Supplementary Information

Electrosynthesis of 1,1-Bis(difluoromethyl)alkenes via Twofold C(sp^2)–H Difluoromethylation: A Bioisosteric Gateway to an Elusive Functional Group

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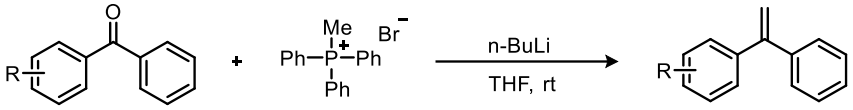
Section 1. General Information

All reactions were performed in oven-dried two-neck glass tubes unless otherwise noted. The tubes were fitted with a rubber septum and a threaded Teflon cap with airtight, electrical feed-throughs. The reactions were conducted under a nitrogen atmosphere. Flash chromatography was performed using silica gel 60 (230-400 mesh) from SiliCycle. Commercial reagents were purchased from Sigma Aldrich, Alfa Aesar, Acros, Aaron Chemicals and TCI and used as received. The difluoromethylating source **2** and starting materials for **3a**, **3d**, **3e**, **3f**, **3g**, **3h**, **3i**, **3j**, **3k**, **3l**, **3m'**, **3n**, **3o**, **3p**, **3q**, **3r**, **3s**, **3t**, **3u**, **3v**, **3w**, **3x**, **3z**, **3aa**, **3ab**, and **3ac** respectively were synthesized by the previously reported procedures $Zn(CF_2H)_2(DMPU)_2$[1], 1-methoxy-4-(1-phenylvinyl)benzene[2], N,N-dimethyl-4-(1-phenylvinyl)aniline[2], 1-methyl-4-(1-phenylvinyl)benzene[2], 1-bromo-4-(1-phenylvinyl)benzene[2], 1-fluoro-4-(1-phenylvinyl)benzene[2], 1-bromo-3-(1-phenylvinyl)benzene[2], 2-(1-phenylvinyl)thiophene[2], 2-(1-(4-methoxyphenyl)vinyl)thiophene[3], 6-(1-phenylvinyl)benzofuran[4], 2,2-dimethyl-5-(1-phenylvinyl)benzo[d][1,3]dioxole[5], 1,2,3,4,5-pentamethyl-6-(1-phenylvinyl)benzene[6], N,N-dimethyl-2-(4-(1-phenylvinyl)phenoxy)ethan-1-amine[2,7], N,N-diethyl-2-(4-(1-phenylvinyl)phenoxy)ethan-1-amine[2,7], 2-(4-(1-(3-methoxyphenyl)vinyl)phenoxy)-N,N-dimethylethan-1-amine[3,8], 2-(4-(1-(4-methoxyphenyl)vinyl)phenoxy)-N,N-dimethylethan-1-amine[3,8], 4,4'-(ethene-1,1-diyl)bis(methoxybenzene)[2], ethene-1,1-diylbis(4,1-phenylene) diacetate[2,9], 2-(4-(1-phenylvinyl)phenoxy)ethyl benzoate[2,10], 2-(4-(1-phenylvinyl)phenoxy)ethan-1-ol[2,10,11], methyl 2-(3-(1-phenylvinyl)phenyl)propanoate[2,12], 2-(3-(1-phenylvinyl)phenyl)propanoic acid[2,12,13], isopropyl 2-(4-(1-(4-chlorophenyl)vinyl)phenoxy)-2-methylpropanoate[2], 11-methylene-6,11-dihydrodibenzo[b,e]oxepine[2], methyl 2-(11-methylene-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate[2,14], 11-methylene-6,11-dihydrodibenzo[b,e]thiepine[2], and 5-methylene-10,11-dihydro-5H-dibenzo[a,d][7]annulene[2]. Proton nuclear magnetic resonance (^{1}H NMR) spectra was recorded on 300 MHz, 500 MHz, and 850 MHz, carbon nuclear magnetic resonance (^{13}C NMR) spectra was recorded on 126 MHz, 214 MHz, and fluorine nuclear magnetic resonance (^{19}F NMR) was recorded on 471 MHz by Bruker 500. Chemical shifts for protons are reported in parts per million downfield from tetramethylsilane and are referenced to residual protium in the NMR solvent ($CHCl_3$ = δ 7.26). Chemical shifts for carbon are reported in parts per million downfield from tetramethylsilane and are referenced to the carbon resonances of the solvent ($CDCl_3$ = δ 77.0). Data are represented as follows: chemical shift, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, m = multiplet), coupling constants in Hertz (Hz), integration. The voltaic profiles were recorded with a Biologics SP-50 potentiostat. High-resolution mass spectra (HRMS) were acquired on a Supercritical Fluid Chromatograph combined with Xevo G2-XS QTOF Mass Spectrometer (Waters, Milford, MA, USA, NFEC-2022-12-283850) at the Chiral Material Core Facility Center of Sungkyunkwan University were recorded on electrospray ionization (ESI) and atmospheric pressure chmical ionization (APCI) method or obtained with JEOL JMS-700 at Korea Basic Science Institute (Daegu) by electron ionization (EI). X-ray diffraction data was collected on a Bruker SMART APEX III or PAL beamline coated with Paraton-Noil under a stream of N2(g) at 133 K. Electrolysis experiments were performed using a Biologics SP-50 potentiostat/galvanostat. Carbon Felt was purchased from Fuel Cell Store. The carbon was cut into 1 x 0.5 x 0.6 cm^3 pieces before use, and was connected to electrical feed-through on the Teflon cap of the electrochemical cell via a piece of graphite (2B pencil lead, 2 mm in diameter). The platinum plate was cut into 1 x 0.5 x 0.02 cm^3 and was connected to electrical feed-through on the Teflon cap of the electrochemical cell via a piece of graphite (2B pencil lead, 2 mm in diameter). Ag/Ag^+ quasi-reference electrode with 0.1 M $TBAClO_4$ and 0.01 M $AgNO_3$ in MeCN was used as the reference electrode. The reference electrode was calibrated against an internal standard of ferrocene (Fc) following electrolysis so that the voltammograms could be referenced against Fc/Fc^+.

Abbreviations: *t*-Bu—*tert*-butyl, Me—methyl, Et—ethyl, Ph—phenyl, Bz—benzoyl, DCM—dichloromethane, DMSO—dimethyl sulfoxide, MeCN—acetonitrile, DMPU—*N,N'*-dimethylpropyleneurea

Section 2. Preparation of Starting Materials

1. Procedure 1[2]

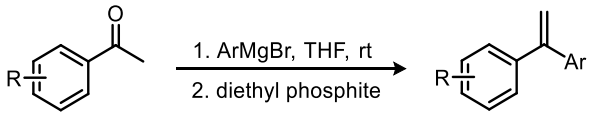


S1 **S2** **1**

Under an nitrogen atmosphere and at 0º C cold bath, an oven-dried flask containing a magnetic stir bar was sequentially charged with **S2** (1.2 equiv) and dry THF (30 mL), then the n-BuLi (1.6 M in THF solution, 1.2 equiv.) was slowly added. After stirring in the cold bath for 30 minutes, A THF solution of **S1** (10 mmol) was added slowly with a syringe.The reaction flask was left to stir overnight at room temperature. After aryl ketone is fully converted, the mixture was quenched water and aqueous phases were extracted by ethyl acetate for 3 times. Then the organic phase were collected, and dried with anhydrous Na_2SO_4, condensed under vacuum, which afforded crude mixture that was subjected to purification by flash chromatography (silica gel) to obtain product.

The starting materials **S1** for **1n**[7], **1o**[7], **1s**[9], **1t**[10], **1v**[12], and **1aa**[14] respectively were synthesized by the previously reported procedures and their spectroscopic data and synthetic methods were consistent with the respective previous reports.

2. Procedure 2[3]

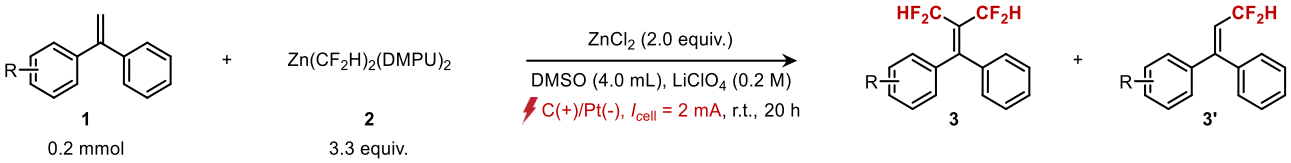


S3 **1**

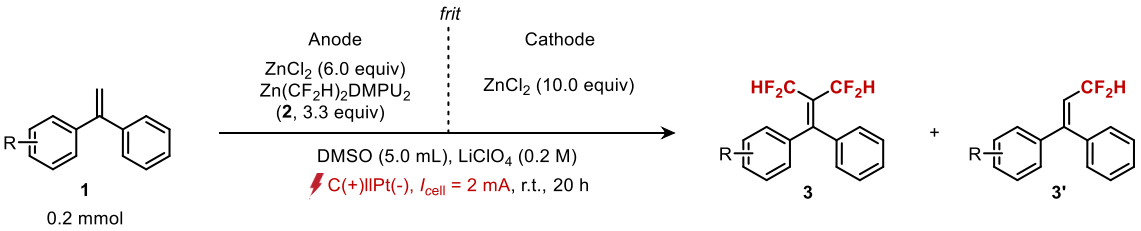
Under an nitrogen atmosphere and at 0º C cold bath, an oven-dried flask containing a magnetic stir bar was sequentially charged with **S3** (10 mmol) and dry THF (30 mL), then the Grignard reagent (1 M in THF solution, 1.2 equiv.) was slowly added. After stirring in the cold bath for 15 minutes, diethyl phosphite (1.55 mL, 1.2 equiv) was added slowly by a syringe. The reaction flask was left to stir overnight. After aryl ketone is fully converted, the mixture was quenched by sat. aq. NH_4Cl, and aqueous phases were extracted by ethyl acetate for 3 times. Then the organic phase were collected, washed with saturated brine, and dried with anhydrous Na_2SO_4, condensed under vacuum, which afforded crude mixture that was subjected to purification by flash chromatography (silica gel) to obtain product.

The starting materials **S3** for **1p**[8] and **1q**[8] respectively were synthesized by the previously reported procedures and their spectroscopic data and synthetic methods were consistent with the respective previous reports.

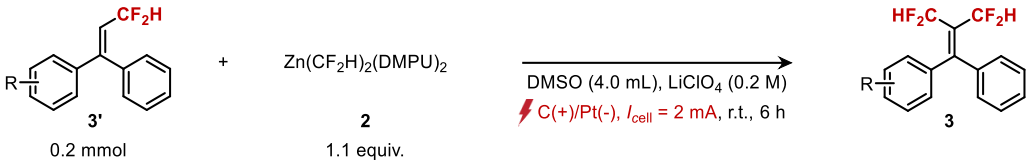
Section 3. General Procedure for Electrochemical Double C(sp^2)-H Difluoromethylation of alkenes



Method A: An oven-dried, 10 mL two-neck glass tube was equipped with a magnetic stir bar, a rubber septum, a threaded Teflon cap fitted with electrical feed-throughs, a carbon felt anode (1.0 *0.5 cm^2) (connected to the electrical feedthrough via a 9 cm in length, 2 mm in diameter graphite rod), and a platinum plate cathode (1 x 0.5 x 0.02 cm^3). In a nitrogen-filled glove-box, substrate (0.2 mmol) was added, followed by the sequential addition via syringe of degassed DMSO (4.0 mL), **2** (185.7 mg, 0.44 mmol, 2.2 equiv), $LiClO_4$ (85.1 mg, 0.8 mmol), and $ZnCl_2$ (55 mg, 0.4 mmol, 2.0 equiv). The cell was sealed and removed from the glove-box. After stirring 5 -10 minutes of the reaction vessel, electrolysis was initiated at a constant current of 2.0 mA at r.t. for 20 h. After completion of the reaction, the mixture was diluted with DCM (30 mL) and then washed with water, brine, dried over anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was subjected to flash column chromatography on silica gel (eluted with hexanes/ethyl acetate) to yield the desired product.



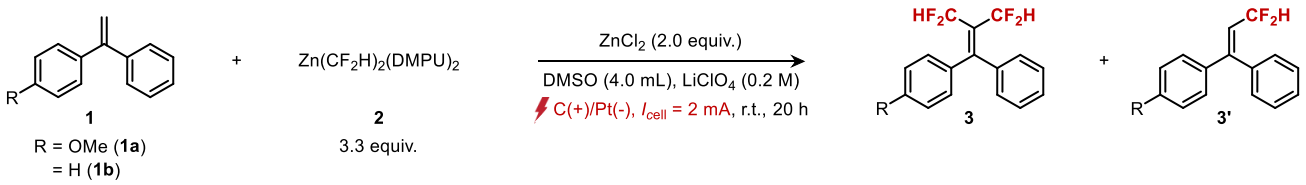
Method B: An oven-dried H-type divided cell, with each half-cell having a volume of 10 mL and a replaceable membrane seal, was prepared and equipped with a stir bar and a rubber septum. The membrane separating the half-cells was a DURAN® glass fritted filter disc (20 mm in diameter) with a porosity of P5. In a nitrogen-filled glove-box, substrate (0.2 mmol) was added in anodic chamber, followed by the sequential addition via syringe of degassed DMSO (5.0 mL), **2** (185.7 mg, 0.44 mmol, 2.2 equiv), $LiClO_4$ (110 mg, 1 mmol), and $ZnCl_2$ (165 mg, 1.2 mmol, 6.0 equiv), while DMSO (5.0 mL), $LiClO_4$ (85.1 mg, 0.8 mmol), and $ZnCl_2$ (275 mg, 2 mmol, 10.0 equiv) were added to the cathodic chamber. The divided cell was equipped with a carbon felt anode (1.0 × 0.5 cm^2), connected to the electrical feedthrough via a graphite rod (9 cm in length, 2 mm in diameter), and a platinum plate cathode (0.5 × 1.0 cm^2) were installed. The anodic chamber and cathodic chamber were connected by a cannula, and a nitrogen-filled balloon was attached to the cell and the system was purged three times. The cell was sealed and removed from the glove-box. After stirring 5 -10 minutes of the reaction vessel, electrolysis was initiated at a constant current of 2.0 mA at r.t. for 20 h. After completion of the reaction, the mixture from the anodic chamber was then diluted with DCM (30 mL) and then washed with water, brine, dried over anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was subjected to flash column chromatography on silica gel (eluted with hexanes/ethyl acetate) to yield the desired product.



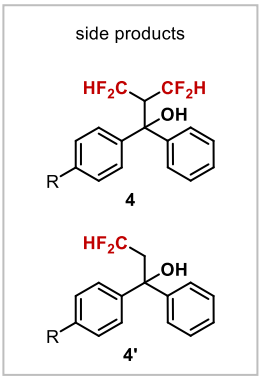
Method C: An oven-dried, 10 mL two-neck glass tube was equipped with a magnetic stir bar, a rubber septum, a threaded Teflon cap fitted with electrical feed-throughs, a carbon felt anode (1.0 *0.5 cm^2) (connected to the electrical feedthrough via a 9 cm in length, 2 mm in diameter graphite rod), and a platinum plate cathode (1 x 0.5 x 0.02 cm^3). In a nitrogen-filled glove-box, substrate (0.2 mmol) was added, followed by the sequential addition via syringe of degassed DMSO (4.0 mL), **2** (185.7 mg, 0.44 mmol, 2.2 equiv), and $LiClO_4$ (85.1 mg, 0.8 mmol). The cell was sealed and removed from the glove-box. After stirring 5 -10 minutes of the reaction vessel, electrolysis was initiated at a constant current of 2.0 mA at r.t. for 6 h. After completion of the reaction, the mixture was diluted with DCM (30 mL) and then washed with water, brine, dried over anhydrous $MgSO_4$, and concentrated under reduced pressure. The residue was subjected to flash column chromatography on silica gel (eluted with hexanes/ethyl acetate) to yield the desired product.

Section 4. Optimization of Reaction Parameters

1. Optimization study



Entry	**1**	Variation from "standard conditions"	**3** (%)	**3'** (%)
1		none	**82**	7
2	**1a**	$Zn(CF_2H)_2(DMPU)_2$ 1.1 equiv., w/o $ZnCl_2$, 6 h	4	**70**
3		w/o $ZnCl_2$	76	3
4		w/o $ZnCl_2$	16	1
5		$ZnCl_2$ 4.0 equiv.	48	1
6		$ZnCl_2$ 4.0 equiv., divided cell	**52**	1
7		ZnF_2 intead of $ZnCl_2$	20	1
8		$ZnBr_2$ intead of $ZnCl_2$	38	2
9	**1b**	ZnI_2 intead of $ZnCl_2$	1	6
10		$Zn(OTf)_2$ intead of $ZnCl_2$	14	15
11		$MgCl_2$ intead of $ZnCl_2$	0	22
12		MeCN intead of DMSO	16	2
13		DMF intead of DMSO	0	0
14		no applied electric current	0	0



Supplementary Table 1. Optimization study

2. Screening of zinc(II) halides

Entry	Additive	Yield (**3b**, %)
1	none	16
2	$ZnCl_2$ (50 mol %)	26
3	$ZnCl_2$ (2.0 equiv)	38
4	$ZnCl_2$ (4.0 equiv)	48
5	$ZnCl_2$ (5.0 equiv)	50
6	**$ZnCl_2$ (6.0 equiv)**	**56**
7	$ZnCl_2$ (8.0 equiv)	44
8	$ZnBr_2$ (1.0 equiv)	38
9	$ZnBr_2$ (2.0 equiv)	44
10	$ZnBr_2$ (4.0 equiv)	38
11	$ZnBr_2$ (6.0 equiv)	16
12	ZnI_2 (50 mol %)	0
13	ZnI_2 (1.0 equiv)	0
14	ZnI_2 (4.0 equiv)	1
15	ZnI_2 (6.0 equiv)	0

Supplementary Table 2. Screening of zinc(II) halides

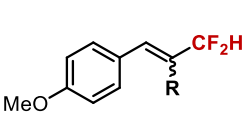
3. Screening of zinc(II) additives

Entry	Additive	Yield (**3b**, %)
1	none	16
2	$ZnCl_2$ (6.0 equiv)	56
3	ZnF_2 (4.0 equiv)	20
4	$ZnBr_2$ (4.0 equiv)	38
5	ZnI_2 (6.0 equiv)	0
6	**2** (4.4 eqeuiv), w/o additive	40
7	$Zn(OTf)_2$ (4.0 equiv)	14
8	$Zn(OAc)_2$ (4.0 equiv)	0
9	$Zn(CN)_2$ (6.0 equiv)	18
10	$ZnSO_4$ (6.0 equiv)	0
11	Zn (4.0 equiv)	8

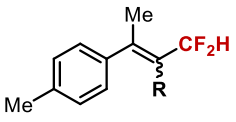
Supplementary Table 3. Screening of zinc(II) additives

Section 5. Unsuccessful Scopes

1. Styrene-type substrates



R=CF_2H: 0%
R=H: 0%
Remaining SM: 0%



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R=H: 28%
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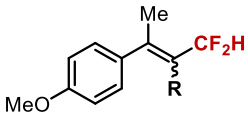

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R=H: 44%
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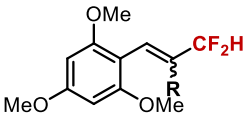

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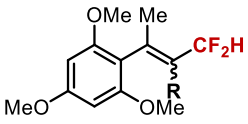

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R=H: 2%
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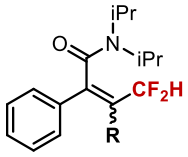

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R=H: 18%
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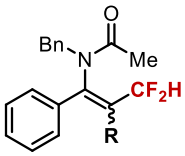

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R=H: 54%
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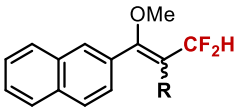

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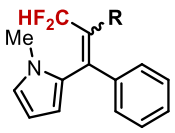
R=H: 11%
Remaining SM:0%

2. Heteroaromatic substrates



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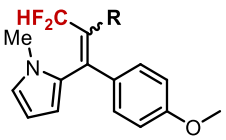

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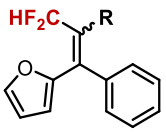
R=H: 4%
Remaining SM: 2%



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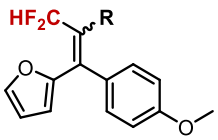

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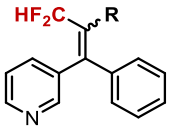

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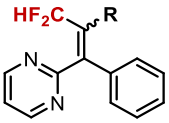

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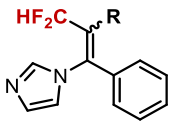

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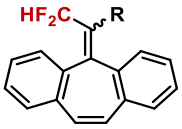

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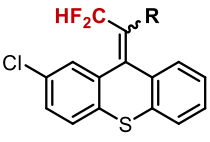
3. 6-membered fused rings



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R=H: trace
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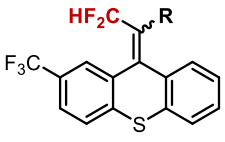

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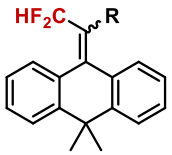
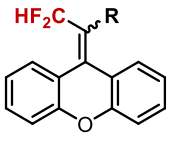
R=H: 0%
Remaining SM: trace

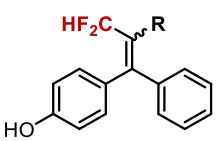


R=CF_2H: 16%
R=H: 3%
Remaining SM: 0%

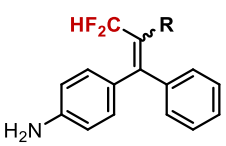


R=CF_2H: trace
R=H: 2%
Remaining SM: 0%

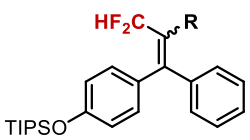
4. Functional group bearing alkenes



R=CF_2H: 13%
R=H: 3%
Remaining SM:0%

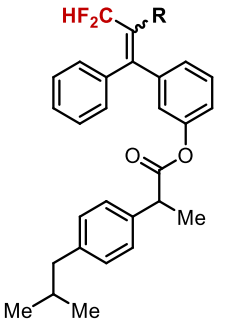


R=CF_2H: 20%
R=H: 3%
Remaining SM: trace

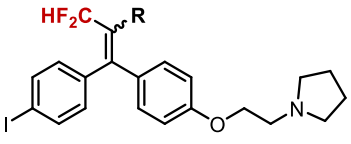


R=CF_2H: 7%
R=H: 3%
Remaining SM: trace

5. Electron-deficient alkenes



R=CF_2H: 8%
R=H: 3%
Remaining SM: trace



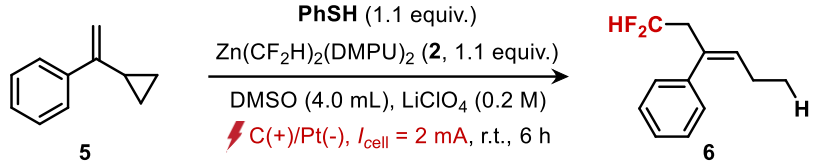
R=CF_2H: 0%
R=H: 10%
Remaining SM:20%

Section 6. Procedures of Mechanistic Studies

1. Radical probe experiments

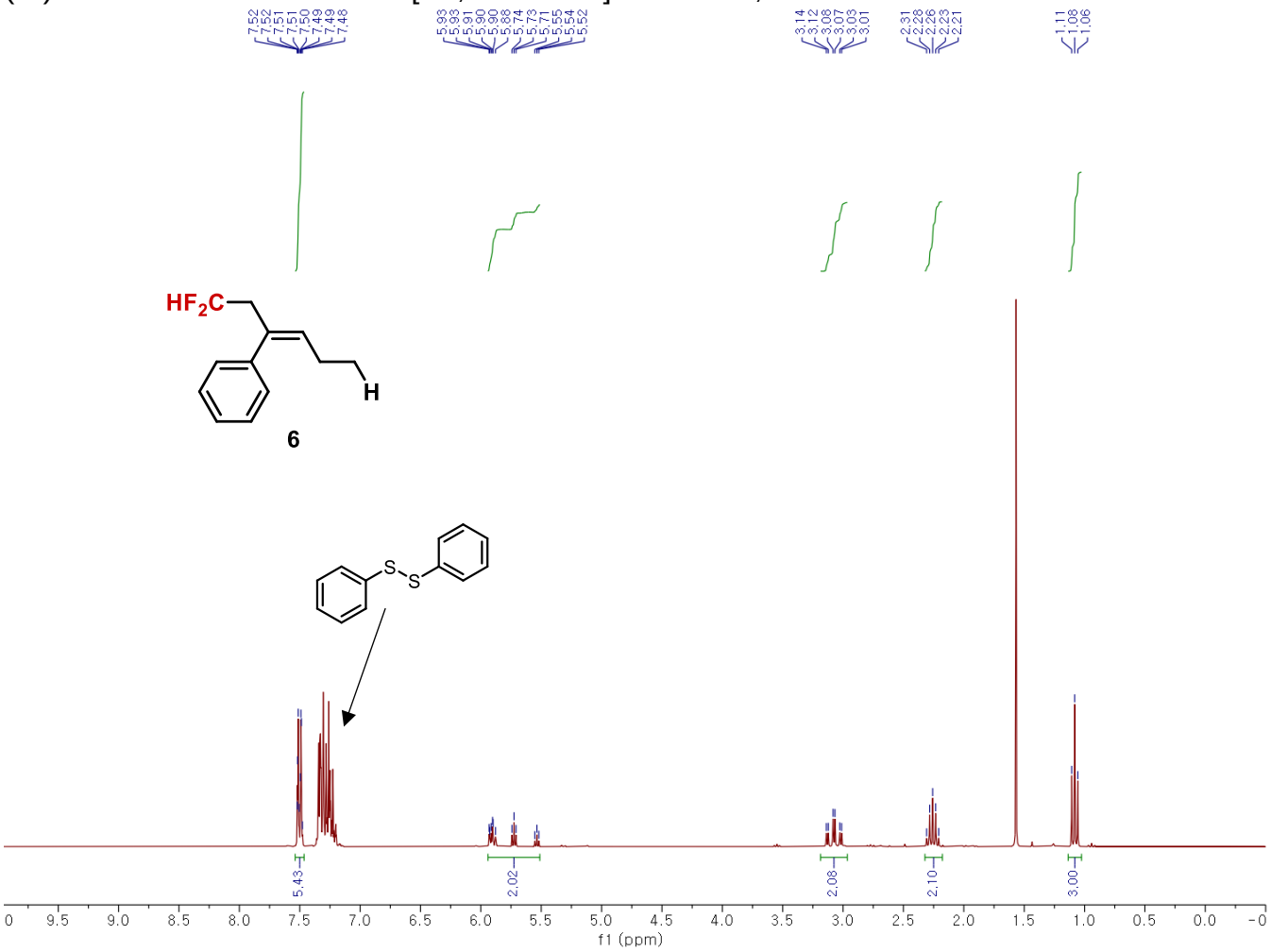
1.1. Ring-opening reation of (1-cyclopropylvinyl)benzene (**5**) with PhSH

The procedure described in **Section 3**, **Method A** was followed using **2** (1.1 equiv.) and PhSH (1.1 equiv.) for 6 h with the radical probe substrate **5**. Yields were determined by ^{1}H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



55%

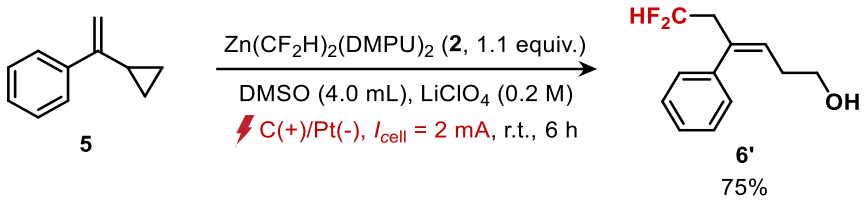
(Z)-(1,1-difluorohex-3-en-3-yl)benzene (6). Purified using silica gel chromatography to give 55% yield of **7** as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.61 – 7.43 (m, 5H), 6.00 – 5.50 (m, 2H), 3.08 (td, *J* = 16.5, 4.9 Hz, 2H), 2.26 (p, *J* = 7.5 Hz, 2H), 1.08 (t, *J* = 7.5 Hz, 3H); HRMS (EI) exact mass calculated for [M^+, $C_{12}H_{14}F_2^+$]: 196.1064, found 196.1060.



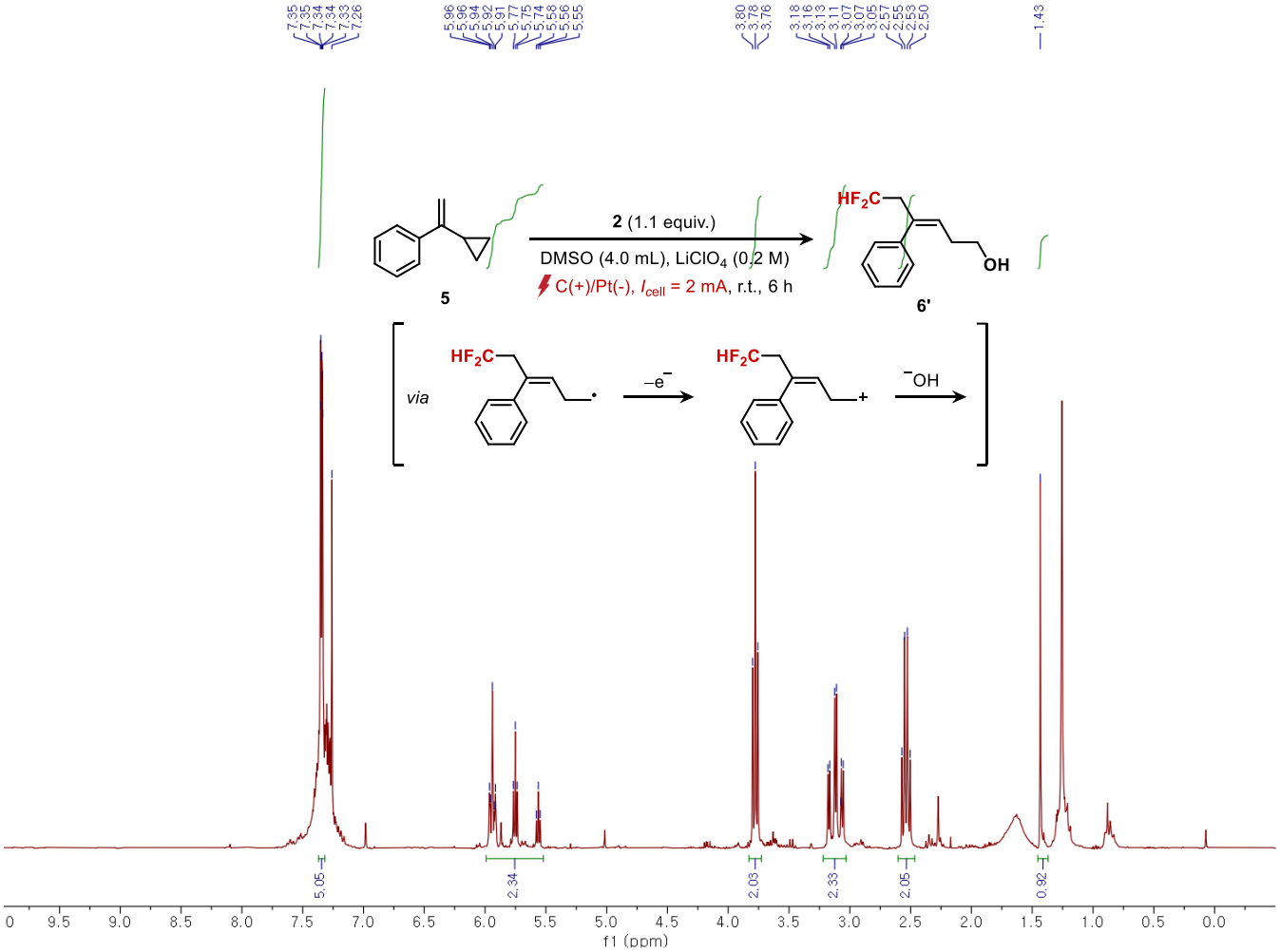
Supplementary Figure 1. ^{1}H NMR Spectrum of (Z)-(1,1-difluorohex-3-en-3-yl)benzene (**6**)

1.2. Ring-opening reation of (1-cyclopropylvinyl)benzene (**5**) without PhSH

The procedure described in **Section 3**, **Method A** was followed using **2** (1.1 equiv.) for 6 h with the radical probe substrate **5**. Yields were determined by ^{1}H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



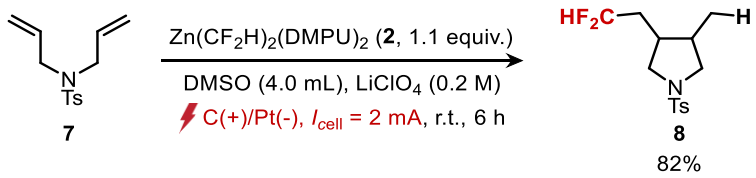
(Z)-6,6-difluoro-4-phenylhex-3-en-1-ol (6'). Purified using silica gel chromatography to give 75% yield of **7'** as a colorless oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.38 – 7.30 (m, 5H), 5.99 – 5.51 (m, 2H), 3.78 (t, *J* = 6.4 Hz, 2H), 3.12 (td, *J* = 16.5, 4.8 Hz, 2H), 2.54 (q, *J* = 6.7 Hz, 2H), 1.43 (s, 1H); HRMS (EI) exact mass calculated for [M^+, $C_{12}H_{14}F_2O^+$]: 212.1013, found 212.1009.



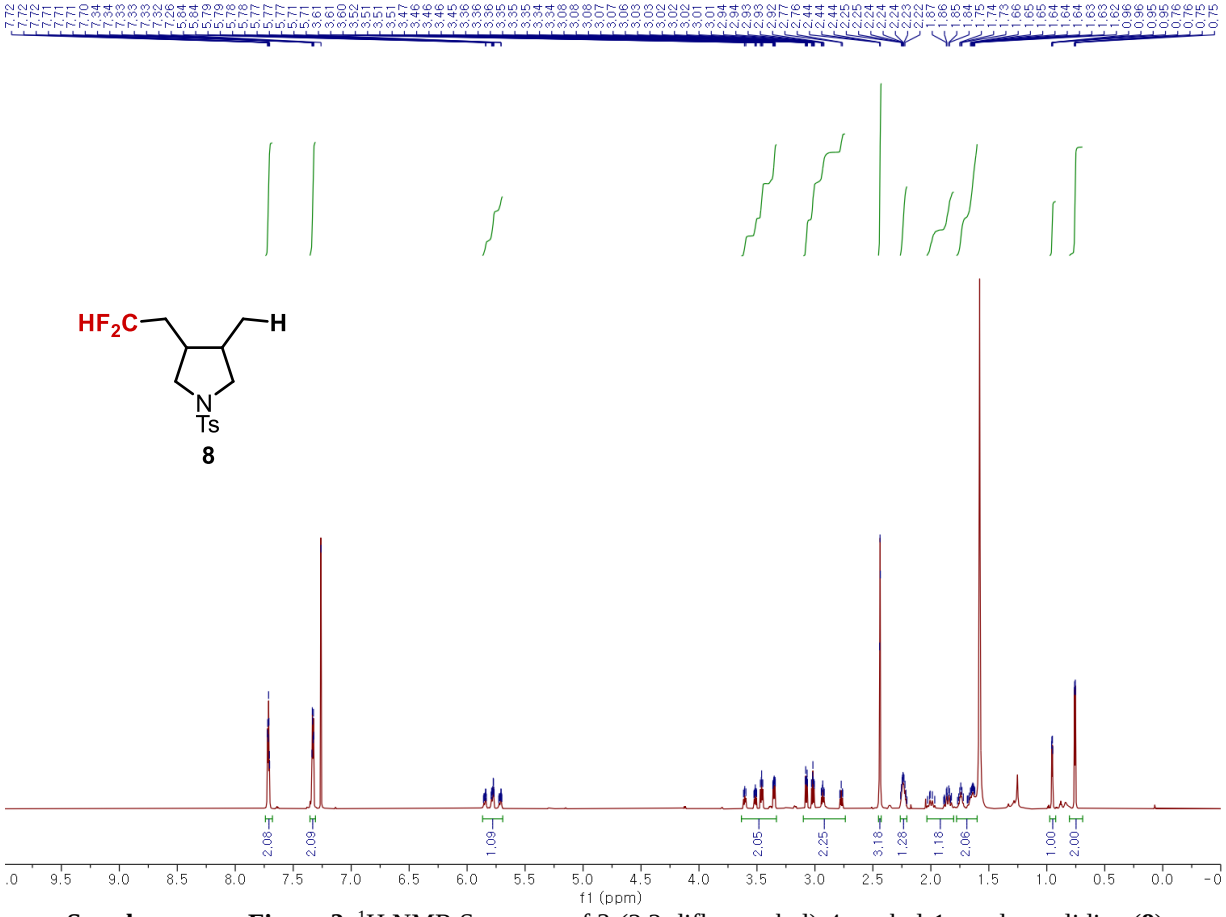
Supplementary Figure 2. ^{1}H NMR Spectrum of (Z)-6,6-difluoro-4-phenylhex-3-en-1-ol (**6'**)

2. Radical cyclization of *N*,*N*-diallyl-4-methylbenzenesulfonamide (**7**)

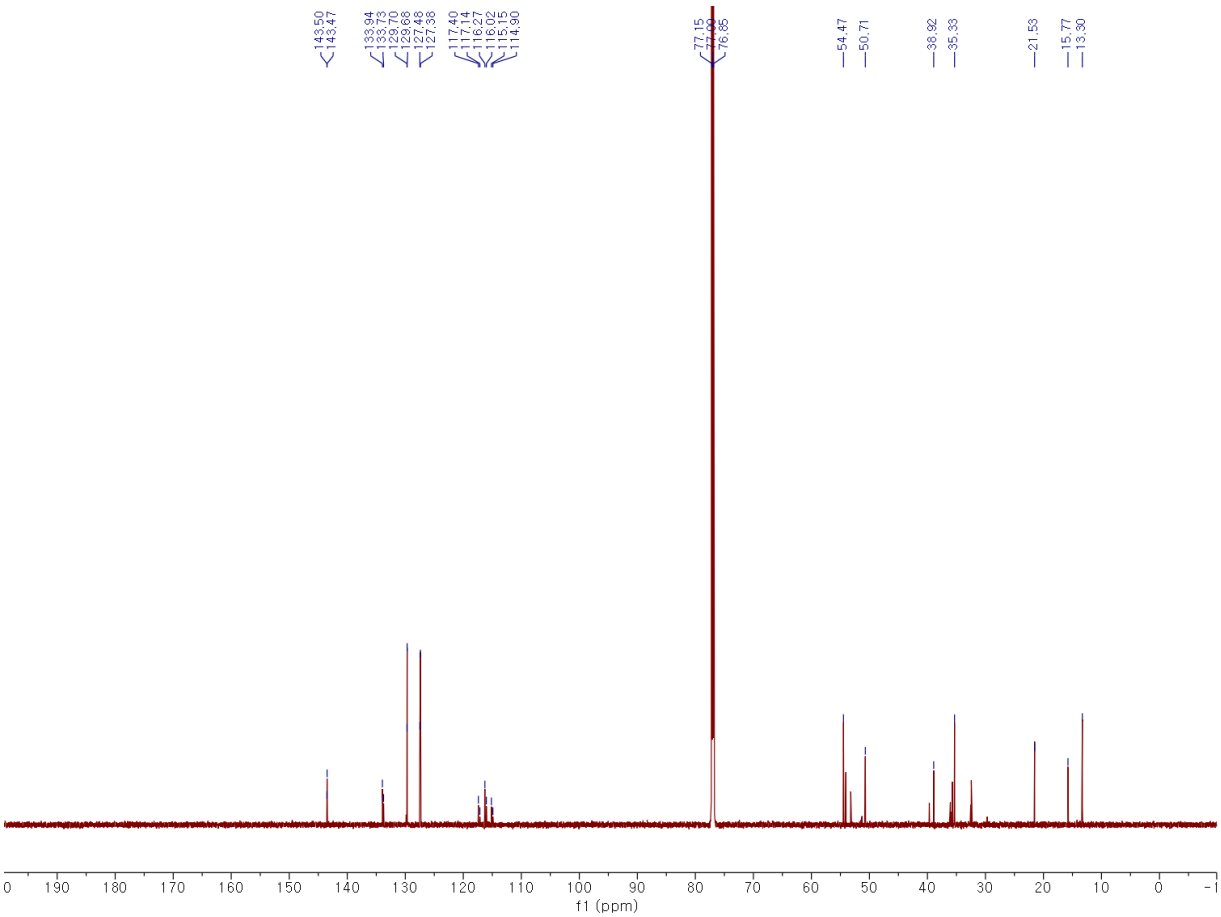
The procedure described in **Section 3**, **Method A** was followed using **2** (1.1 equiv.) for 6 h with the radical probe substrate **7**. Yields were determined by ^{1}H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



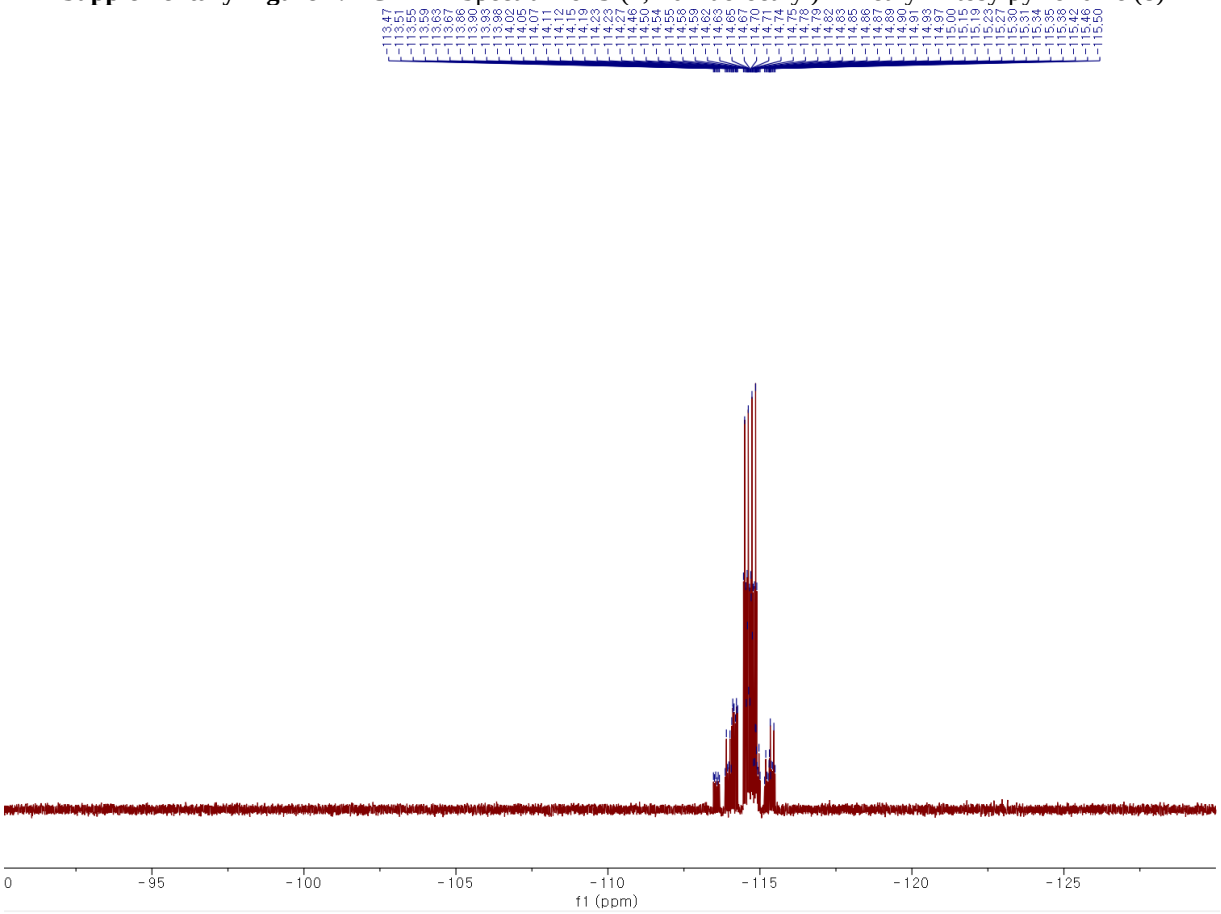
3-(2,2-difluoroethyl)-4-methyl-1-tosylpyrrolidine (8). Method A. Purified using silica gel chromatography to give 82% yield of **9** as a colorless oil; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.71 (ddd, *J* = 7.6, 5.6, 1.9 Hz, 2H), 7.33 (dt, *J* = 8.1, 2.3 Hz, 2H), 5.90 – 5.67 (m, 1H), 3.69 – 3.30 (m, 2H), 3.12 – 2.71 (m, 2H), 2.44 (t, *J* = 2.6 Hz, 3H), 2.29 – 2.20 (m, 1H), 2.04 – 1.81 (m, 1H), 1.78 – 1.62 (m, 2H), 0.95 (dd, *J* = 6.2, 1.9 Hz, 1H), 0.76 (dd, *J* = 6.8, 1.8 Hz, 2H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 143.5 (d, *J* = 5.4 Hz), 133.8 (d, *J* = 44.4 Hz), 129.7 (d, *J* = 4.4 Hz), 127.4 (d, *J* = 20.8 Hz), 116.2 (td, *J* = 239.8, 54.4 Hz), 54.5, 50.7, 38.9, 35.3, 21.5, 15.8, 13.3; ^{19}F NMR (471 MHz, $CDCl_3$) δ -113.0 – -115.8 (m); HRMS (EI) exact mass calculated for [M^+, $C_{14}H_{19}F_2NO_2S^+$]: 303.1105, found 303.1104



Supplementary Figure 3. ^{1}H NMR Spectrum of 3-(2,2-difluoroethyl)-4-methyl-1-tosylpyrrolidine (**8**)



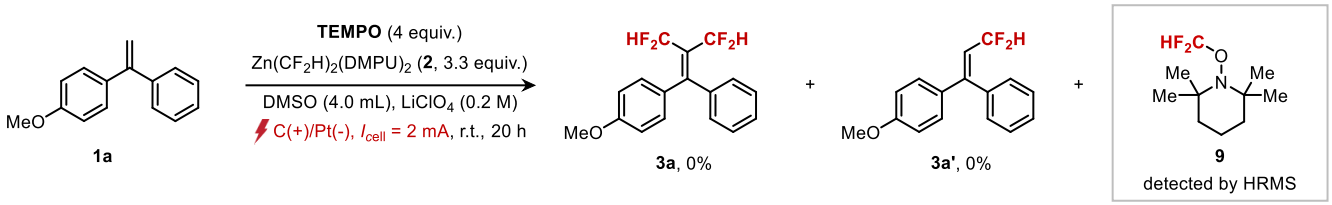
Supplementary Figure 4. ^{13}C NMR Spectrum of 3-(2,2-difluoroethyl)-4-methyl-1-tosylpyrrolidine (**8**)



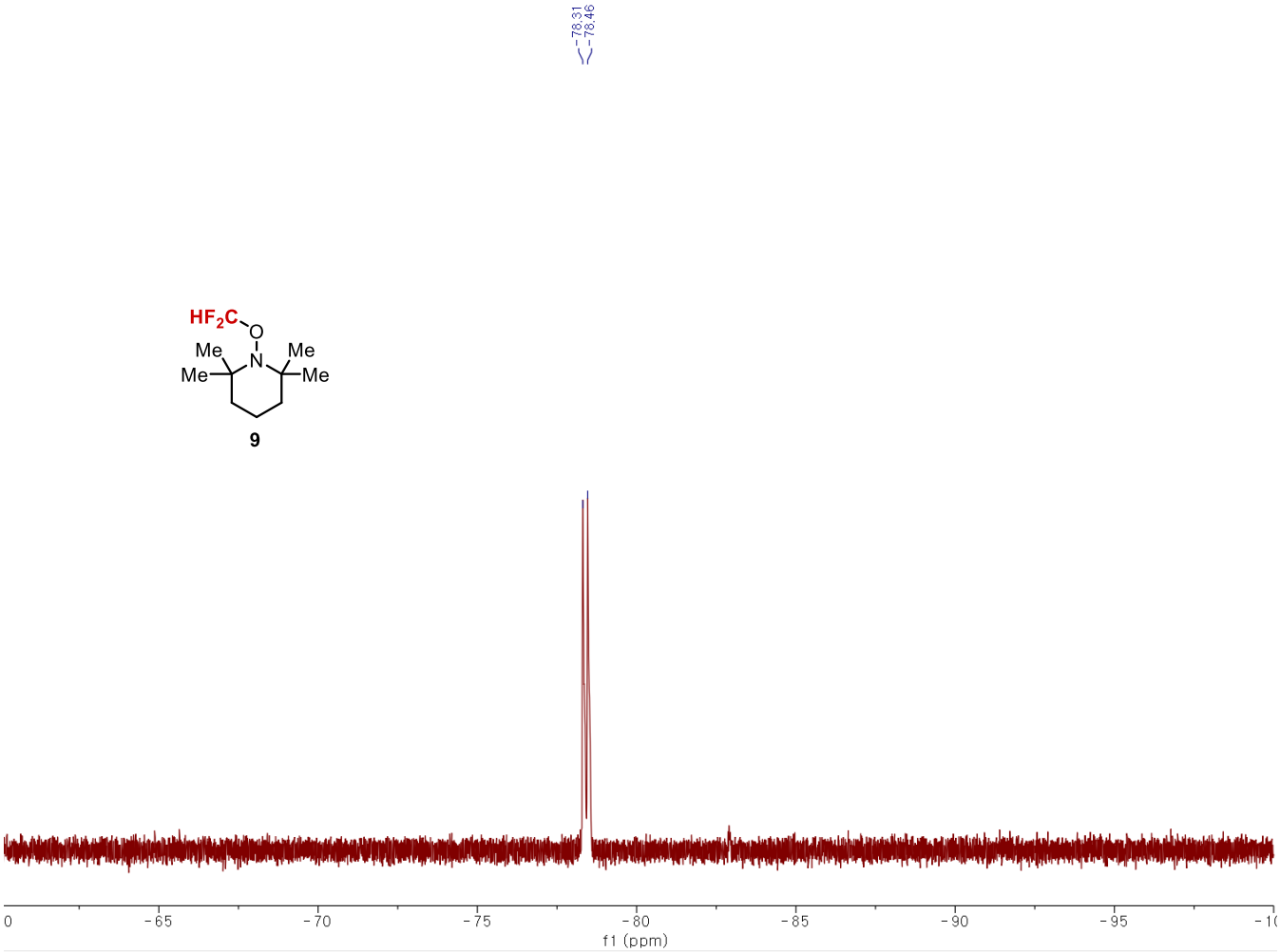
Supplementary Figure 5. ^{19}F NMR Spectrum of 3-(2,2-difluoroethyl)-4-methyl-1-tosylpyrrolidine (**8**)

3. Radical trapping with TEMPO

The procedure described in **Section 3**, **Method A** was followed with **TEMPO** (4 equiv.) as a radical trapping reagent. Yields were determined by ^{1}H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



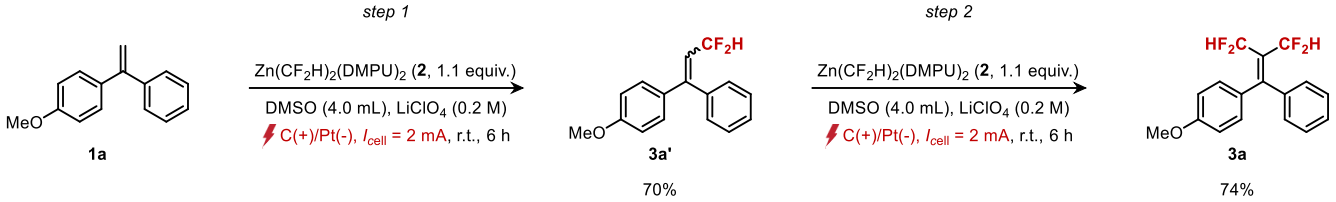
1-(difluoromethoxy)-2,2,6,6-tetramethylpiperidine (9). ^{19}F NMR (471 MHz, $CDCl_3$) δ -78.38 (d, *J* = 72.3 Hz); HRMS (ESI) exact mass calculated for [M+H$^+$, $C_{10}H_{20}F_2NO^+$]: 208.1508, found 208.1512.



Supplementary Figure 6. ^{19}F NMR Spectrum of 1-(difluoromethoxy)-2,2,6,6-tetramethylpiperidine (**9**)

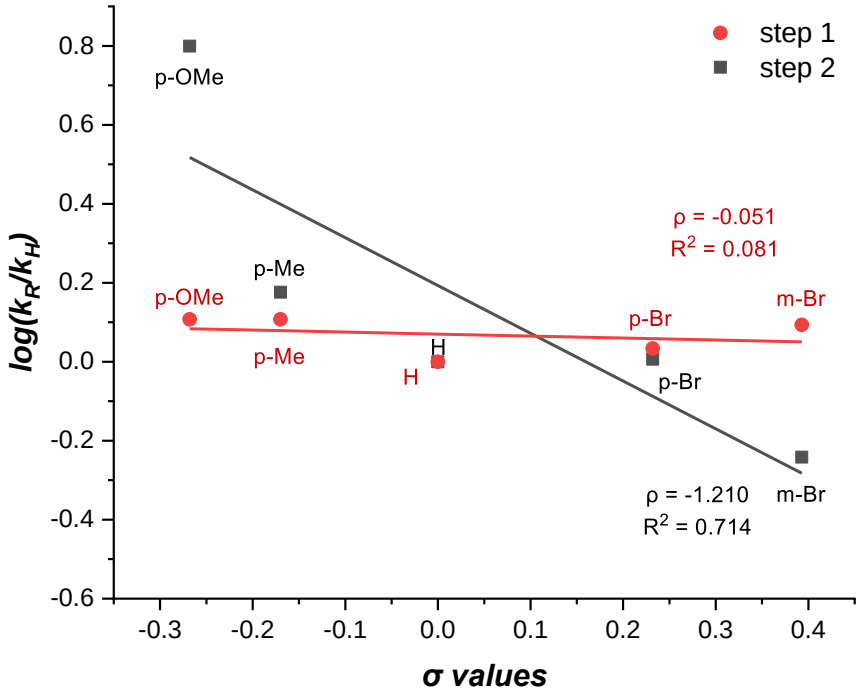
4. Stepwise C(sp^2)-H difluoromethylation

The procedure described in **Section 3**, **Method A** was followed using **2** (1.1 equiv) for 6 h in the absence of $ZnCl_2$. Yields were determined by ^1H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.

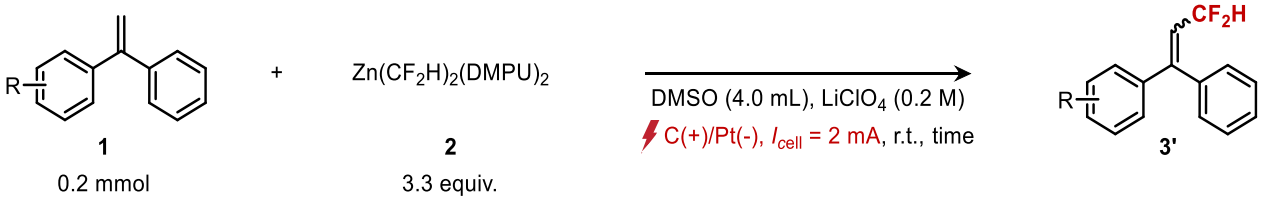


Supplementary Figure 7. Stepwise C(sp^2)-H difluoromethylation of **1a**

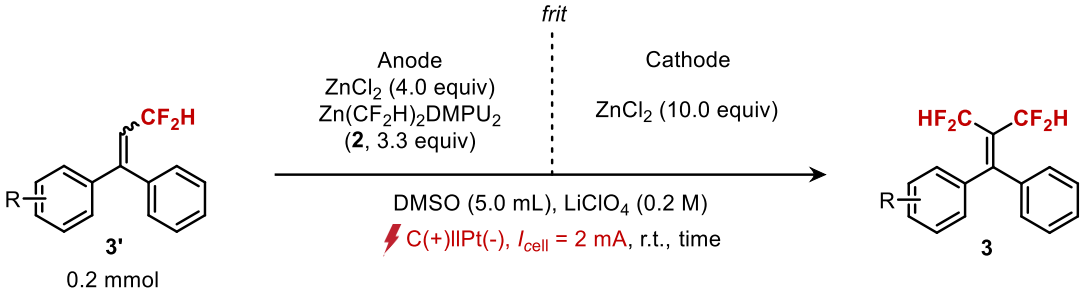
5. Hammett analysis



Supplementary Figure 8. Hammett analysis



The procedure described in **Section 3**, **Method A** was followed using **2** (1.1 equiv) in the absence of $ZnCl_2$. 50 µl aliquots were withdrawn at 10 min intervals. Yields for each aliquot were determined by ^{19}F NMR, using fluorobenzene as the internal standard.



The procedure described in **Section 3**, **Method B** was followed using **2** (1.1 equiv) and $ZnCl_2$ (4.0 equiv) in the anode chamber and $ZnCl_2$ (5.0 equiv) in the cathode chamber. 50 µl aliquots were withdrawn at 10 min intervals. Yields for each aliquot were determined by ^{19}F NMR, using fluorobenzene as the internal standard.

Compound	step 1		Compound	step 1	
	Time (s)	Concentration (M)		Time (s)	Concentration (M)
p-OMe	600	0.0012	**p-Br**	600	0
	1200	0.0038		1200	0.0004
	1800	0.0072		1800	0.0008
	2400	0.0112		2400	0.0018
	3000	0.0138		3000	0.0022
p-Me	600	0.0018	**m-Br**	600	0.0034
	1200	0.0034		1200	0.0045
	1800	0.0042		1800	0.0064
	2400	0.0058		2400	0.008
	3000	0.0084		3000	0.0092
H	600	0.0006			
	1200	0.0018			
	1800	0.0028			
	2400	0.0036			
	3000	0.0058			

Supplementary Table 4. Time-dependent concentration profiles of substrates in step 1

Compound	step 2		Compound	step 2	
	Time (s)	Concentration (M)		Time (s)	Concentration (M)
p-OMe	600	0.0005	**p-Br**	600	0.0002
	1200	0.00185		1200	0.00045
	1800	0.0023		1800	0.0006
	2400	0.0035		2400	0.00035
	3000	0.00495		3000	0.00075
	3600	0.00665		3600	0.0014
p-Me	600	0.0006	**m-Br**	600	0.0004
	1200	0.00055		1200	0.0005
	1800	0.0007		1800	0.00075
	2400	0.00095		2400	0.0004
	3000	0.0014		3000	0.00095
	3600	0.002		3600	0.00095
H	600	0.00015			
	1200	0.0002			
	1800	0.00035			
	2400	0.0005			
	3000	0.00075			
	3600	0.0011			

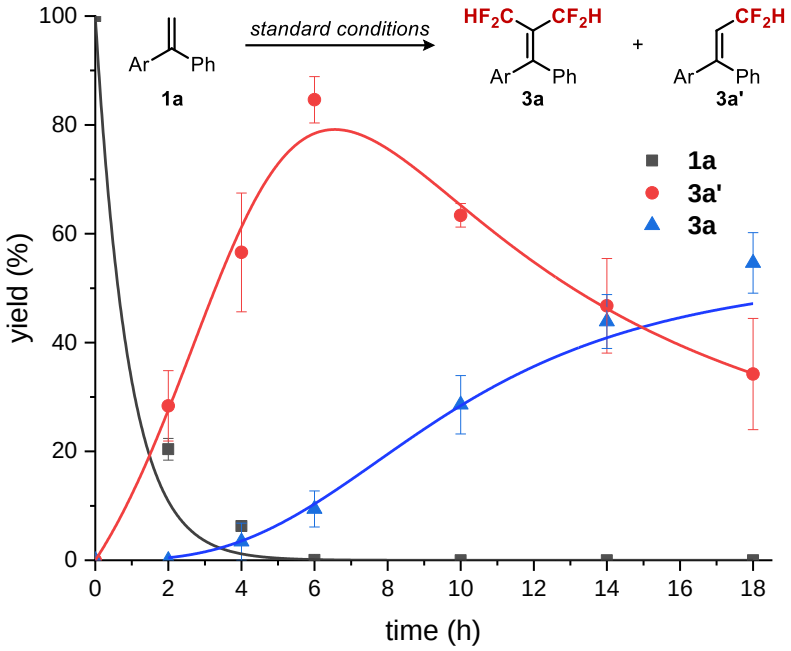
Supplementary Table 5. Time-dependent concentration profiles of substrates in step 2

Substituent	para-effect	meta-effect
Methoxy	-0.268	+0.115
Methyl	-0.170	-0.069
none	0.000	0.000
Bromo	+0.232	+0.393

Supplementary Table 6. Hammett σ values

6. Time-course analysis

An identical procedure was followed as described in **Section 3**, **Method A.** Yields were determined by ^{1}H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



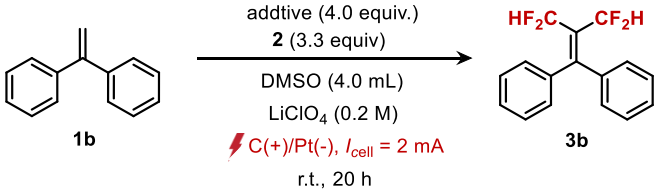
Supplementary Figure 9. Time-course analysis

Compound	Time (h)	Trial 1 yield (%)	Trial 2 yield (%)	Trial 3 yield (%)	Average (%)	standard deviation
1a	2	22.4	18.4	20.4	20.4	2
	4	6.48	6.8	5.6	6.3	0.62
	6	0	0	0.2	0.07	0.12
	10	0	0	0	0	0
	14	0	0	0	0	0
	18	0	0	0	0	0
3a'	2	20.9	31.96	32.25	28.37	6.47
	4	44.55	59.33	65.85	56.58	10.91
	6	79.86	88.06	85.95	84.62	4.26
	10	61.2	63.41	65.55	63.39	2.17
	14	48.28	37.4	54.6	46.76	8.70
	18	37.4	22.78	42.45	34.21	10.22
3a	2	0	0	0	0	0
	4	1.21	1.7	7.35	3.42	3.41
	6	12.82	6.21	9.23	9.42	3.31
	10	30.6	32.64	22.5	28.58	5.36
	14	48.03	45.22	38.4	43.88	4.95
	18	54.83	60.10	49.00	54.63	5.56

Supplementary Table 7. Time-course of yields for each component

7. Additive studies

The procedure described in **Section 3**, **Method A** was followed with the indicated additive (4.0 equiv). Yields were determined by ^{1}H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



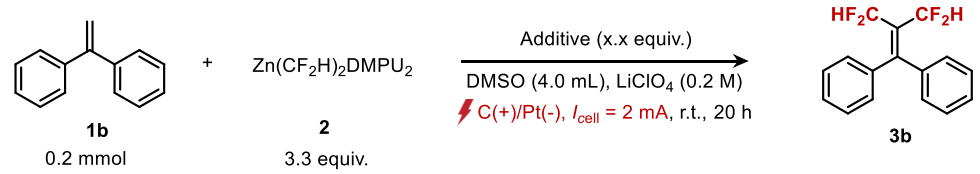
Entry	Additives	Yield (**3a**, %)
1	$ZnCl_2$	48
2	$Zn(OTf)_2$	14
3	Et_4NCl	0
4	$Zn(OTf)_2$ (4.0 equiv.), Et_4NCl (4.0 equiv.)	42

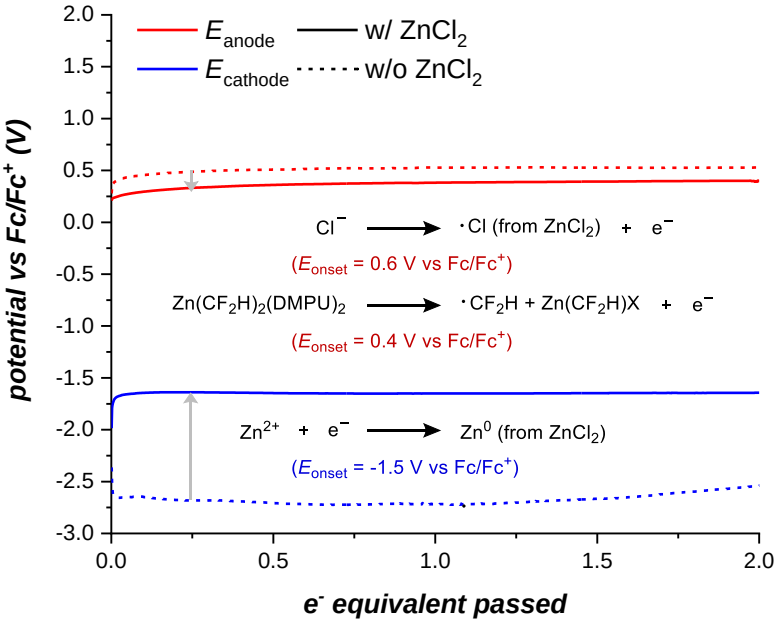
Supplementary Table 8. Additive studies

8. Voltammetric studies

8.1. General procedure for voltaic profile

An identical procedure was followed as described in **Section 3**, **Method A** with a Ag/Ag^+ quasi-reference electrode with 0.1 M $TBA{\cdot}ClO_4$ and 0.01 M $AgNO_3$ in MeCN. The reference electrode was calibrated against an internal standard of ferrocene (Fc) following electrolysis so that voltaic profiles could be referenced against Fc/Fc^+.

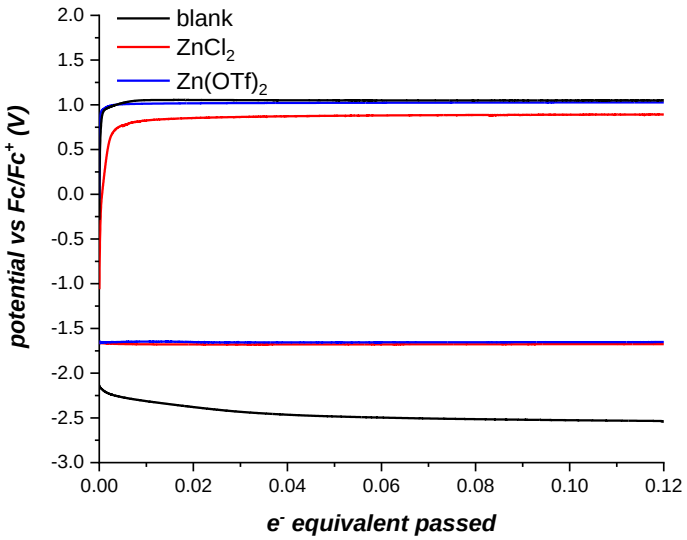




Supplementary Figure 10. Voltaic profile under the optimized reaction conditions

8.2. Voltaic profile of each reaction component

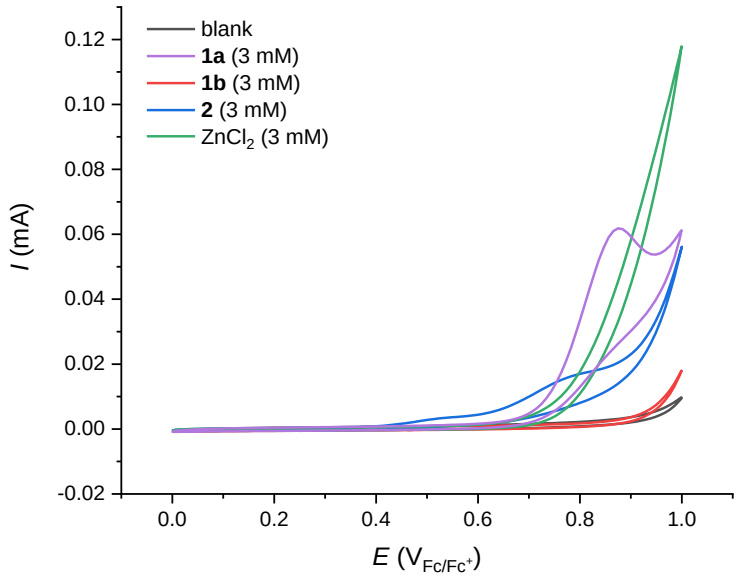
Voltaic profiles of the reaction components. An identical procedure was followed as described in **Section 3**, **Method A** with a Ag/Ag^+ quasi-reference electrode with 0.1 M $TBA{\cdot}ClO_4$ and 0.01 M $AgNO_3$ in MeCN. The blank profile was obtained in DMSO (4.0 mL) containing $LiClO_4$ (0.2 M) under constant current conditions (I_{cell} = 2 mA). Under identical conditions, profiles were measured upon addition of $ZnCl_2$ (0.8 mmol) or $Zn(OTf)_2$ (0.8 mmol). The reference electrode was calibrated against an internal standard of ferrocene (Fc) following electrolysis so that voltaic profiles could be referenced against Fc/Fc^+.



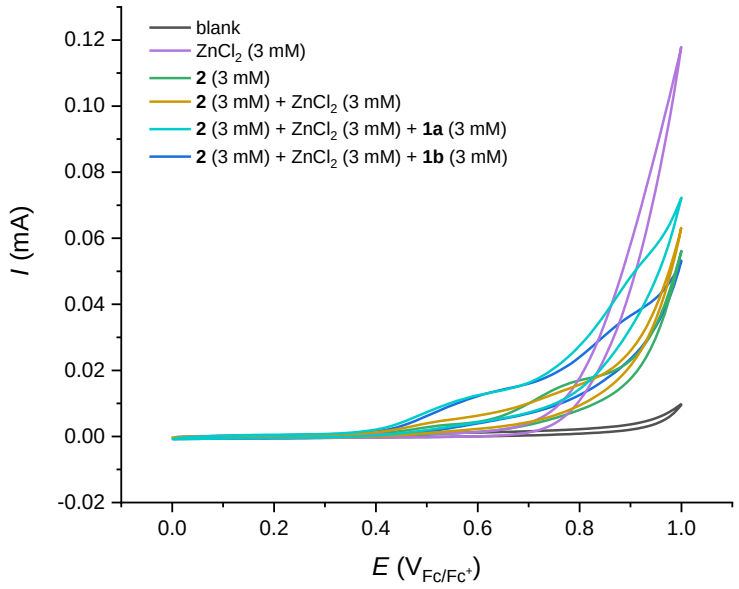
Supplementary Figure 11. Voltaic profile of each reaction component

8.3. General procedure for cyclic voltammetry

Cyclic voltammetry (CV) was conducted in a 10 mL glass vial fitted with a glassy carbon working electrode (3 mm in diameter), Ag/Ag^+ quasi-reference electrode with 0.1 M $TBAClO_4$ and 0.01 M $AgNO_3$ in MeCN, and a platinum wire counter electrode. The solution of interest was sparged with nitrogen for 10 minutes before data collection. The reference electrode was calibrated against an internal standard of ferrocene (Fc) following electrolysis so that voltaic profiles could be referenced against Fc/Fc^+.



