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Visible-light-induced installation of oxyfluoroalkyl groups

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Supplementary Information

General Considerations

General Reagent Information

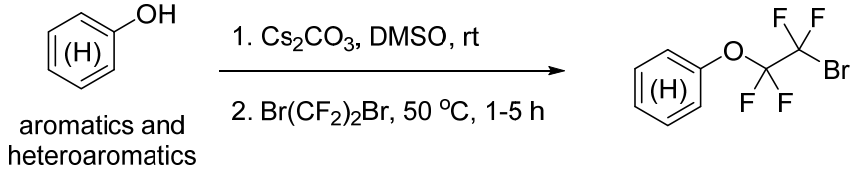
Anhydrous Solvents were purchased from Sigma-Aldrich, Alfa Aesar chemical company in Sure-Seal bottles and degassed by repeated sonication under light vacuum and replenishing the atmosphere with argon. Commercially available reagents including $[Ru(Phen)_3]Cl_2$ were purchased from Sigma-Aldrich, Alfa Aesar, Acros Organics, TCI companies, Junsei or Combi-blocks. Flash column chromatography was performed using Merck silica gel 60 (70–230 mesh).

General Analytical Information

The (hetero)aryloxytetrafluoroethylated products were characterized by ^{1}H, ^{13}C, and ^{19}F NMR, and FT-IR spectroscopy. NMR spectra were recorded on a Varian 600 MHz instrument (600 MHz for ^{1}H NMR, 151 MHz for ^{13}C NMR, and 564 MHz for ^{19}F NMR) and Varian 300 MHz instrument (300 MHz for ^{1}H NMR). Copies of ^{1}H NMR and ^{13}C NMR spectra can be found at the end of the Supporting Information. ^{1}H NMR experiments are reported in units, parts per million (ppm), and were measured relative to residual chloroform (7.26 ppm) and in the deuterated solvent. ^{13}C NMR spectra are reported in ppm relative to deuterochloroform (77.23 ppm), and all were obtained with ^{1}H decoupling. ^{19}F NMR spectra are reported in ppm, and all were taken composite pulse decoupling (CPD) mode. Coupling constants were reported in Hz. FT-IR spectra were recorded on a Tensor 27 Bruker FT-IR spectrometer. Reactions were monitored by GC-MS using the Agilent GC 7890B/5977A inert MSD with Triple-Axis Detector. Mass spectral data of all unknown compounds were obtained from the Korea Basic Science Institute (Daegu) on a Jeol JMS 700 high resolution mass spectrometer.

Experimental Details

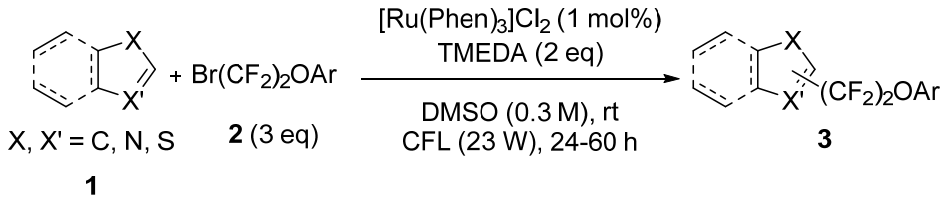
Preparation of (hetero)aryloxytetrafluoroethyl reagents



The aryloxyfluoroalkylation reagents were synthesized on 10 mmol scale following a reported procedure.[S1]

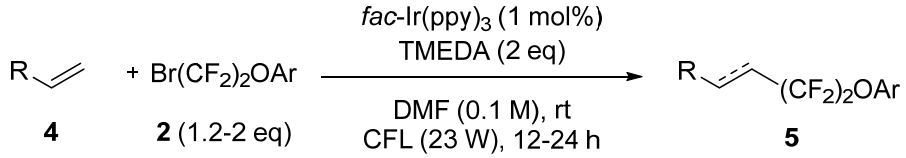
Ref. S1: J. Li, J. X. Qiao, D. Smith, B. -C. Chen, M. E. Salvati, J. Y. Roberge and B. N. Balasubramanian, *Tetrahedron Lett.*, 2007, **48**, 7516.

Aryloxytetrafluoroethylation of heteroaromatic alkenes



A flame-dried tube equipped with a magnetic stirring bar was charged with argon. The substrate (**1**: 0.3 mmol), $[Ru(Phen)_3]Cl_2$ (0.003 mmol), TMEDA (0.6 mmol), and DMSO (1.0 mL) were added to the tube. Argon was bubbled through the reaction mixture for 5 min. Then, $Br(CF_2)_2OAr$ (**2**: 0.9 mmol) was added. The mixture was stirred at room temperature and irradiated with visible light using a 23 W CFL. The reaction progress was monitored by thin layer chromatography and gas chromatography. Upon completion of the reaction, the mixture was diluted with diethyl ether and washed with brine. The layers were separated, and the organic layer was dried with $MgSO_4$, filtered, and concentrated in vacuo to give a crude residue that was purified by silica gel column chromatography to give the corresponding aryloxytetrafluoroethylated product.

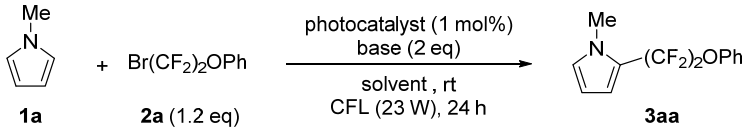
Aryloxytetrafluoroethylation of alkenes



A flame-dried tube equipped with a magnetic stirring bar was charged with argon. The substrate (**4**: 0.3 mmol), *fac*-$Ir(ppy)_3$ (0.003 mmol), TMEDA (0.6 mmol) and DMF (3.0 mL) were added to the tube. Argon was bubbled through the reaction mixture for 5 min. Then, $Br(CF_2)_2OAr$ (2: 0.36-0.6 mmol) was added. The mixture was stirred at room temperature and irradiated with visible light using a 23 W CFL. The reaction progress was monitored by thin layer chromatography and gas chromatography. Upon completion of the reaction, the mixture was diluted with diethyl ether and washed with brine. The layers were separated, and the organic layer was dried with $MgSO_4$, filtered, and concentrated in vacuo to give a crude residue that was purified by silica gel column chromatography to give the corresponding aryloxytetrafluoroethylated product.

Optimization Studies of Alkenes

Table S1. Optimization Studies of Heteroaromatics[a]

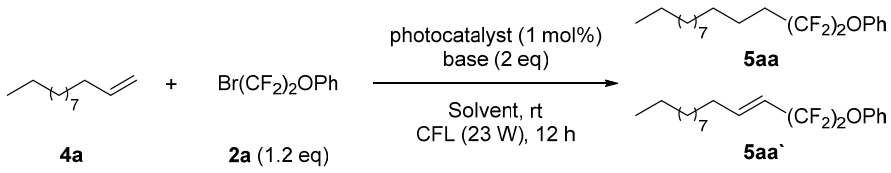


1a **2a** (1.2 eq) **3aa**

Entry	Photocatalyst (PC)	Base	Solvent (Conc.)	Variations	Yield (%)[b]
1	$[Ru(Phen)_3]Cl_2$	TMEDA	MeCN (0.2 M)		46
2	$[Ru(bpy)_3]Cl_2$	TMEDA	MeCN (0.2 M)		43
3	*fac*-Ir(ppy)$_3$	TMEDA	MeCN (0.2 M)		31
4	*fac*-Ir(dFppy)$_3$	TMEDA	MeCN (0.2 M)		28
5	Nile red	TMEDA	MeCN (0.2 M)		-
6	$[Ru(Phen)_3]Cl_2$	TMEDA	DMF (0.2 M)		67
7	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.2 M)		71
8	$[Ru(Phen)_3]Cl_2$	TMEDA	DCM (0.2 M)		18
9	$[Ru(Phen)_3]Cl_2$	TMEDA	MeOH (0.2 M)		trace
10	$[Ru(Phen)_3]Cl_2$	TMEDA	THF (0.2 M)		-
11	$[Ru(Phen)_3]Cl_2$	TMEDA	1,4-dioxane (0.2 M)		-
12	$[Ru(Phen)_3]Cl_2$	TMEDA	pyridine (0.2 M)		trace
13	$[Ru(Phen)_3]Cl_2$	TEA	DMSO (0.2 M)		58
14	$[Ru(Phen)_3]Cl_2$	DBU	DMSO (0.2 M)		24
15	$[Ru(Phen)_3]Cl_2$	DIPEA	DMSO (0.2 M)		65
16	$[Ru(Phen)_3]Cl_2$	2,6-lutidine	DMSO (0.2 M)		-
17	$[Ru(Phen)_3]Cl_2$	K_2CO_3	DMSO (0.2 M)		trace
18	$[Ru(Phen)_3]Cl_2$	Cs_2CO_3	DMSO (0.2 M)		trace
19	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.2 M)	no hv	trace
20	-	TMEDA	DMSO (0.2 M)		trace
21	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.2 M)	blue LEDs (21 W)	64
22	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.1 M)		70
23	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.3 M)		76
24	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.5 M)		58
25	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.3 M)	2 mol % PC	75
26	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.3 M)	0.5 mol % PC	60
27	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.3 M)	1 equiv TMEDA	62
28	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.3 M)	3 equiv TMEDA	76
29	$[Ru(Phen)_3]Cl_2$	TMEDA	DMSO (0.3 M)	2 equiv **2a**	82
30	**$[Ru(Phen)_3]Cl_2$**	**TMEDA**	**DMSO (0.3 M)**	**3 equiv 2a**	**87**

[a]Reaction scale: **1a** (0.1 mmol); [b]yield (%) was determined by GC spectroscopy using dodecane as internal standard.

Table S2. Optimization Studies of Alkenes[a]

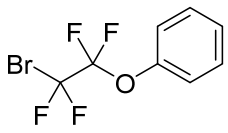


4a **2a** (1.2 eq) **5aa** **5aa`**

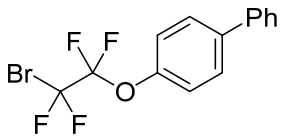
Entry	Photocatalyst	Base	Solvent (Conc.)	Variations	Yield (%) [b]	
					5aa	**5aa`**
1	$[Ru(Phen)_3]Cl_2$	TMEDA	DCM (0.2 M)		trace	-
2	$[Ru(bpy)_3]Cl_2$	TMEDA	DCM (0.2 M)		trace	-
3	*fac*-Ir(ppy)$_3$	TMEDA	DCM (0.2 M)		55	9
4	*fac*-Ir(dFppy)$_3$	TMEDA	DCM (0.2 M)		52	8
5	Nile red	TMEDA	DCM (0.2 M)		-	-
6	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.2 M)		75	8
7	*fac*-Ir(ppy)$_3$	TMEDA	DMSO (0.2 M)		26	9
8	*fac*-Ir(ppy)$_3$	TMEDA	MeCN (0.2 M)		46	14
9	*fac*-Ir(ppy)$_3$	TMEDA	MeOH (0.2 M)		14	3
10	*fac*-Ir(ppy)$_3$	TMEDA	THF (0.2 M)		66	7
11	*fac*-Ir(ppy)$_3$	TMEDA	1,4-dioxane (0.2 M)		51	14
12	*fac*-Ir(ppy)$_3$	TMEDA	pyridine (0.2 M)		19	13
13	*fac*-Ir(ppy)$_3$	TEA	DMF (0.2 M)		58	5
14	*fac*-Ir(ppy)$_3$	DBU	DMF (0.2 M)		70	15
15	*fac*-Ir(ppy)$_3$	DIPEA	DMF (0.2 M)		34	15
16	*fac*-Ir(ppy)$_3$	2,6-Lutidine	DMF (0.2 M)		-	-
17	*fac*-Ir(ppy)$_3$	K_2CO_3	DMF (0.2 M)		66	15
18	*fac*-Ir(ppy)$_3$	Cs_2CO_3	DMF (0.2 M)		74	20
19	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.2 M)	no hv	-	-
20	-	TMEDA	DMF (0.2 M)		-	-
21	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.2 M)	blue LEDs (21 W)	69	11
22	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.02 M)		88	4
23	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.05 M)		89	6
24	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.1 M)		**89**	**5**
25	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.3 M)		63	12
26	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.**1** M)	0.5 mol% *fac*-Ir(ppy)$_3$	86	6
27	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.**1** M)	2 mol% *fac*-Ir(ppy)$_3$	75	9
28	*fac*-Ir(ppy)$_3$	TMEDA	DMF (0.**1** M)	2 equiv **2a**	89	5

[a]Reaction scale: **4a** (0.1 mmol); [b]The yield was determined by GC-Chromatography with dodecane as internal standard.

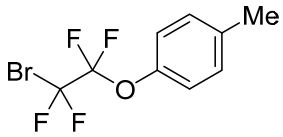
Analytic Data for Aryloxytetrafluoroethyl Reagents



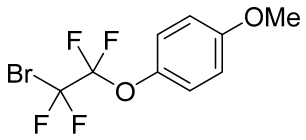
2a ((2-bromo-1,1,2,2-tetrafluoroethoxy)benzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.40 (dd, *J* = 8.1, 7.4 Hz, 2H), 7.30 (t, *J* = 7.4 Hz, 1H), 7.23 (d, *J* = 8.1 Hz, 2H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 148.8, 129.7, 126.7, 121.6 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –68.03, –85.89; **IR (neat)**: ν_{max} = 2361, 1492, 1194, 904, 725 cm^{-1}; $\boldsymbol{R_f}$ = 0.70 (hex:EtOAc = 4:1).



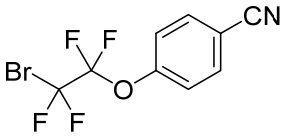
2b (4-(2-bromo-1,1,2,2-tetrafluoroethoxy)-1,1'-biphenyl): white solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.61 (d, *J* = 8.8 Hz, 2H), 7.57 (d, *J* = 8.1 Hz, 2H), 7.46 (dd, *J* = 8.1, 7.4 Hz, 2H), 7.38 (t, *J* = 7.4 Hz, 1H), 7.30 (d, *J* = 8.8 Hz, 2H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 148.1, 139.8, 128.9, 128.8, 128.4, 127.6, 127.1, 121.8 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –67.99, –85.87; **IR (neat)**: ν_{max} = 2973, 2361, 1488, 1328, 1200 cm^{-1}; $\boldsymbol{R_f}$ = 0.75 (hex:EtOAc = 4:1).



2c (1-(2-bromo-1,1,2,2-tetrafluoroethoxy)-4-methylbenzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.19 (d, *J* = 8.6 Hz, 2H), 7.11 (d, *J* = 8.6 Hz, 2H), 2.36 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 146.5, 136.6, 130.2, 121.4, 20.8 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –67.96, –85.96; **IR (neat)**: ν_{max} = 2360, 1508, 1327, 1193, 929 cm^{-1}; $\boldsymbol{R_f}$ = 0.72 (hex:EtOAc = 4:1).



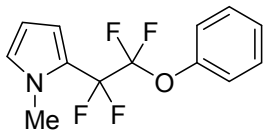
2d (1-(2-bromo-1,1,2,2-tetrafluoroethoxy)-4-methoxybenzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.15 (d, *J* = 8.9 Hz, 2H), 6.89 (d, *J* = 8.9 Hz, 2H), 3.81 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 158.1, 142.0, 122.8, 114.6, 55.6 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –67.93, –86.19; **IR (neat)**: ν_{max} = 2957, 2341, 1506, 1465, 1327, 1177, 929, cm^{-1}; $\boldsymbol{R_f}$ = 0.60 (hex:EtOAc = 4:1).



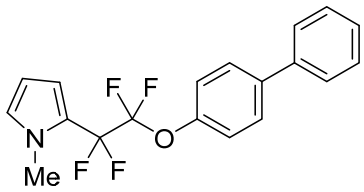
2e (4-(2-bromo-1,1,2,2-tetrafluoroethoxy)benzonitrile): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.73 (d, *J* = 8.8 Hz, 2H), 7.35 (d, *J* = 8.8 Hz, 2H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 151.9, 134.1, 122.0, 117.6, 110.9 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –68.39, –86.19;

IR (neat): ν_{max} = 2973, 2235, 1604, 1328, 1250, 1202, 1093, 931 cm^{-1}; $\boldsymbol{R_f}$ = 0.50 (hex:EtOAc = 4:1).

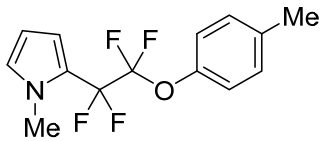
Analytic Data for Aryloxytetrafluoroethylated Compounds



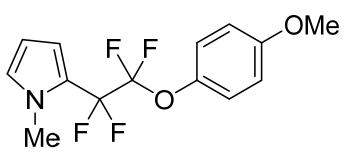
3aa (1-methyl-2-(1,1,2,2-tetrafluoro-2-phenoxyethyl)-1*H*-pyrrole): yellow liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.38 (dd, *J* = 7.9, 6.9 Hz, 2H), 7.27 (t, *J* = 6.9 Hz, 1H), 7.21 (d, *J* = 7.9 Hz, 2H), 6.74(d, *J* = 2.7 Hz, 1H), 6.64 (d, *J* = 2.9 Hz, 1H), 6.16 (dd, *J* = 2.9, 2.7 Hz, 1H), 3.81 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 149.2, 132.7, 129.6, 127.1, 126.3, 121.6, 113.4, 107.4, 35.8 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −85.62, −105.98; **IR (neat)**: ν_{max} = 2962, 1544, 1490, 1309, 1182, 1081, 1019, 951, 728 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{13}H_{11}F_4NO$ [M+] 273.0777, found 273.0775; $\boldsymbol{R_f}$ = 0.55 (hex:EtOAc = 8:1).



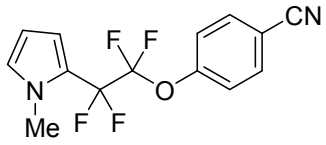
3ab (2-(2-([1,1'-biphenyl]-4-yloxy)-1,1,2,2-tetrafluoroethyl)-1-methyl-1*H*-pyrrole): white solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.59–7.55 (m, 4H), 7.45 (dd, *J* = 7.6, 7.3 Hz, 2H), 7.36 (t, *J* = 7.3 Hz, 1H), 7.26 (d, *J* = 7.9 Hz, 2H), 6.74 (d, *J* = 2.7 Hz, 1H), 6.65 (d, *J* = 3.0 Hz, 1H), 6.16 (dd, *J* = 3.0, 2.7 Hz, 1H), 3.82 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 148.6, 140.0, 139.5, 131.4, 128.8, 128.2, 127.5, 127.1, 127.0, 121.8, 113.5, 107.4, 35.8 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −85.61, −105.94; **IR (neat)**: ν_{max} = 2927, 1725, 1487, 1310, 1186, 1118, 952, 904, 759 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{19}H_{15}F_4NO$ [M+] 349.1090, found 349.1091; $\boldsymbol{R_f}$ = 0.74 (hex:EtOAc = 4:1).



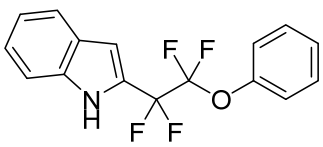
3ac (1-methyl-2-(1,1,2,2-tetrafluoro-2-(p-tolyloxy)ethyl)-1*H*-pyrrole): colorless oil; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.16 (d, *J* = 8.5 Hz, 2H), 7.07 (d, *J* = 8.5 Hz, 2H), 6.72 (d, *J* = 3.0 Hz, 1H), 6.62 (d, *J* = 3.7 Hz, 1H), 6.14 (dd, *J* = 3.7, 3.0 Hz, 1H), 3.79 (s, 3H), 2.34 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 146.9, 136.0, 134.1, 130.0, 127.1, 121.4, 113.4, 107.4, 35.8, 29.7 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −85.68, −106.00; **IR (neat)**: ν_{max} = 2921, 1596, 1507, 1310, 1250, 1177, 1098, 953, 730 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{14}H_{13}F_4NO$ [M+] 287.0933, found 287.0935; $\boldsymbol{R_f}$ = 0.55 (hex:EtOAc = 4:1)



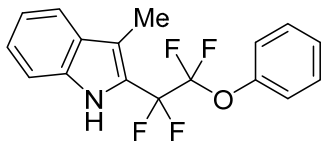
3ad (1-methyl-2-(1,1,2,2-tetrafluoro-2-(4-methoxyphenoxy)ethyl)-1*H*-pyrrole): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.11 (d, *J* = 9.1 Hz, 2H), 6.86 (d, *J* = 9.1 Hz, 2H), 6.72 (d, *J* = 3.0 Hz, 1H), 6.61 (d, *J* = 3.5 Hz, 1H), 6.14 (dd, *J* = 3.5, 3.0 Hz, 1H), 3.80 (s, 3H), 3.79 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ = 157.7, 142.5, 140.7, 127.1, 122.9, 114.5, 113.4, 107.4, 55.6, 29.7 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −85.85, −105.95; **IR (neat)**: ν_{max} = 2926, 1509, 1310, 1187, 1119, 904, 728, 650 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{14}H_{13}F_4NO_2$ [M+] 303.0882, found 303.0879; $\boldsymbol{R_f}$ = 0.56 (hex:EtOAc = 6:1).



3ae(4-(1,1,2,2-tetrafluoro-2-(1-methyl-1*H*-pyrrol-2-yl)ethoxy)benzonitrile): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.69 (d, *J* = 8.5 Hz, 2H), 7.31 (d, *J* = 8.5 Hz, 2H), 6.74(d, *J* = 2.9 Hz, 1H), 6.59 (d, *J* = 3.1 Hz, 1H), 6.15 (d, *J* = 3.1, 2.9 Hz, 1H), 3.79 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 152.5, 133.9, 127.4, 121.9, 119.6, 117.8, 113.6, 110.2, 107.6, 35.8 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −85.88, −105.86; **IR (neat)**: ν_{max} = 2233, 1605, 1504, 1309, 1173, 1123, 952, 903, 730 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{14}H_{10}F_4N_2O$ [M+] 298.0729, found 298.0730; $\boldsymbol{R_f}$ = 0.52 (hex:EtOAc = 4:1).

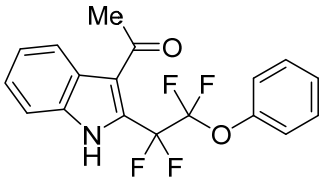


3ba (2-(1,1,2,2-tetrafluoro-2-phenoxyethyl)-1*H*-indole): yellow solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 8.51 (s, 1H), 7.71 (d, *J* = 8.1 Hz, 1H), 7.46 (d, *J* = 8.3 Hz, 1H), 7.38–7.31 (m, 3H), 7.27 (t, *J* = 7.5 Hz, 1H), 7.21–7.17 (m, 3H), 7.02 (s, 1H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 136.4, 129.6, 129.6, 126.9, 126.6, 125.9, 124.3, 121.9, 121.8, 120.8, 111.6, 105.4 (carbon peaks of $– C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −86.77, −117.06; **IR (neat)**: ν_{max} = 3477, 2927, 2340, 1590, 1491, 1298, 1188, 1022, 739 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{16}H_{11}F_4NO$ [M+] 309.0777, found 309.0778; $\boldsymbol{R_f}$ = 0.67 (hex:EtOAc = 4:1).

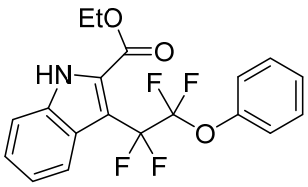


3ca (3-methyl-2-(1,1,2,2-tetrafluoro-2-phenoxyethyl)-1*H*-indole): yellow liquid; **^{1}H NMR (300 MHz, $CDCl_3$)** δ 8.24 (s, 1H), 7.64 (d, *J* = 8.0 Hz, 1H), 7.37 (d, *J* = 8.2 Hz, 1H), 7.35–7.27 (m, 3H), 7.25–7.14 (m, 2H), 7.11 (d, *J* = 7.9 Hz, 2H), 2.47 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 149.0, 135.6, 129.6, 128.5, 126.4, 124.3, 121.7, 120.0, 119.8, 117.9, 115.3, 111.4, 8.7 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 Hz, $CDCl_3$)** δ −86.86, −111.55; **IR (neat)**:

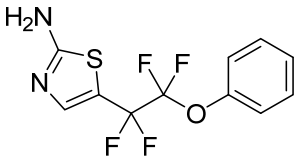
ν_{max} = 3479, 3063, 1590, 1491, 1304, 1186, 1025, 958, 737 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{17}H_{13}F_4NO$ [M+] 323.0933, found 323.0934; R_f = 0.52 (hex:EtOAc = 2:1).



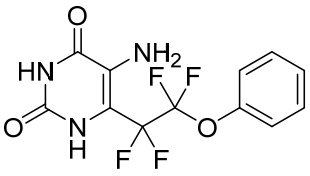
3da (1-(2-(1,1,2,2-tetrafluoro-2-phenoxyethyl)-1*H*-indol-3-yl)ethan-1-one): white solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 9.08 (s, 1H), 8.13 (d, *J* = 8.2 Hz, 1H), 7.48 (d, *J* = 8.4 Hz, 1H), 7.38–7.30(m, 4H), 7.26 (t, *J* = 6.9 Hz, 1H), 7.12 (d, *J* = 8.2 Hz, 2H), 2.71 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 196.1, 148.7, 134.7, 129.7, 126.7, 125.3, 125.1, 122.8, 122.5, 121.6, 119.9, 111.6, 31.5 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −85.81, −107.93; **IR (neat)**: ν_{max} = 3250, 2928, 1660, 1591, 1492, 1436, 1316, 1188, 1071, 740 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{18}H_{13}F_4NO_2$ [M+] 351.0882, found 351.0880; R_f = 0.30 (hex:EtOAc = 4:1).



3ea (ethyl 3-(1,1,2,2-tetrafluoro-2-phenoxyethyl)-1*H*-indole-2-carboxylate): white solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 9.41 (s, 1H), 7.98 (d, *J* = 8.3 Hz, 1H), 7.46 (d, *J* = 8.4 Hz, 1H), 7.38 (t, *J* = 7.7 Hz, 1H), 7.31 (dd, *J* = 8.2, 7.7 Hz, 2H), 7.25 (dd, *J* = 8.4, 7.6 Hz, 1H), 7.20 (dd, *J* = 8.3, 7.6 Hz, 1H), 7.11 (d, *J* = 8.2 Hz, 2H), 4.45 (q, *J* = 7.2 Hz, 2H), 1.42 (t, *J* = 7.2 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 160.5, 149.5, 134.6, 132.5, 129.4, 126.6, 125.9, 125.8, 122.9, 122.2, 121.3, 111.8, 109.3, 61.9, 13.9 (carbon peaks of $– C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −86.71, −104.62; **IR (neat)**: ν_{max} = 3324, 2990, 1683, 1591, 1492, 1334, 1187, 1064, 742 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{19}H_{15}F_4NO_3$ [M+] 381.0988, found 381.0990; R_f = 0.33 (hex:EtOAc = 4:1).

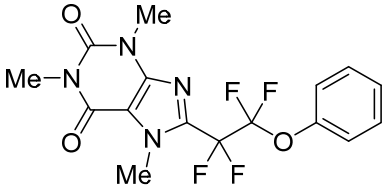


3fa (5-(1,1,2,2-tetrafluoro-2-phenoxyethyl)thiazol-2-amine): yellow liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.47 (s, 1H), 7.37 (dd, *J* = 7.9, 7.5 Hz, 2H), 7.27 (t, *J* = 7.5 Hz, 1H), 7.19 (d, *J* = 7.9 Hz, 2H), 5.23 (s, 2H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 170.5, 156.6, 149.0, 141.7, 129.6, 126.4, 121.6, 109.9, 94.9; **^{19}F NMR (564 MHz, $CDCl_3$)** δ −87.33, −103.62; **IR (neat)**: ν_{max} = 3156, 1607, 1552, 1492, 1284, 1190, 903, 724 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{11}H_8F_4N_2OS$ [M+] 292.0293, found 292.0296; R_f = 0.47 (hex:EtOAc = 1:1).

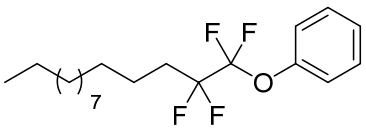


3ga (5-amino-6-(1,1,2,2-tetrafluoro-2-phenoxyethyl)pyrimidine-2,4(1*H*,3*H*)-dione): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 8.70 (s, 1H), 7.61 (s,

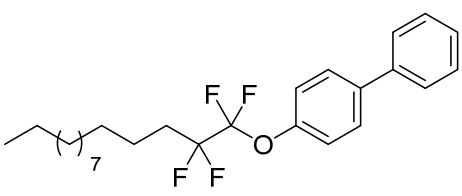
1H), 7.39 (dd, *J* = 8.0, 7.3 Hz, 2H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.18 (d, *J* = 8.0 Hz, 2H), 4.34 (s, 2H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 160.1, 148.4, 148.0, 129.8, 126.9, 124.2, 121.4, 110.6 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –86.13, –119.18; **IR (neat)**: ν_{max} = 3368, 3180, 3066, 2924, 1704, 1593, 1438, 1305, 1156, 957, 740 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{12}H_9F_4N_3O_3$ [M+] 319.0580, found 319.0578; $\boldsymbol{R_f}$ = 0.44 (hex:EtOAc = 1:1).



3ha (1,3,7-trimethyl-8-(1,1,2,2-tetrafluoro-2-phenoxyethyl)-3,7-dihydro-1*H*-purine-2,6-dione): yellow solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.38 (dd, *J* = 8.1, 7.4 Hz, 2H), 7.29 (t, *J* = 7.4 Hz, 1H), 7.18 (d, *J* = 8.1 Hz, 2H), 4.24 (s, 3H), 3.62 (s, 3H), 3.43 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 155.5, 151.4, 148.6, 146.9, 139.5, 129.7, 126.8, 121.6, 109.8, 33.8, 29.9, 28.1 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –85.12, –111.97; **IR (neat)**: ν_{max} = 2926, 1668, 1609, 1547, 1328, 1291, 1192, 994, 747 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{16}H_{14}F_4N_4O_3$ [M+] 386.1002, found 386.1004; $\boldsymbol{R_f}$ = 0.43 (hex:EtOAc = 1:1).

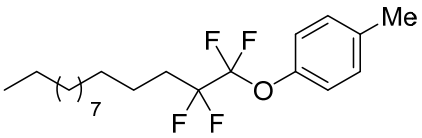


5aa ((1,1,2,2-tetrafluorotetradecyl)oxy)benzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.38 (dd, *J* = 8.2, 7.3 Hz, 2H), 7.26 (t, *J* = 7.3 Hz, 1H), 7.21 (d, *J* = 8.2 Hz, 2H), 2.12 (tt, J_{H-F} = 9.8, *J* = 8.1 Hz, 2H), 1.64 (tt, *J* = 8.1, 7.5 Hz, 2H), 1.45–1.21 (m, 18H), 0.89 (t, *J* = 6.9 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 149.2, 129.5, 126.2, 121.7, 31.9, 31.6, 31.1(t, J_{C-F} = 22.5 Hz), 29.6, 29.5, 29.4, 29.3, 29.2, 29.1, 22.7, 20.5, 14.1 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –87.05, –117.71; **IR (neat):** ν_{max} = 2924, 2855, 1592, 1492, 1184, 1109, 806, 731 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{20}H_{30}F_4O$ [M+] 362.2233, found 362.2230; $\boldsymbol{R_f}$ = 0.68 (hex:EtOAc = 6:1).

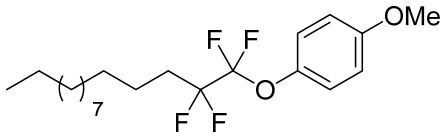


5ab (4-((1,1,2,2-tetrafluorotetradecyl)oxy)-1,1'-biphenyl): white solid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.59–7.55 (m, 4H), 7.45 (dd, *J* =8.6, 7.4 Hz, 2H), 7.36 (t, *J* = 7.4 Hz, 1H), 7.27 (d, *J* = 8.6 Hz, 2H), 2.13 (tt, J_{H-F} = 18.27, *J* = 7.7 Hz, 2H), 1.65 (tt, *J* = 12.3, 7.7 Hz, 2H), 1.43–1.26 (m, 18H), 0.89 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 148.6, 140.0, 139.4, 128.8, 128.2, 127.5, 127.1, 121.9, 31.9, 31.1, 29.6, 29.6, 29.4, 29.4, 29.3, 29.2, 29.1, 22.7, 20.5, 14.1; **^{19}F NMR (564 MHz, $CDCl_3$)** δ –87.93, –117.69;

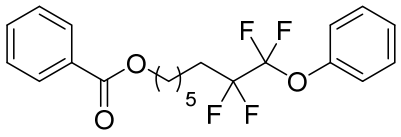
IR (neat): ν_{max} = 2926, 1711, 1420, 1220, 1103, 903, 763, 529 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{26}H_{34}F_4O$ [M+] 438.2546, found 438.2548; $\boldsymbol{R_f}$ = 0.45 (hex).



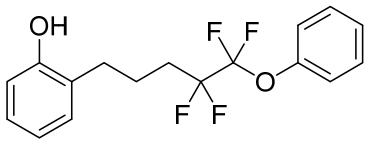
5ac (1-methyl-4-((1,1,2,2-tetrafluorotetradecyl)oxy)benzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.16 (d, *J* = 8.4 Hz, 2H), 7.08 (d, *J* = 8.4 Hz, 2H), 2.35 (s, 3H), 2.09 (tt, $J_{H\text{-}F}$ = 18.4, *J* = 8.3 Hz, 2H), 1.63 (tt, *J* = 8.3, 7.7 Hz, 2H), 1.27 (m, 18H), 0.88 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 146.9, 135.9, 129.9, 121.5, 31.9, 31.1, 29.7, 29.6, 29.5, 29.4, 29.3, 29.2, 29.1, 22.7, 20.8, 20.5, 14.1 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −88.01, −117.76; **IR (neat)**: ν_{max} = 2925, 2855, 1507 1466, 1176, 1099, 1037, 906, 846, 731 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{21}H_{32}F_4O$ [M+] 376.2389, found 376.2387; $\boldsymbol{R_f}$ = 0.70 (hex:EtOAc = 6:1).



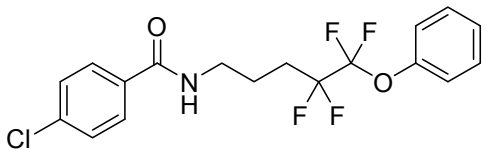
5ad (1-methoxy-4-((1,1,2,2-tetrafluorotetradecyl)oxy)benzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** 7.12 (d, *J* = 8.9 Hz, 2H), 6.87 (d, *J* = 8.9 Hz, 2H), 3.80 (s, 3H), 2.11 (tt, $J_{H\text{-}F}$ = 18.4, *J* = 8.4 Hz, 2H), 1.63 (tt, *J* = 8.4, 8.0 Hz, 2H), 1.41–1.24 (m, 18H), 0.88 (t, *J* = 6.8 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 165.4, 157.7, 122.9, 114.4, 55.6, 31.9, 31.1, 30.9, 29.6, 29.5, 29.4, 29.3, 29.2, 29.1, 22.6, 20.5, 14.1 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −88.19, −117.72; **IR (neat)**: ν_{max} = 2924, 2855, 1660, 1508, 1467, 1182, 1020, 904, 726 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{21}H_{32}F_4O_2$ [M+] 392.2338, found 392.2341; $\boldsymbol{R_f}$ = 0.68 (hex:EtOAc = 8:1).



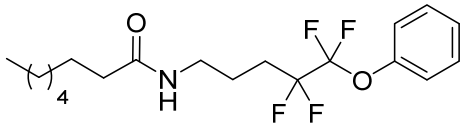
5ba (7,7,8,8-tetrafluoro-8-phenoxyoctyl benzoate): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 8.06 (d, *J* = 6.6 Hz, 2H), 7.56 (t, *J* = 7.5 Hz, 1H), 7.44 (dd, *J* = 7.5, 6.6 Hz, 2H), 7.37 (dd, *J* = 8.0, 7.2 Hz, 2H), 7.27 (t, *J* = 7.2 Hz, 1H), 7.21 (d, *J* = 8.0 Hz, 2H), 4.34 (t, *J* = 6.6 Hz, 2H), 2.15 (tt, $J_{H\text{-}F}$ = 18.2, *J* = 8.3 Hz, 2H), 1.81 (tt, *J* =7.2, 6.6 Hz, 2H), 1.69 (tt, *J* =8.3, 7.8 Hz, 2H), 1.55–1.47 (m, 4H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 166.6, 138.3, 136.3, 132.8, 130.4, 129.5, 128.3, 126.3, 121.7, 117.8, 117.0, 64.8, 31.0, 28.9, 28.5, 25.8, 20.5; **^{19}F NMR (564 MHz, $CDCl_3$)** δ −87.93, −117.75; **IR (neat)**: ν_{max} = 3324, 2990, 1683, 1591, 1335, 1259, 1187, 1064, 742 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{21}H_{22}F_4O_3$ [M+] 398.1505, found 398.1503; $\boldsymbol{R_f}$ = 0.66 (hex:EtOAc = 4:1).



