Supporting Information

Chemoselective intermolecular cross-enolate-type coupling of amides

Daniel Kaiser[†], Christopher J. Teskey[†], Pauline Adler and Nuno Maulide*

Institute of Organic Chemistry, University of Vienna, Währinger Strasse 1090, Vienna, Austria

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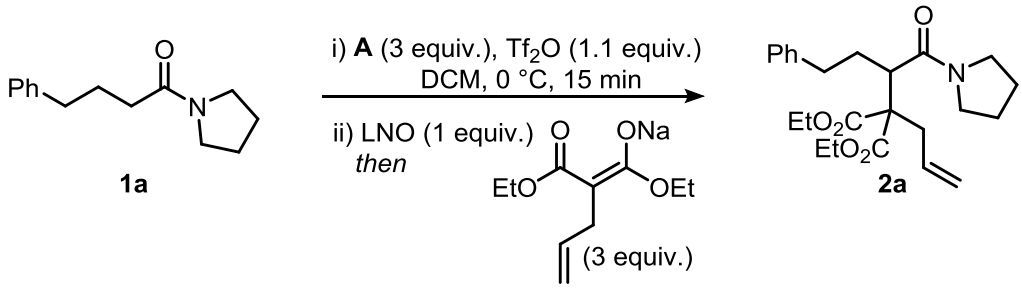
1. General Information

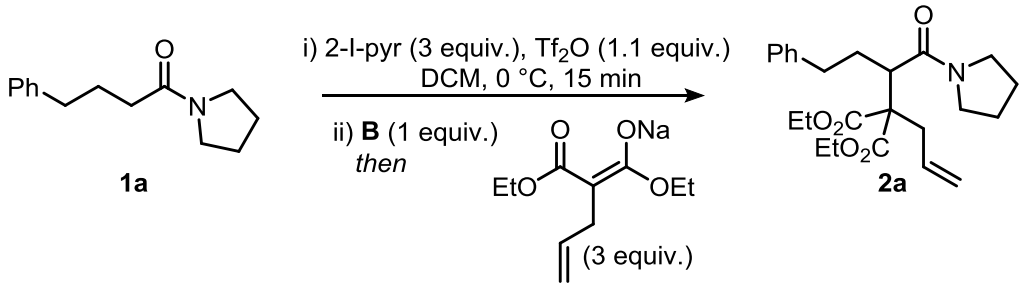
Unless otherwise stated, all glassware was flame-dried before use and all reactions were performed under an atmosphere of argon. All solvents were distilled from appropriate drying agents prior to use. Triflic anhydride was distilled over P_4O_{10} prior to use. All other reagents were used as received from commercial suppliers unless otherwise stated. Reaction progress was monitored by thin layer chromatography (TLC) performed on aluminium plates coated with silica gel F_{254} with 0.2 mm thickness. Chromatograms were visualized by fluorescence quenching with UV light at 254 nm or by staining using potassium permanganate. Flash column chromatography was performed using silica gel 60 (230-400 mesh, Merck and co.). Neat infra-red spectra were recorded using a Perkin-Elmer Spectrum 100 FT-IR spectrometer. Wavenumbers (ν_{max}) are reported in cm^{-1}. Mass spectra were obtained using a Finnigan MAT 8200 or (70 eV) or an Agilent 5973 (70 eV) spectrometer, using electrospray ionization (ESI). All ^1H NMR and ^{13}C NMR spectra were recorded using a Bruker AV-400 or AV-600 spectrometer at 300K. Chemical shifts were given in parts per million (ppm, δ), referenced to the solvent peak of $CDCl_3$, defined at δ = 7.26 ppm (^1H NMR) and δ = 77.16 (^{13}C NMR) or acetone-d_6, defined at δ = 2.05 ppm (^1H NMR) and δ = 206.26/29.84 (^{13}C NMR). Coupling constants are quoted in Hz (*J*). ^1H NMR splitting patterns were designated as singlet (s), doublet (d), triplet (t), quartet (q), pentet (p). Splitting patterns that could not be interpreted or easily visualized were designated as multiplet (m) or broad (br). Selected ^{13}C NMR spectra were recorded using the attached proton test (APT) to facilitate the confirmation and assignment of the structure.

2. Optimization



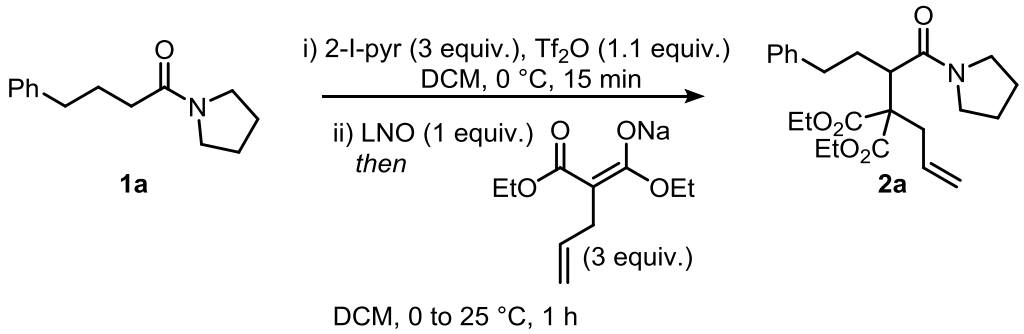
A	NMR yield[a]
2-I-pyr	*72% (isolated)*
2,6-diF-pyr	13%
2-F-pyr	62%
2-Cl-pyr	46%
2-NO_2-pyr	0%
DTBMP	14%
2-F-pyr (2 equiv.)	55%

[a]NMR yield determined using 1,3,5-trimethoxybenzene as internal standard. Tf_2O = trifluoromethanesulfonic anhydride; LNO = 2,6-lutidine *N*-oxide; 2-I-pyr = 2-iodopyridine; 2,6-diF-pyr = 2,6-difluoropyridine; 2-F-pyr = 2-fluoropyridine; 2-Cl-pyr = 2-chloropyridine; 2-NO_2-pyr = 2-nitropyridine; DTBMP = 2,6-di-tert-butyl-4-methylpyridine.



B	NMR yield[a]
PNO	43% (isolated)
LNO	***72% (isolated)***
4-CN-PNO	64%
2,6-diCl-PNO	57%
4-NO_2-PNO	77%
3-F-PNO	70%
3,5-diF-PNO	78%
2-Me-4-NO_2-PNO	*80%*
2-Cl-PNO	*77%*

[a]NMR yield determined using 1,3,5-trimethoxybenzene as internal standard. PNO = pyridine *N*-oxide; 4-CN-PNO = 4-cyanopyridine *N*-oxide; 2,6-diCl-PNO = 2,6-dichloropyridine *N*-oxide; 4-NO_2-PNO = 4-nitropyridine *N*-oxide; 3-F-PNO = 3-fluoropyridine *N*-oxide; 3,5-diF-PNO = 3,5-difluoropyridine *N*-oxide; 2-Me-4-NO_2-PNO = 2-methyl-4-nitropyridine *N*-oxide; 2-Cl-PNO = 2-chloropyridine *N*-oxide.



Change from standard conditions	NMR yield[a]
Quenched after 15 min	50%
Cs_2CO_3 for enolate formation	0 %
2 equiv. malonate	Traces
40 °C, 12 h	58%
2.2 equiv. 2-I-pyr	***83% (isolated)***
2.2 equiv. 2-I-pyr, 2-Me-4-NO_2-PNO	79%
2.2 equiv. 2-I-pyr, 2-Cl-PNO	84%

[a]NMR yield determined using 1,3,5-trimethoxybenzene as internal standard.

3. Amides

3.1. Synthesis of Amides

General Procedure A:

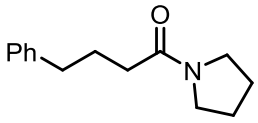
To a solution of the amine (1.00 equiv.) and triethylamine (2.00 equiv.) in DCM (0.1 M) at 0°C, the corresponding acyl chloride (1.20 equiv.) was added dropwise and the resulting reaction mixture was allowed to warm to room temperature while stirring overnight (14 h). After this time, a saturated aqueous solution of sodium bicarbonate was added and the biphasic system was separated. The aqueous phase was extracted with DCM (1 ×) and the organic phases were combined and dried over anhydrous sodium sulfate. The dried solution was filtered and concentrated under reduced pressure. The resulting crude material was purified by flash column chromatography on silica gel (heptane/ethyl acetate) to afford the desired compound.

General Procedure B:

To a solution of the amine (1.00 equiv.), triethylamine (1.00 equiv.), hydroxybenzotriazole (HOBt, 1.00 equiv.) and 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride (EDCI*HCl, 1.00 equiv.) in DCM (0.1 M), the corresponding carboxylic acid was added and the resulting solution was stirred at room temperature overnight (14 h). After this time, the organic solution was extracted sequentially with 0.5 M aqueous hydrochloric acid, saturated aqueous sodium bicarbonate and saturated aqueous sodium chloride. The washed solution was dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure. The resulting crude material was purified by flash column chromatography on silica gel (heptane/ethyl acetate) to afford the desired compound.

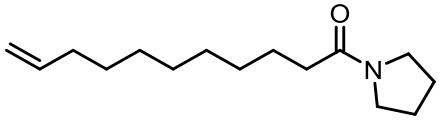
3.2. Characterization

4-Phenyl-1-(pyrrolidin-1-yl)butan-1-one (1a)



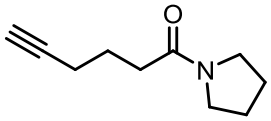
General Procedure A; (Quant.). All analytical data were in good accordance with data reported in the literature.[1]

1-(Pyrrolidin-1-yl)undec-10-en-1-one (1b)



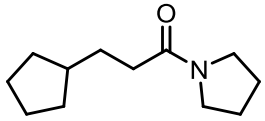
General Procedure A; (Quant.). All analytical data were in good accordance with data reported in the literature.[2]

1-(Pyrrolidin-1-yl)hex-5-yn-1-one (1c)



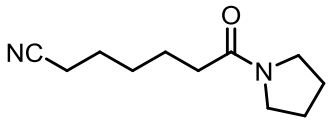
General Procedure B; (93%). All analytical data were in good accordance with data reported in the literature.[3]

3-Cyclopentyl-1-(pyrrolidin-1-yl)propan-1-one (1d)



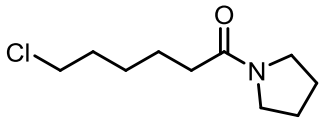
General Procedure A; (Quant.). All analytical data were in good accordance with data reported in the literature.[1]

7-Oxo-7-(pyrrolidin-1-yl)heptanenitrile (1e)



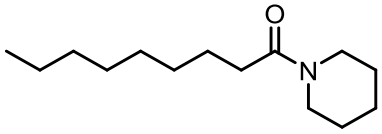
(Quant.). Prepared according to the procedure reported in the literature.[4] All analytical data were in good accordance with data reported in the literature.

6-Chloro-1-(pyrrolidin-1-yl)hexan-1-one (1f)



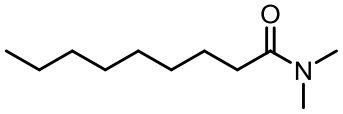
General Procedure A; (Quant.). All analytical data were in good accordance with data reported in the literature.[4]

1-(Piperidin-1-yl)nonan-1-one (1g)



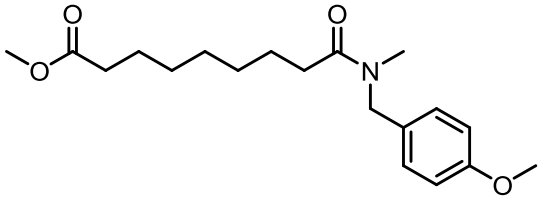
General Procedure A; (Quant.). All analytical data were in good accordance with data reported in the literature.[5]

***N,N*-Dimethylnonanamide (1h)**



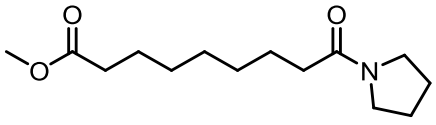
General Procedure A; (Quant.). All analytical data were in good accordance with data reported in the literature.[6]

Methyl 9-((4-methoxybenzyl)(methyl)amino)-9-oxononanoate (1i)



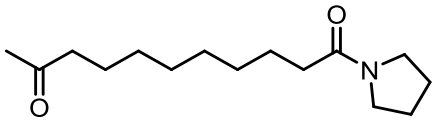
General Procedure B; (95%). All analytical data were in good accordance with data reported in the literature.[3]

Methyl 9-oxo-9-(pyrrolidin-1-yl)nonanoate (1j)



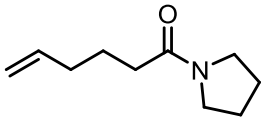
General Procedure B; (95%). All analytical data were in good accordance with data reported in the literature.[4]

1-(Pyrrolidin-1-yl)undecane-1,10-dione (1k)



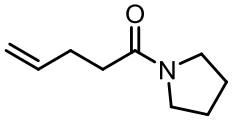
(48%). Prepared according to the procedure reported in the literature. All analytical data were in good accordance with data reported in the literature.[1]

1-(Pyrrolidin-1-yl)hex-5-en-1-one (1l)



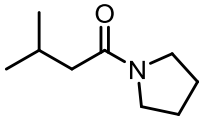
General Procedure B; (87%). All analytical data were in good accordance with data reported in the literature.[3]

1-(Pyrrolidin-1-yl)pent-4-en-1-one (1m)



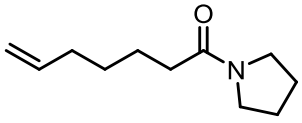
General Procedure B; (82%). All analytical data were in good accordance with data reported in the literature.[7]

3-Methyl-1-(pyrrolidin-1-yl)butan-1-one (1n)



General Procedure B; (Quant.). All analytical data were in good accordance with data reported in the literature.[3]

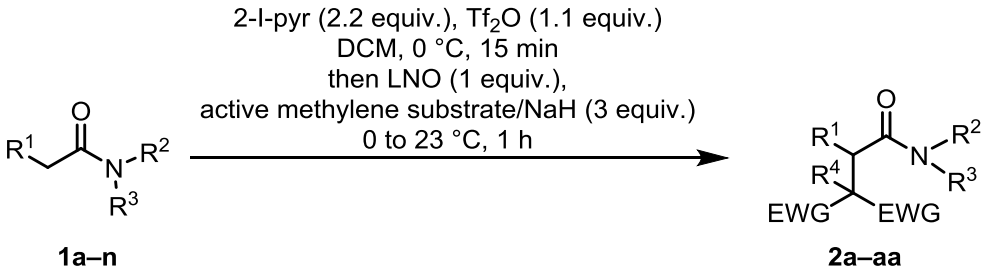
1-(Pyrrolidin-1-yl)hept-6-en-1-one (1o)



General Procedure B; (Quant.). All analytical data were in good accordance with data reported in the literature.[8]

4. Products of Cross-Enolate Coupling

4.1. General Procedure C – Sodium Hydride



1a–n **2a–aa**

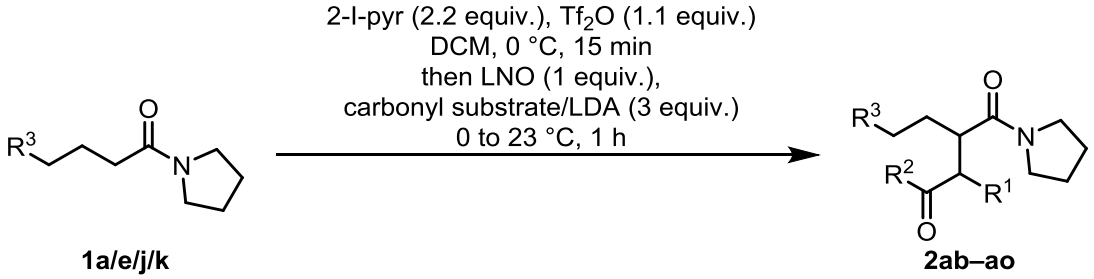
All reactions were run on a 0.2 mmol scale.

To a solution of amide **1** (1.00 equiv.) and 2-iodopyridine (2.20 equiv.) in dichloromethane (2 mL, 0.1M) at 0 °C was added triflic anhydride (1.10 equiv.) and the resulting mixture was stirred at 0 °C and colouration of the solution was observed. After 15 min, 2,6-lutidine *N*-oxide (1.00 equiv.) was added in one portion and the reaction mixture was stirred at 0 °C for 1 min. After this time, and the observation of colour-change or decolourisation, a pre-formed solution of the corresponding active methylene substrate (3.00 equiv.) and sodium hydride (60%, 3.00 equiv.) – for the preparation, see below – was added. The resulting mixture was allowed to warm to ambient temperature (25 °C) over the course of 1 h, after which time a saturated aqueous solution of ammonium chloride (5 mL) was added. The biphasic mixture was separated and the aqueous phase was extracted with dichloromethane (2 × 5 mL). The combined organic phases were dried over anhydrous sodium sulfate, the dried solution was filtered and the filtrate was concentrated under reduced pressure. The crude residue was purified by flash column chromatography (SiO_2, heptanes/ethyl acetate or toluene/ethyl acetate) to afford the compounds **2**.

Sodium enolate formation:

To a solution of the malonate (3.00 equiv.) in THF (1 mL, 0.6M) at 0 °C was added sodium hydride (60%, 3.00 equiv.) in one portion. The resulting suspension was stirred at 0 °C for 30 min, until complete disappearance of the solids was observed.

4.2. General Procedure D – Lithium Diisopropylamide



All reactions were run on a 0.2 mmol scale.

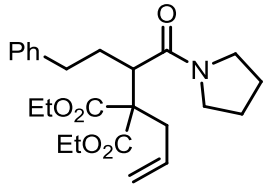
To a solution of amide **1** (1.00 equiv.) and 2-iodopyridine (2.20 equiv.) in dichloromethane (2 mL, 0.1M) at 0 °C was added triflic anhydride (1.10 equiv.) and the resulting mixture was stirred at 0 °C and colouration of the solution was observed. After 15 min, 2,6-lutidine *N*-oxide (1.00 equiv.) was added in one portion and the reaction mixture was stirred at 0 °C for 1 min. After this time, and the observation of colour-change or decolourisation, a pre-formed solution of the corresponding carbonyl substrate (3.00 equiv.) and lithium di*iso*propylamide (freshly prepared; 3.00 equiv.) – for the preparation, see below – was added. The resulting mixture was allowed to warm to ambient temperature (25 °C) over the course of 1 h, after which time a saturated aqueous solution of ammonium chloride (5 mL) was added. The biphasic mixture was separated and the aqueous phase was extracted with dichloromethane (2 × 5 mL). The combined organic phases were dried over anhydrous sodium sulfate, the dried solution was filtered and the filtrate was concentrated under reduced pressure. The crude residue was purified by flash column chromatography (SiO_2, heptanes/ethyl acetate or toluene/ethyl acetate) to afford the compounds **2**.

Lithium enolate formation:

To a solution of di*iso*propylamine (3.8 equiv.) in THF (1 mL, 0.76m) at –78 °C, *n*-butyllithium (1.6M in hexanes, 3.50 equiv.) was added. After stirring at the same temperature for 5 min, the malonate (3.00 equiv.) was slowly added and the resulting solution was allowed to stir at –78 °C for 15 min.

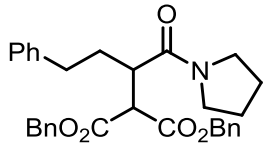
4.3. Characterization

Diethyl 2-allyl-2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (2a)



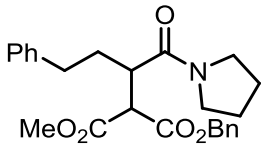
83% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.23–7.15 (m, 2H), 7.13–7.06 (m, 3H), 5.81–5.66 (m, 1H), 5.04–4.95 (m, 2H), 4.22–4.13 (m, 2H), 4.08 (q, *J* = 7.1 Hz, 2H), 3.52–3.34 (m, 3H), 3.26–3.18 (m, 1H), 3.15 (dd, *J* = 10.8, 3.1 Hz, 1H), 2.83–2.74 (m, 1H), 2.64–2.42 (m, 3H), 2.34–2.21 (m, 1H), 2.05–1.94 (m, 1H), 1.84–1.72 (m, 4H), 1.22–1.18 (m, 3H), 1.16 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.3, 170.6, 170.2, 141.6, 133.9, 128.5, 128.4, 126.1, 118.5, 61.4, 61.3, 60.6, 47.7, 47.3, 45.9, 38.5, 34.3, 31.8, 26.2, 24.5, 14.2; **IR (neat) ν_{max}:** 2978, 2925, 2874, 1727, 1638, 1496, 1440, 1367, 1285, 1221 1029, 919, 863, 749, 701; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{24}H_{33}NO_5Na$) requires *m*/*z* 438.2251, found *m*/*z* 438.2250.

Dibenzyl 2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (2b)



89% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.33–7.27 (m, 8H), 7.26–7.20 (m, 4H), 7.19–7.13 (m, 1H), 7.05–7.01 (m, 2H), 5.21–5.11 (m, 3H), 5.06–5.01 (m, 1H), 4.08 (d, *J* = 10.9 Hz, 1H), 3.62 (dt, *J* = 9.6, 6.6 Hz, 1H), 3.47–3.37 (m, 2H), 3.35–3.28 (m, 1H), 3.23 (dt, *J* = 10.0, 6.7 Hz, 1H), 2.67–2.58 (m, 1H), 2.55–2.46 (m, 1H), 1.96–1.70 (m, 6H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.3, 168.6, 168.3, 141.2, 135.4, 135.3, 128.7 (2C), 128.6 (2C), 128.5, 128.5 (3C), 128.4, 128.3 (2C), 128.2 (2C), 126.2, 67.5, 67.4, 54.9, 46.9, 46.0, 42.7, 32.5, 32.2, 26.1, 24.4; **IR (neat) ν_{max}:** 2953, 1733, 1635, 1454, 1377, 1344, 1143, 750, 699; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{31}H_{33}NO_5Na$) requires *m*/*z* 521.2251, found *m*/*z* 522.2252.

1-Benzyl 3-methyl 2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (2c)

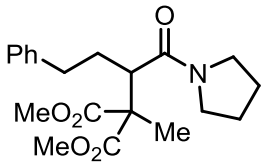


87% yield (2 mmol: 89%), d.r. 1.2:1.

Diastereomer 1: **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.37–7.26 (m, 6H), 7.26–7.12 (m, 4H), 5.19 (d, *J* = 12.4 Hz, 1H), 5.04 (d, *J* = 12.4 Hz, 1H), 4.05 (d, *J* = 10.9 Hz, 1H), 3.71 (s, 3H), 3.65–3.61 (m, 1H), 3.44–3.38 (m, 2H), 3.34–3.29 (m, 1H), 3.28–3.23 (m, 1H), 2.69–2.63 (m, 1H), 2.58–2.51 (m, 1H), 1.97–1.90 (m, 1H), 1.87–1.74 (m, 5H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 171.3, 169.2, 168.3, 141.2, 135.4, 128.6 (2C), 128.5 (2C), 128.4, 128.4 (2C), 128.1 (2C), 126.2, 67.3, 54.8, 52.8, 46.9, 45.9, 42.6, 32.6, 32.4, 26.0, 24.4; **IR (neat) ν_{max}:** 2952, 1735, 1635, 1453, 1343, 1191, 1148, 750, 700; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{25}H_{29}NO_5Na$) requires *m*/*z* 446.1938, found *m*/*z* 446.1939.

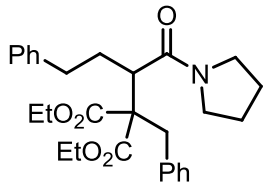
Diastereomer 2: **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.37–7.29 (m, 5H), 7.23 (d, *J* = 7.6 Hz, 2H), 7.17 (d, *J* = 7.6 Hz, 1H), 7.02 (d, *J* = 7.6 Hz, 2H), 5.24–5.17 (m, 2H), 4.05 (d, *J* = 10.9 Hz, 1H), 3.74–3.69 (m, 1H), 3.65 (s, 3H), 3.53–3.48 (m, 1H), 3.45–3.39 (m, 1H), 3.32–3.23 (m, 2H), 2.65–2.59 (m, 1H), 2.51–2.45 (m, 1H), 1.96–1.79 (m, 5H), 1.74–1.67 (m, 1H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 171.4, 168.9, 168.7, 141.1, 135.3, 128.7 (2C), 128.6, 128.5 (2C), 128.5 (2C), 128.3 (2C), 126.1, 67.5, 54.6, 52.7, 46.9, 46.0, 42.6, 32.5, 32.1, 26.1, 24.5; **IR (neat) ν_{max}:** 2954, 1750, 1734, 1635, 1452, 1199, 1115, 751, 700; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{25}H_{29}NO_5Na$) requires *m*/*z* 446.1938, found *m*/*z* 446.1939.

Dimethyl 2-methyl-2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (2d)



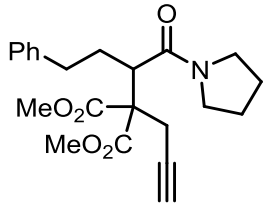
89% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.29–7.24 (m, 2H), 7.20–7.15 (m, 3H), 3.73 (s, 3H), 3.67 (s, 3H), 3.56 (dt, *J* = 10.2, 6.5 Hz, 1H), 3.46 (t, *J* = 6.6 Hz, 2H), 3.35 (dd, *J* = 10.9, 3.1 Hz, 1H), 3.27 (dt, *J* = 10.0, 6.5 Hz, 1H), 2.71–2.61 (m, 1H), 2.57–2.48 (m, 1H), 2.28–2.17 (m, 1H), 1.94–1.79 (m, 5H), 1.61 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 172.2, 171.7, 171.4, 141.4, 128.5 (2C), 128.4 (2C), 126.2, 57.1, 52.8, 52.7, 47.3, 46.7, 45.9, 33.9, 31.1, 26.3, 24.6, 17.8; **IR (neat) ν_{max}:** 2953, 1735, 1636, 1451, 1435, 1253, 1121; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{20}H_{27}NO_5Na$) requires *m*/*z* 384.1781, found *m*/*z* 384.1778.

Diethyl 2-benzyl-2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (2e)



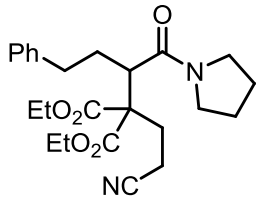
70% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.32–7.13 (m, 10H), 4.33–4.20 (m, 2H), 4.11–4.04 (m, 1H), 3.98–3.92 (m, 1H), 3.60–3.55 (m, 1H), 3.54–3.47 (m, 2H), 3.31 (d, *J* = 14.1 Hz, 1H), 3.23–3.16 (m, 3H), 2.71–2.63 (m, 1H), 2.54–2.45 (m, 1H), 2.38–2.29 (m, 1H), 2.17–2.09 (m, 1H), 1.90–1.79 (m, 4H), 1.28 (t, *J* = 7.1 Hz, 3H), 1.07 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 171.4, 170.7, 170.4, 141.5, 136.8, 130.4 (2C), 128.4 (2C), 128.4 (2C), 128.1 (2C), 126.9, 126.1, 61.4, 61.3, 47.7, 47.1, 45.9, 39.3, 34.1, 32.1, 29.8, 26.2, 24.5, 14.1, 13.8; **IR (neat) ν_{max}:** 3061, 3027, 2954, 2923, 2854, 1721, 1634, 1495, 1437, 1389, 1367, 1246, 1221, 1185, 1091, 1029, 917, 863, 777, 745, 700; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{28}H_{35}NO_5Na$) requires *m*/*z* 488.2407, found *m*/*z* 488.2410.

Dimethyl 2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)-2-(prop-2-yn-1-yl)malonate (2f)



62% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.28–7.24 (m, 2H), 7.22–7.12 (m, 3H), 3.76 (s, 3H), 3.72 (s, 1H), 3.52–3.47 (m, 2H), 3.46–3.41 (m, 1H), 3.32–3.27 (m, 1H), 3.03 (dd, *J* = 17.4, 2.1 Hz, 1H), 2.84 (dd, *J* = 17.4, 2.1 Hz, 1H), 2.66–2.57 (m, 2H), 2.29–2.19 (m, 2H), 2.07 (t, *J* = 2.1 Hz, 1H), 1.91–1.80 (m, 4H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 171.1, 170.0, 169.9, 141.4, 128.4 (2C), 128.4 (2C), 126.1, 72.0, 59.3, 52.9, 52.8, 47.3, 46.7, 45.9, 34.2, 31.4, 29.8, 26.2, 24.5, 24.0; **IR (neat) ν_{max}:** 3229, 3223, 3026, 2952, 2923, 2873, 2853, 1731, 1629, 1495, 1435, 1340, 1282, 1202, 1054, 977, 747, 700; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{22}H_{27}NO_5Na$) requires *m*/*z* 408.1781, found *m*/*z* 408.1784.

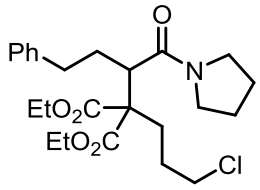
Diethyl 2-(2-cyanoethyl)-2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (2g)



73% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.29–7.26 (m, 2H), 7.19 (*app* t, *J* = 7.4 Hz, 1H), 7.15 (d, *J* = 7.1 Hz, 1H), 4.28–4.23 (m, 2H), 4.23–4.16 (m, 2H), 3.52–3.42 (m, 3H), 3.30–3.24 (m, 2H),

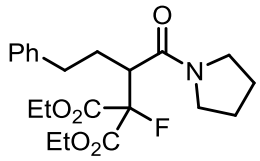
2.73–2.63 (m, 1H), 2.54–2.26 (m, 5H), 1.96–1.80 (m, 5H), 1.29–1.25 (m, 6H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 170.6, 169.8, 169.5, 140.9, 128.6, 128.4, 126.3, 119.7, 62.2, 62.0, 59.7, 48.1, 47.4, 46.1, 34.0, 31.6, 29.8, 28.6, 26.2, 24.5, 14.2, 14.1; **IR (neat) ν_{max}:** 2978, 2931, 1729, 1637, 1444, 1369, 1341, 1256, 1194, 1094, 1021, 750, 701; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{24}H_{33}N_2O_5$) requires *m*/*z* 429.2384, found *m*/*z* 429.2393.

Ethyl 2-(3-chloropropyl)-2-((ethylperoxy)-λ²-methyl)-5-phenyl-3-(pyrrolidine-1-carbonyl)pentanoate (2h)



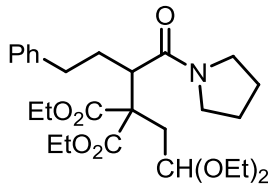
76% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.29–7.24 (m, 2H), 7.20–7.14 (m, 3H), 4.27–4.14 (m, 4H), 3.57–3.41 (m, 5H), 3.32–3.22 (m, 2H), 2.73–2.63 (m, 1H), 2.51 (ddd, *J* = 13.7, 9.7, 6.6 Hz, 1H), 2.41–2.30 (m, 1H), 2.16–1.79 (m, 8H), 1.68–1.56 (m, 1H), 1.30–1.22 (m, 6H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 171.1, 170.8, 170.3, 141.3, 128.5, 128.4, 126.1, 61.6, 61.4, 60.1, 48.1, 47.3, 45.9, 45.2, 34.1, 31.7, 31.1, 28.7, 26.2, 24.5, 14.2, 14.2; **IR (neat) ν_{max}:** 2977, 2875, 1726, 1638, 1442, 1368, 1340, 1299, 1249, 1214, 1163, 1095, 1027, 749, 701; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{24}H_{35}ClNO_5$) requires *m*/*z* 452.2198, found *m*/*z* 452.2207.

Ethyl 2-((ethylperoxy)-λ²-methyl)-2-fluoro-5-phenyl-3-(pyrrolidine-1-carbonyl)pentanoate (2i)



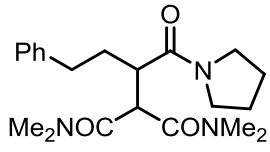
57% yield; **^{1}H NMR (700 MHz, $CDCl_3$)**: δ 7.28–7.24 (m, 2H), 7.19–7.13 (m, 3H), 4.33–4.30 (m, 2H), 4.28–4.21 (m, 2H), 3.56–3.45 (m, 3H), 3.39 (dt, *J* = 12.6, 6.4 Hz, 1H), 3.13 (*app* dt, *J* = 9.9, 6.6 Hz, 1H), 2.73–2.67 (m, 1H), 2.55 (ddd, *J* = 14.1, 9.1, 7.4 Hz, 1H), 2.33–2.27 (m, 1H), 2.08–2.01 (m, 1H), 1.91–1.77 (m, 4H), 1.31 (t, *J* = 7.1 Hz, 3H), 1.27 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (176 MHz, $CDCl_3$):** δ 168.6, 166.0 (d, *J* = 25 Hz), 165.6 (d, *J* = 25 Hz), 140.8, 128.5, 128.4, 126.3, 95.0 (d, *J* = 207 Hz), 62.9, 62.9, 47.6 (d, *J* = 20 Hz), 47.1, 46.0, 33.3, 28.9 (d, *J* = 6.4 Hz), 26.2, 24.5, 14.2, 14.0; **^{19}F NMR (659 MHz, $CDCl_3$):** δ -166.0. **IR (neat) ν_{max}:** 2978, 2876, 1748, 1642, 1442, 1392, 1369, 1340, 1231, 1095, 1049, 1021, 859, 751, 702; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{21}H_{29}FNO_5$) requires *m*/*z* 394.2024, found *m*/*z* 394.2038.

Ethyl 2-(2,2-diethoxyethyl)-2-((ethylperoxy)- λ²-methyl)-5-phenyl-3-(pyrrolidine-1-carbonyl)pentanoate (2j)



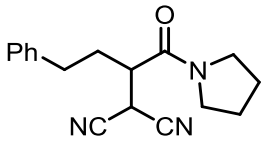
52% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.28–7.25 (m, 2H), 7.19–7.16 (m, 3H), 4.67 (dd, J = 7.0, 3.4 Hz, 1H), 4.31–4.11 (m, 4H), 3.65–3.50 (m, 5H), 3.44 (*app* dt, *J* = 12.3, 6.9 Hz, 1H), 3.37–3.25 (m, 3H), 2.65 (ddd, *J* = 13.9, 10.8, 5.2 Hz, 1H), 2.52 (ddd, *J* = 13.7, 10.2, 6.3 Hz, 1H), 2.41–2.34 (m, 2H), 2.12–2.03 (m, 2H), 1.94–1.79 (m, 4H), 1.30–1.24 (m, 6H), 1.18 (t, *J* = 7.1 Hz, 3H), 1.13 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 171.4, 170.6, 170.3, 141.5, 128.4, 128.4, 126.1, 100.9, 62.3, 61.9, 61.3, 61.3, 58.0, 48.8, 47.3, 45.9, 38.5, 34.3, 31.9, 26.2, 24.5, 15.5, 15.2, 14.2, 14.1; **IR (neat) ν_{max}:** 2975, 2931, 2874, 1725, 1636, 1438, 1369, 1341, 1288, 1226, 1196, 1118, 1095, 1057, 1028, 916, 865, 731, 700; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{27}H_{40}NNaO_7$) requires *m*/*z* 514.2781, found *m*/*z* 514.2766.

***N*^{1},*N*^{1},*N*^{3},*N*^{3}-tetramethyl-2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonamide (2k)**



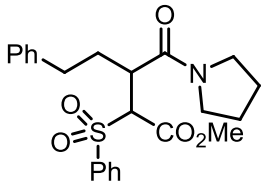
72 % yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.27–7.24 (m, 2H), 7.18–7.15 (m, 3H), 4.32 (d, *J* = 10.2 Hz, 1H), 3.97–3.92 (m, 1H), 3.58 (td, *J* = 10.2, 3.8 Hz, 1H), 3.42 (t, *J* = 6.6 Hz, 2H), 3.32 (dt, *J* = 10.0, 6.6 Hz, 1H), 3.11 (*s*, 3H), 3.02 (s, 3H), 2.98 (s, 3H), 2.89 (s, 3H), 2.67–2.54 (m, 2H), 1.99–1.75 (m, 6H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 172.8, 168.8, 168.7, 141.6, 128.5, 126.1, 50.0, 47.1, 46.0, 44.8, 37.7, 37.4, 36.5, 36.2, 33.5, 32.7, 26.1, 24.6; **IR (neat) ν_{max}:** 2927, 1634, 1496, 1455, 1399, 1259, 1140, 753, 702; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{21}H_{32}N_3O_3$) requires *m*/*z* 374.2438, found *m*/*z* 374.2434.

2-(1-Oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malononitrile (2l)



36% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.34–7.28 (m, 2H), 7.25–7.20 (m, 1H), 7.19–7.15 (m, 2H), 4.14 (d, *J* = 9.9 Hz, 1H), 3.62–3.54 (m, 1H), 3.49–3.39 (m, 2H), 3.20–3.10 (m, 2H), 2.80–2.61 (m, 2H), 2.23–2.16 (m, 2H), 1.98–1.83 (m, 4H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 167.2, 139.5, 128.9 (2C), 128.4 (2C), 126.9, 112.0, 112.0, 47.0, 46.5, 44.4, 32.2, 31.9, 26.1, 25.6, 24.3; **IR (neat) ν_{max}:** 2879, 1632, 1495, 1451, 1342, 752, 701; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{17}H_{19}N_3ONa$) requires *m*/*z* 304.1420, found *m*/*z* 304.1417.

Methyl 5-phenyl-2-(phenylsulfonyl)-3-(pyrrolidine-1-carbonyl)pentanoate (2m)



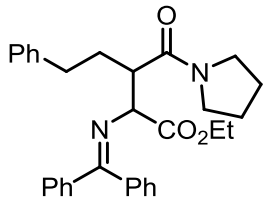
65% yield, d.r. 1.5:1. Diastereomer have not been separated.

Major diastereomer: **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.87–7.83 (m, 2H), 7.69–7.64 (m, 1H), 7.57–7.52 (m, 2H), 7.31–7.24 (m, 2H), 7.22–7.16 (m, 2H), 7.12 (d, J = 7.5 Hz, 1H), 4.68 (d, J = 10.7 Hz, 1H), 3.88–3.80 (m, 1H), 3.60 (s, 3H), 3.47–3.43 (m, 1H), 3.32–3.25 (m, 2H), 3.20–3.15 (m, 1H), 2.70–2.51 (m, 2H), 2.02–1.94 (m, 2H), 1.94–1.73 (m, 4H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 169.2, 165.5, 140.6, 138.8, 134.4, 134.3, 129.2, 129.1, 129.1, 128.6, 128.5, 128.5, 128.3, 126.3, 72.9, 53.1, 47.1, 46.2, 40.8, 32.8, 32.4, 26.1, 24.4.

Minor diastereomer, caracteristic signals: **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 4.43 (d, J = 9.9 Hz, 1H), 3.59–3.49 (m, 3H), 3.36 (s, 3H), 2.80–2.73 (m, 1H), 2.35–2.28 (m, 1H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 170.2, 166.6, 140.9, 138.0, 126.2, 72.5, 52.9, 47.0, 46.0, 41.9, 32.3, 32.1, 26.0.

Mixture: **IR (neat) ν_{max}:** 3060, 3026, 2952, 2876, 2665, 1734, 1631, 1445, 1325, 1226, 1143, 1082, 914, 732, 689; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{23}H_{27}NO_5SNa$) requires *m*/*z* 452.1502, found *m*/*z* 452.1517.

Ethyl 2-((diphenylmethylene)amino)-5-phenyl-3-(pyrrolidine-1-carbonyl)pentanoate (2n)

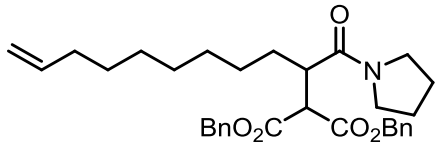


56% yield, d.r. 1.1:1.

Diastereomer 1: **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.52 (d, *J* = 7.7 Hz, 2H), 7.47–7.40 (m, 3H), 7.35 (t, *J* = 7.2 Hz, 1H), 7.30–7.22 (m, 4H), 7.20 (d, *J* = 7.0 Hz, 2H), 7.17–7.12 (m, 3H), 4.27 (d, *J* = 9.9 Hz, 1H), 4.16–4.05 (m, 2H), 4.00–3.95 (m, 1H), 3.53–3.47 (m, 1H), 3.40–3.34 (m, 1H), 3.34–3.28 (m, 1H), 3.20–3.14 (m, 1H), 2.69–2.63 (m, 1H), 2.54–2.48 (m, 1H), 2.05–1.97 (m, 1H), 1.89–1.83 (m, 1H), 1.81–1.64 (m, 4H), 1.20 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 171.4, 171.2, 171.0, 141.5, 139.5, 135.7, 130.4, 128.8 (2C), 128.7, 128.5 (2C), 128.4 (2C), 128.3 (2C), 128.2 (2C), 128.0 (2C), 126.0, 69.3, 61.0, 47.1, 47.0, 45.8, 33.5, 30.5, 26.1, 24.6, 14.2; **IR (neat) ν_{max}:** 3059, 3027, 2923, 2853, 1736, 1658, 1633, 1578, 1493, 1447, 1277, 1182, 1156, 1001, 700; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{31}H_{34}N_2O_3Na$) requires *m*/*z* 505.2462, found *m*/*z* 505.2459.

Diastereomer 2: **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.58–7.54 (m, 2H), 7.36–7.30 (m, 4H), 7.28–7.23 (m, 2H), 7.20–7.05 (m, 7H), 4.43 (d, *J* = 9.0 Hz, 1H), 4.02 (q, *J* = 7.1 Hz, 2H), 3.60–3.51 (m, 1H), 3.37–3.27 (m, 3H), 3.22–3.15 (m, 1H), 2.60–2.50 (m, 1H), 2.49–2.40 (m, 1H), 1.84–1.70 (m, 6H), 1.14 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 172.2, 172.0, 171.3, 141.8, 139.8, 136.2, 130.5, 129.1 (2C), 128.9, 128.6 (2C), 128.5 (4C), 128.3 (2C), 128.2 (2C), 126.0, 67.7, 61.2, 46.8, 46.4, 45.8, 33.0, 31.1, 26.2, 24.5, 14.2; **IR (neat) ν_{max}:** 3058, 3025, 2923, 2855, 1731, 1629, 1576, 1492, 1440, 1186, 1027, 696; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{31}H_{34}N_2O_3Na$) requires *m*/*z* 505.2462, found *m*/*z* 505.2459.

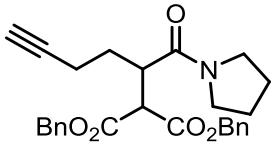
Dibenzyl 2-(1-oxo-1-(pyrrolidin-1-yl)undec-10-en-2-yl)malonate (2o)



69% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.32–7.27 (m, 8H), 7.25–7.21 (m, 2H), 5.79 (ddt, *J* = 16.9, 10.2, 6.7 Hz, 1H), 5.18–5.11 (m, 3H), 5.03–4.90 (m, 3H), 4.03 (d, *J* = 10.9 Hz, 1H), 3.72–3.67 (m, 1H), 3.44–3.37 (m, 3H), 3.23 (td, *J* = 10.2, 3.9 Hz, 1H), 2.04–1.99 (m, 2H), 1.90–1.83 (m, 2H), 1.82–1.76 (m, 2H), 1.58–1.51 (m, 1H), 1.36–1.30 (m, 3H), 1.26–1.11 (m, 8H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 171.8, 168.7, 168.3, 139.2, 135.3 (2C), 128.6 (2C), 128.6 (2C), 128.5, 128.4 (2C), 128.3, 128.1 (2C), 114.3, 67.3 (2C), 54.9, 46.9, 45.8, 43.0, 33.8, 31.0, 29.7, 29.3, 29.1, 28.9, 26.4, 26.0, 24.4; **IR**

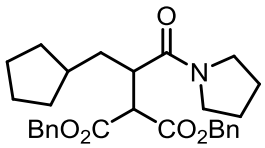
(neat) ν_{max}: 3066, 3033, 2925, 2854, 1730, 1634, 1498, 1441, 1379, 1165, 1141, 998, 909, 738, 697; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{32}H_{41}NO_5Na$) requires *m*/*z* 542.2877, found *m*/*z* 542.2878.

Dibenzyl 2-(1-oxo-1-(pyrrolidin-1-yl)hex-5-yn-2-yl)malonate (2p)



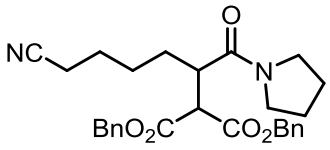
55% yield; **^{1}H NMR (500 MHz, $CDCl_3$)**: δ 7.32–7.27 (m, 8H), 7.24–7.21 (m, 2H), 5.19 (d, *J* = 12.3 Hz, 1H), 5.15–5.10 (m, 2H), 5.02 (d, *J* = 12.3 Hz, 1H), 4.00 (d, *J* = 10.8 Hz, 1H), 3.75–3.68 (m, 1H), 3.65–3.59 (m, 1H), 3.47–3.36 (m, 3H), 2.26–2.19 (m, 1H), 2.12–2.05 (m, 1H), 1.95 (t, *J* = 2.6 Hz, 1H), 1.92–1.75 (m, 5H), 1.70–1.62 (m, 1H); **^{13}C NMR (126 MHz, $CDCl_3$):** δ 170.9, 168.2, 168.0, 135.2, 135.2, 128.7 (2C), 128.6 (2C), 128.5, 128.3 (br.), 128.1 (2C), 69.3, 67.5, 67.4, 54.8, 47.1, 46.0, 41.7, 29.9, 26.0, 24.4, 15.8; **IR (neat) ν_{max}:** 3288, 3065, 3034, 2953, 2927, 2877, 1498, 1730, 1631, 1498, 1452, 1378, 1221, 1189, 1145, 1001, 744, 698; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{27}H_{29}NO_5Na$) requires *m*/*z* 470.1938, found *m*/*z* 470.1935.

Dibenzyl 2-(3-cyclopentyl-1-oxo-1-(pyrrolidin-1-yl)propan-2-yl)malonate (2q)



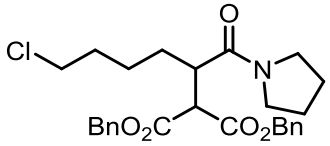
59% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.33–7.28 (m, 8H), 7.25–7.22 (m, 2H), 5.19–5.10 (m, 3H), 5.03–5.00 (m, 1H), 3.96 (d, *J* = 10.8 Hz, 1H), 3.76 (dt, *J* = 9.8, 6.6 Hz, 1H), 3.46–3.36 (m, 3H), 3.24 (td, *J* = 10.6, 3.6 Hz, 1H), 1.91–1.83 (m, 2H), 1.82–1.77 (m, 2H), 1.74–1.68 (m, 1H), 1.68–1.72 (m, 3H), 1.52–1.38 (m, 4H), 1.24 1.18 (m, 1H), 1.03–0.94 (m, 2H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 172.1, 168.6, 168.3, 135.4, 135.3, 128.7 (2C), 128.6 (2C), 128.6 (2C), 128.5, 128.4, 128.1 (2C), 67.4, 67.3, 55.7, 47.1, 46.0, 42.5, 38.0, 37.2, 33.4, 32.9, 26.1, 25.4, 25.4, 24.4; **IR (neat) ν_{max}:** 2950, 1749, 1734, 1449, 1341, 1168, 749, 698; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{29}H_{36}NO_5$) requires *m*/*z* 478.2588, found *m*/*z* 478.2593.

Dibenzyl 2-(6-cyano-1-oxo-1-(pyrrolidin-1-yl)hexan-2-yl)malonate (2r)



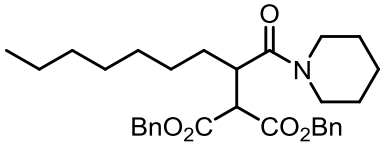
85% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.35–7.28 (m, 8H), 7.26–7.22 (m, 2H), 5.20–5.10 (m, 3H), 5.05–5.00 (m, 1H), 4.00 (d, *J* = 10.9 Hz, 1H), 3.71 (dt, *J* = 9.7, 6.7 Hz, 1H), 3.44–3.36 (m, 3H), 3.28–3.20 (m, 1H), 2.19 (td, *J* = 7.1, 2.0 Hz, 2H), 1.96–1.75 (m, 4H), 1.59–1.43 (m, 3H), 1.40–1.29 (m, 3H); **^{13}C NMR (175 MHz, $CDCl_3$):** δ 171.3, 168.5, 168.1, 135.3, 135.3, 128.7 (2C), 128.7, 128.6 (2C), 128.6 (2C), 128.4, 128.2 (2C), 119.5, 67.4, 67.4, 54.7, 47.1, 46.0, 42.7, 30.0, 26.0, 25.5 (2C), 24.4, 17.0; **IR (neat) ν_{max}:** 2951, 1731, 1632, 1453, 1261, 1144, 1003, 751, 699; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{28}H_{33}N_2O_5$) requires *m*/*z* 477.2384, found *m*/*z* 477.2387.

Dibenzyl 2-(6-chloro-1-oxo-1-(pyrrolidin-1-yl)hexan-2-yl)malonate (2s)



73% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.33–7.27 (m, 8H), 7.25–7.21 (m, 2H), 5.15 (s, 2H), 5.13 (d, *J* = 12.4 Hz, 1H), 5.02 (d, *J* = 12.4 Hz, 1H), 4.01 (d, *J* = 10.9 Hz, 1H), 3.74–3.66 (m, 1H), 3.46–3.36 (m, 5H), 3.28–3.21 (m, 1H), 1.92–1.74 (m, 4H), 1.65–1.54 (m, 3H), 1.40–1.33 (m, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.4, 168.5, 168.2, 135.3 (2C), 128.7 (2C), 128.6 (2C), 128.5 (2C), 128.3 (2C), 128.1 (2C), 67.4, 67.3, 54.8, 47.0, 45.9, 44.6, 42.8, 32.6, 30.2, 26.0, 24.4, 23.7; **IR (neat) ν_{max}:** 3064, 3034, 2953, 2875, 1732, 1634, 1498, 1452, 1377, 1342, 1143, 1002, 910, 740, 699; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{27}H_{32}ClNO_5Na$) requires *m*/*z* 508.1861, found *m*/*z* 508.1860.

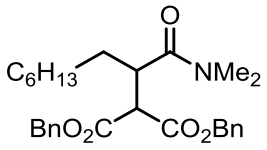
Dibenzyl 2-(1-oxo-1-(piperidin-1-yl)nonan-2-yl)malonate (2t)



59% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.26–7.19 (m, 8H), 7.19–7.15 (m, 2H), 5.08–5.04 (m, 3H), 4.96 (d, *J* = 12.4 Hz, 1H), 4.00 (d, *J* = 10.8 Hz, 1H), 3.47–3.39 (m, 4H), 1.63–1.51 (m, 3H), 1.46–1.37 (m, 4H), 1.31–1.23 (m, 1H), 1.21–1.01 (m, 11H), 0.79 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.5, 168.8, 168.3, 135.5, 135.4, 128.6, 128.6, 128.5, 128.4, 128.2, 128.1, 67.3, 67.2, 54.9, 47.3, 43.2, 40.4, 31.9, 30.8, 29.8, 29.1, 26.4, 26.3, 25.8, 24.7, 22.7, 14.2; **IR (neat) ν_{max}:** 3065,

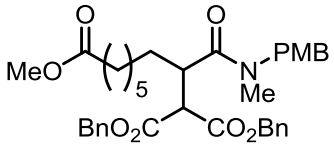
3033, 2925, 2854, 1749, 1731, 1631, 1498, 1453, 1376, 1251, 1175, 1137, 1003, 737, 697; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{31}H_{41}NO_5Na$) requires *m*/*z* 530.2877, found *m*/*z* 530.2880.

Dibenzyl 2-(1-(dimethylamino)-1-oxononan-2-yl)malonate (2u)



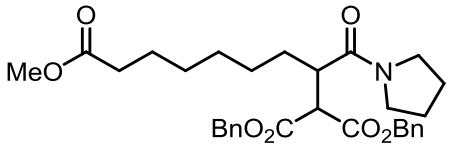
74% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.30–7.23 (m, 8H), 7.22–7.19 (m, 2H), 5.15–5.06 (m, 3H), 5.00–4.94 (m, 1H), 3.99 (dd, *J* = 10.8, 4.1 Hz, 1H), 3.41 (ddd, *J* = 10.8, 9.0, 4.1 Hz, 1H), 3.03 (s, 3H), 2.86 (s, 3H), 1.53–1.43 (m, 1H), 1.36–1.26 (m, 1H), 1.26–1.05 (m, 10H), 0.82 (t, *J* = 7.0 Hz, 3H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 173.5, 168.7, 168.4, 135.4, 135.4, 128.7, 128.6, 128.5, 128.4, 128.3, 128.2, 67.3, 67.3, 55.1, 40.7, 37.8, 35.9, 31.9, 31.1, 29.8, 29.2, 26.4, 22.7, 14.2. **IR (neat) ν_{max}:** 2926, 2856, 1731, 1641, 1498, 1456, 1415, 1401, 1377, 1341, 1234, 1214, 1143, 1002, 748, 698; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{28}H_{38}NO_5$) requires *m*/*z* 468.2744, found *m*/*z* 468.2756.

1,1-dibenzyl 8-methyl 2-((4-methoxybenzyl)(methyl)carbamoyl)octane-1,1,8-tricarboxylate (2v)



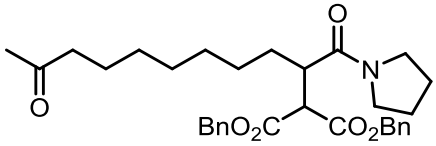
51% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.36–7.22 (m, 10H), 7.21–7.12 (m, 2H), 6.90–6.79 (m, 2H), 5.21–5.04 (m, 4H), 4.61–4.35 (m, 2H), 4.11–4.06 (m, 1H), 3.83–3.74 (m, 3H), 3.66 (s, 3H), 3.62–3.44 (m, 1H), 2.98–2.75 (m, 3H), 2.28–2.22 (m, 2H), 1.58–1.33 (m, 4H), 1.30–1.06 (m, 6H) (rotameric effects present); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 174.2, 173.4, 173.3, 168.6, 168.4, 168.3, 159.2, 159.1, 135.5, 135.4, 135.4, 129.6, 129.5, 128.7, 128.7, 128.6, 128.5, 128.5, 128.4, 128.3, 128.2, 128.1, 128.1, 114.3, 114.0, 67.4, 67.3, 55.4, 55.0, 54.6, 53.1, 51.5, 50.6, 41.0, 40.9, 35.1, 34.1, 33.6, 30.9, 29.5, 28.9, 26.0, 24.9 (rotameric effects present); **IR (neat) ν_{max}:** 2936, 2858, 1733, 1639, 1613, 1512, 1456, 1246, 1175, 1033, 751, 699; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{36}H_{43}NO_8$) requires *m*/*z* 618.3061, found *m*/*z* 618.3069.

1,1-Dibenzyl 8-methyl 2-(pyrrolidine-1-carbonyl)octane-1,1,8-tricarboxylate (2w)



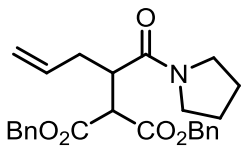
68% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.31–7.27 (m, 8H), 7.24–7.20 (m, 2H), 5.15–5.09 (m, 3H), 5.00 (d, *J* = 12.4 Hz, 1H), 4.01 (d, *J* = 10.9 Hz, 1H), 3.72–3.66 (m, 1H), 3.64 (s, 3H), 3.43–3.36 (m, 3H), 3.26–3.18 (m, 1H), 2.25 (t, *J* = 7.5 Hz, 2H), 1.89–1.74 (m, 4H), 1.58–1.49 (m, 3H), 1.30–1.12 (m, 7H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 174.2, 171.7, 168.6, 168.3, 135.4 (2C), 128.6, 128.5, 128.5, 128.4, 128.3, 128.1, 67.3 (2C), 54.9, 51.5, 46.9, 45.8, 43.0, 34.0, 30.9, 29.4, 28.9, 26.3, 26.0, 24.9, 24.4; **IR (neat) ν_{max}:** 3033, 2931, 2858, 1730, 1633, 1498, 1439, 1212, 1002, 749, 698; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{31}H_{39}NO_7Na$) requires *m*/*z* 560.2619, found *m*/*z* 560.2615.

Dibenzyl 2-(1,10-dioxo-1-(pyrrolidin-1-yl)undecan-2-yl)malonate (2x)



67% yield (88% brsm); **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.31–7.26 (m, 8H), 7.23–7.19 (m, 2H), 5.14–5.09 (m, 3H), 5.00 (d, *J* = 12.4 Hz, 1H), 4.00 (d, *J* = 10.9 Hz, 1H), 3.71–3.64 (m, 1H), 3.43–3.34 (m, 3H), 3.25–3.18 (m, 1H), 2.37 (t, *J* = 7.4 Hz, 2H), 2.10 (s, 3H), 1.90–1.74 (m, 4H), 1.54–1.46 (m, 3H), 1.36–1.28 (m, 1H), 1.26–1.10 (m, 8H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 209.2, 171.7, 168.6, 168.2, 135.3 (2C), 128.6, 128.5, 128.4, 128.3, 128.3, 128.0, 67.2 (2C), 54.9, 46.9, 45.8, 43.7, 43.0, 30.9, 29.9, 29.6, 29.1, 29.1, 26.3, 26.0, 24.3, 23.8; **IR (neat) ν_{max}:** 3065, 3034, 2928, 2856, 1732, 1634, 1498, 1452, 1345, 1260, 1166, 1001, 749, 699; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{32}H_{41}NO_6Na$) requires *m*/*z* 558.2826, found *m*/*z* 558.2825.

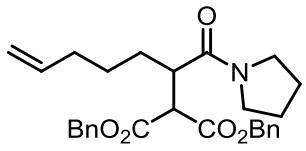
Dibenzyl 2-(1-oxo-1-(pyrrolidin-1-yl)pent-4-en-2-yl)malonate (2y)



70% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.34–7.27 (m, 8H), 7.25–7.21 (m, 2H), 5.68 (ddt, *J* = 17.4, 10.1, 7.3 Hz, 1H), 5.20–5.08 (m, 3H), 5.05–4.95 (m, 3H), 4.04 (d, *J* = 10.8 Hz, 1H), 3.64–3.56 (m, 1H), 3.46–3.35 (m, 3H), 3.35–3.27 (m, 1H), 2.36–2.26 (m, 1H), 2.22–2.14 (m, 1H), 1.88–1.74 (m, 4H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.9, 168.4, 168.1, 135.3, 135.3, 133.9, 128.6, 128.6, 128.5, 128.3, 128.3, 128.1, 118.0, 67.3 (2C), 54.5, 46.8, 45.8, 43.0, 35.0, 26.0, 24.4; **IR (neat) ν_{max}:** 3065, 3034, 2971, 2876,

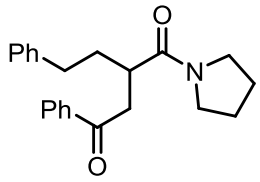
1730, 1632, 1498, 1448, 1218, 1167, 1146, 999, 915, 748, 698; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{26}H_{29}NO_5Na$) requires *m*/*z* 458.1938, found *m*/*z* 458.1937.