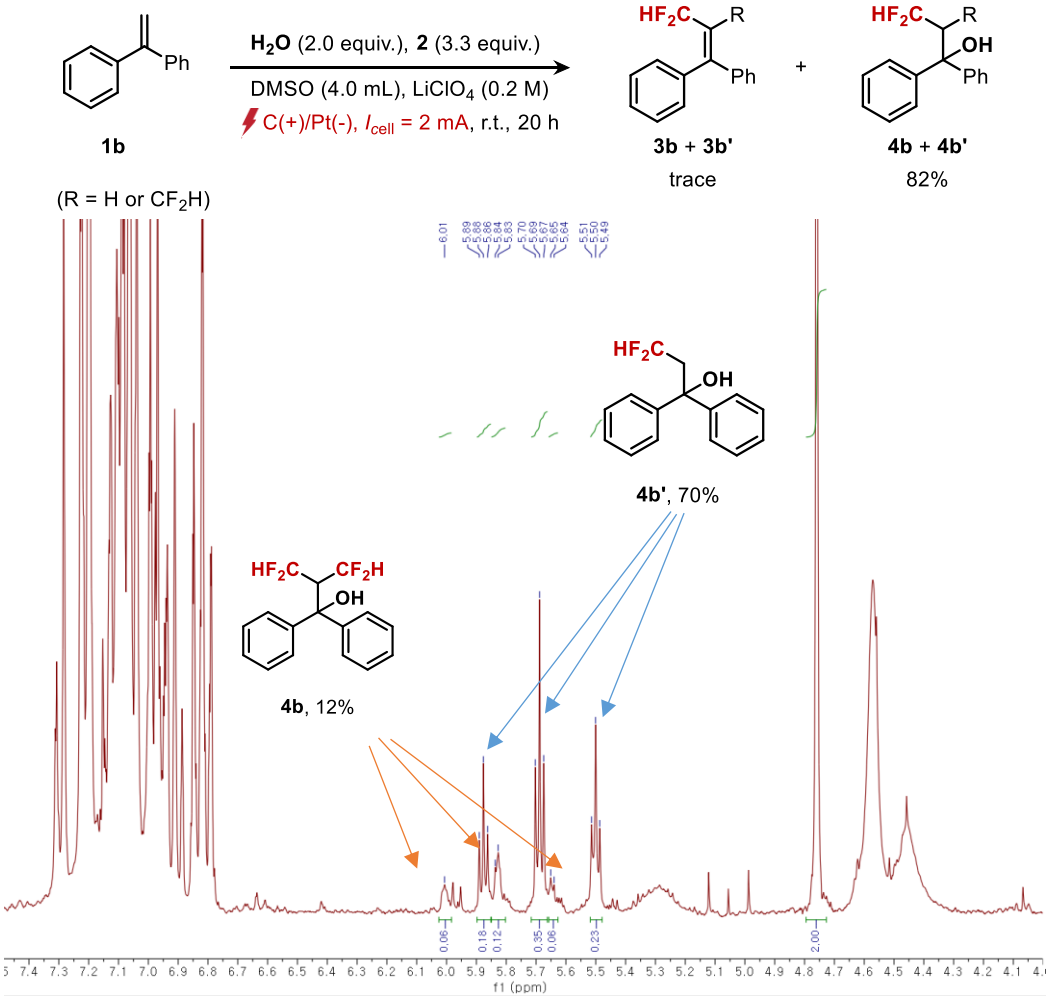
Supplementary Figure 12. Cyclic voltammograms of reaction components in DMSO. Conditions: $LiClO_4$ (0.10 M), black line; **1a** (3 mM), purple line; **1b** (3 mM), red line; **2** (3 mM), blue line; $ZnCl_2$ (3 mM), green line respectively. Scan rate: 50 mV s -1 .



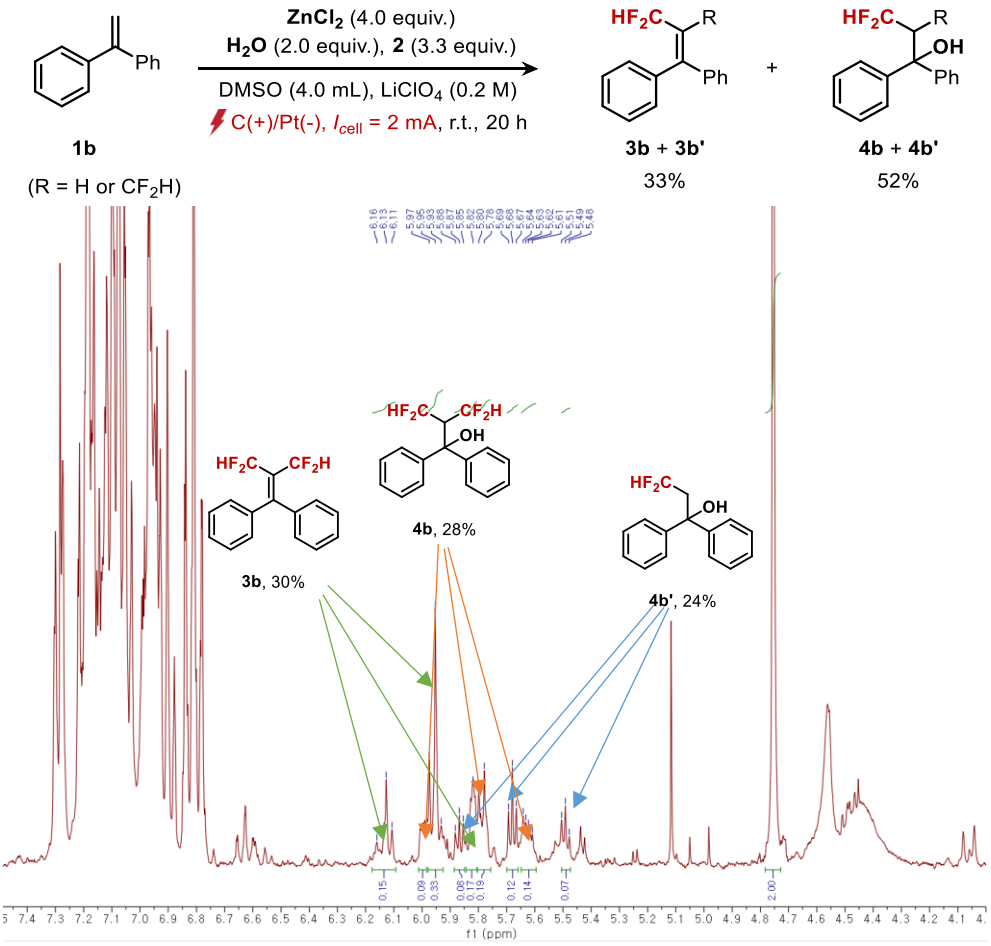
Supplementary Figure 13. Cyclic voltammograms of $ZnCl_2$, **2**, the mixture of **2** and $ZnCl_2$, the mixture of **2**, $ZnCl_2$, and **1a** and the mixture of **2**, $ZnCl_2$, and **1b** in DMSO. Conditions: $LiClO_4$ (0.10 M), $ZnCl_2$ (3 mM), purple line; **2** (3 mM), green line; **2** (3 mM) + $ZnCl_2$ (3 mM), yellow line; **2** (3 mM) + $ZnCl_2$ (3 mM) + **1a** (3 mM), sky blue line; and **2** (3 mM) + $ZnCl_2$ (3 mM) + **1a** (3 mM), blue line respectively. Scan rate: 50 mV s -1 .

9. Control studies on selectivity: H_2O-trapping effect of $ZnCl_2$

The procedure described in **Section 3**, **Method A** was followed either with $ZnCl_2$ (4.0 equiv) or without $ZnCl_2$; H_2O (2.0 equiv) was included in both cases. Yields were determined by ^1H NMR of the crude reaction mixture with CH_2Br_2 as the internal standard.



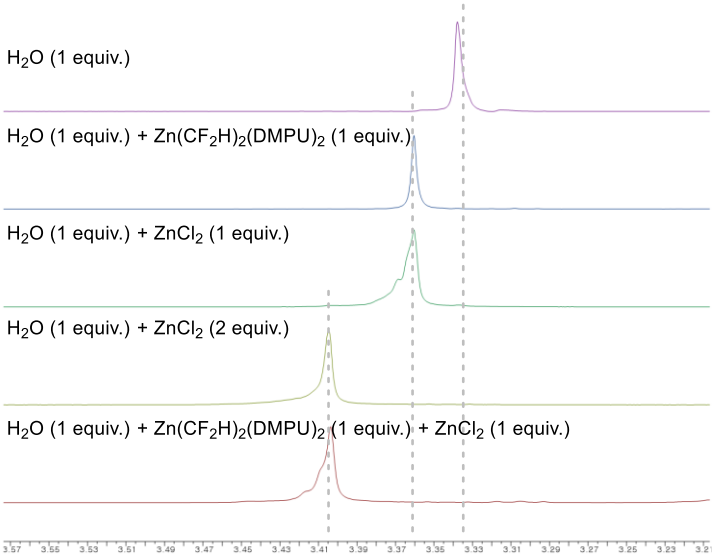
Supplementary Figure 14. ^1H NMR Spectrum of H_2O-trapping effect experiment crude mixture (**4b + 4b'**)



Supplementary Figure 15. ^{1}H NMR Spectrum of H_2O-trapping effect experiment crude mixture (**3b** + **4b** + **4b'**)

10. ^{1}H NMR analysis

Samples were prepared in DMSO-d_6 as follows: (i) H_2O (80 mM); (ii) H_2O (80 mM) + **2** (80 mM); (iii) H_2O (80 mM) + $ZnCl_2$ (80 mM); (iv) H_2O (80 mM) + $ZnCl_2$ (160 mM); (v) H_2O (80 mM) + **2** (80 mM) + $ZnCl_2$ (80 mM). Spectra were recorded under identical conditions.



Supplementary Figure 16. ^{1}H NMR peak-shift analysis

Section 7. Biological assay

1. Materials and methods

1.1 Cell Culture

Jurkat cells (KCLB, #40152, Korea) were purchased from Korean Cell Line Bank The cells were cultured in DMEM medium (Gibco, #11995065, USA) supplemented with 10% FBS (Gibco, #16000044, USA) and 1% penicillin-streptomycin solution (Gibco, #15140122, USA). Cells were cultured in a humidified incubator at 37°C with 5% CO2.

1.2. Cell viability assay

The Cell Counting Kit-8 (CCK-8, Dojindo, #CK04-20, Japan) was used to evaluate the viability of the Bexarotene derivative, **3y**. Jurkat cells were seeded into 96-well plates at a density of 20,000 cells/ml. After incubation in an incubator for 24 hours for stabilization, the cells were treated with various concentrations of the compound (100, 50, 10, 1, 0.5, and 0 μM) for 48 hours. Following the treatment, 10 μl of CCK-8 solution was added to each well and incubated for 3 hrs, according to the manufacturer's protocol. The optical density (OD) was measured at a wavelength of 450 nm using a SpectraMax® iD5 microplate reader (Molecular Devices, USA). Cell viability was calculated as the OD value of treated cells / OD value of control cells. The IC_{50} was calculated by fitting the dose–response curve, where the IC_{50} corresponds to the concentration causing 50% inhibition of viability by the 3y compound. The data were fitted using GraphPad Prism® 10.6.1 software.

1.3. Metabolic Stability in Liver Microsomes

The metabolic stability assay was performed to evaluate the in vitro stability of the test compounds using liver microsomes were supplied by Corning, specifically Mouse (Cat# 452701), Rat (Cat# 452501), and Mixed Gender Pooled 150-donor Human (Cat# 452117) microsomes. Microsomes (0.5 mg/mL), diluted in 0.5 M Potassium Phosphate buffer (pH 7.4), were pre-incubated at 37 ℃ for 5 minutes. The reaction was initiated by adding the test compound (1 μM, 10 mM in DMSO) and NADPH, followed by incubation of the mixture at 37 ℃ for 30 minutes. The reaction was terminated by adding cold acetonitrile containing an Internal Standard (IS) to induce protein precipitation. The resulting samples were then centrifuged at 4,000 rpm for 15 minutes at 4 ℃. A 100 μL aliquot of the resulting supernatant was collected and analyzed by LC-MS/MS to quantify the residual test compound concentration. The analysis system consisted of an Agilent 1260 HPLC coupled with an Agilent 6460 Mass Spectrometry system.

1.4. Plasma Stability Assay

The plasma stability assay was conducted using animal plasma obtained from Innovative Research. Test compounds were prepared as 10 mM stock solutions in DMSO and spiked into plasma to achieve a final concentration of 5 μM. The plasma samples were incubated in a shaking incubator at 37 °C for 4 h. The reaction was quenched by adding cold acetonitrile containing an internal standard (IS), followed by protein precipitation and centrifugation at 4,000 rpm for 15 min at 4 °C. The resulting supernatants were analyzed by LC–MS/MS, and plasma stability (%) was calculated based on the amount of the test compound remaining in each sample relative to the 0 h control. The analysis system consisted of an Agilent 1260 HPLC coupled with an Agilent 6460 Mass Spectrometry system.

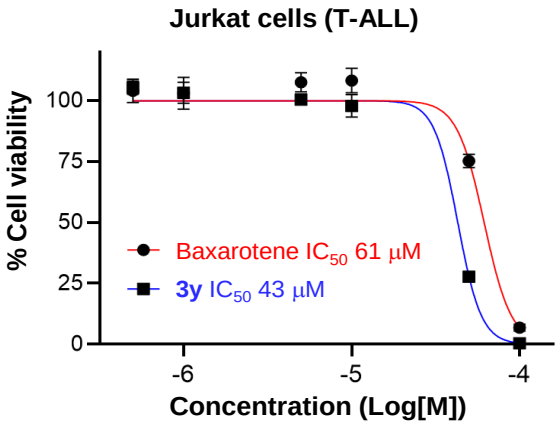
1.5. PAMPA Permeability Assay

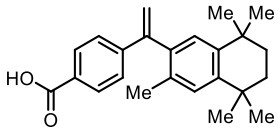
The PAMPA assay was performed using the pION Gut-Box system. Test compounds were prepared as 10 mM stock solutions in DMSO. Aliquots of DMSO, the 10 mM test compound solutions, and 10 mM propranolol (positive control) were dispensed into a pION Deep-Well plate (5 µL each, in triplicate). PBS buffer was added to each well (1 mL) to dilute the samples. The underside of the pION membrane plate was coated with 5 µL of GIT-0 lipid solution to fully wet the membrane. The diluted samples were then transferred to the bottom plate (200 µL per well), and 200 µL of ascending sink buffer (pION) was added to the acceptor side of the membrane plate. The membrane plate was placed onto the bottom plate and incubated in the Gut-Box under controlled humidity conditions for 4 h. After incubation, UV absorption spectra were recorded using a spectrophotometer in the order of Blank, Acceptor, Donor, and Reference, assisted by the PAMPA Explorer software. Following spectral acquisition, permeability values were calculated using the PAMPA Explorer software.

2. Results

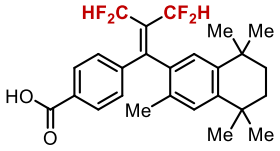
compound	PAMPA	Plasma stability[a]		Microsomal Stability[b]		
		mouse	human	mouse	Rat	human
Bexarotene	-4.824 (medium)	77.09	99.62	49.44	75.99	9.05
3y	-4.238 (medium)	>99	>99	1.84	55.01	1.26

[a] % of remaining after 4 h incubation at 37°C, [b] % remaining after 30 min





Bexarotene



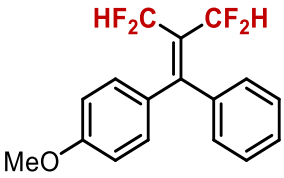
3y

	Baxarotene	**3y**
Permeability (PAMPA)	-4.824 (medium)	-4.238 (medium)
Microsomal Stability (m/r/h MS[a])	49/76/9	2/55/1
Plasma Stability (m/h PS[b])	77/99	>99/>99

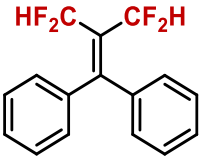
[a]m = mouse, r = rat, h = human, Liver microsomal phase I stability (% of remaining after 30 min). [b]Plasma stability (% of remaining after 4 h incubation at 37°C).

Supplementary Figure 17. Anti-cancer activity and pharmacokinetic properties of Baxarotene and its derivative (**3y**).

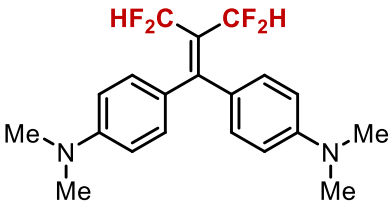
Section 8. Spectral Data for Products



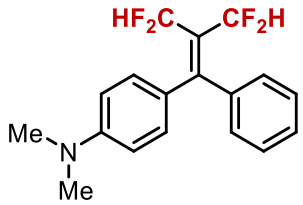
1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (3a). Method A. Purified using silica gel chromatography to give 82% yield of **3a** as a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 – 7.36 (m, 3H), 7.21 – 7.18 (m, 2H), 7.15 – 7.11 (m, 2H), 6.93 – 6.87 (m, 2H), 6.24 (t, *J* = 52.7 Hz, 1H), 6.15 (t, *J* = 52.7 Hz, 1H), 3.84 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.8 (s), 155.8 – 155.4 (m), 138.0 (s), 131.4 (s), 129.9 (s), 129.8 (s), 129.6 (s), 128.4 (s), 123.4 – 123.0 (m), 113.8 (s), 113.7 (t, *J* = 237.0 Hz), 55.3 (s); ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.8 (dt, *J* = 52.7, 8.2 Hz), -109.0 (dt, *J* = 52.8, 8.3 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{17}H_{14}F_4O^+$]: 310.0981, found 310.0984.



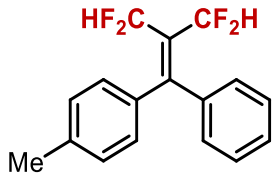
(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (3b). Method B. Purified using silica gel chromatography to give 64% yield of **3b** as a white solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 – 7.38 (m, 6H), 7.22 – 7.19 (m, 4H), 6.33 – 6.08 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 137.7, 137.6, 129.7, 129.6, 128.6, 128.5, 113.5 (td, *J* = 238.7, 9.9 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.5 – -109.7 (m); HRMS (EI) exact mass calculated for [M^+, $C_{16}H_{12}F_4^+$]: 280.0875, found 280.0875.



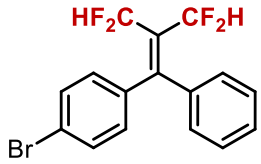
4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(N,N-dimethylaniline) (3c). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified on silica gel chromatography with Et_3N to enable isolation, giving 42% yield of **3c** as a green oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.13 – 7.01 (m, 4H), 6.76 – 6.60 (m, 4H), 6.41 – 6.02 (m, 2H), 3.00 (s, 12H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 157.1 – 157.0 (m), 151.1, 131.8, 125.8, 120.2 – 118.4 (m), 115.0 (t, *J* = 236.6 Hz), 111.1, 40.1; ^{19}F NMR (471 MHz, $CDCl_3$) δ -106.56 – -106.98 (m); HRMS (ESI) exact mass calculated for [[M+H]$^+$, $C_{20}H_{23}F_4N_2^+$]: 367.1797, found 367.1799.



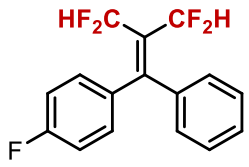
4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-N,N-dimethylaniline (3d). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography with Et_3N to enable isolation, giving 58% yield of **3d** as a yellow oil; ^1H NMR (500 MHz, $CDCl_3$) δ 7.47 – 7.34 (m, 3H), 7.22 – 7.19 (m, 2H), 7.09 – 7.01 (m, 2H), 6.69 – 6.62 (m, 2H), 6.46 – 5.97 (m, 2H), 3.00 (s, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 156.6 – 156.3 (m), 151.1, 138.6, 131.5, 130.1, 129.4, 128.6, 128.2, 121.5 – 121.1 (m), 114.3 (td, *J* = 236.4, 16.0 Hz), 111.2, 40.1; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.2 (ddt, *J* = 159.3, 52.9, 8.2 Hz); HRMS (ESI) exact mass calculated for [$[M+H]^+$, $C_{18}H_{18}F_4N^+$]: 324.1375, found 324.1374.



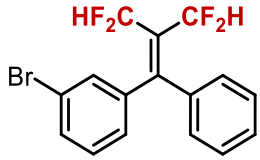
1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methylbenzene (3e). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 45% yield of **3e** as a white solid; ^1H NMR (851 MHz, $CDCl_3$) δ 7.42 – 7.37 (m, 3H), 7.20 – 7.18 (m, 4H), 7.09 – 7.08 (m, 2H), 6.29 – 6.11 (m, 2H), 2.38 (s, 3H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 156.1 – 155.9 (m), 139.9, 137.8, 134.7, 129.7, 129.5, 129.2, 128.4, 123.9 – 123.5 (m), 116.1 – 111.5 (m), 21.3; ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.0 – -109.6 (m); HRMS (EI) exact mass calculated for [M^+, $C_{17}H_{14}F_4^+$]: 294.1032, found 294.1034.



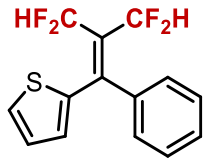
1-bromo-4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (3f). Method B. Purified using silica gel chromatography to give 41% yield of **3f** as a white solid; ^1H NMR (500 MHz, $CDCl_3$) δ 7.55 – 7.52 (m, 2H), 7.44 – 7.38 (m, 3H), 7.19 – 7.17 (m, 2H), 7.09 – 7.07 (m, 2H), 6.29 – 6.07 (m, 2H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 154.6 – 154.5 (m), 137.1, 136.5, 131.8, 131.2, 129.9, 129.6, 128.6, 124.8 – 124.6 (m), 124.3, 113.2 (td, *J* = 237.9, 46.4 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.3 – 109.7 (m); HRMS (EI) exact mass calculated for [M^+, $C_{16}H_{11}BrF_4^+$]: 357.9980, found 357.9978.



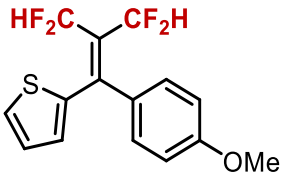
1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-fluorobenzene (3g). Method B. Purified using silica gel chromatography to give 50% yield of **3g** as a white soild; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.54 – 7.37 (m, 3H), 7.22 – 7.15 (m, 4H), 7.09 (m, 2H), 6.35 – 6.03 (m, 2H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 164.0, 162.8, 137.5, 133.6 (d, *J* = 3.5 Hz), 131.7 (d, *J* = 8.5 Hz), 129.8, 129.6, 128.6, 115.7 (d, *J* = 21.8 Hz), 113.3 (td, *J* = 237.6, 33.5 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.2 – -109.6 (m), -109.6 (ddd, *J* = 13.8, 8.6, 5.2 Hz); HRMS (APCI) exact mass calculated for [[M+H]$^+$, $C_{16}H_{12}F_5^+$]: 299.0859, found 299.0858.



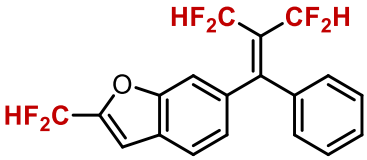
1-bromo-3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (3h). Method B. Purified using silica gel chromatography to give 22% yield of **3h** as a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (ddd, *J* = 8.1, 2.0, 1.0 Hz, 1H), 7.44 – 7.39 (m, 3H), 7.33 (t, *J* = 1.8 Hz, 1H), 7.29 (t, *J* = 7.9 Hz, 1H), 7.19 (dt, *J* = 7.5, 1.3 Hz, 3H), 6.28 – 6.08 (m, 2H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 154.2 – 154.0 (m), 139.5, 136.9, 132.7, 132.3, 130.0, 129.9, 129.5, 128.7, 128.1, 125.2 – 125.0 (m) 122.7, 113.0 (td, *J* = 238.8, 47.0 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.8 (ddt, *J* = 102.1, 52.7, 8.0 Hz); HRMS (EI) exact mass calculated for [M$^+$, $C_{16}H_{11}BrF_4^+$]: 357.9980, found 357.9978.



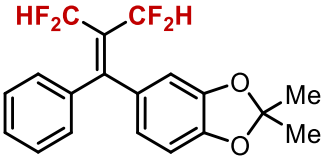
2-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)thiophene (3i). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 51% yield of **3i** as a white soild; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (dd, *J* = 5.2, 1.2 Hz, 1H), 7.50 – 7.38 (m, 3H), 7.32 (dd, *J* = 3.7, 1.2 Hz, 1H), 7.30 – 7.24 (m, 2H), 7.12 (dd, *J* = 5.1, 3.7 Hz, 1H), 6.49 (t, 1H), 6.08 (t, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 148.9 – 147.6 (m), 139.8, 137.6, 131.3, 130.8, 130.1, 129.7, 128.5, 127.4, 123.6 (t, *J* = 22.0 Hz), 113.5 (t, *J* = 237.7 Hz), 113.3 (t, *J* = 237.7 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.7– -109.5 (m); HRMS (EI) exact mass calculated for [M$^+$, $C_{14}H_{10}F_4S^+$]: 286.0439, found 286.0442.



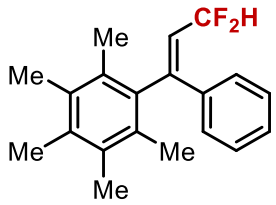
2-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)thiophene (3j). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 52% yield of **3j** as a white soild; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (dt, *J* = 5.2, 1.2 Hz, 1H), 7.32 (d, *J* = 3.7 Hz, 1H), 7.23 – 7.20 (m, 2H), 7.12 (ddd, *J* = 5.0, 3.6, 1.1 Hz, 1H), 6.94 – 6.91 (m, 2H), 6.54 – 6.01 (m, 2H), 3.86 (d, *J* = 1.2 Hz, 3H); ^{13}C NMR(214 MHz, $CDCl_3$) δ 161.1, 148.0 (p, *J* = 8.8 Hz), 140.3, 131.6, 131.4, 130.8, 129.8, 127.4, 122.7 (p, *J* = 21.9 Hz), 113.7 (td, *J* = 237.4, 56.4 Hz), 113.8, 55.4; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.4 (ddt, *J* = 203.5, 52.9, 8.4 Hz); HRMS (ESI) exact mass calculated for [[M+Na]$^+$, $C_{15}H_{12}F_4OSNa^+$]: 339.0437, found 339.0441.



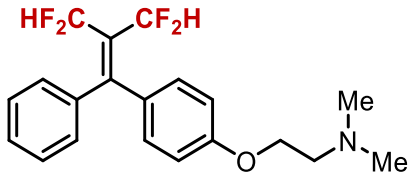
2-(difluoromethyl)-6-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzofuran (3k). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 39% yield of **3k** as a white solid; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.55 – 7.54 (m, 2H), 7.44 – 7.39 (m, 3H), 7.21 – 7.18 (m, 3H), 7.05 (s, 1H), 6.76 (m, 1H), 6.28 – 6.13 (m, 2H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 155.6 – 155.5 (m), 155.4, 137.7, 133.4, 129.8, 129.7, 128.6, 127.8, 126.8, 124.5 (t, *J* = 21.5 Hz), 123.7, 113.4 (td, *J* = 238.2, 13.9 Hz), 112.1, 108.4 (t, *J* = 236.8 Hz), 106.9 (t, *J* = 4.6 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.3 (ddt, *J* = 127.4, 52.8, 8.2 Hz), -116.1 (d, *J* = 53.7 Hz); HRMS (EI) exact mass calculated for [M$^+$, $C_{19}H_{12}F_6O^+$]: 370.0792, found 370.0795.



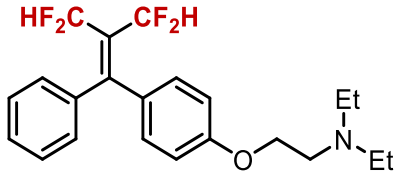
5-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-2,2-dimethylbenzo[d][1,3]dioxole (3l). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 32% yield of **3l** as a yellow oil; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.42 – 7.38 (m, 3H), 7.21 – 7.20 (m, 2H), 6.75 – 6.69 (m, 2H), 6.47 (d, *J* = 1.7 Hz, 1H), 6.35 – 6.23 (m, 1H), 6.18 – 6.06 (m, 1H), 1.68 (s, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 155.8 – 155.8 (m), 148.8, 147.6, 137.8, 130.6, 129.7, 129.6, 128.4, 123.7, 123.5 – 123.3 (m), 119.0, 113.7 (t, *J* = 237.4 Hz), 109.9, 107.8, 29.7, 25.9; ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.0 – -109.3 (m); HRMS (EI) exact mass calculated for [M$^+$, $C_{19}H_{16}F_4O_2^+$]: 352.1086, found 337.0854.



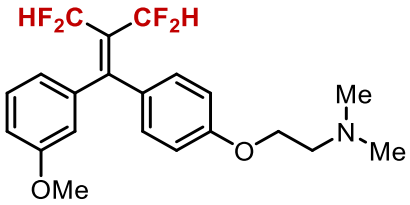
(*E*)-1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-2,3,4,5,6-pentamethylbenzene (3m'). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 67% yield of **3m'** as a white soild; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (s, 5H), 6.39 (q, *J* = 7.5 Hz, 1H), 5.93 – 5.57 (m, 1H), 2.29 (s, 3H), 2.23 (s, 6H), 2.04 (s, 6H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 150.1 – 149.9 (m), 138.0, 134.8, 133.2, 132.7, 131.2, 129.0, 128.6, 126.7, 119.1 (t, *J* = 26.3 Hz), 114.2 (t, *J* = 229.8 Hz), 17.6, 16.8, 16.5; ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.6 (dd, *J* = 56.0, 7.5 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{20}H_{22}F_2^+$]: 300.1690, found 300.1686.



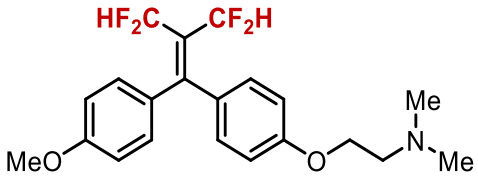
2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (3n). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 69% yield of **3n** as a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 – 7.32 (m, 3H), 7.18 (d, *J* = 7.1 Hz, 2H), 7.11 (d, *J* = 8.3 Hz, 2H), 6.91 (d, *J* = 8.3 Hz, 2H), 6.45 – 5.95 (m, 2H), 4.10 (t, *J* = 5.7 Hz, 2H), 2.76 (t, *J* = 5.7 Hz, 2H), 2.36 (s, 6H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.0, 138.0, 131.4, 130.0, 129.8, 129.6, 128.4, 128.7 – 128.1 (m), 114.4, 116.3 – 111.4 (m), 66.0, 58.1, 45.8; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.9 (ddt, *J* = 115.3, 52.9, 8.2 Hz); HRMS (ESI) exact mass calculated for [[M+H]$^+$, $C_{20}H_{22}F_4NO^+$]: 368.1637, found 368.1640.



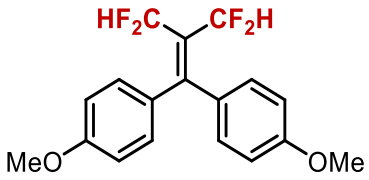
2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-diethylethan-1-amine (3o). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 48% yield of **3o** as a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 – 7.37 (m, 3H), 7.19 – 7.18 (m, 2H), 7.12 – 7.08 (m, 2H), 6.91 – 6.87 (m, 2H), 6.34 – 6.04 (m, 2H), 4.08 (t, *J* = 6.2 Hz, 2H), 2.90 (t, *J* = 6.2 Hz, 2H), 2.66 (q, *J* = 7.1 Hz, 4H), 1.08 (t, *J* = 7.1 Hz, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 160.0, 155.7 – 155.7 (m), 138.0, 131.4, 129.9, 129.8, 129.6, 128.4, 123.2 – 123.0 (m), 114.9 – 112.7 (m), 114.3, 66.6, 51.6, 47.8, 11.7; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.7 – 109.1 (m); HRMS (EI) exact mass calculated for [M^+, $C_{22}H_{25}F_4NO^+$]: 395.1872, found 395.1874.



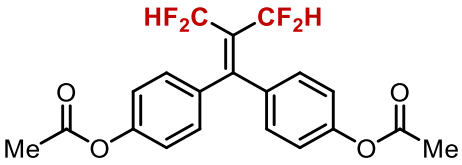
2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(3-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (3p). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 29% yield of **3p** as a yellow oil; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.29 (t, *J* = 7.9 Hz, 1H), 7.13 (d, *J* = 8.4 Hz, 2H), 6.98 – 6.90 (m, 3H), 6.75 (d, *J* = 7.5 Hz, 1H), 6.68 (t, *J* = 2.1 Hz, 1H), 6.30 – 6.04 (m, 2H), 4.42 (t, *J* = 4.9 Hz, 2H), 3.77 (s, 3H), 3.36 – 3.33 (m, 2H), 2.80 (s, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 159.4, 158.7, 155.3 – 155.2 (m), 139.0, 131.4, 130.6, 129.5, 123.6 – 123.4 (m), 122.1, 115.3, 115.2, 114.5, 113.6 (td, *J* = 237.8, 18.8 Hz), 63.8, 57.2, 55.3, 44.6; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.8 – 109.4 (m); HRMS (EI) exact mass calculated for [M^+, $C_{21}H_{23}F_4NO_2^+$]: 397.1665, found 397.1662.



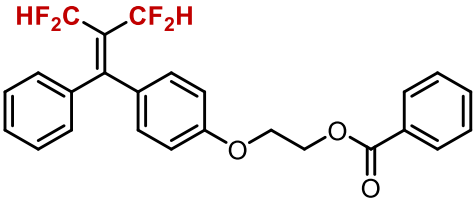
2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (3q). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 66% yield of **3q** as a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.11 – 7.08 (m, 4H), 6.97 – 6.82 (m, 4H), 6.28 – 6.04 (m, 2H), 4.40 (t, *J* = 5.0 Hz, 2H), 3.82 (s, 3H), 3.34 (t, *J* = 5.0 Hz, 2H), 2.80 (s, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 160.8, 158.8, 155.3 (m), 131.7, 131.6, 131.2, 123.0, 122.3 (m), 114.4, 113.9 (td, *J* = 237.0, 10.7 Hz), 113.8, 63.9, 57.3, 55.3, 44.8; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.1 – -108.4 (m); HRMS (EI) exact mass calculated for [M^+, $C_{21}H_{23}F_4NO_2^+$]: 397.1665, found 397.1663.



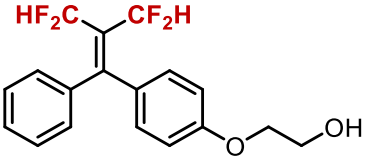
4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(methoxybenzene) (3r). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 84% yield of **3r** as a yellow solid; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.13 – 7.11 (m, 4H), 6.91 – 6.89 (m, 4H), 6.27 – 6.12 (m, 2H), 3.84 (s, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 160.7, 155.6 – 155.4 (m), 131.6, 130.3, 122.4 – 122.0 (m), 115.2 – 112.9 (m), 113.7, 55.3; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.2 – -108.3 (m); HRMS (ESI) exact mass calculated for [[M+Na]$^+$, $C_{18}H_{16}F_4O_2Na^+$]: 363.0984, found 363.0980.



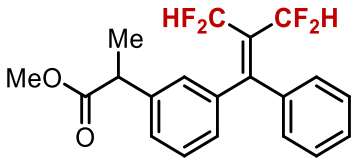
(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(4,1-phenylene) diacetate (3s). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 27% yield of **3s** as a dark brown solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.23 – 7.20 (m, 4H), 7.15 – 7.12 (m, 4H), 6.32 – 6.07 (m, 2H), 2.31 (s, 1H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 169.0, 154.0 – 153.9 (m), 151.7, 134.8, 131.0, 121.8, 114.4 – 112.1 (m), 21.1; ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.3 – -109.4 (m); HRMS (EI) exact mass calculated for [M^+, $C_{20}H_{16}F_4O_4^+$]: 396.0985, found 396.0987.



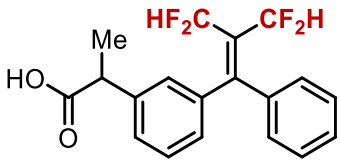
2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethyl benzoate (3t). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 41% yield of **3t** as a yellow oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.07 – 8.04 (m, 2H), 7.63 – 7.52 (m, 1H), 7.49 – 7.36 (m, 5H), 7.23 – 7.08 (m, 4H), 7.00 – 6.86 (m, 2H), 6.50 – 5.92 (m, 2H), 4.69 (t, *J* = 4.7 Hz, 2H), 4.34 (t, *J* = 4.7 Hz, 2H); ^{13}C NMR (151 MHz, $CDCl_3$) δ 166.5, 159.7, 156.2 – 154.7 (m), 137.9, 133.2, 131.5, 130.4, 129.8, 129.8, 129.7, 129.6, 128.4, 128.4, 123.6 – 123.1 (m), 114.5, 115.8 – 111.7 (m), 66.1, 63.1; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.9 (ddt, *J* = 129.4, 52.8, 8.1 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{25}H_{20}F_4O_3^+$]: 444.1349, found 444.1346.



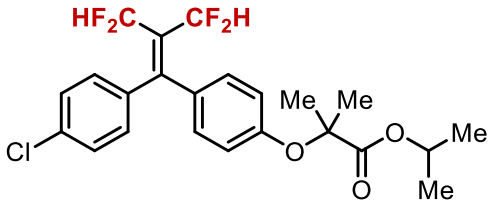
2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethan-1-ol (3u). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 86% yield of **3u** as a red oil; ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.42 – 7.37 (m, 3H), 7.20 – 7.18 (m, 2H), 7.15 – 7.11 (m, 2H), 6.94 – 6.90 (m, 2H), 6.33 – 6.04 (m, 2H), 4.13 – 4.09 (m, 2H), 3.98 (q, *J* = 4.7 Hz, 2H), 2.11 – 2.09 (m, 1H); ^{13}C NMR (151 MHz, $CDCl_3$) δ 159.8, 155.6 (p, *J* = 8.9 Hz), 137.9, 131.5, 130.3, 129.8, 129.6, 128.4, 123.3 (p, *J* = 21.7 Hz), 114.4, 115.9 – 111.5 (m), 69.3, 61.3; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.9 (ddt, *J* = 128.6, 53.3, 8.0 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{18}H_{16}F_4O_2^+$]: 340.1086, found 340.1089.



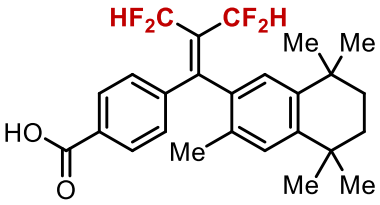
methyl 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoate (3v). Method B. Purified using silica gel chromatography to give 42% yield of **3v** as a colorless oil; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.44 – 7.37 (m, 3H), 7.37 – 7.32 (m, 2H), 7.21 – 7.18 (m, 2H), 7.14 (t, *J* = 1.8 Hz, 1H), 7.07 (dt, *J* = 7.0, 1.7 Hz, 1H), 6.32 – 6.06 (m, 2H), 3.72 (q, *J* = 7.2 Hz, 1H), 3.66 (s, 3H), 1.49 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 174.4, 155.7 – 155.6 (m), 140.9, 137.9, 137.4, 129.7, 129.6, 128.9, 128.8, 128.7, 128.5, 128.4, 124.5 – 124.1 (m), 113.4 (td, *J* = 238.2, 3.6 Hz), 52.1, 45.2, 18.4; ^{19}F NMR (471 MHz, $CDCl_3$) δ -109.34 – -109.70 (m); HRMS (ESI) exact mass calculated for [[M+Na]$^+$, $C_{20}H_{18}F_4O_2Na^+$]: 389.1135, found 389.1141.



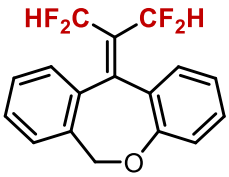
2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoic acid (3w). Method B. Purified using silica gel chromatography to give 44% yield of **3w** as a colorless oil; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.43 – 7.37 (m, 4H), 7.36 – 7.34 (m, 1H), 7.21 – 7.18 (m, 2H), 7.18 – 7.17 (m, 1H), 7.09 – 7.07 (m, 1H), 6.28 – 6.04 (m, 2H), 3.74 (q, *J* = 7.2 Hz, 1H), 2.65 (s, 1H), 1.51 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 179.3, 155.6 – 155.5 (m), 140.3, 137.9, 137.3, 129.7, 129.6, 129.0, 128.8, 128.8, 128.7, 128.5, 124.6 – 124.2 (m), 113.4 (t, *J* = 237.9 Hz), 45.0, 18.1; ^{19}F NMR (471 MHz, $CDCl_3$) δ -107.65 – -110.41 (m); HRMS (ESI) exact mass calculated for [[M+Na]$^+$, $C_{19}H_{16}F_4O_2Na^+$]: 375.0978, found 375.0982.



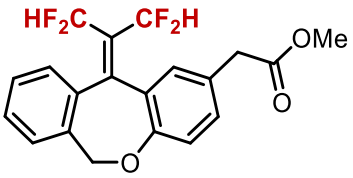
isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (3x). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 62% yield of **3x** as a white soild; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.42 – 7.33 (m, 2H), 7.16 – 7.10 (m, 2H), 7.07 – 7.02 (m, 2H), 6.84 – 6.77 (m, 2H), 6.30 – 6.03 (m, 2H), 5.08 (hept, *J* = 6.3 Hz, 1H), 1.62 (s, 6H), 1.20 (d, *J* = 6.4 Hz, 6H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 173.1, 157.2, 154.3 – 154.1 (m), 136.3, 136.0, 131.2, 131.0, 130.1, 128.7, 123.8 (p, *J* = 21.8 Hz), 117.8, 115.6 – 110.5 (m), 79.3, 69.2, 25.4, 21.5; ^{19}F NMR (471 MHz, $CDCl_3$) δ -108.8 – 109.0 (m); HRMS (EI) exact mass calculated for [M$^+$, $C_{23}H_{23}ClF_4O_3^+$]: 458.1272, found 458.1273.



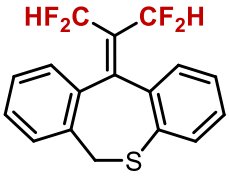
4-(2-(difluoromethyl)-3,3-difluoro-1-(3,5,5,8,8-pentamethyl-5,6,7,8-tetrahydronaphthalen-2-yl)prop-1-en-1-yl)benzoic acid (3y). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 60% yield of **3y** as a yellow soild; ^{1}H NMR (851 MHz, $CDCl_3$) δ 8.01 (d, *J* = 8.1 Hz, 2H), 7.27 (d, *J* = 7.9 Hz, 2H), 7.13 (s, 1H), 7.02 (s, 1H), 6.39 – 5.86 (m, 2H), 1.83 (s, 3H), 1.68 (p, *J* = 6.4 Hz, 4H), 1.29 – 1.26 (m, 12H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 171.3, 155.5 – 155.3 (m), 146.5, 142.7, 141.0, 133.2, 132.2, 129.8, 129.4, 129.0, 128.1, 125.9 (t, *J* = 21.3 Hz), 113.1 (td, *J* = 238.2, 119.3 Hz), 34.9, 34.9, 34.1, 33.9, 31.8, 31.7, 31.7, 31.6, 19.5; ^{19}F NMR (471 MHz, $CDCl_3$) δ -104.7 (ddd, *J* = 318.1, 53.7, 7.4 Hz), -106.1 (ddd, *J* = 319.0, 53.7, 9.6 Hz), -114.6 (ddt, *J* = 318.2, 52.0, 9.5 Hz), -116.9 (ddt, *J* = 318.9, 52.5, 8.6 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{26}H_{28}F_4O_2^+$]: 448.2025, found 448.2028.



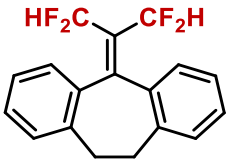
11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepine (3z). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 36% yield of **3z** as a white soild; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 – 7.40 (m, 3H), 7.31 – 7.27 (m, 2H), 7.14 – 7.11 (m, 1H), 6.95 – 6.92 (m, 1H), 6.86 – 6.84 (m, 1H), 6.76 – 6.33 (m, 2H), 5.56 (d, *J* = 12.9 Hz, 1H), 4.89 (d, *J* = 12.8 Hz, 1H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 154.7, 153.6 – 153.2 (m), 138.8, 131.8, 131.5, 130.1, 129.7, 129.3, 129.0, 125.6, 121.0, 120.8, 120.3, 119.8, 112.9 (t, *J* = 237.5 Hz), 112.0 (t, *J* = 238.9 Hz), 69.2; ^{19}F NMR (471 MHz, $CDCl_3$) δ -110.0 (ddd, *J* = 53.7, 14.9, 4.3 Hz), -110.6 – -110.8 (m), -111.4 (dt, *J* = 52.7, 4.2 Hz), -112.2 (ddd, *J* = 52.8, 15.2, 6.1 Hz), -112.9 (ddd, *J* = 52.8, 14.8, 6.1 Hz), -114.2 (dt, *J* = 52.8, 5.1 Hz), -114.9 (dt, *J* = 52.8, 5.1 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{17}H_{12}F_4O^+$]: 308.0824, found 308.0822.



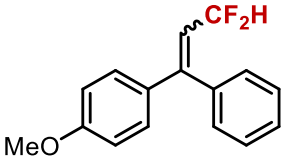
methyl 2-(11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (3aa). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 36% yield of **3aa** as a yellow oil; ^{1}H NMR (851 MHz, $CDCl_3$) δ 7.42 – 7.40 (m, 3H), 7.32 – 7.27 (m, 1H), 7.18 (dd, *J* = 8.5, 2.3 Hz, 1H), 7.04 (d, *J* = 2.3 Hz, 1H), 6.81 (d, *J* = 8.5 Hz, 1H), 6.73 – 6.35 (m, 2H), 5.53 (d, *J* = 12.8 Hz, 1H), 4.88 (d, *J* = 12.8 Hz, 1H), 3.70 (s, 3H), 3.63 – 3.50 (m, 2H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 171.7, 153.8, 153.0 – 152.8 (m), 138.7, 132.7, 131.5, 130.8, 129.7, 129.4, 129.0, 126.3, 125.7, 125.1 – 124.7 (m), 120.8, 120.5, 112.4 (td, *J* = 238.2, 189.8 Hz), 69.2, 52.1, 39.9; ^{19}F NMR (471 MHz, $CDCl_3$) δ -110.1 (ddd, *J* = 53.7, 13.9, 5.2 Hz), -110.8 (ddd, *J* = 53.6, 14.0, 5.2 Hz), -111.0 (dt, *J* = 53.0, 4.6 Hz), -111.7 (dt, *J* = 52.6, 4.8 Hz), -112.1 (ddd, *J* = 52.8, 14.2, 5.8 Hz), -112.8 (ddd, *J* = 52.8, 14.0, 5.9 Hz), -114.2 (dt, *J* = 52.7, 5.0 Hz), -114.8 (dt, *J* = 52.8, 5.0 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{20}H_{16}F_4O_3^+$]: 380.1036, found 380.1037.



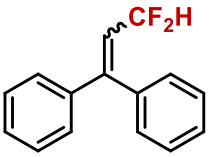
11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]thiepine (3ab). Method A was followed with $ZnCl_2$ (4.0 equiv). Purified using silica gel chromatography to give 34% yield of **3ab** as a white solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 – 7.30 (m, 3H), 7.21 – 7.09 (m, 5H), 6.57 – 6.19 (m, 2H), 4.76 (d, *J* = 14.1 Hz, 1H), 3.51 (d, *J* = 14.1 Hz, 1H); ^{13}C NMR (214 MHz, $CDCl_3$) δ 154.2 – 154.0 (m), 136.7, 134.9, 133.2, 130.8, 130.0, 129.9, 129.7, 128.5, 128.0, 127.4, 126.6 – 126.4 (m), 125.7, 124.7, 113.7 – 110.8 (m), 32.7; ^{19}F NMR (471 MHz, $CDCl_3$) δ -110.0 (ddt, *J* = 320.7, 53.5, 4.1 Hz), -110.8 (dddd, *J* = 320.1, 53.8, 11.2, 3.1 Hz), -114.7 (dddd, *J* = 321.3, 52.7, 11.4, 7.8 Hz), -117.8 (ddt, *J* = 320.1, 52.4, 6.5 Hz); HRMS (ESI) exact mass calculated for [[M+H]$^+$, $C_{17}H_{13}F_4S^+$]: 325.0669, found 325.0669.



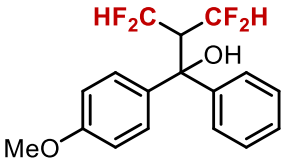
5-(1,1,3,3-tetrafluoropropan-2-ylidene)-10,11-dihydro-5H-dibenzo[a,d][7]annulene (3ac). Method A was followed with $ZnCl_2$ (6.0 equiv). Purified using silica gel chromatography to give 41% yield of **3ac** as a white solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.33 (m, 1H), 7.30 – 7.27 (m, 1H), 7.25 – 7.16 (m, 5H), 7.11 – 7.10 (m, 1H), 6.19 – 5.95 (m, 2H), 3.40 – 3.33 (m, 2H), 3.01 – 2.86 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 152.6 – 152.4 (m), 139.0, 138.7, 137.5, 137.4, 130.3, 128.9, 128.5, 128.4, 128.2, 128.1, 126.4, 126.2, 124.8 – 120.9 (m), 113.4 (t, *J* = 229.7 Hz), 33.4, 31.9; ^{19}F NMR (471 MHz, $CDCl_3$) δ -104.00 – -111.13 (m); HRMS (APCI) exact mass calculated for [[M+Na]$^+$, $C_{18}H_{14}F_4Na^+$]: 329.0924, found 329.0914.



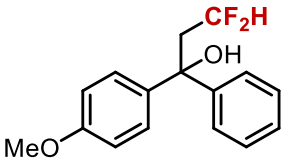
1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (3a'). Method A was followed using **2** (1.1 equiv) for 6 h in the absence of $ZnCl_2$. Purified using silica gel chromatography to give 70% yield of **3a'** as a white solid; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.46 – 7.31 (m, 3H), 7.31 – 7.12 (m, 4H), 6.99 – 6.79 (m, 2H), 6.36 – 5.71 (m, 2H), 3.84 (d, *J* = 11.2 Hz, 4H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 160.2 (d, *J* = 52.0 Hz), 151.1 – 149.8 (m), 141.0 – 137.1 (m), 132.5 – 129.7 (m), 130.4 (d, *J* = 213.4 Hz), 129.1 (d, *J* = 46.0 Hz), 128.5 (d, *J* = 21.2 Hz), 128.3 (d, *J* = 24.1 Hz), 118.9 (dt, *J* = 172.2, 26.6 Hz), 116.2 – 111.4 (m), 55.3; ^{19}F NMR (471 MHz, $CDCl_3$) δ -105.3 (d, *J* = 69.7 Hz); HRMS (APCI) exact mass calculated for [[M+H]$^+$, $C_{16}H_{15}F_2O^+$]: 261.1091, found 261.1092.



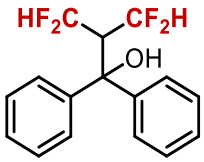
(3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (3bᴵ). Method A was followed using **2** (1.1 equiv) for 7 h in the absence of $ZnCl_2$. Purified using silica gel chromatography to give 74% yield of **3bᴵ** as a white solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 – 7.41 (m, 3H), 7.38 – 7.32 (m, 3H), 7.31 – 7.28 (m, 2H), 7.27 – 7.22 (m, 2H), 6.30 – 5.87 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 150.6 (t, *J* = 12.9 Hz), 140.1, 137.2, 129.8, 129.0, 128.7, 128.4, 128.4, 128.0, 120.1 (t, *J* = 26.6 Hz), 113.7 (t, *J* = 229.4 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -105.9 (dt, *J* = 55.4, 9.2 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{15}H_{12}F_2^+$]: 230.0907, found 230.0908.



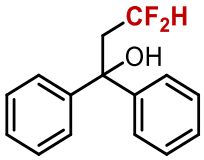
2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (4a). Method C was followed with H_2O (10.0 equiv). Purified using silica gel chromatography to give **4bᴵ** as a colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 – 7.46 (m, 2H), 7.43 – 7.39 (m, 2H), 7.37 – 7.34 (m, 2H), 7.29 – 7.21 (m, 1H), 6.93 – 6.83 (m, 2H), 6.24 – 5.85 (m, 2H), 3.78 (s, 3H), 3.74 – 3.58 (m, 1H), 3.06 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.9, 144.0, 135.8, 128.7, 127.5, 126.3, 124.9, 117.8 – 113.1 (m), 114.1, 55.2, 53.5 – 53.1 (m); ^{19}F NMR (471 MHz, $CDCl_3$) δ -113.7 – -115.6 (m), -118.8 – -120.3 (m); HRMS (APCI) exact mass calculated for [[M-H]$^-$, $C_{17}H_{15}F_4O_2^-$]: 327.1013, found 327.1009.



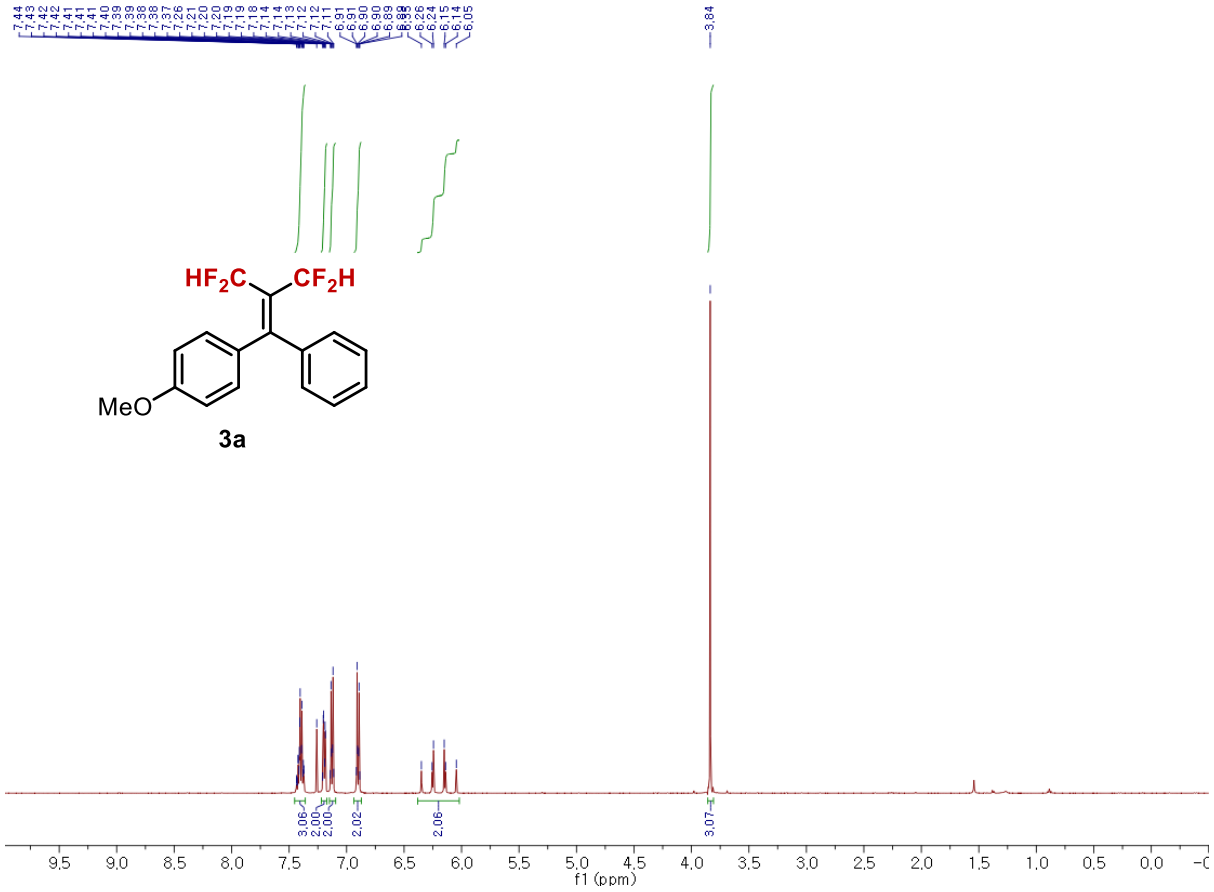
3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (4aᴵ). Method A was followed with H_2O (10.0 equiv) for 6 h in the absence of $ZnCl_2$. Purified using silica gel chromatography to give **4aᴵ** as a green oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 – 7.37 (m, 2H), 7.38 – 7.28 (m, 4H), 7.28 – 7.24 (m, 1H), 6.90 – 6.83 (m, 2H), 5.99 – 5.65 (m, 1H), 3.79 (s, 3H), 2.87 (tdd, *J* = 15.9, 4.5, 0.9 Hz, 2H), 2.57 (s, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.8, 145.6, 137.8, 128.4, 127.4, 127.0, 125.7, 116.5 (t, *J* = 238.5 Hz), 113.8, 75.6 (t, *J* = 5.9 Hz), 55.2, 46.1 (t, *J* = 20.2 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -110.6 (dtd, *J* = 56.3, 15.7, 4.8 Hz); HRMS (APCI) exact mass calculated for [[M-H]$^-$, $C_{16}H_{15}F_2O_2^-$]: 277.1045, found 277.1035.



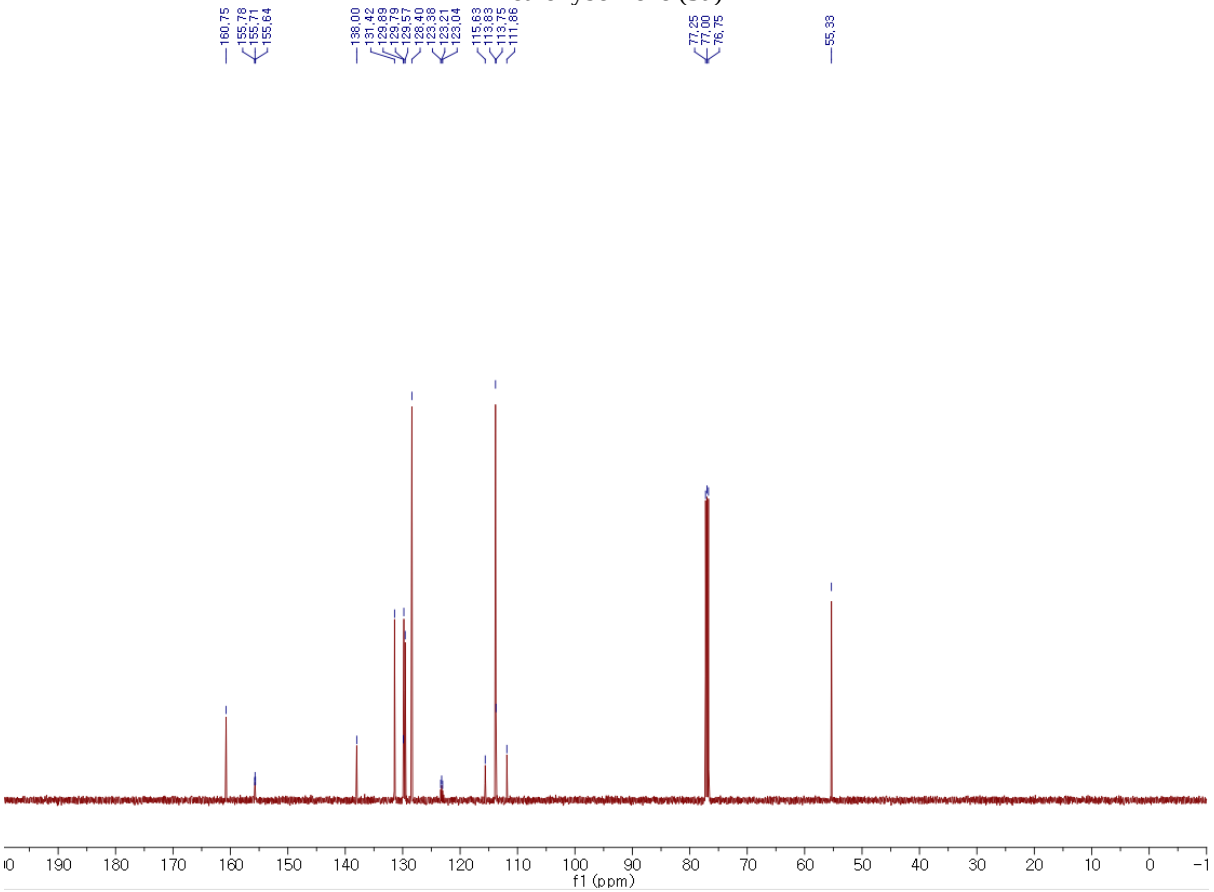
2-(difluoromethyl)-3,3-difluoro-1,1-diphenylpropan-1-ol (4b). Method C. Purified using silica gel chromatography to give 72% yield of **4b'** as a yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.8 Hz, 4H), 7.35 (t, *J* = 7.7 Hz, 4H), 7.25 (t, *J* = 7.3 Hz, 2H), 6.15 – 5.84 (m, 2H), 3.82 – 3.57 (m, 1H), 3.06 (s, 1H); ^{13}C NMR (126 MHz, CDCl3) δ 143.7, 128.8, 127.7, 124.9, 118.9 – 110.9 (m), 53.2 (p, J = 17.5 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -113.1 – -115.6 (m), -118.2 – -120.2 (m); HRMS (EI) exact mass calculated for [M^+, $C_{16}H_{14}F_4O^+$]: 298.0981, found 298.0983.



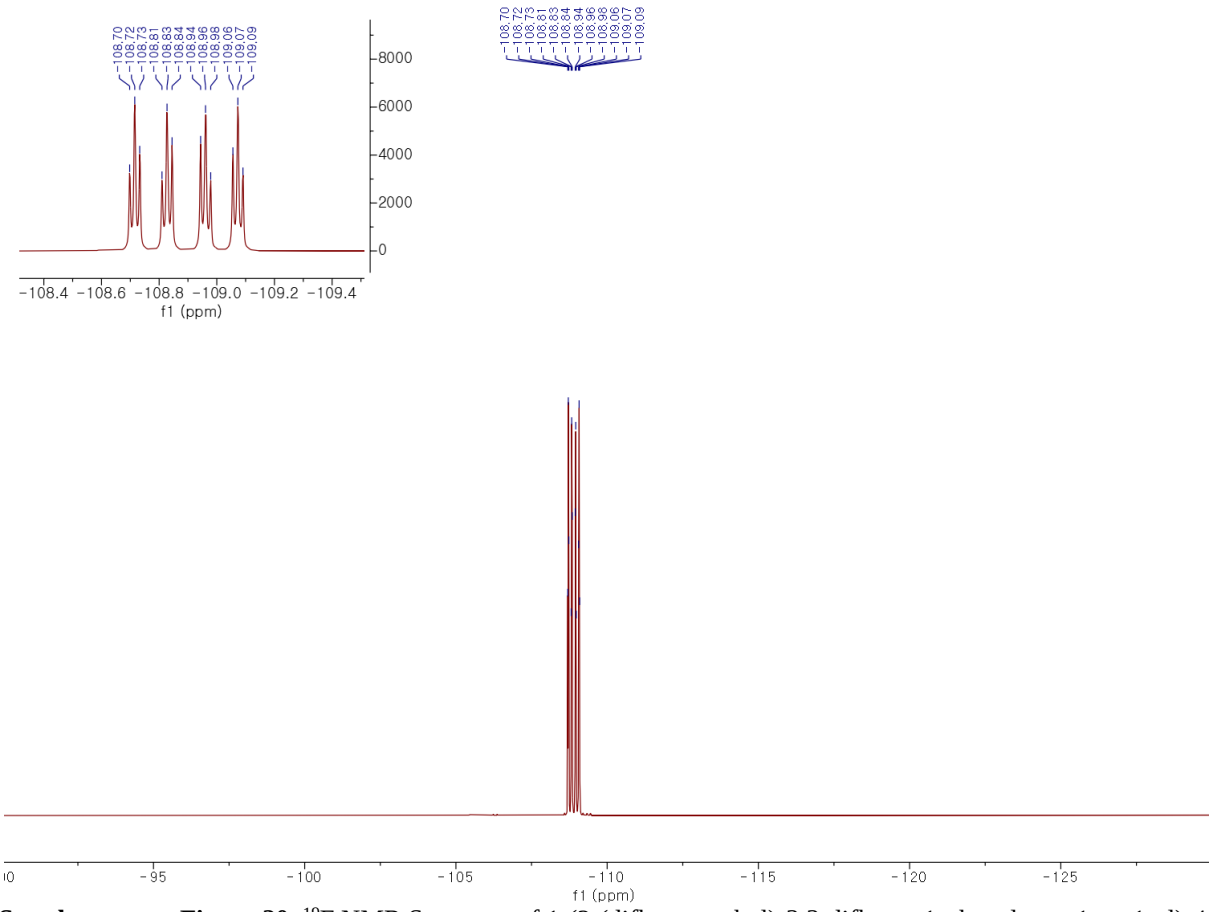
3,3-difluoro-1,1-diphenylpropan-1-ol (4b'). Method A was followed with H_2O (10.0 equiv) for 6 h in the absence of $ZnCl_2$. Purified using silica gel chromatography to give 52% yield of **4b'** as a yellow oil; ^{1}H NMR (300 MHz, $CDCl_3$) δ 7.45 – 7.23 (m, 10H), 6.04 – 5.59 (m, 1H), 2.91 (td, *J* = 15.8, 4.5 Hz, 2H), 2.57 (t, *J* = 1.9 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 145.5, 128.5, 127.5, 125.7, 116.4 (t, *J* = 238.6 Hz), 75.9 – 75.8 (m), 46.0 (t, *J* = 20.4 Hz); ^{19}F NMR (471 MHz, $CDCl_3$) δ -110.6 (dt, *J* = 56.0, 15.7 Hz); HRMS (EI) exact mass calculated for [M^+, $C_{15}H_{14}F_2O^+$]: 248.1013, found 248.1016.