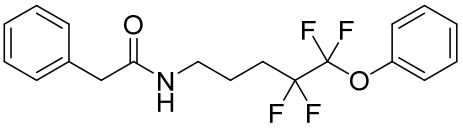
5ca (2-(4,4,5,5-tetrafluoro-5-phenoxypentyl)phenol) colorless liquid; **^{1}H NMR (600 MHz, CDCl$_3$)** δ 7.39 (dd, *J* = 8.2, 7.7 Hz, 2H), 7.28 (dd, *J* = 7.4, 7.2 Hz, 1H), 7.21 (d, *J* = 8.2 Hz, 2H), 7.17 (d, *J* = 7.4 Hz, 1H), 7.12 (t, *J* = 7.7 Hz, 1H), 6.92 (dd, *J* =7.9, 7.2 Hz, 1H), 6.76 (d, *J* = 7.9 Hz, 1H), 4.87 (s, 1H), 2.76 (t, *J* = 7.9 Hz, 2H), 2.28–2.16 (m, 2H), 2.02 (tt, $J_{H\text{-}F}$ = 15.7, *J* = 7.9 Hz, 2H); **^{13}C NMR (151 MHz, CDCl$_3$)** δ 153.4, 149.2, 130.3, 129.6, 127.5, 126.3, 121.7, 120.9, 117.2, 115.3, 30.8(t, $J_{C\text{-}F}$ = 30.8 Hz), 29.5, 20.8 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, CDCl$_3$)** δ –87.78, –117.32; **IR (neat)**: ν_{max} = 3324, 2990, 1683, 1492, 1335, 1187, 1117, 953, 743 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{17}H_{16}F_4O_2$ [M+] 328.1086, found 328.1089; $\boldsymbol{R_f}$ = 0.50 (hex:EtOAc = 4:1).



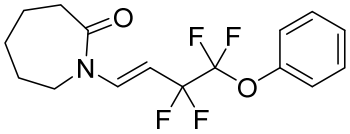
5da (4-chloro-*N*-(4,4,5,5-tetrafluoro-5-phenoxypentyl) benzamide) white solid; **^{1}H NMR (600 MHz, CDCl$_3$)** ; δ 7.71 (d, *J* = 8.1 Hz, 2H), 7.39 (d, *J* = 8.1 Hz, 2H), 7.36 (d, *J* = 8.1, 7.7 Hz, 2H), 7.26 (t, *J* = 7.7 Hz, 1H), 7.18 (d, *J* = 8.1 Hz, 2H), 6.40 (t, *J* = 6.0 Hz, 1H), 3.56 (td, *J* = 7.4, 6.0 Hz, 2H), 2.23 (tt, $J_{H\text{-}F}$ =17.9 , *J* = 7.7 Hz, 2H), 1.98 (tt, *J* = 7.7, 7.4 Hz, 2H); **^{13}C NMR (151 MHz, CDCl$_3$)** δ 166.7, 149.0, 137.8, 129.6, 128.8, 128.3, 126.4, 121.6, 123.4, 39.4, 28.6 (t, $J_{C\text{-}F}$ = 22.7 Hz), 21.3 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, CDCl$_3$)** δ –87.85, –117.37; **IR (neat)**: ν_{max} = 3324, 2990, 1683, 1591, 1492, 1335, 1259, 1187, 1117, 1014, 743 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{18}H_{16}ClF_4NO_2$ [M+] 389.0806, found 389.0805; $\boldsymbol{R_f}$ = 0.27 (hex:EtOAc = 4:1).



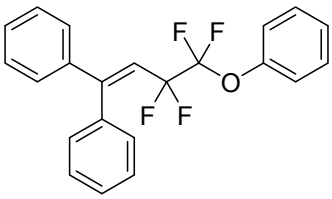
5ea (*N*-(4,4,5,5-tetrafluoro-5-phenoxypentyl)octanamide) yellow oil; **^{1}H NMR (600 MHz, CDCl$_3$)** δ 7.37 (dd, *J* = 8.3, 7.4 Hz, 2H), 7.26 (t, *J* = 7.4 Hz, 1H), 7.19 (d, *J* = 8.3 Hz, 2H), 5.53 (s, 1H), 3.37 (t, *J* = 6.8 Hz, 2H), 2.20–2.16 (m, 2H), 1.86 (tt, $J_{H\text{-}F}$ =14.9, *J* = 7.3 Hz, 2H), 1.61 (tt, *J* = 7.3, 6.8 Hz, 2H), 1.34–1.23 (m, 10H), 0.87 (t, *J* = 6.8 Hz, 3H); **^{13}C NMR (151 MHz, CDCl$_3$)** δ 173.3, 129.6, 126.3, 121.7, 116.3, 38.6, 36.8, 31.6, 31.5, 29.2, 28.9, 28.5 (t, $J_{C\text{-}F}$ = 22.7 Hz), 25.7, 22.6, 14.0 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, CDCl$_3$)** δ -87.92, -117.51; **IR (neat)**: ν_{max} = 3293, 2927, 1644, 1550, 1492, 1189, 1115, 1004, 744 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{19}H_{27}F_4NO_2$ [M+] 377.1978, found 377.1981; $\boldsymbol{R_f}$ = 0.60 (hex:EtOAc = 1:1).



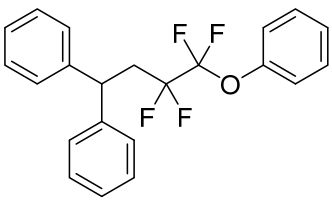
5fa (2-phenyl-*N*-(4,4,5,5-tetrafluoro-5-phenoxypentyl) acetamide): yellow oil; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.39–7.33 (m, 4H), 7.29 (t, *J* = 7.2 Hz, 1H), 7.27–7.24 (m, 3H), 7.18 (d, *J* = 8.3 Hz, 2H), 5.47 (t, *J* = 6.5, 1H), 3.59 (s, 2H), 3.32 (td, *J* = 6.9, 6.5 Hz, 2H), 2.09 (tt, $J_{H\text{-}F}$ = 18.3, *J* = 7.6 Hz, 2H), 1.79 (tt, *J* = 7.6, 6.9 Hz, 2H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 171.2, 149.0, 134.7, 129.6, 129.4, 129.1, 127.4, 126.4, 121.6, 43.9, 38.8, 28.4, 21.2 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ -87.95, -117.56; **IR (neat)**: ν_{max} = 3324, 2990, 1683, 1591, 1541, 1492, 1334, 1258, 1187, 1064, 953, 742 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{19}H_{19}F_4NO_2$ [M+] 369.1352, found 369.1349; $\boldsymbol{R_f}$ = 0.40 (hex:EtOAc = 2:1).



5ga ((*E*)-1-(3,3,4,4-tetrafluoro-4-phenoxybut-1-en-1-yl)azepan-2-one): colorless oil; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.98 (d, *J* = 14.5 Hz, 1H), 7.37 (dd, *J* = 7.9, 7.4 Hz, 2H), 7.25 (t, *J* = 7.4 Hz, 1H), 7.20 (d, *J* = 7.9 Hz, 2H), 5.14 (dt, *J* = 14.5, $J_{H\text{-}F}$ = 11.5 Hz, 1H), 3.62 (t, *J* = 4.6 Hz, 2H), 2.69 (t, *J* = 5.3 Hz, 2H), 1.80–1.71 (m, 6H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 174.6, 149.3, 134.4, 129.5, 126.2, 121.6, 96.3, 45.3, 37.0, 29.2, 27.1, 23.3 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –87.71, –110.79; **IR (neat)**: ν_{max} = 2933, 1654, 1491, 1330, 1178, 1082, 969, 740 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{16}H_{17}F_4O_2$ [M+] 331.1195, found 331.1193; $\boldsymbol{R_f}$ = 0.40 (hex:EtOAc = 4:1).

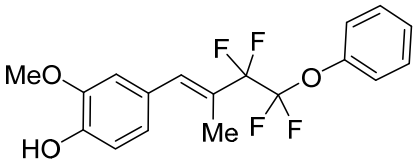


5ha ((3,3,4,4-tetrafluoro-4-phenoxybut-1-ene-1,1-diyl)dibenzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.40–7.20 (m, 13H), 7.21 (d, *J* = 8.1 Hz, 2H), 6.24 (t, *J* = 14.4 Hz, 1H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 141.1, 137.9, 129.6, 129.2, 129.1, 128.4, 128.0, 127.9, 127.7, 126.2, 121.6, 114.6; **^{19}F NMR (564 MHz, $CDCl_3$)** δ –87.57, –107.30; **IR (neat)**: ν_{max} =3061, 2926, 1640, 1591, 1191, 1017, 730, 699 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{22}H_{16}F_4O$ [M+] 372.1137, found 372.1139; $\boldsymbol{R_f}$ = 0.61 (hex:EtOAc = 6:1).



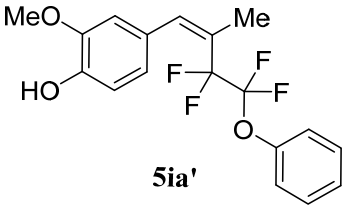
5ha' ((3,3,4,4-tetrafluoro-4-phenoxybutane-1,1-diyl)dibenzene): colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 7.38–7.33 (m, 2H), 7.32–7.29 (m, 7H), 7.27–7.23 (m, 2H), 7.23–7.18 (m, 2H), 7.16 (d, *J* = 7.6 Hz, 2H), 4.52 (t, *J* = 6.4 Hz 1H), 2.98 (td, $J_{H\text{-}F}$ = 18.0, *J* = 6.4 Hz, 2H); **^{13}C NMR (151 MHz, cdcl$_3$)** δ 149.0, 143.6, 129.5, 128.6, 127.6, 126.6, 126.3, 121.7, 44.0,

36.6(t, $J_{C\text{-}F}$ = 22.7 Hz) (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –88.31, –116.22; **IR (neat)**: ν_{max} = 3030, 1592, 1492, 1191, 1106, 907, 743, 700 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{22}H_{18}F_4O$ [M+] 374.1294, found 374.1297; $\boldsymbol{R_f}$ = 0.58 (hex:EtOAc = 6:1).



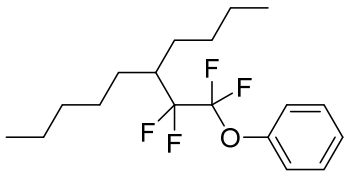
5ia

+

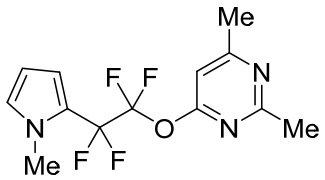


5ia'

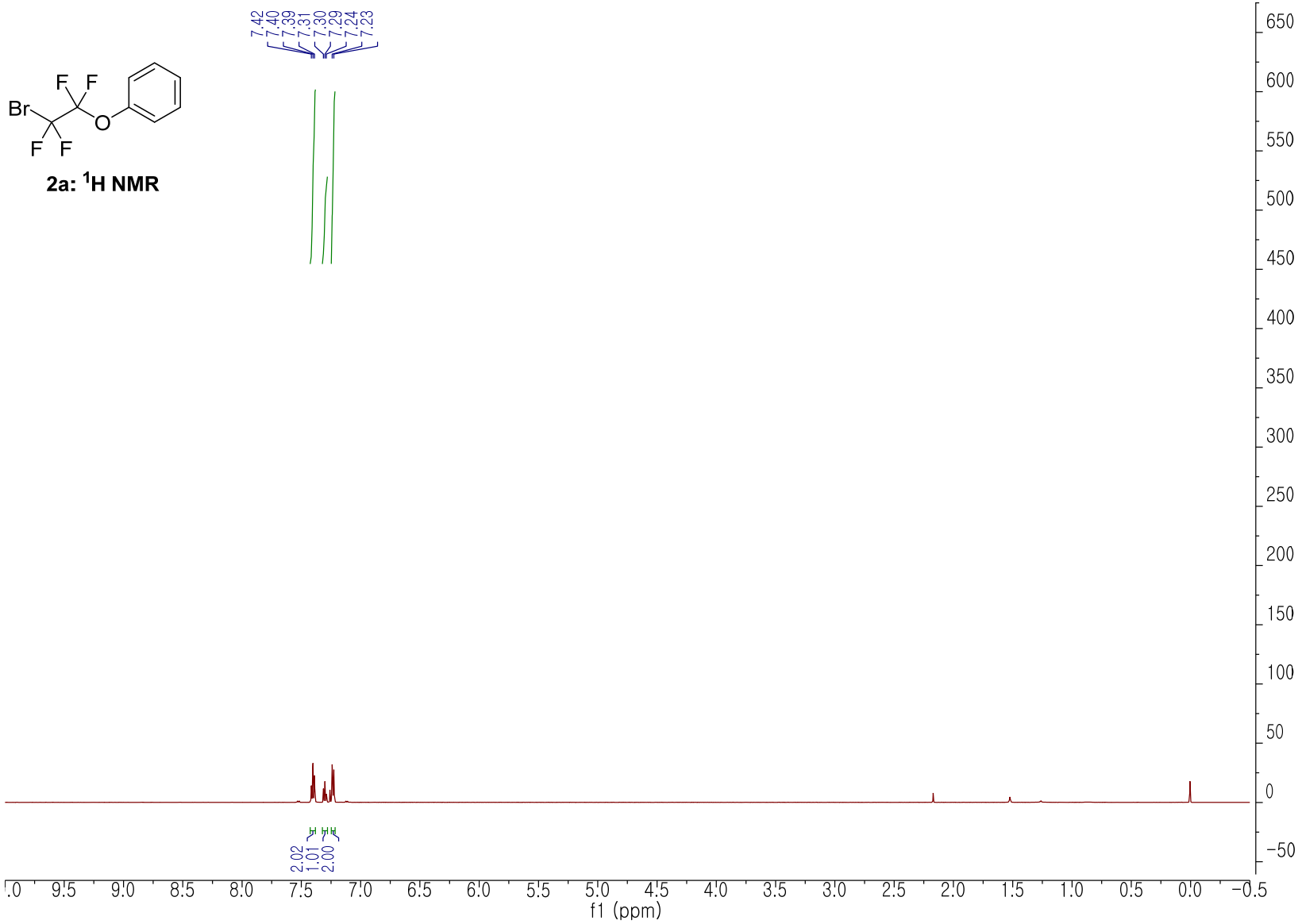
5ia ((E,)-2-methoxy-4-(3,3,4,4-tetrafluoro-2-methyl-4-phenoxybut-1-en-1-yl)phenol) and **5ia'** ((z,)-2-methoxy-4-(3,3,4,4-tetrafluoro-2-methyl-4-phenoxybut-1-en-1-yl)phenol) colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$) 5ia**: δ 7.37 (dd, *J* = 8.2, 7.4 Hz, 2H), 7.28–7.24 (m, 1H), 7.21 (d, *J* = 8.2 Hz, 2H), 6.99 (s, 1H), 6.94 (s, 1H), 6.89–6.85 (m, 2H), 5.69 (s, 1H), 3.92 (s, 3H), 2.11 (s, 3H); **5ia'**: δ 7.37 (dd, *J* = 8.2, 7.4 Hz, 2H), 7.28–7.24 (m, 1H), 7.18 (d, *J* = 8.2 Hz, 2H), 6.94 (s, 1H), 6.91 (s, 1H), 6.84–6.80 (m, 2H), 5.59 (s, 1H), 3.83 (s, 3H), 2.11 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 145.5, 145.0, 129.6, 129.5, 127.6, 126.3, 126.2, 122.9, 121.6, 121.6, 114.3, 113.6, 111.9, 111.1, 109.9, 109.9, 67.5, 56.5, 55.9, 29.7 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$) 5ia**: δ –84.69, –109.62; **5ia'**: δ –85.62, –115.60; **IR (neat)**: ν_{max} = 3542, 2925, 2853, 1594, 1492, 1093, 978, 904, 730 cm^{-1}; **HRMS** m/z (EI) calc.for $C_{18}H_{16}F_4O_3$ [M+] 356.1036, found 356.1036; $\boldsymbol{R_f}$ = 0.42 (hex:EtOAc = 3:1).

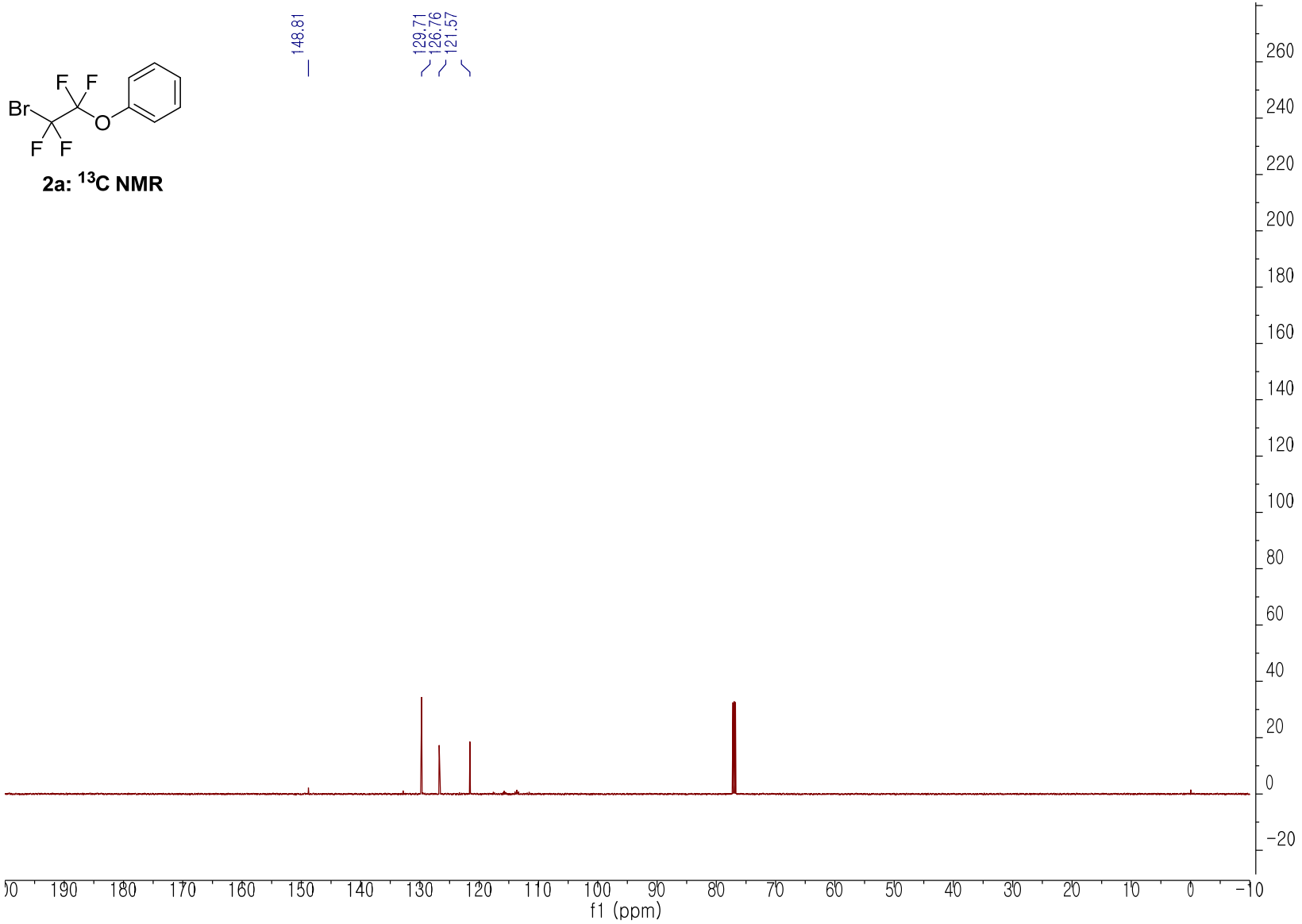


5ja (((3-butyl-1,1,2,2-tetrafluorooctyl)oxy)benzene) colorless liquid; **^{1}H NMR (600 MHz, $CDCl_3$)** ; δ 7.38 (dd, *J* = 8.1, 7.4 Hz, 2H), 7.26 (t, *J* = 7.4 Hz, 1H), 7.20 (d, *J* = 8.1 Hz, 2H), 2.25–2.14 (m, 1H), 1.79–1.70 (m, 2H), 1.53–1.27 (m, 12H), 0.92 (t, *J* = 7.1 Hz, 3H), 0.90 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 149.2, 129.5, 126.2, 121.7, 67.1, 40.7, 32.0, 29.2, 27.0, 26.8, 26.7, 22.9, 22.5, 14.0 (carbon peaks of –C_2F_4– are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ –83.91, –116.79; **IR (neat)**: ν_{max} = 2958, 1593, 1492, 1183, 1109, 1027, 741, 689 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{18}H_{26}F_4O$ [M+] 334.1920, found 334.1924; $\boldsymbol{R_f}$ = 0.66 (hex).

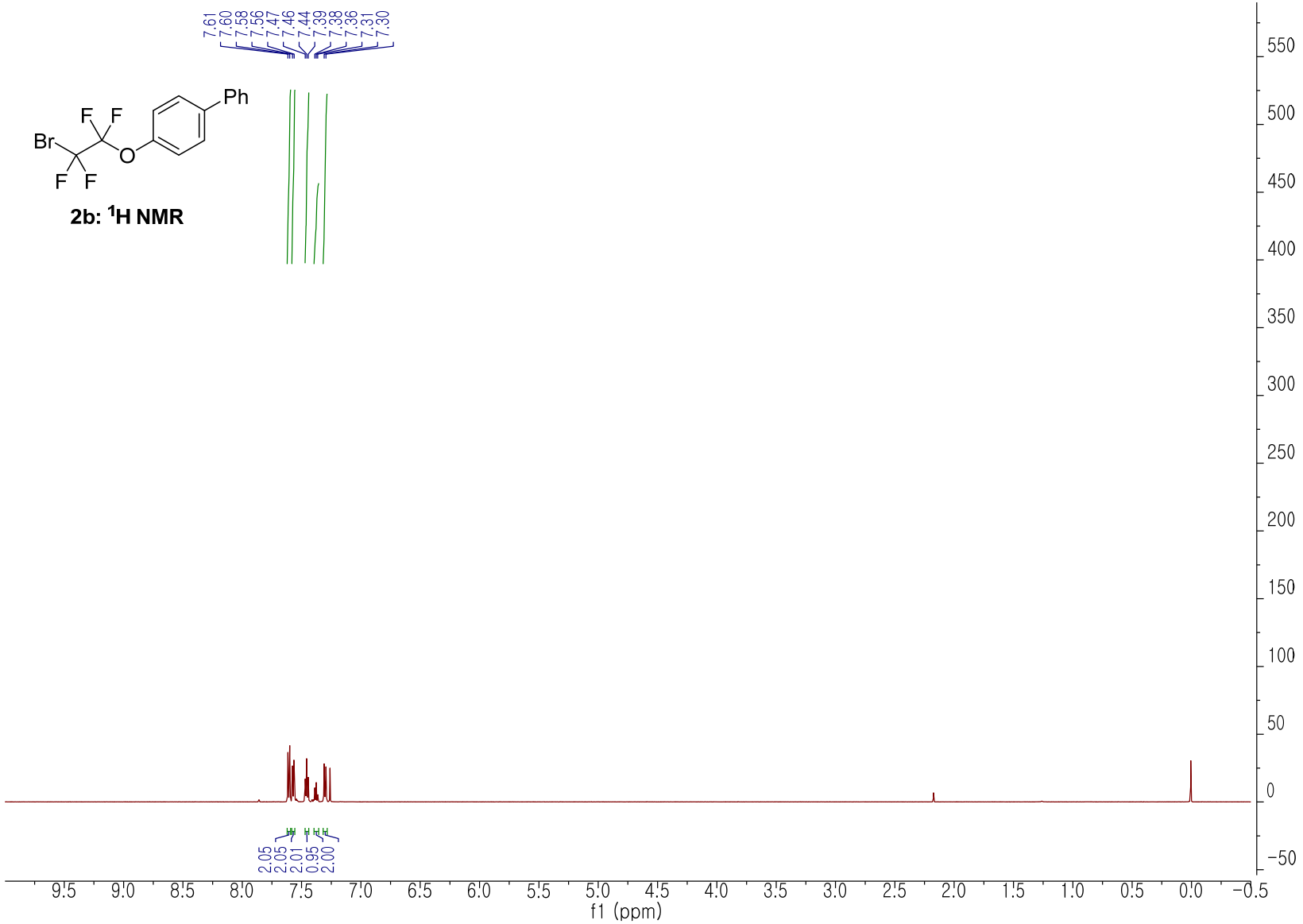


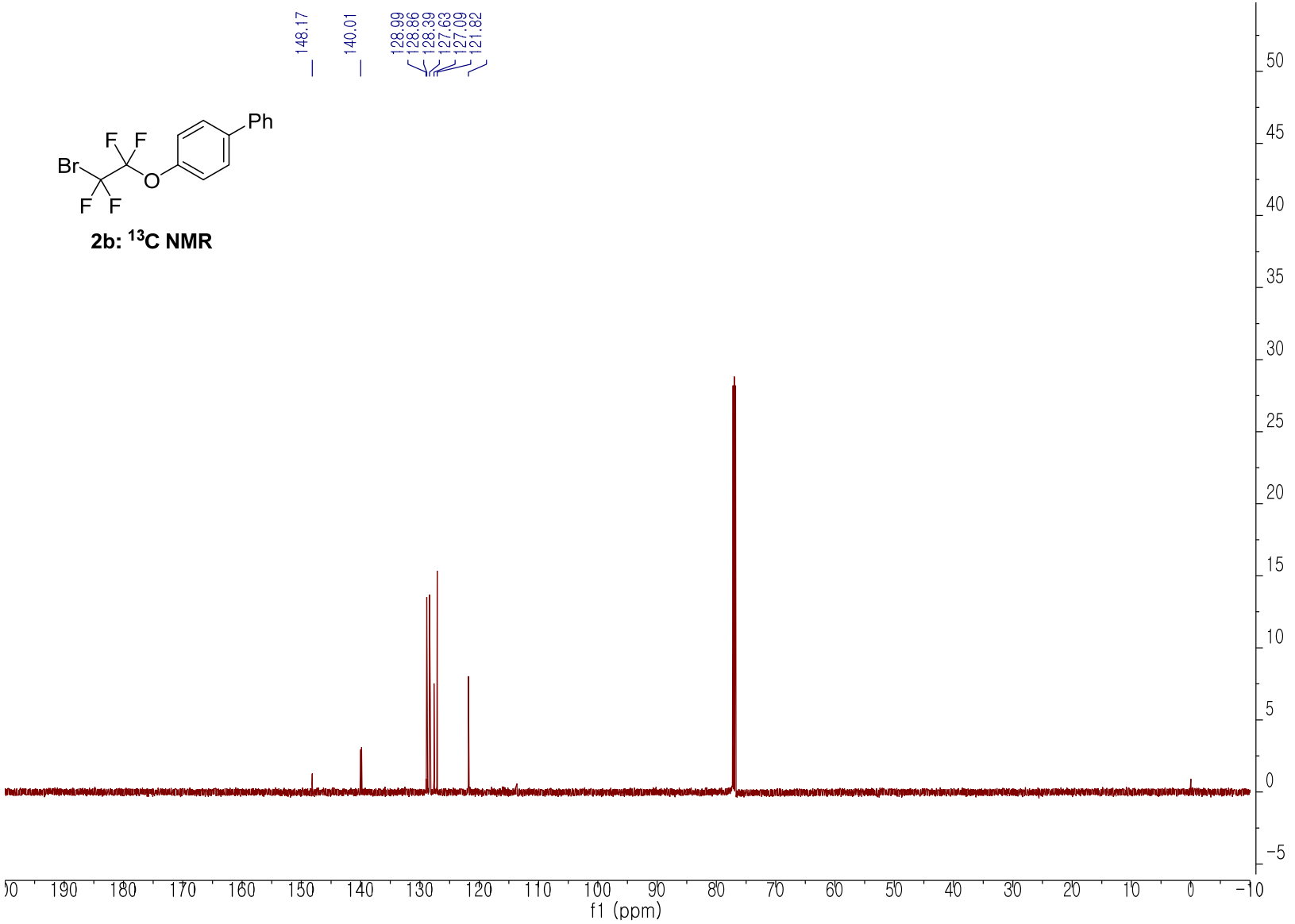
7 (2,4-dimethyl-6-(1,1,2,2-tetrafluoro-2-(1-methyl-1*H*-pyrrol-2-yl)ethoxy) pyrimidine): yellow oil; **^{1}H NMR (600 MHz, $CDCl_3$)** δ 6.72 (d, 1H), 6.70 (m, *J* = 2.9 Hz, 1H), 6.59 (d, *J* = 3.2 Hz, 1H), 6.12 (dd, *J* = 3.2, 2.9 Hz, 1H), 3.80 (s, 3H), 2.65 (s, 3H), 2.50 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$)** δ 170.2, 168.5, 164.1, 127.3, 113.6, 107.5, 105.7, 35.8, 25.8, 24.1 (carbon peaks of $–C_2F_4–$ are omitted due to complicated C-F splitting); **^{19}F NMR (564 MHz, $CDCl_3$)** δ −87.25, −106.43; **IR (neat)**: ν_{max} = 2929, 1593, 1566, 1437, 1358, 1154 1092, 956, 802, 733 cm^{-1}; **HRMS** m/z (EI) calc. for $C_{13}H_{13}F_4N_3O$ [M+] 303.0995, found 303.0993; $\boldsymbol{R_f}$ = 0.40 (hex:EtOAc = 2:1)

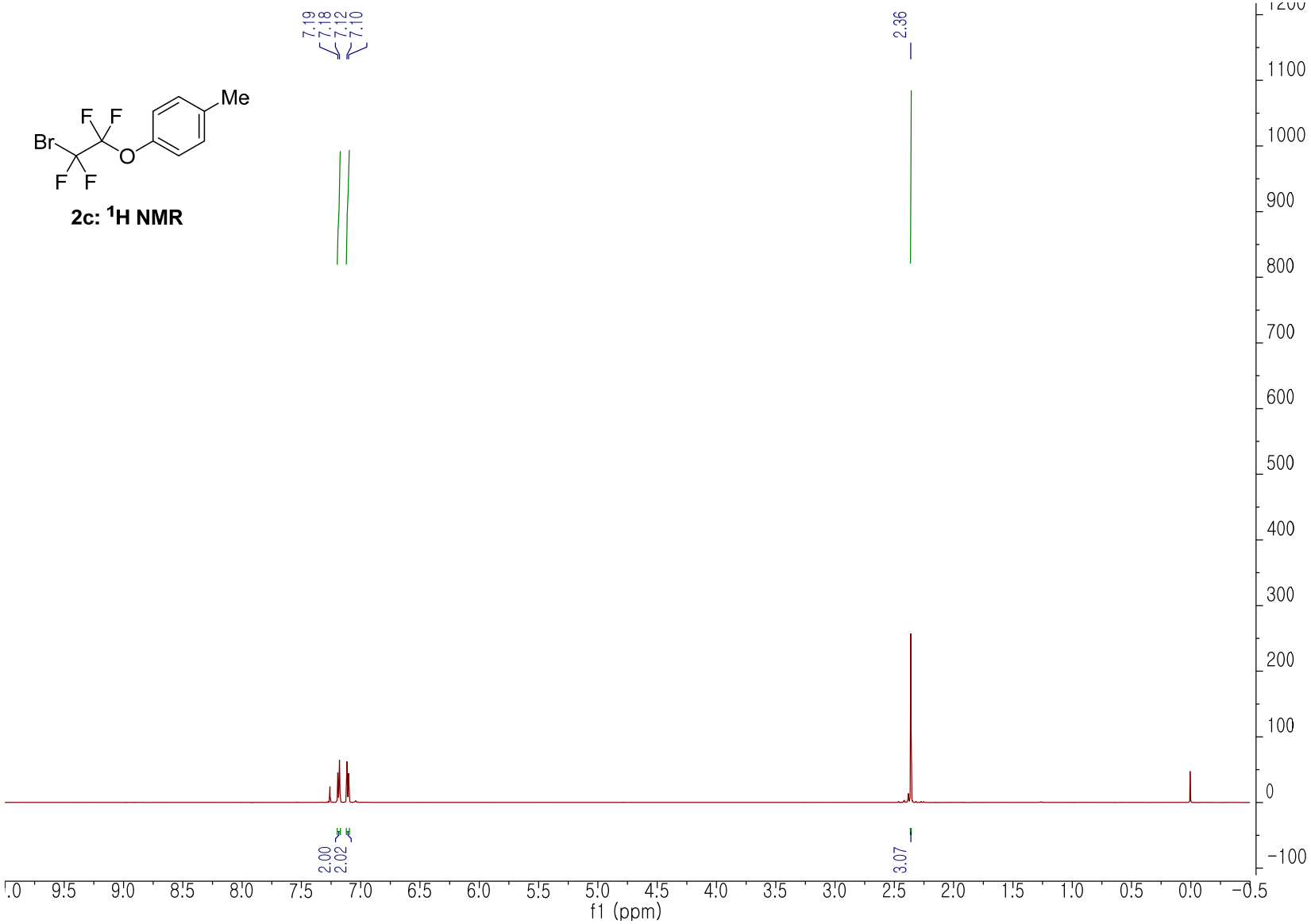

F F
Br
O
F F
2a: 1H NMR
7.42
7.40
7.39
7.31
7.30
7.29
7.24
7.23
2.02
1.01
2.00
650
600
550
500
450
400
350
300
250
200
150
100
50
0
−50
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5
f1 (ppm)

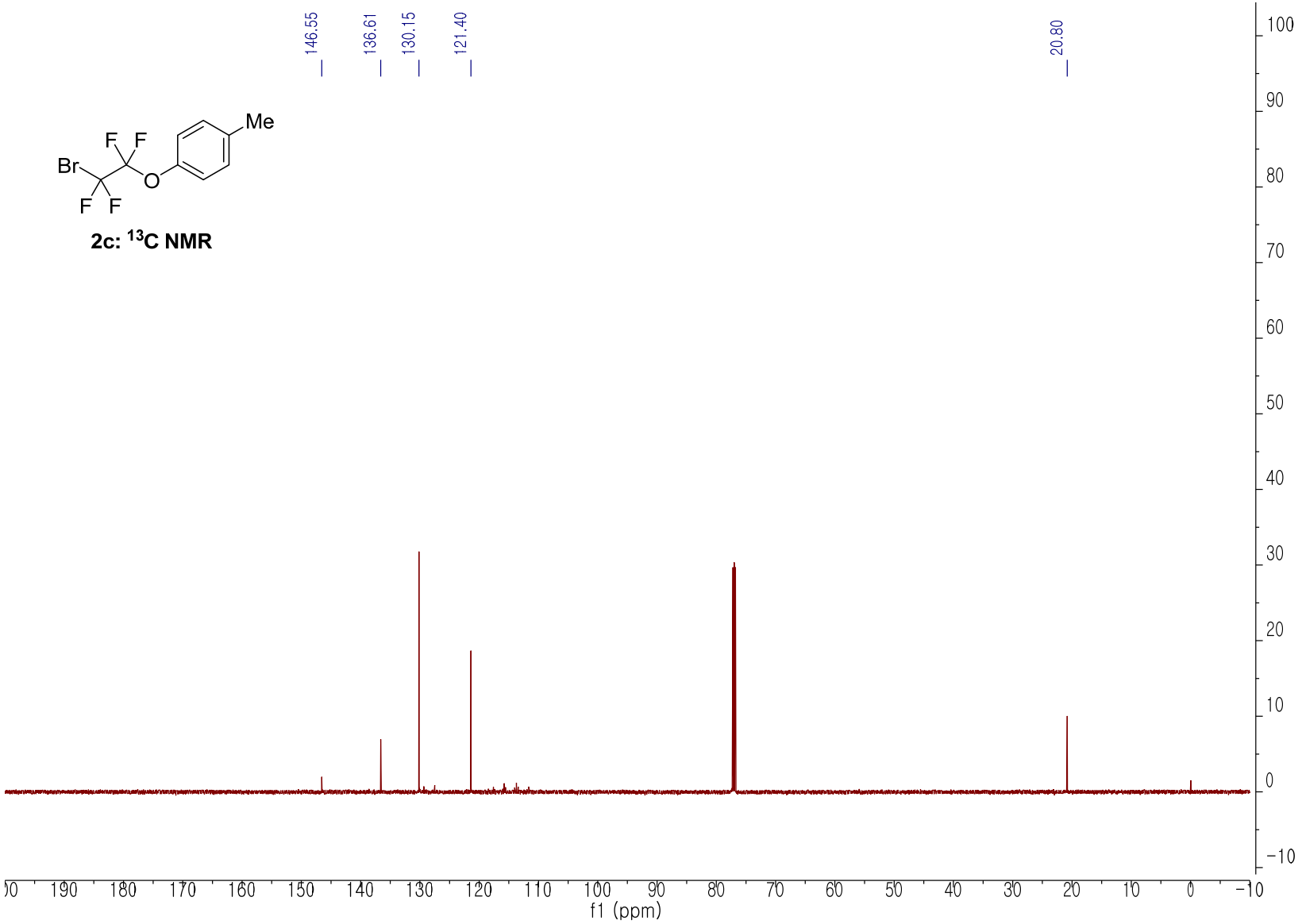

148.81
129.71
126.76
121.57
F F
Br
O
F F
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

