Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

Enantioselective Synthesis of 2,3-Disubstituted *trans*-2,3-Dihydrobenzofurans Using a Brønsted Base/Thiourea Bifunctional Catalyst

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Supporting Information

General Experimental Information

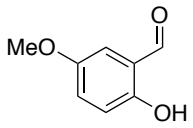
Anhydrous solvents (THF and toluene) were obtained from an anhydrous solvent system (purified using an alumina column). Petroleum ether is defined as petroleum ether 40-60 °C. All other solvents and commercial reagents were used as supplied without further purification unless otherwise stated. Room temperature (rt) refers to 20-25 °C. Temperatures 0 °C, −20 °C and −78 °C were obtained using ice/water, ice/salt and CO_2(s)/acetone baths respectively. Ozone used for ozonolysis was generated using an ozone generator. Flash column chromatography was performed on Kieselgel 60 silica in the solvent system stated. ^{1}H NMR spectra were acquired at either 300, 400, 500 MHz, ^{13}C{^{1}H} NMR spectra were acquired at either 101 or 126 MHz, ^{19}F{^{1}H} NMR spectra were acquired at 471 MHz and ^{31}P{^{1}H} NMR spectra were acquired at 162 MHz. Chemical shifts are quoted in parts per million (ppm) relative to the residual solvent peak, coupling constants, *J*, are quoted in Hertz (Hz). When the product was isolated as an inseparable mixture of diastereoisomers, the characteristic peaks of the minor diastereoisomer in the ^{1}H NMR are reported. Infra red spectra (ν_{max}) were recorded on an IR using an ATR accessory. Only the characteristic peaks are quoted. Samples were directly placed on the crystal (ATR).

Melting points are uncorrected. Sample decomposition is denoted as dec. Optical rotations were measured on a polarimeter operating at the sodium D line with a 100 mm path cell. All chiral HPLC traces were compared with an authentic racemic sample prepared using triazabicyclodecene (10 mol%), *i*-Pr_2NEt (1 eq.) in CH_2Cl_2 (1 M). Mass spectrometry (m/z) data were acquired by electrospray ionization (ESI) or nanospray ionization (NSI).

Catalysts: Catalysts **3**,[1] **4**,[2] **7**,[3] and **8**[4] were synthesised by previously reported literature methods. Catalyst **5** and **6** were purchased from Aldrich and Stream respectively.

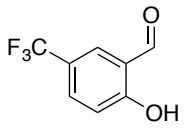
Synthetic procedures and analytical data for starting materials

2-Hydroxy-5-methoxybenzaldehyde (S1)



In a flame-dried 2-neck flask $MgCl_2$ (5.71 g, 60.0 mmol) and paraformaldehyde (3.00 g, 100 mmol) were added, followed by anhydrous THF (100 mL) and Et_3N (8.40 mL, 60.0 mmol). The resulting solution was stirred at rt for 10 min. 4-Methoxyphenol (2.48 g, 20.0 mmol) was added and the reaction stirred at reflux overnight. The reaction mixture was cooled to rt and diluted with Et_2O. The organics were washed with 1M HCl, water, dried ($MgSO_4$) and concentrated under reduced pressure to give 2-hydroxy-5-methoxybenzaldehyde **S1** as a yellow oil (3.05 g, 100%), which was used without further purification.[1]H NMR (400 MHz, $CDCl_3$)[5] δ_H: 3.81 (3H, s, C*H*$_3$), 6.94 (1H, d, *J* 9.1, Ar*H*), 7.01 (1H, d, *J* 3.1, Ar*H*), 7.16 (1H, dd, *J* 9.1, 3.1, Ar*H*), 9.87 (1H, d, *J* 0.6, C*H*O), 10.67 (1H, s, O*H*). Data in agreement with the literature.[5]

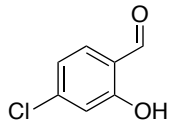
2-Hydroxy-5-(trifluoromethyl)benzaldehyde (S2)



In a flame-dried 2-neck flask $MgCl_2$ (2.86 g, 30.00 mmol) and paraformaldehyde (1.5 g, 50.0 mmol) were added, followed by anhydrous THF (50 mL) and Et_3N (4.20 mL, 30.0 mmol). The resulting solution was stirred at rt for 10 min. 4-(Trifluoromethyl)phenol (4.86 g, 30.0 mmol) was added and the reaction stirred at reflux overnight. The reaction mixture was cooled to rt and diluted with Et_2O. The organics were washed with 1M HCl, water, dried ($MgSO_4$) and concentrated under reduced pressure to give the crude product, which was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→15% EtOAc in

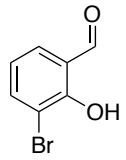
hexanes) to give 2-hydroxy-5-(trifluoromethyl)benzaldehyde **S2** as a colourless solid (586 mg, 10%). m.p**.** 59-61 °C {lit[6] m.p. 60°C}. ^{1}H NMR (400 MHz, $CDCl_3$)[6] δ_H: 7.11 (1H, ddd, *J* 9.0, 1.3, 0.7, C(3)*H*), 7.76 (1H, ddt, *J* 8.9, 2.3, 0.6, C(4)*H*), 7.86 (1H, dd, *J* 2.1, 0.7, C(6)*H*), 9.95 (1H, d, *J* 0.6, C*H*O), 11.30 (1H, d, *J* 0.5, O*H*). Data in agreement with the literature.[6]

4-Chloro-2-hydroxybenzaldehyde (S3).



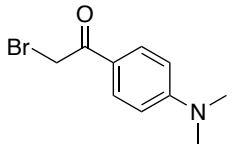
In a flame-dried 2-neck flask $MgCl_2$ (2.86 g, 30.0 mmol) and paraformaldehyde (1.50 g, 50.0 mmol) were added, followed by anhydrous THF (50 mL) and Et_3N (4.20 mL, 30.9 mmol). The resulting solution was stirred at rt for 10 min. 3-Chlorophenol (2.48 g, 20.0 mmol) was added and the reaction stirred at reflux overnight. The reaction mixture was cooled to rt and diluted with Et_2O. The organics were washed with 1 M HCl, water, dried ($MgSO_4$) and concentrated under reduced pressure to give the crude product, which was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→5% Et_2O in hexanes) to give 4-chloro-2-hydroxybenzaldehyde **S3** as a colourless solid (586 mg, 12%). m.p. 47-49 °C {lit[7] m.p. 51-52 °C}. ^{1}H NMR (400 MHz, $CDCl_3$) [7] δ_H: 6.98–7.02 (2H, m (C(5)*H*+C(6)*H*), 7.49 (1H, d, *J* 8.8, C(3)*H*), 9.86 (1H, d, *J* 0.6, C*H*O), 11.17 (1H, s, O*H*). Data in agreement with the literature.[7]

3-Bromo-2-hydroxybenzaldehyde (S4).



In a flame-dried 2-neck flask $MgCl_2$ (1.43 g, 15.00 mmol) and paraformaldehyde (0.75 g, 25.0 mmol) were added, followed by anhydrous THF (25 mL) and Et_3N (2.10 mL, 15.00 mmol). The resulting solution was stirred at rt for 10 min. 2-Bromophenol (1.74 mL, 15.0 mmol) was added and the reaction stirred at reflux overnight. The reaction mixture was cooled to rt and diluted with Et_2O. The organics were washed with 1M HCl, water, dried ($MgSO_4$) and concentrated under reduced pressure to give 3-bromo-2-hydroxybenzaldehyde **S4** as a yellow oil (3.01 g, 100%), which was used without further purification.[1]H NMR (500 MHz, $CDCl_3$)[8] δ_H: 6.93 (1H, t, *J* 7.8, C(5)*H*), 7.53 (1H, dd, *J* 7.7, 1.6, C(6)*H*), 7.76 (1H, dd, *J* 7.9, 1.6, (C(4)*H*), 9.83 (1H, s, C*H*O), 11.61 (1H, s, O*H*). Data in agreement with the literature.[8]

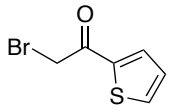
2-Bromo-1-(4-(dimethylamino)phenyl)ethan-1-one (S5).



Bromine (1.72 mL, 33.7 mmol) was added dropwise over 2 h to a solution of 1-(4-(dimethylamino)phenyl)ethan-1-one (5 g, 30.6 mmol) in 8.9M HBr (100 mL) at 0 °C. The reaction mixture was stirred at rt overnight, then basified with 5M aq. NaOH until pH 10. The solution was extracted with CH_2Cl_2 (× 3) and purified by column chromatography (eluent: 50%→100% CH_2Cl_2 in hexanes) to give 2-bromo-1-(4-(dimethylamino)phenyl)ethan-1-one **S5** as a pale yellow oil (1.92 g, 26%).[1]H NMR (500 MHz, $CDCl_3$)[9] δ_H: 3.08 (6H, s, CH_3),

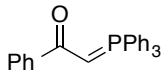
4.36 (2H, s, C*H*$_2$), 6.66 (2H, d, *J* 9.0, Ar(3+5)*H*), 7.89 (2H, d, *J* 9.0, Ar(2+6)*H*). Data in agreement with the literature.[9]

2-Bromo-1-(thiophen-2-yl)ethan-1-one (S6).



A solution of bromine (0.41 mL, 7.9 mmol) in CH_2Cl_2 (5 mL) was added dropwise to a solution of 2-acethylthiophene (0.86 mL, 7.9 mmol) in CH_2Cl_2 (5 mL) at 0 °C. The reaction mixture was stirred at rt for 3h, worked up with water and CH_2Cl_2, then purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→15% Et_2O in hexanes) to afford 2-bromo-1-(thiophen-2-yl)ethan-1-one **S6** as a yellow oil (861 mg, 53%). ^{1}H NMR (400 MHz, $CDCl_3$) [10] δ_H: 4.36 (2H, s, C*H*$_2$), 7.16 (1H, dd, *J* 5.0, 3.8, Ar(4)*H*), 7.71 (1H, dd, *J* 4.9, 1.1, Ar(3)*H*), 7.80 (1H, dd, *J* 3.9, 1.1, Ar(5)*H*). Data in agreement with the literature.[10]

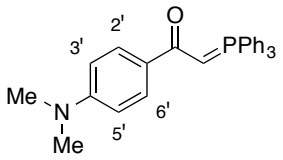
1-Phenyl-2-(triphenylphosphanylidene)ethanone (S7).



A solution of triphenylphosphine (50.0 g, 190 mmol) and 2-bromo-1-phenylethanone (37.6 g, 190 mmol) were stirred in CH_2Cl_2 (800 mL) at rt for 2 h. The colourless solid precipitate was filtered, washed with CH_2Cl_2 and suspended in CH_2Cl_2 (230 mL), water (350 mL) and 2M aq. NaOH (100 mL). The biphasic reaction mixture was stirred at rt for 16 h. The layers were separated and the aqueous layer extracted with CH_2Cl_2 (× 3). The combined organic layers were washed with brine, dried ($MgSO_4$) and concentrated *in vacuo* to give 1-phenyl-2-(triphenylphosphanylidene)ethanone **S7** as a colourless solid (43 g, 64%). m.p. 182-183 °C (CH_2Cl_2); {lit[11] m.p. 173-175°C (THF)}. ^{1}H NMR (500 MHz, $CDCl_3$) [11] δ_H: 4.40 (1H, d, *J*

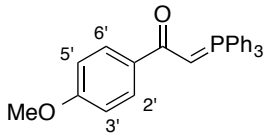
24.5, C*H*PPh$_3$), 7.34-7.38 (3H, m, Ar*H*), 7.45-7.51 (7H, m, Ar*H*), 7.54-7.59 (2H, m, Ar*H*), 7.70-7.76 (6H, m, Ar*H*), 7.96-8.00 (2H, m, Ar*H*). Data in agreement with the literature.[11]

1-(4-(Dimethylamino)phenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one (S8).



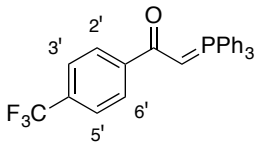
Following a literature procedure,[12] 2-bromo-1-(4-(dimethylamino)phenyl)ethan-1-one (1.92 g, 7.9 mmol), and triphenylphosphine (2.07 g, 7.9 mmol) were heated at reflux in anhydrous THF (45 mL) for 4 h. The reaction was cooled and the phosphonium salt filtered and washed with Et_2O (x 3). The phosphonium salt was dissolved in water (16 mL), CH_2Cl_2 (10 mL) and 2M aq. NaOH (12 mL). The mixture was stirred for 16 h and then extracted with CH_2Cl_2 (× 3). The combined organic layers were washed with brine and dried ($MgSO_4$) to give *1-(4-(dimethylamino)phenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one* **S8** as a pale yellow solid (2.22 g, 66%). m.p. 198-201 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 2.98 (6H, s, CH_3), 4.31 (1H, d, *J* 25.1, C(2)*H*), 6.65-6.70 (2H, m, C(3')*H*+C(5')*H*)), 7.42-7.48 (6H, m, Ph*H*), 7.54 (3H, td, *J* 7.2, 1.6, Ph*H*), 7.69–7.76 (6H, m, Ph*H*), 7.87–7.92 (2H, m, C(2')*H*+C(6')*H*). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 40.46 (*C*H$_3$), 48.33 (d, *J* 114.0, *C*(2)), 111.15 (*C*(3')+*C*(5'), 127.27 (C(1')), 128.18 (*C*(1)Ph), 128.27 (*C*(2')+*C*(6'), 128.75 (d, *J* 12.3, Ph*CH*), 131.79 (d, *J* 2.9, Ph*C*H), 133.18 (d, *J* 10.1, Ph*C*H), 151.52 (*C*(4')), 184.92 (*C*(1)). ^{31}P NMR (162 MHz, $CDCl_3$) δ_P: 16.49. IR (solid) ν_{max} cm^{-1}: 1749 (CO). HRMS (p NSI) $C_{28}H_{27}NOP$ $[M+H]^+$ found 424.1822 requires 424.1825 (−0.5 ppm).

1-(4-Methoxyphenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one (S9).



Following a literature procedure,[12] 2-bromo-1-(4-methoxy)phenylethanone (4.0 g, 17.5 mmol) and triphenylphosphine (4.56 g, 17.5 mmol) were heated at reflux in anhydrous THF (53 mL) for 4 h. The reaction was cooled and the precipitate filtered and washed with Et_2O (× 3). The phosphonium salt was suspended in water (35 mL), CH_2Cl_2 (23 mL) and 2 M aq. NaOH (27 mL). The mixture was stirred for 16 h and then extracted with CH_2Cl_2 (× 3). The combined organic layers were washed with brine and dried ($MgSO_4$) to give 1-(4-methoxyphenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one **S9** as an orange solid. (6.45 g, 90%). m.p. 145-147 °C {lit[13] m.p. {150-153 °C}. ^{1}H NMR (500 MHz, $CDCl_3$)[13] δ_H: 3.82 (3H, s, C*H*$_3$), 4.35 (1H, d, *J* 24.0, C*H*), 6.84-6.90 (2H, m, C(3')*H*+C(4')*H*), 7.45-7-50 (6H, m, Ph*H*), 7.52-7.58 (3H, m, Ph*H*), 7.52-7.58 (3H, m, Ph*H*), 7.68-7.75 (6H, m , Ph*H*), 7.92-7.96 (2H, m, C(2')*H*-C(6')*H*). Data in agreement with the literature.[13]

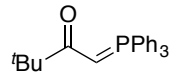
1-(4-(Trifluoromethyl)phenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one (S10).



Following a literature procedure,[12] 2-bromo-1-[4-(trifluoromethyl)phenyl]ethanone (15.00 g, 18.7 mmol), and triphenylphosphine (4.91 g, 18.7 mmol) were heated at reflux in anhydrous THF (100 mL) for 3.5 h. The reaction was cooled and the phosphonium salt filtered and washed with Et_2O (× 3). The phosphonium salt was dissolved in water (38 mL), CH_2Cl_2 (24 mL) and 2 M aq. NaOH (28 mL). The mixture was stirred for 16 h and then extracted with CH_2Cl_2 (× 3). The combined organic layers were washed with brine and dried ($MgSO_4$) to

give 1-(4-(trifluoromethyl)phenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one **S10** as a pale yellow solid (7.38 g, 88%). m.p. 157-159 °C. {lit[12] m.p. 158-160 °C}. ^{1}H NMR (400 MHz, $CDCl_3$) [12] δ_H: 4.57 (1H, d, J 24.6, C(2)*H*), 7.67-7.70 (6H, m, Ph*H*), 7.71-7.73 (5H, m, Ph*H*), 7.74-7.77 (6H, m, Ph*H*×4+C(3')*H*+*C*(5')*H*), 8.06- 8.10 (2H, m, C(2')*H*+*C*(6')*H*). Data in agreement with the literature.[12]

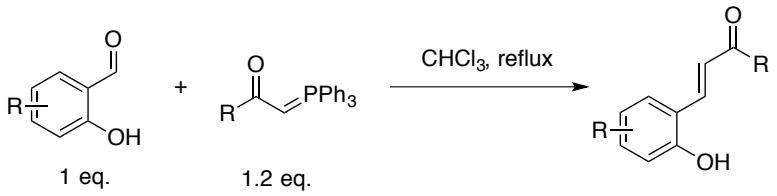
3,3-Dimethyl-1-(triphenyl-λ^5-phosphanylidene)butan-2-one (S11).



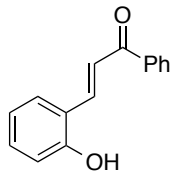
Following a literature procedure,[12] a solution of 1-bromopinacolone (5.00 mL, 40 mmol,) and triphenylphosphine (9.7 g, 40 mmol) were heated at reflux in anhydrous toluene for 4 h. After completion, the reaction mixture was allowed to cool to rt and the phosphonium salt was filtered and washed with Et_2O (× 3). The phosphonium salt was then dissolved in H_2O:CH_2Cl_2 (130 mL:85 mL) and 2M aq. NaOH (100 mL) was added. The mixture was stirred for 2 h and then extracted with CH_2Cl_2 (3 × 100 mL). The combined organic phases were washed with brine, dried ($MgSO_4$) and concentrated *in vacuo* to give 3,3-dimethyl-1-(triphenyl-λ^5-phosphanylidene)butan-2-one as a colourless powder (10.3 g, 77%). m.p. 177-178 °C {lit[12] m.p. 175-177 °C}; ^{1}H NMR (400 MHz, $CDCl_3$)[12] 1.23 (9H, s, C(CH_3)$_3$), 3.80 (1H, d, *J* 27.1 C*H*), 7.44-7.47 (6H, m, Ar*H*), 7.53-7.56 (3H, m, Ar*H*), 7.62-7.66 (6H, m, Ar*H*). Data in agreement with the literature.[12]

General procedure for the synthesis of enones

The suitable salicylaldehyde (1 eq.) and corresponding phosphorane (1.2 eq.) were stirred in chloroform at reflux for 16 h. The reactions were cooled to rt, concentrated *in vacuo* and purified as described.

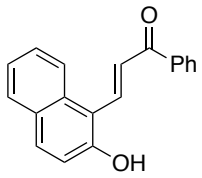


(*E*)-3-(2'-Hydroxyphenyl)-1-phenylprop-2-en-1-one (S12).



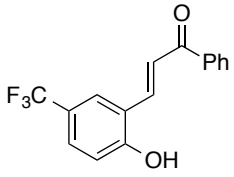
Following the general procedure, salicylic aldehyde (16.4 mmol, 1.75 mL), 1-phenyl-2-(triphenylphosphanylidene)ethanone **S7** (7.50 g, 19.7 mmol) and chloroform (35 mL) were reacted, and the crude product purified by column chromatography (eluent 1:1 Et_2O in petroleum ether) to give (*E*)-3-(2-hydroxyphenyl)-1-phenylprop-2-en-1-one **S12** as a yellow solid (3.7 g, quantitative yield). m.p. 150-152 °C. {lit[14] m.p. 151-153 °C (ethanol)}. ^{1}H NMR (400 MHz, $CDCl_3$)[14] δ_H: 6.32 (1H, br, O*H*), 6.91 (1H, dd, *J* 8.2, 1.1, Ar*H*), 6.97 (1H, td, *J* 7.5, 1.1, Ar*H*), 7.27-7.31 (1H, m, Ar*H*), 7.48-7.54 (2H, m, Ar*H*+Ph*H*), 7.56-7.62 (2H, m, Ph*H*) , 7.71 (1H, d, *J* 15.9, C(2)*H*), 8.02-8.06 (2H, m, Ph*H*), 8.16 (1H, d, *J* 15.9, C(3)*H*). Data in agreement with the literature.[14]

(*E*)-3-(2'-Hydroxynaphthalen-1-yl)-1-phenylprop-2-en-1-one (S13).



Following the general procedure, 2-hydroxy-1-naphthaldehyde (2 g, 11.6 mmol), 1-phenyl-2-(triphenylphosphanylidene)ethanone **S7** (5.24 g, 13.94 mmol) and chloroform (40 mL) were reacted to give the crude product which was purified by column chromatography (EtOAc: hexane, 0%→40%). The obtained solid was recrystallized from EtOAc to give *(E)-3-(2-hydroxynaphthalen-1-yl)-1-phenylprop-2-en-1-one* **S13** as a yellow solid (580 mg, 18%). m.p. 139-142 °C (EtOAc). ^{1}H NMR (500 MHz, MeOD) δ_H: 7.20 (1H, d, *J* 8.9, Nap*H*), 7.36 (1H, ddd, *J* 7.9, 6.8, 1.1, Nap*H*), 7.55 (3H, tdd, *J* 8.5, 6.6, 1.5, Ph(3+5)*H*+Nap*H*), 7.62–7.68 (1H, m, Ph(4)*H*), 7.78–7.83 (2H, m, Nap*H*), 8.05–8.09 (2H, m, Ph(2+6)*H*), 8.19–8.24 (2H, m, C(3)*H*+Nap*H*), 8.60 (1H, d, *J* 15.6, C(3)*H*). ^{13}C NMR (126 MHz, MeOD) δ_C: 114.6 (Nap*C*(1)), 119.1 (Nap*C*H), 123.3 (Nap*C*H), 124.5 (Nap*C*H), 126.5 (*C*(2)), 128.6 (Nap*C*H), 129.5 (Ph*C*(2+6)), 129.8 (Ph*C*(3+5)), 129.9 (Nap*C*H), 130.1 (Nap*C*(5)), 133.5 (Nap*C*H), 134.0 (Ph*C*(4)), 135.1 (Ph*C*(1)), 139.5 (*C*(3)) , 139.9 (Nap*C*(10)), 158.3 (Nap*C*(2)), 193.8 (*C*O). IR (solid) ν_{max} cm^{-1}: 1647 (CO). HRMS (NSI$^+$) $C_{19}H_{15}O_2$ $[M+H]^+$ found 275.1069 requires 275.1067 (0.9 ppm).

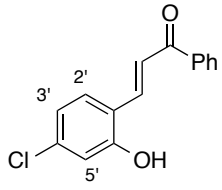
(*E*)-3-(2'-Hydroxy-5'-(trifluoromethyl)phenyl)-1-phenylprop-2-en-1-one (S14).



Following the general procedure, 2-hydroxy-5-(trifluoromethyl)benzaldehyde (582 mg, 3.06 mmol), phosphorane 1-phenyl-2-(triphenylphosphanylidene)ethanone **S7** (1.38 g, 3.67 mmol) and chloroform (10 mL) were reacted to give the crude product which was purified by

column chromatography (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(2-hydroxy-5-(trifluoromethyl)phenyl)-1-phenylprop-2-en-1-one* **S14** as a yellow solid (724 mg, 81%). m.p. 189-190 °C. ^{1}H NMR (500 MHz, MeOD) δ_H: 7.02 (1H, d, *J* 8.6, Ar*H*), 7.50-7.58 (3H, m, Ph*H*), 7.61-7.65 (1H, m, Ph*H*), 7.89 (1H, dd, *J* 15.8, 3.1, C(2)*H*), 7.96-7.98 (1H, m, Ph*H*), 8.04-8.10 (3H, m, Ar*H*+C(3)*H*). ^{13}C NMR (126 MHz, MeOD) δ_C: 117.5 (Ar*C*H), 122.84 (Ar*C*(1)) , 123.10 (Ar*C*(5)) , 123.52 (Ar*C*H), 124.4 (*C*(2)) , 125.8 (q, *J* 270.0, *C*F$_3$), 127.7 (q, *J* 3.9, (*C*PhH), 129.4 (t, *J* 3.7, (Ph*C*H)), 129.7 (d, *J* 20.1, (Ar*C*H)), 134.2 (Ph*C*H), 139.4 (Ph*C*(1)) , 140.6 (*C*(3)) , 161.5 (Ar*C*(2) , 192.7 (*C*(1)). ^{19}F NMR (470 MHz, MeOD) δ_F: −63.01 (C*F*$_3$). IR (solid) ν_{max} cm^{-1}: 1656 (CO). HRMS (NSI$^+$) $C_{16}H_{12}F_3O_2$ $[M+H]^+$ found 293.0785 requires 293.0784 (0.4 ppm).

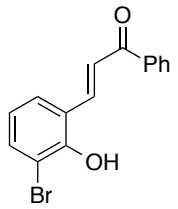
(*E*)-3-(4'-Chloro-2'-hydroxyphenyl)-1-phenylprop-2-en-1-one (S15).



Following the general procedure, 4-chloro-2-hydroxybenzaldehyde (586 mg, 3.70 mmol), 1-phenyl-2-(triphenylphosphanylidene)ethanone **S7** (1.67 g, 4.44 mmol) and chloroform (10 mL) were reacted to give the crude product which was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(4-chloro-2-hydroxyphenyl)-1-phenylprop-2-en-1-one* **S15** as a yellow solid (902 mg, 94%). m.p. 165-166 °C. ^{1}H NMR (400 MHz, MeOD) δ_H: 6.87–6.92 (2H, m, Ar*H*+C(5')*H*), 7.50–7.56 (2H, m, Ph*H*), 7.59–7.68 (2H, m, Ph*H*), 7.79 (1H, d, *J* 15.8, C(2)*H*), 8.00–8.07 (3H, m, C(3)*H*+Ph*H*+Ar*H*). ^{13}C NMR (101 MHz, MeOD) δ_C: 117.0 (*C*(5')), 121.0 (Ar*C*H), 122.2 (Ar*C*(1))) , 123.1 (*C*(2)), 129.6 (Ph*C*H), 129.8 (Ar*C*H), 131.6 (Ph*C*H), 134.0 (Ph*C*H), 138.1 (*C*(4')), 139.5 (Ph*C*(1)), 141.2 (*C*(3)), 159.5 (*C*(6')), 192.9 (*C*(1)). IR (solid) ν_{max} cm^{-1}: 1651

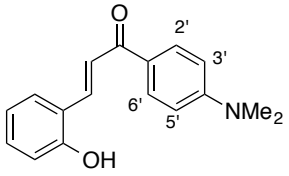
(CO). HRMS (NSI$^+$) $C_{15}H_{12}ClO_2$ $[M+H]^+$ found 259.0523 requires 259.0520 (1.0 ppm).

(*E*)-3-(3'-Bromo-2'-hydroxyphenyl)-1-phenylprop-2-en-1-one (S16).



Following the general procedure, 3-bromo-2-hydroxybenzaldehyde (2.25 g, 7.50 mmol), 1-phenyl-2-(triphenylphosphanylidene)ethanone **S7** (3.39 g, 9.0 mmol) and chloroform (20 mL) were reacted to give the crude product which was purified by column chromatography using a Biotage® Isolera 4 (eluent: 50%→85% CH_2Cl_2 in hexanes) to give *(E)-3-(3-bromo-2-hydroxyphenyl)-1-phenylprop-2-en-1-one* **S16** as a yellow solid (902 mg, 94%). m.p. 153-154 °C. ^{1}H NMR (400 MHz, MeOD) δ_H: 6.87 (1H, t, *J* 7.9, Ar*H*), 7.51–7.58 (3H, m, Ph*H*+Ar*H*×2), 7.60–7.66 (1H, m, Ph*H*), 7.72 (1H, ddd, *J* 7.8, 1.5, 0.5, Ph*H*), 7.80 (1H, d, *J* 15.8, (C(2)*H*), 8.04–8.08 (2H, m, Ph*H*), 8.13 (1H, d, *J* 15.8, C(3)*H*). ^{13}C NMR (101 MHz, MeOD) δ_C: 112.9 (ArC(3)), 122.4 (Ar*C*H), 124.1 (Ar*C*(1)), 125.9 (*C*(2), 129.3 (Ar*C*H), 129.6 (Ar*C*H), 129.8 (Ph*C*H), 134.2 (Ph*C*H), 135.9 (Ph*C*H), 139.4 (Ph*C*(1)), 141.3 (*C*(3)), 154.7 (Ar*C*(2)), 192.6 (*C*(1)). IR (solid) ν_{max} cm^{-1}: 1651 (CO). HRMS (NSI$^+$) $C_{15}H_{12}BrO_2$ $[M+H]^+$ found 303.0020 requires 303.0015 (1.6 ppm).

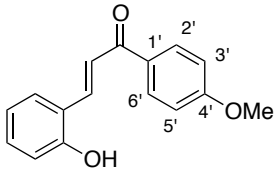
(*E*)-1-(4'-(Dimethylamino)phenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one (S17).



Following the general procedure, salicylaldehyde **S8** (0.51 mL, 4.76 mmol 1-(4-(dimethylamino)phenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one (2.22 g, 5.24 mmol)

and chloroform (10 mL) were reacted to give the crude product which was purified by column chromatography using a Biotage® Isolera 4 (EtOAc: hexane, 0%→100%). The solid obtained was purified by column chromatography (eluent: 80% EtOAc in hexanes) to give *(E)-1-(4-(dimethylamino)phenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one* **S17** as a brown solid (1.25 g, 98%). m.p. 148 °C (dec). ^{1}H NMR (500 MHz, MeOD) δ_H: 3.10 (6H, s, C*H*$_3$), 6.75–6.82 (2H, m, C(3')*H*+C(5')*H*), 6.84–6.91 (2H, m, Ar*H*), 7.20–7.26 (1H, m, Ar*H*), 7.65 (1H, dd, *J* 7.6, 1.7, Ar*H*), 7.85 (1H, d, *J* 15.7, C(2)*H*), 7.99–8.03 (2H, m, C(2')*H*+C(6')*H*), 8.05 (1H, d, *J* 15.7, C(3)*H*). ^{13}C NMR (126 MHz, MeOD) δ_C: 40.1 (*C*H$_3$), 112.0 (*C*(3')+*C*(5'), 117.0 (Ar*C*H*)*, 120.8 (Ar*C*(1)), 122.7 (*C*(2)), 129.9 (Ar*C*H), 130.0 (Ar*C*H), 132.1 (*C*(2')+*C*(6')), 133.0 (Ar*C*H), 133.1 (*C*(1')), 140.3 (*C*(3)), 155.4 (*C*(4'), 158.6 (Ar*C*(2)), 190.8 (*C*(1)). IR (solid) ν_{max} cm^{-1}: 1637 (CO). HRMS (NSI$^+$) $C_{17}H_{18}NO_2$ $[M+H]^+$ found 268.1332 requires 268.1332 (0 ppm).

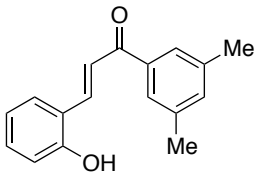
(*E*)-3-(2-Hydroxyphenyl)-1-(4'-methoxyphenyl)prop-2-en-1-one (S18).



Following the general procedure, salicylaldehyde (1.7 mL, 13.1 mmol) 1-(4-methoxyphenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one **S9** (6.45 g, 15.7 mmol) and chloroform (34 mL) were reacted to give the crude product, which was purified by column chromatography (eluent: 50%→80% diethyl ether in hexanes) to give (*E*)-3-(2-hydroxyphenyl)-1-(4'-methoxyphenyl)prop-2-en-1-one **S18** as a yellow solid (60%, 1.98 g). m.p. 145-148 °C {lit[15] m.p. 148-149 °C (EtOH)}. ^{1}H NMR (500 MHz, $CDCl_3$) [15] δ_H: 3.90 (3H, s, C*H*$_3$), 6.68 (1H, br, O*H*), 6.91-7.01 (4H, m, C(3')*H*+C(5')*H*+Ar*H*×2), 7.25-7.29 (1H, m, Ar*H*), 7.60 (1H, dd, *J*

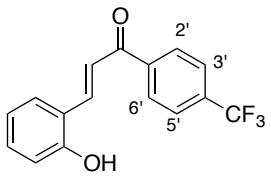
7.8, 1.6, Ar*H*), 7.71 (1H, d, *J* 15.8, C(2)*H*), 8.05-8.09 (2H, m, *C*(2')*H*+C(6')*H*), 8.19 (1H, d, *J* 15.8, C(3)*H*). Data in agreement with the literature.[15]

(*E*)-1-(3',5'-Dimethylphenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one (S19).



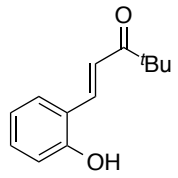
Following a modified literature procedure by Yin,[15] a solution of 30% of KOH in EtOH (2.53 mL) was added dropwise to a solution of 3,5-dimethylacetophenone (1 g, 6.75 mmol) and salicylaldehyde (0.77 mL, 7.67 mmol) in ethanol (8 mL). The mixture was then heated at 60 °C for 75 h. The reaction mixture was cooled to rt and acidified to pH 1 with 6M HCl. The solution was extracted with CH_2Cl_2 (× 3) and the organic layer dried ($MgSO_4$) and concentrated. The residue was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-1-(3',5'-dimethylphenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one* **S19** as a yellow solid (410 mg, 21%). m.p. 119-121 °C. ^{1}H NMR (500 MHz, MeOD) δ_H: 2.38 (6H, s, CH_3), 6.85–6.91 (2H, m, Ar*H*), 7.22–7.27 (2H, m, Ar*H*), 7.62 (2H, s, C(2')*H*+C(6')*H*), 7.66 (1H, dd, *J* 8.2, 1.7, C(4')*H*), 7.75 (1H, d, *J* 15.8, C(2)*H*), 8.08 (1H, d, *J* 15.8, C(3)*H*). ^{13}C NMR (126 MHz, MeOD) δ_C: 21.3 (*C*H_3), 117.1 (Ar*C*H), 120.8 (Ar*C*H), 122.9 (*C*(2)), 123.1 (Ar*C*(1)), 127.3 (*C*(2')+*C*(6')), 130.4 (*C*(4')), 133.0 (Ar*C*H), 135.5 (Ar*C*H), 139.6 (*C*(1')), 139.8 (*C*(3')+*C*(5')), 142.3 (*C*(3)), 158.8 (Ar*C*(2)), 193.6 (*C*(1)). IR (solid) ν_{max} cm^{-1}: 1645 (CO). HRMS (NSI$^+$) $C_{17}H_{17}O_2$ $[M+H]^+$ found 253.1221 requires 253.1223 (−1.5 ppm).

(*E*)-3-(2-Hydroxyphenyl)-1-(4'-(trifluoromethyl)phenyl)prop-2-en-1-on (S20).



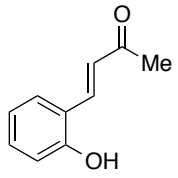
Following the general procedure, salicylaldehyde (1.2 mL, 9.3 mmol), 1-(4-(trifluoromethyl)phenyl)-2-(triphenyl-λ^5-phosphanylidene)ethan-1-one **S10** (5.0 g, 11.15 mmol) and chloroform (25 mL) were reacted to give the crude product which was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(2-hydroxyphenyl)-1-(4'-(trifluoromethyl)phenyl)prop-2-en-1-one* **S20** as a yellow solid (2.0 g, 74%). m.p. 149-151 °C. ^{1}H NMR (500 MHz, MeOD) δ_H: 6.86–6.91 (2H, m, Ar*H*), 7.26 (1H, ddd, *J* 8.5, 7.3, 1.7, Ar*H*), 7.68 (1H, dd, *J* 8.1, 1.7, Ar*H*), 7.79 (1H, d, *J* 15.8, C(2)*H*), 7.83 (2H, d, *J* 8.2, C(3')*H*+C(5')*H*), 8.14 (1H, d, *J* 15.8, C(3)*H*), 8.16–8.20 (2H, m, C(2')*H*+C(6')*H*). ^{13}C NMR (126 MHz, MeOD) δ_C: 117.1 (Ar*C*H), 120.9 (Ar*C*H), 122.2 (*C*(2)), 122.9 (Ar*C*(1)), 125.3 (q, *J* 271.7, *C*F$_3$), 126.7 (q, *J* 3.8, *C*(3')+*C*(5')), 130.1 (*C*(2')+*C*(6')), 130.6 (Ar*C*H), 133.4 (Ar*C*H), 134.8 (q, *J* 32.3, *C*(4')), 142.9 (*C*(1')), 143.6 (*C*(3)), 159.1 (Ar*C*(2), 191.9 (*C*(1)). ^{19}F NMR (471 MHz, MeOD) δ_F: −64.48 . IR (solid) ν_{max} cm^{-1}: 1703 (CO). HRMS (NSI$^+$) $C_{16}H_{12}O_2F_3$ $[M+H]^+$ found 293.0784 requires 293.0784 (0 ppm).

(*E*)-3-(2-Hydroxyphenyl)-1-phenylprop-2-en-1-one (S21).



Following the general procedure, salicylaldehyde (0.450 mL, 4.62 mmol), 3,3-dimethyl-1-(triphenyl-λ^5-phosphanylidene)butan-2-one **S11** (2.00 g, 5.55 mmol) and chloroform (9 mL) were reacted to give the crude product which was purified by column chromatography (eluent: 20%→40% Et_2O in petroleum ether) to give *(E)-3-(2-hydroxyphenyl)-1-phenylprop-2-en-1-one* **S21** as a pale yellow solid (883 mg, 94%). m.p. 123-125 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 1.23 (9H, s, C*H*$_3$), 6.04(1H, br, O*H*) 6.82 (1H, dd, *J* 8.1, 1.1, Ar*H*), 6.93-6.97 (1H, m, Ar*H*), 7.22-7.27 (1H, m, Ar*H*), 7.25 (1H, d, *J* 15.7, C(2)*H*), 7.52 (1H, dd, *J* 7.8, 1.7, Ar*H*), 7.96 (1H, d, *J* 15.7, C(3)*H*). ^{13}C NMR (125 MHZ, $CDCl_3$) δ_C: 26.4 ((C*H*$_3$)$_3$), 43.3 (*C*(CH$_3$)$_3$), 116.5 (Ar*C*H), 120.9 (Ar*C*H), 121.5 (C(2)), 122.3 (Ar*C*(1)), 129.0 (C(3)), 131.4 (Ar*C*H), 138.2 (Ar*C*H), 155.1 (Ar*C*(2)), 205.2 (*C*O). IR (film) ν_{max} cm^{-1}: 3319 (OH), 1666 (CO). HRMS (APCI$^+$) $C_{13}H_{17}O_2$ $[M+H]^+$ found 205.1223, requires 205.1223 (−1.5 ppm).

(*E*)-4-(2-Hydroxyphenyl)but-3-en-2-one (S22).



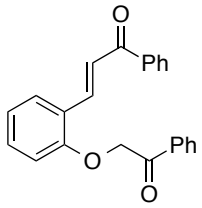
Following the general procedure, salicylaldehyde (0.870 mL, 8.19 mmol), and (acetylmethylene)triphenylphosphorane (3.13 g, 9.85 mmol) in chloroform (18 mL) were reacted to give the crude product, which was purified by column chromatography (eluent: 1:1 diethyl ether in petroleum ether) to give *(E)-4-(2-hydroxyphenyl)but-3-en-2-one* **S22** as a pale yellow solid (1.43 g, quantitative). m.p. 132-134 °C; {lit[15] m.p. 138-139 °C (ethanol)}. ^{1}H

NMR (400 MHz, $CDCl_3$)[15] δ_H: 2.42 (3H, s, C*H*$_3$), 6.51-6.58 (1H, m, Ar*H*), 6.85-6.96 (2H, m, Ar*H*), 6.99 (1H, d, *J* 16.4, C(2)*H*), 7.45-7.52 (1H, m, Ar*H*), 7.84 (1H, d, *J* 16.4, C(3)*H*). Data in agreement with the literature.[15]

General procedure for the synthesis of keto-enones

Following a modified method by Jørgensen,[16] the appropriate enone (1 eq.), α-bromoketone (2 eq.), potassium carbonate (1.25 eq.) and tetrabutylammonium iodide (0.1 eq.) were stirred at rt in acetone for the stated time. The reactions were concentrated *in vacuo*, dissolved in CH_2Cl_2 and washed with water. The organic layer was dried ($MgSO_4$) and concentrated *in vacuo* to give the crude product, which was purified as described.

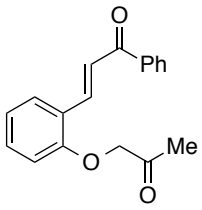
(*E*)-3-(2-(2-Oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one (1).



Following the general procedure, (*E*)-3-(2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S12** (1.00 g, 4.46 mmol), 2-bromoacetophenone (1.78 g, 8.92 mmol), potassium carbonate (769 mg, 5.56 mmol) and tetrabutylammonium iodide (164 mg, 0.45 mmol) were reacted in acetone (45 mL) for 16 h. The crude product was purified by column chromatography (eluent: 20%→50% diethyl ether in petroleum ether) to give (*E*)-3-(2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one **1** as a pale yellow solid (1.01 g, 65%). m.p. 115-116 °C {lit[17] m.p. 121-125 °C}. ^{1}H NMR (500 MHz, $CDCl_3$)[17] δ_H: 5.40 (2H, s, C*H*$_2$), 6.89 (1H, d, *J* 8.3, Ar*H*), 7.05 (1H, t, *J* 7.5, Ar*H*), 7.34 (1H, td, *J* 7.8, 1.7,Ar*H*), 7.48-7.53 (4H, m, Ar*H*), 7.57 (1H, t, *J* 7.3, Ar*H*), 7.60-7.65 (2H, m, Ar*H*), 7.97 (1H, d, *J* 15.7, C(2)*H*),

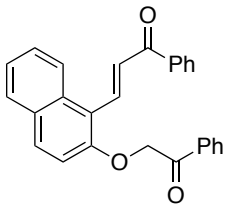
8.01-8.05 (2H, m, Ar*H*), 8.06-8.12 (3H, m, Ar*H* and C(3)*H*). Data in accordance with the literature.[17]

(*E*)-3-(2-(2-Oxopropoxy)phenyl)-1-phenylprop-2-en-1-one (9).



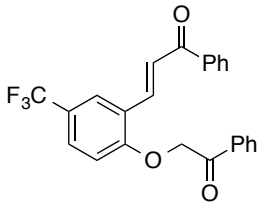
Following the general procedure, phenol derivative (*E*)-3-(2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S22** (1.85 g, 8.26 mmol), bromoacetone (2.26 g, 16.5 mmol), potassium carbonate (1.42 g, 10.3 mmol) and tetrabutylammonium iodide (0.3 g, 0.83 mmol) were reacted in acetone (83 mL) for 3.5 h. The crude product was purified by column chromatography (eluent: 10%→30% ethyl acetate in hexanes) and further purified by column chromatography (eluent: 30% → 50% diethyl ether:petroleum ether) to give (*E*)-3-(2-(2-oxopropoxy)phenyl)-1-phenylprop-2-en-1-one **9** as a yellow solid (1.47 g, 64 %). m.p. 80-81 °C {lit[16] m.p. 97-98 °C}. ^{1}H NMR (400 MHz, $CDCl_3$)[16] δ_H: 2.33 (3H, s, CH_3), 4.66 (2H, s, CH_2), 6.79 (1H, dd, *J* 8.4, 1.0, Ar*H*), 7.07 (1H, td, *J* 7.5, 0.8, Ar*H*), 7.34-7.39 (1H, m, Ar*H*), 7.49-7.55 (2H, m, Ar*H*+Ph*H*), 7.56-7.62 (1H, m, Ph*H*), 7.69 (1H, dd, *J* 7.7, 1.7, Ph*H*), 7.79 (1H, d, *J* 15.9, C(2)*H*), 8.07-8.11 (2H, m, Ph*H*), 8.16 (1H, d, *J* 15.9, C(3)*H*). Data in agreement with the literature.[16]

(*E*)-3-(2-(2-Oxo-2-phenylethoxy)naphthalen-1-yl)-1-phenylprop-2-en-1-one (S23).



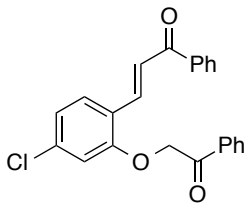
Following the general procedure, (*E*)-3-(2'-hydroxynaphthalen-1-yl)-1-phenylprop-2-en-1-one **S13** (580 mg, 2.11 mmol), 2-bromoacetophenone (838 mg, 4.24 mmol), potassium carbonate (361 mg, 2.63 mmol) and tetrabutylammonium iodide (77 mg, 0.21 mmol) were reacted in acetone (20 mL) for 4 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→25% EtOAc in hexanes) to give *(E)-3-(2-(2-oxo-2-phenylethoxy)naphthalen-1-yl)-1-phenylprop-2-en-1-one* **S23** as a yellow solid (640 mg, 81%). m.p. 162-164 °C . ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.51 (2H, s, CH_2), 7.25 (1H, d, *J* 9.2, Nap*H*), 7.43 (1H, ddd, *J* 7.9, 6.7, 1.0, Nap*H*), 7.47–7.54 (4H, m,Ph*H*), 7.54–7.63 (3H, m, Ph*H*×2+Nap*H*X1), 7.78–7.82 (1H, m, Nap*H*), 7.86 (1H, d, *J* 9.1, Nap*H*), 8.00–8.05 (2H, m, Ph*H*), 8.13–8.17 (2H, m, Ph*H*), 8.21 (1H, d, *J* 15.8, 3.1, C(2)*H*), 8.28–8.33 (1H, m, Nap*H*), 8.58 (1H, d, *J* 15.8, C(3)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ 71.8 (*C*H_2), 113.8 (Nap*C*H), 118.3 (Nap(1)*C*), 123.7 (Nap*C*H), 124.6 (Nap*C*H), 127.8 (Ph*C*H), 128.0 (*C*(2)), 128.2 (Ph*C*H), 128.7 (Nap*C*H), 128.8 (Ph*C*H), 128.9 (Ph*C*H), 129.1 (Ph*C*H), 129.6(Nap(5)*C*)), 131.9 (Nap*C*H), 132.8 (Nap*C*H), 133.4 (Ph(1)*C*), 134.2 (Ph*C*H), 134.5 (Ph(1)*C*), 137.0 (*C*(3)), 138.6 (Nap(10)*C*), 155.5 (Nap(2)*C*), 191.3 (*C*(1)), 193.7 (*C*OCH_2). IR (solid) ν_{max} cm^{-1}: 1707 (CO), 1649 (CO). HRMS (NSI^+) $C_{27}H_{21}O_3$ $[M+H]^+$ found 393.1484 requires 393.1485 (−0.3 ppm).

(*E*)-3-(2-(2-Oxo-2-phenylethoxy)-5-(trifluoromethyl)phenyl)-1-phenylprop-2-en-1-one (S24).



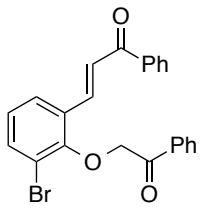
Following the general procedure, phenol derivative (*E*)-3-(2'-hydroxy-5'-(trifluoromethyl)phenyl)-1-phenylprop-2-en-1-one **S14** (724 mg, 2.47 mmol), bromoacetophenone (981 mg, 5.0 mmol), potassium carbonate (428 mg, 3.07 mmol) and tetrabutylammonium iodide (92 mg, 0.25 mmol) were reacted in acetone (25 mL) for 2 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(2-(2-oxo-2-phenylethoxy)-5-(trifluoromethyl)phenyl)-1-phenylprop-2-en-1-one* **S24** as a pale yellow solid (895 mg, 88%). m.p. 174-176 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.49 (2H, s, CH_2), 6.92 (1H, d, *J* 8.7, Ar*H*), 7.50–7.62 (6H, m, Ar*H*×2, Ph*H*×4), 7.63–7.69 (1H, m, Ph*H*), 7.88 (1H, d, *J* 2.3, Ph*H*), 7.96 (1H, d, *J* 15.8, C(2)*H*), 8.00–8.04 (2H, m, Ph*H*), 8.06–8.14 (3H, m, C(3)*H*+Ph*H*×2). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 71.0 (*C*H_2), 112.4 (Ar*C*H), 124.4 (*C*(1')), 124.6 (q, *J* 132.8, *C*F_3)), 125.1 (Ar*C*(5')), 125.4 (*C*(2)), 127.6 (d, *J* 3.6, Ph*C*H), 128.2 (Ph*C*H), 128.2 (d, *J* 4.1, Ar*C*H), 128.8 (Ph*C*H), 128.9 (Ar*C*H), 129.2 (*Ph*C*H*), 133.0 (Ph*C*H), 134.2 (Ph*C*(1)), 134.5 (Ph*C*H), 138.2 (Ph*C*(1)), 138.7 (*C*(3)), 159.3 (Ar*C*(2)), 190.7 (*C*(1)), 192.8 (*C*OCH_2). ^{19}F NMR (470 MHz, $CDCl_3$) δ_F: −61.87. IR (solid) ν_{max} cm^{-1}: 1651 (CO), 1703 (CO). HRMS (NSI$^+$) $C_{24}H_{18}F_3O_3$ $[M+H]^+$ found 411.1199 requires 411.1203 (−0.9 ppm).

(*E*)-3-(4-Chloro-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one (S25).



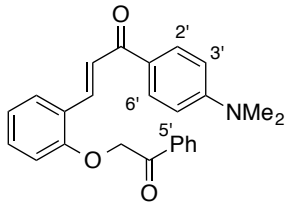
Following the general procedure, (*E*)-3-(4'-chloro-2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S15** (902 mg, 3.50 mmol), bromoacetophenone (1.39 g, 7.04 mmol), potassium carbonate (600 mg, 4.40 mmol) and tetrabutylammonium iodide (130 mg, 0.35 mmol) were reacted in acetone (35 mL) for 5 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 20%→80% CH_2Cl_2 in hexanes) to give *(E)-3-(4-chloro-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one* **S25** as a colourless solid (602 mg, 23 %). m.p. 132-133 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.41 (2H, s, C*H*$_2$), 6.88 (1H, d, *J* 1.9, Ar*H*), 7.04 (1H, dd, *J* 8.2, 1.9, Ar*H*), 7.48–7.61 (6H, m, Ph*H*), 7.61–7.68 (1H, m, Ar*H*), 7.97–8.06 (4H, m, C(2)H+Ph*H*×3), 8.09–8.15 (2H, m, C(3)*H*+Ph*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 71.1 (*C*H$_2$), 113.1 (Ar*C*H), 122.2 (Ar*C*H), 123.3 (Ar*C*(1)), 124.5 (*C*(2)), 128.2 (Ph*C*H), 128.7 (Ph*C*H), 128.9 (Ph*C*H), 129.2 (Ph*C*H), 132.2 (Ph*C*H), 132.9 (Ph*C*H), 134.3 (Ar*C*H), 134.4 (Ph*C*(1)), 136.9 (Ar*C*(4)), 138.4 (Ph*C*(1)), 139.4 (*C*(3)), 157.8 (Ar*C*(2)), 191.1 (*C*(1)), 192.7 (*C*OCH$_2$). IR (solid) ν_{max} cm^{-1}: 1699 (CO), 1654 (CO). HRMS (NSI$^+$) $C_{23}H_{18}ClO_3$ $[M+H]^+$ found 377.0941 requires 377.0939 (0.5 ppm).

(*E*)-3-(3-Bromo-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one (S26).



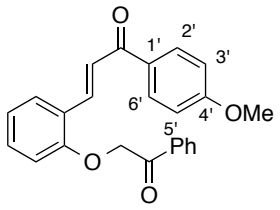
Following the general procedure, (*E*)-3-(3'-bromo-2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S16** (1.89 g, 6.24 mmol), bromoacetophenone (2.48 g, 12.5 mmol), potassium carbonate (1.07 g, 7.80 mmol) and tetrabutylammonium iodide (231 mg, 0.62 mmol) were reacted in acetone (60 mL) for 5 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(3-bromo-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one* **S26** as a colourless solid (1.75 g, 68%) m.p. 174-176 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.29 (2H, s,CH_2), 7.12 (1H, t, *J* 7.9, Ar*H*), 7.47 (4H, td, *J* 7.8, 2.6, Ph*H*), 7.54–7.65 (4H, m, Ar*H*×2+Ph*H*×2), 7.76 (1H, d, *J* 15.9, C(2)*H*), 7.95–7.98 (2H, m, Ph*H*), 7.99–8.03 (3H, m, C(3)*H*+Ph*H*×2). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 75.2 (*C*H_2), 118.3 (Ar*C*(1)), 125.6 (*C*(2)), 126.4 (Ar*C*H), 128.0 (Ph*C*H), 128.8 (Ph*C*H), 128.8 (Ph*C*H), 129.0 (Ar*H*), 129.1 (Ar*H*), 130.8 (Ar*C*(3)) , 133.1 (Ph*C*H), 134.0 (Ph*C*H), 134.4 (Ph*C*(1)), 135.4 (Ph*C*H) , 137.8 (Ph*C*(1)), 139.0 (*C*(3)), 154.8 (Ar*C*(2)), 190.6 (*C*(1)), 192.8 (*C*OCH_2). IR (solid) ν_{max} cm^{-1}: 1699 (CO), 1660 (CO). HRMS (NSI$^+$) $C_{23}H_{18}BrO_3$ $[M+H]^+$ found 421.0433 requires 421.0434 (−0.2 ppm).

(*E*)-1-(4-(Dimethylamino)phenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one (S27).



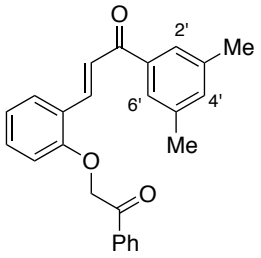
Following the general procedure, (*E*)-1-(4'-(dimethylamino)phenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one **S17** (1.25 g, 4.68 mmol), bromoacetophenone (1.86 g, 5.94 mmol), potassium carbonate (803 mg, 5.82 mmol) and tetrabutylammonium iodide (173 mg, 0.47 mmol) were reacted in acetone (45 mL) for 4h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 5%→40% EtOAc in hexanes) to give *(E)-1-(4-(dimethylamino)phenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one* **S27** as a yellow solid (448 mg, 25%). m.p. 150-151 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 3.08 (6H, s, C*H*$_3$), 5.38 (2H, s, C*H*$_2$), 6.70 (2H, d, *J* 9.0, C(3')*H*+C(5')*H*), 6.87 (1H, dd, *J* 8.4, 1.0, Ar*H*), 7.03 (1H, td, *J* 7.5, 0.9, Ar*H*), 7.28–7.33 (1H, m, Ph(4)*H*), 7.48–7.53 (2H, m, Ph(3+5)*H*), 7.59–7.64 (2H, m, Ph(2+6)*H*), 7.96 (1H, d, *J* 15.8, (C(2)*H*), 8.02–8.09 (5H, m, (C(3)*H*)+ C(2')*H*+C(6')*H*+Ar*H*×2). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 40.2 (*C*H$_3$), 71.3 (*C*H$_2$), 111.0 (*C*(3')+*C*(5')), 112.5 (*C*ArH), 121.9 (*C*ArH), 124.5 (*C*(2)) , 125.3 (Ar*C*(1)) , 126.5 (*C*(1'), 128.3 (Ar*C*H), 129.0 (Ph*C*(3+5)), 130.9 (Ph*C*(2+6)+ Ph*C*(4)), 131.1 (*C*(2')+*C*(6')), 134.1 (Ar*C*H), 134.6 (Ph*C*(1)) , 138.2 (*C*(3)), 153.4 (*C*(4')), 157.2 (*C*(2)Ar), 188.6 (*C*(1)), 194.0 (*C*OCH$_2$) . IR (solid) ν_{max} cm^{-1}: 1699 (CO). HRMS (NSI$^+$) $C_{25}H_{24}NO_3$ $[M+H]^+$ found 386.1752 requires 386.1751 (0.3 ppm).

(*E*)-1-(4-Methoxyphenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one (S28).



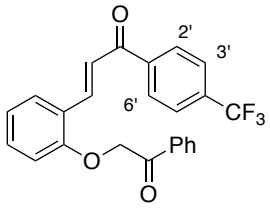
Following the general procedure, (*E*)-3-(2-hydroxyphenyl)-1-(4'-methoxyphenyl)prop-2-en-1-one **S18** (1.98 g, 7.80 mmol), 2-bromoacetophenone (3.10 g, 15.60 mmol), potassium carbonate (1.34 g, 9.75 mmol) and tetrabutylammonium iodide (287 mg, 0.78 mmol) were reacted in acetone (78 mL) for 4 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 10%→100% EtOAc in hexanes) to give *(E)-1-(4-methoxyphenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one* **S28** as an orange solid (1.01 g, 35%). m.p. 140-142 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.90 (3H, s, C*H*$_3$), 5.40 (2H, s, C*H*$_2$), 6.89 (1H, d, *J* 8.4, Ar*H*), 6.96-7.00 (2H, m, C(3')*H*+C(5')*H*), 7.05 (1H, td, *J* 7.5, 1.0, Ar*H*), 7.31-7.35 (1H, m, Ar*H*), 7.50-7.54 (2H, m, Ph*H*), 7.60-7.64 (2H, m, Ph*H*), 7.99-8.07 (4H, m, C(2)*H*+C(3)*H*, Ar*H*+Ph*H*), 8.11-8.15 (2H, m, C(2')*H*+C(6')*H*). ^{13}C NMR (500 MHz, $CDCl_3$) δ_C: 55.6 (*C*H$_3$), 71.2 (*C*H$_2$), 112.4 (Ar*C*H), 113.9 (*C*(3')+(*C*(5')), 121.9 (Ar*C*H), 124.3 (*C*(2)), 124.8 (Ar*C*(2)), 128.3 (Ar*C*H), 129.1 (Ph*C*H), 131.2 (Ph*C*H), 131.3 (*Ar*C*H*), 131.4 (*C*(2')+*C*(6')), 131.5 (*C*(1')), 134.2 (Ph*C*H), 134.6 (Ph*C*(1)), 139.8 (*C*(3)), 157.4 (Ar*C*(2)), 163.4 (*C*(4')), 189.6 (*C*(1')), 193.7 (*C*OCH$_2$). IR (solid) ν_{max} cm^{-1}: 1695 (CO), 1647 (CO). HRMS (NSI$^+$) $C_{24}H_{21}O_4$ $[M+H]^+$ requires 373.1434 found 373.1433 (−0.4 ppm).

(*E*)-1-(3,5-Dimethylphenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one (S29).



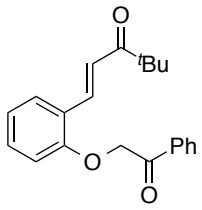
Following the general procedure, (*E*)-1-(3',5'-dimethylphenyl)-3-(2-hydroxyphenyl)prop-2-en-1-one **S19** (410 mg, 1.62 mmol), 2-bromoacetophenone (647 mg, 3.24 mmol), potassium carbonate (279 mg, 0.45 mmol) and tetrabutylammonium iodide (60 mg, 0.16 mmol) were reacted in acetone (16 mL) for 4 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-1-(3,5-dimethylphenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one* **S29** as a yellow solid (430 mg, 72%). m.p. 143-144 °C . ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 2.43 (6H, s, CH_3), 5.41 (2H, s, CH_2), 6.90 (1H, d, *J* 8.2, Ar*H*), 7.00–7.08 (1H, m, Ar*H*), 7.22 (1H, s, C(4')*H*), 7.34 (1H, ddd, *J* 8.7, 7.5, 1.7, Ar*H*), 7.49–7.53 (2H, m, Ph(3+5)*H*), 7.62 (2H, td, *J* 7.7, 1.6, Ar*H*+Ph(4)*H*), 7.79–7.83 (2H, m, C(2')*H*+C(6')*H*), 8.00–8.11 (4H, m, C(2)*H*+C(3)*H*+Ph(2+6)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 21.4 (*C*H_3), 71.0 (*C*H_2), 112.4 (Ar*C*H), 121.9 (Ar*C*H), 124.7 (*C*(2)), 124.8 (Ar*C*(1)), 126.7 (*C*(2')+*C*(6')), 128.1 (Ph(2+6)*C*), 129.1 (Ph(3+5)*H*), 131.4 (Ar*C*H), 131.5 (Ar*C*H), 134.2 (Ph*C*(4)), 134.5 (*C*(4')), 134.5 (Ph(1)*C*), 138.3 (*C*(3')+*C*(5')), 138.6 (*C*(1')), 140.1 (*C*(3)), 157.4 (Ar*C*(2)), 191.6 (*C*(1)), 193.4 (*C*OCH_2). IR (solid) ν_{max} cm^{-1}: 1655 (CO), 1707 (CO). HRMS (NSI^+) $C_{25}H_{23}O_3$ $[M+H]^+$ requires 371.1637 found 371.1642 (−1.3 ppm).

