Dearomative Indole (3+2) Reactions with Azaoxyallyl Cations – New Method for the Synthesis of Pyrroloindolines

Supporting Information

Maria C. DiPoto, Russell P. Hughes, and Jimmy Wu*

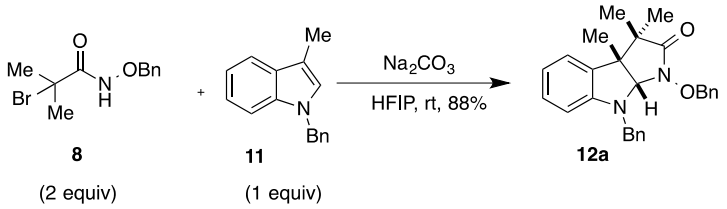
Department of Chemistry, Dartmouth College, Hanover, New Hampshire 03755, United States

1. General Information

^{1}H-NMR data were recorded on a Bruker Avance III 500 MHz spectrometer (TBI probe) and a Bruker Avance III 600 MHz spectrometer (BBFO probe) with calibration of spectra to $CHCl_3$ (7.26 ppm) or CH_2Cl_2 (5.32 ppm). ^{13}C-NMR data were recorded at 125 MHz on a Bruker Avance III 500 MHz spectrometer (TBI probe) and at 150 MHz on a Bruker Avance III 600 MHz spectrometer (BBFO probe) at ambient temperature (unless otherwise noted) and are expressed in ppm using solvent as the internal standard ($CDCl_3$ at 77.16 ppm, CD_2Cl_2 at 53.84 ppm). Two-dimensional NMR spectra, including COSY, HSQC, HMBC and NOESY were recorded on a Bruker Avance III 500 MHz spectrometer (TBI probe) and a Bruker Avance III 600 MHz spectrometer (BBFO probe). Infrared spectra were recorded on a JASCO FT/IRM4100 Fourier Transform Infrared Spectrometer. Chemical shift values (δ) are expressed in ppm downfield relative to internal standard (tetramethylsilane at 0 ppm). Multiplicities are indicated as s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet) and br s (broad singlet). Coupling constants are reported in hertz (Hz). Analytical thin layer chromatography (TLC) was performed on SILICYCLE pre-coated TLC plates (silica gel 60 F-254, 0.25 mm). Visualization was accomplished with UV light and/or with ceric ammonium molybdate (CAM) or $KMnO_4$ staining solutions. Flash column chromatography was performed using Biotage® Isolera System on Biotage® SNAP Ultra 10 g or 25 g columns (part No. FSUL-0442-0010 and FSUL-0442-0025). High resolution mass spectra were acquired from the Mass Spectrometry Laboratory of University of Illinois (Urbana-Champaign, IL). Melting points were determined using a Stanford Research Systems DigiMelt MPA-160 capillary melting point apparatus.

All reactions were carried out in oven or flame-dried glassware with magnetic stirring. Toluene, tetrahydrofuran (THF), diethyl ether (Et_2O) and methylene chloride (CH_2Cl_2) were dried and purified using the Glass Contour Solvent Purification System® (from Pure Process Technology, LLC) by passing the solvents through two drying columns after being purged with nitrogen. All reagents and starting materials, unless otherwise noted, were purchased from commercial vendors and used without further purification.

2. Full Optimization Table

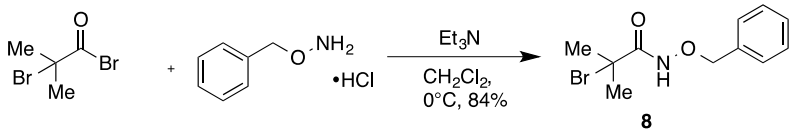


Entry	Base	Solvent	Conc.[a]	Temp.[b]	Time[c]	Yield[d]
1	Na_2CO_3	TFE	0.25	rt	4	94
2	Na_2CO_3	TFE	0.25	0	6	61
3[e]	Na_2CO_3	TFE	0.25	rt	6	91
4	Na_2CO_3	THF	0.25	rt	18	No rxn
5	NEt_3	HFIP	0.25	rt	16	42
6	K_2CO_3	HFIP	0.25	rt	8	40
7	Cs_2CO_3	HFIP	0.25	rt	12	46
8	Na_2CO_3	HFIP	0.25	rt	4	89
9[e]	Na_2CO_3	HFIP	0.25	rt	18	66
10	Na_2CO_3	HFIP	0.50	rt	6	39
11	K_2CO_3	HFIP	0.25	0	8	40
12[f]	Na_2CO_3	HFIP	0.25	0	10+	64
13	NEt_3	$LiClO_4/Et_2O$	0.25	rt	48	50
14	Na_2CO_3	$LiClO_4/Et_2O$	0.25	rt	48	No rxn
15	Na_2CO_3	$LiClO_4$/THF	0.25	rt	48	30
16	Na_2CO_3	$LiClO_4/CHCl_3$	0.25	rt	48	50
17	Na_2CO_3	MeOH	0.25	rt	36	trace
18	Na_2CO_3	CH_2Cl_2	0.25	rt	48	No rxn
19	Na_2CO_3	TFE	0.1	rt	6	53
20	Na_2CO_3	TFE	1	rt	4	61

[a](M), [b] (°C), [c] (h), [d] (% isolated yield), [e] 2 equiv indole, 1 equiv haloamide, [f] 1 equiv indole, 1 equiv haloamide

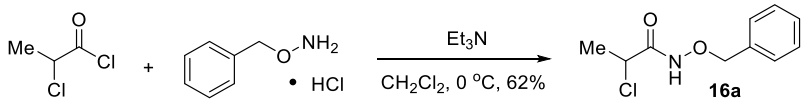
3. Experimental Procedures

a. General procedure A for synthesis of α-haloamide [1]



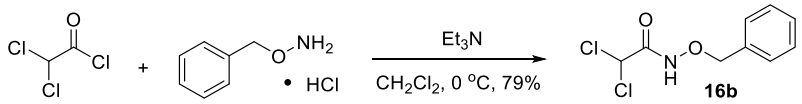
8

To a solution of *O*-benzylhydroxylamine HCl (2 g, 12.5 mmol, 1 eq.) in dicholoromethane (50 mL), triethylamine (1.75mL, 12.5 mmol, 1 eq.) was added. The reaction mixture was then cooled to 0 ºC. Next, 2-bromo-2-methylpropanoyl bromide (1.5 mL, 12.5 mmol, 1 eq) was added dropwise to the reaction mixture. The reaction was stirred for 4 h at 0 ºC. After 4 h, the reaction mixture was then allowed to warm to room temperature and was quenched with water. The resulting mixture was then washed with brine (x3). The organic layer was dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give haloamide **8** as a white solid (2.8 g, 84%).[1]



16a

To a solution of *O*-benzylhydroxylamine HCl (2 g, 12.5 mmol, 1 eq.) in dicholoromethane (50 mL), triethylamine (1.75mL, 12.5 mmol, 1 eq.) was added. The reaction mixture was then cooled to 0 ºC. Next, 2-chloropropionyl chloride (1.2 mL, 12.5 mmol, 1 eq) was added dropwise to the reaction mixture. The reaction was stirred for 8 h at 0 ºC. After 8 h, the reaction mixture was then allowed to warm to room temperature and was quenched with water. The resulting mixture was then washed with brine (x3). The organic layer was dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give haloamide **16a** as a white solid (1.6 g, 62%).

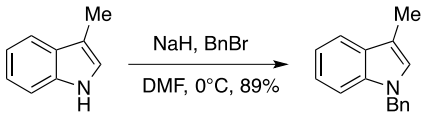


16b

To a solution of *O*-benzylhydroxylamine HCl (2.1 g, 13.6 mmol, 1 eq.) in dicholoromethane (54 mL), triethylamine (1.9 mL, 13.6 mmol, 1 eq.) was added. The reaction mixture was then cooled to 0 ºC. Next, dichloroacetyl chloride (1.3 mL, 13.6 mmol, 1 eq) was added dropwise to the reaction mixture. The reaction was stirred for 4 h at 0 ºC. After 4 h, the reaction mixture was then allowed to warm to room temperature and was quenched with water. The resulting mixture was washed with brine (x3). The organic layer was dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give haloamide **16b** as a white solid (2.5 g, 79%).[1]

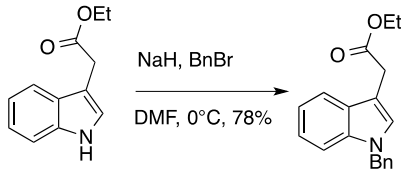
[1] Jeffrey, C. S.; Barnes, K.; Eickhoff, J.; Carson, C. *J. Am. Chem. Soc.* **2011**, *133*, 7688−7691.

b. Synthesis of 3-Substituted Indoles

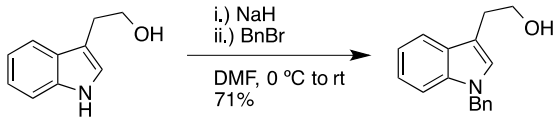


11

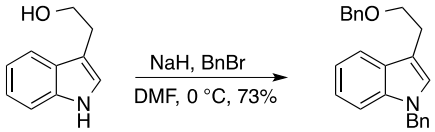
To a flame-dried flask containing 3-methylindole (500 mg, 3.9 mmol, 1 eq.), dry DMF (8 mL) was added. The solution was cooled to 0 ºC. NaH (273 mg, 11.44 mmol, 3 eq.) in dry DMF (2mL) was then added dropwise. The reaction was stirred at 0 ºC for 45 min. After 45 min, benzyl bromide (0.6 mL, 4.96 mmol, 1.2 eq) was added dropwise. The reaction was allowed to warm to room temperature. Once reaction was determined to be complete via thin layer chromatographic analysis, the reaction was quenched with saturated aqueous ammonium chloride. The resulting mixture was washed with water (x3), followed by brine (x1). The organic layer was then dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give N-benzylindole product **11** as a white solid (769 mg, 89%).[2]



By following the general procedure B described above, a mixture of ethyl-3-indole acetate (203 mg, 1.00 mmol, 1 eq), NaH (71.9 mg, 3.00 mmol, 3 eq), and BnBr (0.3 mL, 2.60 mmol) in DMF (10 mL) afforded N-benzyl-ethyl-3-indole acetate as a white solid (228 mg, 78%).[3]



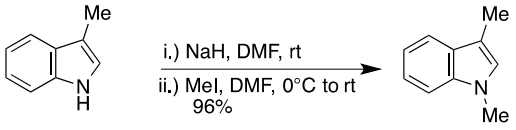
By following the general procedure B described above, a mixture of tryptophol (1g, 6.2 mmol), NaH (446 mg, 18.6 mmol), benzyl bromide (0.8 mL, 6.8 mmol) in dry DMF (56 mL) afforded N-benzyltryptophol as a yellow oil (1.0 g, 71%).[4]



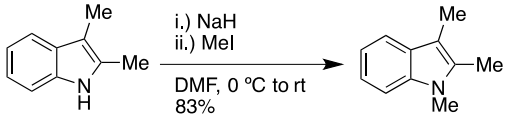
By following the general procedure B described above, a mixture of tryptophol (500 mg, 3.102 mmol), NaH (223 mg, 9.305 mmol), benzyl bromide (0.96 mL, 8.065 mmol) in dry DMF (30 mL) afforded O-benzyl-N-methyl tryptamine (772 mg, 73%).[5]

---

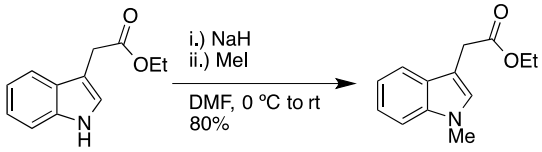
[2] Cheng, H-G.; Lu, L-Q.; Wang, T.; Yang, Q-Q.; Liu, X-P..; Deng, Q-H.; Chen, J-R.; Xiao, W-J. *Angew. Chem. Int. Ed.* **2013**, *52*, 3250−3254.
[3] Alemany et al. *Anales de Quimica* **1974**, *70*, 1102−1105.
[4] Han, L.; Liu, C.; Zhang, W.; Shi, X-X.; You, S-L. *Chem. Commun.* **2014**, *50*, 1231−1233.
[5] Davis, F. A.; Melamed, J.Y.; Sharik, S.S. *J. Org. Chem.* **2006**, *71*, 8761−8766.