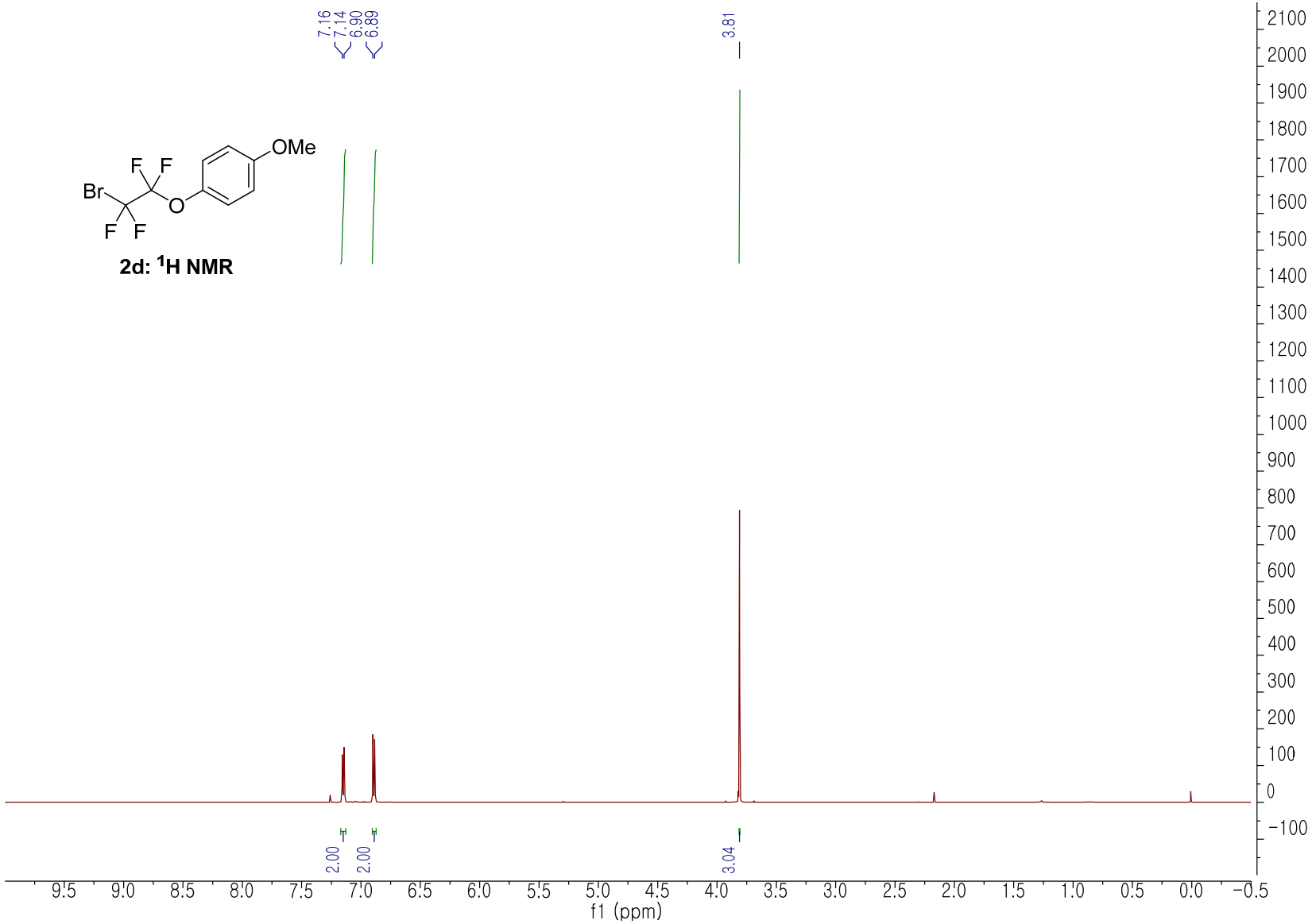
2a: ^{13}C NMR

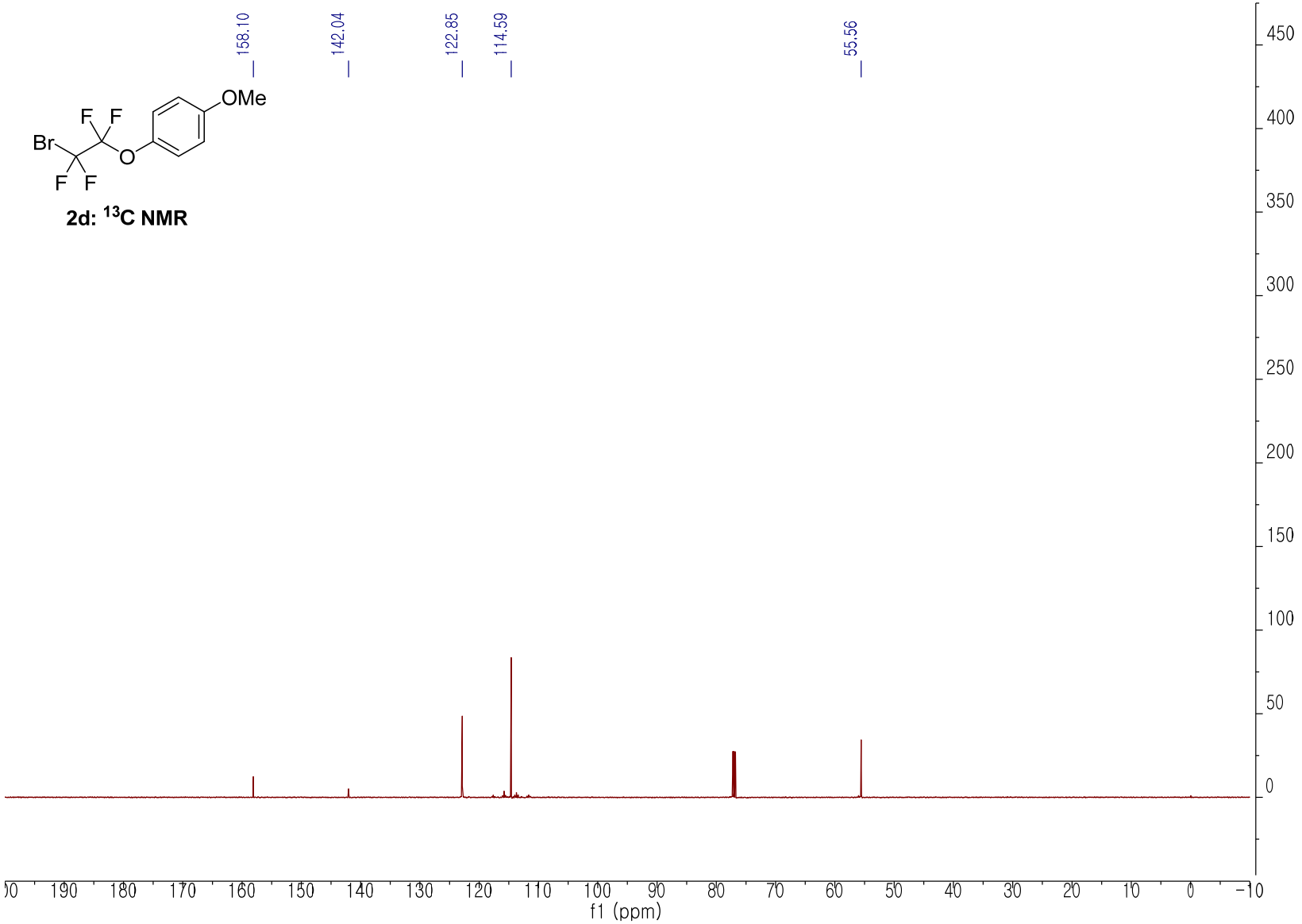

7.61
7.60
7.58
7.56
7.47
7.46
7.44
7.39
7.38
7.36
7.31
7.30
Ph
F F
Br
O
F F
2b: 1H NMR
2.05
2.05
2.01
0.95
2.00
550
500
450
400
350
300
250
200
150
100
50
0
−50
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
f1 (ppm)

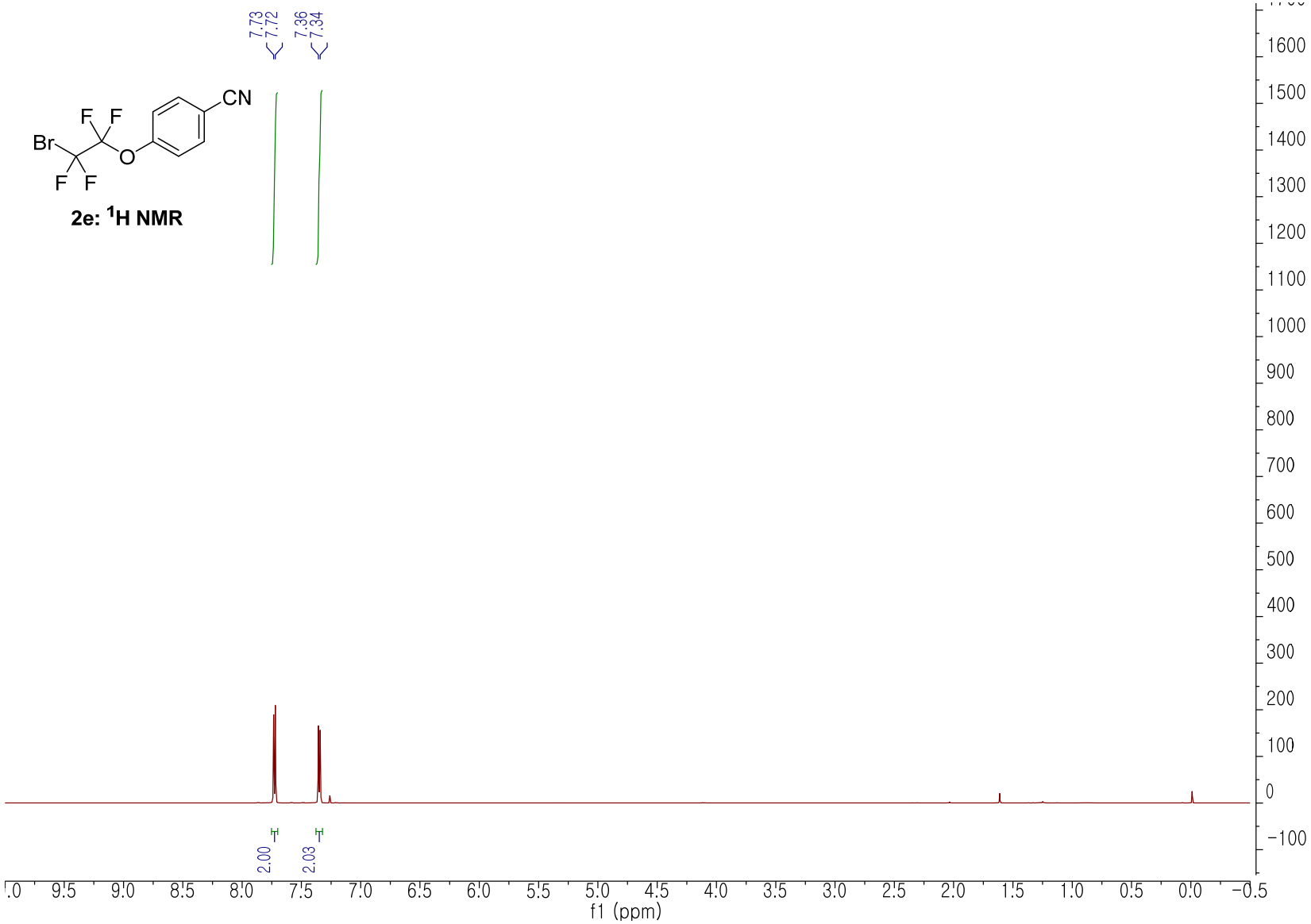

148.17
140.01
128.99
128.86
128.39
127.63
127.09
121.82
Ph
F F
Br
O
F F
2b: 13C NMR
f1 (ppm)

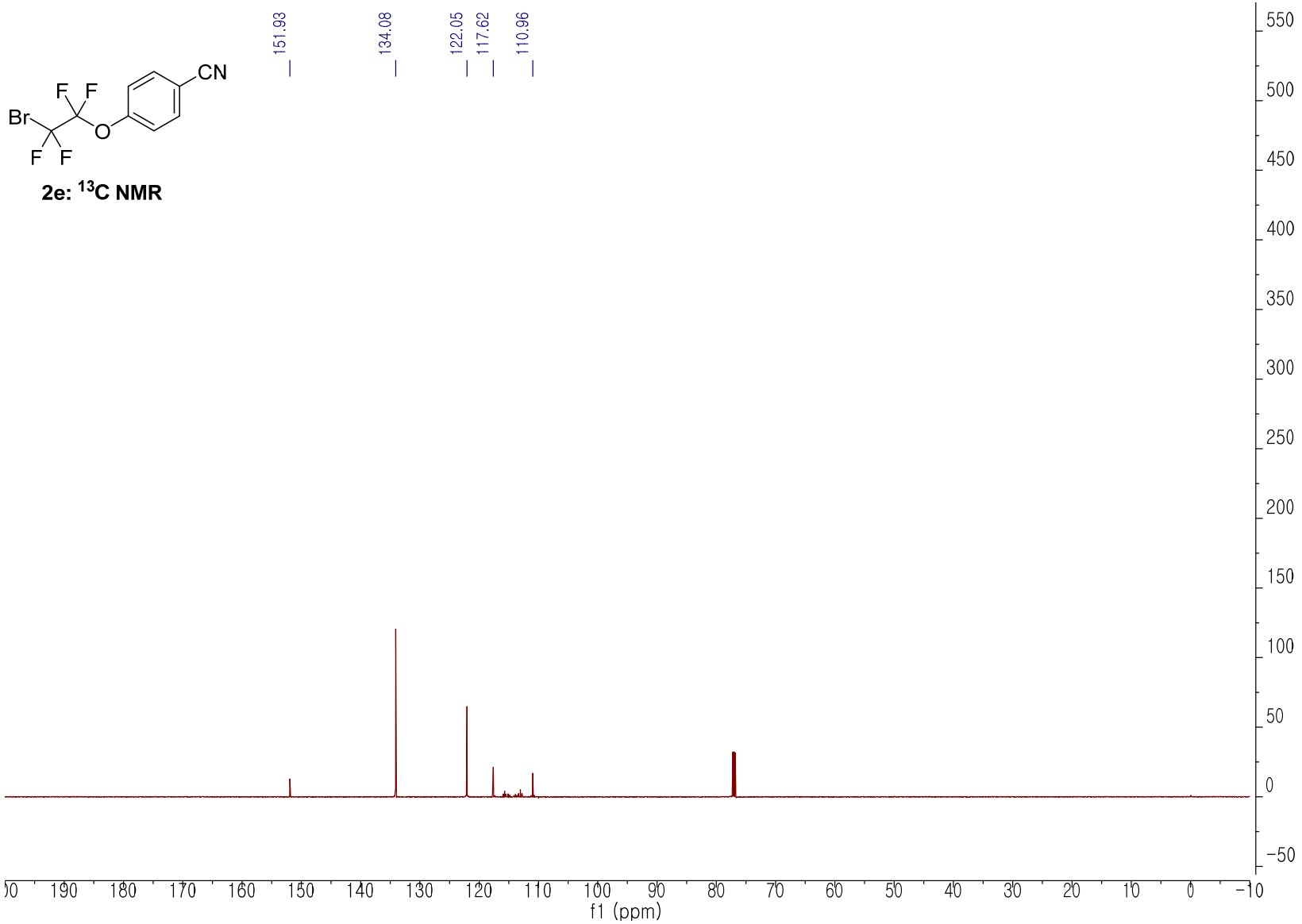

Me
F F
Br
O
F F
2c: 1H NMR
7.19
7.18
7.12
7.10
2.36
2.00
2.02
3.07
f1 (ppm)

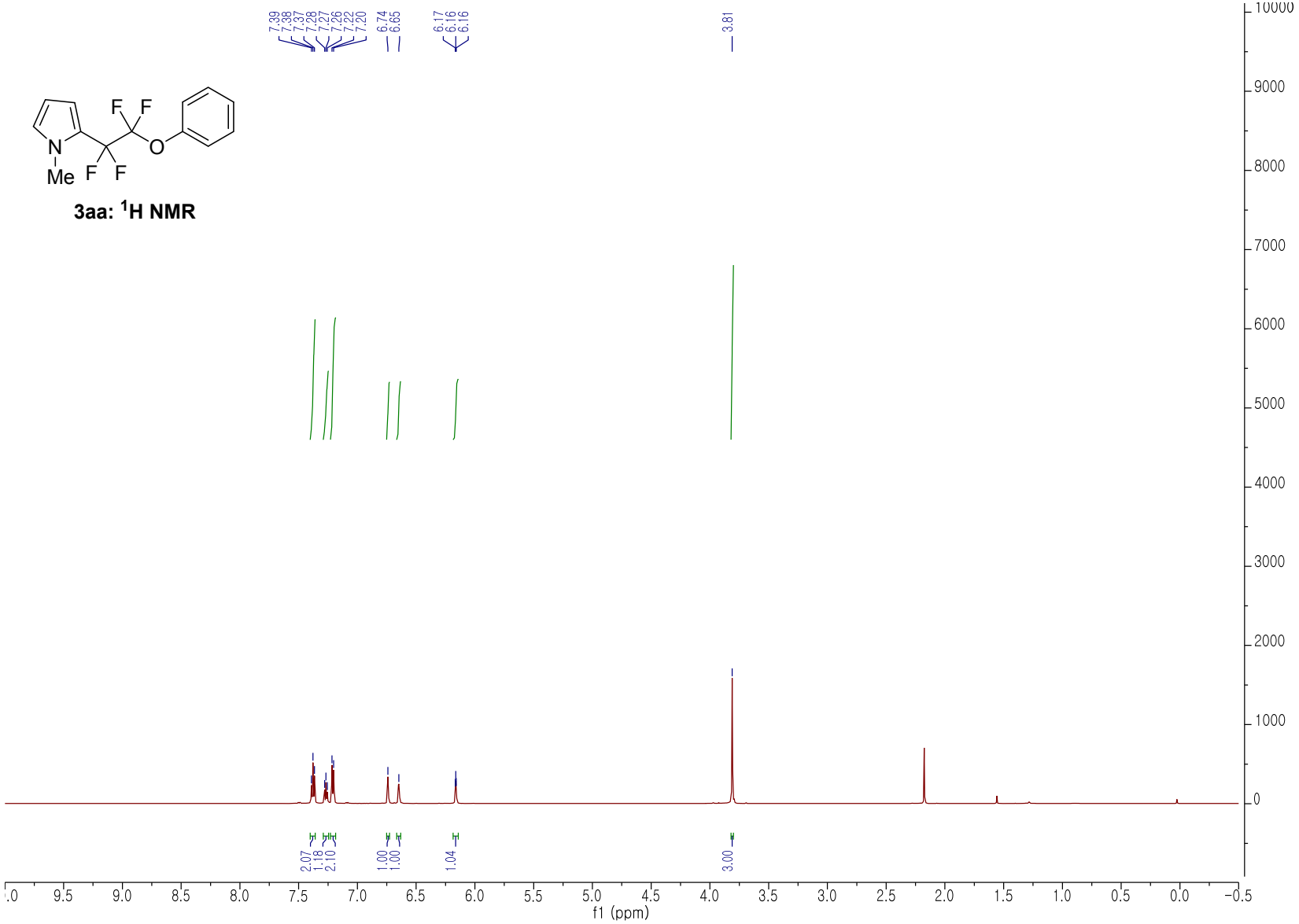

146.55
136.61
130.15
121.40
20.80
Me
F F
Br
O
F F
2c: ^{13}C NMR
f1 (ppm)


7.16
7.14
6.90
6.89
3.81
OMe
F F
Br
O
F F
2d: ^{1}H NMR
2.00
2.00
3.04
f1 (ppm)

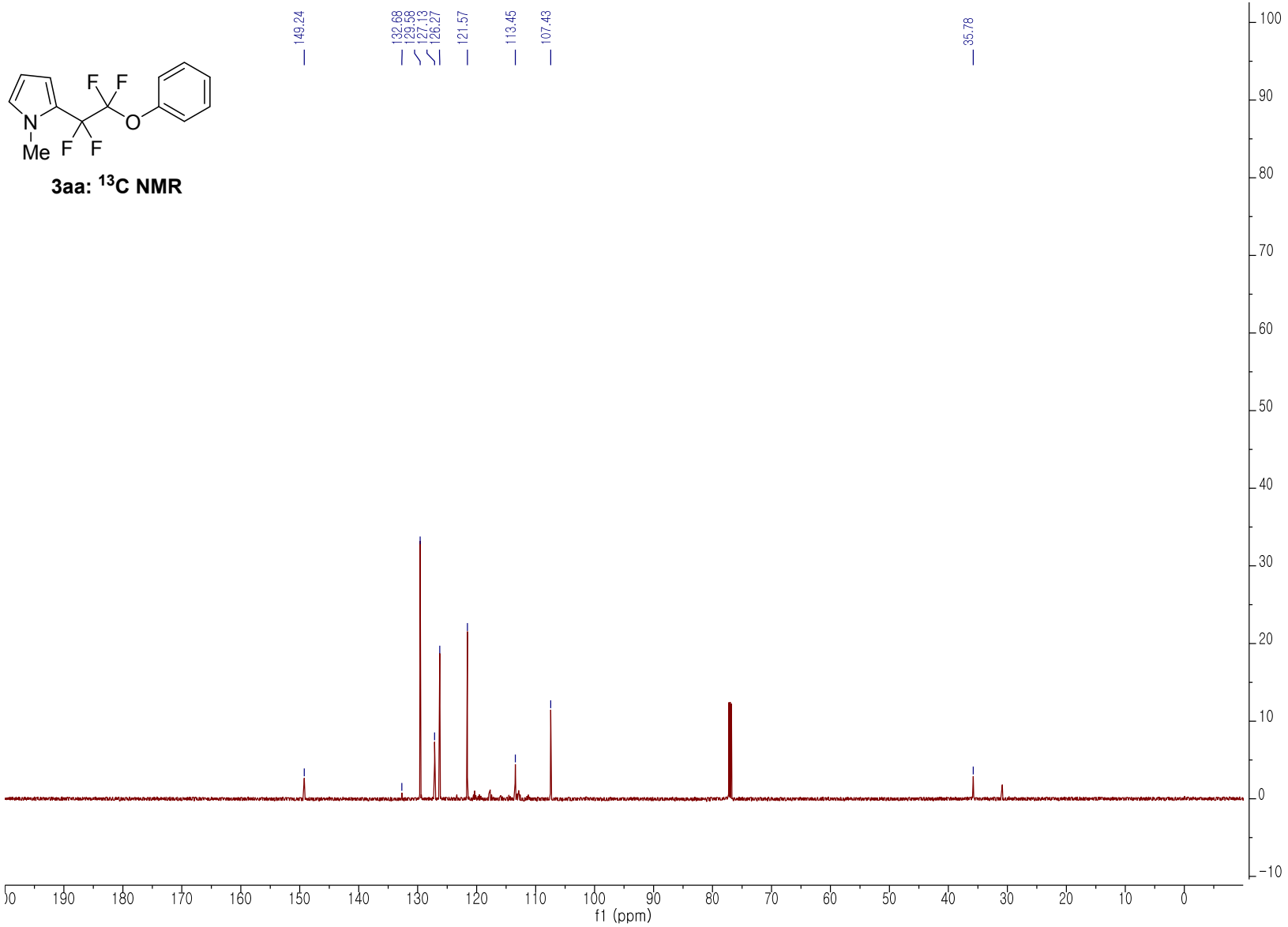

158.10
142.04
122.85
114.59
55.56
OMe
F F
Br
O
F F
2d: 13C NMR
450
400
350
300
250
200
150
100
50
0
f1 (ppm)


7.73
7.72
7.36
7.34
CN
F F
Br
O
F F
2e: 1H NMR
2.00
2.03
f1 (ppm)

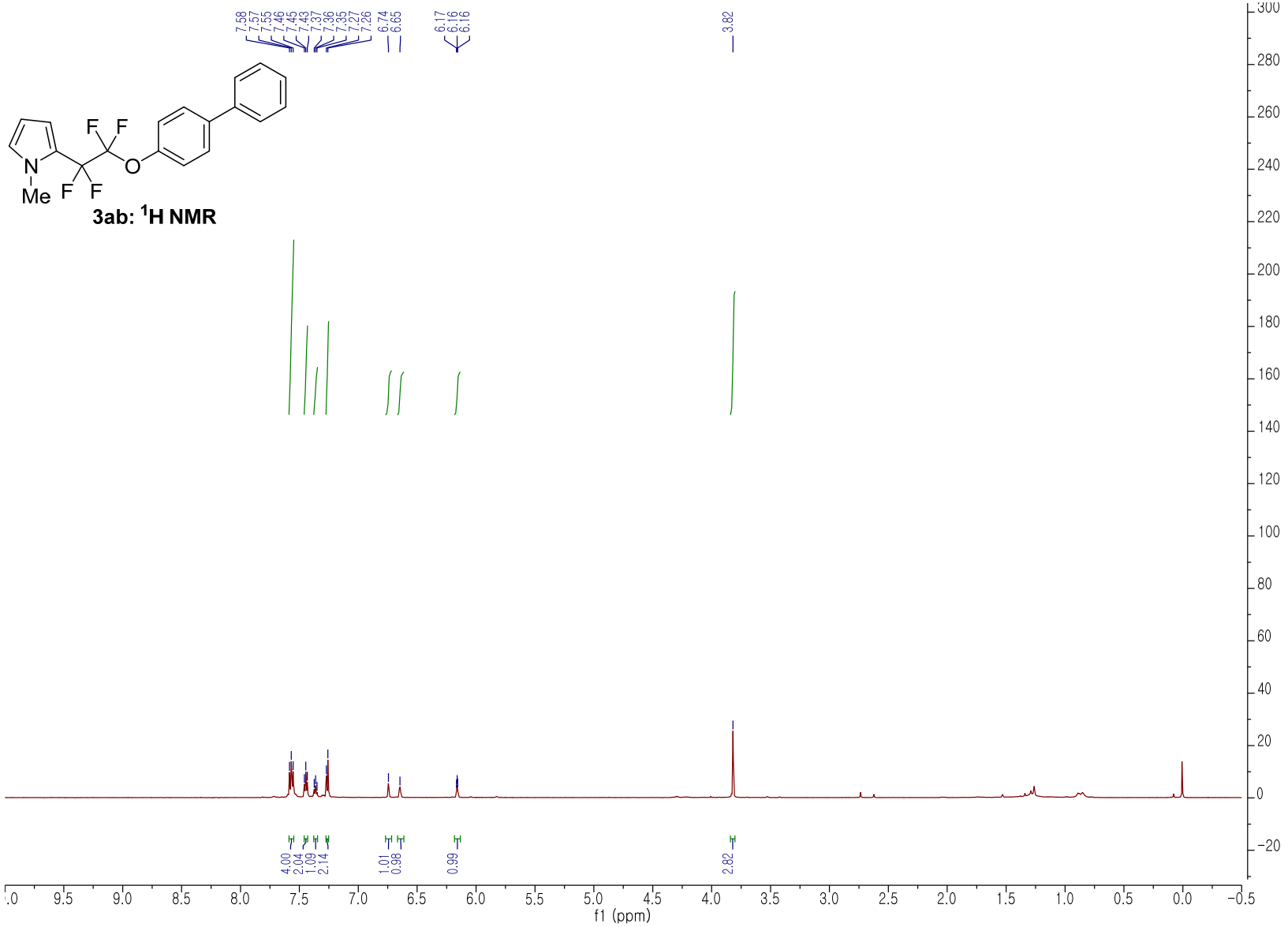

151.93
134.08
122.05
117.62
110.96
CN
F F
Br
O
F F
2e: 13C NMR
550
500
450
400
350
300
250
200
150
100
50
0
−50
f1 (ppm)

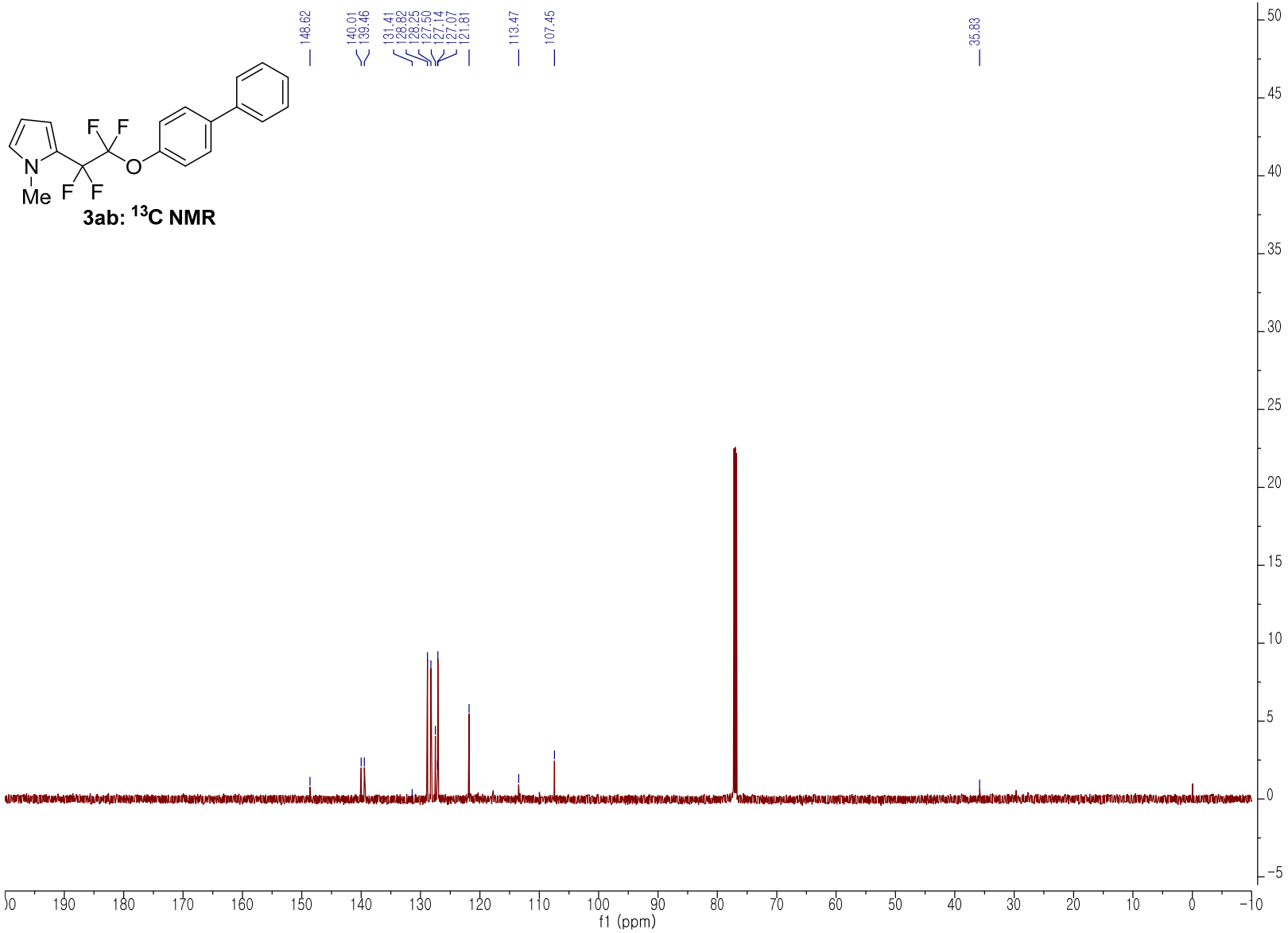

F F
O
N
Me F F
7.39
7.38
7.37
7.28
7.27
7.26
7.22
7.20
6.74
6.65
6.17
6.16
6.16
3.81
2.07
1.18
2.10
1.00
1.00
1.04
3.00
f1 (ppm)

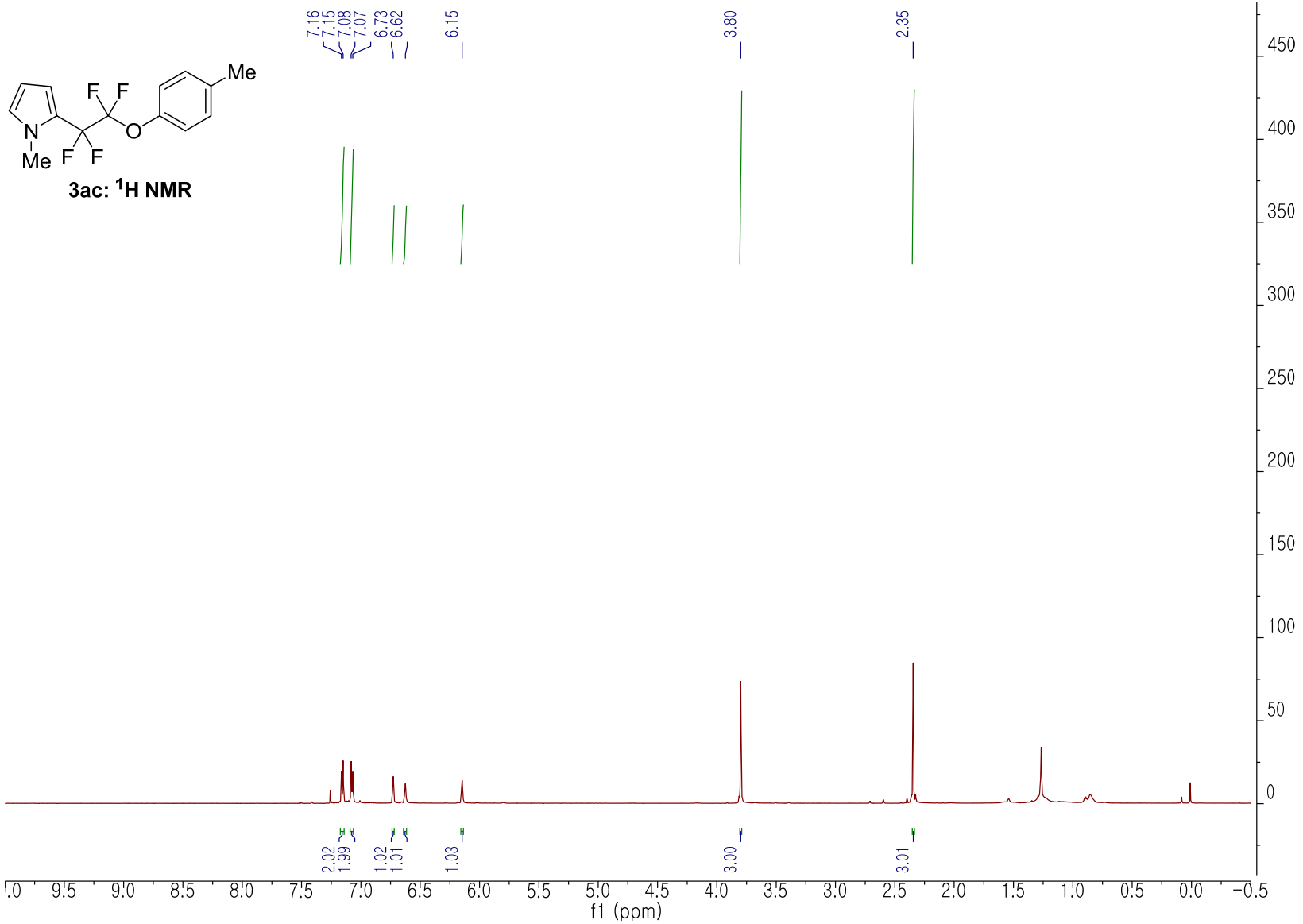
3aa: ^{1}H NMR

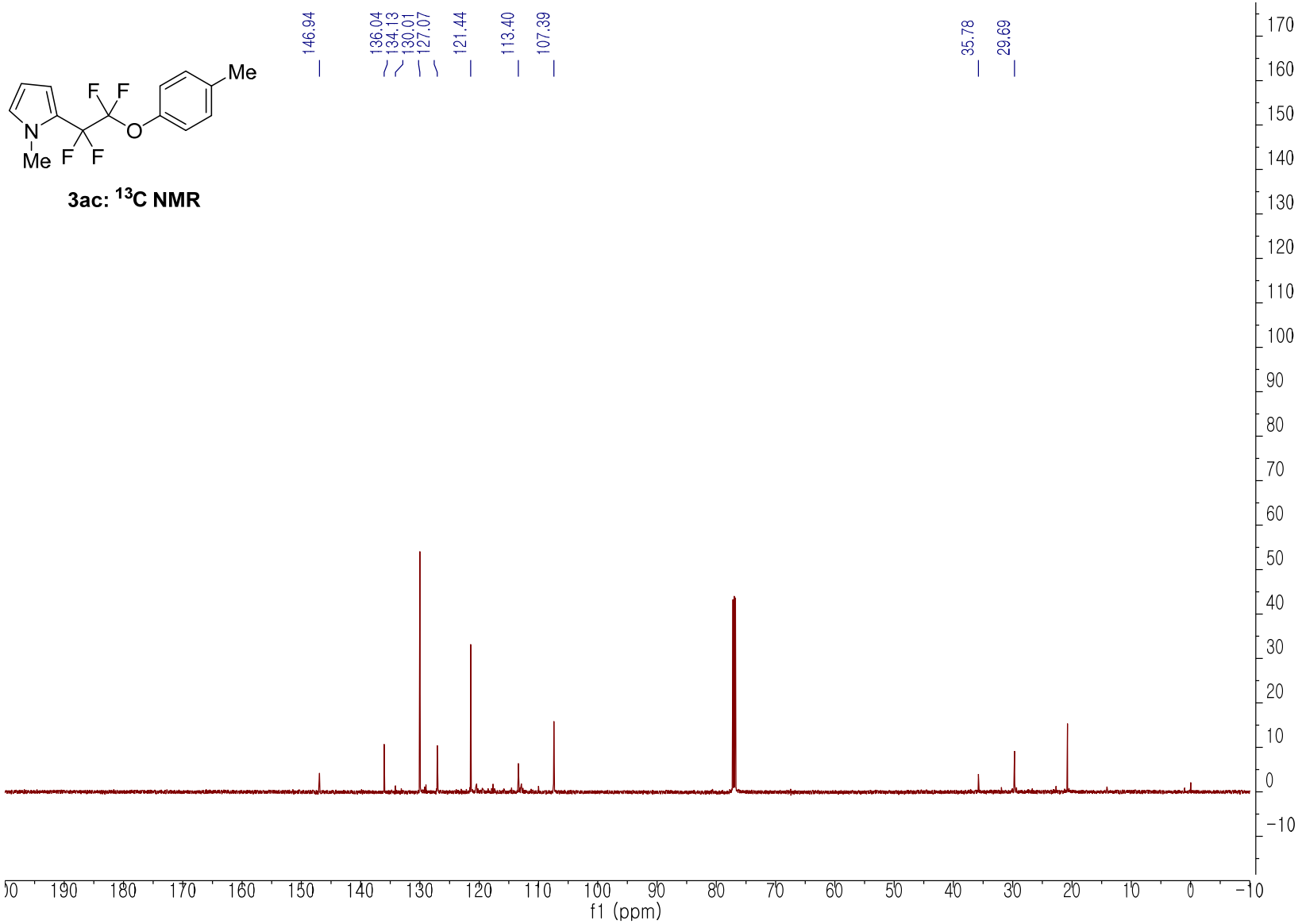

F
F
N
O
Me
F
F
149.24
132.68
129.58
127.13
126.27
121.57
113.45
107.43
35.78
100
90
80
70
60
50
40
30
20
10
0
−10
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

