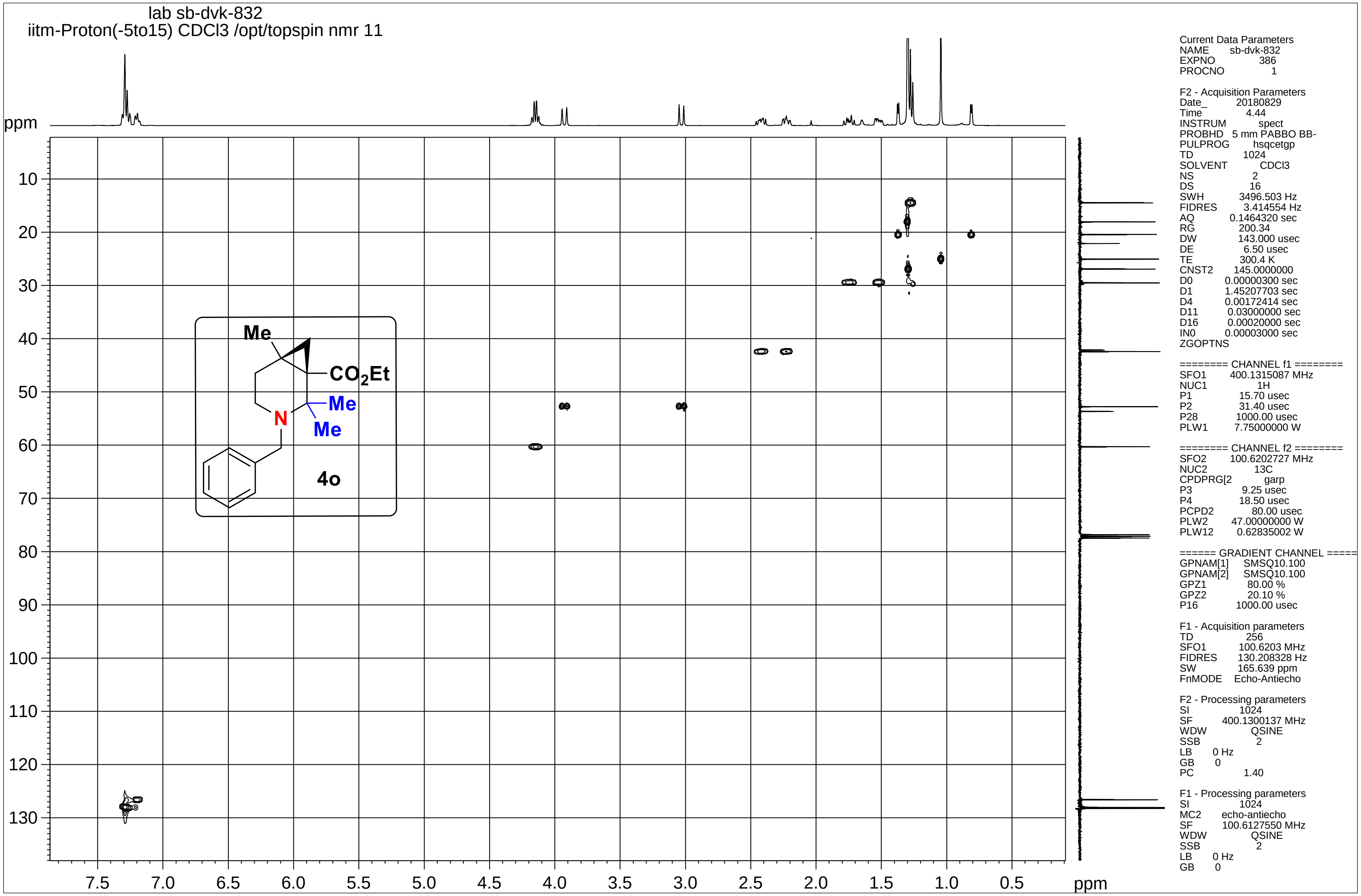

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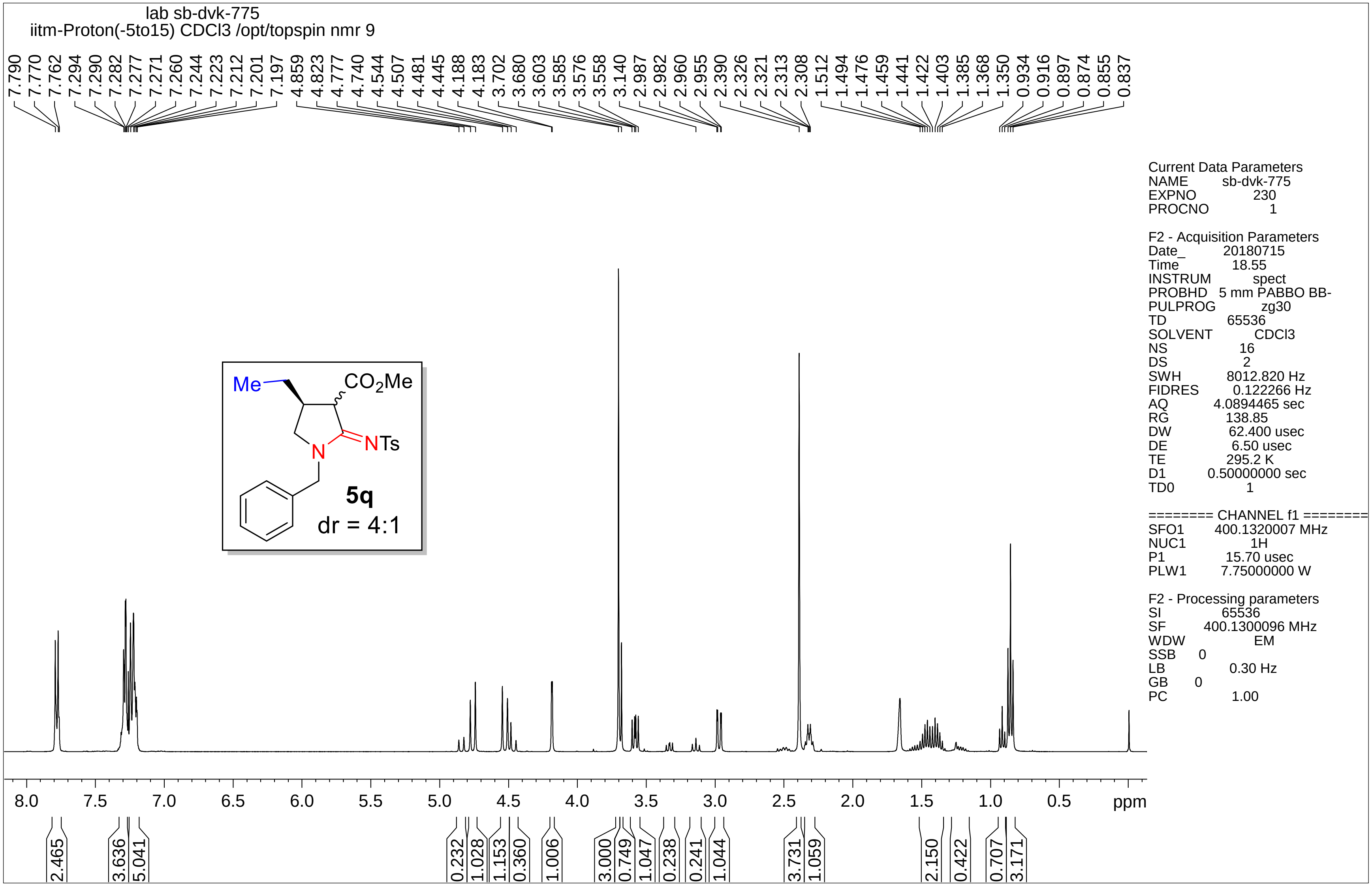
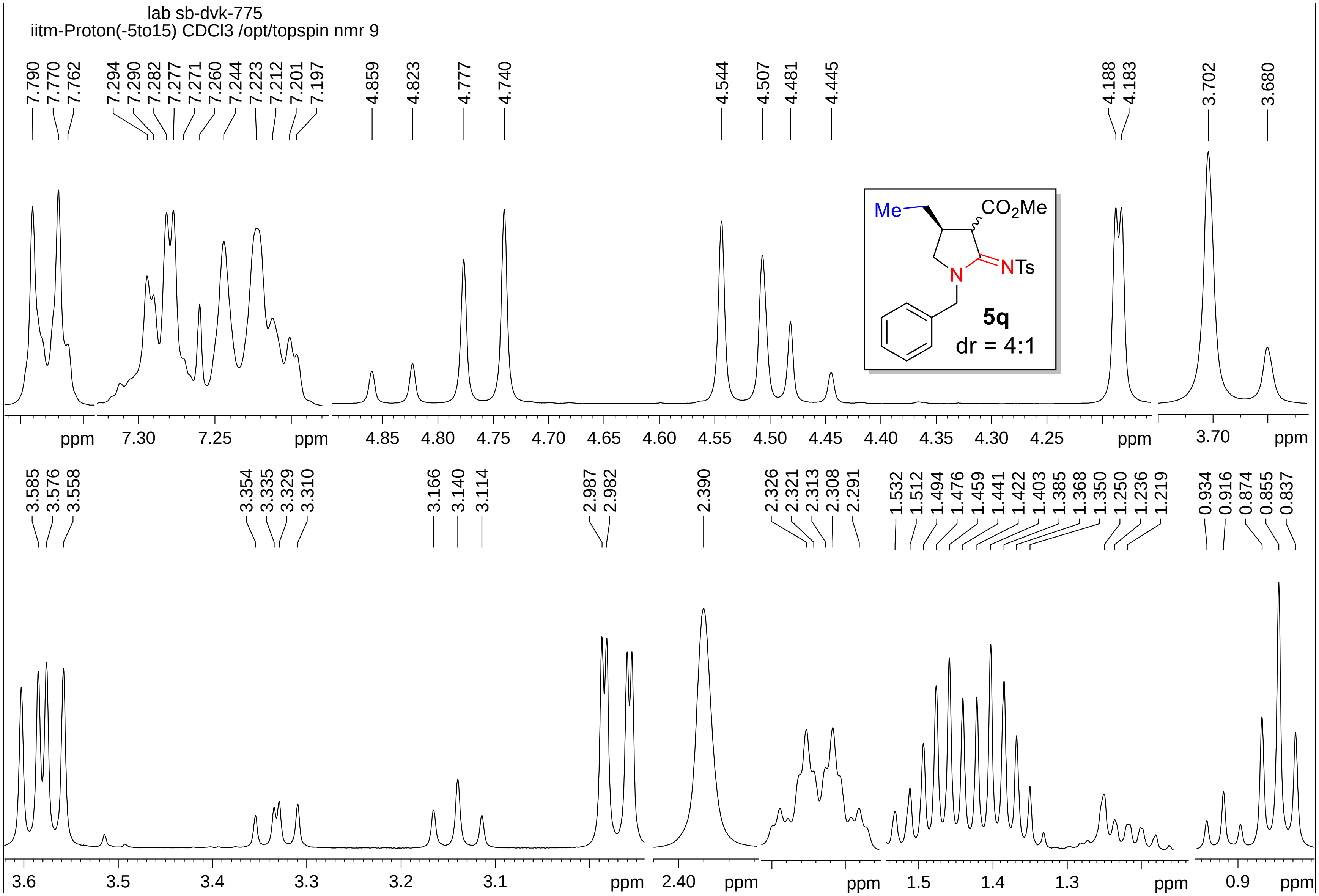
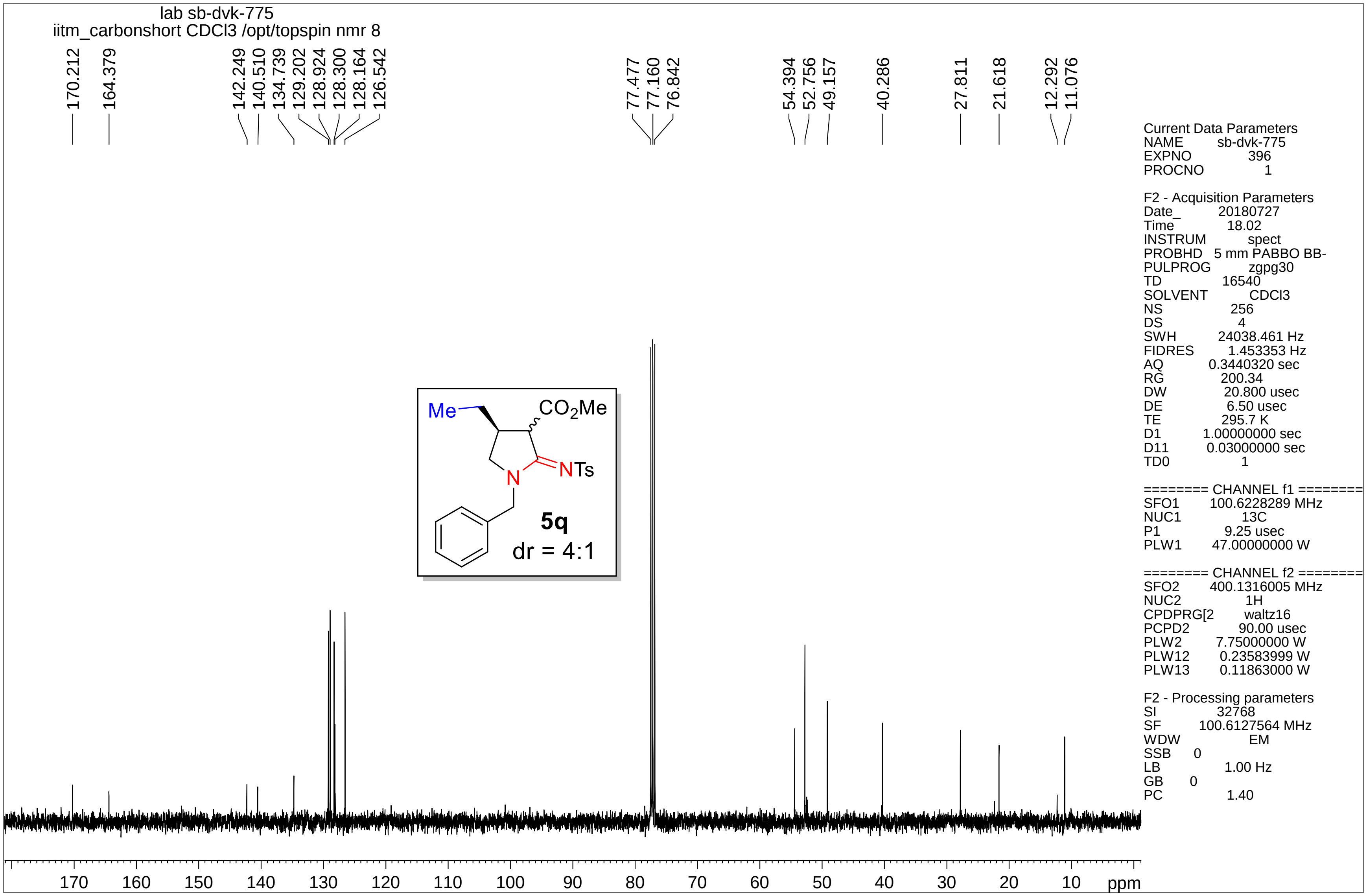