Dibenzyl 2-(1-oxo-1-(pyrrolidin-1-yl)hept-6-en-2-yl)malonate (2z)



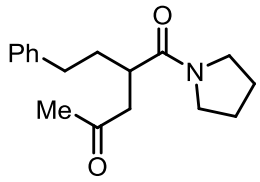
61% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.34–7.27 (m, 8H), 7.25–7.20 (m, 2H), 5.68 (ddt, *J* = 16.9, 10.2, 6.7 Hz, 1H), 5.16–5.10 (m, 3H), 5.02 (d, *J* = 12.4 Hz, 1H), 4.97–4.87 (m, 2H), 4.03 (d, *J* = 10.9 Hz, 1H), 3.74–3.66 (m, 1H), 3.46–3.35 (m, 3H), 3.29–3.20 (m, 1H), 1.94–1.73 (m, 6H), 1.61–1.52 (m, 1H), 1.41–1.23 (m, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 171.7, 168.6, 168.3, 138.2, 135.4 (2C), 128.6, 128.6, 128.5, 128.4, 128.3, 128.1, 114.9, 67.3 (2C), 54.9, 46.9, 45.9, 43.0, 33.8, 30.5, 26.0, 25.7, 24.4; **IR (neat) ν_{max}:** 3066, 3034, 2929, 2874, 1731, 1634, 1498, 1447, 1166, 1144, 998, 911, 740, 698; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{28}H_{35}NO_5Na$) requires *m*/*z* 486.2251, found *m*/*z* 486.2249.

2-Phenethyl-4-phenyl-1-(pyrrolidin-1-yl)butane-1,4-dione (2ab)



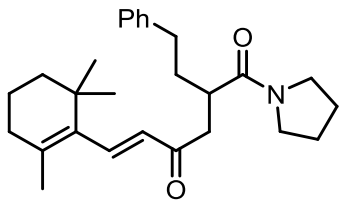
66% yield (65% yield on 2 mmol scale); **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.96 (d, *J* = 7.6 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 (*app* t, *J* = 7.7 Hz, 2H), 7.28 (*app* t, *J* = 7.6 Hz, 2H), 7.20–7.18 (m, 3H), 3.75–3.71 (m 1H), 3.66 (*app* dd, *J* = 17.8, 9.2 Hz, 1H), 3.49–3.39 (m, 2H), 3.33–3.28 (m, 1H), 3.23–3.18 (m, 1H), 3.04 (*app* dd, *J* = 17.8, 4.0 Hz, 1H), 2.72–2.65 (m, 2H), 2.08–1.80 (m, 6H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 199.3, 173.6, 141.6, 136.8, 133.3, 128.7, 128.6, 128.5, 128.2, 126.2, 46.7, 45.9, 41.7, 38.5, 34.4, 33.6, 26.2, 24.5; **IR (neat) ν_{max}:** 2922, 2853, 1683, 1631, 1450, 1362, 1343, 1220,747, 696; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{22}H_{26}NO_2$) requires *m*/*z* 336.1958, found *m*/*z* 336.1963.

2-Phenethyl-1-(pyrrolidin-1-yl)pentane-1,4-dione (2ac)



50% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.29–7.24 (m, 2H), 7.20–7.13 (m, 3H), 3.65 (dt, *J* = 10.0, 6.9 Hz, 1H), 3.51–3.35 (m, 2H), 3.28–3.21 (m, 1H), 3.14–3.05 (m, 1H), 3.03–2.95 (m, 1H), 2.62 (dt, *J* = 14.4, 7.2 Hz, 2H), 2.51 (*app* dd, *J* = 17.6, 3.6 Hz, 1H), 1.96–1.70 (m, 6H); **^{13}C NMR (101 MHz, $CDCl_3$):** δ 207.9, 173.5, 141.5, 128.6, 128.4, 126.2, 46.6, 46.3, 45.9, 38.2, 34.1, 33.4, 30.3, 26.2, 24.5; **IR (neat) ν_{max}:** 2952, 2926, 2874, 1712, 1318, 1445, 1365, 1343, 1169, 1040, 750, 701; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{17}H_{24}NO_2$) requires *m*/*z* 274.1802, found *m*/*z* 274.1807.

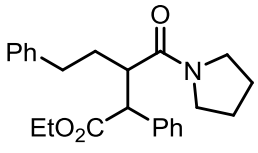
(*E*)-2-Phenethyl-1-(pyrrolidin-1-yl)-6-(2,6,6-trimethylcyclohex-1-en-1-yl)hex-5-ene-1,4-dione (2ad)



58% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.34–7.24 (m, 3H), 7.20–7.16 (m, 3H), 6.11 (d, *J* = 16.4 Hz, 1H), 3.68 (dt, *J* = 10.2, 6.9 Hz, 1H), 3.53–3.38 (m, 2H), 3.31–3.23 (m, 1H), 3.23–3.15 (m, 1H), 3.13–3.05 (m, 1H), 2.73–2.61 (m, 3H), 2.06 (t, *J* = 6.4 Hz, 2H), 2.01–1.79 (m, 6H), 1.75 (s, 3H), 1.64–1.58 (m, 2H), 1.48–1.45 (m, 2H), 1.05 (app d, *J* = 2.1 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 199.3, 173.7, 142.6, 141.7, 136.6, 136.2, 130.5, 128.5 (2C), 128.5 (2C), 126.1, 46.7, 45.9, 43.5, 40.0, 38.5,

34.4, 34.2, 33.8, 33.6, 29.0, 28.9, 26.2, 24.5, 21.9, 19.0; **IR (neat) ν_{max}:** 2931, 2873, 1718, 1617, 1453, 1364, 1255, 1229, 1190, 701; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{27}H_{37}NO_2Na$) requires *m*/*z* 430.2717, found *m*/*z* 430.2716.

Ethyl 2,5-diphenyl-3-(pyrrolidine-1-carbonyl)pentanoate (2ae)

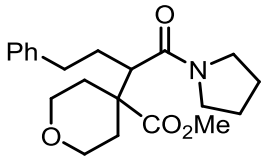


73% yield (d.r. 1.1:1 from isolation)

Major diasteromer **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.36–7.32 (m, 2H), 7.29–7.15 (m, 8H), 4.21–4.15 (m, 1H), 4.12–4.06 (m, 1H), 3.86 (d, *J* = 11.2 Hz, 1H), 3.25–3.17 (m, 2H), 3.03–2.97 (m, 1H), 2.91–2.86 (m, 1H), 2.72–2.61 (m, 2H), 2.56–2.48 (m, 1H), 2.23–2.14 (m, 1H), 1.95–1.88 (m, 1H), 1.62–1.53 (m, 2H), 1.38–1.30 (m, 2H), 1.20 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 173.1, 171.1, 141.4, 136.9, 128.5, 128.5, 128.4, 128.3, 127.6, 126.1, 61.1, 54.9, 48.1, 46.4, 45.3, 33.5, 32.9, 25.8, 24.1, 14.2; **IR (neat) ν_{max}:** 2972, 2930, 2874, 1727, 1632, 1494, 1450, 1340, 1151, 1029, 748, 701; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{24}H_{30}NO_3$) requires *m*/*z* 380.2220, found *m*/*z* 380.2220.

Minor diasteromer **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.35–7.27 (m, 5H), 7.19 (*app* t, *J* = 7.5 Hz, 2H), 7.12 (t, *J* = 7.3 Hz, 1H), 6.97 (d, *J* = 7.4 Hz, 2H), 4.08–3.94 (m, 3H), 3.87–3.79 (m, 1H), 3.56–3.43 (m, 2H), 3.32–3.26 (m, 1H), 3.22 (ddd, *J* = 11.1, 9.6, 3.9 Hz, 1H), 2.61–2.53 (m, 1H), 2.41–2.34 (m, 1H), 2.01–1.73 (m, 5H), 1.55–1.47 (m, 1H), 1.11 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 173.7, 173.0, 141.5, 137.3, 128.9, 128.7, 128.4, 128.3, 127.7, 126.0, 61.0, 54.4, 46.9, 46.0, 45.9, 32.7, 31.6, 26.2, 24.5, 14.0; **IR (neat) ν_{max}:** 3027, 2975, 2875, 1725, 1633, 1495, 1452, 1342, 1174, 1030, 752, 701; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{24}H_{30}NO_3$) requires *m*/*z* 380.2220, found *m*/*z* 380.2213.

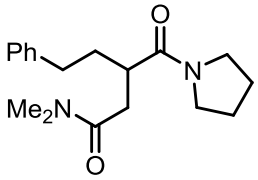
Methyl 4-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)tetrahydro-*2H*-pyran-4-carboxylate (2af)



83% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.30–7.25 (m, 2H), 7.22–7.10 (m, 3H), 3.89–3.78 (m, 2H), 3.72 (s, 3H), 3.55–3.29 (m, 5H), 3.23 (t, *J* = 12.0 Hz, 1H), 3.17–3.08 (m, 1H), 2.73–2.63 (m, 2H), 2.42–2.32 (m, 1H), 2.32–2.20 (m, 1H), 2.11 (d, *J* = 13.4 Hz, 1H), 2.01–1.95 (m, 2H), 1.90–1.79 (m, 4H), 1.64 (td, *J* = 12.8, 4.4 Hz, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 175.2, 170.7, 141.3, 128.5 (2C), 128.4 (2C), 126.2, 66.0, 65.6, 52.1, 50.8, 48.6, 47.3, 45.9, 33.8, 32.9, 30.5, 28.8, 26.3, 24.5; **IR (neat) ν_{max}:** 2954,

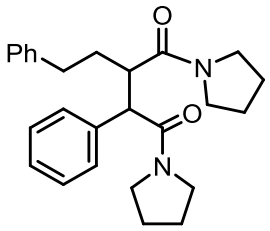
2871, 1725, 1633, 1444, 1340, 1220, 1199, 1034, 702; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{21}H_{29}NO_4Na$) requires *m*/*z* 382.1989, found *m*/*z* 382.1990.

***N*,*N*-dimethyl-5-phenyl-3-(pyrrolidine-1-carbonyl)pentanamide (2ag)**



66% yield; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.27–7.24 (m, 2H), 7.18–7.15 (m, 3H), 3.75–3.68 (m, 1H), 3.51–3.44 (m, 1H), 3.44–3.37 (m, 1H), 3.30–3.23 (m, 1H), 3.16–3.09 (m, 1H), 2.99 (s, 3H), 2.97–2.91 (m, 1H), 2.89 (s, 3H), 2.68–2.57 (m, 2H), 2.34 (dd, J = 16.2, 3.8 Hz, 1H), 1.96–1.77 (m, 6H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 174.0, 171.7, 141.7, 128.5, 128.4, 126.1, 46.6, 45.8, 39.5, 37.4, 36.2, 35.6, 34.5, 33.5, 26.1, 24.5; **IR (neat) ν_{max}:** 2930, 2876, 1630, 1496, 1454, 1402, 1344, 1144, 751, 702; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{30}H_{26}N_2O_2$) requires *m*/*z* 303.2067, found *m*/*z* 303.2063.

2-Phenethyl-3-phenyl-1,4-di(pyrrolidin-1-yl)butane-1,4-dione (2ah)



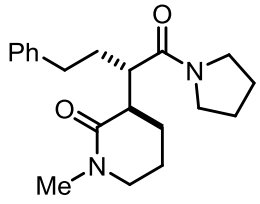
86% yield, d.r. 2.3:1.

Diastereomer 1: **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.40–7.36 (m, 2H), 7.34–7.29 (m, 2H), 7.28–7.26 (m, 1H), 7.21–7.15 (m, 2H), 7.13–7.07 (m, 1H), 6.99–6.94 (m, 2H), 4.05 (d, *J* = 10.6 Hz, 1H), 4.03–3.98 (m, 1H), 3.71–3.64 (m, 1H), 3.50–3.24 (m, 6H), 3.23–3.16 (m, 1H), 2.57–2.48 (m, 1H), 2.38–2.30 (m, 1H), 1.99–1.65 (m, 9H), 1.53–1.44 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 173.8, 171.1, 141.8, 137.7, 129.2 (2C), 128.8 (2C), 128.4 (4C), 127.4, 125.9, 53.8, 47.0, 46.8, 46.3, 46.1, 45.9, 33.0, 31.9, 26.1, 26.0, 24.6, 24.2; **IR (neat) ν_{max}:** 2924, 1632, 1439, 1342, 1032, 756, 702; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{26}H_{32}N_2O_2Na$) requires *m*/*z* 427.2356, found *m*/*z* 427.2359.

Diastereomer 2: **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.42–7.37 (m, 2H), 7.28–7.12 (m, 8H), 3.86 (d, *J* = 10.3 Hz, 1H), 3.56 3.47 (m, 2H), 3.43–3.33 (m, 2H), 3.26–3.12 (m, 2H), 3.01–2.94 (m, 1H), 2.93–2.87 (m, 1H), 2.68–2.51 (m, 3H), 2.10–2.01 (m, 2H), 1.91–1.82 (m, 1H), 1.81–1.69 (m, 3H), 1.57–1.49 (m, 2H), 1.38–1.28 (m, 2H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 172.1, 170.2, 141.9, 137.3, 128.8 (2C), 128.7 (2C), 128.4 (2C), 128.3 (2C), 127.3, 125.9, 54.0, 48.5, 46.4 (2C), 46.1, 45.2, 33.9, 33.4, 26.0, 25.7, 24.3, 24.1; **IR (neat) ν_{max}:**

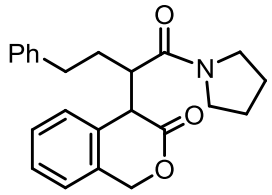
2925, 1635, 1437, 1343, 1032, 755, 702; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{26}H_{32}N_2O_2Na$) requires *m*/*z* 427.2356, found *m*/*z* 427.2359.

1-methyl-3-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)piperidin-2-one (2ai)



61% yield (d.r. 7:1, major diastereomer pictured and assigned from crystal structure), NMR data reported only for major diastereomer; **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.28–7.23 (m, 2H), 7.19–7.14 (m, 3H), 3.74–3.70 (m, 1H), 3.40–3.34 (m, 4H), 3.27–3.22 (m, 1H), 3.20–3.17 (m, 1H), 2.88 (s, 3H), 2.67–2.57 (m, 2H), 2.48–2.44 (m, 1H), 2.37–2.30 (m, 1H), 2.04–1.98 (m, 1H), 1.96–1.73 (m, 7H), 1.72–1.64 (m, 1H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 173.6, 171.9, 141.7, 128.5, 128.4, 126.1, 50.0, 46.8, 45.7, 44.1, 42.5, 35.2, 33.9, 32.4, 26.2, 24.5, 23.2, 22.9; **IR (neat) ν_{max}:** 2926, 2869, 1616, 1497, 1441, 1409, 1344, 1246, 1197, 1043, 1032, 749, 730, 701, 678; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{20}H_{29}N_2O_2$) requires *m*/*z* 329.2224, found *m*/*z* 329.2216.

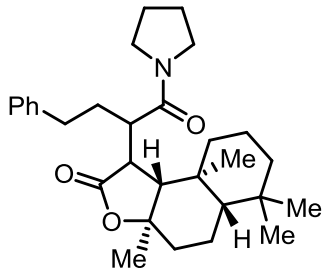
4-(1-Oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)isochroman-3-one (2aj)



55% yield, d.r. 1.8/1; Diastereomers not completely separable, therefore only the major isomer is reported (for NMR of the mixture of diastereomers, see below).

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.29–7.22 (m, 4H), 7.19–7.10 (m, 5H), 5.40 (d, *J* = 14.5 Hz, 1H), 5.20 (d, *J* = 14.5 Hz, 1H), 3.99 (d, *J* = 11.1 Hz, 1H), 3.36–3.19 (m, 2H), 2.87–2.76 (m, 2H), 2.62–2.55 (m, 1H), 2.53–2.36 (m, 2H), 2.14–2.05 (m, 1H), 1.90–1.83 (m, 1H), 1.69–1.60 (m, 1H), 1.58–1.48 (m, 1H), 1.48–1.38 (m, 1H), 1.33–1.23 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.6, 169.9, 140.9, 133.4, 131.0, 128.6, 128.6 (2C), 128.5 (2C), 128.3, 127.9, 126.3, 124.4, 69.6, 49.8, 45.9, 45.7, 43.3, 33.0, 31.7, 25.8, 24.1; **IR (neat) ν_{max}:** 2922, 1737, 1630, 1451, 1233, 1191, 1032, 701; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{23}H_{25}NO_3Na$) requires *m*/*z* 386.1727, found *m*/*z* 386.1728.

(3aR,5aS,9aS,9bR)-3a,6,6,9a-Tetramethyl-1-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)decahydronaphtho[2,1-b]furan-2(*1H*)-one (2ak)

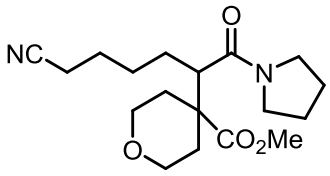


63% yield (d.r. 1.3:1 from isolation)

Major diasteromer **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.28–7.24 (m, 2H), 7.19–7.14 (m, 3H), 3.62–3.51 (m, 2H), 3.39–3.34 (m, 1H), 3.34–3.28 (m, 1H), 2.99 (dd, *J* = 13.1, 2.9 Hz, 1H), 2.86–2.78 (m, 2H), 2.56–2.49 (m, 1H), 2.48–2.41 (m, 1H), 2.04–1.79 (m, 8H), 1.73–1.69 (m, 1H), 1.63 (*app* td, *J* = 12.6, 4.0 Hz, 1H), 1.55–1.47 (m, 1H), 1.34–1.17 (m, 7H), 1.09 (*app* td, *J* = 13.5, 3.8 Hz, 1H), 1.00 (dd, *J* = 12.7, 2.5 Hz, 1H), 0.92 (s, 3H), 0.86 (s, 3H), 0.79 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 175.5, 170.9, 142.0, 128.9, 128.4, 126.1, 83.3, 59.9, 56.5, 46.7, 46.5, 42.2, 41.7, 41.5, 39.2, 38.7, 38.1, 33.9, 33.4, 28.7, 26.7, 24.3, 23.2, 21.0, 20.5, 18.3, 16.6; **IR (neat) ν_{max}:** 2930, 2869, 1771, 1637, 1439, 1390, 1341, 1285, 1192, 1168, 1120, 1024, 950, 730, 702; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{30}H_{43}NO_3$) requires *m*/*z* 466.3316, found *m*/*z* 466.3309.

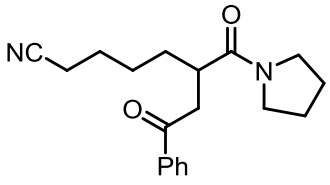
Minor diasteromer **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.29 (*app* t, *J* = 7.5 Hz, 2H), 7.23 (d, *J* = 7.1 Hz, 2H), 7.20 (t, *J* = 7.3 Hz, 1H), 3.50–3.41 (m, 2H), 3.20–3.08 (m, 2H), 3.04–2.95 (m, 2H), 2.83 (dt, *J* = 11.1, 3.4 Hz, 1H), 2.73–2.65 (m, 2H), 2.16 (d, *J* = 12.8 Hz, 1H), 2.00 (dt, *J* = 11.8, 3.1 Hz, 1H), 1.90–1.74 (m, 7H), 1.63–1.54 (m, 1H), 1.35–1.25 (m, 8H), 1.07 (*app* td, *J* = 13.6, 3.9 Hz, 1H), 1.04–1.00 (m, 1H), 0.89 (s, 3H), 0.82 (s, 3H), 0.79 (s, 3H); **^{13}C NMR (151 MHz, $CDCl_3$):** δ 177.4, 171.6, 141.2, 128.8, 128.6, 126.4, 83.0, 58.3, 56.0, 45.9, 45.9, 43.2, 41.9, 39.8, 38.4, 38.2, 37.7, 33.8, 33.3, 29.4, 26.4, 24.3, 23.0, 21.0, 20.6, 18.4, 16.4; **IR (neat) ν_{max}:** 2926, 2868, 1763, 1630, 1438, 1388, 1340, 1280, 1215, 1189, 1169, 1155, 1120, 1097, 1081, 1063, 1040, 1020, 1006, 949, 910, 726, 701, 643; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{30}H_{43}NO_3$) requires *m*/*z* 466.3316, found *m*/*z* 466.3308.

Methyl 4-(6-cyano-1-oxo-1-(pyrrolidin-1-yl)hexan-2-yl)tetrahydro-*2H*-pyran-4-carboxylate (2al)



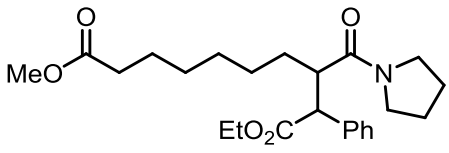
64% yield; **^{1}H NMR (600 MHz, acetone-d_6)**: δ 3.78–3.71 (m, 2H), 3.71 (s, 3H), 3.64–3.51 (m, 2H), 3.44–3.33 (m, 3H), 3.16 (td, *J* = 12.1, 1.9 Hz, 1H), 2.83 (dd, *J* = 11.7, 2.8 Hz, 1H), 2.47–2.38 (m, 2H), 2.14–2.07 (m, 1H), 2.02–1.91 (m, 3H), 1.91–1.78 (m, 4H), 1.66–1.54 (m, 3H), 1.46–1.39 (m, 1H), 1.36–1.27 (m, 2H); **^{13}C NMR (150 MHz, acetone-d_6):** δ 175.4, 171.2, 120.6, 66.1, 65.8, 52.1, 51.6, 49.0, 47.9, 46.3, 33.4, 30.9, 27.8, 27.5, 26.8, 26.3, 24.9, 16.9; **IR (neat) ν_{max}:** 2955, 2872, 1724, 1628, 1446, 1342, 1224, 1200, 1033; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{18}H_{28}N_2O_4Na$) requires *m*/*z* 359.1941, found *m*/*z* 359.1925.

8-Oxo-8-phenyl-6-(pyrrolidine-1-carbonyl)octanenitrile (2am)



65% yield (89% brsm); **^{1}H NMR (400 MHz, acetone-d_6)**: δ 8.03–7.98 (m, 2H), 7.64–7.59 (m, 1H), 7.53–7.48 (m, 2H), 3.82 (dt, *J* = 9.8, 6.8 Hz, 1H), 3.63–3.53 (m, 2H), 3.38–3.29 (m, 2H), 3.22–3.15 (m, 1H), 3.06 (dd, *J* = 17.7, 3.9 Hz, 1H), 2.47 (t, *J* = 7.0 Hz, 2H), 1.98 (app p, *J* = 6.7 Hz, 2H), 1.86–1.80 (m, 2H), 1.73–1.62 (m, 3H), 1.61–1.48 (m, 3H); **^{13}C NMR (150 MHz, acetone-d_6):** δ 199.4, 173.7, 137.9, 133.8, 129.4 (2C), 128.8 (2C), 120.6, 47.1, 46.3, 42.1, 39.2, 32.5, 26.9, 26.8, 26.3, 25.0, 17.0; **IR (neat) ν_{max}:** 2923, 2854, 1683, 1624, 1452, 1258, 1225, 1033; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{19}H_{24}N_2O_2Na$) requires *m*/*z* 335.1730, found *m*/*z* 335.1726.

1-Ethyl 10-methyl 2-phenyl-3-(pyrrolidine-1-carbonyl)decanedioate (2an)



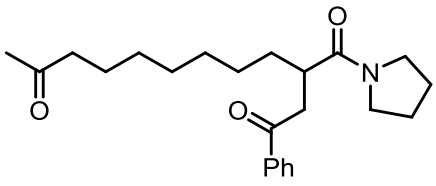
58% yield (69% brsm), d.r. 2.3:1.

Diastereomer 1: **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.37–7.31 (m, 2H), 7.25–7.16 (m, 3H), 4.23–4.14 (m, 1H), 4.12–4.04 (m, 1H), 3.81 (d, *J* = 11.2 Hz, 1H), 3.64 (s, 3H), 3.26–3.12 (m, 3H), 3.01–2.93 (m, 1H), 2.86 (dt, *J* = 9.8, 7.4 Hz, 1H), 2.30–2.23 (m, 2H), 1.86–1.76 (m, 1H), 1.69–1.54 (m, 4H), 1.51–1.35 (m, 3H), 1.31–1.17 (m, 9H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 174.4, 173.2, 171.5, 137.0, 128.3 (2C), 128.2 (2C), 127.5, 61.0,

54.8, 51.6, 48.7, 46.6, 45.2, 34.1, 32.0, 29.5, 29.1, 27.6, 25.8, 25.0, 24.1, 14.2; **IR (neat) ν_{max}:** 2926, 2856, 1728, 1632, 1493, 1441, 1370, 1341, 1157, 741, 702; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{24}H_{35}NO_5Na$) requires *m*/*z* 440.2407, found *m*/*z* 440.2414.

Diastereomer 2: **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.37–7.27 (m, 5H), 4.08–3.98 (m, 2H), 3.97–3.91 (m, 2H), 3.65 (s, 3H), 3.55–3.46 (m, 3H), 3.19–3.13 (m, 1H), 2.23 (t, *J* = 7.5 Hz, 2H), 2.06–1.96 (m, 2H), 1.94–1.84 (m, 2H), 1.55–1.48 (m, 2H), 1.45–1.39 (m, 1H), 1.28–1.20 (m, 1H), 1.18–1.05 (m, 9H); **^{13}C NMR (150 MHz, $CDCl_3$):** δ 174.3, 173.8, 173.5, 137.5, 128.8 (2C), 128.6 (2C), 127.6, 60.9, 54.4, 51.6, 47.0, 46.6, 45.9, 34.1, 30.6, 29.5, 29.0, 26.7, 26.2, 24.9, 24.6, 14.0; **IR (neat) ν_{max}:** 2933, 2859, 1727, 1634, 1438, 1369, 1342, 1171, 1029, 702; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{24}H_{35}NO_5Na$) requires *m*/*z* 440.2407, found *m*/*z* 440.2414.

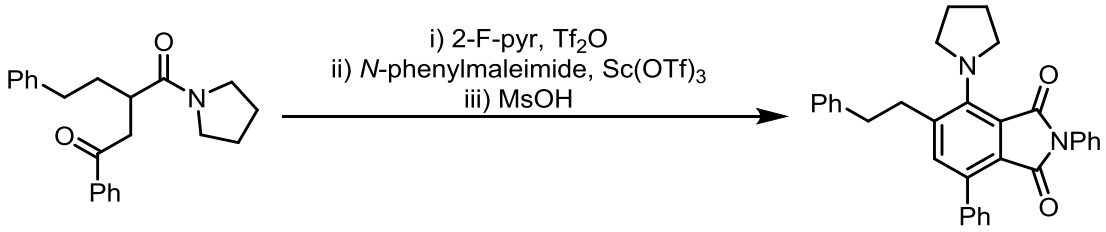
1-Phenyl-3-(pyrrolidine-1-carbonyl)dodecane-1,11-dione (2ao)



43% yield (71% brsm); **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.97–7.93 (m, 2H), 7.55–7.50 (m, 1H), 7.45–7.40 (m, 2H), 3.85 (dt, *J* = 9.7, 6.9 Hz, 1H), 3.62 (dd, *J* = 17.8, 9.3 Hz, 1H), 3.55–3.39 (m, 3H), 3.20–3.10 (m, 1H), 2.96 (dd, *J* = 17.8, 3.8 Hz, 1H), 2.40 (t, *J* = 7.4 Hz, 2H), 2.11 (s, 3H), 2.03–1.93 (m, 2H), 1.89–1.81 (m, 2H), 1.71–1.63 (m, 1H), 1.59–1.47 (m, 3H), 1.34–1.24 (m, 8H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 209.3, 199.6, 174.1, 137.0, 133.2, 128.6 (2C), 128.2 (2C), 46.8, 45.9, 43.9, 41.8, 39.0, 33.0, 30.0, 29.7, 29.4, 27.4, 26.2, 24.5, 23.9; **IR (neat) ν_{max}:** 2926, 2854, 1712, 1682, 1627, 1446, 1359, 1221, 1170, 750, 692; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{23}H_{33}NO_3Na$) requires *m*/*z* 394.2353, found *m*/*z* 394.2342.

4.3.1. Product Derivatizations and Other Products

5-Phenethyl-2,7-diphenyl-4-(pyrrolidin-1-yl)isoindoline-1,3-dione (3)

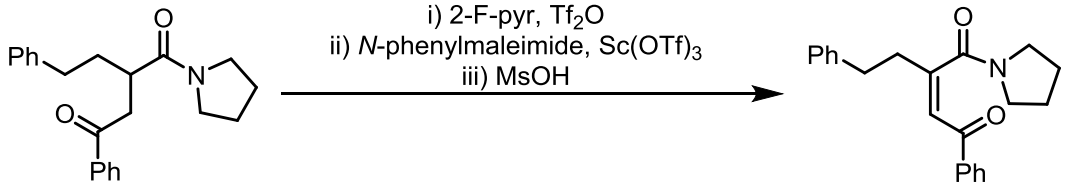


2ab **3**

To a solution of 2-phenethyl-4-phenyl-1-(pyrrolidin-1-yl)butane-1,4-dione (**2ab**, 33.5 mg, 0.100 mmol, 1.00 equiv.) and 2-fluoropyridine (18.9 µL, 0.220 mmol, 2.20 equiv.) in dichloromethane (2 mL, 0.05M) at 0 °C, triflic anhydride (18.5 µL, 0.110 mmol, 1.10 equiv.) was added and the resulting mixture was allowed to warm to ambient temperature (25 °C) over the course of 4 h. After this time, *N*-phenylmaleimide (17.3 mg, 0.100 mmol, 1.00 equiv.) and scandium(III) triflate (4.90 mg, 0.010 mmol, .10 mol%) were added and the reaction mixture was stirred at ambient temperature for 12 h. After this time, a saturated aqueous solution of sodium bicarbonate (5 mL) was added and the resulting biphasic mixture was extracted with dichloromethane (3 × 5 mL). The combined organic extracts were concentrated under reduced pressure and the resulting residue was redissolved in a mixture of toluene and acetonitrile (PhMe/MeCN 3 mL/2 mL, 0.02M). After the subsequent addition of mesylic acid (26.0 µL, 0.400 mmol, 4.00 equiv.), the reaction mixture was heated at 60 °C for 18 h. After this time, excess acid was quenched by the addition of a saturated aqueous solution of sodium bicarbonate (5 mL) and the biphasic mixture was extracted with dichloromethane (3 × 5 mL). The combined organic phases were dried over anhydrous sodium sulfate, the dried solution was filtered and the filtrate was concentrated under reduced pressure. The resulting crude residue was purified by flash column chromatography (SiO_2, heptanes/ethyl acetate 3/1) to afford 38 mg (80%) of **3**.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.51–7.39 (m, 10H), 7.38–7.30 (m, 3H), 7.26–7.18 (m, 3H), 3.41–3.35 (m, 4H), 3.18–3.12 (m, 2H), 2.99–2.93 (m, 2H), 2.15–2.09 (m, 4H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 166.9, 166.7, 150.4, 147.4, 141.6, 138.7, 137.7, 136.8, 132.0, 129.6 (2C), 129.1 (2C), 128.6 (4C), 128.4, 128.0 (2C), 127.9, 127.8, 127.5, 127.1 (2C), 126.3, 52.7 (2C), 37.6, 34.8, 26.6 (2C).; **IR (neat) ν_{max}:** 2923, 2853, 1711, 1500, 1470, 1454, 1373, 1129, 1114, 743, 696; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{32}H_{29}N_2O_2$) requires *m*/*z* 473.2224, found *m*/*z* 473.2225.

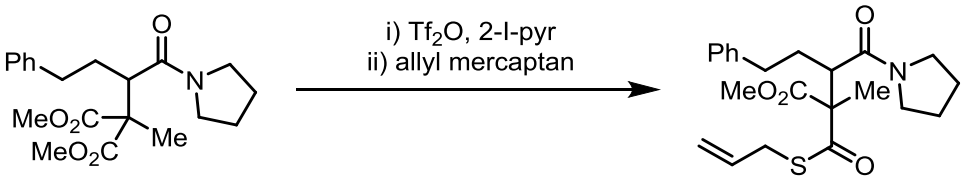
(*Z*)-2-Phenethyl-4-phenyl-1-(pyrrolidin-1-yl)but-2-ene-1,4-dione (4)



2ab **4**

A schlenk tube containing molecular sieves was flame dried under vacuum before being backfilled with argon. 2-phenethyl-4-phenyl-1-(pyrrolidin-1-yl)butane-1,4-dione (2ab) (33.5 mg, 0.1 mmol, 1.0 equiv.) was added followed by dichloromethane (2 mL), 2-fluoropyridine (8.6 µL, 0.1 mmol, 1.0 equiv.) and TEMPO (34.3 mg, 0.22 mmol, 2.2 equiv.). After cooling to 0 °C, triflic anhydride (18.5 µL, 0.11 mmol, 1.1 equiv.) was added dropwise and the reaction was then allowed to warm to room temperature where it was stirred for 2.5 hours. Water was then added, the layers separated and the aqueous layer extracted once with dichloromethane. The combined organic layers were dried over anhydrous $MgSO_4$ and the solvent removed *in vacuo*. The crude reaction mixture was purified on silica gel (EtOAc/heptanes) to yield **4** as a yellow oil (25.0 mg, 75%). **^{1}H NMR (600 MHz, $CDCl_3$)**: δ 7.85–7.81 (m, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.44 (*app* t, *J* = 7.7 Hz, 2H), 7.32 (*app* t, *J* = 7.5 Hz, 2H), 7.27 (d, *J* = 7.1 Hz, 2H), 7.23 (t, *J* = 7.2 Hz, 1H), 6.73 (s, 1H), 3.59 (t, *J* = 6.8 Hz, 2H), 3.23 (t, *J* = 6.6 Hz, 2H), 3.00–2.96 (m, 2H), 2.80–2.75 (m, 2H), 1.94–1.86 (m, 4H).; **^{13}C NMR (151 MHz, $CDCl_3$):** δ 189.1, 169.2, 154.1, 140.4, 137.5, 133.1, 128.6, 128.6, 128.5, 128.4, 126.3, 120.7, 46.9, 45.2, 37.1, 33.1, 25.9, 24.3; **IR (neat) ν_{max}:** 2951, 2875, 1735, 1666, 1610, 1495, 1445, 1365, 1337, 1239, 1192, 1043, 784, 750, 701; **HRMS (ESI+):** exact mass calculated for $[M+H]^+$ ($C_{22}H_{24}NO_2$) requires *m*/*z* 334.1802, found *m*/*z* 334.1794.

Methyl 2-((allylthio)carbonyl)-2-methyl-5-phenyl-3-(pyrrolidine-1-carbonyl)pentanoate (5)



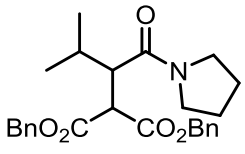
2d **5**

To a solution of dimethyl 2-methyl-2-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)malonate (**2d**, 36.1 mg, 0.100 mmol, 1.00 equiv.) and 2-iodopyridine (21.3 µL, 0.200 mmol, 2.0 equiv.) in dichloromethane (1 mL, 0.1M) at 0 °C, triflic anhydride (18.5 µL, 0.110 mmol, 1.10 equiv.) was added and the resulting mixture was allowed to warm to ambient temperature (25 °C) over the course of 1 h. After this timeallyl mercaptan (70%, 35.4 µL, 0.300 mmol, 3.00 equiv.) was added and the reaction mixture was stirred at ambient temperature for 1 h. After this time, a saturated aqueous solution of sodium bicarbonate (2 mL) was added and the resulting biphasic mixture was extracted with dichloromethane (3 × 5 mL). The combined organic phases were dried over anhydrous sodium sulfate, the dried solution was filtered and the filtrate was concentrated under reduced pressure. The resulting crude residue was purified by flash column chromatography (SiO_2, heptanes/ethyl acetate 3/2) to afford **5** as two diastereomers (43%, d.r. 1.3:1; diastereomer 1: 10 mg (25%); diastereomer 2: 7.4 mg (18%)).

Diastereomer 1: **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.29–7.24 (m, 2H), 7.20–7.15 (m, 3H), 5.79–5.67 (m, 1H), 5.22 (app dq, *J* = 16.9, 1.4 Hz, 1H), 5.08 (app dq, *J* = 9.9, 1.2 Hz, 1H), 3.74 (s, 3H), 3.61–3.53 (m, 1H), 3.52–3.34 (m, 5H), 3.29–3.22 (m, 1H), 2.70–2.60 (m, 1H), 2.59–2.49 (m, 1H), 2.25–2.15 (m, 1H), 1.89–1.75 (m, 5H), 1.73 (s, 3H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 199.0, 171.3, 170.8, 141.3, 132.6, 128.5 (4C), 126.2, 118.4, 64.3, 53.0, 47.3, 47.0, 45.9, 34.0, 32.3, 31.3, 26.3, 24.5, 17.0; **IR (neat) ν_{max}:** 2951, 1739, 1664, 1635, 1231, 1105, 962, 701; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{22}H_{29}NO_4SNa$) requires *m*/*z* 426.1710, found *m*/*z* 426.1711.

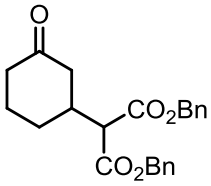
Diastereomer 2: **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.29–7.24 (m, 2H), 7.20–7.14 (m, 3H), 5.85–5.73 (m, 1H), 5.26 (app dq, *J* = 16.9, 1.3 Hz, 1H), 5.13 (app dq, *J* = 10.0, 1.1 Hz, 1H), 3.74–3.69 (m, 1H), 3.66 (s, 3H), 3.60 (dd, *J* = 10.9, 3.3 Hz, 1H), 3.55 (dt, *J* = 6.9, 1.0 Hz, 2H), 3.44 (t, *J* = 7.0 Hz, 2H), 3.31 (dt, *J* = 10.1, 7.0 Hz, 1H), 2.67–2.59 (m, 1H), 2.57–2.49 (m, 1H), 2.14–2.02 (m, 1H), 1.94–1.79 (m, 7H), 1.73–1.64 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 198.5, 171.6, 141.3, 132.5, 128.5 (2C), 128.4 (2C), 126.2, 118.5, 64.4, 53.0, 47.3, 46.2, 46.0, 33.9, 32.4, 30.9, 26.3, 24.9, 15.8; **IR (neat) ν_{max}:** 2951, 1741, 1683, 1636, 1434, 1377, 1231, 955; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{22}H_{29}NO_4SNa$) requires *m*/*z* 426.1710, found *m*/*z* 426.1711.

Dibenzyl 2-(3-methyl-1-oxo-1-(pyrrolidin-1-yl)butan-2-yl)malonate (6)



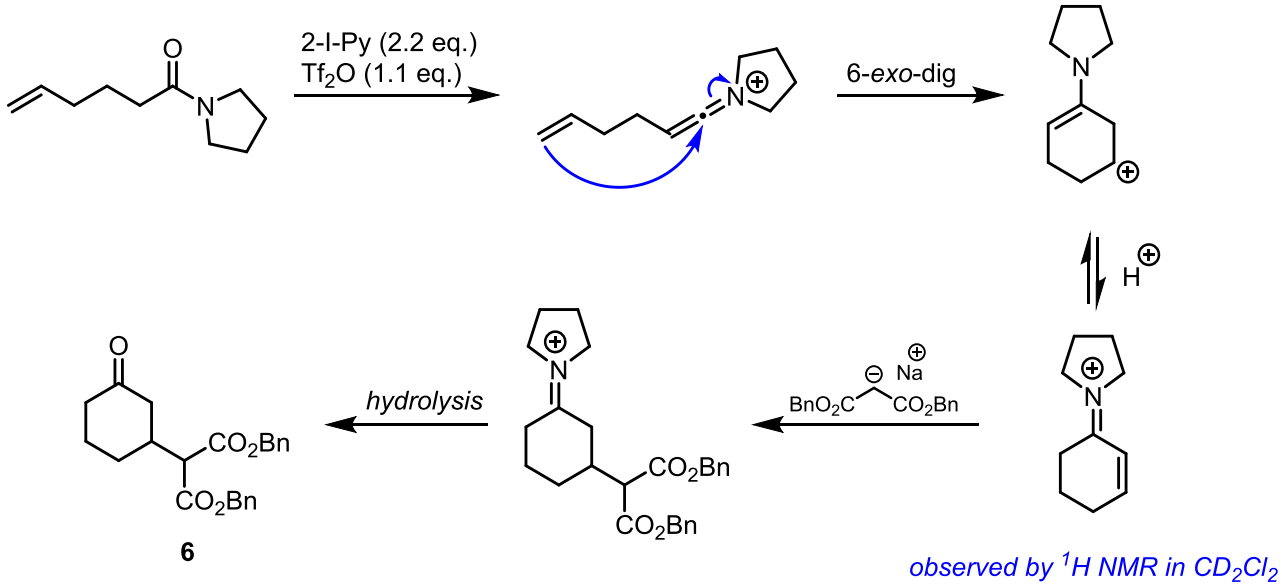
Synthesized following general procedure C, section 4.1; 20% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.40–7.16 (m, 10H), 5.15–5.10 (m, 3H), 5.06–5.00 (m, 1H), 4.13 (d, *J* = 10.7 Hz, 1H), 3.74–3.67 (m, 1H), 3.49–3.31 (m, 3H), 3.23 (dd, *J* = 10.7, 4.9 Hz, 1H), 1.91–1.75 (m, 5H), 0.95 (d, *J* = 6.9 Hz, 6H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 170.7, 168.9, 168.6, 135.5, 135.3, 128.7, 128.6, 128.5, 128.4, 128.3, 128.1, 67.4, 67.3, 53.6, 48.0, 47.4, 45.8, 29.7, 26.1, 24.5, 20.7, 18.8; **IR (neat) ν_{max}:** 2958, 2922, 2873, 1730, 1631, 1440, 1373, 1355, 1261, 1215, 1184, 1166, 1150, 1080, 991, 908 738, 698; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{26}H_{31}NO_5Na$) requires *m*/*z* 460.2094, found *m*/*z* 460.2090.

Dibenzyl 2-(3-oxocyclohexyl)malonate (7)



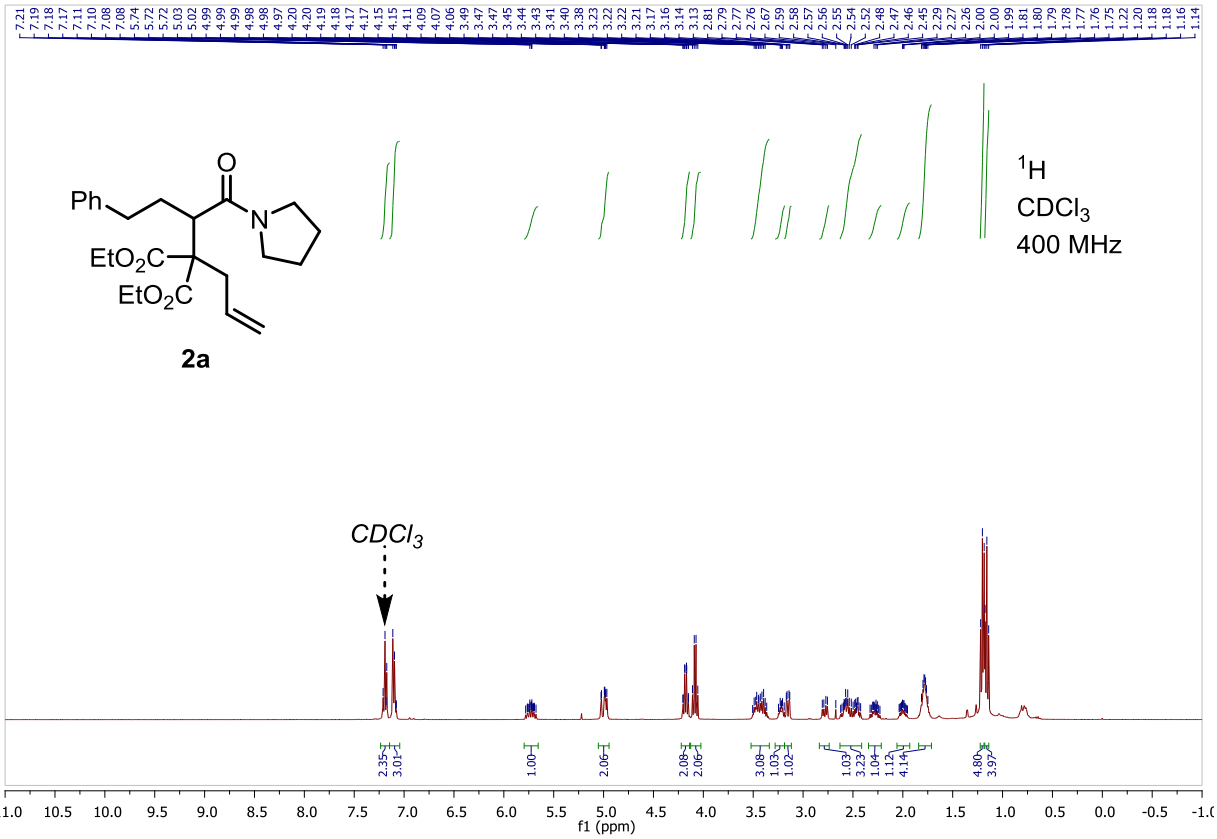
Synthesized following general procedure C, section 4.1; 71% yield; **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.27–7.22 (m, 6H), 7.21–7.15 (m, 4H), 5.09–5.02 (m, 4H), 3.33 (d, *J* = 7.7 Hz, 1H), 2.53–2.41 (m, 1H), 2.39–2.32 (m, 1H), 2.31–2.25 (m, 1H), 2.19–2.14 (m, 1H), 2.14–2.06 (m, 1H), 1.97–1.88 (m, 1H), 1.85–1.77 (m, 1H), 1.61–1.47 (m, 1H), 1.44–1.32 (m, 1H); **^{13}C NMR (100 MHz, $CDCl_3$):** δ 209.4, 167.6, 167.5, 135.2 (2C), 128.7 (4C), 128.5 (2C), 128.3 (4C), 67.3 (2C), 56.8, 45.1, 41.0, 38.2, 28.7, 24.6; **IR (neat) ν_{max}:** 3065, 3034, 2946, 1728, 1711, 1587, 1498, 1454, 1255, 1224, 1147, 1002, 907, 740, 698; **HRMS (ESI+):** exact mass calculated for $[M+Na]^+$ ($C_{23}H_{24}O_5Na$) requires *m*/*z* 403.1516, found *m*/*z* 403.1517.

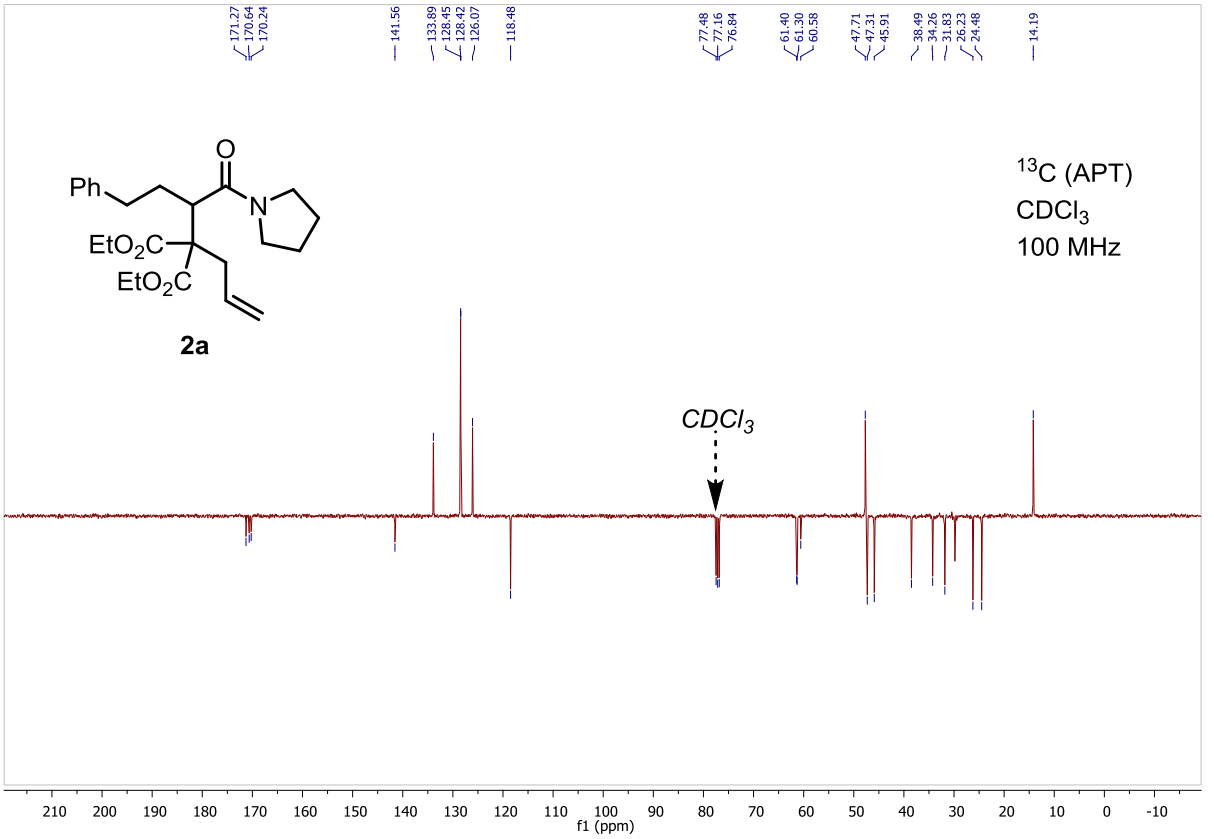
Mechanistic proposal for the formation of 6.

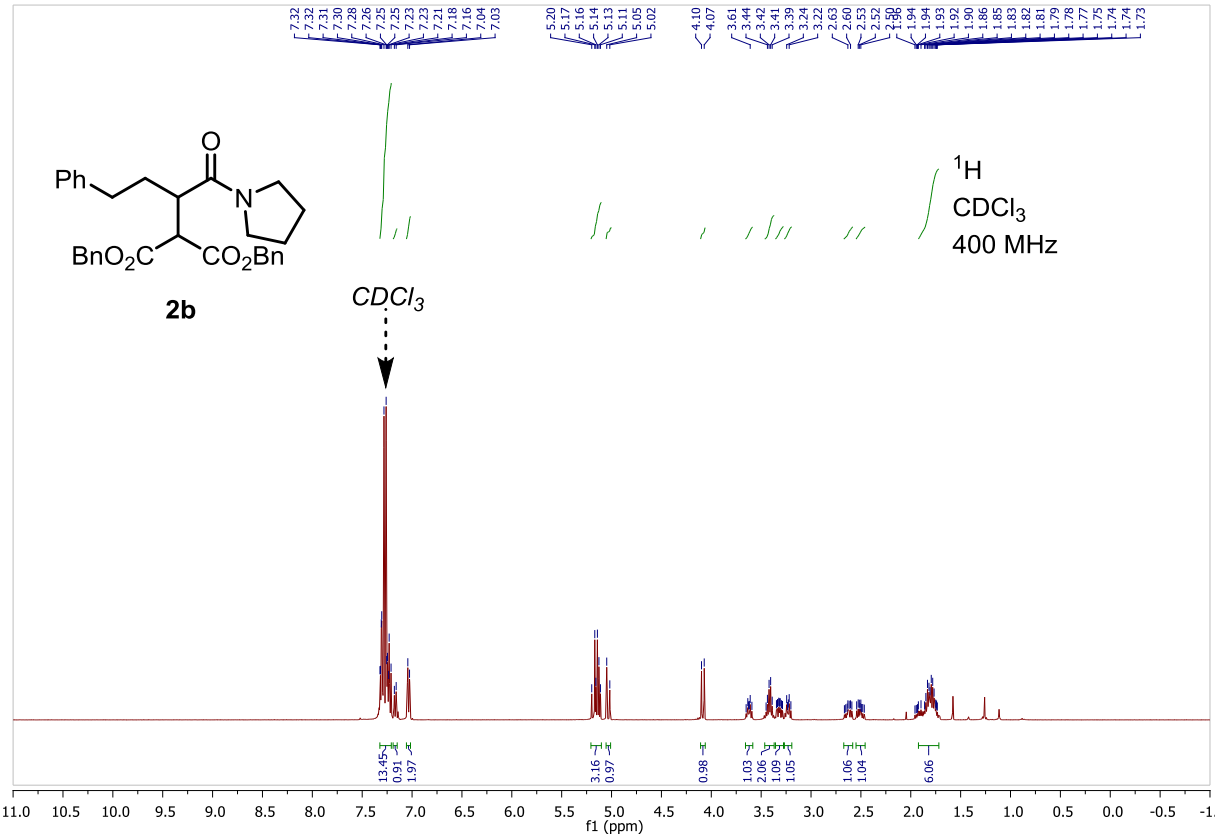


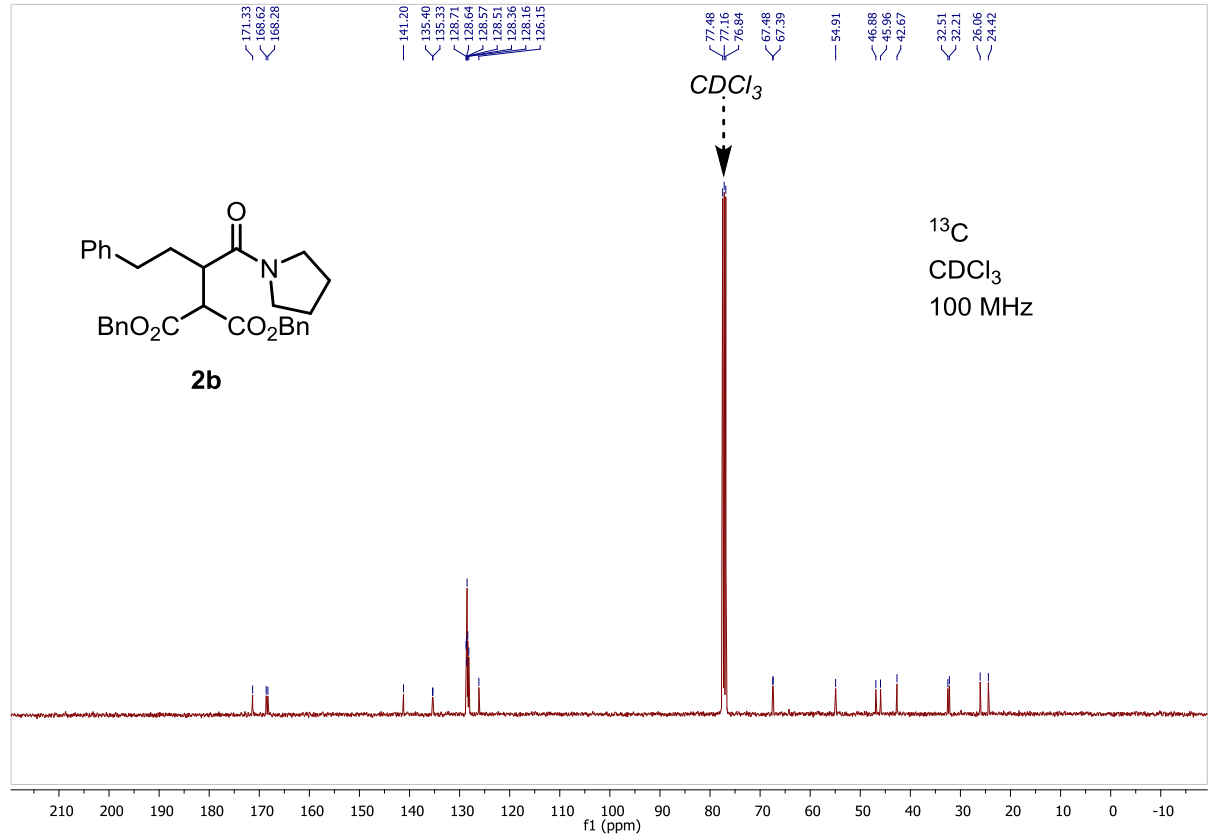
observed by ^{1}H NMR in CD_2Cl_2

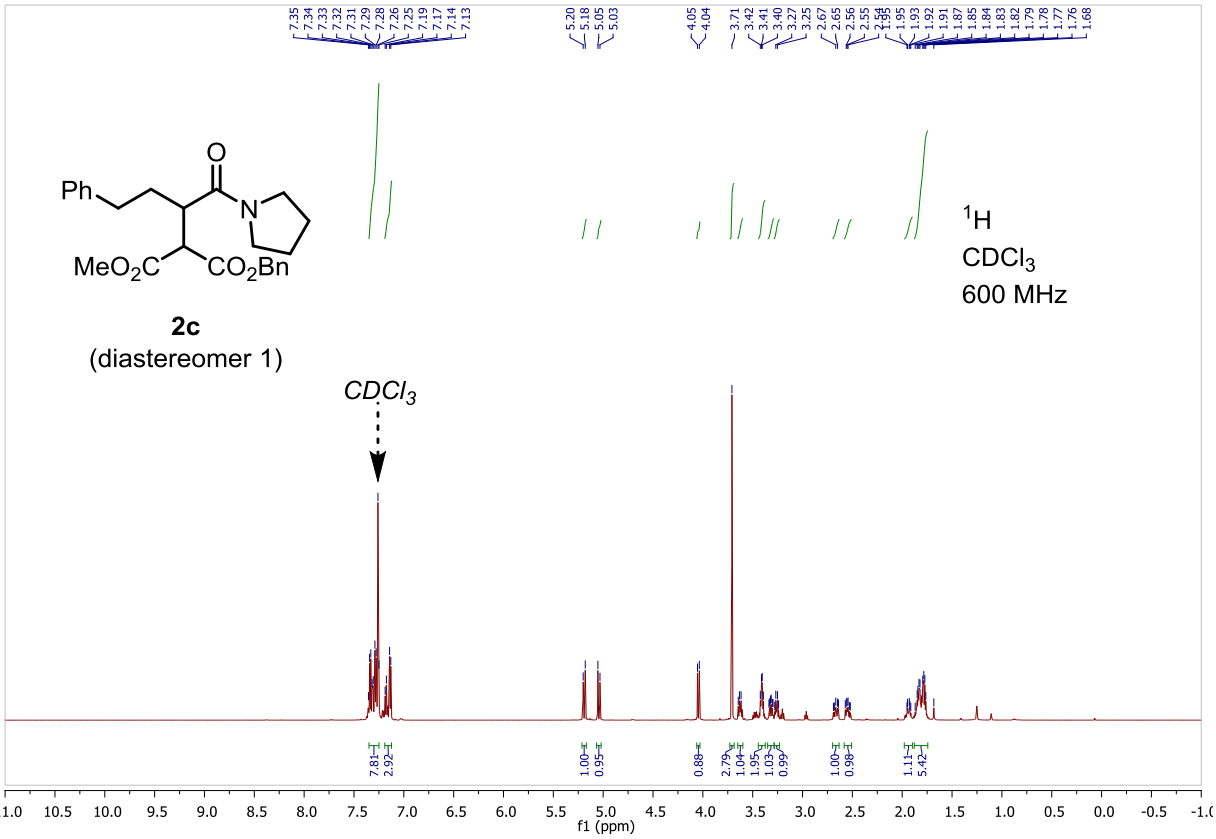
5. NMR Spectra

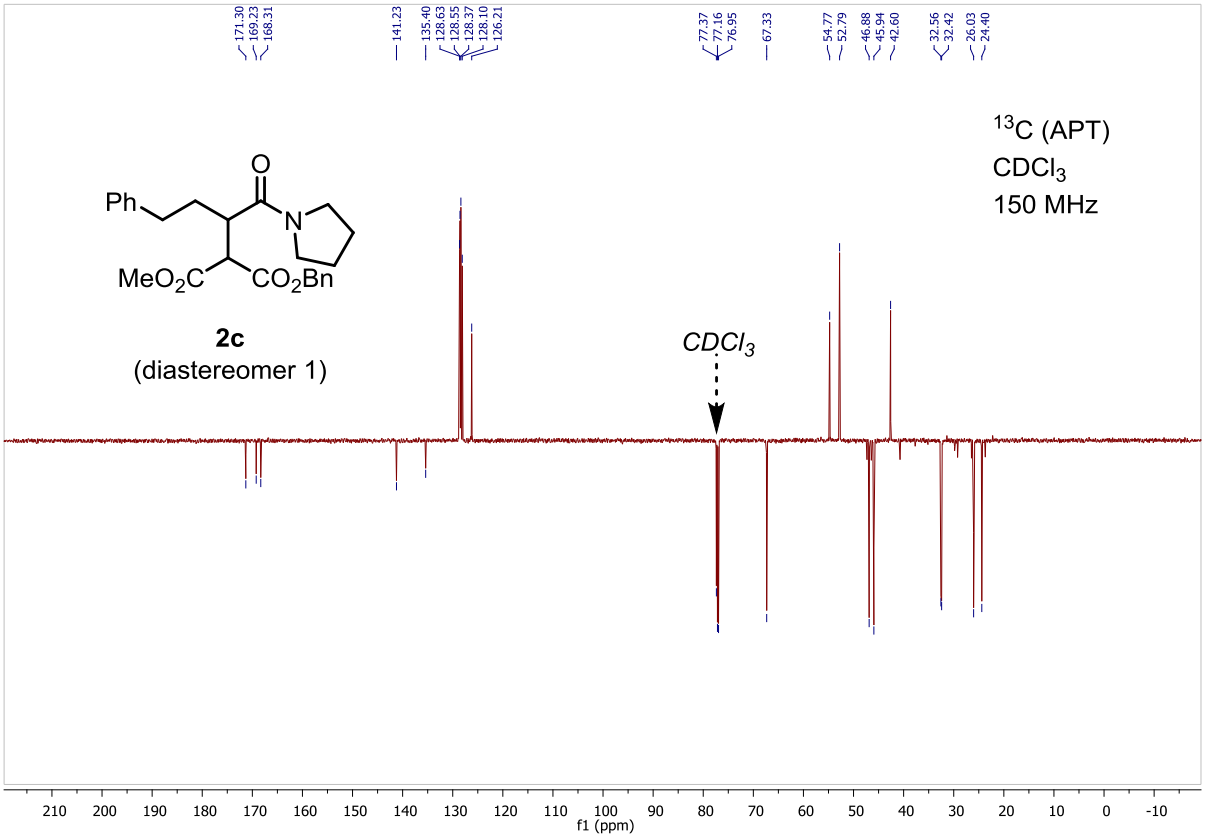

Ph
O
N
EtO2C
EtO2C
2a
1H
CDCl3
400 MHz
CDCl3
f1 (ppm)