3aa: ^{13}C NMR

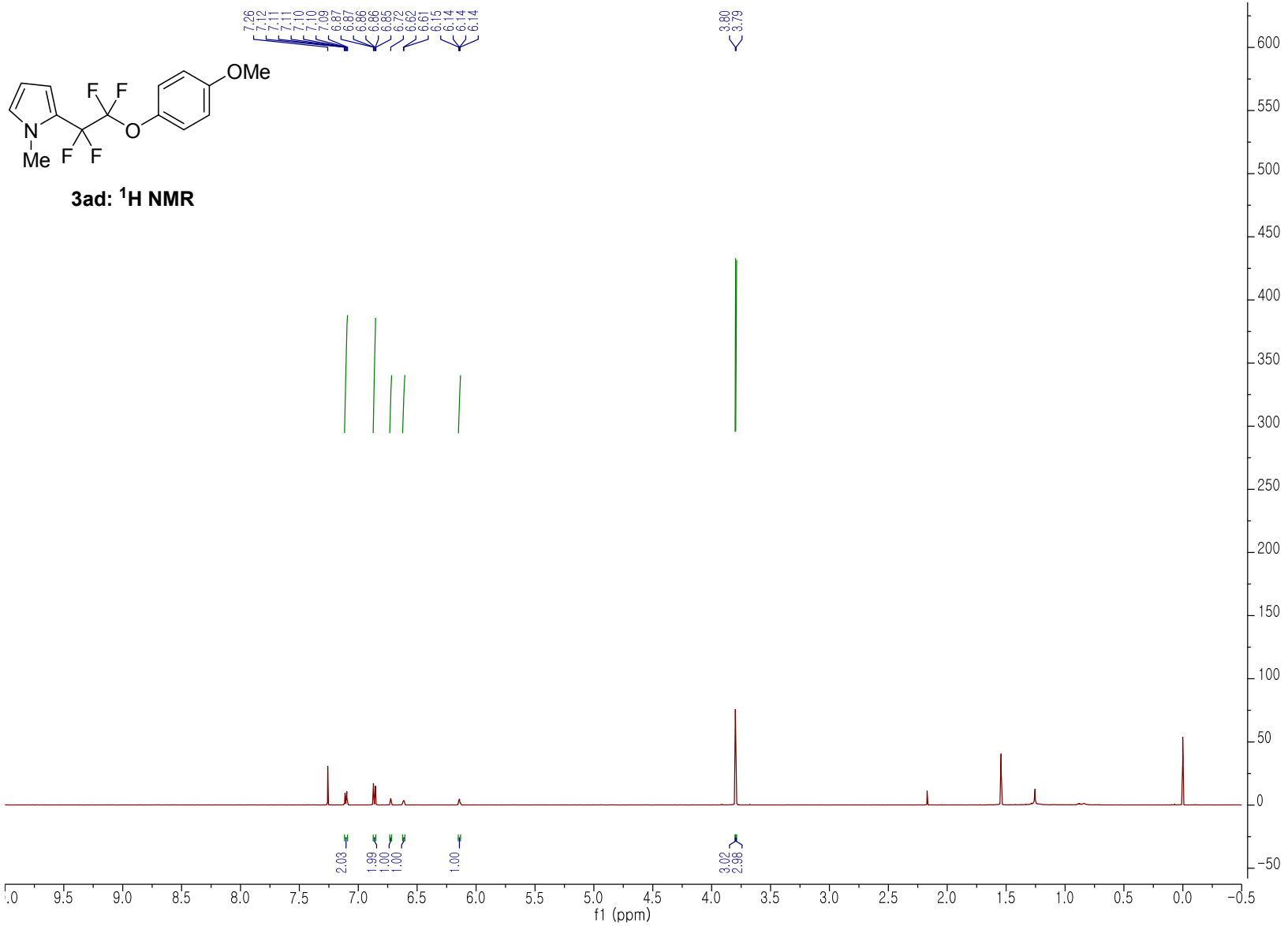

7.58
7.57
7.55
7.46
7.45
7.43
7.37
7.36
7.35
7.27
7.26
6.74
6.65
6.17
6.16
6.16
3.82
F F
O
N
Me F F
3ab: 1H NMR
4.00
2.04
1.09
2.14
1.01
0.98
0.99
2.82
f1 (ppm)


148.62
140.01
139.46
131.41
128.82
128.25
127.50
127.14
127.07
121.81
113.47
107.45
35.83
F
F
O
N
Me
F
F
3ab: 13C NMR
50
45
40
35
30
25
20
15
10
5
0
−5
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

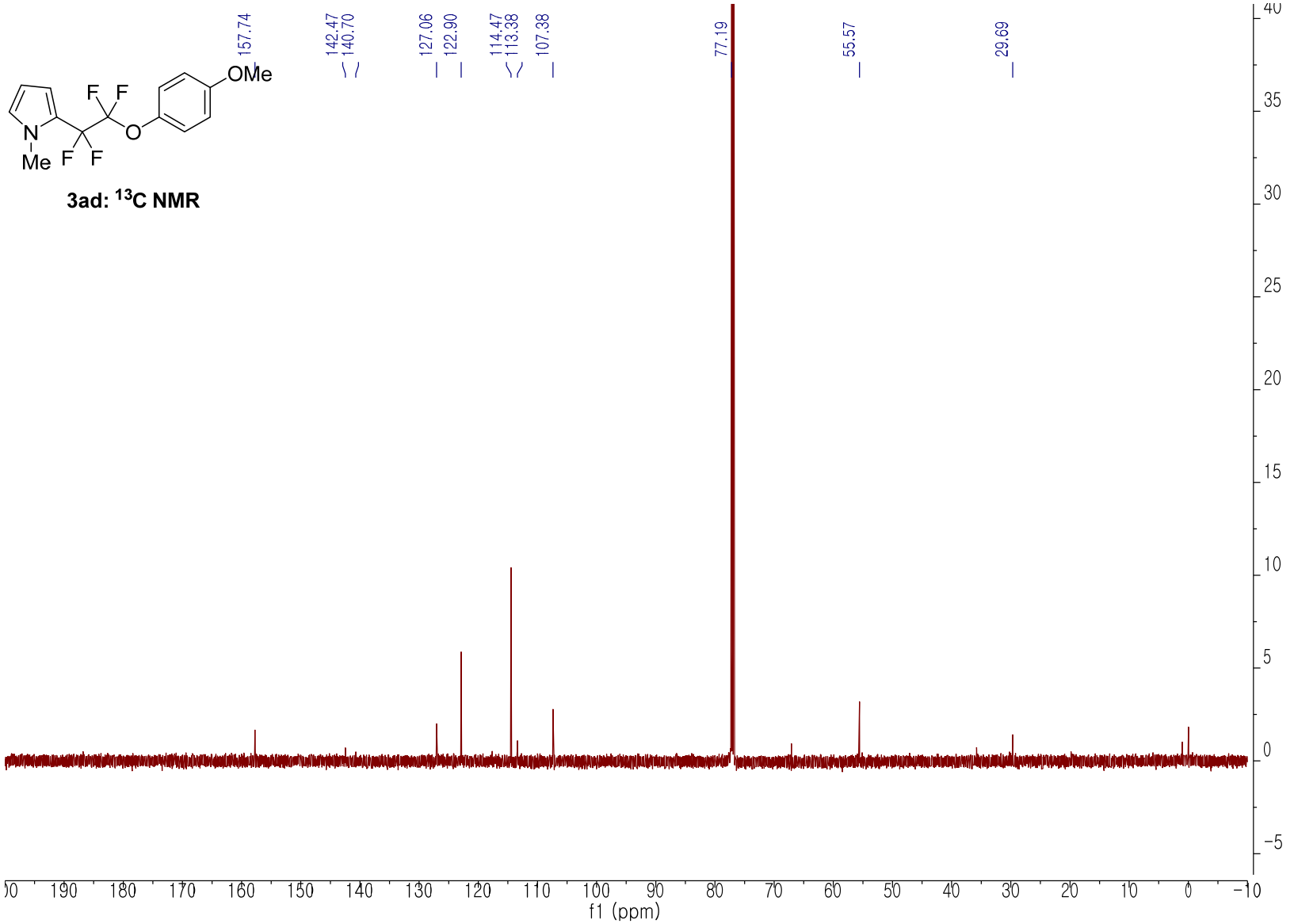

Me
F F
N
O
Me F F
3ac: 1H NMR
7.16
7.15
7.08
7.07
6.73
6.62
6.15
3.80
2.35
2.02
1.99
1.02
1.01
1.03
3.00
3.01
f1 (ppm)

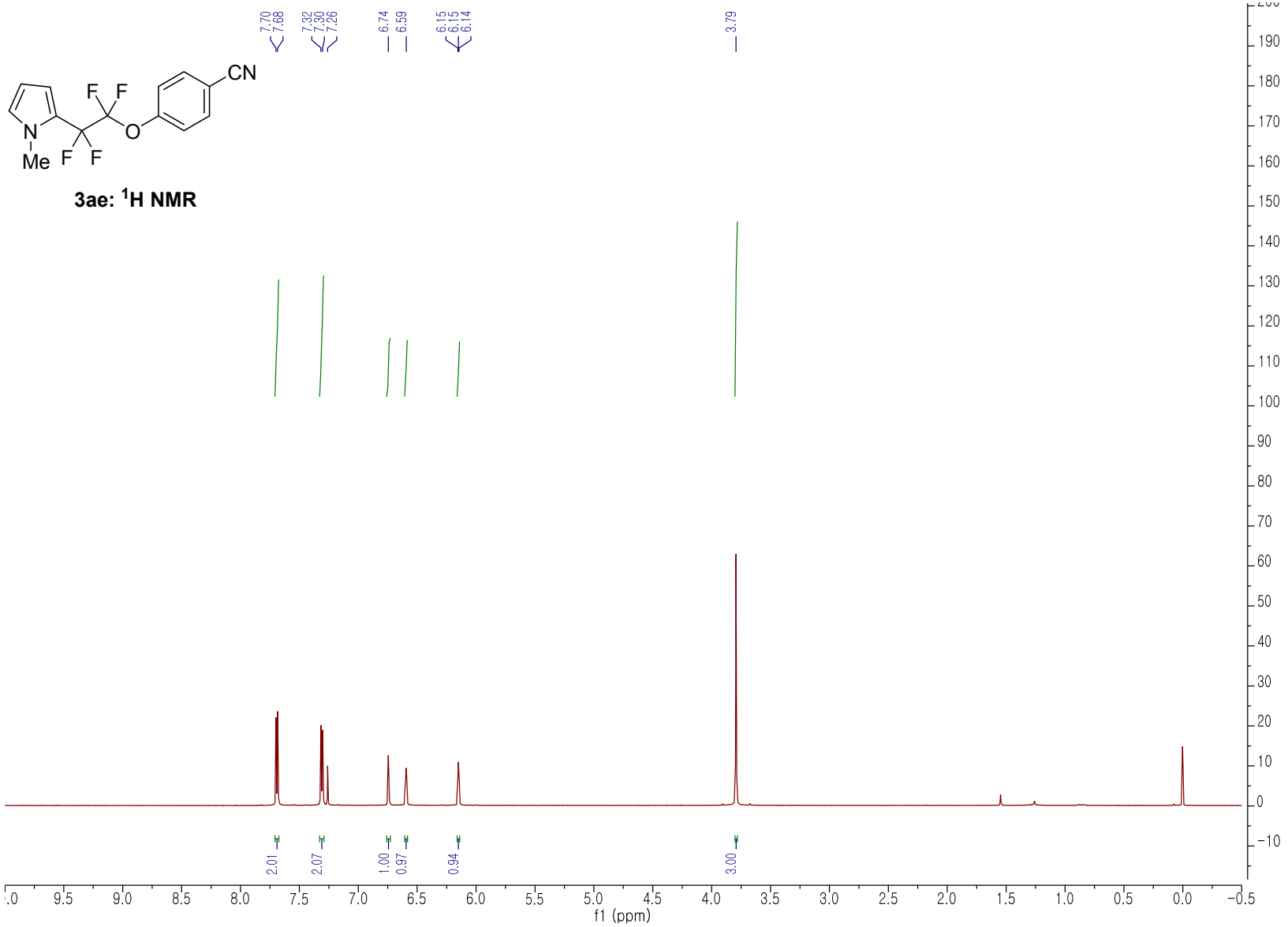

Me
F F
N
O
Me F F
146.94
136.04
134.13
130.01
127.07
121.44
113.40
107.39
35.78
29.69
f1 (ppm)

3ac: ^{13}C NMR

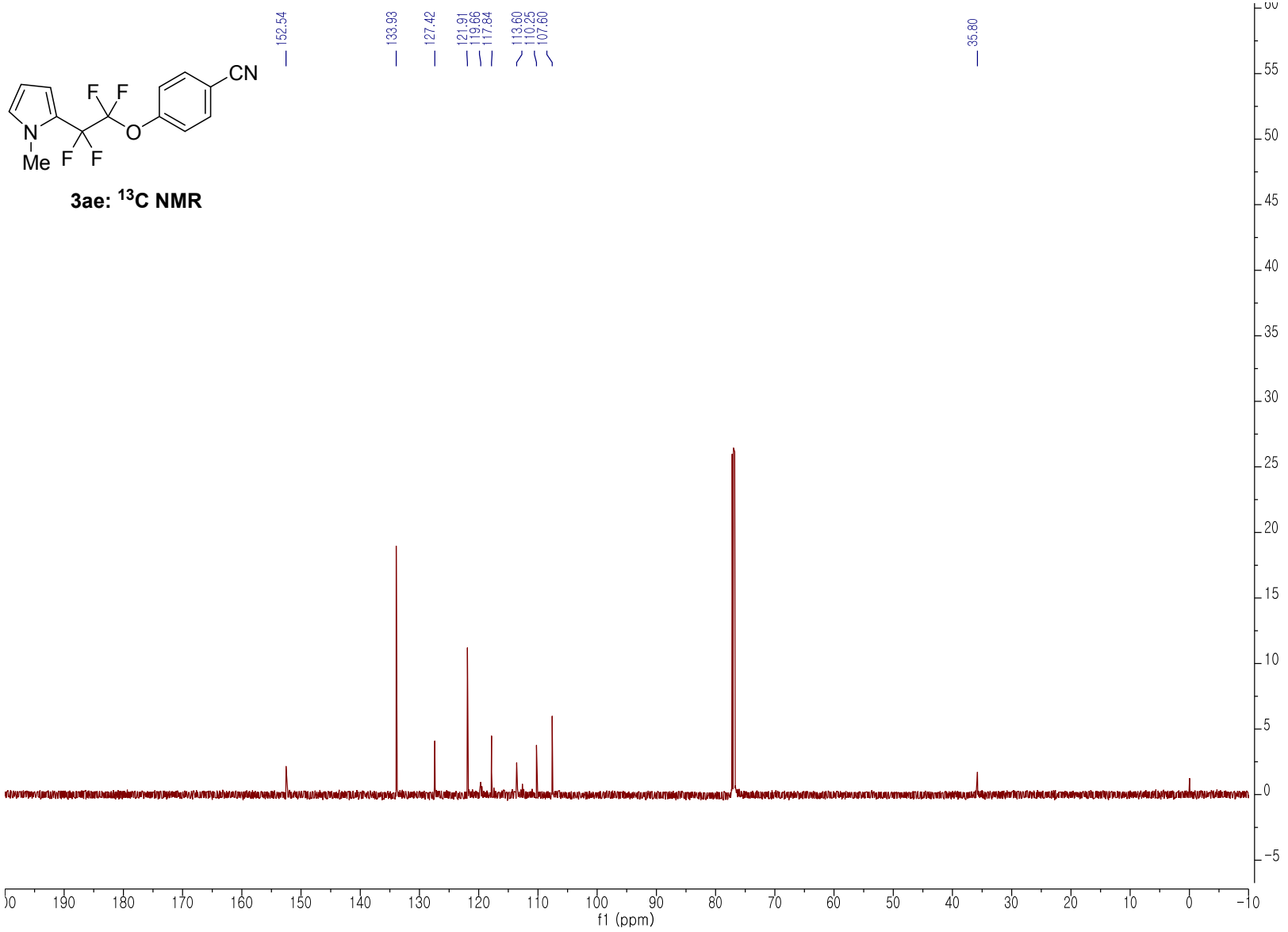

7.26
7.12
7.11
7.11
7.10
7.10
7.09
6.87
6.87
6.86
6.86
6.85
6.72
6.62
6.61
6.15
6.14
6.14
6.14
3.80
3.79
OMe
F
F
N
O
Me
F
F
2.03
1.99
1.00
1.00
1.00
3.02
2.98
f1 (ppm)

3ad: ^{1}H NMR

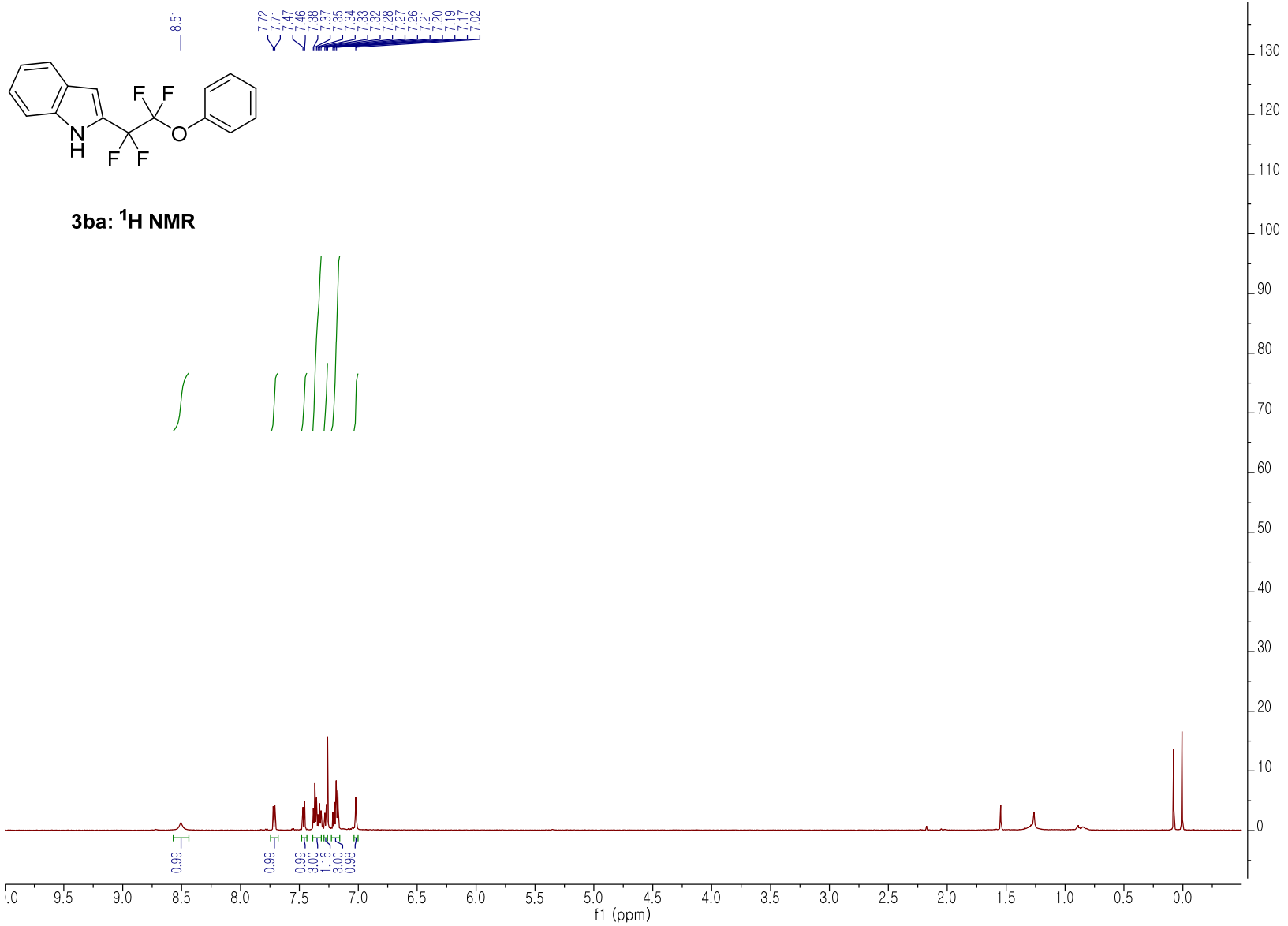

157.74
142.47
140.70
127.06
122.90
114.47
113.38
107.38
77.19
55.57
29.69
OMe
F F
O
N
Me F F
3ad: 13C NMR
f1 (ppm)


7.70
7.68
7.32
7.30
7.26
6.74
6.59
6.15
6.15
6.14
3.79
CN
F F
N
O
Me F F
2.01
2.07
1.00
0.97
0.94
3.00
f1 (ppm)

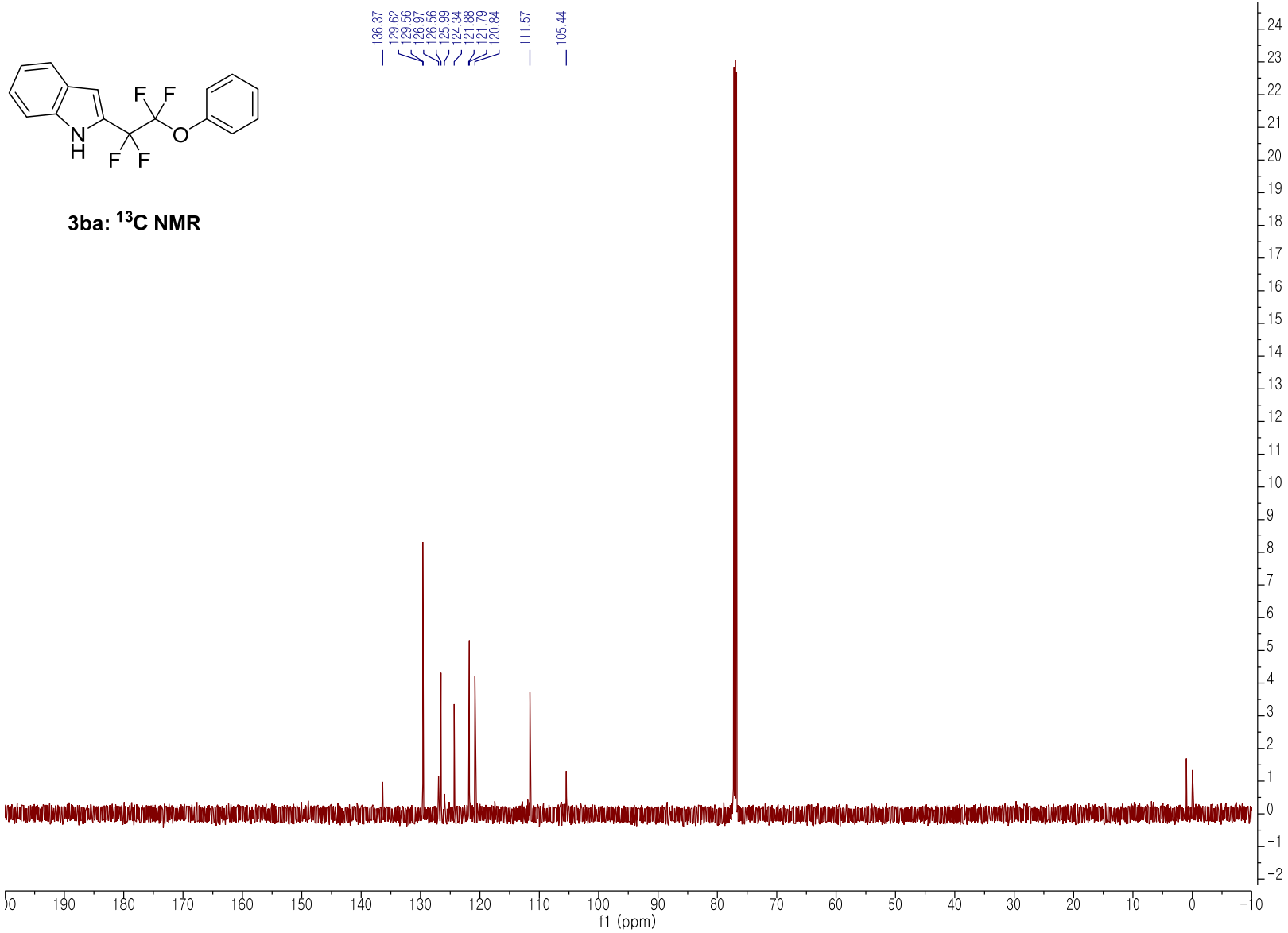
3ae: ^{1}H NMR


152.54
133.93
127.42
121.91
119.66
117.84
113.60
110.25
107.60
35.80
CN
F F
O
N
Me F F
f1 (ppm)

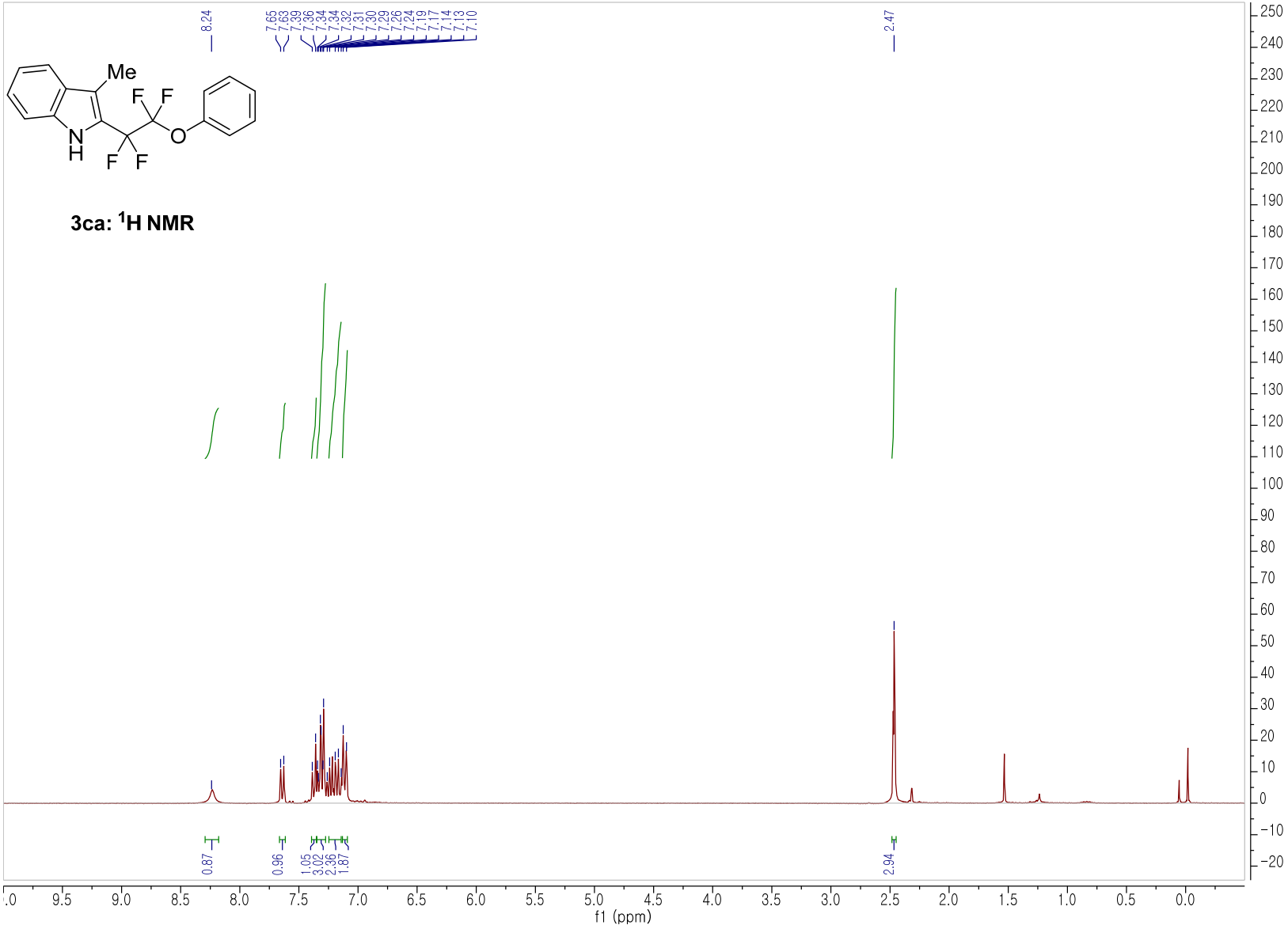
3ae: ^{13}C NMR

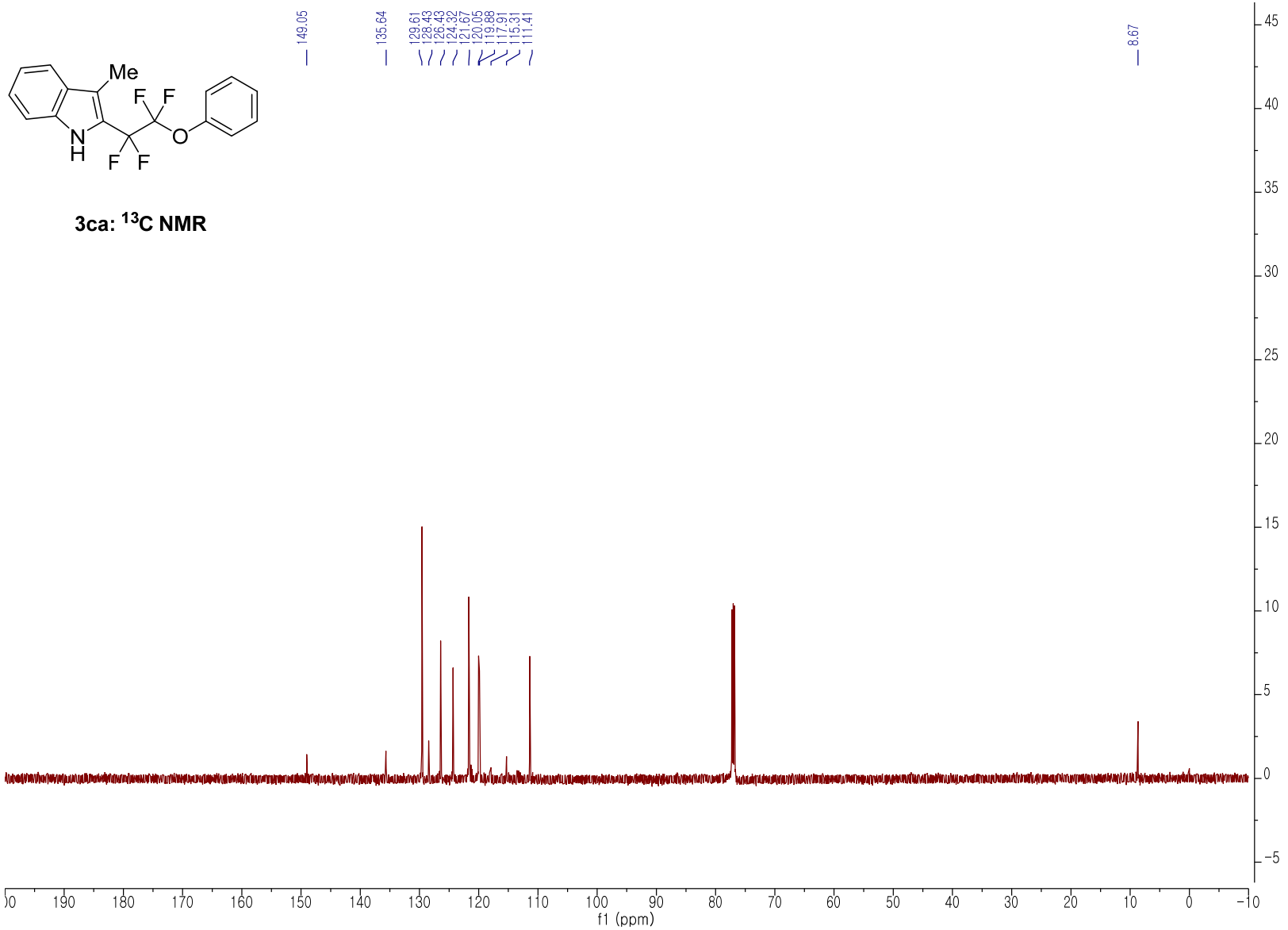

8.51
7.72
7.71
7.47
7.46
7.38
7.37
7.35
7.34
7.33
7.32
7.28
7.27
7.26
7.21
7.20
7.19
7.17
7.02
F F
N
H
O
F F
0.99
0.99
0.99
3.00
1.16
3.00
0.98
f1 (ppm)

3ba: ^{1}H NMR

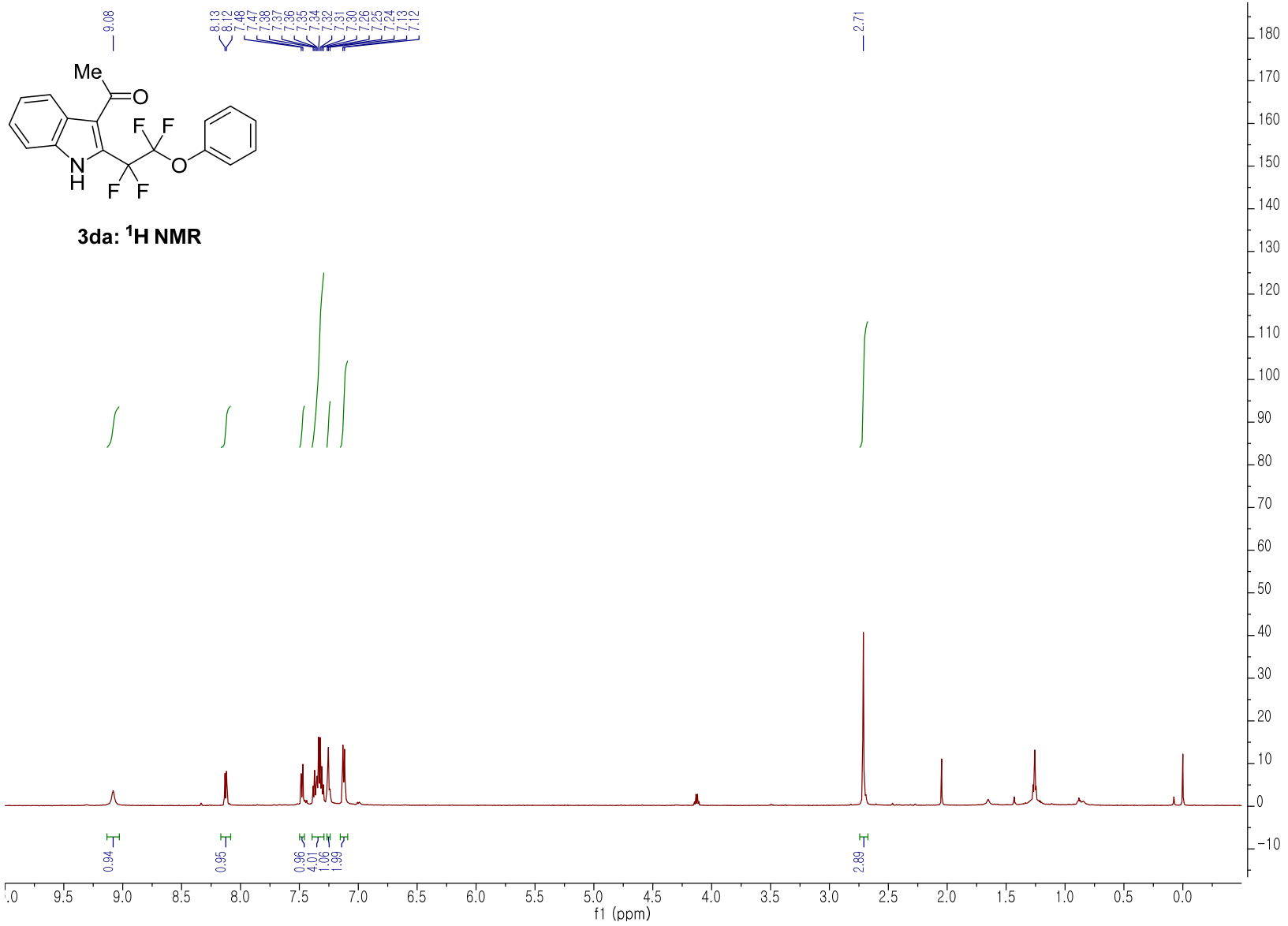

136.37
129.62
129.56
126.97
126.56
125.99
124.34
121.88
121.79
120.84
111.57
105.44
F F
N
H
O
F F
f1 (ppm)