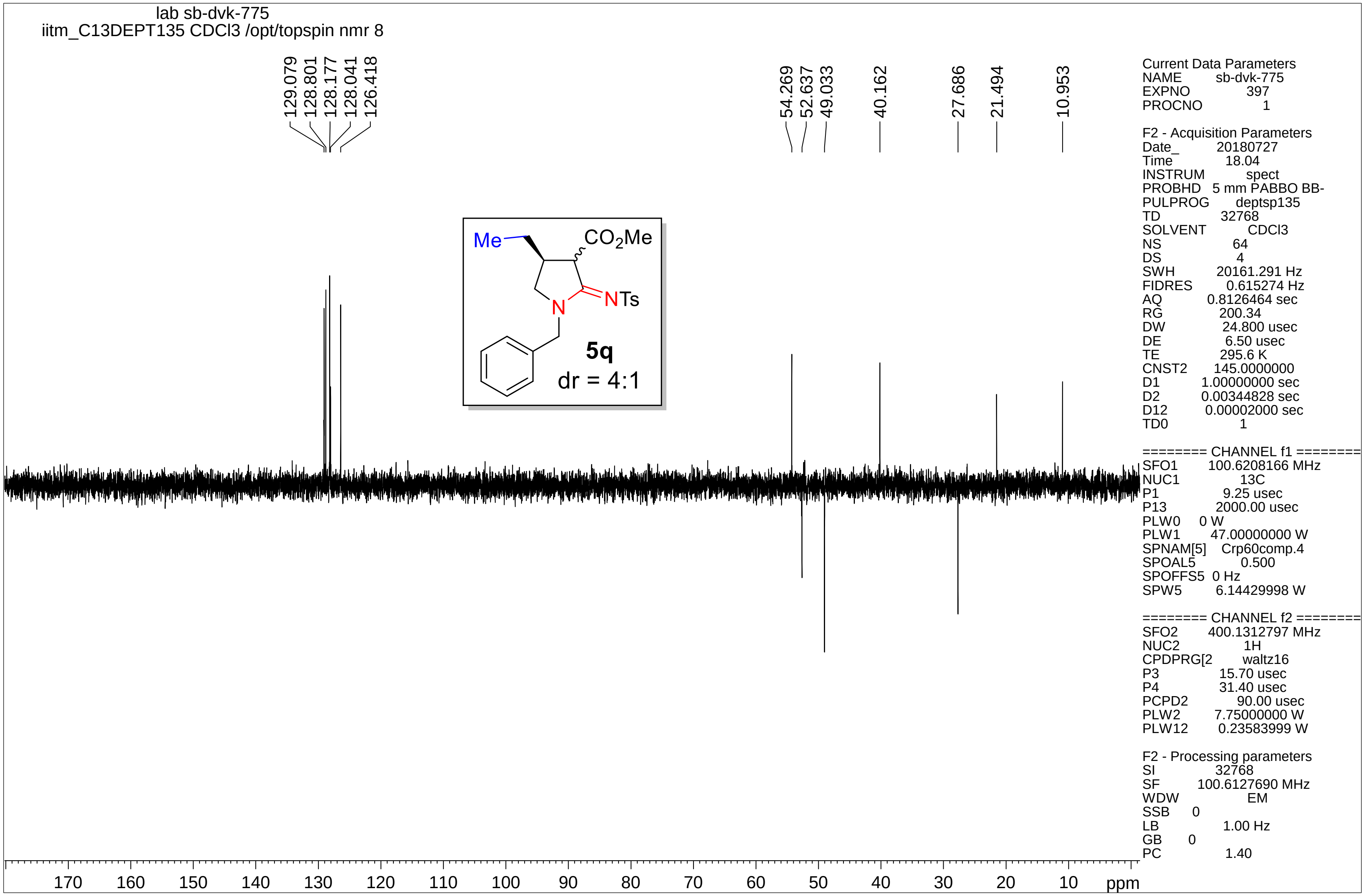
[1]H NMR spectrum of crude compound 5q



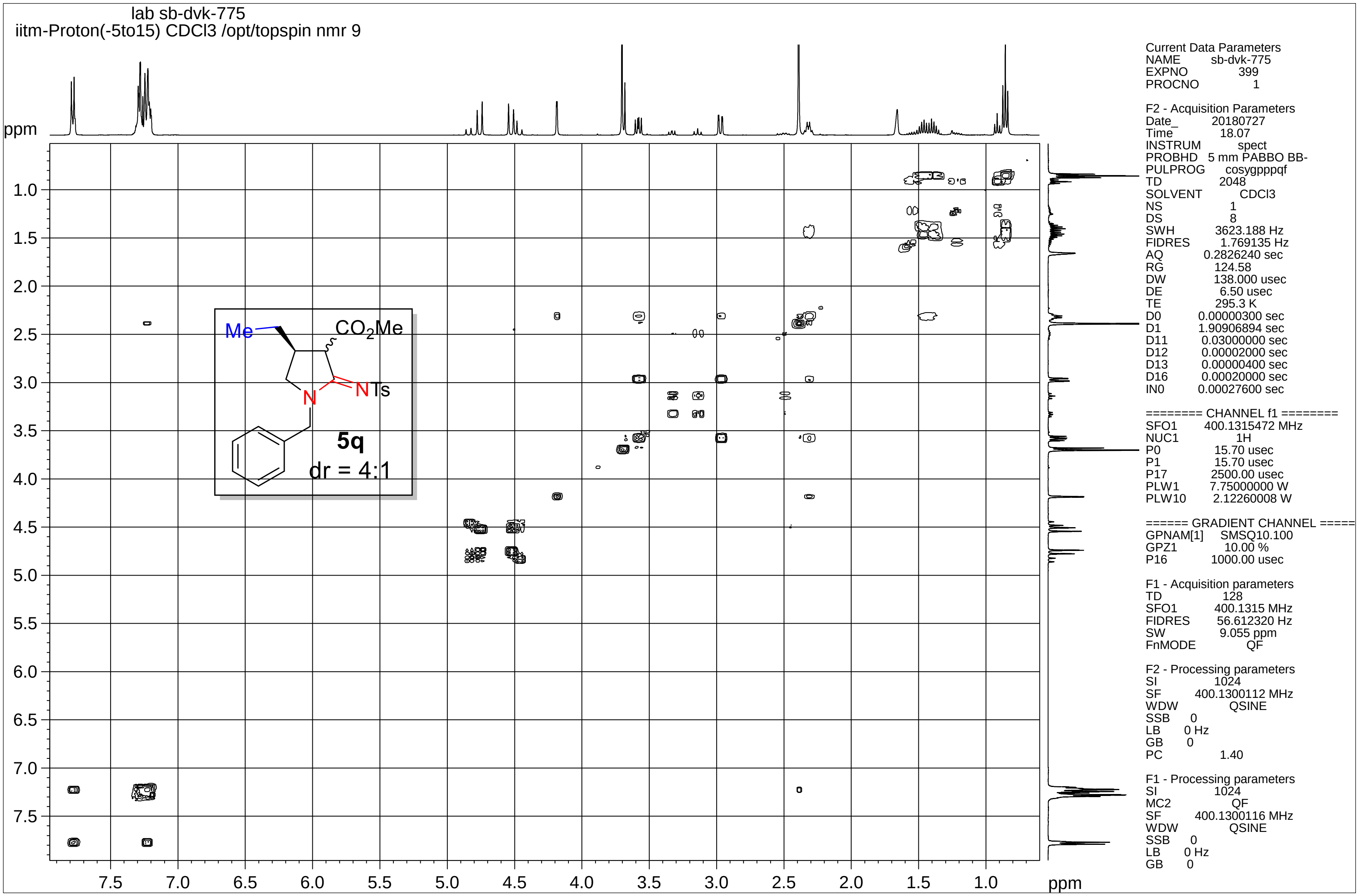
^{1}H NMR spectrum of crude compound 5q



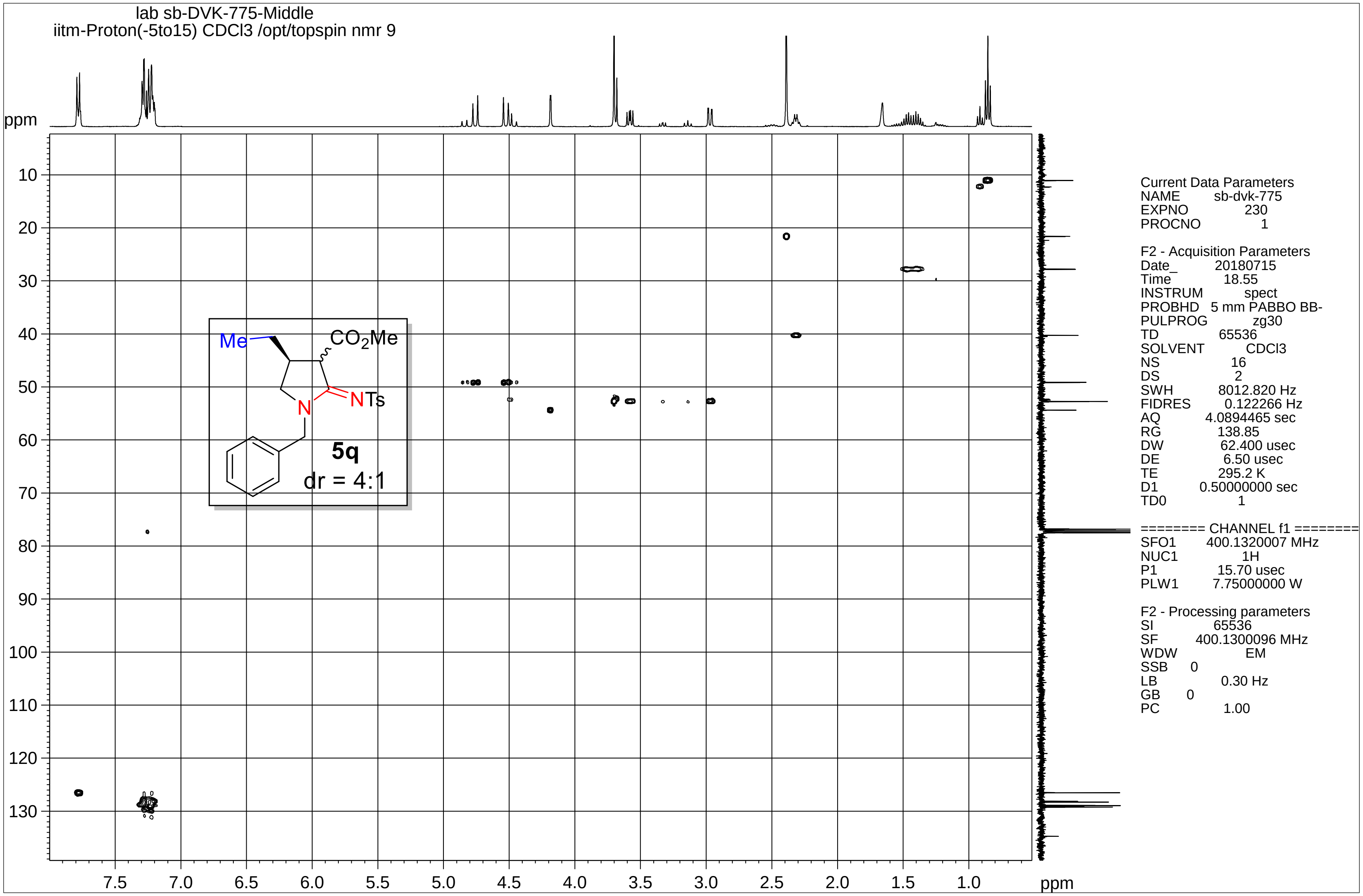
^{13}C NMR spectrum of crude compound 5q



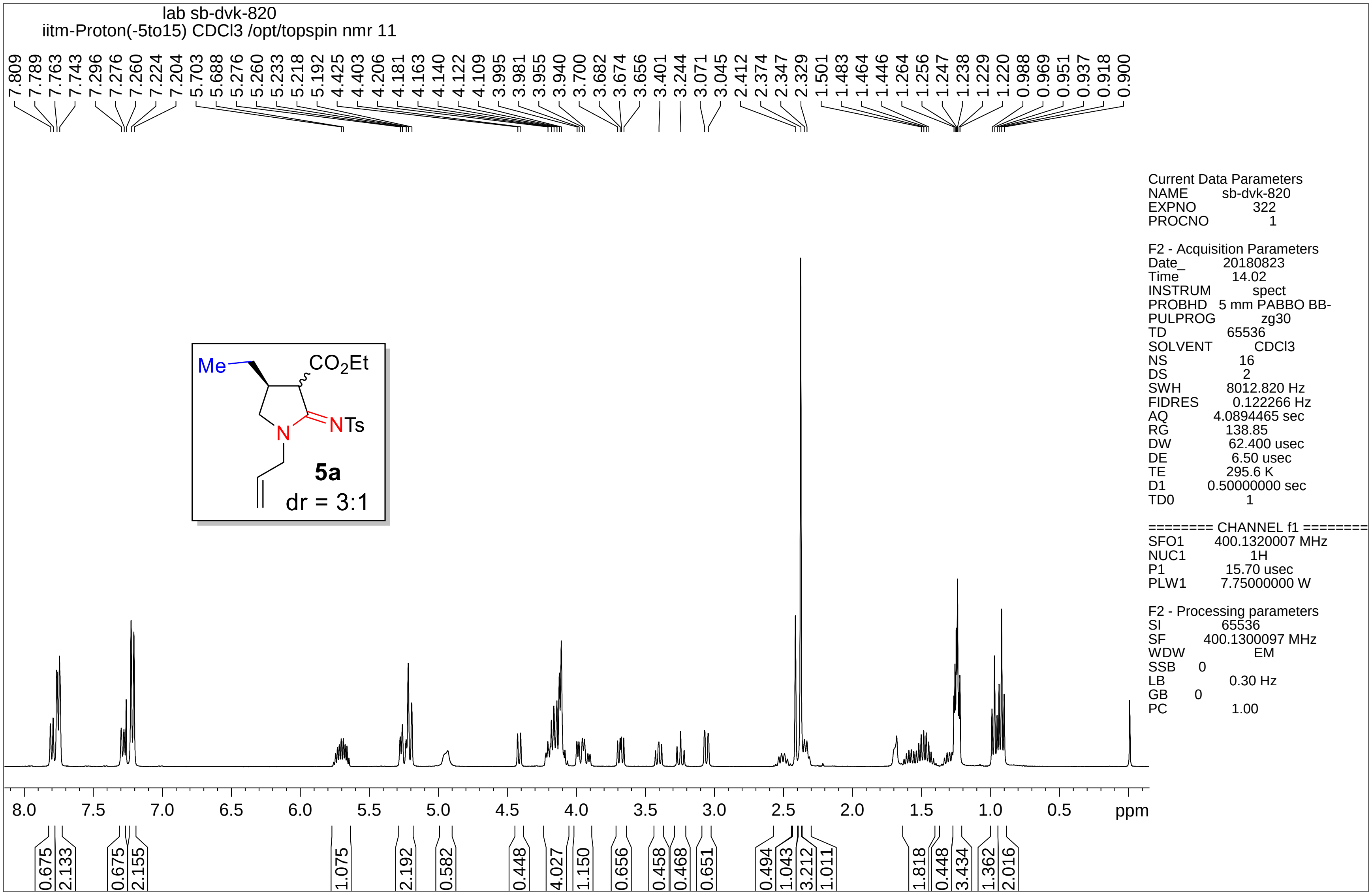
DEPT-135 NMR spectrum of crude compound 5q