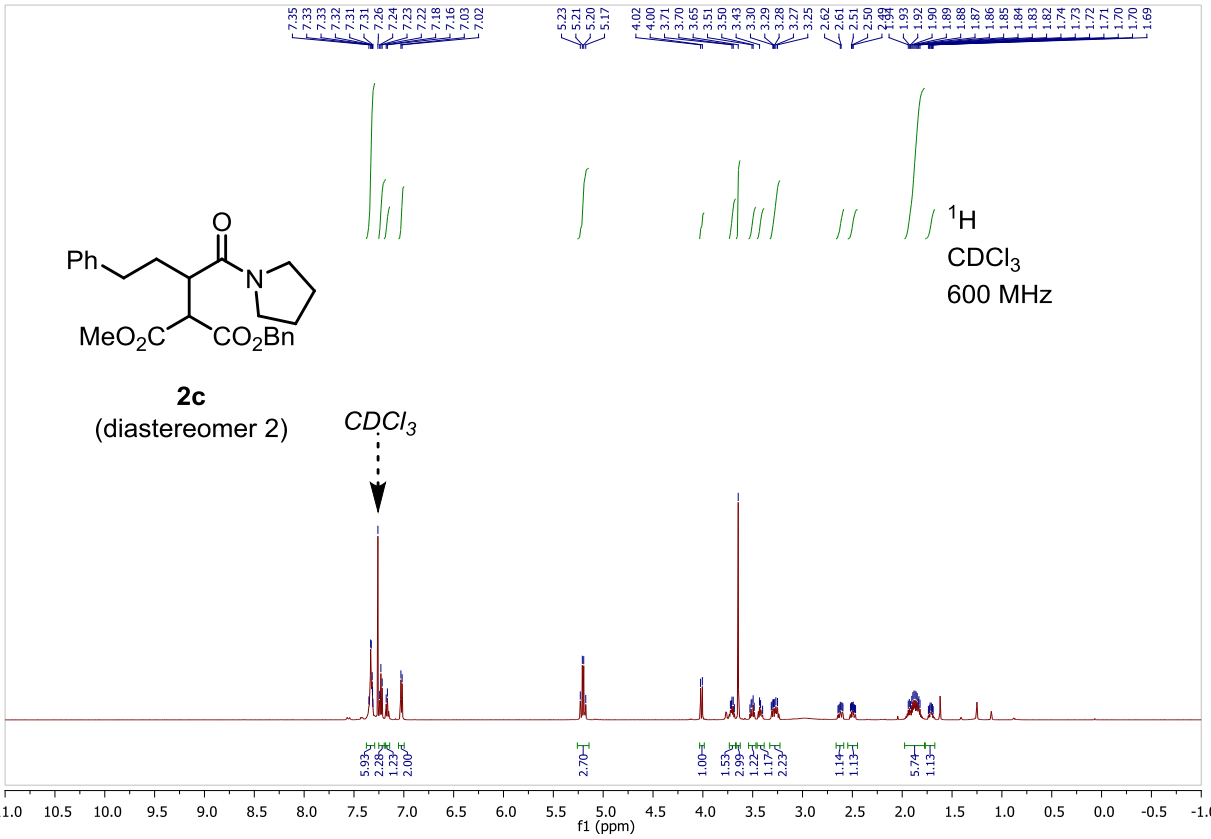

Ph
O
N
EtO2C
EtO2C
2a
13C (APT)
CDCl3
100 MHz
CDCl3
f1 (ppm)

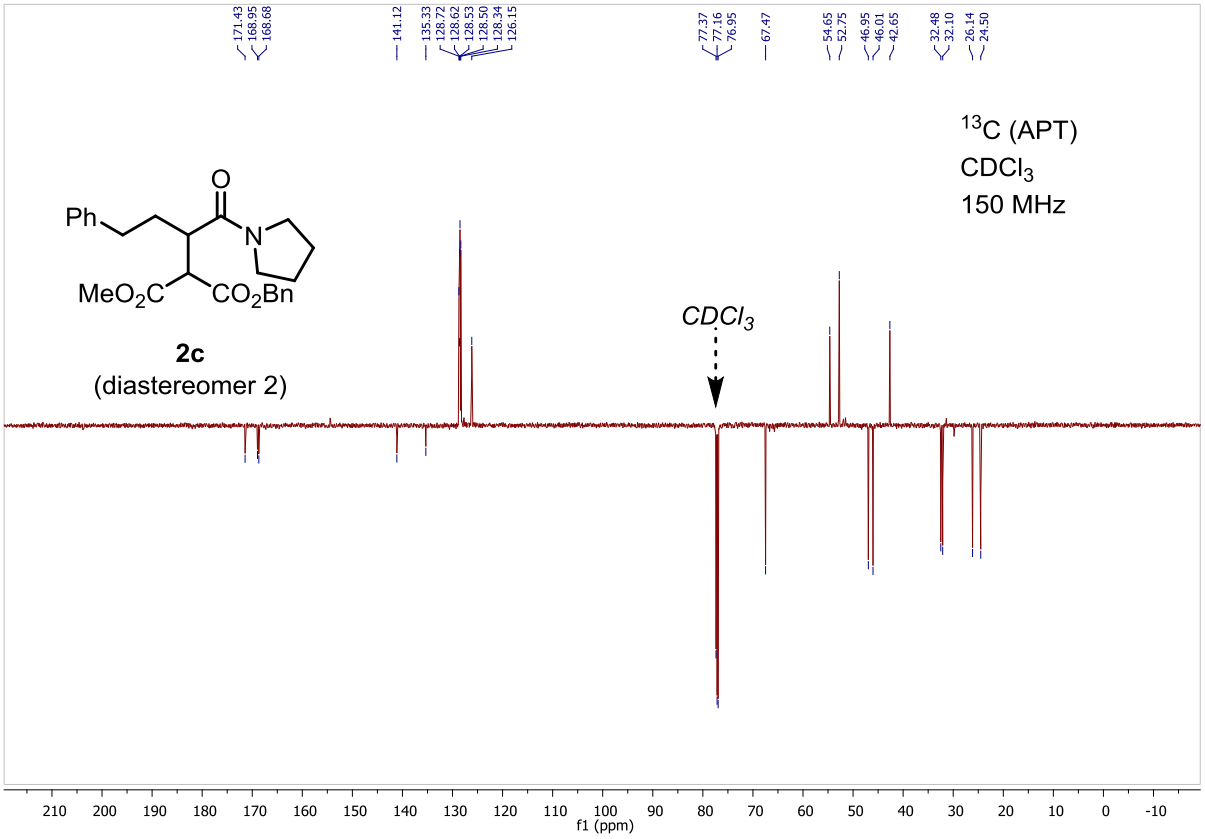

Ph
O
N
BnO2C
CO2Bn
2b
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

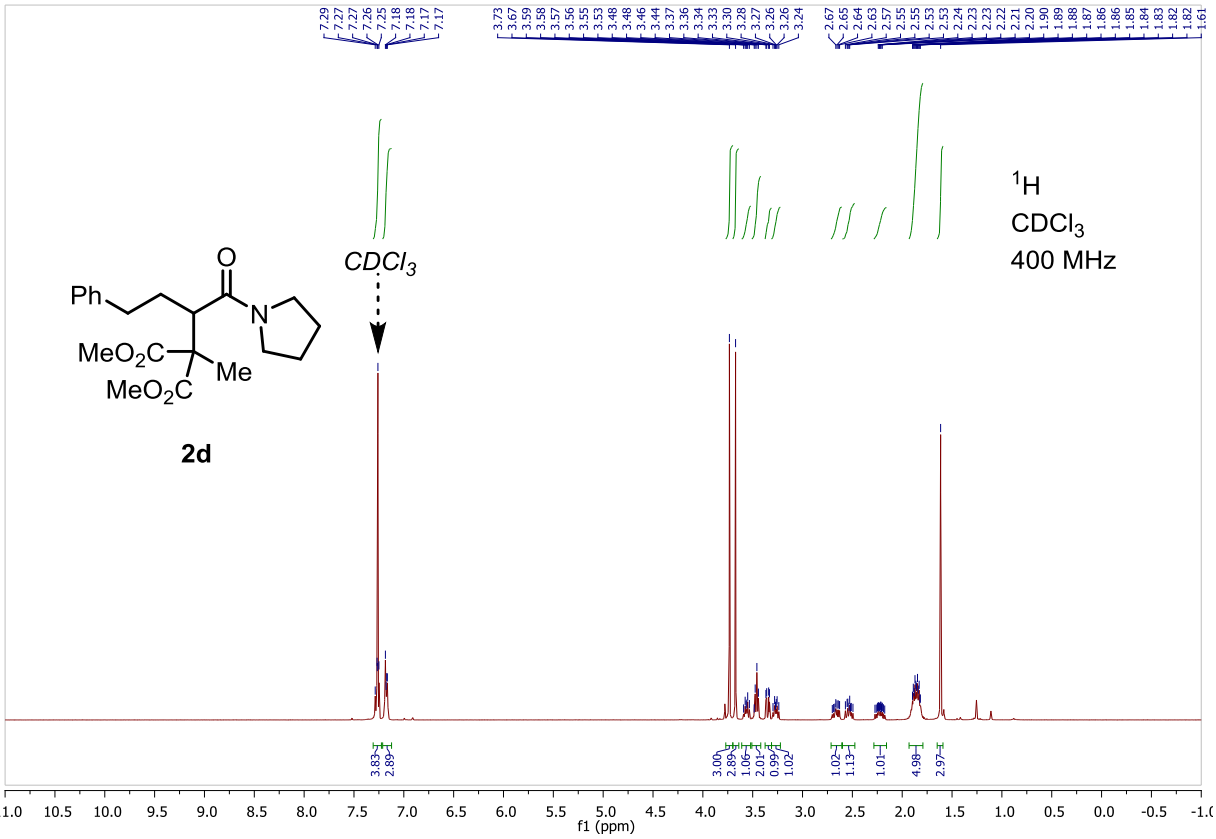

Ph
O
N
BnO2C
CO2Bn
2b
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)

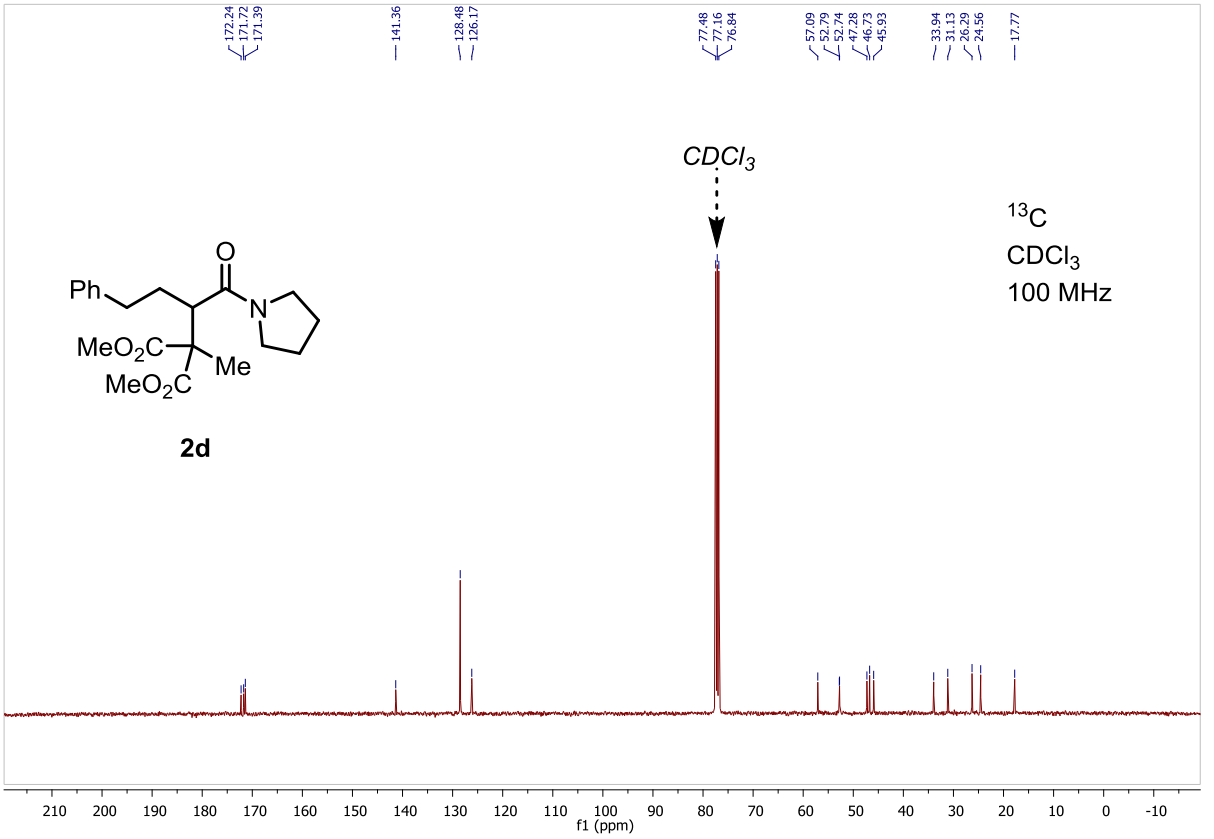

Ph
O
N
MeO2C
CO2Bn
2c
(diastereomer 1)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

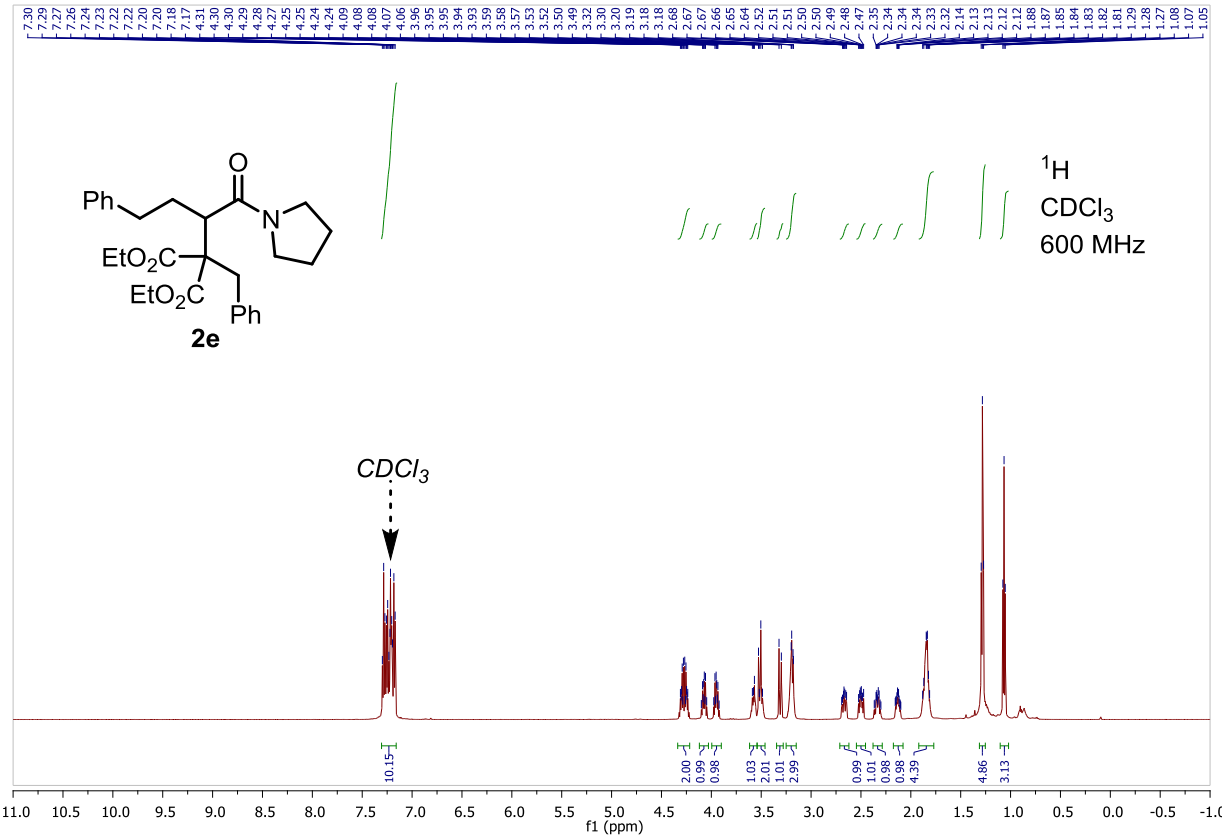

Ph
O
N
MeO2C
CO2Bn
2c
(diastereomer 1)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

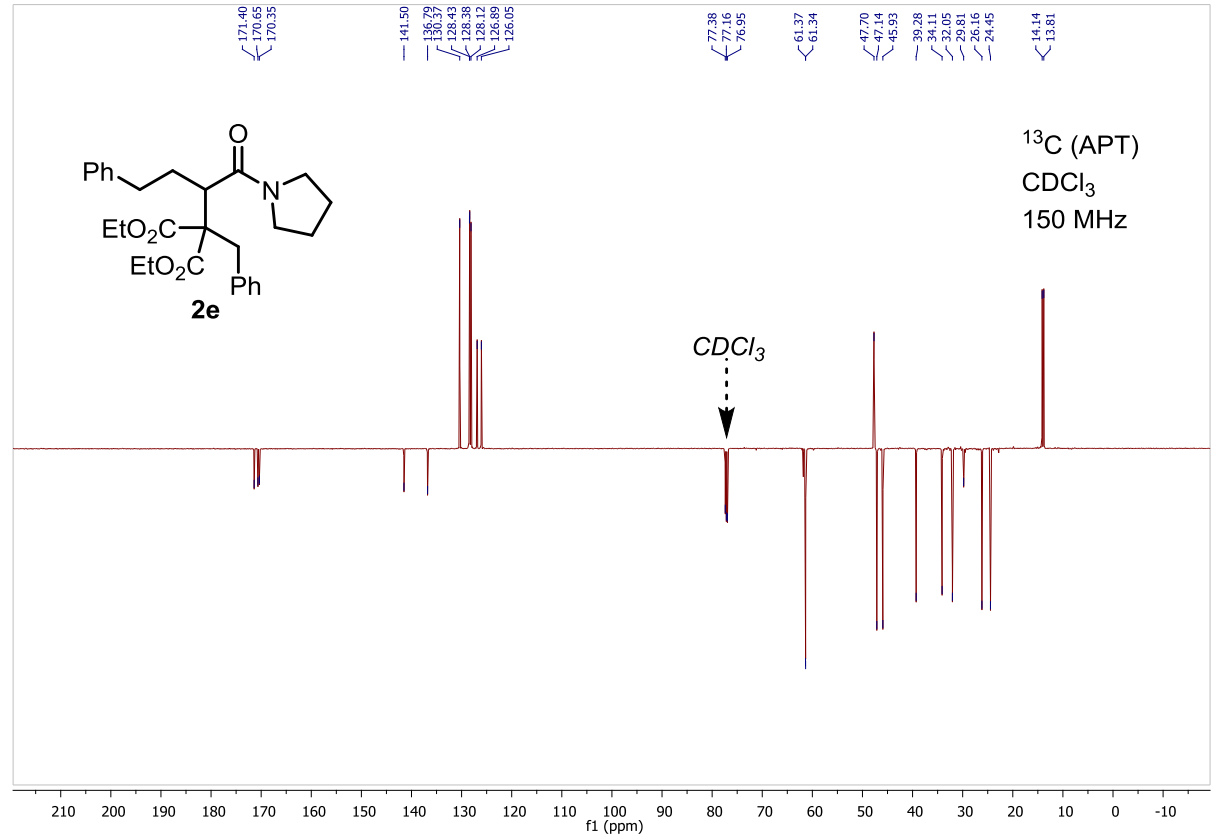

Ph
O
N
MeO2C
CO2Bn
2c
(diastereomer 2)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

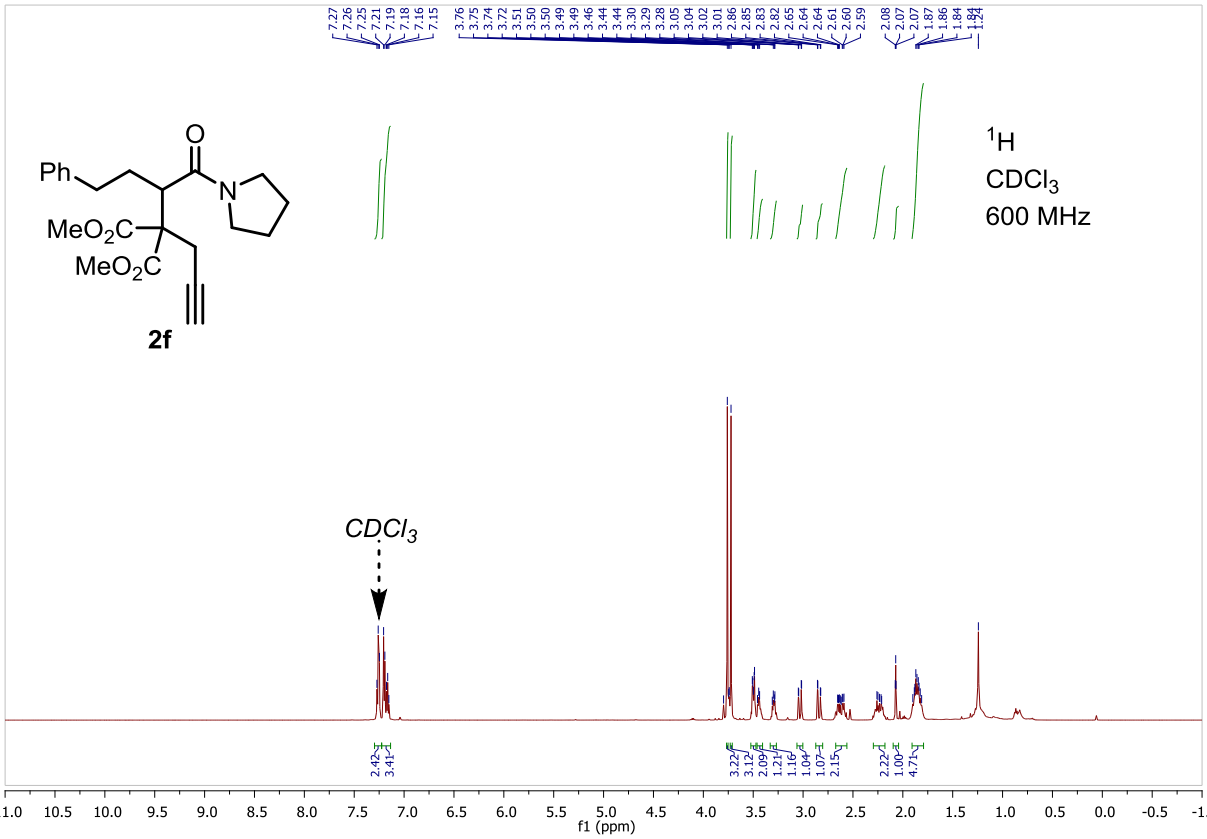

Ph
O
N
MeO2C
CO2Bn
2c
(diastereomer 2)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

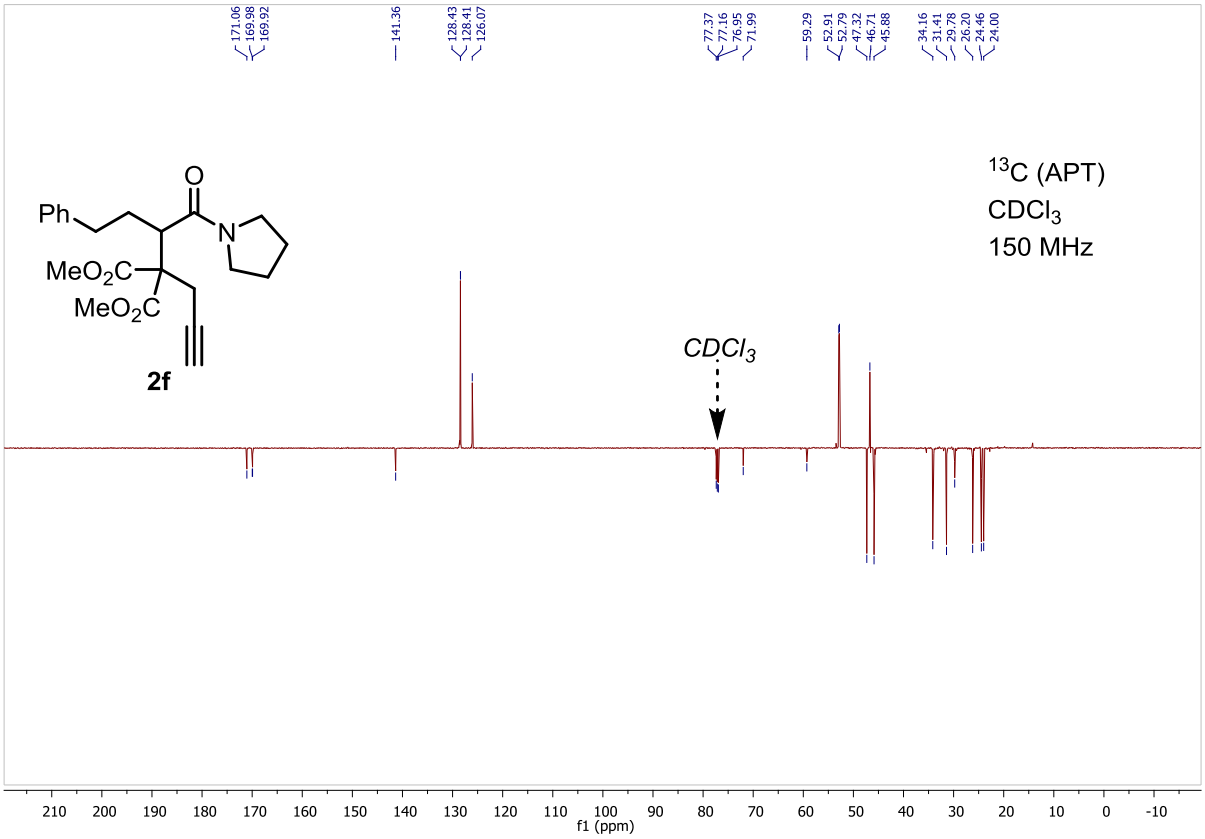

^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
Ph
MeO_2C
MeO_2C
Me
N
O
2d
f1 (ppm)

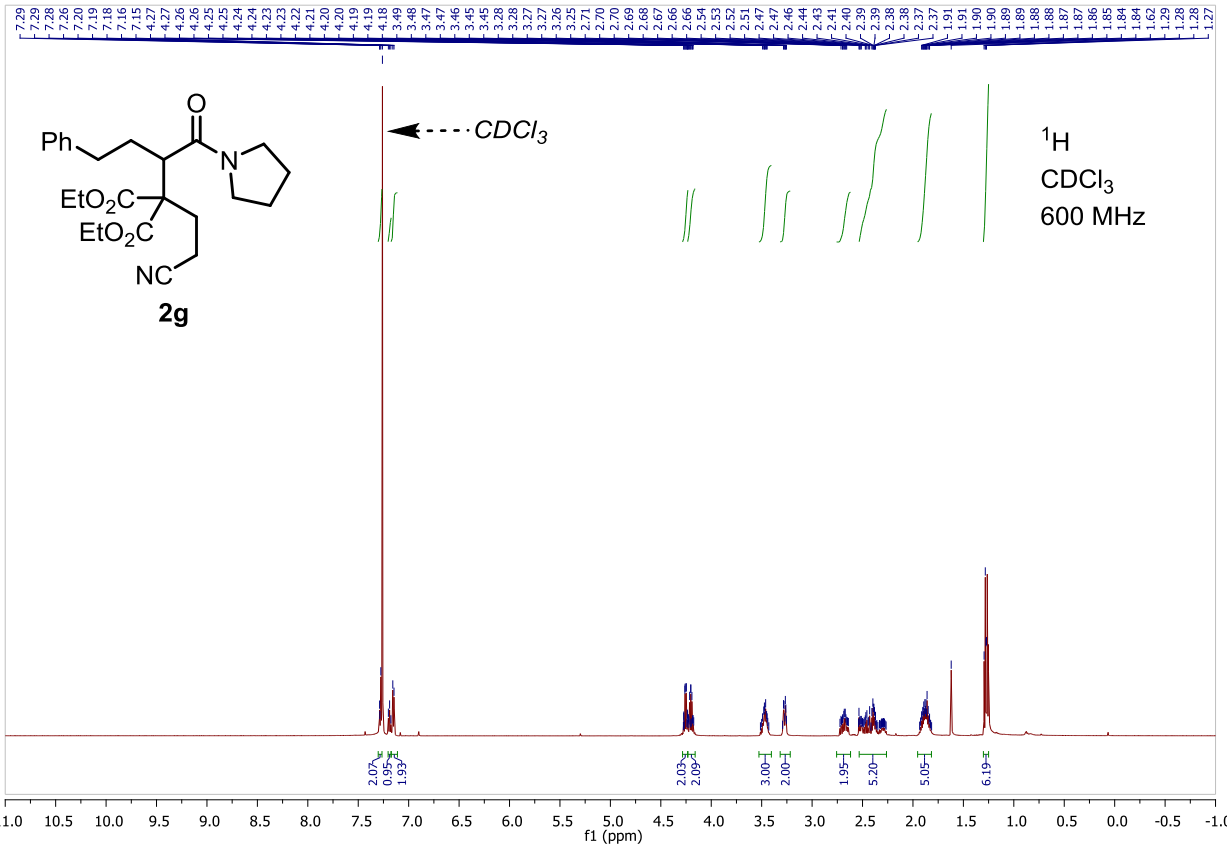

^{13}C
$CDCl_3$
100 MHz
$CDCl_3$
Ph
MeO_2C
MeO_2C
Me
N
O
2d
f1 (ppm)

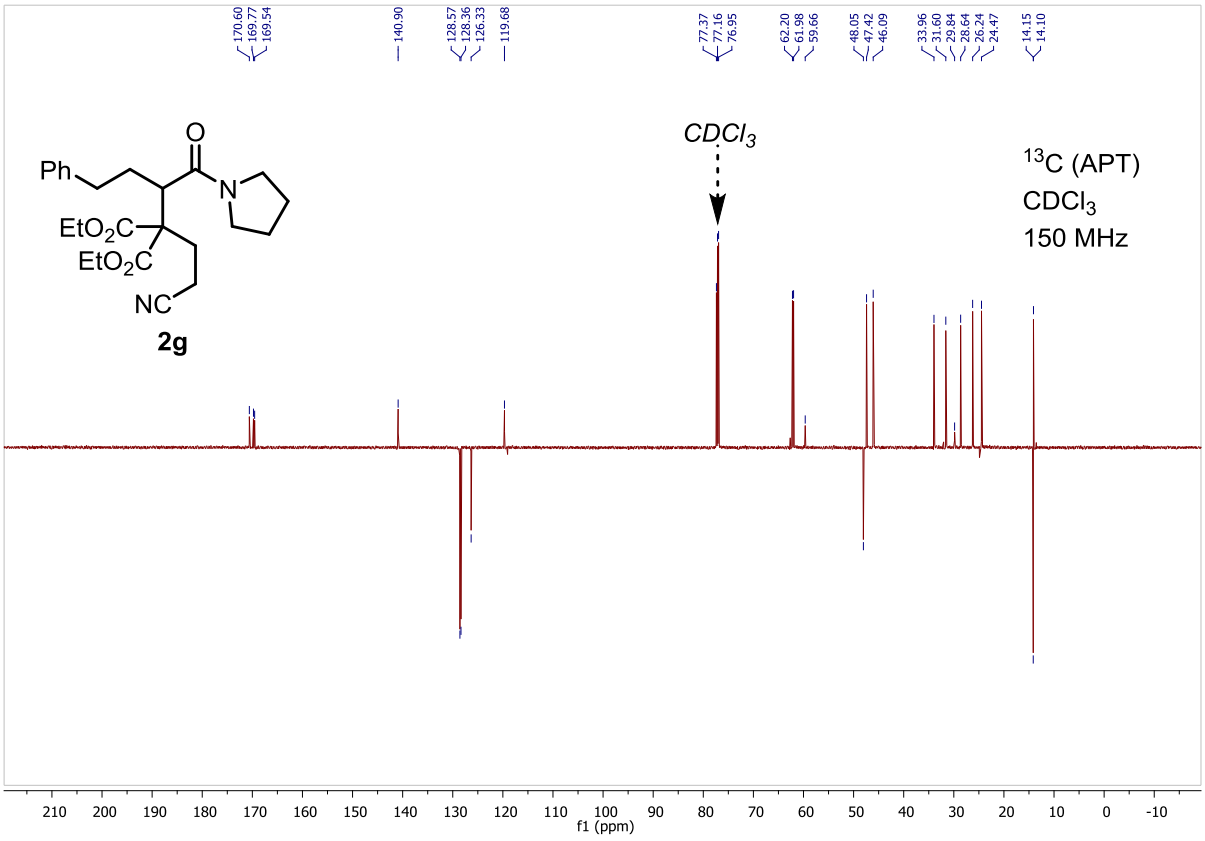

Ph
O
N
EtO2C
EtO2C
Ph
2e
1H
CDCl3
600 MHz
CDCl3
f1 (ppm)

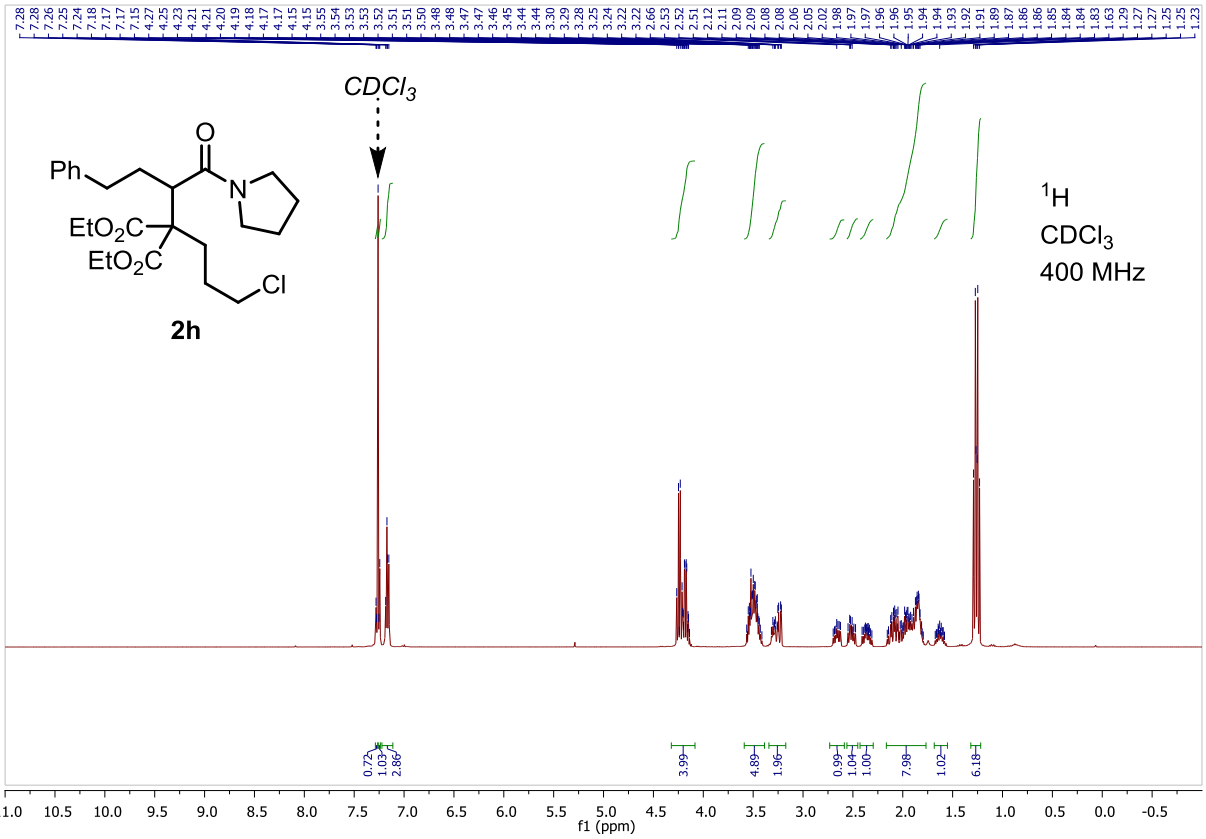

Ph
O
N
EtO2C
EtO2C
Ph
2e
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)

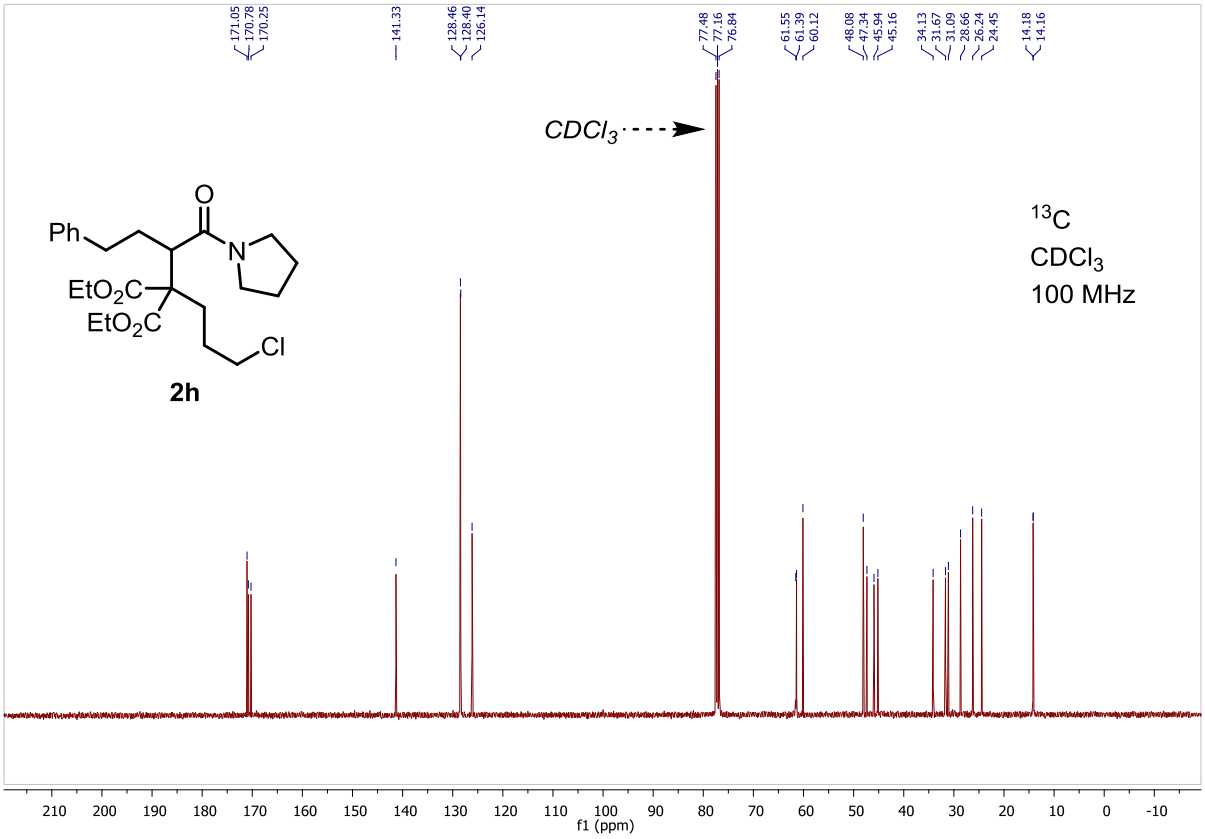

Ph
MeO2C
MeO2C
O
N
2f
1H
CDCl3
600 MHz
CDCl3
f1 (ppm)

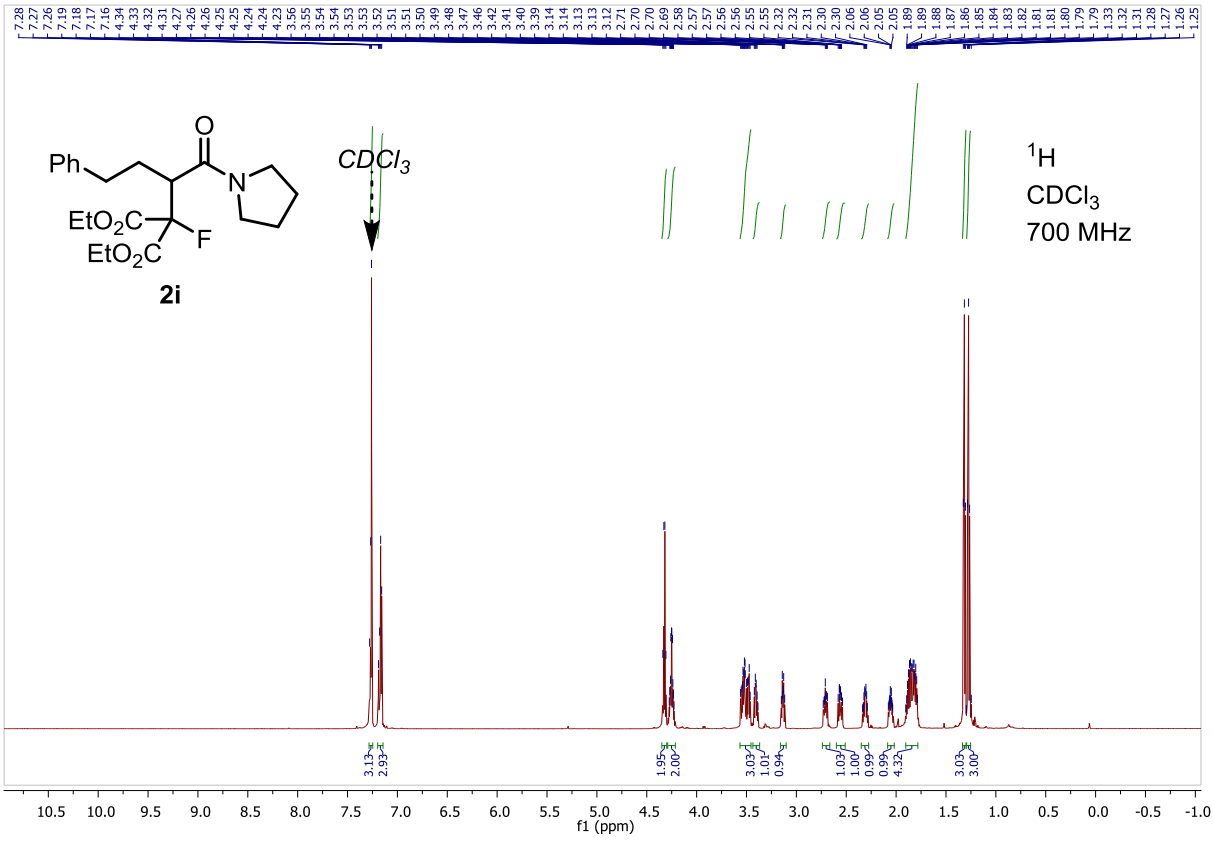

Ph
MeO2C
MeO2C
O
N
2f
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)

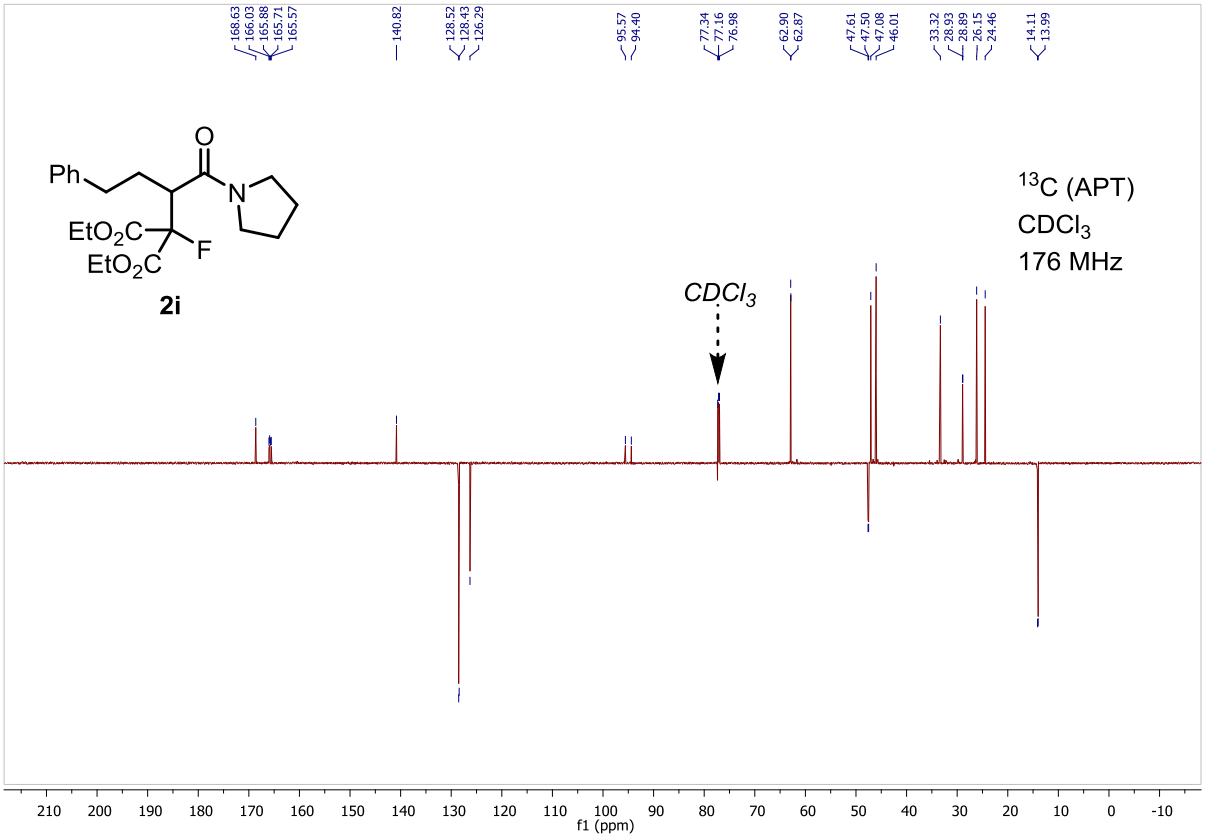

Ph
N
O
EtO2C
EtO2C
NC
2g
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

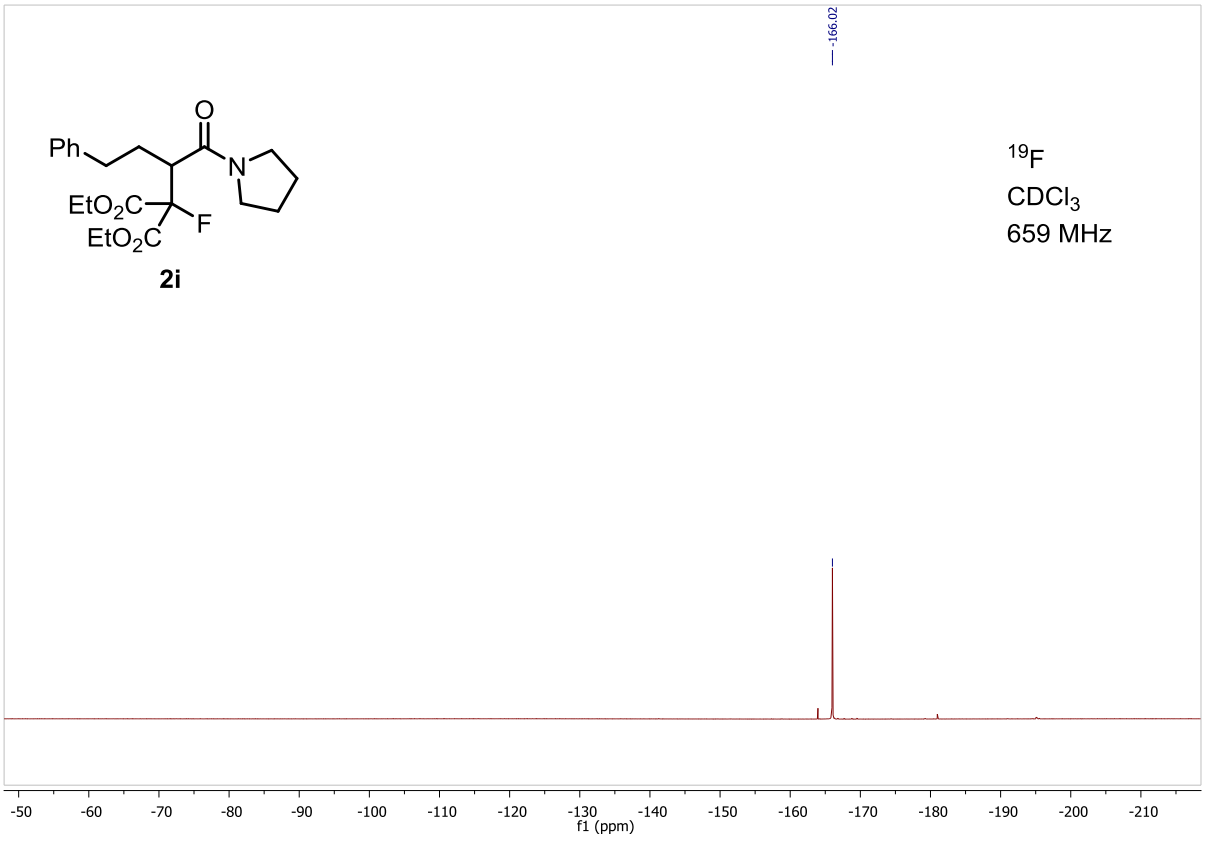

Ph
N
O
EtO2C
EtO2C
NC
2g
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

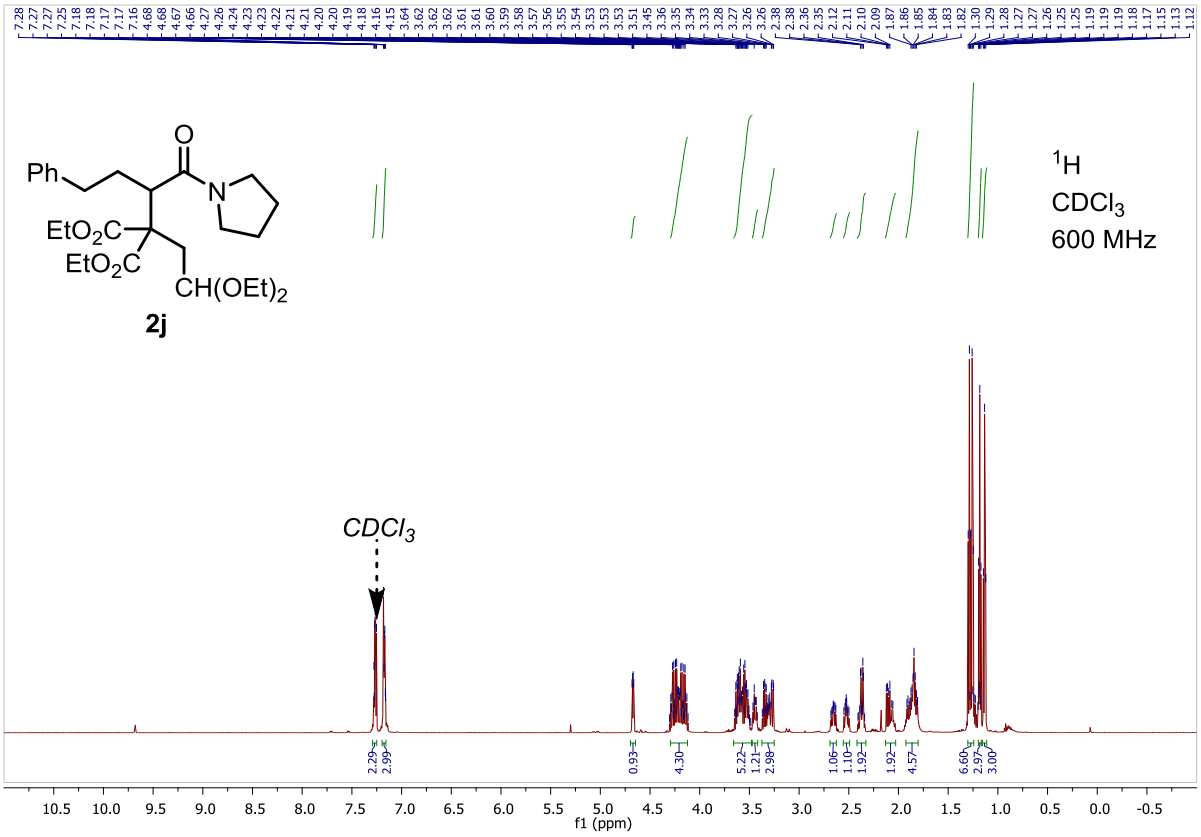

CDCl3
Ph
O
N
EtO2C
EtO2C
Cl
2h
1H
CDCl3
400 MHz
f1 (ppm)

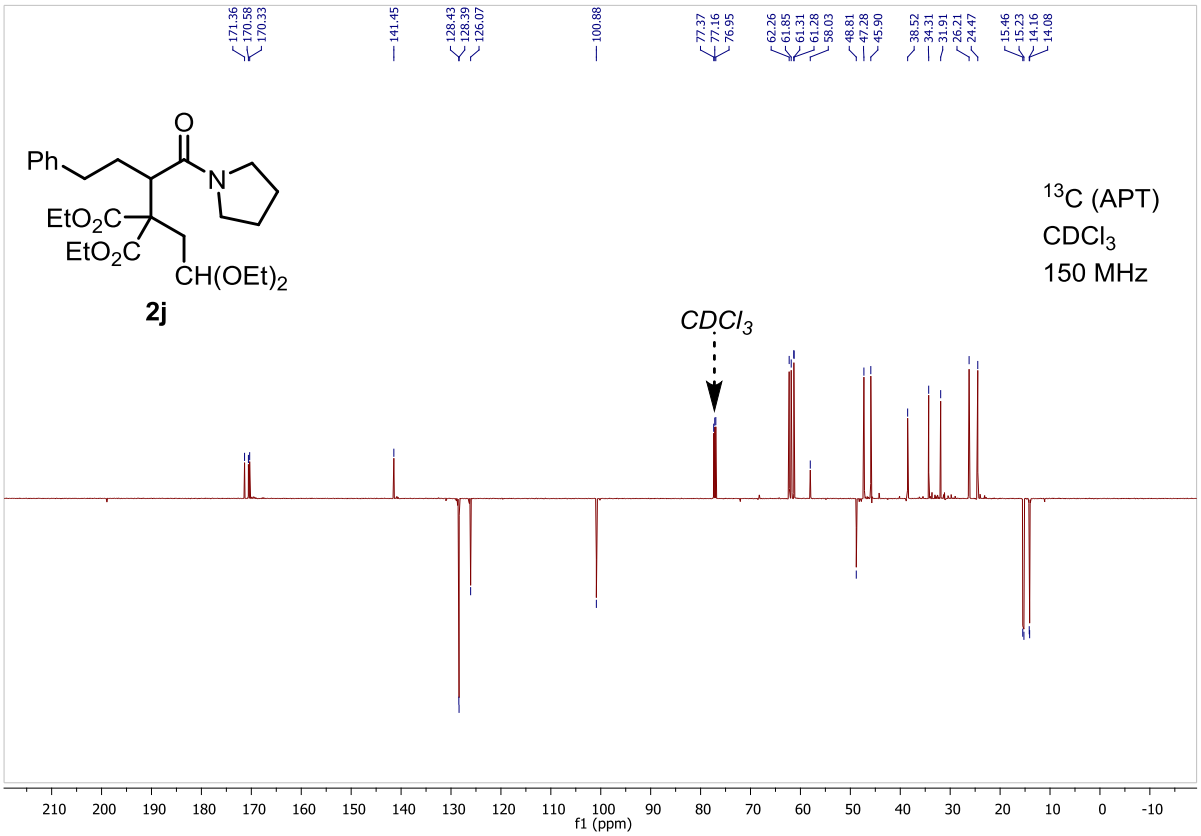

CDCl3
Ph
O
N
EtO2C
EtO2C
Cl
2h
13C
CDCl3
100 MHz
f1 (ppm)