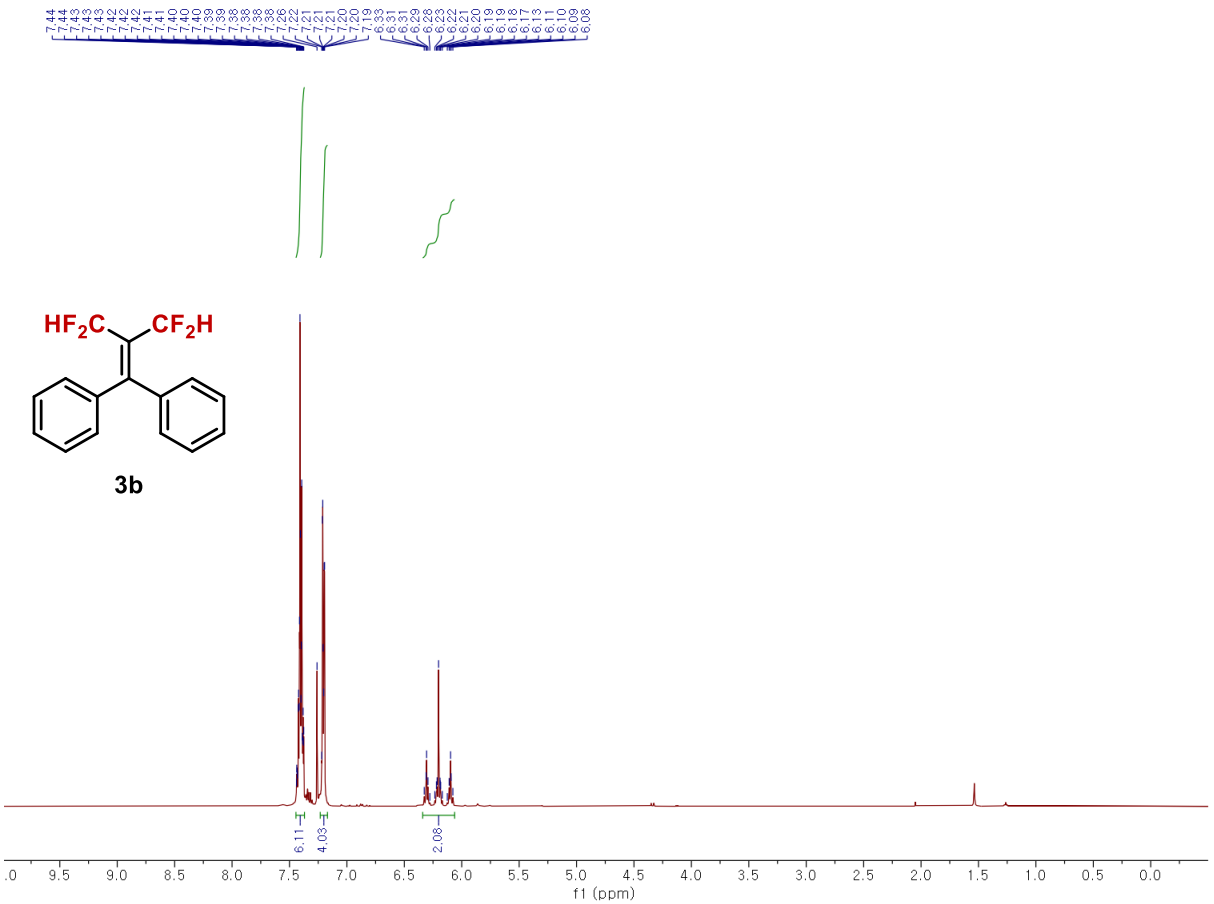
Supplementary Figure 18. ^{1}H NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (**3a**)



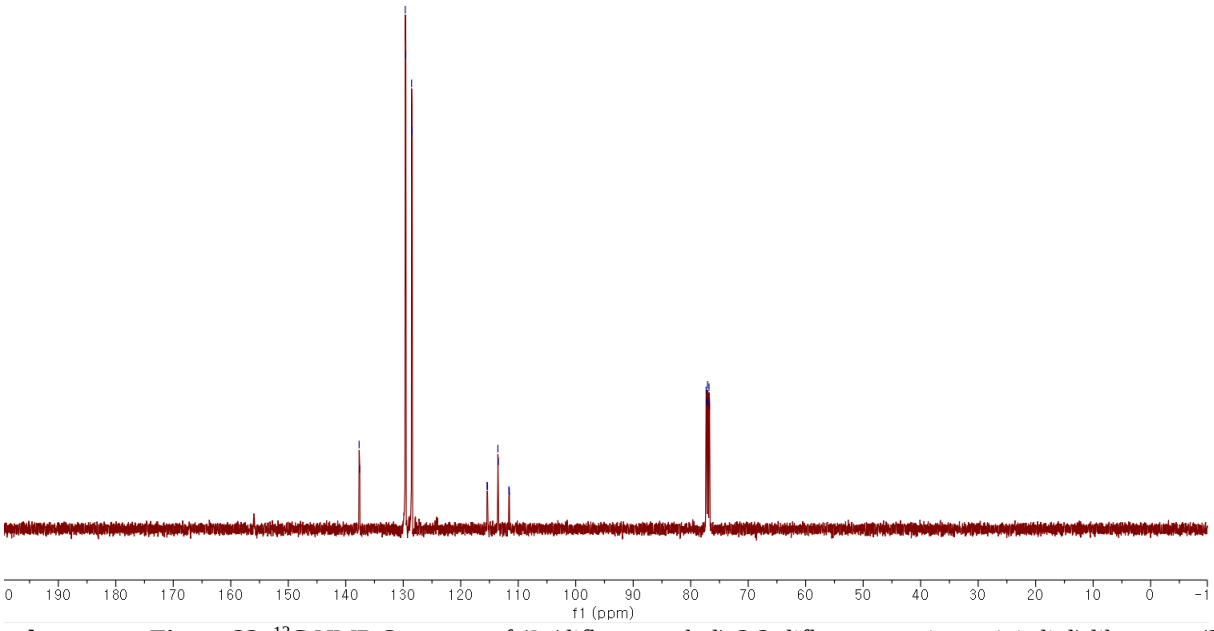
Supplementary Figure 19. ^{13}C NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (**3a**)



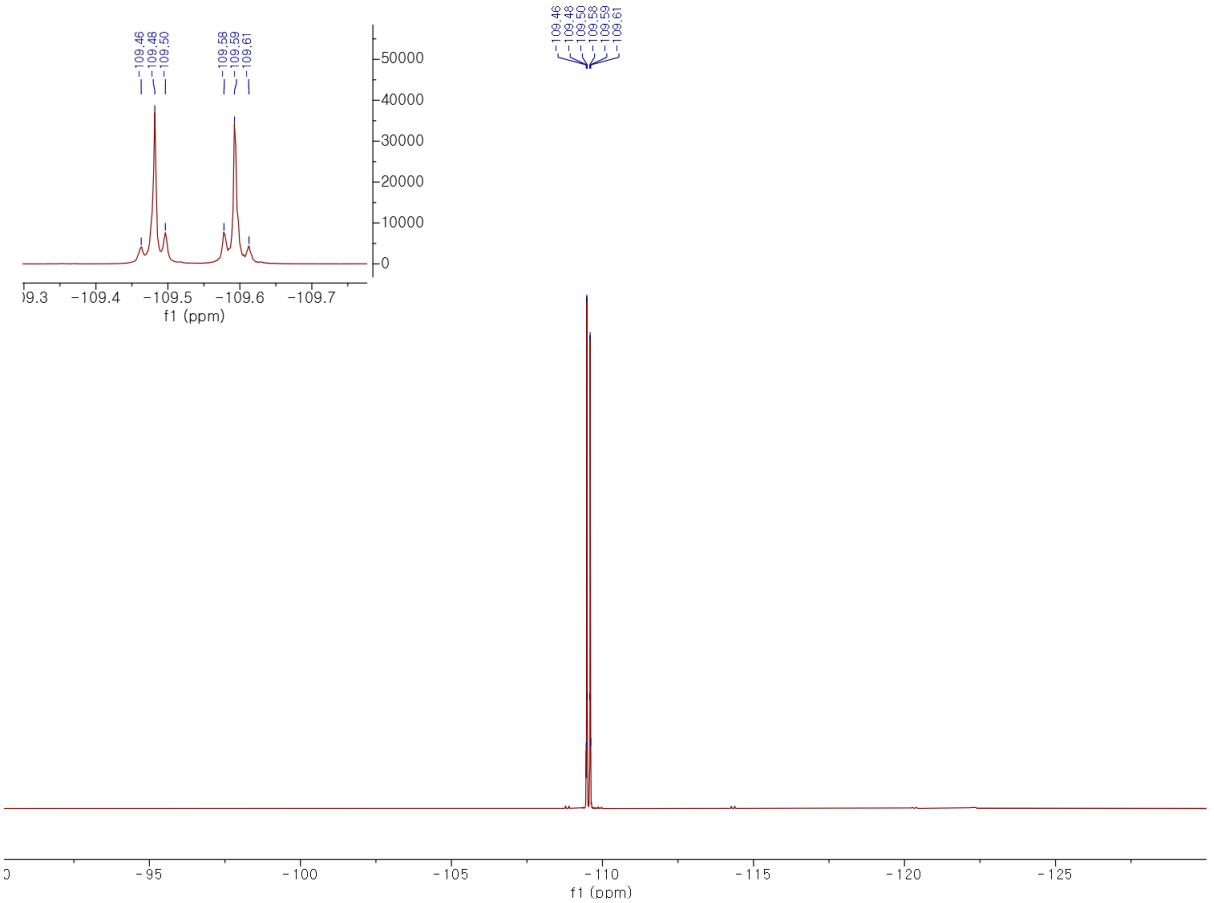
Supplementary Figure 20. ^{19}F NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (**3a**)



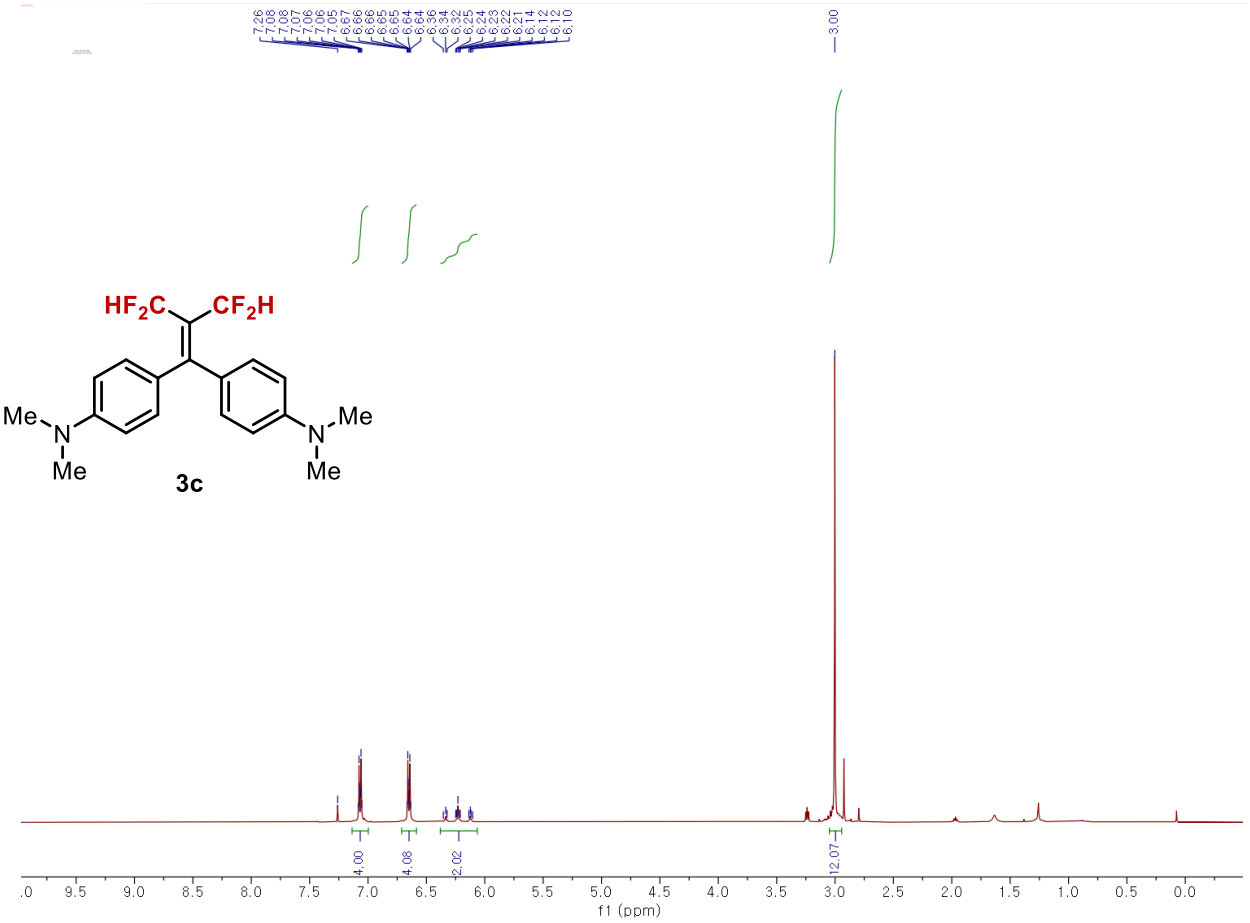
Supplementary Figure 21. ^{1}H NMR Spectrum of (2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (**3b**)



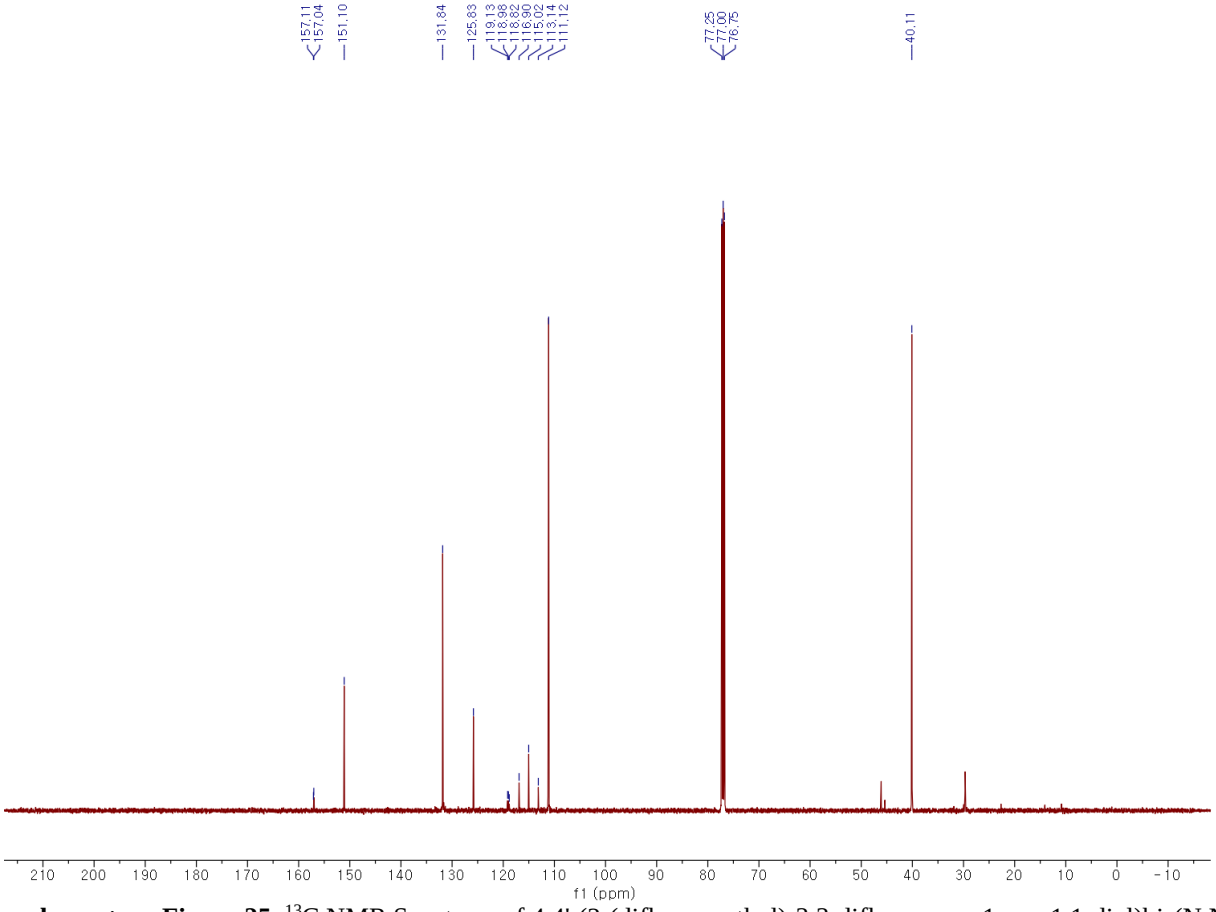
Supplementary Figure 22. ^{13}C NMR Spectrum of (2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (**3b**)



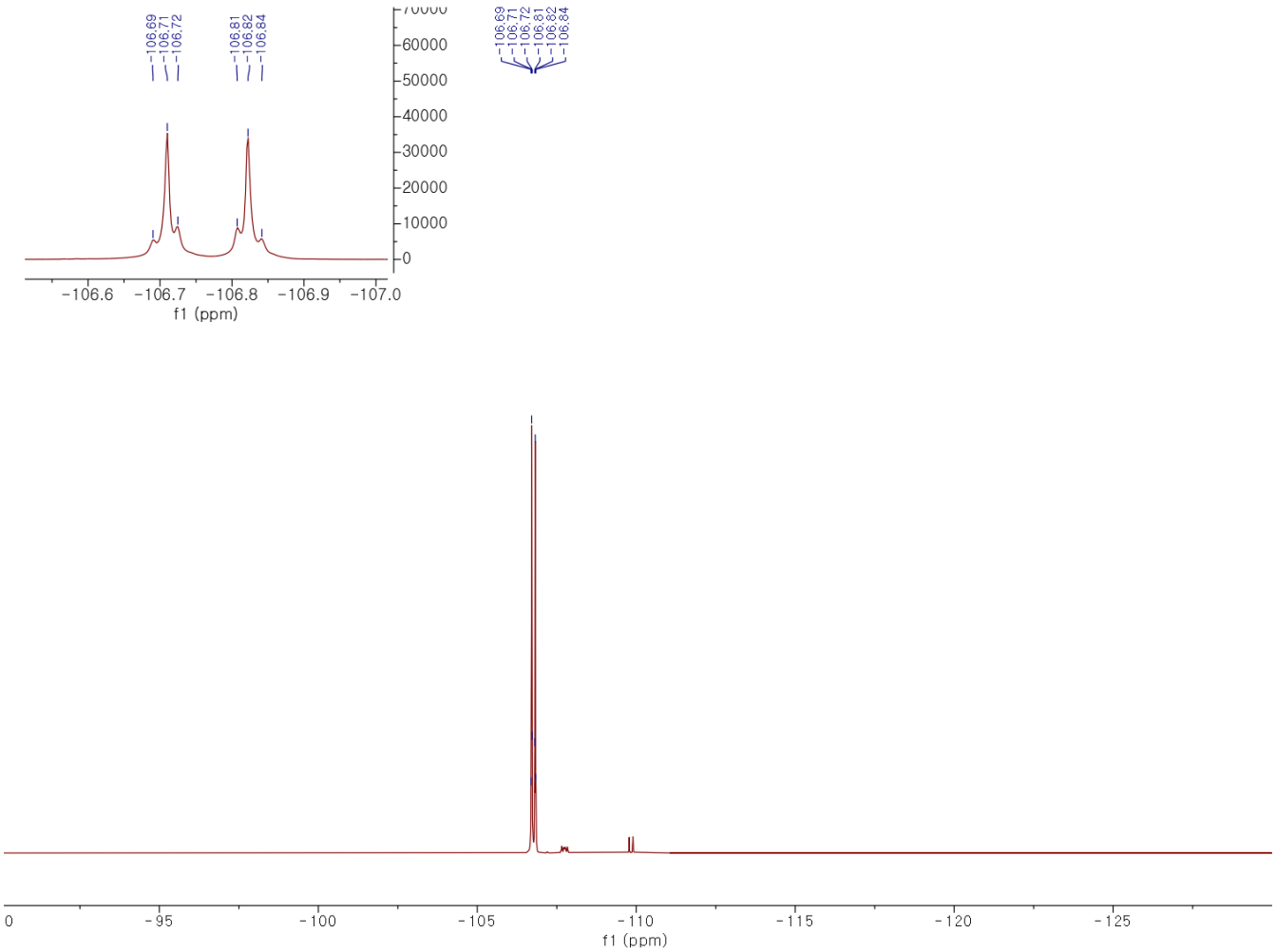
Supplementary Figure 23. ^{19}F NMR Spectrum of (2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (**3b**)



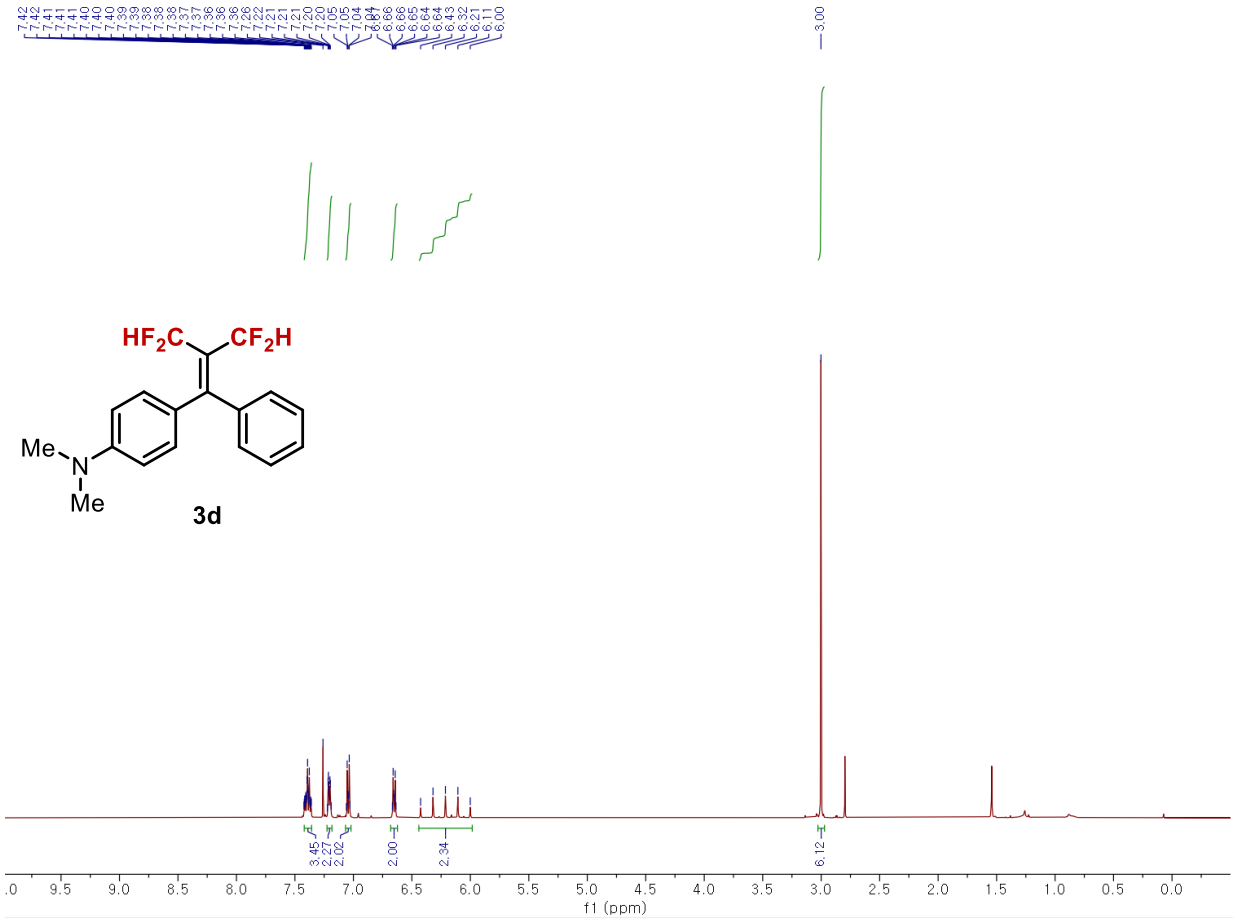
Supplementary Figure 24. ^{1}H NMR Spectrum of 4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(N,N-dimethylaniline) (**3c**)



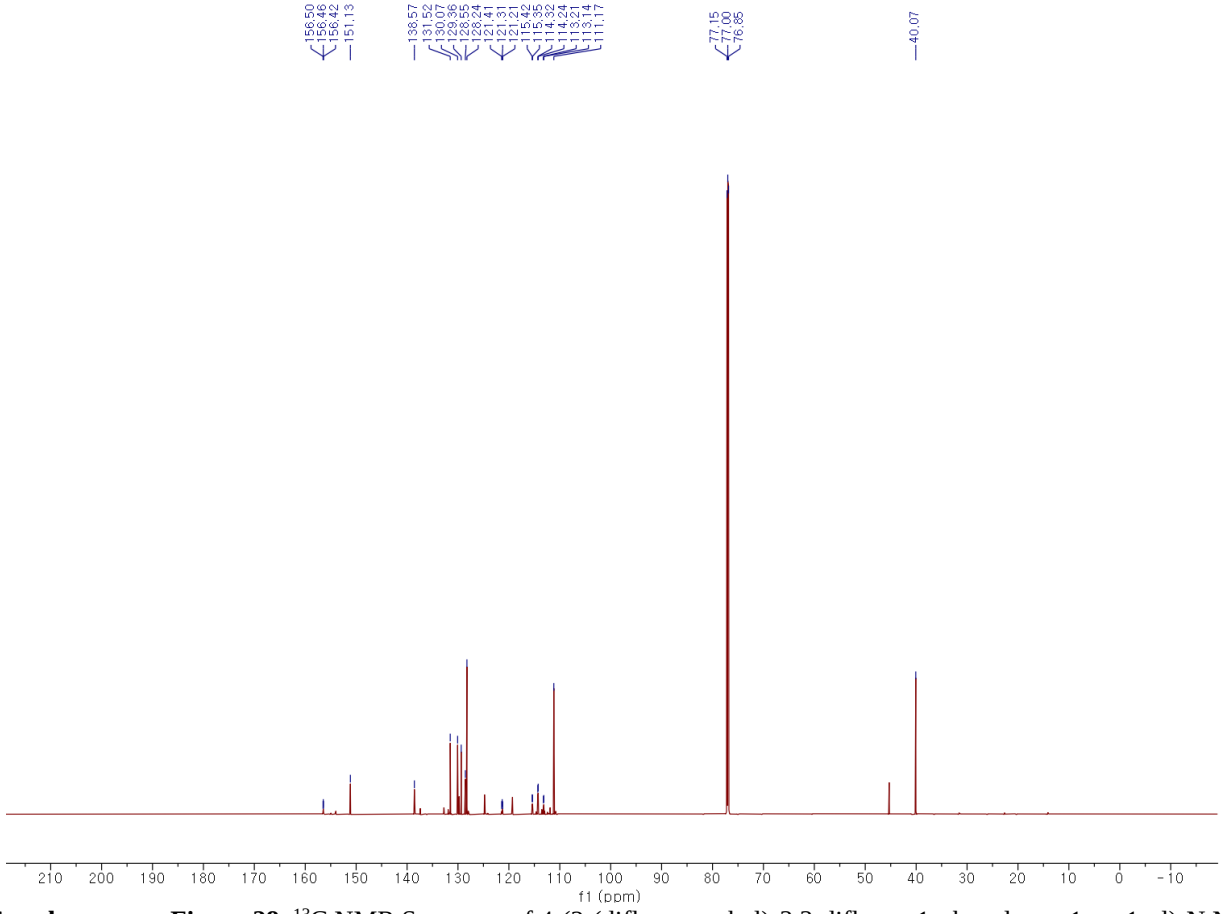
Supplementary Figure 25. ^{13}C NMR Spectrum of 4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(N,N-dimethylaniline) (**3c**)



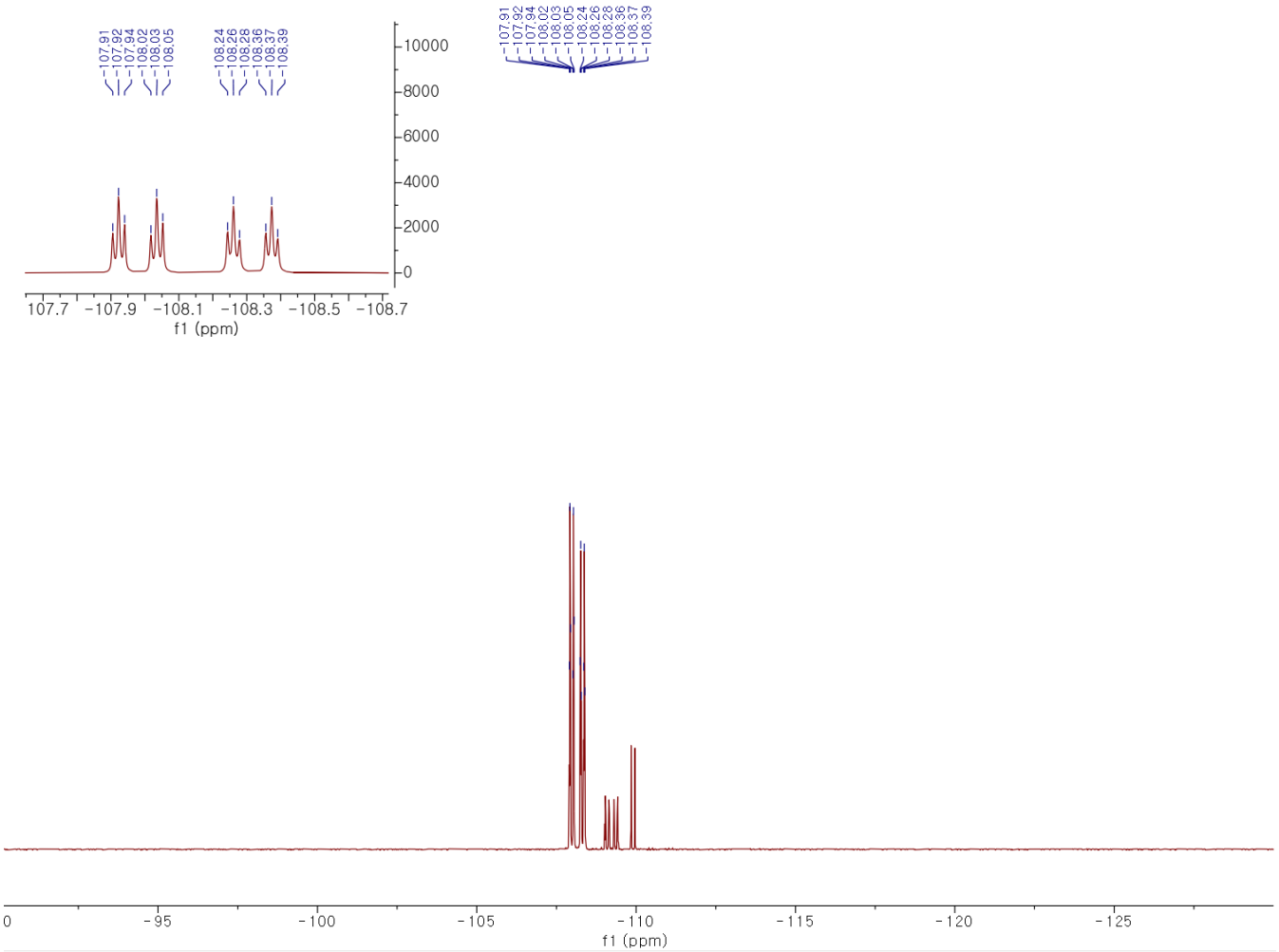
Supplementary Figure 26. ^{19}F NMR Spectrum of 4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(N,N-dimethylaniline) (**3c**)



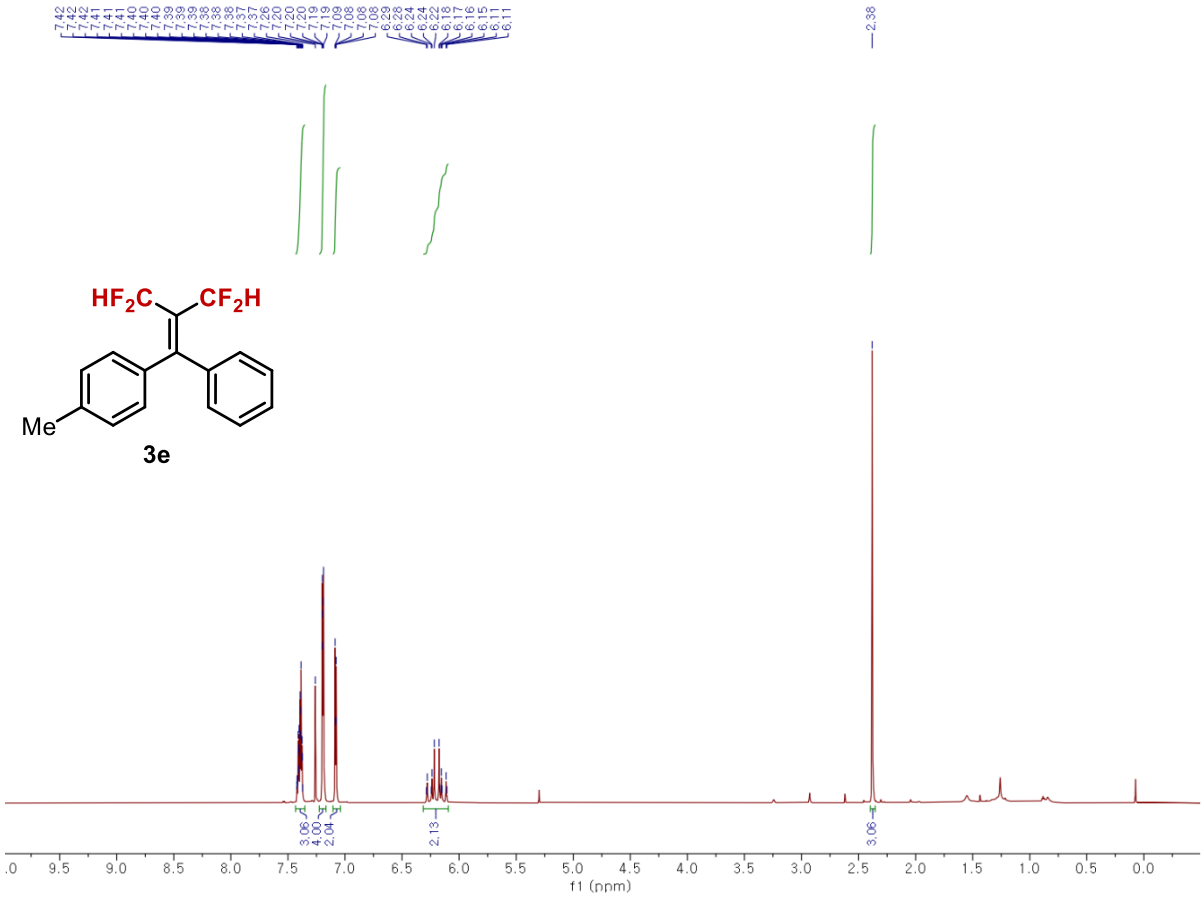
Supplementary Figure 27. ^{1}H NMR Spectrum of 4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-N,N-dimethylaniline (**3d**)



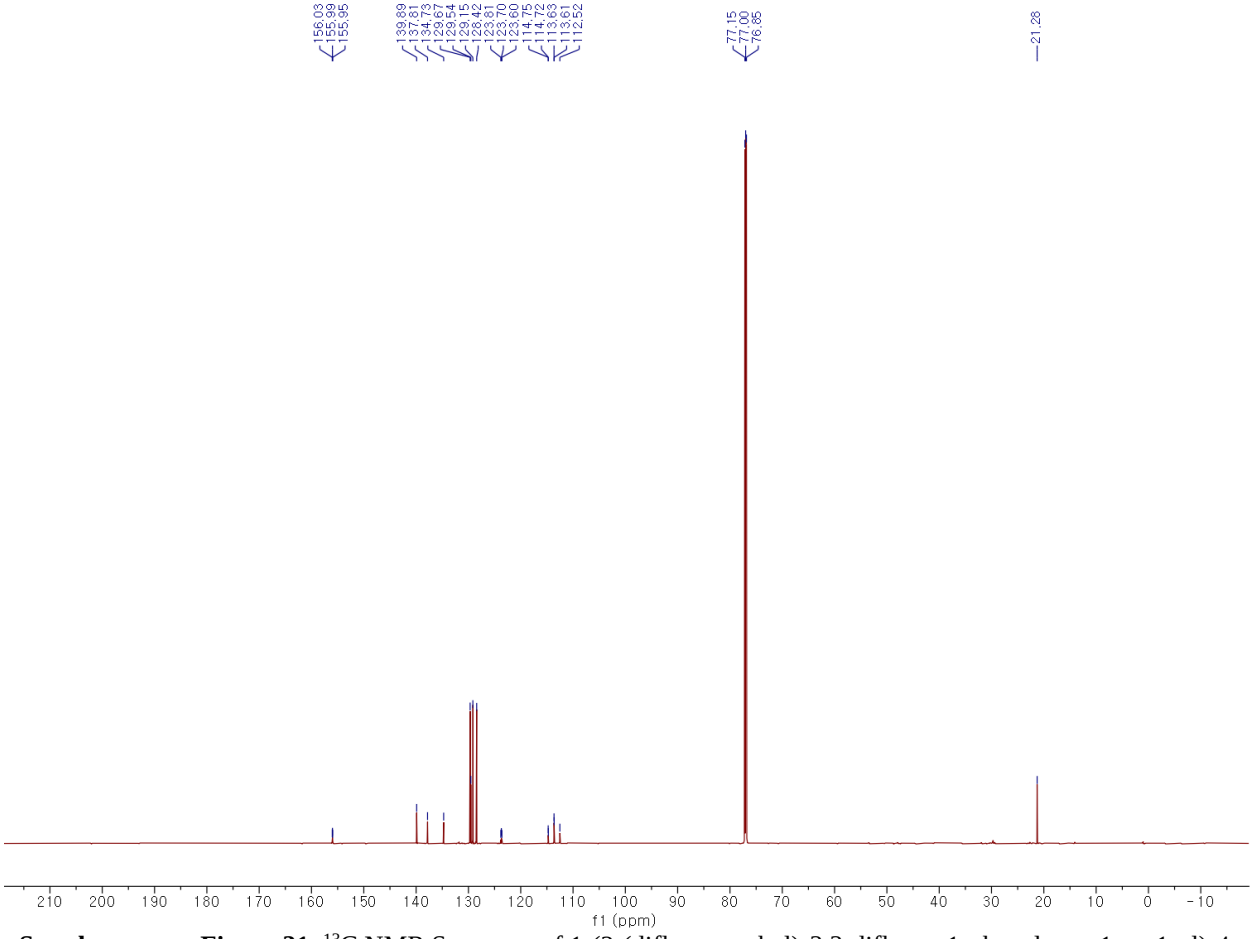
Supplementary Figure 28. ^{13}C NMR Spectrum of 4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-N,N-dimethylaniline (**3d**)



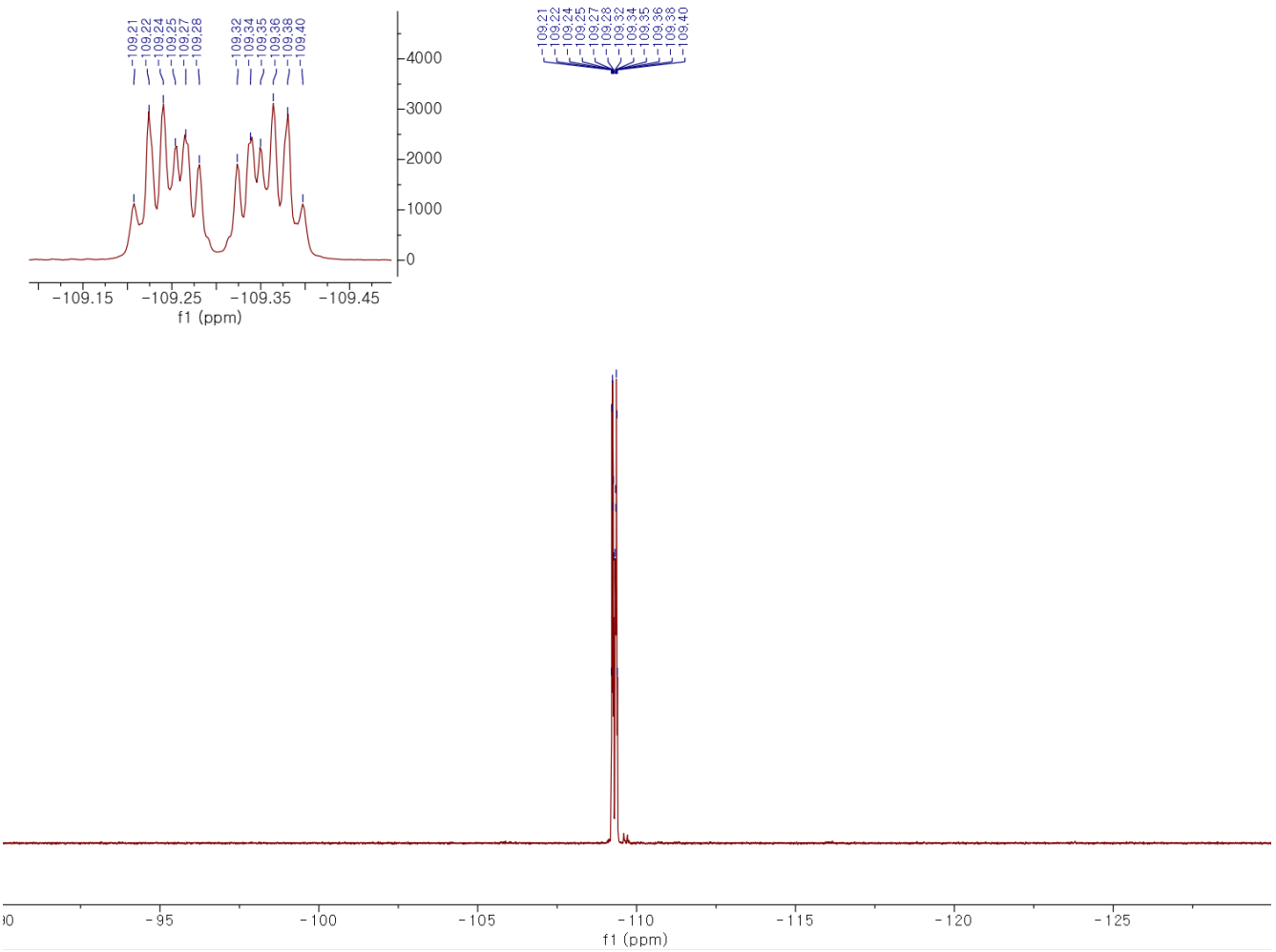
Supplementary Figure 29. ^{19}F NMR Spectrum of 4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-N,N-dimethylaniline (**3d**)



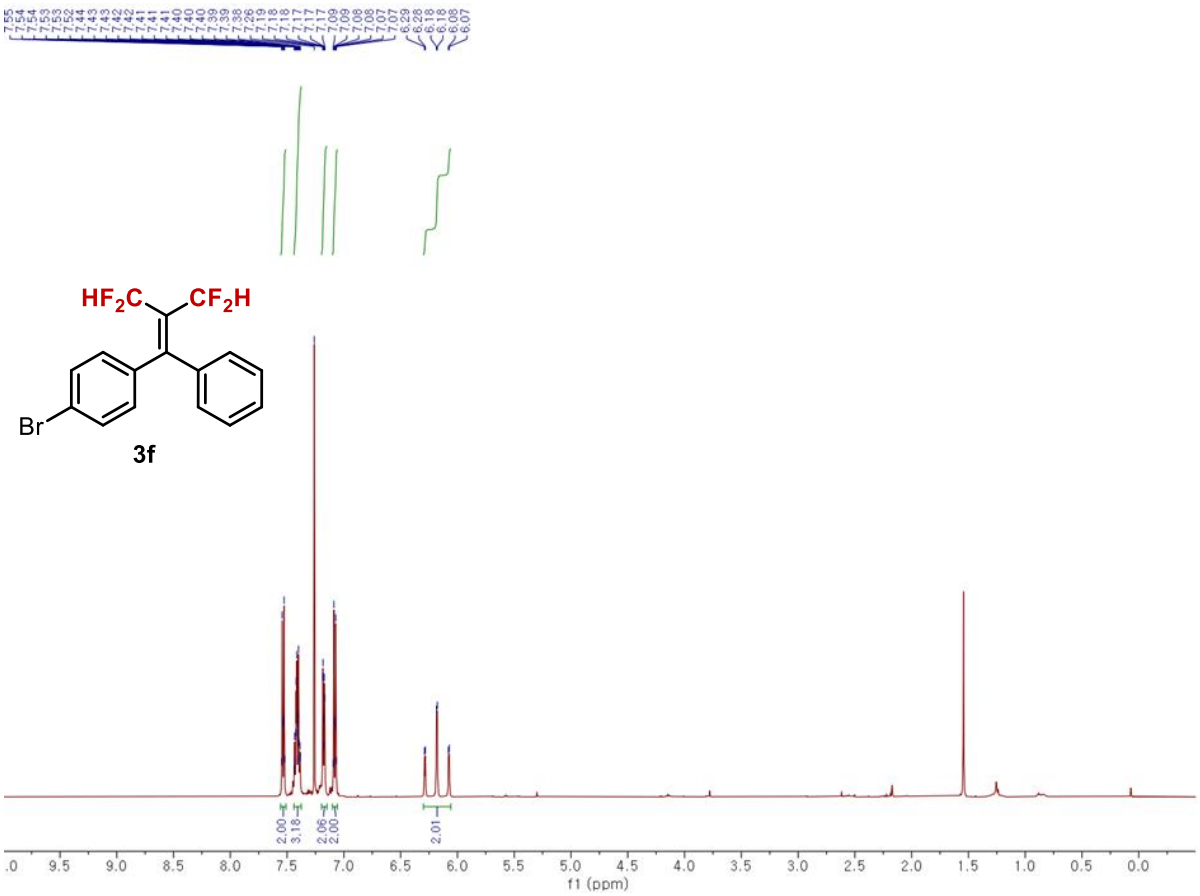
Supplementary Figure 30. ^{1}H NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methylbenzene (**3e**)



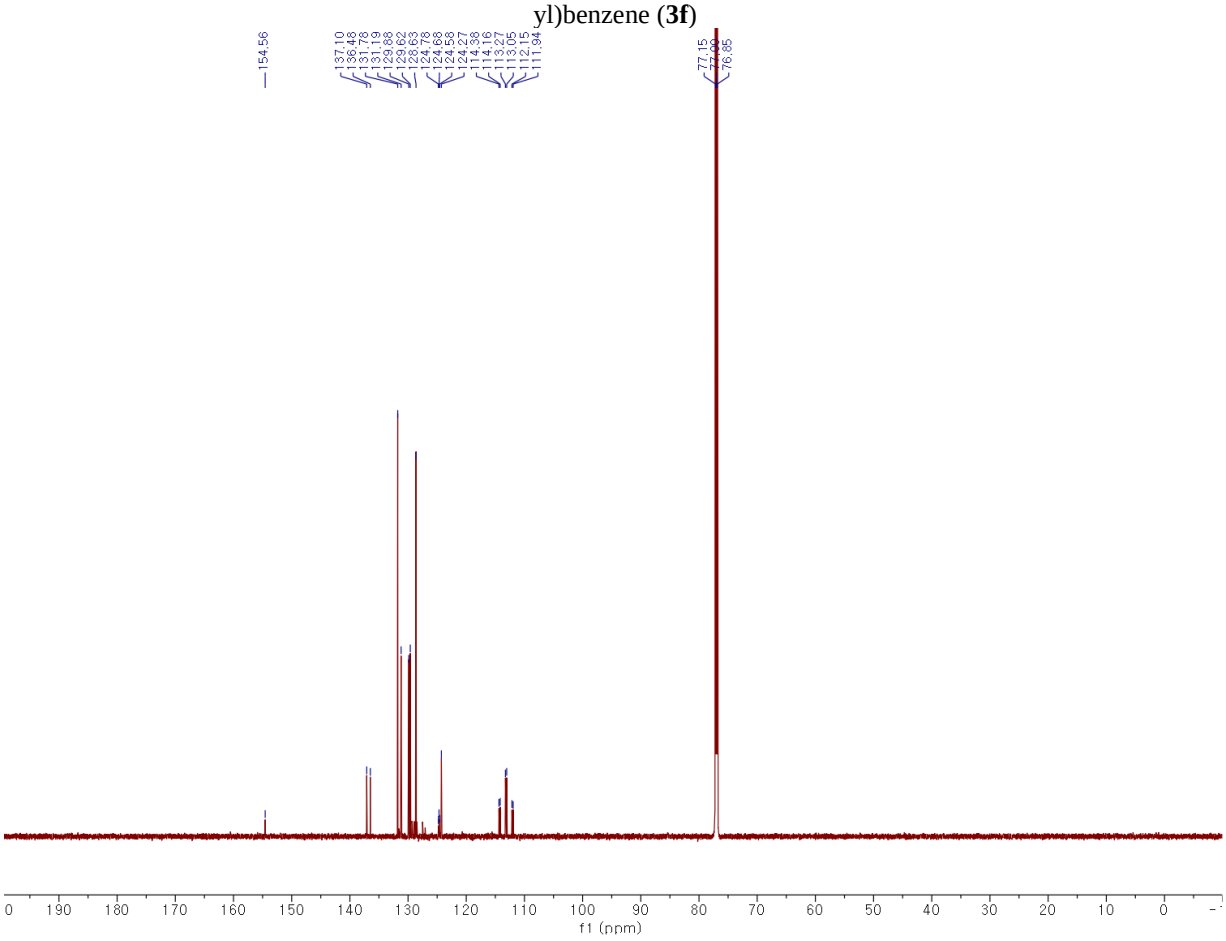
Supplementary Figure 31. ^{13}C NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methylbenzene (**3e**)



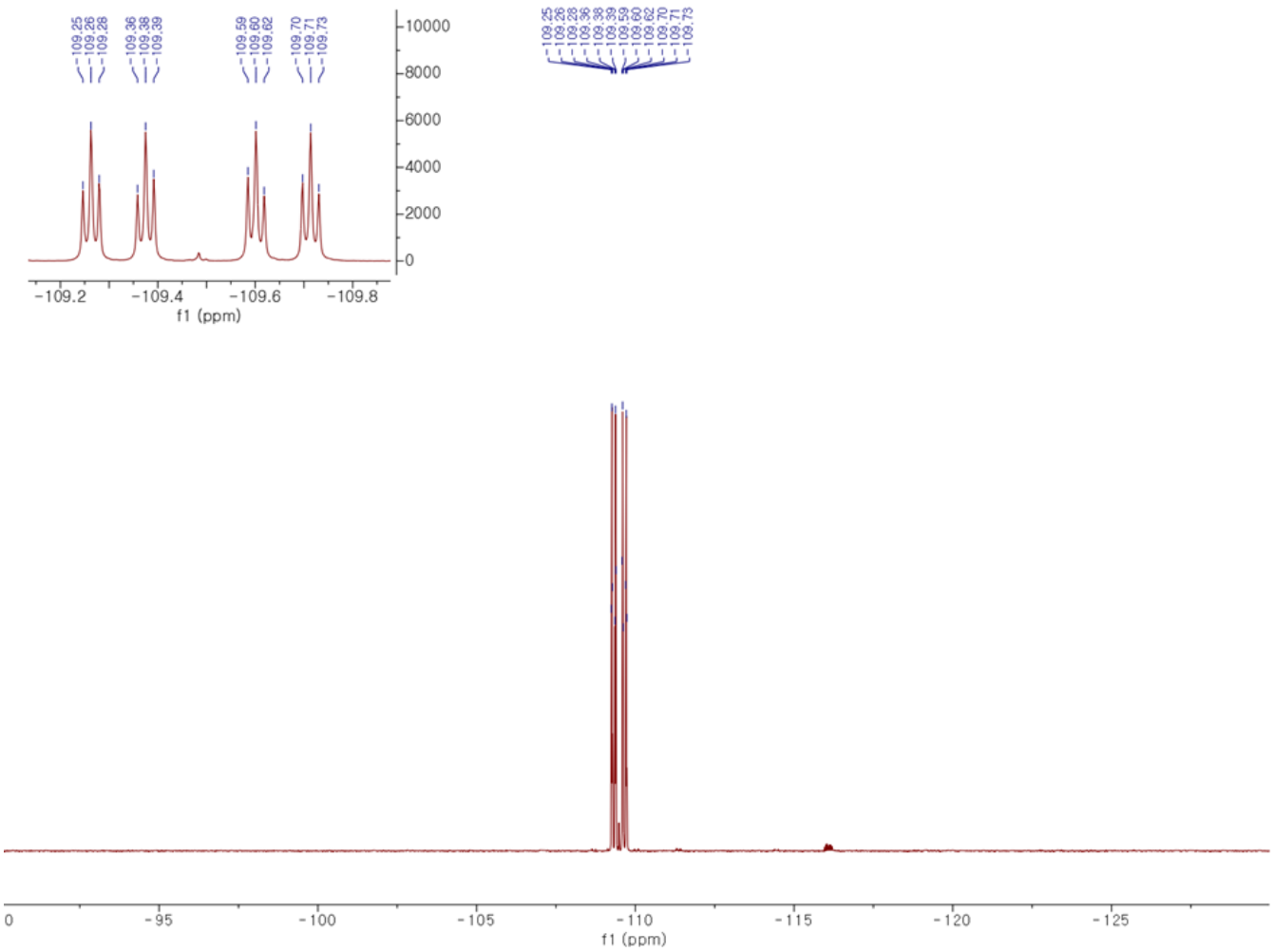
Supplementary Figure 32. ^{19}F NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methylbenzene (**3e**)



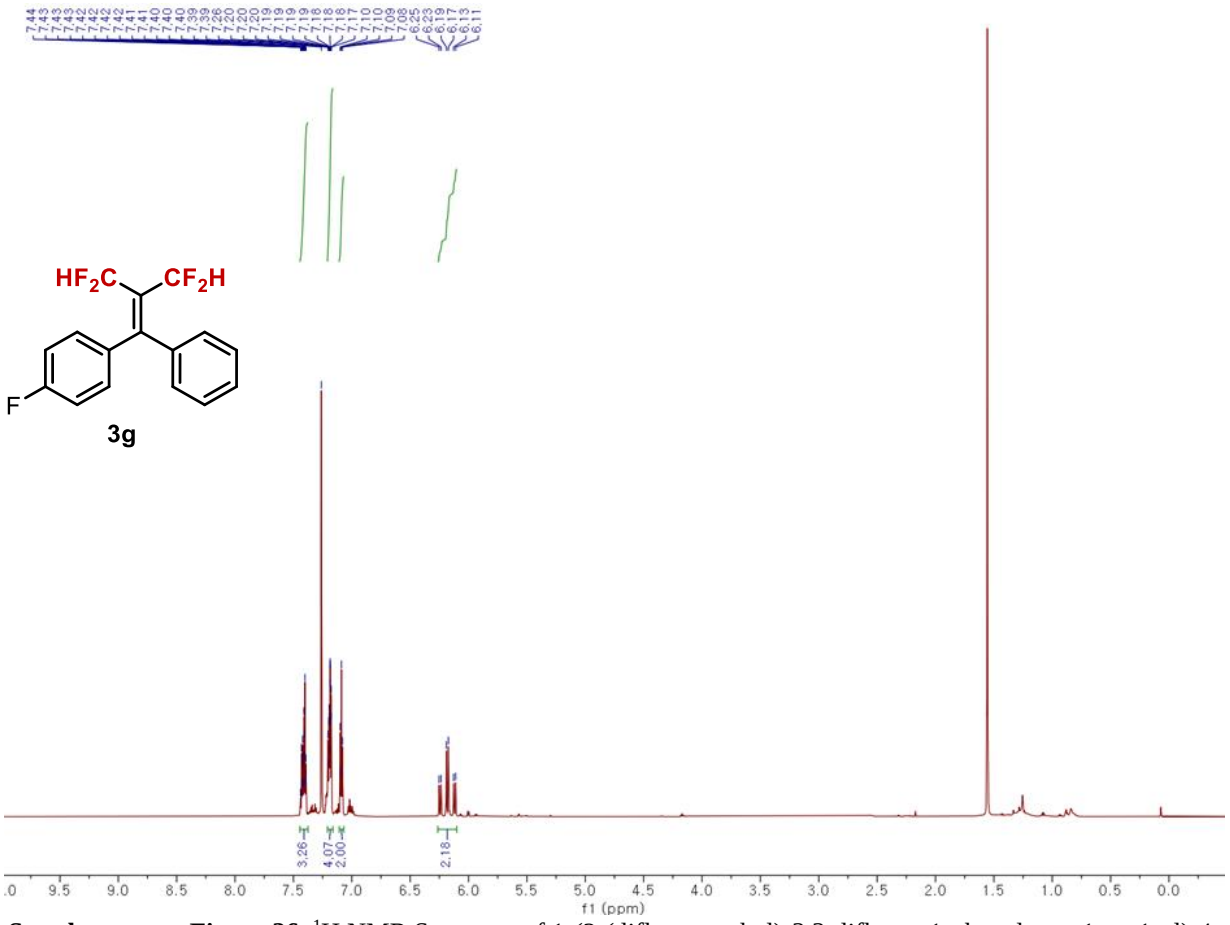
Supplementary Figure 33. ^{1}H NMR Spectrum of 1-bromo-4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (**3f**)



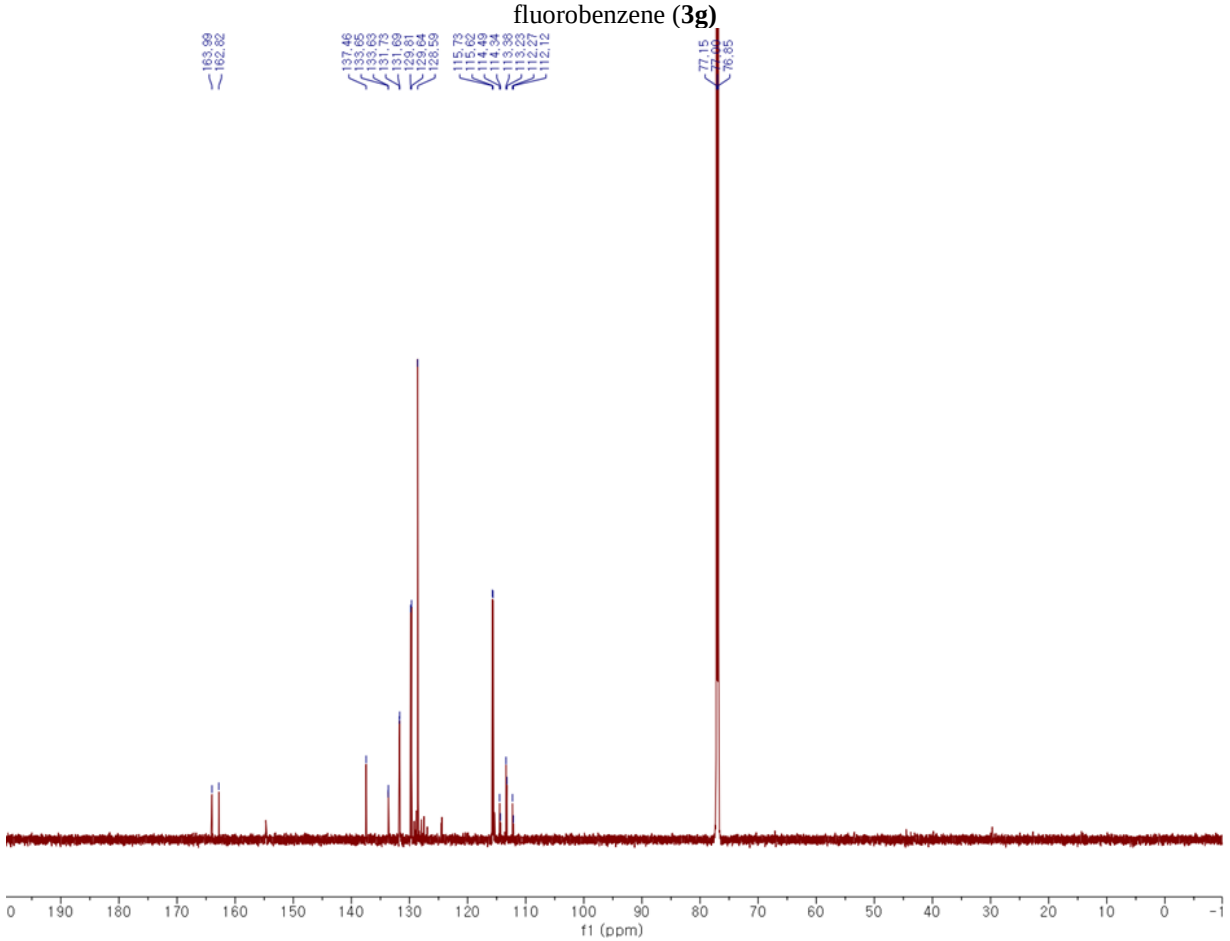
Supplementary Figure 34. ^{13}C NMR Spectrum of 1-bromo-4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (**3f**)



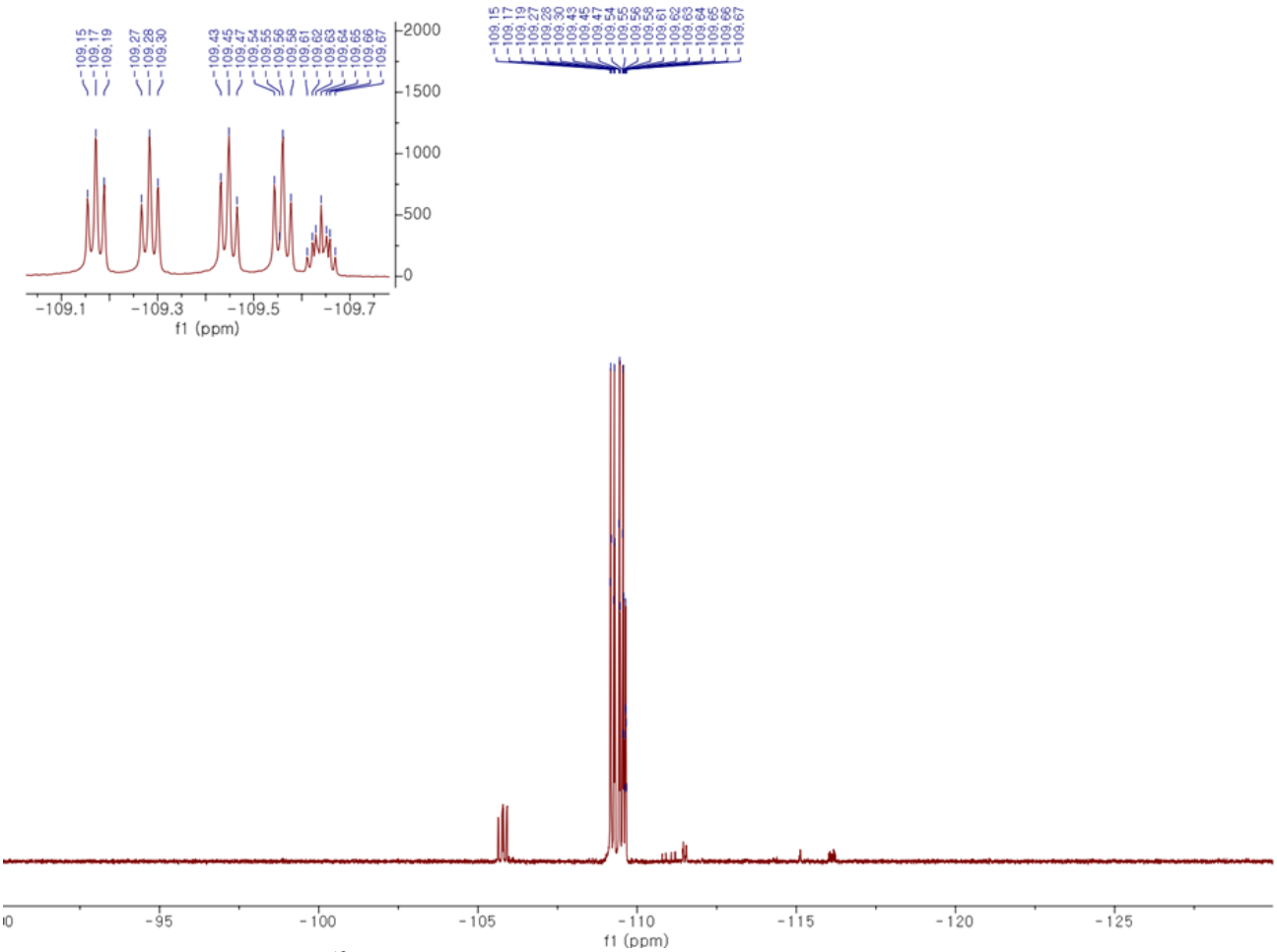
Supplementary Figure 35. ^{19}F NMR Spectrum of 1-bromo-4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (**3f**)



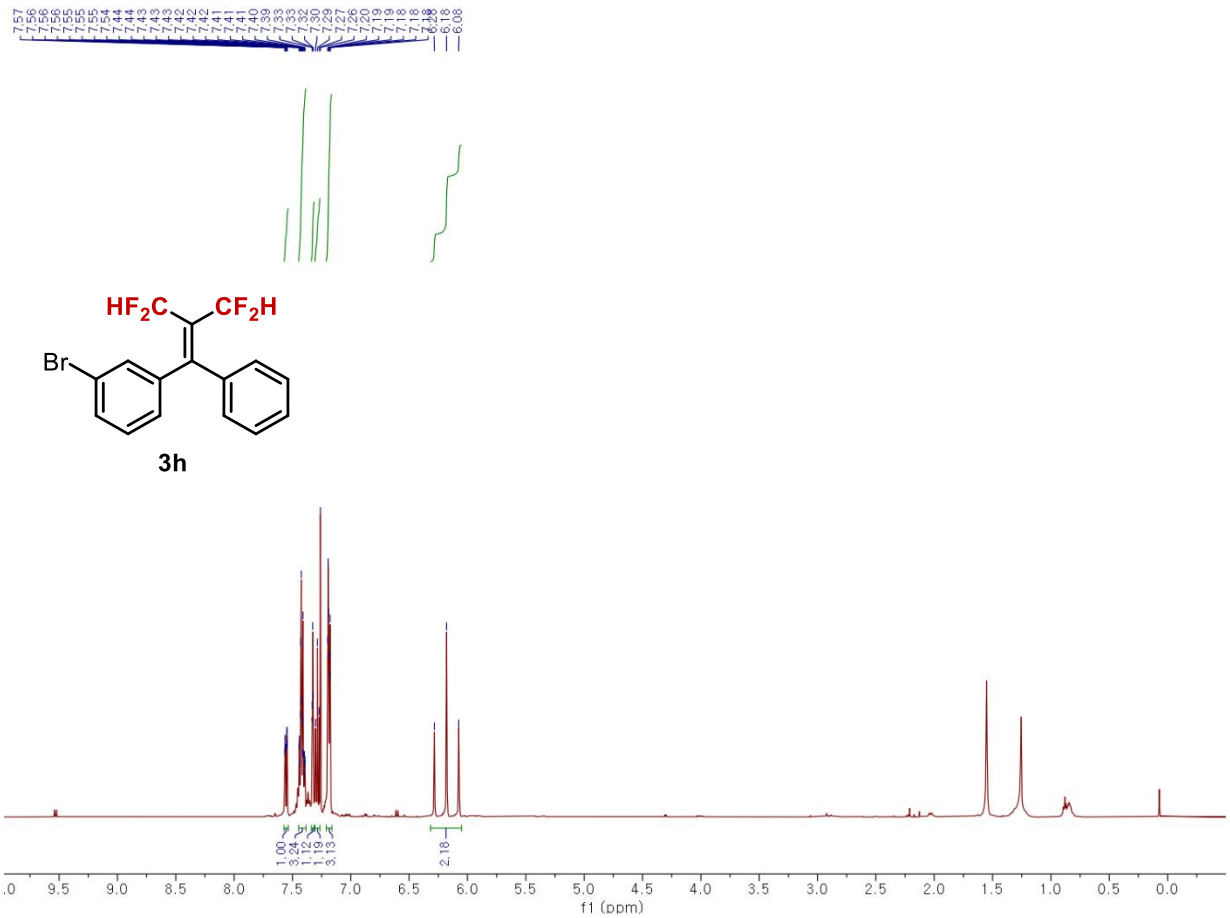
Supplementary Figure 36. ^{1}H NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-fluorobenzene (**3g)**



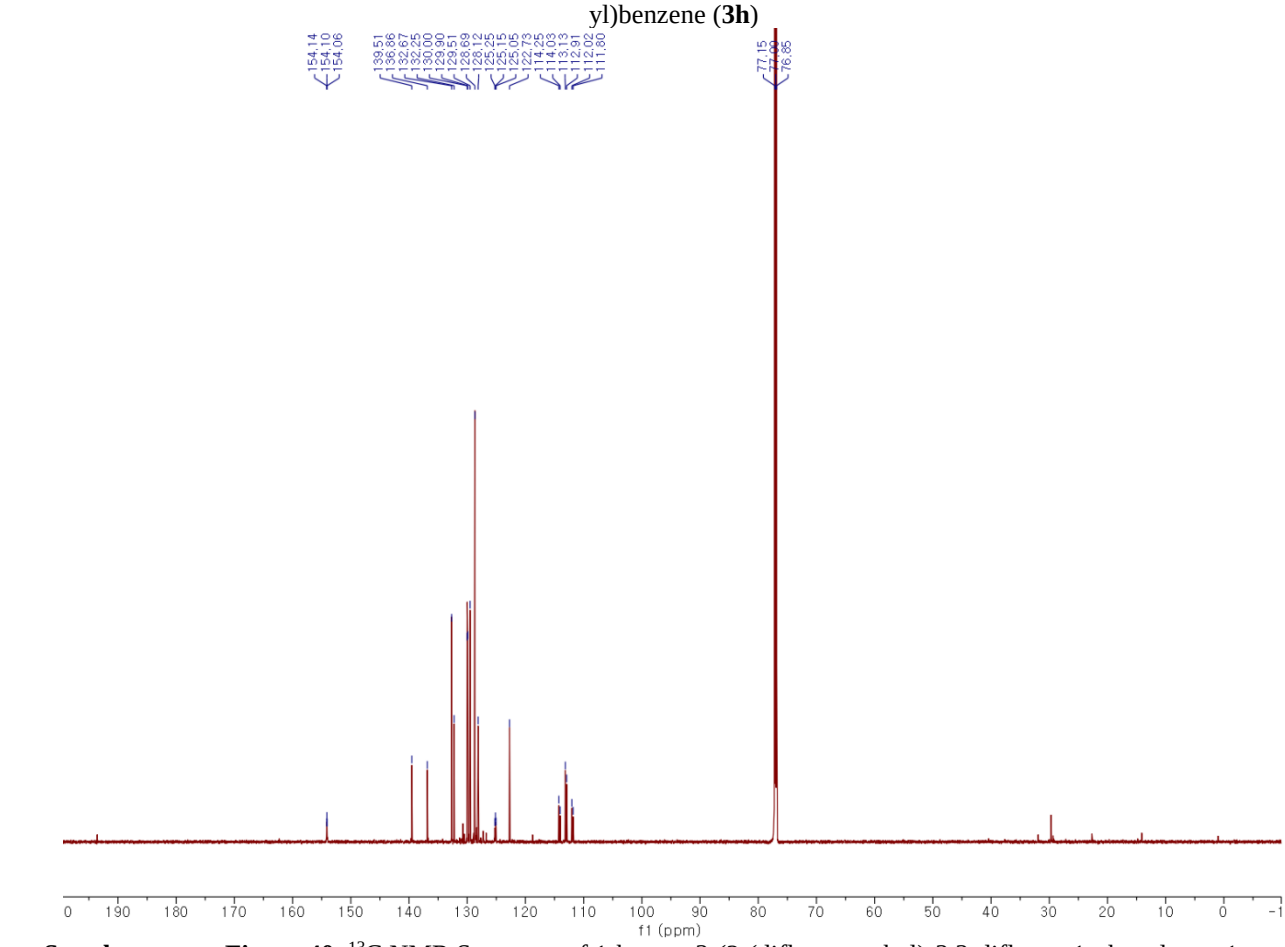
Supplementary Figure 37. ^{13}C NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-fluorobenzene (**3g)**



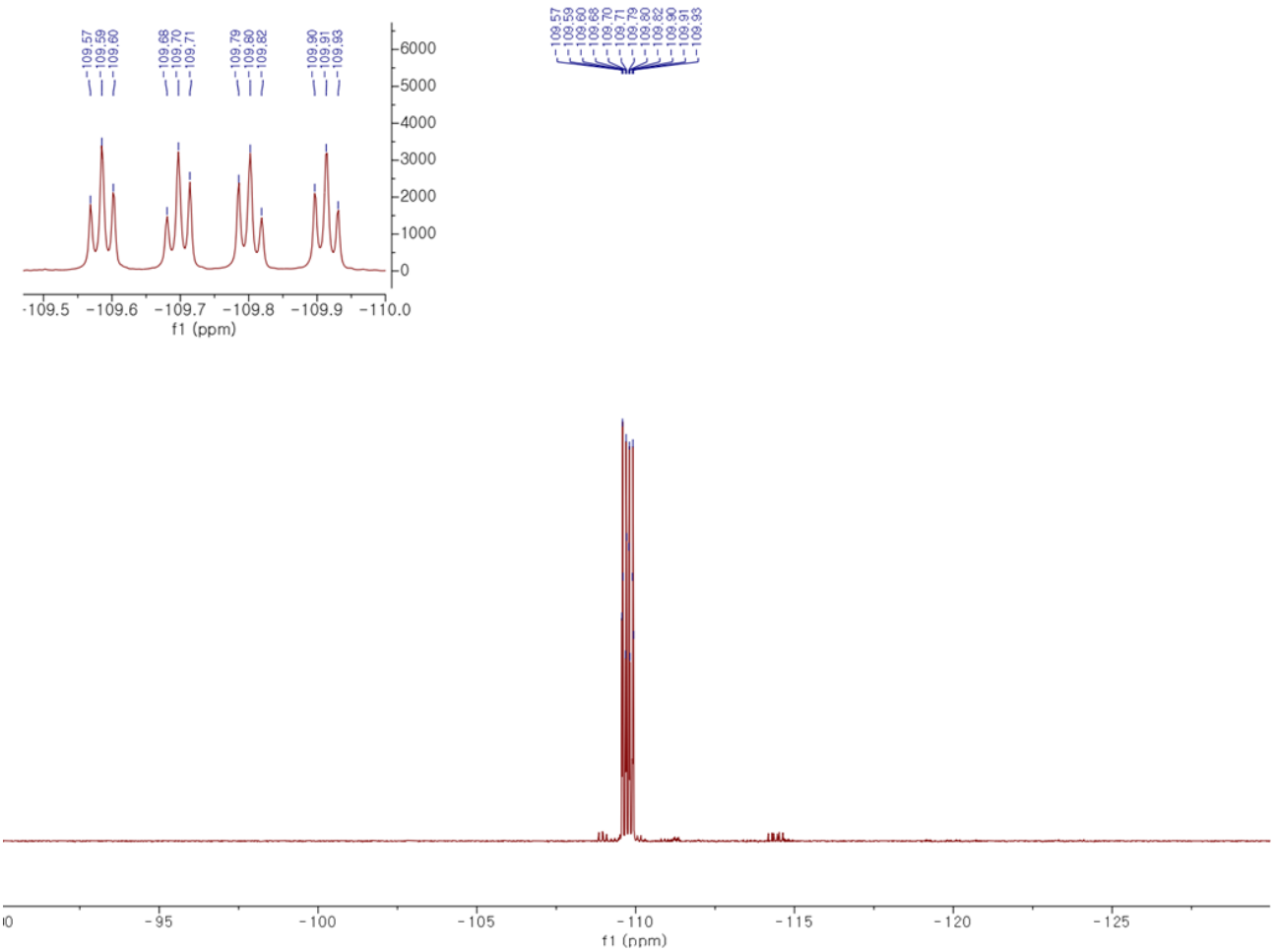
Supplementary Figure 38. ^{19}F NMR Spectrum of 1-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-4-fluorobenzene (**3g)**



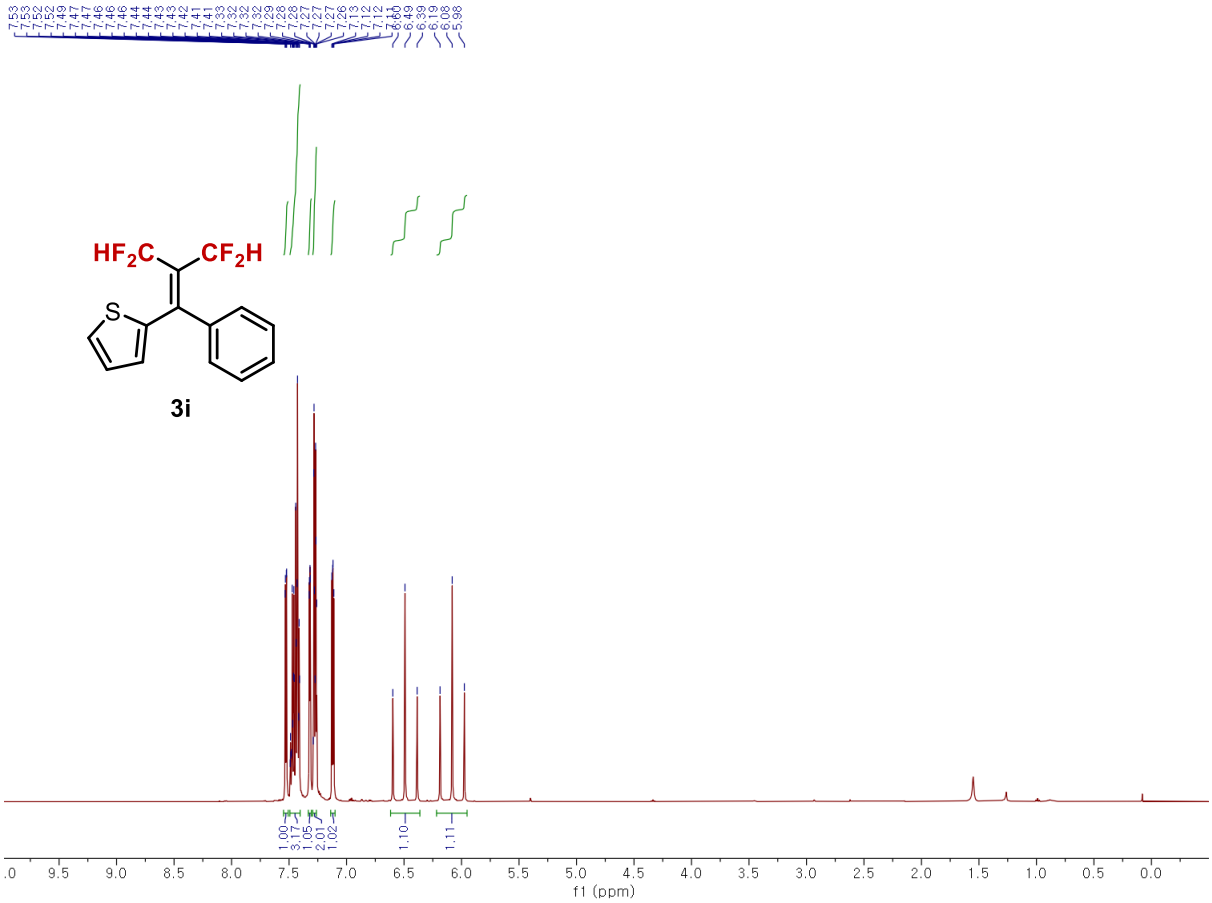
Supplementary Figure 39. ^{1}H NMR Spectrum of 1-bromo-3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (**3h**)



