*Supplementary Information for*

# Atroposelective Brominations to Access Chiral Biaryl Scaffolds Using High-Valent Pd-Catalysis

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## 1. General Methods

NMR spectra were acquired on a Bruker AVANCE III HD spectrometer operating at 400 MHz for $^{1}H$, 100 MHz for $^{13}C$, 377 MHz for $^{19}F$, and 162 MHz for $^{31}P$. Chemical shifts (δ) are reported in ppm relative to residual solvent signals ($CHCl_3$, 7.26 ppm for $^{1}H$ NMR and $CDCl_3$, 77.16 ppm for $^{13}C$ NMR; $CH_2Cl_2$, 5.32 ppm for $^{1}H$ NMR and $CD_2Cl_2$, 53.84 ppm for $^{13}C$. Chemical shifts (δ) for $^{19}F$ and $^{31}P$ NMR were collected in broad band proton decoupled mode, unless otherwise noted, and are reported in ppm. The following abbreviations are used to indicate the multiplicity in NMR spectra: s, singlet; d, doublet; t, triplet; q, quartet; p, pentet; hept, heptet; dd, double doublet; ddd, double double doublet; dt, double triplet; td, triple doublet; m, multiplet. $^{13}C$ NMR spectra were acquired in a broad band decoupled mode unless otherwise noted. Mass spectra were recorded on a Bruker MicroTOF-Q High-Performance LC-MS system using electrospray ($ES^+$) ionization. Thin layer chromatography (TLC) was performed using pre-coated aluminium-backed plates (Merck Kieselgel 60 $F_{254}$) and visualized by UV radiation, or $KMnO_4$ stain. For flash chromatography (FC) Sigma-Aldrich®Silica gel high-purity grade (9385) ($SiO_2$60, 230-400 mesh) were used. Optical rotations were measured on a Bellingham + Stanley ADP440+ polarimeter, [α] values are given in $deg \cdot cm^3 \cdot g^{-1} \cdot dm^{-1}$; concentration c in $g \cdot (100\ mL)^{-1}$. The enantiomeric excess (*ee*) of the products was determined by chiral stationary phase Waters ACQUITY $UPC^2$ (Daicel Chiralpak). Racemic samples for $UPC^2$ analysis were prepared using ± *tert*-butylglycine (Fluorochem) as TDG. Absolute configuration was determined using single crystal X-ray crystallography of **3c** and assigned in analogy. The analyzed single crystal was resubjected to $UPC^2$ conditions to verify correct assignment of major and minor enantiomers. Regioselectivity in the tandem reaction was determined using single crystal X-ray crystallography of **6p**.

## 2. Preparation of Starting Materials

### 2.1 Synthesis of aldehydes

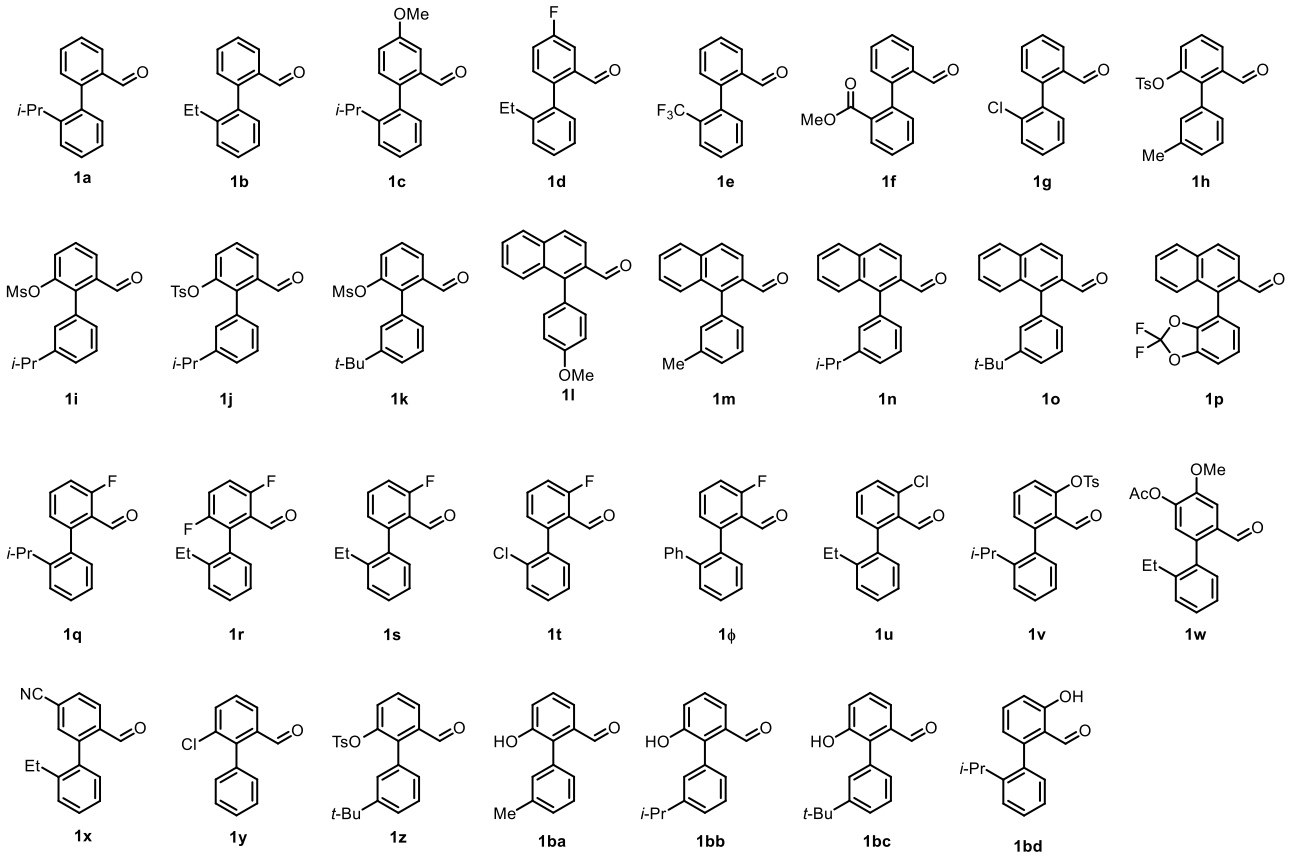



***Figure S1.*** *Overview of aldehydes used in manuscript.*

The aldehydes were prepared according to known literature procedures and were stored at 5 °C.

| Aldehyde | Characterization | Preparation Method |
|---|---|---|
| **1a** | Ref [1] | Procedure 1 |
| **1b** | See below | Procedure 1 |
| **1c** | See below | Procedure 1 |
| **1d** | See below | Procedure 1 |
| **1e** | Commercially available | Procedure 1 |
| **1f** | Ref [1] | Procedure 2 |
| **1g** | See below | Procedure 1 |
| **1h** | See below | Procedure 4 |
| **1i** | See below | Procedure 4 |
| **1j** | See below | Procedure 4 |

[1] Q.-J. Yao, S. Zhang, B.-B. Zhan, B.-F. Shi, *Angew. Chem. Int. Ed.* 2017, **56**, 6617-6621.

| | | |
|---|---|---|
| **1k** | See below | Procedure 4 |
| **1l** | Ref [1] | Procedure 1 |
| **1m** | See below | Procedure 1 |
| **1n** | See below | Procedure 1 |
| **1o** | See below | Procedure 1 |
| **1p** | See below | Procedure 1 |
| **1q** | See below | Procedure 1 |
| **1r** | See below | Procedure 1 |
| **1s** | See below | Procedure 1 |
| **1t** | See below | Procedure 1 |
| **1ϕ** | See below | Procedure 1 |
| **1u** | See below | Procedure 3 |
| **1v** | See below | Procedure 4 |
| **1w** | See below | Procedure 1 |
| **1x** | See below | Procedure 2 |
| **1y** | See below | Procedure 1 |
| **1z** | See below | Procedure 4 |
| **1ba** | See below | Procedure 1 |
| **1bb** | See below | Procedure 1 |
| **1bc** | See below | Procedure 1 |
| **1bd** | See below | Procedure 1 |

***Table S1.*** *Characterization and preparation of the aldehydes.*

**Procedure 1**

A round bottom flask was charged with arylbromide (4 mmol, 1 equiv), boronic acid (4.4 mmol, 1.1 equiv), $Pd(PPh_3)_4$ (0.12 mmol, 3 mol%), magnetic stir bar, and $Na_2CO_3$ (8 mmol, 2 equiv). Then $H_2O$ (5 mL), MeOH (4 mL), and DME (10 mL) was added, and the flask was capped with a septum. The resulting solution was sparged with Ar (30-60 sec.) and a balloon of Ar was placed on top. The reaction mixture was stirred at 80 °C overnight. After cooling to rt, the mixture was quenched with $H_2O$ (20 mL) and extracted with $CH_2Cl_2$ (3 x 20 mL). The combined organic layers were dried over $Na_2SO_4$, filtered, concentrated, and the residue was purified by silica gel column chromatography.[1]

**Procedure 2**

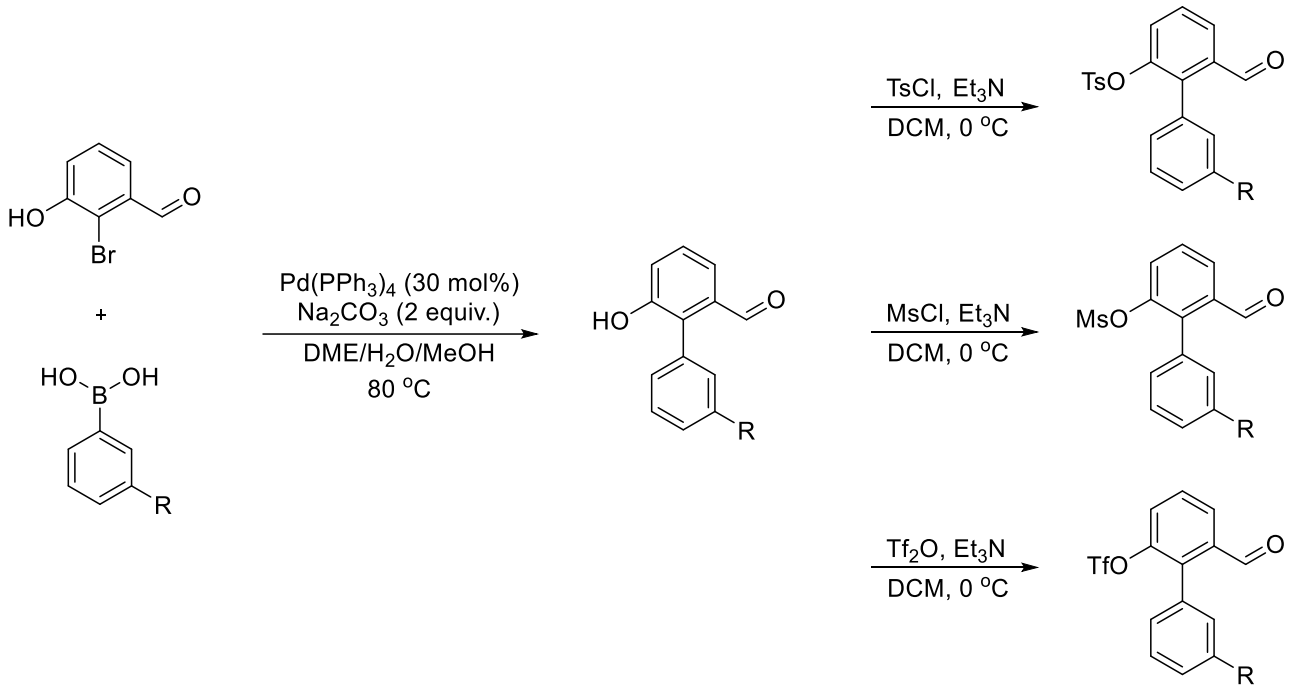
A round bottom flask was charged with arylbromide (1.8 mmol, 1.1 equiv), boronic acid (2.0 mmol, 1.2 equiv), $Pd(PPh_3)_4$ (0.08 mmol, 5 mol%), KF (5 mmol, 3 equiv), magnetic stir bar, and solvent (10:1, 1,4-dioxane to $H_2O$, 5 mL). The resulting solution was sparged with Ar (30-60 sec.) and a balloon of Ar was placed on top. The reaction mixture was stirred at 100 °C overnight. After cooling to rt, the mixture was quenched with $H_2O$ (20 mL), diluted, and extracted with EtOAc (3 x 10 mL). The combined organic layers were dried over $Na_2SO_4$, filtered, concentrated, and the residue was purified by FC.[2]

[2] X. Yao, Y. Shao, M. Hu, M. Zhang, S. Li, Y. Xia, T. Cheng, J. Chen, *Adv. Synth. Catal.* 2019, **361***,* 4707-4713.

**Procedure 3: *ortho*-Chlorination of aldehyde to form 1u**

To an 8-mL vial, equipped with a stir bar, was added the aldehyde (0.10 mmol, 1 equiv), TDG (0.030 mmol, 0.3 equiv), $Pd(OAc)_2$ (0.010 mmol, 0.1 equiv), NCS (0.11, mmol, 1.1 equiv), $Ag_2CO_3$ (0.010 mmol, 0.1 equiv), DCE (1 mL) and TFA (1.0 mmol, 10 equiv). The vial was purged with Ar, capped and heated at 60 °C overnight. Upon completion of the reaction, the resulting solution was directly loaded onto a column and purified by FC using the described stationery and eluent system.

**Procedure 4: Procedure to form 1h, 1i, 1j, 1k, 1w, 1z.**



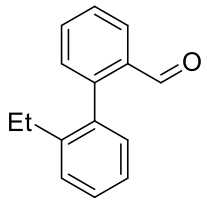

***Scheme S1.*** *Overview of Procedure 4*

The desired compounds are formed in a two-step-sequence. First the corresponding phenol is formed employing Procedure 1. The formed phenol compound (0.55 mmol, 1 equiv) was dissolved in $CH_2Cl_2$ (0.8 mL), and $Et_3N$ (1.54 mmol, 2.8 equiv) was added and stirred for 10 min. After cooling to 0 °C, either TsCl (0.55 mmol, 1 equiv), MsCl (0.55 mmol, 1 equiv), or $Tf_2O$ (0.80 mmol, 1.45 equiv) was added dropwise over 20 min. After the addition was complete, the mixture was allowed to warm to rt and stirred overnight. The resulting solution was diluted with $CH_2Cl_2$, washed with water three times. The organic phase dried over $Na_2SO_4$, filtered, concentrated, and the residue was purified by FC.[3]

[3] H.-Y. Chen, M.-Y. Liu, A. K. Sutar, C.-C. Lin, *Inorg. Chem.* 2010, **49**, 665-674.

## 2.2 Characterization of aldehydes

**2'-Ethyl-[1,1'-biphenyl]-2-carbaldehyde (1b).**



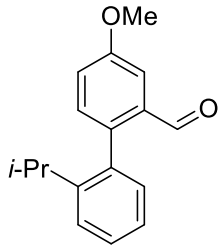

The title compound was prepared employing Procedure 1 and isolated by FC pentane/$CH_2Cl_2$ 1:1 as an eluent to afford the title compound as a colorless oil (447.6 mg, 2.129 mmol, 71% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.73 (d, *J* = 0.8 Hz, 1H), 7.99 (ddd, *J* = 7.8, 1.5, 0.5 Hz, 1H), 7.65 (td, *J* = 7.5, 1.5 Hz, 1H), 7.55 – 7.49 (m, 1H), 7.41 – 7.32 (m, 3H), 7.26 (td, *J* = 7.1, 1.9 Hz, 1H), 7.18 – 7.15 (m, 1H), 2.51 – 2.35 (m, 2H), 1.01 (t, *J* = 7.5 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (101 MHz, $CD_2Cl_2$) δ 192.4, 145.8, 142.8, 137.4, 134.4, 133.9, 131.5, 130.7, 128.8, 128.8, 128.2, 127.3, 125.8, 26.8, 15.3.

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{15}O^+$ $[M+H]^+$: 211.1118; found: 211.1115.

**2'-*iso*-Propyl-4-methoxy-[1,1'-biphenyl]-2-carbaldehyde (1c).**



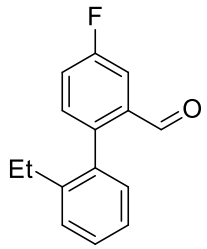

The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a white, amorphous solid (263 mg, 1.034 mmol, 94% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.71 (s, 1H), 7.51 (d, *J* = 2.7 Hz, 1H), 7.41 – 7.38 (m, 2H), 7.25 – 7.16 (m, 3H), 7.13 – 7.10 (m, 1H), 3.91 (s, 3H), 2.76 (hept, *J* = 6.9 Hz, 1H), 1.11 (d, *J* = 6.9 Hz, 3H), 1.07 (s, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 192.2, 159.2, 147.6, 138.7, 136.0, 135.0, 132.3, 130.9, 128.7, 125.7, 125.4, 121.4, 109.3, 55.6, 30.1, 24.5, 23.5.

**HRMS (ESI$^+$)** m/z calcd. for $C_{17}H_{18}O_2Na^+$ $[M+Na]^+$: 277.1199; found: 277.1198.

**2'-Ethyl-4-fluoro-[1,1'-biphenyl]-2-carbaldehyde (1d).**




The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a yellow oil (712 mg, 3.12 mmol, 78% yield).

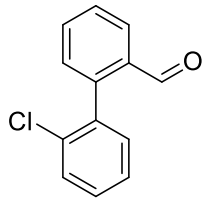
**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.34 (d, *J* = 3.4 Hz, 1H), 7.73 (dt, *J* = 9.0, 1.7 Hz, 1H), 7.46 – 7.37 (m, 4H), 7.30 (td, *J* = 7.0, 2.3 Hz, 1H), 7.22 – 7.18 (m, 1H), 2.57 – 2.40 (m, 2H), 1.07 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 191.1 (d, *J* = 2.9 Hz), 162.6 (d, *J* = 248.2 Hz), 143.0, 141.9 (d, *J* = 3.3 Hz), 136.4, 136.1 (d, *J* = 6.3 Hz) 133.5 (d, *J* = 7.2 Hz), 131.0, 129.2, 129.0, 126.1, 121.0 (d, *J* = 22.1 Hz), 113.3 (d, *J* = 22.2 Hz), 26.8, 15.3.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -113.13

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{13}FONa^+$ $[M+Na]^+$; 251.0843 found: 251.0840.

**2'-Chloro-[1,1'-biphenyl]-2-carbaldehyde (1g).**



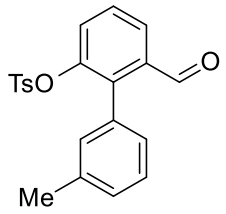

The title compound was prepared employing Procedure 1 and isolated by FC using $CH_2Cl_2$/pentane 1:1 as an eluent to afford the title compound as an orange, amorphous solid (410.9 mg, 1.896 mmol, 95% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.78 (s, 1H), 8.00 (d, *J* = 7.7 Hz, 1H), 7.69 (tt, *J* = 7.5, 1.3 Hz, 1H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.54 – 7.50 (m, 1H), 7.43 – 7.33 (m, 4H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 191.7, 143.0, 137.3, 134.2, 134.1, 133.8, 132.1 131.4, 130.1, 129.9, 128.9, 127.7, 127.3.

**HRMS (ESI$^+$)** m/z calcd. for $C_{13}H_9ClONa^+$ $[M+Na]^+$: 239.0234; found: 239.0240.

**6-Formyl-3'-methyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (1h).**



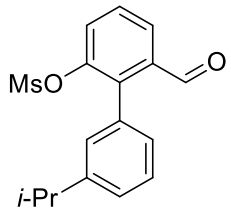

The title compound was prepared employing Procedure 4 and isolated by FC using a $CH_2Cl_2$/pentane gradient going from 1:1 to 3:1 as an eluent to afford the title compound as a colorless oil (370 mg, 1.00 mmol, >99% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.59 (d, *J* = 0.9 Hz, 1H), 7.90 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.74 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.54 (td, *J* = 8.0, 0.9 Hz, 1H), 7.25 – 7.17 (m, 4H), 7.14 – 7.09 (m, 2H), 6.88 – 6.84 (m, 1H), 6.71 – 6.69 (m, 1H), 2.40 (s, 3H), 2.20 (s, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 191.4, 147.5, 145.7, 139.4, 138.1, 136.3, 132.6, 131.9, 131.3, 130.0, 129.3, 129.1, 128.6, 128.4, 128.3, 128.2, 126.2, 21.8, 21.5.

**HRMS (ESI$^+$)** m/z calcd. for $C_{21}H_{19}O_4S^+$ $[M+H]^+$: 367.0999; found: 367.0996.

**6-Formyl-3'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (1i).**



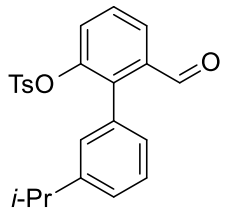

The title compound was prepared employing Procedure 4 and isolated by FC using $CH_2Cl_2$ as an eluent to afford the title compound as a yellow oil (161 mg, 0.56 mmol, 92% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.79 (s, 1H), 8.00 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.69 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.56 (t, *J* = 8.0 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 1H), 7.34 (dt, *J* = 7.8, 1.5 Hz, 1H), 7.28 – 7.26 (m, 1H), 7.21 (dt, *J* = 7.4, 1.5 Hz, 1H), 2.98 (hept, *J* = 6.9 Hz, 1H), 2.50 (s, 3H), 1.28 (d, *J* = 6.9 Hz, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.2, 149.5, 147.1, 139.1, 136.0, 131.5, 129.4, 129.2, 128.8, 128.7, 128.6, 127.2, 126.4, 38.3, 34.2, 24.3 – 24.0 (m, 2C).

**HRMS (ESI$^+$)** m/z calcd. for $C_{17}H_{18}O_4SNa^+$ $[M+Na]^+$: 341.0818; found: 341.0811.

**6-Formyl-3'-*iso*-propyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (1j).**



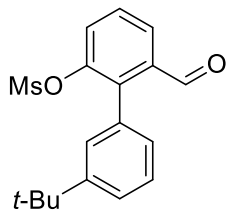

The title compound was prepared employing Procedure 4 and isolated by FC using $CH_2Cl_2$ as an eluent to afford the title compound as a colorless oil (213 mg, 0.54 mmol, 98% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.65 (s, 1H), 7.94 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.75 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.52 (t, *J* = 8.0 Hz, 1H), 7.25 – 7.18 (m, 4H), 7.06 (d, *J* = 8.2 Hz, 2H), 7.02 (t, *J* = 1.7 Hz, 1H), 6.79 (dt, *J* = 7.2, 1.7 Hz, 1H), 2.87 (hept, *J* = 6.9 Hz, 1H), 2.38 (s, 3H), 1.27 – 1.22 (m, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz $CDCl_3$) δ 191.5, 148.8, 147.1, 145.1, 139.5, 136.1, 132.6, 131.0, 129.7, 129.4, 128.9, 128.8, 128.4, 128.1, 128.1, 126.4, 126.2, 34.1, 24.2 – 23.9 (m, 2C), 21.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{23}H_{23}O_4S^+$ $[M+H]^+$: 395.1312; found: 395.1322.

**3'-(*tert*-butyl)-6-formyl-[1,1'-biphenyl]-2-yl methanesulfonate (1k).**



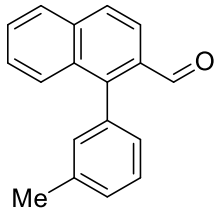

The title compound was prepared employing Procedure 4 and isolated by FC using $CH_2Cl_2$ as an eluent to afford the title compound as a colorless oil (173.7 mg, 0.42 mmol, 77% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.79 (d, *J* = 0.8 Hz, 1H), 8.00 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.69 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.56 (td, *J* = 7.9, 0.9 Hz, 1H), 7.51 (ddd, *J* = 8.0, 2.0, 1.2 Hz, 1H), 7.46 – 7.41 (m, 2H), 7.23 – 7.19 (m, 1H), 2.48 (s, 3H), 1.35 (s, 9H).

**$^{13}$C-{$^{1}$H} NMR** (100 MHz, $CDCl_3$) δ 191.2, 151.8, 147.2, 139.3, 136.0, 131.2, 129.2, 128.8, 128.5, 128.4, 128.4, 126.4, 125.9, 38.2, 35.0, 31.4.

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{20}O_4SNa^+$ $[M+Na]^+$: 355.0975; found: 355.0982.

**1-(3-Methylphenyl)-2-naphthaldehyde (1m).**



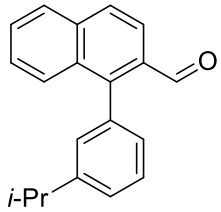

The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a yellow oil (289 mg, 1.17 mmol, 59% yield).

**$^{1}$H NMR (400 MHz, $CDCl_3$) δ** 9.87 (s, 1H), 8.02 (d, *J* = 8.7 Hz, 1H), 7.95 (d, *J* = 8.4 Hz, 2H), 7.67 (d, *J* = 8.6 Hz, 1H), 7.63 (ddd, *J* = 8.1, 6.8, 1.3 Hz, 1H), 7.50 – 7.41 (m, 2H), 7.36 (d, *J* = 7.6 Hz, 1H), 7.25 – 7.19 (m, 2H), 2.45 (s, 3H).

**$^{13}$C-{$^{1}$H} NMR** (101 MHz, $CD_2Cl_2$) δ 192.9, 147.2, 138.5, 136.5, 135.5, 133.0, 132.2, 131.7, 129.4, 129.1, 128.6, 128.6, 128.5, 128.2, 127.2, 122.3, 21.6.

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{14}NaO^+$ $[M+Na]^+$: 269.0937; found: 269.0929.

**1-(3-*iso*-Propylphenyl)-2-naphthaldehyde (1n).**



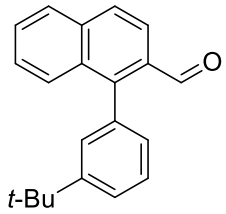

The title compound was prepared employing Procedure 1 and isolated by FC using 2% EtOAc in pentane as an eluent to afford the title compound as a yellow oil (488 mg, 1.78 mmol, 89% yield).

**$^{1}$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.87 (d, *J* = 0.9 Hz, 1H), 8.03 (d, *J* = 8.7 Hz, 1H), 7.96 – 7.93 (m, 2H), 7.68 (dq, *J* = 8.5, 0.9 Hz, 1H), 7.63 (ddd, *J* = 8.2, 6.8, 1.2 Hz, 1H), 7.50 – 7.45 (m, 2H), 7.41 (dt, *J* = 7.8, 1.6 Hz, 1H), 7.28 (t, *J* = 1.8 Hz, 1H), 7.23 (dt, *J* = 7.3, 1.5 Hz, 1H), 3.00 (hept, *J* = 6.9 Hz, 1H), 1.30 (d, *J* = 6.9 Hz, 6H).

**$^{13}$C-{$^{1}$H} NMR** (101 MHz, $CDCl_3$) δ 193.1, 149.1, 147.2, 136.2, 135.2, 132.6, 131.3, 129.4, 128.9, 128.7, 128.3, 128.3, 128.0, 126.9, 126.5, 122.2, 34.2, 24.2, 24.1.

**HRMS (ESI$^+$)** m/z calcd. for $C_{20}H_{18}NaO^+$ $[M+Na]^+$: 297.1250; found: 297.1253.

**1-(3-*tert*-Butylphenyl)-2-naphthaldehyde (1o).**



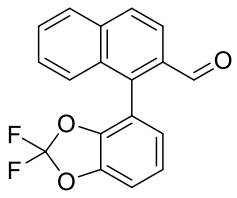

The title compound was prepared employing Procedure 1 and isolated by FC 2% EtOAc in pentane as an eluent to afford the title compound as a white, amorphous solid (412 mg, 1.43 mmol, 71% yield).

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 9.89 (s, 1H), 8.07 (d, *J* = 8.7 Hz, 1H), 7.93 (d, *J* = 8.6 Hz 2H), 7.69 (d, *J* = 8.6 Hz, 1H), 7.62 (ddd, *J* = 8.1, 6.8, 1.2 Hz, 1H), 7.55 (dt, *J* = 8.0, 1.5 Hz, 1H), 7.50 – 7.44 (m, 2H), 7.42 (t, *J* = 1.9 Hz, 1H), 7.23 (dt, *J* = 7.4, 1.5 Hz, 1H), 1.37 (s, 9H).

**$^{13}$C-{$^{1}$H} NMR** (101 MHz, $CDCl_3$) δ 193.2, 151.4, 147.4, 136.3, 134.8, 132.7, 131.4, 128.9, 128.4, 128.3, 128.0, 128.0, 127.0, 125.3, 122.3, 35.0, 31.5.

**HRMS (ESI$^+$)** m/z calcd. for $C_{21}H_{20}NaO^+$ $[M+Na]^+$: 311.1406; found: 311.1405.

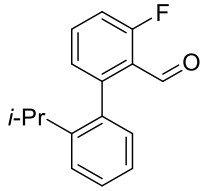
**1-(2,2-Difluorobenzo[d][1,3]dioxol-4-yl)-2-naphthaldehyde (1p).**




The title compound was prepared employing Procedure 1 to couple 1-(pinacol boronate)-2-naphthaldehyde and 4-bromo-2,2-difluoro-1,3-benzodioxole and isolated by FC pentane/$CH_2Cl_2$ 1:1 as an eluent to afford the title compound as a white, amorphous solid (153 mg, 0.49 mmol, 49% yield).

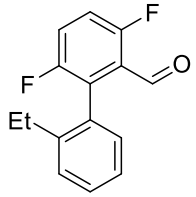
**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.94 (s, 1H), 8.10 – 7.98 (m, 3H), 7.69 (ddd, *J* = 8.2, 6.7, 1.3 Hz, 1H), 7.65 – 7.62 (m, 1H), 7.55 (ddd, *J* = 8.4, 6.7, 1.3 Hz, 1H), 7.34 – 7.29 (m, 2H), 7.17 (dd, *J* = 6.2, 2.9 Hz, 1H).
**$^{13}$C-{$^1$H} NMR** (101 MHz, $CD_2Cl_2$) δ 191.6, 144.1, 142.9, 137.9, 136.6, 132.0, 131.9, 131.8 (t, *J* 255.3 Hz), 130.1, 129.6, 128.9, 128.0, 127.4, 127.0, 124.3, 122.7, 118.3, 110.4.
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CD_2Cl_2$) δ -50.19 (d, *J* = 95.8 Hz), -50.55 (d, *J* = 95.8 Hz).
**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{10}F_2O_3Na^+$ $[M+Na]^+$: 335.0490; found: 335.0494.

**3-Fluoro-2'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (1q).**



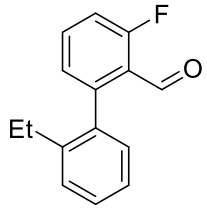

The title compound was prepared employing Procedure 1 and isolated by FC using $CH_2Cl_2$/pentane 2:1 as an eluent to afford the title compound as a yellow oil (854 mg, 3.53 mmol, 88% yield).
**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.87 (s, 1H), 7.57 (td, *J* = 8.0, 5.4 Hz, 1H), 7.43 – 7.40 (m, 2H), 7.25 – 7.16 (m, 2H), 7.09 (d, *J* = 7.5 Hz, 2H), 2.71 (hept, *J* = 6.8 Hz, 1H), 1.14 – 1.09 (m, 6H).
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 189.2 (d, *J* = 1.5 Hz), 162.5 (d, *J* = 263.3 Hz), 146.9, 146.9, 136.1 (d, *J* = 2.3 Hz), 134.5 (d, *J* = 10.3 Hz), 129.8, 129.0, 127.1 (d, *J* = 3.7 Hz), 125.8, 125.6, 123.1 (d, *J* = 6.6 Hz), 116.0 (d, *J* = 21.3 Hz), 30.3, 24.6, 23.4.
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -116.10.
**HRMS (ESI$^+$)** m/z calcd. for $C_{16}H_{15}FONa^+$ $[M+Na]^+$: 265.0999; found: 265.0999.

**2'-Ethyl-3,6-difluoro-[1,1'-biphenyl]-2-carbaldehyde (1r).**



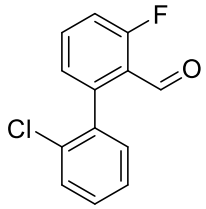

The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a colorless, amorphous solid (136 mg, 0.552 mmol, 28% yield).
**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.79 (s, 1H), 7.46 – 7.34 (m, 3H), 7.29 (t, *J* = 7.2 Hz, 1H), 7.21 (td, *J* = 9.3, 4.2 Hz, 1H), 7.12 (d, *J* = 7.6 Hz, 1H), 2.42 (q, *J* = 7.6 Hz, 2H), 1.06 (t, *J* = 7.6 Hz, 3H).
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 188.3 (dd, *J* = 2.7, 1.9 Hz), 159.0 (dd, *J* = 258.6, 2.4 Hz), 156.0 (d, *J* = 241.9, 2.8 Hz), 143.2, 132.6 (dd, *J* = 20.9, 1.5 Hz), 130.5, 130.2 (d, *J* = 1.5 Hz), 129.6, 128.9, 126.2, 124.0 (dd, *J* = 8.4, 2.5 Hz), 122.2 (dd, *J* = 26.3, 10.1 Hz), 117.5 (dd, *J* = 24.0, 8.2 Hz), 26.76, 14.85.
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -118.73 (d, *J* = 18.2 Hz), -122.41 (d, *J* = 18.2 Hz).
**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{12}F_2ONa^+$ $[M+Na]^+$: 269.0748; found: 269.0748.

**2'-Ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (1s).**




The title compound was prepared employing Procedure 1 and isolated by FC using a pentane/$CH_2Cl_2$ gradient 2:1 to 1:1 as eluent to afford the title compound as a beige oil (855 mg, 3.75 mmol, 94% yield).
**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.85 (s, 1H), 7.58 (ddd, *J* = 8.4, 7.6, 5.4 Hz, 1H), 7.38 (td, *J* = 7.4, 1.4 Hz, 1H), 7.33 (d, *J* = 7.8 Hz, 1H), 7.25 (td, *J* = 7.4, 1.6 Hz, 1H), 7.21–7.15 (m, 1H), 7.13-7.08 (m, 2H), 2.51 – 2.33 (m, 2H), 1.05 (t, *J* = 7.5 Hz, 3H).
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 189.3 (d, *J* = 1.7 Hz), 162.5 (d, *J* = 263.4 Hz), 146.7, 142.0, 136.8 (d, *J* = 2.3 Hz), 134.6 (d, *J* = 10.4 Hz), 129.9, 128.8, 128.6, 127.0 (d, *J* = 3.7 Hz), 125.8, 123.0 (d, *J* = 6.7 Hz), 116.0 (d, *J* = 21.3 Hz), 26.4, 15.1.
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -116.10.
**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{14}FO^+$ $[M+H]^+$; 229.1023 found: 229.1021.

**2'-Chloro-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (1t).**



The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a pink, amorphous solid (339 mg, 1.445 mmol, 96% yield).

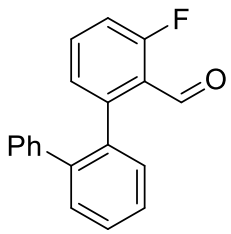
**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 10.02 (s, 1H), 7.64 (ddd, *J* = 8.4, 7.6, 5.5 Hz, 1H), 7.50 – 7.45 (m, 1H), 7.42 – 7.34 (m, 2H), 7.30 – 7.22 (m, 2H), 7.10 (d, *J* = 7.6 Hz, 1H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 188.3 (d, *J* = 4.3 Hz), 163.6 (d, *J* = 250.1 Hz), 143.3 (d, *J* = 1.7 Hz), 137.6 (d, *J* = 2.5 Hz), 135.3 (d, *J* = 10.3 Hz), 133.3, 131.3, 130.0, 129.8, 127.5 (d, *J* = 3.6 Hz), 127.3, 123.1 (d, *J* = 7.2 Hz), 116.9 (d, *J* = 21.4 Hz).

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CD_2Cl_2$) δ -118.57.

**HRMS (ESI$^+$)** m/z calcd. for $C_{13}H_8ClFONa^+$ [M+Na]$^+$: 257.0140, 259.0111; found: 257.0134, 259.0105.

**3-Fluoro-[1,1':2',1''-terphenyl]-2-carbaldehyde (1ϕ).**



The title compound was prepared employing Procedure 1 and isolated by FC using heptane/EtOAc 39:1 as an eluent to afford the title compound as a white amorphous solid (1072.0 mg, 3.881 mmol, 97% yield).

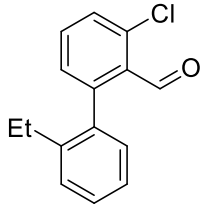
**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9 9.85 (s, 1H), 7.55 – 7.47 (m, 1H), 7.48 – 7.39 (m, 3H), 7.35 – 7.28 (m, 1H), 7.22 – 7.15 (m, 3H), 7.09 – 7.00 (m, 4H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 188.8 (d, *J* = 4.3 Hz), 162.7 (d, *J* = 262.2 Hz), 146.4, 141.6, 140.4, 136.4 (d, *J* = 2.5 Hz), 134.3 (d, *J* = 10.3 Hz), 130.8, 130.3, 129.8, 128.9, 128.2, 128.0 (d, *J* = 3.6 Hz), 127.5, 127.1, 122.9 (d, *J* = 7.1 Hz), 115.7 (d, *J* = 21.3 Hz).

**$^{19}$F NMR** (376 MHz, $CDCl_3$) δ -116.99 (dd, *J* = 10.9, 5.5 Hz).

**HRMS (ESI+)** m/z calcd. for $C_{19}H_{14}FO+$ [M+H]+: 277.1023; found: 277.1028.

**3-Chloro-2'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (1u).**



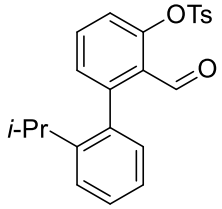
The title compound was prepared employing Procedure 3 and isolated by FC using pentane/$CH_2Cl_2$ 5:1 as an eluent to afford the title compound as a yellow oil (84mg, 0.34 mmol, 69% yield) .

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 10.04 (s, 1H), 7.52 (d, *J* = 1.6 Hz, 1H), 7.51 (s, 1H), 7.39 – 7.31 (m, 2H), 7.25 – 7.18 (m, 2H), 7.08 – 7.03 (m, 1H), 2.47 – 2.32 (m, 2H), 1.02 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 190.9, 146.4, 142.2, 138.0, 135.6, 133.3, 132.0, 130.6, 130.5, 129.9, 128.7, 128.7, 125.9, 26.6, 15.1.

**HRMS (ESI+)** m/z calcd. for $C_{15}H_{13}ClONa^+$ [M+Na]$^+$: 267.0547; found: 267.0551.

**2-Formyl-2'-*iso*-propyl-[1,1'-biphenyl]-3-yl 4-methylbenzenesulfonate (1v).**



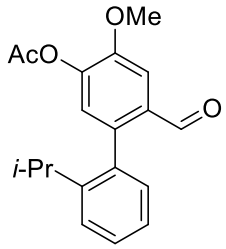
The title compound was prepared according to Procedure 4 employing TsCl and isolated by FC using $CH_2Cl_2$ as an eluent to afford the title compound as a white, amorphous solid (250 mg, 0.63 mmol, 85% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.81 – 7.76 (m, 2H), 7.57 (dd, *J* = 8.2, 7.6 Hz, 1H), 7.44 – 7.29 (m, 5H), 7.22 – 7.15 (m, 2H), 7.00 – 6.94 (m, 1H), 2.52 (hept, *J* = 6.8 Hz, 1H), 2.44 (s, 3H), 1.06 (d, *J* = 6.8 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 188.7, 148.9, 146.6, 146.1, 145.9, 136.4, 133.4, 132.2, 130.2, 129.9, 129.5, 128.9, 128.9, 128.2, 125.6, 125.5, 123.2, 30.3, 24.5, 23.2, 21.9.

**HRMS (ESI$^+$)** m/z calcd. for $C_{23}H_{22}O_4SNa^+$ $[M+Na]^+$: 417.1131; found: 417.1130.

**2'-*iso*-Propyl-6-formyl-4-methoxy-[1,1'-biphenyl]-3-yl acetate (1w).**



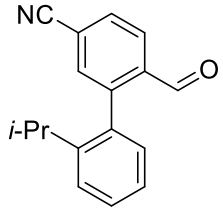

The title compound was prepared employing Procedure 1 and isolated by FC using $CH_2Cl_2$ as an eluent to afford the title compound as a white solid (200 mg, 0.64 mmol, 32% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.64 (d, *J* = 0.6 Hz, 1H), 7.58 (s, 1H), 7.44 – 7.38 (m, 2H), 7.26 – 7.20 (m, 1H), 7.17 – 7.13 (m, 1H), 7.00 (d, *J* = 0.8 Hz, 1H), 3.93 (s, 3H), 2.77 (hept, *J* = 6.8 Hz, 1H), 2.30 (s, 3H), 1.12 (d, *J* = 6.8 Hz, 3H), 1.08 (d, *J* = 6.8 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (101 MHz, $CD_2Cl_2$) δ 191.1, 168.6, 151.4, 147.9, 144.3, 139.5, 135.4, 133.0, 131.0, 129.2, 126.0, 125.8, 125.6, 109.9, 56.5, 30.4, 24.4, 23.5, 20.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{19}H_{20}O_4Na^+$ $[M+Na]^+$: 335.1254; found: 335.1253.

**6-Formyl-2'-*iso*-propyl-[1,1'-biphenyl]-3-carbonitrile (1x).**



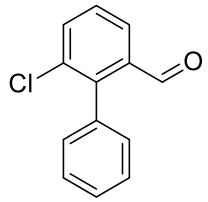

The title compound was prepared employing Procedure 2 and isolated by FC using pentane/$CH_2Cl_2$ 1:1 as an eluent to afford the title compound as an orange, amorphous solid (400 mg, 1.60 mmol, 80% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.78 (d, *J* = 0.6 Hz, 1H), 8.08 (d, *J* = 8.1 Hz, 1H), 7.82 (ddd, *J* = 8.1, 1.6, 0.9 Hz, 1H), 7.67 (d, *J* = 1.6 Hz, 1H), 7.50 – 7.45 (m, 2H), 7.32 – 7.25 (m, 1H), 7.14 (dt, *J* = 7.2, 1.1 Hz, 1H), 2.67 (hept, *J* = 6.8 Hz, 1H), 1.14 (d, *J* = 6.8 Hz, 3H), 1.10 (d, *J* = 6.8 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 190.9, 147.4, 146.2, 137.1, 135.2, 134.4, 131.6, 130.5, 129.8, 128.0, 126.3, 126.0, 118.2, 117.0, 30.5, 24.4, 23.4.

**HRMS (ESI$^+$)** m/z calcd. For $C_{17}H_{15}NONa^+$ $[M+Na]^+$: 272.1046; found: 272.1047.

**6-Chloro-[1,1'-biphenyl]-2-carbaldehyde (1y).**



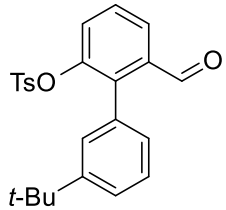

The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a white solid (340 mg, 1.57 mmol, 87% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.68 (d, *J* = 0.7 Hz, 1H), 7.93 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.72 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.53 – 7.43 (m, 4H), 7.33 – 7.29 (m, 2H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.5, 144.1, 136.2, 134.8, 134.5, 130.5, 129.0, 128.7, 128.5, 125.8.

**HRMS (ESI$^+$)** m/z calcd. For $C_{13}H_{10}ClO^+$ $[M+H]^+$: 217.0415, 219.0386; found: 217.0420, 219.0381.

**3'-(*tert*-Butyl)-6-formyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (1z).**



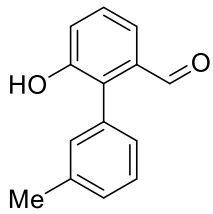

The title compound was prepared according to Procedure 4 employing TsCl and isolated by FC using a $CH_2Cl_2$ as an eluent to afford the title compound as a yellow oil (157 mg, 0.38 mmol, 70% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.63 (d, *J* = 0.9 Hz, 1H), 7.92 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.70 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.53 (td, *J* = 7.9, 0.9 Hz, 1H), 7.44 (ddd, *J* = 7.9, 2.1, 1.1 Hz, 1H), 7.27 (t, *J* = 1.8 Hz, 1H), 7.24 – 7.7.20 (m, 3H), 7.13 – 7.08 (m, 2H), 6.77 (ddd, *J* = 7.5, 1.7, 1.1 Hz, 1H), 2.38 (s, 3H), 1.31 (s, 9H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.6, 151.2, 147.1, 145.1, 139.7, 136.1, 132.7, 130.8, 129.7, 128.9, 128.5, 128.4, 128.3, 128.1, 127.8, 126.2, 125.4, 34.9, 31.4, 21.8.

**HRMS (ESI$^+$)** m/z calcd. For $C_{24}H_{24}O_4Sna^+$ $[M+Na]^+$: 431.1288; found: 431.1293.

**6-Hydroxy-3'-methyl-[1,1'-biphenyl]-2-carbaldehyde (1ba).**



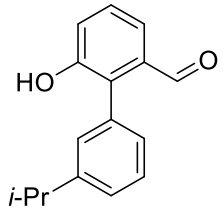

The title compound was prepared employing Procedure 1 and isolated by FC using 10% EtOAc in pentane as an eluent to afford the title compound as a white, amorphous solid (621 mg, 2.93 mmol, 73% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.71 (s, 1H), 7.56 (dd, *J* = 7.8, 1.1 Hz, 1H), 7.50 – 7.37 (m, 2H), 7.33 (d, *J* = 7.7 Hz, 1H), 7.26 – 7.21 (m, 1H), 7.21 – 7.14 (m, 2H), 5.28 (s, 1H), 2.42 (s, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 192.2, 153.8, 139.9, 135.3, 131.9, 131.8, 131.7, 130.2, 129.6, 129.4, 128.2, 121.0, 119.8, 21.5.

**HRMS (ESI+)** m/z calcd. For $C_{14}H_{12}O_2Na^+$ $[M+Na]^+$: 235.0730; found: 235.0729.

**6-Hydroxy-3'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (1bb).**



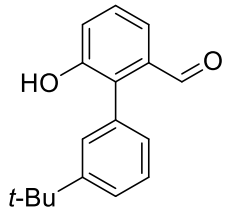

The title compound was prepared employing Procedure 1 and isolated by FC using $CH_2Cl_2$ as an eluent to afford the title compound as a white, amorphous solid (107 mg, 0.46 mmol, 90% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.69 (d, *J* = 0.9 Hz, 1H), 7.57 (dd, *J* = 7.7, 1.3 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 1H), 7.43 – 7.36 (m, 2H), 7.26 – 7.22 (m, 2H), 7.20 (dt, *J* = 7.4, 1.5 Hz, 1H), 5.58 (s, 1H), 2.98 (hept, *J* = 6.9 Hz, 1H), 1.29 (d, *J* = 7.0 Hz, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 192.4, 153.9, 150.7, 135.3, 132.3, 131.9, 129.6, 129.4, 129.3, 128.6, 127.5, 121.2, 119.7, 34.5, 24.1.

**HRMS (ESI$^+$)** m/z calcd. For $C_{16}H_{16}O_2Na^+$ $[M+Na]^+$: 263.1043; found: 263.1074.

**3'-(*tert*-Butyl)-6-hydroxy-[1,1'-biphenyl]-2-carbaldehyde (1bc).**



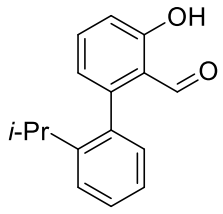

The title compound was prepared employing Procedure 1 and isolated by FC using a $CH_2Cl_2$ as an eluent to afford the title compound as a white, amorphous solid (970 mg, 3.81 mmol, 95% yield).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.68 (d, *J* = 0.8 Hz, 1H), 7.57 (dd, *J* = 7.7, 1.3 Hz, 1H), 7.54 (ddd, *J* = 8.0, 2.0, 1.2 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 1H), 7.40 (td, *J* = 7.9, 0.8 Hz, 2H), 7.24 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.21 – 7.17 (m, 1H), 5.69 (s, 1H), 1.35 (s, 9H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 192.5, 154.0, 152.9, 135.4, 132.6, 131.6, 129.3, 129.3, 128.4, 128.3, 126.4, 121.2, 119.7, 35.1, 31.4.

**HRMS (ESI+)** m/z calcd. For $C_{17}H_{18}O_2Na^+$ $[M+Na]^+$: 277.1199; found: 277.1208.

**3-Hydroxy-2'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (1bd).**




The title compound was prepared employing Procedure 1 and isolated by FC using pentane/$CH_2Cl_2$ 2:1 as an eluent to afford the title compound as a white, amorphous solid (921 mg, 3.83 mmol, 96% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 11.8 (s, 1H), 9.58 (s, 1H), 7.52 (dd, *J* = 8.4, 7.4 Hz, 1H), 7.42 – 7.40 (m, 2H), 7.23 (dt, *J* = 7.5, 4.3 Hz, 1H), 7.13 (dt, *J* = 7.5, 1.1 Hz, 1H), 7.00 (d, *J* = 8.4 Hz, 1H), 6.78 (dd, *J* = 7.4, 1.1 Hz, 1H), 2.76 (hept, *J* = 6.8 Hz, 1H), 1.14 – 1.10 (m, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 197.2, 162.7, 147.3, 147.0, 136.7, 135.8, 130.3, 129.0, 125.8, 125.5, 121.8, 119.0, 117.1, 30.2, 24.7, 23.6.

**HRMS (ESI$^+$)** m/z calcd. For $C_{16}H_{16}O_2Na^+$ $[M+Na]^+$: 263.1043; found: 263.1043.

## 3. Optimization

Optimization reactions were performed on **3l**, and **3a** (*vide infra*). All reported yields for the optimization were determined using $^1$H NMR spectroscopy. The *c*TDGs evaluated are shown in Figure S2:

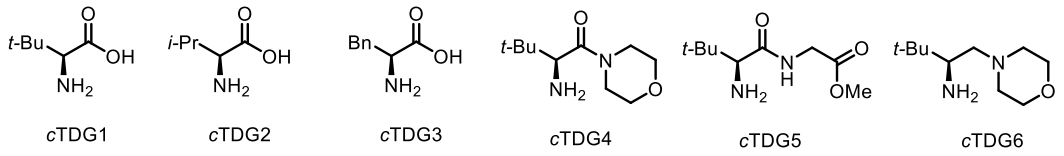



***Figure S2.*** *Suite of cTDGs.*

**3a: Optimization for the monobromination of 1a.**

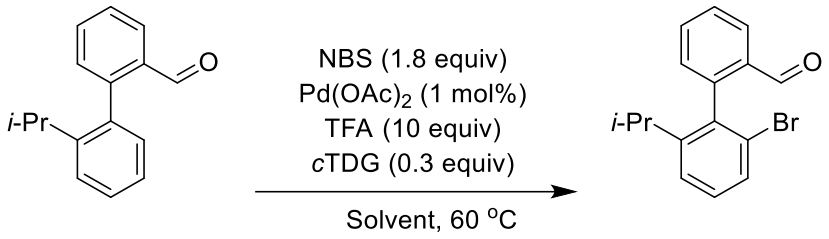



***Figure S3.*** *General reaction scheme of **1a** used to optimize monobromination reaction parameters.*

***Table S2.*** *Summary of optimization reactions for the monobromination of **1a**.*

| *c*TDG | Solvent | $Pd(OAc)_2$ | T (°C) | Additive | Acid | NBS equiv | Yield (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | SM | Mono | Di |
| *c*TDG1 | HFIP/AcOH 4:1 | 10% | 60 | - | TFA | 2 | 54 | 36 | 10 |
| *c*TDG1 | DCE | 10% | 60 | - | TFA | 2 | 0 | 20 | 76 |
| *c*TDG1 | DCE | 1% | 60 | - | TFA | 2 | 14 | 48 | 18 |
| *c*TDG2 | DCE | 1% | 60 | - | TFA | 2 | 42 | 23 | 0 |
| *c*TDG3 | DCE | 1% | 60 | - | TFA | 2 | 18 | 51 | 18 |
| *c*TDG4 | DCE | 1% | 60 | - | TFA | 2 | 32 | 5 | 0 |
| *c*TDG5 | DCE | 1% | 60 | - | TFA | 2 | 70 | 8 | 0 |
| *c*TDG1 | DCE | 1% | 60 | - | TFA | 1.1 | 31 | 47 | 23 |
| *c*TDG1 | DCE | 1% | 60 | - | TFA | 1.5 | 7 | 55 | 28 |
| *c*TDG1 | DCE | 1% | 60 | - | TFA | 1.8 | 13 | 64 | 18 |
| *c*TDG1 | DCE | 1% | rt | - | TFA | 1.8 | 98 | 2 | 0 |
| *c*TDG1 | DCE | 1% | 40 | - | TFA | 1.8 | 58 | 37 | 5 |
| *c*TDG1 | DCE | 1% | 60 | - | TFA | 1.8 | 10 | 68 | 22 |
| *c*TDG1 | DCE | 1% | 60 | AgOTf | TFA | 1.8 | | 45 | 17 |
| *c*TDG1 | DCE | 1% | 60 | $Ag_2CO_3$ | TFA | 1.8 | | 54 | 11 |
| *c*TDG1 | DCE | 1% | 60 | $Cu(OAc)_2$ | TFA | 1.8 | | 51 | 10 |
| *c*TDG1 | DCE | 1% | 60 | $ZnCl_2$ | TFA | 1.8 | | 9 | |
| *c*TDG1 | DCE | 1% | 60 | - | TFA | 1.8 | | 56 | 16 |

**Summary and Rationalization:** Comparison of the use of 10 mol% Pd vs. 1 mol% Pd under otherwise identical conditions resulted in a ratio of Di:Mono of 3.8:1 and 1:2.67, respectively, with starting material remaining

in the latter case. These data highlight the competition among the unfunctionalized SM and the Monohalogenated products towards C–H functionalization. We speculate that this observation manifests as a downstream consequence of the relative rates of both catalytic cycles (e.g. *c*TDG and [Pd]). The rational in lowering Pd loading to favor monohalogenation was driven by the strategy to taper the rate of C–H functionalization of the [Pd] cycle and pace it with the rate of hydrolysis/condensation of the *c*TDG.

**3a: Optimization for the dibromination of 1a.**

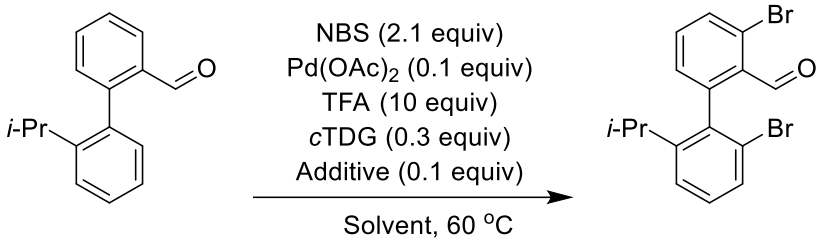



***Figure S4.*** *General reaction scheme of* ***1a*** *used to optimize dibromination reaction parameters.*

***Table S3.*** *Summary of optimization reactions for the dibromination of* ***1a****.*

| ***c*TDG** | **Solvent** | **Additive** | **Yield (%)** | ***ee* (%)** |
|---|---|---|---|---|
| *c*TDG1 | HFIP | - | 0 | - |
| *c*TDG1 | DCE | - | 48 | >99 |
| *c*TDG2 | DCE | - | 22 | 94 |
| *c*TDG3 | DCE | - | 4 | nd |
| *c*TDG4 | DCE | - | 42 | 85 |
| *c*TDG5 | DCE | - | 8 | nd |
| *c*TDG6 | DCE | - | 0 | - |
| *c*TDG1 | DCE | - | 0 | - |
| *c*TDG1 | DCE | AgTFA | 64 | >99 |
| *c*TDG1 | DCE | $Ag_2CO_3$ | 84 | >99 |

**3l: Optimization for tribromination of 1l.**

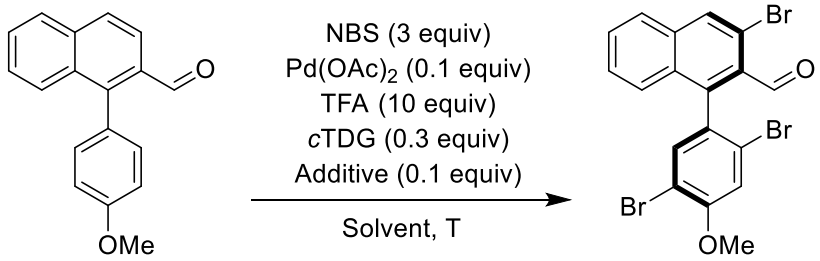



***Figure S5.*** *General reaction scheme of* ***1l*** *used to optimize tribromination reaction parameters****.***

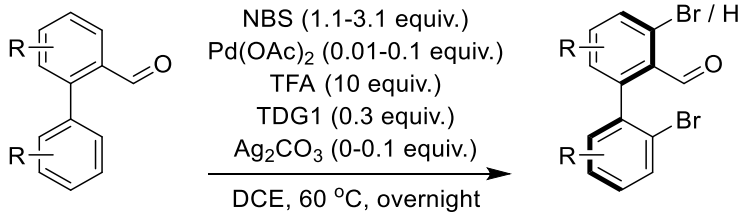
***Table S4.*** *Summary of optimization reactions for the tribromination of* ***1l****.*

| **TDG** | **Solvent** | **T (°C)** | **Additive** | **Acid** | **Conversion** | **Yield (%)** | ***ee* (%)** |
|---|---|---|---|---|---|---|---|
| *c*TDG1 | DCE | 60 | - | TFA | 100 | 62 | nd |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *c*TDG1 | Toluene | 60 | - | TFA | 89 | 19 | nd |
| *c*TDG1 | HFIP | 60 | - | TFA | 88 | 20 | nd |
| *c*TDG1 | $MeNO_2$ | 60 | - | TFA | 100 | 27 | nd |
| *c*TDG1 | EtOAc | 60 | - | TFA | 71 | 8 | nd |
| *c*TDG1 | MeOH | 60 | - | TFA | 78 | 0 | nd |
| *c*TDG1 | THF | 60 | - | TFA | 0 | 0 | nd |
| *c*TDG1 | *o*-dichlorobenzene | 60 | - | TFA | 100 | 62 | nd |
| *c*TDG1 | TCE | 60 | - | TFA | 95 | 29 | nd |
| *c*TDG1 | $CH_2Cl_2$ | 60 | - | TFA | 93 | 46 | nd |
| *c*TDG1 | DCE | 40 | - | TFA | - | - | nd |
| *c*TDG1 | *o*-dichlorobenzene | 40 | - | TFA | - | - | nd |
| *c*TDG1 | $CH_2Cl_2$ | 40 | - | TFA | - | - | nd |
| *c*TDG2 | DCE | 60 | - | TFA | 84 | 38 | nd |
| *c*TDG4 | DCE | 60 | - | TFA | 100 | 42 | 97 |
| *c*TDG5 | DCE | 60 | - | TFA | 95 | 26 | >99 |
| *c*TDG6 | DCE | 60 | - | TFA | - | 0 | >99 |
| *c*TDG1 | DCE | 60 | - | TFA | 100 | 74 | >99 |
| *c*TDG1 | DCE | 60 | AgOTFA | TFA | 100 | 36 | nd |
| *c*TDG1 | DCE | 60 | $Ag_2CO_3$ | TFA | 100 | 92 | nd |
| *c*TDG1 | DCE | 60 | $Cu(OAc)_2$ | TFA | 100 | 52 | nd |
| *c*TDG1 | DCE | 60 | $ZnCl_2$ | TFA | 63 | 0 | nd |
| *c*TDG1 | DCE | 60 | CsF | TFA | 95 | 17 | nd |
| *c*TDG1 | DCE | 60 | - | TFA | 100 | 74 | >99 |

## 4. General procedures for the atroposelective C–H functionalization

### 4.A Atroposelective bromination employing 10 mol% Pd



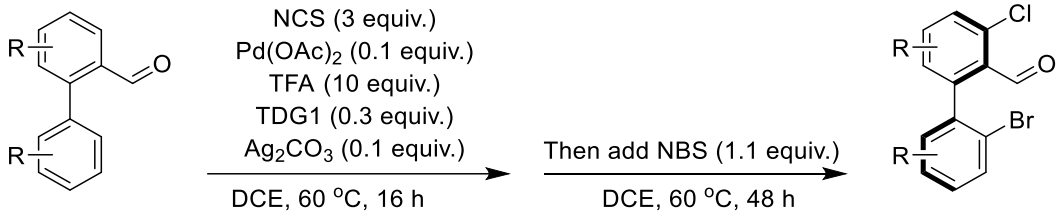

***Scheme S***2. General protocol for atroposelective C–H bromination.

To an 8-mL vial, equipped with a stir bar, was added the aldehyde (0.10 mmol, 1 equiv.), *c*TDG1 (3.9 mg, 0.030 mmol, 0.3 equiv), $Pd(OAc)_2$ (2.3 mg, 0.010 mmol, 0.1 equiv), NBS (0.11, 0.21 or 0.31 mmol, 1.1–3.1 equiv), $Ag_2CO_3$ (2.8 mg, 0.010 mmol, 0.1 equiv), DCE (1 mL), and TFA (77 μL, 1.0 mmol, 10 equiv). The vial was capped and heated at 60 °C overnight. Upon completion of the reaction, the resulting solution was cooled to rt and directly loaded onto a column and purified by FC using the described stationery and eluent system.

### 4.B Atroposelective bromination employing 1 mol% Pd

To an 8-mL vial, equipped with a stir bar, was added the aldehyde (0.10 mmol, 1 equiv), *c*TDG1 (3.9 mg, 0.030 mmol, 0.3 equiv), $Pd(OAc)_2$ (100 μL of 0.01 M solution in DCE, 0.0010 mmol, 0.01 equiv), NBS (32 mg, 0.18 mmol, 1.8 equiv), DCE (0.9 mL) and TFA (77 μL, 1.0 mmol, 10 equiv.). The vial was capped and heated at 60 °C overnight. Upon completion of the reaction, the resulting solution was cooled to rt and directly loaded onto a column and purified by FC using the described stationery and eluent system.

### 4.C Telescoping halogenation

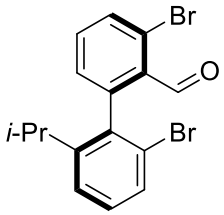



***Scheme S3*.** General protocol for the atropselective telescoping halogenation.

To a 8-mL vial, equipped with a stir bar, was added the aldehyde (0.10 mmol, 1 equiv.), *c*TDG1 (3.9 mg, 0.030 mmol, 0.3 equiv.), $Pd(OAc)_2$ (2.3 mg, 0.010 mmol, 0.1 equiv.), NCS (40.1 mg, 0.3 mmol, 3 equiv), and $Ag_2CO_3$ (2.8 mg, 0.010 mmol, 0.1 equiv.), DCE (1 mL) and TFA (77 μL, 1.0 mmol, 10 equiv). The vial was capped and heated at 60 °C for 16 h. Then NBS (19.6 mg, 0.11 mmol, 1.1 equiv.) was added, and the reaction was heated at 60 °C for 48 h. Upon completion of the reaction, the resulting solution was cooled to rt and directly loaded onto a column and purified by FC using the described stationery and eluent system.

## 4.1 Characterization of atropisomers

**($R_a$)-2',3-Dibromo-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (3a).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent to afford the title compound as a white, amorphous solid (28.7 mg, 0.075 mmol, 75% yield, >99% *ee*).

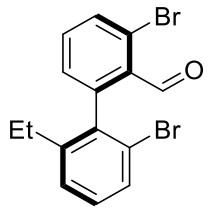
**$^1$H NMR** (400 MHz, $CDCl_3$): δ 10.15 (s, 1H), 7.75 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.46 (ddd, *J* = 7.9, 4.5, 3.2 Hz, 2H), 7.35 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.25 (t, *J* = 7.9 Hz, 1H), 7.14 (dd, *J* = 7.6, 1.2 Hz, 1H), 2.49 (hept, *J* = 6.9 Hz, 1H), 1.08 (dd, *J* = 6.9, 3.1 Hz, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 191.4, 149.3, 144.2, 138.1, 134.1, 133.6, 132.7, 130.7, 129.9, 129.8, 125.5, 124.7, 123.0, 31.7, 24.4, 23.4.

**HRMS (ESI$^+$)** m/z calcd. For $C_{16}H_{14}Br_2ONa^+$ $[M+Na]^+$: 404.9284, 402.9304, 406.9263; found: 404.9285, 402.9310, 406.9266.

**UPC$^2$**: Chiralpak ID column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.241 min; $t_{minor}$ = 2.163 min; General Procedure A: >99% *ee*. $[\alpha]_{25}^{D}$ = –46.0 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2',3-Dibromo-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (3b).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 1:3 as eluent to afford the title compound as a white, amorphous solid (20.9 mg, 0.057 mmol, 57% yield, >99% *ee*).

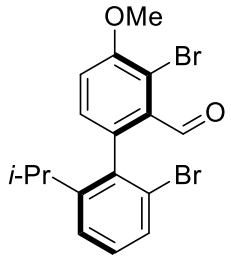
**$^1$H NMR** (400 MHz, $CD_2Cl_2$): 10.12 (s, 1H), 7.76 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.52 – 7.46 (m, 2H), 7.29 (d, *J* = 7.8 Hz, 1H), 7.23 (t, *J* = 7.8 Hz, 1H), 7.15 (dd, *J* = 7.6, 1.1 Hz, 1H), 2.37-2.21(m, 2H), 1.01 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 191.4, 144.3, 144.1, 138.8, 134.1, 133.7, 132.6, 130.7, 130.0, 129.6, 127.3, 125.4, 123.2, 77.5, 77.2, 76.8, 27.5, 14.8.

**HRMS (ESI+)** m/z calcd. For $C_{15}H_{12}Br_2ONa^+$ $[M+Na]^+$: 388.9148, 390.9127, 392.9107; found: 388.9145, 290.9125, 392.9106.

**UPC$^2$**: Chiralpak ID column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.814 min; $t_{minor}$ = 3.522 min; General Procedure A: >99% *ee*. $[\alpha]_{28}^{D}$ = +39.8 (c 0.25, $CH_2Cl_2$).

**($R_a$)-2',3-Dibromo-6'-*iso*-propyl-4-methoxy-[1,1'-biphenyl]-2-carbaldehyde (3c).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 3:1 as eluent to afford the title compound as a white, amorphous solid (29 mg, 0.070 mmol, 70% yield, >99% *ee*).

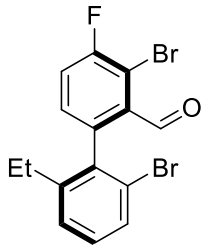
**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 10.20 (s, 1H), 7.44 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.34 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.24 (t, *J* = 7.9 Hz, 1H), 7.18 (d, *J* = 8.4 Hz, 1H), 7.09 (d, *J* = 8.4 Hz, 1H), 3.99 (s, 3H), 2.54 (hept, *J* = 6.8 Hz, 1H), 1.08 – 1.05 (m, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 192.2, 156.3, 150.2, 138.7, 135.2, 134.3, 131.4, 129.8, 129.7, 124.9, 123.8, 115.6, 115.5, 57.1, 31.9, 24.3, 23.4.

**HRMS (ESI$^+$)** m/z calcd. For $C_{17}H_{16}Br_2O_2Na^+$ $[M+Na]^+$: 434.9389, 432.9410, 436.9369; found: 434.9392, 432.9408, 436.9371.

**UPC²**: Chiralpak ID column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.788 min; $t_{minor}$ = 2.592 min; General Procedure A: >99% *ee*. $[\alpha]_{25}^{D}$ = +23.3 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2',3-Dibromo-6'-ethyl-4-fluoro-[1,1'-biphenyl]-2-carbaldehyde (3d).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 4:1 as eluent to afford the title compound as a white, amorphous solid (23.3 mg, 0.06 mmol, 60% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 10.06 (s, 1H), 7.49 (dd, *J* = 7.7, 1.4 Hz, 1H), 7.43 (t, *J* = 8.2 Hz, 1H), 7.30 (dd, *J* = 7.6, 1.4 Hz, 1H), 7.25 (t, *J* = 7.8 Hz, 1H), 7.16 (dd, *J* = 8.4, 5.0 Hz, 1H), 2.40-2.20 (m, 2H), 1.01 (t, *J* = 7.5 Hz, 3H).

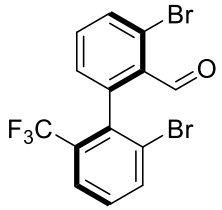
**$^{13}$C-{$^1$H} NMR** (101 MHz, $CDCl_3$) δ 190.5 (d, *J* = 3.3 Hz), 159.0 (d, *J* = 249.5 Hz) 144.6, 139.7 (d, *J* = 4.1 Hz), 137.8, 134.0, 131.7 (d, *J* = 7.4 Hz), 130.1, 139.9, 127.4, 123.6, 120.3 (d, *J* = 23.0 Hz), 112.3 (d, *J* = 22.0 Hz) 27.6, 14.8.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -104.96.

**HRMS (ESI$^+$)** m/z calcd. For $C_{15}H_{11}Br_2FONa^+$ $[M+Na]^+$: 408.9033, 406.9053, 410.9012; found: 408.9033, 406.9049, 410.9020.

**UPC²**: Chiralpak ID column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.122 min; $t_{minor}$ = 2.040 min; General Procedure A: >99% *ee*. $[\alpha]_{24}^{D}$ = +49.5 (c 0.5, $CH_2Cl_2$).

**($R_a$)-2',3-Dibromo-6'-(trifluoromethyl)-[1,1'-biphenyl]-2-carbaldehyde (3e).**




Following General Procedure A employing 2.1 equiv NBS and leaving it for three days, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent to afford the title compound as a yellow, amorphous solid (27 mg, 0.066 mmol, 66% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$): δ 10.29 (s, 1H), 7.83 (d, *J* = 8.1 Hz, 1H), 7.78 (dd, *J* = 8.1, 1.2 Hz, 1H), 7.73 (d, *J* = 8.0 Hz, 1H), 7.48 (t, *J* = 7.9 Hz, 1H), 7.38 (td, *J* = 8.0, 1.0 Hz, 1H), 7.15 (d, *J* = 7.5 Hz, 1H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$): δ 191.5, 140.5, 139.3 (q, *J* = 1.5 Hz), 134.7, 133.7, 132.0, 130.9, 130.1 (q, *J* = 30.2 Hz), 129.2, 127.3, 125.4, 125.3 (q, *J* = 5,2 Hz), 123.2 (q, *J* = 276.2 Hz).

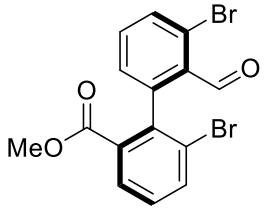
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -59.01.

HRMS (ESI$^+$) m/z calcd. For $C_{14}H_7Br_2F_2OK^+$ $[M+K]^+$: 444.8448, 446.8427, 448.8407; found: 444.8644, 446.8622, 448.8610.

**UPC²**: Chiralpak IB column [$CO_2$/$CH_2Cl_2$ gradient, 1% $CH_2Cl_2$ (0.5 min), then gradient from 1% to 20% (20%/h), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.540 min; $t_{minor}$ = 2.626 min; General Procedure A: >99% *ee*.
$[\alpha]_{25}^{D}$ = +67.2 (c 1.0, $CH_2Cl_2$).[4]

[4] The title compound did not separate well on UPC². Instead, a transformation was conducted to increase separation: The aldehyde was mixed with 10 equiv. ethyl(triphenylphosphoranylidene)acetate in $CH_2Cl_2$. After stirring for 3 h, the reaction was purified with FCC to afford the alkene product which was subsequently subjected to UPC².

**($R_a$)-Methyl 3',6-dibromo-2'-formyl-[1,1'-biphenyl]-2-carboxylate (3f).**



Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$ as eluent to afford the title compound as a white, amorphous solid (26.8 mg, 0.067 mmol, 67% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$): δ 10.29 – 10.27 (m, 1H), 8.01 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.81 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.73 (dd, *J* = 8.1, 1.2 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 1H), 7.34 (t, *J* = 7.9 Hz, 1H), 7.05 (d, *J* = 7.6, 1H), 3.63 (s, 3H).

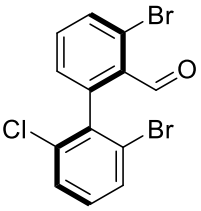
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 191.8, 166.1, 143.8, 141.8, 136.4, 133.8, 133.7, 131.9, 131.3, 129.6, 129.6, 129.0, 126.8, 124.7, 52.3.

**HRMS (ESI$^+$)** m/z calcd. For $C_{15}H_{10}Br_2O_3Na^+$ $[M+Na]^+$: 420.8869, 418.8889, 422.8848; found: 420.8867, 418.8889, 422.8858.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.140 min; $t_{minor}$ = 3.084 min; General Procedure A: >99% *ee*.

$[\alpha]_{25}^{D}$ = –34.7 (c 0.25, $CH_2Cl_2$).

**($R_a$)-2',3-Dibromo-6'-chloro-[1,1'-biphenyl]-2-carbaldehyde (3g).**



Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 3:1 as eluent to afford the title compound as a yellow, amorphous solid (10.3 mg, 0.03 mmol, 28% yield, >95% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.27 (s, 1H), 7.77 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.57 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.51 (t, *J* = 7.8 Hz, 1H), 7.43 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.23 – 7.16 (m, 2H).

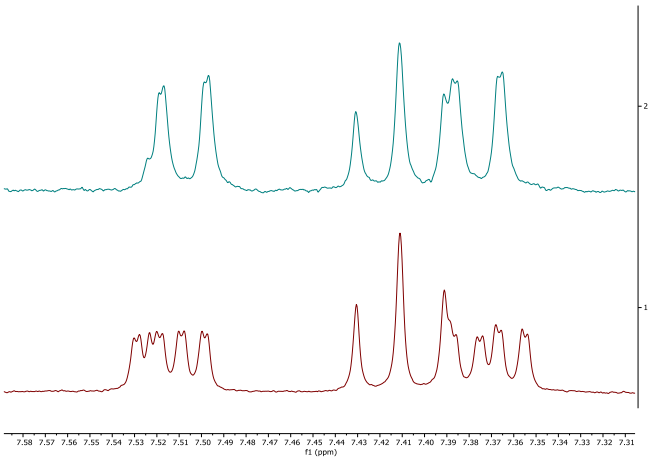
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.4, 141.8, 139.3, 134.5, 134.2, 133.9, 131.9, 131.2, 130.6, 130.0, 128.6, 126.7, 123.8.

**HRMS (ESI$^+$)** m/z calcd. For $C_{13}H_7Br_2ClONa^+$ $[M+Na]^+$: 394.8445, 396.8424, 398.8404; found: 394.8459, 396.8424, 398.8400.

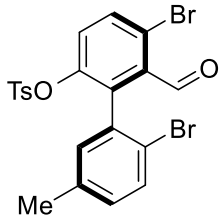
$[\alpha]_{24}^{D}$ = –9.7 (c 0.5, $CH_2Cl_2$).

UPC$^2$ conditions to separate the pair of enantiomers were unable to be obtained. To determine enantioselectivity, the chiral auxiliary, (*R*)-*tert*-butanesulfinamide, was employed to form diastereoisomers to determine the diastereomeric ratio by $^1$H NMR spectroscopy. Below is a zoom-in of the $^1$H NMR spectra (crude mixtures) of the racemate (*below*) and the enantioselective reaction (*above*). Since only a single diastereoisomer was detected for the enantioenriched entry (>20:1 d.r), this corresponds to >95% *ee*.[5]

[5] A 4 mL vial was charged with a solution of (*R*)-*tert*-butanesulfinamide and aldehyde in $CH_2Cl_2$ followed by the addition of Ti(*i*-PrO)$_4$. The reaction mixture was stirred at rt and then heated to reflux overnight (until completion of aldehyde as indicated by TLC). The reaction was then quenched with brine and diluted with $CH_2Cl_2$. Large quantities of white precipitate formed and was filtered away. The organic phase was separated, and the aqueous phase was extracted with $CH_2Cl_2$. The combined organic layers were dried over $Na_2SO_4$. The solvent was removed *in vacuo* and analyzed by $^1$H NMR spectroscopy.



**($S_a$)-2',5-Dibromo-6-formyl-5'-methyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3h).**



Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 1:1 as eluent to afford the title compound as a white, amorphous solid (29.8 mg, 0.03 mmol, 30% yield, 98% *ee*).

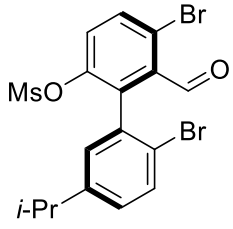
**$^1$H NMR** (400 MHz, $CDCl_3$): δ 9.92 (s, 1H), 7.74 (d, *J* = 8.9 Hz, 1H), 7.58 (d, *J* = 8.8 Hz, 1H), 7.38-7.34 (m, 3H), 7.17 (d, *J* = 8.1 Hz, 2H), 7.01 (dd, *J* = 8.3, 2.2 Hz, 1H), 6.73 (d, *J* = 2.2 Hz, 1H), 2.42 (s, 3H), 2.24 (s, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 190.5, 146.8, 145.5, 137.6, 137.0, 135.1, 134.6, 134.6, 133.3, 132.8, 132.5, 132.4, 130.9, 129.9, 128.1, 127.7, 121.7, 120.3, 77.5, 77.2, 76.8, 21.8, 21.0

**HRMS (ESI$^+$)** m/z calcd. for $C_{21}H_{16}Br_2O_4SK^+$ $[M+K]^+$: 560.8768, 562.8748, 564.8727; found: 560.8768, 562.8754, 564.8743.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.331 min; $t_{minor}$ = 3.251 min; General Procedure A: 98% *ee*. $[\alpha]_{28}^{D}$ = –45.2 (c 0.5, $CH_2Cl_2$).

**($S_a$)-2',5-Dibromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (3i).**



Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 2:1 as eluent to afford the title compound as a colorless oil (30.9 mg, 0.065 mmol, 65% yield, 98% *ee*).

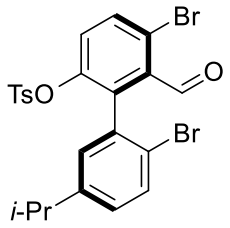
**$^1$H NMR** (400 MHz, $CDCl_3$): δ 10.05 (s, 1H), 7.78 (d, *J* = 8.8 Hz, 1H), 7.56 (d, *J* = 8.3 Hz, 1H), 7.53 (d, *J* = 8.8 Hz, 1H), 7.19 (dd, *J* = 8.3, 2.3 Hz, 1H), 7.16 (d, *J* = 2.3 Hz, 1H), 2.92 (p, *J* = 6.9 Hz, 1H), 2.62 (s, 3H), 1.24 (dd, *J* = 6.9, 5.1 Hz, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): 190.7, 148.9, 146.9, 137.8, 135.6, 134.6, 134.0, 132.8, 130.5, 129.0, 128.3, 122.6, 120.5, 38.8, 34.0, 24.0, 23.8.

**HRMS (ESI$^+$)** m/z calcd. For $C_{17}H_{16}Br_2O_4SK^+$ $[M+K]^+$: 512.8768; found: 512.8767.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.851 min; $t_{minor}$ = 2.765 min; General Procedure A: 98% *ee*. $[\alpha]_{25}^{D}$ = –23.8 (c 1.0, $CH_2Cl_2$).

**($S_a$)-2',5-Dibromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3j).**




Following General Procedure A employing 2.1 equiv NBS, however the reaction time was increased to 48 h. The product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ gradient from 2:1 to 1:1 as eluent to afford the title compound as a white, amorphous solid (31.4 mg, 0.057 mmol, 57% yield, 95% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$): δ 9.95 (s, 1H), 7.74 (d, *J* = 8.8 Hz, 1H), 7.52 (d, *J* = 8.8 Hz, 1H), 7.40 (d, *J* = 8.3 Hz, 1H), 7.33 (d, *J* = 8.3 Hz, 2H), 7.16 (d, *J* = 8.1 Hz, 2H), 7.11 (dd, *J* = 8.3, 2.3 Hz, 1H), 7.04 (d, *J* = 2.2 Hz, 1H), 2.85 (hept, *J* = 6.9 Hz, 1H), 2.41 (s, 3H), 1.22 (dd, *J* = 6.9, 4.3 Hz, 6H).

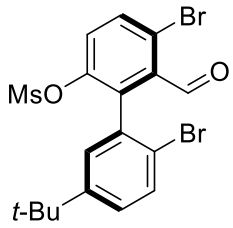
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 190.4, 148.1, 146.6, 145.5, 138.1, 135.1, 134.6, 133.2, 132.8, 132.4, 130.6, 129.8, 128.2, 128.0, 127.7, 121.6, 120.4, 33.7, 23.9, 23.8, 21.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{23}H_{20}Br_2O_4SK^+$ $[M+K]^+$: 588.9081; found: 588.9075.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.199 min; $t_{minor}$ = 3.144 min; General Procedure A: 95% *ee*.

$[\alpha]_{28}^{D}$ = –36.4 (c 1.0, $CH_2Cl_2$).

**($S_a$)-2',5-Dibromo-5'-(*tert*-butyl)-6-formyl-[1,1'-biphenyl]-2-yl methanesulfonate (3k).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 2:1 as eluent to afford the title compound as a colorless oil (24.4 mg, 0.05 mmol, 50% yield, 93% *ee*).

**$^1$H NMR** (400 MHz $CD_2Cl_2$) δ 10.02 (s, 1H), 7.81 (d, *J* = 8.8 Hz, 1H), 7.60 (d, *J* = 8.5 Hz, 1H), 7.52 (dd, *J* = 8.8, 0.7 Hz, 1H), 7.36 (dd, *J* = 8.5, 2.5 Hz, 1H), 7.30 (d, *J* = 2.5 Hz, 1H), 2.63 (d, *J* = 0.7 Hz, 3H), 1.31 (d, *J* = 0.8 Hz, 9H).

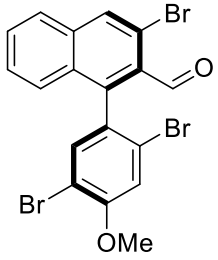
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 190.7, 151.2, 146.9, 138.1, 135.6, 134.7, 133.7, 132.5, 129.8, 128.3, 127.9, 122.6, 120. 4, 38.8, 35.0, 31.2.

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{18}Br_2o_4SNa^+$ $[M+Na]^+$: 512.9165, 510.9185, 514.9144; found: 512.9167, 510.9159, 514.9142.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.020 min; $t_{minor}$ = 2.938 min; General Procedure A: 93% *ee*.

$[\alpha]_{28}^{D}$ = –19.2 (c 0.5, $CH_2Cl_2$).

**($R_a$)-3-Bromo-1-(2,5-dibromo-4-methoxyphenyl)-2-naphthaldehyde (3l).**




Following General Procedure A employing 3.1 equiv NBS, the product was isolated by FC on $SiO_2$ using EtOAc/pentane 1:20 as eluent to afford the title compound as a yellow, amorphous solid (26.8 mg, 0.054 mmol, 54% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$): δ 10.23 (s, 1H), 8.29 (s, 1H), 7.88 (d, *J* = 8.2 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.54 – 7.48 (m, 1H), 7.43 – 7.37 (m, 2H), 7.29 (s, 1H), 4.00 (s, 3H).

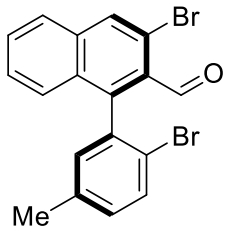
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 191.9, 156.5, 142.4, 135.9, 135.2, 133.7, 131.5, 130.7, 129.7, 129.7, 127.9, 127.4, 127.4, 123.3, 118.9, 116.1, 111.2, 56.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{11}Br_3O_2K^+$ $[M+K]^+$: 534.7941, 536.7921, 538.7900, 540,7880; found: 534.7954, 536.7931, 538.7938, 540.7920.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 4.234 min; $t_{minor}$ = 4.094 min; General Procedure A: >99% *ee*.

$[\alpha]_{23}^{D}$ = +29.1 (c 0.5, $CH_2Cl_2$).

**($R_a$)-3-Bromo-1-(2-bromo-5-methylphenyl)-2-naphthaldehyde (3m).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ gradient from 3:1 to 2:1 as eluent to afford the title compound as a yellow, amorphous solid (28.9 mg, 0.07 mmol, 72% yield, >99% *ee*).

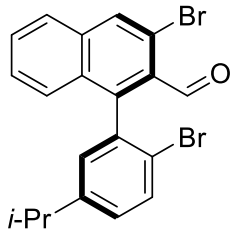
**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.15 (s, 1H), 8.24 (s, 1H), 7.83 (d, *J* = 8.2, 1H), 7.65 – 7.60 (m, 2H), 7.47 (ddd, *J* = 8.2, 6.8, 1.3 Hz, 1H), 7.37 (d, *J* = 8.5 Hz, 1H), 7.18 (ddd, *J* = 8.2, 2.2, 0.6 Hz 1H), 7.07 (d, *J* = 2.2 Hz, 1H), 2.36 (s, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.9, 144.8, 137.6, 136.9, 135.9, 133.5, 132.7, 132.6, 131.3, 131.0, 129.6, 129.4, 127.7, 127.5, 127.3, 120.6, 118.2, 21.1.

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{12}Br_2ONa^+$ $[M+Na]^+$: 424.9148, 426.9127, 428.9107; found: 424.9145, 426.9129, 428,9111.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.368 min; $t_{minor}$ = 3.239 min; General Procedure A: >99% *ee*. $[\alpha]_{25}^{D}$ = +29.1 (c 0.25, $CH_2Cl_2$).

**($R_a$)-3-Bromo-1-(2-bromo-5-*iso*-propylphenyl)-2-naphthaldehyde (3n).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using 1.5% EtOAc in pentane as eluent to afford the title compound as a yellow, amorphous solid (32.5 mg, 0.075 mmol, 75% yield, 97% *ee*).

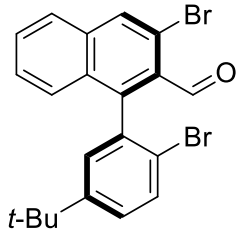
**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.11 (s, 1H), 8.24 (s, 1H), 7.87 – 7.82 (m, 1H), 7.68 – 7.61 (m, 2H), 7.47 (ddd, *J* = 8.3, 6.8, 1.3 Hz, 1H), 7.40 – 7.34 (m, 1H), 7.24 (d, *J* = 2.3 Hz, 1H), 7.11 (d, *J* = 2.3 Hz, 1H), 2.92 (hept, *J* = 6.9 Hz, 1H), 1.26 (d, *J* = 6.9 Hz, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.8, 148.6, 145.3, 136.7, 135.8, 133.6, 132.7, 131.3, 130.2, 129.7, 129.4, 128.4, 127.7, 127.4, 127.3, 120.9, 117.9, 33.7, 24.0, 24.0.

**HRMS (ESI$^+$)** m/z calcd. for $C_{20}H_{16}Br_2ONa^+$ $[M+Na]^+$: 452.9460; found: 452.9471.

UPC$^2$: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.137 min; $t_{minor}$ = 3.059 min; General Procedure A: 97% *ee*. $[\alpha]_{25}^{D}$ = –35.1 (c 1.0, $CH_2Cl_2$).

**($R_a$)-3-Bromo-1-(2-bromo-5-*tert*-butylphenyl)-2-naphthaldehyde (3o).**




Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using 2% EtOAc in pentane as eluent to afford the title compound as a yellow, amorphous solid (42.8 mg, 0.096 mmol, 96% yield, 95% *ee*).

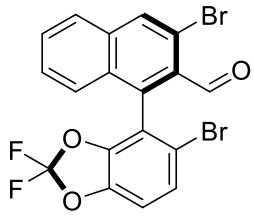
**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.09 (s, 1H), 8.25 (s, 1H), 7.86 – 7.83 (m, 1H), 7.65 (d, *J* = 8.5 Hz, 1H), 7.64 – 7.60 (m, 1H), 7.47 (ddd, *J* = 8.3, 6.9, 1.3 Hz, 1H), 7.40 (dd, *J* = 8.5, 2.4 Hz, 1H), 7.36 (d, *J* = 8.9 Hz, 1H), 7.26 (d, *J* = 1.4 Hz, 1H), 1.32 (s, 9H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.8, 151.0, 145.6, 136.3, 135.8, 133.6, 132.4, 131.3, 129.7, 129.5, 129.2, 127.7, 127.4, 127.4, 127.3, 120.8, 117.8, 34.8, 31.3.

**HRMS (ESI$^+$)** m/z calcd. for $C_{21}H_{18}Br_2ONa^+$ $[M+Na]^+$: 466.9617; found: 466.9677.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.264 min; $t_{minor}$ = 3.421 min; General Procedure A: 95% *ee*. $[\alpha]_{25}^{D}$ = –29.3 (c 1.0, $CH_2Cl_2$).

**($R_a$)-3-Bromo-1-(5-bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-2-naphthaldehyde (3p).**



Following General Procedure A employing 2.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 4:1 as eluent to afford the title compound as a white, amorphous solid (38 mg, 0.081 mmol, 81% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.45 (s, 1H), 8.33 (s, 1H), 7.89 (d, *J* = 8.3 Hz, 1H), 7.67 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.54 (ddd, *J* = 8.3, 6.8, 1.3 Hz, 1H), 7.48 (d, *J* = 8.6 Hz, 1H), 7.38 (d, *J* = 8.7 Hz, 1H), 7.10 (d, *J* = 8.6 Hz, 1H).

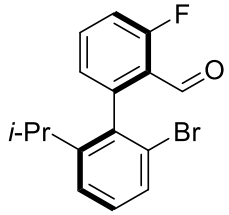
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.7, 142.8, 136.1, 134.4, 134.4, 131.5 (t, *J* = 258.5 Hz), 130.5, 129.9, 129.3, 128.3, 127.5, 127.4, 126.5, 121.2, 120.2, 117.5, 110.4.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -49.32 (d, *J* = 92.7 Hz), -49.61 (d, *J* = 92.7 Hz)

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_8Br_2F_2O_3Na^+$ $[M+Na]^+$: 490.8700; found: 490.8702.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.644 min; $t_{minor}$ = 2.748 min; General Procedure A: >99% *ee*. $[\alpha]_{25}^{D}$ = +8.1 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-3-fluoro-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (4q).**



Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent to afford the title compound as a white, amorphous solid (26 mg, 0.08 mmol, 81% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.97 (s, 1H), 7.61 (ddd, *J* = 8.4, 7.6, 5.5 Hz, 1H), 7.46 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.33 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.25 – 7.17 (m, 2H), 6.96 (d, *J* = 7.6 Hz, 1H), 2.50 (hept, *J* = 6.9 Hz, 1H), 1.06 (d, *J* = 6.9 Hz, 3H), 1.03 (d, *J* = 6.9 Hz, 3H).

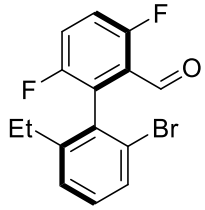
**$^{13}$C-{$^1$H} NMR** (100 MHz $CDCl_3$) δ 188.0 (d, *J* = 4.3 Hz), 163.6 (d, *J* = 262.2 Hz), 149.4, 144.5 (d, *J* = 1.5 Hz), 137.2 (d, *J* = 2.3 Hz), 135.2 (d, *J* = 10.3 Hz), 130.0, 130.0, 127.0 (d, *J* = 3.6 Hz), 124.8, 123.4, 122.9 (d, *J* = 7.0 Hz), 116.6 (d, *J* = 21.4 Hz), 31.7, 24.3, 23.5.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -117.08.

**HRMS (ESI$^+$)** m/z calcd. for $C_{16}H_{15}BrFO^+$ $[M+H]^+$: 321.0285, 323.0265; found: 321.0286, 323.0267.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.320 min; $t_{minor}$ = 2.412 min; General Procedure A: >99% *ee*. $[\alpha]_{25}^{D}$ = –8.3 (c 1.0, $CH_2Cl_2$).

**($S_a$)-2'-Bromo-6'-ethyl-3,6-difluoro-[1,1'-biphenyl]-2-carbaldehyde (4r).**



Following General Procedure A employing 1.1 equiv NBS and left for 72 h, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent to afford the title compound as a white, amorphous solid (17.4 mg, 0.054 mmol, 54% yield, 92% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$): δ 9.95 (s, 1H), 7.54 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.43 (ddd, *J* 9.0, 7.9, 4.4 Hz, 1H), 7.36 – 7.25 (m, 3H), 2.35 (q, *J* 7.6 Hz, 2H), 1.04 (t, *J* 7.5 Hz, 3H).

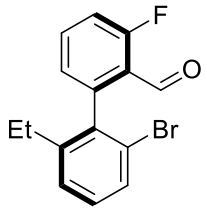
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 187.2 (dd, *J* = 3.9 Hz, 2.8 Hz,), 159.7 (dd, *J* = 258.6 Hz, 2.4 Hz) 155.5 (dd, *J* = 243.6 Hz, 2.8 Hz), 145.0, 131.4 (d, *J* = 1.7 Hz), 130.5, 130.5 (dd, *J* = 20.5 Hz, 2.0 Hz), 130.3, 127.5, 123.9, 123.2 (dd, *J* = 8.7 Hz, 2.4 Hz), 122.4 (dd, *J* = 26.0 Hz, 10.0 Hz), 118.0 (dd, *J* = 23.9 Hz, 8.1 Hz), 27.5, 14.6.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -117.55 (d, *J* 17.7 Hz), -122.24 (d, *J* 17.7 Hz).

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{11}BrF_2ONa^+$ $[M+Na]^+$: 346.9854, 348.9834; found: 346.9852, 348.9835.

**UPC²**: Chiralpak IC column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.045 min; $t_{minor}$ = 2.093 min; General Procedure A: 92% *ee*. $[\alpha]_{25}^{D}$ = –2.7 (c 0.25, $CH_2Cl_2$).

**(*R*$_a$)-2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (4s).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 1:1 as eluent to afford the title compound as a white, amorphous solid (16.0 mg, 0.052 mmol, 52% yield, >99% *ee*).

A scale up reaction (2 mmol) provided the title compound (528.3 mg, 1.72 mmol, 86% yield, >99% *ee*) following the scaled reactions conditions.

**$^1$H NMR** (400 MHz, $CD_2Cl_2$): δ 9.98 (s, 1H), 7.67 (ddd, *J* = 8.3, 7.6, 5.5 Hz, 1H), 7.51 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.32 (d, *J* = 7.8 Hz, 1H), 7.29 – 7.23 (m, 2H), 7.01 (d, *J* = 7.6 Hz, 1H), 2.41-7.23 (m, 2H), 1.02 (t, *J* = 7.6 Hz, 3H).

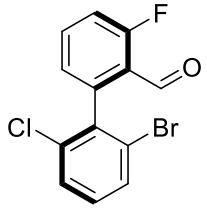
**$^{13}$C-{$^1$H}** NMR (100 MHz, $CD_2Cl_2$): δ 188.2 (d, *J* = 4.5 Hz), 164.0 (d, *J* = 261.1 Hz), 144.9, 144.4 (d, *J* = 1.5 Hz), 138.4 (d, *J* = 2.2 Hz), 135.6 (d, *J* = 10.3 Hz), 130.2, 130.0, 127.8, 127.4 (d, *J* = 3.7 Hz), 123.8, 123.0 (d, *J* = 6.9 Hz), 116.7 (d, *J* = 21.3 Hz), 27.8, 15.0.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CD_2Cl_2$) δ -118.16.

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{12}BrFONa^+$ $[M+Na]^+$: 328.9948, 330.9928; found: 328.9951, 330.9933.

**UPC²**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.463 min; $t_{minor}$ = 2.573 min; General Procedure A: >99% *ee*. $[\alpha]_{26}^{D}$ = –23.6 (c 0.5, $CH_2Cl_2$).

**(*R*$_a$)-2'-Bromo-6'-chloro-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (4t).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 5:1 as eluent to afford the title compound as a white, amorphous solid (25.2 mg, 0.080 mmol, 80% yield, >95% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.18 (s, 1H), 7.67 (td, *J* = 8.1, 5.6 Hz, 1H), 7.59 (dd, *J* = 8.1, 1.2 Hz, 1H), 7.45 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.28 (ddd, *J* = 10.5, 8.4, 1.1 Hz, 1H), 7.22 (t, *J* = 8.1 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 1H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 187.1 (d, *J* = 6.8 Hz), 164.5 (d, *J* = 260.5 Hz), 141.6 (d, *J* = 1.9 Hz), 138.6 (d, *J* = 2.5 Hz), 135.6 (d, *J* = 10.3 Hz), 134.1, 131.2, 130.2, 128.6, 127.0 (d, *J* = 3.7 Hz), 124.0, 122.4 (d, *J* = 7.4 Hz), 117.0 (d, *J* = 21.4 Hz).

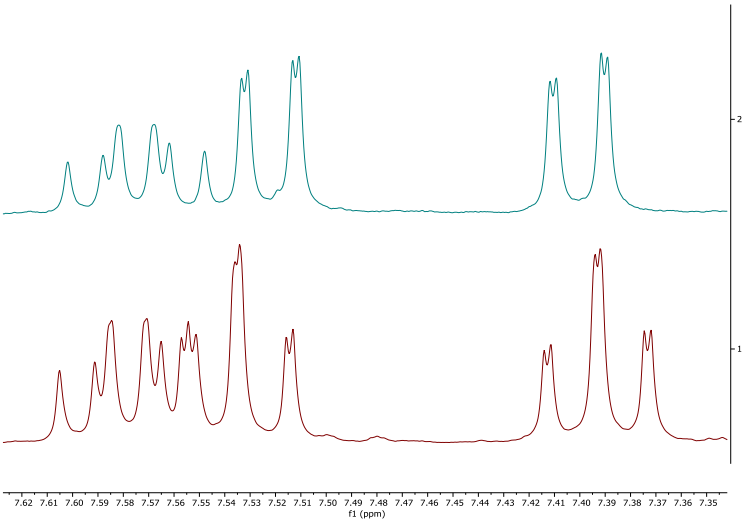
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -118.67.

**HRMS (ESI$^+$)** m/z calcd. for $C_{13}H_7BrClFONa^+$ $[M+Na]^+$: 334.9246, 336.9225, 338.9196; found: 334.9247, 336.9230, 338.9196.

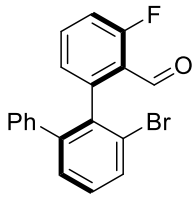
$[\alpha]_{26}^{D}$ = +0.7 (c 0.5, $CH_2Cl_2$).

UPC$^2$ conditions to separate the pair of enantiomers were unable to be obtained. To determine enantioselectivity, the chiral auxiliary, (*R*)-*tert*-butanesulfinamide, was employed to form diastereoisomers to determine the diastereomeric ratio by $^1$H NMR spectroscopy. Below is a zoom-in of the $^1$H NMR spectra

(crude mixtures) of the racemate (*below*) and the enantioselective reaction (*above*). Since only a single diastereoisomer was detected for the enantioenriched entry (>20:1 d.r), this corresponds to >95% *ee*.[6]




**($R_a$)-6'-Bromo-3-fluoro-[1,1':2',1''-terphenyl]-2-carbaldehyde (4ϕ).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent to afford the title compound as a colorless oil (21.0 mg, 0.060 mmol, 58% yield, 98% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.09 (s, 1H), 7.67 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.46 – 7.39 (m, 1H), 7.34 (dt, *J* = 15.3, 4.6 Hz, 2H), 7.18 – 7.12 (m, 3H), 7.05 (dd, *J* = 10.6, 8.4 Hz, 1H), 7.00 (dd, *J* = 6.6, 3.0 Hz, 2H), 6.88 (d, *J* = 7.6 Hz, 1H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 187.9 (d, *J* = 5.7 Hz), 163.8 (d, *J* = 259.3 Hz), 143.6, 140.5, 138.0 (d, *J* = 2.7 Hz), 134.7 (d, *J* = 10.4 Hz), 131.8, 129.5, 129.3, 129.3, 128.2 (d, *J* = 3.3 Hz), 128.0, 127.3, 123.7 (d, *J* = 7.7 Hz), 116.2 (d, *J* = 22.2 Hz).

(Note: 2 carbons were not observed)

**$^{19}$F NMR** (376 MHz, $CDCl_3$) δ - 118.65 (dd, *J* = 10.4, 5.5 Hz, 1F).

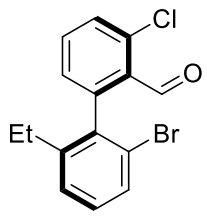
**HRMS (ESI$^+$)** m/z calcd. $C_{19}H_{13}BrFO^+$ $[M+H]^+$: 355.0128, 357.0108; found: 355.1024, 357.0107.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.918 min; $t_{minor}$ = 3.055 min; General Procedure A: 98% *ee*.

$[\alpha]_{24}^{D}$ = +34.8 (c 1.0, $CHCl_3$).

[6] A 4 mL vial was charged with a solution of (*R*)-*tert*-butanesulfinamide and aldehyde in $CH_2Cl_2$ followed by the addition of Ti(*i*-PrO)$_4$. The reaction mixture was stirred at rt and then heated to reflux overnight (until completion of aldehyde as indicated by TLC). The reaction was then quenched with brine and diluted with $CH_2Cl_2$. Large quantities of white precipitate formed and was filtered away. The organic phase was separated, and the aqueous phase was extracted with $CH_2Cl_2$. The combined organic layers were dried over $Na_2SO_4$. The solvent was removed *in vacuo* and analyzed by $^1$H NMR spectroscopy.

**($R_a$)-2'-Bromo-3-chloro-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (4u).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent (26.3 mg, 0.08 mmol, 81% yield, >99% *ee*).
Following the General Procedure C, the product was isolated by FC on $SiO_2$ using pentane:$CH_2Cl_2$ (2:1) as eluent to afford the title compound as a white, amorphous solid (28.4 mg, 0.088 mmol, 88% yield, 98% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 10.22 (s, 1H), 7.59 – 7.54 (m, 2H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.30 (d, *J* = 7.8 Hz, 1H), 7.24 (t, *J* = 7.8 Hz, 1H), 7.11 (dd, *J* = 6.6, 2.2 Hz, 1H), 2.38 – 2.21 (m, 2H), 1.03 (t, *J* = 7.6 Hz, 3H).

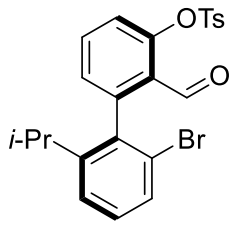
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.0, 144.3, 144.0, 138.7, 136.8, 133.7, 131.4, 130.8, 130.0, 129.6, 127.3, 127.3, 123.2, 27.5, 14.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{12}BrClONa^+$ $[M+Na]^+$: 344.9652; found: 344.9653.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.343 min; $t_{minor}$ = 2.237 min; General Procedure A: >99% *ee*. General Procedure C: 98% *ee*.

$[\alpha]_{25}^{D}$ = –42.7 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-2-formyl-6'-*iso*-propyl-[1,1'-biphenyl]-3-yl 4-methylbenzenesulfonate (4v).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using a gradient from 50% pentane in $CH_2Cl_2$ to 100% $CH_2Cl_2$ as eluent to afford the title compound as a white, amorphous solid (28.3 mg, 0.060 mmol, 60% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.73 (s, 1H), 7.71 – 7.68 (m, 2H), 7.65 (t, *J* = 8.0 Hz, 1H), 7.44 – 7.41 (m, 2H), 7.34 – 7.30 (m, 3H), 7.24 (t, *J* = 7.9 Hz, 1H), 7.09 (dd, *J* = 7.6, 1.2 Hz, 1H), 2.42 (s, 3H), 2.33 (hept, *J* = 6.9 Hz, 1H), 1.05 (d, *J* = 6.9 Hz, 3H), 0.96 (d, *J* = 6.9 Hz, 3H).

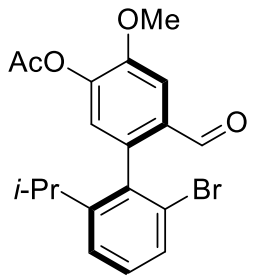
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$): δ 187.9, 150.9, 149.5, 146.8, 143.8, 138.2, 134.4, 131.8, 130.5, 130.5, 130.0, 130.0, 129.1, 128.2, 125.0, 124.0, 123.2, 32.0, 24.2, 23.5, 21.9.

**HRMS (ESI$^+$)** m/z calcd. For $C_{23}H_{22}BrO_4S^+$ $[M+H]^+$: 473.0417; found: 473.0413.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.645 min; $t_{minor}$ = 4.256 min; General Procedure A: 96% *ee*.

$[\alpha]_{25}^{D}$ = –10.9 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-6-formyl-6'-*iso*-propyl-4-methoxy-[1,1'-biphenyl]-3-yl acetate (4w).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$ as eluent to afford the title compound as a white, amorphous solid (26.8 mg, 0.068 mmol, 69% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$): δ 9.58 (s, 1H), 7.61 (s, 1H), 7.53 (d, *J* = 7.9 Hz, 1H), 7.40 (d, *J* = 7.9 Hz, 1H), 7.30 (t, *J* = 7.9 Hz, 1H), 6.92 (s, 1H), 3.95 (s, 3H), 2.62 (hept, *J* = 6.9 Hz, 1H), 2.31 (s, 3H), 1.11 (d, *J* = 6.9 Hz, 3H), 1.04 (d, *J* = 6.9 Hz, 3H).

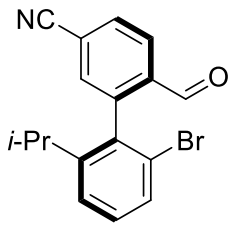
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$): δ 190.5, 168.4, 151.8, 150.8, 144.7, 137.8, 136.0, 132.8, 130.6, 130.1, 125.6, 125.2, 125.1, 110.3, 56.5, 31.8, 24.2, 23.6, 20.8.

**HRMS (ESI$^+$)** m/z calcd. For $C_{19}H_{20}BrO_4^+$ $[M+H]^+$: 391.0539; found: 391.0539.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.505 min; $t_{minor}$ = 2.620 min; General Procedure A: >99% *ee*.

$[\alpha]_{25}^{D}$ = –7.0 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-6'-*iso*-propyl-6-formyl-[1,1'-biphenyl]-3-carbonitrile (4x).**




Following General Procedure A employing 1.1 equiv NBS, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 1:1 as eluent to afford the title compound as a colorless oil (25 mg, 0.076 mmol, 76% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$): δ 9.72 (d, *J* = 0.8 Hz, 1H), 8.14 (d, *J* = 8.1 Hz, 1H), 7.87 – 7.81 (m, 1H), 7.57 – 7.53 (m, 2H), 7.42 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.36 (d, *J* = 7.9 Hz, 1H), 2.47 (hept, *J* = 6.9 Hz, 1H), 1.14 (d, *J* = 6.9 Hz, 3H), 1.04 (d, *J* = 6.9 Hz, 3H).

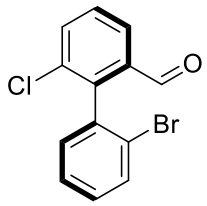
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 190.0, 149.9, 144.7, 136.8, 134.7, 134.6, 132.1, 131.1, 130.4, 128.3, 125.2, 124.0, 117.8, 117.4, 31.7, 24.2, 23.6.

**HRMS (ESI$^+$)** m/z calcd. for $C_{17}H_{14}BrNONa^+$ $[M+Na]^+$: 350.0151; found: 350.0150.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.487 min; $t_{minor}$ = 2.587 min; General Procedure A: >99% *ee*.

$[\alpha]_{25}^{D}$ = –5.3 (c 1.0, $CH_2Cl_2$).

**($S_a$)-2'-Bromo-6-chloro-[1,1'-biphenyl]-2-carbaldehyde (4y).**




Following General Procedure B, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 2:1 as eluent to afford the title compound as a white, amorphous solid (18.0 mg, 0.061 mmol, 61% yield, 93% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.62 (d, *J* = 0.8 Hz, 1H), 7.97 – 7.93 (dd, *J* = 7.8, 1.2, 1H), 7.76 – 7.72 (m, 2H), 7.51 (td, *J* = 7.8, 0.9 Hz, 1H), 7.45 (td, *J* = 7.5, 1.2 Hz, 1H), 7.35 (td, *J* = 7.7, 1.8 Hz, 1H), 7.28 (dd, *J* = 7.5, 1.8 Hz, 1H).

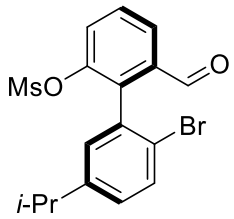
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.6, 142.7, 135.8, 135.6, 134.9, 134.8, 132.8, 131.6, 130.4, 129.6, 127.5, 125.9, 124.1.

**HRMS (ESI$^+$)** m/z calcd. for $C_{13}H_8BrClONa^+$ $[M+Na]^+$: 316,9339; found: 316.9340.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.524 min; $t_{minor}$ = 2.748 min; General Procedure A: 93% *ee*.

$[\alpha]_{26}^{D}$ = +1.6 (c 1, $CH_2Cl_2$).

**($S_a$)-2'-Bromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (4i).**




Following General Procedure B, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 2:1 as eluent to afford the title compound as a colorless oil (22.2 mg, 0.056 mmol, 56% yield, 97% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.70 (d, *J* = 0.9 Hz, 1H), 8.01 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.73 (dd, *J* = 8.2, 1.3 Hz, 1H), 7.64 – 7.60 (m, 2H), 7.27 (d, *J* = 2.3 Hz, 1H), 7.22 (dd, *J* = 8.3, 2.3 Hz, 1H), 2.94 (hept, *J* = 7.3 Hz, 1H), 2.68 (s, 3H), 1.28 – 1.24 (m, 6H).

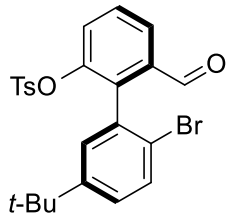
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.4, 148.7, 147.0, 137.6, 135.7, 132.8, 132.7, 131.1, 130.0, 129.0, 128.5, 126.2, 121.4, 38.4, 33.7, 24.1, 23.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{17}H_{17}BrO_4SNa^+$ $[M+Na]^+$: : 418.9924, 420.9903; found: 418.9917, 420.9901.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.720 min; $t_{minor}$ = 2.878 min; General Procedure B: 97% *ee*.

$[\alpha]_{24}^{D}$ = –11.2 (c 0.5, $CH_2Cl_2$).

**($S_a$)-2'-Bromo-5'-(*tert*-butyl)-6-formyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (4z).**




Following General Procedure B, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 2:1 as eluent to afford the title compound as a colorless oil (30.4 mg, 0.062 mmol, 62% yield, >99% *ee*).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.64 (d, *J* = 0.9 Hz, 1H), 7.98 (dd, *J* = 7.7, 1.3 Hz, 1H), 7.65 (dd, *J* = 8.2, 1.3 Hz, 1H), 7.55 (td, *J* = 7.9, 0.9 Hz, 1H), 7.47 (d, *J* = 8.4 Hz, 1H), 7.39 – 7.35 (m, 3H), 7.30 (dd, *J* = 8.5, 2.5 Hz, 1H), 7.16 (dd, *J* = 8.4, 1.6 Hz, 2H), 2.41 (s, 3H), 1.31 (s, 9H).

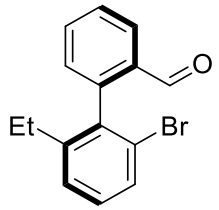
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.7, 150.6, 147.2, 145.3, 138.3, 135.7, 133.2, 132.2, 132.1, 130.3, 129.8, 129.7, 128.2, 128.0, 127.5, 125.8, 121.5, 34.8, 31.3, 21.8.

**HRMS (ESI$^+$)** m/z calcd. for $C_{24}H_{23}BrO_4SNa^+$ $[M+Na]^+$: 509.0393; found: 509.0394.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.279 min; $t_{minor}$ = 3.549 min; General Procedure B: >99% *ee*.

$[\alpha]_{24}^{D}$ = +2.0 (c 1, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (4b).**




Following General Procedure B, the product was isolated by FC on $SiO_2$ using $CH_2Cl_2$/pentane 1:3 as eluent then a second FC on IATRO beads using 5% dioxane in pentane as eluent to provide the title compound to afford the title compound as a colorless oil (20.9 mg, 0.057 mmol, 63% yield, 89% *ee*).

**$^1$H NMR** (400 MHz, $CD_2Cl_2$): δ 9.68 (d, *J* = 0.8 Hz, 1H), 8.01 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.71 (td, *J* = 7.5, 1.5 Hz, 1H), 7.58 (dt, *J* = 7.7, 1.0 Hz, 1H), 7.54 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.34 (dd, *J* = 7.7, 1.4 Hz, 1H), 7.28 (d, *J* = 7.8 Hz, 1H), 7.26 – 7.22 (m, 1H), 2.39– 2.28 (m, 2H), 1.00 (t, *J* = 7.6 Hz, 3H).

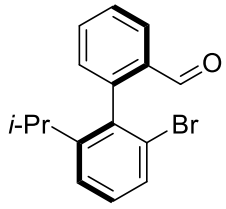
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$): δ 191.7, 145.5, 144.1, 138.1, 134.4, 134.2, 131.3, 130.3, 130.1, 128.9, 127.9 (2C), 124.6, 27.9, 15.1.

**HRMS (ESI+)** m/z calcd. for $C_{15}H_{13}BrONa^+$ $[M+Na]^+$: 311.0042; found: 311.0056.

**UPC$^2$**: Chiralpak IC column [CO2/iPrOH gradient, 1% iPrOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.771 min; $t_{minor}$ = 2.839 min; General Procedure B: >99% *ee*.

$[\alpha]_{25}^{D}$ = –18.9 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (4a).**




Following General Procedure B, the product was isolated as an inseparable mixture containing product and starting material (corrected yield is noted) by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 3:1 as eluent to afford the title compound as a colorless oil (17.8 mg, 0.059 mmol, 59% yield, 97% *ee*).

**$^1$H NMR** (400 MHz $CDCl_3$) δ 9.71 (d, *J* = 0.6 Hz, 1H), 8.06 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.69 (td, *J* = 7.5, 1.5 Hz, 1H), 7.58 – 7.51 (m, 2H), 7.38 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.31 – 7.28 (m, 1H), 7.22 7.20 (dd, *J* = 7.7, 0.6 Hz, 1H), 2.57 (hept, *J* = 6.9 Hz, 1H), 1.11 (d, *J* = 6.9 Hz, 3H), 1.03 (d, *J* = 6.9 Hz, 3H).

