Supporting Information

Palladium-Catalyzed Dearomative *syn*-1,4-Diamination

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1. General Experimental

Unless otherwise noted, all reactions were carried out under an ambient atmosphere. All chemicals were purchased from commercial suppliers and used as received. Tris(dibenzylideneacetone)dipalladium(0) (Pd_2dba_3) was purchased from Acros Organics, and tetrakis(triphenylphosphine)palladium(0) ($Pd(PPh_3)_4$) was purchased from Strem Chemicals, Inc. 1,1'-Bis(diphenylphosphino)ferrocene (dppf) was purchased from Oakwood Chemical. *N*-methyl-1,2,4-triazoline-3,5-dione (MTAD) was prepared based on the literature procedures[1,2] and was sublimed before use. (*S*, S_p)-*t*Bu-phosferrox was prepared based on the literature procedure from the corresponding L-*tert*-leucinol, and the ^{1}H and ^{13}C spectra were in accordance with the reported values.[3,4] Naphthalen-2,3-yl-bispivalate and naphthalen-1-yl-pivalate were synthesized based on the literature procedure from corresponding commercially available naphthols.[5,6] 1-(Dimethoxymethyl)naphthalene was synthesized based on the literature procedure.[7] 4-(5-Pyrimidyl)quinolone was synthesized based on the literature procedure from 4-bromoquinoline and pyrimidine-5-boronic acid.[8,9] Methyl acridine-9-carboxylate was synthesized based on the literature procedure from acridine-9-carboxylic acid.[10] *Tert*-butyl hypochlorite was prepared based on the literature procedure.[11] Ethyl acetate (EtOAc) was purchased from Sigma Aldrich, and freshly distilled over CaH_2, then degassed with nitrogen gas before use. Dry dichloromethane (CH_2Cl_2) and tetrahydrofuran (THF) were obtained by passing commercially available anhydrous, oxygen-free formulations through activated alumina columns. For methanol, acetone, and acetonitrile commercially available anhydrous solvents were used without further purification. Analytical thin-layer chromatography was performed on Merck silica gel 60 F_{254} glass plates. Visualization was accomplished with UV light and/or potassium permanganate ($KMnO_4$) solutions. Retention factor (R_f) values reported were measured using a 5 × 2 cm TLC plate in a developing chamber containing the solvent system described. Flash column chromatography was performed using Silicycle SiliaFlash® P60 (SiO_2, 40-63 μm particle size, 230-400 mesh). ^{1}H and ^{13}C NMR spectra were recorded on Varian Unity Inova 500 (500 MHz, ^{1}H; 125 MHz, ^{13}C) MHz or Bruker 500 (500 MHz, ^{1}H; 125 MHz, ^{13}C) spectrometers. Spectra are referenced to residual chloroform (δ = 7.26 ppm, ^{1}H; 77.16 ppm, ^{13}C) or residual methanol (δ = 3.31 ppm, ^{1}H; 49.0 ppm, ^{13}C). Chemical shifts are reported in parts per million (ppm). Multiplicities are indicated by s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet), and br (broad). Coupling constants *J* are reported in Hertz (Hz). Mass spectrometry (MS) was performed by the University of Illinois Mass Spectrometry Laboratory. Electron Impact (EI^+) spectra were performed at 70 eV using methane as the carrier gas, with time-of-flight (TOF) mass analyzer. Chemical Ionization (CI^+) spectra were performed with methane reagent gas, with either a double focusing sector field (DFSF) or time-of-flight (TOF) mass analyzer. Electrospray ionization (ESI^+) spectra were performed using a time-of-flight (TOF) mass analyzer. Data are reported in the form of m/z. For several compounds, Waters Q-TOF Ultima ESI and Agilent 6230 ESI TOF LC/MS spectrometers were used to obtain the high resolution mass spectra. Infrared spectra were measured neat on a Perkin-Elmer spectrum BX FT-IR spectrometer. Peaks are reported in cm^{-1} with

indicated relative intensities: s (strong, 0–33% T); m (medium, 34–66% T), w (weak, 67–100% T), and br (broad). Visible-light spectrum of LED was recorded using an Avantes Sensline Avaspec-ULS TEC Spectrometer. Melting points were measured on a Buchi B-540 melting point apparatus and are uncorrected. Optical rotations were recorded on a Jasco P-2000 polarimeter at 589 nm, and are reported in units of 10^{-1} (deg cm^2 g^{-1}). HPLC was performed on a Shimadzu Prominence HPLC system with SPD-M20A UV/VIS Photodiode array detector. The x-ray diffraction experiments were conducted using Bruker D8 Venture/Photon 100 diffractometer or Bruker APEX-II CCD diffractometer. Using Olex2,[12] the structure was solved with ShelXT[13] structure solution program using intrinsic phasing solution method, and the XL[14] refinement package using least squares minimization.

2. Experimental Procedures

2-1. LED light source

Generic cool white light LED corn bulbs were used for the photochemical experiments. These can be obtained from several manufactures over amazon.com and proved to give consistent results as well as identical visible spectra. Detailed info:

Socket: G4

LED Chip: 48 LEDs SMD 2835

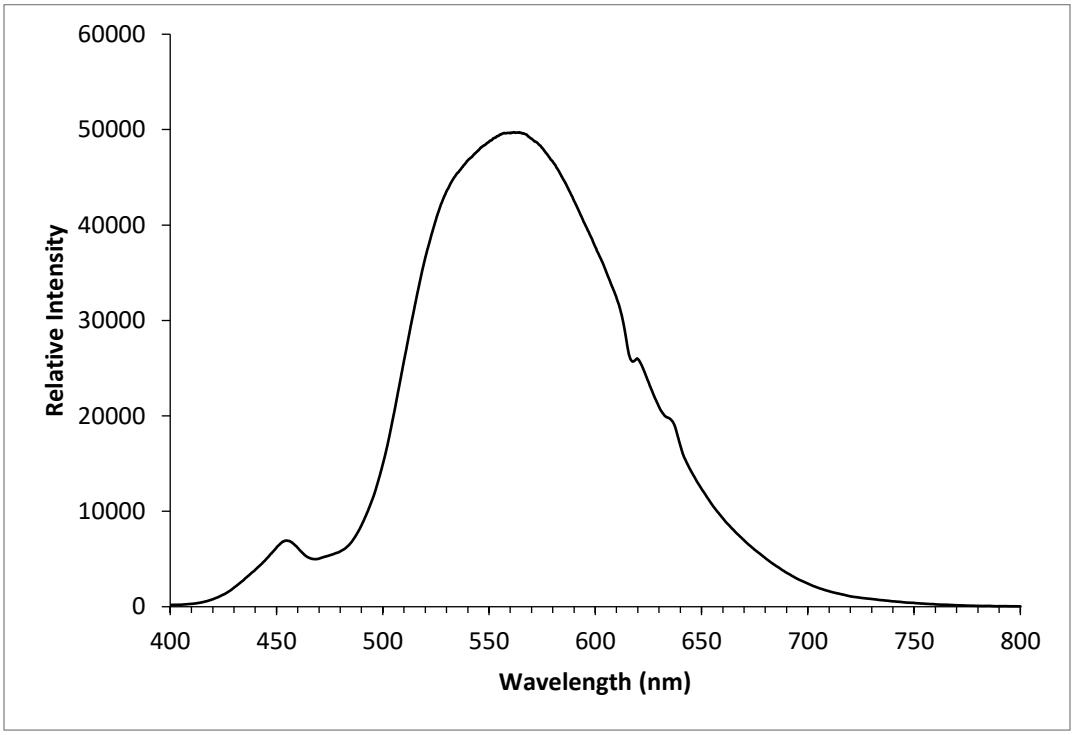
Consume wattage: 4W

Input voltage: AC / DC 12V

Beam degree: 360 degrees

Color temperature: 6500K (Cool White)

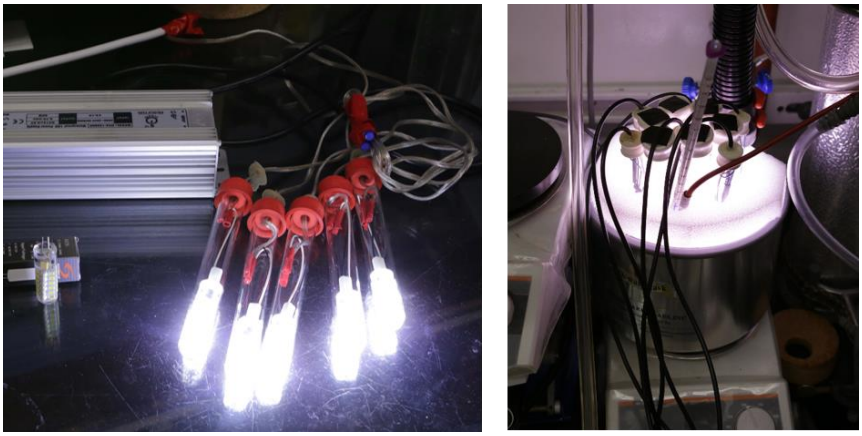
Initial Lumens (lm): 290



Spectra 1. Spectrum of a LED bulb used.

2-2. Set-up for small scale reactions (up to 2.0 mmol scale)

Five 4 W LED corn bulbs (12V, cool white light 6500K) were wired to a suitable 12V power supply, then sealed into test tubes and capped with septa (Picture S1). Lights and reaction tubes were arranged in a merry-go-round fashion for maximal exposure of each reaction vessel to light source and were submerged in a −78 °C bath. Generally, up to four 0.2-2.0 mmol scale reactions can be run in the same bath using five 4 W lamps positioned around them.



Picture S1. Assembly of LED bulbs for small-scale photochemical reactions.

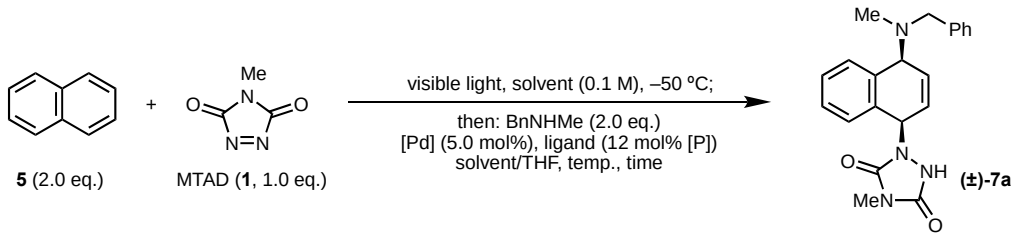
2-3. Set-up for large scale reactions (up to 10 mmol scale)

Eight 4 W LED corn bulbs (12V, cool white light 6500K) were wired to a suitable 12V power supply, then sealed into test tubes and capped with septa (see Picture S1). Lights were arranged in a merry-go-round fashion around a 500 mL clear borosilicate glass bottle (Picture S2). A normal reagent or media bottle can be used. The whole set-up was kept submerged in a −50 °C bath during the photochemical reaction.

Picture S2. Photochemical set-up for large scale reactions.

3. Experimental Procedures

3-1. Optimization for dearomative *syn*-1,4-diamination of naphthalene and *N*-benzylmethylamine (±-7a)



5 (2.0 eq.) MTAD (**1**, 1.0 eq.)

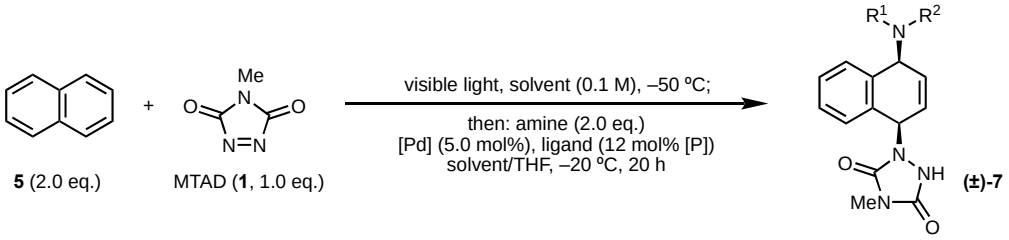
Table S1: Optimization of reaction conditions.

Entry	Solvent	[Pd]	Ligand	Temp. (°C)	Time (h)	Yield (%)[a]
1	CH_2Cl_2	$Pd_2(dba)_3$	PPh_3		5	52
2	CH_2Cl_2	$Pd_2(dba)_3$	P(*p*-$MeOC_6H_4$)$_3$		5	44
3	CH_2Cl_2	$Pd_2(dba)_3$	P(*p*-FC_6H_4)$_3$		5	10
4	CH_2Cl_2	$Pd_2(dba)_3$	P(*o*-MeC_6H_4)$_3$	–50 to 0	5	<5
5	CH_2Cl_2	$Pd_2(dba)_3$	PPh_2Cy		5	48
6	CH_2Cl_2	$Pd_2(dba)_3$	$PPhCy_2$		5	22
7	CH_2Cl_2	$Pd_2(dba)_3$	dppf		5	36
8	CH_2Cl_2	$Pd(dba)_2$	PPh_3		5	55
9	CH_2Cl_2	$[Pd(allyl)Cl]_2$	PPh_3		5	51
10	CH_2Cl_2	$Pd(MeCN)_2Cl_2$	PPh_3	–50 to 0	5	<5
11	CH_2Cl_2	$Pd(OAc)_2$	PPh_3		5	<5
12	CH_2Cl_2	$Pd(PPh_3)_4$	–		5	57
13	CH_2Cl_2	$Pd(PPh_3)_4$	–		20	70
14	EtCN	$Pd(PPh_3)_4$	–	–20	20	70
15	EtOAc	$Pd(PPh_3)_4$	–		20	72 (62)

a) Determined by ^{1}H NMR analysis using nitromethane as the internal standard. Isolated yield shown in parenthesis.

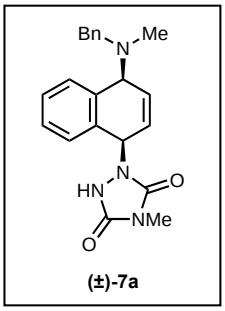
3-2. Dearomative *syn*-1,4-diamination of naphthalene and benzene with amine (7a-7q, 8a-8h)

General procedure A for the dearomative *syn*-1,4-diamination of naphthalene with amines (7a-7q) (Table 2)



5 (2.0 eq.) MTAD (**1**, 1.0 eq.)

MTAD (**1**, 56.7 mg, 0.50 mmol, 1.0 eq.) was combined with naphthalene (**5**, 128 mg, 1.0 mmol) and a stir bar in a test tube with a septum as the cap under nitrogen atmosphere. Ethyl acetate (5.0 mL, 0.1 M) was added to the test tube at rt, the contents were stirred until completely dissolved and then cooled to –50 ºC. The resulting pink solution was stirred under irradiation with LED lights at –50 ºC until the solution became colorless (approximately 6 h). After turning off the lights, to this solution at –50 ºC were added an amine (2.0 mmol, 2.0 eq.) and a solution of a Pd complex in THF (2.0 mL) [primary amines: $Pd_2(dba)_3$ (11.4 mg, 0.0125 mmol, 2.5 mol%) and dppf (16.6 mg, 0.03 mmol, 6.0 mol%); secondary amines: $Pd(PPh_3)_4$ (57.8 mg, 0.05 mmol, 5.0 mol%)], and the resulting mixture was stirred at –20 ºC for 20 h. The reaction was then warmed up to rt, concentrated under reduced pressure, and purified by flash column chromatography (SiO_2, CH_2Cl_2:MeOH mixture).



(±)-7a

Synthesis of (±)-7a (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2 to CH_2Cl_2:MeOH = 50:1) as a white solid (112.3 mg, 62%).

R_f = 0.43 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

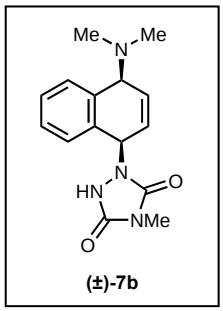
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 7.4, 1.5 Hz, 1H), 7.41 (dd, *J* = 7.1, 1.8 Hz, 1H), 7.36-7.27 (m, 7H), 6.62 (ddd, *J* = 10.0, 4.4, 0.8 Hz, 1H), 6.21 (ddd, *J* = 10.0, 4.4, 0.8 Hz, 1H), 5.89 (t, *J* = 3.8 Hz 1H), 4.07 (t, *J* = 3.8 Hz 1H), 3.80 (d, *J* = 12.9, 1H), 3.73 (d, *J* = 12.9 Hz, 1H), 3.09 (s, 3H), 2.20 (s, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 153.9, 153.4, 137.7, 137.0, 133.2, 132.2, 130.2, 129.3, 128.7, 128.48, 128.47, 128.3, 127.7, 127.5, 59.5, 59.2, 51.9, 38.6, 25.3.

HRMS: (ESI-TOF, m/z) calcd. For $C_{21}H_{23}N_4O_2$ $[M+H]^+$ calc.: 363.1816; found: 363.1834.

IR: (ATR, neat, cm^{-1}): 3466 (w), 3029 (w), 2842 (w), 1763 (m), 1691 (s), 1476 (m), 1453 (m), 1019 (m), 753 (m), 700 (m).

m.p.: 135–136 ºC.



(±)-7b

Synthesis of (±)-7b (Table 2): Following the general procedure A (except that dichloromethane was used in replace of ethyl acetate), the title compound was isolated by flash chromatography (SiO_2, EtOAc then CH_2Cl_2:MeOH = 19:1 to 4:1) as a yellow solid (102.5 mg, 72%).

R_f = 0.11 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

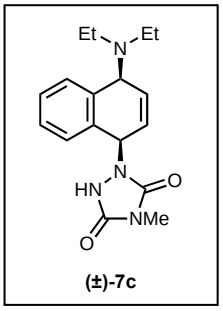
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.46 (d, *J* = 7.4 Hz, 1H), 7.34 (td, *J* = 7.4, 1.4 Hz, 1H), 7.30 (td, *J* = 7.4, 1.4 Hz, 1H), 7.25 (t, *J* = 9.6 Hz, 1H), 6.62 (dd, J = 9.5, 5.5 Hz, 1H), 6.37 (dd, *J* = 9.5, 6.0 Hz, 1H), 5.92 (d, *J* = 6.0 Hz, 1H), 3.71 (d, *J* = 5.5 Hz, 1H), 3.02 (s, 3H), 2.46 (s, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 153.1, 152.6, 136.1, 135.2, 134.5, 130.5, 130.0, 129.8, 129.1, 127.8, 62.1, 51.2, 43.0, 25.1.

HRMS: (ESI-TOF, m/z) calcd. For $C_{15}H_{19}N_4O_2$ $[M+H]^+$ calc.: 287.1503; found: 287.1512.

IR: (ATR, neat, cm^{-1}): 3397 (w), 3054 (w), 1686 (s), 1602 (s), 1464 (s), 1392 (m), 1278 (m), 1149 (m), 1017 (s), 914 (s), 756 (s), 634 (m), 537 (m).

m.p.: 49–51 ºC decomposed.



(±)-7c

Synthesis of (±)-7c (Table 2): Following the general procedure A (except that dichloromethane was used in place of ethyl acetate), the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 19:1 to 4:1) as a white solid (106.5 mg, 68%).

$\boldsymbol{R_f}$ = 0.21 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

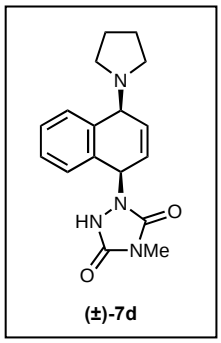
^{1}H NMR: 7.46 (d, *J* = 7.2 Hz, 1H), 7.34 (td, *J* = 7.3, 1.7 Hz, 1H), 7.30 (td, *J* = 7.5, 1.6 Hz, 1H), 7.27 (d, *J* = 7.3 Hz, 1H), 6.58 (dd, *J* = 9.6, 5.4 Hz, 1H), 6.39 (dd, *J* = 9.6, 5.8 Hz, 1H), 5.91 (d, *J* = 5.8, 1H), 4.14 (d, *J* = 5.4, 1H), 3.02 (s, 3H), 2.93-2.82 (m, 4H), 1.15 (t, *J* = 7.2 Hz, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 153.2 (overlap of 2 peaks found by HSQC), 135.9, 135.8, 133.6, 130.6, 130.3, 129.8, 129.0, 127.7, 56.4, 51.1, 42.2, 25.1, 9.5.

HRMS: (ESI-TOF, m/z) calcd. For $C_{17}H_{23}N_4O_2$ $[M+H]^+$ calc.: 315.1816; found: 315.1820.

IR: (ATR, neat, cm^{-1}): 3412 (w), 2985 (w), 1694 (s), 1605 (s), 1463 (s), 1392 (m), 1280 (m), 758 (s).

m.p.: 75–76 ºC decomposed.



(±)-7d

Synthesis of (±)-7d (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, EtOAc then CH_2Cl_2:MeOH = 19:1 to 4:1) as a yellow solid (118.9 mg, 76%).

$\boldsymbol{R_f}$ = 0.23 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

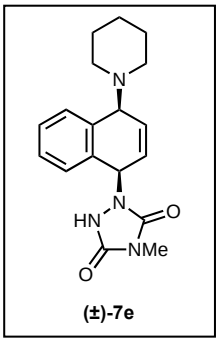
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.42 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.30 (td, *J* = 7.4, 1.6 Hz, 1H), 7.26 (td, *J* = 7.4, 1.6 Hz, 1H), 7.20 (dd, *J* = 7.4, 1.7 Hz, 1H), 6.55 (dd, *J* = 9.4, 5.7 Hz, 1H), 6.34 (dd, *J* = 9.4, 6.1 Hz, 1H), 5.88 (d, *J* = 6.0 Hz, 1H), 3.84 (dd, *J* = 5.9, 1.7 Hz, 1H), 2.94 (s, 3H), 2.89-2.86 (m, 2H), 2.65-2.62 (m, 2H), 1.93-1.85 (m, 4H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 152.8, 152.7, 136.2, 135.2, 134.1, 129.9, 129.6, 129.3, 129.0, 127.9, 60.1, 51.9, 50.8, 24.9, 22.8.

HRMS: (ESI-TOF, m/z) calcd. For $C_{17}H_{21}N_4O_2$ $[M+H]^+$ calc.: 313.1659; found: 313.1656

IR: (ATR, neat, cm^{-1}): 3406 (w), 2886 (w), 1683 (s), 1614 (s), 1459 (s), 1391 (m), 1275 (m), 1146 (m), 922 (m), 755 (s), 726 (s), 631 (m), 530 (m).

m.p.: 84–86 ºC.



(±)-7e

Synthesis of (±)-7e (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (C_{18} reverse phase SiO_2, H_2O:MeOH = 9:1 to 1:1) as a yellow solid (146.1 mg, 90%).

R_f = 0.26 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

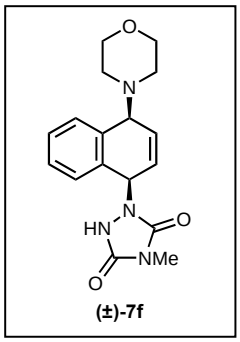
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.48 (dd, *J* = 7.5, 1.0 Hz, 1H), 7.35 (td, *J* = 7.5, 1.4 Hz, 1H), 7.29 (td, *J* = 7.5, 1.4 Hz, 1H), 7.19 (d, *J* = 7.4 Hz, 1H), 6.67 (dd, *J* = 9.5, 5.7 Hz, 1H), 6.40 (dd, *J* = 9.5, 6.2 Hz, 1H), 5.94 (d, *J* = 6.2 Hz, 1H), 3.73 (d, *J* = 5.7 Hz, 1H), 3.03 (s, 3H), 2.84 (br, 2H), 2.66 (br, 2H), 1.75 (p, *J* = 5.7 Hz, 4H), 1.54 (br, 2H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 152.7, 152.5, 135.8, 135.7, 135.0, 131.0, 130.2, 130.1, 129.1, 127.5, 61.6, 52.5, 50.9, 25.0, 24.9, 23.9.

HRMS: (ESI-TOF, m/z) calcd. For $C_{18}H_{23}N_4O_2$ $[M+H]^+$ calc.: 327.1816; found: 327.1834.

IR: (ATR, neat, cm^{-1}): 3401 (w), 2942 (w), 1688 (m), 1598 (s), 1461 (m), 1390 (m), 760 (m).

m.p.: 85–87 ºC decomposed.



(±)-7f

Synthesis of (±)-7f (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 19:1 to 9:1) as a white solid (80.3 mg, 49%).

R_f = 0.35 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

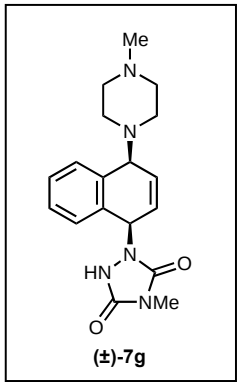
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.48 (dd, *J* = 7.4, 1.2 Hz, 1H), 7.36 (td, *J* = 7.4, 1.5 Hz, 1H), 7.32 (td, *J* = 7.4, 1.5 Hz, 1H), 7.23 (dd, *J* = 7.6, 1.3 Hz, 1H), 6.66 (dd, *J* = 9.6, 5.5 Hz, 1H), 6.38 (dd, *J* = 9.6, 6.0 Hz, 1H), 5.94 (d, *J* = 6.0 Hz, 1H), 3.80-3.76 (m, 5H) 3.05 (s, 3H), 2.84 (br, 2H), 2.67 (dt, *J* = 10.7, 4.7 Hz, 2H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 152.8, 152.1, 135.4, 135.0, 134.7, 130.9, 130.0, 129.7, 129.2, 127.8, 66.3, 61.4, 51.8, 51.3, 25.1.

HRMS: (ESI-TOF, m/z) calcd. For $C_{17}H_{21}N_4O_3$ $[M+H]^+$ calc.: 329.1608; found: 329.1620.

IR: (ATR, neat, cm^{-1}): 3471 (w), 2853 (w), 1768 (w), 1699 (s), 1474 (m), 1115 (m), 758 (m).

m.p.: 122–124 ºC decomposed.



(±)-7g

Synthesis of (±)-7g (Table 2): Following the general procedure A, except that 1-methylpiperazine was dissolved in 1 mL of DCM prior to addition to the reaction, the title compound was isolated by flash chromatography (two columns: SiO_2, MeOH:CH_2Cl_2 = 10:90 to 20:80; C_{18} reverse phase SiO_2, H_2O:MeCN = 80:20 to 0:100) as a white solid (115.8 mg, 68%).

R_f = 0.36 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

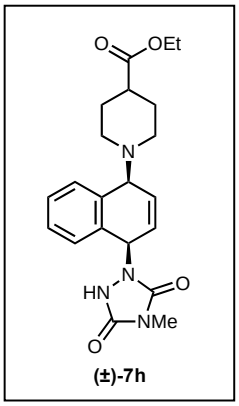
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.46 (dd, *J* = 7.4, 1.5 Hz, 1H), 7.37 – 7.28 (m, 2H), 7.23 (dd, *J* = 7.4, 1.5 Hz, 1H), 6.66 (dd, *J* = 9.6, 5.4 Hz, 1H), 6.35 (dd, *J* = 9.6, 5.9 Hz, 1H), 5.92 (d, *J* = 5.9 Hz, 1H), 3.74 (d, *J* = 5.4 Hz, 1H), 3.03 (s, 3H), 2.89 – 2.30 (m, 8H), 2.30 (s, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 152.6, 152.3, 135.6, 134.9, 134.2, 130.4, 129.49, 129.46, 128.8, 127.6, 60.7, 53.9, 50.9, 50.7, 45.5, 24.9.

HRMS: (ESI-TOF, m/z) calcd. For $C_{18}H_{24}N_5O_2$ $[M+H]^+$ calc.: 342.1925; found: 342.1926.

IR: (ATR, neat, cm^{-1}): 2941 (w), 2802 (w), 1763 (w), 1698 (s), 1598 (s), 1466 (s), 1393 (m), 1282 (m), 1145 (m), 1011 (m), 983 (m), 755 (s), 733 (s).

m.p.: 149–151 ºC decomposed.



(±)-7h

Synthesis of (±)-7h (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:EtOAc:MeOH (sat. with NH_3) = 5:4:1 to 9:0:1) as a white solid (142.0 mg, 71%).

***R*$_f$** = 0.31 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

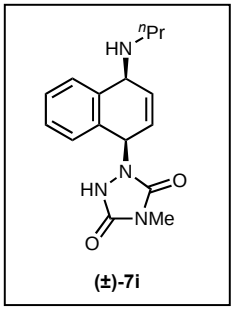
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.44 (dd, *J* = 7.4, 0.9 Hz, 1H), 7.33 (td, *J* = 7.4, 1.5 Hz, 1H), 7.29 (td, *J* = 7.4, 1.5 Hz, 1H), 7.22 (dd, *J* = 7.4, 0.9 Hz, 1H), 6.62 (dd, *J* = 9.6, 5.4 Hz, 1H), 6.33 (dd, *J* = 9.6, 5.9 Hz, 1H), 5.89 (d, *J* = 5.9 Hz, 1H), 4.13 (q, *J* = 7.1 Hz, 2H), 3.75 (d, *J* = 5.4 Hz, 1H), 3.02 – 3.00 (m, 4H), 2.86 (br, 1H), 2.65 (br, 1H), 2.47-2.44 (m, 4H), 2.01-1.89 (m, 2H), 1.24 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 174.1, 152.9, 152.4, 135.9, 135.0, 134.6, 130.8, 129.7, 129.4, 128.9, 127.7, 61.0, 60.6, 51.2, 50.4, 49.8, 39.5 (br), 27.1, 25.0, 14.3.

HRMS: (ESI-TOF, m/z) calcd. For $C_{21}H_{27}N_4O_4$ $[M+H]^+$ calc.: 399.2027; found: 399.2035.

IR: (ATR, neat, cm^{-1}): 3451 (w), 2947 (w), 1702 (s), 1627 (m), 1472 (m), 1192 (m), 1045 (w), 1021 (w), 757 (m).

m.p.: 90–94 ºC decomposed.



(±)-7i

Synthesis of (±)-7i (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, EtOAc then CH_2Cl_2:MeOH = 19:1 to 4:1) as a white solid (123.1 mg, 82%).

Gram-scale synthesis of (±)-7i (Table 2): MTAD (**1**, 1.0 g, 8.8 mmol, 1.0 eq.) and naphthalene (2.3 g, 17.7 mmol, 2.0 eq.) were placed in a 500 mL clear borosilicate glass bottle (see Picture S2) with a septum as the cap under nitrogen atmosphere. Ethyl acetate (100 mL, 0.088 M) was added to the bottle at rt, and the mixture was stirred until both MTAD and the naphthalene were completely dissolved. Then the resulting pink solution was stirred under irradiation with LED lights at –50 ºC until the solution became a white suspension (about 48 hours). Following this discoloration, a solution of $Pd_2(dba)_3$ (202 mg, 0.221 mmol, 2.5 mol%) and dppf (294 mg, 0.531 mmol, 6.0 mol%) in THF (50 mL) was added and the resulting mixture was stirred at –20 ºC for 20 h. The reaction was then warmed up to rt, concentrated under reduced pressure, and isolated by flash column chromatography (SiO_2, CH_2Cl_2:MeOH = 19:1 to 4:1) as a white solid (1.97 g, 74%).

$\boldsymbol{R_f}$ = 0.11 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

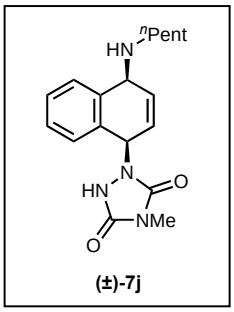
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.43 (d, *J* = 7.6 Hz, 1H), 7.33 (dt, *J* = 7.7, 4.5 Hz, 1H), 7.244-7.235 (m, 2H), 6.39-6.32 (m, 2H), 5.95 – 5.87 (m, 1H), 4.43 – 4.36 (m, 1H), 3.08 (s, 3H), 2.69-2.58 (m, 2H), 1.54-1.40 (m, 2H), 0.77 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.9, 152.9, 136.9, 134.1, 132.5, 129.77, 129.74, 129.5, 128.4, 127.8, 52.6, 49.6, 47.1, 25.4, 19.8, 11.6.

HRMS: (ESI-TOF, m/z) calcd. For $C_{16}H_{21}N_4O_2$ $[M+H]^+$ calc.: 301.1659; found: 301.1666.

IR: (ATR, neat, cm^{-1}): 3411 (w), 2967 (w), 1685 (s), 1614 (s), 1461 (s), 1390 (m), 1146 (m), 923 (m), 777 (m), 753 (s), 729 (s), 634 (m).

m.p.: 139–140 ºC.



(±)-7j

Synthesis of (±)-7j (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, EtOAc then CH_2Cl_2:MeOH = 19:1 to 16:4) as a white solid (145.8 mg, 89%).

$\boldsymbol{R_f}$ = 0.37 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

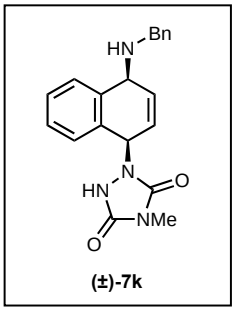
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.41 (d, *J* = 7.5 Hz, 1H), 7.33 – 7.30 (m, 1H), 7.24 - 7.21 (m, 2H), 6.34 (br, 2H), 5.91 – 5.87 (m, 1H), 4.42 – 4.38 (m, 1H), 3.07 (s, 3H), 2.71 - 2.54 (m, 2H), 1.57-1.46 (m, 2H), 1.20-1.12 (m, 4H), 0.82 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR: (125 MHz, CDCl3) δ 155.9, 152.9, 136.9, 134.2, 132.3, 129.8, 129.7, 129.4, 128.2, 127.7, 52.1, 49.6, 45.1, 29.1, 25.6, 25.3, 22.2, 14.0.

HRMS: (ESI-TOF, m/z) calcd. For $C_{18}H_{25}N_4O_2$ $[M+H]^+$ calc.: 329.1972; found: 329.1973.

IR: (ATR, neat, cm^{-1}): 3430 (w), 2957 (w), 1690 (s), 1623 (m), 1465 (m), 1390 (w), 1285 (w), 1146 (w) 755 (m).

m.p.: 144–145 ºC.



(±)-7k

Synthesis of (±)-7k (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 98:2 to 90:10) as a white solid (102.4 mg, 59%).

R_f = 0.37 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

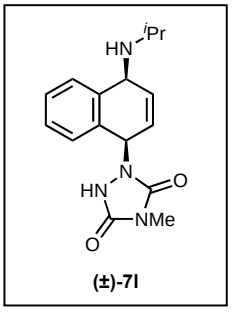
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.39 – 7.36 (m, 3H), 7.31 – 7.28 (m, 3H), 7.26 - 7.17 (m, 3H), 6.39 (dd, *J* = 9.5, 5.4 Hz, 1H), 6.33 (dd, *J* = 9.5, 5.7 Hz, 1H), 5.88 (d, *J* = 5.7 Hz, 1H), 4.38 (d, *J* = 5.4 Hz, 1H), 3.65 (d, *J* = 13.5 Hz, 1H), 3.61 (d, *J* = 13.5 Hz, 1H), 3.08 (s, 3 H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 154.3, 152.7, 135.8, 134.2, 134.0, 132.4, 130.1, 129.6, 129.5, 129.19, 129.18, 129.1, 128.6, 128.1, 52.3, 50.1, 49.8, 25.3.

HRMS: (ESI-TOF, m/z) calcd. For $C_{20}H_{21}N_4O_2$ $[M+H]^+$ calc.: 349.1659; found: 349.1664.

IR: (ATR, neat, cm^{-1}): 3417 (w), 3035 (w), 1690 (s), 1618 (s), 1467 (s), 1392 (w), 920 (w), 732 (m), 753 (m).

m.p.: 94–95 ºC.



(±)-7l

Synthesis of (±)-7l (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, EtOAc then CH_2Cl_2:MeOH = 19:1 to 9:1) as a white solid (130.0 mg, 87%).

R_f = 0.23 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

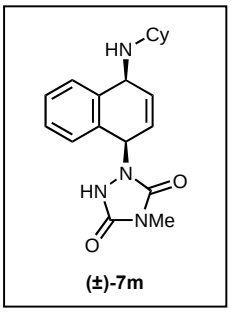
^{1}H NMR: (500 MHz, $CDCl_3$) 7.45 (d, *J* = 7.5 Hz, 1H), 7.37 - 7.28 (m, 2H), 7.25 - 7.22 (m, 1H), 6.52 - 6.46 (m, 2H), 5.97 (d, *J* = 5.5 Hz, 1H), 4.59 (d, *J* = 5.0 Hz, 1H), 3.12 – 2.99 (m, 4H), 1.14 – 1.13 (m, 3H), 0.81 (br, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) 155.7, 152.9, 137.4, 134.3, 132.3, 129.9, 129.8 (overlap of 2 peaks found by HSQC), 128.6, 128.0, 50.0, 49.6, 46.8, 25.4, 19.4, 18.2.

HRMS: (ESI-TOF, m/z) calcd. For $C_{16}H_{21}N_4O_2$ $[M+H]^+$ calc.: 301.1659; found: 301.1663.

IR: (ATR, neat, cm^{-1}): 3407 (w), 2977 (w), 2423 (s), 1688 (m), 1612 (s), 1455 (s), 1388 (m), 1143 (m), 945 (w), 751 (s), 520 (m).

m.p.: 120–125 ºC.



(±)-7m

Synthesis of (±)-7m (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 19:1 to 17:3) as a pale yellow solid (114.4 mg, 67%).

R_f = 0.39 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

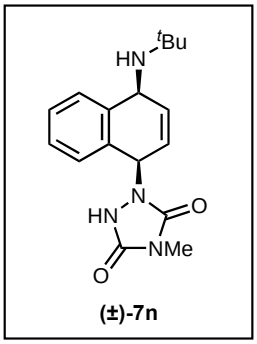
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.5 Hz, 1H), 7.35 – 7.25 (m, 3H), 6.40 (br, 2H), 5.95 – 5.94 (m, 1H), 4.63 – 4.62 (m, 1H), 3.07 (s, 3H), 2.76 – 2.72 (m, 1H), 1.90 – 1.54 (m, 5H), 1.22 – 0.81 (m, 5H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.7, 152.9, 137.4, 134.3, 132.4, 129.8 (overlap of 2 peaks found by HSQC and HMBC), 129.5, 128.4, 127.9, 54.2, 49.6, 49.2, 29.3, 28.7, 25.4, 25.3, 24.9.

HRMS: (ESI-TOF, m/z) calcd. For $C_{19}H_{25}N_4O_2$ $[M+H]^+$ calc.: 341.1972; found: 341.1984.

IR: (ATR, neat, cm^{-1}): 3268 (w), 2926 (m), 2853 (m), 1682 (m), 1585 (s), 1450 (m), 1389 (m), 1286 (m), 1150 (w), 912 (m), 754 (m), 728 (s), 640 (m).

m.p.: 141–142 ºC.



(±)-7n

Synthesis of (±)-7n (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 19:1 to 17:3) as a white solid (114.4 mg, 73%).

R_f = 0.27 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

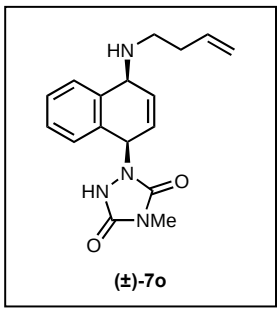
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.44 – 7.42 (m, 1H), 7.35 – 7.28 (m, 3H), 7.06 (br, 2H), 6.54 (dd, *J* = 9.6, 5.6 Hz, 1H), 6.29 (dd, *J* = 9.6, 6.1 Hz, 1H), 5.91 (d, *J* = 6.1 Hz, 1H), 4.54 (d, *J* = 5.6 Hz, 1H), 3.03 (s, 3H), 1.22 (s, 9H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 153.1, 152.9, 138.1, 135.7, 134.7, 129.6, 129.4, 128.9, 128.70, 128.65, 54.4, 50.5, 50.1, 29.3, 25.1.

HRMS: (ESI-TOF, m/z) calcd. For $C_{17}H_{23}N_4O_2$ $[M+H]^+$ calc.: 315.1816; found: 315.1820.

IR: (ATR, neat, cm^{-1}): 3412 (w), 2974 (w), 1684 (m), 1617 (s), 1465 (m), 792 (w), 754 (m).

m.p.: 142–143 ºC.



(±)-7o

Synthesis of (±)-7o (Table 2): General procedure A with the following modifications was used to synthesize the title compound: during the setup 3-butenylamine hydrochloride was dissolved in 2.5 mL of degassed CH_2Cl_2 and added as the amine source and then 2.0 eq. (1.0 mmol) of triethylamine was added. This was followed by the addition of the palladium catalyst. **7o** was isolated by flash chromatography (SiO_2, CH_2Cl_2:EtOAc:MeOH = 5:4:1 to 9:0:1) as a pale yellow solid (101.2 mg, 65%).

$\boldsymbol{R_f}$ = 0.26 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

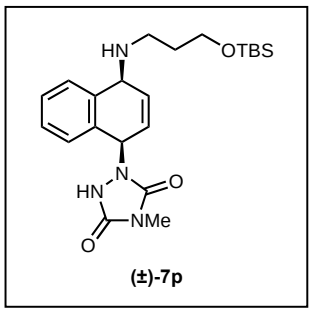
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.44 (d, *J* = 7.4 Hz, 1H), 7.34 (td, *J* = 7.4, 1.6 Hz, 1H), 7.28 (td, *J* = 7.3, 1.2 Hz, 1H), 7.25 (d, *J* = 7.3 Hz, 1H) 6.46 (dd, *J* = 9.5, 5.5 Hz, 1H), 6.36 (dd, *J* = 9.5, 5.9 Hz, 1H), 5.94 (d, *J* = 5.8 Hz, 1H), 5.64 (ddt, *J* = 17.1, 10.6, 6.8 Hz, 1H), 5.07 – 5.03 (m, 2H), 4.38 (d, *J* = 5.5 Hz, 1H), 3.07 (s, 3H), 2.84 – 2.73 (m, 2H), 2.34 – 2.21 (m, 2H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 154.4, 152.8, 135.9, 134.1, 133.7, 132.4, 130.4, 129.8, 129.7, 129.2, 128.2, 118.2, 53.0, 50.2, 45.1, 31.5, 25.3.

HRMS: (ESI-TOF, m/z) calcd. For $C_{17}H_{21}N_4O_2$ $[M+H]^+$ calc.: 313.1659; found: 313.1667.

IR: (ATR, neat, cm^{-1}): 3397 (w), 2969 (w), 1681 (m), 1592 (s), 1464 (s), 1391 (m), 1286 (w), 1146 (w), 923 (w), 774 (m), 755 (s), 641 (w).

m.p.: 70–72 ºC decomposed.



(±)-7p

Synthesis of (±)-7p (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, EtOAc until most impurities had been removed and then switched to a gradient of CH_2Cl_2:MeOH = 19:1 to 9:1) as a white solid (143.0 mg, 66%).

$\boldsymbol{R_f}$ = 0.33 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.45 (d, *J* = 7.6 Hz, 1H), 7.33 (td, *J* = 7.6,

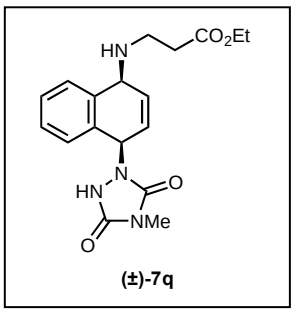
2.1 Hz, 1H), 7.28 – 7.24 (m, 2H), 6.43 (dd, *J* = 9.5, 5.5 Hz, 1H), 6.36 (dd, *J* = 9.5, 5.9 Hz, 1H), 5.92 (d, *J* = 5.9 Hz, 1H), 4.40 (d, *J* = 5.5 Hz, 1H), 3.50 – 3.43 (m, 2H), 3.06 (s, 3H), 2.84 (td, *J* = 10.7, 9.6, 5.9 Hz, 1H), 2.77 (td, *J* = 11.8, 10.7, 5.9 Hz, 1H), 1.62 – 1.57 (m, 2H), 0.83 (s, 9H), -0.01 (s, 3H), -0.03 (s, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.3, 152.8, 136.7, 133.4, 133.3, 129.7, 129.64, 129.60, 129.4, 127.9, 60.6, 52.8, 49.8, 43.4, 29.4, 26.0, 25.3, 18.3, -5.3, -5.4.

HRMS: (ESI-TOF, m/z) calcd. For $C_{22}H_{35}N_4O_3Si$ $[M+H]^+$ calc.: 431.2473; found: 431.2475.

IR: (ATR, neat, cm^{-1}): 3456 (w), 2960 (w), 2861 (w), 1743 (m), 1694 (m), 1625 (s), 1460 (m), 1376 (m), 1217 (w), 835 (m), 780 (m), 755 (m).

m.p.: 83–85 ºC decomposed.



(±)-7q

Synthesis of (±)-7q (Table 2): Following the general procedure A, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:EtOAc:MeOH = 5:4:1) as a white solid (151.3 mg, 84%).

***R*$_f$** = 0.22 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 8.29 (br, 2H), 7.44 – 7.42 (m, 1H), 7.32 (td, *J* = 7.5, 1.5 Hz, 1H), 7.28 (td, *J* = 7.5, 1.5 Hz, 1H), 7.23 (dd, *J* = 7.5, 1.2 Hz, 1H), 6.51 (dd, *J* = 9.6, 5.5 Hz, 1H), 6.31 (dd, *J* = 9.6, 5.8 Hz, 1H), 5.90 (d, *J* = 5.8 Hz, 1H), 4.35 (d, *J* = 5.5 Hz, 1H), 4.10 (q, *J* = 7.1 Hz, 2H), 3.04 – 2.92 (m, 2H), 3.02 (s, 3H), 2.66 – 2.53 (m, 2H), 1.22 (t, *J* = 7.2 Hz, 3H).

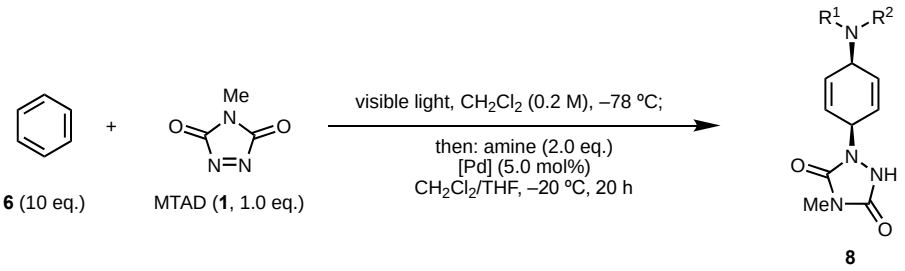
^{13}C NMR: (125 MHz, $CDCl_3$) δ 171.4, 153.9, 152.7, 135.4, 134.7, 131.5, 131.4, 129.7, 129.4, 129.2, 128.2, 61.1, 53.3, 50.4, 41.4, 32.1, 25.2, 14.2.

HRMS: (ESI-TOF, m/z) calcd. For $C_{18}H_{23}N_4O_4$ $[M+H]^+$ calc.: 359.1714; found: 359.1716.

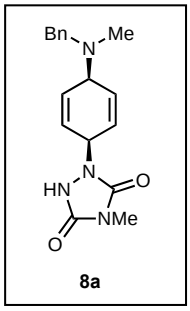
IR: (ATR, neat, cm^{-1}): 3432 (w), 2972 (w), 1760 (m), 1696 (m), 1622 (s), 1469 (m), 1265 (m), 1111 (s), 1030 (m), 784 (m), 757 (m).

m.p.: 101–103 ºC decomposed.

General procedure B for the dearomative *syn*-1,4-diamination of benzene with amines (8a-8h) (Table 2)



MTAD (**1**, 113 mg, 1.0 mmol, 1.0 eq.) was placed in a test tube with a septum as the cap under nitrogen atmosphere. Dichloromethane (5.0 mL, 0.2 M) was added to the test tube at rt, and cooled to –78 ºC. Benzene (0.89 mL, 10 mmol, 10 eq.) was added dropwise at –78 ºC, and the resulting pink solution was stirred under irradiation with LED lights at –78 ºC until the solution became colorless (approximately 12 h). To this solution were added an amine (2.0 mmol, 2.0 eq.) and a solution of Pd complex in THF (2.0 mL) [primary amine: $Pd_2(dba)_3$ (22.9 mg, 0.025 mmol, 2.5 mol%) and dppf (33.3 mg, 0.06 mmol, 6.0 mol%), pre-stirred at rt in THF for 30 min; secondary amine: $Pd(PPh_3)_4$ (57.8 mg, 0.05 mmol, 5.0 mol%)], and the resulting mixture was stirred at –20 ºC for 20 h. The reaction was then warmed up to rt, filtered through a pad of celite, and concentrated under reduced pressure. The product was purified by flash column chromatography (SiO_2, CH_2Cl_2:MeOH mixture).



Synthesis of 8a (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 5:1 to 3:1) as a white solid (149.4 mg, 48%).

***R*$_f$** = 0.27 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

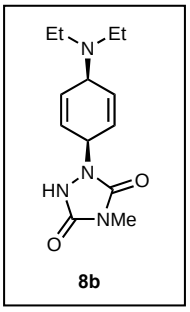
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.33 – 27 (m, 4H), 7.26 – 7.24 (m, 1H), 6.18 (ddd, *J* = 10.4, 3.2, 1.9 Hz, 2H), 5.77 (ddd, *J* = 10.4, 3.2, 1.9 Hz, 2H), 5.16 – 5.12 (m, 1H), 3.76 – 3.73 (m, 1H), 3.58 (s, 2H), 3.02 (s, 3H), 2.25 (s, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.5, 154.5, 139.6, 132.0, 128.8, 128.4, 127.3, 125.1, 57.7, 56.0 50.9, 38.8, 25.2.

HRMS: (ESI-TOF, m/z) calcd. For $C_{17}H_{20}N_4NaO_2$ $[M+Na]^+$ calc.: 335.1478; found: 335.1486.

IR: (ATR, neat, cm^{-1}): 3100 (w), 2831 (w), 1694 (s), 1593 (s), 1488 (s), 1453 (s), 1371 (m), 1138 (m), 750 (s), 739 (s), 695 (s), 666 (m), 633 (m), 539 (m), 468 (m).

m.p.: 120–121 ºC.



8b

Synthesis of 8b (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 10:1 to 5:1) as a white solid (144.2 mg, 55%).

$\boldsymbol{R_f}$ = 0.18 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

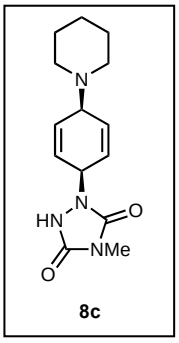
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.14 (br, 1H), 6.14 (ddd, *J* = 10.3, 3.2, 1.7 Hz, 2H), 5.84 (ddd, *J* = 10.3, 3.3, 1.7 Hz, 2H), 5.19 – 5.15 (m, 1H), 3.86 – 3.83 (m, 1H), 3.08 (s, 3H), 2.63 (q, *J* = 7.2 Hz, 4H), 1.09 (t, *J* = 7.2 Hz, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.1, 154.6, 132.4, 125.6, 53.1, 50.4, 44.5, 25.4, 13.6.

HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{21}N_4O_2$ $[M+H]^+$ calc.: 265.1665; found: 265.1676.

IR: (ATR, neat, cm^{-1}): 1693 (m), 1584 (s), 1464 (s), 1455 (s), 1389 (w), 1370 (w), 1286 (w), 795 (w), 768 (m), 755 (m), 665 (w), 536 (w).

m.p.: 122–123 ºC.



8c

Synthesis of 8c (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 10:1 to 5:1) as a white solid (156.7 mg, 57%).

$\boldsymbol{R_f}$ = 0.40 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

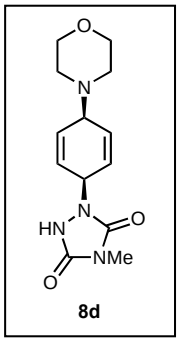
^{1}H NMR: (500 MHz, $CDCl_3$) δ 6.22 (ddd, *J* = 10.4, 3.6, 1.6 Hz, 2H), 5.91 (ddd, *J* = 10.4, 2.7, 1.6 Hz, 2H), 5.22 – 5.19 (m, 1H), 3.58 – 3.56 (m, 1H), 3.08 (s, 3H), 2.64 – 2.62 (m, 4H), 1.67 – 1.62 (m, 4H), 1.49 – 1.45 (m, 2H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.5, 155.1, 130.8, 124.6, 57.9 50.50, 50.46, 25.4, 23.6, 22.7.

HRMS: (ESI-TOF, m/z) calcd. For $C_{14}H_{21}N_4O_2$ $[M+H]^+$ calc.: 277.1665; found: 277.1667.

IR: (ATR, neat, cm^{-1}): 1695 (s), 1586 (m), 1466 (m), 1454 (m), 1413 (w), 1389 (w), 1370 (w), 1032 (w), 800 (w), 748 (s), 692 (w), 664 (w), 624 (w), 593 (w).

m.p.: 100–101ºC.



8d

Synthesis of 8d (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1) as a white solid (172.6 mg, 62%).

R_f = 0.27 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

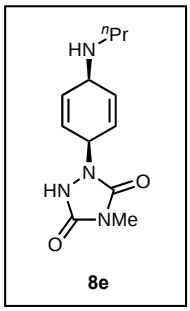
^{1}H NMR: (500 MHz, $CDCl_3$) δ 6.15 (ddd, *J* = 10.3, 3.2, 1.7 Hz, 2H), 5.87 (ddd, *J* = 10.3, 3.4, 1.7 Hz, 2H), 5.19 – 5.15 (m, 1H), 3.72 – 3.70 (m, 4H), 3.64 – 3.62 (m, 1H), 3.08 (s, 3H), 2.63 – 2.61 (m, 4H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.2, 154.7, 131.7, 126.0, 67.4, 57.1, 50.6, 49.7, 25.4.

HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{18}KN_4O_3$ $[M+K]^+$ calc.: 317.1010; found: 317.1009.

IR: (ATR, neat, cm^{-1}): 2950 (w), 2810 (w), 1690 (s), 1484 (m), 1403 (w), 1224 (w), 1112 (s), 1036 (m), 1016 (m), 941 (w), 886 (w), 771 (s), 731 (m), 637 (m), 551 (m), 461 (m).

m.p.: 148–149 ºC.



8e

Synthesis of 8e (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 5:1 to 3:1) as a white solid (155.0 mg, 62%).

R_f = 0.27 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

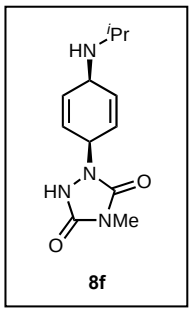
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.05 (br, 1H), 6.13 (ddd, *J* = 10.5, 3.7, 1.7 Hz, 2H), 6.03 (dd, *J* = 10.2, 2.7 Hz, 2H), 5.36 – 5.33 (m, 1H), 3.94 – 3.89 (m, 1H), 3.06 (s, 3H), 2.93 (t, *J* = 7.5 Hz, 2H), 1.76 (tq, *J* = 7.5, 7.4 Hz, 2H), 1.00 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 156.4, 152.8, 131.8, 124.3, 49.7, 47.4, 46.4, 25.4, 20.7, 11.5.

HRMS: (ESI-TOF, m/z) calcd. For $C_{12}H_{19}N_4O_2$ $[M+H]^+$ calc.: 251.1503; found: 251.1497.

IR: (ATR, neat, cm^{-1}): 2968 (w), 1698 (s), 1597 (s), 1462 (m), 1406 (w), 1375 (m), 1283 (w), 1155 (w), 1022 (w), 850 (w), 781 (s), 758 (s), 693 (w), 640 (m), 562 (w), 479 (m).

m.p.: 100–101 ºC.



8f

Synthesis of 8f (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 9:1 to 5:1) as a white solid (180.0 mg, 72%).

R_f = 0.27 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

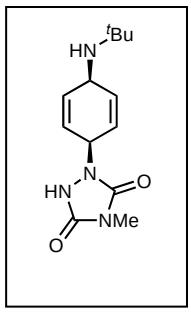
^{1}H NMR: (500 MHz, $CDCl_3$) δ 9.75 (br, 2H), 6.23 (dd, *J* = 9.8, 4.6 Hz, 2H), 6.18 (dd, *J* = 9.8, 4.8 Hz, 2H), 5.36 (td, *J* = 4.8, 2.8 Hz, 1H), 4.06 (td, *J* = 4.6, 2.8 Hz, 1H), 3.26 (hept, *J* = 6.5 Hz, 1H), 3.04 (s, 3H), 1.22 (d, *J* = 6.5 Hz, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 156.2, 153.1, 133.2, 126.4, 46.9, 45.9, 45.6, 25.4, 19.8.

HRMS: (ESI-TOF, m/z) calcd. For $C_{12}H_{19}N_4O_2$ $[M+H]^+$ calc.: 251.1503; found: 251.1513.

IR: (ATR, neat, cm^{-1}): 3242 (w), 2850 (w), 1677 (m), 1599 (s), 1473 (w), 1396 (w), 1376 (w), 1148 (w), 799 (w), 780 (m), 759 (w), 710 (w), 691 (w), 639 (m), 572 (w), 536 (m).

m.p.: 129–130ºC.



Synthesis of 8g (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 9:1 to 5:1) as a white solid (131.0 mg, 50%).

R_f = 0.27 (CH_2Cl_2:MeOH = 5:1, $KMnO_4$).

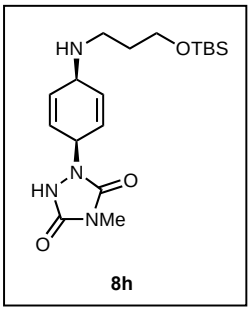
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.12 (br, 2H), 6.15 (ddd, *J* = 10.3, 3.6, 1.6 Hz, 2H), 5.88 (ddd, *J* = 10.3, 3.6, 1.4 Hz, 2H), 5.23 (dtt, *J* = 5.4, 3.6, 1.6 Hz, 1H), 3.97 – 3.91 (m, 1H), 3.06 (s, 3H), 1.30 (s, 9H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.4, 153.8, 130.8, 127.4, 54.1, 47.6, 45.5, 28.8, 25.3.

HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{20}N_4NaO_2$ $[M+Na]^+$ calc.: 287.1478; found: 287.1466.

IR: (ATR, neat, cm^{-1}): 3320 (w), 2974 (w, br), 1692 (s), 1464 (m), 1393 (w), 1234 (w), 1005 (w), 828 (m), 764 (m), 739 (m), 623 (w), 491 (m).

m.p.: 153–155 ºC.



8h

Synthesis of 8h (Table 2): Following the general procedure B, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (sat. with NH_3) = 20:1 to 10:1) as a white solid (202.9 mg, 53%).

R_f = 0.54 (CH_2Cl_2:MeOH = 5:1, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 8.54 (br, 2H), 6.20 (dd, *J* = 9.8, 4.4 Hz, 2H), 6.03 (dd, *J* = 9.8, 4.4 Hz, 2H), 5.29 (dt, *J* = 4.5, 4.4 Hz, 1H), 3.86 (dt, *J* = 4.5, 4.4 Hz, 1H), 3.66 (t, *J* = 6.0 Hz, 2H), 3.05 (s, 3H), 2.92 (t, *J* = 6.8 Hz, 2H), 1.78 (tt, *J* = 6.0, 6.8 Hz, 2H), 0.87 (s, 9H), 0.03 (s, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.8, 153.6, 130.4, 128.4, 60.7, 49.1, 47.3, 43.5, 30.8, 26.0, 25.3, 18.3, –5.3.

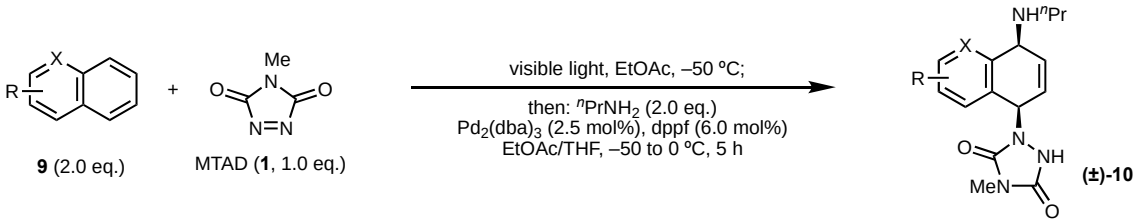
HRMS: (ESI-TOF, m/z) calcd. For $C_{18}H_{33}N_4O_3Si$ $[M+H]^+$ calc.: 381.2316; found: 381.2333.

IR: (ATR, neat, cm^{-1}): 2928 (w), 2856 (w), 1683 (w), 1591 (s), 1575 (s), 1500 (m), 1458 (m), 1373 (m), 1252 (w), 1095 (s), 833 (s), 773 (s), 751 (s), 689 (m), 665 (s), 634 (m), 508 (w).

m.p.: 143–146 ºC.

3-3. Dearomative *syn*-1,4-diamination of arenes with *n*-propylamine (10a-10h)

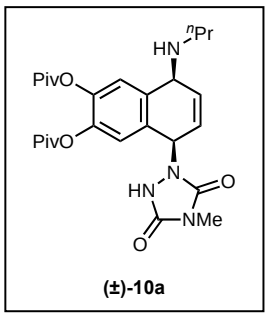
General procedure C for the dearomative *syn*-1,4-diamination of naphthalene derivatives with *n*-propylamine (Table 3)



For solid arene: MTAD (**1**, 113 mg, 1.0 mmol, 1.0 eq.) and arene (2.0 mmol, 1.0 eq.) were placed in a test tube with a septum as the cap under nitrogen atmosphere. Ethyl acetate (10.0 mL, 0.1 M) was added to the test tube at rt, and the mixture was stirred until both MTAD and the naphthalene were completely dissolved.

For liquid arene: MTAD (**1**, 113 mg, 1.0 mmol, 1.0 eq.) was dissolved in ethyl acetate (8.0 mL) at rt under nitrogen atmosphere. Then a solution of arene (2.0 mmol, 1.0 eq.) in ethyl acetate (2.0 mL) was added.

The resulting pink solution was stirred under irradiation with LED lights at –50 °C until the solution became white suspension or colorless solution. To this solution were added propylamine (2.0 mmol, 2.0 eq.) and a solution of $Pd_2(dba)_3$ (28.8 mg, 0.025 mmol, 2.5 mol%) and dppf (33.2 mg, 0.060 mmol, 6.0 mol%) in THF (2.0 mL, pre-stirred at rt in THF for 30 min) and the resulting mixture was slowly warmed up from –50 to 0 °C over 5 h. The reaction was then filtered through a pad of celite, and concentrated under reduced pressure. The product was purified by flash column chromatography (SiO_2, CH_2Cl_2:MeOH mixture).