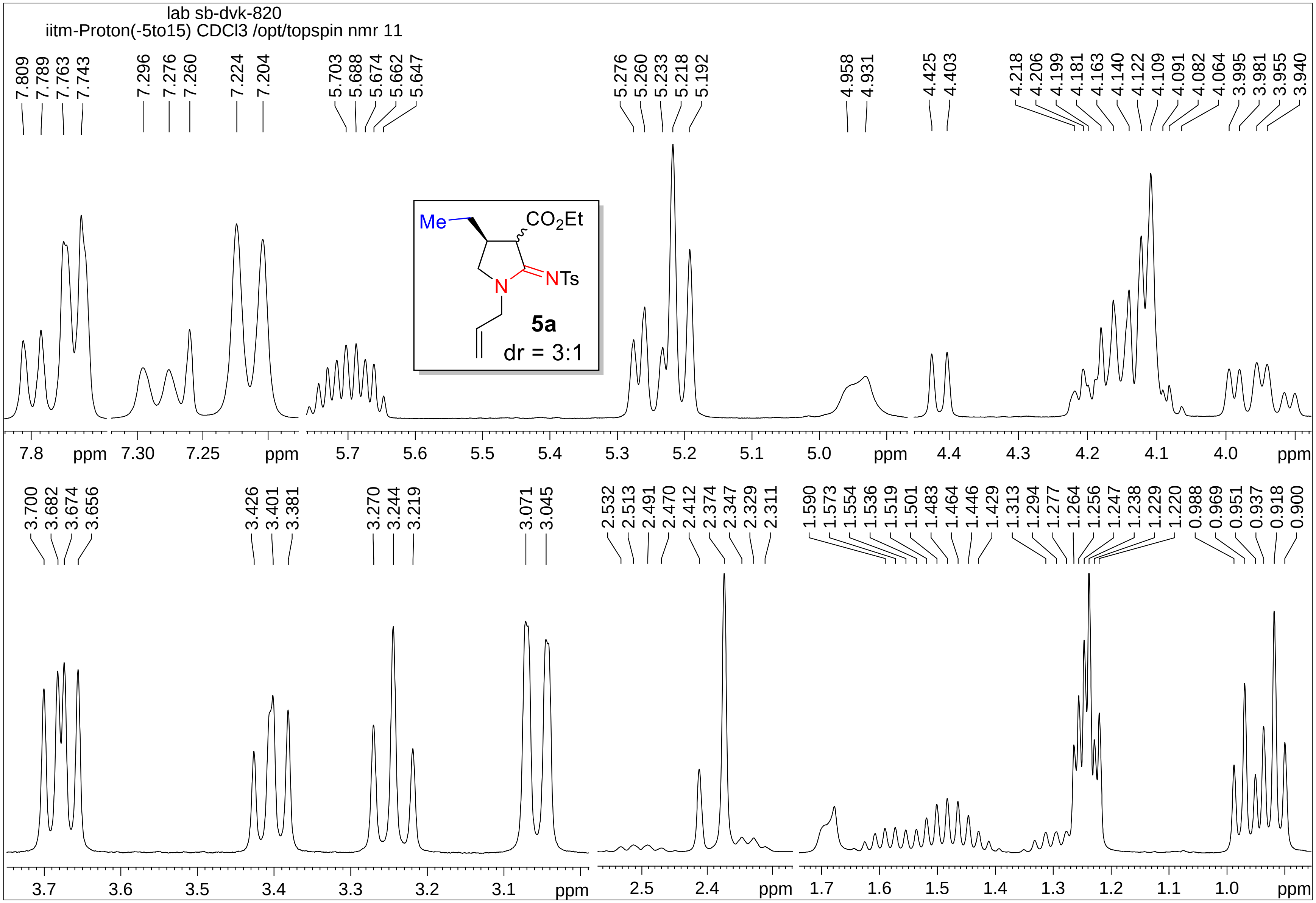
^1H-^1H COSY NMR spectrum of crude compound 5q



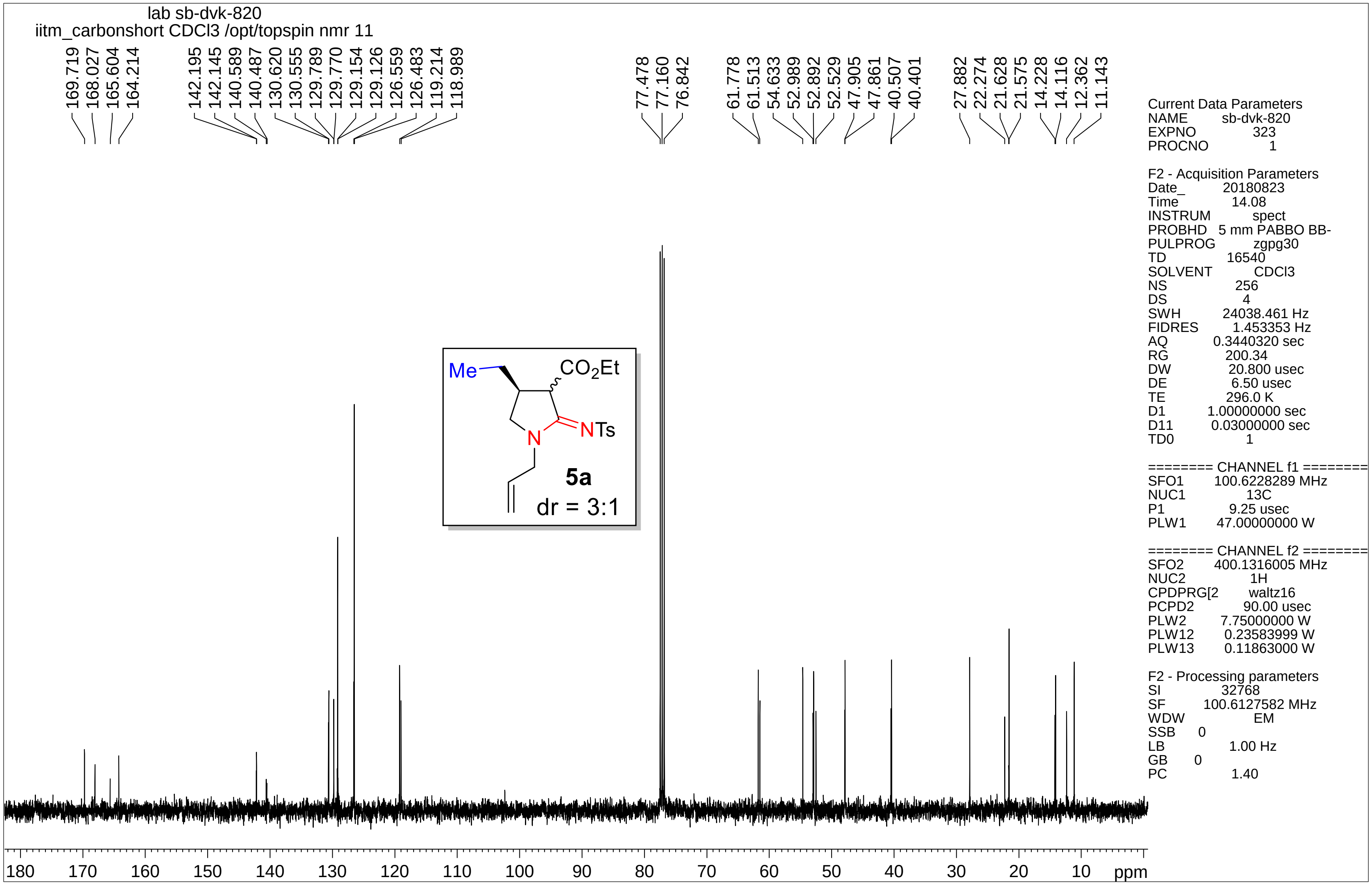
^{1}H-^{13}C HSQC NMR spectrum of crude compound 5q