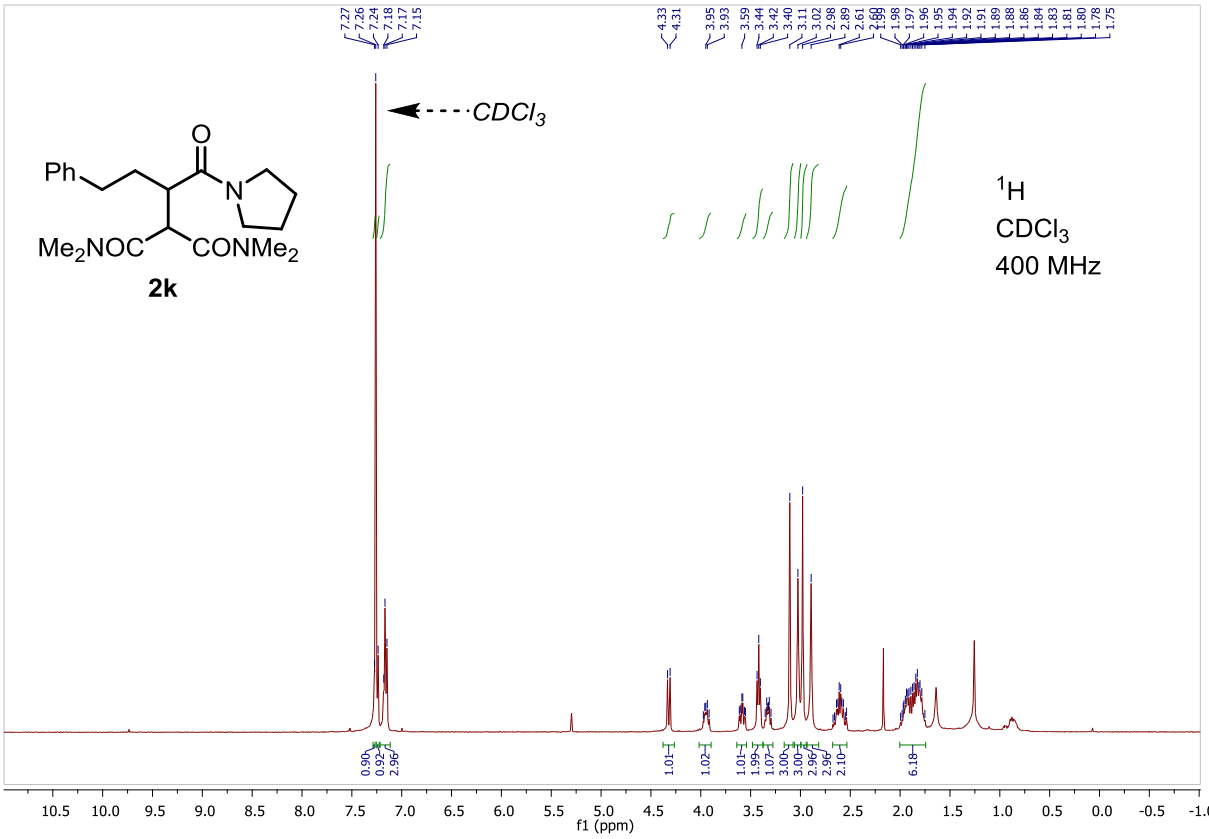

Ph
O
N
EtO2C
F
EtO2C
2i
CDCl3
1H
CDCl3
700 MHz
f1 (ppm)

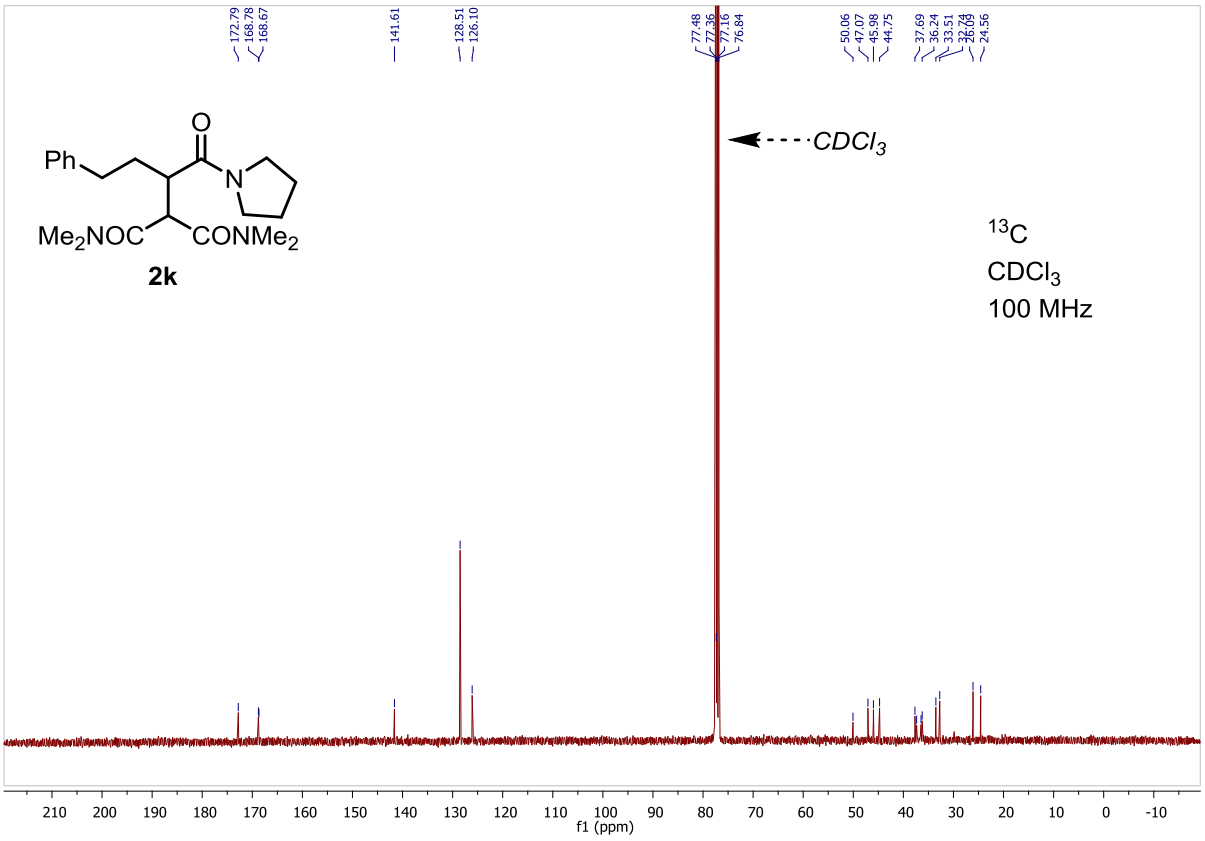

Ph
O
N
EtO2C
F
EtO2C
2i
CDCl3
13C (APT)
CDCl3
176 MHz
f1 (ppm)

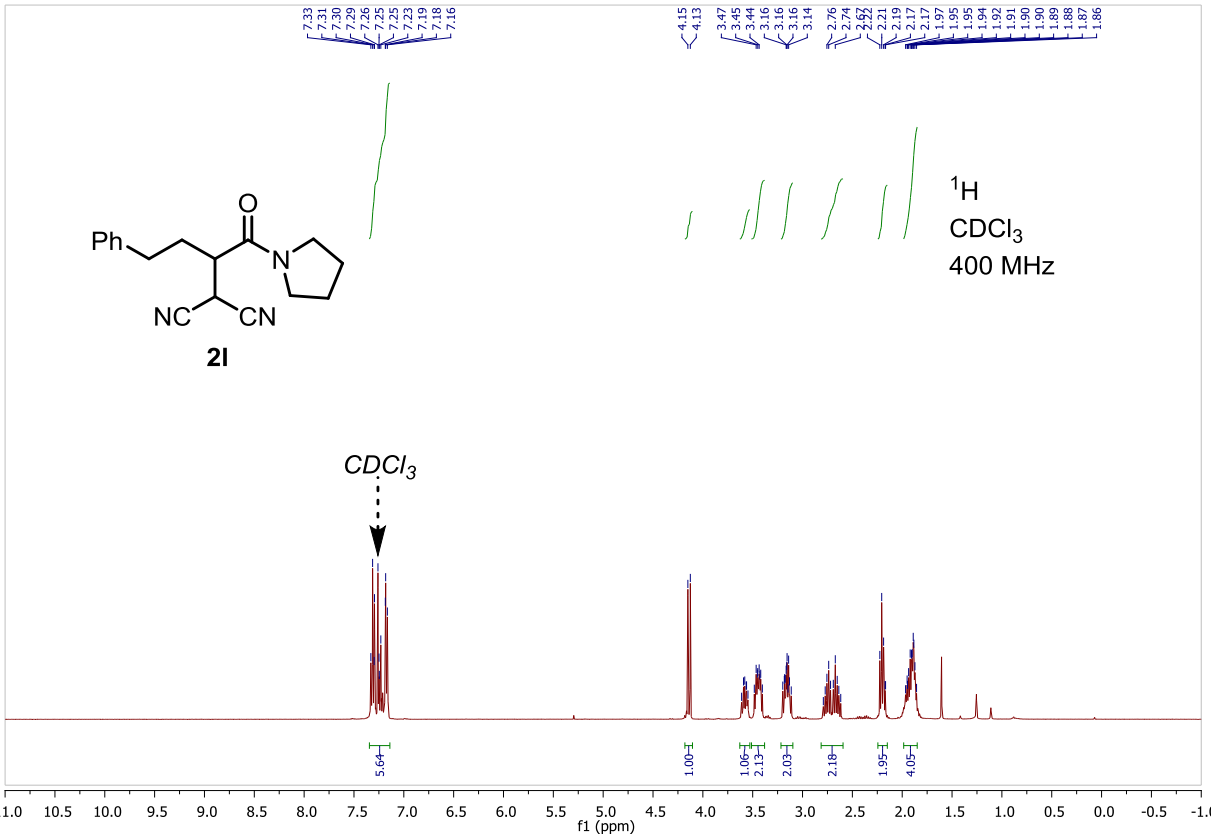

-166.02
Ph
O
N
EtO2C
F
EtO2C
2i
19F
CDCl3
659 MHz
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

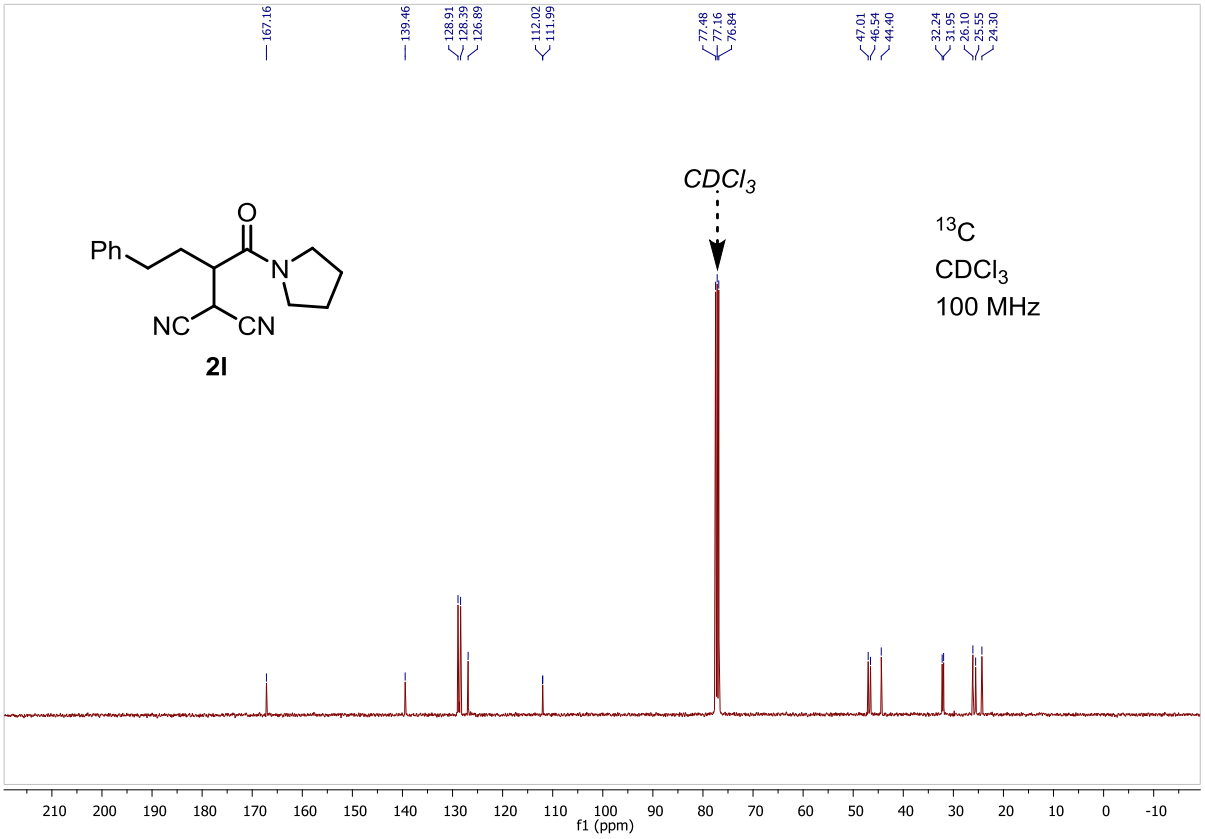

Ph
O
N
EtO2C
EtO2C
CH(OEt)2
2j
1H
CDCl3
600 MHz
CDCl3
f1 (ppm)

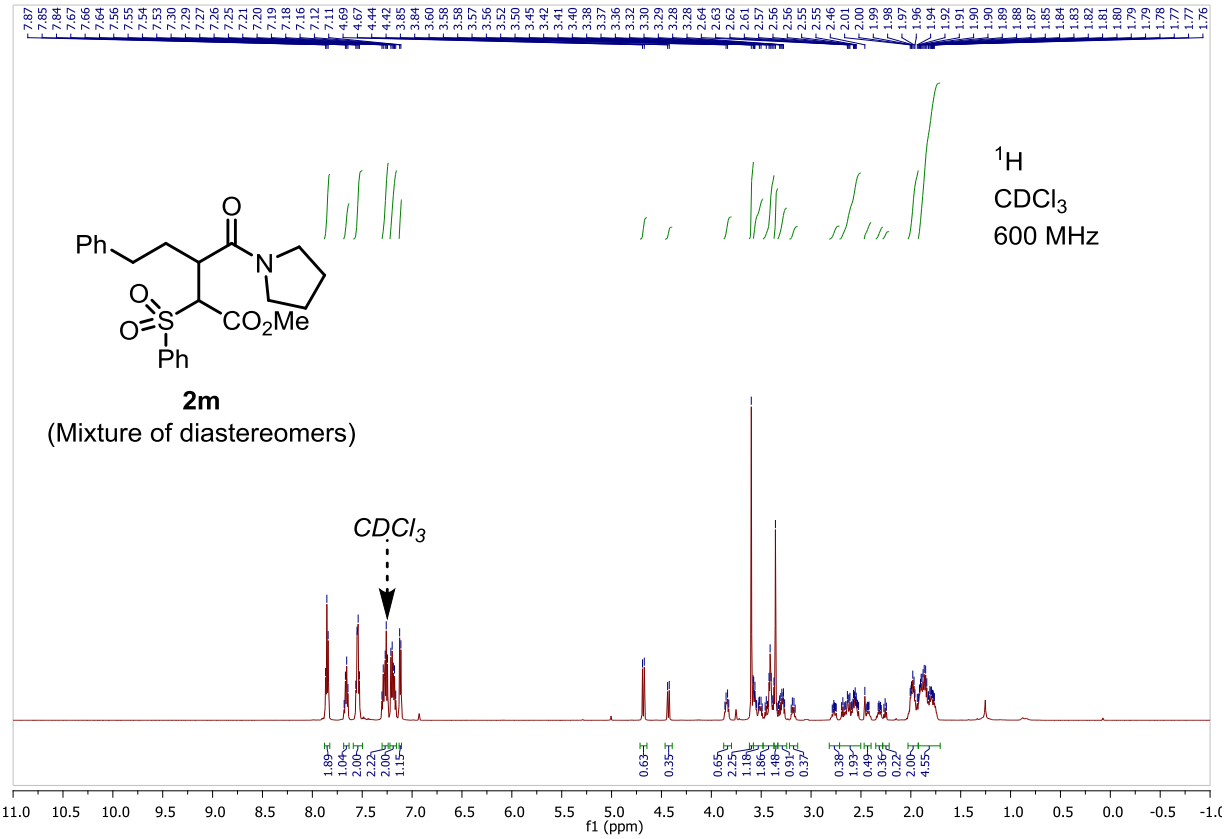

Ph
O
N
EtO2C
EtO2C
CH(OEt)2
2j
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)

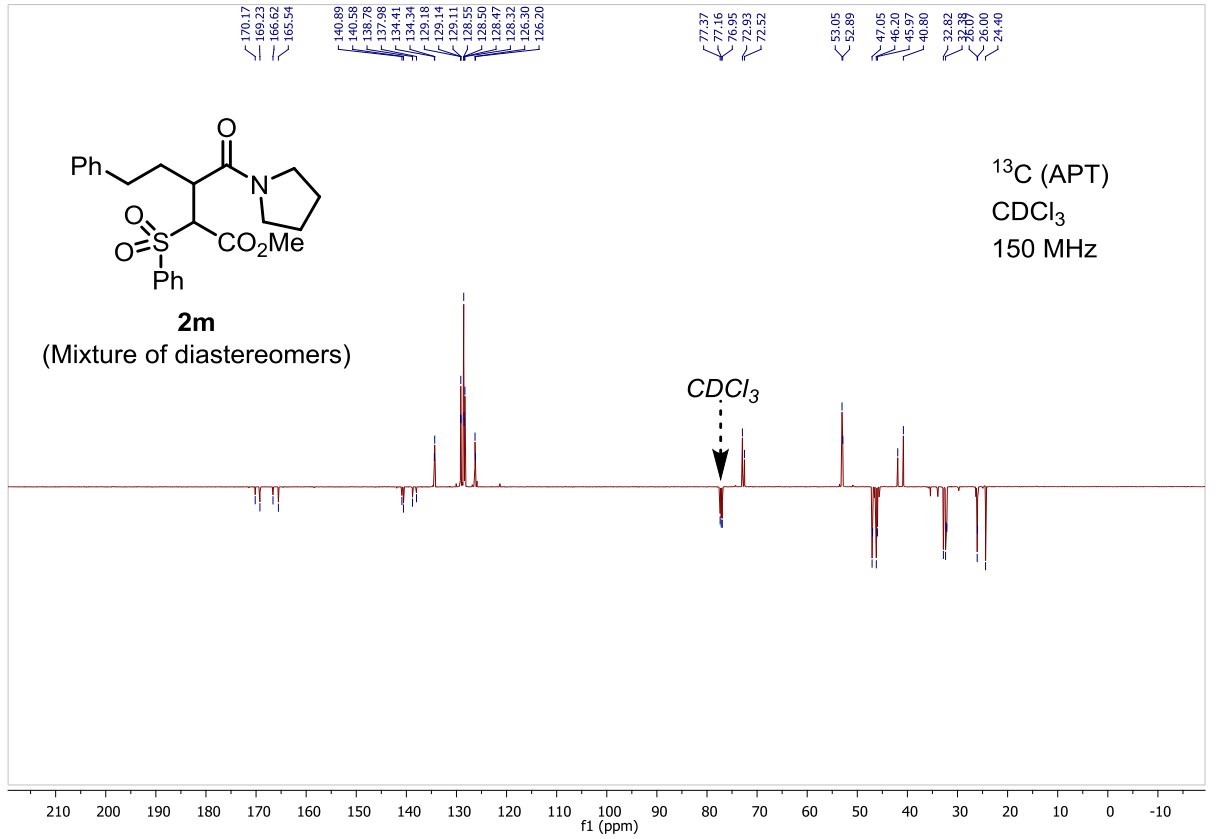

CDCl3
Ph
O
N
Me2NOC
CONMe2
2k
1H
CDCl3
400 MHz
f1 (ppm)

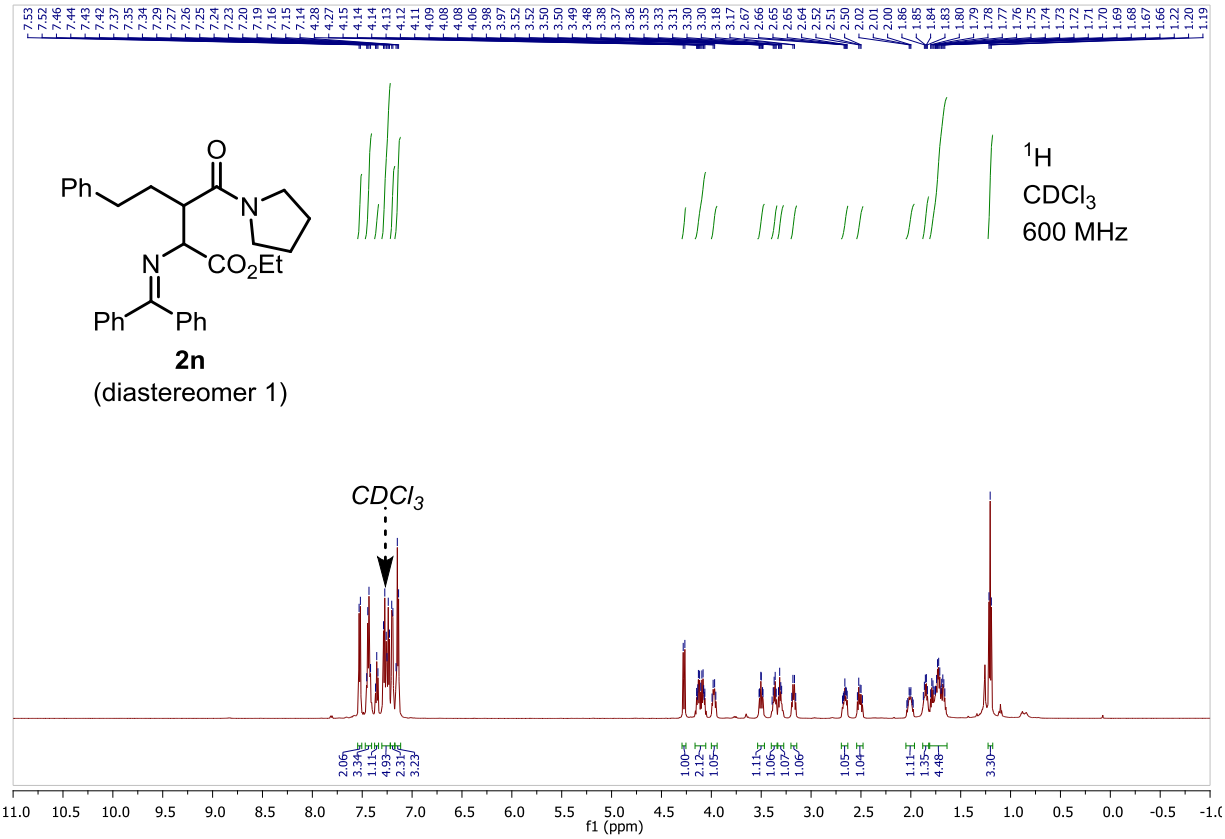

CDCl3
Ph
O
N
Me2NOC
CONMe2
2k
13C
CDCl3
100 MHz
f1 (ppm)

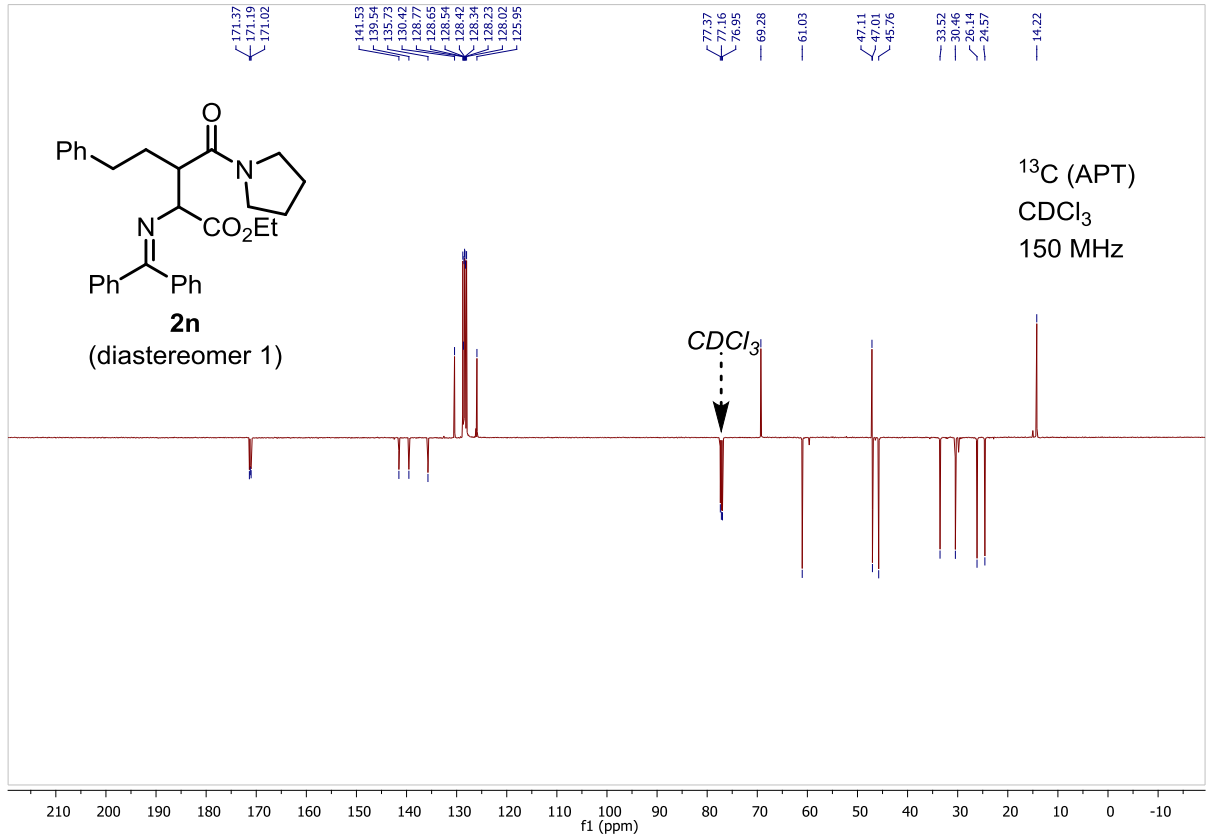

Ph
O
N
NC
CN
2l
^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
f1 (ppm)

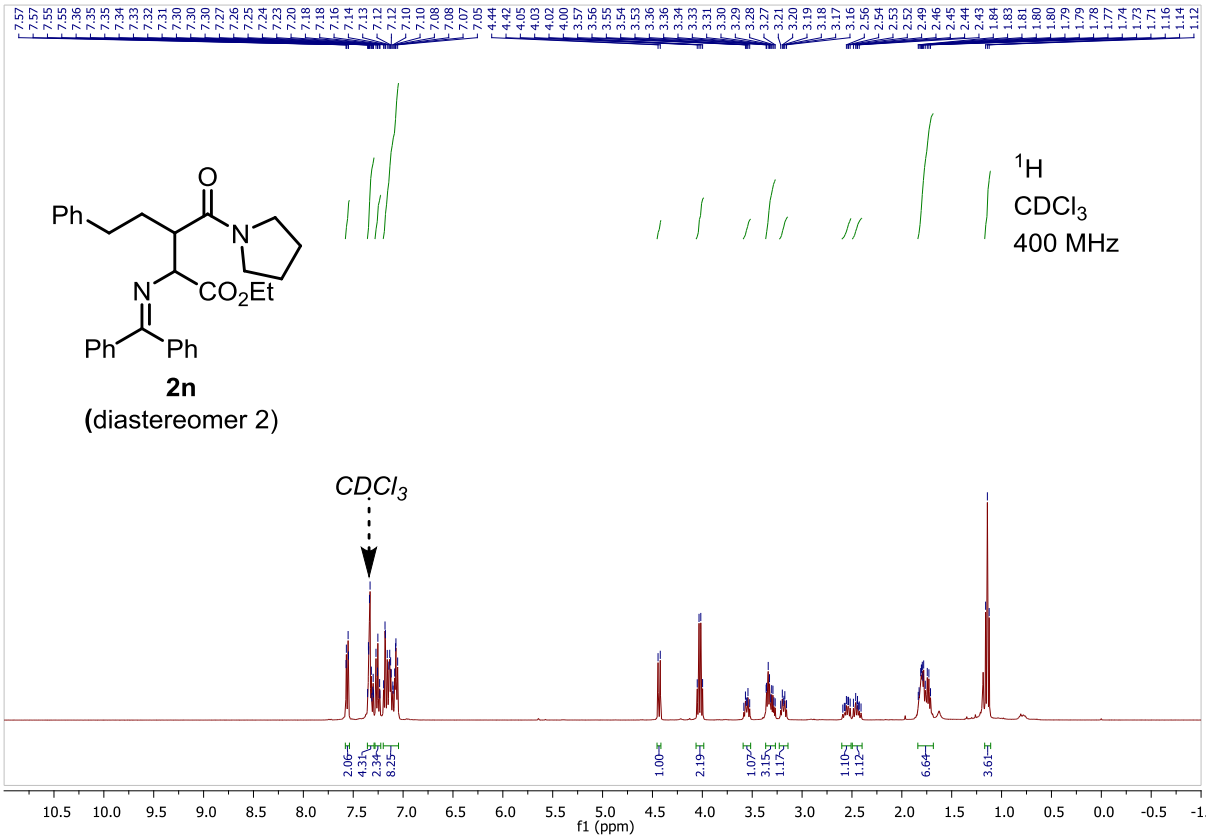

Ph
O
N
NC
CN
2l
^{13}C
$CDCl_3$
100 MHz
$CDCl_3$
f1 (ppm)

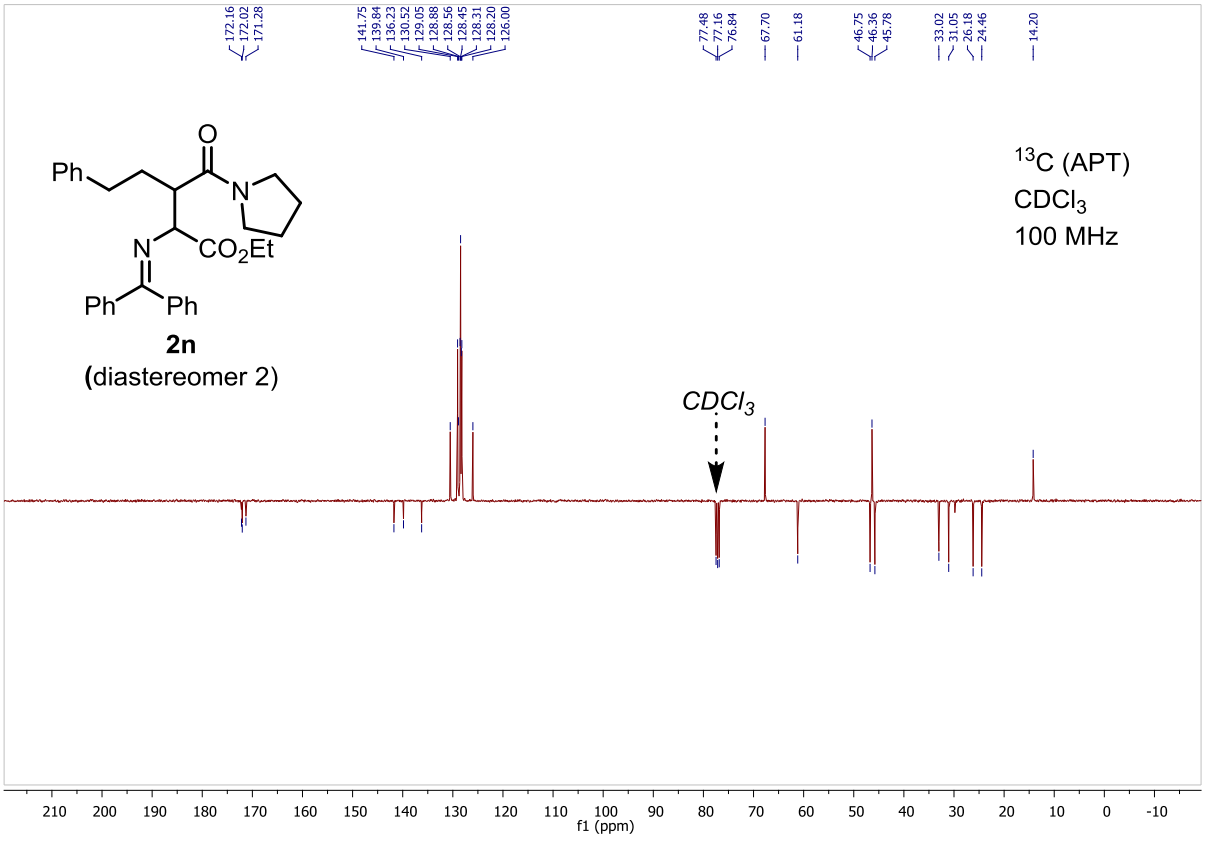

Ph
O
N
O
S
O
CO2Me
Ph
2m
(Mixture of diastereomers)
1H
CDCl3
600 MHz
CDCl3
f1 (ppm)

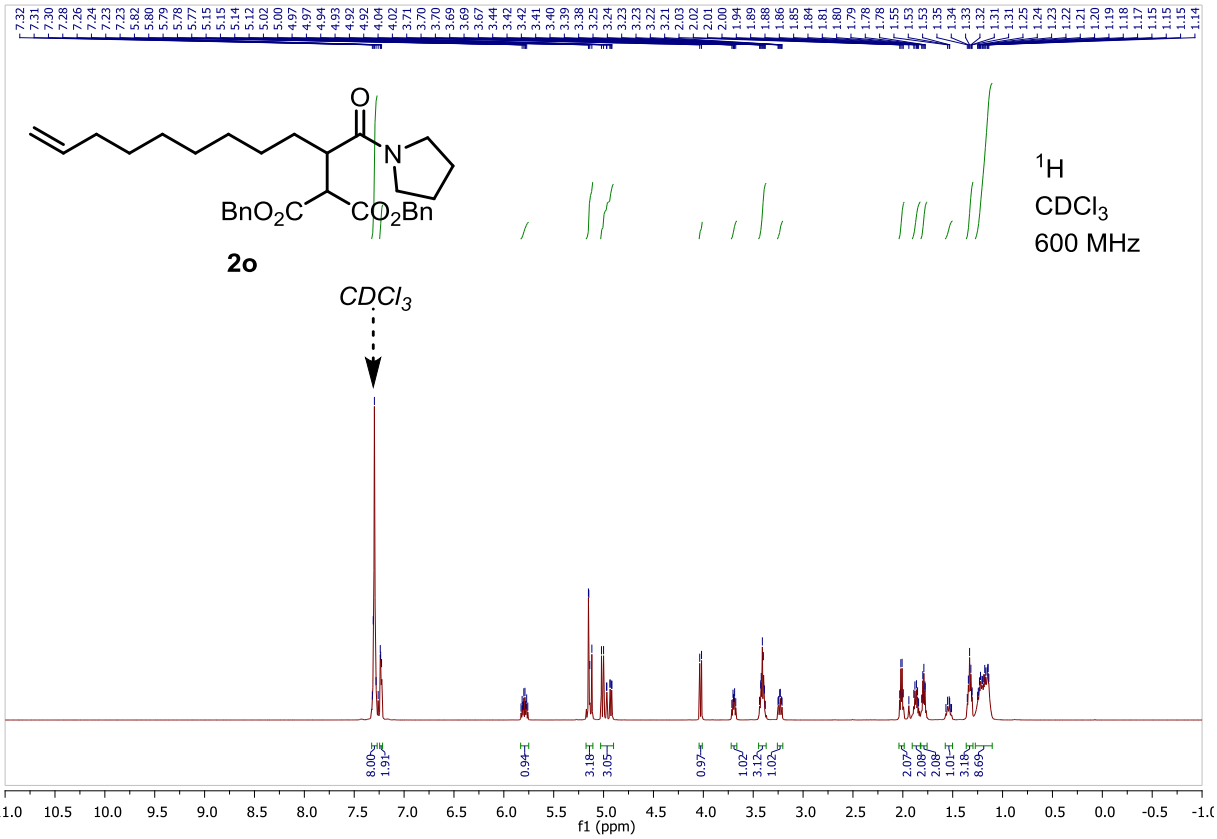

Ph
O
N
O
S
O
CO2Me
Ph
2m
(Mixture of diastereomers)
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)

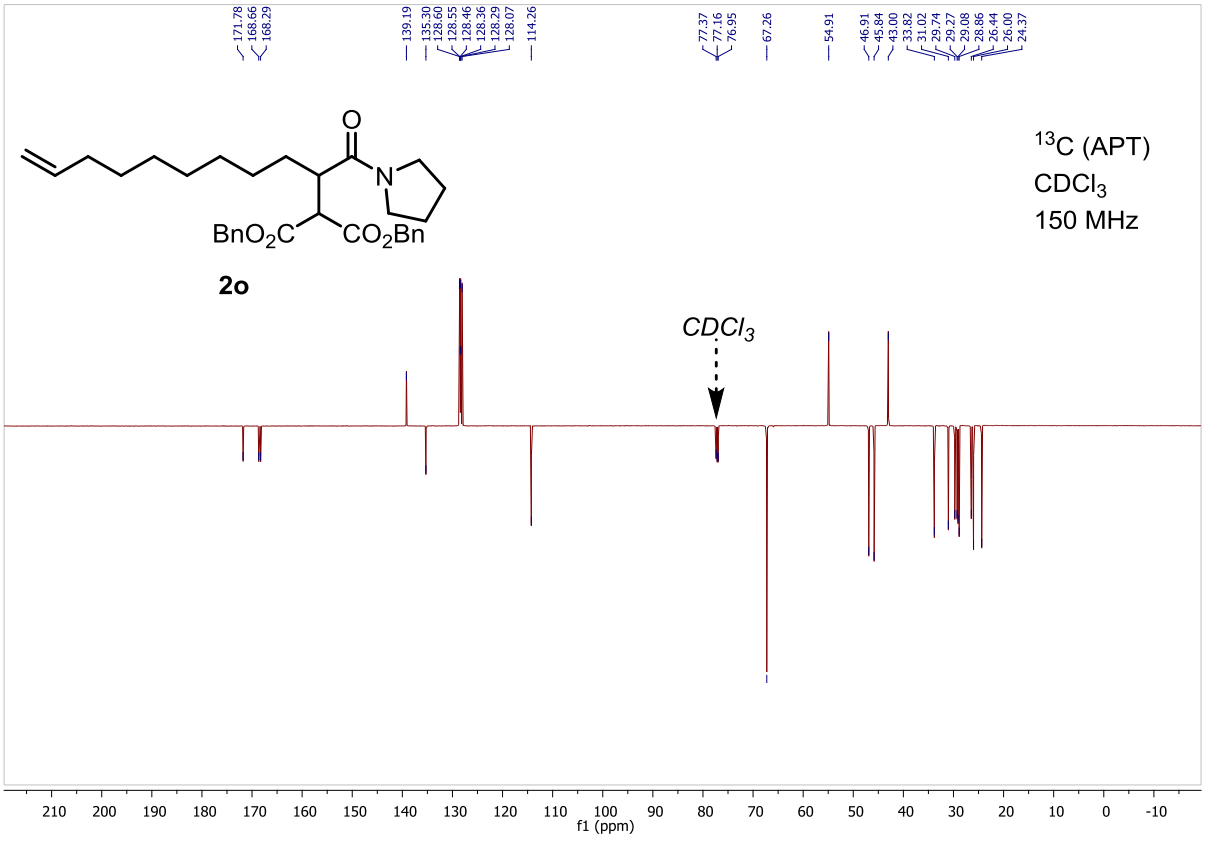

Ph
O
N
N
CO2Et
Ph
Ph
2n
(diastereomer 1)
1H
CDCl3
600 MHz
CDCl3
f1 (ppm)

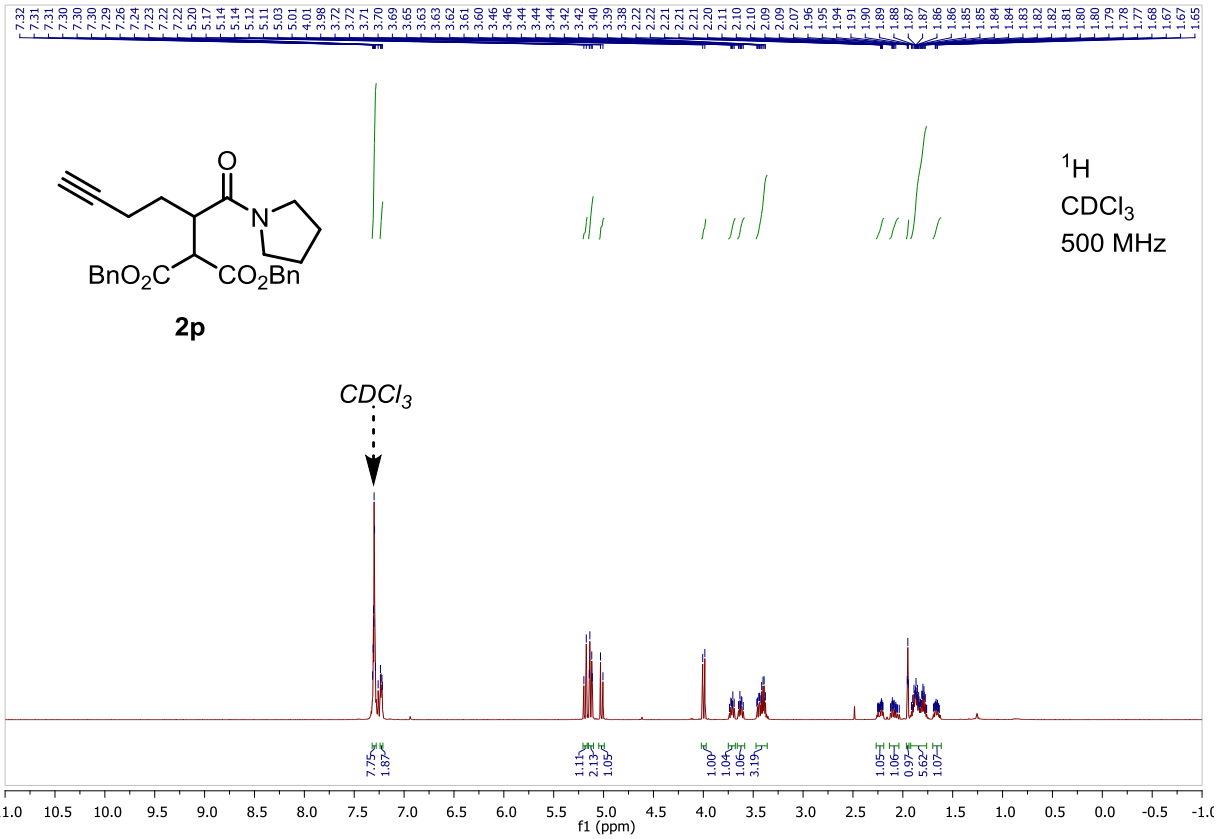

Ph
O
N
N
CO2Et
Ph
Ph
2n
(diastereomer 1)
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)


Ph
O
N
N
CO2Et
Ph
Ph
2n
(diastereomer 2)
1H
CDCl3
400 MHz
CDCl3
f1 (ppm)

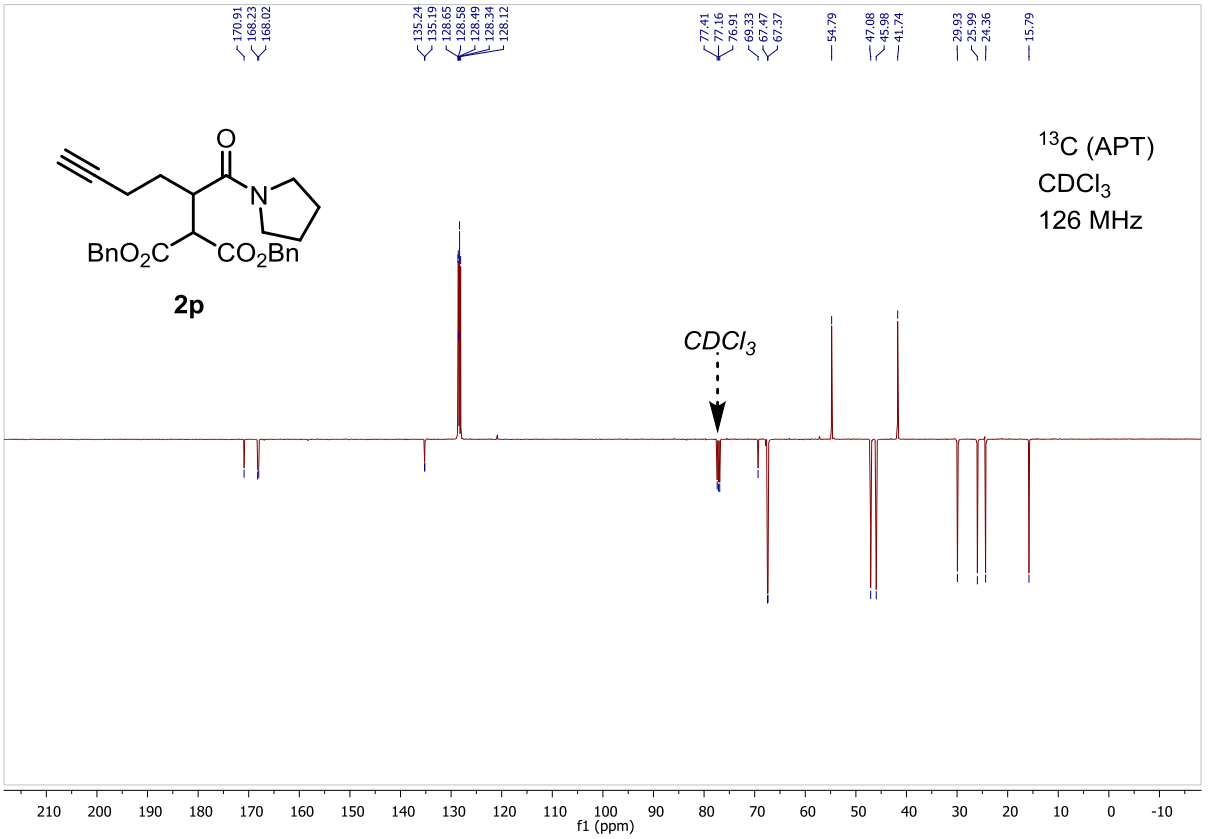

Ph
O
N
N
CO2Et
Ph
Ph
2n
(diastereomer 2)
13C (APT)
CDCl3
100 MHz
CDCl3
f1 (ppm)


BnO2C
CO2Bn
2o
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

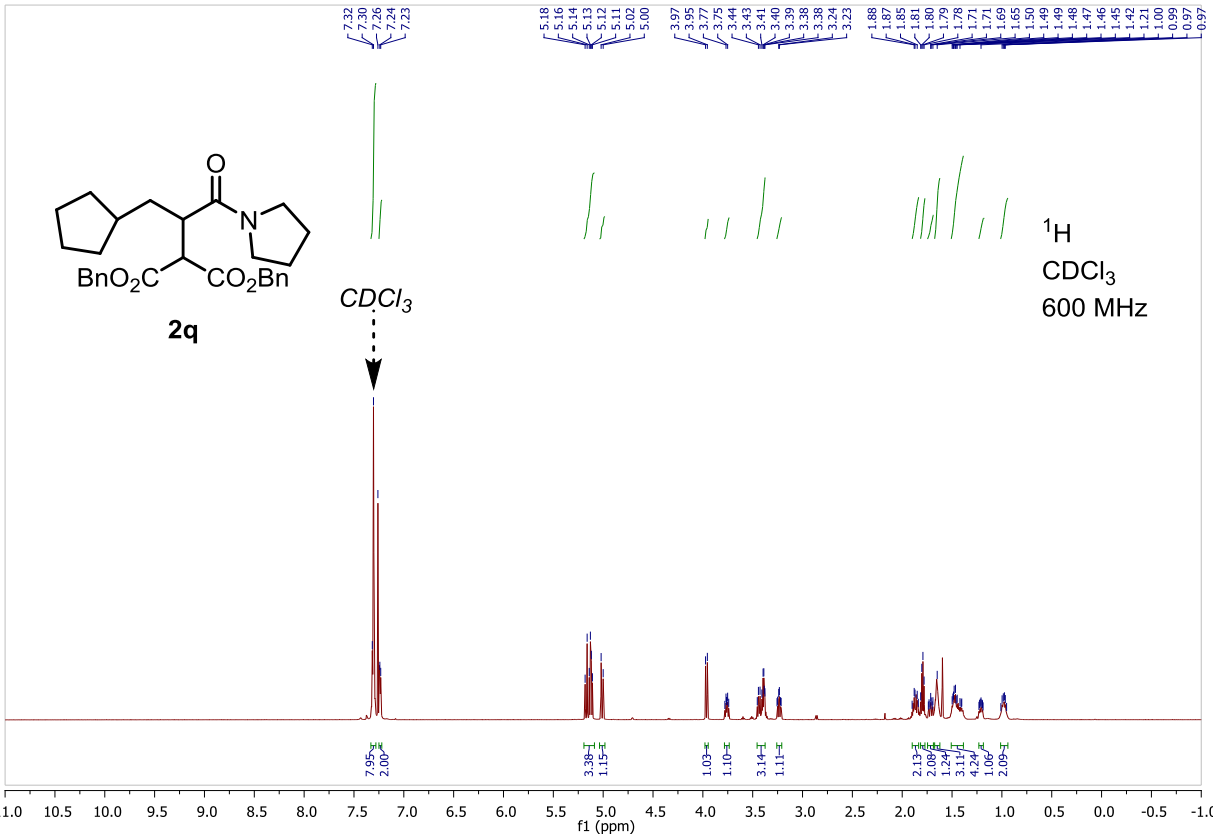

BnO2C
CO2Bn
2o
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

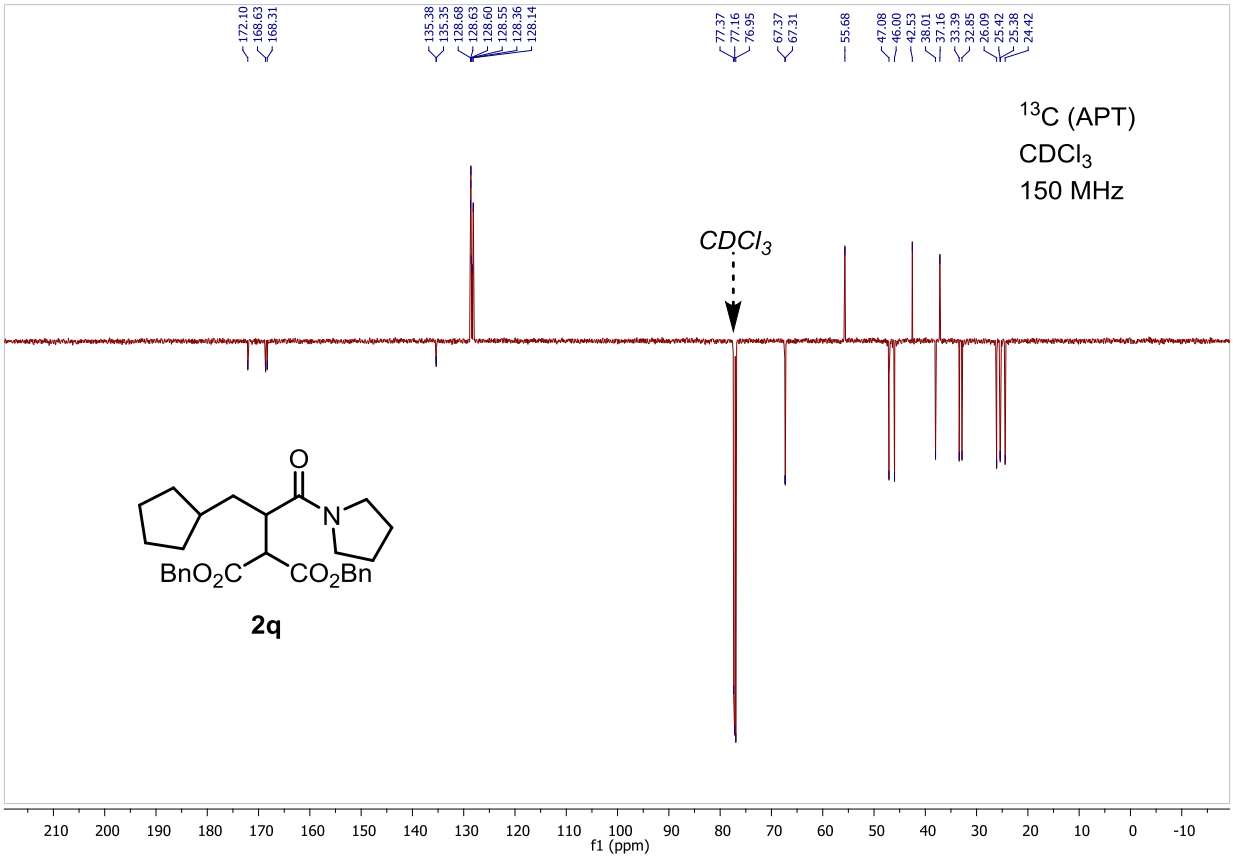

^{1}H
$CDCl_3$
500 MHz
$CDCl_3$
f1 (ppm)

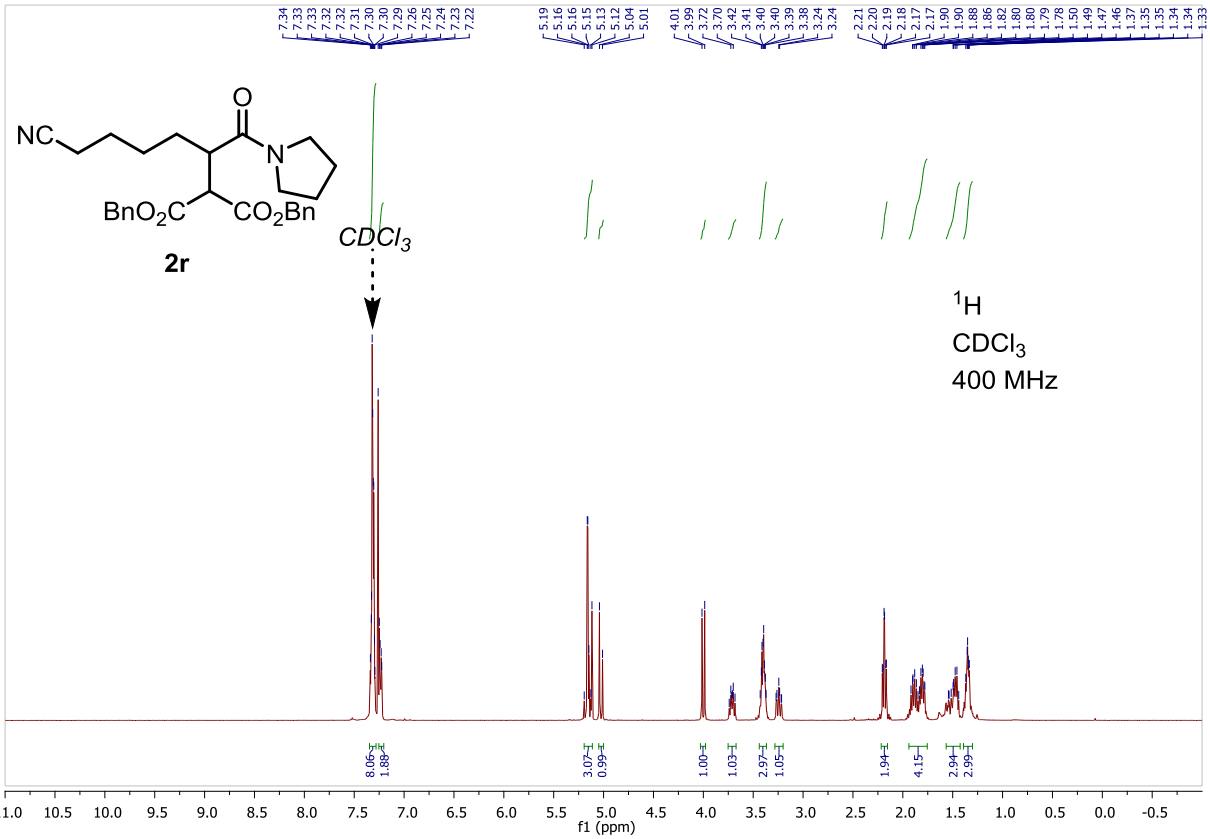
2p

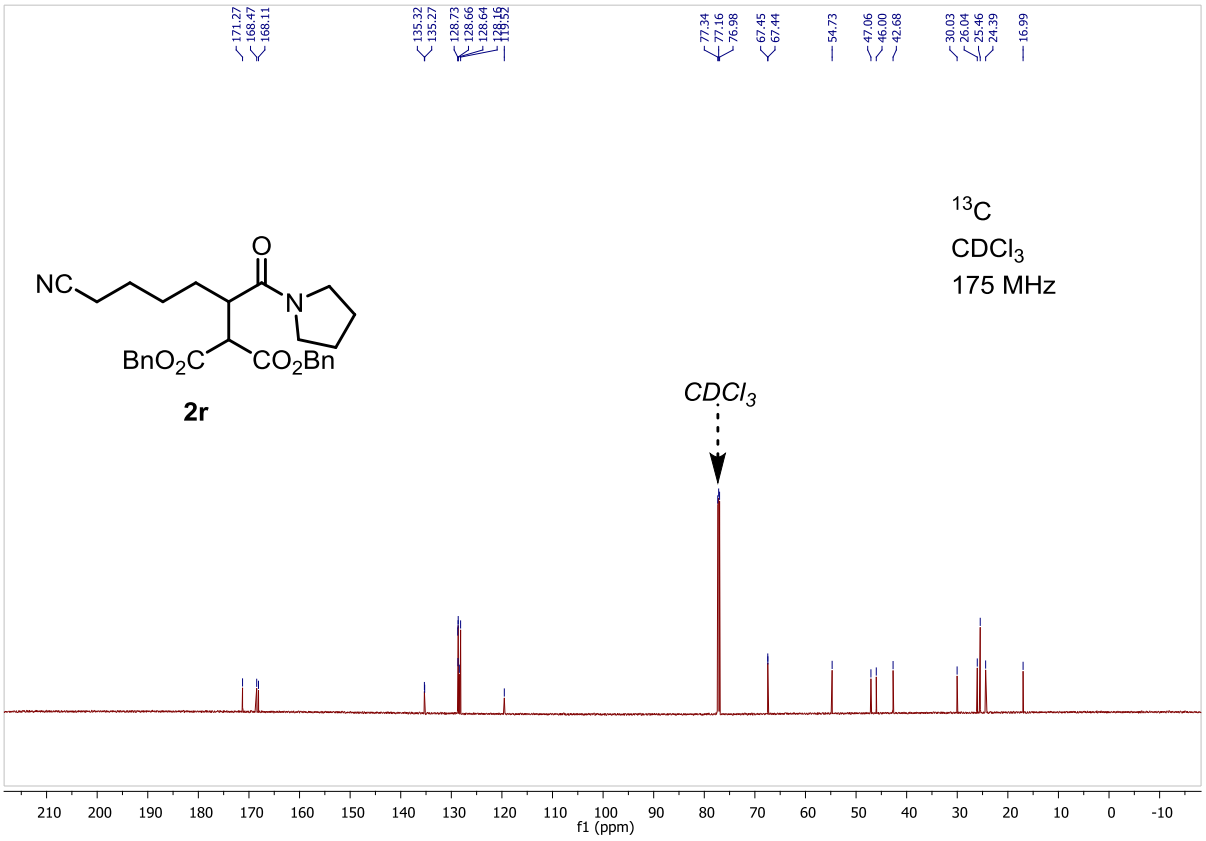

^{13}C (APT)
$CDCl_3$
126 MHz
$CDCl_3$
f1 (ppm)