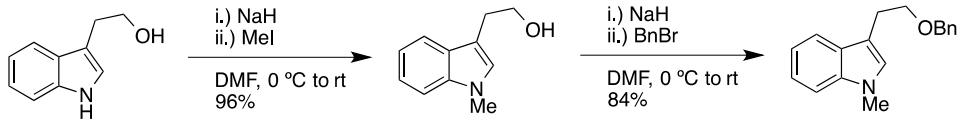
By following the general procedure B described above, a mixture of 3-methylindole (500 mg, 3.91 mmol, 1 eq.), NaH (273 mg, 11.44 mmol, 3 eq), and MeI (308 μL, 4.98 mmol, 1.2 eq) in dry DMF (10 mL) afforded 1,3-dimethylindole as a colorless oil (0.54 g, 96%).[6]



By following the general procedure B described above, a mixture of 2,3-methylindole (290 mg, 4 mmol, 1 eq.), NaH (288 mg, 12 mmol, 3 eq.) in dry DMF (2 mL), and MeI (374 μL, 6 mmol, 1.5 eq) in dry DMF (10 mL) afforded 1,2,3-trimethylindole as a colorless oil (527 mg, 83%)..[7]



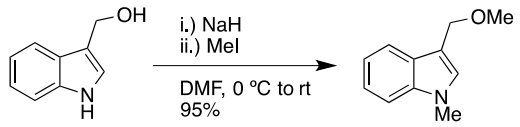
By following the general procedure B described above, a mixture of indole-3-ethyl acetate (500 mg, 2.46 mmol, 1 eq.), NaH (177 mg, 7.39 mmol, 3 eq.), and MeI (400 μL, 6.40 mmol, 2.6 eq) in dry DMF (22 mL) afforded N-methylindole-3-ethyl acetate as a colorless oil (425 mg, 80%).[8]



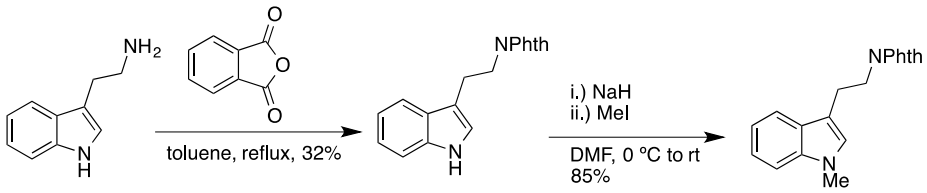
To a flame-dried flask containing tryptophol (230 mg, 1.42 mmol, 1 eq.), dry DMF (2 mL) was added. The solution was cooled to 0 ºC. NaH (102 mg, 4.26 mmol, 3 eq.) in dry DMF (1 mL) was then added dropwise. The reaction was stirred at 0 ºC for 45 min. After 45 min, MeI (96 μL, 1.56 mmol, 1 eq) was then added dropwise. The reaction was allowed to warm to room temperature. Once the reaction was determined to be complete via thin layer chromatographic analysis, the reaction was quenched with saturated aqueous ammonium chloride. The resulting mixture was washed with water (x3), followed by brine (x1). The organic layer was then dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give N-methyltryptophol (240 mg, 96%). Next, to a flame-dried flask containing N-methyltryptophol (215 mg, 1.29 mmol, 1 eq.), dry DMF (10 mL) was added. The solution was cooled to 0 ºC. NaH (88 mg, 3.68 mmol, 3 eq.) in dry DMF (2 mL) was then added dropwise and reaction was stirred at 0 ºC for 45 min. After 45 min, benzyl bromide (0.4 mL, 3.20 mmol, 2.6 eq) was added dropwise, and the reaction was allowed to warm to room temperature. Once the reaction was determined to be complete via thin layer chromatographic analysis, the reaction was quenched with saturated aqueous ammonium chloride.

[6] Klare, H. F. T.; Oestreich, M.; Ito, J-I.; Nishiyama, H.; Ohki, Y.; Tatsumi, K. *J. Am. Chem. Soc.* **2011**, *133*, 3312−3315.
[7] Liu, Y.; Yao, B.; Deng, C-L.; Tang, R-Y.; Zhang, X-G.; Li, J-H. *Org. Lett.* **2011**, *13*, 1126−1129.
[8] Greulich, T. W.; Daniliuc, C.G.; Studer, A. *Org. Lett.* **2015**, *17*, 254−257.

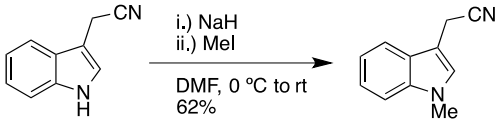
The resulting mixture was washed with water (x3), followed by brine (x1). The organic layer was then dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give O-benzyl-N-methyltryptamine product (271 mg, 84 %).[9]



By following the general procedure B described above, a mixture of 3-indole methanol (500 mg, 3.4 mmol, 1 eq.), NaH (245 mg, 10.2 mmol, 3 eq.), and MeI (0.55 mL, 8.84 mmol, 2.6 eq) in dry DMF (43 mL) afforded N,O-dimethylindole product (169 mg, 95%).[10]

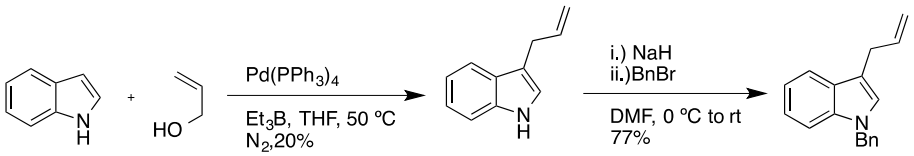


To a round bottom flask containing tryptamine (365 mg, 2.28 mmol, 1 eq) in toluene (5 mL), phthalic anhydride was added (404 mg, 2.73 mmol, 1.2 eq). The reaction was then stirred at reflux for 12 h. Once reaction was determined to be complete via thin layer chromatographic analysis, the reaction mixture was concentrated under vacuum. The product was then recrystallized using ethyl acetate (212 mg, 32 %). Then, to a flame-dried flask containing indole N'-phthalyltryptamine (35 mg, 0.12 mmol, 1 eq.), dry DMF (0.1 mL) was added. The solution was cooled to 0 ºC. Then, NaH (8 mg, 0.24 mmol, 3 eq.) in dry DMF (0.1mL) was added dropwise. The reaction was stirred at 0 ºC for 45 min. After 45 min, MeI (7 µL, 0.1 mmol, 1.2 eq) was added. The reaction was allowed to warm to room temperature. Once reaction was determined to be complete via thin layer chromatographic analysis, the reaction was quenched with saturated aqueous ammonium chloride. The resulting mixture was washed with water (x3), followed by brine (x1). The organic layer was then dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give N-methyl-N'-phthalyltryptamine (588 mg, 85%).[2]

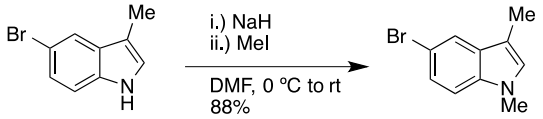


Following general procedure B as described above, a mixture of indole-3-acetonitrile (1 g, 6.4 mmol, 1 eq.), NaH (200 mg, 8.33 mmol, 3 eq.), and MeI (0.6 mL, 9.58 mmol, 1.5 eq) in dry DMF (7 mL) afforded N-methylindole-3-acetonitrile as a colorless oil (672 mg, 62 %).[11]

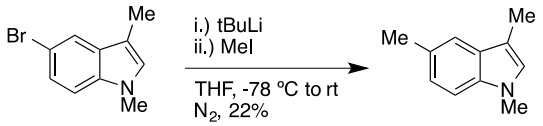
[9] Yadav, J.S.; Reddy, B. V. S.; Reddy, C. S.; Kishna A. D. *Tet. Lett.* **2007**, *41*, 2029−2032.
[10] Lown, J. W.; Weir, G. L. *Can. J. Chem.* **1978**, *58*, 249−255.
[11] Morales-Rios, M. S.; Santos-Sanchez, N.F.; Mora-Perez, Y.; Joseph-Nathan, P. *Heterocycles* **2004**, *63*, 1331−1142.



To a flame-dried flask under nitrogen containing indole (1g, 8.5 mmol, 1 eq) in THF (20 mL), $Ph(PPh_3)_4$ (295 mg, 0.25 mmol, 0.03 eq) was added, followed by allyl alcohol (0.6 mL, 9.4 mmol, 1.1 eq) and Et_3B (1M in hexanes, 2.5 mL, 2.5 mmol, 0.3 eq). The reaction was stirred at 50 ºC. When the reaction was determined to be complete via thin layer chromatographic analysis, the reaction was diluted with ethyl acetate. The mixture was then washed with saturated aqueous sodium bicarbonate (1x), followed by brine (1x). The organic layer was dried over anhydrous sodium sulfate and concentrated under rotary evaporation. The resulting residue was purified by silica gel chromatography (ethyl acetate/hexanes) to give 3-allylindole (260 mg, 20%). Next, to a flame-dried flask containing 3-allylindole (105 mg, 0.66 mmol, 1 eq.), dry DMF (1 mL) was added. The solution was cooled to 0 ºC. Then, NaH (21 mg, 0.87 mmol, 1.3 eq.) in dry DMF (0.5 mL) was added dropwise. The reaction was stirred at 0 ºC for 45 min. After 45 min, benyzyl bromide (63 µL, 1.0 mmol, 1.5 eq) was added dropwise. The reaction was allowed to warm to room temperature. Once reaction was determined to be complete via thin layer chromatographic analysis, the reaction was quenched with saturated aqueous ammonium chloride. The resulting mixture was washed with water (x3), followed by brine (x1). The organic layer was then dried over anhydrous sodium sulfate, filtered, and concentrated under vacuum. The crude reaction mixture was purified by silica gel chromatography (ethyl acetate/hexanes) to give N-benzyl-3-allylindole as a colorless oil (87.5 mg, 77 %).[12]

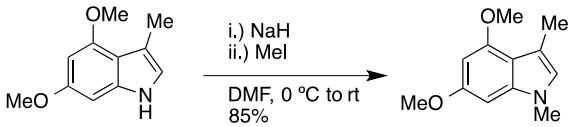


Following general procedure B as described above, a mixture of 5-bromo-3-methylindole (180 mg, 0.86 mmol, 1 eq.), NaH (62 mg, 2.58 mmol, 3 eq.), and MeI (107 µL, 1.72 mmol, 2 eq) in dry DMF (2 mL) afforded 5-bromo-1, 3-dimethylindole as a colorless oil (168 mg, 88 %).[13]

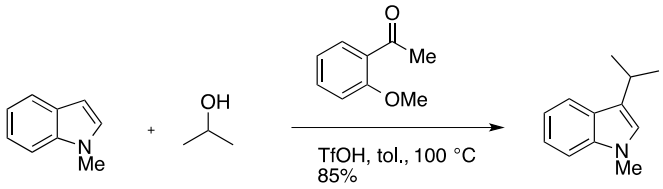


To a flame-dried round bottom flask under nitrogen containing 1,3-dimethyl-5-bromoindole (80 mg, 0.35 mmol, 1 eq) in dry THF (1.5 mL) at −78 ºC, *t*-BuLi in 18% hexanes (480 µL, 0.89 mmol, 2.5 eq) was added dropwise. The reaction was stirred for 15 min at −78 ºC, then the reaction mixture was treated with MeI (27 µL, 0.43, 1.2 eq). The reaction was then allowed to warm to room temperature and was stirred for 4 h. Once reaction was determined to be complete via thin layer chromatographic analysis, the reaction was quenched with saturated aqueous ammonium chloride. The mixture was extracted with ethyl acetate (x3), then dried over anhydrous sodium sulfate, filtered, and concentrated under rotary evanporation. The resulting residue was purified by silica gel chromatography (ethyl acetate/hexanes) to afford 1,3,5-trimethylindole as a colorless oil (56 mg, 22%).[13]

[12] Kimura, M.; Futamata, M.; Mukai, K.; Tamaru, Y. *J. Am. Chem. Soc.* **2005***, 127*, 4592−4593.
[13] Repka, L. M.; Ni, J.; Reisman, S. E. *J Am. Chem. Soc.* **2010**, *132*, 14418−14420.