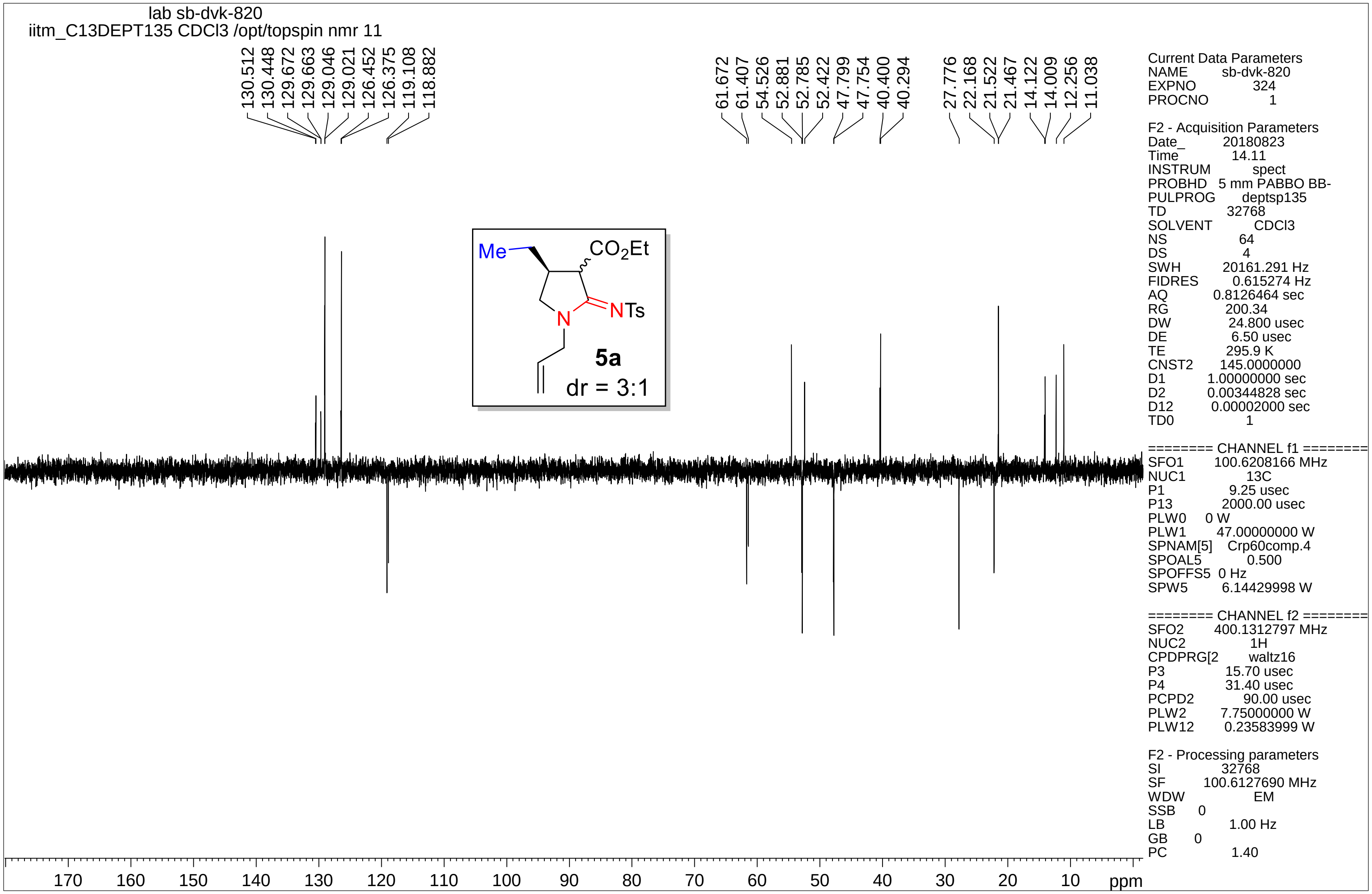
^{1}H NMR spectrum of crude compound 5a



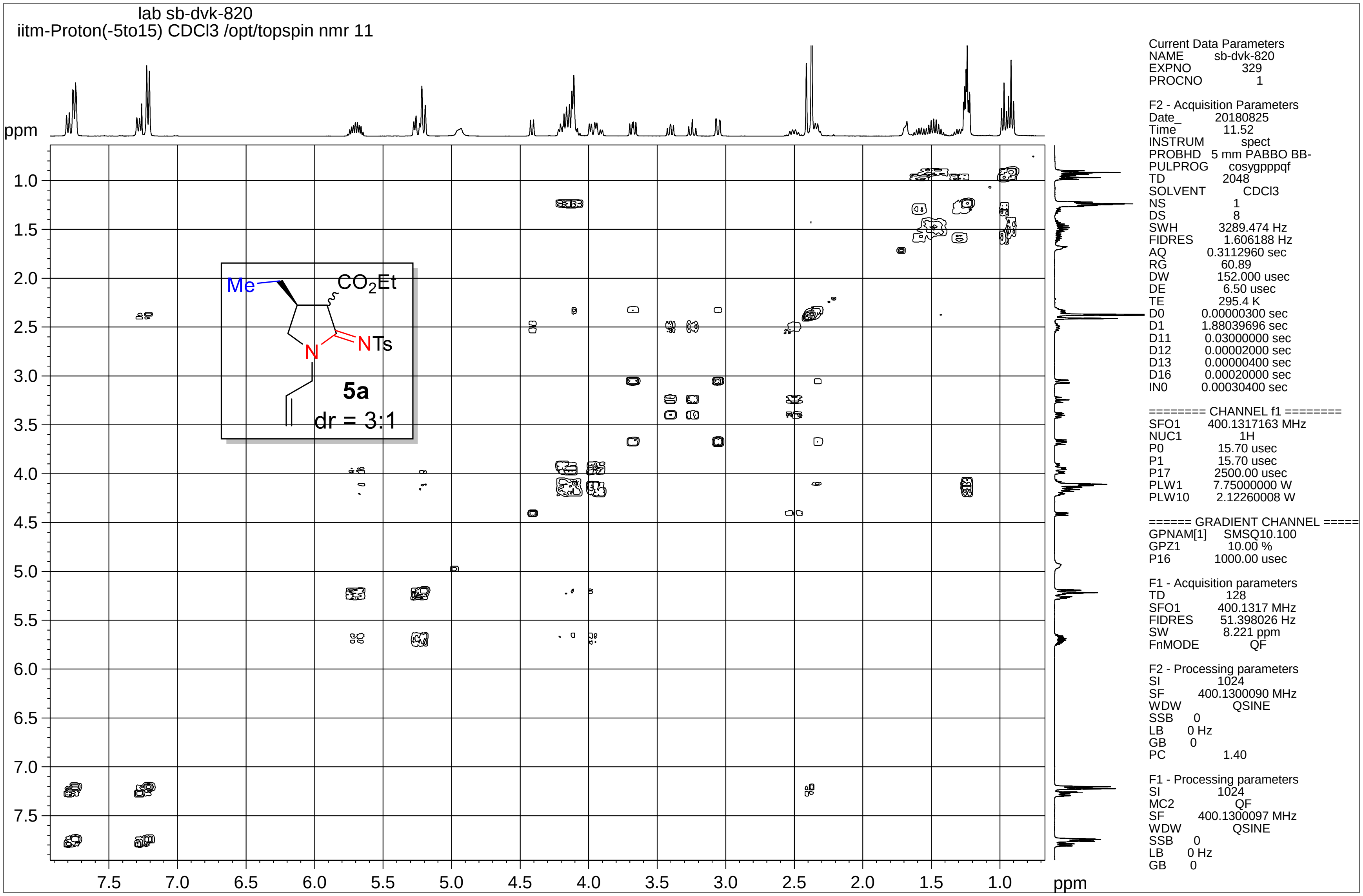
^{1}H NMR spectrum of crude compound 5a



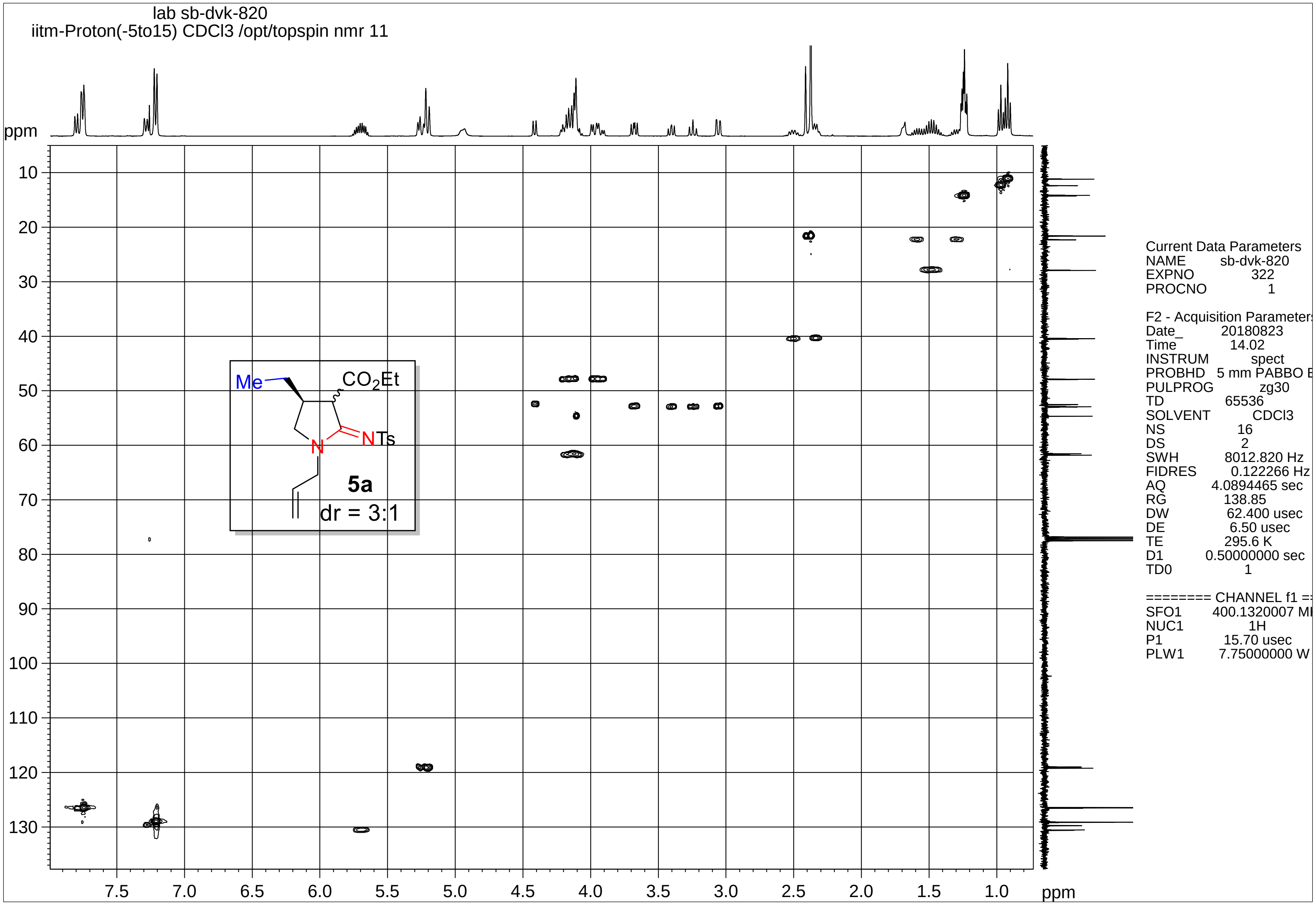
^{13}C NMR spectrum of crude compound 5a



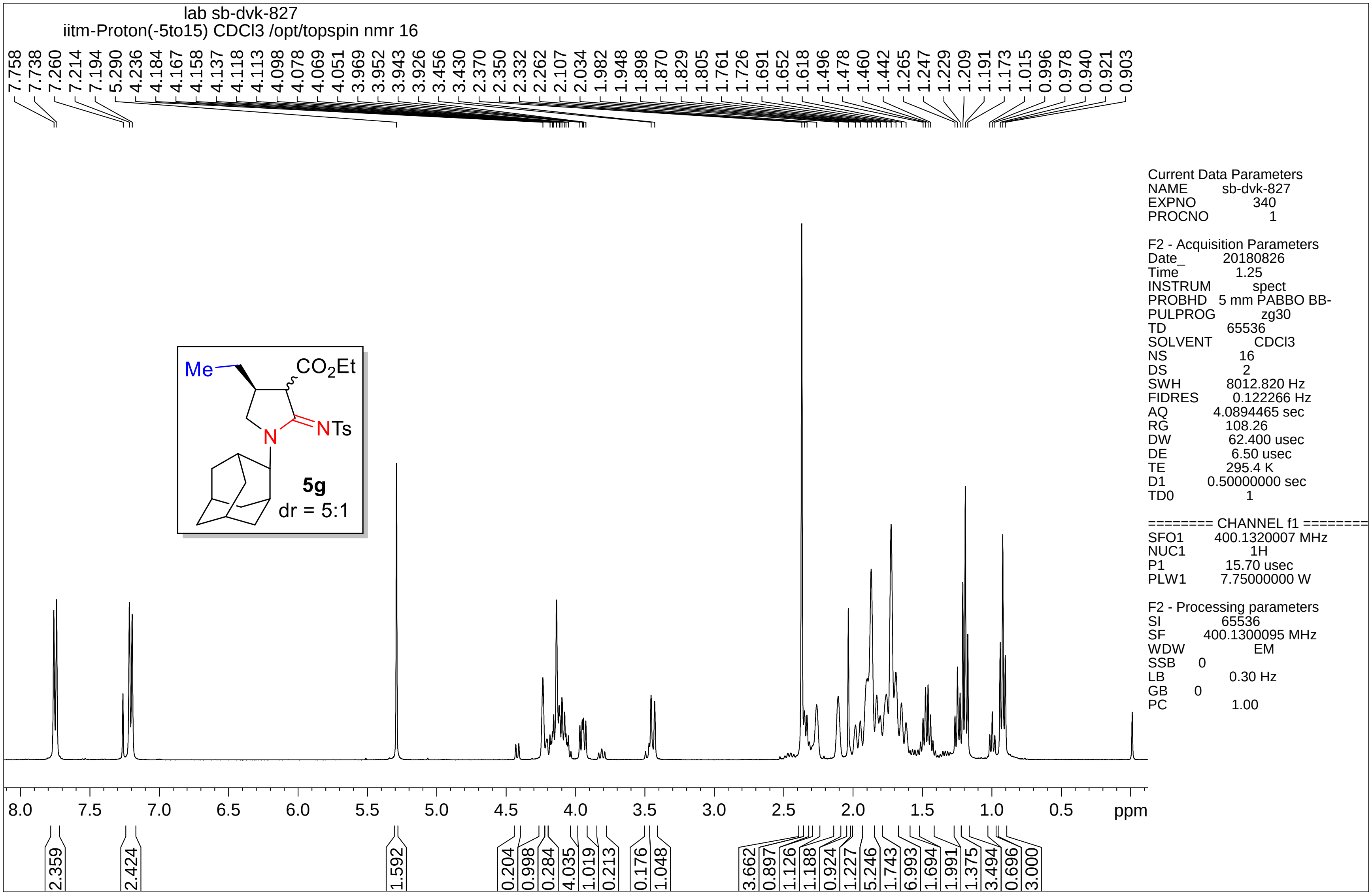
DEPT-135 NMR spectrum of crude compound 5a



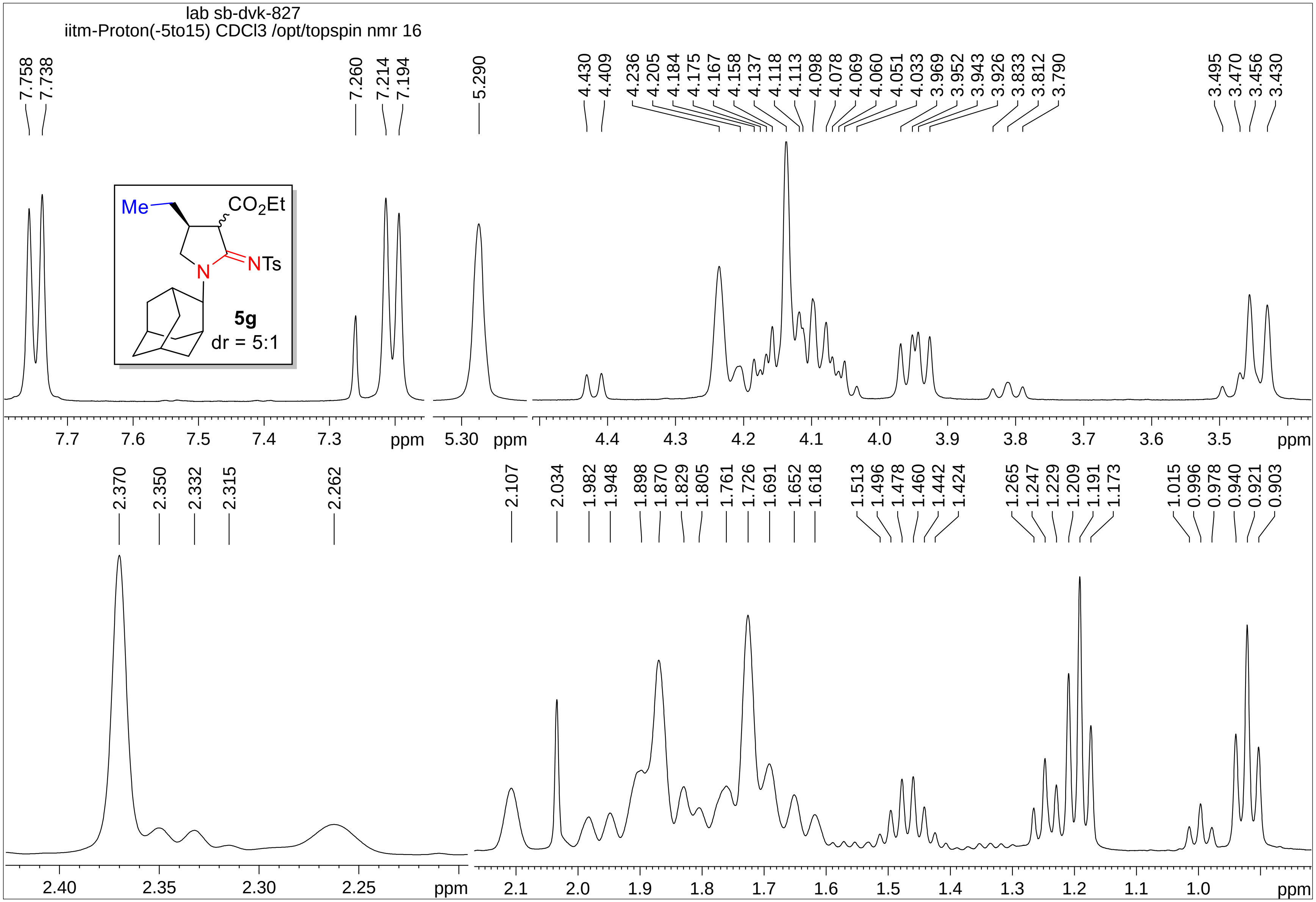
[1]H-[1]H COSY NMR spectrum of crude compound 5a



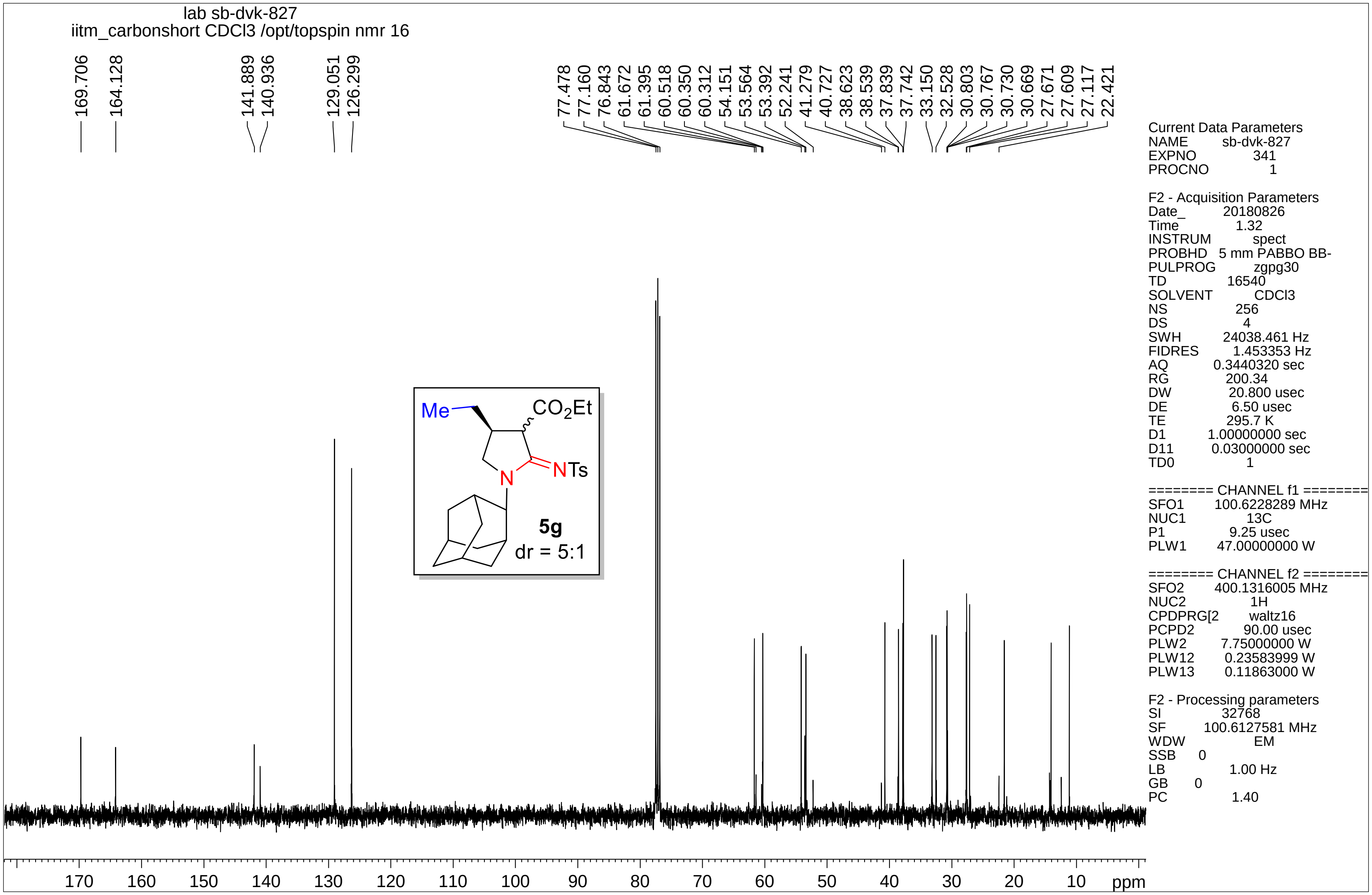
^{1}H-^{13}C HSQC NMR spectrum of crude compound 5a