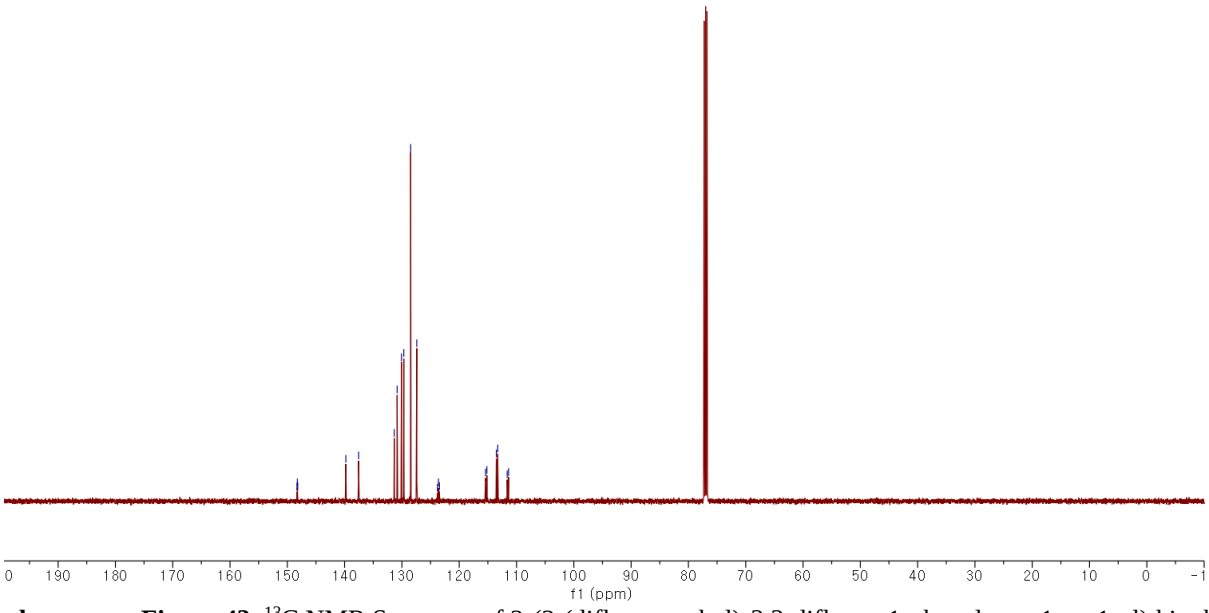
Supplementary Figure 40. ^{13}C NMR Spectrum of 1-bromo-3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (**3h**)



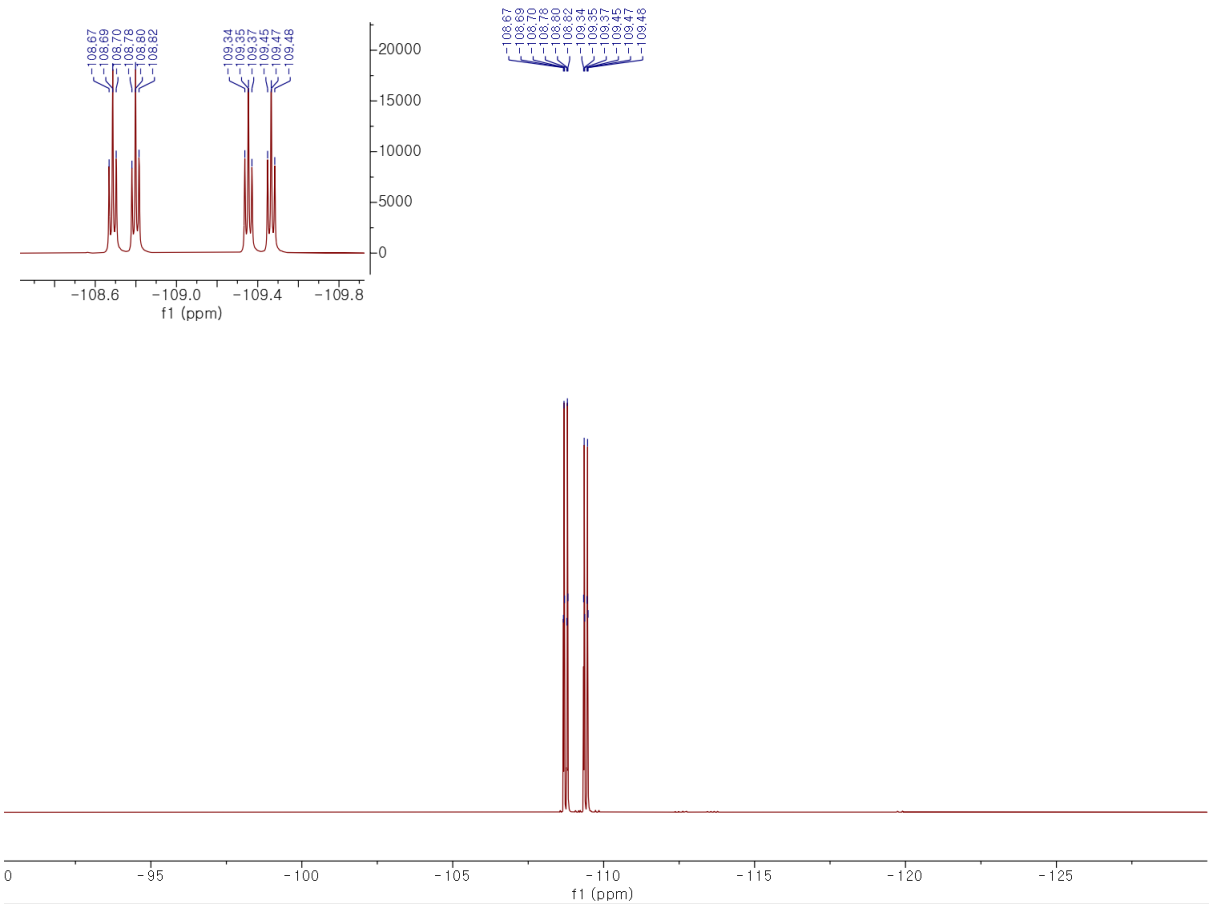
Supplementary Figure 41. ^{19}F NMR Spectrum of 1-bromo-3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzene (**3h**)



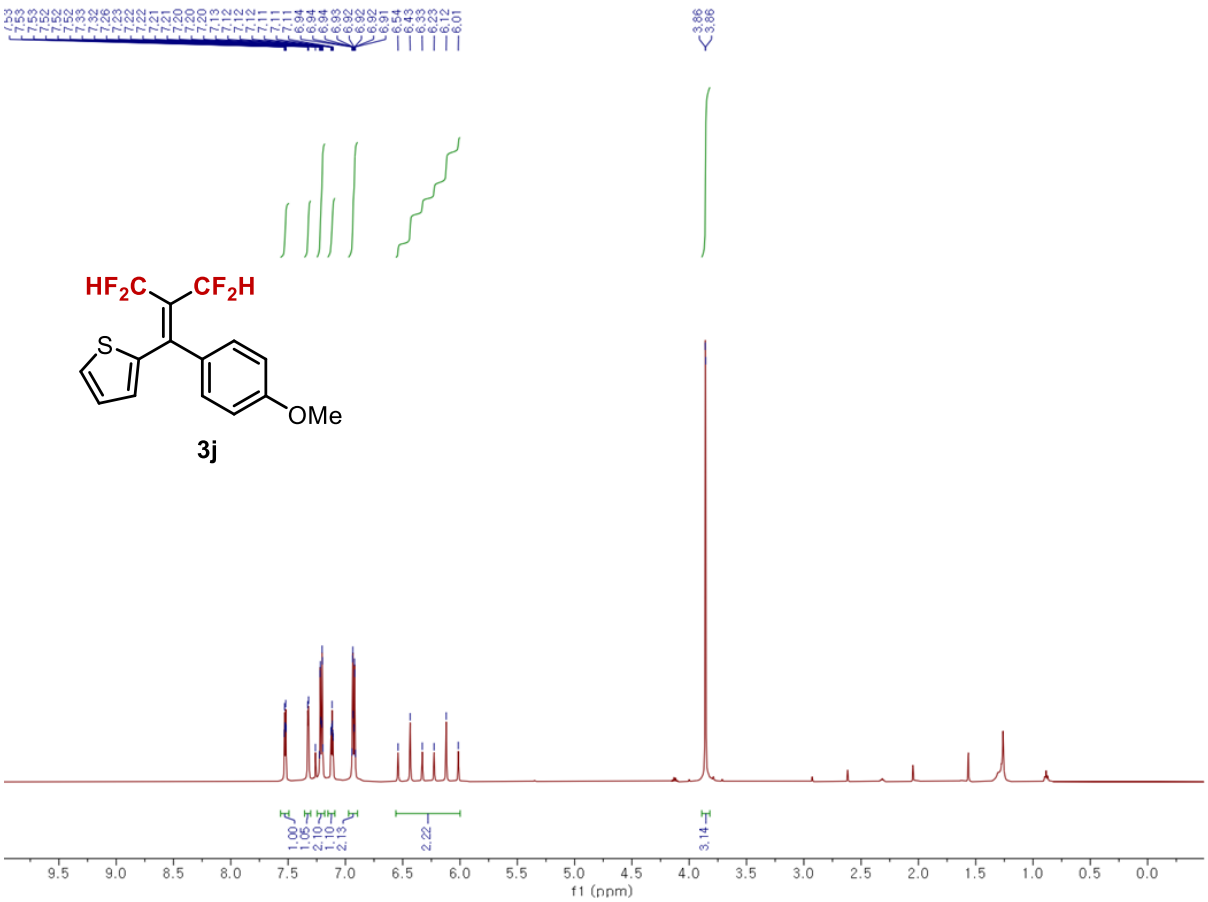
Supplementary Figure 42. ^{1}H NMR Spectrum of 2-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)thiophene (**3i**)



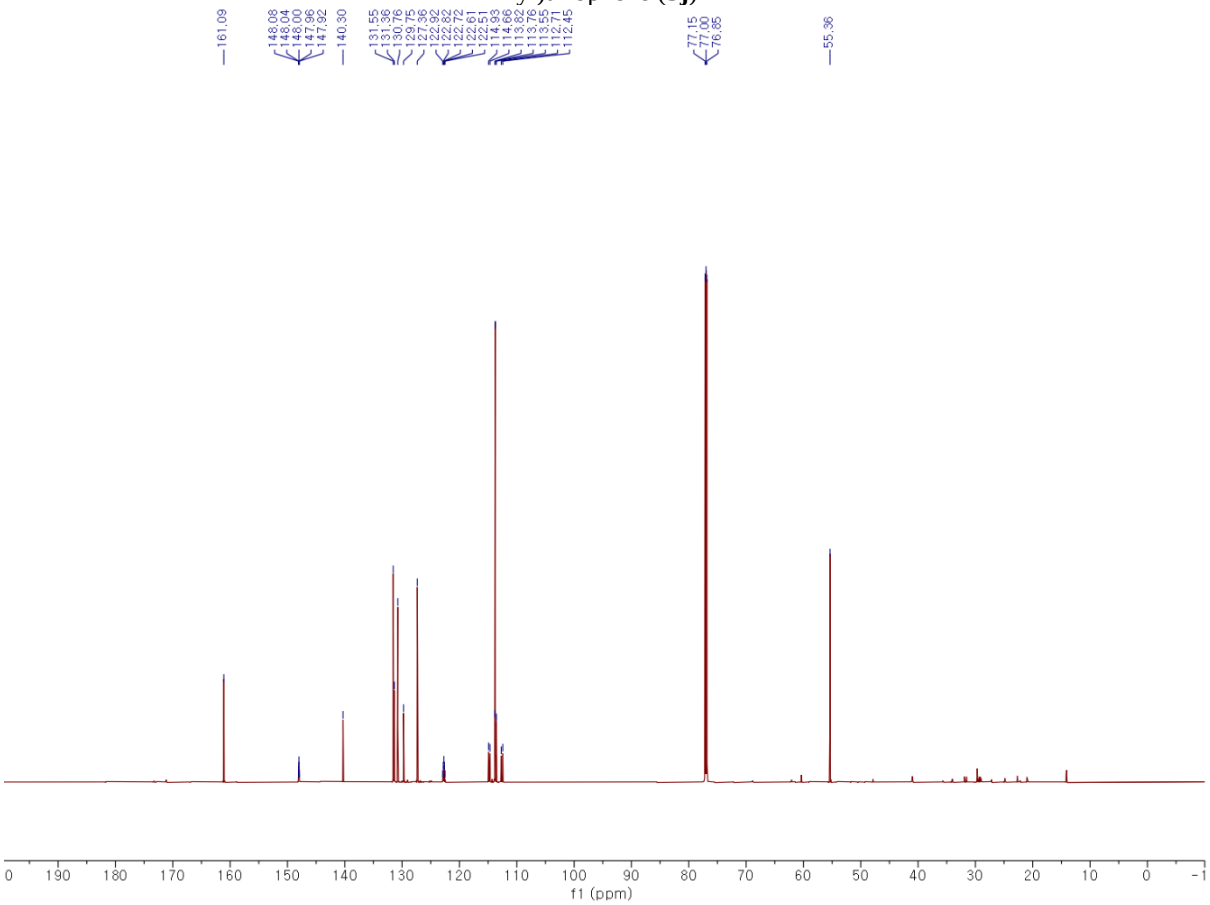
Supplementary Figure 43. ^{13}C NMR Spectrum of 2-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)thiophene (**3i**)



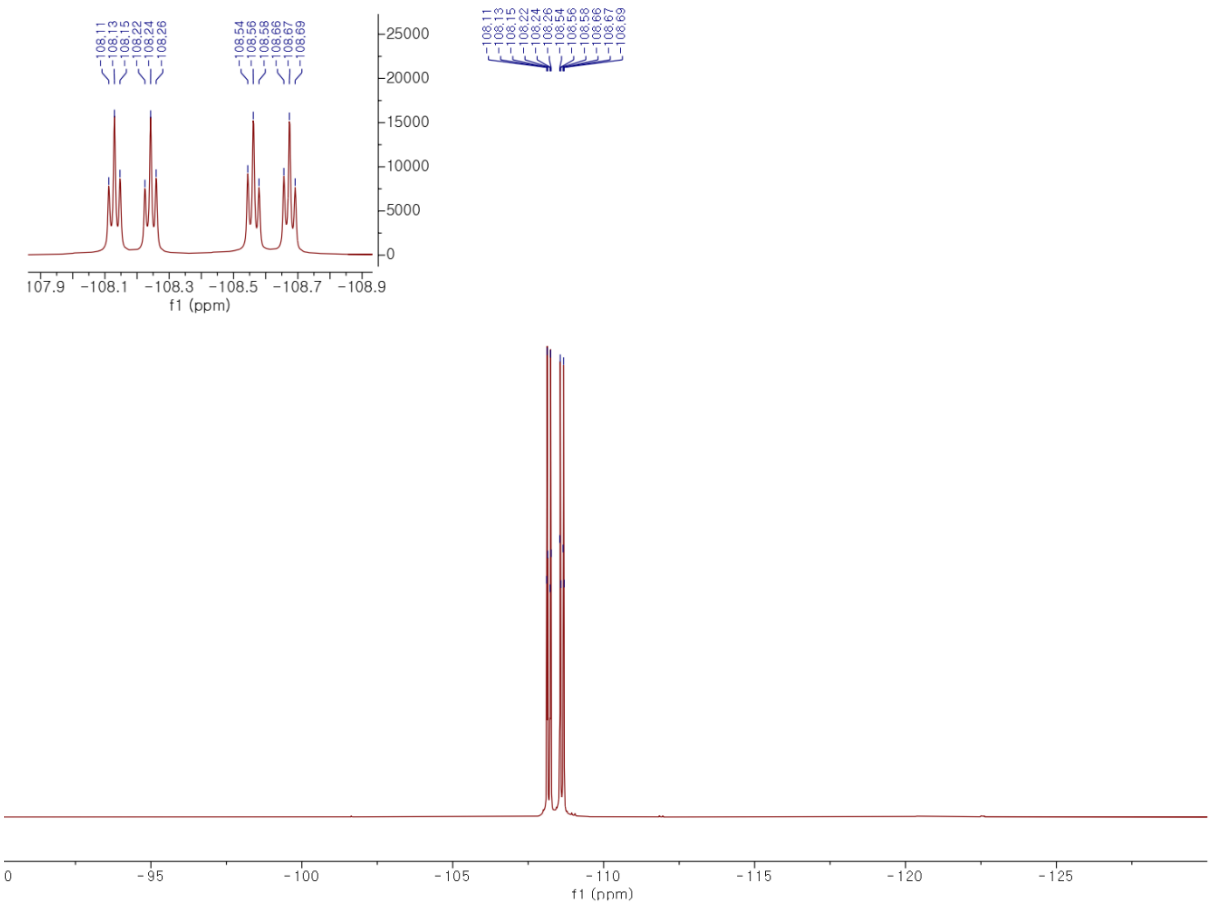
Supplementary Figure 44. ^{19}F NMR Spectrum of 2-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)thiophene (**3i**)



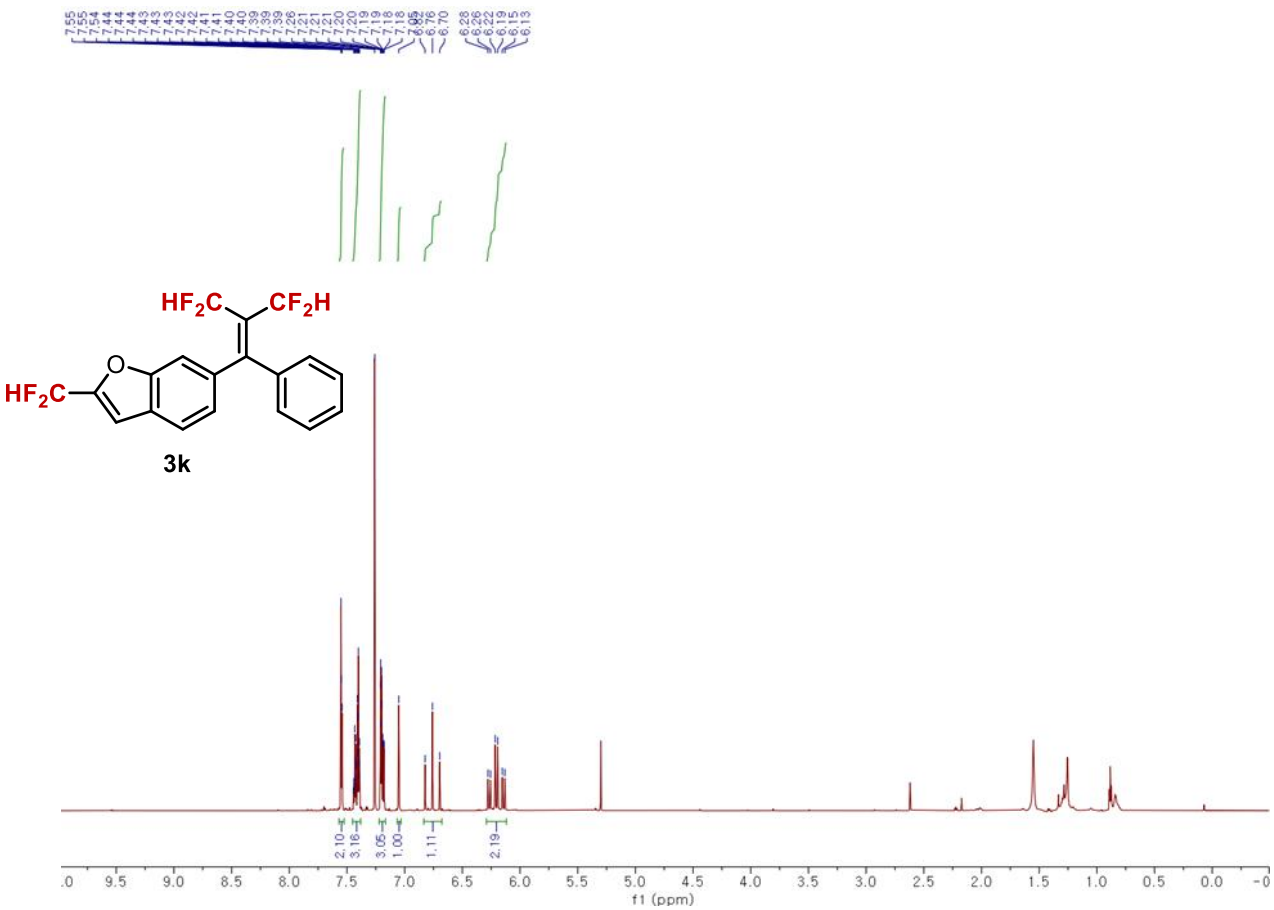
Supplementary Figure 45. ^{1}H NMR Spectrum of 2-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)thiophene (**3j**)



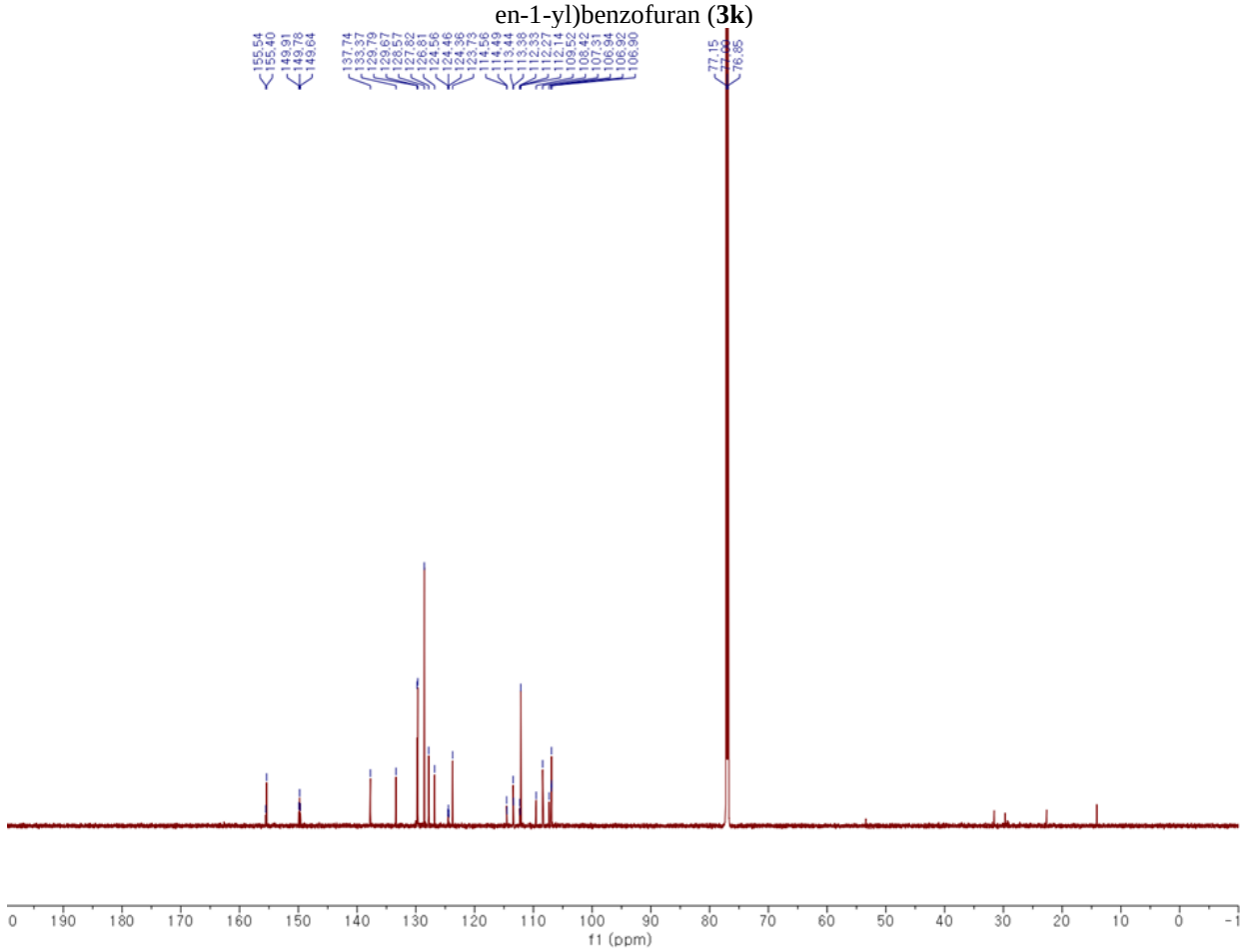
Supplementary Figure 46. ^{13}C NMR Spectrum of 2-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)thiophene (**3j**)



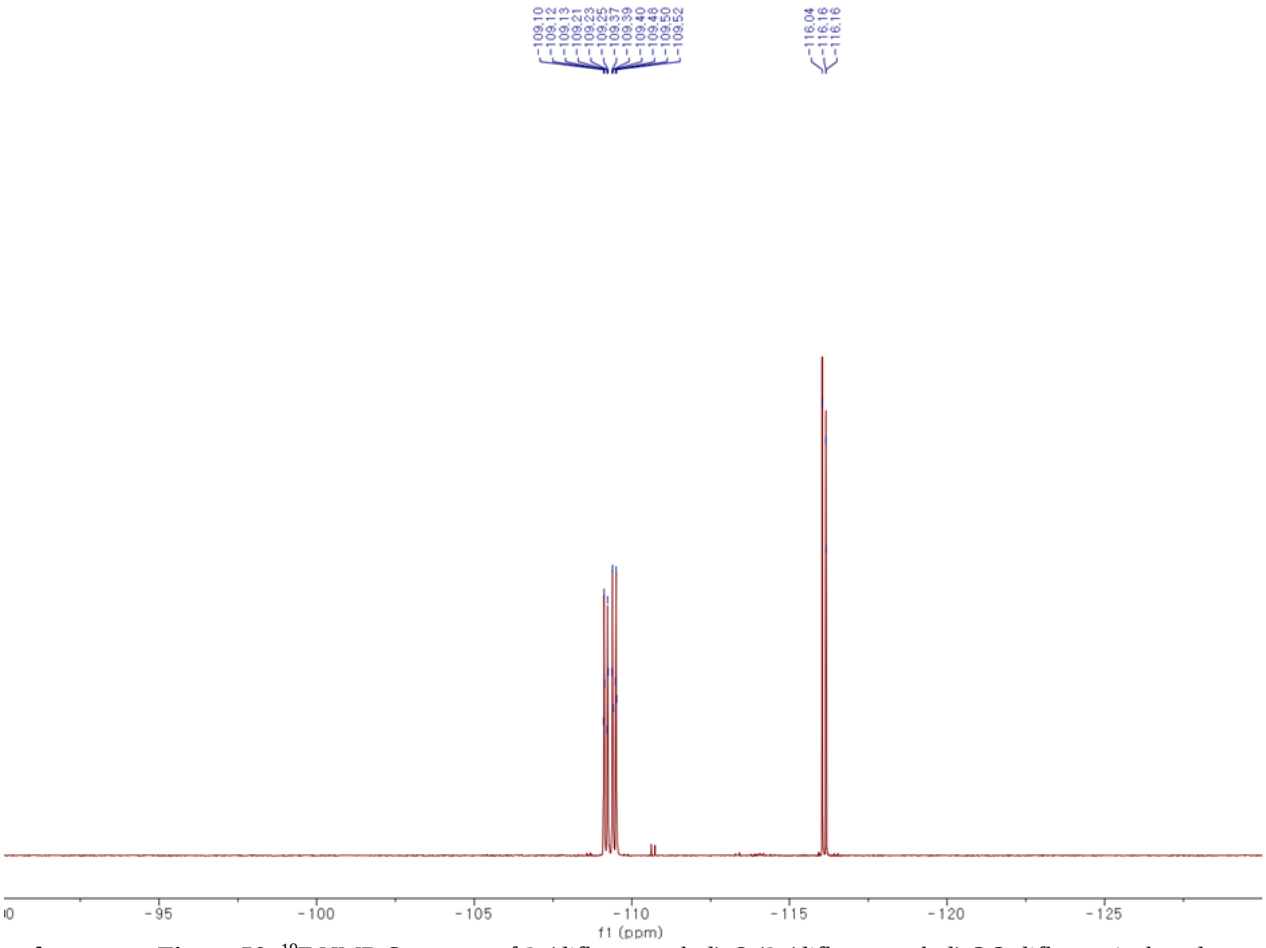
Supplementary Figure 47. ^{19}F NMR Spectrum of 2-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)thiophene (**3j**)



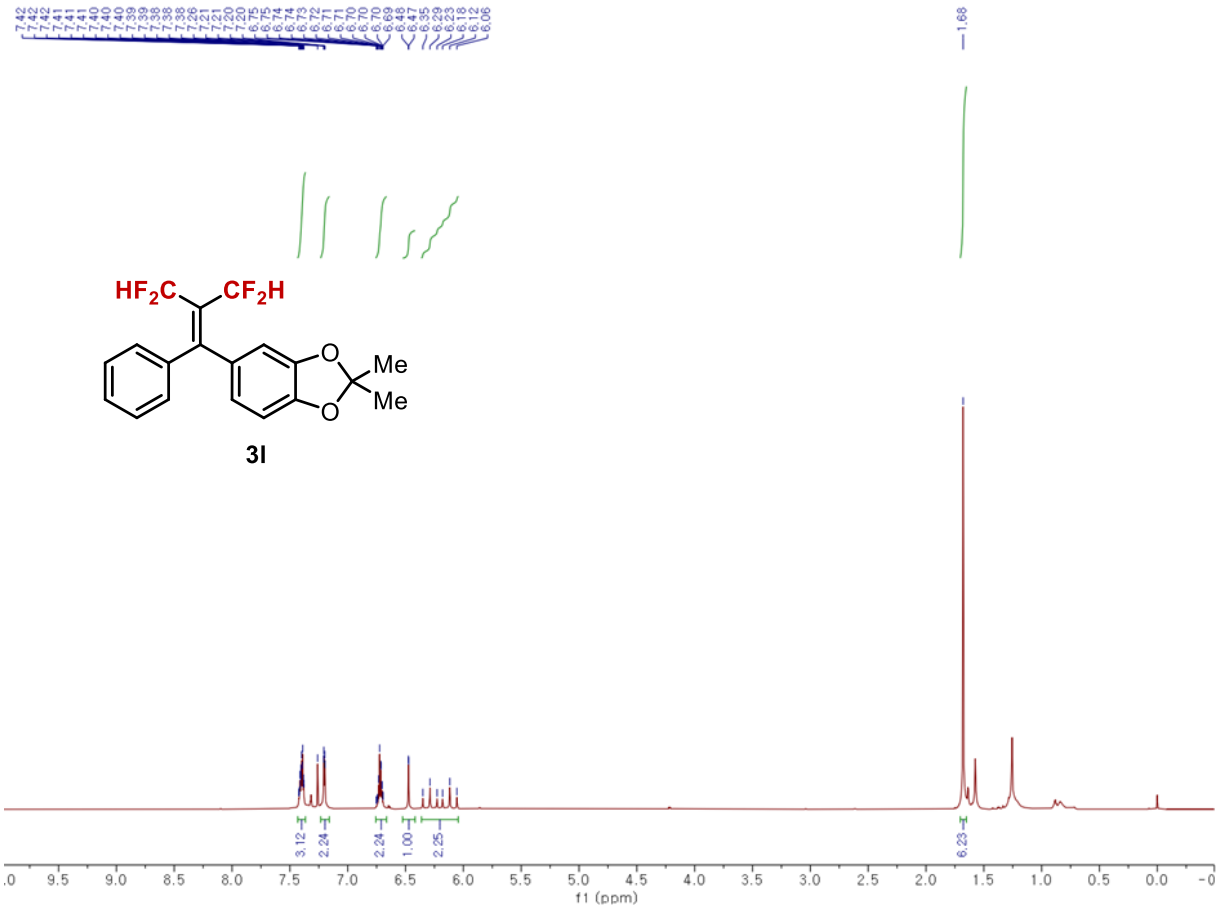
Supplementary Figure 48. ^{1}H NMR Spectrum of 2-(difluoromethyl)-6-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzofuran (**3k**)



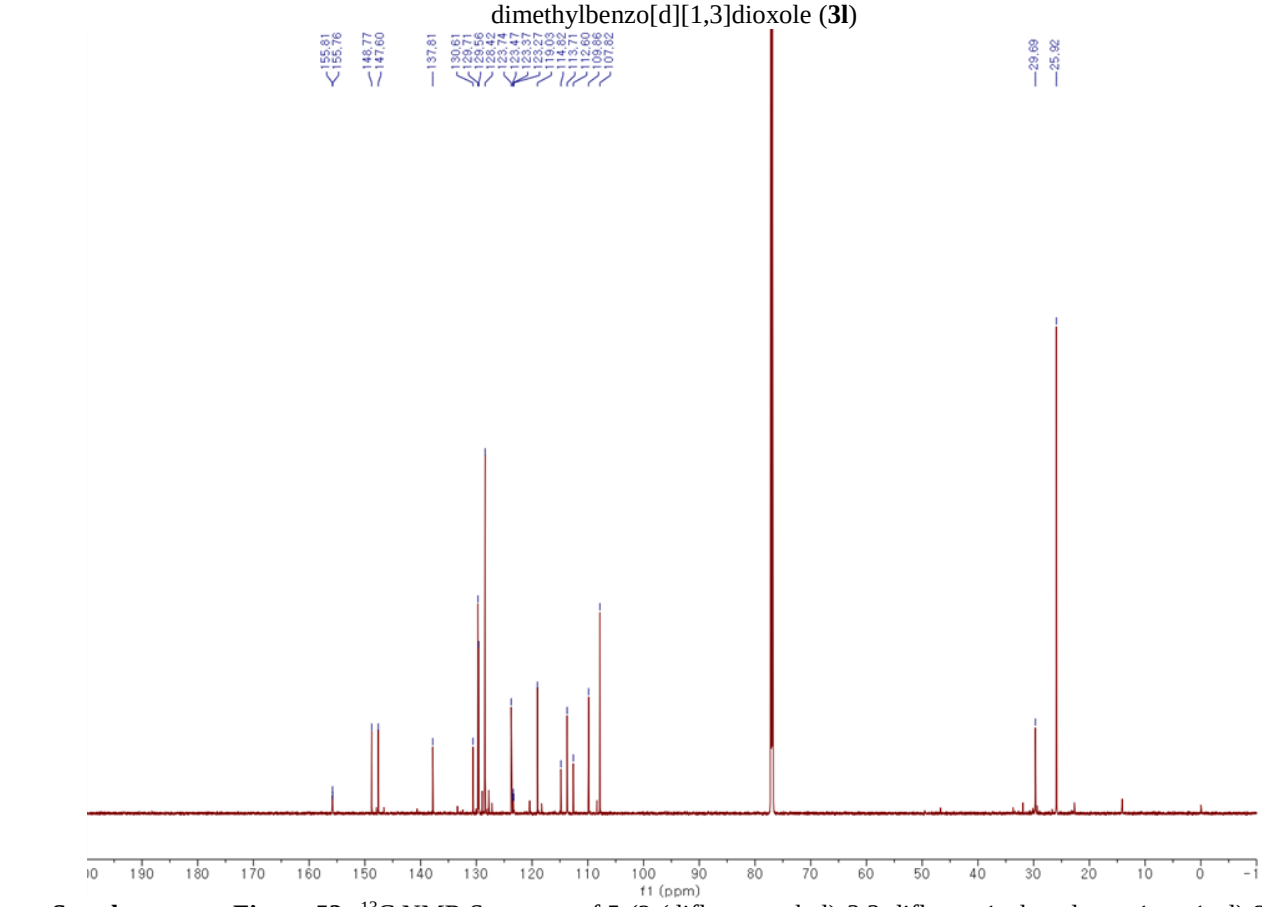
Supplementary Figure 49. ^{13}C NMR Spectrum of 2-(difluoromethyl)-6-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzofuran (**3k**)



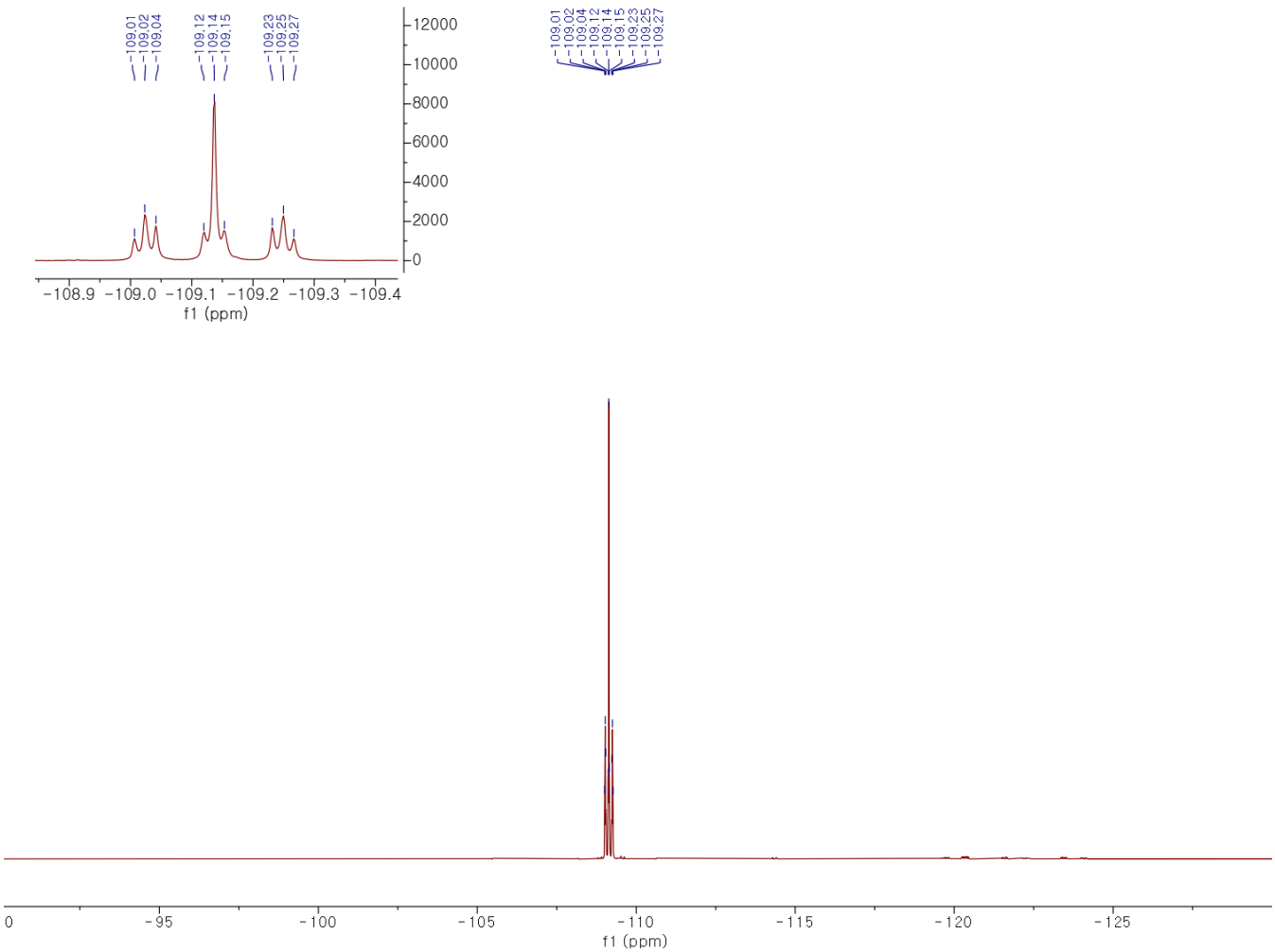
Supplementary Figure 50. ^{19}F NMR Spectrum of 2-(difluoromethyl)-6-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)benzofuran (**3k**)



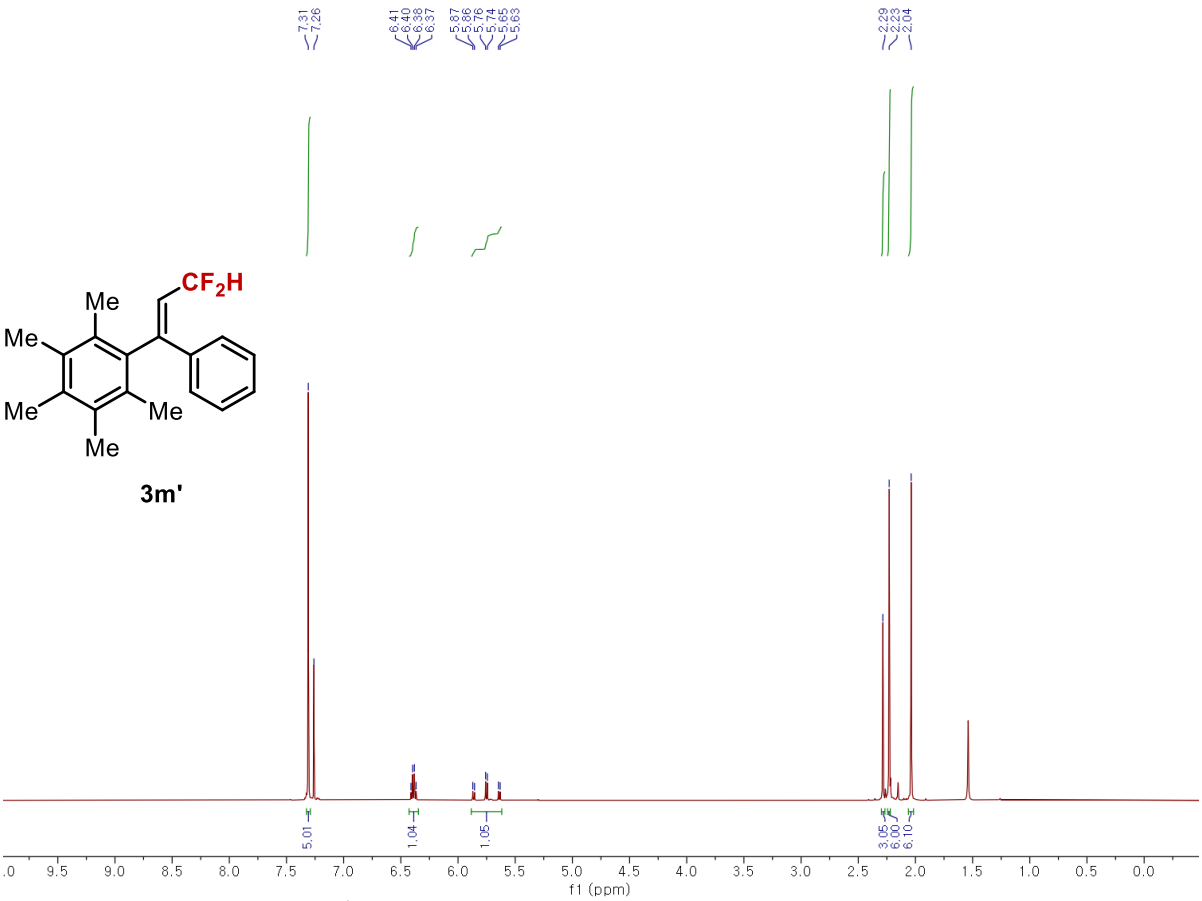
Supplementary Figure 51. ^{1}H NMR Spectrum of 5-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-2,2-dimethylbenzo[d][1,3]dioxole (**3l**)



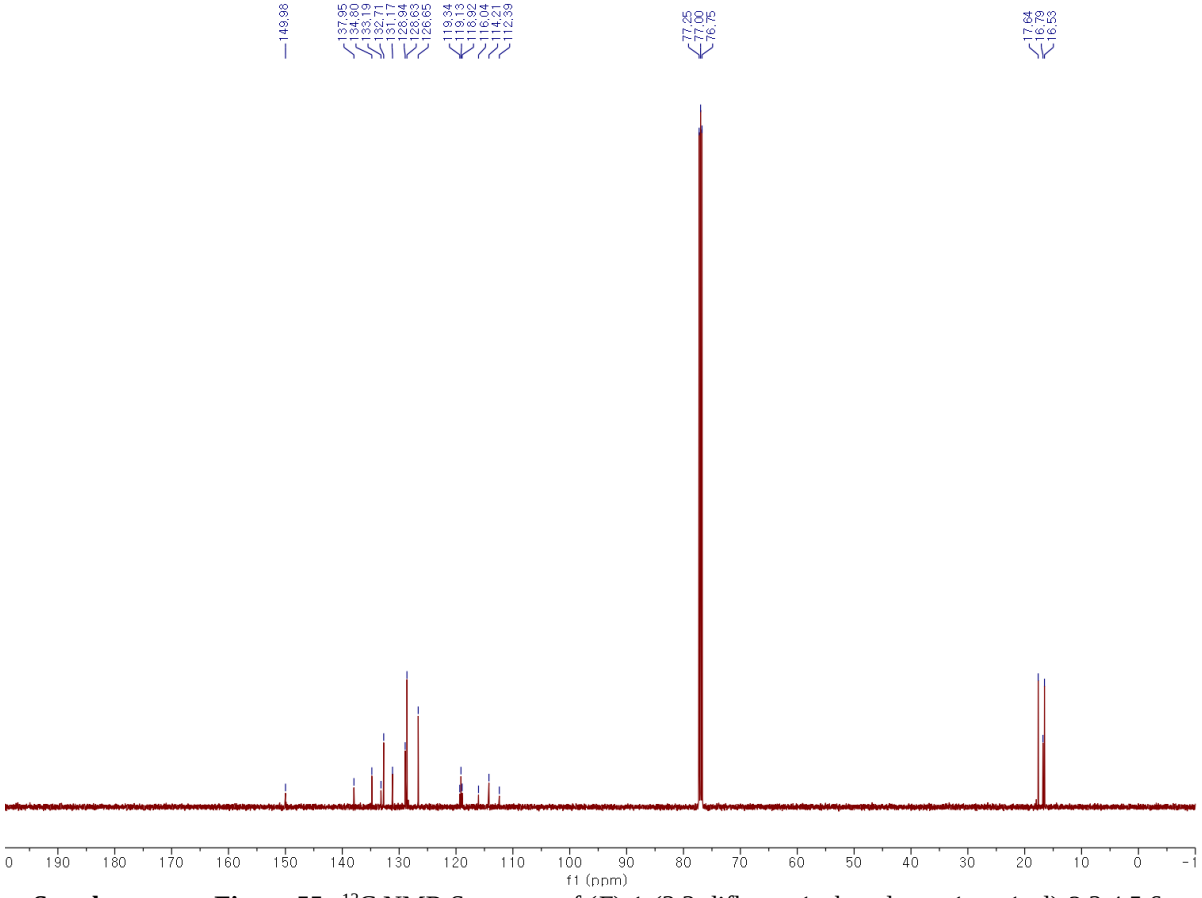
Supplementary Figure 52. ^{13}C NMR Spectrum of 5-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-2,2-dimethylbenzo[d][1,3]dioxole (**3l**)



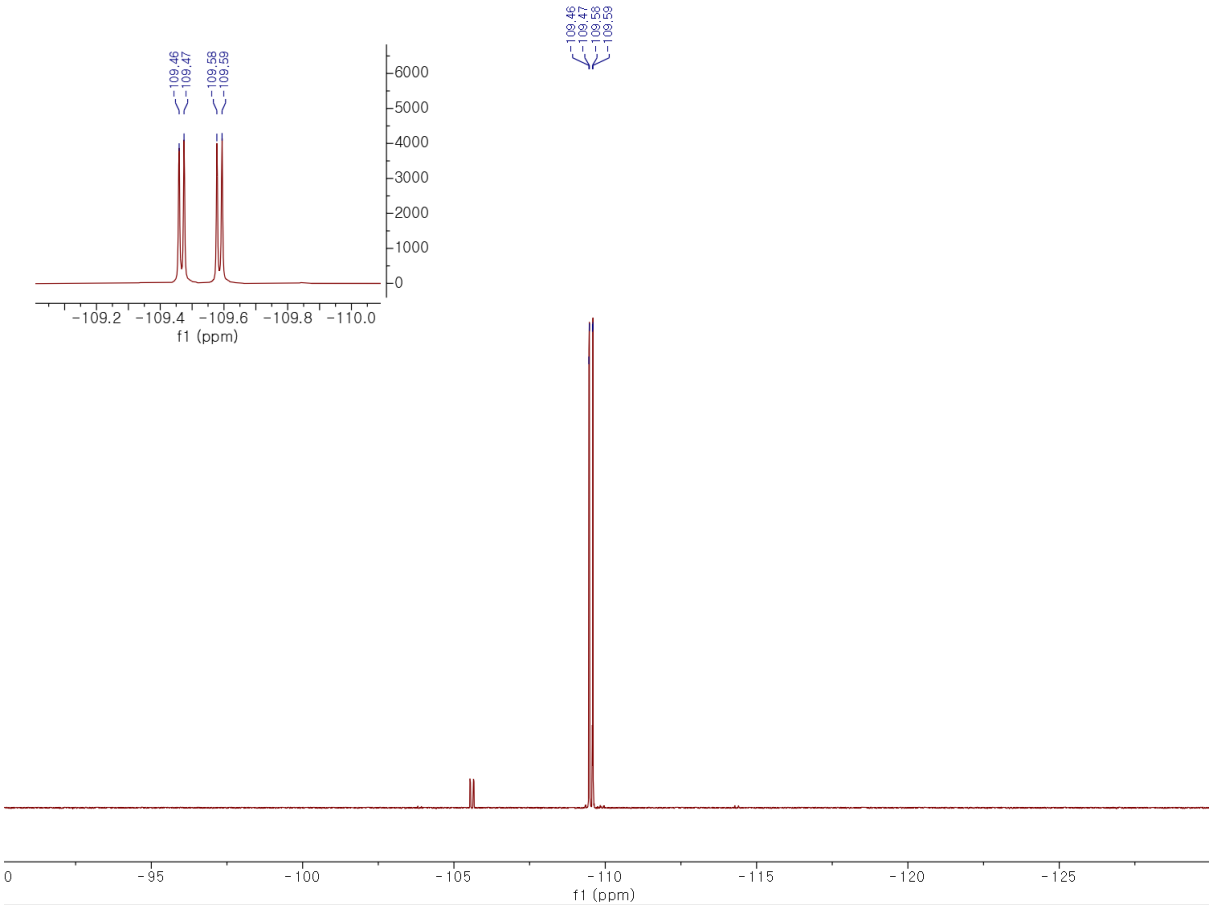
Supplementary Figure 53. ^{19}F NMR Spectrum of 5-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)-2,2-dimethylbenzo[d][1,3]dioxole (**3l**)



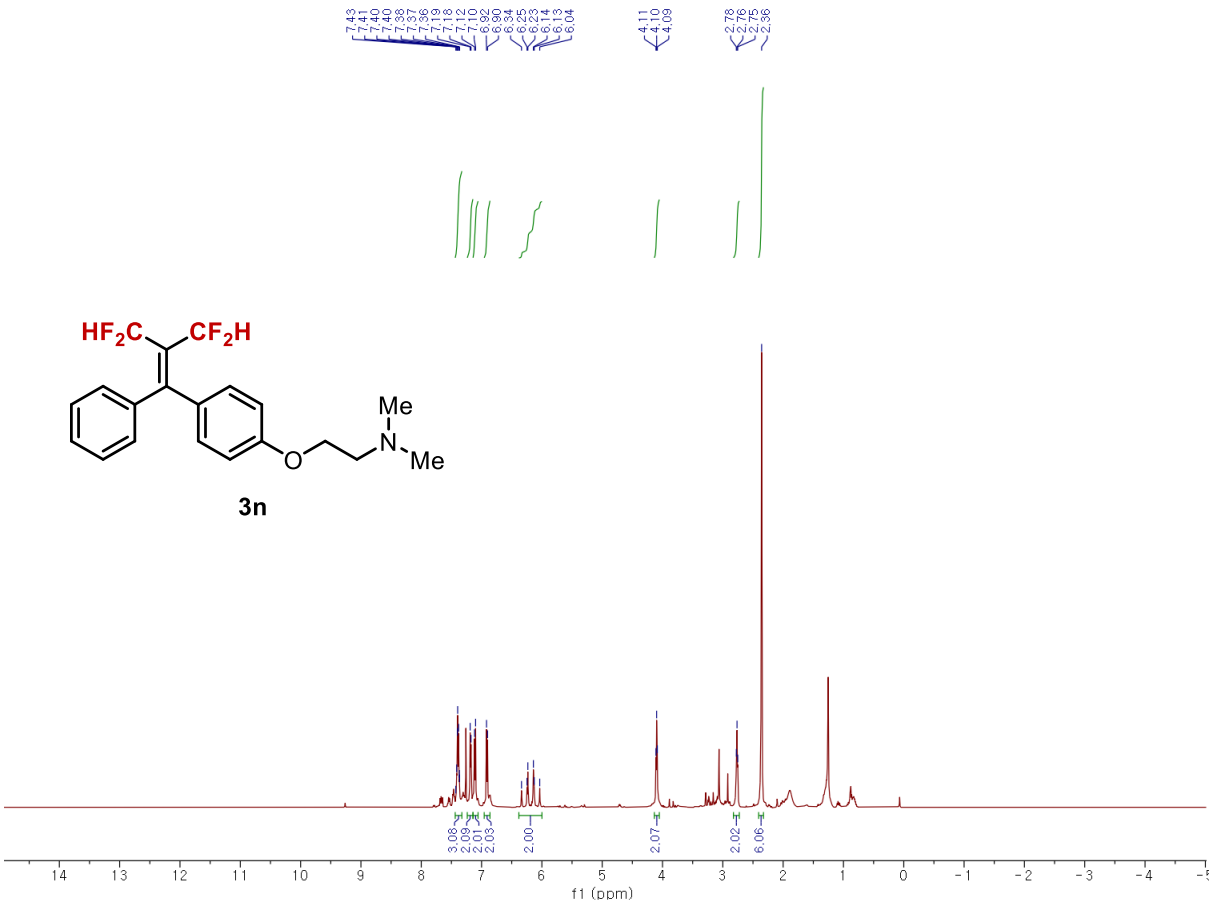
Supplementary Figure 54. ^{1}H NMR Spectrum of (*E*)-1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-2,3,4,5,6-pentamethylbenzene (**3m'**)



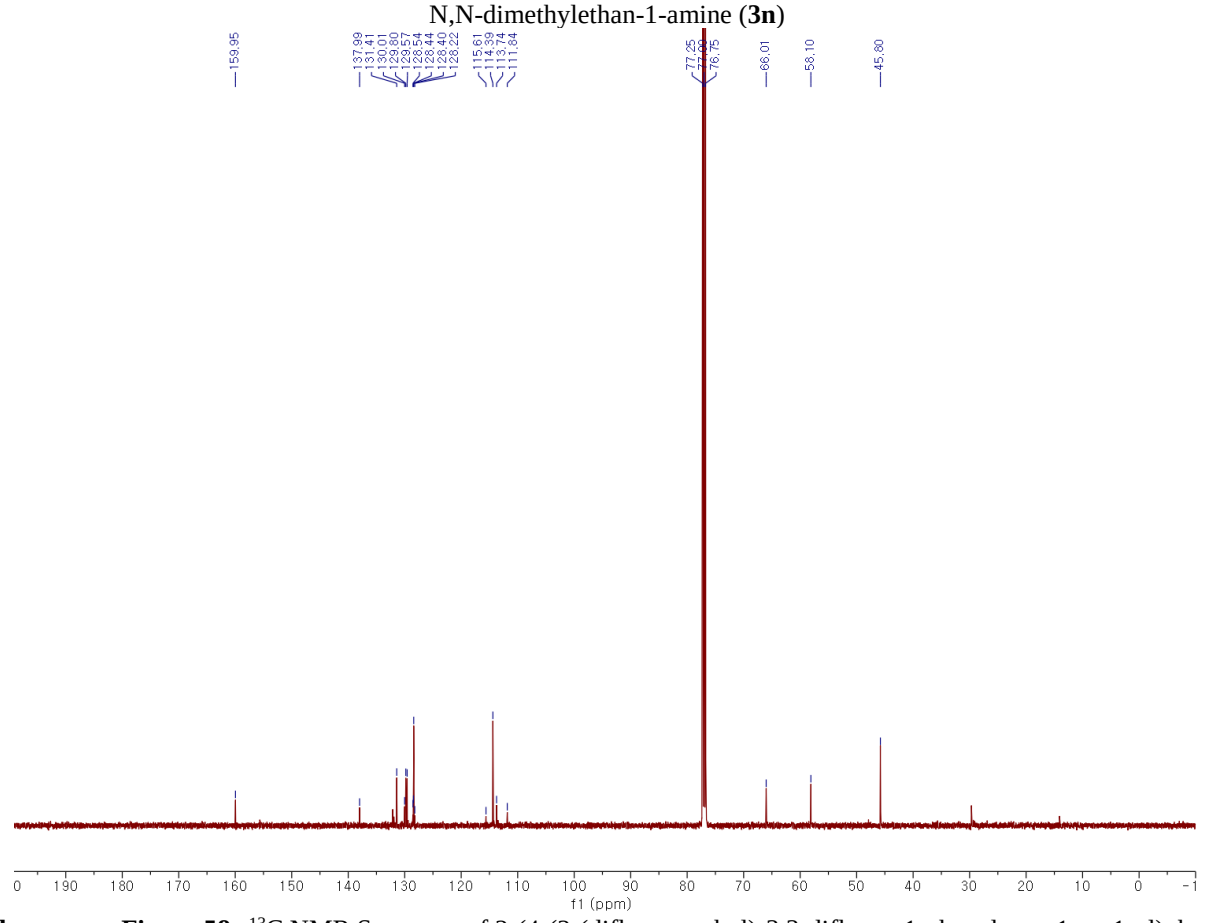
Supplementary Figure 55. ^{13}C NMR Spectrum of (*E*)-1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-2,3,4,5,6-pentamethylbenzene (**3m'**)



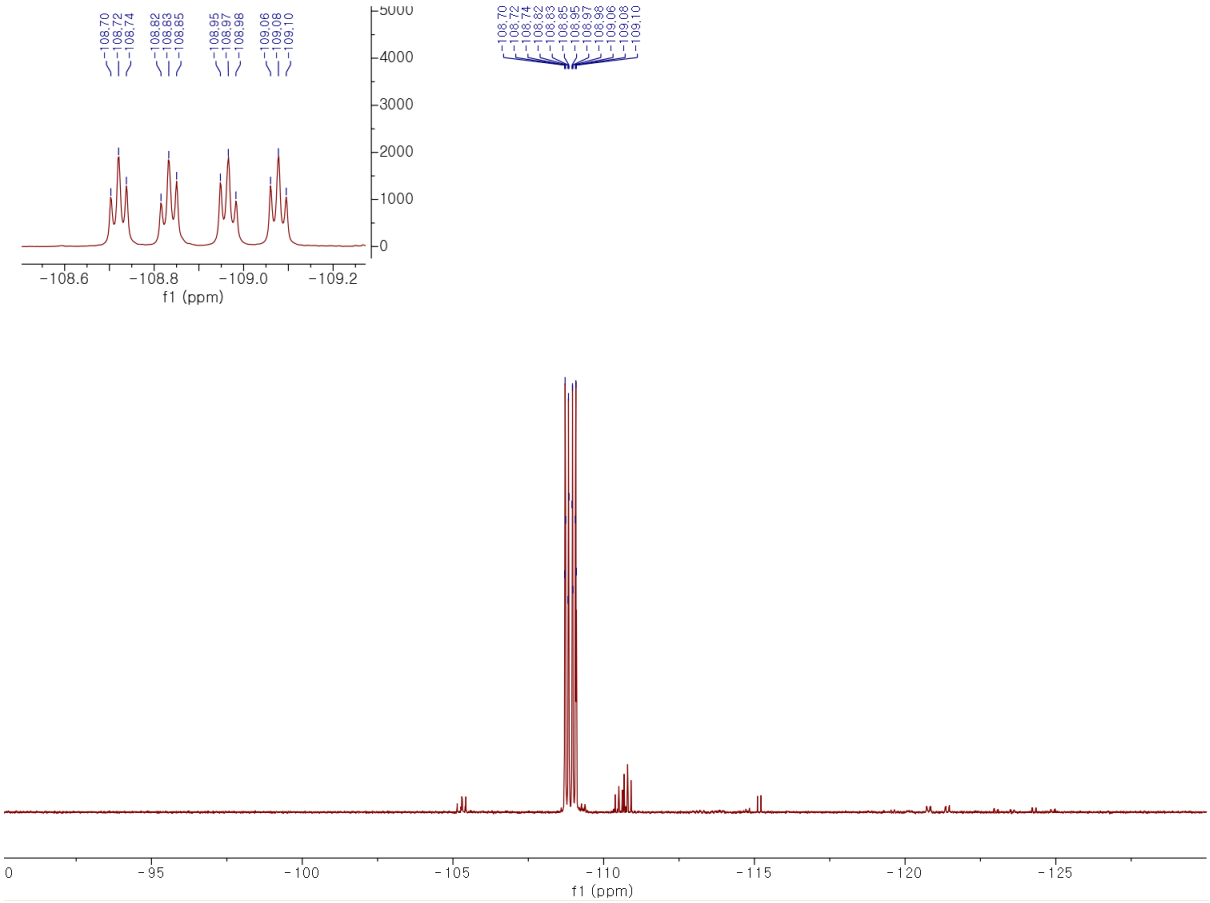
Supplementary Figure 56. ^{19}F NMR Spectrum of (*E*)-1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-2,3,4,5,6-pentamethylbenzene (**3m'**)



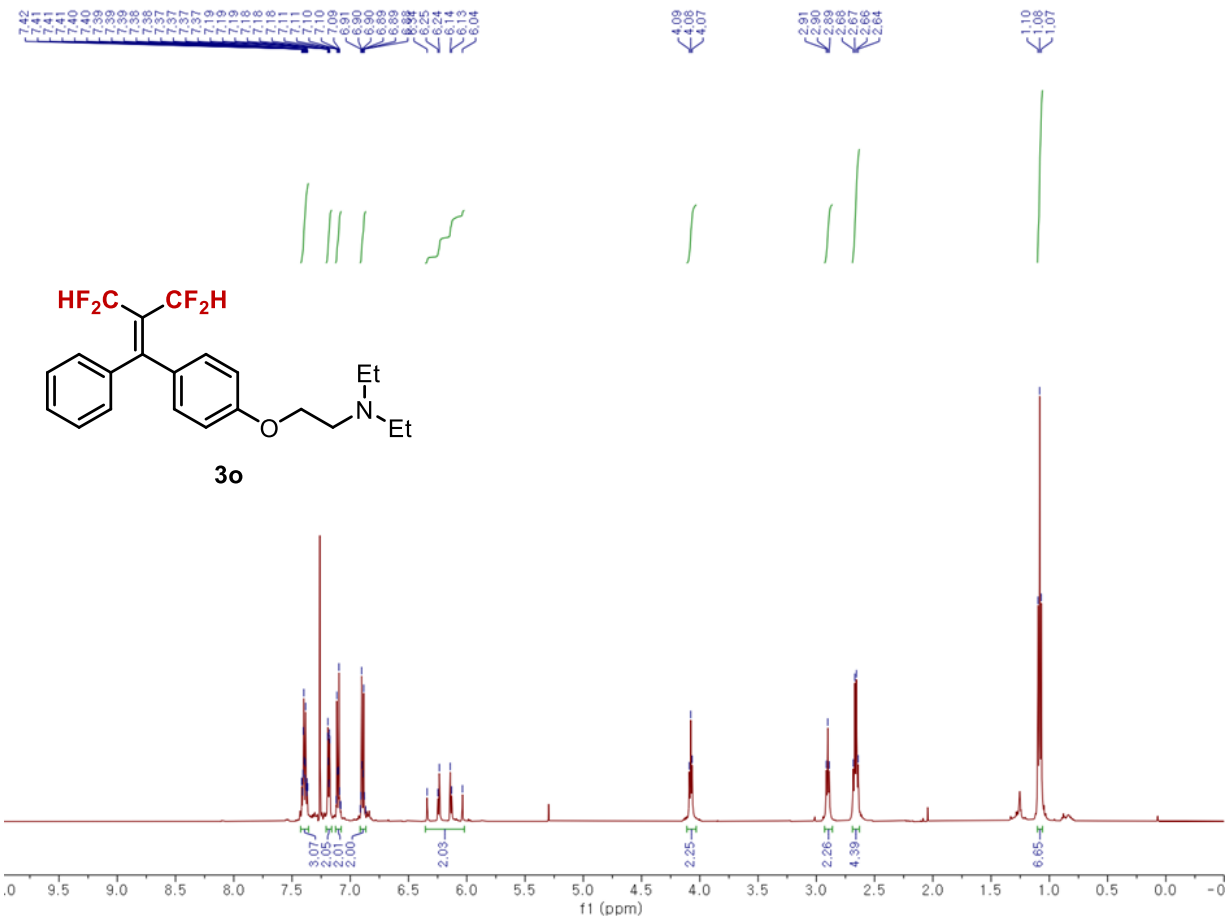
Supplementary Figure 57. ^{1}H NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3n**)



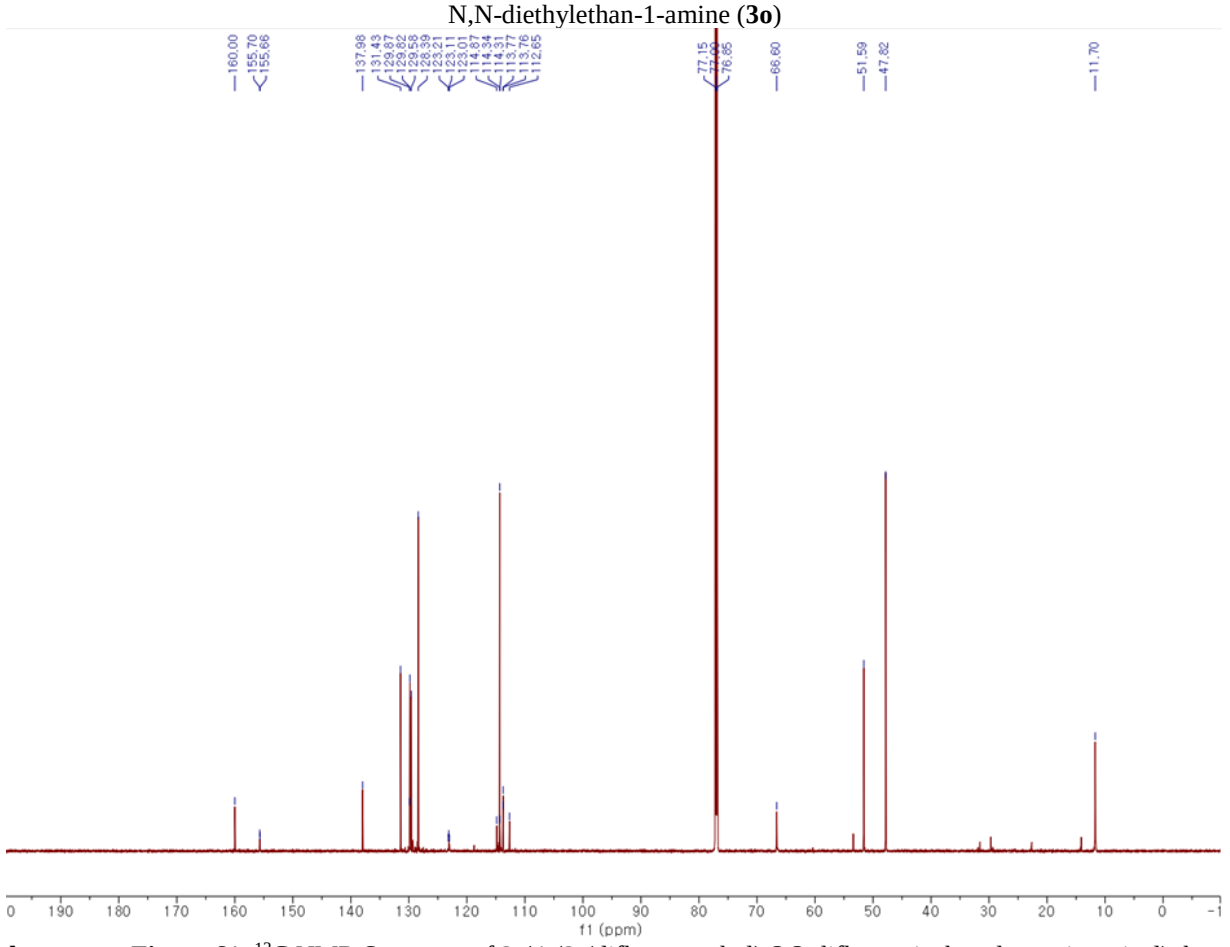
Supplementary Figure 58. ^{13}C NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3n**)