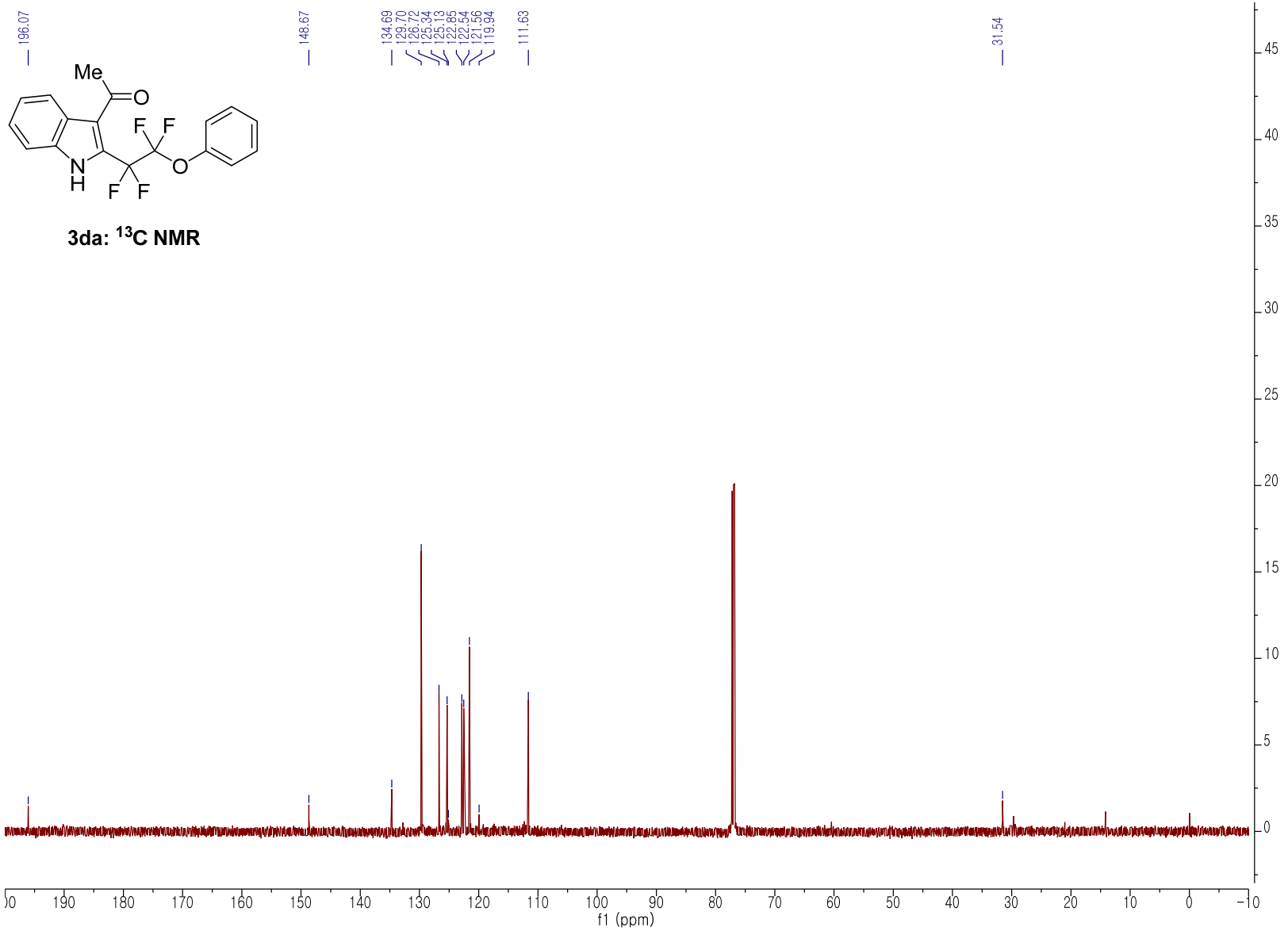
3ba: ^{13}C NMR


8.24
7.65
7.63
7.39
7.36
7.34
7.34
7.32
7.31
7.30
7.29
7.26
7.24
7.19
7.17
7.14
7.13
7.10
2.47
Me
F F
O
N
H
F F
3ca: 1H NMR
0.87
0.96
1.05
3.02
2.36
1.87
2.94
f1 (ppm)

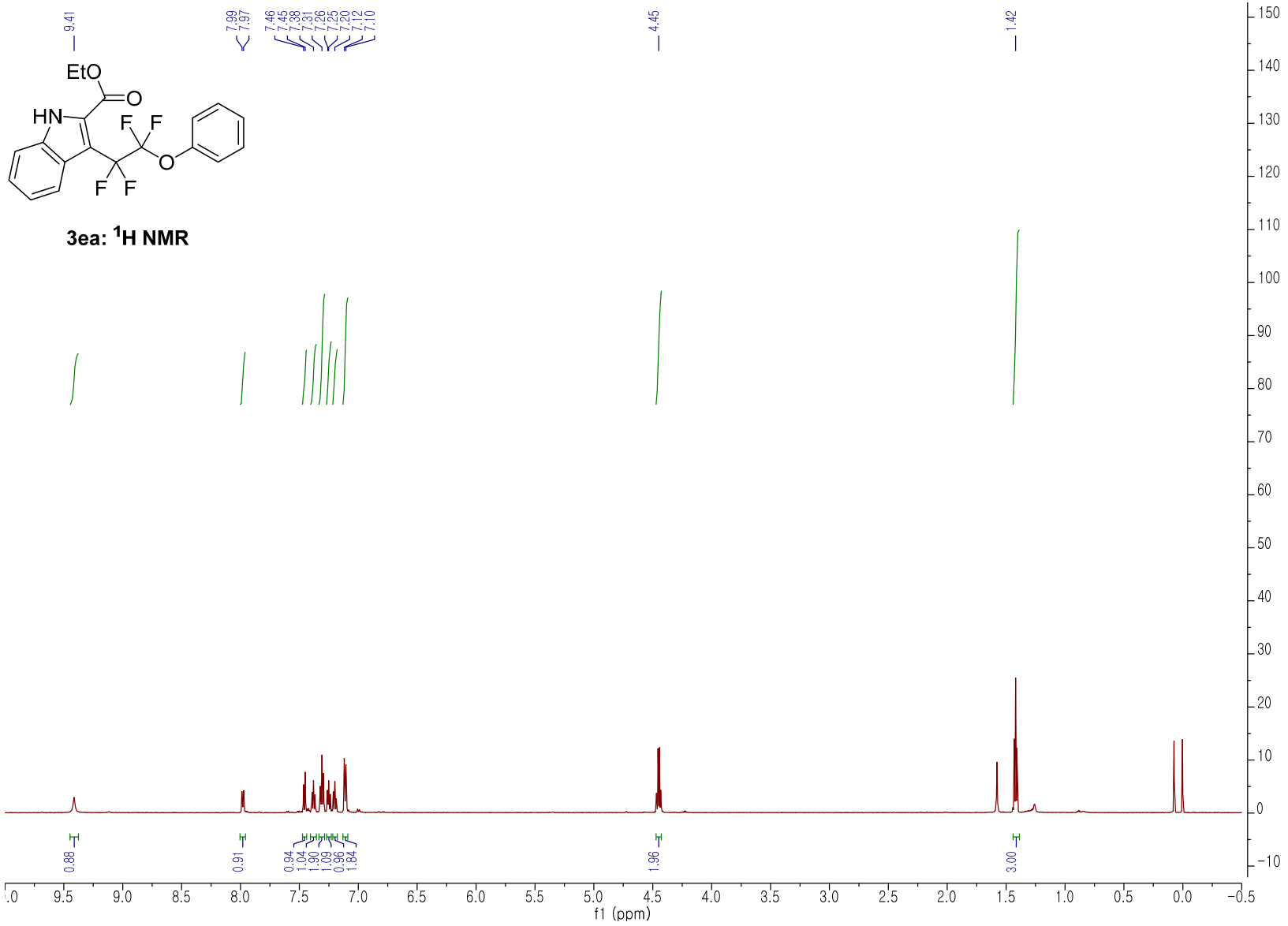

Me
F F
N
H
O
F F
149.05
135.64
129.61
128.43
126.43
124.32
121.67
120.05
119.88
117.91
115.31
111.41
8.67
45
40
35
30
25
20
15
10
5
0
−5
f1 (ppm)

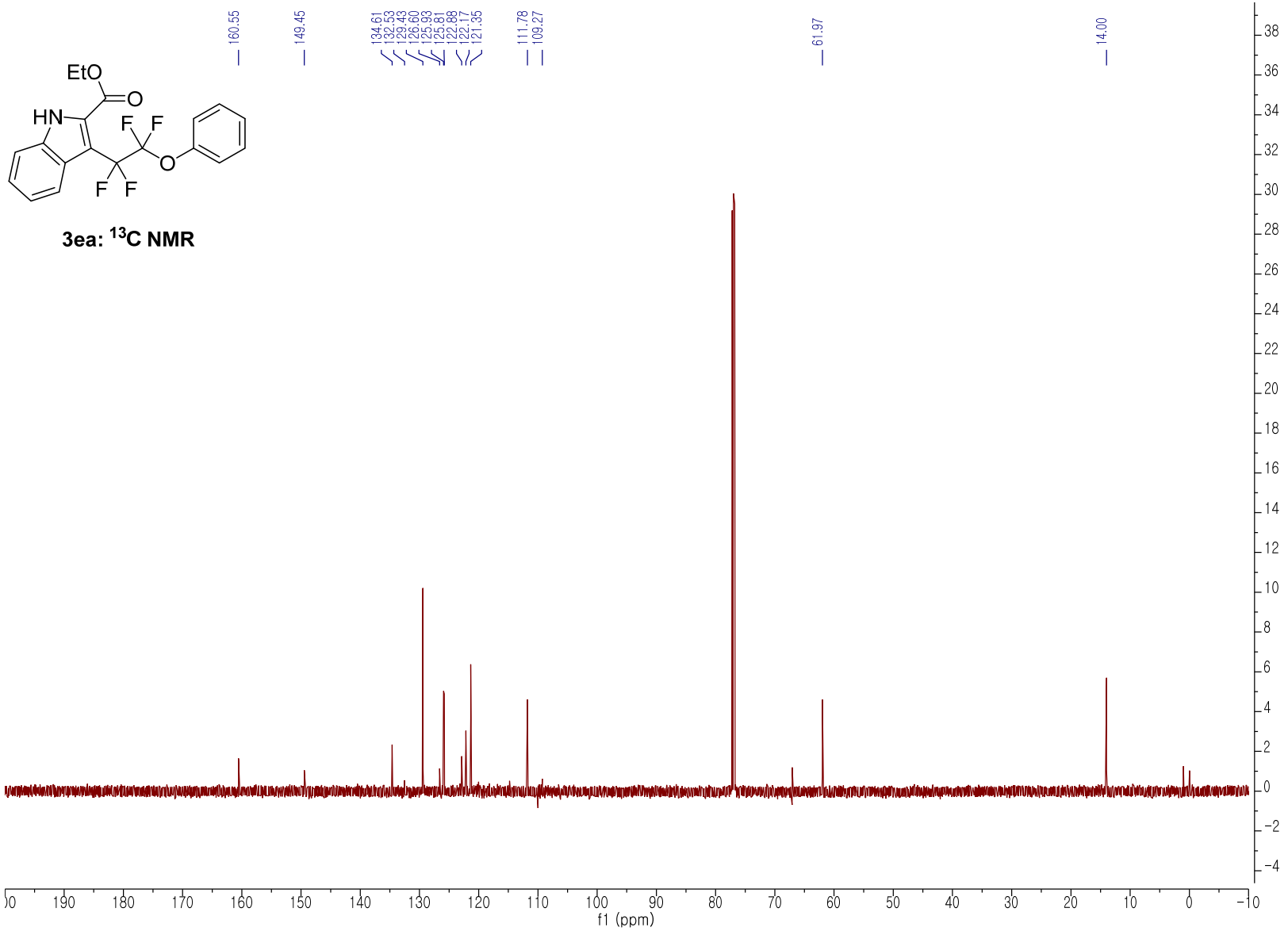
3ca: ^{13}C NMR

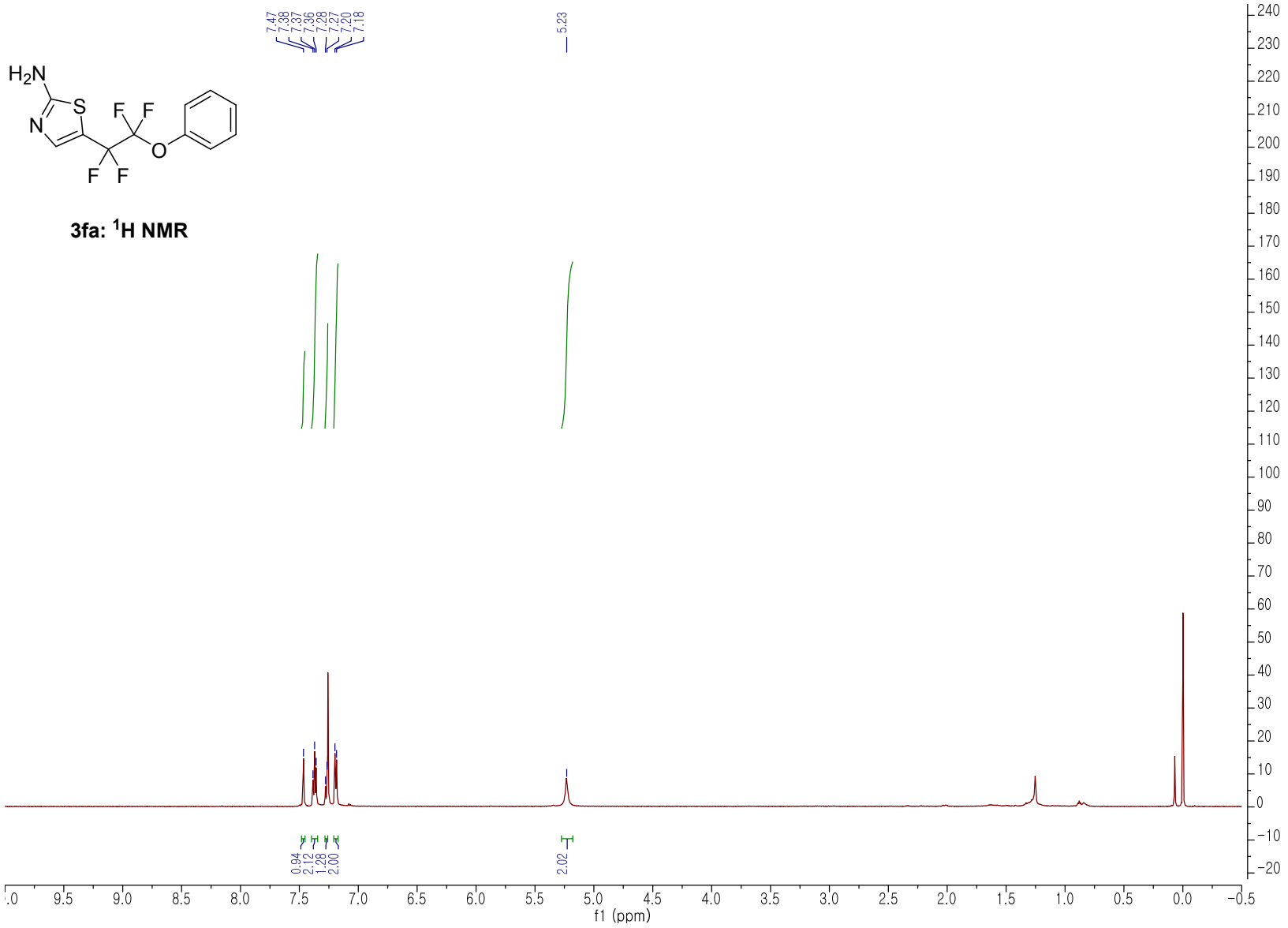

9.08
8.13
8.12
7.48
7.47
7.38
7.37
7.36
7.35
7.34
7.32
7.31
7.30
7.26
7.25
7.24
7.13
7.12
2.71
Me
O
F F
N
H
O
F F
3da: 1H NMR
0.94
0.95
0.96
4.01
1.06
1.99
2.89
f1 (ppm)


196.07
148.67
134.69
129.70
126.72
125.34
125.13
122.85
122.54
121.56
119.94
111.63
31.54
Me
O
F F
N
H
O
F F
f1 (ppm)

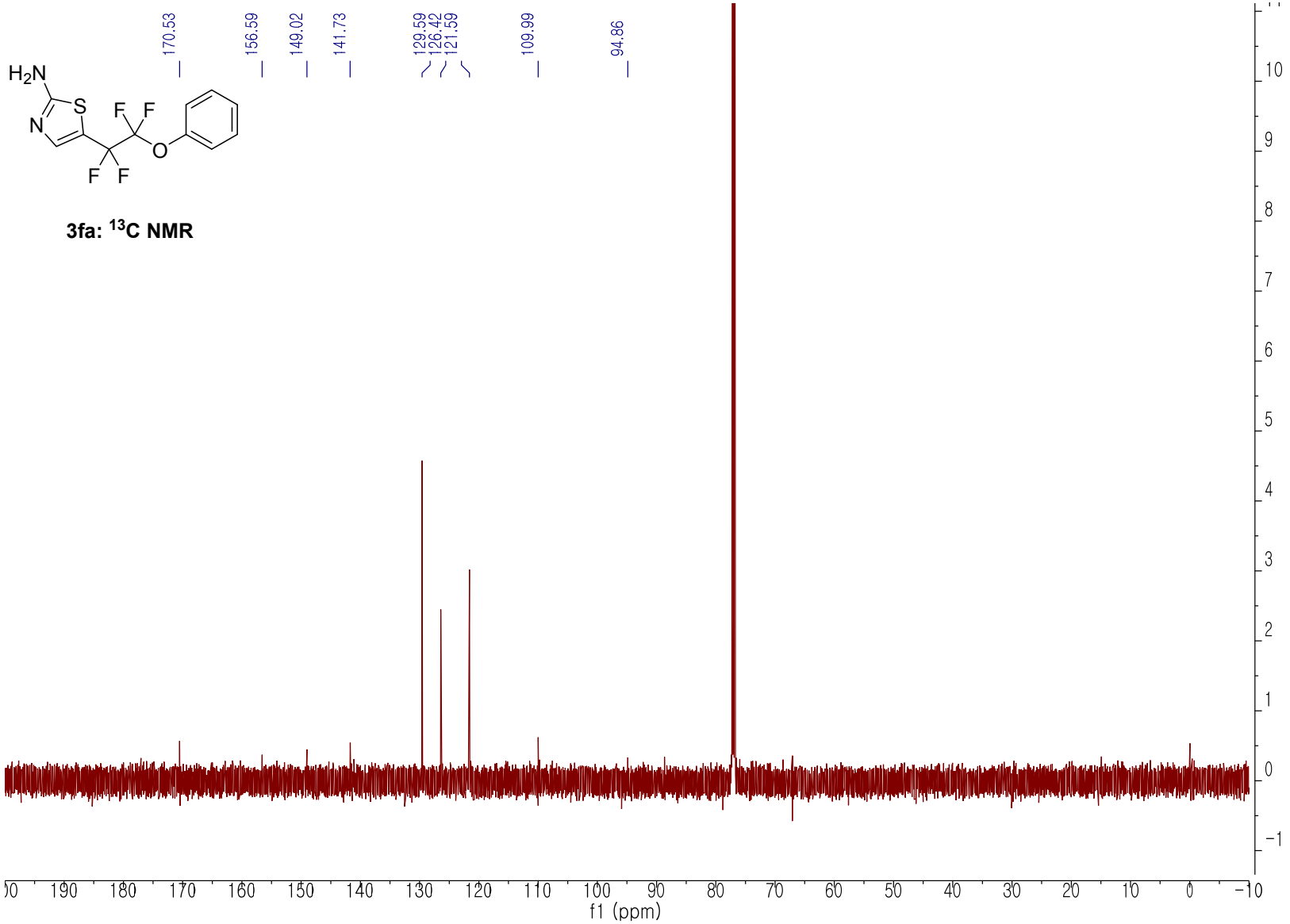
3da: ^{13}C NMR


9.41
7.99
7.97
7.46
7.45
7.38
7.31
7.26
7.25
7.20
7.12
7.10
4.45
1.42
EtO
O
HN
F F
O
F F
3ea: 1H NMR
0.88
0.91
0.94
1.04
1.90
1.09
0.96
1.84
1.96
3.00
f1 (ppm)

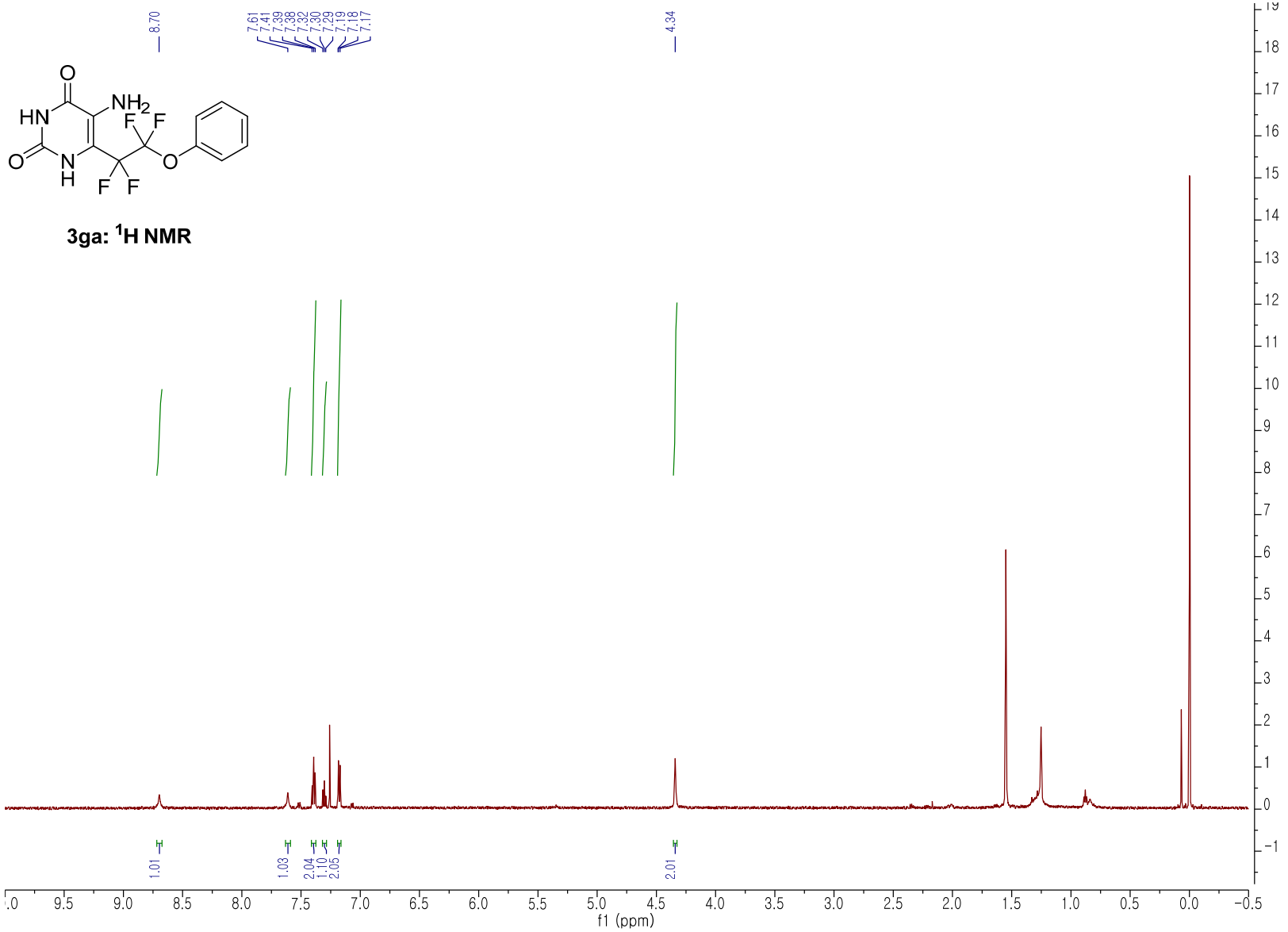

160.55
149.45
134.61
132.53
129.43
128.60
125.93
125.81
122.88
122.17
121.35
111.78
109.27
61.97
14.00
EtO
O
HN
F F
O
F F
3ea: 13C NMR
f1 (ppm)


H2N
S
N
F F
F F
O
7.47
7.38
7.37
7.36
7.28
7.27
7.20
7.18
5.23
0.94
2.12
1.28
2.00
2.02
f1 (ppm)

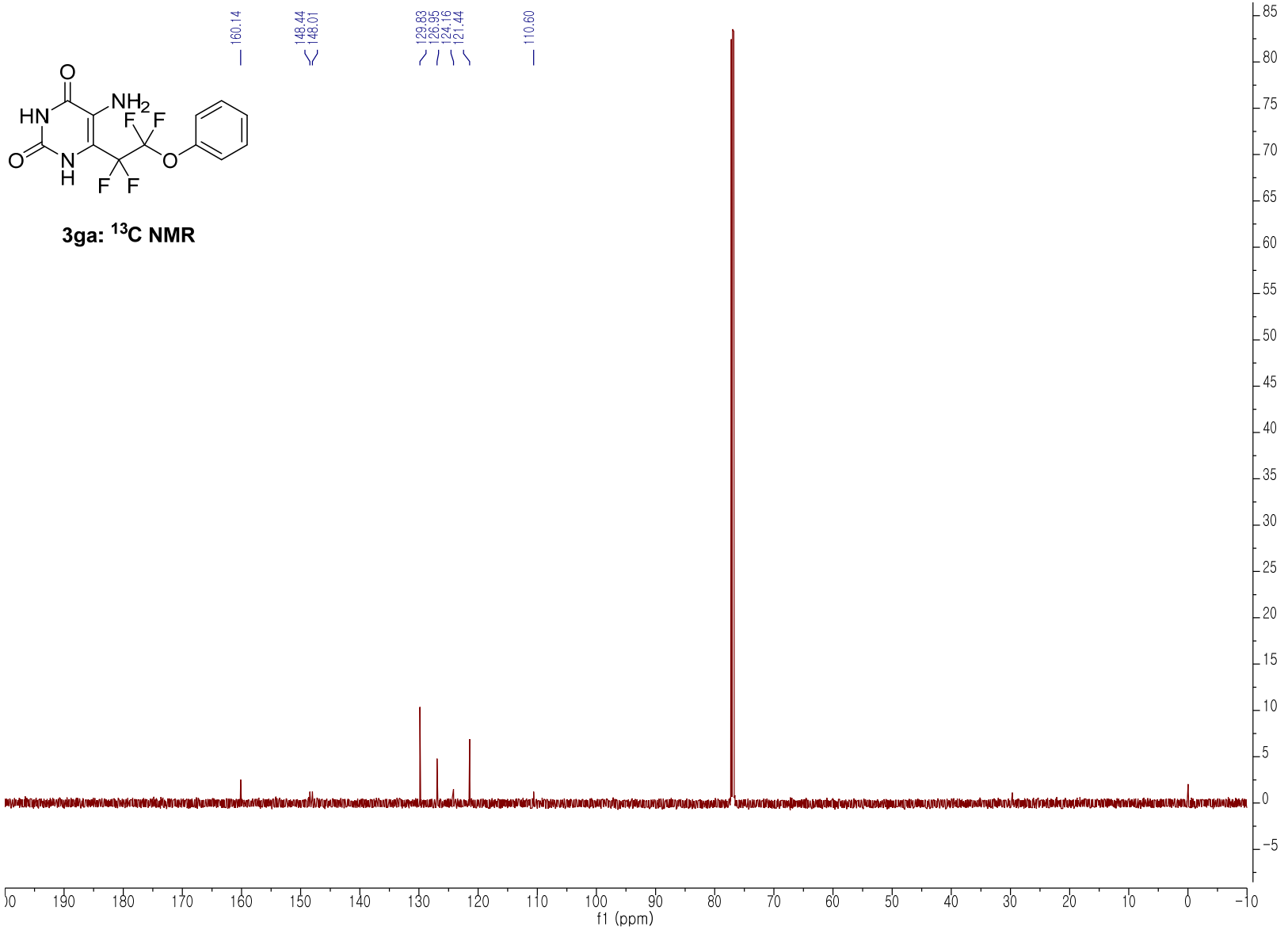
3fa: ^{1}H NMR


170.53
156.59
149.02
141.73
129.59
126.42
121.59
109.99
94.86
H2N
S
N
F F
O
F F
f1 (ppm)

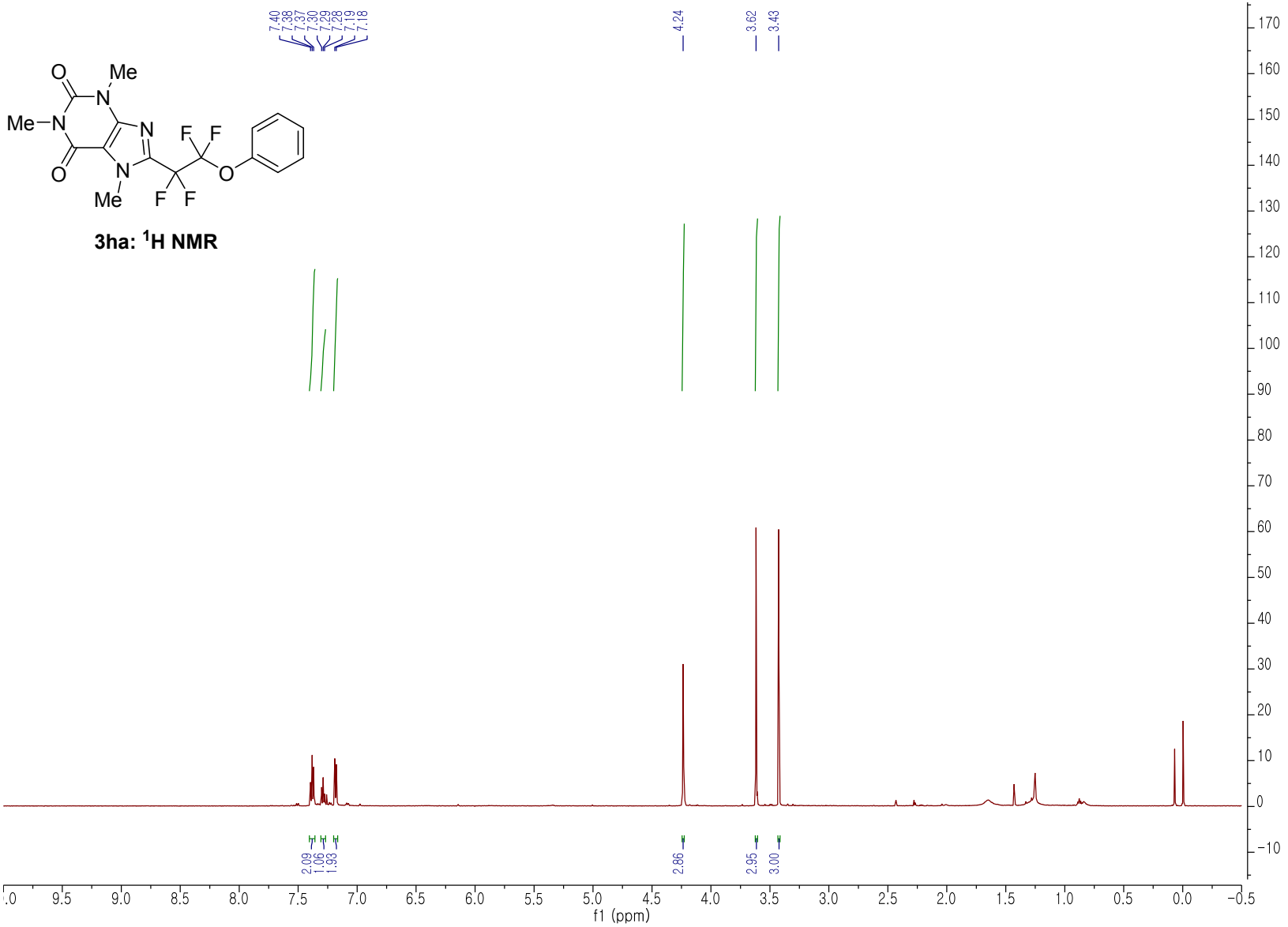
3fa: ^{13}C NMR

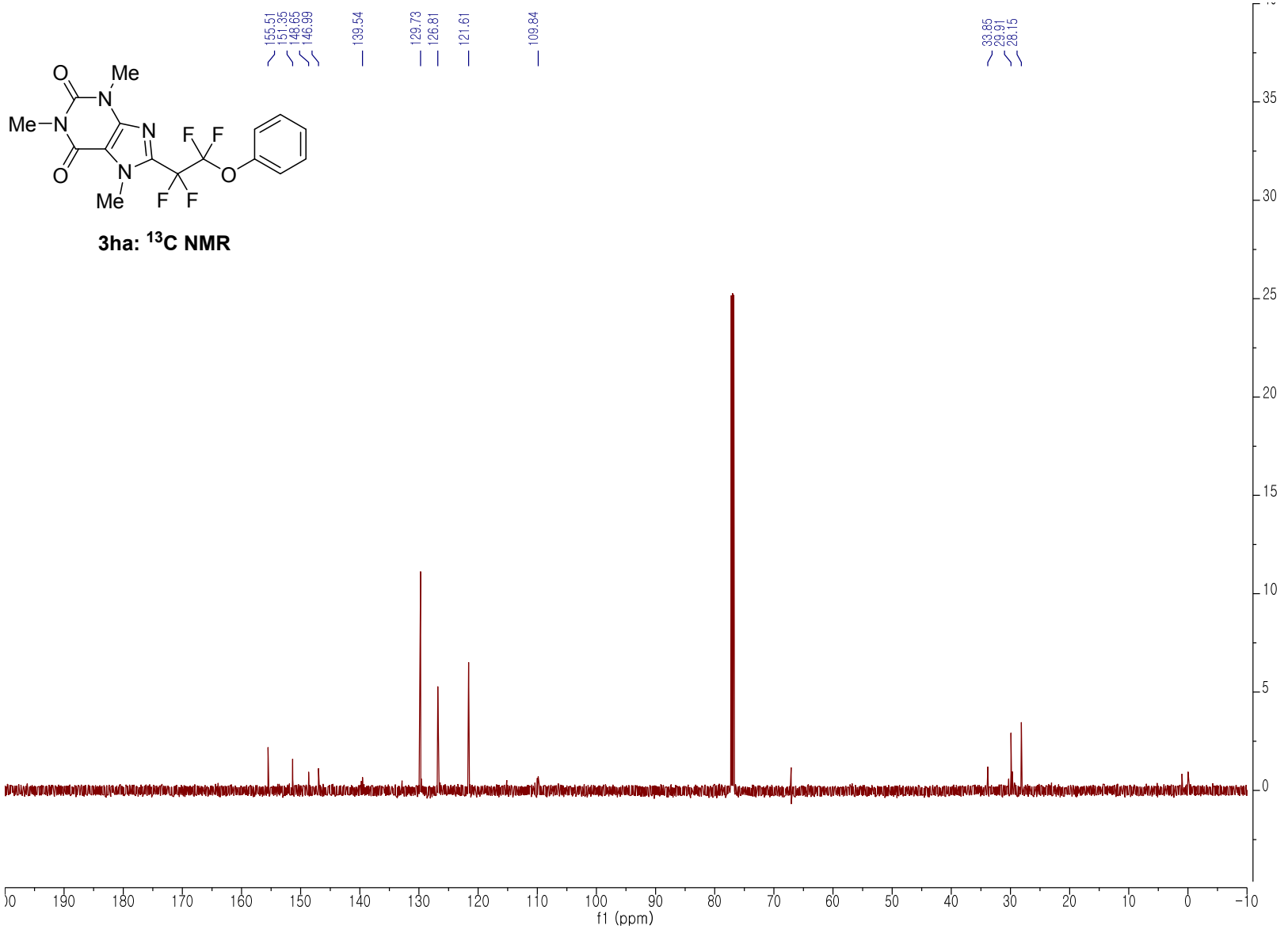

8.70
7.61
7.41
7.39
7.38
7.32
7.30
7.29
7.19
7.18
7.17
4.34
HN
O
O
N
H
NH2
F F
O
F F
1.01
1.03
2.04
1.10
2.05
2.01
f1 (ppm)