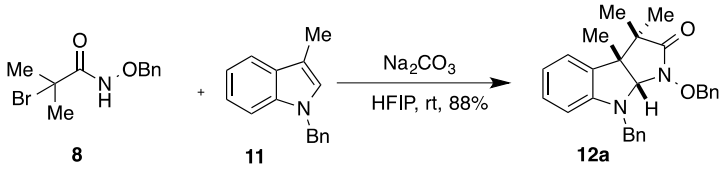


Following general procedure B as described above, a mixture of 3-methyl-4,6-dimethoxyindole (300 mg, 1.57 mmol, 1 eq.), NaH (113 mg, 4.71 mmol, 3 eq), and MeI (147 µL, 2.35 mmol, 1.5 eq) in dry DMF (3.5 mL) afforded 4,5-dimethoxy-1,3-dimethylindole as a colorless oil (272 mg, 85 %).[14]



To a round bottom flask containing 1-methylindole (125 µL, 1 mmol, 1 eq) in toluene (5 mL), isopropanol (150 µL, 2 mmol, 2 eq) and 2-methoxyacetophenone (10 µL, 0.05 mmol, 0.05 eq) was added, followed by triflic acid (9 µL, 0.1 mmol, 0.1 eq). The reaction was then heated to 100 ºC and stirred for 2 hours. Once the reaction was determined to be complete via thin layer chromatographic analysis, the reaction mixture was then warmed to room temperature and concentrated under vacuum. The resulting residue was purified by silica gel chromatography (ethyl acetate/hexanes) to afford 1-methyl-3-isopropylindole as a colorless oil (147 mg, 85%).[15]

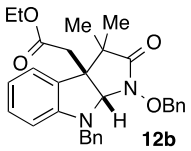
c. General Procedure C for (3+2) Annulation reaction



To a solution of indole **11** (37 mg, 0.25 mmol, 1 eq.) in HFIP (1 mL), α-haloamide **8** (137 mg, 0.5 mmol, 2 eq.) and Na_2CO_3 (106 mg, 1 mmol, 4 eq.) was added. The reaction was stirred at room temperature. Once the reaction was complete as judged by thin layer chromatography analysis, the reaction mixture was diluted with ethyl acetate, filtered through celite and washed with ethyl acetate. The filtrate was then concentrated under rotary evaporation. The resulting residue was purified by silica gel chromatography (ethyl acetate/hexane) to afford indoline **12a** as a colorless oil (84 mg, 88%).

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.27−7.15 (10H, m), 6.93 (2H, ddd, J = 7.2, 7.2, 14.8 Hz), 6.61 (1H, t, J = 7.5 Hz), 6.25 (1H, d, J = 7.9 Hz), 5.24 (2H, d, J = 8.2 Hz), 4.98 (1H, d, J = 10.9 Hz), 4.82 (1H, d, J = 10.0 Hz), 4.54 (2H, d, J = 17.3 Hz), 4.37 (1H, d, J = 17.3 Hz), 1.13 (3H, s), 1.10 (3H, s), 0.95 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 174.1, 149.7, 138.3, 135.1, 132.3, 129.6, 128.8, 128.6, 128.5, 128.3, 127.2, 127.1, 124.3, 118.2, 107.4, 86.0, 76.7, 53.8, 51.5, 43.5, 24.1, 21.7, 21.6.
IR (film, cm^{-1}), 3396, 2973, 1698, 1605, 1486, 1285, 744, 699.
HRMS (ESI) calcd. for $C_{27}H_{28}N_2O_2$ (*m/z* M+H$^+$): 413.2229, found: 413.2224.

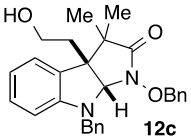
[14] Keawin, T.; Rajviroongit, S.; Black, D. S. *Tetrahedron* **2006**, *61*, 863−861.
[15] Han, X.; Wu, J. *Angew. Chem. Int. Ed.* **2013**, *52*, 4637–4640.



12b

By following the general procedure C described above, a mixture of N-benzyl-3-ethyl acetate (73 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12b** as a colorless oil (78 mg, 65 %).

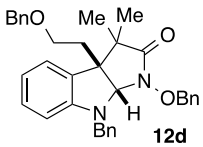
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.46−7.35 (10H, m), 7.32 (1H, dd, J = 7.1, 7.1 Hz), 7.07 (1H, ddd, J = 7.9, 7.9, 1.1 Hz), 7.03 (1H, d, J = 6.8 Hz), 6.73 (1H, dd, J = 7.4, 7.4 Hz), 6.34 (1H, d, J = 8.0 Hz), 5.26 (1H, s), 5.13 (1H, d, J = 12.6 Hz), 4.92 (1H, d, J = 11.4 Hz), 4.66 (1H, d, J = 16.7 Hz), 4.50 (1H, d, J = 16.7 Hz), 3.93 (2H, q, J = 7.1 Hz), 2.87 (1H, d, J = 15.3 Hz), 2.50 (1H, d, J = 15.5 Hz), 1.26 (3H, s), 1.07 (6H, t, J = 8.7 Hz).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.8, 170.2, 151.1, 138.5, 135.0, 129.6, 128.9, 128.8, 128.7, 128.5, 128.4, 127.2, 127.0, 124.3, 118.0, 107.3, 84.6, 76.6, 60.4, 52.7, 44.0, 39.0, 25.4, 23.7, 21.3, 13.7.
IR (film, cm^{-1}): 3437, 3061, 2979, 1712, 1605, 1488, 1186, 746, 700.
HRMS (ESI) calcd. for $C_{30}H_{32}N_2O_4$ (*m/z* M+H$^+$): 485.2440, found: 485.2444.



12c

By following the general procedure C described above, a mixture of N-benzyl-tryptophol (63 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12c** as a white solid (70 mg, 63%).

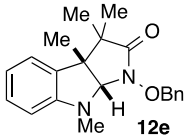
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.29−7.17 (10H, m), 6.98 (1H, ddd, J = 7.7, 7.7, 1.0 Hz), 6.89 (1H, d, J = 7.1 Hz), 6.62 (1H, dd, J = 7.4, 7.4 Hz), 6.32 (1H, d, J = 7.9 Hz), 4.98 (1H, d, J = 10.5 Hz), 4.81 (1H, d, J = 10.5 Hz), 4.80 (1H, s), 4.53 (1H, d, J = 15.5 Hz), 4.37 (1H, d, J = 16.0 Hz), 3.15 (1H, ddd, J = 5.8, 10.8, 13.2 Hz), 3.07 (1H, ddd, J = 11.9, 11.9, 6.9 Hz), 1.93 (1H, ddd, J = 5.8, 8.0, 14.1 Hz), 1.63 (1H, ddd, J = 6.6, 7.7, 14.3 Hz), 1.12 (3H, s), 0.95 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.8, 150.4, 138.0, 135.1, 129.7, 129.0, 128.8, 128.6, 128.5, 128.4, 127.5, 127.2, 125.0, 118.2, 107.7, 82.9, 76.5, 59.4, 54.0, 51.4, 44.1, 36.3, 24.1, 21.9.
IR (film, cm^{-1}): 3419, 3062, 2976, 2359, 1686, 1485, 1265, 1037, 734.
MELTING POINT: 48.1−48.4 ºC
HRMS (ESI) calcd. for $C_{28}H_{30}N_2O_3$ (*m/z* M+H$^+$): 443.2335, found: 443.2338.



12d

By following the general procedure C described above, a mixture of N-benzyl-O-benzyl tryptophol (85 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12d** as a colorless oil (83 mg, 62%).

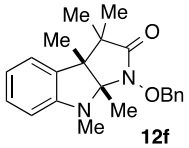
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.26−7.14 (13H, m), 7.09 (2H, dd, J = 2.1, 7.5 Hz), 6.98 (1H, ddd, J = 7.7, 7.7, 1.5 Hz), 6.86 (1H, dd, J = 1.2, 7.3 Hz), 6.62 (1H, ddd, J = 7.5, 7.5, 1.0 Hz), 6.28 (1H, d, J = 7.6 Hz), 4.93 (1H, d, J = 11.7 Hz), 4.83 (1H, s), 4.79 (1H, d, J = 9.9 Hz), 4.46 (1H, d, J = 14.4 Hz), 4.27 (1H, d, J = 14.4 Hz), 4.12 (2H, dd, J = 9.5, 25.7 Hz), 3.03 (1H, ddd, J = 5.3, 7.9, 9.2 Hz), 2.95 (1H, ddd, J = 6.9, 7.9, 9.2 Hz), 2.02 (1H, ddd, J = 5.1, 7.9, 14.0 Hz), 1.73 (1H, ddd, J = 6.2, 7.7, 14.0 Hz), 1.11 (3H, s), 0.91 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.9, 150.7, 138.4, 138.2, 135.1, 129.6, 128.9, 128.8, 128.6, 128.5, 128.4, 128.2, 127.5, 127.4, 127.1, 124.8, 118.2, 118.0, 107.5, 83.3, 76.5, 72.9, 67.4, 54.1, 51.7, 44.2, 33.6, 24.6, 21.6.
IR (film, cm^{-1}): 3418, 2985, 2252, 1696, 1643, 1265, 907, 732, 649.
HRMS (ESI) calcd. for $C_{35}H_{36}N_2O_3$ (*m/z* M+H$^+$): 533.2804, found: 533.2808.



12e

By following the general procedure C described above, a mixture of N-benzyl-3-methylindole (50 mg, 0.225 mmol), α-haloamide **8** (123 mg, 0.452 mmol), and Na_2CO_3 (95.7 mg, 0.903 mmol) in HFIP afforded indoline **12e** (118 mg, 93%) as a colorless oil.

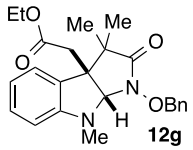
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.52 (2H, dd, J = 1.8, 7.6 Hz), 7.49−7.40 (3H, m), 7.16 (1H, ddd, J = 7.7, 7.7, 1.0 Hz), 7.01 (1H, d, J = 7.6 Hz), 6.74 (1H, t, J = 7.7 Hz), 6.49 (1H, d, J = 7.9 Hz), 5.15 (1H, d, J = 10.7 Hz), 5.03 (1H, d, J = 11.5 Hz), 4.41 (1H, s), 2.98 (3H, s), 1.26 (3H, s), 1.23 (3H, s), 1.00 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 174.1, 150.7, 135.3, 132.2, 129.6, 128.9, 128.5, 128.4, 124.0, 118.1, 107.1, 88.0, 76.8, 51.3, 43.5, 34.6, 24.1, 21.9, 21.4.
IR (film, cm^{-1}): 3434, 2972, 1707, 1605, 1488, 1282, 1089, 1020, 746.
HRMS (ESI) calcd. for $C_{21}H_{24}N_2O_2$ (*m/z* M+H$^+$): 337.1916, found: 337.1911.



12f

By following the general procedure C described above, a mixture of 1,2,3-trimethylindole (40 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12f** as a colorless oil (38 mg, 42%).

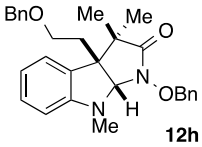
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.37 (2H, dd, J = 1.7, 7.4 Hz), 7.32−7.27 (3H, m), 7.02 (1H, ddd, J = 7.8, 7.8, 1.4 Hz), 6.95 (1H, dd, J = 1.2, 7.4 Hz), 6.59 (1H, dd, J = 7.6, 7.6 Hz), 6.29 (1H, d, J= 8.1 Hz), 4.98 (1H, d, J = 9.7 Hz), 4.83 (1H, d, J = 9.8 Hz), 2.83 (3H, s), 1.38 (3H, s), 1.16 (3H, s), 1.13 (3H, s), 1.05 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.7, 149.0, 135.2, 132.2, 129.3, 128.6, 128.4, 128.3, 125.0, 117.3, 105.9, 87.7, 78.2, 77.4, 43.2, 29.3, 23.9, 22.6, 18.3, 16.0.
IR (film, cm^{-1}): 3419, 3053, 2986, 1698, 1604, 1491, 1265, 1104, 1039, 737, 702.
HRMS (ESI) calcd. for $C_{22}H_{26}N_2O_2$ (*m/z* M+H$^+$): 351.2073, found: 351.2071.



12g

By following the general procedure C described above, a mixture of N-methyl-3-indole-ethyl acetate (54 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12g** as a colorless oil (69 mg, 68%).