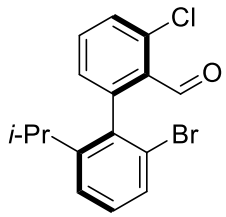
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 191.6, 150.0, 144.3, 137.0, 134.1, 134.1, 130.9, 130.1, 130.0, 128.6, 127. 7, 124.8, 124.4, 31.5, 24.3, 23.6.

**HRMS (ESI$^+$)** m/z calcd. for $C_{16}H_{15}BrONa^+$ $[M+Na]^+$: 325.0199, 327.0179; found: 325.0203, 327.0185.

**UPC$^2$**: Chiralpak IB column [$CO_2$/iPrOH gradient, 1% iPrOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 2.0 mL·min$^{-1}$; $t_{major}$ = 3.212 min; $t_{minor}$ = 3.351 min; General Procedure B: 97% *ee*.

$[\alpha]_{26}^{D}$ = +7.7 (c 0.5, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-3-chloro-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (6a).**




Following General Procedure C, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 3:1 as eluent to afford the title compound as a yellow, amorphous solid (26.6 mg, 0.079 mmol, 79% yield, 98% *ee*).

**$^1$H NMR** (400 MHz $CDCl_3$) δ 10.26 (s, 1H), 7.57 (d, *J* = 3.8 Hz, 1H), 7.56 (s, 1H), 7.48 (d, *J* = 1.3 Hz, 1H), 7.38 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.29 (d, *J* = 5.6 Hz, 1H), 7.12 (dd, *J* = 6.1, 2.6 Hz, 1H), 2.52 (hept, *J* = 6.9 Hz, 1H), 1.11 (d, *J* = 6.9 Hz, 6H).

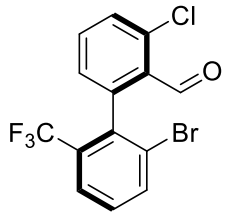
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.0, 149.3, 144.2, 138.0, 136.9, 133.6, 131.5, 130.8, 130.0, 129.9, 129.8, 124.7, 123.0, 31.7, 24.4, 23.4.

**HRMS (ESI$^+$)** m/z calcd. for $C_{16}H_{14}BrClONa^+$ $[M+Na]^+$: 358.9809; found: 358.9806.

**UPC$^2$**: Chiralpak ID column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.050 min; $t_{minor}$ = 1.977 min; General Procedure C: 98% *ee*.

$[\alpha]_{26}^{D}$ = –6.2 (c 1.0, $CH_2Cl_2$).

**($R_a$)-2'-Bromo-3-chloro-6'-(trifluoromethyl)-[1,1'-biphenyl]-2-carbaldehyde (6e).**




Following General Procedure C, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 3:1 as eluent to afford the title compound as a white, amorphous solid (27.7 mg, 0.076 mmol, 76% yield, >99% *ee*).

**$^1$H NMR** (400 MHz $CDCl_3$) δ 10.40 (s, 1H), 7.84 (d, *J* = 8.0 Hz, 1H), 7.73 (d, *J* = 8.0 Hz, 1H), 7.60 – 7.54 (m, 2H), 7.38 (td, *J* = 8.0, 1.0 Hz, 1H), 7.13 – 7.08 (m, 1H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 189.6, 140.2, 139.3 (q, *J* = 1.6 Hz), 138.4, 136.1, 133.6, 131.4, 130.9, 130.2 (q, *J* = 1.2 Hz), 130.0 (d, *J* = 30.1 Hz), 129.2, 125.3, 125,3 (q, *J* = 5.2 Hz), 123.2 (q, *J* = 274.9 Hz).

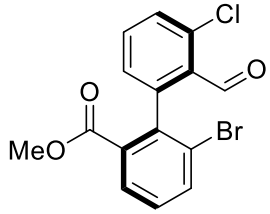
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -59.01.

**HRMS (ESI$^+$)** m/z calcd. for $C_{14}H_7BrClF_3ONa^+$ $[M+Na]^+$: 384.9214, 386.9193, 388.9164; found: 384.9220, 386.9196, 388.9166.

**UPC$^2$**: Chiralpak IB column [$CO_2$/$CH_2Cl_2$ gradient, 1% iPrOH (0.5 min), then gradient from 1% to 20% (0.6%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 4.533 min; $t_{minor}$ = 4.103 min; General Procedure A: >99% *ee*.[7]

$[\alpha]_{26}^{D}$ = +84.6 (c 1, $CH_2Cl_2$).

**($R_a$)-Methyl 6-bromo-3'-chloro-2'-formyl-[1,1'-biphenyl]-2-carboxylate (6f).**




Following General Procedure C, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 3:1 as eluent to afford the title compound as a white, amorphous solid (20.2 mg, 0.057 mmol, 57% yield, >99% *ee*).

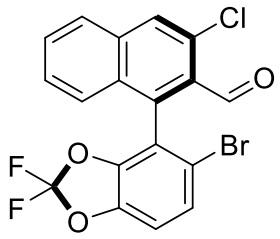
**$^1$H NMR** (400 MHz $CDCl_3$) δ 10.39 (d, *J* = 0.6 Hz, 1H), 8.01 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.82 (dd, *J* = 8.1, 1.2 Hz, 1H), 7.54 – 7.52 (m, 2H), 7.34 (t, *J* = 7.9 Hz, 1H), 7.02 – 6.98 (m, 1H), 3.63 (s, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.0, 166.1, 143.6, 141.8, 137.9, 136.4, 133.7, 131.2, 130.8, 130.5, 129.6, 129.0, 128.9, 124.6, 52.36.

[7] The title compound did not separate well on UPC$^2$. Instead, a transformation was conducted to increase separation: The aldehyde was mixed with 10 equiv. ethyl(triphenylphosphoranylidene)acetate in $CH_2Cl_2$. After stirring for 3 h, the reaction was purified with FCC to afford the alkene product which was subsequently subjected to UPC$^2$.

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{10}BrClO_3Na^+$ $[M+Na]^+$: 374.9395, 376.9374; found: 374.9395, 376.9375. **UPC$^2$**: Chiralpak ID column [$CO_2$/$CH_2Cl_2$ gradient, 1% $CH_2Cl_2$ (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.025 min; $t_{minor}$ = 3.099 min; General Procedure A: >86% *ee* (impurity coelutes with minor peak).[8]
$[\alpha]_{26}^{D}$ = +31.9 (c 1, $CH_2Cl_2$).

**($R_a$)-1-(5-Bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-3-chloro-2-naphthaldehyde (6p).**




Following General Procedure C, the product was isolated by FC on $SiO_2$ using pentane/$CH_2Cl_2$ 5:1 as eluent to afford the title compound as a white, amorphous solid (20.3 mg, 0.048 mmol, 48% yield, 97% *ee*).

**$^1$H NMR** (400 MHz $CDCl_3$) δ 10.54 (s, 1H), 8.11 (s, 1H), 7.89 (d, *J* = 8.2 Hz, 1H), 7.68 (ddd, *J* = 8.2, 6.8, 1.2 Hz, 1H), 7.52 (ddd, *J* = 8.2, 6.8, 1.3 Hz, 1H), 7.48 (d, *J* = 8.5 Hz, 1H), 7.39 (dq, *J* = 8.7, 0.9 Hz, 1H), 7.11 (d, *J* = 8.5 Hz, 1H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 190.2, 143.0, 135.9, 134.7, 132.0, 131.6 (t, *J* = 259.6 Hz), 130.8, 130.2, 130.0, 128.7, 128.3, 127.7, 127.6, 126.6, 121.3, 117.6, 110.6.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -49.34 (d, *J* = 93.1 Hz), -49.63 (d, *J* = 93.1 Hz).

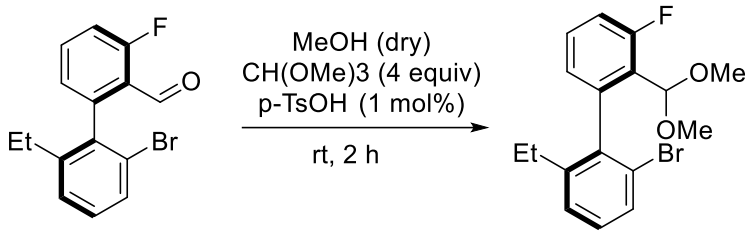
**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_8BrClF_2O_3Na^+$ $[M+Na]^+$: 446.9206 448.9186 450.9156; found: 446.9216, 448.9191, 450.9159.

**UPC$^2$**: Chiralpak IC column [CO2/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.521 min; $t_{minor}$ = 2.696 min; General Procedure A: 97% *ee*.
$[\alpha]_{26}^{D}$ = +13.3 (c 1, $CH_2Cl_2$).

[8] The title compound did not separate well on UPC$^2$. Instead, a transformation was conducted to increase separation: The aldehyde was mixed with 10 equiv. ethyl(triphenylphosphoranylidene)acetate in $CH_2Cl_2$. After stirring for 3 h, the reaction was purified with FCC to afford the alkene product which was subsequently subjected to UPC$^2$.

## 5. Procedures for Derivations of Products

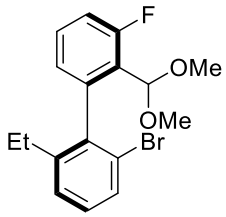
### 5.1 Acetalprotection




***Scheme S4:*** *Acetal protection of* ***4s****.*

An 8-mL vial equipped with a magnetic stir bar was charged with **4s** (1.15 mmol, 1 equiv)*, p*-TsOH (0.012 mmol, 10 mol%), trimethyl orthoformate (4.6 mmol, 4 equiv) and anhydrous MeOH (1 mL). The vial was sparged with Ar and sealed with a Teflon screw cap. The resulting solution was stirred at rt for 2 h and then passed through a short silica plug and eluted with EtOAc to provide pure **4s'** as beige, amorphous solid (208.6 mg, 0.591 mmol, 96% yield, >99% *ee*).[9]

**($R_a$)-2'-Bromo-2-(dimethoxymethyl)-6'-ethyl-3-fluoro-1,1'-biphenyl (4s').**




**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 7.52 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.39 (td, *J* = 7.9, 5.3 Hz, 1H), 7.30 (d, *J* = 7.8, 1.3 Hz, 1H), 7.24 (t, *J* = 7.8 Hz, 1H), 7.13 (ddd, *J* = 11.0, 8.3, 1.2 Hz, 1H), 6.89 (dd, *J* = 7.6, 1.2 Hz, 1H), 4.77 (d, *J* = 1.3 Hz, 1H), 3.30 (s, 3H), 3.25 (s, 3H), 2.43 – 2.21 (m, 2H), 1.03 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 161.3 (d, *J* = 252.5 Hz), 145.4, 141.4 (d, *J* = 4.7 Hz), 139.0 (d, *J* = 2.4 Hz), 130.0, 130.0 (d, *J* = 9.6 Hz), 129.6, 127.2, 125.9 (d, *J* = 3.3 Hz), 124.2, 124.1 (d, *J* = 12.5 Hz), 116.4 (d, *J* = 22.8 Hz), 103.9, 56.1, 55.8, 27.1, 14.8.

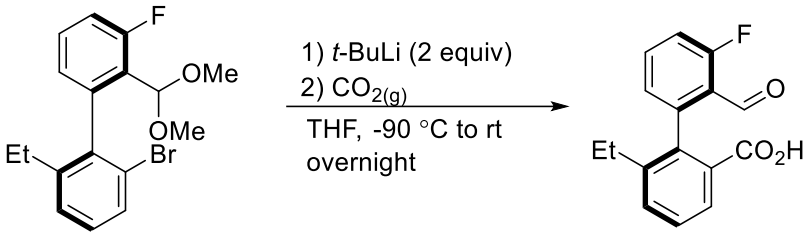
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ –113.29.

**HRMS (ESI$^+$)** m/z calcd. for $C_{17}H_{18}BrFO_2Na^+$ $[M+Na]^+$: 375.0367, 377.0346; found: 375.0365, 377.0346.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.720 min; $t_{minor}$ = 2.434 min: >99% *ee*.

$[\alpha]_{25}^{D}$ = –216.3 (c 0.19, $CH_2Cl_2$).

### 5.2 Carboxylation



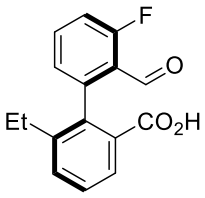

***Scheme S5:*** *Carboxylation of* ***4s'****.*

To a flame-dried, 10 mL schlenk flask equipped with a stir bar was added **4s'** (35.3 mg, 0.1 mmol, 1 equiv), and anhydrous, degassed THF (1 mL, 0.1 M). The reaction was submerged in a cooling bath at ~ –90 °C (toluene, $N_{2(l)}$) followed by *t*-BuLi (0.12 mL of 1.7 M in pentane, 0.2 mmol, 2.0 equiv). After 30 s, $CO_2$ was

[9] M. Shibata, K. Nakajimaa, Y. Nishibayashi, *Chem. Commun.* 2014, **50**, 7874-7877.

bubbled through the resulting yellow solution for 5 min, and kept under a $CO_2$ atmosphere. The resulting solution was removed from the cooling bath and allowed to warm to rt overnight, quenched with 1 M HCl (3 mL), extracted with EtOAc (3 x 5 mL). The combined organic phases were dried over $Na_2SO_4$, filtered, and concentrated. The crude mixture was purified by FC on $SiO_2$ (200 mL of 20% EtOAc in $CH_2Cl_2$, then 100 mL 100 % EtOAc, then 2% AcOH in EtOAc) to provide pure **5sa** as white, amorphous solid (20.1 mg, 0.074 mmol, 74% yield, >99% *ee*).[10]

**($R_a$)-6-Ethyl-3'-fluoro-2'-formyl-[1,1'-biphenyl]-2-carboxylic acid (5sa).**




**$^1$H NMR** (400 MHz, $CDCl_3$) δ 10.04 (s, 1H), 7.93 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.57 – 7.50 (m, 2H), 7.44 (t, *J* = 7.7 Hz, 1H), 7.22 – 7.15 (m, 1H), 6.89 (dd, *J* = 7.6, 1.0 Hz, 1H), 2.31 – 2.20 (m, 2H), 1.01 (t, *J* = 7.5 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 188.4 (d, *J*= 5.2 Hz), 172.1, 163.9 (d, *J*= 258.4 Hz), 144.0, 143.1, 139.1 (d, *J*= 2.3 Hz), 134.8 (d, *J*= 10.3 Hz), 133.0, 128.8, 128.3, 126.2, 126.1 (d, *J*= 3.6 Hz), 122.9 (d, *J*= 6.5 Hz), 115.8 (d, *J*= 21.8 Hz), 26.4, 14.9.

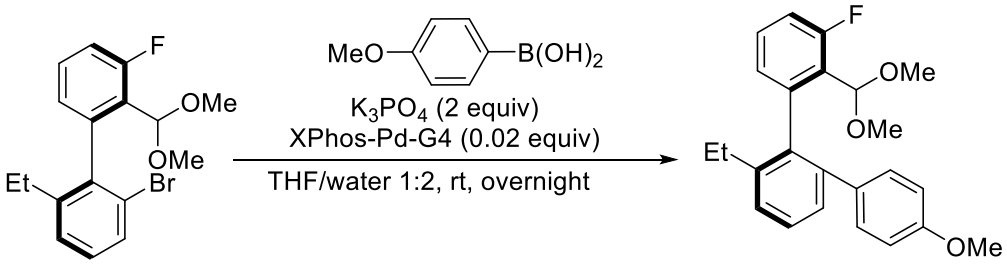
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ –118.89.

**HRMS (ESI$^+$)** m/z calcd. for $C_{16}H_{13}FO_3Na^+$ $[M+Na]^+$: 295.0741; found: 295.0740.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 4.011 min; $t_{minor}$ = 3.581 min: >99% *ee*.

$[\alpha]_{25}^{D}$ = +13.6 (c 1.0, $CH_2Cl_2$).

**5.3 Suzuki coupling**



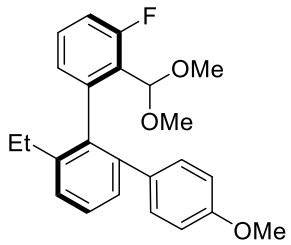

***Scheme S6:*** *Suzuki-Miyuara cross-coupling of **4s'**.*

In a glovebox, a 4-mL vial, equipped with a magnetic stir bar, was loaded with **4s'** (35.3 mg, 0.1 mmol, 1 equiv), boronic acid (0.15 mmol, 1.5 equiv), and XPhos-Pd-G4 (0.002 mmol, 0.02 equiv). After addition of degassed THF (0.2 mL) and degassed 0.5 M $K_3PO_4$ in water (0.4 mL), the vial was sealed with a Teflon screw cap. The resulting reaction was stirred at rt for 2 h. Upon completion of the reaction, the resulting solution was directly loaded onto a column and purified by FC using $CH_2Cl_2$ to provide **5sb** as white, amorphous solid (25.8 mg, 0.068 mmol, 68% yield, >99% *ee*).[11]

[10] C. K. Hazra, Q. Dherbassy, J. Wencel-Delord, F. Colobert, *Angew. Chem. Int. Ed.* 2014**, 53***,* 13871-13875.

[11] T. Kinzel, Y. Zhang, S. L. Buchwald, *J. Am. Chem. Soc.* 2010, **132,** 14073-14075.

**($R_a$)-2-(Dimethoxymethyl)-6'-ethyl-3-fluoro-4''-methoxy-1,1':2',1''-terphenyl (5sb).**




**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 7.41 (t, *J* = 7.6 Hz, 1H), 7.33 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.27 – 7.21 (m, 2H), 7.07 – 7.02 (m, 2H), 7.01 – 6.93 (m, 2H), 6.72 – 6.67 (m, 2H), 4.82 (d, *J* = 1.5 Hz, 1H), 3.72 (s, 3H), 3.20 (s, 3H), 3.09 (s, 3H), 2.42 – 2.23 (m, 2H), 1.08 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 161.0 (d, *J* = 252.4 Hz), 158.3, 143.0, 141.1 (d, *J* = 4.7 Hz), 140.8, 136.7 (d, *J* = 2.2 Hz), 133.80, 130.7, 128.8 (d, *J* = 9.6 Hz), 128.1, 127.6, 127.4 (d, *J* = 3.2 Hz), 126.8, 124.4 (d, *J* = 12.4 Hz), 115.2 (d, *J* = 23.1 Hz), 112.8, 103.6 (d, *J* = 1.2 Hz), 55.2, 55.0, 26.5, 14.8.

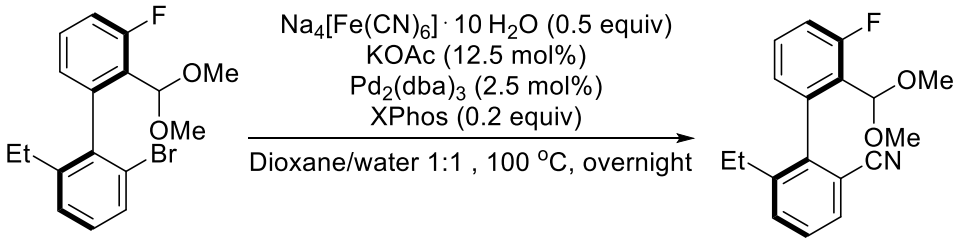
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CD_2Cl_2$) δ –112.90.

**HRMS (ESI$^+$)** m/z calcd. for $C_{24}H_{25}FO_3Na^+$ $[M+Na]^+$: 403.1680; found: 403.1685.

**UPC$^2$**: Upon acetal deprotection with HCl. Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.653 min; $t_{minor}$ = 2.586 min; >99% *ee*.

$[\alpha]_{27}^{D}$ = +3.9 (c 1, $CH_2Cl_2$).

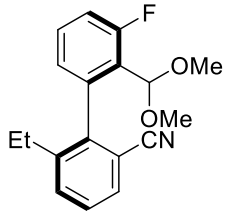
**5.4 Cyanation**




***Scheme S7:*** *Cyanation of **4s'**.*

In a 4-mL vial equipped with a magnetic stir bar was added **4s'** (35.3 mg, 0.1 mmol, 1 equiv), $Na_4[Fe(CN)_6]\cdot 10\ H_2O$ (0.05 mmol, 0.5 equiv), $Pd_2(dba)_3$ (0.0025 mmol, 2.5 mol%), and XPhos (0.02 mmol, 0.2 equiv). After addition of degassed dioxane (0.25 mL) and degassed $KOAc_{(aq)}$ (0.25 mL, 0.05 M), the atmosphere was exchanged with Ar and the vial was sealed with a Teflon screw cap. The resulting solution was stirred at 100 °C overnight. Upon completion of the reaction, the resulting solution was directly loaded onto a column and purified by FC using EtOAc/pentane 1:10 to provide pure **5sc** as white, amorphous solid (22.9 mg, 0.077 mmol, 77% yield, >99% *ee*).[12]

**($R_a$)-2'-(Dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-carbonitrile (5sc).**




**$^1$H NMR** (400 MHz, $CDCl_3$): δ 7.57 (dd, *J* = 7.6, 1.4 Hz, 1H), 7.53 (d, *J* = 7.5 Hz, 1H), 7.45 – 7.38 (m, 2H), 7.19 (ddd, *J* = 10.7, 8.3, 1.2 Hz, 1H), 6.95 (d, *J* = 7.7 Hz, 1H), 4.98 (s, 1H), 3.32 (s, 3H), 3.26 (s, 3H), 2.48-2.30 (m, 2H), 1.06 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 161.3 (d, *J* 251.6 Hz), 144.4, 142.6 (d, *J* 2.4 Hz), 138.8 (s, *J* 4.2 Hz), 132.2, 130.3 (d, *J* 9.6 Hz), 129.8, 128.5, 126.1 (d, *J* 3.35 Hz), 124.3 (s, *J* 12.5 Hz), 118.3, 116.8 (d, *J* 24.3 Hz), 113.8, 102.4 (d, *J* 1,9 Hz), 55.9, 54.8, 26.3, 14.6.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -114.61.

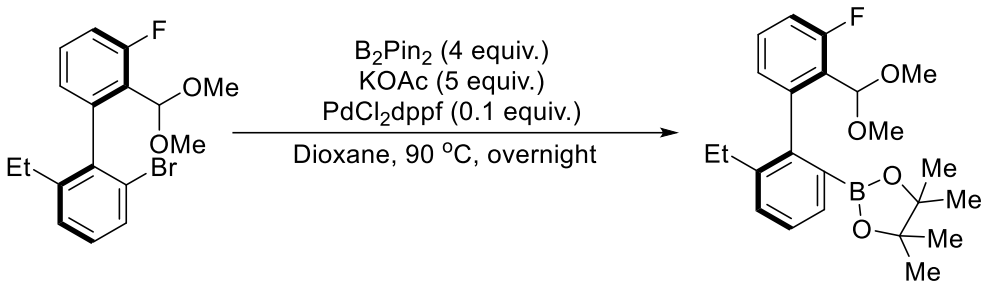
[12] T. D. Senecal, W. Shu, S. L. Buchwald, *Angew. Chem. Int. Ed.* 2013, **52**, 10035-10039.

**HRMS (ESI$^+$)** m/z calcd. for $C_{18}H_{18}FNO_2Na^+$ $[M+Na]^+$ : 322.1214; found: 322.1219.

**UPC$^2$**: Chiralpak IC column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.697 min; $t_{minor}$ = 2.448 min; >99% *ee*.

$[\alpha]_{25}^{D}$ = +46.1 (c 0.06, $CH_2Cl_2$).

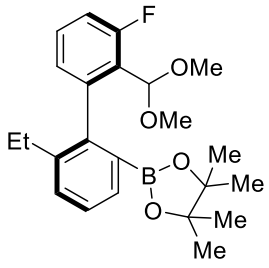
**5.5 Miyuara coupling**




***Scheme S8:*** *Miyuara coupling of* ***4s'****.*

In a flame-dried 4-mL vial, equipped with a magnetic stir bar, was added the **4s'** (35.3 mg, 0.1 mmol, 1 equiv), Pd(dppf)$Cl_2$ (7.3 mg, 0.01 mmol, 10 mol%), $B_2Pin_2$ (102 mg, 0.4 mmol, 4 equiv) and KOAc (49.1 mg, 0.5 mmol, 5 equiv). After addition of degassed dioxane (0.5 mL), the atmosphere was exchanged with Ar and the vial was sealed with a Teflon screw cap. The resulting reaction was stirred at 90 °C overnight. Upon completion of the reaction, the resulting solution was dried under a flow of $N_2$, dissolved in pentane, and then directly loaded onto a column and purified by FC using EtOAc/pentane 1:20 to provide pure **5sd** as white, amorphous solid (25.8 mg, 0.068 mmol, 68% yield, >99% *ee*).[13]

**($S_a$)-2-(2'-(Dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (5sd).**




**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 7.56 (dd, *J* = 7.2, 1.7 Hz, 1H), 7.41 – 7.32 (m, 2H), 7.30 – 7.23 (m, 1H), 7.04 (ddd, *J* = 11.2, 8.3, 1.2 Hz, 1H), 6.89 (dd, *J* = 7.6, 1.2 Hz, 1H), 4.71 (d, *J* = 1.4 Hz, 1H), 3.22 (d, *J* = 9.5 Hz, 6H), 2.44 – 2.28 (m, 2H), 1.07 – 1.00 (m, 15H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$): δ 161.3 (d, *J* = 250.4 Hz) 144.0 (d, *J* = 2.3 Hz), 143.8 (d, *J* = 4.8 Hz), 142.4, 132.2, 130.5, 129.0 (d, *J* = 9.4 Hz), 127.7, 126.7 (d, *J* = 3.3 Hz), 124.9 (d, *J* = 12.3 Hz), 115.2 (d, *J* = 22.8 Hz), 104.4, 83.7, 55.8, 55.7, 26.4, 24.8, 24.7, 15.1.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ –115.70.

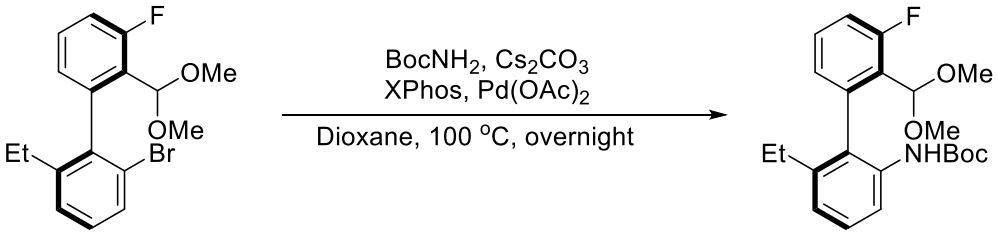
**HRMS (ESI$^+$)** m/z calcd. for $C_{23}H_{30}BFO_4Na^+$ $[M+Na]^+$: 423.2113; found: 423.2120.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeCN gradient, 1% MeCN (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.089 min; $t_{minor}$ = 1.976 min; >99% *ee*.

$[\alpha]_{25}^{D}$ = +3.2 (c 0.25, $CH_2Cl_2$)

[13] M.-M. Xu, X.-Y. You, Y.-Z. Zhang, Y. Lu, K. Tan, L. Yang, Q. Cai, *J. Am. Chem. Soc.* 2021, **143**, 8993-9001.

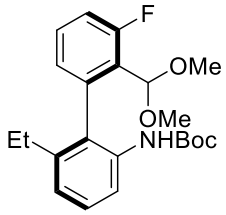
**5.6 Buchwald–Hartwig amination**




***Scheme S9:*** *Buchwald-Hartwig amination of* ***4s'****.*

To a flame-dried 4-mL vial, equipped with a magnetic stir bar, was added the **4s'** (35.3 mg, 0.1 mmol, 1 equiv), $Pd(OAc)_2$ (2.25 mg, 0.01 mmol, 0.1 equiv), $BocNH_2$ (23.4 mg, 0.2 mmol, 2 equiv), $Cs_2CO_3$ (45.6 mg, 0.14 mmol, 1.4 equiv) and XPhos (14.3 mg, 0.03 mmol, 0.3 equiv). After addition of degassed dioxane (1 mL), the atmosphere was exchanged with Ar, and the vial was sealed with a Teflon screw cap. The resulting reaction was stirred at 100 °C overnight. Upon completion of the reaction, the mixture was quenched with saturated $NH_4Cl_{(aq)}$ and extracted with EtOAc. The combined organic layers were combined, dried over $Na_2SO_4$, and concentrated *in vacuo*. The resulting residue was dissolved in $CH_2Cl_2$, and then loaded onto a $SiO_2$ column and purified by FC using EtOAc/pentane 1:20 to provide **5se** as colorless oil (31.4 mg, 0.08 mmol, 81% yield, >99% *ee*).[13]

**(*$R_a$*)-*tert*-Butyl (2'-(dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-yl)carbamate (5se).**




**$^1$H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.2 Hz, 1H), 7.42 (ddd, *J* = 8.2, 7.5, 5.3 Hz, 1H), 7.34 (t, *J* = 8.0 Hz, 1H), 7.19 (ddd, *J* = 10.8, 8.3, 1.2 Hz, 1H), 7.04 (d, *J* = 7.7 Hz, 1H), 6.92 (dd, *J* = 7.6, 1.2 Hz, 1H), 6.05 (s, 1H), 4.83 (d, *J* = 1.3 Hz, 1H), 3.30 (d, *J* = 9.7 Hz, 6H), 2.34 – 2.14 (m, 2H), 1.40 (s, 9H), 1.04 (t, *J* = 7.5 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$): δ 162.5 (d, *J* = 253.4 Hz), 153.0, 142.9, 137.9 (d, *J* = 4.3 Hz), 136.0, 130.8 (d, *J* = 9.6 Hz), 128.9, 126.4 (d, *J* = 3.3 Hz), 125.2 (d, *J* = 12.1 Hz), 123.0, 117.9, 116.9 (d, *J* = 22.7 Hz), 103.8, 80.4, 56.3, 55.7, 28.4, 26.5, 14.9.

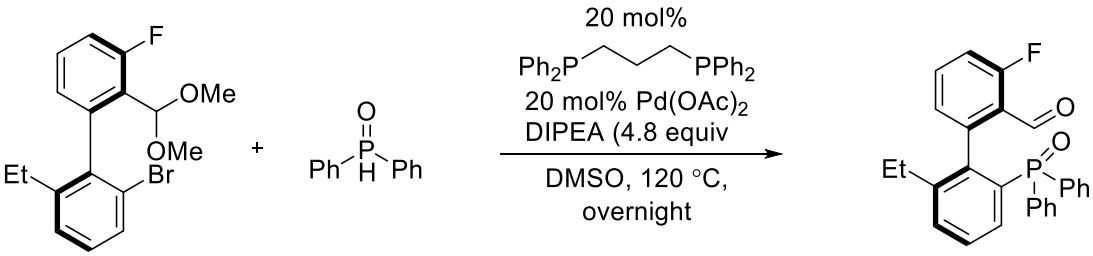
**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ –112.81.

**HRMS (ESI$^+$)** m/z calcd. For $C_{22}H_{28}FNO_4Na^+$ $[M+Na]^+$: 412.1895; found: 412.1896.

**UPC$^2$**: Chiralpak IC column [$CO_2$/$CH_2Cl_2$ gradient, 1% $CH_2Cl_2$ (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.951 min; $t_{minor}$ = 2.993 min: >99% *ee*.

$[\alpha]_{25}^{D}$ = –37.0 (c 1, $CH_2Cl_2$).

**5.7 C–P Cross-coupling reaction**

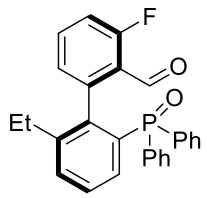



***Scheme S10:*** *C–P Cross-coupling reaction at* ***4s'****.*

To a flame-dried, 4-mL vial equipped with a stir bar was added **4s'** (35.3 mg, 0.1 mmol, 1 equiv), $Pd(OAc)_2$ (4.49 mg, 0.02 mmol, 0.2 equiv), dppp (8.5 mg, 0.02 mmol, 0.2 equiv), DIPEA (84 mL, 0.48 mmol, 4.8 equiv),

DMSO (0.6 mL), and diphenylphosphine oxide (40.4 mg, 2 equiv). The vial was sparged with Ar, capped, and heated to 120 °C overnight, then cooled to rt and diluted with EtOAc (10 mL) and 4 M HCl in dioxane (200 ml). The resulting solution was washed with $H_2O$ (3 x 10 mL) and brine (1 x10 mL). The organic phase was dried over $Na_2SO_4$, filtered, and concentrated. The crude mixture was purified via FC on $SiO_2$ (20% EtOAc in $CH_2Cl_2$) to provide pure **5sf** as white, amorphous solid (36.7 mg, 0.077 mmol, 77% yield, >99% *ee*).[14]

**($R_a$)-2'-(Diphenylphosphoryl)-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (5sf).**



**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 9.75 (s, 1H), 7.57 – 7.45 (m, 7H), 7.41 – 7.33 (m, 5H), 7.16 – 7.10 (m, 2H), 7.01 – 6.96 (m, 1H), 6.57 (d, *J* = 7.7 Hz, 1H), 2.29 – 2.17 (m, 2H), 0.98 (t, *J* = 7.5 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$): δ 188.3 (d, *J* = 5.0 Hz), 163.1 (d, *J* = 260.3 Hz), 144.6 (d, *J* = 8.8 Hz), 142.1 (dd, *J* = 7.7, 2.2 Hz), 141.2 (dd, , *J* = 4.5, 1.6 Hz), 134.0, 133.5, 133.3 (d, *J* = 9.5 Hz), 132.4 (dd, , *J* = 2.6 Hz), 132.4, 132.1 (d, *J* = 9.5 Hz), 132.0 (d, *J* = 26.3, 9.5 Hz), 132.0 (d, *J* = 2.9 Hz), 131.8 (d, *J* = 2.9 Hz), 131.4, 131.2, 128.9 (d, *J* = 4.0 Hz), 128.7 (dd, *J* = 11.9, 2.7 Hz), 128.0 (d, *J* = 13.6 Hz), 124.2 (d, *J* = 7.7 Hz), 116.3 (d, *J* = 21.5 Hz), 26.5 (d, *J* = 1.4 Hz), 14.8.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CD_2Cl_2$) δ -119.95.

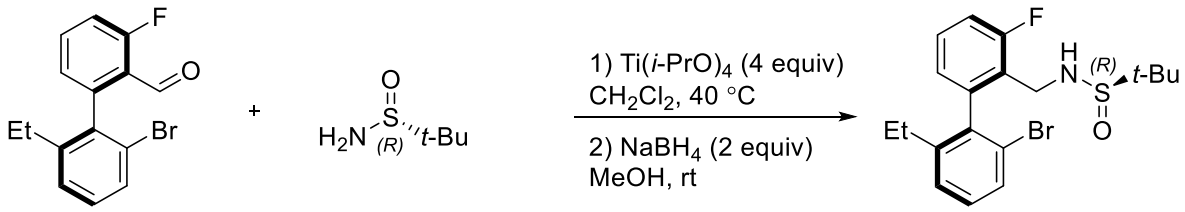
**$^{31}$P-{$^1$H} NMR** (162 MHz, $CD_2Cl_2$) δ 26.68.

**HRMS (ESI$^+$)** m/z calcd. For $C_{27}H_{23}FO_2P^+$ $[M+H]^+$: 429.1414; found: 429.1417.

**UPC$^2$**: Chiralpak IB column [$CO_2$/MeOH gradient, 1% MeOH (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 3.254 min; $t_{minor}$ = 3.330 min; >99% *ee*.

$[\alpha]_{25}^{D}$ = +3.6 (c 1.0, $CH_2Cl_2$)

**5.8 Reductive amination**



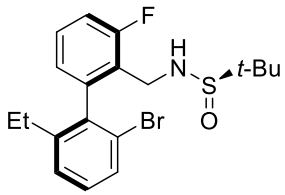

***Scheme S11:*** *Reductive amination of **4s** to furnish **5sg**.*

To a 4-mL vial, equipped with a stir bar, was added **4s** (30.7 mg, 0.1 mmol, 1 equiv), (*R*)-2-methyl-2-propanesulfinamide (14.5 mg, 0.012 mmol, 1.2 equiv), Ti(*i*-PrO)$_4$ (118 mL, 0.40 mmol, 4 equiv), and $CH_2Cl_2$ (0.2 mL) and heated to 40 °C. After 5 h, the solvent was removed *in vacuo* and $NaBH_4$ (15.0 mg, 0.4 mmol, 4 equiv) was added followed by MeOH (50 mL) and stirred overnight at rt. The resulting solution was concentrated and purified by FC on $SiO_2$ ($CH_2Cl_2$:EtOAc 15:1) to provide **5sg** as a colorless oil (32.9 mg, 0.080 mmol, 80% yield, >20:1 dr).[15]

[14] Q.-Y. Zhao, M. Shi, *Tetrahedron* 2011**, 67**, 3724-3732.

15 Q. J. Yao, S. Zhang, B. B. Zhan, B. F. Shi, *Angew. Chem. Int. Ed.* 2017, **56**, 6617-6621.

**($R_a$,*R*)-*N*-((2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl)methyl)-2-methylpropane-2-sulfinamide (5sg).**




**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 7.44 (dd, *J* = 7.9, 1.3 Hz, 1H), 7.34 – 7.27 (m, 1H), 7.24 (d, *J* = 7.6 Hz, 1H), 7.16 (t, *J* = 7.8 Hz, 1H), 7.10 – 7.03 (m, 1H), 6.84 (dd, *J* = 7.7, 1.2 Hz, 1H), 4.03 (ddd, *J* = 13.6, 6.6, 1.4 Hz, 1H), 3.79 (ddd, *J* = 13.3, 7.7, 1.6 Hz, 1H), 3.25 (t, *J* = 7.0 Hz, 1H), 2.34 – 2.13 (m, 2H), 0.99 (s, 9H), 0.96 (t, *J* = 7.6 Hz, 3H).

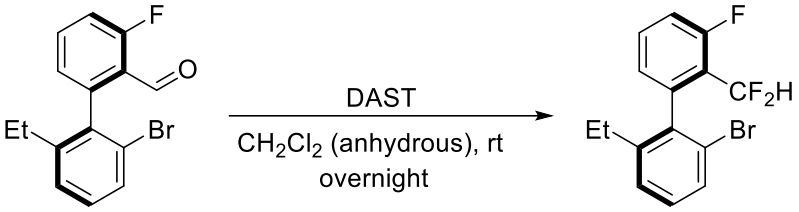
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 162.3 (d, *J* = 247.1 Hz), 145.1, 142.5 (d, *J* = 4.4 Hz), 139.1 (d, *J* = 2.7 Hz), 130.5, 130.1, 129.7 (d, *J* = 9.0 Hz), 127.9, 126.3 (d, *J* = 2.64 Hz), 124.7 (d, *J* = 15.4 Hz), 124.6, 115.4 (d, *J* = 22.4 Hz), 56.0, 41.6 (d, *J* = 3.0 Hz), 27.7, 22.6, 15.2.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ –116.67.

**HRMS (ESI$^+$)** m/z calcd. for $C_{27}H_{23}BrFNOSNa^+$ $[M+Na]^+$: 434.0560, 436.0540; found: 434.0567, 436.0547.

$[\alpha]_{25}^{D}$ = - 23.9 (c 1.0, $CH_2Cl_2$)

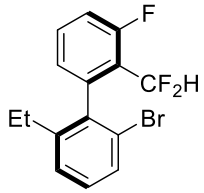
**5.9 DAST reaction**




***Scheme S12:*** *Deoxyfluorination of **4s** to furnish **5sh**.*

To a flame-dried 4-mL vial, equipped with a stir bar, was added **4s** (30.7 mg, 0.1 mmol, 1 equiv), dry $CH_2Cl_2$ (0.1 mL), and (*N*,*N*-diethylamino)sulfur trifluoride (DAST) (0.35 mmol, 3.5 equiv). The mixture was stirred overnight at rt. The resulting mixture was treated with 2 drops off water and loaded onto celite. After evaporation, the powder was transferred on to a $SiO_2$ column and purified by FC using a gradient from pure pentane to pentane/$CH_2Cl_2$ 5:1 to provide pure **5sh** as colorless oil (23.9 mg, 0.074 mmol, 78% yield, >99% *ee*).[16]

**($R_a$)-2'-Bromo-2-(difluoromethyl)-6'-ethyl-3-fluoro-1,1'-biphenyl (5sh).**




**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 7.60 – 7.51 (m, 2H), 7.35 – 7.22 (m, 3H), 6.97 (d, *J* = 7.7 Hz, 1H), 6.28 (t, *J* = 53.2 Hz, 1H), 2.42 – 2.21 (m, 2H), 1.03 (t, *J* = 7.6 Hz, 3H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 161.6 (dt, *J* = 255.9, 2.1 Hz), 145.1, 141.5 (td, *J* = 5.8, 3.3 Hz), 137.3 (d, *J* = 2.3 Hz), 132.5 (d, *J* = 9.4 Hz), 130.2, 130.1, 127.5, 126.1 (d, *J* = 3.6 Hz), 124.2, 120.2 (td, *J* = 22.4, 12.0 Hz), 116.4 (d, *J* = 21.0 Hz), 112.5.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CDCl_3$) δ -110.96 (dd, *J* = 317.3, 10.9 Hz), -112.59 (dd, *J* = 317.3, 15.6 Hz), -114.89 (dd, *J* = 15.6, 10.9 Hz).

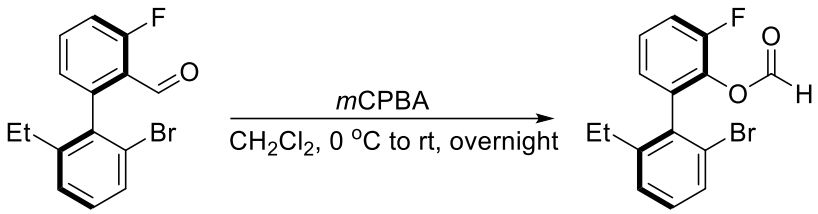
**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{12}BrF_3Na^+$ $[M+Na]^+$: 350.9967; found: 350.9966.

**UPC$^2$**: Chiralpak IB column [$CO_2$/$CH_2Cl_2$ gradient, 1% $CH_2Cl_2$ (0.5 min), then gradient from 1% to 40% (10%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.028 min; $t_{minor}$ = 1.927 min; >99% *ee*.

$[\alpha]_{25}^{D}$ = –5.5 (c 1.0, $CH_2Cl_2$).

[16] X. Zhang, L. Ling, X. Luo, X. Zeng, *Angew. Chem. Int. Ed.* 2019, **58**, 16785-16789.

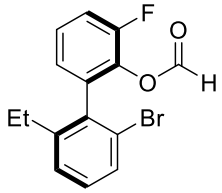
**5.10 Baeyer-Villiger oxidation**




***Scheme S13:*** *Baeyer-Villiger oxidation of* ***4s*** *to prepare* ***5si****.*

To a solution of **4s** (30.7 mg, 0.1 mmol, 1 equiv) in $CH_2Cl_2$ (0.2 mL) was added *m*-chloroperoxybenzoic acid (57 mg, 0.33 mmol, 3.3 equiv.) portion-wise at 0 °C with magnetic stirring. The reaction was stirred overnight at rt. The resulting solution was directly loaded onto a column and purified by FC using pentane/$CH_2Cl_2$ 2:1 to provide pure **5si** as white, amorphous solid (12.0 mg, 0.037 mmol, 37% yield, >99% *ee*).[17]

**($R_a$)-2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl formate (5si).**




**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 8.03 (d, *J* = 2.3 Hz, 1H), 7.51 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.37 (td, *J* = 8.0, 5.3 Hz, 1H), 7.32 – 7.26 (m, 2H), 7.23 (t, *J* = 7.8 Hz, 1H), 7.03 (dt, *J* = 7.6, 1.5 Hz, 1H), 2.35 (ddt, *J* = 17.1, 14.7, 7.3 Hz, 2H), 1.05 (t, *J* = 7.5 Hz, 3H).

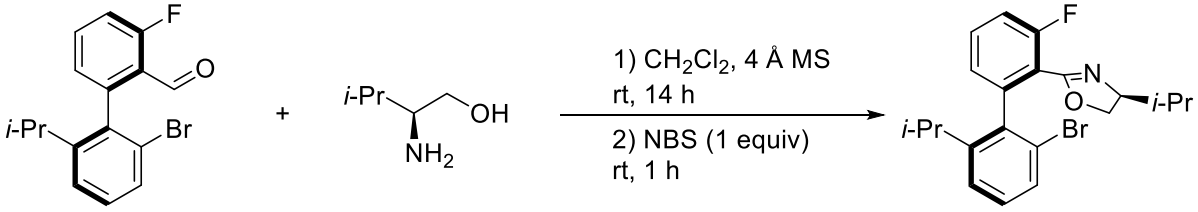
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 157.6 (d, *J* = 0.7 Hz), 154.7 (d, *J* = 249.6 Hz), 145.7, 136.0, 135.8 (d, *J* = 2.0 Hz), 135.5 (d, *J* = 13.5 Hz), 130.3, 130.3, 127.8, 127.6 (d, *J* = 8.0 Hz), 127.0 (d, *J* = 3.3 Hz), 124.4, 116.6 (d, *J* = 18.9 Hz), 27.4, 15.1.

**$^{19}$F-{$^1$H} NMR** (376 MHz, $CD_2Cl_2$) δ –127.52.

**HRMS (ESI$^+$)** m/z calcd. for $C_{15}H_{12}BrFO_2Na^+$ $[M+Na]^+$: 344.9897, 346.9877; found: 344.9898, 346.9880. UPC$^2$: Chiralpak IB column [$CO_2$/iPrOH gradient, 1% iPrOH (0.5 min), then gradient from 1% to 25% (1.7%/min), 120 bar, 40 °C], 3.0 mL·min$^{-1}$; $t_{major}$ = 2.946 min; $t_{minor}$ = 2.821 min; General Procedure A: >99% *ee*.

$[\alpha]_{27}^{D}$ = –4.7 (c 0.5, $CH_2Cl_2$).

**5.11 Oxazole formation**



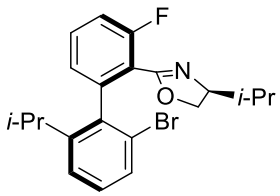

***Scheme S14:*** *Oxazole formation from* ***4q****.*

To an 8-mL flame-dried vial, equipped with a stir bar, was added L-valinol (64.3 mg, 0.623 mmol, 1 equiv), **4s** (200.0 mg, 0.623 mmol, 1 equiv), anhydrous $CH_2Cl_2$ (3 mL), and 4 Å MS (900 mg) under an Ar atmosphere. The mixture was stirred for 14 h, followed by the addition of NBS (111.0 mg, 0.623 mmol, 1 equiv) and stirred for an additional hour. The mixture was diluted with $CH_2Cl_2$, filtered, and washed with sat. $NaHCO_3$ and $H_2O$. The organic phase was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The crude mixture was purified by FC on $SiO_2$ using $CH_2Cl_2$/pentane 1:1 as eluent followed by a second FC on $SiO_2$ employing 5% EtOAc in pentane as eluent to provide the **5qj** as white, amorphous solid (104 mg, 0.257 mmol, 41% yield, >20:1 dr).[18]

[17] N. Fujikawa, T. Ohta, T. Yamaguchi, T. Fukuda, F. Ishibashi, M. Iwao, *Tetrahedron* 2006, **62**, 594-604.

[18] K. Schwekendiek, F. Glorius, *Synthesis* 2006, **18**, 2996-3002.

**($R_a$,*S*)-2-(2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl)-4-*iso*-propyl-4,5-dihydrooxazole (5qj).**




**$^1$H NMR** (400 MHz, $CDCl_3$) δ 7.49 – 7.42 (m, 1H), 7.42 – 7.36 (m, 1H), 7.29 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.16 (t, *J* = 7.9 Hz, 2H), 6.96 (dd, *J* = 7.7, 1.1 Hz, 1H), 4.14 (dd, *J* = 9.4, 7.8 Hz, 1H), 3.91 – 3.82 (m, 1H), 3.79 (t, *J* = 8.0 Hz, 1H), 2.67 (hept, *J* = 6.8 Hz, 1H), 1.45 (hept, *J* = 6.7 Hz, 1H), 1.22 (d, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.9 Hz, 3H), 0.68 (dd, *J* = 6.8, 4.9 Hz, 6H).

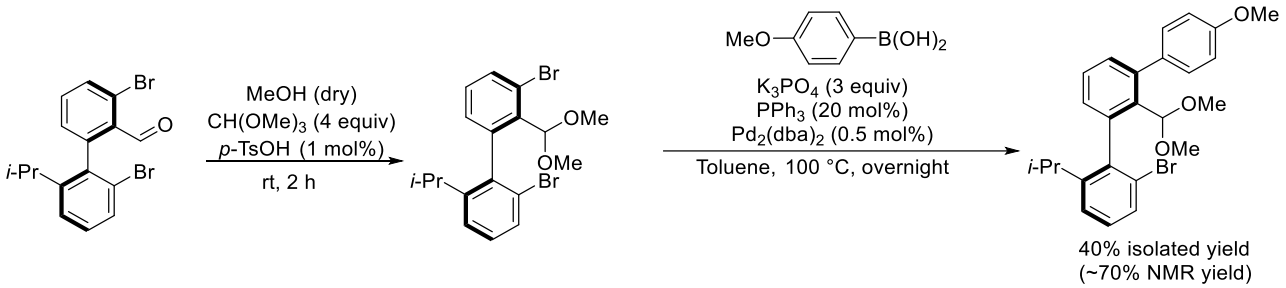
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 161.1 (d, *J* = 251.5 Hz), 158.8, 150.2, 142.8, 142.7, 138.7 (d, *J* = 2.2 Hz), 131.1 (d, *J* = 9.3 Hz), 129.4, 126.0 (d, *J* = 3.3 Hz), 124.2, 123.7, 118.2 (d, *J* = 14.8 Hz), 115.4 (d, *J* = 22.2 Hz), 73.2, 70.3, 32.7, 31.7, 25.1, 22.8, 18.7, 18.4.

**$^{19}$F NMR** (376 MHz, $CDCl_3$) δ –111.74 (dd, *J* = 9.6, 5.5 Hz, 1F).

**HRMS (ESI$^+$)** m/z calcd. for $C_{21}H_{23}BrFNO_2Na^+$ [M+Na]$^+$: 426.0839; found: 426.0855.

$[\alpha]_{25}^{D}$ = –39.2 (c 0.8, $CH_2Cl_2$).

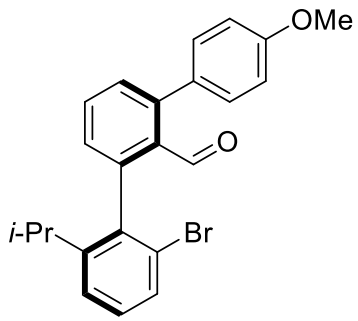
**5.12 Regioselective Suzuki-Miyuara coupling of 3a.**




***Scheme S15:*** *Regioselective Suzuki-Miyuara coupling at site $H_A$ of **3a**.*

A flame-dried 4-mL glass vial was charged with **3a'** (21.4 mg, 0.05 mmol, 1 equiv), boronic acid (7.6 mg, 0.05 mmol, 1 equiv), $Pd_2(dba)_3$ (0.23 mg, 0.5 mol%), $PPh_3$ (0.262 mg, 0.001 mmol. 20 mol%), $K_3PO_4$ (31.8 mg, 0.15 mmol, 3 equiv) and anhydrous toluene (0.2 mL). Upon purging with Ar, a Teflon screwcap was used to seal the vessel and subsequently heated to 100 °C overnight. Upon completion of the reaction, the resulting solution was directly loaded onto a column and purified by FC using pentane/$CH_2Cl_2$ 4:1 to afford **5ab** as white, amorphous solid (8.9 mg, 0.02 mmol, 40% yield).[19]

**($R_a$)-2-Bromo-6-*iso*-propyl-4''-methoxy-[1,1':3',1''-terphenyl]-2'-carbaldehyde (5ab).**



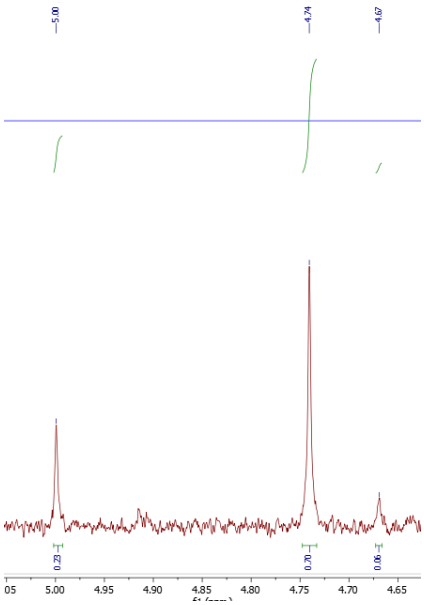

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 9.84 (s, 1H), 7.63 (t, *J* = 7.6 Hz, 1H), 7.47 (ddd, *J* = 9.1, 7.7, 1.2 Hz, 2H), 7.37 – 7.31 (m, 3H), 7.23 (t, *J* = 7.9 Hz, 1H), 7.14 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.02 – 6.97 (m, 2H), 3.87 (s, 3H), 1.13 – 1.10 (m, 6H).

**$^{13}$C-{$^1$H} NMR** (100 MHz, $CDCl_3$) δ 192.4, 159.8, 149.2, 145.3, 141.6, 139.9, 133.1, 132.2, 131.4, 131.1, 130.7, 129.8, 129.6, 129.3, 124.5, 123.2, 114.0, 55.5, 31.8, 24.4, 23.5.

**HRMS (ESI$^+$)** m/z calcd. for $C_{23}H_{22}BrO_2^+$ [M+H]$^+$: 409.0798 , 411.0778; found: 409.0799, 411.0782.

[19] J. Yin, M. P. Rainka, X.-X. Zhang, S. L. Buchwald, S. *J. Am. Chem. Soc.* 2002, **124**, 1162-1163.

The crude mixture upon reaction with 1 equiv of boronic acid yielded a mixture of starting material (5.00 ppm), monosubstituted product (4.74 ppm) and disubstituted product (4.67 ppm). Below is a zoom-in of the acetal-proton region and their relative integrations:



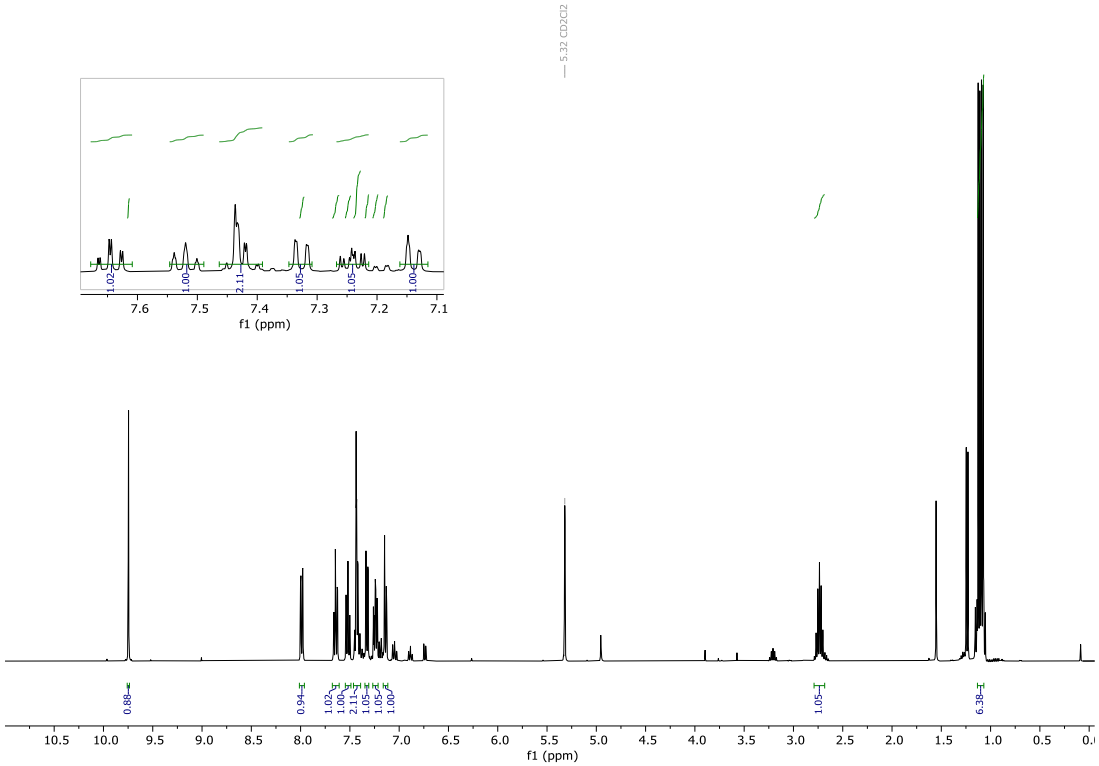
## 6. Deuterium Experiment

To gain insight into the C–H-activation step, deuterium incorporation experiments were conducted. TFA-*d* was used as source of deuterium, and control experiments were conducted with TFA-*H*.[20]

To an 8-mL vial, equipped with a stir bar, was added the aldehyde (0.10 mmol, 1 equiv), *c*TDG1 (0.030 mmol, 0.3 equiv), $Pd(OAc)_2$ (0.010 mmol or 0.0010 mmol, 0.1 or 0.01 equiv), NCS (0.3, or 0 mmol), and $Ag_2CO_3$ (0.010 mmol, 0.1 equiv). DCE (1 mL) and TFA-*d* (1.0 mmol, 10 equiv) were subsequently added and the vial was capped and heated to 60 °C overnight. Upon completion of the reaction, the resulting solution was directly loaded onto a column and purified by FC using the described stationary phase and eluent system.

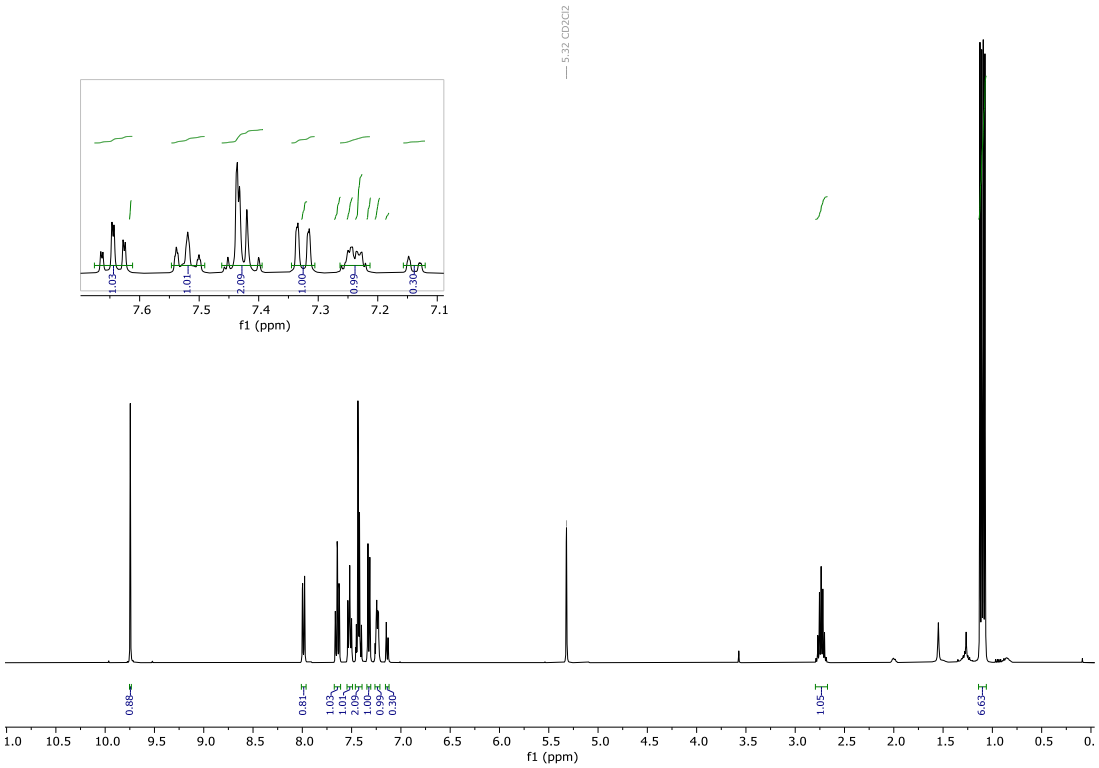
### 6.1 Deuteration only (Scheme 3b)

With TFA-*d*, and ***no*** NCS added, deuteration was observed at a single site ($H_B$):
*Starting material before deuterium incorporation* **(1a)**:




[20] H. Park, P. Verma, K. Hong, J.-Q. Yu, *Nature Chem.* 2018, **10**, 755-762.

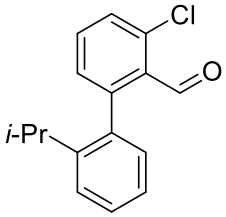
*Starting material after deuterium incorporation* **(1a-*d*)**:




**6.2 Deuteration and chlorination (Scheme 3a).**

With NCS and TFA-*d* added, both deuteration and chlorination was observed.

**3-Chloro-2'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (7a).**



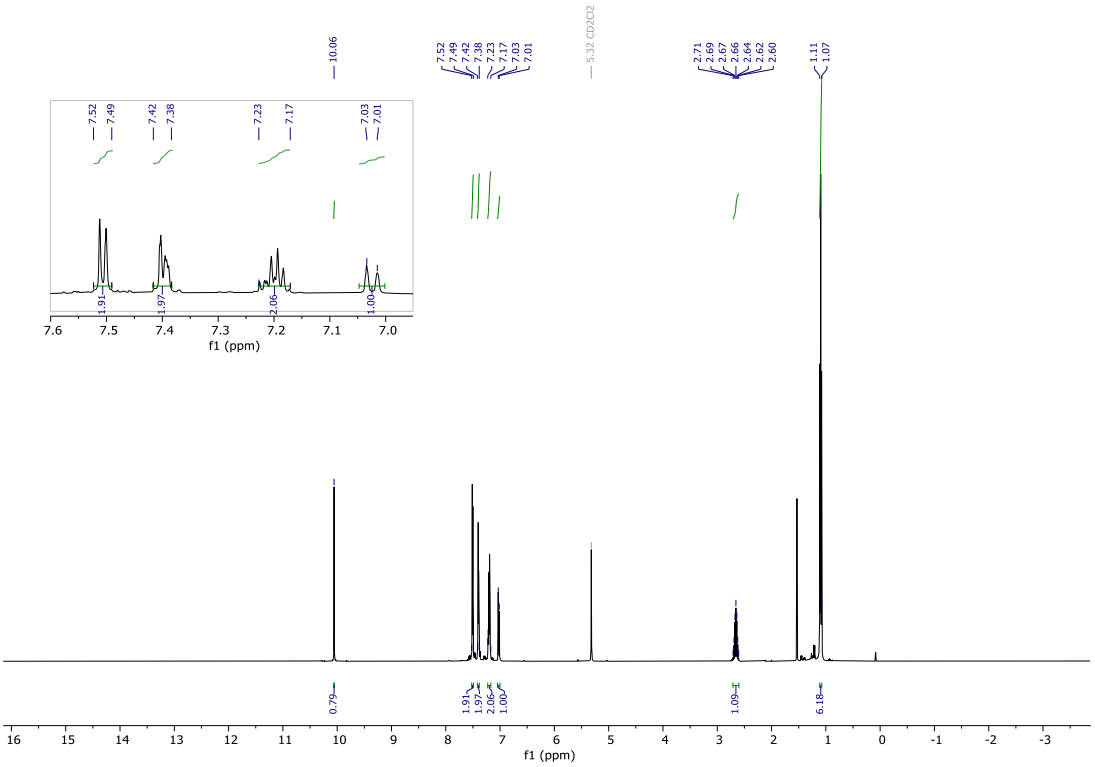

The product was isolated by FC on $SiO_2$ using pentane:$CH_2Cl_2$ (2:1) as eluent to afford **7a** as a yellow oil.

**$^1$H NMR** (400 MHz, $CD_2Cl_2$) δ 10.06 (s, 1H), 7.52 – 7.49 (m, 2H), 7.42 – 7.38 (m, 2H), 7.23 – 7.17 (m, 2H), 7.02 (d, *J* = 7.6 Hz, 1H), 2.66 (hept, *J* = 6.9 Hz, 1H), 1.11 – 1.07 (m 6.5 Hz, 6H).

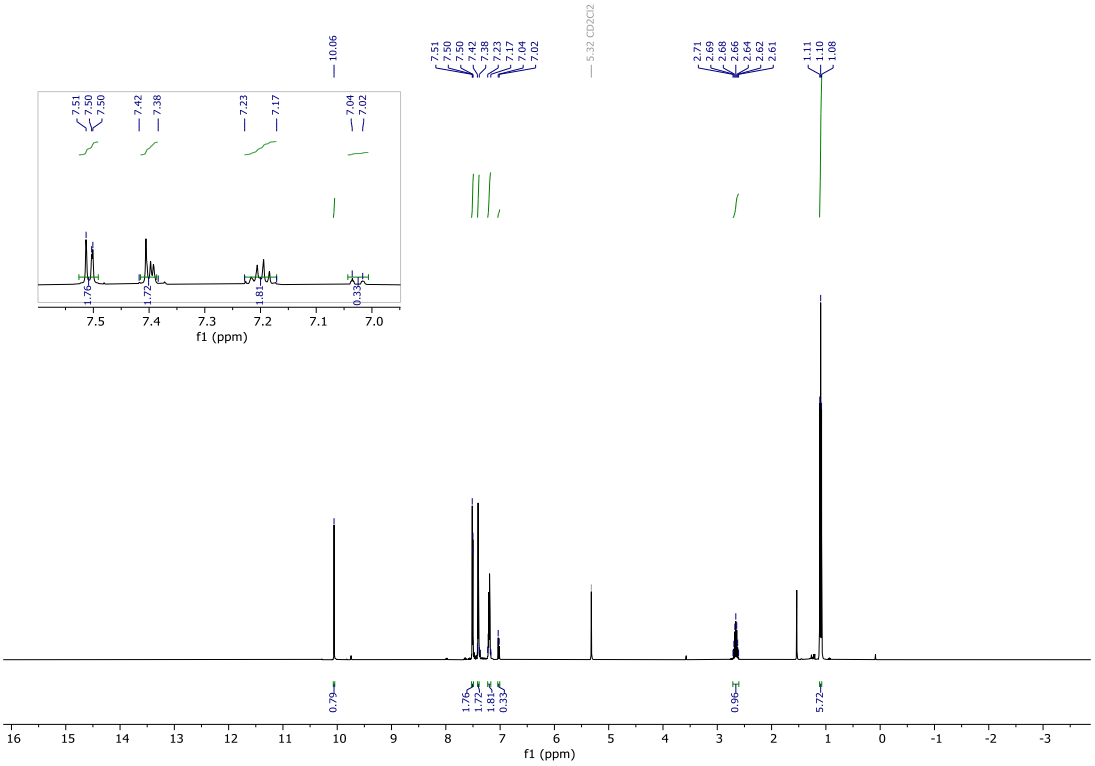
**$^{13}$C-{$^1$H} NMR** (100 MHz, $CD_2Cl_2$) δ 190.9, 147.1, 146.5, 137.4, 135.6, 133.2, 132.1, 130.5, 130.5, 129.8, 128.9, 125.9, 125.7, 30.6, 24.5, 23.3.

**HRMS (ESI$^+$)** m/z calcd. for $C_{16}H_{15}ClONa^+$ $[M+Na]^+$: 281.0704, 283.0675; found: 281.0704, 283.0675.

*Chlorination with TFA*-H **(7a)**:




*Chlorination with TFA*-d **(7a-*d*)**:



## 7. Racemization Studies

**General procedure for racemization studies:**

The barrier of rotation for the atropoisomers was determined by racemization of an enantiomerically pure sample. The racemization follows first order kinetics; hence the slope will give the racemization constant ($k_{rac} = 2 \cdot k_{enantiomerization}$). Then the Eyring equation shows the relationship between the rate constant and the Gibbs Free Energy:

$$\Delta G^{\ddagger}_{enantiomerization} = RT \cdot \ln\left(\frac{k_B \cdot T}{h \cdot k_{enantiomerization}}\right)$$

R = Gas constant = 8.31451 J · $K^{-1}$ · $mol^{-1}$, h = Planck constant = 6.62608 · $10^{-34}$ J · s and $k_B$ = Boltzmann constant = 1.38066 · $10^{-23}$ J · $K^{-1}$.

Experiments were conducted at 140 or 180 °C, 1 mg/mL dichlorobenzene in an Ar-filled NMR-tube.[21]

**Racemization of 3b at 180 °C:**

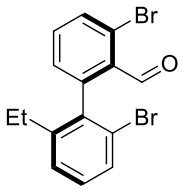



***Table S5.*** *Experimental racemization studies of* ***3b****.*

| Time (sec) | *ee* | ln($ee_0/ee_t$) |
|---|---|---|
| 0 | 98.28 | 0 |
| 11340 | 94.84 | 0.0356293 |
| 19260 | 92.54 | 0.0601796 |
| 25860 | 89.40 | 0.0946999 |
| 32820 | 88.62 | 0.103463 |
| 36600 | 86.72 | 0.125136 |
| 40740 | 85.94 | 0.1341712 |
| 43260 | 85.06 | 0.1444637 |

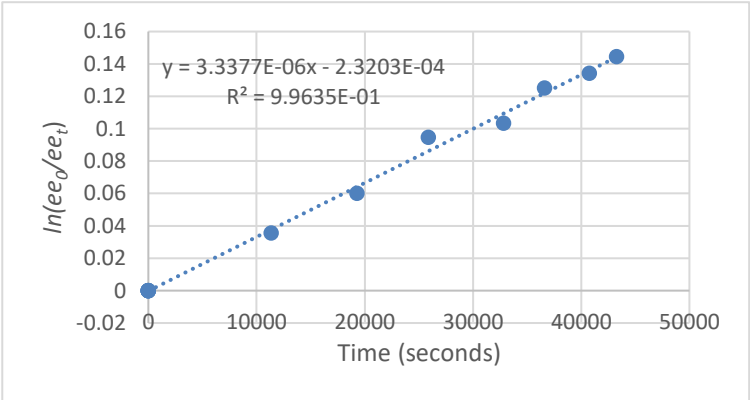



***Figure S6.*** *Plot of racemization of* ***3b*** *at 180 °C.*

$$k_{rac}(180\ °C) = 3.3377 \cdot 10^{-6}\ s^{-1}$$
$$k_{enantiomerization}(180\ °C) = 1.6689 \cdot 10^{-6}\ s^{-1}$$
$$\Delta G^{\ddagger}_{enantiomerization} = 162688.588\ J \cdot mol^{-1} = 38.88\ kcal \cdot mol^{-1}$$

[21] L. Jin, Q.-J. Yao, P.-P. Xie, Y. Li, B.-B. Zhan, Y.-Q. Han, X. Hong, B.-F. Shi, *Chem*, 2020, **6**, 497-511.

**Racemization of 3c at 180 °C:**

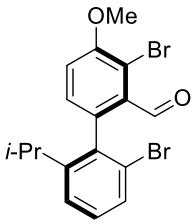



***Table S6.*** *Experimental racemization studies of* ***3c****.*

| Time (sec) | *ee* | ln($ee_0/ee_t$) |
|---|---|---|
| 0 | 99.76 | 0 |
| 3780 | 98.24 | 0.0153538 |
| 6960 | 97.30 | 0.0249683 |
| 15720 | 92.68 | 0.0736146 |
| 23820 | 90.32 | 0.0994084 |
| 30000 | 89.06 | 0.113457 |
| 34980 | 84.92 | 0.1610577 |
| 38820 | 84.80 | 0.1624718 |
| 44400 | 83.40 | 0.179119 |

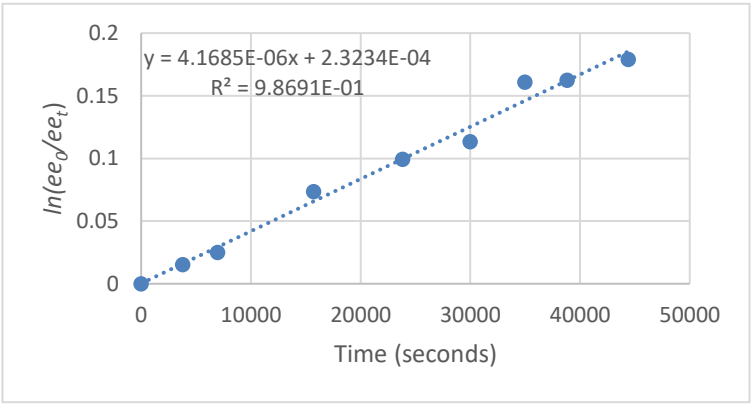



***Figure S7.*** *Plot of racemization of* ***3c*** *at 180 °C.*

$$k_{rac}(180\,°\mathrm{C}) = 4.1703 \cdot 10^{-6}\ s^{-1}$$
$$k_{enantiomerization}(180\,°\mathrm{C}) = 2.08515 \cdot 10^{-6}\ s^{-1}$$
$$\Delta G^{\ddagger}_{enantiomerization} = 161849{,}4944\ J \cdot mol^{-1} = 38{,}68\ kcal \cdot mol^{-1}$$

**Racemization of 3l at 140 °C:**

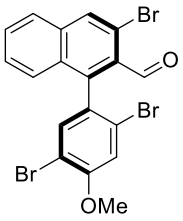



***Table S7.*** *Experimental racemization studies of* ***3l****.*

| Time (sec) | *ee* | ln($ee_0/ee_t$) |
|---|---|---|
| 0 | 99,82 | 0 |
| 2400 | 98,58 | 0.0125002 |
| 7620 | 97,24 | 0.0261864 |
| 16080 | 93,56 | 0.0647656 |
| 23220 | 90,34 | 0.0997882 |
| 28380 | 88,46 | 0.1208181 |
| 32340 | 86,82 | 0.1395316 |

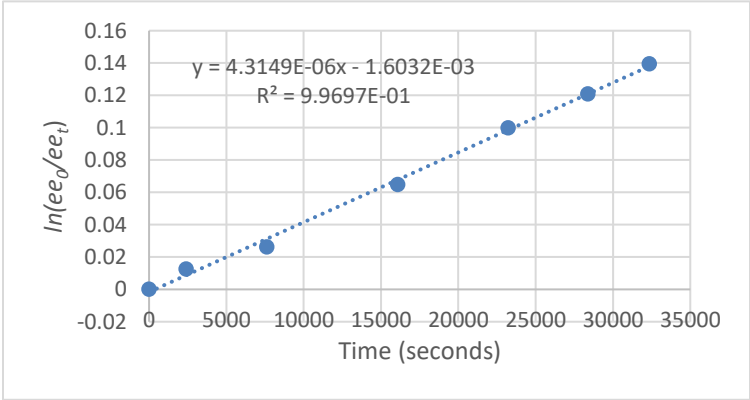



***Figure S8.*** *Plot of racemization of* ***3l*** *at 140 °C.*

$$k_{rac}(140\,°\mathrm{C}) = 4.3149 \cdot 10^{-6}\ s^{-1}$$
$$k_{enantiomerization}(140\,°\mathrm{C}) = 2.15745 \cdot 10^{-6}\ s^{-1}$$
$$\Delta G^{\ddagger}_{enantiomerization} = 147128.3313\ J \cdot mol^{-1} = 35.16\ kcal \cdot mol^{-1}$$

## 8. Crystallographic Data

**2',5-Dibromo-6-formyl-5'-methyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3c) – enantioselective reaction**

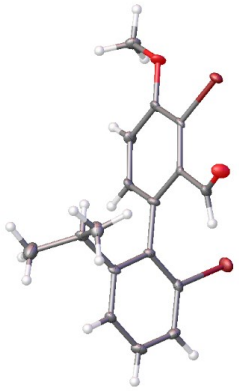


***Figure S9:*** *Crystal structure of* ***3c***

***Table S8.*** *Crystallographic data of* ***3c****.*

| Item | Value |
|---|---|
| Molecular formula | $C_{17}H_{16}Br_2O_2$ |
| Formula weight | 412.1210 |
| Crystal system | orthorhombic |
| Space Group | $P2_12_12_1$ |
| a (Å) | 10.6752 |
| b (Å) | 11.9710 |
| c (Å) | 12.2865 |
| α (°) | 90.00 |
| β (°) | 90.00 |
| γ (°) | 90.00 |
| Volume (Å$^3$) | 1570.13 |
| Z | 7 |
| T (K) | 100 |
| ρ (g cm$^{-1}$) | 1.743 |
| λ (Å) | 0.71073 |
| μ (mm$^{-1}$) | 5.164 |
| # measured refl | 26846 |
| # unique refl | 11138 |
| $R_{int}$ | 0.0744 |
| # parameters | 543 |
| $R(F^2)$, all refl | 0.0337 |
| $R_w(F^2)$, all refl | 0.0715 |
| Goodness of fit | 1.032 |
| Flack parameter | -0.015 |

Crystal data for [**3c**]: $C_{21}H_{18}BrN_5O_3$, *M* = 412.1210, orthorhombic, space group $P2_12_12_1$, *a* = 10.6752(2) Å, *b* = 11.9710(4) Å, *c* = 12.2865(4) Å, *α* = 90.00°, *β* = 90.00°, *γ* = 90.00°, Flack parameter = -0.015(11), *V* = 1570.13(8) Å$^3$, *T* = 100 K, *Z* = 7, $d_c$ = 1.743 g cm$^{-3}$, *μ*(Mo Kα, λ = 0.71073 Å) = 5.164 mm$^{-1}$, 26846 reflections collected, 11138 unique [$R_{int}$ = 0.0744], which were used in all calculations. Refinement on $F^2$, final R(F) = 0.0337, $R_w$(F2) = 0.0715. CCDC number 2169123.

**1-(5-Bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-3-chloro-2-naphthaldehyde (6p) - racemate**

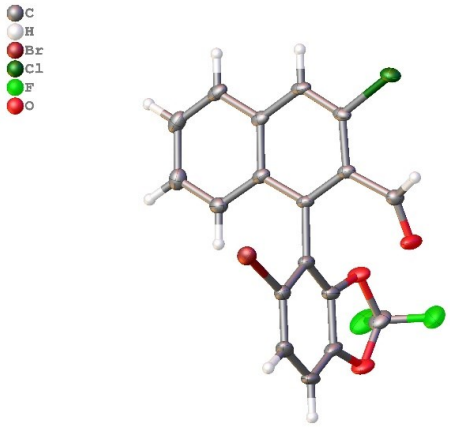



***Figure S10:*** *Crystal structure of* ***6p*** *(racemate)*

***Table S9.*** *Crystallographic data of* ***6p****.*

| Item | Value |
|---|---|
| Molecular formula | $C_{18}H_8O_3ClBrF_2$ |
| Formula weight | 425.615 |
| Crystal system | triclinic |
| Space Group | P-1 |
| a (Å) | 8.3118 |
| b (Å) | 8.4520 |
| c (Å) | 12.0667 |
| α (°) | 80.772 |
| β (°) | 79.030 |
| γ (°) | 72.149 |
| Volume (Å$^3$) | 787.41 |
| Z | 2 |
| T (K) | 100 |
| ρ (g cm$^{-1}$) | 1.795 |
| λ (Å) | 0.71073 |
| μ (mm$^{-1}$) | 2.817 |
| # measured refl | 8373 |
| # unique refl | 4231 |
| $R_{int}$ | 0.0341 |
| # parameters | 226 |

| | |
|---|---|
| $R(F^2)$, all refl | 0.0421 |
| $R_w(F^2)$, all refl | 0.1114 |
| Goodness of fit | 1.0351 |

Crystal data for [**6p**]: $C_{20}H_8O_2ClBrF_2$, $M$ = 425.615, triclinic, space group P-1, $a$ = 8.3118(7) Å, $b$ = 8.4520(5) Å, $c$ = 12.0667(8) Å, $\alpha$ = 80.772(5)°, $\beta$ = 79.030(6)°, $\gamma$ = 72.149(6)°, $V$ = 787.41(10) Å$^3$, $T$ = 100 K, $Z$ = 2, $d_c$ = 1.795 g cm$^{-3}$, $\mu$(Mo Kα, λ = 0.71073 Å) = 2.817 mm$^{-1}$, 8373 reflections collected, 4231 unique [$R_{int}$ = 0.0341], which were used in all calculations. Refinement on $F^2$, final R(F) = 0.0421, $R_w$(F2) = 0.1114. CCDC number 2168153.

# 9. Computational Studies

**Conformational analysis**

Conformations of all ground and transition state structures were generated using force-field method OPLS_2005, Systematic Torsional Sampling, 1000 steps pr. bond, a maximum energy threshold of 5.02 kcal $mol^{-1}$.[22] All conformations were then optimized using DFT and the lowest energy conformation from the optimization was used for single point calculations.

**DFT-calculations**

All DFT calculations were carried out using Gaussian 16 software package revision B.01.[23] Geometry optimizations were performed at ωB97XD/6-31g(d)[24] level of theory in conjunction with SMD model[25] considering the solvent effect of experimentally used dichloroethane at 298.15K. Frequency calculation were conducted at the same level of theory as the geometry optimization for all stationary points to determine whether the optimized structure is a transition state structure (1 imaginary frequency) or a local minimum structure (no imaginary frequencies). Quick Reaction Coordinate (QRC) were performed to confirm the transition states.[26] The QRC endpoints were reoptimized at ωB97XD/6-31g(d) level of theory to verify the stationary structures. Single-point energy calculations were done on the optimized structures using various methods with SMD solvation model. The free energy was obtained by adding the Grimme's quasi rigid rotor-harmonic oscillator (qRRHO)[27] free energy correction from the geometry optimization to the electronic energy from the single-point energy calculations. See scheme below. Cartesian coordinates for all minima and saddle points are at the end of this section.

Rotational barriers of **3b**, **3c**, and **3l**:

| Method | 3c | | 3l | | 3b | | RMS (of deviations) |
|---|---|---|---|---|---|---|---|
| | Barrier $\left(\frac{kcal}{mol}\right)$ | ΔΔG $\left(\frac{kcal}{mol}\right)$ | Barrier $\left(\frac{kcal}{mol}\right)$ | ΔΔG $\left(\frac{kcal}{mol}\right)$ | Barrier $\left(\frac{kcal}{mol}\right)$ | ΔΔG $\left(\frac{kcal}{mol}\right)$ | |
| **Experiment** | 38.68 | 0.00 | 35.16 | 0.00 | 38.88 | 0.00 | 0.00 |

[22] a) Schrödinger Release 2019-1: MacroModel, Schrödinger, LLC, New York, NY, 2019; b) Schrödinger Release 2019-1: Maestro, Schrödinger, LLC, New York, NY, 2019.

[23] Gaussian 16, Revision C.01, M. J. Frisch, G. W. Trucks, H. B. Schlegel, G. E. Scuseria, M. A. Robb, J. R. Cheeseman, G. Scalmani, V. Barone, G. A. Petersson, H. Nakatsuji, X. Li, M. Caricato, A. V. Marenich, J. Bloino, B. G. Janesko, R. Gomperts, B. Mennucci, H. P. Hratchian, J. V. Ortiz, A. F. Izmaylov, J. L. Sonnenberg, D. Williams-Young, F. Ding, F. Lipparini, F. Egidi, J. Goings, B. Peng, A. Petrone, T. Henderson, D. Ranasinghe, V. G. Zakrzewski, J. Gao, N. Rega, G. Zheng, W. Liang, M. Hada, M. Ehara, K. Toyota, R. Fukuda, J. Hasegawa, M. Ishida, T. Nakajima, Y. Honda, O. Kitao, H. Nakai, T. Vreven, K. Throssell, J. A. Montgomery, Jr., J. E. Peralta, F. Ogliaro, M. J. Bearpark, J. J. Heyd, E. N. Brothers, K. N. Kudin, V. N. Staroverov, T. A. Keith, R. Kobayashi, J. Normand, K. Raghavachari, A. P. Rendell, J. C. Burant, S. S. Iyengar, J. Tomasi, M. Cossi, J. M. Millam, M. Klene, C. Adamo, R. Cammi, J. W. Ochterski, R. L. Martin, K. Morokuma, O. Farkas, J. B. Foresman, and D. J. Fox, Gaussian, Inc., Wallingford CT, 2016.

[24] J.-D. Chai, M. Head-Gordon, *Phys. Chem. Chem. Phys.* 2008, **10**, 6615-6620.

[25] A. V. Marenich, C, J. Cramer, D. G. Truhlar, *J. Phys. Chem. B* 2009, **113**, 6378-6396.

[26] J. M. Goodman, M. A. Silva, *Tetrahedron Lett.* 2003, **44**, 8233-8236.

[27] S. Grimme, *Chem. Eur. J.* 2012, **18**, 9955-9964.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **ωb97xd/6-31g(d)** | 39.86 | 1.17 | 35.90 | 0.74 | 40.16 | 1.28 | 1.09 |
| **ωb97xd/6-31++g(2df,2pd)** | 39.46 | 0.78 | 36.33 | 1.17 | 40.26 | 1.38 | 1.14 |
| **ωB97X-D/Def2-TZVPP** | 39.42 | 0.74 | 36.25 | 1.09 | 40.19 | 1.30 | 1.07 |
| **M062X/Def2-TZVPP** | 37.57 | -1.12 | 35.05 | -0.12 | 38.04 | -0.84 | 0.81 |
| **B3LYP/6-31+G(d,p)** | 37.83 | -0.85 | 35.77 | 0.61 | 38.08 | -0.80 | 0.76 |
| **B3LYP/Def2-TZVPP** | 37.32 | -1.37 | 33.88 | -1.29 | 37.70 | -1.18 | 1.28 |
| **B97-D/Def2-TZVPP** | 35.67 | -3.02 | 32.45 | -2.71 | 36.76 | -2.12 | 2.64 |
| **PBE0/Def2-TZVPP** | 39.22 | 0.54 | 36.20 | 1.04 | 39.54 | 0.65 | 0.77 |

***Table S 10:*** *Overview of calculated energies*

**8.4 Cartesian Coordinates**

**3b: starting material**

| | | | |
|---|---|---|---|
| C | -0.02582 | 0.79881 | 1.89146 |
| C | 0.12244 | 0.4676 | 0.54586 |
| C | -1.0196 | 0.19352 | -0.23338 |
| C | -2.27539 | 0.28143 | 0.37879 |
| C | -2.42371 | 0.63355 | 1.71291 |
| C | -1.28674 | 0.88711 | 2.47001 |
| H | 0.8608 | 0.98114 | 2.49023 |
| Br | -3.87167 | -0.03834 | -0.61303 |
| H | -3.41095 | 0.70699 | 2.15508 |
| H | -1.38817 | 1.1514 | 3.51771 |
| C | 1.5124 | 0.3578 | 0.0057 |
| C | 2.17015 | -0.87399 | -0.00969 |
| C | 2.2047 | 1.49456 | -0.4435 |
| C | 3.48415 | -1.00992 | -0.43722 |
| Br | 1.23912 | -2.43908 | 0.5451 |
| C | 3.52741 | 1.35825 | -0.86832 |
| C | 4.16616 | 0.12376 | -0.8637 |
| H | 3.96391 | -1.98242 | -0.43848 |
| H | 4.05963 | 2.23926 | -1.21797 |
| H | 5.19431 | 0.03725 | -1.20149 |
| C | -0.89063 | -0.23568 | -1.65378 |
| H | -1.71688 | -0.86055 | -2.03544 |

| | | | |
|---|---|---|---|
| O | 0.04137 | 0.05165 | -2.37281 |
| C | 1.55202 | 2.85807 | -0.47468 |
| H | 1.91166 | 3.39489 | -1.35956 |
| H | 0.46865 | 2.75344 | -0.58957 |
| C | 1.85841 | 3.69147 | 0.77397 |
| H | 1.39996 | 4.68313 | 0.69558 |
| H | 1.47096 | 3.20906 | 1.67747 |
| H | 2.9387 | 3.82491 | 0.89977 |

**3b: transition state**

| | | | |
|---|---|---|---|
| C | -0.00415 | 2.19394 | -0.73629 |
| C | 0.11728 | 0.84995 | -0.33297 |
| C | -1.11633 | 0.16548 | -0.14164 |
| C | -2.29558 | 0.91395 | -0.04935 |
| C | -2.35771 | 2.28026 | -0.27266 |
| C | -1.19561 | 2.90237 | -0.69626 |
| H | 0.86138 | 2.7104 | -1.12297 |
| Br | -3.95472 | 0.0309 | 0.31462 |
| H | -3.29511 | 2.81859 | -0.19091 |
| H | -1.21113 | 3.9451 | -0.99571 |
| C | 1.52928 | 0.32449 | -0.23245 |
| C | 1.9524 | -1.02788 | -0.25017 |
| C | 2.61372 | 1.25931 | -0.17766 |
| C | 3.23052 | -1.41736 | -0.62951 |
| Br | 0.96265 | -2.45307 | 0.5476 |
| C | 3.89176 | 0.86331 | -0.58146 |
| C | 4.1893 | -0.4519 | -0.8963 |
| H | 3.47683 | -2.47222 | -0.67674 |
| H | 4.67985 | 1.60935 | -0.61772 |
| H | 5.17892 | -0.73786 | -1.23745 |
| C | -1.39156 | -1.29948 | -0.4035 |
| H | -1.81977 | -1.89373 | 0.41863 |
| O | -1.29413 | -1.73183 | -1.52953 |
| C | 2.5347 | 2.64101 | 0.47572 |
| H | 2.69853 | 3.43617 | -0.26203 |
| H | 1.54715 | 2.8067 | 0.90647 |
| C | 3.55712 | 2.78726 | 1.61038 |
| H | 4.59134 | 2.75898 | 1.25526 |
| H | 3.40615 | 3.74874 | 2.11333 |
| H | 3.43056 | 1.99199 | 2.353 |

**3c: starting material**

| | | | |
|---|---|---|---|
| C | 0.14954 | 0.76198 | 1.72612 |

| | | | |
|---|---|---|---|
| C | -0.27261 | 0.297 | 0.48466 |
| C | 0.70183 | -0.0367 | -0.47389 |
| C | 2.05197 | 0.11627 | -0.16132 |
| C | 2.47271 | 0.60463 | 1.08426 |
| C | 1.49613 | 0.92286 | 2.02889 |
| H | -0.59318 | 1.00671 | 2.47924 |
| Br | 3.39122 | -0.28592 | -1.44458 |
| H | 1.77869 | 1.29562 | 3.00639 |
| C | -1.73615 | 0.11565 | 0.24575 |
| C | -2.31713 | -1.15386 | 0.33794 |
| C | -2.5702 | 1.21399 | -0.02887 |
| C | -3.67838 | -1.36609 | 0.17659 |
| Br | -1.21547 | -2.67144 | 0.67298 |
| C | -3.94179 | 0.99813 | -0.18875 |
| C | -4.49459 | -0.27154 | -0.08516 |
| H | -4.093 | -2.36499 | 0.25481 |
| H | -4.58968 | 1.84147 | -0.41036 |
| H | -5.5629 | -0.41617 | -0.21408 |
| C | 0.30268 | -0.62094 | -1.78878 |
| H | 0.97913 | -1.39801 | -2.18597 |
| O | -0.69336 | -0.30149 | -2.39987 |
| C | -2.00488 | 2.61329 | -0.22223 |
| H | -0.9454 | 2.59289 | 0.0466 |
| C | -2.09077 | 3.01567 | -1.70037 |
| H | -3.13397 | 3.08664 | -2.03113 |
| H | -1.61834 | 3.9919 | -1.85929 |
| H | -1.58334 | 2.2769 | -2.3292 |
| C | -2.68481 | 3.64631 | 0.68244 |
| H | -3.74615 | 3.76594 | 0.43614 |
| H | -2.61248 | 3.35928 | 1.73747 |
| H | -2.20526 | 4.62432 | 0.56215 |
| O | 3.79567 | 0.73165 | 1.2792 |
| C | 4.24871 | 1.21138 | 2.53722 |
| H | 3.94141 | 0.54485 | 3.35085 |
| H | 5.33694 | 1.22413 | 2.47068 |
| H | 3.88426 | 2.22672 | 2.72991 |

**3c: transition state**

| | | | |
|---|---|---|---|
| C | -0.14112 | 1.77593 | -0.64037 |
| C | 0.21573 | 0.46314 | -0.29237 |
| C | -0.89313 | -0.41461 | -0.12455 |
| C | -2.17954 | 0.11008 | 0.00649 |
| C | -2.47183 | 1.47218 | -0.14634 |

| | | | |
|---|---|---|---|
| C | -1.42659 | 2.28762 | -0.56567 |
| H | 0.61606 | 2.44185 | -1.02384 |
| Br | -3.66095 | -1.05013 | 0.31601 |
| H | -1.59862 | 3.32234 | -0.8372 |
| C | 1.69404 | 0.17678 | -0.22133 |
| C | 2.32658 | -1.08992 | -0.26967 |
| C | 2.62072 | 1.27026 | -0.14328 |
| C | 3.64895 | -1.26737 | -0.65777 |
| Br | 1.5755 | -2.67131 | 0.4974 |
| C | 3.94553 | 1.08483 | -0.54649 |
| C | 4.44599 | -0.15904 | -0.89512 |
| H | 4.61738 | 1.93779 | -0.54043 |
| H | 5.46982 | -0.27817 | -1.23441 |
| C | -0.92302 | -1.89222 | -0.45714 |
| H | -1.24954 | -2.5873 | 0.33112 |
| O | -0.74724 | -2.24792 | -1.6003 |
| C | 2.34533 | 2.59711 | 0.58716 |
| H | 1.30778 | 2.61963 | 0.92023 |
| C | 3.19357 | 2.63243 | 1.87016 |
| H | 4.26611 | 2.67418 | 1.65078 |
| H | 2.93583 | 3.52158 | 2.45742 |
| H | 3.00653 | 1.74893 | 2.4899 |
| C | 2.61205 | 3.85062 | -0.25505 |
| H | 2.33714 | 4.74602 | 0.31316 |
| H | 3.67298 | 3.93815 | -0.51434 |
| H | 2.04433 | 3.85813 | -1.19189 |
| O | -3.7378 | 1.86897 | 0.04078 |
| C | -4.04325 | 3.24303 | -0.15987 |
| H | -5.10091 | 3.34677 | 0.08324 |
| H | -3.45025 | 3.88117 | 0.5046 |
| H | -3.87903 | 3.53591 | -1.20266 |
| H | 4.05534 | -2.26997 | -0.73166 |

**3l: starting material**

| | | | |
|---|---|---|---|
| C | 1.77163 | -0.47345 | -0.5795 |
| C | 0.85735 | 0.40352 | -0.01559 |
| C | 1.29082 | 1.65778 | 0.51489 |
| C | 2.66684 | 2.00854 | 0.42752 |
| C | 3.58108 | 1.10692 | -0.17056 |
| C | 3.13938 | -0.09426 | -0.64153 |
| H | -0.65162 | 2.31347 | 1.23375 |
| C | 0.39865 | 2.56885 | 1.14493 |
| C | 3.10878 | 3.25265 | 0.94763 |

| | | | |
|---|---|---|---|
| H | 4.62746 | 1.38382 | -0.24724 |
| C | 2.22111 | 4.11182 | 1.54103 |
| C | 0.85387 | 3.76283 | 1.64263 |
| H | 4.1623 | 3.50584 | 0.86909 |
| H | 2.5651 | 5.06127 | 1.93986 |
| H | 0.16026 | 4.44744 | 2.12099 |
| C | -0.58531 | 0.04147 | 0.09708 |
| C | -1.07194 | -0.8229 | 1.07171 |
| C | -1.515 | 0.60255 | -0.78285 |
| C | -2.42017 | -1.14489 | 1.17733 |
| Br | 0.13076 | -1.62629 | 2.29958 |
| C | -2.86028 | 0.29993 | -0.69121 |
| H | -1.16867 | 1.28439 | -1.55239 |
| C | -3.33854 | -0.5862 | 0.28762 |
| H | -2.74649 | -1.82925 | 1.95004 |
| Br | -4.07945 | 1.0832 | -1.90503 |
| C | 1.3524 | -1.83051 | -1.04248 |
| H | 2.09928 | -2.62906 | -0.88544 |
| O | 0.2807 | -2.08367 | -1.54623 |
| O | -4.65655 | -0.83675 | 0.30394 |
| C | -5.15988 | -1.74829 | 1.27094 |
| H | -4.71289 | -2.74122 | 1.14883 |
| H | -4.9853 | -1.38222 | 2.28891 |
| H | -6.23271 | -1.80881 | 1.08675 |
| Br | 4.40999 | -1.25521 | -1.45776 |

**3l: transition state**

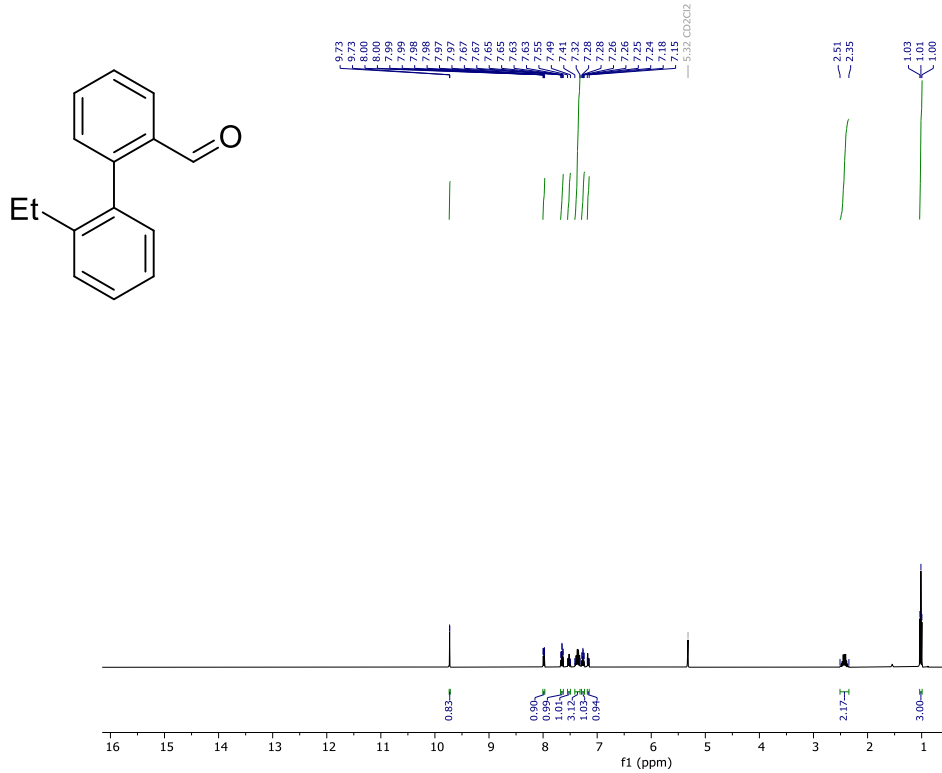
| | | | |
|---|---|---|---|
| C | -2.02484 | -0.28419 | 0.16023 |
| C | -0.80931 | 0.40419 | 0.28817 |
| C | -0.92144 | 1.84851 | 0.42111 |
| C | -2.07807 | 2.51608 | -0.07119 |
| C | -3.17367 | 1.75852 | -0.54511 |
| C | -3.16282 | 0.41372 | -0.32852 |
| H | 0.8293 | 2.16111 | 1.67539 |
| C | 0.01347 | 2.64303 | 1.14908 |
| C | -2.17041 | 3.93221 | -0.00568 |
| H | -4.03819 | 2.25835 | -0.96849 |
| C | -1.20884 | 4.66705 | 0.63395 |
| C | -0.13091 | 4.00277 | 1.25985 |
| H | -3.04645 | 4.41114 | -0.43367 |
| H | -1.29718 | 5.74673 | 0.70442 |
| H | 0.58421 | 4.56955 | 1.84802 |
| C | 0.56406 | -0.20152 | 0.18274 |

| | | | |
|---|---|---|---|
| C | 0.99797 | -1.54549 | 0.19475 |
| C | 1.61326 | 0.69795 | -0.13338 |
| C | 2.34502 | -1.90816 | 0.15041 |
| Br | -0.11692 | -3.08131 | 0.07265 |
| C | 2.94312 | 0.35635 | -0.21181 |
| H | 1.37156 | 1.72276 | -0.36777 |
| C | 3.35434 | -0.96458 | -0.00559 |
| H | 2.59675 | -2.95947 | 0.2027 |
| Br | 4.22406 | 1.68669 | -0.61201 |
| C | -2.35119 | -1.58885 | 0.8391 |
| H | -2.88817 | -2.35075 | 0.25475 |
| O | -2.17829 | -1.70384 | 2.0322 |
| O | 4.6621 | -1.23607 | -0.03289 |
| C | 5.0793 | -2.58529 | 0.14603 |
| H | 4.71368 | -3.22204 | -0.66669 |
| H | 6.16885 | -2.55919 | 0.12532 |
| H | 4.74091 | -2.97807 | 1.11091 |
| Br | -4.76085 | -0.5555 | -0.72419 |

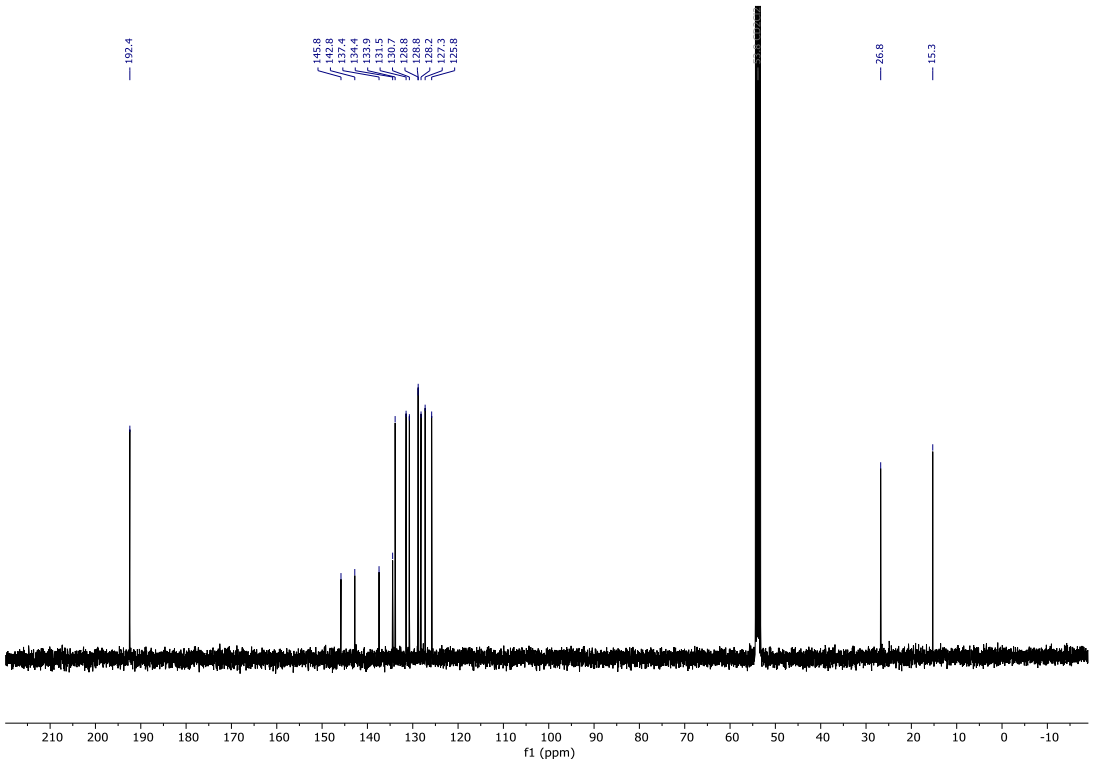
# 10. NMR Spectra

### 2'-Ethyl-[1,1'-biphenyl]-2-carbaldehyde (1b).

$^{1}$H-NMR

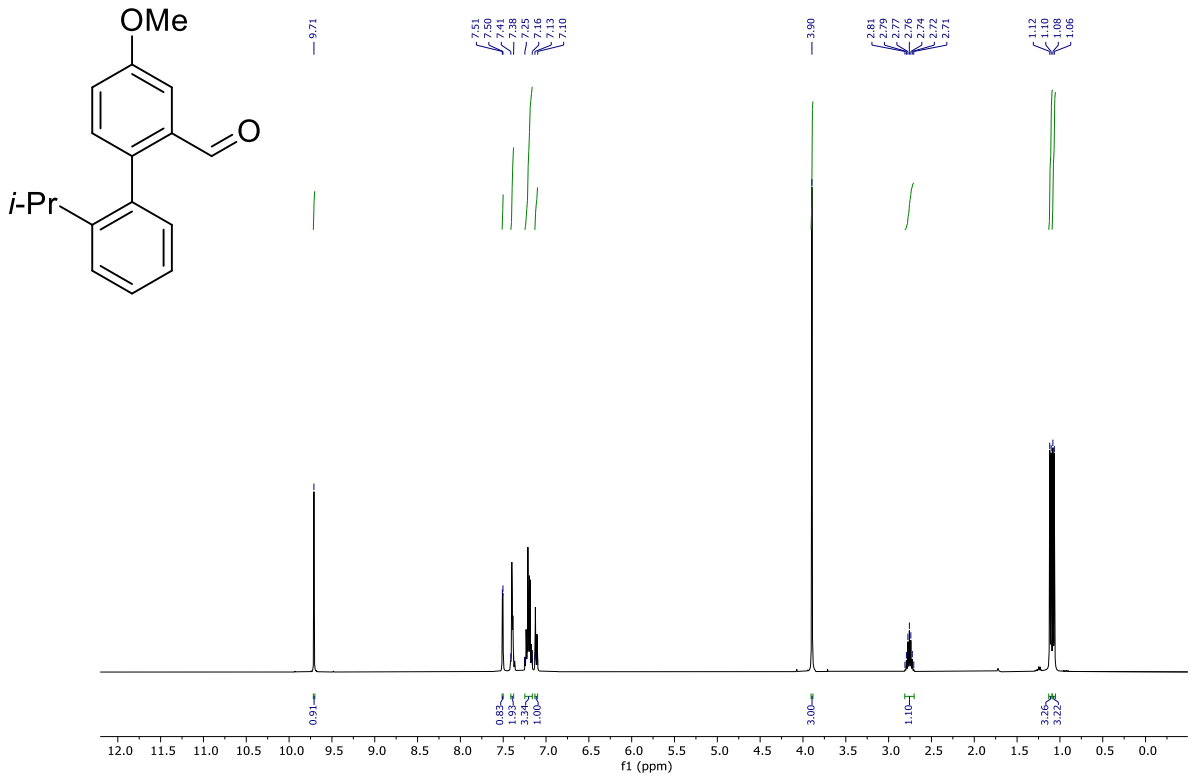



$^{13}$C-{$^{1}$H}-NMR

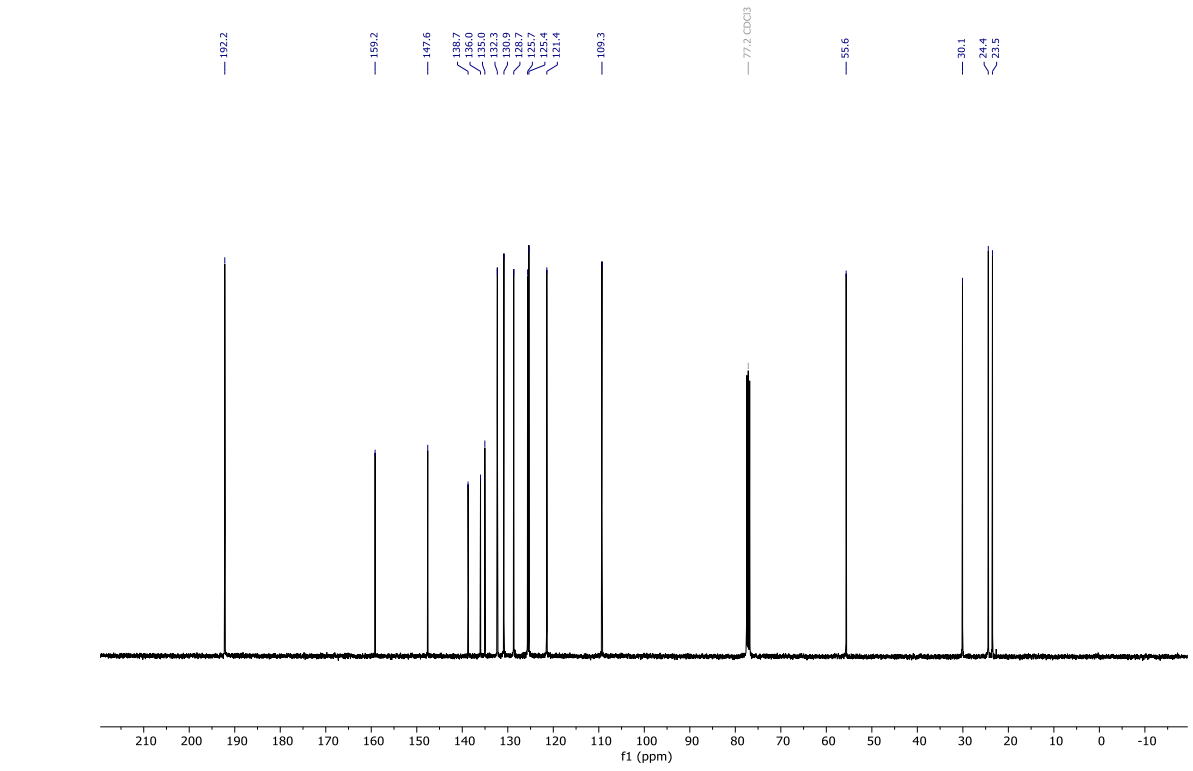


**2'-*iso*-Propyl-4-methoxy-[1,1'-biphenyl]-2-carbaldehyde (1c).**

$^{1}$H-NMR

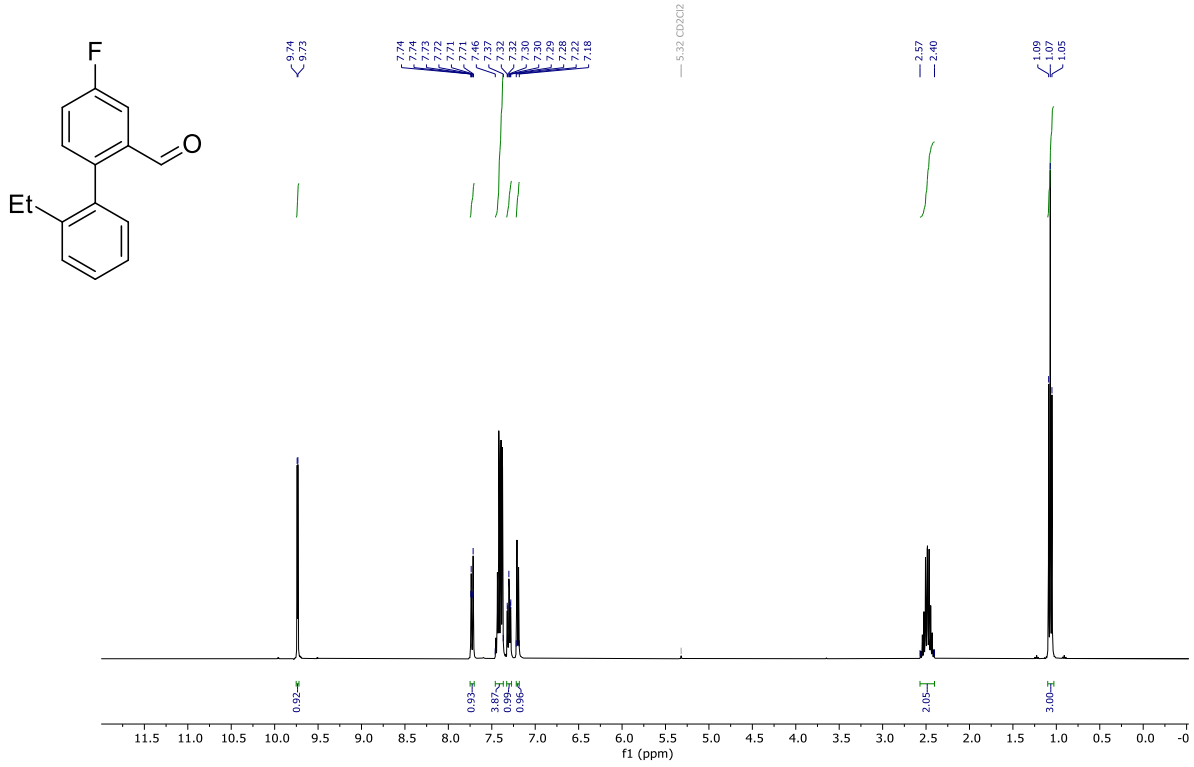



$^{13}$C-{$^{1}$H}-NMR

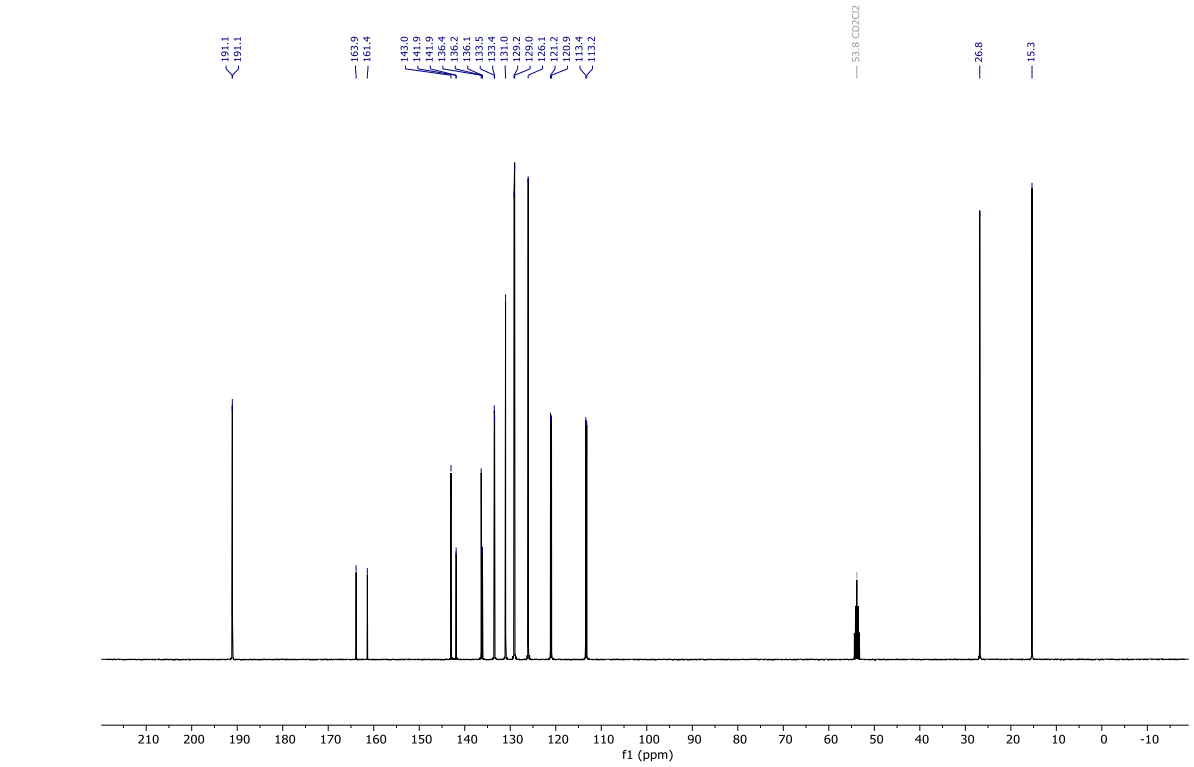


**2'-Ethyl-4-fluoro-[1,1'-biphenyl]-2-carbaldehyde (1d).**

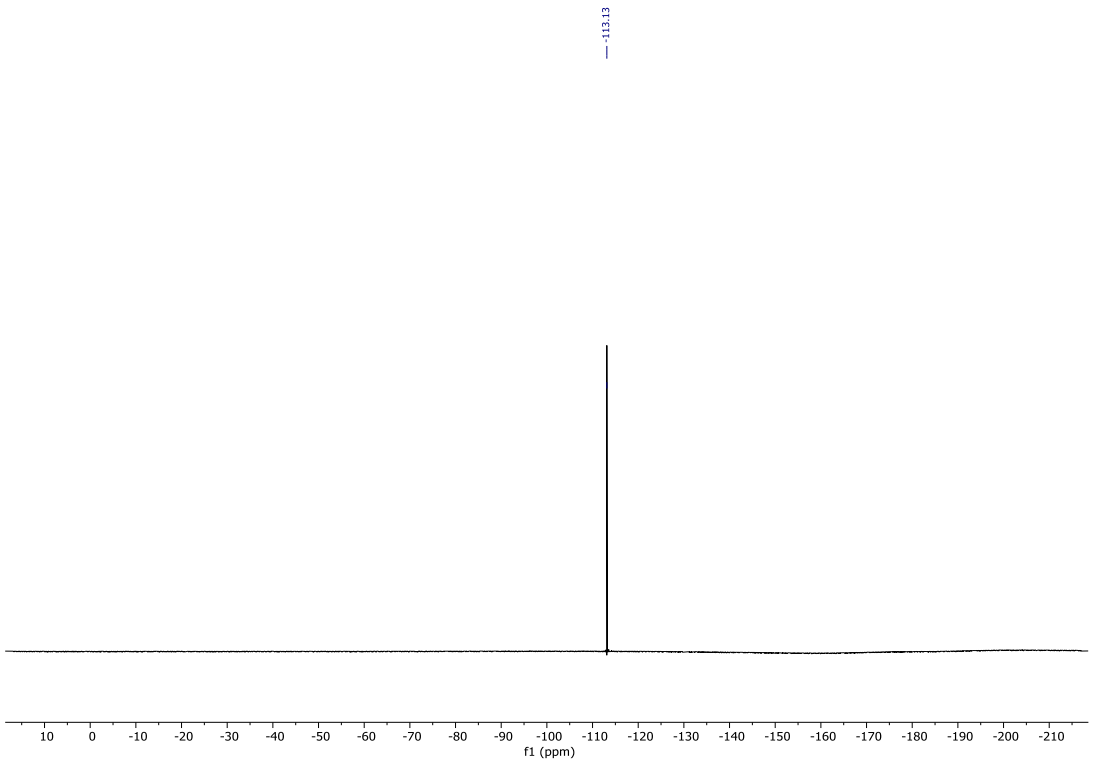
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