(*E*)-3-(2-(2-Oxo-2-phenylethoxy)phenyl)-1-(4-(trifluoromethyl)phenyl)prop-2-en-1-one (S30).



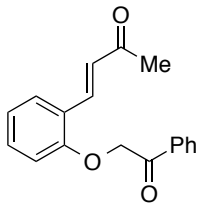
Following the general procedure, phenol derivative (*E*)-3-(2-hydroxyphenyl)-1-(4'-(trifluoromethyl)phenyl)prop-2-en-1-one **S20** (2.0 g, 6.8 mmol), 2-bromoacetophenone (2.71 g, 13.6 mmol), potassium carbonate (1.17g, 1.91 mmol) and tetrabutylammonium iodide (250 mg, 0.68 mmol) were reacted in acetone (70 mL) for 4 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(2-(2-oxo-2-phenylethoxy)phenyl)-1-(4-(trifluoromethyl)phenyl)prop-2-en-1-one* **S30** as a colourless solid (400 mg, 15%). m.p. 142-144 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.43 (2H, s, C*H*$_2$), 6.93 (1H, dd, *J* 8.3, 1.0, Ar*H*), 7.07 (1H, td, *J* 7.5, 1.0, Ar*H*), 7.38 (1H, ddd, *J* 8.3, 7.4, 1.7, Ar*H*), 7.51–7.56 (2H, m, Ph(3+5)*H*), 7.61–7.66 (2H, m, Ph(4)*H*+Ar*H*), 7.74–7.79 (2H, m, C(3')*H*+C(5')*H*), 8.01–8.08 (3H, m, (C(2)*H*+Ph(2+6)*H*), 8.13 (1H, d, *J* 15.8, C(3)*H*), 8.23–8.27 (2H, m, C(2')*H*+C(6')*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 70.9 (*C*H$_2$), 112.3 (Ar*C*H), 122.0 (Ar*C*H), 123.9 (q, *J* 272.7, *C*F$_3$), 124.1 (*C*(2)), 124.3 (Ar(1)*C*), 125.7 (q, *J* 3.9, *C*(3')+*C*(5')), 128.2 (Ph(2+6)*C*), 129.1 (*C*(2')+*C*(6')), 129.2 (Ph(3+5)*C*), 131.9 (Ar*C*H), 132.3 (Ph(4)*C*), 133.9 (q, *J* 32.5, *C*(4')) 134.3 (Ar*C*H), 134.5 (Ph(1)*C*), 141.4 (*C*(1')), 142.0 (*C*(3)), 157.6 (Ar(2)*C*), 190.5 (*C*(1)), 193.2 (COCH$_2$). ^{19}F NMR (471 MHz, $CDCl_3$) δ_F: −62.93 (C*F*$_3$). IR (solid) ν_{max} cm^{-1}: 1703 (CO), 1657 (CO). HRMS (NSI$^+$) $C_{24}H_{18}O_3F_3$ $[M+H]^+$ found 411.1200 requires 411.1203 (−0.6 ppm).

(*E*)-4,4-Dimethyl-1-(2-(2-oxo-2-phenylethoxy)phenyl)pent-1-en-3-one (S31).



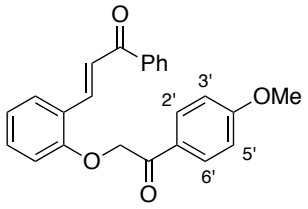
Following the general procedure, (*E*)-3-(2-hydroxyphenyl)-1-phenylprop-2-en-1-one **S21** (883 mg, 4.32 mmol), 2-bromoacetophenone (1.72 g, 8.66 mmol), potassium carbonate (747 mg, 5.41 mmol) and tetrabutylammonium iodide (159 mg, 0.43 mmol) were reacted in acetone (43 mL) for 48 h. The crude product was purified by column chromatography (eluent: 30% diethyl ether in petroleum ether) and recrystallized from Et_2O and petroleum ether to give *(E)-4,4-dimethyl-1-(2-(2-oxo-2-phenylethoxy)phenyl)pent-1-en-3-one* **S31** as a colourless solid (2.32 g, 79%). m.p. 120-121 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 1.23 (9H, s, C*H*$_3$), 5.36 (2H, s, CH_2), 6.86 (1H, dd, *J* 8.7, 1.0, Ar*H*), 7.01 (1H, t, *J* 7.5, Ar*H*), 7.29-7.33 (1H, m, Ar*H*), 7.49-7.56 (4H, m, Ar*H*+C(2)*H*+Ph(3+5)*H*), 7.61-7.65 (1H, m, Ph(4)*H*), 7.92 (1H, d, *J* 15.8, C(1)*H*), 8.00-8.03 (2H, m, Ph(2+6)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 26.4 (*C*H$_3$), 43.4 (*C*(CH$_3$)$_3$), 71.2 (*C*H$_2$), 112.4 (Ar*C*H), 121.9 (Ar*C*H), 123.3 (*C*(2)), 124.7 (Ar*C*(1)), 128.3 (Ph*C*H), 129.1 (Ph*C*H), 131.1 (Ar*C*H), 131.2 (Ar*C*H), 134.2 (Ph*C*(1)), 134.6 (Ph*C*H), 138.5 (*C*(1)), 157.3 (Ar*C*(2)), 193.7 (*C*OPh), 205.3 (*C*(3)). IR (solid) ν_{max} cm^{-1}: 1703 (CO), 1674 (CO). HRMS (NSI$^+$) $C_{21}H_{23}O_3$ $[M+H]^+$ found 323.1644 requires 323.1642 (0.4 ppm).

(*E*)-4-(2-(2-Oxo-2-phenylethoxy)phenyl)but-3-en-2-one (S32).



Following the general procedure, (*E*)-4-(2-hydroxyphenyl)but-3-en-2-one (1.40 g, 8.80 mmol), 2-bromoacetophenone **S22** (3.50 g, 17.6 mmol), potassium carbonate (1.50 g, 11.0 mmol) and tetrabutylammonium iodide (325 mg, 0.88 mmol) were reacted in acetone (88 mL) for 16 h. The crude product was purified by column chromatography (eluent: 10%→50% EtOAc in petroleum ether) to give *(E)-4-(2-(2-oxo-2-phenylethoxy)phenyl)but-3-en-2-one* **S32** as a pale yellow solid (2.32 g, 79%). m.p. 120-123 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 2.36 (3H, s, C*H*$_3$), 5.38 (2H, s, C*H*$_2$), 6.80-6.84 (2H, m, Ar*H* and C(3)*H*), 7.02 (1H, t, *J* 7.5, Ar*H*), 7.32 (1H, ddd, *J* 8.7, 7.5, 1.7, Ar*H*), 7.52 (2H, t, *J* 7.8, Ar*H*+Ph*H*), 7.58 (1H, dd, *J* 7.7, 1.7, Ph*H*), 7.62-7.66 (1H, m, Ph*H*), 7.96 (1H, d, *J* 16.5, C(4)*H*), 7.98-8.02 (2H, m, Ph*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 27.3 (*C*H$_3$), 71.2 (CH$_2$), 112.6 (Ar*C*H), 122.0 (Ar*C*H), 124.2 (Ar*C*(1)), 128.2 (*C*(3)), 128.5 (PhCH), 128.9 (Ph*C*H), 129.1 (Ar*C*H), 131.8 (Ar*C*H), 134.2 (Ph*C*H), 134.6 (Ph*C*(1)), 138.6 (*C*(4)), 156.8 (Ar*C*(2)), 194.0 (*C*OPh), 199.4 (*C*OMe). IR (solid) ν_{max} cm^{-1}: 1701 (CO), 1665 (CO). HRMS (p NSI$^+$) $C_{18}H_{16}O_3Na$ $[M+Na]^+$ found 303.0993 requires 303.0992 (0.4 ppm).

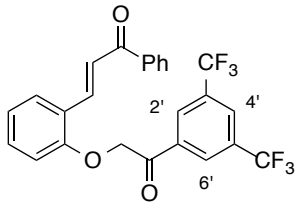
(*E*)-3-(2-(2-(4-Methoxyphenyl)-2-oxoethoxy)phenyl)-1-phenylprop-2-en-1-one (S33).



Following the general procedure, phenol derivative (*E*)-3-(2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S12** (420 mg, 2.59 mmol), 2-bromo-4′-methoxyacetophenone (1.19 g, 5.18 mmol), potassium carbonate (447 mg, 3.24 mmol) and tetrabutylammonium iodide (191 mg, 0.52 mmol) were reacted in acetone (26 mL) for 16 h. The crude product was purified by column chromatography (eluent: 20%→40% diethyl ether in petroleum ether) to give *(E)-3-(2-(2-(4-methoxyphenyl)-2-oxoethoxy)phenyl)-1-phenylprop-2-en-1-one* **S33** as a yellow solid

(447 mg, 46%). m.p. 116-118 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.85 (3H, s, C*H*$_3$), 5.32 (2H, s, C*H*$_2$), 6.88 (1H, d, *J* 8.3, Ar*H*), 6.93-6.97 (2H, m, C(3')*H*+C(5')*H*), 7.03 (1H, t, *J* 7.5, Ar*H*), 7.30-7.35 (1H, m, Ph*H*), 7.48 (2*H*, t, *J* 7.6, Ph*H*), 7.56 (1H, t, *J* 7.3, Ph*H*), 7.60-7.62 (1H, m, Ph*H*), 7.94 (1H, d, *J* 15.9, C(2)*H*), 7.99-8.04 (2H, m, C(2')*H*+C(6')*H*), 8.04-8.11 (3*H*, m, C(3)*H*+Ar*H*×2). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 55.6 (C*H*$_3$), 70.9 (*C*H$_2$), 112.3 (Ar*C*H), 114.1 (*C*(3')+*C*(5')), 121.7 (Ar*C*H), 124.0 (*C*(2)), 124.4 (Ar*C*(1)), 127.4 (*C*(1')), 128.5 (Ar*C*H), 128.7 (Ar*C*H), 130.6 (*C*(2')+*C*(6')), 131.1 (Ph*C*H), 131.5 (Ph*C*H), 132.6 (Ph*C*H), 138.4 (Ph*C*(1)), 140.5 (*C*(3)), 157.4 (Ar*C*(2)), 164.2 (*C*(4')), 191.1 (*C*(1)), 192.15 (CH$_2$*C*O). IR (solid) ν_{max} cm^{-1}: 1683 (CO), 1653 (CO). HRMS (p APCI) $C_{24}H_{21}O_4$ found 373.1434 requires 373.1434 (−0.1 ppm).

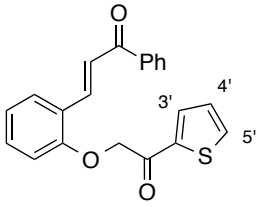
(*E*)-3-(2-(2-(3,5-Bis(trifluoromethyl)phenyl)-2-oxoethoxy)phenyl)-1-phenylprop-2-en-1-one (S33).



Following the general procedure, (*E*)-3-(2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S12** (1.22 g, 5.44 mmol), bromoacetophenone (3.61 g, 10.88 mmol), potassium carbonate (938 mg, 6.80 mmol) and tetrabutylammonium iodide (200 mg, 0.54 mmol) were reacted in acetone (55 mL) for 3h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 15%→70% CH_2Cl_2 in hexanes) to give *(E)-3-(2-(2-(3,5-bis(trifluoromethyl)phenyl)-2-oxoethoxy)phenyl)-1-phenylprop-2-en-1-one* **S33** as a colourless solid (1.49 g, 57%). m.p. 178-180 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.40 (2 H, s, CH_2), 6.90 (1H, d, *J* 8.3, Ar*H*), 7.09 (1H, t, *J* 7.5, Ar*H*), 7.34-7-41 (1H, m, Ph*H*), 7.46-7.53 (2H, m, Ph*H*), 7.55-7-61 (1H, m, Ph*H*), 7.67 (1H, dd, *J* 7.7, 1.7, Ph*H*), 7.82 (1H, d, *J* 15.9,

C(2)*H*), 7.77-7.86 (4 H, m, C(3)*H*+C(4')*H*+Ar*H*(×2)), 8.45 (2H, s, C(2')*H*+C(6')*H*). ^{13}C NMR (126 MHz, $(CD_3)_2SO$) δ_c: 71.2 (*C*H_2), 113.3 (Ar*C*H), 121.4 (Ar*C*H), 122.8 (*C*(2), 123.03 (q, *J* 272.4, *C*F_3), 123.2(Ar*C*(2)), 126.9 (*C*(4')), 128.5 (Ph*C*H), 128.6 (*C*(2')+*C*(6')), 128.8 (Ph*C*H), 130.3 (*C*ArH), 130.8 (q, *J* 33.6, *C*(3')+*C*(5')), 132.0 (Ph*C*H), 133.1 (Ar*C*H), 136.4 (*C*(1'), 137.8 (Ph*C*(1)), 139.3 (*C*(3)), 157.0 (Ar*C*(2)), 189.4 (*C*OPh), 192.5 (*C*(1)). ^{19}F NMR (471 MHz, $(CD_3)_2SO$) δ_F: −61.23 (C*F*$_3$). IR (solid) ν_{max} cm^{-1}: 1703 (CO), 1662 (CO). HRMS (NSI$^+$) $C_{25}H_{17}O_3F_6$ $[M+H]^+$ requires 479.1076 found 479.1069 (−1.5 ppm).

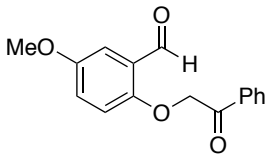
(*E*)-3-(2-(2-Oxo-2-(thiophen-2-yl)ethoxy)phenyl)-1-phenylprop-2-en-1-one (S35).



Following the general procedure, (*E*)-3-(2'-hydroxyphenyl)-1-phenylprop-2-en-1-one **S12** (0.47 g, 2.10 mmol), 2-(bromoacetyl)-thiophene (861 mg, 4.20 mmol), potassium carbonate (361 mg, 2.63 mmol) and tetrabutylammonium iodide (77 mg, 0.21 mmol) were reacted in acetone (20 mL) for 5 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *(E)-3-(2-(2-oxo-2-(thiophen-2-yl)ethoxy)phenyl)-1-phenylprop-2-en-1-one* **S35** as a yellow solid (444 mg, 61%). m.p. 134-136 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 5.22 (2H, s, C*H*$_2$), 6.90 (1H, dd, *J* 8.4, 1.0, Ar*H*), 7.05 (1H, td, *J* 7.6, 1.0, Ar*H*), 7.15 (1H, dd, *J* 4.9, 3.8, Ar*H*), 7.34 (1H, ddd, *J* 8.6, 7.4, 1.7, thiophene C(4)*H*), 7.49 (2H, ddd, *J* 8.3, 6.6, 1.3, Ph*H*(3+5)), 7.54–7.59 (1H, m, Ph*H*(4)), 7.65 (1H, dd, *J* 7.7, 1.7, Ar*H*), 7.71 (1H, dd, *J* 4.9, 1.1, thiophene C(3)*H*), 7.86 (1H, d, *J* 15.9, C(2)*H*), 7.94 (1H, dd, *J* 3.9, 1.1, thiophene C(4)*H*), 8.02–8.08 (2H, m, Ph*H* (2+6)), 8.14 (1H, d, *J* 15.8, C(3)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 71.6 (*C*H_2), 112.4 (ArC*H*), 122.1 (ArC*H*), 124.0 (*C*(2)), 124.5 (Ar*C*(1)), 128.6 (ArC*H*), 128.7 (Ph*C*(3+5)), 128.8

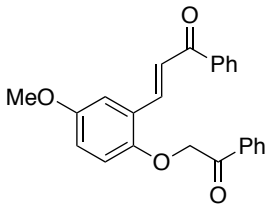
(Ph*C*(2+6)), 130.6 (ArC*H*), 131.7 (thiophene *C*(4)), 132.8 (Ph*C*(4)), 133.2 (thiophene *C*(5)), 134.9 (thiophene *C*(3)), 138.4 (Ph*C*(1)) , 140.3 (*C*(3)), 140.6 (thiophene *C*(2)), 157.2 (Ar*C*(2)), 187.4 (*C*(1)), 191.1 (*C*OCH$_2$). IR (solid) ν_{max} cm^{-1}: 1687 (CO), 1678 (CO). HRMS (NSI$^+$) $C_{21}H_{17}O_3S$ $[M+H]^+$ found 349.0895 requires 349.0893 (0.6 ppm).

5-Methoxy-2-(2-oxo-2-phenylethoxy)benzaldehyde (S36).



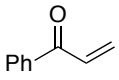
2-Hydroxy-5-methoxybenzaldehyde (520 mg, 3.30 mmol) was dissolved in acetone (20 mL) at rt. Tetrabutylammonium iodide (122 mg, 0.33 mmol), K_2CO_3 (568 mg, 4.12 mmol) and bromoacetophenone (786 mg, 3.95 mmol) were added and the reaction was stirred for 1 h at rt. The solvent was removed under reduced pressure and the remaining residue was dissolved in CH_2Cl_2 (25 mL), extracted with saturated NH_4Cl solution and washed with brine. The organic layer was dried over anhydrous $MgSO_4$, filtered and concentrated under reduced pressure. The residue was purified by column chromatography using a Biotage® Isolera 4 (eluent: 15%→25%, EtOAc:hexane) to give *5-methoxy-2-(2-oxo-2-phenylethoxy)benzaldehyde* **S36** as a colourless solid (305 mg, 34% yield). m.p. 102-103 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 3.79 (3H, s, C*H*$_3$), 5.39 (2H, s, C*H*$_2$), 6.85 (1H, d, *J* 9.1, Ar*H*), 7.08 (1H, dd, *J* 9.1, 3.3, Ar*H*), 7.35 (1H, d, *J* 3.3, Ar*H*), 7.51 (2H, t, *J* 7.8, Ar*H*), 7.60-7.68 (1H, m, Ar*H*), 7.98 (2H, dd, *J*, 8.0, 1.4, Ar*H*). ^{13}C NMR (75 MHz, $CDCl_3$) δ_C: 55.8 (*C*H$_3$), 71.7 (*C*H$_2$), 110.5 (Ar*C*H), 114.8 (Ar*C*H), 123.2 (Ar*C*H), 125.7 (Ar*C*), 128.0 (2×Ar*C*H), 128.9 (2×Ar*C*H), 134.1 (Ar*C*H), 134.2 (Ar*C*), 154.3 (Ar*C*), 155.0 (Ar*C*), 189.4 (*C*HO), 193.9 (*C*O). IR (solid) ν_{max} cm^{-1}: 1703 (CO), 1668 (CO). HMRS (ESI$^+$) $C_{16}H_{14}O_4Na^+$ ([M+Na]$^+$) requires 293.0773; found 293.0773 (−3.9 ppm).

(*E*)-3-(5-Methoxy-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one (S37).



5-Methoxy-2-(2-oxo-2-phenylethoxy)benzaldehyde **S36** (200 mg, 0.74 mmol) and 1-phenyl-2-(triphenylphosphanylidene)ethanone (422 mg, 1.11 mmol) were dissolved in $CHCl_3$ (10 mL) and stirred at rt for 18 h. The solvent was removed under reduced pressure and the residue was purified by column chromatography using a Biotage® Isolera 4 (eluent 5%→50% EtOAc in hexane) to give *(E)-3-(5-methoxy-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one* **S37** as a colourless solid (118 mg, 42%). m.p. 131-132 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.82 (3H, s, ArOCH_3), 5.34 (2H, s, CH_2), 6.85 (1H, d, *J* 9.0, Ar*H*), 6.90 (1H, dd, *J* 9.0, 3.0, Ar*H*), 7.16 (1H, d, *J* 3.0, Ar*H*), 7.47-7.54 (4H, m, Ph*H*), 7.55-7.65 (2H, m, Ph*H*), 7.89 (1H, d, *J* 15.8, (C(2)*H*), 7.99-8.12 (5H, m, C(3)*H*+PhH×5). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 55.8 (*C*H_3), 71.8 (*C*H_2), 113.9 (Ar*C*H), 115.3 (Ar*C*H), 116.8 (Ar*C*H), 124.3 (Ar*C*(1)), 125.3 (*C*(2)), 128.1 (Ph*C*H), 128.5 (Ph*C*H), 128.7 (PhC*H*), 128.9 (PhC*H*), 132.6 (PhC*H*), 134.0 (PhC*H*), 134.4 (Phr*C*(1)), 138.3 (Ph*C*(1)), 140.2 (*C*(3)), 151.7 (Ar*C*(2)), 154.2 (Ar*C*(5)), 191.1 (*C*(1)), 194.0 (*C*OCH$_2$). IR (solid) ν_{max} cm^{-1}: 1701 (CO), 1653 (CO). HMRS (NSI$^+$) $C_{24}H_{21}O_4$ ([M+H]$^+$) requires 373.1434; found 373.1434 (−0.1 ppm).

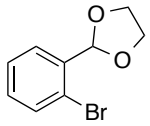
1-Phenylprop-2-en-1-one (S38).



Following a literature procedure from Iwasa,[18] triethylamine (3.00 ml, 21.4 mmol) was added dropwise to a solution of 2-chloroacetophenone (1.50 g, 8.9 mmol) in $CHCl_3$ (20 mL) and the reaction stirred at rt overnight. The reaction mixture was washed with 0.1 M HCl (2 × 20

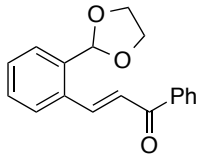
mL), $NaHCO_3$ (× 2) and brine. The organic layer was dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography using a Biotage® Isolera 4 (eluent: 5%→20% EtOAc in hexanes) to give 1-phenylprop-2-en-1-one **S38** as a colourless oil (900 mg, 77%). ^{1}H NMR (400 MHz, $CDCl_3$)[18] δ_H: 5.95 (1H, dd, *J* 10.6, 1.7, C(3)*H*), 6.45 (1H, *J* 17.1, 1.7, C(3)*H*), 7.17 (1H, *J* 17.1, 10.6, C(2)*H*), 7.45-7.53 (2H, m, Ph(3+5)*H*), 7.55-7.64 (1H, m, Ph(4)*H*), 7.92-7.98 (2H, m, Ph(2+6)*H*). Data in agreement with the literature.[18]

2-(2-Bromophenyl)-1,3-dioxolane (S39).



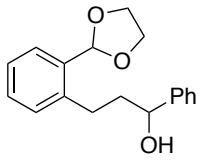
Following a literature procedure[19] by Bull and coworkers, *para*-toluenesulfonic acid (29 mg, 0.14 mmol) and ethylene glycol (1.68 g, 13.5 mmol) were added to a solution of 2-bromobenzaldehyde (2.5 g, 13.5 mmol) in toluene (15 mL). The reaction was heated at reflux under Dean-Stark conditions for 3 h. The reaction mixture was cooled, diluted with toluene and washed sequentially with aqueous $NaHCO_3$, water and brine. The organic layer was dried ($MgSO_4$) and concentrated to give 2-(2-bromophenyl)-1,3-dioxolane **S39** as a colourless oil (2.82 g, 80%). Used without further purification.^{1}H NMR (500 MHz, $CDCl_3$)[20] δ_H: 4.04–4.13 (2H, m, CH_2), 4.13–4.23 (2H, m, CH_2), 6.13 (1H, s, CHO$_2$), 7.21–7.30 (1H, m, Ar*H*), 7.37 (1H, t, *J* 7.5, Ar*H*), 7.59 (1H, dd, *J* 8.0, 1.2, Ar*H*), 7.63 (1H, dd, *J* 7.8, 1.7, Ar*H*). Data in agreement with the literature.[20]

(*E*)-3-(2-(1,3-Dioxolan-2-yl)phenyl)-1-phenylprop-2-en-1-one (S40).



Following a literature procedure reported by Bull,[19] 2-(2-bromophenyl)-1,3-dioxolane **S39** (2.82 g, 10.8 mmol) was dissolved in degassed MeCN (30 mL). $[Pd(OAc)_2]_3$ (123 mg, 0.18 mmol), tri(*o*-tolyl)phosphine (338 mg, 1.10 mmol), $^{i}Pr_2NH$ (5.8 mL, 33.35 mmol) and 1-phenylprop-2-en-1-one **S38** (1.46 g, 10.8 mmol) were added to this solution, and the reaction heated at reflux for 22 h. The reaction mixture was cooled and filtered through a plug of Celite. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give (*E*)-3-(2-(1,3-dioxolan-2-yl)phenyl)-1-phenylprop-2-en-1-one **S40** as a yellow oil (1.58 g, 58%).^{1}H NMR (500 MHz, $CDCl_3$)[20] δ_H: 4.03–4.11 (2H, m, CH_2), 4.12–4.21 (2H, m, CH_2), 6.05 (1H, s, CHO$_2$), 7.41–7.46 (2H, m, ArH), 7.47–7.53 (3H, m, ArH+Ph(3+5)H), 7.56–7.61 (1H, m, Ph(4)H), 7.62–7.67 (1H, m, C(2)H), 7.72–7.77 (1H, m, ArH), 8.01–8.05 (2H, m, Ph(2+6)H), 8.28 (1H, d, *J* 15.6, C(3)H). Data in agreement with the literature.[20]

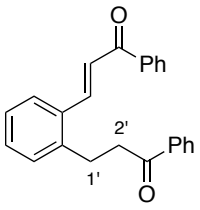
3-(2-(1,3-Dioxolan-2-yl)phenyl)-1-phenylpropan-1-ol (S41).



(*E*)-3-(2-(1,3-Dioxolan-2-yl)phenyl)-1-phenylprop-2-en-1-one **S40** (1.58 g, 6.3 mmol) was dissolved in EtOH (25 mL) and stirred for 30 min. $NiCl_2 \cdot 6H_2O$ (16.4 mg, 0.068 mmol) was added and the reaction mixture cooled in an ice bath. $NaBH_4$ (476 mg, 12.63 mmol) was

added and the reaction allowed to slowly warm up to rt over 48 h. Water (30 mL) was added and solution extracted with EtOAc. The organic layer was washed with brine, dried ($MgSO_4$) and concentrated. The residue was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→35% EtOAc in hexanes) to give *3-(2-(1,3-dioxolan-2-yl)phenyl)-1-phenylpropan-1-ol* **S41** as a yellow oil (1.26 g, 70%). ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 2.07-2.16 (2H, m, C(2)H_2), 2.85-2.92 (2H, m, C(3)H_2), 2.98 (1H, d, *J* 3.5, O*H*), 3.96-4.05 (2H, m, OCH_2), 4.07-4.19 (2H, m, OCH_2), 4.62-4.67 (1H, m, C(1)*H*), 5.98 (1H, s, C*H*O_2), 7.24-7.39 (8H, m, Ph*H*×5+Ar*H*×3)), 7.61 (1H, dd, *J* 7.6, 1.5, Ar*H*). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 27.8 (*C*(3)), 40.9 (*C*(2)), 65.1 (O*C*H_2), 65.3 (O*C*H_2), 73.1 (*C*(1)) , 101.8 (*C*HO_2), 125.9 (Ar*C*H), 126.1 (Ph*C*H), 126.4 (Ar*C*H), 127.4 (Ar*C*H), 128.4 (Ar*C*H), 129.3 (Ph*C*H), 129.7 (Ph*C*H), 134.9 (Ar*C*(1)), 140.6 (Ar*C*(2)), 144.7 (Ph*C*(1)). IR (neat) ν_{max} cm^{-1}: 3433 (OH), 2883 (OCH_2). HRMS (NSI^+) $C_{18}H_{24}O_3N$ $[M+NH_4]^+$ found 302.1753 requires 302.1751 (0.8 ppm).

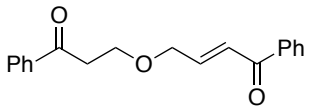
(*E*)-3-(2-(3-Oxo-3-phenylpropyl)phenyl)-1-phenylprop-2-en-1-one (25).



A dried round bottom flask was charged with oxalyl chloride (0.59 mL, 3.14 mmol) and CH_2Cl_2 (5 mL). The solution was cooled to −78 °C, DMSO (0.98 mL) was added dropwise, and the mixture stirred for 45 min. 3-(2-(1,3-Dioxolan-2-yl)phenyl)-1-phenylpropan-1-ol (1.26 g, 4.4 mmol) **S41** in CH_2Cl_2 (5 mL) was added dropwise at −78 °C, followed by the dropwise addition of Et_3N (1.59 mL, 21.66 mL) in CH_2Cl_2 (5 mL). The reaction was stirred overnight, slowly warming to rt. The reaction was concentrated and used without further purification. The crude material was suspended in acetic acid (28 mL) and water (12 mL) and

stirred at rt overnight. Water was added, and the biphasic mixture extracted with Et_2O (× 3). The combined organic layers were dried ($MgSO_4$), concentrated and used without further purification. The crude material was dissolved in $CHCl_3$ (20 mL), and 1-phenyl-2-(triphenylphosphanylidene)ethanone (2.01 g, 5.28 mmol) was added. The reaction mixture was heated at reflux for 64 h. The reaction was concentrated and the crude product purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *(E)-3-(2-(3-oxo-3-phenylpropyl)phenyl)-1-phenylprop-2-en-1-one* **25** as a colourless oil (344 mg, 23%). ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 3.27 (4H, br, C(1')H_2+C(2')H_2), 7.25–7.38 (3H, m, Ar*H*), 7.41–7.54 (6H, m, Ph*H*+C(2)*H*), 7.55–7.60 (1H, m, Ph*H*), 7.74 (1H, dd, *J* 7.7, 1.3, Ar*H*), 7.92–7.96 (2H, m, Ph*H*), 8.02–8.06 (2H, m, Ph*H*), 8.19 (1H, d, *J* 15.5, C(3)*H*). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 27.8 (*C*(2')), 40.3 (*C*(1')), 123.9 (*C*(3)), 126.9 (Ar*C*H), 127.0 (Ar*C*H), 128.1 (Ar*C*H), 128.6 (Ar*C*H), 128.7 (Ph*C*H),128.7 (Ph*C*H), 130.5 (Ph*C*H), 130.6 (Ph*C*H), 133.0 (Ph*C*H), 133.2 (Ph*C*H), 133.7 (Ar*C*(1)), 136.7 (Ar*C*(2)), 138.2 (C(1)-Ph*C*(1)), 141.6 (CH_2CO-Ph*C*(1), 141.9 (*C*(2)), 190.3 (*C*(1)), 198.7 (*C*OCH_2). IR (neat) ν_{max} cm^{-1}: 1682 (CO), 1661 (CO). HRMS (NSI$^+$) $C_{24}H_{21}O_2$ $[M+H]^+$ found 341.1535 requires 341.1536 (−0.3 ppm).

(*E*)-4-(3-Oxo-3-phenylpropoxy)-1-phenylbut-2-en-1-one (27).

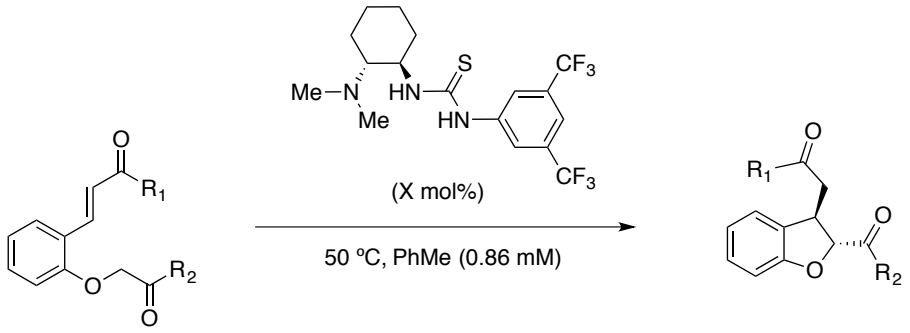


1-Phenylprop-2-en-1-one (500 mg, 3.75 mmol) was dissolved in CH_2Cl_2 (15 mL) and *p*-toluenesulfonic acid hydrate (35 mg, 0.19 mmol) was added at rt, followed by the dropwise addition of allyl alcohol (280 μL, 4.13 mmol). The reaction was stirred at rt for 18 h. Saturated $NaHCO_3$ solution (15 mL) was added and the biphasic mixture extracted with CH_2Cl_2 (× 2). The combined organics were dried ($MgSO_4$), filtered and concentrated to give

3-(allyloxy)-1-phenylpropan-1-one (665 mg, 93%), which was used without further purification. ^{1}H NMR (300 MHz, $CDCl_3$) δ_H: 3.25 (2H, t, *J* 6.6, C*H*$_2$), 3.87 (2H, t, *J* 6.6, C*H*$_2$), 4.01 (2H, dt, *J* 5.6, 1.4, C*H*$_2$), 4.99-5.47 (2H, m, CH=C*H*$_2$), 5.90 (1H, ddt, *J* 17.2, 10.4, 5.6, C*H*=CH$_2$), 7.30-7.49 (2H, m, Ar*H*), 7.49-7.65 (1H, m, Ar*H*), 7.87-8.13 (2H, m, Ar*H*).

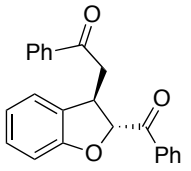
3-(Allyloxy)-1-phenylpropan-1-one (665 mg, 3.50 mmol) was cooled to −78 °C in CH_2Cl_2 (25 mL) and a stream of O_3 in air was passed through the solution until a blue colour remained. Air was passed through the solution to dissipate the blue colour, then Me_2S (384 μL, 5.25 mmol) was added. The solvent was removed *in vacuo* and the residue re-dissolved in $CHCl_3$ (10 mL). 1-Phenyl-2-(triphenylphosphanylidene)ethanone (2.0 g, 5.25 mmol) was added in one portion and the reaction stirred at rt for 18 h. The solvent was removed under reduced pressure and the residue purified by column chromatography using a Biotage® Isolera 4 (eluent: 5→25% EtOAc in hexane) to give *(E)-4-(3-oxo-3-phenylpropoxy)-1-phenylbut-2-en-1-one* **27** as a colourless solid (594 mg, 58%). m.p. 68-70 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 3.33 (2H, t, *J* 6.3 C*H*$_2$), 4.00 (2H, t, *J* 6.3, C*H*$_2$), 4.31 (2H, dd, *J* 3.9, 1.9, C*H*$_2$), 7.04 (1H, dt, *J* 15.5, 3.9, C(2)*H*), 7.16 (1H, dt, *J* 15.5, 1.9, C(3)*H*), 7.41-7.52 (4H, m, Ph*H*), 7.52-7.66 (2H, m, Ph*H*), 7.94-7.96 (2H, m, Ph*H*), 8.00-8.02 (2H, m, Ph*H*). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 38.6 (*C*H$_2$), 66.4 (*C*H$_2$), 70.2 (*C*H$_2$), 124.7 (*C*(2)), 128.1 (PhC*H*), 128.5 (PhC*H*), 128.6 (PhC*H*×2), 132.8 (Ph*C*H), 133.2 (Ph*C*H), 136.9 (Ph*C*(1)), 137.6 (Ph*C*(1)), 144.2 (*C*(3)), 190.2 (*C*O), 198.2 (*C*O). IR (neat) ν_{max} cm^{-1}: 1718 (CO), 1674 (CO). HMRS (NSI$^+$) $C_{19}H_{19}O_3$ ([M+H]$^+$) requires 295.1329; found 295.1331 (0.8 ppm).

General Procedure: Intramolecular Michael addition of keto-enones catalyzed by Takemoto's catalyst



In a flame-dried vial the appropriate keto-enone and Takemoto's catalyst **6** were dissolved in anhydrous PhMe. The reaction vial was capped and heated at 50 °C for the stated time. After cooling to rt the reaction mixture was washed with 1M HCl, and the aqueous layer extracted with CH_2Cl_2 (× 3). The combined organic layers were dried ($MgSO_4$) and concentrated *in vacuo*. The residue was purified by column chromatography.

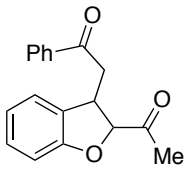
2-((2*R*,3*R*)-2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (2).



Following the general procedure, (*E*)-3-(2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one **1** (90 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 42 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give 2-((2*R*,3*R*)-2-benzoyl-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one **2** as an orange gum. Inseparable mixture of diastereoisomers (94:6, *trans:cis*), (75 mg, 83%). $[\alpha]_D^{20} = -166.3$ (c=1, $CHCl_3$). Chiral HPLC

analysis, Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,3*R*): 7.9 min, t_R (2*S*,3*S*): 11.9 min, 95:5 er. ^{1}H NMR (500 MHz, $CDCl_3$)[21] δ_H: 3.44 (1H, dd, *J* 17.8, 8.1, CH_2), 3.65 (1H, dd, *J* 17.8, 6.0, CH_2), 4.56 (1H, dt, *J* 7.9, 5.7, C(3)*H*), 5.66 (1H, d, *J* 5.5, C(2)*H*), 6.87 (1H, d, *J* 8.0, Ar*H*), 6.91 (1H, td, *J* 7.5, 1.0, Ar*H*), 7.17 (1H, app t, *J* 7.8, Ar*H*), 7.23 (1H, app d, *J* 7.7, Ar*H*), 7.44-7.52 (4H, m, Ph*H*), 7.56-7.63 (2H, m, Ph*H*), 7.94-7.97 (2H, m, Ph*H*), 8.08-8.12 (2H, m, Ph*H*). *Cis*-**2** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: (500 MHz, $CDCl_3$) 3.07 (1H, dd, *J* 17.7, 5.6, CH_2), 3.28 (1H, dd, *J* 17.7, 8.5, CH_2), 6.24 (1H, d, *J* 8.7, C(2)*H*), 6.97 (1H, d, *J* 8.0, Ar*H*), 7.36 (2H, t, *J* 7.8, Ar*H*), 7.69–7.75 (2H, m, Ar*H*). Data in agreement with the literature.[21]

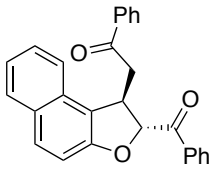
2-(2-Acetyl-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (10).



Following the general procedure, (*E*)-3-(2-(2-oxopropoxy)phenyl)-1-phenylprop-2-en-1-one **9** (73 mg, 0.26 mmol) and catalyst **6** (22 mg, 0.053 mmol) were reacted in PhMe (3 mL) for 144 h to give a mixture of diastereoisomers (65:35, *trans:cis*) which could be purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% Et_2O in hexanes) to give *cis*-**10** and *trans*-**10** as colourless oils (*cis*-**10**: 9 mg, 12%; *trans*-**10**: 18 mg, 25%). *Cis*-**10**: ^{1}H NMR (500 MHz, $CDCl_3$)[16] δ_H: 2.30 (3H, s, CH_3), 3.24 (1H, dd, *J* 17.8, 7.4, CH_2), 3.34 (1H, dd, *J* 17.8, 6.3 CH_2), 4.43-4.49 (1H, m, C(3)*H*), 5.22 (1H, d, *J* 9.7, C(2)*H*), 6.89 (1H, td, *J* 7.5, 1.0, Ar*H*), 6.93 (1H, d, *J* 8.0, Ar*H*), 7.15 (1H, dd, *J* 7.5, 1.3, Ar*H*), 7.16-7.20 (1H, m, Ar*H*), 7.43-7.47 (2H, m, Ph*H*), 7.54-7.59 (1H, m, Ph*H*), 7.88-7.93 (2H, m, Ar*H*). *Trans*-**10**: Chiral HPLC analysis: Chiralcel AD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R: 17.16 min, t_R (2*S*,3*S*): 18.16 min, 50:50 er.^{1}H NMR (500 MHz, $CDCl_3$)[22] δ_H: 2.38

(3H, s, *C*H$_3$), 3.47 (1H, dd, *J* 17.4, 7.0, *C*H$_2$), 3.52 (1H, dd, 17.8, 6.7, *C*H$_2$), 4.21 (1H, q, *J* 6.5, C(3)*H*), 4.81 (1H, d, *J* 5.6, C(2)*H*), 6.90-6.95 (2H, Ar*H*), 7.19-7.24 (2H, m, Ar*H*), 7.48-7.52 (2H, m, Ph*H*), 7.59-7.64 (1H, m, Ph*H*), 7.98-8.01 (2H, m, Ph*H*). Data in agreement with the literature.[16, 22]

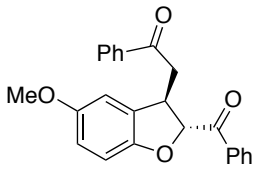
2-((1*R*,2*R*)-2-Benzoyl-1,2-dihydronaphtho[2,1-b]furan-1-yl)-1-phenylethan-1-one (11).



Following the general procedure, (*E*)-3-(2-(2-oxo-2-phenylethoxy)naphthalen-1-yl)-1-phenylprop-2-en-1-one **S23** (112 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 20 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *2-((1R,2R)-2-benzoyl-1,2-dihydronaphtho[2,1-b]furan-1-yl)-1-phenylethan-1-one* **11** as a yellow semisolid. Inseparable mixture of diastereomers (97:3, *trans:cis*) (95 mg, 93%). $[\alpha]_D^{20} = -131.8$ (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 10.9 min, t_R (2*S*,3*S*): 14.9 min, 95:5 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.50 (1H, dd, *J* 18.1, 11.0, C*H*$_2$), 3.90 (1H, dd, *J* 18.1, 3.0, C*H*$_2$), 4.97 (1H, dt, *J* 10.9, 2.9, C(1)*H*), 5.90 (1H, d, *J* 2.9, C(2)*H*), 7.17 (1H, d, *J* 8.8, Nap*H*), 7.34 (1H, ddd, *J* 8.1, 6.8, 1.1, Nap*H*), 7.43–7.48 (2H, m, Ph(3+5)*H*), 7.48–7.53 (3H, m, Ph(3+5)*H*+Nap*H*), 7.55–7.64 (2H, m, Ph(4)*H*×2), 7.72 (2H, dd, *J* 11.1, 8.6, Nap*H*), 7.84 (1H, d, *J* 8.2, Nap*H*), 7.92–7.98 (2H, m, Ph(2+6)*H*), 8.11–8.17 (2H, m, Ph(2+6)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 38.7 (C(1')), 42.8 (*C*H$_2$), 88.1 (*C*(2')), 112.4 (Nap*C*H), 120.2 (Nap*C*H), 122.3 (Nap*C*H), 123.4 (Nap*C*H), 127.2 (Nap*C*H), 128.2 (Nap*C*H), 128.7 (Ph*C*(3+5)), 128.9 (Ph*C*(3+5)), 129.3 (Nap*C*(5a)+Nap*C*(9b)), 129.7 (Ph*C*(2+6)), 130.1 (Ph*C*(2+6)), 130.2 (Nap*C*(9a)), 133.7

(Ph*C*(4)), 133.7 (Ph*C*(4)), 135.0 (Ph*C*(1)), 136.5 (Ph*C*(1)), 156.5 (Nap*C*(3a)), 194.1 (*C*OCH$_2$), 198.5 (*C*OCHO). IR (neat) ν_{max} cm^{-1}: 1697 (CO), 1674 (CO). HRMS: (NSI$^+$) $C_{27}H_{21}O_3$ $[M+H]^+$ found 393.1485 requires 393.1485 (−0.1 ppm). *Cis*-**11** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.06 (1H, dd, *J* 18.4, 3.0, C*H*$_2$), 3.67 (1H, dd, *J* 18.4, 8.8, C*H*$_2$), 5.10 (1H, td, *J* 8.4, 3.1, C(3)*H*), 6.40 (1H, d, *J* 8.1, C(2)*H*).

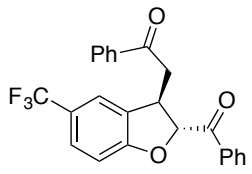
2-((2*R*,3*R*)-2-Benzoyl-5-methoxy-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (12).



Following the general procedure, (*E*)-3-(5-methoxy-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one **S37** (65 mg, 0.17 mmol) and catalyst **6** (4 mg, 0.0086 mmol) were reacted in PhMe (2 mL) for 48 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-5-methoxy-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one* **12** as a pale yellow solid. Inseparable mixture of diastereomers (96:4, *trans:cis*), (58 mg, 89%). m.p. 110-113 °C. $[\alpha]_D^{20}$ = −150.4 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,3*R*): 10.3 min, t_R (2*S*,3*S*): 21.2 min, 92.5:7.5 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.45 (1H, dd, *J* 17.8, 8.0, C*H*$_2$), 3.63 (1H, dd, *J* 17.8, 6.1, C*H*$_2$), 3.74 (3H, s, C*H*$_3$), 4.53 (1H, dt, *J* 7.8, 5.7, C(3)*H*), 5.63 (1H, d, *J* 5.4, C(2)*H*), 6.71 (1H, dd, *J* 8.6, 2.6, Ar*H*), 6.77 (1H, d, *J* 8.7, Ar*H*), 6.81 (1H, dd, *J* 2.7, 0.9, Ar*H*), 7.44–7.52 (4H, m, Ph*H*), 7.56–7.63 (2H, m, Ph*H*), 7.93–7.98 (2H, m, Ph*H*), 8.07–8.11 (2H, m, Ph*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 40.1 (*C*(3)), 44.1 (*C*H$_2$), 56.2 (*C*H$_3$), 88.1 (*C*(2)), 110.1 (Ar*C*H), 111.0 (Ar*C*H), 114.1 (Ar*C*H), 128.2 (Ph*C*H), 128.8 (Ph*C*H), 128.9 (Ph*C*H), 129.5 (Ph*C*H), 130.0 (Ar*C*(3a)), 133.7 (Ph*C*H), 133.7 (Ph*C*H), 135.1 (Ph*C*(1)), 136.5 (Ph*C*(1)),

152.8 (Ar*C*(7a)), 154.9 (Ar*C*(5)), 195.0 (*C*OCH$_2$), 197.8 (*C*OC(1)). IR (neat) ν_{max} cm^{-1}: 1684 (CO). HRMS (NSI$^+$) $C_{24}H_{21}O_4$ $[M+H]^+$ found 373.1435 requires 373.1434 (−0.2 ppm). *Cis*-**12** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.05 (1H, dd, *J* 17.7, 5.4, C*H*$_2$), 3.28 (1H, dd, *J* 18.0, 8.9, C*H*$_2$), 6.22 (1H, d, *J* 8.4, C(2)*H*).

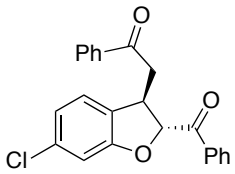
2-((2*R*,3*R*)-2-Benzoyl-5-(trifluoromethyl)-2,3-dihydrobenzofuran-3-yl)-1 phenylethan-1-one (13).



Following the general procedure, (*E*)-3-(2-(2-oxo-2-phenylethoxy)-5-(trifluoromethyl)phenyl)-1-phenylprop-2-en-1-one **S24** (107 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 48 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-5-(trifluoromethyl)-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one* **13** as a colourless solid. Inseparable mixture of diastereomers (94:6, *trans:cis*) (95 mg, 89%). m.p. 108-110 °C. $[\alpha]_D^{20}$ = −164.6 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IB (95:5 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 12.7 min, t_R (2*S*,3*S*): 16.9 min, 93:7 er. ^{1}H NMR (400 MHz, $CDCl_3$) δ_H: 3.47 (1H, dd, *J* 18.0, 8.4, C*H*$_2$), 3.67 (1H, dd, *J* 18.0, 5.7, C*H*$_2$), 4.56-4.63 (1H, m, C(3)*H*), 5.80 (1H, d, *J* 5.3, C(2)*H*), 6.92 (1H, d, *J* 8.4, Ar*H*), 7.43-7.55 (6H, m, Ar*H*×2+Ph*H*×4), 7.56-7.66 (2H, m, Ph*H*), 7.93-7.99 (2H, m, Ph*H*), 8.07-8.12 (2H, m, Ph*H*). ^{13}C NMR (101 MHz, $CDCl_3$) δ_C: 39.2 (*C*(3)),43.9 (*C*H$_2$), 88.1 (*C*(2)), 110.1 (Ar*C*H), 122.0–123.7 (m, Ar*C*(5)), 123.9 (Ar*C*H) , 124.2 (Ph*C*H), 124.51 (q, *J* 271.4, *C*F$_3$), 126.8-127.1 (m, Ar*C*H), 128.2 (Ph*C*H), 128.9 (d, *J* 2.3, Ph*C*H), 129.5 (Ph*C*H), 130.0 (Ar*C*(3a)), 133.9 (Ph*C*H), 134.0 (Ph*C*(1)), 134.9 (Ph*C*(1)), 136.3 (Ph*C*H), 161.4

(Ar*C*(7a)), 193.9 (*C*OCH$_2$), 197.5 (*C*OCHO). ^{19}F NMR (377 MHz, CDCl$_3$) δ_F: −61.08 (C*F*$_3$). IR (neat) ν_{max} cm^{-1}: 1685 (br, CO). HRMS (NSI$^+$) $C_{24}H_{18}O_3F_3$ $[M+H]^+$ found 411.1201 requires 411.1203 (−0.4 ppm). *Cis*-**13** ^{1}H NMR (400 MHz, CDCl$_3$) δ_H: 3.20 (1H, dd, *J* 18.0, 6.4, C*H*$_2$), 3.32 (1H, dd, *J* 18.0, 7.8, C*H*$_2$), 6.36 (1H, d, *J* 8.9,C(2)*H*), 7.01 (1H, d, *J* 8.6, Ar*H*), 7.33–7.40 (2H, m, Ar*H*), 7.68–7.75 (2H, m, Ar*H*).

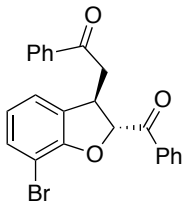
2-((2*R*,3*R*)-2-Benzoyl-6-chloro-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (14).



Following the general procedure, (*E*)-3-(4-chloro-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one **S25** (98 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 60 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-6-chloro-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one* **14** as a pale yellow solid. Inseparable mixture of diastereomers (96:4, *trans:cis*) (82 mg, 84%). m.p. 122-124 °C. $[\alpha]_D^{20}$ = −139.0 (c=1, CHCl$_3$). Chiral HPLC analysis: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 13.1 min, t_R (2*S*,3*S*): 17.9 min, 92.5:7.5 er. ^{1}H NMR (500 MHz, CDCl$_3$) δ_H: 3.44 (1H, dd, *J* 17.8, 7.9, C*H*$_2$), 3.61 (1H, dd, *J* 17.8, 6.2, C*H*$_2$), 4.47–4.54 (1H, m, C(3)*H*), 5.71 (1H, d, *J* 5.3, C(2)*H*), 6.85–6.90 (2H, m, Ar*H*), 7.11–7.16 (1H, m, Ar*H*), 7.43–7.55 (4H, m, Ph*H*), 7.56–7.65 (2H, m, Ph*H*), 7.92–7.98 (2H, m, Ph*H*), 8.04–8.10 (2H, m, Ph*H*). ^{13}C NMR (126 MHz, CDCl$_3$) δ_C: 39.2 (*C*(3)), 44.0 (*C*H$_2$), 88.4 (*C*(2)), 110.9 (Ar*C*H), 121.7 (Ar*C*H), 125.6 (Ar*C*H), 127.8 (Ar*C*(3a)),128.2 (Ph*C*H), 128.9 (Ph*C*H), 128.9 (Ph*C*H), 129.5 (Ph*C*H), 133.8 (Ph*C*H), 133.9 (Ph*C*H), 134.3 (*Ar*C(6)), 134.8 (Ph*C* (1)), 136.4 (Ph*C*(1)), 159.5 (Ar*C*(7a)), 194.4 (*C*OCH$_2$), 197.6 (*C*OCHO). IR

(neat) ν_{max} cm^{-1}: 1697 (CO), 1674 (CO). HRMS (NSI^+) $C_{23}H_{18}O_3Cl$ $[M+H]^+$ found 377.0941 requires 377.0939 (+0.5 ppm). *Cis*-**14** ^1H NMR (500 MHz, $CDCl_3$) δ_H: 3.05 (1H, dd, *J* 17.8, 5.6, CH_2), 3.27 (1H, dd, *J* 17.8, 8.7, CH_2), 4.57 (1H, td, *J* 8.7, 5.6, C(3)*H*), 6.27 (1H, d, *J* 8.7, C(2)*H*), 6.95 (1H, d, *J* 1.8, Ar*H*), 7.34–7.41 (2H, m, Ar*H*), 7.70–7.74 (2H, m, Ar*H*).

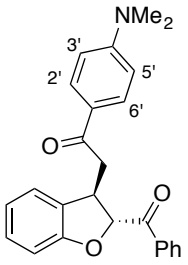
2-((2*R*,3*R*)-2-Benzoyl-7-bromo-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (15).



Following the general procedure, (*E*)-3-(3-bromo-2-(2-oxo-2-phenylethoxy)phenyl)-1-phenylprop-2-en-1-one **S26** (110 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 60 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-7-bromo-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one* **15** as a colourless solid. Inseparable mixture of diastereomers (93:7, *trans:cis*) (86 mg, 78%). m.p. 74-76 °C. $[\alpha]_D^{20}$ = −144.4 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.0 $mLmin^{-1}$, 211 nm, 30 °C), t_R (2*R*,3*R*): 17.2 min, t_R (2*S*,3*S*): 31.6 min, 91:9 er. ^1H NMR (500 MHz, $CDCl_3$) δ_H: 3.47 (1H, dd, *J* 17.8, 7.9, *C*H_2), 3.63 (1H, dd, *J* 17.8, 6.2, *C*H_2), 4.63 (1H, dt, *J* 7.6, 5.6, C(3)*H*), 5.73 (1H, d, *J* 5.3, C(2)*H*), 6.79 (1H, t, *J* 7.7, Ar*H*), 7.16 (1H, dt, *J* 7.5, 1.1, Ar*H*), 7.32 (1H, d, *J* 7.9, Ar*H*), 7.45–7.49 (2H, m, Ph*H*), 7.49–7.53 (2H, m, Ph*H*), 7.56–7.64 (2H, m, Ph*H*), 7.93–7.97 (2H, m, Ph*H*), 8.10–8.14 (2H, m, Ph*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 40.9 (*C*(3)), 44.1 (*C*H_2), 87.9 (*C*(2)), 103.1 (Ar*C*(7)), 122.9 (Ar*C*H), 124.0 (Ar*C*H), 128.2 (Ph*C*H), 128.8 (Ph*C*H), 128.9 (Ph*C*H), 129.6 (Ph*C*H), 130.5 (Ar*C*(3a)), 132.1 (ArC*H*), 133.8 (Ph*C*H), 133.9 (Ph*C*H), 134.9 (Ph*C*(1)), 136.4 (Ph*C*(1)), 156.1 (Ar*C*(7a)), 194.4 (*C*OCH_2), 197.5 (*C*OCHO). IR (neat) ν_{max} cm^{-1}: 1678 (CO). HRMS (NSI^+)

$C_{23}H_{18}O_3Br$ $[M+H]^+$ found 421.0433 requires 421.0434 (−0.2 ppm). *Cis*-**15** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.17 (1H, dd, *J* 17.9, 6.2, CH_2), 3.30 (1H, dd, *J* 17.9, 8.0, CH_2), 4.67–4.75 (1H, m, C(3)*H*), 6.32 (1H, d, *J* 8.9, C(2)*H*), 7.13 (1H, d, *J* 7.6, Ar*H*), 7.34–7.39 (3H, m, Ar*H*), 7.72 (2H, dd, *J* 8.3, 1.4, Ar*H*).

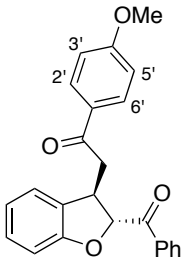
2-((2*R*,3*R*)-2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(4-(dimethylamino)phenyl)ethan-1-one (16).



Following the general procedure, (*E*)-1-(4-(dimethylamino)phenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one **S27** (100 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 84 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(4-(dimethylamino)phenyl)ethan-1-one* **16** as yellow crystals. Inseparable mixture of diastereomers (96:4, *trans:cis*) (70 mg, 70%). m.p. 151-154 °C. $[\alpha]_D^{20}$ = −184.6 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,3*R*): 21.7 min, t_R (2*S*,3*S*): 54.8 min, 92.5:7.5 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.05 (6H, s, CH_3×2), 3.33 (1H, dd, *J* 17.1, 8.4, CH_2), 3.54 (1H, dd, *J* 17.1, 5.9, CH_2), 4.50 (1H, dt, *J* 8.2, 5.7, C(3)*H*), 5.70 (1H, d, *J* 5.4, C(2)*H*), 6.60–6.66 (2H, m, C(3')*H*+C(5')*H*), 6.85–6.92 (2H, m, Ar*H*), 7.14–7.19 (1H, m, Ar*H*), 7.24 (1H, dt, *J* 7.5, 1.2, Ar*H*), 7.46–7.51 (2H, m, Ph(3+5)*H*), 7.56–7.61 (1H, m, Ph(4)*H*), 7.84–7.88 (2H, m, C(2')*H*+C(6')*H*), 8.07–8.10 (2H, m, Ph(2+6)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 40.1 (*C*H_3), 40.2 (*C*(3)), 43.4 (*C*H_2), 87.7 (*C*(2)), 109.9 (Ar*C*H), 110.7

(*C*(3')+*C*(5')), 121.4 (Ar*C*H), 124.5(*C*(1')), 125.0 (Ar*C*H), 128.7 (Ph*C*(3+5)), 128.8 (Ar*C*H), 129.4 (Ar*C*(3a)), 129.5 (Ph*C*(2+6)), 130.4 (*C*(2')+*C*(6')), 133.6 (Ph*C*(4)), 135.1 (Ph*C*(1)), 153.7 (*C*(4')), 158.8 (Ar*C*(7a)), 195.0 (*C*OCH$_2$), 195.6 (*C*OPh). IR (neat) ν_{max} cm^{-1}: 1686 (CO), 1653 (CO). HRMS (NSI$^+$) $C_{25}H_{24}O_3N$ $[M+H]^+$ found 386.1752 requires 386.1751 (+0.3 ppm). *Cis*-**16** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 2.85–2.90 (1H, m,CH_2), 3.00 (6H, s, CH_3), 3.19–3.25 (1H, m, CH_2), 4.63 (1H, td, *J* 8.9, 5.2, C(3)*H*), 6.23 (1H, d, *J* 8.7, C(2)*H*), 6.50–6.59 (2H, m, Ar*H*), 6.96 (1H, d, *J* 8.1, Ar*H*), 7.63 (2H, d, *J* 9.0, Ar*H*), 7.96–8.03 (2H, m, Ar*H*).

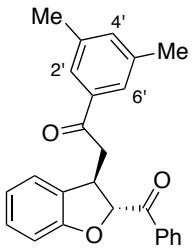
2-((2*R*,3*R*)-2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(4-methoxyphenyl)ethan-1-one (17).



Following the general procedure, (*E*)-1-(4-methoxyphenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one **S28** (99 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 72 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→25% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(4-methoxyphenyl)ethan-1-one* **17** as a pale yellow solid. Inseparable mixture of diastereomers (95:5, *trans:cis*) (81 mg, 82%). m.p. 91-92 °C. $[\alpha]_D^{20}$ = −155.1 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IC (90:10 hexane:IPA, flow rate 1 mLmin^{-1}, 254 nm, 30 °C), t_R (2*S*,3*S*): 36.6 min, t_R (2*R*,3*R*): 56.8 min, 90.5:9.5 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.38 (1H, dd, *J* 17.5, 8.2, CH_2), 3.59 (1H, dd, *J* 17.5, 5.9, CH_2), 3.86 (3H, s, CH_3), 4.54 (1H, dt, *J* 8.0, 5.7, C(3)*H*), 5.67 (1H, d, *J* 5.5, C(2)*H*),

6.85-6.91 (2H, m, CAr*H*), 6.93 (2H, d, *J* 8.8, C(3')*H*+C(5')*H*), 7.17 (1H, t, *J* 7.7, Ar*H*), 7.23 (1H, d, *J* 7.6, Ar*H*), 7.49 (2H, t, *J* 8.4, Ph(3+5)*H*), 7.60 (1H, t, *J* 7.4, Ph(4)*H*), 7.93 (2H, d, *J* 8.9, C(2')*H*+C(6')*H*), 8.07-8.11 (2H, m, Ph(2+6)*H*). ^{13}C NMR (126MHz, $CDCl_3$) δ_C: 39.9 (*C*(3)), 43.8 (*C*H_2), 55.6 (*C*H_3), 87.7 (*C*(2)), 110.0 (*C*ArH), 114.0 (*C*(3')+*C*(5')), 121.5 (*C*ArH), 124.9 (*C*ArH), 128.7 (*C*ArH), 128.8 (Ph*C*(3+5)), 129.1 (*C*(1')), 129.5 ((Ph*C*(2+6)), 129.6 (Ar*C*(3a)), 130.5 (C(2')+C(6')), 133.7 (Ph*C*(4)), 135.1 (Ph*C*(1)), 158.7 (Ar*C*(7a)), 163.9 (*C*(4')), 194.9 (*C*OCH_2), 196.3 (*C*OHO). IR (neat) ν_{max} cm^{-1}: 1694 (CO), 1667 (CO). HRMS (NSI^+) $C_{24}H_{21}O_4$ $[M+H]^+$ found 373.1436 requires 373.1434 (+0.4 ppm). *Cis*-**17** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.01 (1H, dd, *J* 17.4, 5.6, CH_2), 3.25 (1H, dd, *J* 17.4, 8.7, CH_2), 3.84 (3H, s, CH_3), 4.63 (1H, td, *J* 8.7, 5.6, C(3)*H*), 6.26 (1H, d, *J* 8.7, C(2)*H*), 6.84 (2H, d, *J* 8.9, Ar*H*), 7.70-7.75 (2H, m, Ar*H*), 7.85-7.89 (1H, m, Ar*H*), 7.99-8.03 (2H, m, Ar*H*).