3ga: ^{1}H NMR

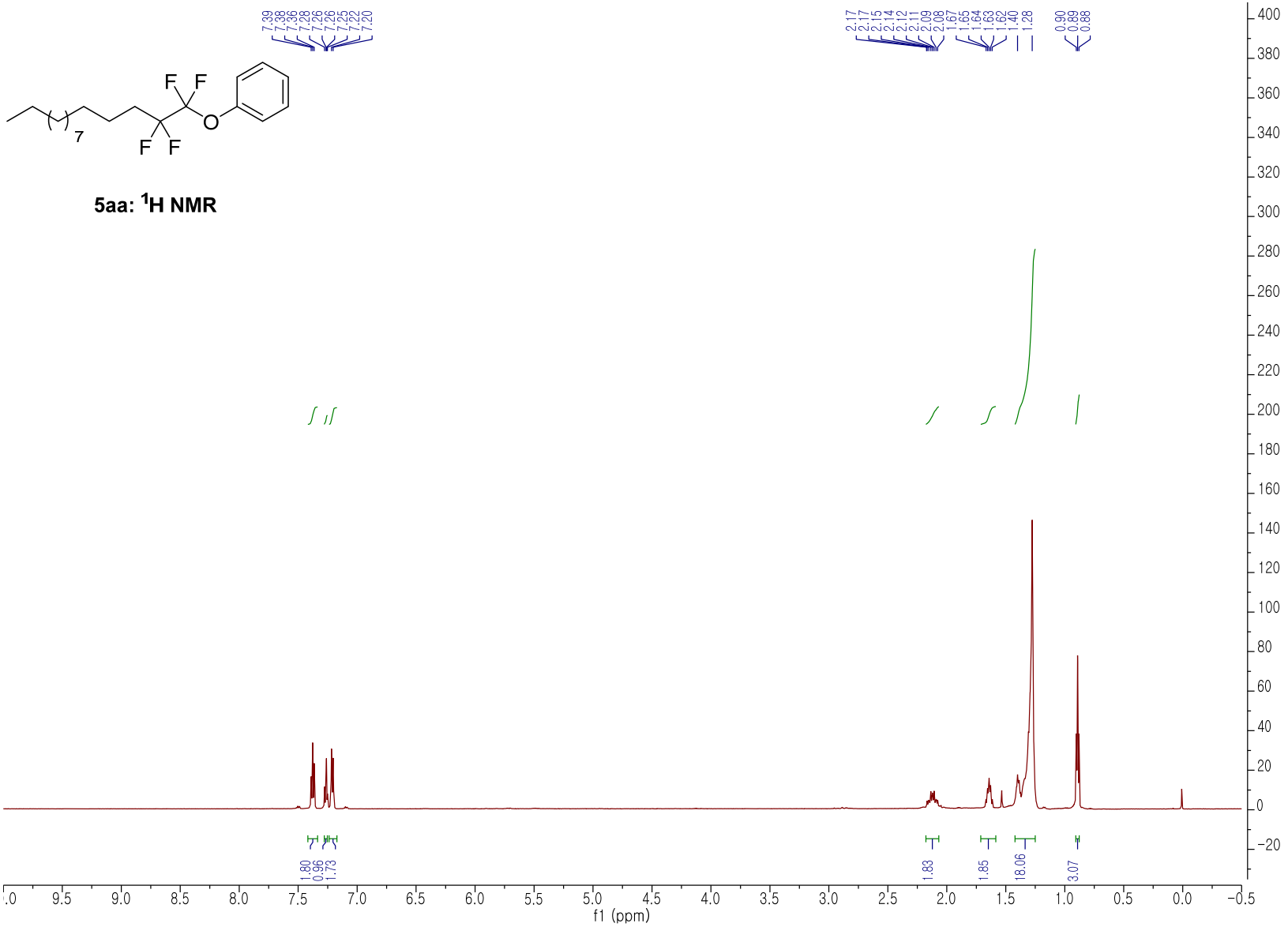

160.14
148.44
148.01
129.83
126.95
124.16
121.44
110.60
O
HN
NH2
F F
O
N
H
O
F F
f1 (ppm)

3ga: ^{13}C NMR

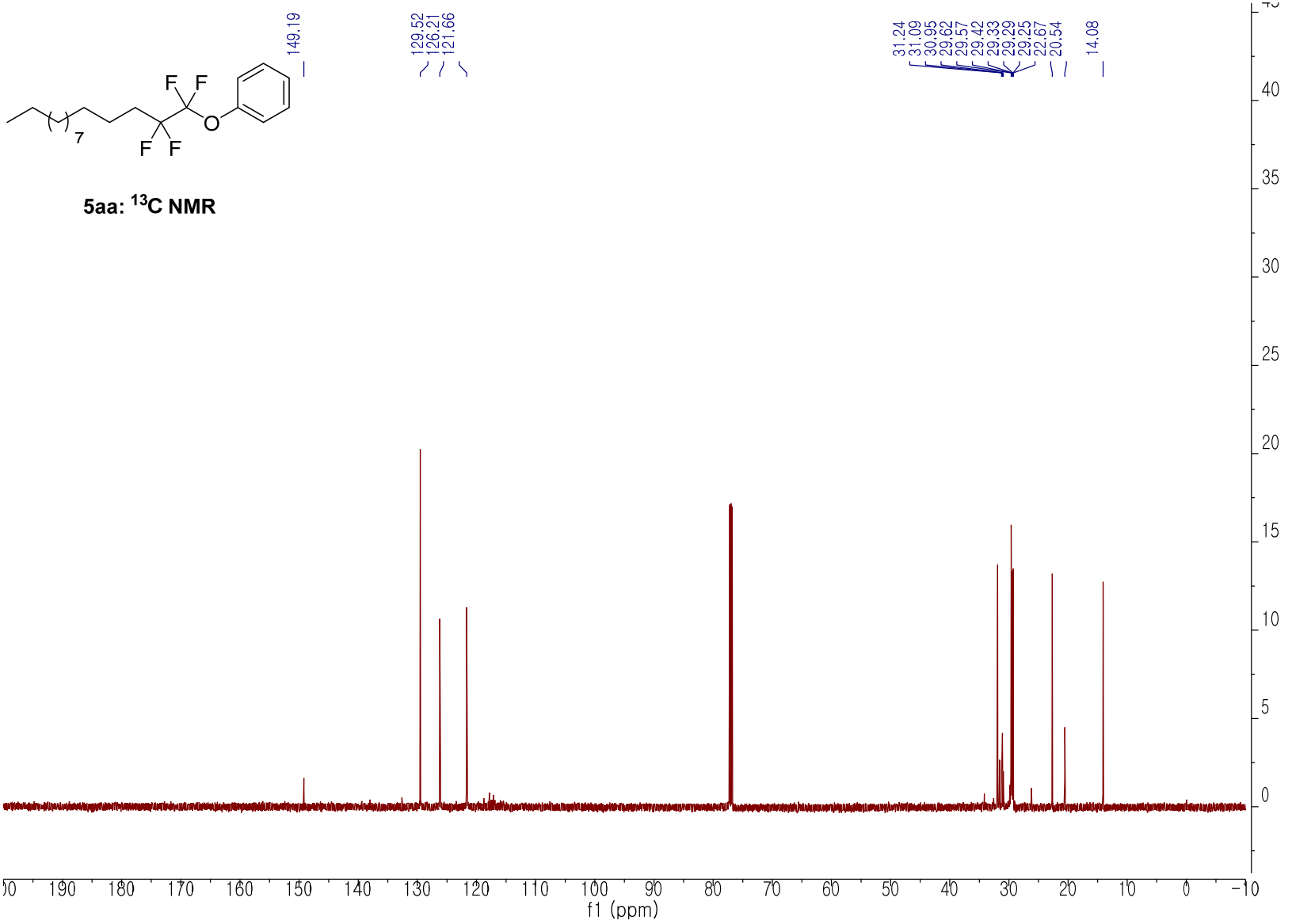

7.40
7.38
7.37
7.30
7.29
7.28
7.19
7.18
4.24
3.62
3.43
Me
N
O
Me–N
N
F F
O
N
O
Me
F F
3ha: 1H NMR
2.09
1.06
1.93
2.86
2.95
3.00
f1 (ppm)


155.51
151.35
148.65
146.99
139.54
129.73
126.81
121.61
109.84
33.85
29.91
28.15
Me
N
O
Me
N
N
F
F
O
N
O
Me
F
F
f1 (ppm)

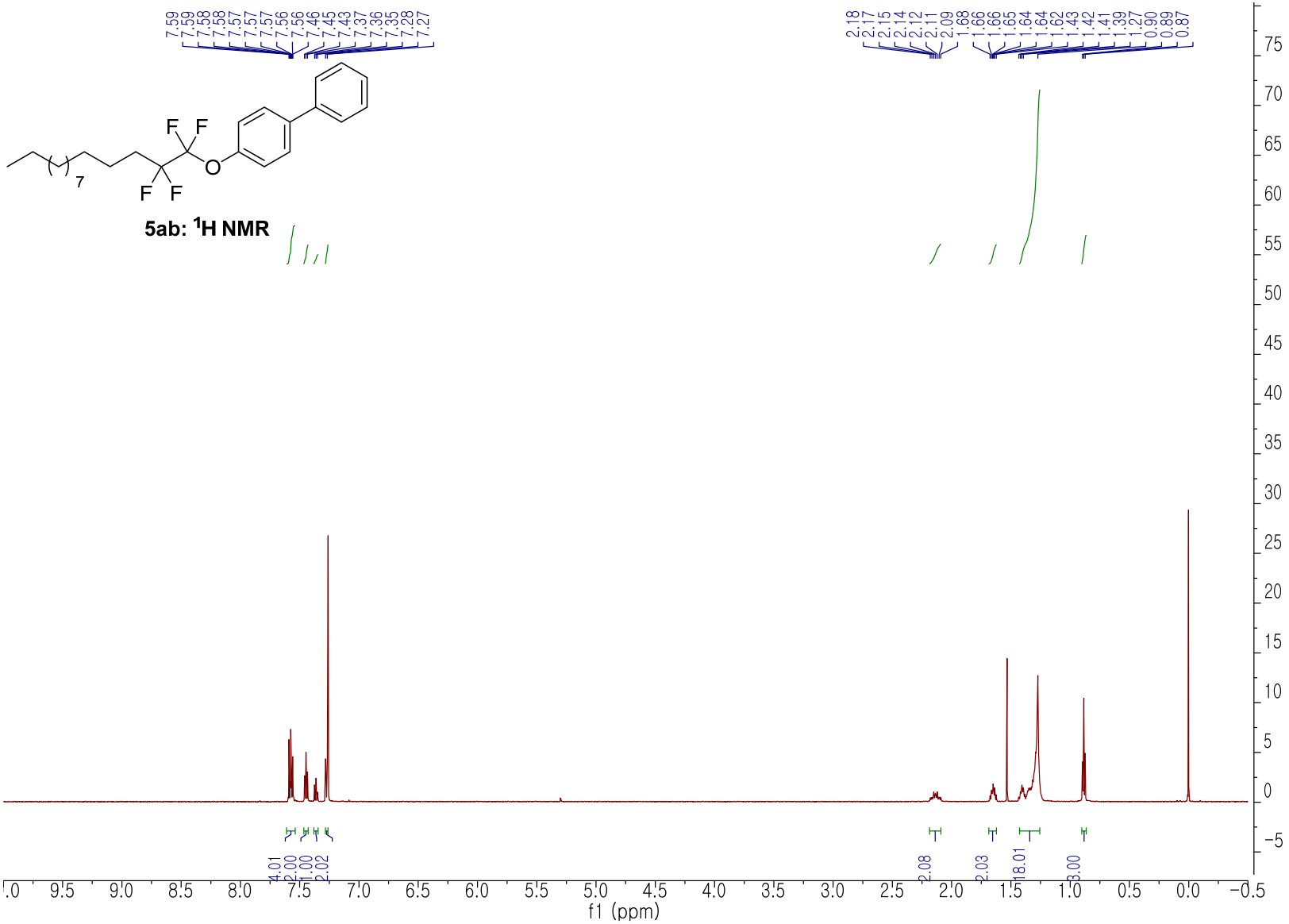
3ha: ^{13}C NMR

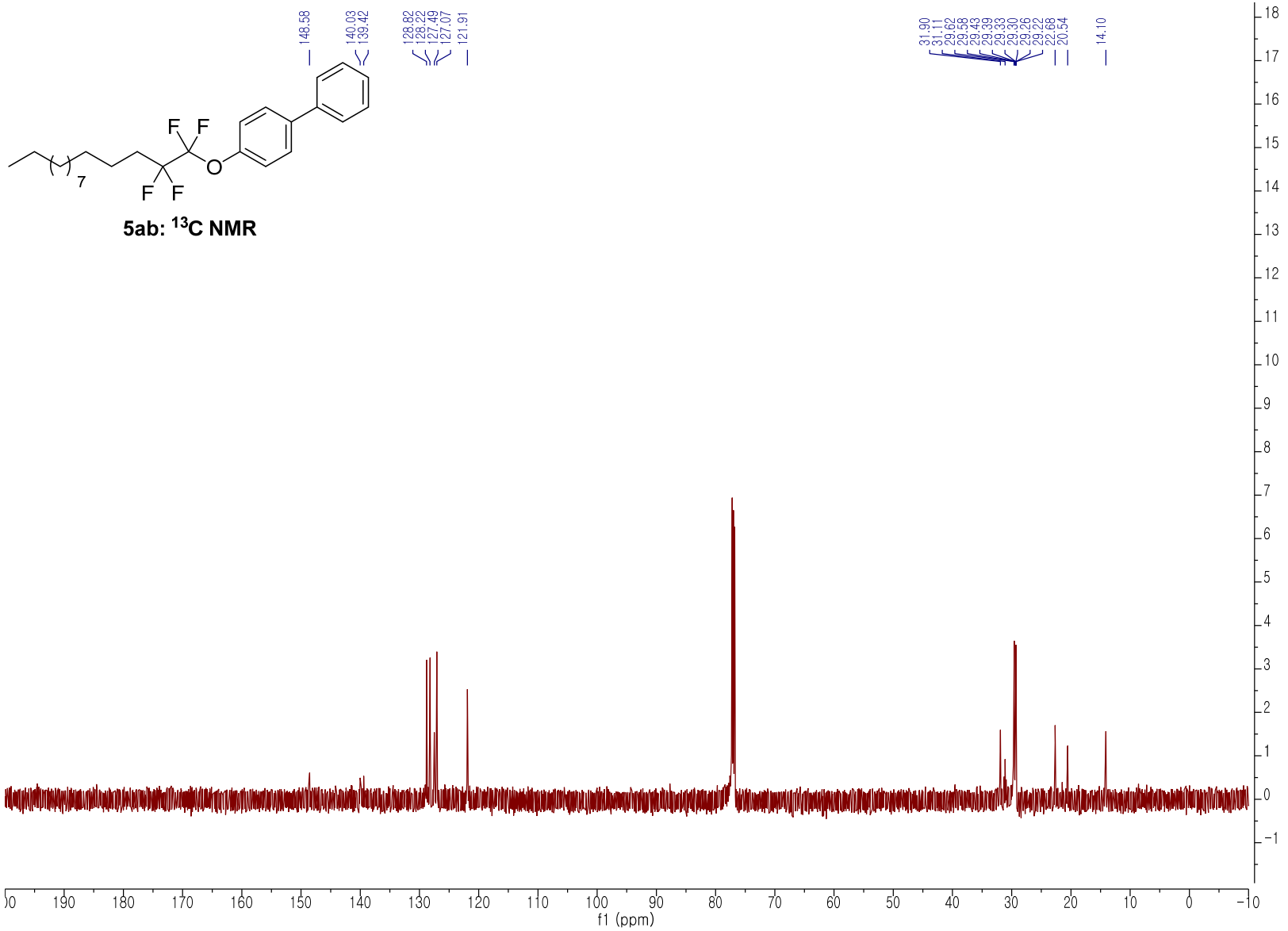

F F
O
F F
7
7.39
7.38
7.36
7.28
7.26
7.26
7.25
7.22
7.20
2.17
2.17
2.15
2.14
2.12
2.11
2.09
2.08
1.67
1.65
1.64
1.63
1.62
1.40
1.28
0.90
0.89
0.88
1.80
0.96
1.73
1.83
1.85
18.06
3.07
f1 (ppm)

5aa: ^{1}H NMR

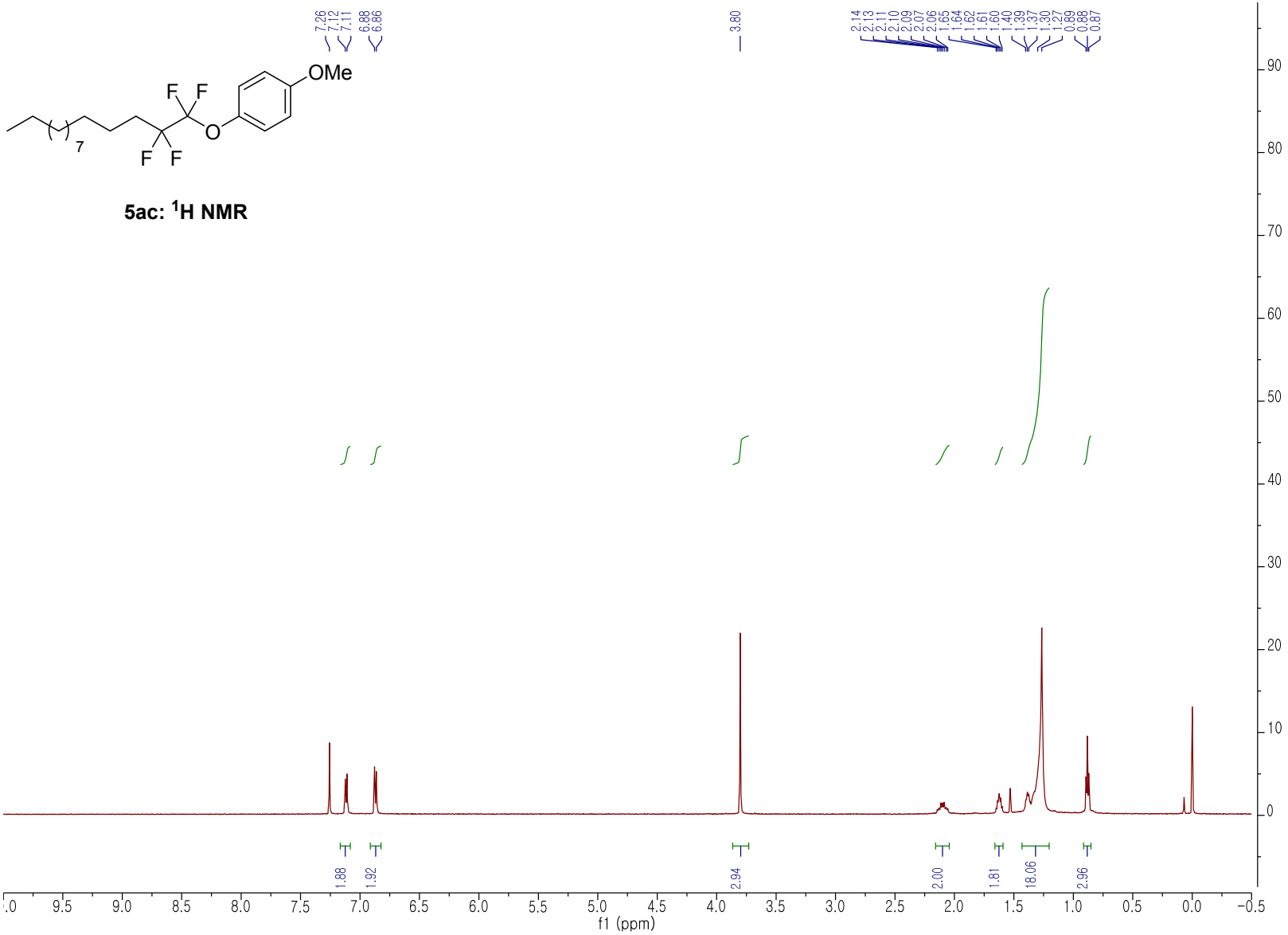

149.19
129.52
126.21
121.66
31.24
31.09
30.95
29.62
29.57
29.42
29.33
29.29
29.25
22.67
20.54
14.08
F F
O
F F
7
f1 (ppm)

5aa: ^{13}C NMR

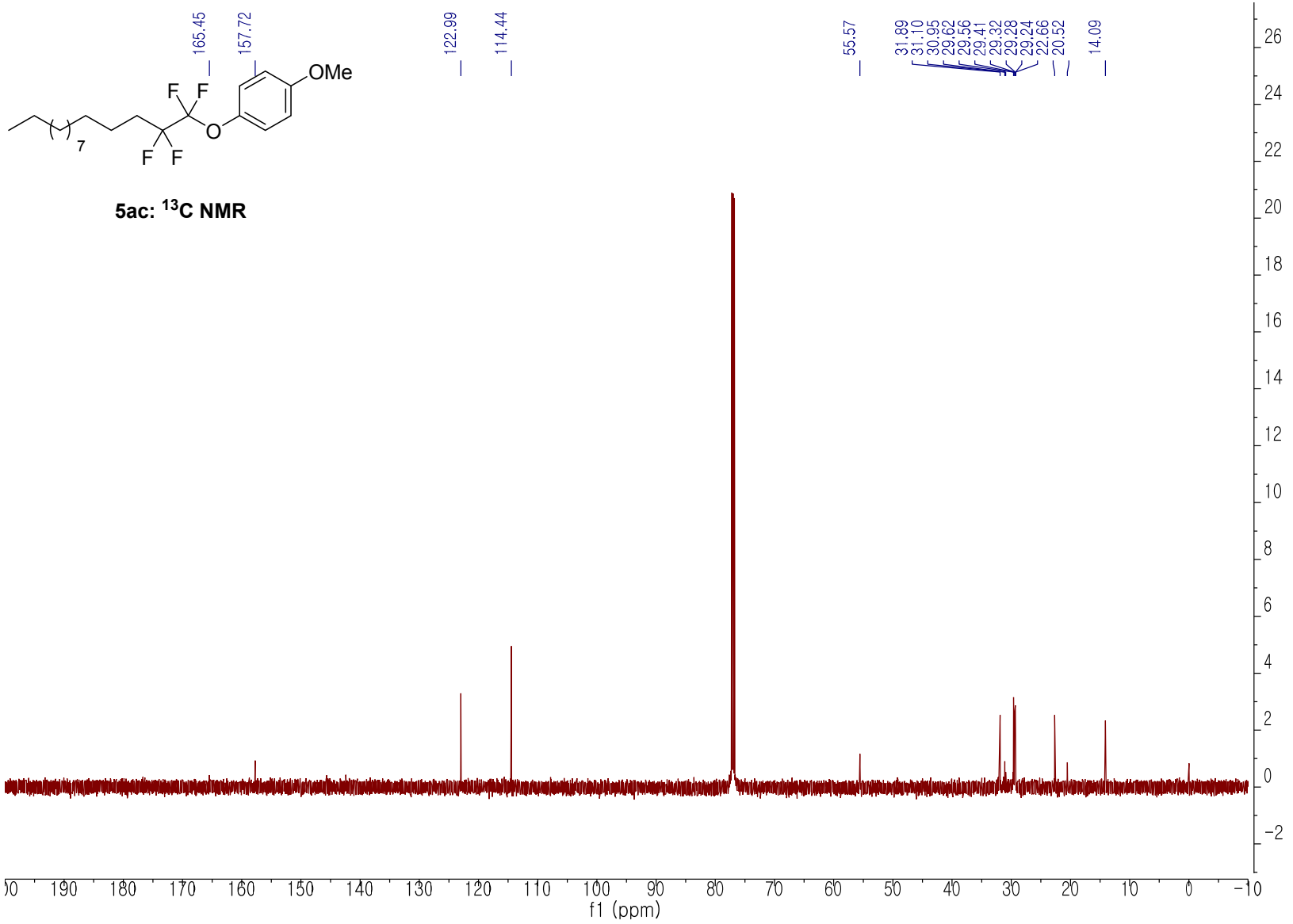

7.59
7.59
7.58
7.58
7.57
7.57
7.57
7.56
7.56
7.46
7.45
7.43
7.37
7.36
7.35
7.28
7.27
2.18
2.17
2.15
2.14
2.12
2.11
2.09
1.68
1.66
1.66
1.65
1.64
1.64
1.62
1.43
1.42
1.41
1.39
1.27
0.90
0.89
0.87
F F
O
F F
7
5ab: 1H NMR
4.01
2.00
1.00
2.02
2.08
2.03
18.01
3.00
f1 (ppm)


148.58
140.03
139.42
128.82
128.22
127.49
127.07
121.91
31.90
31.11
29.62
29.58
29.43
29.39
29.33
29.30
29.26
29.22
22.68
20.54
14.10
F F
O
F F
7
f1 (ppm)

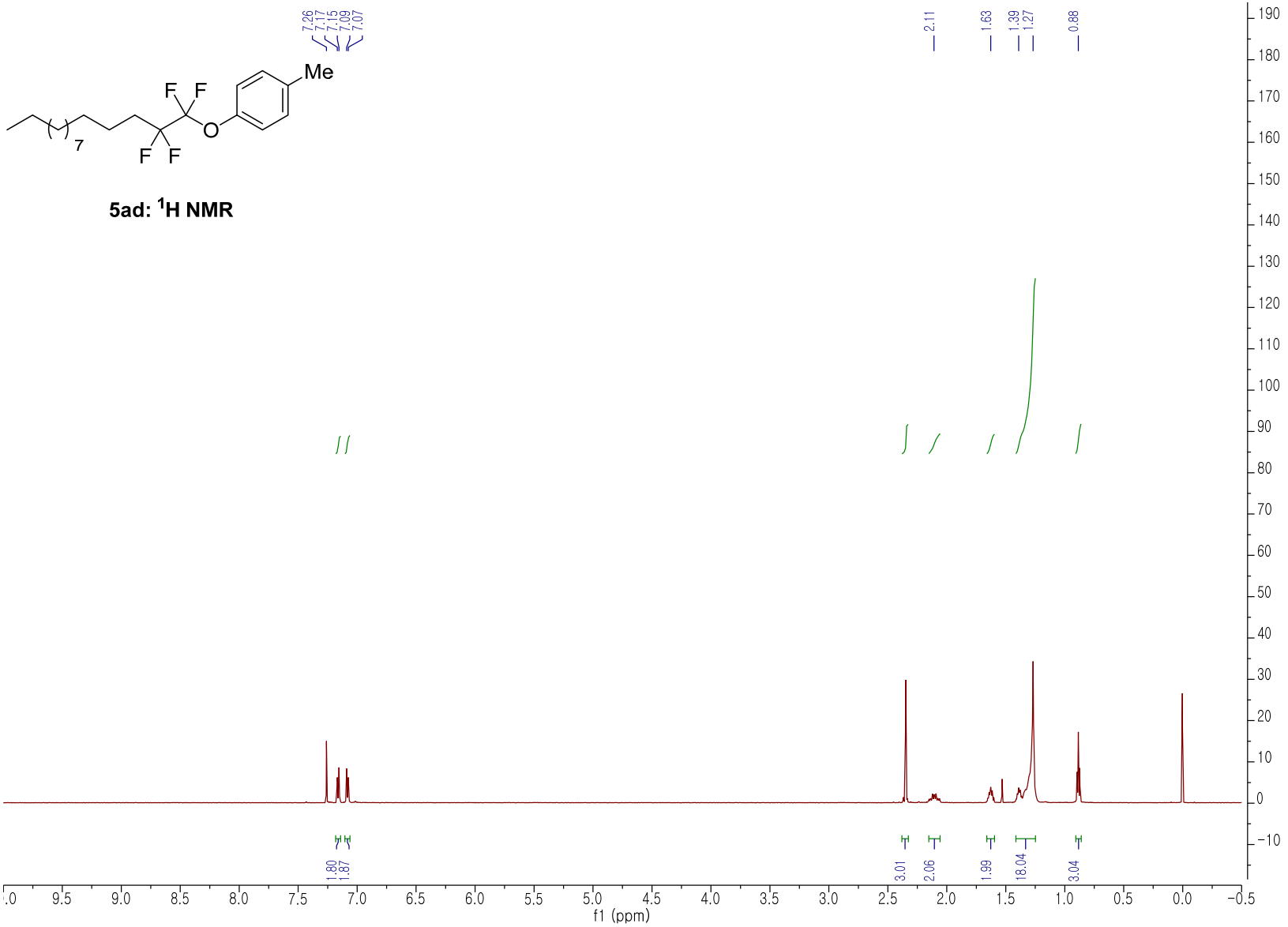
5ab: ^{13}C NMR


7.26
7.12
7.11
6.88
6.86
3.80
2.14
2.13
2.11
2.10
2.09
2.07
2.06
1.65
1.64
1.62
1.61
1.60
1.40
1.39
1.37
1.30
1.27
0.89
0.88
0.87
OMe
F F
O
F F
7
1.88
1.92
2.94
2.00
1.81
18.06
2.96
f1 (ppm)

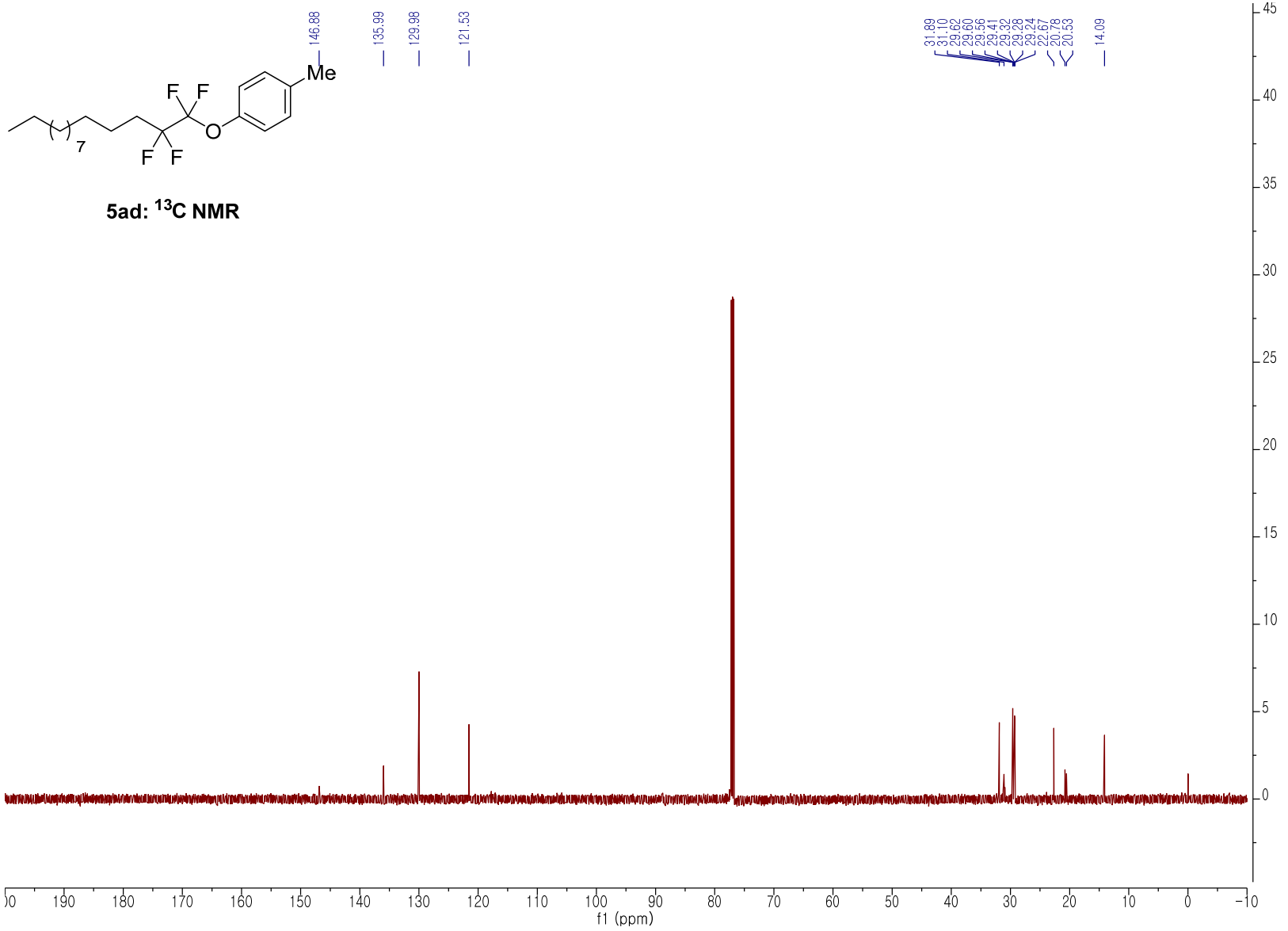
5ac: ^{1}H NMR


165.45
157.72
122.99
114.44
55.57
31.89
31.10
30.95
29.62
29.56
29.41
29.32
29.28
29.24
22.66
20.52
14.09
OMe
F F
O
F F
7
f1 (ppm)

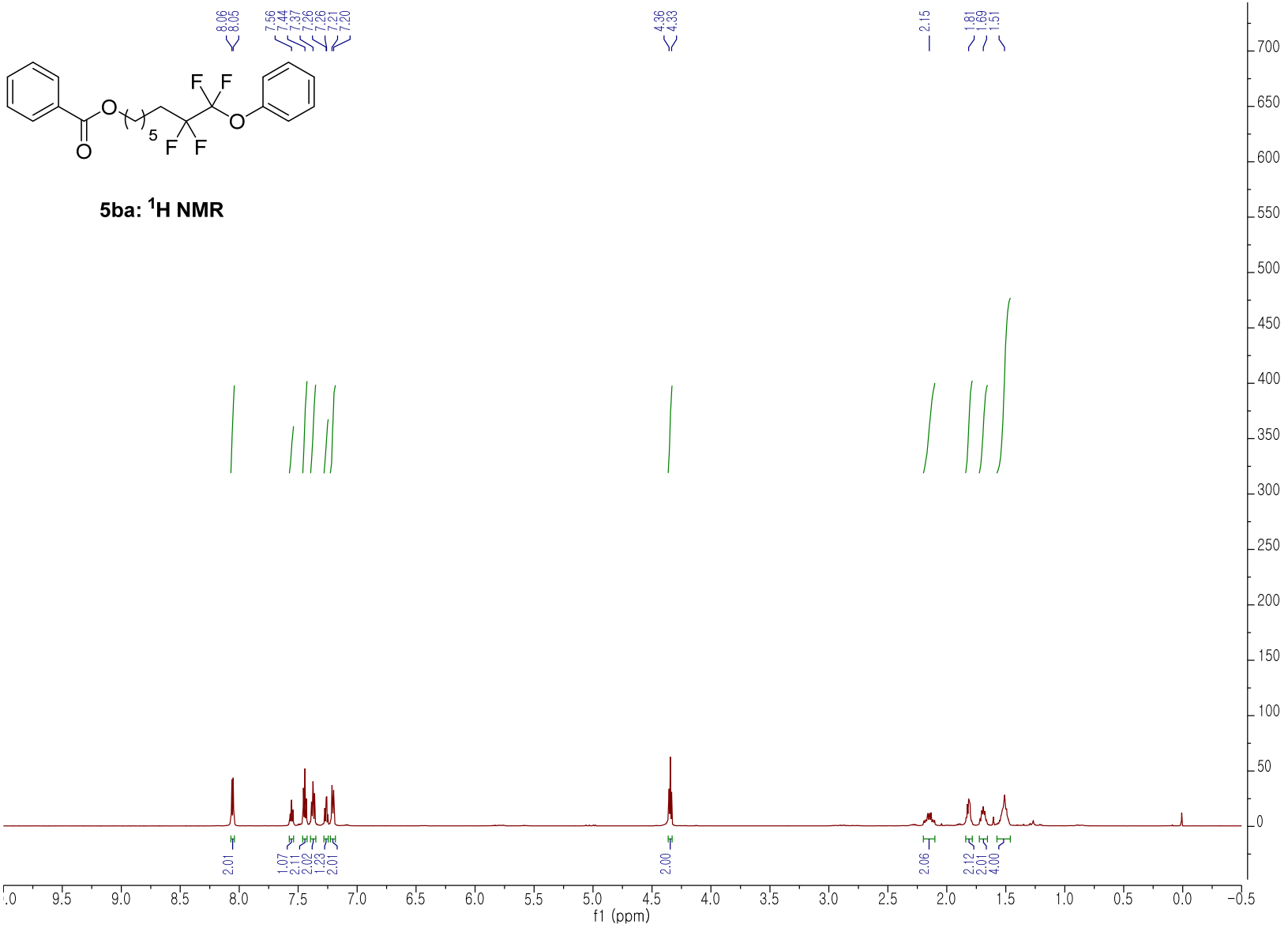
5ac: ^{13}C NMR


7.26
7.17
7.15
7.09
7.07
2.11
1.63
1.39
1.27
0.88
Me
F F
O
F F
7
1.80
1.87
3.01
2.06
1.99
18.04
3.04
f1 (ppm)

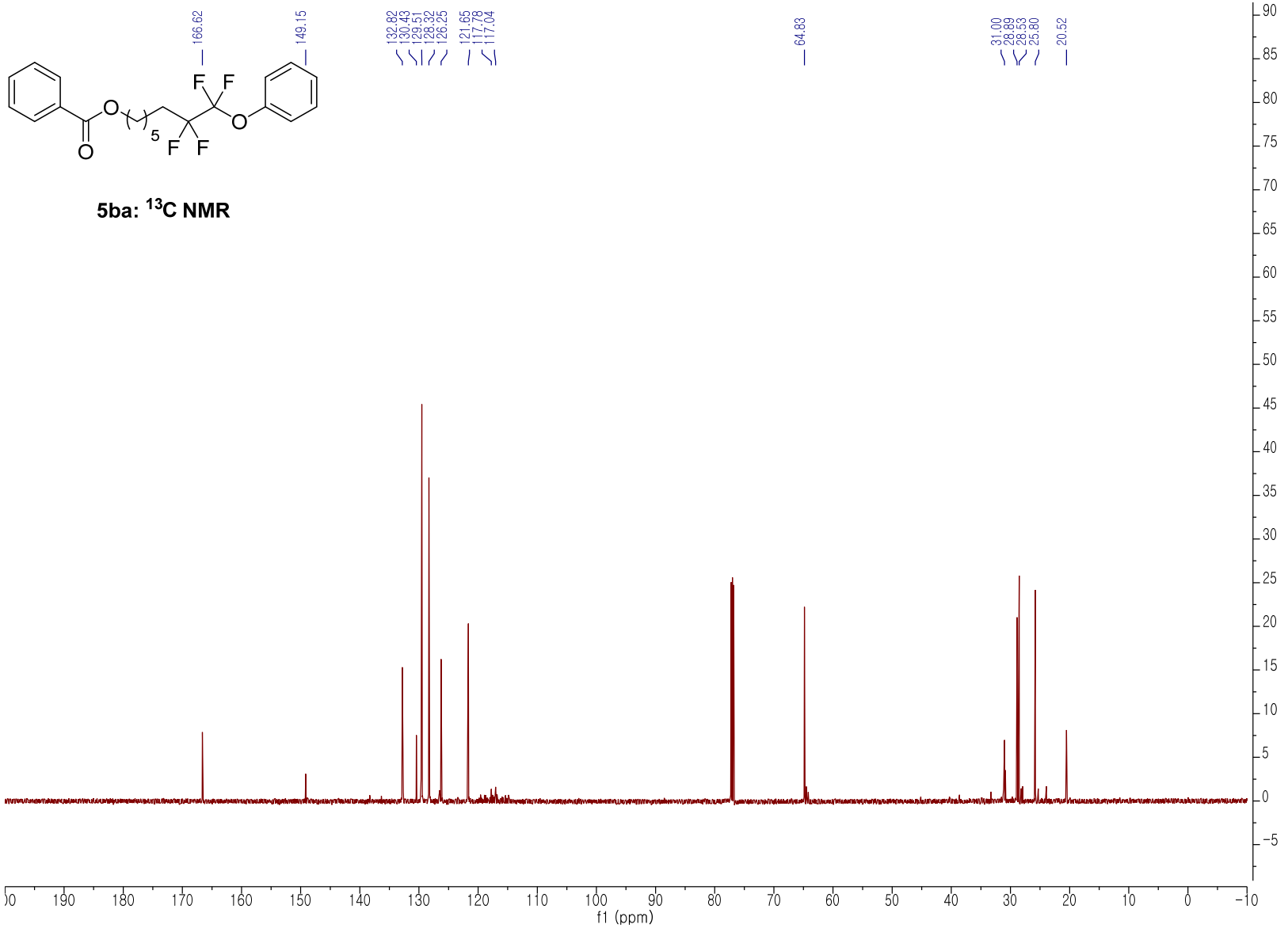
5ad: ^{1}H NMR


146.88
135.99
129.98
121.53
31.89
31.10
29.62
29.60
29.56
29.41
29.32
29.28
29.24
22.67
20.78
20.53
14.09
Me
F F
O
F F
7
f1 (ppm)