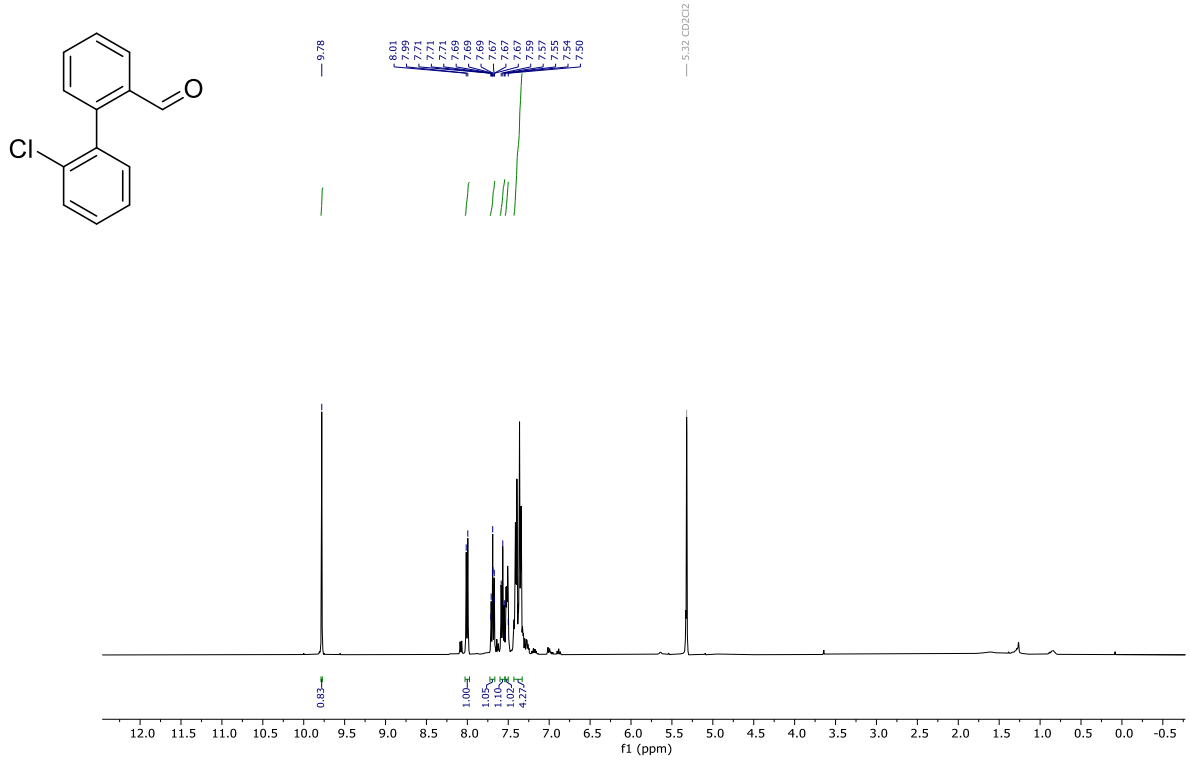


$^{19}F$-{$^{1}H$}-NMR

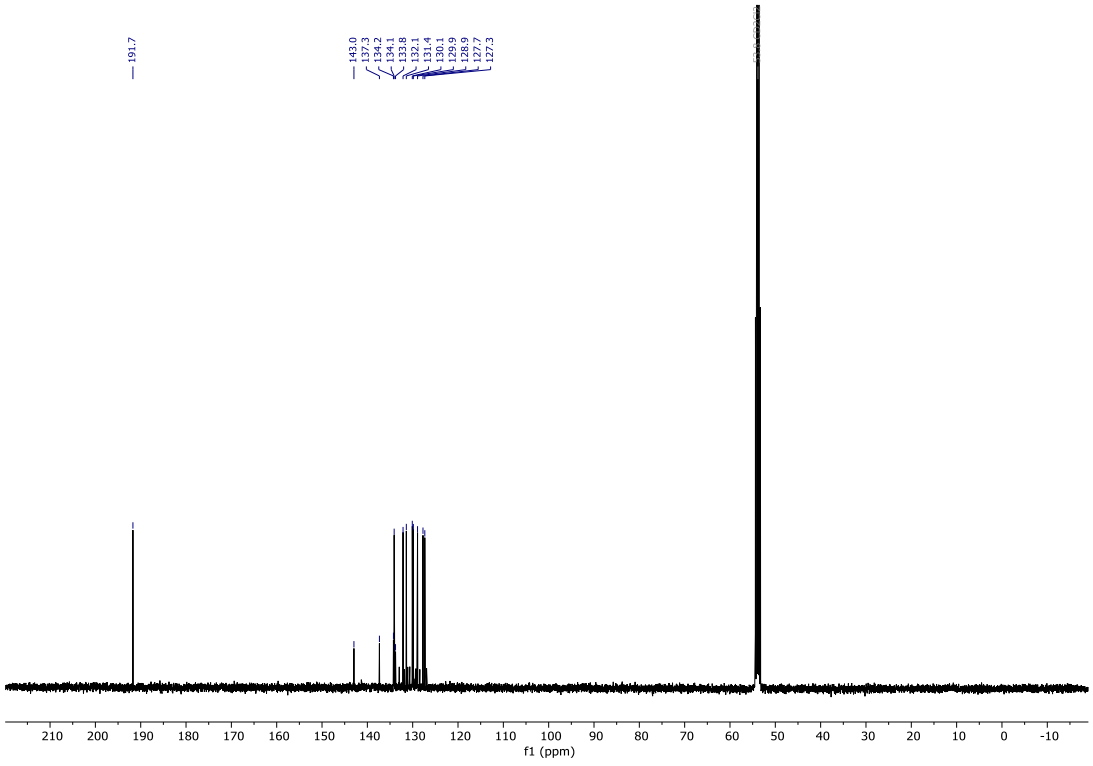

-113.13
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**2'-Chloro-[1,1'-biphenyl]-2-carbaldehyde (1g).**

$^{1}$H-NMR

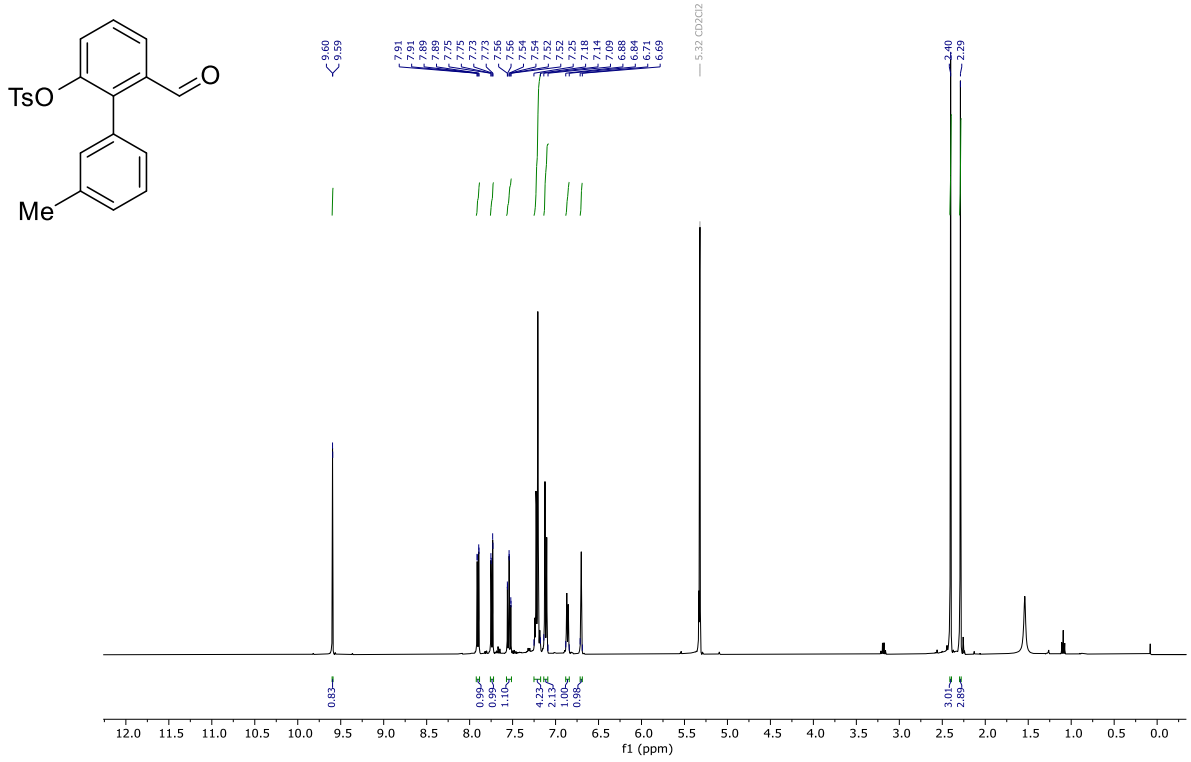



$^{13}$C-{$^{1}$H}-NMR

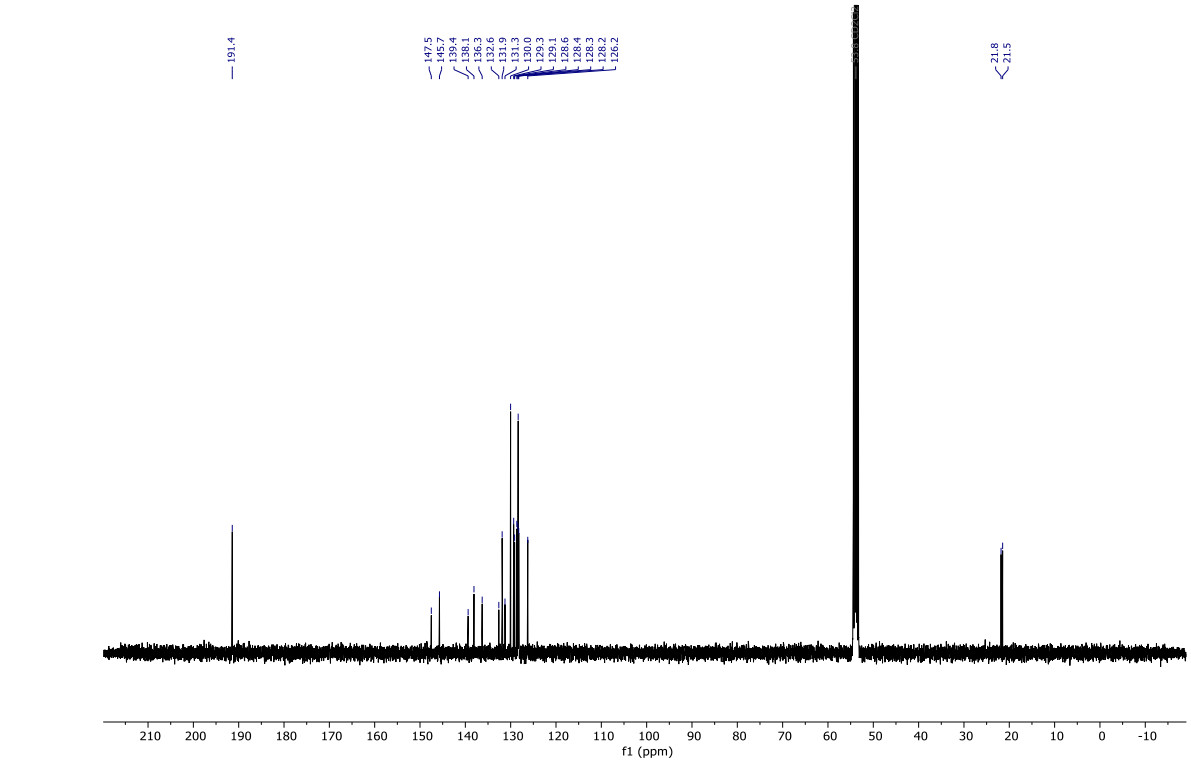


**6-Formyl-3'-methyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (1h).**

$^{1}$H-NMR

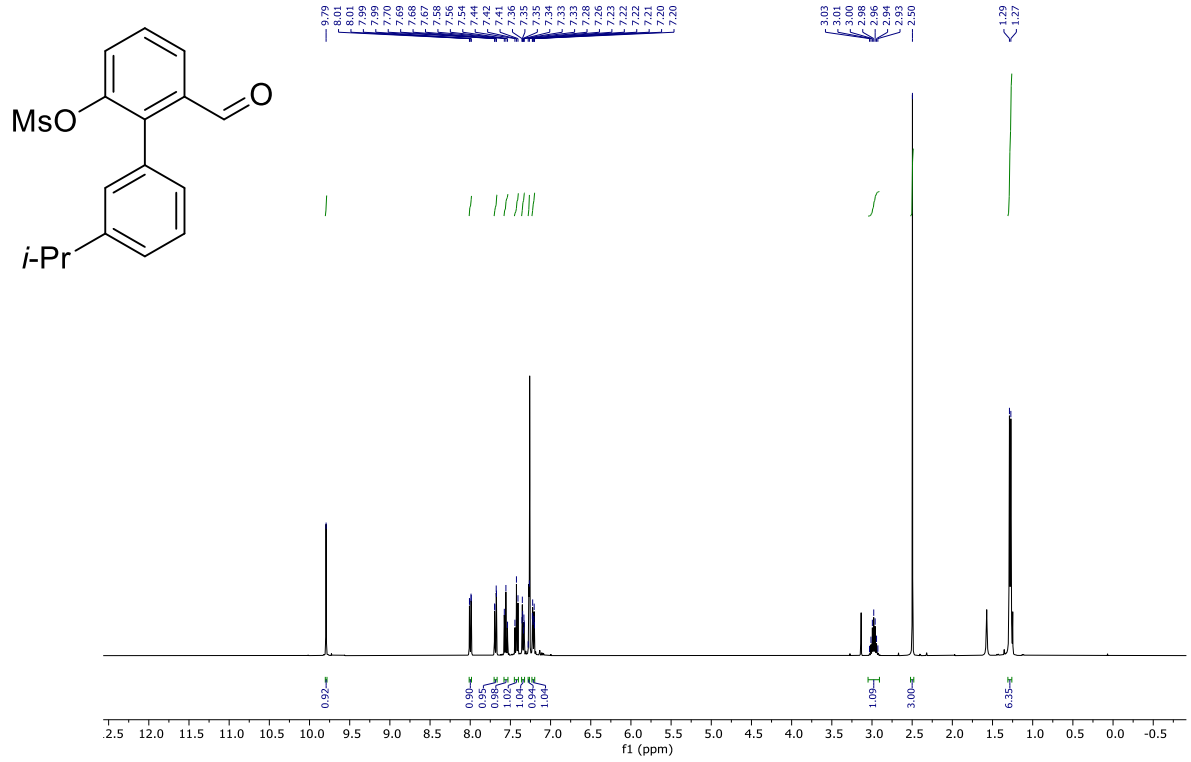



$^{13}$C-{$^{1}$H}-NMR

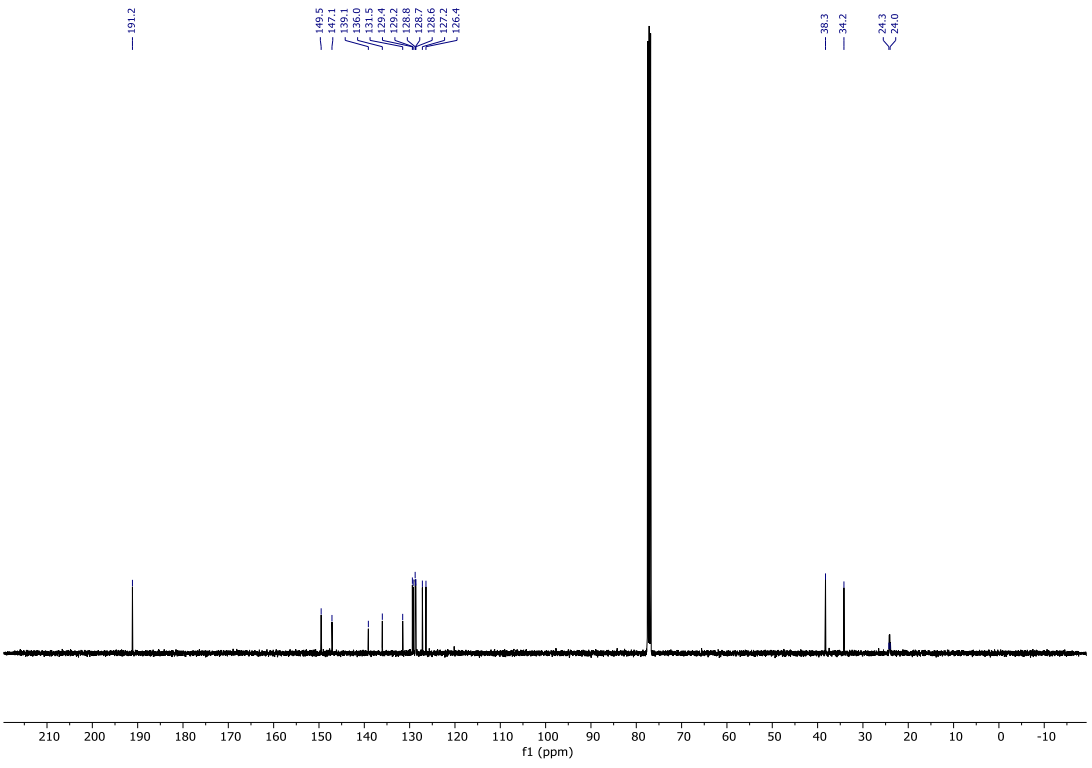


**6-Formyl-3'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (1i).**

$^{1}$H-NMR

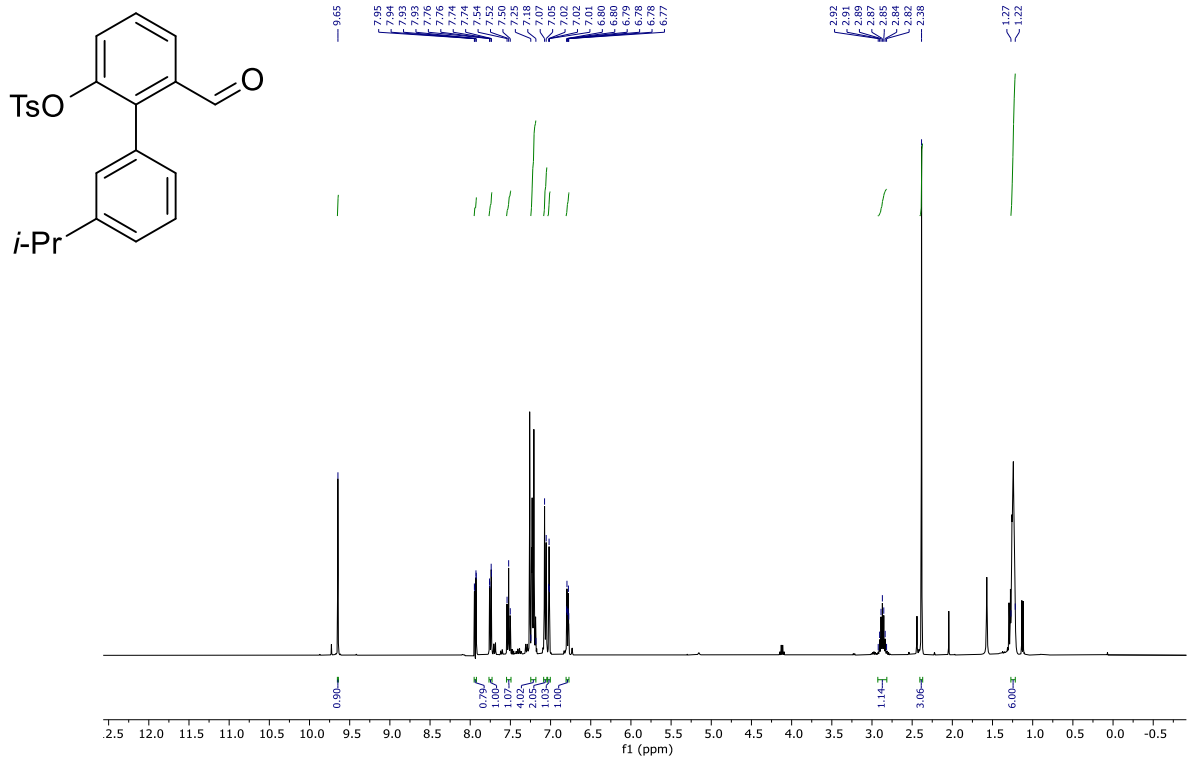



$^{13}$C-{$^{1}$H}-NMR

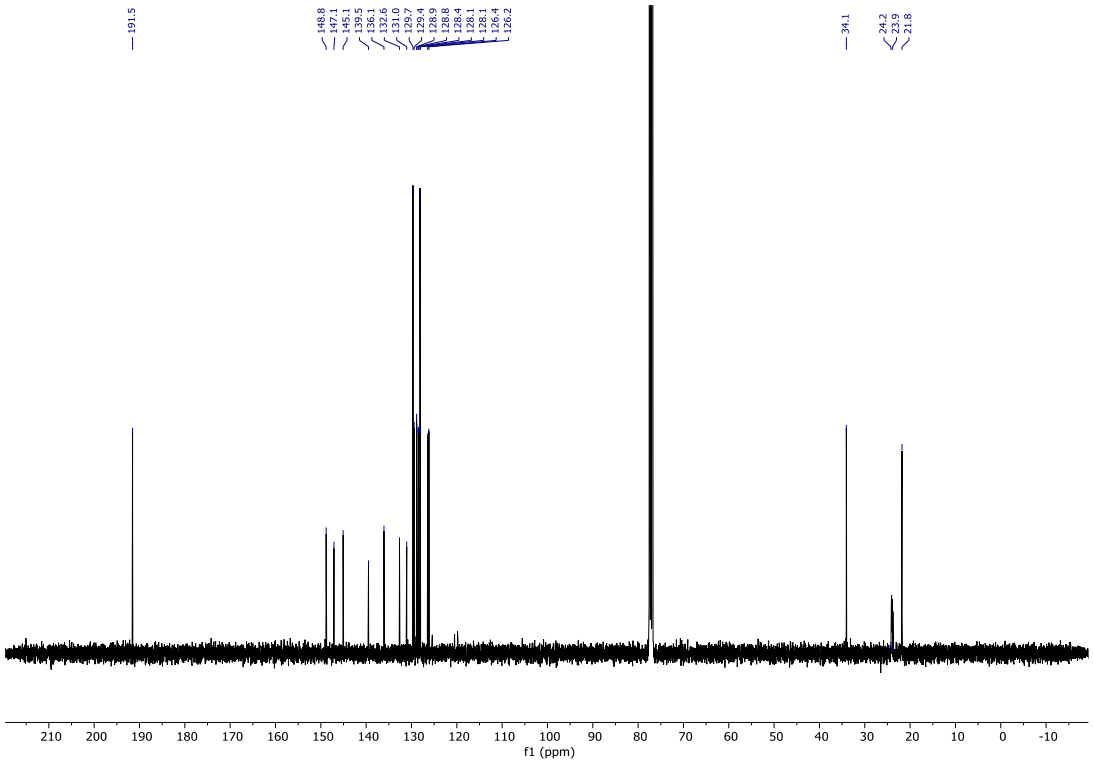


**6-Formyl-3'-*iso*-propyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (1j).**

$^{1}$H-NMR

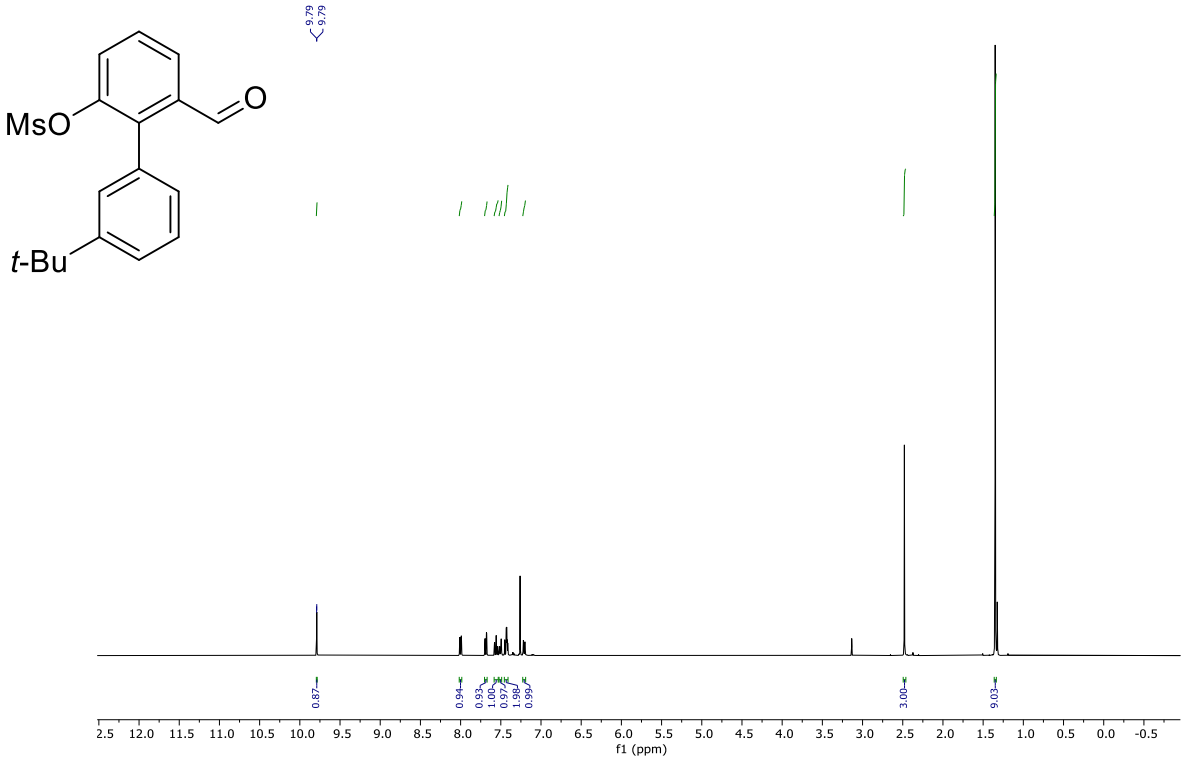



$^{13}$C-{$^{1}$H}-NMR

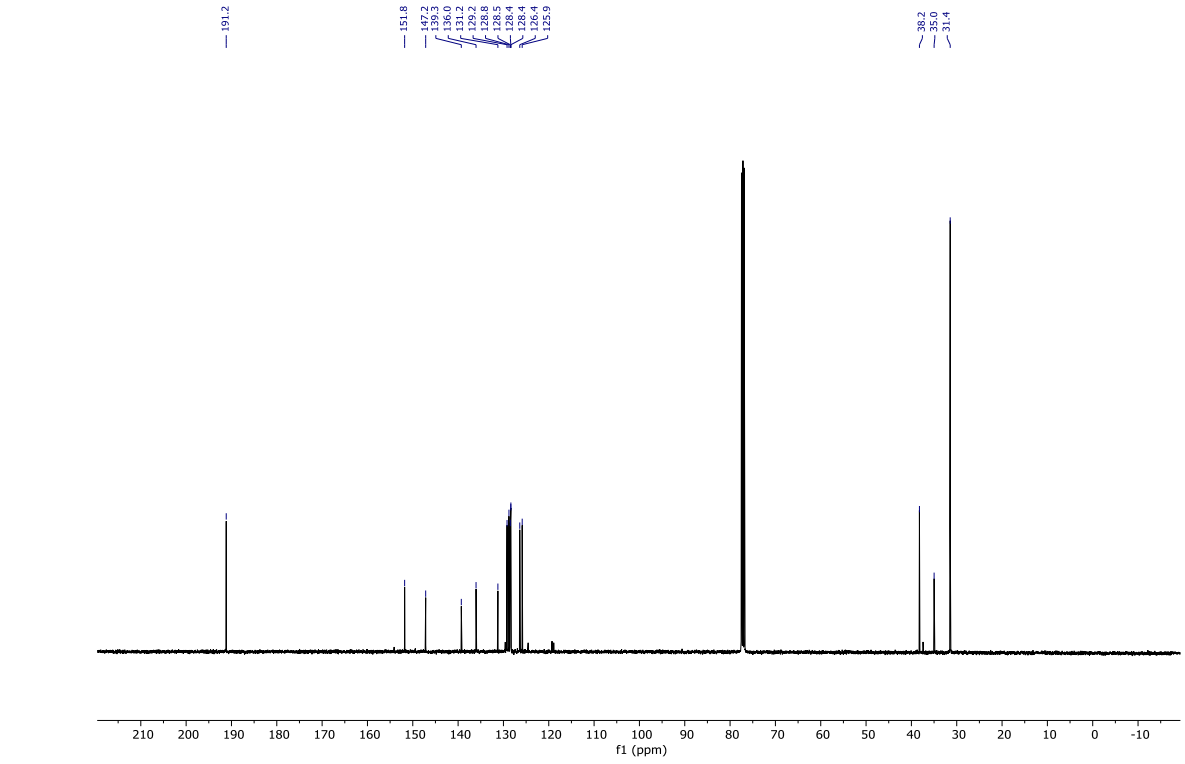


**3'-(*tert*-Butyl)-6-formyl-[1,1'-biphenyl]-2-yl methanesulfonate (1k).**

$^{1}$H-NMR

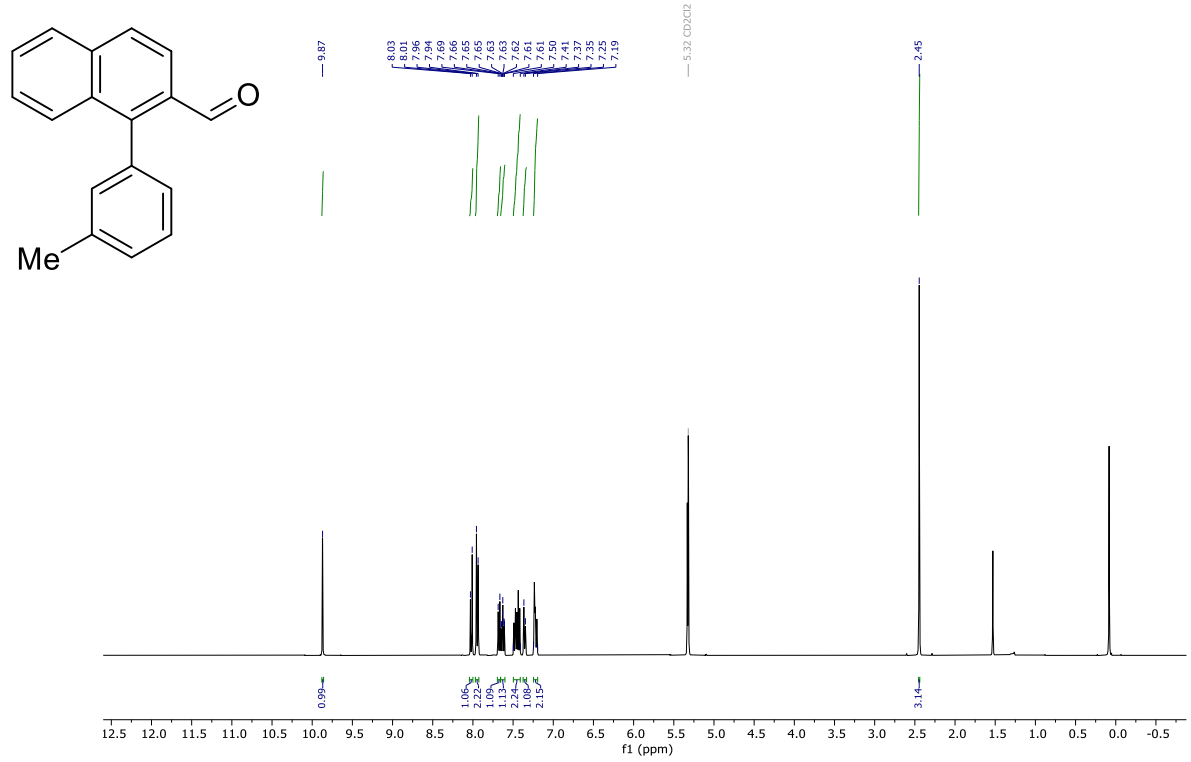



$^{13}$C-{$^{1}$H}-NMR

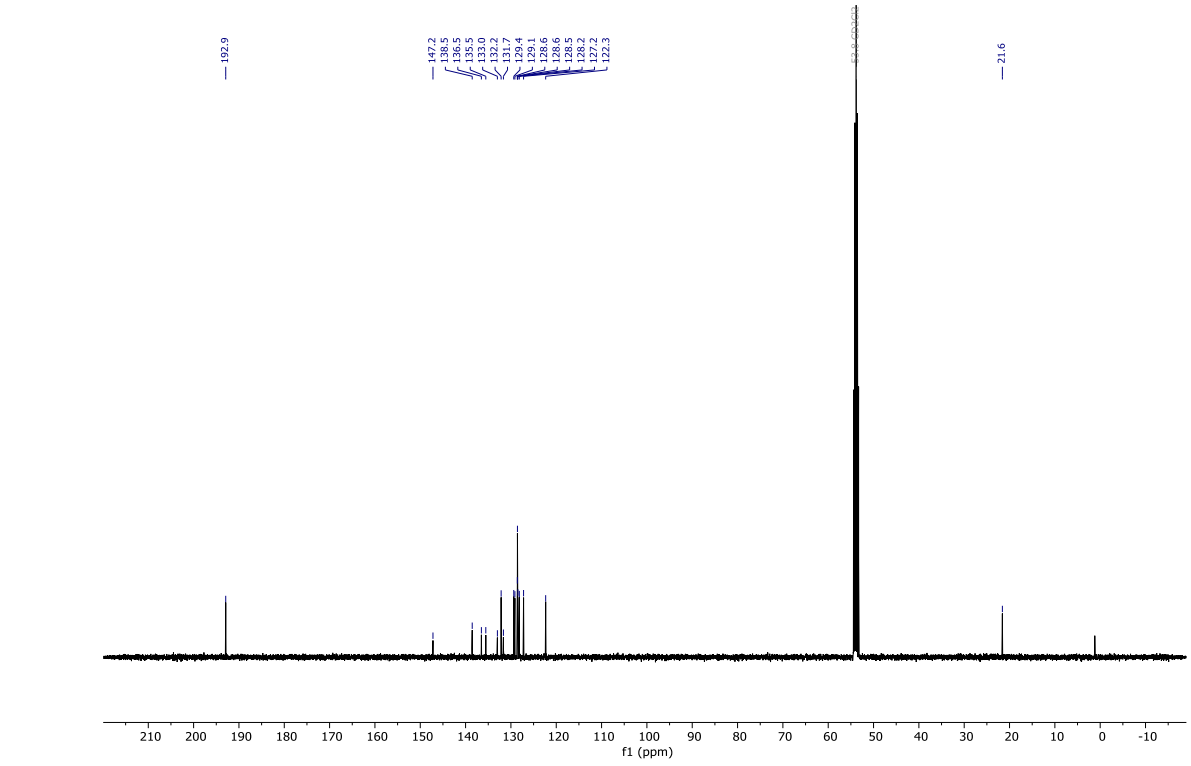


**1-(3-Methylphenyl)-2-naphthaldehyde (1m).**

$^{1}$H-NMR

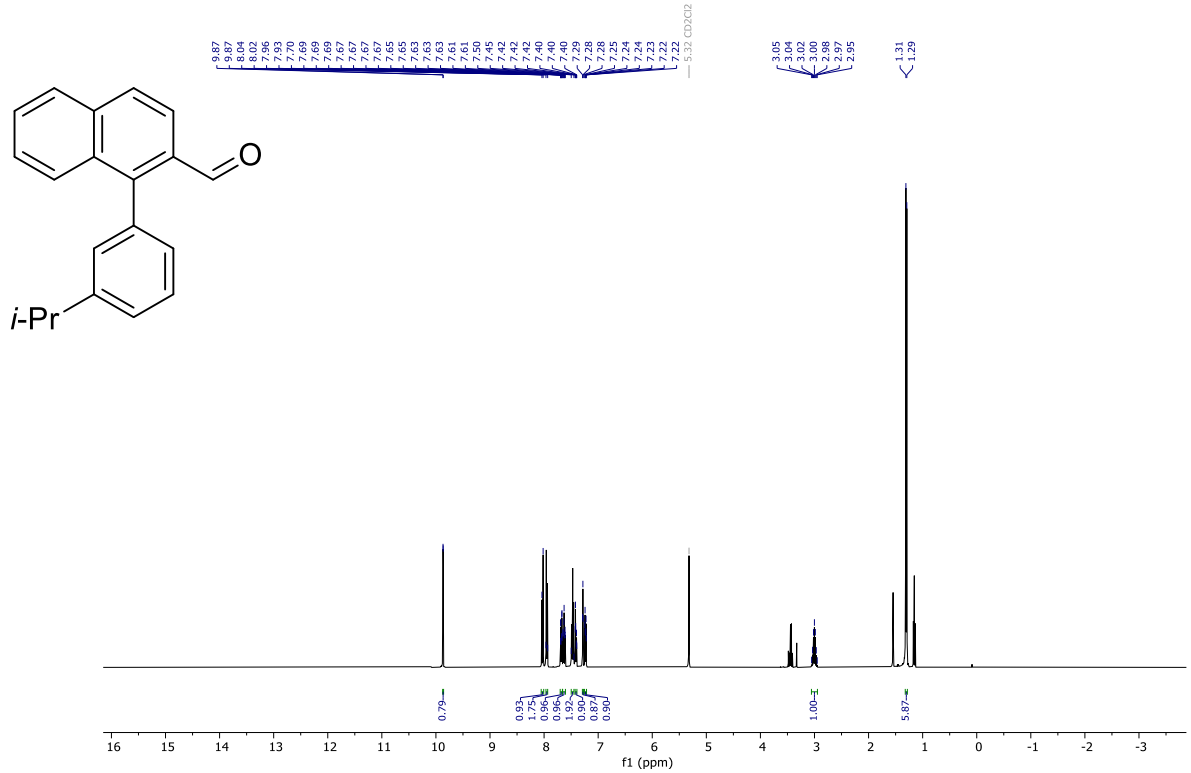



$^{13}$C-{$^{1}$H}-NMR

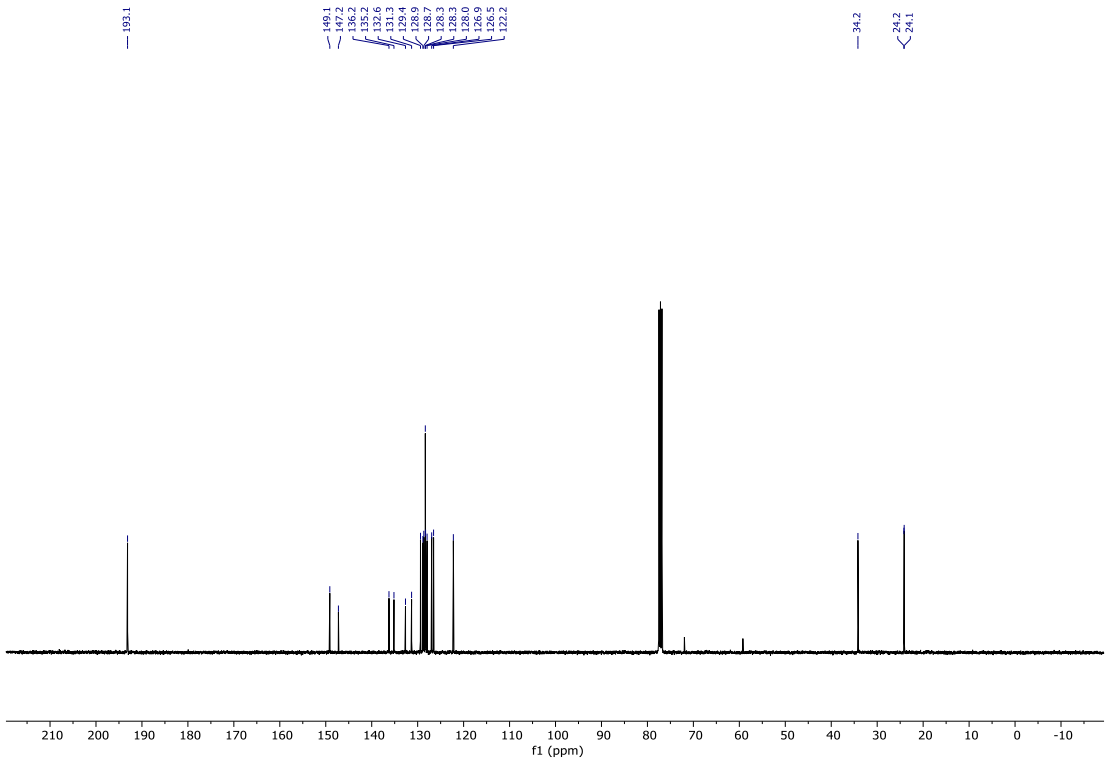


**1-(3-*iso*-Propylphenyl)-2-naphthaldehyde (1n).**

$^{1}$H-NMR

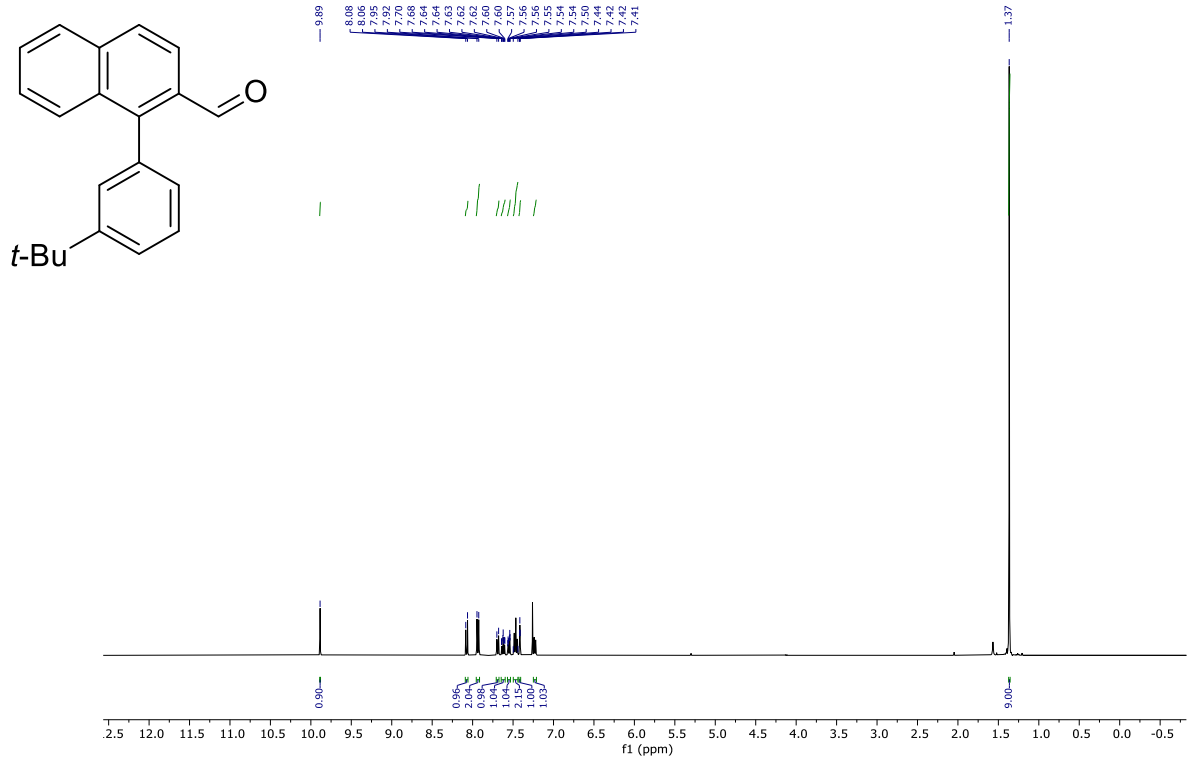



$^{13}$C-{$^{1}$H}-NMR

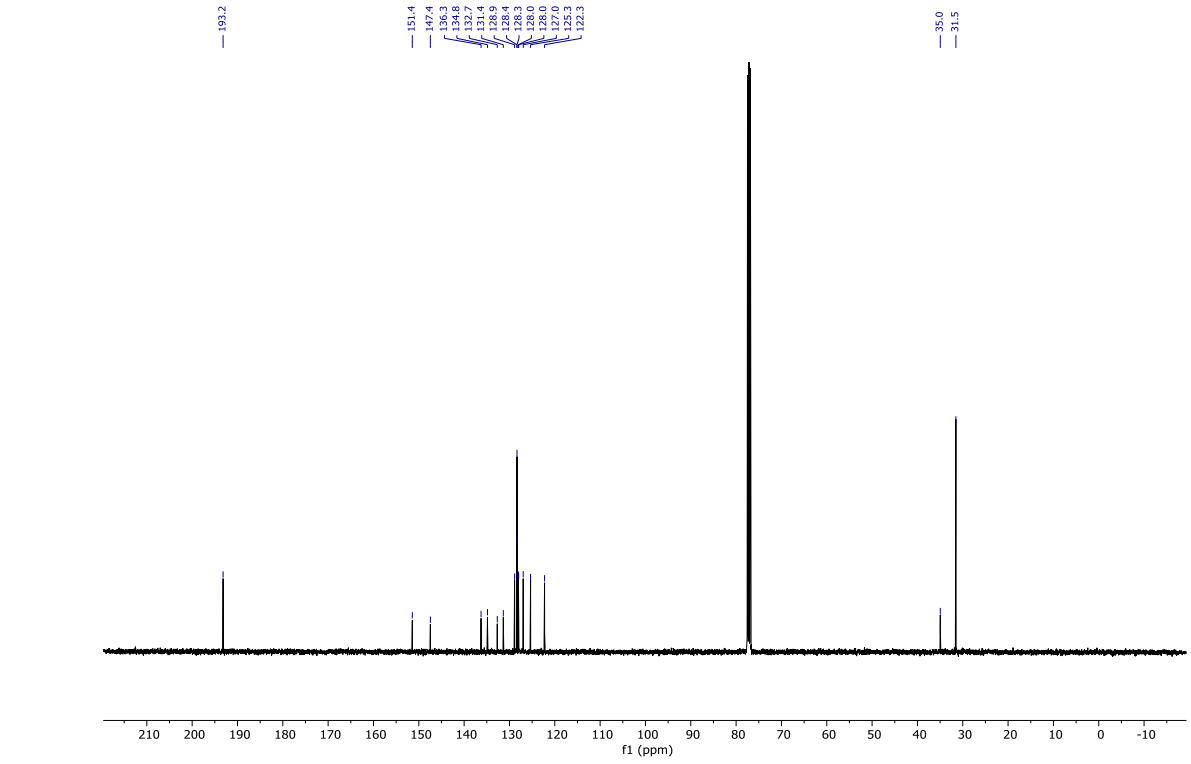


**1-(3-*tert*-Butylphenyl)-2-naphthaldehyde (1o).**

$^{1}$H-NMR

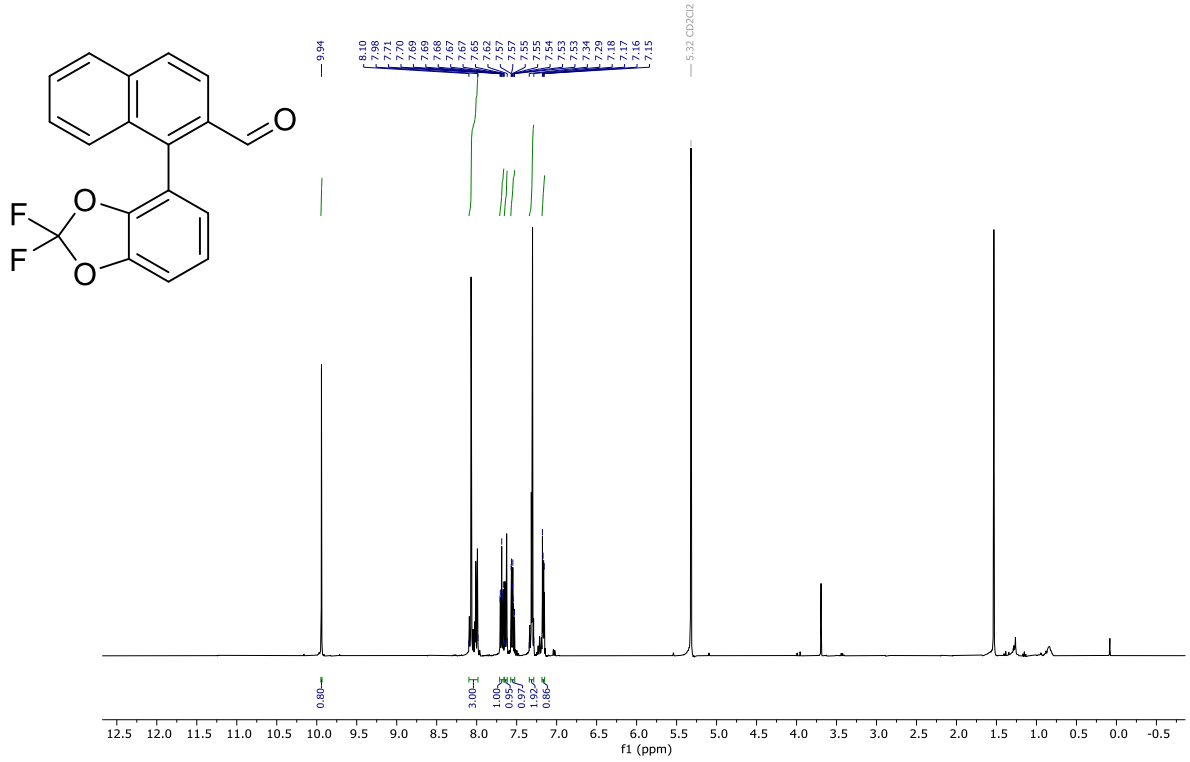



$^{13}$C-{$^{1}$H}-NMR

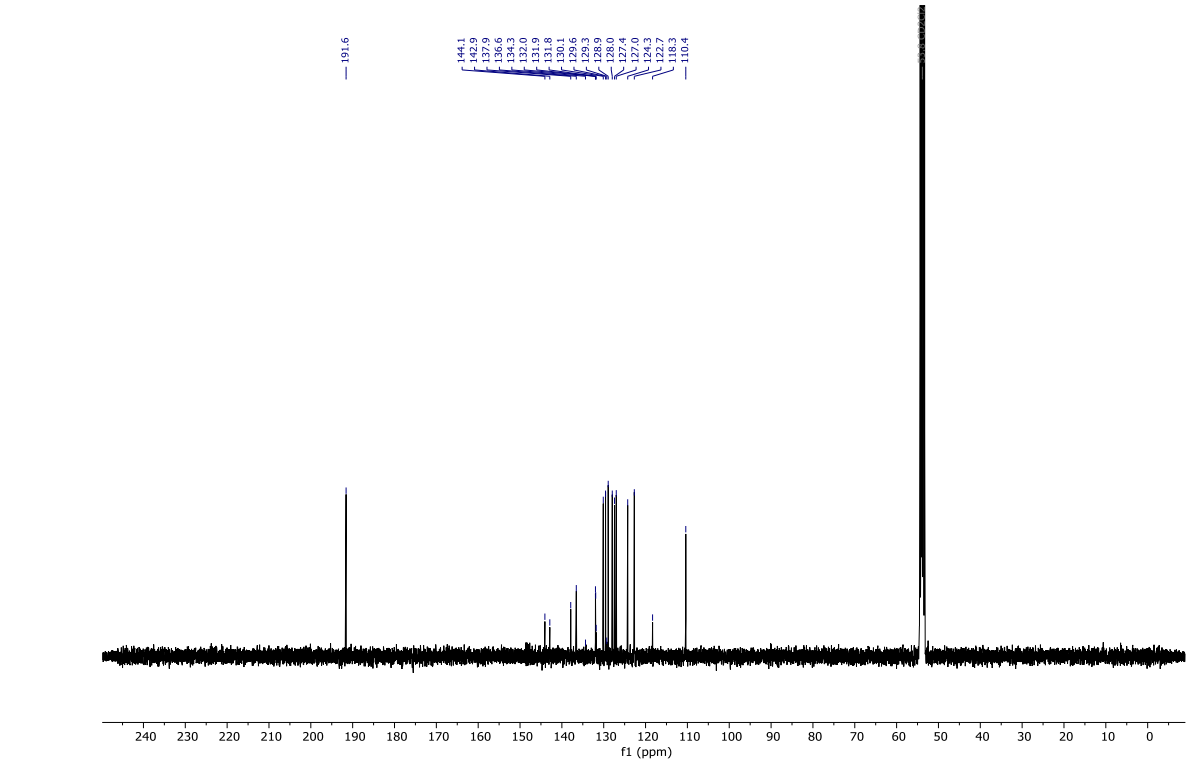


**1-(2,2-Difluorobenzo[d][1,3]dioxol-4-yl)-2-naphthaldehyde (1p).**

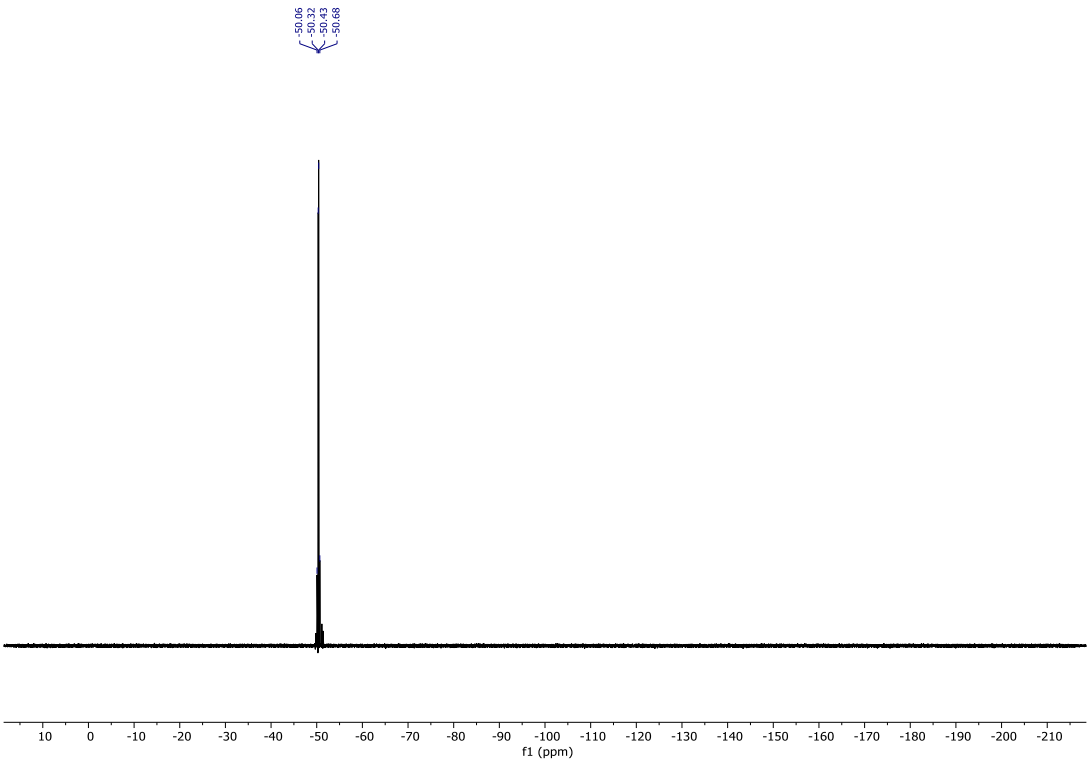
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

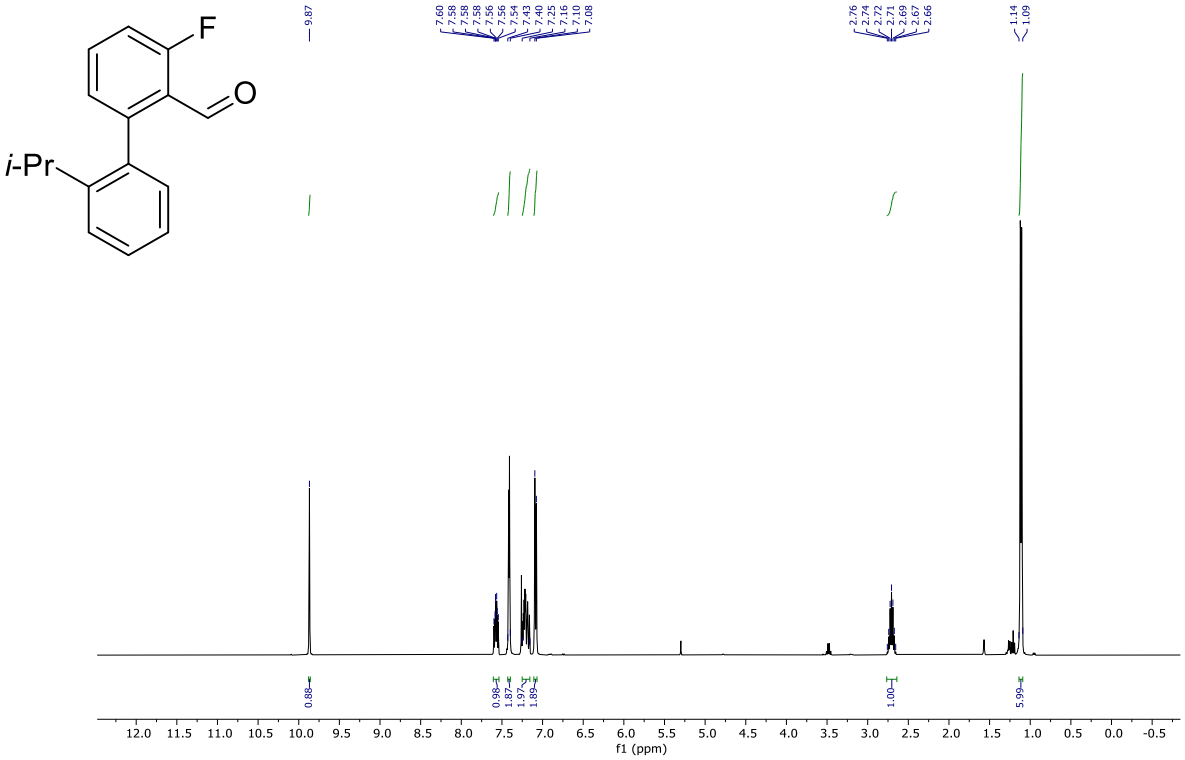


$^{19}F$-{$^{1}H$}-NMR

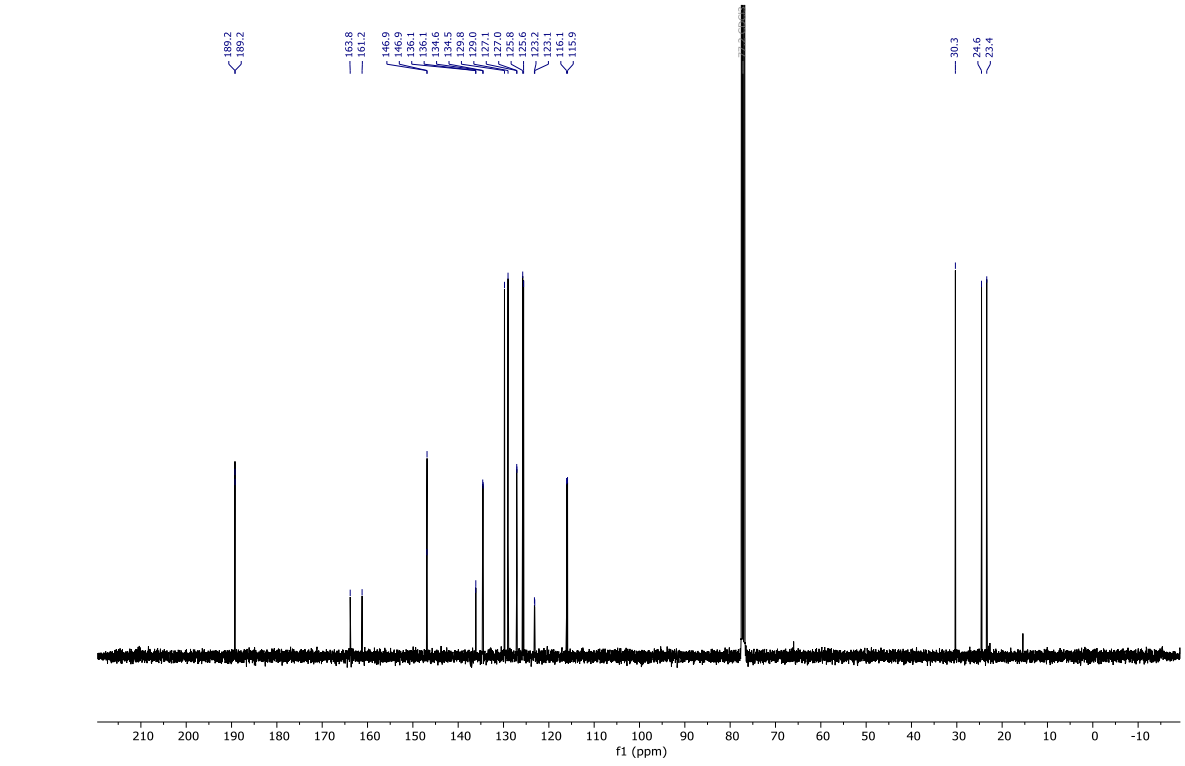

-50.06
-50.32
-50.43
-50.68
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**3-Fluoro-2'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (1q).**

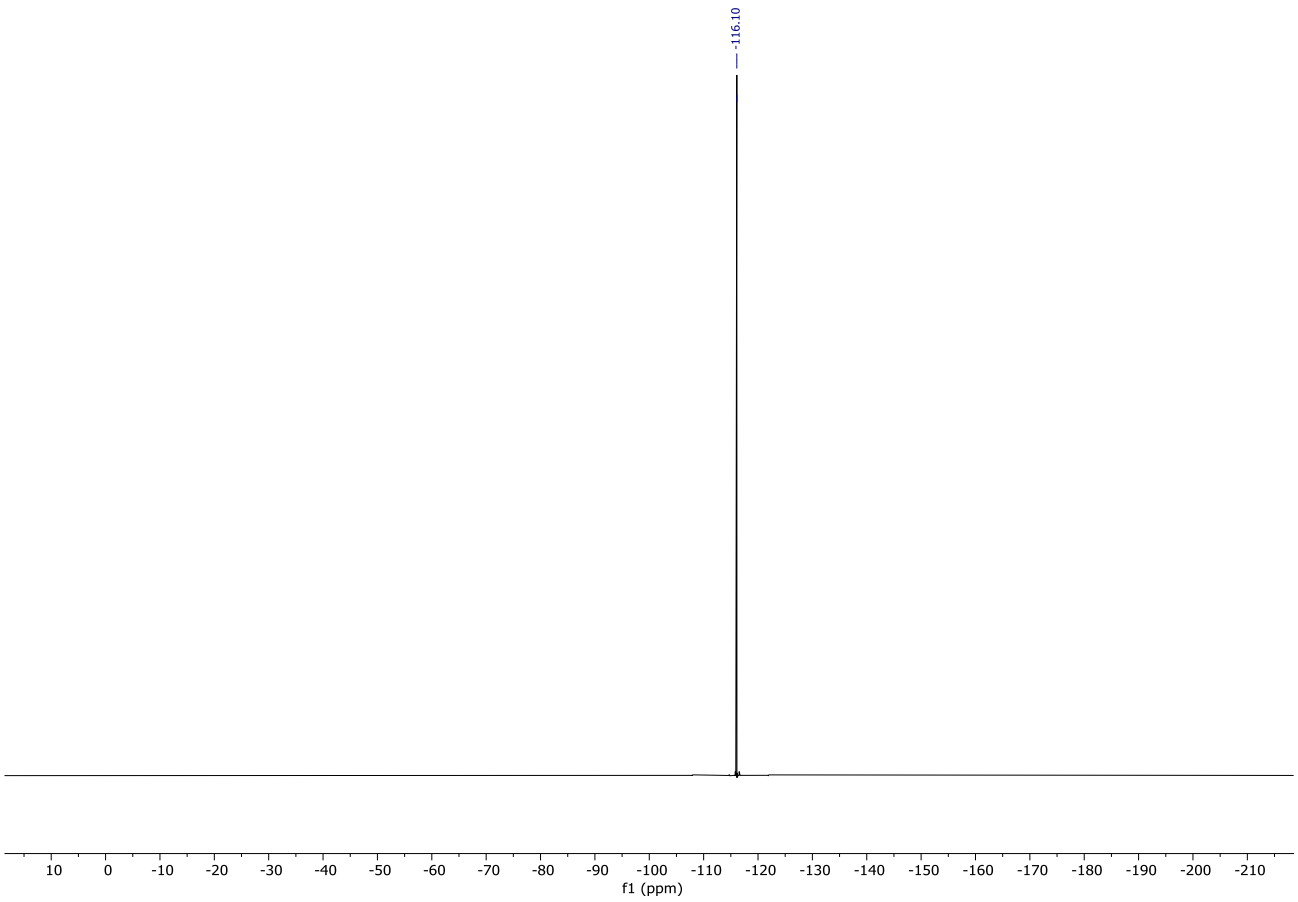
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

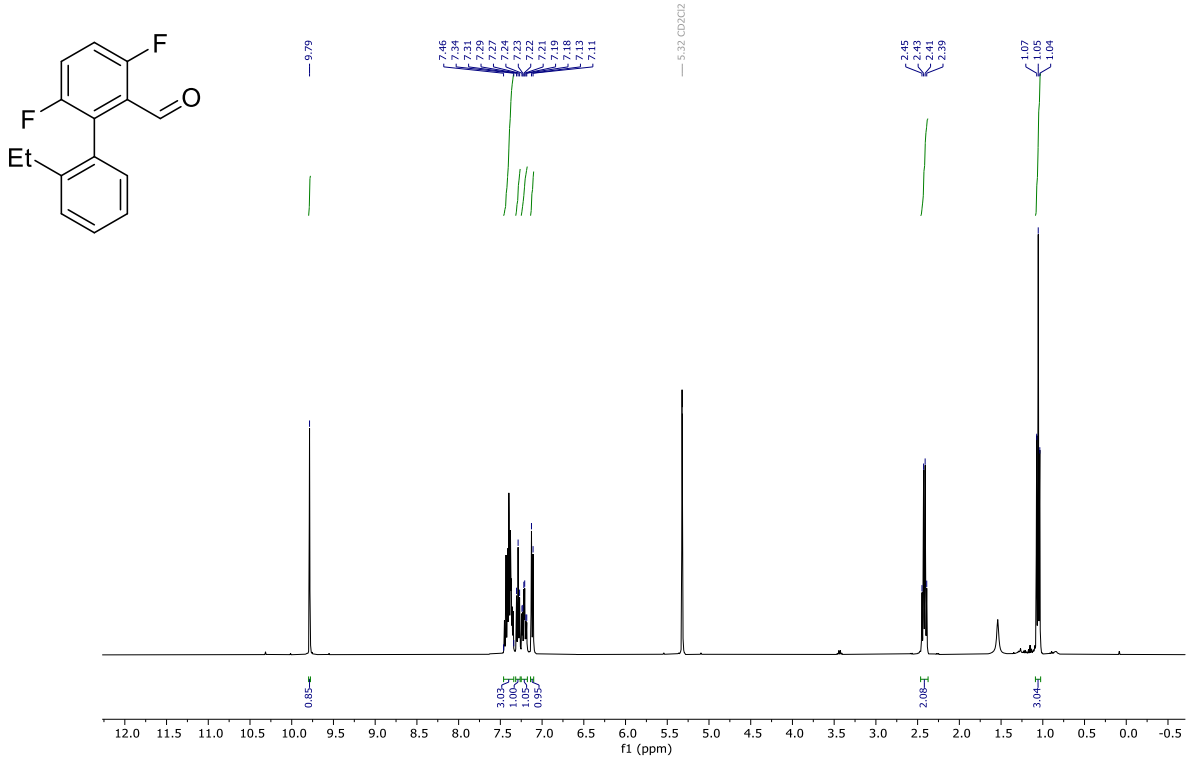


$^{19}F$-{$^{1}H$}-NMR

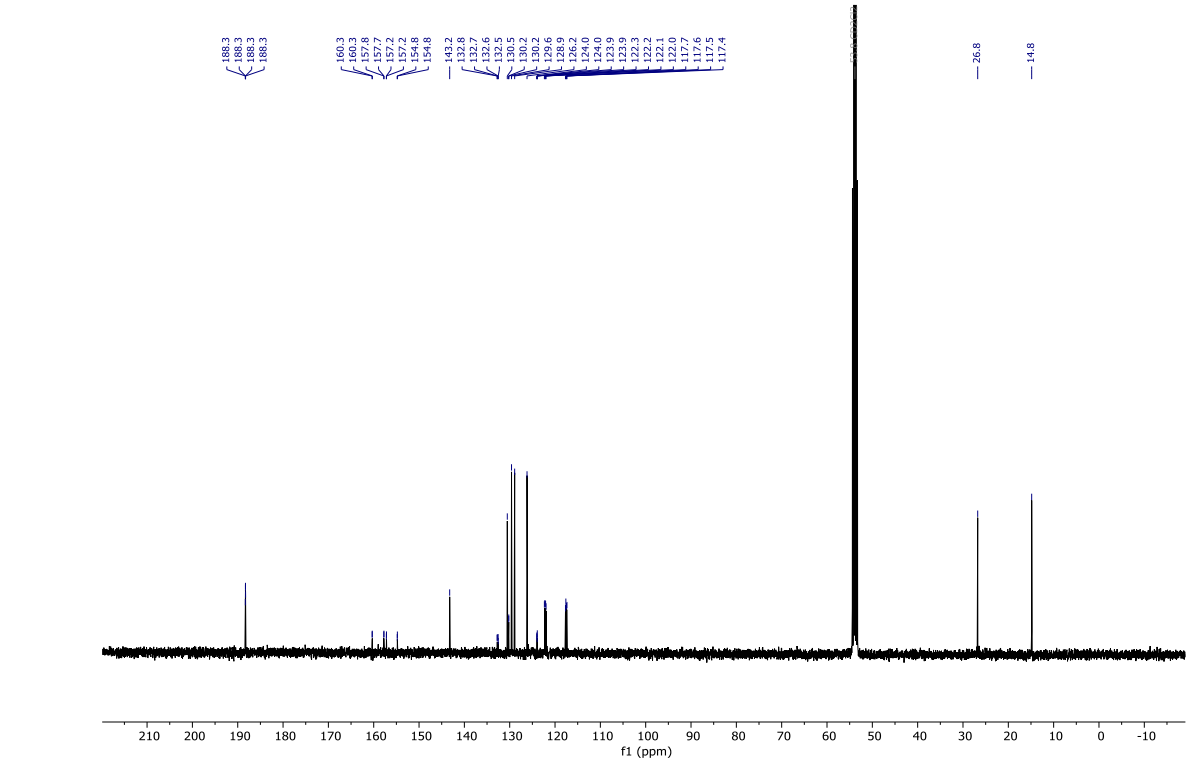

-116.10
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**2'-Ethyl-3,6-difluoro-[1,1'-biphenyl]-2-carbaldehyde (1r).**

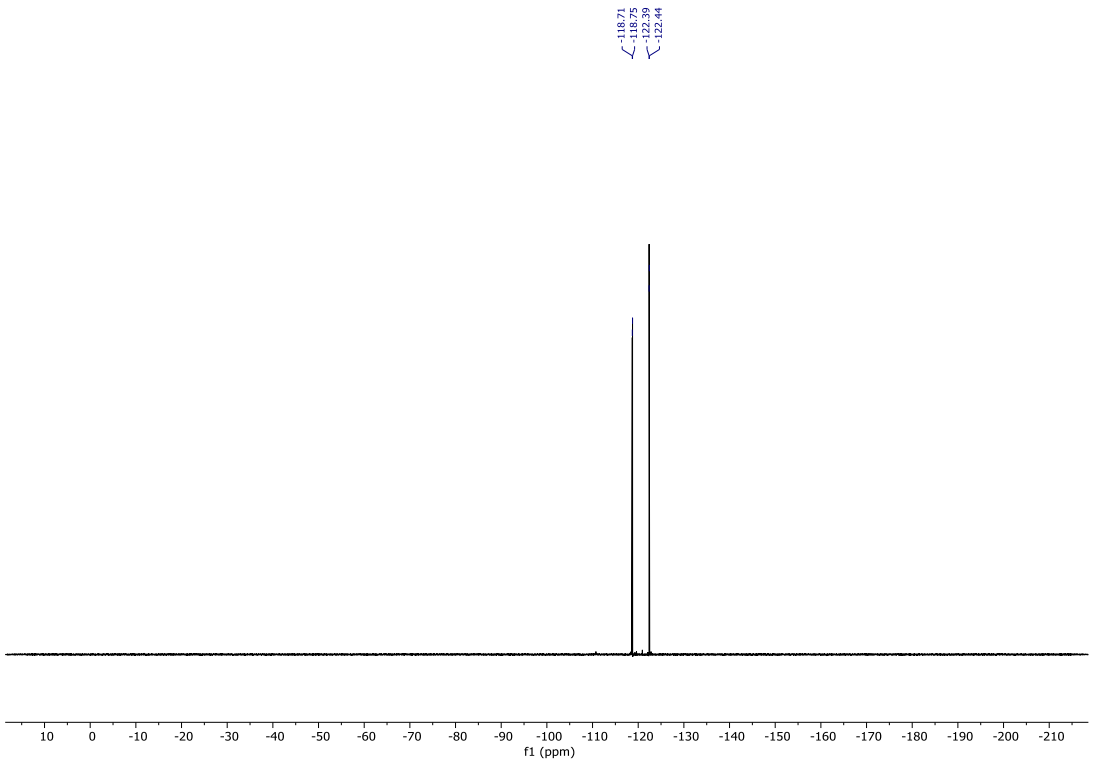
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

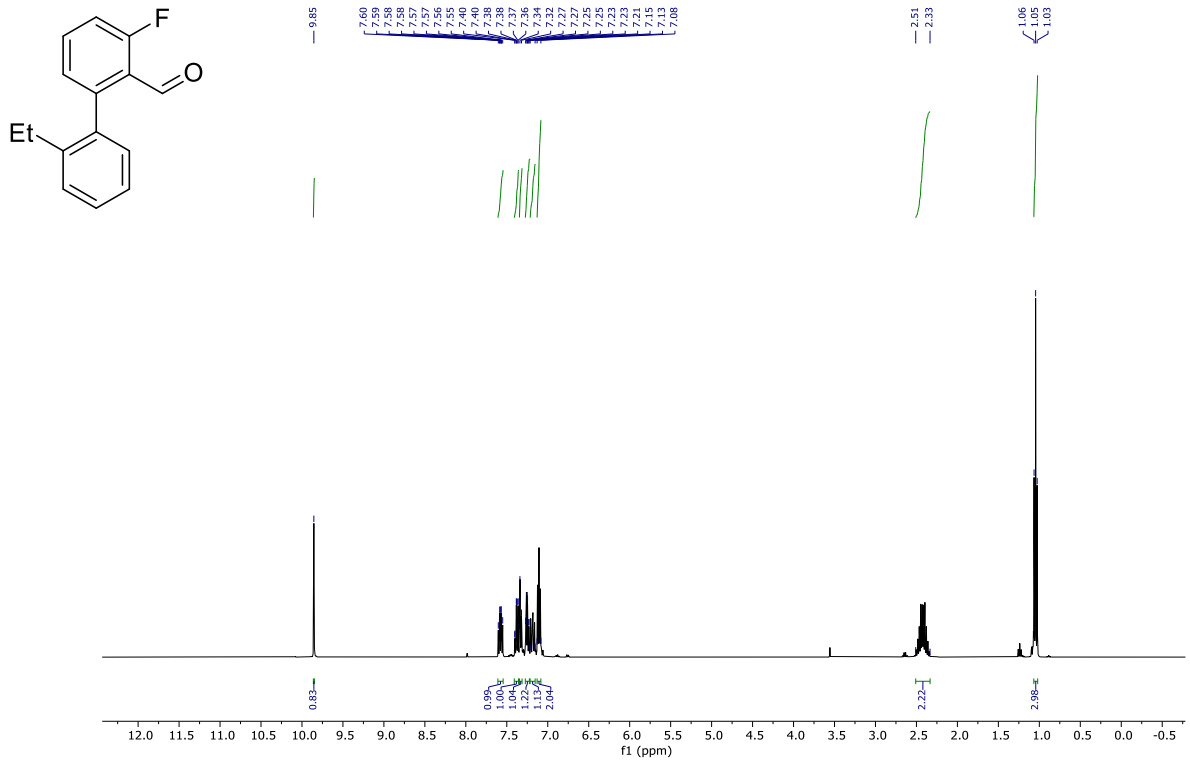


$^{19}F$-{$^{1}H$}-NMR

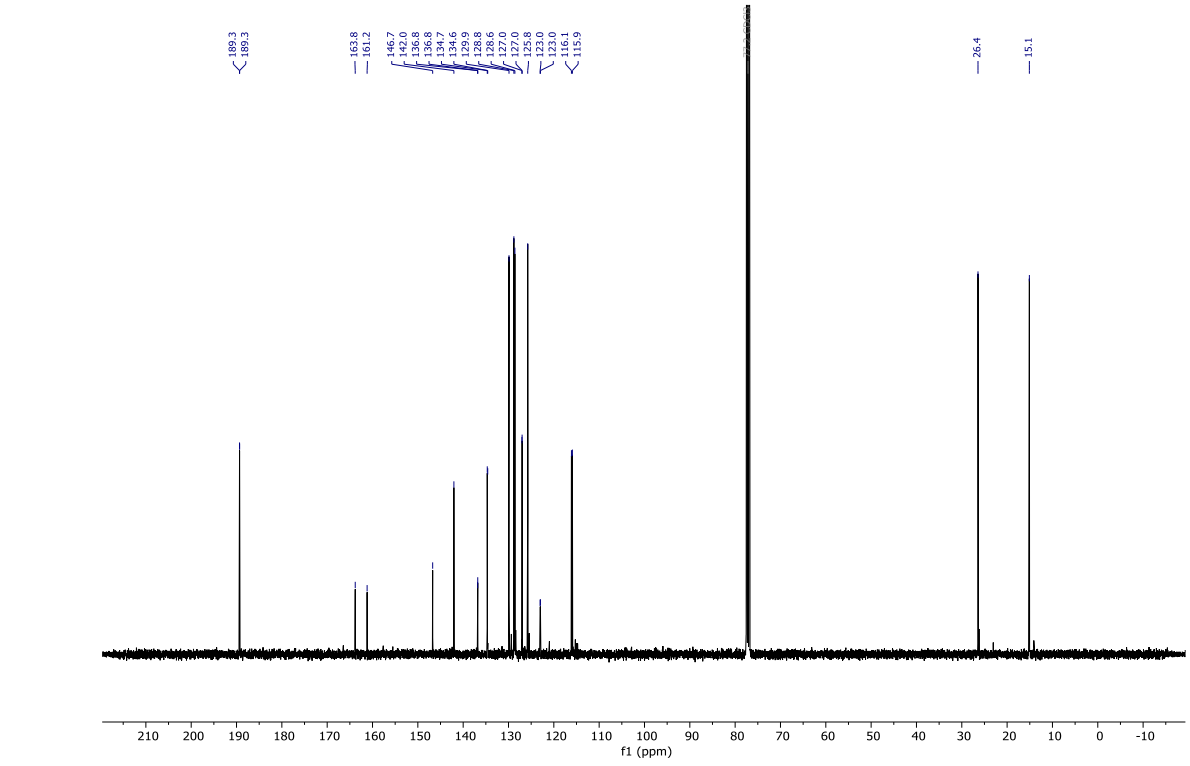

-118.71
-118.75
-122.39
-122.44
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**2'-Ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (1s).**

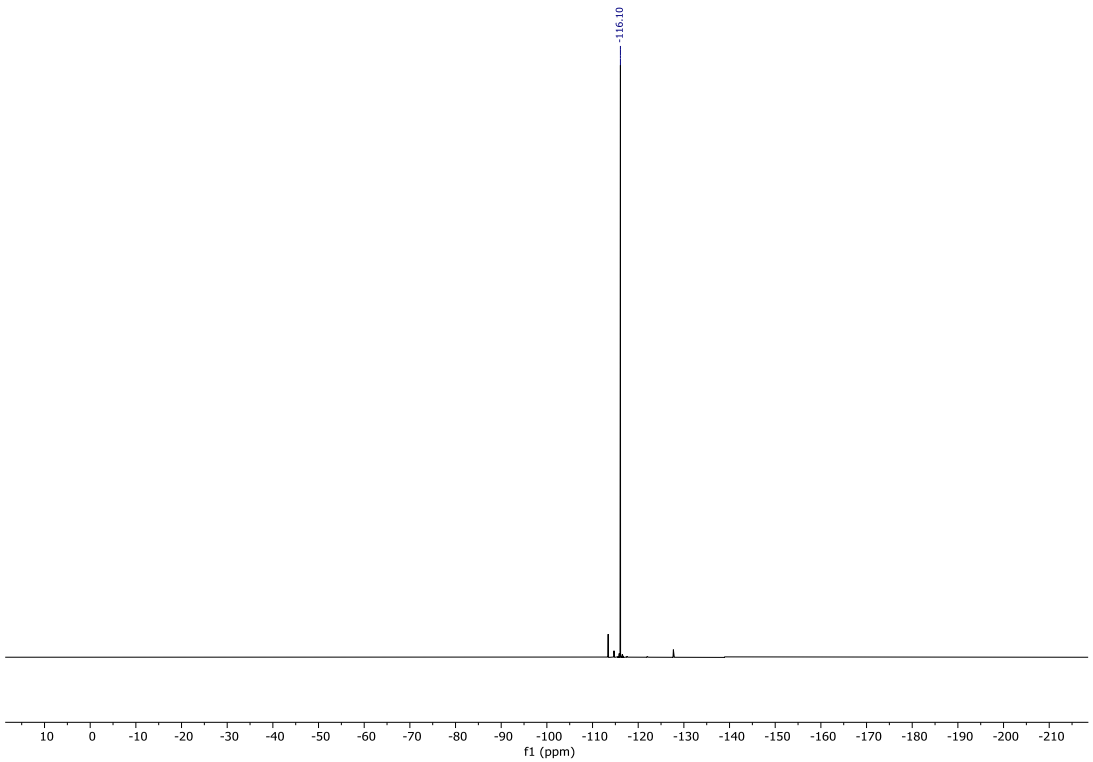
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

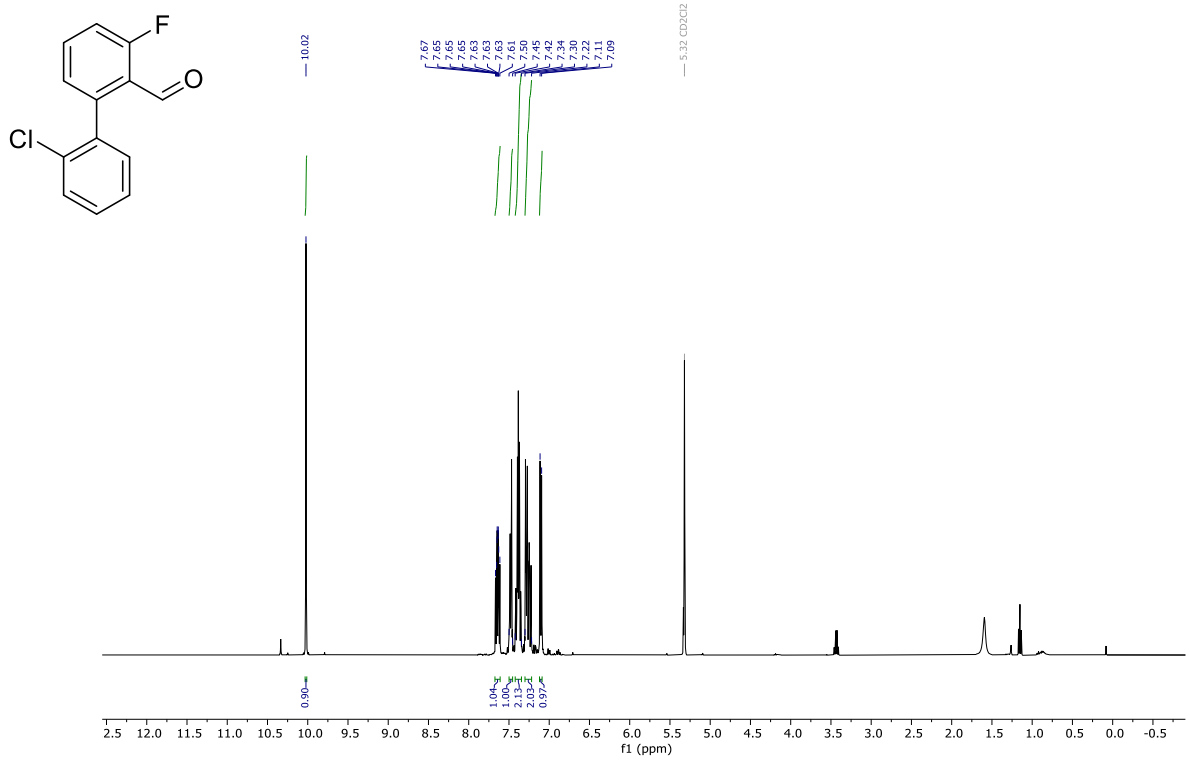


$^{19}F$-{$^{1}H$}-NMR

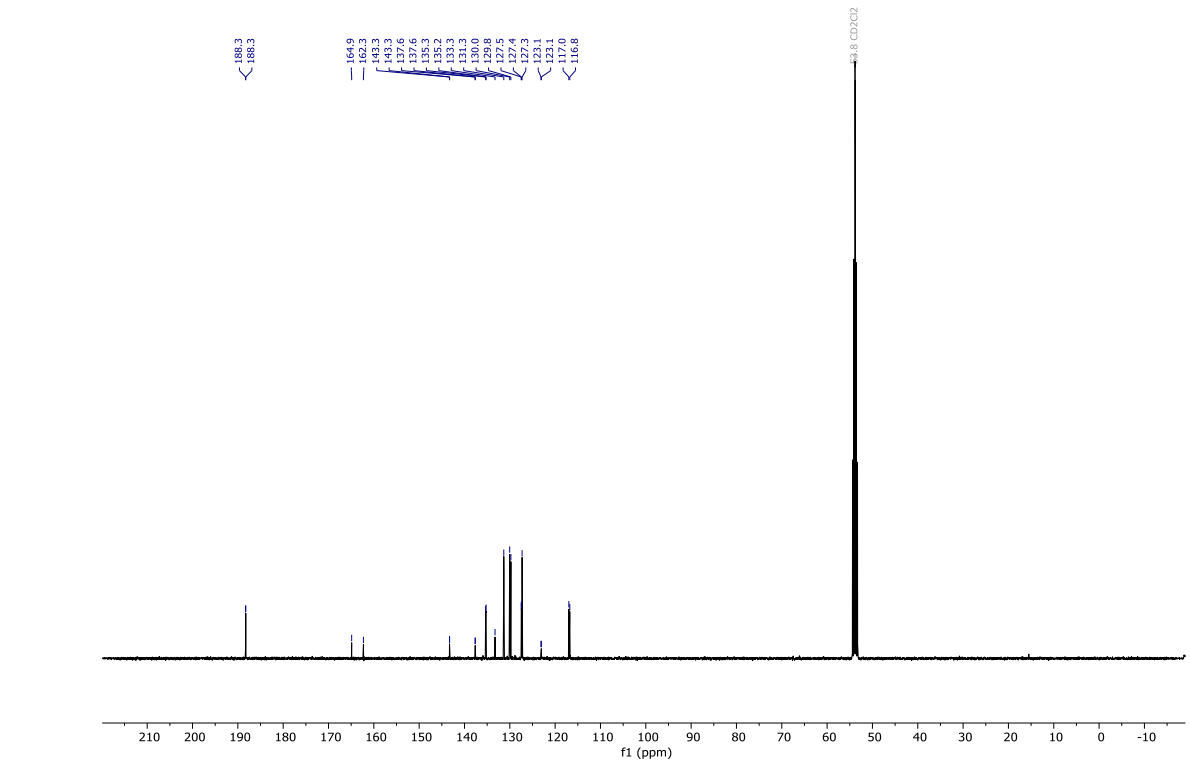

-116.10
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**2'-Chloro-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (1t).**

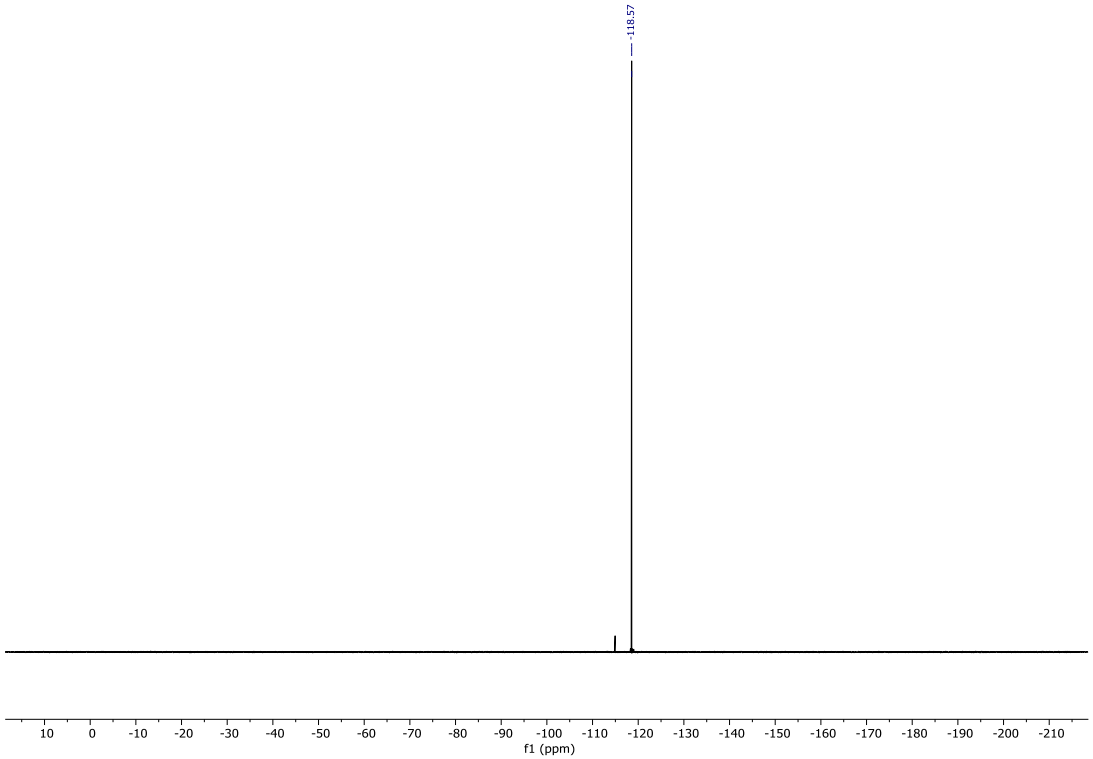
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

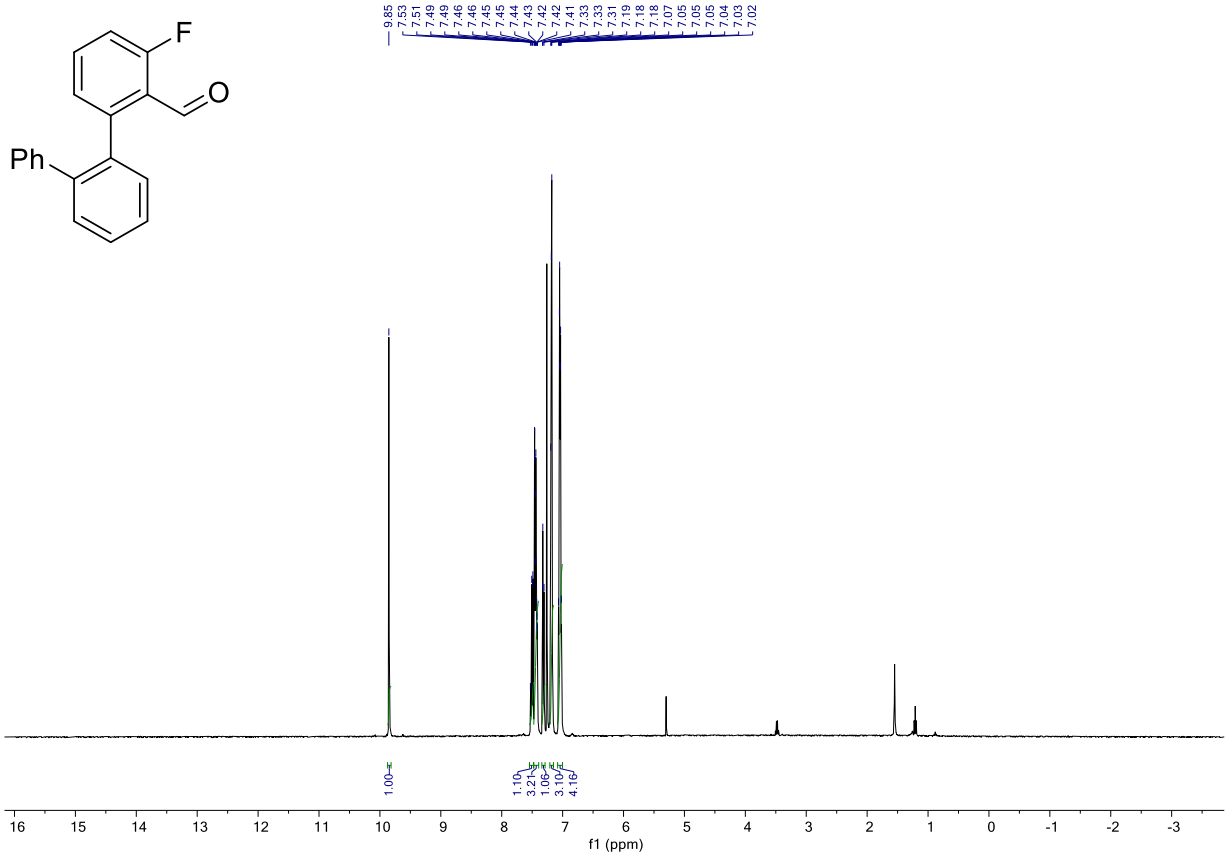


$^{19}F$-{$^{1}H$}-NMR

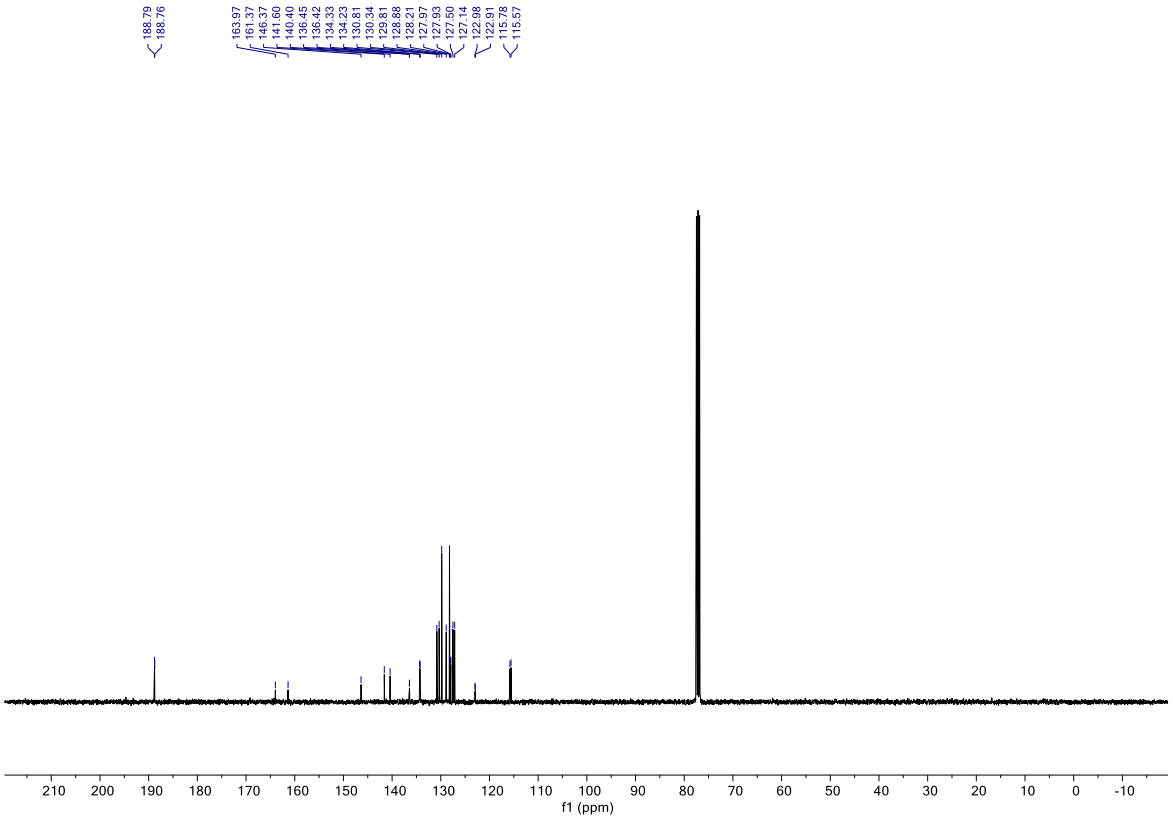

-118.57
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**3-Fluoro-[1,1':2',1''-terphenyl]-2-carbaldehyde (1ϕ)**

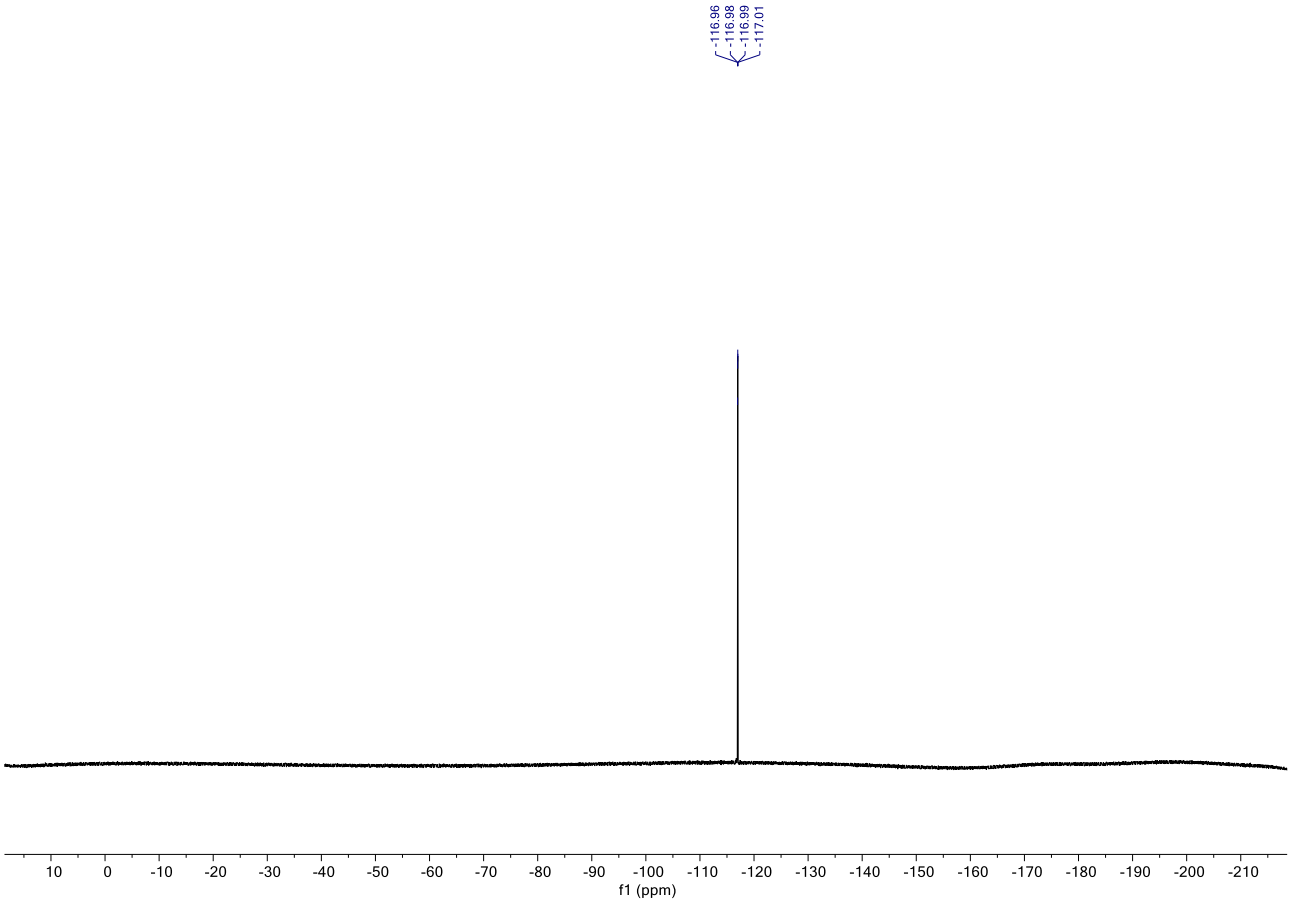
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

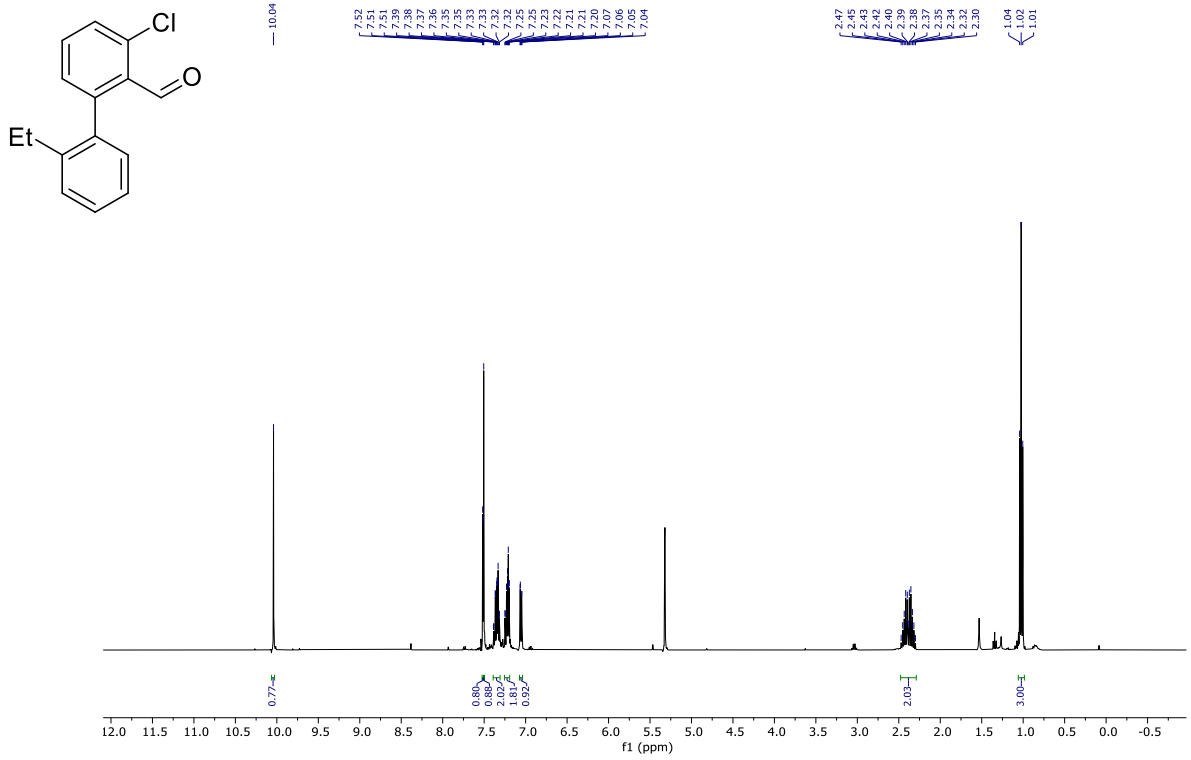


$^{19}$F-NMR

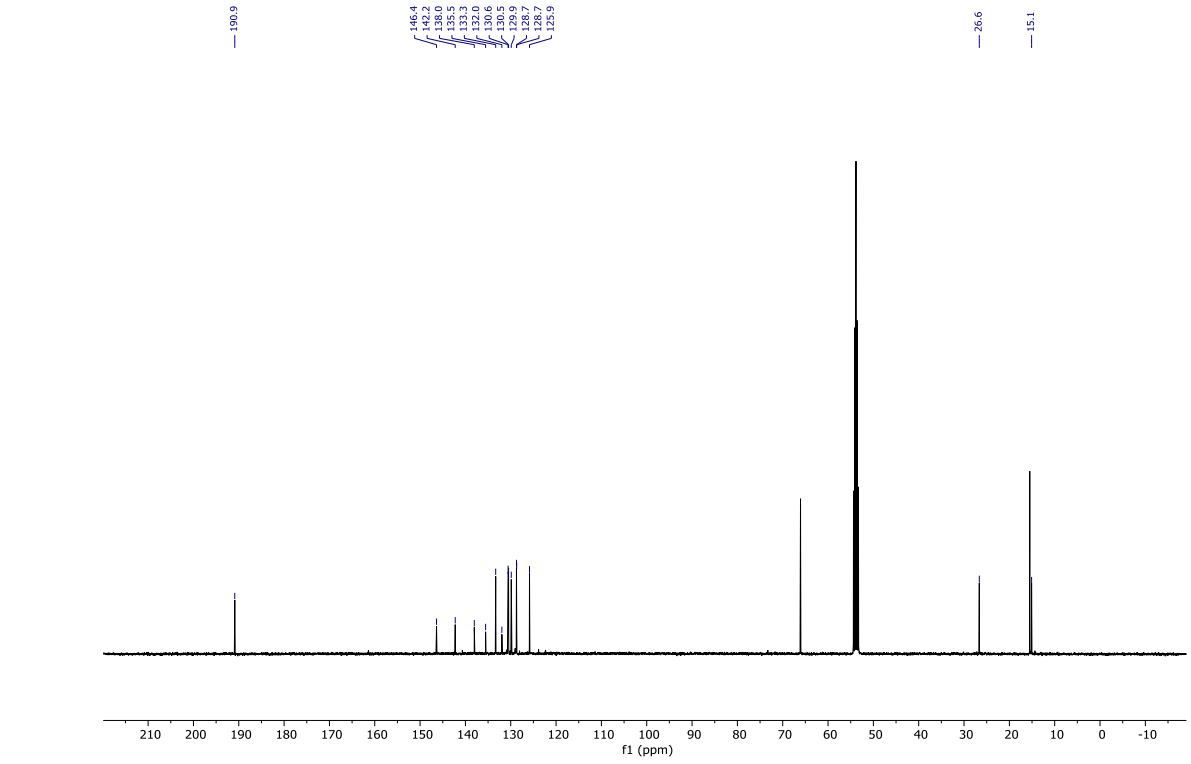

-116.96
-116.98
-116.99
-117.01
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