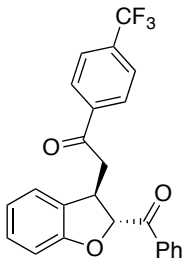
2-((2*R*,3*R*)-2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(3,5-dimethylphenyl)ethan-1-one (18)



Following the general procedure, (*E*)-1-(3,5-dimethylphenyl)-3-(2-(2-oxo-2-phenylethoxy)phenyl)prop-2-en-1-one **S29** (96 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 42 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give *2-((2R,3R)-2-benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(3,5-dimethylphenyl)ethan-1-one* **18** as a red semisolid. Inseparable mixture of diastereomers (95:5, *trans:cis*) (78 mg, 81%). $[\alpha]_D^{20}$ = −138.6 (c=0.8, $CHCl_3$). Chiral HPLC analysis: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0

mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 8.1 min, t_R (2*S*,3*S*): 10.1 min, 92:8 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 2.36 (6H, s, CH_3), 3.42 (1H, dd, *J* 17.7, 8.1, CH_2), 3.62 (1H, dd, *J* 17.7, 6.0, CH_2), 4.54 (1H, dt, *J* 8.1, 5.8, C(3)*H*), 5.65 (1H, d, *J* 5.5, C(2)*H*), 6.87 (1H, d, *J* 8.0, Ar*H*), 6.91 (1H, td, *J* 7.5, 1.0, Ar*H*), 7.15-7.20 (1H, m, Ar*H*), 7.21 (1H, s, C(4')*H*), 7.24 (1H, dt, *J* 7.5, 1.2, Ar*H*), 7.47-7.52 (2H, m, Ph(3+5)*H*), 7.54-7.57 (2H, m, C(2')*H*+C(6')*H*), 7.58-7.63 (1H, m, Ph(4)*H*), 8.08-8.12 (2H, m, Ph(2+6)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 21.4 (*C*H_3), 39.8 (*C*(3)), 44.4 (*C*H_2), 87.7 (*C*(2)), 110.1 (Ar*C*(H), 121.5 (Ar*C*H), 125.0 (Ar*C*H), 126.0 (*C*(2')+*C*(6')), 128.8 (PH(3+5)*C*), 128.9 (Ar*C*H), 129.1 (Ar(3a)*C*), 129.5 (Ph(2+6)*C*), 133.7 (Ph(4)*C*), 135.1 Ph(1)*C*), 135.3 (*C*(4')), 136.6 (*C*(1')), 138.5 (*C*(3')+*C*(5')), 158.7 (Ar(7a)*C*), 194.9 (*C*OCH_2), 198.2 (*C*OCHO). IR (neat) ν_{max} cm^{-1}: 1676 (CO), 1597 (CO). HRMS (NSI$^+$) $C_{25}H_{23}O_3$ $[M+H]^+$ found 371.1638 requires 371.1642 (−1.0 ppm). *Cis*-**18** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 2.28 (6H, s, CH_3), 3.00 (1H, dd, *J* 17.6, 5.5, CH_2), 3.26 (1H, dd, *J* 17.6, 8.8, CH_2), 4.13 (2H, q, *J* 7.2, C(3)*H*), 6.23 (1H, d, *J* 8.6, C(2)*H*), 6.97 (1H, d, *J* 8.0, Ar*H*), 7.32 (2H, d, *J* 1.7, Ar*H*), 7.98–8.02 (2H, m, Ar*H*).

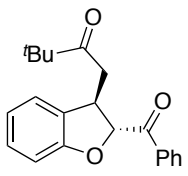
2-((2*R*,3*R*)-2-benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(4-(trifluoromethyl)phenyl)ethan-1-one (19)



Following the general procedure, (*E*)-3-(2-(2-oxo-2-phenylethoxy)phenyl)-1-(4-(trifluoromethyl)phenyl)prop-2-en-1-one **S30** (107 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 18 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to

give *2-(2-benzoyl-2,3-dihydrobenzofuran-3-yl)-1-(4-(trifluoromethyl)phenyl)ethan-1-one* **19** as a red semisolid. Inseparable mixture of diastereomers (94:6, *trans:cis*), (99 mg, 93%). $[\alpha]_D^{20} = -129$ (c=1 $CHCl_3$). Chiral HPLC analysis: Chiralcel IA (92:8 hexane:IPA, flow rate 1.5 $mLmin^{-1}$, 211 nm, 40 °C), t_R (2*R*,3*S*): 13.0 min, t_R (2*S*,3*S*): 24.3 min 92:8 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.46 (1H, dd, *J* 17.9, 8.0, CH_2), 3.66 (1H, dd, *J* 17.9, 6.0, CH_2), 4.59 (1H, dt, *J* 7.9, 5.8, C(3)*H*), 5.65 (1H, d, *J* 5.6, C(2)*H*), 6.85-6.94 (2H, m, Ar*H*), 7.15-7.25 (2H, m, Ar*H*), 7.47-7.54 (2H, m, PH(3+5)*H*), 7.58-7.64 (1H, m, Ph(4)*H*), 7.73 (2H, d, *J* 8.2, C(3')*H*+C(5')*H*), 8.02-8.08 (2H, m, Ph(2+6)*H*), 8.08-8.13 (2H, m, C(2')*H*+C(6')*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 39.5 (*C*(3)), 44.4 (*C*H_2), 87.7 (*C*(2)), 110.2 (Ar*C*H), 121.6 (Ar*C*H), 123.6 (q, *J* 273.1, *C*F_3), 124.8 (Ar*C*H), 125.9 (q, *J* 3.8, *C*(3')+*C*(5')), 128.6 (Ph(2+6)*C*), 128.7 (Ar(3a)*C*), 128.8(Ph(3+5)*H*), 129.1(Ar*C*H), 129.5 (*C*(2')+*C*(6')), 133.8 (Ph(4)*C*), 134.7 (*C*(4')), 135.0 (Ph(1)*C*), 139.1 (*C*(1')), 158.7 (Ar(7a)*C*), 194.8 (*C*OCH_2), 197.0 (*C*OPh). ^{19}F NMR (471 MHz, $CDCl_3$) δ_F: −63.15 (CF_3). IR (neat) ν_{max} cm^{-1}: 1686 (CO). HRMS (NSI^+) $C_{24}H_{18}F_3O_3$ $[M+H]^+$ found 411.1203 requires 411.1198 (−1.1 ppm). *Cis*-**19** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.16 (1H, dd, *J* 17.8, 6.2, C(3)*H*), 3.26 (1H, dd, *J* 17.8, 7.9, C(3)*H*), 6.24 (1H, d, *J* 8.6, C(2)*H*), 6.97 (1H, d, *J* 8.3, Ar*H*), 7.81 (2H, d, *J* 8.2, Ar*H*), 7.98 (2H, dd, *J* 8.2, 1.5, Ar*H*).

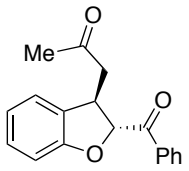
1-((2*R*,3*R*)-2-Benzoyl-2,3-dihydrobenzofuran-3-yl)-3,3-dimethylbutan-2-one (20)



Following the general procedure, (*E*)-4,4-dimethyl-1-(2-(2-oxo-2-phenylethoxy)phenyl)pent-1-en-3-one **S31** (84 mg, 0.26 mmol) and catalyst **6** (22 mg, 0.053 mmol) were reacted in PhMe (3 mL) for 60 h. The crude product was purified by column chromatography using a

Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *1-((2R,3R)-2-benzoyl-2,3-dihydrobenzofuran-3-yl)-3,3-dimethylbutan-2-one* **20** as a colourless solid. Inseparable mixture of diastereoisomers (94:6, *trans:cis*) (66 mg, 79%). m.p. 84-86 °C. $[\alpha]_D^{20} = -152.3$ (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel AD-H (90:10 hexane:IPA, flow rate 1.0 $mLmin^{-1}$, 211 nm, 30 °C), t_R (2*R*,3*R*): 11.1 min, t_R (2*S*,3*S*): 12.4 min, 94:6 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 1.14 (9H, s, (CH_3)$_3$), 2.92 (1H, dd, *J* 18.0, 7.9, CH_2), 3.16 (1H, dd, *J* 18.0, 6.2, CH_2), 4.33-4.39 (1H, m, C(3)*H*), 5.52 (1H, d, *J* 5.7, C(2)*H*), 6.84 (1H, d, *J* 8.0, Ar*H*), 6.89 (1H, td, *J* 7.5, 1.0, Ar*H*), 7.11-7.18 (2H, m, Ar*H*), 7.45-7.55 (2H, m, Ph*H*), 7.57-7.62 (1H, m, Ph*H*), 8.04-8.08 (2H, m , Ph*H*). ^{13}C NMR (126MHz, $CDCl_3$) δ_C: 26.4 (CH_3), 39.5 (*C*(3)), 42.2 (CH_2), 44.1 ($C(CH_3)_3$), 87.8 (*C*(2)), 110.0 (Ar*C*H), 121.35 (Ar*C*H), 124.7 (Ar*C*(3a)), 128.6 (Ph*C*H), 128.8 (Ph*C*H), 129.0 (Ar*C*H),129.4 (Ar*C*H), 133.6 (Ph*C*H), 134.9 (Ph*C*(1)), 158.5 (Ar*C*(7a)), 194.9 (*C*O^{t}Bu), 213.8 (*C*OPh). IR (neat) ν_{max} cm^{-1}: 1697 (CO), 1597 (CO). HRMS (NMS$^+$) $C_{21}H_{23}O_3$ [M+H]+ requires 323.1642 found 323.1642 (+0.7 ppm). *Cis*-**20** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 0.88 (9H, s, (CH_3)$_3$), 2.55 (1H, dd, *J* 18.0, 5.9, CH_2), 2.83 (1H, dd, *J* 17.9, 8.5, CH_2), 6.17 (1H, d, *J* 8.5, C(2)*H*), 6.94 (1H, d, *J* 8.0, Ar*H*), 7.08–7.11 (1H, m, Ar*H*), 7.97–8.02 (2H, m, Ar*H*).

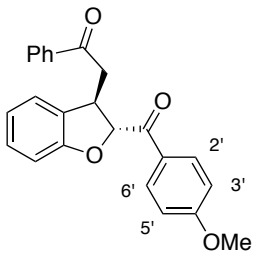
1-((2*R*,3*R*)-2-Benzoyl-2,3-dihydrobenzofuran-3-yl)propan-2-one (21)



Following the general procedure, (*E*)-4-(2-(2-oxo-2-phenylethoxy)phenyl)but-3-en-2-one **S32**(79 mg, 0.26 mmol) and catalyst **6** (22 mg, 0.053 mmol) were reacted in PhMe (3 mL) for 64 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→20% EtOAc in hexanes) to give 1-((2*R*,3*R*)-2-benzoyl-2,3-dihydrobenzofuran-

3-yl)propan-2-one **21** as a yellow semi-solid. Inseparable mixture of diastereoisomers (79:21, *trans:cis*) (69 mg, 87%). $[\alpha]_D^{20}$ = −103.8 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel AD-H (90:10 hexane:IPA, flow rate 1.0 $mLmin^{-1}$, 211 nm, 30 °C), t_R (2*R*,3*R*): 17.9 min, t_R (2*S*, 3*S*): 20.4 min, 86:14 er. ^{1}H NMR (500 MHz, $CDCl_3$)[21] δ_H: 2.19 (3H, s, CH_3), 2.90 (1H, dd, *J* 17.7, 7.8, CH_2), 3.07 (1H, dd, *J* 17.7, 6.3, CH_2), 4.35 (1H, q, *J* 6.5, C(3)*H*), 5,53 (1H, d, *J* 5.8, C(2)*H*), 6.85 (1H, dd, *J* 8.4, 1.0, Ar*H*), 6.90 (1H, td, *J* 7.5, 1.0, Ar*H*), 7.14-7.19 (2H, m, Ar*H*), 7.47-7.52 (2H, m, Ph*H*), 7.58-7.63 (1H, m, Ph*H*), 8.05-8.08 (2H, m, Ph*H*). *Cis*-**21** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 2.78 (1H, dd, *J* 16.6, 6.7, CH_2), 2.98–3.03 (1H, m, CH_2), 3.93–4.06 (1H, m, C(3)*H*), 5.45 (1H, d, *J* 10.0, C(2)*H*), 7.31–7.40 (1H, m, Ar*H*). Data in agreement with the literature.[21]

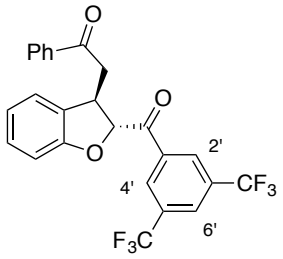
2-((2*R*,3*R*)-2-(4-Methoxybenzoyl)-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (22)



Following the general procedure, (*E*)-3-(2-(2-(4-methoxyphenyl)-2-oxoethoxy)phenyl)-1-phenylprop-2-en-1-one **S33** (83 mg, 0.22 mmol) and catalyst **6** (5 mg, 0.011 mmol) were reacted in PhMe (3 mL) for 72 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 5%→25% EtOAc in hexanes) to give *2-((2R,3R)-2-(4-methoxybenzoyl)-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one* **22** as a pale yellow solid. Inseparable mixture of diastereomers (96:4, *trans:cis*) (60 mg, 72%). m.p. 106-109 °C. $[\alpha]_D^{20}$ = −161.7 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IA (90:10 hexane:IPA, flow rate 1.0 $mLmin^{-1}$, 211 nm, 30 °C), t_R (2*R*,3*R*): 43.8 min, t_R (2*S*,3*S*): 54.4 min, 94.5:5.5 er. ^{1}H

NMR (500 MHz, $CDCl_3$) δ_H: 3.44 (1H, dd, *J* 17.7, 7.9, CH_2), 3.62 (1H, dd, *J* 17.7, 6.1, CH_2), 3.88 (3H, s, CH_3), 4.55 (1H, dt, *J* 7.8, 5.9, C(3)*H*), 5.61 (1H, d, *J* 5.7, C(2)*H*), 6.87 (1H, d, *J* 8.0, Ar*H*), 6.90 (1H, td, *J* 7.5, 1.0, Ar*H*), 6.94-7.00 (2H, m, C(3')*H*+C(5')*H*), 7.14-7.19 (1H, m, Ar*H*), 7.22 (1H, dt, *J* 7.4, 1.2, Ar*H*), 7.47 (2H, t, *J* 7.8, Ph(3+5)*H*), 7.56-7.61 (1H, m, Ph(4)*H*), 7.94-7.99 (2H, m, C(2')*H*+C(6)*H*), 8.07-8.12 (2H, m, Ph(2+6)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 39.9 (*C*(3)), 44.2 (*C*H_2), 55.7 (*C*H_3), 87.8 (*C*(2)), 110.0 (Ar*C*H), 114.0 (*C*(3')+C(5')), 121.5 (Ar*C*H), 124.9 (Ar*C*H), 128.0 (*C*(1')), 128.3 (*C*(2')+C(6')), 128.9 (Ph*C*(3+5)), 128.9 (Ar*C*H), 129.1 (Ar*C*(3a)), 131.9 (Ph*C*(2+6)), 133.6 (Ph*C*(4)), 136.6 (Ph*C*(1)), 158.8 (Ar*C*(7a)), 164.0 (*C*(4')), 193.4 (*C*OCH_2), 197.9 (*C*OCHO). IR (neat) ν_{max} cm^{-1}: 1674 (br, CO). HRMS (NSI^+) $C_{24}H_{21}O_4$ $[M+H]^+$ found 373.1434 requires 373.1434 (−0.1 ppm). *Cis*-**22** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.06 (1H, dd, *J* 17.7, 5.7, CH_2), 3.25 (1H, dd, *J* 17.7, 8.6, CH_2), 6.20 (1H, d, *J* 8.7, C(2)*H*), 7.32-7.37 (3H, m, Ar*H*), 7.69-7.73 (2H, m, Ar*H*), 8.04 (2H, d, *J* 8.8, Ar*H*).

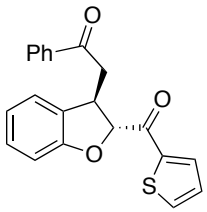
2-((2*R*,3*R*)-2-(3,5-Bis(trifluoromethyl)benzoyl)-2,3-dihydrobenzofuran-3-yl)-1-phenylethan-1-one (23)



Following the general procedure, (*E*)-3-(2-(2-(3,5-bis(trifluoromethyl)phenyl)-2-oxoethoxy)phenyl)-1-phenylprop-2-en-1-one **S33** (124 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 18 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→10% EtOAc in hexanes) to give *2-((2R,3R)-2-(3,5-bis(trifluoromethyl)benzoyl)-2,3-dihydrobenzofuran-3-yl)-1-*

phenylethan-1-one **23** as a pale yellow solid. Inseparable mixture of diastereomers (95:5, *trans:cis*) (110 mg, 89%). m.p. 94-96 °C. $[\alpha]_D^{20}$ = −112.8 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 $mLmin^{-1}$, 211 nm, 30 °C), t_R (2*R*,3*R*): 7.3 min, t_R (2*S*,3*S*): 13.3 min, 94:6 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.45 (1H, dd, *J* 18.1, 9.7, CH_2), 3.72 (1H, dd, *J*, 18.1, 4.7, CH_2), 4.60 (1H, dt, *J* 9.8, 4.9, C(3)*H*), 5.65 (1H, d, *J* 5.2, C(2)*H*), 6.87 (1H, d, *J* 8.0, Ar*H*), 6.97 (1H, td, *J* 7.4, 1.0, Ar*H*), 7.20 (1H, t, *J* 7.4, Ar*H*), 7.27 (1H, d, *J* 6.9, Ar*H*), 7.46-7.50 (2H, m, Ph(3+5)*H*), 7.60 (1H, tt, *J* 7.3, 1.5, Ph(4)*H*), 7.94-7.97 (2H, m, Ph(2+6)*H*), 8.11 (1H, s, C(6')*H*), 8.58 (2H, s, C(2')*H*+C(4')*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 39.2 (*C*(3)), 44.0 (*C*H_2), 87.5 (*C*(2)), 110.3 (ArCH), 122.0 (Ar*C*H), 124.8 (Ar*C*H), 124.9 (q, *J* 271.9, *C*F_3) 126.7-126.9 (m, *C*(6')), 128.2 (Ph*C*(2+6)), 128.4 (Ar*C*(3a)), 128.9 (Ph*C*(3+5)), 129.2 (Ar*C*H), 129.7 (d, *J* 4.2, *C*(2')+*C*(6')), 132.4 (q, *J* 34.1, *C*(3')+*C*(5')), 133.9 (Ph*C*(4)), 136.2 (*C*(1')), 136.8 (Ph*C*(1)), 158.2 (Ar*C*(7a)), 192.4 (*C*OPh), 198.1 (*C*OCHO). ^{19}F NMR (471 MHz, $CDCl_3$) δ_F: −62.90. IR (neat) ν_{max} cm^{-1}: 1680 (CO), 1701 (CO). HRMS (NSI^+) $C_{25}H_{20}F_6O_3N$ $[M+NH_4]^+$ found 496.1333 requires 496.1342 (−1.8 ppm). *Cis*-**23** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 6.24 (1H, d, *J* 9.0 C(2)*H*).

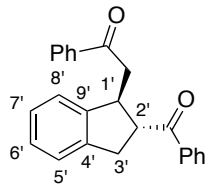
1-Phenyl-2-((2*R*,3*R*)-2-(thiophene-2-carbonyl)-2,3-dihydrobenzofuran-3-yl)ethan-1-one (24)



Following the general procedure, (*E*)-3-(2-(2-oxo-2-(thiophen-2-yl)ethoxy)phenyl)-1-phenylprop-2-en-1-one **S35** (91 mg, 0.26 mmol) and catalyst **6** (6 mg, 0.013 mmol) were reacted in PhMe (3 mL) for 48 h. The crude product was purified by column chromatography using a Biotage® Isolera 4 (eluent: 0%→15% EtOAc in hexanes) to give *1-phenyl-2-*

((2R,3R)-2-(thiophene-2-carbonyl)-2,3-dihydrobenzofuran-3-yl)ethan-1-one **24** as a brown semi-solid. Inseparable mixture of diastereomers (90:10, *trans:cis*) (89 mg, 98%). $[\alpha]_D^{20}$ = −120.4 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel OD-H (99:1 hexane:IPA, flow rate 1.5 $mLmin^{-1}$, 211 nm, 40 °C), t_R (2*R*,3*R*): 40.5 min, t_R (2*S*,3*S*): 72.8 min, 83.5:16.5 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.49 (1H, dd, *J* 17.8, 7.0, CH_2), 3.61 (1H, dd, *J* 17.8, 6.7, CH_2), 4.47-4.53 (1H, m, C(3)*H*), 5.40 (1H, d, *J* 6.2, C(2)*H*), 6.88-6.95 (2H, m, Ar*H*), 7.16 (1H, dd, *J* 4.9, 3.9, Thiophene(4)*H*), 7.18-7.24 (2H, m, Ar*H*), 7.47 (2H, t, *J* 7.8, Ph(3+5)*H*), 7.55-7.60 (1H, m, Ph(4)*H*), 7.71 (1H, dd, *J* 5.0, 1.1. Thiophene(3)*H*), 7.95-8.00 (2H, m, Ph(2+6)*H*), 8.03 (1H, dd, *J* 3.9, 1.2, Thiophene(5)*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 41.1 (*C*(3)), 44.2 (*C*H_2), 89.2 (*C*(2)), 110.1 (Ar*C*H), 121.7 (Ar*C*H), 125.1 (Ar*C*H), 128.2 (Ph*C*(2+6)+Ar*C*(3a)), 128.4 (Thiophene*C*(4)), 128.9 (Ph*C*(2+6)), 129.0 (Ar*C*H), 133.6 (Ph*C*(4)), 134.5 (Thiophene*C*(5)), 135.2 (Thiophene*C*(3)), 136.5 (Ph*C*(1)), 140.9 (Thiophene*C*(1)), 158.7 (Ar*C*(7a)), 189.3 (*C*OThiophene), 197.7 (*C*OCH_2). IR (neat) ν_{max} cm^{-1}: 1672 (CO), 1663 (CO). HRMS (NSI^+) $C_{21}H_{17}O_3S$ $[M+H]^+$ found 349.0895 requires 349.0893 (+0.6 ppm). *Cis*-**24** ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 4.62 (1H, q, *J* 7.6, C(3)*H*), 5.96 (1H, d, *J* 9.2, C(2)*H*), 6.97 (1H, d, *J* 8.0, ar*H*), 7.38 (2H, t, *J* 7.8, Ar*H*), 7.77 (2H, dd, *J* 8.3, 1.4, Ar*H*), 7.92 (1H, dd, *J* 3.9, 1.1, Ar*H*).

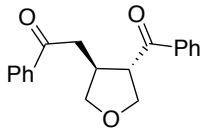
2-((1*S*,2*R*)-2-Benzoyl-2,3-dihydro-1H-inden-1-yl)-1-phenylethan-1-one (26)



Following the general procedure, (*E*)-3-(2-(3-oxo-3-phenylpropyl)phenyl)-1-phenylprop-2-en-1-one **25** (88 mg, 0.26 mmol) and catalyst **6** (24 mg, 0.053 mmol) were reacted in PhMe (3 mL) for 120 h. The crude product was purified by column chromatography using a

Biotage® Isolera 4 (eluent: 0%→15% EtOAc in hexanes) to give *2-((1S,2R)-2-benzoyl-2,3-dihydro-1H-inden-1-yl)-1-phenylethan-1-one* **26** as a yellow gum (86 mg, 78%, single diastereoisomer). $[\alpha]_D^{20}$ = −97.0 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (1*S*,2*R*): 11.4 min, t_R (1*R*, 2*S*): 14.6 min, 87:13 er. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.12 (1H, dd, *J* 16.0, 7.4, C(3')*H*), 3.24-3.31 (1H, m, C(2)*H*), 3.45 (1H, dd, *J* 16.0, 9.3, C(3')*H*), 3.53 (1H, dd, *J* 16.7, 5.9, C(2)*H*), 4.15 (1H, dt, *J* 9.3, 7.0, C(1')*H*), 4.45 (1 H, q, *J* 6.7, C(2')*H*), 7.20 (3H, q, *J* 2.7, 2.0, Ar*H*), 7.42-7.49 (5H, m, Ar*H*+Ph*H*×4), 7.53-7.57 (2H, m, Ph*H*), 7.93-7.96 (2H, m, Ph*H*), 7.97-8.01 (2H, m, Ph*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 37.0 (*C*(3')), 43.2 (*C*(2')), 44.0 (C(2)H), 52.7 (*C*(1')), 124.0 (Ar*C*H), 124.5 (Ar*C*H), 127.1 (Ar*C*H), 127.3 (Ar*C*H), 128.3 (Ph*C*H), 128.7 (Ph*C*H), 128.7 (Ph*C*H), 128.8 (Ph*C*H), 133.1 (Ph*C*H), 133.3 (Ph*C*H), 136.6 (Ph*C*(1)), 137.0 (Ph*C*(1)), 140.8 (Ar*C*(7a)), 145.0 (Ar*C*(3a)), 198.9 (*C*(1)), 200.8 (*C*OCH). IR (neat) ν_{max} cm^{-1}: 1678 (CO). HRMS (NSI$^+$) $C_{24}H_{21}O_2$ $[M+H]^+$ found 341.1538 requires 341.1536 (+0.6 ppm).

2-((3*S*,4*S*)-4-Benzoyltetrahydrofuran-3-yl)-1-phenylethan-1-one (28)



Following the general procedure, (*E*)-4-(3-oxo-3-phenylpropoxy)-1-phenylbut-2-en-1-one **27** (77 mg, 0.26 mmol) and catalyst **6** (24 mg, 0.052 mmol) were reacted in PhMe (3 mL) for 84 h. Purified by column chromatography (eluent: 0%→25% EtOAc in hexanes) to give *2-((3S,4S)-4-benzoyltetrahydrofuran-3-yl)-1-phenylethan-1-one* **28** as a colourless semi-solid (35 mg, 45%, single diastereoisomer). $[\alpha]_D^{20}$ = −55.0 (c=1, $CHCl_3$). Chiral HPLC analysis: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*S*,3*S*): 14.2

min, t_R (2*R*, 3*R*): 15.5 min, 92:8 ee. ^{1}H NMR (500 MHz, $CDCl_3$) δ_H: 3.16 (1H, dd, *J* 16.9, 8.1, CH_2), 3.28 (1H, dd, *J* 16.9, 6.1, CH_2), 3.31-3.40 (1H, m, C(3)*H*), 3.67 (1H, dd, *J* 8.8, 5.7, C(4)*H*), 3.82-3.90 (2H, m, C(2)*H*), 4.21-4.30 (2H, m, *C*(5)*H*), 7.42-7.51 (4H, m, Ph*H*), 7.54-7.62 (2H, m, Ph*H*), 7.90-7.98 (4H, m, Ph*H*). ^{13}C NMR (126 MHz, $CDCl_3$) δ_C: 38.4 (*C*(3)), 42.1 (*C*H_2), 52.7 (*C*(2)), 70.8 (*C*(5)), 73.9 (*C*(4)), 128.2 (*PhC*H), 128.6 (*PhC*H), 128.8 (*PhC*H), 128.9 (*PhC*H), 133.5 (*PhC*H), 133.6 (*PhC*H), 136.6 (Ph*C*(1)), 136.7 (Ph*C*(1)), 198.6 (*C*OC(4)), 199.0 (*C*OCH_2). IR (neat) ν_{max} cm^{-1}: 1674 (CO). HRMS (NSI^+) $C_{19}H_{19}O_3$ $[M+H]^+$ found 295.1328 requires 295.1329 (−0.2ppm).

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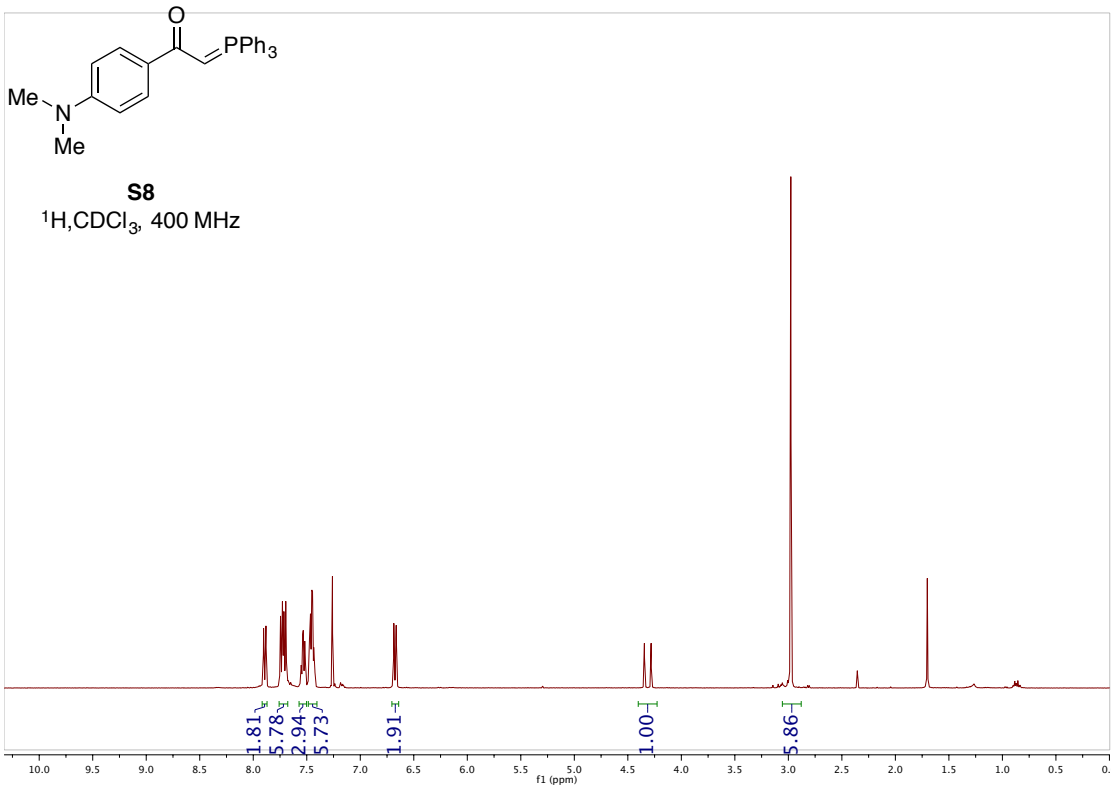
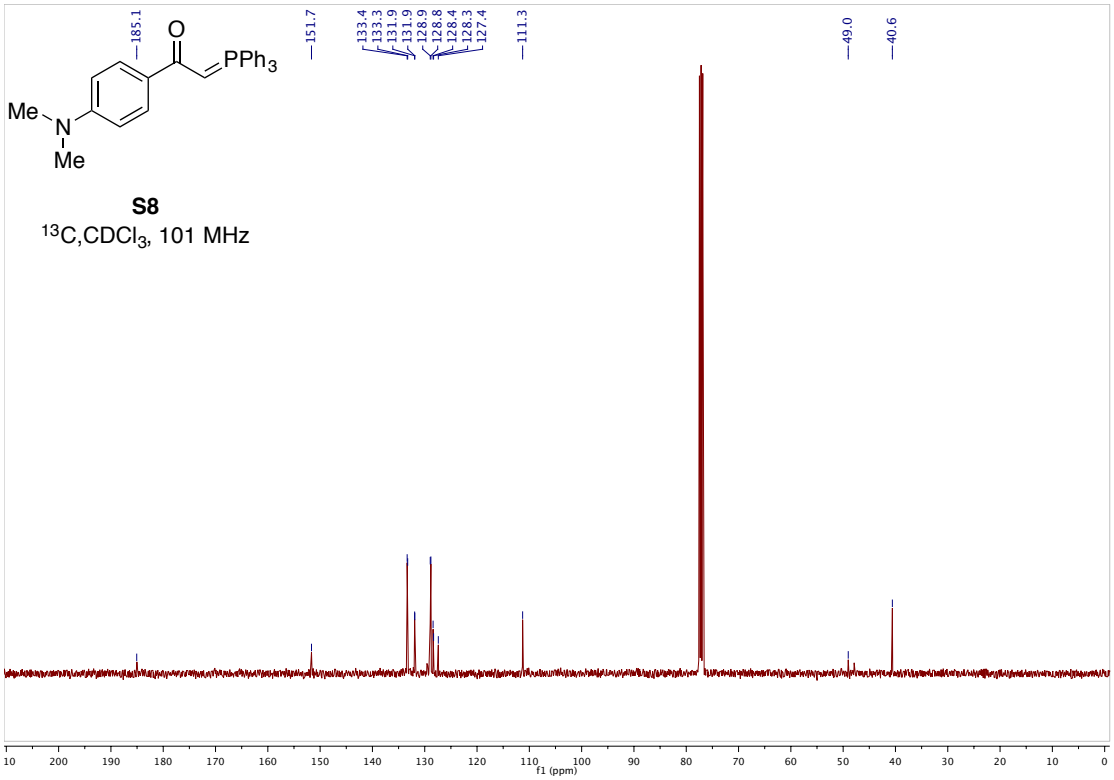
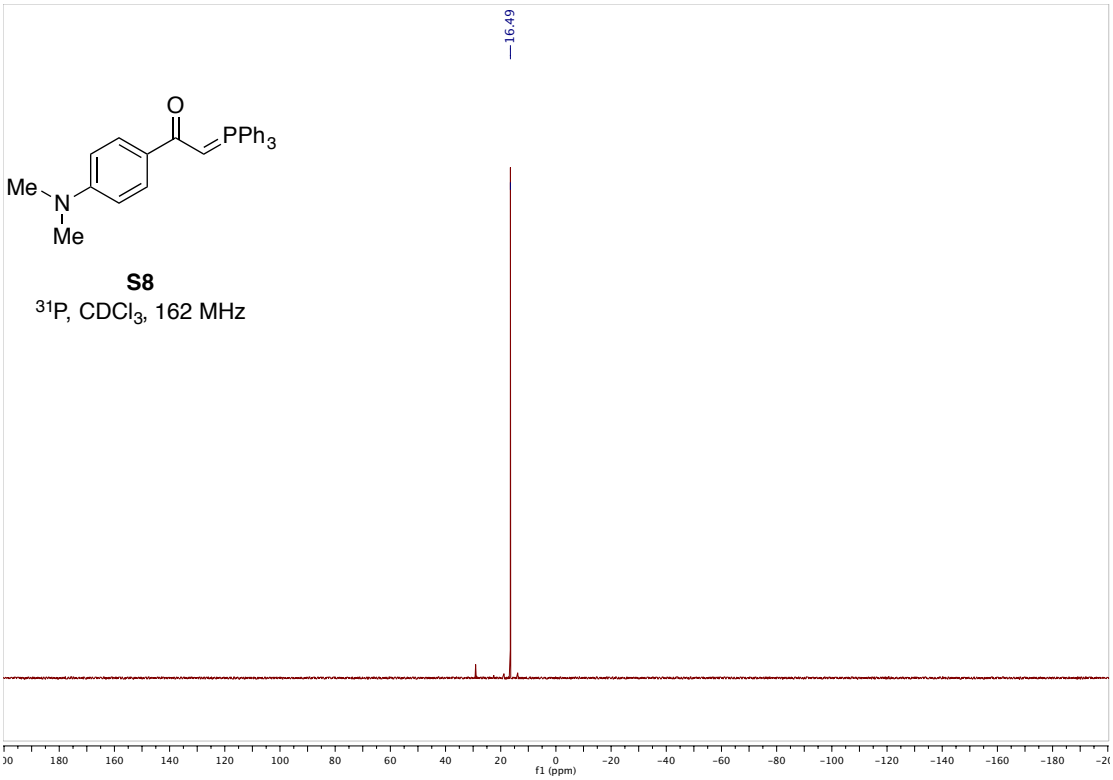
NMR traces

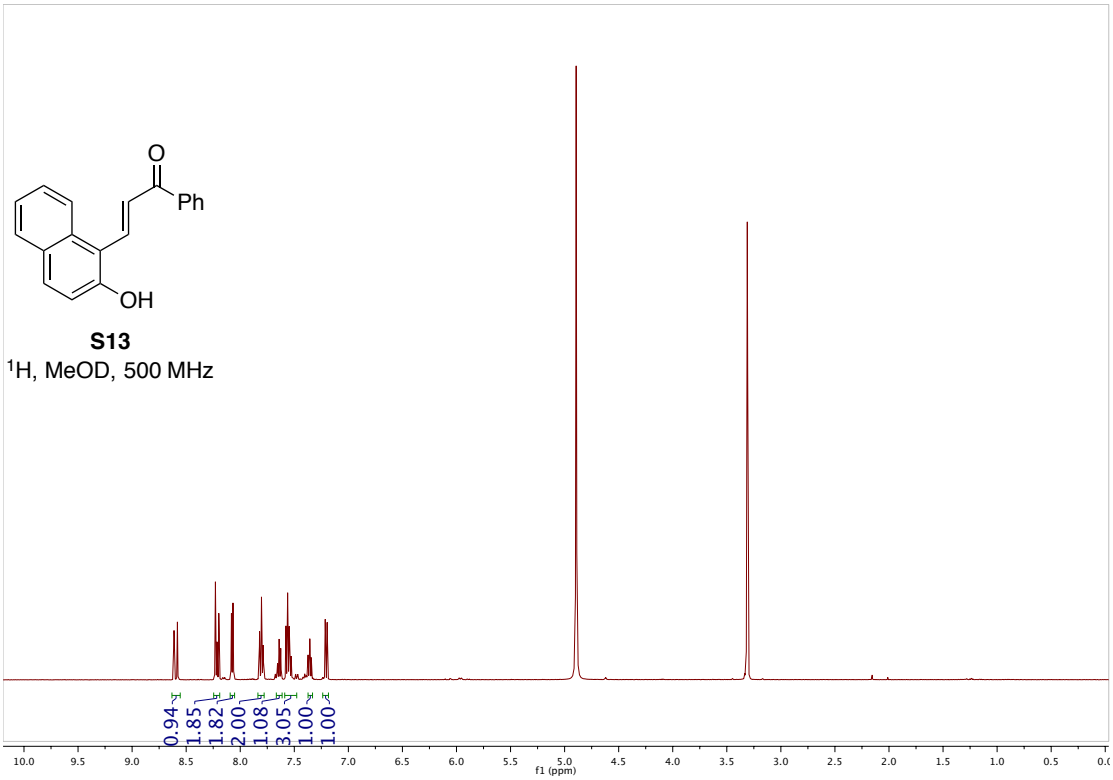

O
PPh3
Me
N
Me
S8
1H,CDCl3, 400 MHz
1.81
5.78
2.94
5.73
1.91
1.00
5.86
f1 (ppm)


185.1
151.7
133.4
133.3
131.9
131.9
128.9
128.8
128.4
128.3
127.4
111.3
49.0
40.6
O
PPh3
Me
N
Me
S8
13C,CDCl3, 101 MHz
f1 (ppm)



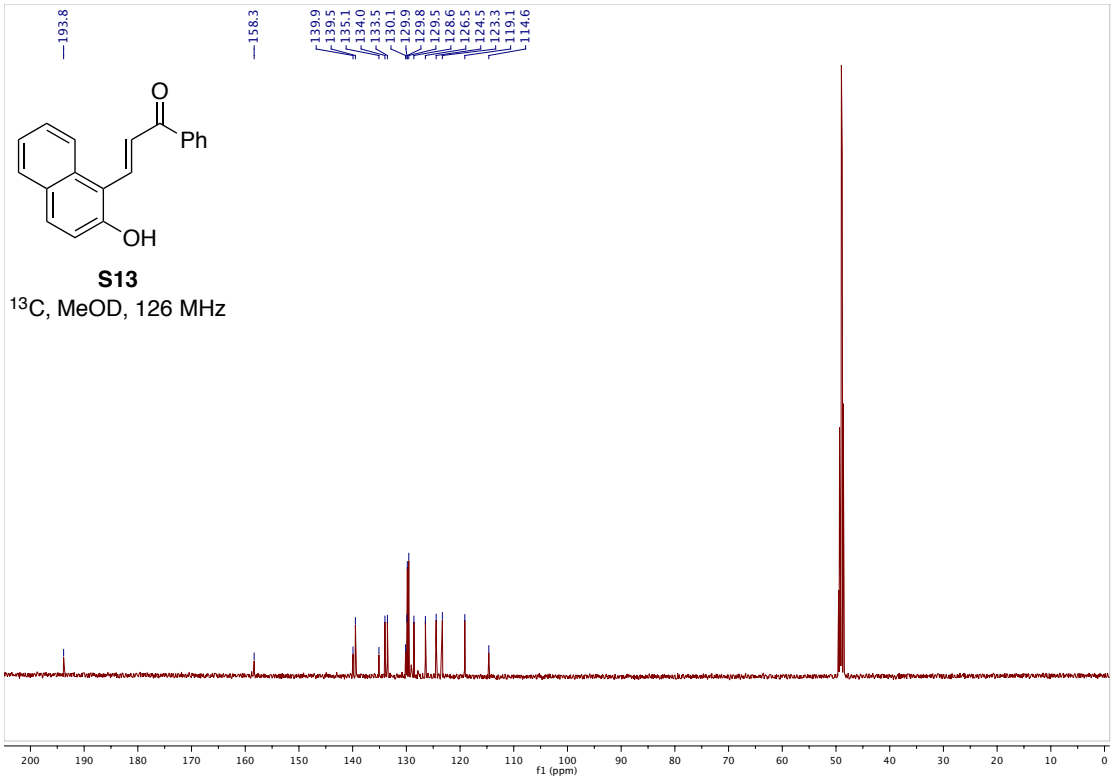
S8

^{31}P, $CDCl_3$, 162 MHz



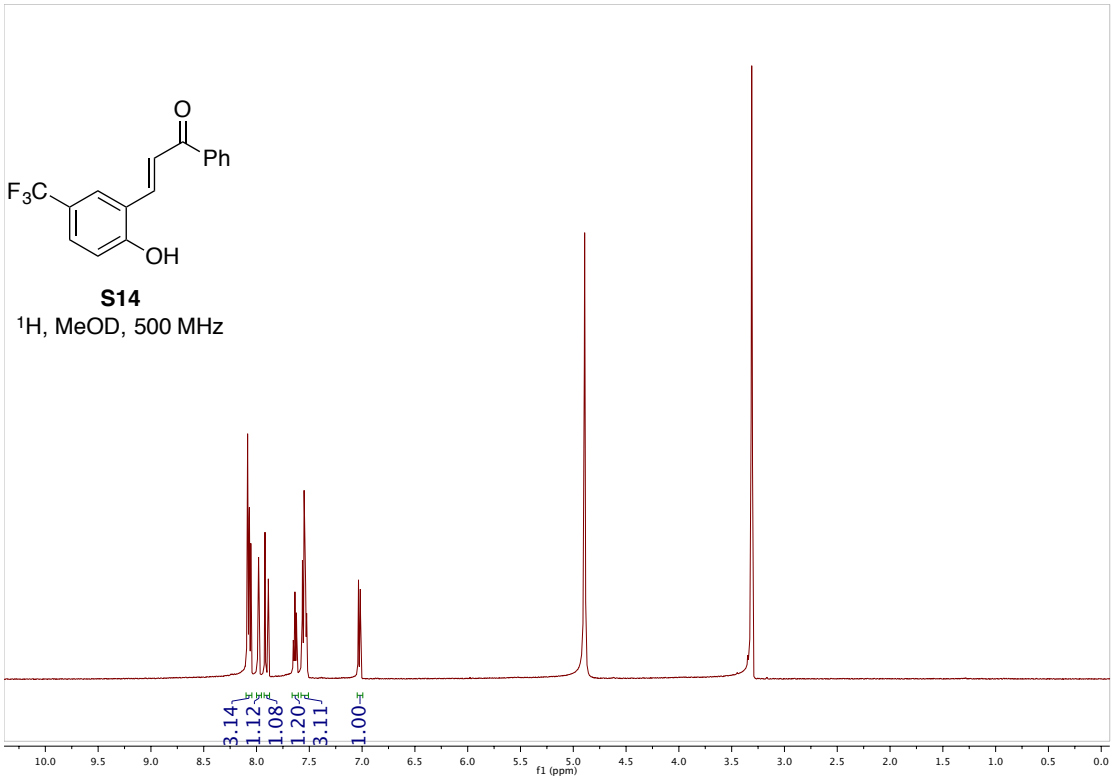
S13

^{1}H, MeOD, 500 MHz



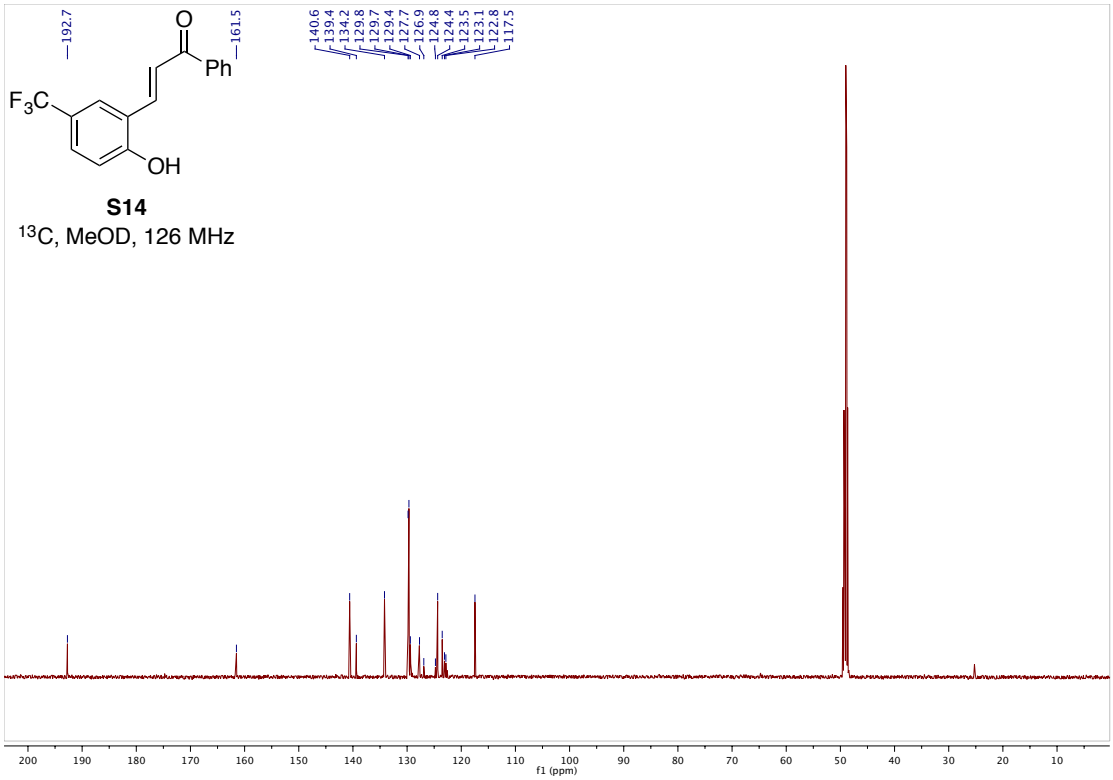
S13

^{13}C, MeOD, 126 MHz



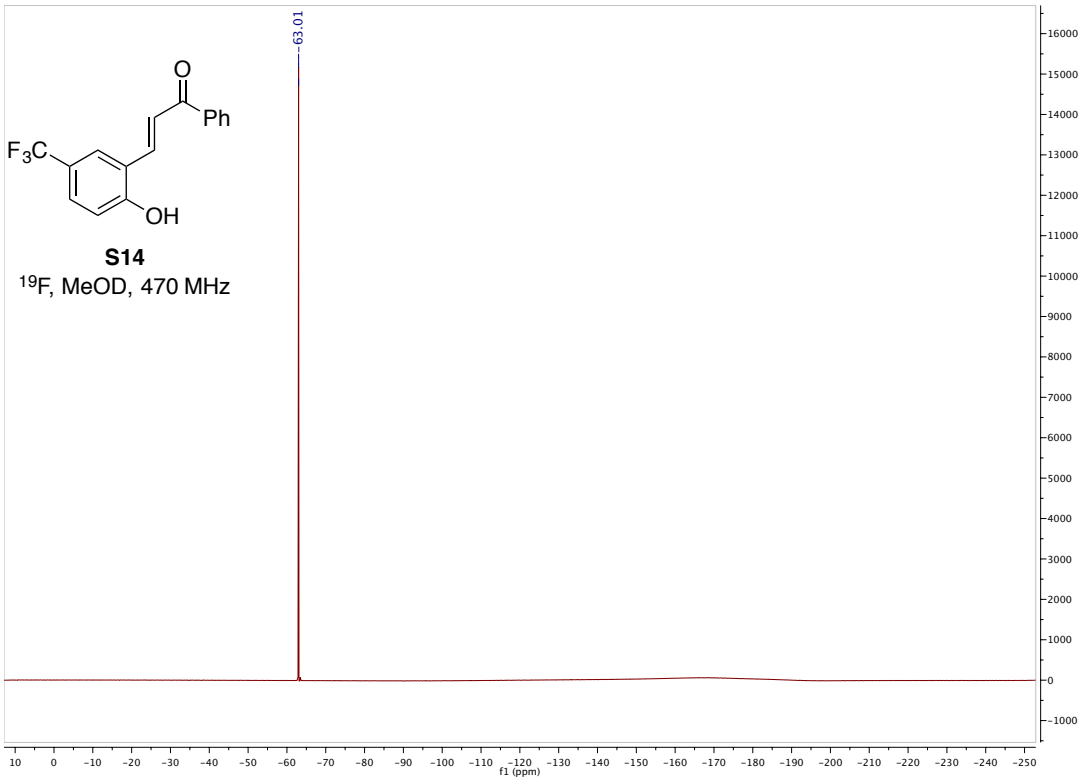
S14

^{1}H, MeOD, 500 MHz



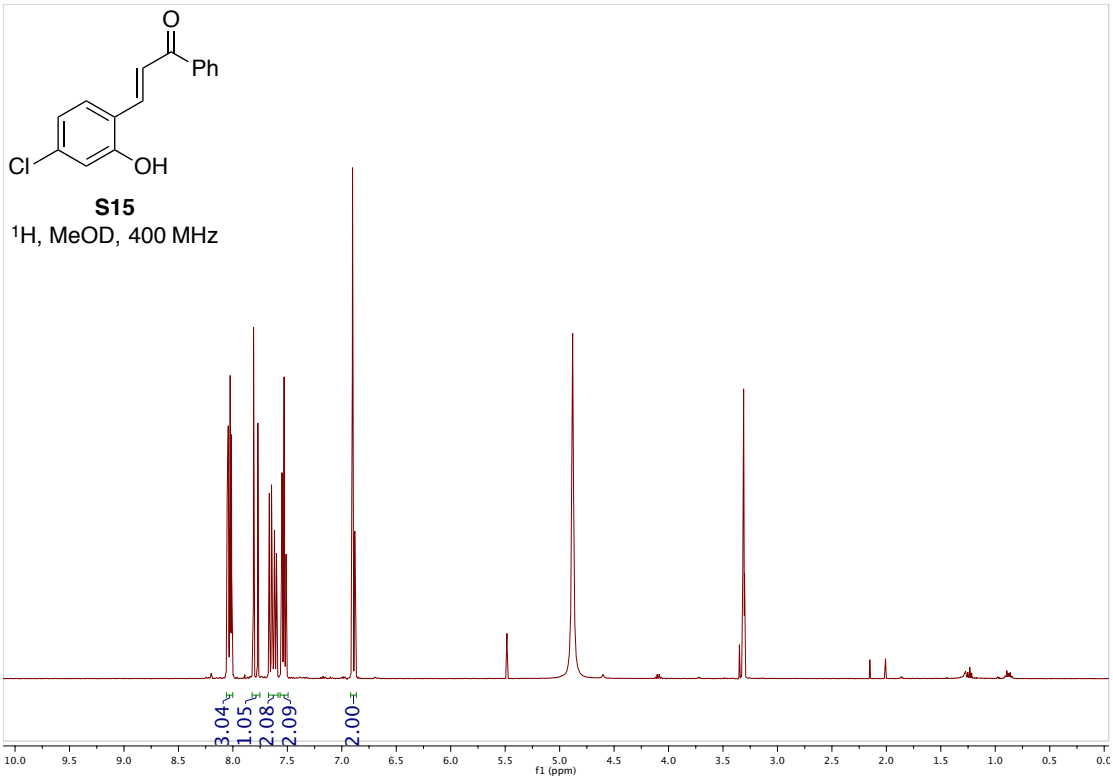
S14

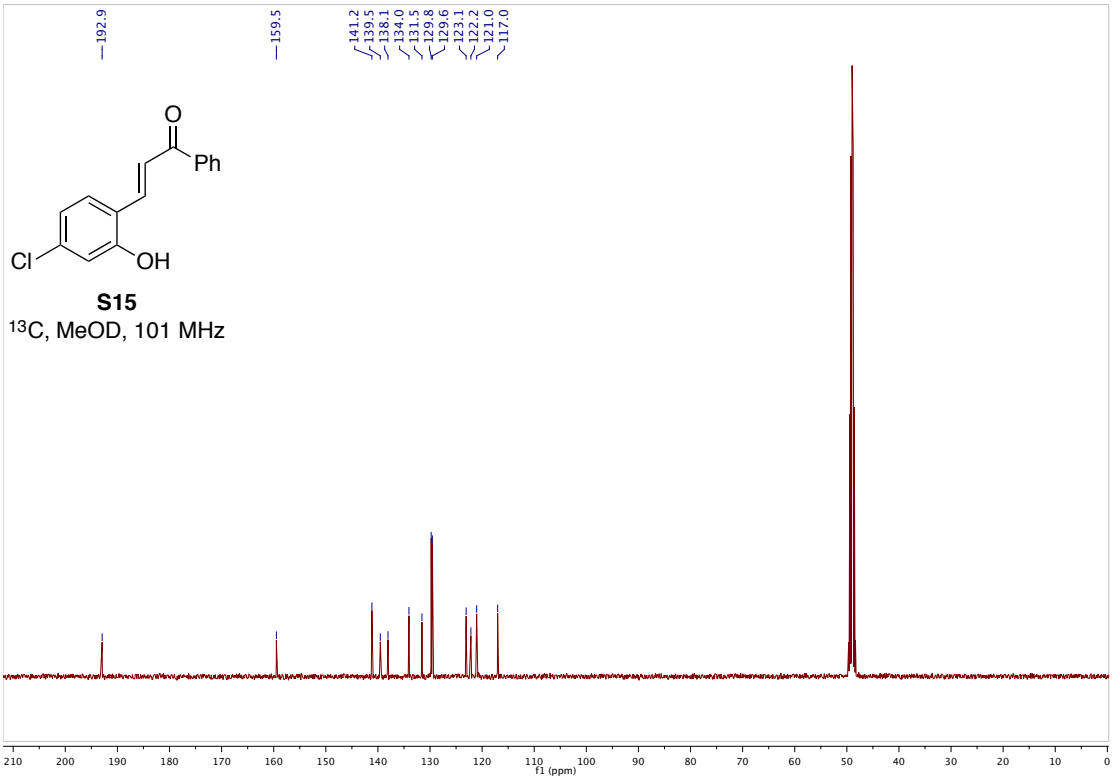
^{13}C, MeOD, 126 MHz

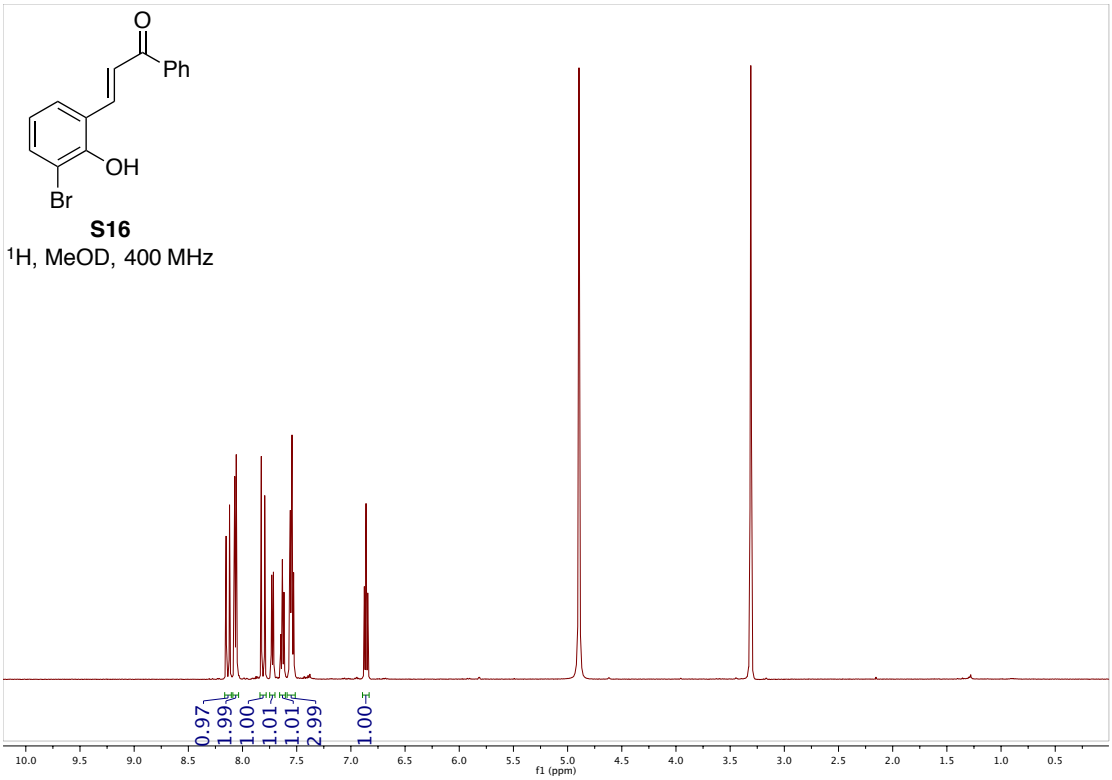


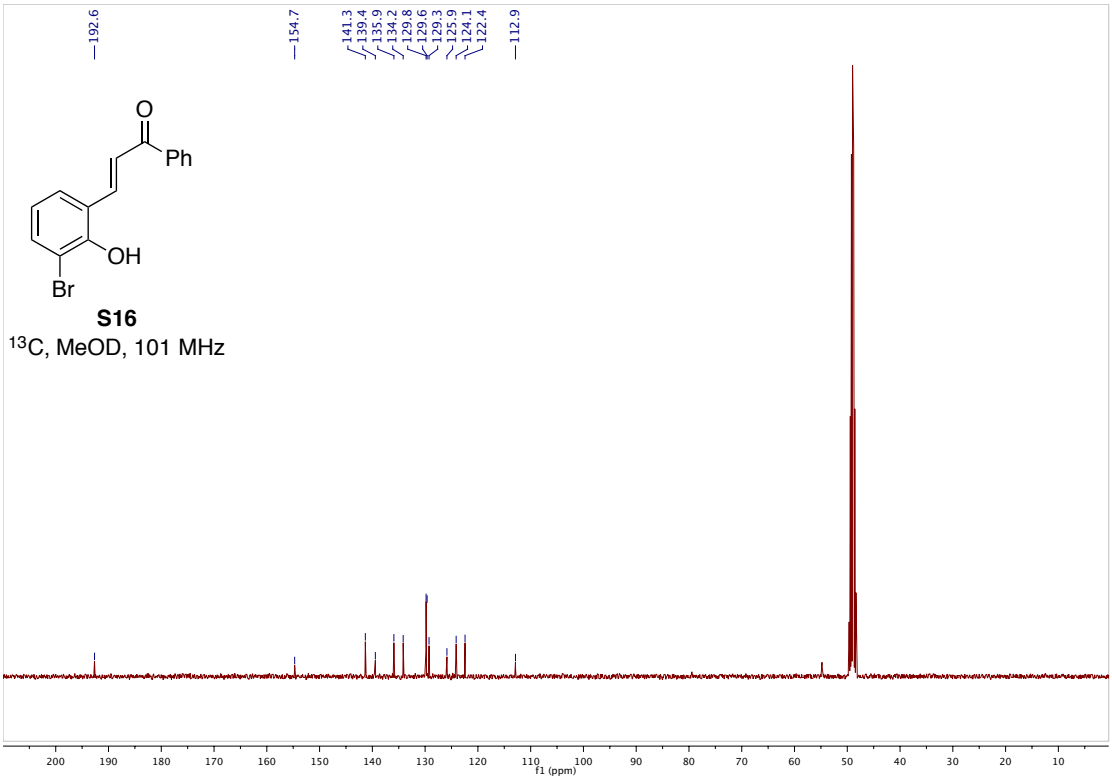
S14

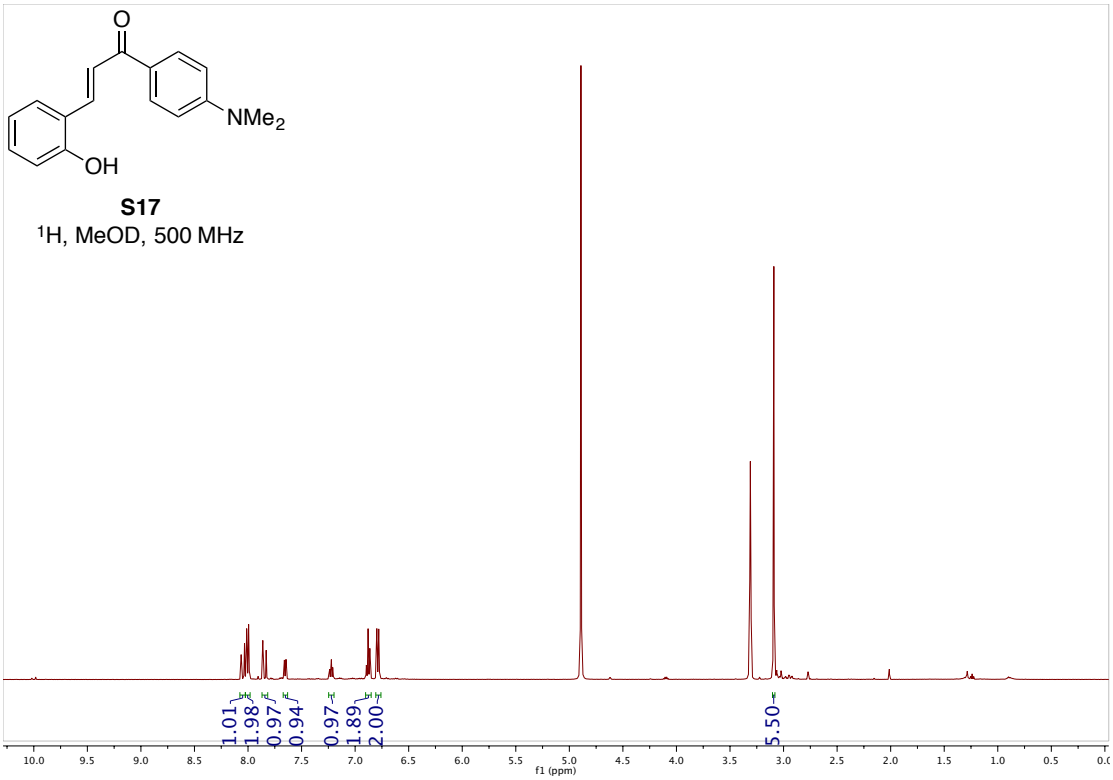
^{19}F, MeOD, 470 MHz


O
Ph
Cl
OH
S15
1H, MeOD, 400 MHz
3.04
1.05
2.08
2.09
2.00
f1 (ppm)