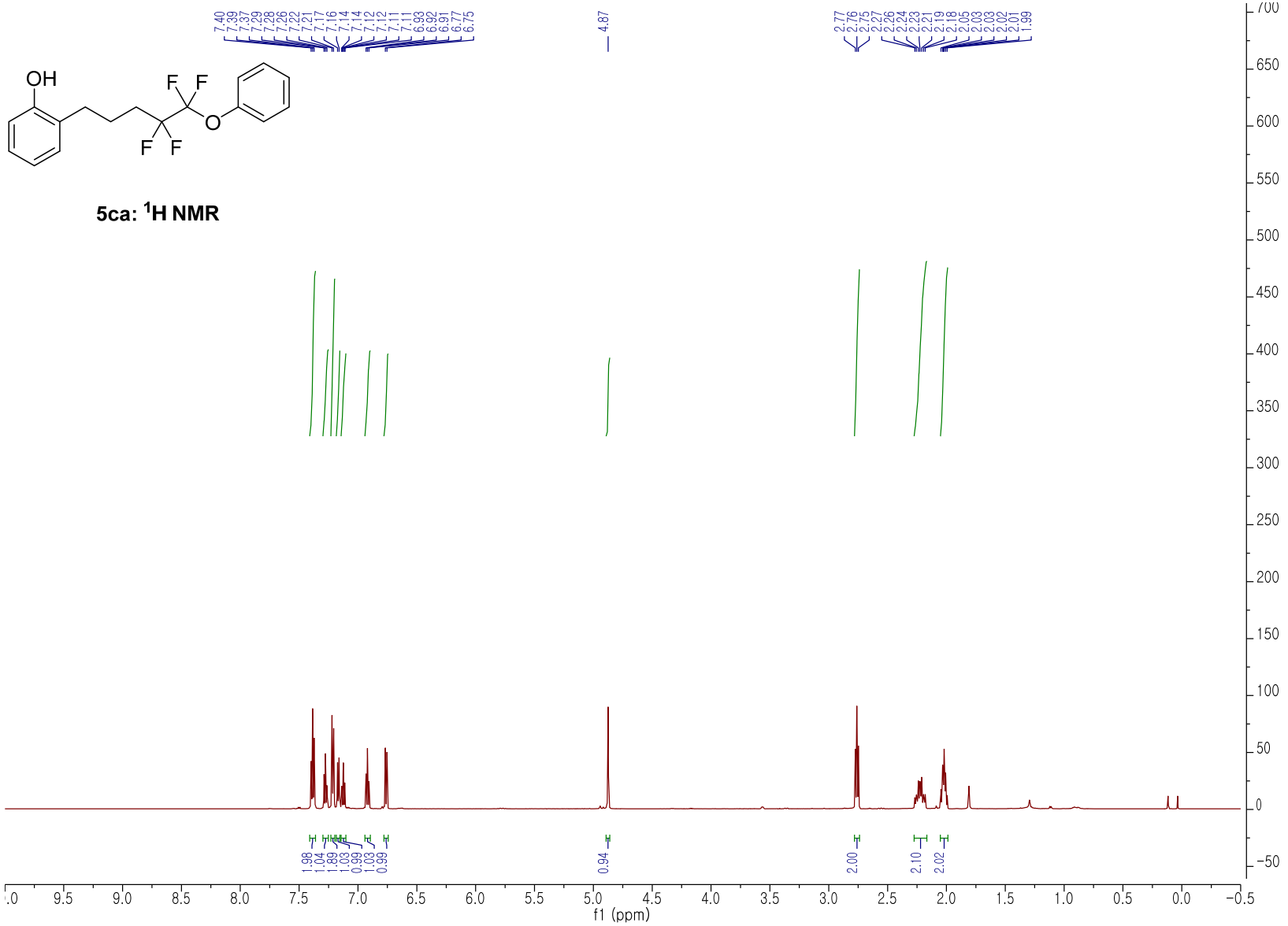
5ad: ^{13}C NMR

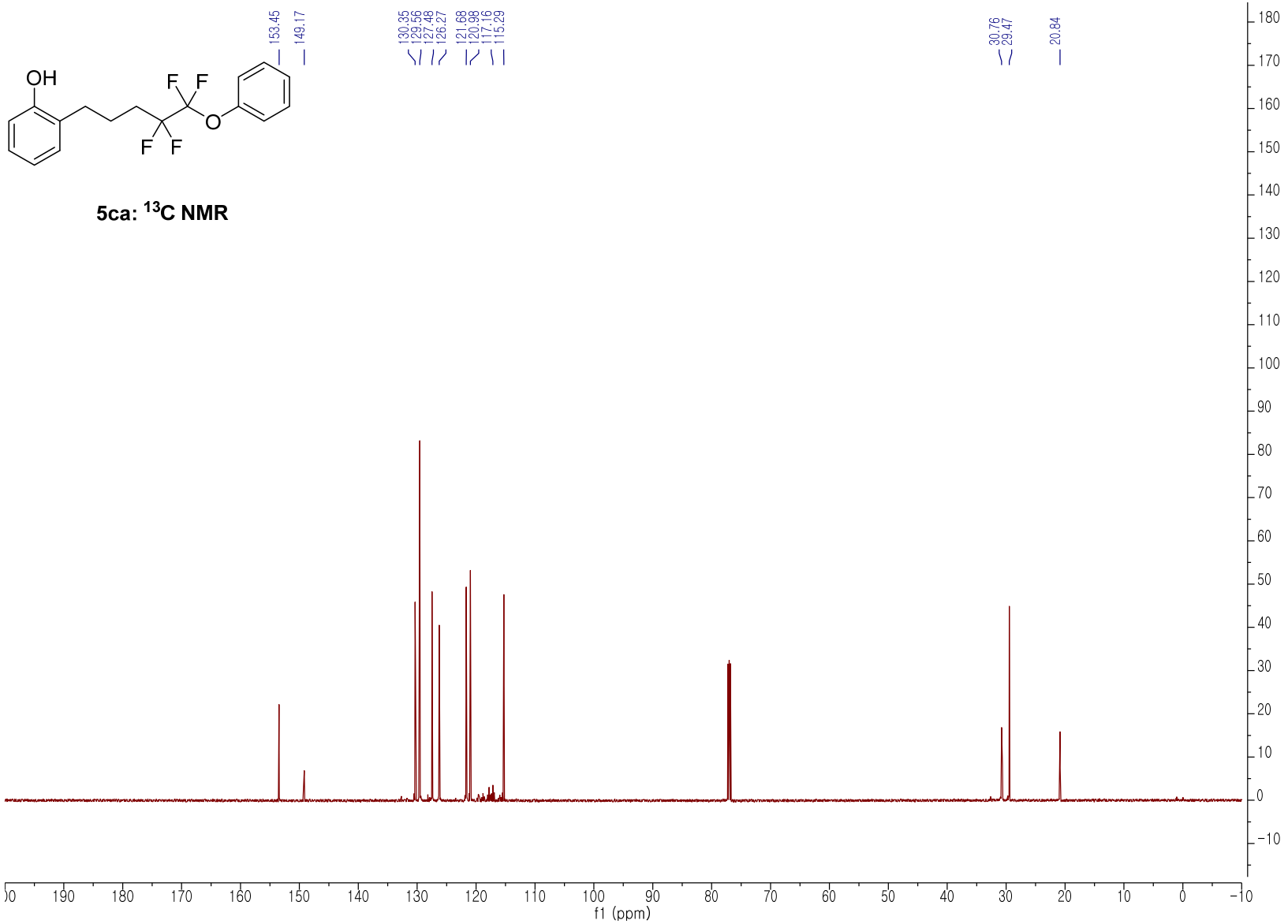

8.06
8.05
7.56
7.44
7.37
7.26
7.26
7.21
7.20
4.36
4.33
2.15
1.81
1.69
1.51
F F
O
O
5
F F
O
2.01
1.07
2.11
2.02
1.23
2.01
2.00
2.06
2.12
2.01
4.00
f1 (ppm)

5ba: ^{1}H NMR

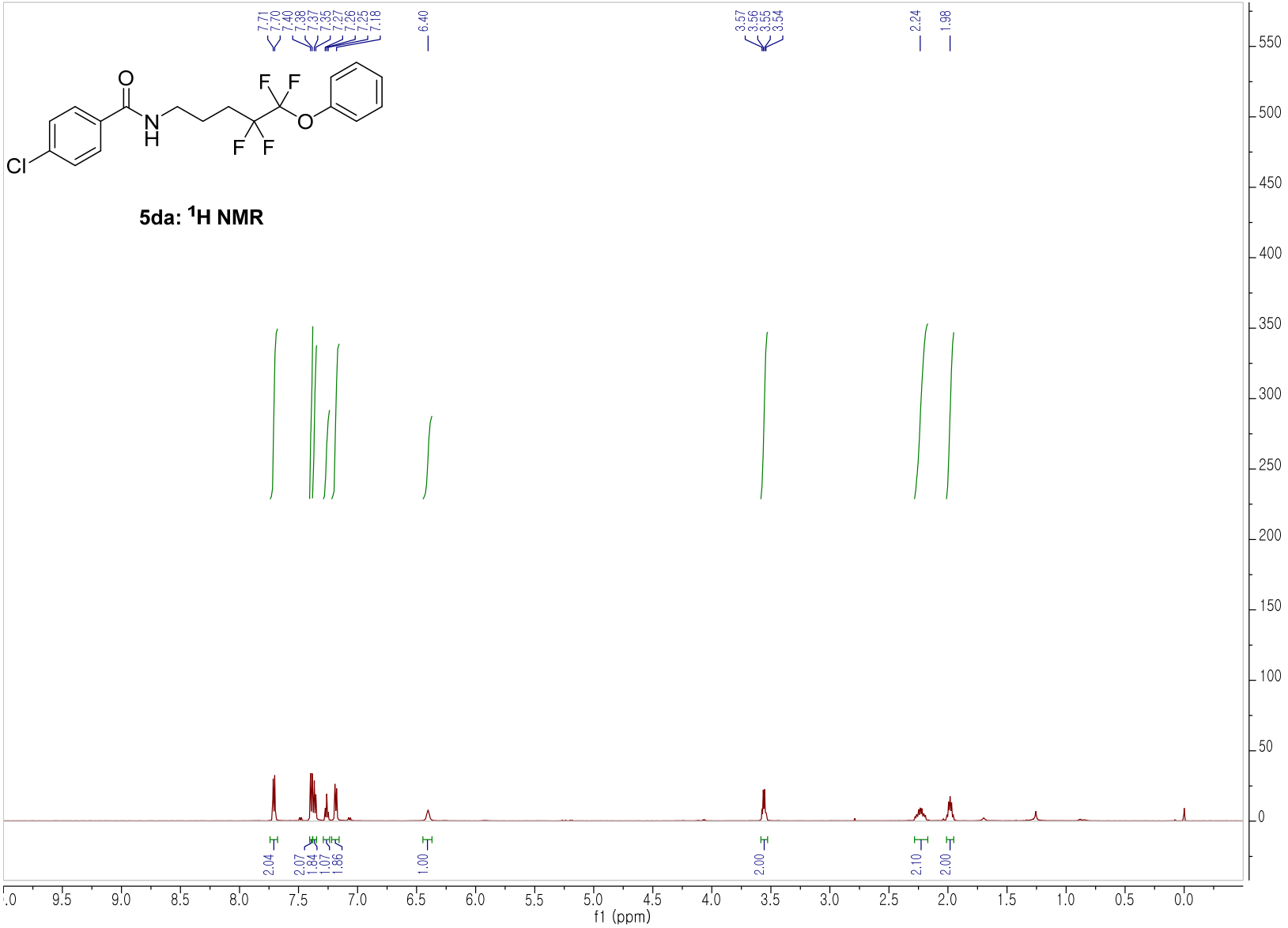

166.62
149.15
132.82
130.43
129.51
128.32
126.25
121.65
117.78
117.04
64.83
31.00
28.89
28.53
25.80
20.52
f1 (ppm)

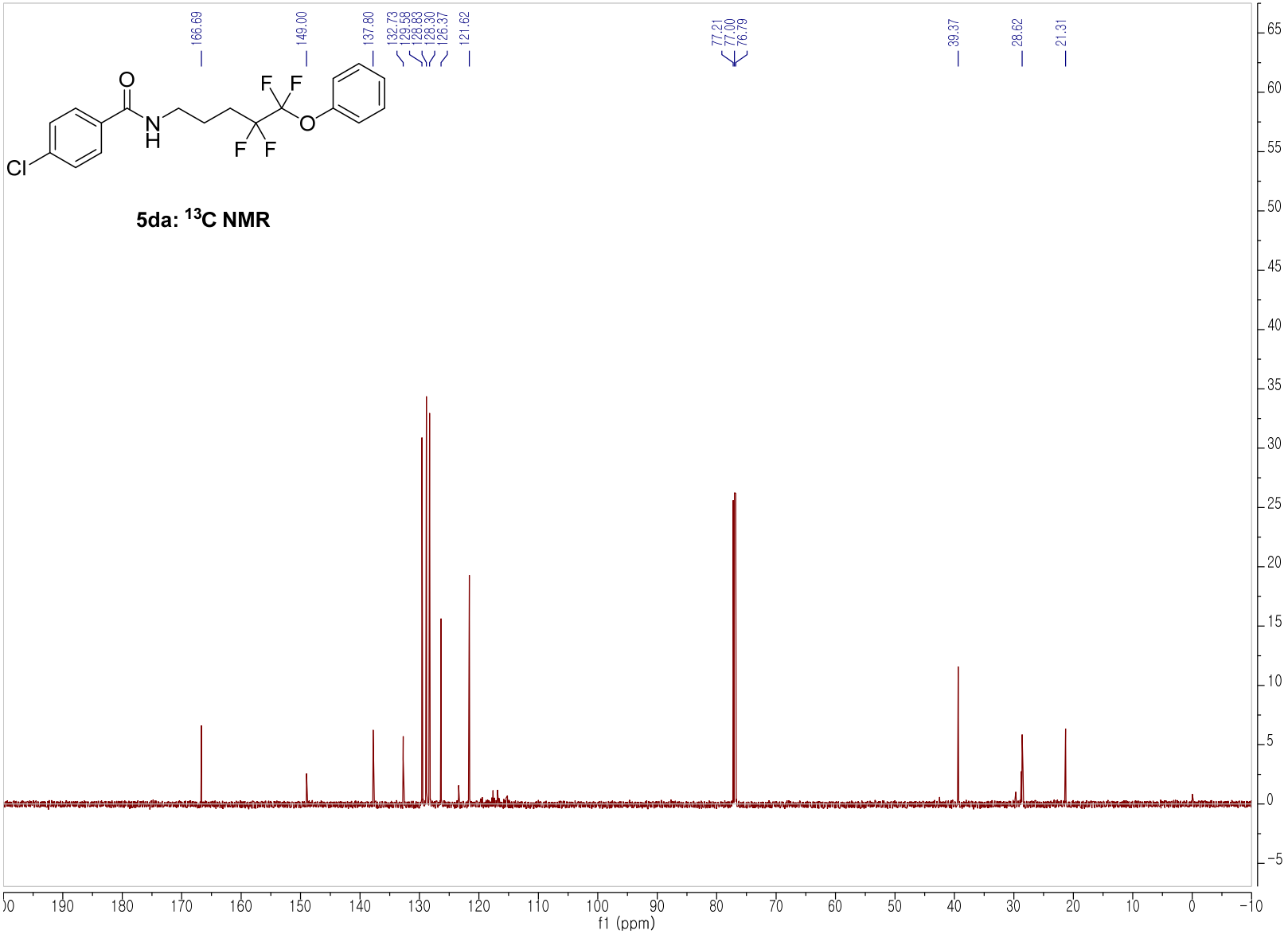
5ba: ^{13}C NMR

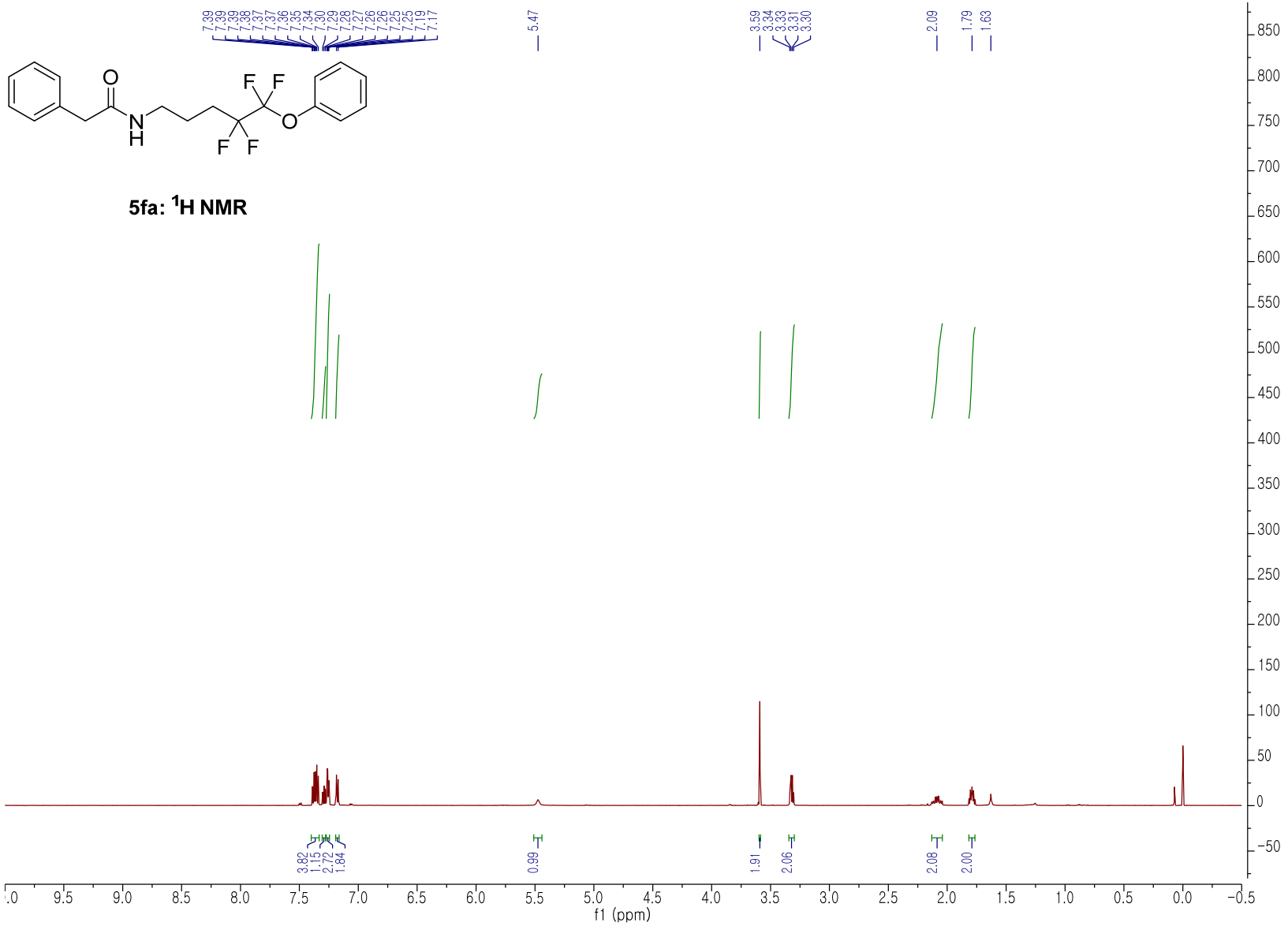

OH
F F
F F
O
5ca: 1H NMR
7.40
7.39
7.37
7.29
7.28
7.26
7.22
7.21
7.17
7.16
7.14
7.14
7.12
7.12
7.11
6.93
6.92
6.91
6.77
6.75
4.87
2.77
2.76
2.75
2.27
2.26
2.24
2.23
2.21
2.19
2.18
2.05
2.03
2.03
2.02
2.01
1.99
1.98
1.04
1.89
1.03
0.99
1.03
0.99
0.94
2.00
2.10
2.02
f1 (ppm)

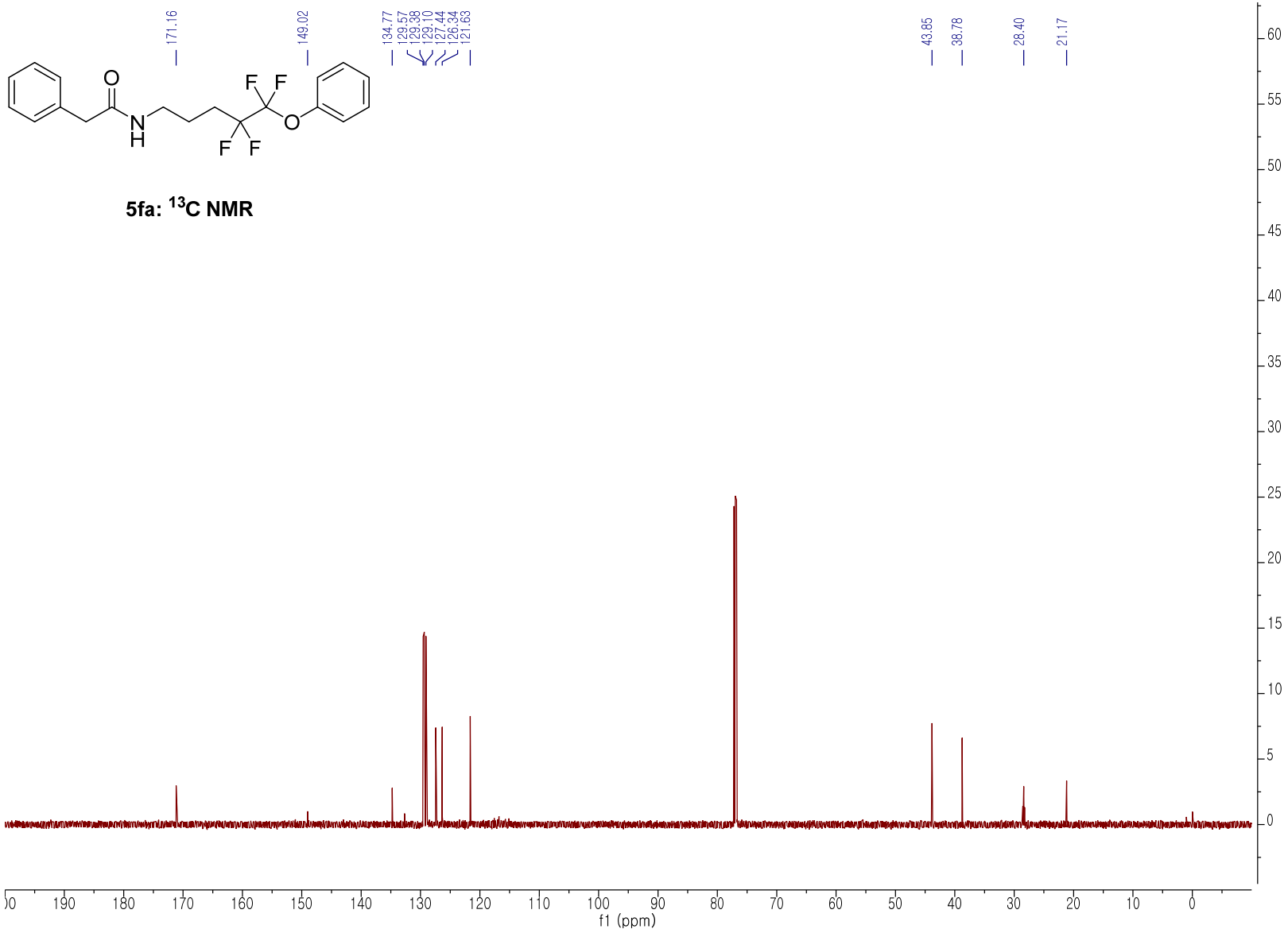

OH
F F
F F
O
153.45
149.17
130.35
129.56
127.48
126.27
121.68
120.98
117.16
115.29
30.76
29.47
20.84
f1 (ppm)

5ca: ^{13}C NMR

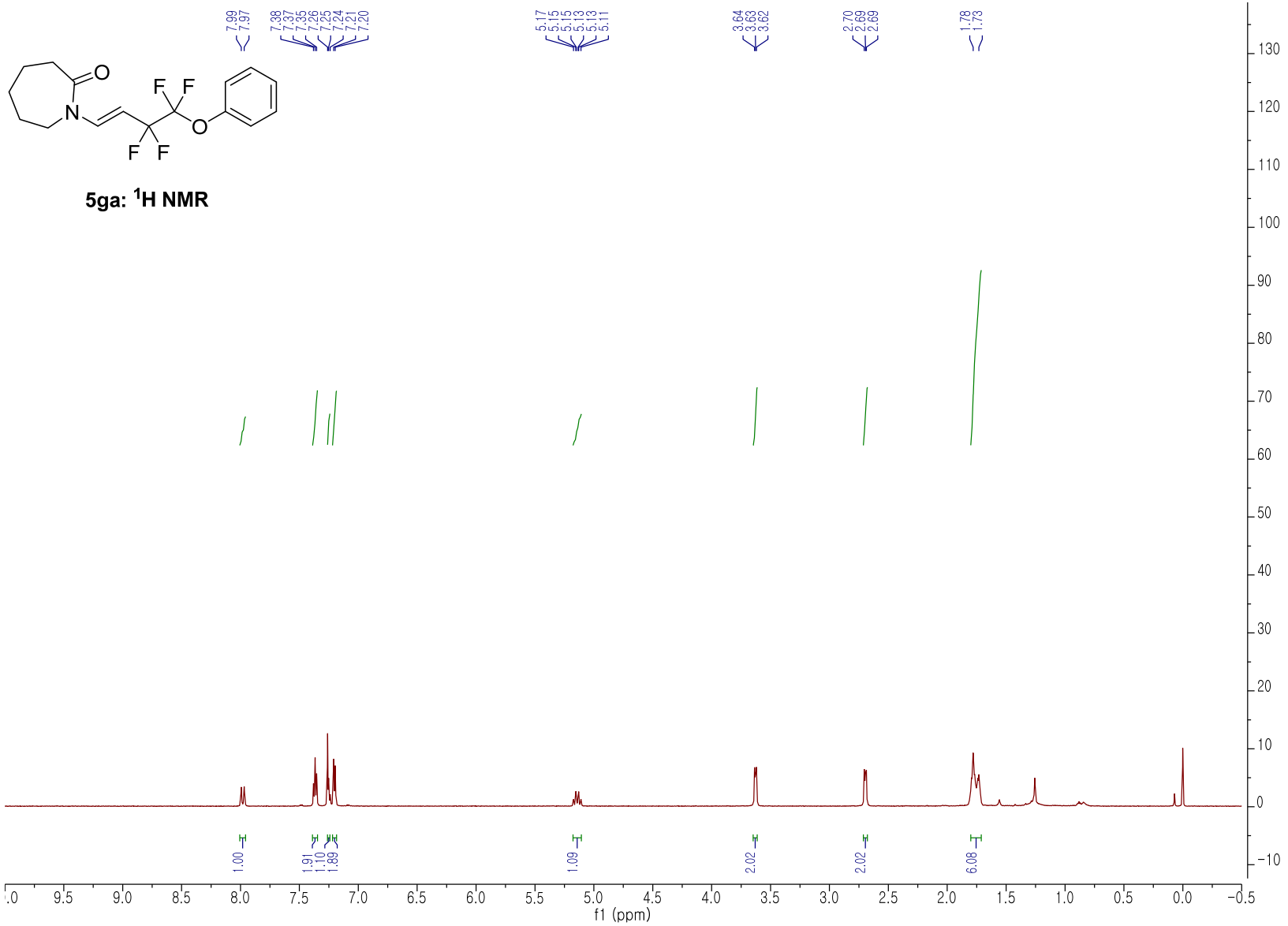

7.71
7.70
7.40
7.38
7.37
7.35
7.27
7.26
7.25
7.18
6.40
3.57
3.56
3.55
3.54
2.24
1.98
O
N
H
F F
F F
O
Cl
5da: 1H NMR
2.04
2.07
1.84
1.07
1.86
1.00
2.00
2.10
2.00
f1 (ppm)


166.69
149.00
137.80
132.73
129.58
128.83
128.30
126.37
121.62
77.21
77.00
76.79
39.37
28.62
21.31
O
N
H
F
F
F
F
O
Cl
5da: 13C NMR
f1 (ppm)

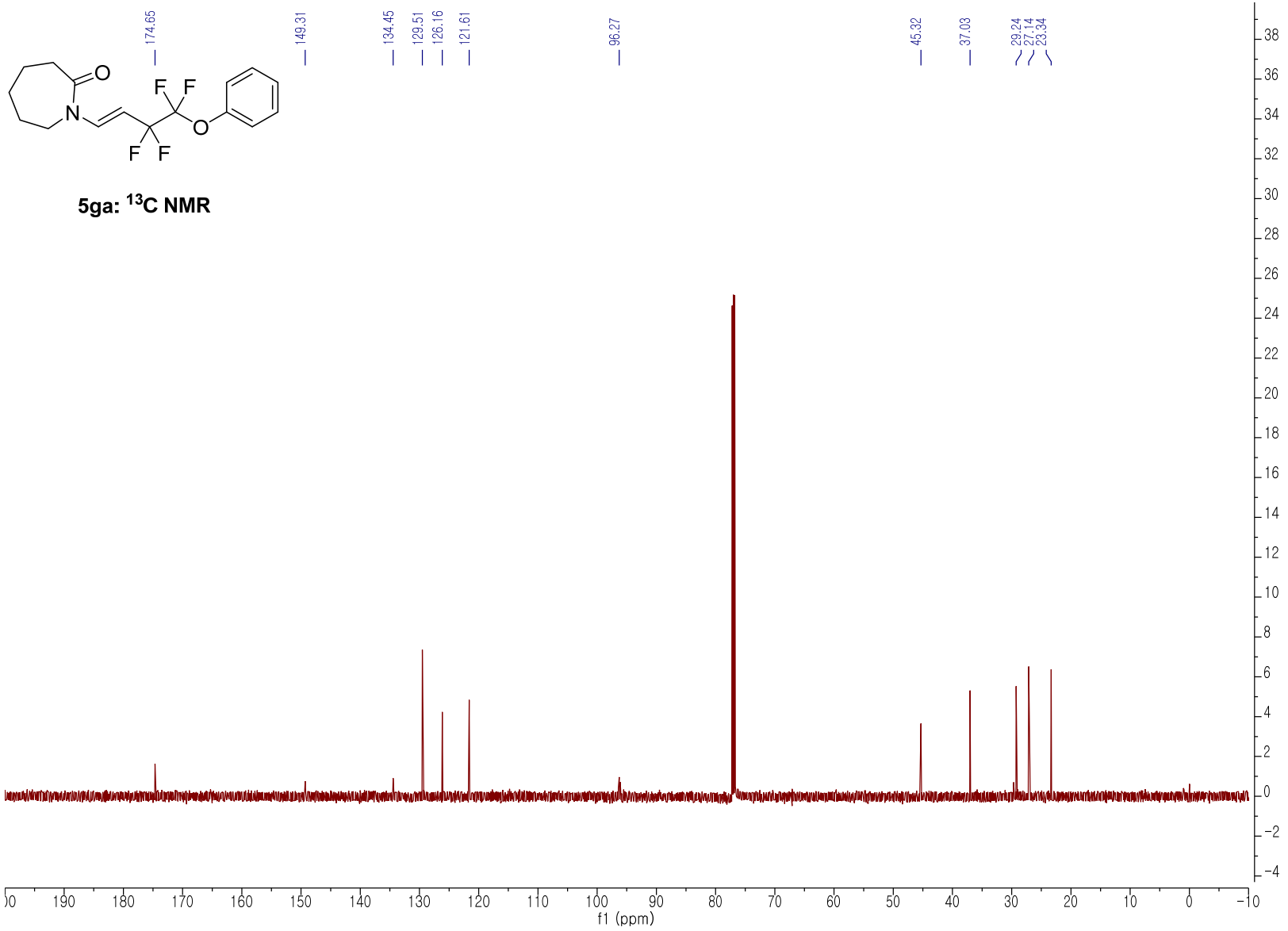

7.39
7.39
7.39
7.38
7.38
7.37
7.37
7.36
7.35
7.34
7.30
7.29
7.28
7.27
7.26
7.26
7.25
7.25
7.19
7.17
5.47
3.59
3.34
3.33
3.31
3.30
2.09
1.79
1.63
O
N
H
F F
F F
O
5fa: 1H NMR
3.82
1.15
2.72
1.84
0.99
1.91
2.06
2.08
2.00
f1 (ppm)


171.16
149.02
134.77
129.57
129.38
129.10
127.44
126.34
121.63
43.85
38.78
28.40
21.17
O
N
H
F
F
F
F
O
f1 (ppm)