**3-Chloro-2'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (1u).**

$^{1}$H-NMR

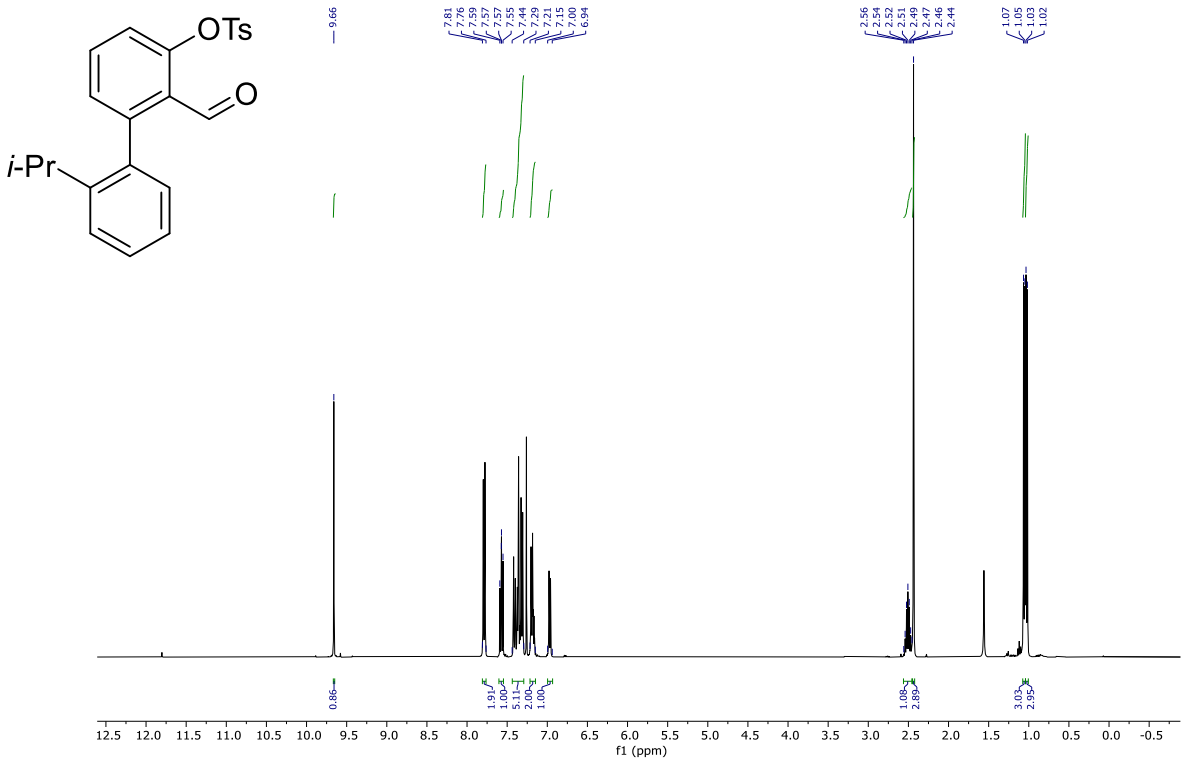



$^{13}$C-{$^{1}$H}-NMR

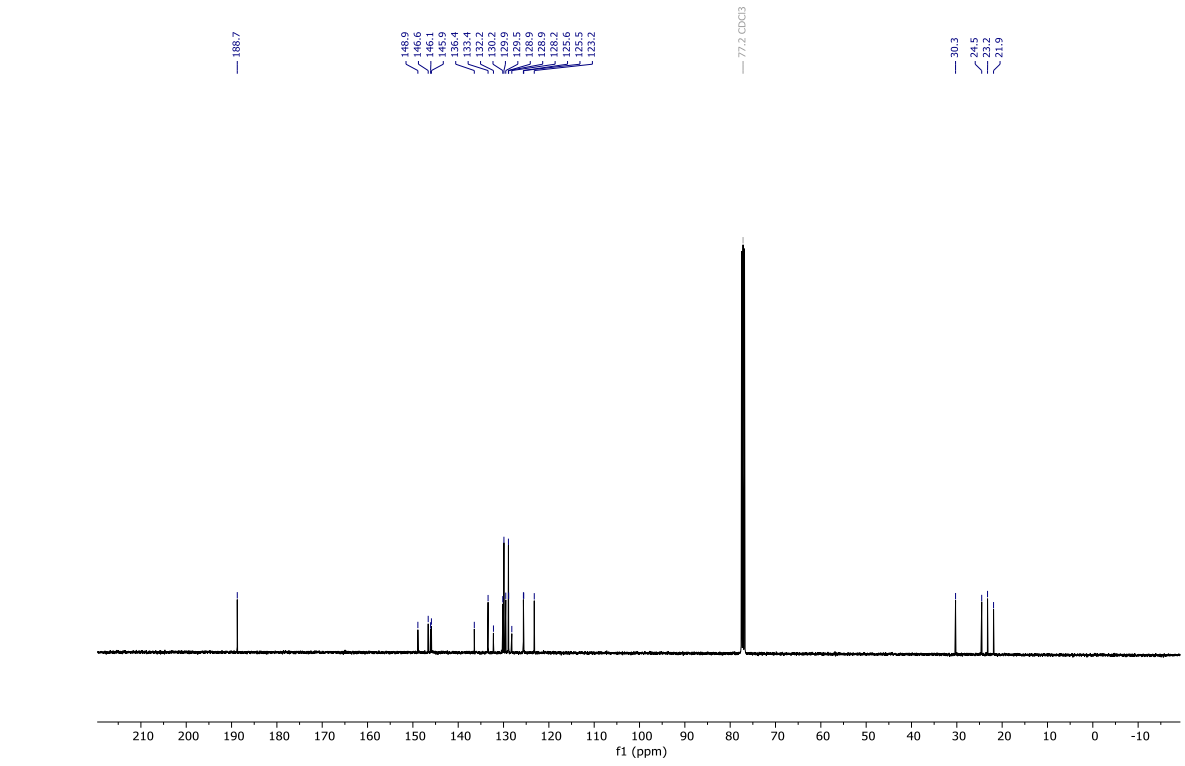


**2-Formyl-2'-*iso*-propyl-[1,1'-biphenyl]-3-yl 4-methylbenzenesulfonate (1v).**

$^{1}$H-NMR

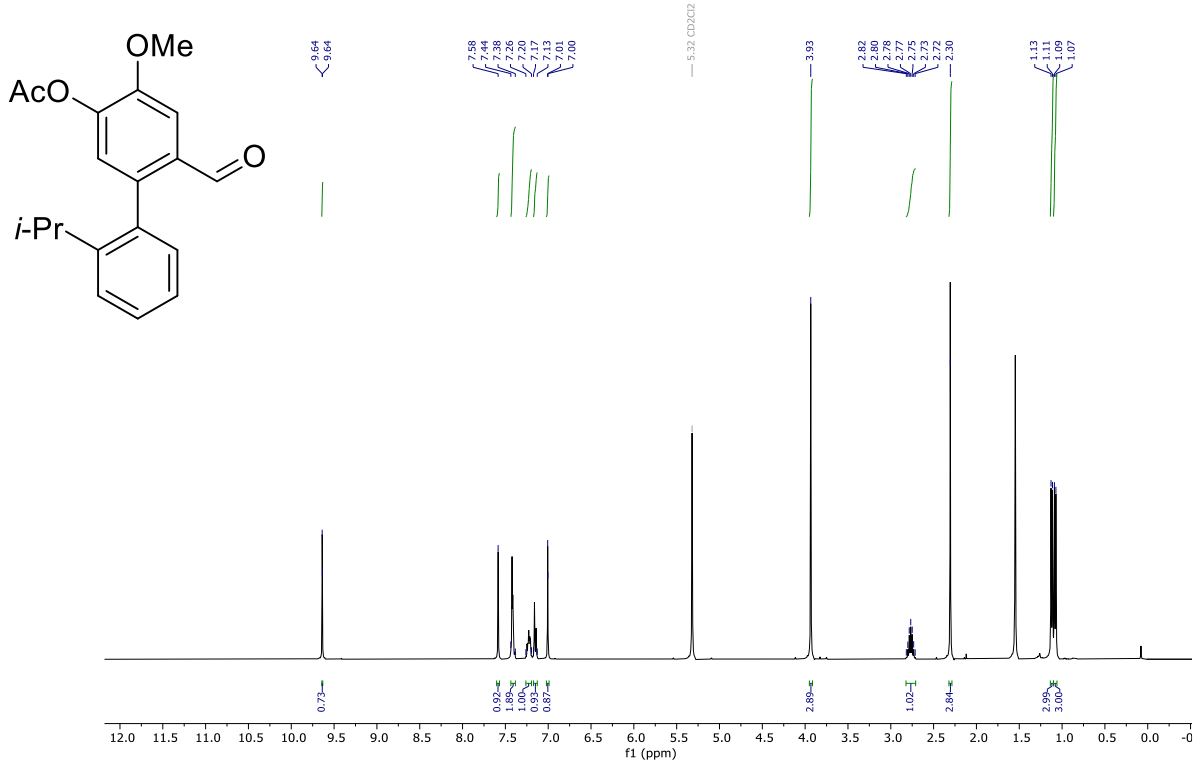



$^{13}$C-{$^{1}$H}-NMR

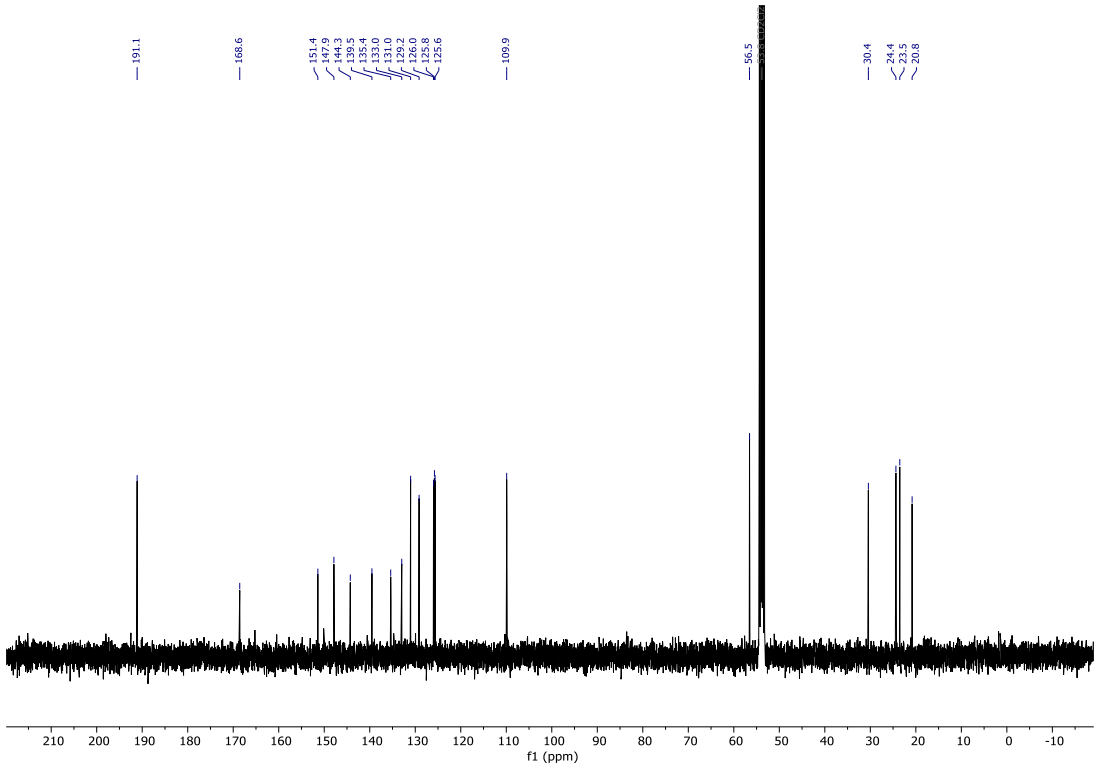


**2'-*iso*-Propyl-6-formyl-4-methoxy-[1,1'-biphenyl]-3-yl acetate (1w).**

$^{1}$H-NMR

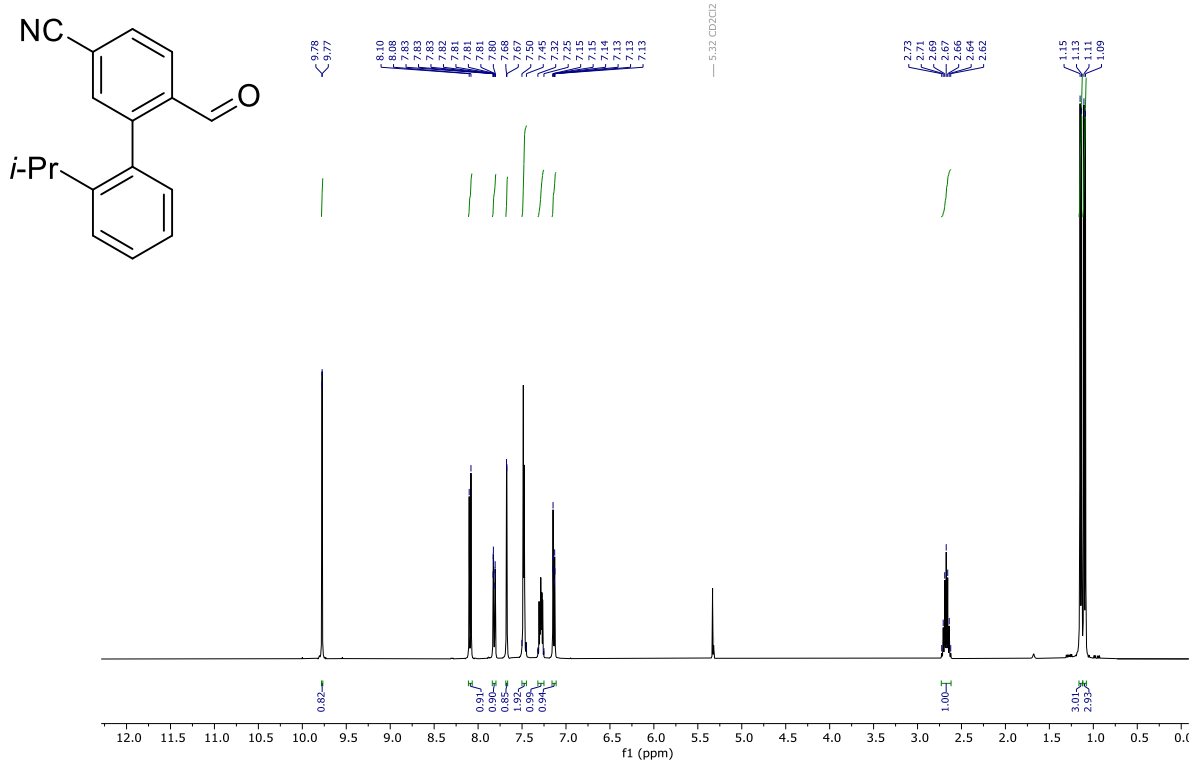



$^{13}$C-{$^{1}$H}-NMR

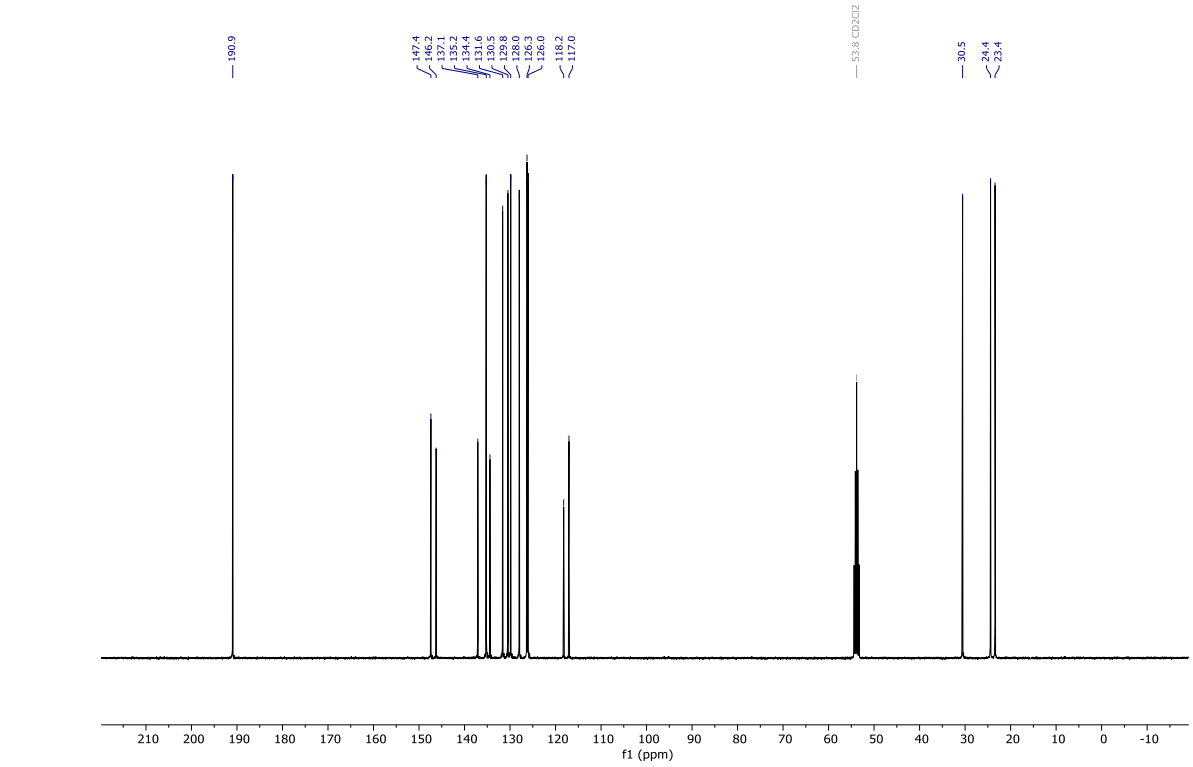


**6-Formyl-2'-*iso*-propyl-[1,1'-biphenyl]-3-carbonitrile (1x).**

$^{1}$H-NMR

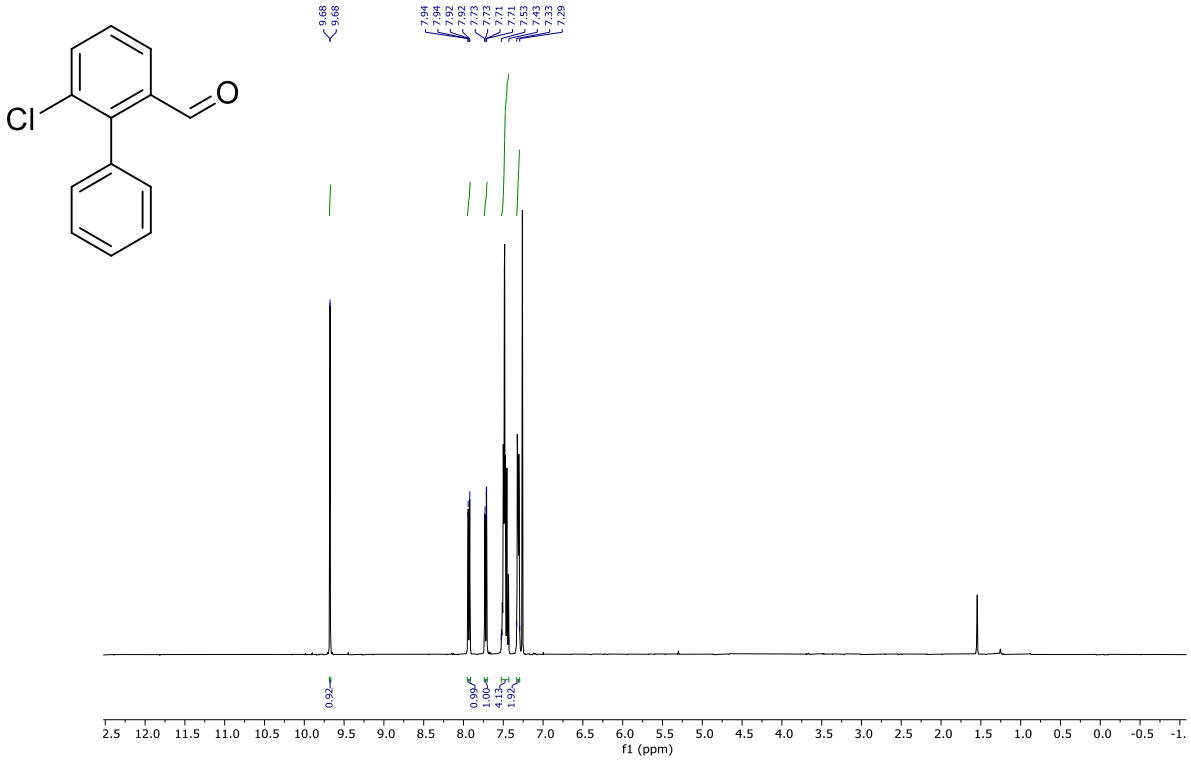



$^{13}$C-{$^{1}$H}-NMR

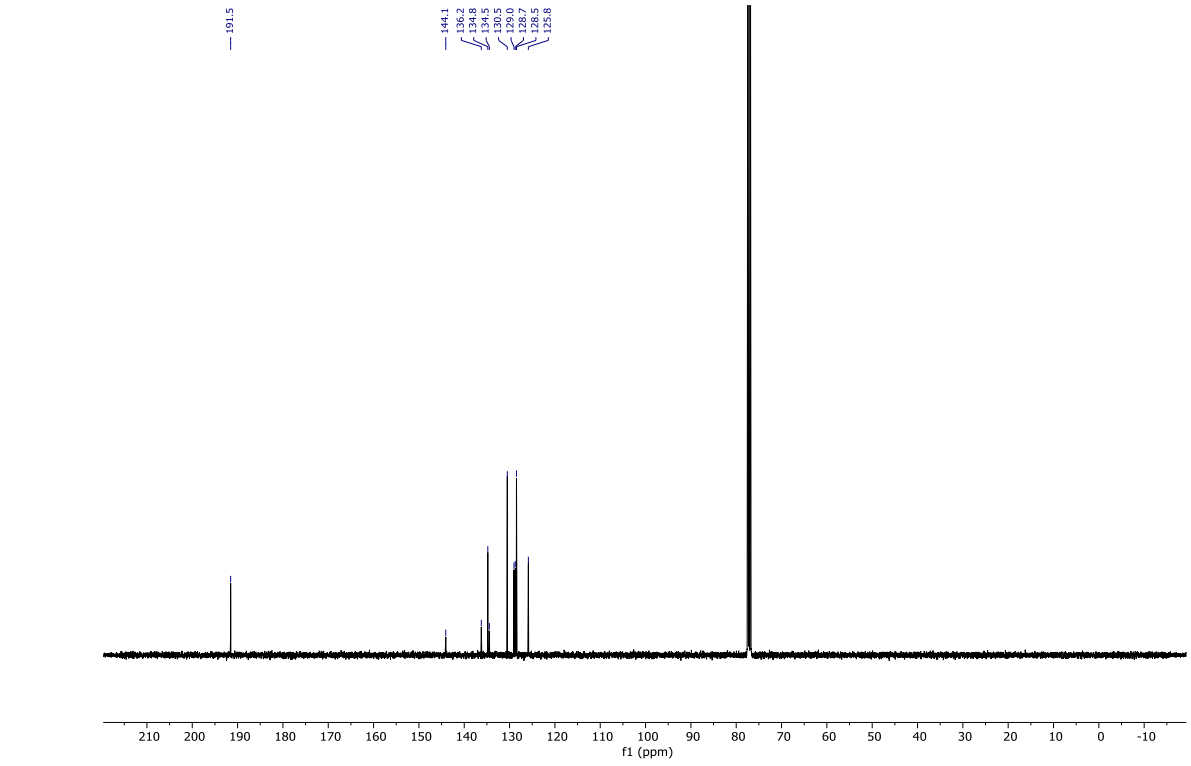


**6-Chloro-[1,1'-biphenyl]-2-carbaldehyde (1y).**

$^{1}$H-NMR

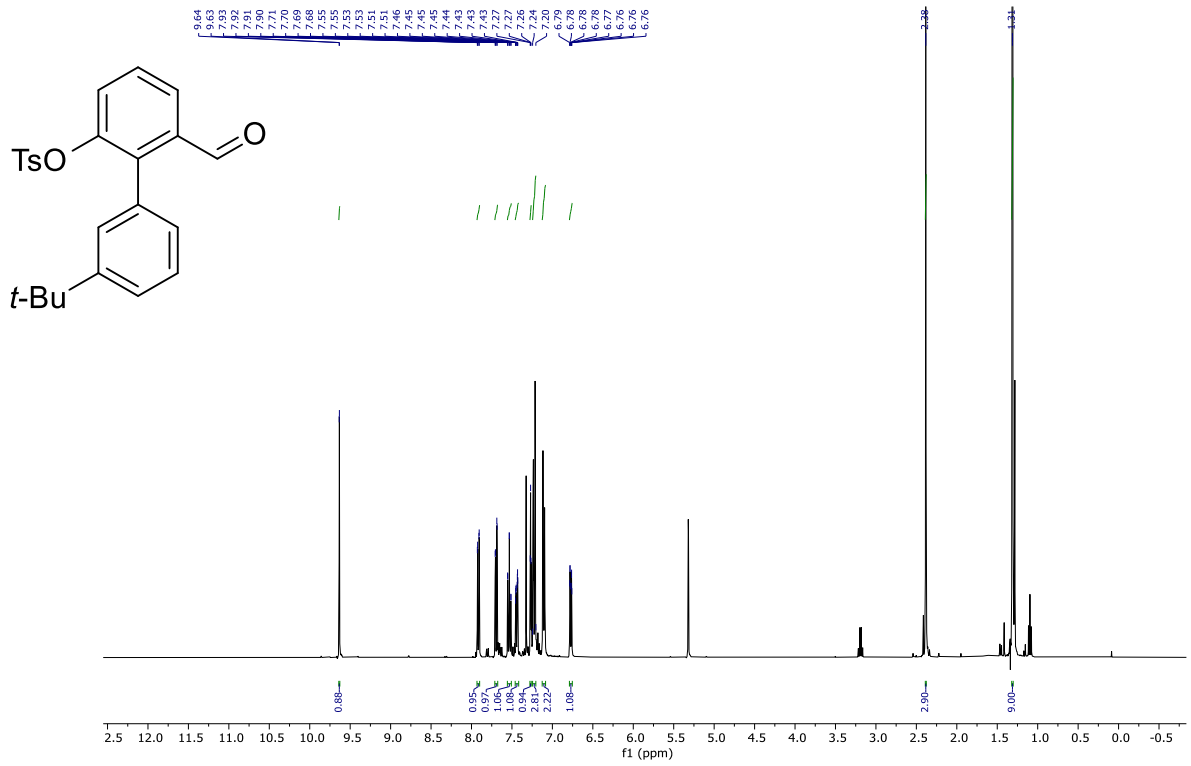



$^{13}$C-{$^{1}$H}-NMR

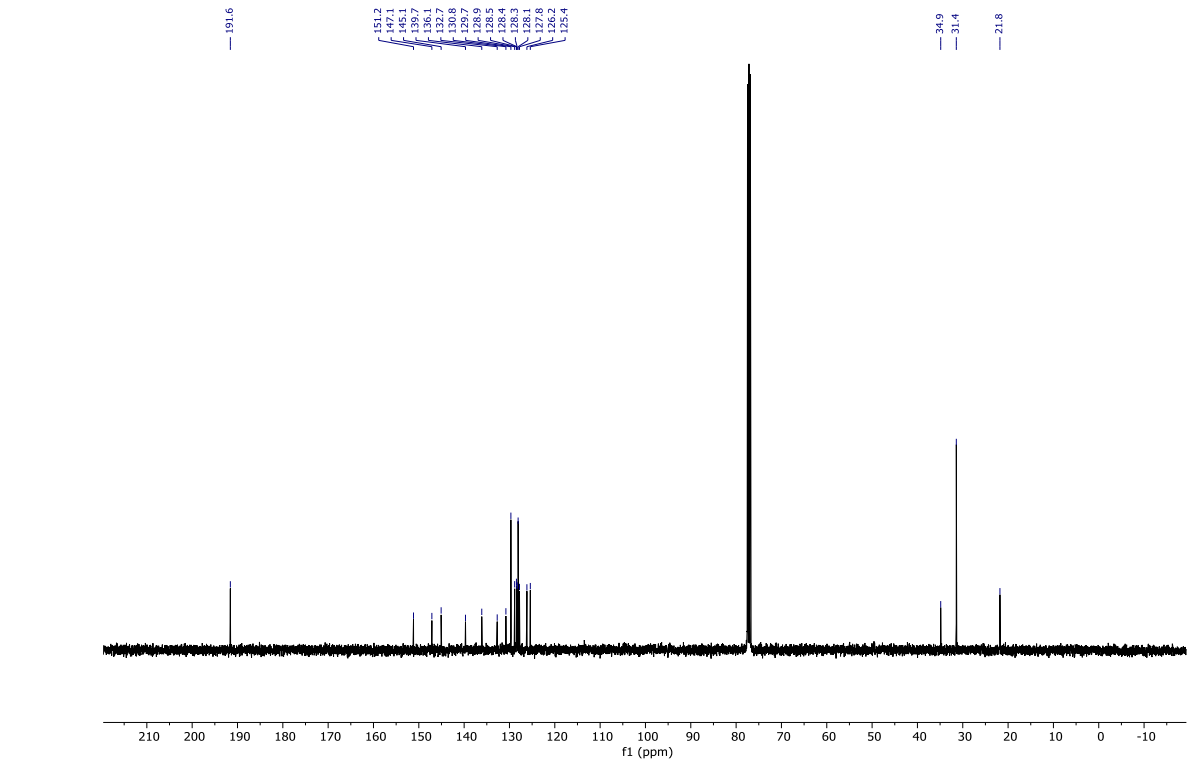


**3'-(*tert*-Butyl)-6-formyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (1z).**

$^{1}$H-NMR

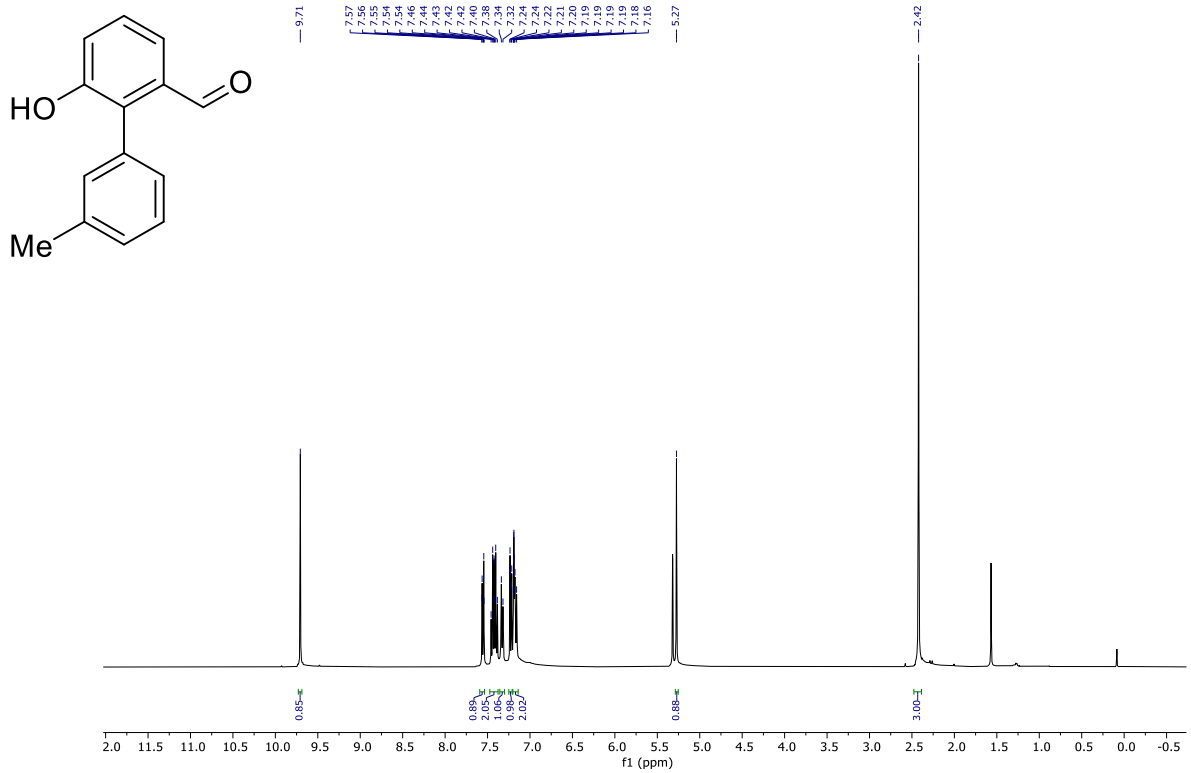



$^{13}$C-{$^{1}$H}-NMR

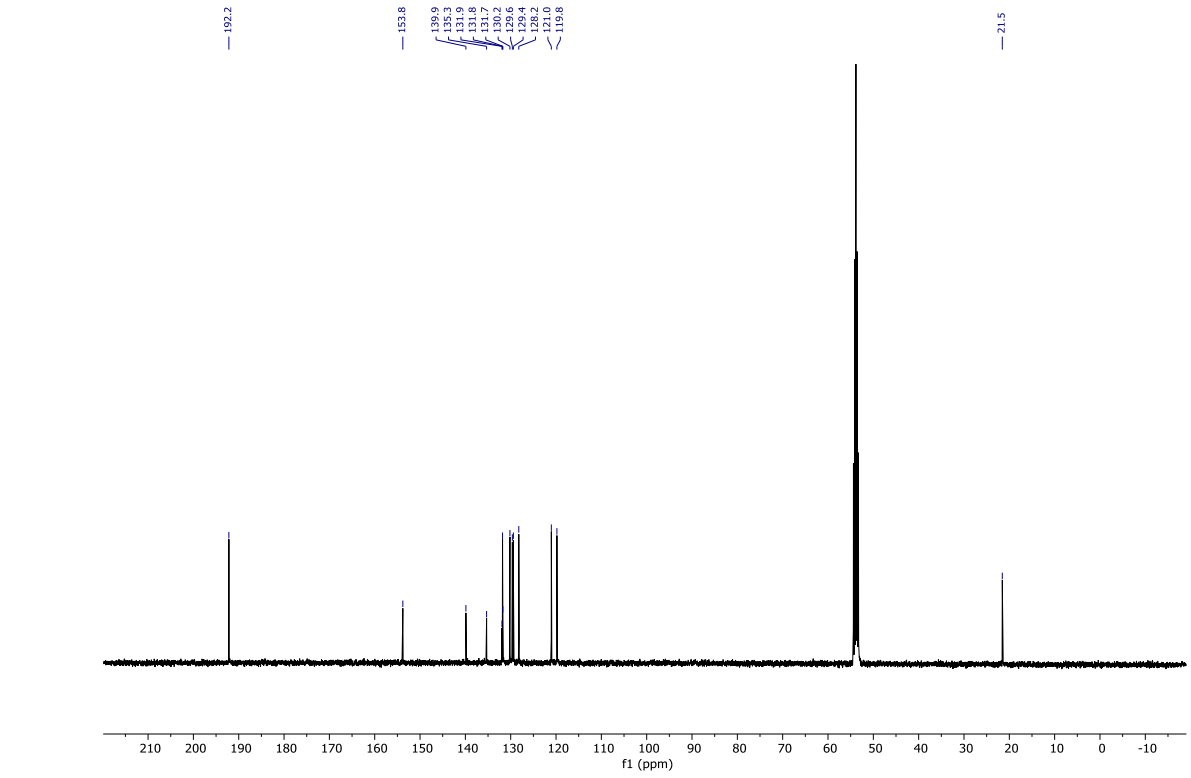


**6-Hydroxy-3'-methyl-[1,1'-biphenyl]-2-carbaldehyde (1ba).**

$^{1}$H-NMR

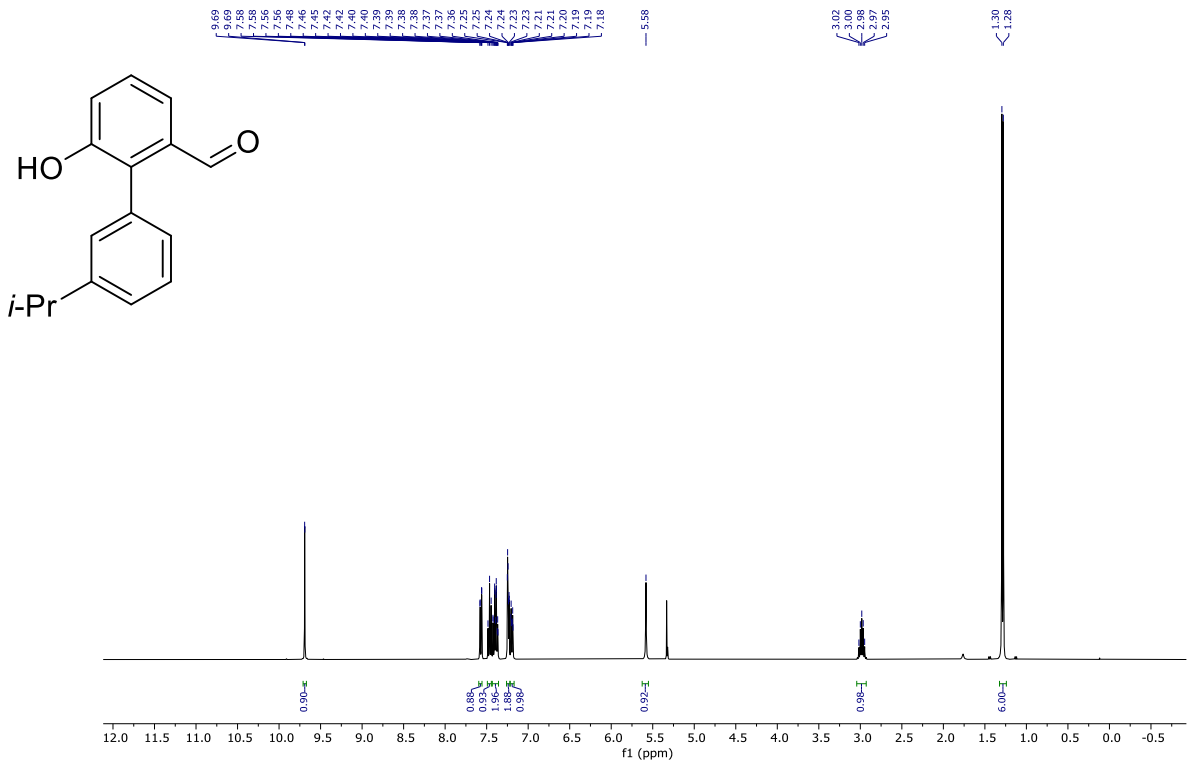



$^{13}$C-{$^{1}$H}-NMR

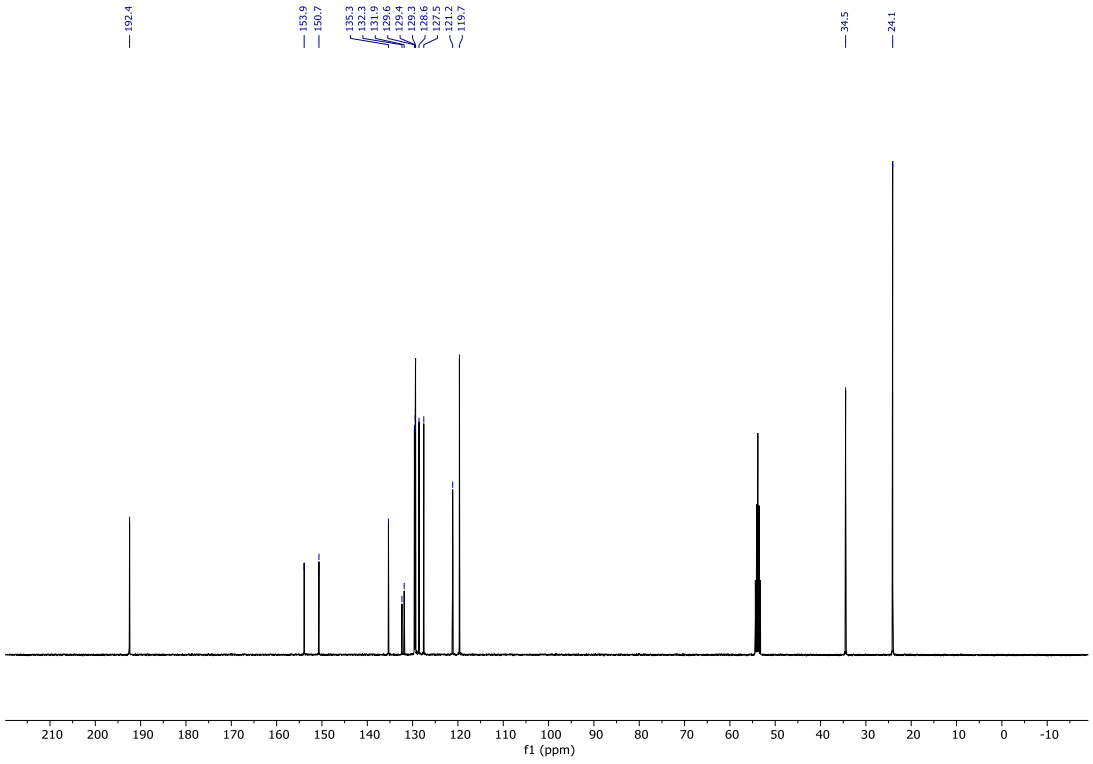


**6-Hydroxy-3'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (1bb).**

$^{1}$H-NMR

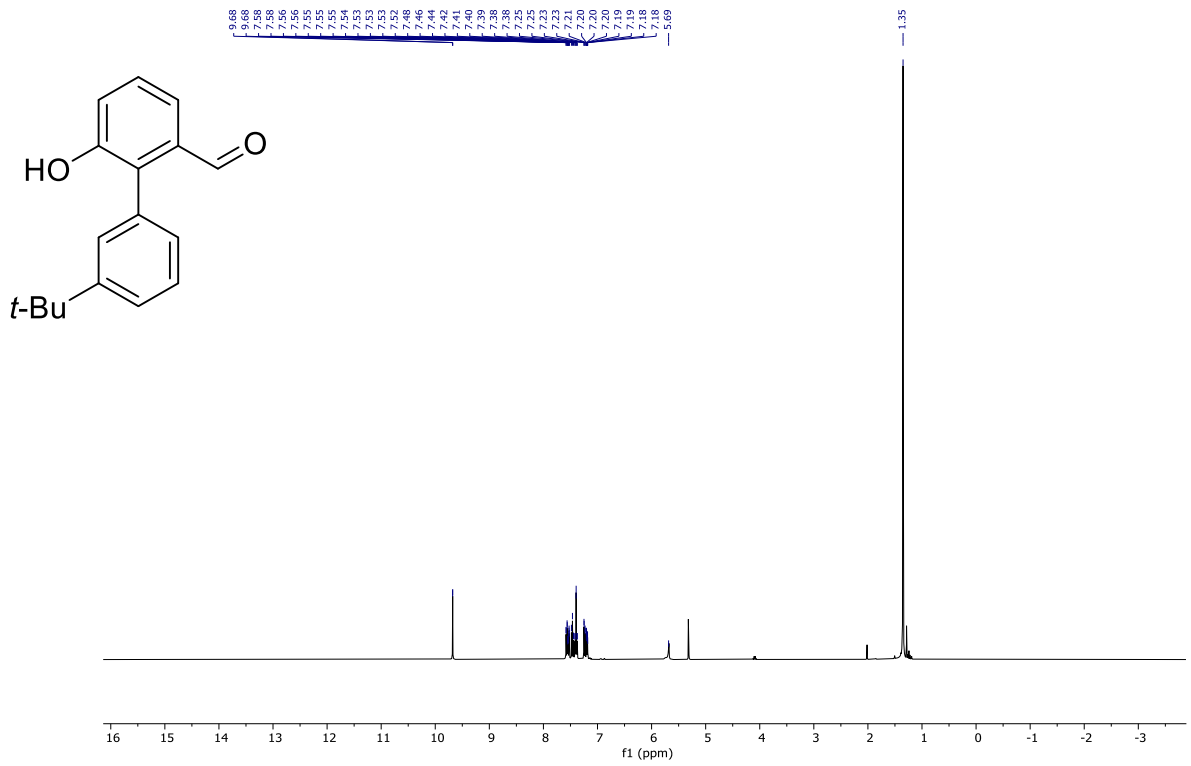



$^{13}$C-{$^{1}$H}-NMR

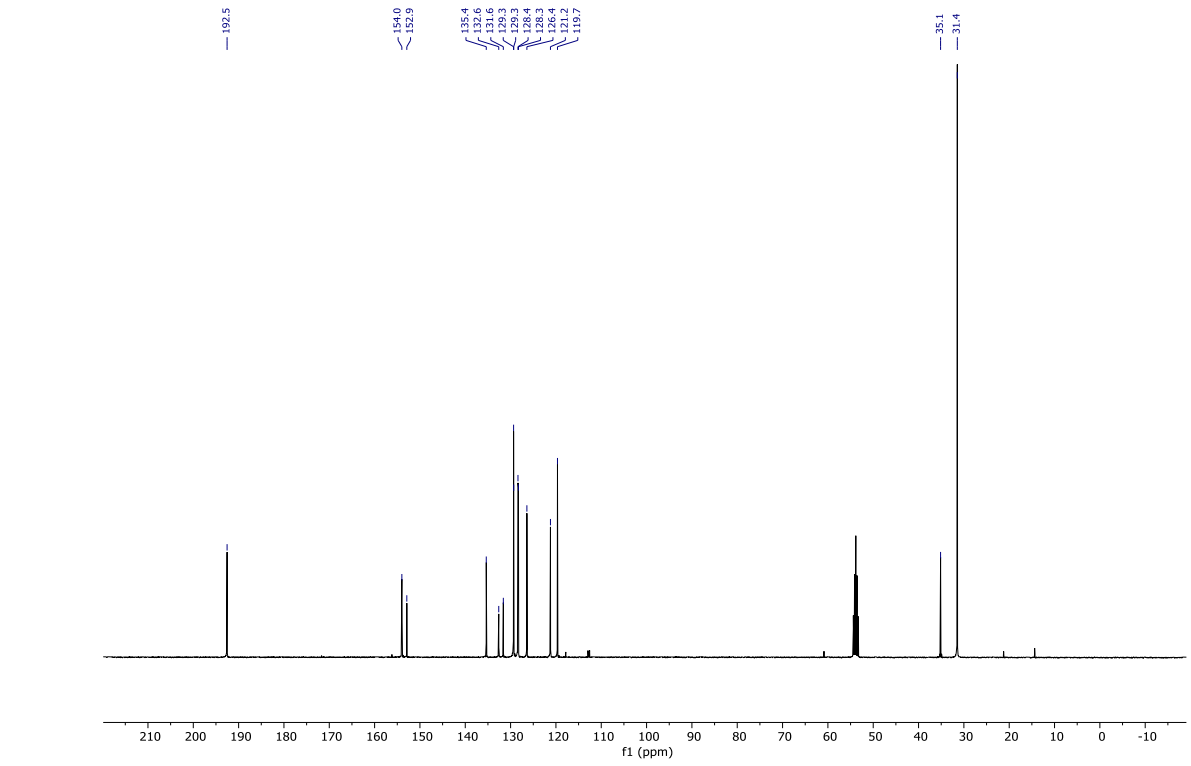


**3'-(*tert*-Butyl)-6-hydroxy-[1,1'-biphenyl]-2-carbaldehyde (1bc).**

$^{1}$H-NMR

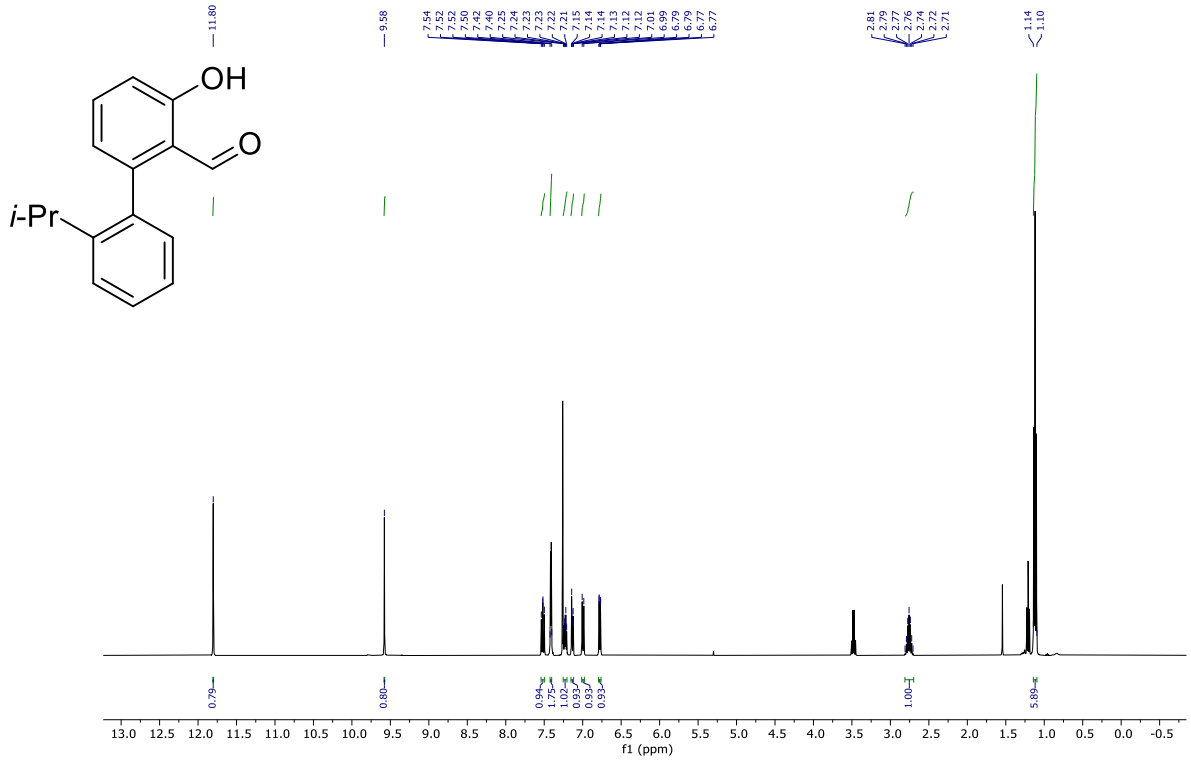



$^{13}$C-{$^{1}$H}-NMR

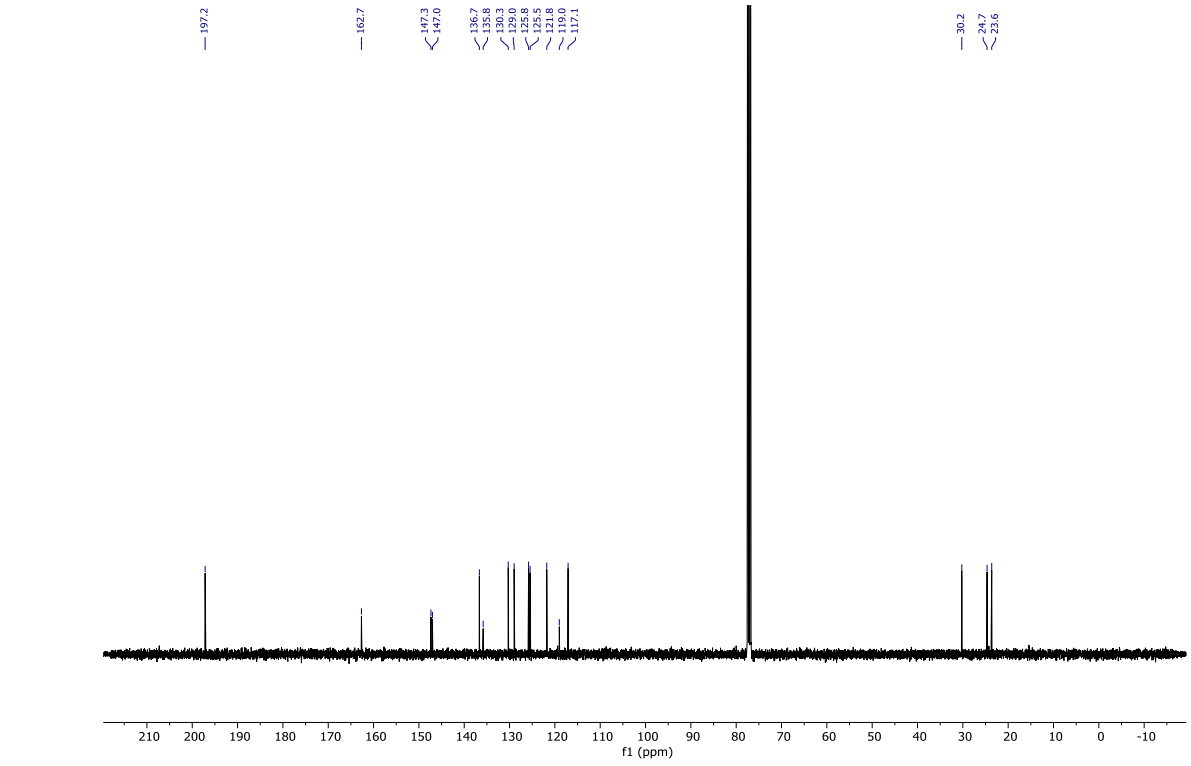


**3-Hydroxy-2'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (1bd).**

$^{1}$H-NMR

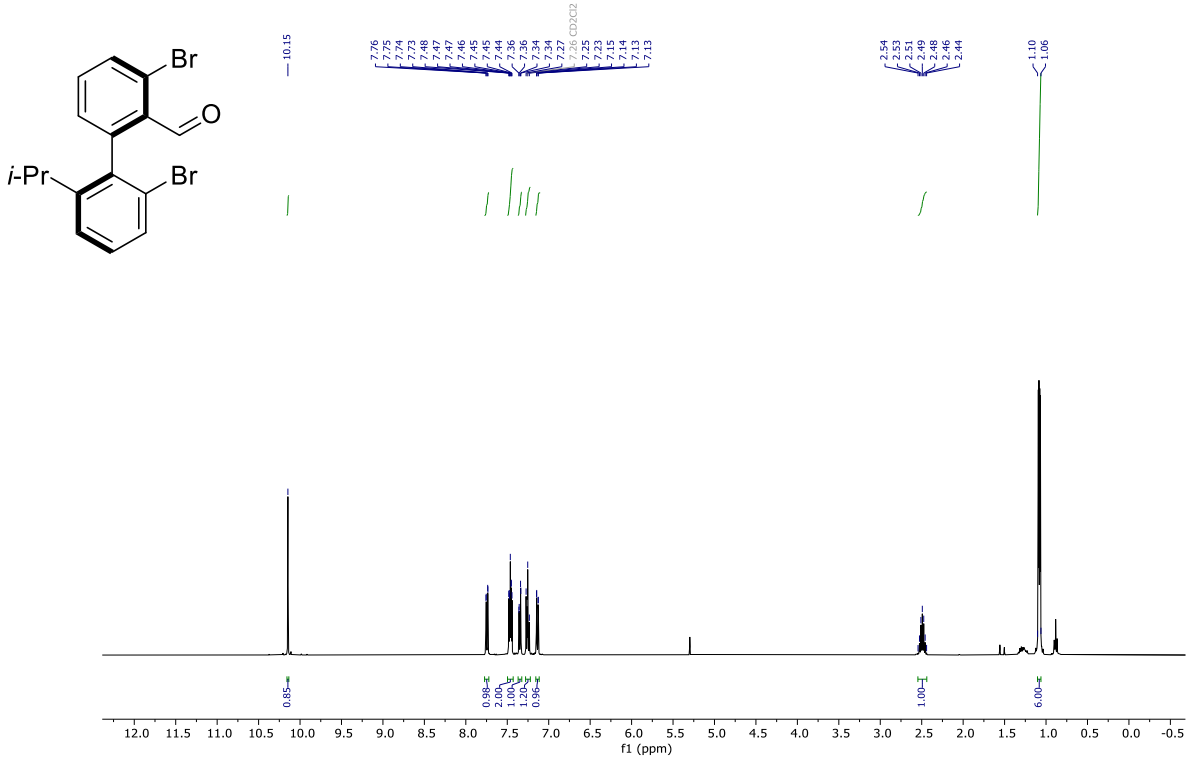



$^{13}$C-{$^{1}$H}-NMR

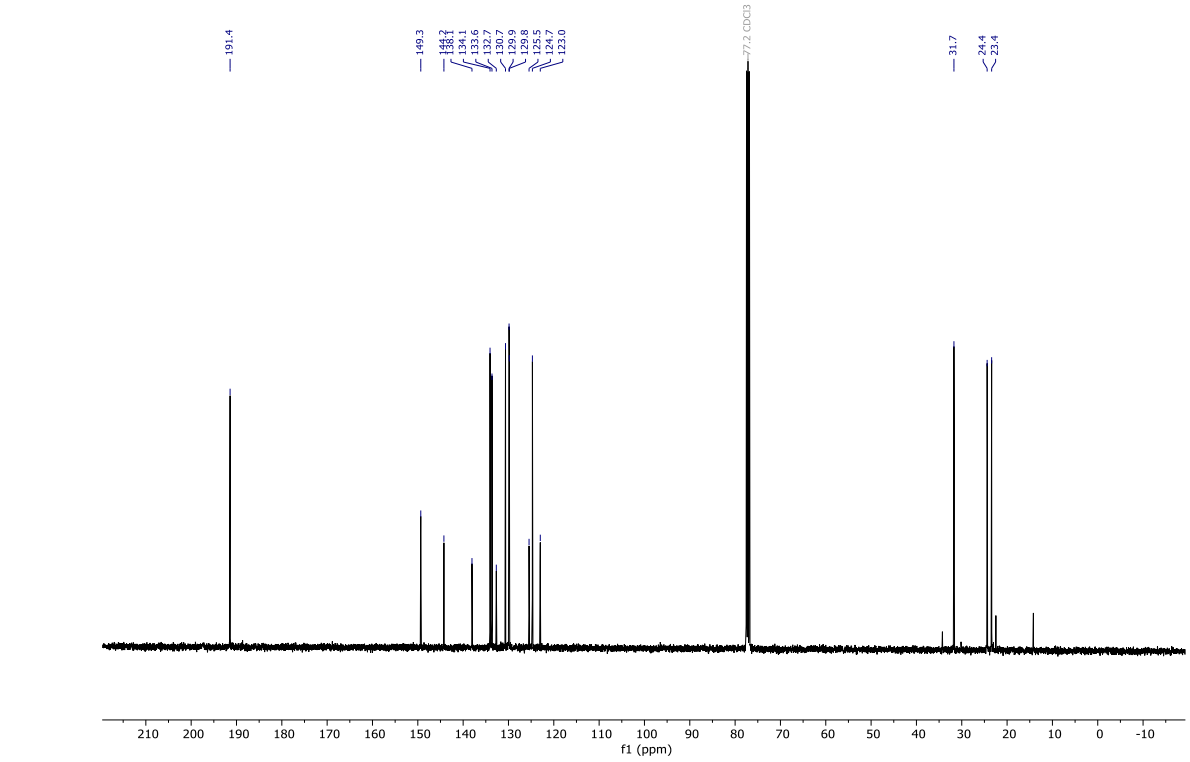


**($R_a$)-2',3-Dibromo-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (3a).**

$^1$H-NMR

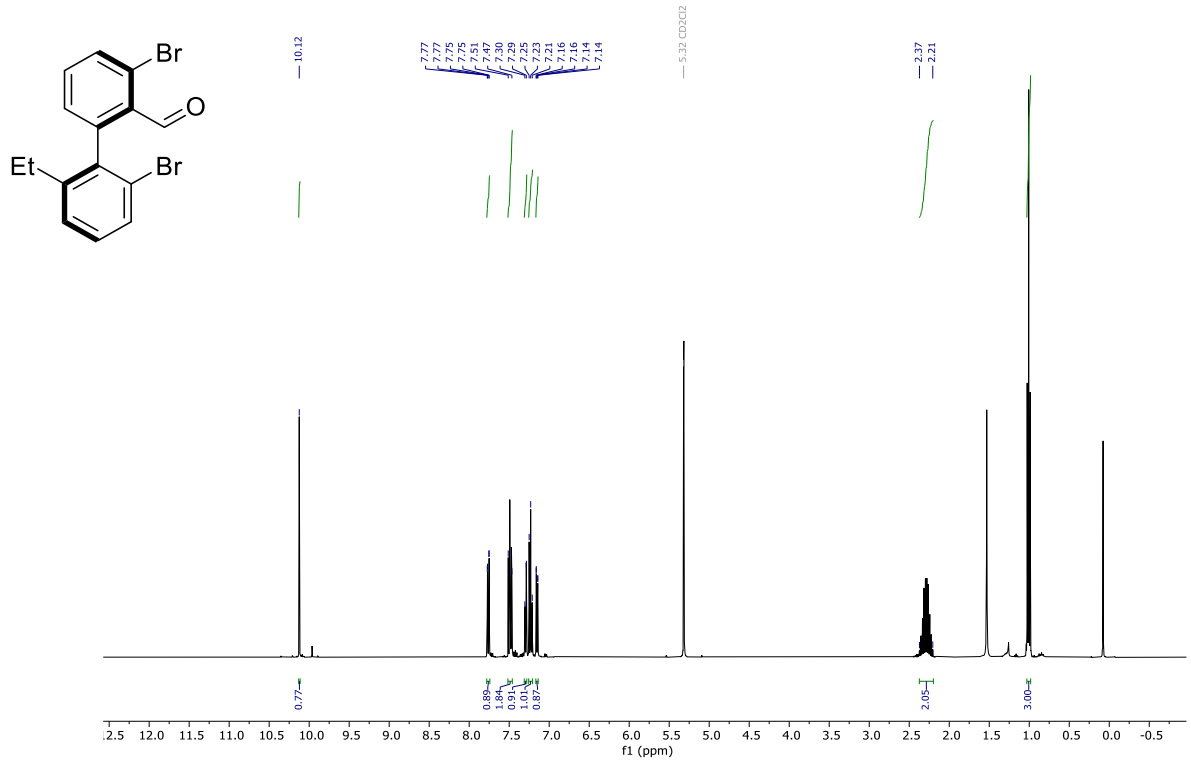



$^{13}$C-{$^1$H}-NMR

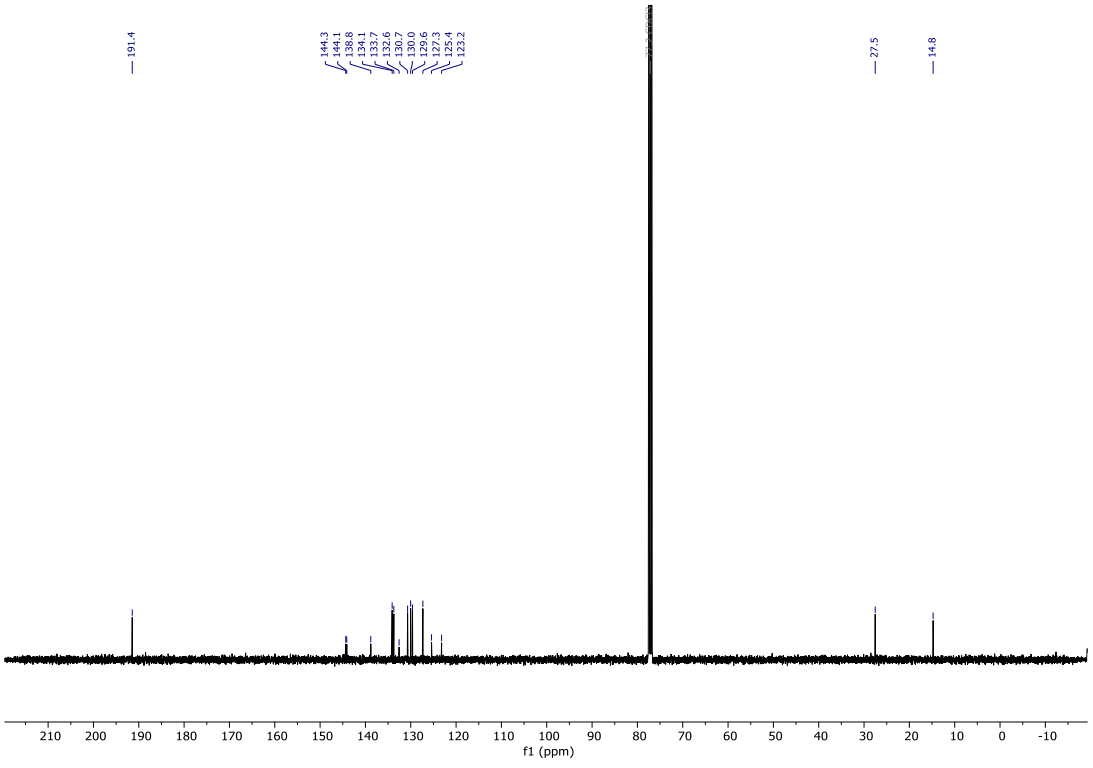


**($R_a$)-2',3-Dibromo-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (3b).**

$^1$H-NMR

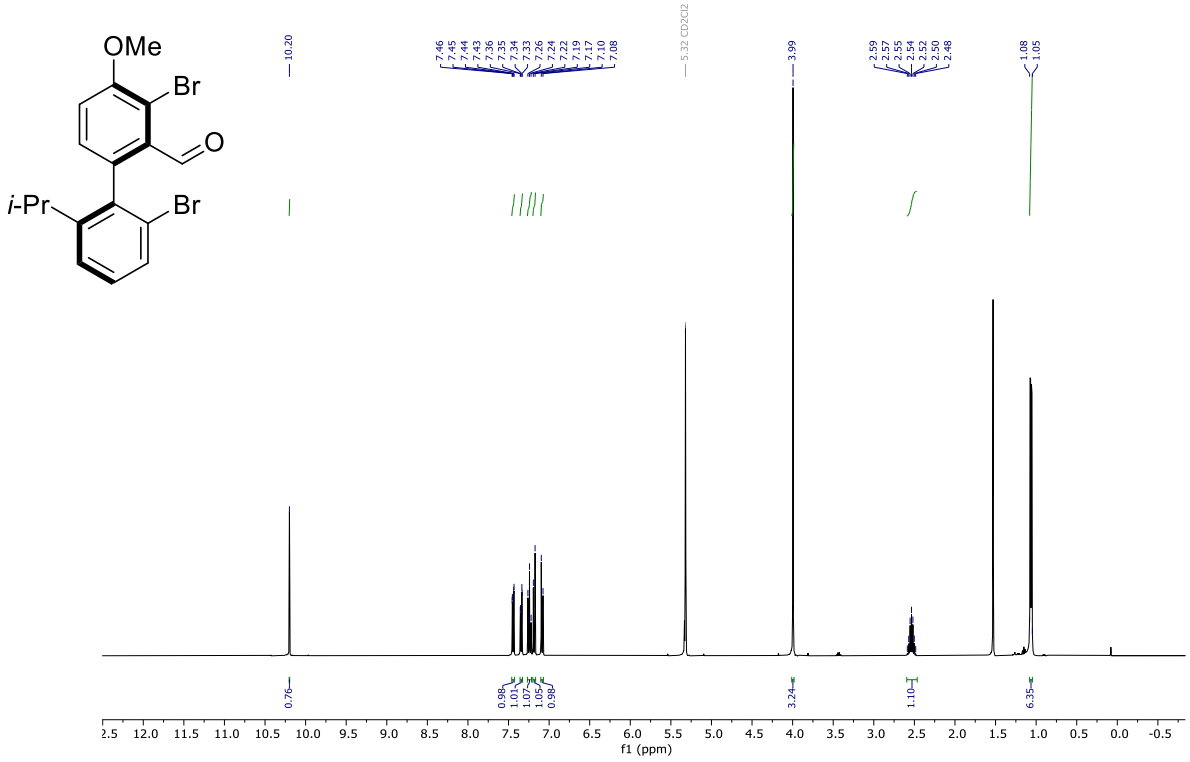



$^{13}$C-{$^1$H}-NMR

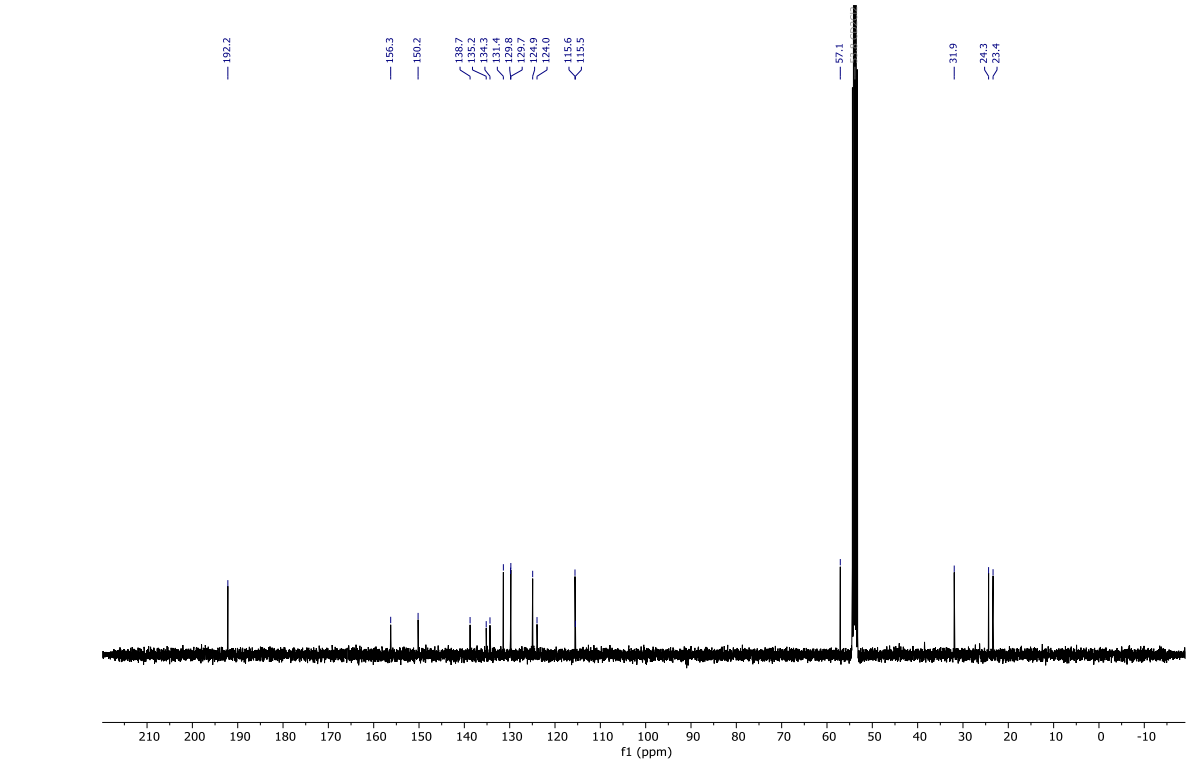


**($R_a$)-2',3-Dibromo-6'-*iso*-propyl-4-methoxy-[1,1'-biphenyl]-2-carbaldehyde (3c).**

$^{1}$H-NMR

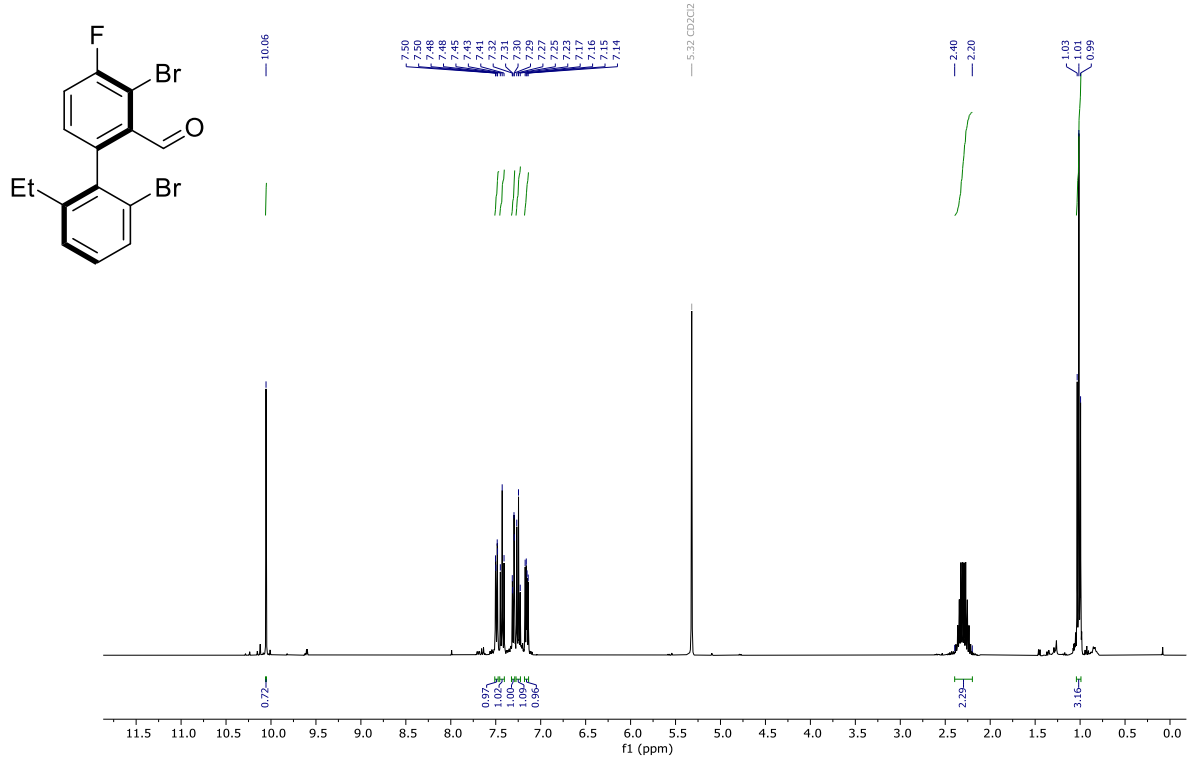



$^{13}$C-{$^{1}$H}-NMR

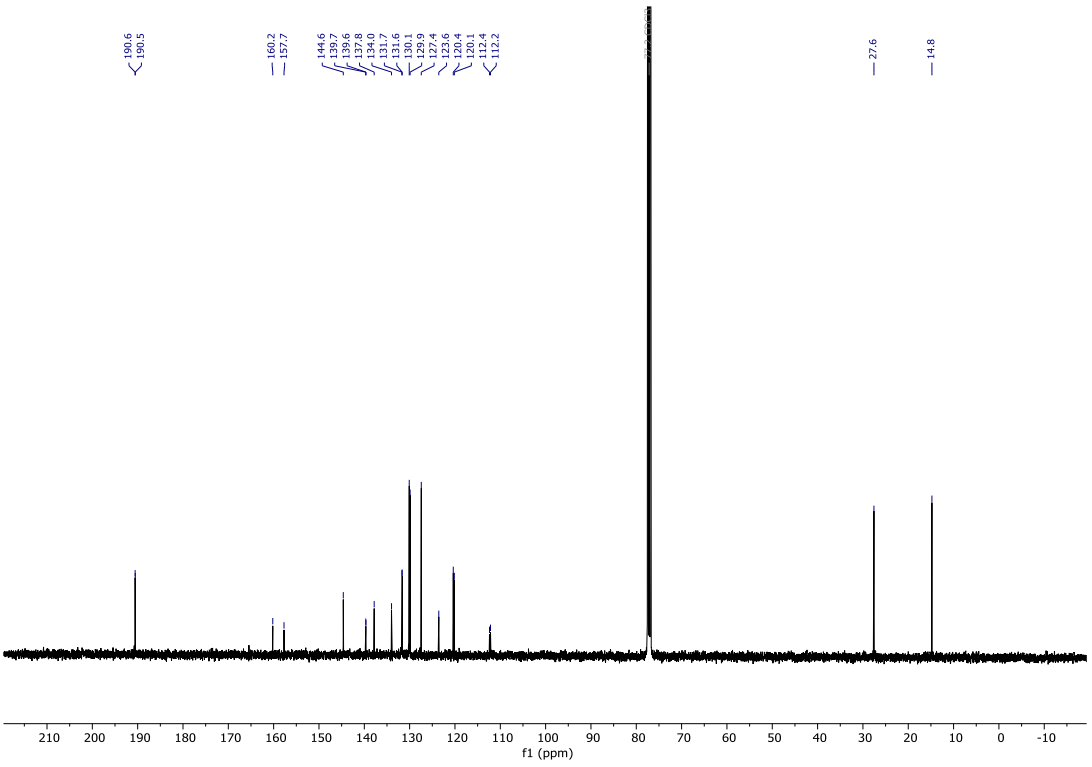


**($R_a$)-2',3-Dibromo-6'-ethyl-4-fluoro-[1,1'-biphenyl]-2-carbaldehyde (3d).**

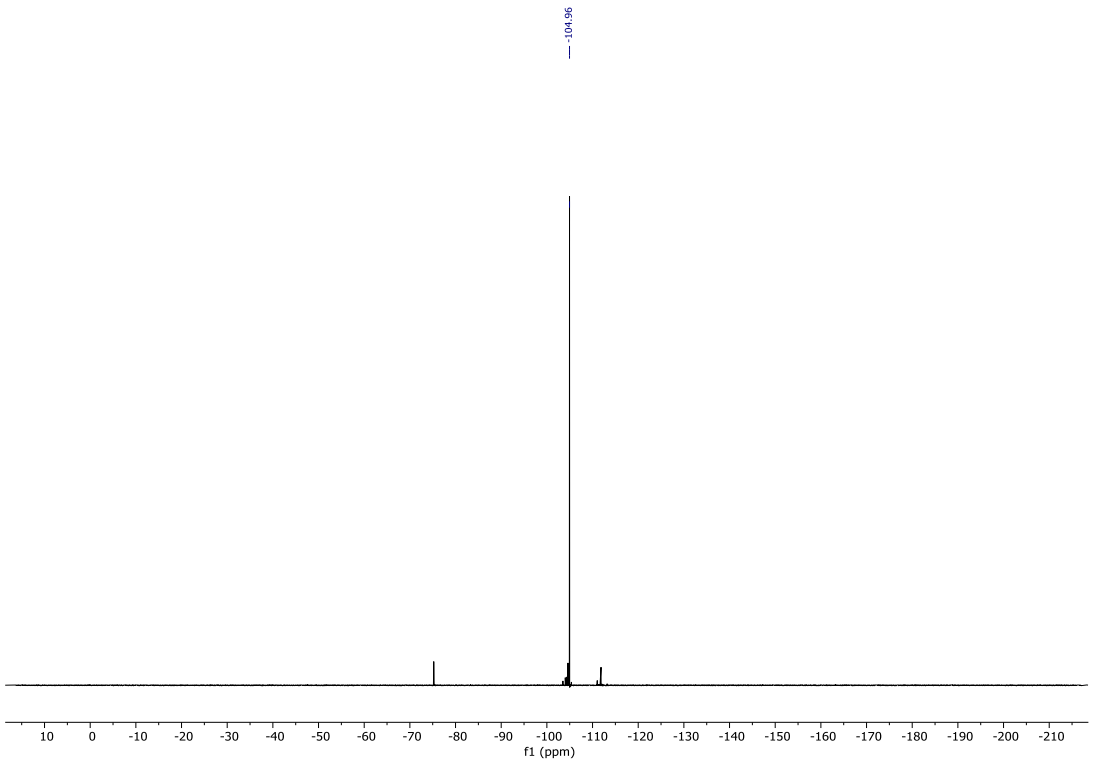
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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10
0
-10
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-30
-40
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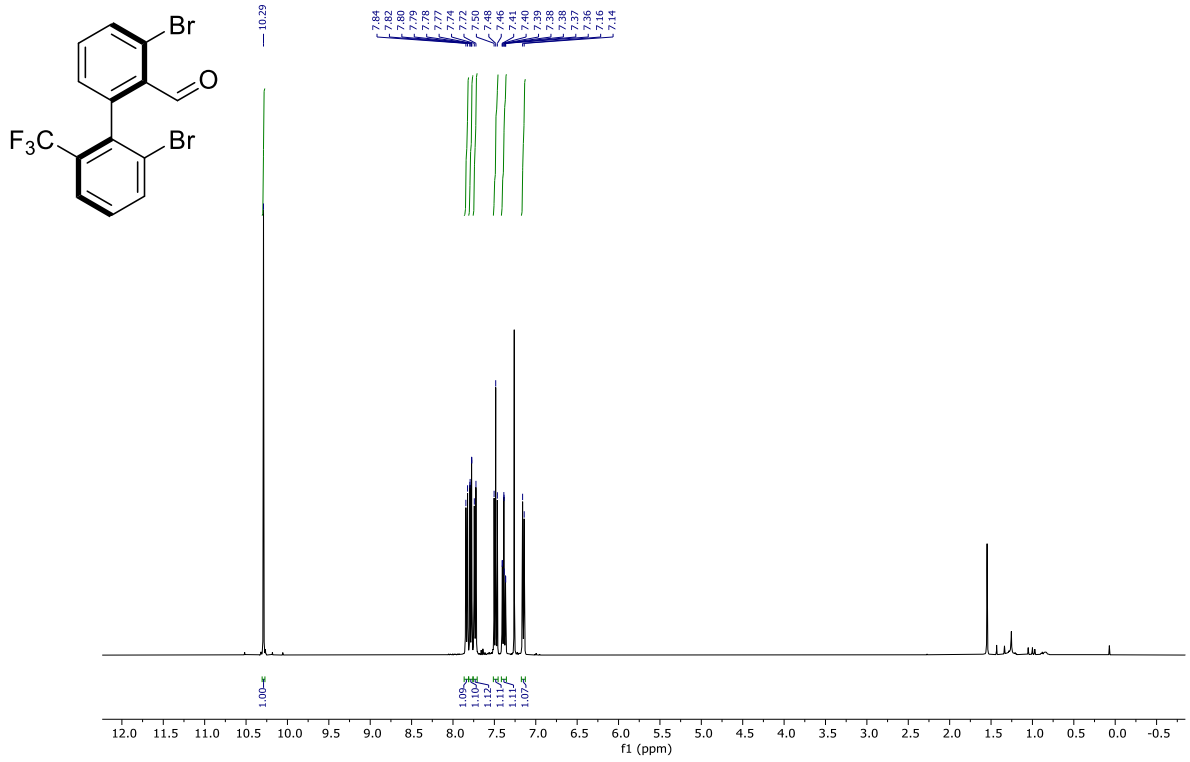
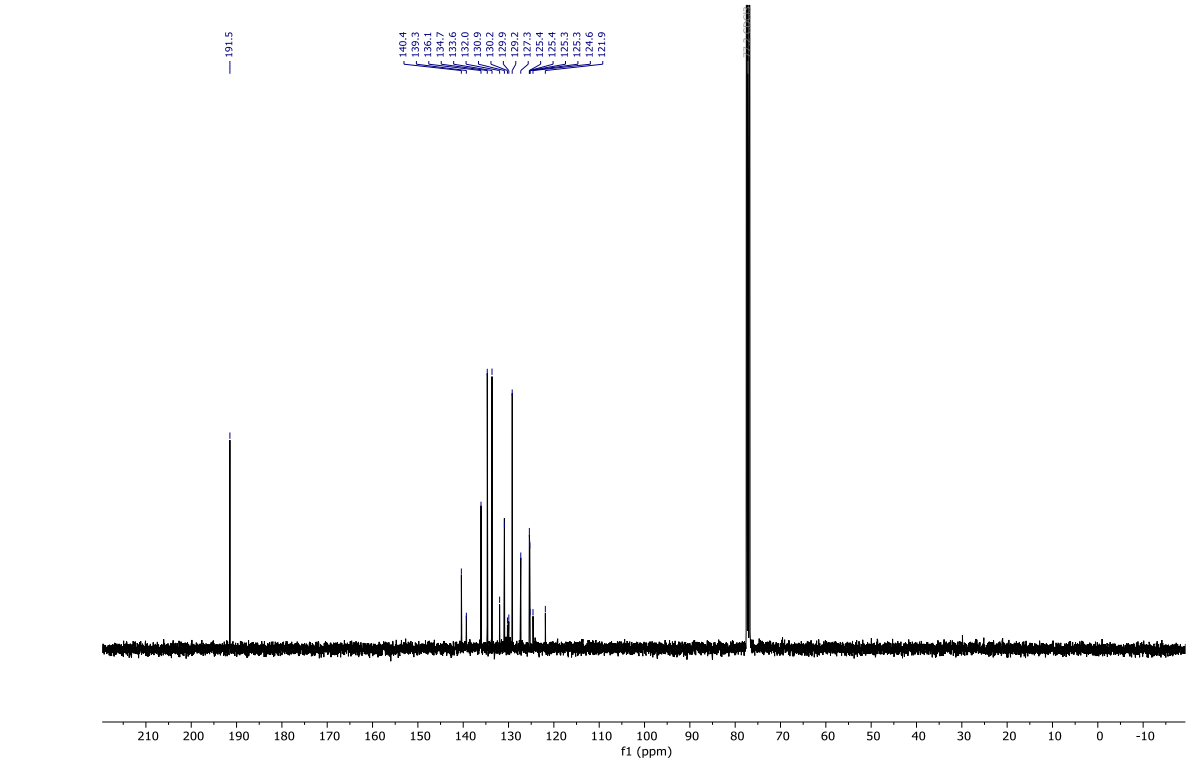
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-2',3-Dibromo-6'-(trifluoromethyl)-[1,1'-biphenyl]-2-carbaldehyde (3e).**

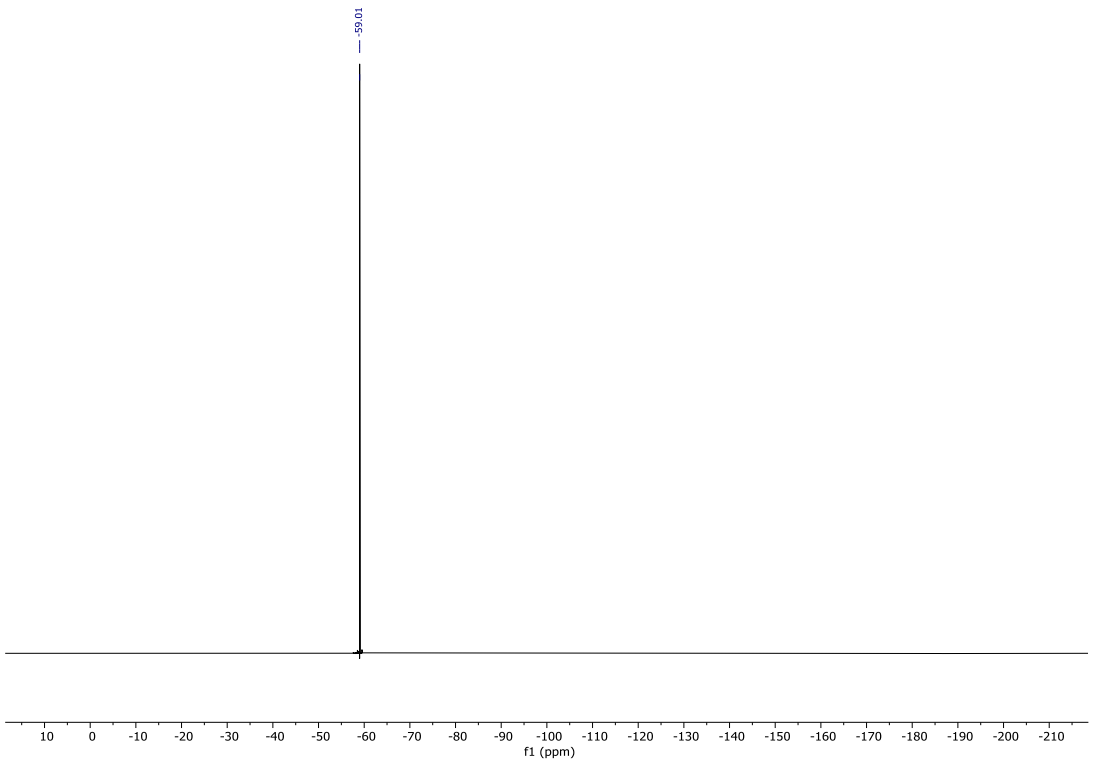
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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-110
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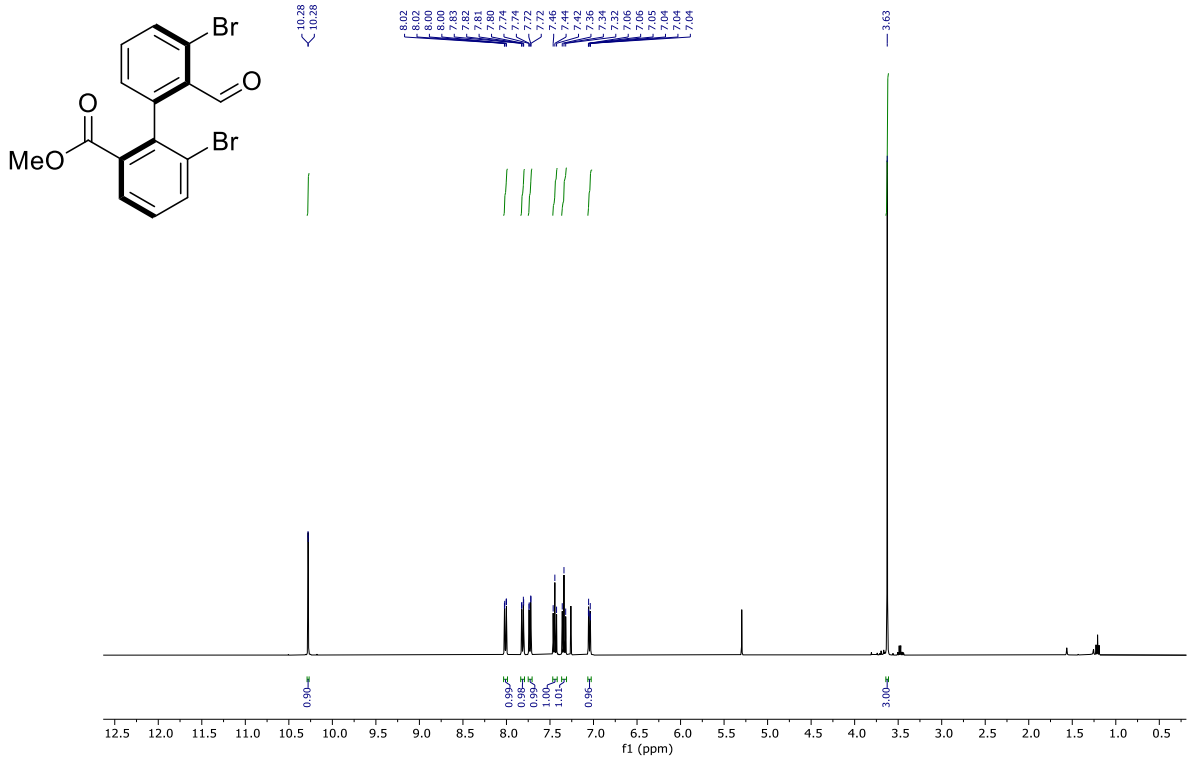
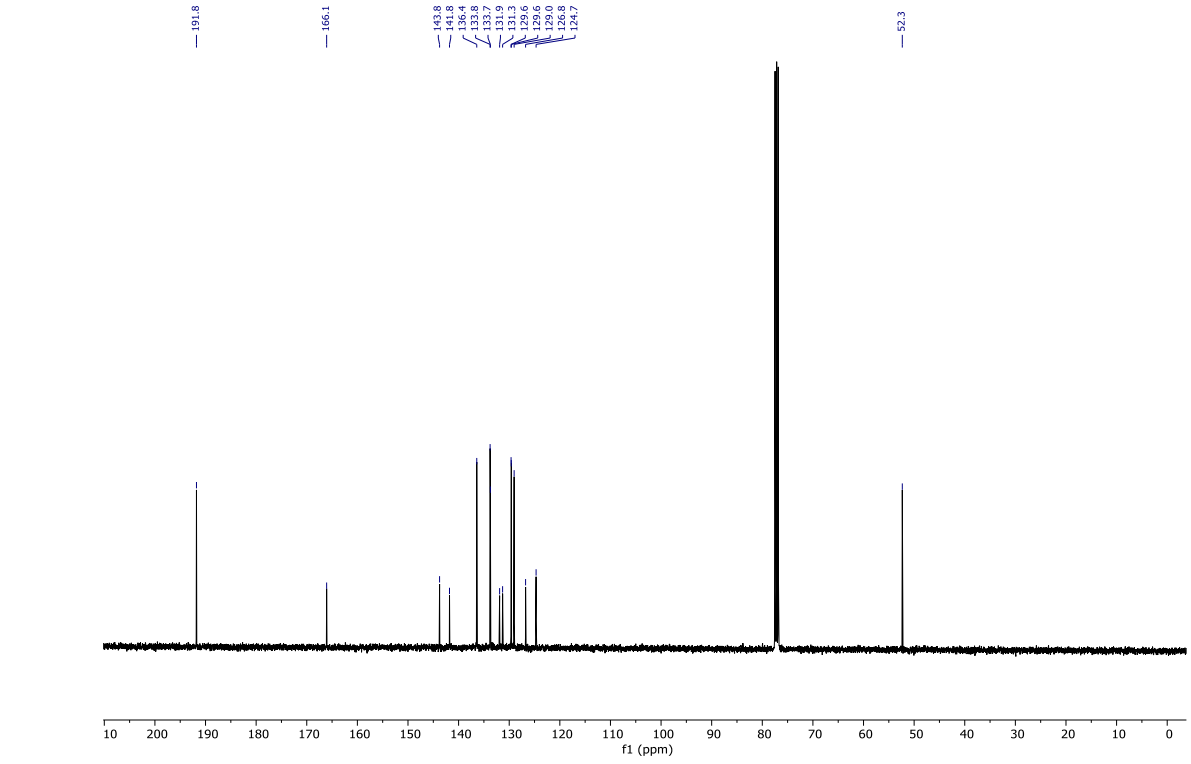
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-Methyl 3',6-dibromo-2'-formyl-[1,1'-biphenyl]-2-carboxylate (3f).**