192.9
159.5
141.2
139.5
138.1
134.0
131.5
129.8
129.6
123.1
122.2
121.0
117.0
O
Ph
Cl
OH
S15
13C, MeOD, 101 MHz
f1 (ppm)

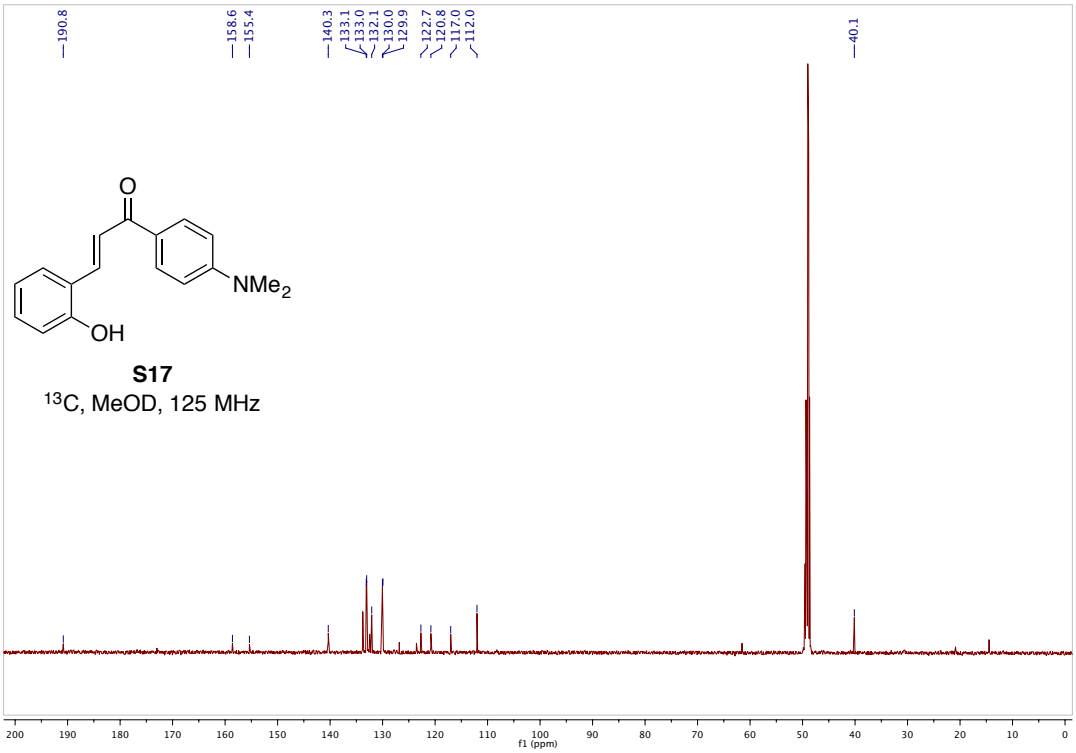

O
Ph
OH
Br
S16
1H, MeOD, 400 MHz
0.97
1.99
1.00
1.01
1.01
2.99
1.00
f1 (ppm)


192.6
154.7
141.3
139.4
135.9
134.2
129.8
129.6
129.3
125.9
124.1
122.4
112.9
O
Ph
OH
Br
S16
13C, MeOD, 101 MHz
f1 (ppm)



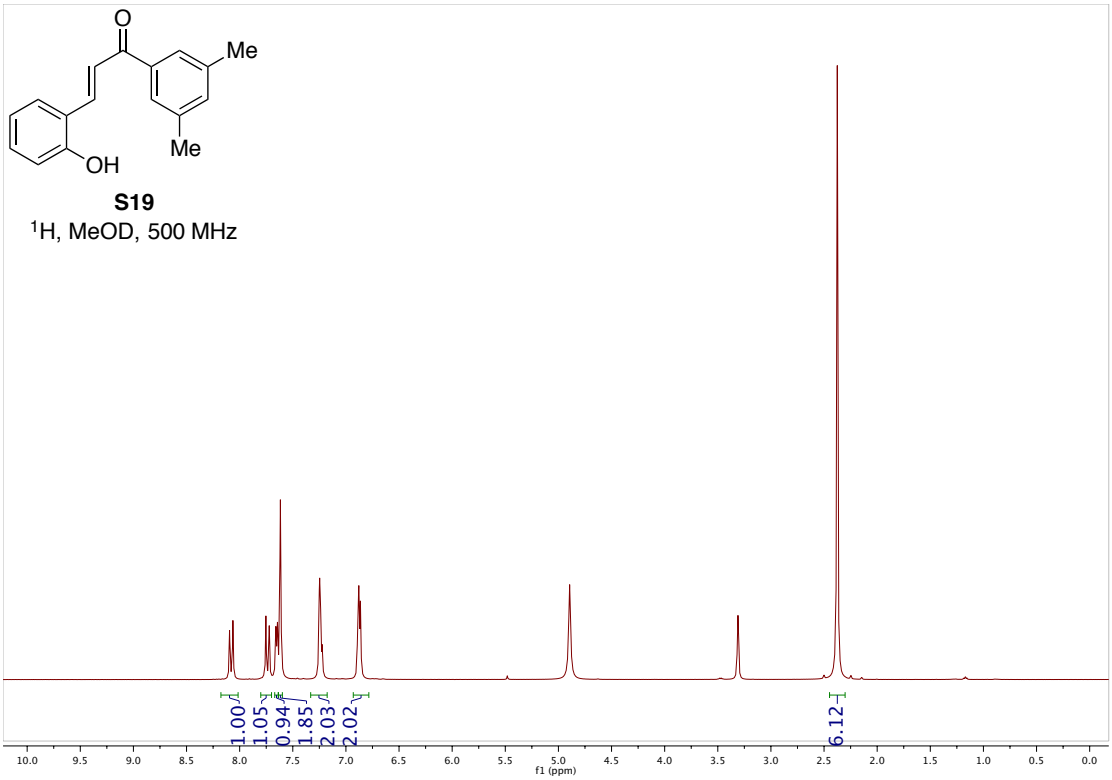
S17

^{1}H, MeOD, 500 MHz



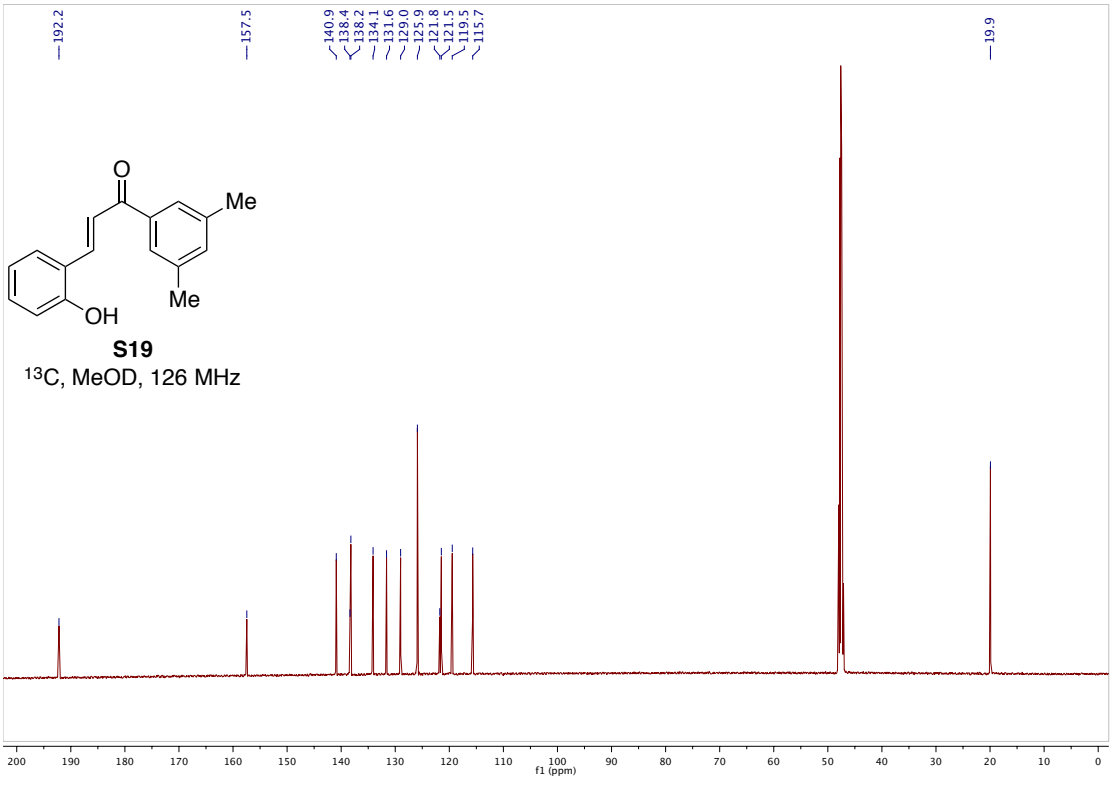
S17

^{13}C, MeOD, 125 MHz



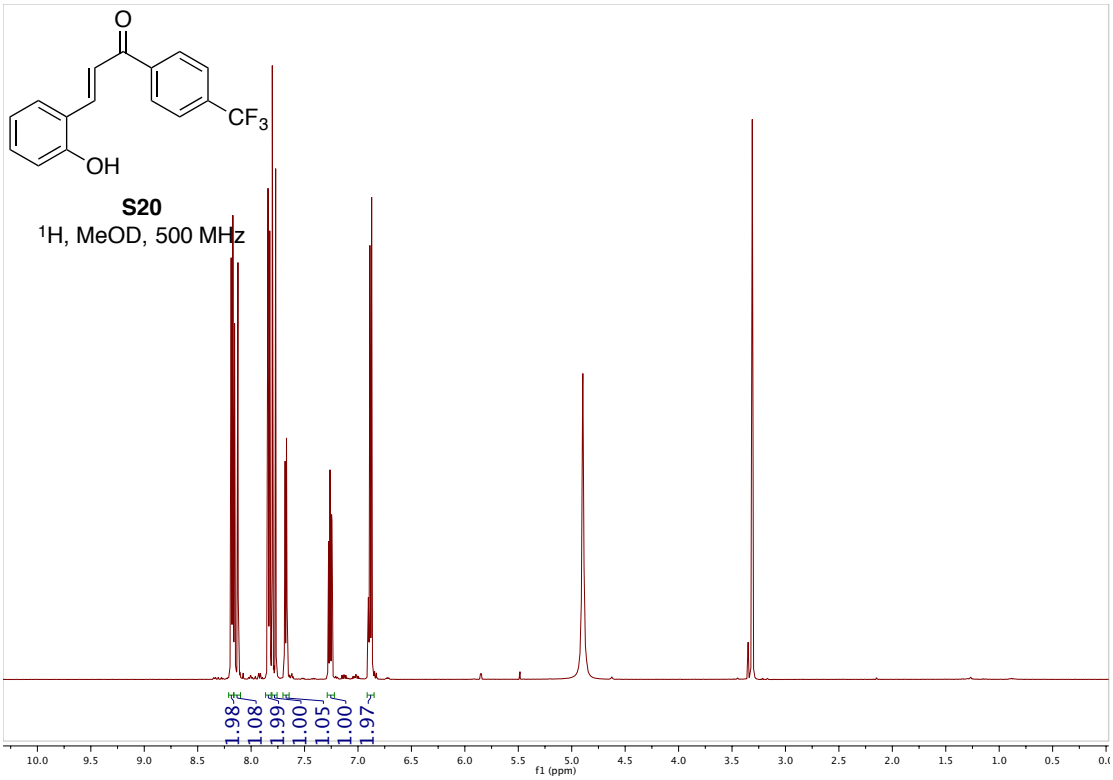
S19

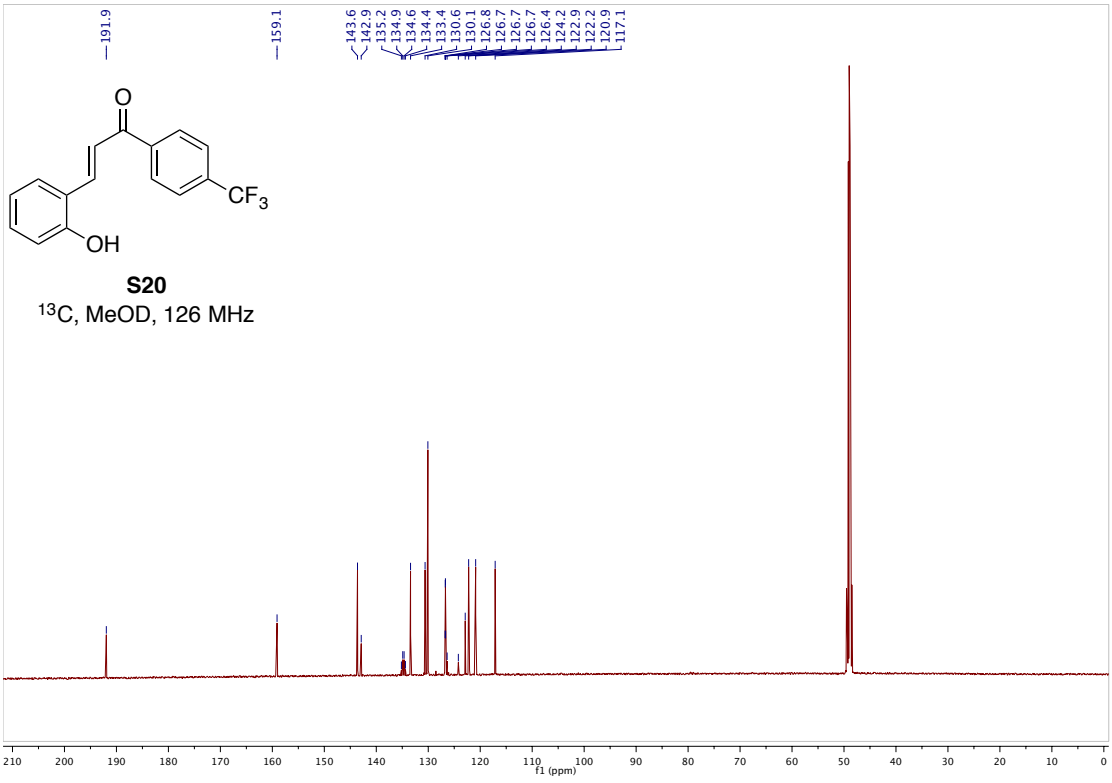
^{1}H, MeOD, 500 MHz

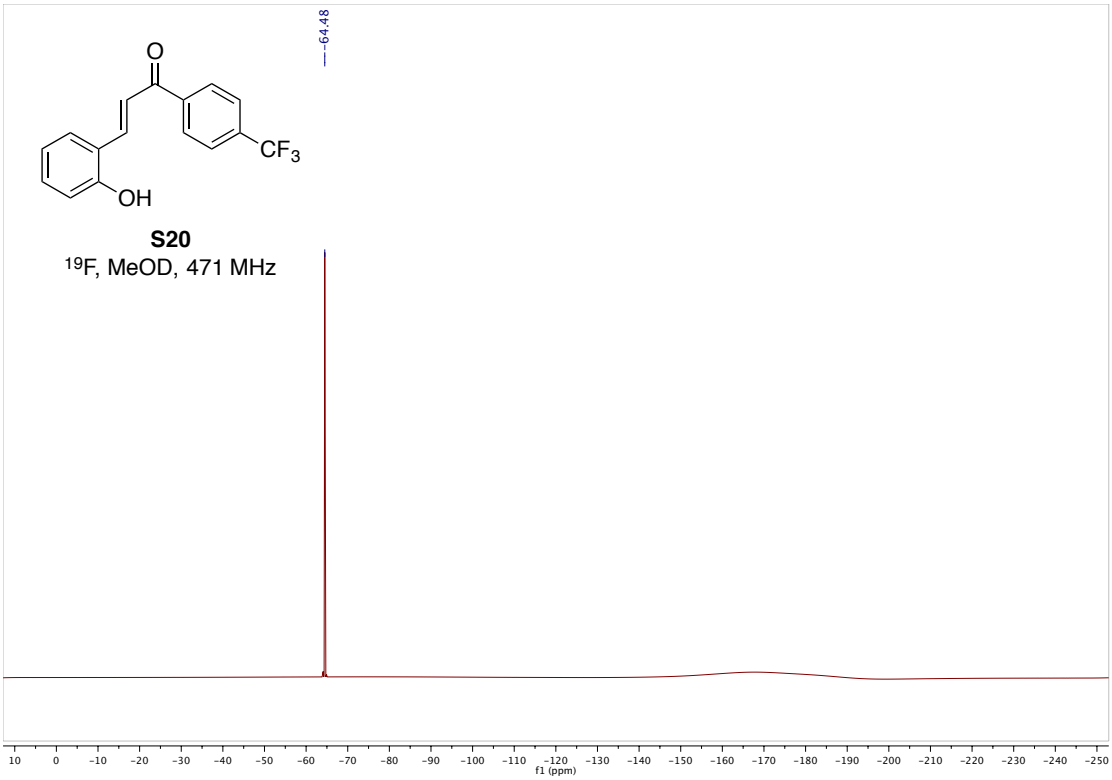


S19

^{13}C, MeOD, 126 MHz

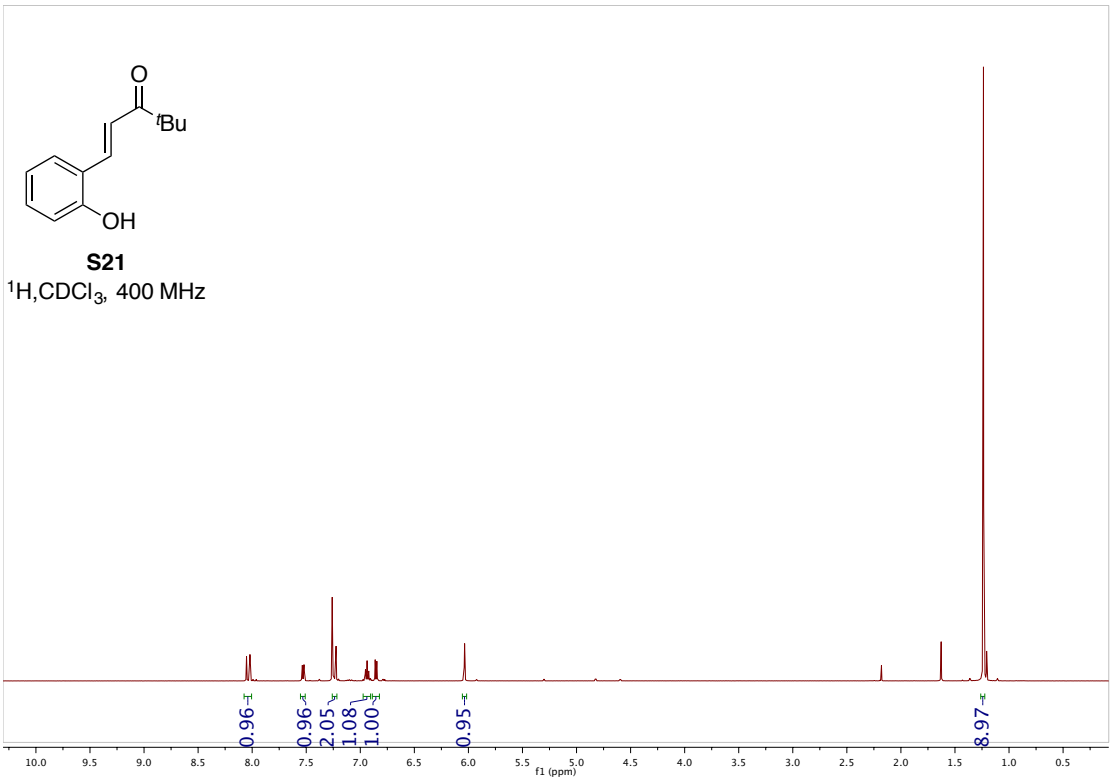

O
CF3
OH
S20
1H, MeOD, 500 MHz
1.98
1.08
1.99
1.00
1.05
1.00
1.97
f1 (ppm)


191.9
159.1
143.6
142.9
135.2
134.9
134.6
134.4
133.4
130.6
130.1
126.8
126.7
126.7
126.7
126.4
124.2
122.9
122.2
120.9
117.1
O
CF3
OH
S20
13C, MeOD, 126 MHz
f1 (ppm)



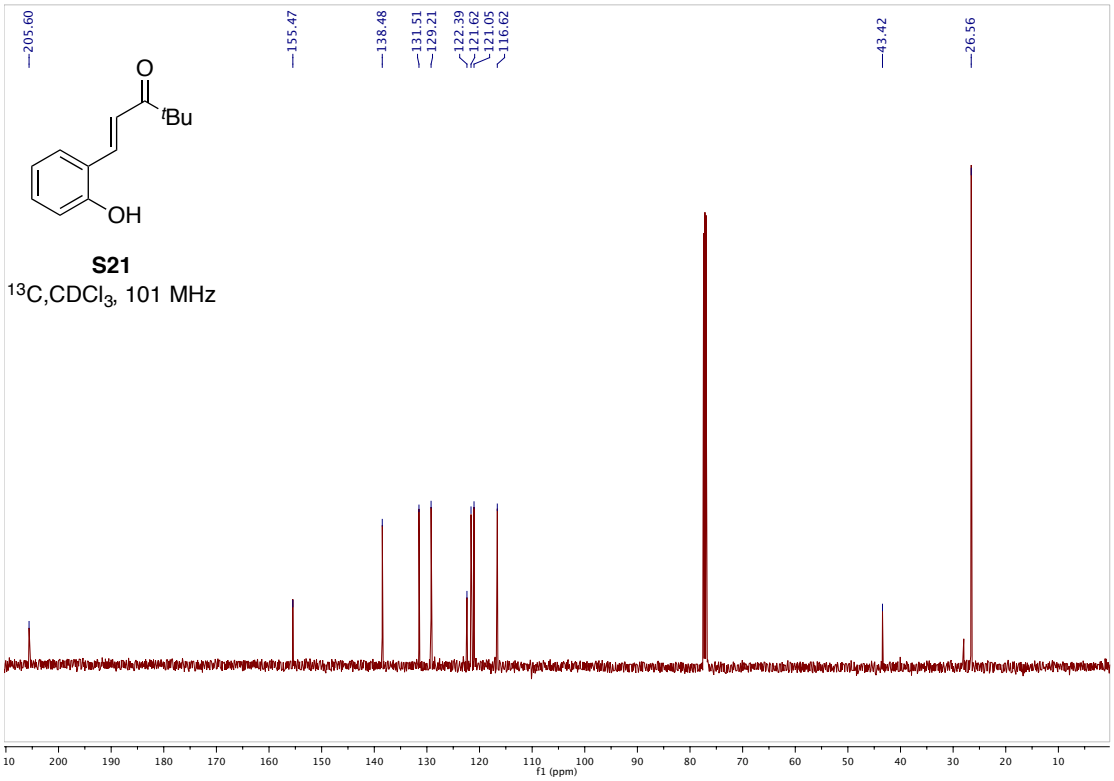
S20

^{19}F, MeOD, 471 MHz



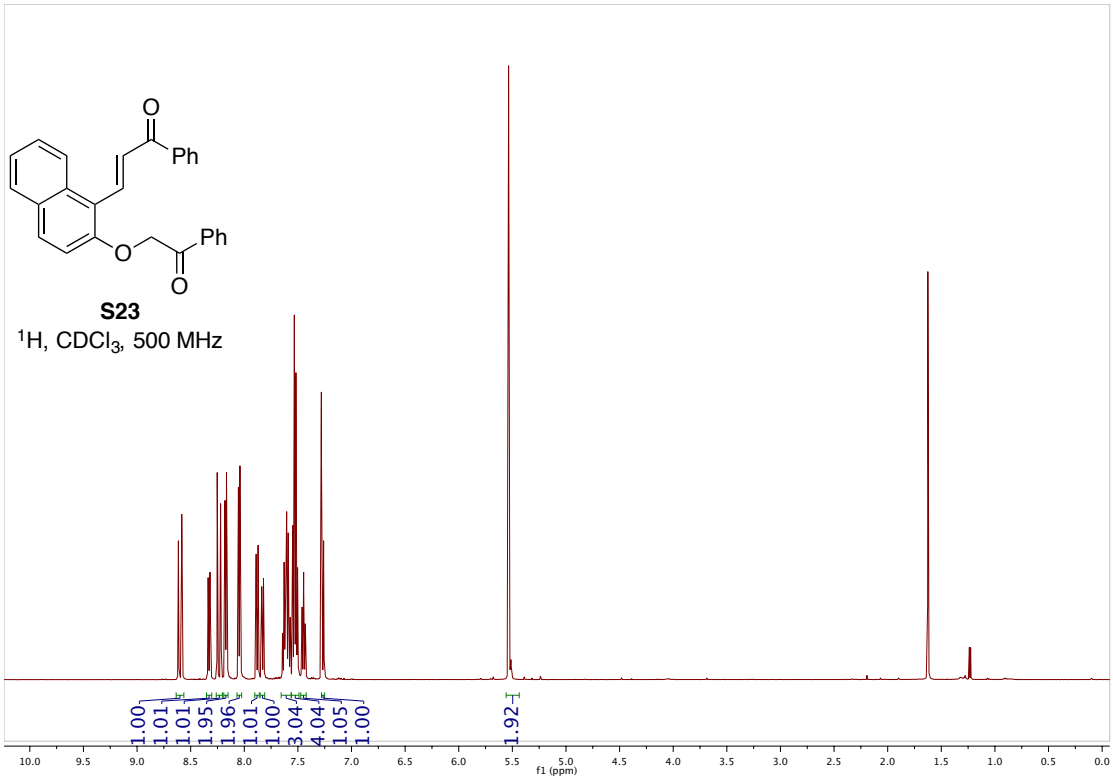
S21

^{1}H,$CDCl_3$, 400 MHz



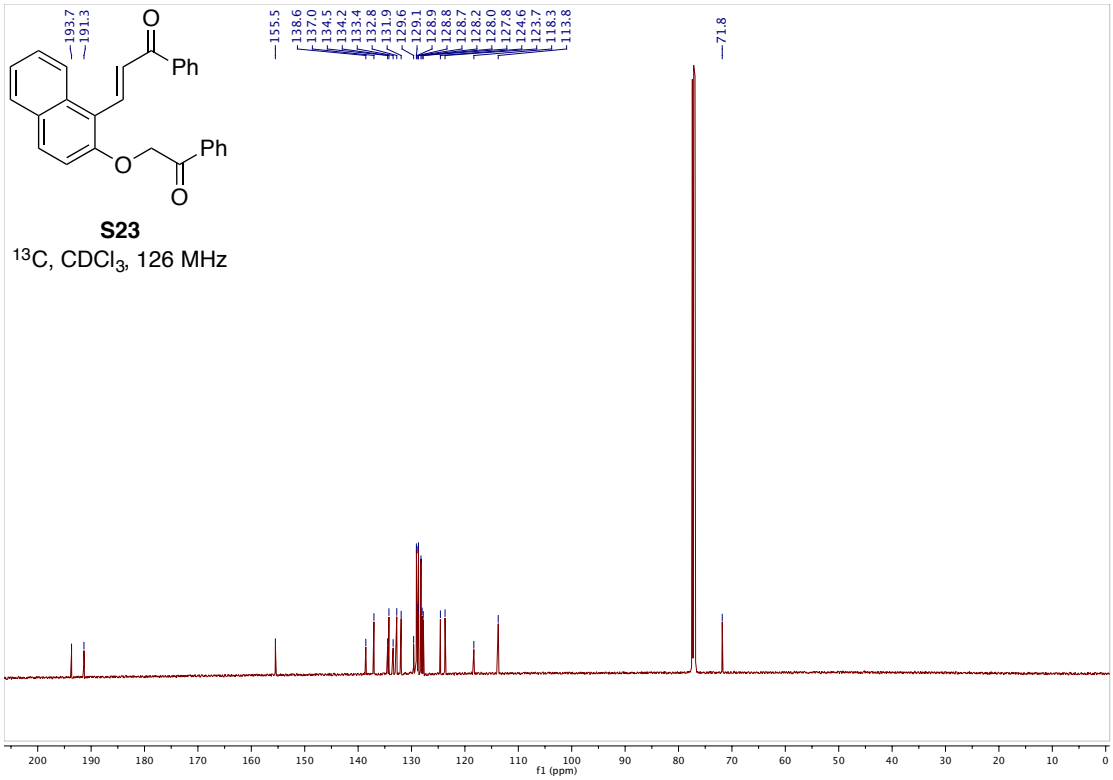
S21

^{13}C,$CDCl_3$, 101 MHz



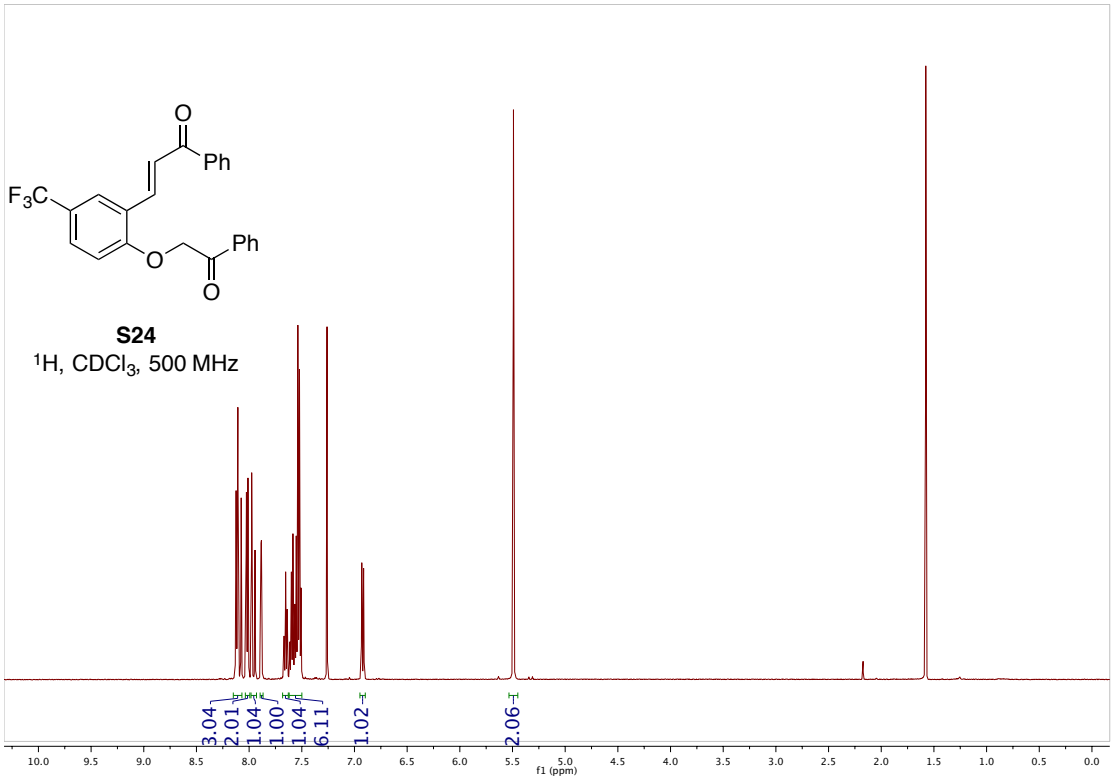
S23

^{1}H, $CDCl_3$, 500 MHz



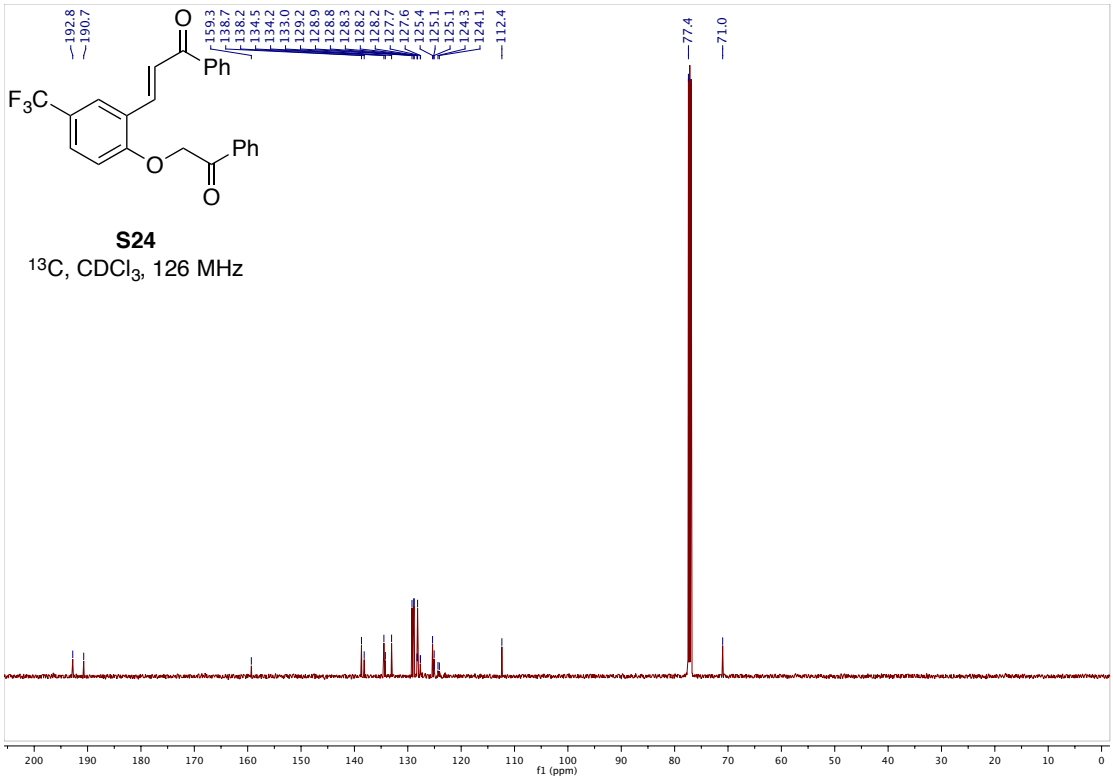
S23

^{13}C, $CDCl_3$, 126 MHz



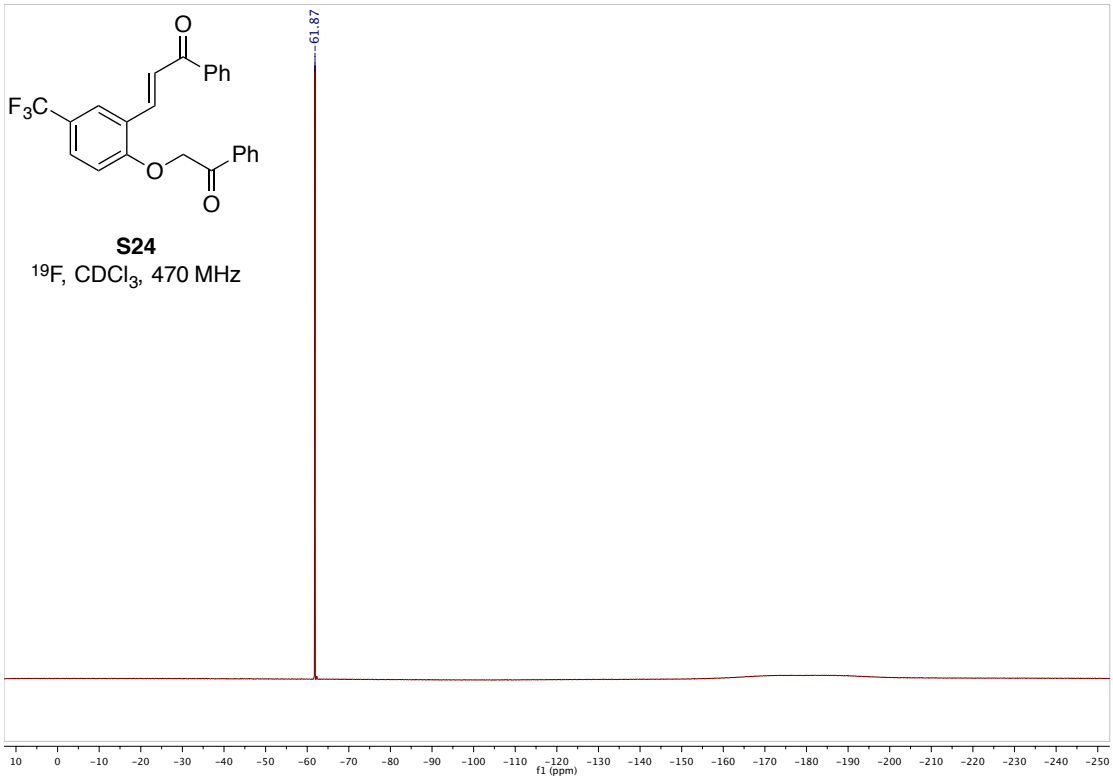
S24

^{1}H, $CDCl_3$, 500 MHz



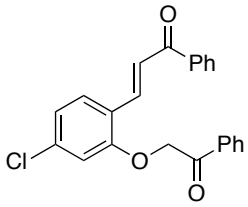
S24

^{13}C, $CDCl_3$, 126 MHz



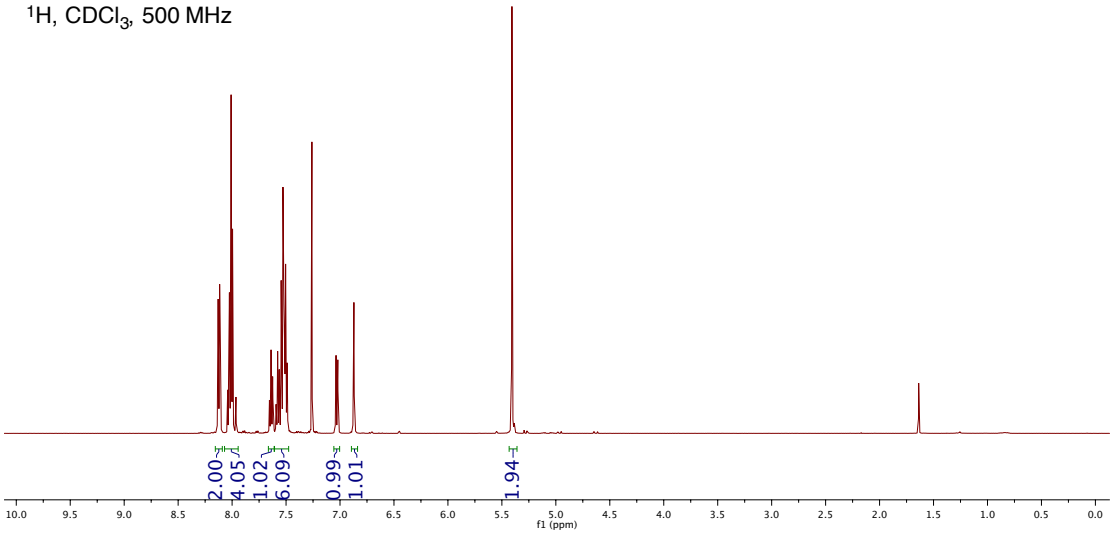
S24

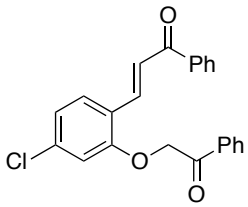
^{19}F, $CDCl_3$, 470 MHz



S25

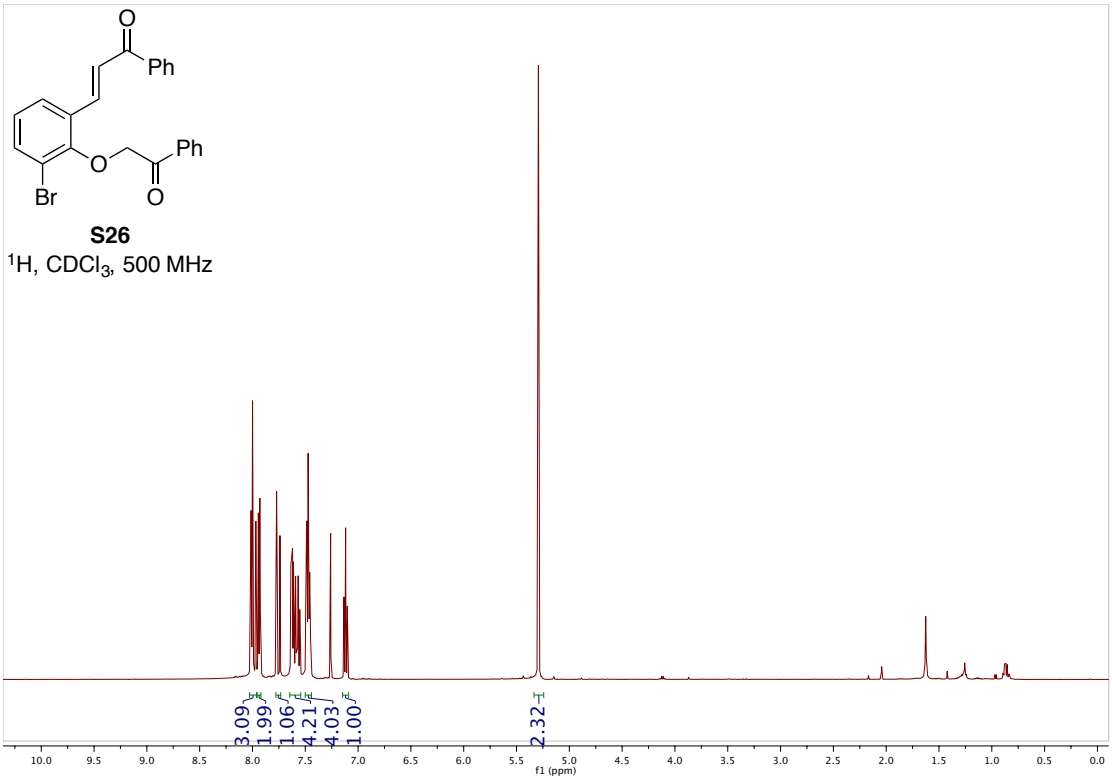
^{1}H, $CDCl_3$, 500 MHz





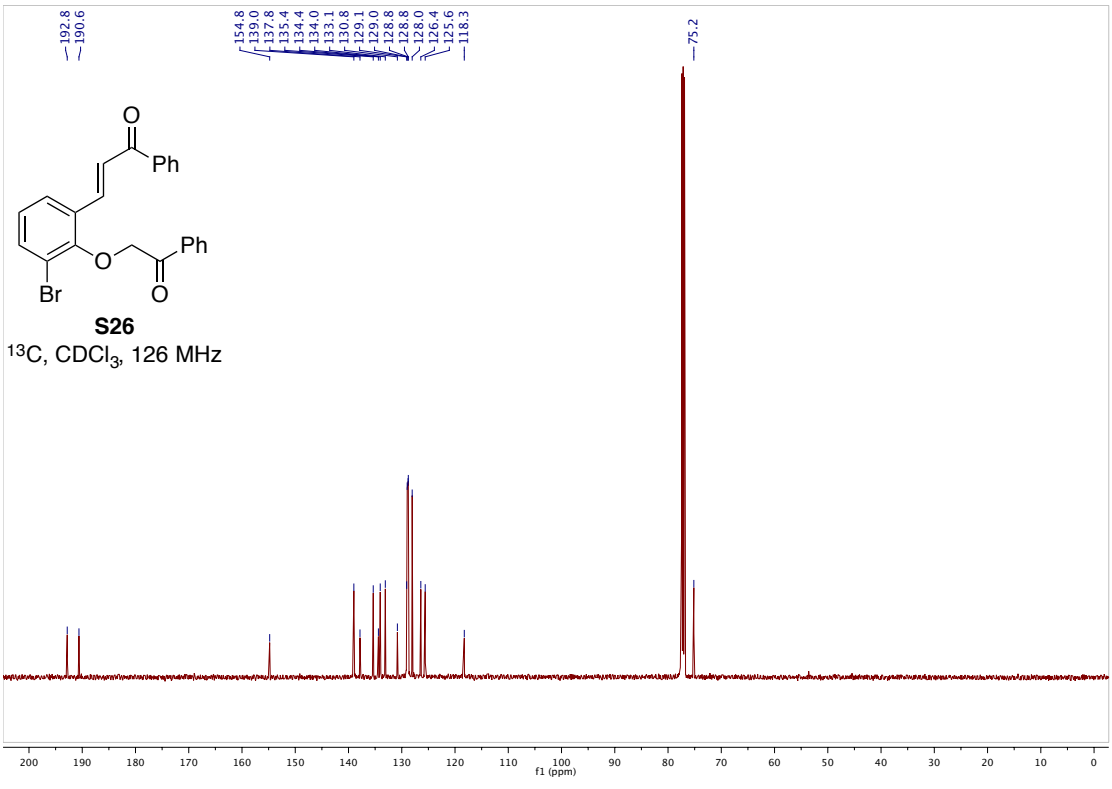
S25

^{13}C, $CDCl_3$, 126 MHz



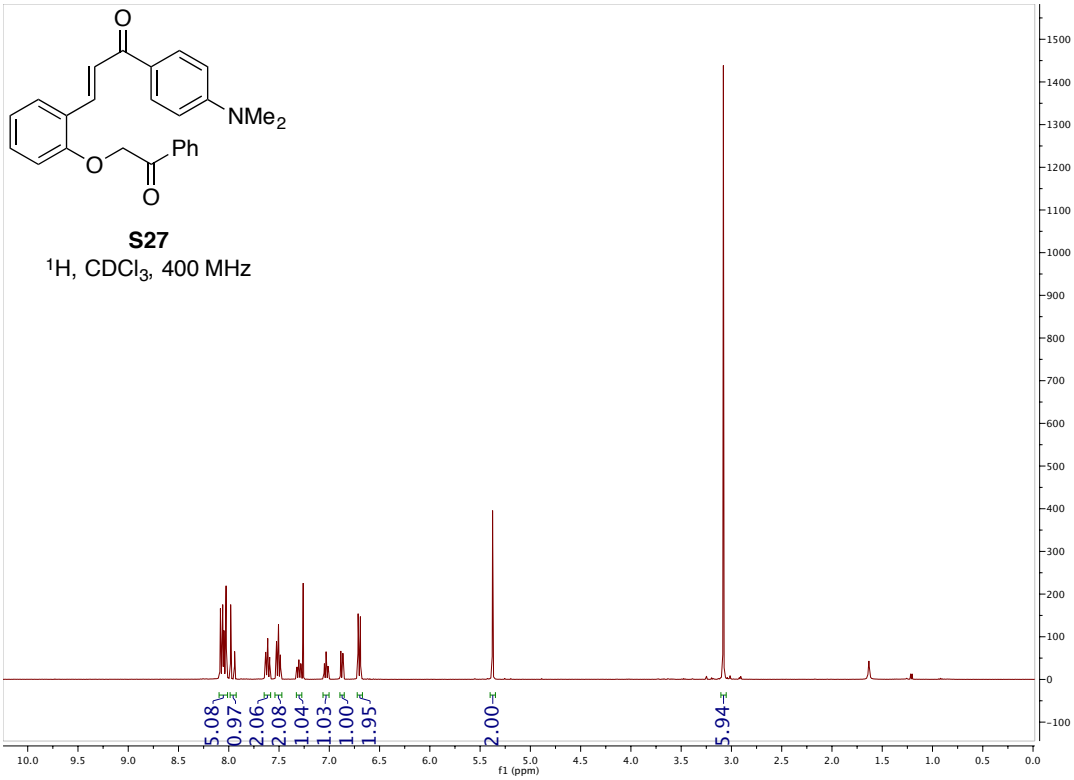
S26

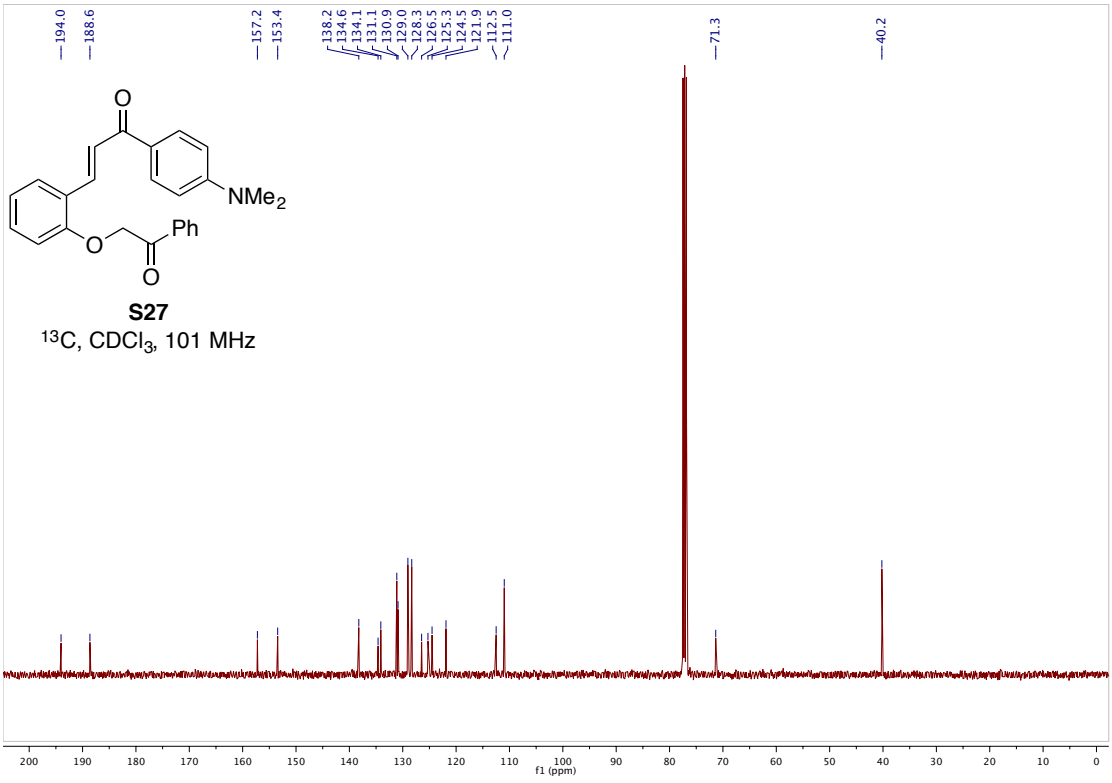
^{1}H, $CDCl_3$, 500 MHz

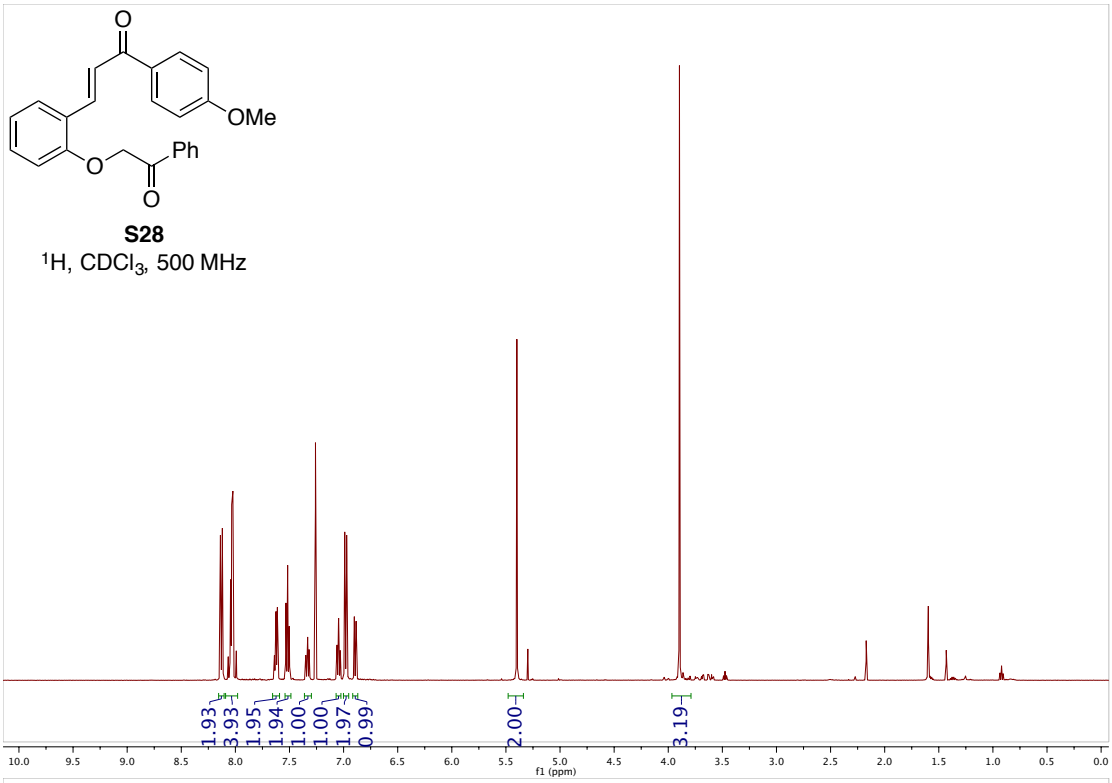


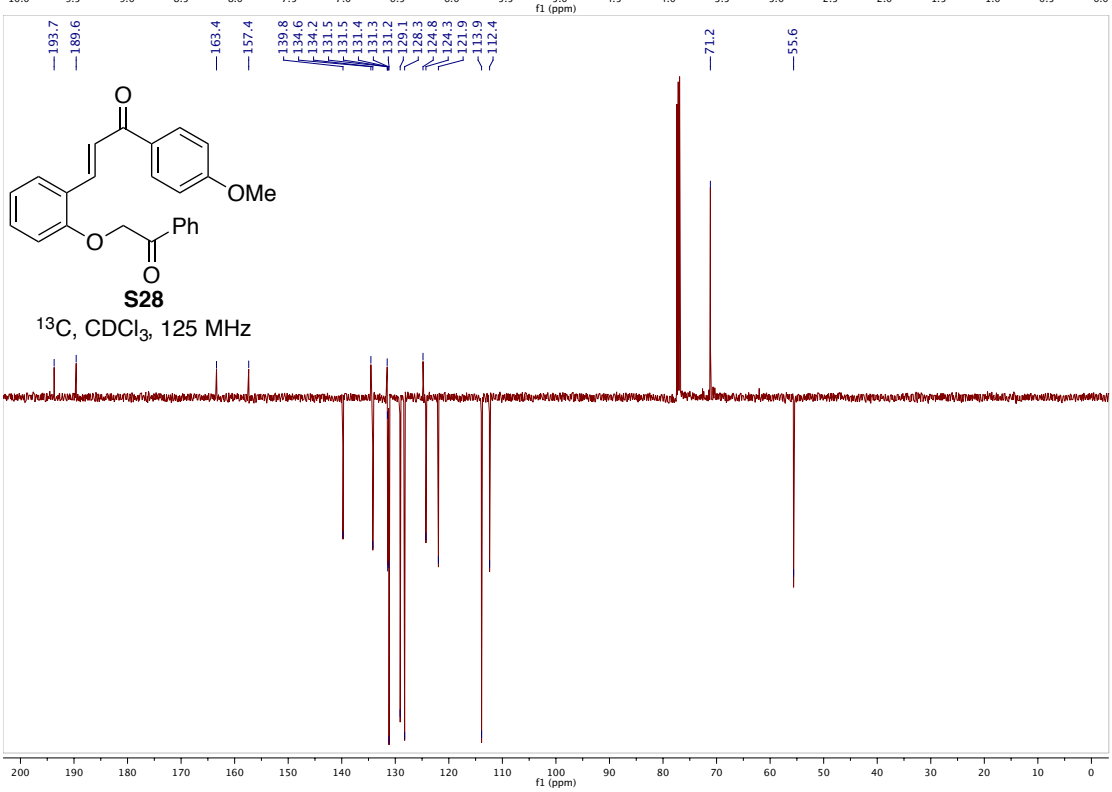
S26

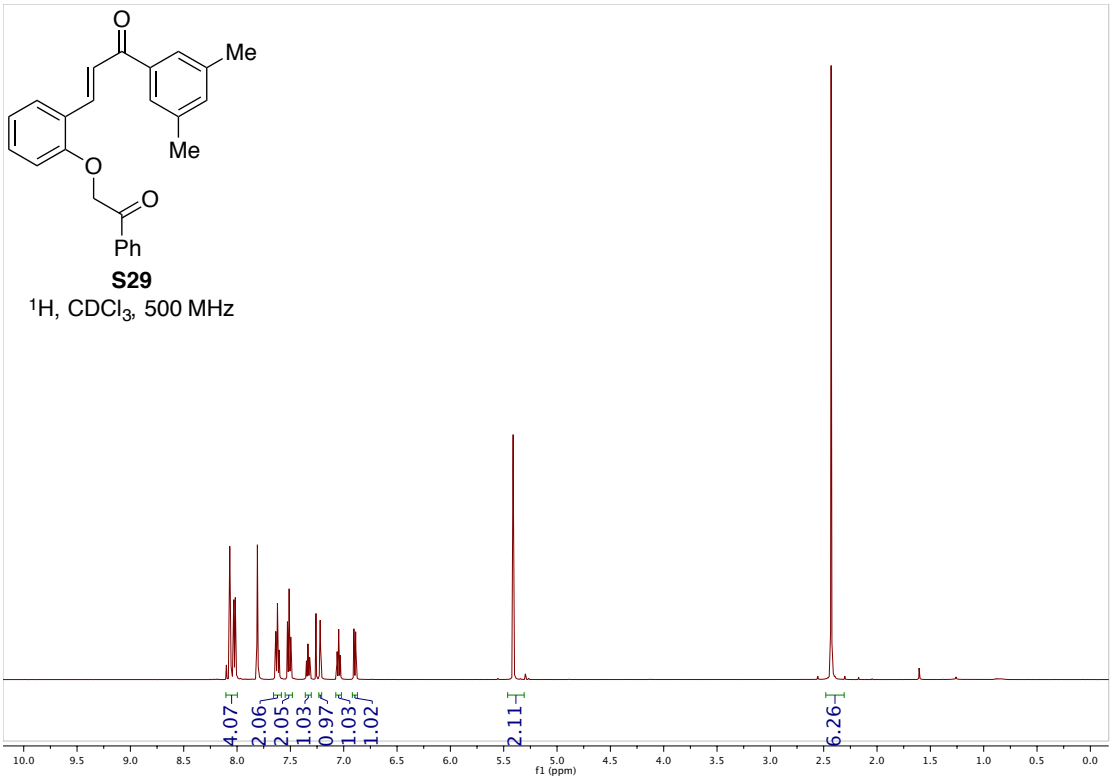
^{13}C, $CDCl_3$, 126 MHz


O
NMe2
Ph
O
O
S27
1H, CDCl3, 400 MHz
5.08
0.97
2.06
2.08
1.04
1.03
1.00
1.95
2.00
5.94
f1 (ppm)