Synthesis of (±)-10a (Table 3): The reaction was conducted following the general procedure C, except the substitution step was done by stirring the mixture at –20 °C for 20 h. The title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 30:1 to 15:1) as a light-red solid (257.7 mg, 53%).

R_f = 0.34 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

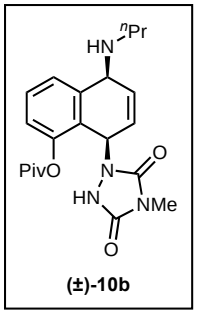
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.28 (s, 1H), 7.26 (s, 1H), 7.11 (br, 1H), 6.41 (dd, *J* = 9.4, 5.6 Hz, 1H), 6.34 (dd, *J* = 94, 5.7 Hz, 1H), 5.91 (d, *J* = 5.7 Hz, 1H), 4.35 (d, *J* = 5.6 Hz, 1H), 3.05 (s, 3H), 2.71 – 2.61 (m, 2H), 1.52 – 1.45 (m, 2H), 1.32 (s, 18H), 0.82 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 175.7, 175.4, 155.7, 152.8, 143.3, 142.0, 135.1, 133.3, 130.5, 128.6, 124.9, 124.7, 52.0, 49.1, 47.2, 39.3, 39.2, 27.31, 27.25, 25.3, 19.8, 11.4.

HRMS: (ESI-TOF, m/z) calcd. For $C_{26}H_{37}N_4O_6$ $[M+H]^+$ calc.: 501.2729; found: 501.2713.

IR: (ATR, neat, cm^{-1}): 2973 (w), 1703 (m), 1622 (s), 1479 (w), 1458 (m), 1387 (w), 1262 (w), 1114 (s), 1093 (s), 1029 (w), 1029 (w), 782 (m), 757 (w), 631 (w).

m.p.: 143–144 °C (recrystallized from CH_2Cl_2/diethyl ether).



(±)-10b

Synthesis of (±)-10b (Table 3): The reaction was conducted following the general procedure C, except the reaction was run in dichloromethane (10 mL, 0.1 M) with 10 mol% of Pd_2dba_3 and 12 mol% dppf. The title compound was isolated as a mixture of **10b** and **10b'** by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1) as a light-yellow solid (174.3 mg, 44%). The isomers were further separated by careful flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1).

R_f = 0.34 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.28 (dd, *J* = 8.0, 7.7 Hz, 1H), 7.19 (d, *J* = 7.7 Hz, 1H), 7.00 (d, *J* = 8.0 Hz, 1H), 6.40 – 6.34 (m, 2H), 5.98 (d, *J* = 5.4 Hz, 1H), 4.42 (d, *J* = 5.0 Hz, 1H), 3.05 (s, 3H), 2.68 – 2.65 (m, 2H), 1.56 – 1.47 (m, 2H), 1.43 (s, 9H), 0.81 (t, *J* = 7.4 Hz, 3H).

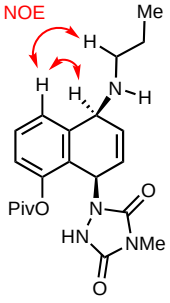
^{13}C NMR: (125 MHz, $CDCl_3$) δ 177.5, 155.1, 152.3, 149.4, 136.0, 133.3, 128.8, 128.5, 128.3, 127.0, 123.4, 52.5, 47.6, 44.4, 39.6, 27.3, 25.2, 20.4, 11.6.

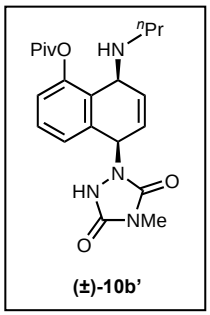
HRMS: (ESI-TOF, m/z) calcd. For $C_{21}H_{29}N_4O_4$ $[M+H]^+$ calc.: 401.2189; found: 401.2180.

IR: (ATR, neat, cm^{-1}): 2965 (w), 2341 (w), 1752 (w), 1703 (m), 1623 (s), 1456 (m), 1390 (w), 1236 (w), 1100 (s), 980 (w), 871 (w), 785 (w), 758 (w), 746 (m), 635 (w).

m.p.: 181–182 °C.

Observed NOE correlation:





(±)-10b'

***R*f** = 0.53 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

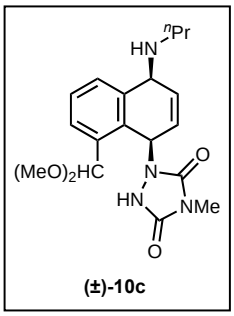
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.41 – 7.36 (m, 2H), 7.02 (dd, *J* = 7.6, 1.7 Hz, 1H), 6.53 (dd, *J* = 9.4, 5.7 Hz, 1H), 6.34 (dd, *J* = 9.4, 6.0 Hz, 1H), 5.99 (d, *J* = 6.0 Hz, 1H), 4.40 (d, *J* = 5.7 Hz, 1H), 3.03 (s, 3H), 2.81 – 2.76 (m, 1H), 2.65 – 2.59 (m, 1H), 1.60 – 1.49 (m, 2H), 1.41 (s, 9H), 0.89 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 177.1, 153.6, 152.6, 148.6, 137.6, 131.6, 131.1, 130.2, 128.0, 127.5, 122.2, 50.2, 48.7, 47.5, 39.5, 27.3, 25.2, 21.5, 11.8.

HRMS: (ESI-TOF, m/z) calcd. For $C_{21}H_{29}N_4O_4$ $[M+H]^+$ calc.: 401.2189; found: 401.2182.

IR: (ATR, neat, cm^{-1}): 2963 (w), 2320 (w), 1700 (m), 1617 (m), 1468 (m), 1446 (m), 1386 (w), 1279 (w), 1233 (w), 1104 (s), 1027 (w), 950 (w), 784 (s), 754 (s), 635 (w).

m.p.: 145–146 ºC.



Synthesis of (±)-10c (Table 3): The reaction was conducted following the general procedure C, except the reaction in dichloromethane (10 mL, 0.1 M). The title compound was isolated as a mixture of **10c** and **10c'** by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1) as a light-yellow solid (179.8 mg, 48%). The isomers were further separated by careful flash chromatography (SiO_2, CH_2Cl_2:MeOH = 9:1 to 5:1).

***R*f** = 0.45 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.5 Hz, 1H), 7.32 (dd, *J* = 7.6, 7.5 Hz, 1H), 7.27 – 7.25 (m, 1H), 6.35 – 6.32 (m, 2H), 6.29 – 6.27 (m, 1H), 5.76 (s, 1H), 4.44 – 4.42 (m, 1H), 3.42 (s, 3H), 3.39 (s, 3H), 3.10 (s, 3H), 2.68 – 2.56 (m, 2H), 1.49 – 1.44 (m, 2H), 0.77 (t, *J* = 7.5 Hz, 3H).

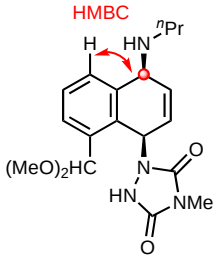
^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.4, 152.2, 138.1, 134.2, 133.8, 133.7, 130.2, 128.3, 127.9, 127.7, 100.9, 55.7, 53.8, 53.3, 47.5, 45.4, 25.4, 20.2, 11.6.

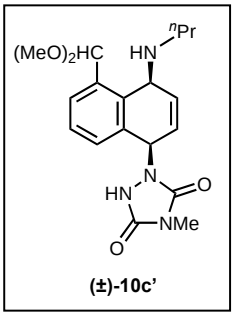
HRMS: (ESI-TOF, m/z) calcd. For $C_{19}H_{27}N_4O_4$ $[M+H]^+$ calc.: 375.2032; found: 375.2024.

IR: (ATR, neat, cm^{-1}): 3491 (w), 2958 (w), 1681 (m), 1615 (s), 1571 (m), 1462 (w), 1444 (w), 1103 (w), 1026 (s), 991 (w), 867 (w), 784 (m), 756 (m), 749 (m), 670 (w), 563 (w), 525 (w).

m.p.: 192–193 ºC.

Observed HMBC correlation:





(±)-10c'

***R*f** = 0.55 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

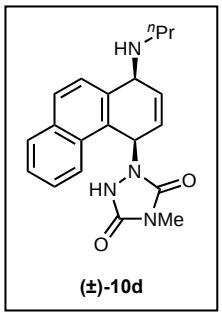
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.51 – 7.48 (m, 1H), 7.37 – 7.32 (m, 2H), 6.55 (dd, *J* = 9.5, 5.8 Hz, 1H), 6.44 (dd, *J* = 9.5, 6.1 Hz, 1H), 5.99 (d, *J* = 6.1 Hz, 1H), 5.28 (s, 1H), 4.96 (d, *J* = 5.8 Hz, 1H), 3.55 (s, 3H), 3.31 (s, 3H), 2.99 (s, 3H), 2.98 – 2.94 (m, 1H), 2.76 (ddd, *J* = 11.6, 8.3, 6.6 Hz, 1H), 1.875 – 1.66 (m, 2H), 1.01 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 153.3, 152.8, 137.3, 135.5, 135.4, 132.2, 131.2, 130.7, 128.8, 128.4, 106.7, 56.5, 54.1, 50.8, 49.1, 48.7, 25.0, 22.0, 11.8.

HRMS: (ESI-TOF, m/z) calcd. For $C_{19}H_{27}N_4O_4$ $[M+H]^+$ calc.: 375.2032; found: 375.2024.

IR: (ATR, neat, cm^{-1}): 3442 (w), 2938 (w), 2226 (w), 1684 (m), 1618 (s), 1459 (m), 1389 (w), 1353 (w), 1192 (w), 1112 (w), 1044 (m), 1031 (w), 998 (w), 912 (w), 895 (w), 780 (m), 773 (m), 759 (w), 723 (s), 637 (w).

m.p.: 146–147 ºC.



Synthesis of (±)-10d (Table 3): Following the general procedure C, the title compound was isolated as a mixture of **10d** and **10d'** by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1) as a light-yellow solid (199.3 mg, 57%). The isomers were further separated by careful flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1).

***R*f** = 0.54 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.99 (d, *J* = 8.5 Hz, 1H), 7.88 (d, *J* = 8.1 Hz, 1H), 7.84 (d, *J* = 8.5 Hz, 1H), 7.64 – 7.61 (m, 1H), 7.57 – 7.54 (m, 2H), 6.77 (dd, *J* = 9.5, 5.7 Hz, 1H), 6.47 (dd, *J* = 9.5, 5.8 Hz, 1H), 6.08 (d, *J* = 5.8 Hz, 1H), 5.18 (d, *J* = 5.7 Hz, 1H), 3.03 (s, 3H), 2.95 – 2.88 (m, 1H), 2.84 – 2.77 (m, 1H), 1.69 – 1.55 (m, 2H), 0.80 (t, *J* = 6.7 Hz, 3H).

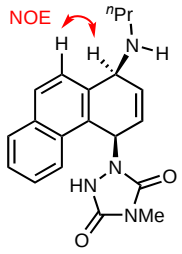
^{13}C NMR: (125 MHz, $CDCl_3$) δ 153.9, 152.8, 134.2, 133.3, 131.8, 131.3, 130.9, 130.6, 130.0, 129.3, 127.5, 127.0, 126.6, 121.9, 51.1, 48.8, 48.1, 25.3, 21.4, 11.7.

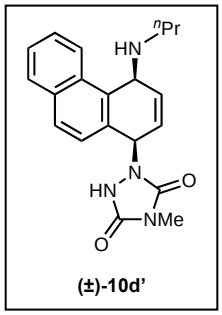
HRMS: (ESI-TOF, m/z) calcd. For $C_{20}H_{23}N_4O_2$ $[M+H]^+$ calc.: 351.1821; found: 351.1833.

IR: (ATR, neat, cm^{-1}): 3052 (w), 2965 (w), 1692 (m), 1616 (s), 1461 (m), 1387 (w), 1283 (w), 1197 (w), 1092 (w), 802 (w), 782 (s), 757 (m), 737 (w), 710 (w), 655 (w), 629 (m), 607 (w), 491 (w).

m.p.: 128–129 °C.

Observed NOE correlations:





(±)-10d'

***R*$_f$** = 0.45 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

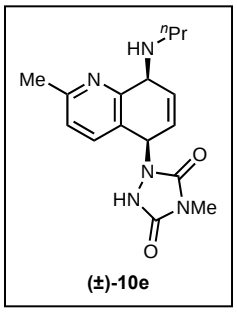
^{1}H NMR: (500 MHz, $CDCl_3$) δ 8.51 (d, *J* = 8.4 Hz, 1H), 7.83 (d, *J* = 8.2 Hz, 1H), 7.76 (d, *J* = 8.4 Hz, 1H), 7.63 (ddd, *J* = 8.4, 6.8, 1.3 Hz, 1H), 7.51 (dd, *J* = 8.2, 6.8 Hz, 1H), 7.33 (d, *J* = 8.4 Hz, 1H), 6.51 (d, *J* = 5.8 Hz, 1H), 6.27 (br, 1H), 6.08 (br, 1H), 4.49 (d, *J* = 5.4 Hz, 1H), 3.10 (s, 3H), 2.58 (br, 1H), 2.47 (br, 1H), 1.41 – 1.17 (m, 2H), 0.45 (br, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.9, 152.1, 134.6, 133.6, 133.1, 131.0, 130.7, 128.6, 128.5, 127.8, 127.3, 127.0, 126.5, 124.3, 53.2, 47.2, 45.6, 25.4, 19.6, 11.1.

HRMS: (ESI-TOF, m/z) calcd. For $C_{20}H_{23}N_4O_2$ $[M+H]^+$ calc.: 351.1821; found: 351.1833.

IR: (ATR, neat, cm^{-1}): 3412 (w), 2968 (w), 1686 (w), 1622 (s), 1573 (w), 1470 (w), 1373 (w), 1141 (w), 1025 (w), 819 (m), 783 (m), 754 (m), 655 (w), 634 (w), 618 (w), 574 (w).

m.p.: 168–169 °C.



(±)-10e

Synthesis of (±)-10e (Table 3): Following the general procedure C, the title compound was isolated as a mixture of **10e** and **10e'** by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1) as a light-yellow solid (240.1 mg, 76%). The isomers were further separated by careful flash chromatography (SiO_2, CH_2Cl_2:MeOH = 9:1 to 5:1).

R_f = 0.46 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.9 Hz, 1H), 7.15 (d, *J* = 7.9 Hz, 1H), 6.51 (dd, *J* = 9.6, 5.4 Hz, 1H), 6.28 (dd, *J* = 9.6, 5.7 Hz, 1H), 5.95 (d, *J* = 5.7 Hz, 1H), 4.42 (d, *J* = 5.4 Hz, 1H), 3.04 (s, 4H), 2.81 (t, *J* = 7.8 Hz, 2H), 2.55 (s, 4H), 1.73 – 1.66 (m, 1H), 1.57 – 1.50 (m, 1H), 0.91 (t, *J* = 7.4 Hz, 3H).

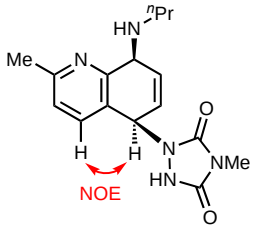
^{13}C NMR: (125 MHz, $CDCl_3$) δ 158.3, 154.8, 153.1, 152.9, 137.6, 130.9, 130.6, 128.5, 124.0, 54.9, 49.9, 48.1, 25.3, 24.4, 21.0, 11.7.

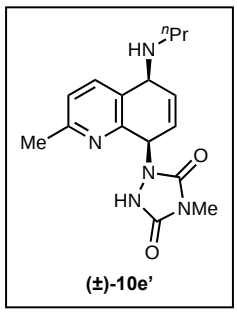
HRMS: (ESI-TOF, m/z) calcd. For $C_{16}H_{22}N_5O_2$ $[M+H]^+$ calc.: 316.1774; found: 316.1779.

IR: (ATR, neat, cm^{-1}): 2890 (w), 1694 (m), 1615 (m), 1589 (s), 1574 (m), 1453 (s), 1408 (w), 1381 (m), 1372 (m), 1300 (w), 1283 (w), 1142 (w), 802 (m), 777 (s), 756 (s), 643 (m), 602 (w), 561 (w).

m.p.: 119–120 ºC.

Observed NOE correlation:





(±)-10e'

(±)-10e'

R_f = 0.32 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

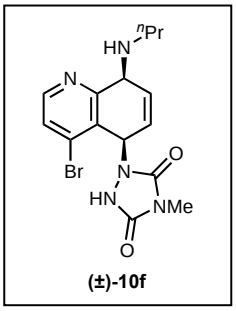
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.59 (d, *J* = 7.9 Hz, 1H), 7.09 (d, *J* = 7.9 Hz, 1H), 6.42 – 6.36 (m, 2H), 5.90 – 5.89 (m, 1H), 4.38 (d, *J* = 4.3 Hz, 1H), 3.08 (s, 3H), 2.63 – 2.59 (m, 2H), 2.55 (s, 3H), 1.47 – 1.39 (m, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) 159.6, 155.0, 153.7, 153.4, 137.3, 132.5, 129.3, 126.7, 122.6, 53.0, 52.7, 47.7, 25.4, 24.5, 20.9, 11.6.

HRMS: (ESI-TOF, m/z) calcd. For $C_{16}H_{22}N_5O_2$ $[M+H]^+$ calc.: 316.1774; found: 316.1764.

IR: (ATR, neat, cm^{-1}): 3390 (w), 2967 (w), 1694 (m), 1620 (s), 1600 (w), 1473 (m), 1448 (m), 1372 (w), 1146 (w), 1022 (w), 831 (w), 778 (m), 757 (s), 637 (m), 566 (w).

m.p.: 131–132 ºC.



(±)-10f

Synthesis of (±)-10f (Table 3): The reaction was conducted following the general procedure C, except the reaction was run with MTAD (**1**, 0.5 mmol, 1.0 eq.) in EtOAc (10 mL, 0.05 M). Single constitutional- and diastereoisomer was observed in crude ^{1}H NMR. The title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 9:1 to 5:1) as a light-yellow solid (115.3 mg, 61%).

R_f = 0.44 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 8.23 (d, *J* = 5.2 Hz, 1H), 7.58 (d, *J* = 5.2 Hz, 1H), 6.39 (dd, *J* = 9.5, 5.5 Hz, 1H), 6.31 (dd, *J* = 9.5, 5.9 Hz, 1H), 6.16 (d, *J* = 5.9 Hz, 1H), 4.50 (d, *J* = 5.5 Hz, 1H), 3.12 (s, 3H), 2.88 – 2.77 (m, 2H), 1.7 – 1.63 (m, 2H), 0.92 (t, *J* = 7.4 Hz, 3H).

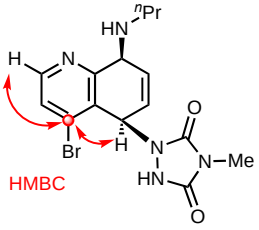
^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.3, 154.9, 152.2, 149.1, 135.1, 132.6, 131.4, 128.8, 128.4, 54.9, 49.7, 47.7, 25.4, 20.6, 11.6.

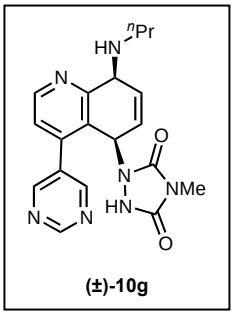
HRMS: (ESI-TOF, m/z) calcd. For $C_{15}H_{19}BrN_5O_2$ $[M+H]^+$ calc.: 380.0710; found: 380.0722.

IR: (ATR, neat, cm^{-1}): 3030 (w), 1705 (m), 1613 (s), 1455 (s), 1386 (m), 1279 (w), 1239 (w), 1019 (w), 827 (m), 791 (s), 760 (s), 710 (w), 654 (w), 635 (m), 608 (m), 493 (m).

m.p.: 136–137 ºC.

Observed HMBC correlations:





(±)-10g

Synthesis of (±)-10g (Table 3): The reaction was conducted following the general procedure C, except the reaction was run with MTAD (**1**, 0.5 mmol, 1.0 eq.) in dichloromethane (5 mL, 0.1 M). The title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 10:1 to 5:1) as a off-white solid (94.9 mg, 50%).

R_f = 0.21 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 9.33 (s, 1H), 8.65 (d, *J* = 4.9 Hz, 1H), 8.61 (s, 2H), 7.24 (d, *J* = 4.9 Hz, 1H), 6.48 (dd, *J* = 9.5, 5.6 Hz, 1H), 6.20 (dd, *J* = 9.5, 5.9 Hz, 1H), 5.77 (d, *J* = 5.9 Hz, 1H), 4.61 (d, *J* = 5.6 Hz, 1H), 3.02 (s, 3H), 2.93 – 2.82 (m, 2H), 1.74 – 1.70 (m, 1H), 1.68 – 1.63 (m, 1H), 0.94 (t, *J* = 7.4 Hz, 3H).

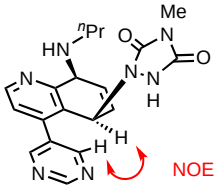
^{13}C NMR: (125 MHz, $CDCl_3$) δ 159.2, 157.0, 155.9, 155.8, 154.5, 152.0, 149.3, 144.2, 131.0, 130.9, 130.3, 129.2, 125.2, 55.5, 48.4, 47.6, 25.3, 21.3, 11.7.

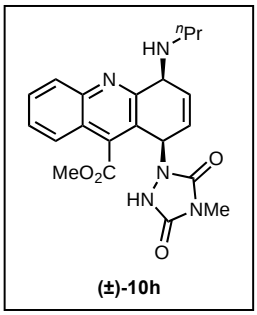
HRMS: (ESI-TOF, m/z) calcd. For $C_{19}H_{22}N_7O_2$ $[M+H]^+$ calc.: 380.1835; found: 380.1846.

IR: (ATR, neat, cm^{-1}): 1703 (m), 1612 (s), 1587 (w), 1453 (w), 1417 (m), 1381 (w), 1285 (w), 1036 (w), 853 (w), 791 (w), 774 (w), 762 (w), 729 (m), 634 (s), 531 (w).

m.p.: 138–139 °C.

Observed NOE correlation:





Synthesis of (±)-10h (Table 3): The reaction was conducted following the general procedure C, except the reaction was run with MTAD (**1**, 0.5 mmol, 1.0 eq.) in dichloromethane (5 mL, 0.1 M). The title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 15:1 to 9:1) as a light-red solid (108.8 mg, 53%).

R_f = 0.53 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 8.06 (d, *J* = 8.4 Hz, 1H), 7.83 – 7.78 (m, 2H), 7.64 (ddd, *J* = 8.4, 7.0, 1.2 Hz, 1H), 6.53 (dd, *J* = 9.5, 5.7 Hz, 1H), 6.34 (d, *J* = 6.1 Hz, 1H), 6.27 (dd, *J* = 9.5, 6.1 Hz, 1H), 4.69 (d, *J* = 5.7 Hz, 1H), 4.16 (s, 3H), 3.06 (s, 3H), 2.86 (ddd, *J* = 11.9, 9.9, 5.7 Hz, 1H), 2.76 (ddd, *J* = 11.9, 9.8, 5.7 Hz, 1H), 1.69 – 1.65 (m, 1H), 1.55 – 1.51 (m, 1H), 0.84 (t, *J* = 7.4 Hz, 3H).

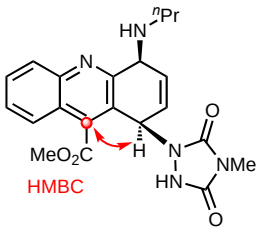
^{13}C NMR: (125 MHz, $CDCl_3$) δ 166.4, 154.9, 153.2, 152.2, 146.8, 140.1, 132.0, 131.1, 129.7, 129.1, 128.7, 125.2, 125.0, 123.9, 55.5, 53.9, 47.7, 46.7, 25.3, 20.6, 11.5.

HRMS: (ESI-TOF, m/z) calcd. For $C_{21}H_{24}N_5O_4$ $[M+H]^+$ calc.: 410.1828; found: 410.1812.

IR: (ATR, neat, cm^{-1}): 2980 (w), 1743 (m), 1702 (m), 1688 (m), 1625 (s), 1471 (m), 1456 (m), 1228 (m), 1213 (m), 785 (s), 770 (s), 747 (s), 728 (m), 624 (m).

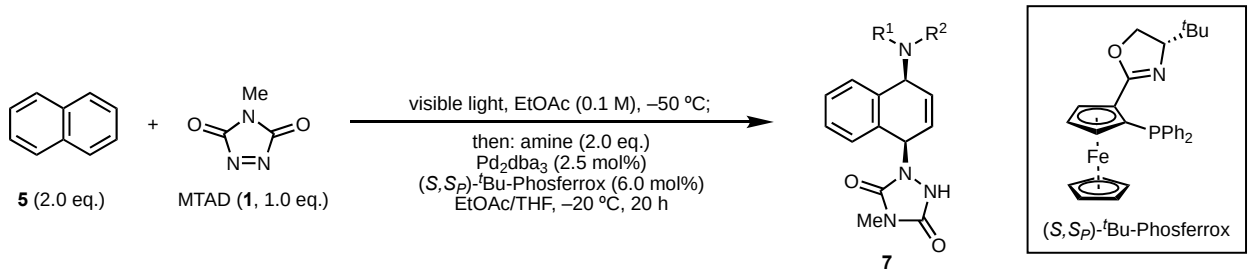
m.p.: 100–101 °C.

Observed HMBC correlation:

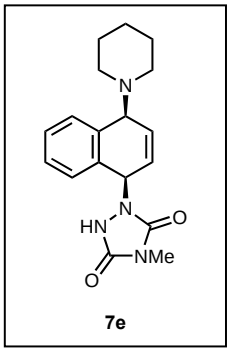


3-4. Asymmetric dearomative *syn*-1,4-diamination of naphthalene (7e, 7f, 7i, 7l, 7m)

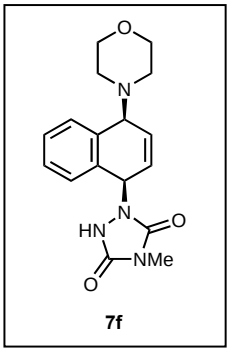
General procedure D for the asymmetric dearomative *syn*-1,4-diamination of naphthalene (Table 4)



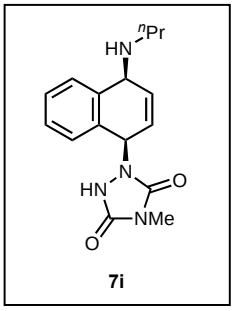
MTAD (**1**, 56.7 mg, 0.50 mmol, 1.0 eq.) was combined with naphthalene (**5**, 128 mg, 1.0 mmol, 2.0 eq.) and a stir bar in a test tube with a septum as the cap under nitrogen atmosphere. Ethyl acetate (5.0 mL, 0.1 M) was added to the test tube at rt, the contents were stirred until completely dissolved and then cooled to –50 ºC. The resulting pink solution was stirred under irradiation with LED lights at –50 ºC until the solution became colorless (approximately 6 h). After turning off the lights, to this solution at –50 ºC were added an amine (2.0 mmol, 2.0 eq.) and a solution of $Pd_2(dba)_3$ (11.4 mg, 0.0125 mmol, 2.5 mol%) and (*S*,*Sp*)-*t*Bu-Phosferrox (14.9 mg, 0.03 mmol, 6.0 mol%) in THF (2.0 mL), and the resulting mixture was stirred at –20 ºC for 20 h. The reaction was then warmed up to rt, concentrated under reduced pressure, and purified by flash column chromatography (SiO_2, CH_2Cl_2:MeOH mixture).



Synthesis of 7e (Table 4): Following the general procedure D, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (saturated with NH_3) = 95:5 to 85:15) as a white solid (107.5 mg, 66%). Enantiomeric excess was determined with HPLC analysis using Diacel Chiracel® OD-3 column, 25% ^{i}PrOH in *n*-hexane, 0.8 mL/min. 97:3 er, t_R(major) = 11.2 min, t_R(minor) = 7.9 min.
$[\alpha]_D^{20}$ = +204.4 (c = 0.50 in $CHCl_3$)



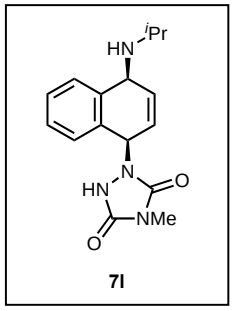
Synthesis of 7f (Table 4): Following the general procedure D, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (saturated with NH_3) = 95:5 to 85:15) as a white solid (86.5 mg, 53%). Enantiomeric excess was determined with HPLC analysis using Diacel Chiracel® IA-3 column, 50% ^{i}PrOH in *n*-hexane, 0.8 mL/min. 99:1 er, t_R(major) = 6.1 min, t_R(minor) = 4.3 min.
$[\alpha]_D^{20}$ = +952.0 (c = 0.10 in $CHCl_3$)



7i

Synthesis of 7i (Table 4): Following the general procedure D, the title compound was isolated by flash chromatography (SiO_2, CH_2Cl_2:MeOH (saturated with NH_3) = 98:2 to 85:15) as a white solid (140.2 mg, 93%). Both the free N–H bonds in **7i** were acetylated prior to HPLC analysis and taking optical rotation. Enantiomeric excess was determined with HPLC analysis using Diacel Chiracel® IA-3 column, 10% ^{i}PrOH in *n*-hexane, 0.8 mL/min. 97:3 er, t_R(major) = 10.4 min, t_R(minor) = 8.5 min.

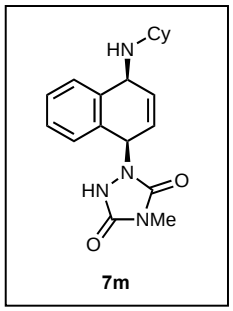
$[\alpha]_D^{20}$ = –363.9 (c = 0.50 in $CHCl_3$)



7l

Synthesis of 7l (Table 4): Following the general procedure D, the title compound was isolated by flash chromatography (SiO_2, *n*-hexane:EtOAc = 2:1 to 1:1) as a white solid (131.8 mg, 88%). The double bond was hydrogenated and both the free N–H bonds in **7l** were acetylated prior to HPLC analysis and taking optical rotations. Enantiomeric excess was determined with HPLC analysis using Diacel Chiracel® OD-3 column, 20% ^{i}PrOH in *n*-hexane, 0.8 mL/min. >99:1 er, t_R(major) = 10.0 min, t_R(minor) = 11.6 min.

$[\alpha]_D^{20}$ = +64.3 (c = 1.00 in $CHCl_3$)

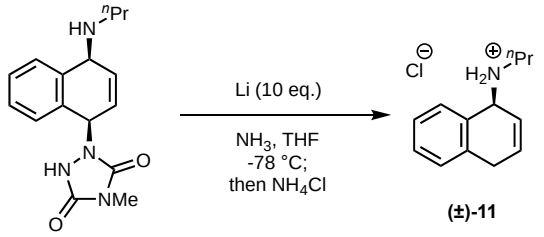


7m

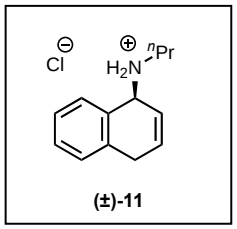
Synthesis of 7m (Table 4): Following the general procedure D, the title compound was isolated by flash chromatography (SiO_2, *n*-hexane:EtOAc = 2:1 to 1:1) as a white solid (142.6 mg, 84%). Both the free N–H bonds in **7m** were acetylated prior to HPLC analysis and taking optical rotation. Enantiomeric excess was determined with HPLC analysis using Diacel Chiracel® IA-3 column, 25% ^{i}PrOH in *n*-hexane, 0.8 mL/min. 97:3 er, t_R(major) = 6.4 min, t_R(minor) = 4.8 min.

$[\alpha]_D^{20}$ = –397.6 (c = 0.50 in $CHCl_3$)

3-5. Derivatizations of (±)-7i



(±)-7i (±)-11



(±)-11

Synthesis of (±)-11 (Figure 2): **(±)-7i** (75 mg, 0.25 mmol, 1.0 eq.) was added to a 100 mL three-necked flask charged with a stir bar. To the flask was then attached a bubbler and purged thoroughly with nitrogen gas, and the flask was cooled in an acetone/dry ice bath. Next, ammonia was introduced as a gas into the flask, and approximately 10 mL of liquid ammonia was allowed to condense in the flask. After turning off the ammonia and putting the flask back under nitrogen pressure, small chunks of lithium metal (approximately 17.4 mg, 10 eq., 2.5 mmol) were added to the reaction and allowed to stir until the whole solution became dark blue. At this point ammonium chloride was added to quench the remaining lithium and then the reaction was poured over a saturated ammonium chloride solution (100 mL), extracted with dichloromethane (3 × 100 mL), dried over magnesium sulfate, and concentrated under reduced pressure. The resulting residue was purified by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 99:1 to 9:1) as a yellow solid (33.6 mg, 60%).

$\boldsymbol{R_f}$ = 0.23 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

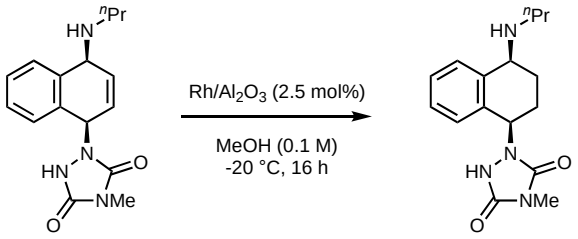
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.41 (d, *J* = 7.5 Hz, 1H), 7.24 (t, *J* = 7.4 Hz, 1H), 7.20 (t, *J* = 6.8 Hz, 1H), 7.15 (d, *J* = 7.3 Hz, 1H), 6.10 (dt, *J* = 10.1, 3.4 Hz, 1H), 6.03 (ddd, *J* = 10.1, 3.7, 1.7 Hz, 1H), 4.38 (q, *J* = 3.8 Hz, 1H), 3.46 – 3.41 (m, 1H), 3.36 – 3.31 (m, 1H), 2.53 (dt, *J* = 11.1, 7.1 Hz, 1H), 2.39 (dt, *J* = 11.1, 7.3 Hz, 1H), 1.46 (sextet, *J* = 7.0 Hz, 2H), 0.88 (t, *J* = 7.4 Hz, 3H).

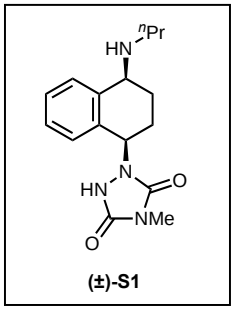
^{13}C NMR: (125 MHz, $CDCl_3$) δ 136.9, 135.2, 128.4, 128.3, 128.2, 127.1, 126.6, 126.3, 53.9, 46.9, 30.0, 23.8, 12.0.

HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{18}N$ $[M+H]^+$ calc.: 188.1434; found: 188.1436.

IR: (ATR, neat, cm^{-1}): 3392 (w), 3024 (m), 2949 (s), 1742 (s), 1604 (m), 1460 (m), 1374 (m), 1217 (w), 750 (s).

m.p.: 205–207 ºC.





Synthesis of (±)-S1: To a round bottom flask charged with a stir bar was added **(±)-7i** (1.96 g, 6.5 mmol, 1.0 eq.) and 5% Rh on Alumina (336 mg, 0.16 mmol, 0.025 eq.) and MeOH (65 mL, 0.10 M). The flask was purged by bubbling nitrogen gas through the resulting suspension at room temperature. Then a hydrogen-containing balloon was used to bubble hydrogen gas through the suspension at room temperature for approximately five minutes before cooling to –20 °C and stirring under a hydrogen atmosphere until complete conversion was observed (as monitored by NMR; usually about 16 hours). After complete conversion, the reaction was warmed up to room temperature, purged with nitrogen atmosphere, and filtered over a pad of celite using MeOH. The resulting filtrate was concentrated under reduced pressure and purified by flash chromatography (SiO_2, EtOAc then CH_2Cl_2/MeOH = 9:1 to 4:1) as a white solid (1.64 g, 83%).

R_f = 0.19 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

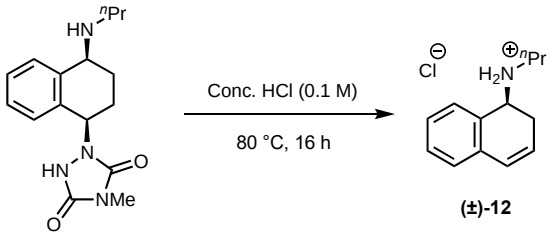
^{1}H NMR: (500 MHz, $CDCl_3$) δ 10.42 (br, 2H), 7.49 (d, *J* = 7.6 Hz, 1H), 7.34 (td, *J* = 7.6, 1.2 Hz, 1H), 7.21 (td, *J* = 7.5, 1.1 Hz, 1H), 7.07 (d, *J* = 7.5 Hz, 1H), 5.63 (dd, *J* = 10.2, 3.5 Hz, 1H), 4.02-4.01 (m, 1H), 3.03 (s, 3H), 2.68 (td, *J* = 11.7, 5.4 Hz, 1H), 2.61 (td, *J* = 11.7, 5.4 Hz, 1H), 2.28 – 2.22 (m, 1H), 2.16 – 2.15 (m, 1H), 1.97 – 1.67 (m, 4H), 0.87 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 155.8, 152.2, 137.0, 132.7, 131.3, 130.6, 129.6, 127.8, 54.8, 48.4, 46.8, 25.6, 25.3, 21.3, 19.8, 11.6.

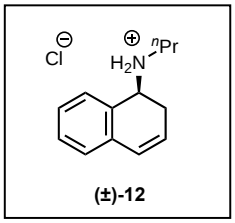
HRMS: (ESI-TOF, m/z) calcd. For $C_{16}H_{23}N_4O_2$ $[M+H]^+$ calc.: 303.1816; found: 303.1813.

IR: (ATR, neat, cm^{-1}): 3383 (w), 2966 (w), 1682 (m), 1595 (s), 1467 (m), 1389 (w), 1288 (w), 1159 (w), 758 (w), 732 (w), 650 (w).

m.p.: 116–118 ºC.



(±)-S1 (±)-12



(±)-12

Synthesis of (±)-12 (Figure 2): **(±)-S1** (20 mg, 0.066 mmol) was dissolved in concentrated aqueous HCl (0.66 mL, 0.1 M) in a 4 mL vial. The vial was sealed without any exclusion of air and heated to 80 °C for 16 hours. Upon cooling, the contents of the vial were concentrated under reduced pressure. The resulting residue was purified by flash chromatography (SiO_2 CH_2Cl_2:MeOH = 99:1 to 9:1) as a yellow solid (7.1 mg, 48%).

R_f = 0.29 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

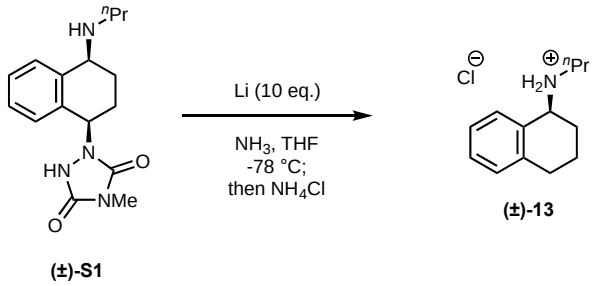
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.4 Hz, 1H), 7.37 (td, *J* = 7.5, 1.1 Hz, 1H), 7.30 (td, *J* = 7.5, 1.1 Hz, 1H), 7.16 (d, *J* = 7.4 Hz, 1H), 6.61 (dd, *J* = 9.7, 2.9 Hz, 1H), 6.03 (ddd, *J* = 8.9, 5.7, 2.4 Hz, 1H), 4.52 (d, *J* = 6.2 Hz, 1H), 3.15 (ddd, *J* = 19.2, 5.7, 1.4 Hz, 1H), 2.78 – 2.73 (m, 2H), 2.62 – 2.56 (m, 1H), 1.85 – 1.76 (m, 2H), 0.86 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 134.4, 130.5, 130.4, 128.2, 128.1, 127.3, 126.2, 125.0, 53.1, 45.3, 26.8, 20.0, 11.5.

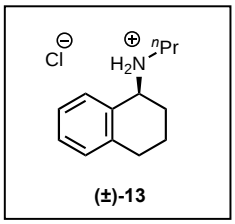
HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{18}N$ $[M+H]^+$ calc.: 188.1434; found: 188.1437**.**

IR: (ATR, neat, cm^{-1}): 3397 (w), 2965 (w), 1687 (s), 1590 (m), 1472 (m), 1266 (w), 980 (w), 761 (s), 731 (s), 698 (m), 517 (m).

m.p.: 70–72 ºC decomposed.



(±)-S1 (±)-13



(±)-13

Synthesis of (±)-13 (Figure 2): **(±)-S1** (75 mg, 1.0 eq., 0.25 mmol) was added to a 100 mL three-necked flask charged with a stir bar. Next, the flask and attached bubbler were purged thoroughly with nitrogen gas, and THF (10 mL, 0.025 M) was added to dissolve the substrate. The flask was cooled in an acetone/dry ice bath. Next, ammonia was introduced as a gas into the flask, and approximately 10 mL of liquid ammonia was allowed to condense in the flask. After turning off the ammonia and putting the flask back under nitrogen pressure, small chunks of lithium metal (approximately 17.4 mg, 10 eq., 2.5 mmol) were added to the reaction and allowed to stir until the whole solution became dark blue. At this point ammonium chloride was added to quench the remaining lithium and then the reaction was poured over a saturated ammonium chloride solution (100 mL), extracted with CH_2Cl_2 (3 × 100 mL), dried over magnesium sulfate, and concentrated under reduced pressure. The resulting residue was purified by flash chromatography (SiO_2 CH_2Cl_2:MeOH = 99:1 to 9:1) as a yellow solid (39.7 mg, 71%).

$\boldsymbol{R_f}$ = 0.29 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

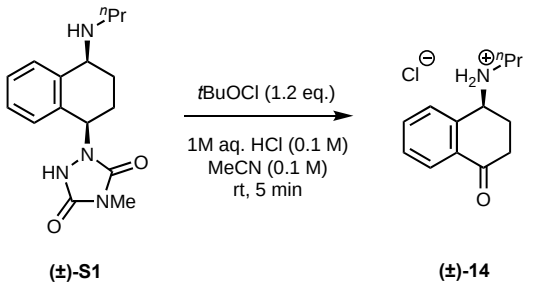
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.34 (m, 1H), 7.17 – 7.12 (m, 2H), 7.09 – 7.07 (m, 1H), 3.77 (t, *J* = 4.9 Hz, 1H), 2.81 (dt, *J* = 11.2, 5.6 Hz, 1H), 2.75 – 2.61 (m, 3H), 2.00 – 1.91 (m, 1H), 1.89 – 1.85 (m, 2H), 1.77 – 1.70 (m, 1H), 1.54 (sextet, *J* = 7.3 Hz, 2H), 0.95 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 139.4, 137.4, 129.2, 128.8, 126.7, 125.8, 55.5, 49.4, 29.5, 28.5, 23.7, 19.1, 12.1.

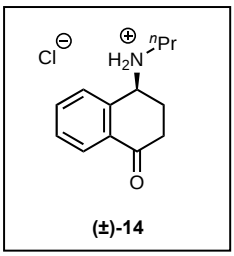
HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{20}N$ $[M+H]^+$ calc.: 190.1590; found: 190.1600.

IR: (ATR, neat, cm^{-1}): 3018 (w), 2928 (s), 2862 (m), 1489 (w), 1451 (m), 1107 (w), 739 (s).

m.p.: 160–162 °C.



(±)-S1 **(±)-14**



(±)-14

Synthesis of (±)-14 (Figure 2): The title compound was synthesized by dissolving **(±)-S1** (36 mg, 0.12 mmol, 1.0 eq.) in 1 M aqueous HCl (1.2 mL, 0.1 M). Following dissolution, *t*BuOCl (16 uL, 0.14 mmol) in MeCN (1.2 mL, 0.1 M) was added dropwise to the aqueous solution containing the substrate. Upon waiting five minutes, the contents of the vial were concentrated under reduced pressure and isolated by flash chromatography (SiO_2, *n*-hexanes:EtOAc = 9:1 to EtOAc) as a white solid (14.4 mg, 50%).

$\boldsymbol{R_f}$ = 0.37 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

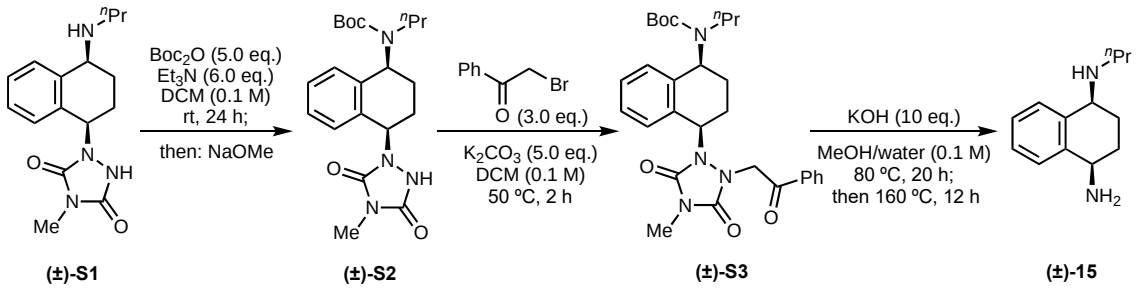
^{1}H NMR: (500 MHz, $CDCl_3$) δ 9.97 (br, 2H), 8.07 (d, *J* = 7.7 Hz, 1H), 7.79 (d, *J* = 7.7 Hz, 1H), 7.61 (t, *J* = 7.3 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 4.58 (b, 1H), 3.17 (dt, *J* = 17.5, 6.7 Hz, 1H), 2.85 (t, *J* = 7.7 Hz, 2H), 2.67 (dt, *J* = 17.5, 5.7 Hz, 1H), 2.57 – 2.54 (m, 2H), 1.90 – 1.89 (m, 2H), 0.93 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 195.3, 135.5, 134.2, 133.0, 130.0, 129.3, 128.1, 54.9, 46.2, 34.6, 24.9, 19.8, 11.5.

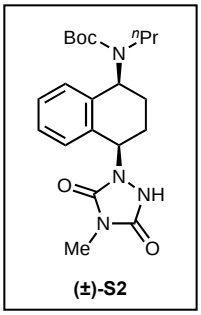
HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{18}NO$ $[M+H]^+$ calc.: 204.1383; found: 204.1386.

IR: (ATR, neat, cm^{-1}): 3387 (w), 2967 (w), 2791 (w), 1685 (s), 1604 (m), 1451 (m), 1287 (w), 767 (m), 733 (m).

m.p.: 105–107 ºC decomposed.



(±)-S1 (±)-S2 (±)-S3 (±)-15



(±)-S2

Synthesis of (±)-S2: The title compound was synthesized by dissolving **(±)-S1** (100 mg, 0.33 mmol, 1.0 eq.) in CH_2Cl_2 (3.3 mL, 0.10 M) and then triethyl amine (276 µL, 1.98 mmol, 6.0 eq.) and di-*tert*-butyl dicarbonate (334 µL, 1.65 mmol, 5.0 eq.) was added at 0 ºC. The reaction was allowed to stir for 24 hours at room temperature (or until complete conversion by TLC). Then, NaOMe (25% weight solution in MeOH, 2 mL) was added dropwise to the mixture and the reaction was allowed to stir for five more minutes at room temperature. The contents were then diluted with 50 mL of CH_2Cl_2 and 1 M HCl was added until the pH = 1. The aqueous layer was then extracted with CH_2Cl_2 (3 × 50 mL), and the combined organic layers were dried over $MgSO_4$, filtered, and concentrated under reduced pressure. The desired compound was isolated by flash chromatography (SiO_2, EtOAc) as a white solid (105 mg, 79%).

$\boldsymbol{R_f}$ = 0.20 (EtOAc, UV, $KMnO_4$).

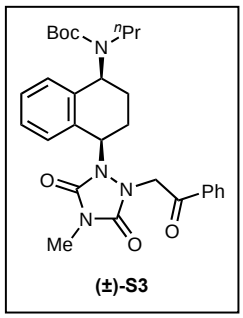
^{1}H NMR: (500 MHz, $CDCl_3$) 7.30 - 7.15 (m, 4H), 5.35 – 5.34 (m, 1H), 4.28 (br, 1H), 3.43 – 3.33 (m, 2H), 3.08 (s, 3H), 2.44 - 2.42 (m, 1H), 2.28 – 2.25 (m, 1H), 2.07 – 1.95 (m, 2H), 1.74 – 1.67 (m, 2H), 1.39 (s, 9H), 0.97 (t, *J* = 6.5 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 154.7 (overlap of 2 peaks detected by HSQC and HMBC), 152.2, 139.1, 131.5, 130.6, 129.4, 127.4, 126.0, 81.0, 57.9, 52.8 (overlap of 2 peaks detected by HSQC), 28.6, 28.3, 25.1, 23.25, 23.17, 11.5.

HRMS: (ESI-TOF, m/z) calcd. For $C_{21}H_{30}N_4NaO_4$ $[M+Na]^+$ calc.: 425.2159; found: 425.2156.

IR: (ATR, neat, cm^{-1}): 3137 (w), 2968 (w), 1767 (w), 1687 (s), 1474 (m), 1410 (m), 1366 (m), 1148 (m), 742 (m).

m.p.: 73-74 ºC.



(±)-S3

Synthesis of (±)-S3 (Figure 2): The title compound was synthesized by combining **(±)-S2** (500 mg, 1.2 mmol, 1.0 eq.) with K_2CO_3 (858 mg, 6.2 mmol, 5.0 eq.) in 12 mL of CH_2Cl_2 and then 2-bromoacetophenone (371 mg, 1.9 mmol, 1.5 eq.) was added as a solid. The reaction was allowed to stir at room temperature for 24 hours and then 50 mL of water was added and the aqueous layer was extracted with CH_2Cl_2 (3 × 100 mL). The organic layers were combined, dried over $MgSO_4$, and concentrated under reduced pressure. The desired compound was isolated by flash chromatography (SiO_2, *n*-hexane:EtOAc = 4:1 to 1:1) as a white solid (523 mg, 81%).

$\boldsymbol{R_f}$ = 0.36 (*n*-hexane:EtOAc = 2:1, UV, $KMnO_4$).

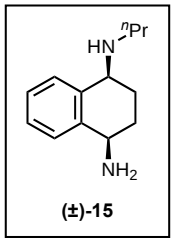
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.55 – 7.41 (m, 3H), 7.23 – 7.15 (m, 4H) 6.90 (t, *J* = 7.7 Hz, 1H), 6.60 (t, *J* = 7.3 Hz, 1H), 5.46 – 5.40 (m, 1H), 5.03 (d, *J* = 18.9 Hz, 1H), 4.68 (d, *J* = 18.9 Hz, 1H), 4.24 (br, 1H), 3.36 – 3.29 (m, 2H), 3.24 (s, 3H), 2.60 (d, *J* = 14.7 Hz, 1H), 2.27 – 2.04 (m, 2H), 2.01 – 1.90 (m, 1H), 1.78 – 1.61 (m, 2H), 1.50 (s, 9H), 0.97 (t, *J* = 7.5 Hz, 3H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 193.1, 158.0, 156.0, 154.6, 138.3, 134.3, 133.6, 132.9, 129.4, 128.3 (overlap of 2 peaks detected by HSQC), 127.9, 127.3, 125.6, 79.6, 58.7, 53.6, 52.7, 51.9, 28.6, 26.7, 26.0, 24.5, 23.2, 11.6.

HRMS: (ESI-TOF, m/z) calcd. For $C_{29}H_{37}N_4O_5$ $[M+H]^+$ calc.: 521.2764; found: 521.2755.

IR: (ATR, neat, cm^{-1}): 2967 (w), 1711 (m), 1684 (s), 1364 (w), 1246 (w), 1151 (s), 769 (w), 741 (m), 687 (w), 594 (w), 552 (w).

m.p.: 80–81 ºC.



(±)-15

Synthesis of (±)-15 (Figure 2): A degassed mixture of compound **(±)-S3** (100 mg, 0.192 mmol, 1.0 eq.) and 40% aq. potassium hydroxide (0.40 mL, 2.88 mmol, 15 eq.) in methanol (1.0 mL, 0.2 M) in a pressure tube was heated at 80 ºC for 30 h and then at 160 ºC for 20 h under nitrogen atmosphere. After cooling the reaction to rt, volatiles were removed under reduced pressure. The crude residue was purified by flash column chromatography (SiO_2, CH_2Cl_2:MeOH = 5:1, then CH_2Cl_2:MeOH (sat. with NH_3) = 4:1) to afford the compound **(±)-15** as a colorless oil (25.0 mg, 64%).

$\boldsymbol{R_f}$ = 0.40 (CH_2Cl_2:MeOH(sat. with NH_3) = 4:1, $KMnO_4$).

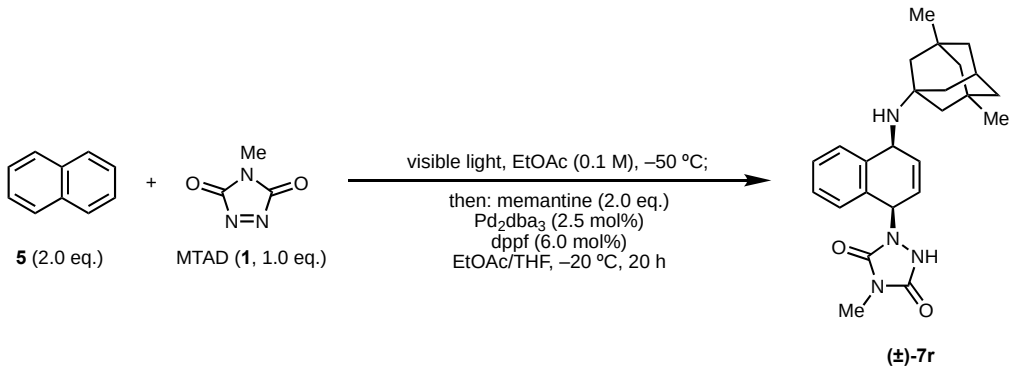
^{1}H NMR: (500 MHz, CD_3OD) δ 7.49 – 7.42 (m, 3H), 7.32 – 7.27 (m, 1H), 4.48 (dd, *J* = 5.7, 3.9 Hz, 1H), 4.24 (dd, *J* = 4.9, 3.2 Hz, 1H), 2.81 (ddd, *J* = 11.8, 8.9, 6.0 Hz, 1H), 2.58 (ddd, *J* = 11.8, 8.9, 6.4 Hz, 1H), 2.38 – 2.26 (m, 1H), 2.26 – 1.97 (m, 3H), 1.71 – 1.51 (m, 2H), 0.94 (t, *J* = 7.4 Hz, 3H).

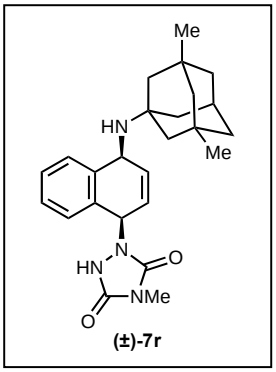
^{13}C NMR: (125 MHz, CD_3OD) δ 141.2, 139.0, 129.8, 129.3, 128.9, 128.4, 74.5, 56.7, 50.4, 28.4, 26.0, 23.6, 12.1.

HRMS: (ESI-TOF, m/z) calcd. For $C_{13}H_{21}N_2$ $[M+H]^+$ calc.: 205.1705; found: 205.1707.

IR: (ATR, neat, cm^{-1}): 2930 (w), 1594 (m), 1493 (w), 1450 (w), 1366 (m), 1281 (w), 1056 (w), 1027 (w), 953 (w), 757 (m), 734 (w), 698 (s), 530 (w).

3-6. Synthesis and derivatizations of (±)-7r





Synthesis of (±)-7r (Figure 2b): **(±)-7r** was synthesized following the general procedure A, with the following modifications: the reaction was run on a 1.50 mmol (MTAD, **1**) scale and the other reagents were scaled accordingly; memantine was prepared from dissolving 5 mmol of Memantine•HCl salt in 100 mL of H_2O and 100 mL of CH_2Cl_2 and increasing the pH of the aqueous layer to at least 12 with KOH, stirred rapidly until everything was dissolved, and then extracted with 3:1 $CHCl_3$:*i*PrOH (3 × 100 mL). The title compound was isolated by flash column chromatography (two columns: (SiO_2, CH_2Cl_2:MeOH = 19:1 to 9:1) and (C_{18} reverse phase SiO_2, H_2O:MeOH = 19:1 to 9:1) as a white solid (416.3 mg, 66%).

$\boldsymbol{R_f}$ = 0.39 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

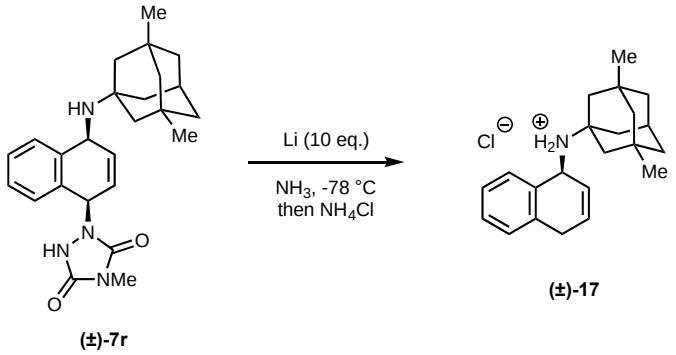
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.42 – 7.41 (m, 1H), 7.31 – 7.27 (m, 2H), 7.21 – 7.20 (m, 1H), 6.51 (dd, *J* = 9.7, 5.4 Hz, 1H), 6.17 (dd, *J* = 9.6, 5.9 Hz, 1H), 5.86 (d, *J* = 5.8 Hz, 1H), 4.55 (d, *J* = 5.3, 1H), 2.99 (s, 3H), 2.15 (m, 1H), 1.63 (q, *J* = 11.5 Hz, 2H), 1.50 (d, *J* = 11.6 Hz, 1H), 1.43 – 1.27 (m, 7H), 1.16 – 1.10 (m, 2H), 0.85 (s, 6H).

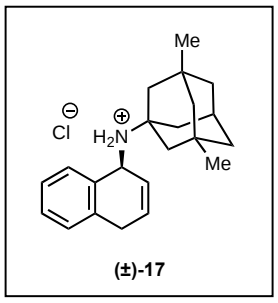
^{13}C NMR: (125 MHz, $CDCl_3$) δ 152.6, 152.2, 139.4, 136.0, 134.7, 129.5, 128.8, 128.5, 128.1, 127.3, 55.5, 50.7, 50.6, 49.1, 48.1, 42.55, 42.52, 41.7, 32.75, 32.74, 30.27, 30.23, 30.21, 25.0.

HRMS: (ESI-TOF, m/z) calcd. For $C_{25}H_{33}N_4O_2$ $[M+H]^+$ calc.: 421.2598; found: 421.2588.

IR: (ATR, neat, cm^{-1}): 3402 (w), 2945 (w), 2904 (m), 2843 (w), 1691 (s), 1611 (s), 1461 (m), 754 (m).

m.p.: 120–121 °C.





Synthesis of (±)-17 (Figure 2): **(±)-7r** (100 mg, 1.0 eq., 0.237 mmol) was added to a 100 mL three-necked flask charged with a stir bar. Next, the flask and attached bubbler were purged thoroughly with nitrogen gas, and then the flask was cooled in an acetone/dry ice bath. Next, ammonia was released as a gas into the flask, and approximately 10 mL of liquid ammonia was allowed to condense in the flask. After turning off the ammonia and putting the flask back under nitrogen pressure, very small chunks of lithium metal were added to the reaction and allowed to stir until the whole solution became dark blue. At this point ammonium chloride was added to quench the remaining lithium, and then the reaction was poured over a saturated ammonium chloride solution (100 mL), extracted with CH_2Cl_2 (3 × 100 mL), dried over magnesium sulfate, and concentrated under reduced pressure. The resulting residue was purified by flash chromatography (SiO_2, *n*-hexane:EtOAc = 100:0 to 1:1) as a white solid (52.4 mg, 64%).

$\boldsymbol{R_f}$ = 0.30 (*n*-hexane:EtOAc = 1:1, UV, $KMnO_4$).

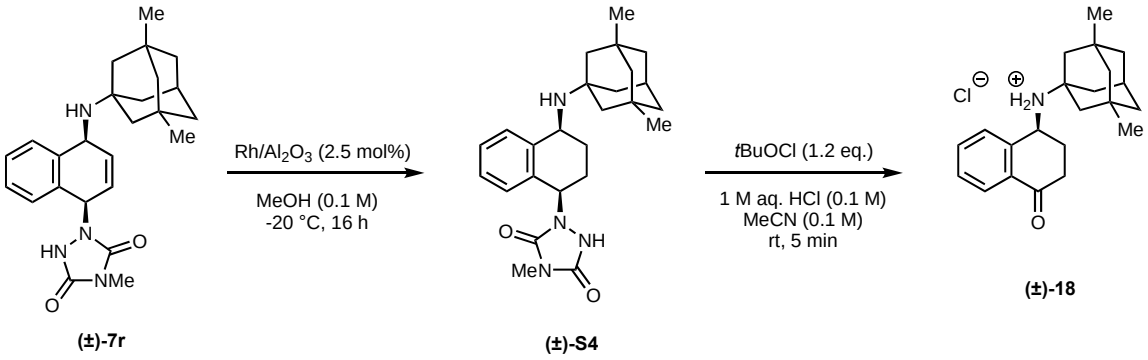
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.7 Hz, 1H), 7.22 (td, *J* = 7.4, 1.3 Hz, 1H), 7.14 (td, *J* = 7.4, 1.3 Hz, 1H), 7.09 (d, *J* = 7.7 Hz, 1H), 5.98 – 5.91 (m, 2H), 4.37 (q, *J* = 4.4, 3.7 Hz, 1H), 3.45 - 3.39 (m, 1H), 3.31 – 3.24 (m, 1H), 2.18 (dt, *J* = 6.1, 3.1 Hz, 1H), 1.65 – 1.15 (m, 12H), 0.88 (s, 6H).

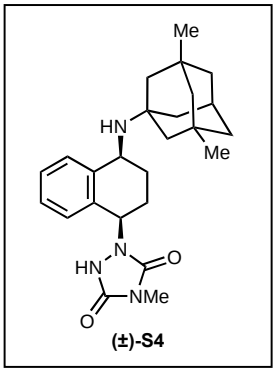
^{13}C NMR: (125 MHz, $CDCl_3$) δ 139.6, 134.5, 131.6, 129.2, 128.1, 126.5, 126.2, 124.6, 53.4, 51.1, 50.62, 50.60, 46.7, 43.1, 42.9, 32.7, 30.60, 30.57, 29.7.