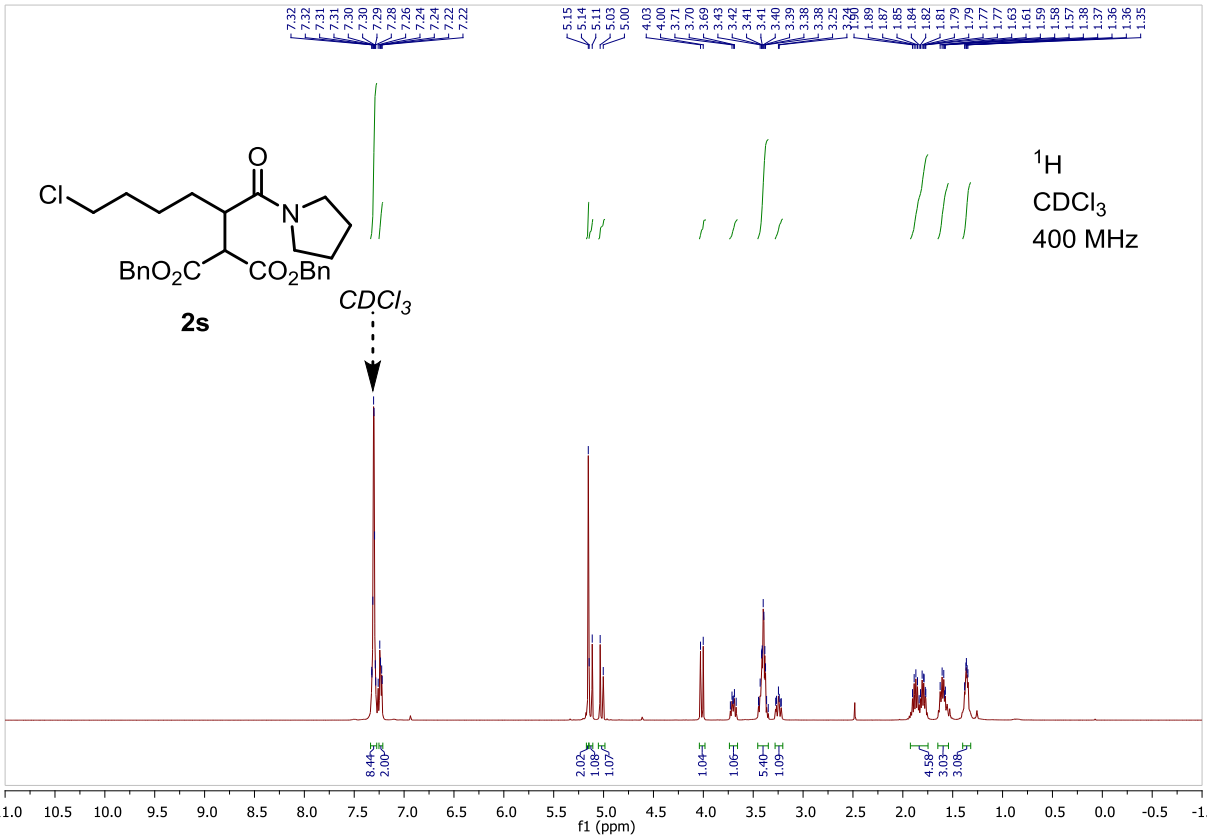
2p

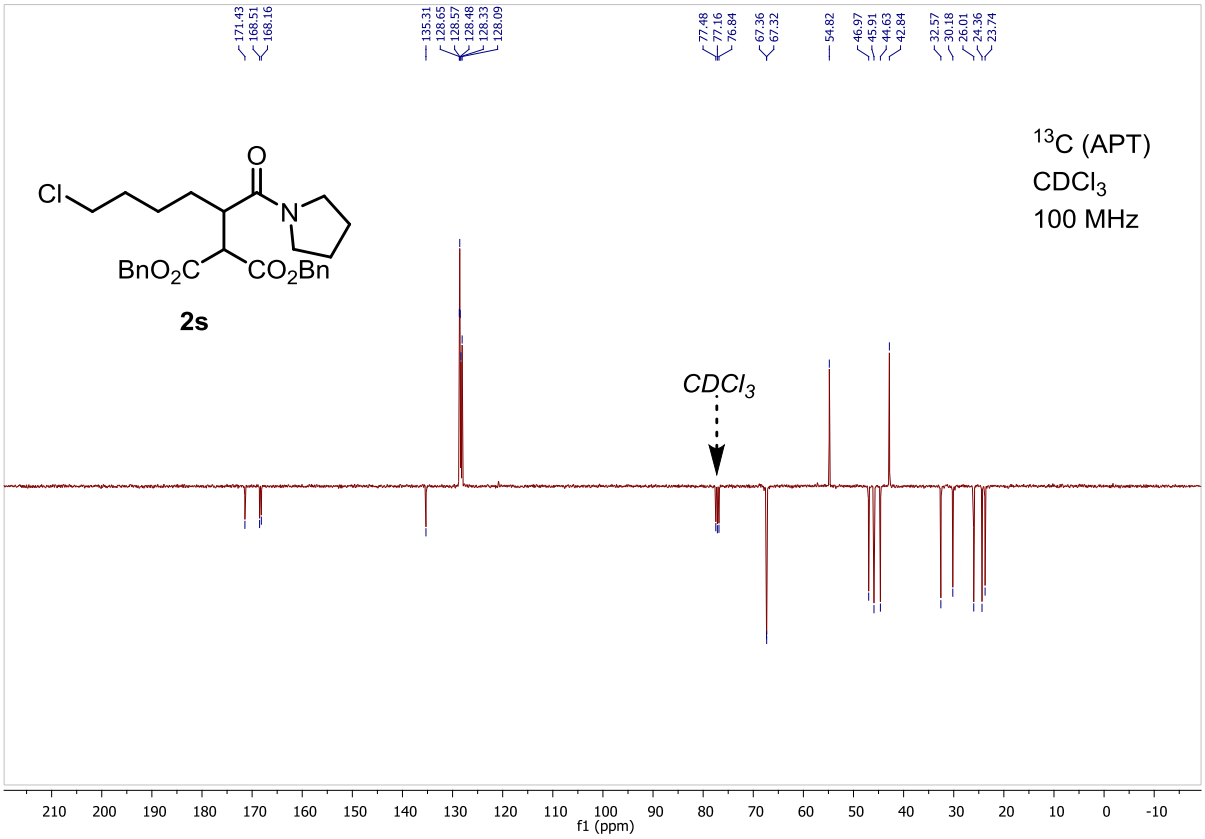

2q
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

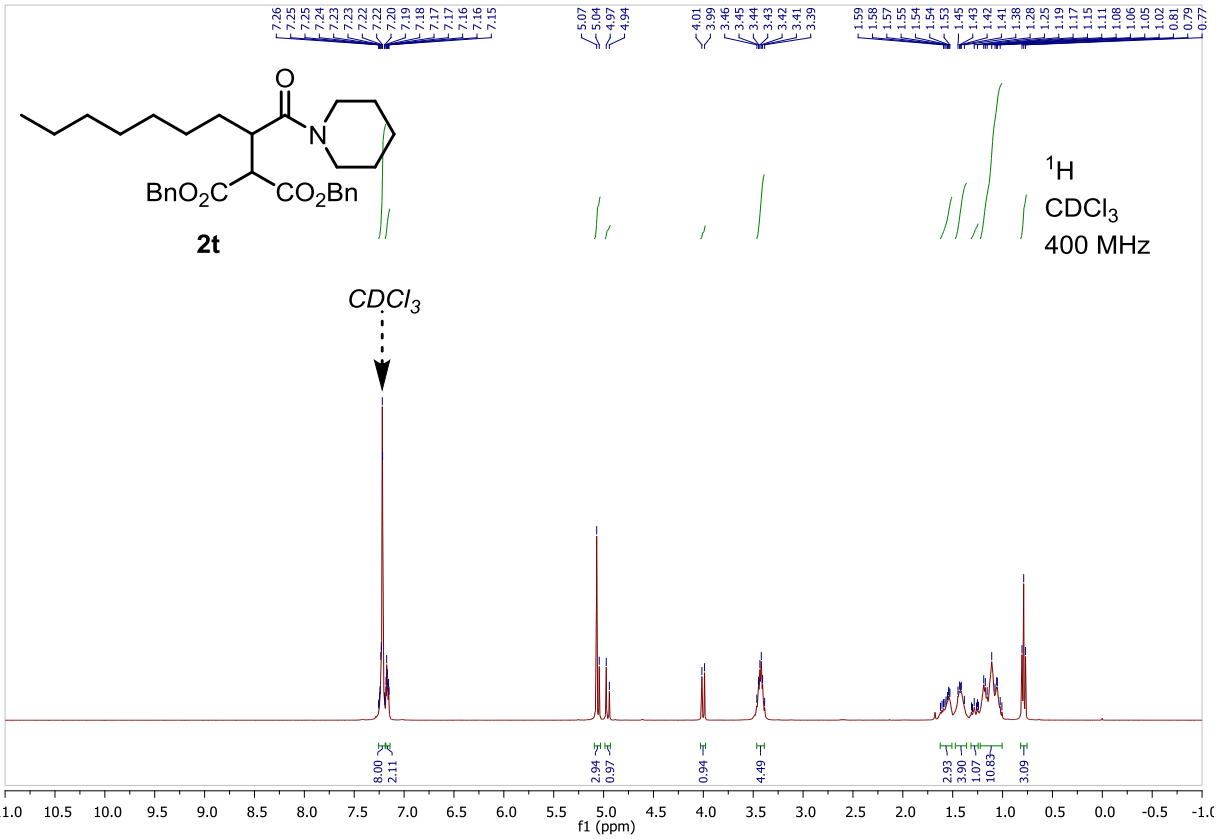

2q
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

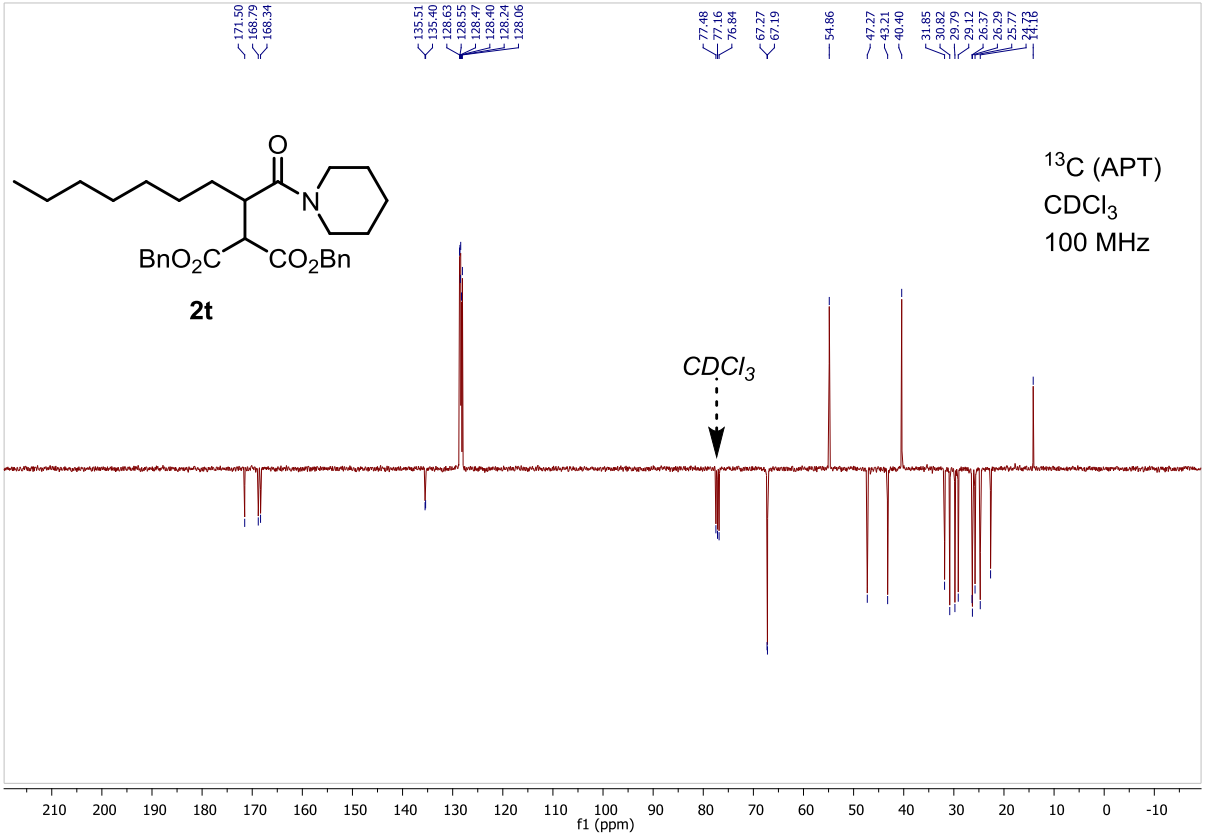

NC
O
N
BnO2C
CO2Bn
2r
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

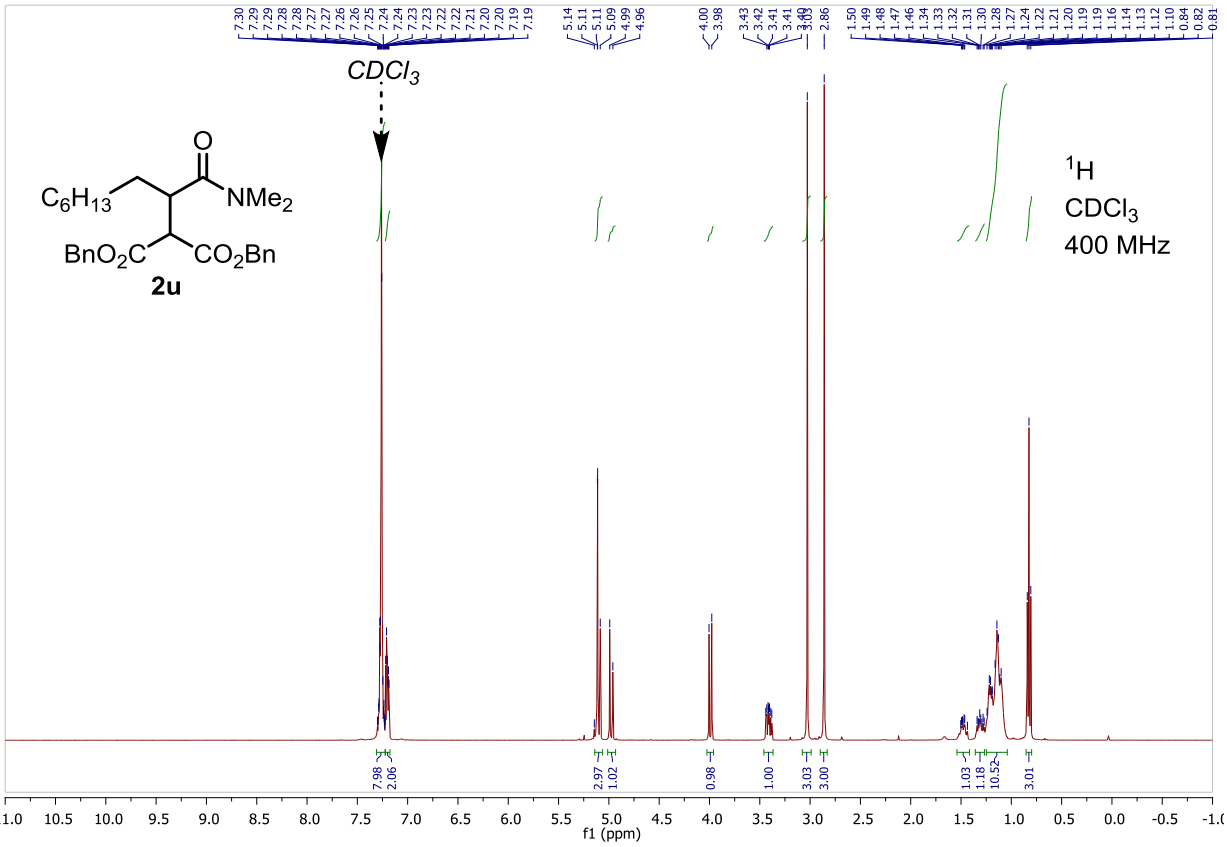

NC
O
N
BnO2C
CO2Bn
2r
CDCl3
13C
CDCl3
175 MHz
f1 (ppm)

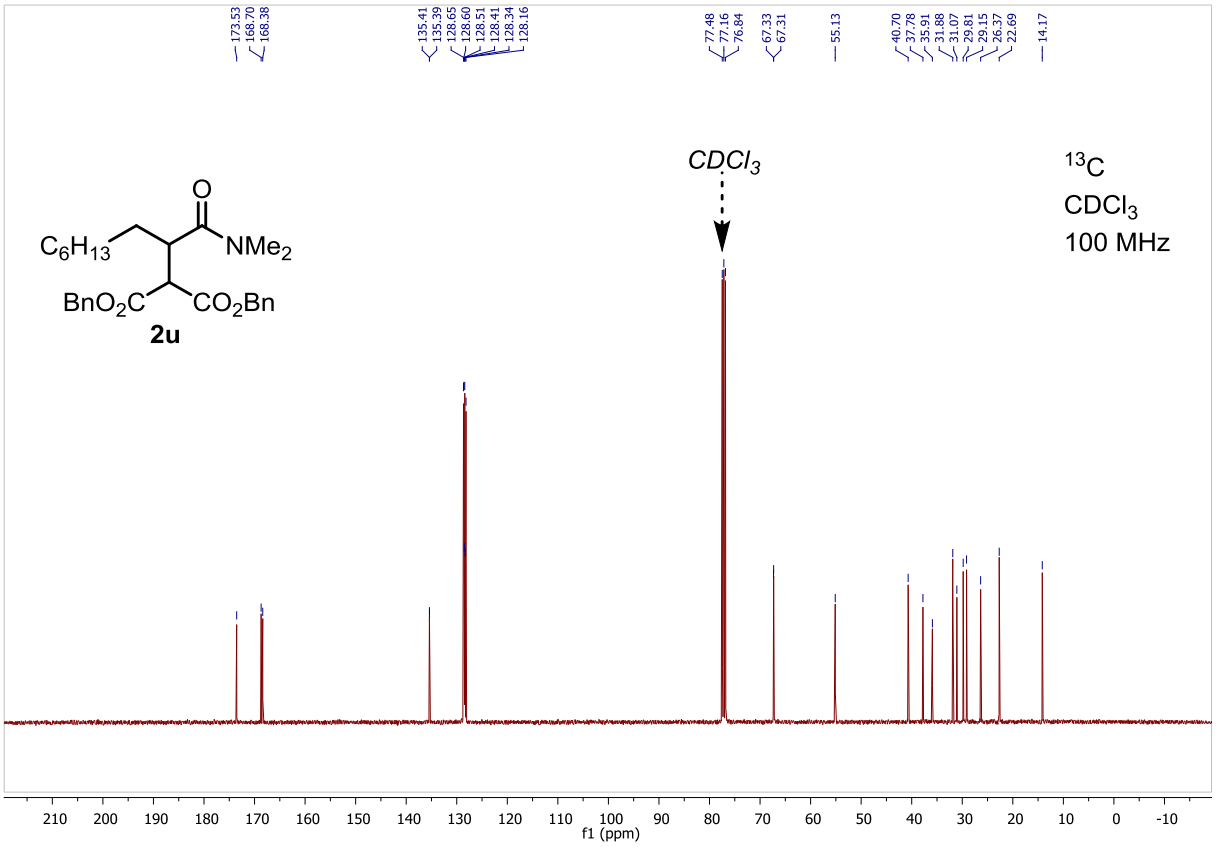

Cl
O
N
BnO2C
CO2Bn
2s
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

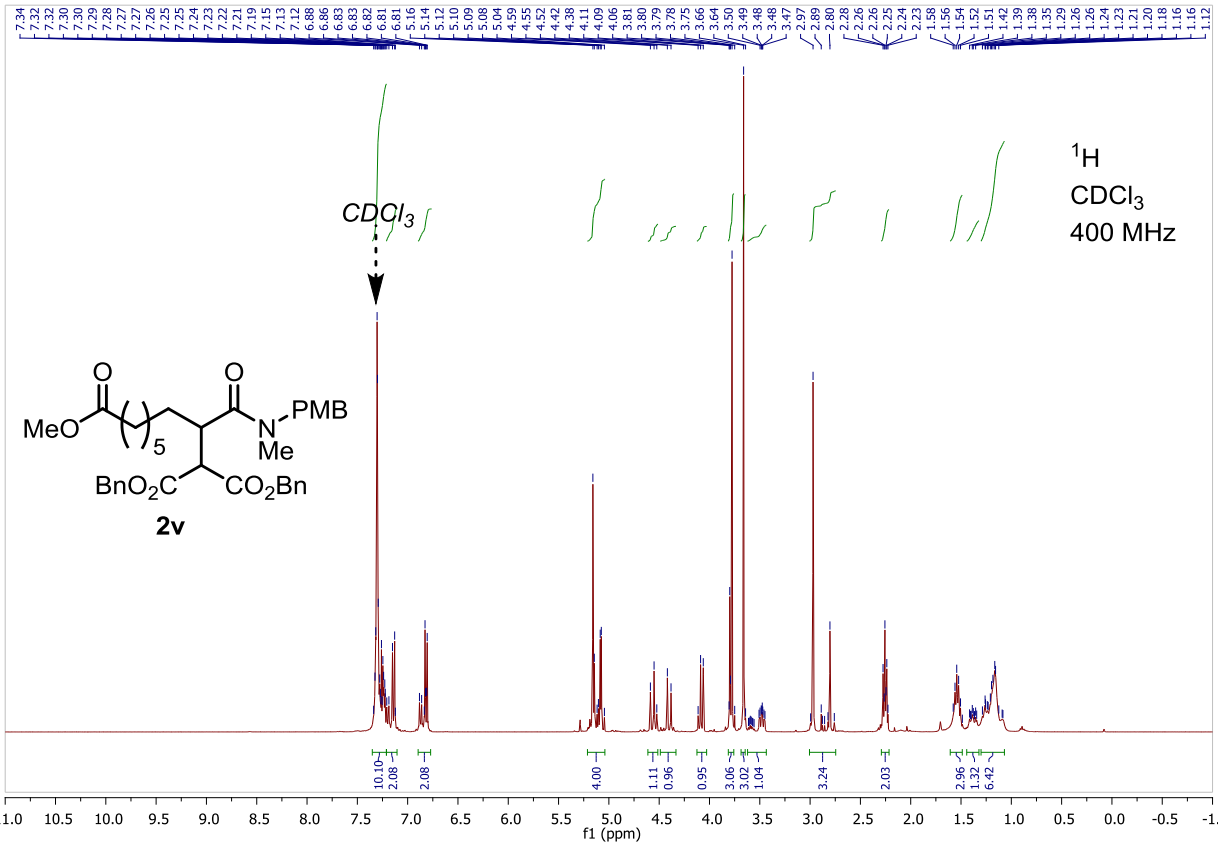

Cl
O
N
BnO2C
CO2Bn
2s
CDCl3
13C (APT)
CDCl3
100 MHz
f1 (ppm)

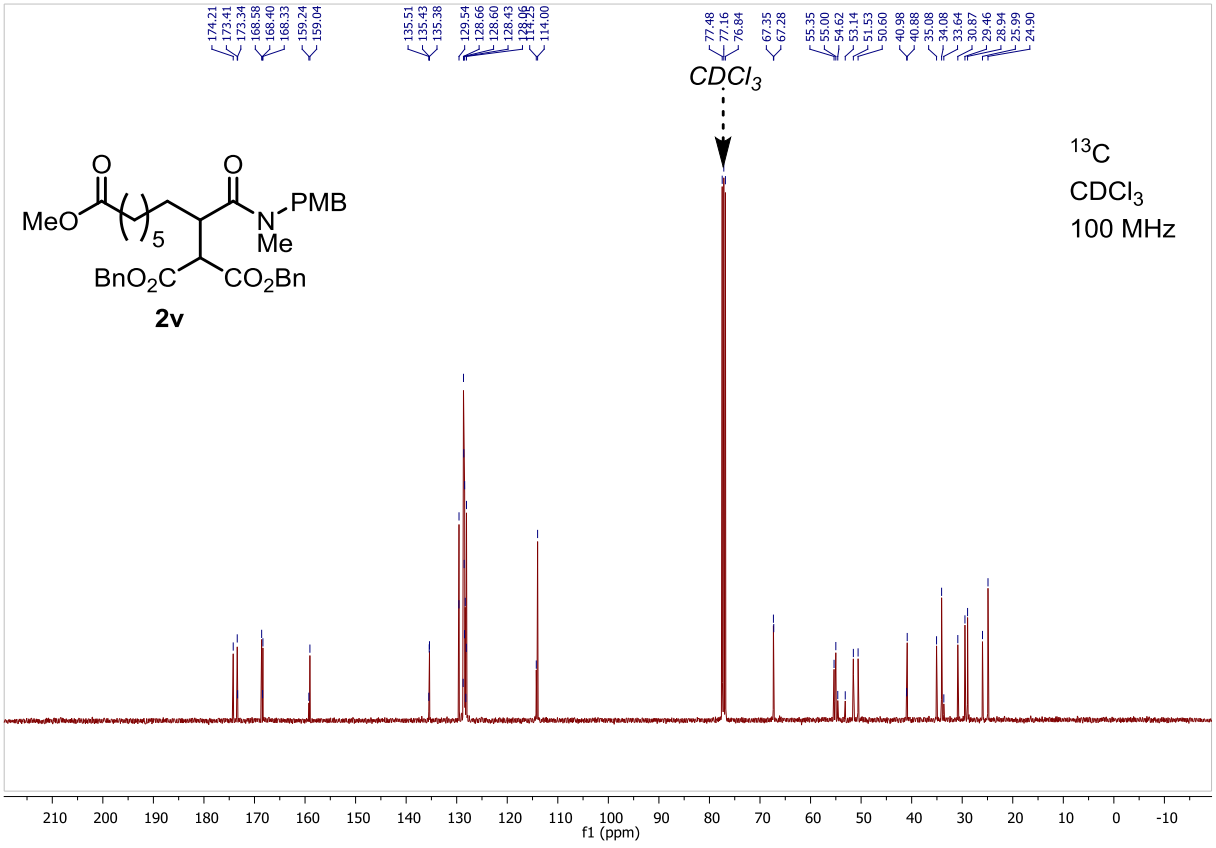

2t
^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
f1 (ppm)

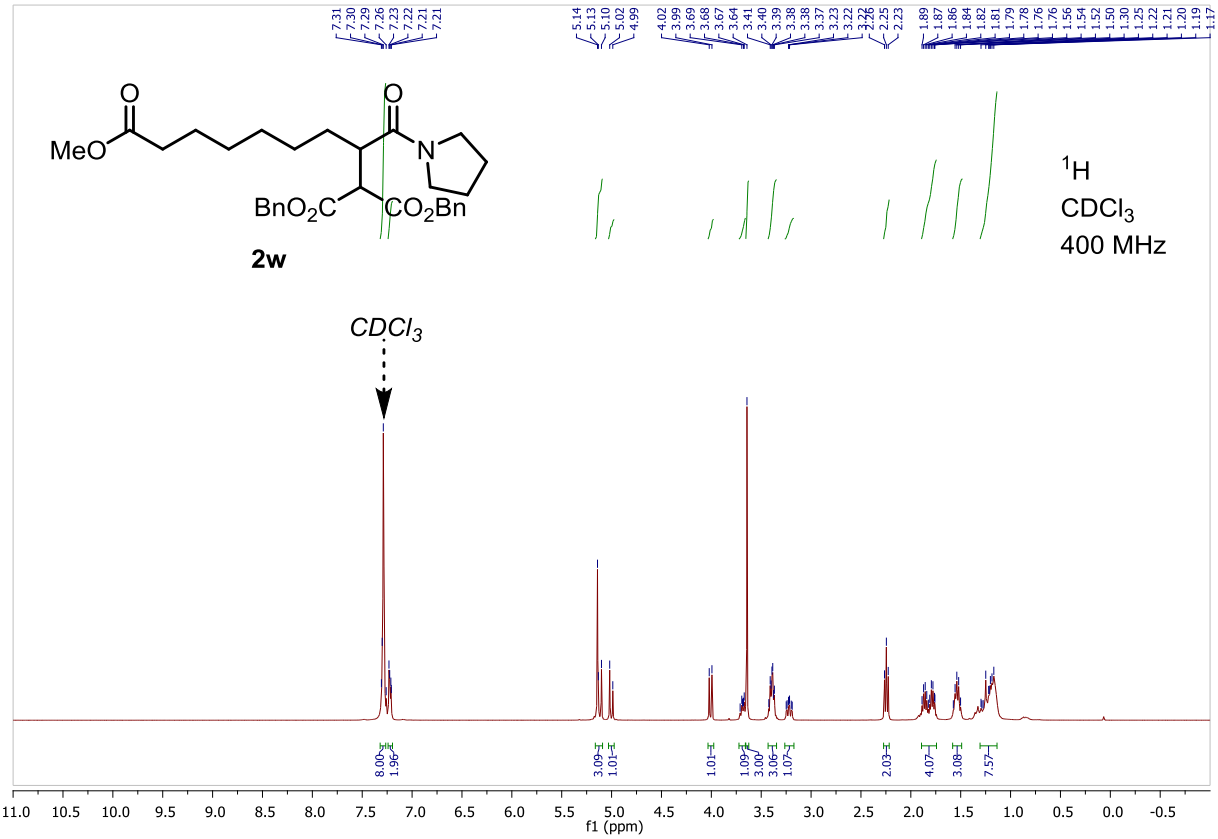

2t
^{13}C (APT)
$CDCl_3$
100 MHz
$CDCl_3$
f1 (ppm)

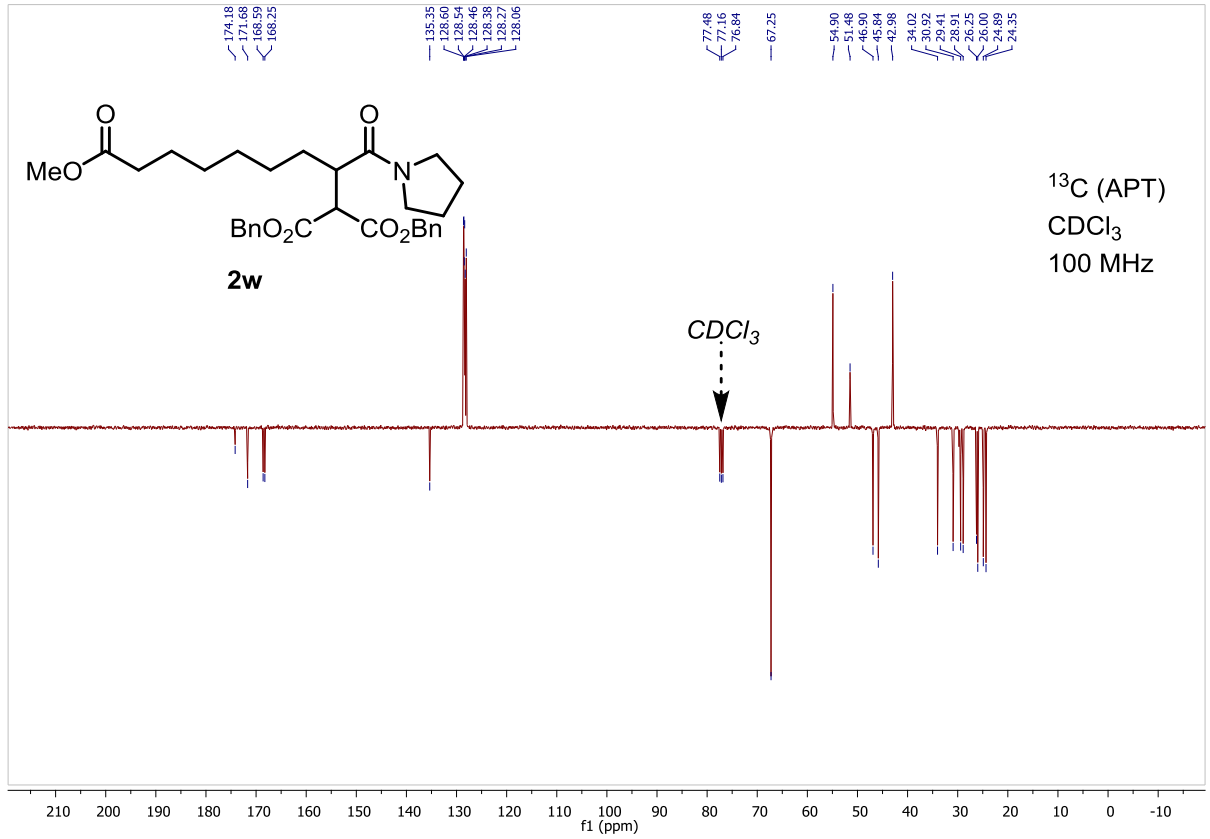

CDCl3
C6H13
NMe2
BnO2C
CO2Bn
2u
1H
CDCl3
400 MHz
f1 (ppm)

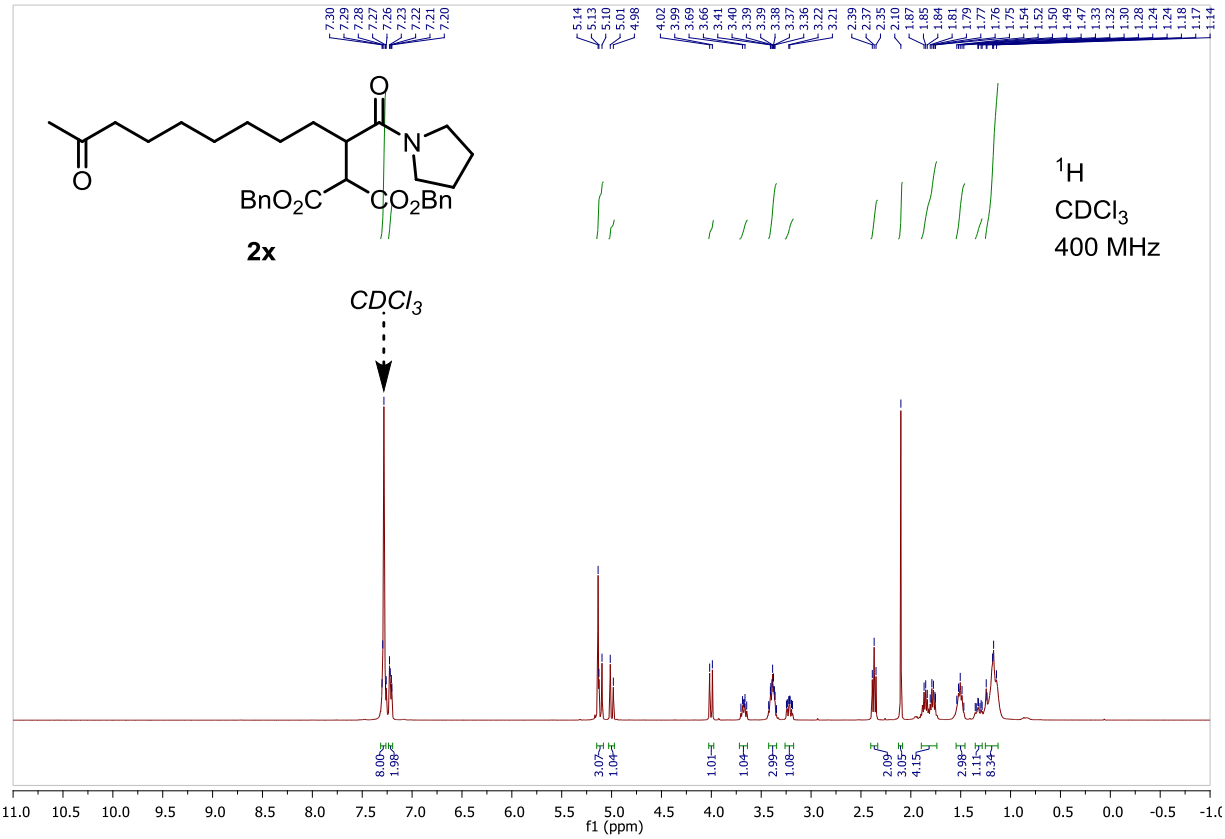

CDCl3
C6H13
NMe2
BnO2C
CO2Bn
2u
13C
CDCl3
100 MHz
f1 (ppm)

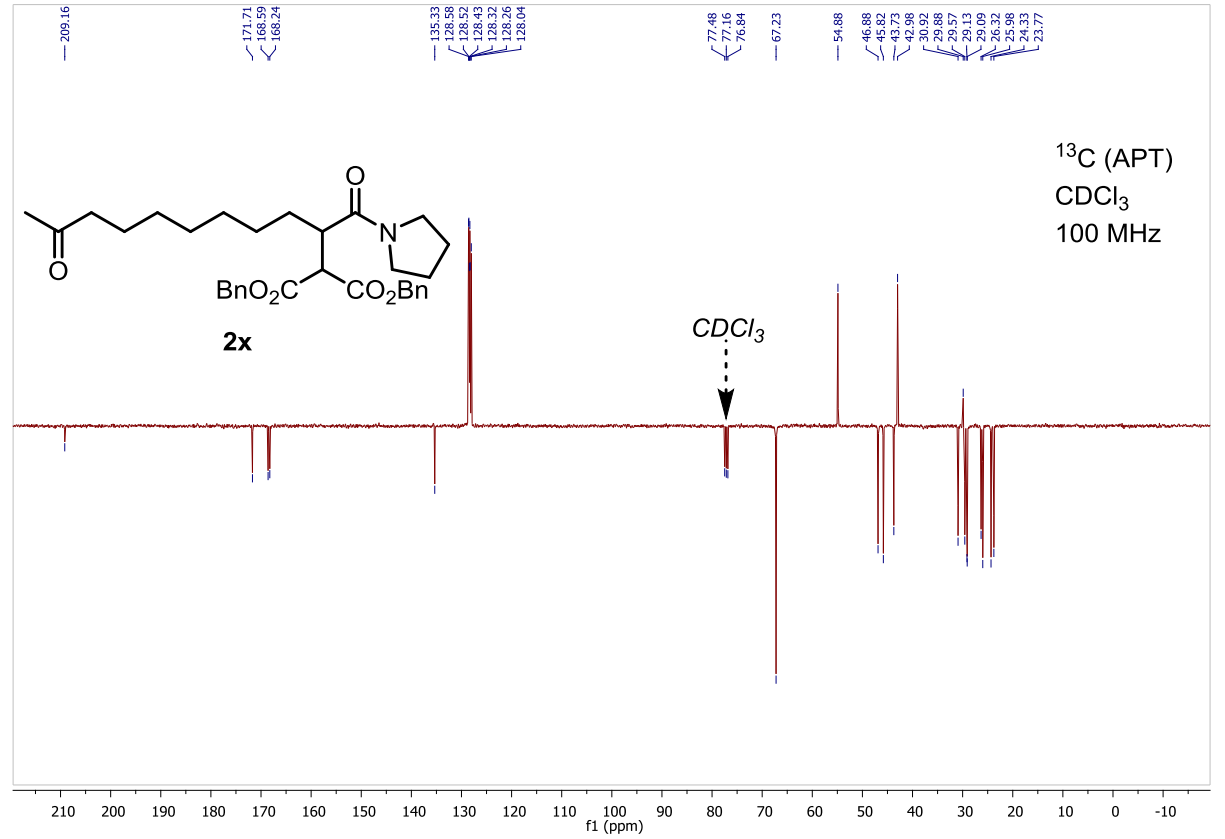

CDCl3
1H
CDCl3
400 MHz
MeO
PMB
N
Me
BnO2C
CO2Bn
2v
f1 (ppm)

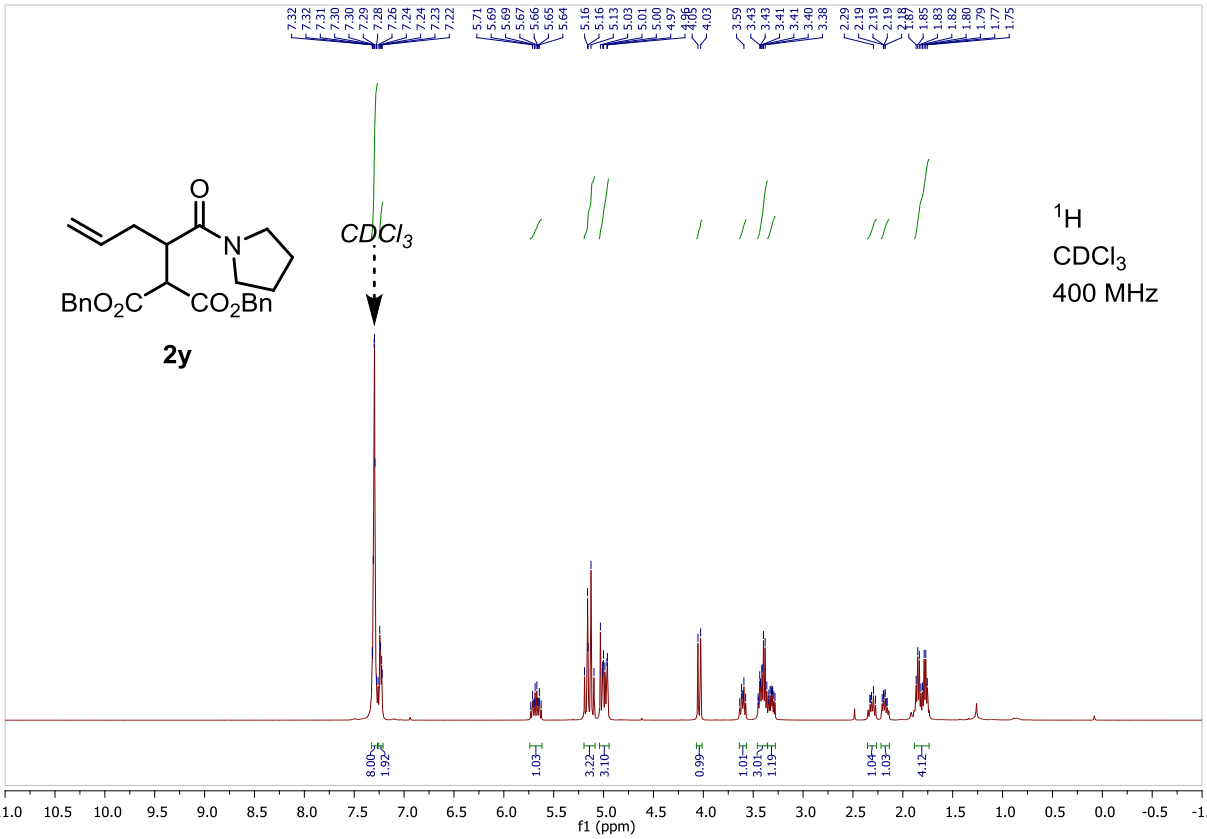

CDCl3
13C
CDCl3
100 MHz
MeO
PMB
N
Me
BnO2C
CO2Bn
2v
f1 (ppm)

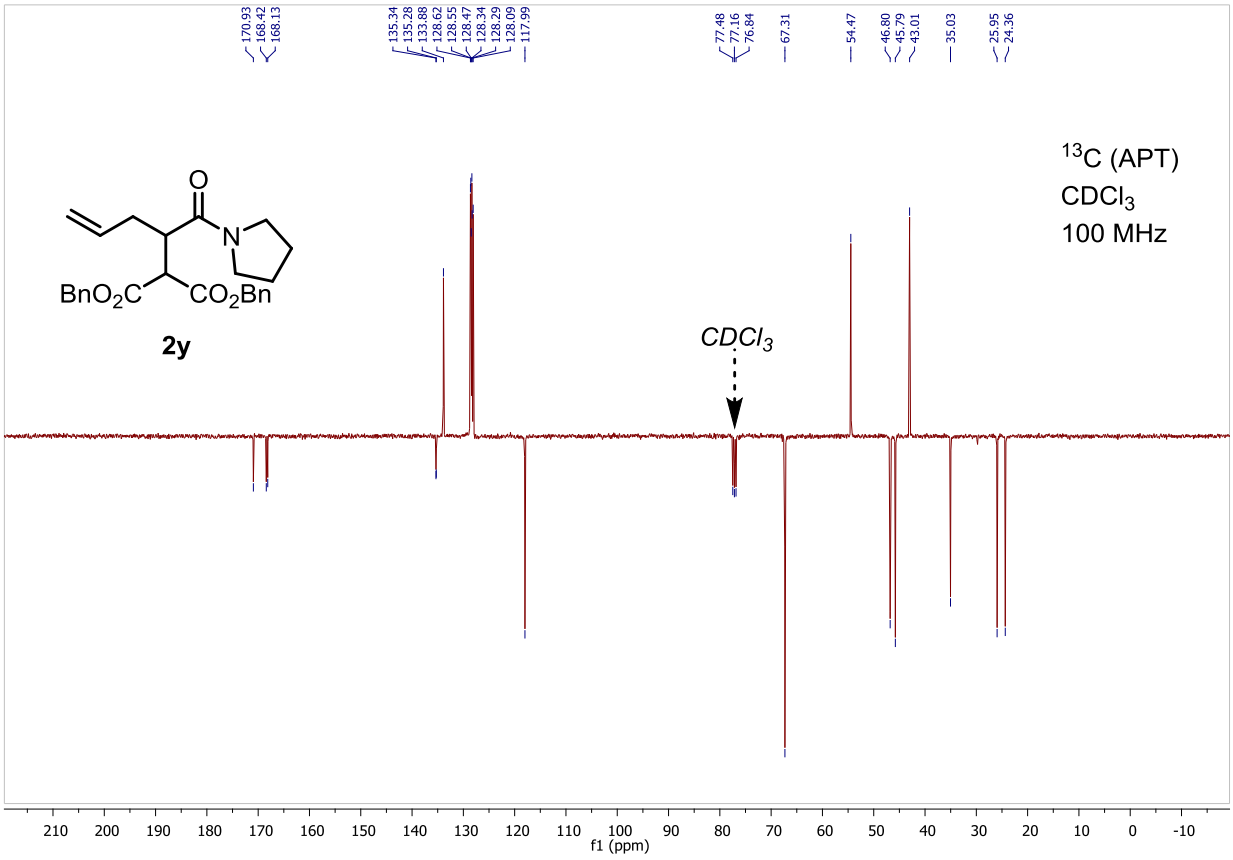

MeO
O
O
N
BnO2C
CO2Bn
2w
1H
CDCl3
400 MHz
CDCl3
f1 (ppm)

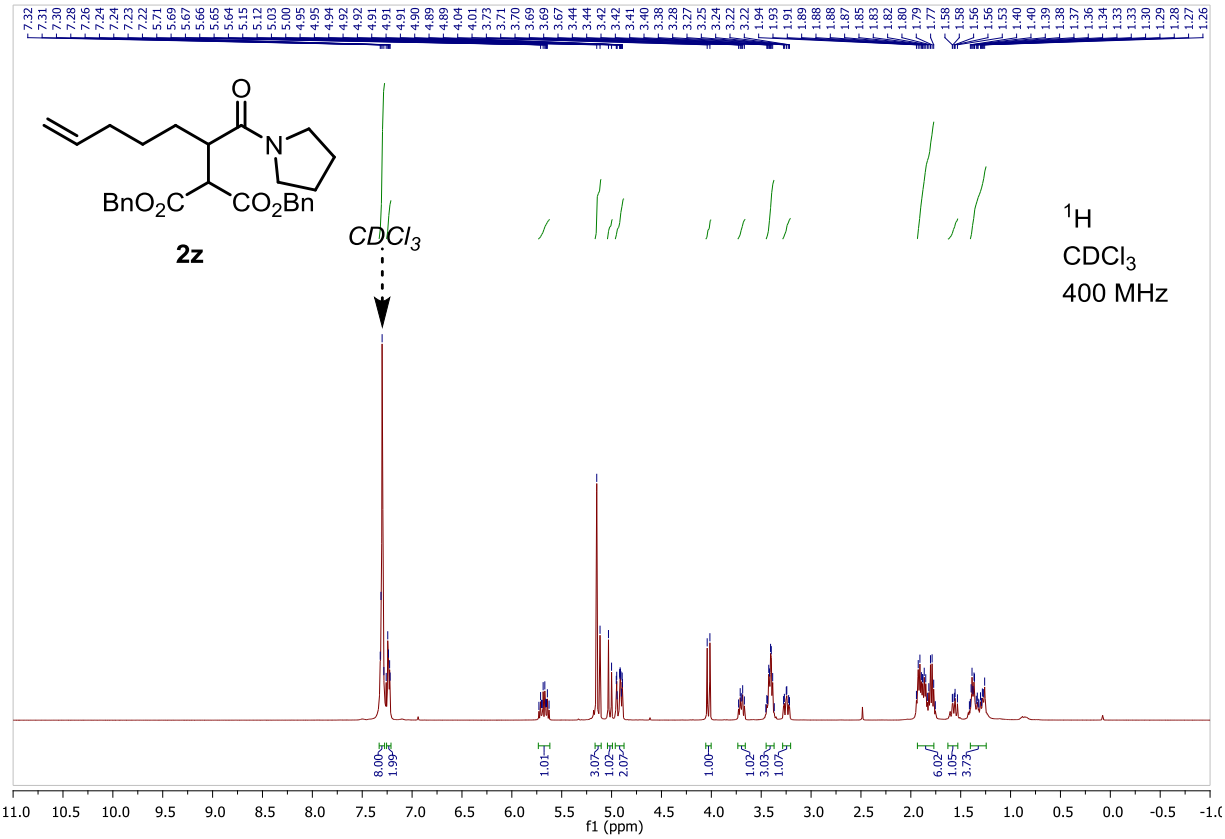

MeO
O
O
N
BnO2C
CO2Bn
2w
13C (APT)
CDCl3
100 MHz
CDCl3
f1 (ppm)

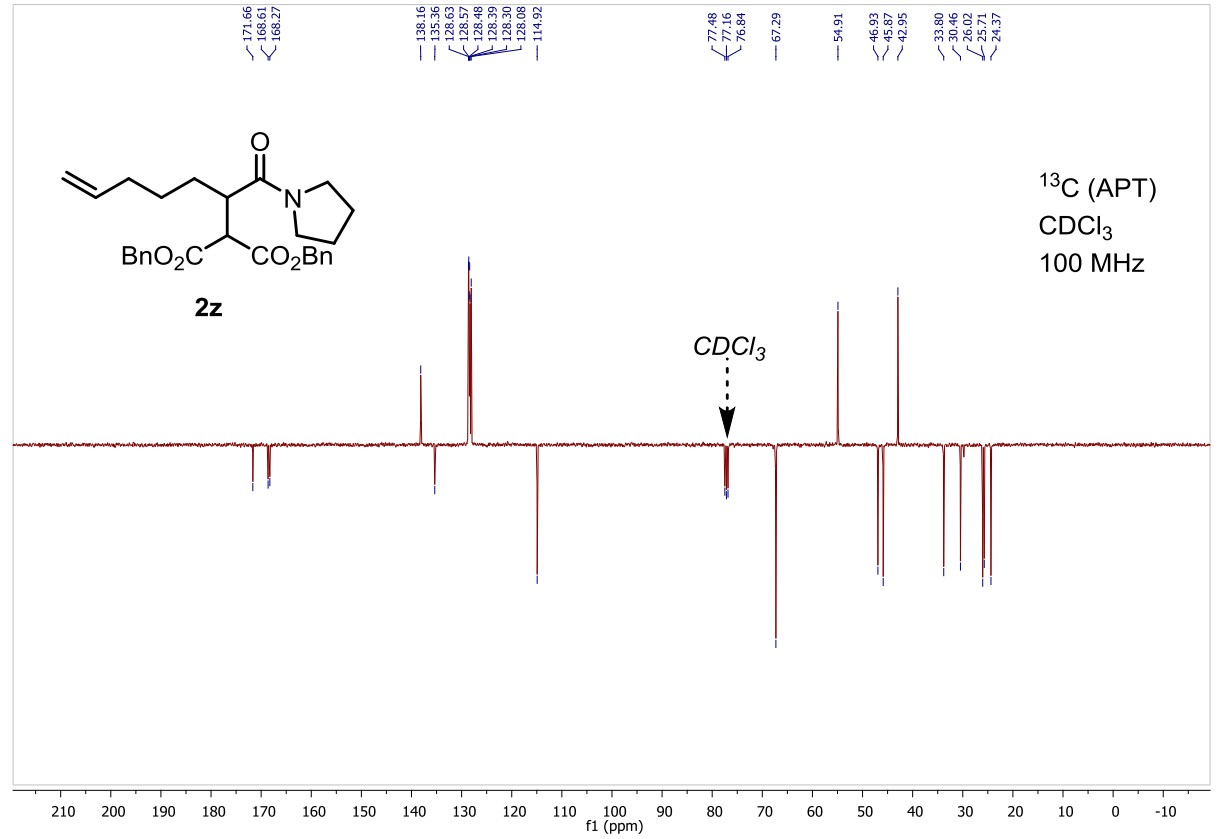

2x
^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
f1 (ppm)

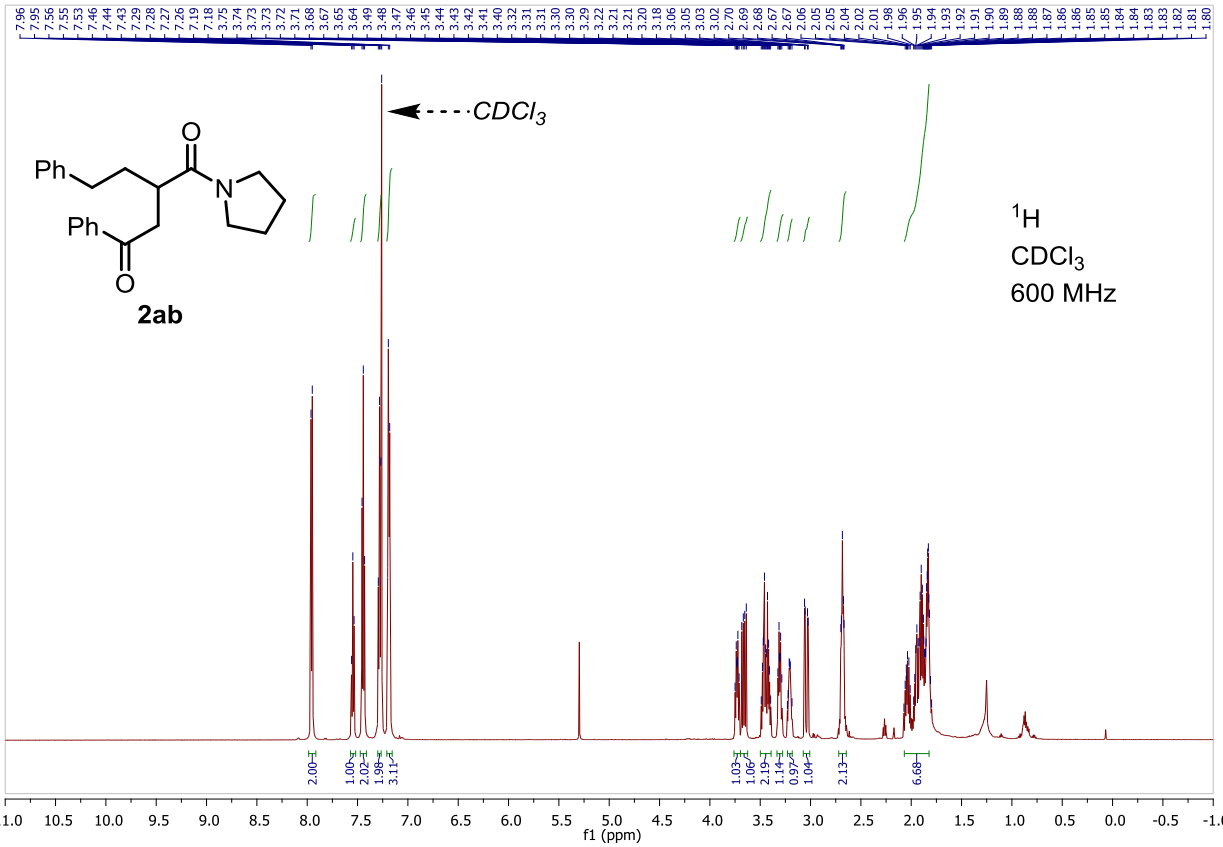

2x
^{13}C (APT)
$CDCl_3$
100 MHz
$CDCl_3$
f1 (ppm)