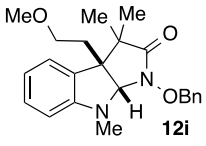
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.40 (2H, dd, J = 1.5, 7.2 Hz), 7.34−7.27 (3H, m), 7.04 (1H, ddd, J = 7.8, 7.8, 1.3 Hz), 6.86 (1H, d, J = 7.6 Hz), 6.59 (1H, dd, J = 7.6, 7.6 Hz), 6.34 (1H, d, J = 8.3 Hz), 5.06 (1H, d, J = 9.7 Hz), 4.93 (2H, d, J = 11.9 Hz), 4.92 (2H, s), 3.77 (2H, dq, J = 2.2, 7.2 Hz), 2.87 (3H, s), 2.71 (1H, d, J = 15.2 Hz), 2.36 (1H, d, J = 15.2 Hz), 1.11 (3H, s), 0.91 (3H, t, J = 7.0 Hz), 0.89 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.4, 170.1, 151.6, 135.2, 129.6, 128.9, 128.8, 128.6, 128.5, 124.5, 117.7, 107.1, 85.6, 76.4, 60.3, 53.1, 43.8, 39.2, 34.9, 29.6, 24.9, 21.6, 13.6.
IR (film, cm^{-1}): 3427, 2979, 2878, 1708, 1644, 1607, 1490, 1283, 1184, 1028, 736, 700.
HRMS (ESI) calcd. for $C_{24}H_{28}N_2O_4$ (*m/z* $M+H^+$): 409.2127, found: 409.2130.



12h

By following the general procedure C described above, a mixture of O-benzyl-N-methyltryptophol (66 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12h** as a colorless oil (86 mg, 76%).

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.35 (2H, q, J = 3.3 Hz), 7.32−7.25 (3H, m), 7.21 (2H, dd, J = 7.2, 7.2 Hz), 7.16 (1H, dd, J = 7.4, 7.4 Hz), 7.09 (2H, d, J = 7.4 Hz), 7.04 (1H, ddd, J = 7.6, 7.6, 1.2 Hz), 6.83 (1H, d, J = 7.4 Hz), 6.60 (1H, dd, J = 7.4, 7.4 Hz), 6.34 (1H, d, J = 7.8 Hz), 4.97 (1H, d, J = 10.9 Hz), 4.86 (1H, d, J = 12.0 Hz), 4.67 (1H, s), 4.15 (2H, dd, J = 12.6, 18.3 Hz), 3.06 (1H, ddd, J = 5.3, 7.2, 9.4 Hz), 2.98 (1H, ddd, J = 7.1, 7.1, 9.3 Hz), 2.79 (3H, s), 1.95 (1H, ddd, J = 5.1, 6.9, 14.0 Hz), 1.79 (1H, ddd, J = 7.1, 7.1, 14.3 Hz), 1.11 (3H, s), 0.91 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.7, 151.3, 138.4, 135.3, 129.6, 129.0, 128.9, 128.6, 128.5, 128.2, 127.6, 127.5, 127.4, 124.9, 117.8, 107.0, 85.1, 76.7, 72.9, 67.3, 54.2, 44.0, 34.3, 33.6, 24.1, 22.2.
IR (film, cm^{-1}): 3440, 3060, 3030, 2973, 2871, 1706, 1604, 1490, 1282, 1097, 1026, 744, 699.
HRMS (ESI) calcd. for $C_{29}H_{32}N_2O_3$ (*m/z* $M+H^+$): 457.2491, found: 457.2497.

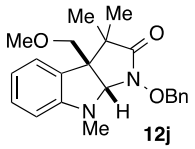


12i

By following the general procedure C described above, a mixture of N, O-dimethyl-tryptophol (47 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12i** as a colorless oil (62 mg, 66%).

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.39 (2H, dd, J = 1.7, 7.1 Hz), 7.34−7.28 (3H, m), 7.05 (1H, ddd, J = 7.6, 7.6, 1.1 Hz), 6.85 (1H, dd, J = 1.0, 7.3 Hz), 6.61 (1H, ddd, J = 7.4, 7.4, 0.7 Hz), 6.35 (1H, d, J =

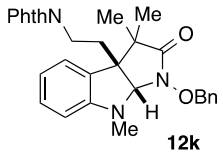
7.3 Hz), 5.01 (1H, d, J = 11.1 Hz), 4.89 (1H, d, J = 10.0 Hz), 4.61, (1H, s), 3.01 (3H, s), 2.91 (1H, ddd, J = 5.2, 7.7, 9.5 Hz), 2.86 (3H, s), 2.81 (1H, ddd, J = 7.1, 7.1, 9.4 Hz), 1.89 (1H, ddd, J = 5.9, 8.3, 13.3 Hz), 1.75 (1H, ddd, J = 7.2, 7.2, 14.1 Hz), 1.13 (3H, s), 0.94 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.6, 151.2, 135.3, 129.6, 129.1, 128.8, 128.6, 128.5, 125.0, 117.8, 107.0, 85.0, 76.6, 69.4, 58.2, 54.2, 43.9, 34.4, 33.6, 23.9, 22.2.
IR (film, cm^{-1}): 3438, 3053, 2975, 2927, 2877, 2832, 2810, 1703, 1604, 1490, 1282, 1115, 1026, 745, 700.
HRMS (ESI) calcd. for $C_{23}H_{28}N_2O_3$ (*m/z* M+H$^+$): 381.2178, found: 381.2177.



12j

By following the general procedure C described above, a mixture of N-methyl-tryptophol (44 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12j** as a white solid (57 mg, 63%).

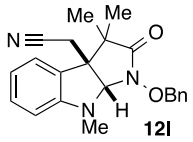
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.41 (2H, dd, J = 1.3, 8.4 Hz), 7.35−7.28 (3H, m), 7.06 (1H, ddd, J = 7.7, 7.7, 1.1 Hz), 6.86 (1H, dd, J = 0.8, 7.3 Hz), 6.61 (1H, ddd, J = 7.4, 7.4, 0.7 Hz), 6.37 (1H, d, J = 8.1 Hz), 5.02 (1H, d, J = 11.4 Hz), 4.95 (1H, d, J = 10.5 Hz), 4.70 (1H, s), 3.42 (2H, dd, J = 9.1, 24.1 Hz), 3.17 (3H, s), 2.83 (3H, s), 1.15 (3H, s), 0.80 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 174.5, 152.0, 135.5, 129.5, 128.8, 128.7, 128.4, 128.1, 123.7, 118.0, 107.3, 84.5, 76.8, 74.4, 58.7, 55.5, 42.7, 35.0, 29.6, 25.6, 19.2.
IR (film, cm^{-1}): 3425, 2924, 2095, 1642, 1488, 1278, 1095, 1024, 745, 698.
MELTING POINT: 59.9−60.8 ºC
HRMS (ESI) calcd. for $C_{22}H_{26}N_2O_3$ (*m/z* M+H$^+$): 367.2022, found: 367.2015.



12k

By following the general procedure C described above, a mixture of N-methyl-N'-phthalimide-tryptamine (76 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12k** as a yellow solid (66 mg, 54%).

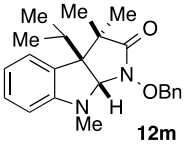
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.64−7.61 (2H, m), 7.61−7.57 (2H, m), 7.43 (2H, d, J = 7.5 Hz), 7.36−7.29 (3H, m), 6.91 (1H, ddd, J = 7.7, 7.7, 0.9 Hz), 6.88 (1H, d, J = 7.6 Hz), 6.30 (1H, d, J = 7.2 Hz), 6.47 (1H, dd, J = 7.9, 7.9 Hz), 5.06 (1H, d, J = 10.1 Hz), 4.93 (1H, d, J = 10.6 Hz), 4.79 (1H, s), 3.29 (1H, ddd, J = 4.1, 10.3, 14.2 Hz), 3.13 (1H, ddd, J = 6.9, 9.3, 13.9 Hz), 2.91 (3H, s), 2.19 (1H, ddd, J = 7.3, 10.2, 13.8 Hz), 1.66 (1H, ddd, J = 4.1, 9.6, 13.6 Hz), 1.10 (3H, s), 0.88 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.6, 167.7, 151.1, 135.2, 133.7, 132.0, 129.6, 128.9, 128.7, 128.6, 128.1, 124.5, 122.8, 118.0, 107.2, 84.3, 76.8, 54.0, 44.2, 34.3, 34.2, 31.6, 24.1, 21.5.
IR (film, cm^{-1}): 3424, 3058, 2974, 1770, 1709, 1489, 1401, 1372, 1286, 1034, 732.
MELTING POINT: 95.2−96.7 ºC
HRMS (ESI) calcd. for $C_{30}H_{29}N_3O_4$ (*m/z* M+H$^+$): 496.2236, found: 496.2241.



12l

By following the general procedure C described above, a mixture of N-methylindole-3-acetonitrile (43 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12l** as a white solid (67 mg, 75%).

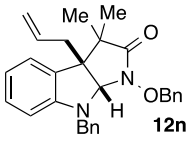
^{1}H NMR (500 MHz, CD_2Cl_2): δ, ppm 7.52 (2H, ddd, J = 3.3, 3.3, 3.3 Hz), 7.47 (3H, ddd, J = 4.2, 4.2, 1.7 Hz), 7.27 (1H, ddd, J = 7.6, 7.6, 1.3 Hz), 7.19 (1H, dd, J = 0.9, 7.5 Hz), 6.83 (1H, ddd, J = 7.6, 7.6, 1.1 Hz), 6.57 (1H, d, J = 7.7 Hz), 5.19 (1H, d, J = 11.7 Hz), 5.04 (1H, d, J = 11.7 Hz), 4.64 (1H, s), 3.04 (3H, s), 2.78 (1H, d, J = 18.4 Hz), 2.50 (1H, d, J = 18.4 Hz), 1.31 (3H, s), 1.17 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 172.4, 150.4, 134.8, 129.8, 129.7, 129.1, 128.6, 127.4, 124.7, 118.5, 116.8, 107.7, 85.0, 76.9, 52.7, 43.4, 34.2, 24.0, 23.9, 21.8.
IR (film, cm^{-1}): 3435, 3056, 2978, 2879, 2252, 1705, 1606, 1490, 1283, 1030, 987, 735, 700.
MELTING POINT: 94.8−95.2 ºC
HRMS (ESI) calcd. for $C_{22}H_{23}N_3O_2$ (*m/z* M+H$^+$): 362.1869, found: 362.1870.



12m

By following the general procedure C described above, a mixture of N-methyl-3-isopropylindole (39 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12m** as a colorless oil (45 mg, 54 %).

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.39 (2H, dd, J = 2.3, 7.3 Hz), 7.35−7.29 (3H, m), 7.06 (1H, ddd, J = 7.7, 7.7, 1.2 Hz), 6.91 (1H, d, J = 7.5 Hz), 6.61 (1H, dd, J = 7.5, 7.5 Hz), 6.35 (1H, d, J = 8.6 Hz), 5.02 (1H, d, J = 10.0 Hz), 4.88 (1H, d, J = 10.0 Hz), 4.54 (1H, s), 2.87 (3H, s), 2.21−2.10 (1H, m), 1.20 (4H, s), 1.03 (3H, s), 0.74 (3H, d, J = 8.5 Hz), 0.58 (3H, d, J = 6.3 Hz).
^{13}C NMR (150 MHz, CD_2Cl_2): 174.6, 151.3, 135.3, 129.4, 128.7, 128.5, 128.4, 128.1, 125.9, 117.4, 106.8, 83.4, 76.8, 59.2, 44.0, 34.0, 30.9, 25.5, 21.3, 18.8, 17.5.
IR (film, cm^{-1}): 3461, 2972, 2872, 1706, 1605, 1488, 1281, 1105, 1020, 745, 700.
HRMS (ESI) calcd. for $C_{21}H_{24}N_2O_2$(*m/z* M+H$^+$): 337.1916, found: 337.1916.

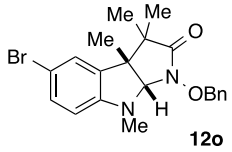


12n

By following the general procedure C described above, a mixture of N-benzyl-3-allylindole (61mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12n** as a colorless oil (27 mg, 25%).