HRMS: (ESI-TOF, m/z) calcd. For $C_{22}H_{30}N$ $[M+H]^+$ calc.: 308.2373; found: 308.2379.

IR: (ATR, neat, cm^{-1}): 2907 (s), 2841 (m), 1740 (m), 1454 (m), 1355 (w), 1196 (w), 746 (m).

m.p.: 68–69 ºC.





Synthesis of (±)-S4: To a 250 mL round bottom flask charged with a stir bar was added **(±)-7r** (40 mg, 0.095 mmol, 1.0 eq.) and 5% Rh on Alumina (5 mg 0.0024 mmol, 0.025 eq.), and 1 mL (0.1 M) of MeOH. The flask was thoroughly purged by bubbling nitrogen gas through the resulting suspension at room temperature. Then a hydrogen-containing balloon was used to bubble hydrogen gas through the suspension at room temperature for approximately five minutes before cooling to -20 °C and stirring under a hydrogen atmosphere until complete conversion was observed (as monitored by NMR; usually about 16 hours). After complete conversion, the reaction was warmed up to room temperature, purged with nitrogen atmosphere, and filtered over a pad of celite using MeOH. The resulting filtrate was concentrated under reduced pressure and purified by flash chromatography (SiO_2, CH_2Cl_2:MeOH = 99:1 to 9:1) as a white solid (23.0 mg, 57%).

$\boldsymbol{R_f}$ = 0.41 (CH_2Cl_2:MeOH = 9:1, UV, $KMnO_4$).

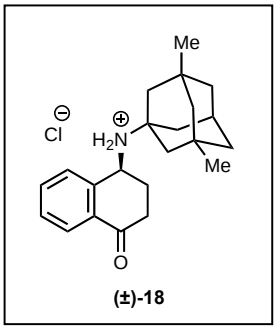
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.22 – 7.17 (m, 4H), 6.27 (br, 2H), 5.41 (t, *J* = 7.9 Hz, 1H), 4.24 (br, 1H), 3.02 (s, 3H), 2.42 – 2.39 (m, 1H), 2.22 – 2.19 (m, 2H), 2.06 (br, 1H), 1.91 (t, *J* = 13.2 Hz, 1H), 1.74 (d, *J* = 10.9 Hz, 1H), 1.67 (d, *J* = 10.9 Hz, 1H), 1.59 – 1.44 (m, 4H), 1.32 (s, 4H), 1.15 (q, *J* = 12.6 Hz, 2H), 0.87 (s, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 154.9, 153.4, 137.2, 136.4, 129.4, 129.2, 128.8, 127.8, 57.6, 51.5, 50.5, 48.8, 47.5, 47.4, 42.5, 40.2, 32.76, 32.75, 30.3, 30.2, 28.7, 25.3, 22.5.

HRMS: (ESI-TOF, m/z) calcd. For $C_{25}H_{35}N_4O_2$ $[M+H]^+$ calc.: 423.2755; found: 423.2764.

IR: (ATR, neat, cm^{-1}): 2912 (m), 2846 (w), 1694 (s), 1610 (m), 1468 (m), 1020 (w), 731 (w).

m.p.: 121–124 ºC decomposed.



(±)-18

Synthesis of (±)-18 (Figure 2): The title compound was synthesized by dissolving **(±)-S4** (38 mg, 0.090 mmol, 1.0 eq.) in 1M aqueous HCl (0.90 mL, 0.1 M). Following dissolution, *t*BuOCl (24 uL, 0.22 mmol, 2.4 eq.) in MeCN (1.2 mL, 0.1 M) was added dropwise to the aqueous solution containing the substrate. Upon waiting five minutes, the contents of the vial were concentrated under reduced pressure and isolated by flash chromatography (SiO_2, *n*-hexane:EtOAc = 9:1 to EtOAc) as a white solid (25.8 mg, 80%).

$\boldsymbol{R_f}$ = 0.24 (*n*-hexane:EtOAc = 1:1, UV, $KMnO_4$).

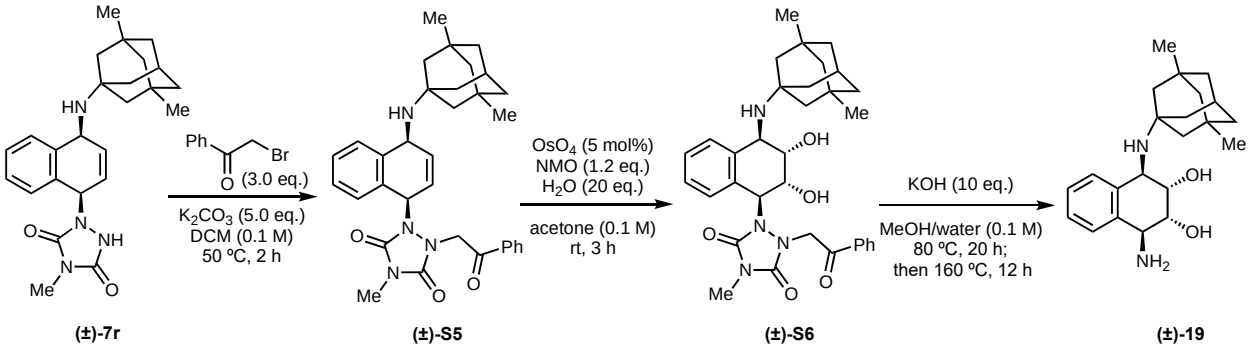
^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.98 (d, *J* = 7.8 Hz, 1H), 7.61 (d, *J* = 7.7 Hz, 1H), 7.53 (t, *J* = 7.2 Hz, 1H), 7.33 (t, *J* = 7.5 Hz, 1H), 4.14 (dd, *J* = 6.8, 3.4 Hz, 1H), 3.07 (ddd, *J* = 17.1, 8.4, 4.2 Hz, 1H), 2.57 (ddd, *J* = 17.2, 8.5, 4.4 Hz, 1H), 2.24 (ddt, *J* = 12.6, 8.2, 3.9 Hz, 1H), 2.18 (dt, *J* = 5.5, 2.7 Hz, 1H), 2.03 – 1.96 (m, 1H), 1.64 – 1.05 (m, 12H), 0.88 (s, 6H).

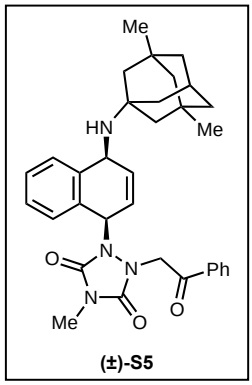
^{13}C NMR: (125 MHz, $CDCl_3$) δ 198.7, 148.7, 133.9, 132.1, 128.5, 127.3, 127.1, 53.4, 51.1, 50.5, 48.5, 43.1, 42.8, 36.0, 33.2, 32.7, 30.5, 29.9.

HRMS: (ESI-TOF, m/z) calcd. For $C_{22}H_{30}NO$ $[M+H]^+$ calc.: 324.2322; found: 324.2321.

IR: (ATR, neat, cm^{-1}): 3384 (w), 3035 (m), 2921 (m), 2313 (w), 1685 (s), 1500 (m), 1401 (m), 1117 (m), 1069 (m), 760 (m).

m.p.: 114–116 ºC decomposed.





Synthesis of (±)-S5 (Figure 2): A mixture of compound **(±)-7r** (50.0 mg, 0.12 mmol, 1.0 eq.), 2'-bromoacetophenone (71.0 mg, 0.36 mmol, 3.0 eq.), and K_2CO_3 (82.2 mg, 0.60 mmol, 5.0 eq.) in dichloromethane (1.2 mL, 0.1 M) was stirred at 50 ºC for 2 h. After cooling to rt, water (2.0 mL) was added, and the organic phase was separated. The aqueous layer was extracted with dichloromethane (3 × 2.0 mL), the combined organic extracts were washed with saturated aqueous sodium chloride solution (20 mL), dried over anhydrous magnesium sulfate, and concentrated under reduced pressure. The crude residue was purified by flash column chromatography (SiO_2, *n*-hexane:EtOAc = 4:1) to afford the compound **(±)-S5** as a colorless oil (45.2 mg, 71%).

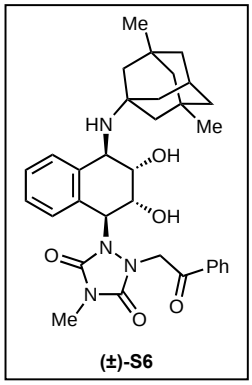
$\boldsymbol{R_f}$ = 0.63 (*n*-hexane:EtOAc = 1:4, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.60 – 7.58 (m, 2H), 7.54 (td, *J* = 7.5, 1.3 Hz, 1H), 7.41 (d, *J* = 7.8 Hz, 1H), 7.36 – 7.33 (m, 2H), 7.13 – 7.08 (m, 2H), 6.91 (t, *J* = 7.5 Hz, 1H), 6.14 (ddd, *J* = 10.2, 3.9, 2.0 Hz, 1H), 5.86 – 5.84 (m, 1H), 5.72 (dd, *J* = 10.2, 3.6 Hz, 1H), 4.96 (d, *J* = 18.4 Hz, 1H), 4.45 (d, *J* = 18.4 Hz, 1H), 4.40 – 4.32 (m, 1H), 3.25 (s, 3H), 2.25 – 2.22 (m, 1H), 1.71 – 1.66 (m, 1H), 1.63 – 1.60 (m, 1H), 1.54 – 1.31 (m, 8H), 1.23 – 1.16 (m, 2H), 0.92 (s, 6H).

^{13}C NMR: (125 MHz, $CDCl_3$) δ 192.1, 156.9, 155.7, 139.3, 135.6, 134.3, 133.9, 131.4, 129.3, 128.6, 128.5, 128.1, 127.9, 127.4, 122.4, 53.8, 52.8, 52.5, 51.0, 50.5, 45.8, 43.0, 42.8, 32.8, 32.7, 30.5, 26.0.

HRMS: (ESI-TOF, m/z) calcd. For $C_{33}H_{39}N_4O_3$ $[M+H]^+$ calc.: 539.3022; found: 539.3029.

IR: (ATR, neat, cm^{-1}): 2899 (w), 1770 (w), 1708 (s), 1693 (s), 1598 (w), 1469 (m), 1449 (m), 1397 (w), 1355 (w), 1225 (m), 1192 (w), 1002 (w), 963 (w), 790 (s), 728 (m), 686 (m), 649 (w), 592 (m).



Synthesis of (±)-S6 (Figure 2): Compound **(±)-S5** (90.0 mg, 0.167 mmol, 1.0 eq.) and 4-methylmorpholine *N*-oxide (25.4 mg, 0.217 mmol, 1.3 eq.) were dissolved in acetone (1.7 mL, 0.1 M) and water (60.0 μL, 3.34 mmol, 20 eq.). To this solution was dropwise added osmium tetroxide (42 μL, 0.2 M solution in acetonitrile, 0.0084 mmol, 5.0 mol%) and the resulting solution was stirred at rt for 3 h. Then the reaction was quenched with saturated aqueous sodium thiosulfate solution (0.3 mL), and diluted with EtOAc (3.0 mL) and water (3.0 mL). The organic phase was separated, then the aqueous layer was extracted with EtOAc (3 × 3.0 mL), the combined organic extracts were washed with saturated aqueous sodium chloride solution (3.0 mL), dried over anhydrous magnesium sulfate, and concentrated under reduced pressure. The crude residue was purified by flash column chromatography (SiO_2, *n*-hexane:EtOAc = 1:4) to afford the compound **(±)-S6** as a colorless oil (76.5 mg, 80%).

$\boldsymbol{R_f}$ = 0.44 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

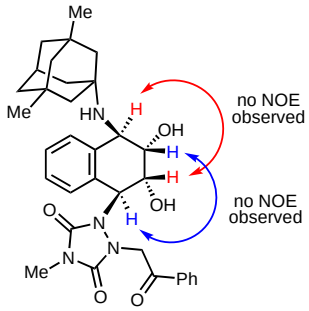
^{1}H NMR: (500 MHz, CD_3OD) δ 7.60 – 7.56 (m, 3H), 7.40 – 7.37 (m, 2H), 7.22 (d, *J* = 7.8 Hz, 1H), 7.09 (d, *J* = 7.8 Hz, 1H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.67 (t, *J* = 7.6 Hz, 1H), 5.44 (d, *J* = 10.1 Hz, 1H), 4.98 (d, *J* = 18.6 Hz, 1H), 4.63 (dd, *J* = 10.1, 2.1 Hz, 1H), 4.35 (d, *J* = 18.6 Hz, 1H), 4.10 – 4.05 (d, *J* = 2.5 Hz, 1H), 4.08 – 4.04 (m, 1H), 3.21 (s, 3H), 2.23 – 2.21 (m, 1H), 1.77 (d, *J* = 11.4 Hz, 1H), 1.62 (d, *J* = 11.7 Hz, 1H), 1.56 – 1.34 (m, 8H), 1.20 – 1.17 (m, 2H), 0.92 (s, 6H).

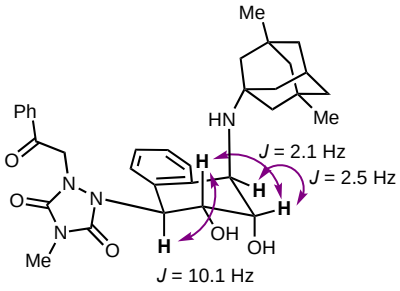
^{13}C NMR: (125 MHz, CD_3OD) δ 194.1, 159.1, 158.9, 139.3, 135.5, 135.2, 135.1, 131.9, 129.7, 129.4, 128.9, 128.5, 127.3, 76.8, 67.7, 60.4, 56.4, 55.0, 54.3, 52.0, 51.0, 50.9, 43.99, 43.97, 43.2, 33.6, 33.5, 31.9, 30.9, 26.1.

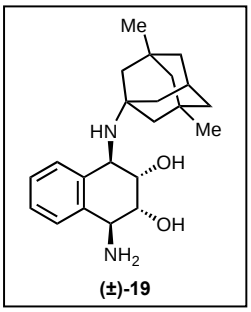
HRMS: (ESI-TOF, m/z) calcd. For $C_{33}H_{41}N_4O_5$ $[M+H]^+$ calc.: 573.3077; found: 573.3068.

IR: (ATR, neat, cm^{-1}): 2903 (w), 1770 (w), 1692 (s), 1477 (m), 1450 (w), 1226 (m), 753 (w), 686 (w).

Observed NOE correlations and *J* couplings:







Synthesis of (±)-19 (Figure 2): A degassed mixture of compound **(±)-S6** (100 mg, 0.175 mmol, 1.0 eq.) and 40% aq. potassium hydroxide (0.24 mL, 1.75 mmol, 10 eq.) in methanol (1.7 mL, 0.1 M) in a pressure tube was heated at 80 ºC for 24 h and then at 160 ºC for 12 h under nitrogen atmosphere. After cooling the reaction to rt, volatiles were removed under reduced pressure. The crude residue was purified by flash column chromatography (SiO_2, CH_2Cl_2:MeOH = 10:1) to afford the compound **(±)-19** as a colorless oil (36.3 mg, 58%).

$\boldsymbol{R_f}$ = 0.44 (CH_2Cl_2:MeOH = 5:1, UV, $KMnO_4$).

^{1}H NMR: (500 MHz, CD_3OD) δ 7.46 – 7.31 (m, 4H), 4.32 – 4.21 (m, 2H), 4.14 – 4.06 (m, 1H), 4.01 – 3.98 (m, 1H), 2.20 (s, 1H), 1.72 (d, *J* = 12.7 Hz, 1H), 1.57 (d, *J* = 11.9 Hz, 1H), 1.53 – 1.43 (m, 8H), 1.21 – 1.15 (m, 2H), 0.90 (s, 6H).

^{13}C NMR: (125 MHz, CD_3OD) δ 139.3, 134.5, 132.1, 129.9, 128.7, 126.8, 76.2, 70.2, 56.2, 54.8, 53.4, 51.9, 51.0, 50.9, 44.0, 43.2, 33.52, 33.51, 31.9, 30.9.

HRMS: (ESI-TOF, m/z) calcd. For $C_{22}H_{33}N_2O_2$ $[M+H]^+$ calc.: 357.2542; found: 357.2540.

IR: (ATR, neat, cm^{-1}): 2898 (br), 2839 (m), 2454 (w), 1559 (w), 1453 (s), 1336 (w), 1066 (m), 977 (w), 757 (m), 630 (w).

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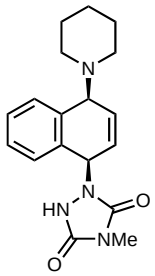
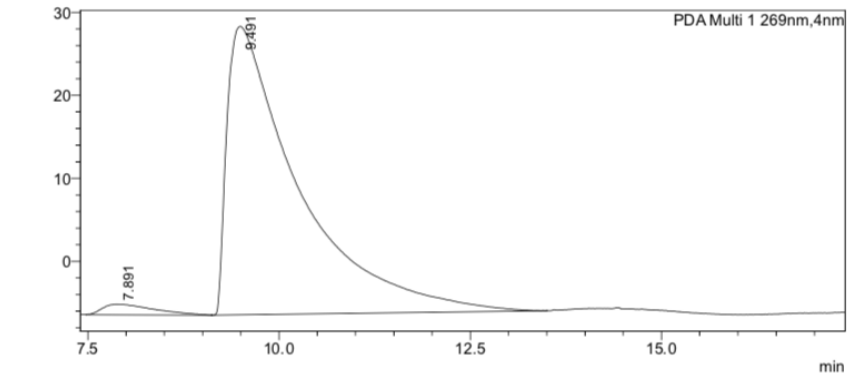
5. HPLC spectra



7e

<Chromatogram>



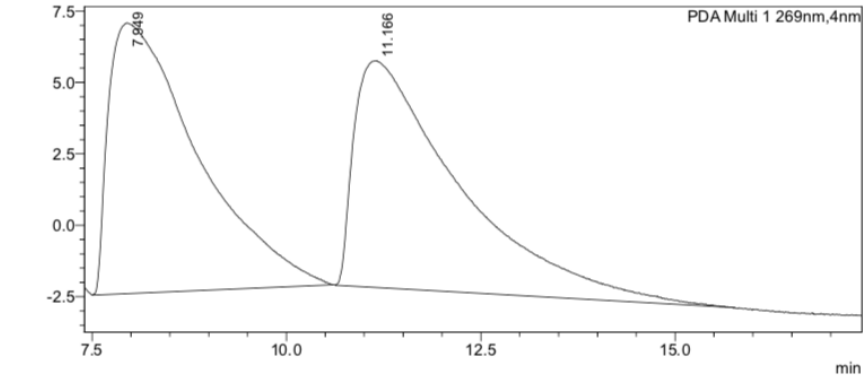
<Peak Table>

PDA Ch1 269nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	7.891	58885	1270	0.000	2.532	3.528
2	9.491	2266868	34733	0.000	97.468	96.472
Total		2325754	36003		100.000	100.000

Racemic

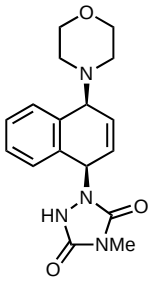
<Chromatogram>



<Peak Table>

PDA Ch1 269nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	7.949	749546	9475	0.000	50.174	54.409
2	11.166	744361	7940	0.000	49.826	45.591
Total		1493907	17415		100.000	100.000



7f

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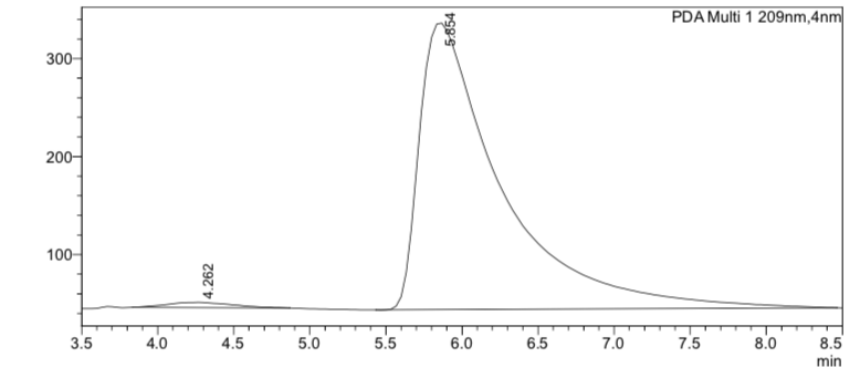


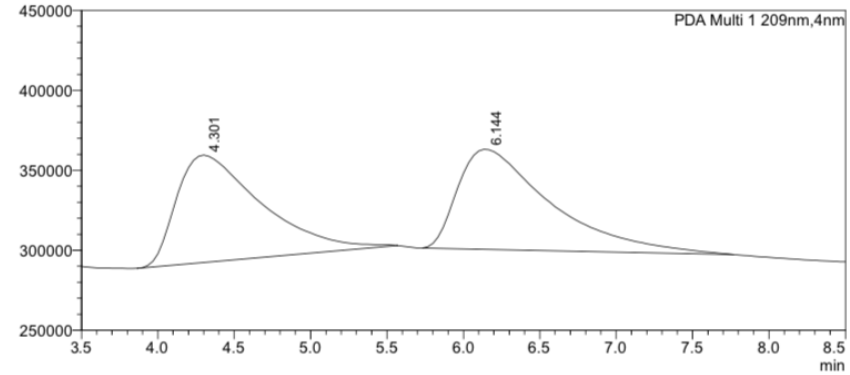
<Peak Table>

PDA Ch1 209nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	4.262	161268	5406	0.000	1.447	1.816
2	5.854	10980408	292212	0.000	98.553	98.184
Total		11141676	297618		100.000	100.000

Racemic

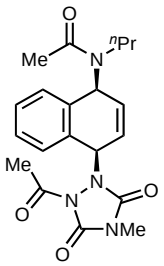
<Chromatogram>



<Peak Table>

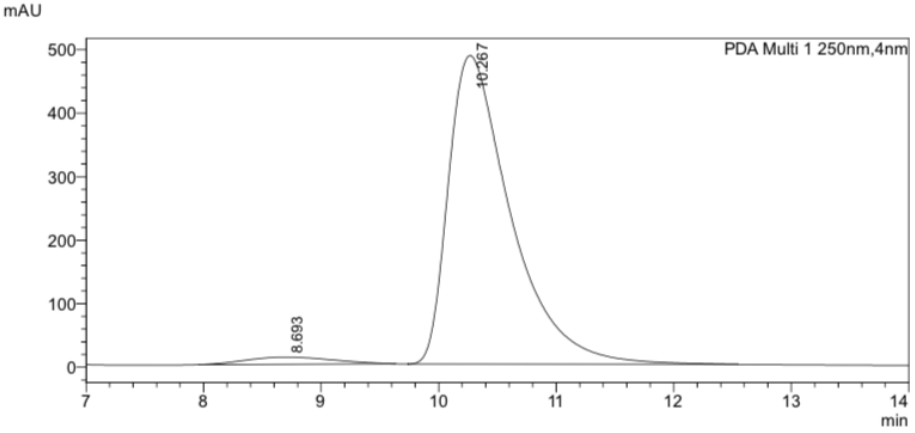
PDA Ch1 209nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	4.301	2593062	67152	0.000	49.637	51.769
2	6.144	2630980	62562	0.000	50.363	48.231
Total		5224041	129714		100.000	100.000



7i–bis acetate

<Chromatogram>



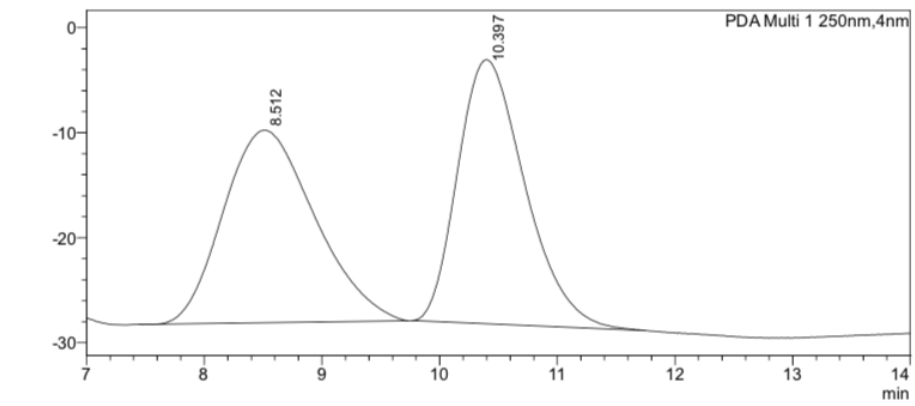
<Peak Table>

PDA Ch1 250nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	8.693	583617	11312	0.000	3.148	2.276
2	10.267	17953330	485797	0.000	96.852	97.724
Total		18536947	497108		100.000	100.000

Racemic

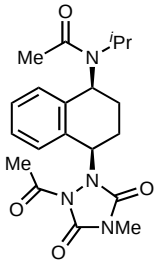
<Chromatogram>



<Peak Table>

PDA Ch1 250nm

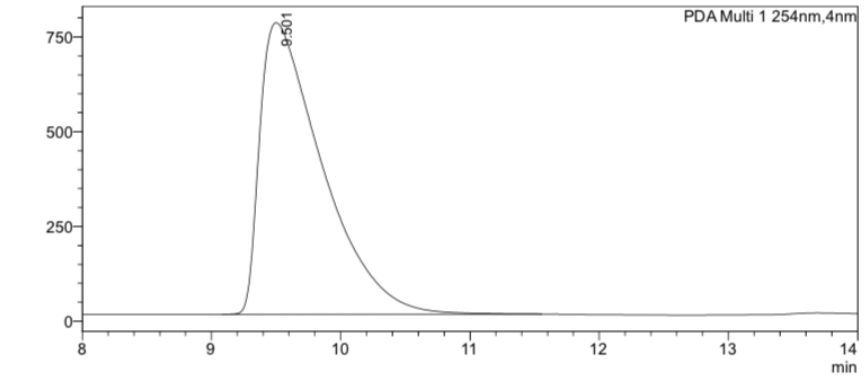
Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	8.512	990075	18328	0.000	49.752	42.168
2	10.397	999946	25137	0.000	50.248	57.832
Total		1990021	43465		100.000	100.000



7l–bis acetate

<Chromatogram>

mAU



<Peak Table>

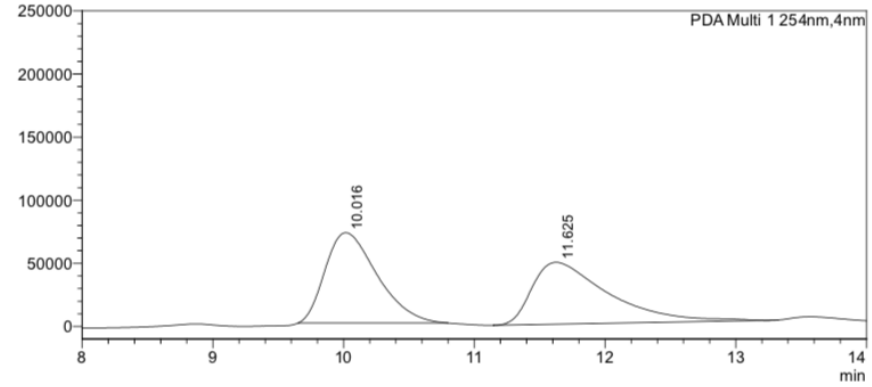
PDA Ch1 254nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	9.501	25860139	769241	0.000	100.000	100.000
Total		25860139	769241		100.000	100.000

Racemic

<Chromatogram>

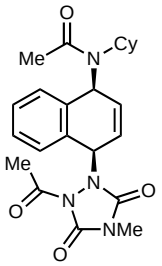
uAU



<Peak Table>

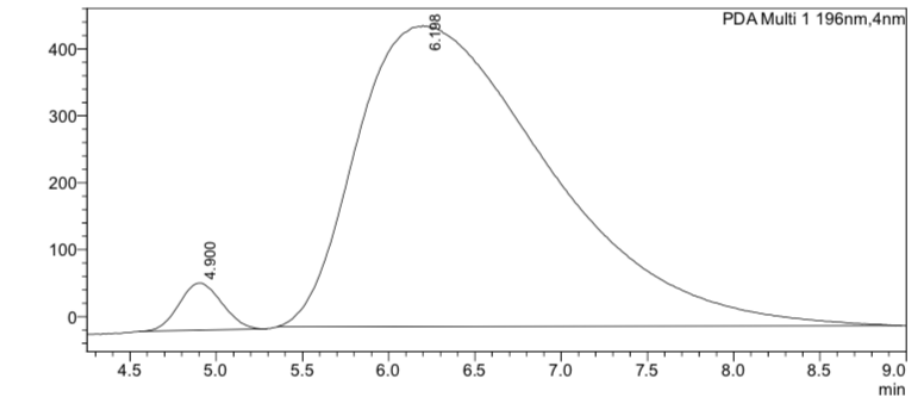
PDA Ch1 254nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	10.016	1980518	71601	0.000	50.041	59.377
2	11.625	1977254	48987	0.000	49.959	40.623
Total		3957772	120589		100.000	100.000



7m–bis acetate

<Chromatogram>



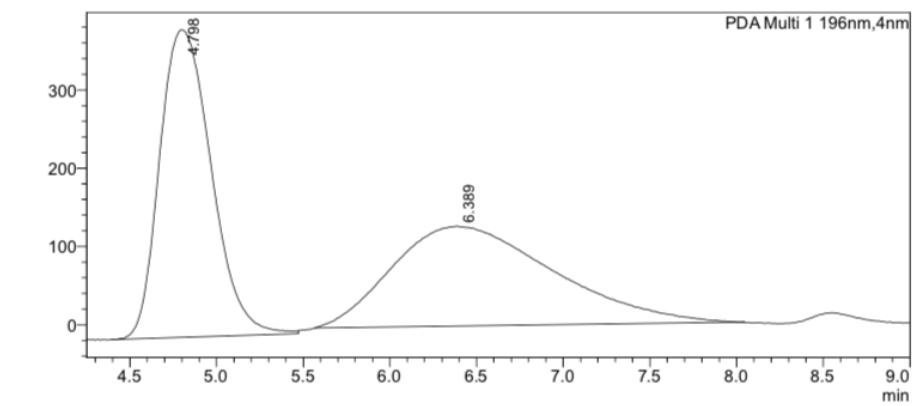
<Peak Table>

PDA Ch1 196nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	4.900	1216791	70277	0.000	3.367	13.515
2	6.198	34921391	449736	0.000	96.633	86.485
Total		36138181	520013		100.000	100.000

Racemic

<Chromatogram>

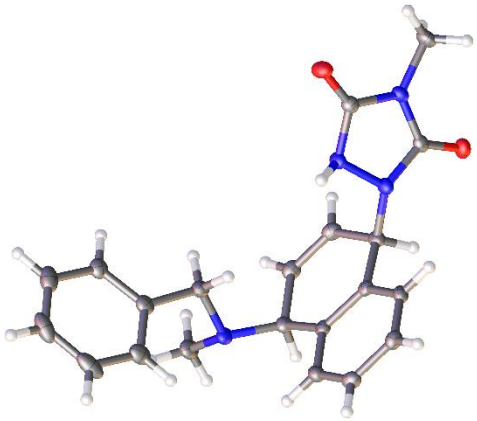


<Peak Table>

PDA Ch1 196nm

Peak#	Ret. Time	Area	Height	Conc.	Area%	Height%
1	4.798	8153484	392943	0.000	49.729	75.479
2	6.389	8242271	127658	0.000	50.271	24.521
Total		16395754	520601		100.000	100.000

6. Crystallographic Data



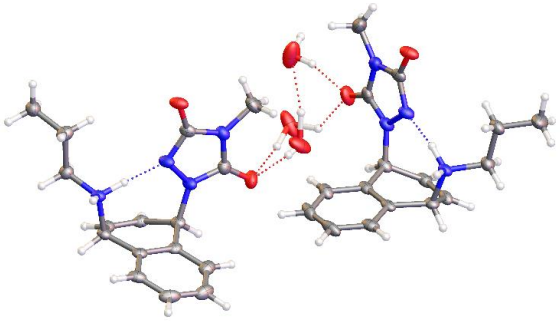
Crystallographic Data for compound (±)-7a

Single crystals of compound **(±)-7a** were obtained by slow recrystallization from *n*-hexanes/ethyl acetate mixtures. A suitable crystal was selected and diffraction data were collected on a Bruker D8 Venture/Photon 100 diffractometer. The crystal was kept at 100.03 K during data collection.

Table 1 Crystal data and structure refinement for compound (±)-7a.

Identification code	CCDC 1877219
Empirical formula	$C_{21}H_{22}N_4O_2$
Formula weight	362.42
Temperature/K	100.03
Crystal system	triclinic
Space group	P-1
a/Å	9.5948(2)
b/Å	12.3669(3)
c/Å	16.3965(4)
α/°	99.9720(10)
β/°	104.3150(10)
γ/°	91.5190(10)
Volume/Å^3	1851.78(8)
Z	4
ρ_{calc}g/cm^3	1.300
μ/mm^{-1}	0.692
F(000)	768.0
Crystal size/mm^3	0.143 × 0.129 × 0.048
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	5.66 to 136.796
Index ranges	-11 ≤ h ≤ 11, -14 ≤ k ≤ 14, -19 ≤ l ≤ 19
Reflections collected	27751
Independent reflections	6678 [R_{int} = 0.0355, R_{sigma} = 0.0293]
Data/restraints/parameters	6678/0/498
Goodness-of-fit on F^2	1.068
Final R indexes [I>=2σ (I)]	R_1 = 0.0365, wR_2 = 0.0805
Final R indexes [all data]	R_1 = 0.0449, wR_2 = 0.0851
Largest diff. peak/hole / e Å^{-3}	0.21/-0.21

Crystallographic Data for compound (±)-7i

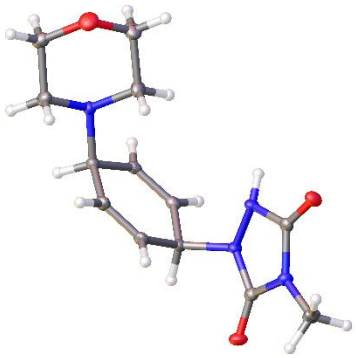


Twin crystals of compound **(±)-7i** were obtained by slow recrystallization from CH_2Cl_2/diethyl ether mixtures. A suitable crystal was selected and diffraction data were collected on a Bruker D8 Venture/Photon 100 diffractometer. The crystal was kept at 100.01 K during data collection.

Table 1 Crystal data and structure refinement for compound (±)-7i.

Identification code	CCDC 1877220
Empirical formula	$C_{16}H_{21.31}N_4O_{2.66}$
Formula weight	312.20
Temperature/K	100.01
Crystal system	triclinic
Space group	P-1
a/Å	9.8206(4)
b/Å	11.1581(5)
c/Å	15.3236(7)
α/°	101.9240(10)
β/°	100.7390(10)
γ/°	100.1540(10)
Volume/Å^3	1573.33(12)
Z	4
ρ_{calc}g/cm^3	1.318
μ/mm^{-1}	0.092
F(000)	666.0
Crystal size/mm^3	0.561 × 0.39 × 0.238
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	4.33 to 56.72
Index ranges	$-13 \leq h \leq 13$, $-14 \leq k \leq 14$, $-20 \leq l \leq 20$
Reflections collected	117799
Independent reflections	117799 [R_{int} = 0.0542, R_{sigma} = 0.0645]
Data/restraints/parameters	117799/1/463
Goodness-of-fit on F^2	1.028
Final R indexes [I>=2σ (I)]	R_1 = 0.0550, wR_2 = 0.1245
Final R indexes [all data]	R_1 = 0.0798, wR_2 = 0.1374
Largest diff. peak/hole / e Å^{-3}	0.47/-0.29

Crystallographic Data for compound 8d



Single crystals of compound **8d** were obtained by slow recrystallization from dichloromethane/diethyl ether mixtures. A suitable crystal was selected and diffraction data were collected on a Bruker D8 Venture/Photon 100 diffractometer. The crystal was kept at 99.95 K during data collection.

Table 1 Crystal data and structure refinement for 8d.

Identification code	CCDC 1877221
Empirical formula	$C_{13}H_{18}N_4O_3$
Formula weight	278.31
Temperature/K	99.95
Crystal system	monoclinic
Space group	C2/c
a/Å	22.4136(10)
b/Å	6.0223(3)
c/Å	19.9058(8)
α/°	90
β/°	94.244(2)
γ/°	90
Volume/Å^3	2679.5(2)
Z	8
ρ_{calc}g/cm^3	1.380
μ/mm^{-1}	0.101
F(000)	1184.0
Crystal size/mm^3	0.404 × 0.222 × 0.128
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	5.284 to 54.372
Index ranges	$-28 \leq h \leq 28$, $-7 \leq k \leq 7$, $-25 \leq l \leq 25$
Reflections collected	28276
Independent reflections	2980 [R_{int} = 0.0367, R_{sigma} = 0.0170]
Data/restraints/parameters	2980/0/196
Goodness-of-fit on F^2	1.050
Final R indexes [I>=2σ (I)]	R_1 = 0.0376, wR_2 = 0.0947
Final R indexes [all data]	R_1 = 0.0402, wR_2 = 0.0969
Largest diff. peak/hole / e Å^{-3}	0.27/-0.29

Crystallographic Data for compound 8f

Single crystals of compound **8f** were obtained by slow recrystallization from dichloromethane/diethyl ether mixtures. A suitable crystal was selected and diffraction data were collected on a Bruker D8 Venture/Photon 100 diffractometer. The crystal was kept at 99.99 K during data collection.

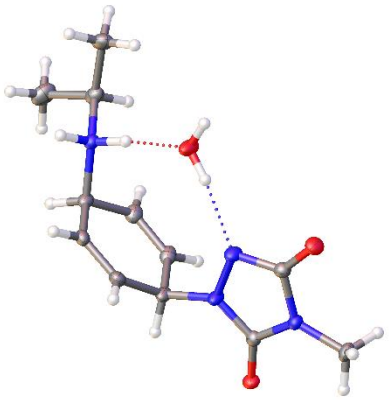
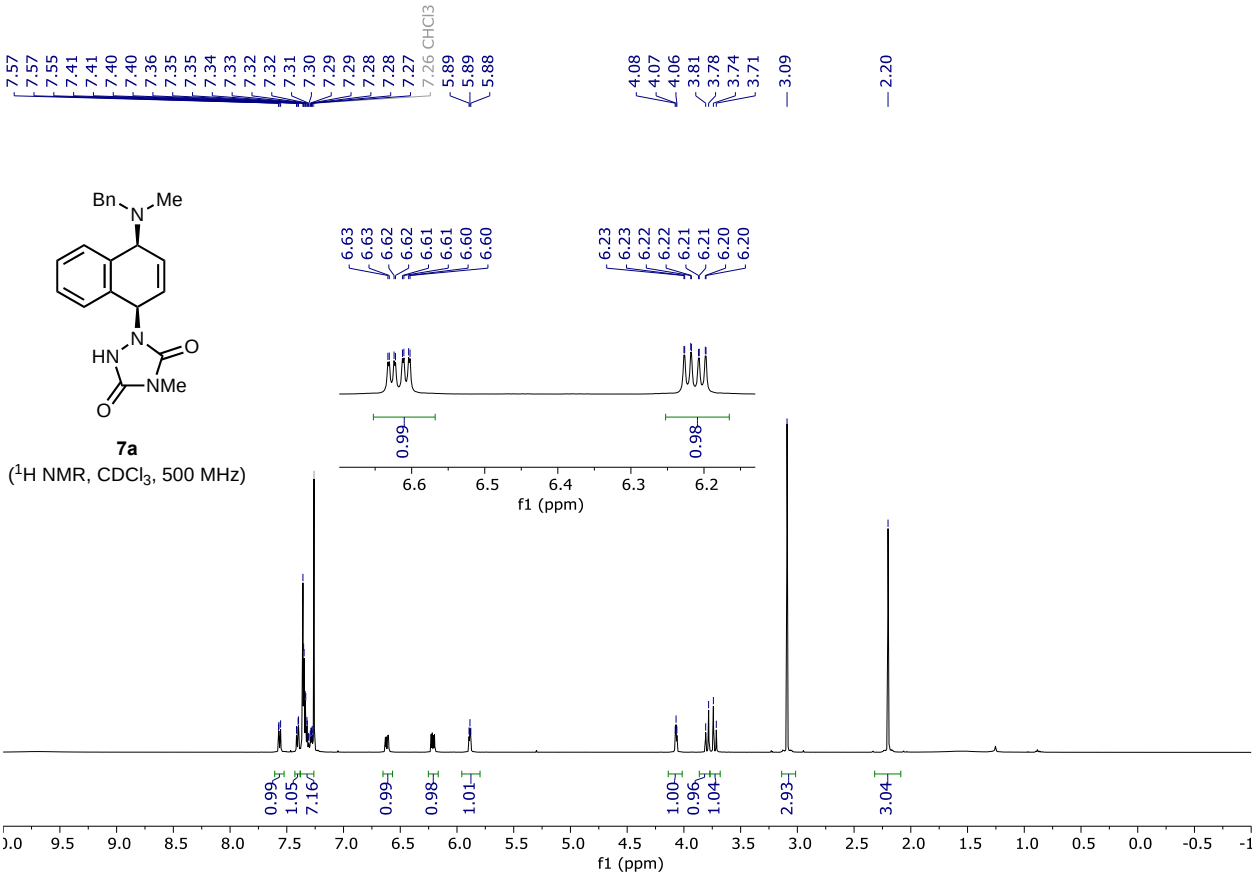


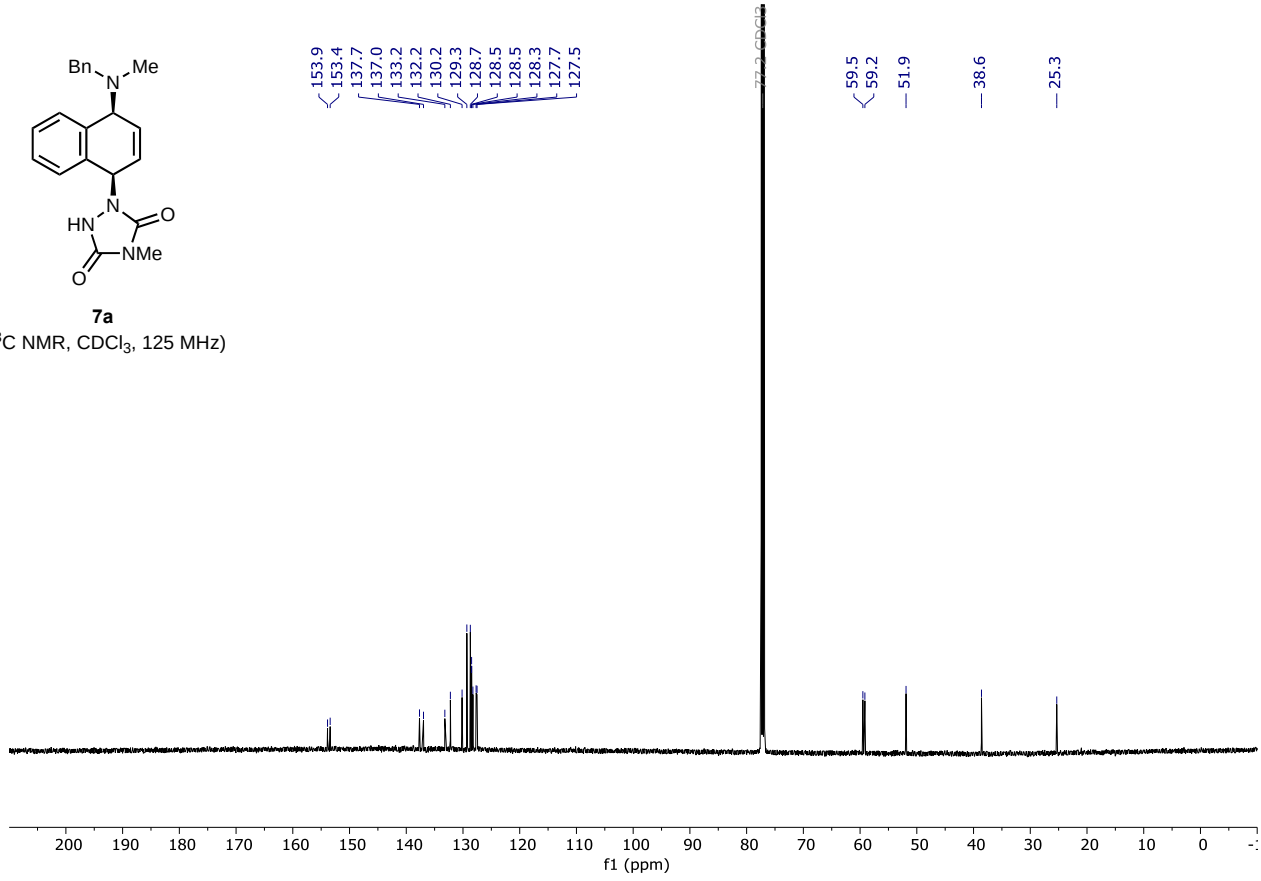
Table 1 Crystal data and structure refinement for 8f.

Identification code	CCDC 1877222
Empirical formula	$C_{12}H_{20}N_4O_3$
Formula weight	268.32
Temperature/K	99.99
Crystal system	triclinic
Space group	P-1
a/Å	8.0480(3)
b/Å	8.8580(4)
c/Å	10.9924(5)
α/°	69.1109(16)
β/°	76.8504(17)
γ/°	68.7540(16)
Volume/Å^3	678.01(5)
Z	2
ρ_{calc}g/cm^3	1.314
μ/mm^{-1}	0.096
F(000)	288.0
Crystal size/mm^3	0.317 × 0.154 × 0.08
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	5.176 to 52.886
Index ranges	-10 ≤ h ≤ 10, -11 ≤ k ≤ 11, -13 ≤ l ≤ 13
Reflections collected	5557
Independent reflections	2779 [R_{int} = 0.0192, R_{sigma} = 0.0255]
Data/restraints/parameters	2779/0/188
Goodness-of-fit on F^2	1.107
Final R indexes [I>=2σ (I)]	R_1 = 0.0472, wR_2 = 0.0940
Final R indexes [all data]	R_1 = 0.0584, wR_2 = 0.0980
Largest diff. peak/hole / e Å^{-3}	0.28/-0.23

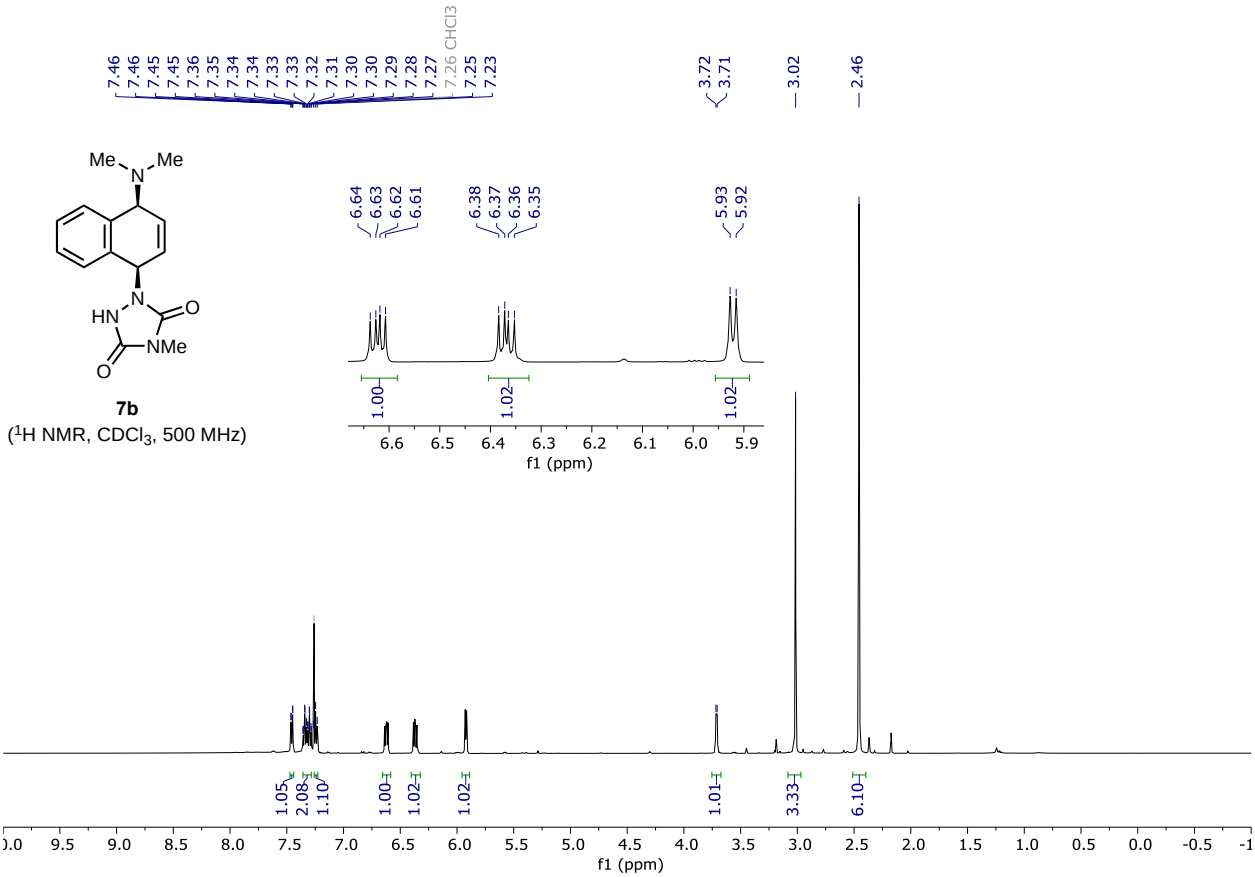
7. ^{1}H and ^{13}C NMR Spectra



7a
(^{1}H NMR, $CDCl_3$, 500 MHz)

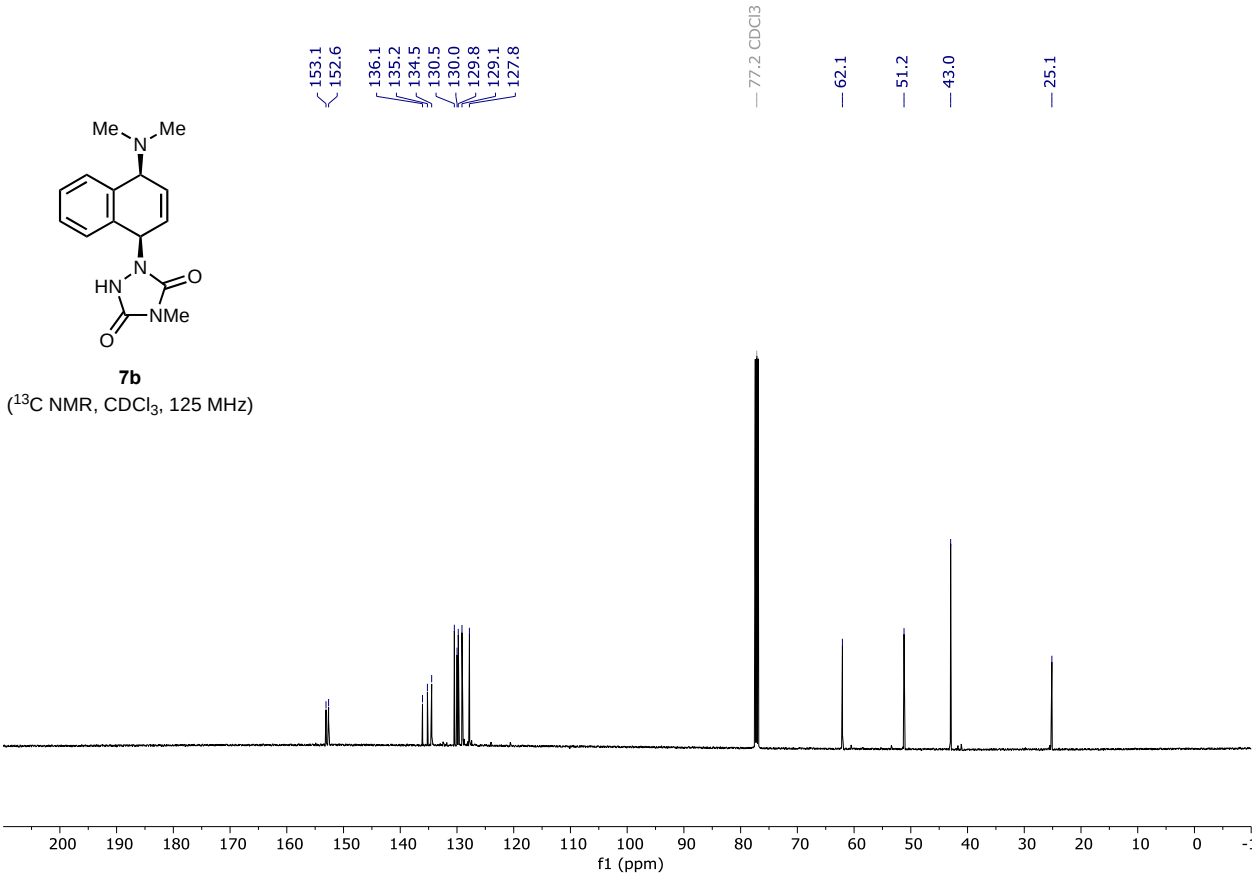


7a
(^{13}C NMR, $CDCl_3$, 125 MHz)



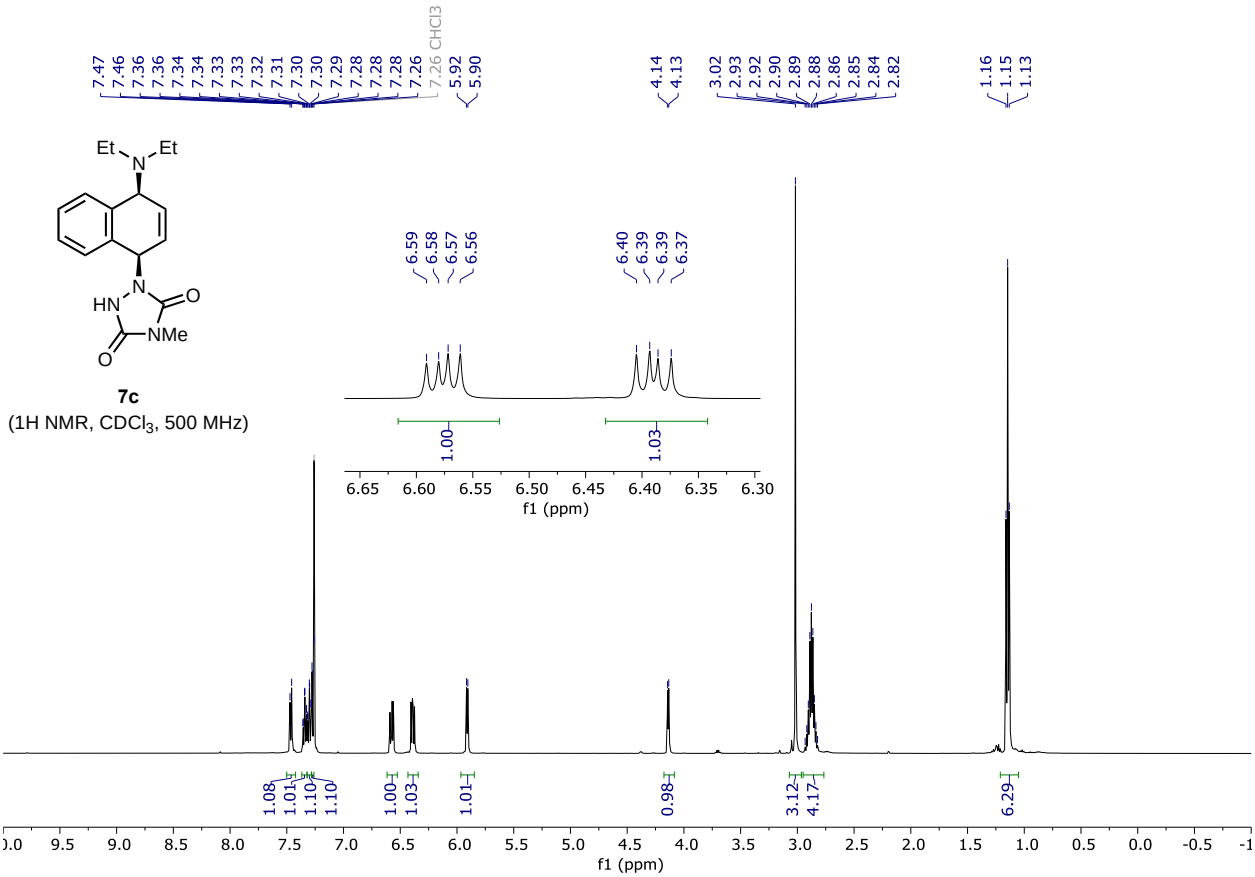
7b

(^{1}H NMR, $CDCl_3$, 500 MHz)



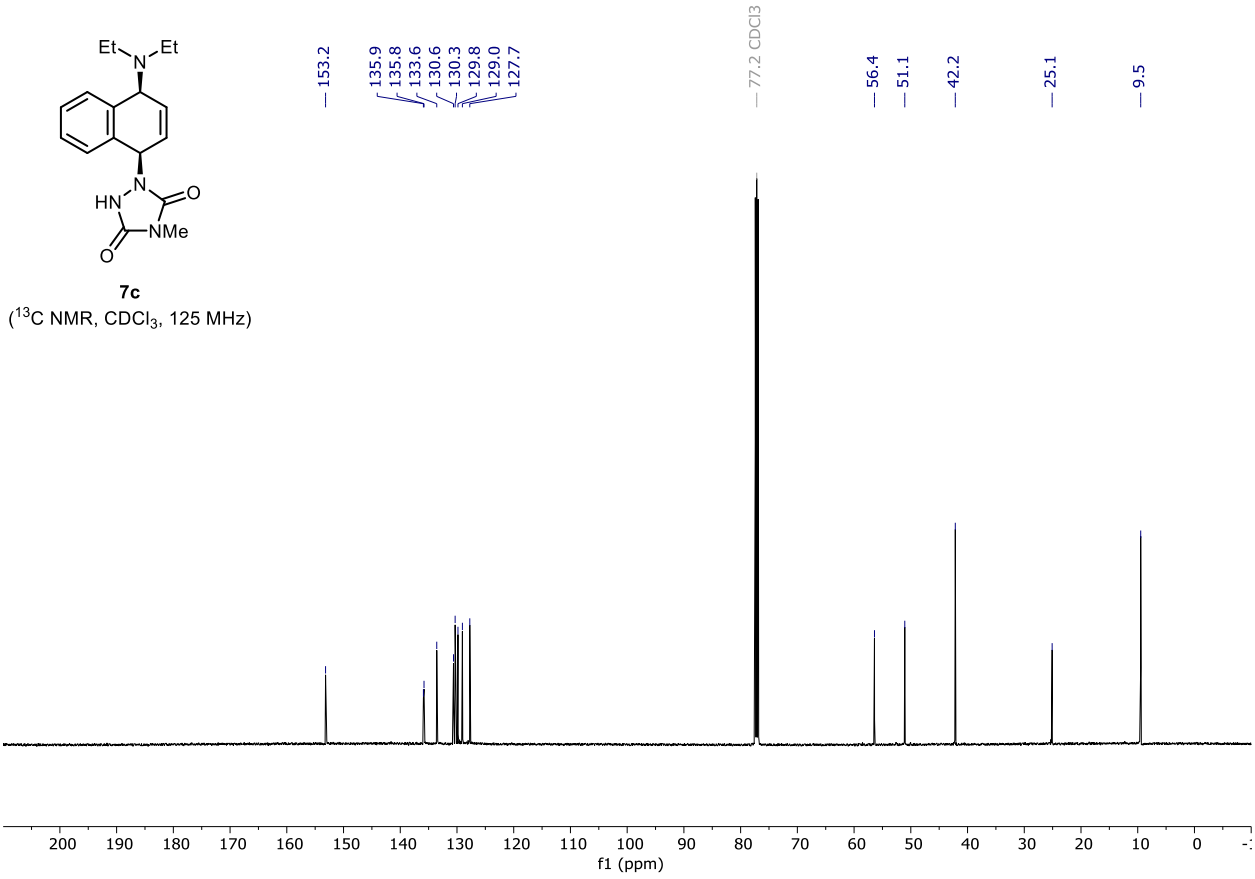
7b

(^{13}C NMR, $CDCl_3$, 125 MHz)



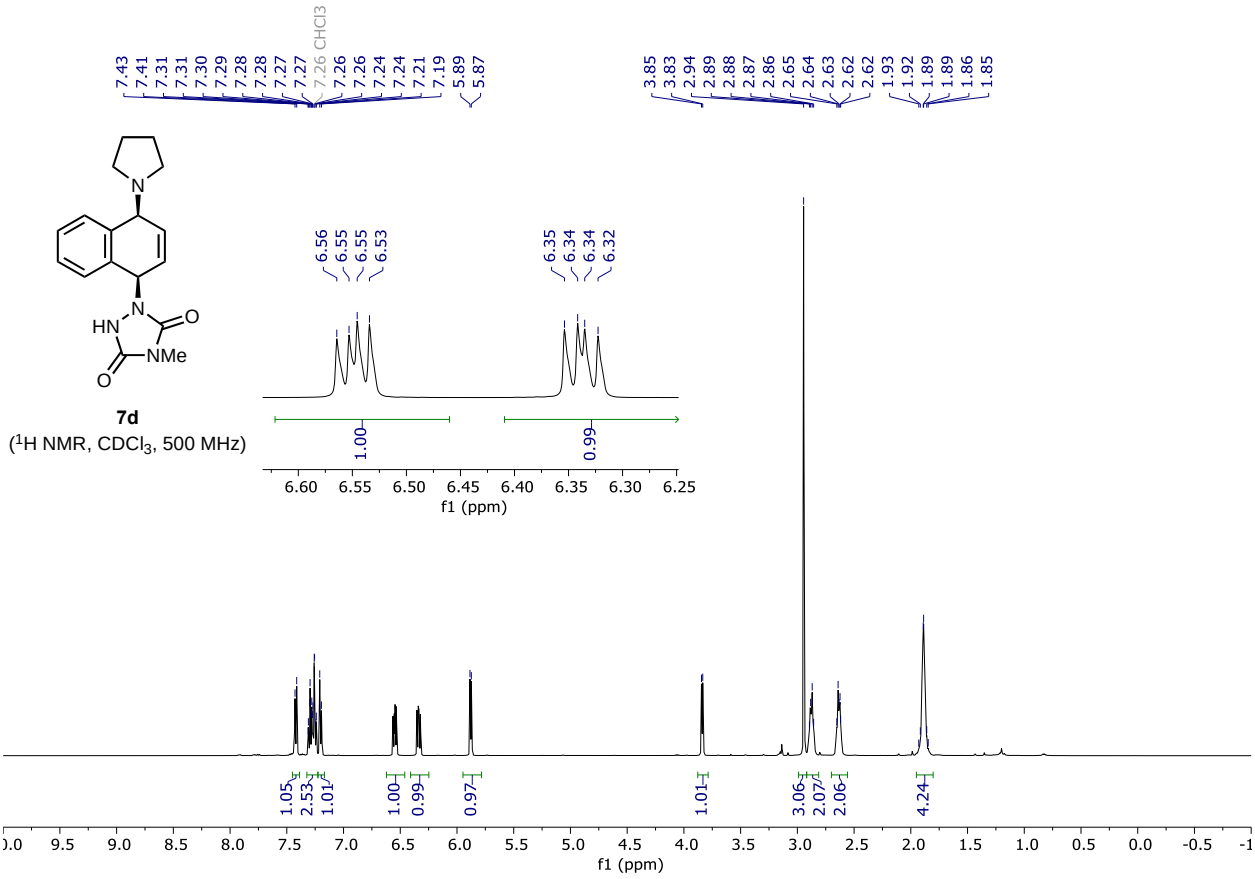
7c

(1H NMR, $CDCl_3$, 500 MHz)