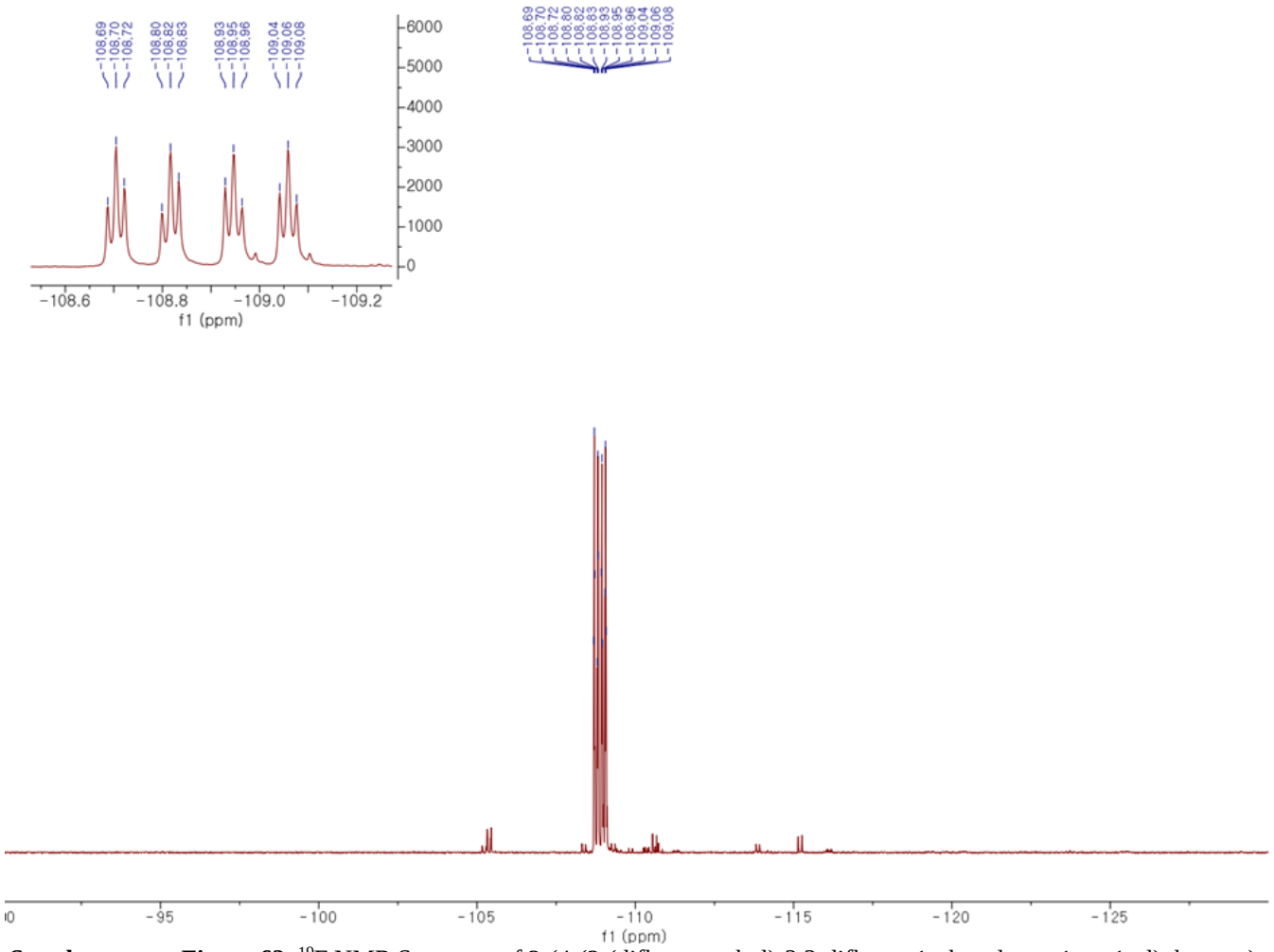
Supplementary Figure 59. ^{19}F NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3n**)



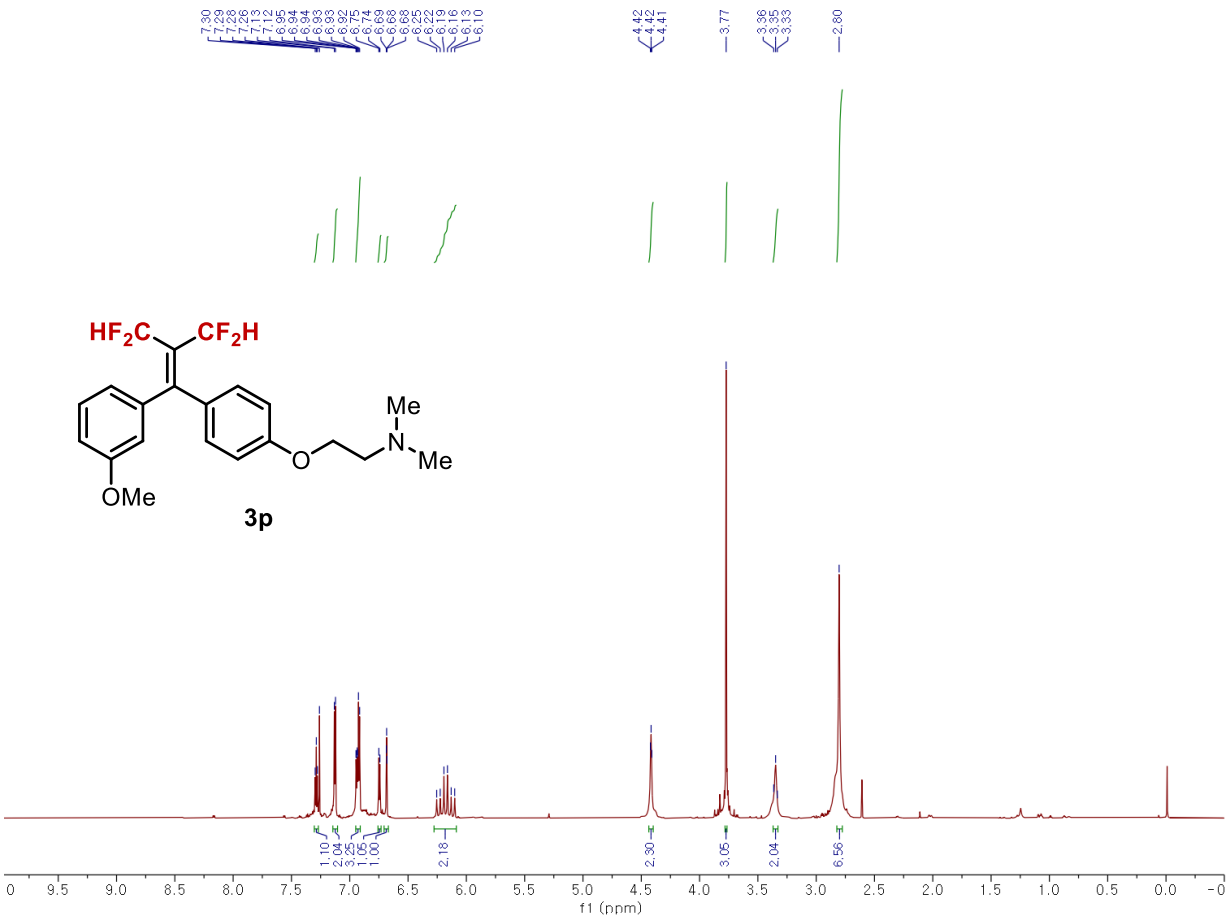
Supplementary Figure 60. ^{1}H NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-diethylethan-1-amine (**3o**)



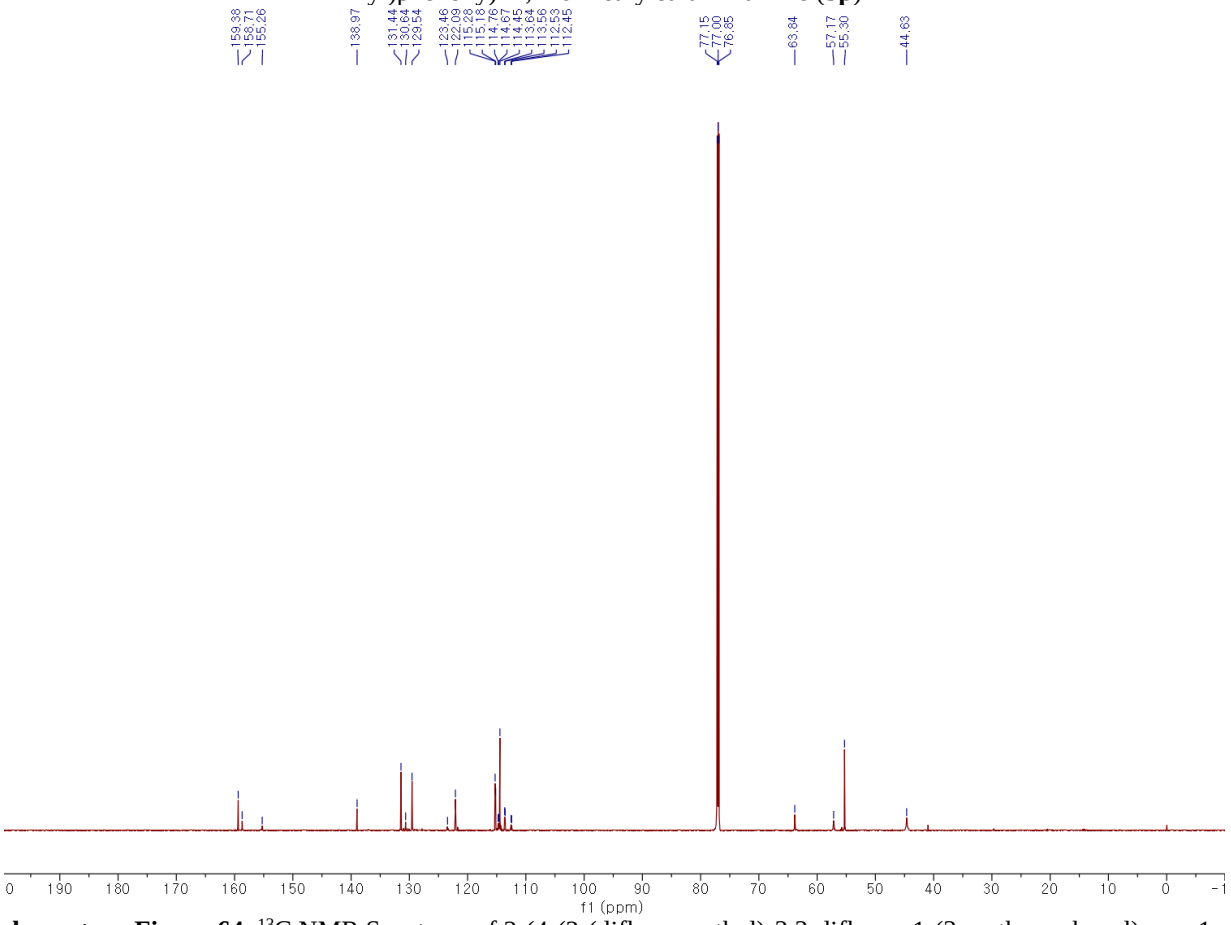
Supplementary Figure 61. ^{13}C NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-diethylethan-1-amine (**3o**)



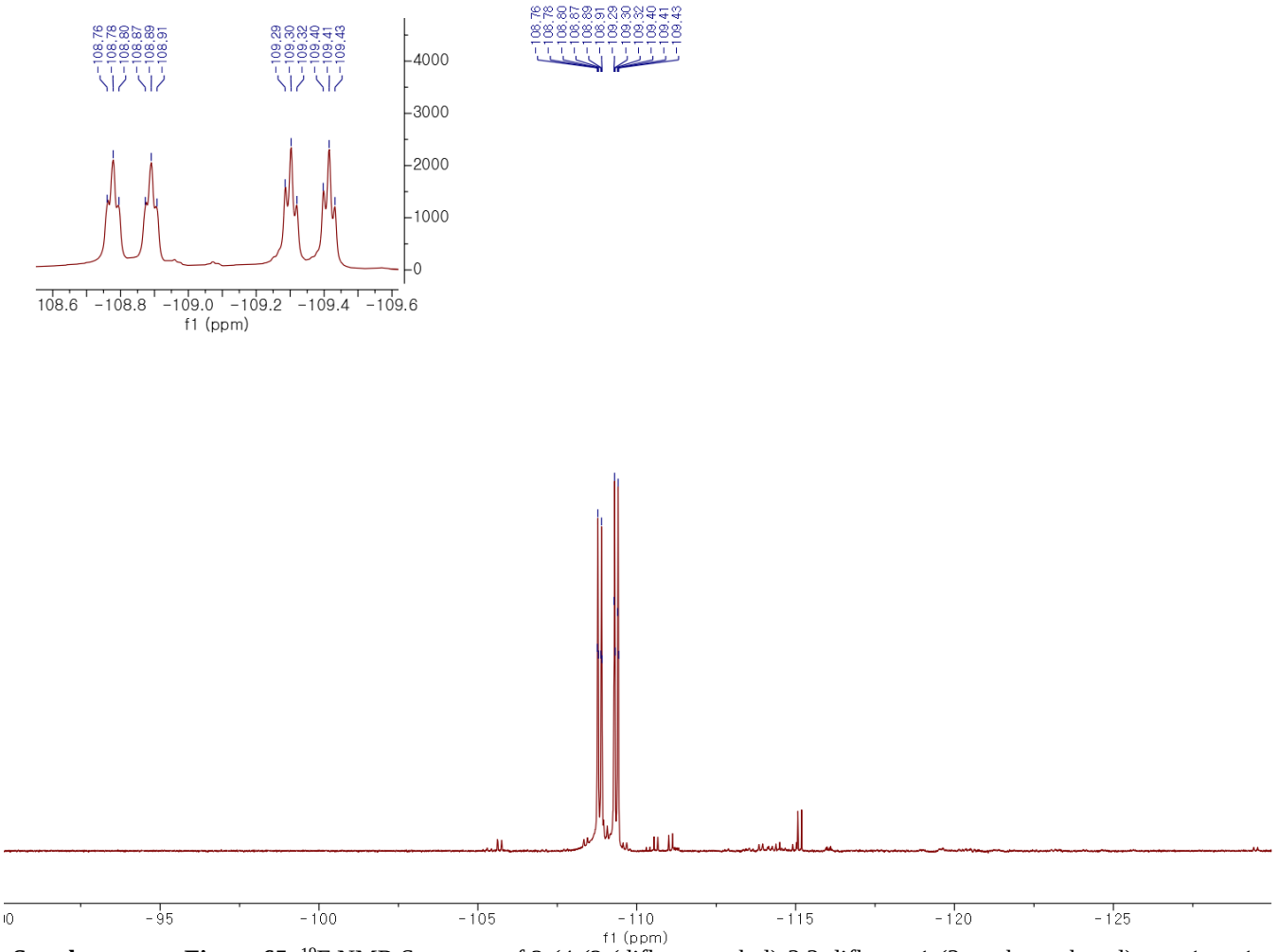
Supplementary Figure 62. ^{19}F NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)-N,N-diethylethan-1-amine (**3o**)



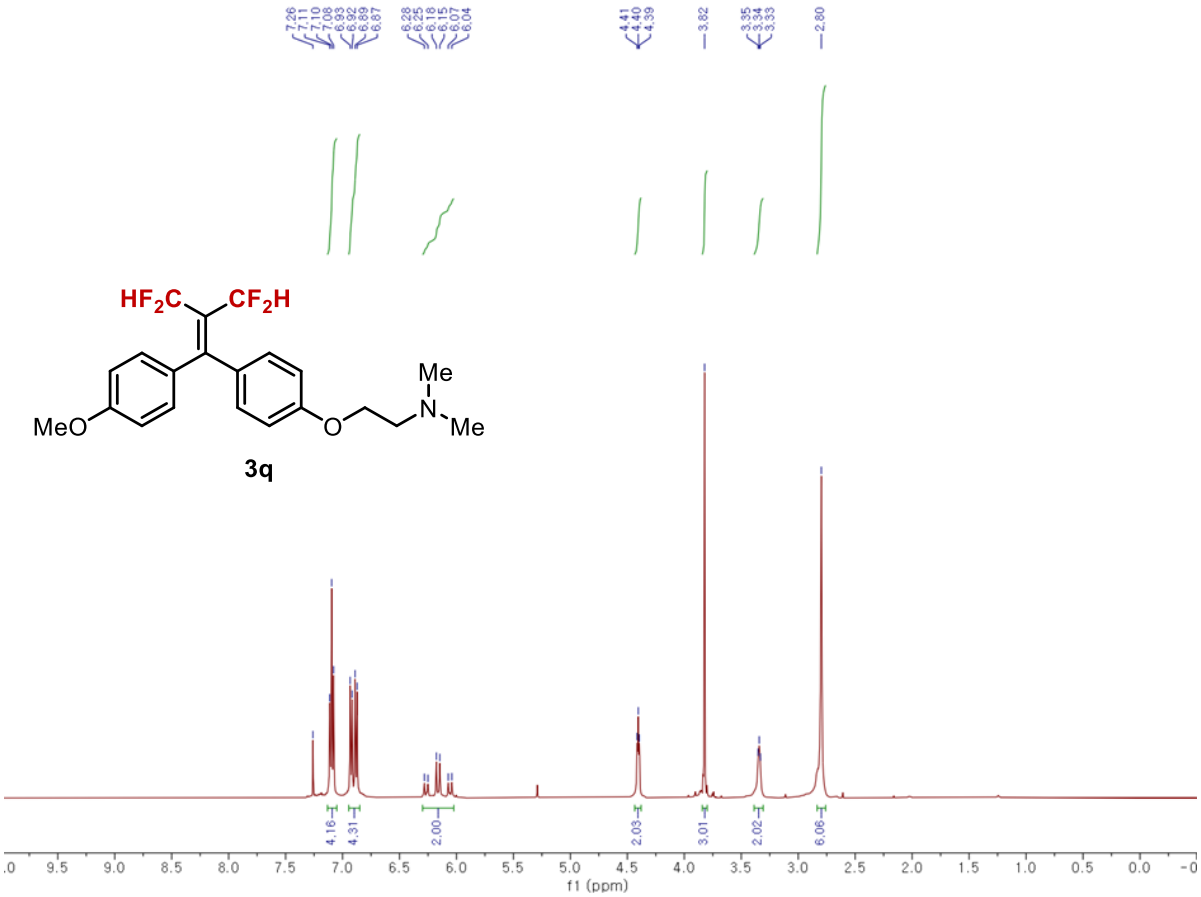
Supplementary Figure 63. ^{1}H NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(3-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3p**)



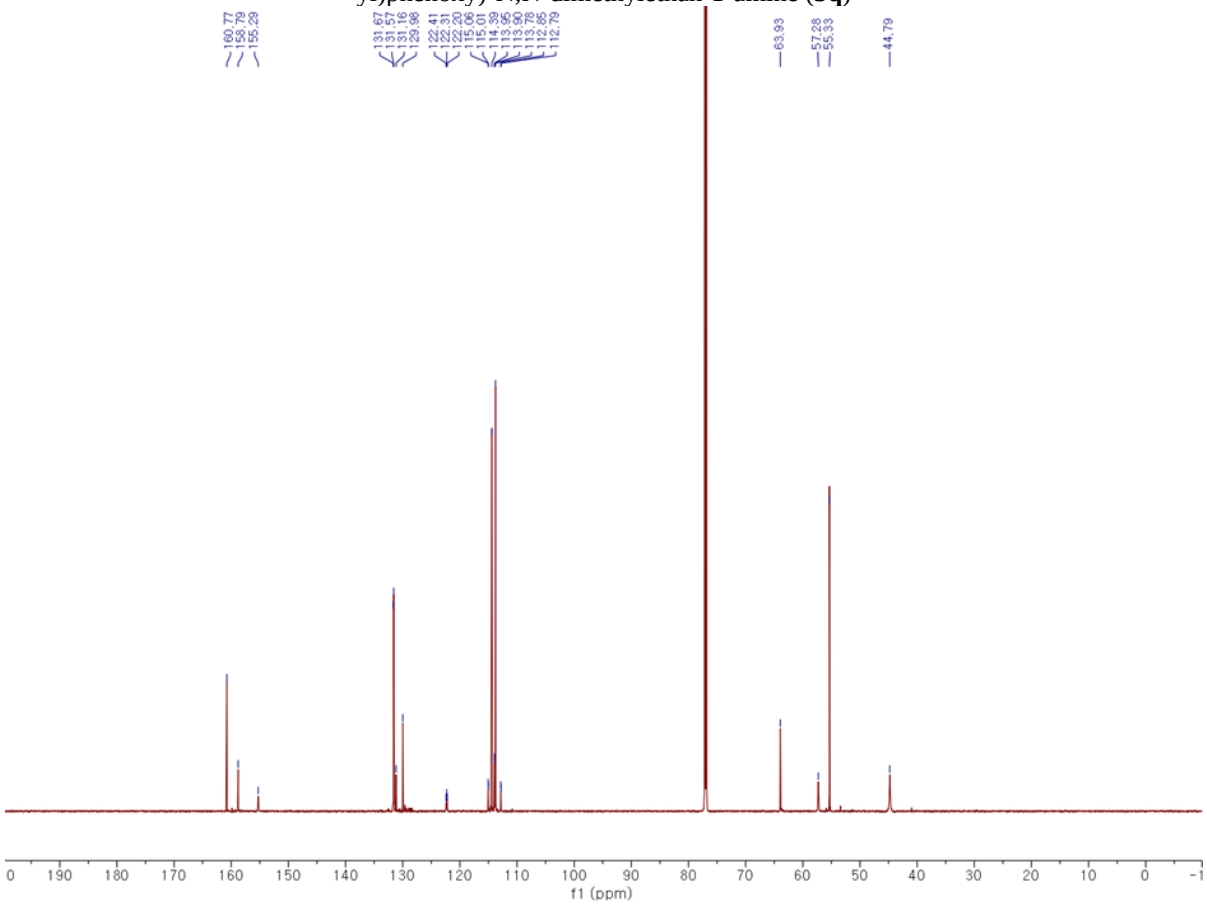
Supplementary Figure 64. ^{13}C NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(3-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3p**)



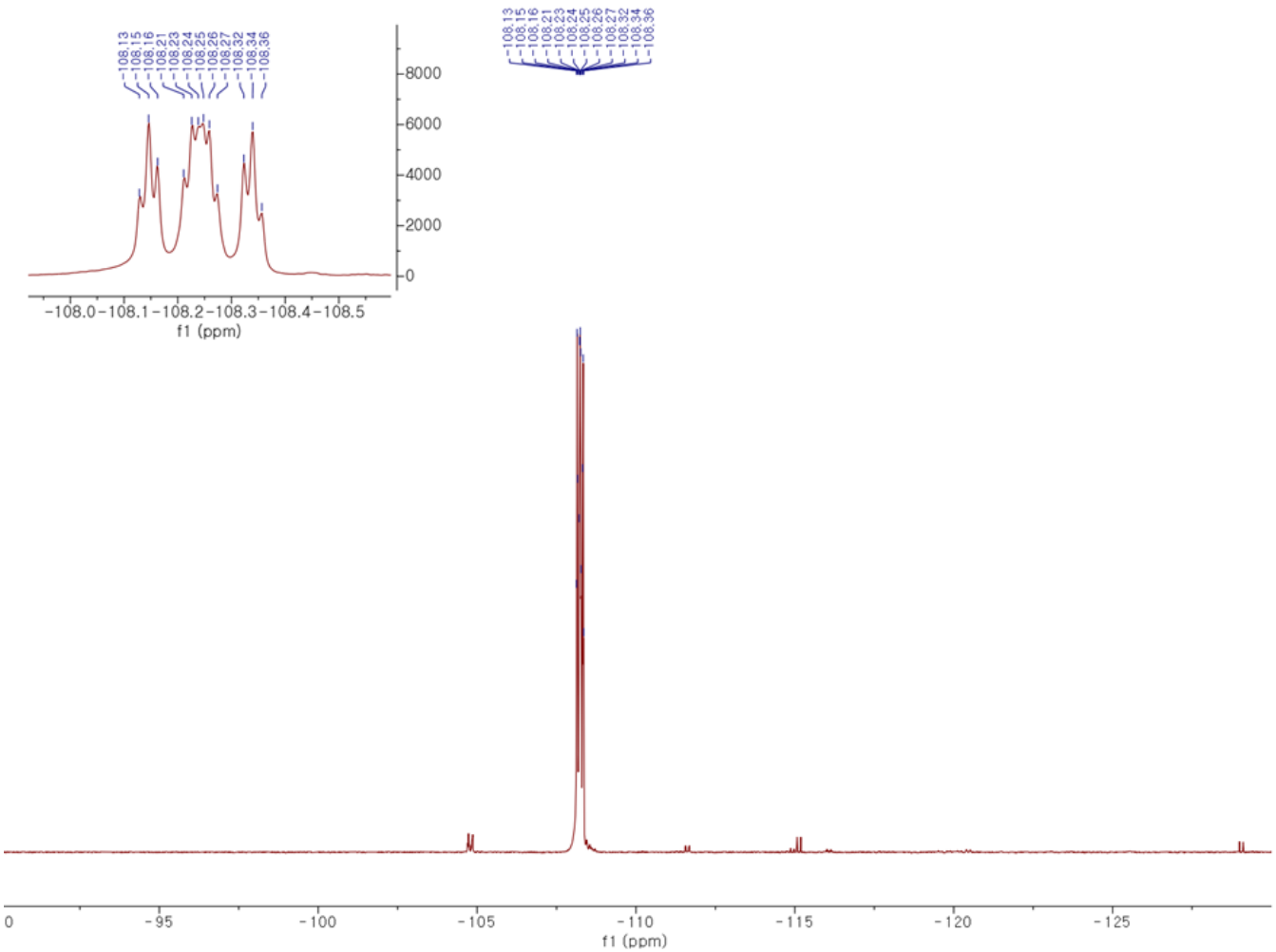
Supplementary Figure 65. ^{19}F NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(3-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3p**)



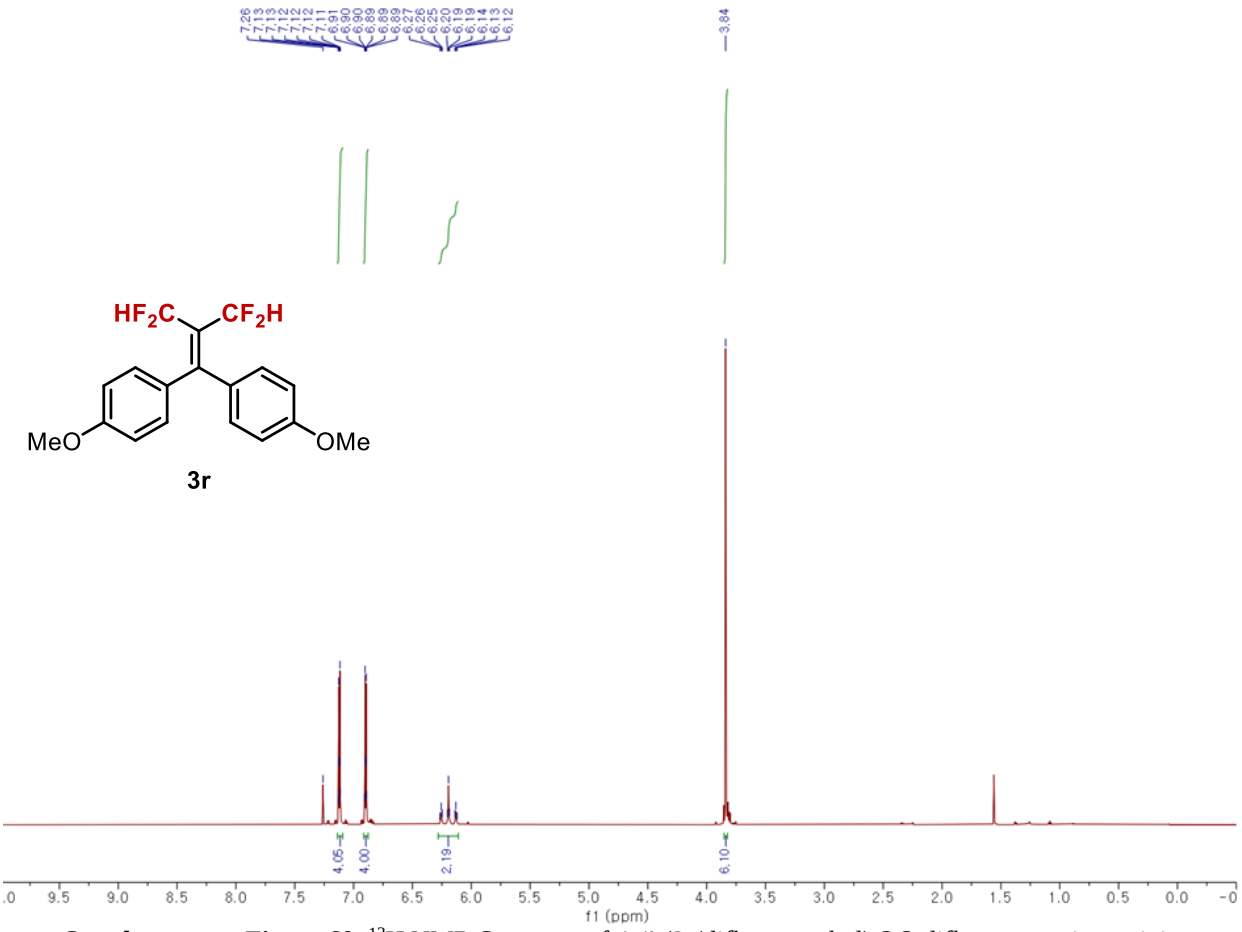
Supplementary Figure 66. ^{1}H NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3q**)



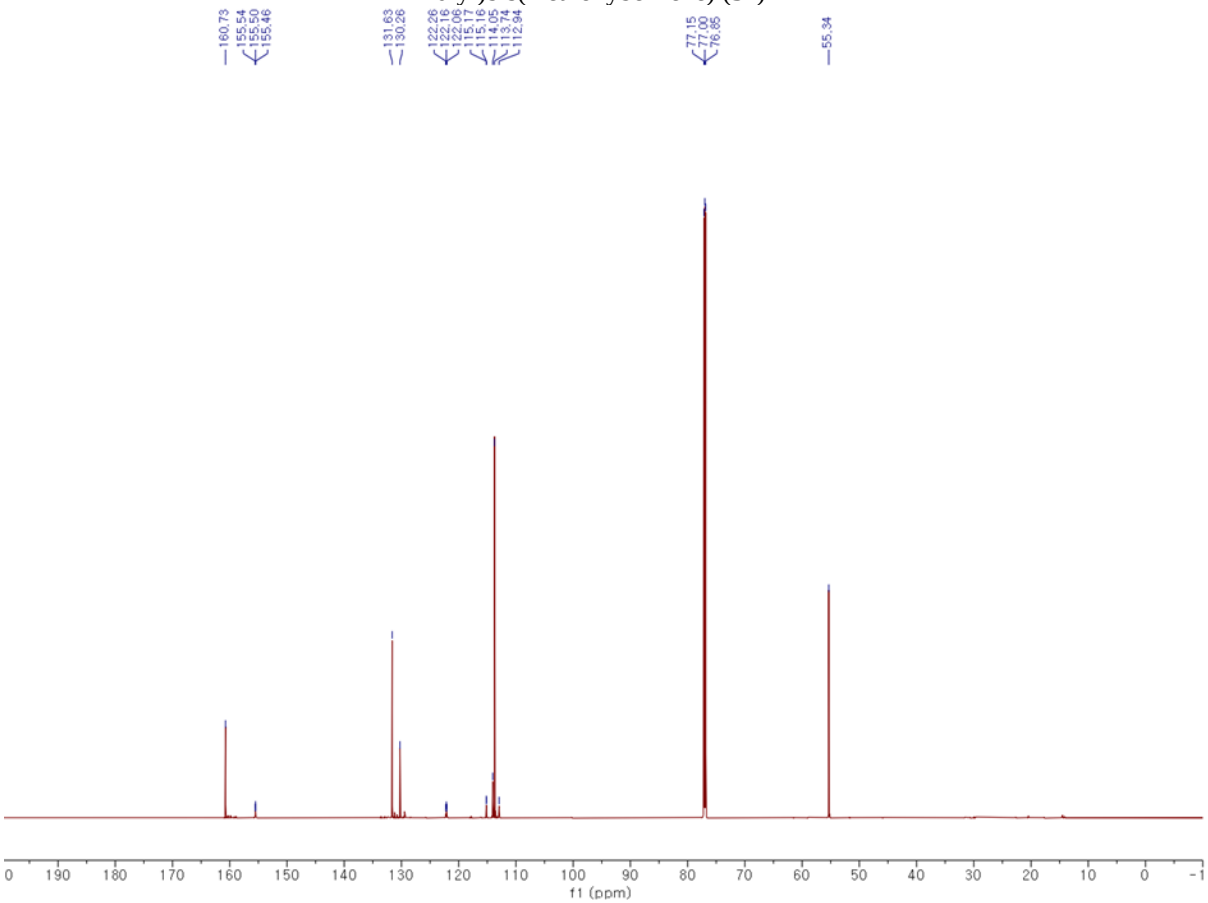
Supplementary Figure 67. ^{13}C NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3q**)



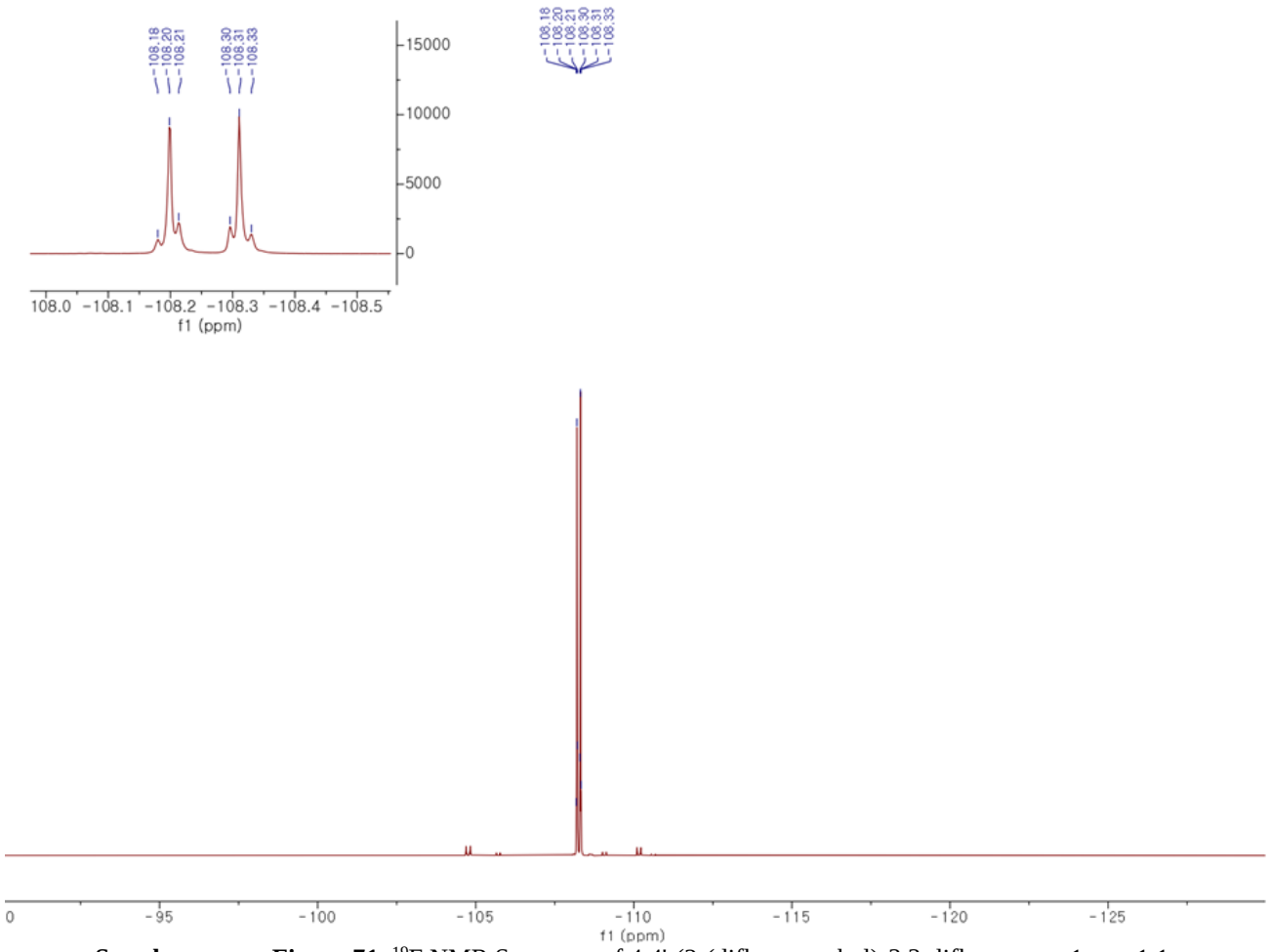
Supplementary Figure 68. ^{19}F NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)prop-1-en-1-yl)phenoxy)-N,N-dimethylethan-1-amine (**3q**)



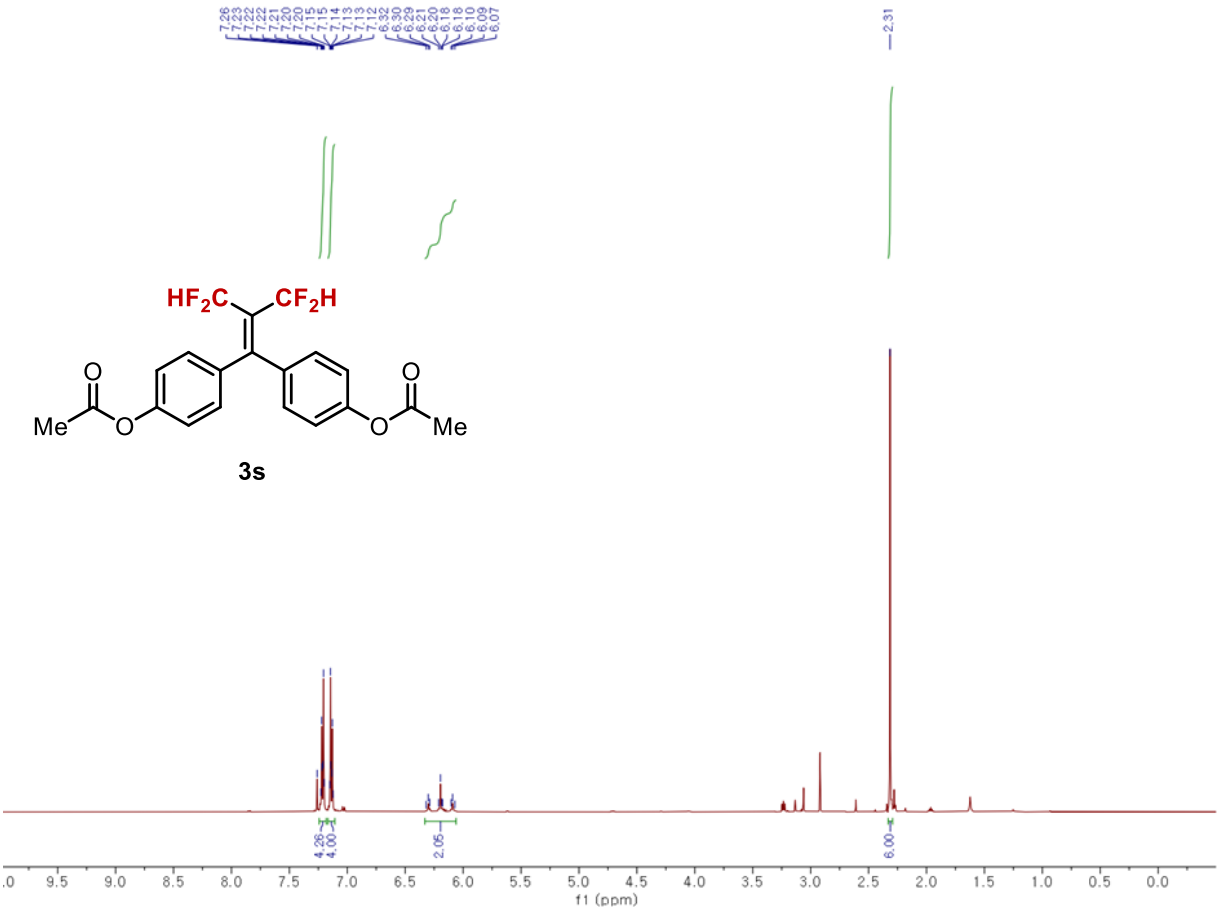
Supplementary Figure 69. ^{13}H NMR Spectrum of 4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(methoxybenzene) (**3r**)



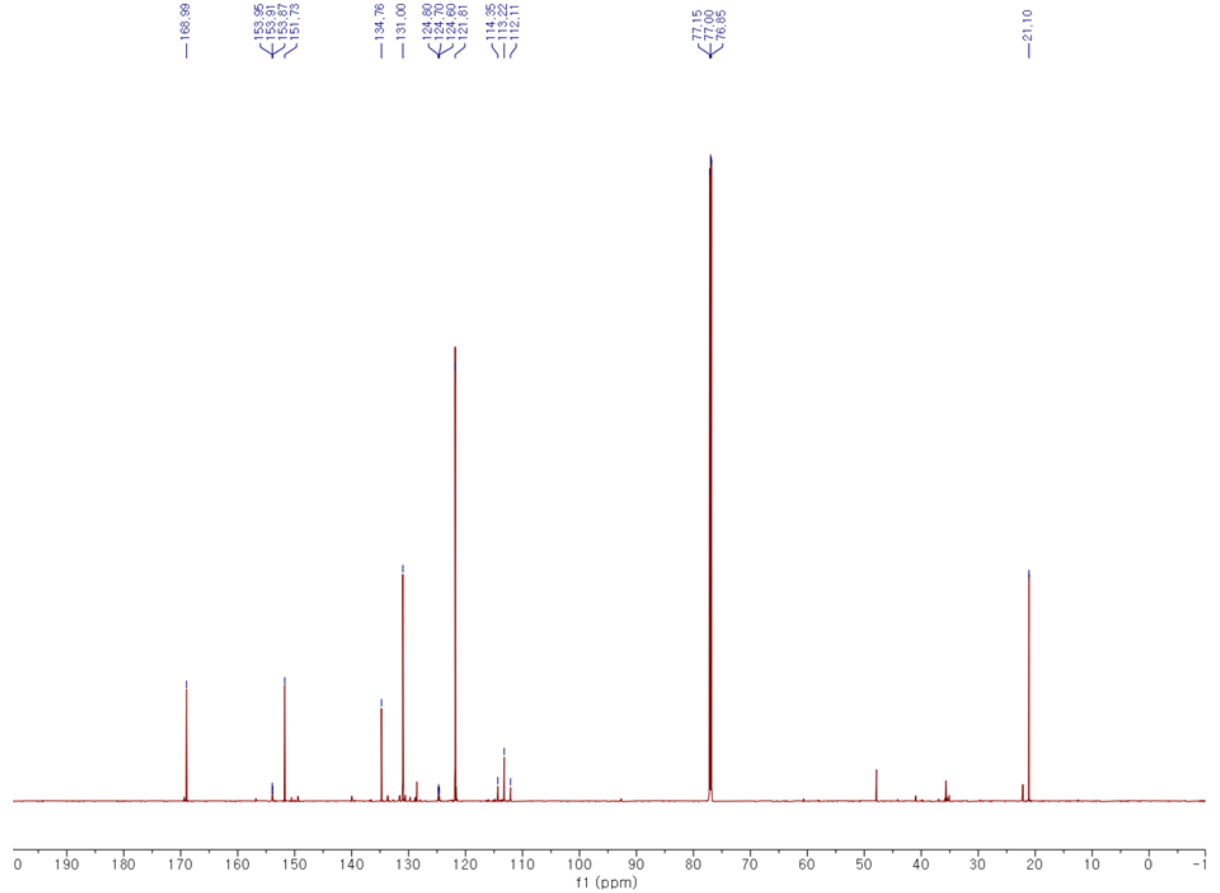
Supplementary Figure 70. ^{13}C NMR Spectrum of 4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(methoxybenzene) (**3r**)



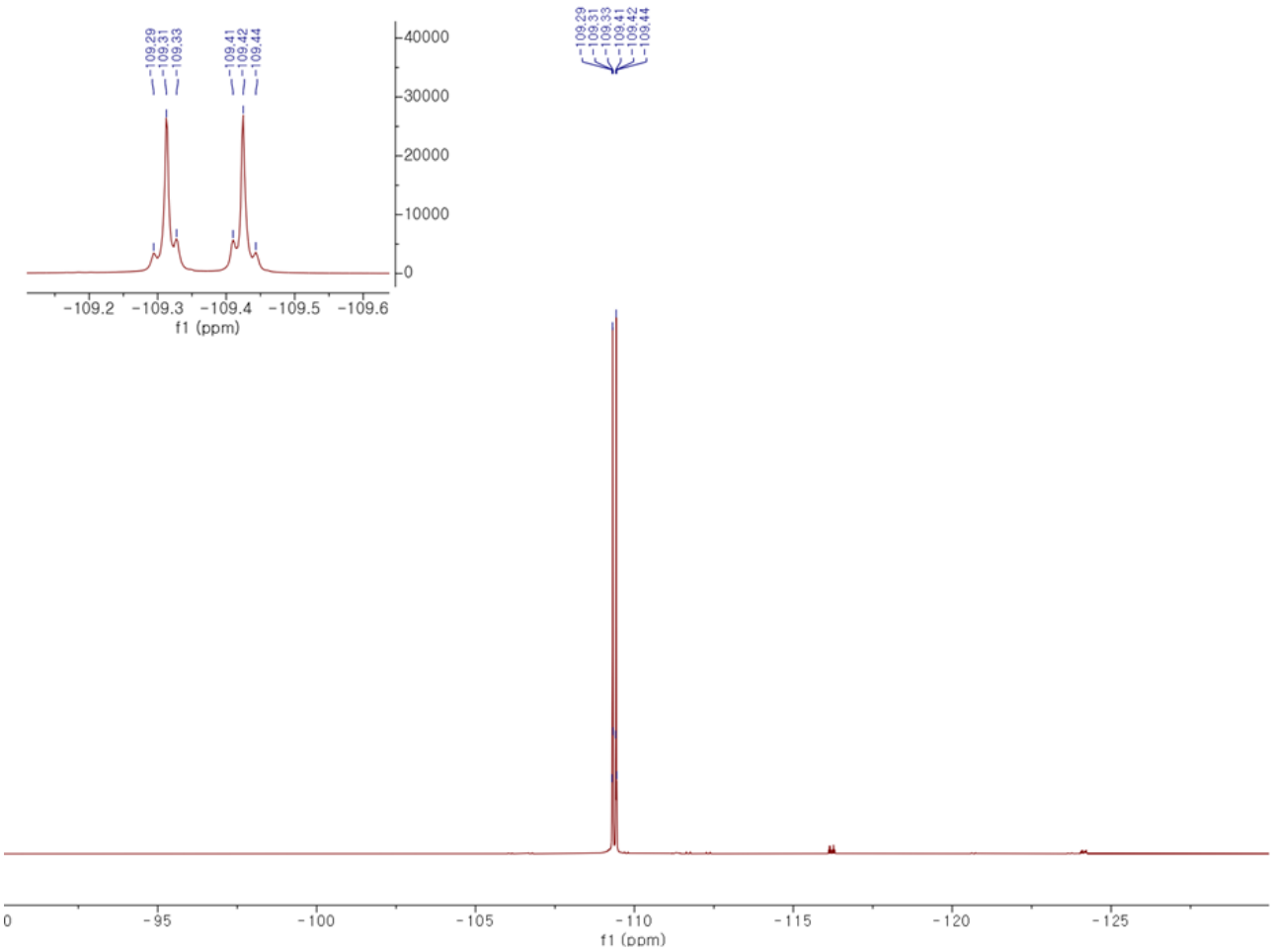
Supplementary Figure 71. ^{19}F NMR Spectrum of 4,4'-(2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(methoxybenzene) (**3r**)



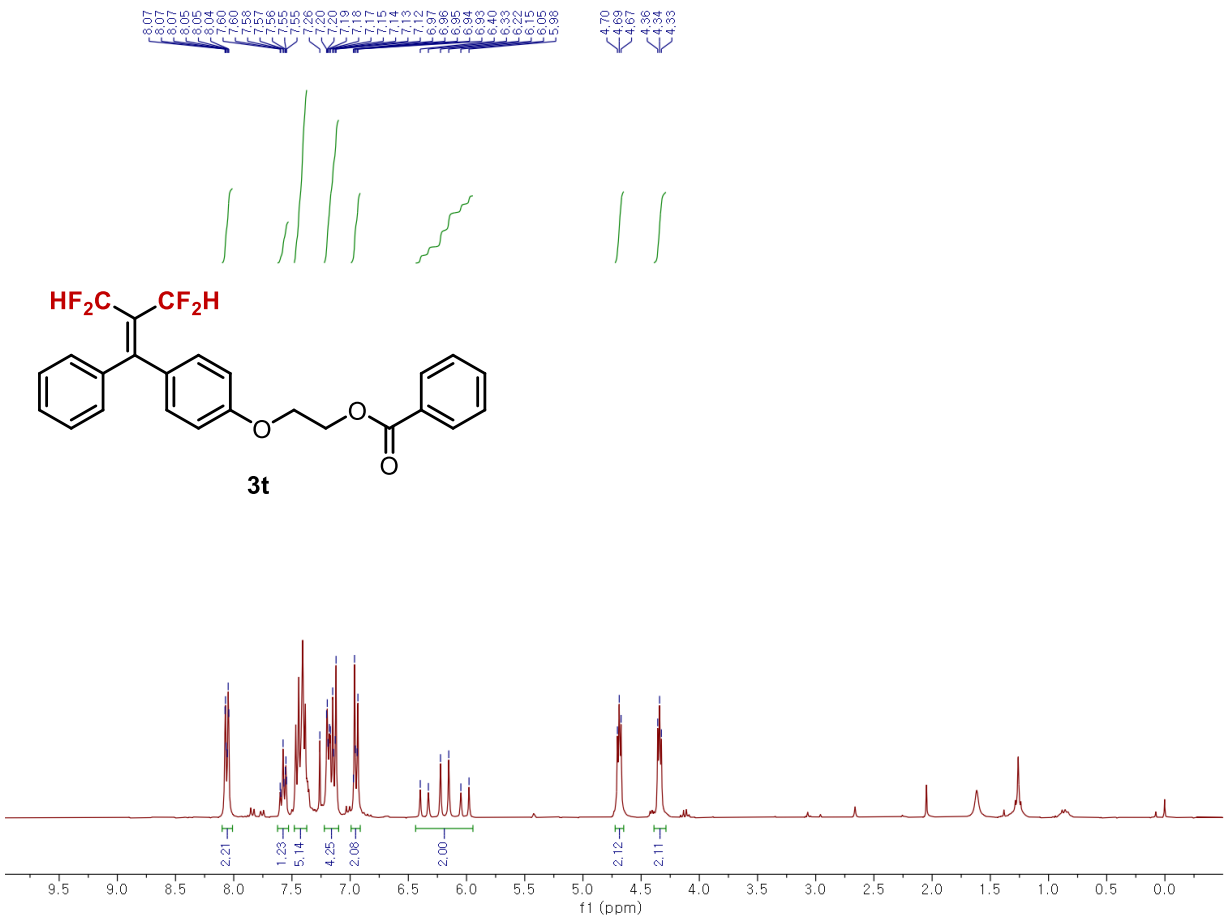
Supplementary Figure 72. ^{1}H NMR Spectrum of (2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(4,1-phenylene) diacetate (**3s**)



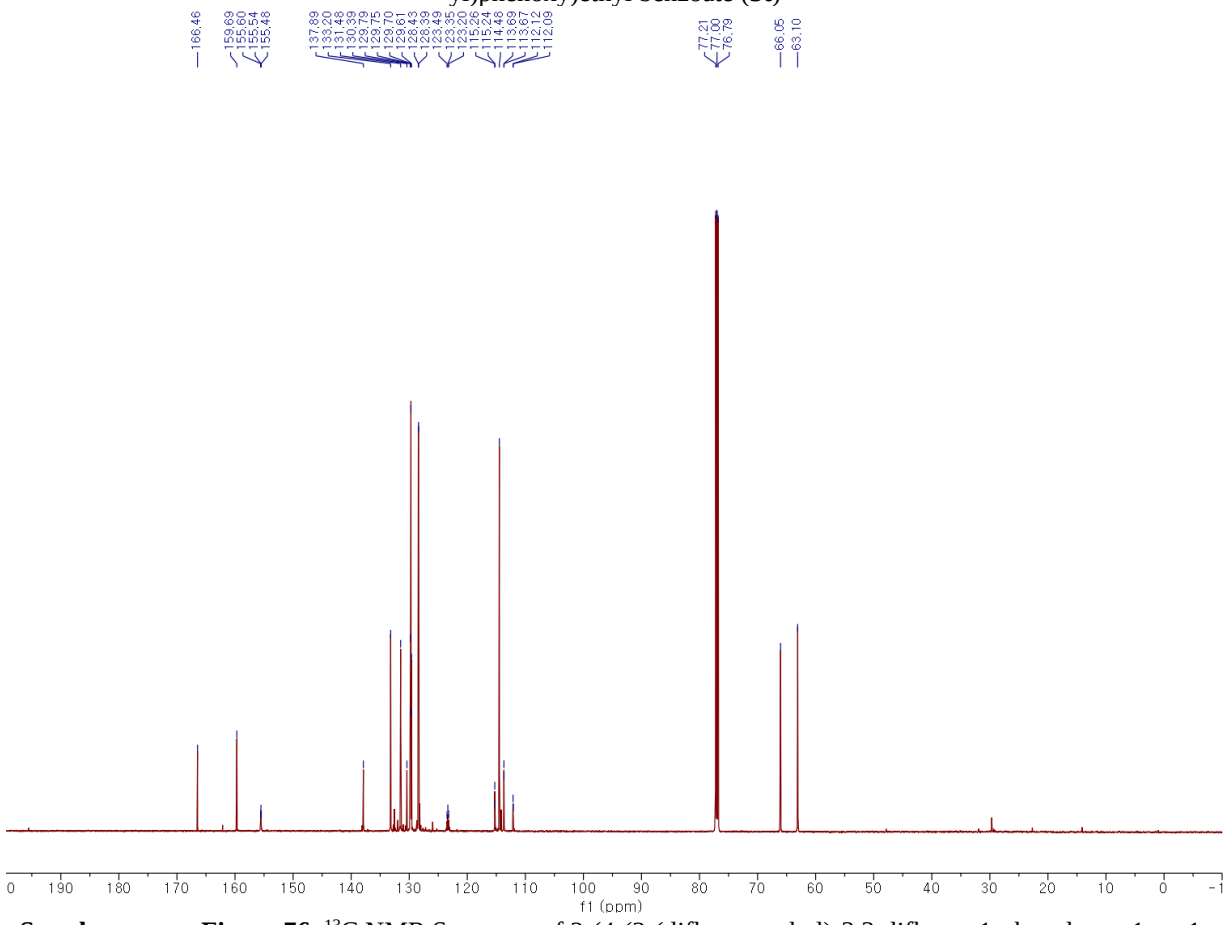
Supplementary Figure 73. ^{13}C NMR Spectrum of (2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(4,1-phenylene) diacetate (**3s**)



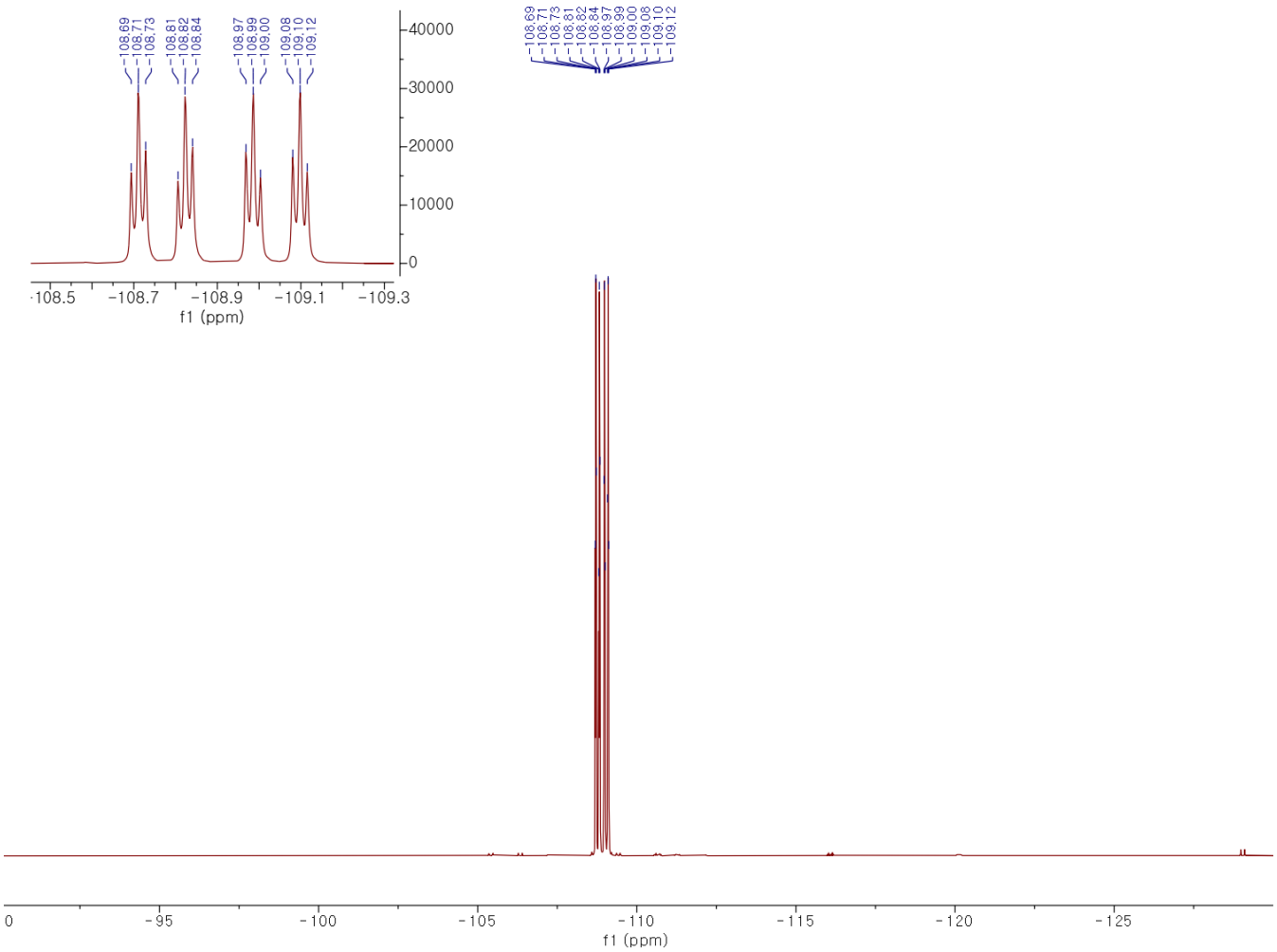
Supplementary Figure 74. ^{19}F NMR Spectrum of (2-(difluoromethyl)-3,3-difluoroprop-1-ene-1,1-diyl)bis(4,1-phenylene) diacetate (**3s**)



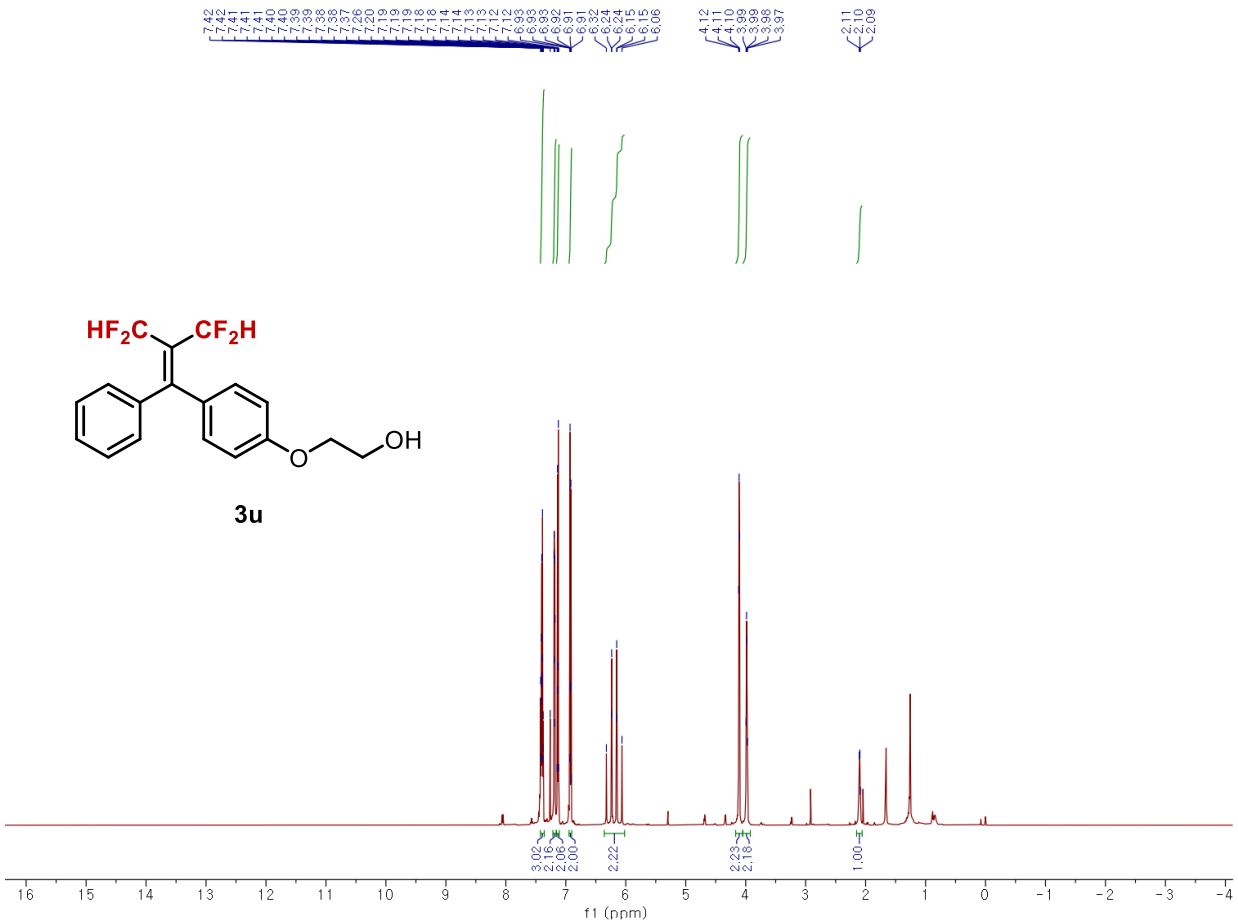
Supplementary Figure 75. ^{1}H NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethyl benzoate (**3t**)



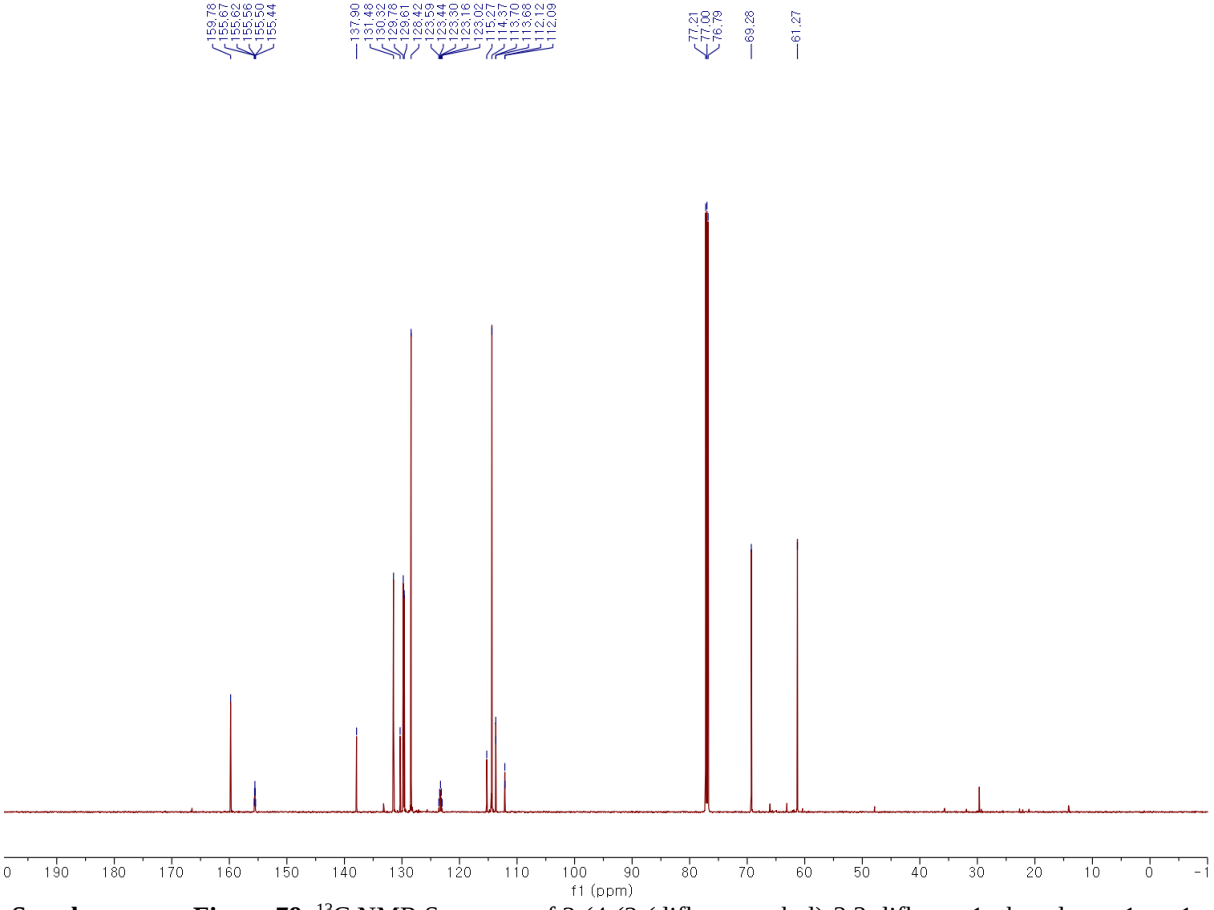
Supplementary Figure 76. ^{13}C NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethyl benzoate (**3t**)



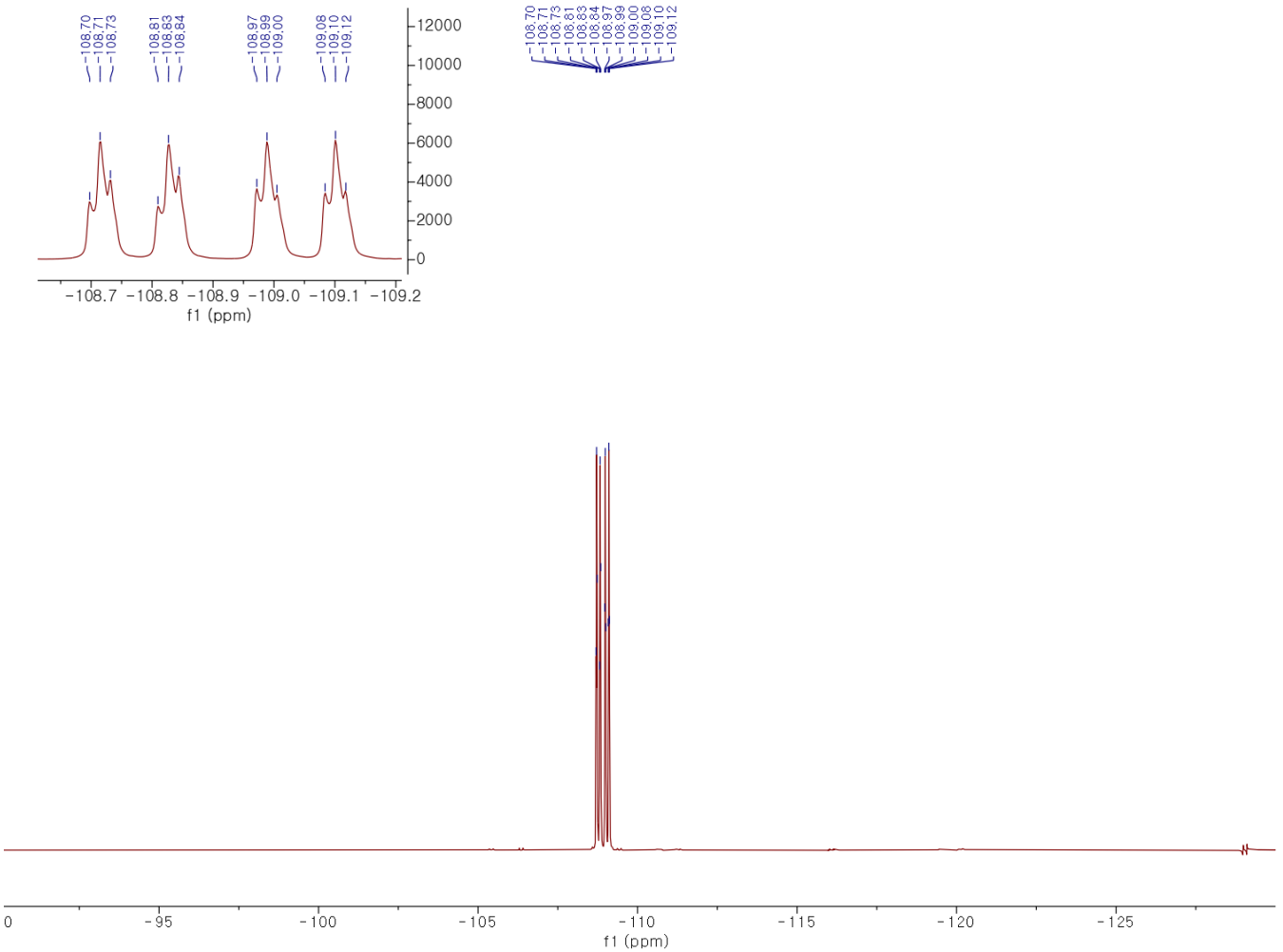
Supplementary Figure 77. ^{19}F NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethyl benzoate (**3t**)



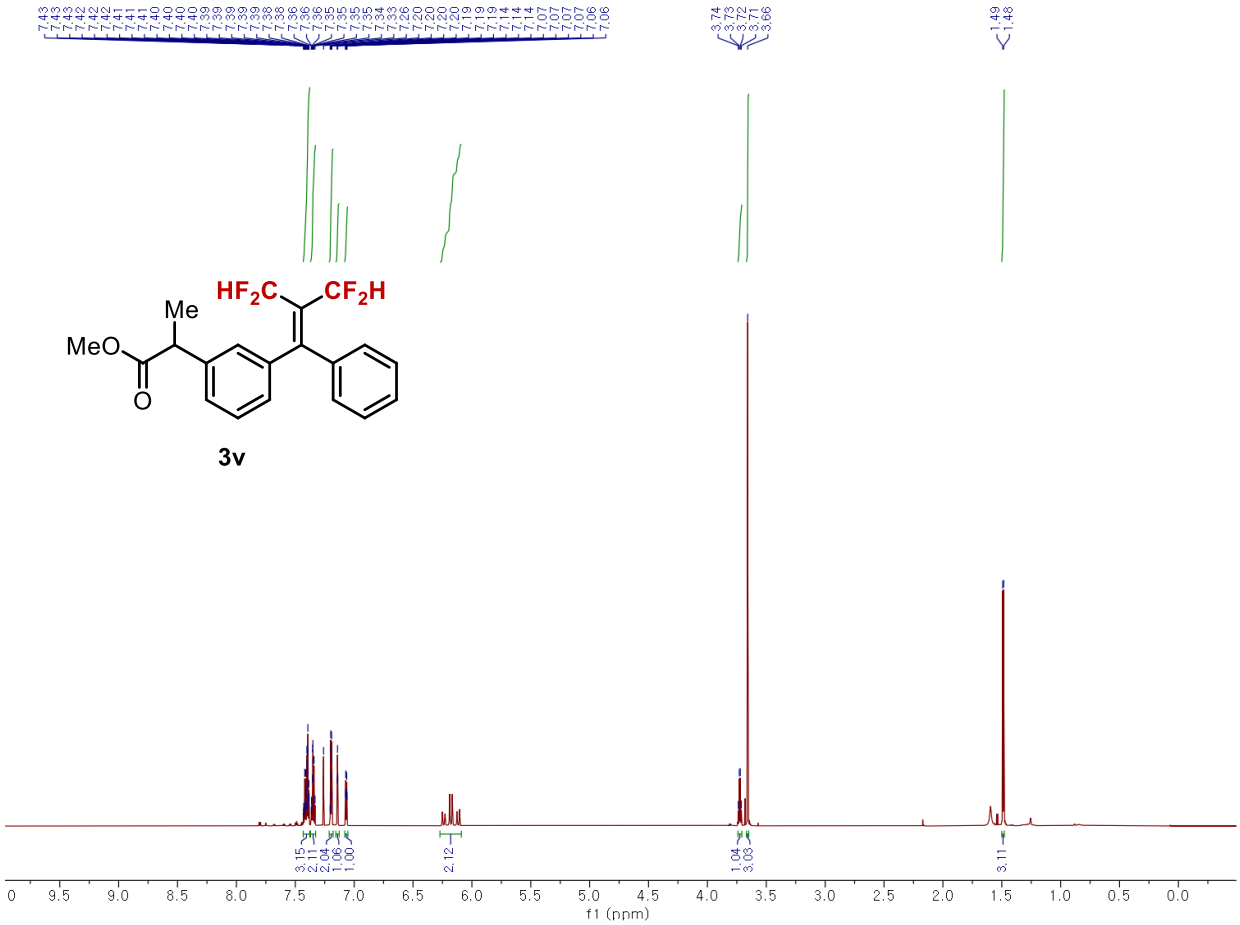
Supplementary Figure 78. ^{1}H NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethan-1-ol (**3u**)