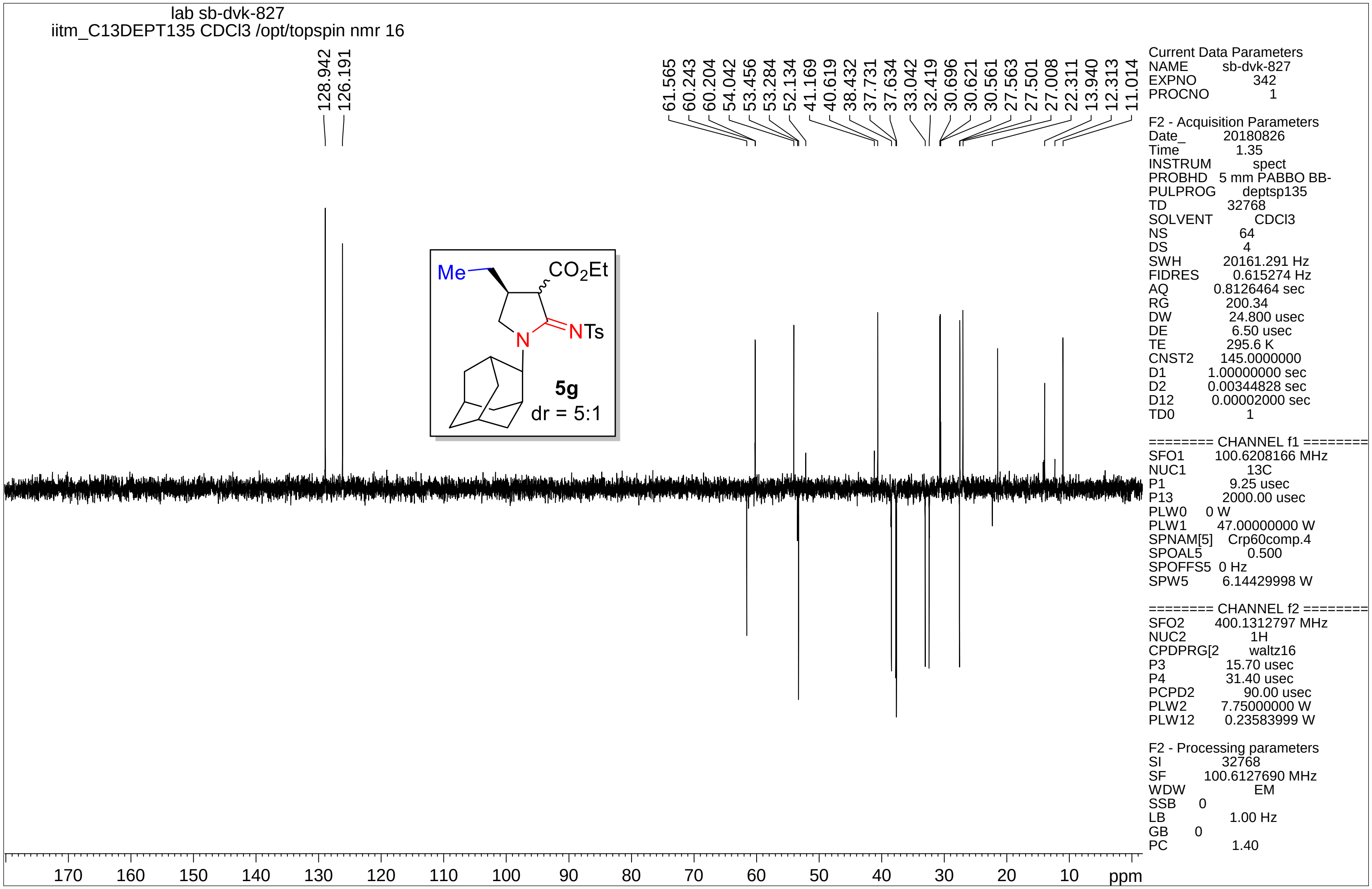
^{1}H NMR spectrum of crude compound 5g



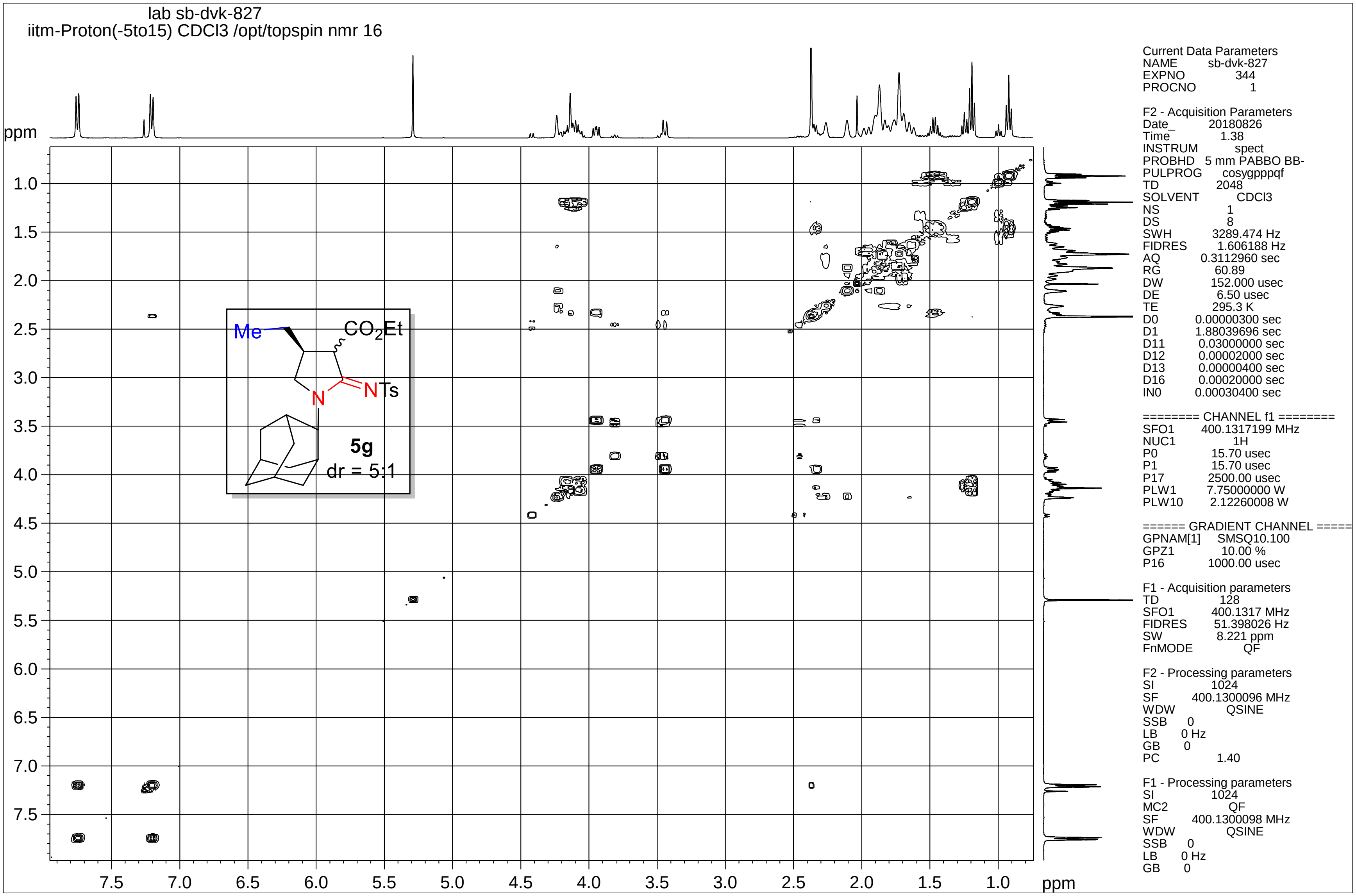
^{1}H NMR spectrum of crude compound 5g



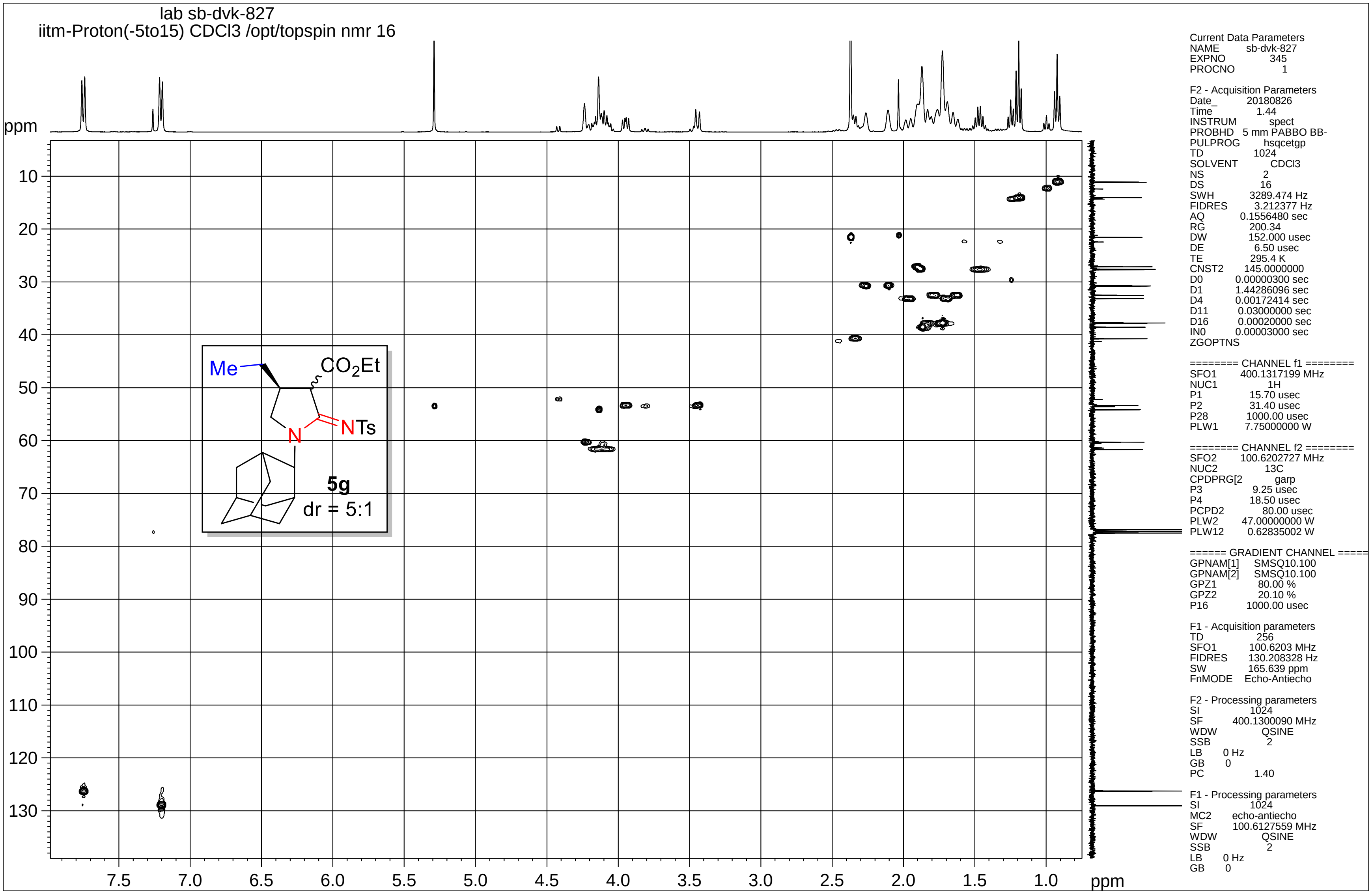
^{13}C NMR spectrum of crude compound 5g