^{1}H NMR (600 MHz, $CDCl_3$): δ, ppm 7.36−7.24 (10H, m), 7.04 (1H, ddd, J = 7.6, 7.6, 0.8 Hz), 6.99 (1H, dd, J = 0.9, 7.3 Hz), 6.71 (1H, ddd, J = 7.4, 7.4, 1.0 Hz), 6.35 (1H, d, J = 8.3 Hz), 5.29−5.21 (1H, m), 5.06 (1H, d, J = 11.4 Hz), 4.86 (3H, ddd, J = 13.0, 13.0, 3.4 Hz), 4.81 (1H, s), 4.60 (1H, d, J = 19.4

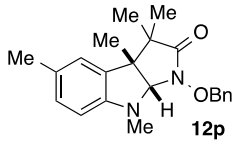
Hz), 4.43 (1H, d, J = 14.8 Hz), 2.63 (1H, dd, J = 5.1, 14.3 Hz), 2.17 (1H, q, J = 7.6 Hz), 1.25 (3H, s), 1.02 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 174.2, 151.0, 138.1, 135.2, 134.2, 129.6, 128.9, 128.6, 128.5, 127.5, 127.1, 124.7, 118.6, 118.1, 107.4, 82.9, 76.6, 55.0, 51.7, 44.0, 38.7, 25.1, 21.2.
IR (film, cm^{-1}): 3433, 3062, 2936, 2869, 1706, 1606, 1266, 1027, 949, 736, 699.
HRMS (ESI) calcd. for $C_{29}H_{30}N_2O_2$ (*m/z* M+H$^+$): 439.2386, found: 439.2383.



12o

By following the general procedure C described above, a mixture of N-methyl-3-methyl-5-bromoindole (56 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12o** as a yellow oil (77 mg, 72%).

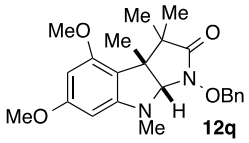
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.47 (2H, dd, J = 1.9, 7. 3 Hz), 7.40−7.38 (3H, m), 7.21 (1H, dd, J = 2.1, 8.9 Hz), 7.05 (1H, d, J = 1.8 Hz), 6.30 (1H, d, J = 8.4 Hz), 5.01 (1H, d, J = 10.5 Hz), 4.97 (1H, d, J = 10.5 Hz), 4.35 (1H, s), 2.92 (3H, s), 1.18 (3H, s), 1.17 (3H, s), 0.98 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 173.8, 149.7, 135.2, 134.6, 131.1, 129.7 129.0, 128.6, 127.0, 109.6, 108.5, 87.9, 76.9, 51.4, 43.4, 34.4, 24.1, 21.7, 21.5.
IR (film, cm^{-1}): 3429, 3054, 2978, 2937, 2875, 2304, 1706, 1600, 1487, 1266, 1018, 808, 734, 701.
HRMS (ESI) calcd. for $C_{21}H_{23}N_2O_2Br$ (*m/z* M+H$^+$): 415.1021, found: 415.1022.



12p

By following the general procedure C described above, a mixture of 1,3,5-trimethylindole (39 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12p** as a colorless oil (56 mg, 65%).

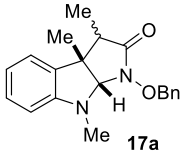
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.52 (2H, dd, J = 1.7, 7.6 Hz), 7.47−7.41 (3H, m), 6.98 (1H, d, J = 8.2 Hz), 6.83 (1H, s), 6.40 (1H, d, J = 8.2 Hz), 5.16 (1H, d, J = 11.3 Hz), 5.04 (1H, d, J = 10.0 Hz), 4.37 (1H, s), 2.96 (3H, s), 2.28 (3H, s), 1.26 (3H, s), 1.22 (3H, s), 1.00 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 174.2, 148.8, 135.3, 132.3, 129.6, 128.8, 128.6, 128.5, 127.6, 124.7, 107.1, 88.6, 76.8, 51.3, 43.4, 35.1, 24.3, 22.0, 21.2, 20.5.
IR (film, cm^{-1}): 3461, 2973, 2933, 2689, 2300, 1706, 1616, 1498, 1455, 1373, 1278, 1093, 1019, 807, 749, 701.
HRMS (ESI) calcd. for $C_{22}H_{26}N_2O_2$ (*m/z* M+H$^+$): 351.2073, found: 351.2075.



12q

By following the general procedure C described above, a mixture of N-methyl-4, 6-dimethoxyindole (51 mg, 0.25 mmol), α-haloamide **8** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded indoline **12q** as a white solid (65 mg, 72%).

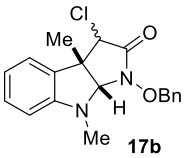
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.41−7.38 (2H, m), 7.34−7.29 (3H, m), 5.79 (1H, d, J = 2.3 Hz), 5.61 (1H, d, J = 2.0 Hz), 5.03 (1H, d, J = 10.5 Hz), 4.94 (1H, d, J = 10.4 Hz), 4.14 (1H, s), 3.66 (6H, s), 2.78 (3H, s), 1.22 (3H, s), 1.13 (3H, s), 0.74 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 175.1, 162.1, 157.2, 153.7, 135.2, 129.6, 128.8, 128.5, 128.3, 126.8, 110.2, 89.8, 88.8, 87.0, 76.9, 55.2, 54.9, 50.8, 43.8, 35.3, 25.3, 22.3, 20.1.
IR (film, cm^{-1}): 3447, 2971, 2938, 1707, 1609, 1455, 1208, 1149, 1058, 804, 746, 700.
MELTING POINT: 109.3−110.4ºC
HRMS (ESI) calcd. for $C_{23}H_{28}N_2O_4$ (*m/z* M+H$^+$): 397.2127, found: 397.2129.



17a

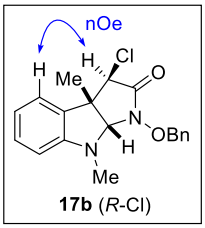
By following the general procedure C described above but at 50 ºC, a mixture of 1,3-dimethylindole (108 mg, 0.75 mmol), α-haloamide **16a** (213 mg, 1.25 mmol), and Na_2CO_3 (265 mg, 2.50 mmol) in HFIP (3 mL) afforded an inseparable 1:1 diastereomeric mixture of indoline **17a** as a colorless oil (131 mg, 54 %).

As a 1:1 diastereomer mixture:
^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.38 (4H, d, J = 8.0 Hz), 7.35−7.27 (5H, m), 7.23−7.14 (1H, m), 7.05−7.00 (2H, m), 6.88 (2H, d, J = 7.5 Hz), 6.61 (2H, dt, J = 4.3, 7.2 Hz), 6.34 (2H, t, J = 7.7 Hz), 5.00 (2H, dd, J = 10.5, 15.7 Hz), 4.87 (2H, dd, J = 3.8, 11.2 Hz), 4.33 (1H, s), 4.26 (1H, s), 2.87 (3H, s), 2.86 (3H, s), 2.48 (1H, q, J = 7.1 Hz), 2.33 (1H, q, J = 7.7 Hz), 1.24 (3H, s), 1.14 (3H, d, J = 9.8 Hz), 1.08 (3H, s), 0.95 (3H, d, J = 8.3 Hz).
^{13}C NMR (150 MHz, CD_2Cl_2): ppm, 171.6, 171.5, 150.5, 149.4, 135.6, 135.3, 130.8, 129.7, 129.6, 128.94, 128.90, 128.6, 128.5, 128.4, 124.6, 121.8, 118.3, 117.8, 107.1, 107.0, 88.1, 87.9, 76.9, 48.0, 47.2, 44.2, 43.3, 34.3, 34.1, 26.6, 19.6, 13.7, 11.4.
IR (film, cm^{-1}): 3460, 3032, 2973, 2301, 1708, 1607, 1490, 1276, 1058, 954, 747, 710.
HRMS (ESI) calcd. for $C_{20}H_{22}N_2O_2$ (*m/z* M+H$^+$): 323.1760, found: 323.1758.



17b

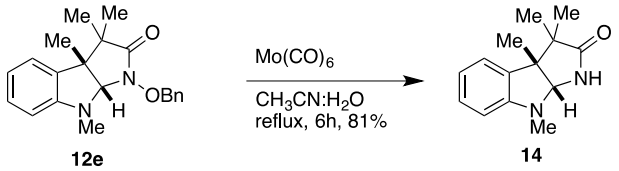
By following the general procedure C described above, a mixture of 1,3-dimethylindole (36 mg, 0.25 mmol), α-haloamide **16b** (137 mg, 0.5 mmol), and Na_2CO_3 (106 mg, 1 mmol) in HFIP (1 mL) afforded a 1:1 diastereomeric mixture indoline **17b** as a colorless oil (36 mg, 42 %). Purification by silica gel flash chromatography provided an analytically pure sample of the following diastereomer.



17b (*R*-Cl)

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.54−7.50 (2H, m), 7.50−7.45 (3H, m), 7.21 (1H, ddd, J = 7.9, 7.9, 1.2 Hz), 7.08 (1H, d, J = 7.5 Hz), 6.79 (1H, dd, J = 7.3, 7.3 Hz), 6.50 (1H, d, J = 7.7 Hz), 5.12 (1H, d, J = 10.9 Hz), 4.99 (1H, d, J = 14.5 Hz), 4.56 (1H, s), 4.43 (1H, s), 2.98 (3H, s), 1.34 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 134.7, 130.0, 129.7, 129.2, 128.6, 122.7, 118.7, 107.4, 86.0, 76.7, 60.5, 33.2, 29.3, 20.8, 13.8.
IR (film, cm^{-1}): 3418, 2926, 2851, 2196, 1721, 1640, 1609, 993, 711, 678.
HRMS (ESI) calcd. for $C_{19}H_{19}ClN_2O_4$ (*m/z* M+H$^+$): 343.1213, found: 343.1210.

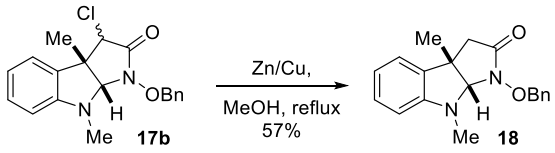
d. General Procedure D for N−O bond cleavage reaction[16]



To a solution of indoline **12e** (100 mg, 0.2 mmol, 1 eq) in acetonitrile/water (9:1, 2 mL), $Mo(CO)_6$ (95 mg, 0.357 mmol, 1.2 eq) was added. The reaction was stirred at reflux for 6 h. Once the reaction was determined to be complete via thin layer chromatographic analysis, the reaction mixture was cooled to room temperature. The mixture was the filtered through celite and washed with ethyl acetate. Then, filtrate was concentrated under rotary evaporation, and the resulting residue was purified by silica gel chromatography (ethyl acetate/hexane) to afford **14** as a white solid (41 mg, 81%).

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.11 (1H, s), 7.03 (1H, ddd, J = 7.9, 7.9, 1.4 Hz), 6.93 (1H, dd, J = 1.0, 7.2 Hz), 6.62 (1H, ddd, J = 7.3, 7.3, 0.7 Hz), 6.36 (1H, d, J = 7.4 Hz), 4.55 (1H, d, J = 0.9 Hz), 2.72 (3H, s), 1.26 (3H, s), 1.10 (3H, s), 0.93 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 182.8, 150.5, 132.8, 128.2, 124.2, 117.9, 107.0, 84.4, 54.2, 45.5, 32.3, 23.3, 21.7, 21.2.
IR (film, cm^{-1}): 3422, 2970, 2919, 2869, 2824, 2359, 1694, 1487, 1288, 1024, 740.
MELTING POINT: 147.2−148.0ºC
HRMS (ESI) calcd. for $C_{14}H_{18}N_2O$ (*m/z* $M+H^+$): 231.1497, found: 231.1502.

e. General Procedure E for Protodehalogenation reaction[17]



To a round bottom flask containing indoline **17b** (36 mg, 0.105 mmol) in MeOH (3 mL), Zn/Cu couple (290 mg, 2.22 mmol) was added. The reaction mixture was stirred at reflux for 7 h. Once the reaction was determined to be complete via thin layer chromatographic analysis, the reaction mixture was filtered and repeatedly washed with MeOH. The filtrate was then diluted with water, extracted with CH_2Cl_2 (x3), dried over anhydrous sodium sulfate, and concentrated under rotary evaporation. The resulting residue was purified by silica gel chromatography (ethyl acetate/hexanes) to afford **18** (18 mg, 57%).

^{1}H NMR (600 MHz, CD_2Cl_2): δ, ppm 7.37 (2H, dd, J = 2.1, 7.7 Hz), 7.34−7.28 (3H, m), 7.03 (1H, ddd, J = 7.7, 7.7, 1.2 Hz), 6.93 (1H, dd, J = 0.7, 7.3 Hz), 6.63 (1H, ddd, J = 7.5, 7.5, 0.8 Hz), 6.35 (1H, d, J = 8.1 Hz), 5.02 (1H, d, J = 10.8 Hz), 4.83 (1H, d, J = 10.4 Hz), 4.43 (1H, s), 2.91 (3H, s), 2.57 (1H, d, J = 17.3 Hz), 2.40 (1H, d, J = 16.2 Hz), 1.25 (3H, s).
^{13}C NMR (150 MHz, CD_2Cl_2): 168.5, 149.0, 135.2, 135.1, 129.6, 128.8, 128.6, 128.5, 122.1, 118.3, 106.9, 88.0, 76.8, 43.7, 41.4, 33.6, 25.9.
IR (film, cm^{-1}): 3430, 3055, 2926, 2097, 1641, 1492, 1265, 736, 702.
HRMS (ESI) calcd. for $C_{19}H_{20}N_2O_2$ (*m/z* $M+H^+$): 309.1603, found: 309.1602.