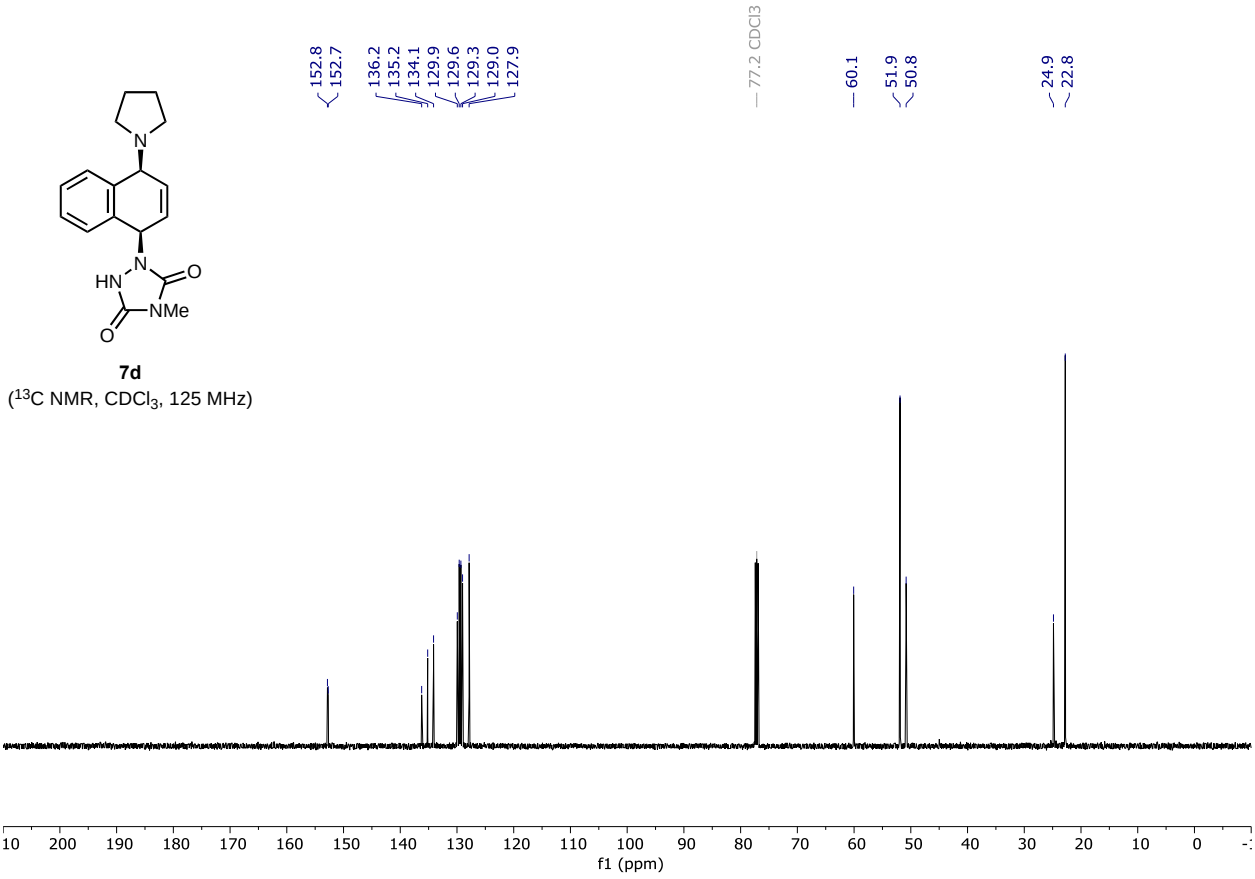


7c

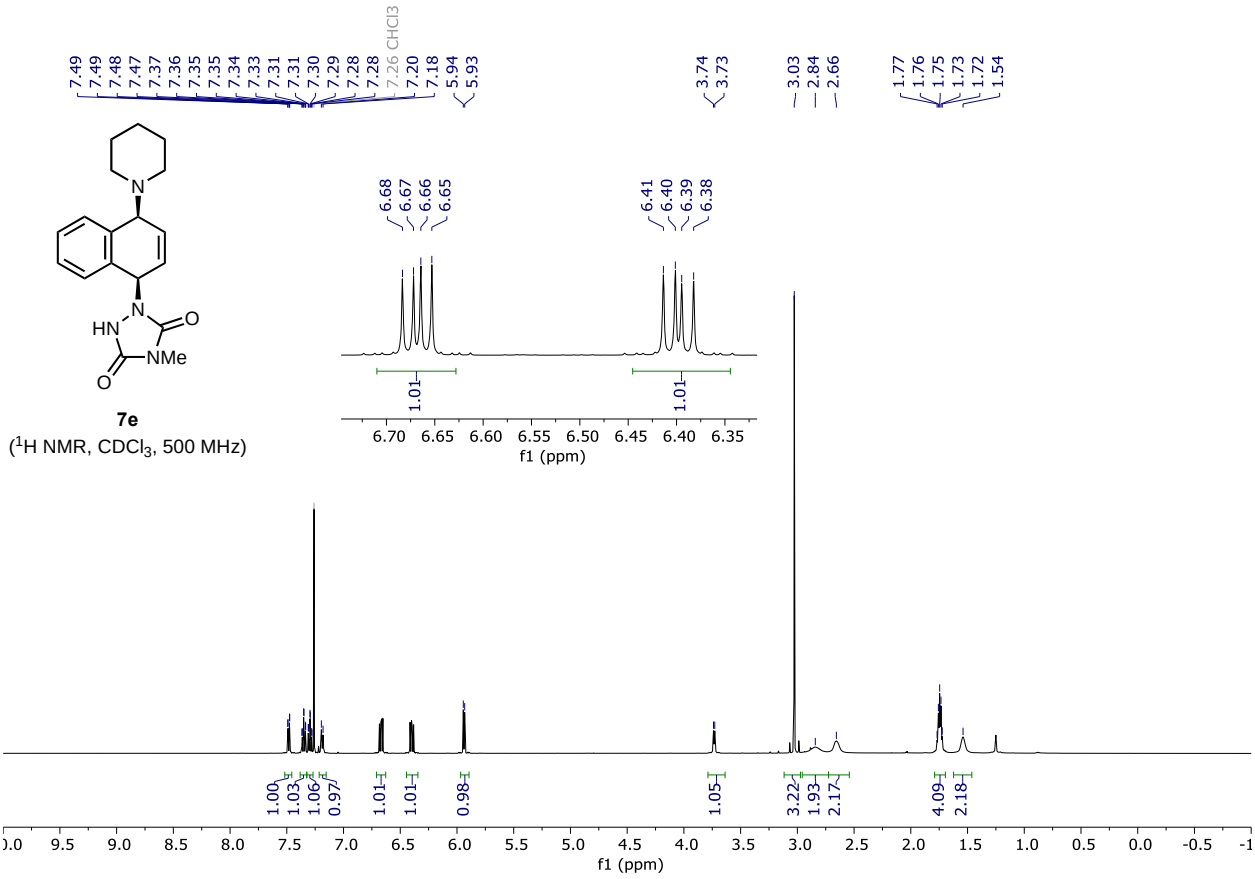
(^{13}C NMR, $CDCl_3$, 125 MHz)



7d
(^{1}H NMR, $CDCl_3$, 500 MHz)

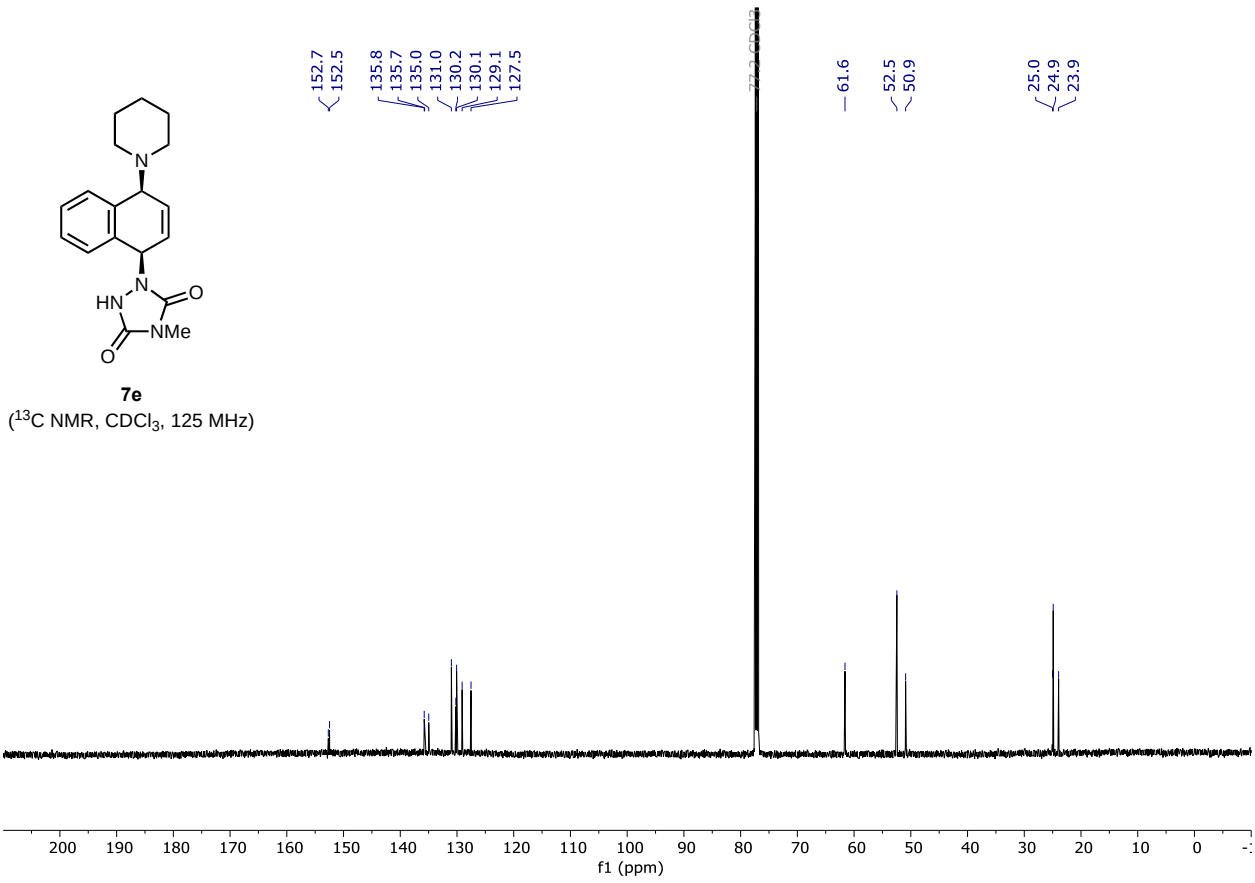


7d
(^{13}C NMR, $CDCl_3$, 125 MHz)



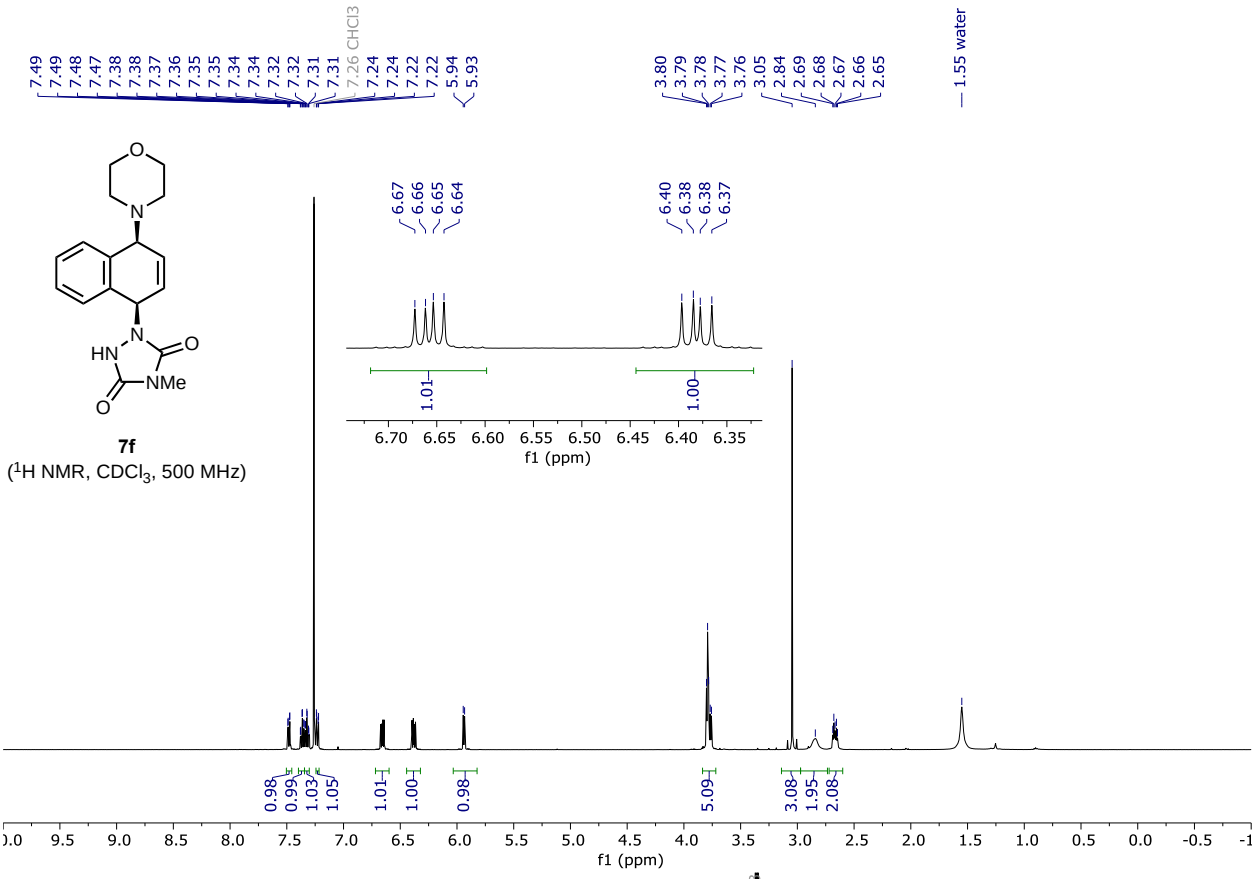
7e

(^{1}H NMR, $CDCl_3$, 500 MHz)

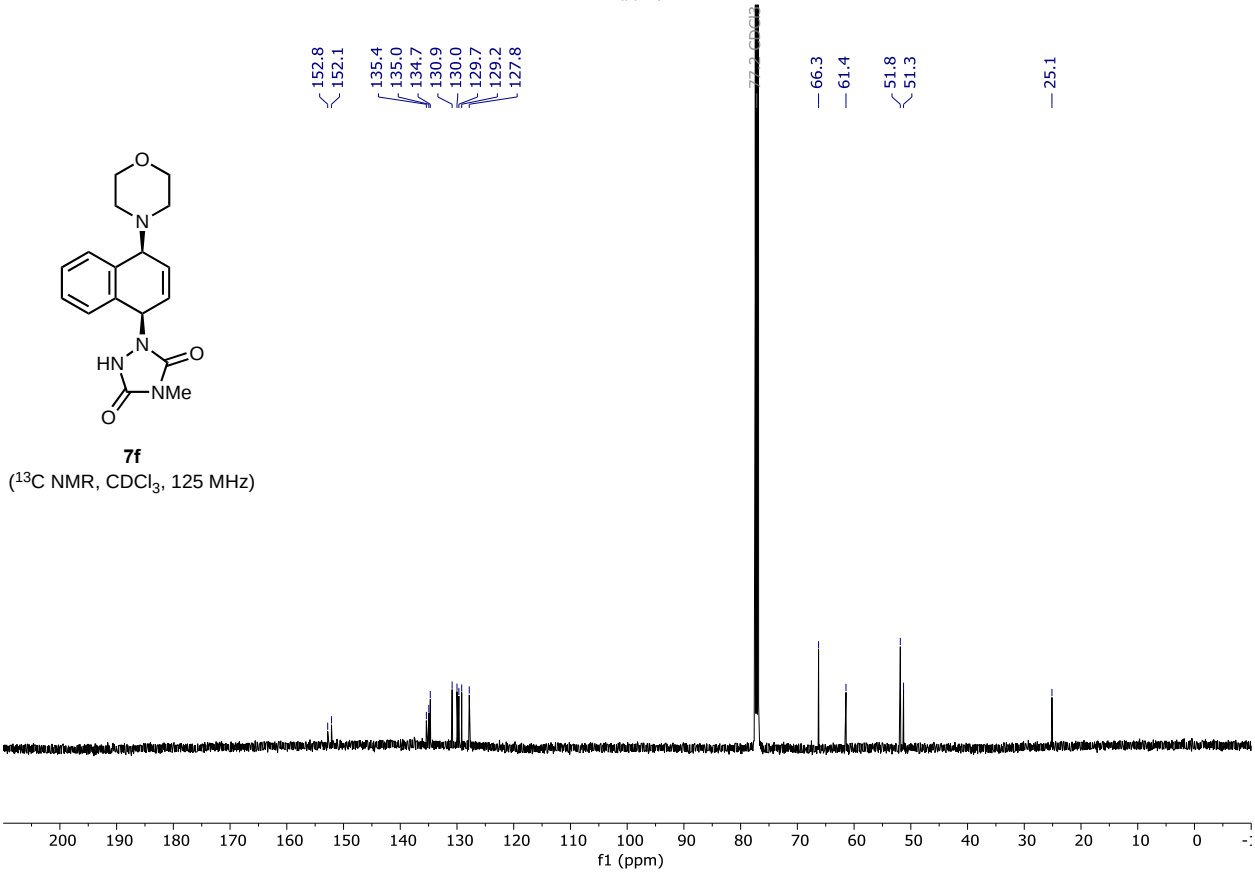


7e

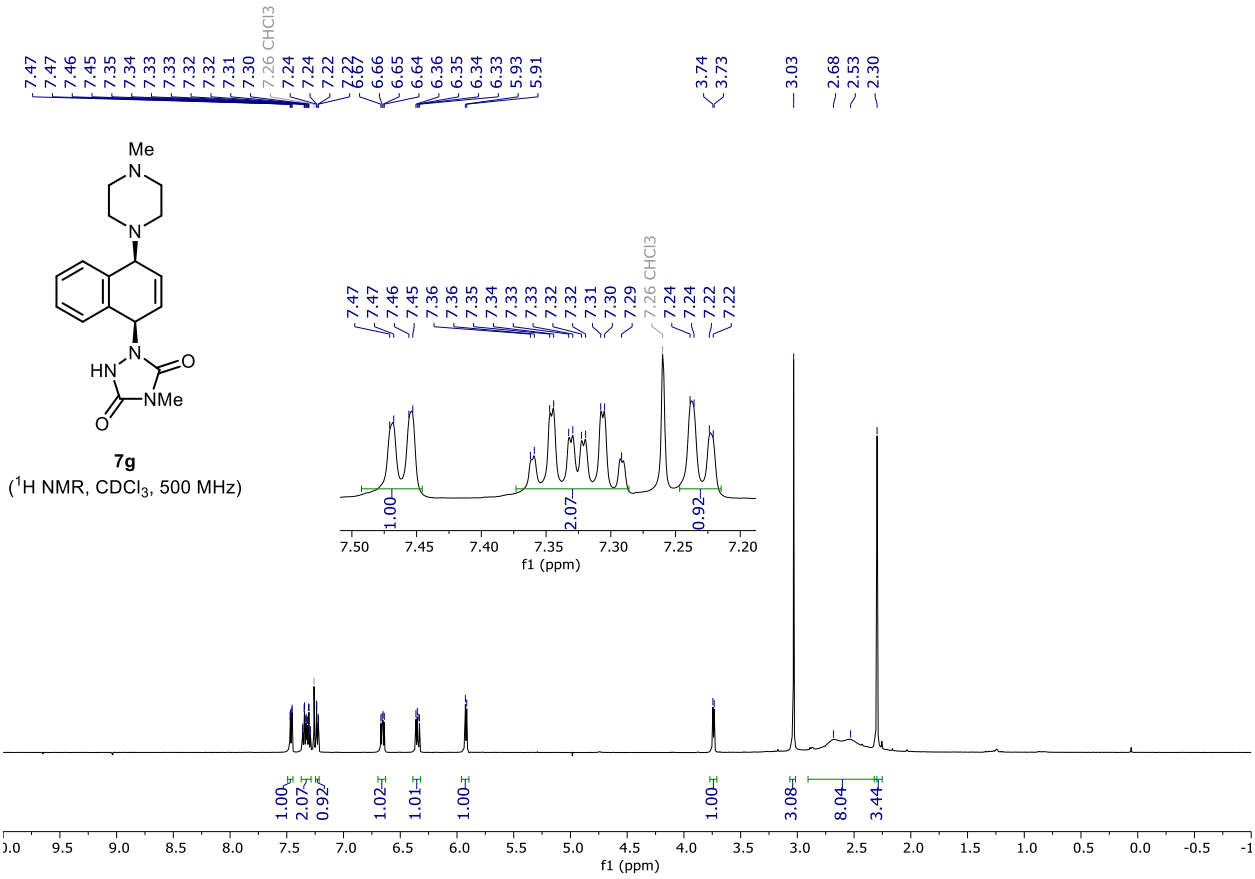
(^{13}C NMR, $CDCl_3$, 125 MHz)



7f
(^{1}H NMR, $CDCl_3$, 500 MHz)

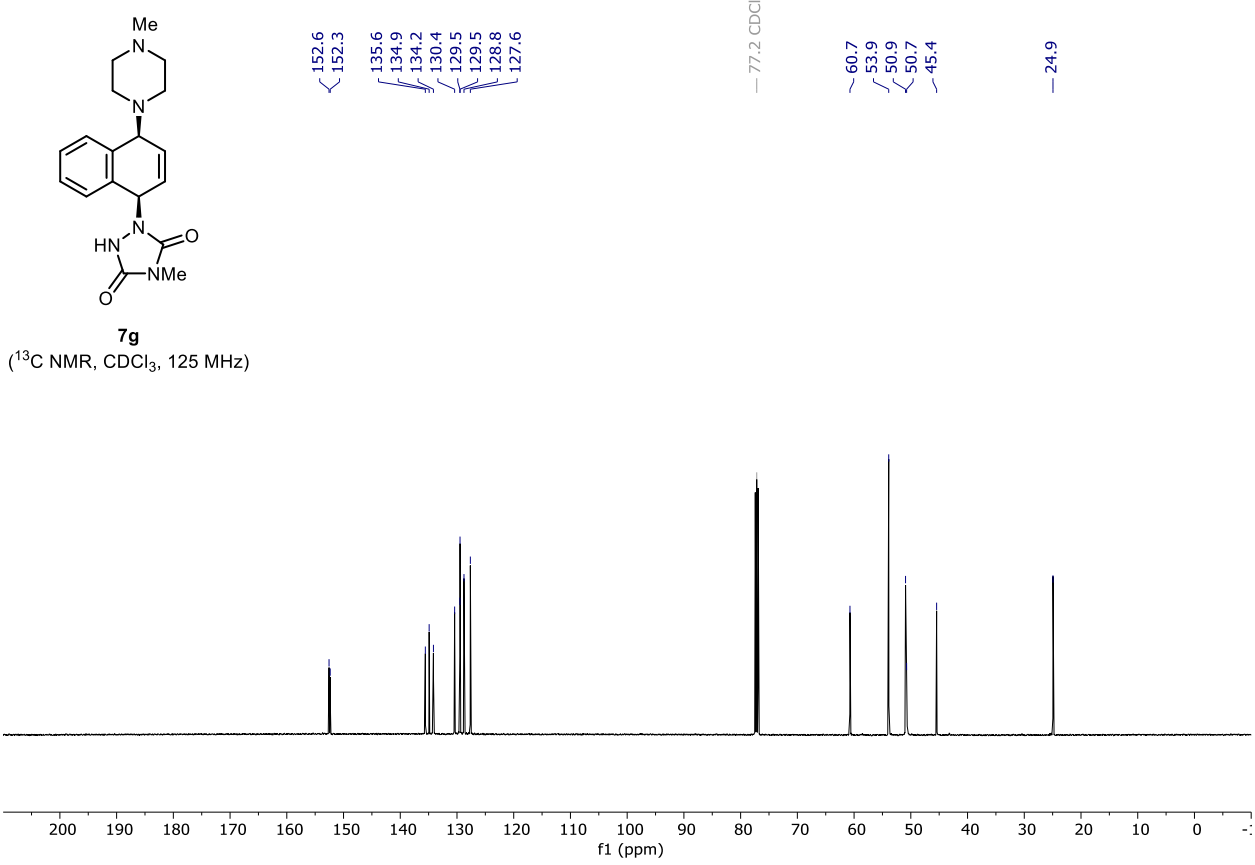


7f
(^{13}C NMR, $CDCl_3$, 125 MHz)



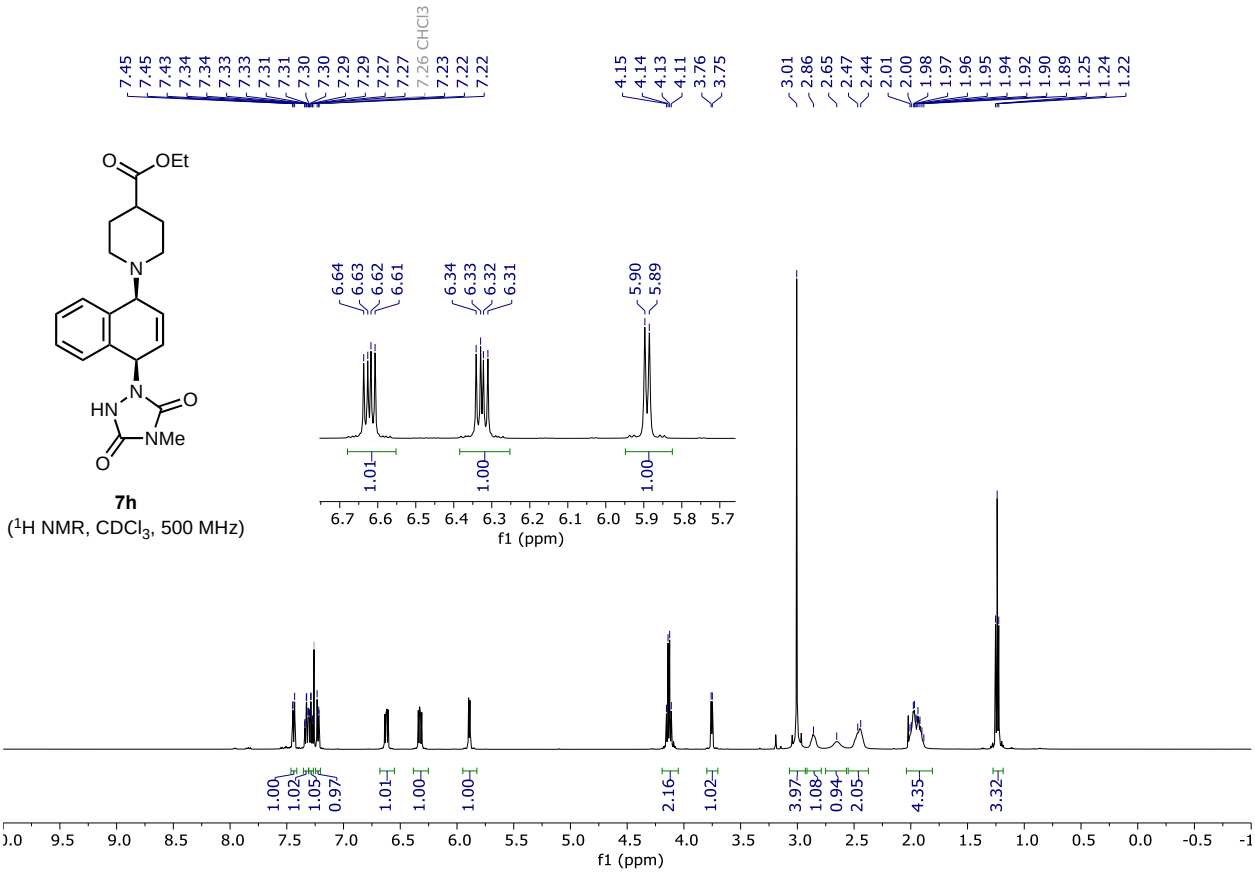
7g

(^{1}H NMR, $CDCl_3$, 500 MHz)

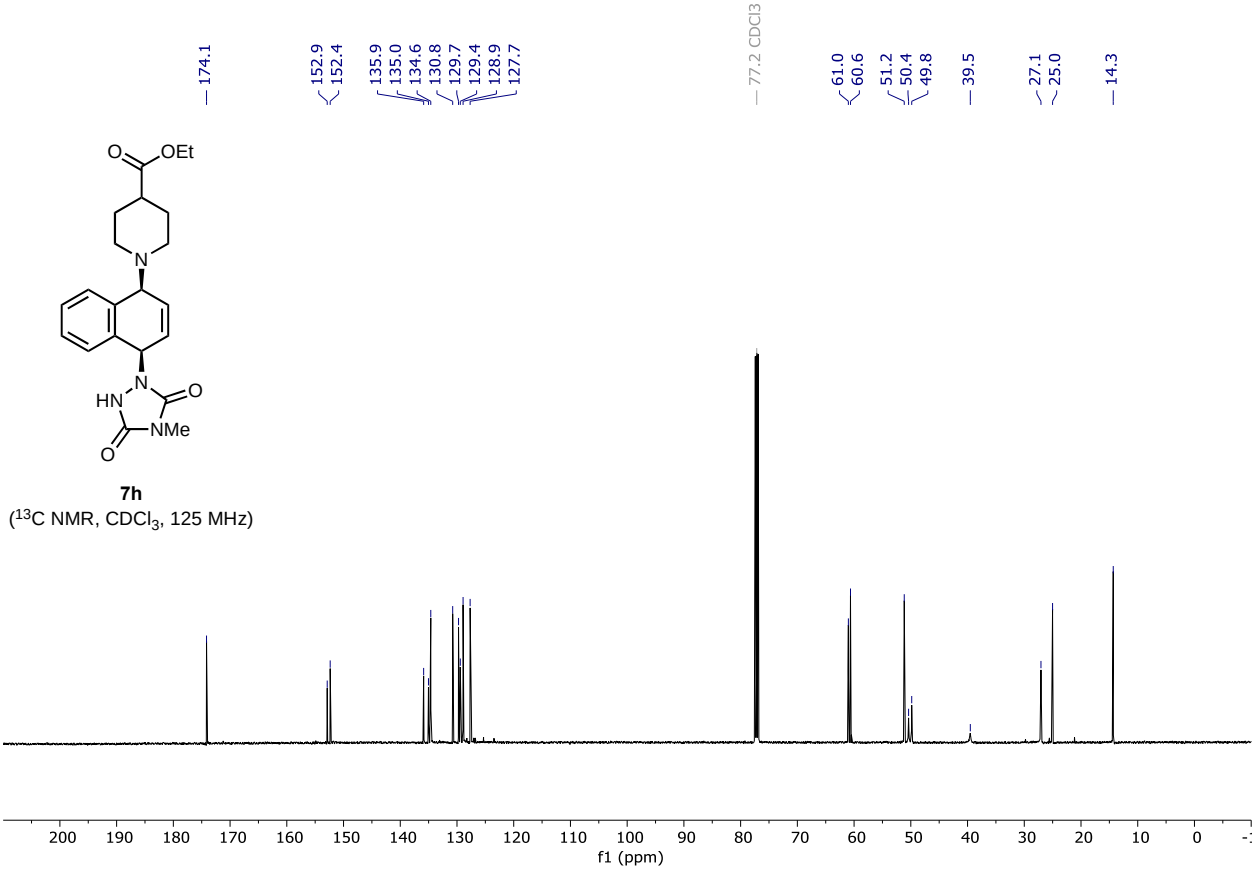


7g

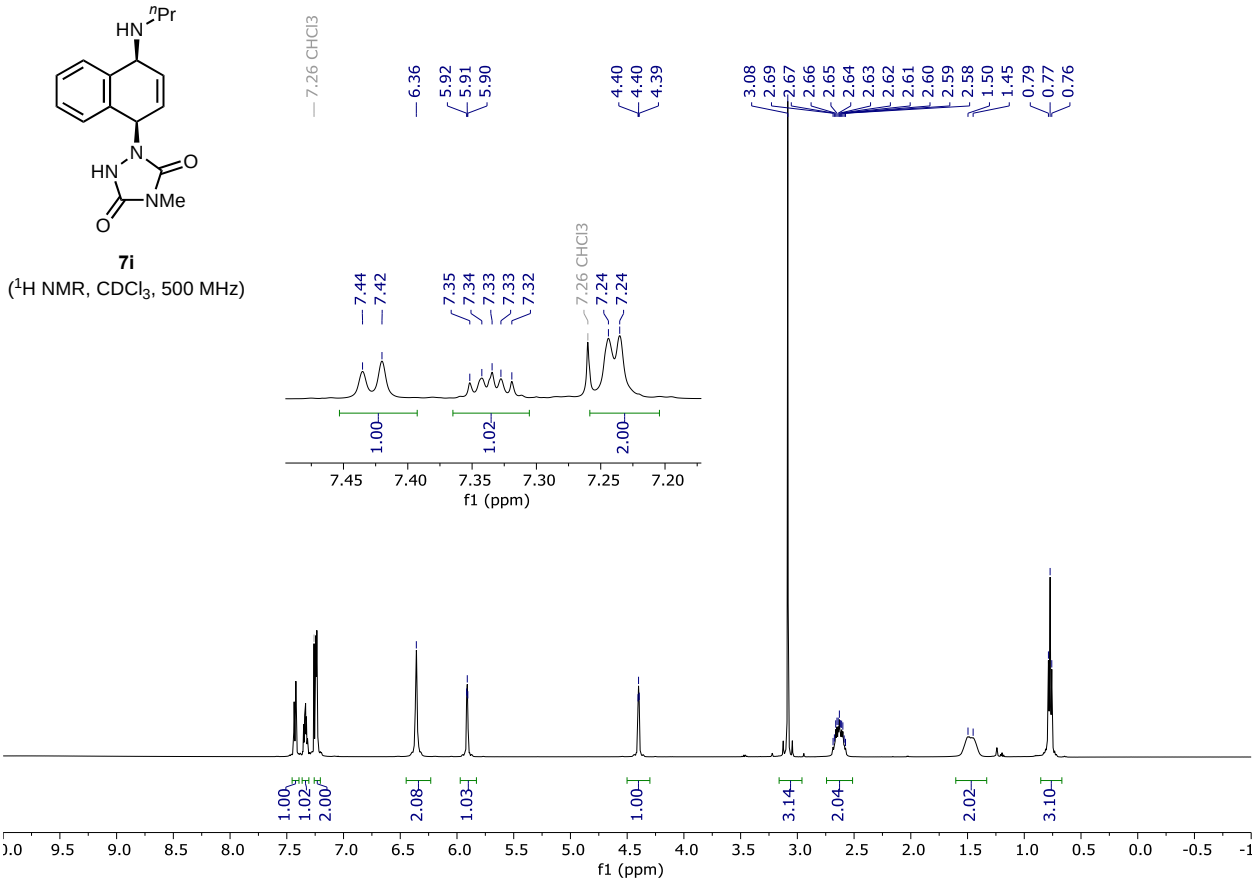
(^{13}C NMR, $CDCl_3$, 125 MHz)



7h
(^{1}H NMR, $CDCl_3$, 500 MHz)

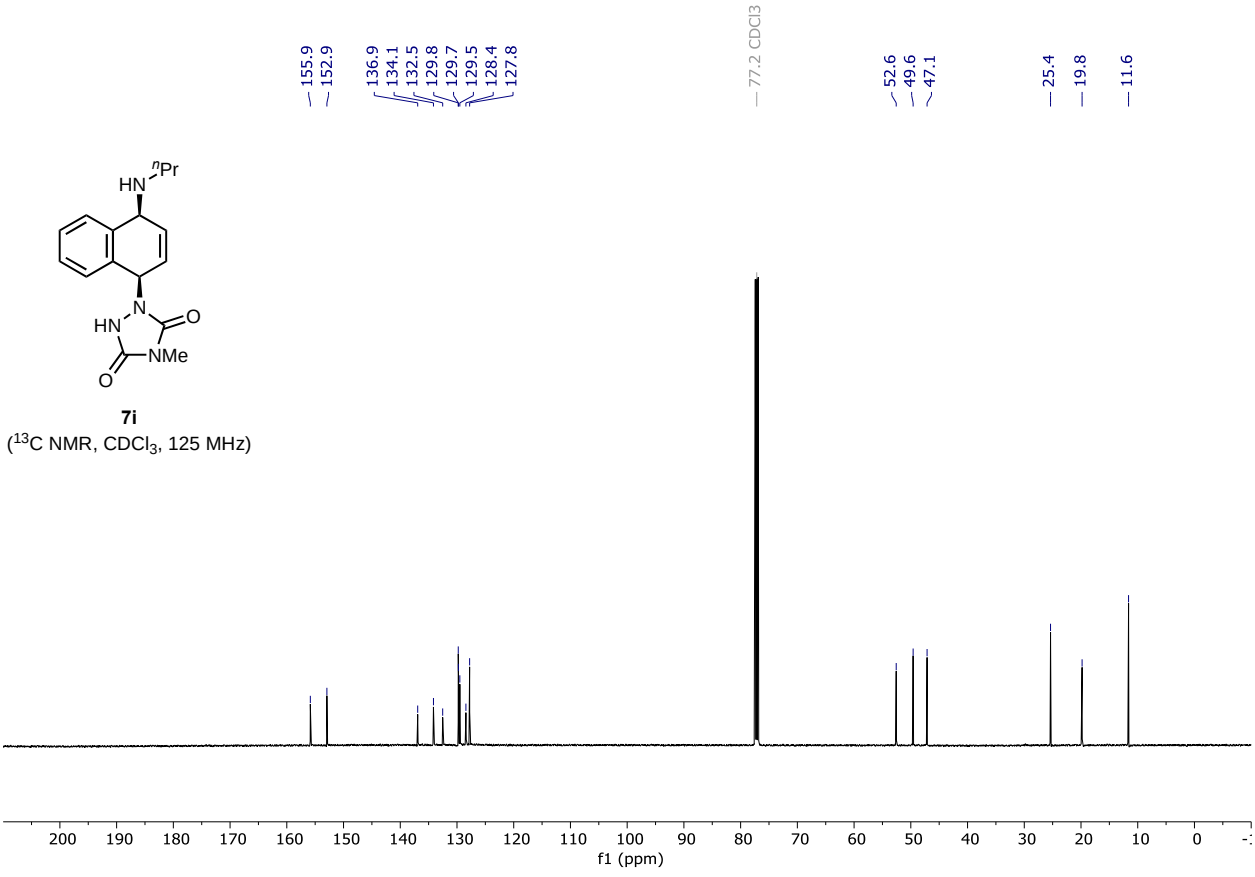


7h
(^{13}C NMR, $CDCl_3$, 125 MHz)



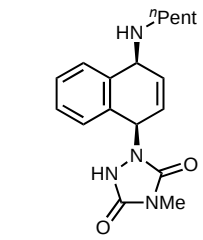
7i

(^{1}H NMR, $CDCl_3$, 500 MHz)

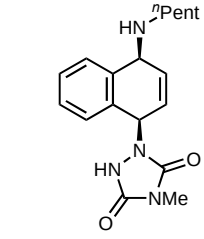


7i

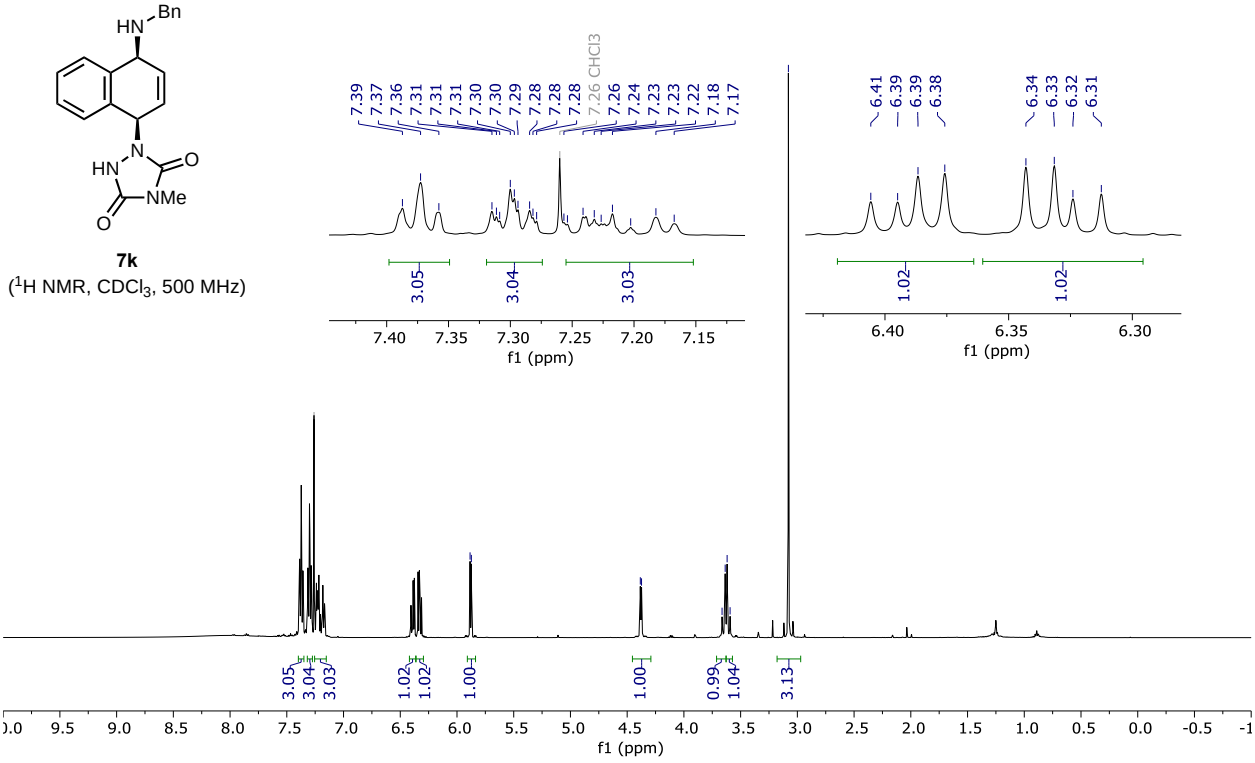
(^{13}C NMR, $CDCl_3$, 125 MHz)



7j
(^{1}H NMR, $CDCl_3$, 500 MHz)

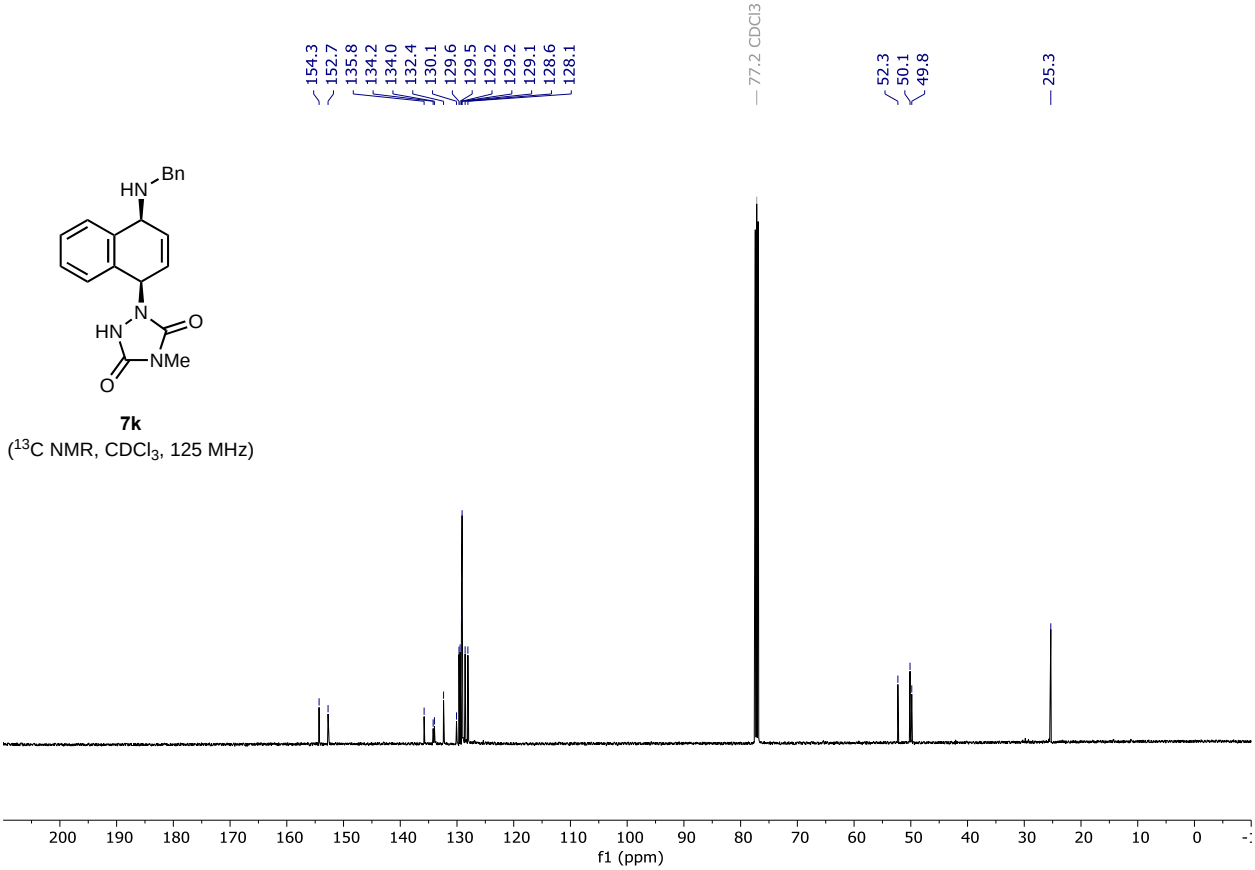


7j
(^{13}C NMR, $CDCl_3$, 125 MHz)



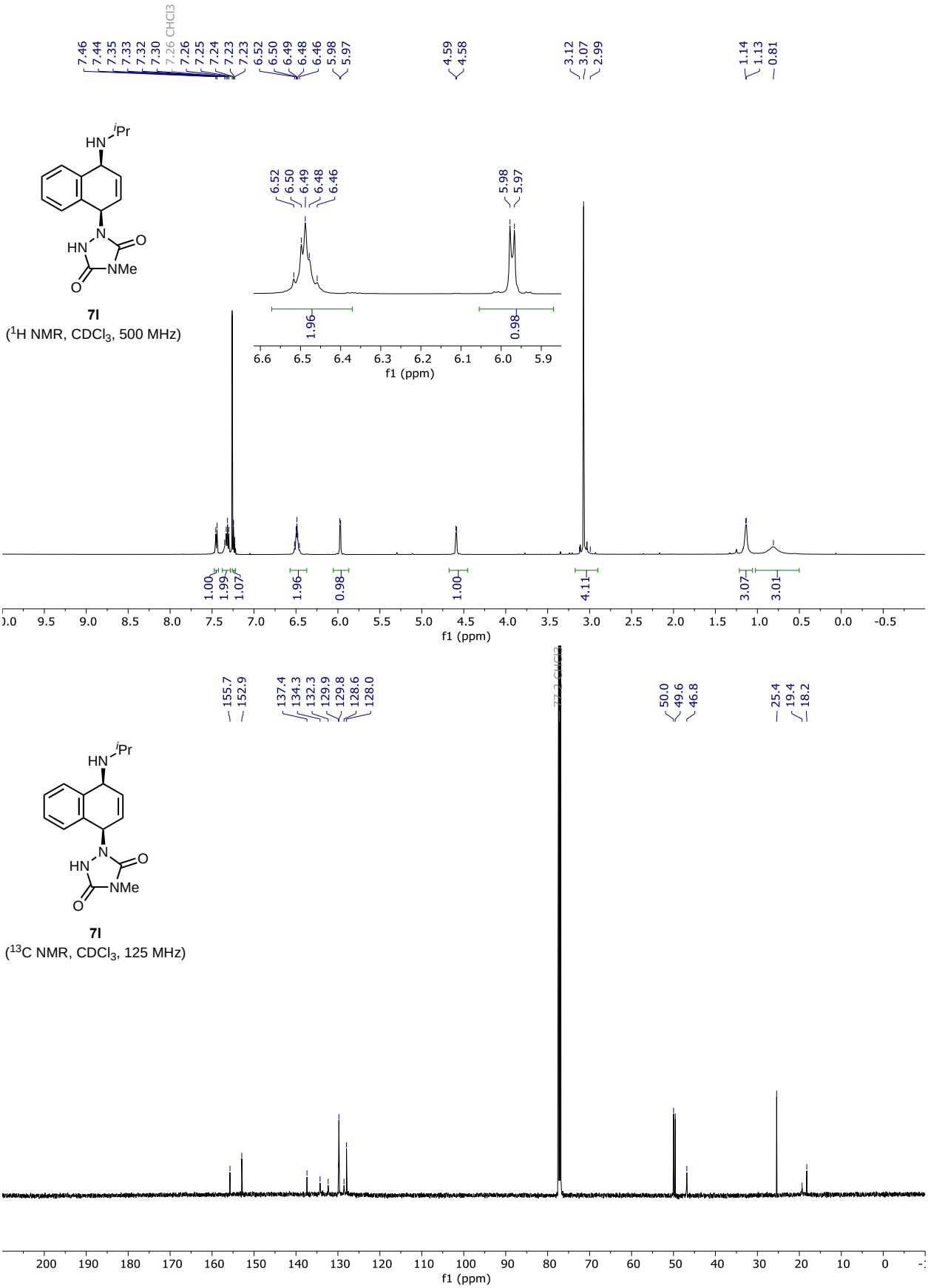
7k

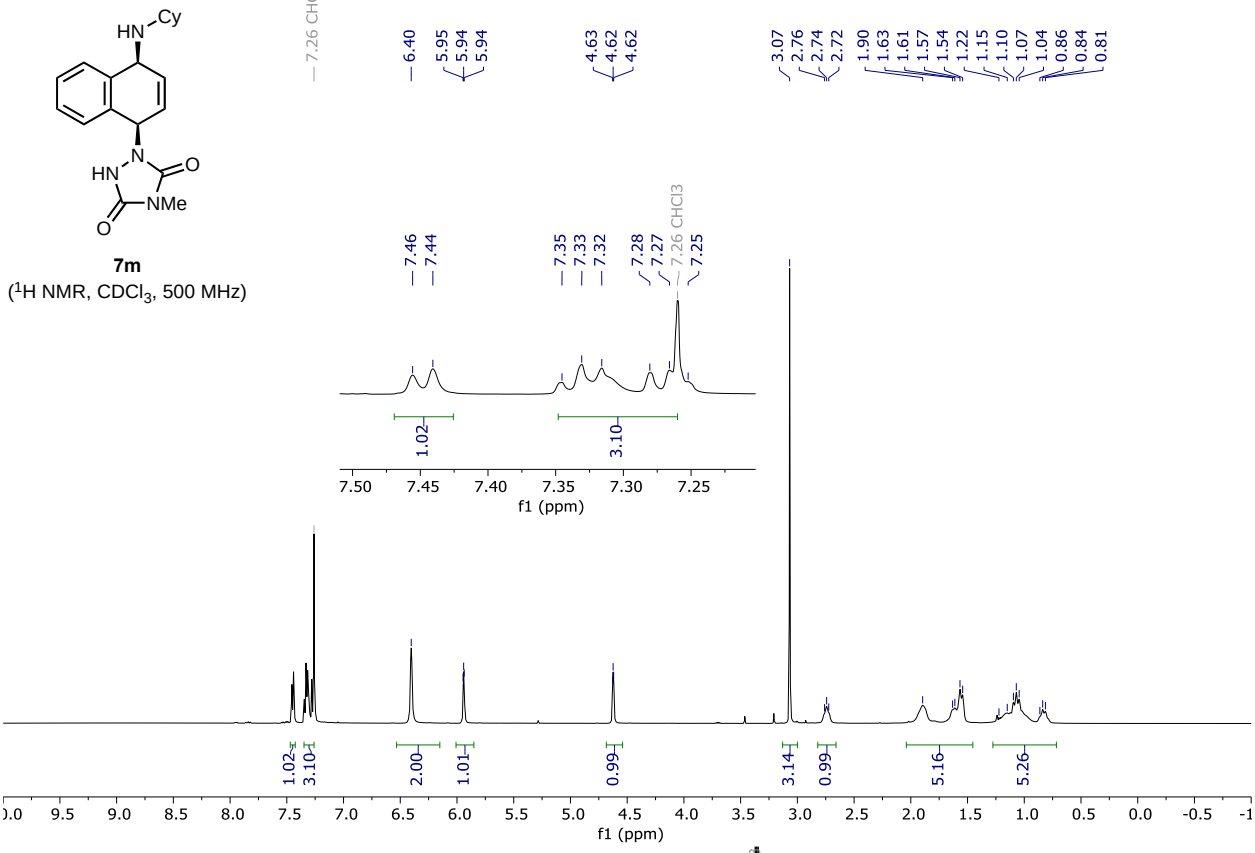
(^{1}H NMR, $CDCl_3$, 500 MHz)



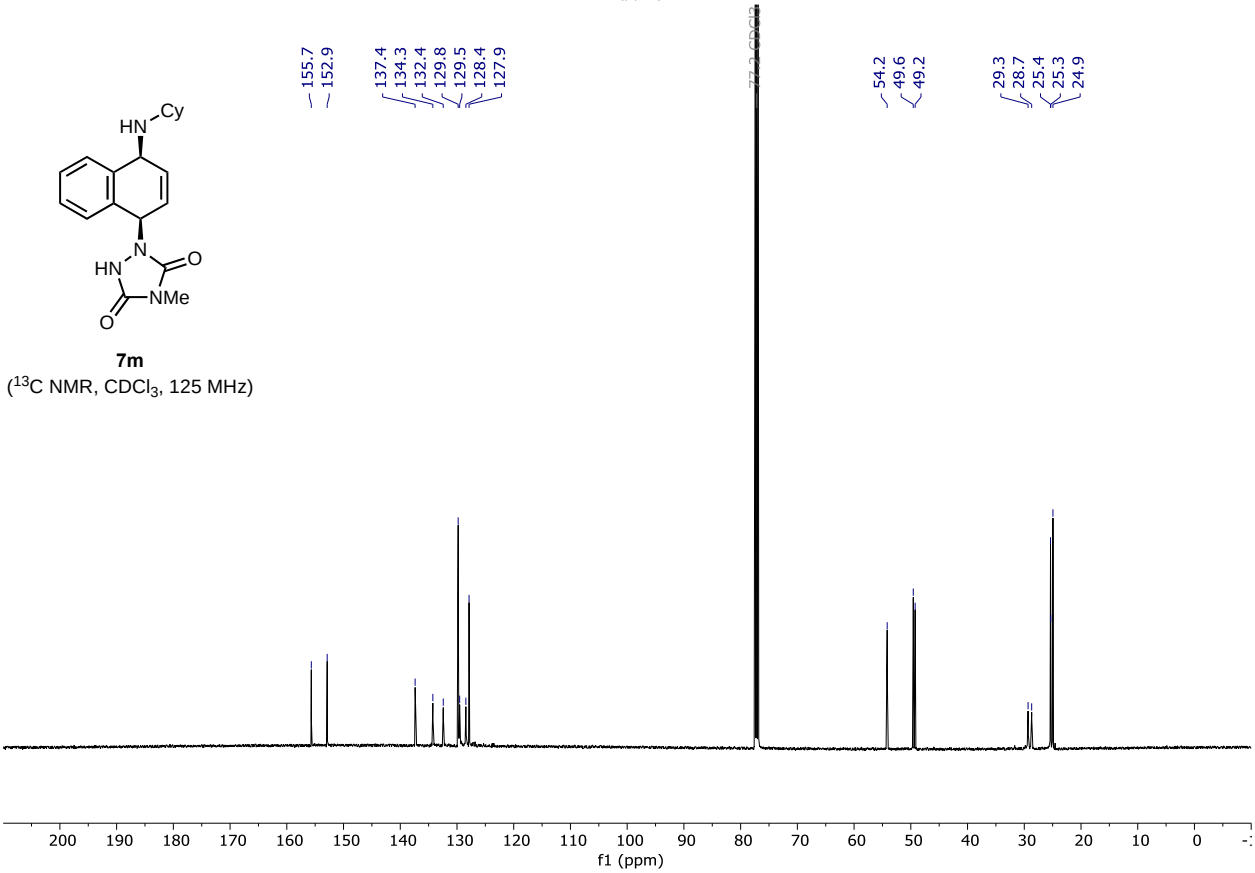
7k

(^{13}C NMR, $CDCl_3$, 125 MHz)

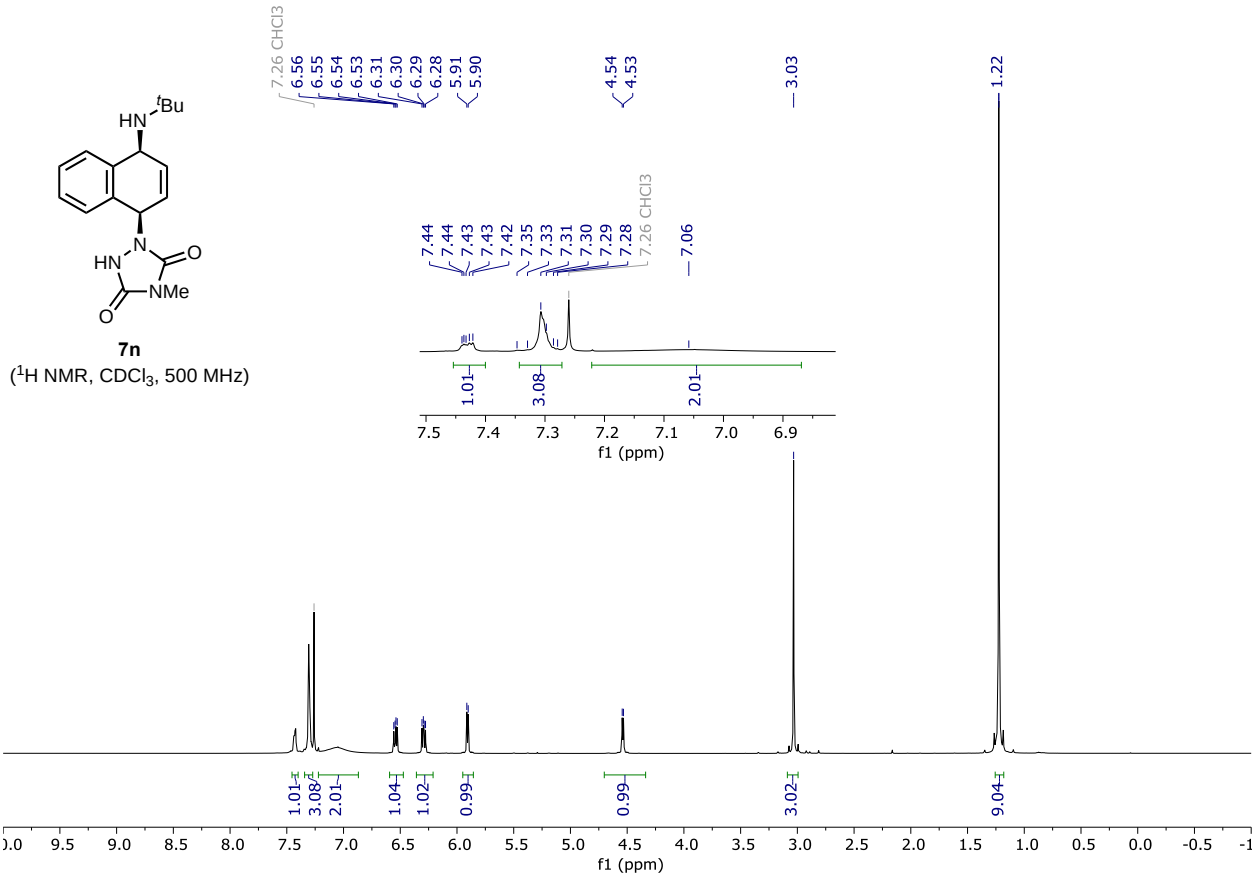

7.46
7.44
7.35
7.33
7.32
7.30
7.26 CHCl3
7.26
7.25
7.24
7.23
7.23
6.52
6.50
6.49
6.48
6.46
5.98
5.97
4.59
4.58
3.12
3.07
2.99
1.14
1.13
0.81
HN
iPr
HN
N
O
NMe
O
7l
(1H NMR, CDCl3, 500 MHz)
1.96
0.98
f1 (ppm)
1.00
1.99
1.07
1.96
0.98
1.00
4.11
3.07
3.01
f1 (ppm)
155.7
152.9
137.4
134.3
132.3
129.9
129.8
128.6
128.0
77.2 CDCl3
50.0
49.6
46.8
25.4
19.4
18.2
7l
(13C NMR, CDCl3, 125 MHz)
f1 (ppm)