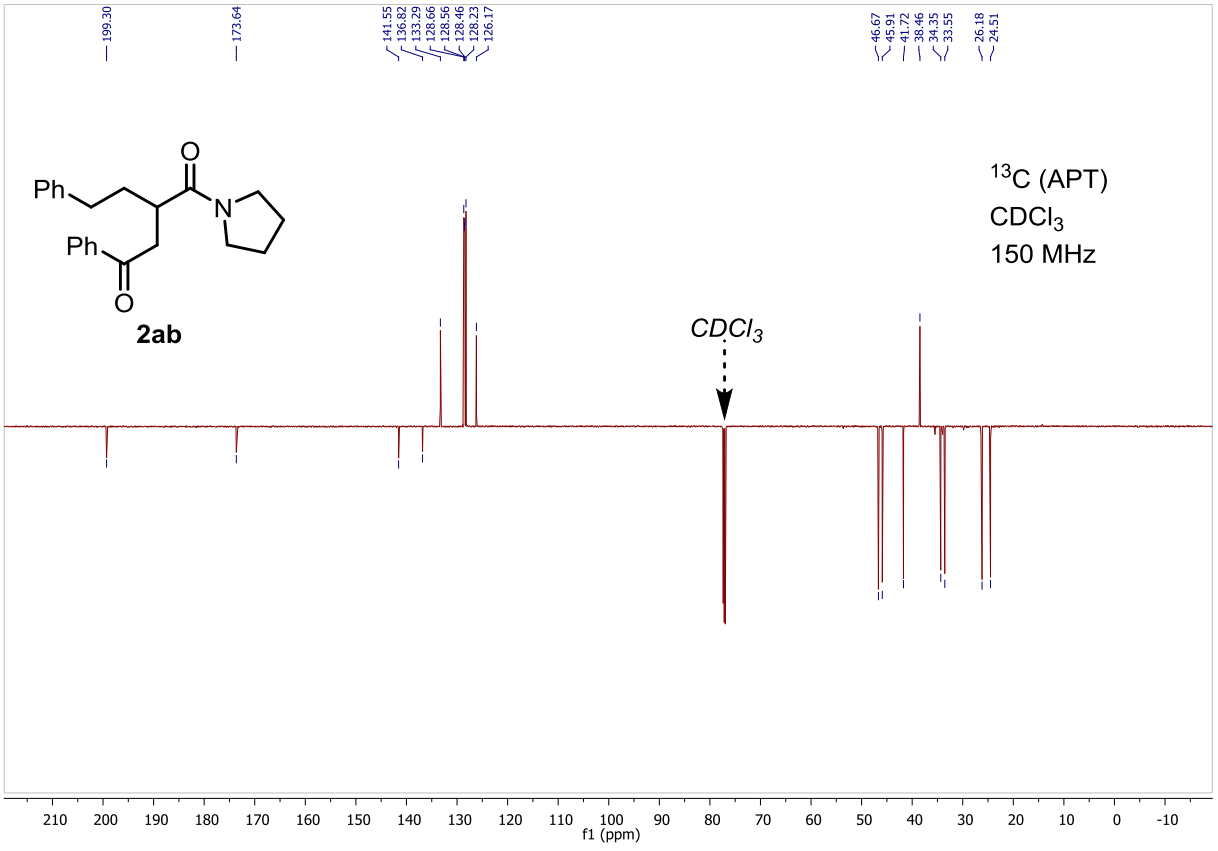

2y
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

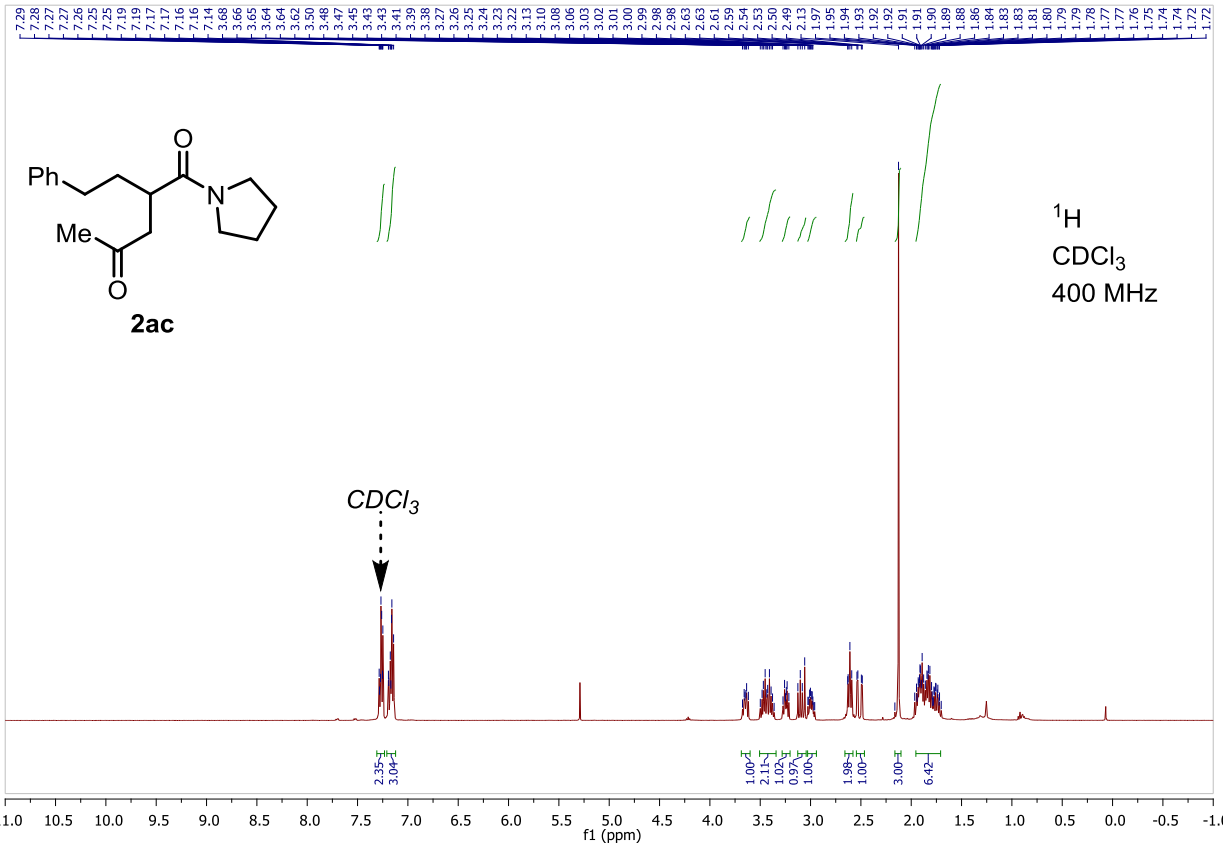

2y
CDCl3
13C (APT)
CDCl3
100 MHz
f1 (ppm)

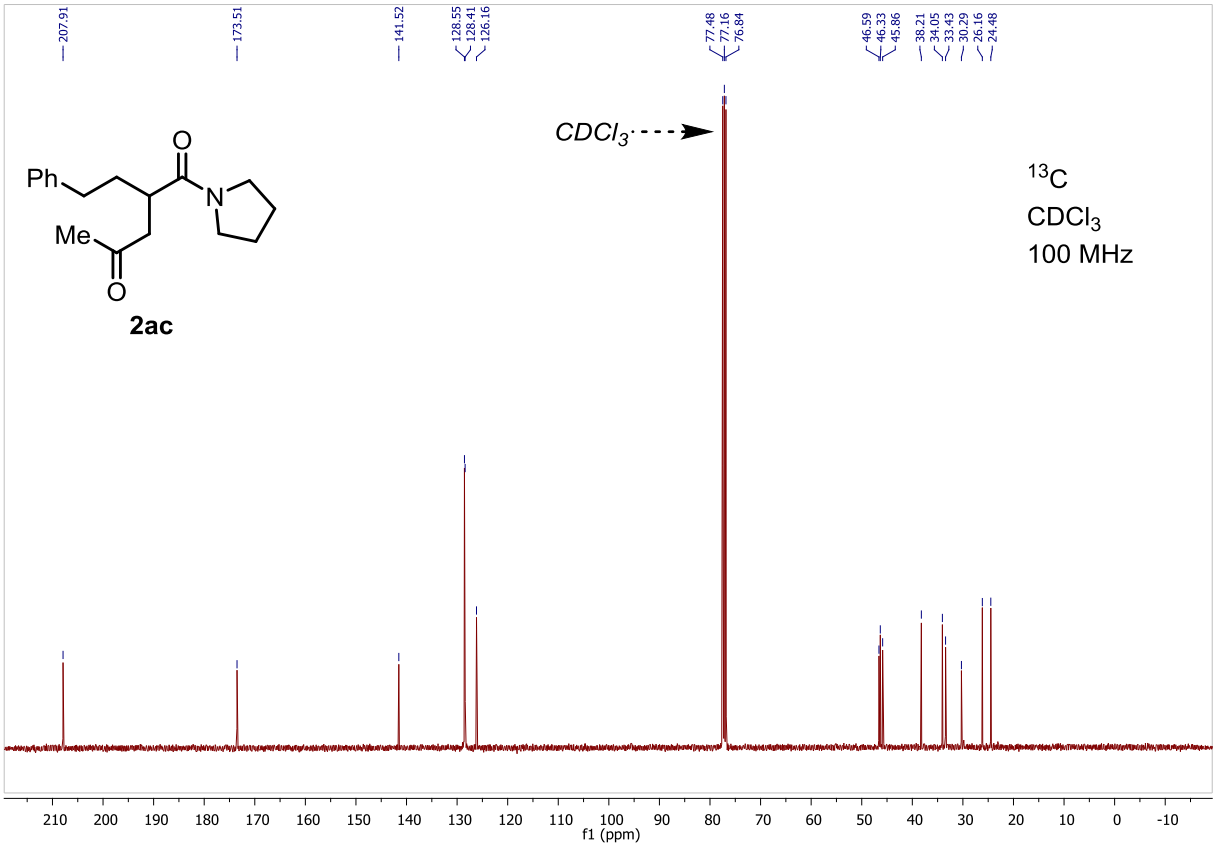

2z
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

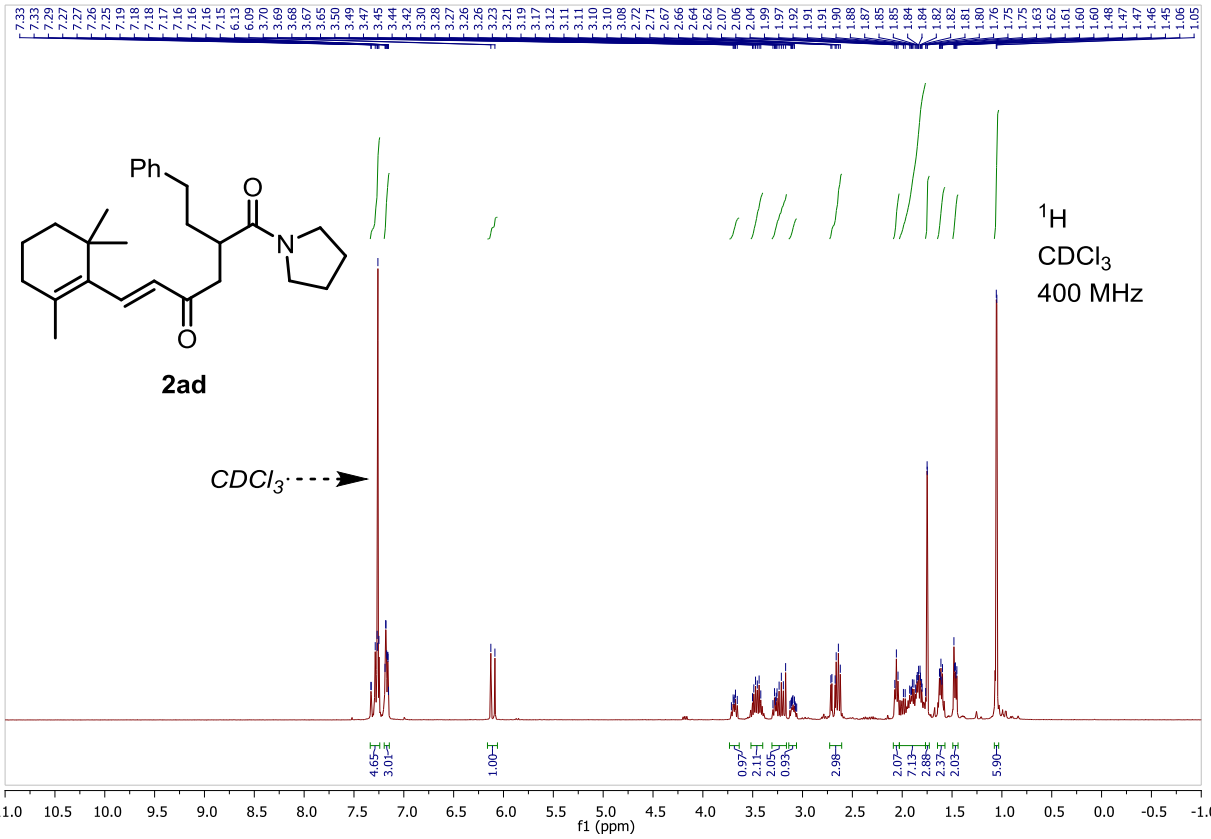

2z
CDCl3
13C (APT)
CDCl3
100 MHz
f1 (ppm)

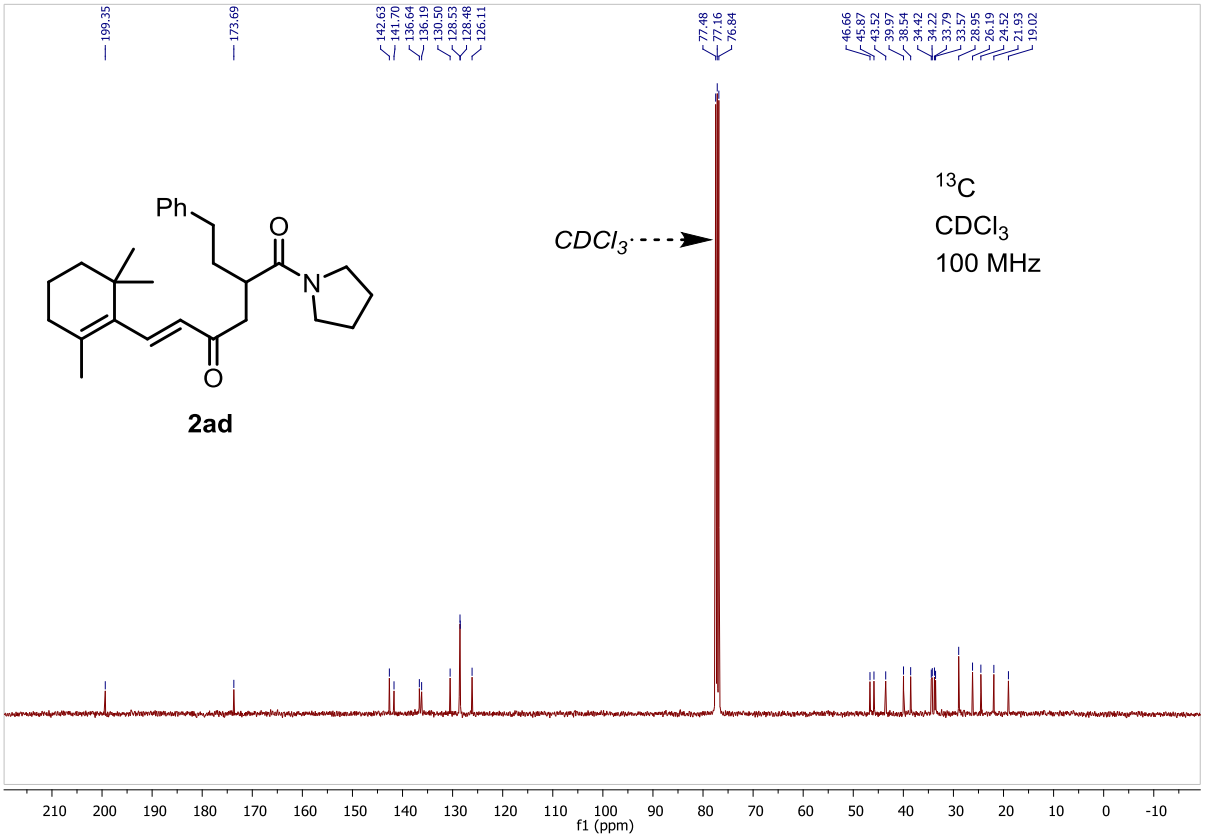

CDCl3
Ph
Ph
O
N
O
2ab
1H
CDCl3
600 MHz
f1 (ppm)

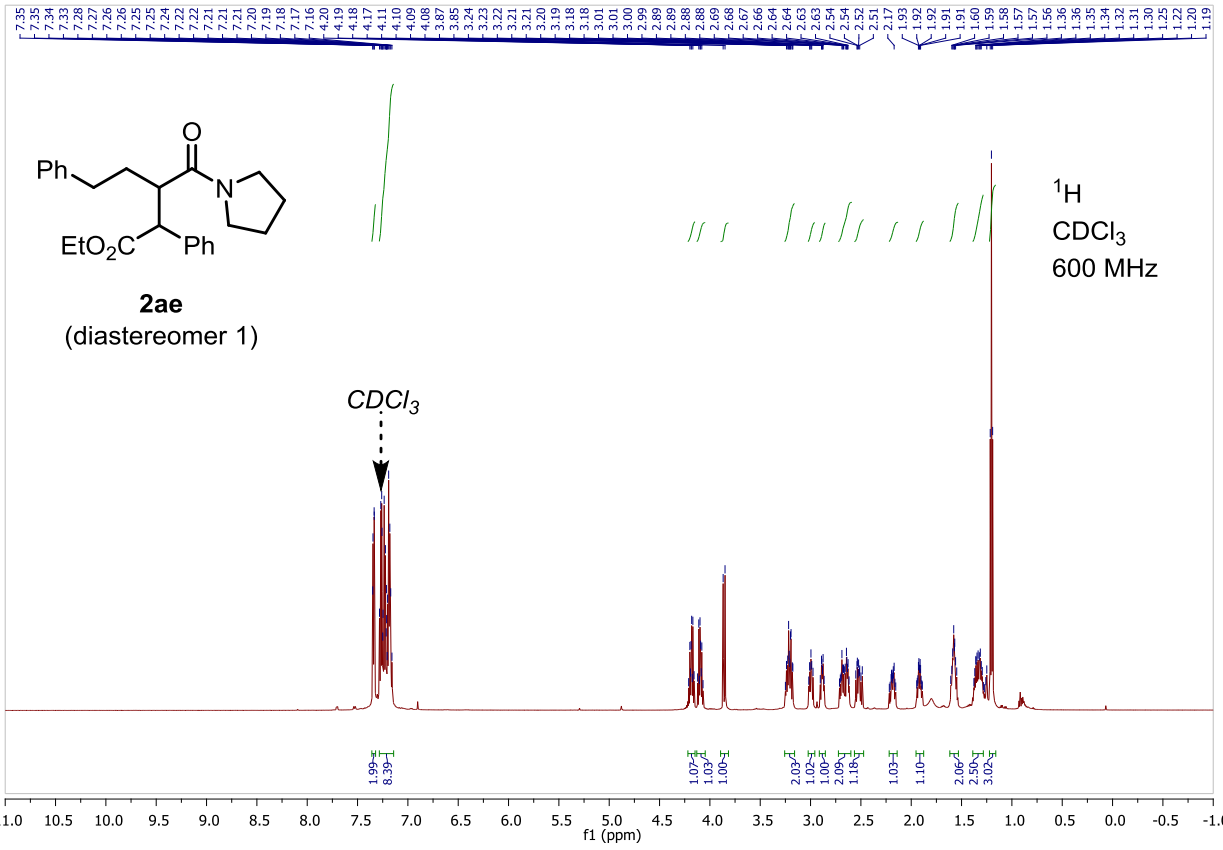

199.30
173.64
141.55
136.82
133.29
128.66
128.56
128.46
128.23
126.17
46.67
45.91
41.72
38.46
34.35
33.55
26.18
24.51
Ph
Ph
O
N
O
2ab
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)

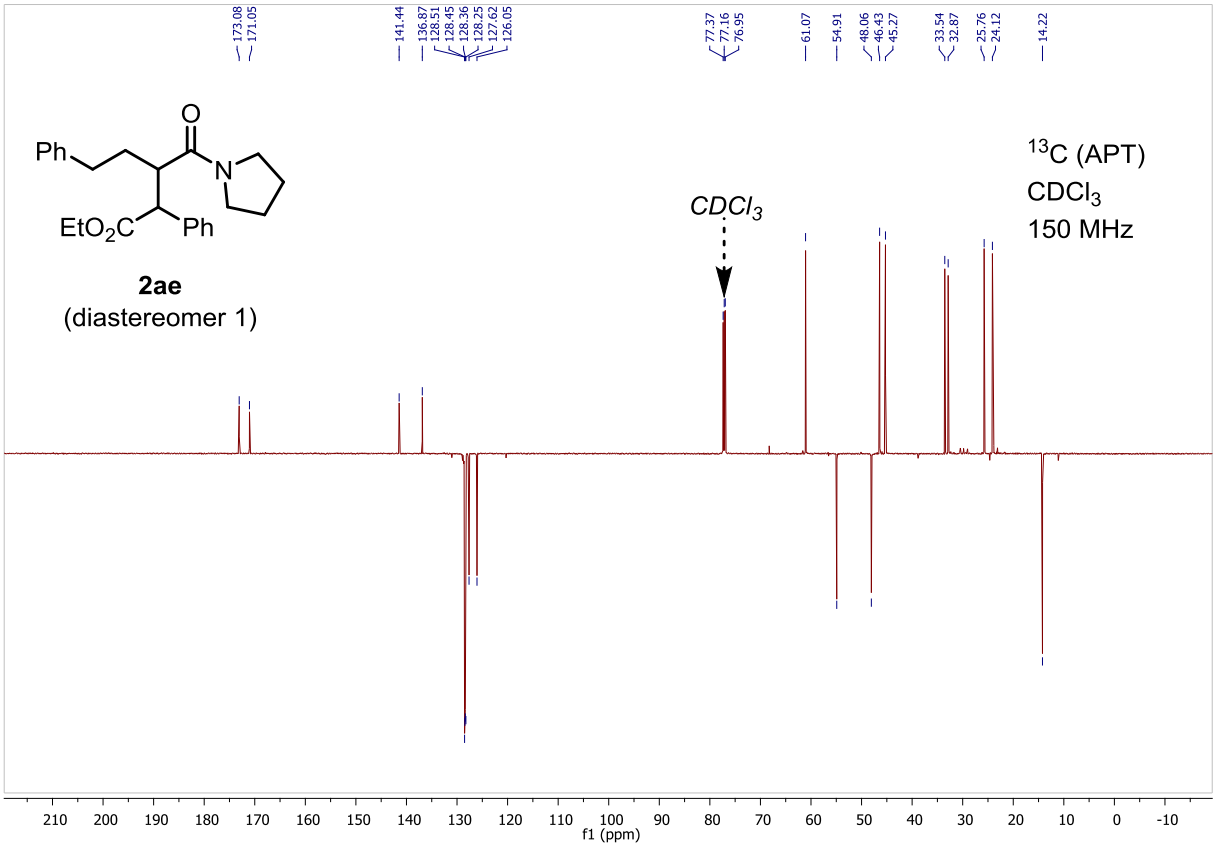

Ph
Me
O
N
O
2ac
^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
f1 (ppm)

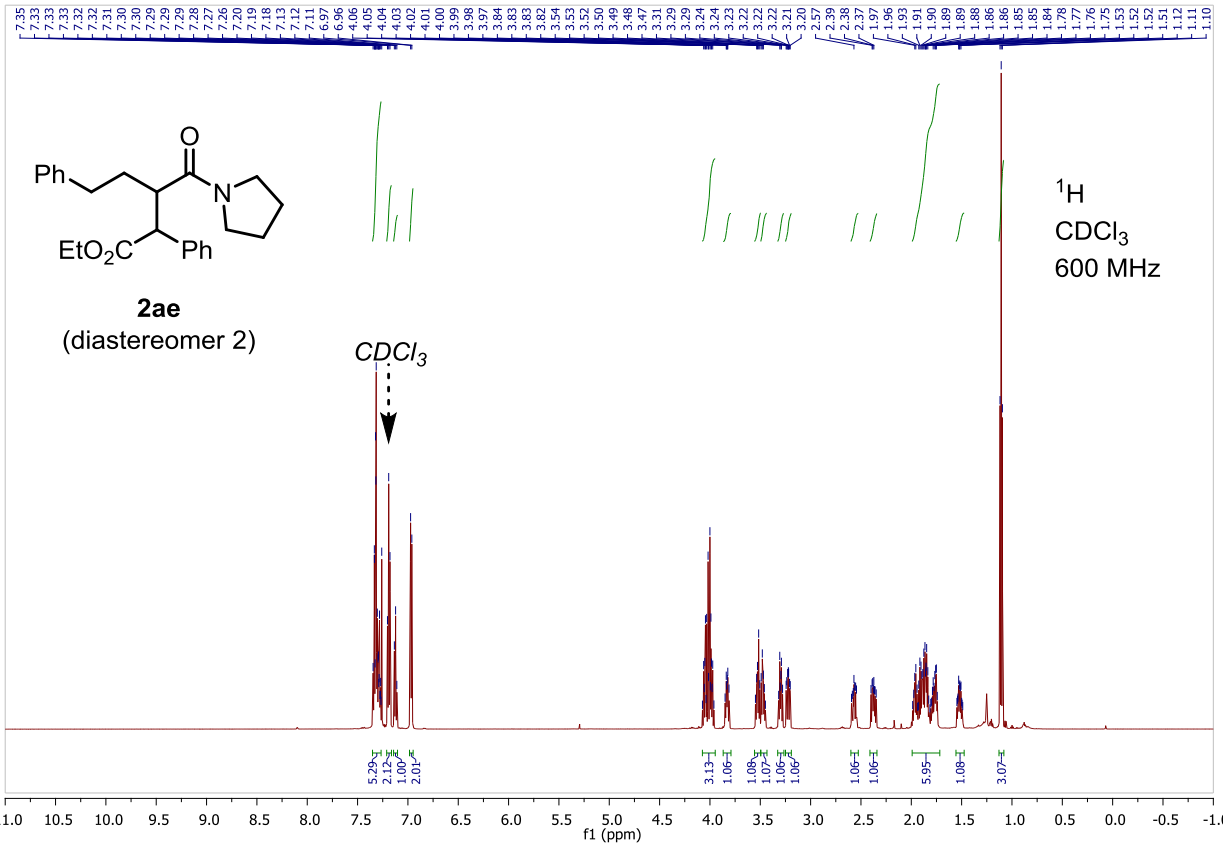

Ph
Me
O
N
O
2ac
$CDCl_3$
^{13}C
$CDCl_3$
100 MHz
f1 (ppm)

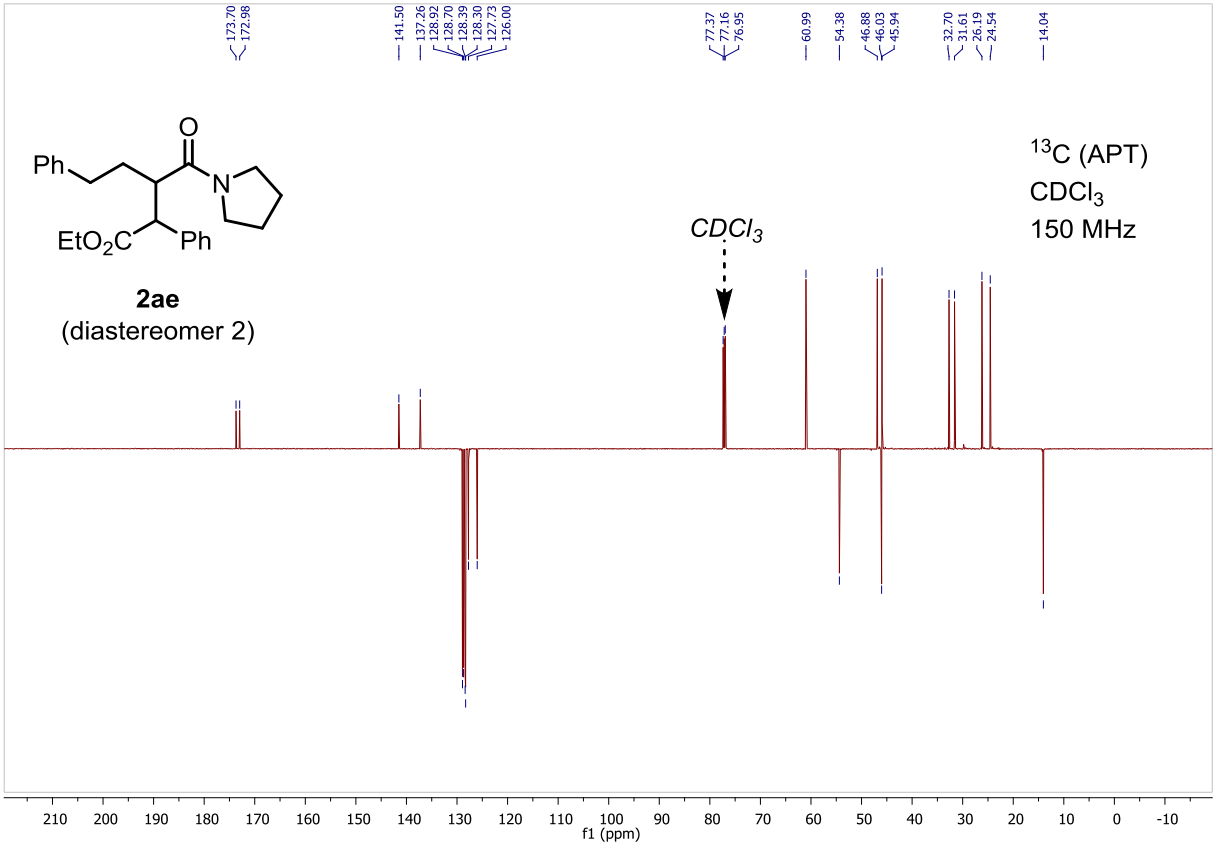

Ph
O
N
O
2ad
^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
f1 (ppm)

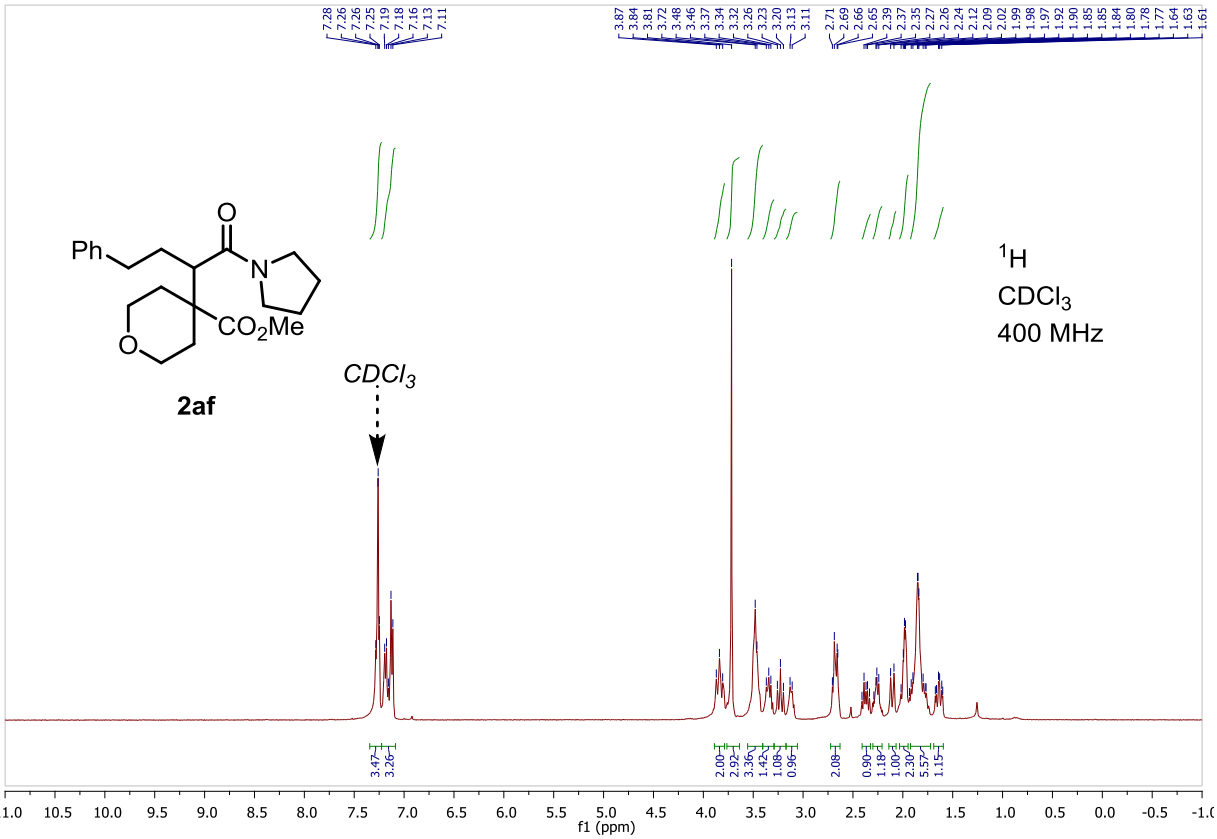

Ph
O
N
O
2ad
^{13}C
$CDCl_3$
100 MHz
$CDCl_3$
f1 (ppm)

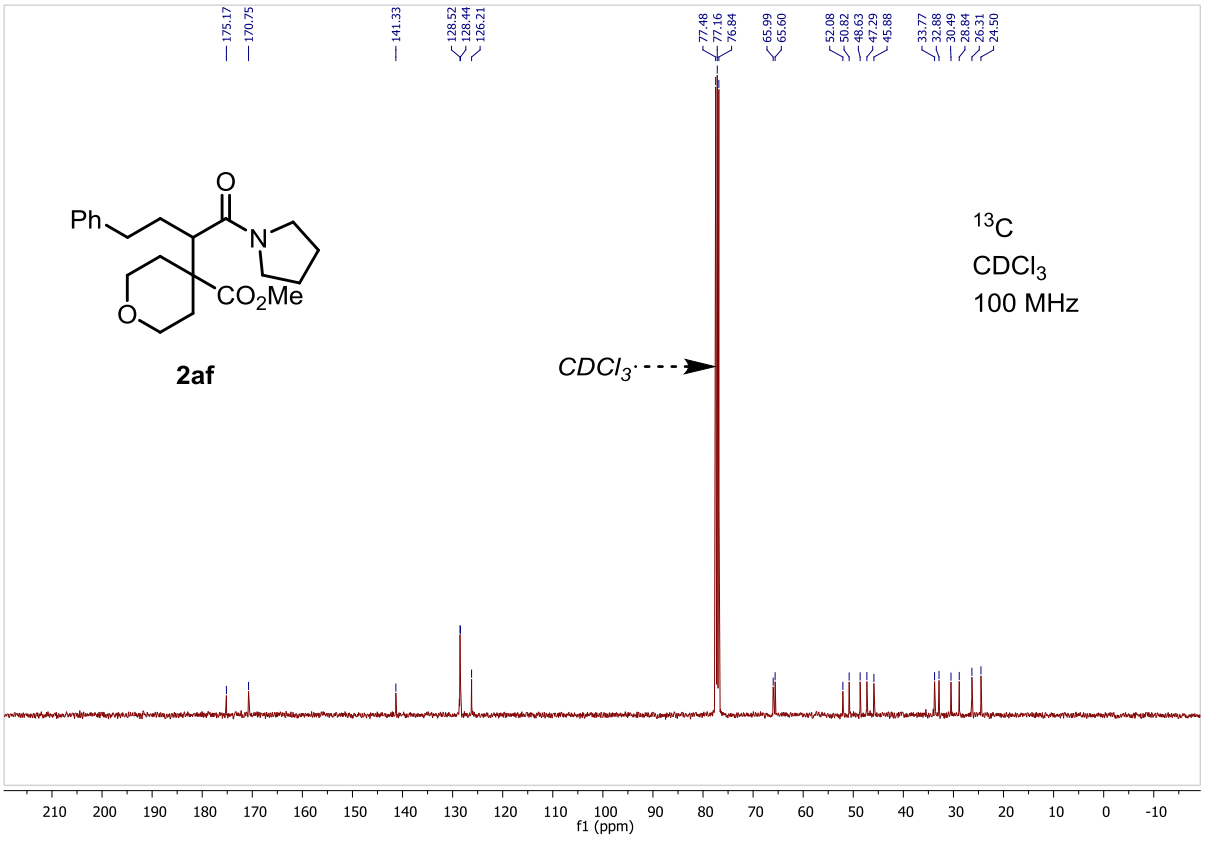

Ph
O
N
EtO2C
Ph
2ae
(diastereomer 1)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

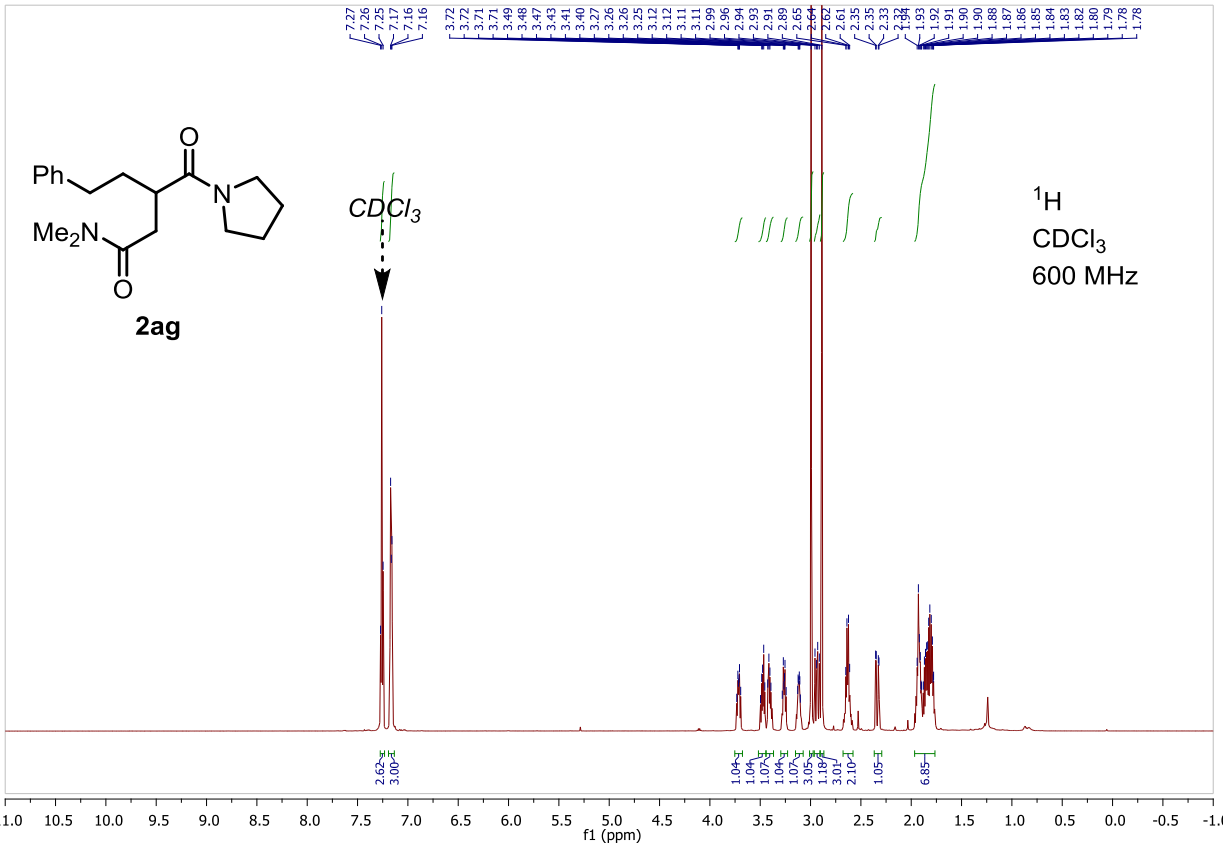

Ph
O
N
EtO2C
Ph
2ae
(diastereomer 1)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

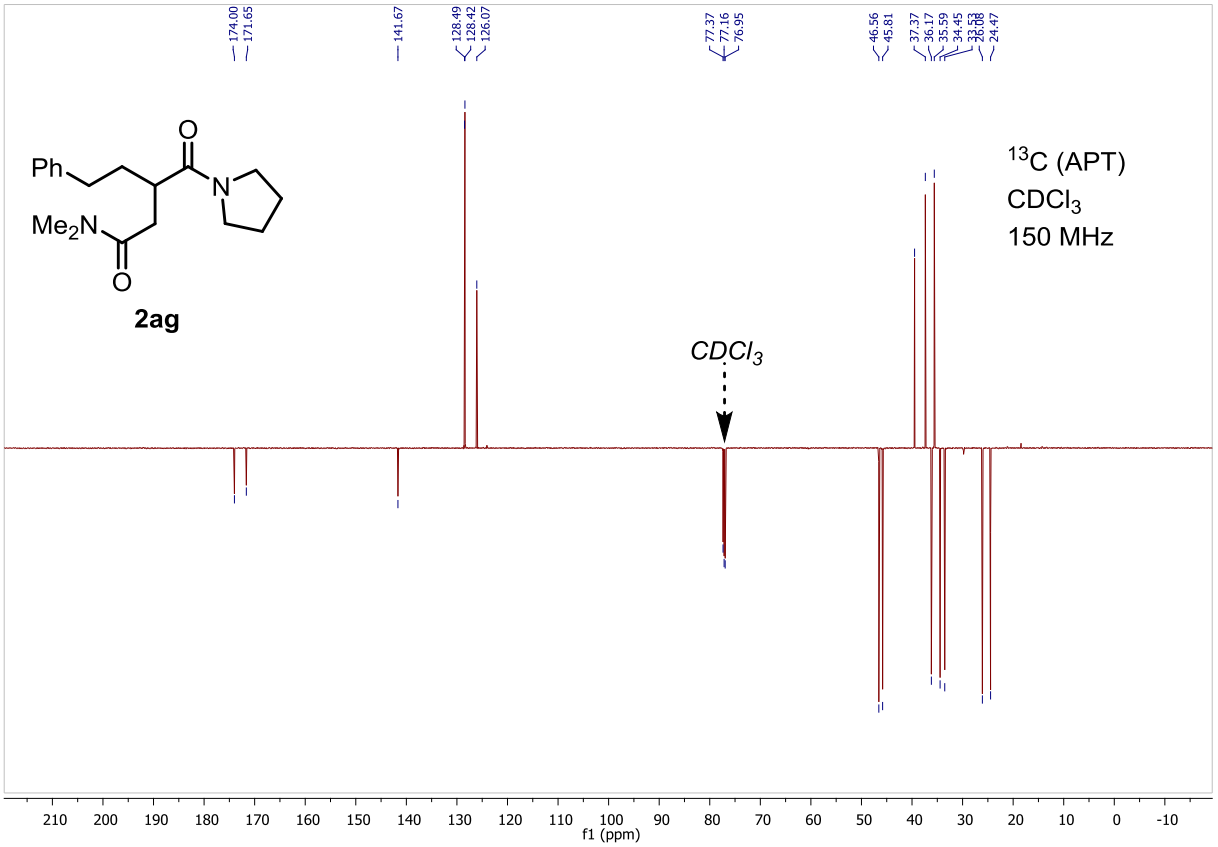

Ph
O
N
EtO2C
Ph
2ae
(diastereomer 2)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

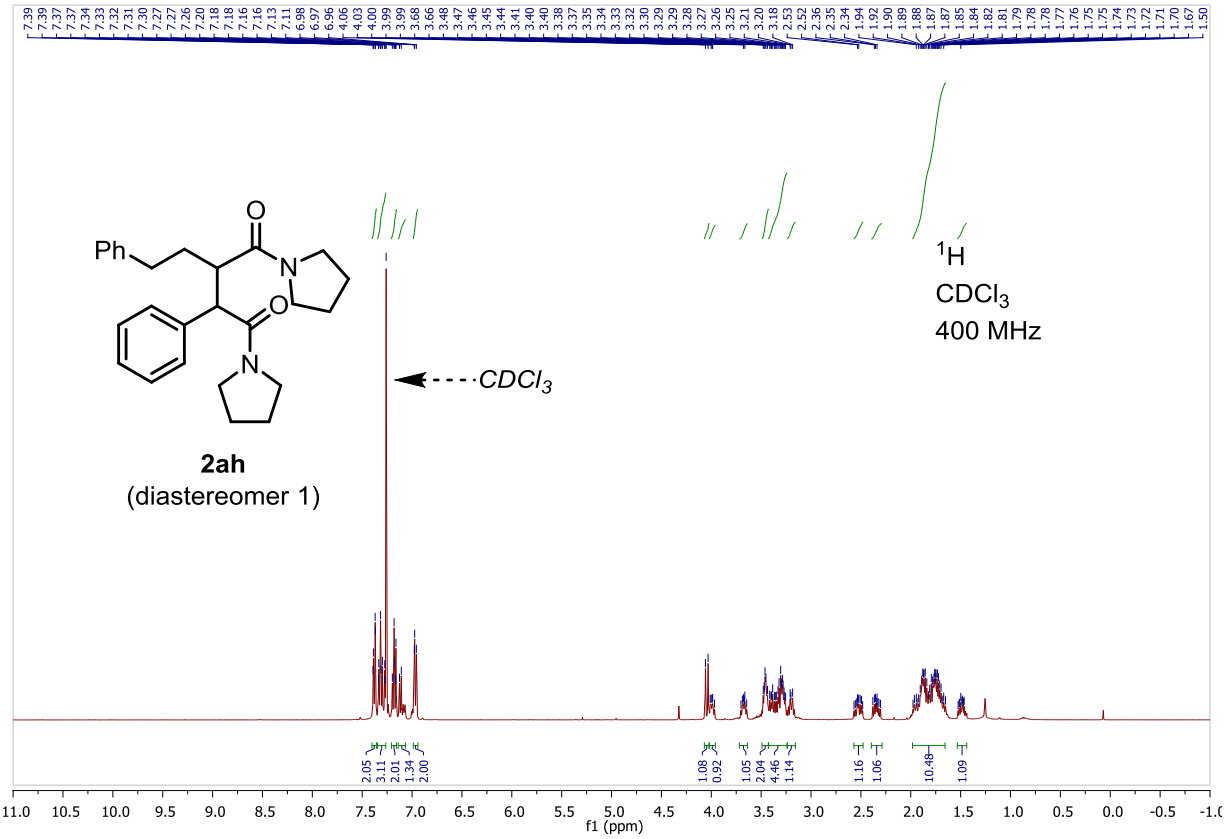

Ph
O
N
EtO2C
Ph
2ae
(diastereomer 2)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

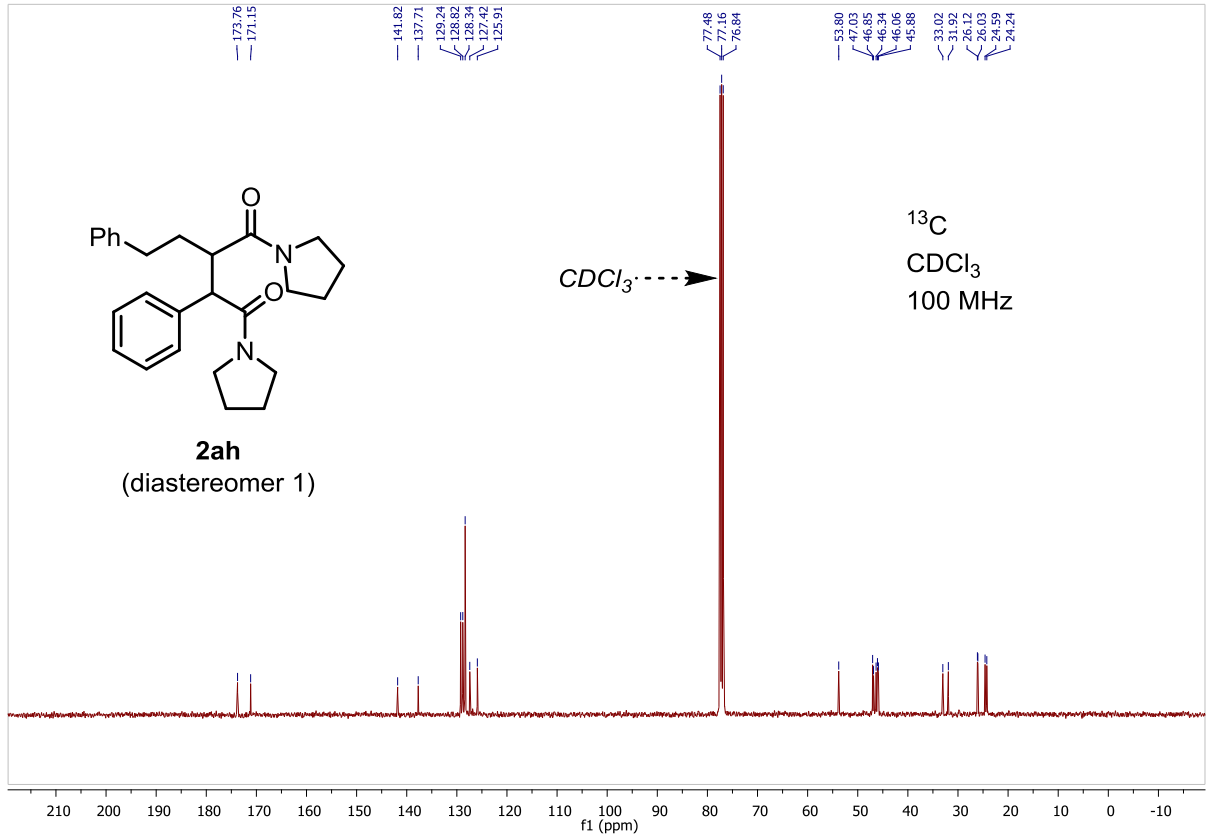

Ph
O
N
CO2Me
O
2af
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

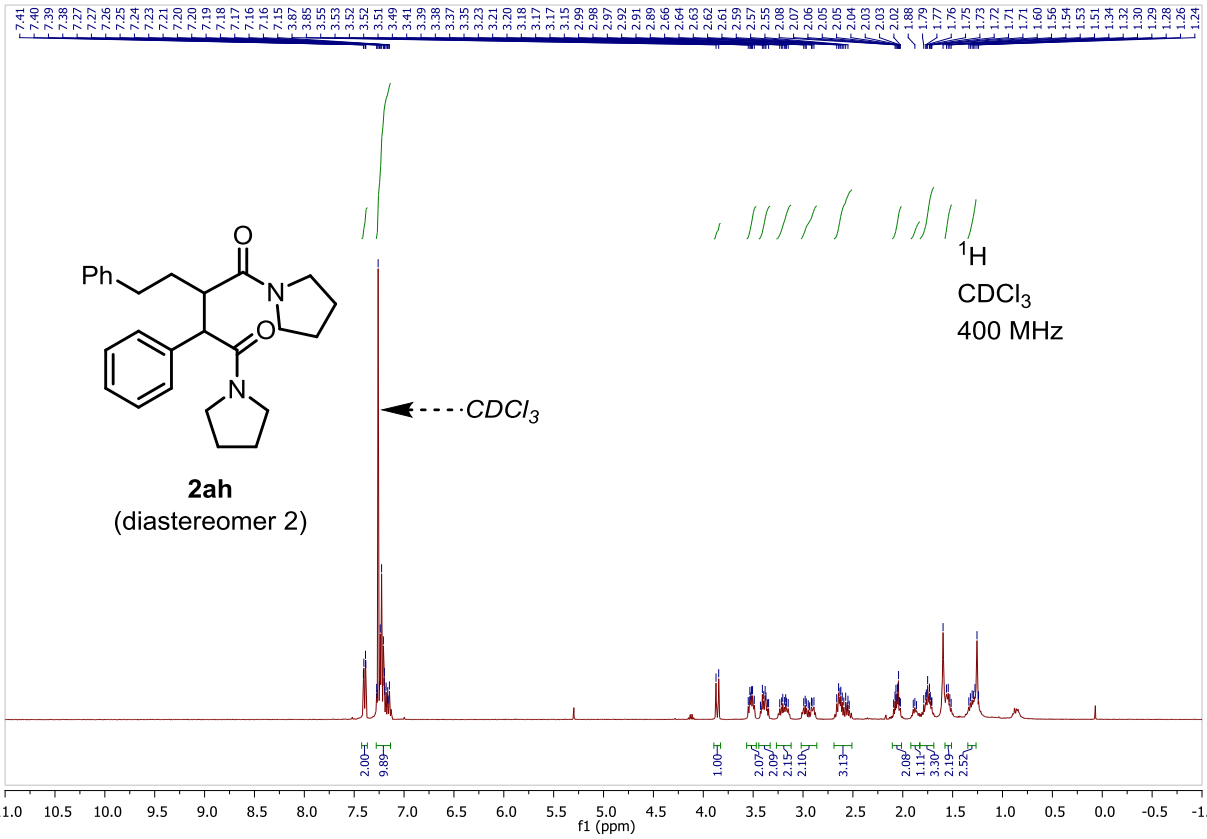

Ph
O
N
CO2Me
O
2af
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)

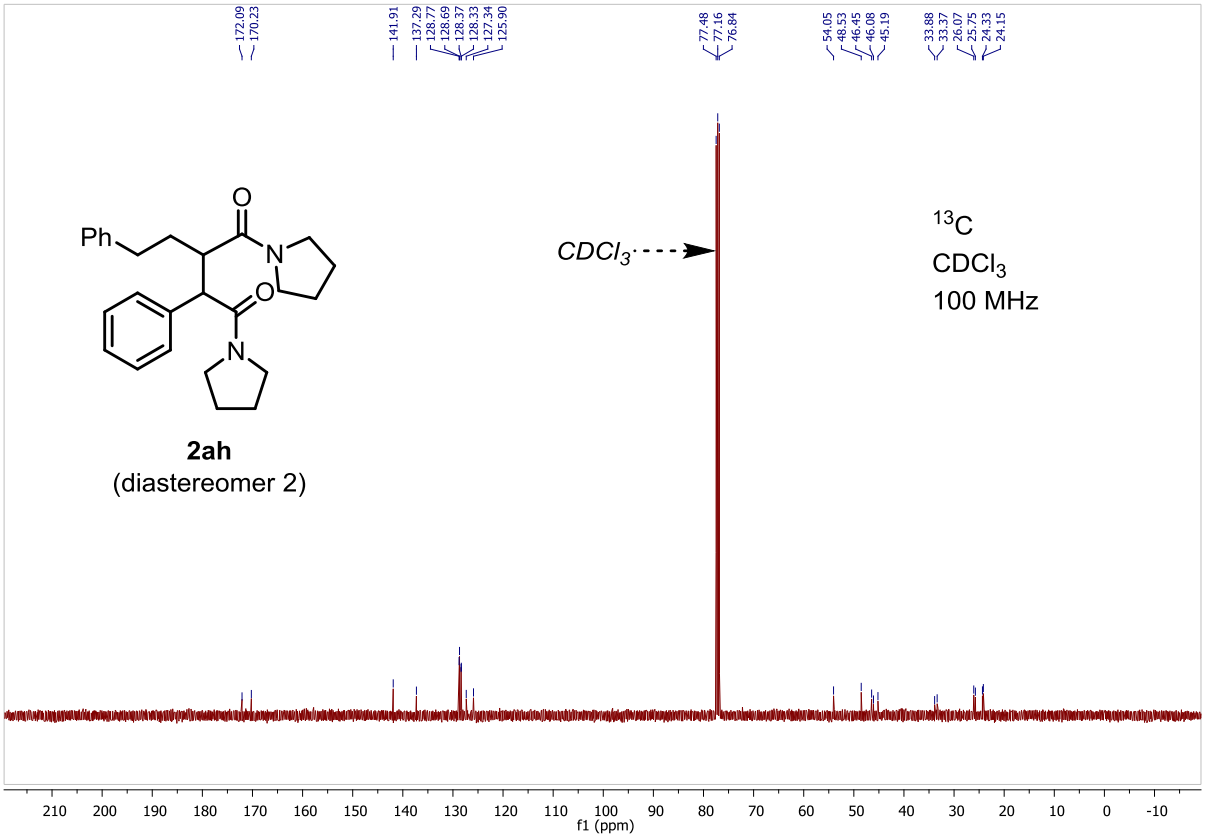

Ph
Me2N
O
N
O
2ag
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

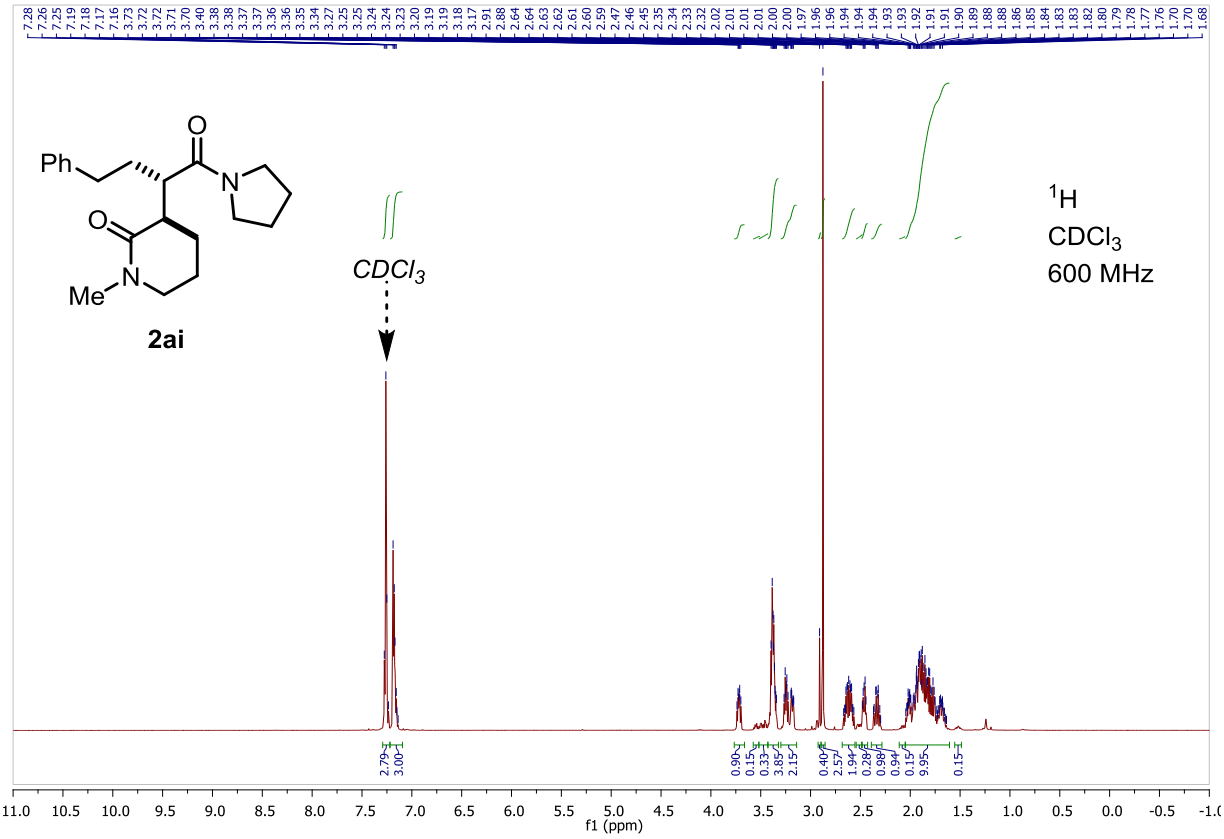

Ph
Me2N
O
N
O
2ag
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

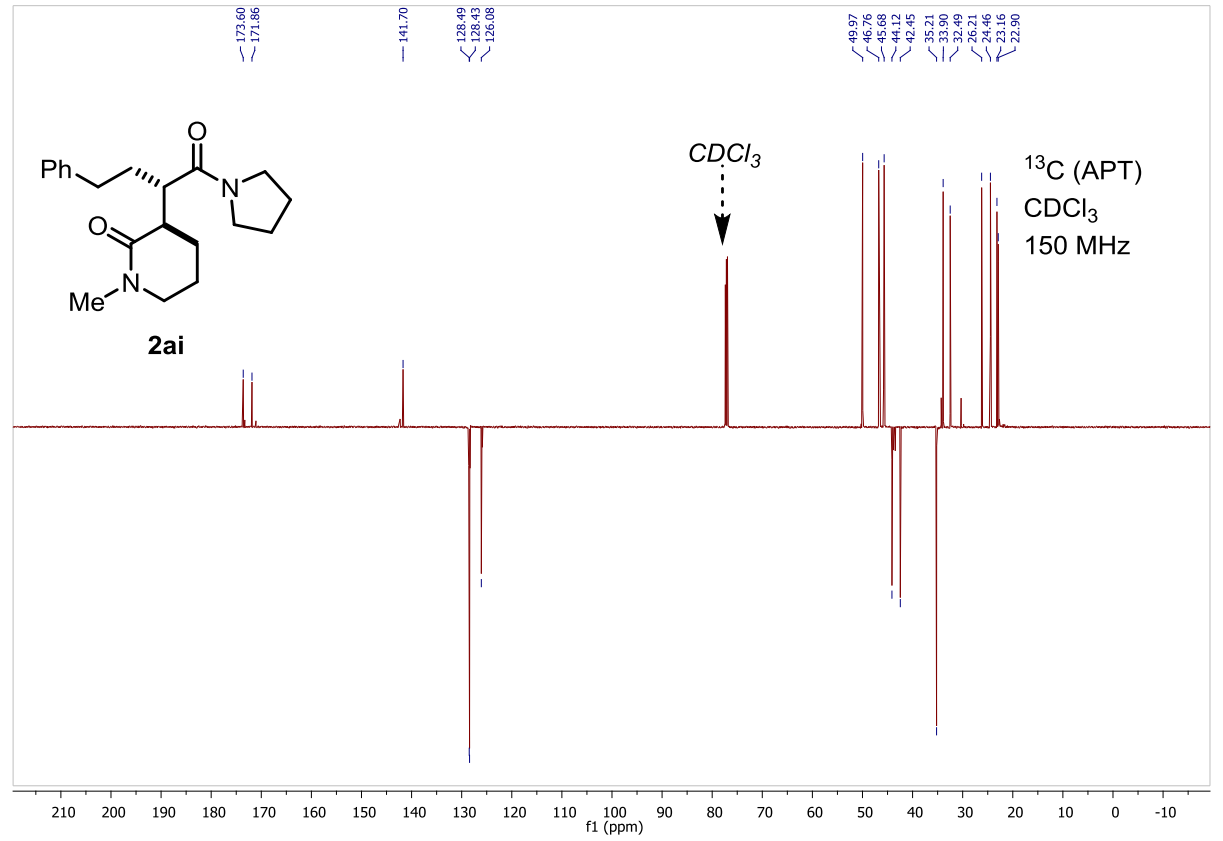

Ph
O
N
O
N
2ah
(diastereomer 1)
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