[16] Zhao, G-L.; Lin, S.; Korotvicka, A.; Deiana, L.; Kullberg, M.; Cordova, *Adv. Synth. Cat.* **2010**, *352*, 2291−2298.
[17] Sondengam, B.L.; Fomum, Z.T.; Charles, G.; Akam, T.M. *J. Chem. Soc. Perkin. Trans. I* **1983**, 1219−1221.

SUPPORTING INFORMATION

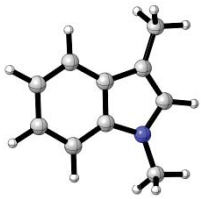
DFT Calculation Details.

Full-molecule calculations were carried out using the hybrid B3LYP-D3 functional[1] with the zero-damping, two-body only D3 correction of Grimme et al.,[2] and the 6-311++G** basis,[3] as implemented in the Jaguar[4] suite of programs. All computations were carried out using the Poisson-Boltzmann solver[5] implemented as part of the Jaguar suite, and using an implicit trifluoroethanol solvent model with settings: dielectric constant 26.7; molecular weight 100.04 g/mol; density 1.39 g/mL; probe radius 2.43Å. Computed structures were confirmed as stationary points by calculating the vibrational frequencies using second derivative analytic methods, and confirming the absence of imaginary frequencies for minima, and the presence of a single imaginary frequency for transition states. Thermodynamic quantities were calculated assuming an ideal gas, and are zero point energy corrected. Graphical representations of structures were made using the CYLView program.[6]

Material Relevant to all DFT output

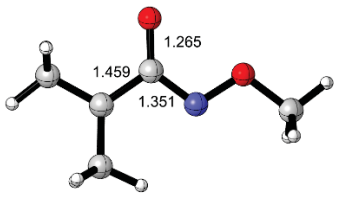
Jaguar version 7.9, release 23
Copyright Schrodinger, LLC
All Rights Reserved.
Jaguar, version 7.9, Schrodinger, LLC, New York, NY, 2011

Non-default options chosen:
SCF calculation type: DFT(b3lyp-d3)
DFT=Becke_3_Parameter/HF+Slater+Becke88+VWN+LYP (B3LYP)
Solvation energy will be computed using PBF
Vibrational frequencies and related properties computed from analytic second derivatives
Molecular symmetry not used
Energy convergence criterion: 1.00E-05 hartrees
RMS density matrix convergence criterion: 1.00E-06
Highest accuracy cutoffs used in SCF



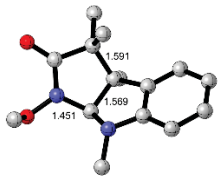
15

C	-1.21670	1.69910	0.13790
C	-2.53040	1.80950	0.62520
C	-3.51440	0.97370	0.10650
C	-3.21000	0.02440	-0.89320
C	-1.91850	-0.10720	-1.39650
C	-0.93170	0.73840	-0.87530
C	0.01670	2.37840	0.43800
C	0.96840	1.82040	-0.38110
N	0.40780	0.83620	-1.18200
H	-2.77420	2.53540	1.39570
H	-4.53320	1.04850	0.47420
H	-3.99850	-0.61580	-1.27650
H	-1.69010	-0.84040	-2.16340
H	2.02290	2.05200	-0.46630
C	1.11780	-0.00470	-2.13190
H	2.12960	0.37940	-2.26470
H	1.17570	-1.03880	-1.77610
H	0.61310	0.00650	-3.10200
C	0.20650	3.47820	1.43980
H	1.24810	3.80820	1.47430
H	-0.41240	4.35080	1.20140
H	-0.07510	3.15600	2.44880



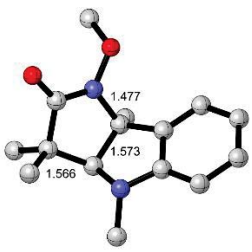
9-Me

C	-0.21990	5.03400	-1.17580
N	1.93660	4.35980	-1.52140
C	-1.33320	5.96150	-1.44060
H	-1.03140	6.97200	-1.12600
H	-2.25440	5.67380	-0.93440
C	1.03420	5.30320	-1.87030
O	1.19040	6.27700	-2.66290
C	-0.45900	3.92310	-0.22950
H	-0.80280	4.34720	0.72700
H	-1.31130	3.32970	-0.59640
H	0.40400	3.28460	-0.07100
H	-1.49260	6.04670	-2.52380
O	3.11850	4.56150	-2.14240
C	4.08110	3.54840	-1.76150
H	4.99850	3.80770	-2.28920
H	4.24200	3.57150	-0.68100
H	3.72830	2.56170	-2.07130



12

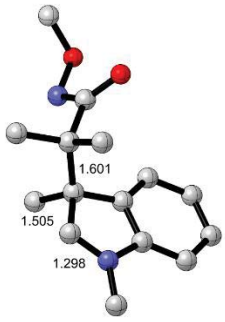
C	-1.34150	2.06290	-0.21100
C	-2.60710	2.08320	0.35320
C	-3.52110	1.07030	0.02570
C	-3.14600	0.05140	-0.85260
C	-1.86780	0.01820	-1.42340
C	-0.97330	1.04150	-1.10050
C	-0.18230	3.01860	-0.02200
C	0.96650	2.27680	-0.79190
N	0.33190	1.21720	-1.57790
H	-2.89170	2.86840	1.04740
H	-4.51490	1.07370	0.46110
H	-3.85360	-0.73600	-1.09580
H	-1.59010	-0.78380	-2.09860
H	1.73190	1.85910	-0.12540
C	1.13600	0.04690	-1.92210
H	2.12870	0.36880	-2.23830
H	1.24590	-0.64010	-1.07000
H	0.67810	-0.49500	-2.75200
C	0.19200	3.18540	1.45750
H	1.10330	3.77930	1.57480
H	-0.61020	3.67160	2.01650
H	0.36510	2.20260	1.90290
C	-0.33510	4.40250	-0.79090
N	1.57400	3.33390	-1.57950
C	-1.37960	4.33220	-1.93050
H	-2.38670	4.26270	-1.51490
H	-1.21560	3.46570	-2.57410
C	1.02300	4.56960	-1.48530
O	1.49960	5.60020	-1.95260
C	-0.65280	5.60870	0.09930
H	-0.70640	6.50860	-0.51790
H	-1.62250	5.47510	0.58740
H	0.10340	5.77650	0.86780
H	-1.31960	5.23640	-2.54090
O	2.81200	3.12530	-2.16920
C	2.69040	3.01010	-3.61120
H	3.70420	2.81460	-3.96490
H	2.03020	2.18100	-3.87240
H	2.31520	3.94460	-4.03610



21

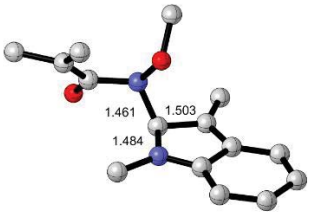
C	-0.34610	1.89330	0.37610
C	-0.19900	1.75280	1.74710

C	-1.22140	1.13310	2.48080
C	-2.35800	0.65530	1.82140
C	-2.51190	0.79150	0.43750
C	-1.49650	1.43410	-0.28150
C	0.61000	2.47570	-0.64550
C	-0.13020	2.23190	-2.01140
N	-1.45680	1.70770	-1.64400
H	0.69660	2.10750	2.24690
H	-1.12540	1.01390	3.55470
H	-3.14020	0.16260	2.39150
H	-3.39940	0.40910	-0.05390
H	0.40710	1.48810	-2.61130
C	-2.12250	0.80880	-2.57980
H	-2.03390	1.19720	-3.59340
H	-1.68920	-0.20240	-2.55420
H	-3.18650	0.73990	-2.34550
C	2.01710	1.88080	-0.55800
H	2.66650	2.28380	-1.33900
H	2.46400	2.09280	0.41670
H	1.96150	0.79590	-0.67310
C	-0.15620	3.61040	-2.75390
N	0.64420	3.95100	-0.59590
C	1.02460	3.69790	-3.74550
H	0.88590	2.96400	-4.54480
H	1.98080	3.49160	-3.25760
C	0.10630	4.62860	-1.63550
O	-0.06260	5.84630	-1.68600
C	-1.46800	3.93900	-3.47180
H	-1.44070	4.97680	-3.81250
H	-1.60230	3.29990	-4.34870
H	-2.32520	3.81020	-2.80890
H	1.07770	4.69340	-4.19360
O	0.98120	4.58250	0.58950
C	2.28370	5.21370	0.50530
H	2.43890	5.67300	1.48300
H	3.06080	4.47090	0.31180
H	2.28380	5.97940	-0.27290



19a

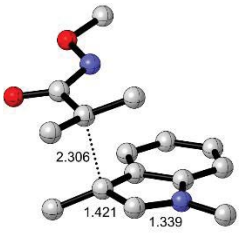
C	-1.38840	2.09190	0.00020
C	-2.59420	2.53220	0.53030
C	-3.67740	1.64530	0.54340
C	-3.55930	0.34150	0.04600
C	-2.34740	-0.12090	-0.47710
C	-1.29540	0.78400	-0.47890
C	-0.03540	2.76830	-0.14800
C	0.75500	1.65400	-0.77870
N	0.04850	0.57630	-0.93490
H	-2.69470	3.53640	0.92270
H	-4.62870	1.97640	0.94790
H	-4.41770	-0.32180	0.06930
H	-2.24620	-1.13220	-0.85590
H	1.80640	1.67460	-1.05080
C	0.52190	-0.70660	-1.47470
H	1.56190	-0.60180	-1.78040
H	0.42990	-1.47040	-0.69860
H	-0.09910	-0.97480	-2.33220
C	0.60830	3.01420	1.24850
H	1.66690	3.26480	1.16000
H	0.08110	3.84460	1.71580
H	0.51480	2.11800	1.86720
C	-0.07230	4.05200	-1.10380
N	-0.93390	5.59190	0.55220
C	1.30330	4.74870	-1.12410
H	2.09760	4.06860	-1.45200
H	1.56290	5.15480	-0.14830
C	-1.18060	5.08920	-0.64770
O	-2.12960	5.35460	-1.43770
C	-0.40560	3.58290	-2.53300
H	-0.50790	4.44360	-3.19380
H	0.39540	2.94930	-2.92930
H	-1.34510	3.02910	-2.56760
H	1.27020	5.58220	-1.83120
O	-1.96420	6.55400	0.93710
C	-1.55630	7.85800	0.53080
H	-2.30170	8.56190	0.91170
H	-0.57320	8.11250	0.95010
H	-1.50750	7.93520	-0.56180



19b

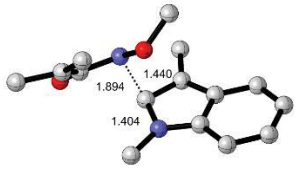
C	-1.04910	1.55350	0.13530
C	-2.31180	1.32590	0.77080
C	-3.27120	0.63000	0.09190
C	-3.01830	0.12830	-1.22980
C	-1.82470	0.31760	-1.88480
C	-0.81430	1.04930	-1.20940
C	0.07940	2.21260	0.55070
C	1.09350	2.16970	-0.55790
N	0.41260	1.37720	-1.61220
H	-2.49300	1.70630	1.77040
H	-4.23910	0.44260	0.54380
H	-3.80830	-0.42540	-1.72840
H	-1.66970	-0.07780	-2.88150
H	2.01940	1.65710	-0.25920
C	1.07330	0.98030	-2.84750
H	1.80560	0.19010	-2.65240
H	0.33880	0.62020	-3.56990
H	1.59710	1.84090	-3.26800
C	0.35350	2.90500	1.82850