DEPT-135 NMR spectrum of crude compound 5g



^{1}H-^{1}H COSY NMR spectrum of crude compound 5g



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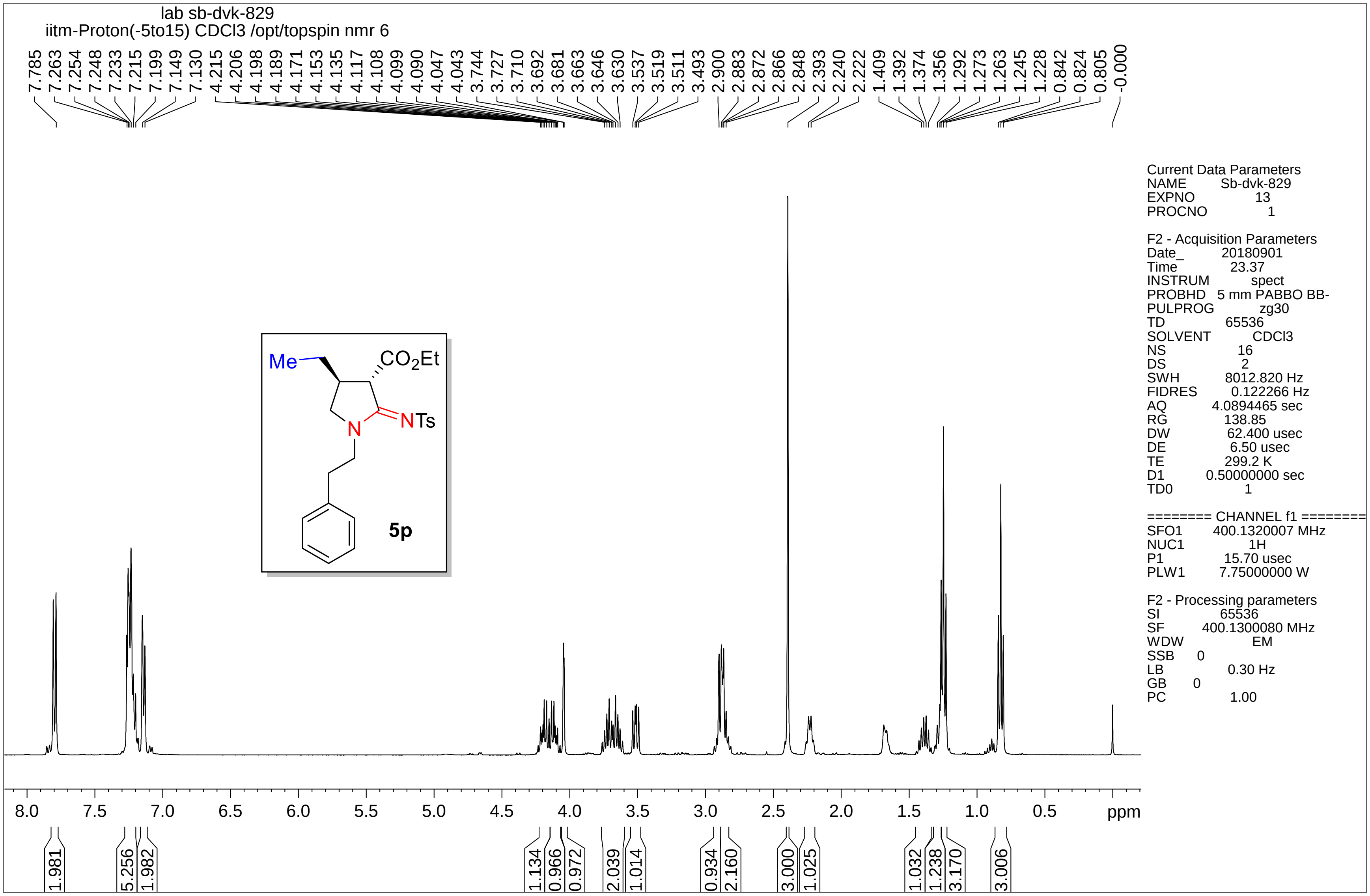
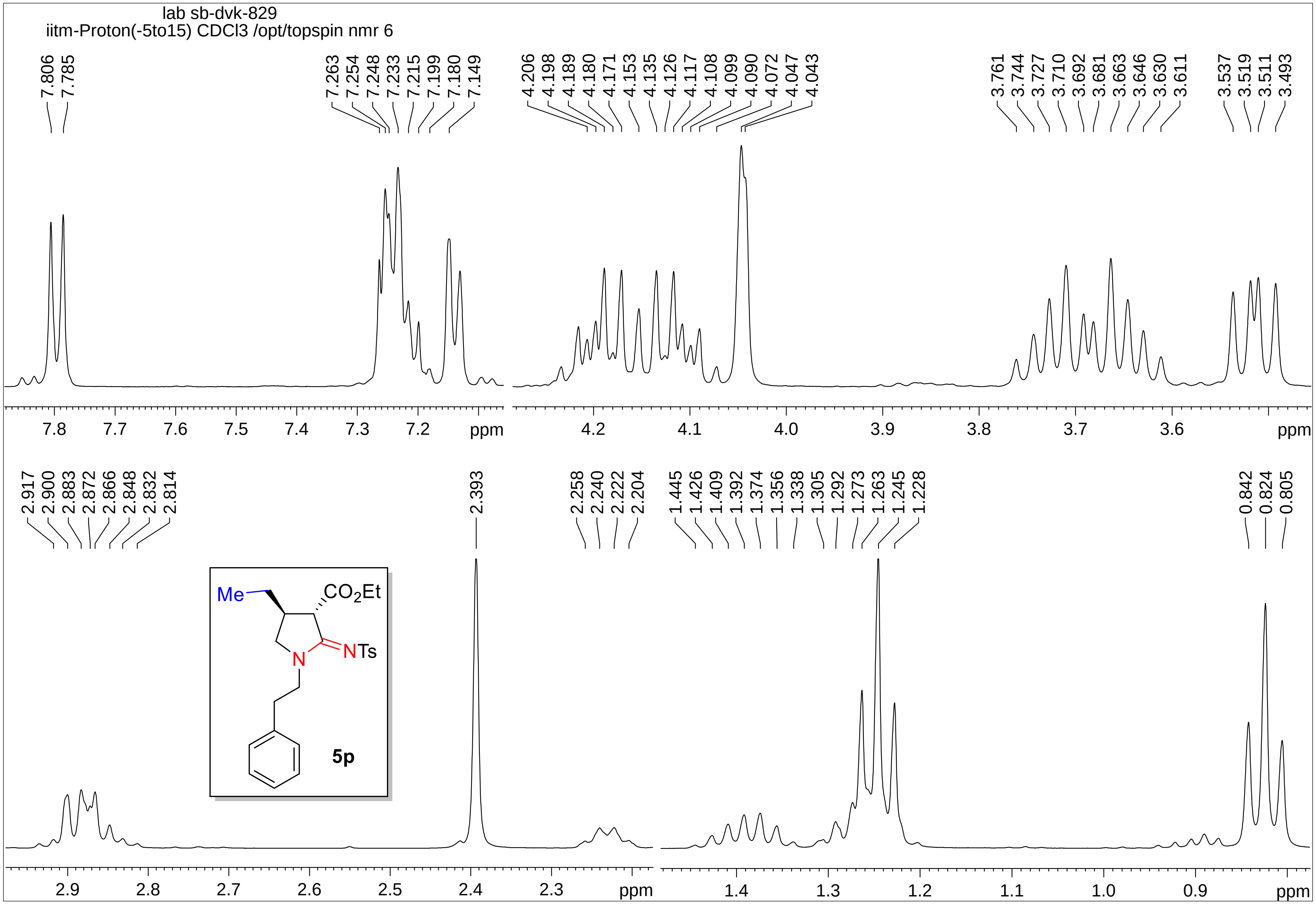
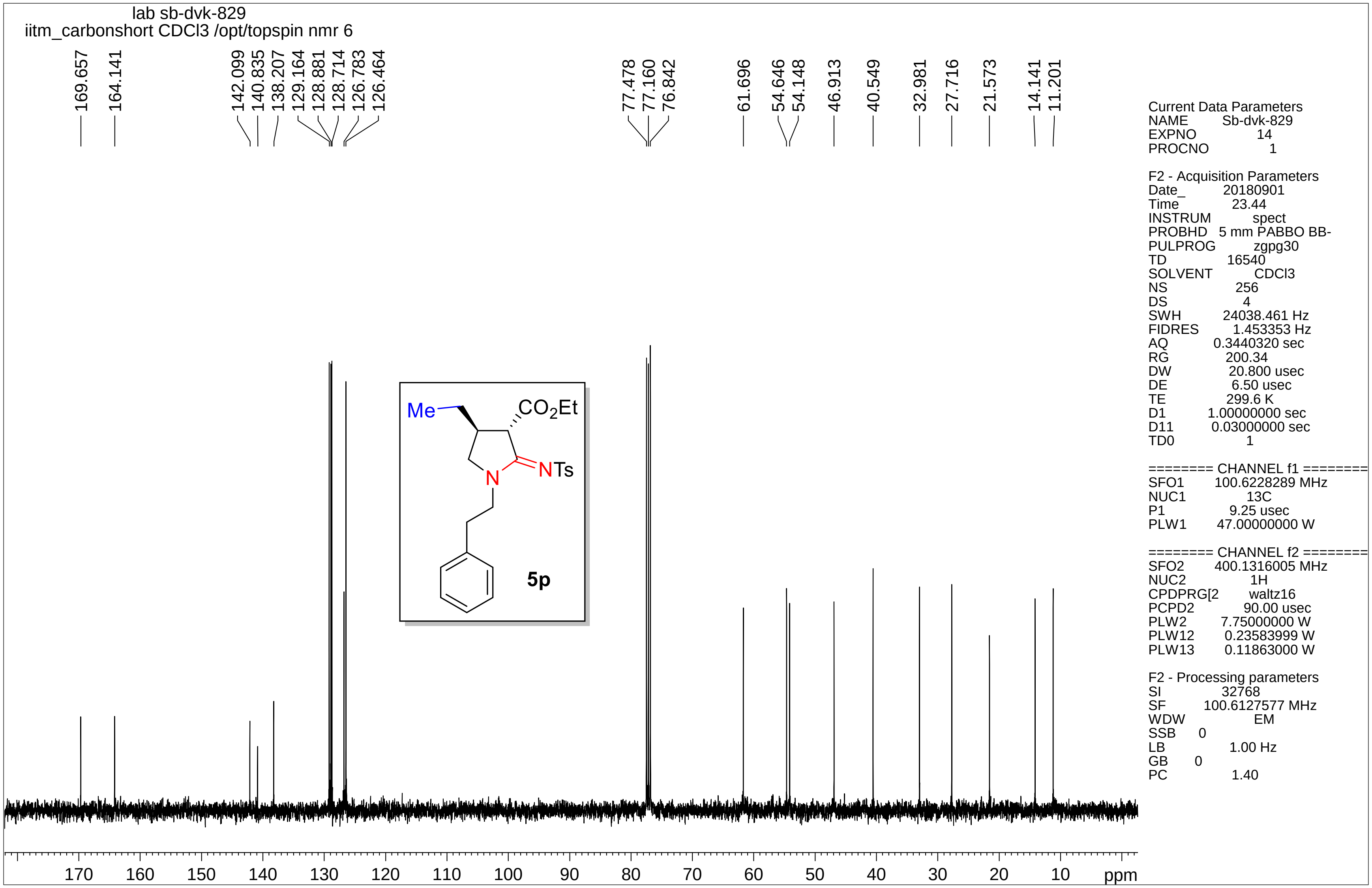


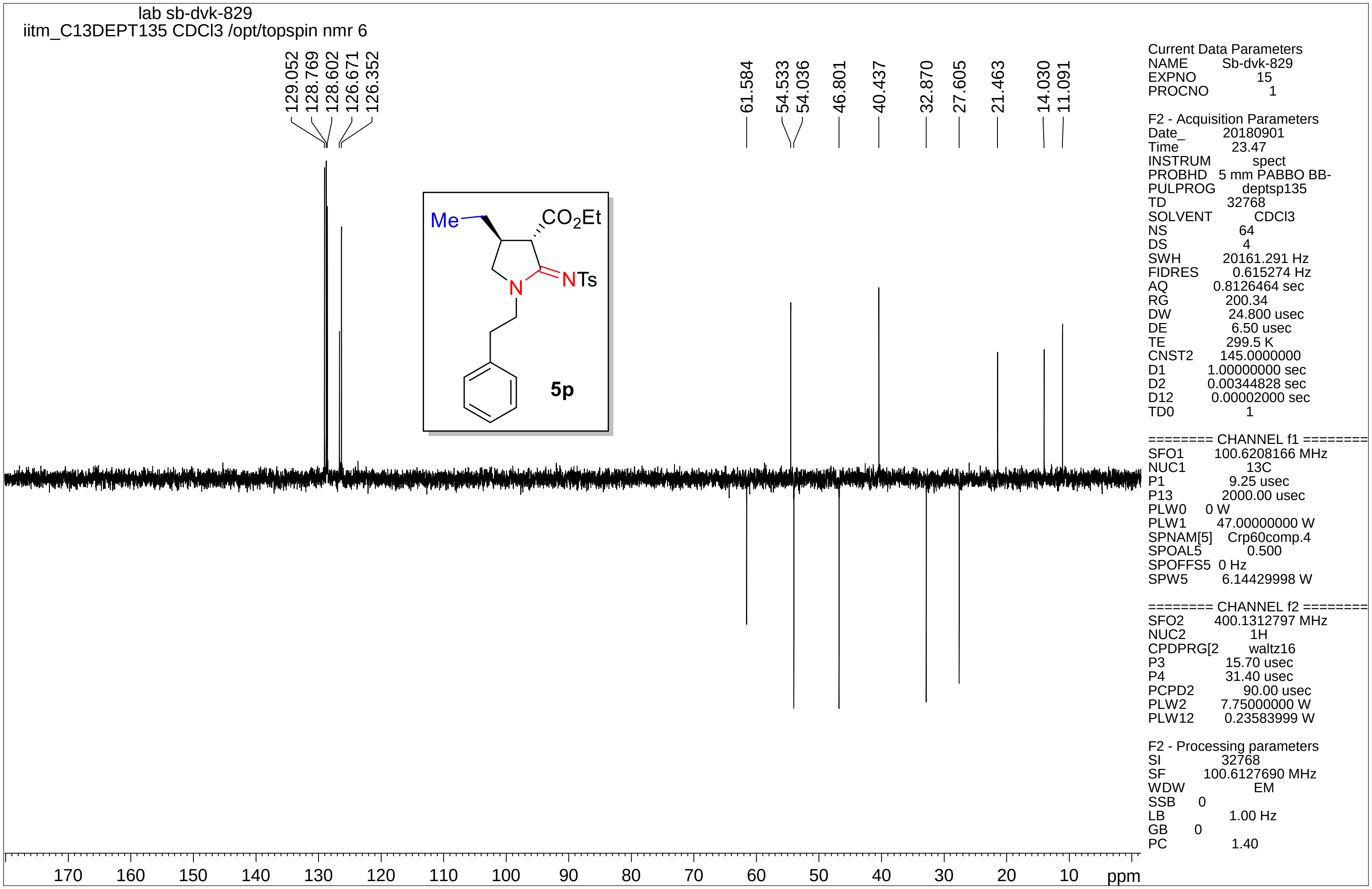
^{1}H NMR spectrum of major diastereomer 5p