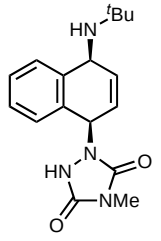


7m
(^{1}H NMR, $CDCl_3$, 500 MHz)



7m
(^{13}C NMR, $CDCl_3$, 125 MHz)



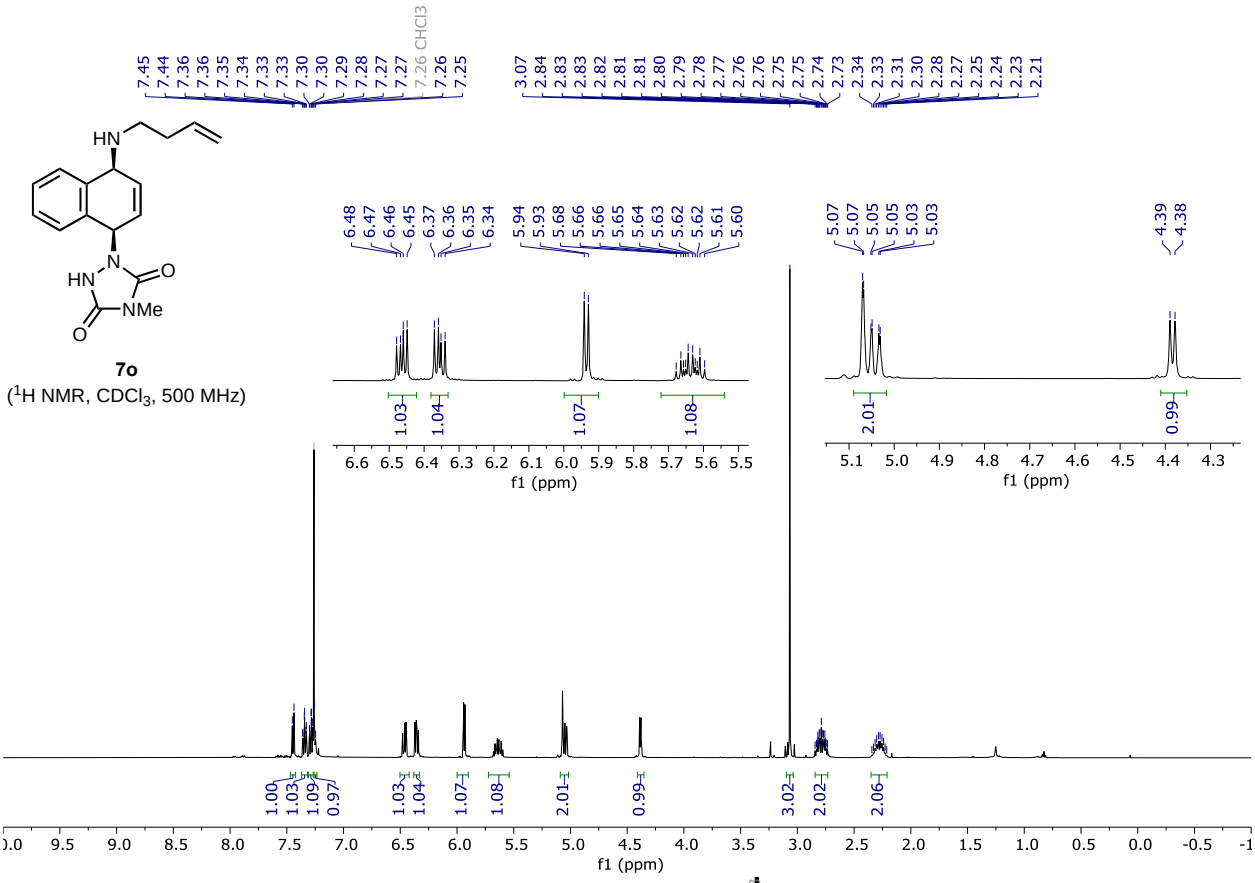


7n

(^{1}H NMR, $CDCl_3$, 500 MHz)

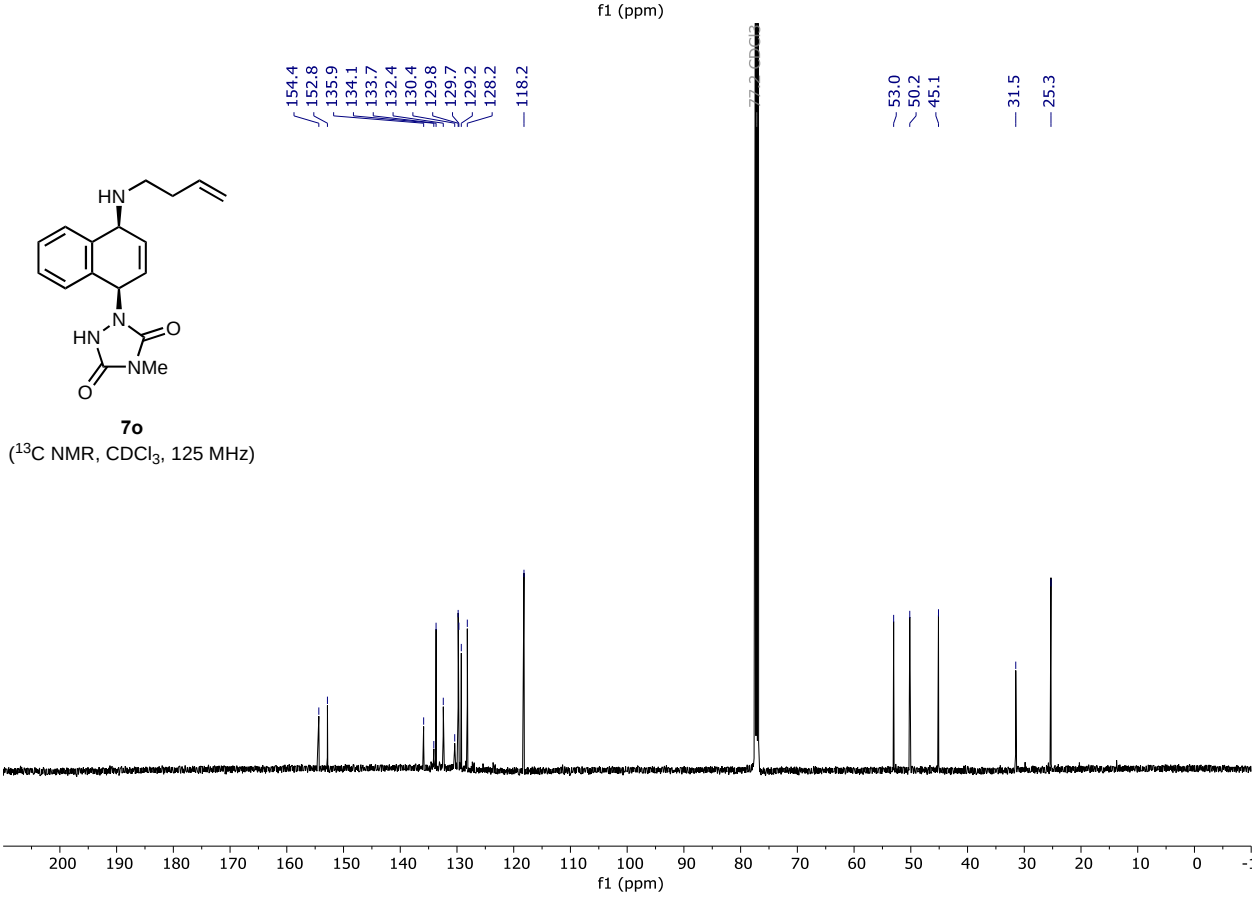
7n

(^{13}C NMR, $CDCl_3$, 125 MHz)



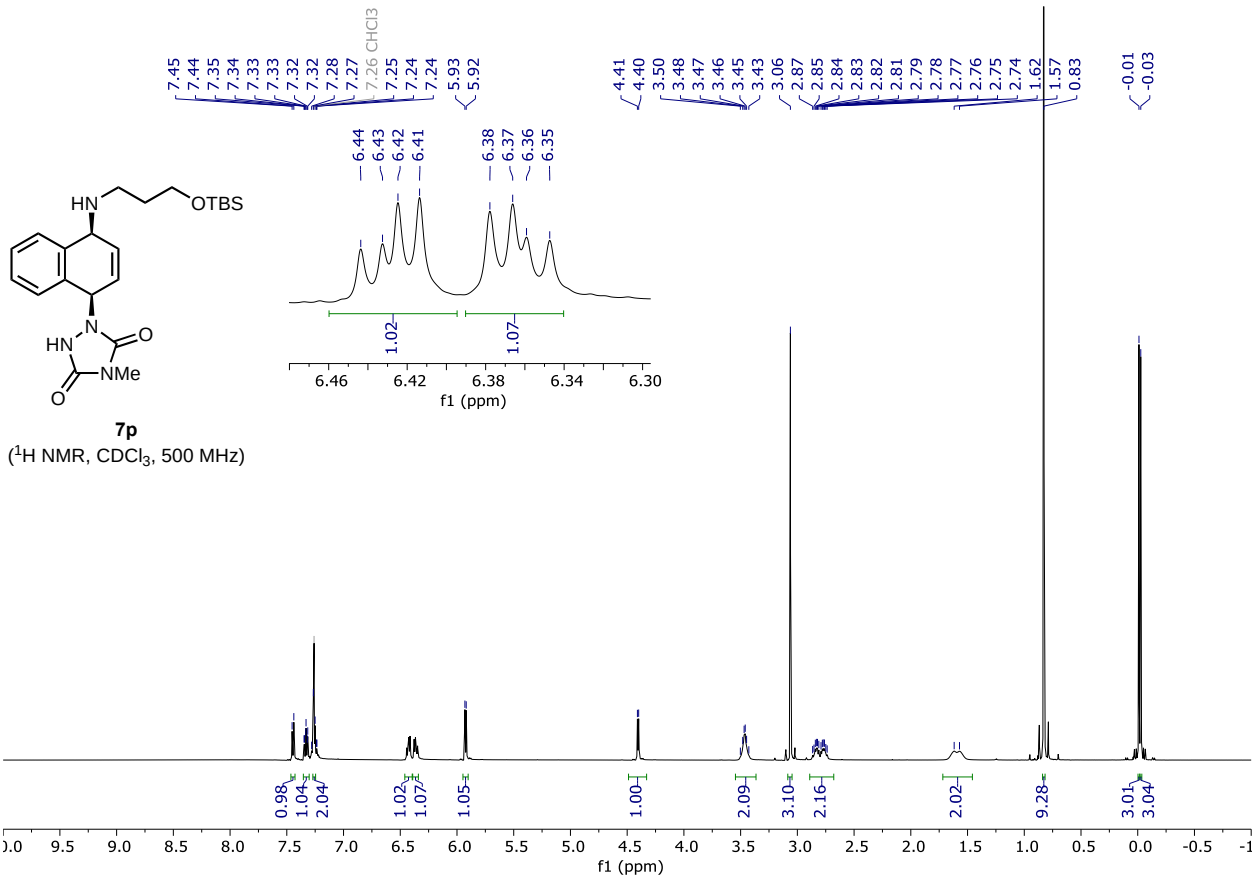
7o

(^{1}H NMR, $CDCl_3$, 500 MHz)

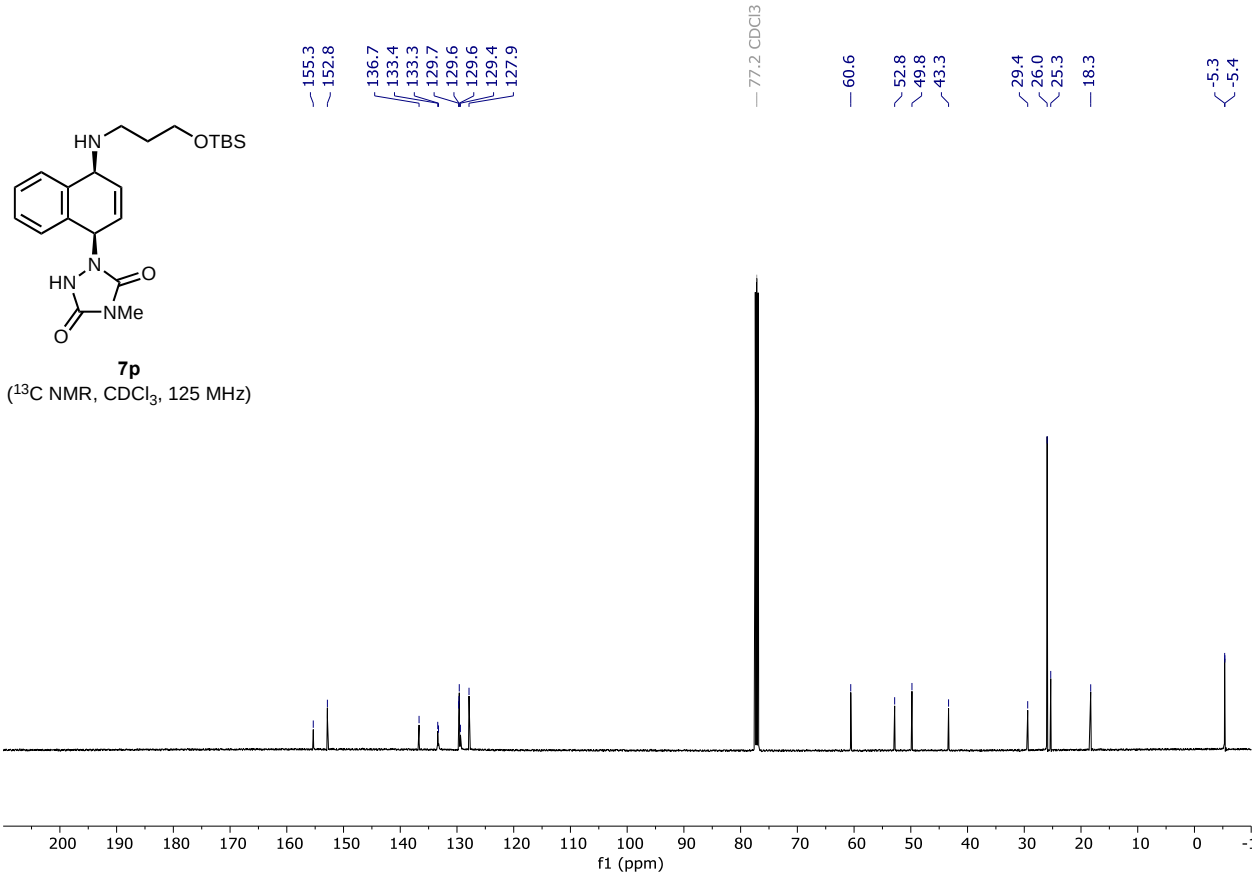


7o

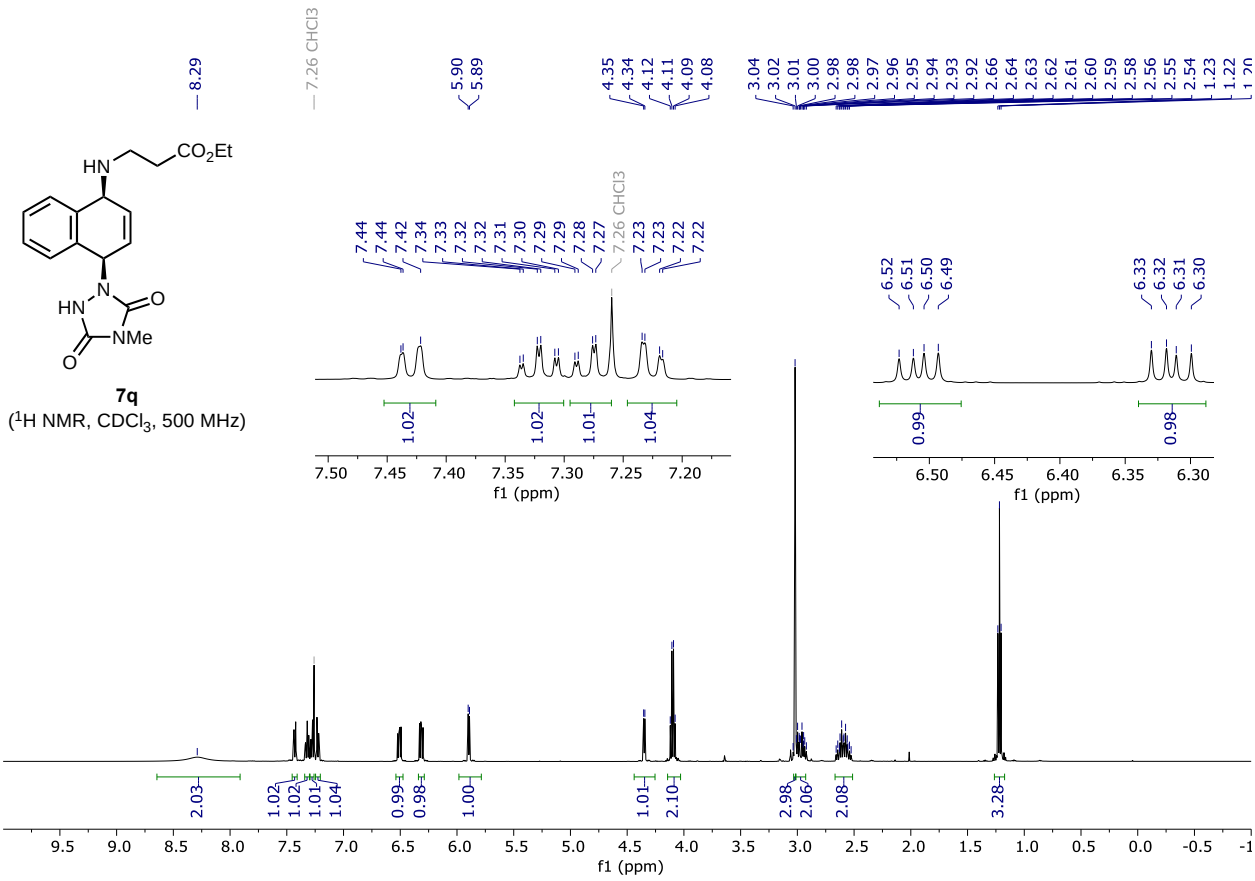
(^{13}C NMR, $CDCl_3$, 125 MHz)



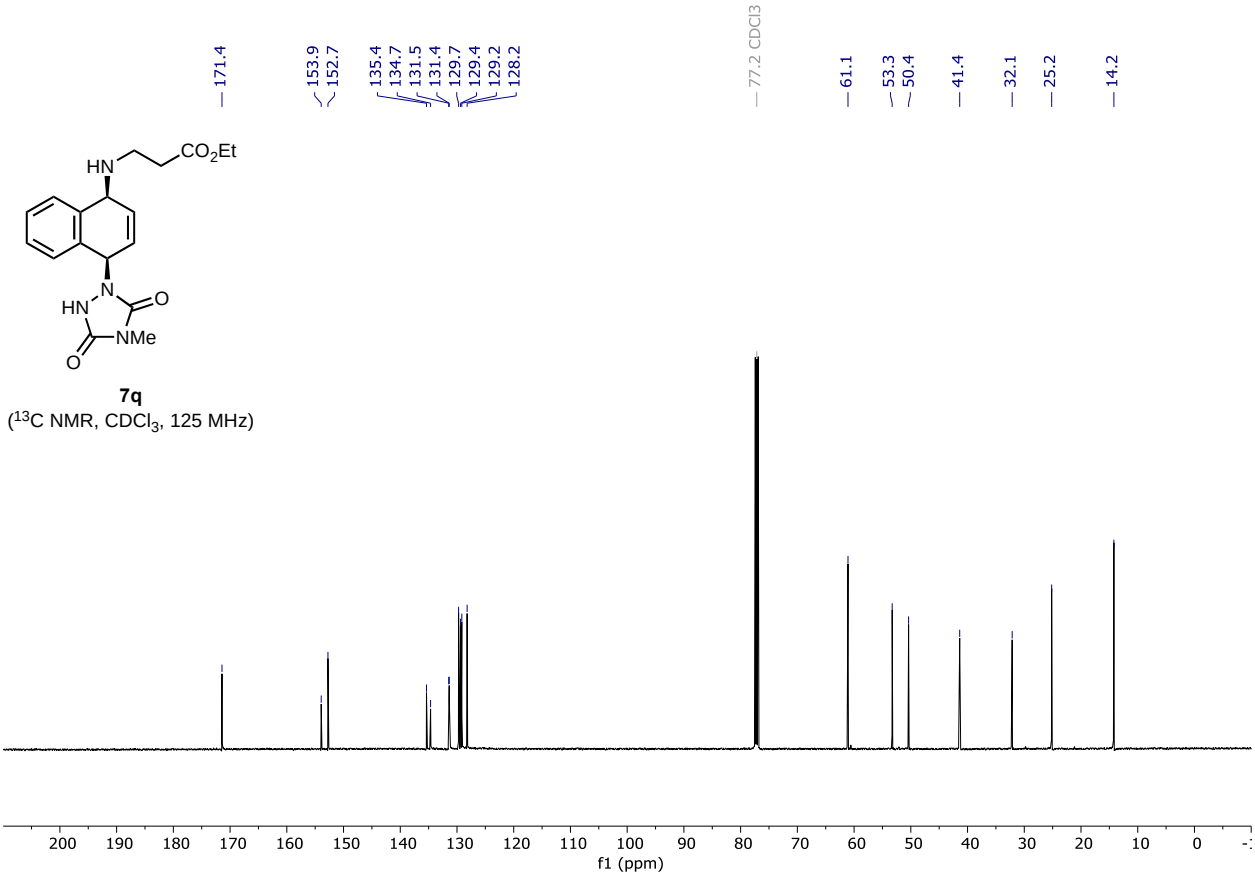
7p
(^{1}H NMR, $CDCl_3$, 500 MHz)



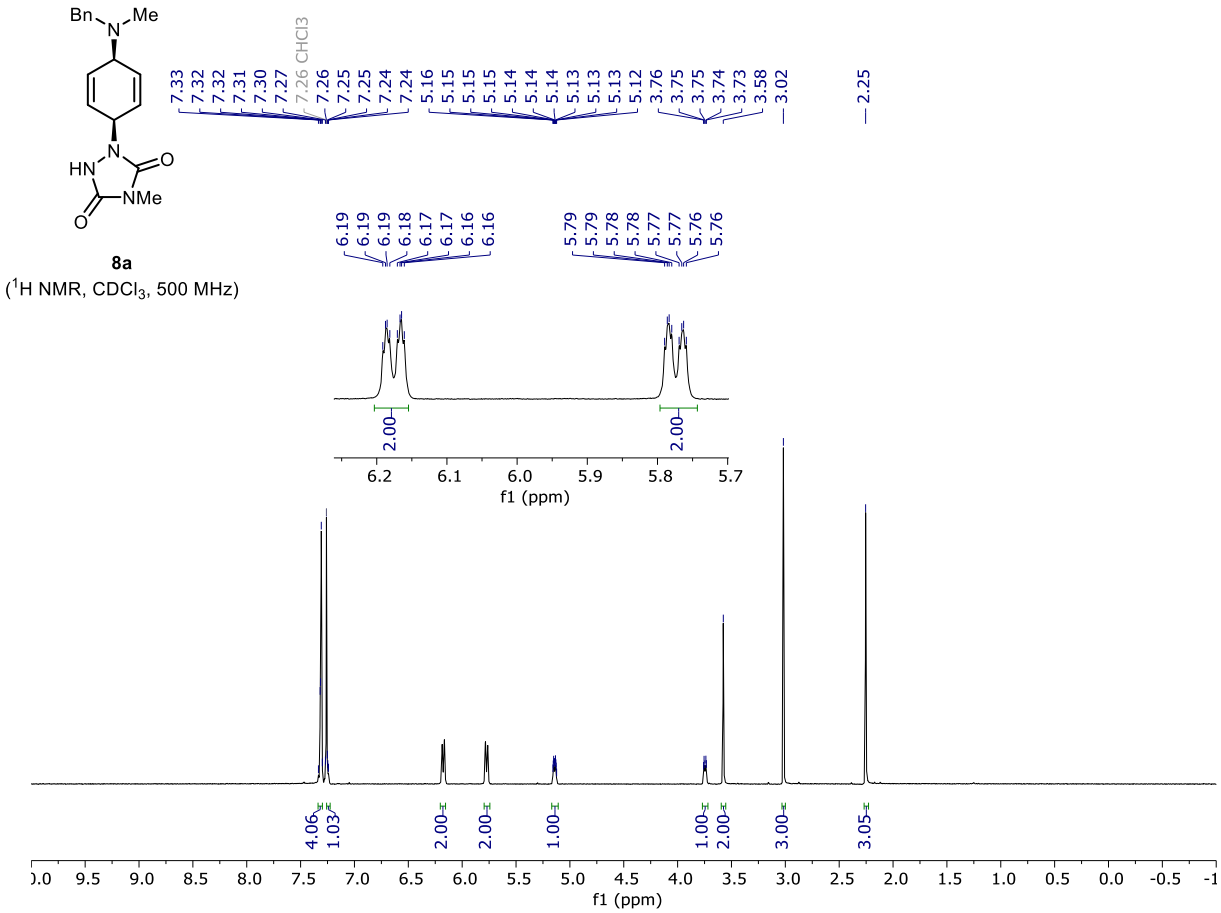
7p
(^{13}C NMR, $CDCl_3$, 125 MHz)



7q
(^{1}H NMR, $CDCl_3$, 500 MHz)

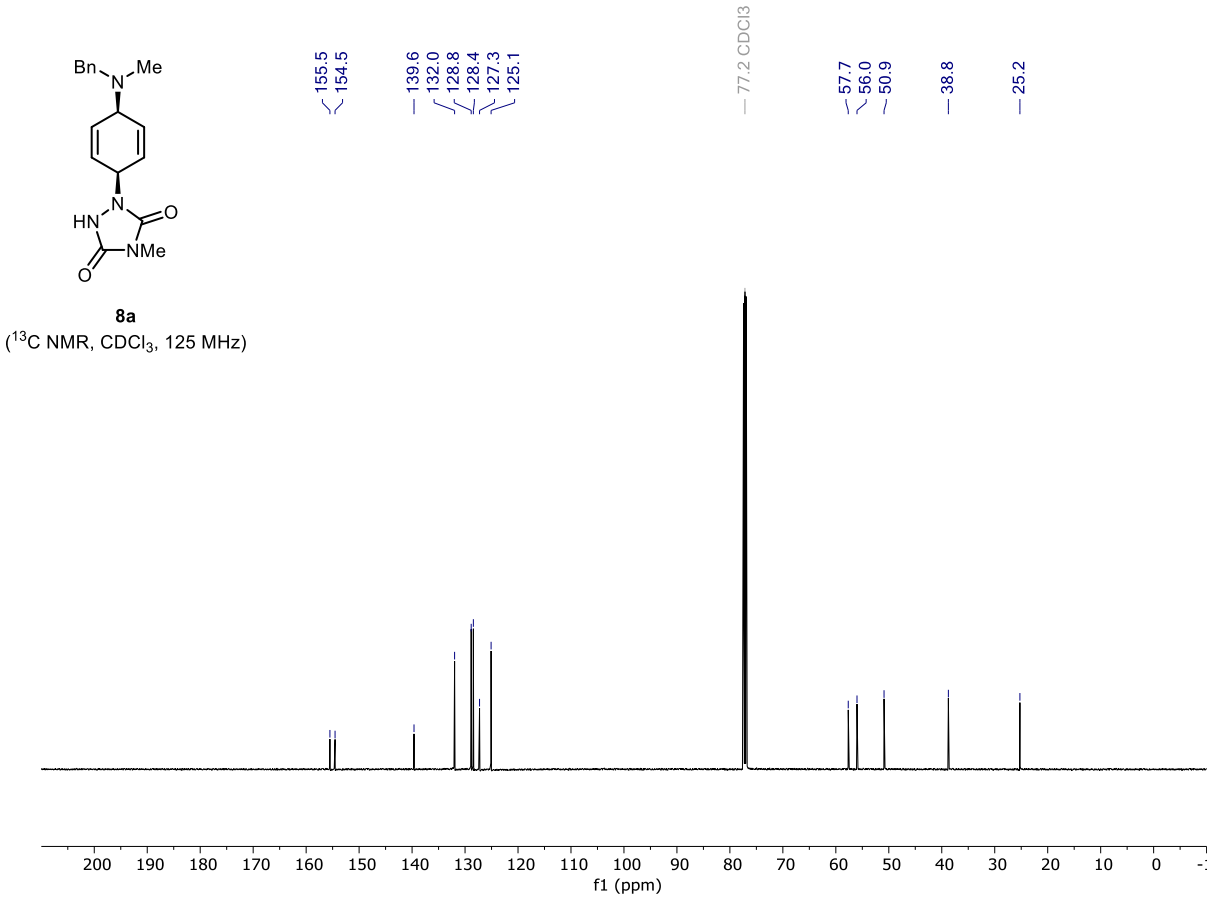


7q
(^{13}C NMR, $CDCl_3$, 125 MHz)



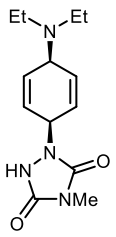
8a

(^{1}H NMR, $CDCl_3$, 500 MHz)



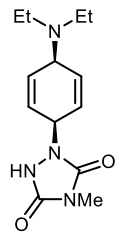
8a

(^{13}C NMR, $CDCl_3$, 125 MHz)



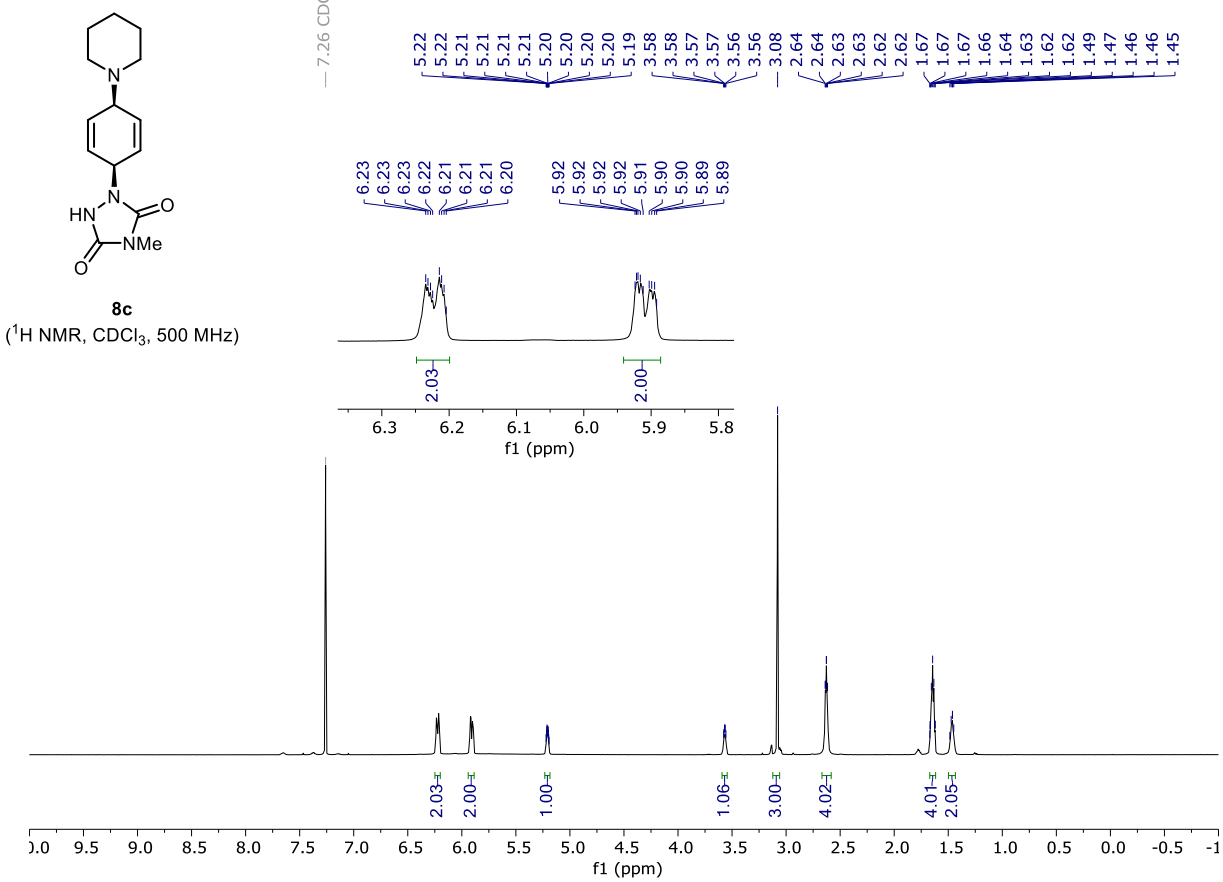
8b

(^{1}H NMR, $CDCl_3$, 500 MHz)

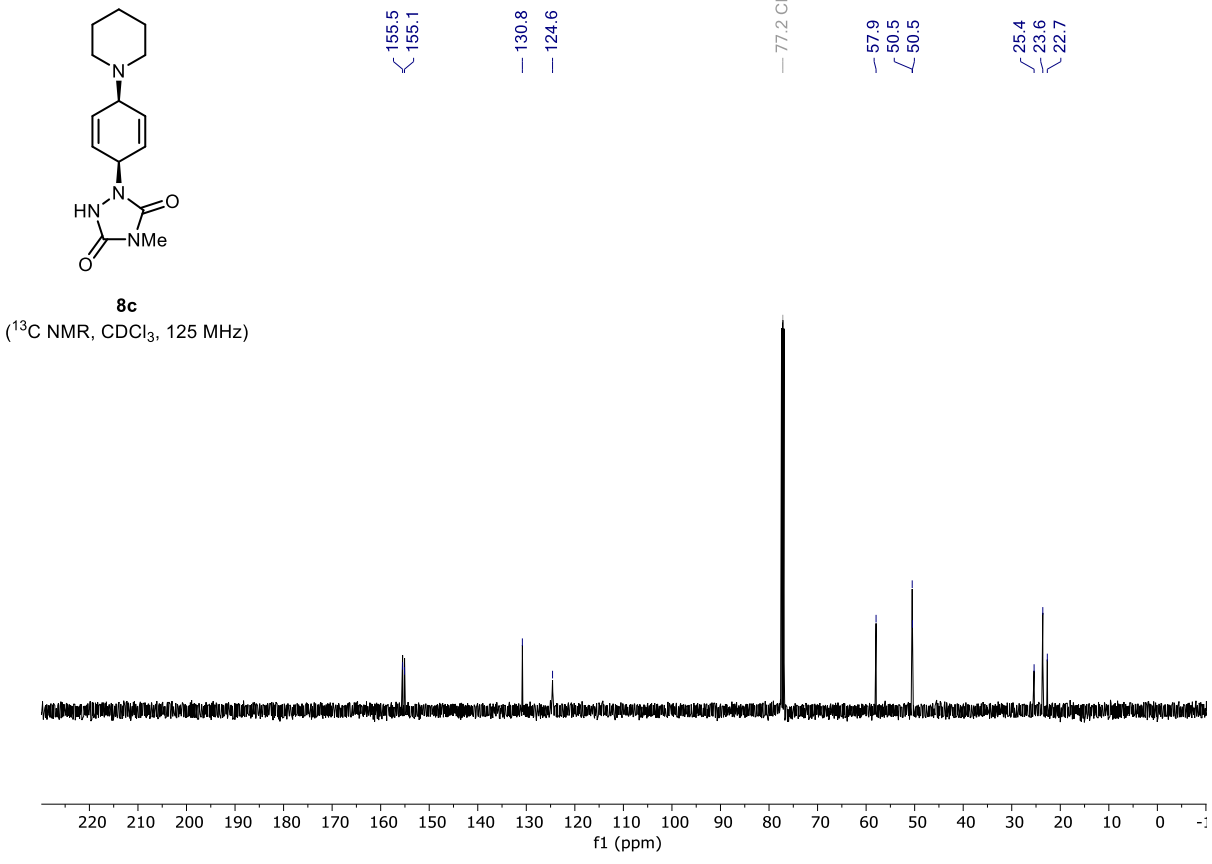


8b

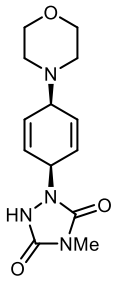
(^{13}C NMR, $CDCl_3$, 125 MHz)



8c
(^{1}H NMR, $CDCl_3$, 500 MHz)

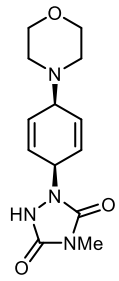


8c
(^{13}C NMR, $CDCl_3$, 125 MHz)



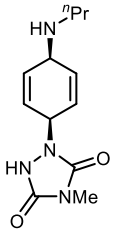
8d

(^{1}H NMR, $CDCl_3$, 500 MHz)



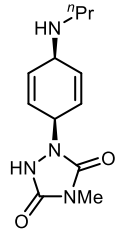
8d

(^{13}C NMR, $CDCl_3$, 125 MHz)



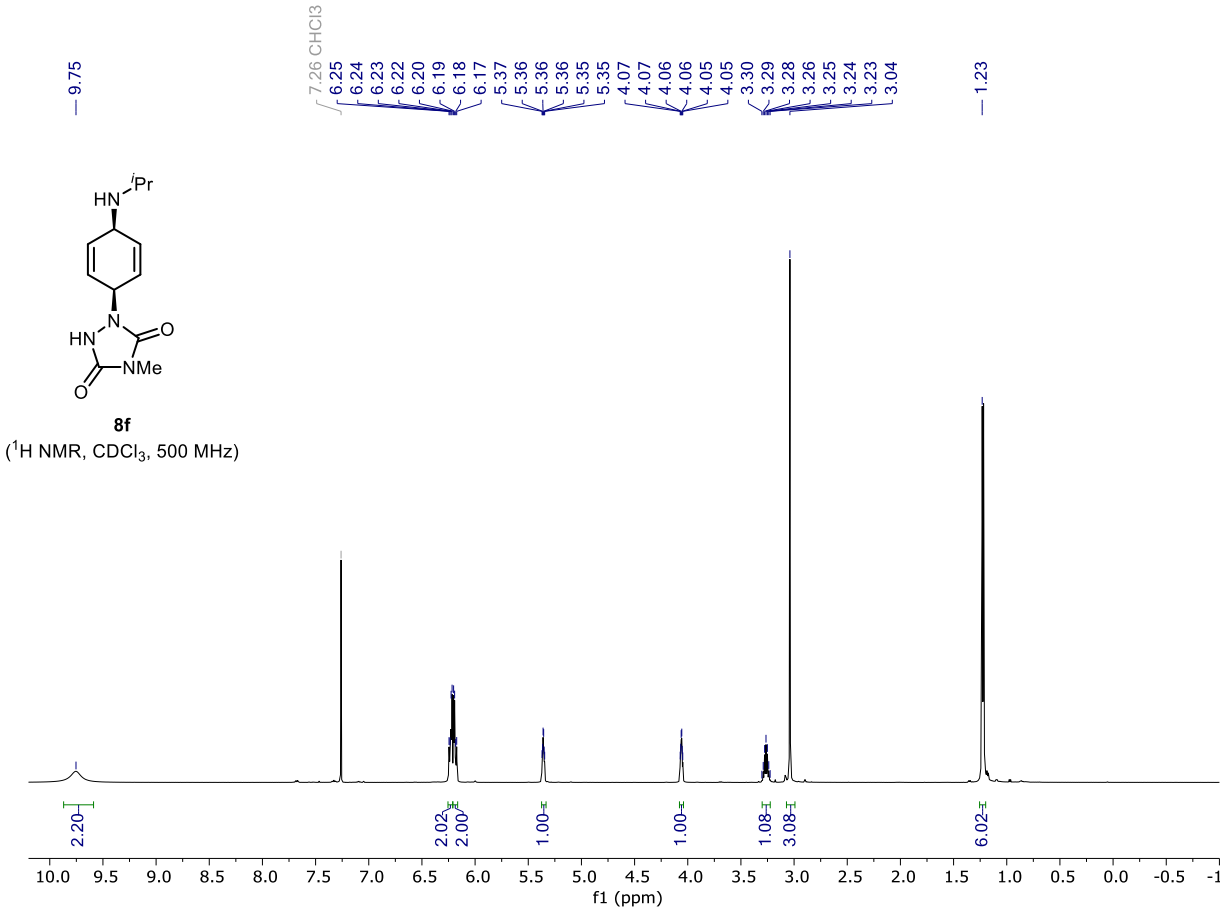
8e

(^{1}H NMR, $CDCl_3$, 500 MHz)



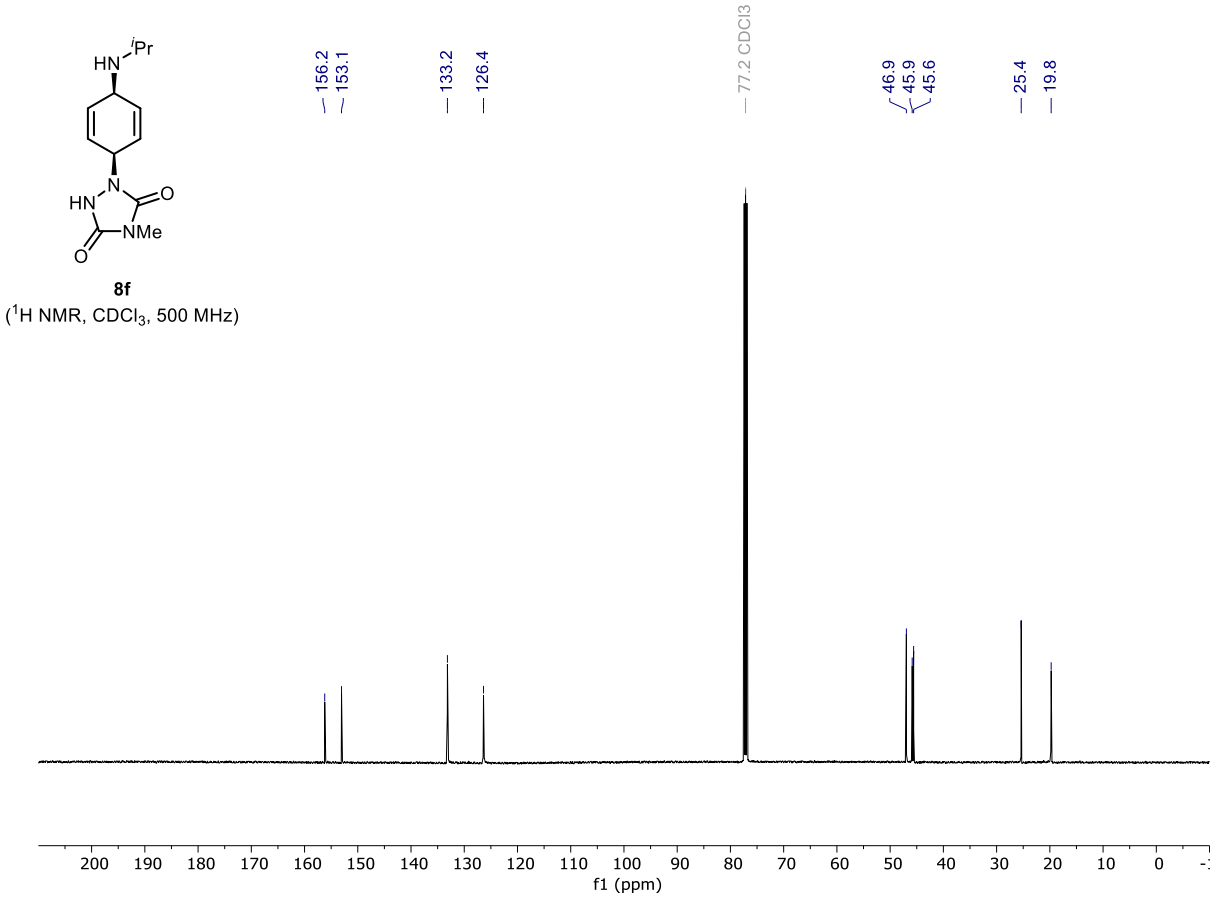
8e

(^{13}C NMR, $CDCl_3$, 125 MHz)



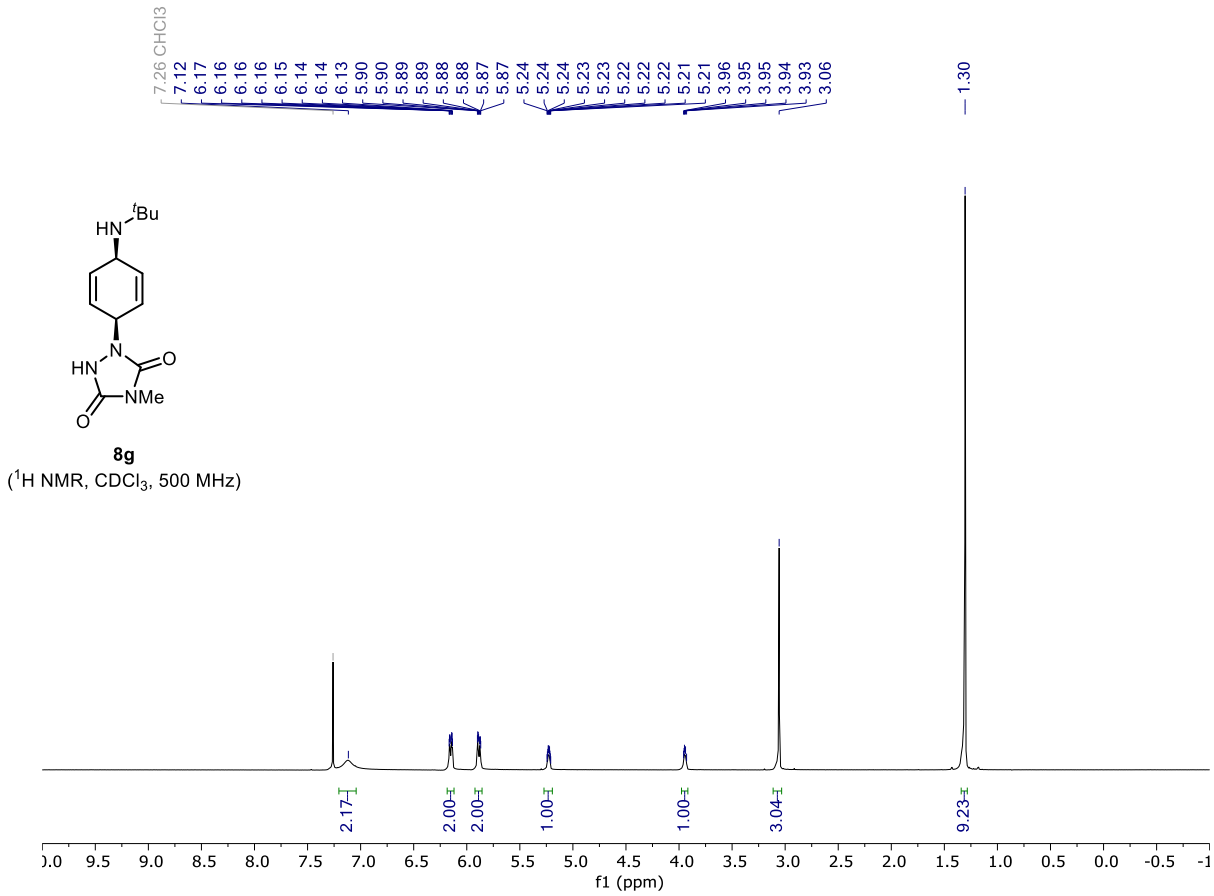
8f

(^{1}H NMR, $CDCl_3$, 500 MHz)



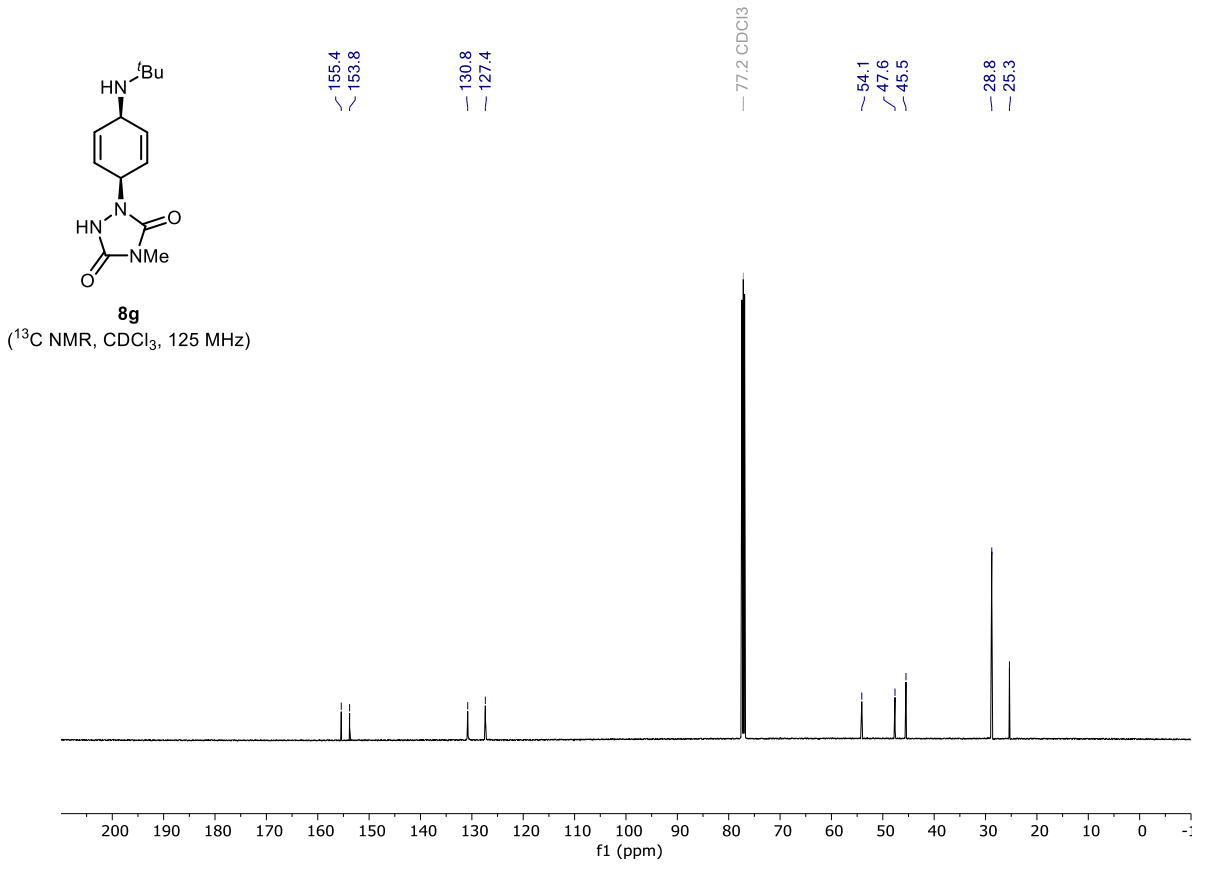
8f

(^{1}H NMR, $CDCl_3$, 500 MHz)



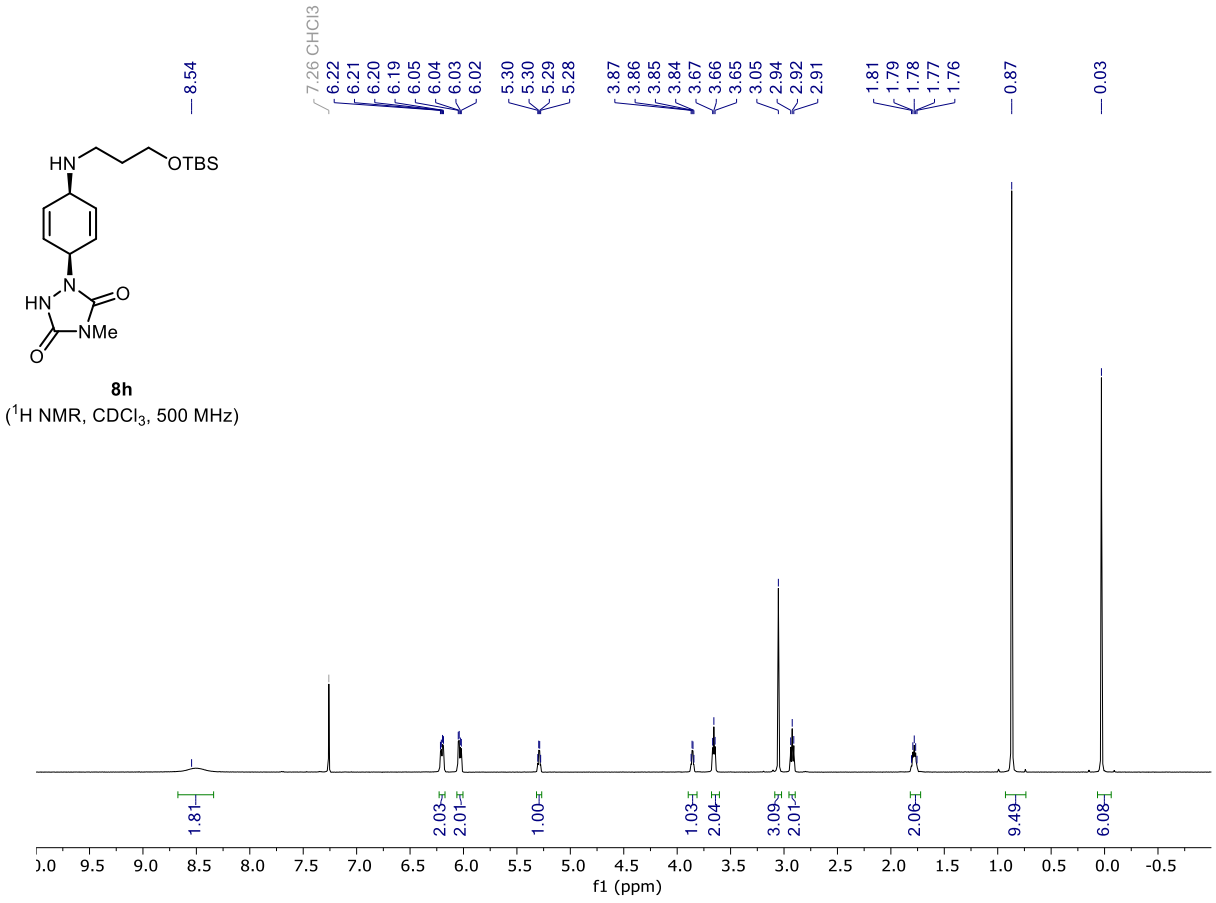
8g

(^{1}H NMR, $CDCl_3$, 500 MHz)



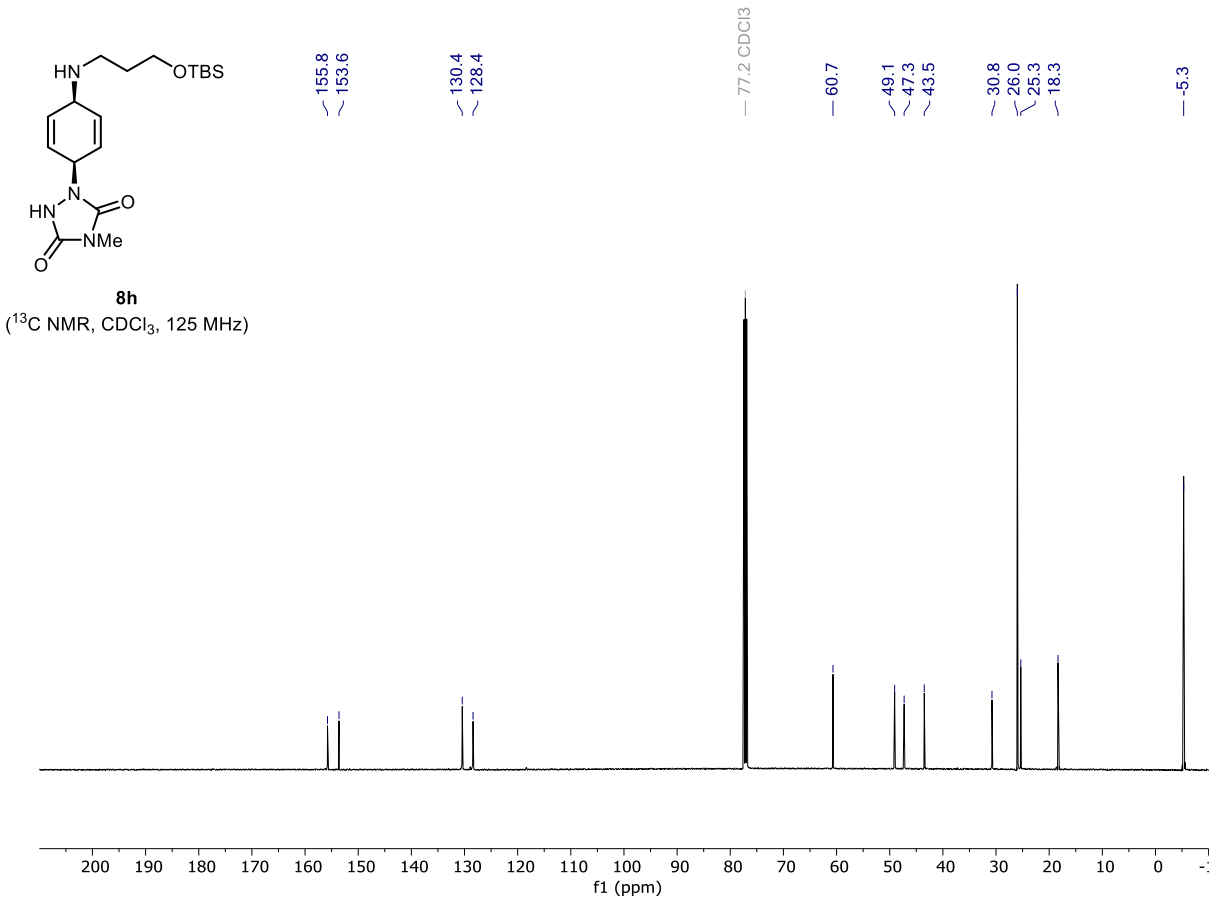
8g

(^{13}C NMR, $CDCl_3$, 125 MHz)



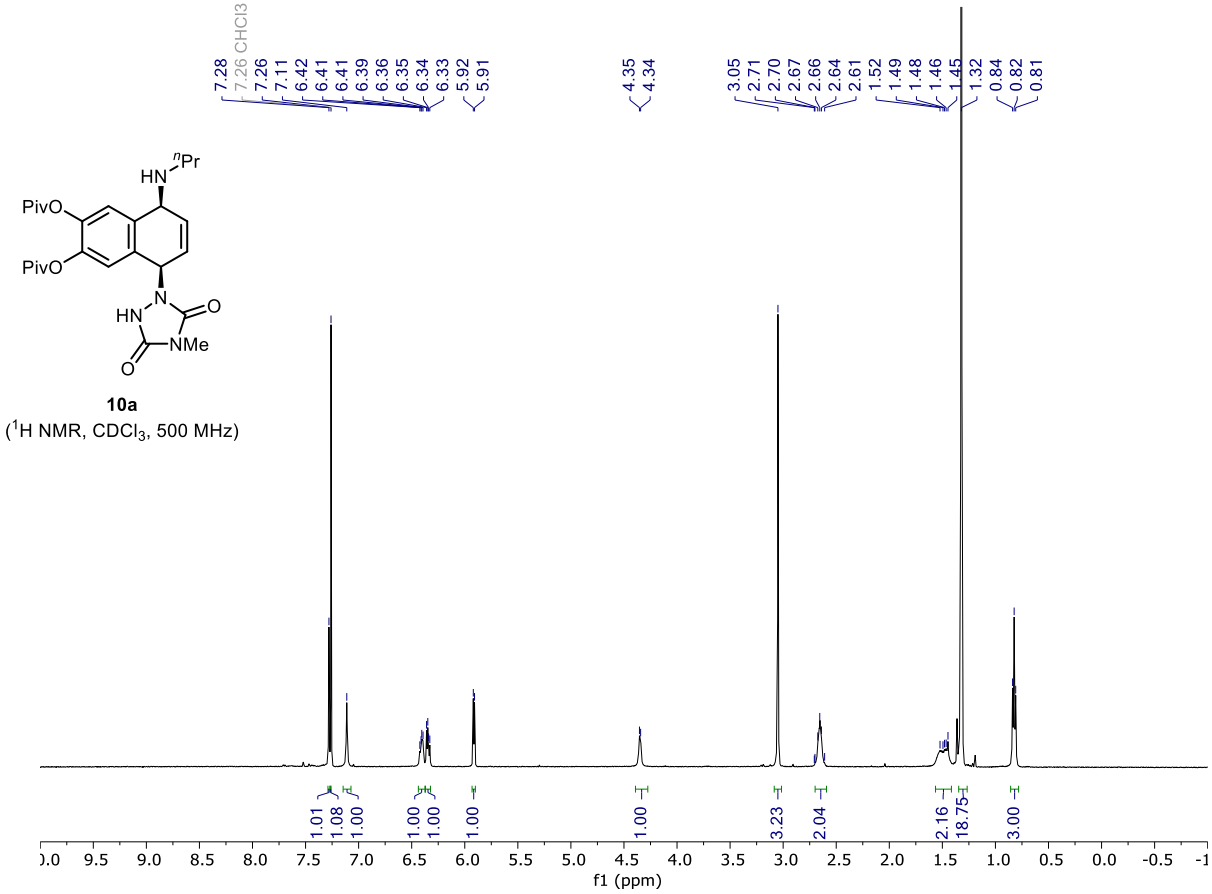
8h

(^{1}H NMR, $CDCl_3$, 500 MHz)