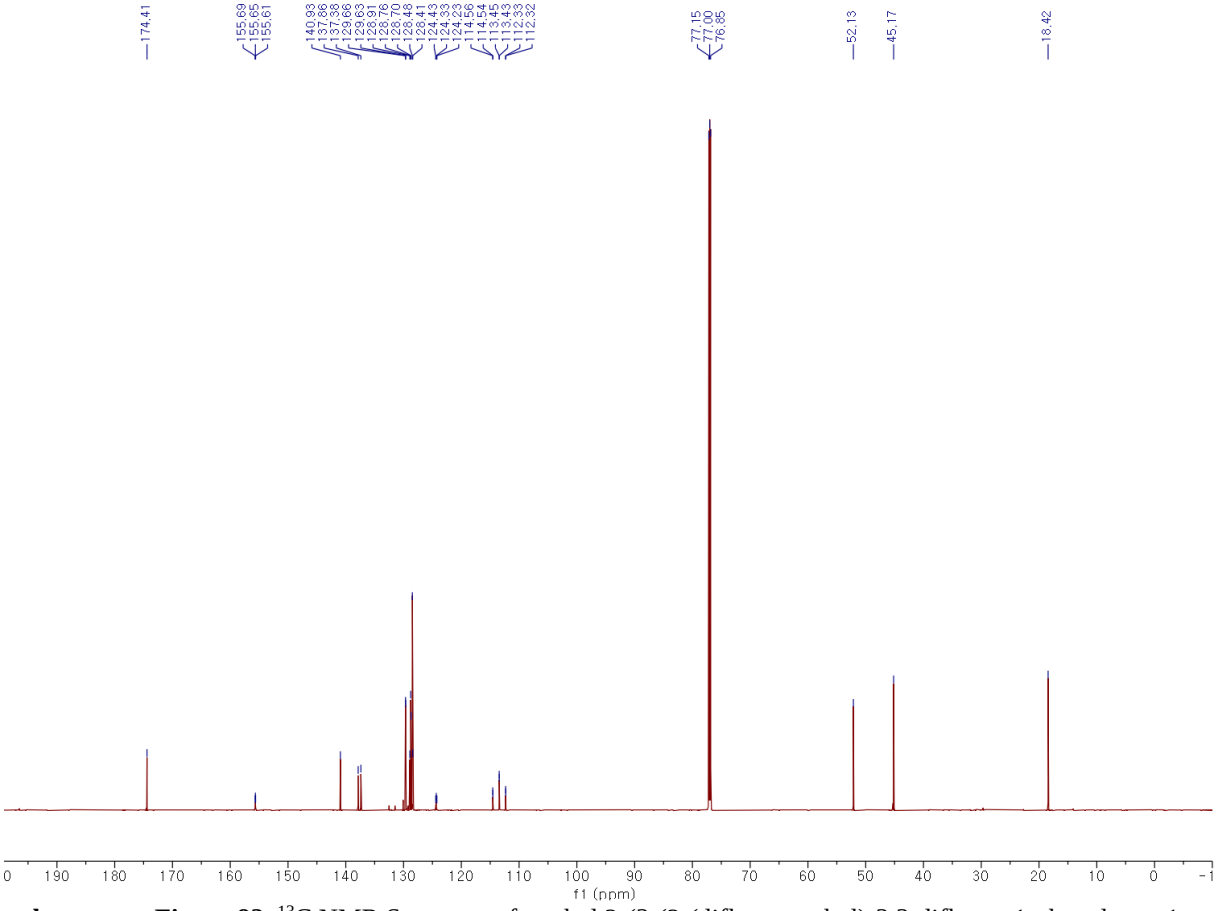
Supplementary Figure 79. ^{13}C NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethan-1-ol (**3u**)



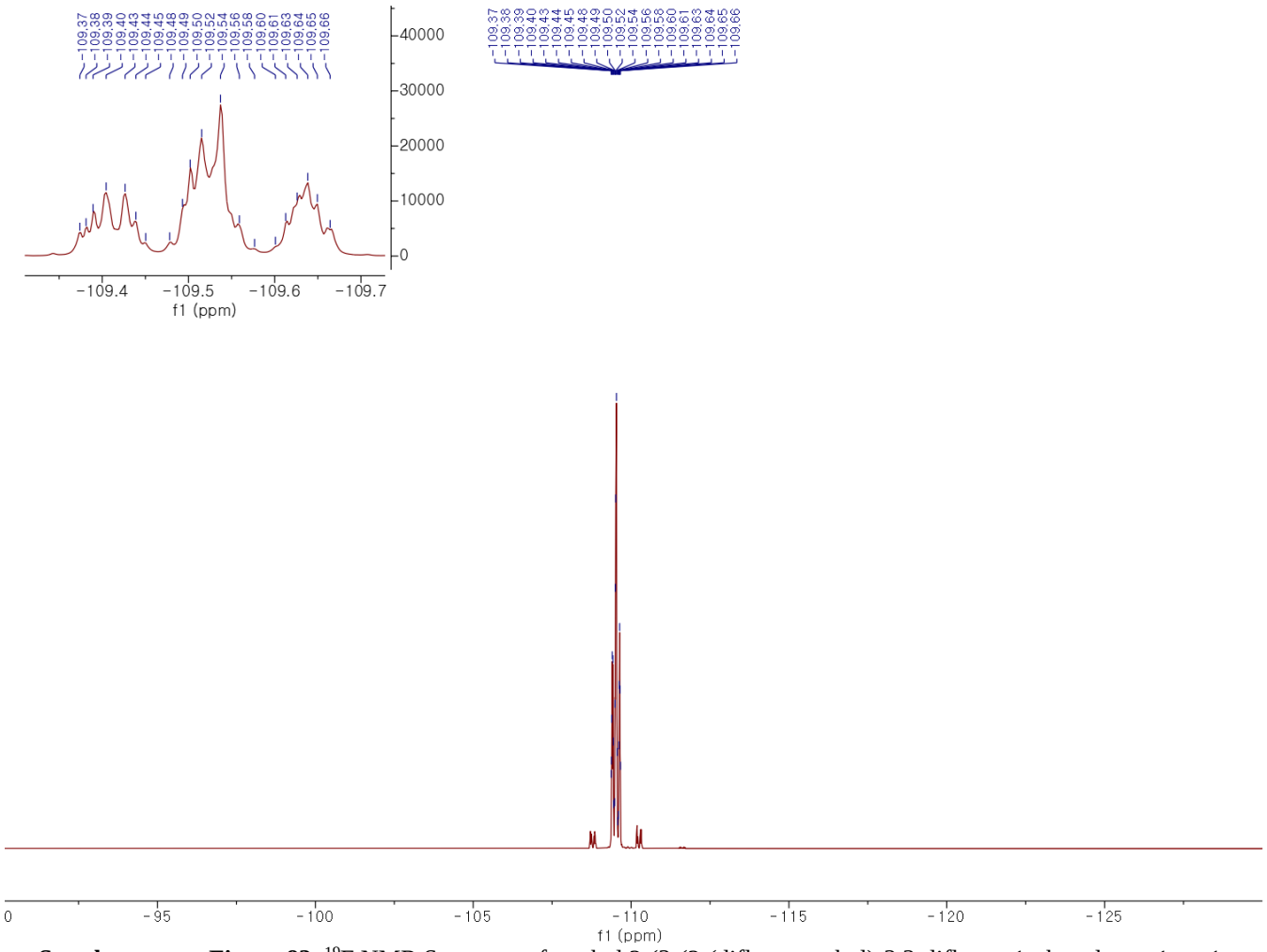
Supplementary Figure 80. ^{19}F NMR Spectrum of 2-(4-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenoxy)ethan-1-ol (**3u**)



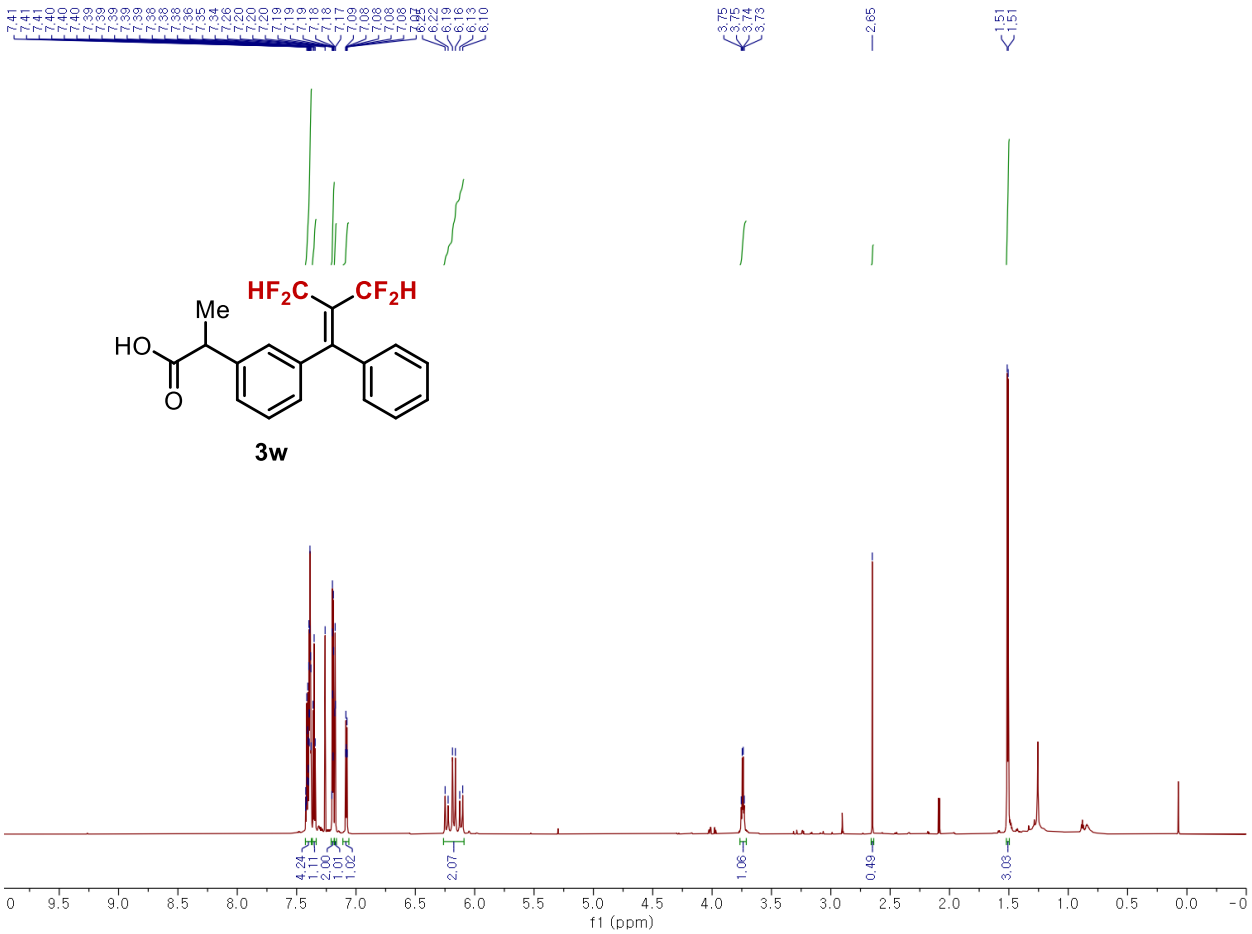
Supplementary Figure 81. ^{1}H NMR Spectrum of methyl 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoate (**3v**)



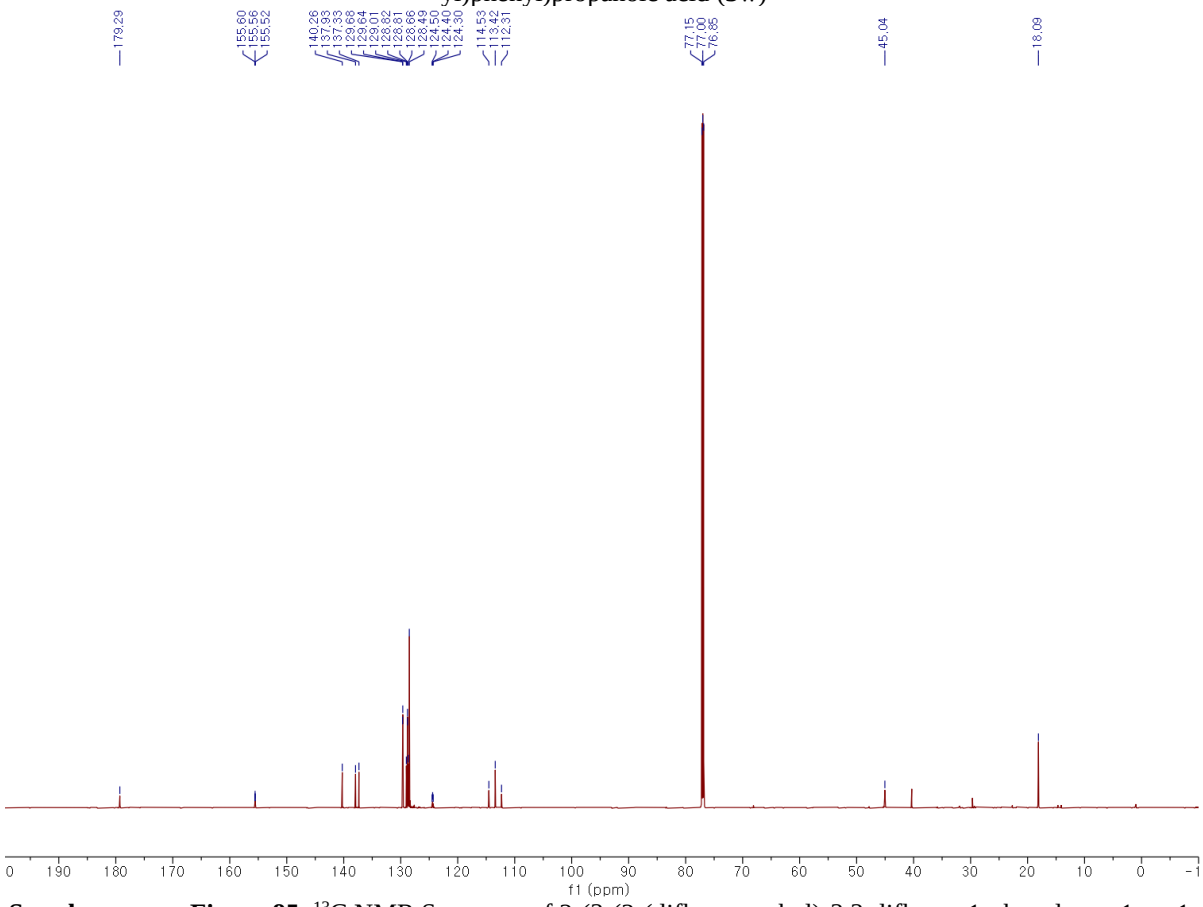
Supplementary Figure 82. ^{13}C NMR Spectrum of methyl 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoate (**3v**)



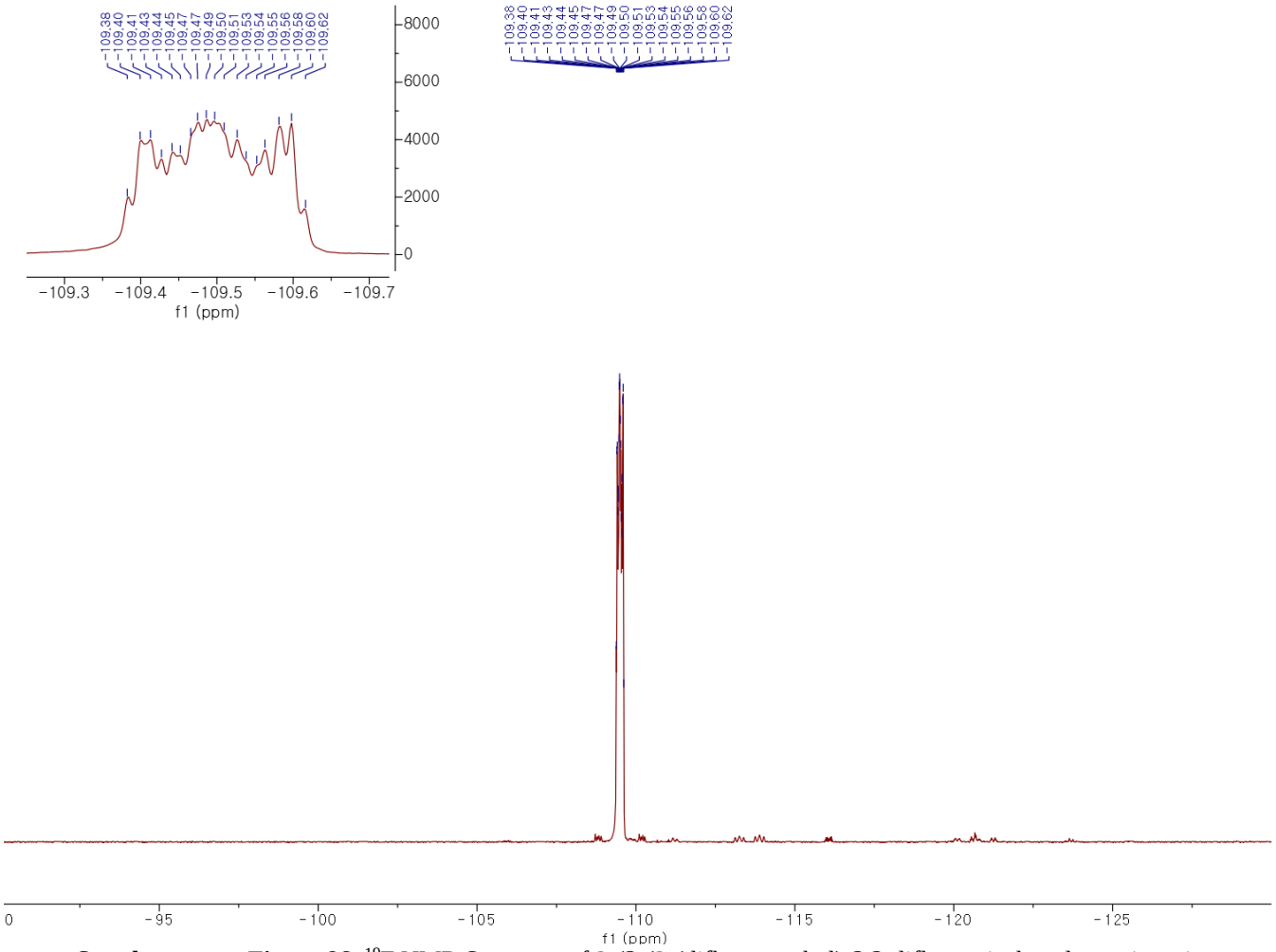
Supplementary Figure 83. ^{19}F NMR Spectrum of methyl 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoate (**3v**)



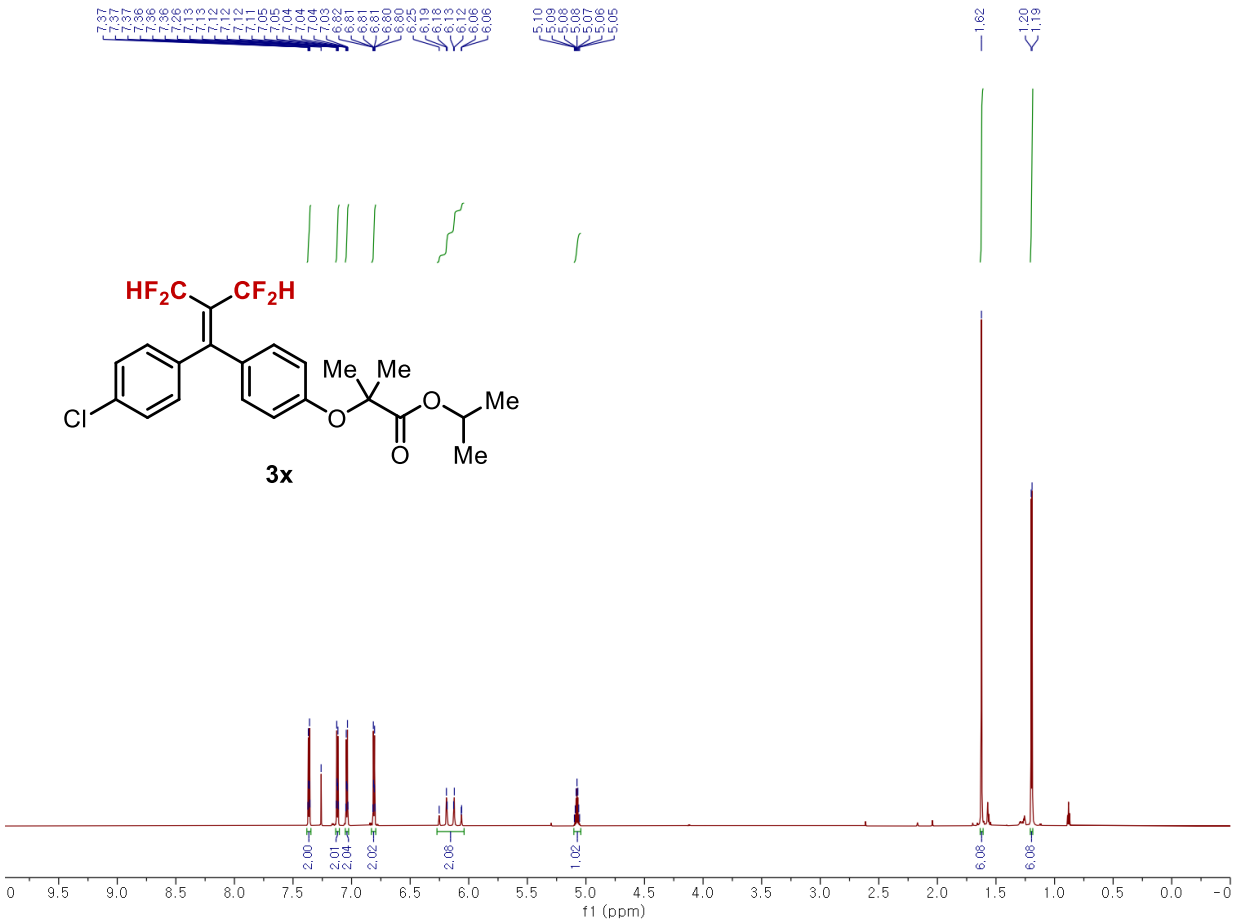
Supplementary Figure 84. ^{1}H NMR Spectrum of 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoic acid (**3w**)



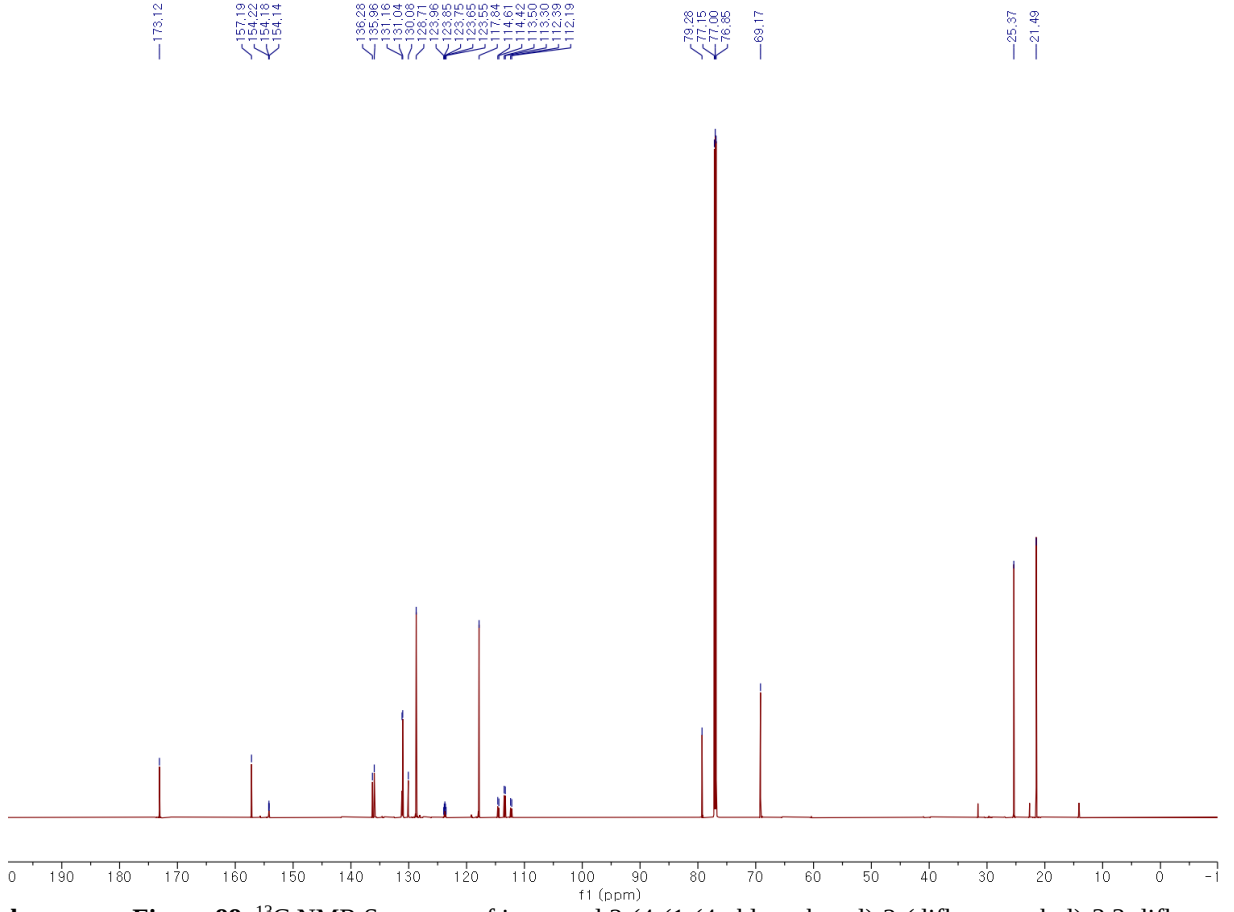
Supplementary Figure 85. ^{13}C NMR Spectrum of 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoic acid (**3w**)



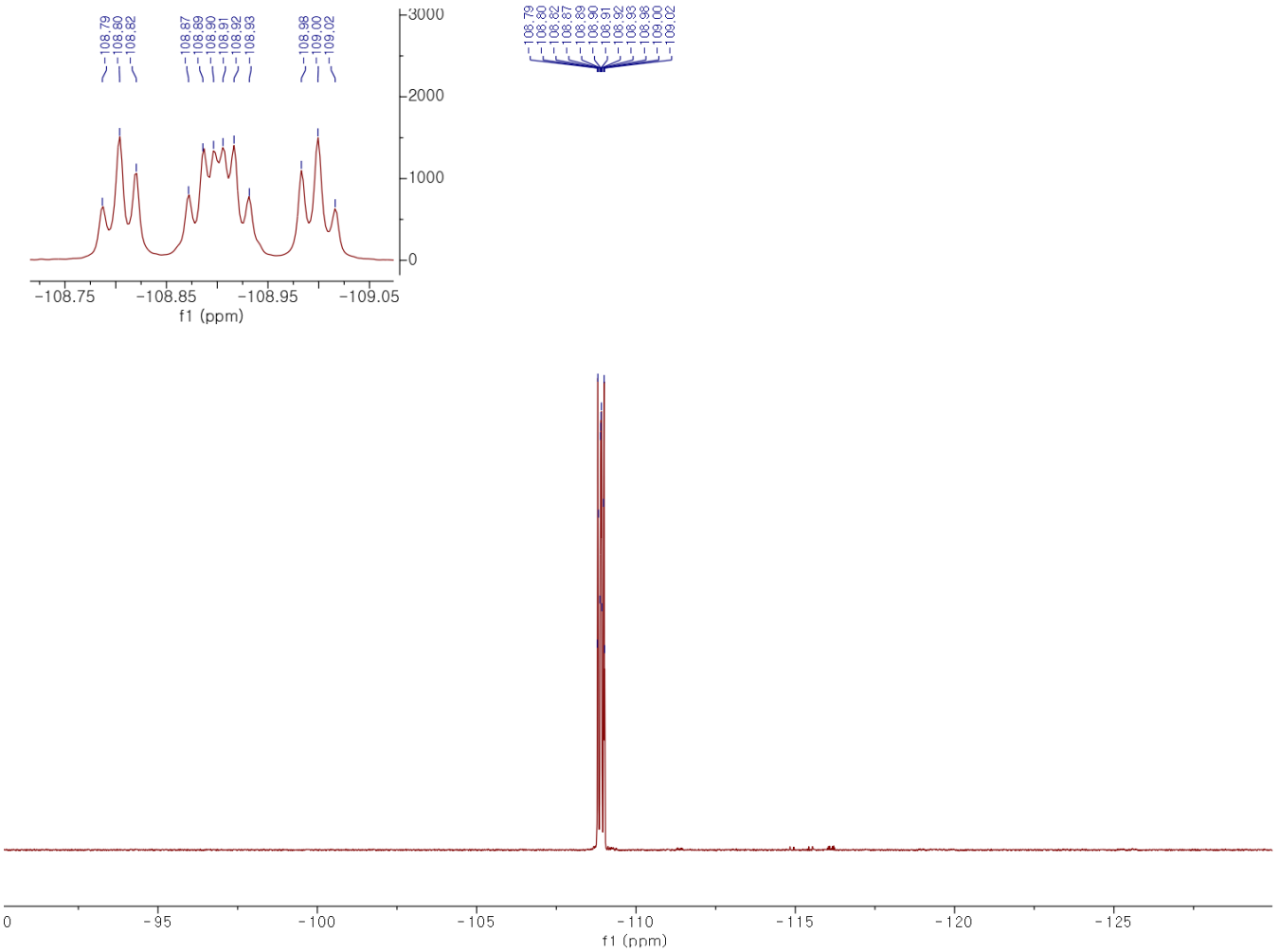
Supplementary Figure 86. ^{19}F NMR Spectrum of 2-(3-(2-(difluoromethyl)-3,3-difluoro-1-phenylprop-1-en-1-yl)phenyl)propanoic acid (**3w**)



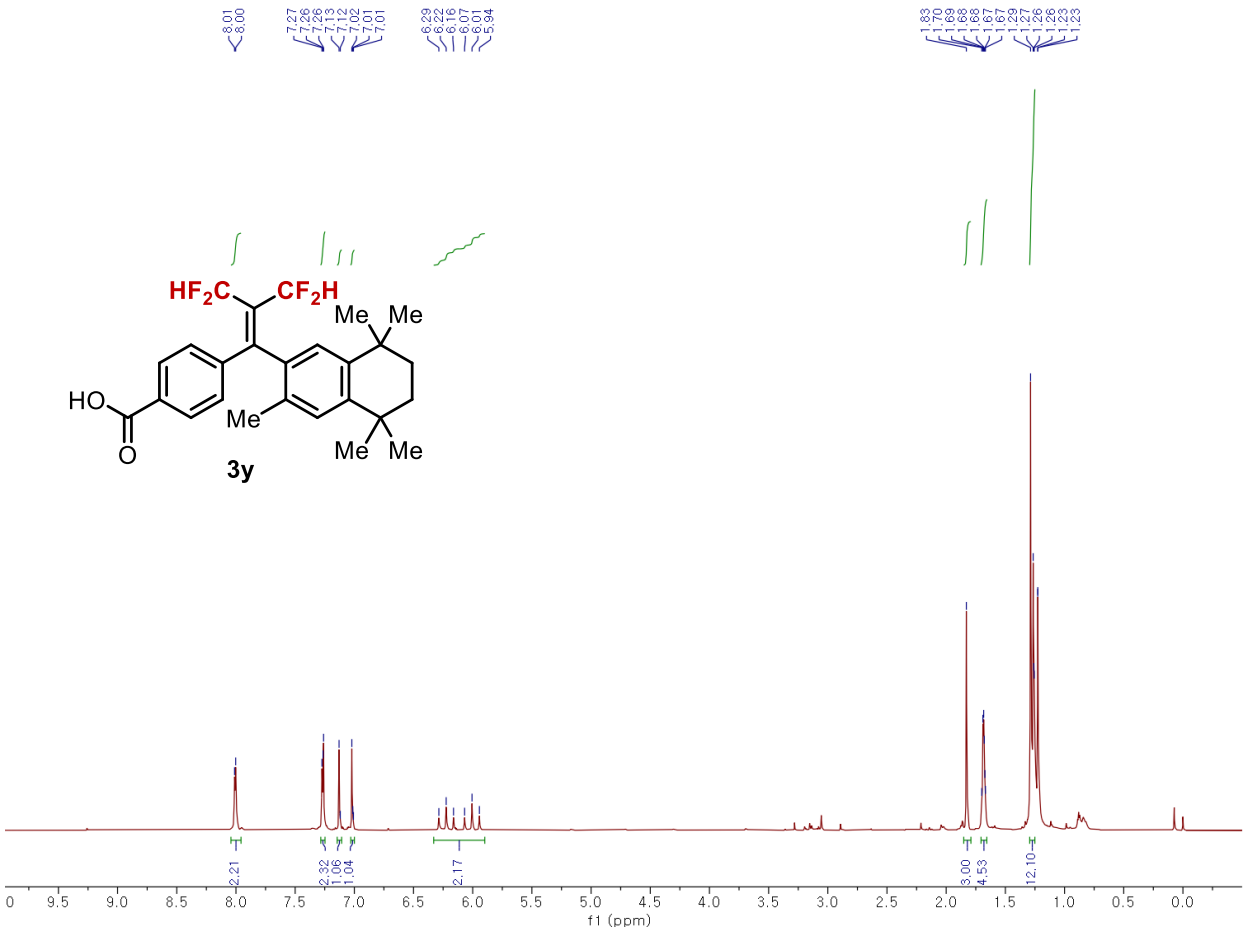
Supplementary Figure 87. ^{1}H NMR Spectrum of isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (**3x**)



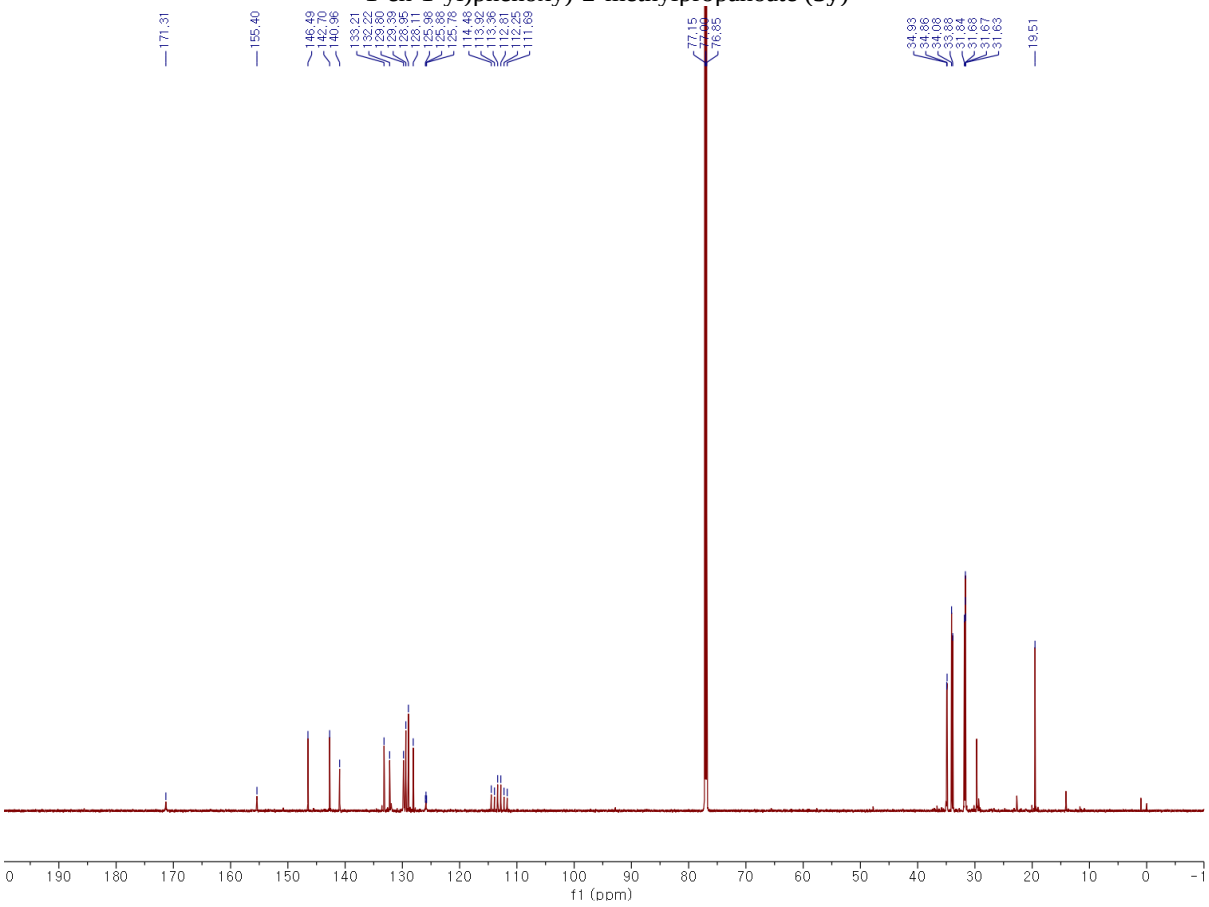
Supplementary Figure 88. ^{13}C NMR Spectrum of isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (**3x**)



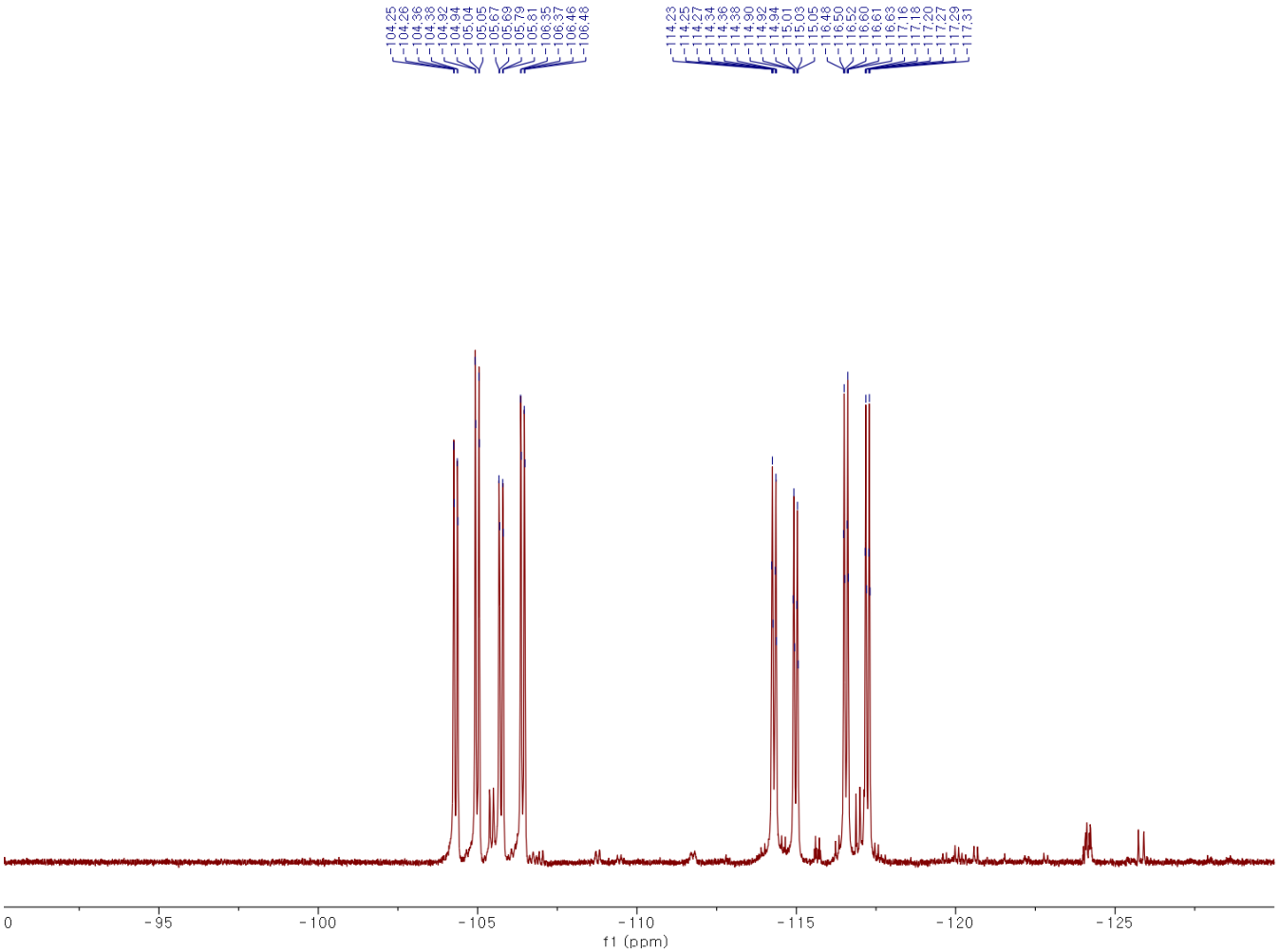
Supplementary Figure 89. ^{19}F NMR Spectrum of isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (**3x**)



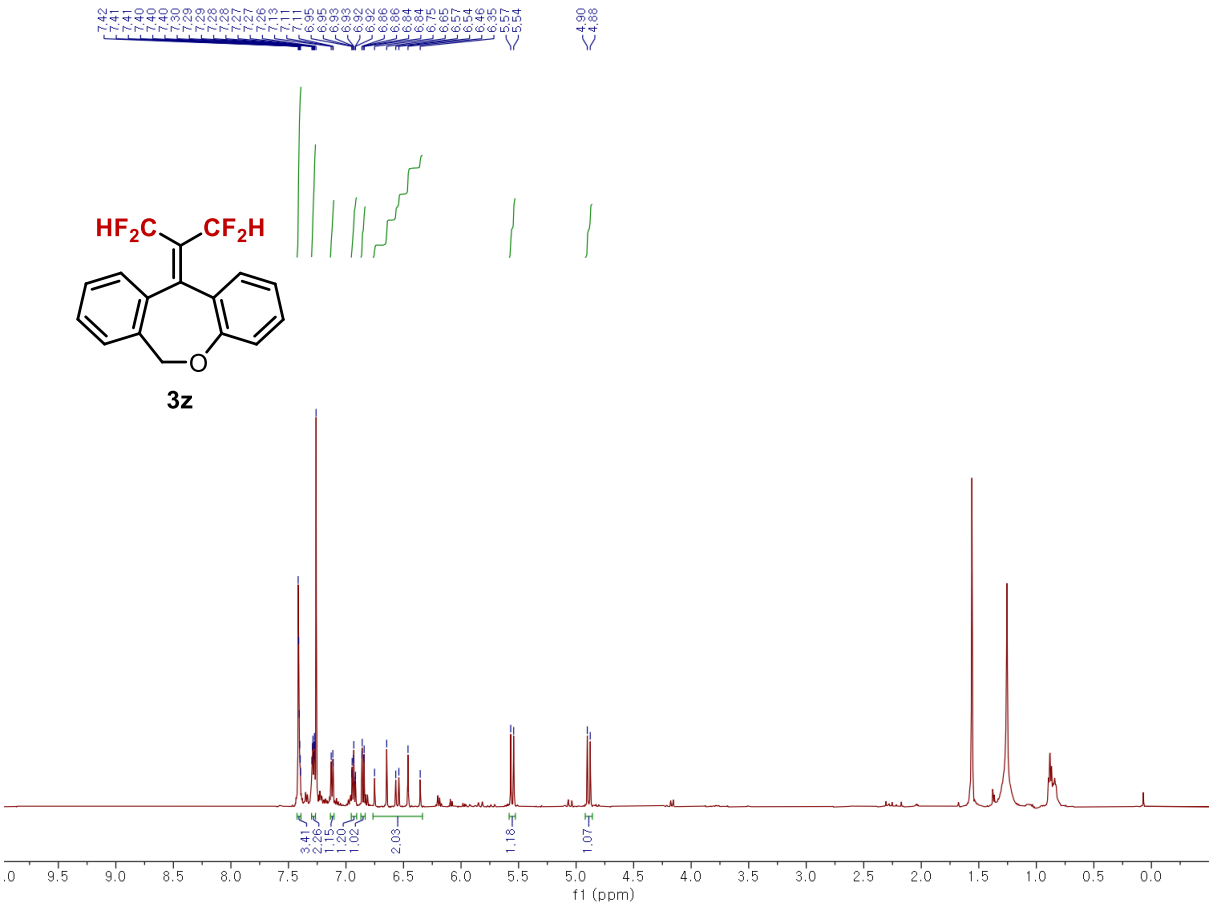
Supplementary Figure 90. ^{1}H NMR Spectrum of isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (**3y**)



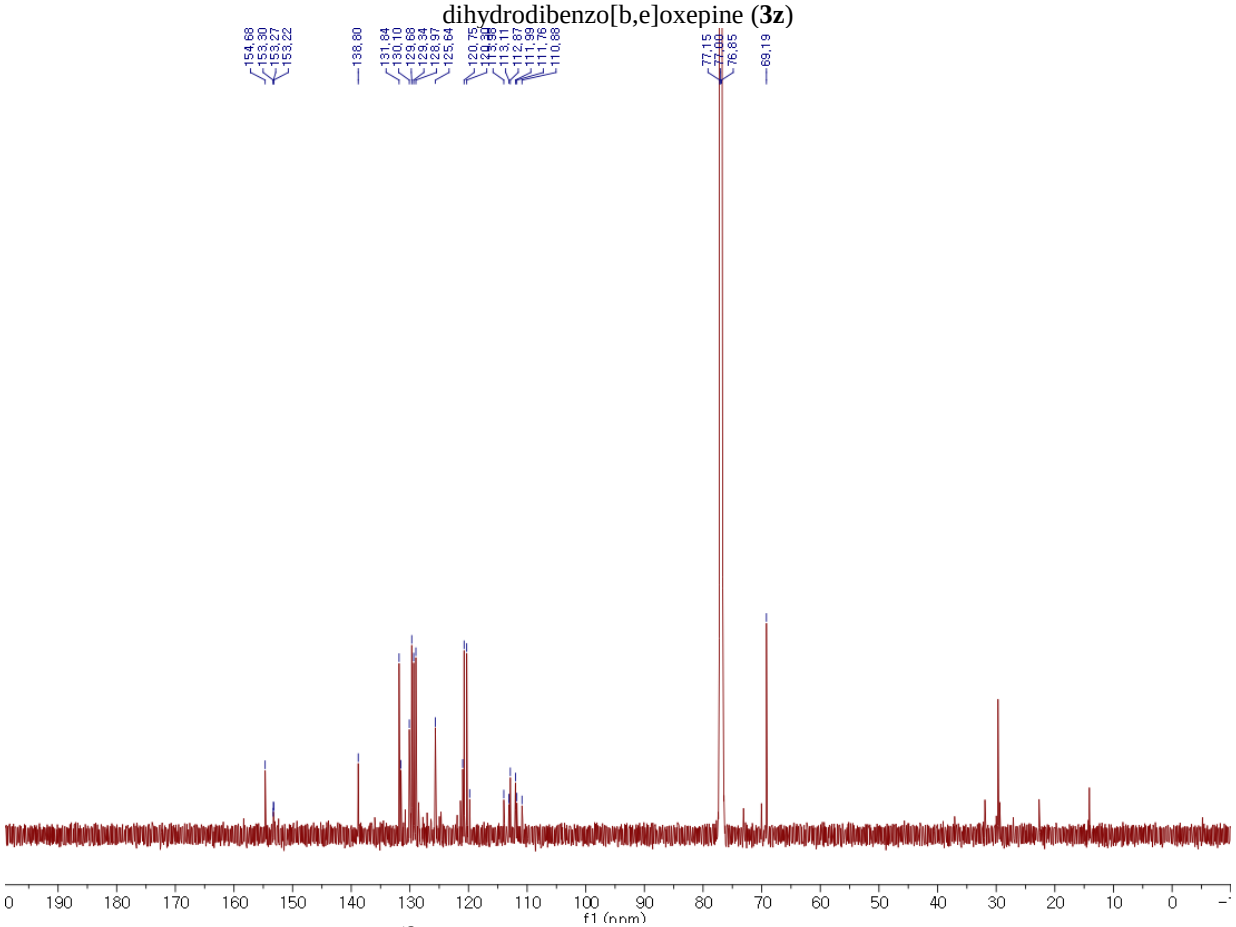
Supplementary Figure 91. ^{13}C NMR Spectrum of isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (**3y**)



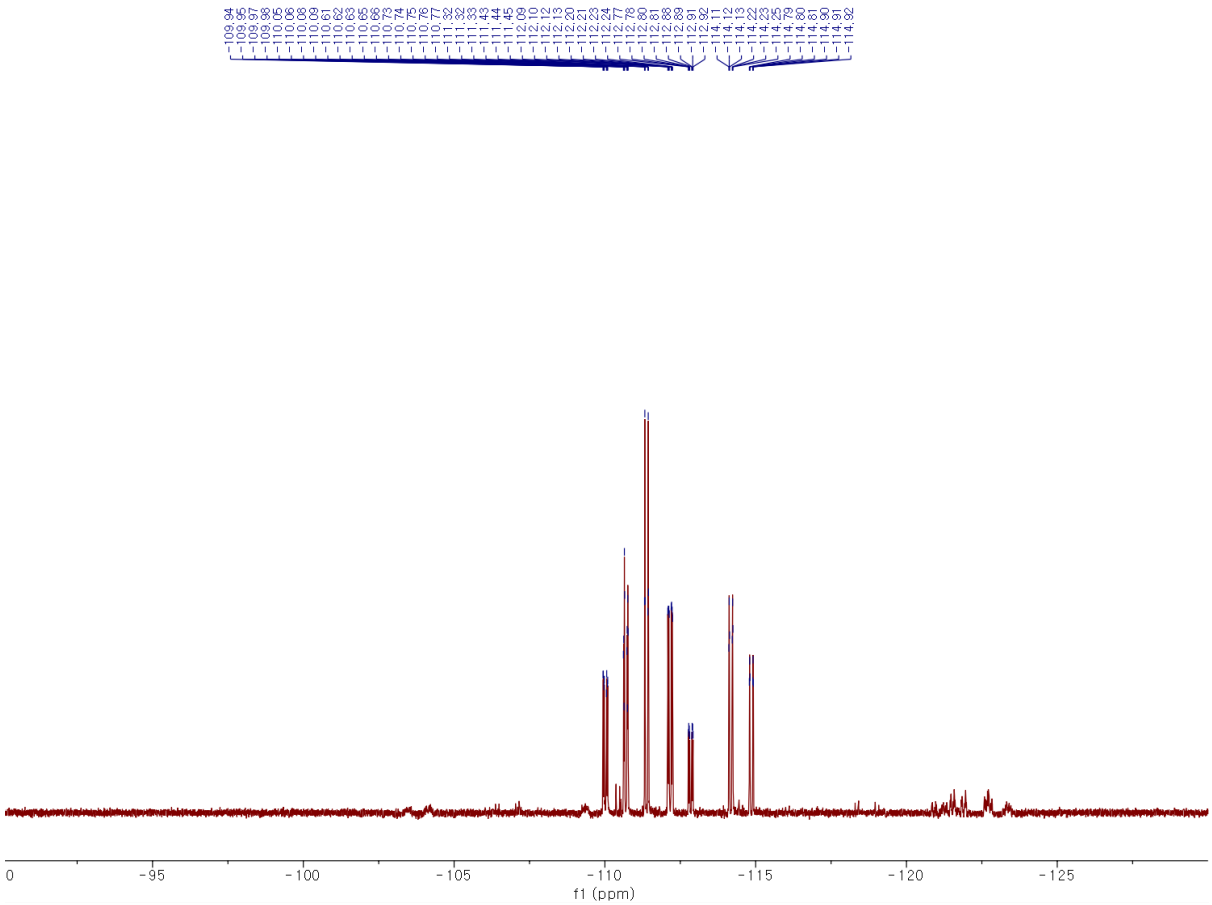
Supplementary Figure 92. ^{19}F NMR Spectrum of isopropyl 2-(4-(1-(4-chlorophenyl)-2-(difluoromethyl)-3,3-difluoroprop-1-en-1-yl)phenoxy)-2-methylpropanoate (**3y**)



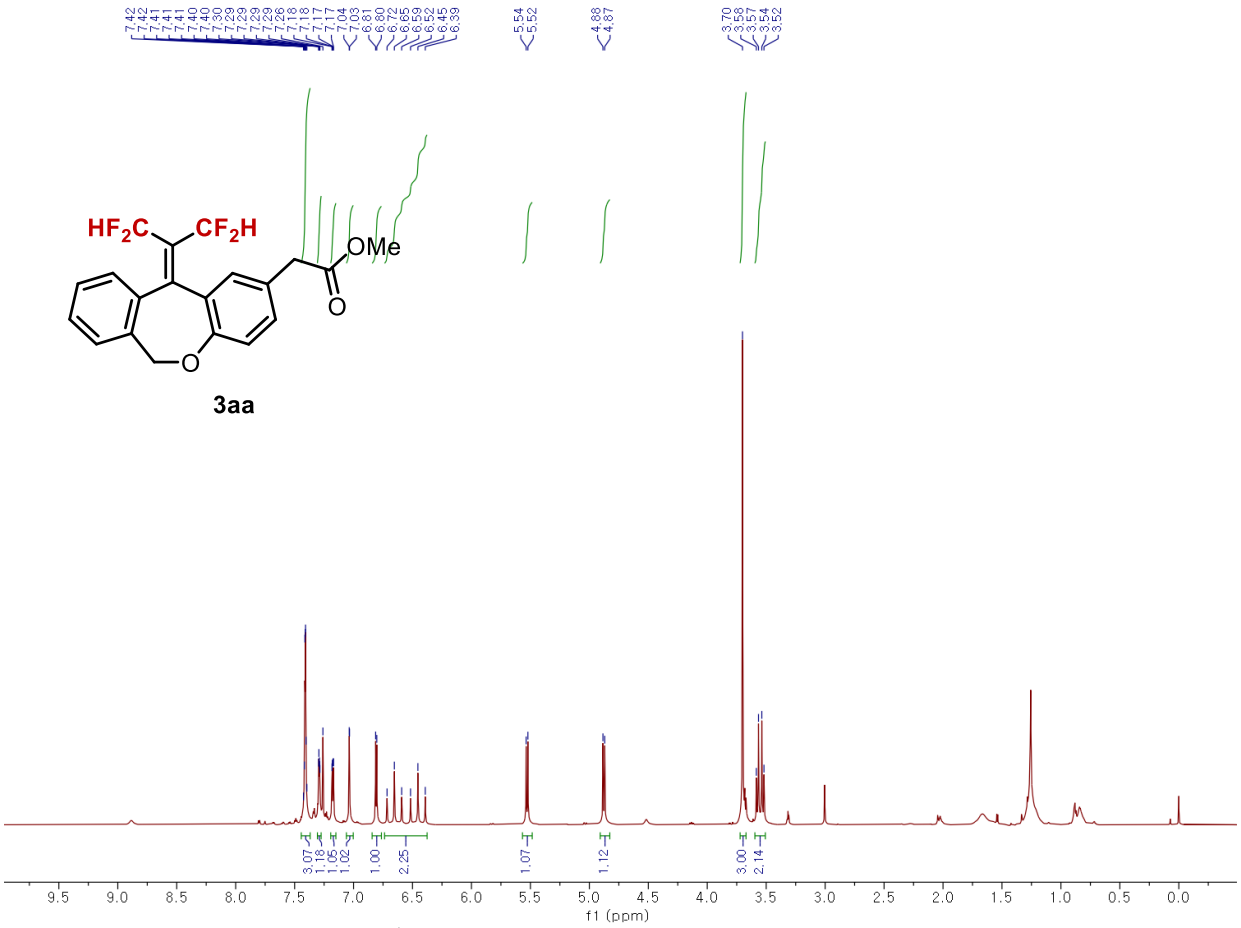
Supplementary Figure 93. ^{1}H NMR Spectrum of 11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepine (**3z**)



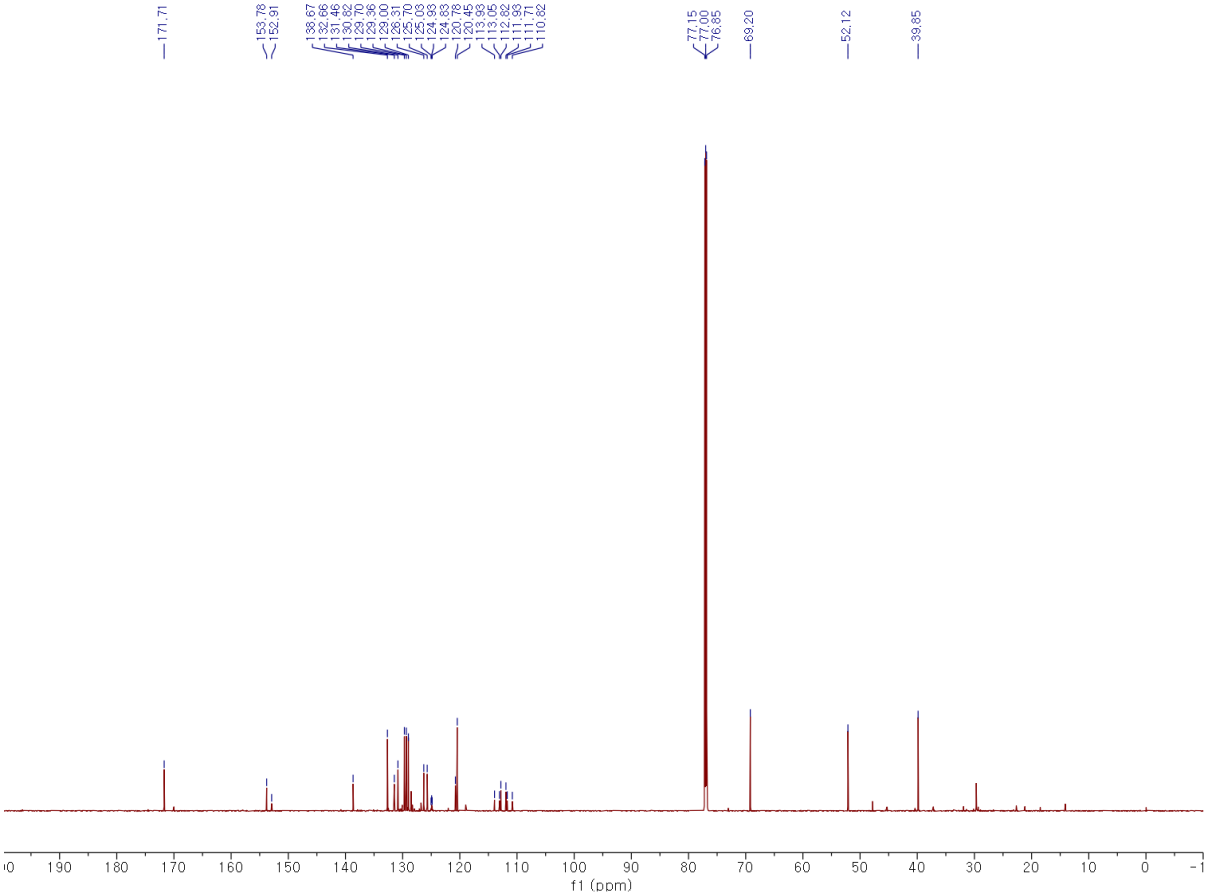
Supplementary Figure 94. ^{13}C NMR Spectrum of 11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepine (**3z**)



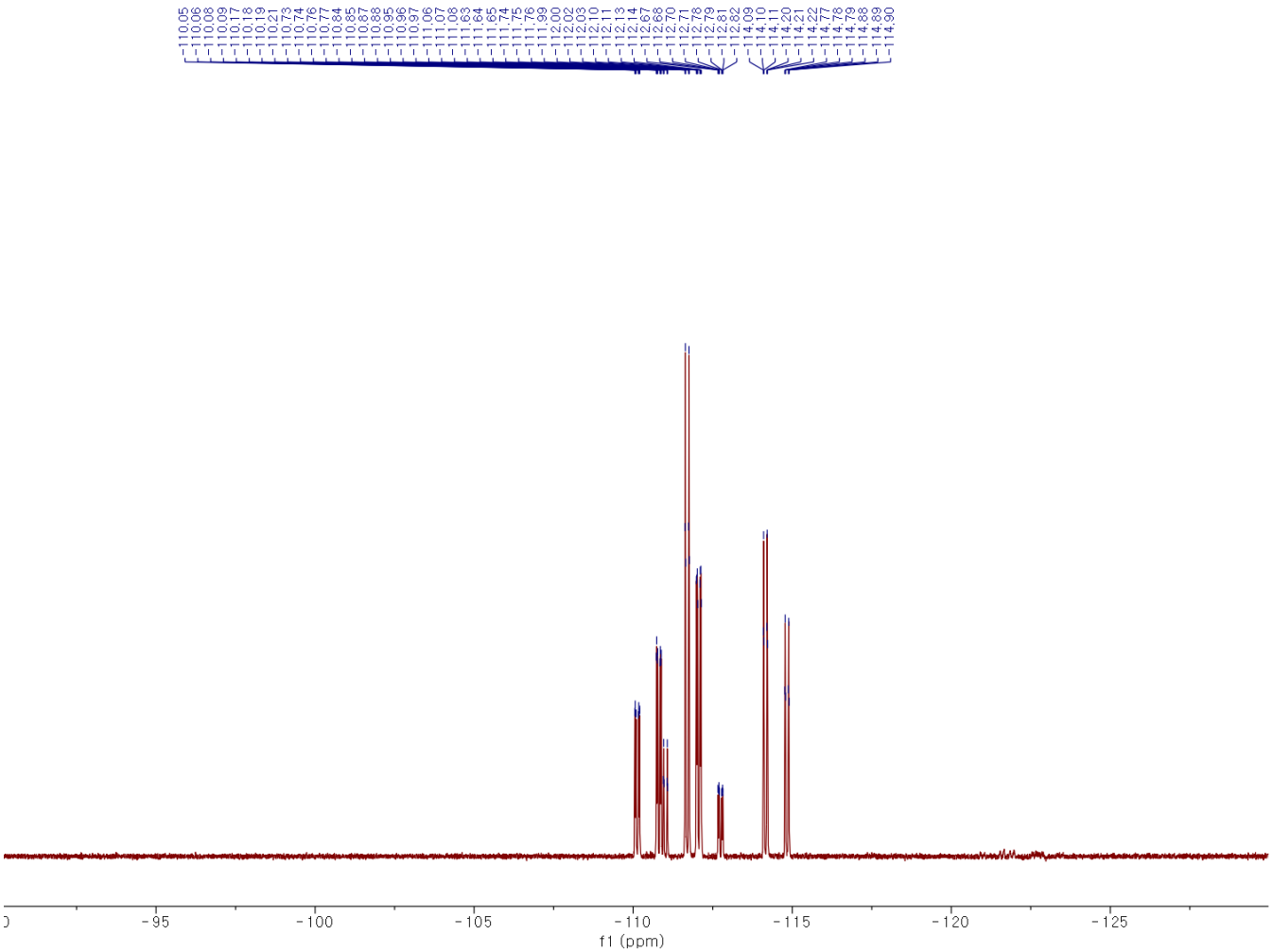
Supplementary Figure 95. ^{19}F NMR Spectrum of 11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepine (**3z**)



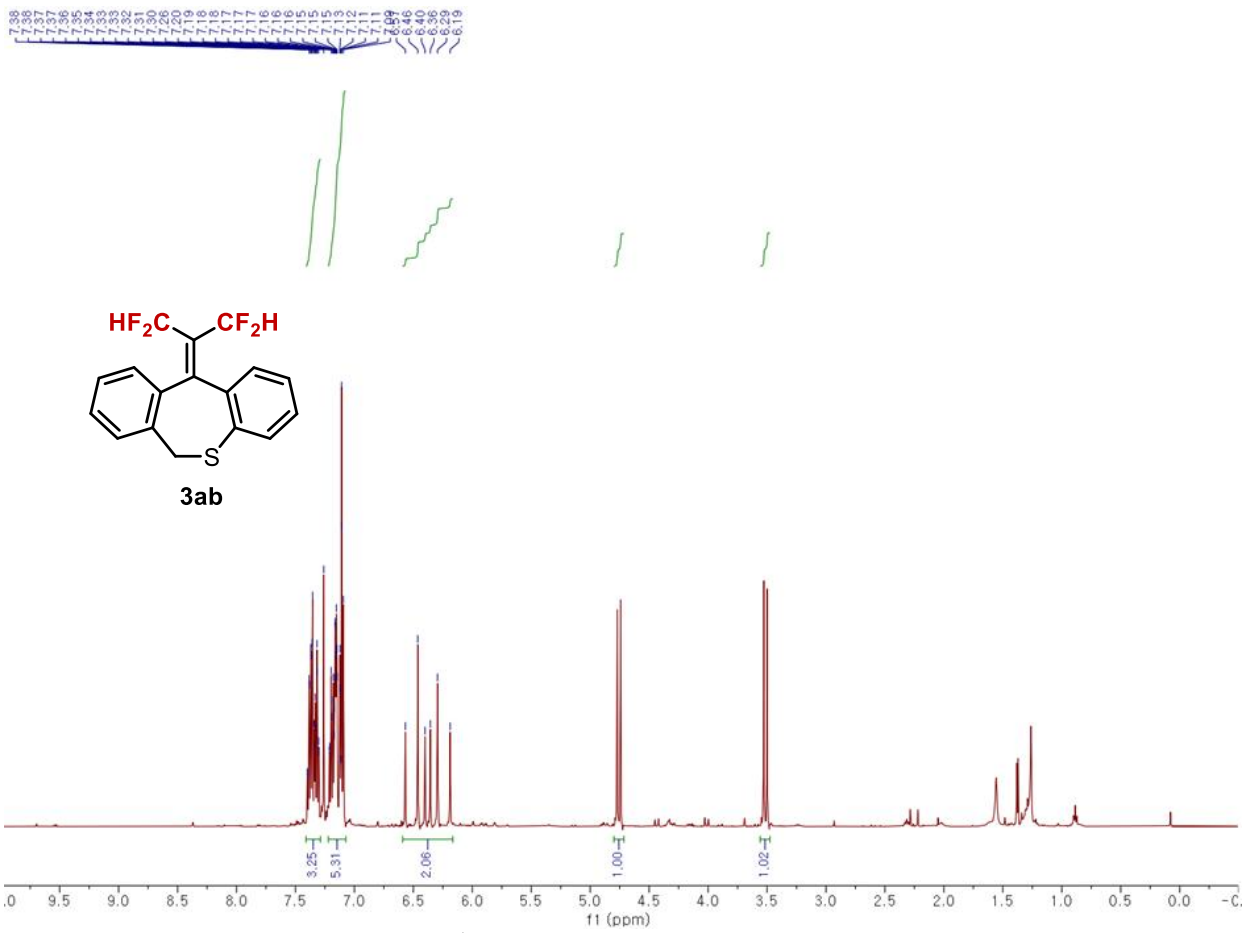
Supplementary Figure 96. ^{1}H NMR Spectrum of methyl 2-(11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (**3aa**)



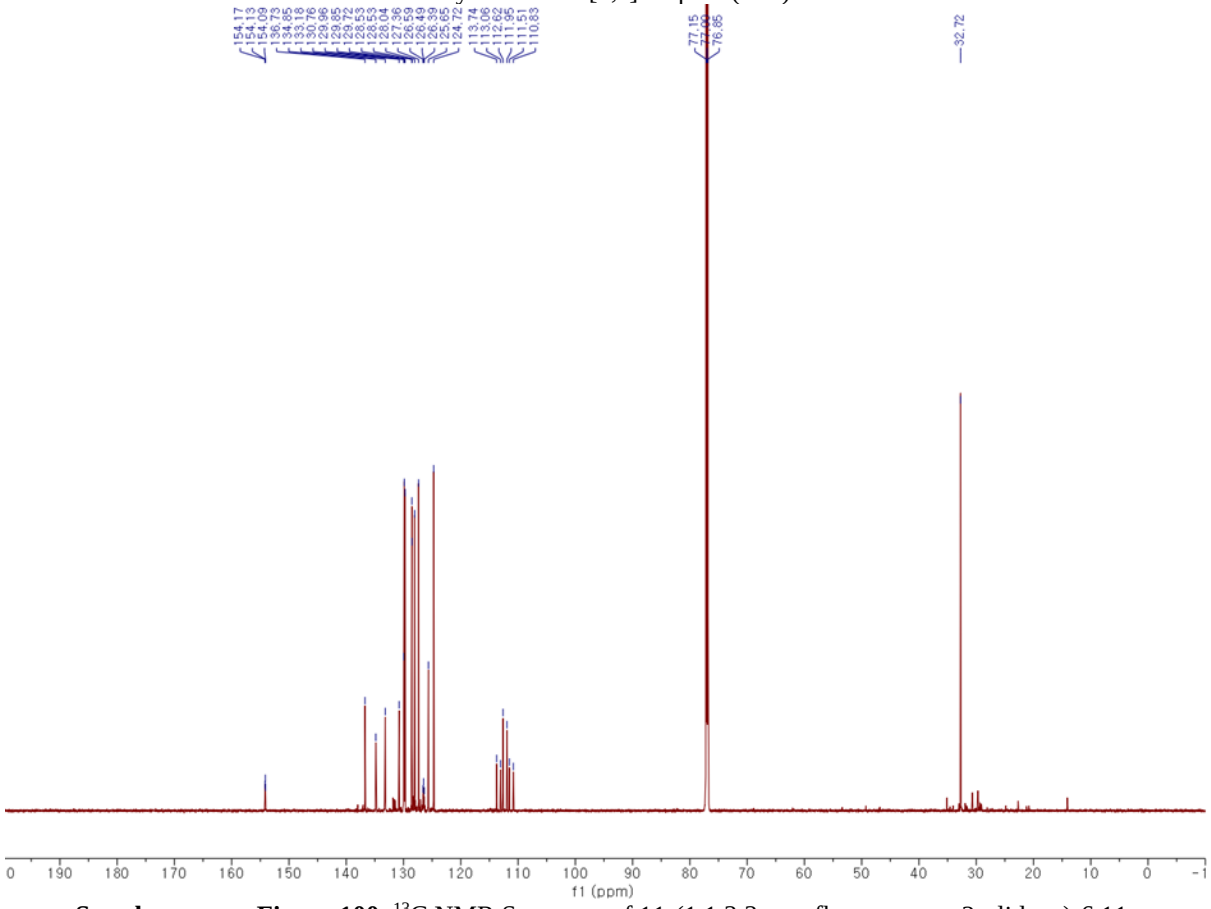
Supplementary Figure 97. ^{13}C NMR Spectrum of methyl 2-(11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (**3aa**)