H	0.88800	3.84030	1.63760
H	-0.55580	3.10650	2.39620
H	1.01970	2.29300	2.45060
C	2.77650	4.16690	-3.00410
N	1.50400	3.51100	-0.96610
C	1.60770	4.52060	-3.89910
H	1.31750	5.58030	-3.82220
H	0.71190	3.93470	-3.71180
C	2.74590	3.60420	-1.74720
O	3.74410	3.15020	-1.06370
C	4.11730	4.50390	-3.60510
H	4.31070	3.91140	-4.51230
H	4.15280	5.55820	-3.91830
H	4.93590	4.32800	-2.90620
H	1.89480	4.36050	-4.94580
O	0.34330	4.17830	-1.47180
C	0.27400	5.51180	-0.96130
H	-0.62020	5.94840	-1.41200
H	0.17710	5.52000	0.12690
H	1.15280	6.08720	-1.26110



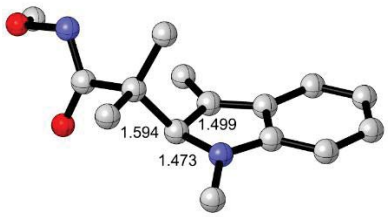
TS1‡

C	-1.33760	2.15840	0.19360
C	-2.40640	2.88020	0.72600
C	-3.69380	2.35800	0.59390
C	-3.92380	1.14000	-0.06690
C	-2.86980	0.40380	-0.61140
C	-1.59230	0.93450	-0.45980
C	0.09960	2.41010	0.11670
C	0.62230	1.24920	-0.51370
N	-0.35550	0.41060	-0.88040
H	-2.24270	3.82600	1.23000
H	-4.53660	2.90140	1.00870
H	-4.93750	0.76200	-0.15420
H	-3.04560	-0.53790	-1.12060
H	1.65970	1.00140	-0.70380
C	-0.19620	-0.85970	-1.58790
H	0.86190	-1.03040	-1.78390
H	-0.58460	-1.67200	-0.96820
H	-0.74430	-0.83480	-2.53280
C	0.88010	3.18150	1.15270
H	1.95230	3.12130	0.95370
H	0.58600	4.23050	1.18410
H	0.70060	2.74280	2.14020
C	0.24580	3.81670	-1.70500
N	-1.80780	4.89160	-1.55690
C	1.72560	4.04220	-1.76740
H	2.28880	3.11700	-1.89590
H	2.08560	4.60790	-0.91060
C	-0.54420	4.98140	-1.16950
O	0.01490	5.89790	-0.47980
C	-0.32960	2.97690	-2.81160
H	-0.43120	3.61620	-3.69680
H	0.33350	2.14920	-3.07100
H	-1.32490	2.60360	-2.57820
H	1.90520	4.66650	-2.65670
O	-2.55390	6.00320	-1.11590
C	-3.92310	5.78510	-1.46760
H	-4.46790	6.67470	-1.14720
H	-4.03660	5.65390	-2.54890
H	-4.31580	4.90020	-0.95740



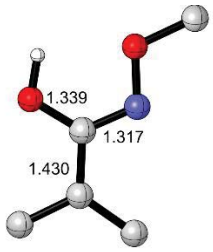
TS1A‡

C	-0.83040	1.90760	0.09670
C	-2.14460	1.84060	0.62930
C	-3.14420	1.28900	-0.14240
C	-2.87390	0.79710	-1.45040
C	-1.60600	0.84600	-2.00730
C	-0.57830	1.39940	-1.22630
C	0.37900	2.41130	0.59100
C	1.35000	2.27690	-0.46380
N	0.74880	1.54270	-1.49920
H	-2.35430	2.21870	1.62490
H	-4.15650	1.22590	0.24320
H	-3.68930	0.37250	-2.02780
H	-1.42160	0.47280	-3.00870
H	2.41440	2.13040	-0.29670
C	1.40610	1.19080	-2.74940
H	2.47730	1.09310	-2.57450
H	1.02290	0.23440	-3.11000
H	1.23920	1.95630	-3.51200
C	0.65700	3.09360	1.88140
H	1.07790	4.08770	1.68640
H	-0.24430	3.20630	2.48670
H	1.40180	2.54690	2.47070
C	2.75860	4.45850	-3.22590
N	1.57430	4.05220	-1.08480
C	1.60670	4.97530	-4.04790
H	1.05950	5.77630	-3.54220
H	0.86210	4.20490	-4.27090
C	2.74540	3.99710	-1.89780
O	3.78240	3.58220	-1.26220
C	4.09420	4.56430	-3.89980
H	4.04160	4.11920	-4.90250
H	4.37250	5.61810	-4.05360
H	4.88430	4.07750	-3.33120
H	1.98040	5.36740	-4.99780
O	0.41640	4.34740	-1.77940
C	-0.44370	5.20300	-1.00500
H	-1.33880	5.34060	-1.61320
H	-0.71270	4.73390	-0.05740
H	0.04210	6.16550	-0.82190



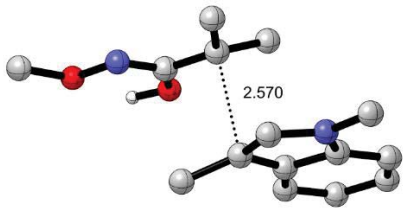
20a

C	-0.16960	1.50310	0.28670
C	-0.21570	1.27460	1.69920
C	-1.38950	0.84270	2.24940
C	-2.54890	0.62000	1.43080
C	-2.55650	0.82790	0.07230
C	-1.35170	1.28840	-0.51940
C	0.85040	1.88890	-0.55460
C	0.30110	2.00870	-1.94460
N	-1.09070	1.54830	-1.80230
H	0.66300	1.44480	2.31250
H	-1.46320	0.66010	3.31600
H	-3.45850	0.27470	1.91430
H	-3.45170	0.66150	-0.51600
H	0.83980	1.34450	-2.63380
C	-1.96710	1.13920	-2.90410
H	-1.38210	1.04680	-3.81720
H	-2.40190	0.16300	-2.67470
H	-2.77150	1.86300	-3.06060
C	2.25490	2.18470	-0.19390
H	2.47390	3.24600	-0.36540
H	2.46330	1.94800	0.84970
H	2.93730	1.62320	-0.84050
C	0.44750	3.48550	-2.52620
N	2.44040	4.83530	-2.55570
C	-0.34840	3.64880	-3.83800
H	-1.42530	3.63150	-3.66280
H	-0.08730	2.88230	-4.56860
C	1.95120	3.66280	-2.93040
O	2.49930	2.73640	-3.59430
C	-0.08130	4.50330	-1.50320
H	-0.08940	5.50300	-1.93800
H	-1.10820	4.24840	-1.22060
H	0.52670	4.54430	-0.59910
H	-0.10170	4.62340	-4.26750
O	3.78960	5.03050	-3.08110
C	4.74740	4.50960	-2.16140
H	5.73540	4.76210	-2.55580
H	4.62990	4.96350	-1.16910
H	4.65720	3.42200	-2.07270



22

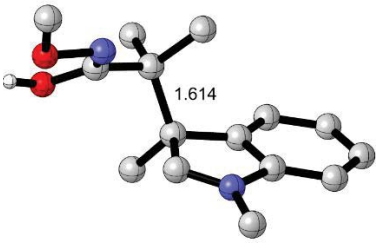
C	-0.38120	4.89870	-1.12400
N	1.22530	3.82480	-2.42850
C	-1.46720	4.08270	-1.69150
H	-1.98990	3.58310	-0.85950
H	-1.14740	3.35520	-2.43170
C	0.98520	4.74580	-1.51880
O	1.91190	5.52860	-0.95300
C	-0.70830	5.91310	-0.11020
H	-0.36050	6.89990	-0.45370
H	-1.77380	5.94330	0.11580
H	-0.12820	5.71590	0.80470
H	-2.21820	4.76650	-2.11940
O	2.51610	3.76020	-2.72070
C	2.82070	2.74530	-3.72710
H	3.90090	2.80730	-3.85070
H	2.52000	1.76560	-3.35080
H	2.30000	2.99290	-4.65410
H	2.80700	5.34080	-1.29690



TS1‡(H+)

C	-1.68950	2.14650	0.03940
C	-3.06140	2.23390	0.30090
C	-3.89480	1.22310	-0.17740
C	-3.37920	0.13470	-0.90340
C	-2.01400	0.02430	-1.17250
C	-1.19500	1.04050	-0.69000
C	-0.55540	2.99410	0.35870
C	0.56880	2.31510	-0.16400
N	0.19850	1.18930	-0.79930
H	-3.47060	3.06950	0.85900
H	-4.96190	1.27270	0.01450
H	-4.05460	-0.63710	-1.25850
H	-1.61770	-0.81860	-1.72880
H	1.61380	2.58490	-0.07620
C	1.09100	0.21700	-1.43170
H	2.10970	0.60290	-1.41200
H	1.05030	-0.72770	-0.88330
H	0.78780	0.04640	-2.46700
C	-0.49270	3.99680	1.46870
H	0.37230	4.65570	1.36780
H	-1.39970	4.60370	1.51090

H	-0.40550	3.47610	2.42970
C	-0.52080	4.53070	-1.70050
N	-0.22650	6.54630	-0.52380
C	0.91630	4.59820	-2.12270
H	1.24770	3.64280	-2.53060
H	1.58210	4.92280	-1.32520
C	-1.06520	5.64520	-0.94520
O	-2.39600	5.68390	-0.74850
C	-1.43920	3.74580	-2.56550
H	-1.50600	4.28570	-3.52510
H	-1.02260	2.76250	-2.79640
H	-2.44430	3.65010	-2.16090
H	0.98360	5.34220	-2.92990
O	-0.88110	7.56170	0.12750
C	0.04680	8.58760	0.54700
H	-0.56370	9.33030	1.05910
H	0.79050	8.16750	1.22830
H	0.53540	9.03170	-0.32460
H	-2.64540	6.49550	-0.26740



19a(H+)

C	-1.48710	2.05440	-0.03630
C	-2.75080	2.41130	0.41720
C	-3.79820	1.49310	0.26340
C	-3.58910	0.23800	-0.31950
C	-2.31670	-0.14750	-0.75260
C	-1.30340	0.78500	-0.58780
C	-0.15270	2.79050	-0.05250
C	0.74000	1.72180	-0.62820
N	0.08690	0.64170	-0.91650
H	-2.94110	3.37280	0.88040
H	-4.79350	1.76120	0.60360
H	-4.42110	-0.44990	-0.42890
H	-2.14300	-1.12500	-1.18920
H	1.81480	1.78320	-0.76810
C	0.65430	-0.59610	-1.47350
H	1.72410	-0.46080	-1.62950
H	0.47460	-1.41060	-0.76820
H	0.15600	-0.80760	-2.42220
C	0.32720	3.09690	1.39210
H	1.29620	3.59570	1.38770
H	-0.40220	3.73870	1.88920
H	0.40140	2.16970	1.96660
C	-0.16070	4.07710	-1.02620
N	1.67410	4.11330	-2.61990
C	-0.99710	3.76620	-2.28720
H	-2.04930	3.66390	-2.01980
H	-0.67340	2.85130	-2.78610
C	1.27450	4.41490	-1.43840
O	2.03700	5.01680	-0.50440
C	-0.77610	5.30220	-0.31950
H	-0.79690	6.14110	-1.02100
H	-1.80500	5.09720	-0.01950
H	-0.20750	5.61330	0.55500
H	-0.90500	4.58350	-3.00370
O	3.02640	4.49050	-2.80160
C	3.31420	4.56120	-4.20640
H	4.37810	4.79040	-4.27870
H	3.10310	3.60330	-4.68950
H	2.72980	5.35420	-4.68300
H	2.91230	5.22100	-0.88670

References.

(1) (a) Becke, A. D. *J. Chem. Phys.* **1993**, *98*, 5648-5652; (b) Becke, A. D. *J. Chem. Phys.* **1993**, *98*, 1372-1377; (c) Lee, C.; Yang, W.; Parr, R. G. *Phys. Rev. B* **1988**, *37*, 785-789; (d) Stephens, P. J.; Devlin, F. J.; Chabalowski, C. F.; Frisch, M. J. *J. Phys. Chem.* **1994**, *98*, 11623-11627.