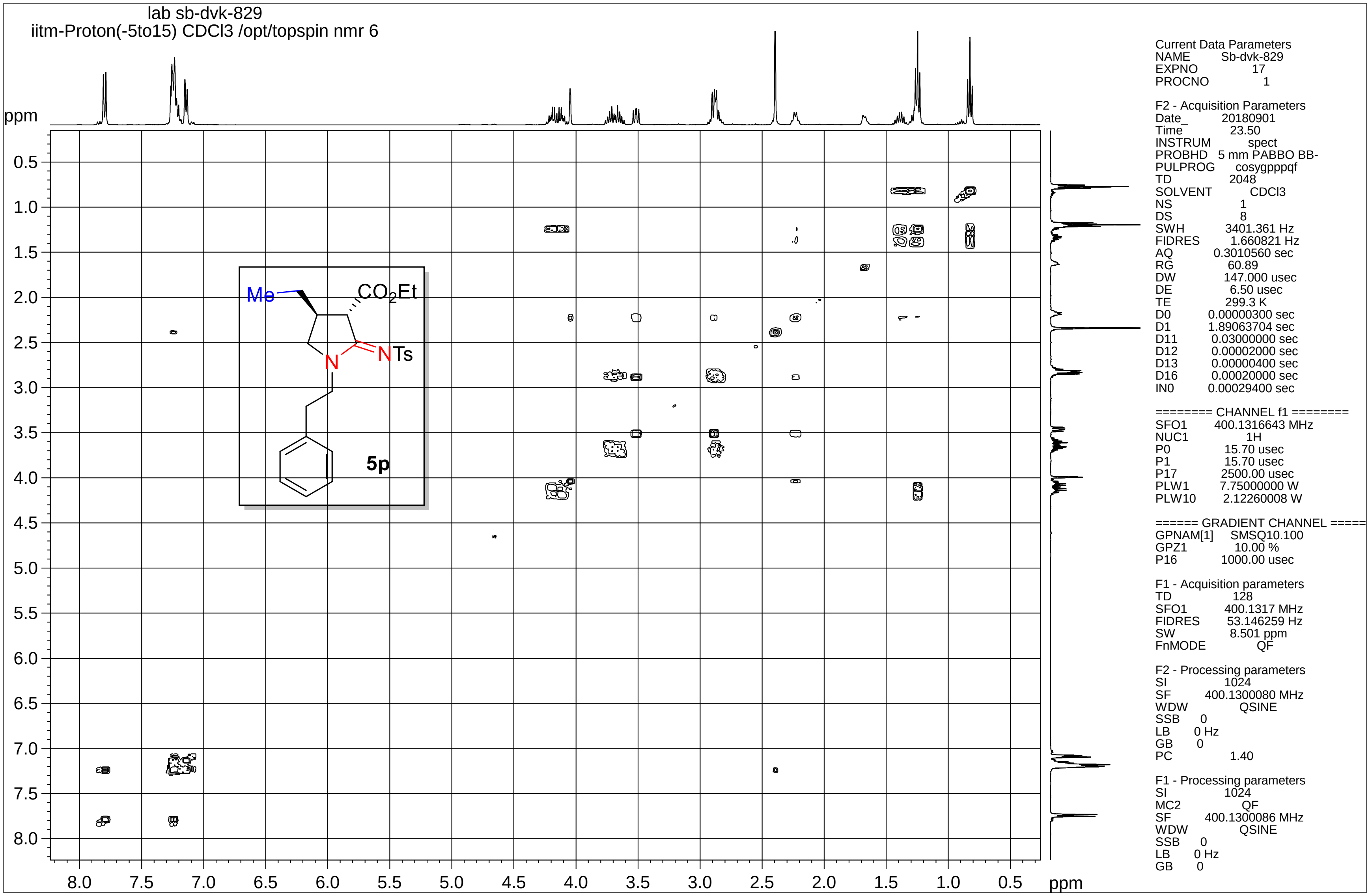
[1]H NMR spectrum of major diastereomer 5p



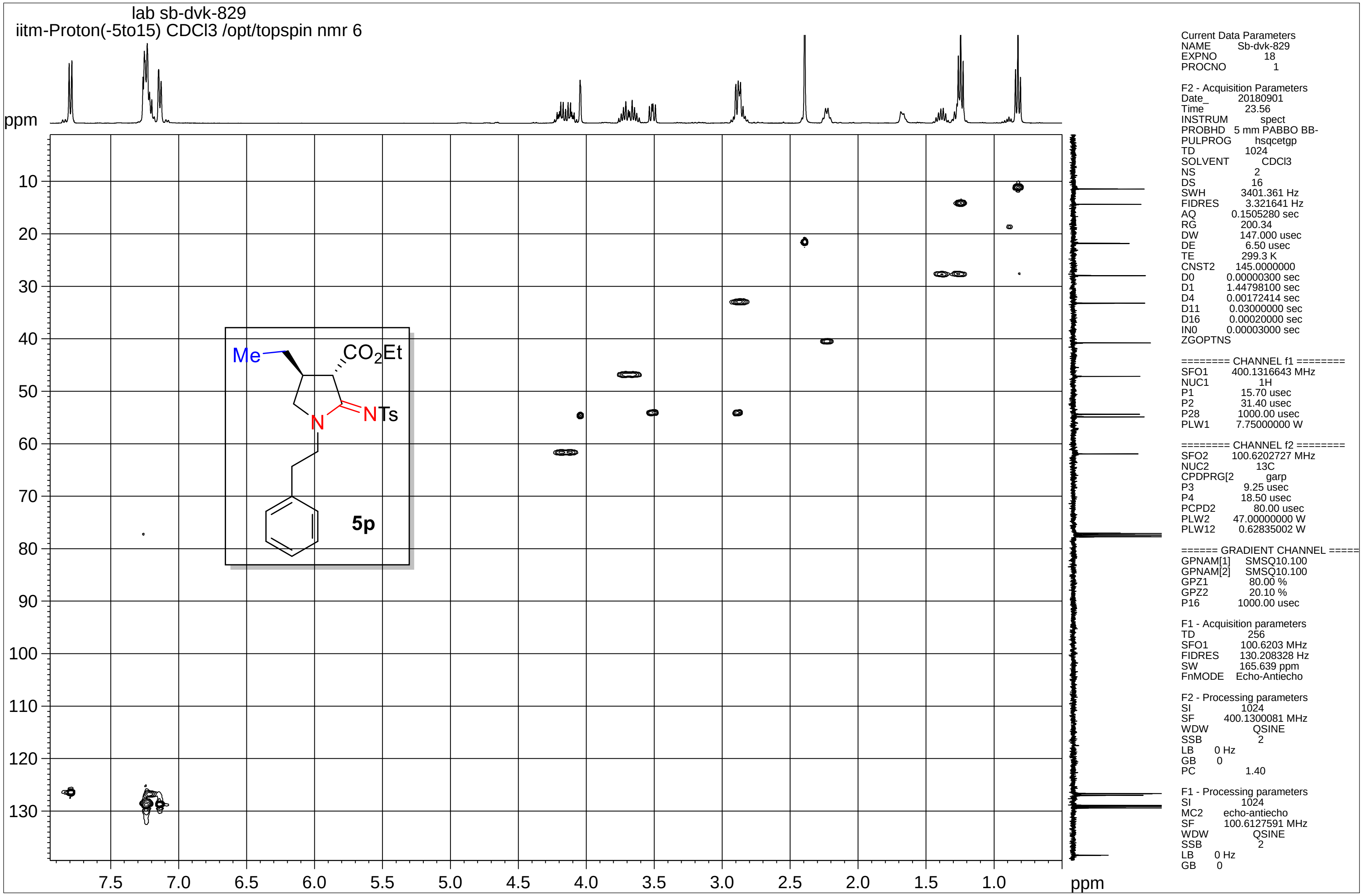
^{13}C NMR spectrum of major diastereomer 5p



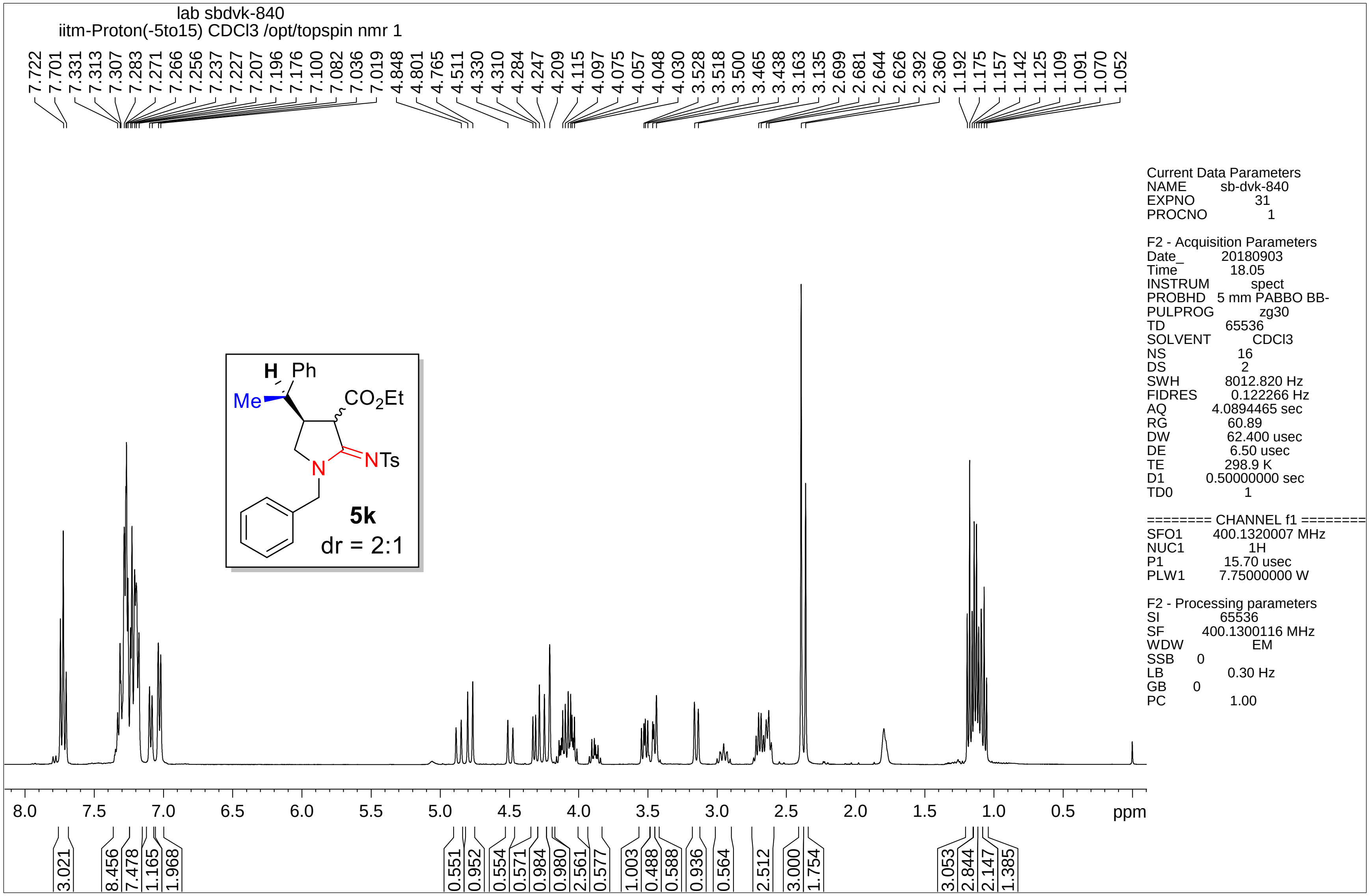
DEPT-135 NMR spectrum of major diastereomer 5p



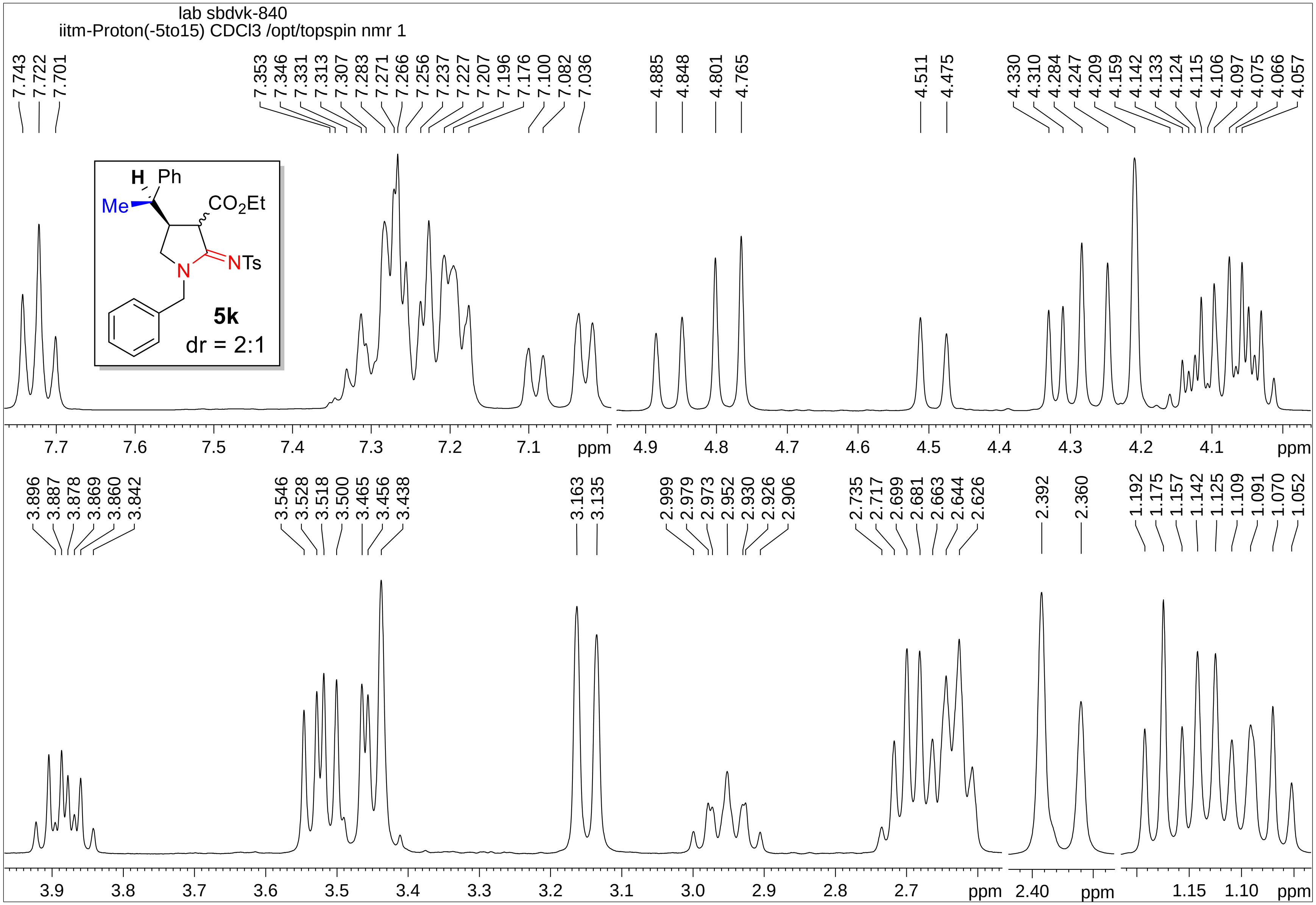
^{1}H-^{1}H COSY NMR spectrum of major diastereomer 5p