$^1$H-NMR

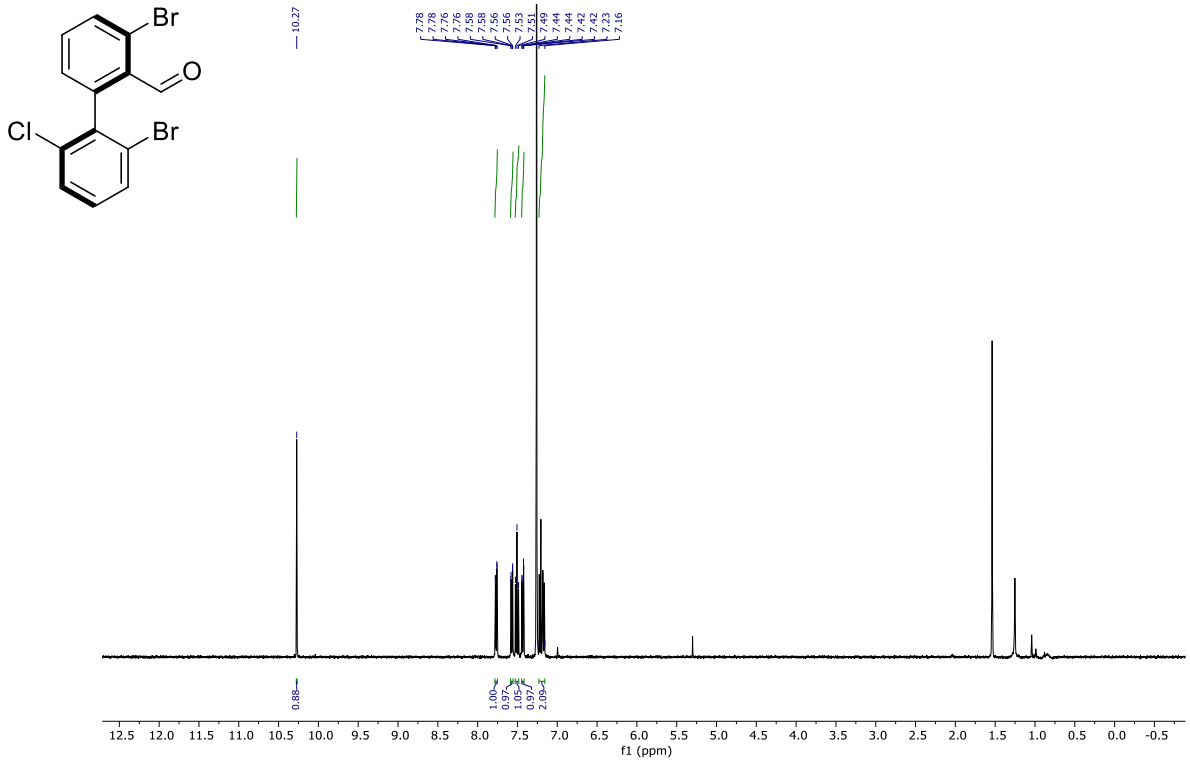



$^{13}$C-{$^1$H}-NMR

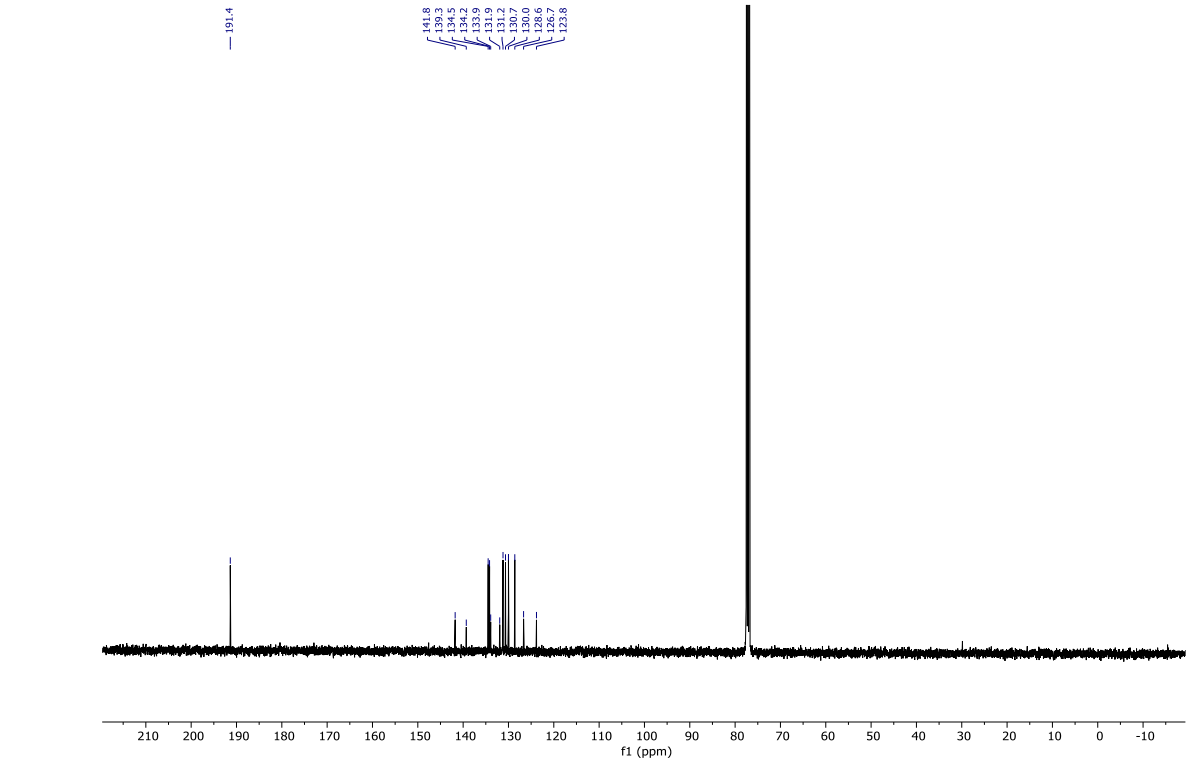


**($R_a$)-2',3-Dibromo-6'-chloro-[1,1'-biphenyl]-2-carbaldehyde (3g).**

$^{1}$H-NMR

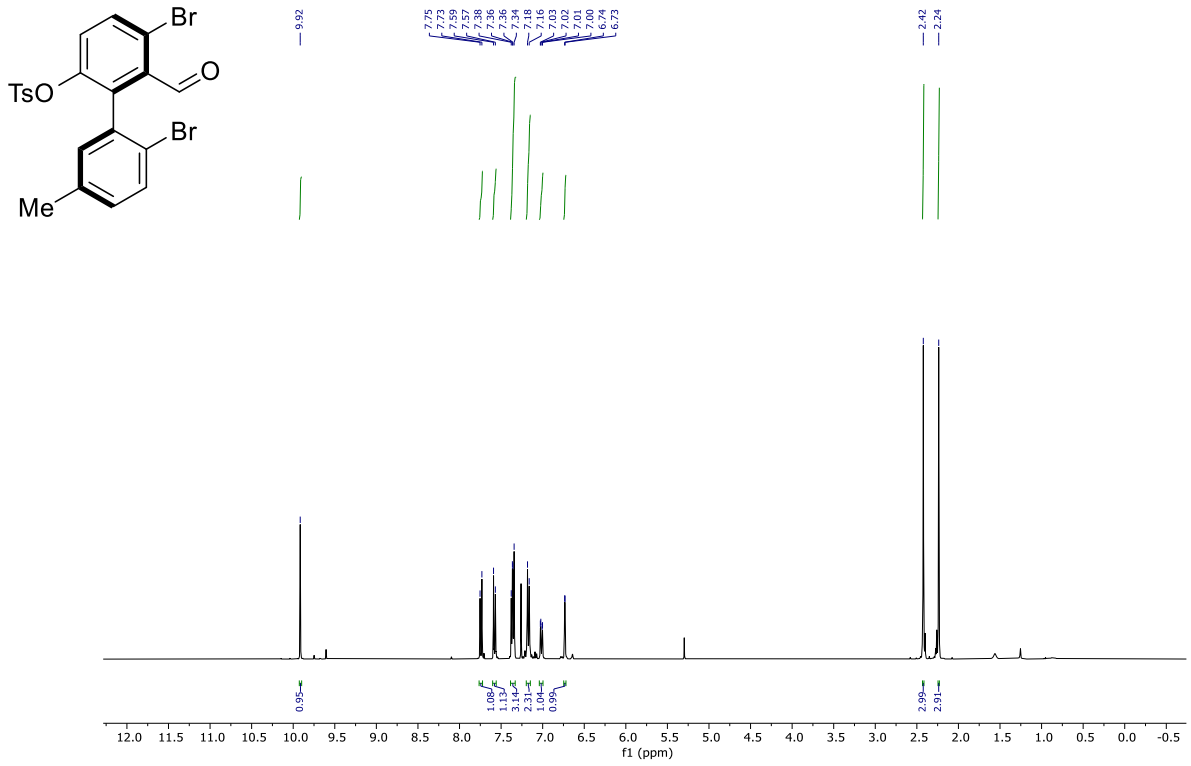



$^{13}$C-{$^{1}$H}-NMR

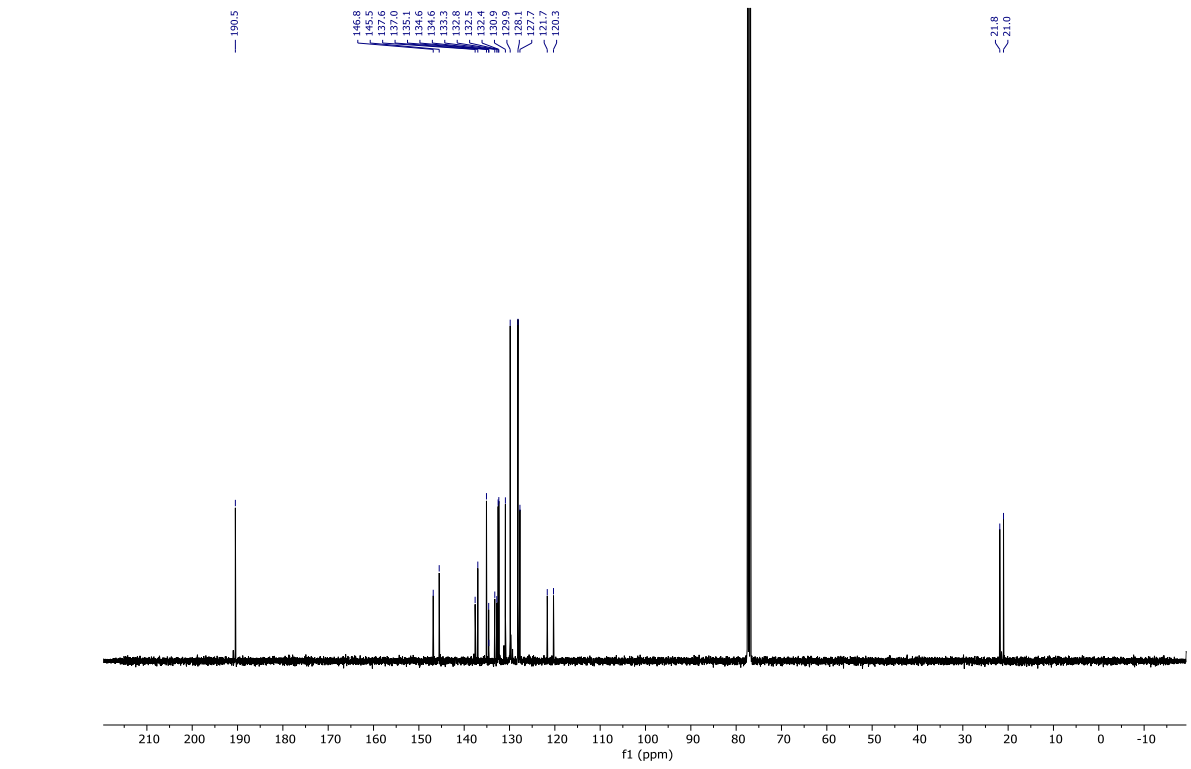


**($S_a$)-2',5-Dibromo-6-formyl-5'-methyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3h).**

$^1$H-NMR

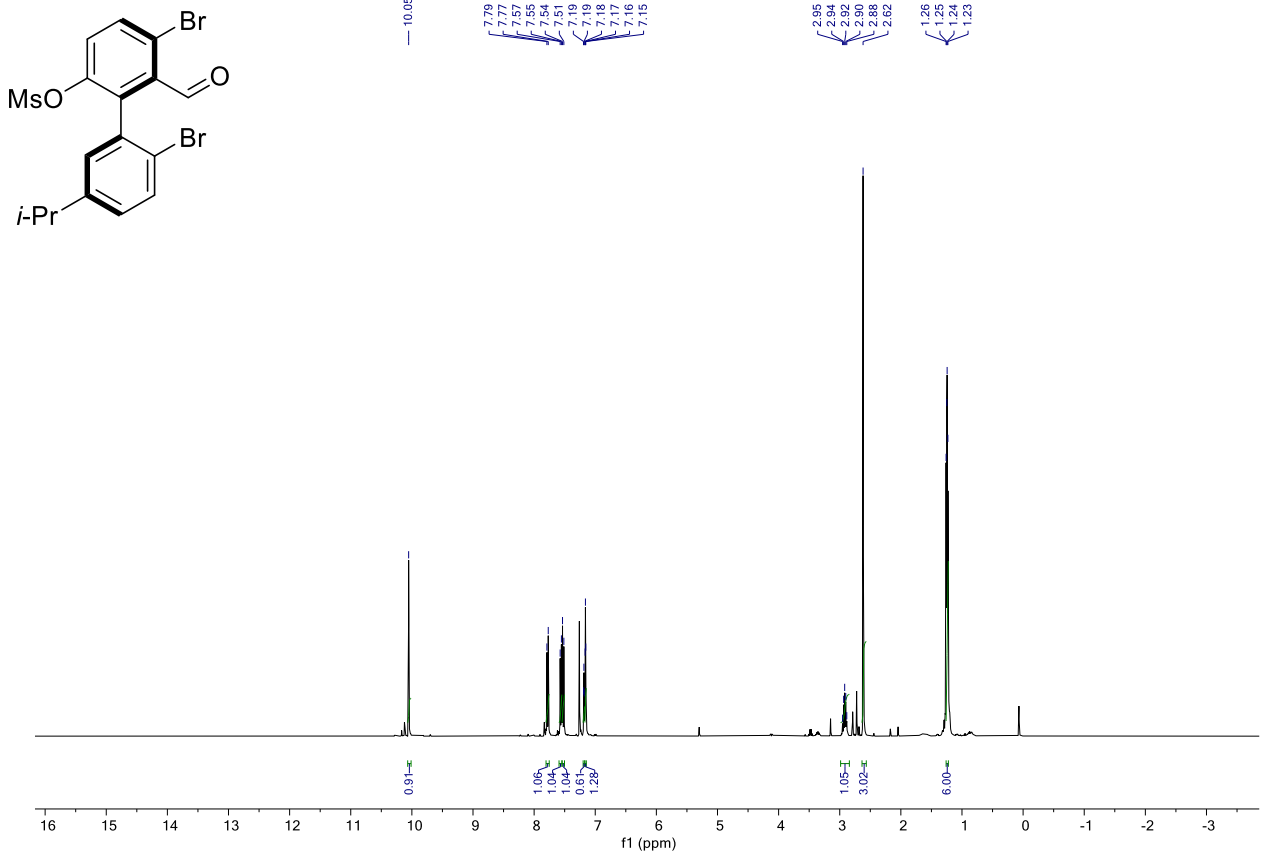



$^{13}$C-{$^1$H}-NMR

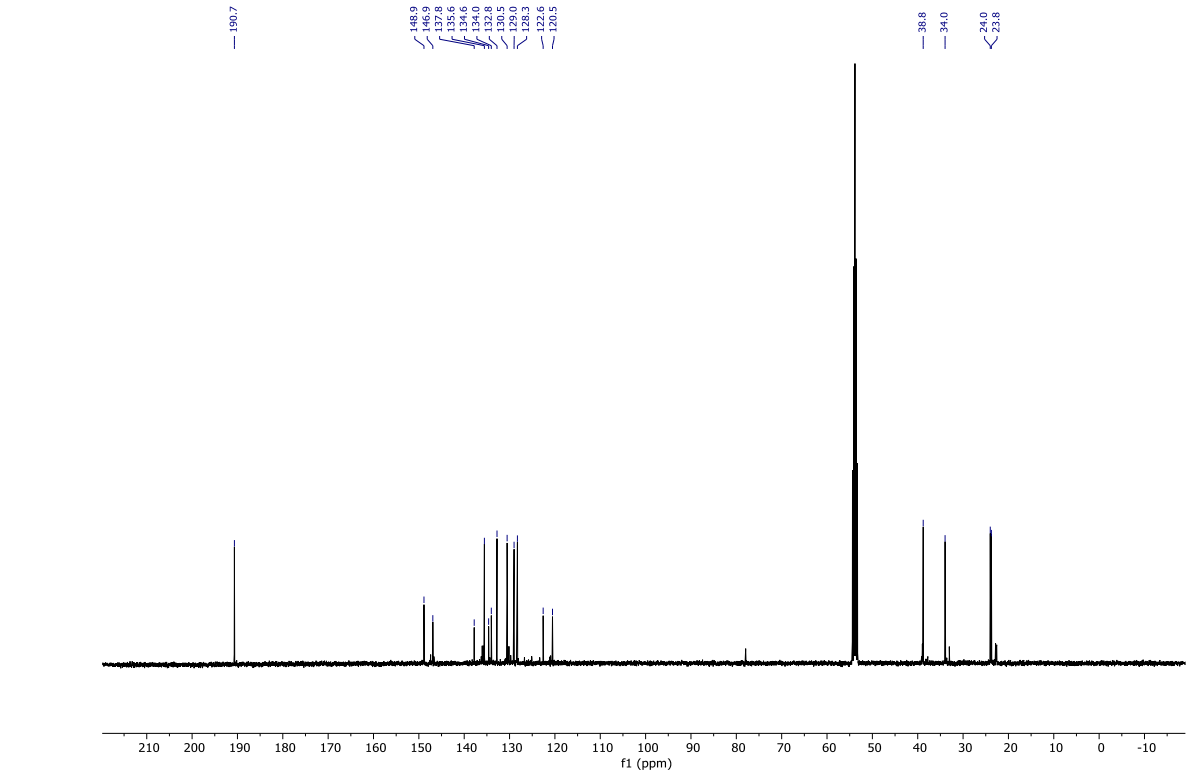


**($S_a$)-2',5-Dibromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (3i).**

$^1$H-NMR

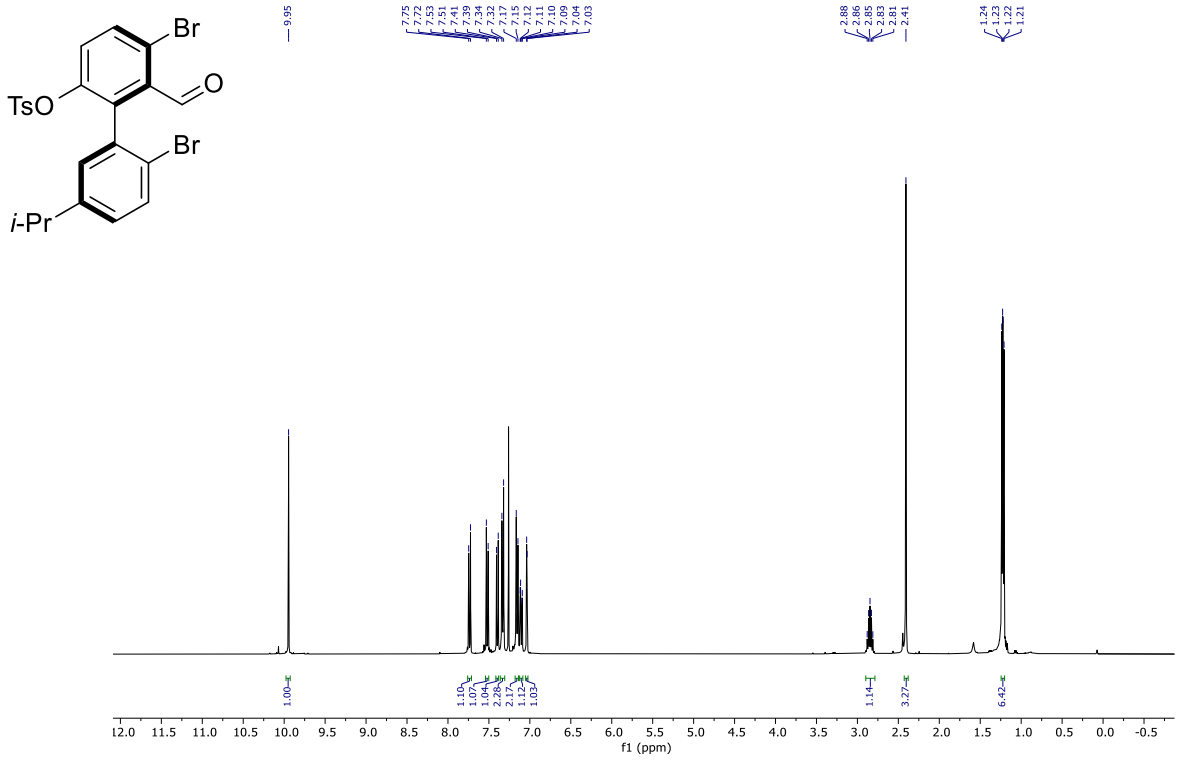



$^{13}$C-{$^1$H}-NMR

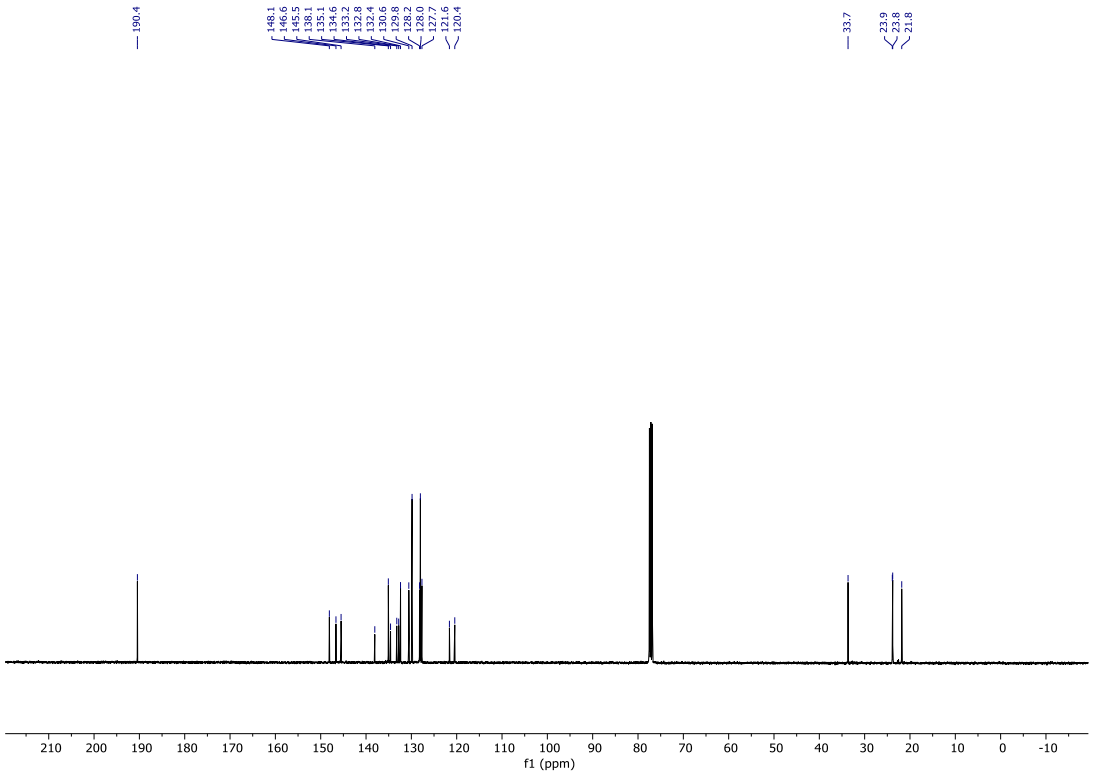


**($S_a$)-2',5-Dibromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3j).**

$^1$H-NMR

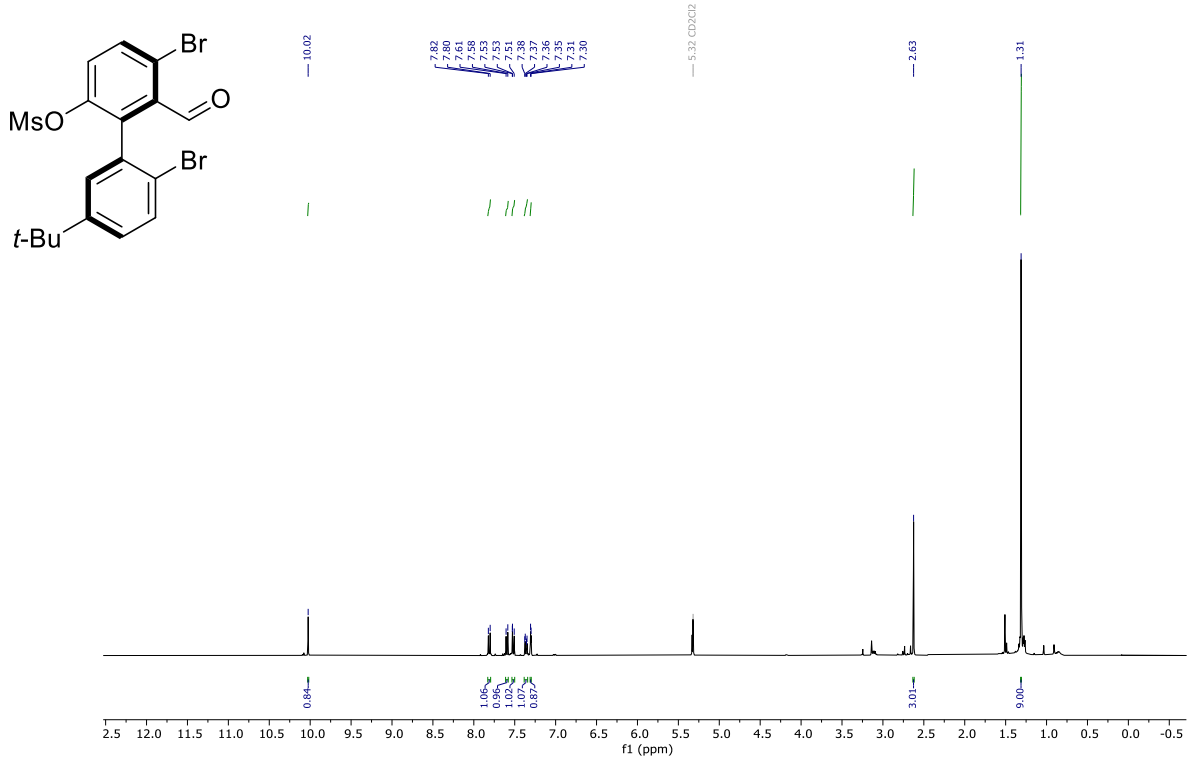



$^{13}$C-{$^1$H}-NMR

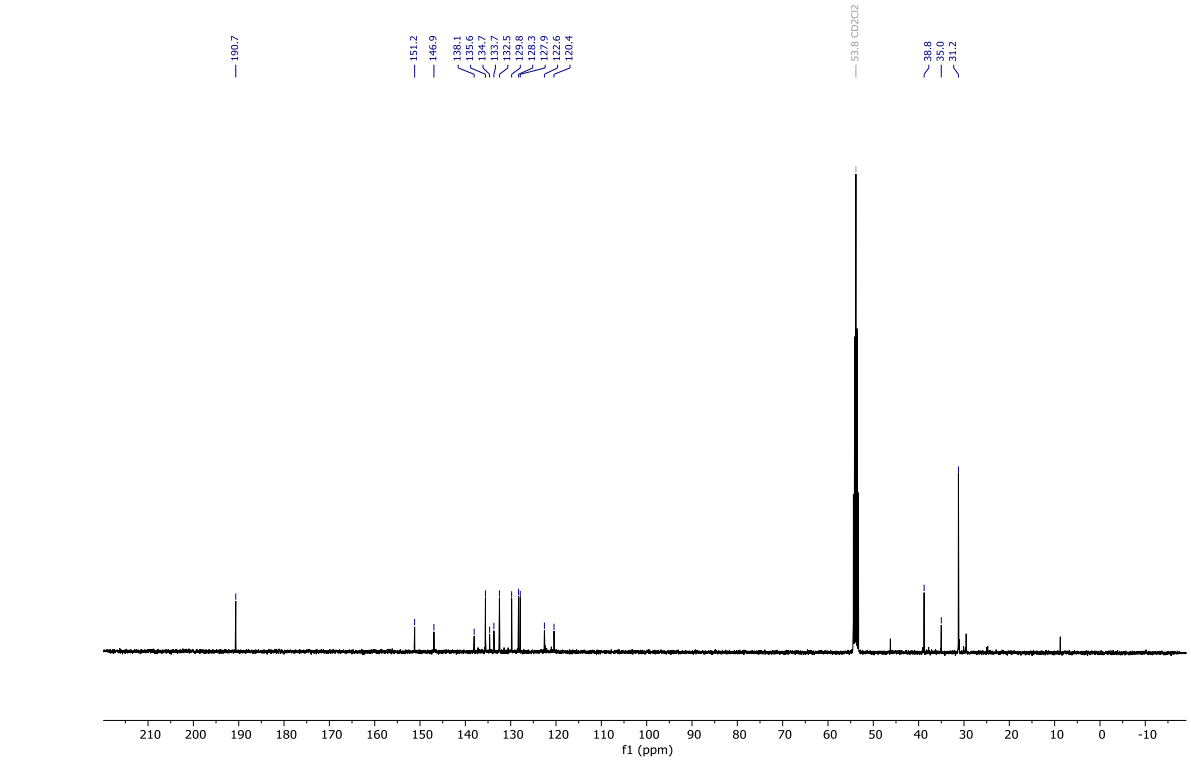


**($S_a$)-2',5-Dibromo-5'-(tert-butyl)-6-formyl-[1,1'-biphenyl]-2-yl methanesulfonate (3k).**

$^1$H-NMR

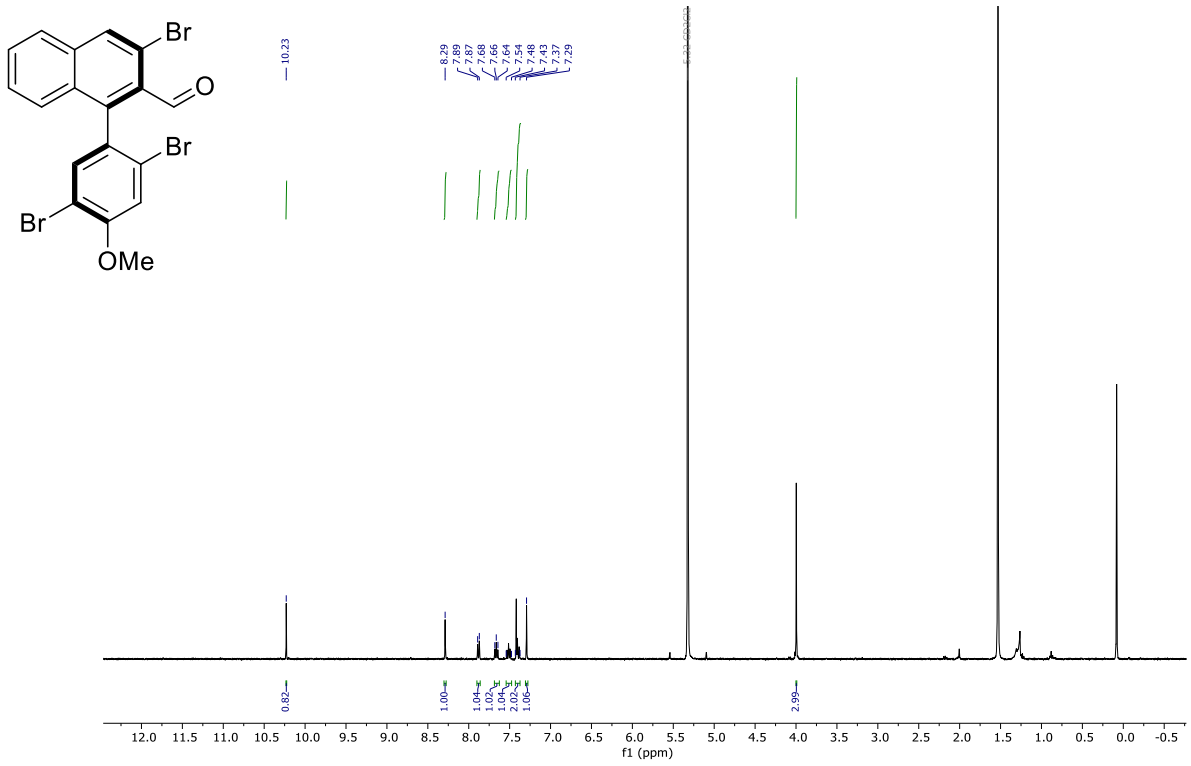



$^{13}$C-{$^1$H}-NMR

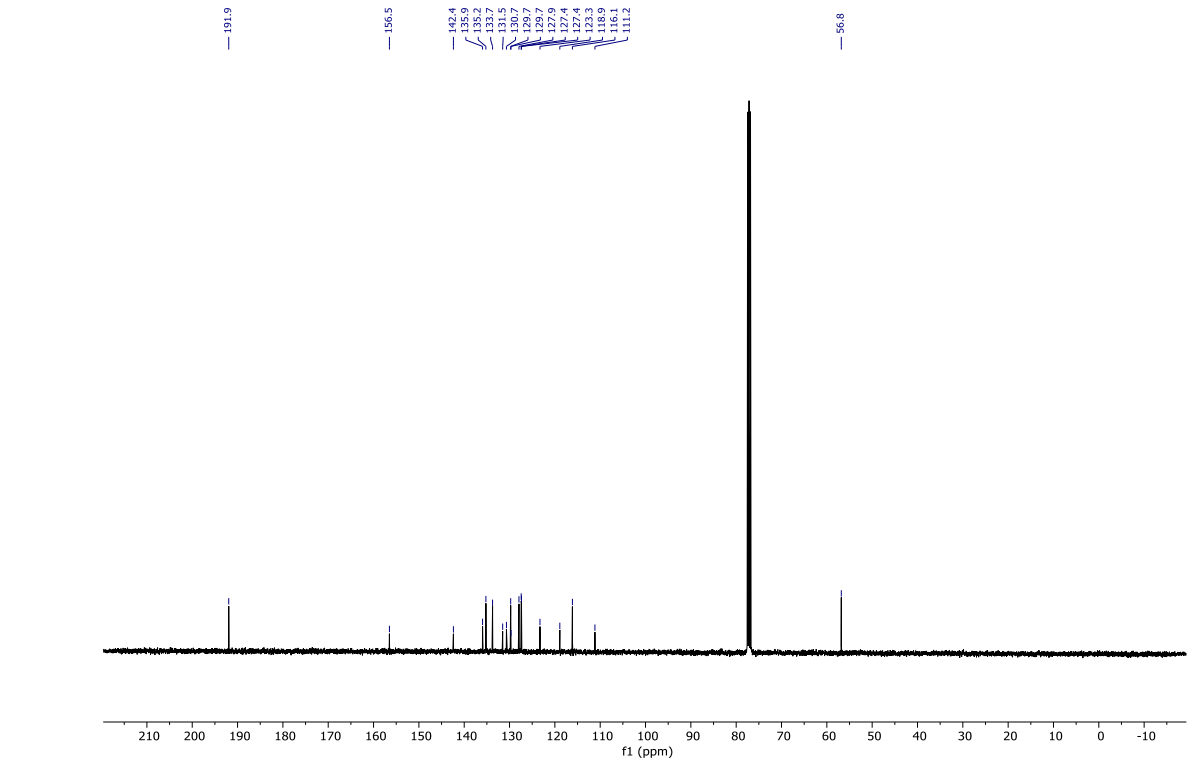


**($R_a$)-3-Bromo-1-(2,5-dibromo-4-methoxyphenyl)-2-naphthaldehyde (3l).**

$^1$H-NMR

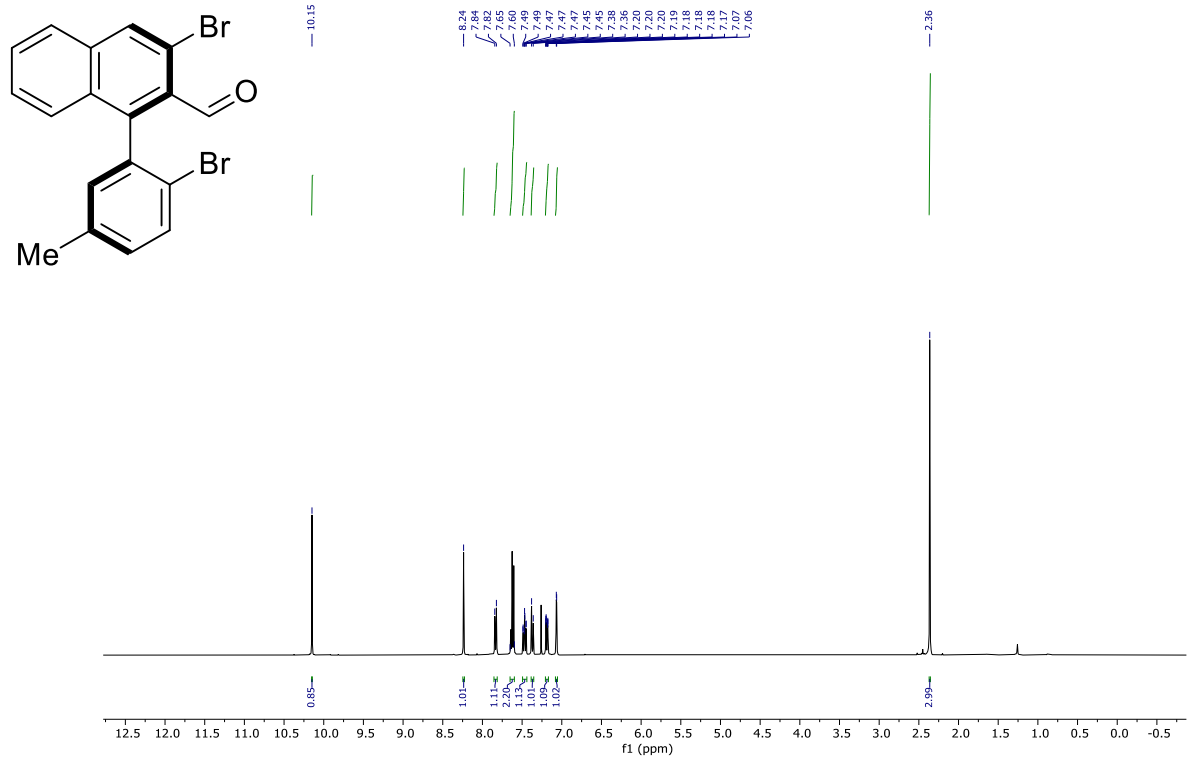



$^{13}$C-{$^1$H}-NMR

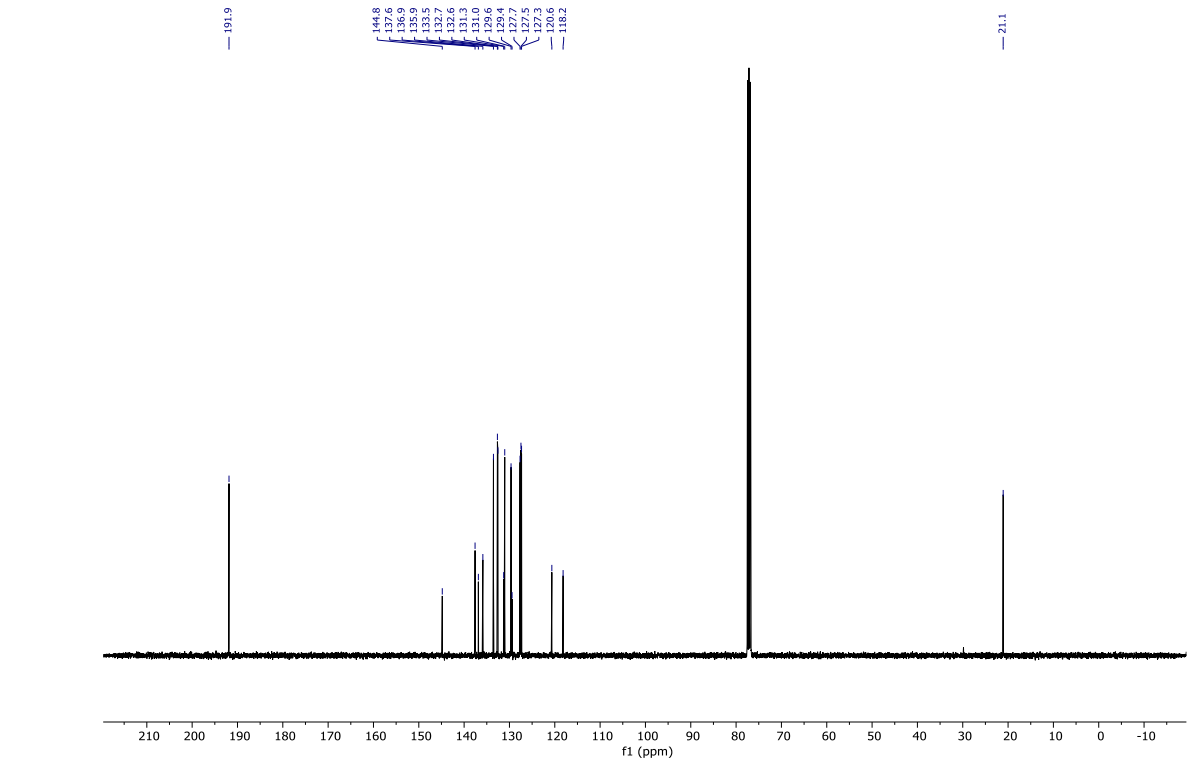


**($R_a$)-3-Bromo-1-(2-bromo-5-methylphenyl)-2-naphthaldehyde (3m).**

$^1$H-NMR

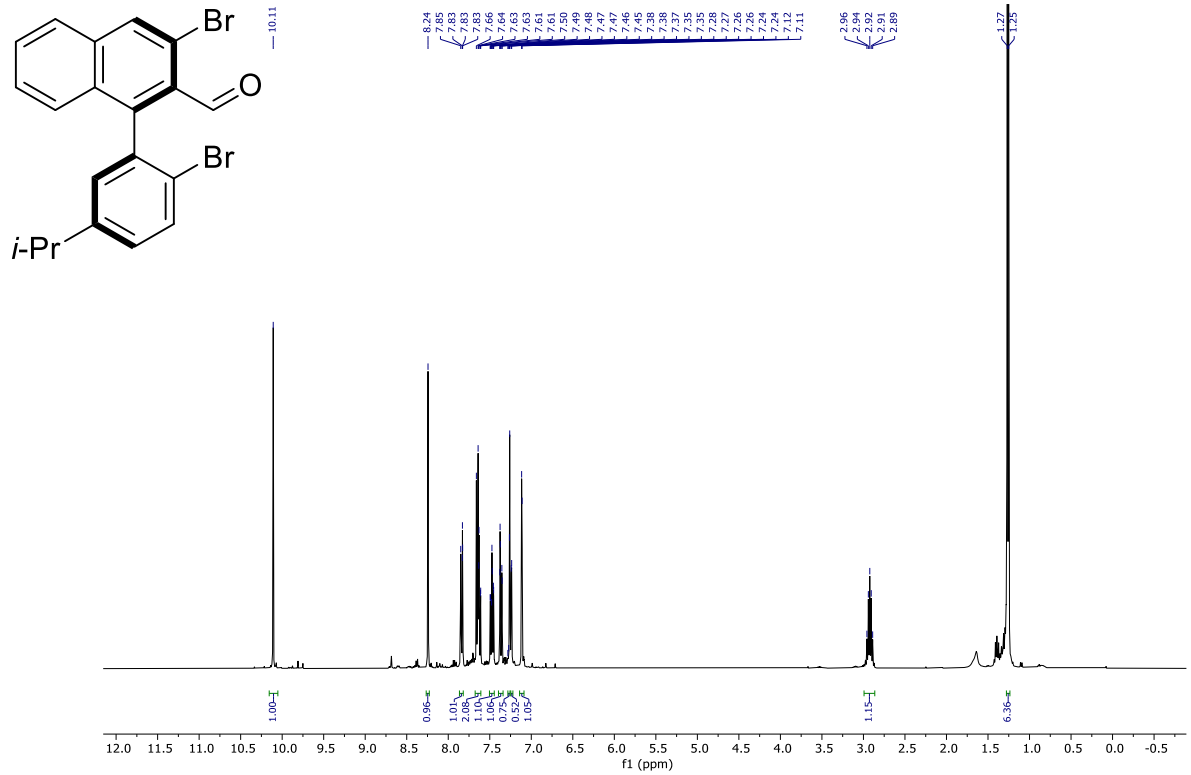



$^{13}$C-{$^1$H}-NMR

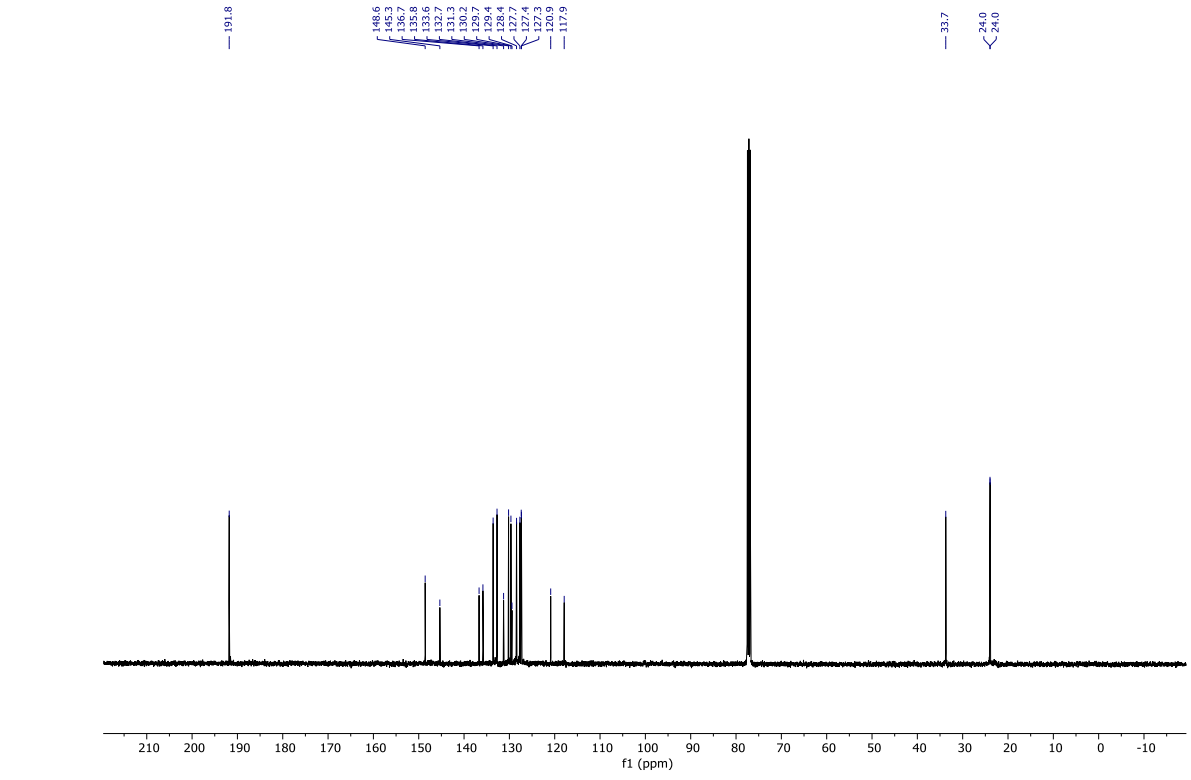


**($R_a$)-3-Bromo-1-(2-bromo-5-*iso*-propylphenyl)-2-naphthaldehyde (3n).**

$^1$H-NMR

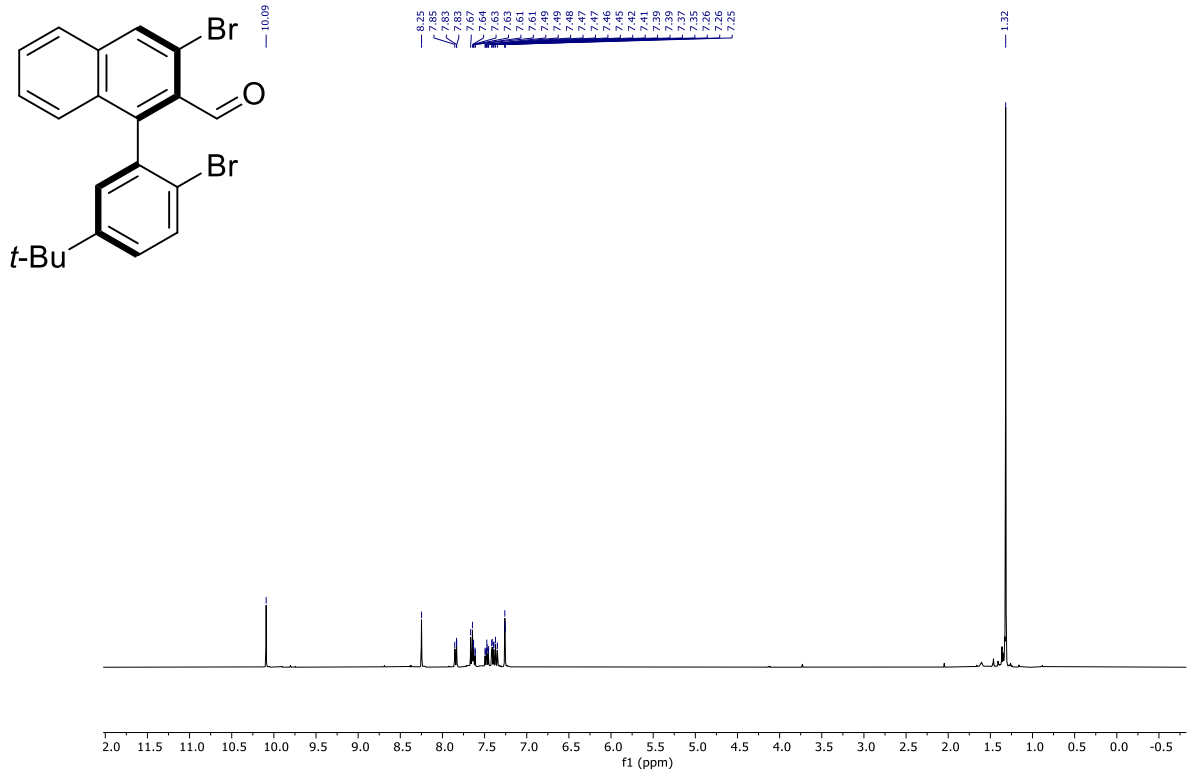



$^{13}$C-{$^1$H}-NMR

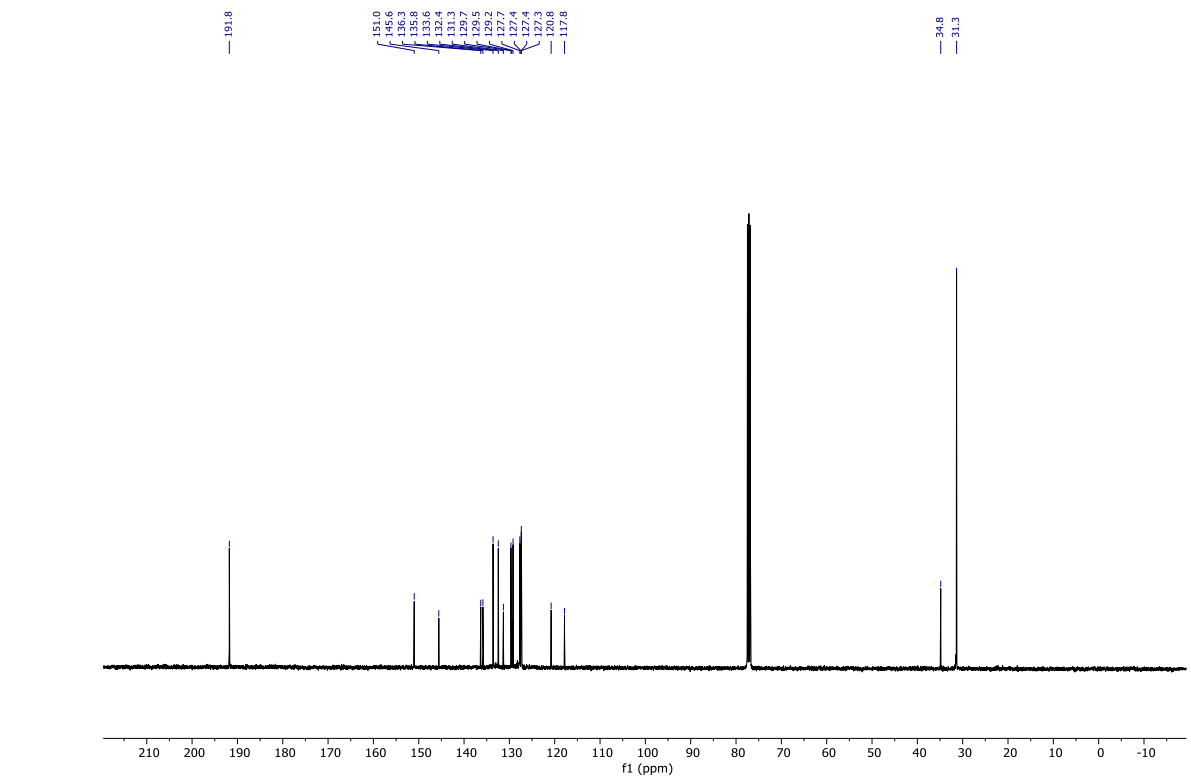


**($R_a$)-3-Bromo-1-(2-bromo-5-tertbutylphenyl)-2-naphthaldehyde (3o).**

$^1$H-NMR

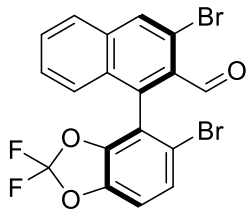



$^{13}$C-{$^1$H}-NMR



**($R_a$)-3-Bromo-1-(5-bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-2-naphthaldehyde (3p)**

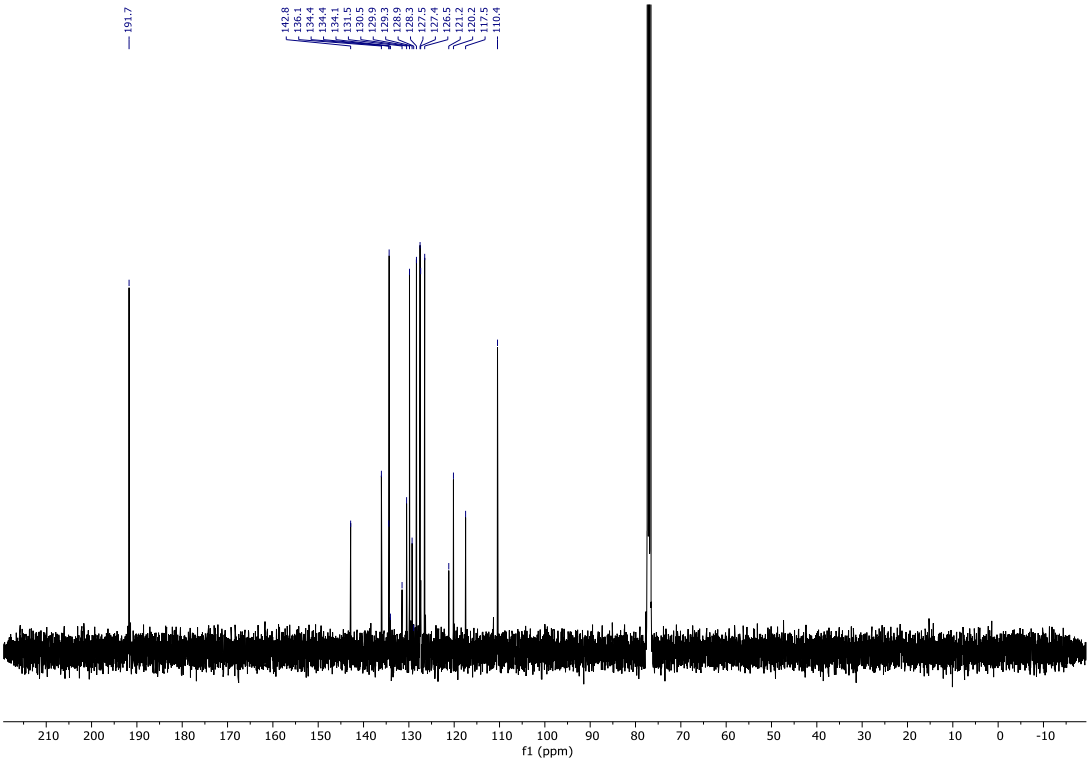
$^1$H-NMR



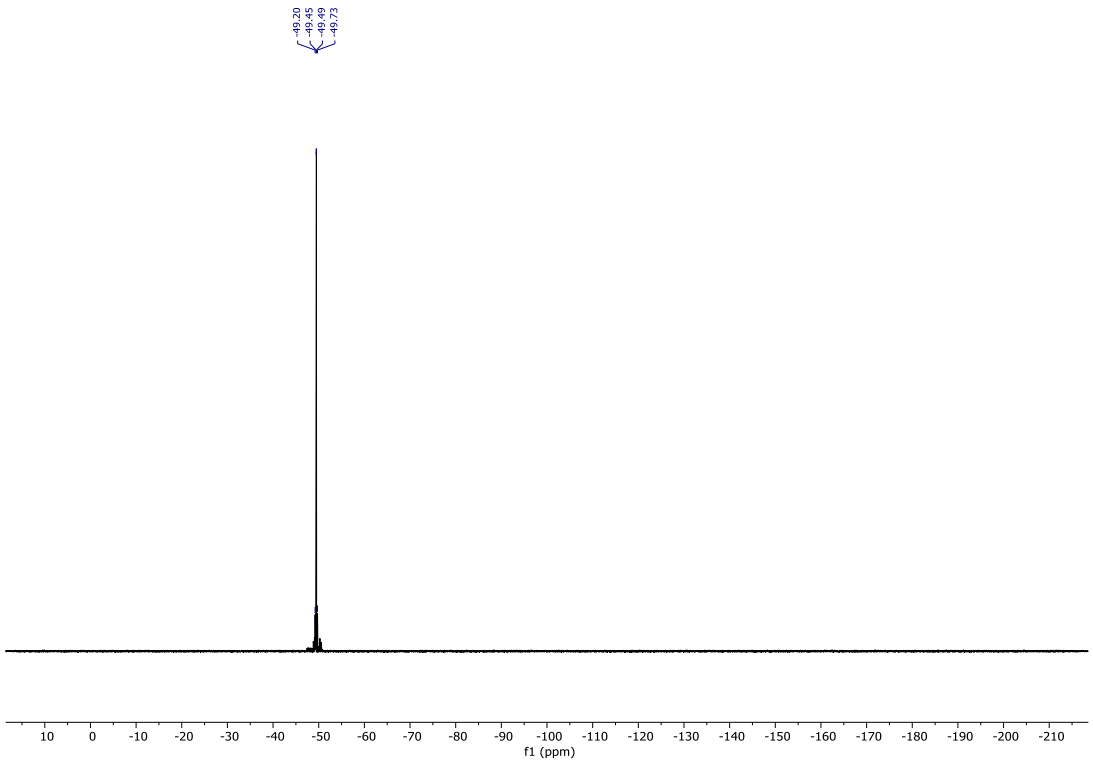




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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-49.49
-49.73
10
0
-10
-20
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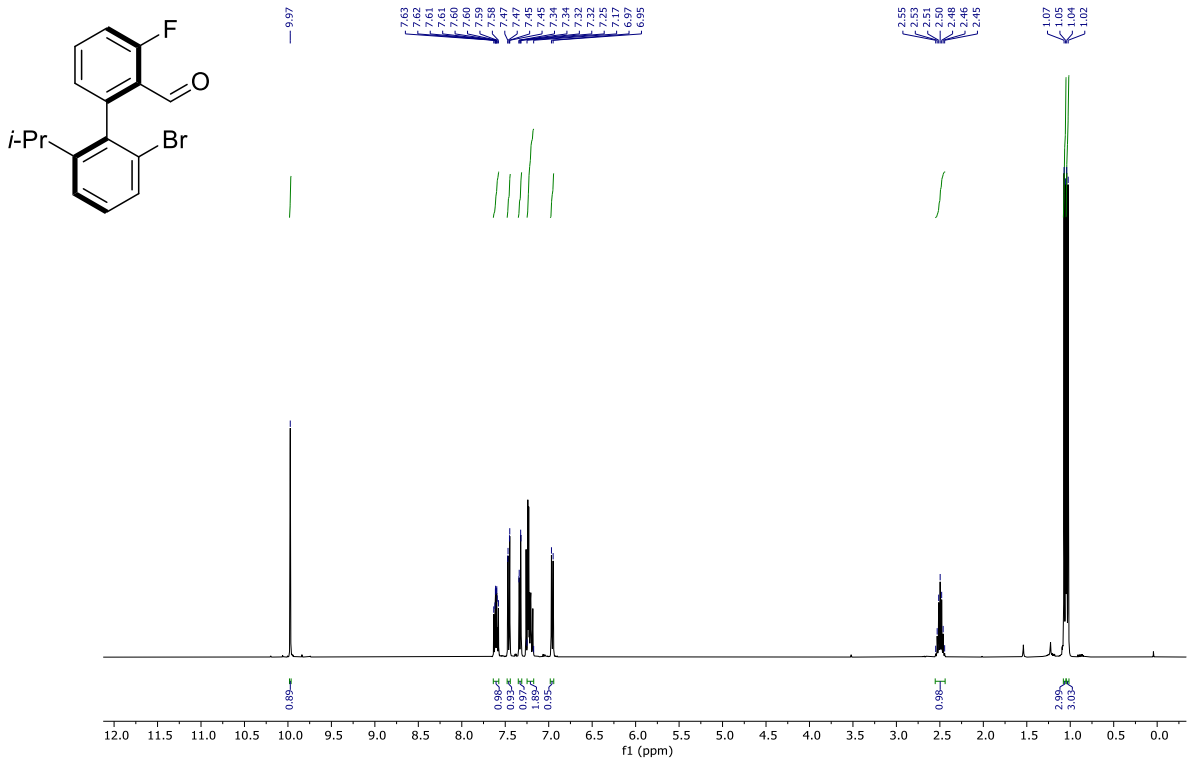
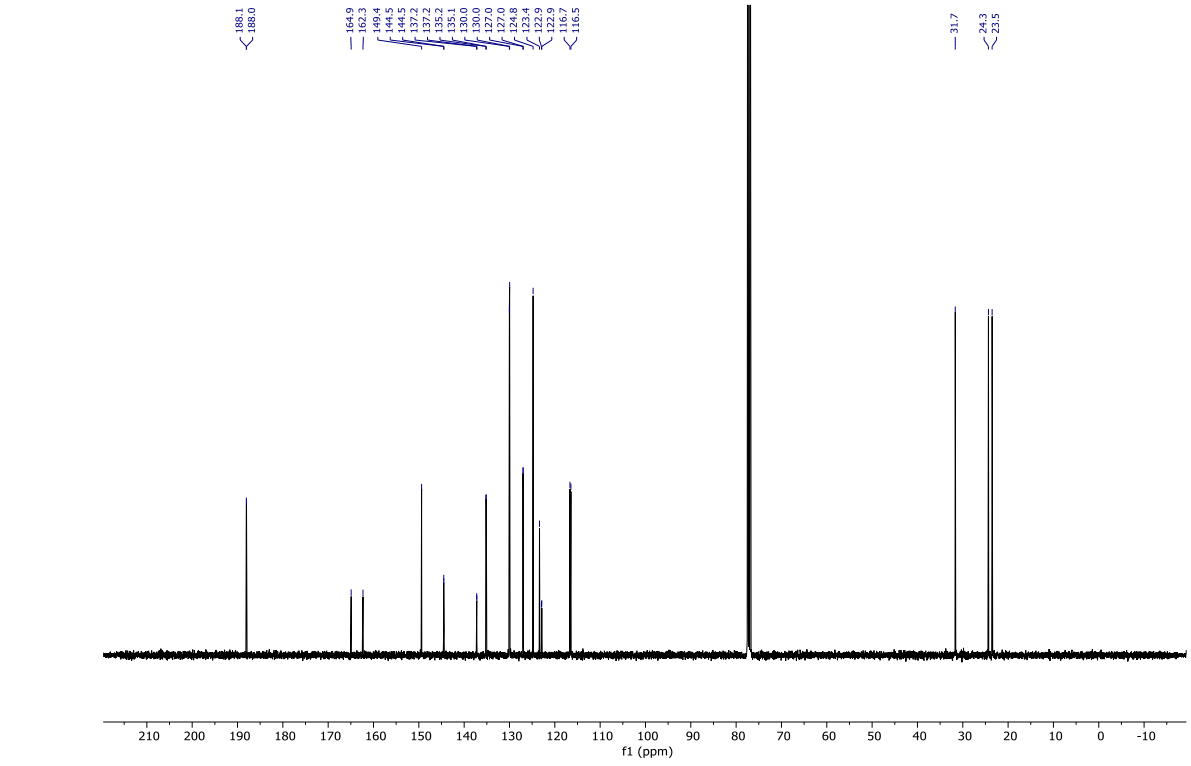
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-2'-Bromo-3-fluoro-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (4q).**

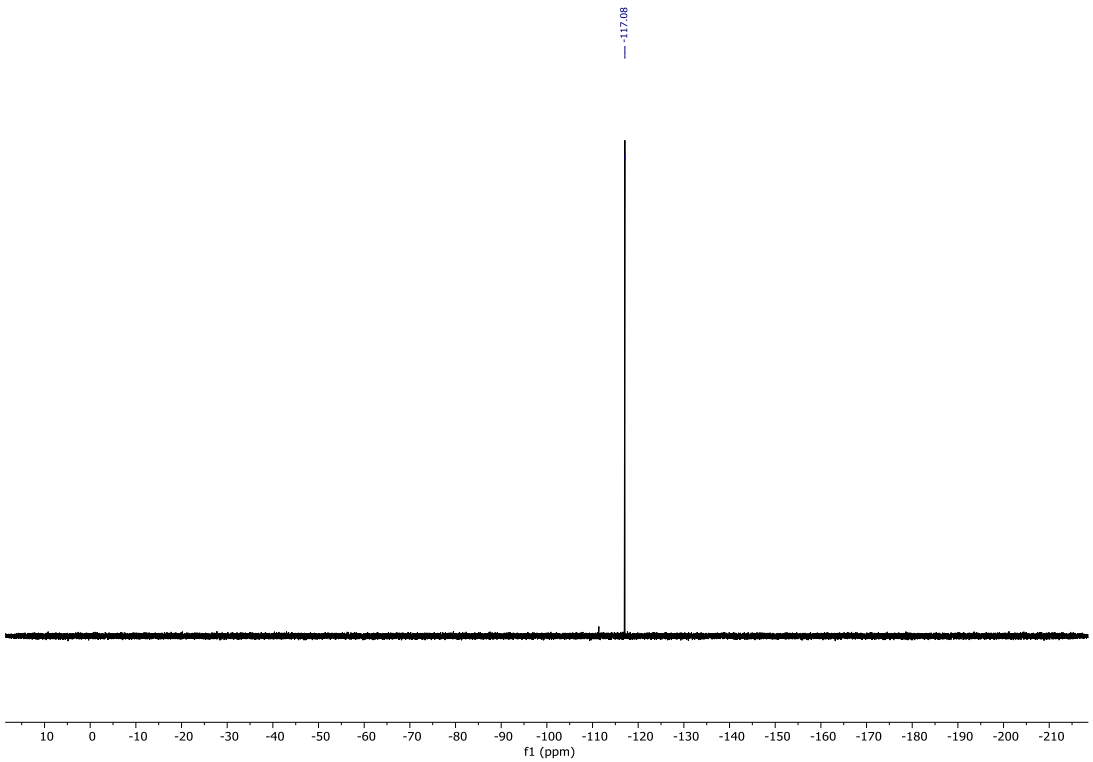
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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-70
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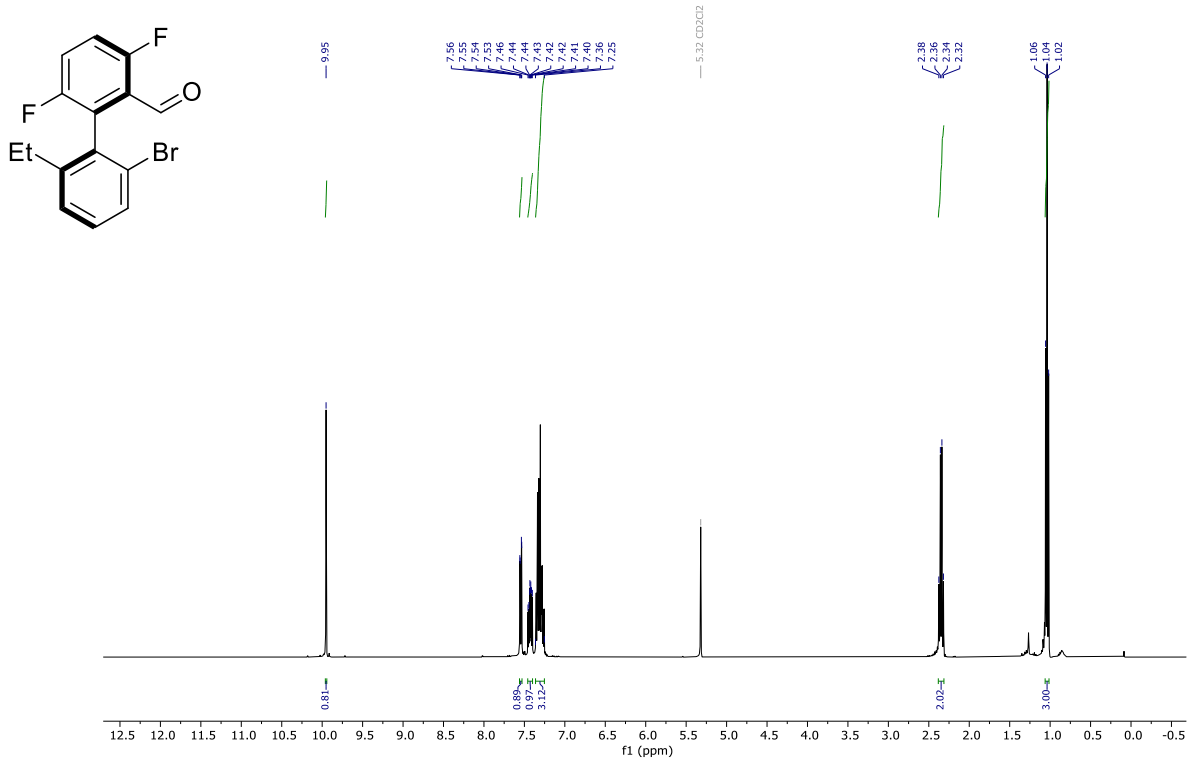
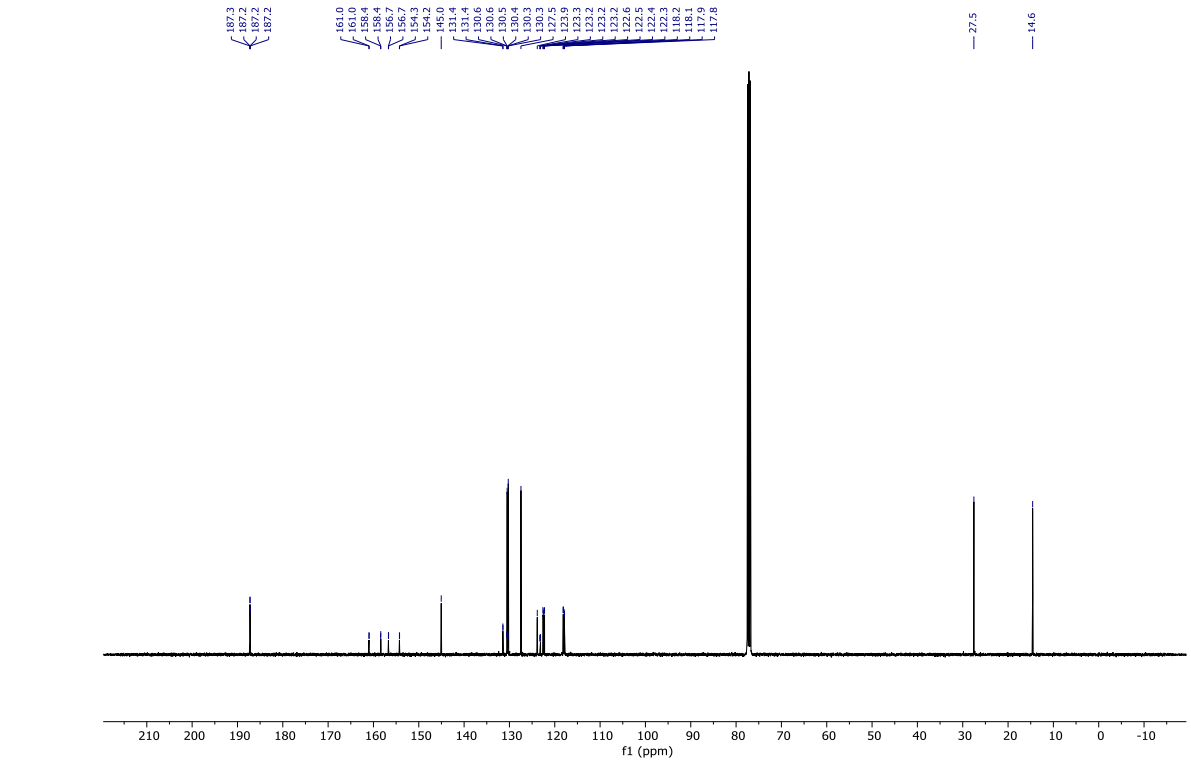
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($S_a$)-2'-Bromo-6'-ethyl-3,6-difluoro-[1,1'-biphenyl]-2-carbaldehyde (4r).**

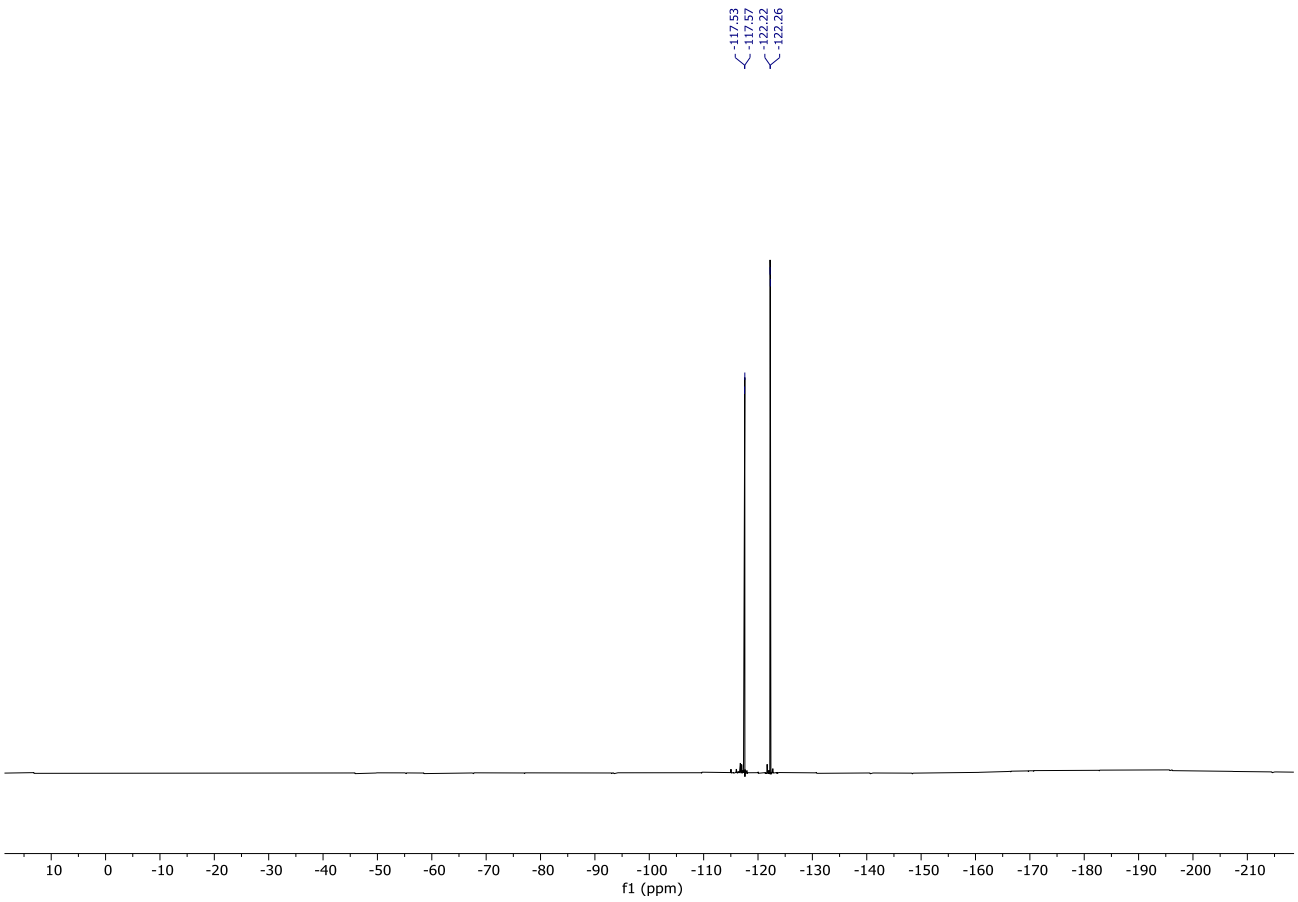
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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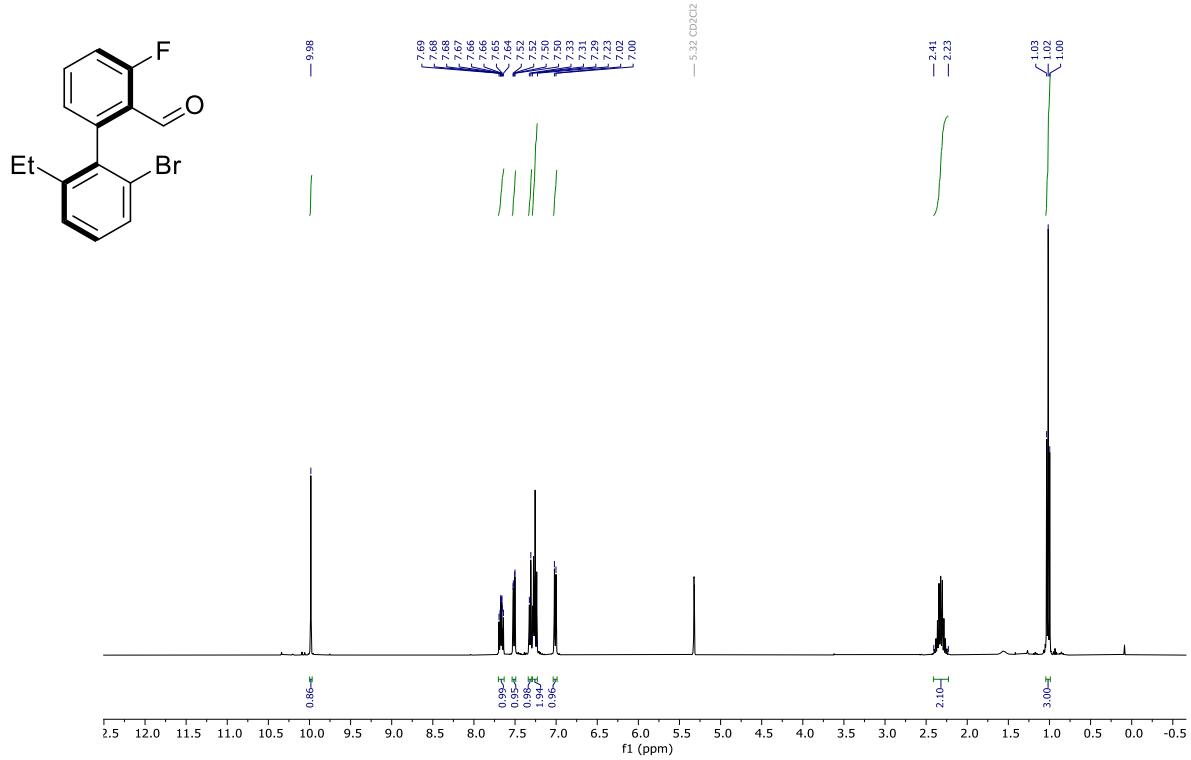
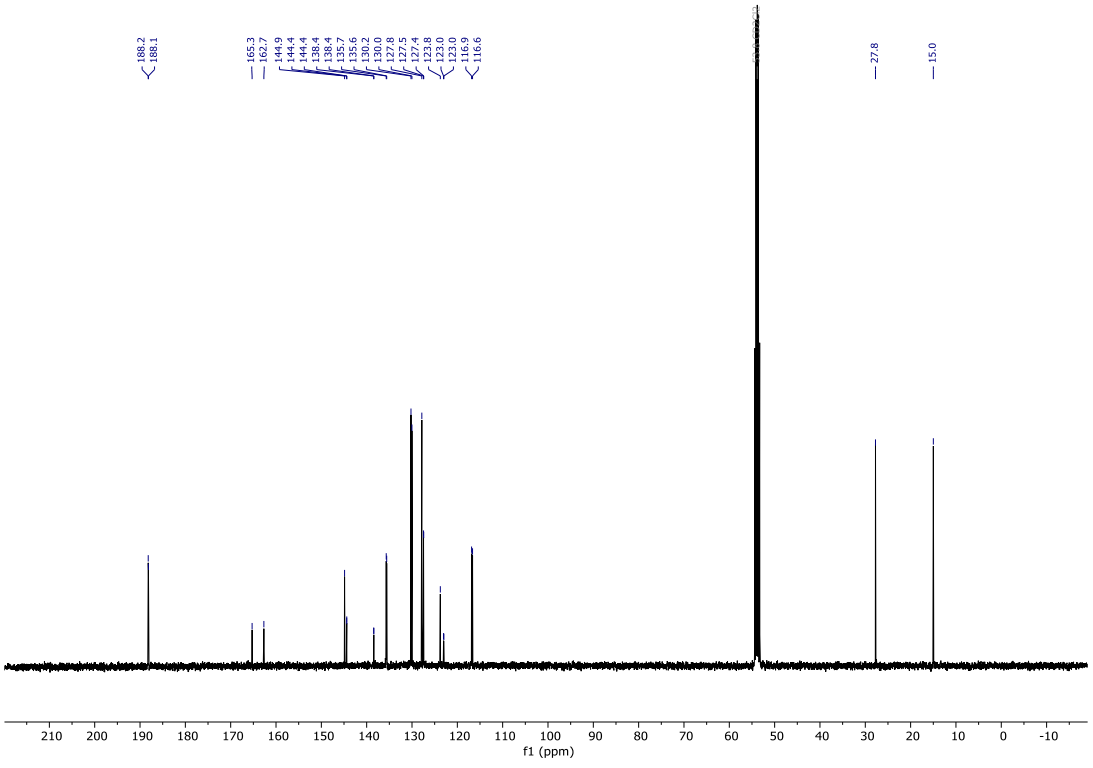
-117.57
-122.22
-122.26
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

**($R_a$)-2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (4s).**

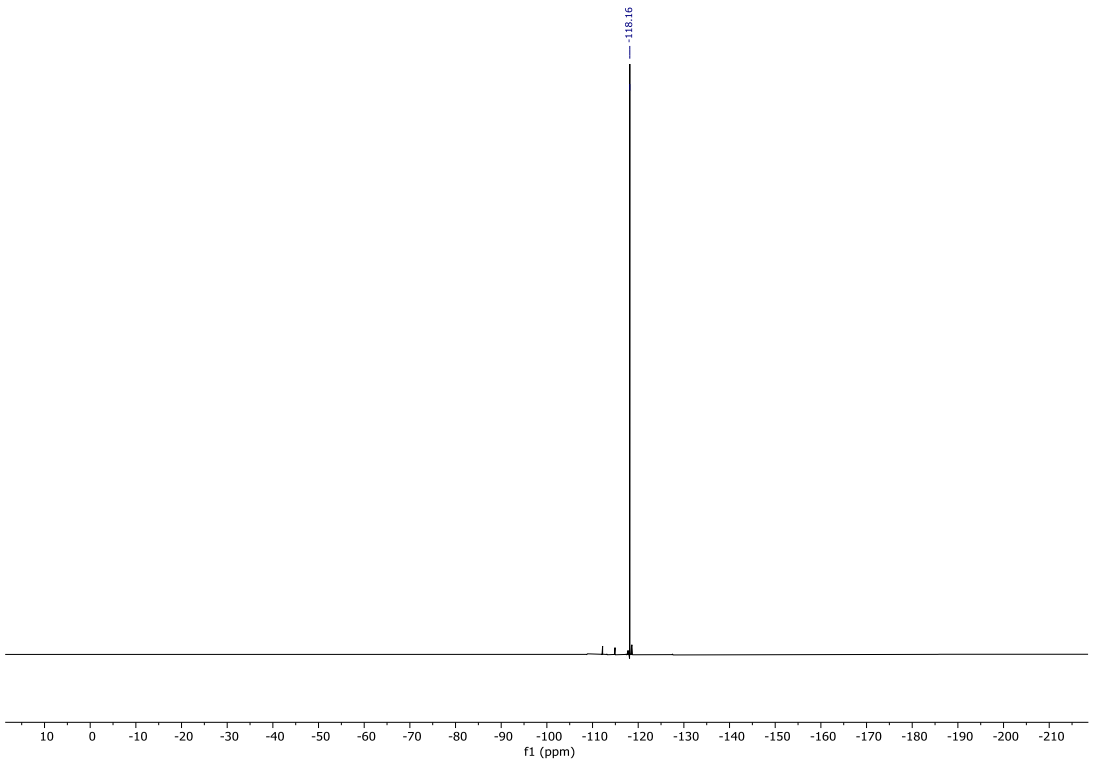
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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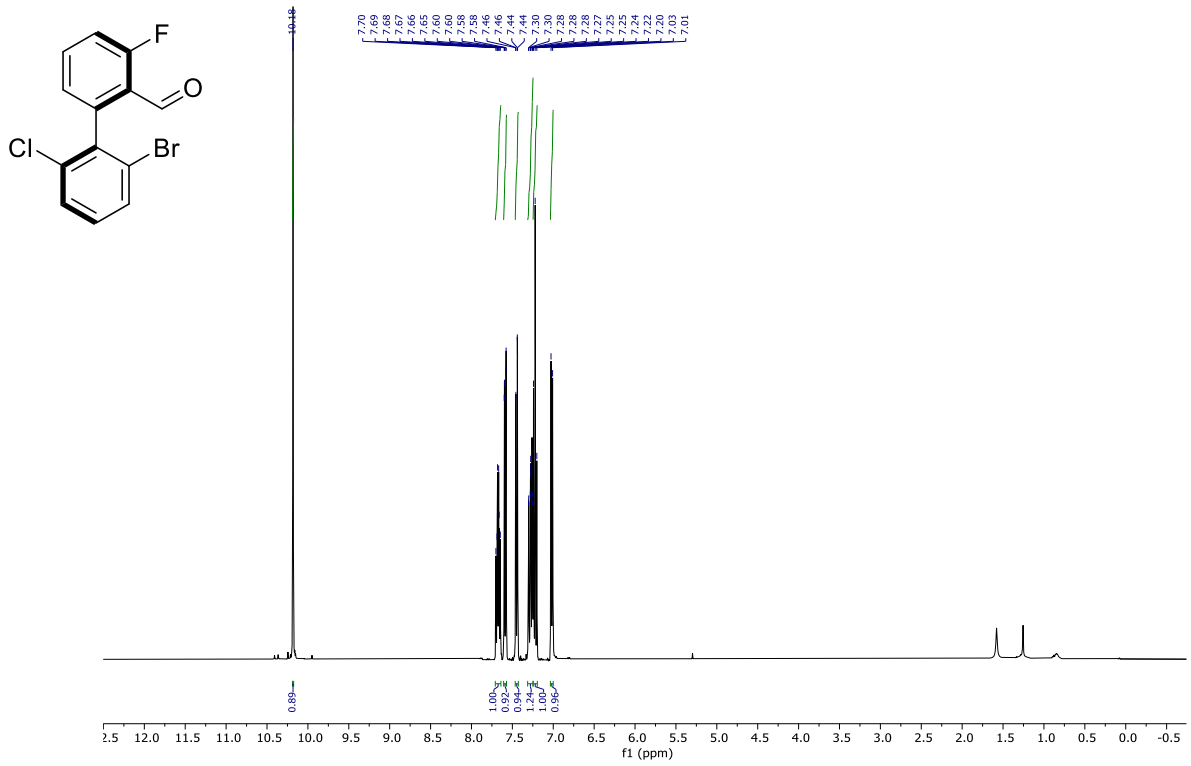
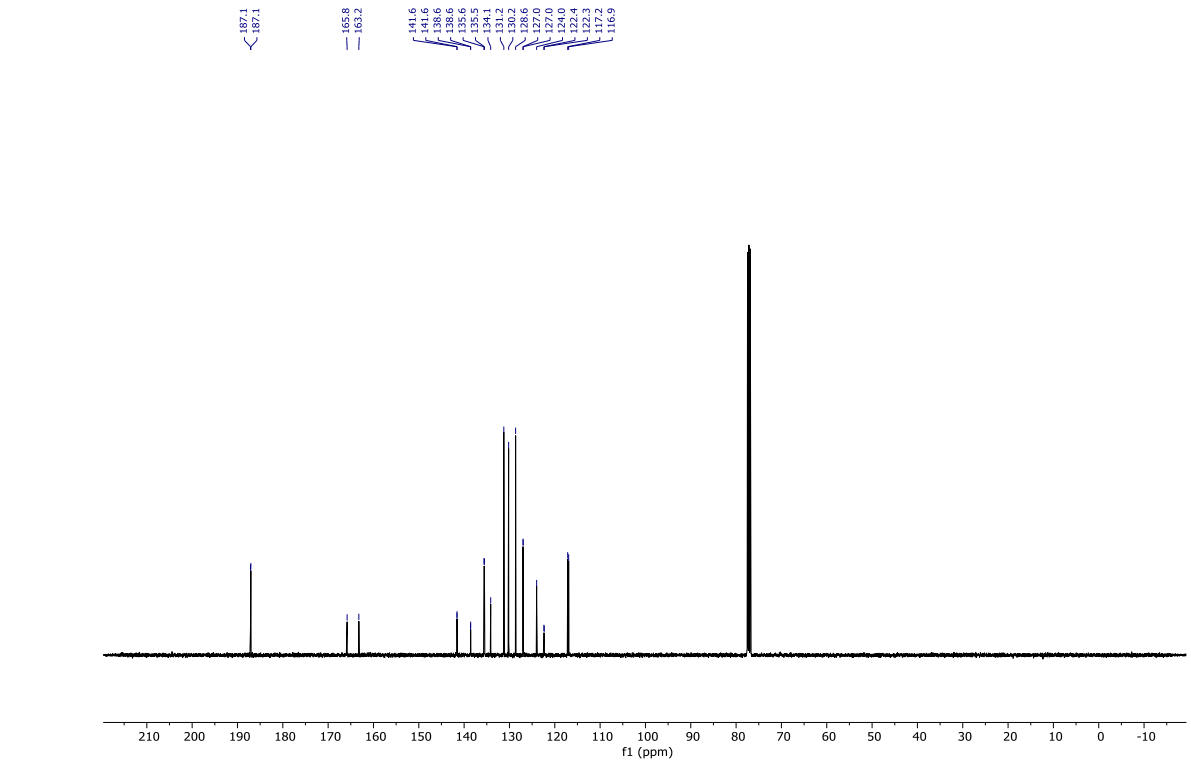
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-2'-Bromo-6'-chloro-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (4t).**

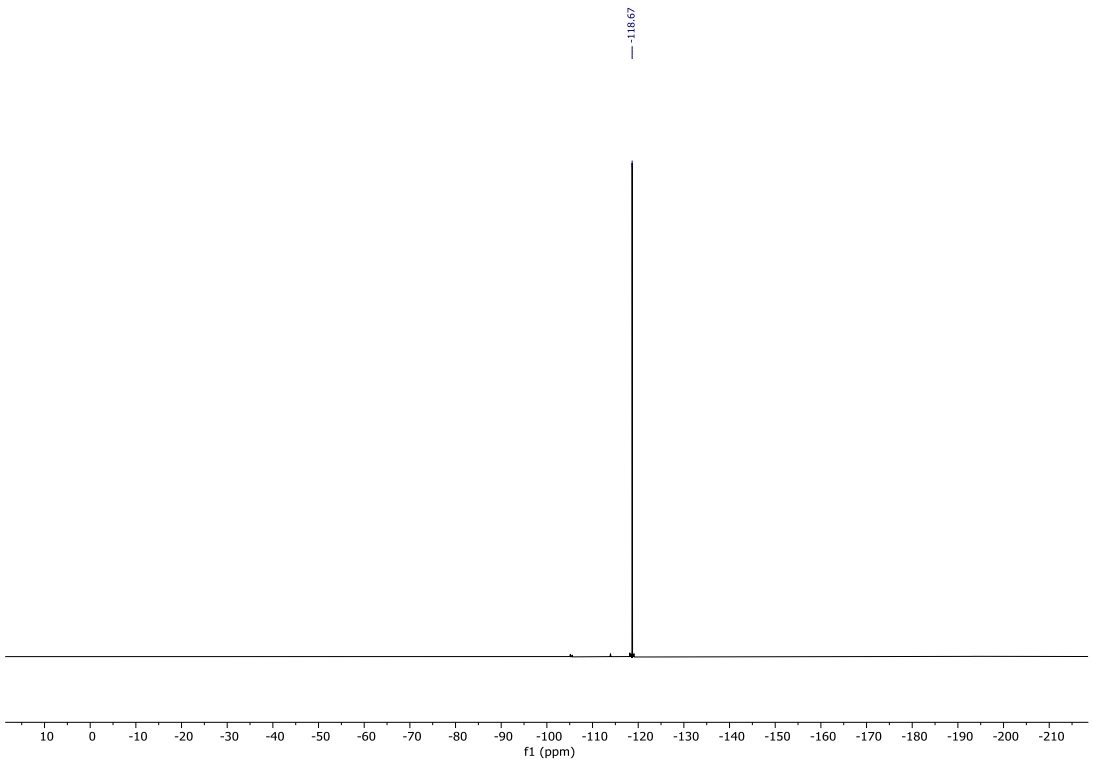
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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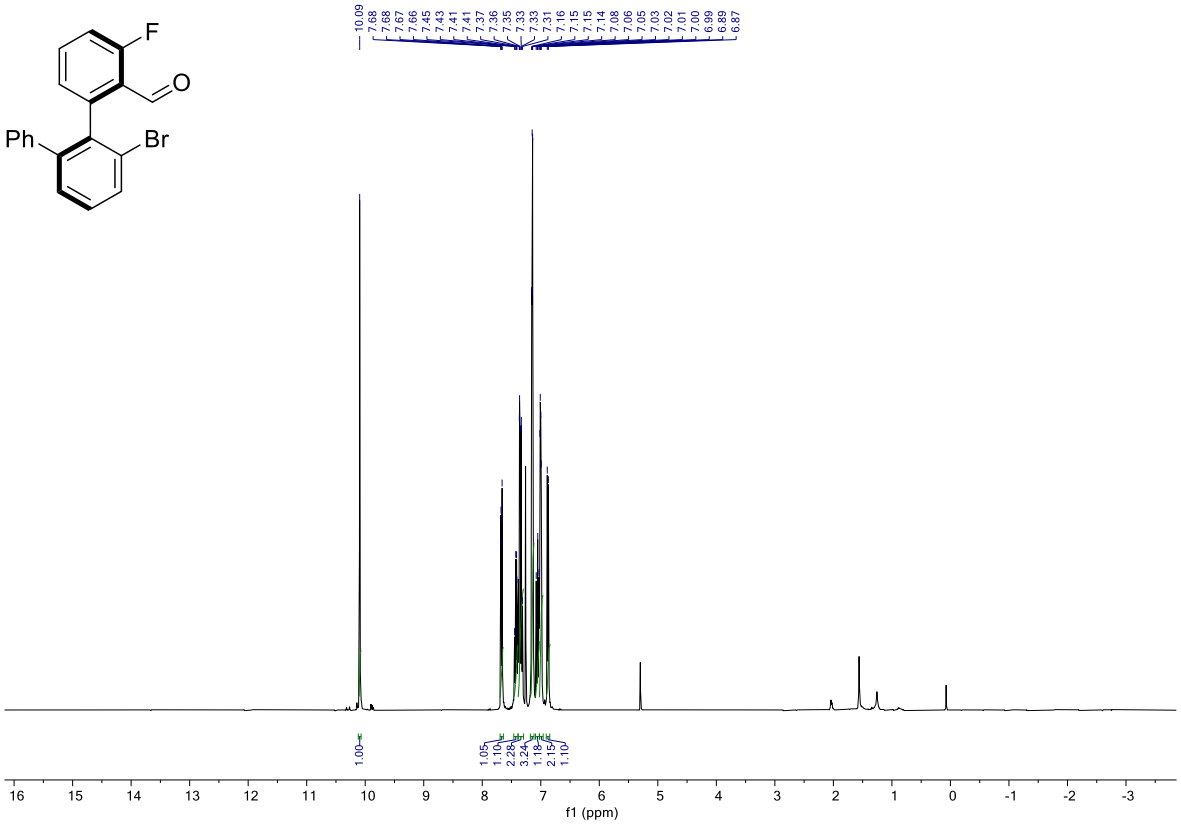
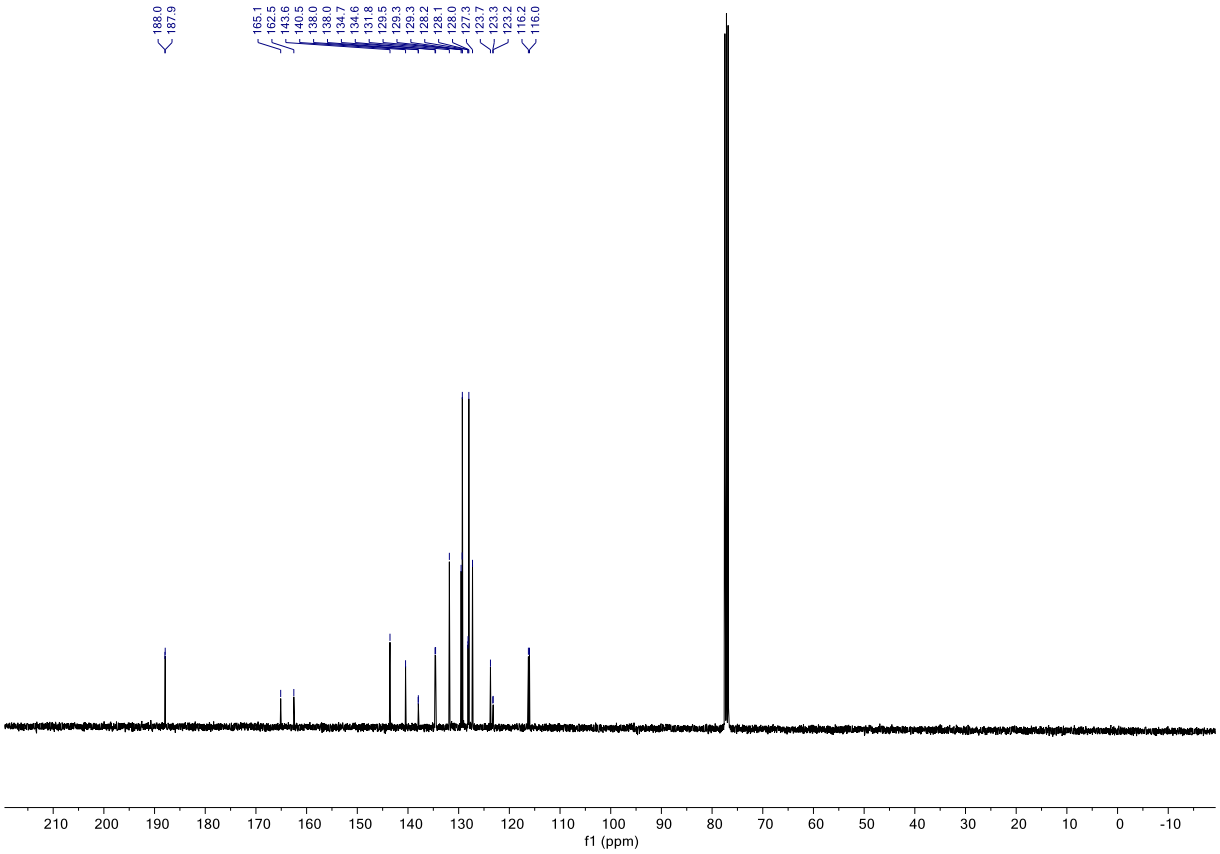
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-6'-Bromo-3-fluoro-[1,1':2',1''-terphenyl]-2-carbaldehyde (4ϕ).**

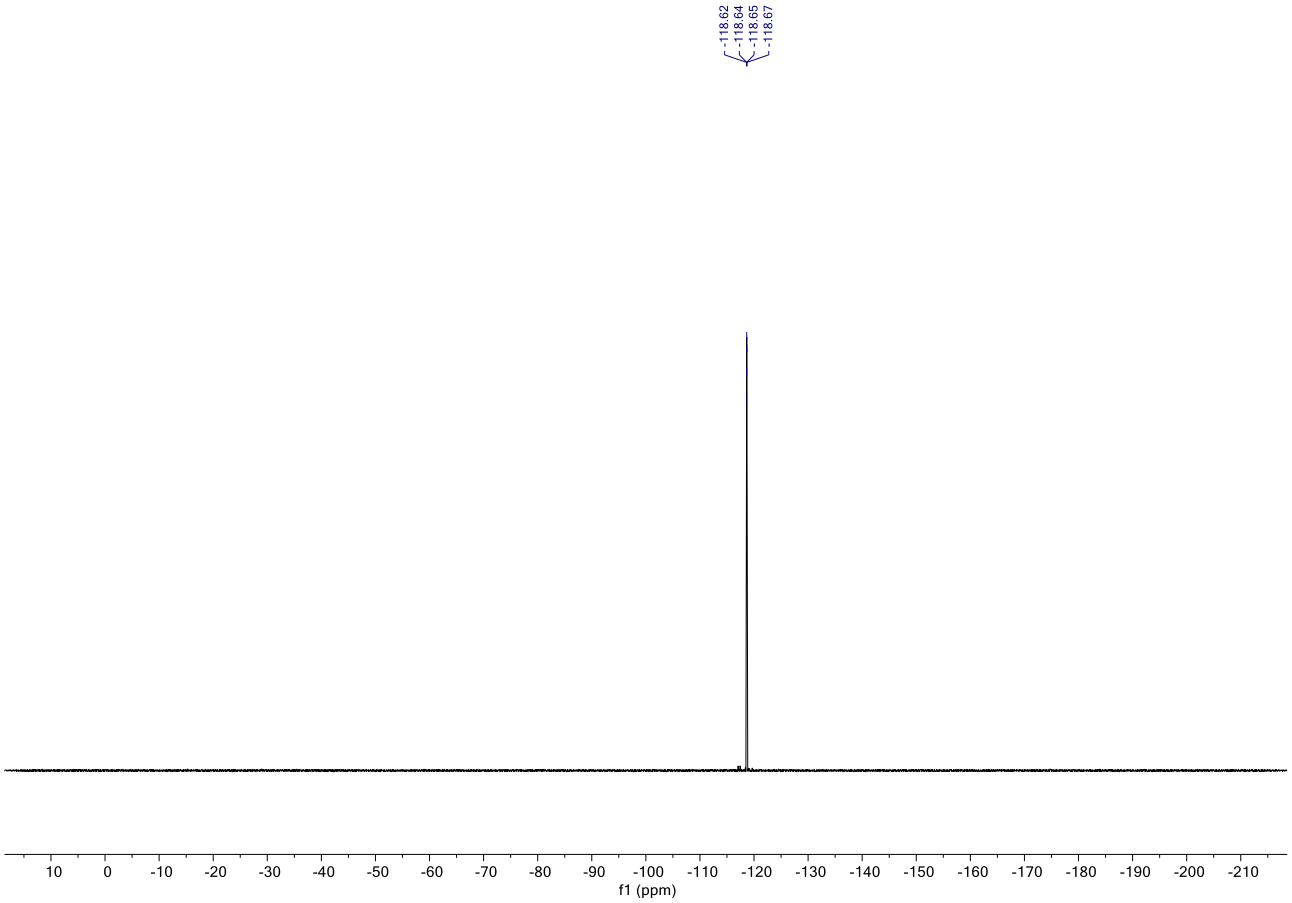
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

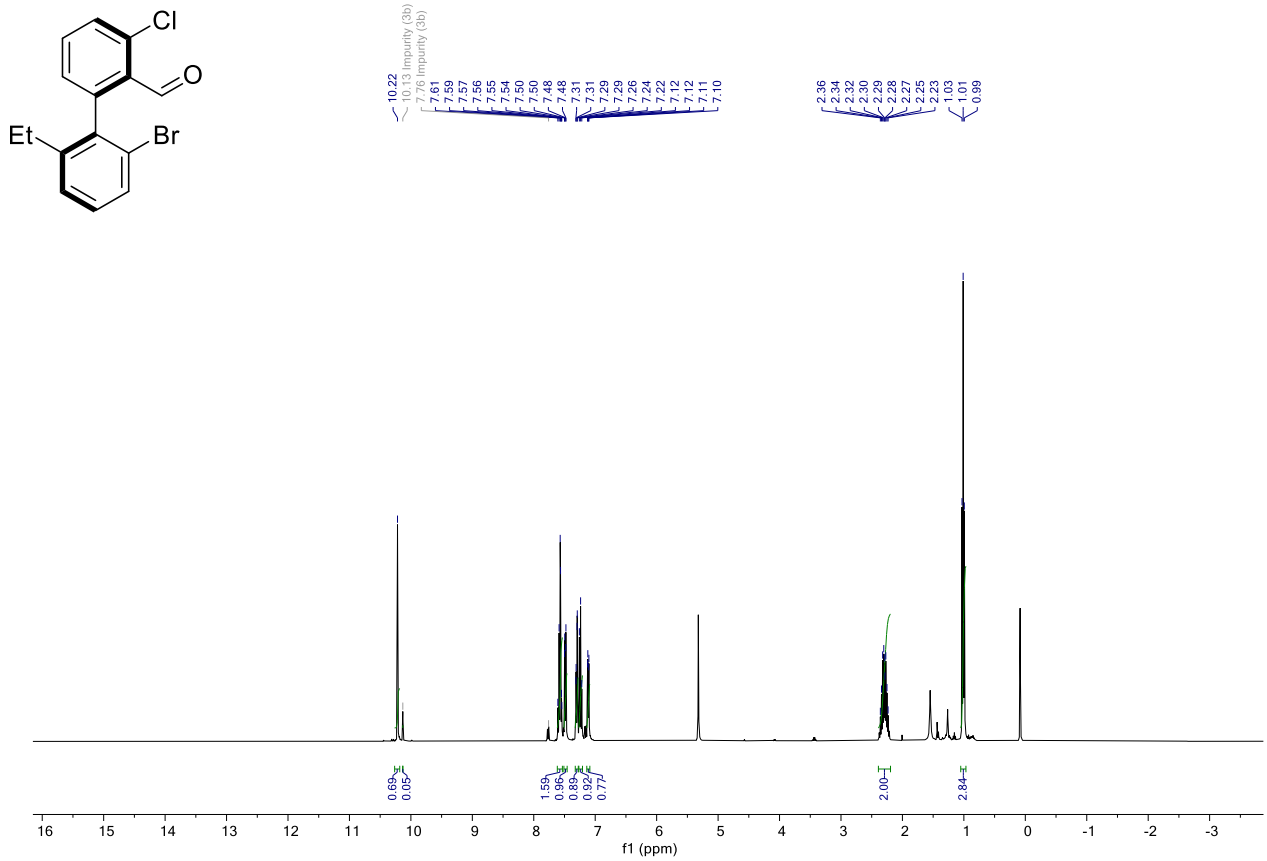


$^{19}$F-NMR

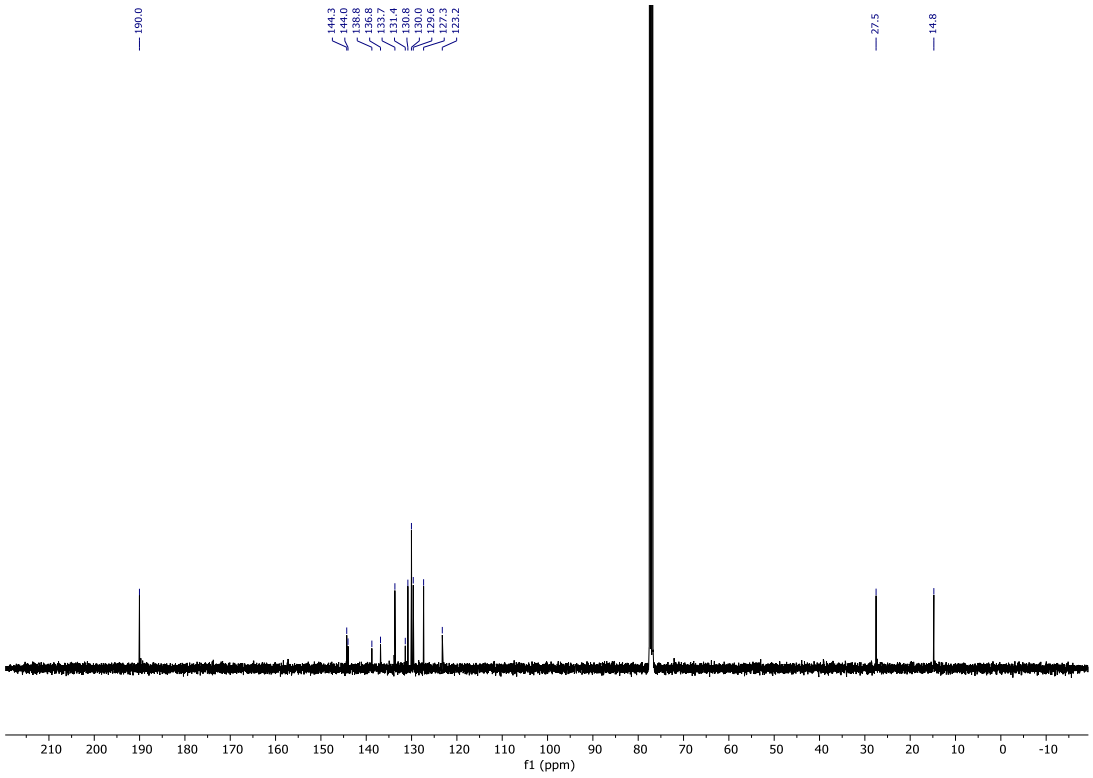

-118.62
-118.64
-118.65
-118.67
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