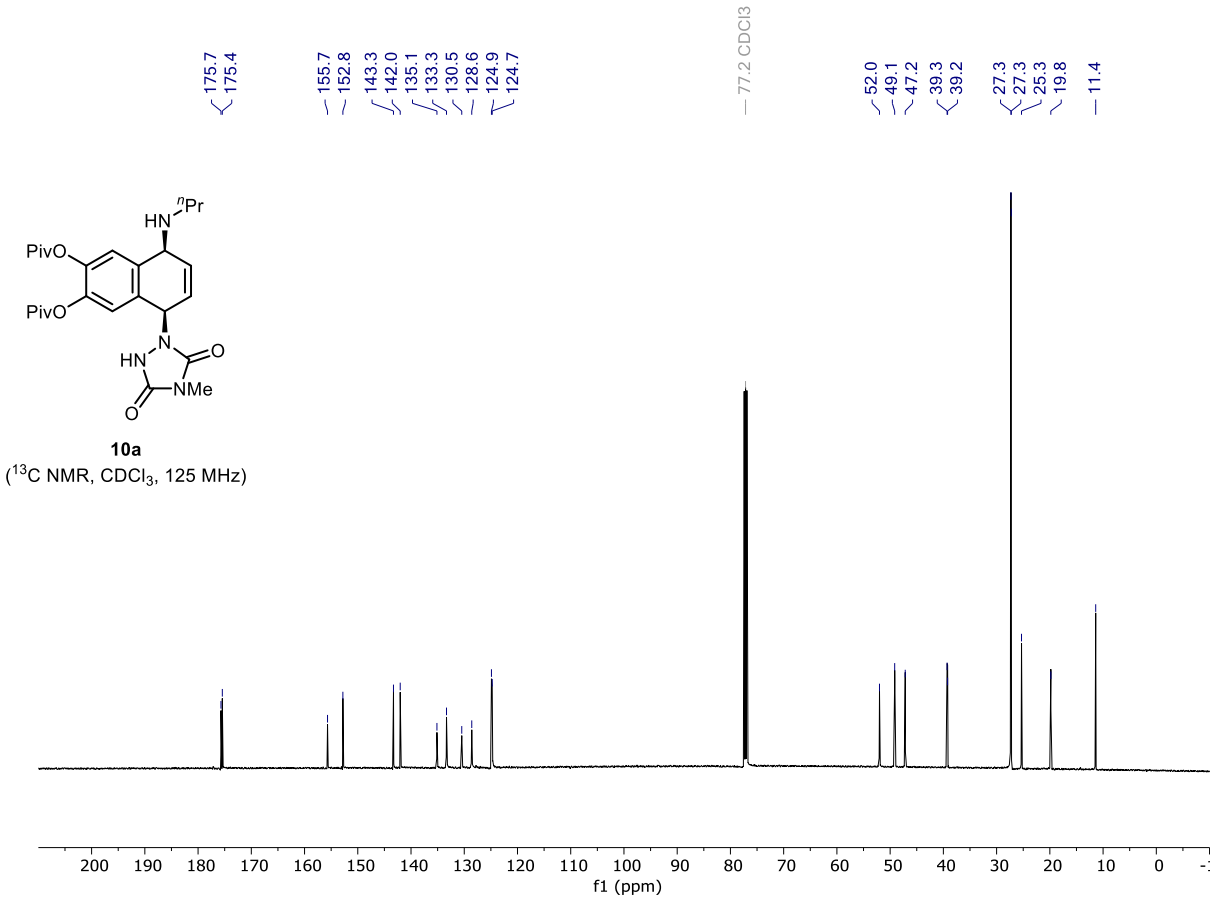


8h

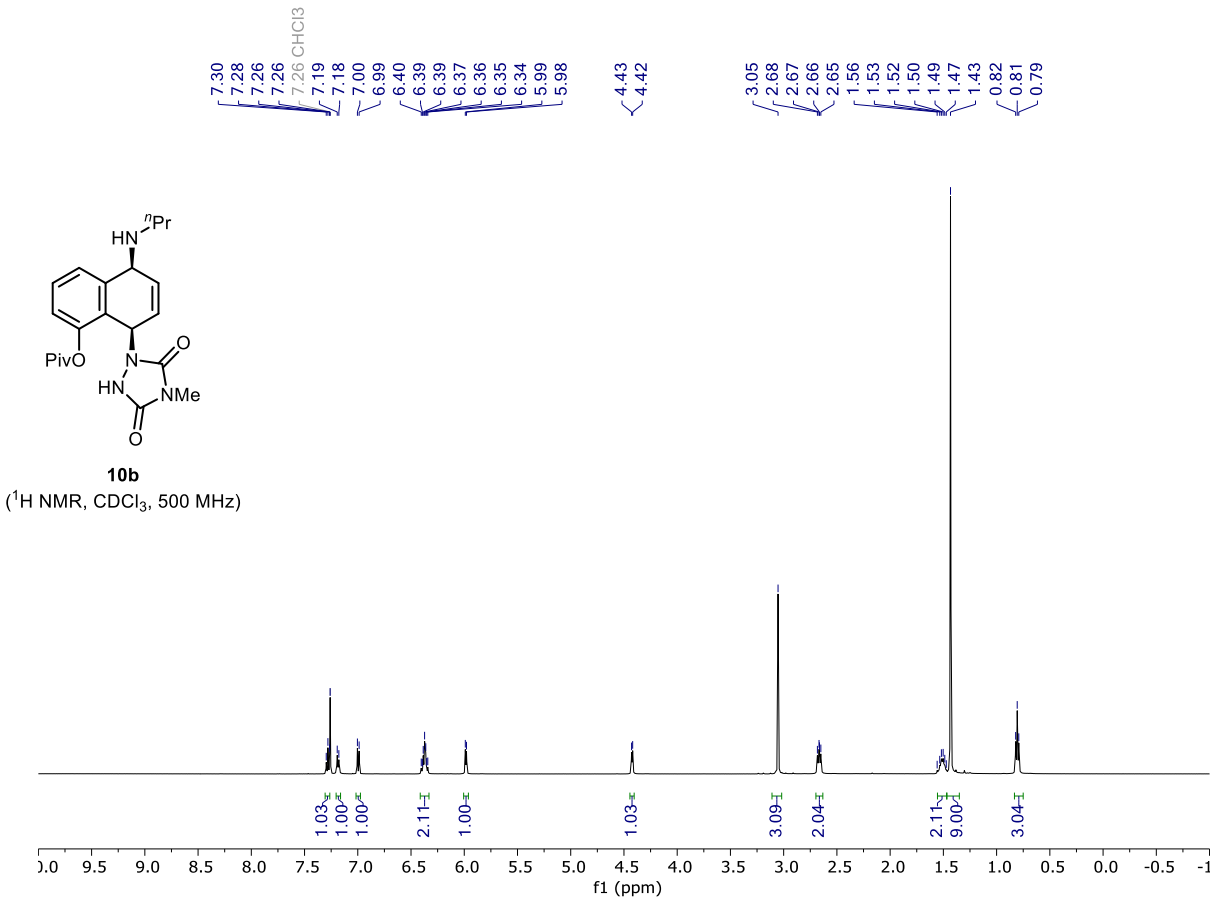
(^{13}C NMR, $CDCl_3$, 125 MHz)



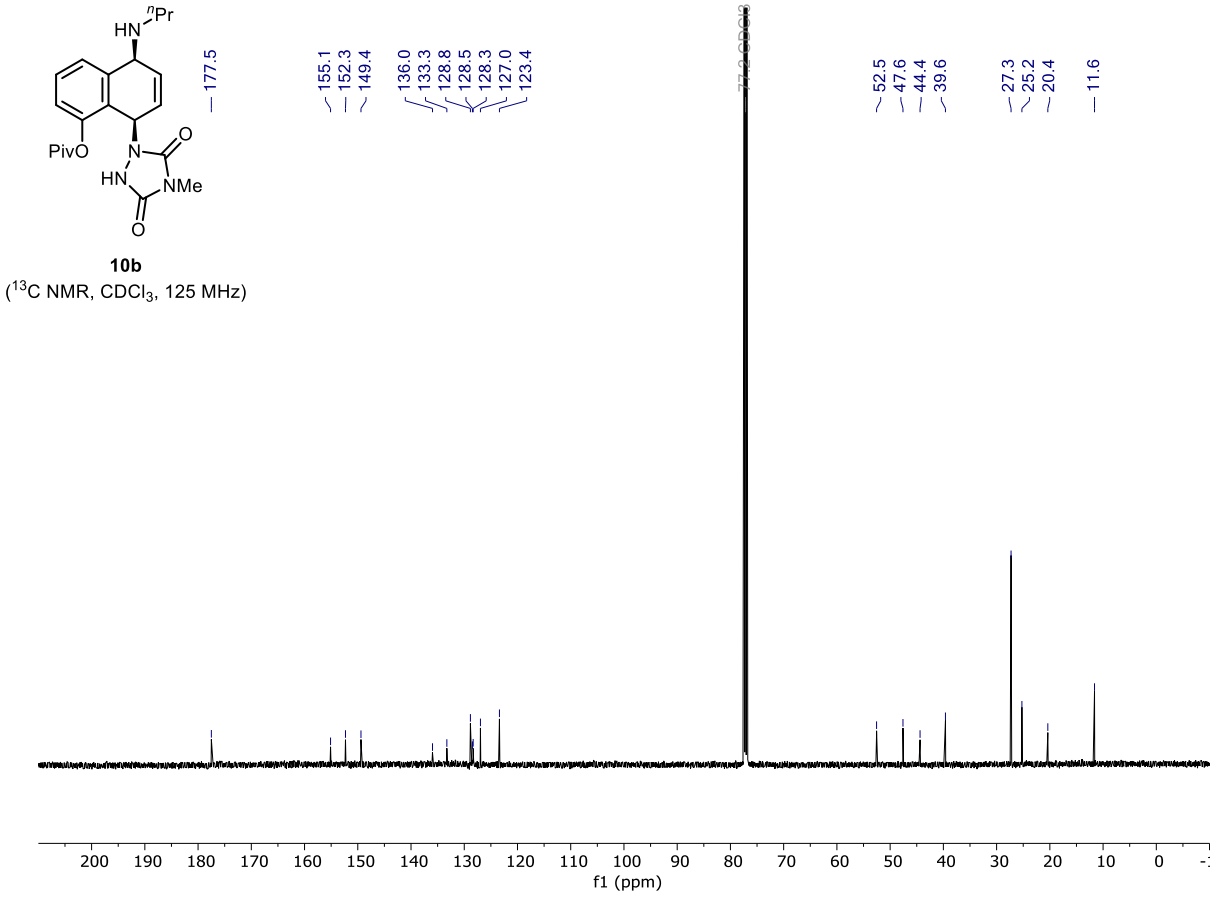
10a
(^{1}H NMR, $CDCl_3$, 500 MHz)



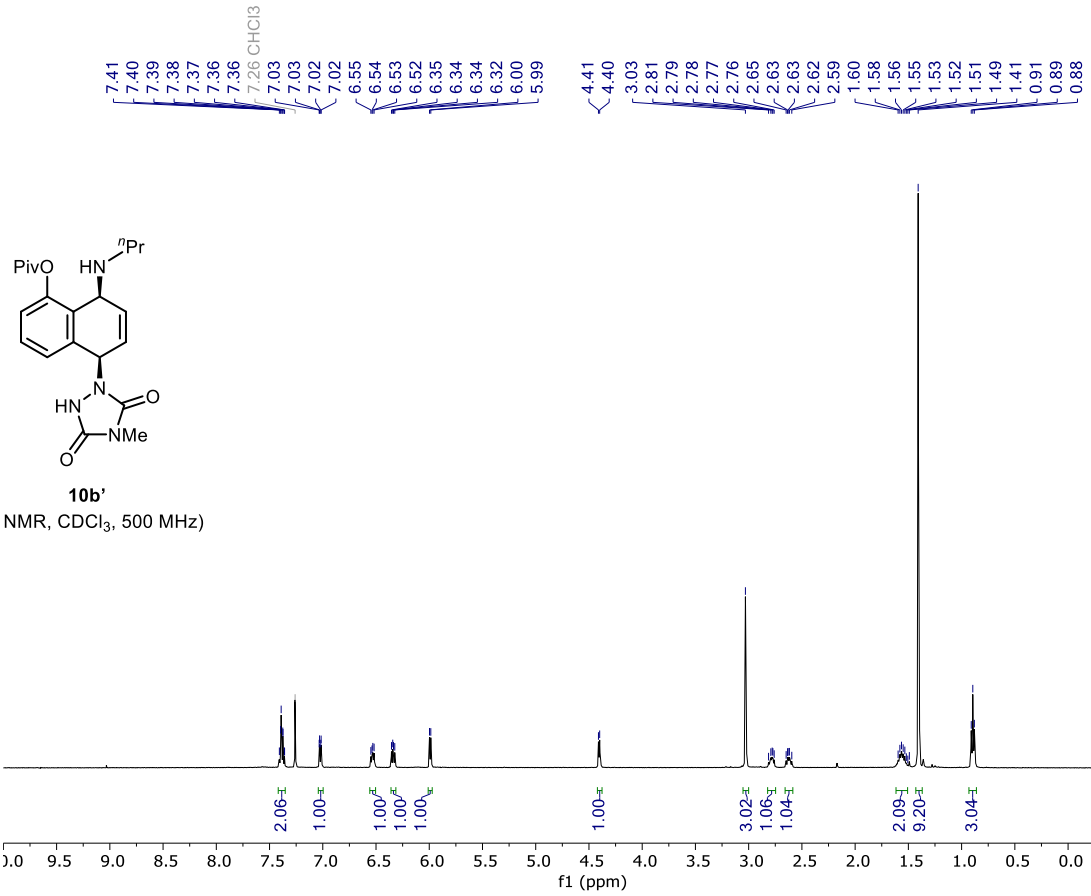
10a
(^{13}C NMR, $CDCl_3$, 125 MHz)



10b
(^{1}H NMR, $CDCl_3$, 500 MHz)

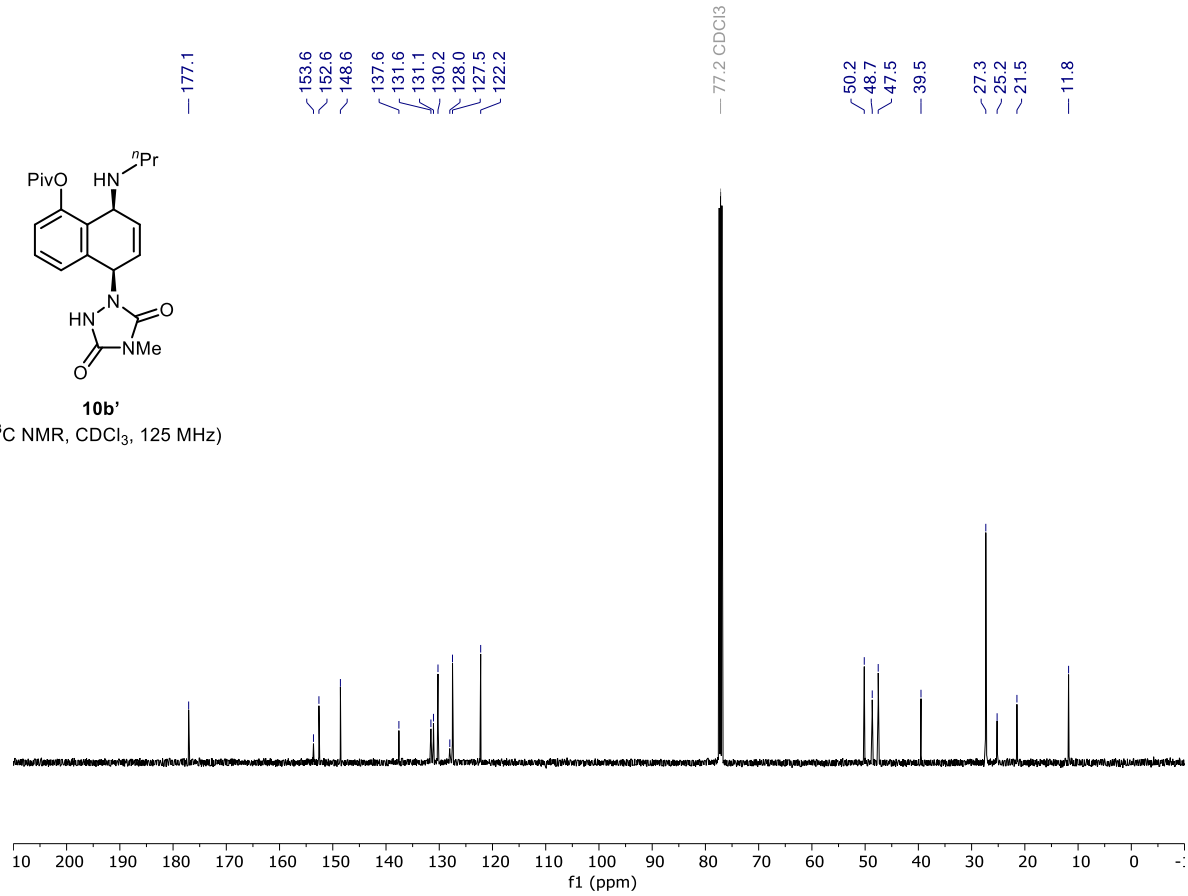


10b
(^{13}C NMR, $CDCl_3$, 125 MHz)



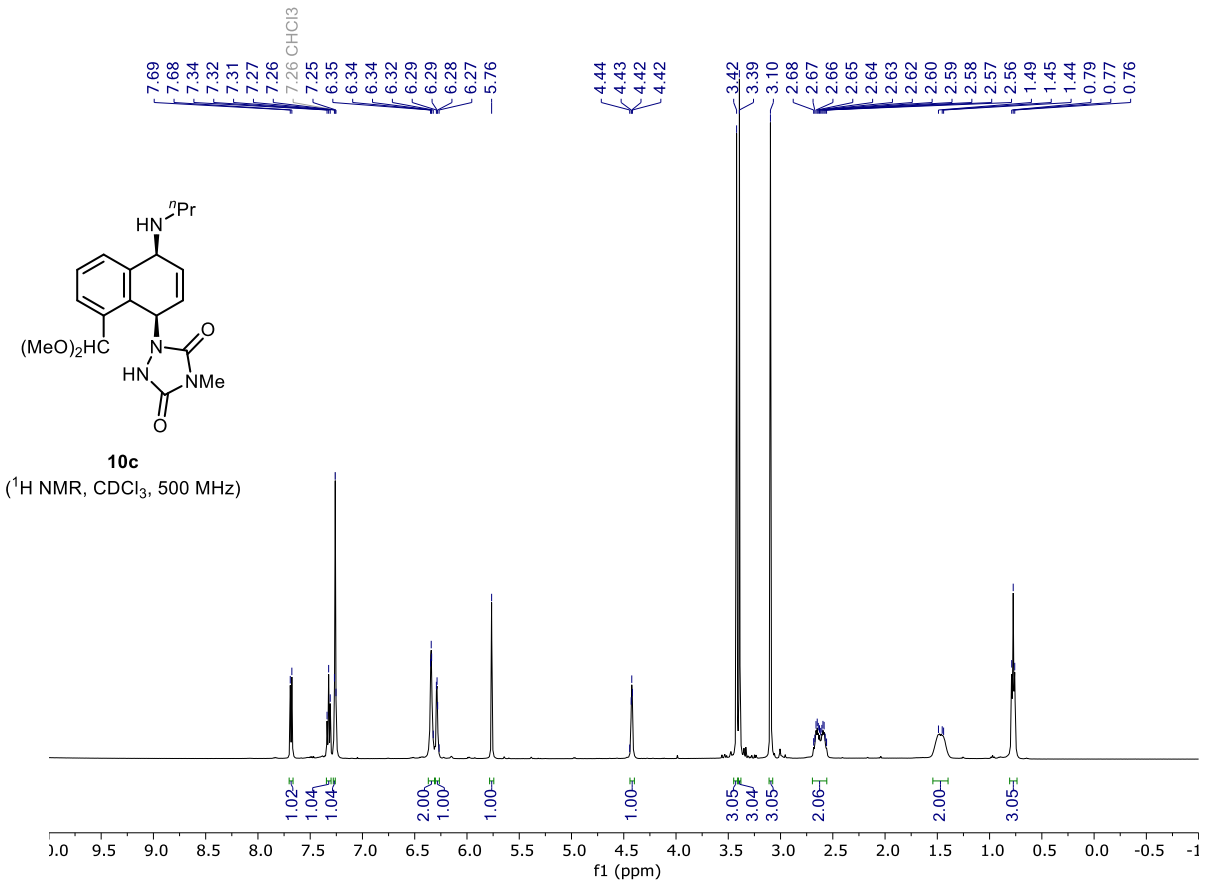
10b'

(^{1}H NMR, $CDCl_3$, 500 MHz)



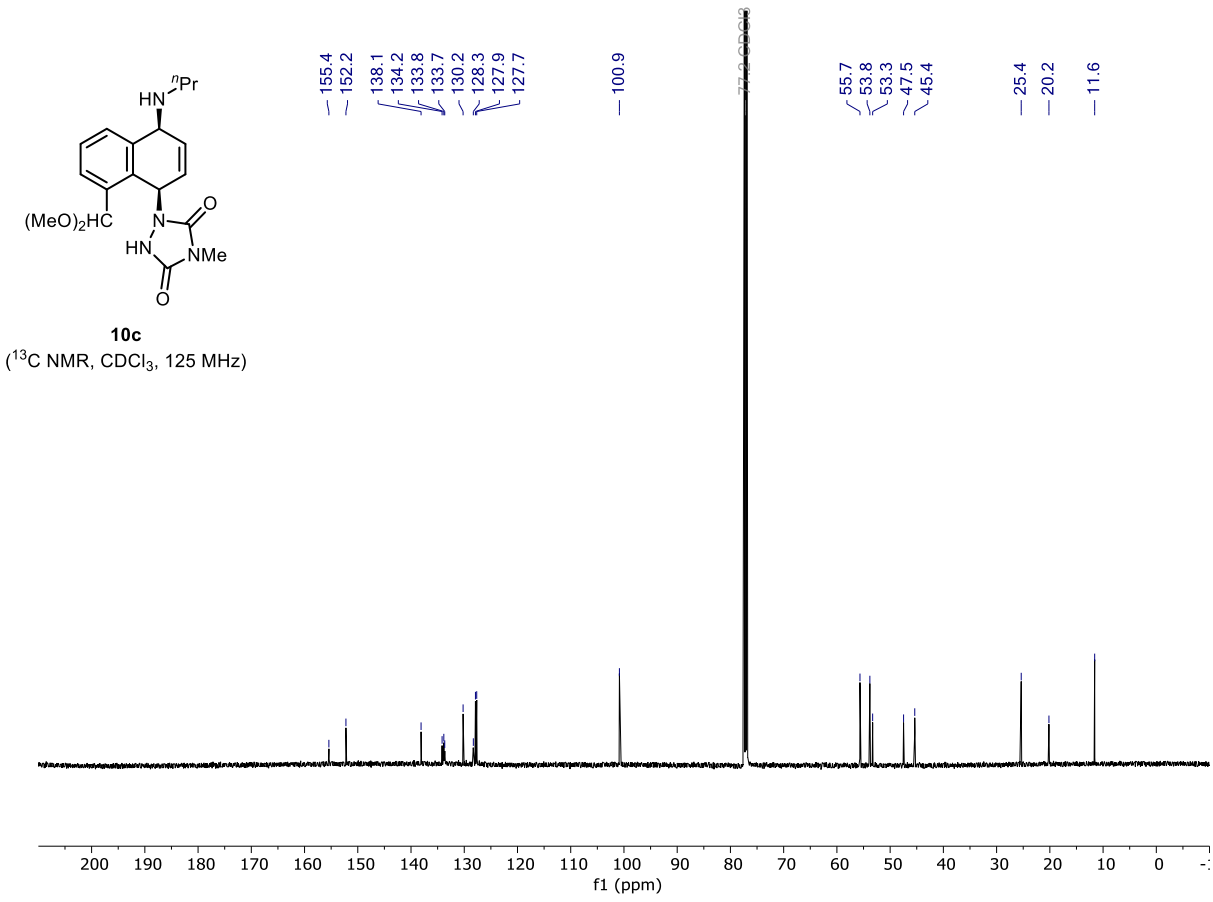
10b'

(^{13}C NMR, $CDCl_3$, 125 MHz)



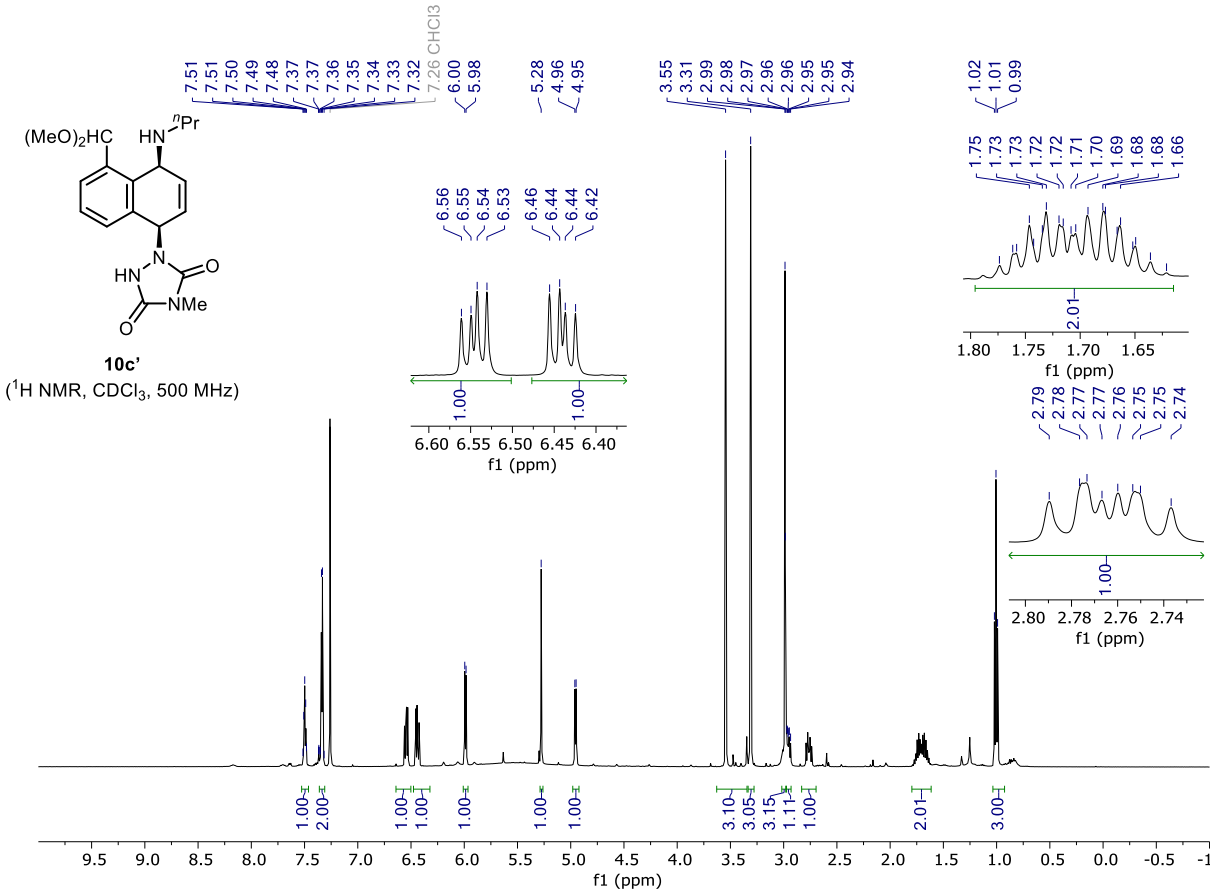
10c

(^{1}H NMR, $CDCl_3$, 500 MHz)



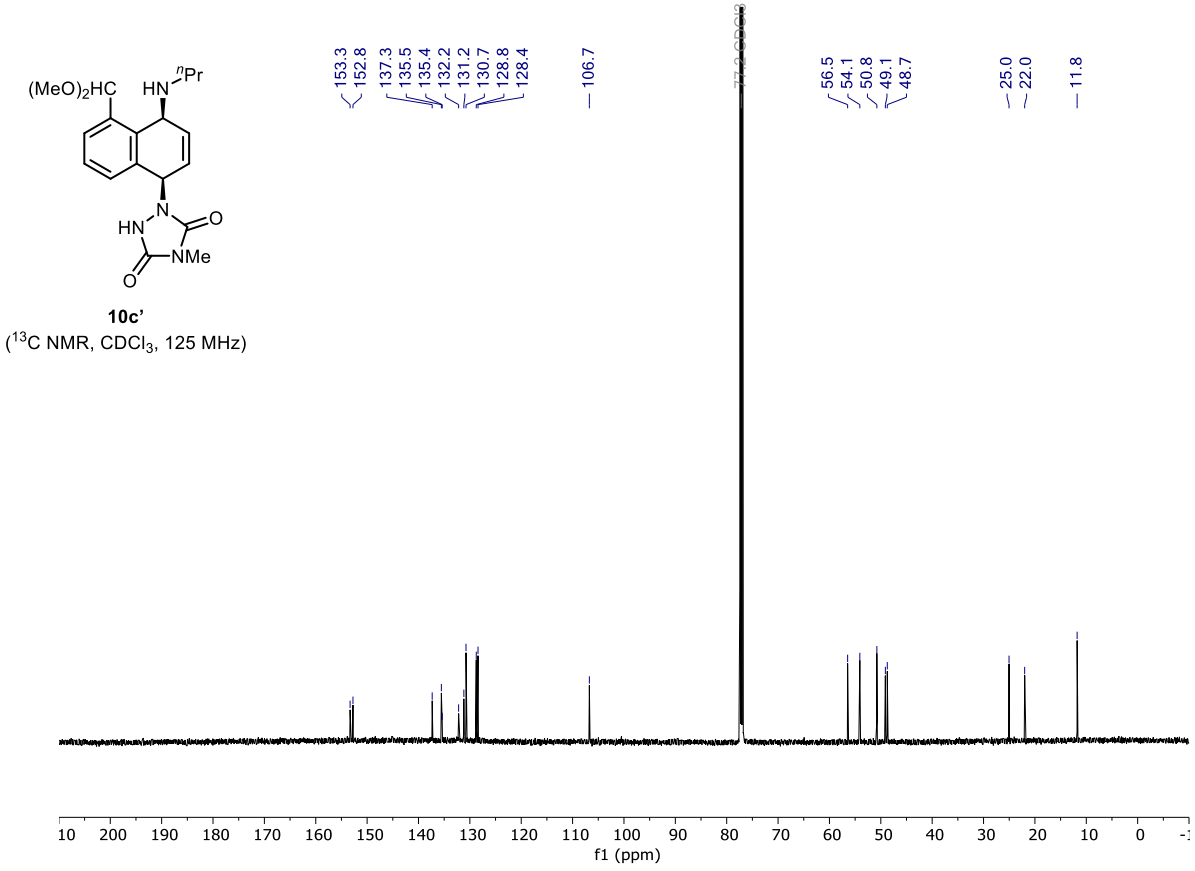
10c

(^{13}C NMR, $CDCl_3$, 125 MHz)



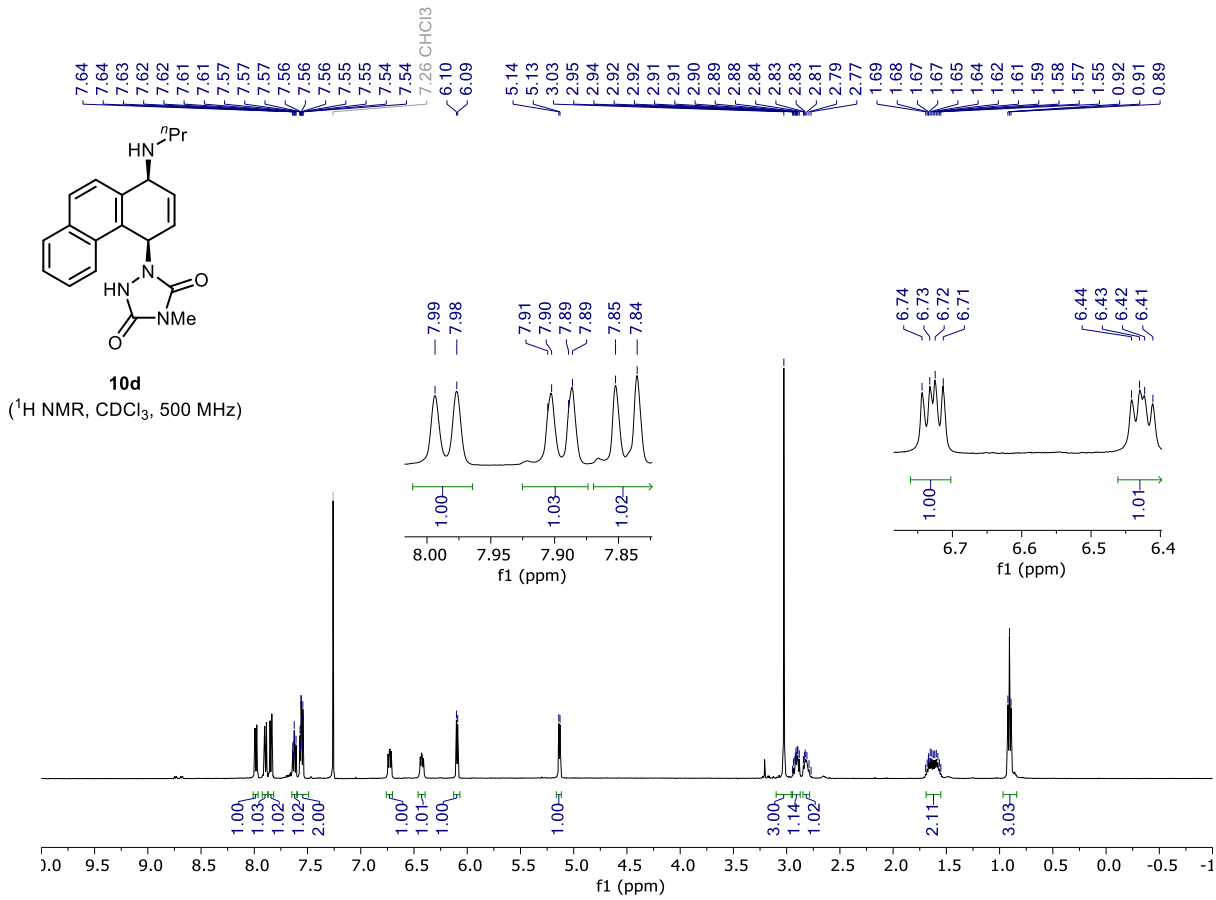
10c'

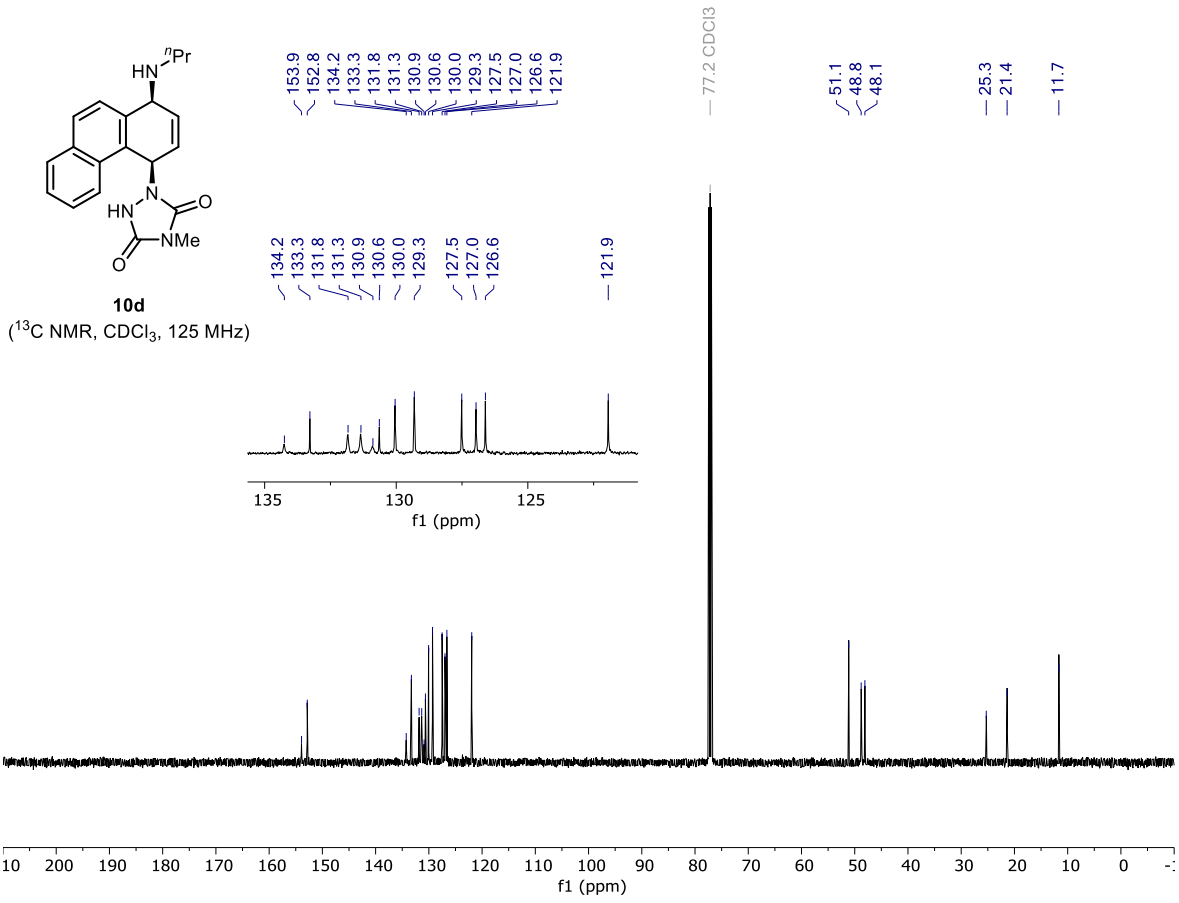
(^{1}H NMR, $CDCl_3$, 500 MHz)

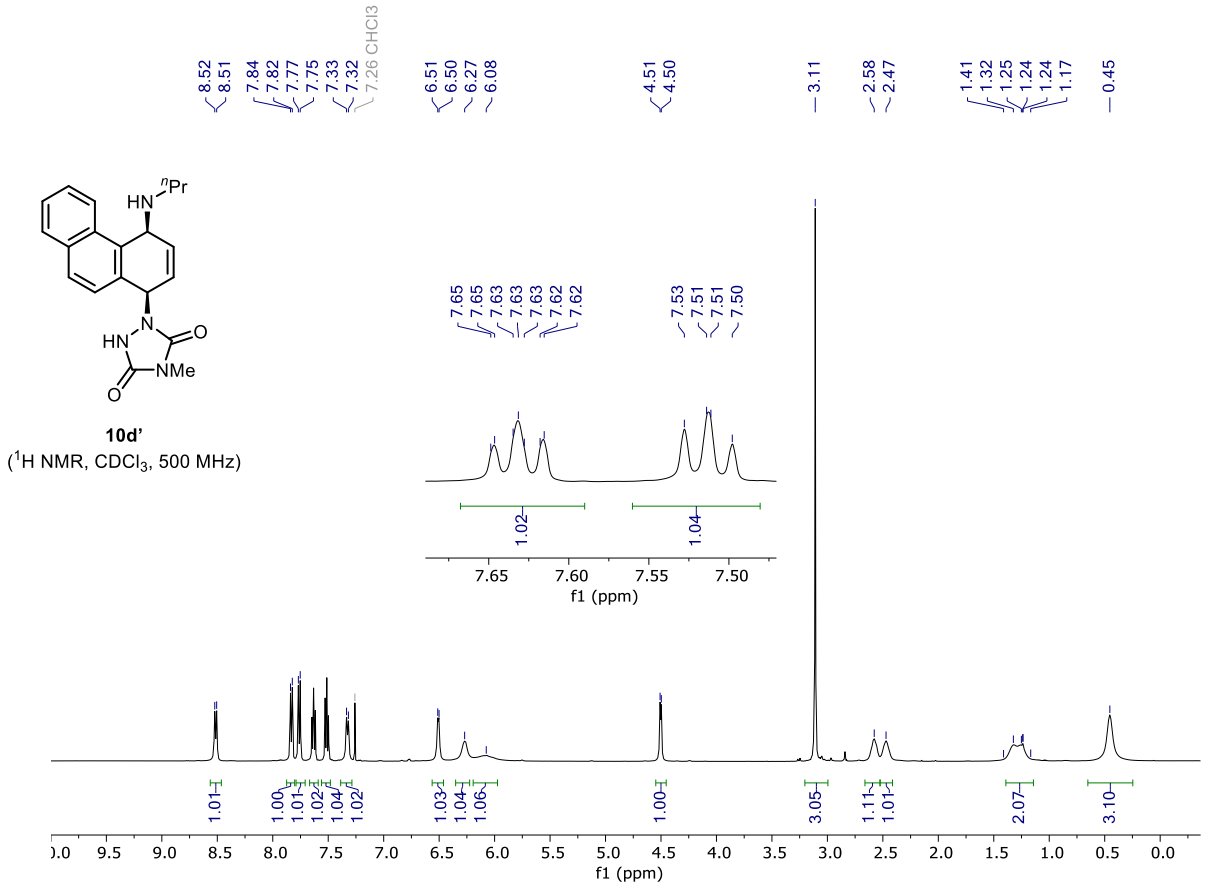


10c'

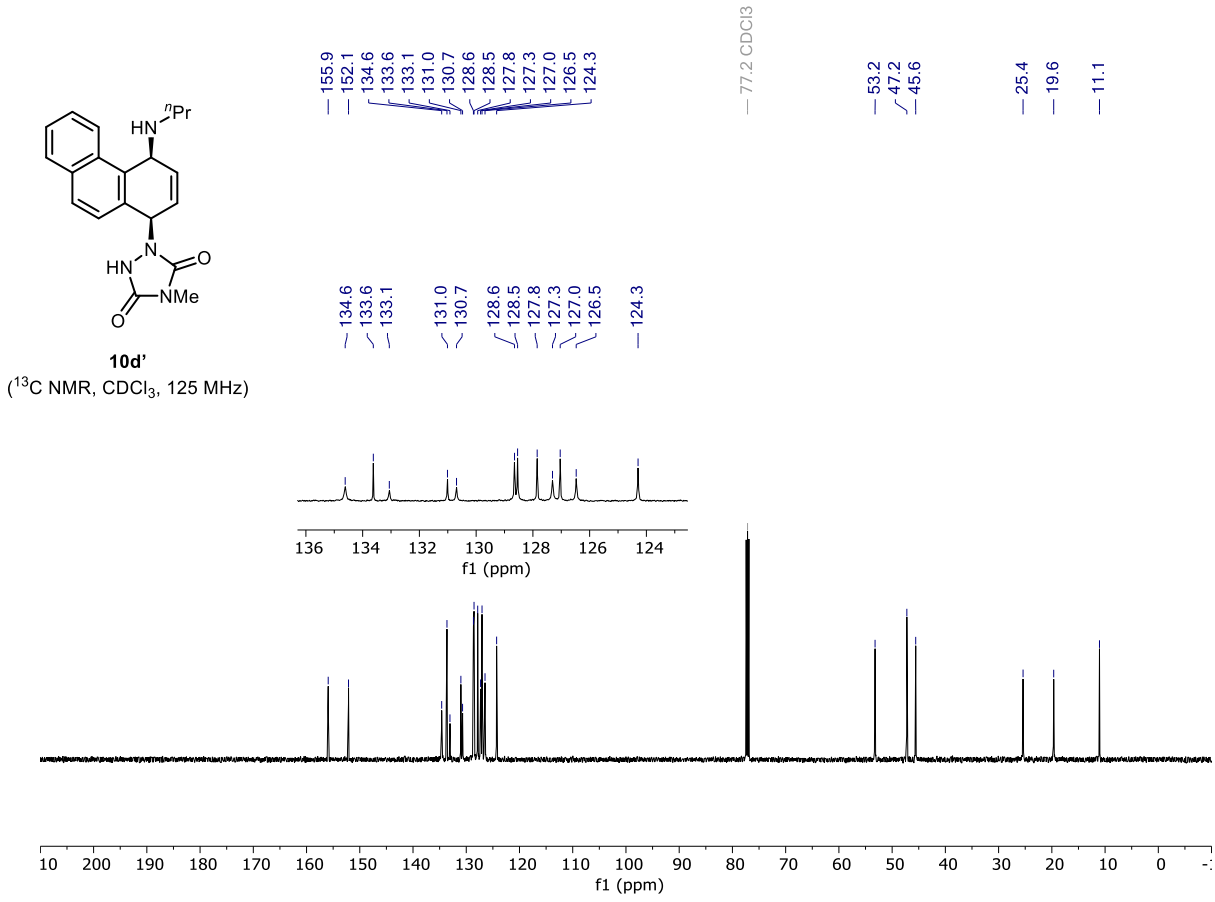
(^{13}C NMR, $CDCl_3$, 125 MHz)


7.64 7.64 7.63 7.62 7.62 7.61 7.61 7.57 7.57 7.57 7.56 7.56 7.56 7.55 7.55 7.54 7.54 7.26 CHCl3 6.10 6.09
5.14 5.13 3.03 2.95 2.94 2.92 2.92 2.91 2.91 2.90 2.89 2.88 2.84 2.83 2.83 2.81 2.79 2.77 1.69 1.68 1.67 1.67 1.65 1.64 1.62 1.61 1.59 1.58 1.57 1.55 0.92 0.91 0.89
HN nPr
HN N O
NMe
O
10d
(1H NMR, CDCl3, 500 MHz)
7.99 7.98 7.91 7.90 7.89 7.89 7.85 7.84
6.74 6.73 6.72 6.71 6.44 6.43 6.42 6.41
1.00 1.03 1.02 1.02 2.00 1.00 1.01 1.00 1.00 3.00 1.14 1.02 2.11 3.03
f1 (ppm)

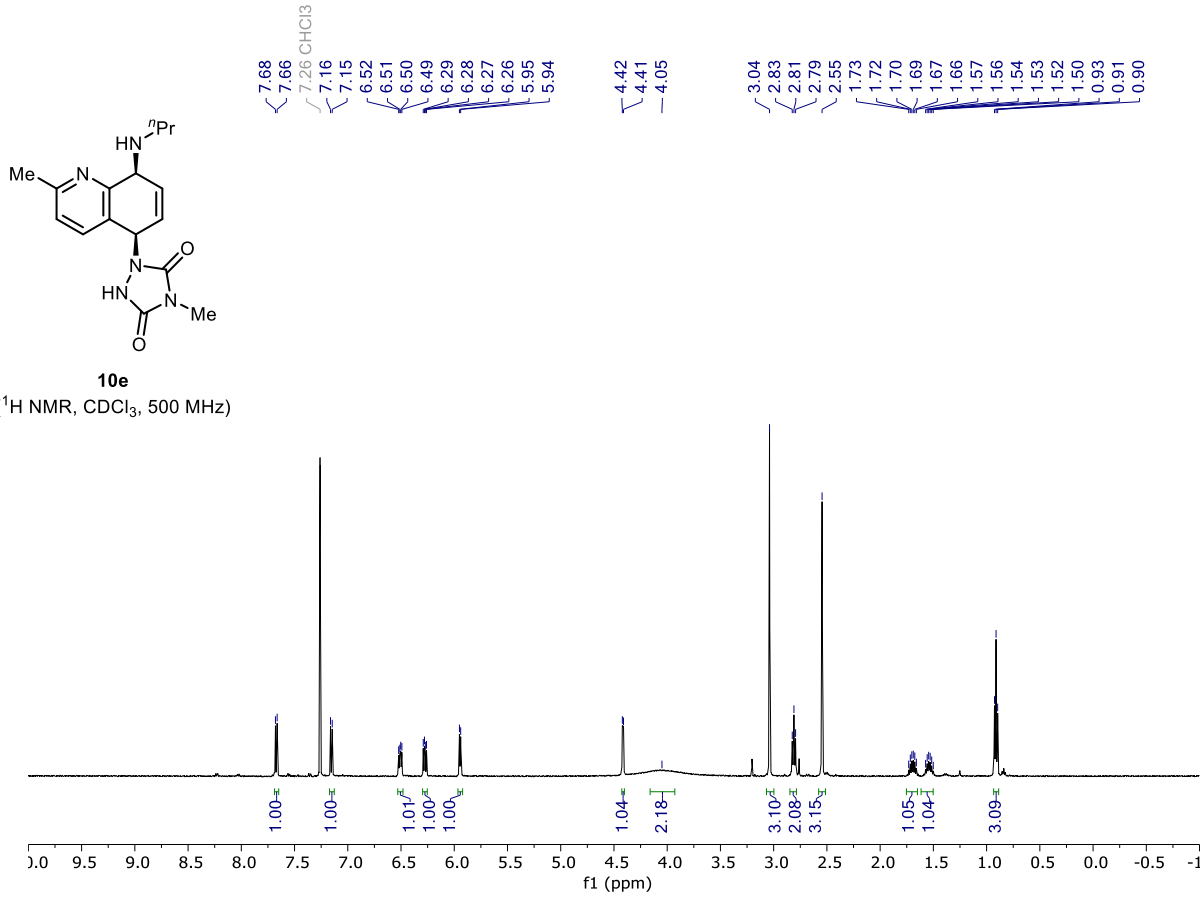

HN nPr
HN N O
NMe
O
10d
(13C NMR, CDCl3, 125 MHz)
153.9 152.8 134.2 133.3 131.8 131.3 130.9 130.6 130.0 129.3 127.5 127.0 126.6 121.9
77.2 CDCl3
51.1 48.8 48.1
25.3 21.4 11.7
f1 (ppm)



10d'
(^{1}H NMR, $CDCl_3$, 500 MHz)

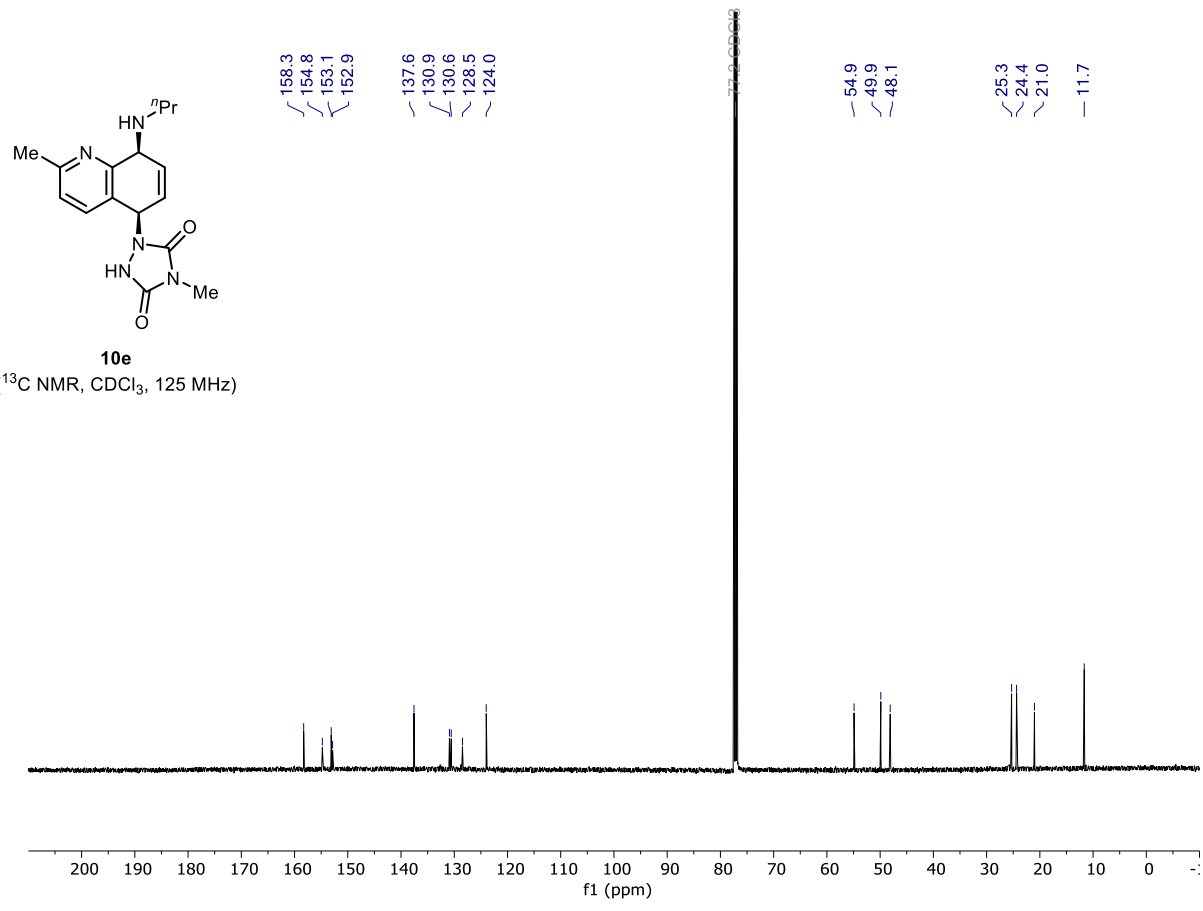


10d'
(^{13}C NMR, $CDCl_3$, 125 MHz)



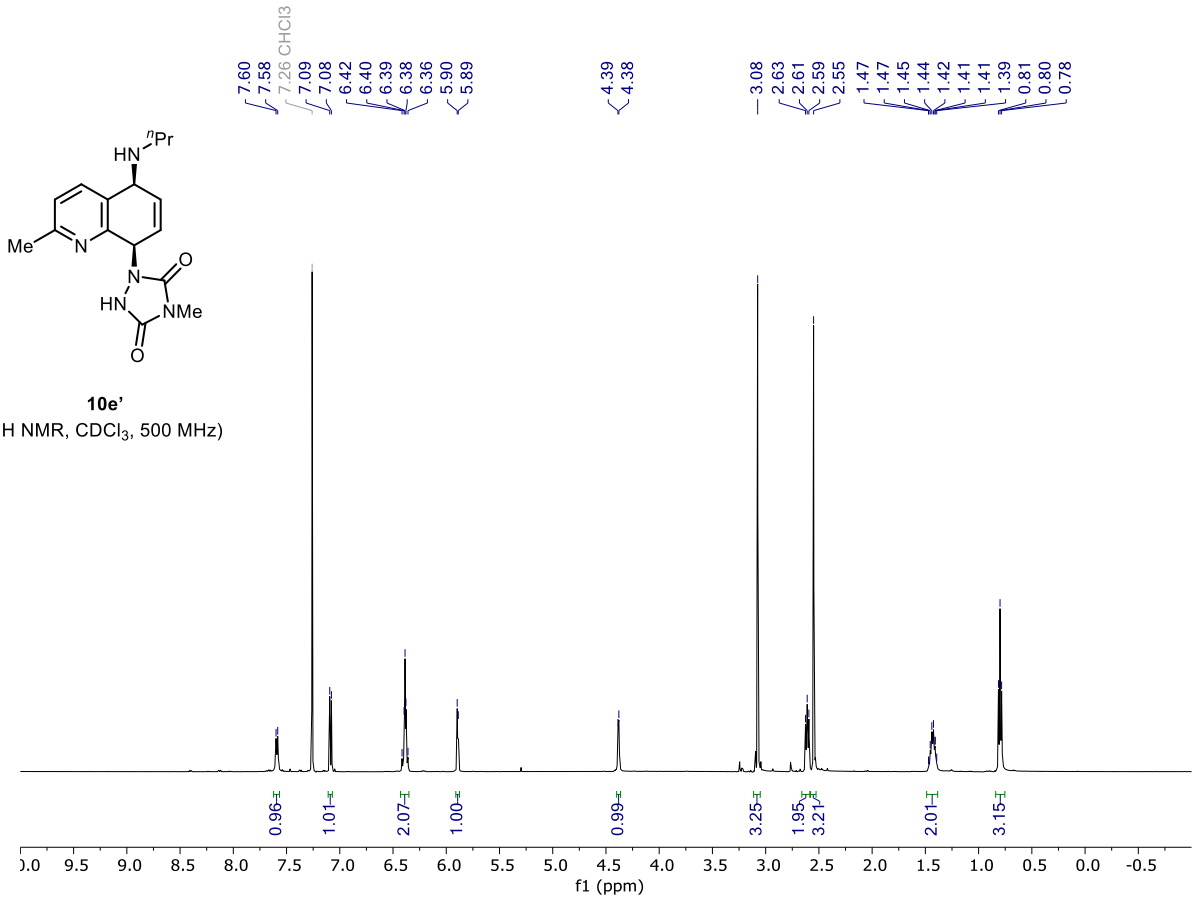
10e

(^{1}H NMR, $CDCl_3$, 500 MHz)

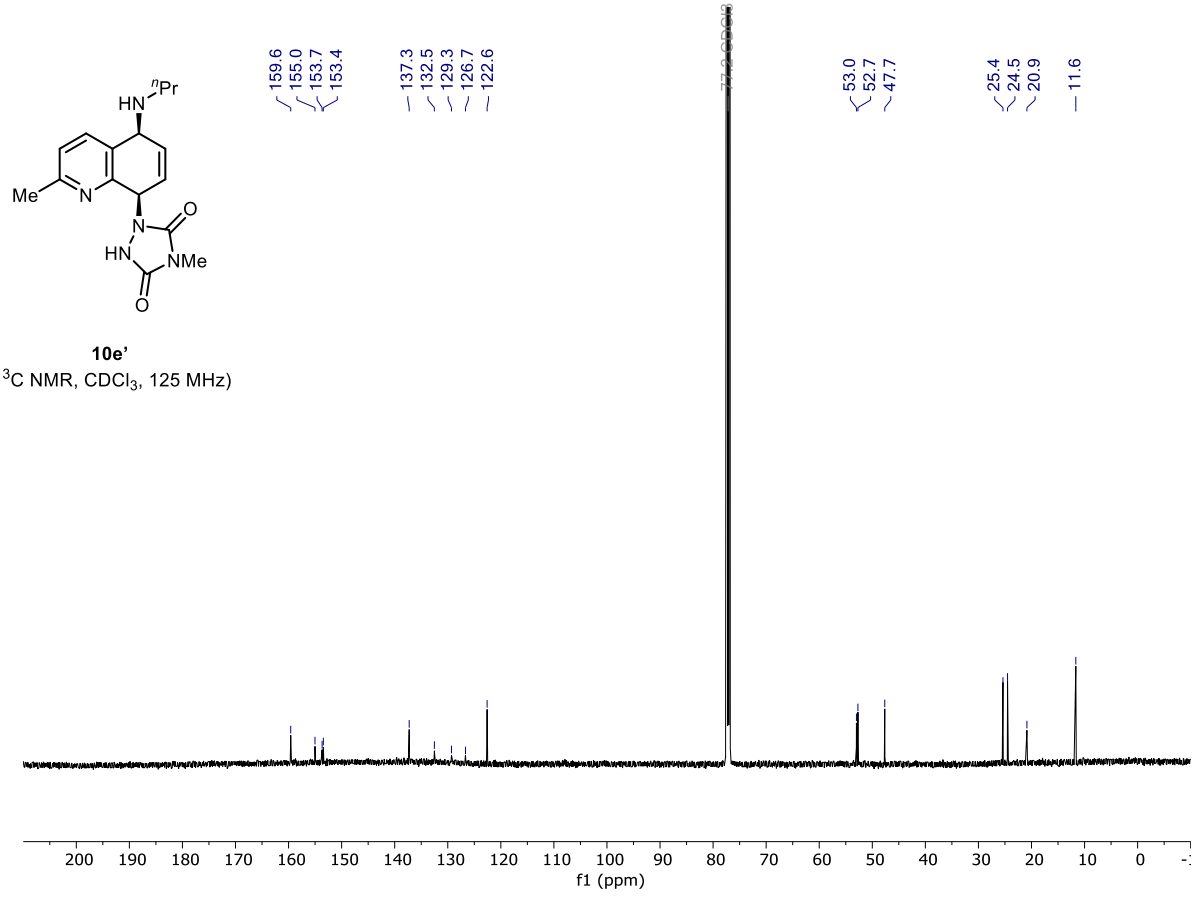


10e

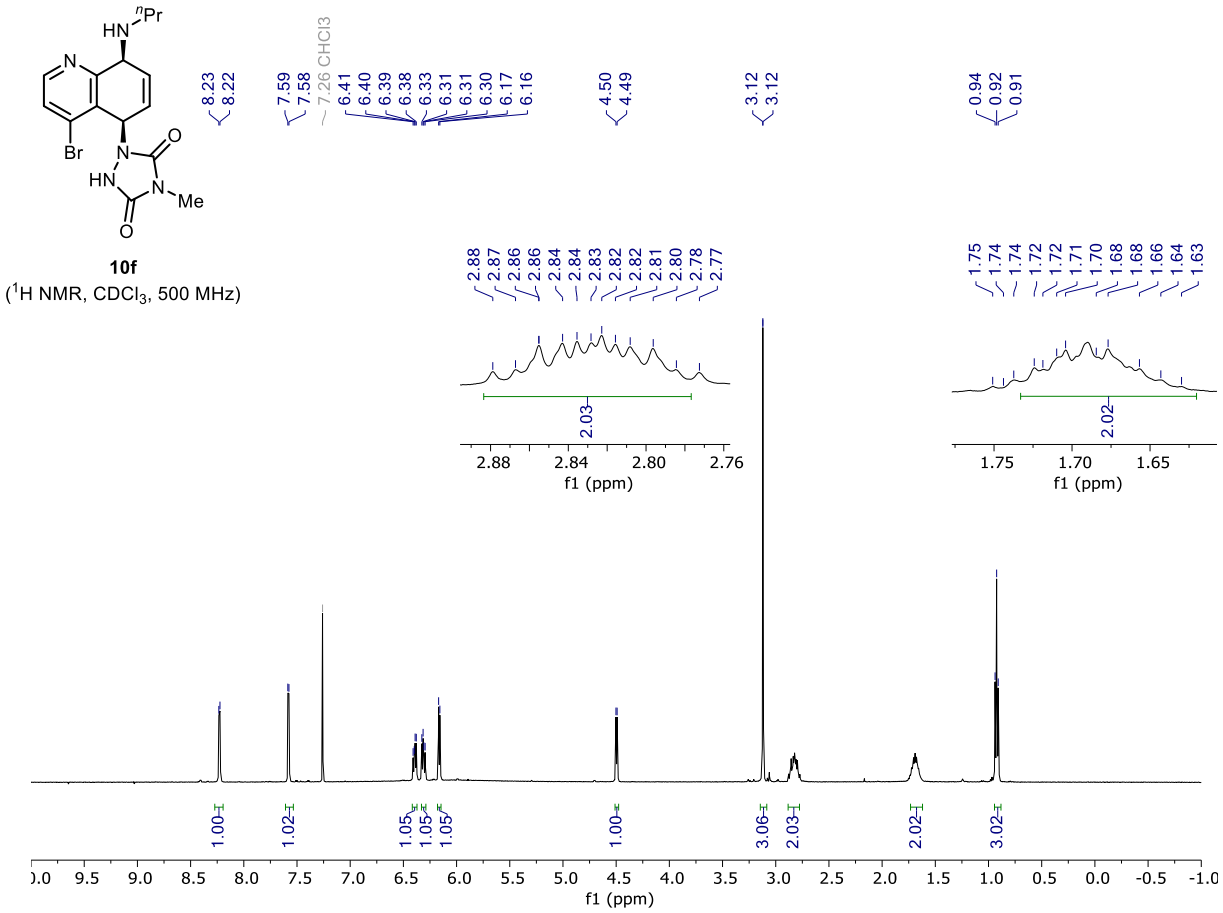
(^{13}C NMR, $CDCl_3$, 125 MHz)