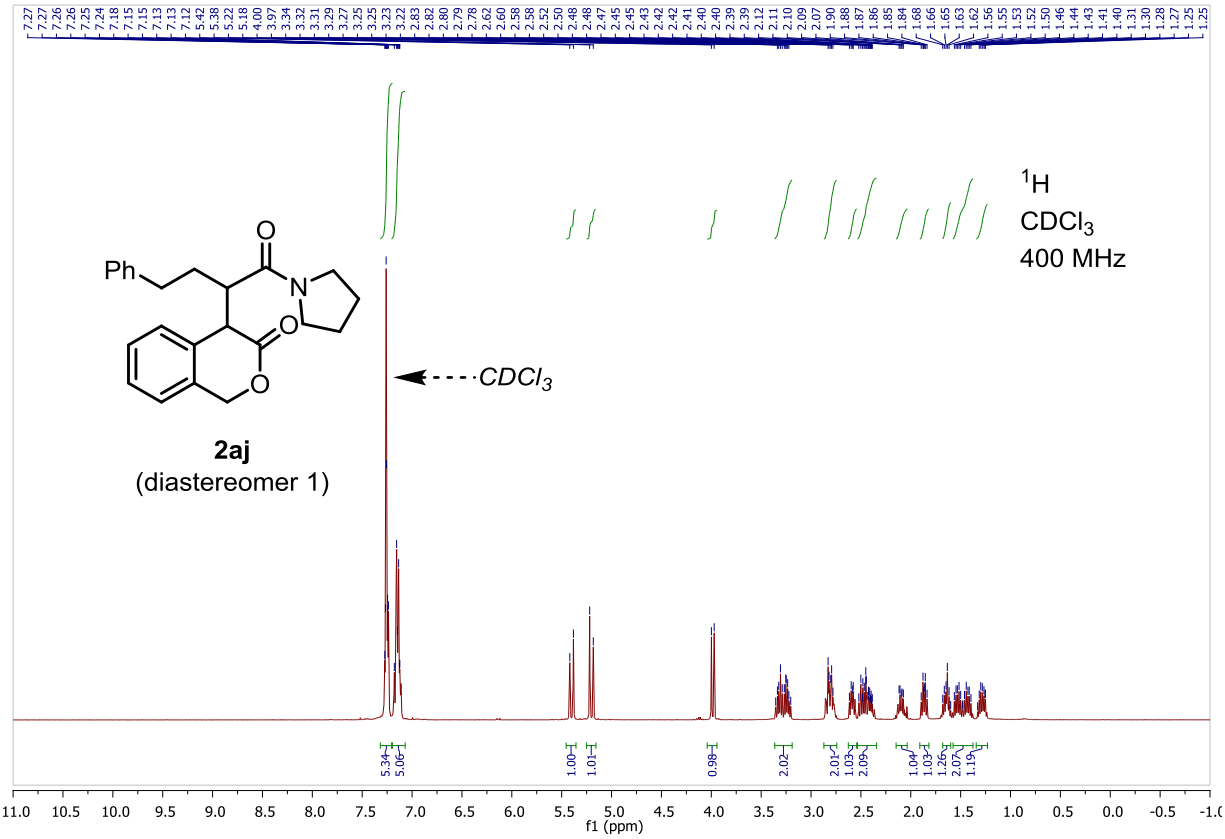

Ph
O
N
O
N
2ah
(diastereomer 1)
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)

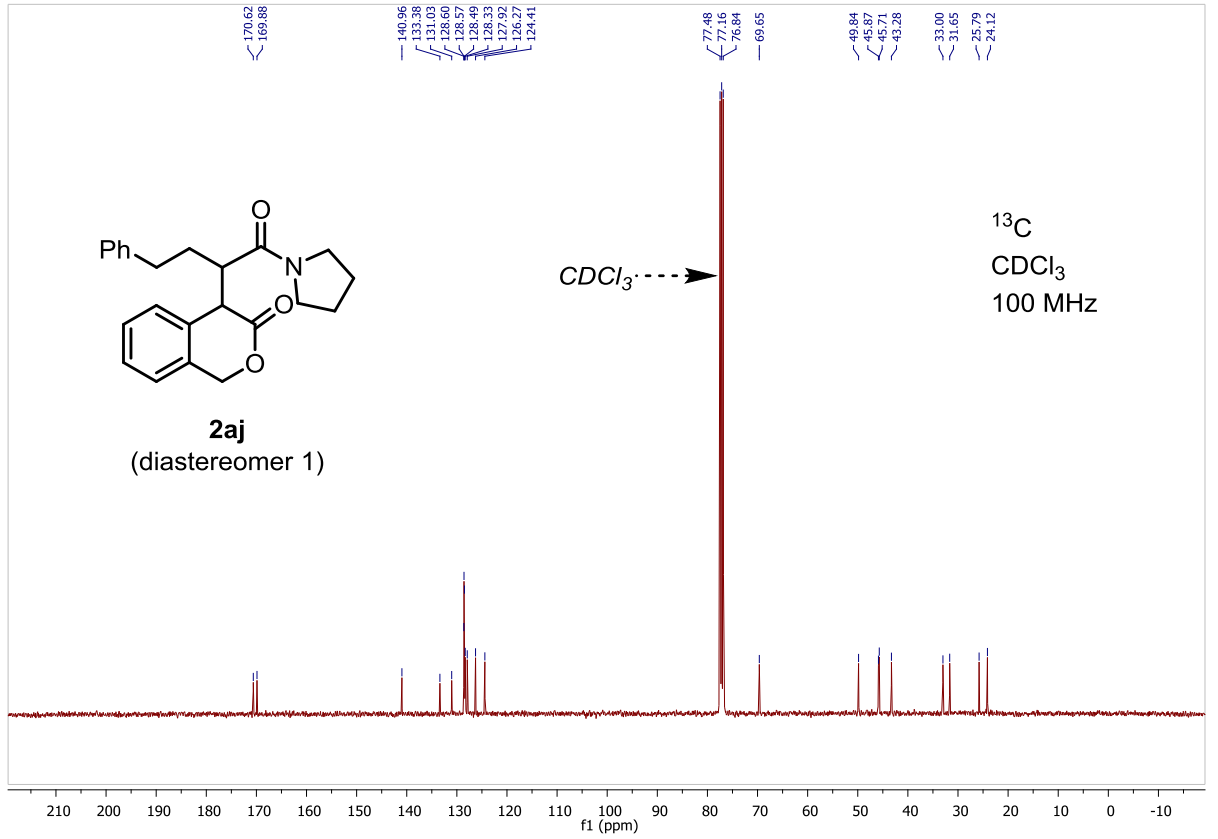

Ph
O
N
O
N
2ah
(diastereomer 2)
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

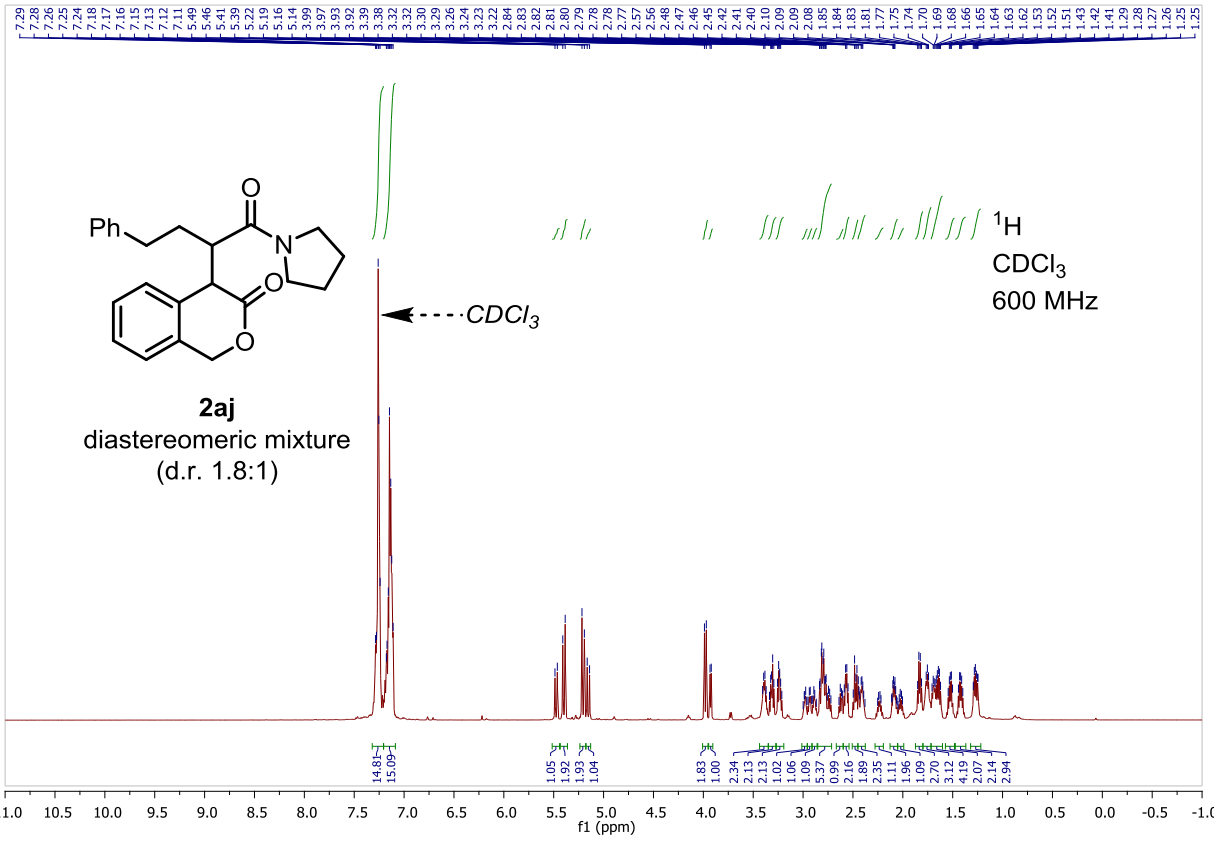

Ph
O
N
O
N
2ah
(diastereomer 2)
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)

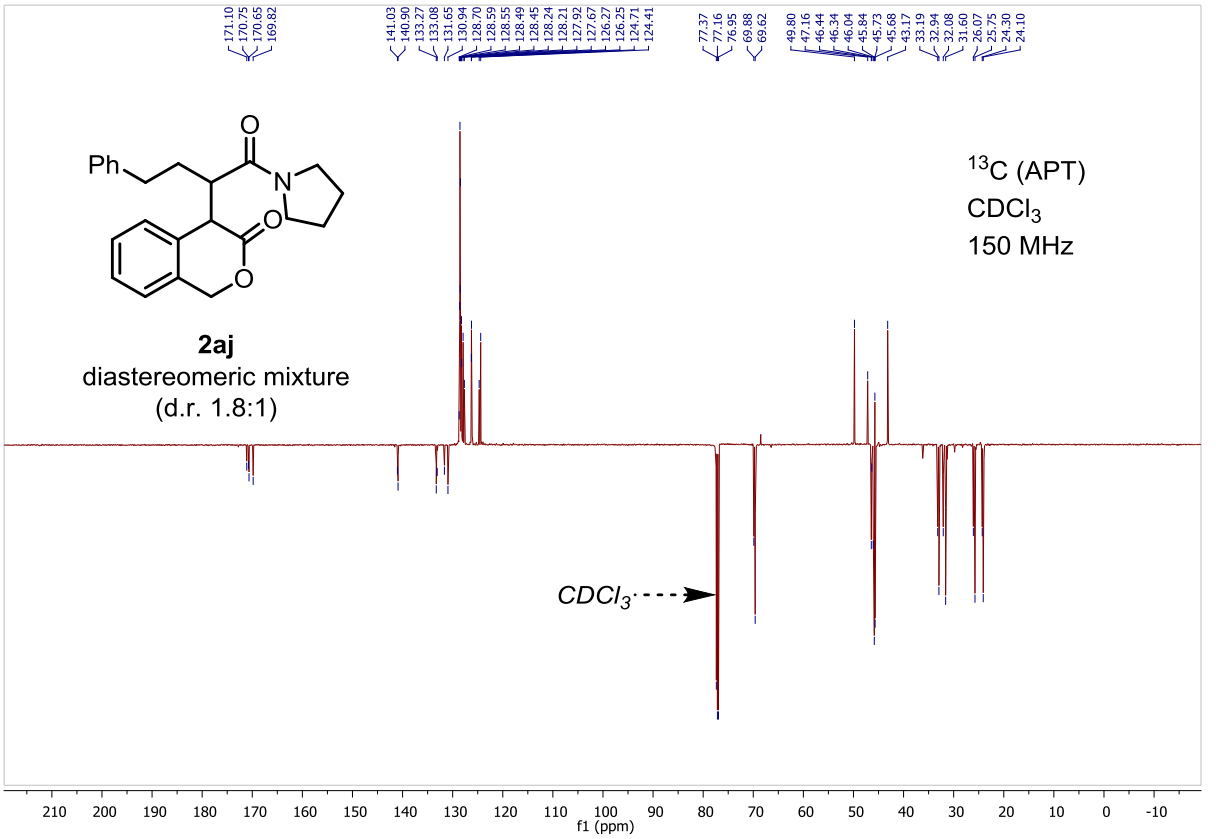

Ph
O
N
O
N
Me
2ai
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

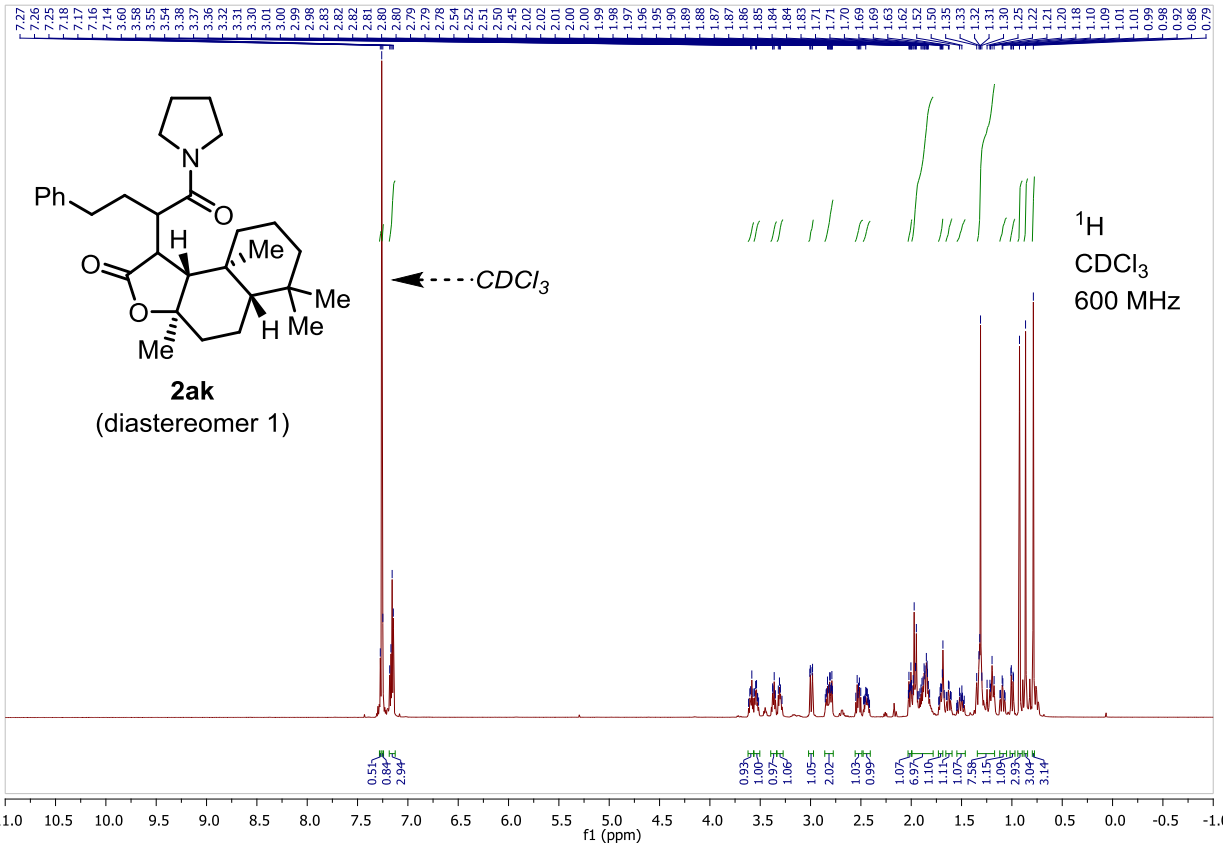

Ph
O
N
O
N
Me
2ai
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

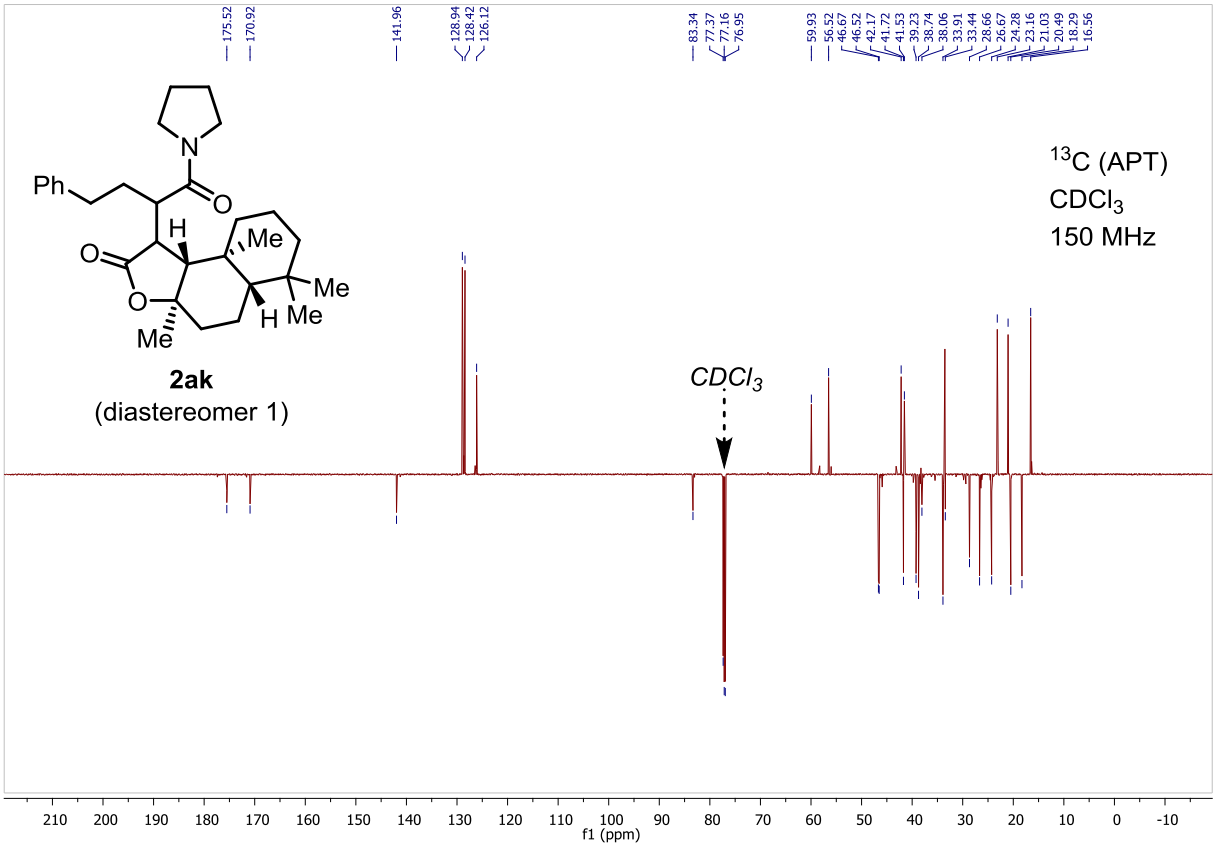

Ph
O
N
O
O
$CDCl_3$
2aj
(diastereomer 1)
^1H
$CDCl_3$
400 MHz
f1 (ppm)

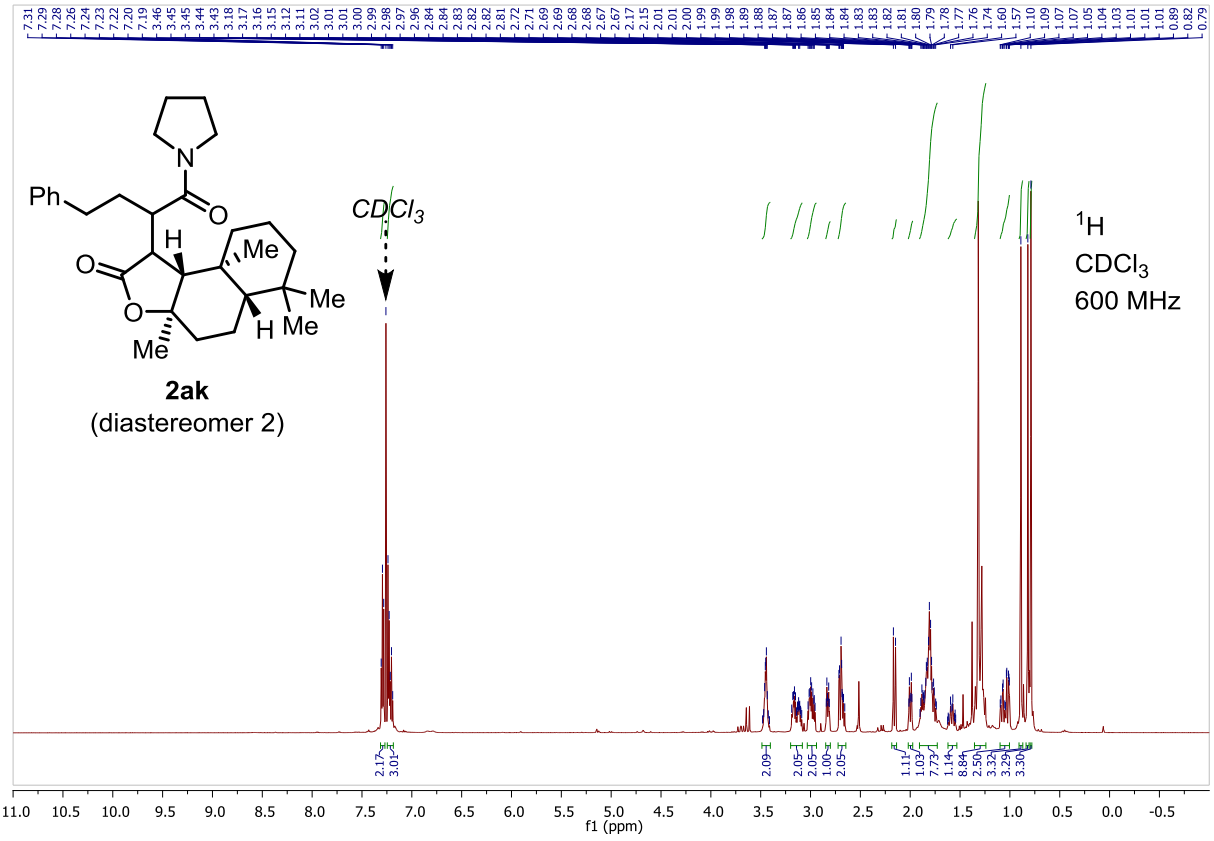

Ph
O
N
O
O
$CDCl_3$
2aj
(diastereomer 1)
^{13}C
$CDCl_3$
100 MHz
f1 (ppm)


Ph
O
N
O
O
2aj
diastereomeric mixture
(d.r. 1.8:1)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)


Ph
O
N
O
O
2aj
diastereomeric mixture
(d.r. 1.8:1)
13C (APT)
CDCl3
150 MHz
CDCl3
f1 (ppm)


Ph
N
O
H
Me
O
O
Me
Me
H Me
Me
2ak
(diastereomer 1)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)


Ph
N
O
H
Me
O
O
Me
Me
H Me
Me
2ak
(diastereomer 1)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)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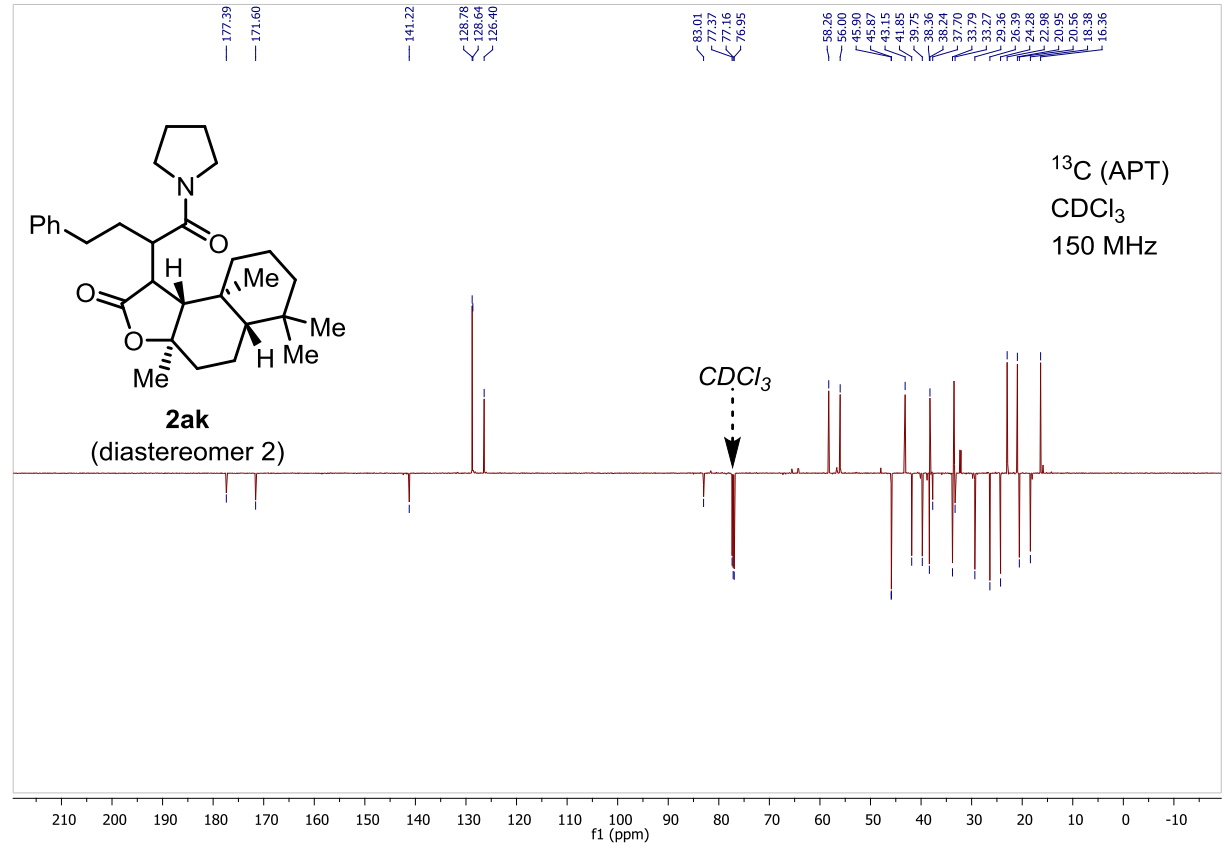
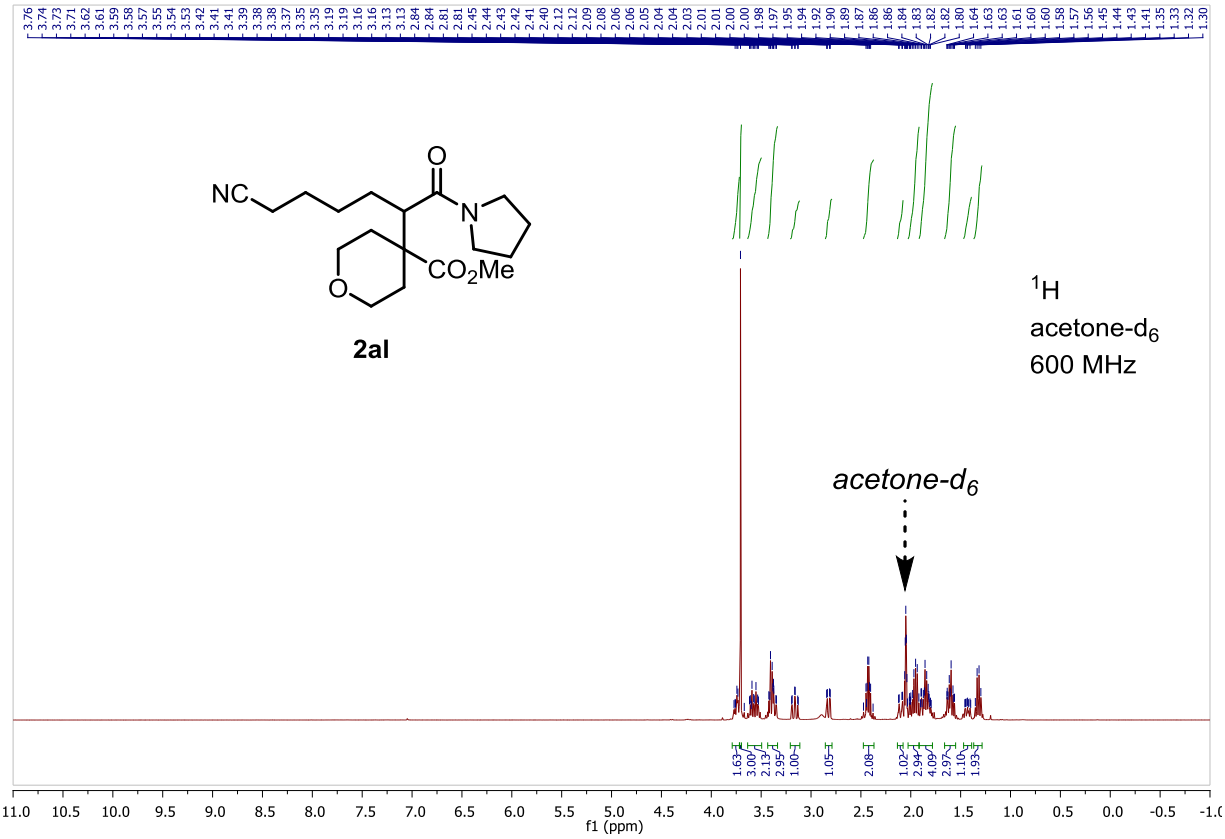
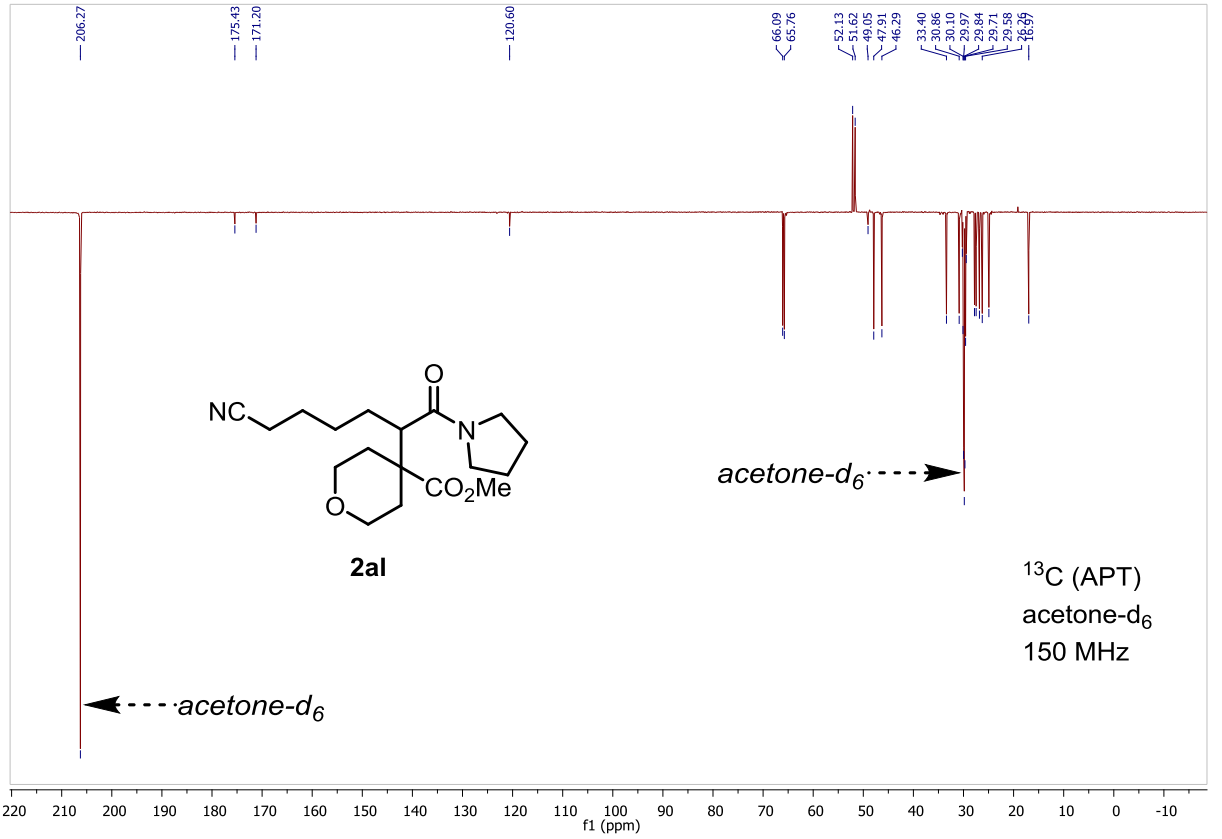
N
O
H
O
Me
O
Me
H Me
Me
2ak
(diastereomer 2)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)


Ph
N
O
H
O
Me
O
Me
H Me
Me
2ak
(diastereomer 2)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)


NC
O
N
CO2Me
O
2al
1H
acetone-d6
600 MHz
acetone-d6
f1 (ppm)


206.27
175.43
171.20
120.60
66.09
65.76
52.13
51.62
49.05
47.91
46.29
33.40
30.86
30.10
29.97
29.84
29.71
29.58
26.26
16.99
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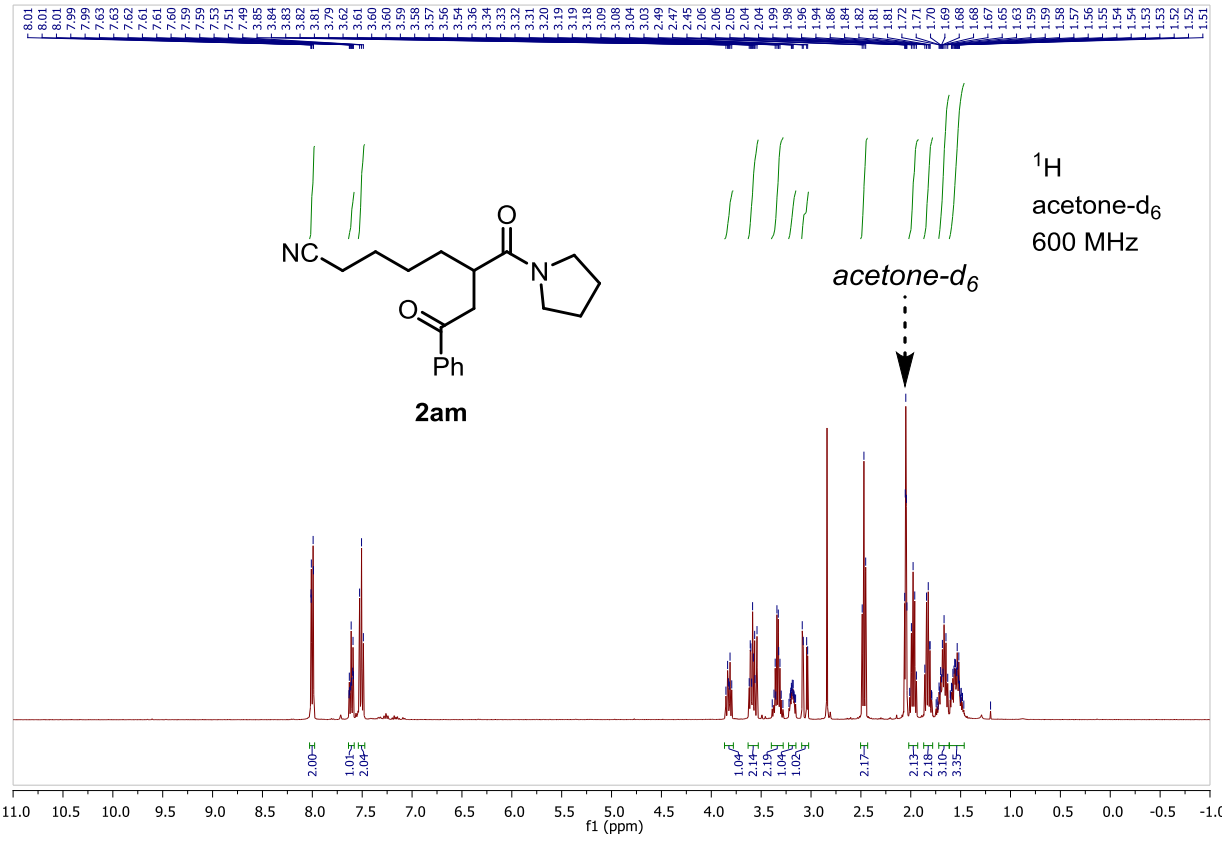
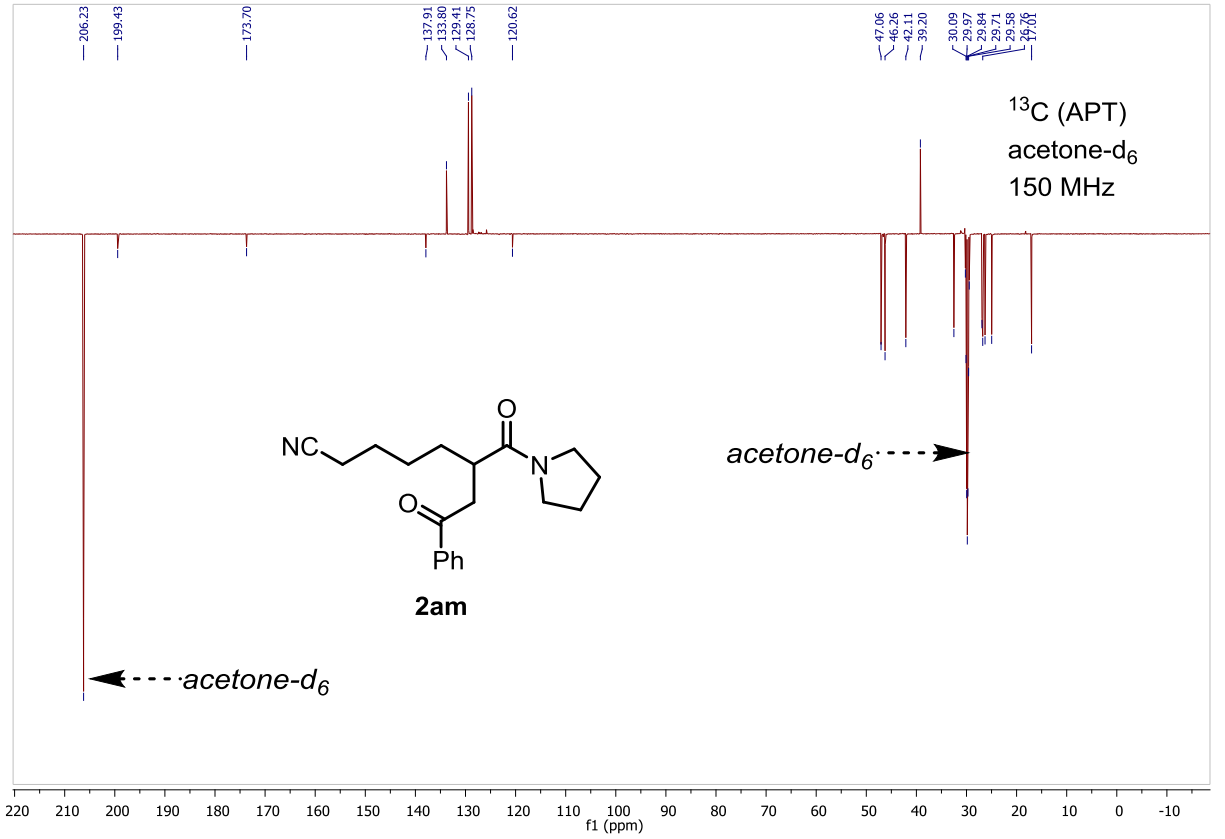
O
N
CO2Me
O
2al
acetone-d6
acetone-d6
13C (APT)
acetone-d6
150 MHz
f1 (ppm)


^{1}H
acetone-d$_6$
600 MHz
acetone-d$_6$
NC
O
N
O
Ph
2am
f1 (ppm)


^{13}C (APT)
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150 MHz
acetone-d$_6$
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NC
O
N
O
Ph
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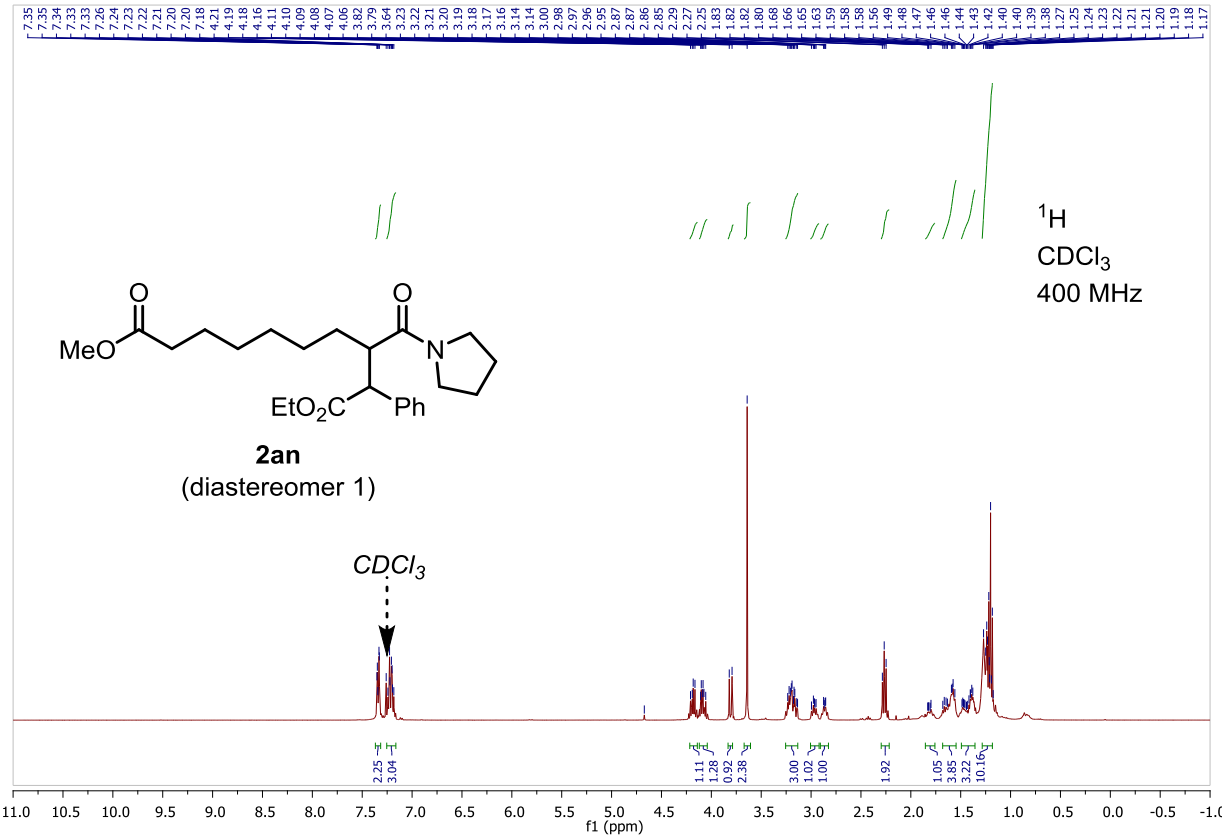
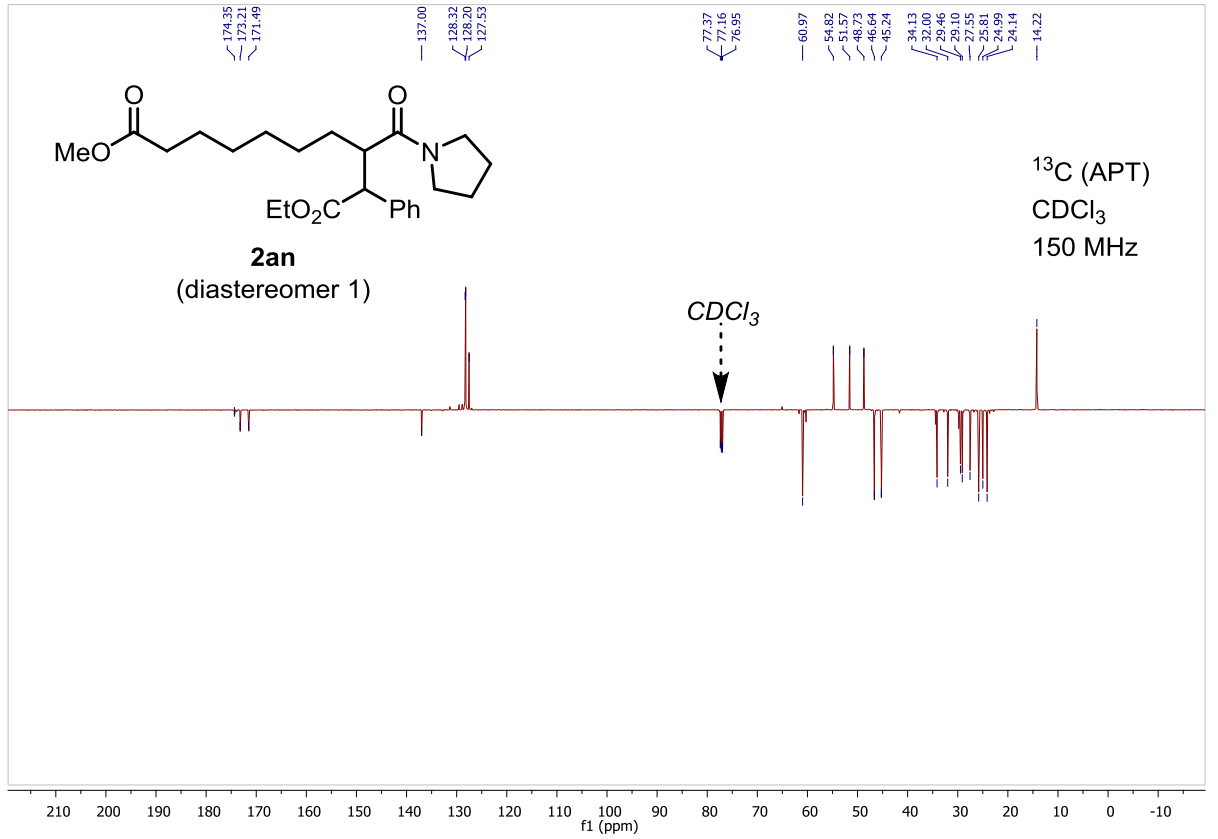
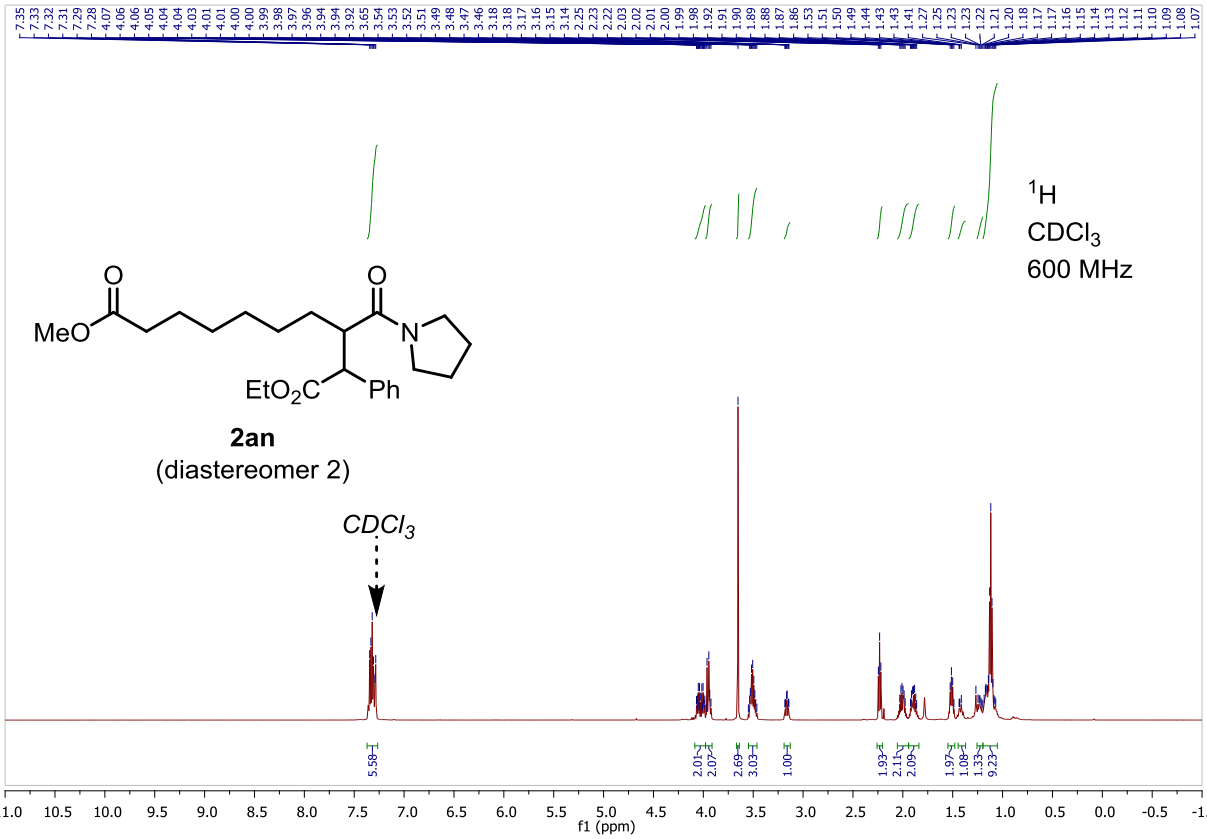
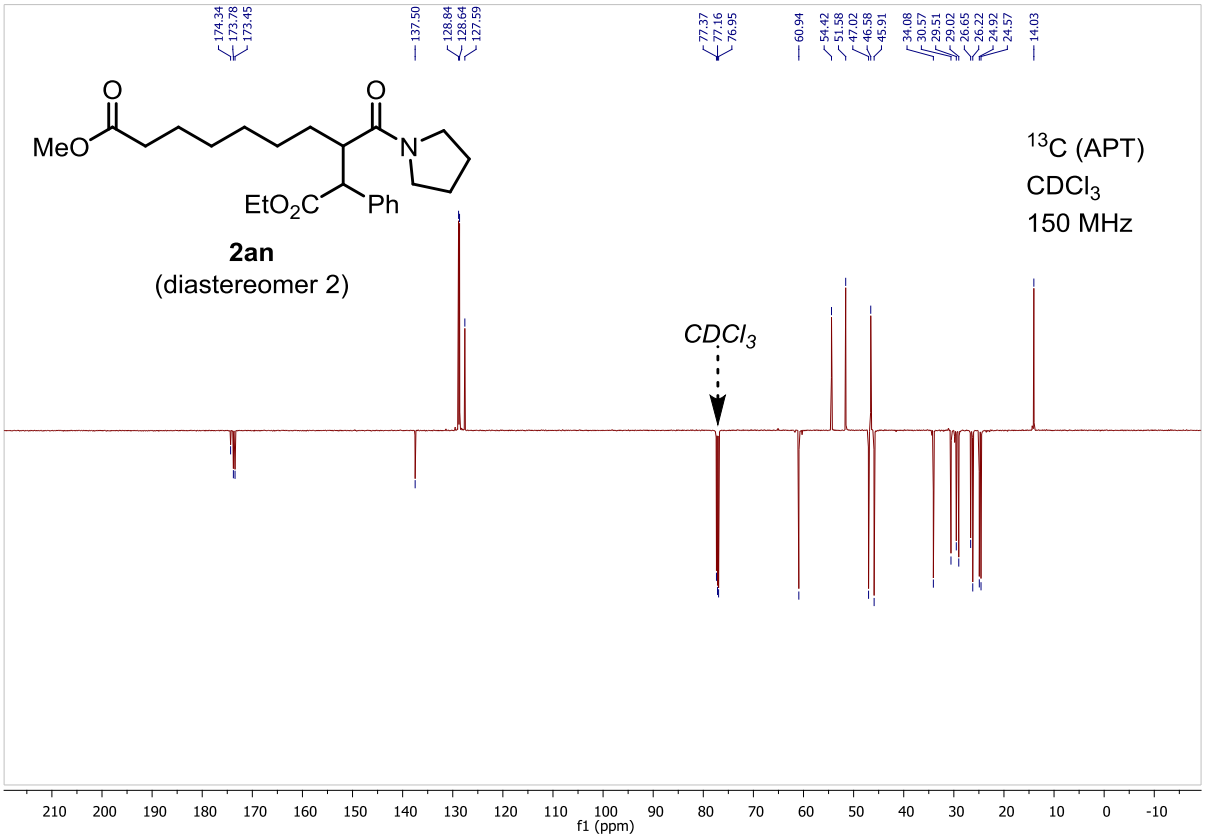
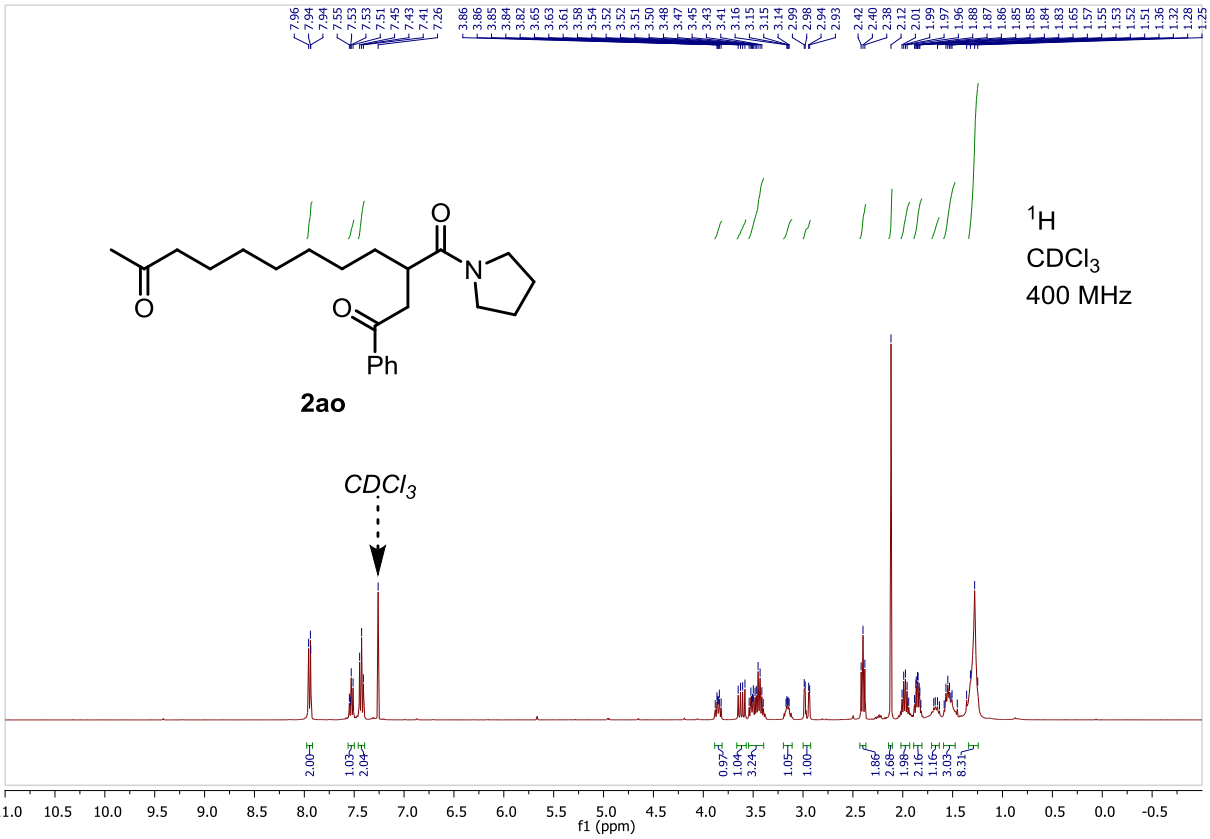
f1 (ppm)