**($R_a$)-2'-Bromo-3-chloro-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (4u).**

$^1$H-NMR

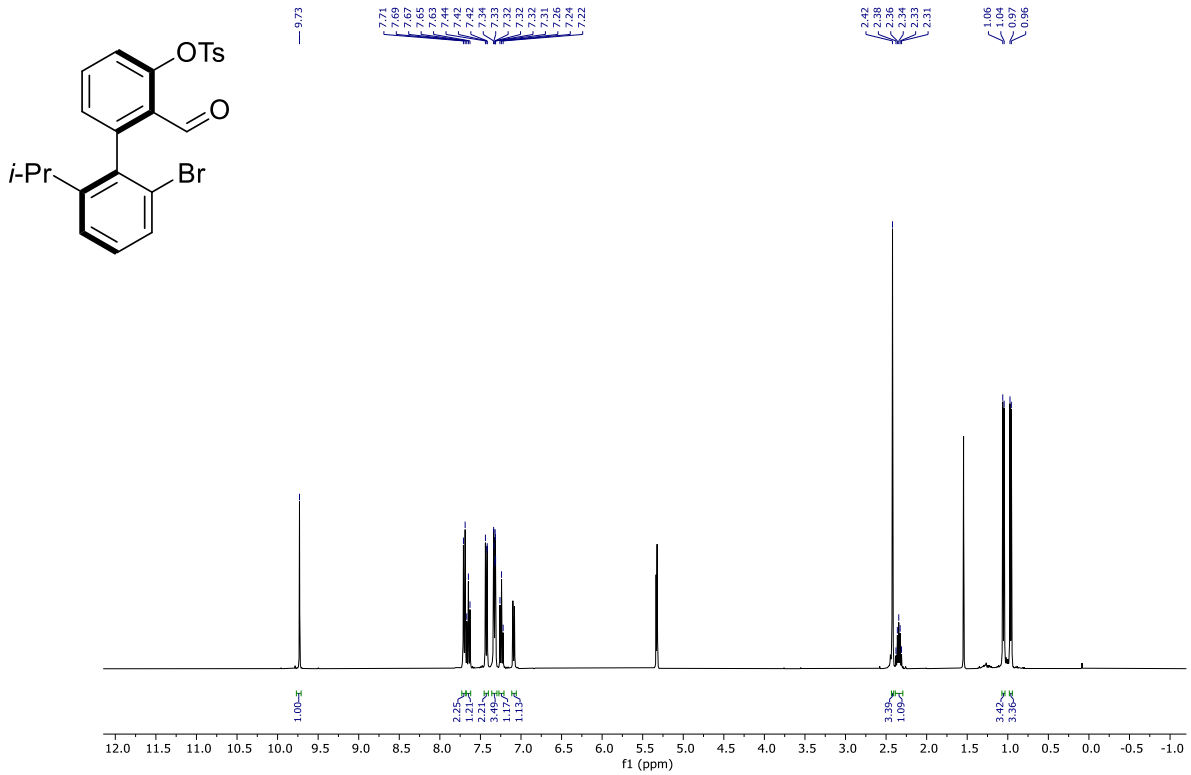



$^{13}$C-{$^1$H}-NMR

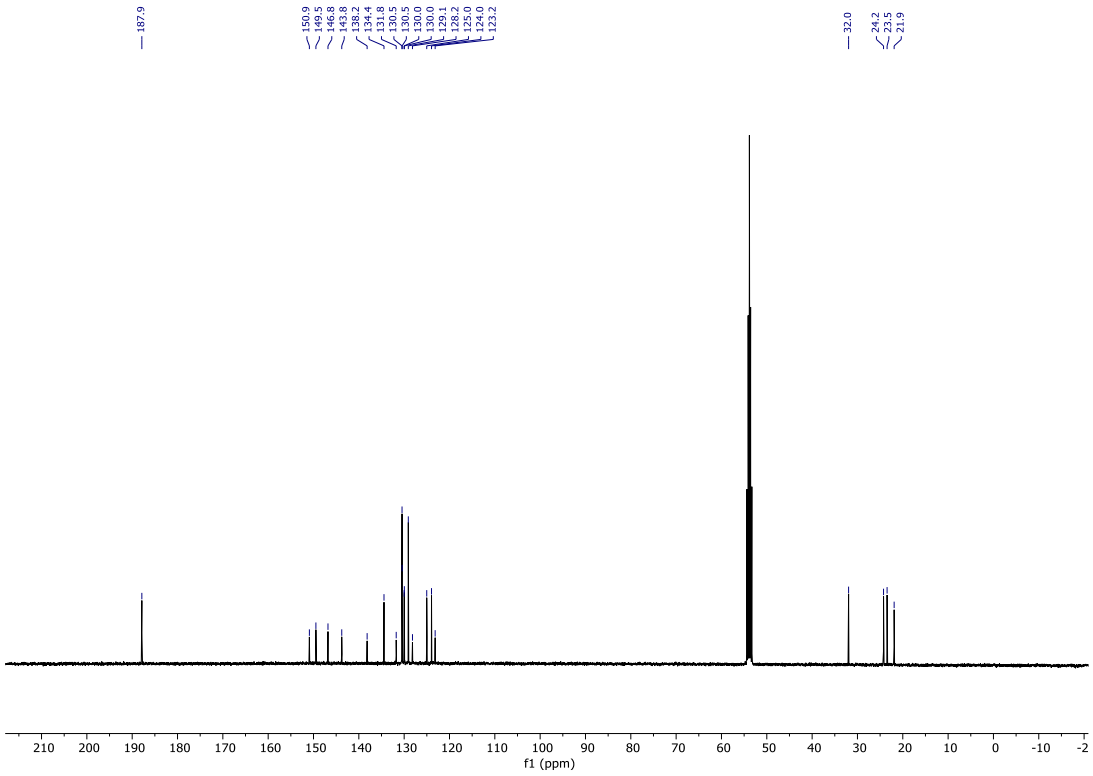


**($R_a$)-2'-Bromo-2-formyl-6'-*iso*-propyl-[1,1'-biphenyl]-3-yl 4-methylbenzenesulfonate (4v).**

$^1$H-NMR

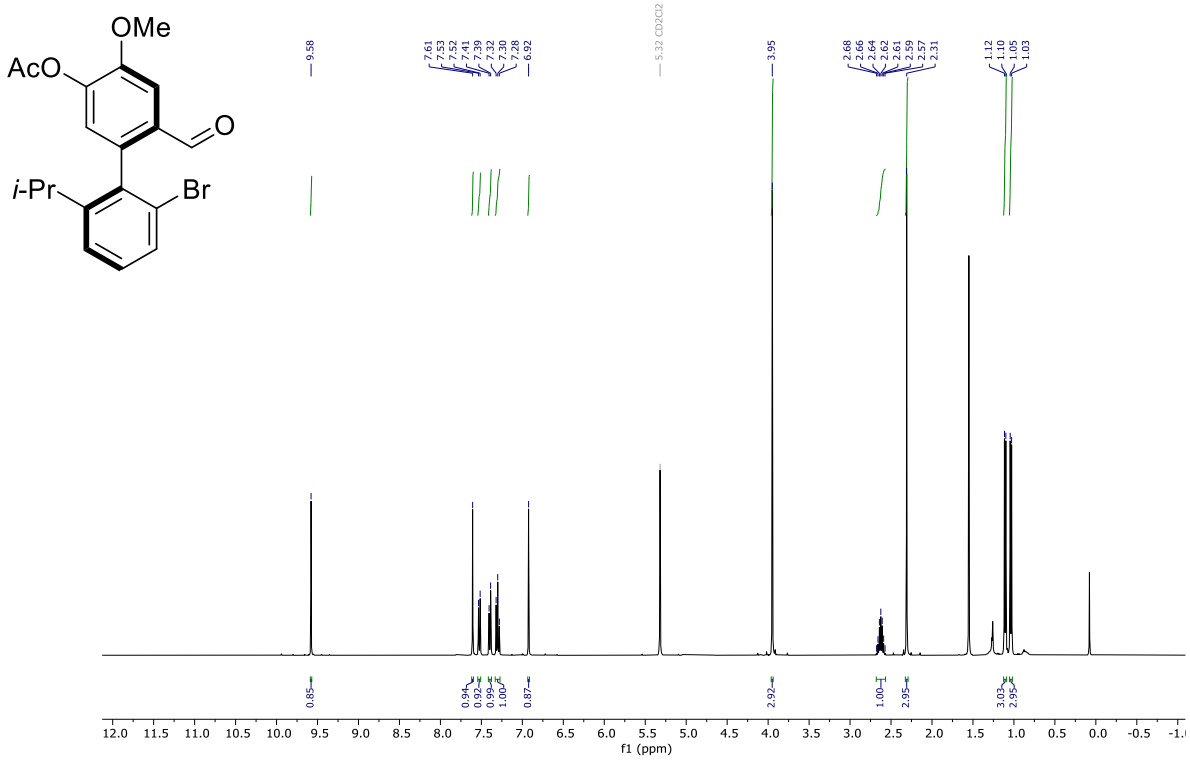



$^{13}$C-{$^1$H}-NMR

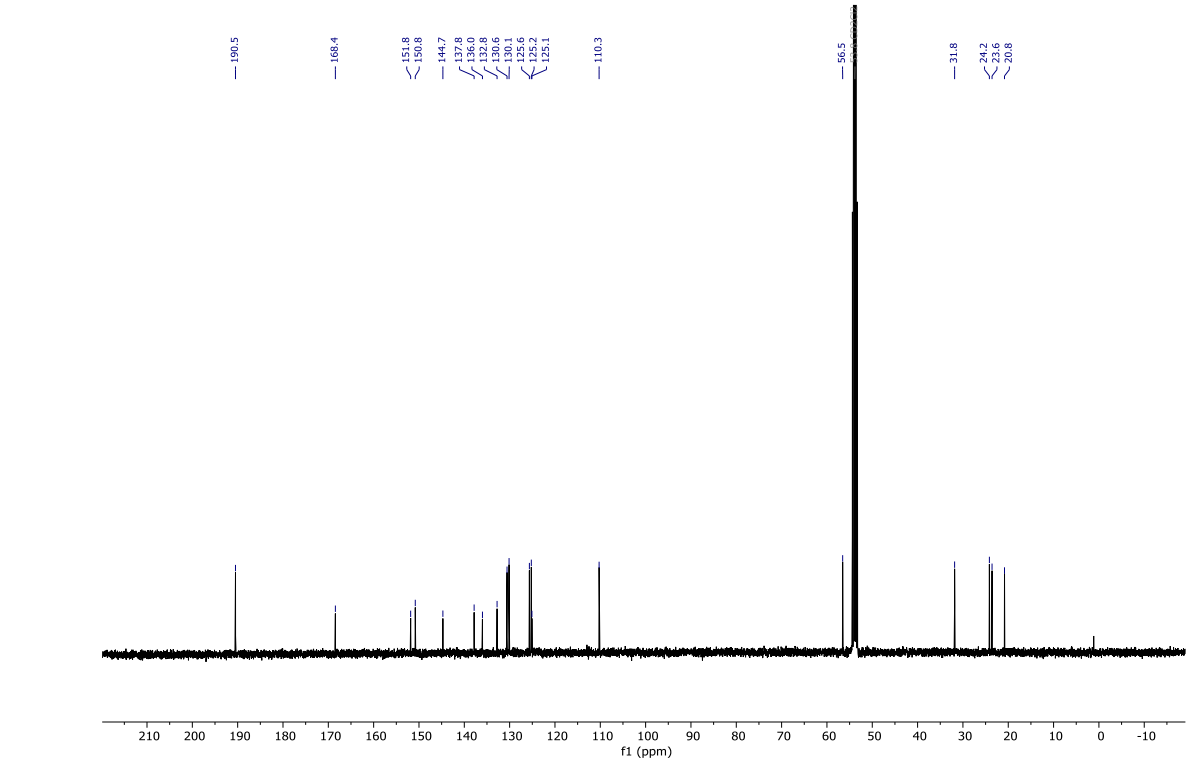


**($R_a$)-2'-Bromo-6'-*iso*-propyl-6-formyl-4-methoxy-[1,1'-biphenyl]-3-yl acetate (4w).**

$^1$H-NMR

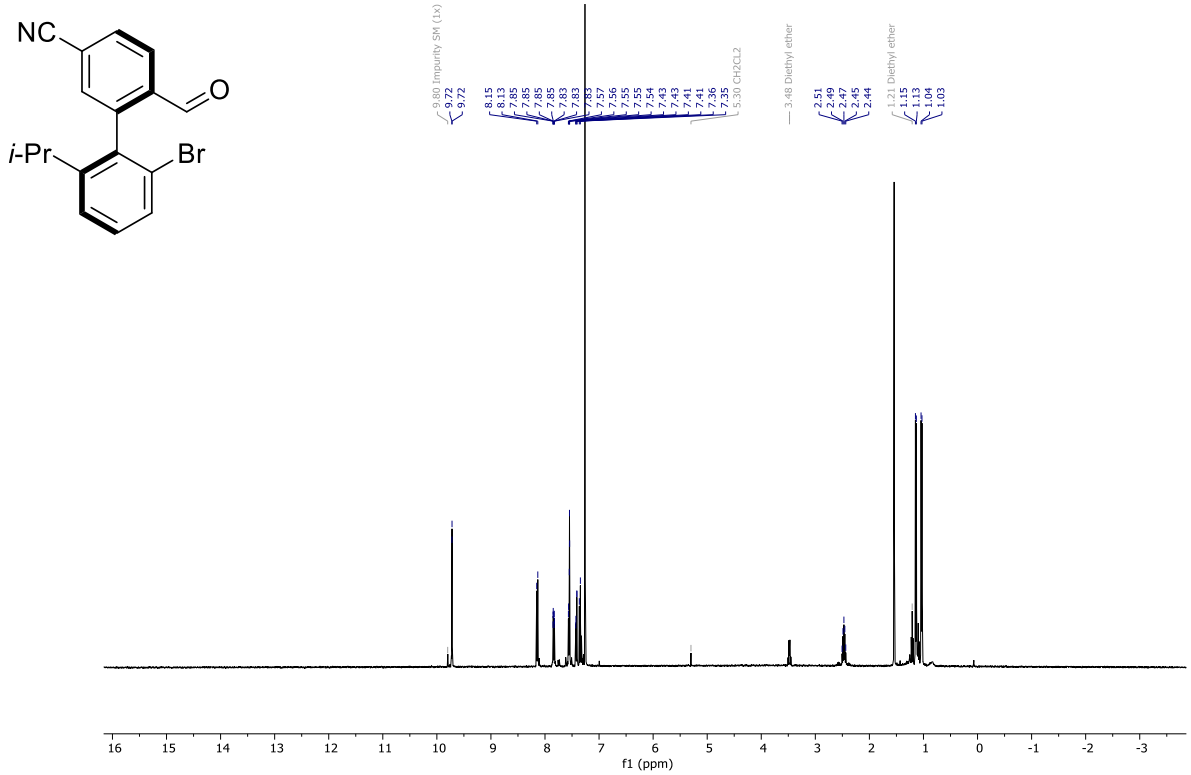



$^{13}$C-{$^1$H}-NMR

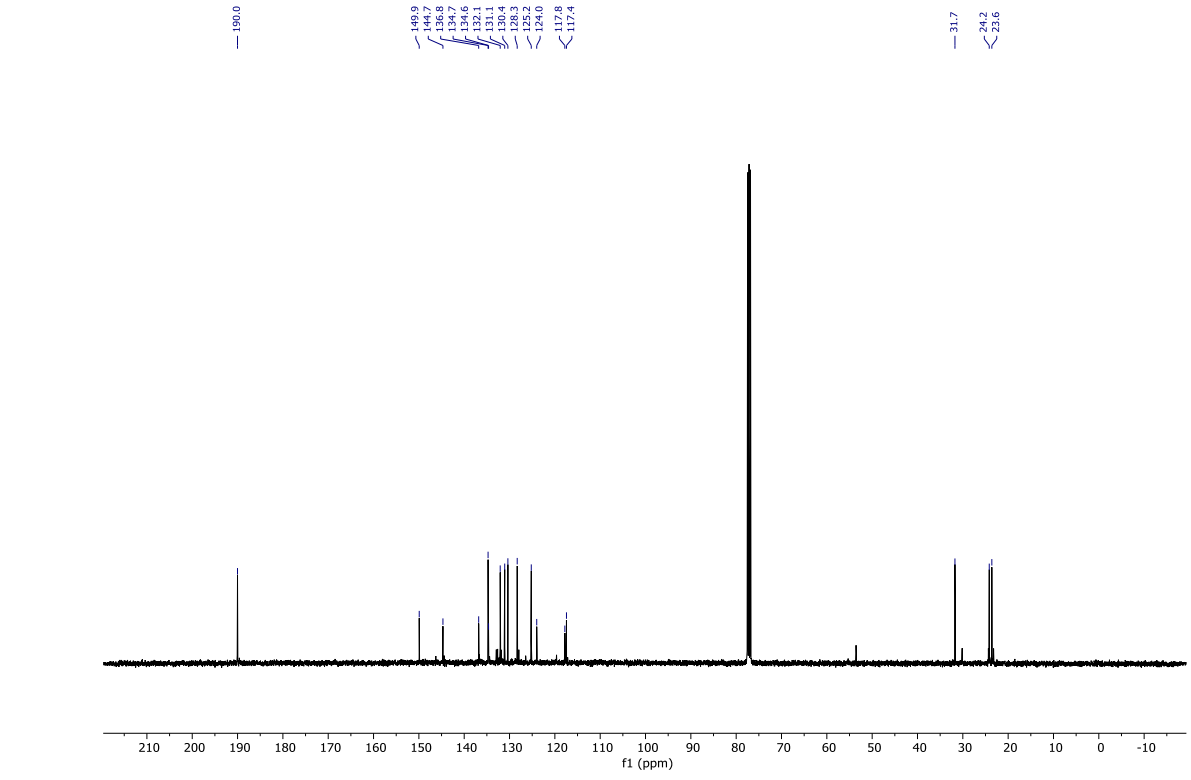


**($R_a$)-2'-Bromo-6'-*iso*-propyl-6-formyl-[1,1'-biphenyl]-3-carbonitrile (4x).**

$^1$H-NMR

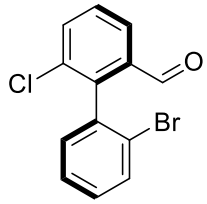


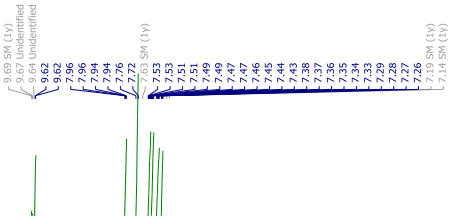

$^{13}$C-{$^1$H}-NMR

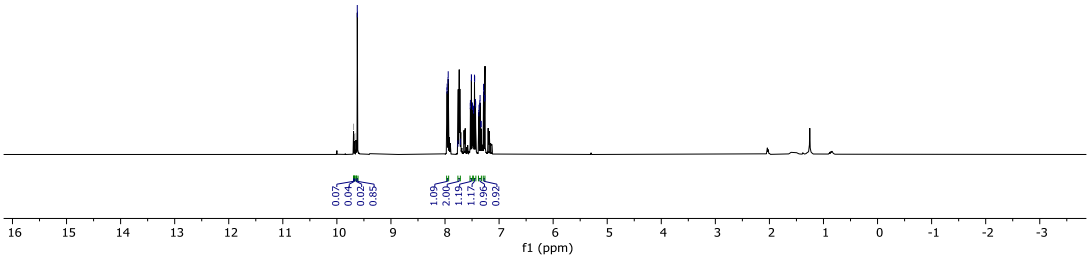


**($S_a$)-2'-Bromo-6-chloro-[1,1'-biphenyl]-2-carbaldehyde (4y).**

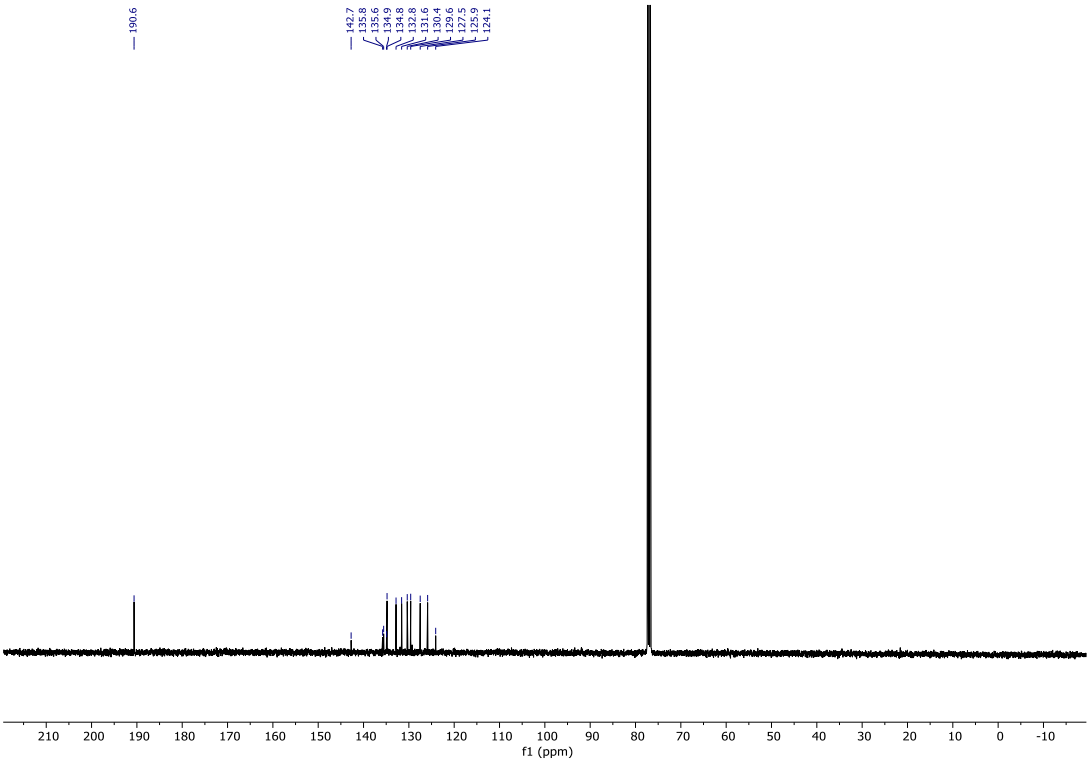
$^1$H-NMR



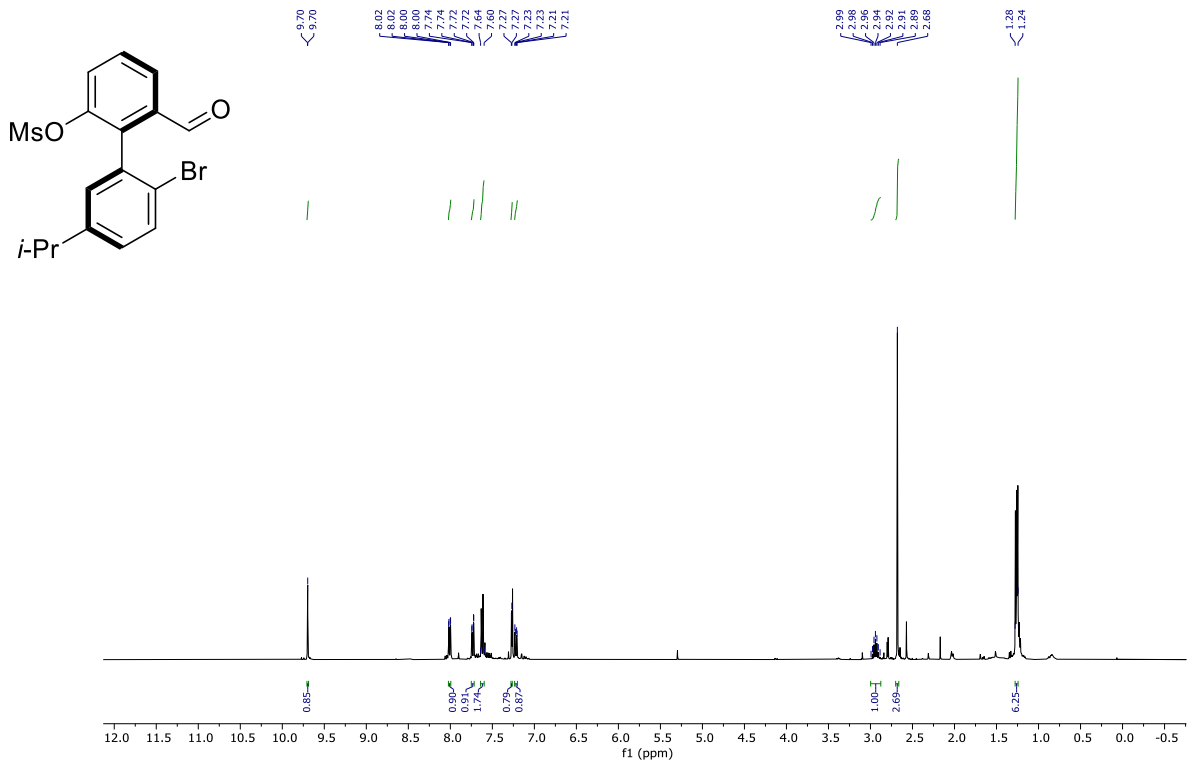




$^{13}$C-{$^1$H}-NMR

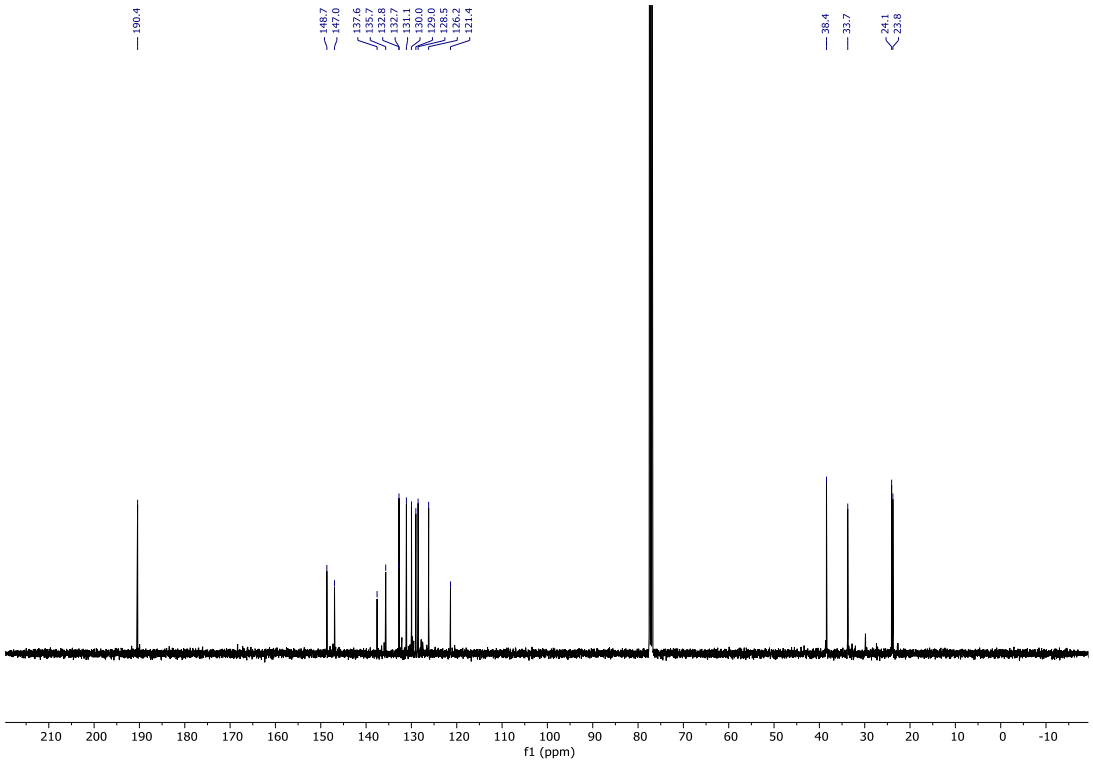


**($S_a$)-2'-Bromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (4i).**

$^1$H-NMR

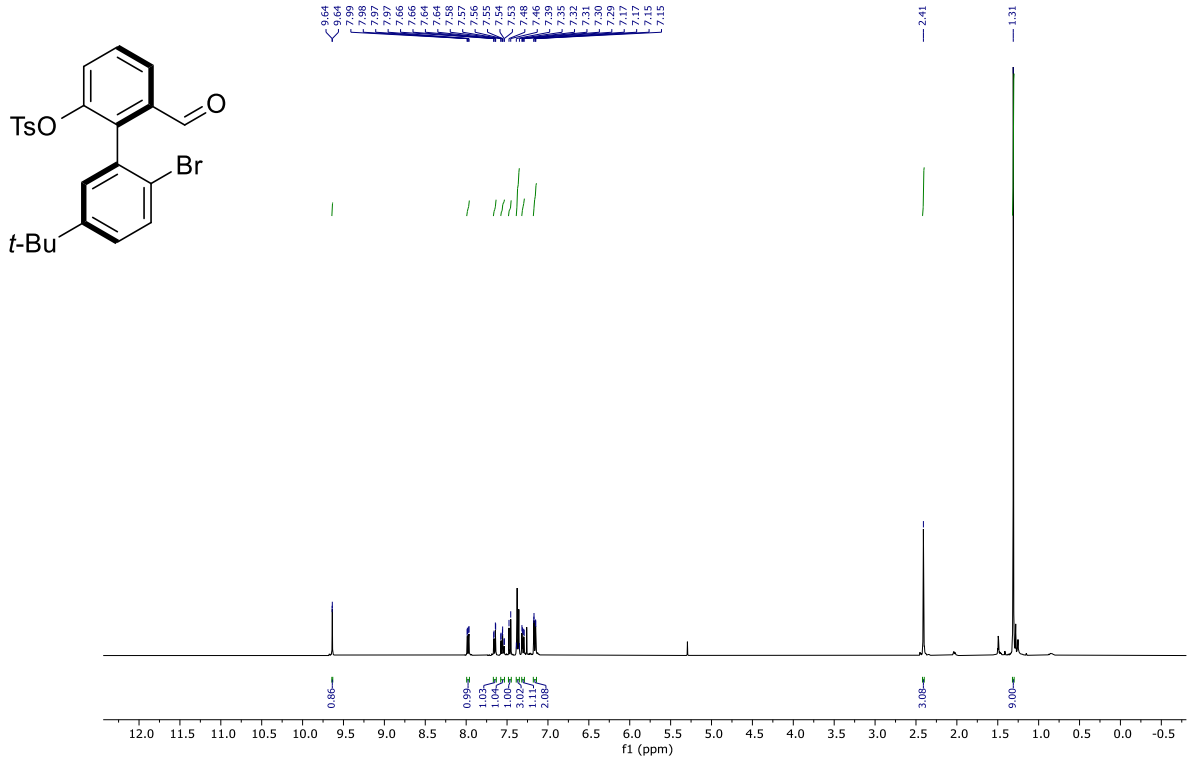



$^{13}$C-{$^1$H}-NMR

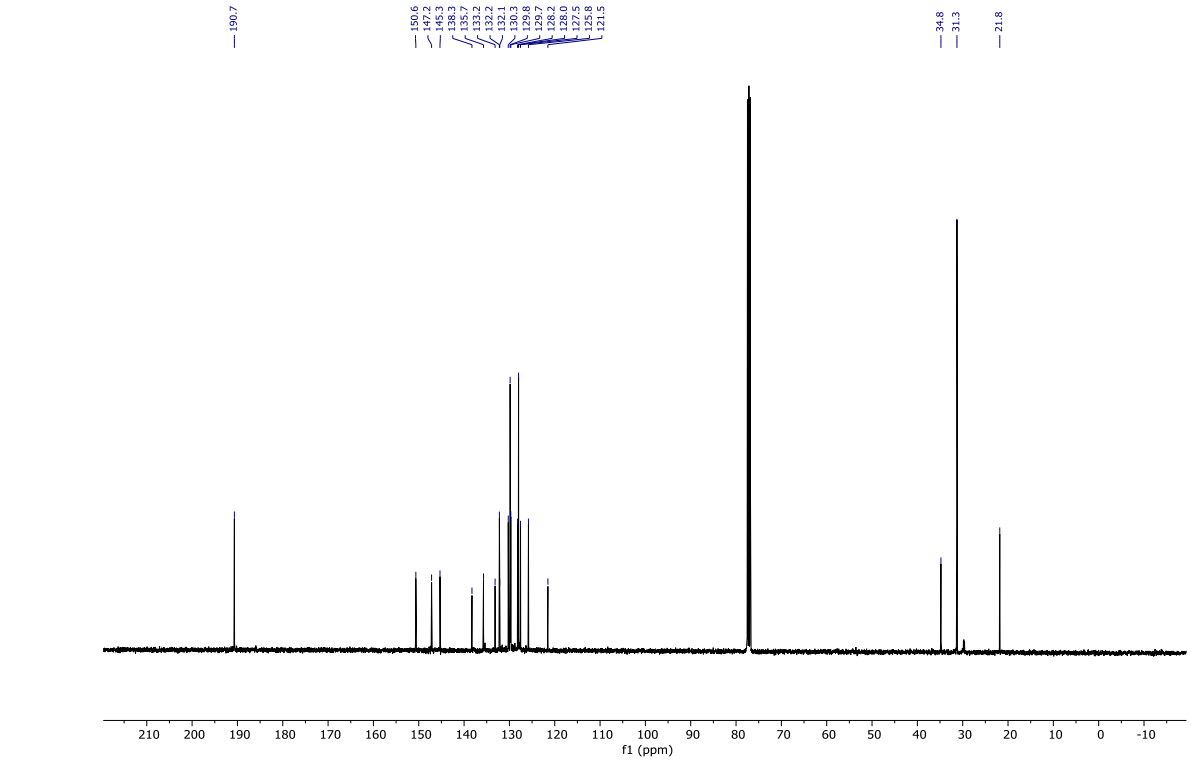


**($S_a$)-2'-Bromo-5'-(tert-butyl)-6-formyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (4z).**

$^1$H-NMR

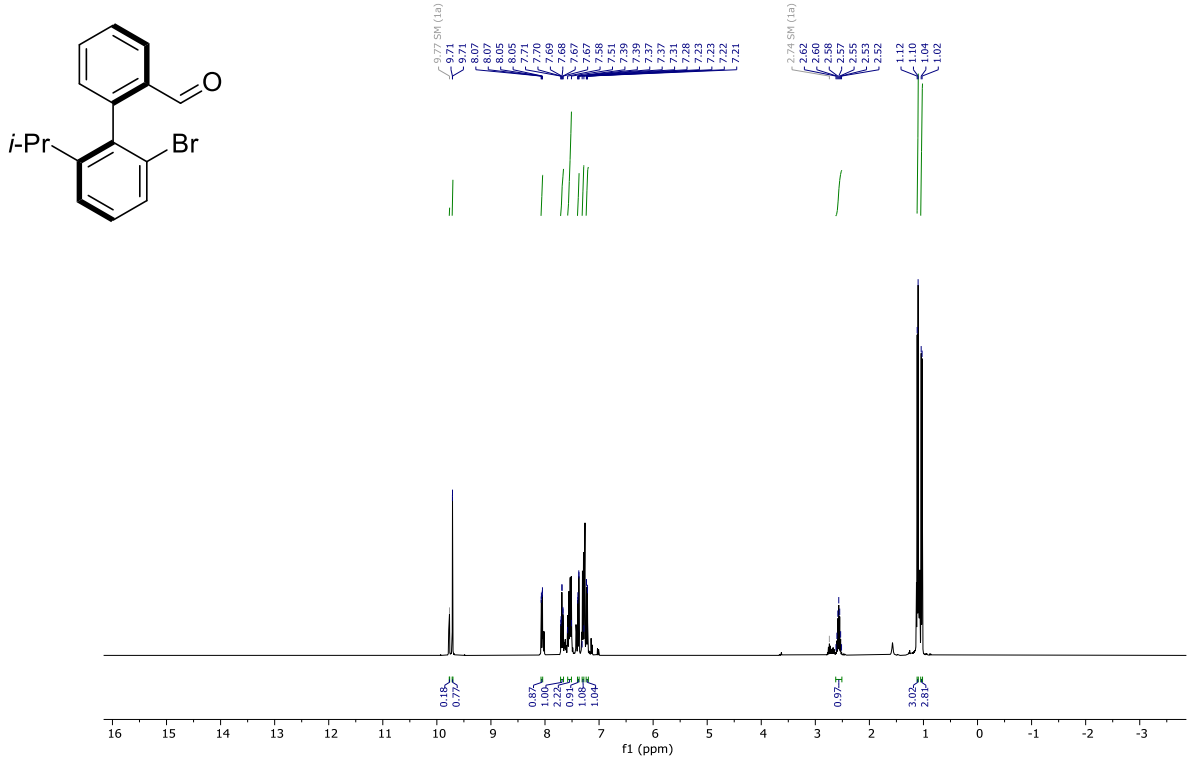



$^{13}$C-{$^1$H}-NMR

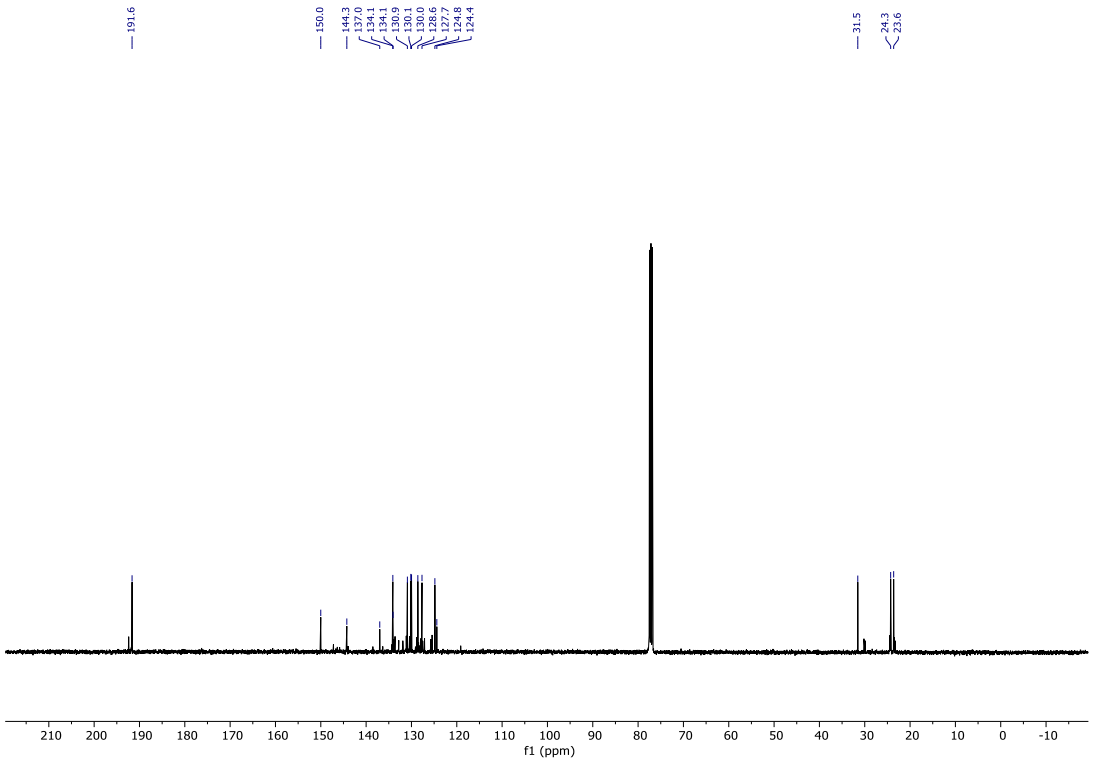


**($R_a$)-2'-Bromo-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (4a).**

$^1$H-NMR

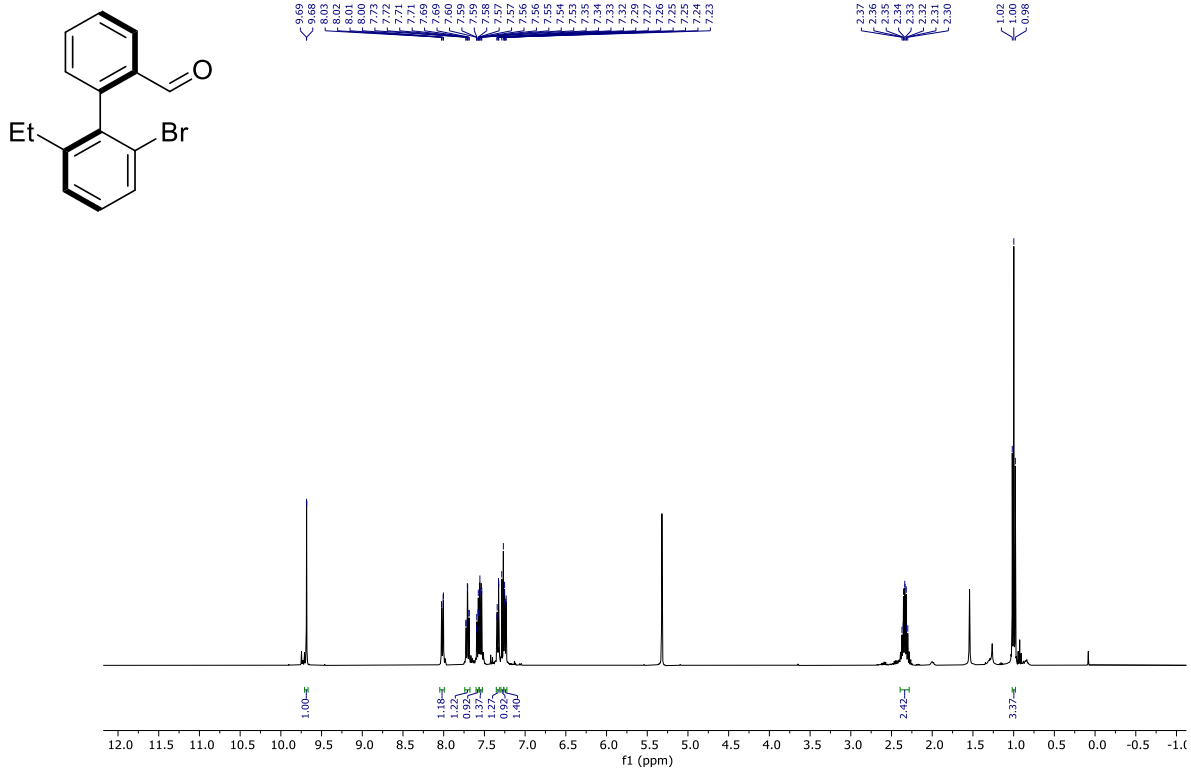



$^{13}$C-{$^1$H}-NMR

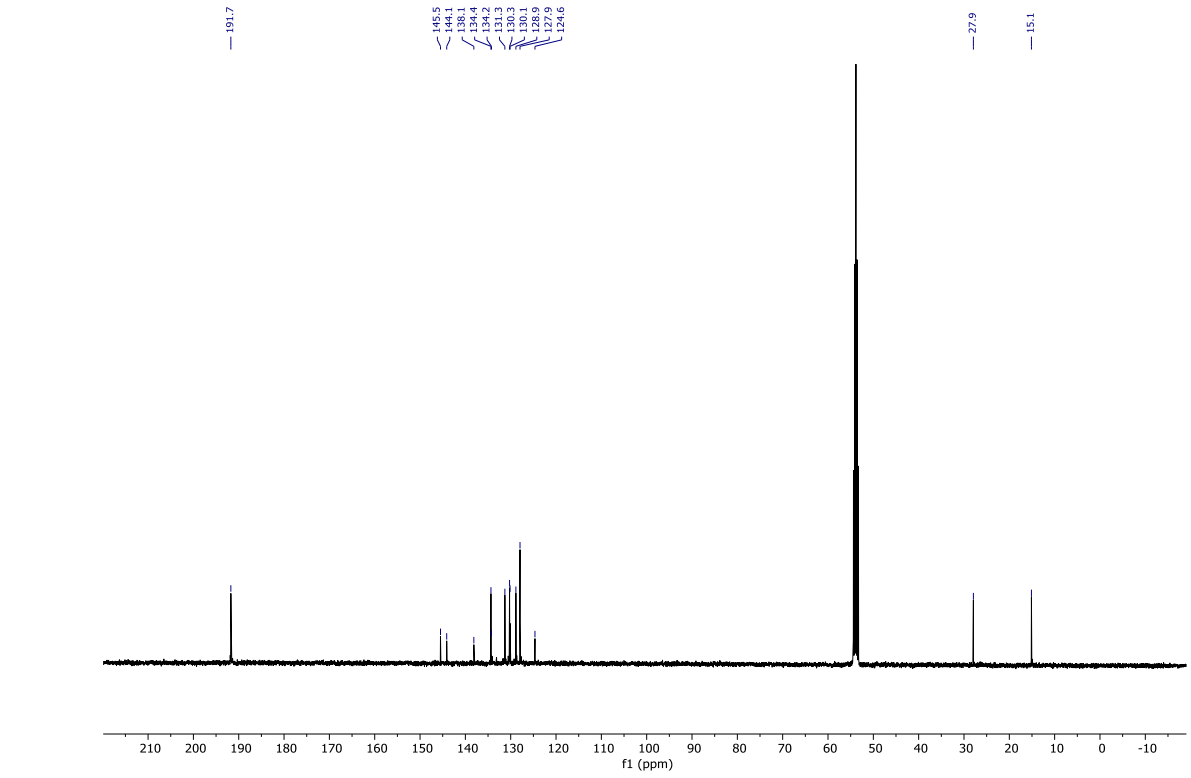


**($R_a$)-2'-Bromo-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (4b).**

$^1$H-NMR

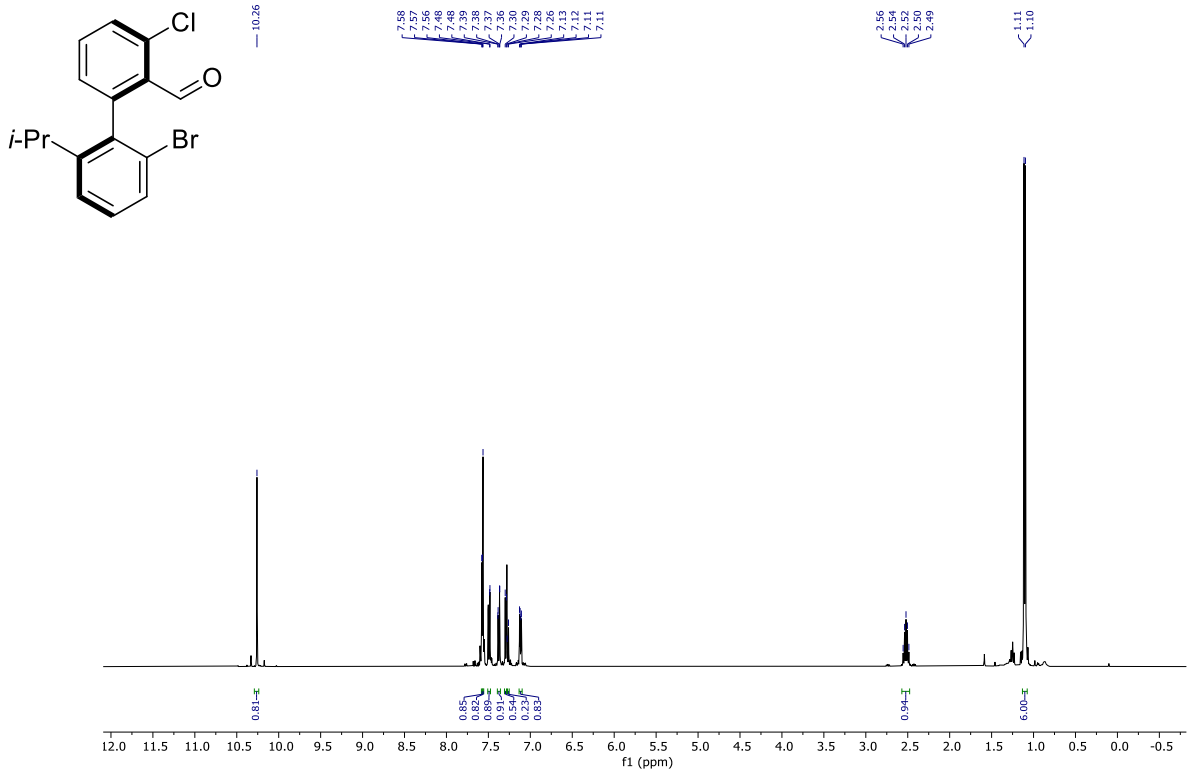



$^{13}$C-{$^1$H}-NMR

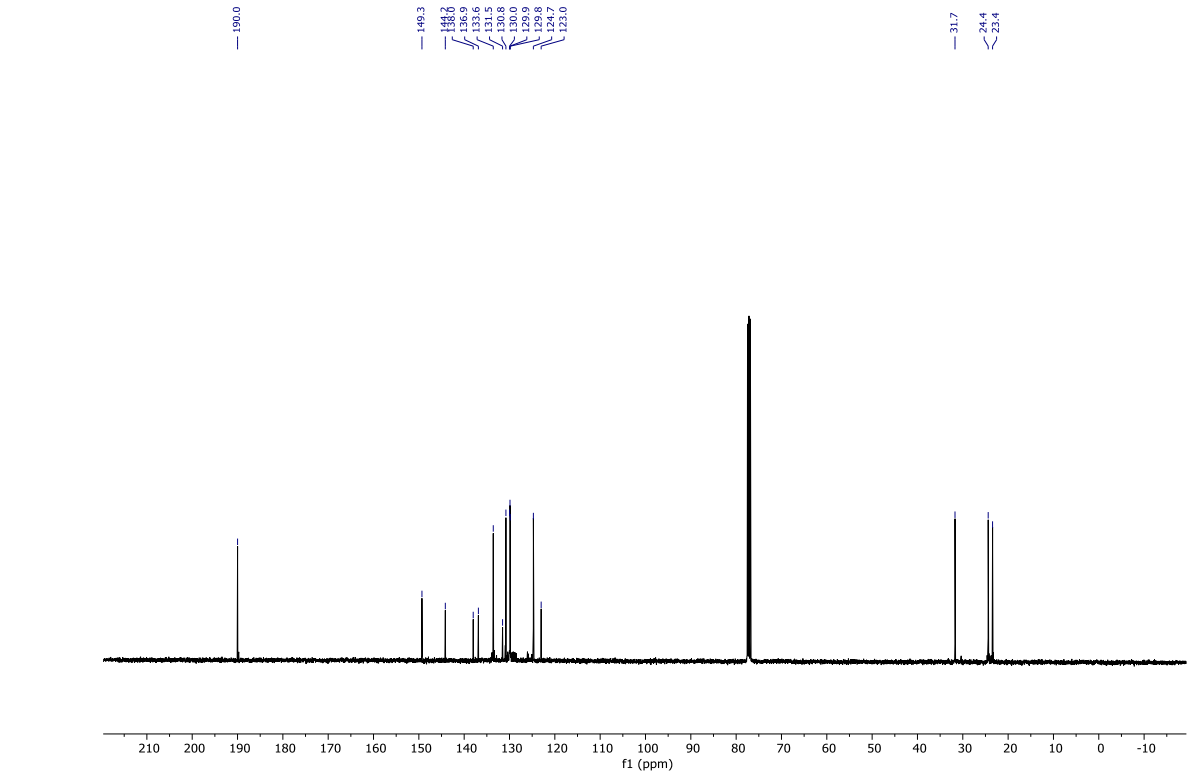


**($R_a$)-2'-Bromo-3-chloro-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (6a).**

$^1$H-NMR

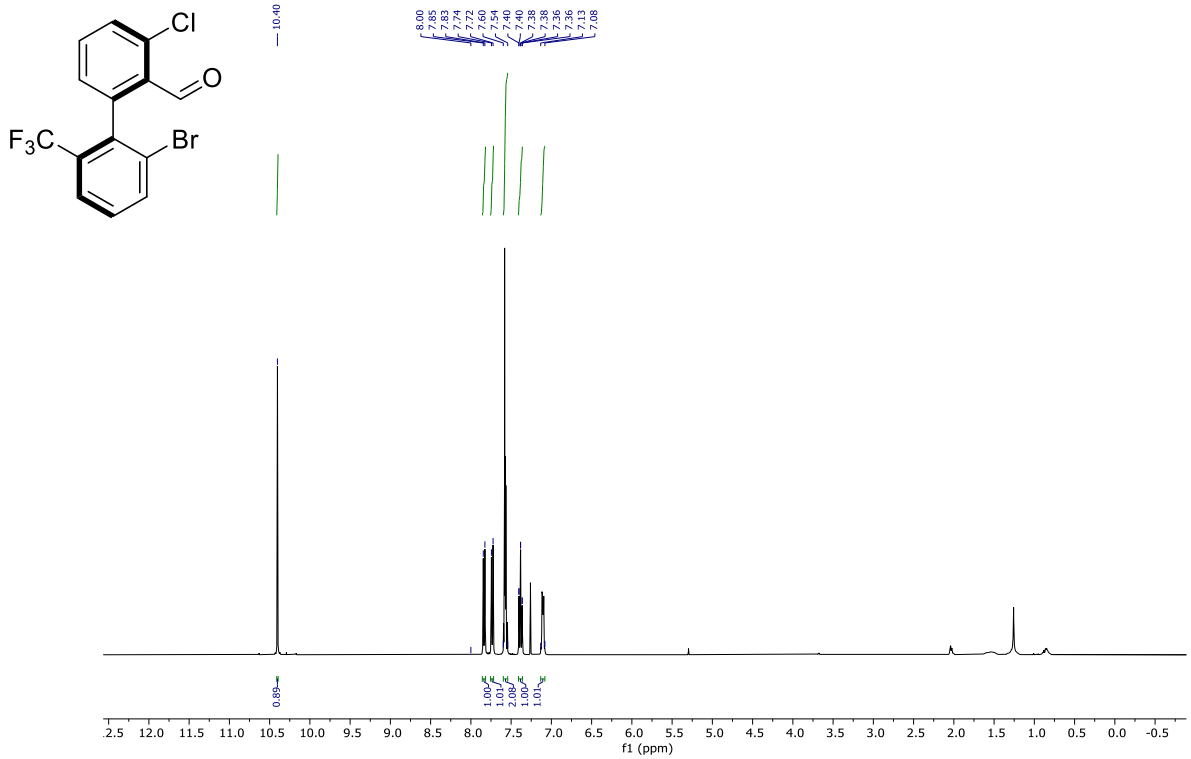



$^{13}$C-{$^1$H}-NMR

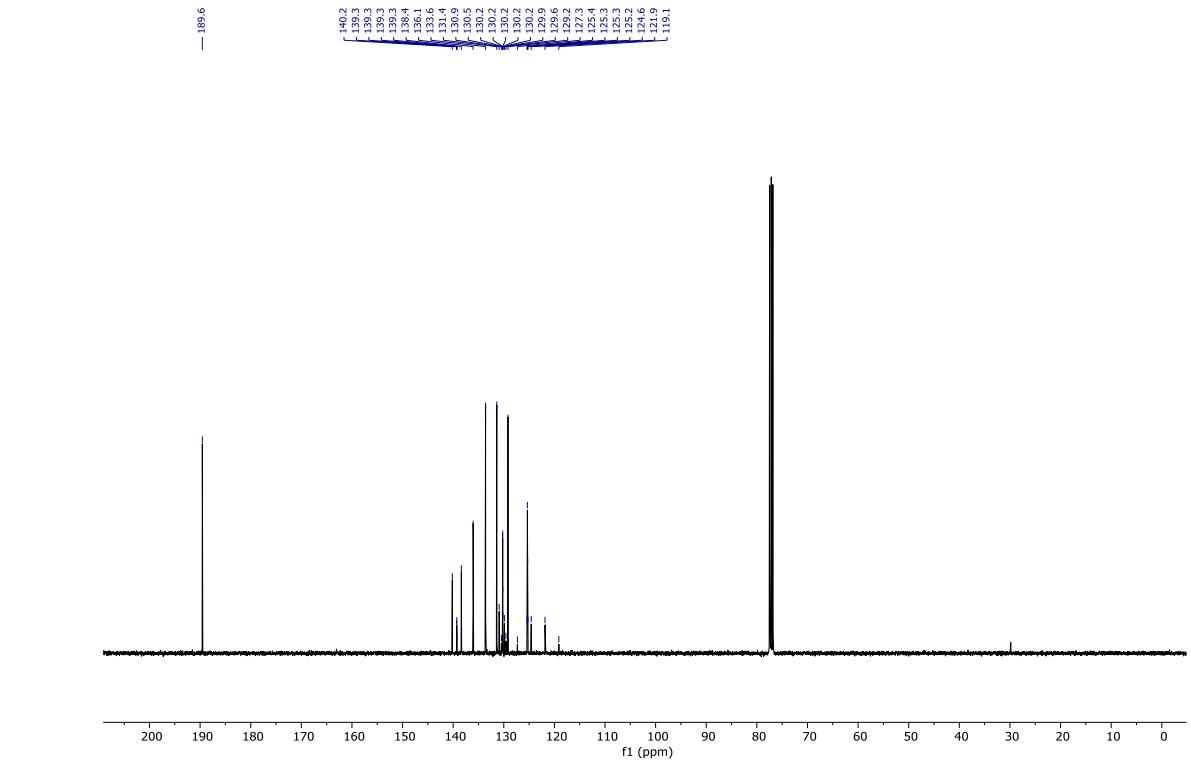


**($R_a$)-2'-Bromo-3-chloro-6'-(trifluoromethyl)-[1,1'-biphenyl]-2-carbaldehyde (6e).**

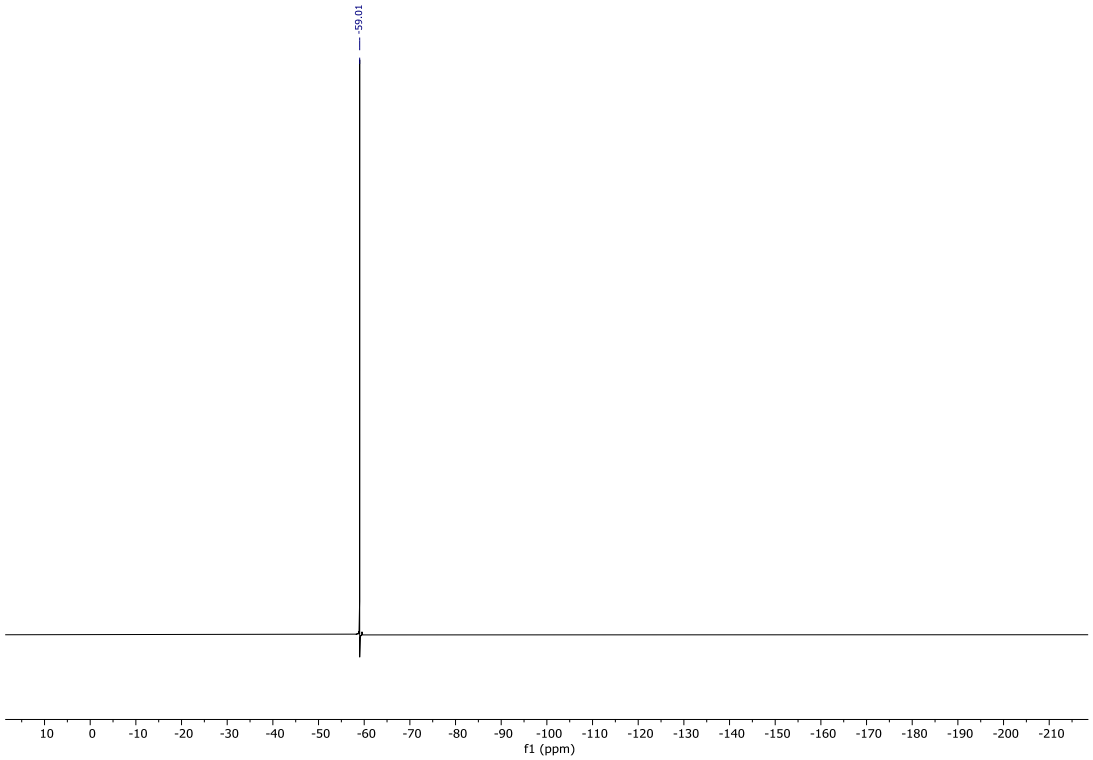
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR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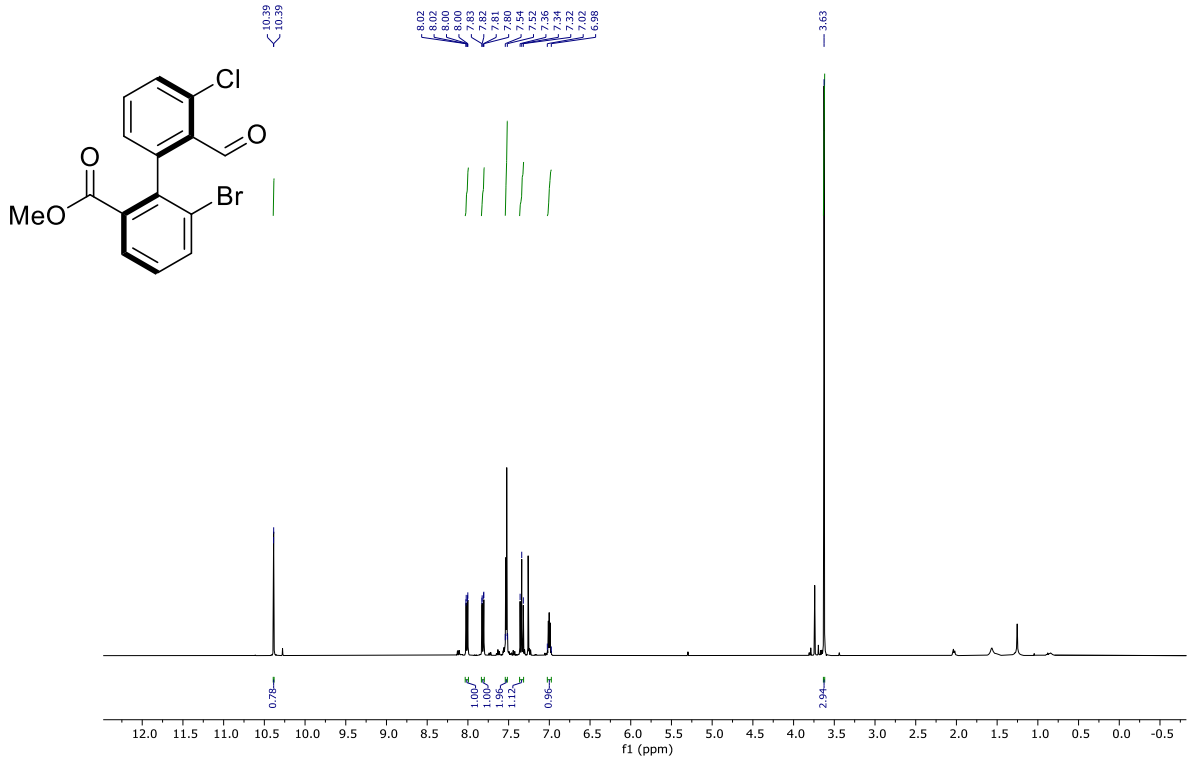
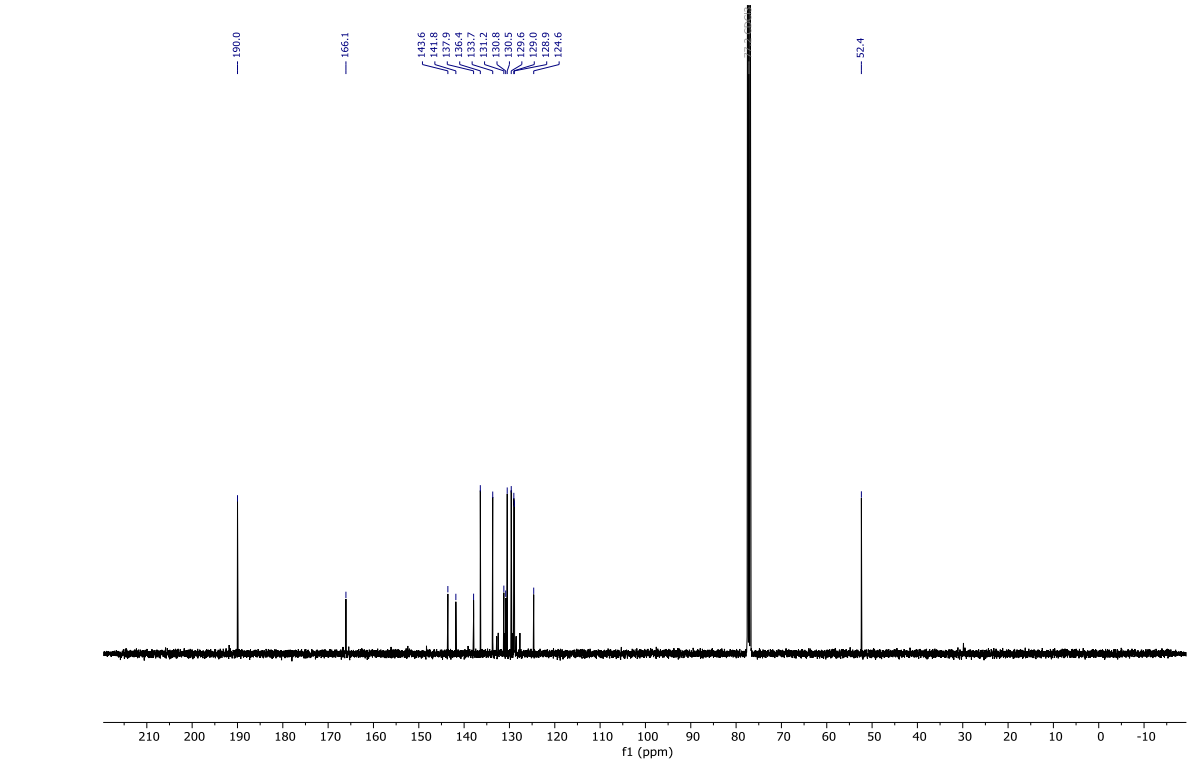
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-Methyl 6-bromo-3'-chloro-2'-formyl-[1,1'-biphenyl]-2-carboxylate (6f).**

$^1$H-NMR

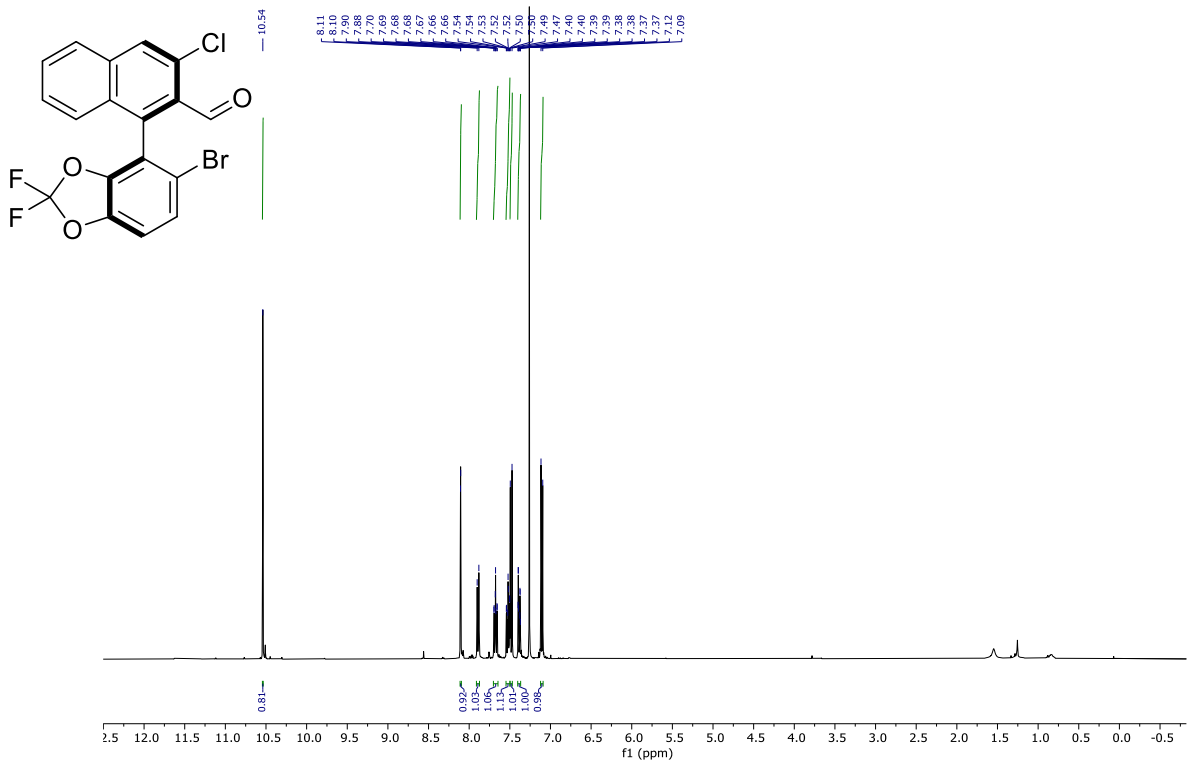



$^{13}$C-{$^1$H}-NMR

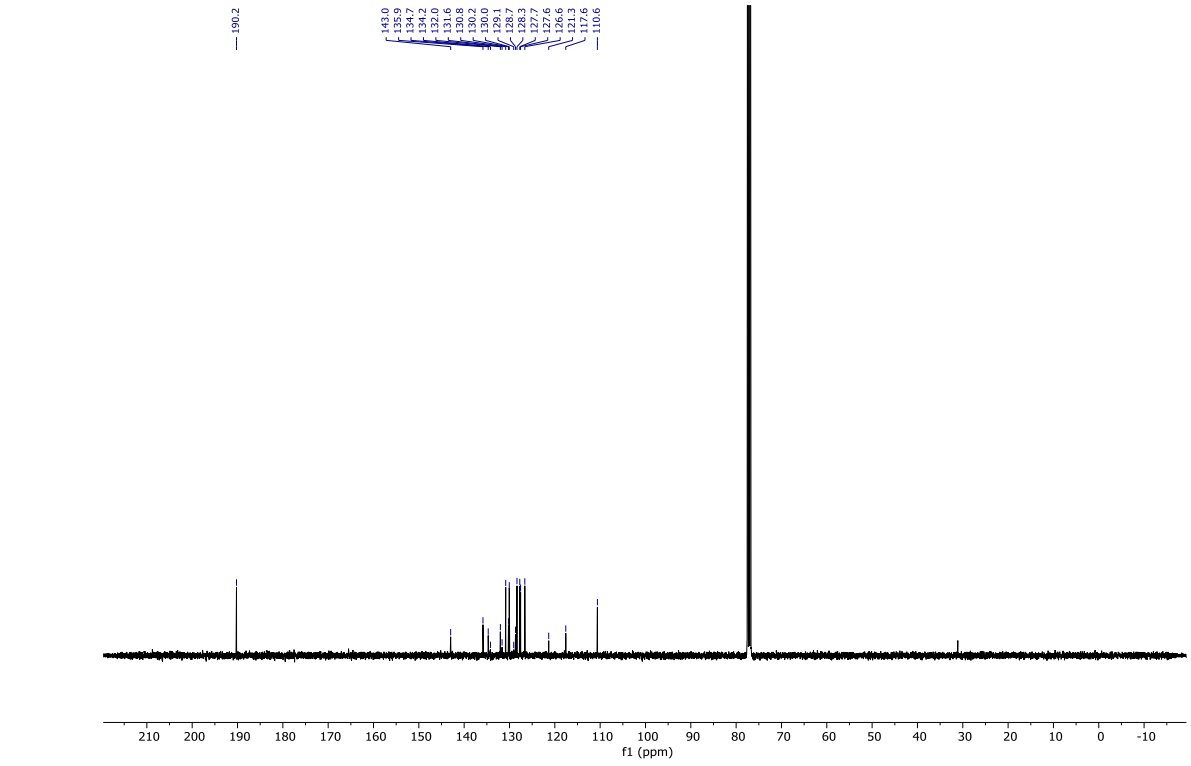


**($R_a$)-1-(5-Bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-3-chloro-2-naphthaldehyde (6p).**

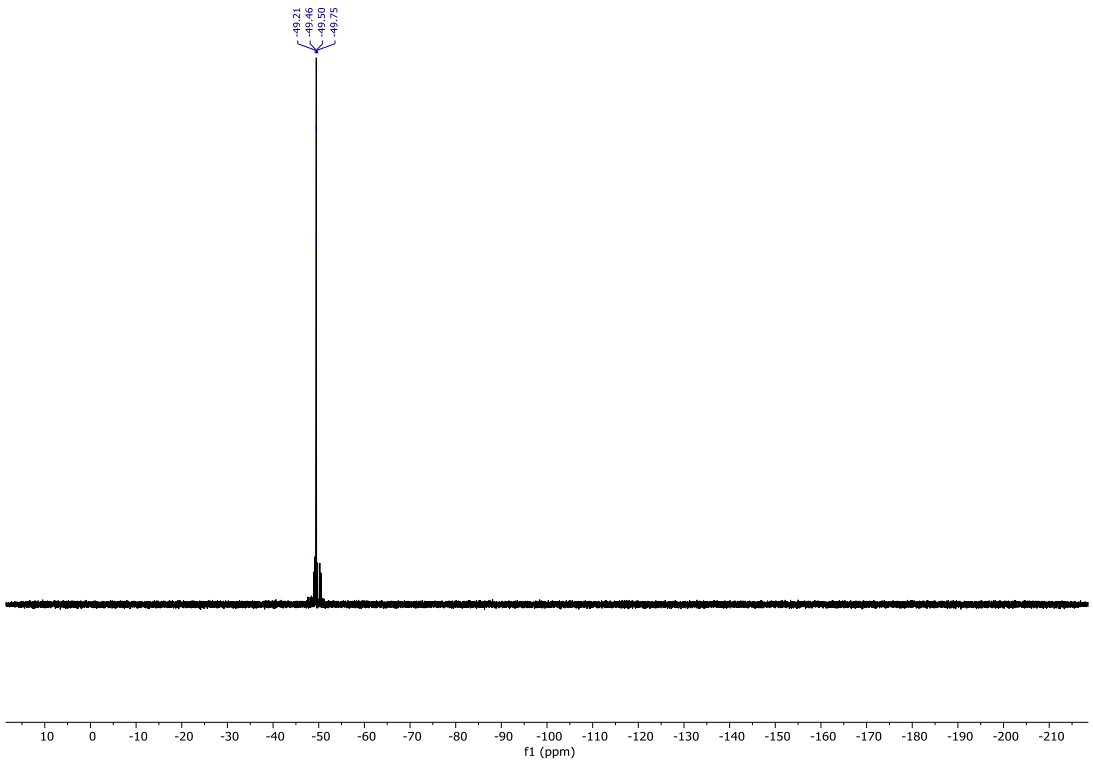
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

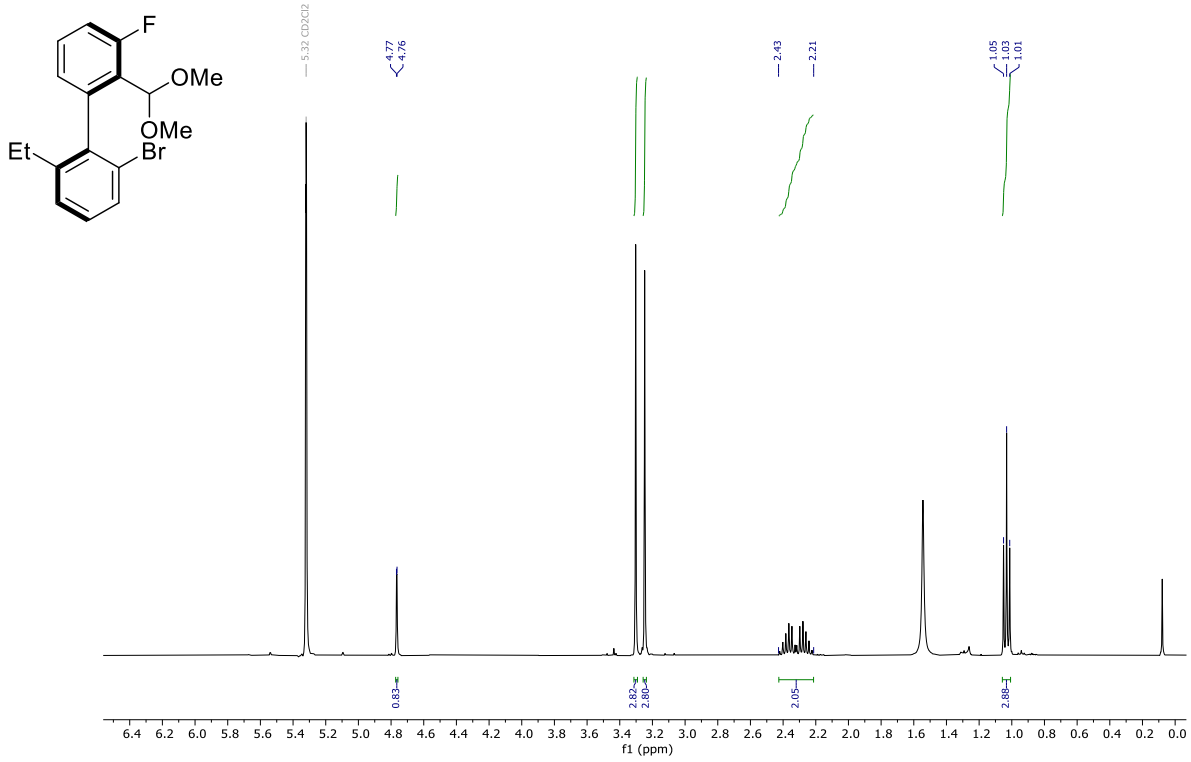


$^{19}F$-{$^{1}H$}-NMR

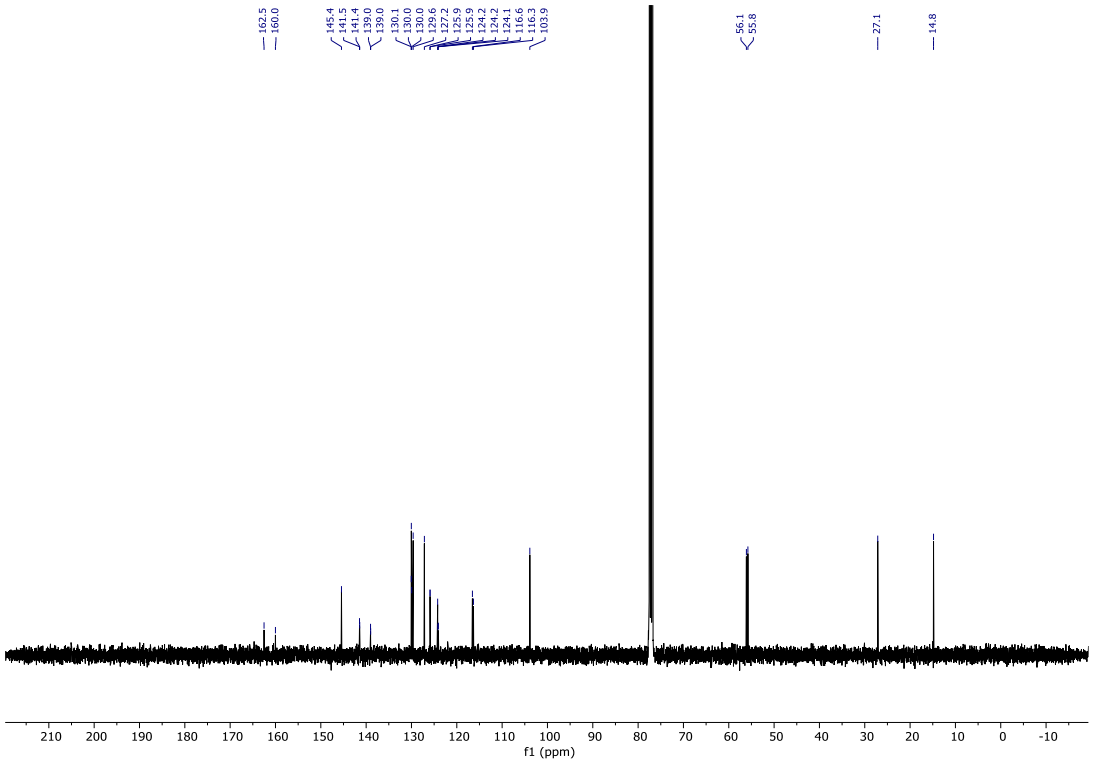

-49.21
-49.46
-49.50
-49.75
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-2'-Bromo-2-(dimethoxymethyl)-6'-ethyl-3-fluoro-1,1'-biphenyl (4s').**

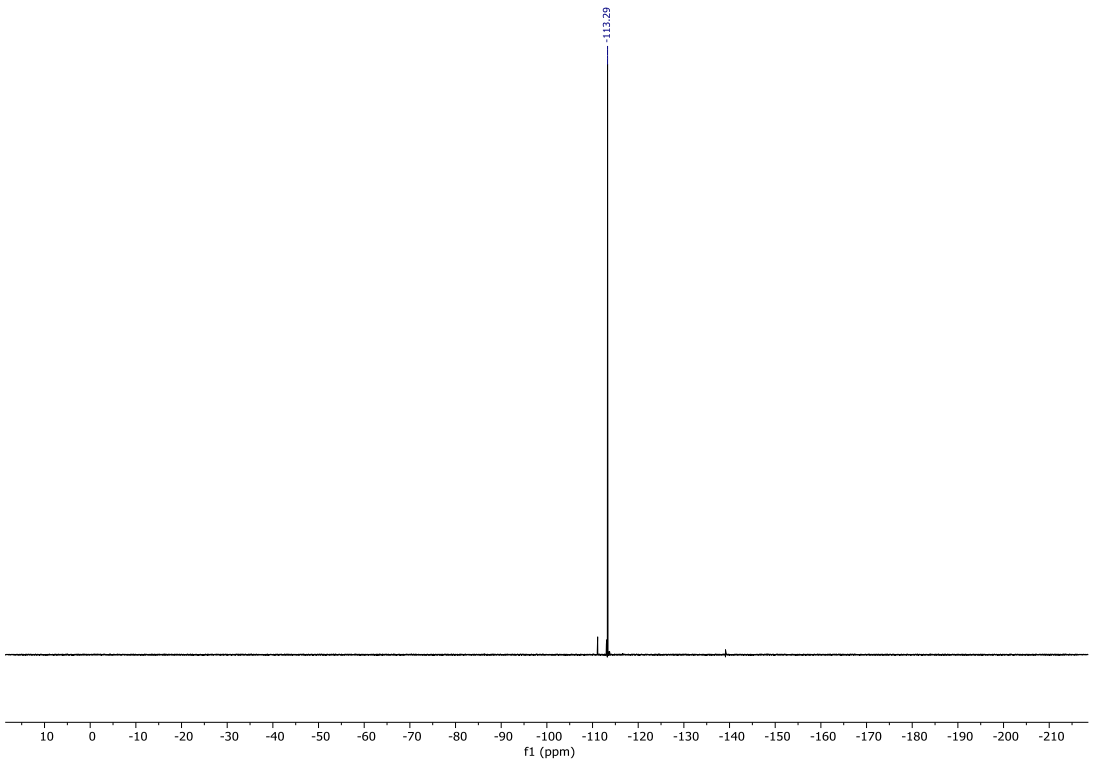
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

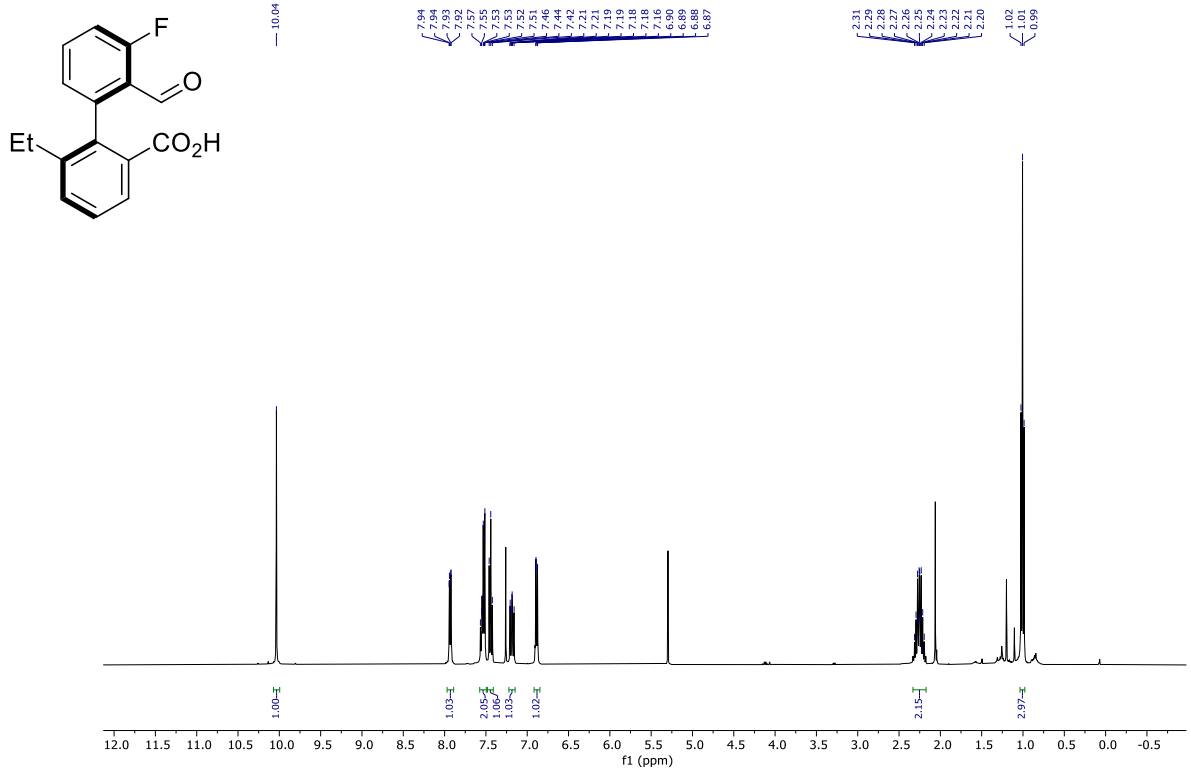


$^{19}F$-{$^{1}H$}-NMR

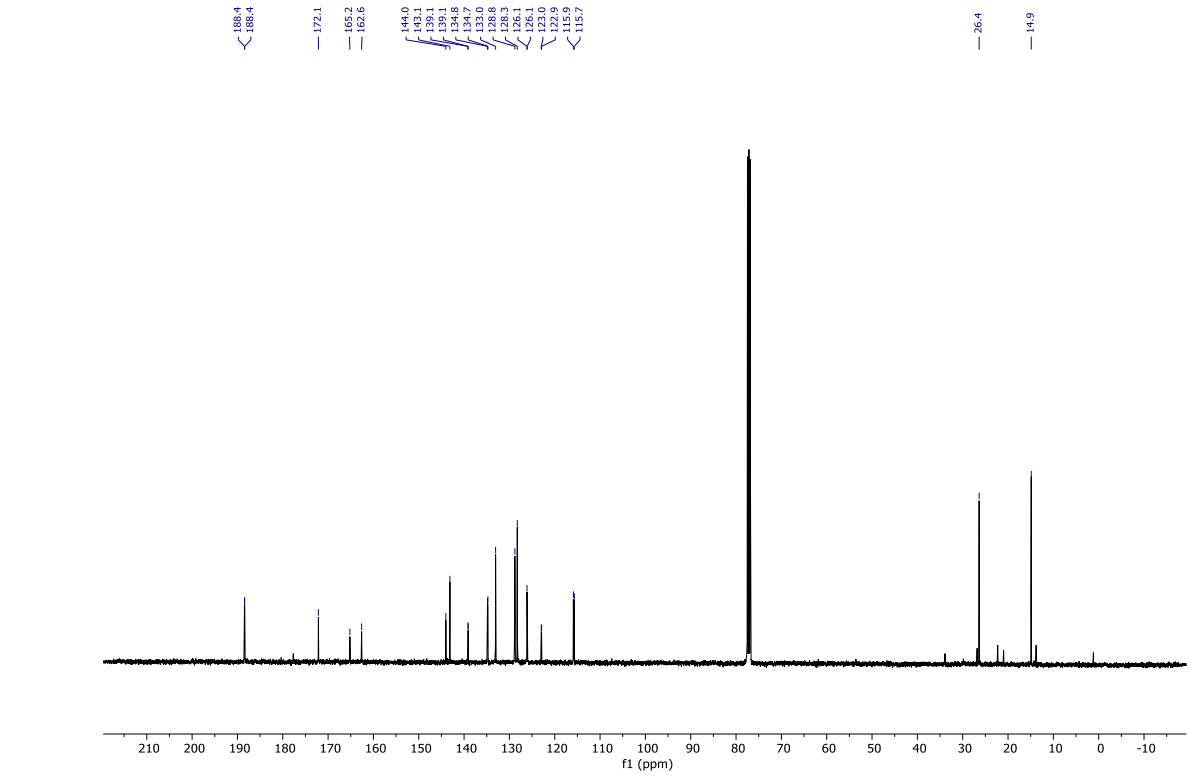

-113.29
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-6-Ethyl-3'-fluoro-2'-formyl-[1,1'-biphenyl]-2-carboxylic acid (5sa).**

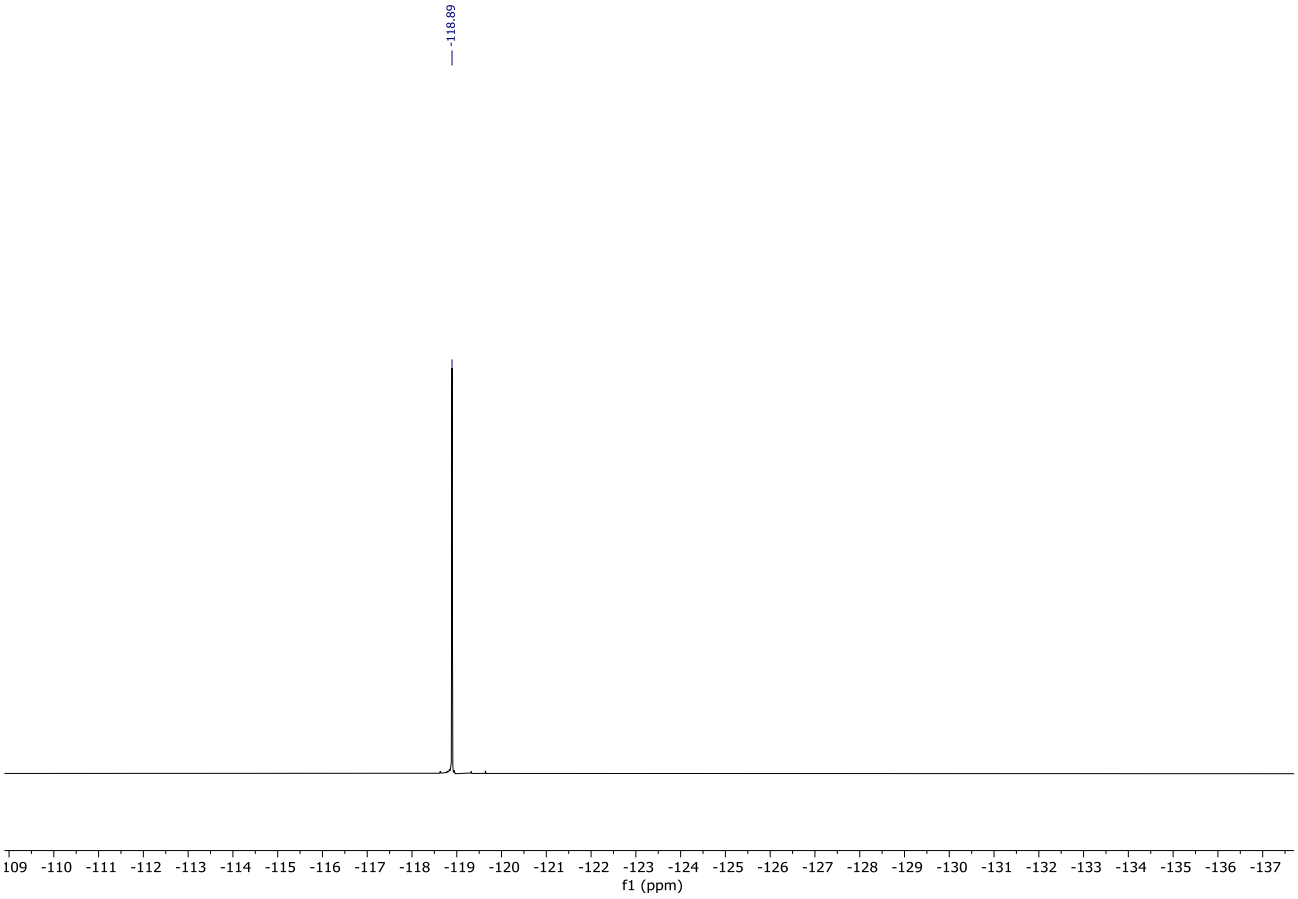
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

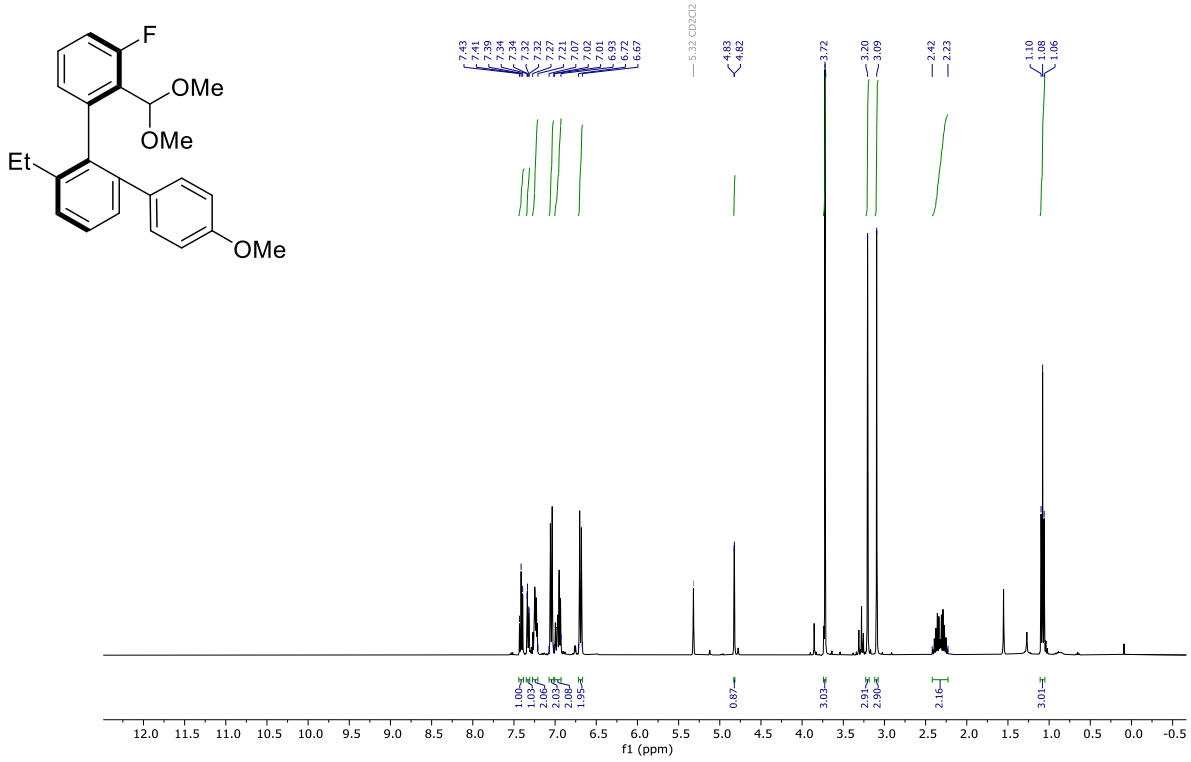


$^{19}F$-{$^{1}H$}-NMR

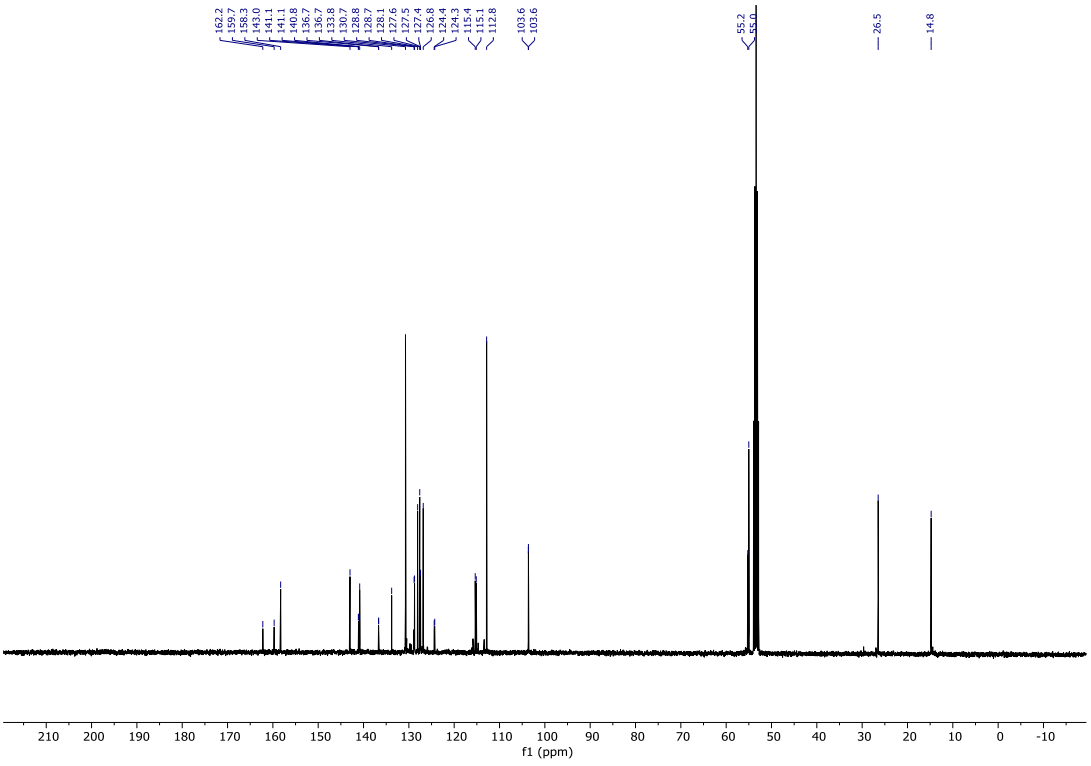

-118.89
109 -110 -111 -112 -113 -114 -115 -116 -117 -118 -119 -120 -121 -122 -123 -124 -125 -126 -127 -128 -129 -130 -131 -132 -133 -134 -135 -136 -137
f1 (ppm)

**($R_a$)-2-(Dimethoxymethyl)-6'-ethyl-3-fluoro-4''-methoxy-1,1':2',1''-terphenyl (5sb).**

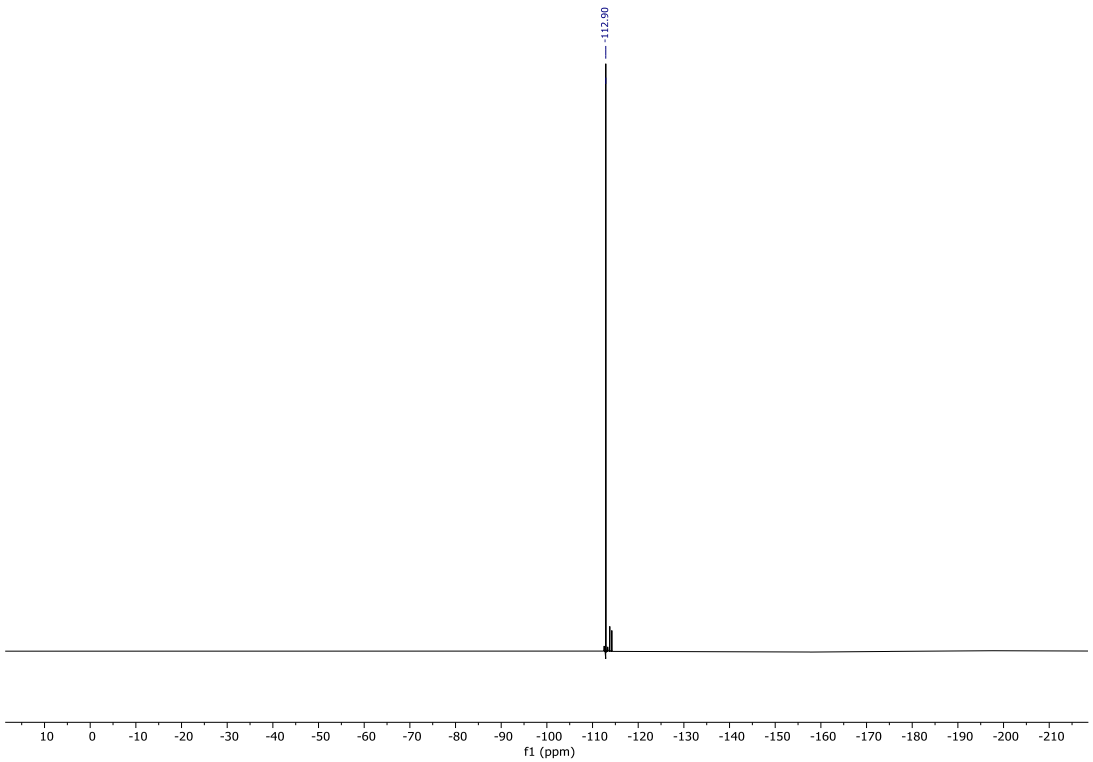
$^{1}$H-NMR




$^{13}$C-{$^{1}$H}-NMR

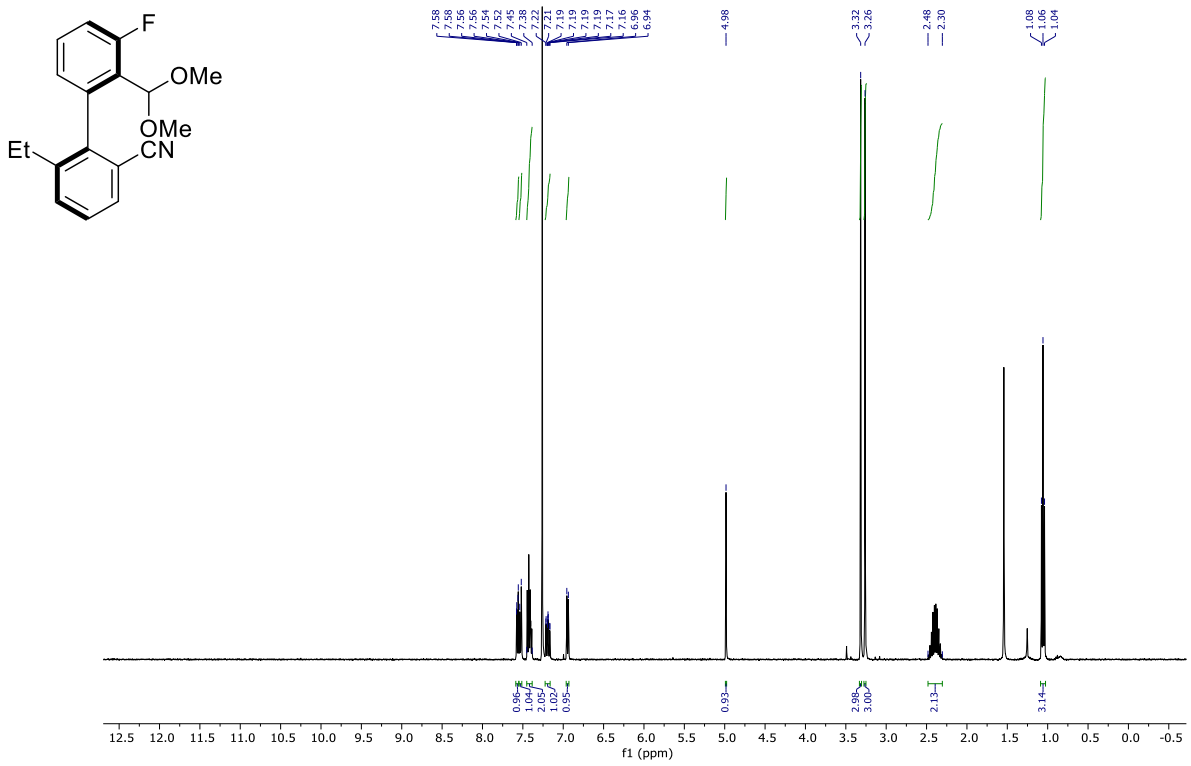


$^{19}F$-{$^{1}H$}-NMR

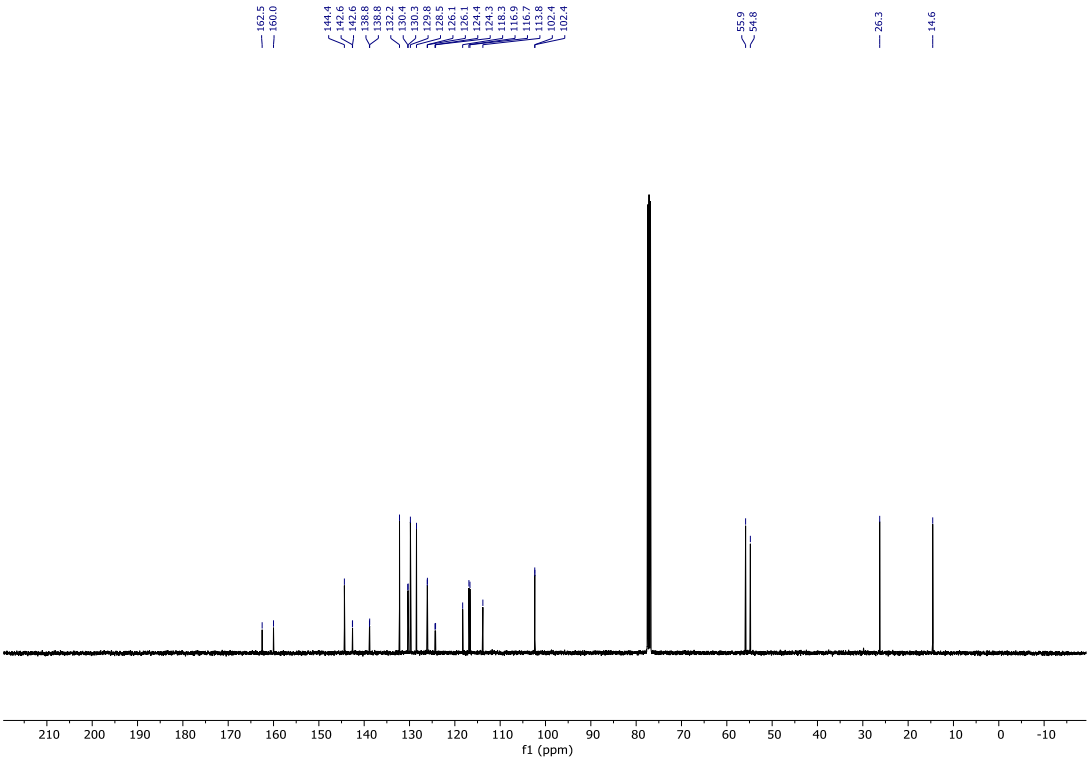

-112.90
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-2'-(Dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-carbonitrile (5sc).**

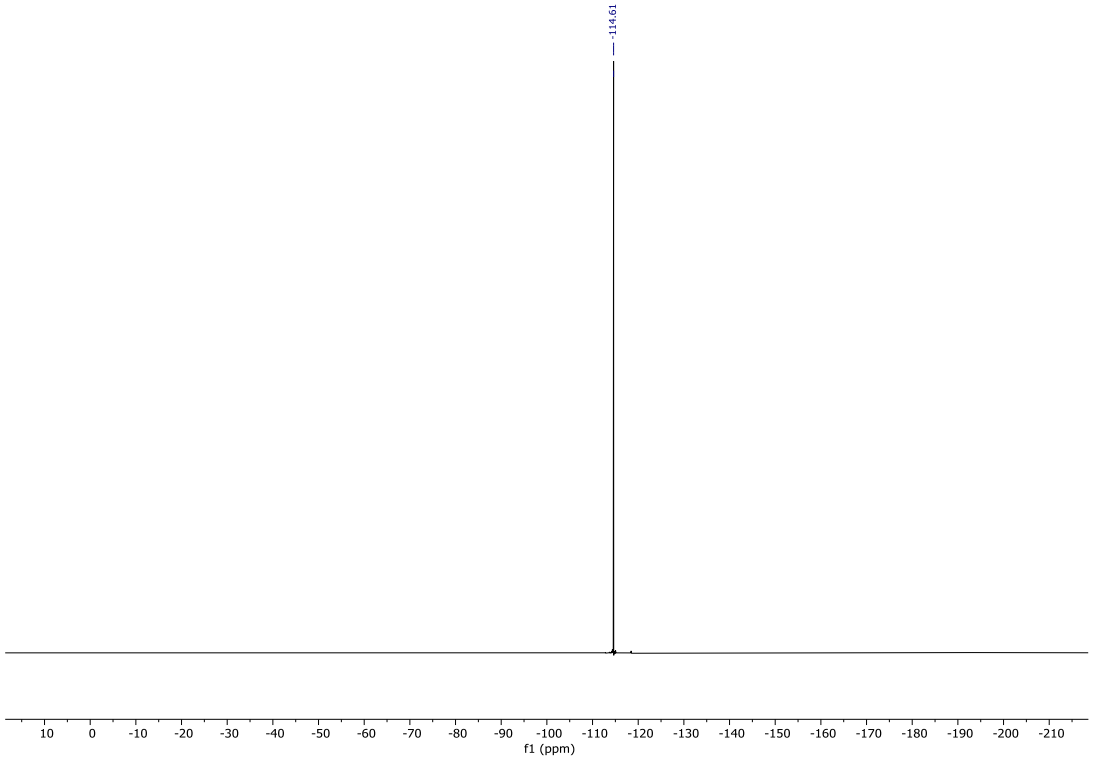
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

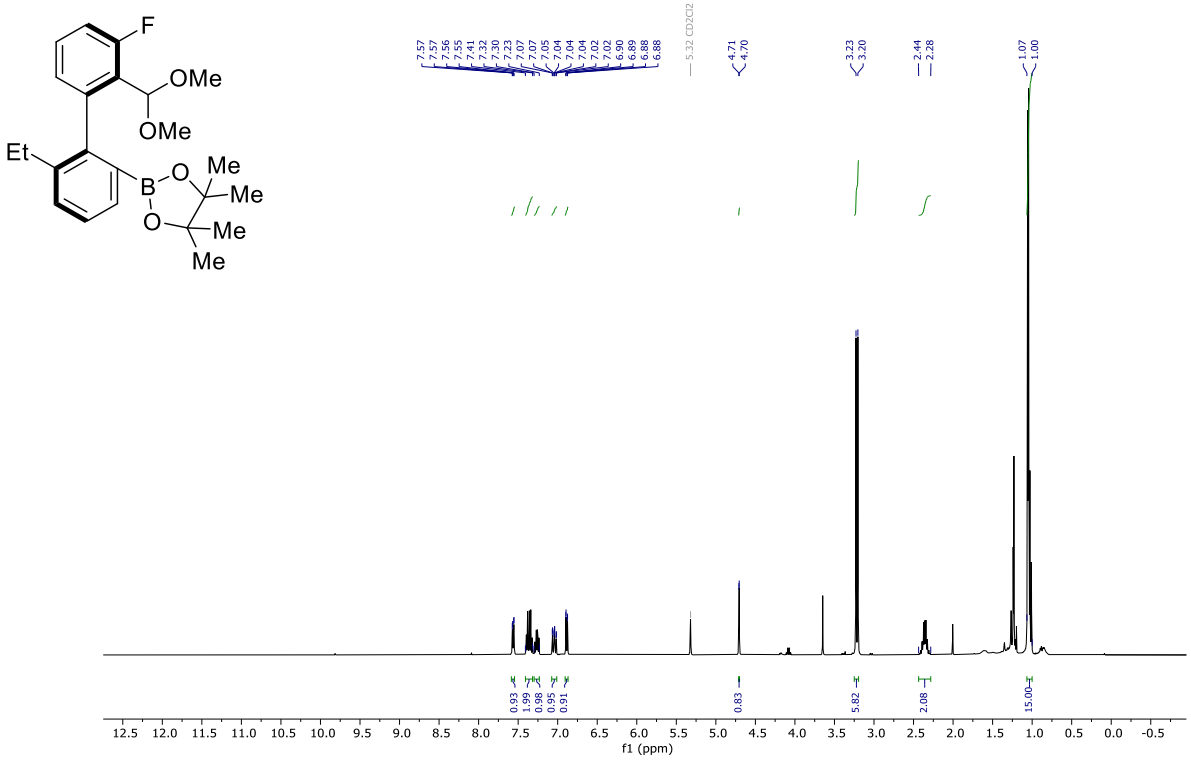


$^{19}F$-{$^{1}H$}-NMR

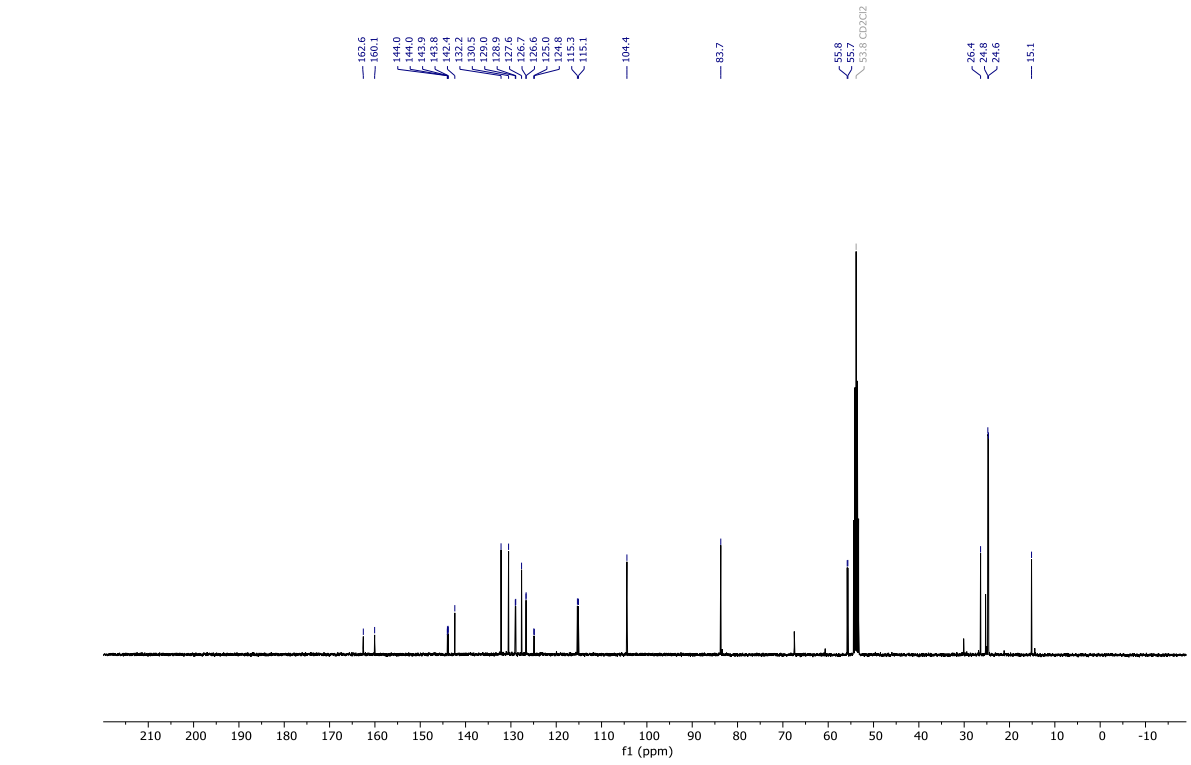

-114.61
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($S_a$)-2-(2'-(Dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (5sd).**

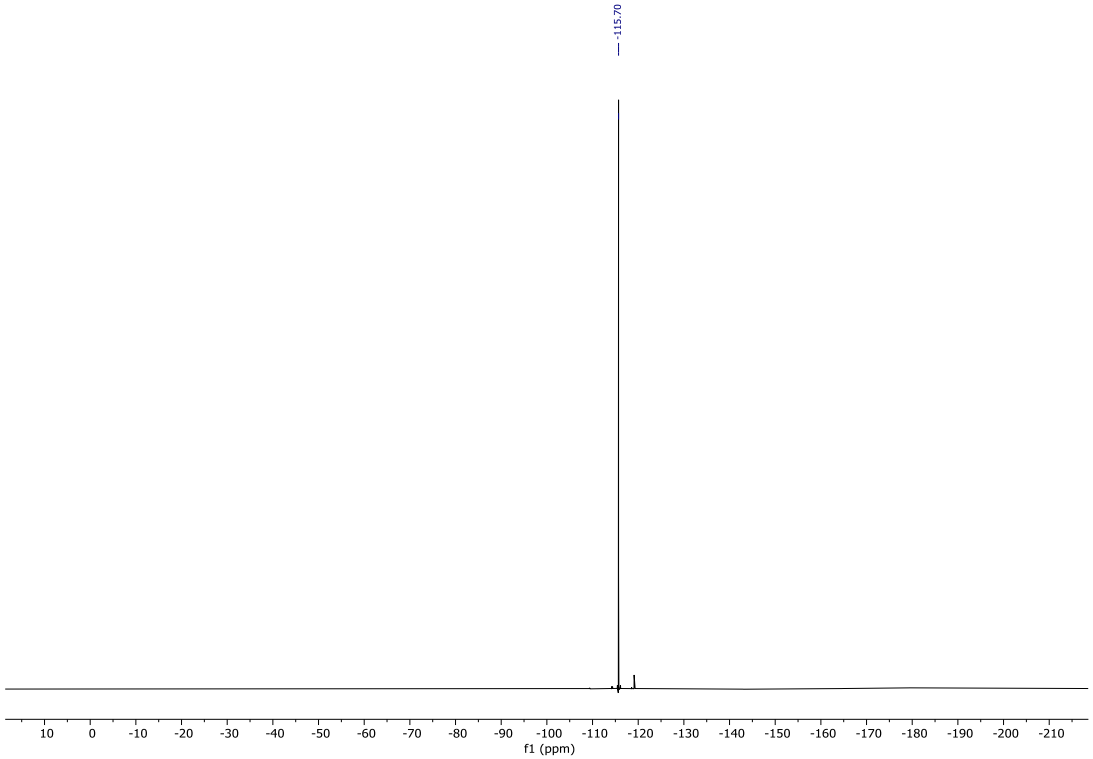
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

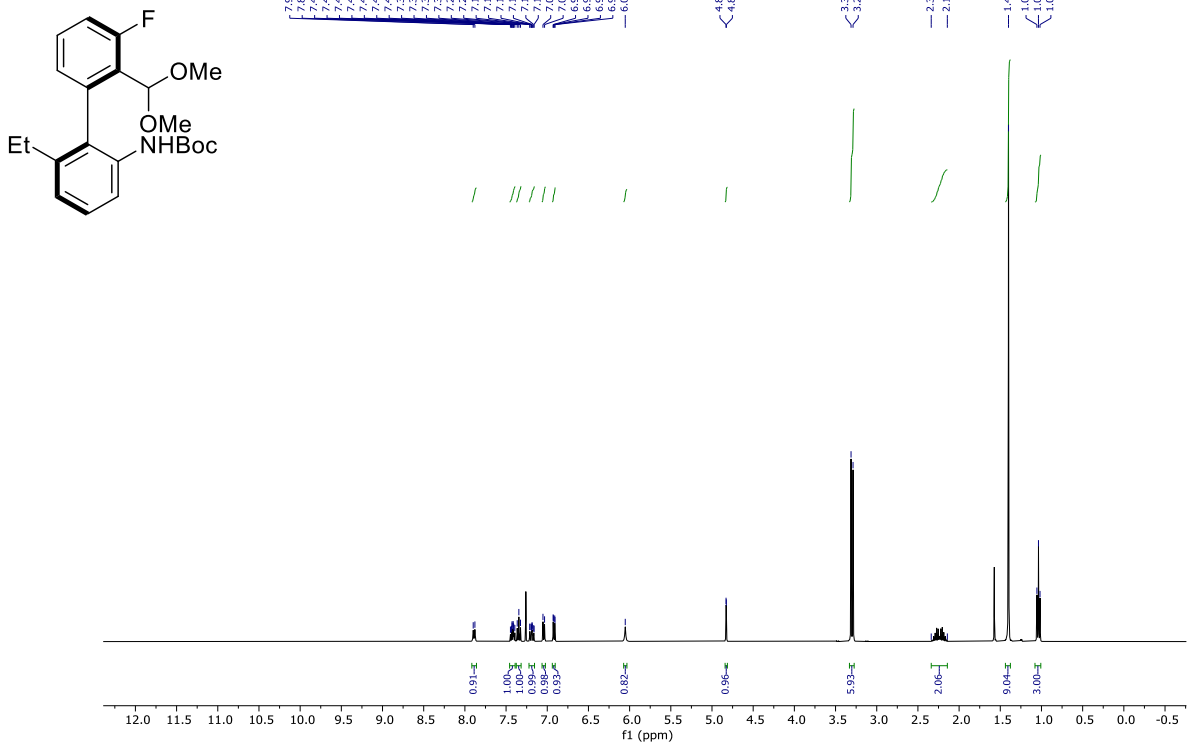


$^{19}F$-{$^{1}H$}-NMR

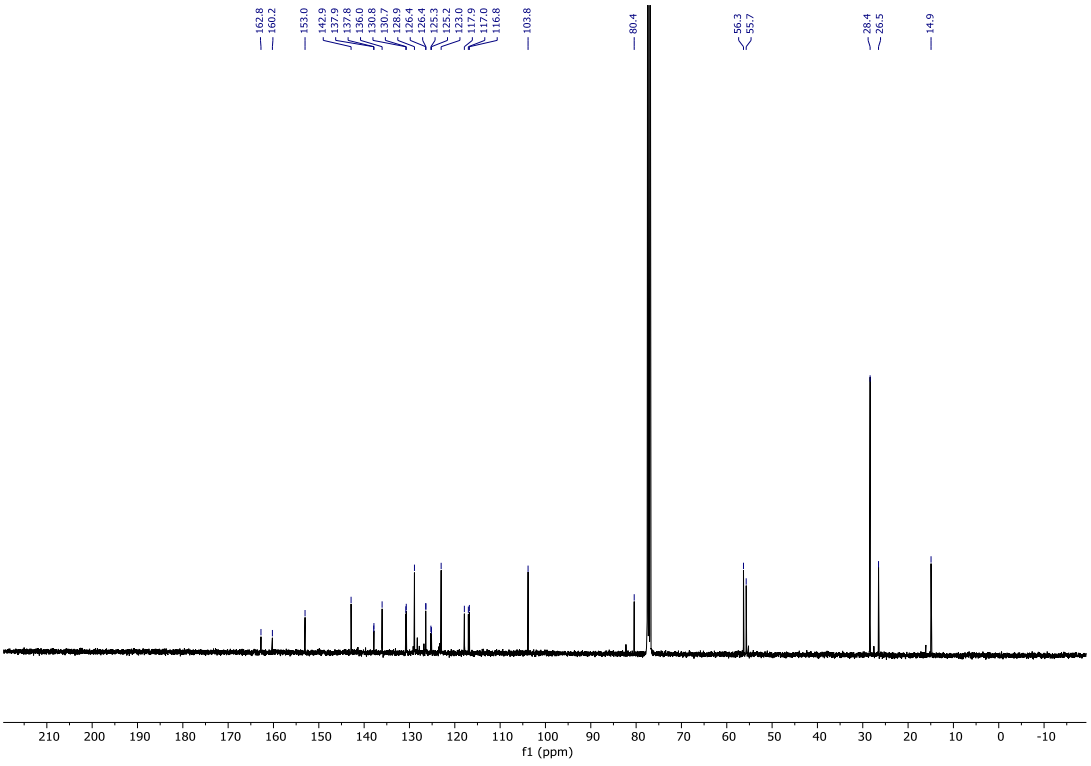

-115.70
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-*tert*-Butyl (2'-(dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-yl)carbamate (5se).**

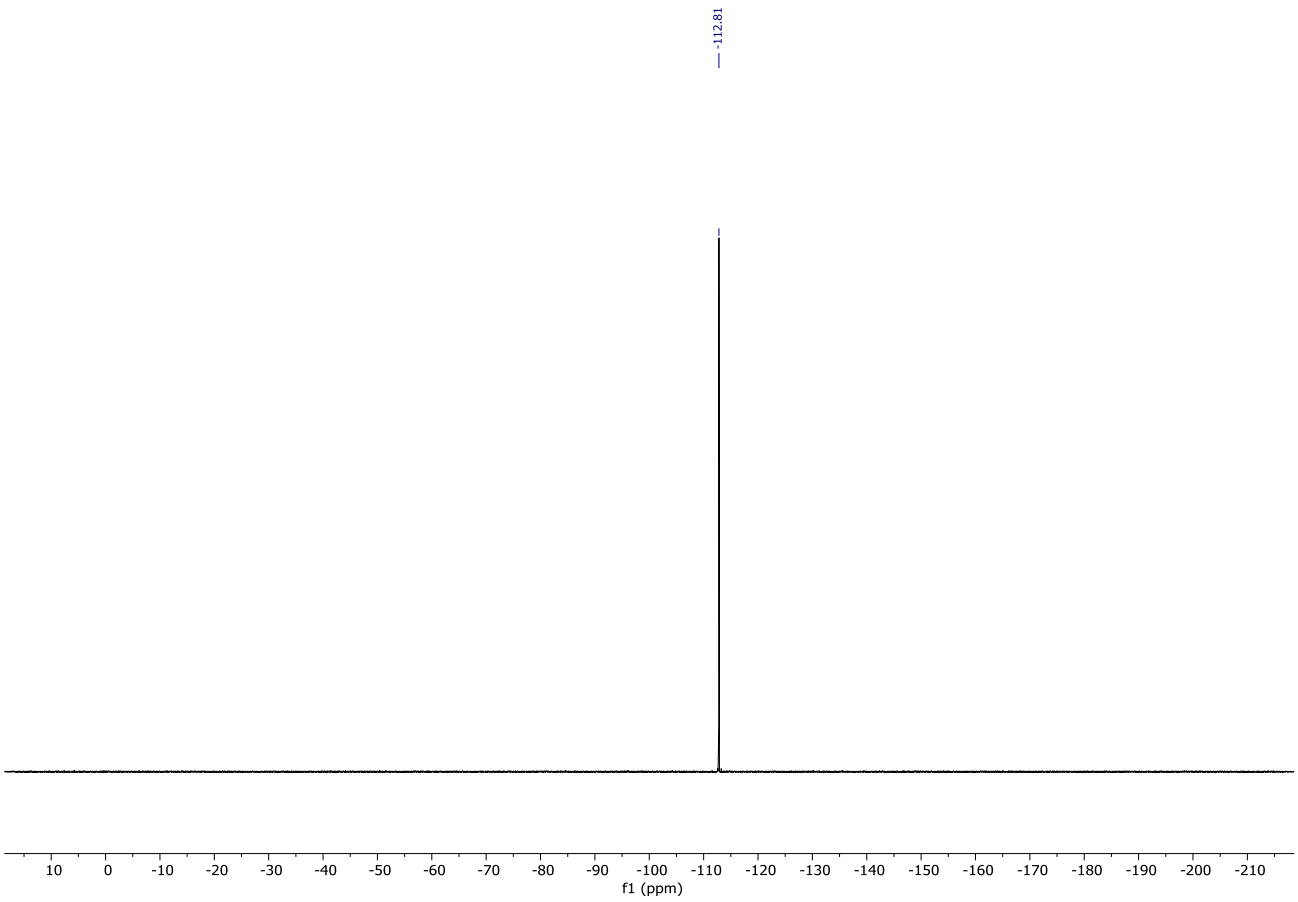
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

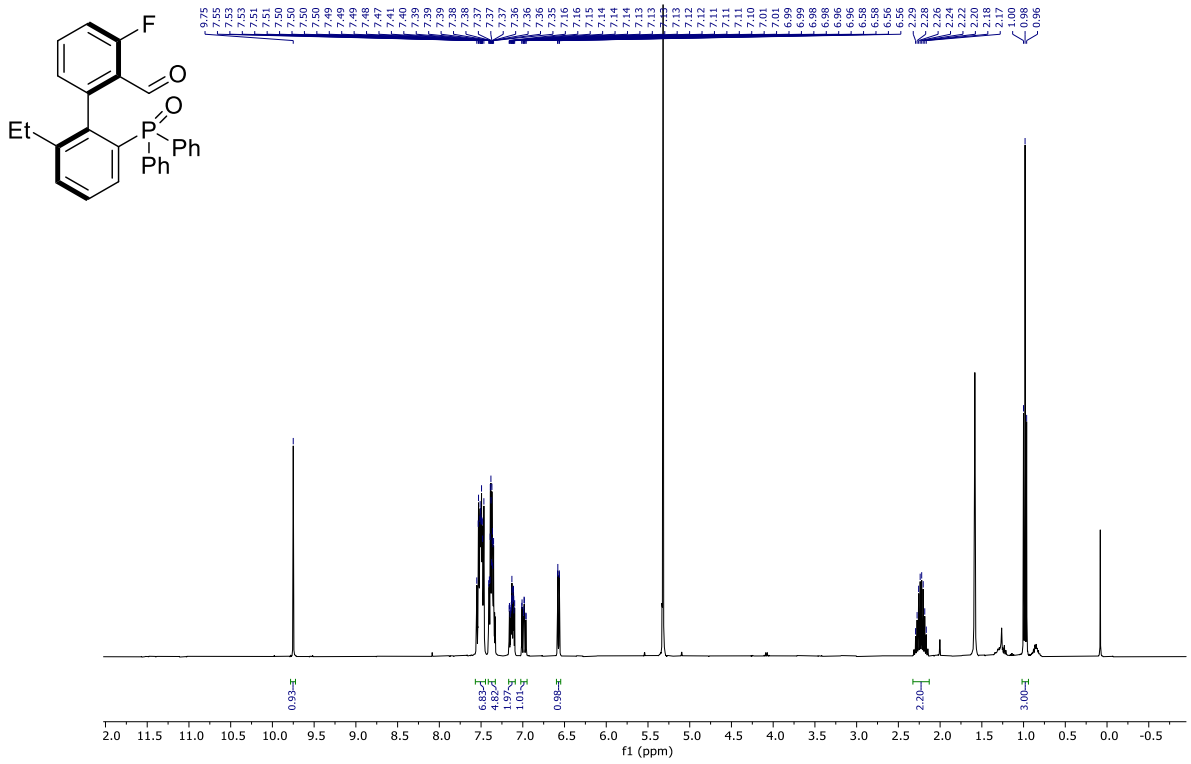


$^{19}F$-{$^{1}H$}-NMR

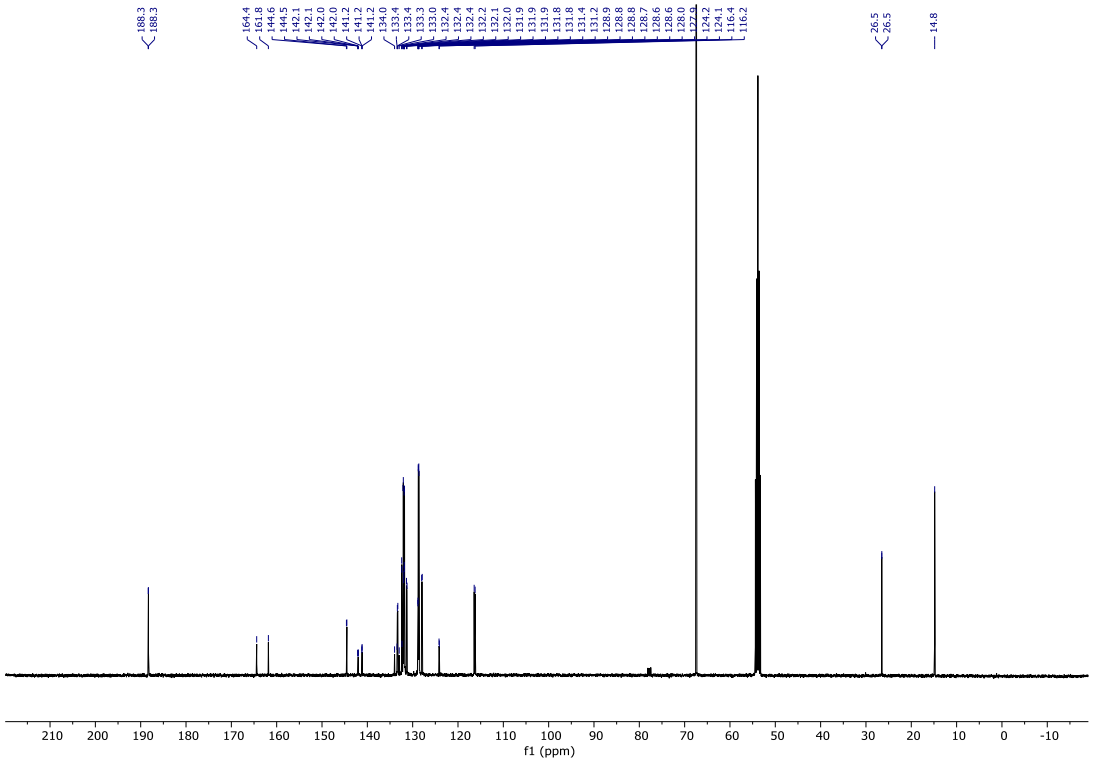

-112.81
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$)-2'-(Diphenylphosphoryl)-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (5sf).**