194.0
188.6
157.2
153.4
138.2
134.6
134.1
131.1
130.9
129.0
128.3
126.5
125.3
124.5
121.9
112.5
111.0
71.3
40.2
O
NMe2
Ph
O
O
S27
13C, CDCl3, 101 MHz
f1 (ppm)

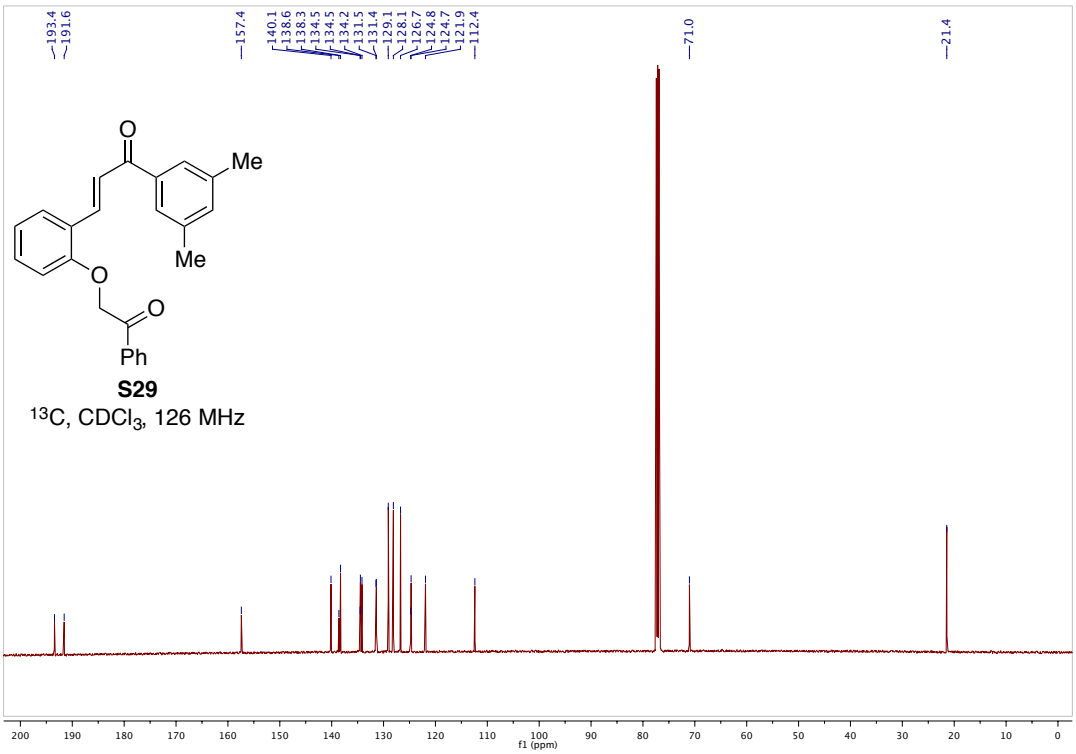

O
OMe
Ph
O
O
S28
1H, CDCl3, 500 MHz
1.93
3.93
1.95
1.94
1.00
1.00
1.97
0.99
2.00
3.19
f1 (ppm)


193.7
189.6
163.4
157.4
139.8
134.6
134.2
131.5
131.5
131.4
131.3
131.2
129.1
128.3
124.8
124.3
121.9
113.9
112.4
71.2
55.6
O
OMe
Ph
O
O
S28
13C, CDCl3, 125 MHz
f1 (ppm)



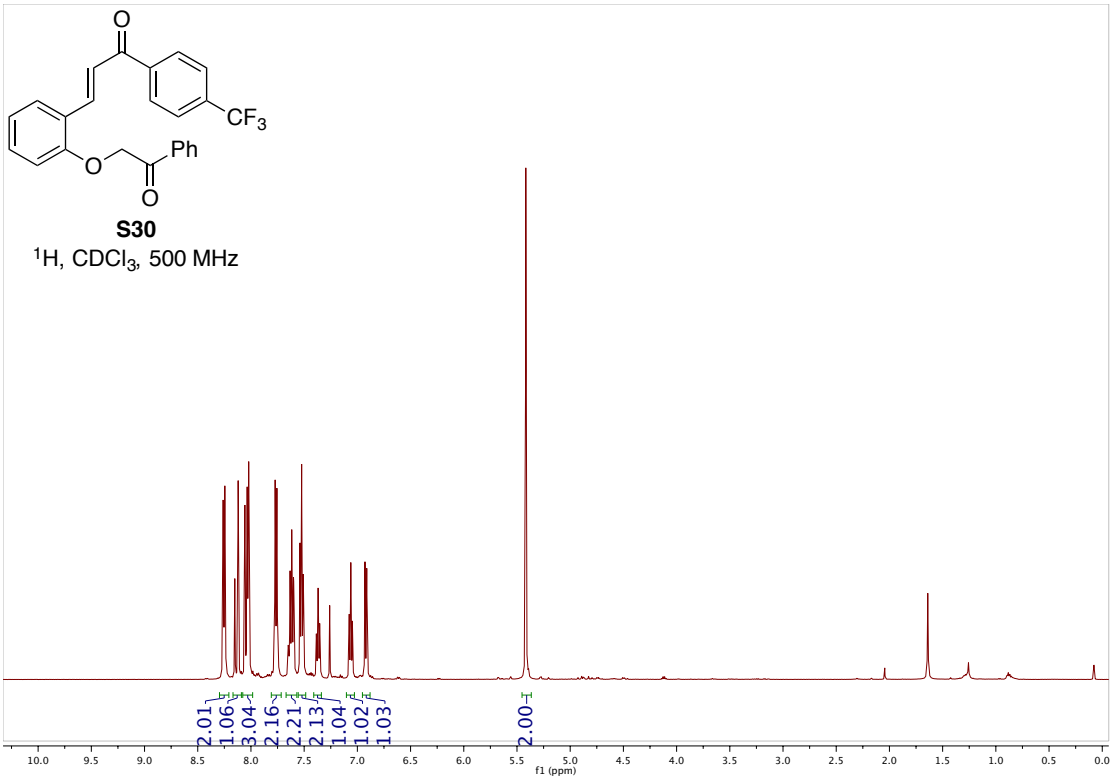
S29

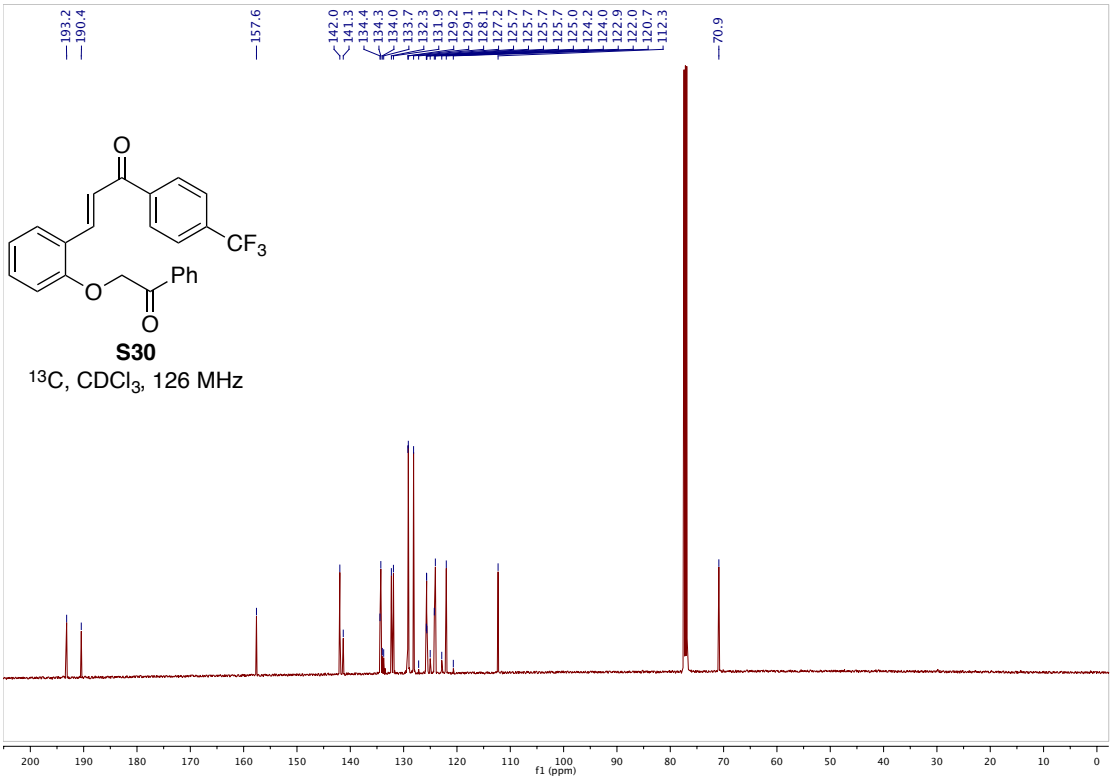
^{1}H, $CDCl_3$, 500 MHz

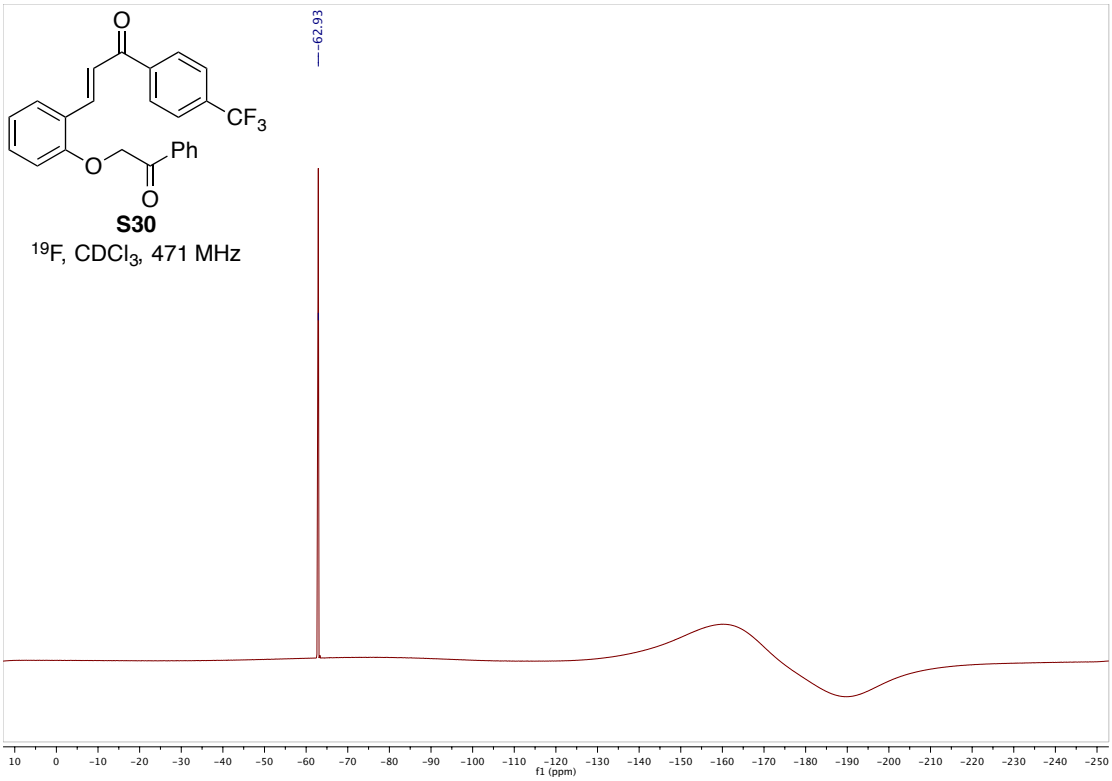


S29

^{13}C, $CDCl_3$, 126 MHz

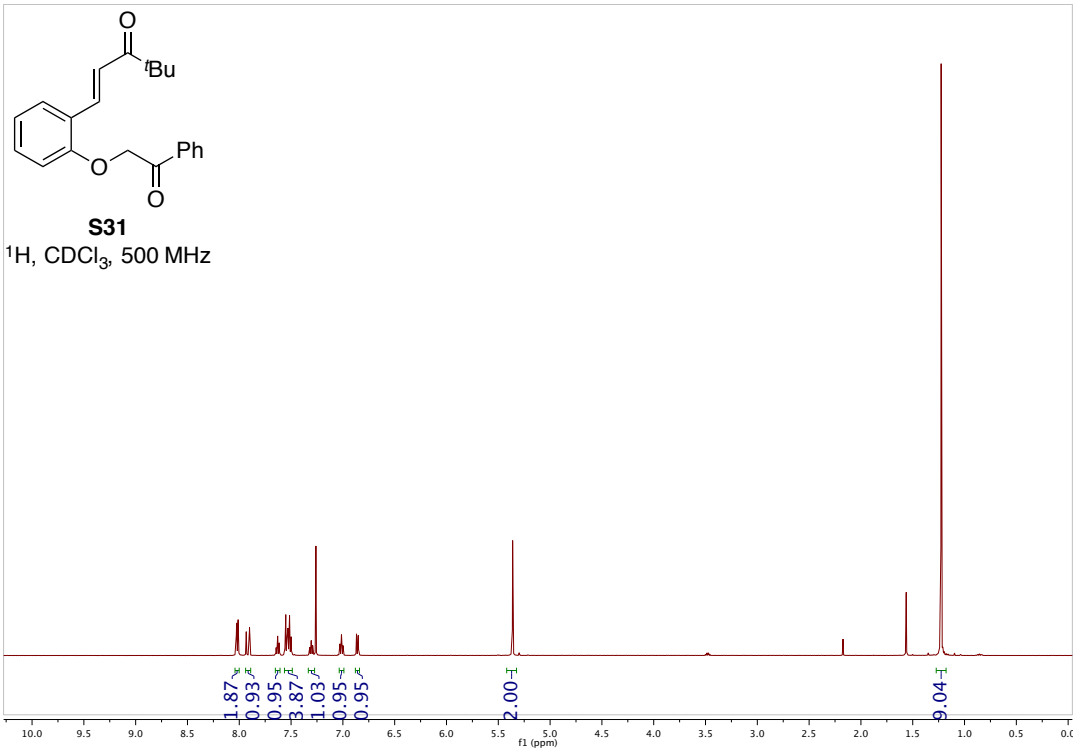

O
CF3
Ph
O
O
S30
1H, CDCl3, 500 MHz
2.01
1.06
3.04
2.16
2.21
2.13
1.04
1.02
1.03
2.00
f1 (ppm)


193.2
190.4
157.6
142.0
141.3
134.4
134.3
134.0
133.7
132.3
131.9
129.2
129.1
128.1
127.2
125.7
125.7
125.7
125.7
125.0
124.2
124.0
122.9
122.0
120.7
112.3
70.9
O
CF3
Ph
O
O
S30
13C, CDCl3, 126 MHz
f1 (ppm)