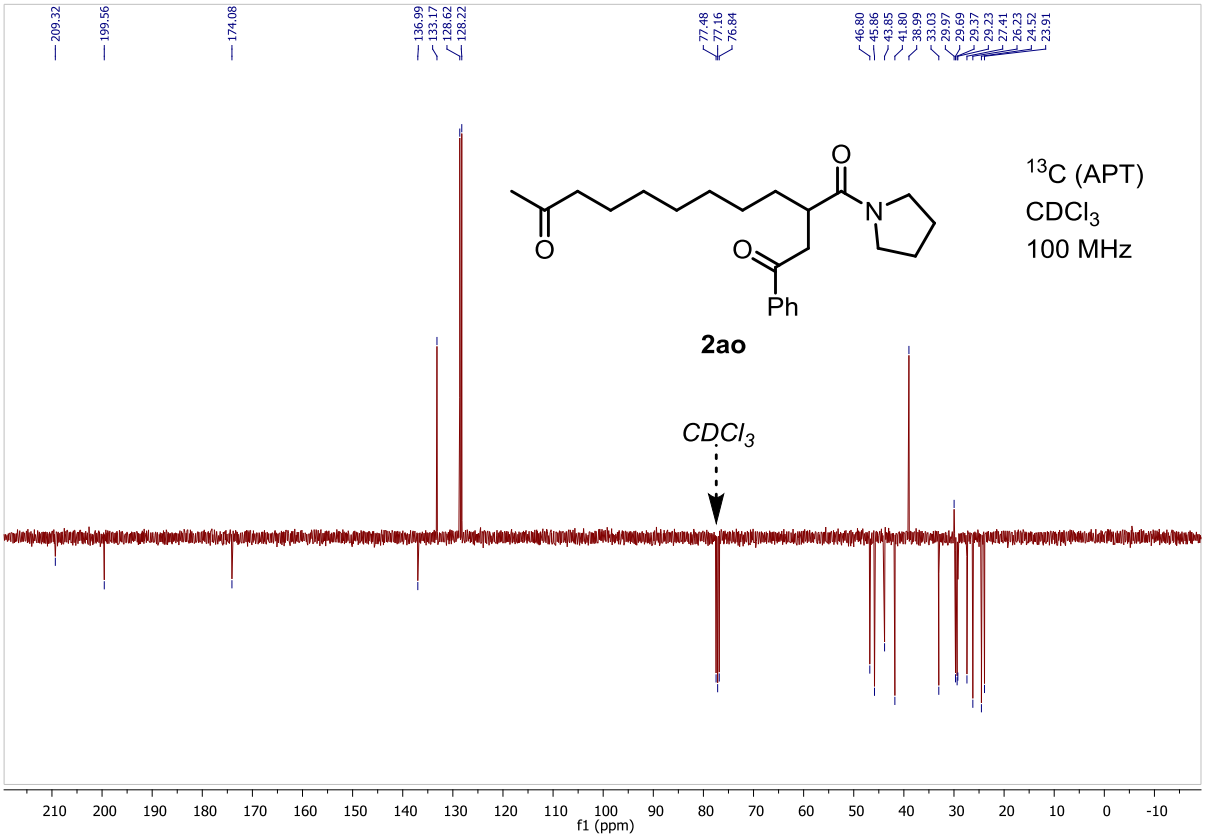

MeO
O
O
N
EtO2C
Ph
2an
(diastereomer 1)
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

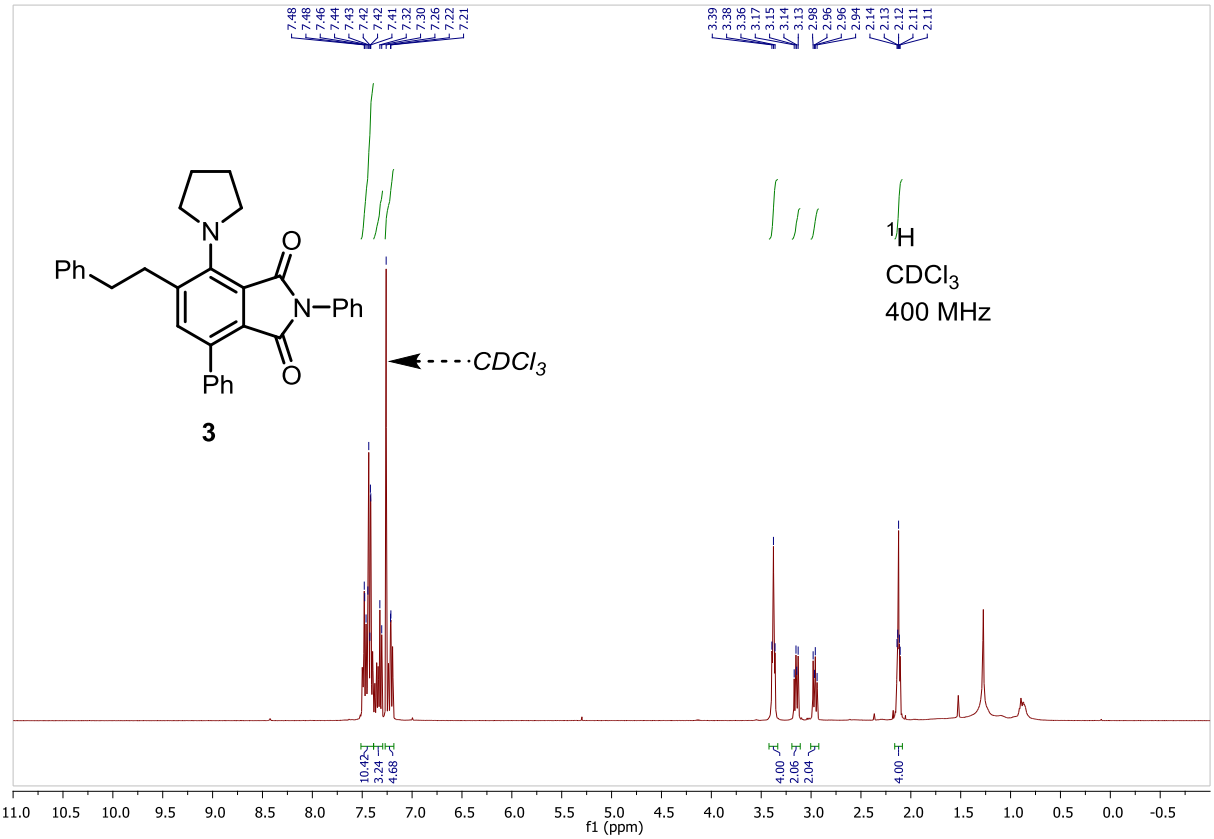

MeO
O
O
N
EtO2C
Ph
2an
(diastereomer 1)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

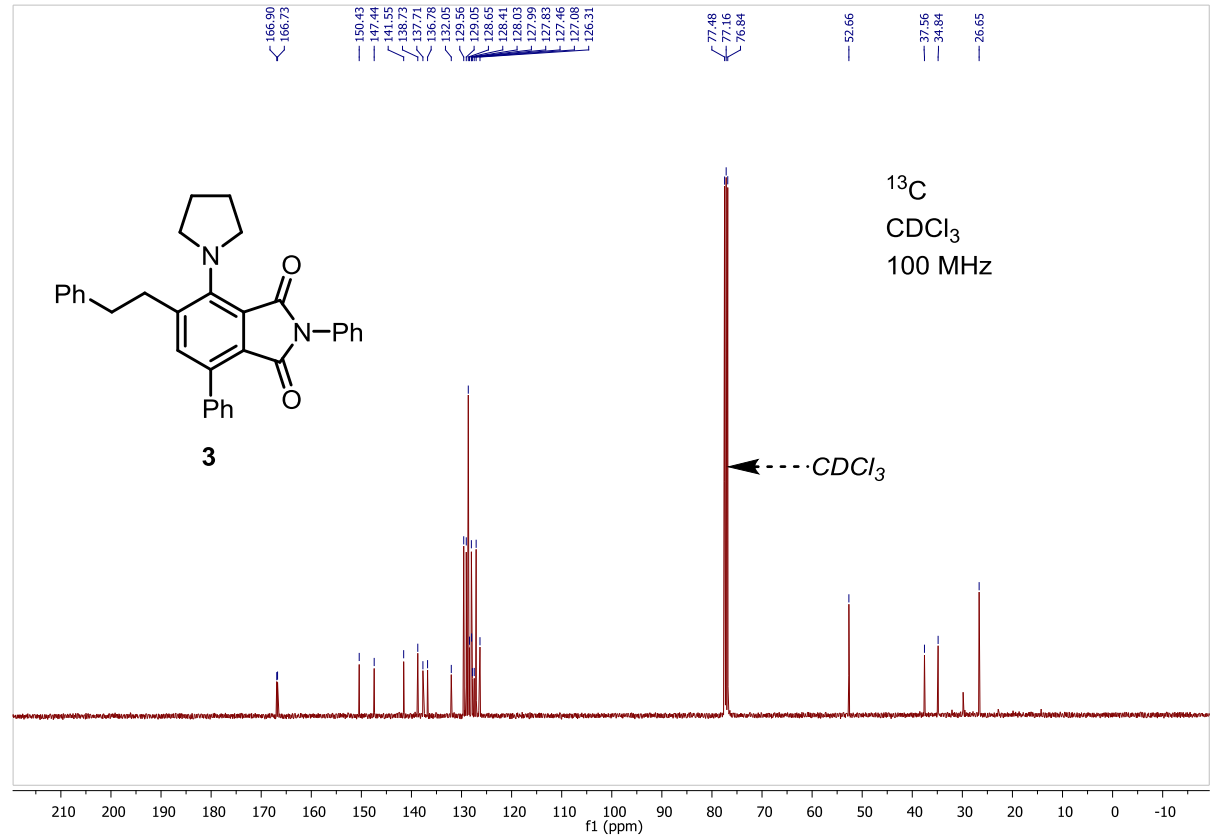

MeO
O
O
N
EtO2C
Ph
2an
(diastereomer 2)
CDCl3
1H
CDCl3
600 MHz
f1 (ppm)

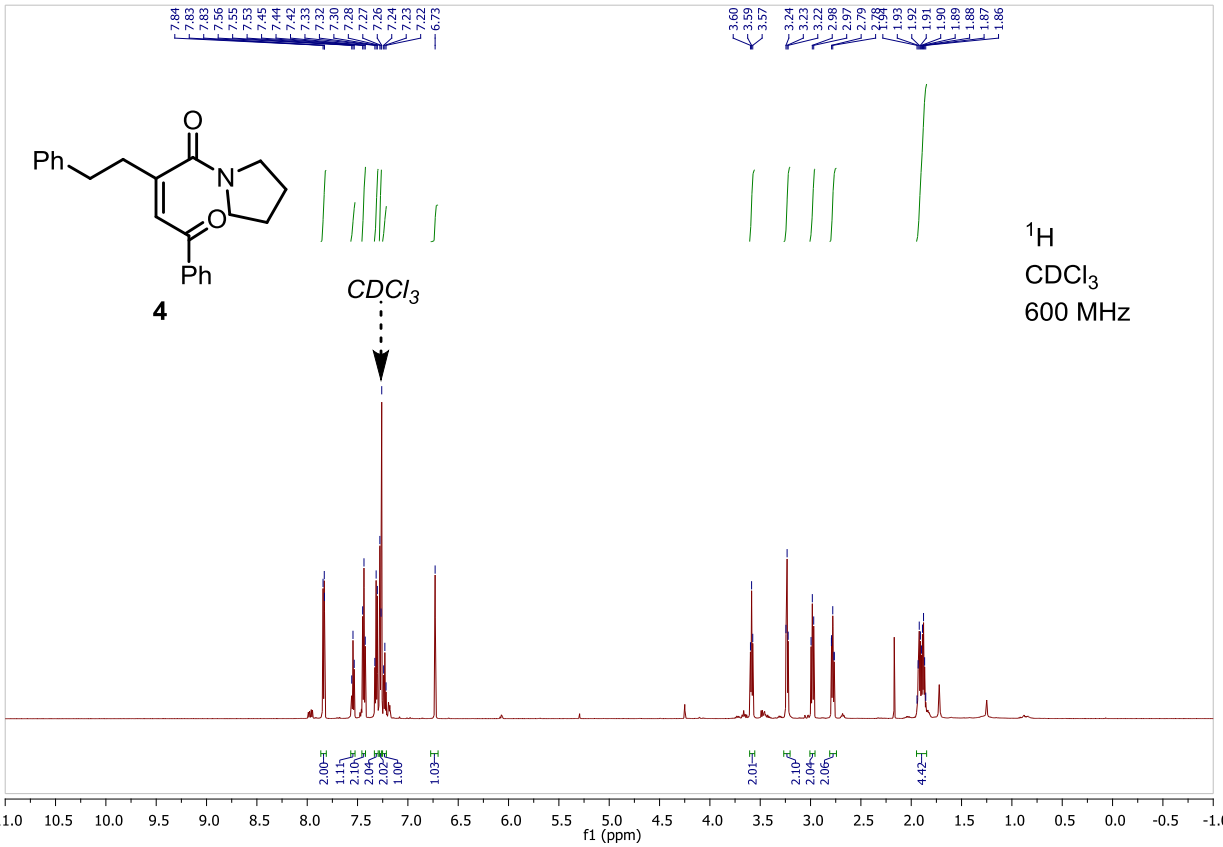

MeO
O
O
N
EtO2C
Ph
2an
(diastereomer 2)
CDCl3
13C (APT)
CDCl3
150 MHz
f1 (ppm)

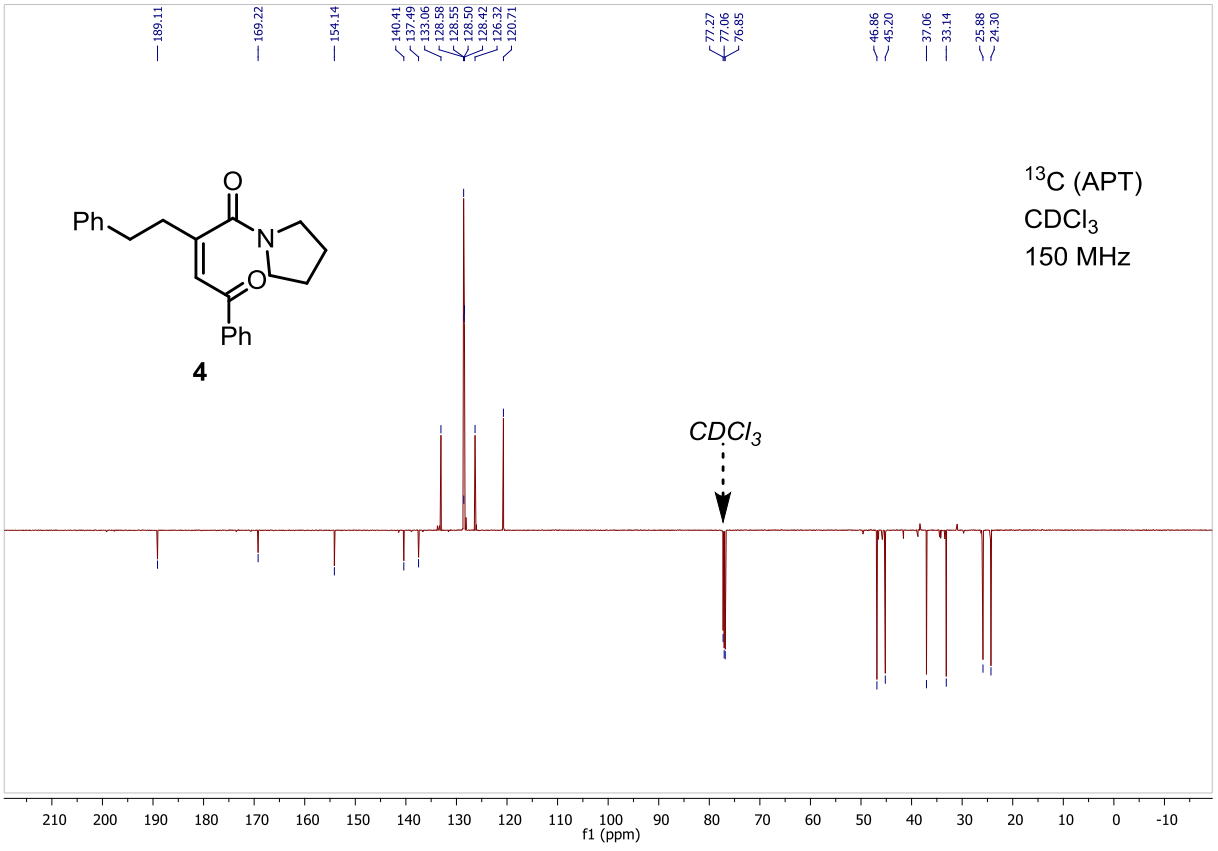

^{1}H
$CDCl_3$
400 MHz
2ao
$CDCl_3$
f1 (ppm)

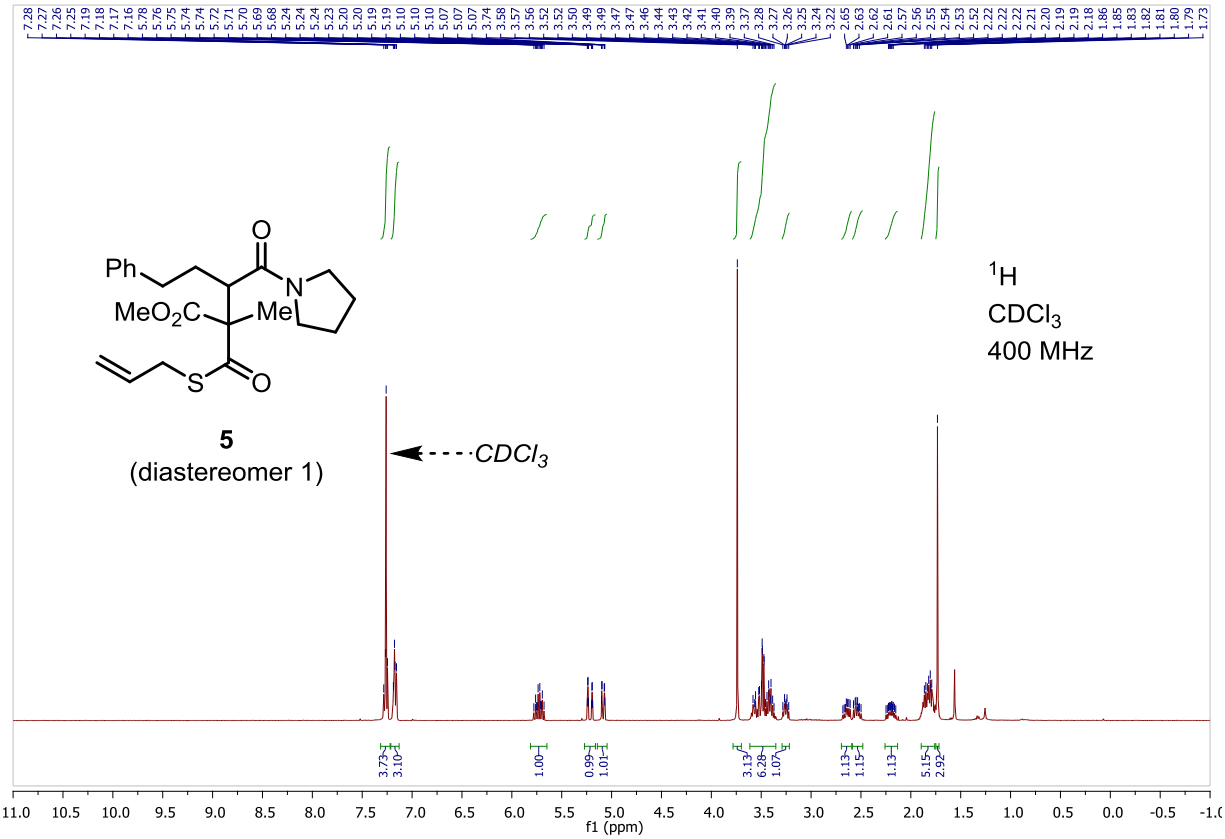

^{13}C (APT)
$CDCl_3$
100 MHz
2ao
$CDCl_3$
f1 (ppm)

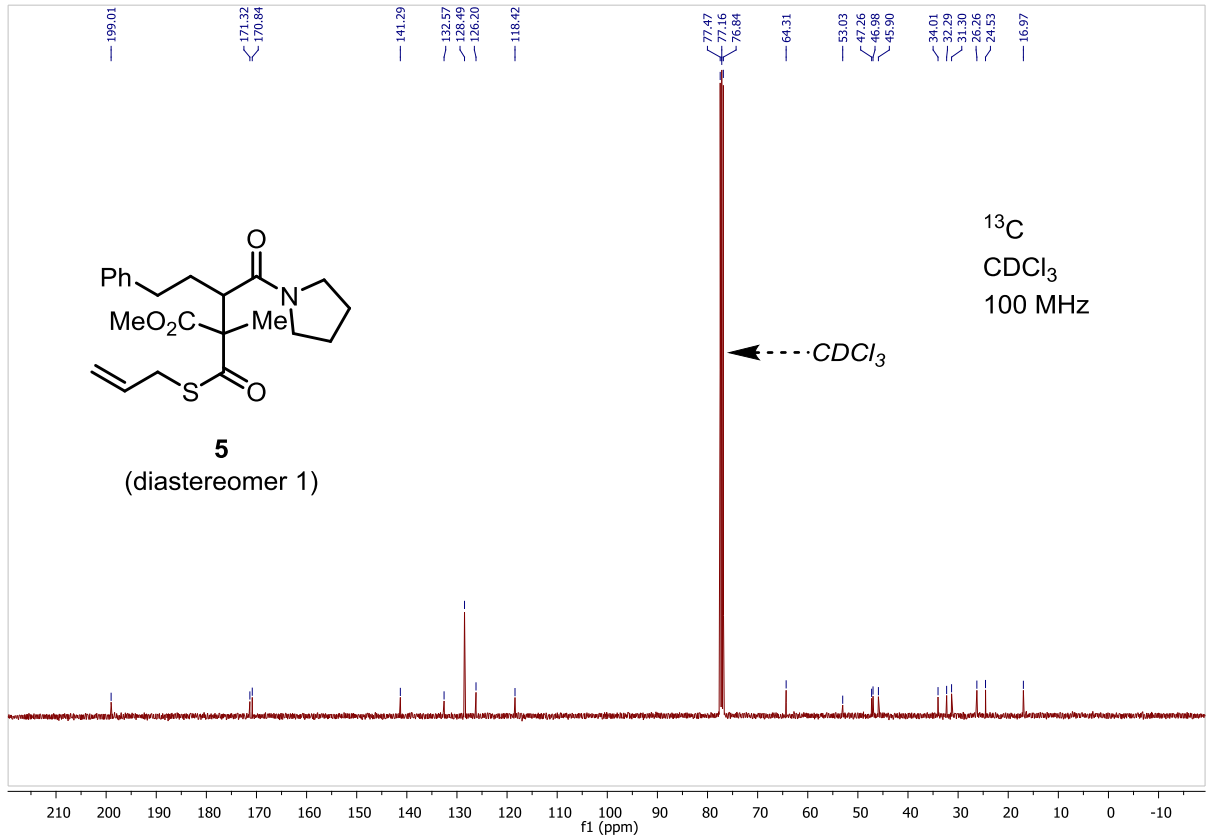

Ph
N
O
N–Ph
O
Ph
3
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

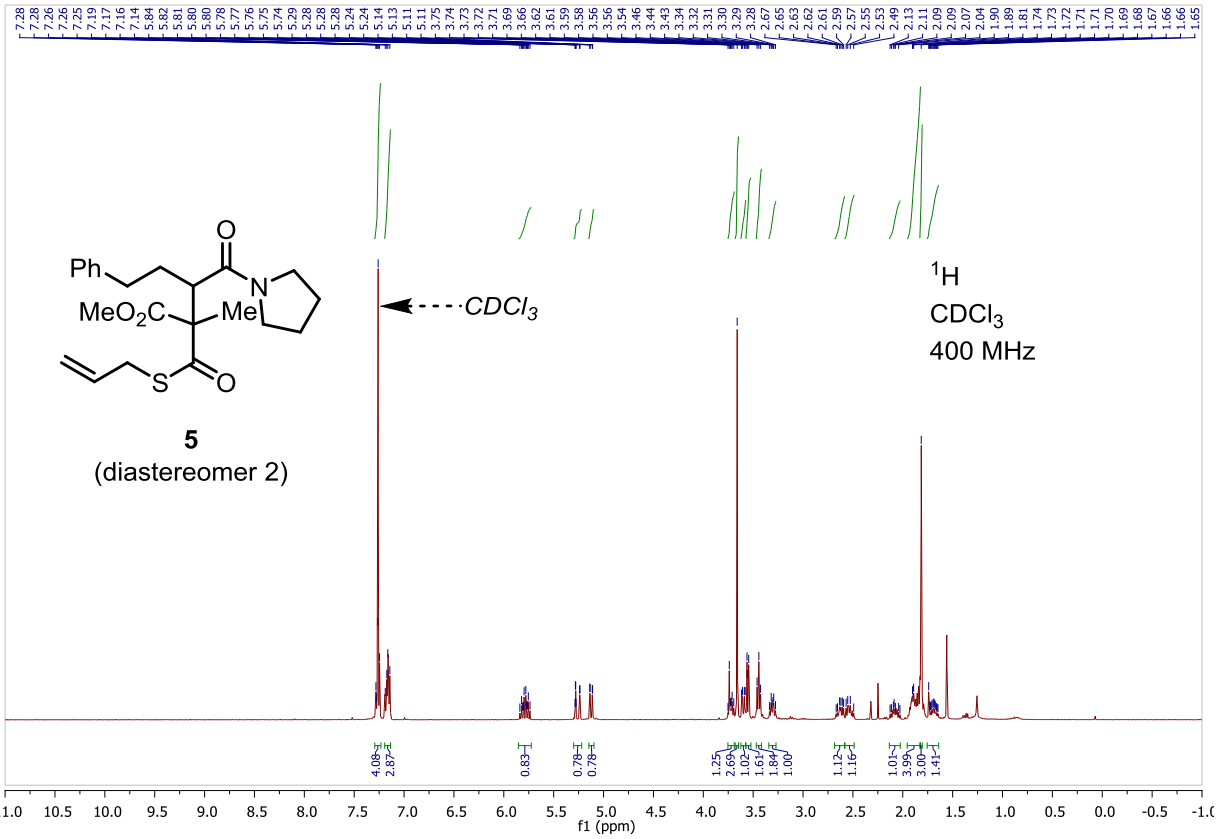

Ph
N
O
N–Ph
O
Ph
3
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)

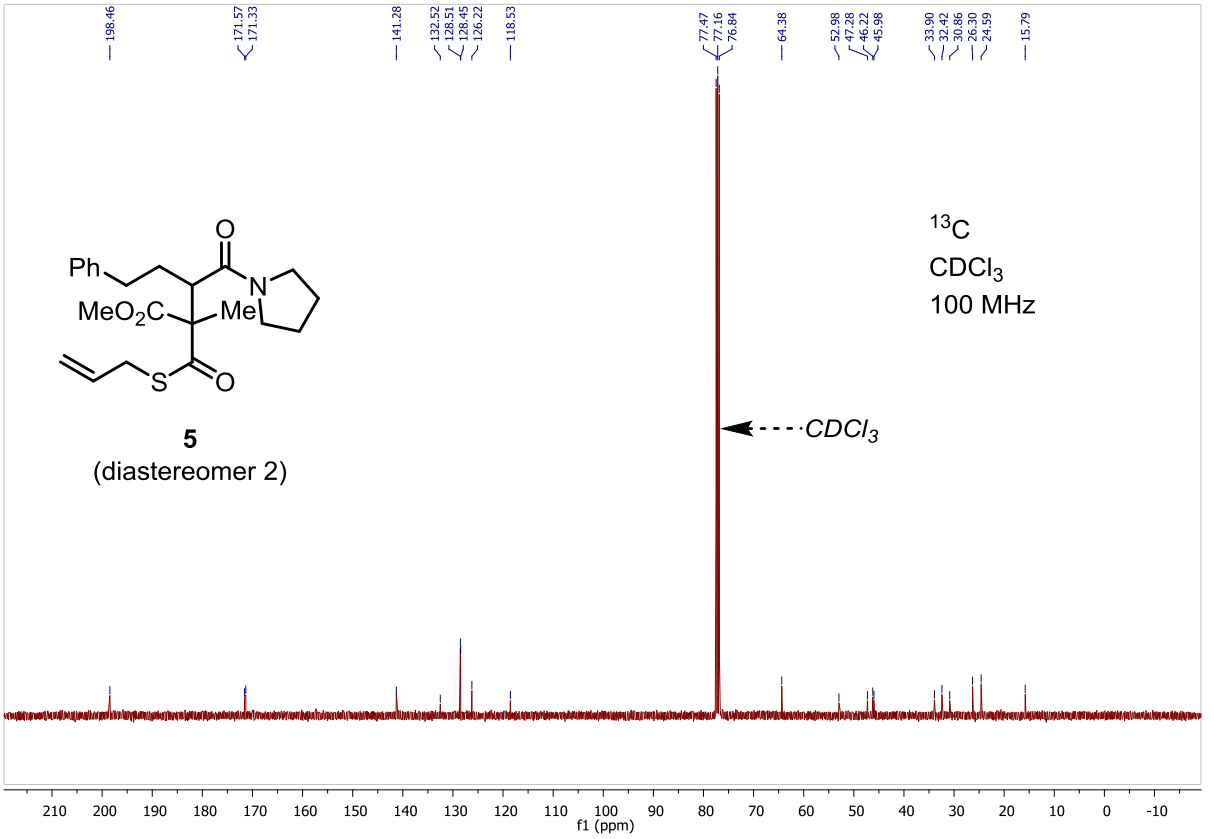

7.84
7.83
7.83
7.56
7.55
7.53
7.45
7.44
7.42
7.33
7.32
7.30
7.28
7.27
7.26
7.24
7.23
7.22
6.73
3.60
3.59
3.57
3.24
3.23
3.22
2.98
2.97
2.79
2.78
1.94
1.93
1.92
1.91
1.90
1.89
1.88
1.87
1.86
Ph
O
N
O
Ph
4
CDCl3
1H
CDCl3
600 MHz
2.00
1.11
2.10
2.04
2.02
1.00
1.03
2.01
2.10
2.04
2.06
4.42
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

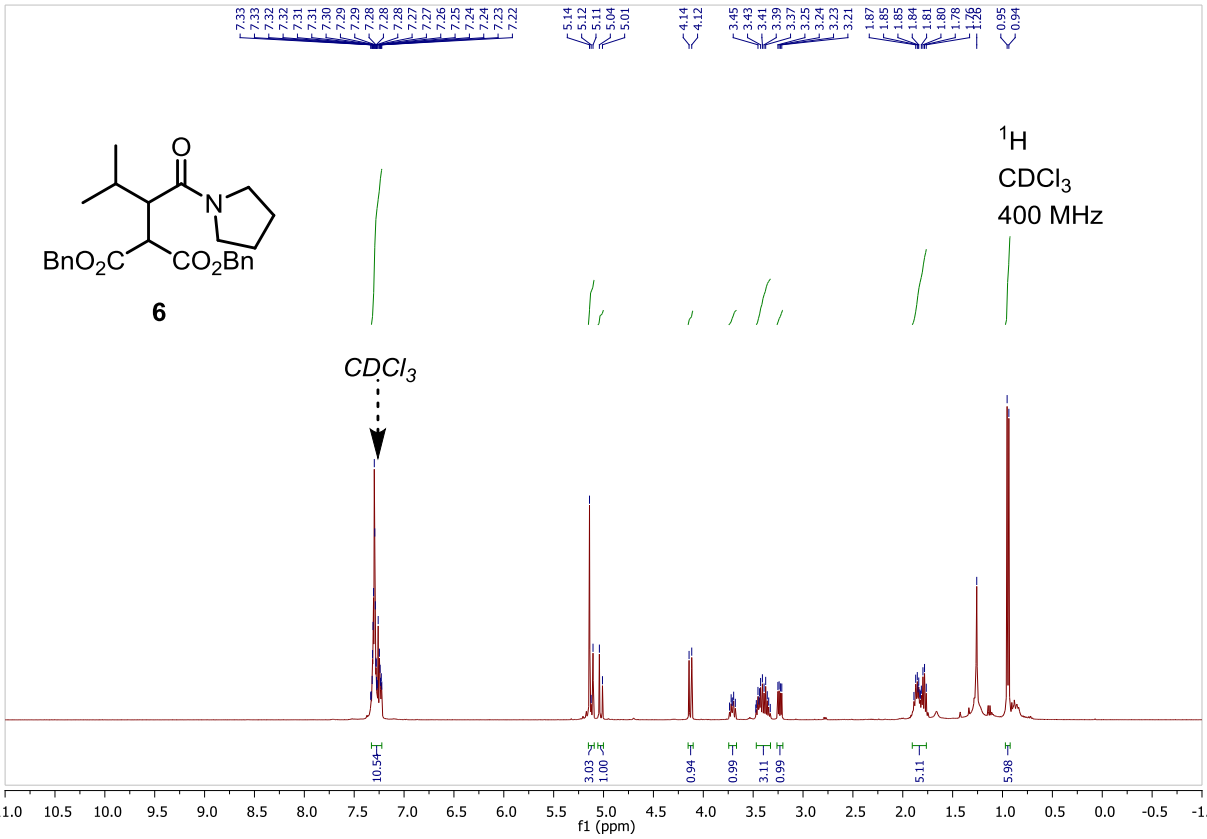

189.11
169.22
154.14
140.41
137.49
133.06
128.58
128.55
128.50
128.42
126.32
120.71
77.27
77.06
76.85
46.86
45.20
37.06
33.14
25.88
24.30
Ph
O
N
O
Ph
4
13C (APT)
CDCl3
150 MHz
CDCl3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

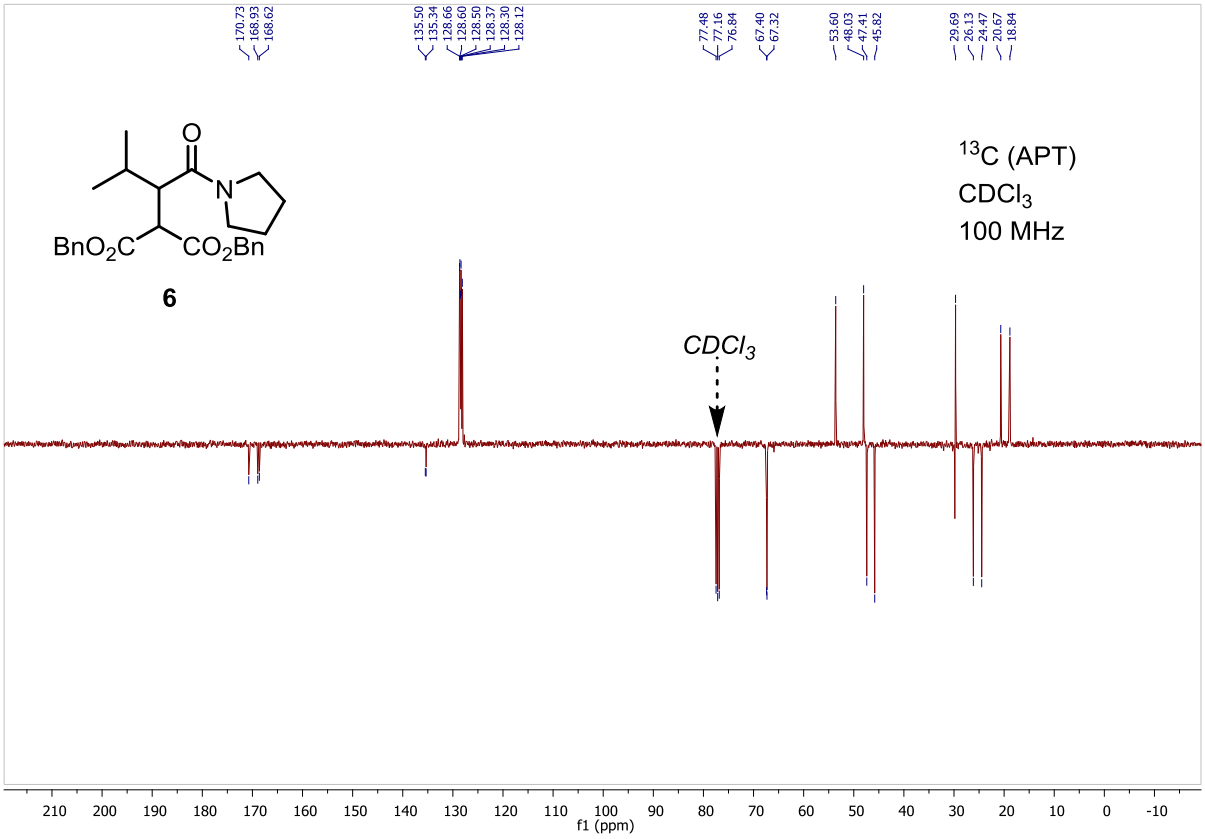

Ph
MeO2C
Me
N
O
S
O
5
(diastereomer 1)
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)

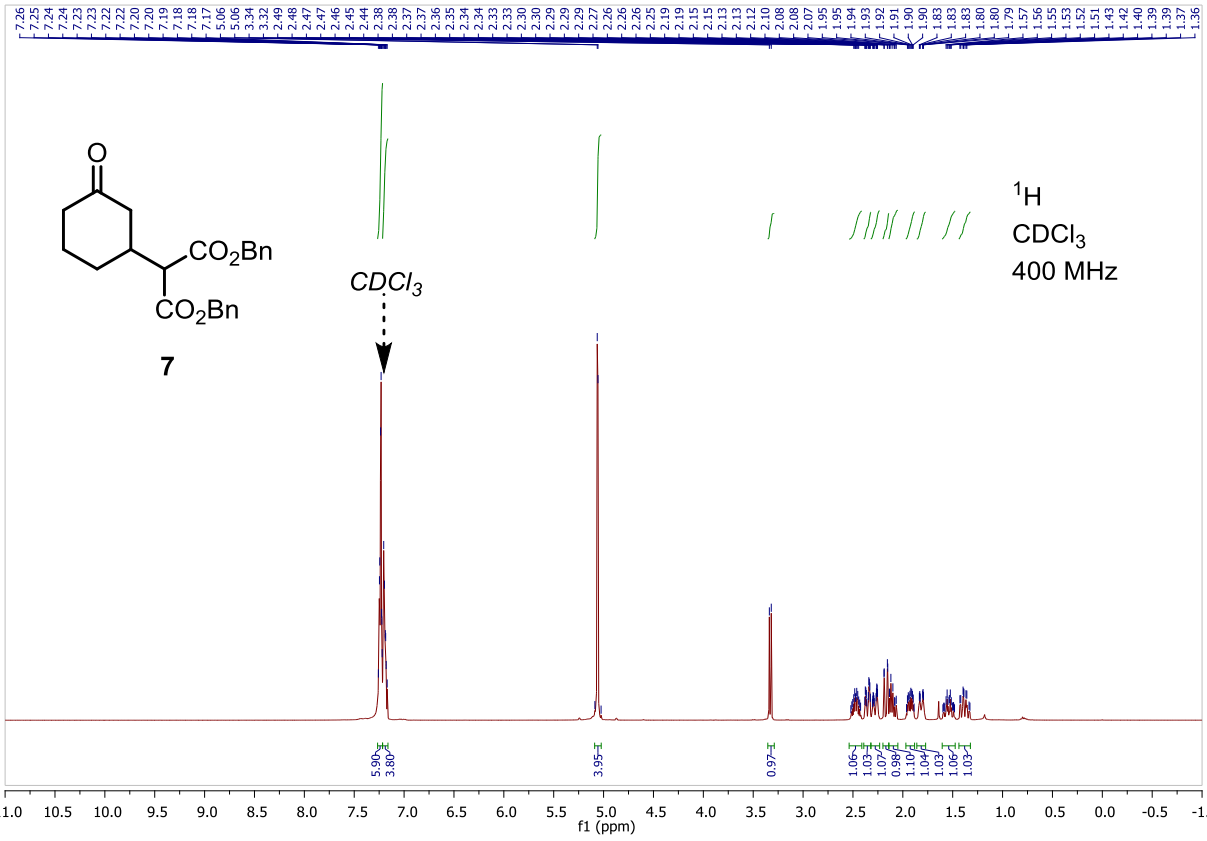

Ph
MeO2C
Me
N
O
S
O
5
(diastereomer 1)
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)

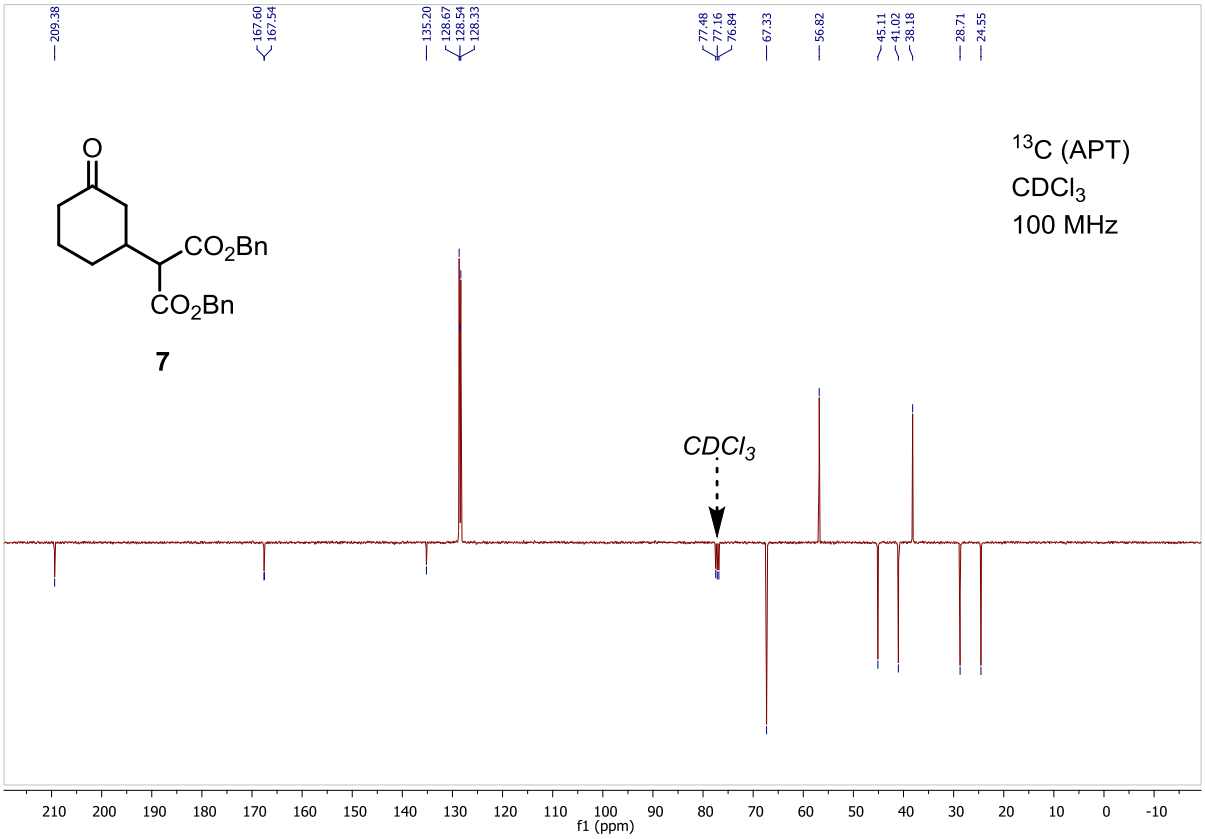

Ph
MeO2C
Me
N
O
S
O
5
(diastereomer 2)
CDCl3
1H
CDCl3
400 MHz
f1 (ppm)


Ph
MeO2C
Me
N
O
S
O
5
(diastereomer 2)
CDCl3
13C
CDCl3
100 MHz
f1 (ppm)


^{1}H
$CDCl_3$
400 MHz
$CDCl_3$
6
f1 (ppm)


^{13}C (APT)
$CDCl_3$
100 MHz
$CDCl_3$
6
f1 (ppm)


O
CO2Bn
CO2Bn
7
CDCl3
1H
CDCl3
400 MHz
5.90
3.80
3.95
0.97
1.06
1.03
1.07
0.98
1.10
1.04
1.03
1.06
1.03
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


209.38
167.60
167.54
135.20
128.67
128.54
128.33
77.48
77.16
76.84
67.33
56.82
45.11
41.02
38.18
28.71
24.55
O
CO2Bn
CO2Bn
7
CDCl3
13C (APT)
CDCl3
100 MHz
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

6. X-Ray Crystallographic Data

The X-ray intensity data were measured on Bruker X8 APEX2 diffractometer equipped with multilayer monochromator, Mo K/a INCOATEC micro focus sealed tube and Kryoflex cooling device. The structures were solved by *direct methods* and refined by *full-matrix least-squares techniques*. Non-hydrogen atoms were refined with *anisotropic displacement parameters*. Hydrogen atoms were inserted at calculated positions and refined with a riding model. The following software was used: *Bruker SAINT software package*[9] using a narrow-frame algorithm for frame integration, *SADABS*[10] for absorption correction, *OLEX2*[11] for structure solution, refinement, molecular diagrams and graphical user-interface, *Shelxle*[12] for refinement and graphical user-interface *SHELXS-2013*[13] for structure solution, *SHELXL-2013*[14] for refinement, *Platon*[15] for symmetry check. Experimental data and CCDC-Codes can be found in Table 1. Crystal data, data collection parameters, and structure refinement details are given in Tables 2 to 5. Crystal structures visualized in Figures 1 and 2.

Table 1 Experimental parameter and CCDC-Code.

Sample	Machine	Source	Temp.	Detector Distance	Time/ Frame	#Frames	Frame width	CCDC
	Bruker		[K]	[mm]	[s]		[°]	
2af	X8	Mo	100	35	30	2580	0.5	1569559
2ai	X8	Mo	100	35	16	4433	0.5	1577972

Methyl 4-(1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)tetrahydro-*2H*-pyran-4-carboxylate [2af] for "Journal of the American Chemical Society".

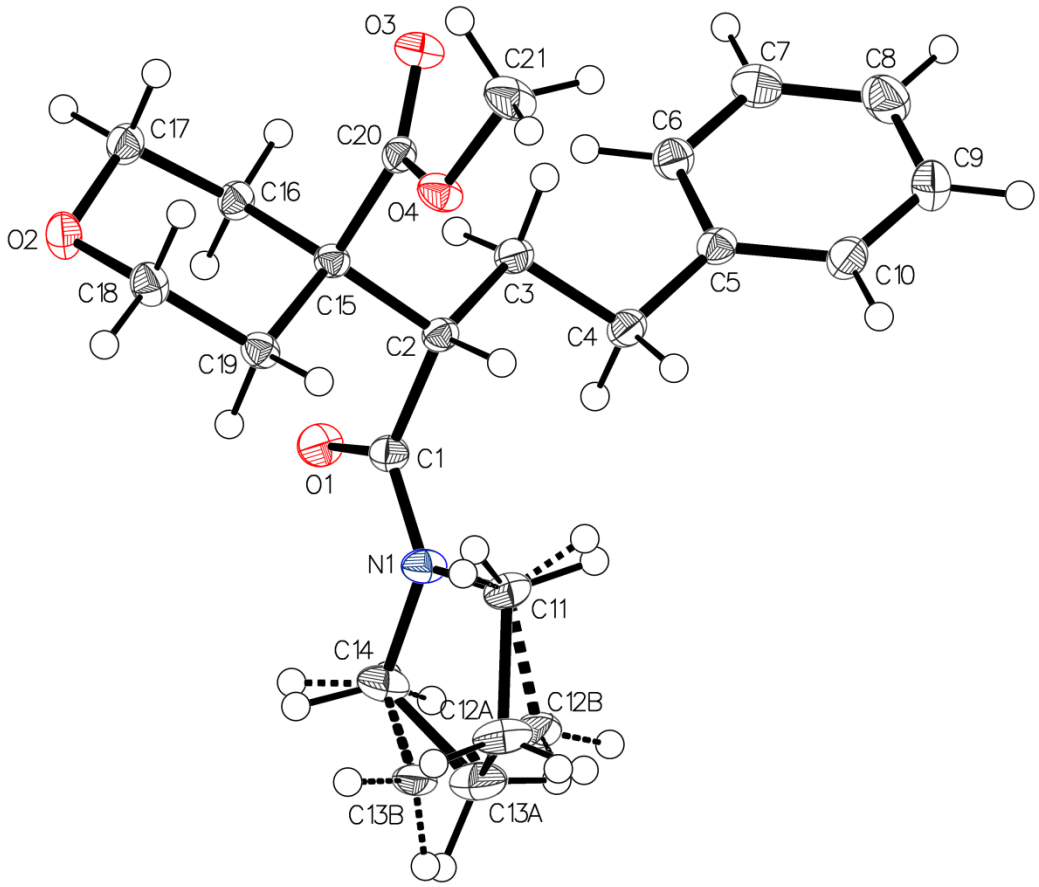


Figure 1 Asymmetric Unit of [**2af**], drawn with 50% displacement ellipsoids. Bond Precision on C-C Bonds: 0.0017 Ang. Main Residue Disorder : 8%.

Table 2 Sample and crystal data of [**2af**].

Chemical formula	C21H29NO4	**Crystal system**	monoclinic	
Formula weight [g/mol]	359.45	**Space group**	*P21/c*	
Temperature [K]	100	**Z**	4	
Measurement method	\f and \w scans	**Volume [Å^3]**	1852.29(18)	
Radiation (Wavelength [Å])	MoKα (λ = 0.71073)	**Unit cell dimensions [Å] and [°]**	6.0618(3)	90
Crystal size / [mm^3]	0.16 × 0.09 × 0.045		18.1122(10)	92.091(3)
Crystal habit	clear colourless block		16.8821(10)	90

Density (calculated) / [g/cm^3]	1.289	**Absorption coefficient / [mm^{-1}]**	0.088
Abs. correction Tmin	0.5151	**Abs. correction Tmax**	0.746
Abs. correction type	multi-scan	**F(000) [e$^-$]**	776

Table 3 Data collection and structure refinement of [**2af**].

Index ranges	$-8 \le h \le 8$, $-25 \le k \le 25$, $-23 \le l \le 23$	**Theta range for data collection [°]**	4.498 to 60.58	
Reflections number	59598	**Data / restraints / parameters**	5493/0/254	
Refinement method	Least squares	**Final R indices**	all data	R1 = 0.0604, wR2 = 0.1149
Function minimized	$\Sigma\, w(F_o^2 - F_c^2)^2$		$I>2\sigma(I)$	R1 = 0.0429, wR2 = 0.1048
Goodness-of-fit on F^2	1.068	**Weighting scheme**	$w=1/[\sigma^2(F_o^2)+(0.0428P)^2+0.7327P]$	
Largest diff. peak and hole [e Å^{-3}]	0.42/-0.22		where $P=(F_o^2+2F_c^2)/3$	

(R*)-1-methyl-3-((S*)-1-oxo-4-phenyl-1-(pyrrolidin-1-yl)butan-2-yl)piperidin-2-one [2ai] for "Journal of the American Chemical Society".

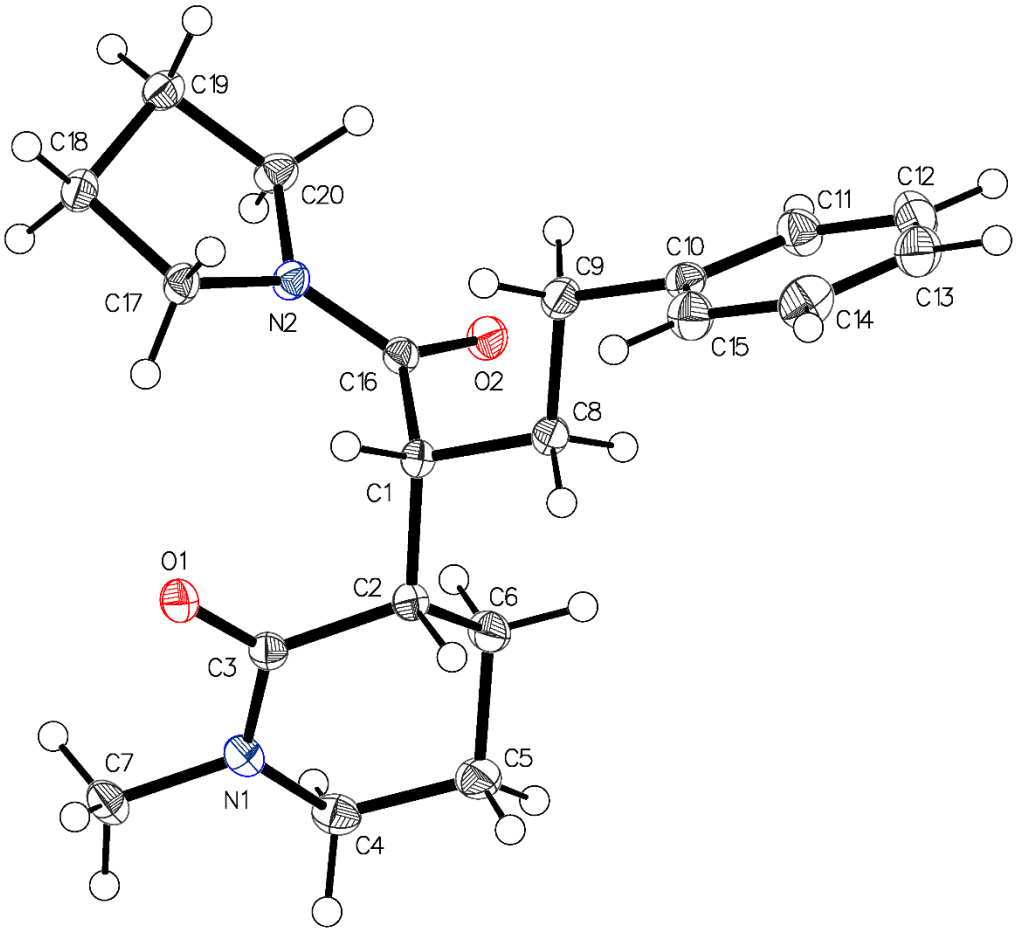


Figure 2 Asymmetric Unit of [**2ai**], drawn with 50% displacement ellipsoids. The chiral atoms C1 and C2 are defined as R,S and S,R forced by the space group *P2₁/c* in detail by center of symmetry.

Table 4 Data collection and structure refinement of [**2ai**].

Index ranges	-25 ≤ h ≤ 24, -8 ≤ k ≤ 8, -24 ≤ l ≤ 23	**Theta range for data collection [°]**	4.704 to 60.378	
Reflections number	79104	**Data / restraints / parameters**	5150/0/218	
Refinement method	Least squares	**Final R indices**	all data	R1 = 0.0490, wR2 = 0.1128
Function minimized	$\Sigma\, w(F_o^2 - F_c^2)^2$		I>2σ(I)	R1 = 0.0407, wR2 = 0.1071
Goodness-of-fit on F^2	1.051	**Weighting**	$w=1/[\sigma^2(F_o^2)+(0.0507P)^2+0.6729P]$	

Largest diff. peak and hole [e Å^{-3}]	0.40/-0.21	**scheme**	where P=(F_o^2+2F_c^2)/3

Table 5 Sample and crystal data of [**2ai**].

Chemical formula	C20H28N2O2	**Crystal system**	monoclinic	
Formula weight [g/mol]	328.44	**Space group**	*P21/c*	
Temperature [K]	100	**Z**	4	
Measurement method	\f and \w scans	**Volume [Å^3]**	1747.7(2)	
Radiation (Wavelength [Å])	MoKα (λ = 0.71073)	**Unit cell dimensions [Å] and [°]**	17.8604(14)	90
Crystal size / [mm^3]	0.5 × 0.14 × 0.08		5.8441(5)	104.184(3)
Crystal habit	clear colourless block		17.2700(14)	90
Density (calculated) / [g/cm^3]	1.248	**Absorption coefficient / [mm^{-1}]**	0.08	
Abs. correction Tmin	0.594	**Abs. correction Tmax**	0.746	
Abs. correction type	multi-scan	**F(000) [e$^-$]**	712	

7. References

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