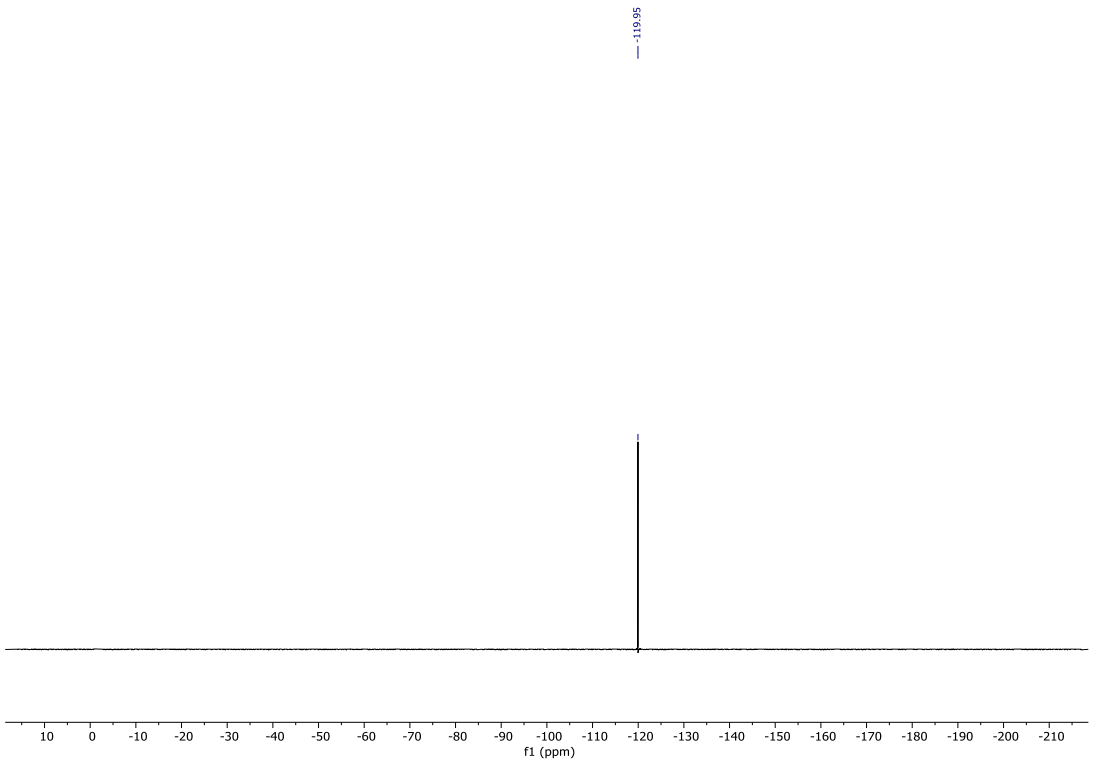
$^1$H-NMR



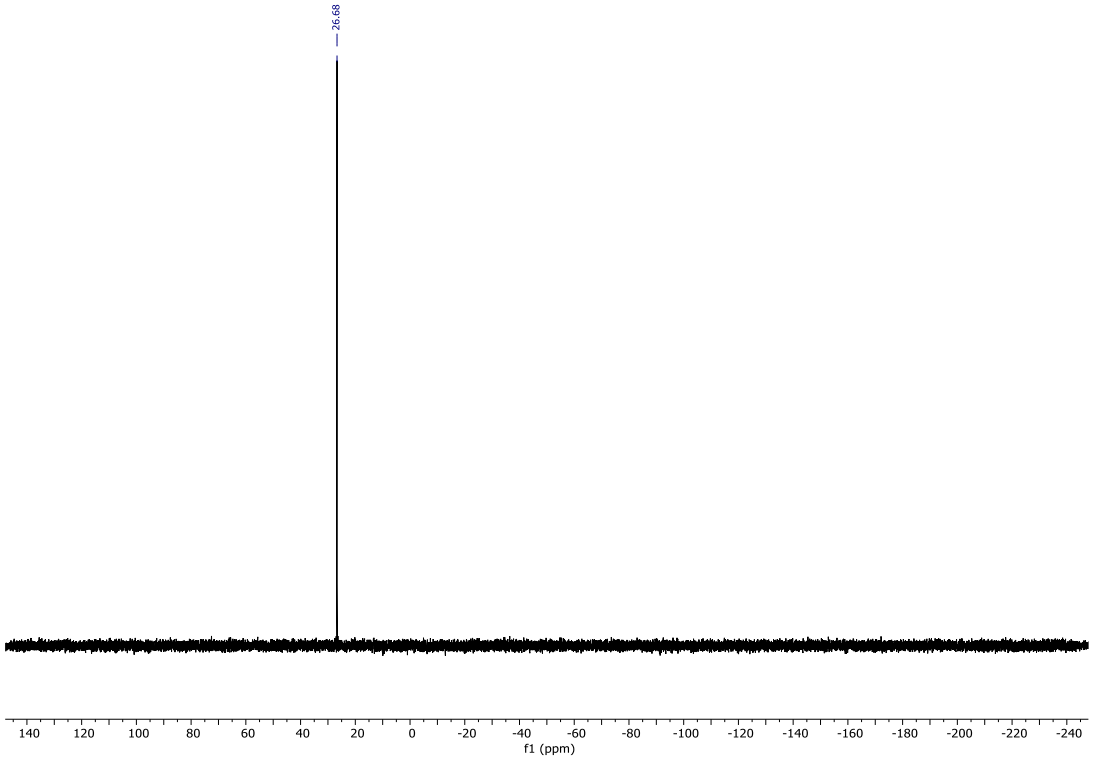

$^{13}$C-{$^1$H}-NMR



$^{19}F$-{$^{1}H$}-NMR

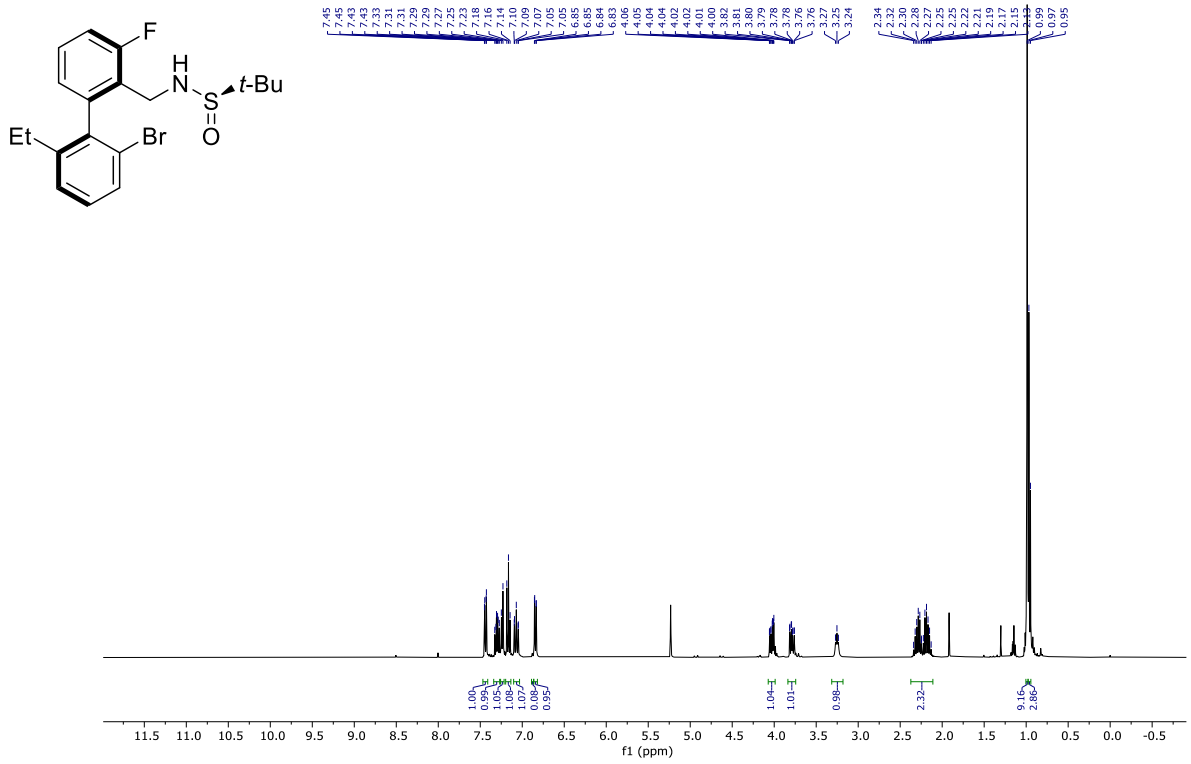



$^{31}P$-{$^{1}H$} NMR

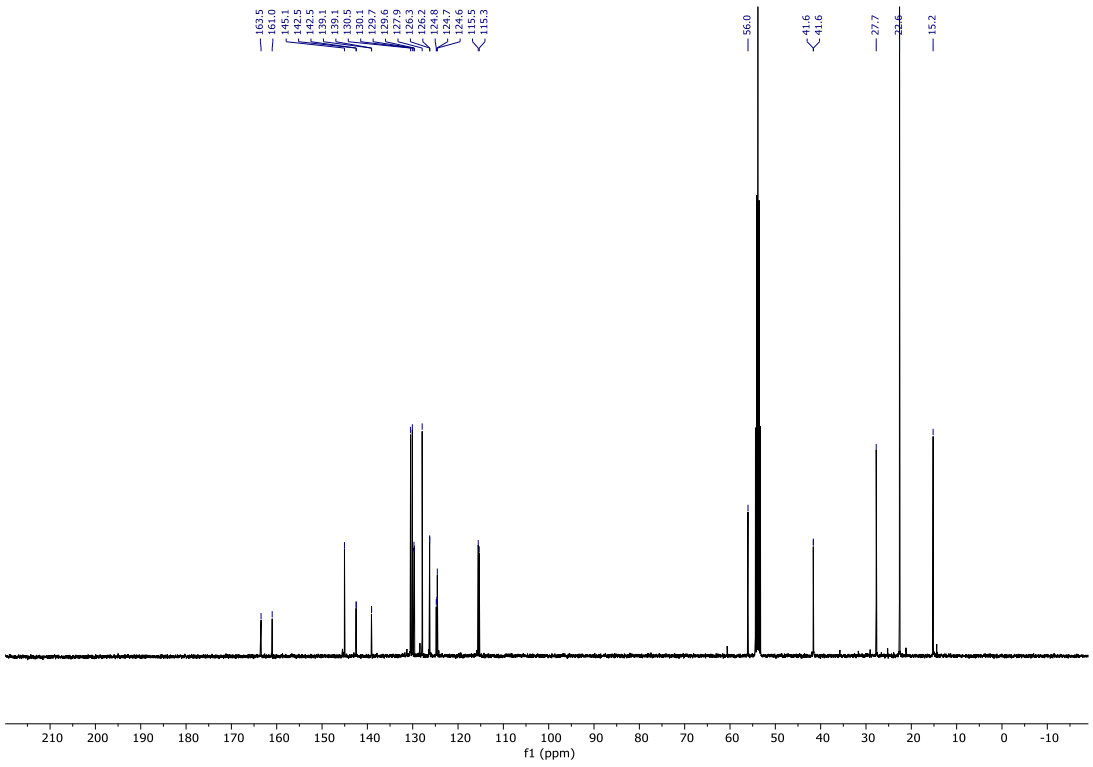


**($R_a$,*R*)-*N*-((2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl)methyl)-2-methylpropane-2-sulfinamide (5sg).**

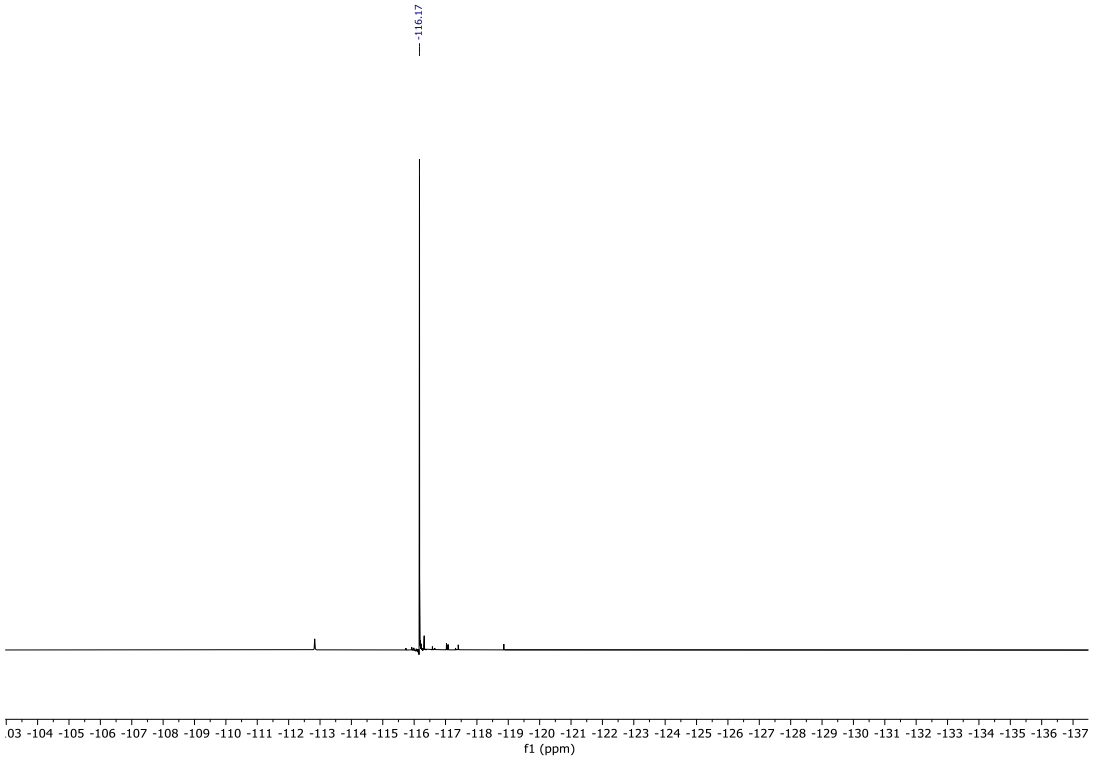
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

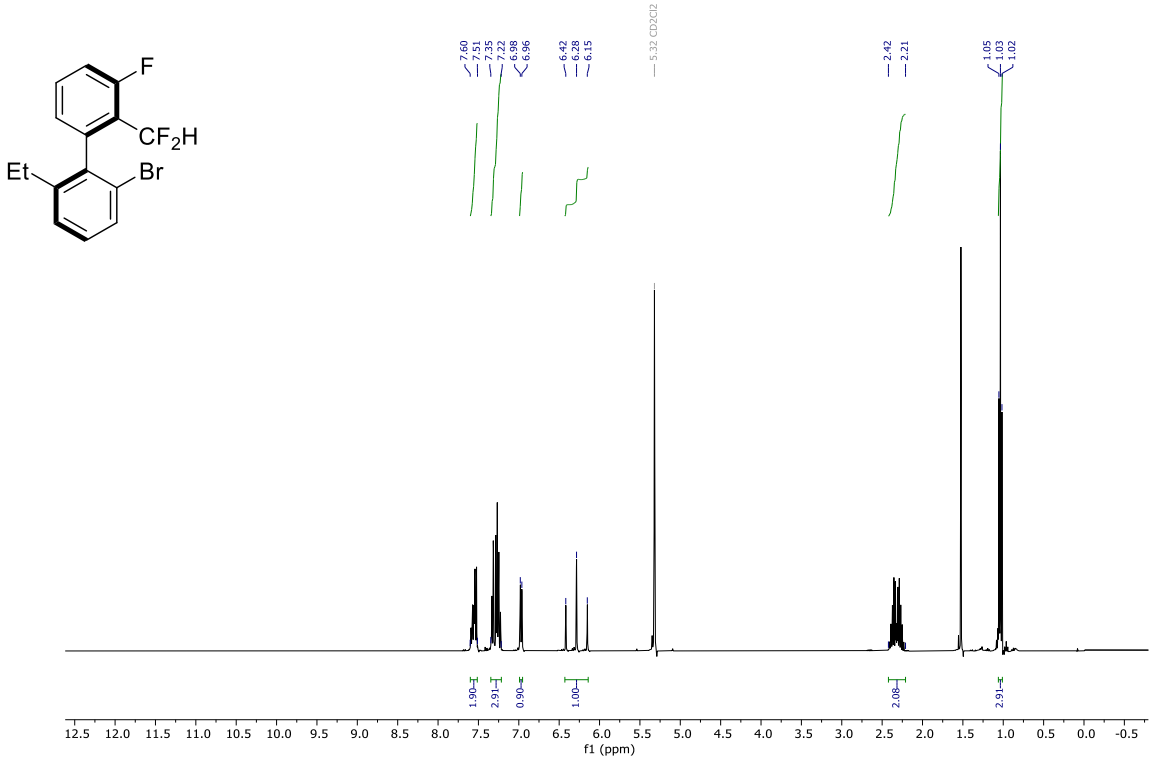


$^{19}F$-{$^{1}H$}-NMR

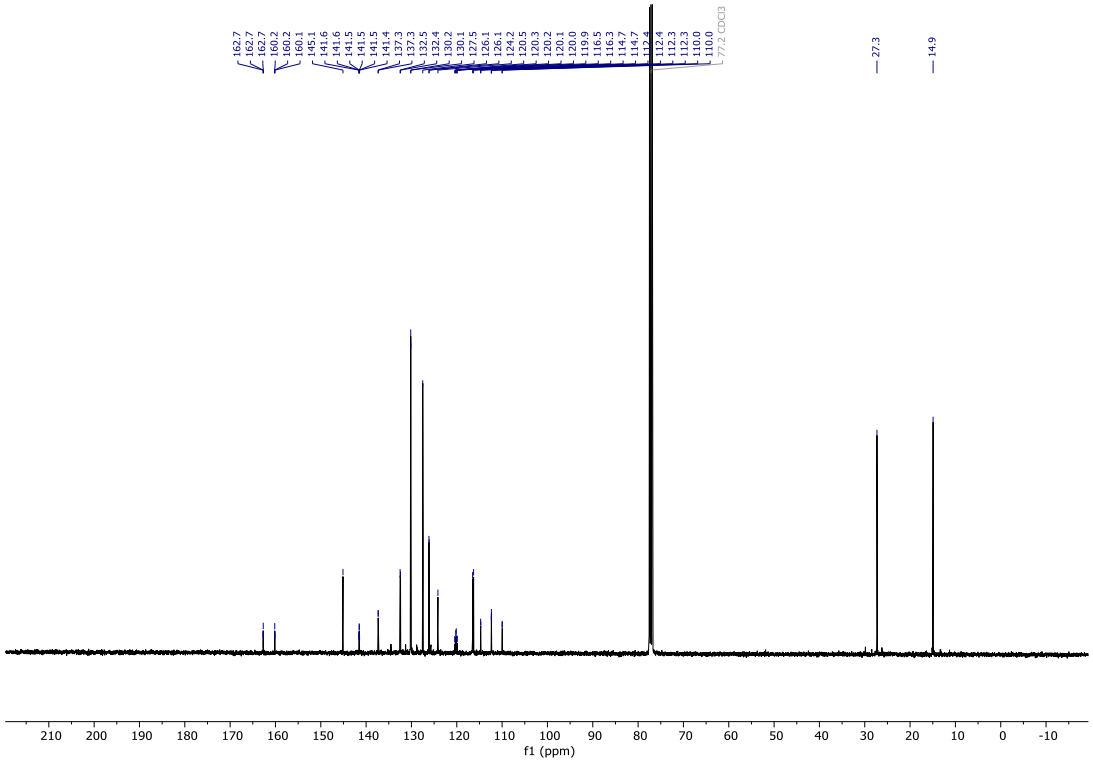

-116.17
.03 -104 -105 -106 -107 -108 -109 -110 -111 -112 -113 -114 -115 -116 -117 -118 -119 -120 -121 -122 -123 -124 -125 -126 -127 -128 -129 -130 -131 -132 -133 -134 -135 -136 -137
f1 (ppm)

**($R_a$)-2'-Bromo-2-(difluoromethyl)-6'-ethyl-3-fluoro-1,1'-biphenyl (5sh).**

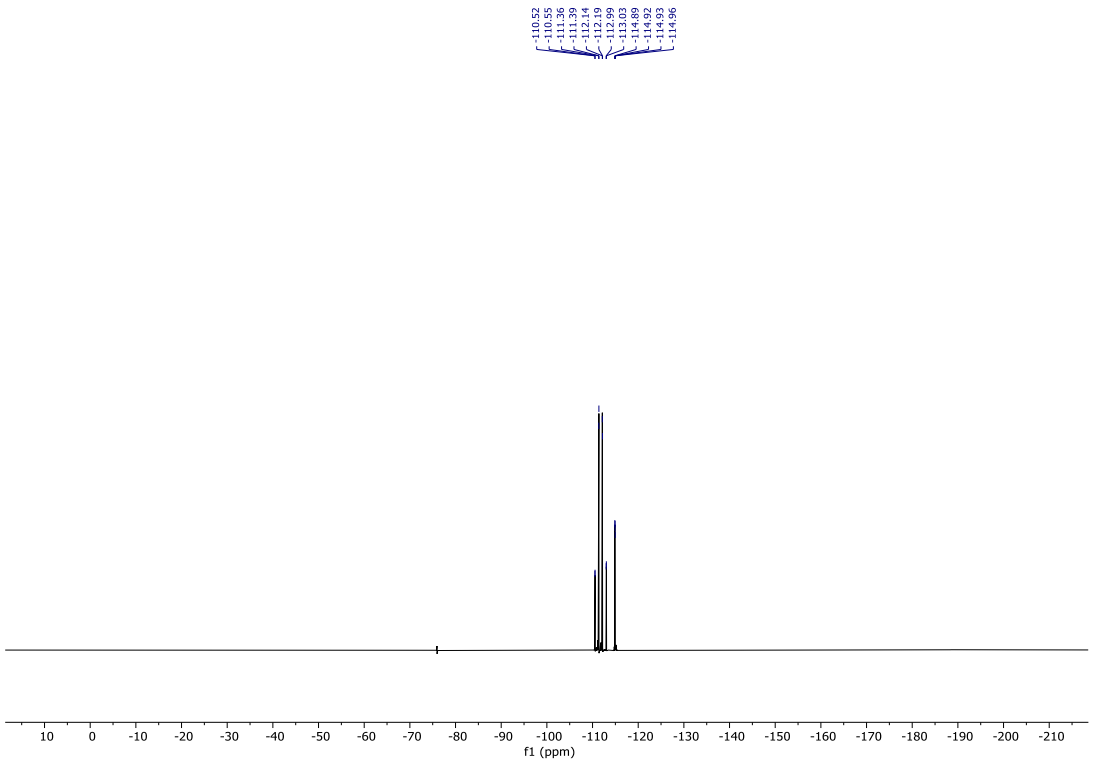
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

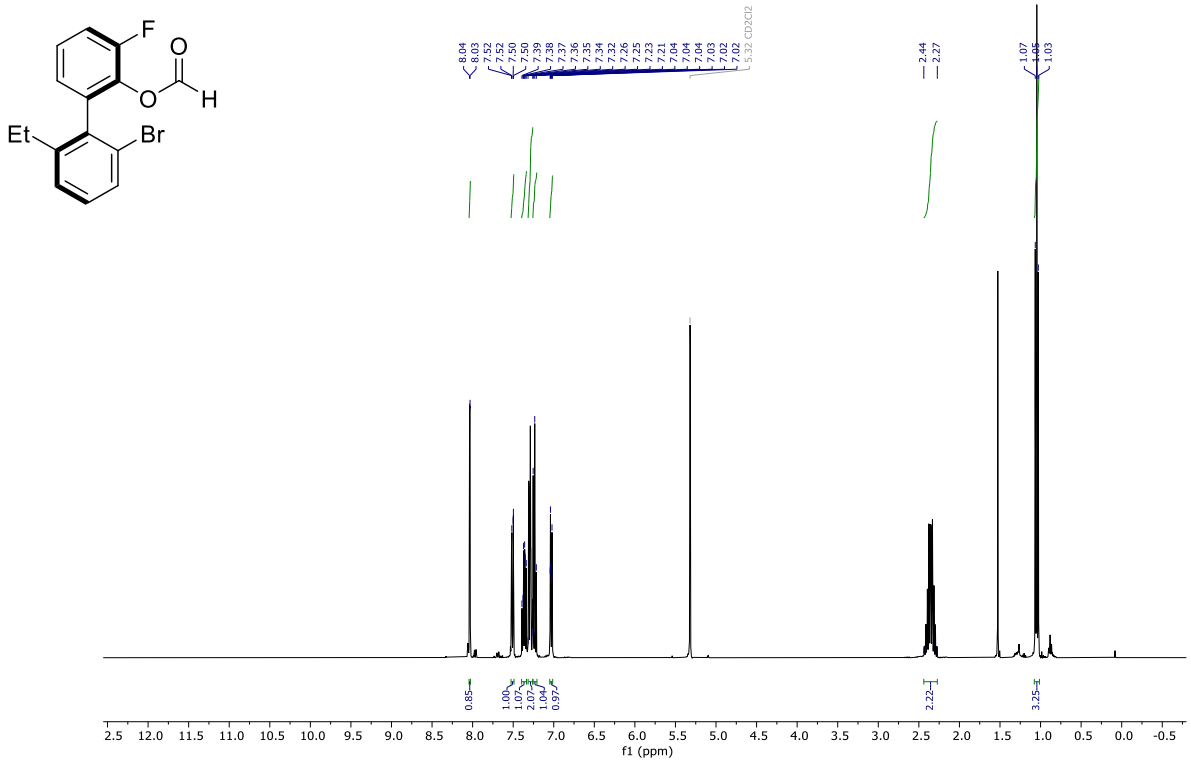


$^{19}F$-{$^{1}H$}-NMR

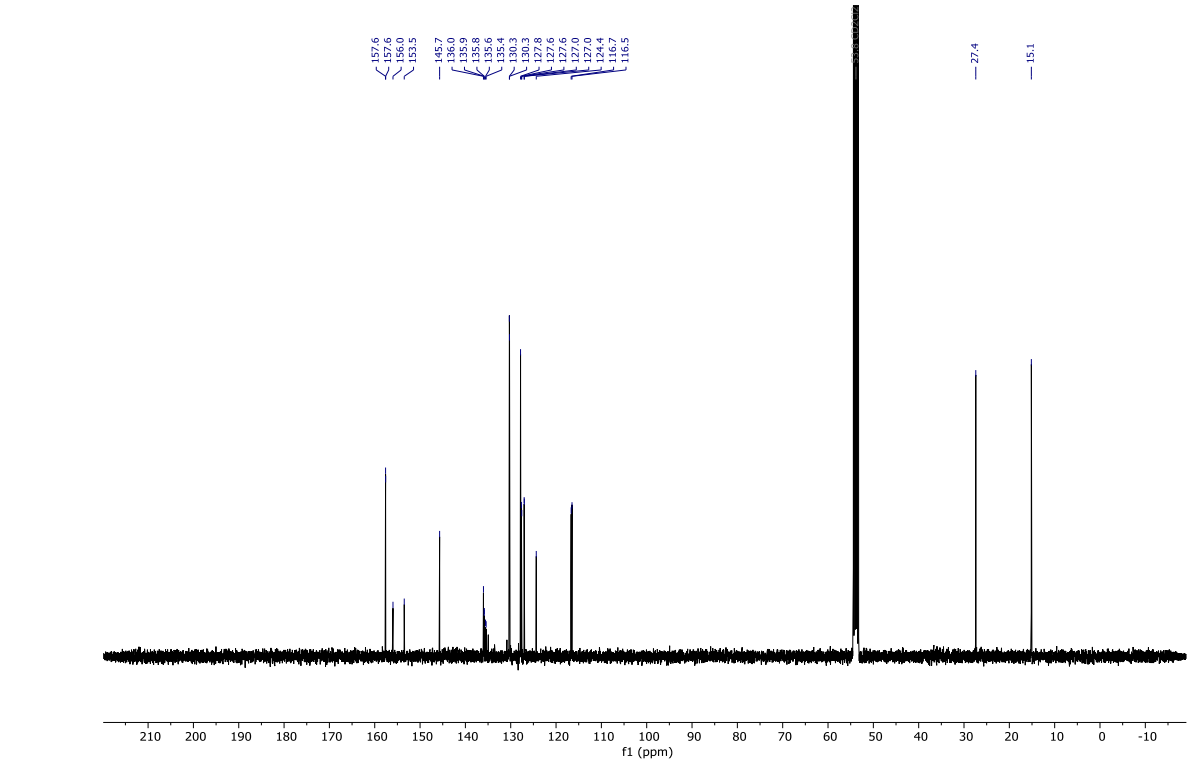

-110.52
-110.55
-111.36
-111.39
-112.14
-112.19
-112.99
-113.03
-114.89
-114.92
-114.93
-114.96
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

**($R_a$)-2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl formate (5si).**

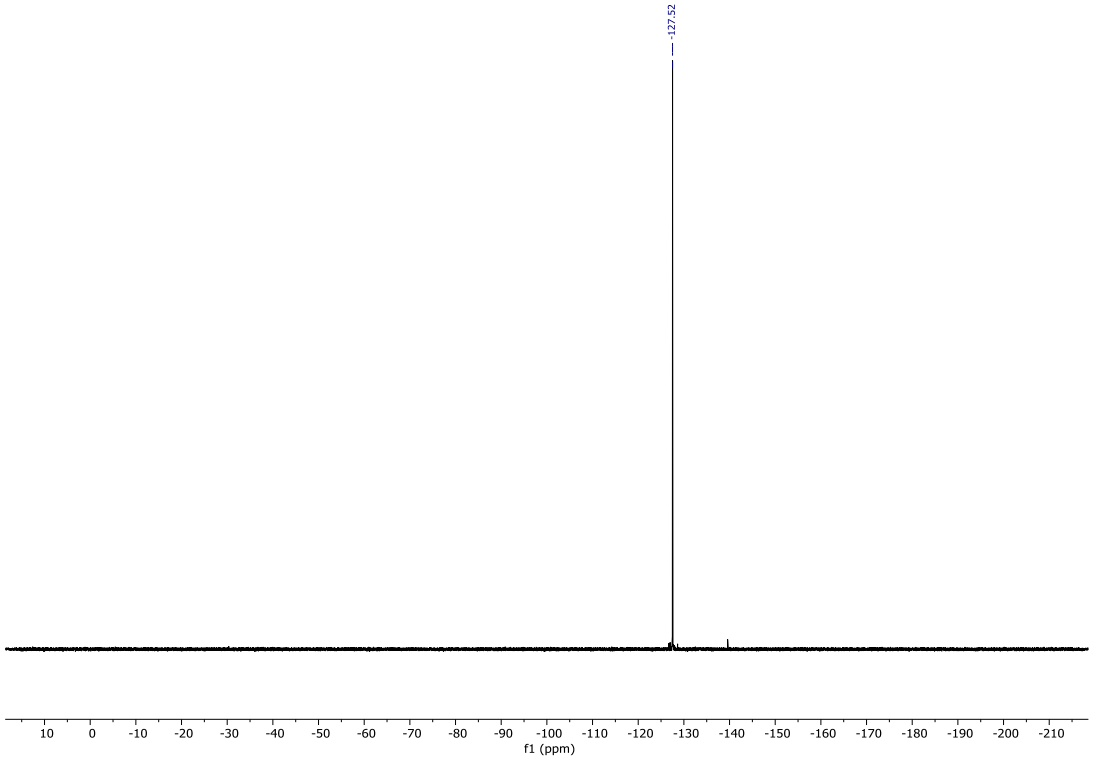
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

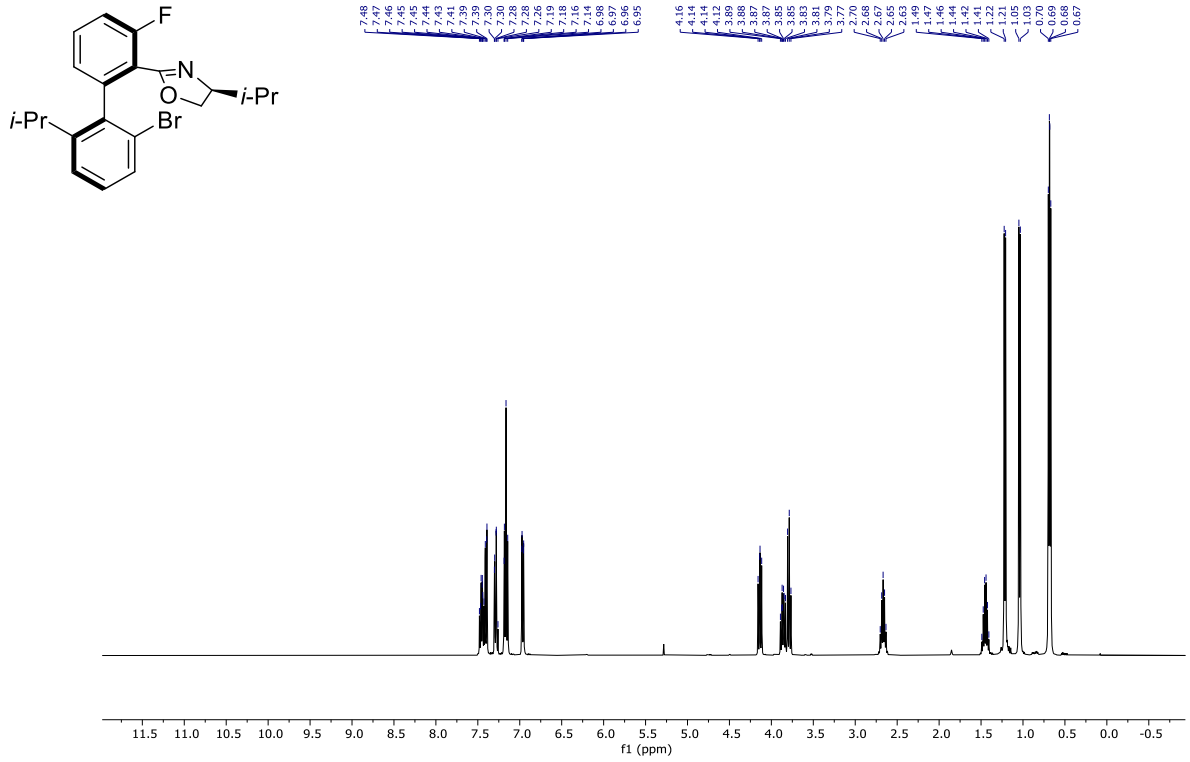


$^{19}F$-{$^{1}H$}-NMR

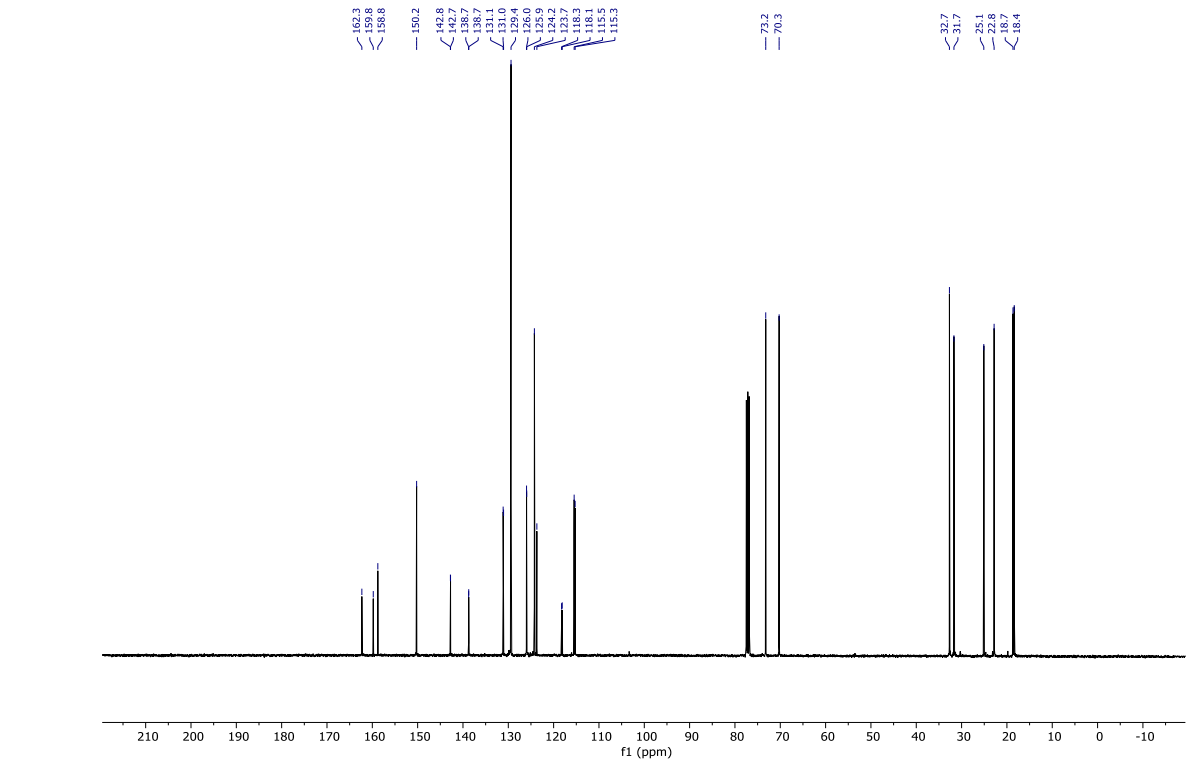

-127.52
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

**($R_a$,*S*)-2-(2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl)-4-*iso*-propyl-4,5-dihydrooxazole (5qj).**

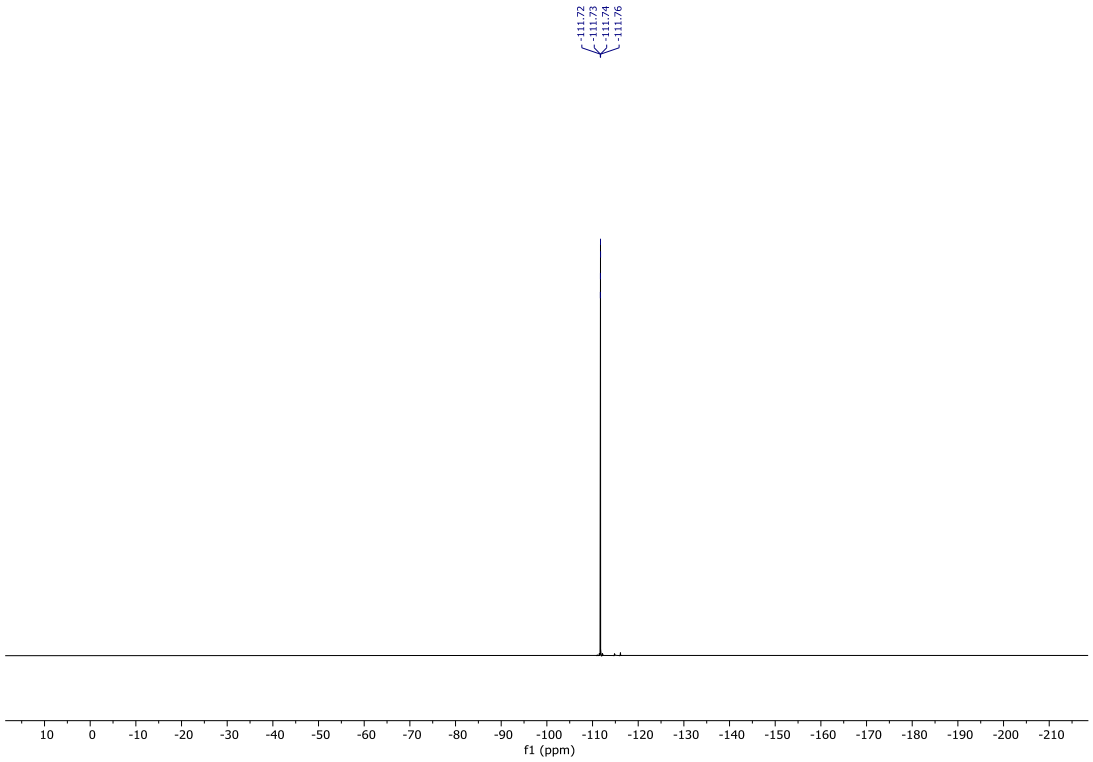
$^1$H-NMR




$^{13}$C-{$^1$H}-NMR

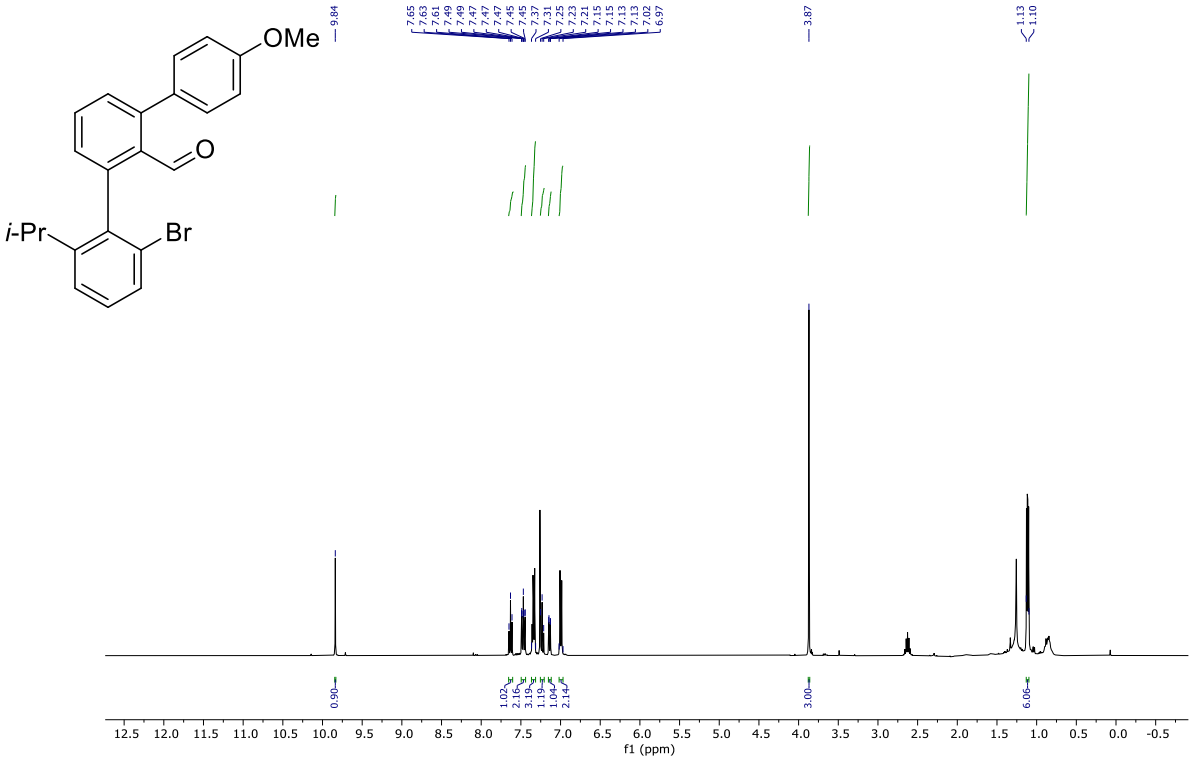


$^{19}$F-NMR

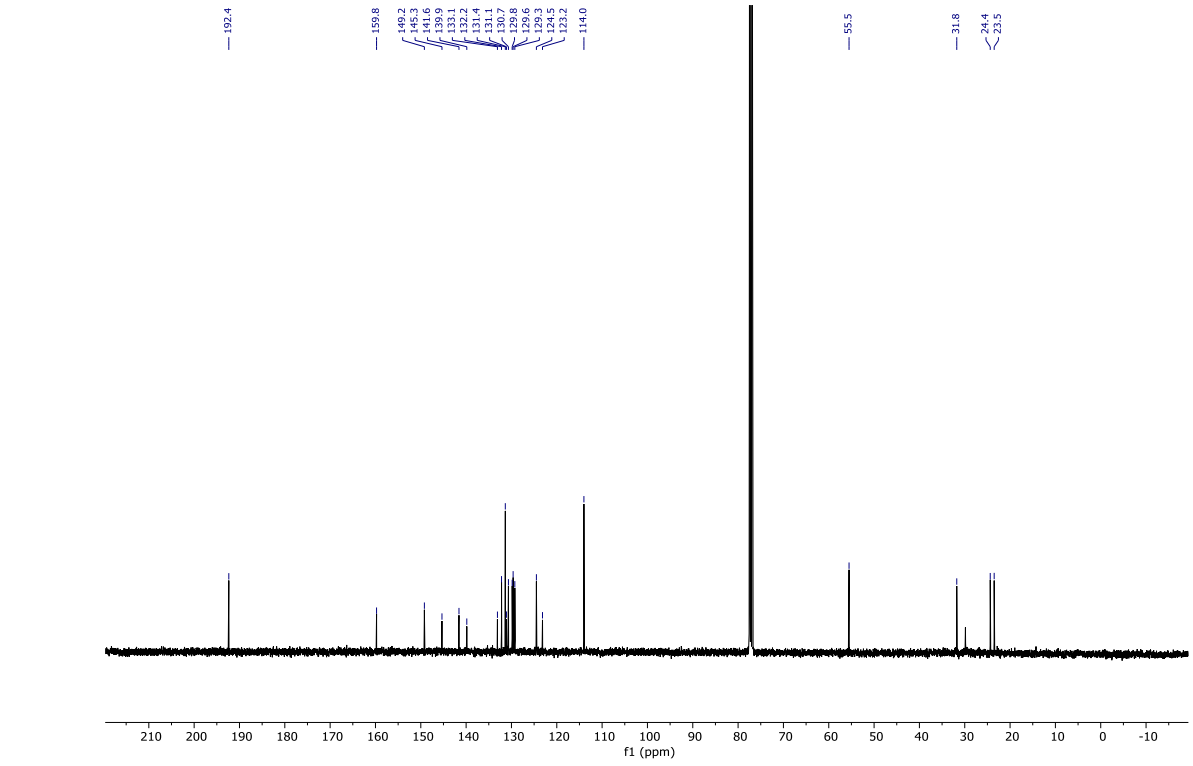

-111.72
-111.73
-111.74
-111.76
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

**($R_a$)-2-Bromo-6-*iso*-propyl-4''-methoxy-[1,1':3',1''-terphenyl]-2'-carbaldehyde (5ab).**

$^1$H-NMR

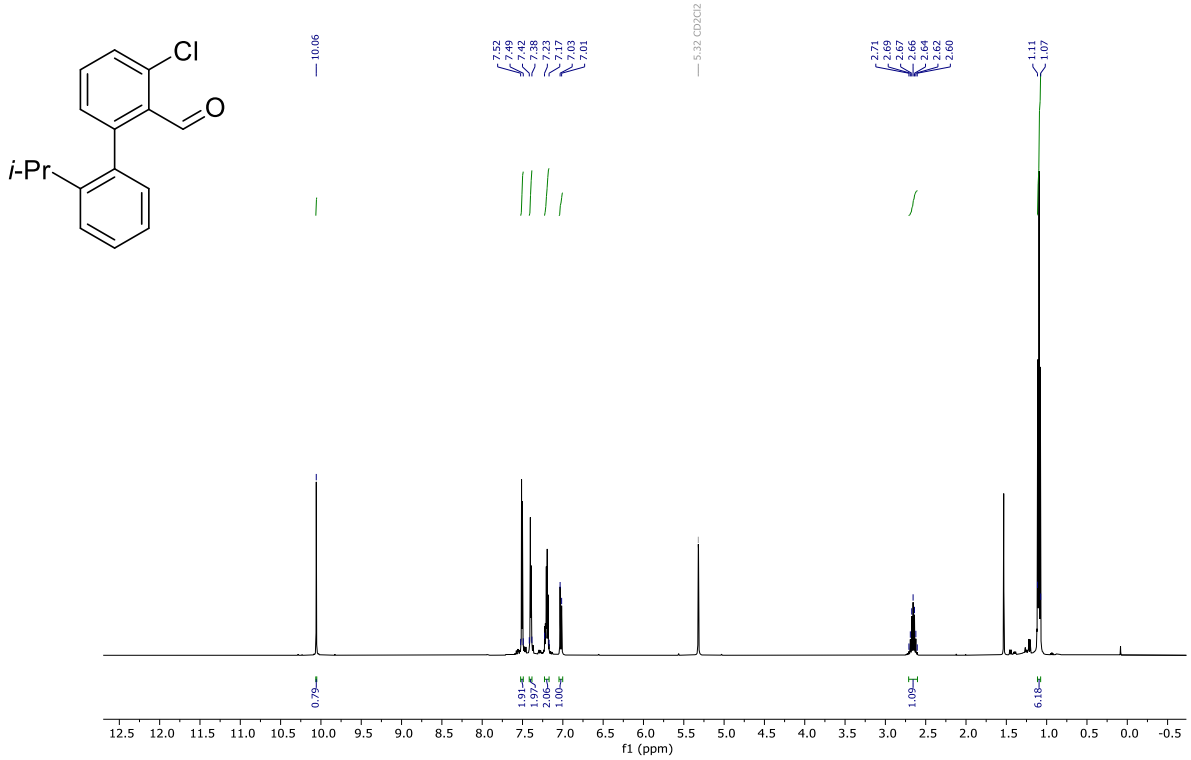



$^{13}$C-{$^1$H}-NMR

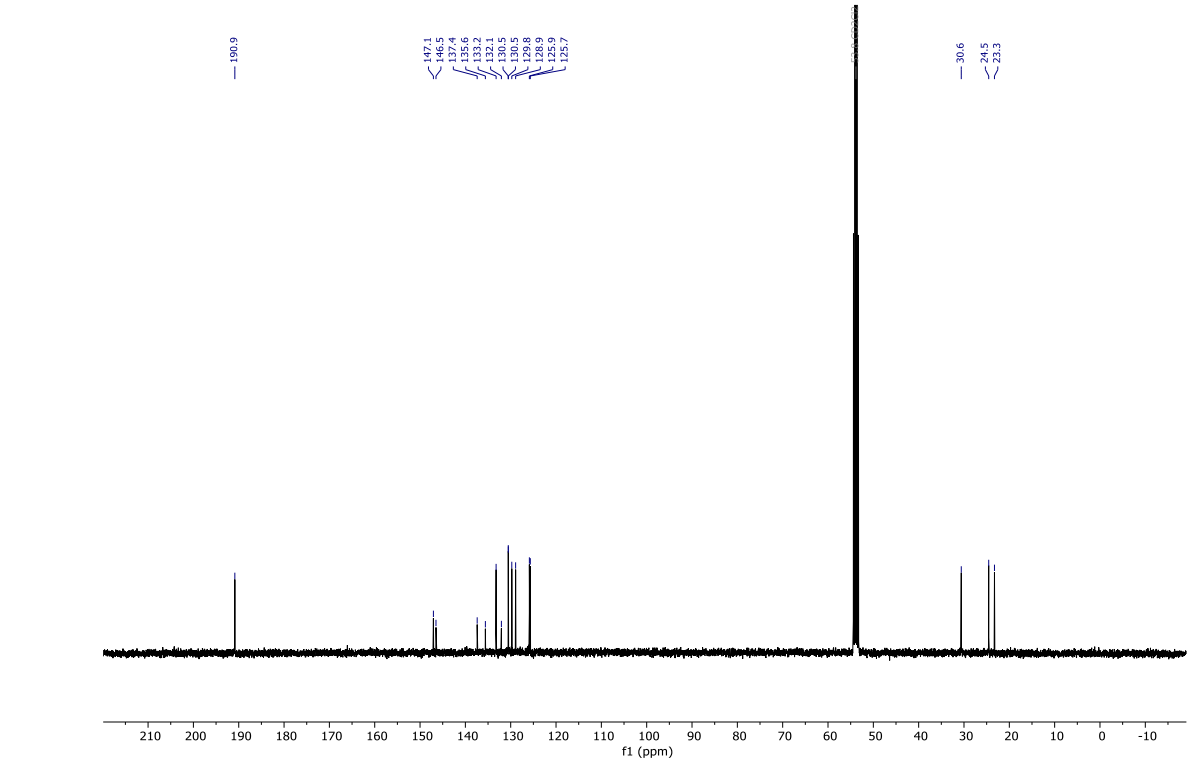


**3-Chloro-2'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (7f).**

$^{1}$H-NMR



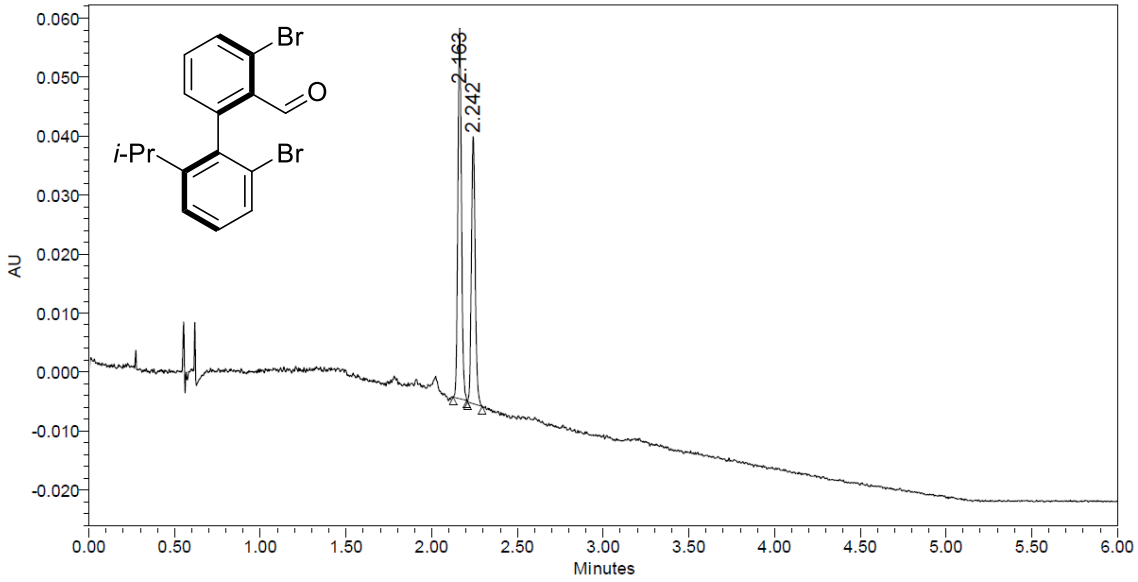

$^{13}$C-{$^{1}$H}-NMR



## 11. UPC$^2$ Traces

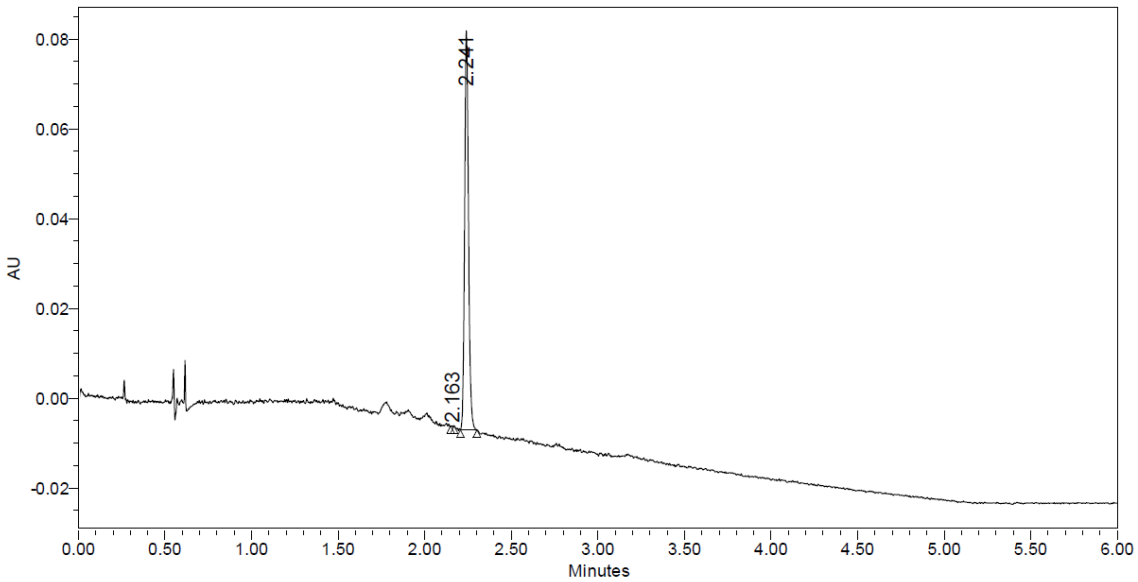
**($R_a$)-2',3-Dibromo-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (3a).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.163 | 56.48 |
| 2 | 2.242 | 43.52 |

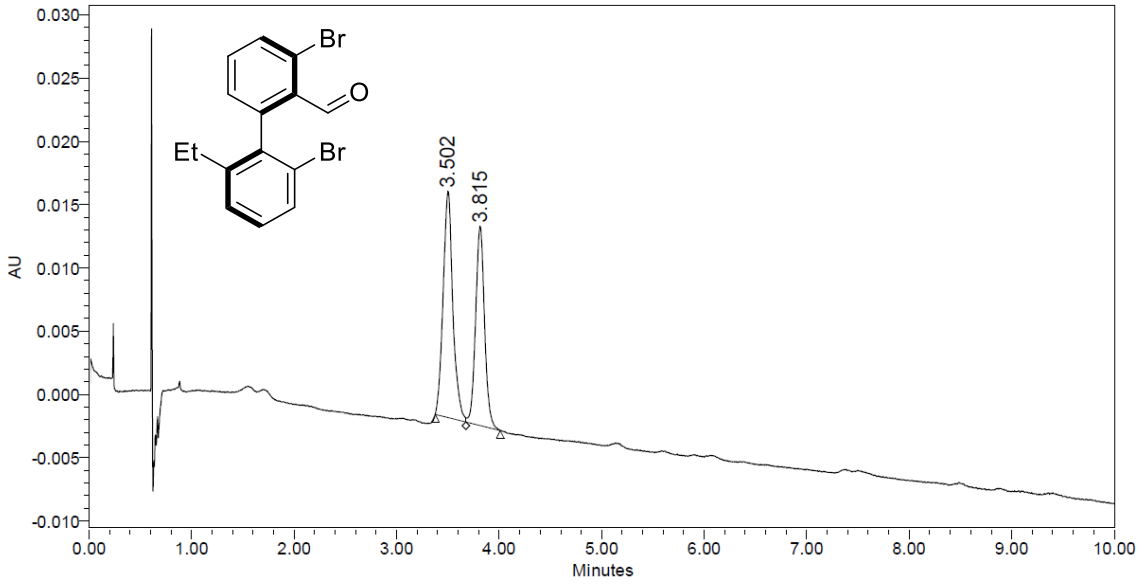
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.163 | 0.07 |
| 2 | 2.241 | 99.93 |

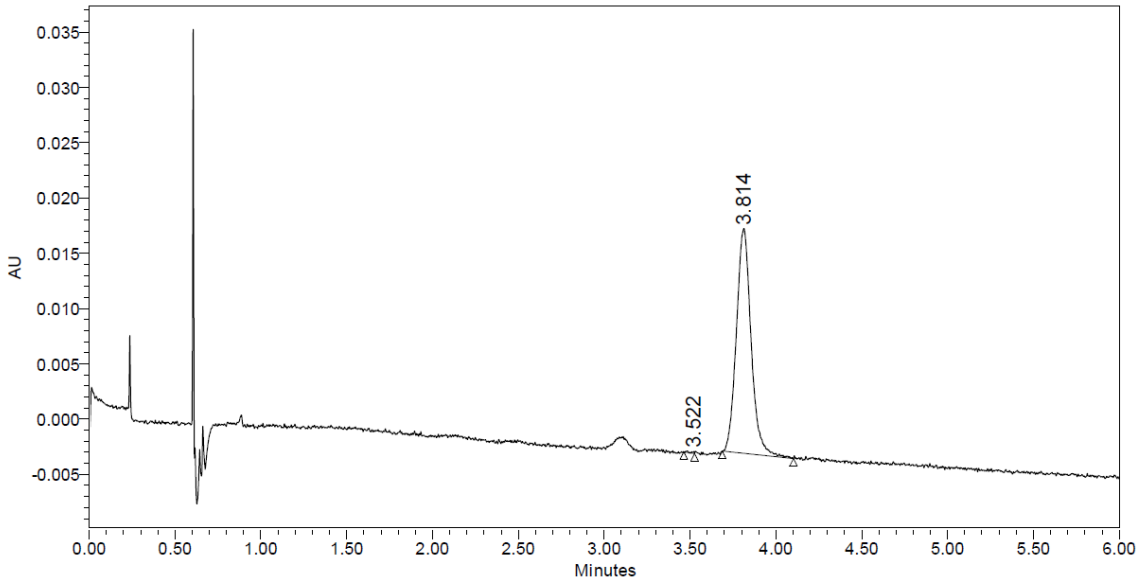
**($R_a$)-2',3-Dibromo-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (3b).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.502 | 55.19 |
| 2 | 3.815 | 44.81 |

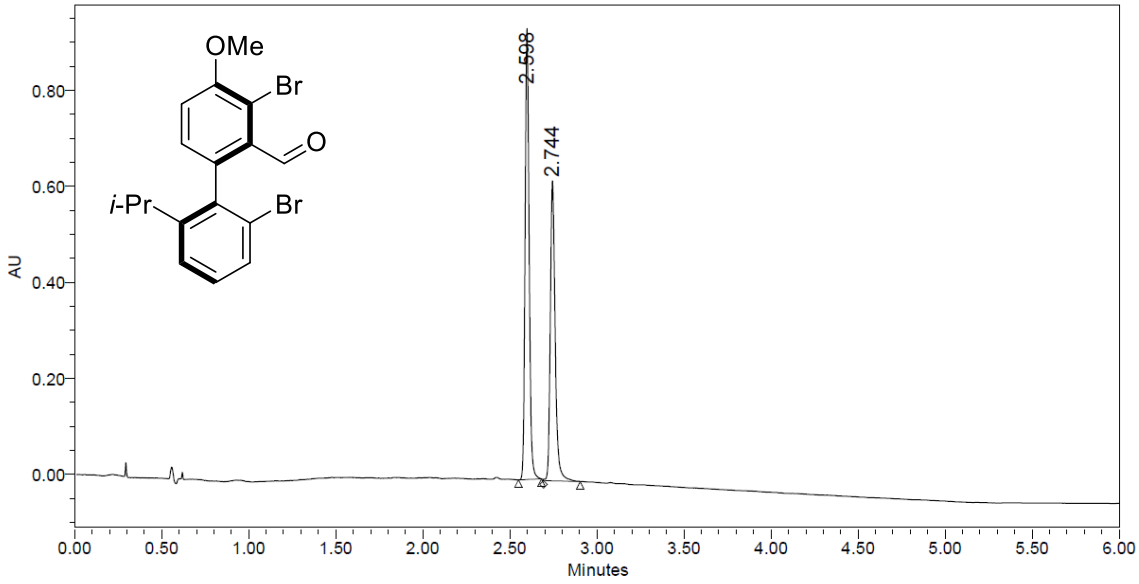
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.522 | 0.23 |
| 2 | 3.814 | 99.77 |

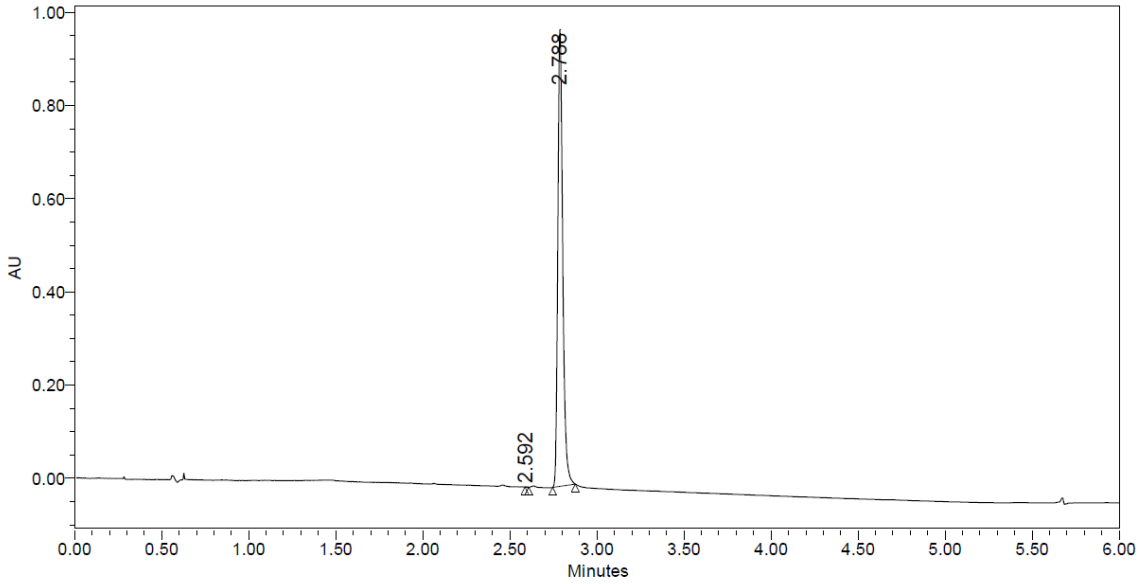
**($R_a$)-2',3-Dibromo-6'-*iso*-propyl-4-methoxy-[1,1'-biphenyl]-2-carbaldehyde (3c).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.598 | 55.40 |
| 2 | 2.744 | 44.60 |

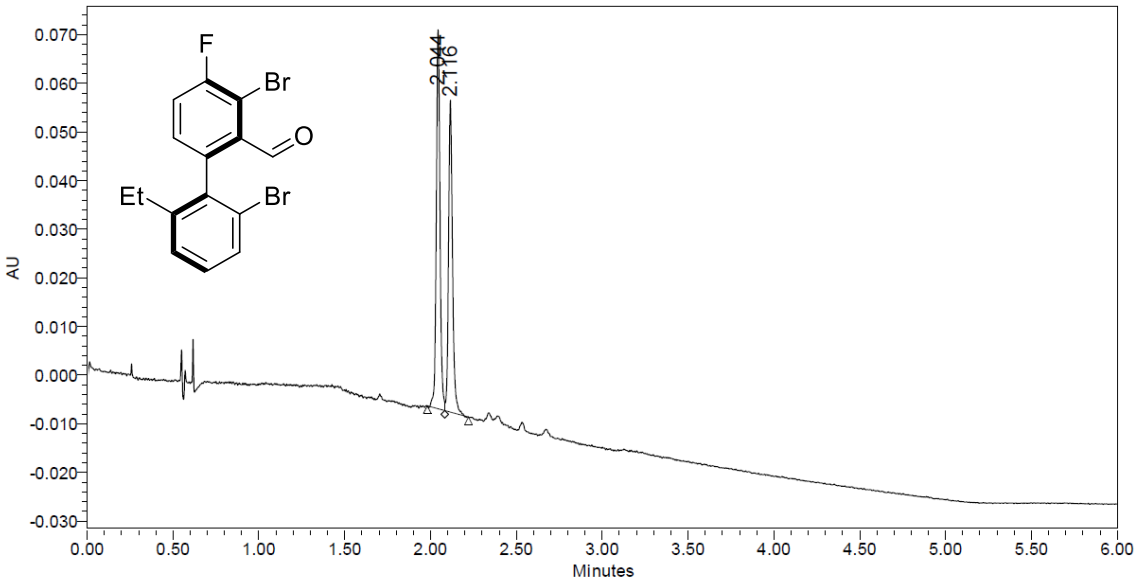
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.592 | 0.00 |
| 2 | 2.788 | 100.00 |

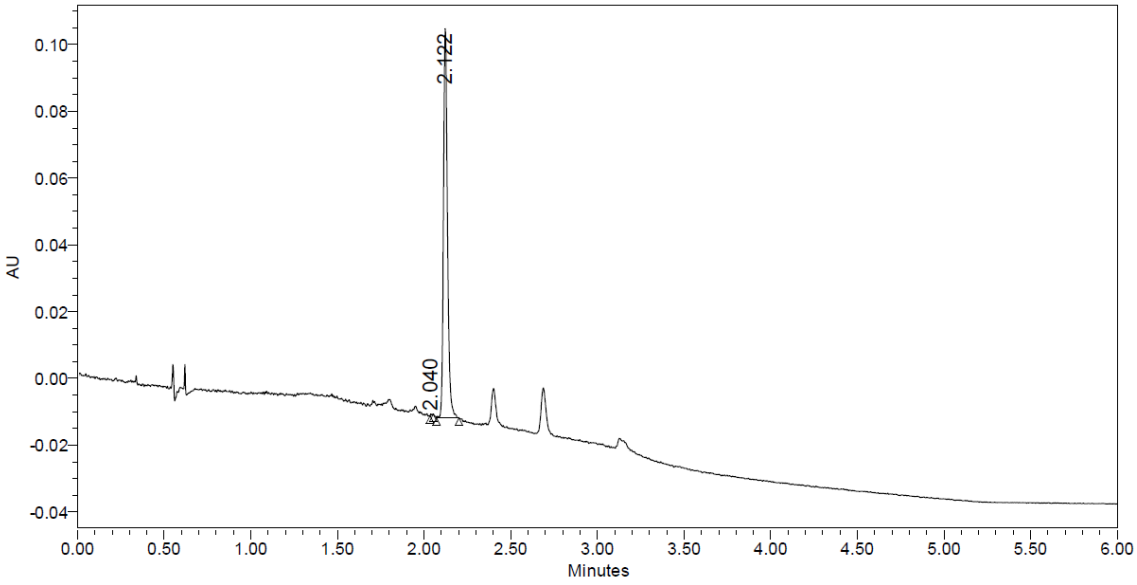
**($R_a$)-2',3-Dibromo-6'-ethyl-4-fluoro-[1,1'-biphenyl]-2-carbaldehyde (3d).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.044 | 52.77 |
| 2 | 2.116 | 47.23 |

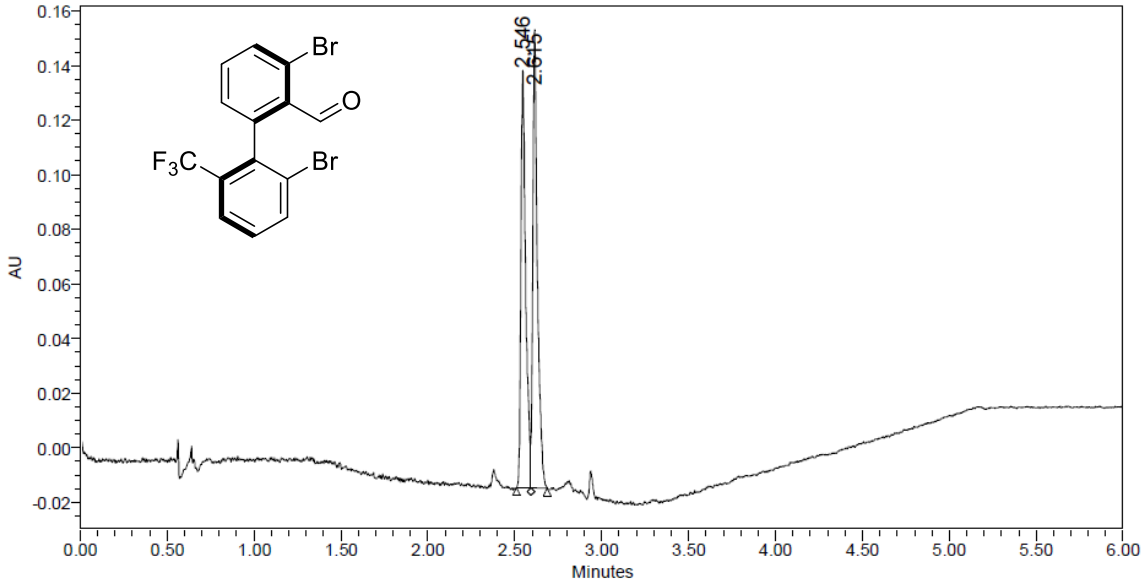
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.040 | 0.08 |
| 2 | 2.122 | 99.92 |

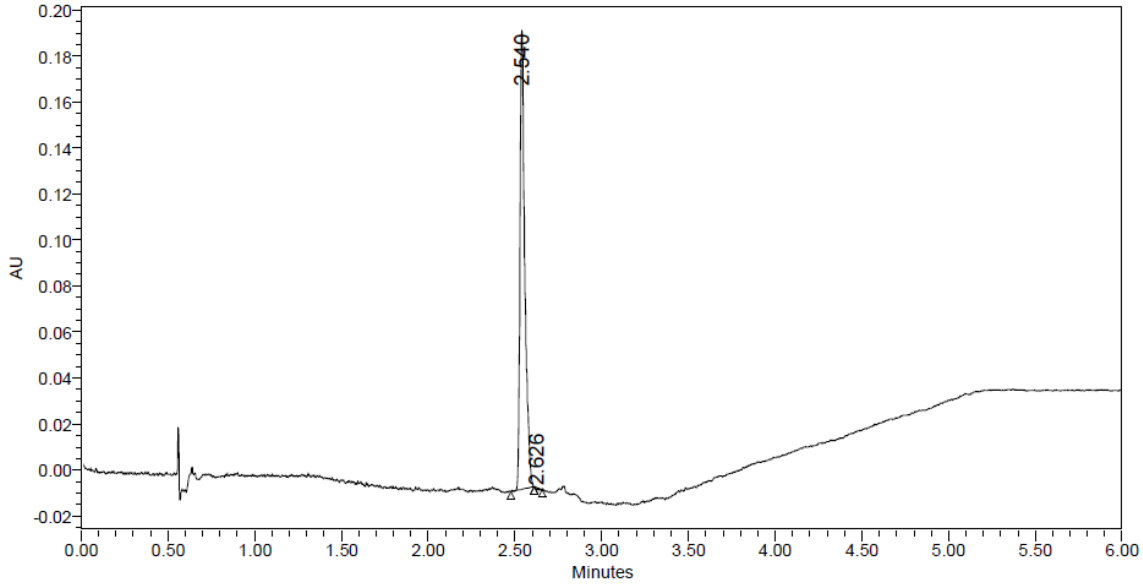
**($R_a$)-2',3-Dibromo-6'-(trifluoromethyl)-[1,1'-biphenyl]-2-carbaldehyde (3e).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.546 | 48.14 |
| 2 | 2.615 | 51.86 |

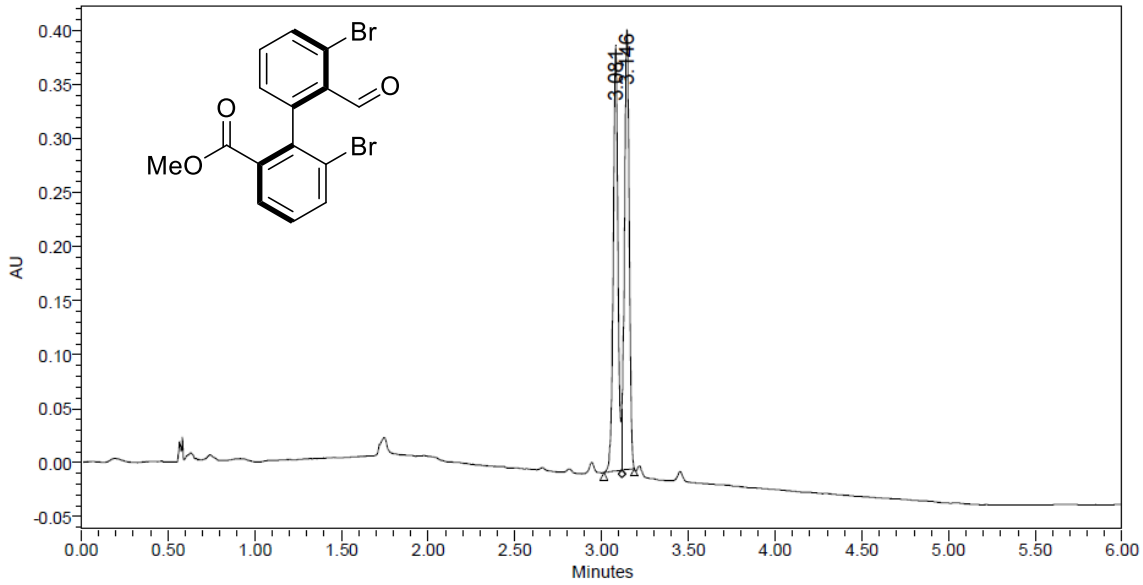
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.540 | 99.74 |
| 2 | 2.626 | 0.26 |

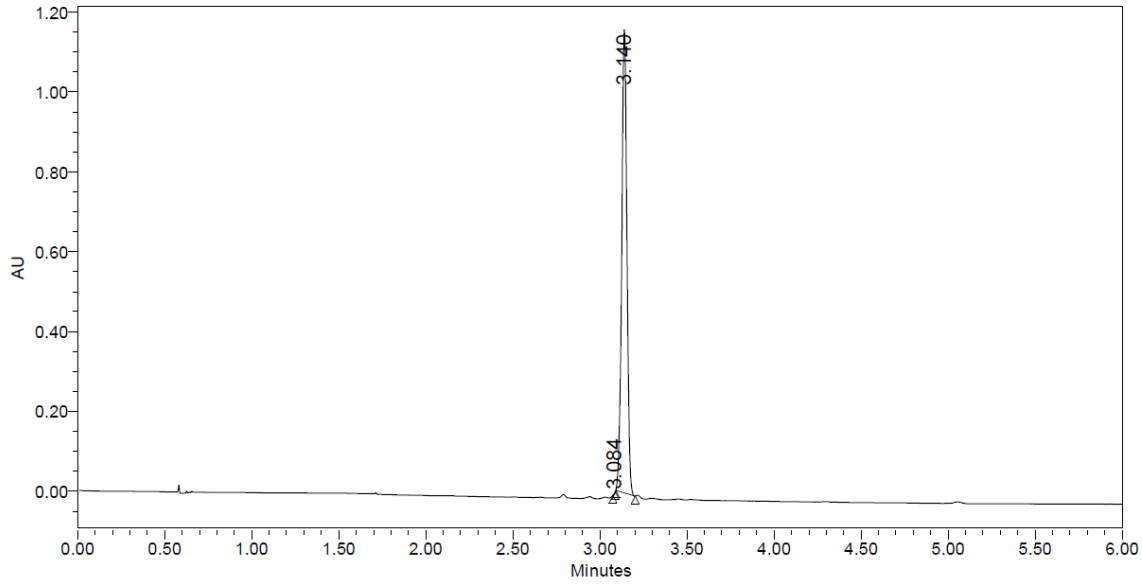
**($R_a$)-Methyl 3',6-dibromo-2'-formyl-[1,1'-biphenyl]-2-carboxylate (3f).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.081 | 49.91 |
| 2 | 3.146 | 50.09 |

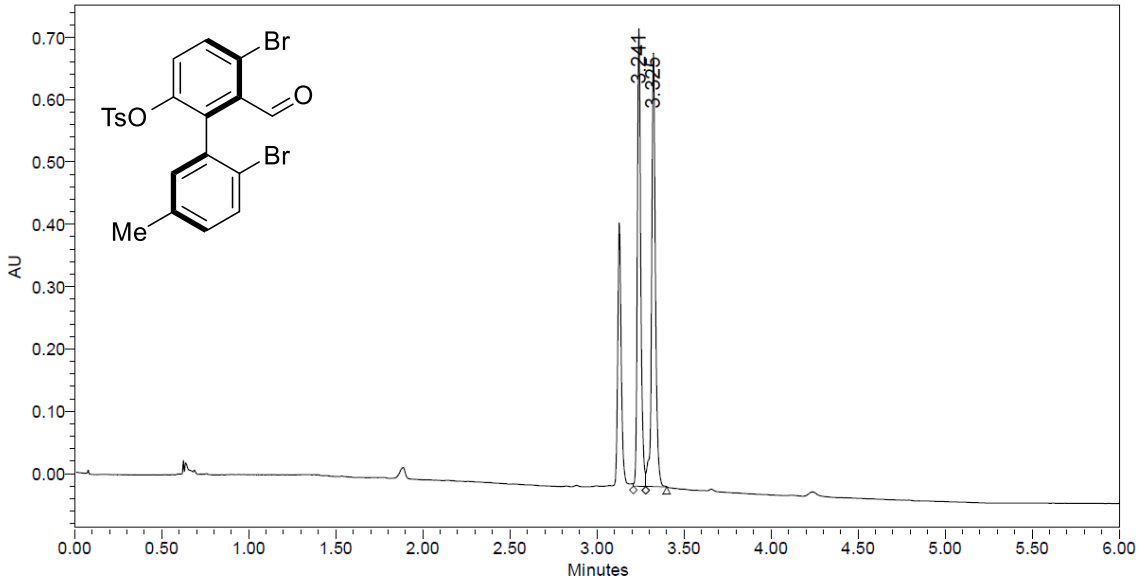
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.084 | 0.03 |
| 2 | 3.140 | 99.97 |

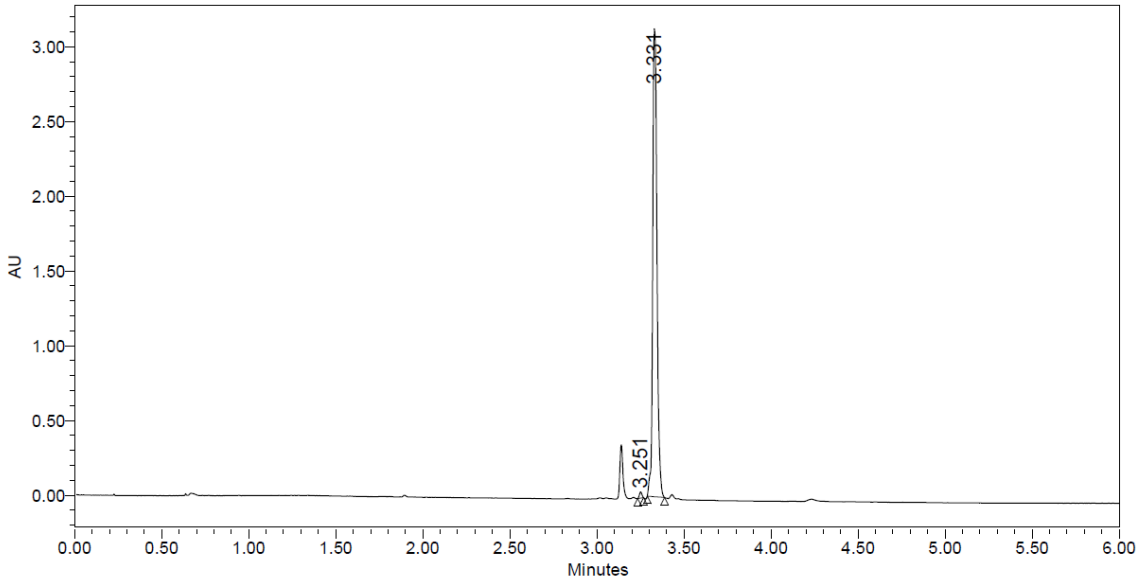
**($S_a$)-2',5-Dibromo-6-formyl-5'-methyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3h).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.241 | 48.65 |
| 2 | 3.325 | 51.35 |

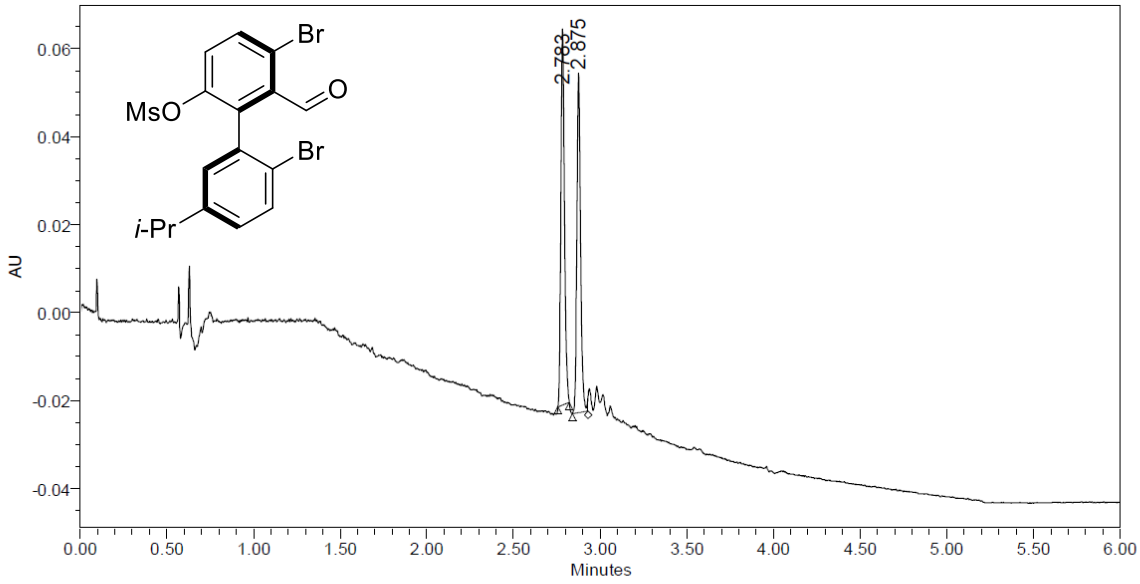
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.251 | 0.77 |
| 2 | 3.331 | 99.23 |

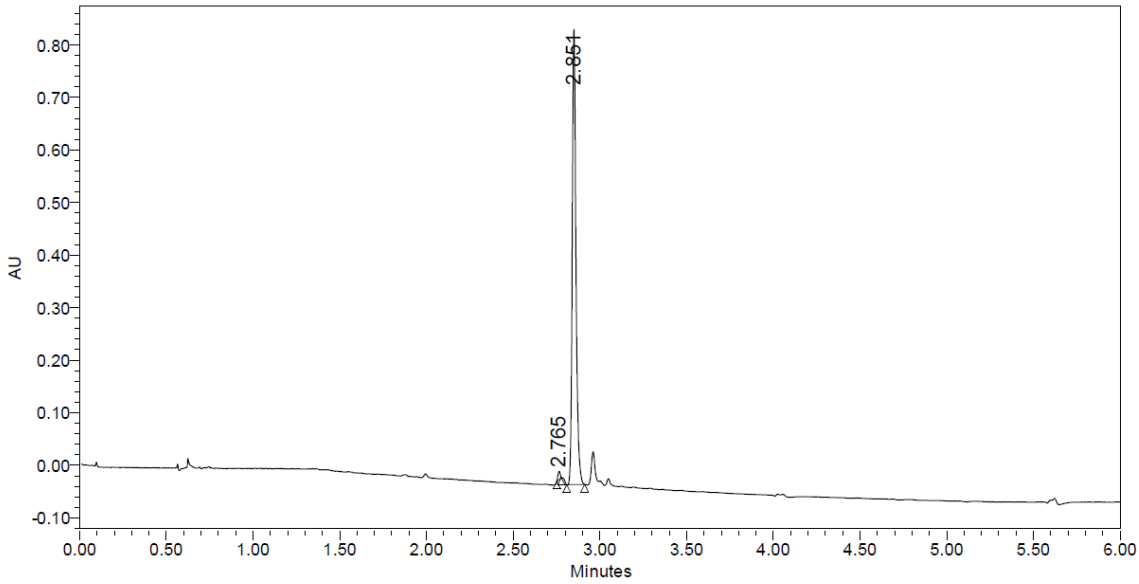
**($S_a$)-2',5-Dibromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (3i).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.783 | 51.82 |
| 2 | 2.875 | 48.18 |

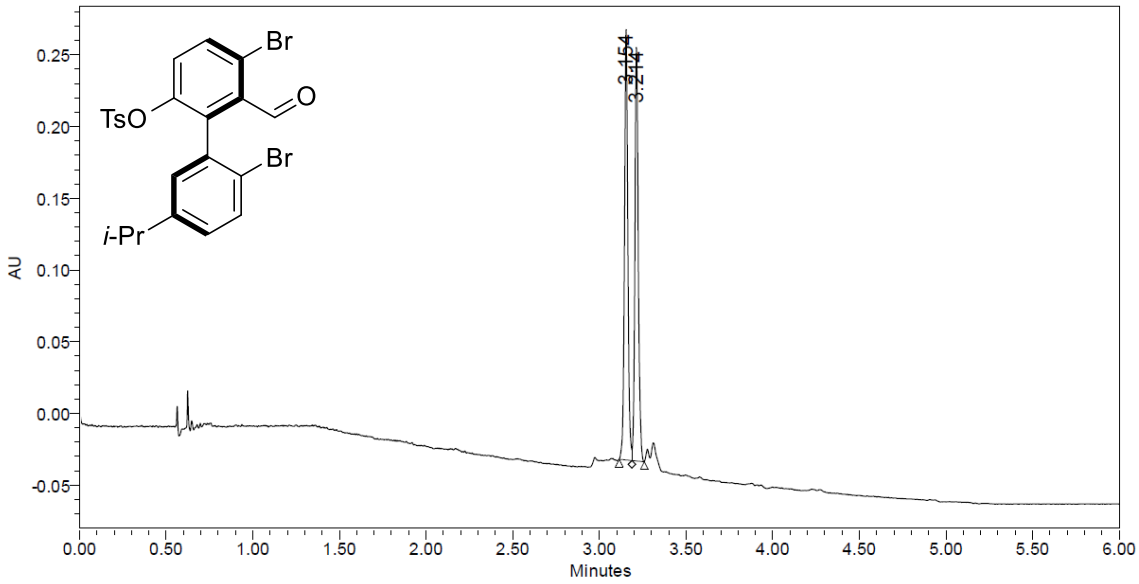
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.765 | 1.06 |
| 2 | 2.851 | 98.94 |

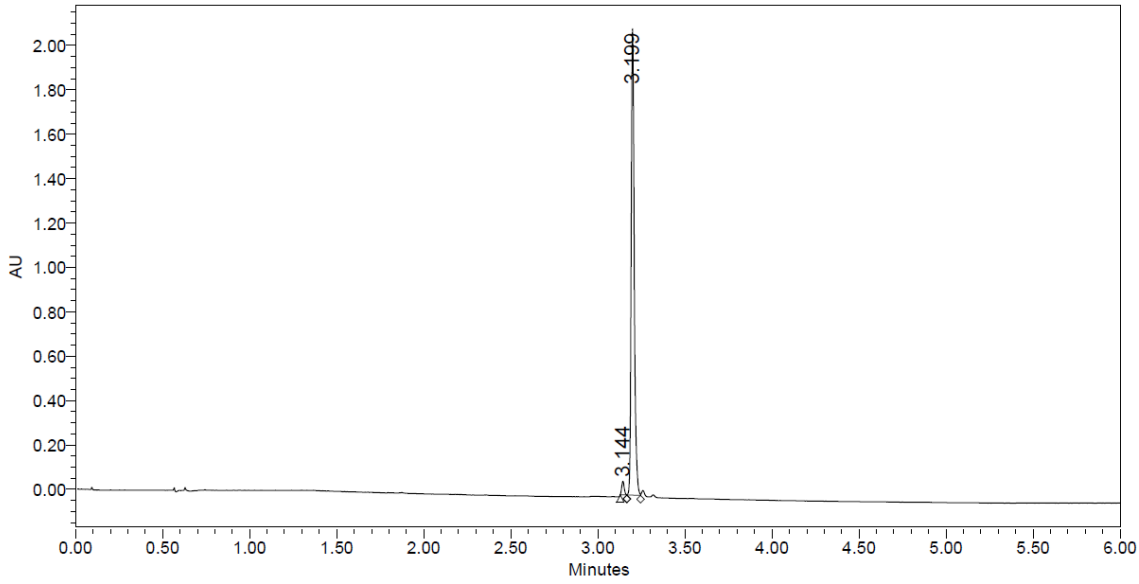
**($S_a$)-2',5-Dibromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (3j).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.154 | 50.78 |
| 2 | 3.214 | 49.22 |

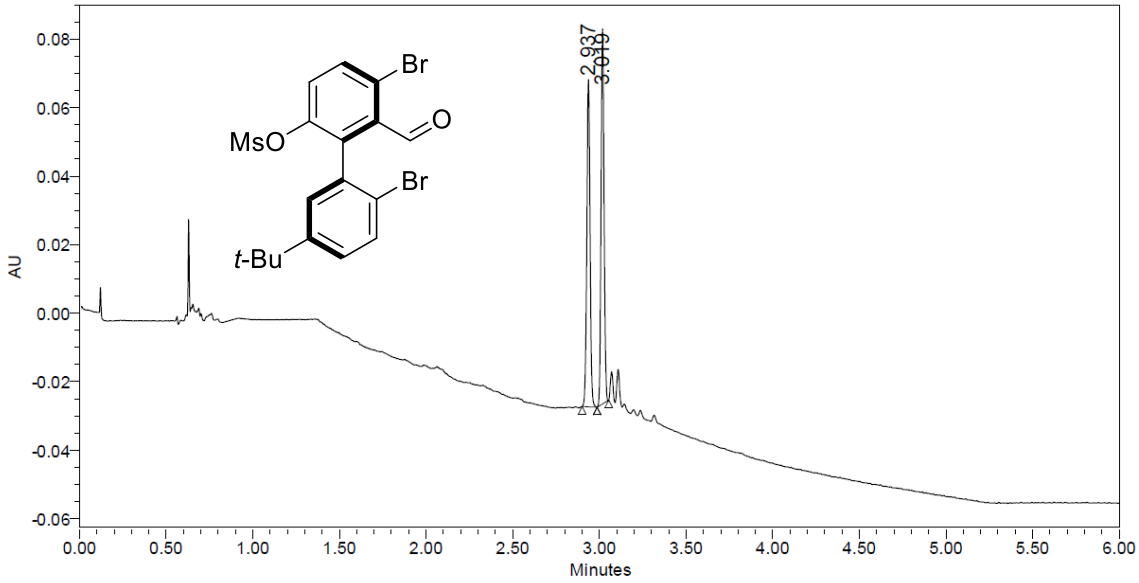
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.144 | 2.34 |
| 2 | 3.199 | 97.66 |

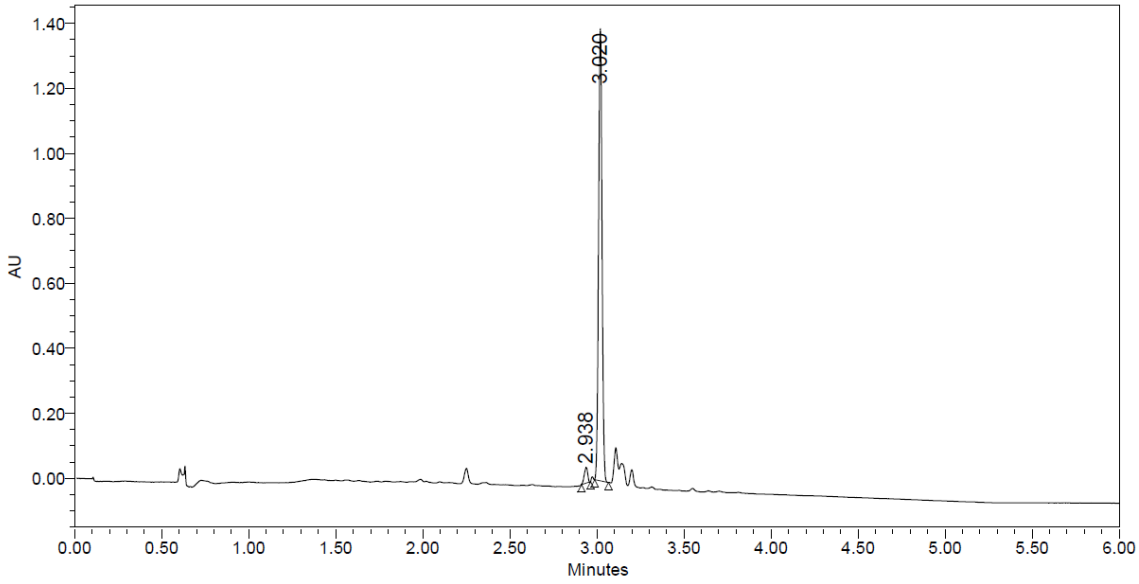
**($S_a$)-2',5-Dibromo-5'-(tert-butyl)-6-formyl-[1,1'-biphenyl]-2-yl methanesulfonate (3k).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.937 | 48.64 |
| 2 | 3.019 | 51.36 |

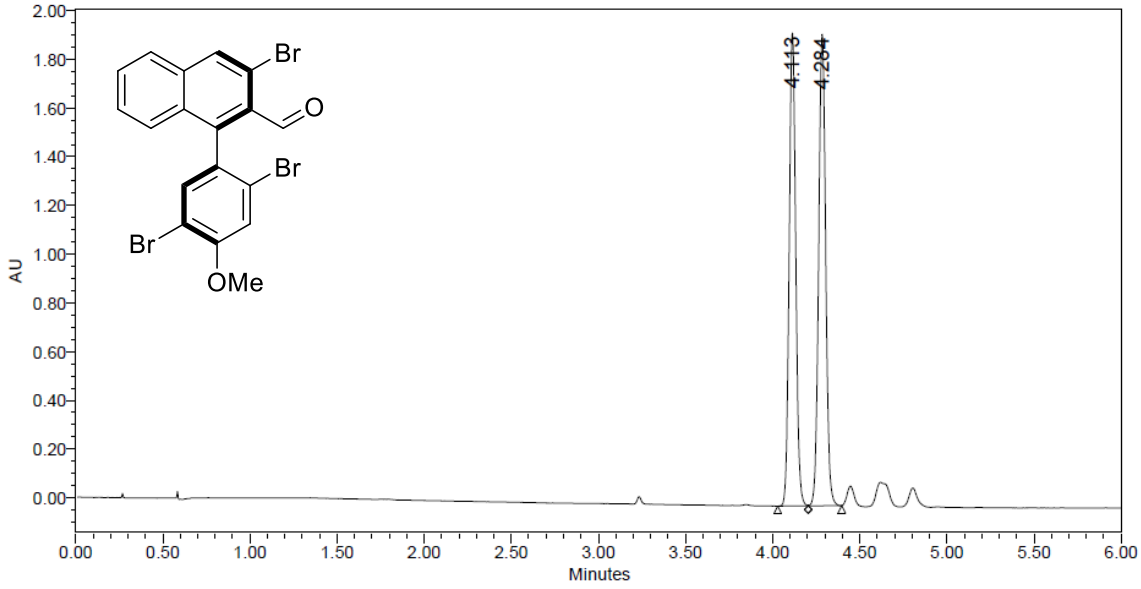
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.938 | 3.27 |
| 2 | 3.020 | 96.73 |

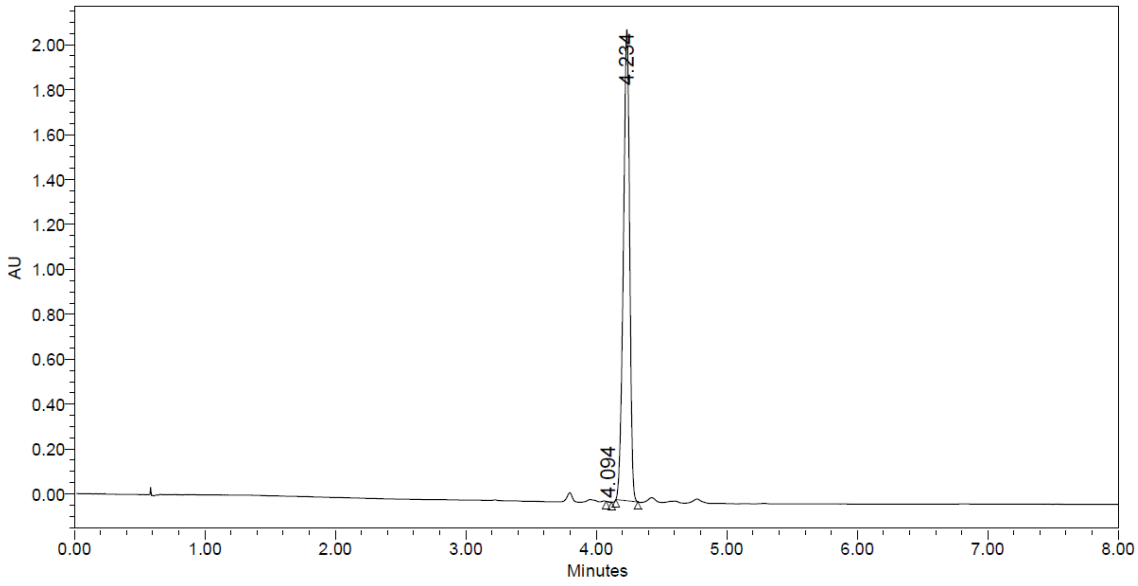
**($R_a$)-3-Bromo-1-(2,5-dibromo-4-methoxyphenyl)-2-naphthaldehyde (3l).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 4.113 | 48.41 |
| 2 | 4.284 | 51.59 |

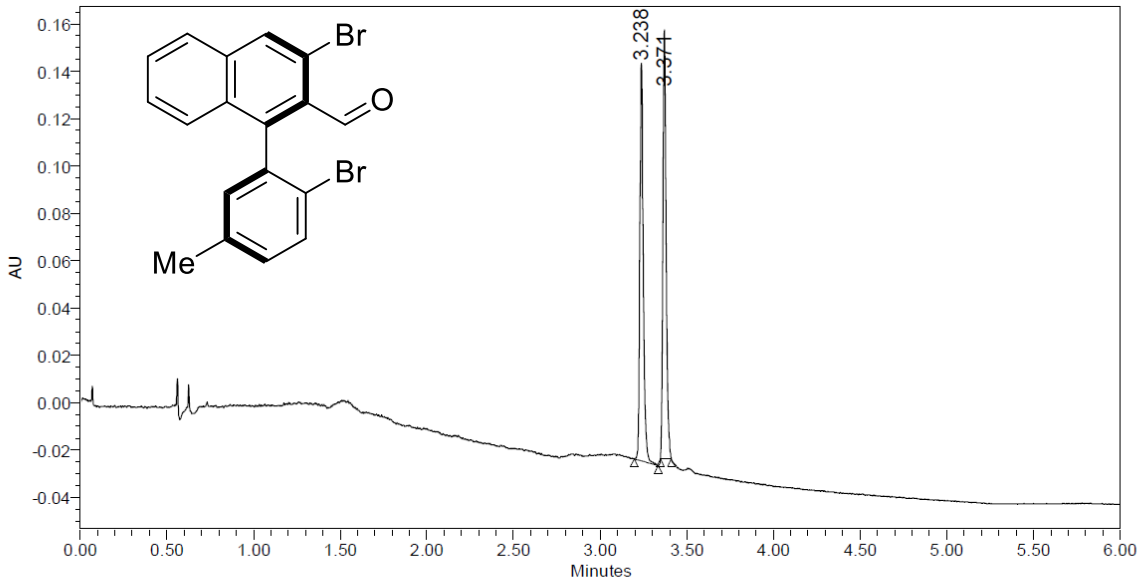
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 4.094 | 0.03 |
| 2 | 4.234 | 99.97 |

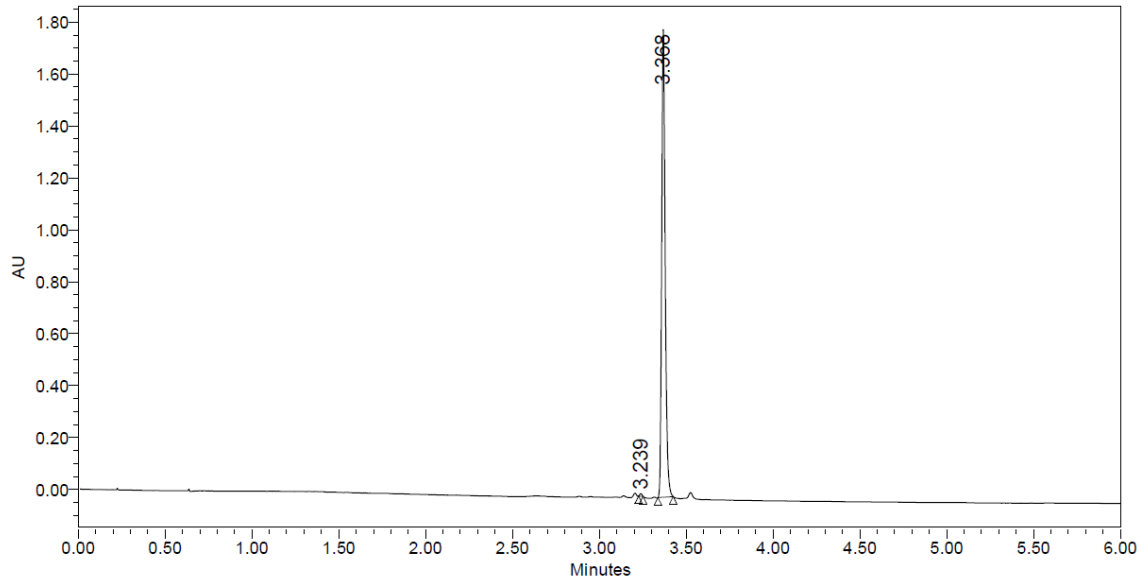
**($R_a$)-3-Bromo-1-(2-bromo-5-methylphenyl)-2-naphthaldehyde (3m).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.238 | 48.67 |
| 2 | 3.371 | 51.33 |

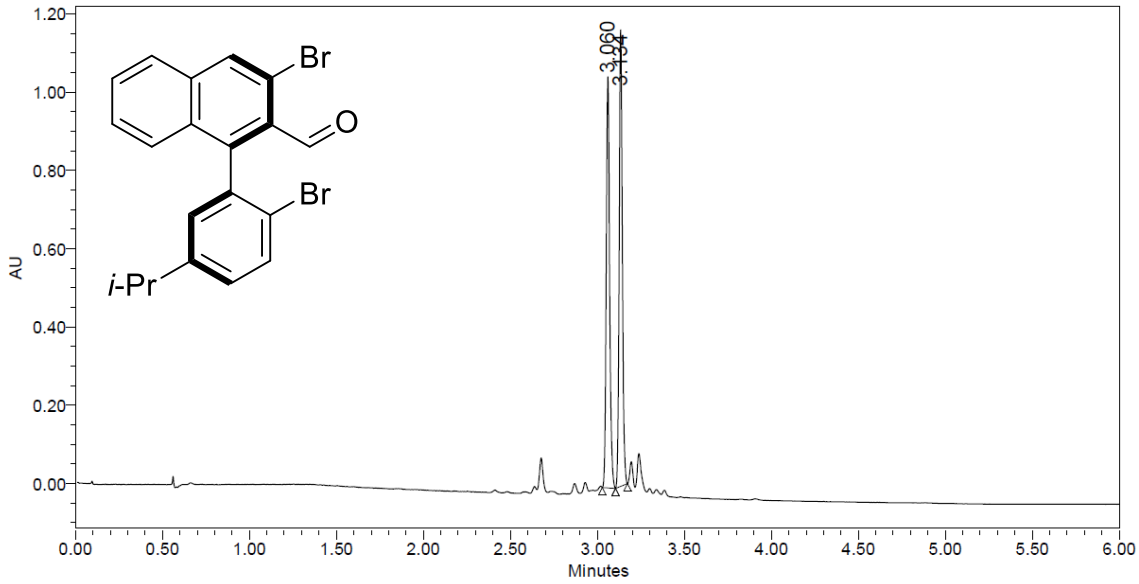
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.239 | 0.34 |
| 2 | 3.368 | 99.66 |

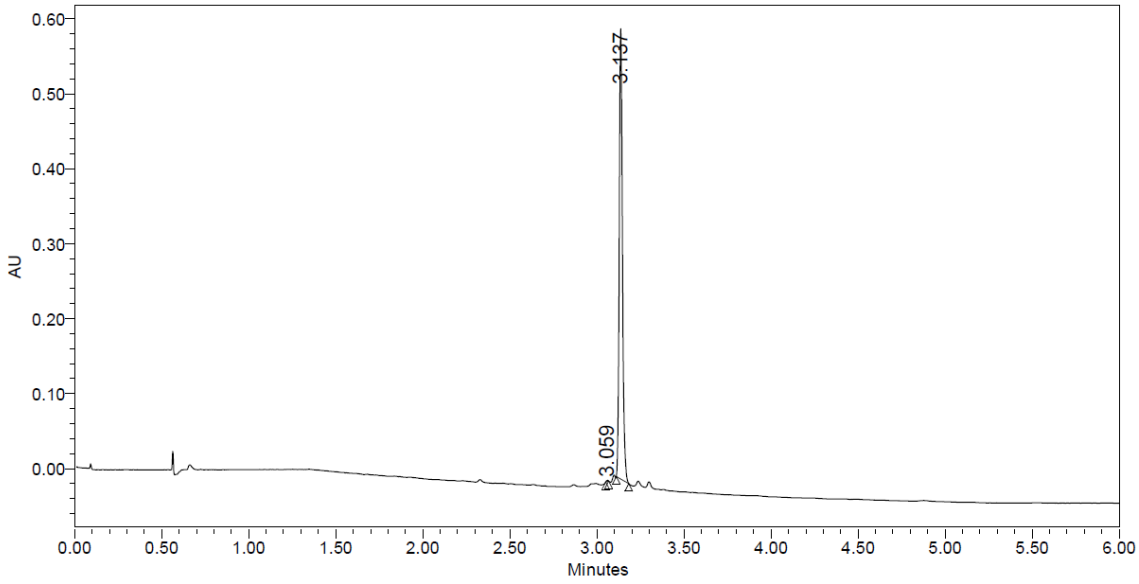
**($R_a$)-3-Bromo-1-(2-bromo-5-*iso*-propylphenyl)-2-naphthaldehyde (3n).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.060 | 49.00 |
| 2 | 3.134 | 51.00 |

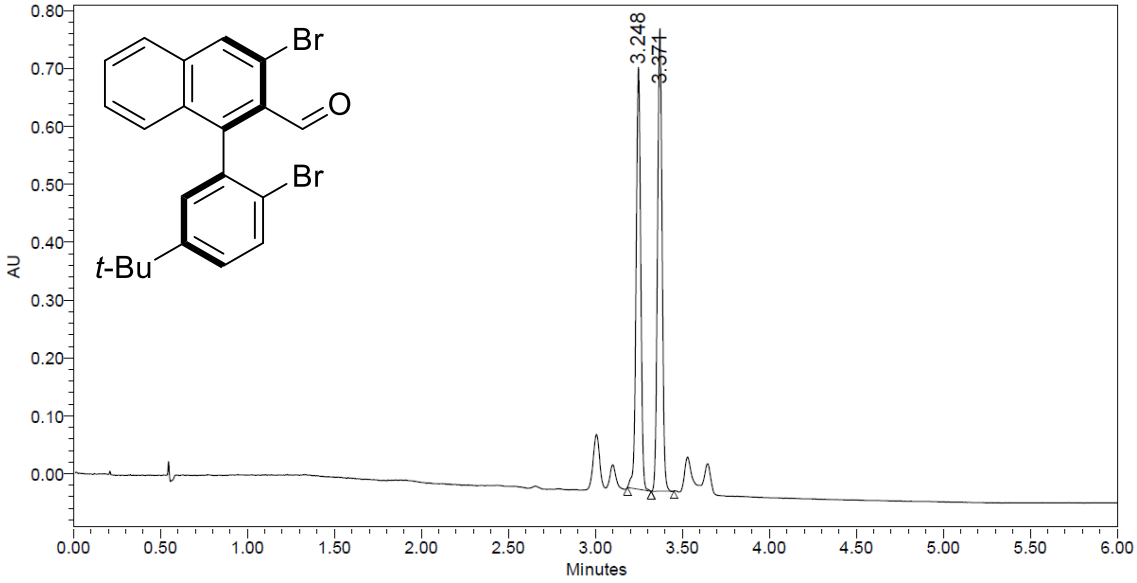
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.059 | 0.12 |
| 2 | 3.137 | 99.88 |

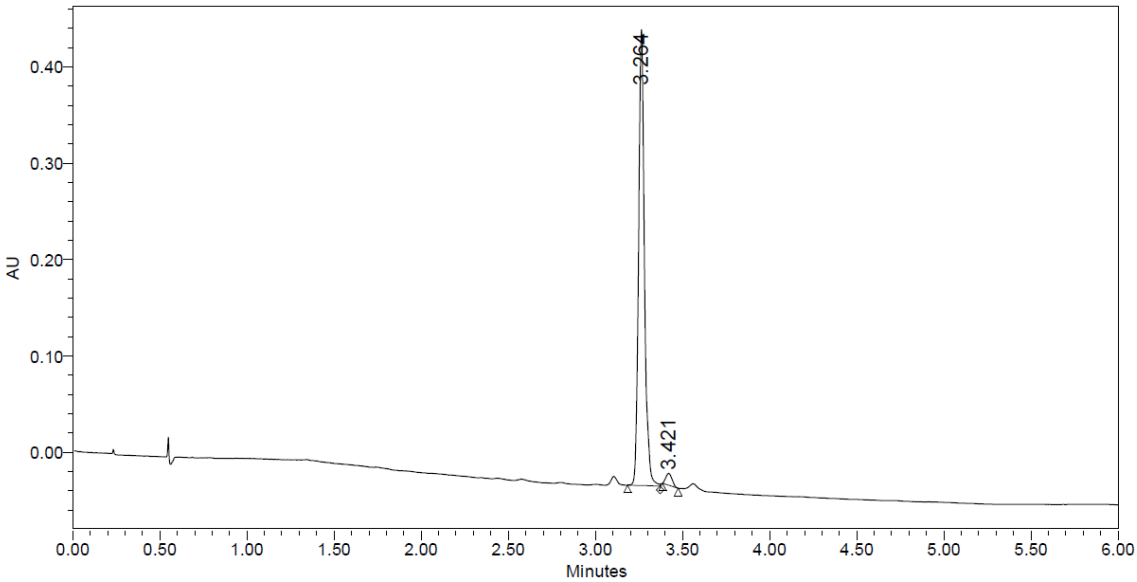
**($R_a$)-3-Bromo-1-(2-bromo-5-tertbutylphenyl)-2-naphthaldehyde (3o).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.248 | 47.96 |
| 2 | 3.371 | 52.04 |

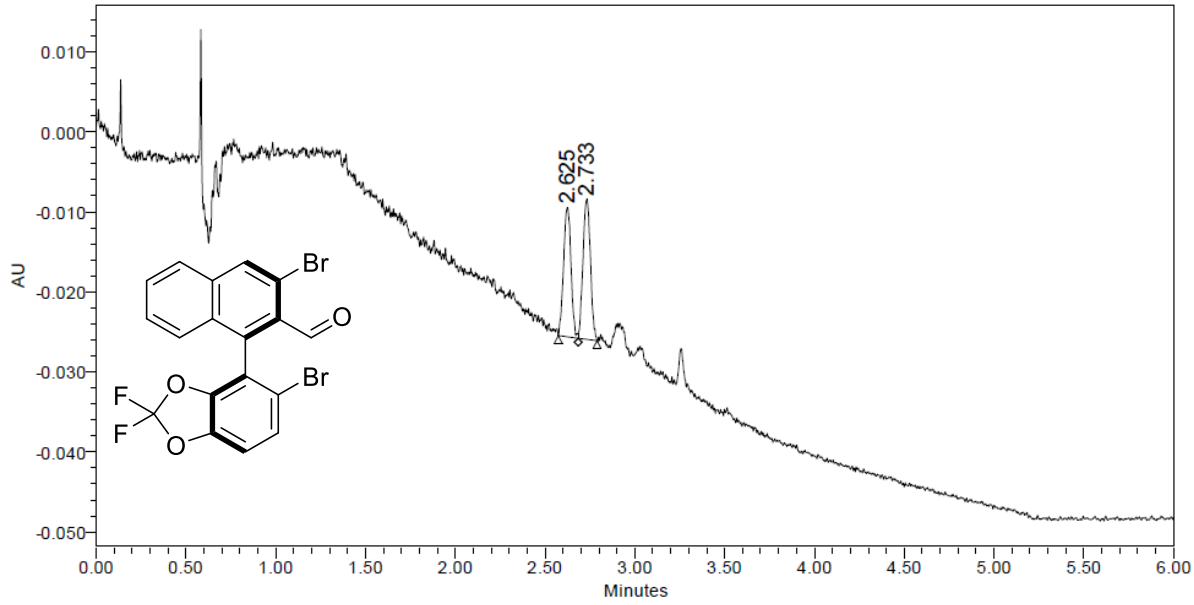
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.264 | 97.32 |
| 2 | 3.421 | 2.68 |

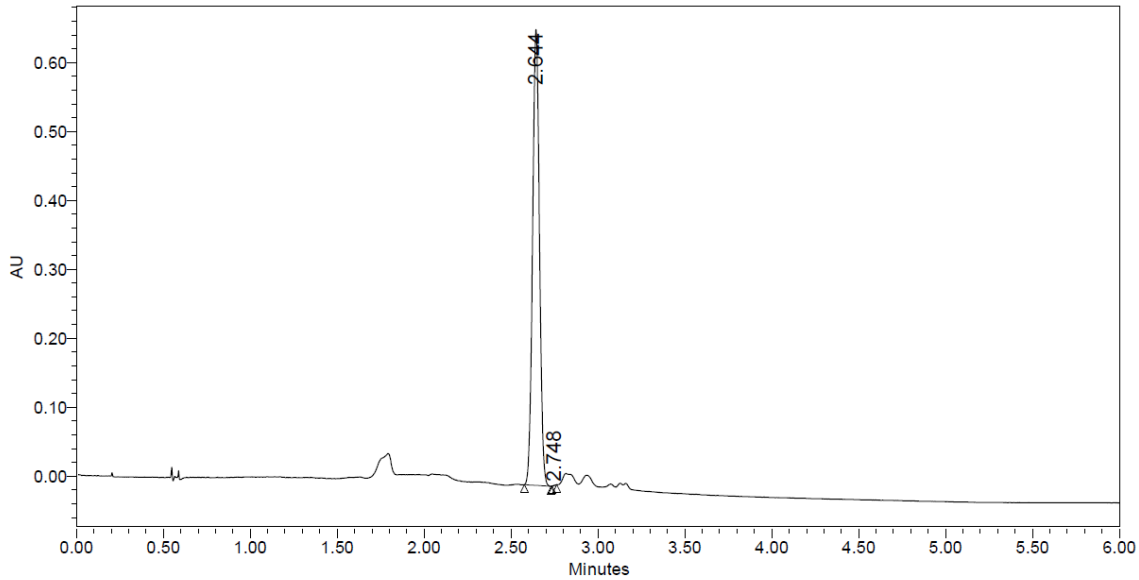
**($R_a$)-3-Bromo-1-(5-bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-2-naphthaldehyde (3p).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.625 | 47.94 |
| 2 | 2.733 | 52.06 |

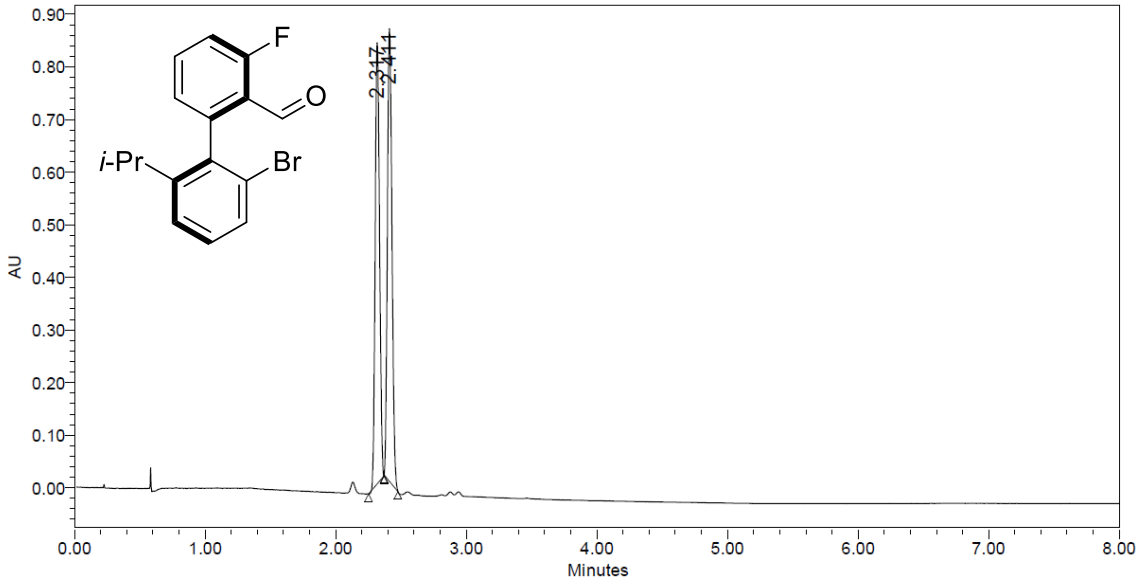
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.644 | 99.99 |
| 2 | 2.748 | 0.01 |