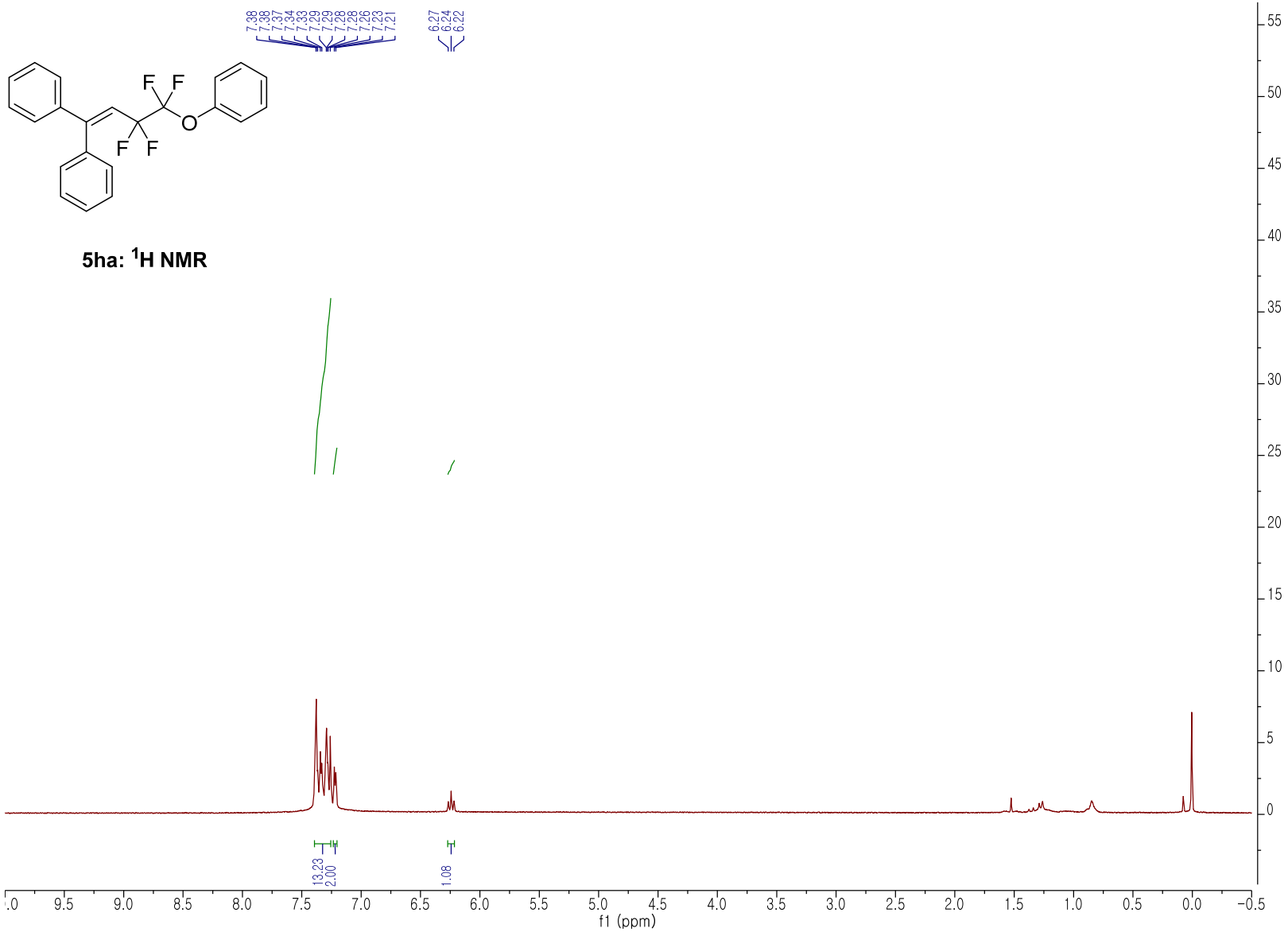
5fa: ^{13}C NMR

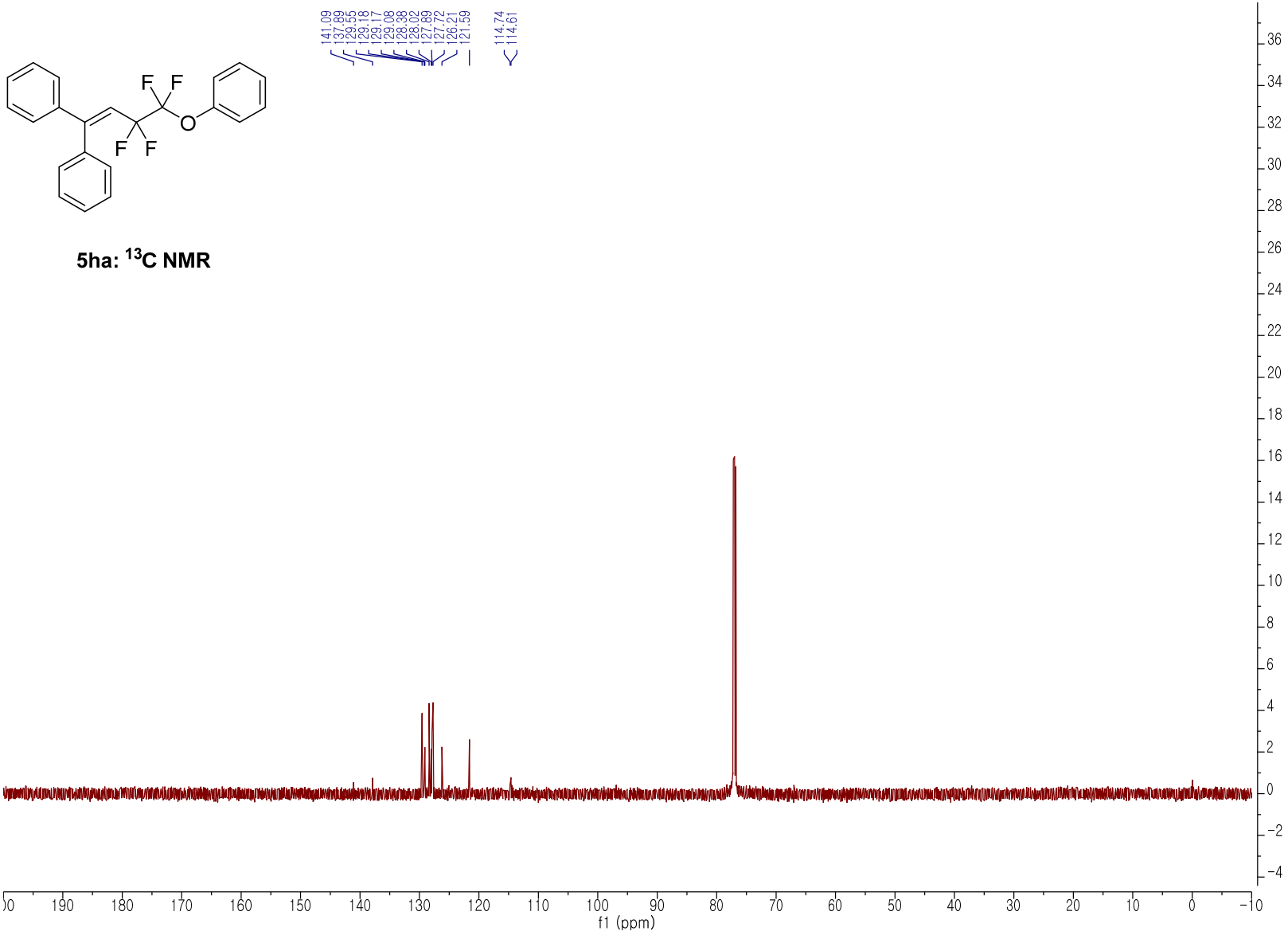

7.99
7.97
7.38
7.37
7.35
7.26
7.25
7.24
7.21
7.20
5.17
5.15
5.15
5.13
5.13
5.11
3.64
3.63
3.62
2.70
2.69
2.69
1.78
1.73
O
N
F F
O
F F
1.00
1.91
1.10
1.89
1.09
2.02
2.02
6.08
f1 (ppm)

5ga: ^{1}H NMR

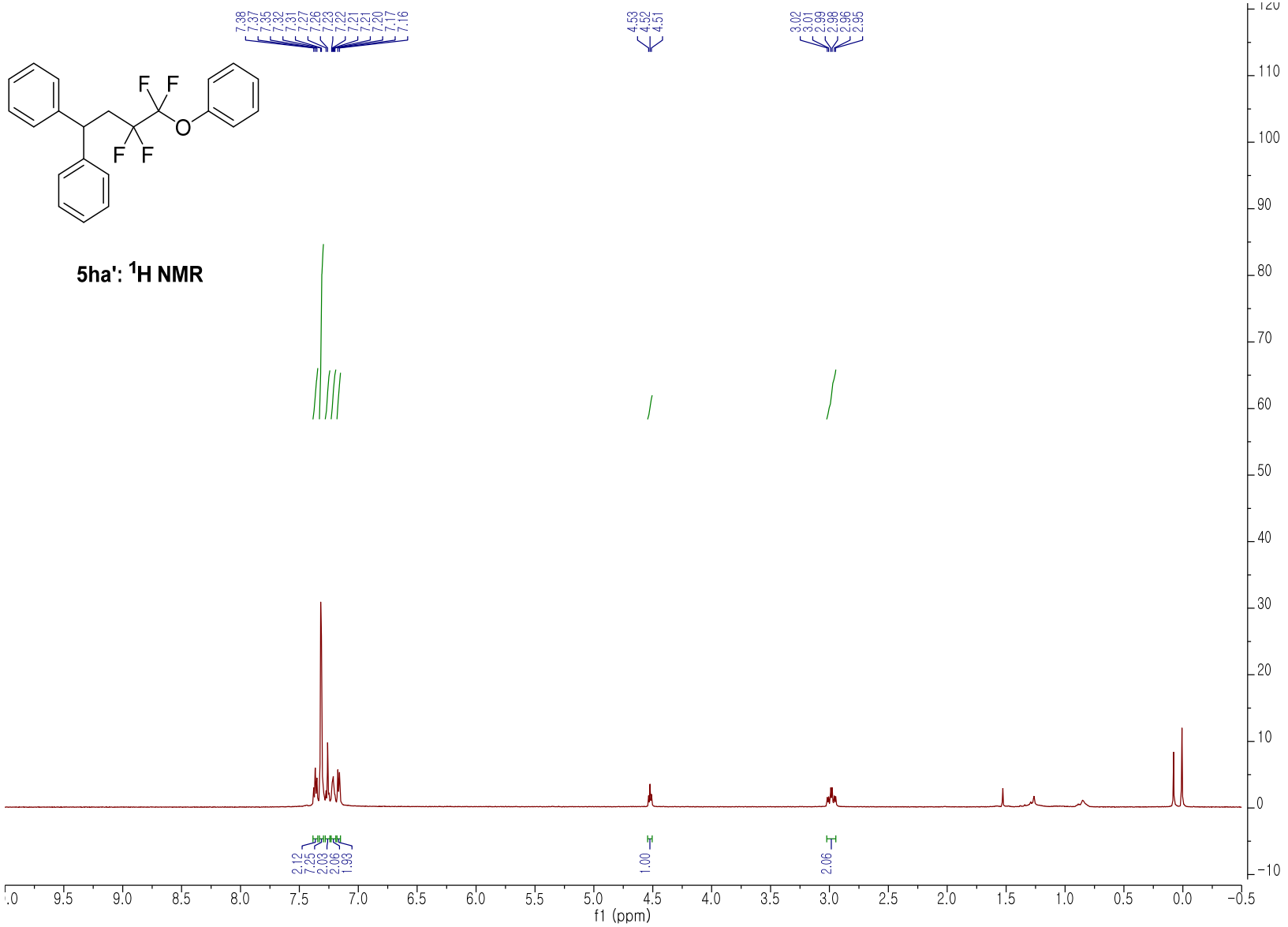

174.65
149.31
134.45
129.51
126.16
121.61
96.27
45.32
37.03
29.24
27.14
23.34
O
N
F F
O
F F
f1 (ppm)

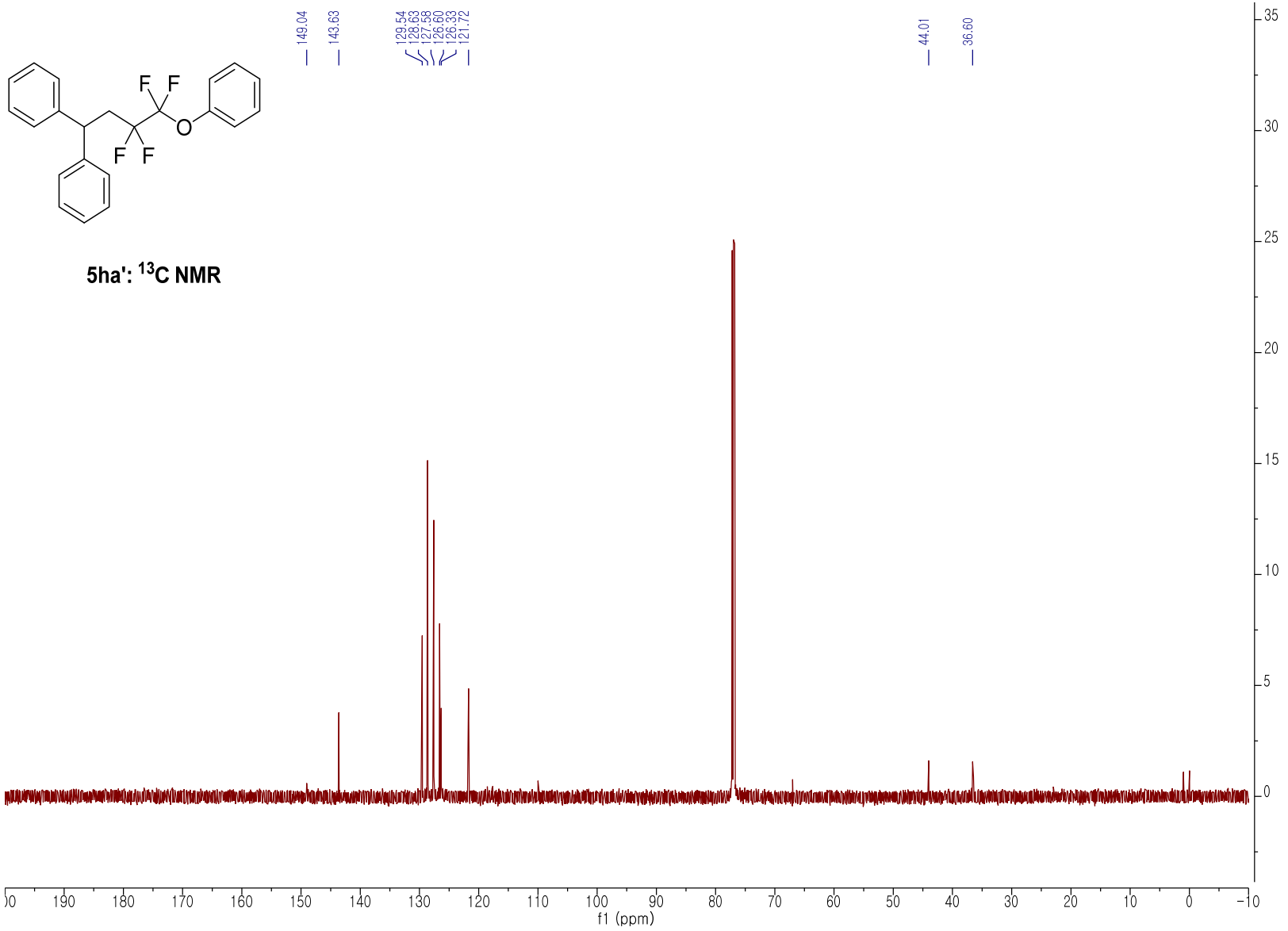
5ga: ^{13}C NMR

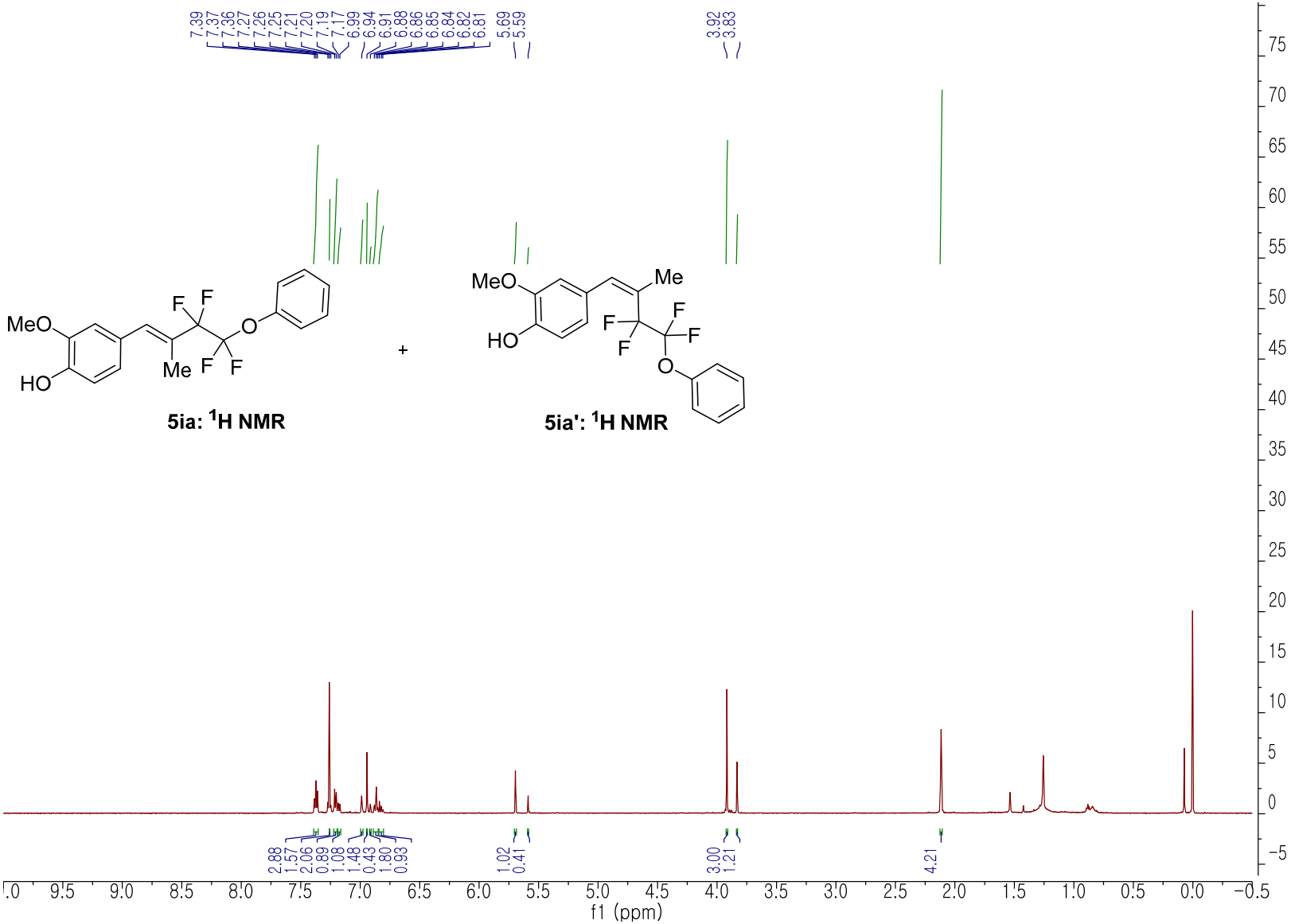

7.38
7.38
7.37
7.34
7.33
7.29
7.29
7.28
7.28
7.26
7.23
7.21
6.27
6.24
6.22
F F
O
F F
5ha: 1H NMR
13.23
2.00
1.08
f1 (ppm)


141.09
137.89
129.55
129.18
129.17
129.08
128.38
128.02
127.89
127.72
126.21
121.59
114.74
114.61
F
F
F
F
O
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

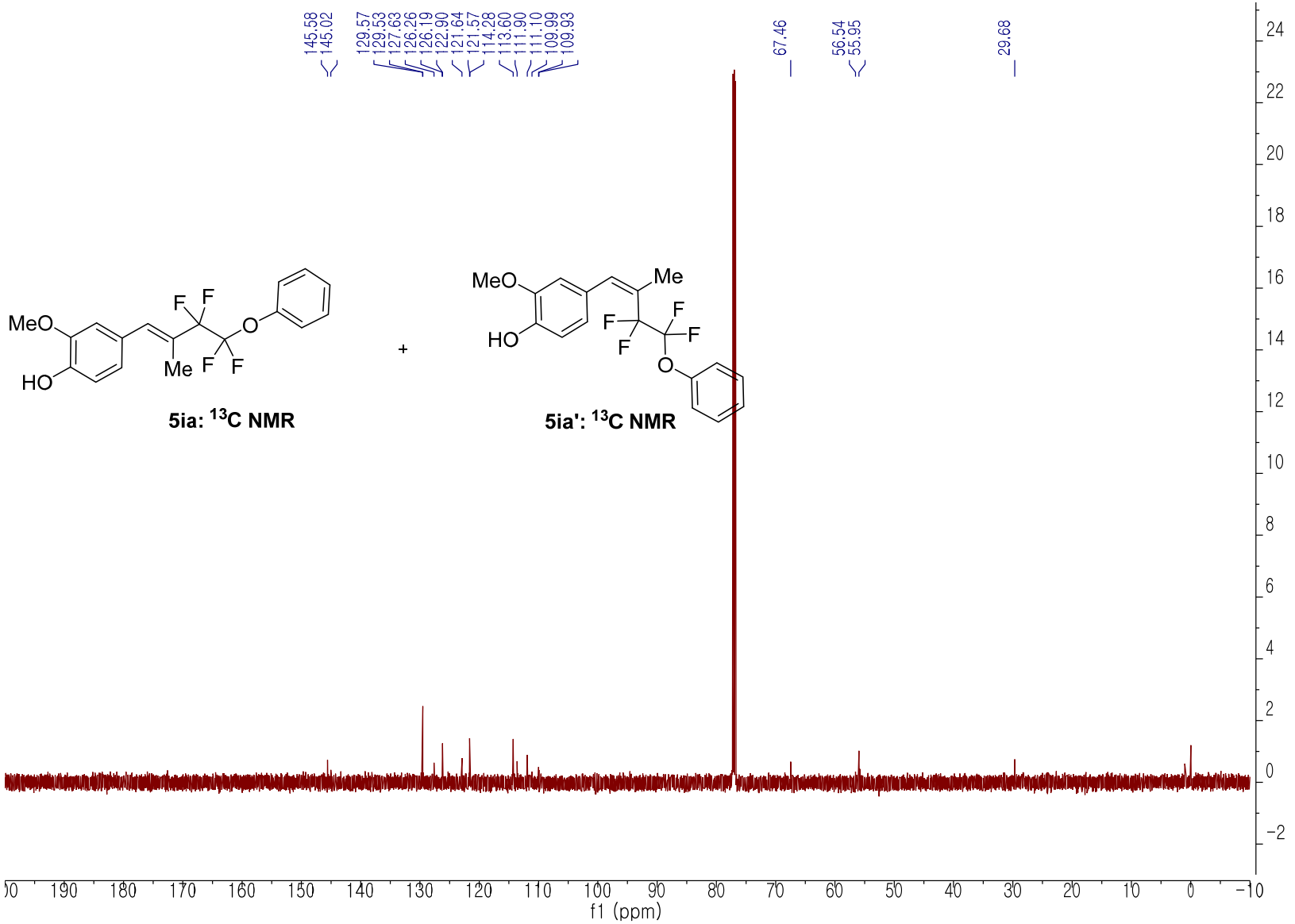
5ha: ^{13}C NMR

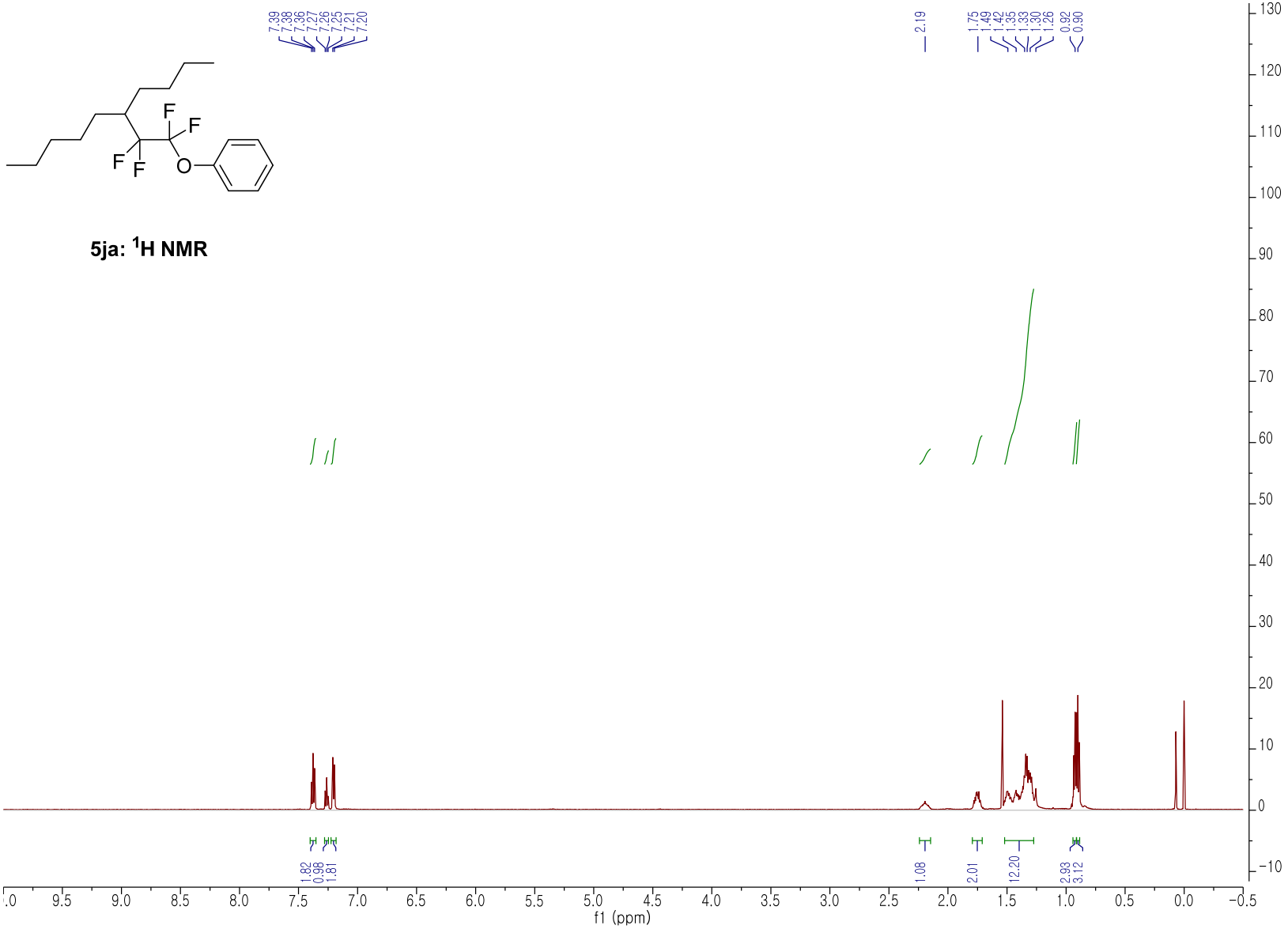

7.38
7.37
7.35
7.32
7.31
7.27
7.26
7.23
7.22
7.21
7.21
7.20
7.17
7.16
4.53
4.52
4.51
3.02
3.01
2.99
2.98
2.96
2.95
F F
O
F F
5ha': 1H NMR
2.12
7.25
2.03
2.06
1.93
1.00
2.06
f1 (ppm)


F F
F F
O
149.04
143.63
129.54
128.63
127.58
126.60
126.33
121.72
44.01
36.60
5ha': 13C NMR
f1 (ppm)

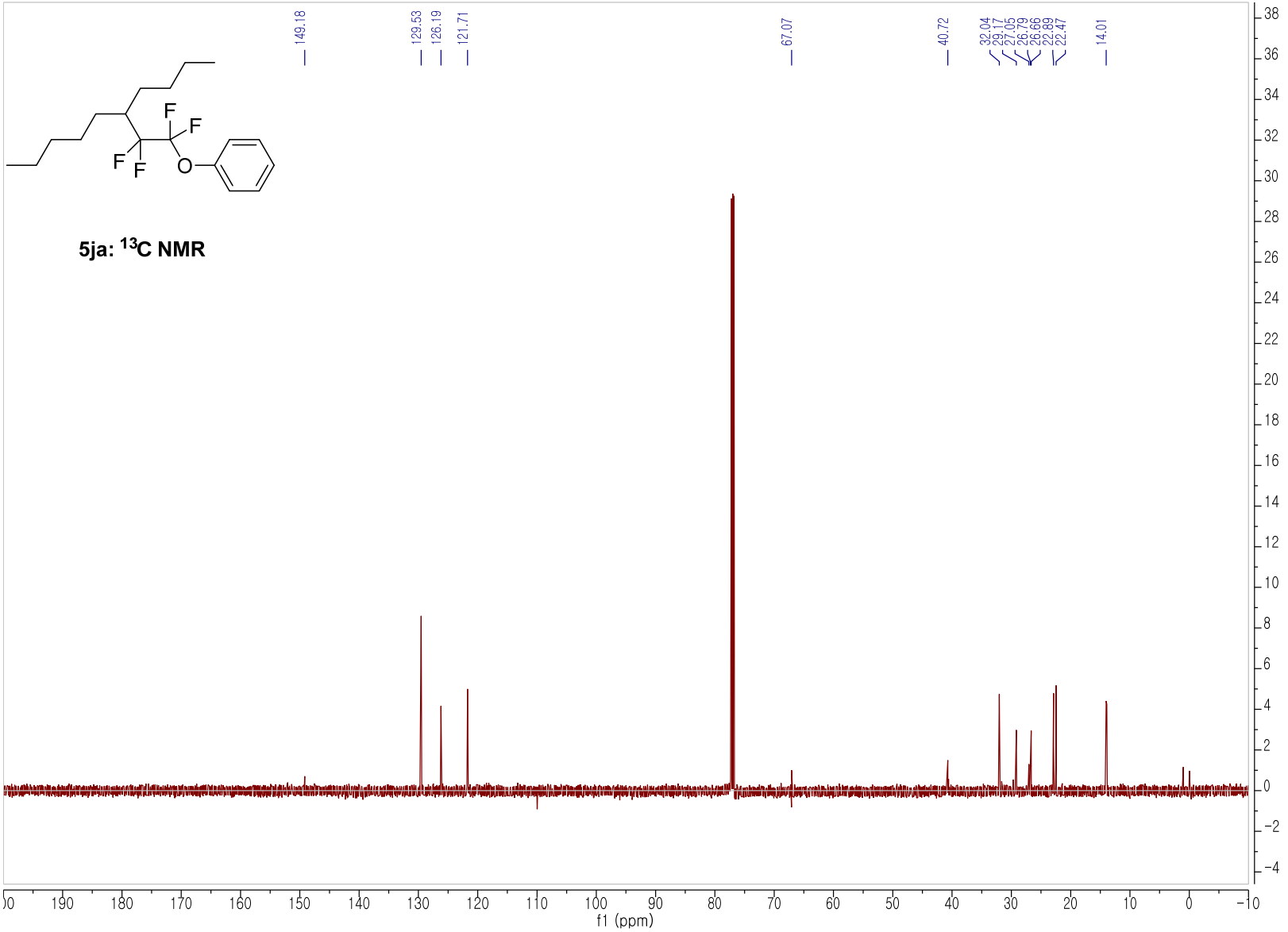


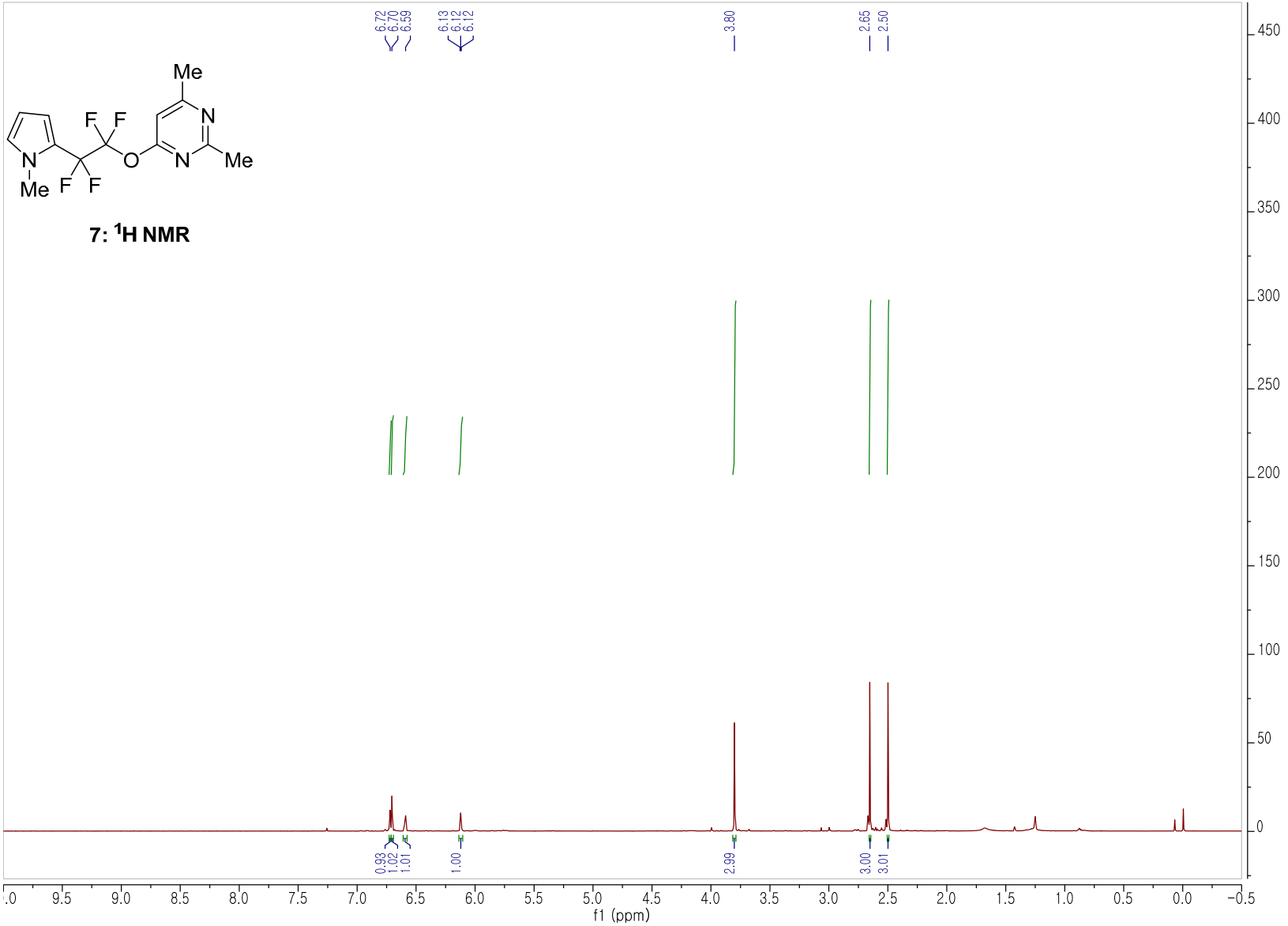
5ia: ^{1}H NMR + **5ia': ^{1}H NMR**

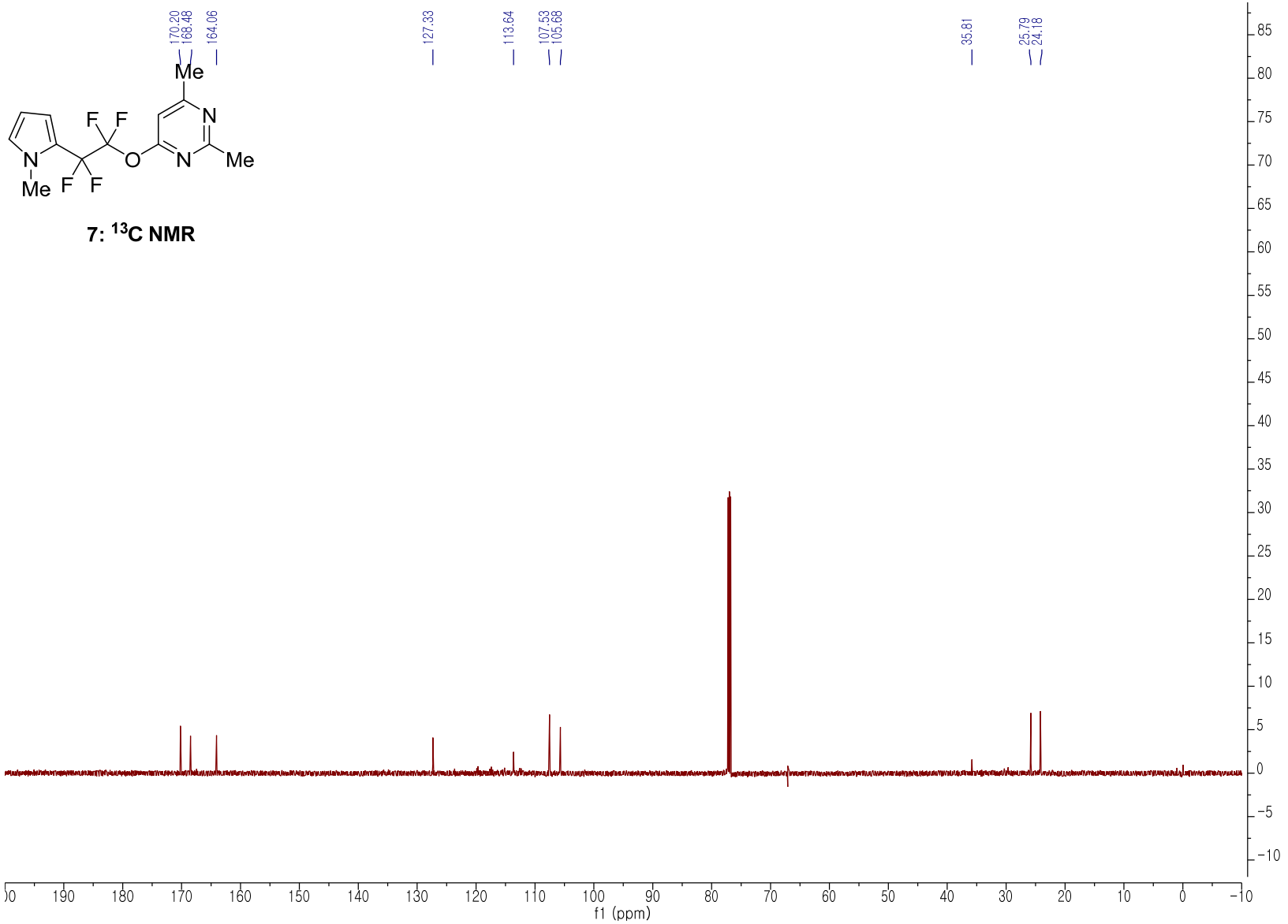

145.58
145.02
129.57
129.53
127.63
126.26
126.19
122.90
121.64
121.57
114.28
113.60
111.90
111.10
109.99
109.93
67.46
56.54
55.95
29.68
MeO
HO
F
F
O
Me
F
F
5ia: 13C NMR
+
MeO
HO
Me
F
F
F
F
O
5ia': 13C NMR
f1 (ppm)


F
F
F
F
O
7.39
7.38
7.36
7.27
7.26
7.25
7.21
7.20
2.19
1.75
1.49
1.42
1.35
1.33
1.30
1.26
0.92
0.90
1.82
0.98
1.81
1.08
2.01
12.20
2.93
3.12
f1 (ppm)

5ja: ^{1}H NMR


149.18
129.53
126.19
121.71
67.07
40.72
32.04
29.17
27.05
26.79
26.66
22.89
22.47
14.01
F
F
F
F
O
5ja: ^{13}C NMR
f1 (ppm)


Me
F F
N
O
N
Me
N
Me
F F
7: 1H NMR
6.72
6.70
6.59
6.13
6.12
6.12
3.80
2.65
2.50
0.93
1.02
1.01
1.00
2.99
3.00
3.01
f1 (ppm)


170.20
168.48
164.06
127.33
113.64
107.53
105.68
35.81
25.79
24.18
Me
F F
N
N
O
N
Me
Me
F F
f1 (ppm)

7: ^{13}C NMR