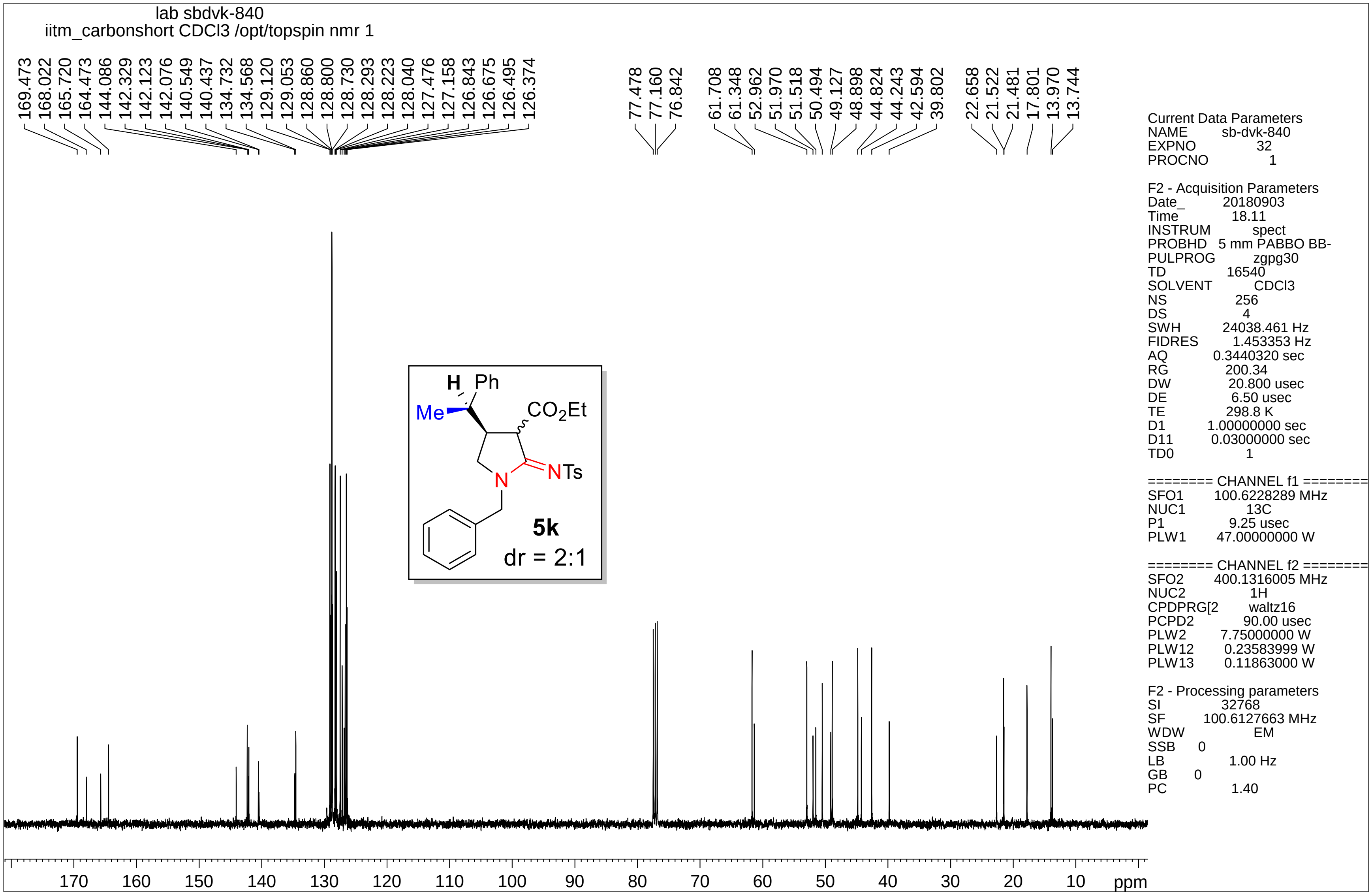
^{1}H-^{13}C HSQC NMR spectrum of major diastereomer 5p



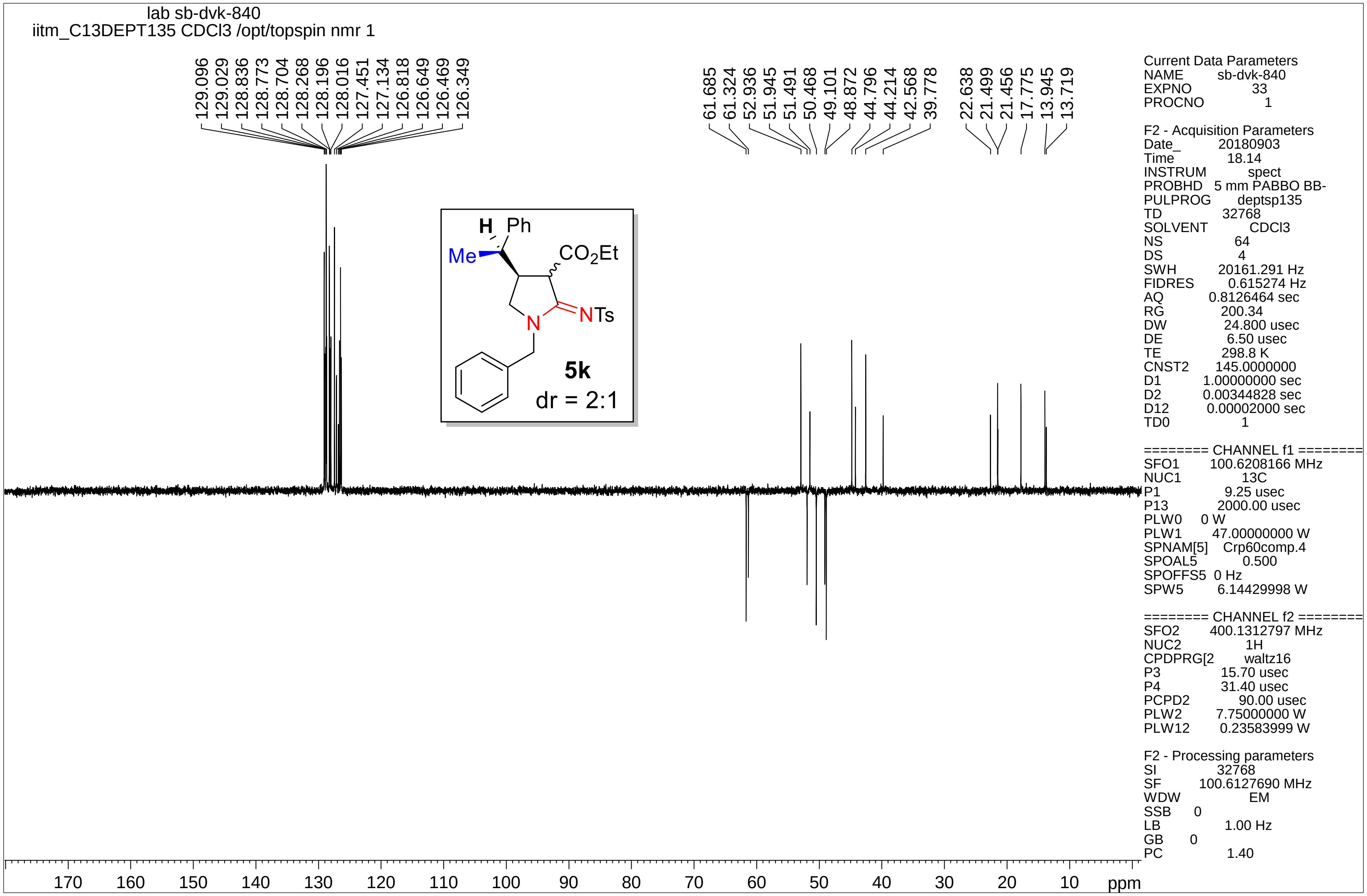
^{1}H NMR spectrum of crude compound 5k



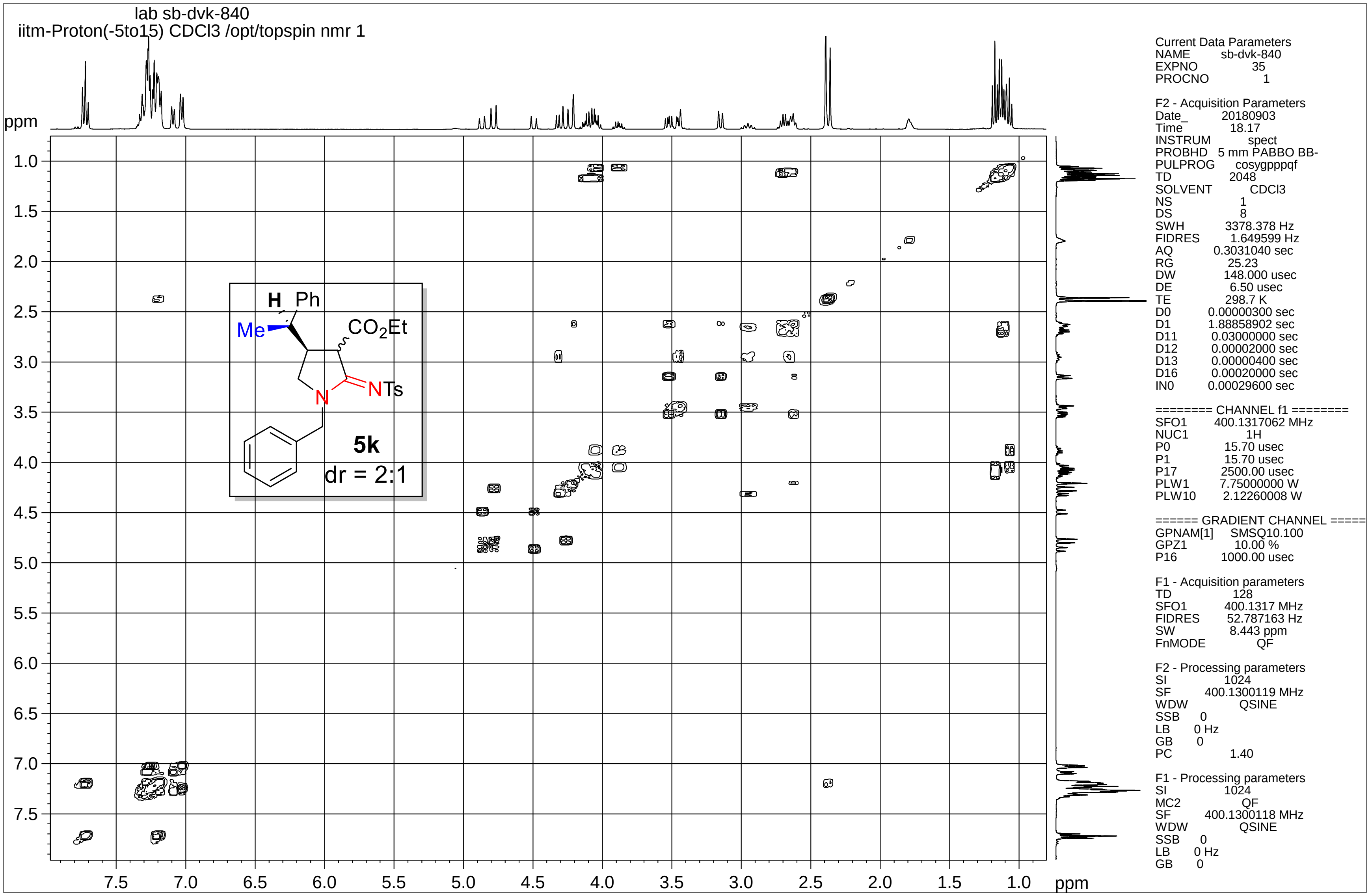
^{1}H NMR spectrum of crude compound 5k



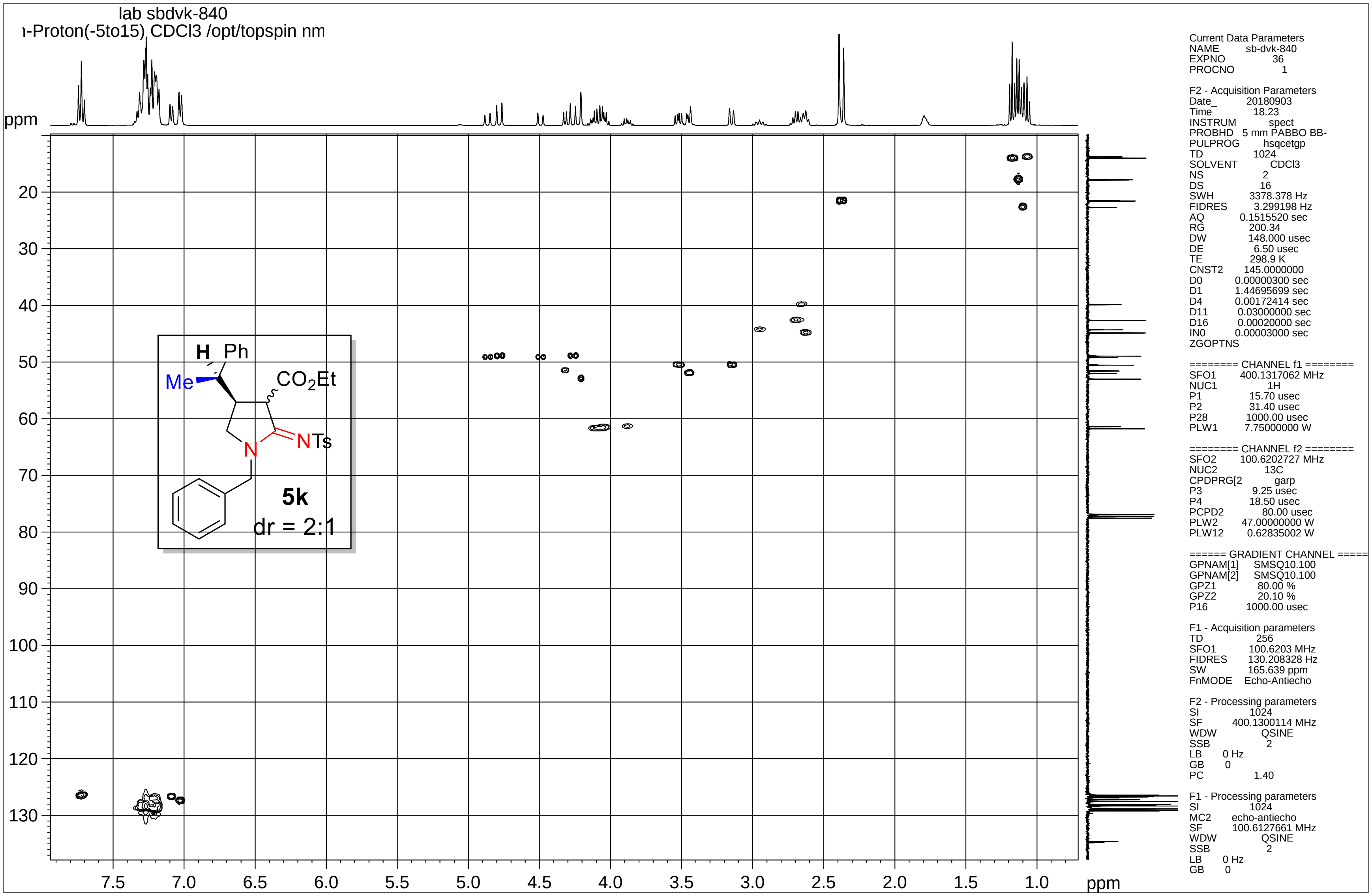
^{13}C NMR spectrum of crude compound 5k



DEPT-135 NMR spectrum of crude compound 5k



^{1}H-^{1}H COSY NMR spectrum of crude compound 5k



^{1}H-^{13}C HSQC NMR spectrum of crude compound 5k