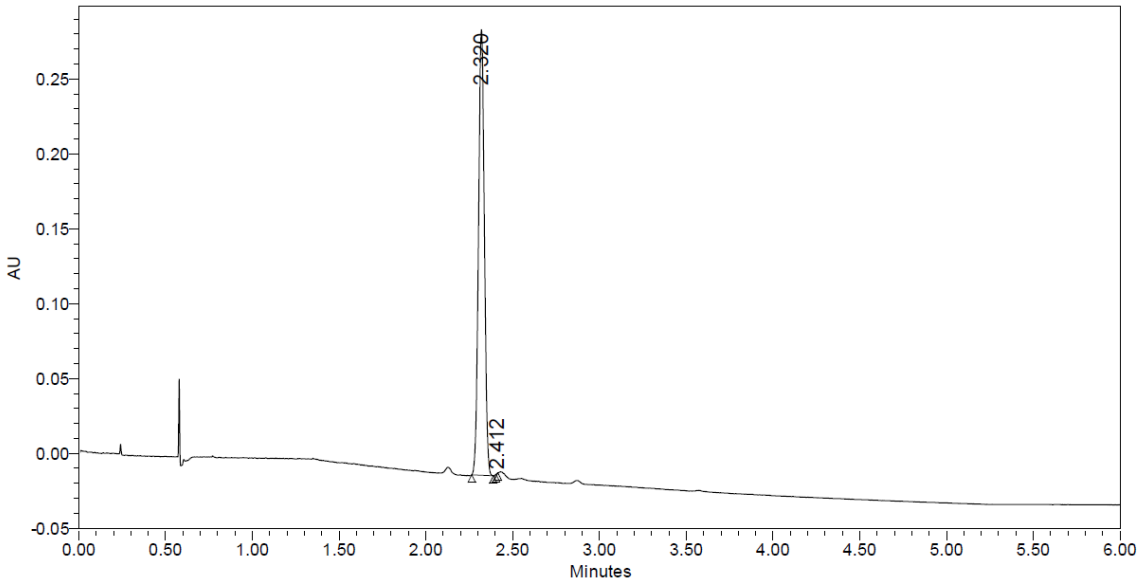
**($R_a$)-2'-Bromo-3-fluoro-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (4q).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.317 | 48.32 |
| 2 | 2.411 | 51.68 |

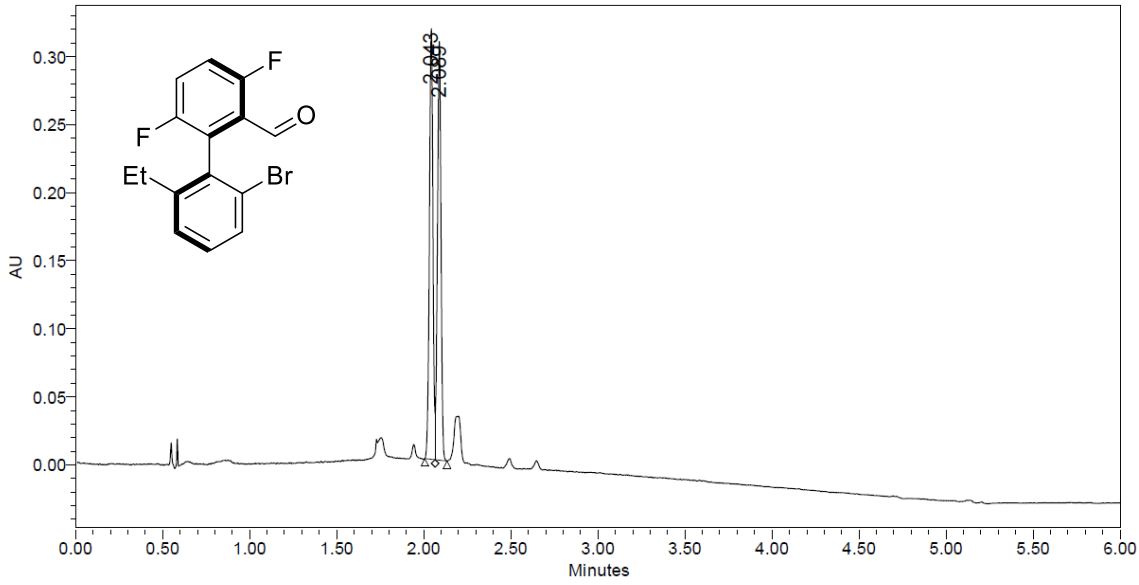
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.320 | 99.99 |
| 2 | 2.412 | 0.01 |

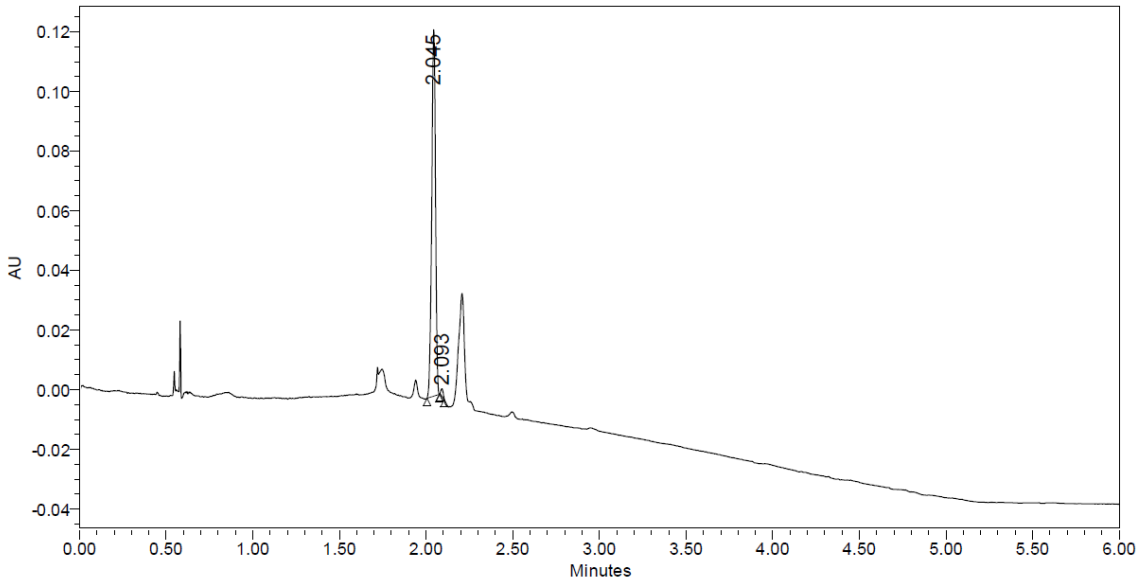
**($S_a$)-2'-Bromo-6'-ethyl-3,6-difluoro-[1,1'-biphenyl]-2-carbaldehyde (4r).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.043 | 50.48 |
| 2 | 2.089 | 49.52 |

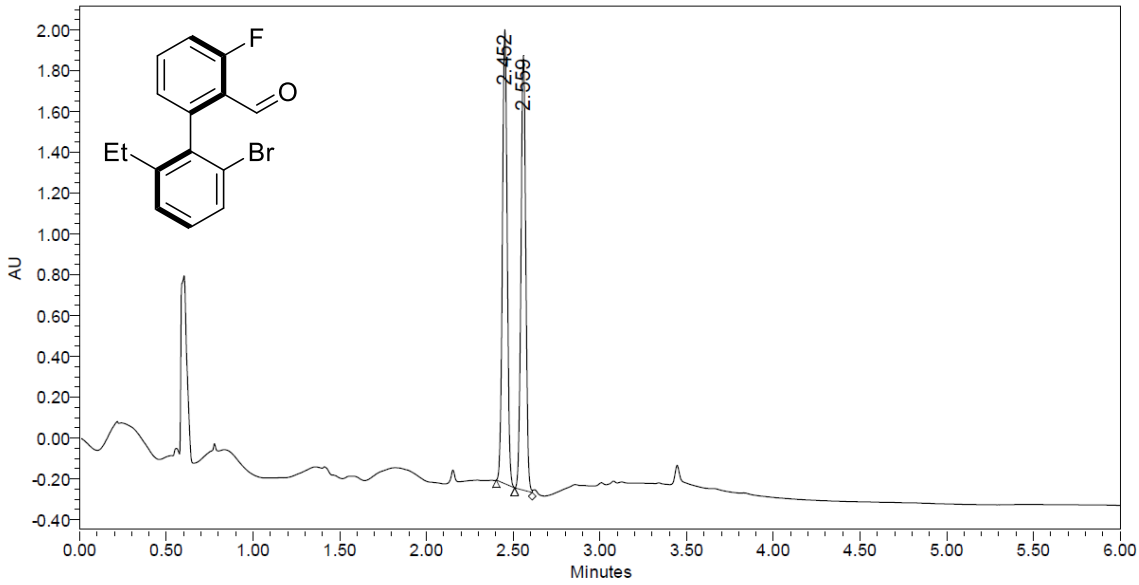
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.045 | 98.76 |
| 2 | 2.093 | 1.24 |

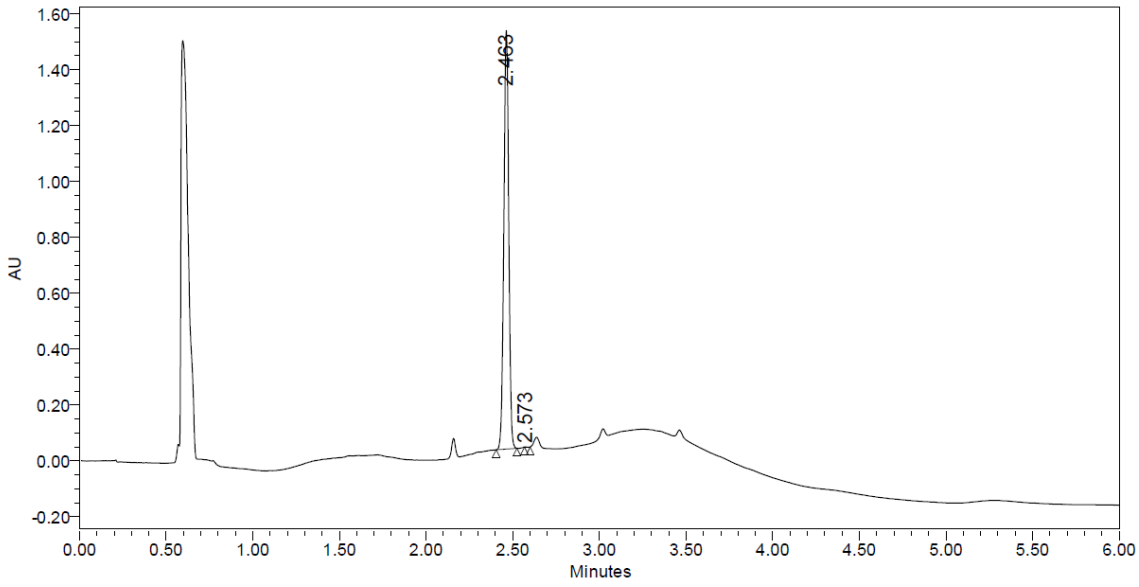
**($R_a$)-2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (4s).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.452 | 50.92 |
| 2 | 2.559 | 49.08 |

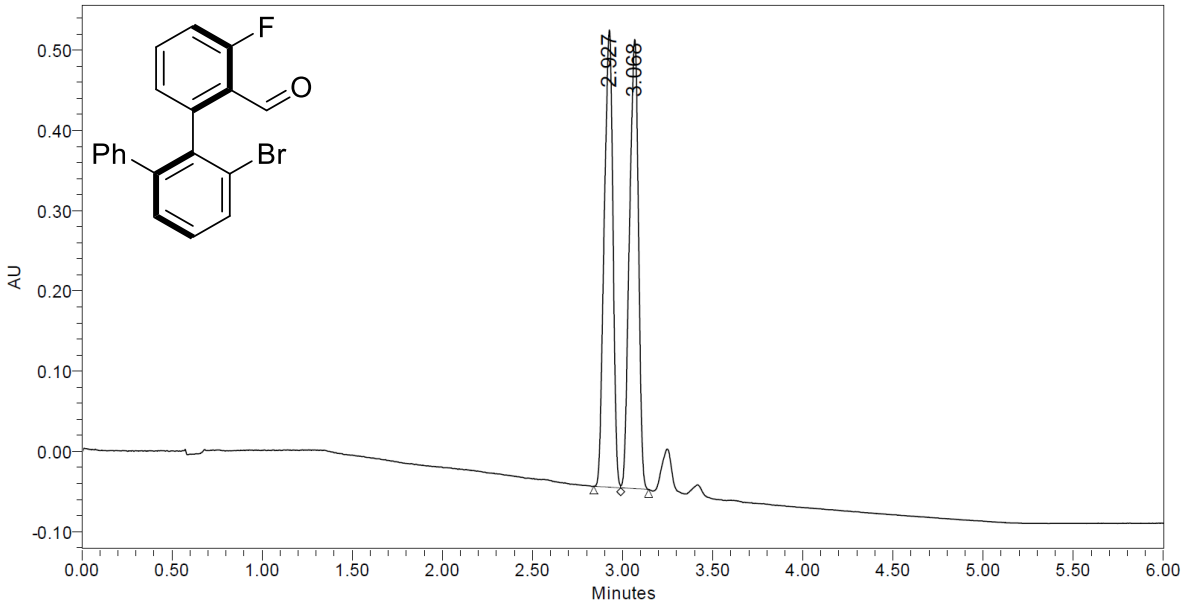
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.463 | 99.96 |
| 2 | 2.573 | 0.04 |

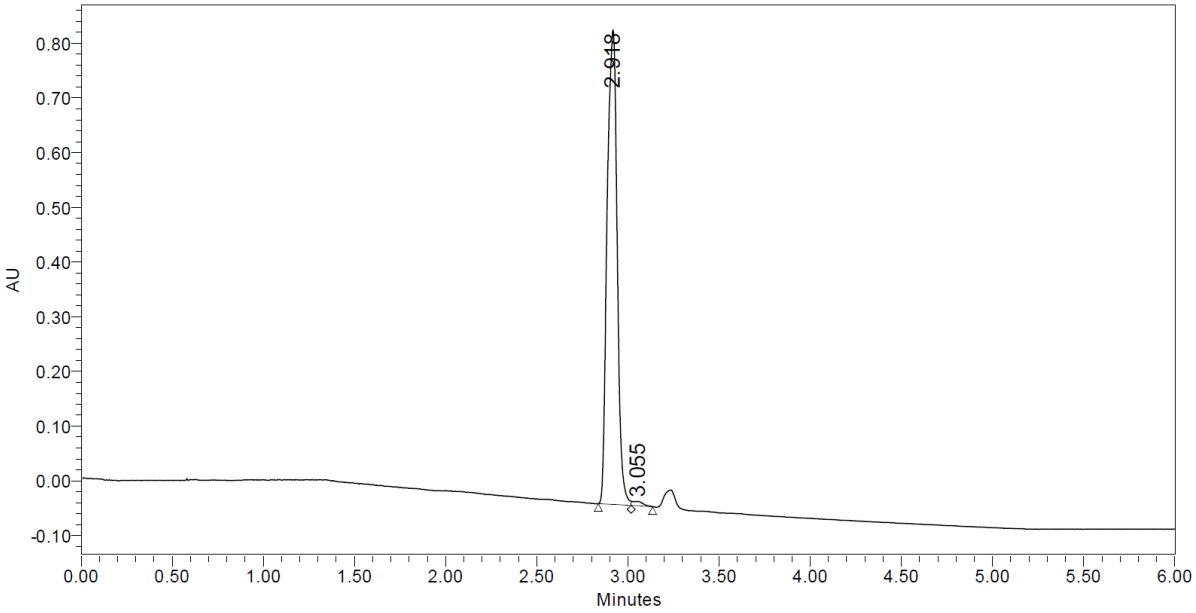
**($R_a$)-6'-Bromo-3-fluoro-[1,1':2',1''-terphenyl]-2-carbaldehyde (4ϕ).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.927 | 49.61 |
| 2 | 3.068 | 50.39 |

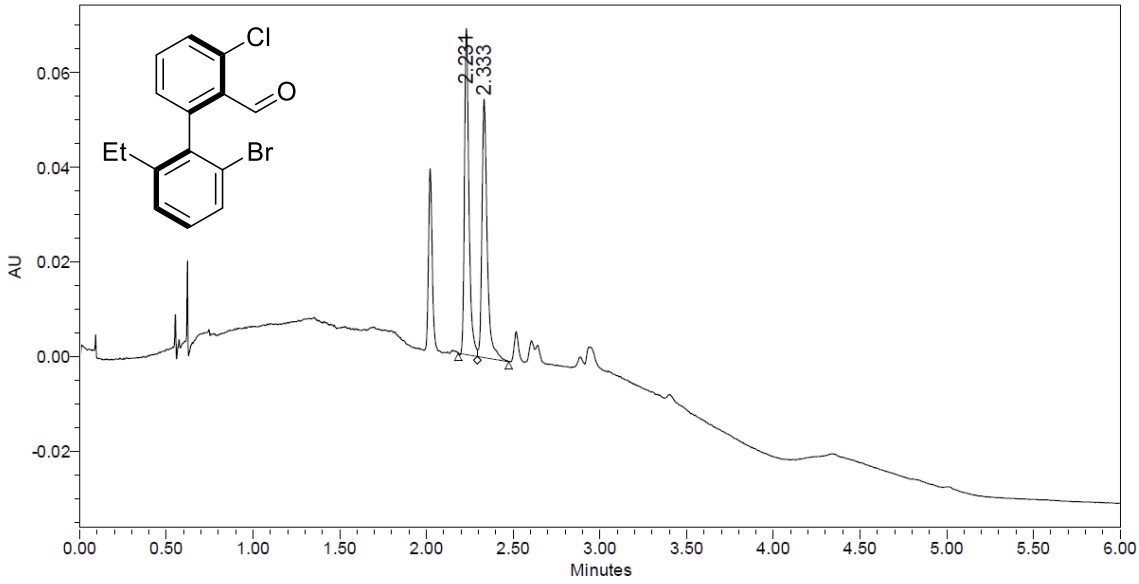
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.055 | 0.97 |
| 2 | 2.918 | 99.03 |

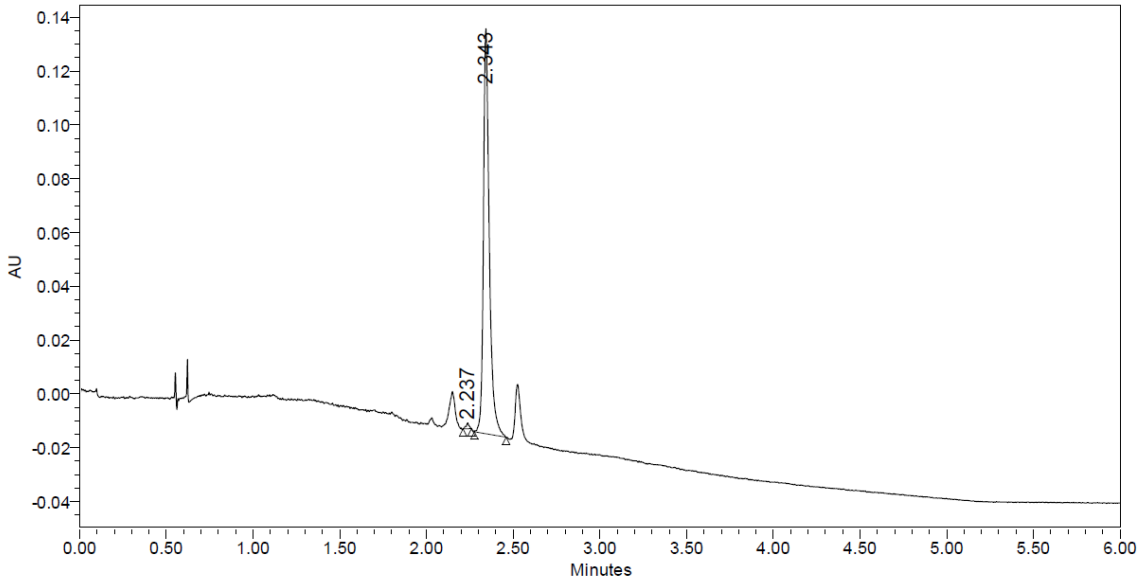
**($R_a$)-2'-Bromo-3-chloro-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (4u).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.231 | 51.78 |
| 2 | 2.333 | 48.22 |

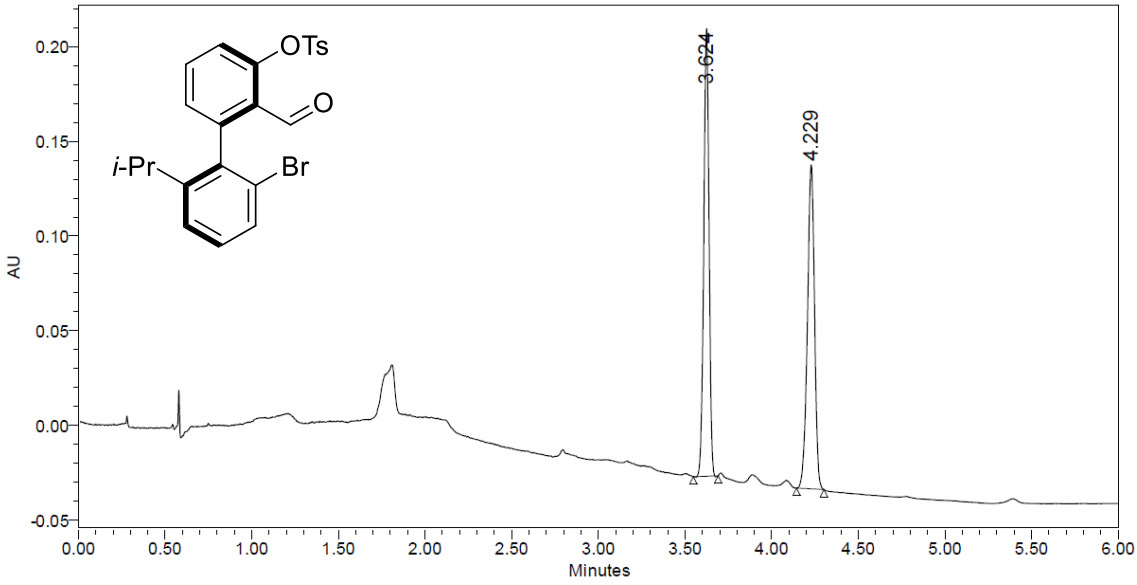
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.237 | 0.72 |
| 2 | 2.343 | 99.28 |

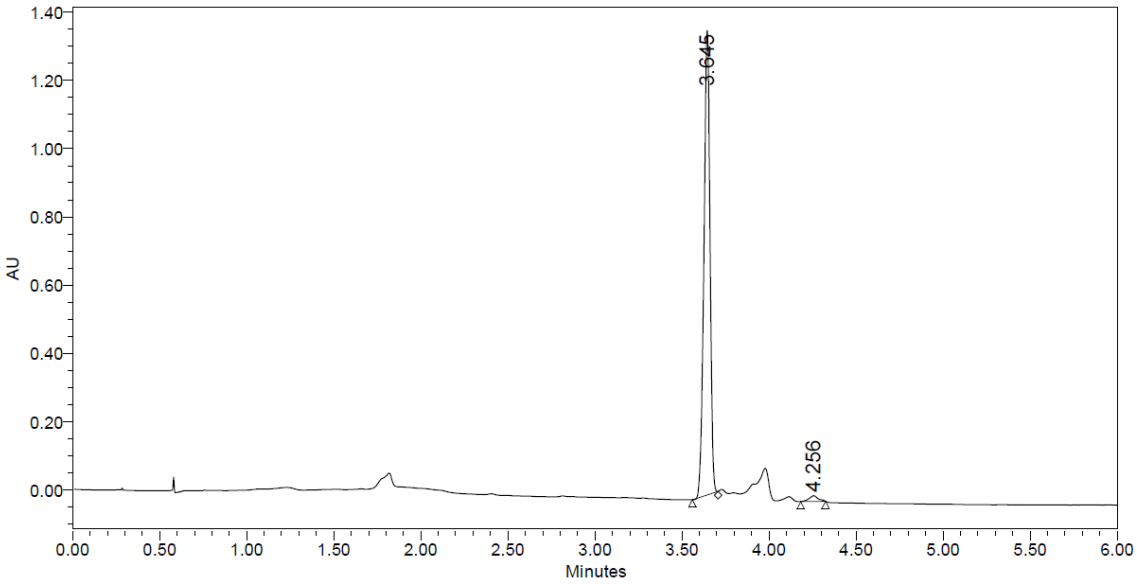
**($R_a$)-2'-Bromo-2-formyl-6'-*iso*-propyl-[1,1'-biphenyl]-3-yl 4-methylbenzenesulfonate (4v).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.624 | 50.51 |
| 2 | 4.229 | 49.49 |

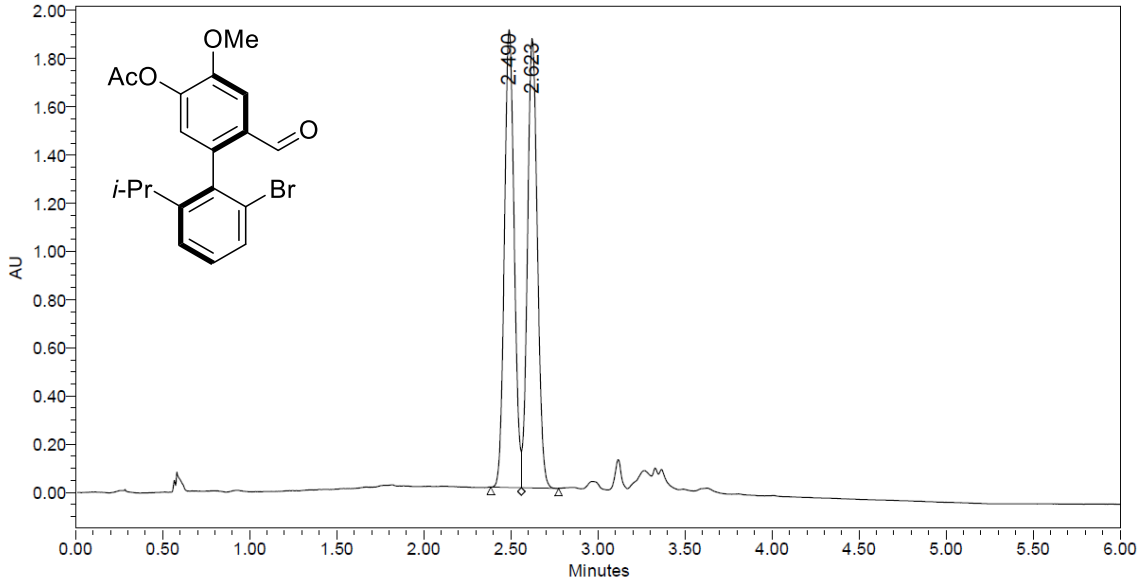
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.645 | 98.21 |
| 2 | 4.256 | 1.79 |

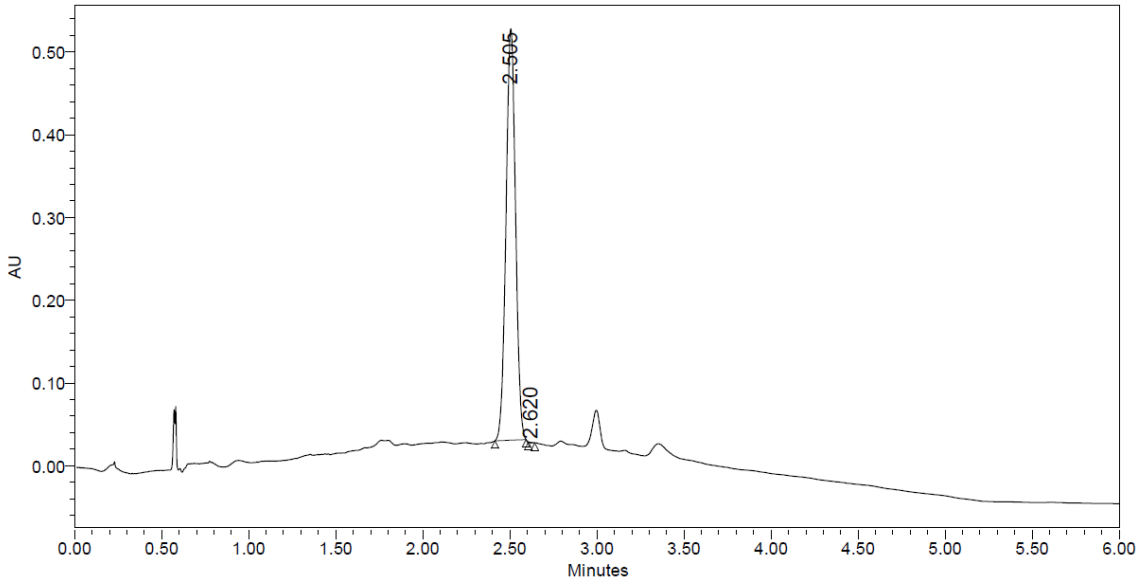
**($R_a$)-2'-Bromo-6'-*iso*-propyl-6-formyl-4-methoxy-[1,1'-biphenyl]-3-yl acetate (4w).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.623 | 49.88 |
| 2 | 2.490 | 50.12 |

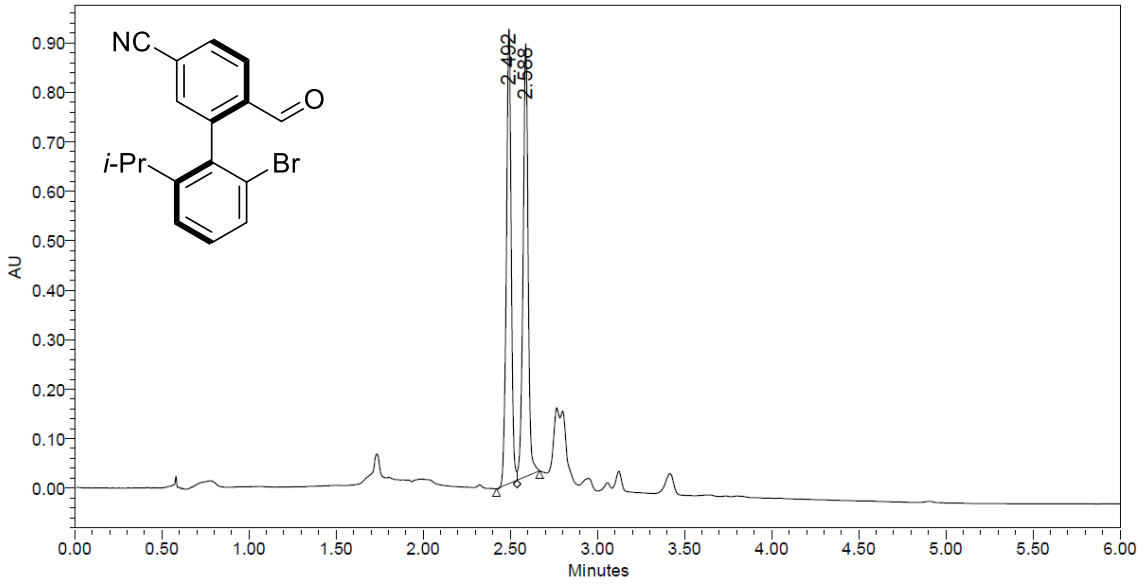
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.505 | 99.96 |
| 2 | 2.620 | 0.04 |

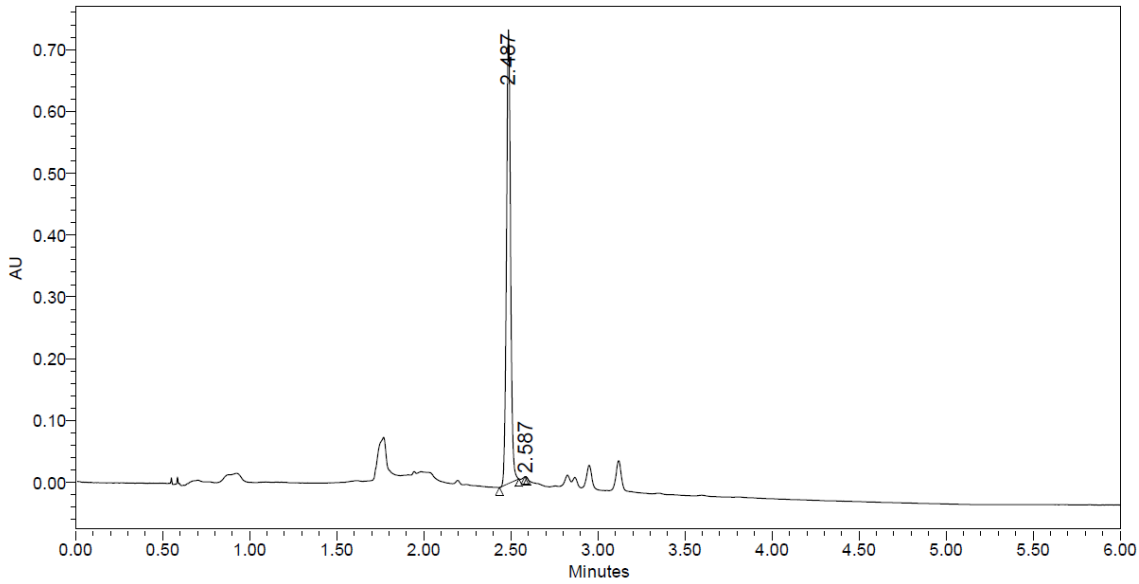
**($R_a$)-2'-Bromo-6'-*iso*-propyl-6-formyl-[1,1'-biphenyl]-3-carbonitrile (4x).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.492 | 50.16 |
| 2 | 2.588 | 49.84 |

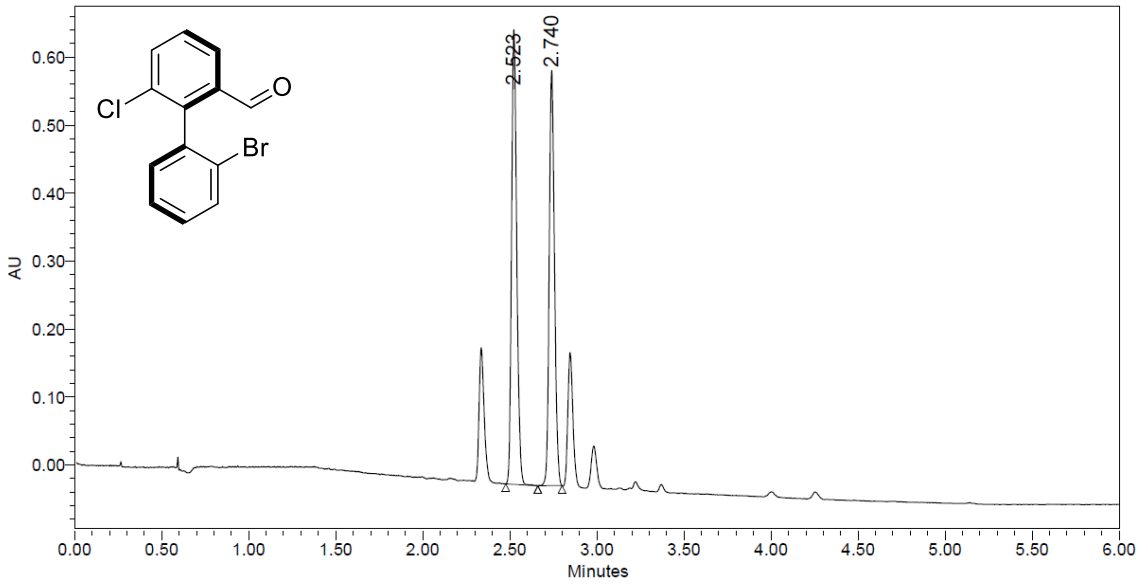
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.487 | 99.97 |
| 2 | 2.587 | 0.03 |

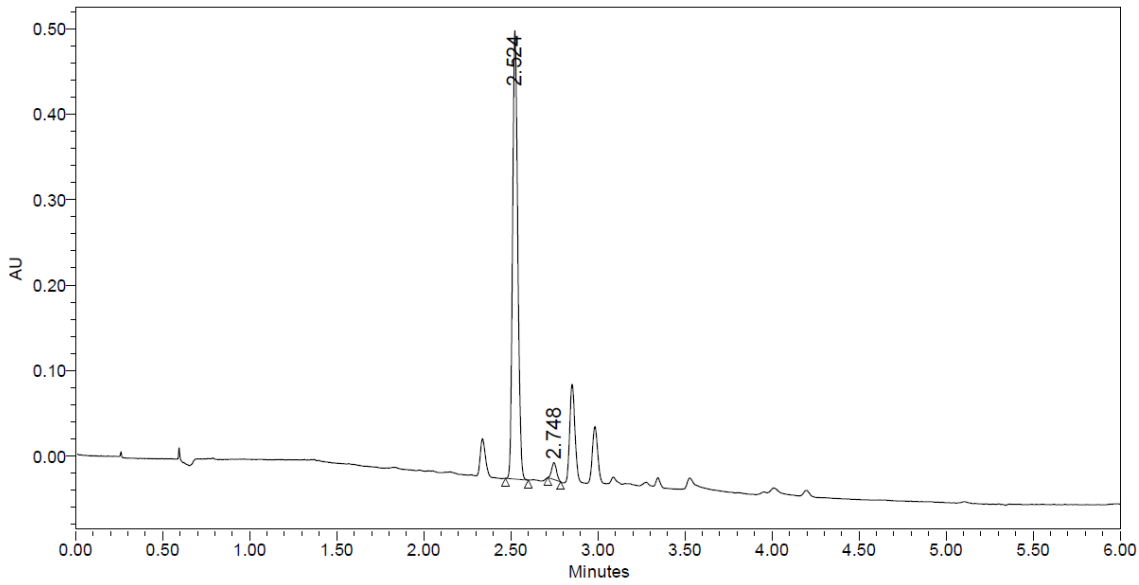
**($S_a$)-2'-Bromo-6-chloro-[1,1'-biphenyl]-2-carbaldehyde (4y).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.523 | 51.75 |
| 2 | 2.740 | 48.25 |

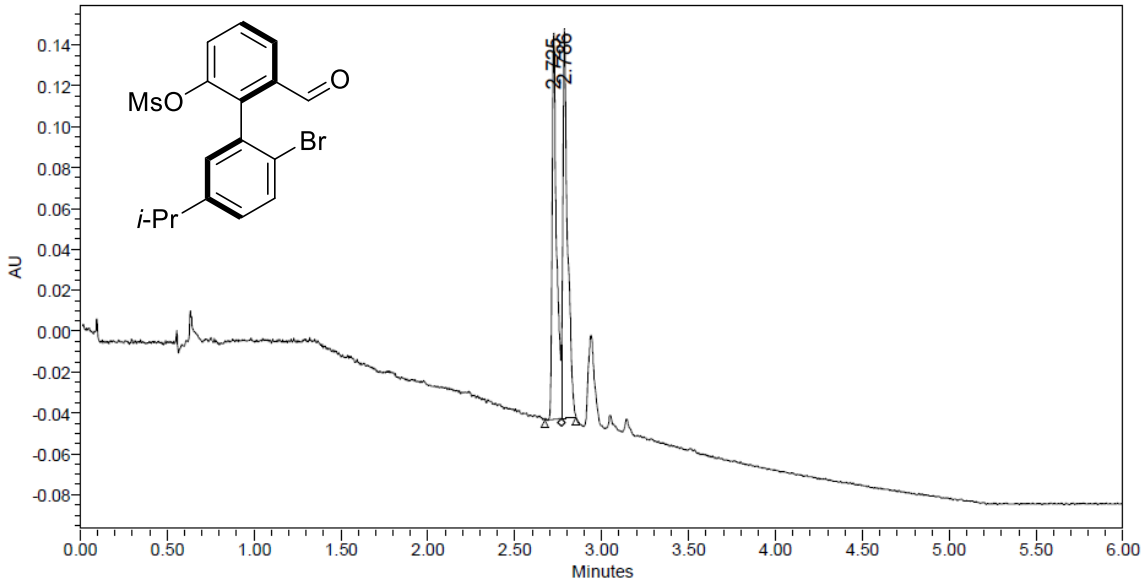
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.524 | 96.56 |
| 2 | 2.748 | 3.44 |

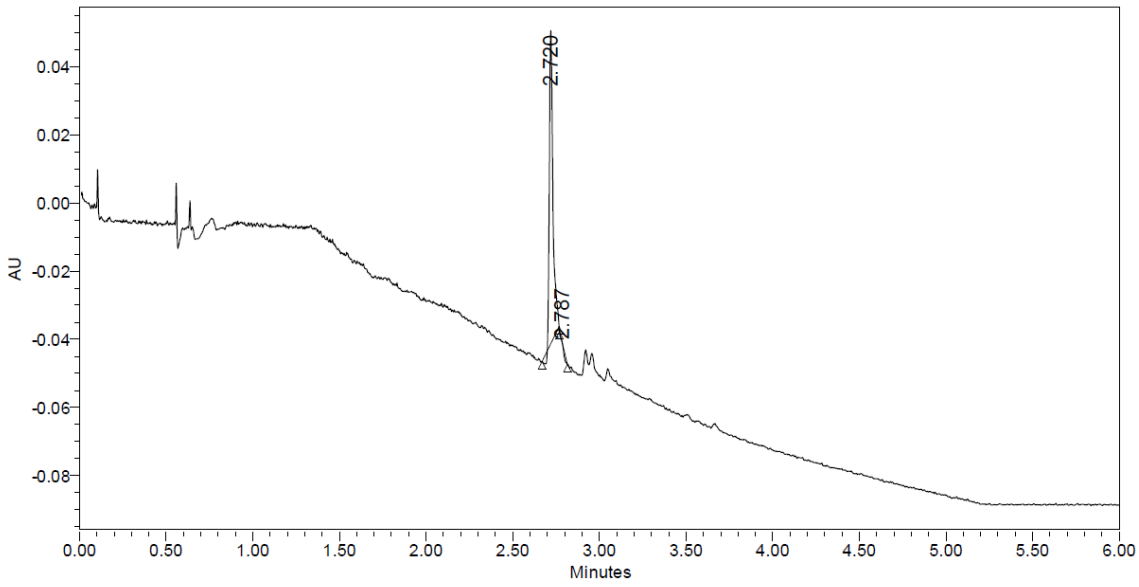
**($S_a$)-2'-Bromo-6-formyl-5'-*iso*-propyl-[1,1'-biphenyl]-2-yl methanesulfonate (4i).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.725 | 47.94 |
| 2 | 2.786 | 52.06 |

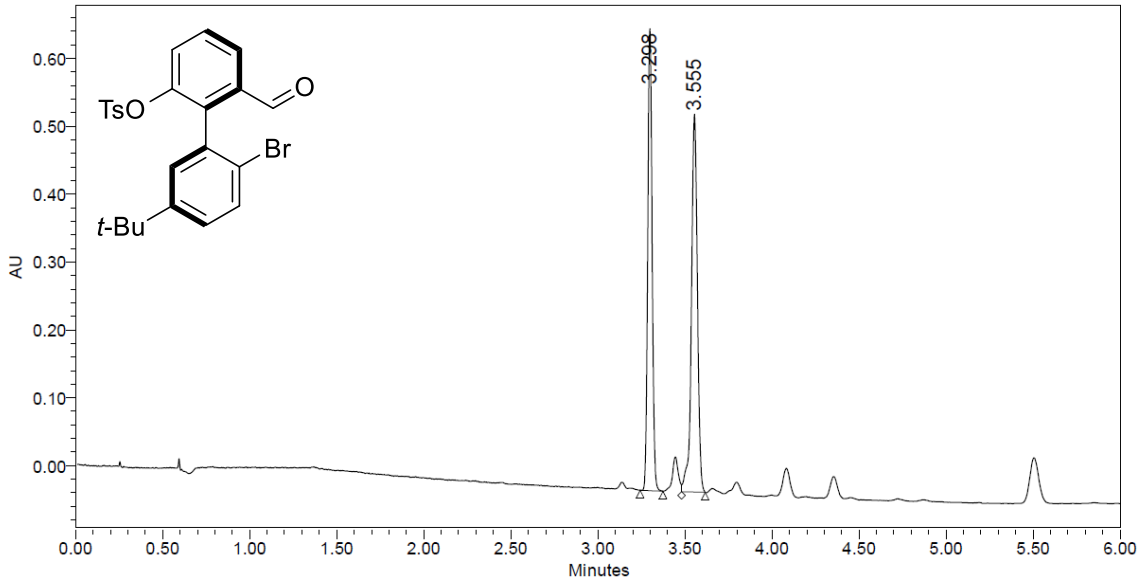
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.720 | 98.50 |
| 2 | 2.787 | 1.50 |

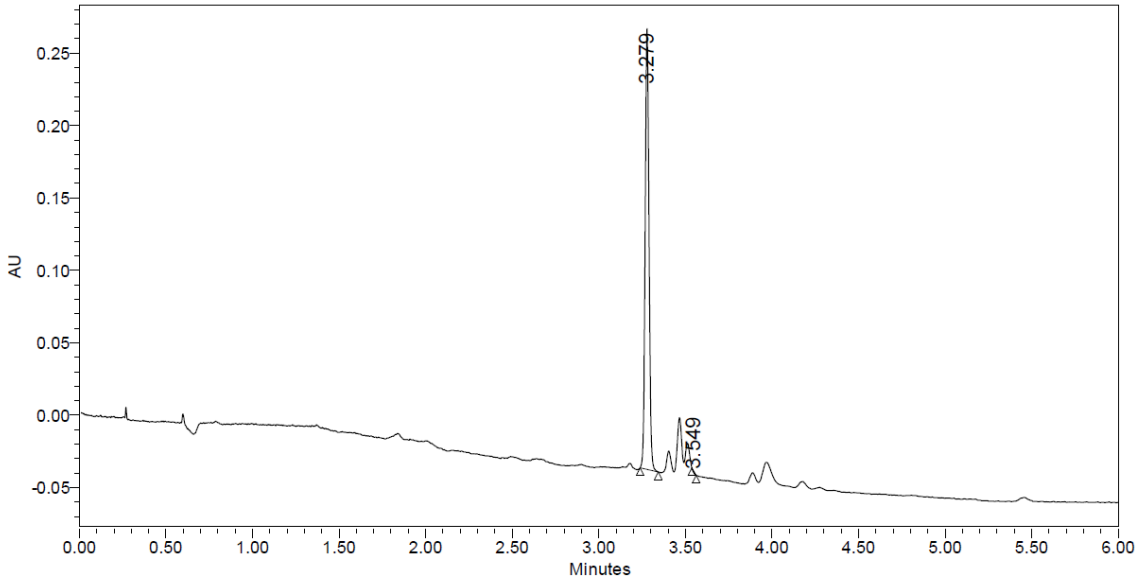
**($S_a$)-2'-Bromo-5'-(tert-butyl)-6-formyl-[1,1'-biphenyl]-2-yl 4-methylbenzenesulfonate (4z).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.298 | 47.29 |
| 2 | 3.555 | 52.71 |

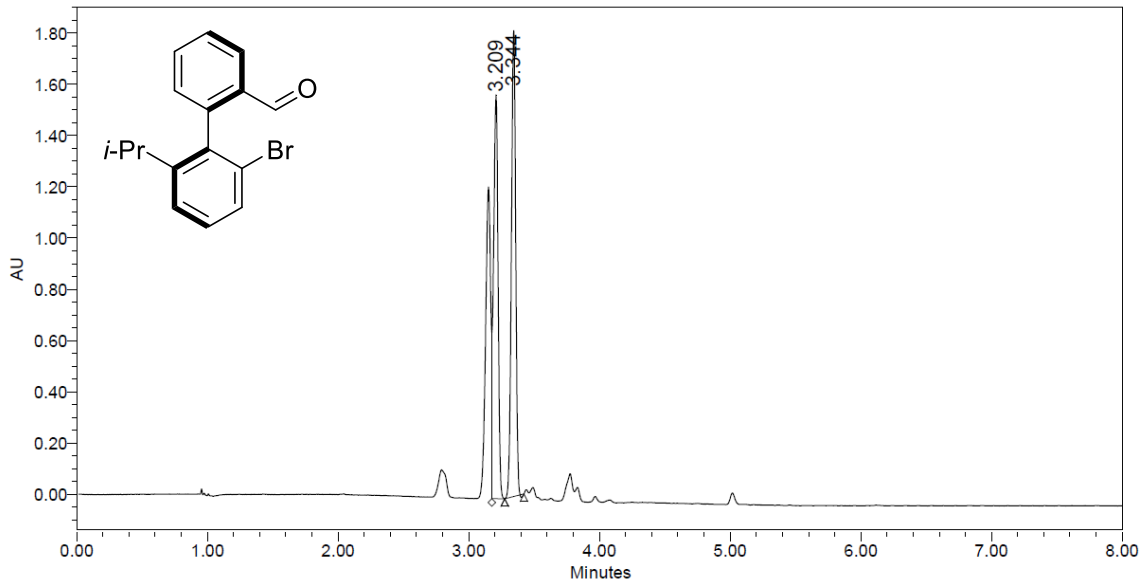
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.279 | 99.78 |
| 2 | 3.549 | 0.22 |

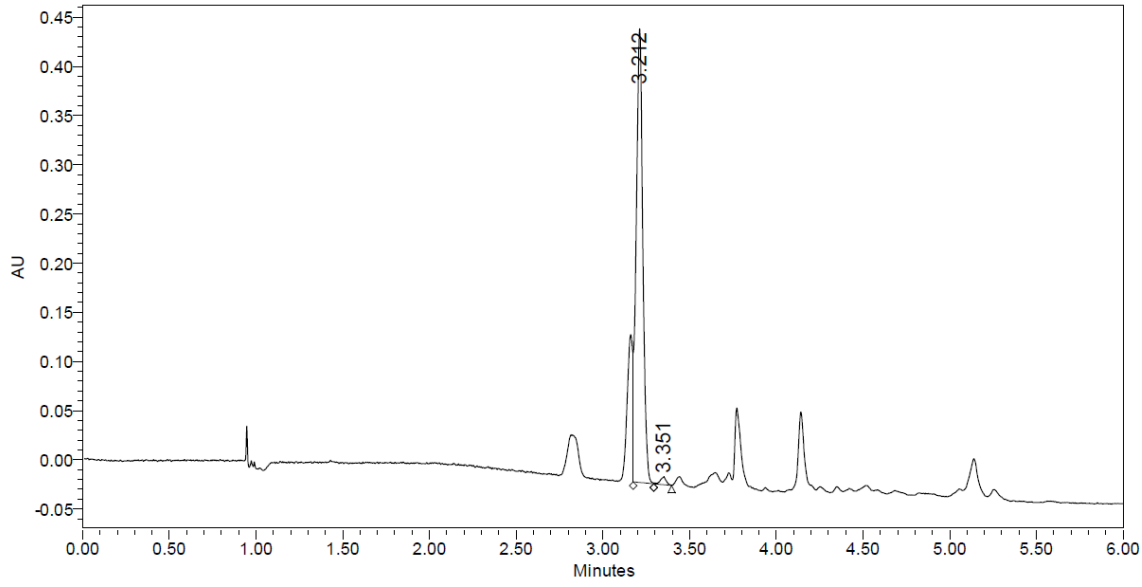
**($R_a$)-2'-Bromo-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (4a).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.209 | 47.93 |
| 2 | 3.344 | 52.07 |

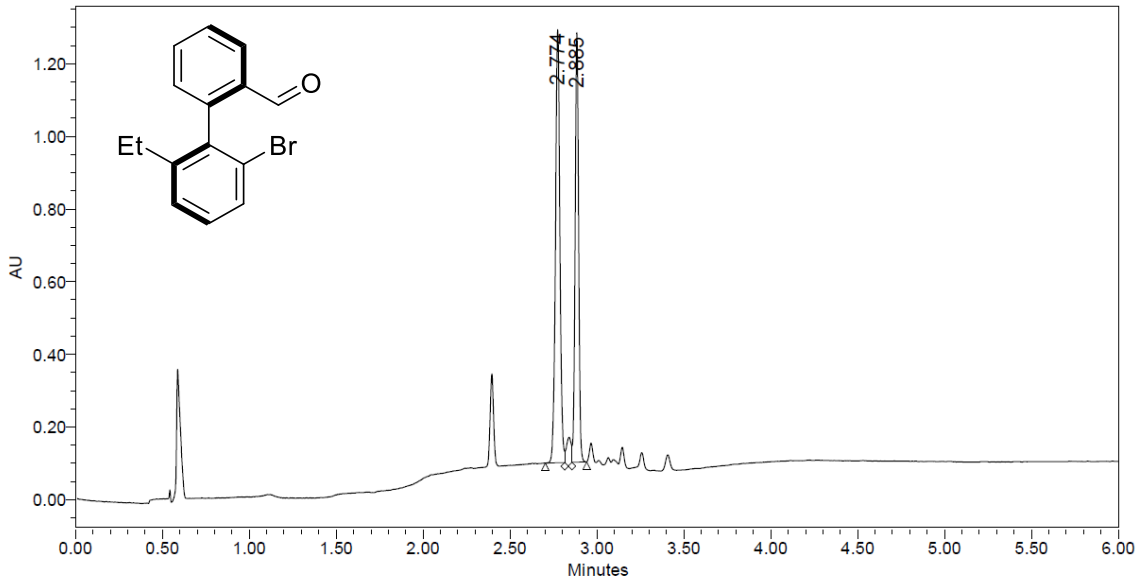
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.212 | 98.50 |
| 2 | 3.351 | 1.50 |

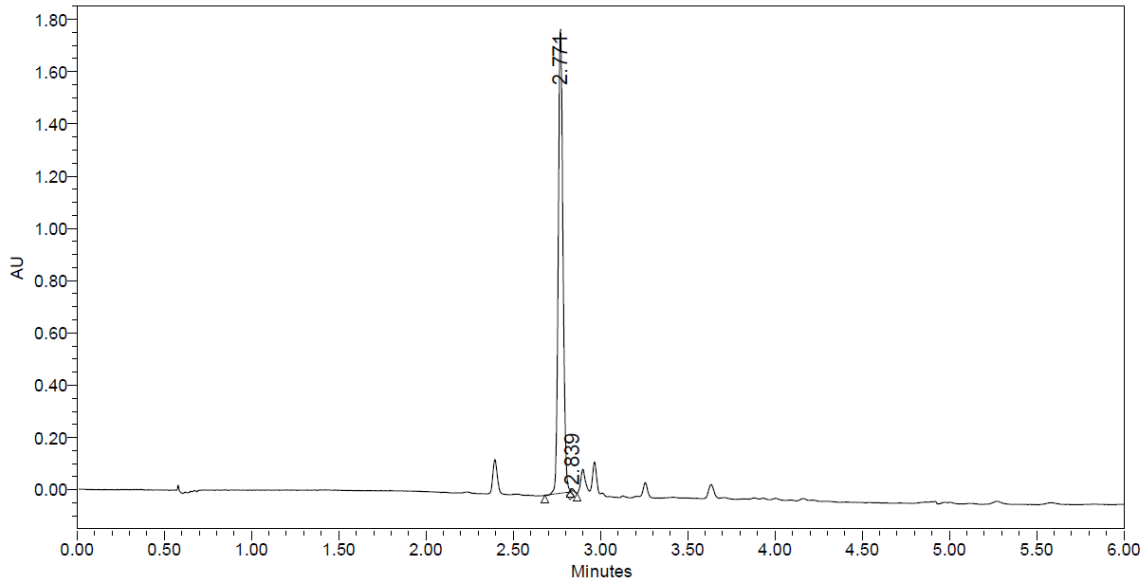
**($R_a$)-2'-Bromo-6'-ethyl-[1,1'-biphenyl]-2-carbaldehyde (4b).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.774 | 56.23 |
| 2 | 2.885 | 43.77 |

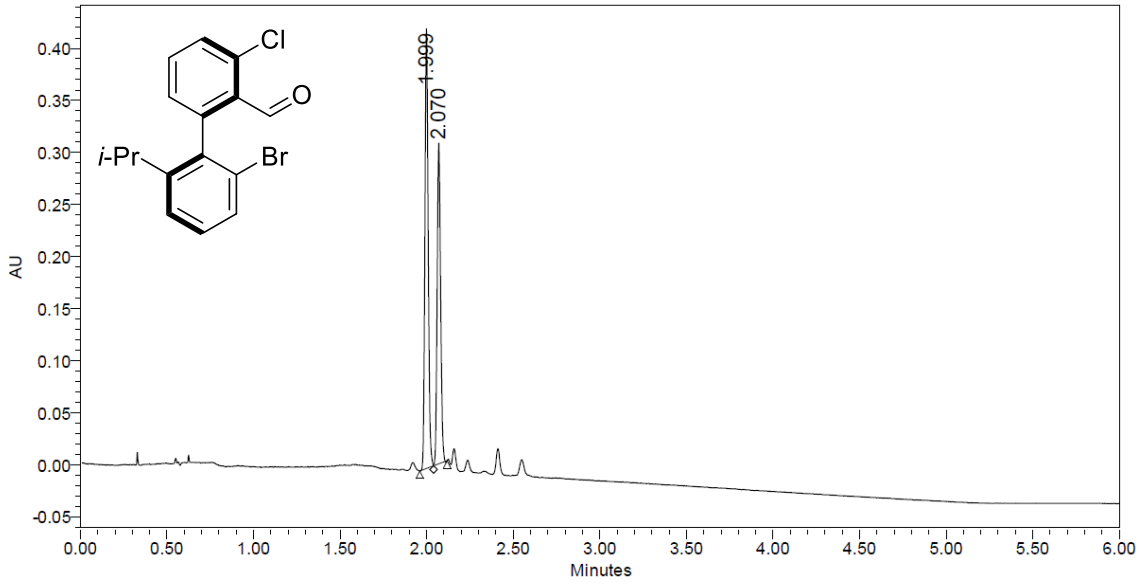
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.771 | 99.76 |
| 2 | 2.839 | 0.24 |

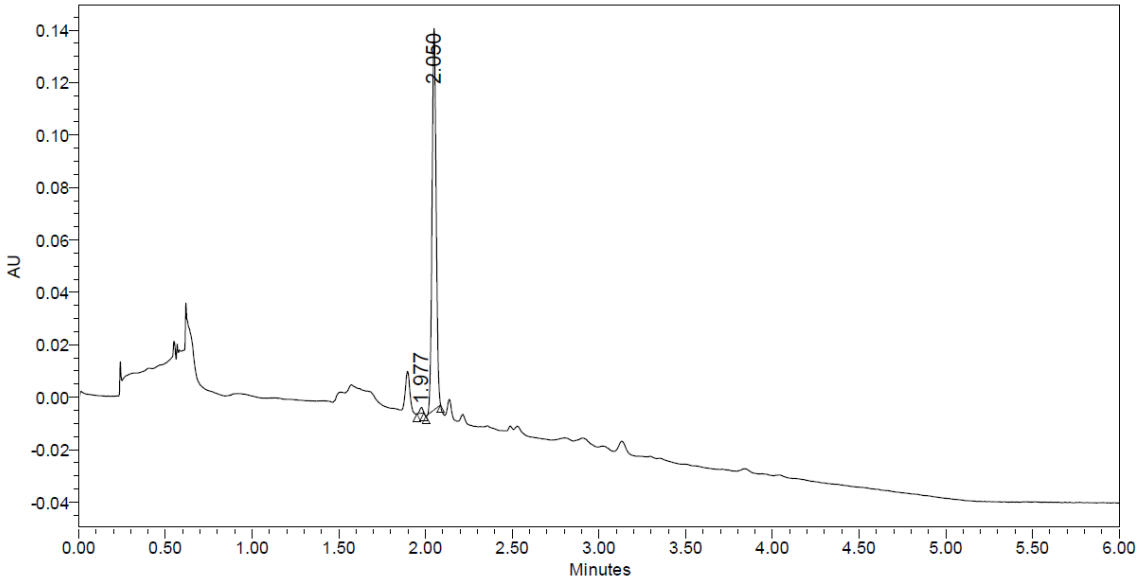
**($R_a$)-2'-Bromo-3-chloro-6'-*iso*-propyl-[1,1'-biphenyl]-2-carbaldehyde (6a).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 1.999 | 56.74 |
| 2 | 2.070 | 43.26 |

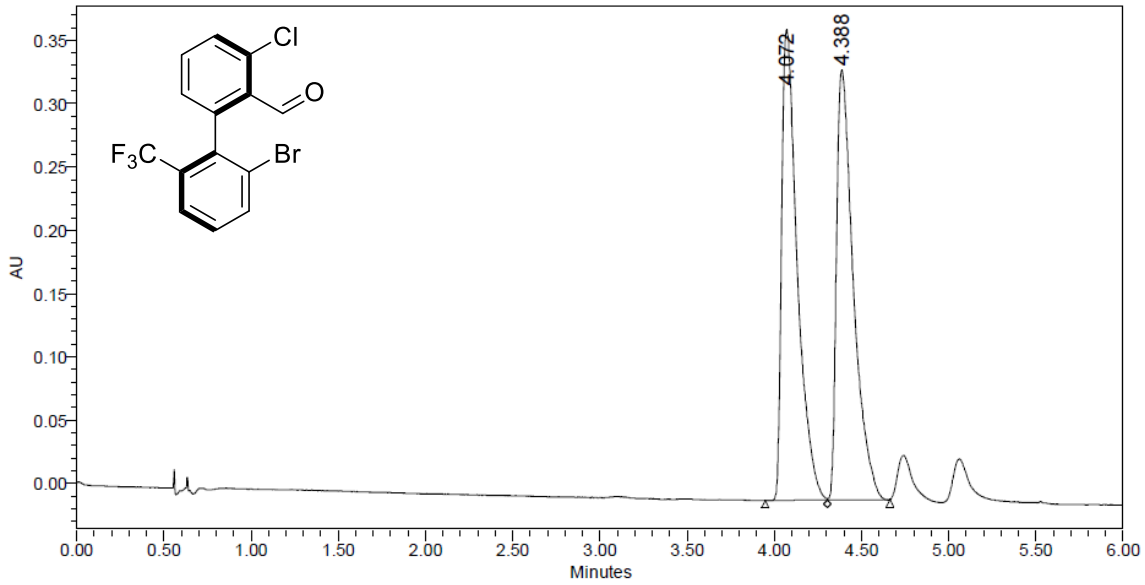
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 1.977 | 1.10 |
| 2 | 2.050 | 98.90 |

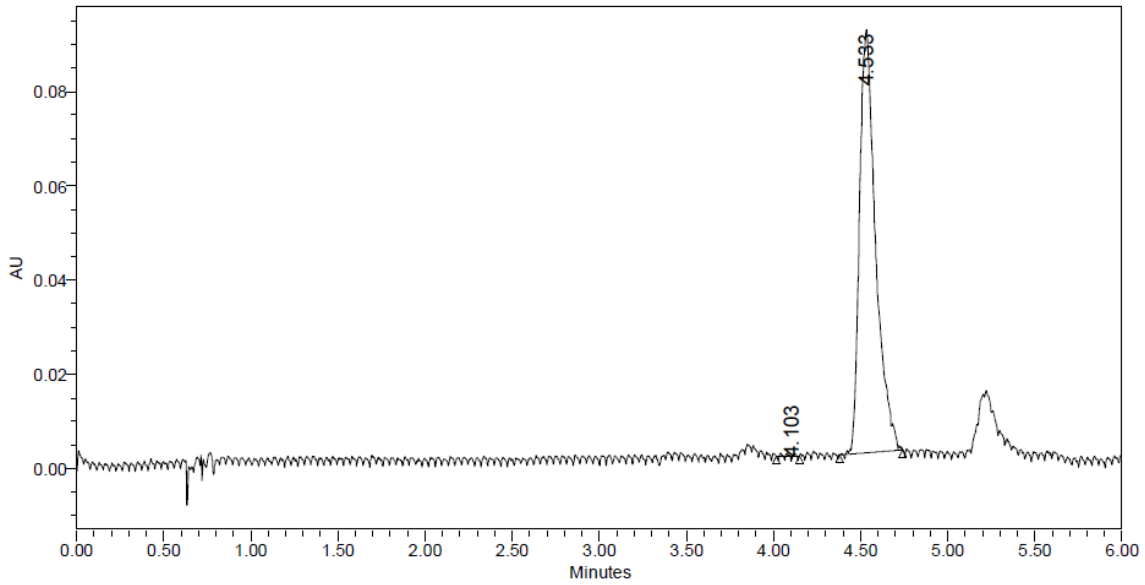
**($R_a$)-2'-Bromo-3-chloro-6'-(trifluoromethyl)-[1,1'-biphenyl]-2-carbaldehyde (6e).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 4.072 | 50.25 |
| 2 | 4.388 | 49.75 |

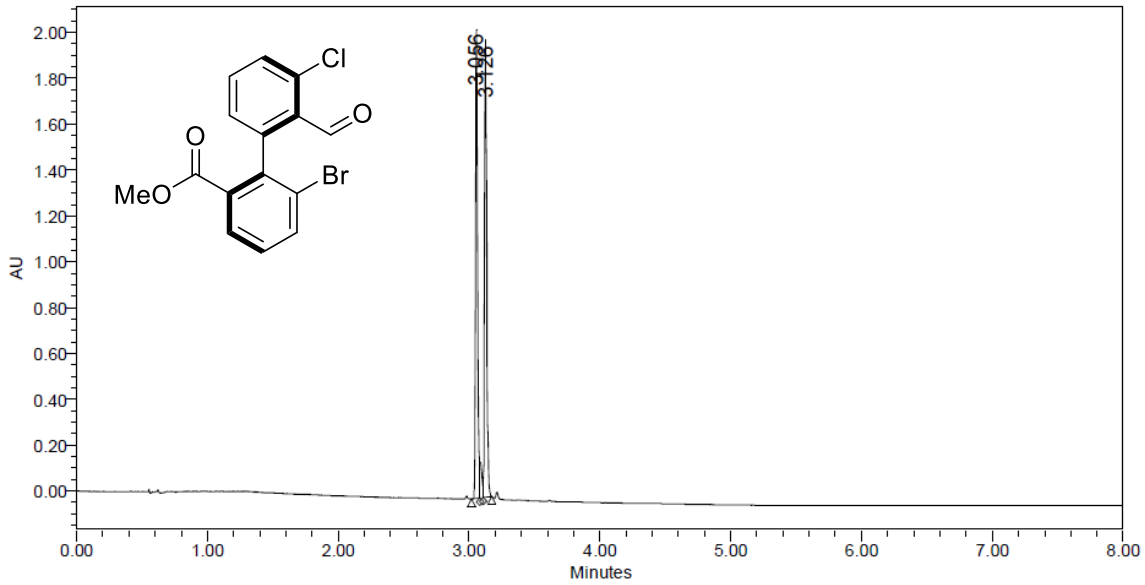
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 4.103 | 0.52 |
| 2 | 4.533 | 99.48 |

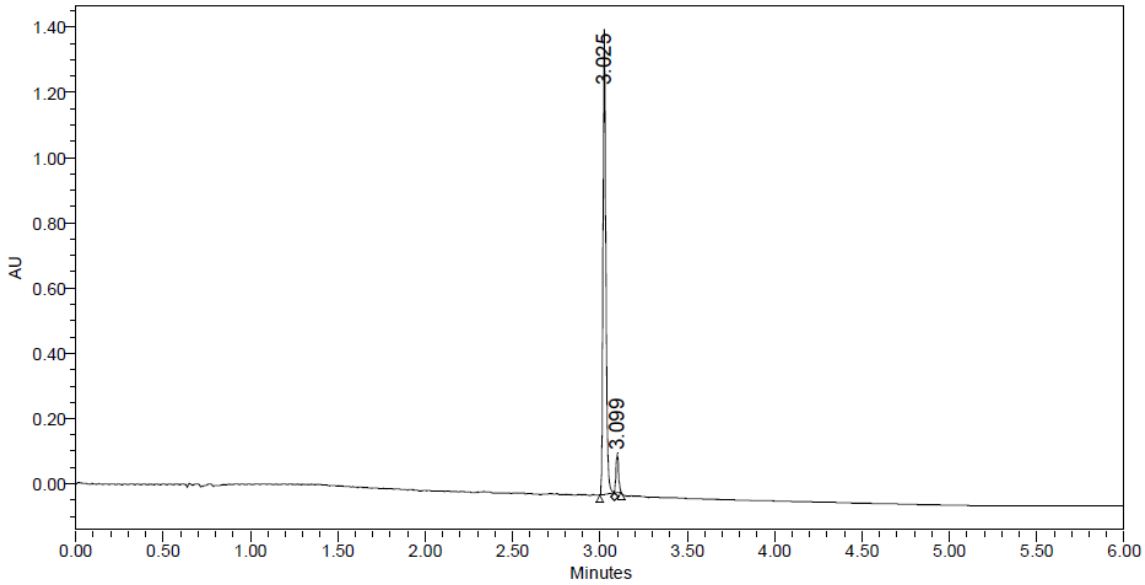
**($R_a$)-Methyl 6-bromo-3'-chloro-2'-formyl-[1,1'-biphenyl]-2-carboxylate (6f).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.056 | 50.39 |
| 2 | 3.126 | 49.61 |

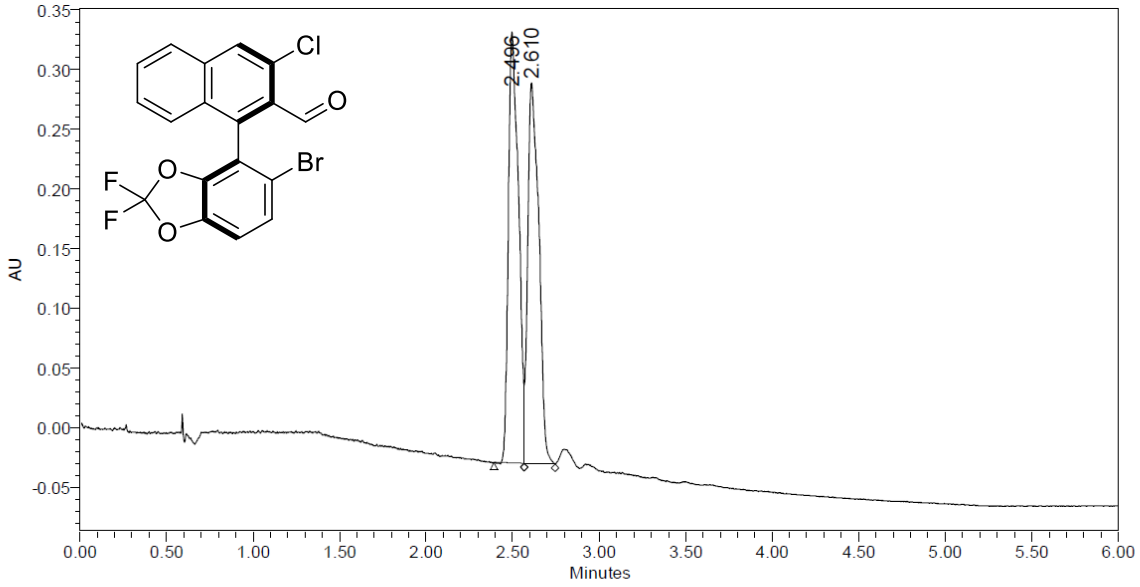
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.025 | 93.23 |
| 2 | 3.099 | 6.77 |

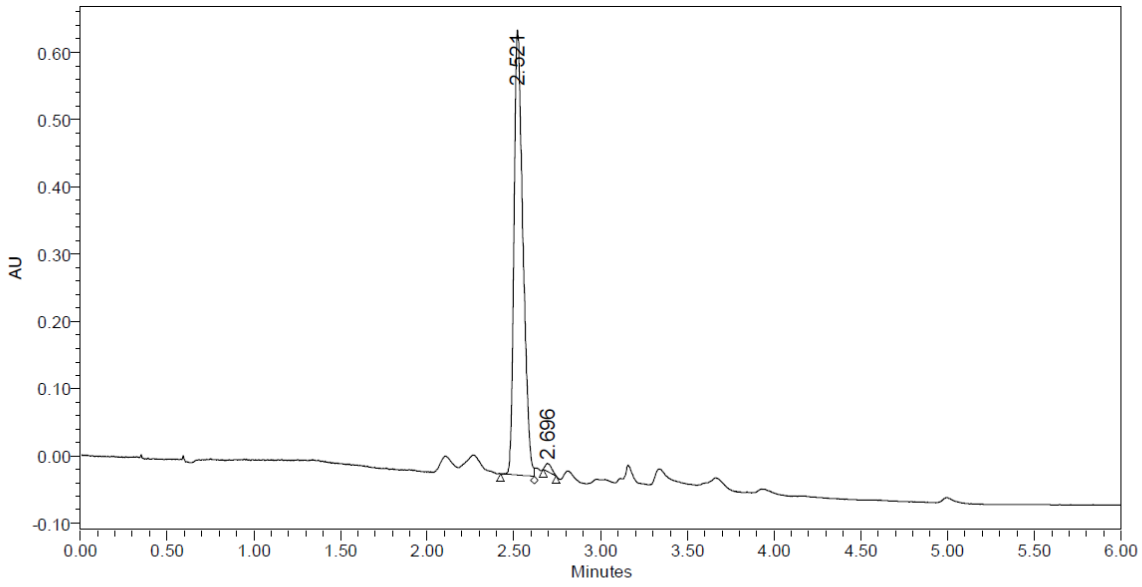
**($R_a$)-1-(5-Bromo-2,2-difluorobenzo[d][1,3]dioxol-4-yl)-3-chloro-2-naphthaldehyde (6p).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.496 | 50.81 |
| 2 | 2.610 | 49.19 |

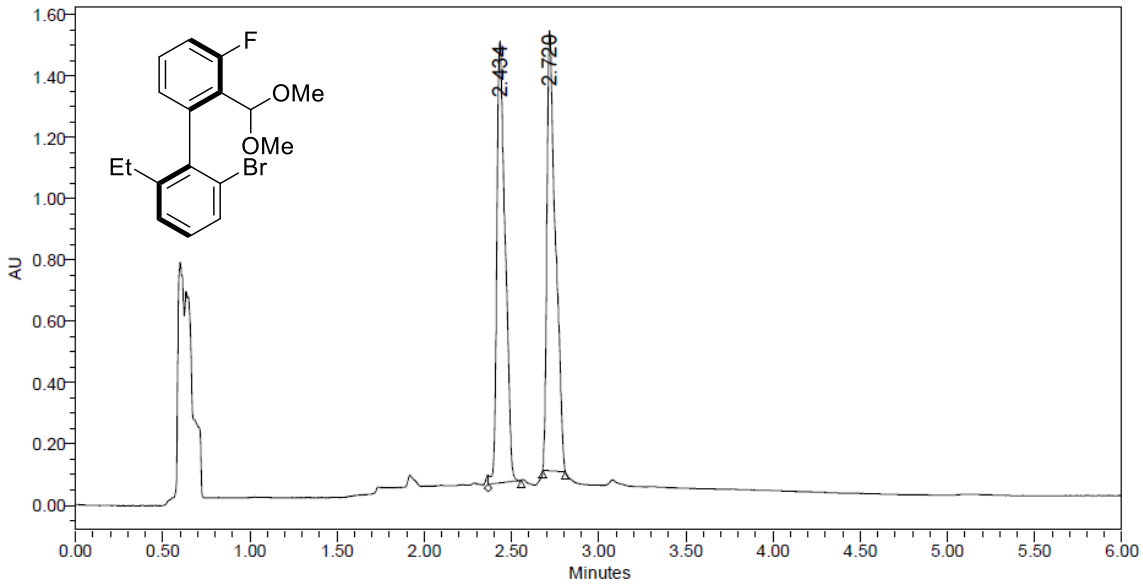
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.521 | 98.71 |
| 2 | 2.696 | 1.29 |

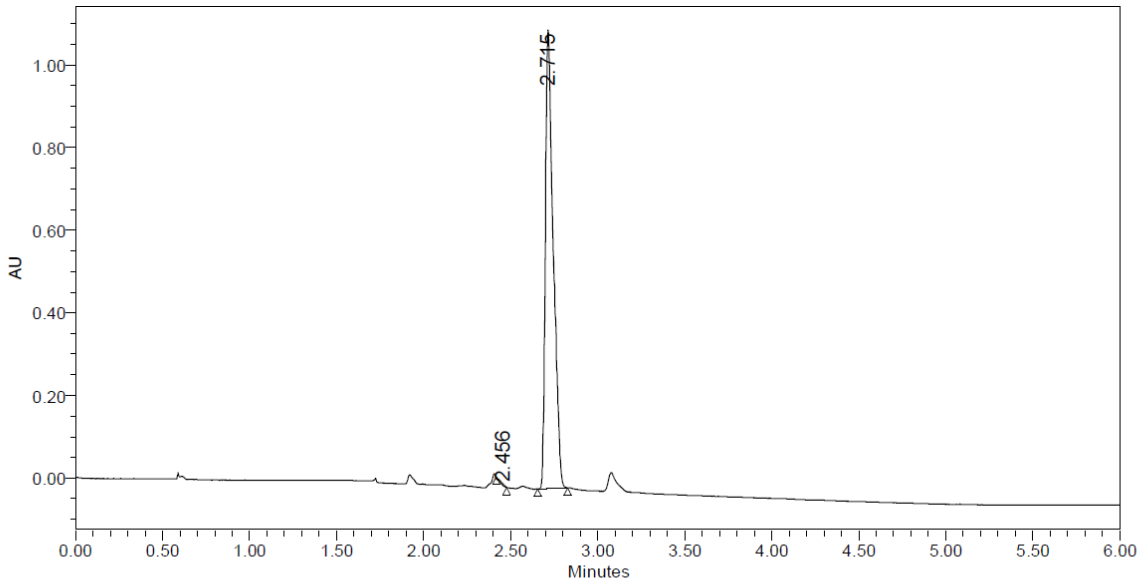
**($R_a$)-2'-Bromo-2-(dimethoxymethyl)-6'-ethyl-3-fluoro-1,1'-biphenyl (4s').**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.434 | 48.99 |
| 2 | 2.720 | 51.01 |

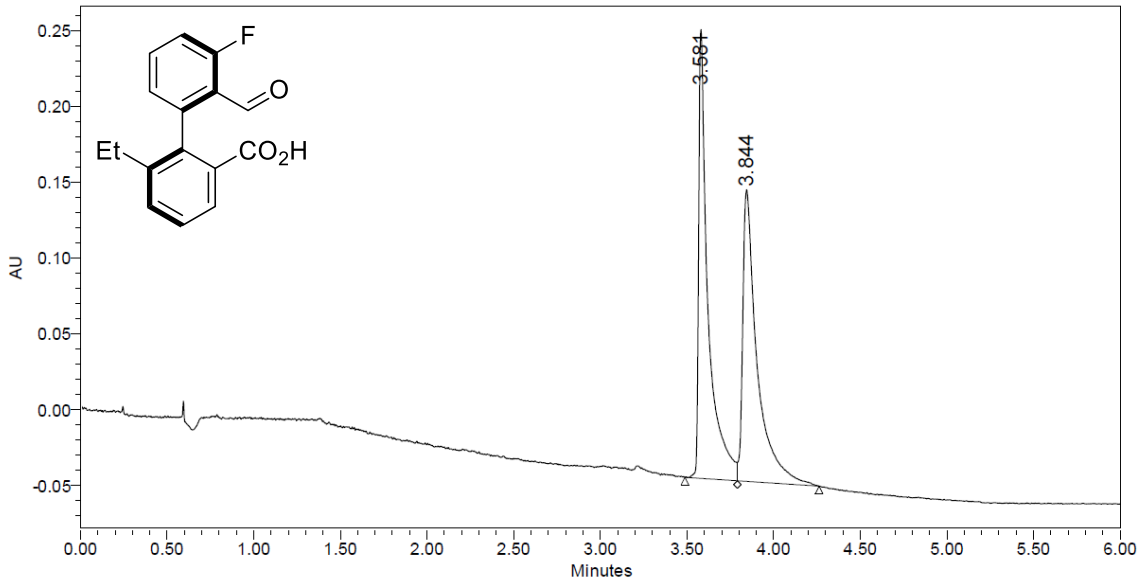
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.456 | 0.25 |
| 2 | 2.715 | 99.75 |

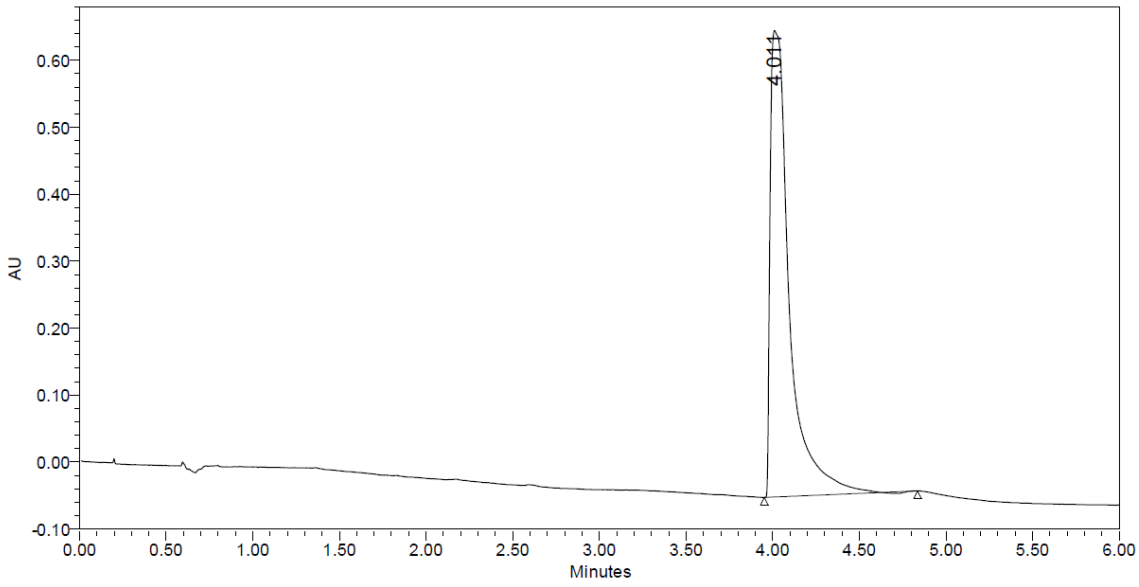
**($R_a$)-6-Ethyl-3'-fluoro-2'-formyl-[1,1'-biphenyl]-2-carboxylic acid (5sa).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.581 | 50.19 |
| 2 | 3.844 | 49.81 |

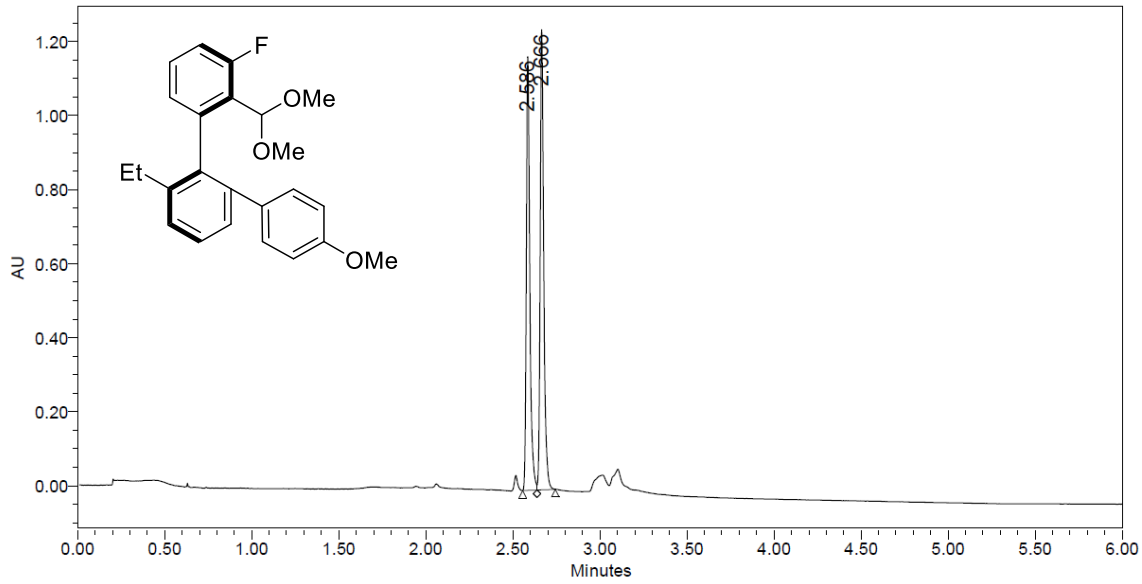
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 4.011 | 100.00 |

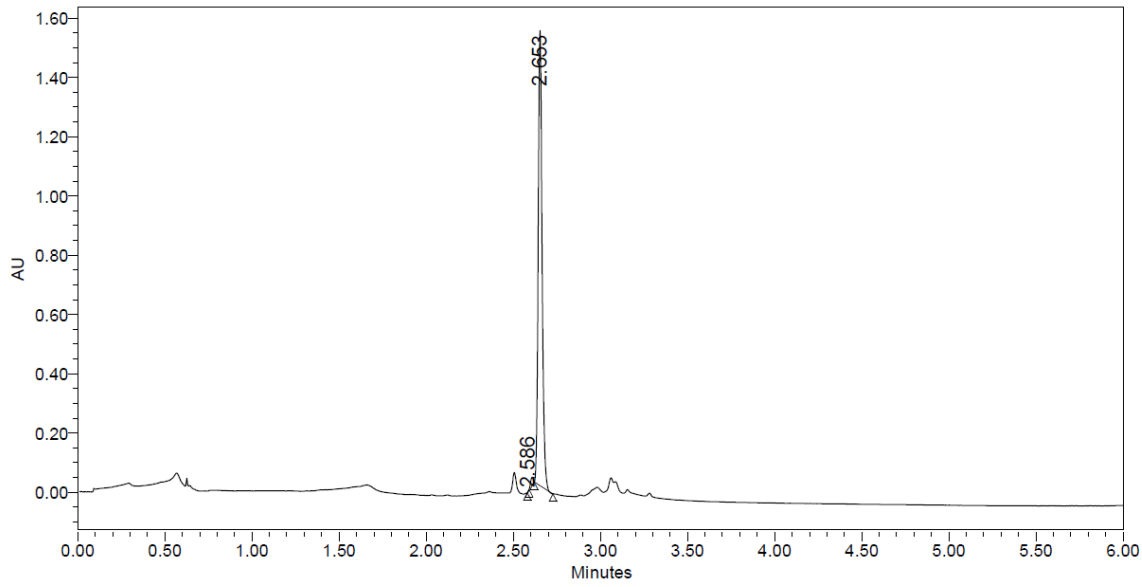
**($R_a$)-2-(Dimethoxymethyl)-6'-ethyl-3-fluoro-4''-methoxy-1,1':2',1''-terphenyl (5sb).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.586 | 47.99 |
| 2 | 2.666 | 52.01 |

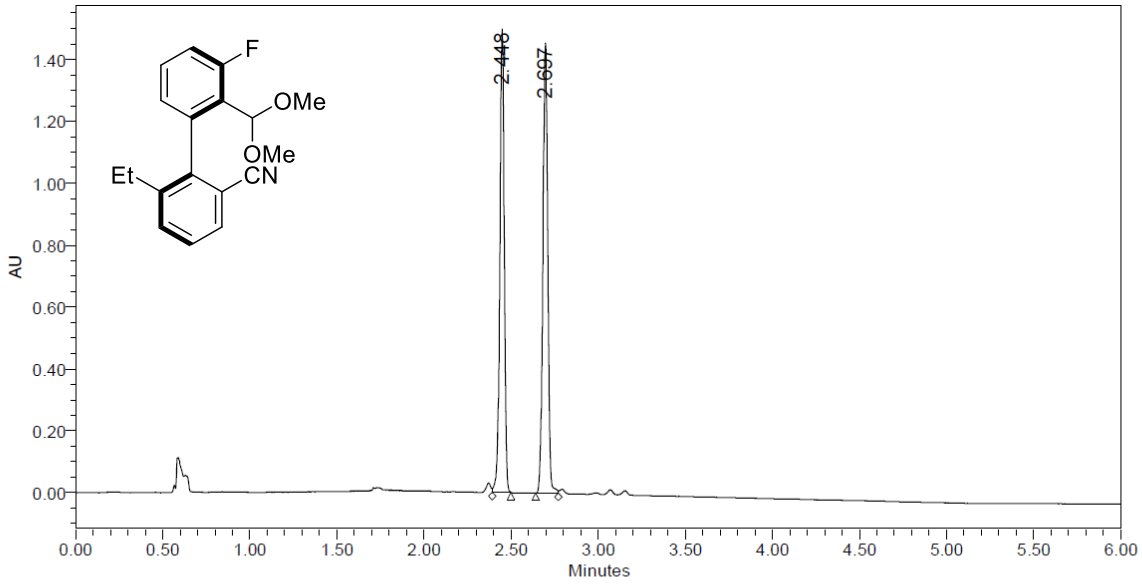
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.586 | 0.04 |
| 2 | 2.653 | 99.96 |

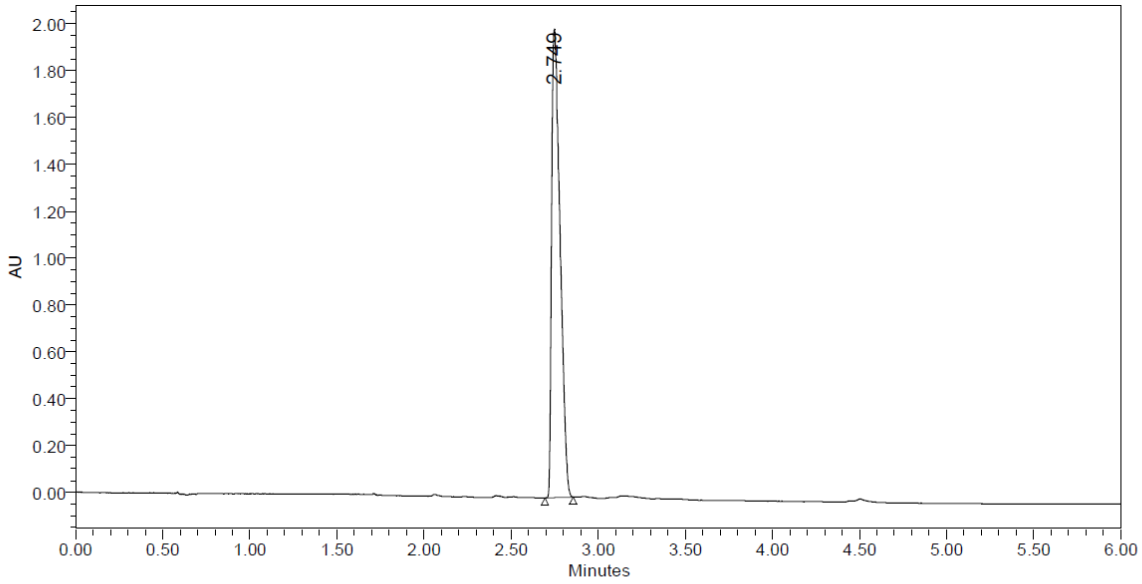
**($R_a$)-2'-(Dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-carbonitrile (5sc).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.448 | 48.52 |
| 2 | 2.697 | 51.48 |

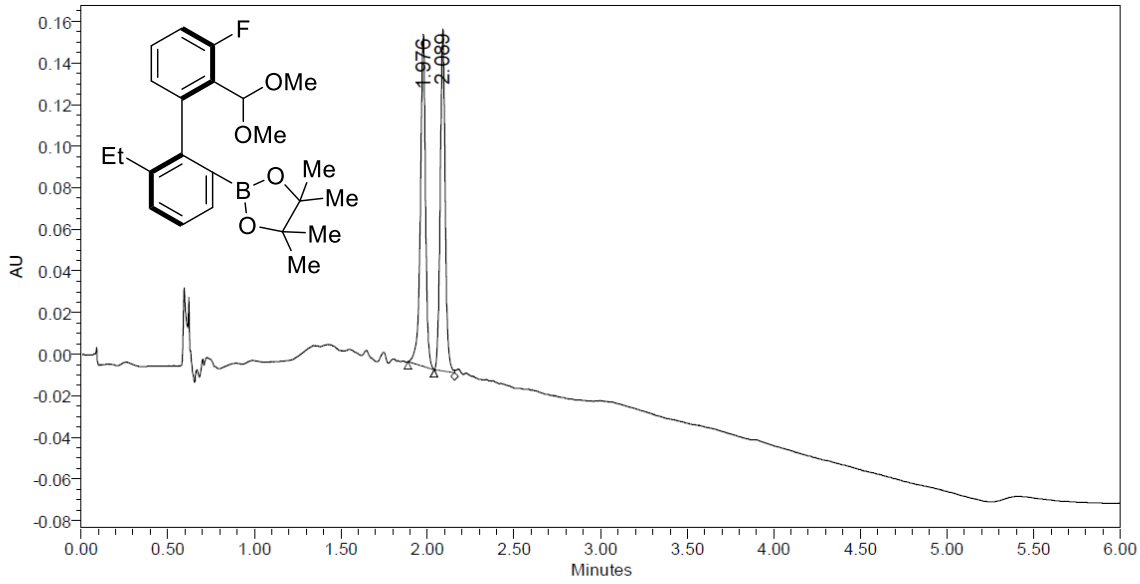
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.749 | 100.00 |

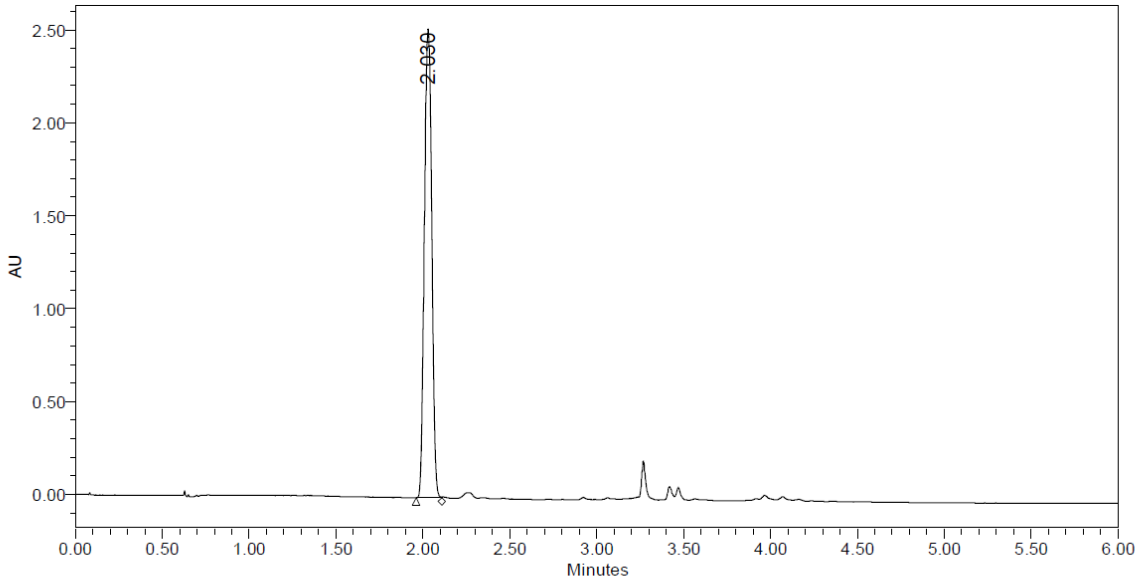
**($S_a$)-2-(2'-(Dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-yl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (5sd).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 1.976 | 50.36 |
| 2 | 2.089 | 49.64 |

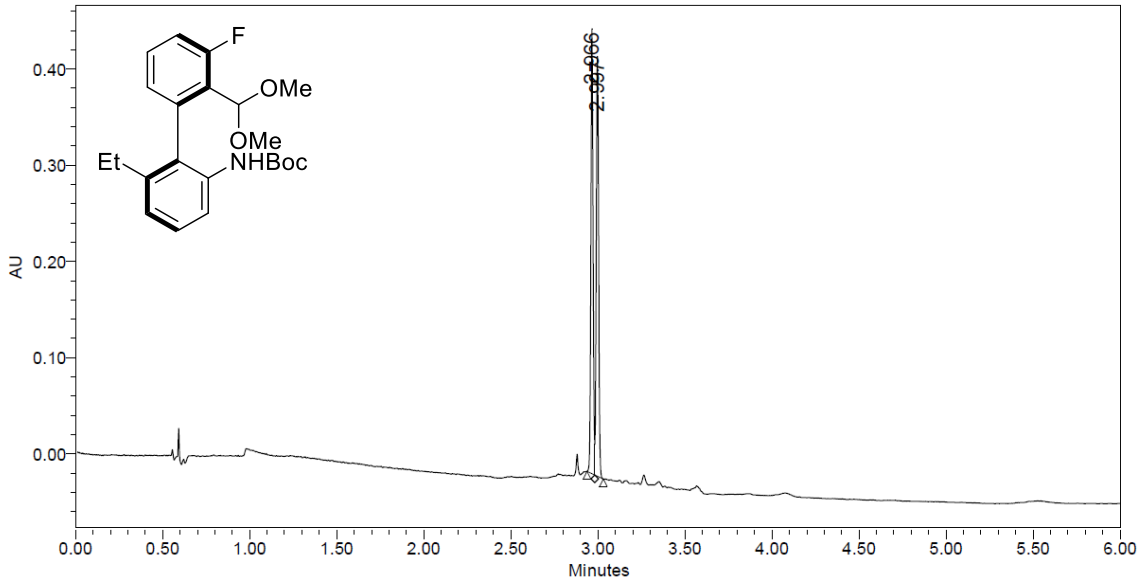
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.030 | 100.00 |

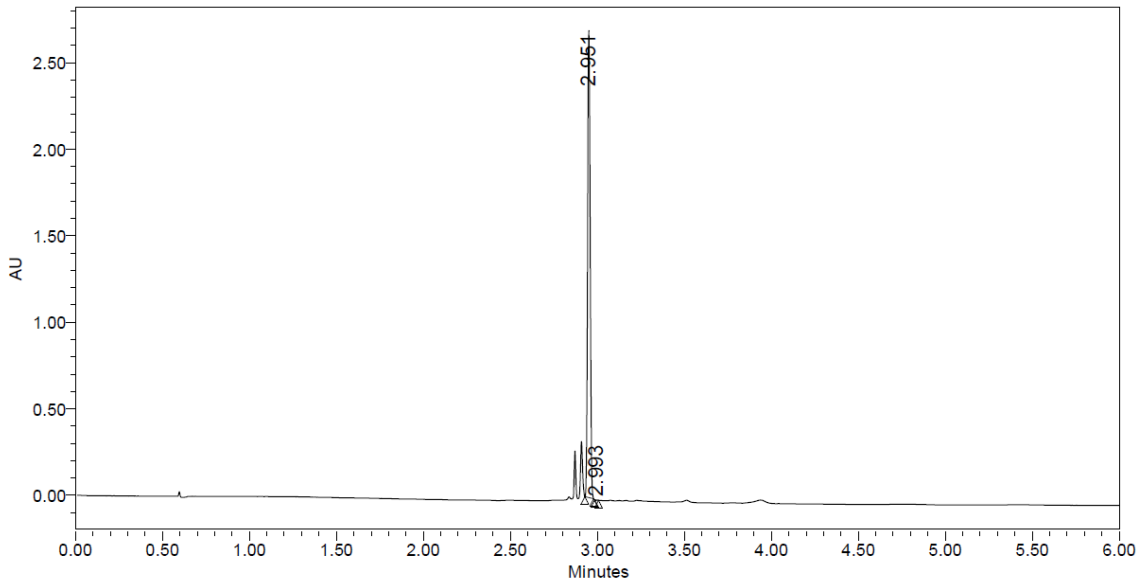
**($R_a$)-*tert*-Butyl (2'-(dimethoxymethyl)-6-ethyl-3'-fluoro-[1,1'-biphenyl]-2-yl)carbamate (5se).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.966 | 50.07 |
| 2 | 2.997 | 49.93 |

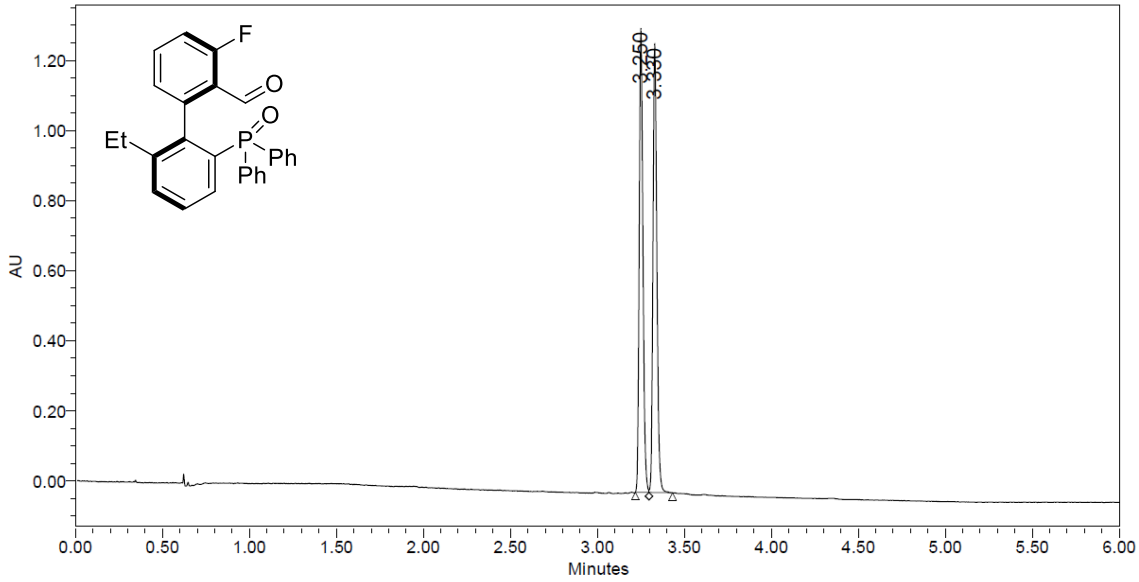
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.951 | 99.97 |
| 2 | 2.993 | 0.03 |

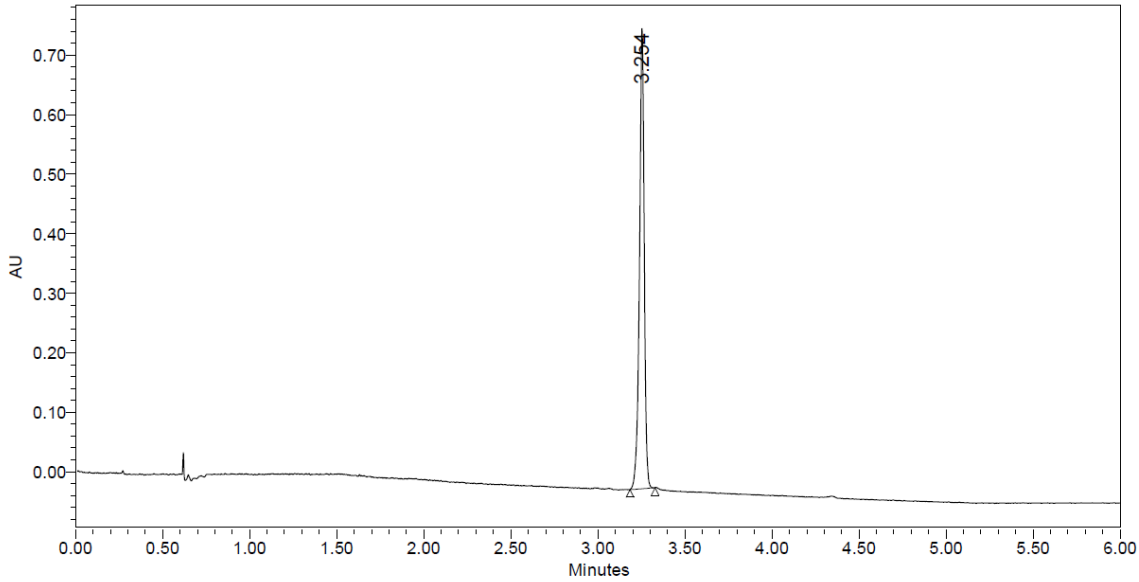
**($R_a$)-2'-(Diphenylphosphoryl)-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-carbaldehyde (5sf).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.250 | 49.64 |
| 2 | 3.330 | 50.36 |

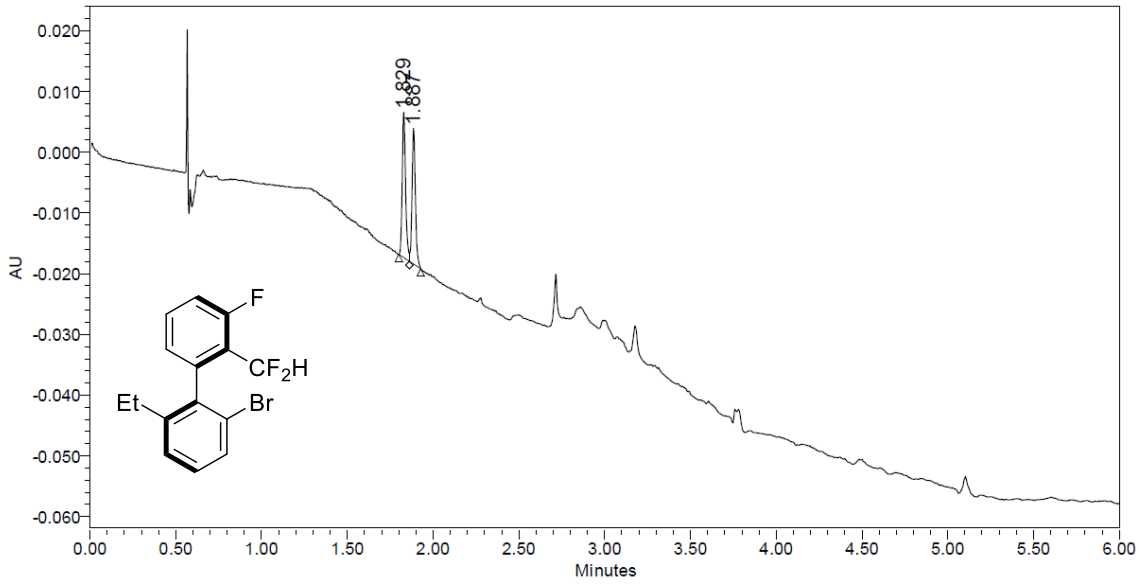
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 3.254 | 100.00 |

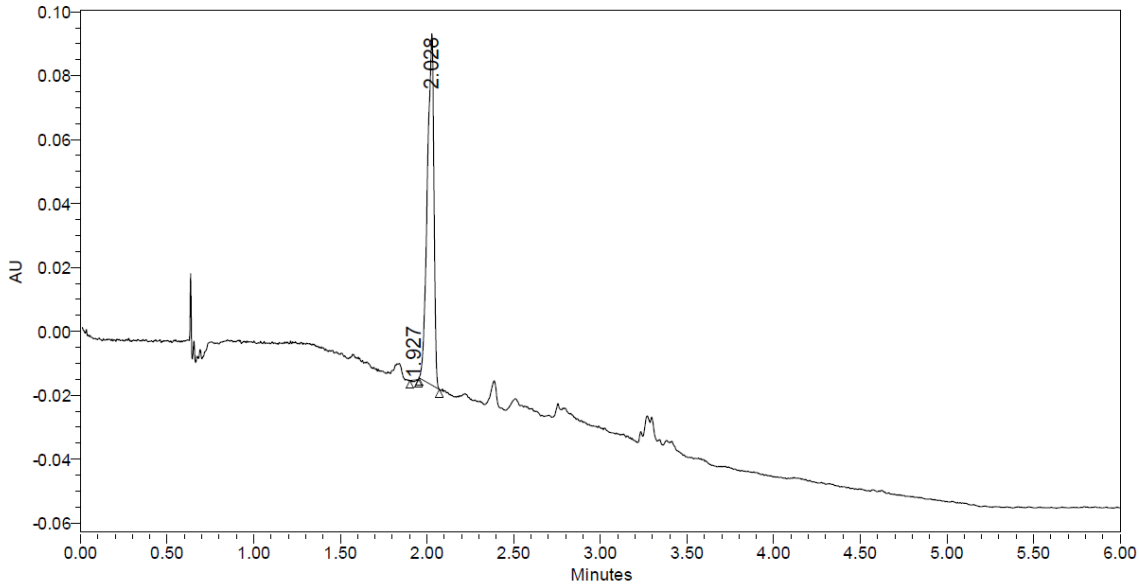
**($R_a$)-2'-Bromo-2-(difluoromethyl)-6'-ethyl-3-fluoro-1,1'-biphenyl (5sh).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 1.829 | 51.75 |
| 2 | 1.887 | 48.25 |

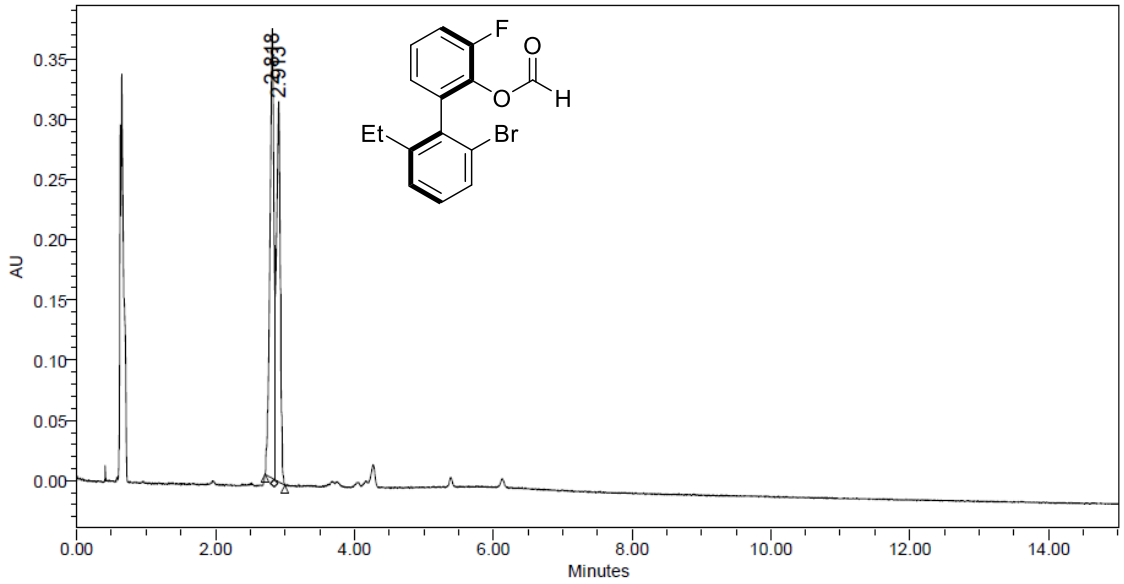
*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.028 | 99.67 |
| 2 | 1.927 | 0.33 |

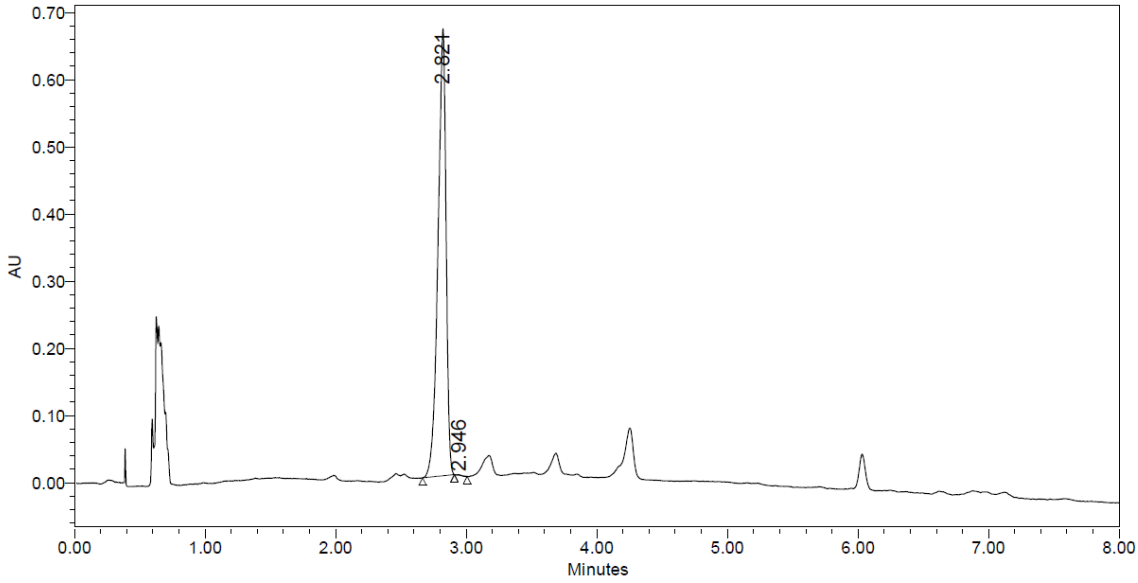
**($R_a$)-2'-Bromo-6'-ethyl-3-fluoro-[1,1'-biphenyl]-2-yl formate (5si).**

*Racemate*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.818 | 50.25 |
| 2 | 2.913 | 49.75 |

*Enantioselective*




| | Retention Time (min) | % Area |
|---|---|---|
| 1 | 2.821 | 99.92 |
| 2 | 2.946 | 0.08 |