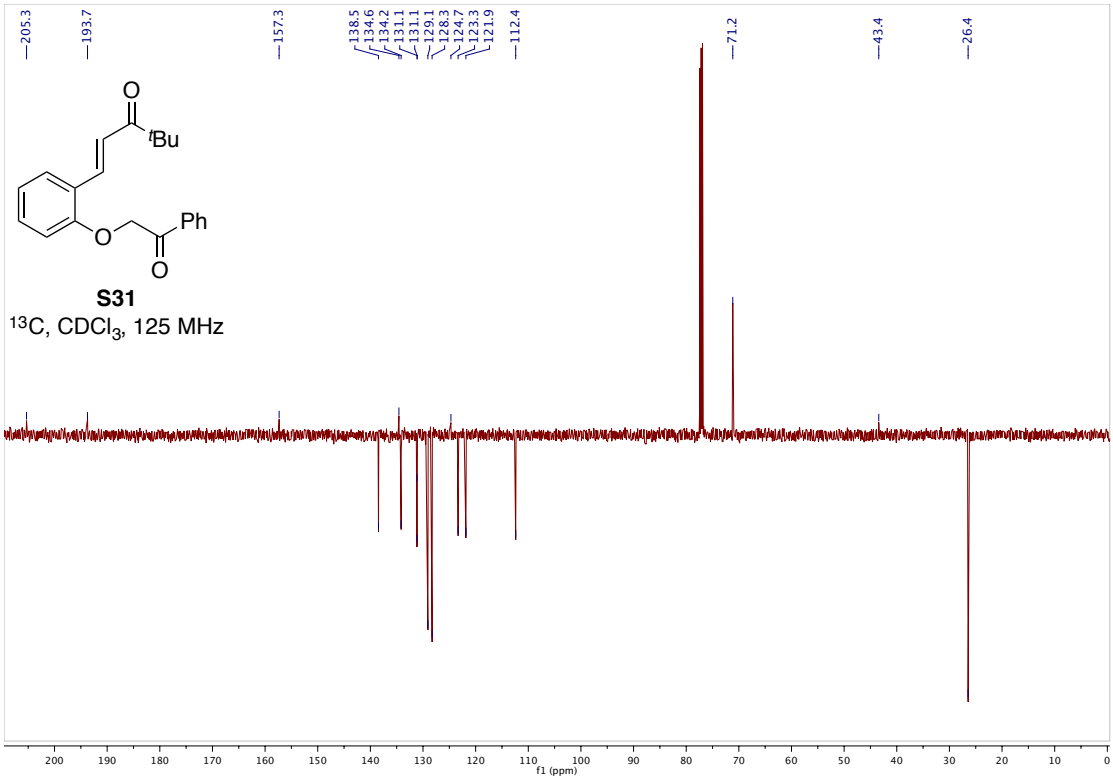
S30

^{19}F, $CDCl_3$, 471 MHz



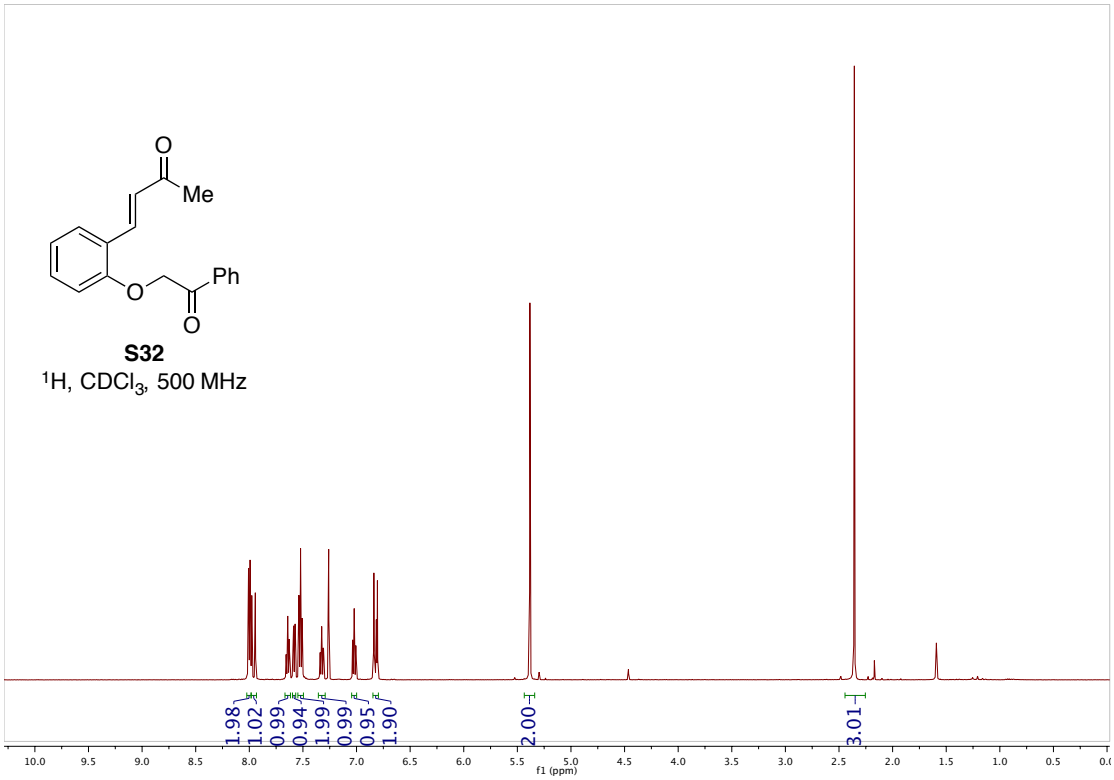
S31

^{1}H, $CDCl_3$, 500 MHz



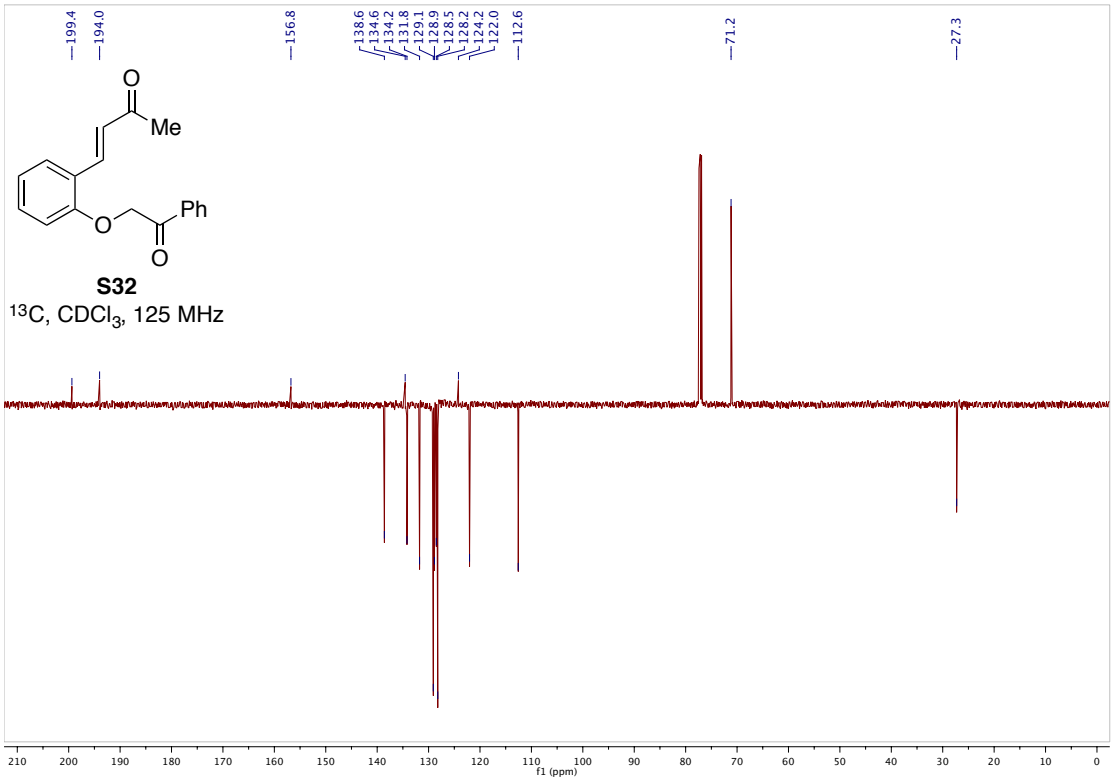
S31

^{13}C, $CDCl_3$, 125 MHz



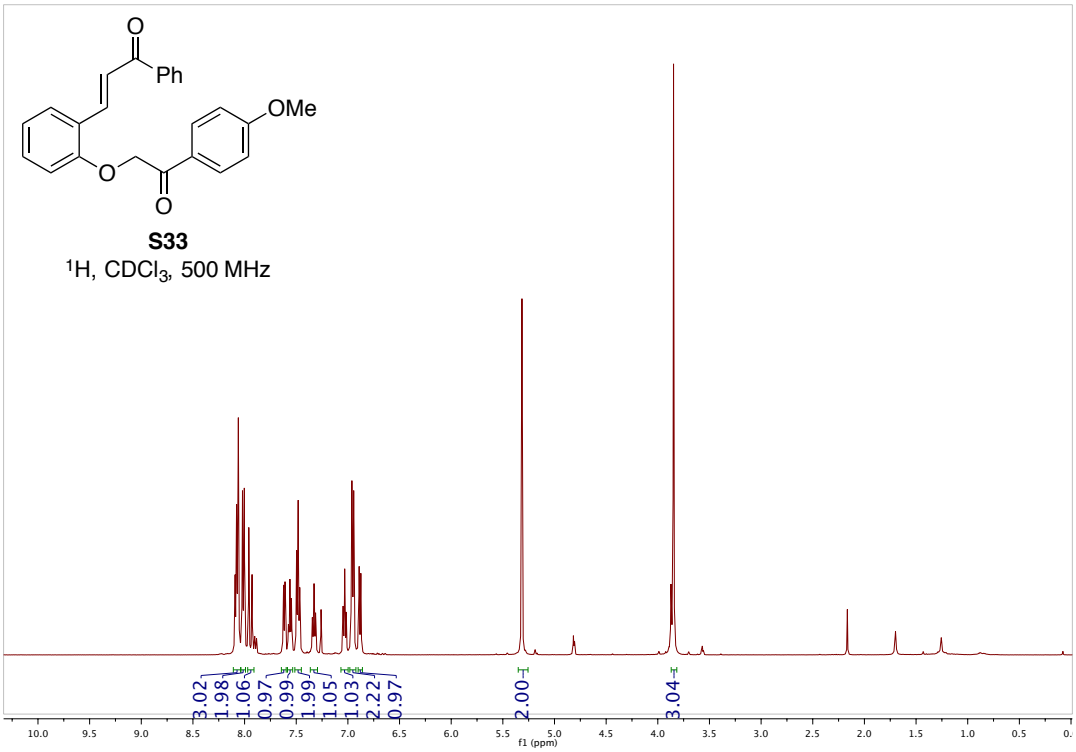
S32

^{1}H, $CDCl_3$, 500 MHz



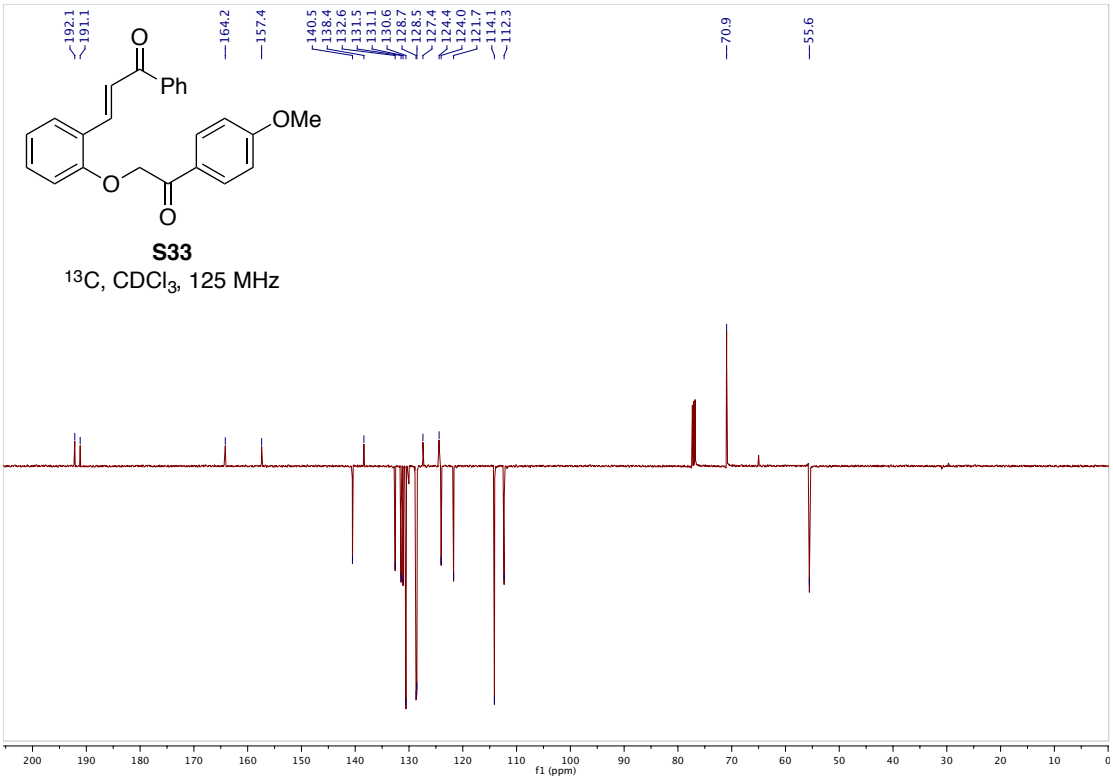
S32

^{13}C, $CDCl_3$, 125 MHz



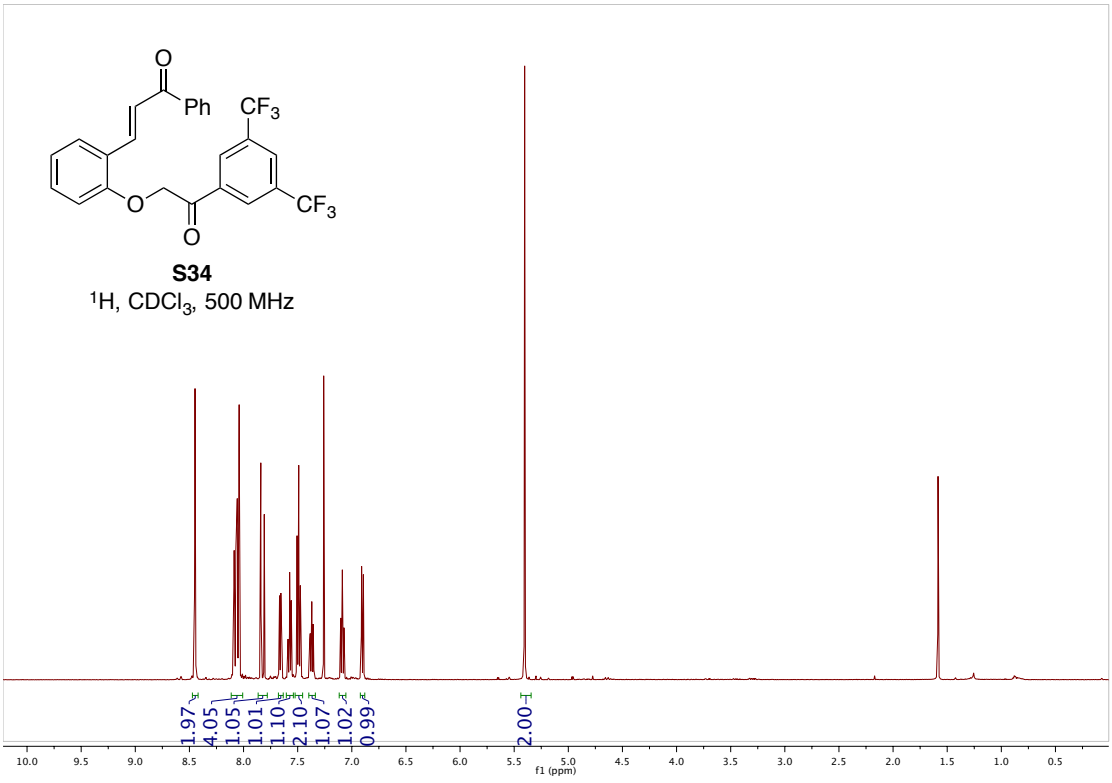
S33

^{1}H, $CDCl_3$, 500 MHz



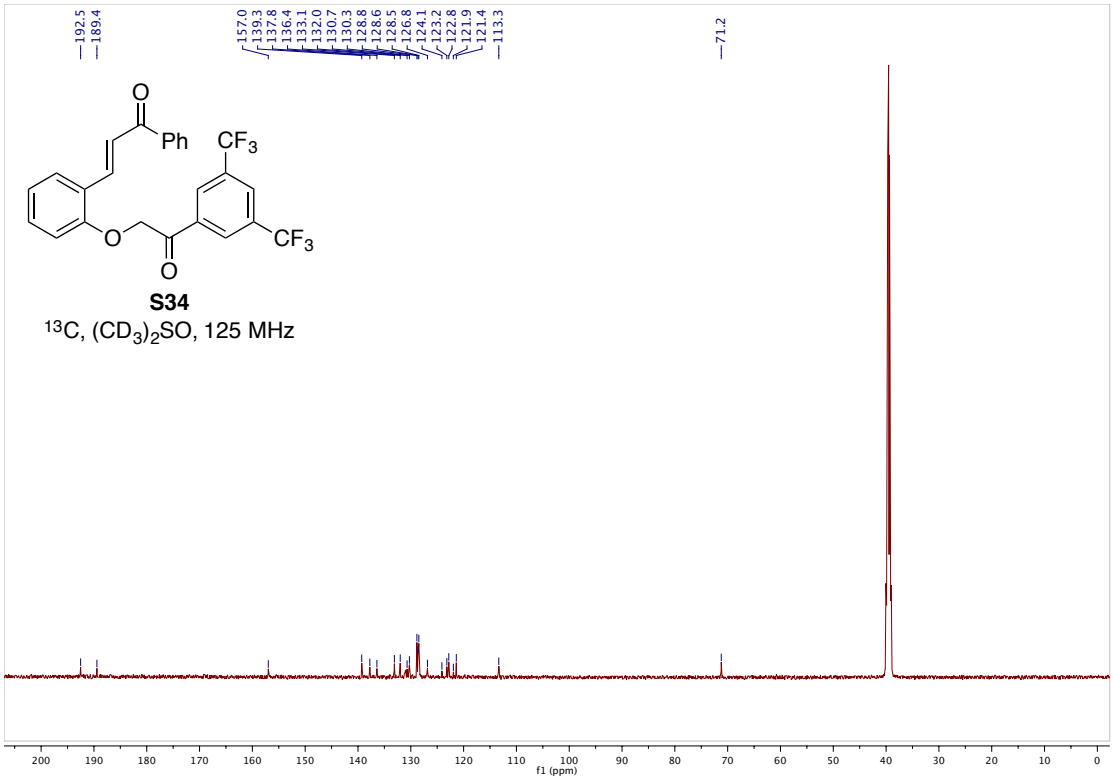
S33

^{13}C, $CDCl_3$, 125 MHz



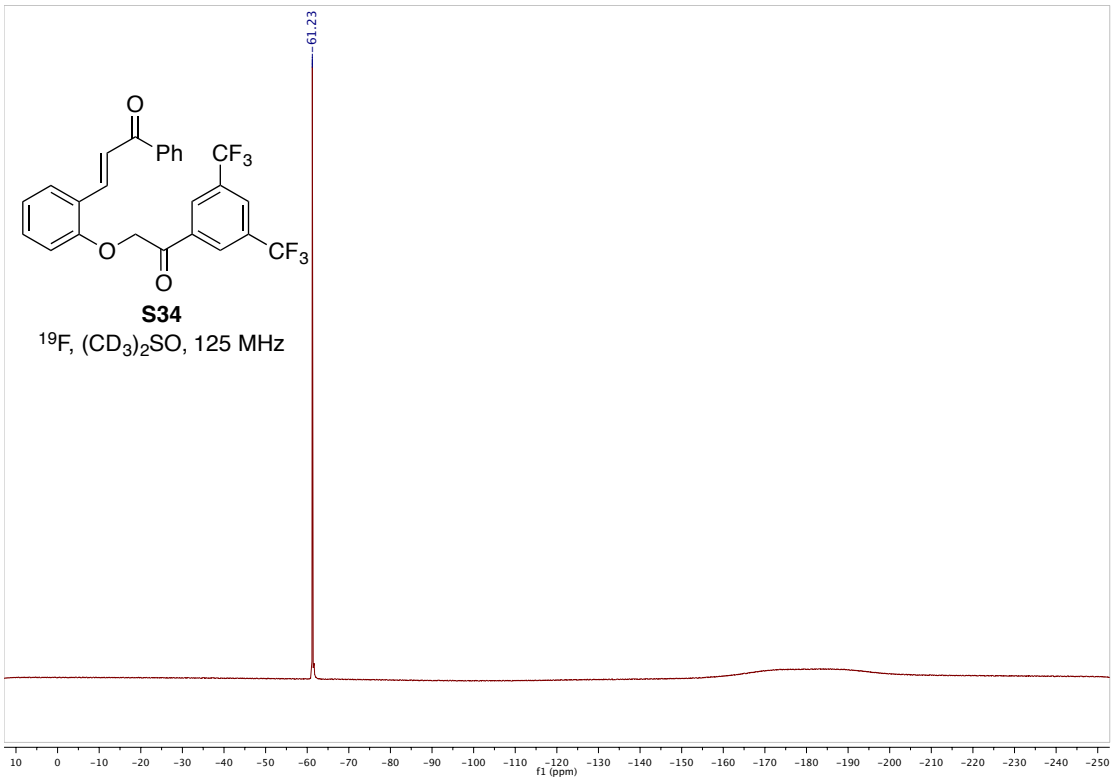
S34

^{1}H, $CDCl_3$, 500 MHz



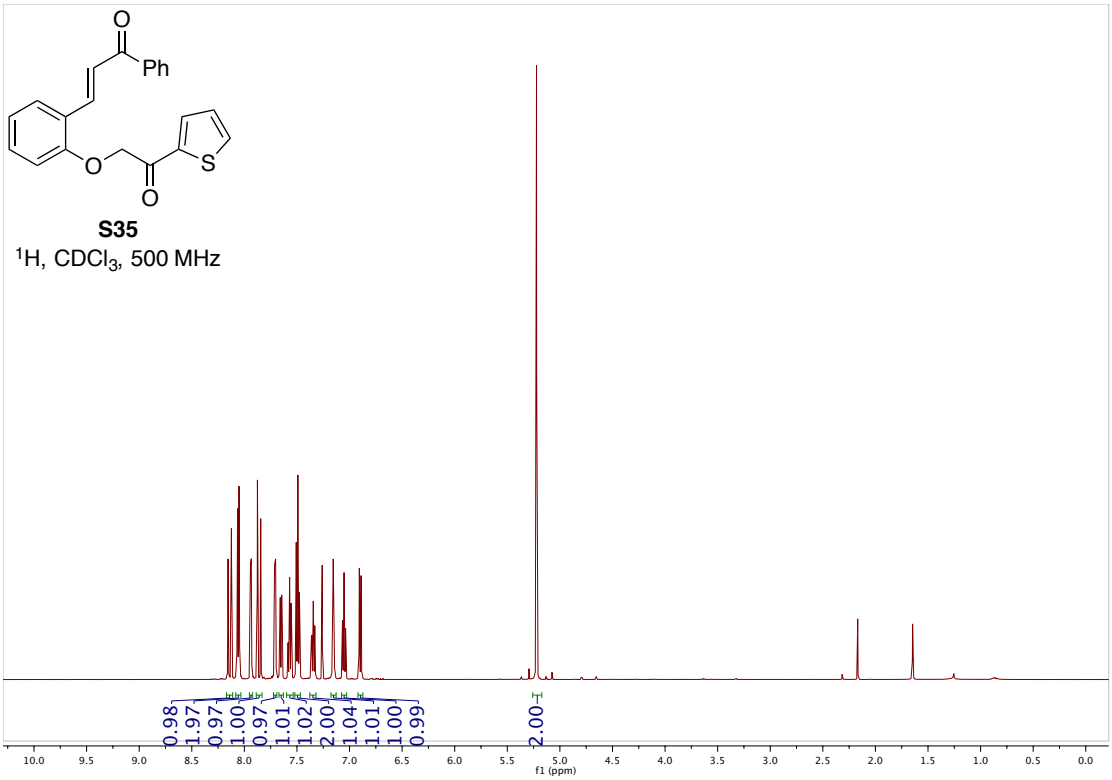
S34

^{13}C, $(CD_3)_2SO$, 125 MHz



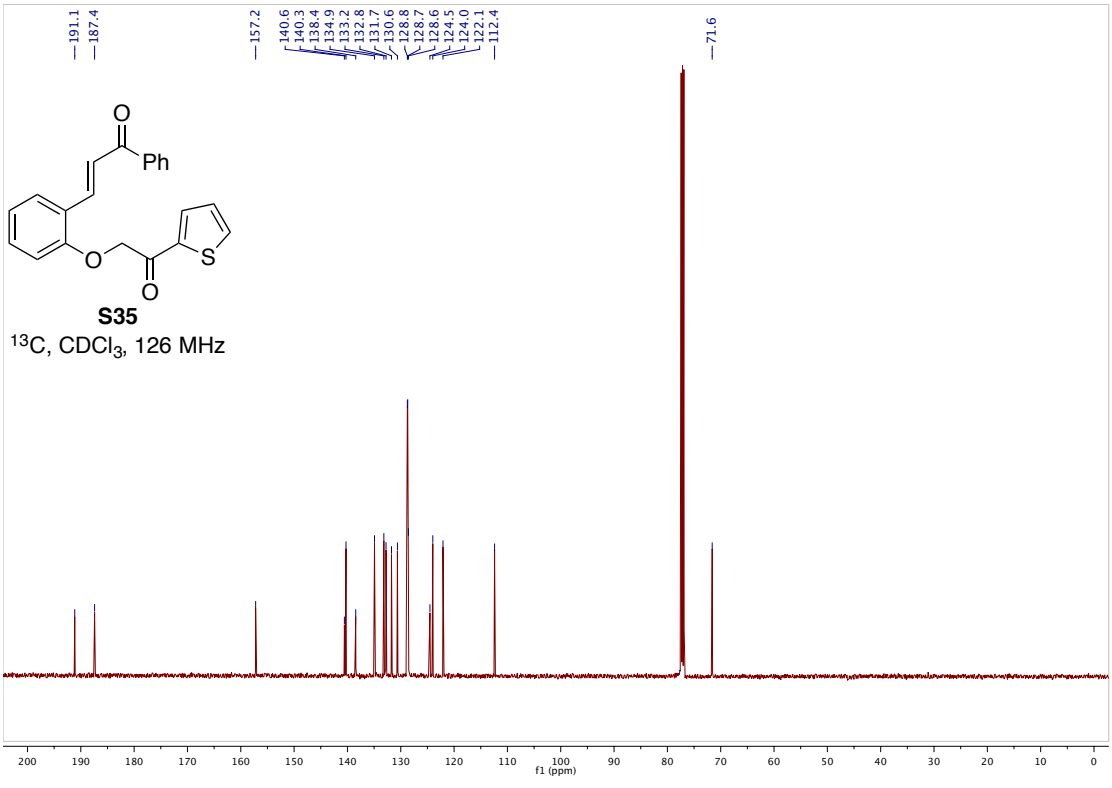
S34

^{19}F, $(CD_3)_2SO$, 125 MHz



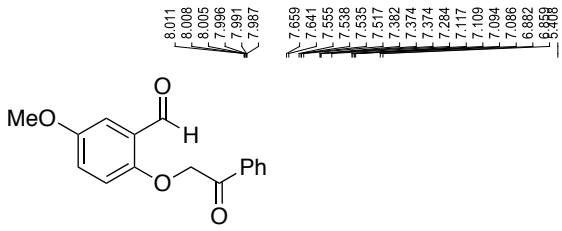
S35

^{1}H, $CDCl_3$, 500 MHz



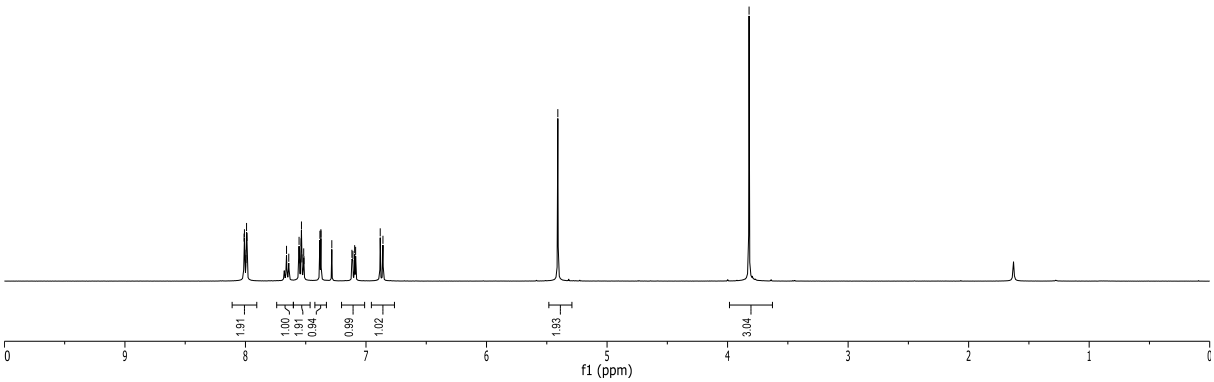
S35

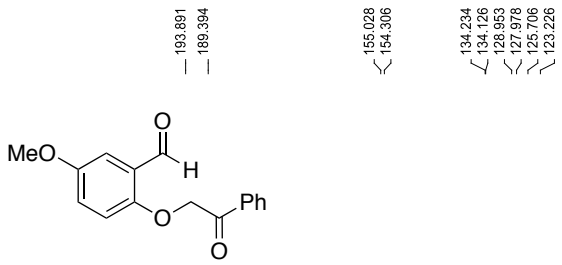
^{13}C, $CDCl_3$, 126 MHz



S36

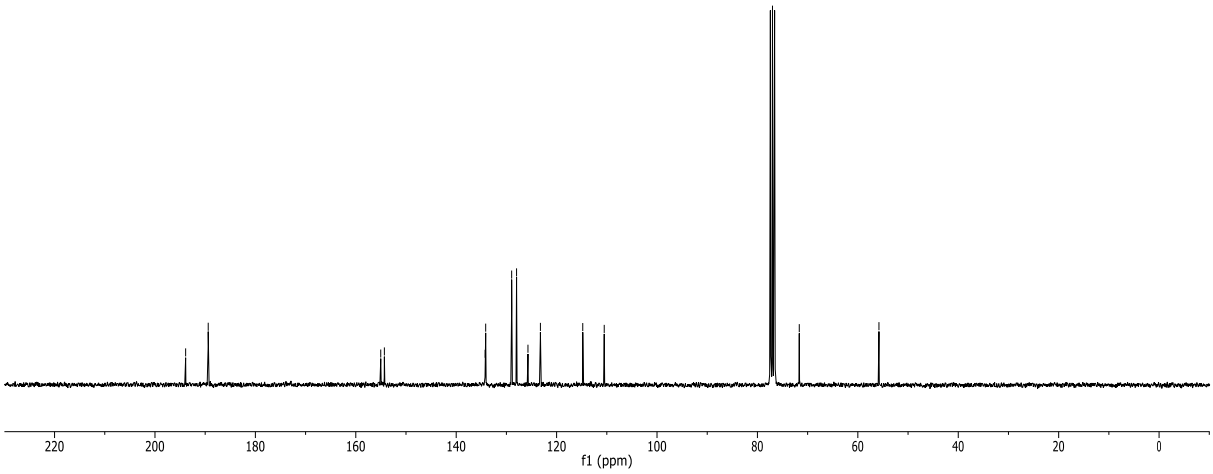
^{1}H, $CDCl_3$, 400 MHz

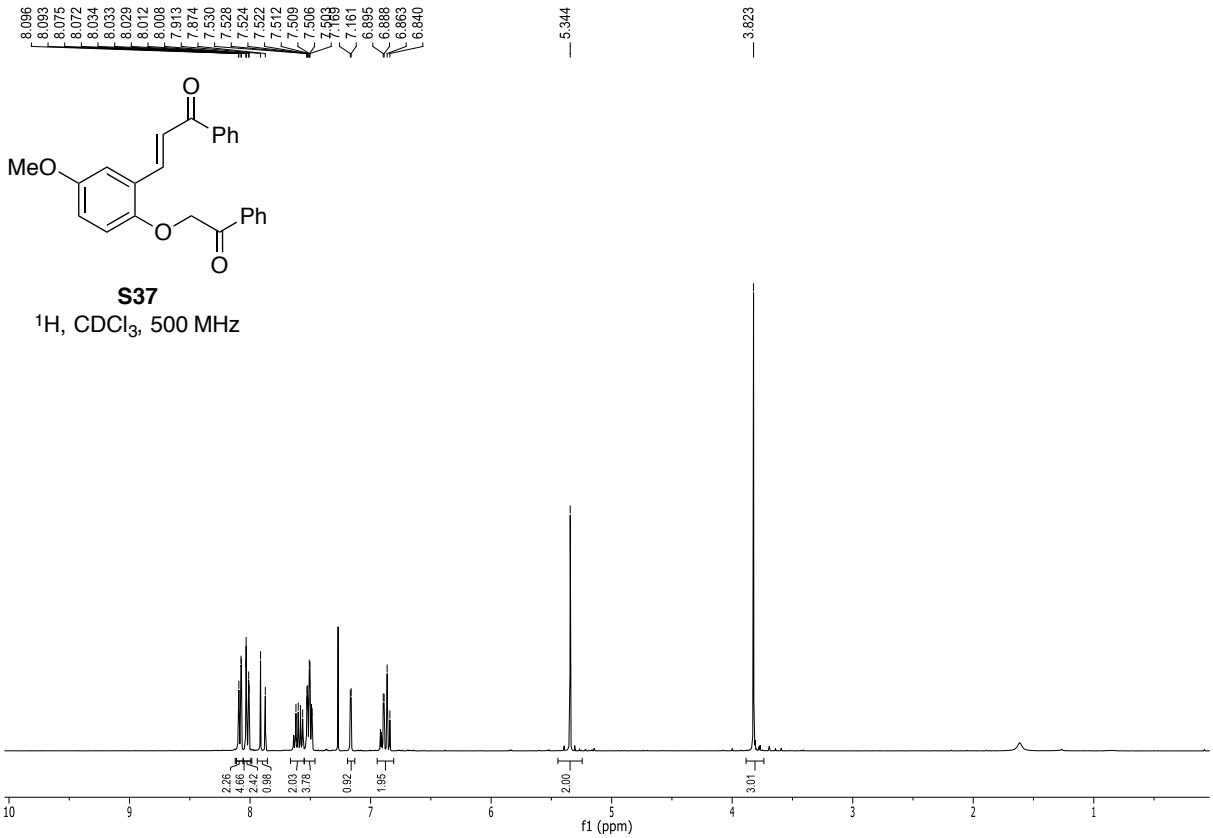




S36

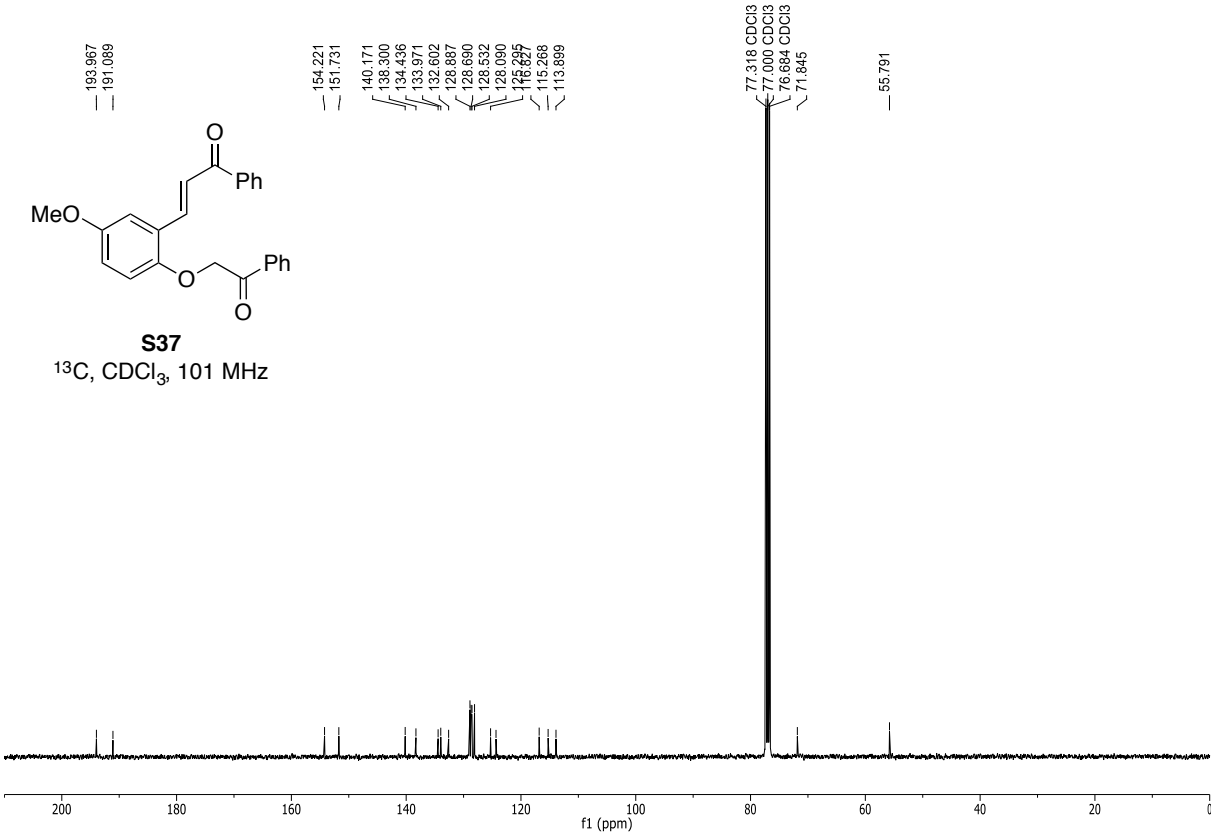
^{13}C, $CDCl_3$, 75 MHz





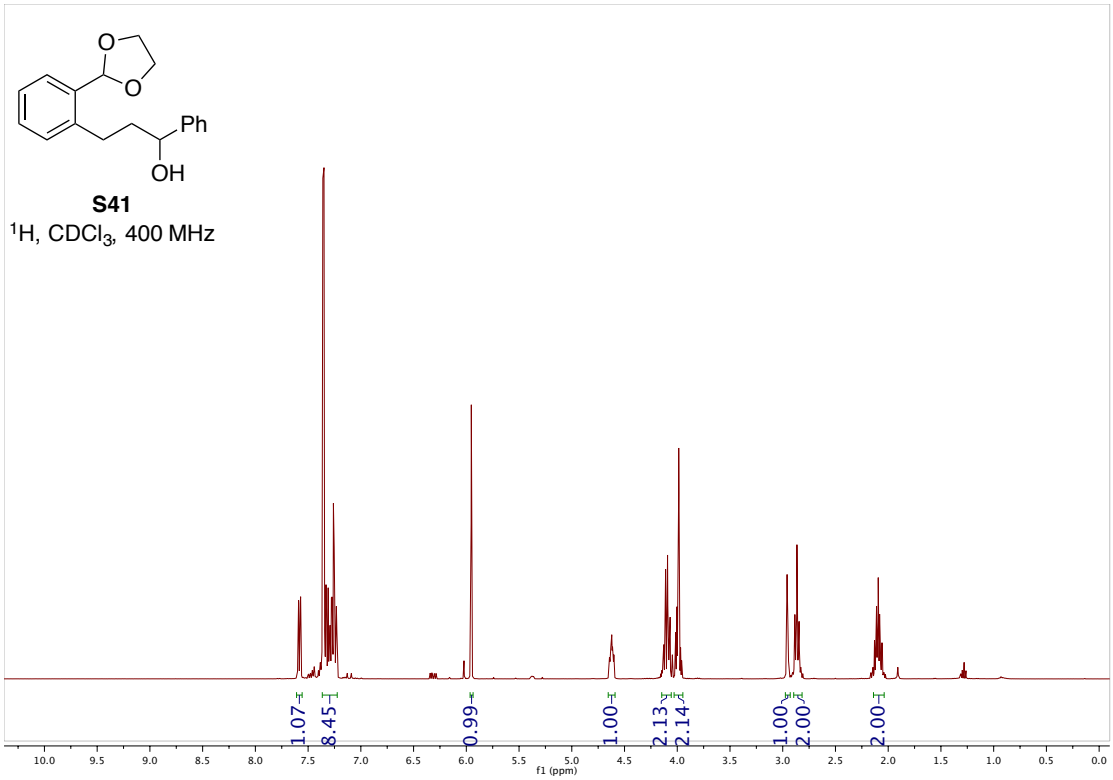
S37

^{1}H, $CDCl_3$, 500 MHz



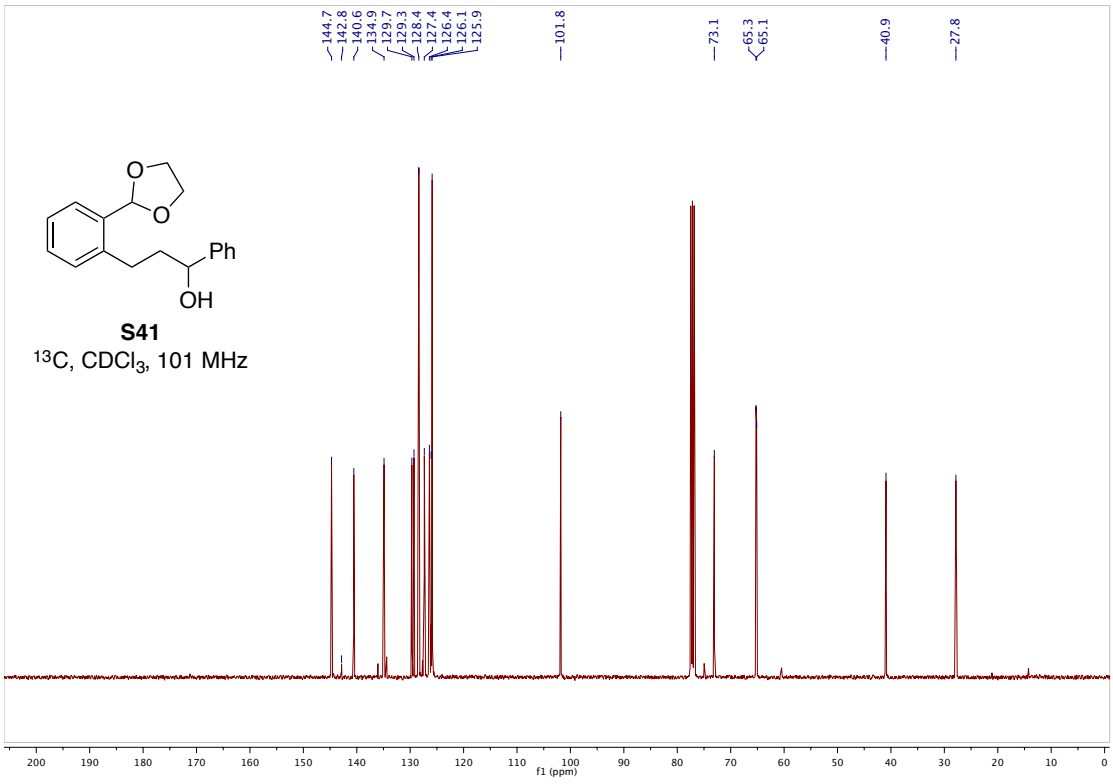
S37

^{13}C, $CDCl_3$, 101 MHz



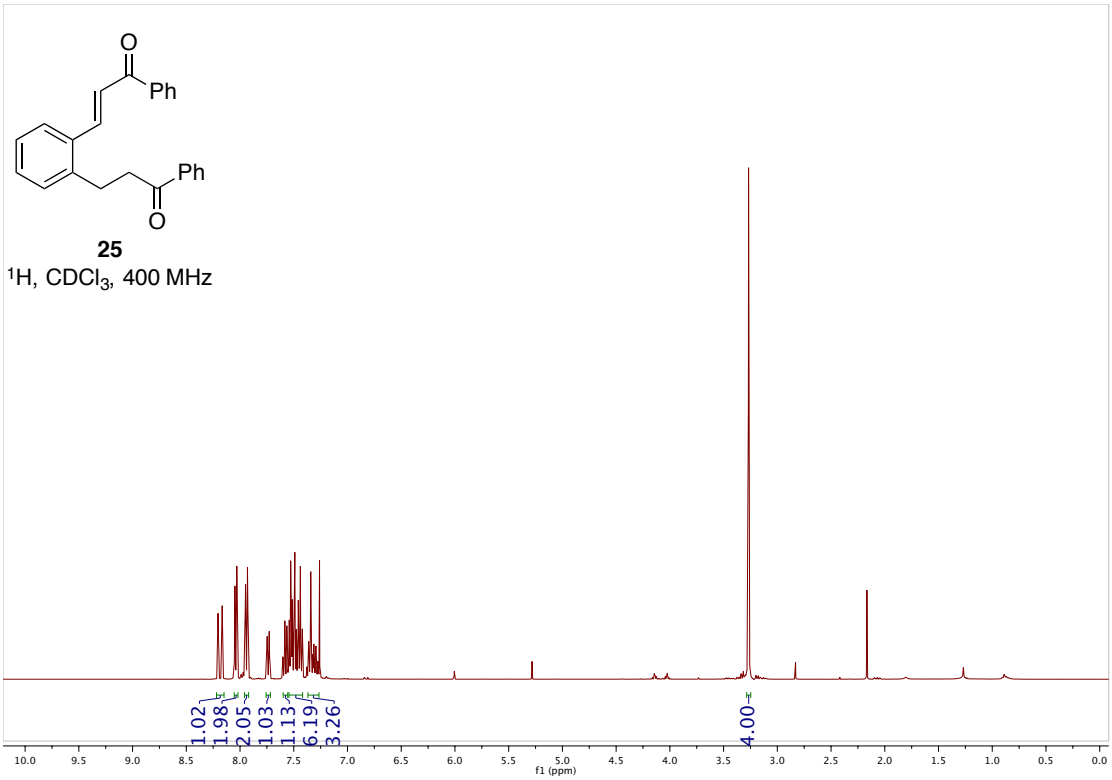
S41

^{1}H, $CDCl_3$, 400 MHz



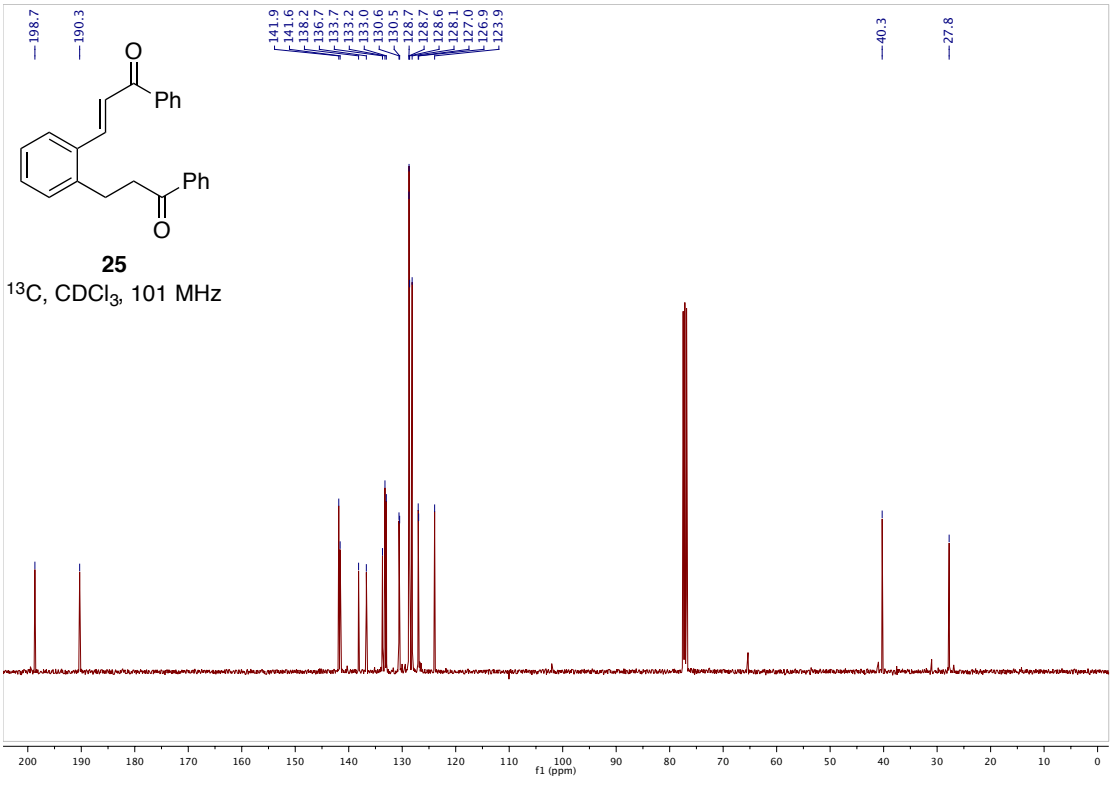
S41

^{13}C, $CDCl_3$, 101 MHz



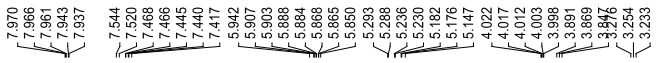
25

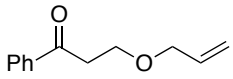
^{1}H, $CDCl_3$, 400 MHz



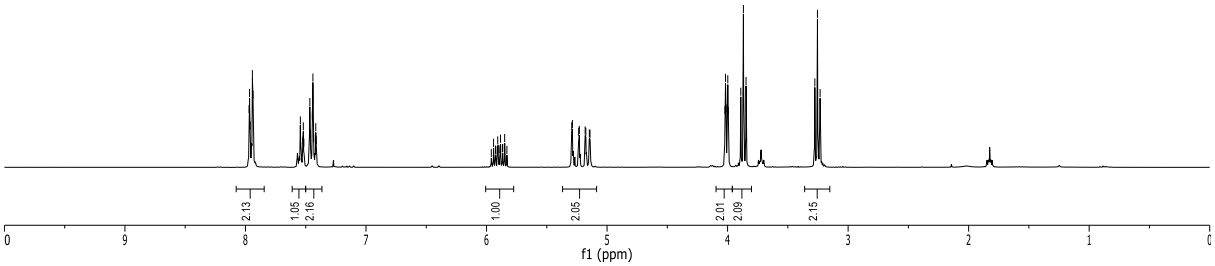
25

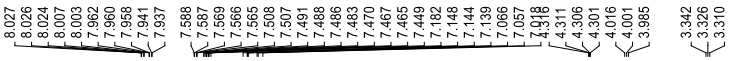
^{13}C, $CDCl_3$, 101 MHz

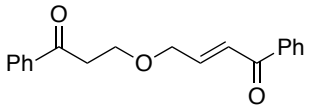




^{1}H, $CDCl_3$, 300 MHz

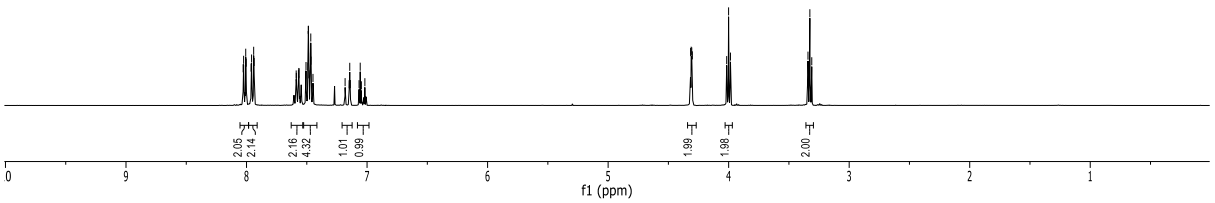


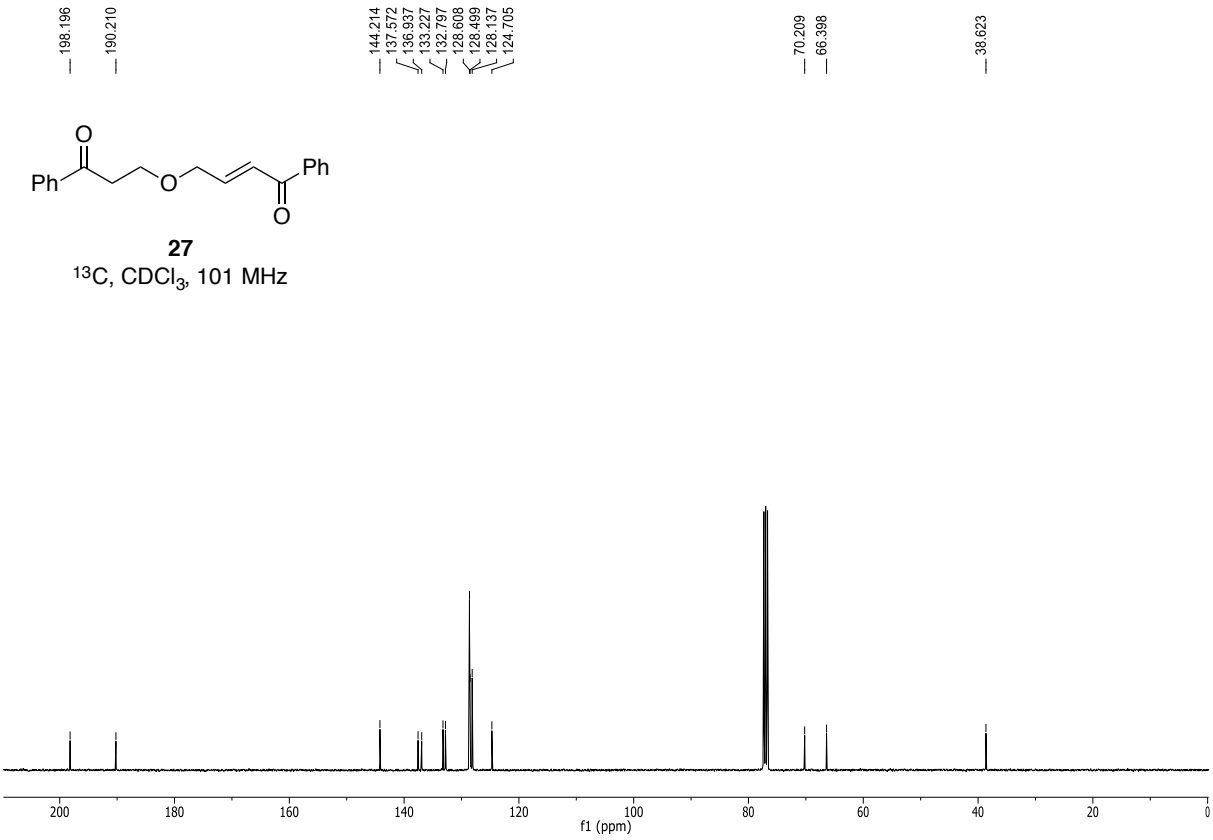




27

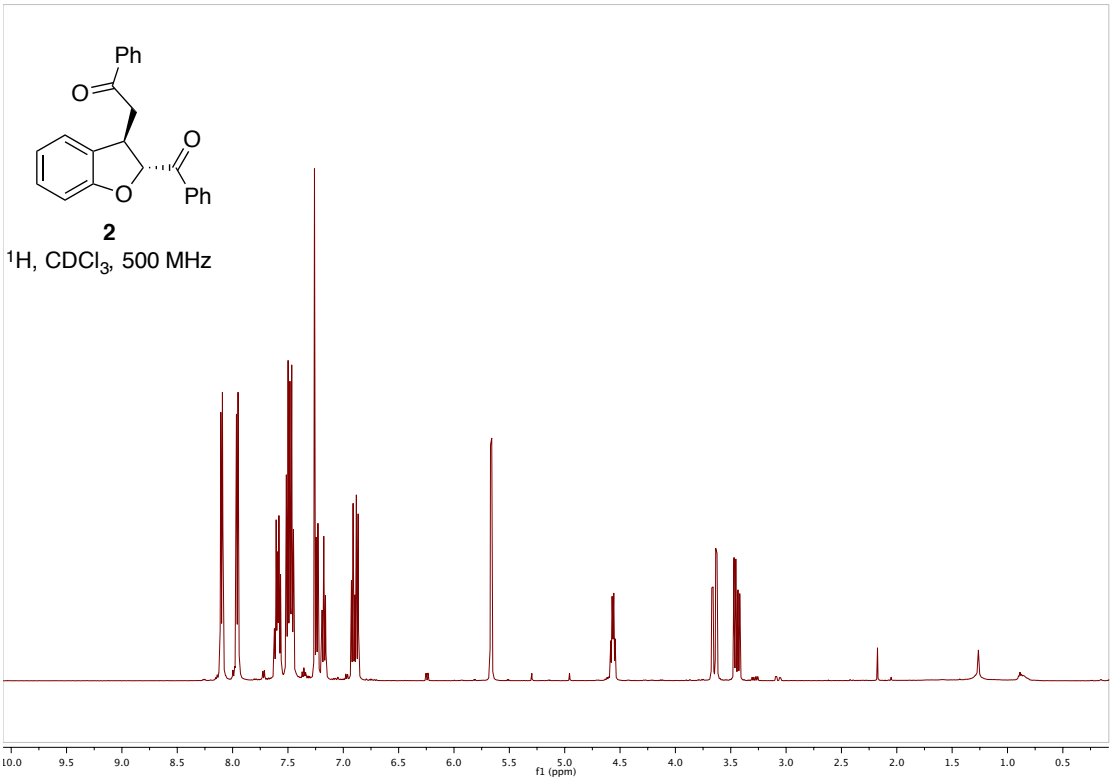
^{1}H, $CDCl_3$, 400 MHz





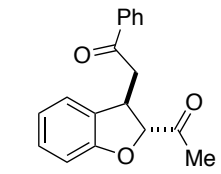
27

^{13}C, $CDCl_3$, 101 MHz



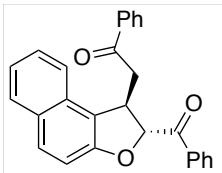
2

^{1}H, $CDCl_3$, 500 MHz



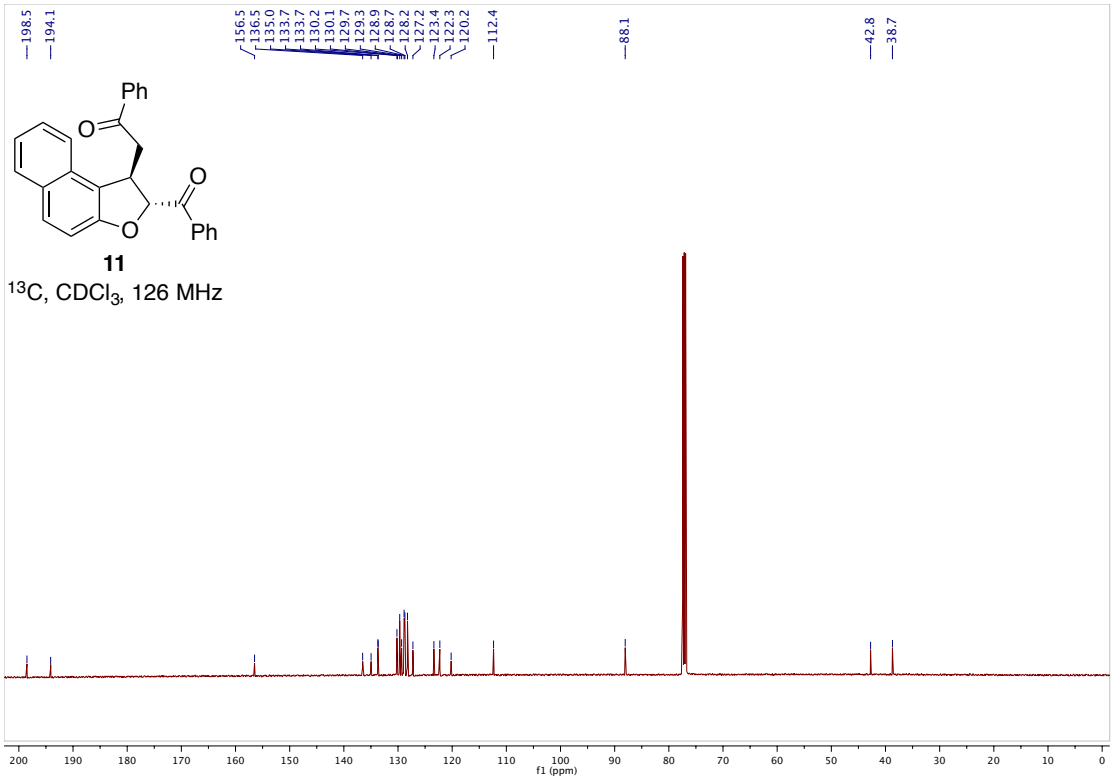
10

^{1}H, $CDCl_3$, 500 MHz



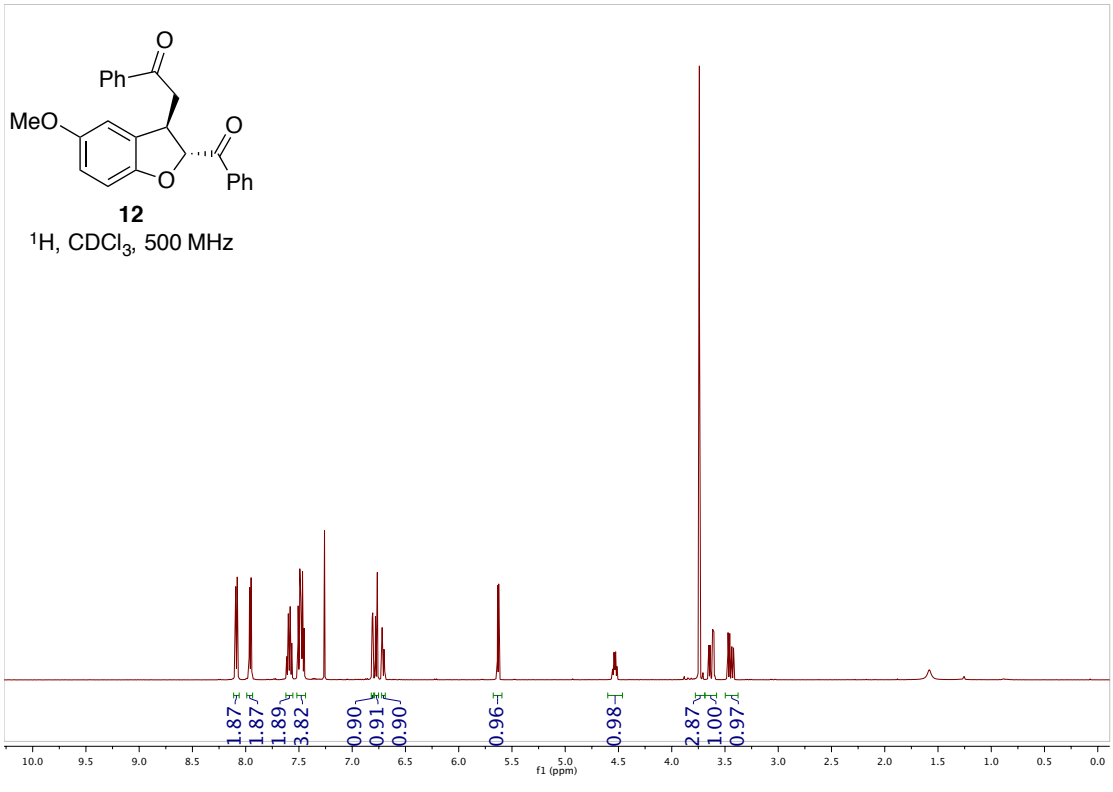
11

^{1}H, $CDCl_3$, 500 MHz



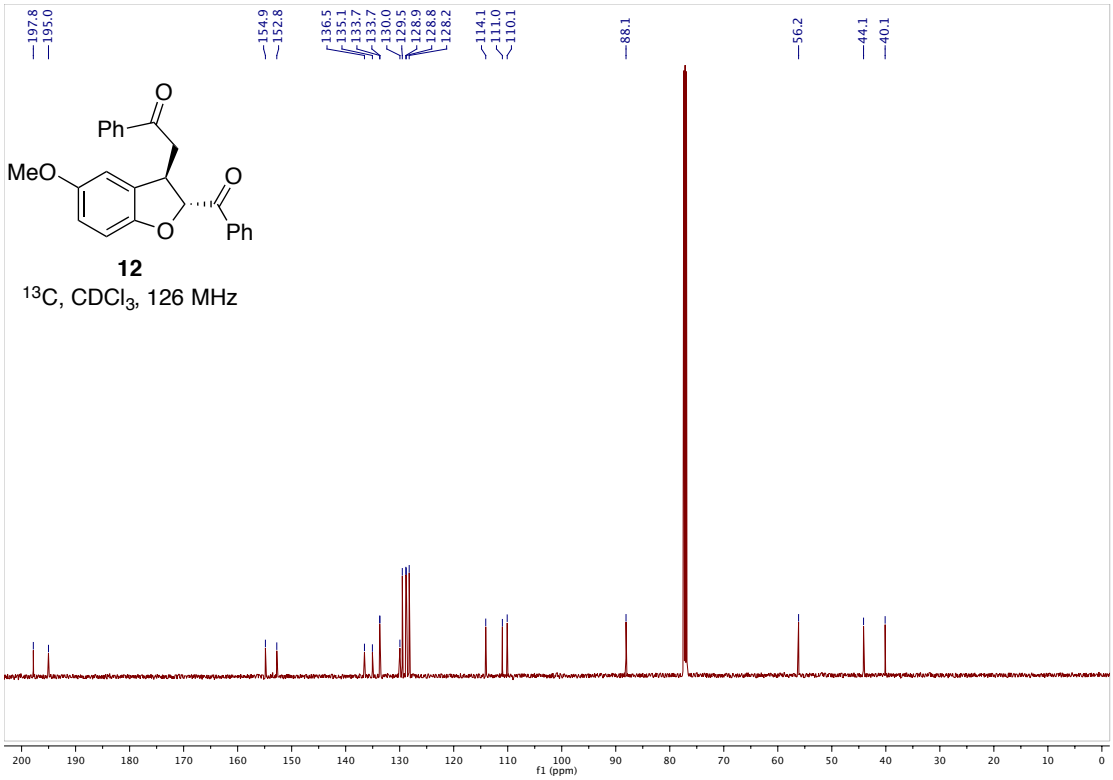
11

^{13}C, $CDCl_3$, 126 MHz



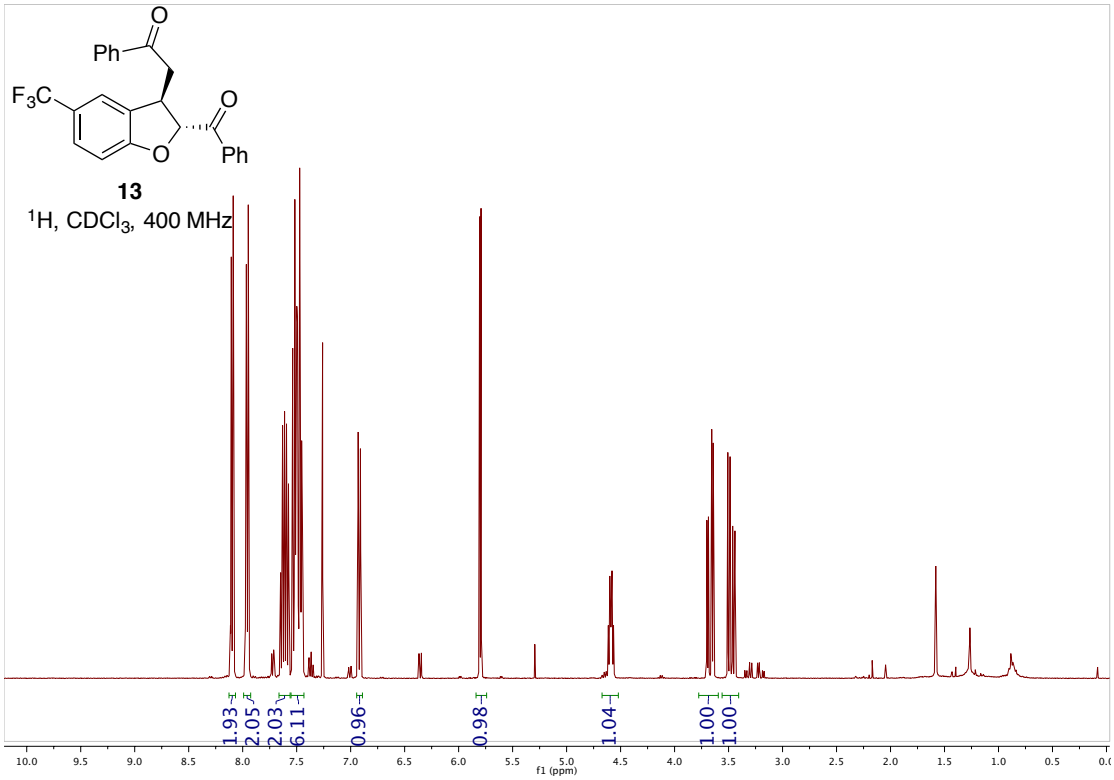
12

^{1}H, $CDCl_3$, 500 MHz



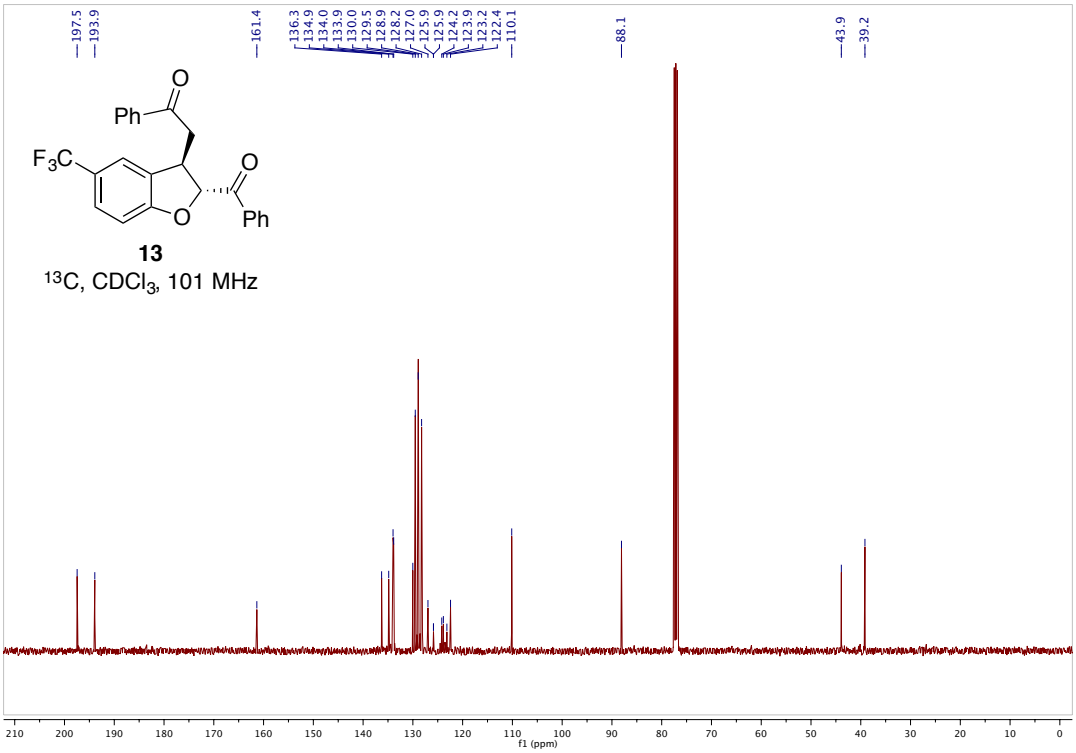
12

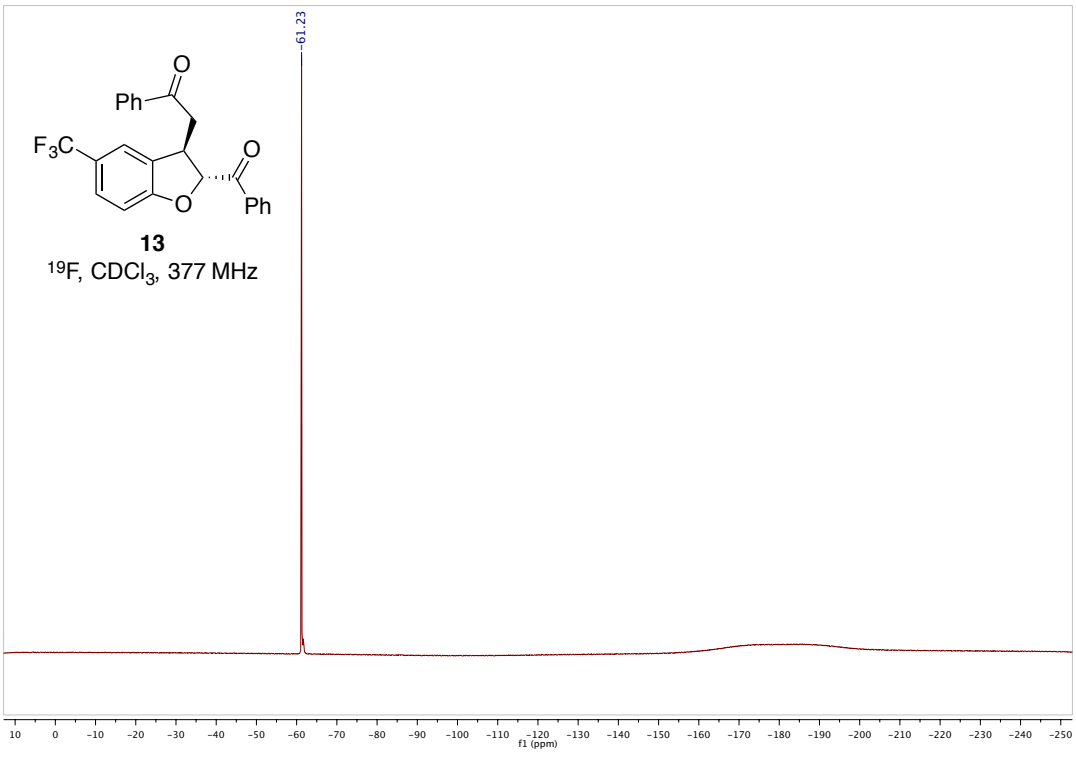
^{13}C, $CDCl_3$, 126 MHz

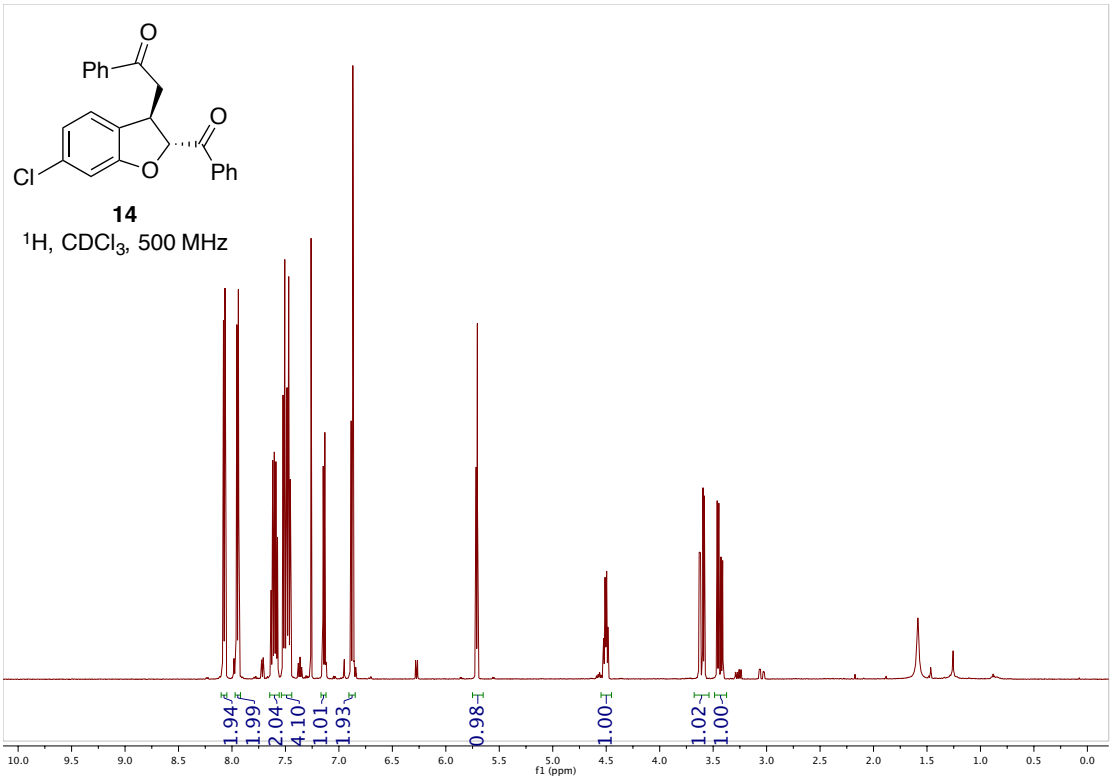


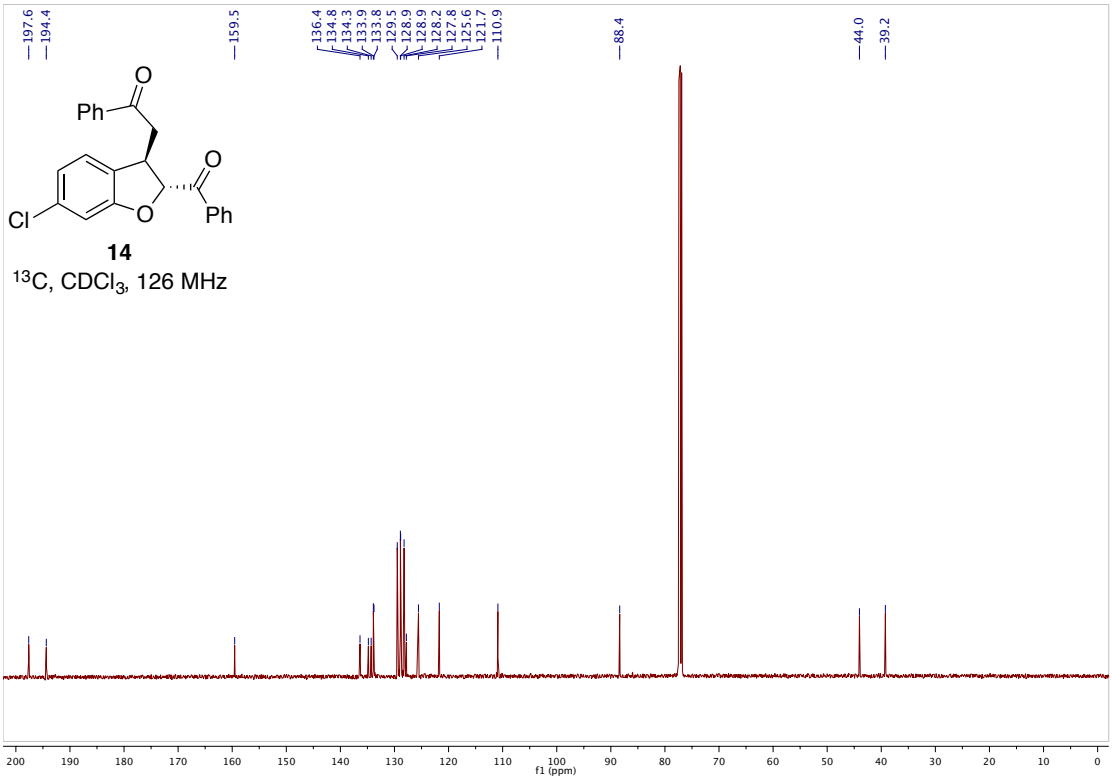
13

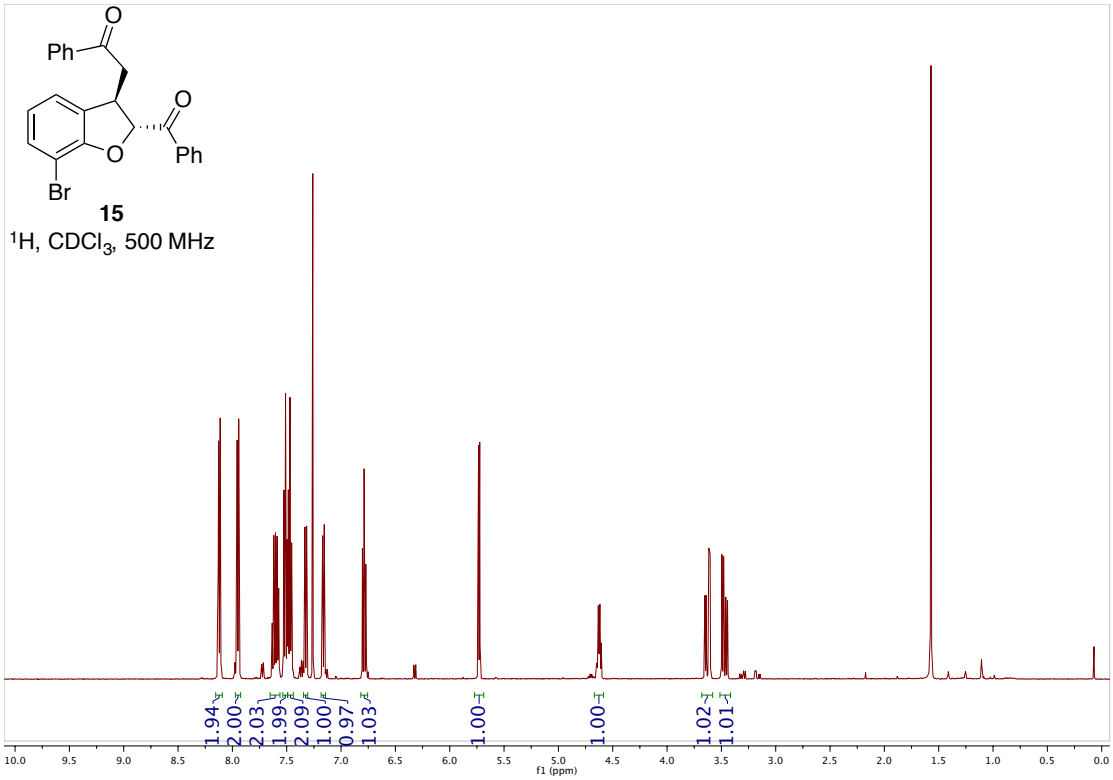
^{1}H, $CDCl_3$, 400 MHz

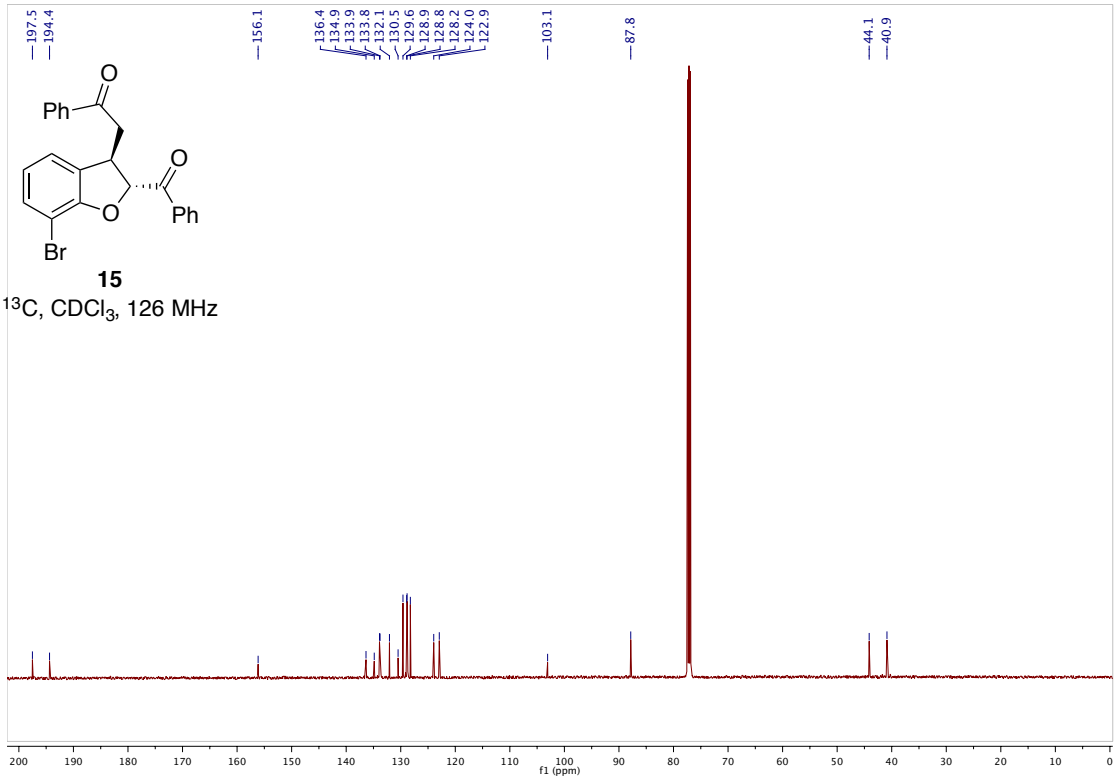

197.5
193.9
161.4
136.3
134.9
134.0
133.9
130.0
129.5
128.9
128.2
127.0
125.9
125.9
124.2
123.9
123.2
122.4
110.1
88.1
43.9
39.2
Ph
O
F3C
O
O
Ph
13
13C, CDCl3, 101 MHz
f1 (ppm)

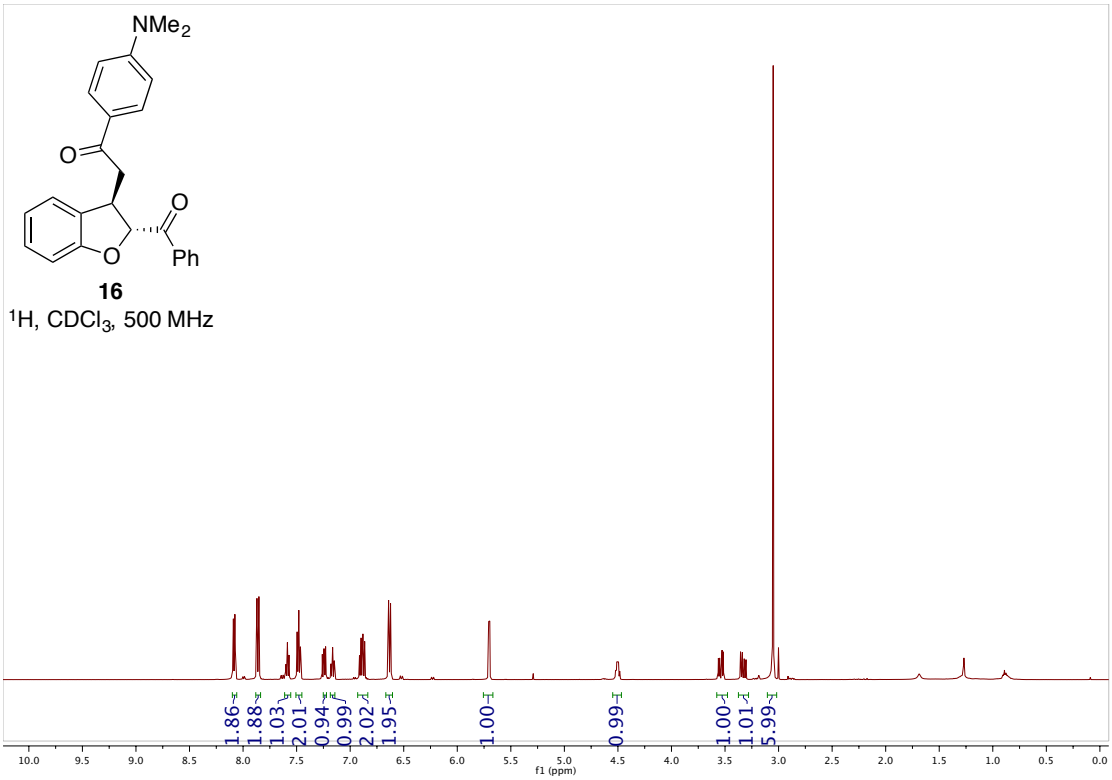

61.23
Ph
O
F3C
O
O
Ph
13
19F, CDCl3, 377 MHz
f1 (ppm)

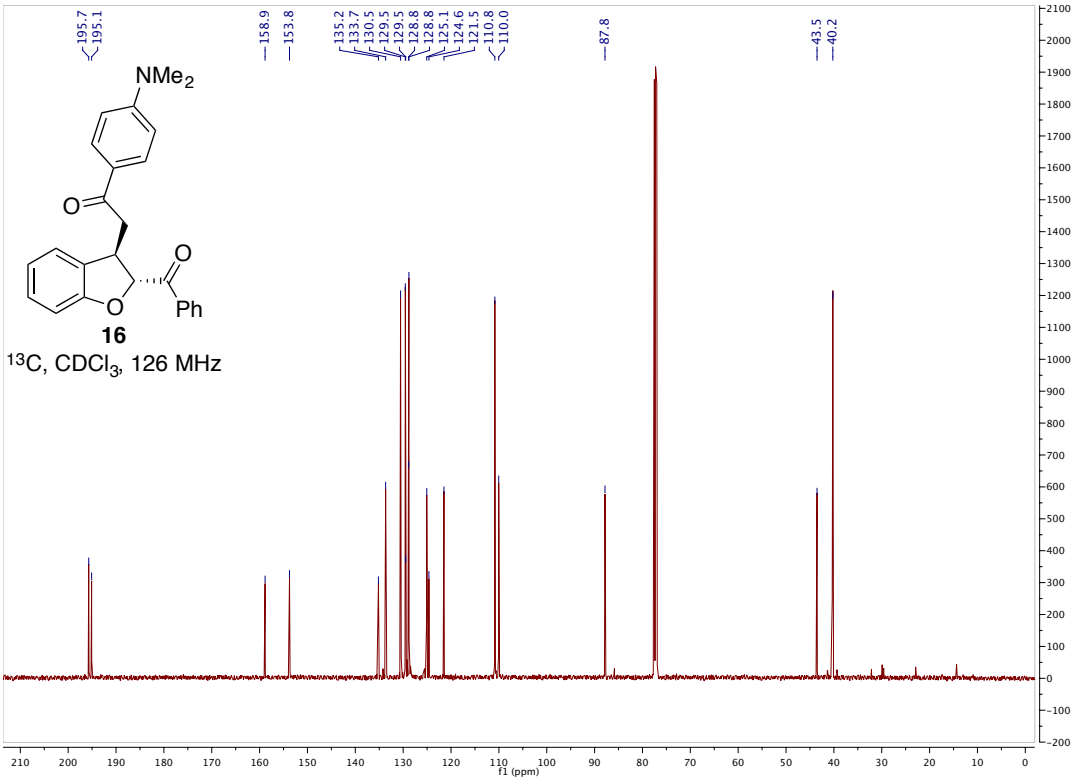

Ph
O
O
Cl
O
Ph
14
1H, CDCl3, 500 MHz
1.94
1.99
2.04
4.10
1.01
1.93
0.98
1.00
1.02
1.00
f1 (ppm)

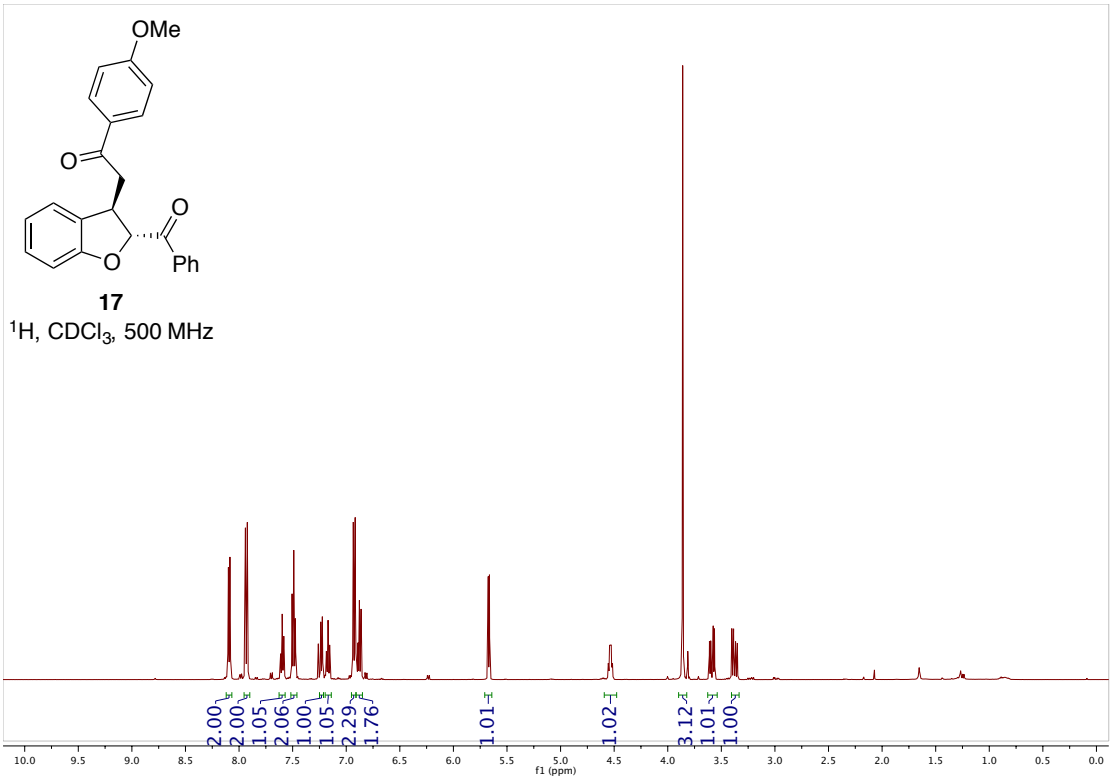

197.6
194.4
159.5
136.4
134.8
134.3
133.9
133.8
129.5
128.9
128.9
128.2
127.8
125.6
121.7
110.9
88.4
44.0
39.2
Ph
O
O
Cl
O
Ph
14
13C, CDCl3, 126 MHz
f1 (ppm)

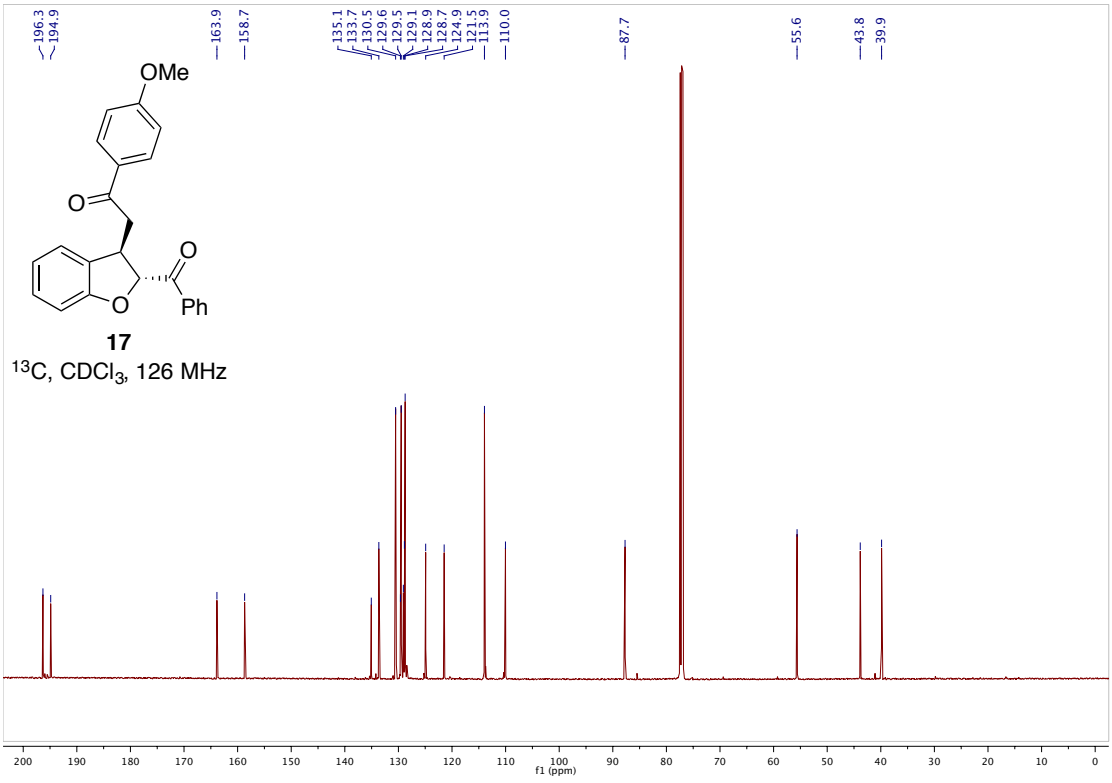

Ph
O
O
O
Ph
Br
15
1H, CDCl3, 500 MHz
1.94
2.00
2.03
1.99
2.09
1.00
0.97
1.03
1.00
1.00
1.02
1.01
f1 (ppm)

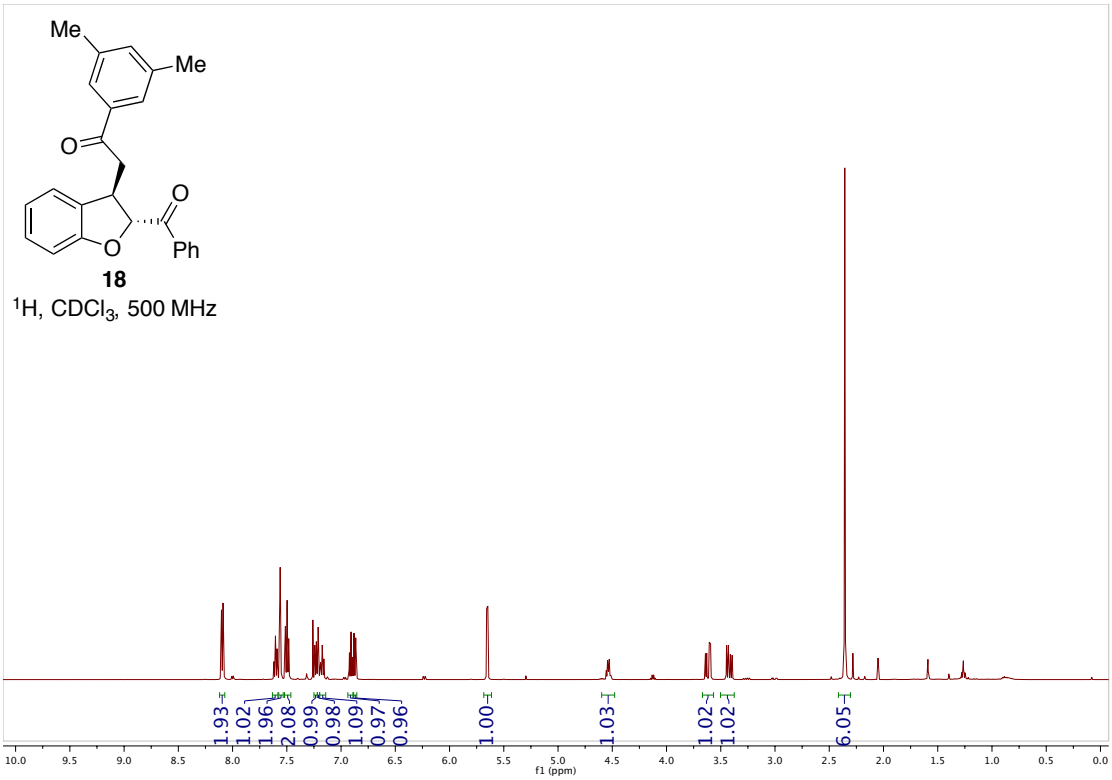

197.5
194.4
156.1
136.4
134.9
133.9
133.8
132.1
130.5
129.6
128.9
128.8
128.2
124.0
122.9
103.1
87.8
44.1
40.9
Ph
O
O
O
Ph
Br
15
13C, CDCl3, 126 MHz
f1 (ppm)

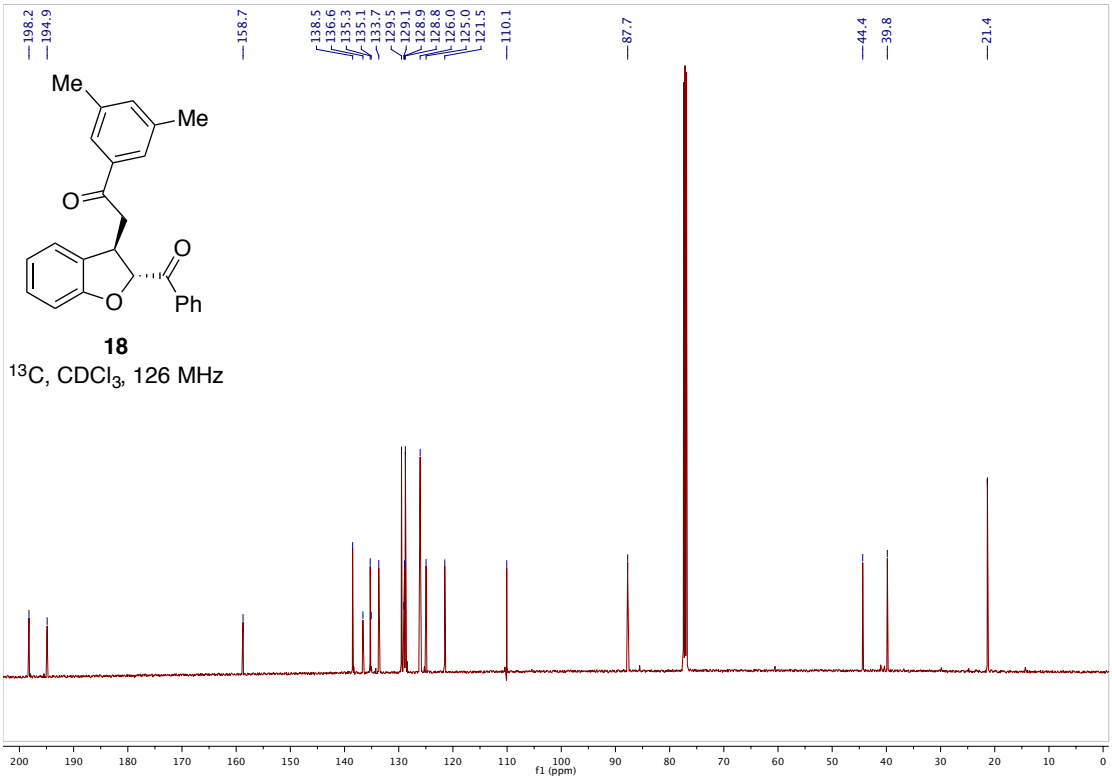

NMe2
O
O
O
Ph
16
1H, CDCl3, 500 MHz
1.86
1.88
1.03
2.01
0.94
0.99
2.02
1.95
1.00
0.99
1.00
1.01
5.99
f1 (ppm)

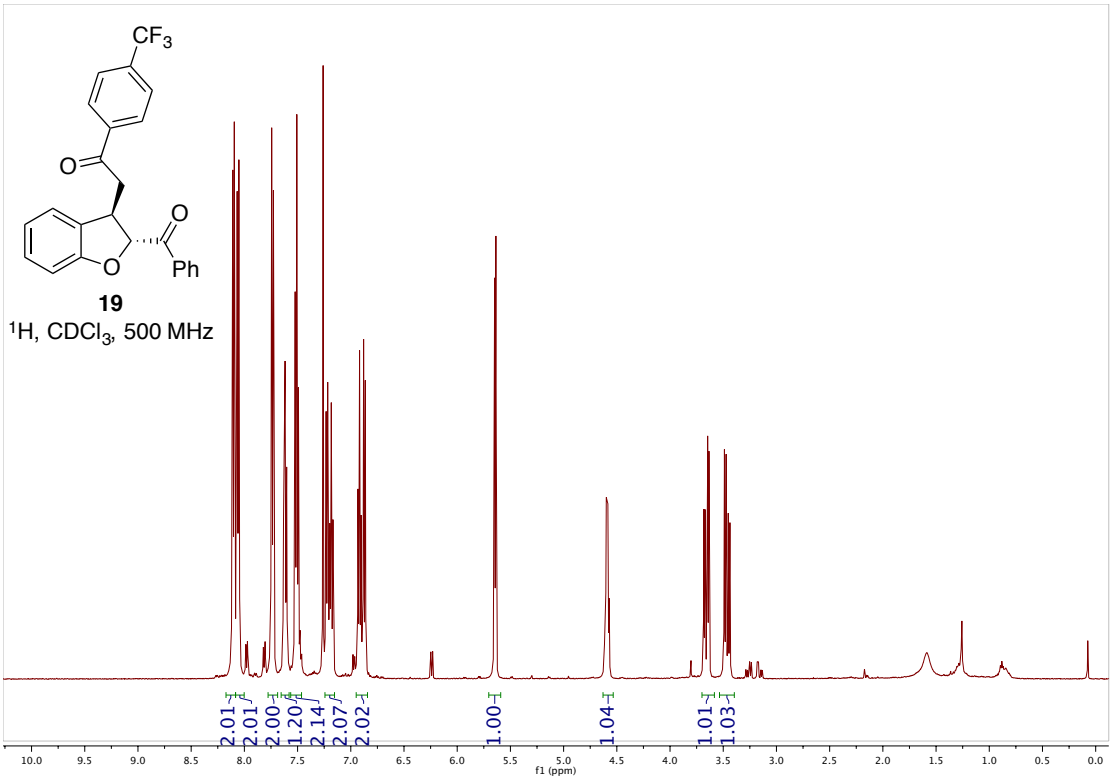

195.7
195.1
158.9
153.8
135.2
133.7
130.5
129.5
129.5
128.8
128.8
125.1
124.6
121.5
110.8
110.0
87.8
43.5
40.2
NMe2
O
O
O
Ph
16
13C, CDCl3, 126 MHz
f1 (ppm)