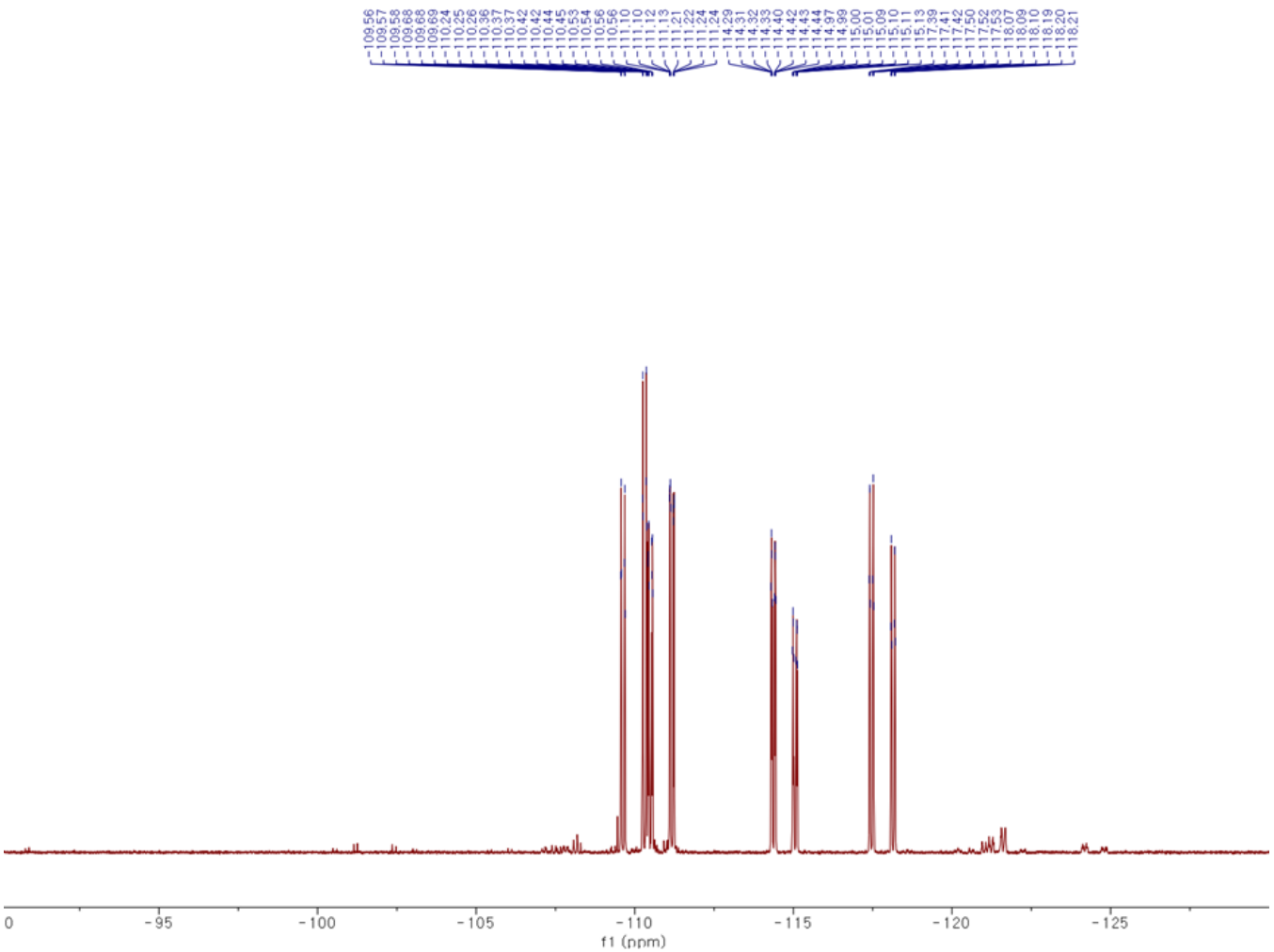
Supplementary Figure 98. ^{19}F NMR Spectrum of methyl 2-(11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]oxepin-2-yl)acetate (**3aa**)



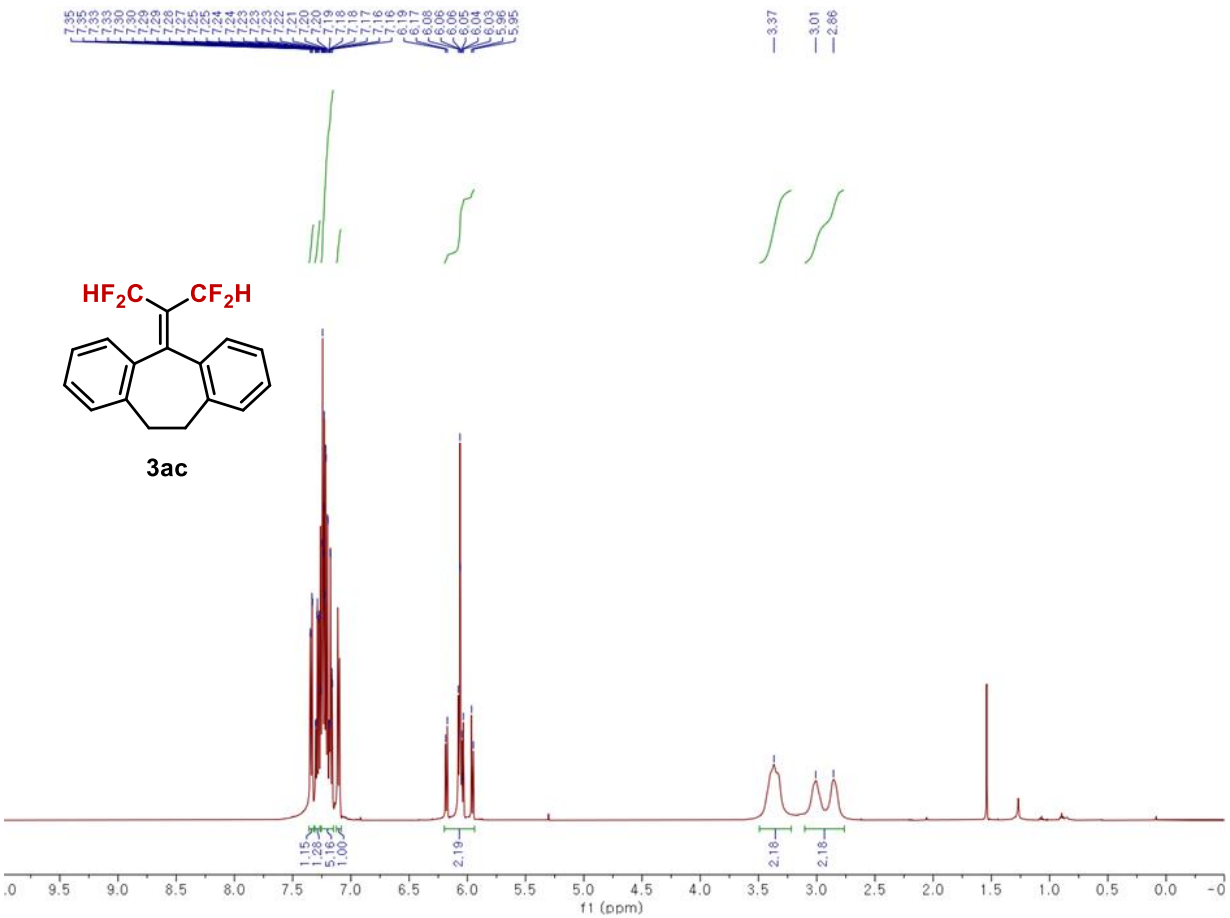
Supplementary Figure 99. ^{1}H NMR Spectrum of 11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]thiepine (**3ab**)



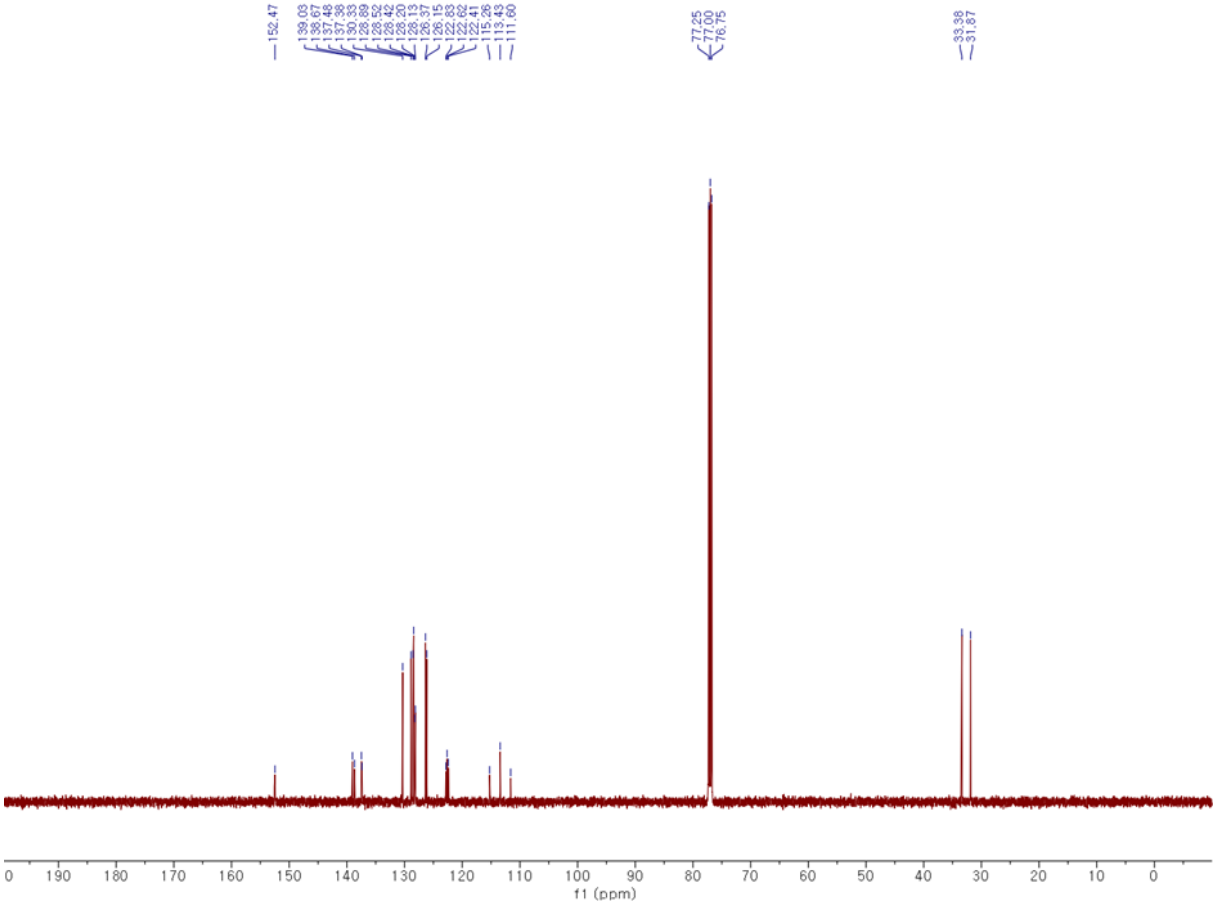
Supplementary Figure 100. ^{13}C NMR Spectrum of 11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]thiepine (**3ab**)



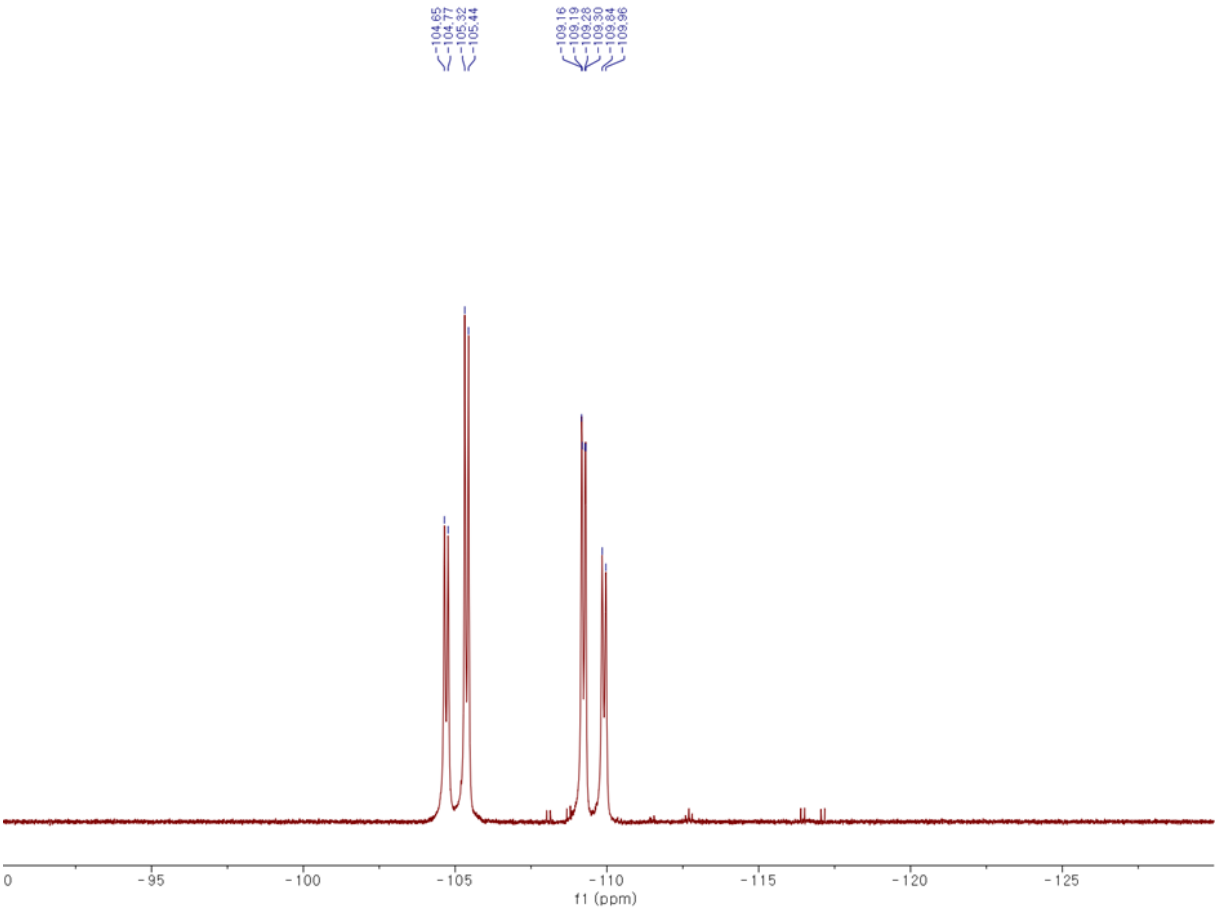
Supplementary Figure 101. ^{19}F NMR Spectrum of 11-(1,1,3,3-tetrafluoropropan-2-ylidene)-6,11-dihydrodibenzo[b,e]thiepine (**3ab**)



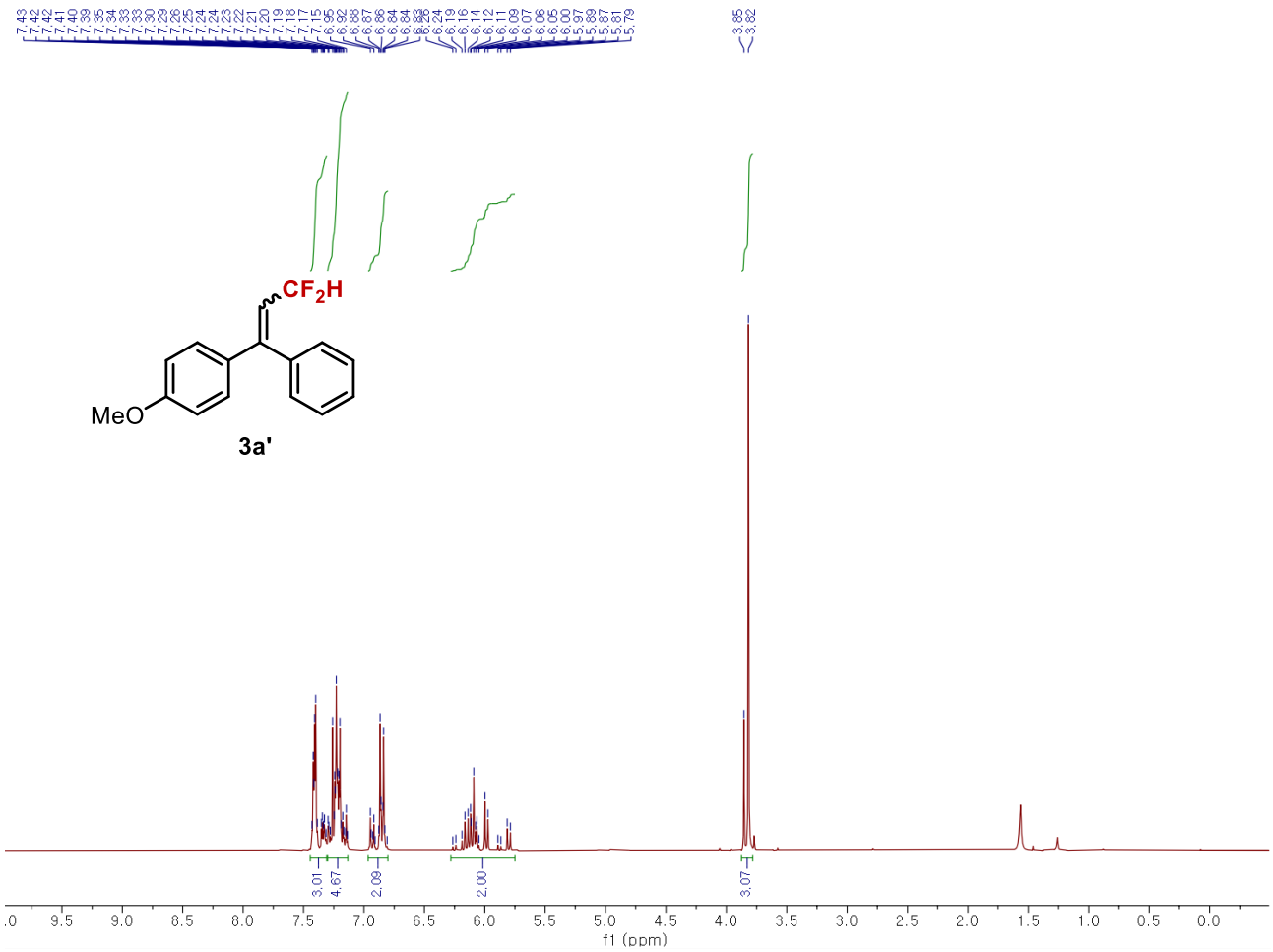
Supplementary Figure 102. ^{1}H NMR Spectrum of 5-(1,1,3,3-tetrafluoropropan-2-ylidene)-10,11-dihydro-5H-dibenzo[a,d][7]annulene (**3ac**)



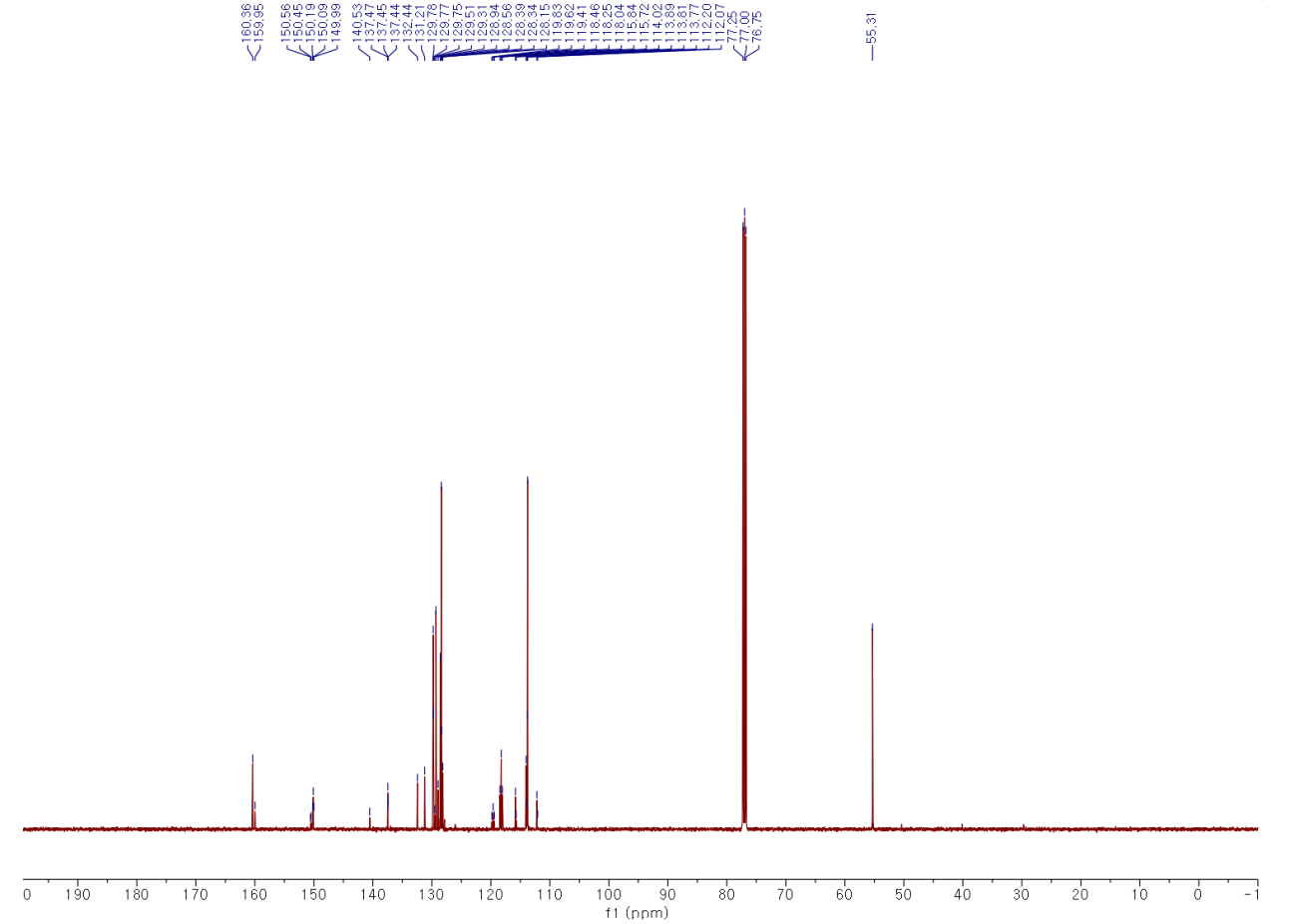
Supplementary Figure 103. ^{13}C NMR Spectrum of 5-(1,1,3,3-tetrafluoropropan-2-ylidene)-10,11-dihydro-5H-dibenzo[a,d][7]annulene (**3ac**)



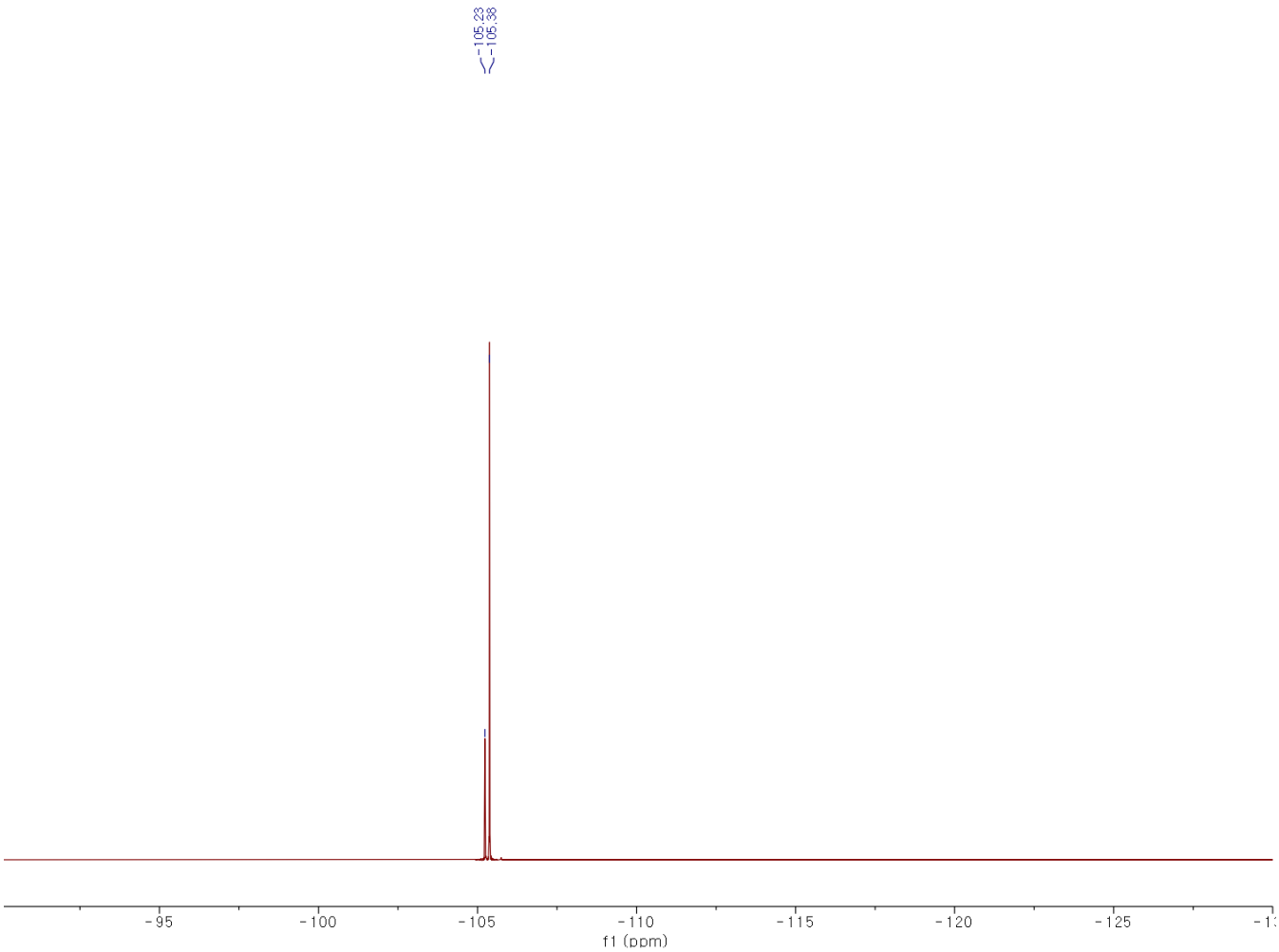
Supplementary Figure 104. ^{19}F NMR Spectrum of 5-(1,1,3,3-tetrafluoropropan-2-ylidene)-10,11-dihydro-5H-dibenzo[a,d][7]annulene (**3ac**)



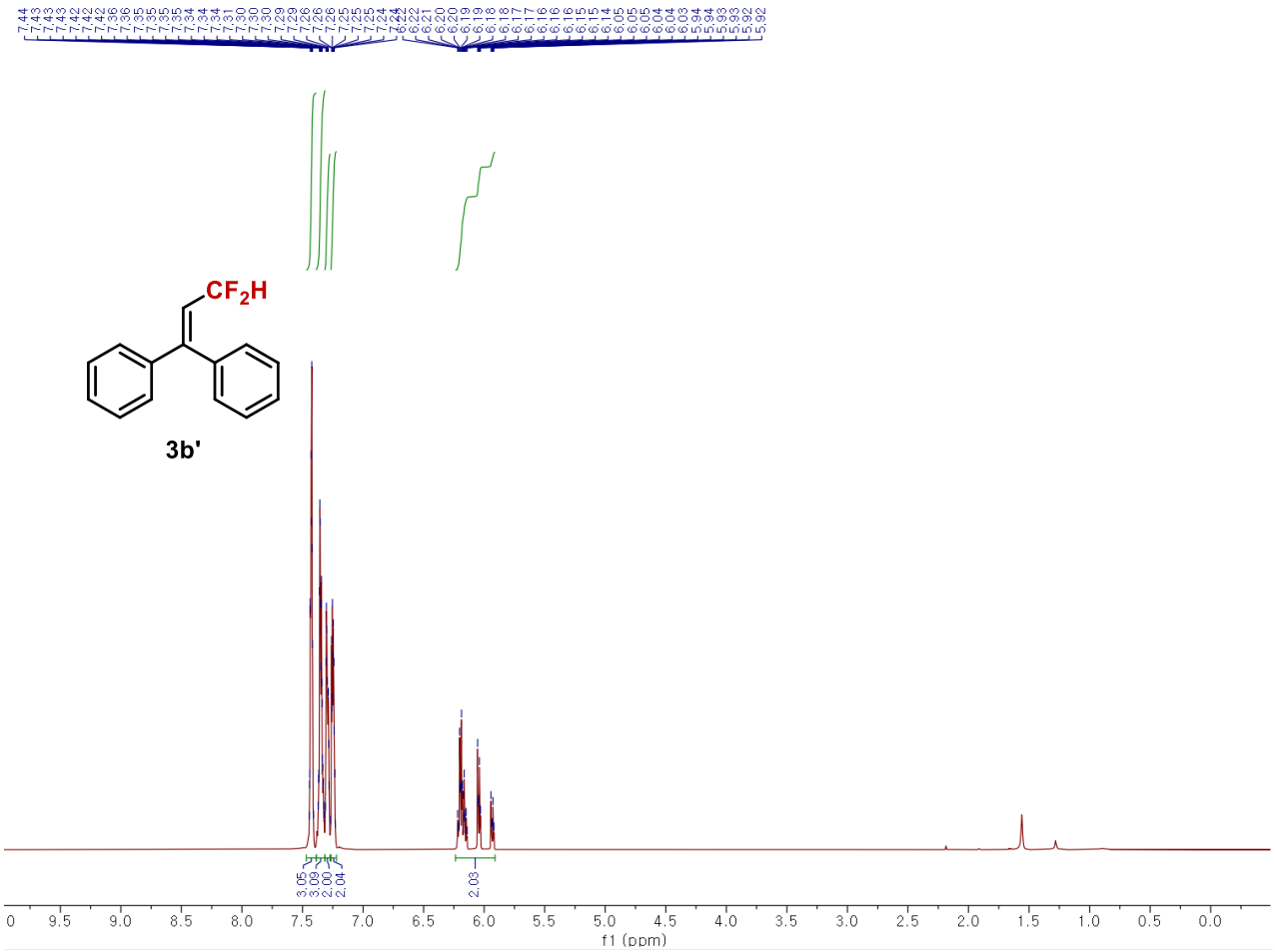
Supplementary Figure 105. ^{1}H NMR Spectrum of 1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (**3a'**)



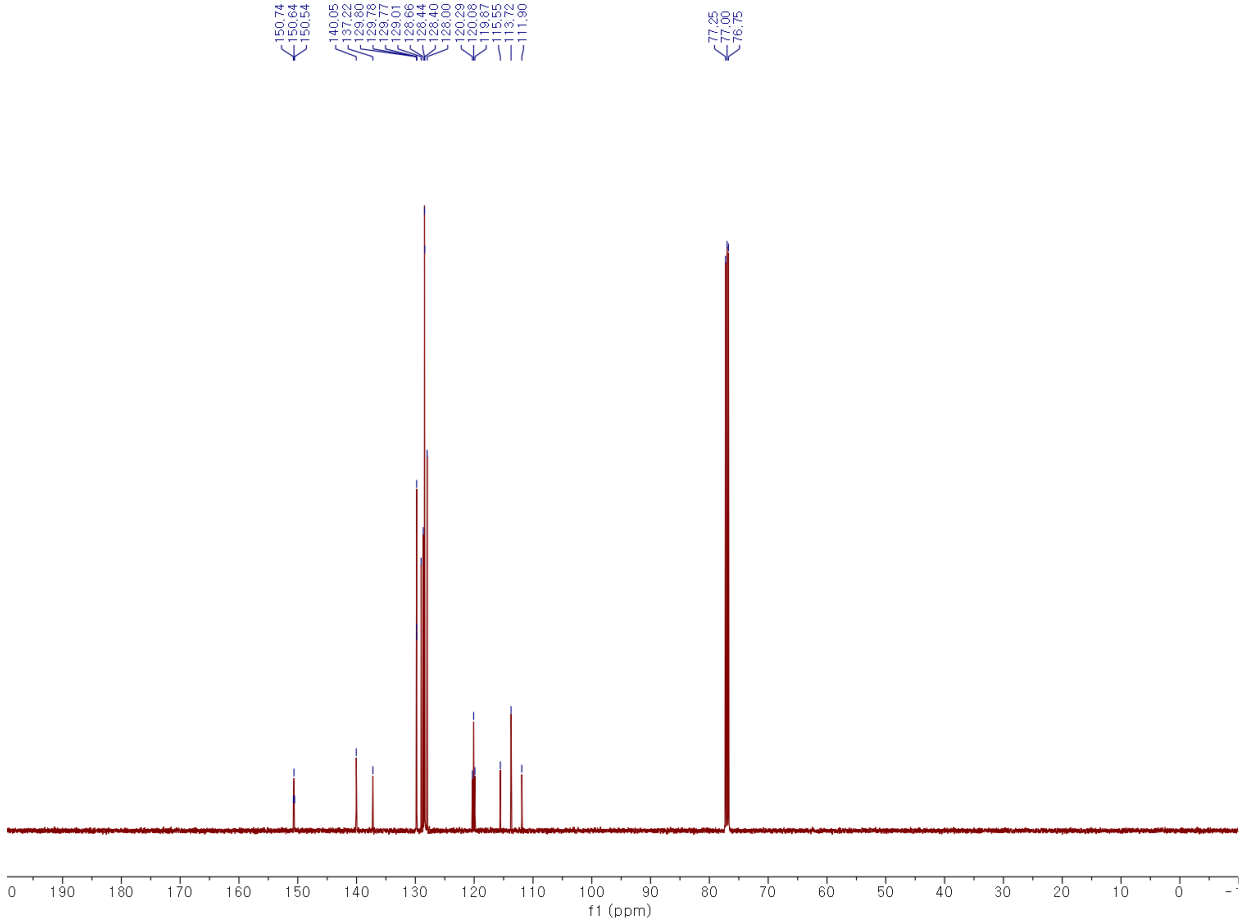
Supplementary Figure 106. ^{13}C NMR Spectrum of 1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (**3a'**)



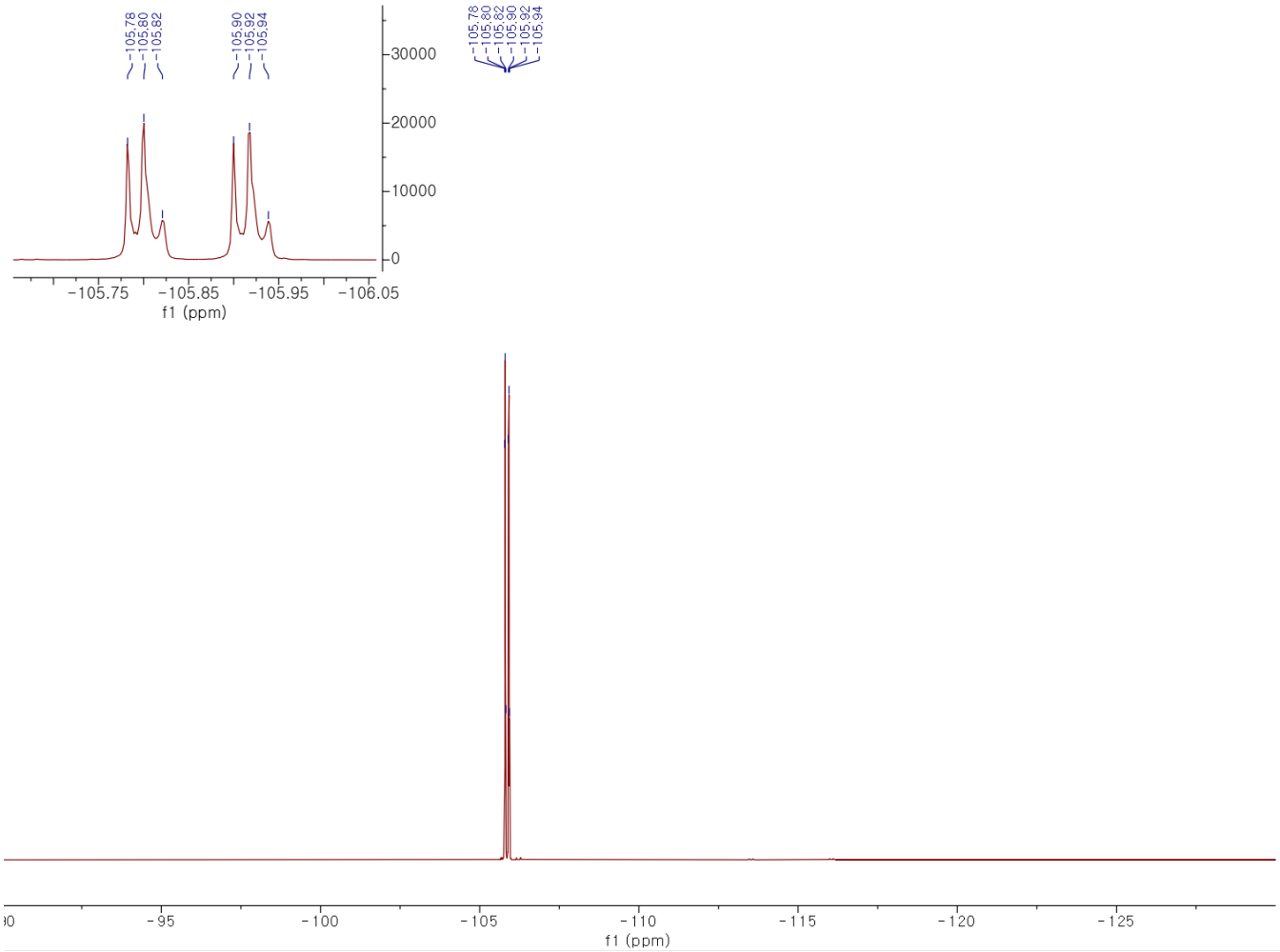
Supplementary Figure 107. ^{19}F NMR Spectrum of 1-(3,3-difluoro-1-phenylprop-1-en-1-yl)-4-methoxybenzene (**3a'**)



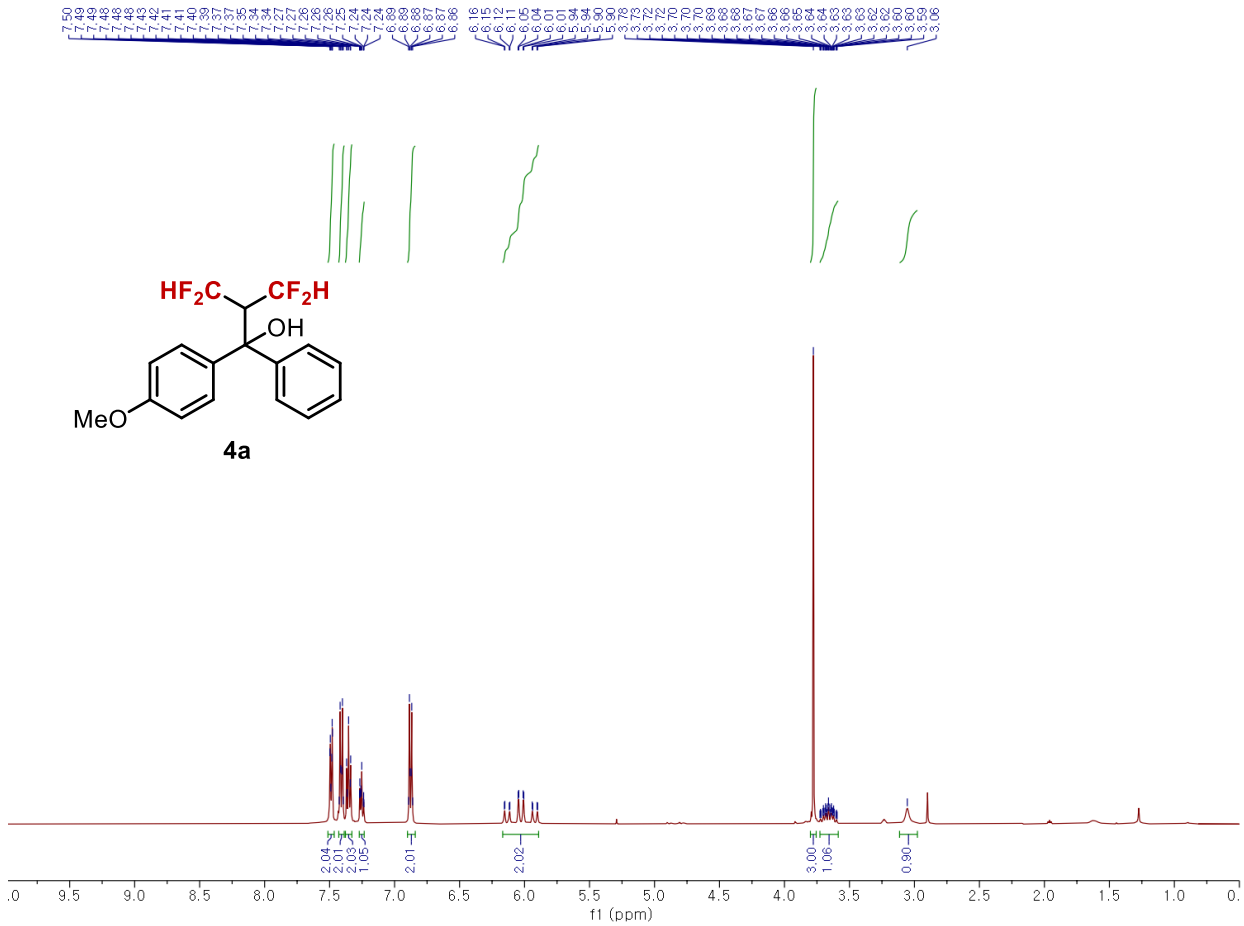
Supplementary Figure 108. ^{1}H NMR Spectrum of (3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (**3b'**)



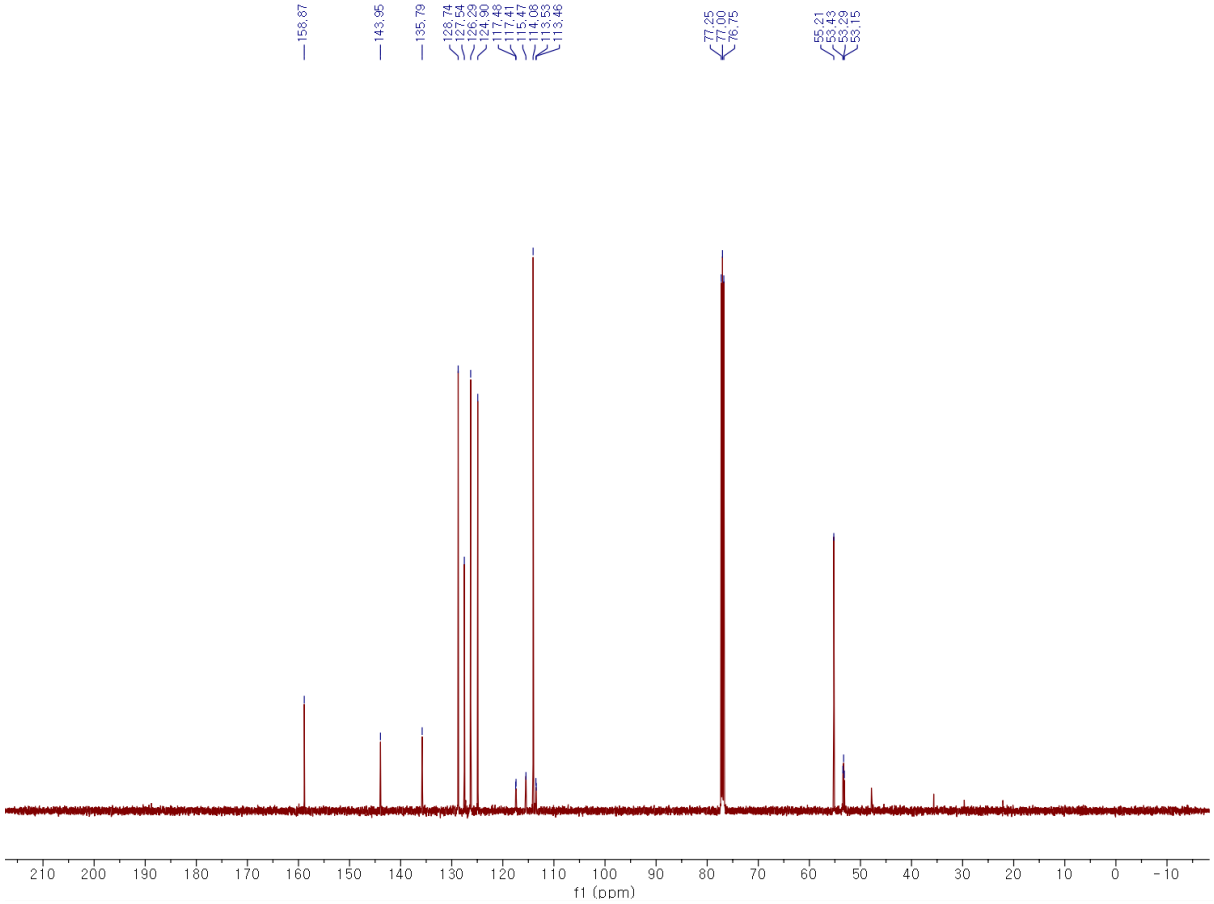
Supplementary Figure 109. ^{13}C NMR Spectrum of (3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (**3b'**)



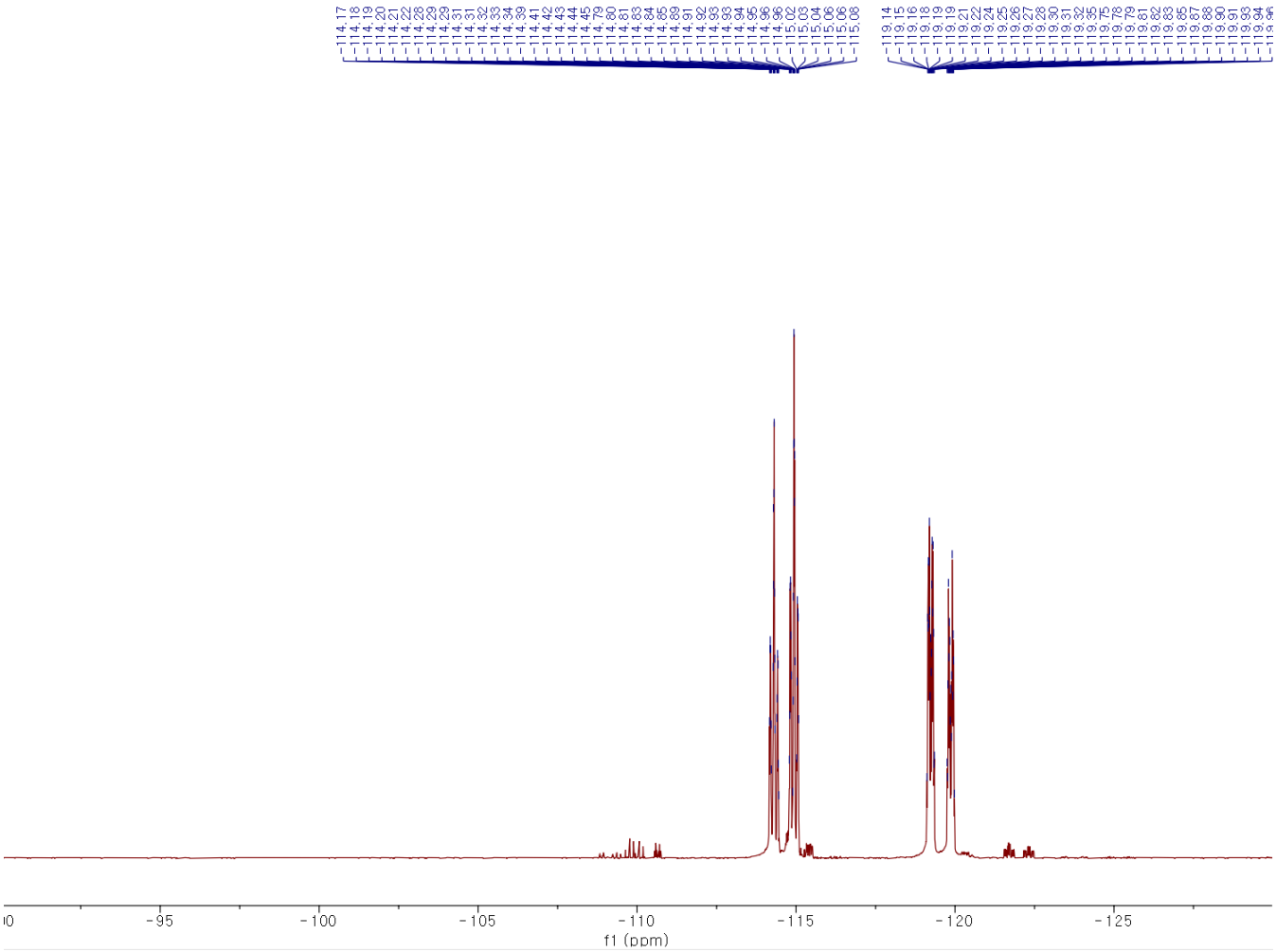
Supplementary Figure 110. ^{19}F NMR Spectrum of (3,3-difluoroprop-1-ene-1,1-diyl)dibenzene (**3b'**)



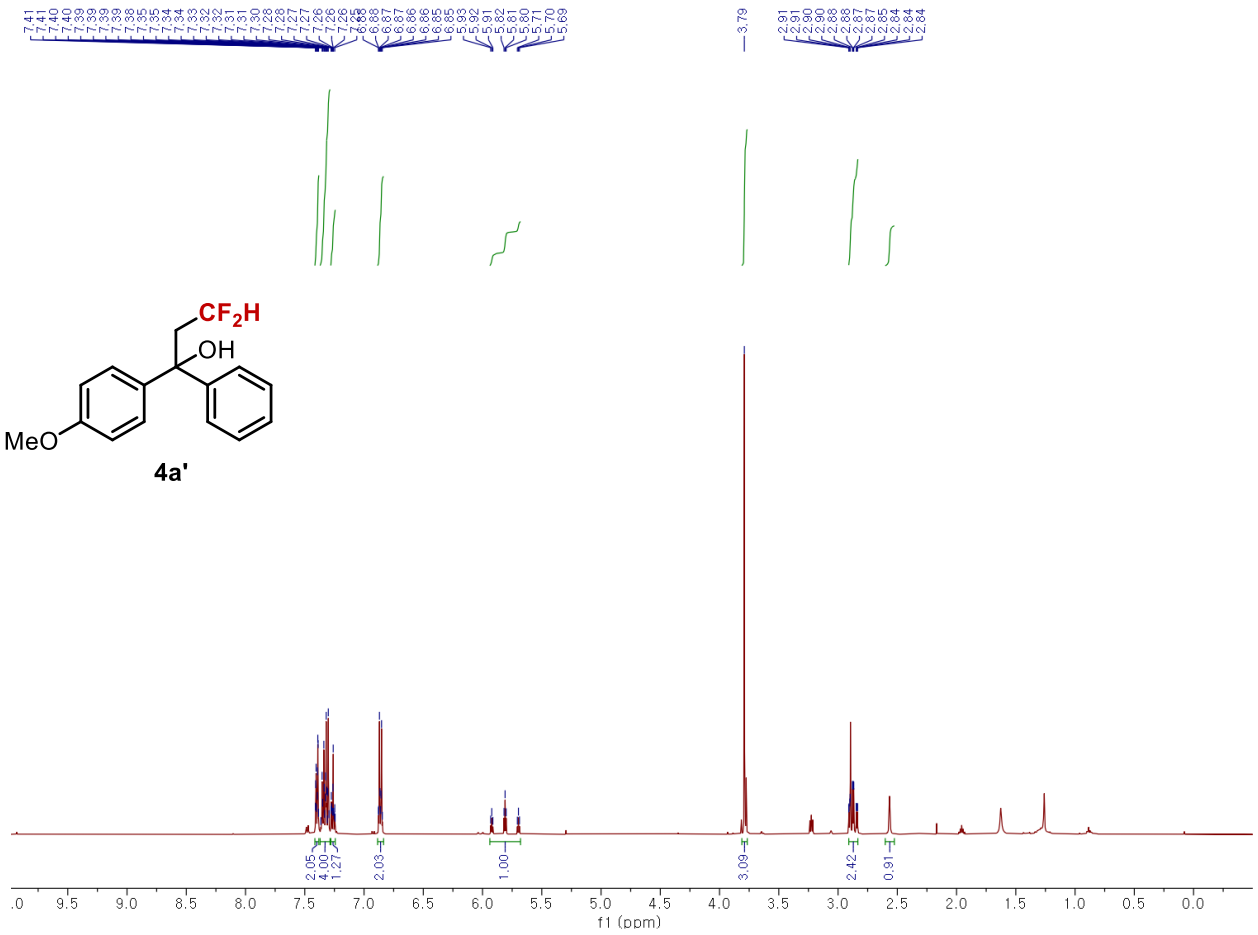
Supplementary Figure 111. ^{1}H NMR Spectrum of 2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (**4a**)



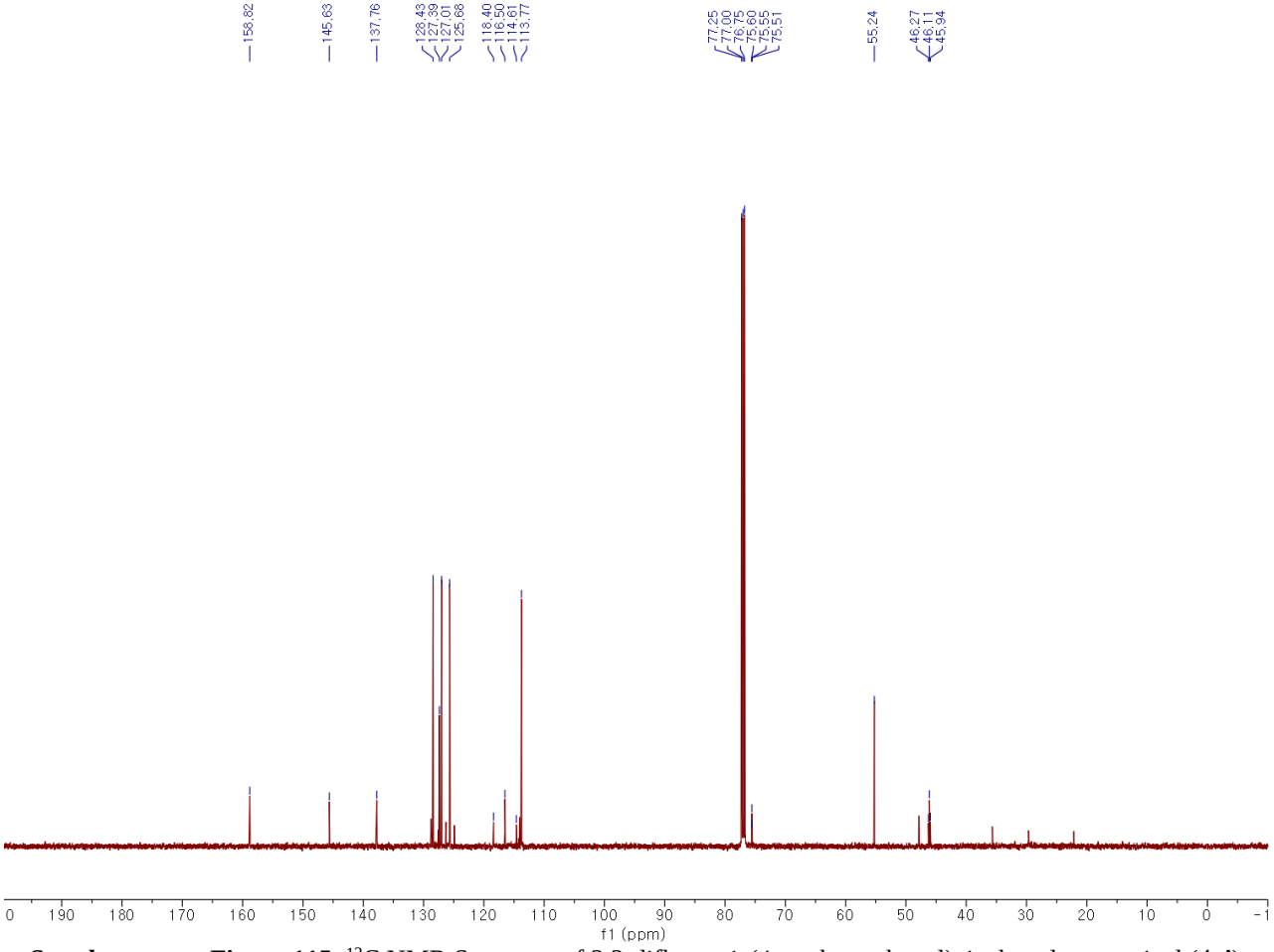
Supplementary Figure 112. ^{13}C NMR Spectrum of 2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (**4a**)



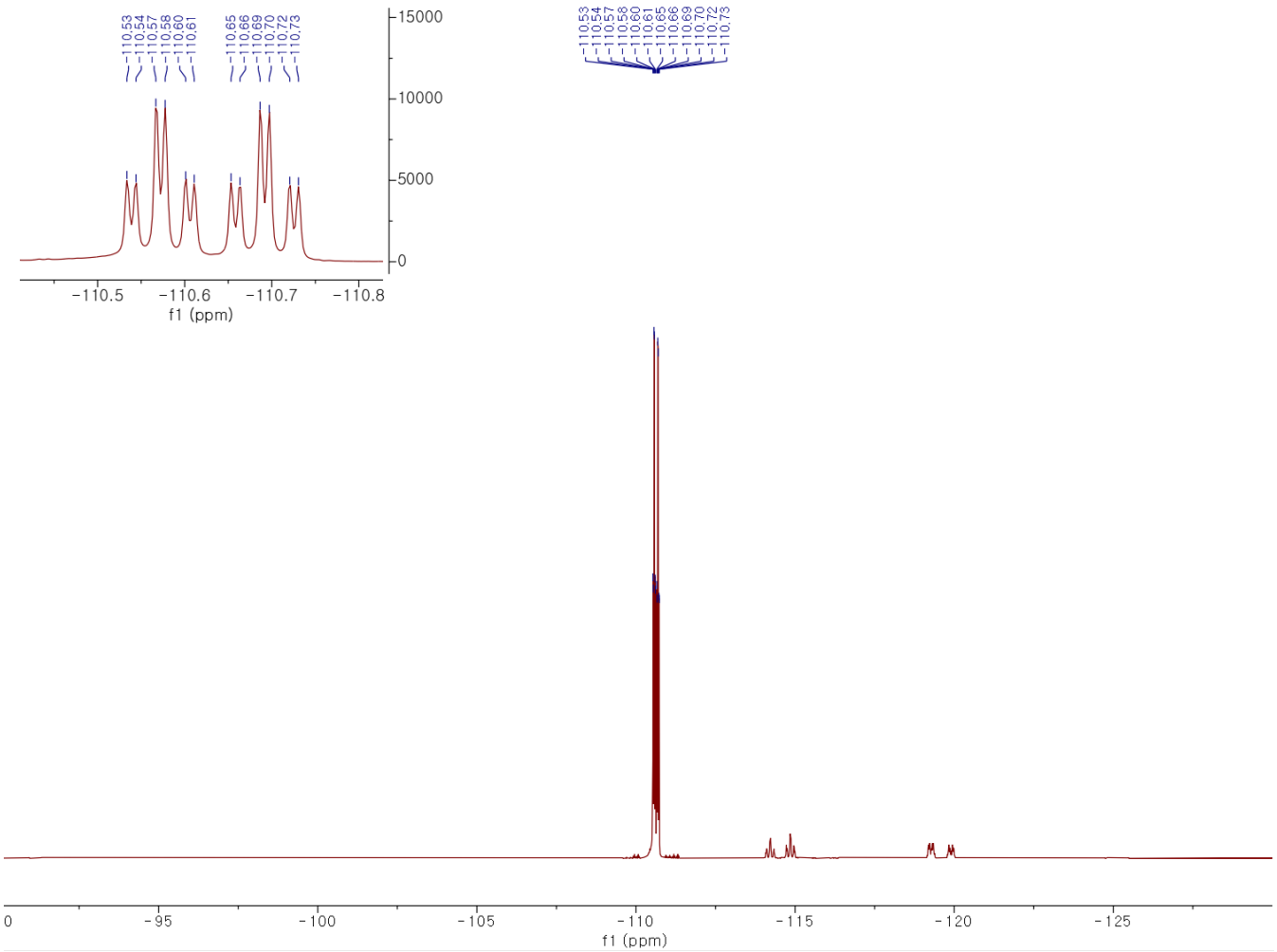
Supplementary Figure 113. ^{19}F NMR Spectrum of 2-(difluoromethyl)-3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (**4a**)



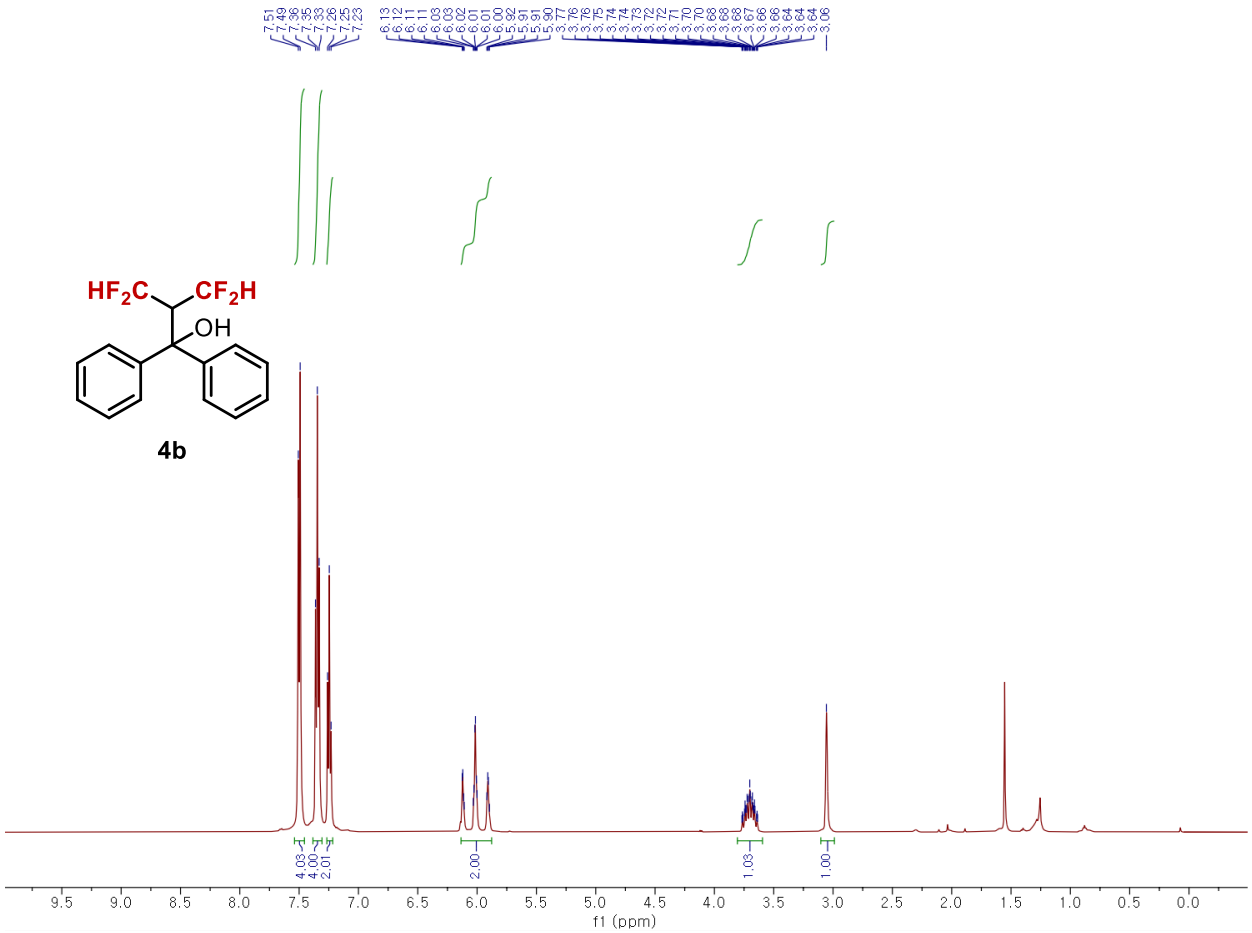
Supplementary Figure 114. ^{1}H NMR Spectrum of 3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (**4a'**)



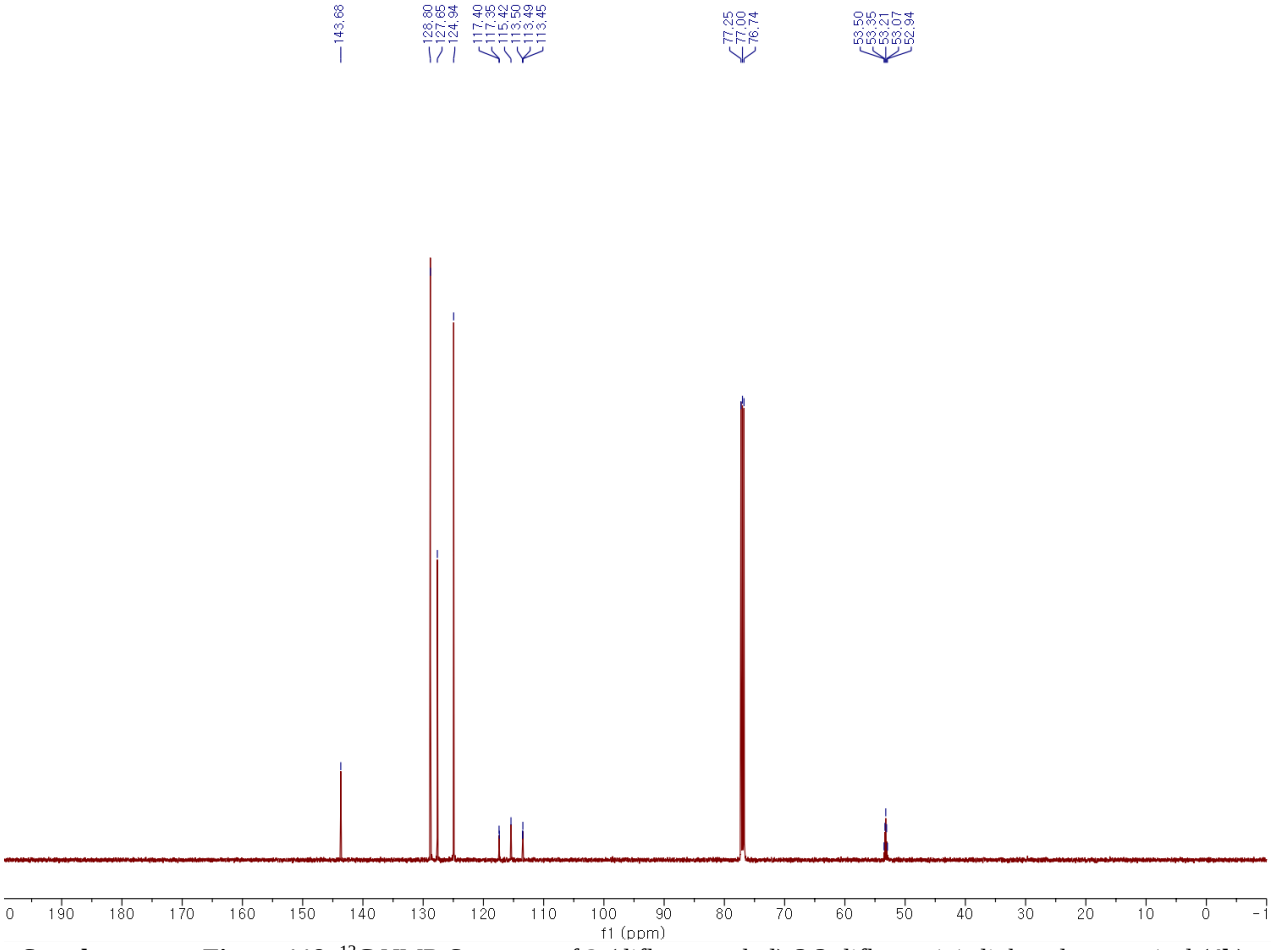
Supplementary Figure 115. ^{13}C NMR Spectrum of 3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (**4a'**)



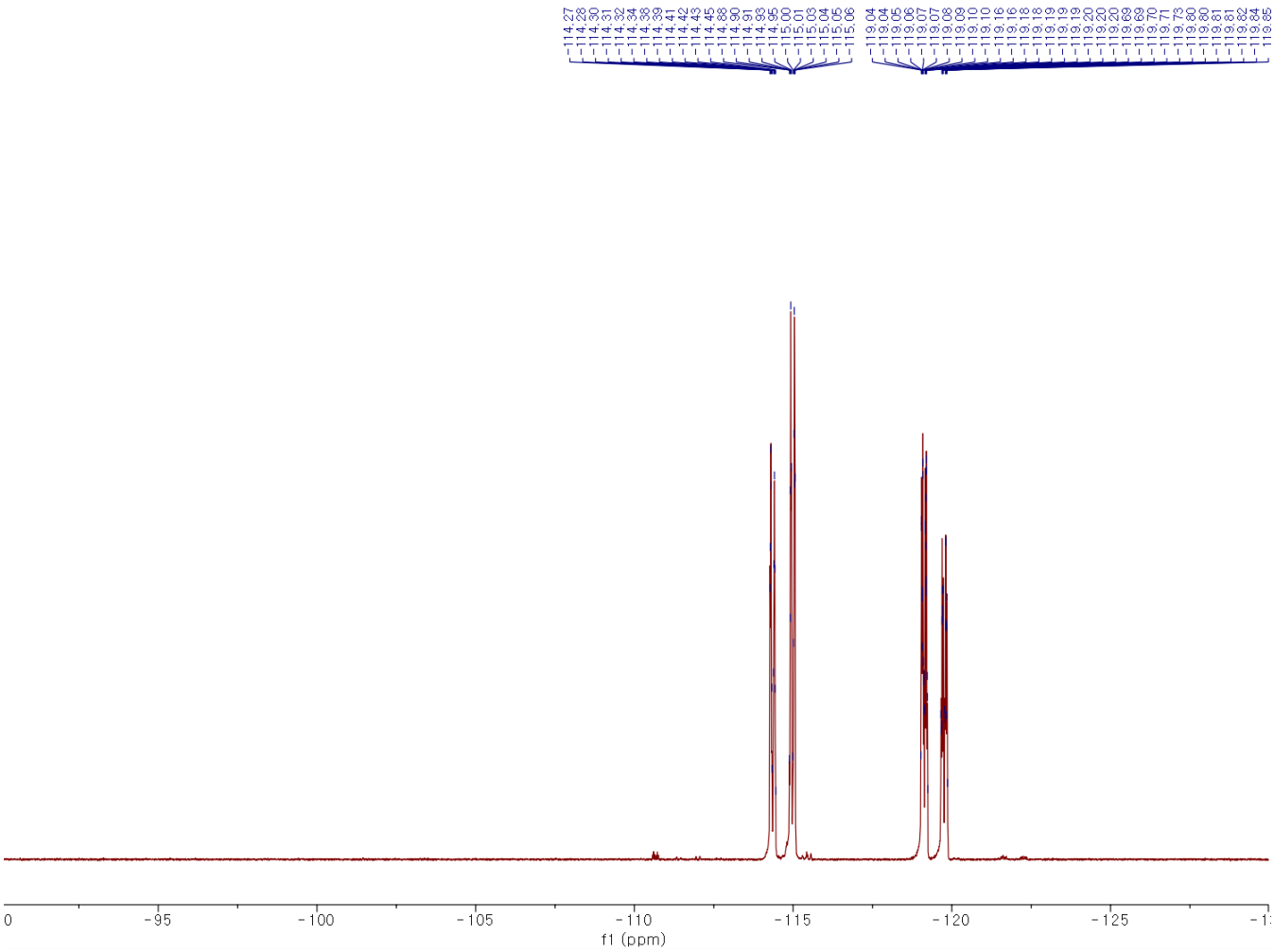
Supplementary Figure 116. ^{19}F NMR Spectrum of 3,3-difluoro-1-(4-methoxyphenyl)-1-phenylpropan-1-ol (**4a'**)