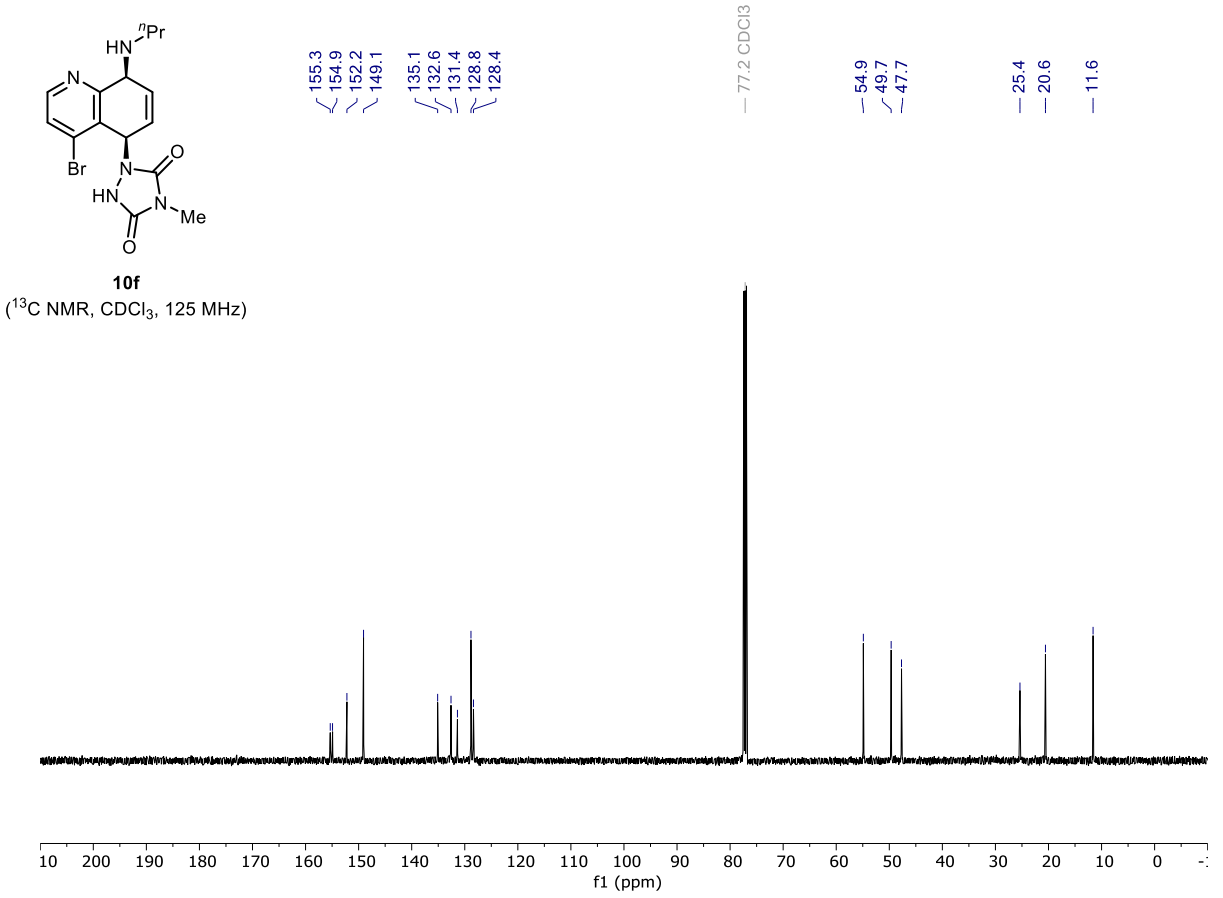


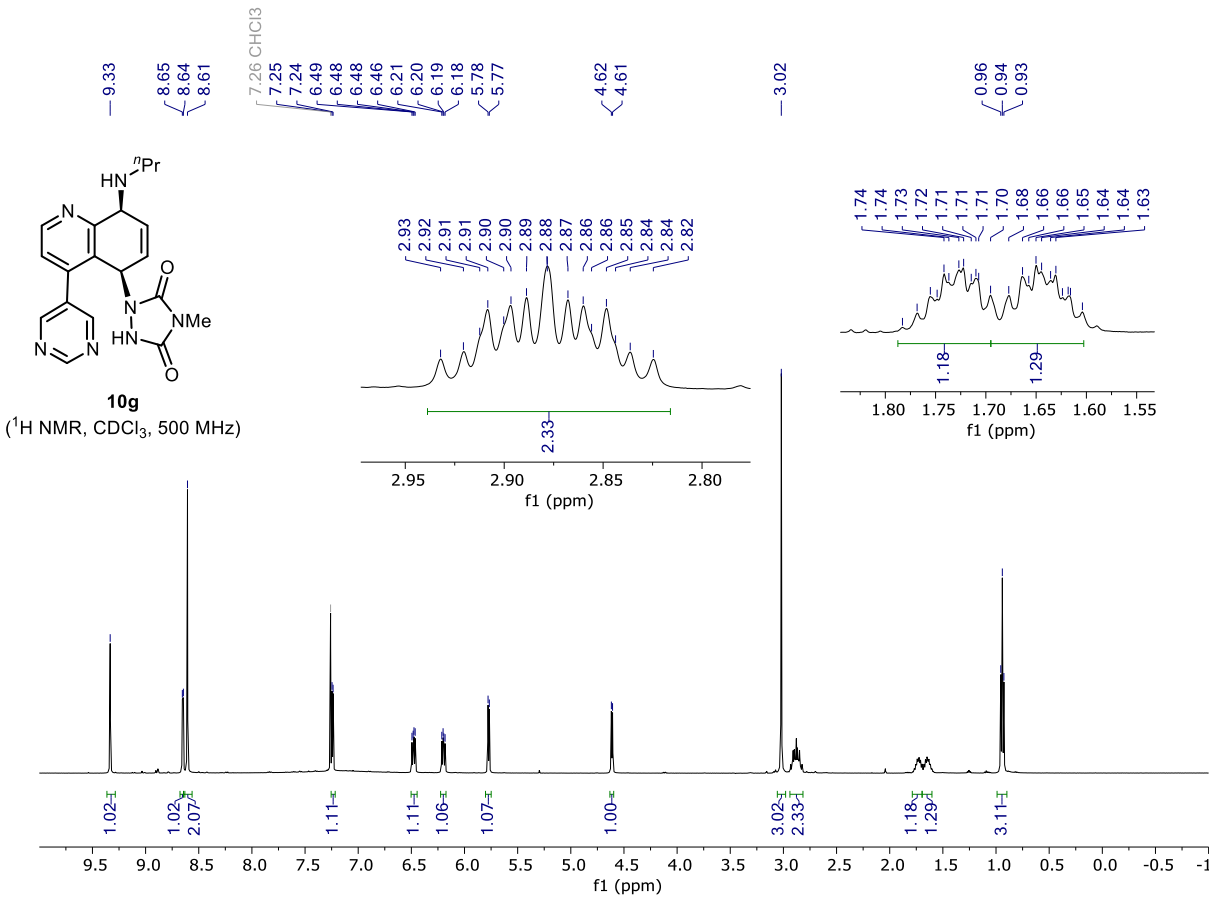
10e'
(^{1}H NMR, $CDCl_3$, 500 MHz)

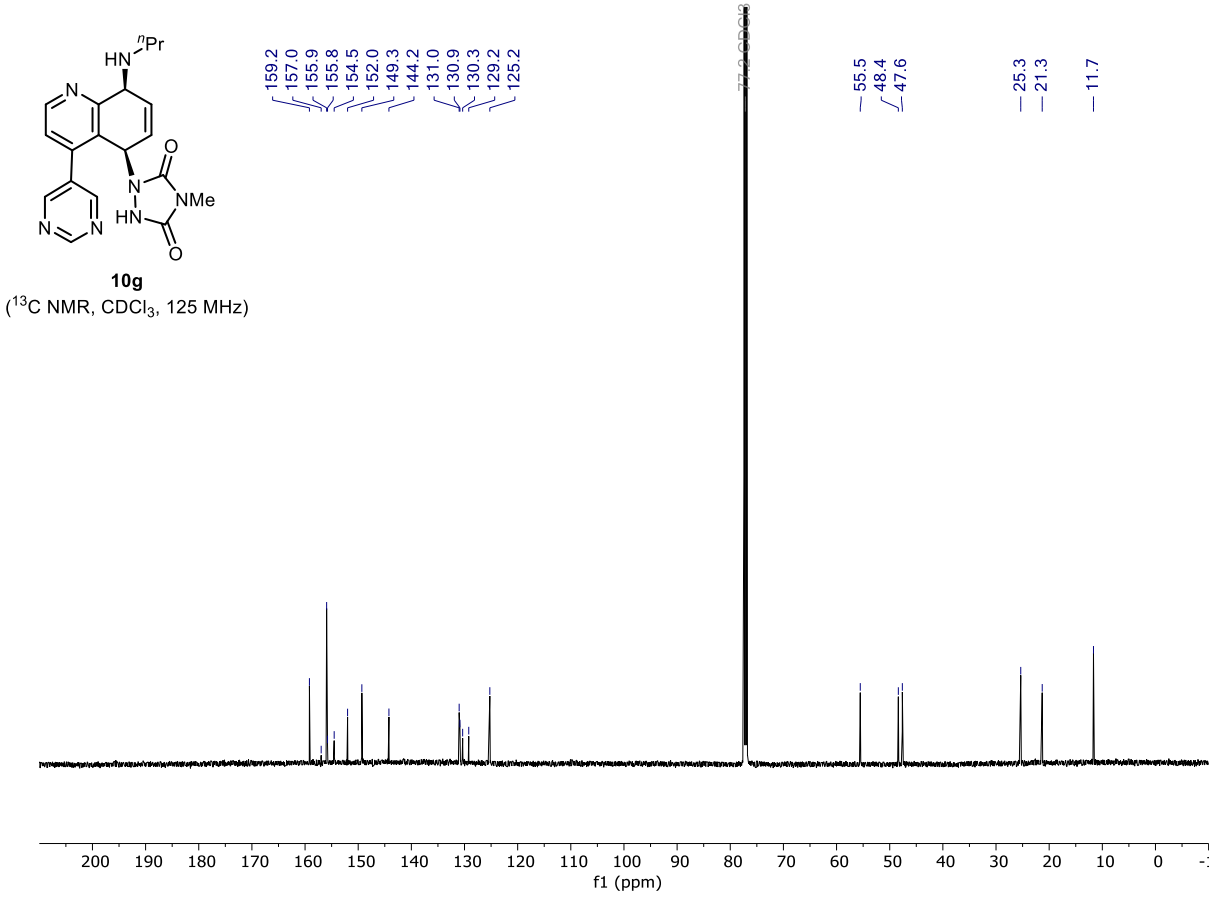


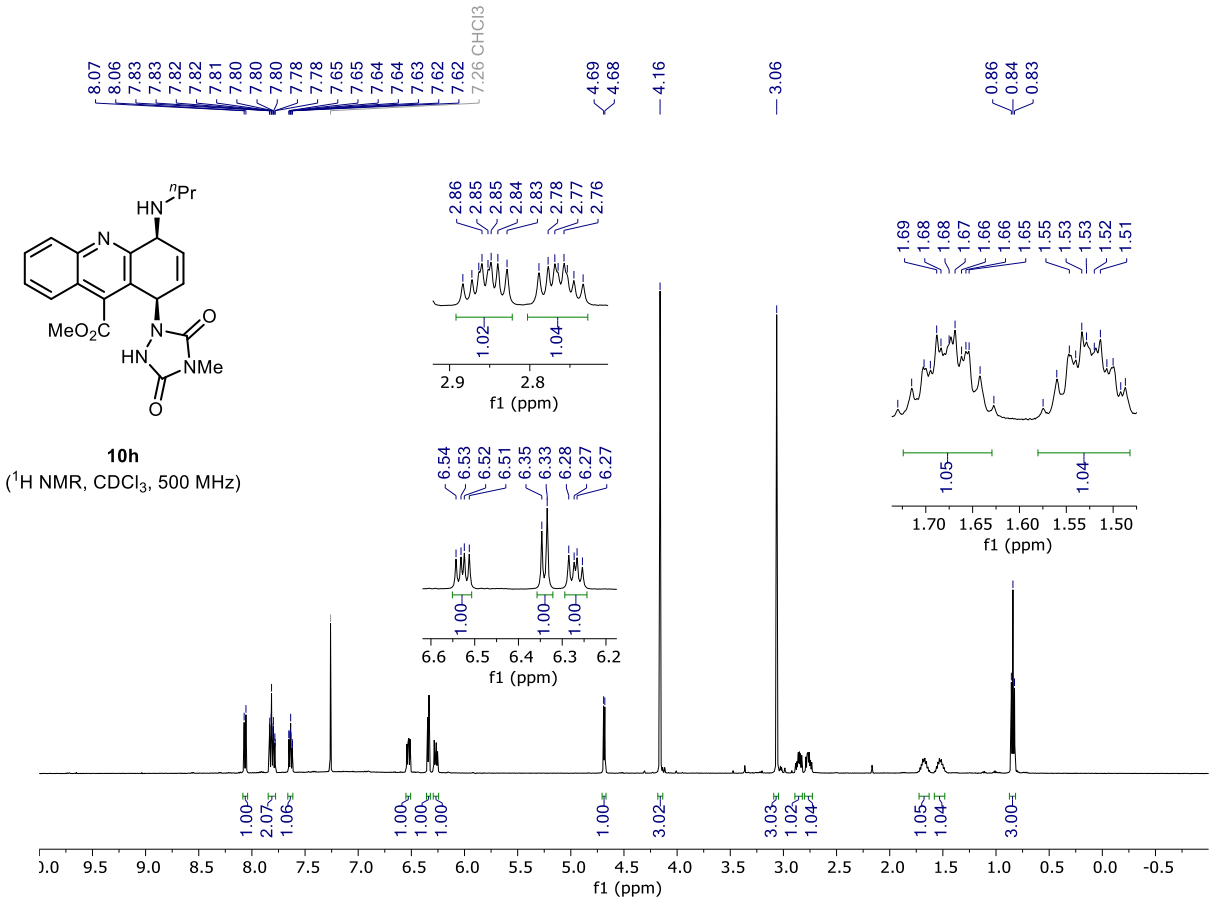
10e'
(^{13}C NMR, $CDCl_3$, 125 MHz)


10f
(1H NMR, CDCl3, 500 MHz)
8.23
8.22
7.59
7.58
7.26 CHCl3
6.41
6.40
6.39
6.38
6.33
6.31
6.31
6.30
6.17
6.16
4.50
4.49
3.12
3.12
0.94
0.92
0.91
2.88
2.87
2.86
2.86
2.84
2.84
2.83
2.82
2.82
2.81
2.80
2.78
2.77
1.75
1.74
1.74
1.72
1.72
1.71
1.70
1.68
1.68
1.66
1.64
1.63
2.03
2.02
f1 (ppm)
1.00
1.02
1.05
1.05
1.05
1.00
3.06
2.03
2.02
3.02
f1 (ppm)


10f
(13C NMR, CDCl3, 125 MHz)
155.3
154.9
152.2
149.1
135.1
132.6
131.4
128.8
128.4
77.2 CDCl3
54.9
49.7
47.7
25.4
20.6
11.6
f1 (ppm)

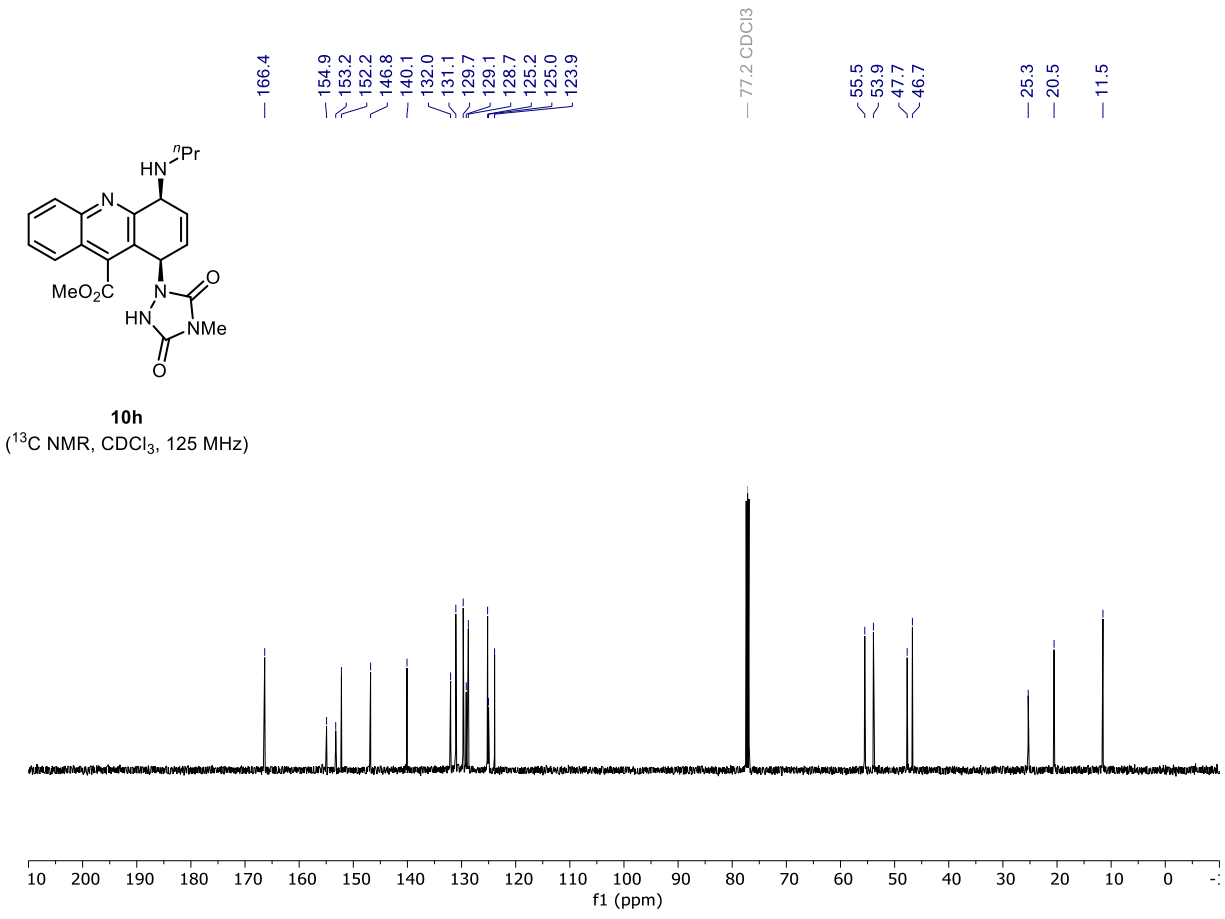

9.33
8.65
8.64
8.61
7.26 CHCl3
7.25
7.24
6.49
6.48
6.48
6.46
6.21
6.20
6.19
6.18
5.78
5.77
4.62
4.61
3.02
0.96
0.94
0.93
HN
nPr
N
O
N
NMe
HN
O
N
N
10g
(1H NMR, CDCl3, 500 MHz)
2.93
2.92
2.91
2.91
2.90
2.90
2.89
2.88
2.87
2.86
2.86
2.85
2.84
2.84
2.82
2.33
2.95
2.90
2.85
2.80
f1 (ppm)
1.74
1.74
1.73
1.72
1.71
1.71
1.71
1.70
1.68
1.66
1.66
1.65
1.64
1.64
1.63
1.18
1.29
1.80
1.75
1.70
1.65
1.60
1.55
f1 (ppm)
1.02
1.02
2.07
1.11
1.11
1.06
1.07
1.00
3.02
2.33
1.18
1.29
3.11
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)


HN
nPr
N
O
N
NMe
HN
O
N
N
10g
(13C NMR, CDCl3, 125 MHz)
159.2
157.0
155.9
155.8
154.5
152.0
149.3
144.2
131.0
130.9
130.3
129.2
125.2
77.2 CDCl3
55.5
48.4
47.6
25.3
21.3
11.7
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



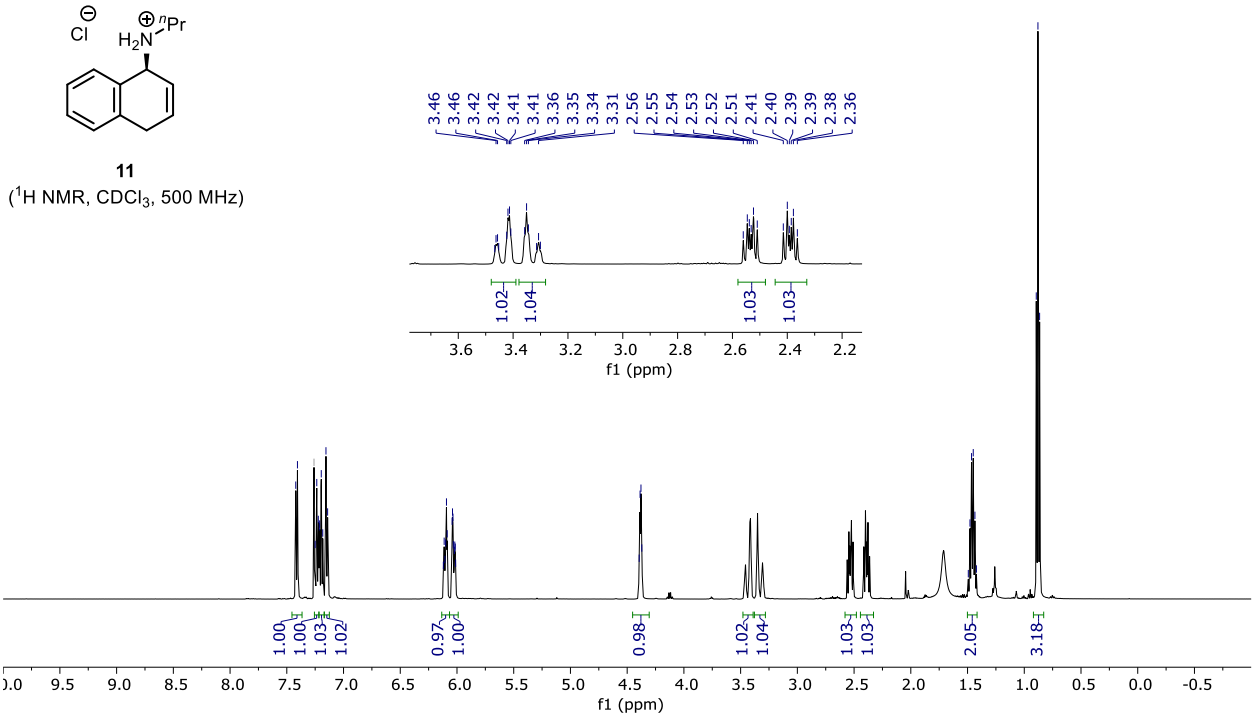
10h

(^{1}H NMR, $CDCl_3$, 500 MHz)

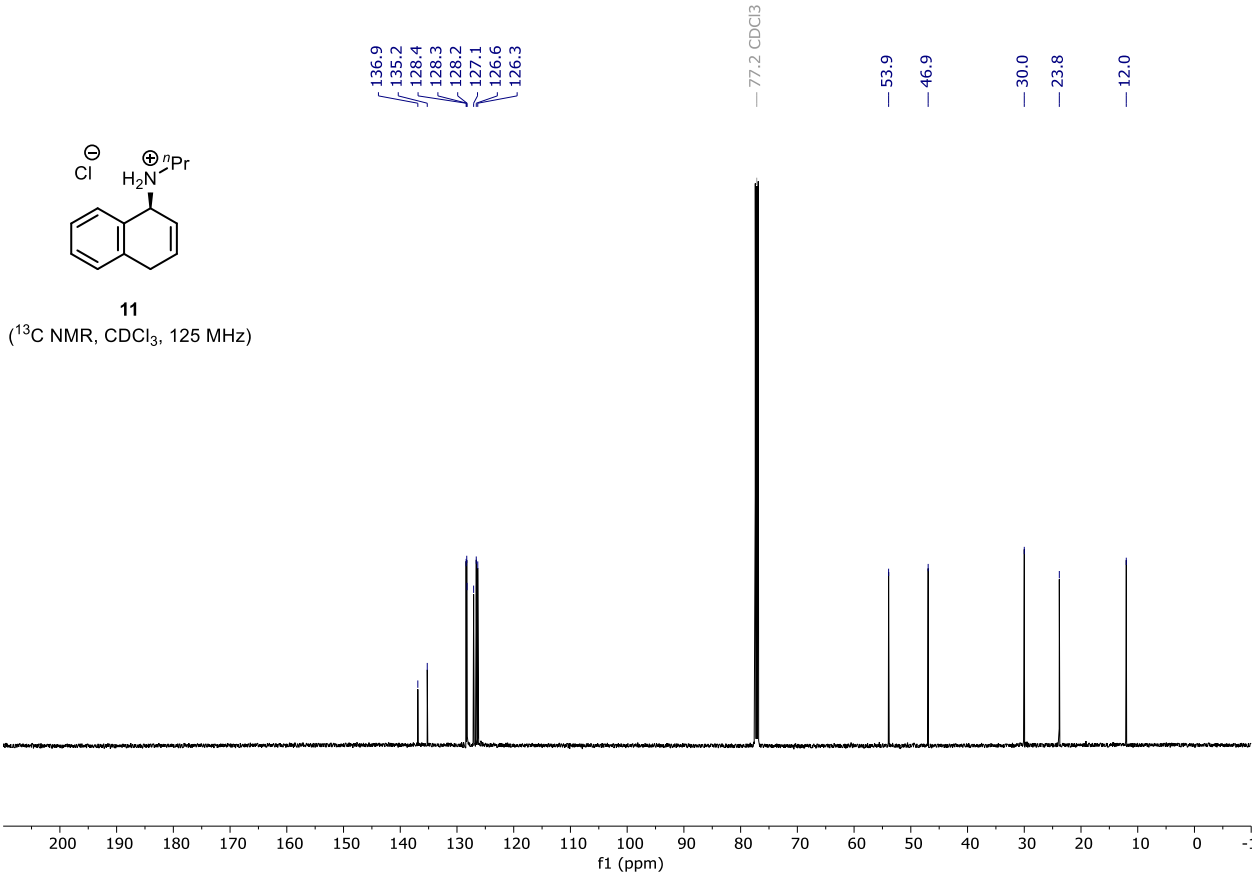


10h

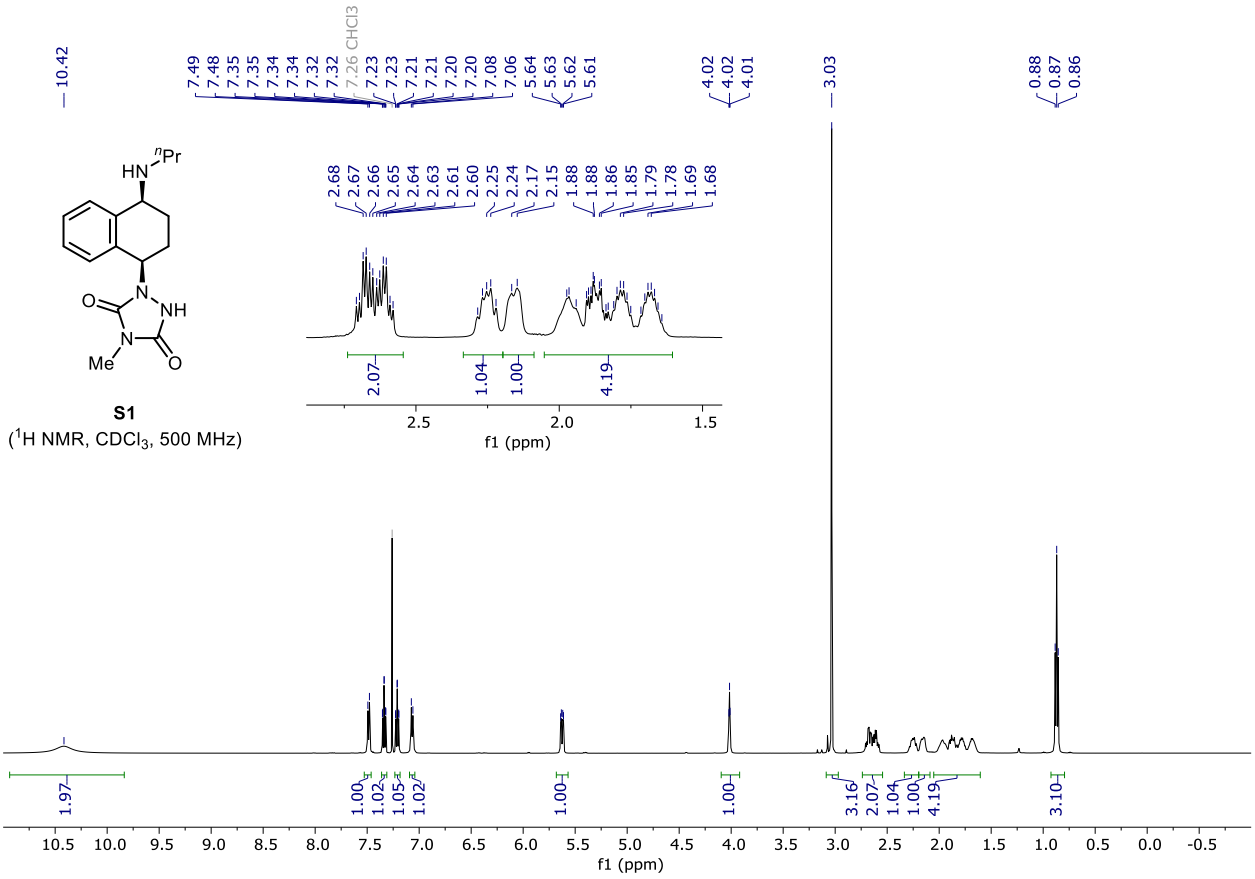
(^{13}C NMR, $CDCl_3$, 125 MHz)



11
(^{1}H NMR, $CDCl_3$, 500 MHz)

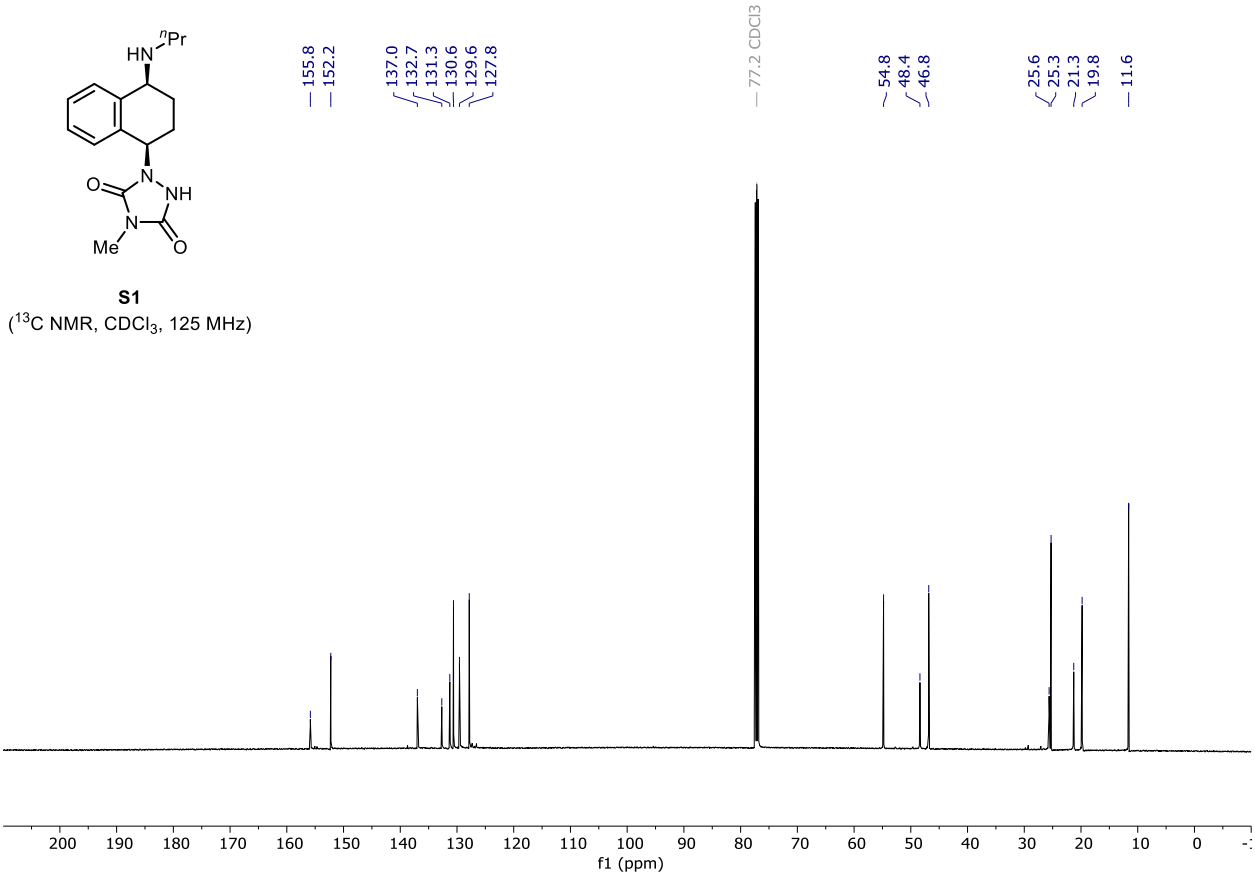


11
(^{13}C NMR, $CDCl_3$, 125 MHz)



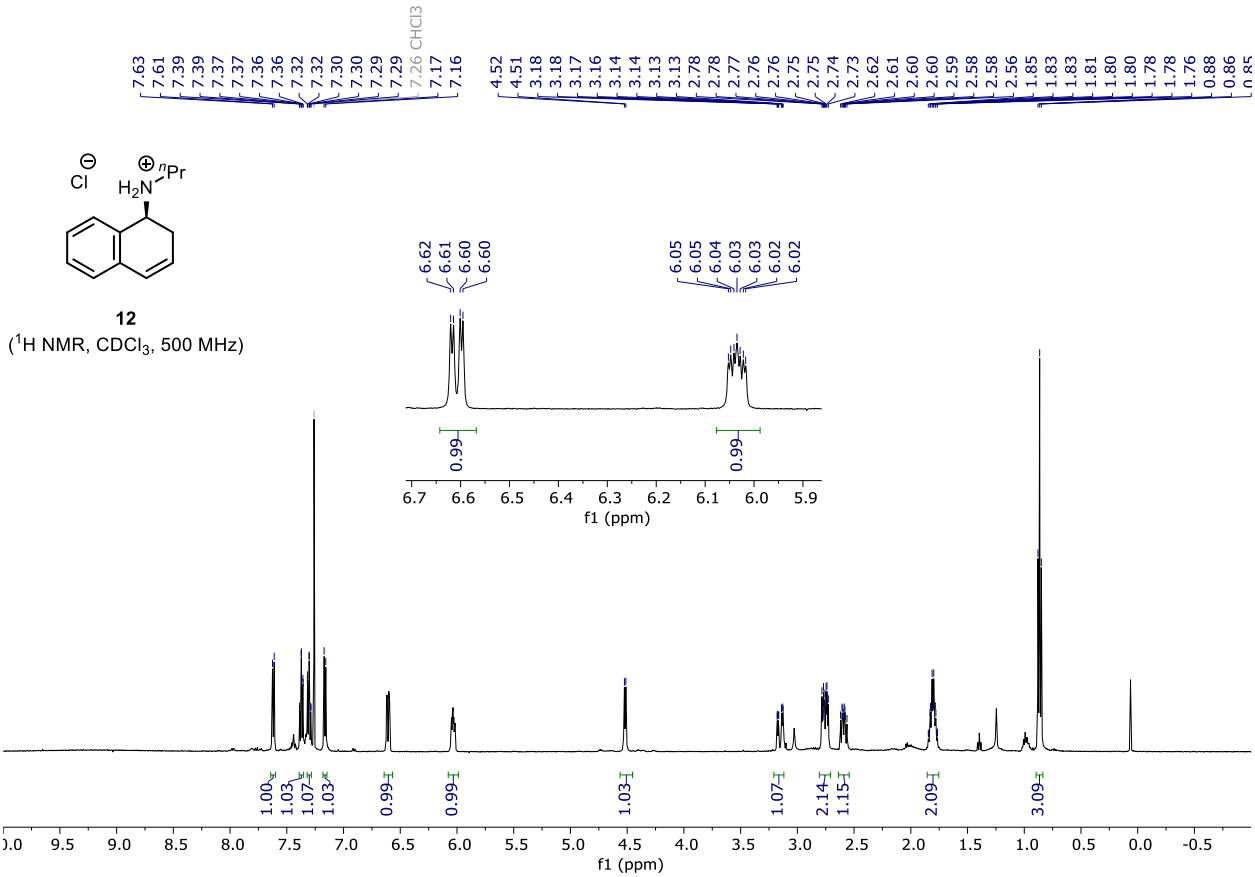
S1

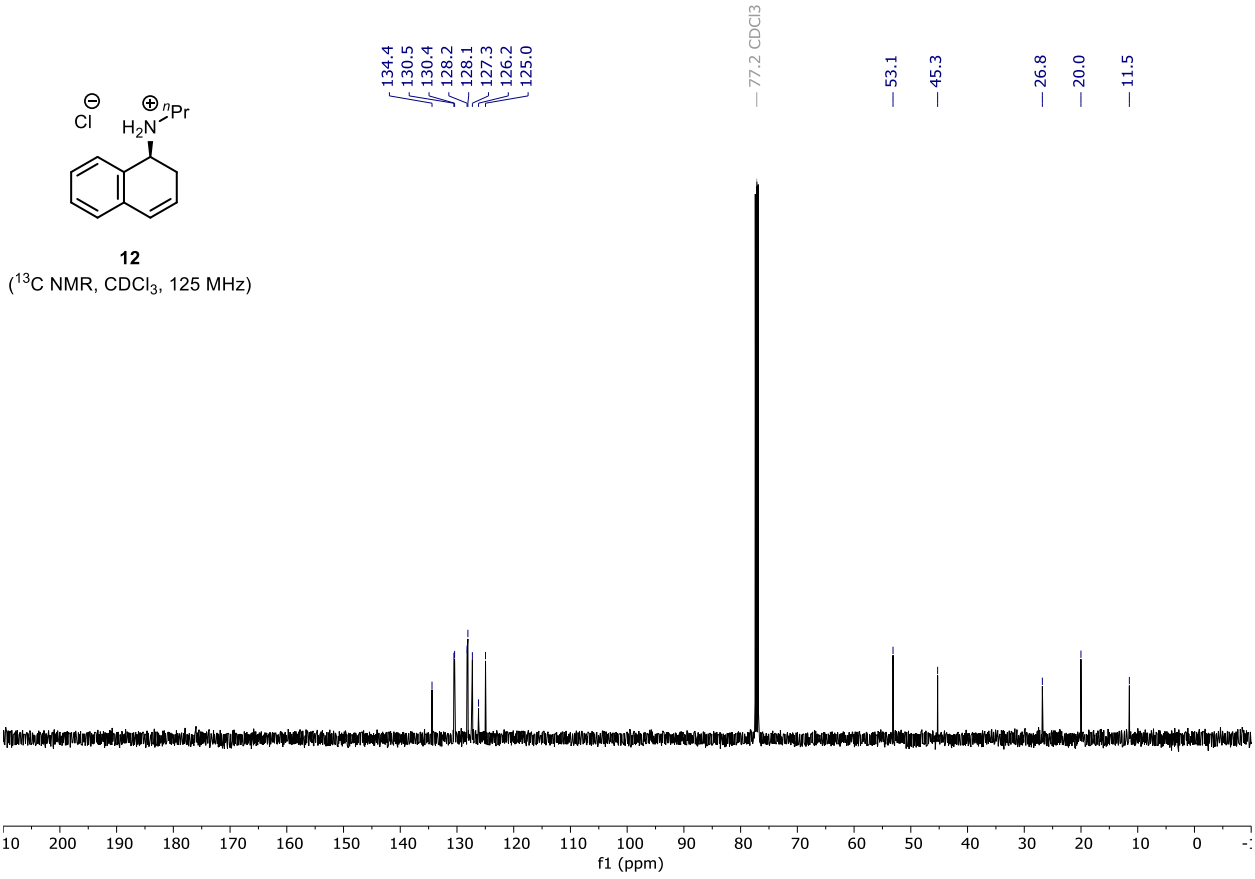
(^{1}H NMR, $CDCl_3$, 500 MHz)

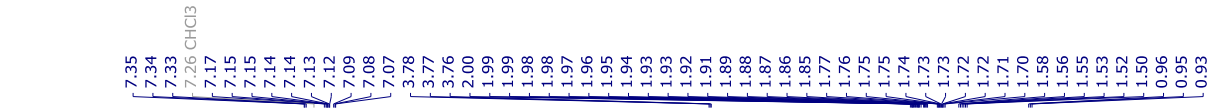


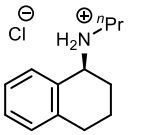
S1

(^{13}C NMR, $CDCl_3$, 125 MHz)


7.63 7.61 7.39 7.39 7.37 7.37 7.36 7.36 7.32 7.32 7.30 7.30 7.29 7.29 7.26 CHCl3 7.17 7.16
4.52 4.51 3.18 3.18 3.17 3.16 3.14 3.14 3.13 3.13 2.78 2.78 2.77 2.76 2.76 2.75 2.75 2.74 2.73 2.62 2.61 2.60 2.60 2.59 2.58 2.58 2.56 1.85 1.83 1.83 1.81 1.80 1.80 1.78 1.78 1.76 0.88 0.86
Cl
H2N
nPr
12
(1H NMR, CDCl3, 500 MHz)
6.62 6.61 6.60 6.60
6.05 6.05 6.04 6.03 6.03 6.02 6.02
0.99
0.99
6.7 6.6 6.5 6.4 6.3 6.2 6.1 6.0 5.9
f1 (ppm)
1.00 1.03 1.07 1.03 0.99 0.99 1.03 1.07 2.14 1.15 2.09 3.09
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)

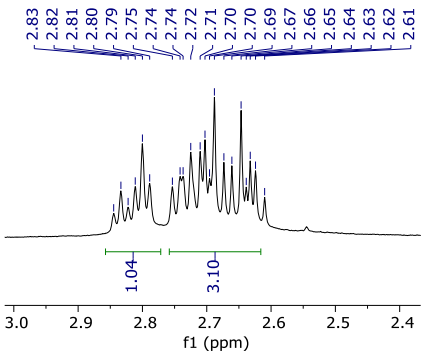

134.4 130.5 130.4 128.2 128.1 127.3 126.2 125.0
77.2 CDCl3
53.1 45.3 26.8 20.0 11.5
Cl
H2N
nPr
12
(13C NMR, CDCl3, 125 MHz)
10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

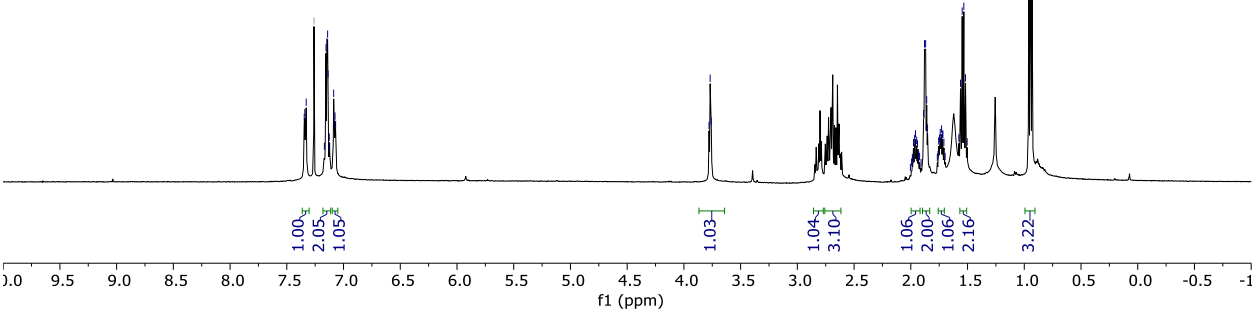


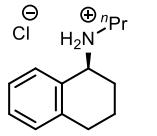


13

(^{1}H NMR, $CDCl_3$, 500 MHz)

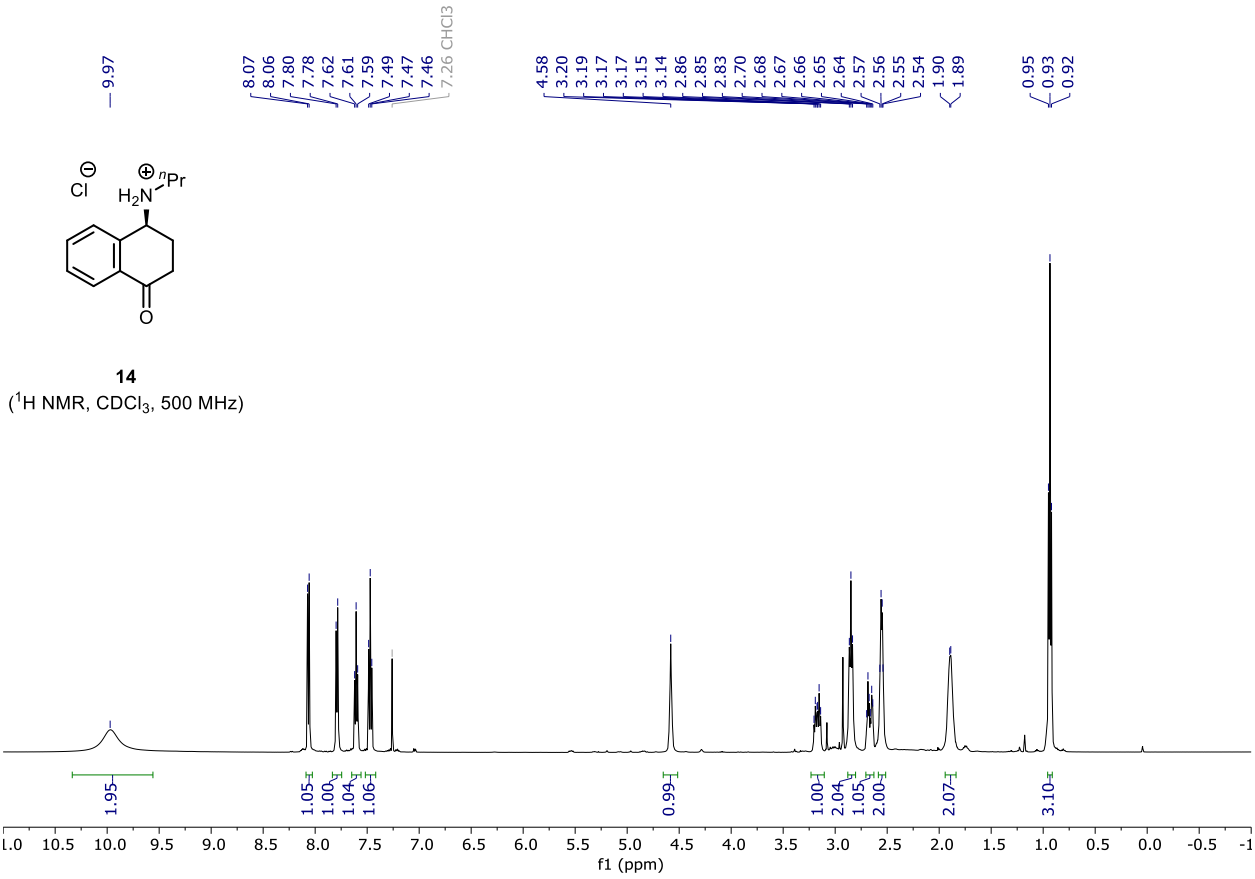




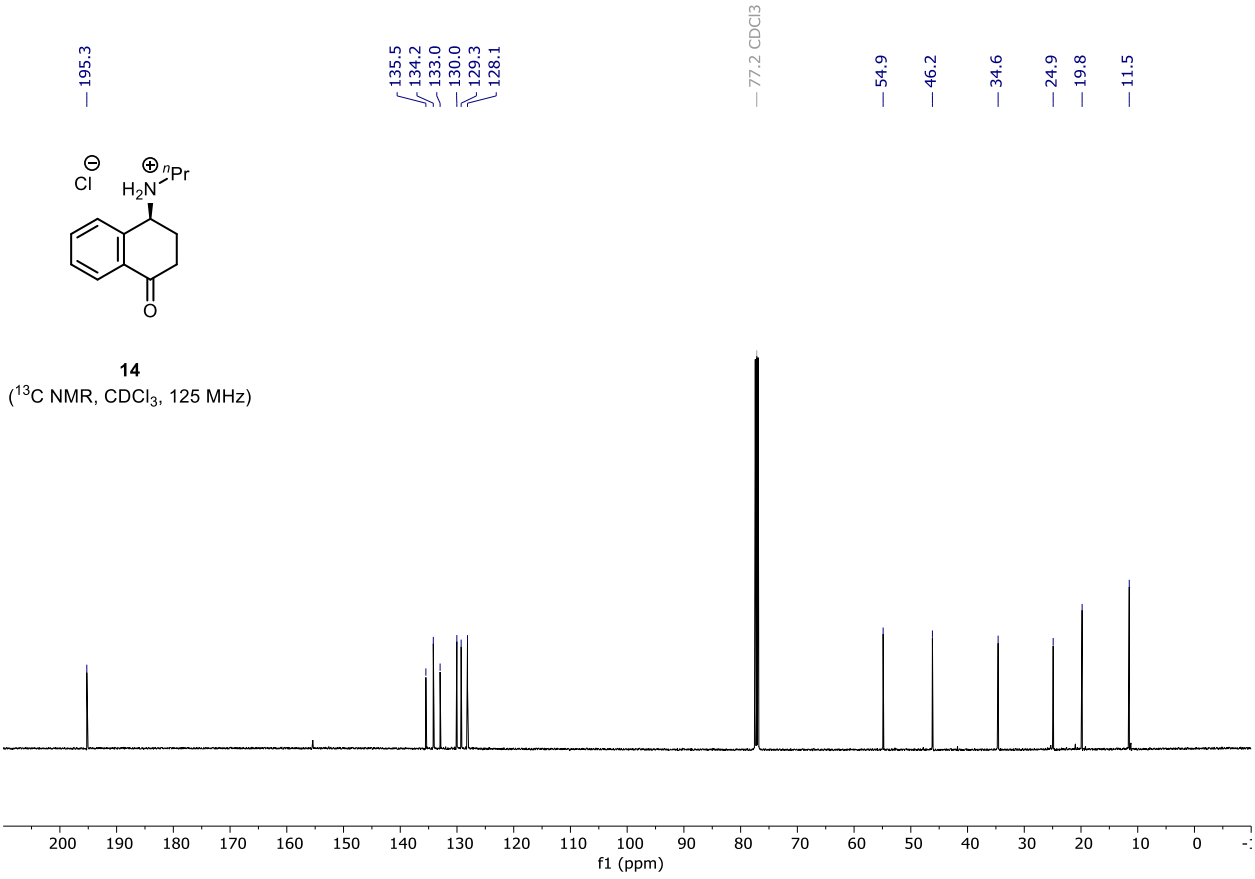


13

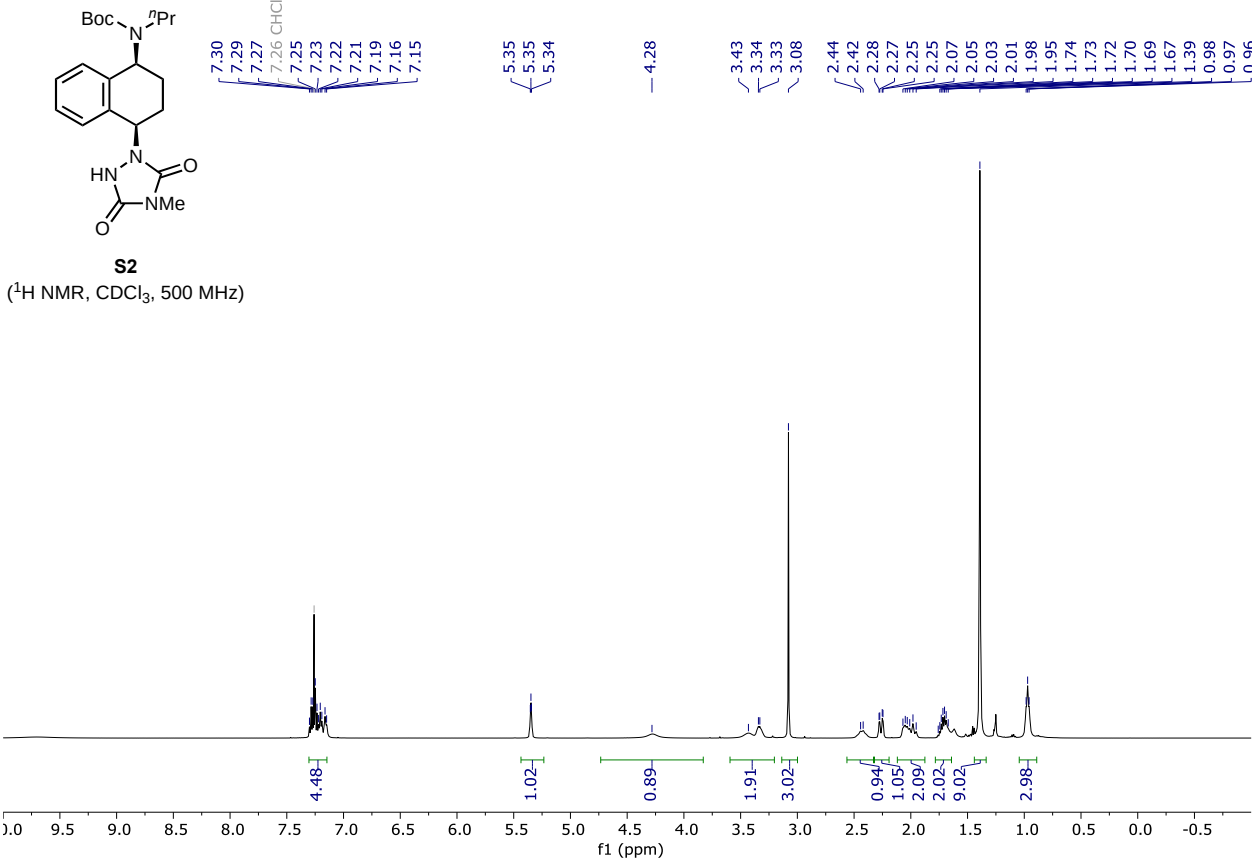
(^{13}C NMR, $CDCl_3$, 125 MHz)



14
(^{1}H NMR, $CDCl_3$, 500 MHz)

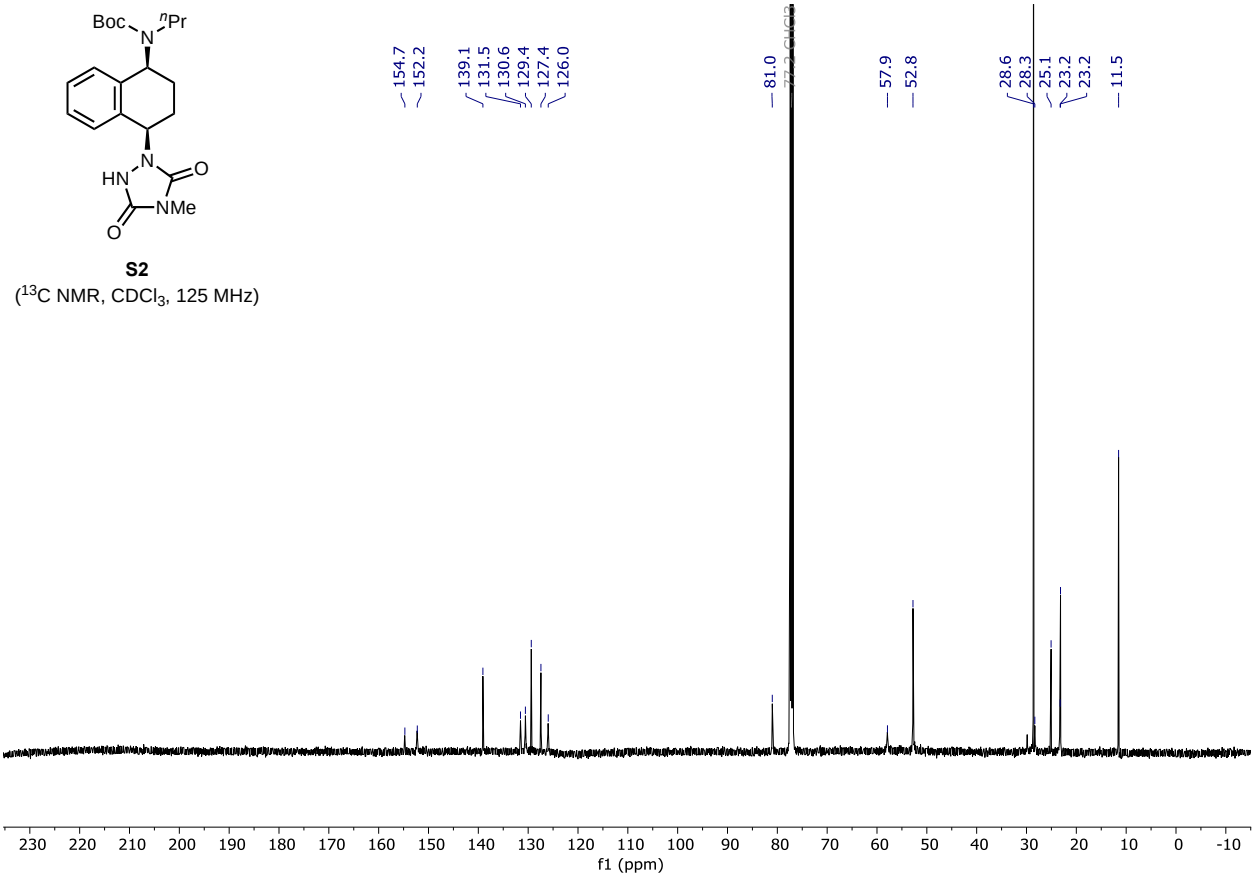


14
(^{13}C NMR, $CDCl_3$, 125 MHz)



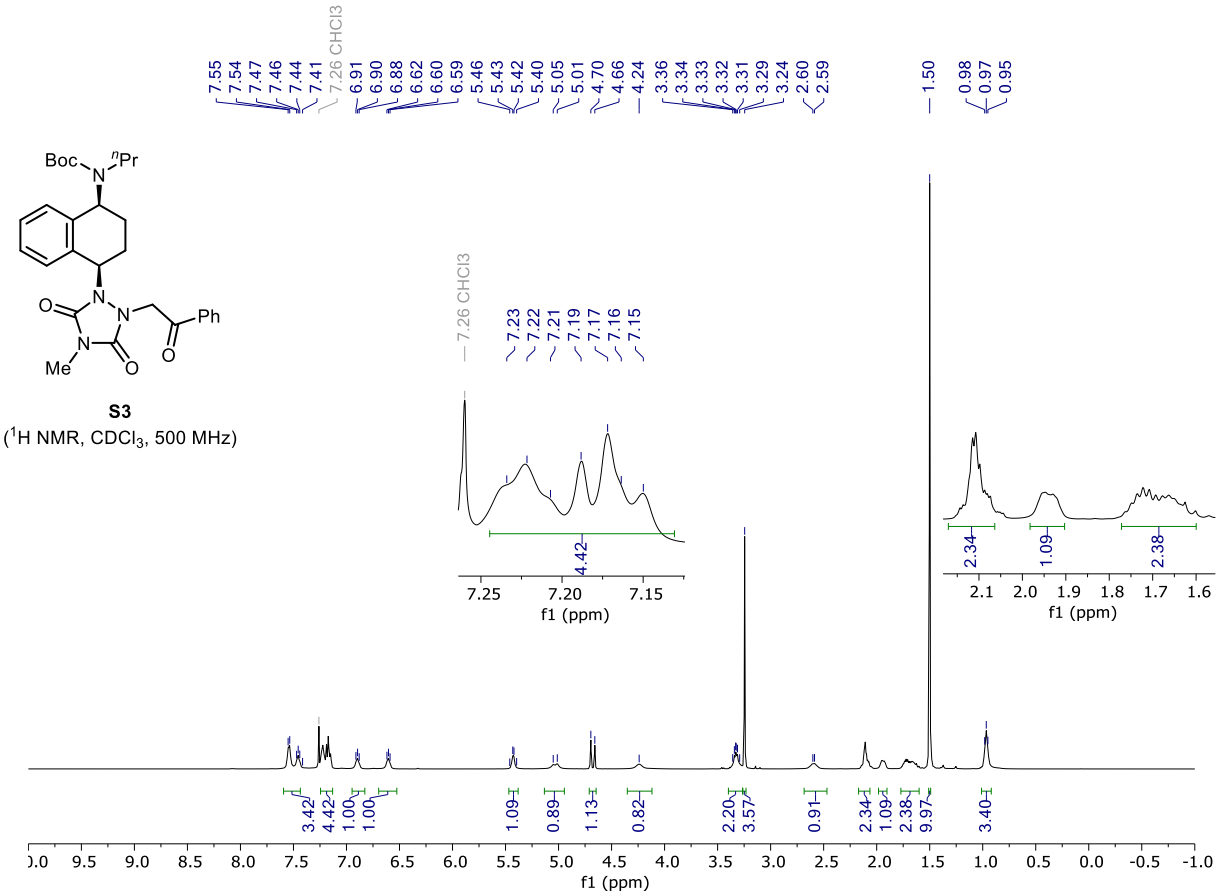
S2

(^{1}H NMR, $CDCl_3$, 500 MHz)