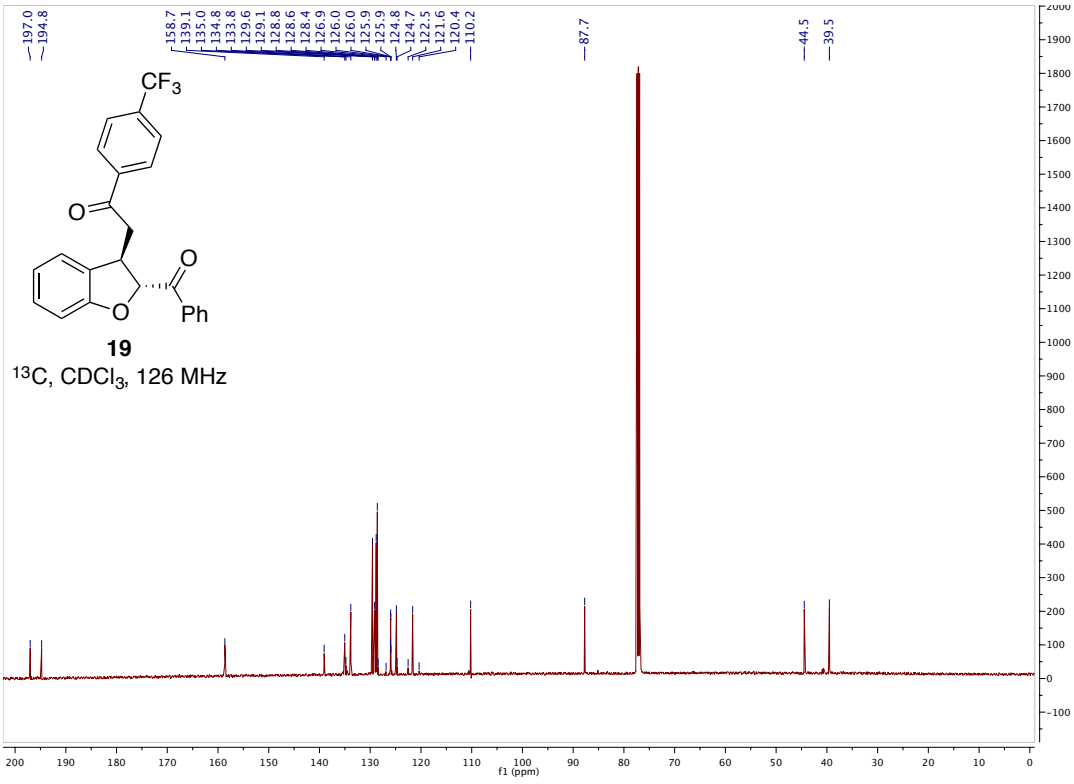

OMe
O
O
O
Ph
17
1H, CDCl3, 500 MHz
2.00
2.00
1.05
2.06
1.00
1.05
2.29
1.76
1.01
1.02
3.12
1.01
1.00
f1 (ppm)

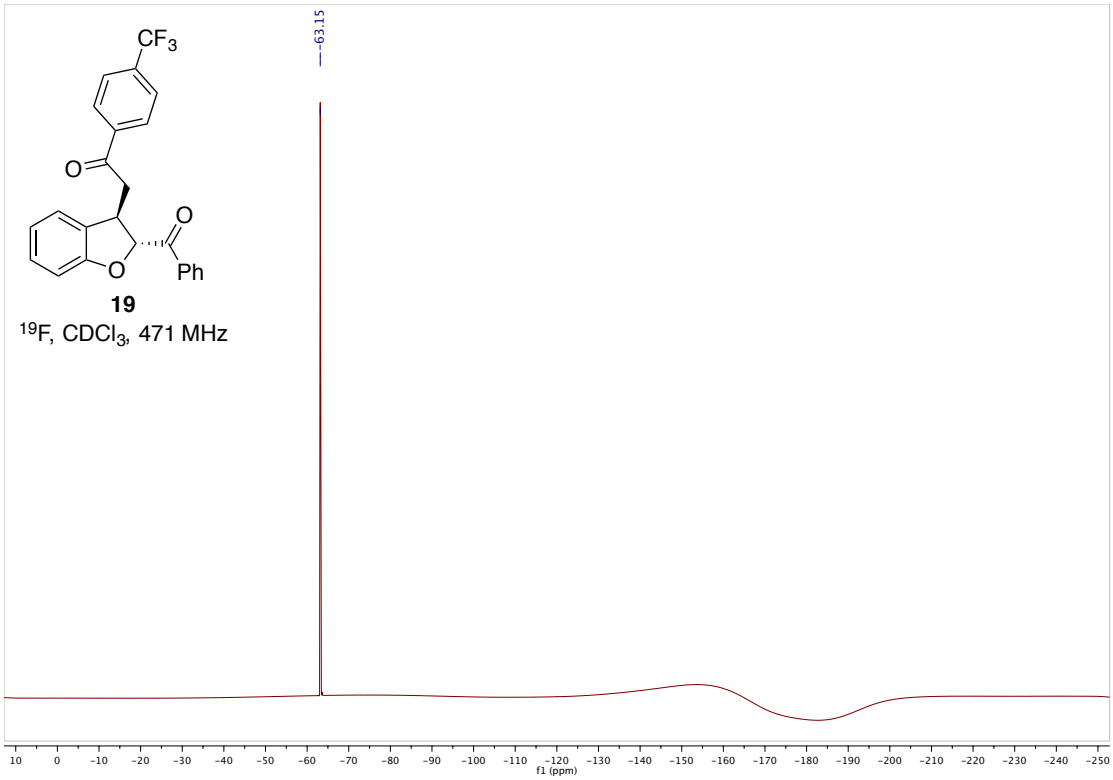

196.3
194.9
163.9
158.7
135.1
133.7
130.5
129.6
129.5
129.1
128.9
128.7
124.9
121.5
113.9
110.0
87.7
55.6
43.8
39.9
OMe
O
O
O
Ph
17
13C, CDCl3, 126 MHz
f1 (ppm)


Me
Me
O
O
O
Ph
18
1H, CDCl3, 500 MHz
1.93
1.02
1.96
2.08
0.99
0.98
1.09
0.97
0.96
1.00
1.03
1.02
1.02
6.05
f1 (ppm)


198.2
194.9
158.7
138.5
136.6
135.3
135.1
133.7
129.5
129.1
128.9
128.8
126.0
125.0
121.5
110.1
87.7
44.4
39.8
21.4
Me
Me
O
O
O
Ph
18
13C, CDCl3, 126 MHz
f1 (ppm)

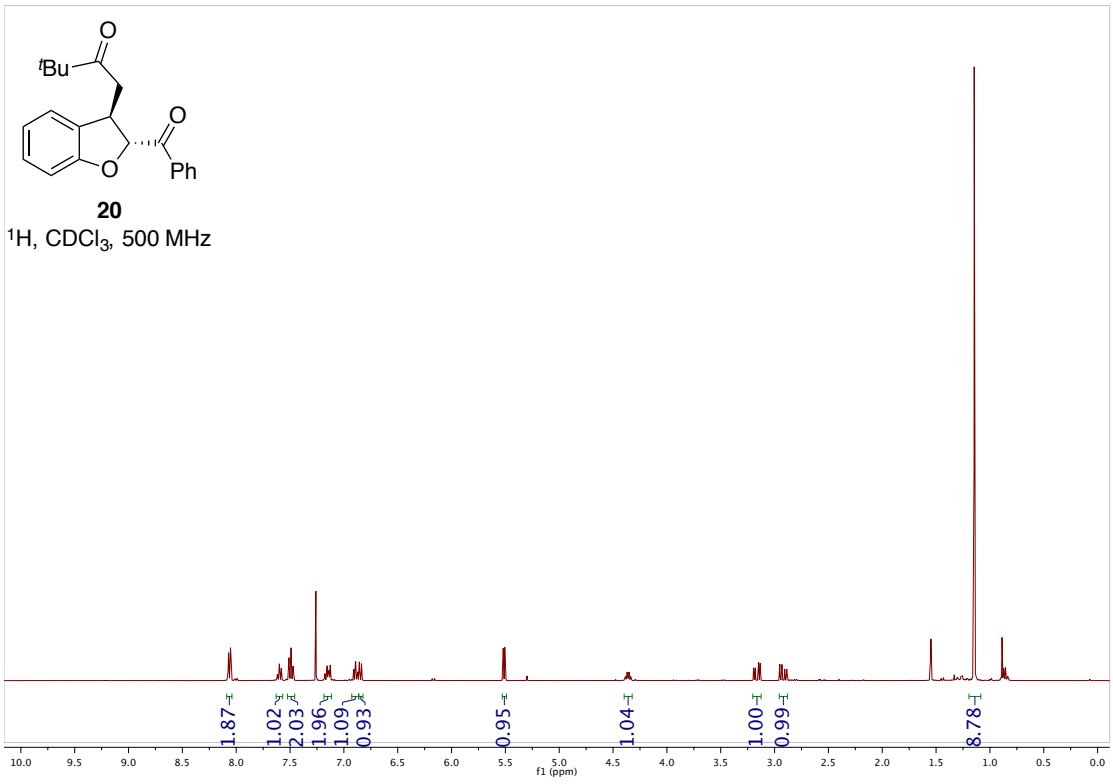

CF3
O
O
O
Ph
19
1H, CDCl3, 500 MHz
2.01
2.01
2.00
1.20
2.14
2.07
2.02
1.00
1.04
1.01
1.03
f1 (ppm)


197.0
194.8
158.7
139.1
135.0
134.8
133.8
129.6
129.1
128.8
128.6
128.4
126.9
126.0
126.0
125.9
125.9
124.8
124.7
122.5
121.6
120.4
110.2
87.7
44.5
39.5
CF3
O
O
O
Ph
19
13C, CDCl3, 126 MHz
f1 (ppm)



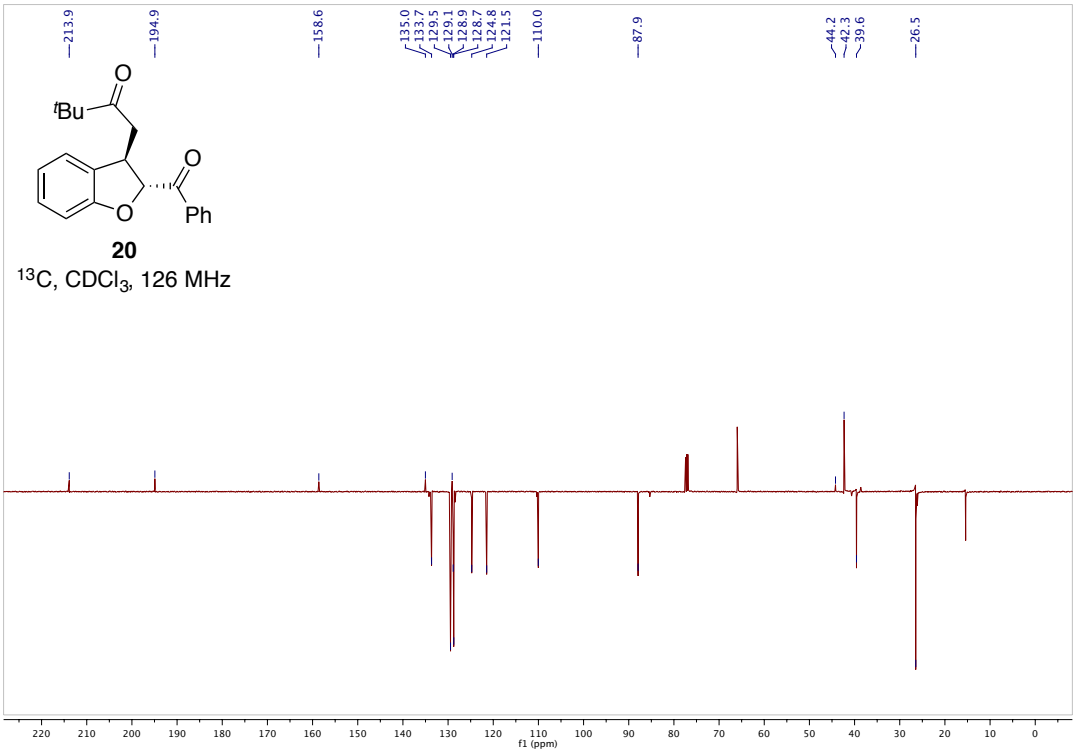
19

^{19}F, $CDCl_3$, 471 MHz



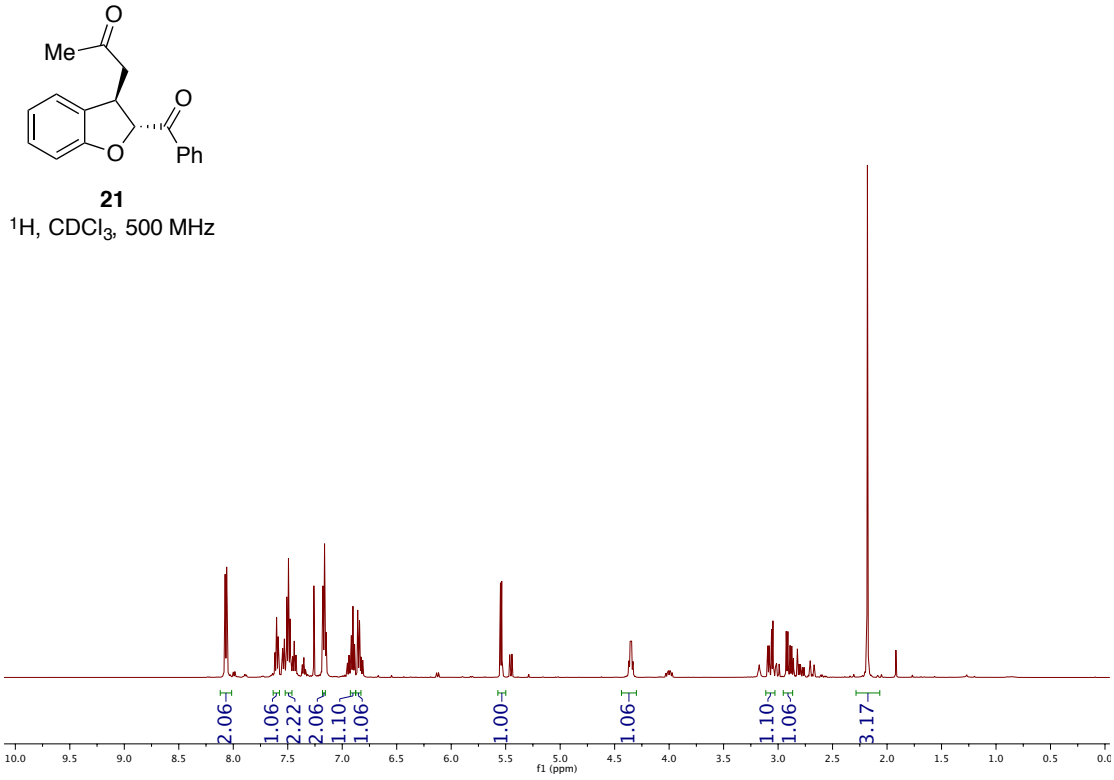
20

^{1}H, $CDCl_3$, 500 MHz



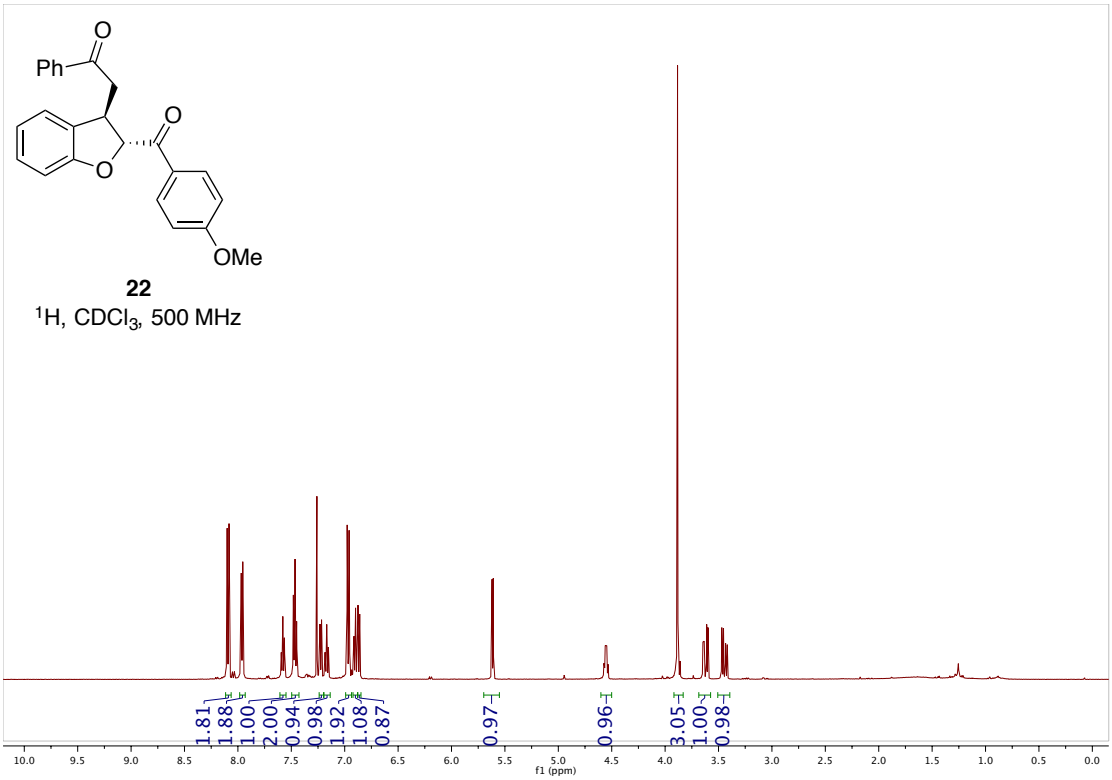
20

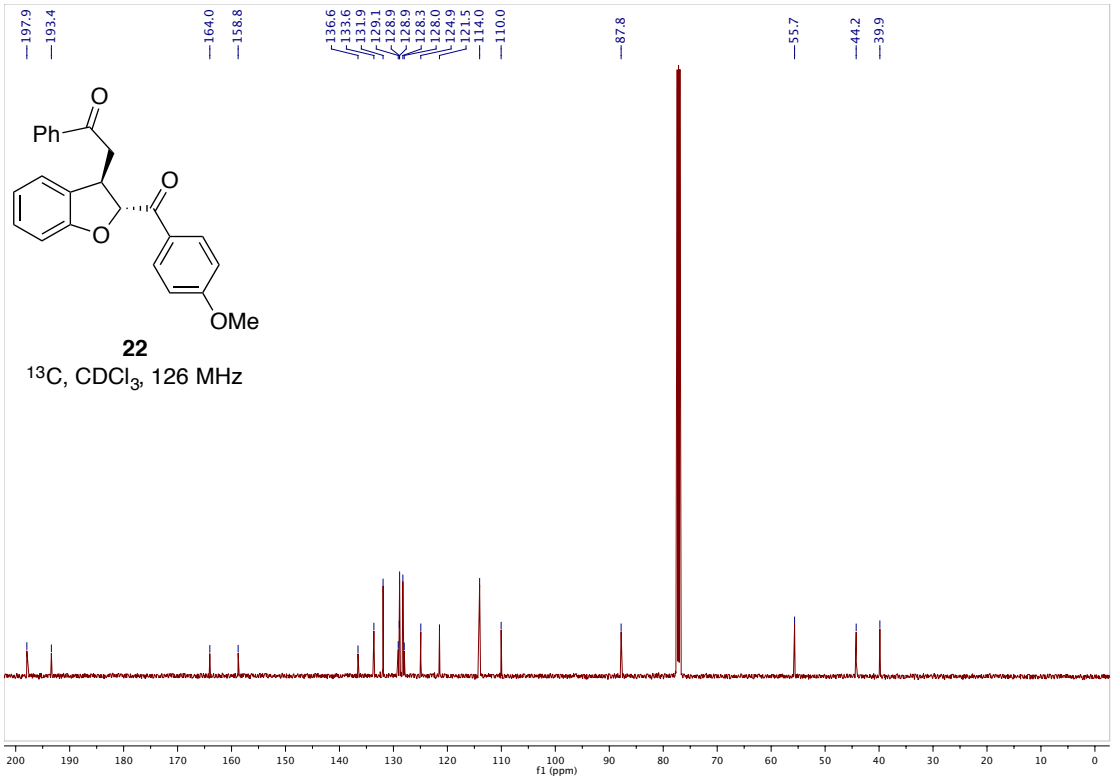
^{13}C, $CDCl_3$, 126 MHz

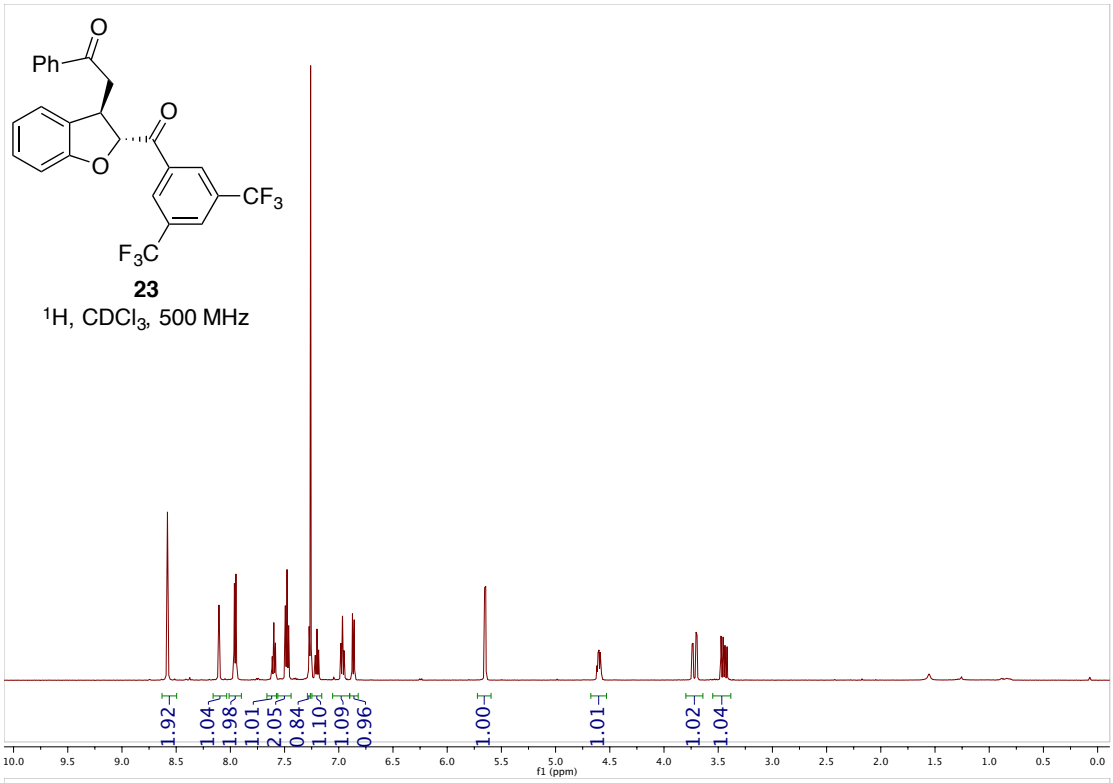


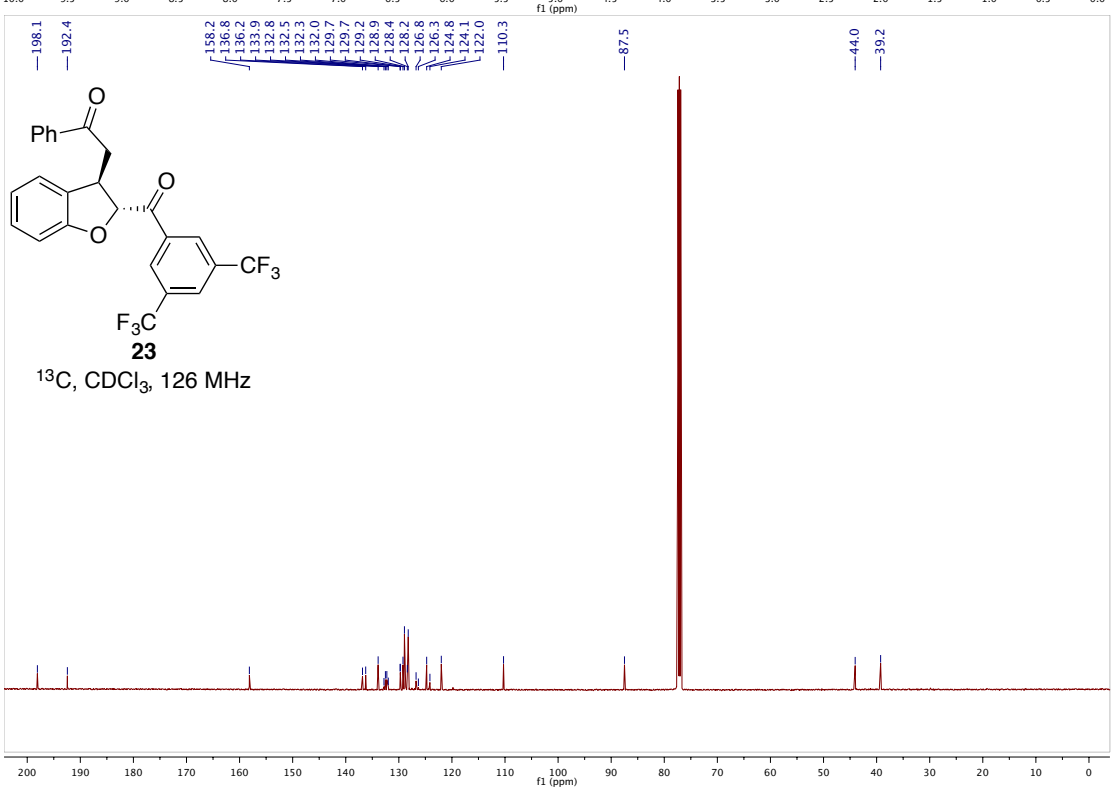
21

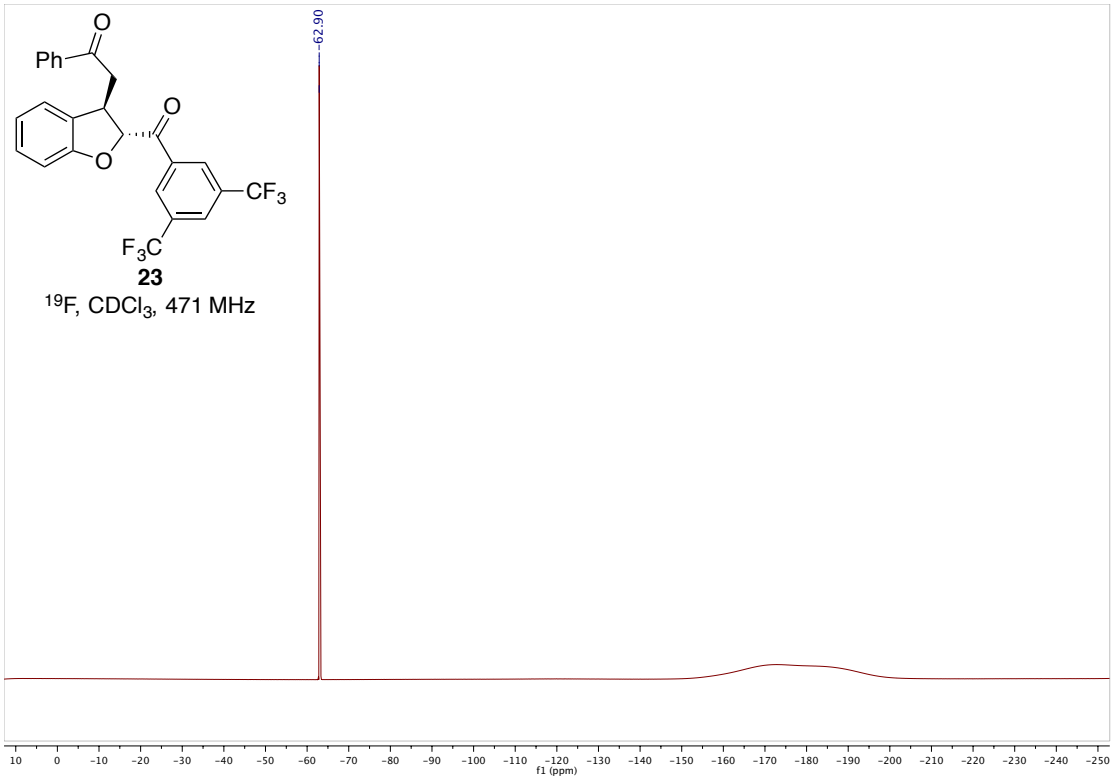
^{1}H, $CDCl_3$, 500 MHz


Ph
O
O
O
OMe
22
1H, CDCl3, 500 MHz
1.81
1.88
1.00
2.00
0.94
0.98
1.92
1.08
0.87
0.97
0.96
3.05
1.00
0.98
f1 (ppm)


197.9
193.4
164.0
158.8
136.6
133.6
131.9
129.1
128.9
128.9
128.3
128.0
124.9
121.5
114.0
110.0
87.8
55.7
44.2
39.9
Ph
O
O
O
OMe
22
13C, CDCl3, 126 MHz
f1 (ppm)

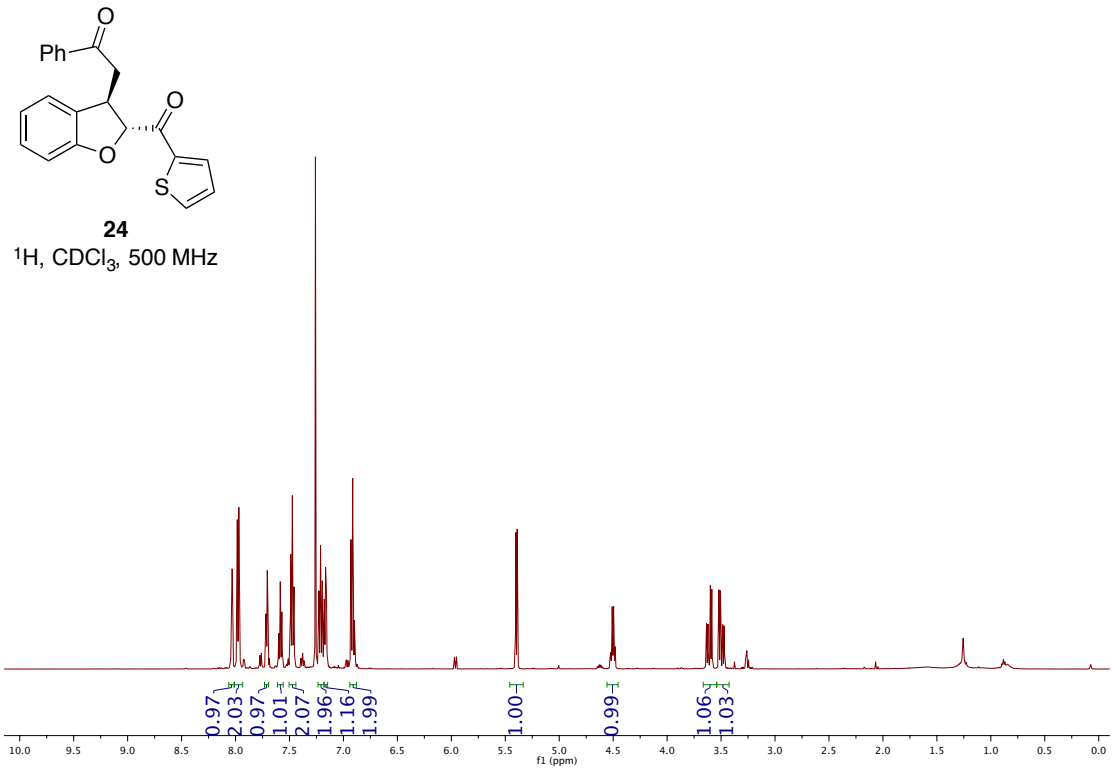

Ph
O
O
O
CF3
F3C
23
1H, CDCl3, 500 MHz
1.92
1.04
1.98
1.01
2.05
0.84
1.10
1.09
0.96
1.00
1.01
1.02
1.04
f1 (ppm)


198.1
192.4
158.2
136.8
136.2
133.9
132.8
132.5
132.3
132.0
129.7
129.7
129.2
128.9
128.4
128.2
126.8
126.3
124.8
124.1
122.0
110.3
87.5
44.0
39.2
Ph
O
O
O
CF3
F3C
23
13C, CDCl3, 126 MHz
f1 (ppm)



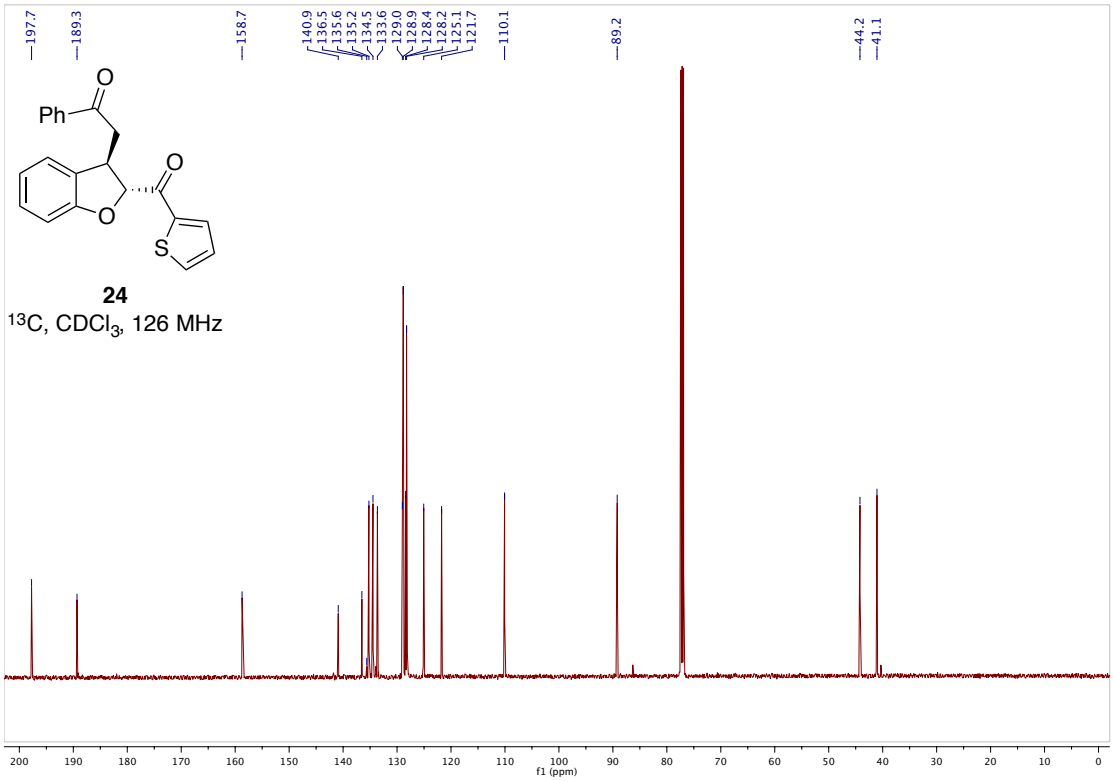
23

^{19}F, $CDCl_3$, 471 MHz



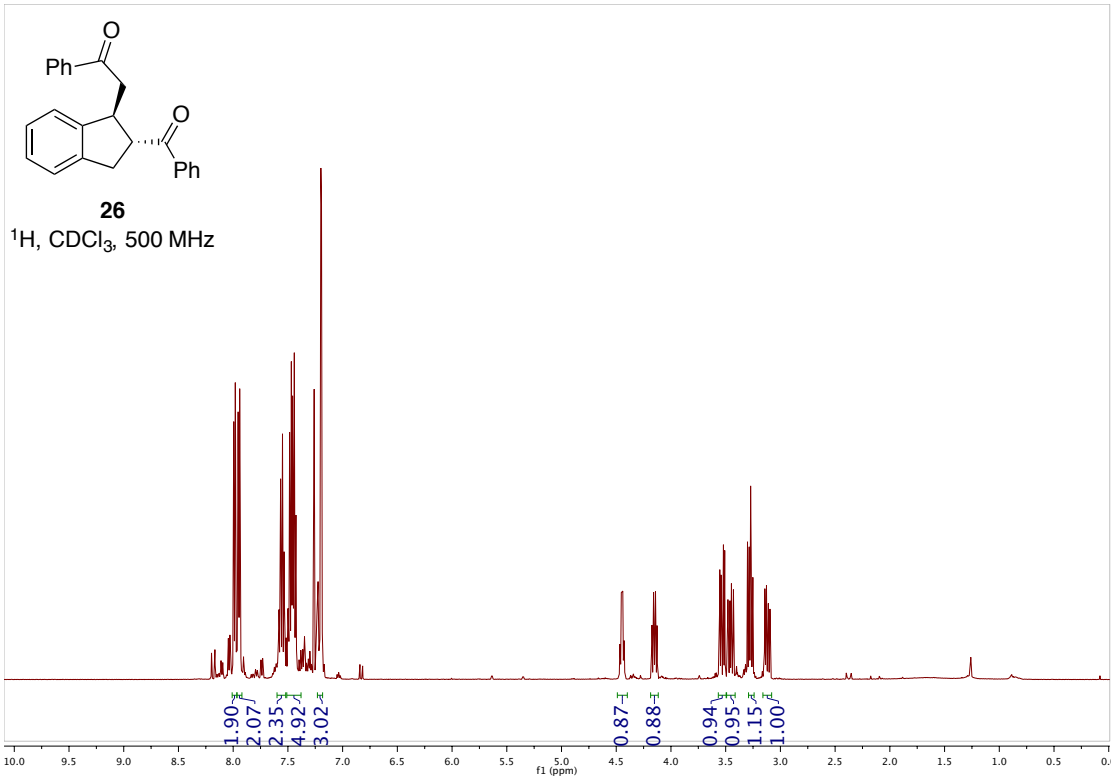
24

^{1}H, $CDCl_3$, 500 MHz



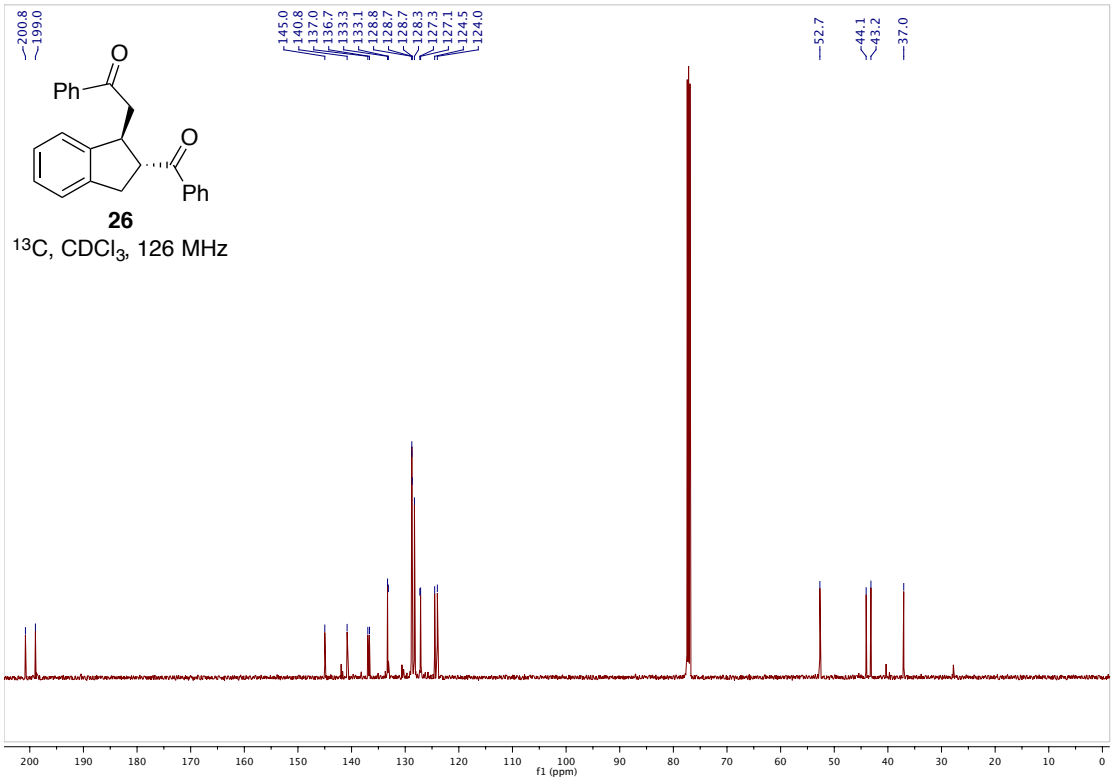
24

^{13}C, $CDCl_3$, 126 MHz



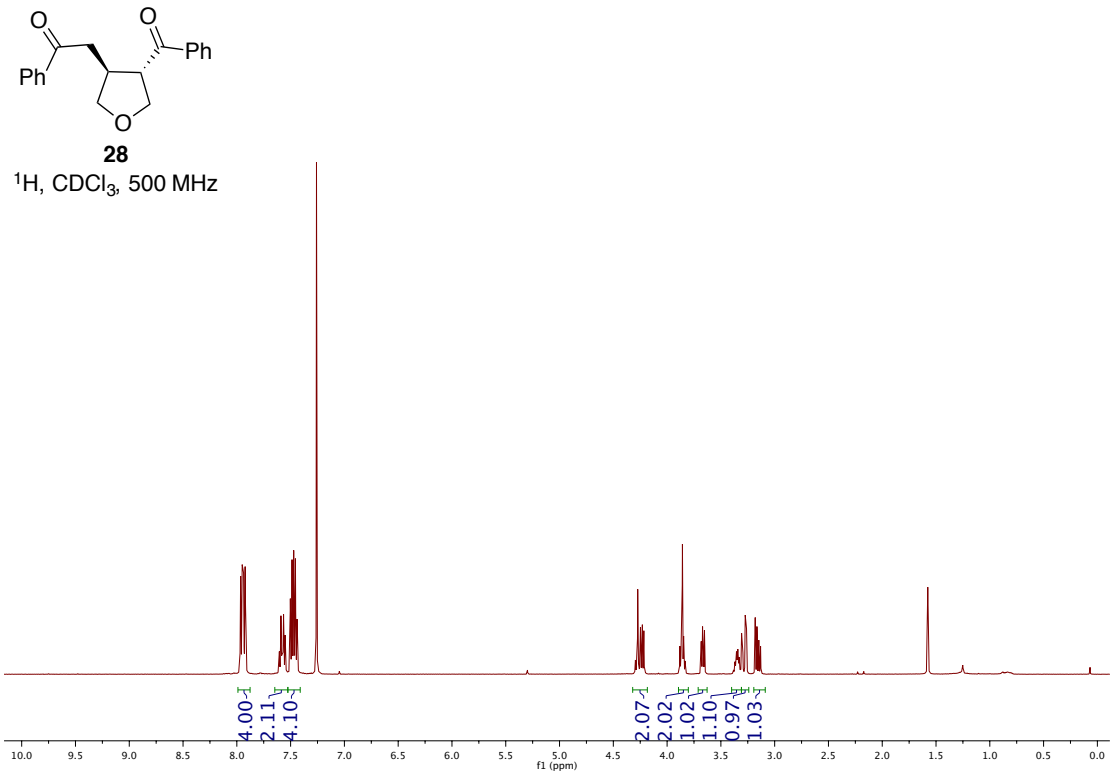
26

^{1}H, $CDCl_3$, 500 MHz



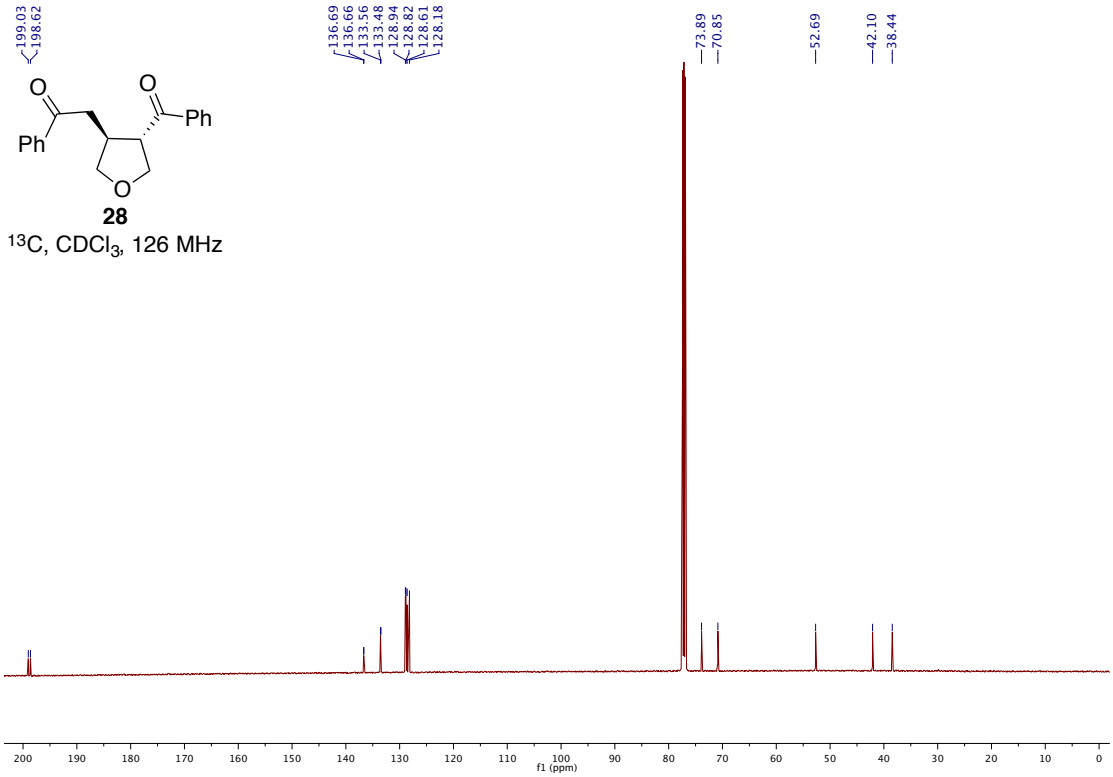
26

^{13}C, $CDCl_3$, 126 MHz

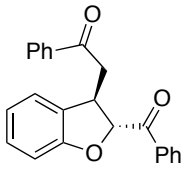


28

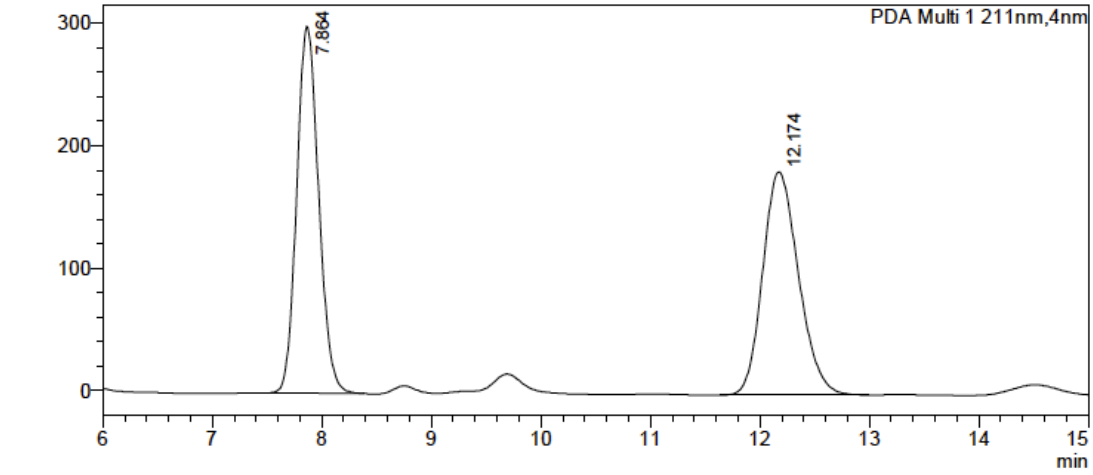
^{1}H, $CDCl_3$, 500 MHz


199.03
198.62
136.69
136.66
133.56
133.48
128.94
128.82
128.61
128.18
73.89
70.85
52.69
42.10
38.44
O
O
Ph
Ph
O
28
^{13}C, $CDCl_3$, 126 MHz
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

HPLC traces



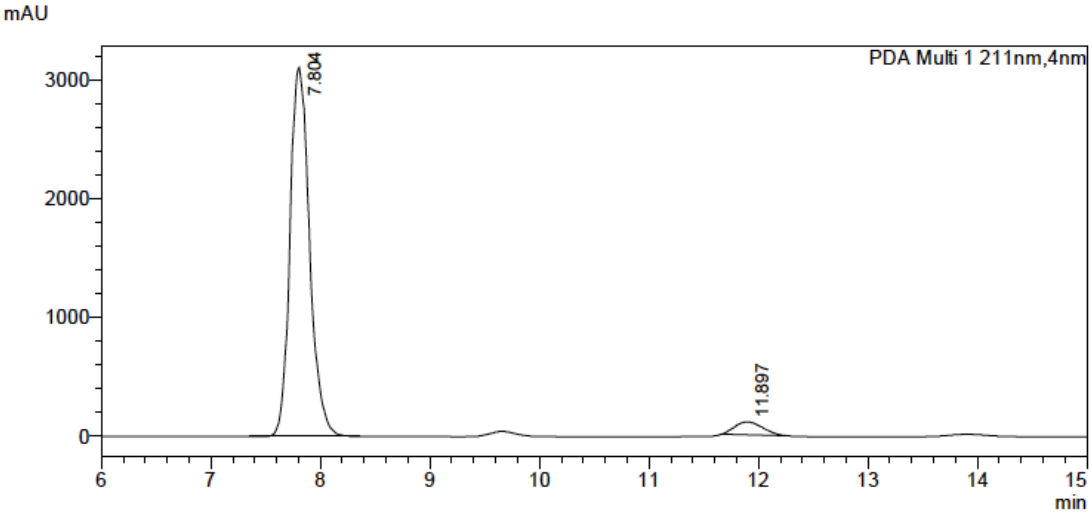
HPLC data for compound **2**: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,3*R*): 9.7 min, t_R (2*S*, 3*S*): 11.9 min, 95:5 er.



<Peak Table>

PDA Ch1 211nm

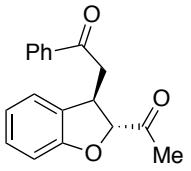
Peak#	Ret. Time	Area%
1	7.864	50.176
2	12.174	49.824
Total		100.000



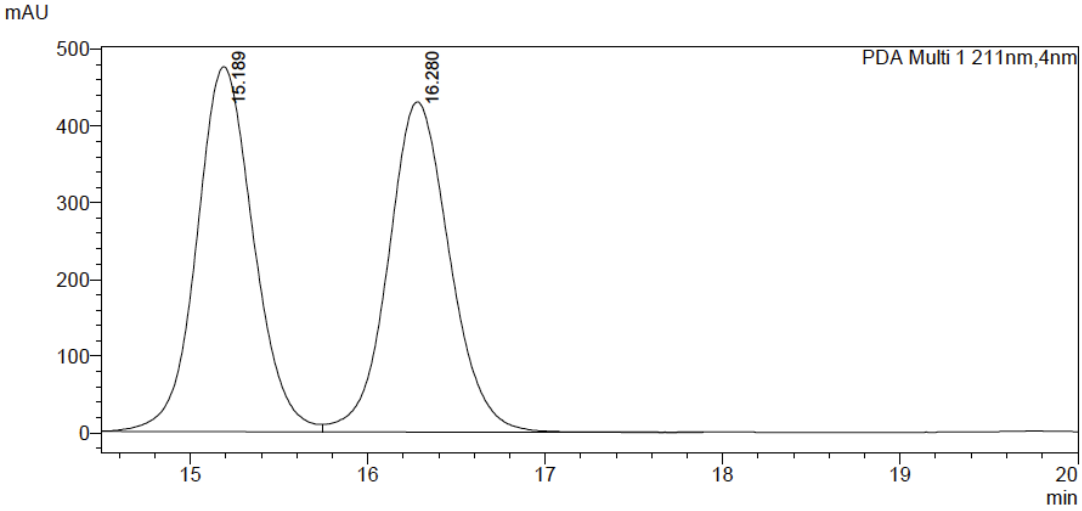
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	7.804	95.248
2	11.897	4.752
Total		100.000



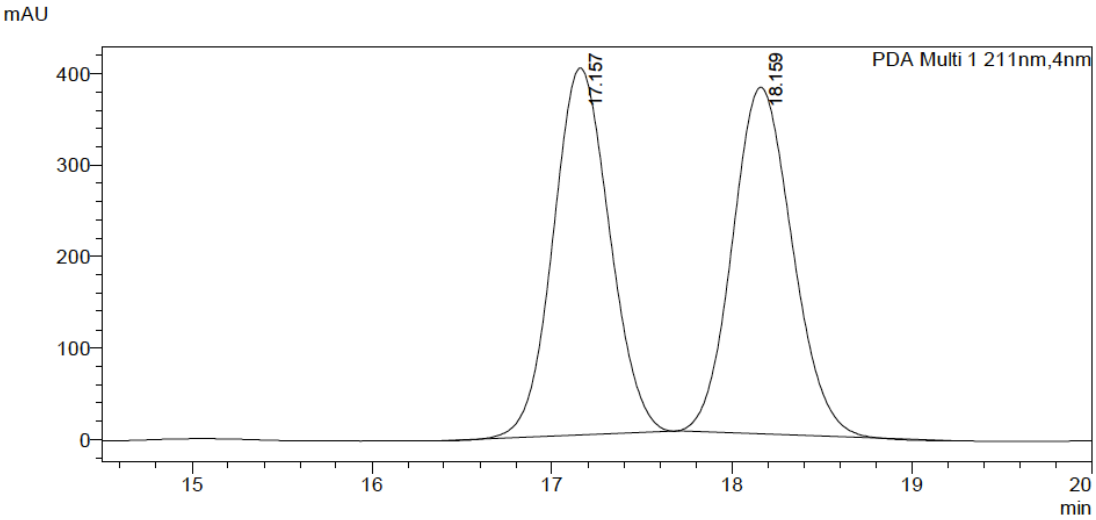
HPLC data for compound **10**: Chiralcel AD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R: 17.16 min, t_R 18.16 min, 50:50 er.



<Peak Table>

PDA Ch1 211nm

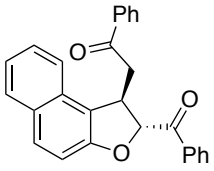
Peak#	Ret. Time	Area%
1	15.189	50.547
2	16.280	49.453
Total		100.000



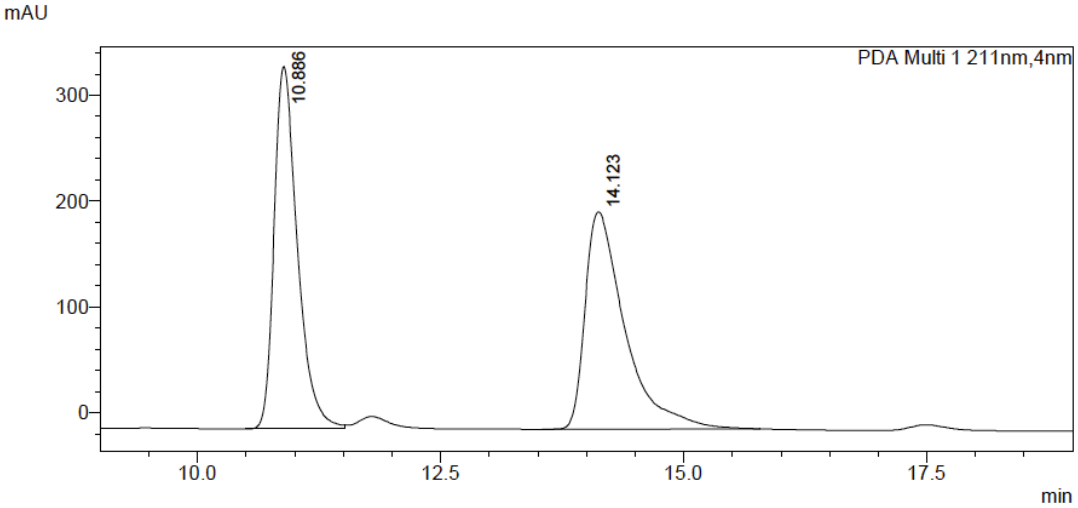
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	17.157	49.926
2	18.159	50.074
Total		100.000



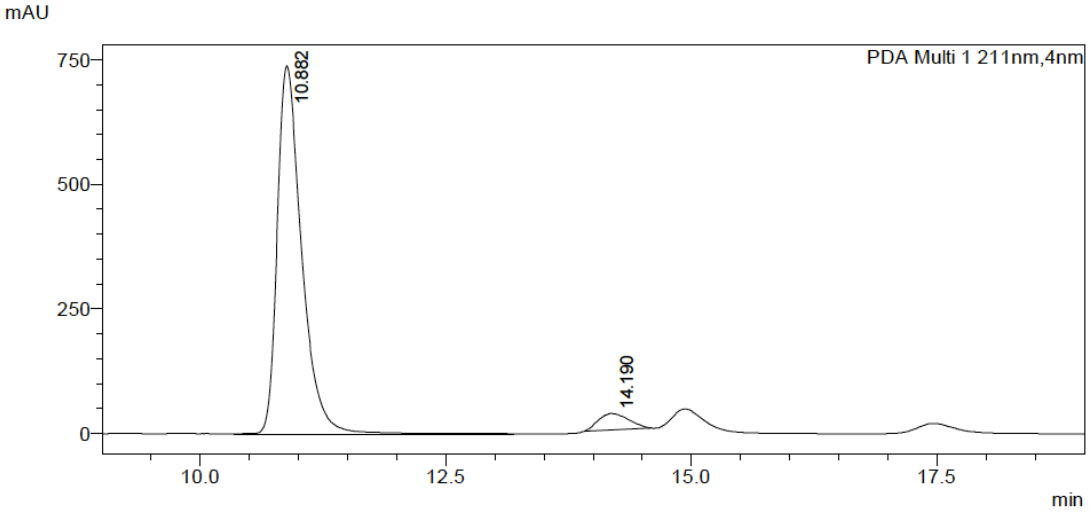
HPLC data for compound **11**: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 10.9 min, t_R (2*S*, 3*S*): 14.9 min, 93.5:6.5 er.



<Peak Table>

PDA Ch1 211nm

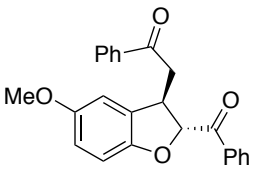
Peak#	Ret. Time	Area%
1	10.886	49.411
2	14.123	50.589
Total		100.000



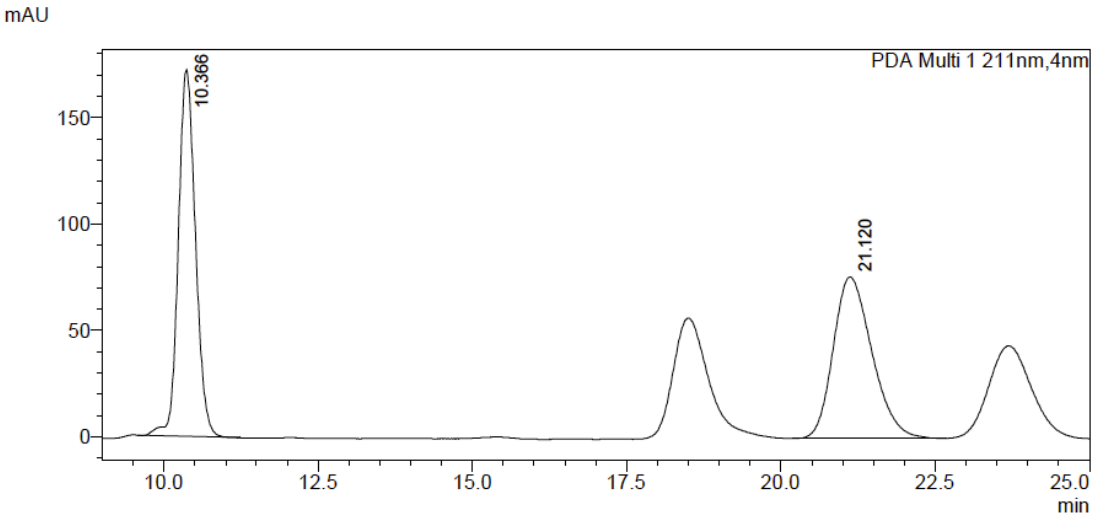
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	10.882	94.712
2	14.190	5.288
Total		100.000



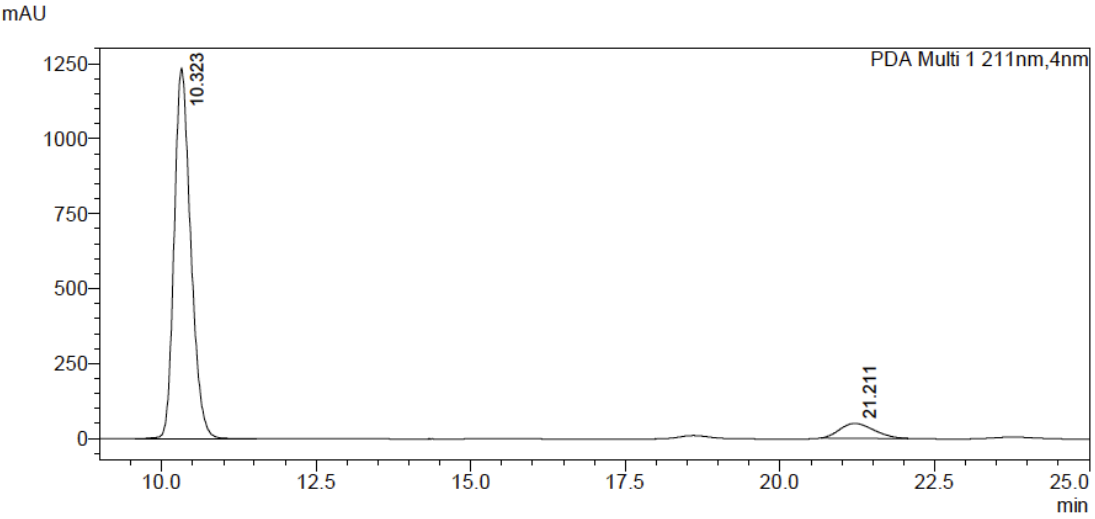
HPLC data for compound **12**: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.5 $mLmin^{-1}$, 211 nm, 40 °C), t_R (2*R*,3*R*): 10.3 min, t_R (2*S*, 3*S*): 21.2 min, 92.5:7.5 er.