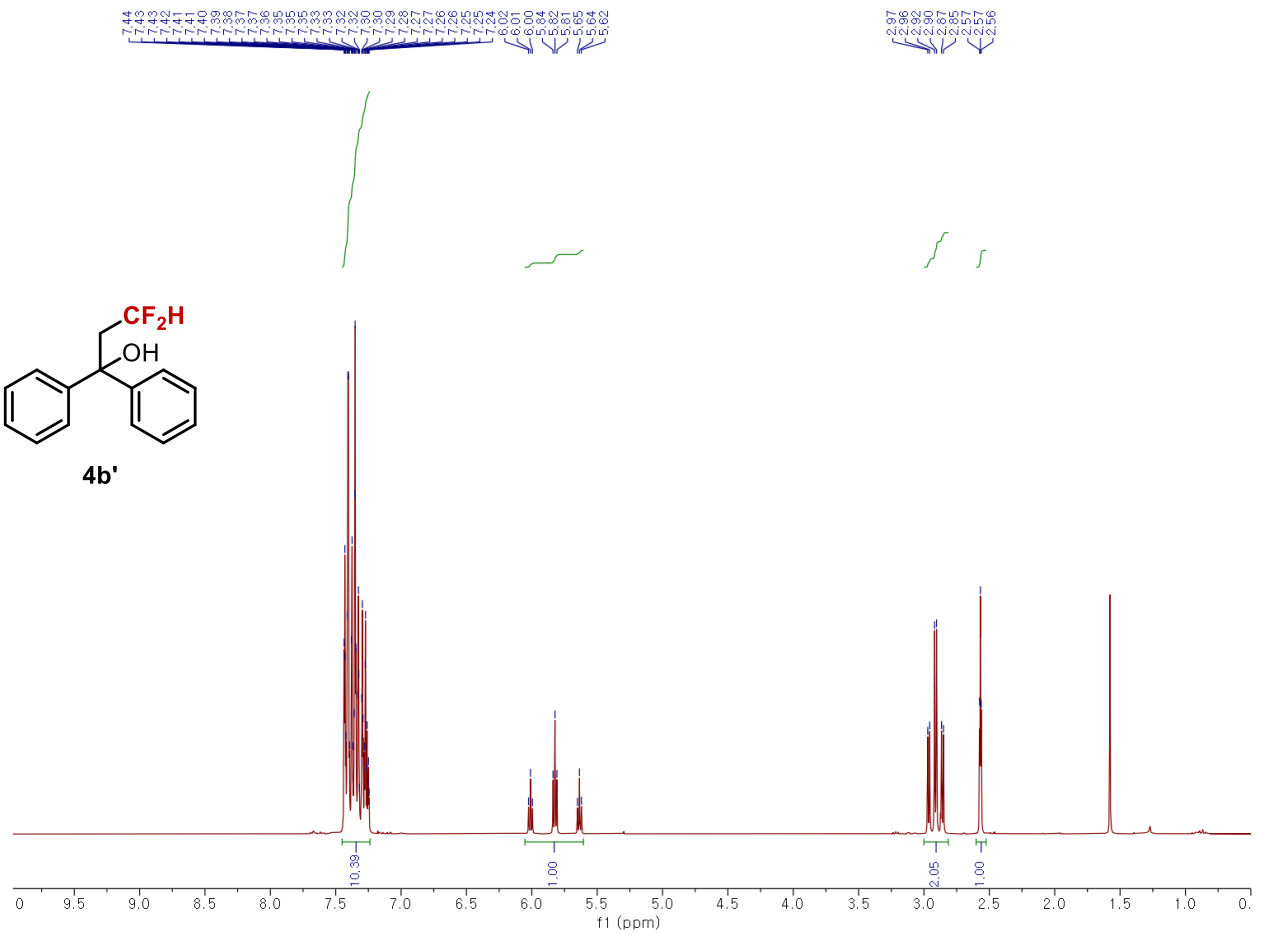
Supplementary Figure 117. ^{1}H NMR Spectrum of 2-(difluoromethyl)-3,3-difluoro-1,1-diphenylpropan-1-ol (**4b**)



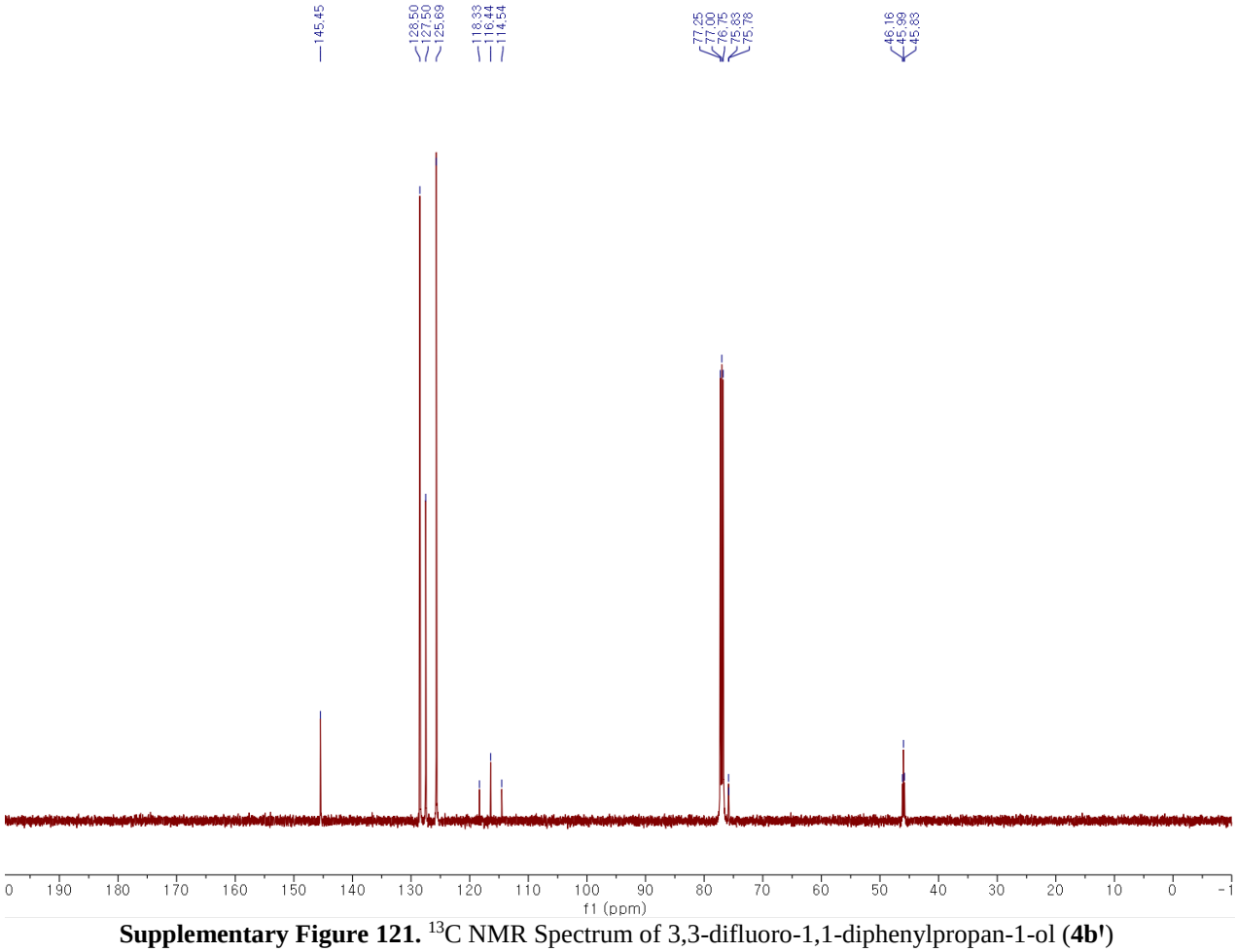
Supplementary Figure 118. ^{13}C NMR Spectrum of 2-(difluoromethyl)-3,3-difluoro-1,1-diphenylpropan-1-ol (**4b**)



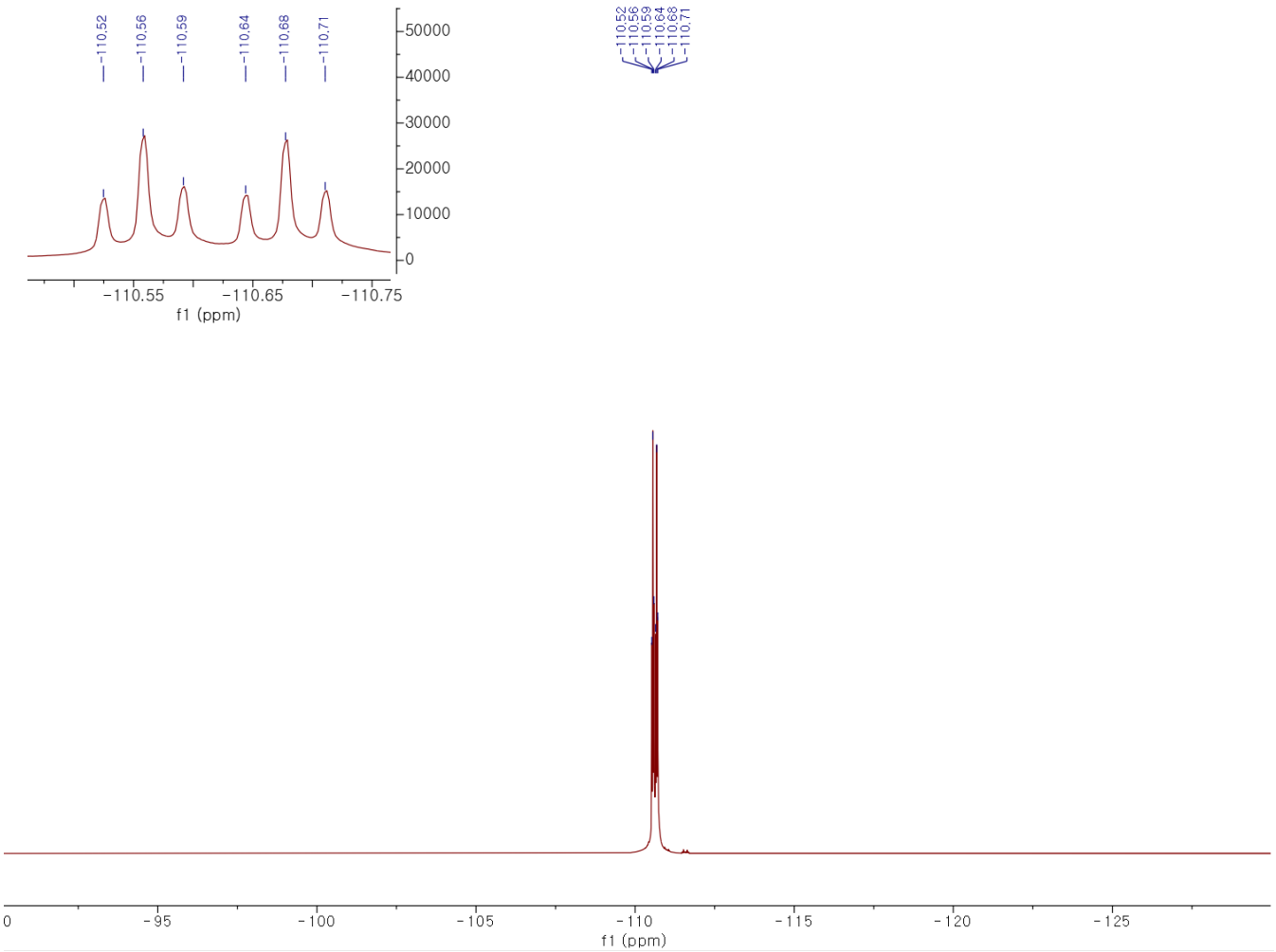
Supplementary Figure 119. ^{19}F NMR Spectrum of 2-(difluoromethyl)-3,3-difluoro-1,1-diphenylpropan-1-ol (**4b**)



Supplementary Figure 120. ^{1}H NMR Spectrum of 3,3-difluoro-1,1-diphenylpropan-1-ol (**4b'**)



Supplementary Figure 121. ^{13}C NMR Spectrum of 3,3-difluoro-1,1-diphenylpropan-1-ol (**4b'**)



Supplementary Figure 122. ^{19}F NMR Spectrum of 3,3-difluoro-1,1-diphenylpropan-1-ol (**4b'**)

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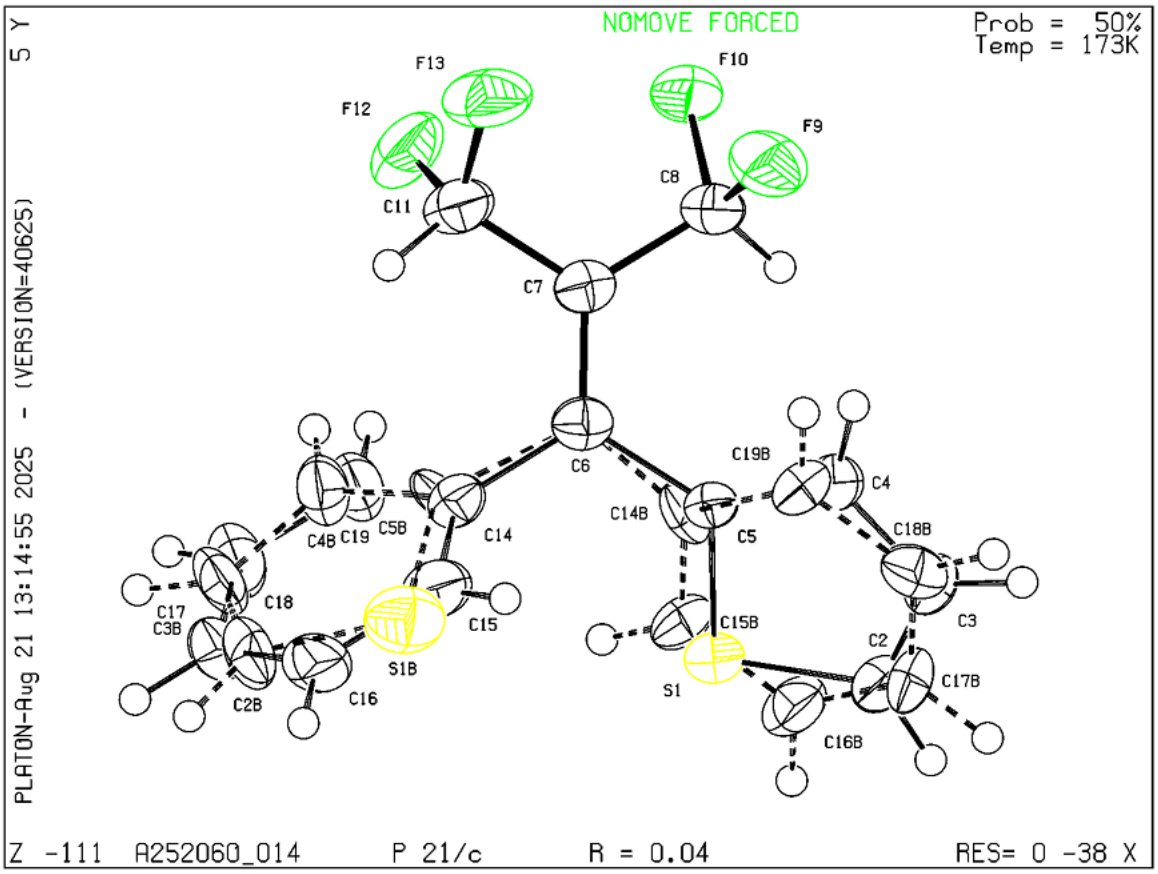
Appendix

*(Crystallographic Data of Compound **3i, 3j, and 3x**)*



Supplementary Figure 123. Crystallographic data of **3i (CCDC deposition number 2495625)**

Table 1. Crystal data and structure refinement for **3i**.

Empirical formula	$C_{14}H_{10}F_4S$	
Formula weight	286.28	
Temperature	173(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1/c$	
Unit cell dimensions	a = 9.5486(6) Å	α = 90°
	b = 7.5608(5) Å	β = 98.1501(18)°
	c = 17.9953(10) Å	γ = 90°
Volume	1286.05(14) $Å^3$	
Z	4	
Density (calculated)	1.479 Mg/m^3	
Absorption coefficient	0.282 mm^{-1}	
F(000)	584	
Crystal size	0.191 x 0.117 x 0.052 mm^3	

Theta range for data collection	2.912 to 28.017°.
Index ranges	–12<=h<=12, –9<=k<=9, –23<=l<=23
Reflections collected	31708
Independent reflections	3099 [R(int) = 0.0448]
Completeness to theta = 25.242°	99.8 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7456 and 0.6951
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	3099 / 574 / 248
Goodness-of-fit on F^2	1.092
Final R indices [I>2sigma(I)]	R1 = 0.0369, wR2 = 0.0805
R indices (all data)	R1 = 0.0481, wR2 = 0.0879
Largest diff. peak and hole	0.243 and –0.223 e·$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$ x 10^3) for **3i**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
S(1)	180(1)	5293(1)	6104(1)	35(1)
C(2)	-459(3)	4166(5)	6796(2)	44(1)
C(3)	538(4)	3902(6)	7395(2)	49(1)
C(4)	1864(4)	4618(6)	7294(2)	41(1)
C(5)	1866(2)	5395(6)	6612(2)	28(1)
C(14)	2638(5)	7868(3)	5832(2)	32(1)
C(15)	2040(3)	9300(4)	6156(1)	44(1)
C(16)	1662(2)	10808(2)	5734(2)	53(1)
C(17)	1881(3)	10885(3)	4987(2)	57(1)
C(18)	2480(4)	9454(3)	4663(1)	58(1)
C(19)	2858(4)	7945(3)	5086(2)	45(1)
S(1B)	1851(5)	9832(7)	6075(2)	54(1)
C(2B)	1838(17)	10961(16)	5285(7)	47(3)
C(3B)	2414(18)	10047(17)	4781(7)	47(3)
C(4B)	2950(20)	8408(18)	5044(9)	42(3)
C(5B)	2750(20)	8014(18)	5763(9)	35(3)
C(14B)	1857(9)	5650(20)	6507(8)	30(3)
C(15B)	615(10)	5420(17)	6011(5)	36(3)
C(16B)	-548(8)	4614(11)	6253(5)	44(2)
C(17B)	-470(12)	4037(17)	6991(6)	42(3)
C(18B)	772(17)	4260(20)	7487(5)	43(3)
C(19B)	1935(13)	5070(20)	7245(8)	38(3)
C(6)	3033(1)	6280(2)	6274(1)	31(1)
C(7)	4365(1)	5639(2)	6384(1)	34(1)
C(8)	4726(2)	3916(2)	6772(1)	41(1)
F(9)	5256(1)	4175(2)	7512(1)	62(1)
F(10)	5791(1)	3087(1)	6470(1)	57(1)
C(11)	5555(2)	6686(2)	6148(1)	43(1)
F(12)	6021(1)	5996(1)	5525(1)	60(1)
F(13)	6703(1)	6627(1)	6694(1)	62(1)

Table 3. Bond lengths [Å] and angles [°] for **3i**.

S(1)-C(2)	1.693(4)
S(1)-C(5)	1.737(3)
C(2)-C(3)	1.348(4)
C(2)-H(2)	0.9500
C(3)-C(4)	1.412(4)
C(3)-H(3)	0.9500
C(4)-C(5)	1.361(4)
C(4)-H(4)	0.9500
C(5)-C(6)	1.500(3)
C(14)-C(15)	1.3900
C(14)-C(19)	1.3900
C(14)-C(6)	1.460(2)
C(15)-C(16)	1.3900
C(15)-H(15)	0.9500
C(16)-C(17)	1.3900
C(16)-H(16)	0.9500
C(17)-C(18)	1.3900
C(17)-H(17)	0.9500
C(18)-C(19)	1.3900
C(18)-H(18)	0.9500
C(19)-H(19)	0.9500
S(1B)-C(2B)	1.656(11)
S(1B)-C(5B)	1.756(11)
C(2B)-C(3B)	1.321(14)
C(2B)-H(2B)	0.9500
C(3B)-C(4B)	1.399(13)
C(3B)-H(3B)	0.9500
C(4B)-C(5B)	1.368(12)
C(4B)-H(4B)	0.9500
C(5B)-C(6)	1.602(12)
C(14B)-C(6)	1.341(9)
C(14B)-C(15B)	1.3900
C(14B)-C(19B)	1.3900
C(15B)-C(16B)	1.3900
C(15B)-H(15B)	0.9500
C(16B)-C(17B)	1.3900
C(16B)-H(16B)	0.9500
C(17B)-C(18B)	1.3900

C(17B)-H(17B)	0.9500
C(18B)-C(19B)	1.3900
C(18B)-H(18B)	0.9500
C(19B)-H(19B)	0.9500
C(6)-C(7)	1.3493(18)
C(7)-C(11)	1.495(2)
C(7)-C(8)	1.495(2)
C(8)-F(10)	1.3700(17)
C(8)-F(9)	1.3705(18)
C(8)-H(8)	1.0000
C(11)-F(13)	1.3650(19)
C(11)-F(12)	1.3661(18)
C(11)-H(11)	1.0000

C(2)-S(1)-C(5)	92.20(14)
C(3)-C(2)-S(1)	112.1(2)
C(3)-C(2)-H(2)	124.0
S(1)-C(2)-H(2)	124.0
C(2)-C(3)-C(4)	112.6(2)
C(2)-C(3)-H(3)	123.7
C(4)-C(3)-H(3)	123.7
C(5)-C(4)-C(3)	113.4(2)
C(5)-C(4)-H(4)	123.3
C(3)-C(4)-H(4)	123.3
C(4)-C(5)-C(6)	130.9(2)
C(4)-C(5)-S(1)	109.64(19)
C(6)-C(5)-S(1)	119.5(2)
C(15)-C(14)-C(19)	120.0
C(15)-C(14)-C(6)	120.14(19)
C(19)-C(14)-C(6)	119.86(19)
C(16)-C(15)-C(14)	120.0
C(16)-C(15)-H(15)	120.0
C(14)-C(15)-H(15)	120.0
C(15)-C(16)-C(17)	120.0
C(15)-C(16)-H(16)	120.0
C(17)-C(16)-H(16)	120.0
C(18)-C(17)-C(16)	120.0
C(18)-C(17)-H(17)	120.0
C(16)-C(17)-H(17)	120.0
C(17)-C(18)-C(19)	120.0

C(17)-C(18)-H(18)	120.0
C(19)-C(18)-H(18)	120.0
C(18)-C(19)-C(14)	120.0
C(18)-C(19)-H(19)	120.0
C(14)-C(19)-H(19)	120.0
C(2B)-S(1B)-C(5B)	94.2(6)
C(3B)-C(2B)-S(1B)	111.5(8)
C(3B)-C(2B)-H(2B)	124.2
S(1B)-C(2B)-H(2B)	124.2
C(2B)-C(3B)-C(4B)	113.6(9)
C(2B)-C(3B)-H(3B)	123.2
C(4B)-C(3B)-H(3B)	123.2
C(5B)-C(4B)-C(3B)	114.7(9)
C(5B)-C(4B)-H(4B)	122.6
C(3B)-C(4B)-H(4B)	122.6
C(4B)-C(5B)-C(6)	133.4(10)
C(4B)-C(5B)-S(1B)	105.8(7)
C(6)-C(5B)-S(1B)	120.4(9)
C(6)-C(14B)-C(15B)	121.3(9)
C(6)-C(14B)-C(19B)	118.4(9)
C(15B)-C(14B)-C(19B)	120.0
C(16B)-C(15B)-C(14B)	120.0
C(16B)-C(15B)-H(15B)	120.0
C(14B)-C(15B)-H(15B)	120.0
C(17B)-C(16B)-C(15B)	120.0
C(17B)-C(16B)-H(16B)	120.0
C(15B)-C(16B)-H(16B)	120.0
C(16B)-C(17B)-C(18B)	120.0
C(16B)-C(17B)-H(17B)	120.0
C(18B)-C(17B)-H(17B)	120.0
C(19B)-C(18B)-C(17B)	120.0
C(19B)-C(18B)-H(18B)	120.0
C(17B)-C(18B)-H(18B)	120.0
C(18B)-C(19B)-C(14B)	120.0
C(18B)-C(19B)-H(19B)	120.0
C(14B)-C(19B)-H(19B)	120.0
C(14B)-C(6)-C(7)	129.8(6)
C(7)-C(6)-C(14)	122.7(2)
C(7)-C(6)-C(5)	121.27(18)
C(14)-C(6)-C(5)	116.0(2)

C(14B)-C(6)-C(5B)	113.1(9)
C(7)-C(6)-C(5B)	117.1(7)
C(6)-C(7)-C(11)	120.45(13)
C(6)-C(7)-C(8)	122.13(13)
C(11)-C(7)-C(8)	117.36(12)
F(10)-C(8)-F(9)	104.99(11)
F(10)-C(8)-C(7)	110.42(12)
F(9)-C(8)-C(7)	110.98(13)
F(10)-C(8)-H(8)	110.1
F(9)-C(8)-H(8)	110.1
C(7)-C(8)-H(8)	110.1
F(13)-C(11)-F(12)	104.86(12)
F(13)-C(11)-C(7)	110.05(13)
F(12)-C(11)-C(7)	112.33(13)
F(13)-C(11)-H(11)	109.8
F(12)-C(11)-H(11)	109.8
C(7)-C(11)-H(11)	109.8

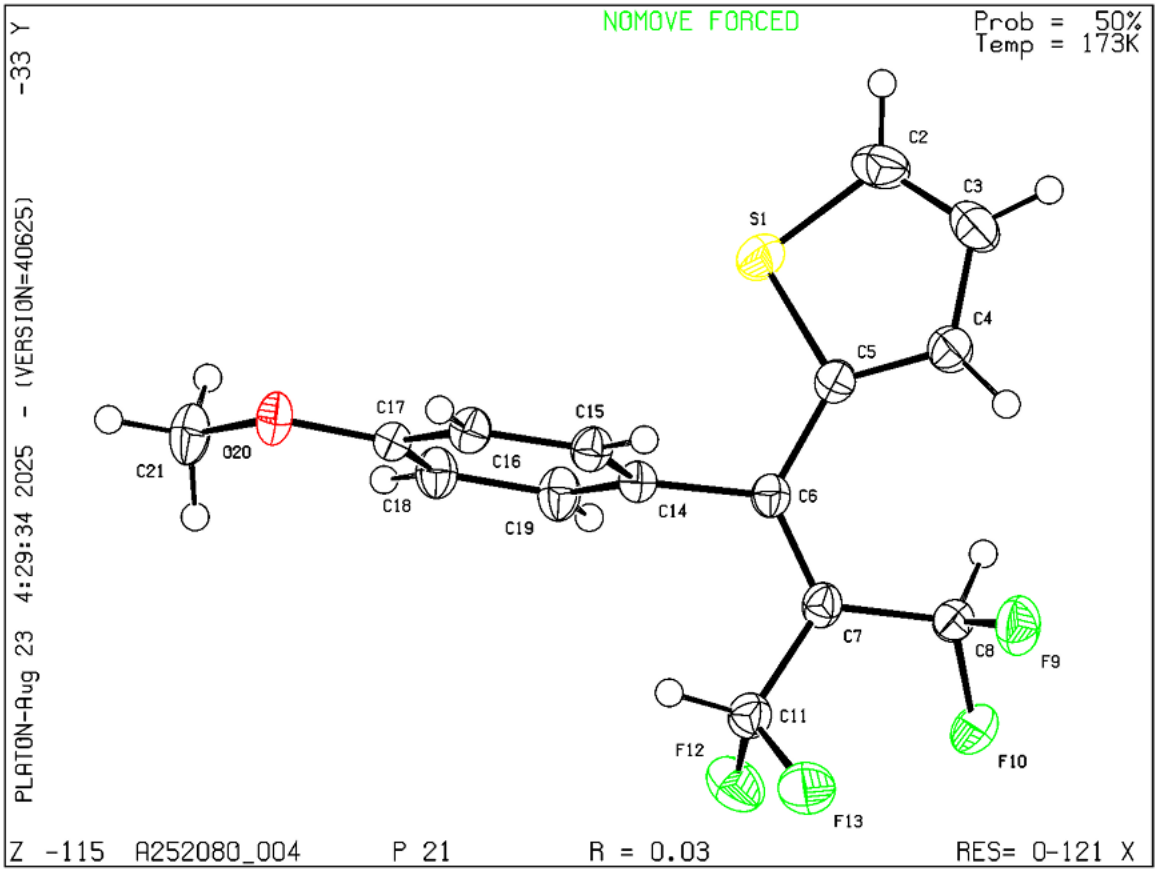
Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2$ x 10^3) for **3i**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U^{11} + ... + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
S(1)	26(1)	40(1)	40(1)	4(1)	3(1)	2(1)
C(2)	33(1)	43(1)	58(2)	11(1)	18(1)	2(1)
C(3)	39(2)	59(2)	53(2)	22(2)	23(1)	6(1)
C(4)	34(2)	57(2)	35(1)	14(1)	8(1)	7(1)
C(5)	23(1)	32(1)	31(2)	2(1)	6(1)	4(1)
C(14)	28(1)	33(2)	35(1)	-3(1)	9(1)	-1(1)
C(15)	34(1)	40(2)	60(2)	-5(1)	10(1)	0(1)
C(16)	40(1)	28(1)	92(2)	7(1)	11(1)	6(1)
C(17)	44(1)	40(2)	86(3)	28(2)	9(2)	5(1)
C(18)	67(2)	48(2)	61(2)	24(2)	21(1)	13(2)
C(19)	56(2)	36(2)	44(2)	12(1)	17(1)	11(2)
S(1B)	50(2)	59(3)	56(2)	-6(2)	11(1)	10(2)
C(2B)	60(5)	25(4)	58(6)	15(4)	12(5)	5(4)
C(3B)	60(5)	33(6)	50(5)	20(4)	13(4)	18(5)
C(4B)	57(5)	33(5)	38(5)	8(4)	20(4)	8(5)
C(5B)	34(6)	22(5)	49(6)	13(4)	1(4)	10(4)
C(14B)	46(5)	27(5)	18(4)	5(3)	3(3)	9(4)
C(15B)	29(6)	46(5)	37(4)	-3(3)	17(4)	1(4)
C(16B)	31(4)	40(4)	62(5)	-2(4)	15(4)	-7(4)
C(17B)	40(5)	46(5)	45(6)	15(4)	21(4)	-4(4)
C(18B)	33(6)	48(6)	45(5)	9(4)	-5(4)	6(4)
C(19B)	27(4)	44(7)	45(6)	4(4)	13(4)	-2(4)
C(6)	30(1)	35(1)	28(1)	-5(1)	4(1)	3(1)
C(7)	28(1)	38(1)	36(1)	-2(1)	5(1)	2(1)
C(8)	29(1)	48(1)	45(1)	7(1)	5(1)	8(1)
F(9)	47(1)	86(1)	47(1)	17(1)	-7(1)	10(1)
F(10)	42(1)	51(1)	82(1)	13(1)	22(1)	18(1)
C(11)	30(1)	41(1)	60(1)	-4(1)	10(1)	1(1)
F(12)	54(1)	58(1)	76(1)	-5(1)	38(1)	-5(1)
F(13)	30(1)	60(1)	92(1)	-9(1)	-4(1)	-3(1)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$ x 10^3) for **3i**.

	x	y	z	U(eq)
H(2)	-1409	3768	6766	52
H(3)	367	3299	7837	59
H(4)	2675	4564	7666	50
H(15)	1890	9248	6666	53
H(16)	1252	11787	5955	63
H(17)	1623	11916	4698	68
H(18)	2630	9506	4153	69
H(19)	3267	6967	4865	53
H(2B)	1463	12120	5205	57
H(3B)	2458	10464	4286	57
H(4B)	3425	7629	4746	50
H(15B)	561	5814	5506	44
H(16B)	-1397	4458	5914	52
H(17B)	-1265	3486	7157	51
H(18B)	826	3870	7992	51
H(19B)	2784	5226	7584	45
H(8)	3871	3139	6728	49
H(11)	5252	7941	6051	52



Supplementary Figure 124. Crystallographic data of **3j (CCDC deposition number 2495628)**

Table 1. Crystal data and structure refinement for **3j**.

Empirical formula	$C_{15}\ H_{12}\ F_4\ O\ S$	
Formula weight	316.31	
Temperature	173(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1$	
Unit cell dimensions	a = 7.9666(8) Å	α = 90°
	b = 5.5479(6) Å	β = 102.364(3)°
	c = 15.6652(16) Å	γ = 90°
Volume	676.31(12) $Å^3$	
Z	2	
Density (calculated)	1.553 Mg/m^3	
Absorption coefficient	0.281 mm^{-1}	
F(000)	324	
Crystal size	0.114 x 0.071 x 0.023 mm^3	

Theta range for data collection	2.617 to 26.004°.
Index ranges	–9<=h<=9, –6<=k<=6, –19<=l<=19
Reflections collected	8442
Independent reflections	2549 [R(int) = 0.0885]
Completeness to theta = 25.242°	98.1 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7453 and 0.7156
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	2549 / 1 / 191
Goodness-of-fit on F^2	1.082
Final R indices [I>2sigma(I)]	R1 = 0.0287, wR2 = 0.0708
R indices (all data)	R1 = 0.0395, wR2 = 0.0740
Absolute structure parameter	0.08(4)
Largest diff. peak and hole	0.204 and –0.163 e·$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$ x 10^3) for **3j**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
S(1)	9614(1)	7281(2)	8105(1)	33(1)
C(2)	10114(4)	9454(6)	8884(2)	36(1)
C(3)	8820(4)	9876(6)	9296(2)	36(1)
C(4)	7370(4)	8418(5)	8983(2)	28(1)
C(5)	7596(3)	6867(5)	8322(2)	23(1)
C(6)	6400(3)	5183(5)	7782(2)	22(1)
C(7)	5122(3)	3994(5)	8043(2)	24(1)
C(8)	4883(4)	4151(6)	8966(2)	26(1)
F(9)	3734(2)	5959(4)	9048(1)	38(1)
F(10)	4138(2)	2088(4)	9190(1)	38(1)
C(11)	3864(3)	2507(6)	7411(2)	26(1)
F(12)	4062(3)	90(4)	7587(1)	40(1)
F(13)	2226(2)	3027(4)	7472(1)	41(1)
C(14)	6707(3)	4868(5)	6874(2)	21(1)
C(15)	6158(3)	6647(5)	6244(2)	23(1)
C(16)	6501(3)	6439(5)	5420(2)	24(1)
C(17)	7424(3)	4483(5)	5211(2)	21(1)
C(18)	7991(3)	2711(5)	5831(2)	26(1)
C(19)	7607(4)	2909(5)	6656(2)	28(1)
O(20)	7713(3)	4501(4)	4380(1)	28(1)
C(21)	8582(4)	2470(7)	4118(2)	36(1)

Table 3. Bond lengths [Å] and angles [°] for **3j**.

S(1)-C(2)	1.700(3)
S(1)-C(5)	1.728(3)
C(2)-C(3)	1.349(4)
C(2)-H(2)	0.9500
C(3)-C(4)	1.409(4)
C(3)-H(3)	0.9500
C(4)-C(5)	1.388(3)
C(4)-H(4)	0.9500
C(5)-C(6)	1.467(4)
C(6)-C(7)	1.348(4)
C(6)-C(14)	1.504(3)
C(7)-C(11)	1.497(4)
C(7)-C(8)	1.501(3)
C(8)-F(10)	1.369(3)
C(8)-F(9)	1.382(3)
C(8)-H(8)	1.0000
C(11)-F(13)	1.360(3)
C(11)-F(12)	1.371(4)
C(11)-H(11)	1.0000
C(14)-C(19)	1.384(4)
C(14)-C(15)	1.398(3)
C(15)-C(16)	1.380(3)
C(15)-H(15)	0.9500
C(16)-C(17)	1.389(4)
C(16)-H(16)	0.9500
C(17)-O(20)	1.369(3)
C(17)-C(18)	1.388(4)
C(18)-C(19)	1.395(3)
C(18)-H(18)	0.9500
C(19)-H(19)	0.9500
O(20)-C(21)	1.428(4)
C(21)-H(21A)	0.9800
C(21)-H(21B)	0.9800
C(21)-H(21C)	0.9800
C(2)-S(1)-C(5)	92.19(15)
C(3)-C(2)-S(1)	112.4(2)
C(3)-C(2)-H(2)	123.8

S(1)-C(2)-H(2)	123.8
C(2)-C(3)-C(4)	112.8(3)
C(2)-C(3)-H(3)	123.6
C(4)-C(3)-H(3)	123.6
C(5)-C(4)-C(3)	112.8(3)
C(5)-C(4)-H(4)	123.6
C(3)-C(4)-H(4)	123.6
C(4)-C(5)-C(6)	130.8(2)
C(4)-C(5)-S(1)	109.8(2)
C(6)-C(5)-S(1)	119.19(18)
C(7)-C(6)-C(5)	125.2(2)
C(7)-C(6)-C(14)	121.1(2)
C(5)-C(6)-C(14)	113.7(2)
C(6)-C(7)-C(11)	120.8(2)
C(6)-C(7)-C(8)	121.6(3)
C(11)-C(7)-C(8)	117.6(2)
F(10)-C(8)-F(9)	104.5(2)
F(10)-C(8)-C(7)	110.5(2)
F(9)-C(8)-C(7)	110.8(2)
F(10)-C(8)-H(8)	110.3
F(9)-C(8)-H(8)	110.3
C(7)-C(8)-H(8)	110.3
F(13)-C(11)-F(12)	105.3(2)
F(13)-C(11)-C(7)	110.7(2)
F(12)-C(11)-C(7)	112.0(2)
F(13)-C(11)-H(11)	109.6
F(12)-C(11)-H(11)	109.6
C(7)-C(11)-H(11)	109.6
C(19)-C(14)-C(15)	118.7(2)
C(19)-C(14)-C(6)	121.5(2)
C(15)-C(14)-C(6)	119.7(2)
C(16)-C(15)-C(14)	120.4(2)
C(16)-C(15)-H(15)	119.8
C(14)-C(15)-H(15)	119.8
C(15)-C(16)-C(17)	120.4(2)
C(15)-C(16)-H(16)	119.8
C(17)-C(16)-H(16)	119.8
O(20)-C(17)-C(18)	125.1(2)
O(20)-C(17)-C(16)	115.1(2)
C(18)-C(17)-C(16)	119.8(2)

C(17)-C(18)-C(19)	119.3(2)
C(17)-C(18)-H(18)	120.3
C(19)-C(18)-H(18)	120.3
C(14)-C(19)-C(18)	121.2(2)
C(14)-C(19)-H(19)	119.4
C(18)-C(19)-H(19)	119.4
C(17)-O(20)-C(21)	117.3(2)
O(20)-C(21)-H(21A)	109.5
O(20)-C(21)-H(21B)	109.5
H(21A)-C(21)-H(21B)	109.5
O(20)-C(21)-H(21C)	109.5
H(21A)-C(21)-H(21C)	109.5
H(21B)-C(21)-H(21C)	109.5

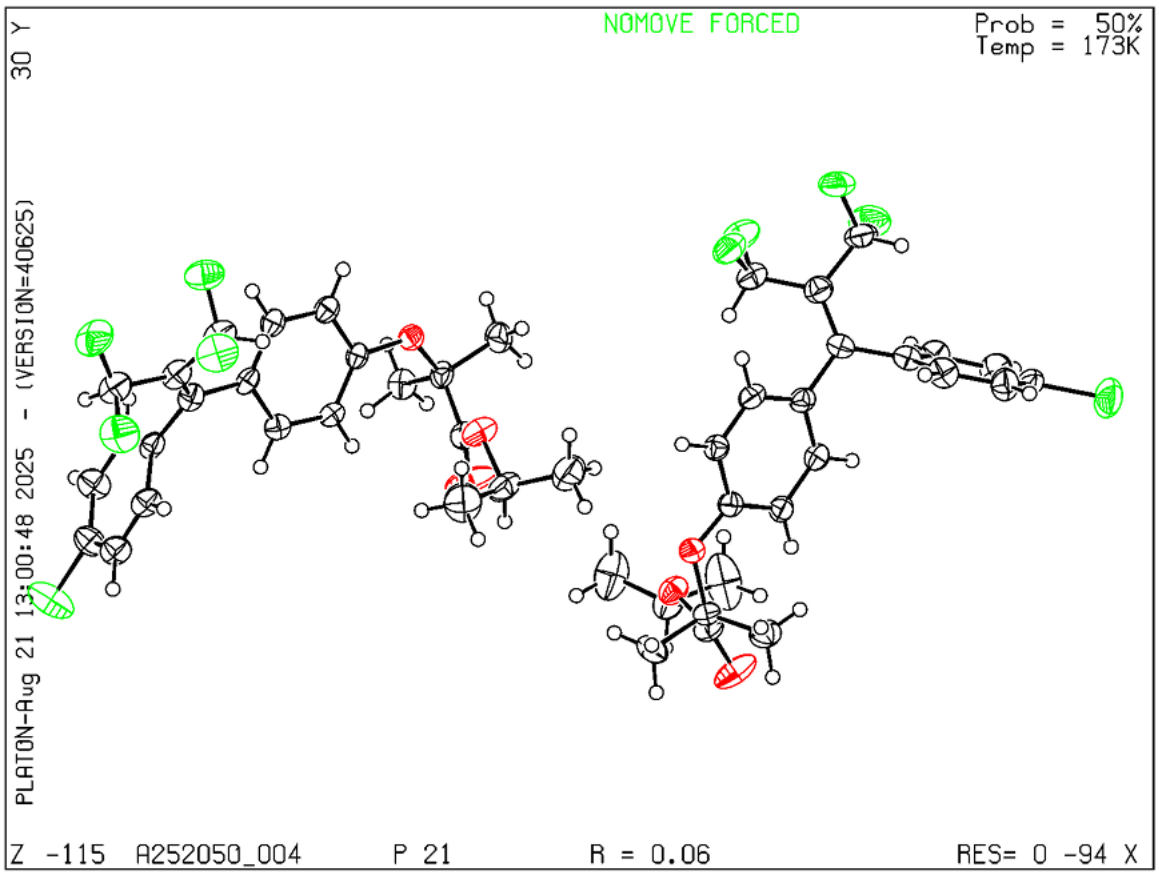
Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2$ x 10^3) for **3j**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U^{11} + ... + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
S(1)	25(1)	42(1)	32(1)	-2(1)	10(1)	-4(1)
C(2)	31(2)	39(2)	34(2)	2(1)	-3(1)	-10(1)
C(3)	41(2)	34(2)	30(1)	-8(1)	2(1)	-6(2)
C(4)	24(1)	31(2)	29(1)	-4(1)	7(1)	1(1)
C(5)	22(1)	26(2)	21(1)	1(1)	5(1)	1(1)
C(6)	24(1)	22(1)	20(1)	1(1)	5(1)	1(1)
C(7)	22(1)	29(1)	19(1)	1(1)	4(1)	2(1)
C(8)	23(1)	33(2)	23(1)	-2(1)	6(1)	-4(1)
F(9)	34(1)	49(1)	33(1)	-7(1)	12(1)	6(1)
F(10)	45(1)	43(1)	28(1)	4(1)	15(1)	-11(1)
C(11)	26(1)	29(1)	24(1)	1(1)	5(1)	0(1)
F(12)	51(1)	29(1)	37(1)	-1(1)	1(1)	-3(1)
F(13)	24(1)	55(1)	43(1)	-7(1)	3(1)	-3(1)
C(14)	22(1)	22(1)	20(1)	0(1)	5(1)	0(1)
C(15)	21(1)	26(1)	24(1)	0(1)	6(1)	3(1)
C(16)	23(1)	26(1)	21(1)	3(1)	4(1)	3(1)
C(17)	22(1)	23(1)	20(1)	-2(1)	7(1)	-3(1)
C(18)	31(1)	25(2)	25(1)	-1(1)	8(1)	6(1)
C(19)	38(2)	25(1)	24(1)	3(1)	9(1)	6(1)
O(20)	31(1)	35(1)	19(1)	0(1)	10(1)	4(1)
C(21)	44(2)	40(2)	31(1)	-5(1)	18(1)	8(2)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$ x 10^3) for **3j**.

	x	y	z	U(eq)
H(2)	11184	10277	9014	43
H(3)	8880	11033	9749	43
H(4)	6348	8489	9202	34
H(8)	6011	4436	9377	31
H(11)	4006	2830	6802	31
H(15)	5546	8008	6384	28
H(16)	6102	7642	4993	28
H(18)	8634	1377	5695	32
H(19)	7969	1677	7076	34
H(21A)	8655	2654	3505	55
H(21B)	7946	996	4186	55
H(21C)	9743	2366	4484	55



Supplementary Figure 125. Crystallographic data of **3x (CCDC deposition number 2495624)**

Table 1. Crystal data and structure refinement for **3x**.

Empirical formula	C_{23} H_{23} Cl F_4 O_3	
Formula weight	458.86	
Temperature	173(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	$P2_1$	
Unit cell dimensions	a = 8.1082(10) Å	α = 90°
	b = 9.6429(11) Å	β = 92.047(3)°
	c = 28.474(3) Å	γ = 90°
Volume	2224.9(5) $Å^3$	
Z	4	
Density (calculated)	1.370 Mg/m^3	
Absorption coefficient	0.227 mm^{-1}	
F(000)	952	
Crystal size	0.157 x 0.052 x 0.037 mm^3	

Theta range for data collection	2.514 to 27.086°.
Index ranges	–10<=h<=8, –12<=k<=12, –34<=l<=36
Reflections collected	25822
Independent reflections	9494 [R(int) = 0.1102]
Completeness to theta = 25.242°	99.6 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.7455 and 0.6654
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	9494 / 1 / 567
Goodness-of-fit on F^2	1.088
Final R indices [I>2sigma(I)]	R1 = 0.0638, wR2 = 0.1494
R indices (all data)	R1 = 0.0963, wR2 = 0.1605
Absolute structure parameter	0.17(4)
Largest diff. peak and hole	0.420 and –0.323 e·$Å^{-3}$

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$ x 10^3) for **3x**. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Cl(1)	2560(3)	1877(2)	-1441(1)	76(1)
C(1)	5877(8)	1485(5)	-380(2)	37(1)
C(2)	4780(8)	1185(5)	-745(2)	43(1)
C(3)	3971(8)	2270(6)	-985(2)	44(1)
C(4)	4281(8)	3630(6)	-863(2)	42(1)
C(5)	5403(7)	3906(5)	-500(2)	38(1)
C(6)	6212(7)	2851(5)	-249(2)	32(1)
C(7)	7282(7)	3191(5)	173(2)	34(1)
C(8)	8641(7)	3990(6)	131(2)	39(1)
C(9)	9288(8)	4290(6)	-348(2)	47(1)
F(10)	8826(6)	5612(4)	-496(2)	65(1)
F(11)	10978(5)	4321(5)	-329(2)	67(1)
C(12)	9561(8)	4602(6)	543(2)	45(1)
F(13)	11019(5)	3919(5)	651(2)	58(1)
F(14)	10020(5)	5938(4)	442(2)	61(1)
C(15)	7092(6)	1929(5)	1431(2)	32(1)
C(16)	7693(6)	2310(5)	1004(2)	32(1)
C(17)	6653(6)	2695(5)	629(2)	30(1)
C(18)	4938(6)	2652(5)	689(2)	30(1)
C(19)	4306(6)	2267(5)	1116(2)	29(1)
C(20)	5390(6)	1923(5)	1492(2)	27(1)
O(21)	4939(4)	1555(4)	1936(1)	33(1)
C(22)	3256(6)	1206(5)	2035(2)	32(1)
C(23)	3334(8)	885(7)	2561(2)	45(1)
C(24)	2661(7)	-61(6)	1755(2)	40(1)
C(25)	2080(7)	2424(6)	1963(2)	36(1)
O(26)	650(5)	2281(5)	1862(2)	68(2)
O(27)	2802(5)	3642(4)	2060(2)	43(1)
C(28)	1778(8)	4908(6)	2023(2)	48(1)
C(29)	2514(13)	5832(8)	1662(3)	71(2)
C(30)	1740(11)	5533(9)	2503(3)	69(2)
Cl(31)	-1743(3)	7828(3)	6456(1)	76(1)
C(31)	1274(8)	8016(6)	5386(2)	41(1)
C(32)	373(9)	8377(6)	5769(2)	46(1)
C(33)	-596(8)	7368(6)	5973(2)	42(1)

C(34)	-657(8)	6030(6)	5808(2)	47(1)
C(35)	306(8)	5686(6)	5433(2)	40(1)
C(36)	1254(7)	6675(5)	5214(2)	33(1)
C(37)	2209(7)	6287(5)	4797(2)	33(1)
C(38)	3505(7)	5422(6)	4846(2)	39(1)
C(39)	4165(8)	5004(7)	5327(2)	46(1)
F(40)	3603(6)	3743(5)	5462(2)	67(1)
F(41)	5861(5)	4900(5)	5331(2)	60(1)
C(42)	4330(8)	4792(7)	4440(2)	46(1)
F(43)	4699(6)	3418(4)	4525(2)	62(1)
F(44)	5829(5)	5418(5)	4361(2)	56(1)
C(45)	2026(6)	7799(5)	3566(2)	31(1)
C(46)	2651(6)	7294(6)	3992(2)	35(1)
C(47)	1590(6)	6863(5)	4342(2)	32(1)
C(48)	-110(6)	6991(5)	4251(2)	33(1)
C(49)	-766(6)	7478(5)	3823(2)	33(1)
C(50)	322(6)	7902(5)	3477(2)	30(1)
O(51)	-125(5)	8409(4)	3045(1)	35(1)
C(52)	-1788(6)	8849(6)	2932(2)	34(1)
C(53)	-2334(8)	10024(6)	3248(2)	46(1)
C(54)	-1717(8)	9367(7)	2425(2)	44(1)
C(55)	-3018(7)	7658(6)	2922(2)	38(1)
O(56)	-4483(6)	7812(6)	2963(2)	66(2)
O(57)	-2323(5)	6442(4)	2827(1)	39(1)
C(58)	-3416(8)	5226(7)	2779(2)	46(1)
C(59)	-2609(12)	4176(8)	2492(3)	75(3)
C(60)	-3882(16)	4746(9)	3243(3)	91(4)

Table 3. Bond lengths [Å] and angles [°] for **3x**.

Cl(1)-C(3)	1.741(6)
C(1)-C(2)	1.374(9)
C(1)-C(6)	1.393(7)
C(1)-H(1)	0.9500
C(2)-C(3)	1.399(8)
C(2)-H(2)	0.9500
C(3)-C(4)	1.378(9)
C(4)-C(5)	1.379(9)
C(4)-H(4)	0.9500
C(5)-C(6)	1.393(7)
C(5)-H(5)	0.9500
C(6)-C(7)	1.493(8)
C(7)-C(8)	1.354(8)
C(7)-C(17)	1.490(6)
C(8)-C(12)	1.488(9)
C(8)-C(9)	1.509(8)
C(9)-F(11)	1.370(8)
C(9)-F(10)	1.389(7)
C(9)-H(9)	1.0000
C(12)-F(14)	1.374(7)
C(12)-F(13)	1.378(8)
C(12)-H(12)	1.0000
C(15)-C(16)	1.374(7)
C(15)-C(20)	1.398(7)
C(15)-H(15)	0.9500
C(16)-C(17)	1.389(7)
C(16)-H(16)	0.9500
C(17)-C(18)	1.408(7)
C(18)-C(19)	1.388(7)
C(18)-H(18)	0.9500
C(19)-C(20)	1.401(7)
C(19)-H(19)	0.9500
C(20)-O(21)	1.373(6)
O(21)-C(22)	1.443(6)
C(22)-C(25)	1.522(7)
C(22)-C(24)	1.528(7)
C(22)-C(23)	1.530(7)
C(23)-H(23A)	0.9800

C(23)-H(23B)	0.9800
C(23)-H(23C)	0.9800
C(24)-H(24A)	0.9800
C(24)-H(24B)	0.9800
C(24)-H(24C)	0.9800
C(25)-O(26)	1.193(7)
C(25)-O(27)	1.336(7)
O(27)-C(28)	1.478(7)
C(28)-C(30)	1.495(10)
C(28)-C(29)	1.501(10)
C(28)-H(28)	1.0000
C(29)-H(29A)	0.9800
C(29)-H(29B)	0.9800
C(29)-H(29C)	0.9800
C(30)-H(30A)	0.9800
C(30)-H(30B)	0.9800
C(30)-H(30C)	0.9800
Cl(31)-C(33)	1.744(6)
C(31)-C(32)	1.379(8)
C(31)-C(36)	1.382(7)
C(31)-H(31)	0.9500
C(32)-C(33)	1.392(9)
C(32)-H(32)	0.9500
C(33)-C(34)	1.374(9)
C(34)-C(35)	1.386(9)
C(34)-H(34)	0.9500
C(35)-C(36)	1.386(7)
C(35)-H(35)	0.9500
C(36)-C(37)	1.490(7)
C(37)-C(38)	1.345(8)
C(37)-C(47)	1.481(7)
C(38)-C(42)	1.487(8)
C(38)-C(39)	1.507(8)
C(39)-F(40)	1.359(8)
C(39)-F(41)	1.379(7)
C(39)-H(39)	1.0000
C(42)-F(43)	1.378(7)
C(42)-F(44)	1.383(8)
C(42)-H(42)	1.0000
C(45)-C(46)	1.387(8)

C(45)-C(50)	1.400(7)
C(45)-H(45)	0.9500
C(46)-C(47)	1.400(7)
C(46)-H(46)	0.9500
C(47)-C(48)	1.399(7)
C(48)-C(49)	1.394(7)
C(48)-H(48)	0.9500
C(49)-C(50)	1.407(7)
C(49)-H(49)	0.9500
C(50)-O(51)	1.360(6)
O(51)-C(52)	1.439(6)
C(52)-C(55)	1.521(7)
C(52)-C(53)	1.523(8)
C(52)-C(54)	1.530(7)
C(53)-H(53A)	0.9800
C(53)-H(53B)	0.9800
C(53)-H(53C)	0.9800
C(54)-H(54A)	0.9800
C(54)-H(54B)	0.9800
C(54)-H(54C)	0.9800
C(55)-O(56)	1.207(7)
C(55)-O(57)	1.333(7)
O(57)-C(58)	1.473(7)
C(58)-C(60)	1.462(10)
C(58)-C(59)	1.469(10)
C(58)-H(58)	1.0000
C(59)-H(59A)	0.9800
C(59)-H(59B)	0.9800
C(59)-H(59C)	0.9800
C(60)-H(60A)	0.9800
C(60)-H(60B)	0.9800
C(60)-H(60C)	0.9800

C(2)-C(1)-C(6)	121.1(5)
C(2)-C(1)-H(1)	119.5
C(6)-C(1)-H(1)	119.5
C(1)-C(2)-C(3)	119.4(5)
C(1)-C(2)-H(2)	120.3
C(3)-C(2)-H(2)	120.3
C(4)-C(3)-C(2)	120.7(6)

C(4)-C(3)-Cl(1)	120.3(5)
C(2)-C(3)-Cl(1)	119.0(5)
C(3)-C(4)-C(5)	118.8(5)
C(3)-C(4)-H(4)	120.6
C(5)-C(4)-H(4)	120.6
C(4)-C(5)-C(6)	121.9(5)
C(4)-C(5)-H(5)	119.0
C(6)-C(5)-H(5)	119.0
C(1)-C(6)-C(5)	118.0(5)
C(1)-C(6)-C(7)	121.7(4)
C(5)-C(6)-C(7)	120.1(5)
C(8)-C(7)-C(17)	124.3(5)
C(8)-C(7)-C(6)	120.4(5)
C(17)-C(7)-C(6)	115.1(4)
C(7)-C(8)-C(12)	123.0(5)
C(7)-C(8)-C(9)	119.9(6)
C(12)-C(8)-C(9)	117.1(5)
F(11)-C(9)-F(10)	104.5(5)
F(11)-C(9)-C(8)	110.3(6)
F(10)-C(9)-C(8)	110.6(5)
F(11)-C(9)-H(9)	110.4
F(10)-C(9)-H(9)	110.4
C(8)-C(9)-H(9)	110.4
F(14)-C(12)-F(13)	105.0(5)
F(14)-C(12)-C(8)	109.8(5)
F(13)-C(12)-C(8)	112.8(5)
F(14)-C(12)-H(12)	109.7
F(13)-C(12)-H(12)	109.7
C(8)-C(12)-H(12)	109.7
C(16)-C(15)-C(20)	119.7(5)
C(16)-C(15)-H(15)	120.2
C(20)-C(15)-H(15)	120.2
C(15)-C(16)-C(17)	121.8(5)
C(15)-C(16)-H(16)	119.1
C(17)-C(16)-H(16)	119.1
C(16)-C(17)-C(18)	118.3(4)
C(16)-C(17)-C(7)	122.7(5)
C(18)-C(17)-C(7)	119.1(5)
C(19)-C(18)-C(17)	120.8(5)
C(19)-C(18)-H(18)	119.6

C(17)-C(18)-H(18)	119.6
C(18)-C(19)-C(20)	119.5(4)
C(18)-C(19)-H(19)	120.2
C(20)-C(19)-H(19)	120.2
O(21)-C(20)-C(15)	114.4(4)
O(21)-C(20)-C(19)	125.7(4)
C(15)-C(20)-C(19)	119.9(4)
C(20)-O(21)-C(22)	121.7(4)
O(21)-C(22)-C(25)	112.7(4)
O(21)-C(22)-C(24)	111.6(4)
C(25)-C(22)-C(24)	111.2(5)
O(21)-C(22)-C(23)	103.5(4)
C(25)-C(22)-C(23)	106.9(4)
C(24)-C(22)-C(23)	110.5(5)
C(22)-C(23)-H(23A)	109.5
C(22)-C(23)-H(23B)	109.5
H(23A)-C(23)-H(23B)	109.5
C(22)-C(23)-H(23C)	109.5
H(23A)-C(23)-H(23C)	109.5
H(23B)-C(23)-H(23C)	109.5
C(22)-C(24)-H(24A)	109.5
C(22)-C(24)-H(24B)	109.5
H(24A)-C(24)-H(24B)	109.5
C(22)-C(24)-H(24C)	109.5
H(24A)-C(24)-H(24C)	109.5
H(24B)-C(24)-H(24C)	109.5
O(26)-C(25)-O(27)	124.5(5)
O(26)-C(25)-C(22)	122.8(5)
O(27)-C(25)-C(22)	112.5(4)
C(25)-O(27)-C(28)	118.1(5)
O(27)-C(28)-C(30)	107.4(6)
O(27)-C(28)-C(29)	107.6(5)
C(30)-C(28)-C(29)	114.2(7)
O(27)-C(28)-H(28)	109.2
C(30)-C(28)-H(28)	109.2
C(29)-C(28)-H(28)	109.2
C(28)-C(29)-H(29A)	109.5
C(28)-C(29)-H(29B)	109.5
H(29A)-C(29)-H(29B)	109.5
C(28)-C(29)-H(29C)	109.5

H(29A)-C(29)-H(29C)	109.5
H(29B)-C(29)-H(29C)	109.5
C(28)-C(30)-H(30A)	109.5
C(28)-C(30)-H(30B)	109.5
H(30A)-C(30)-H(30B)	109.5
C(28)-C(30)-H(30C)	109.5
H(30A)-C(30)-H(30C)	109.5
H(30B)-C(30)-H(30C)	109.5
C(32)-C(31)-C(36)	121.1(5)
C(32)-C(31)-H(31)	119.5
C(36)-C(31)-H(31)	119.5
C(31)-C(32)-C(33)	118.5(6)
C(31)-C(32)-H(32)	120.8
C(33)-C(32)-H(32)	120.8
C(34)-C(33)-C(32)	121.9(5)
C(34)-C(33)-Cl(31)	119.7(5)
C(32)-C(33)-Cl(31)	118.5(5)
C(33)-C(34)-C(35)	118.3(5)
C(33)-C(34)-H(34)	120.9
C(35)-C(34)-H(34)	120.9
C(34)-C(35)-C(36)	121.2(5)
C(34)-C(35)-H(35)	119.4
C(36)-C(35)-H(35)	119.4
C(31)-C(36)-C(35)	119.0(5)
C(31)-C(36)-C(37)	121.1(5)
C(35)-C(36)-C(37)	119.9(5)
C(38)-C(37)-C(47)	124.3(5)
C(38)-C(37)-C(36)	119.9(5)
C(47)-C(37)-C(36)	115.8(4)
C(37)-C(38)-C(42)	122.9(5)
C(37)-C(38)-C(39)	120.8(5)
C(42)-C(38)-C(39)	116.3(5)
F(40)-C(39)-F(41)	106.1(5)
F(40)-C(39)-C(38)	112.6(6)
F(41)-C(39)-C(38)	110.4(5)
F(40)-C(39)-H(39)	109.2
F(41)-C(39)-H(39)	109.2
C(38)-C(39)-H(39)	109.2
F(43)-C(42)-F(44)	105.2(5)
F(43)-C(42)-C(38)	111.0(5)

F(44)-C(42)-C(38)	111.8(6)
F(43)-C(42)-H(42)	109.6
F(44)-C(42)-H(42)	109.6
C(38)-C(42)-H(42)	109.6
C(46)-C(45)-C(50)	120.7(5)
C(46)-C(45)-H(45)	119.7
C(50)-C(45)-H(45)	119.7
C(45)-C(46)-C(47)	120.7(5)
C(45)-C(46)-H(46)	119.6
C(47)-C(46)-H(46)	119.6
C(48)-C(47)-C(46)	118.0(5)
C(48)-C(47)-C(37)	119.6(5)
C(46)-C(47)-C(37)	122.3(5)
C(49)-C(48)-C(47)	122.2(5)
C(49)-C(48)-H(48)	118.9
C(47)-C(48)-H(48)	118.9
C(48)-C(49)-C(50)	118.8(5)
C(48)-C(49)-H(49)	120.6
C(50)-C(49)-H(49)	120.6
O(51)-C(50)-C(45)	114.7(4)
O(51)-C(50)-C(49)	125.8(5)
C(45)-C(50)-C(49)	119.5(5)
C(50)-O(51)-C(52)	121.7(4)
O(51)-C(52)-C(55)	113.0(4)
O(51)-C(52)-C(53)	112.1(4)
C(55)-C(52)-C(53)	111.7(5)
O(51)-C(52)-C(54)	104.0(4)
C(55)-C(52)-C(54)	106.0(5)
C(53)-C(52)-C(54)	109.6(5)
C(52)-C(53)-H(53A)	109.5
C(52)-C(53)-H(53B)	109.5
H(53A)-C(53)-H(53B)	109.5
C(52)-C(53)-H(53C)	109.5
H(53A)-C(53)-H(53C)	109.5
H(53B)-C(53)-H(53C)	109.5
C(52)-C(54)-H(54A)	109.5
C(52)-C(54)-H(54B)	109.5
H(54A)-C(54)-H(54B)	109.5
C(52)-C(54)-H(54C)	109.5
H(54A)-C(54)-H(54C)	109.5

H(54B)-C(54)-H(54C)	109.5
O(56)-C(55)-O(57)	123.6(6)
O(56)-C(55)-C(52)	123.5(5)
O(57)-C(55)-C(52)	112.7(4)
C(55)-O(57)-C(58)	117.5(4)
C(60)-C(58)-C(59)	114.7(7)
C(60)-C(58)-O(57)	110.1(6)
C(59)-C(58)-O(57)	108.8(5)
C(60)-C(58)-H(58)	107.7
C(59)-C(58)-H(58)	107.7
O(57)-C(58)-H(58)	107.7
C(58)-C(59)-H(59A)	109.5
C(58)-C(59)-H(59B)	109.5
H(59A)-C(59)-H(59B)	109.5
C(58)-C(59)-H(59C)	109.5
H(59A)-C(59)-H(59C)	109.5
H(59B)-C(59)-H(59C)	109.5
C(58)-C(60)-H(60A)	109.5
C(58)-C(60)-H(60B)	109.5
H(60A)-C(60)-H(60B)	109.5
C(58)-C(60)-H(60C)	109.5
H(60A)-C(60)-H(60C)	109.5
H(60B)-C(60)-H(60C)	109.5

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2$ x 10^3) for **3x**. The anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U^{11} + ... + 2 h k a^* b^* U^{12}]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Cl(1)	90(2)	73(1)	63(1)	21(1)	-31(1)	-19(1)
C(1)	52(3)	25(2)	35(2)	8(2)	4(2)	5(2)
C(2)	55(4)	26(2)	48(3)	6(2)	-3(3)	-3(2)
C(3)	53(3)	40(3)	38(3)	11(2)	-1(2)	-3(3)
C(4)	46(3)	33(3)	47(3)	13(2)	7(2)	4(2)
C(5)	41(3)	25(2)	49(3)	7(2)	8(2)	3(2)
C(6)	37(3)	25(2)	36(2)	7(2)	12(2)	7(2)
C(7)	39(3)	24(2)	38(2)	3(2)	8(2)	1(2)
C(8)	37(3)	31(2)	49(3)	6(2)	11(2)	0(2)
C(9)	44(3)	40(3)	59(4)	13(3)	14(3)	1(2)
F(10)	70(3)	53(2)	71(3)	28(2)	11(2)	-9(2)
F(11)	39(2)	84(3)	79(3)	15(2)	21(2)	-5(2)
C(12)	37(3)	35(3)	63(4)	2(3)	9(3)	-5(2)
F(13)	38(2)	59(2)	77(3)	7(2)	-4(2)	-2(2)
F(14)	57(2)	40(2)	87(3)	6(2)	3(2)	-19(2)
C(15)	32(2)	27(2)	37(2)	-5(2)	4(2)	0(2)
C(16)	32(2)	28(2)	35(2)	-4(2)	6(2)	-2(2)
C(17)	28(2)	22(2)	38(2)	-2(2)	10(2)	0(2)
C(18)	34(3)	20(2)	36(2)	-1(2)	1(2)	-1(2)
C(19)	24(2)	26(2)	36(2)	-3(2)	2(2)	1(2)
C(20)	29(2)	23(2)	29(2)	-4(2)	4(2)	-1(2)
O(21)	26(2)	39(2)	32(2)	0(1)	3(1)	-1(1)
C(22)	27(2)	38(2)	31(2)	-2(2)	8(2)	-3(2)
C(23)	40(3)	59(3)	36(3)	5(3)	8(2)	-2(3)
C(24)	39(3)	38(3)	42(3)	-1(2)	5(2)	-7(2)
C(25)	30(3)	39(3)	38(3)	-2(2)	3(2)	-4(2)
O(26)	26(2)	42(2)	134(5)	-9(3)	-17(2)	1(2)
O(27)	31(2)	29(2)	68(3)	-9(2)	-2(2)	-2(2)
C(28)	40(3)	41(3)	63(4)	-10(3)	3(3)	11(3)
C(29)	98(7)	46(4)	70(5)	9(4)	10(5)	14(4)
C(30)	59(5)	79(5)	69(5)	-20(4)	3(4)	16(4)
Cl(31)	91(2)	88(1)	51(1)	16(1)	33(1)	30(1)
C(31)	50(3)	30(2)	43(3)	5(2)	2(2)	-5(2)
C(32)	61(4)	37(3)	41(3)	2(2)	9(3)	6(3)
C(33)	46(3)	43(3)	39(3)	10(2)	10(2)	15(2)

C(34)	47(3)	44(3)	50(3)	15(3)	11(3)	1(3)
C(35)	45(3)	28(2)	46(3)	5(2)	4(2)	-3(2)
C(36)	34(3)	31(2)	34(2)	3(2)	-6(2)	-1(2)
C(37)	32(2)	34(2)	33(2)	2(2)	-4(2)	-1(2)
C(38)	35(3)	41(3)	42(3)	1(2)	2(2)	2(2)
C(39)	35(3)	49(3)	54(3)	9(3)	-1(3)	13(2)
F(40)	63(3)	62(3)	76(3)	30(2)	1(2)	6(2)
F(41)	37(2)	81(3)	60(2)	11(2)	-7(2)	14(2)
C(42)	43(3)	46(3)	50(3)	1(3)	3(3)	15(3)
F(43)	63(3)	43(2)	82(3)	-2(2)	4(2)	23(2)
F(44)	42(2)	65(2)	62(2)	3(2)	11(2)	14(2)
C(45)	28(2)	33(2)	33(2)	-2(2)	2(2)	-2(2)
C(46)	27(2)	36(2)	42(3)	-4(2)	3(2)	4(2)
C(47)	32(2)	26(2)	36(2)	-4(2)	-1(2)	3(2)
C(48)	33(3)	30(2)	35(2)	-3(2)	4(2)	1(2)
C(49)	29(2)	38(3)	32(2)	-5(2)	2(2)	0(2)
C(50)	32(2)	26(2)	32(2)	-3(2)	-1(2)	1(2)
O(51)	29(2)	43(2)	32(2)	2(2)	2(1)	3(2)
C(52)	24(2)	39(3)	37(3)	0(2)	-1(2)	2(2)
C(53)	44(3)	40(3)	52(3)	-5(3)	-4(3)	5(2)
C(54)	41(3)	56(3)	35(3)	7(2)	-8(2)	-6(3)
C(55)	29(3)	40(3)	46(3)	2(2)	4(2)	-1(2)
O(56)	29(2)	57(3)	113(4)	-3(3)	18(2)	6(2)
O(57)	29(2)	38(2)	49(2)	-7(2)	3(2)	-2(2)
C(58)	34(3)	46(3)	57(3)	-7(3)	9(2)	-13(2)
C(59)	79(6)	59(4)	87(6)	-28(4)	27(5)	-26(4)
C(60)	150(11)	60(5)	65(5)	-7(4)	26(6)	-39(6)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$ x 10^3) for **3x**.

	x	y	z	U(eq)
H(1)	6416	749	-215	45
H(2)	4573	250	-834	52
H(4)	3731	4365	-1026	50
H(5)	5631	4844	-418	46
H(9)	8878	3580	-580	57
H(12)	8847	4600	822	54
H(15)	7830	1672	1682	38
H(16)	8852	2310	965	38
H(18)	4204	2888	434	36
H(19)	3147	2238	1154	34
H(23A)	2218	712	2669	67
H(23B)	3816	1677	2733	67
H(23C)	4020	62	2620	67
H(24A)	1591	-363	1868	60
H(24B)	3465	-813	1796	60
H(24C)	2544	182	1421	60
H(28)	631	4649	1917	57
H(29A)	1858	6682	1629	107
H(29B)	2516	5347	1359	107
H(29C)	3649	6069	1761	107
H(30A)	1194	6439	2484	103
H(30B)	2872	5650	2630	103
H(30C)	1130	4921	2710	103
H(31)	1919	8699	5237	49
H(32)	414	9295	5890	55
H(34)	-1342	5357	5947	56
H(35)	317	4756	5323	48
H(39)	3843	5718	5562	55
H(42)	3594	4870	4152	56
H(45)	2763	8077	3332	38
H(46)	3811	7241	4049	42
H(48)	-842	6738	4490	39
H(49)	-1926	7523	3766	40
H(53A)	-3450	10319	3150	68
H(53B)	-1572	10808	3223	68

H(53C)	-2329	9702	3574	68
H(54A)	-2835	9589	2306	66
H(54B)	-1244	8644	2229	66
H(54C)	-1028	10201	2416	66
H(58)	-4445	5527	2604	55
H(59A)	-3299	3342	2472	112
H(59B)	-1531	3941	2637	112
H(59C)	-2459	4544	2176	112
H(60A)	-4808	4096	3208	136
H(60B)	-4210	5541	3432	136
H(60C)	-2940	4278	3399	136