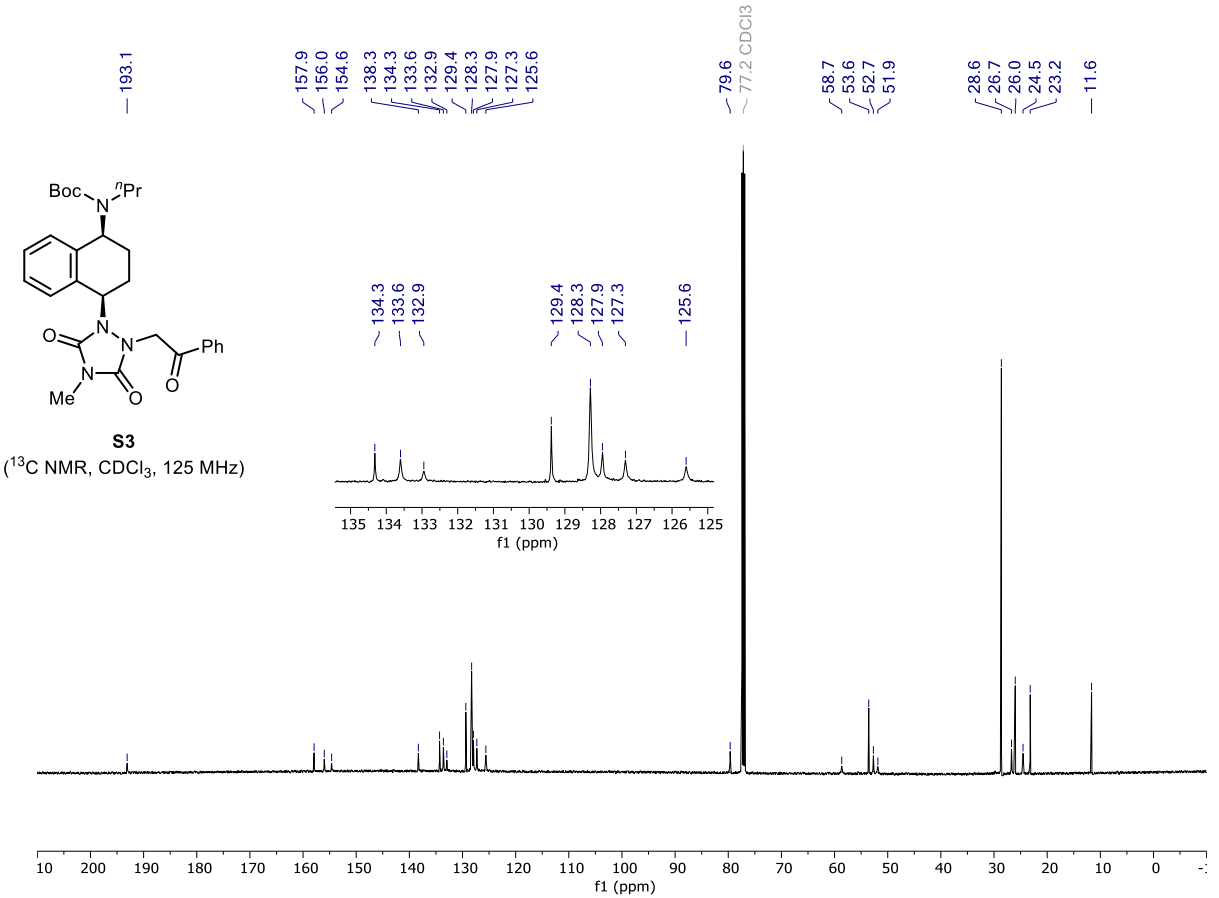


S2

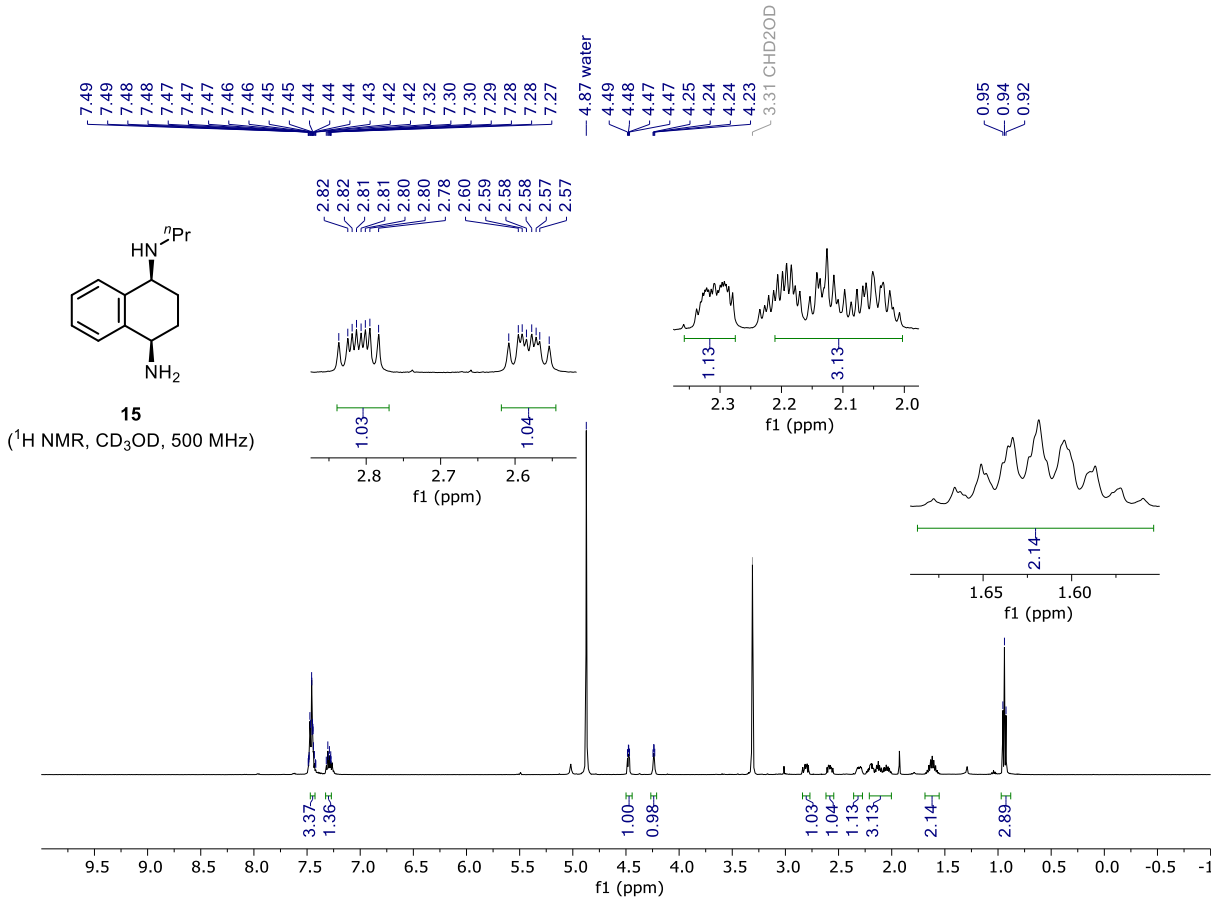
(^{13}C NMR, $CDCl_3$, 125 MHz)

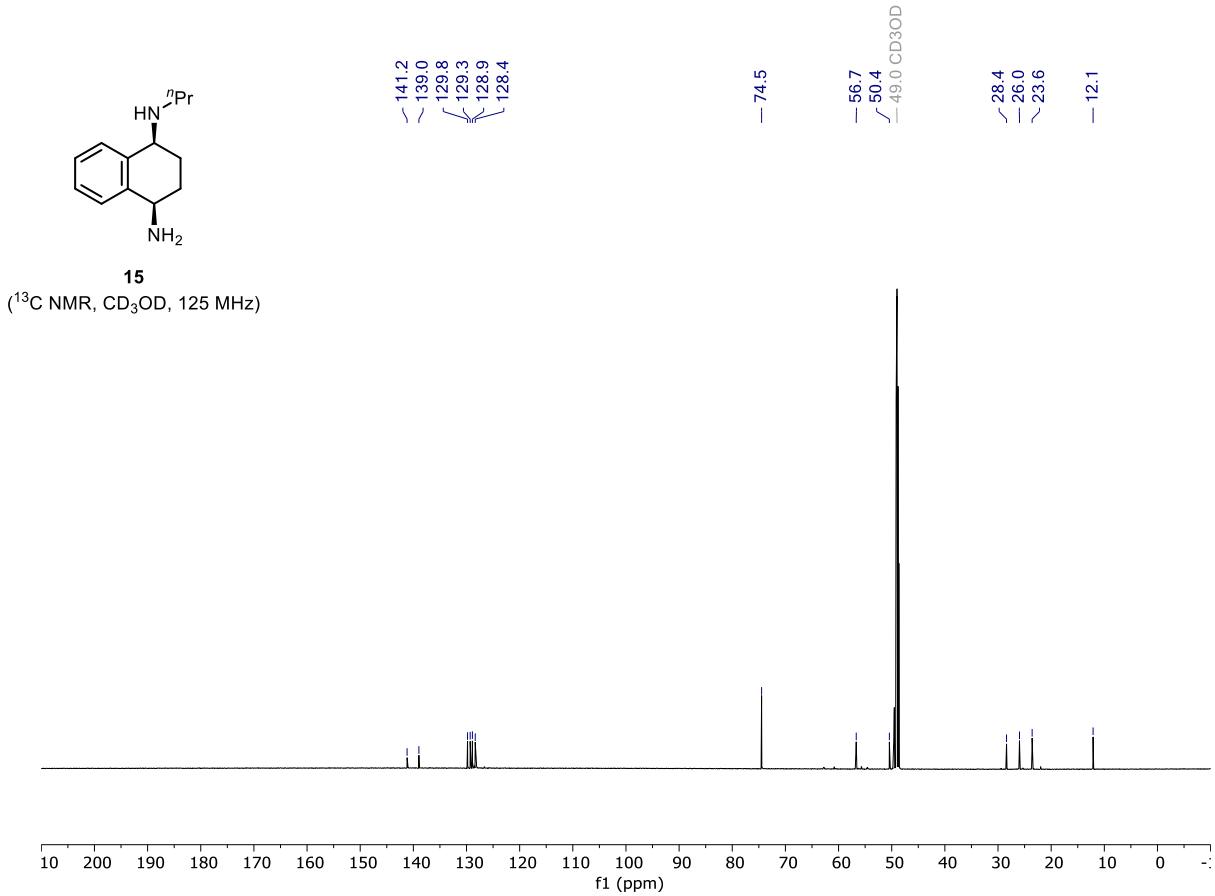


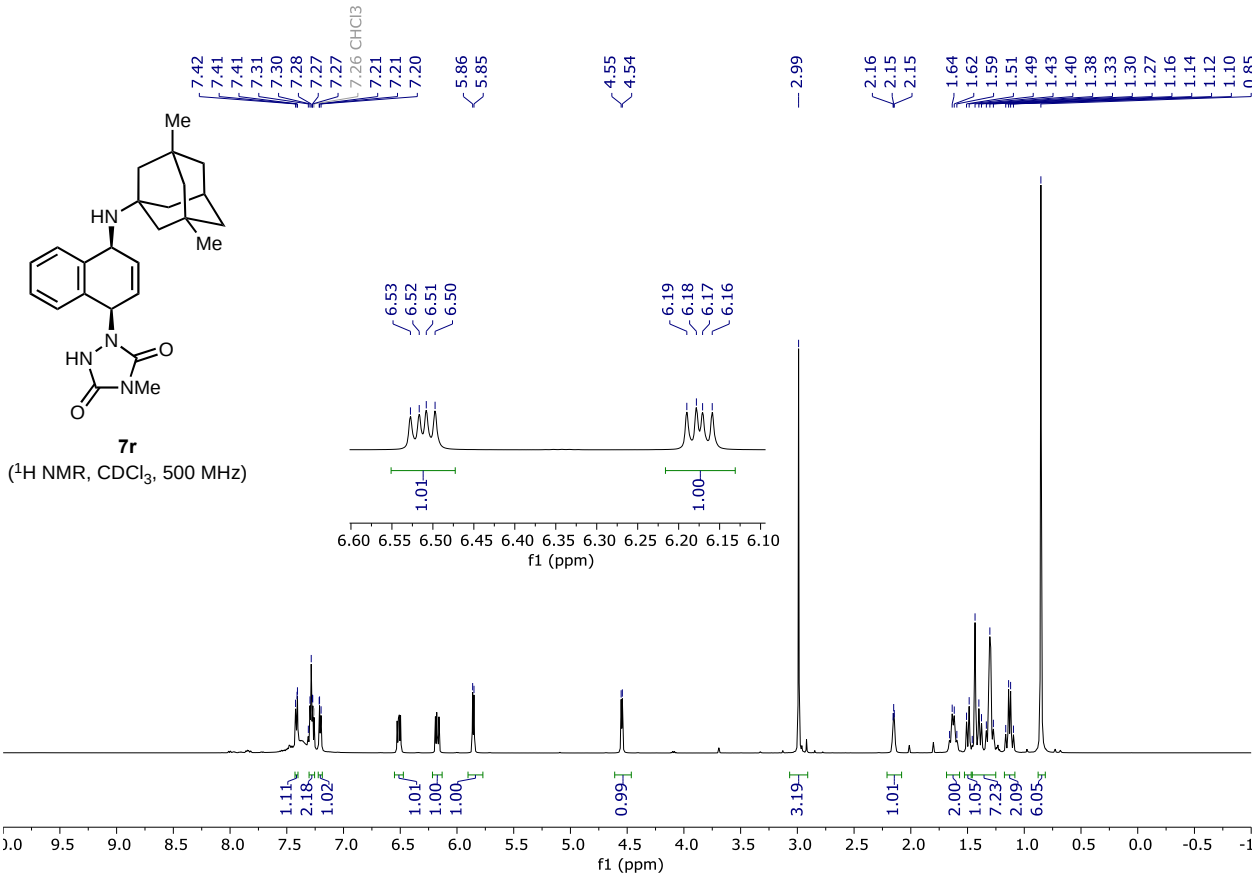
S3
(^{1}H NMR, $CDCl_3$, 500 MHz)



S3
(^{13}C NMR, $CDCl_3$, 125 MHz)

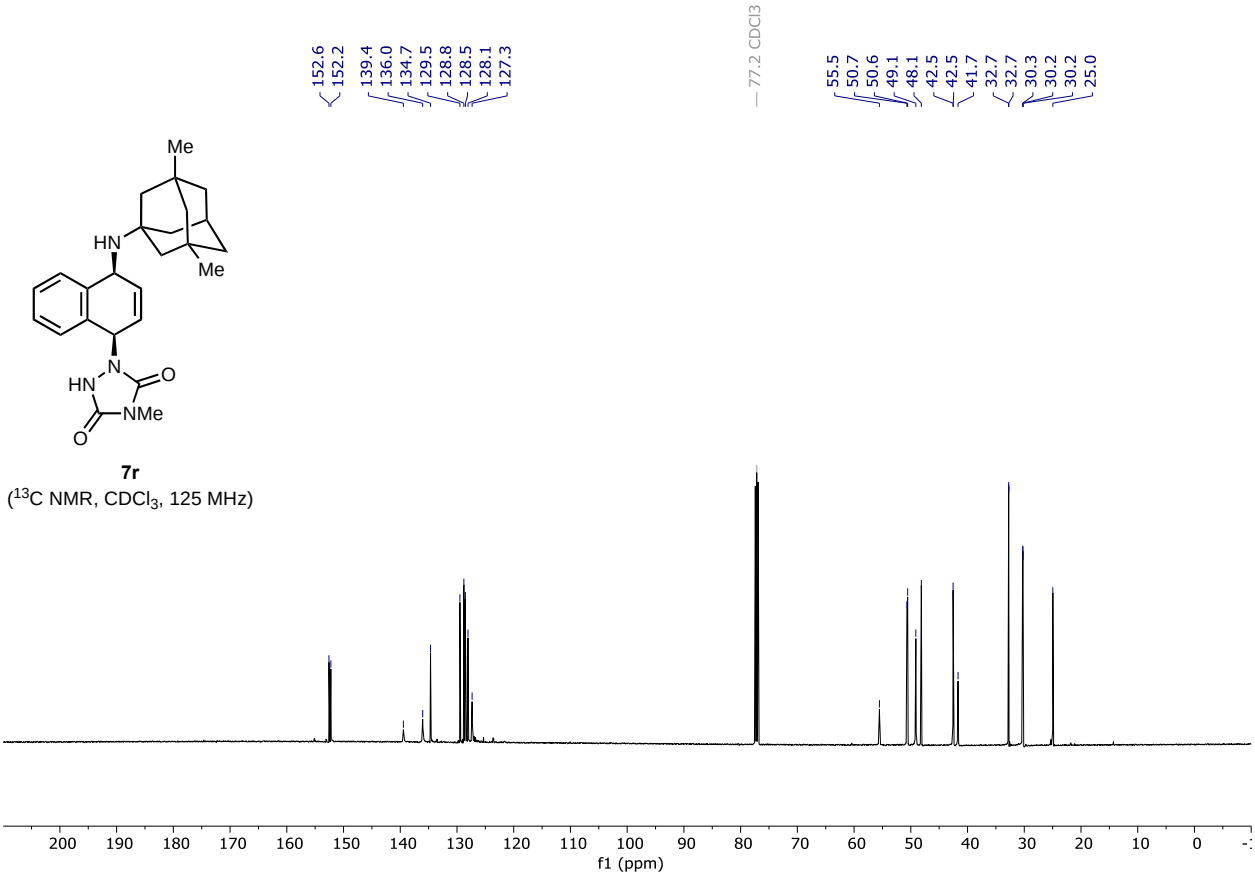

7.49 7.49 7.48 7.48 7.47 7.47 7.47 7.46 7.46 7.45 7.45 7.44 7.44 7.44 7.43 7.42 7.42 7.32 7.30 7.30 7.29 7.28 7.28 7.27
4.87 water
4.49 4.48 4.47 4.47 4.25 4.24 4.24 4.23
3.31 CHD2OD
0.95 0.94 0.92
2.82 2.82 2.81 2.81 2.80 2.80 2.78 2.60 2.59 2.58 2.58 2.57 2.57
HN nPr
NH2
15
(1H NMR, CD3OD, 500 MHz)
1.03
1.04
f1 (ppm)
1.13
3.13
f1 (ppm)
2.14
f1 (ppm)
3.37 1.36 1.00 0.98 1.03 1.04 1.13 3.13 2.14 2.89
f1 (ppm)


141.2 139.0 129.8 129.3 128.9 128.4
74.5
56.7 50.4 49.0 CD3OD
28.4 26.0 23.6
12.1
HN nPr
NH2
15
(13C NMR, CD3OD, 125 MHz)
f1 (ppm)



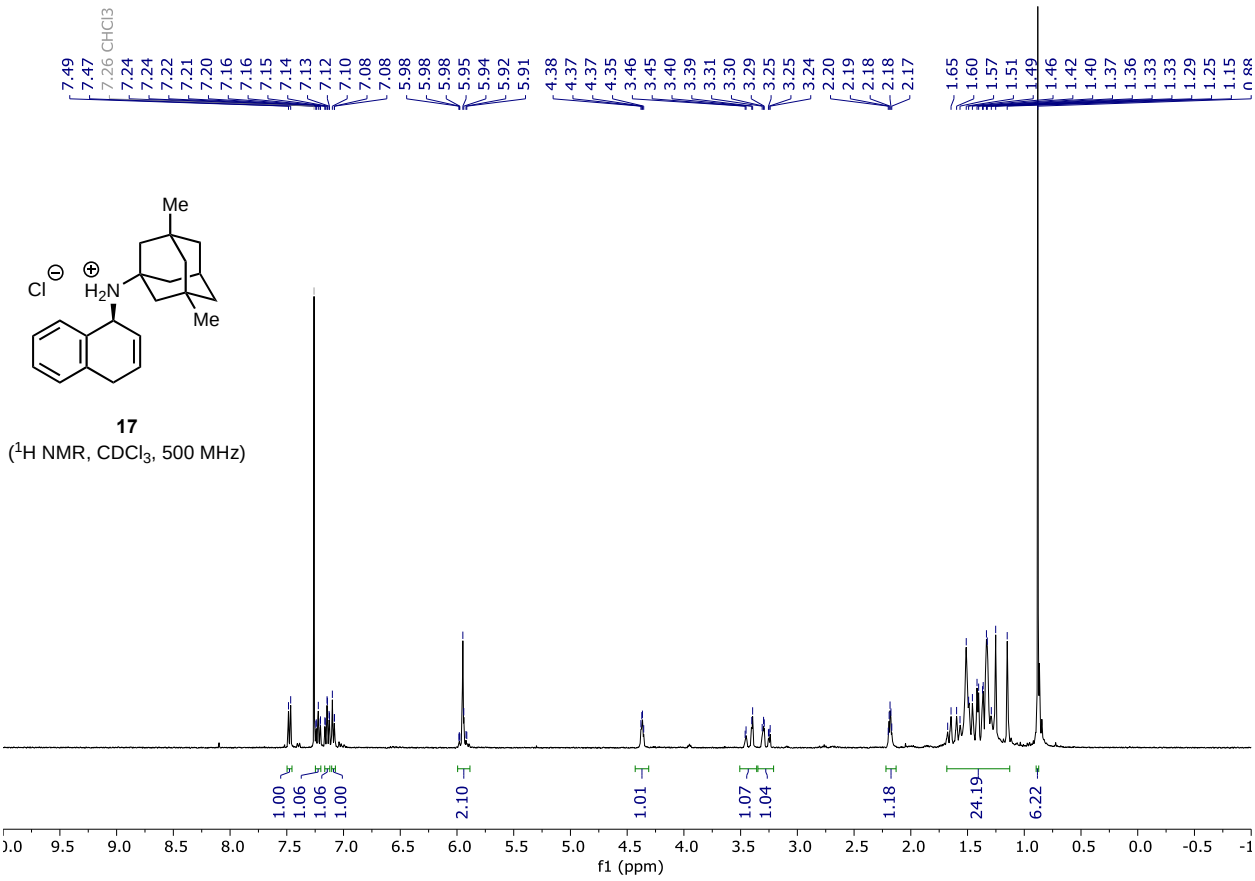
7r

(^{1}H NMR, $CDCl_3$, 500 MHz)

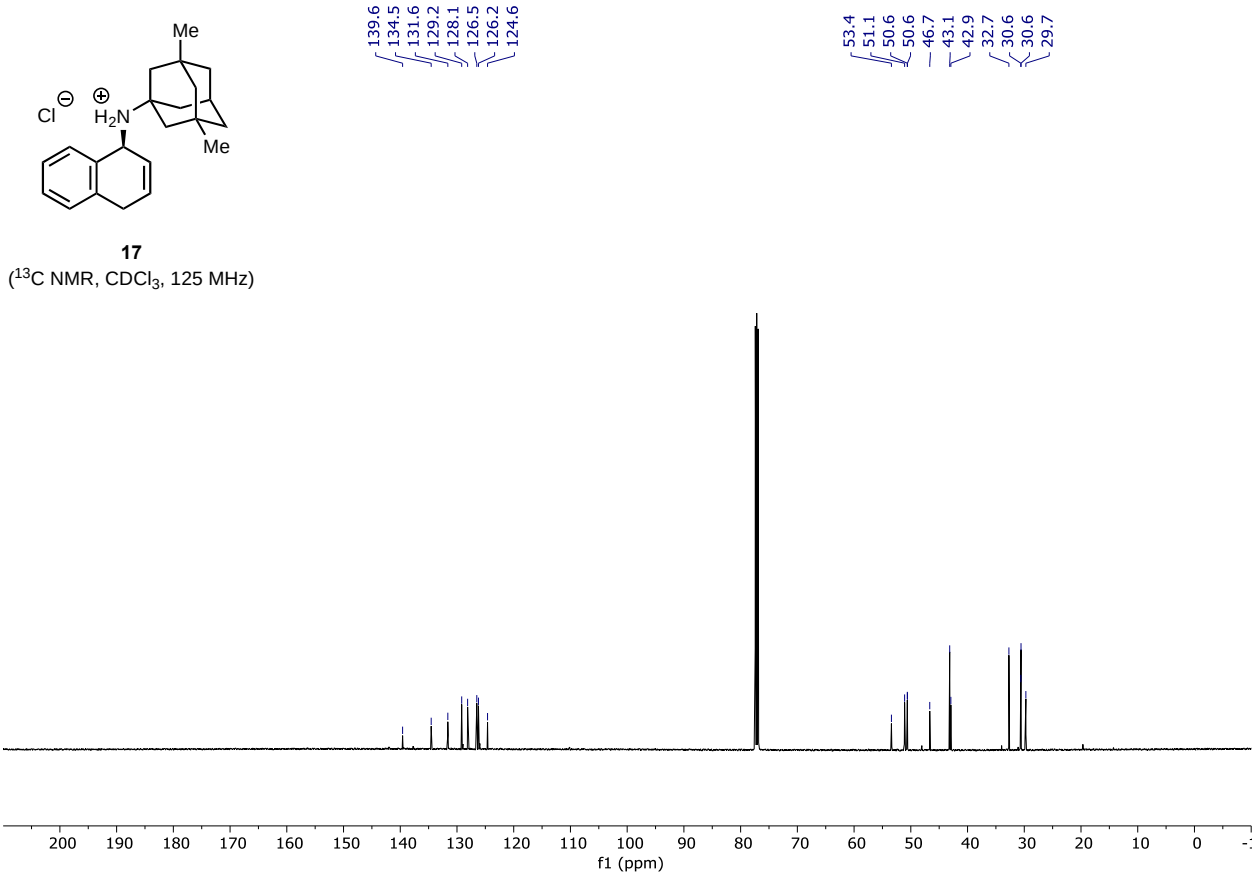


7r

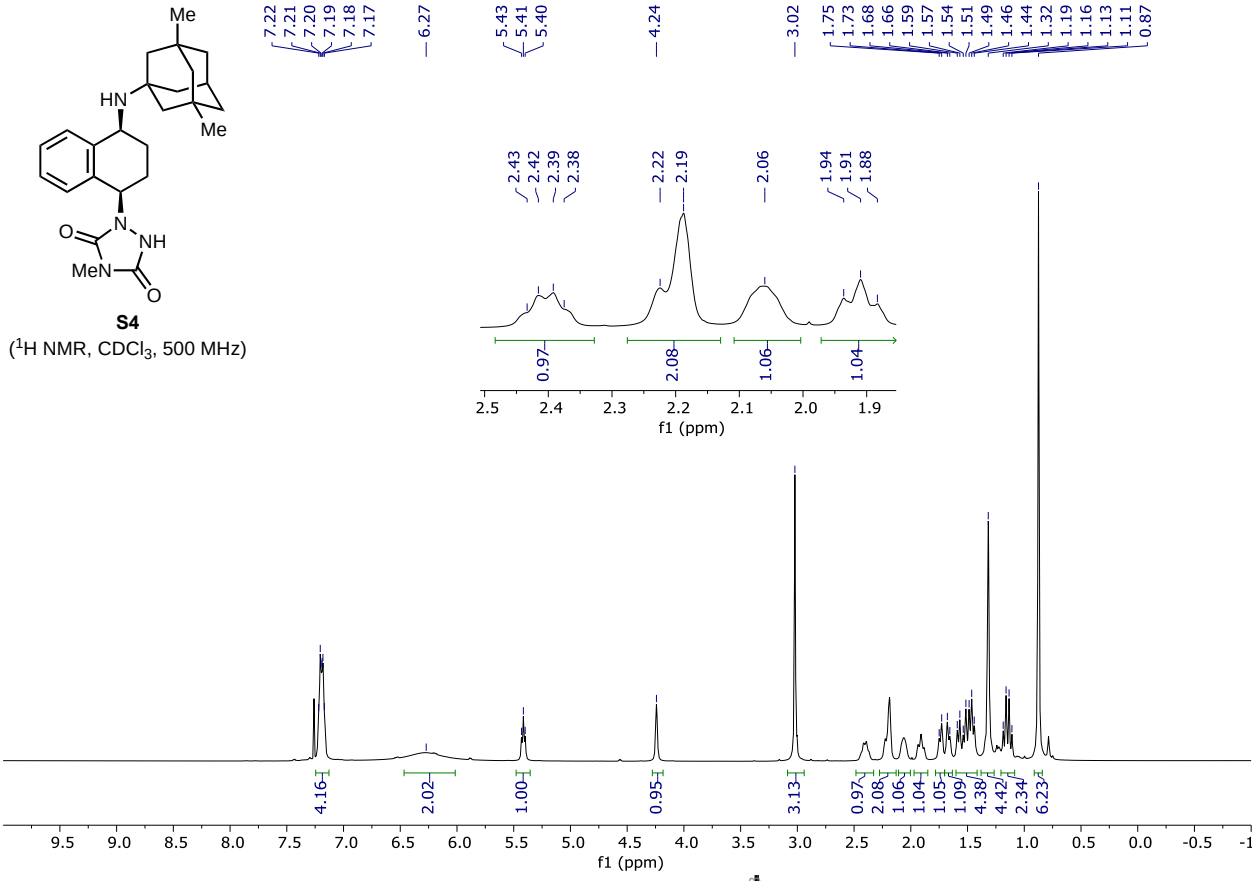
(^{13}C NMR, $CDCl_3$, 125 MHz)

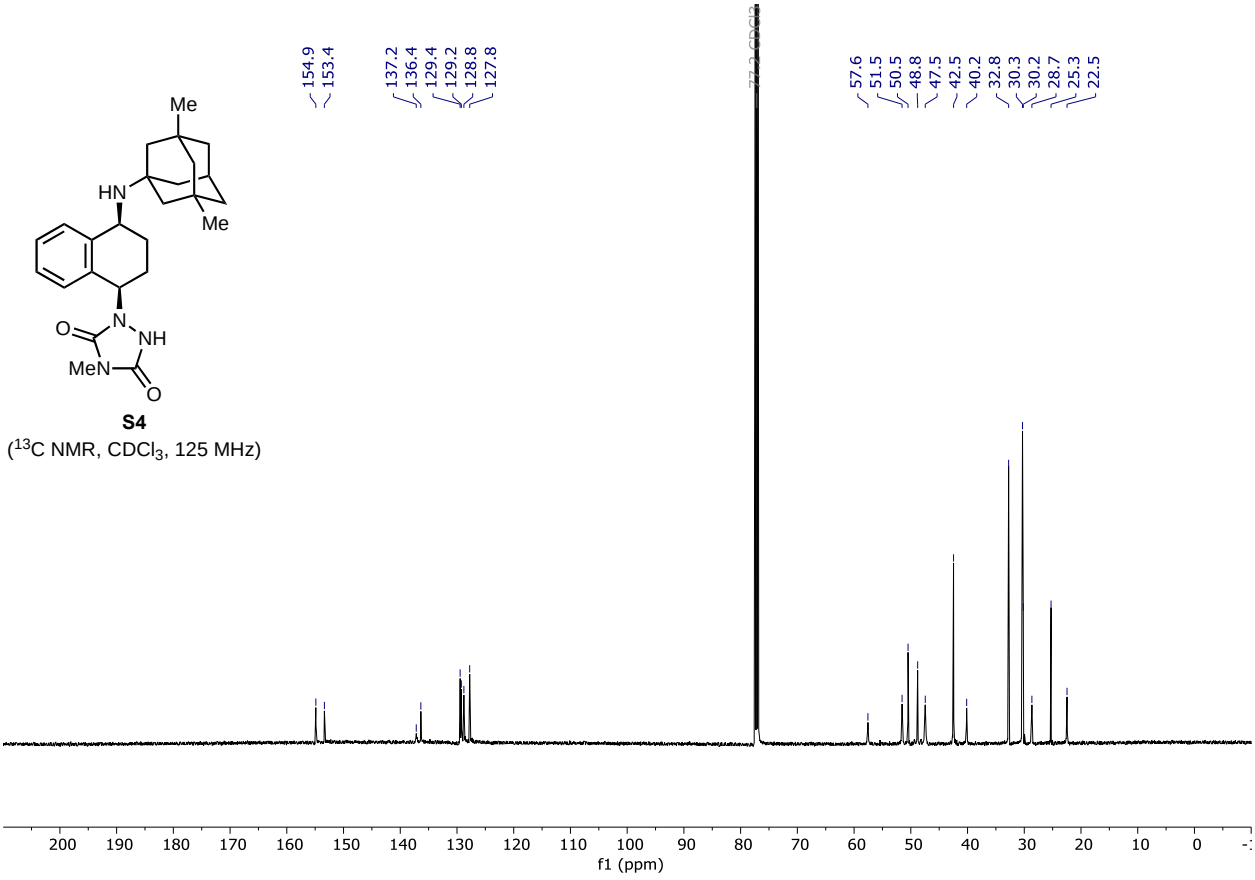


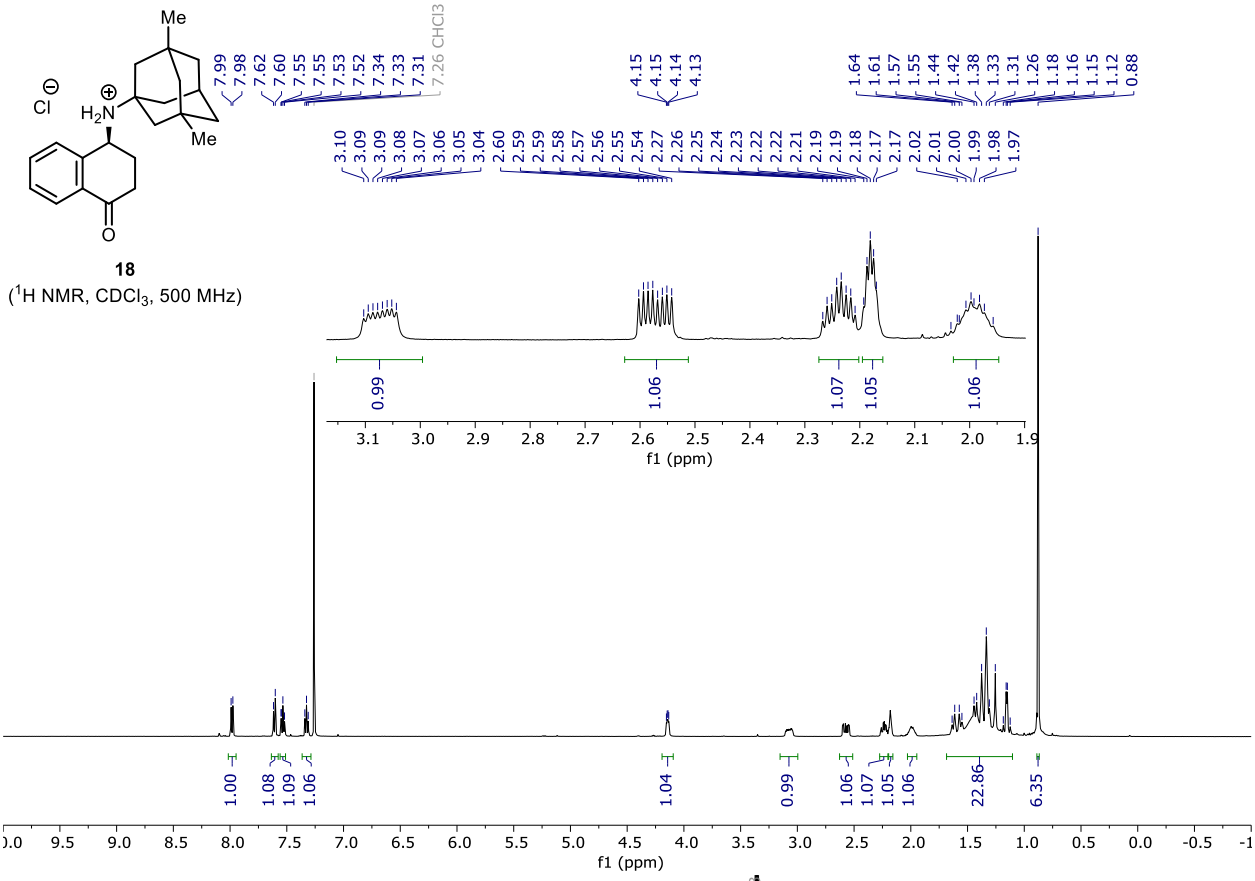
17
(^{1}H NMR, $CDCl_3$, 500 MHz)



17
(^{13}C NMR, $CDCl_3$, 125 MHz)

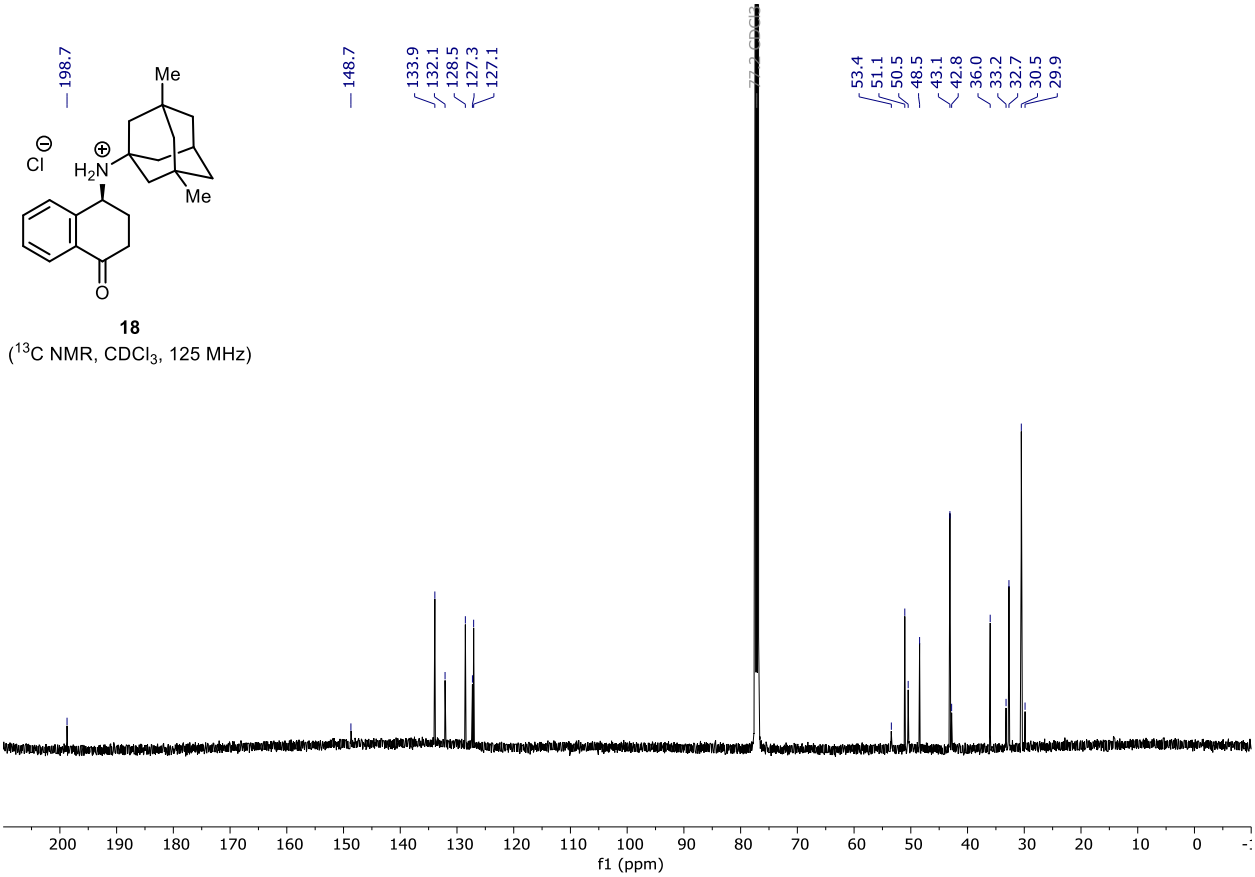

Me
HN
Me
N
NH
O
MeN
O
S4
(1H NMR, CDCl3, 500 MHz)
7.22
7.21
7.20
7.19
7.18
7.17
6.27
5.43
5.41
5.40
4.24
3.02
1.75
1.73
1.68
1.66
1.59
1.57
1.54
1.51
1.49
1.46
1.44
1.32
1.19
1.16
1.13
1.11
0.87
2.43
2.42
2.39
2.38
2.22
2.19
2.06
1.94
1.91
1.88
0.97
2.08
1.06
1.04
f1 (ppm)
4.16
2.02
1.00
0.95
3.13
0.97
2.08
1.06
1.04
1.05
1.09
4.38
4.42
2.34
6.23
f1 (ppm)


Me
HN
Me
N
NH
O
MeN
O
S4
(13C NMR, CDCl3, 125 MHz)
154.9
153.4
137.2
136.4
129.4
129.2
128.8
127.8
77.3
57.6
51.5
50.5
48.8
47.5
42.5
40.2
32.8
30.3
30.2
28.7
25.3
22.5
f1 (ppm)



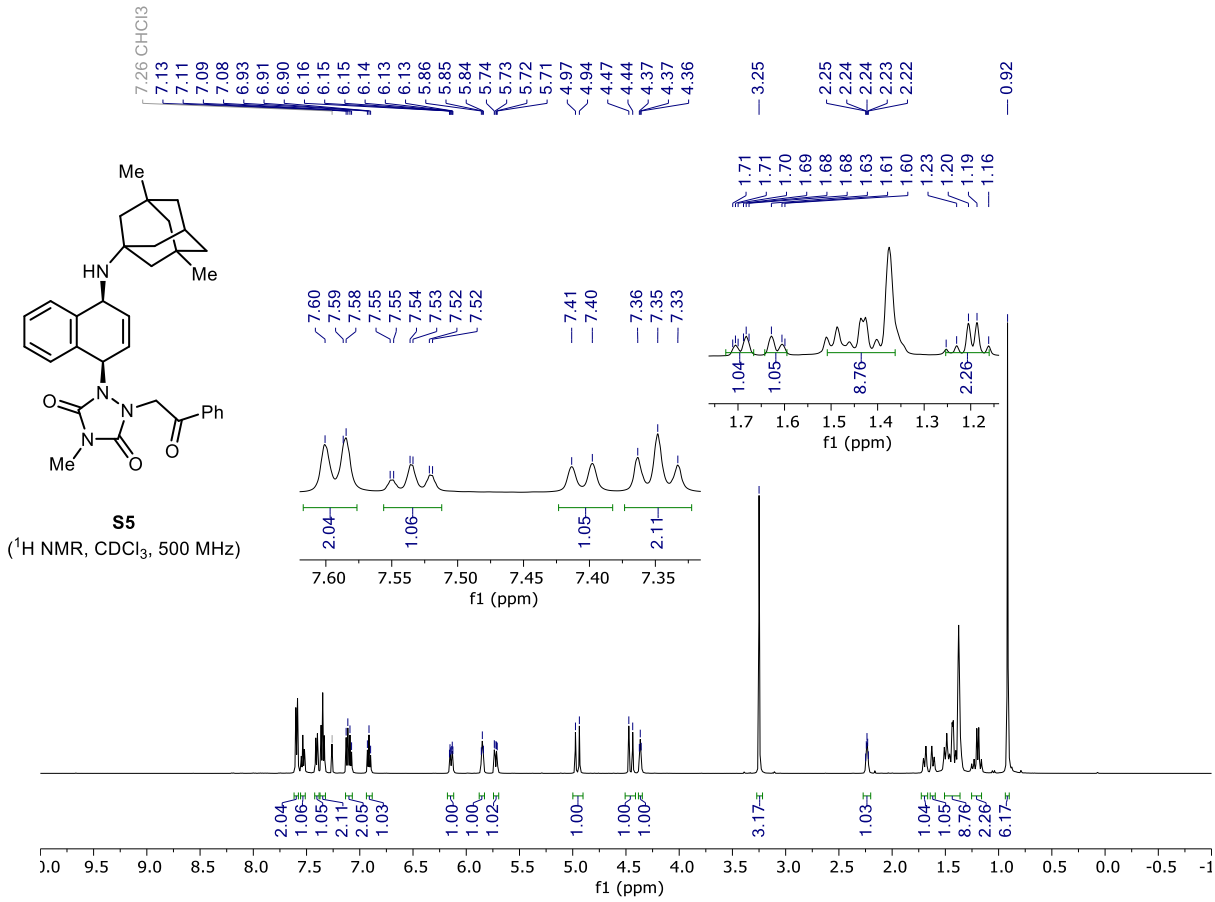
18

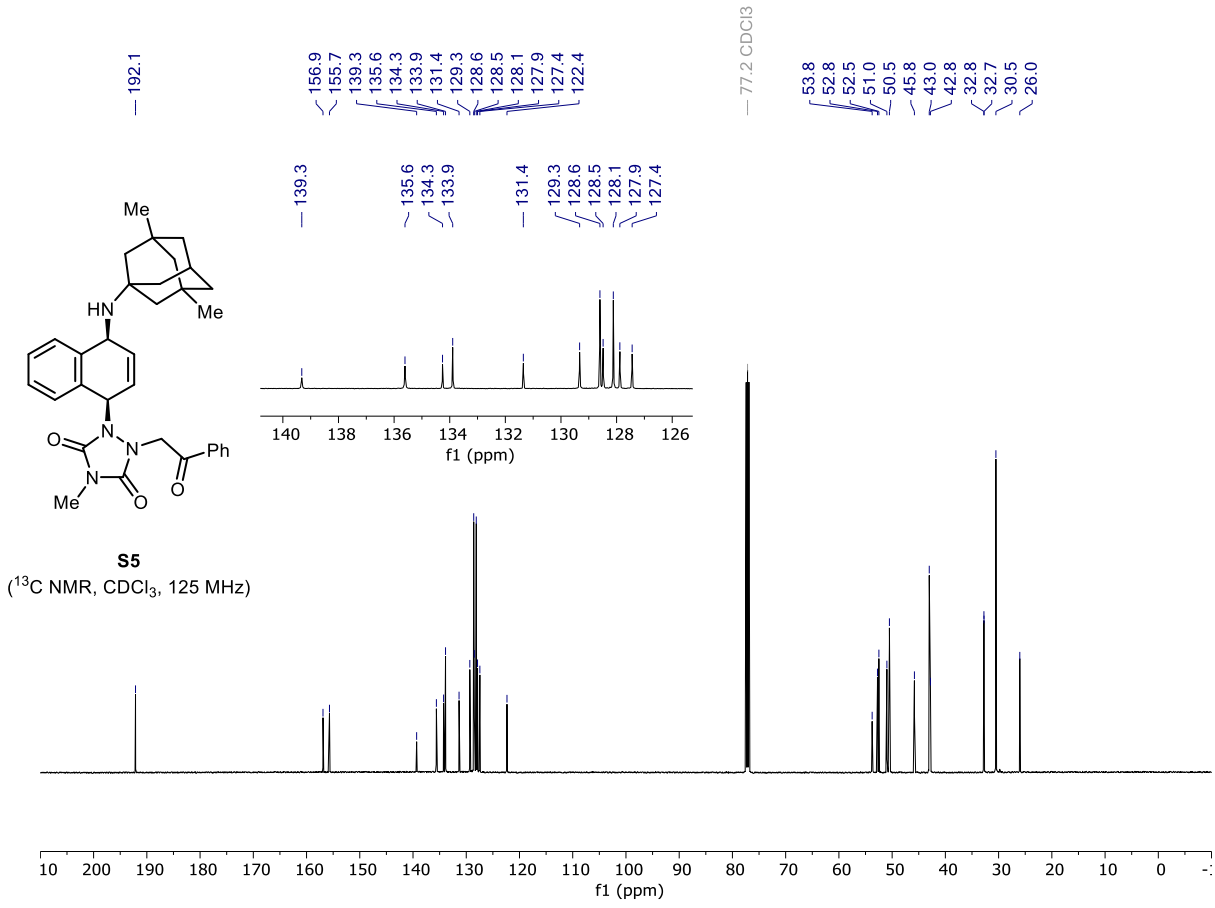
(^{1}H NMR, $CDCl_3$, 500 MHz)

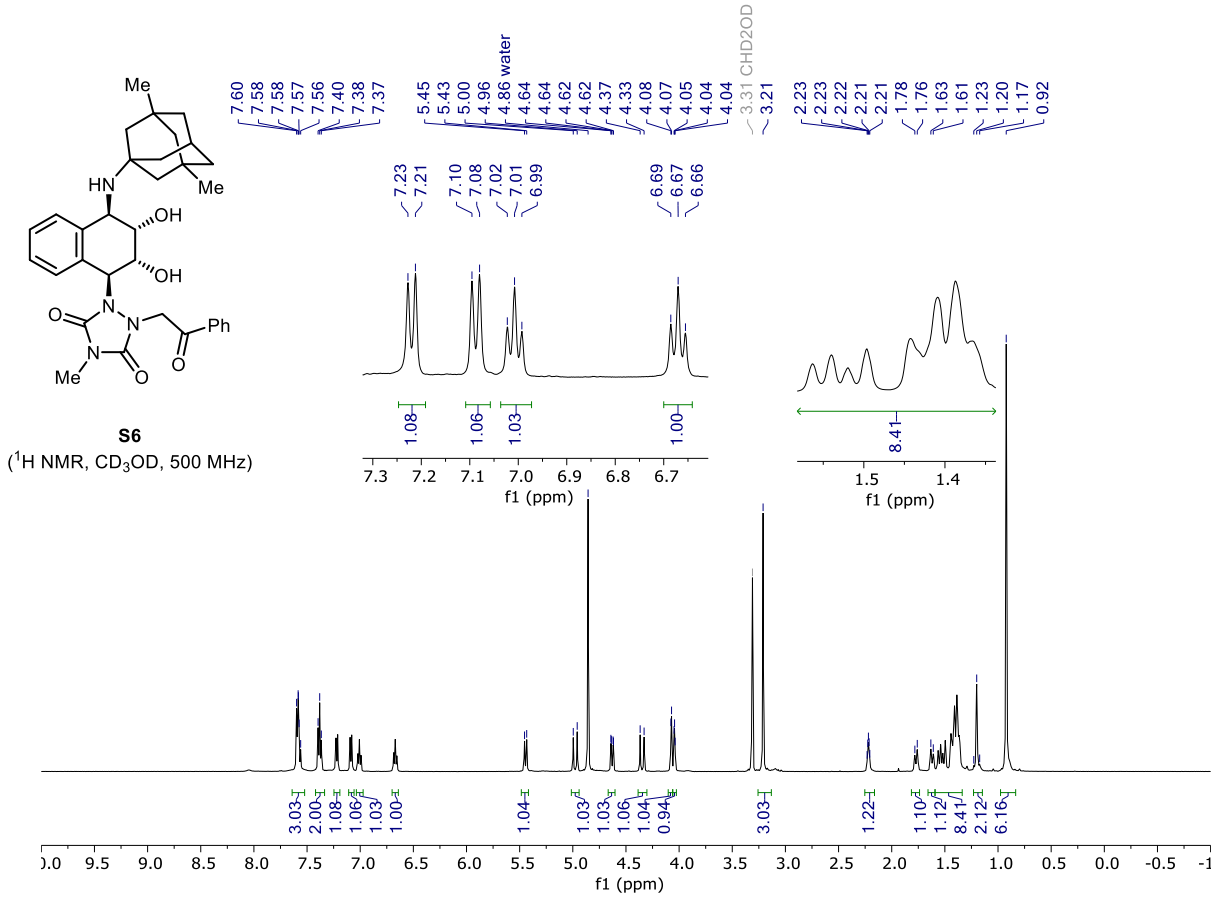


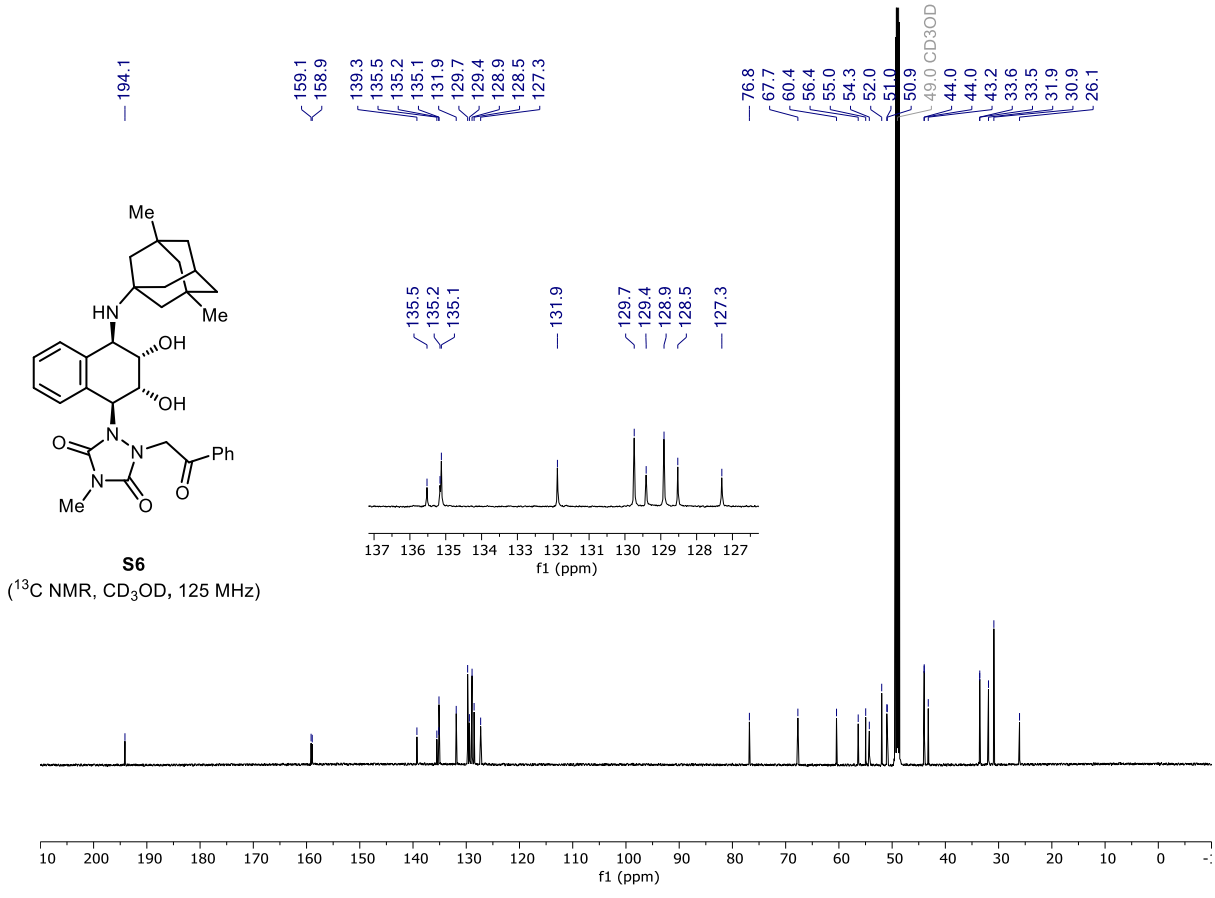
18

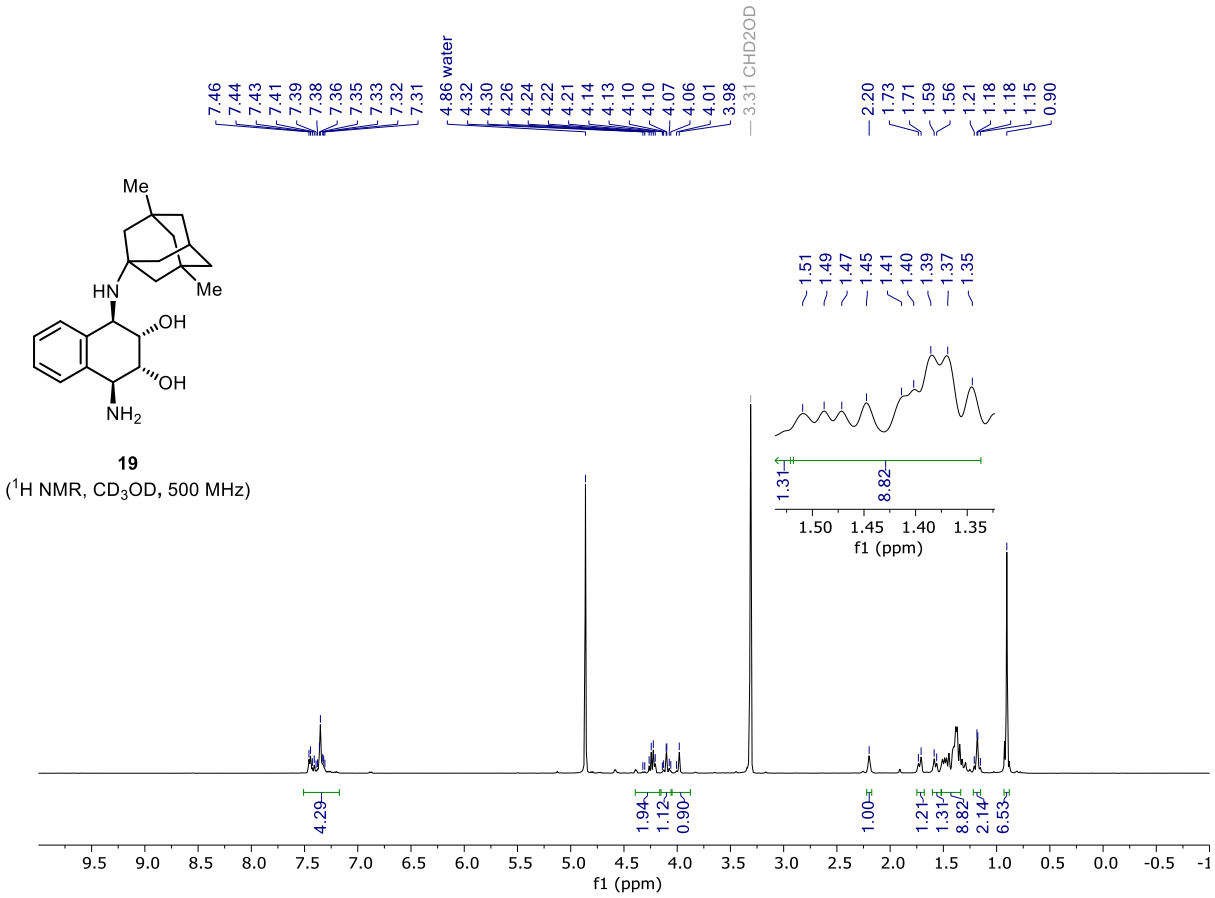
(^{13}C NMR, $CDCl_3$, 125 MHz)


S5
(1H NMR, CDCl3, 500 MHz)
f1 (ppm)


S5
(13C NMR, CDCl3, 125 MHz)
f1 (ppm)


S6
(1H NMR, CD3OD, 500 MHz)
f1 (ppm)


S6
(13C NMR, CD3OD, 125 MHz)
f1 (ppm)



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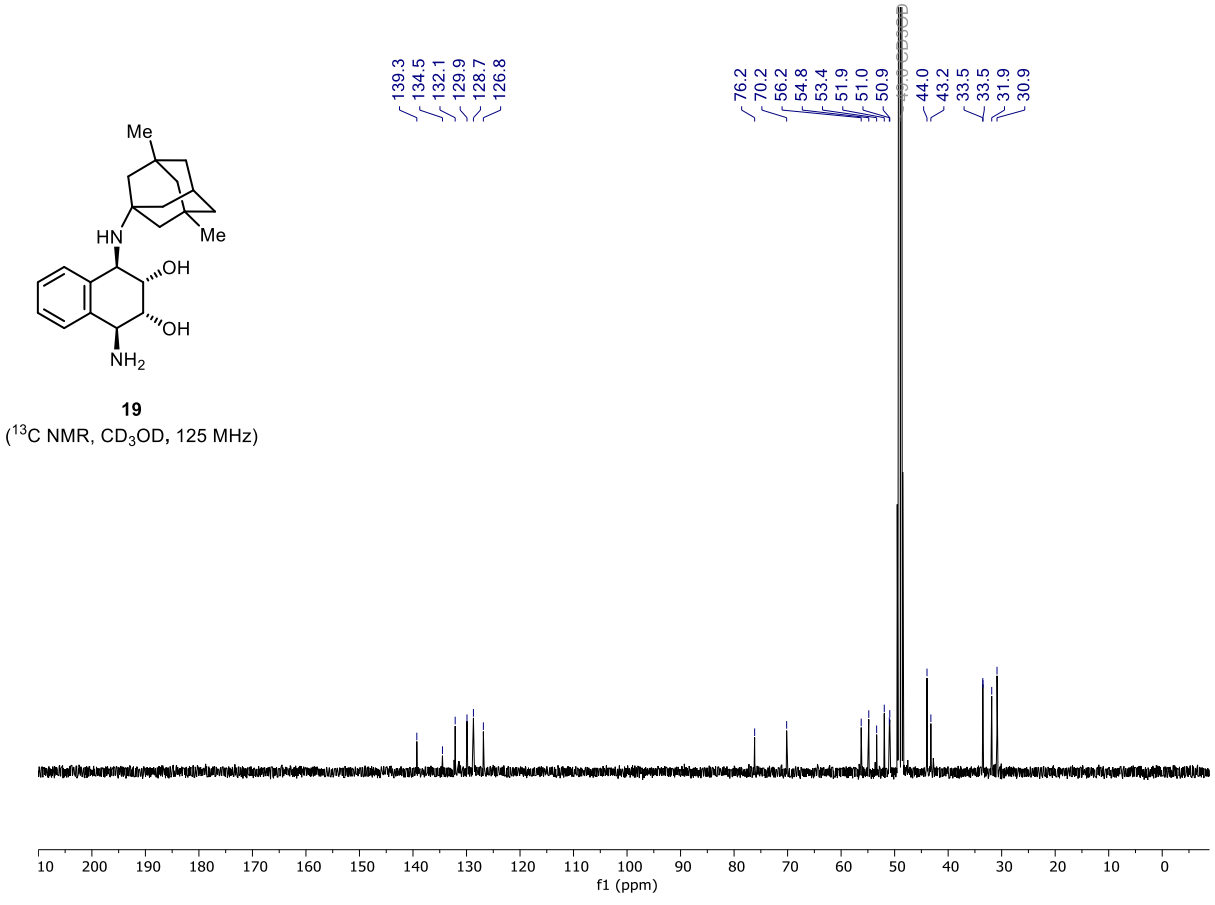
(^{1}H NMR, CD_3OD, 500 MHz)



19

(^{13}C NMR, CD_3OD, 125 MHz)