<Peak Table>

PDA Ch1 211nm

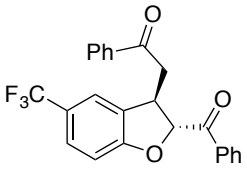
Peak#	Ret. Time	Area%
1	10.366	50.188
2	21.120	49.812
Total		100.000



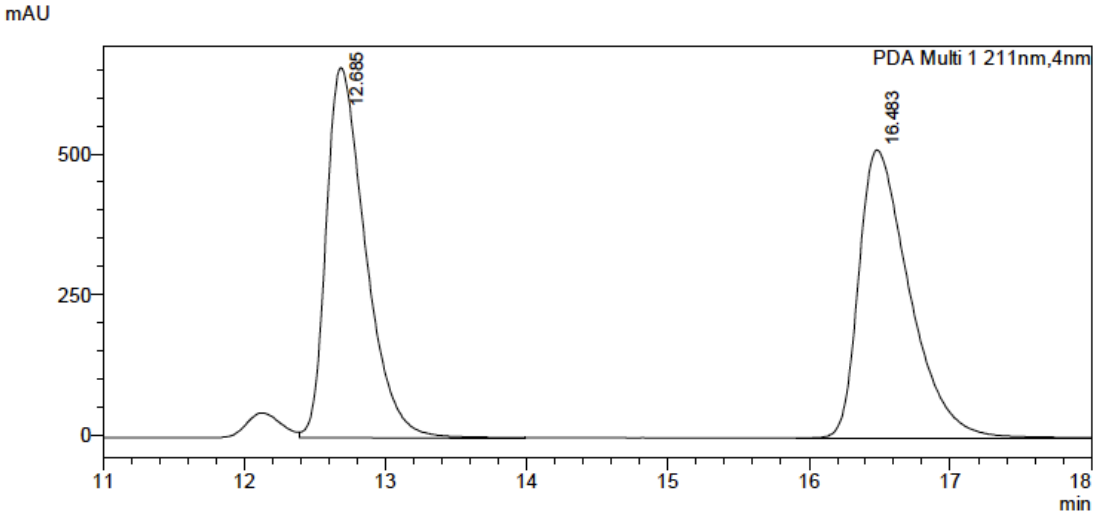
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	10.323	92.431
2	21.211	7.569
Total		100.000



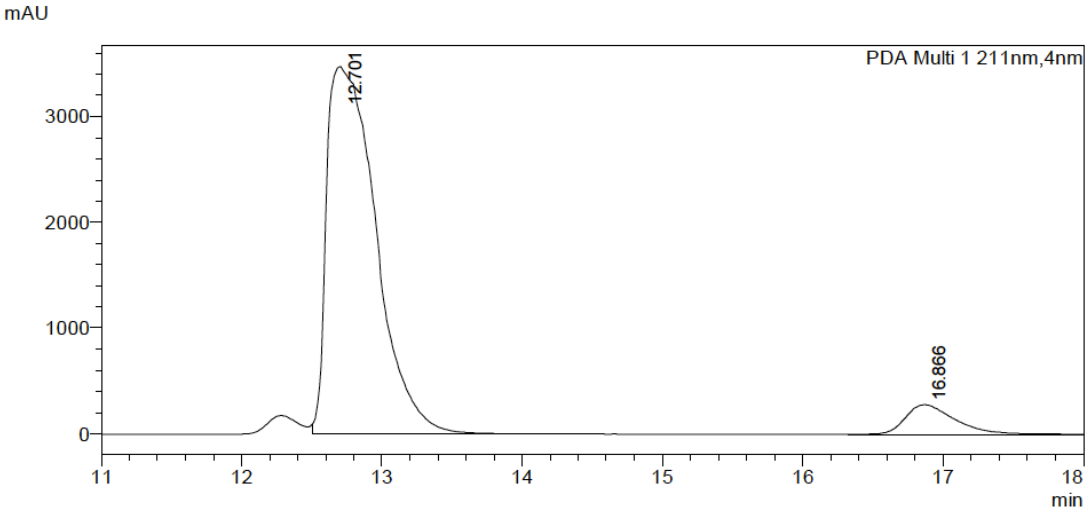
HPLC data for compound **13**: Chiralcel IB (95:5 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 12.7 min, t_R (2*S*, 3*S*): 16.9 min, 93:7 er.



<Peak Table>

PDA Ch1 211nm

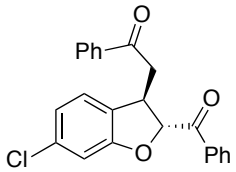
Peak#	Ret. Time	Area%
1	12.685	50.018
2	16.483	49.982
Total		100.000



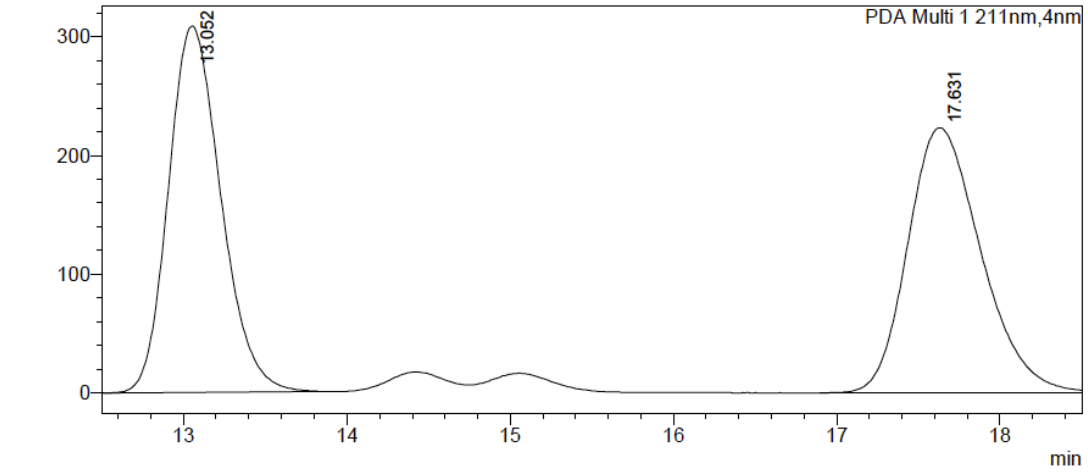
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	12.701	92.589
2	16.866	7.411
Total		100.000



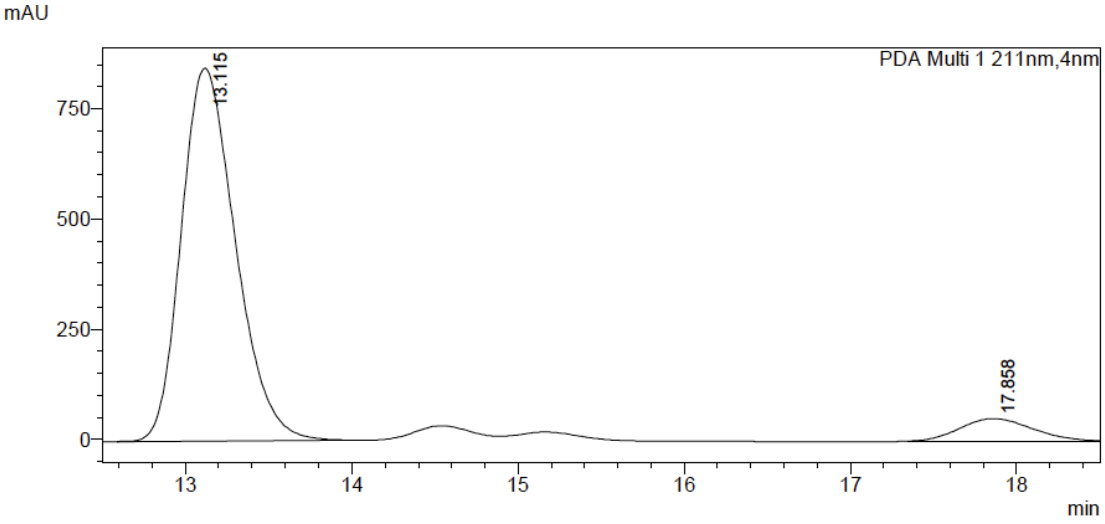
HPLC data for compound **14**: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 13.1 min, t_R (2*S*, 3*S*): 17.9 min, 92.5:7.5 er.



<Peak Table>

PDA Ch1 211nm

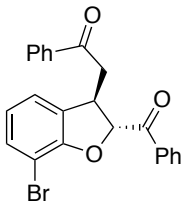
Peak#	Ret. Time	Area%
1	13.052	49.712
2	17.631	50.288
Total		100.000



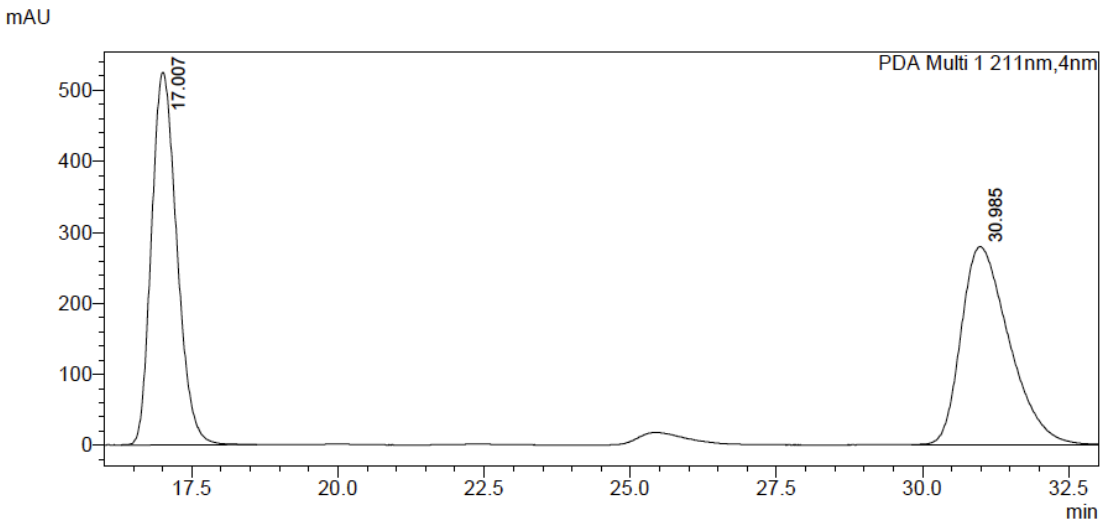
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	13.115	92.561
2	17.858	7.439
Total		100.000



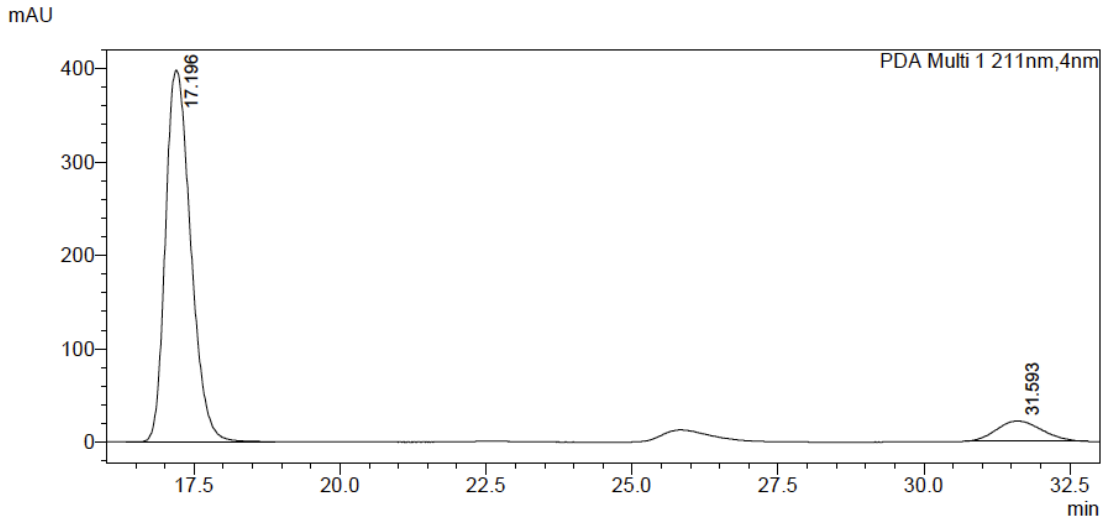
HPLC data for compound **15**: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 17.2 min, t_R (2*S*, 3*S*): 31.6 min, 91:9 er.



<Peak Table>

PDA Ch1 211nm

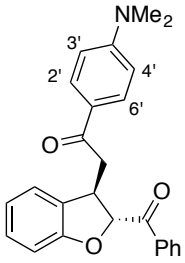
Peak#	Ret. Time	Area%
1	17.007	49.896
2	30.985	50.104
Total		100.000



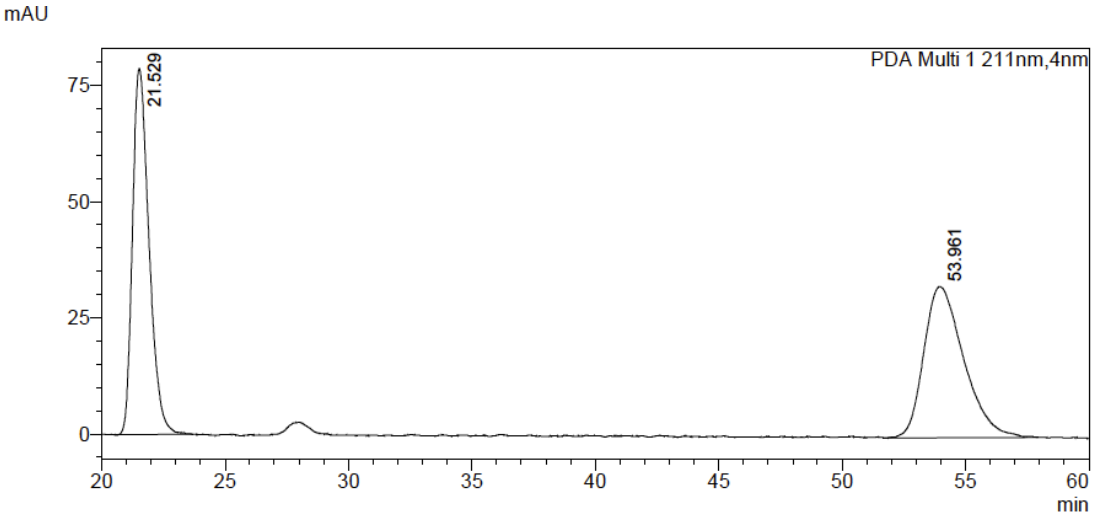
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	17.196	90.932
2	31.593	9.068
Total		100.000



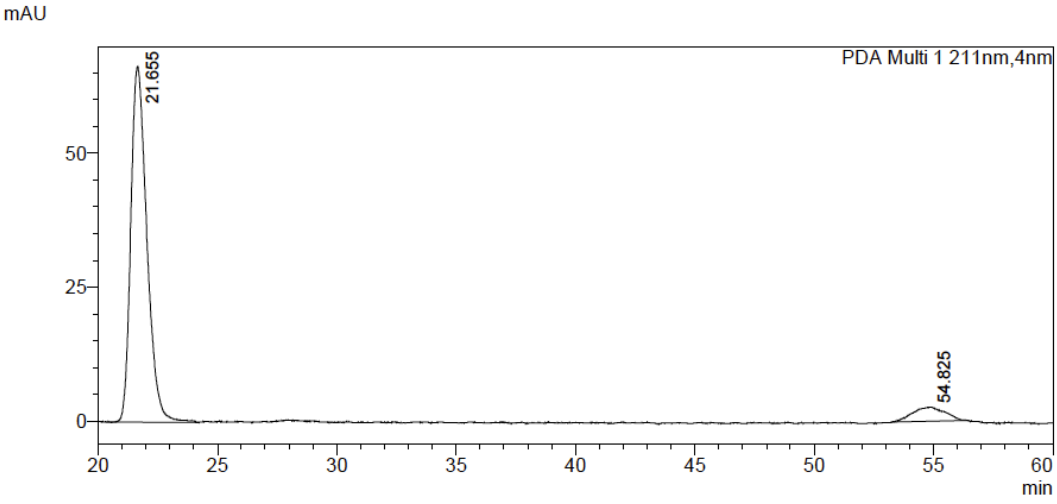
HPLC data for compound **16**: Chiralcel OD-H (90:10 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,3*R*): 21.7 min, t_R (2*S*, 3*S*): 54.8 min, 92.5:7.5 er.



<Peak Table>

PDA Ch1 211nm

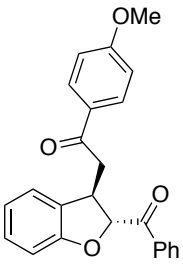
Peak#	Ret. Time	Area%
1	21.529	50.070
2	53.961	49.930
Total		100.000



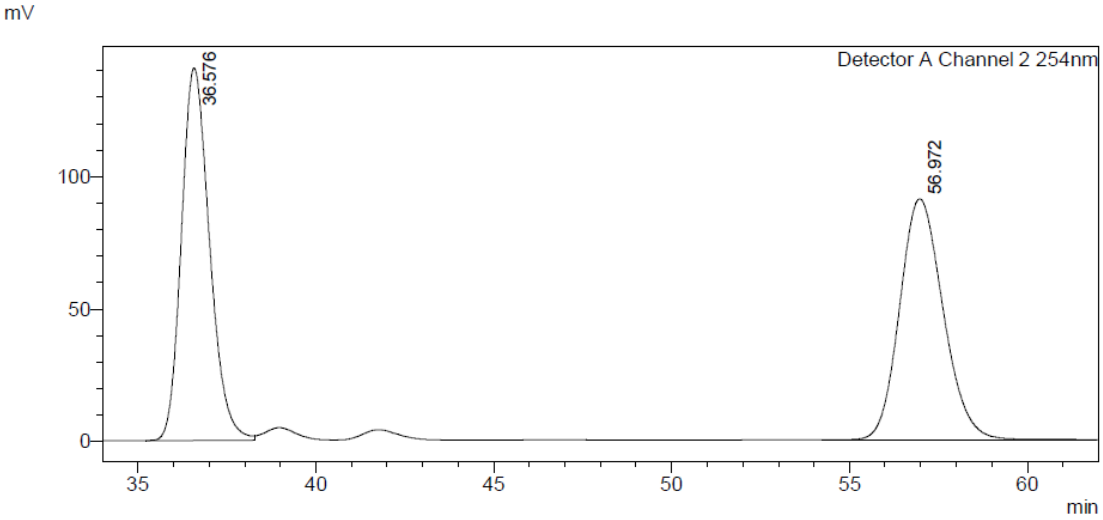
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	21.655	92.417
2	54.825	7.583
Total		100.000



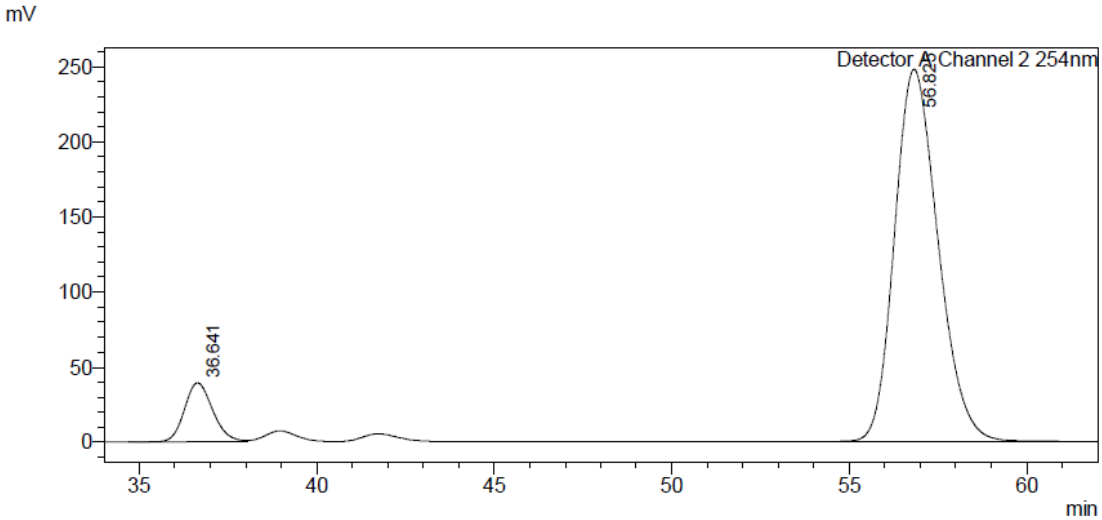
HPLC data for compound **17**: Chiralcel IC (90:10 hexane:IPA, flow rate 1 mLmin^{-1}, 254 nm, 30 °C), t_R (2*S*,3*S*): 36.6 min, t_R (2*R*,3*R*): 56.8 min, 90.5:9.5 er.



<Peak Table>

Detector A Channel 2 254nm

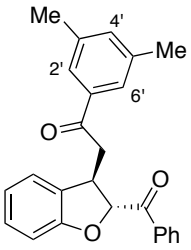
Peak#	Ret. Time	Area%
1	36.576	50.083
2	56.972	49.917
Total		100.000



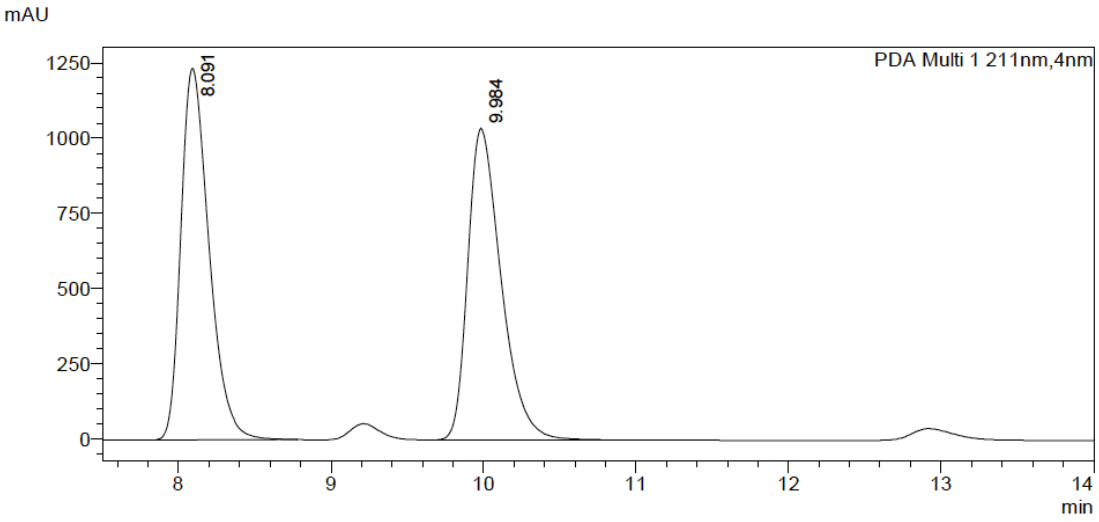
<Peak Table>

Detector A Channel 2 254nm

Peak#	Ret. Time	Area%
1	36.641	9.314
2	56.825	90.686
Total		100.000



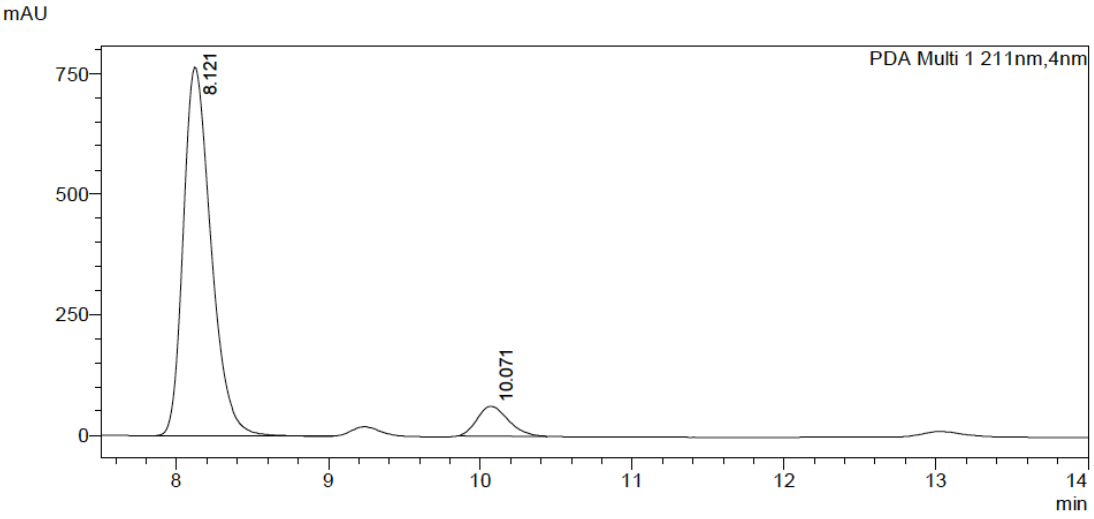
HPLC data for compound **18**: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 8.1 min, t_R (2*S*, 3*S*): 10.1 min, 92:8 er.



<Peak Table>

PDA Ch1 211nm

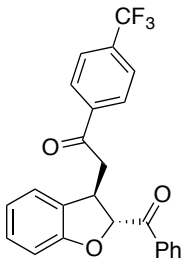
Peak#	Ret. Time	Area%
1	8.091	49.883
2	9.984	50.117
Total		100.000



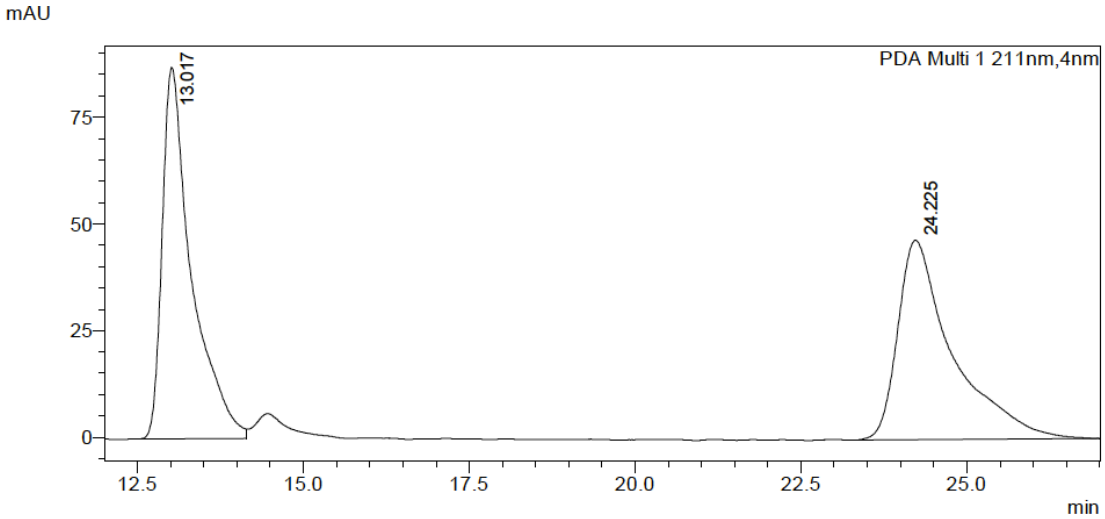
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	8.121	91.712
2	10.071	8.288
Total		100.000



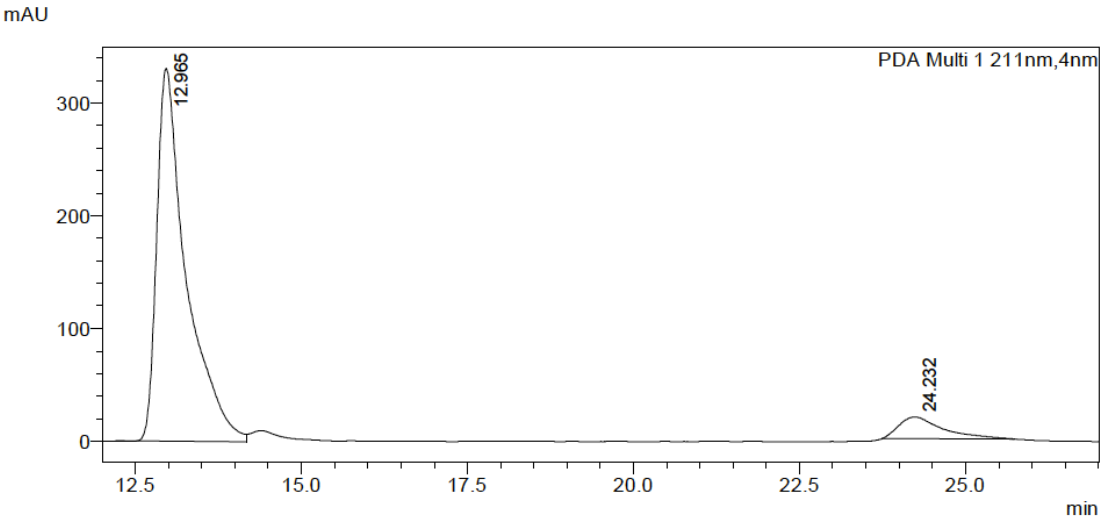
HPLC data for compound **19**: Chiralcel IA (92:8 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,R*S*): 13.0 min, t_R (2*S*, 3*S*): 24.3 min, 83.5:16.5 er.



<Peak Table>

PDA Ch1 211nm

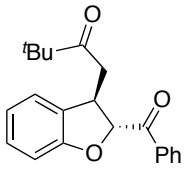
Peak#	Ret. Time	Area%
1	13.017	49.990
2	24.225	50.010
Total		100.000



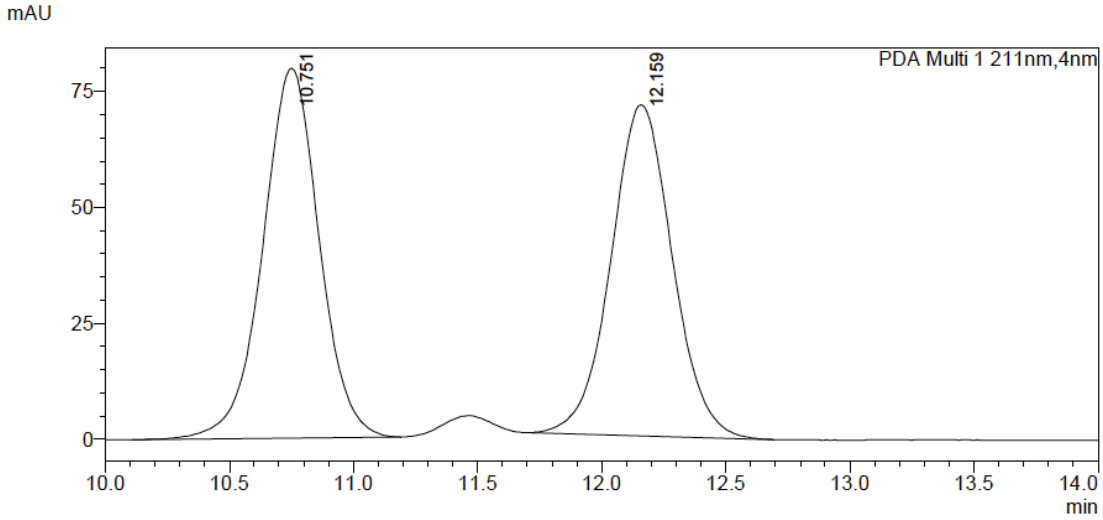
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	12.965	91.993
2	24.232	8.007
Total		100.000



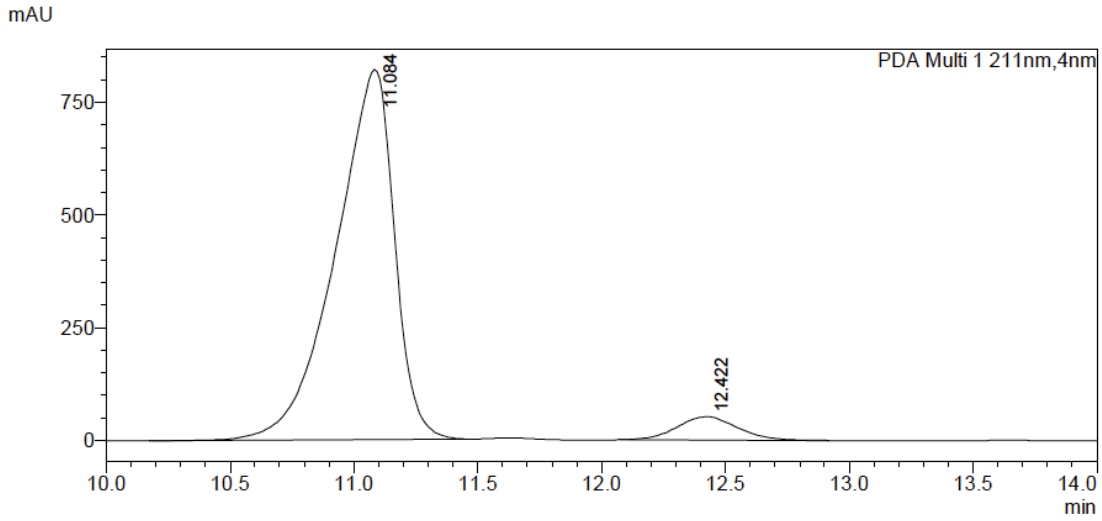
HPLC data for compound **20**: Chiralcel AD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 11.1 min, t_R (2*S*, 3*S*): 12.4 min, 94:6 er.



<Peak Table>

PDA Ch1 211nm

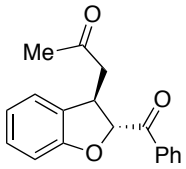
Peak#	Ret. Time	Area%
1	10.751	50.633
2	12.159	49.367
Total		100.000



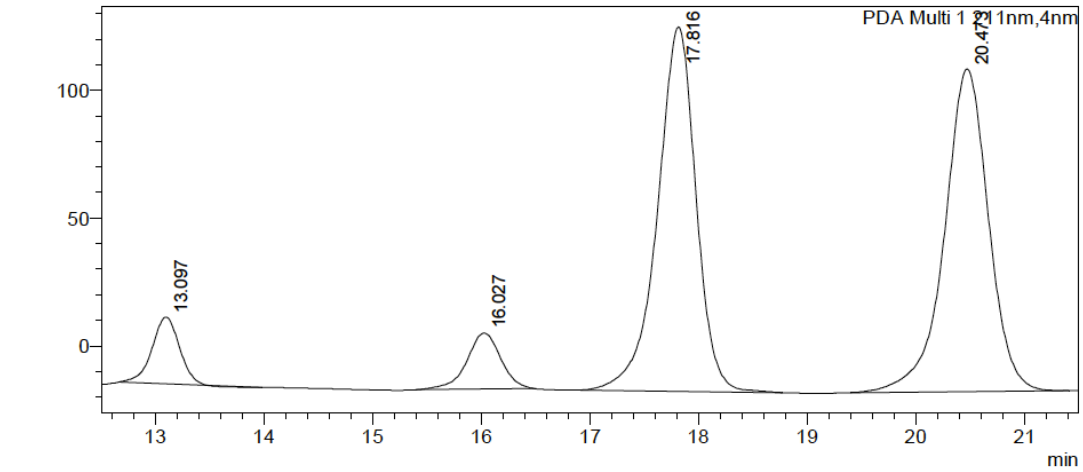
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	11.084	93.893
2	12.422	6.107
Total		100.000



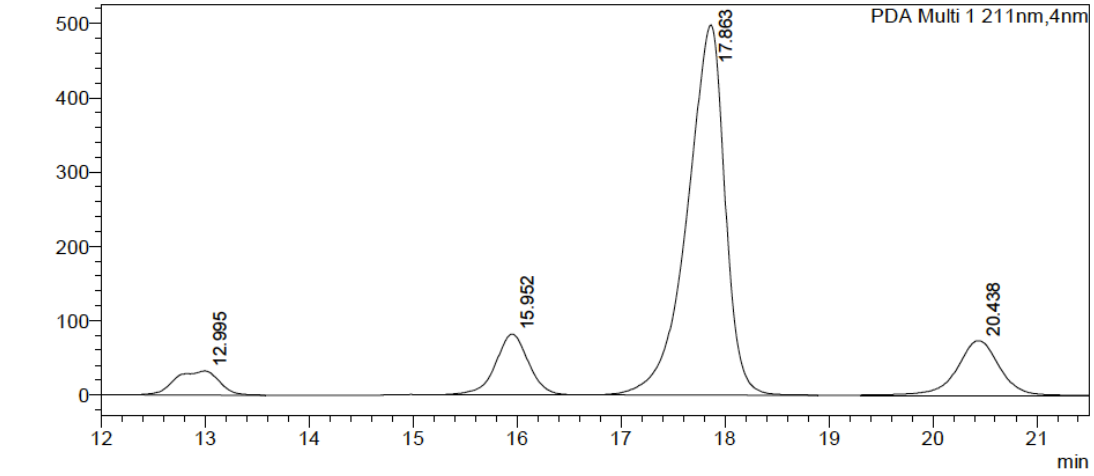
HPLC data for compound **21**: Chiralcel AD-H (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 17.9 min, t_R (2*S*, 3*S*): 20.4 min, 86:14 er.



<Peak Table>

PDA Ch1 211nm

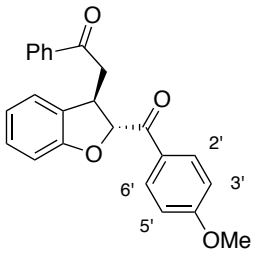
Peak#	Ret. Time	Area%
1	13.097	5.705
2	16.027	5.958
3	17.816	43.905
4	20.473	44.432
Total		100.000



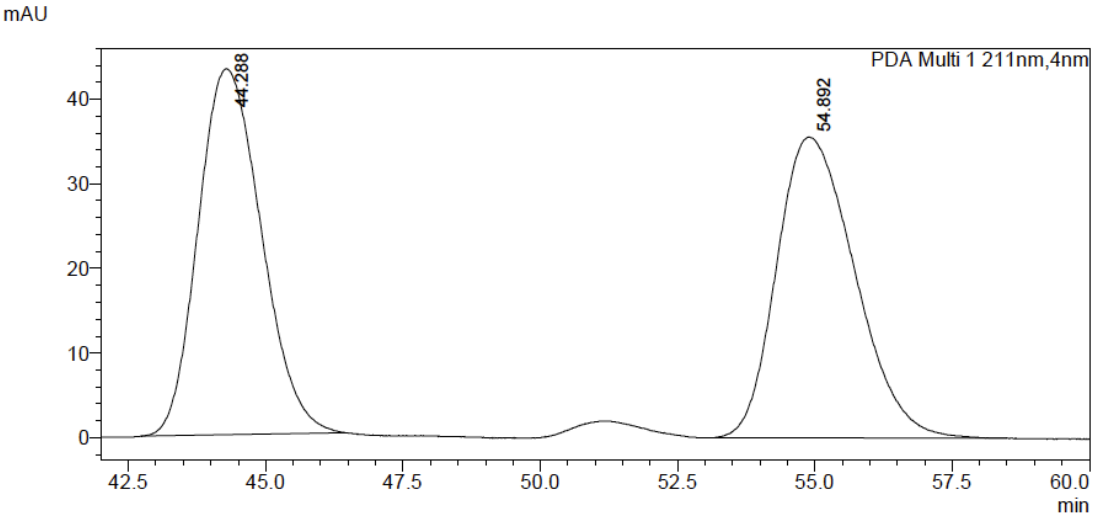
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	12.995	5.474
2	15.952	10.431
3	17.863	72.265
4	20.438	11.830
Total		100.000



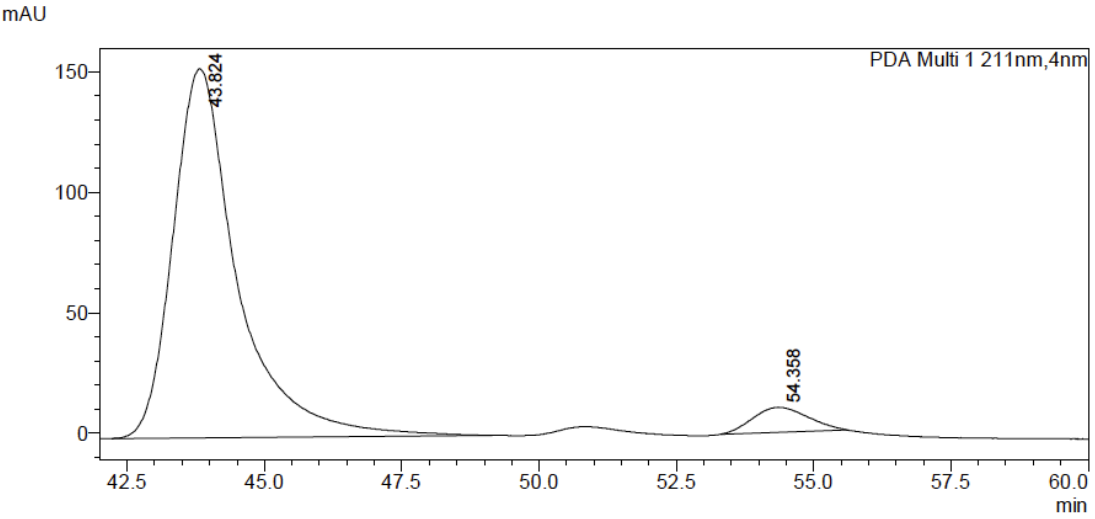
HPLC data for compound **22**: Chiralcel IA (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*R*,3*R*): 43.8 min, t_R (2*S*, 3*S*): 54.4 min, 94.5:5.5 er.



<Peak Table>

PDA Ch1 211nm

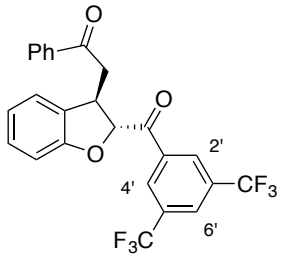
Peak#	Ret. Time	Area%
1	44.288	49.596
2	54.892	50.404
Total		100.000



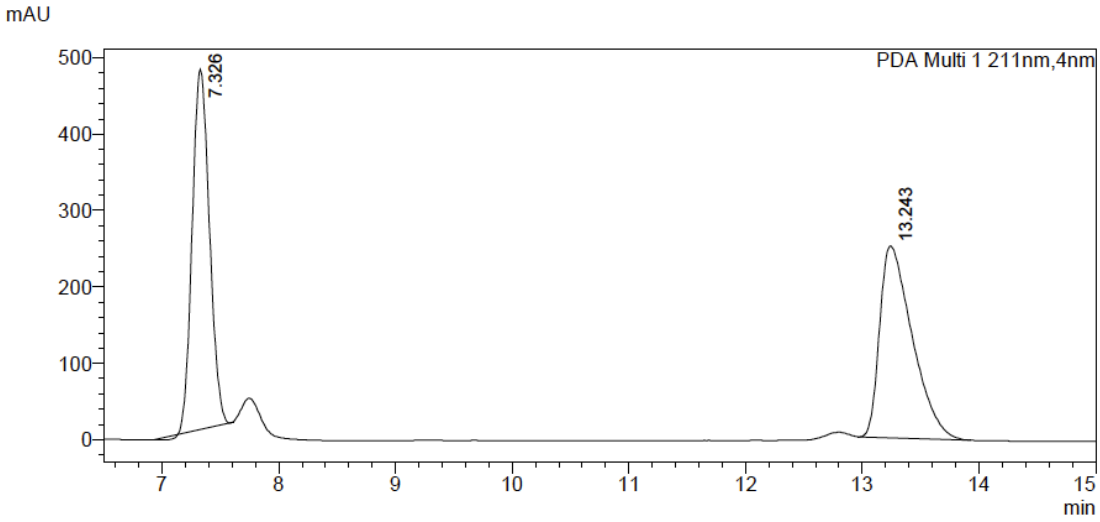
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	43.824	94.545
2	54.358	5.455
Total		100.000



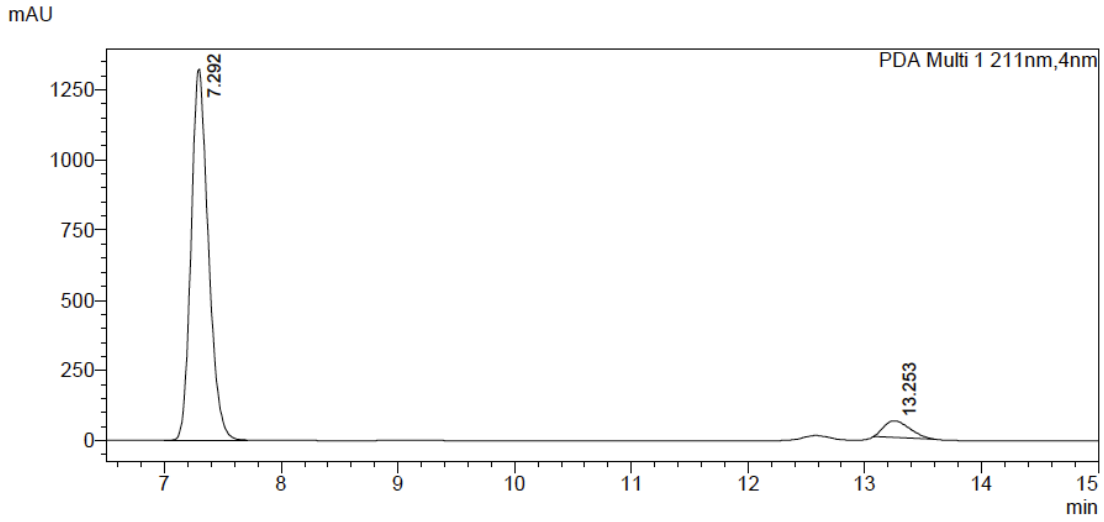
HPLC data for compound **23**: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 $mLmin^{-1}$, 211 nm, 30 °C), t_R (2*R*,3*R*): 7.3 min, t_R (2*S*, 3*S*): 13.3 min, 94:6 er.



<Peak Table>

PDA Ch1 211nm

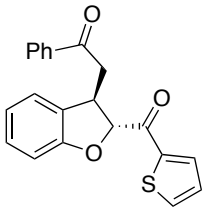
Peak#	Ret. Time	Area%
1	7.326	49.729
2	13.243	50.271
Total		100.000



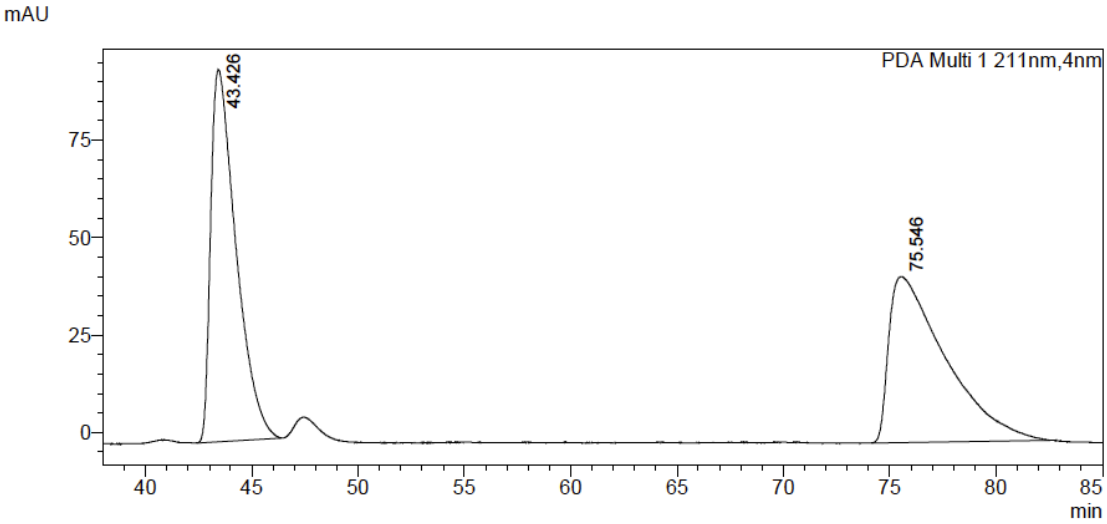
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	7.292	93.701
2	13.253	6.299
Total		100.000



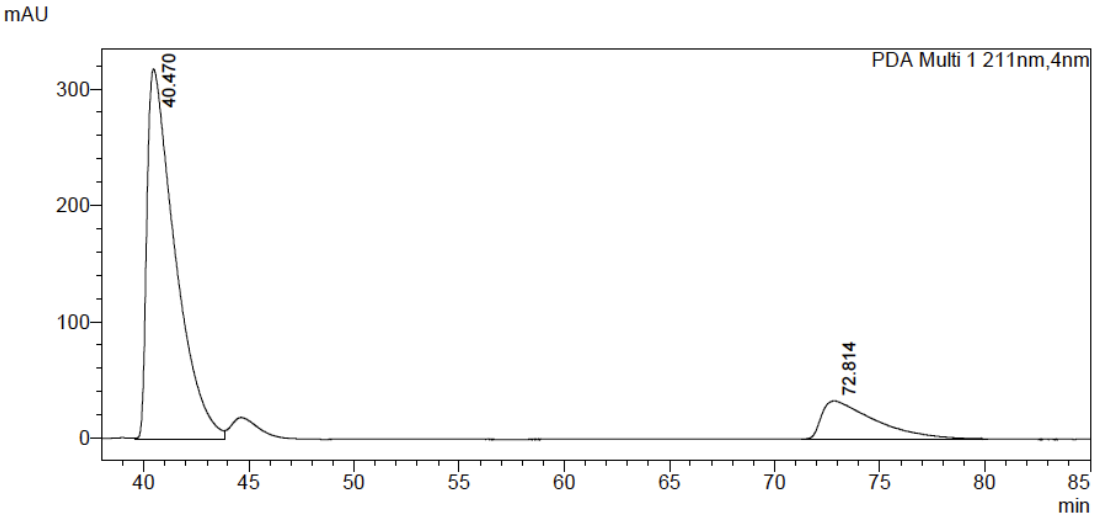
HPLC data for compound **24**: Chiralcel OD-H (99:1 hexane:IPA, flow rate 1.5 mLmin^{-1}, 211 nm, 40 °C), t_R (2*R*,3*R*): 40.5 min, t_R (2*S*, 3*S*): 72.8 min, 83.5:16.5 er.



<Peak Table>

PDA Ch1 211nm

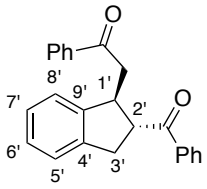
Peak#	Ret. Time	Area%
1	43.426	50.098
2	75.546	49.902
Total		100.000



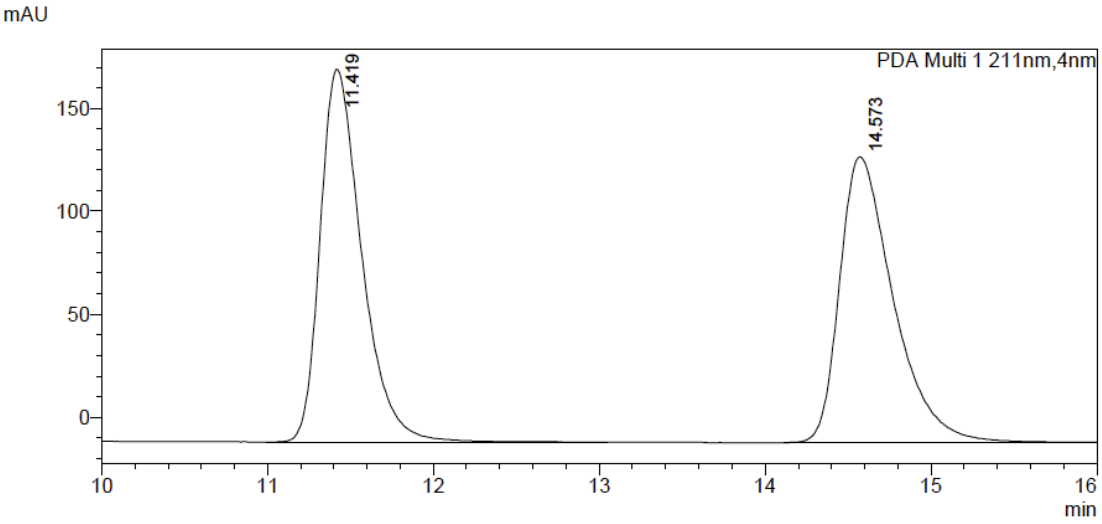
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	40.470	83.695
2	72.814	16.305
Total		100.000



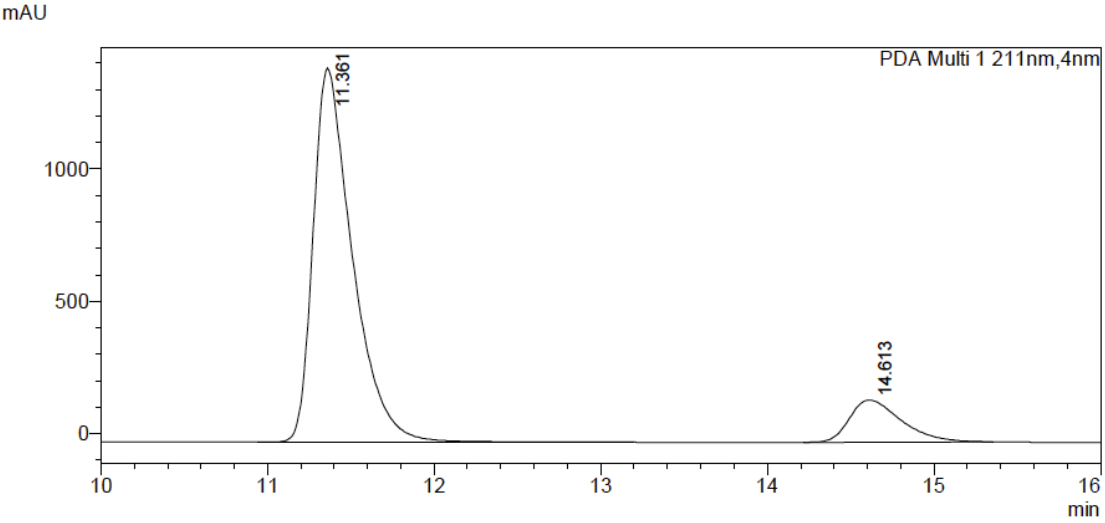
HPLC data for compound **26**: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (1*S*,2*R*): 11.4 min, t_R (1*R*, 2*S*): 14.6 min, 87:13 er.



<Peak Table>

PDA Ch1 211nm

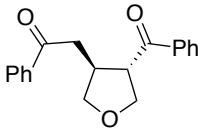
Peak#	Ret. Time	Area%
1	11.419	50.230
2	14.573	49.770
Total		100.000



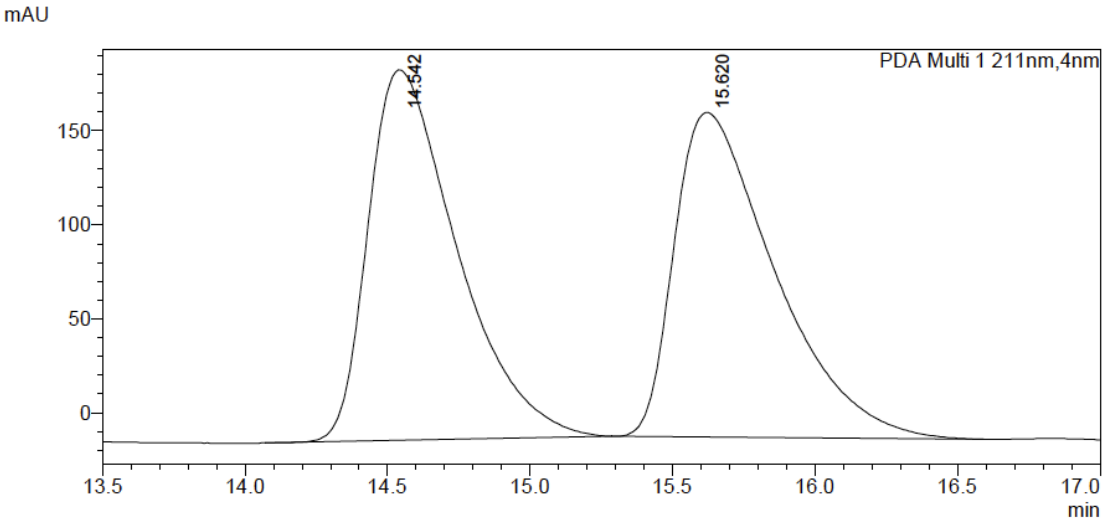
<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	11.361	87.069
2	14.613	12.931
Total		100.000



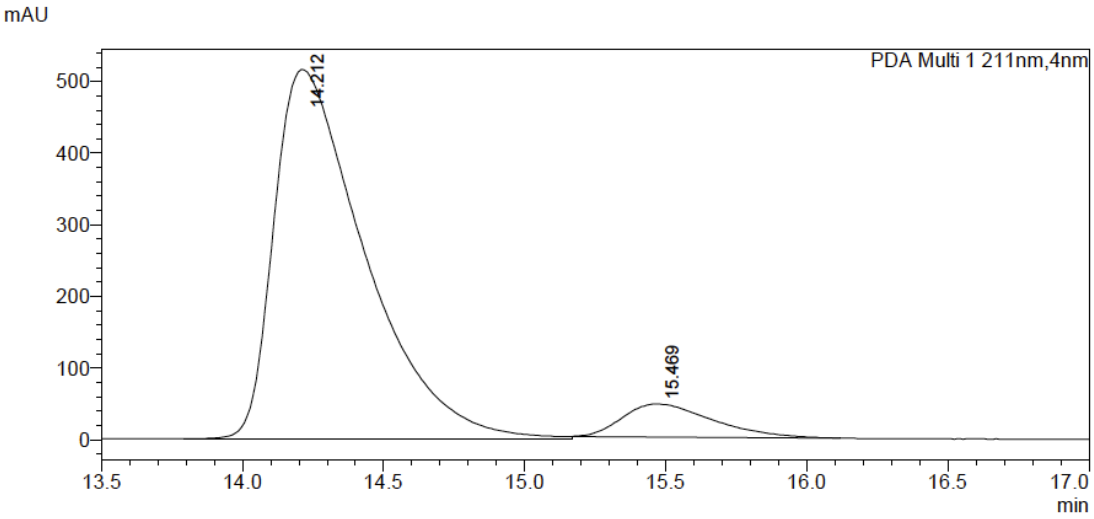
HPLC data for compound **28**: Chiralcel IB (90:10 hexane:IPA, flow rate 1.0 mLmin^{-1}, 211 nm, 30 °C), t_R (2*S*,3*S*): 14.2 min, t_R (2*R*, 3*R*): 15.5 min, 92:8 er.



<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	14.542	50.273
2	15.620	49.727
Total		100.000



<Peak Table>

PDA Ch1 211nm

Peak#	Ret. Time	Area%
1	14.212	91.900
2	15.469	8.100
Total		100.000