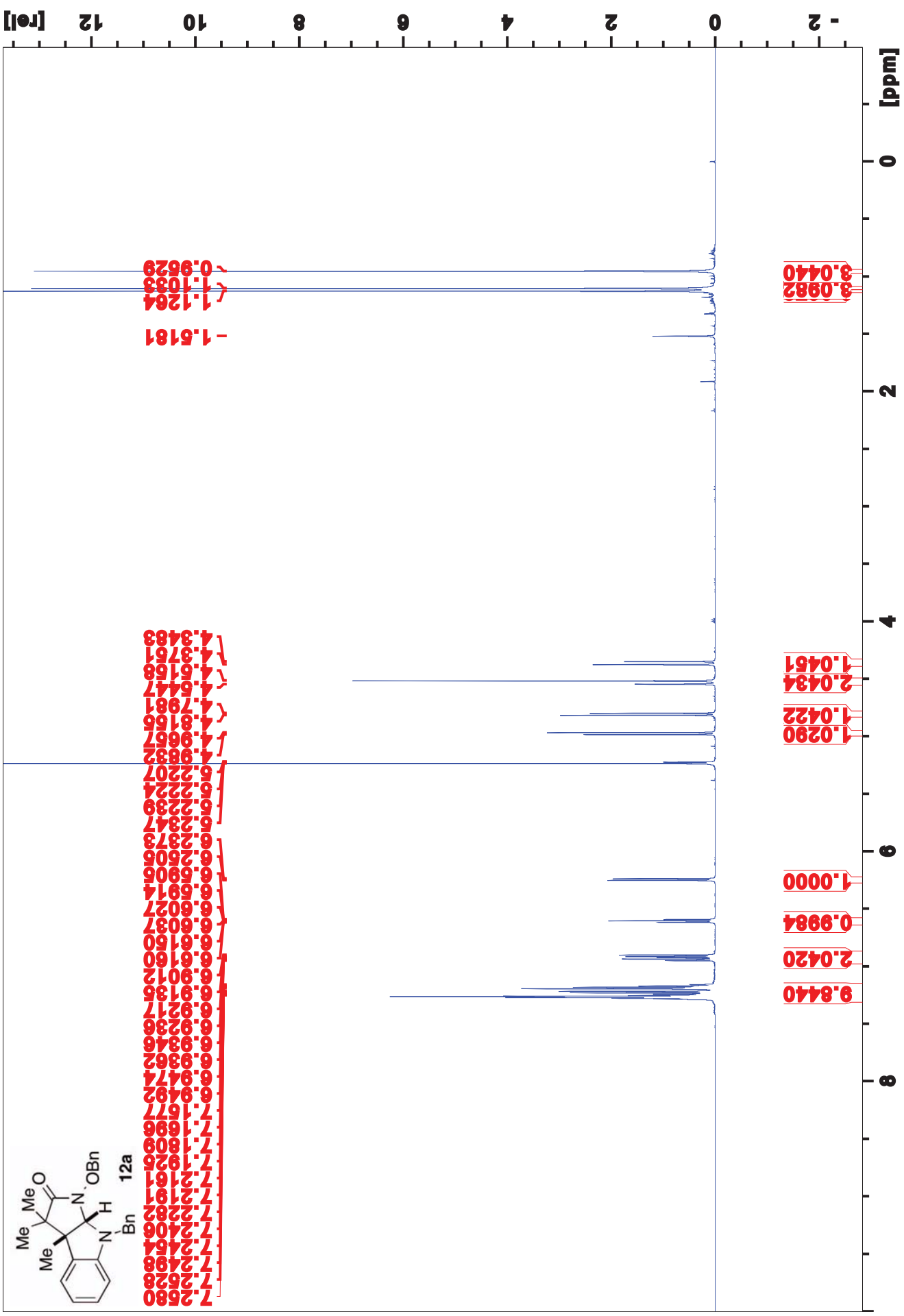
(2) (a) Grimme, S.; Antony, J.; Ehrlich, S.; Krieg, H. *J. Chem. Phys.* **2010**, *132*, 154104; (b) Goerigk, L.; Grimme, S. *Phys. Chem. Chem. Phys.* **2011**, *13*, 6670-6688.

(3) (a) Frisch, M. J.; Pople, J. A.; Binkley, J. S. *J. Chem. Phys.* **1984**, *80*, 3265-3269; (b) Clark, T.; Chandrasekhar, J.; Spitznagel, G. W.; Schleyer, P. v. R. *J. Comput. Chem.* **1983**, *4*, 294-301; (c) McLean, A. D.; Chandler, G. S. *J, Chem. Phys.* **1980**, *72*, 5639-5648; (d) Krishnan, R.; Binkley, J. S.; Seeger, R.; Pople, J. A. *J. Chem. Phys.* **1980**, *72*, 650-654.

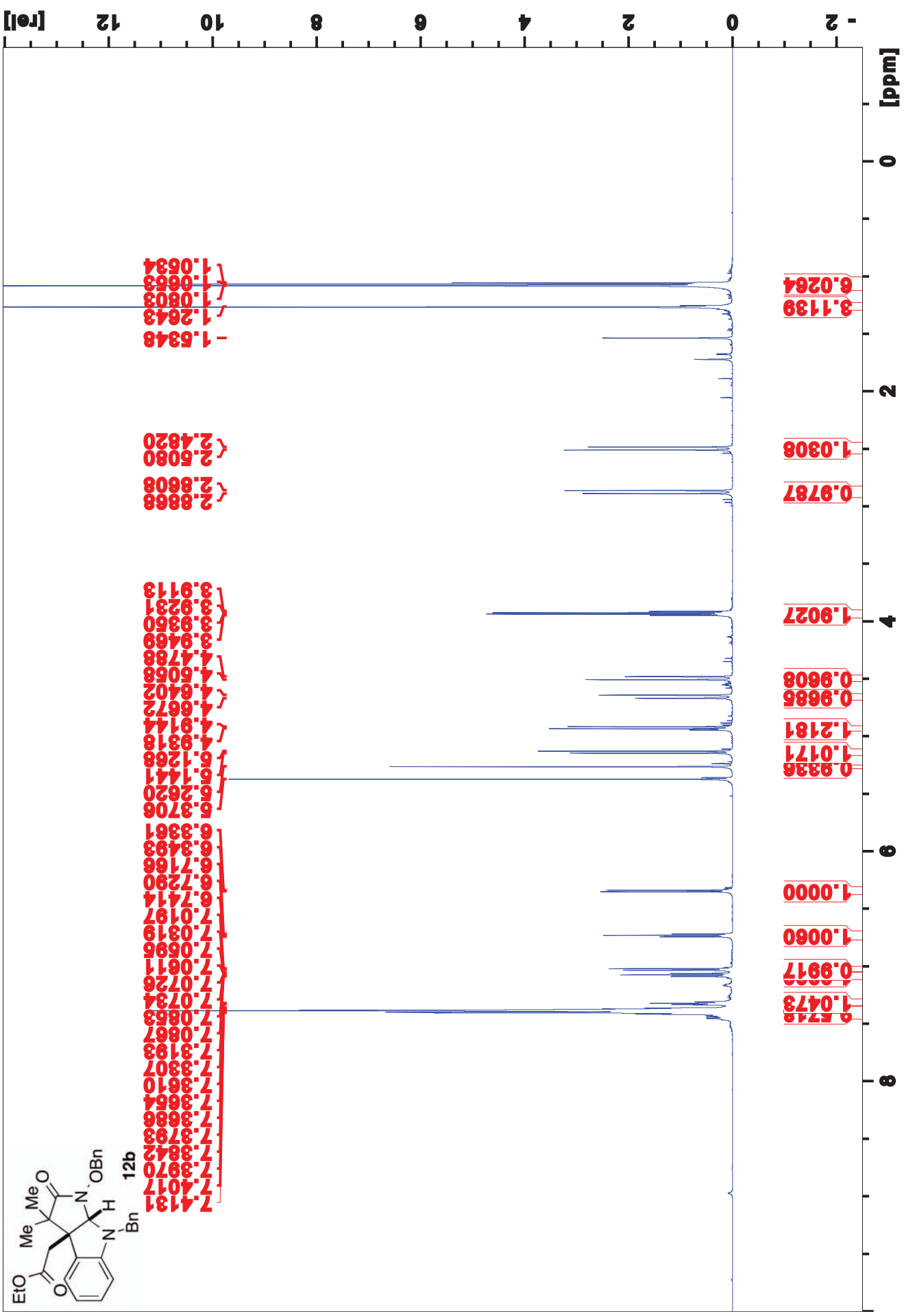
(4) *Jaguar, versions 7.0-8.3*, Schrödinger, LLC, New York, NY: 2007-2014.

(5) (a) Marten, B.; Kim, K.; Cortis, C.; Friesner, R. A.; Murphy, R. B.; Ringnalda, M. N.; Sitkoff, D.; Honig, B. *J. Phys. Chem.* **1996**, *100*, 11775-11788; (b) Tannor, D. J.; Marten, B.; Murphy, R.; Friesner, R. A.; Sitkoff, D.; Nicholls, A.; Honig, B.; Ringnalda, M.; Goddard, W. A. *J. Am. Chem. Soc.* **1994**, *116*, 11875-11882.

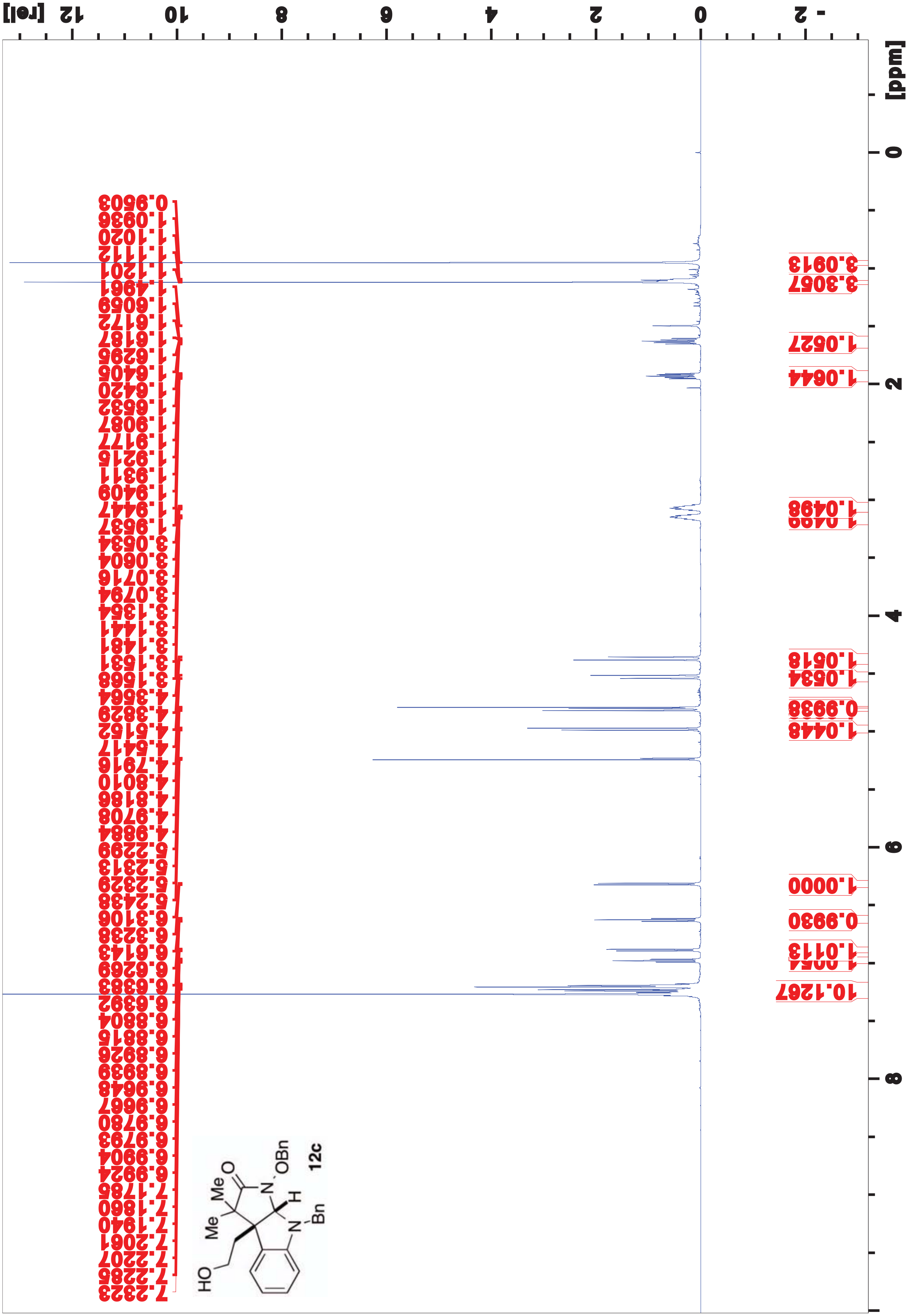
(6) Legault, C. Y. *CYLview, 1.0b*, Université de Sherbrooke: Université de Sherbrooke, 2009.

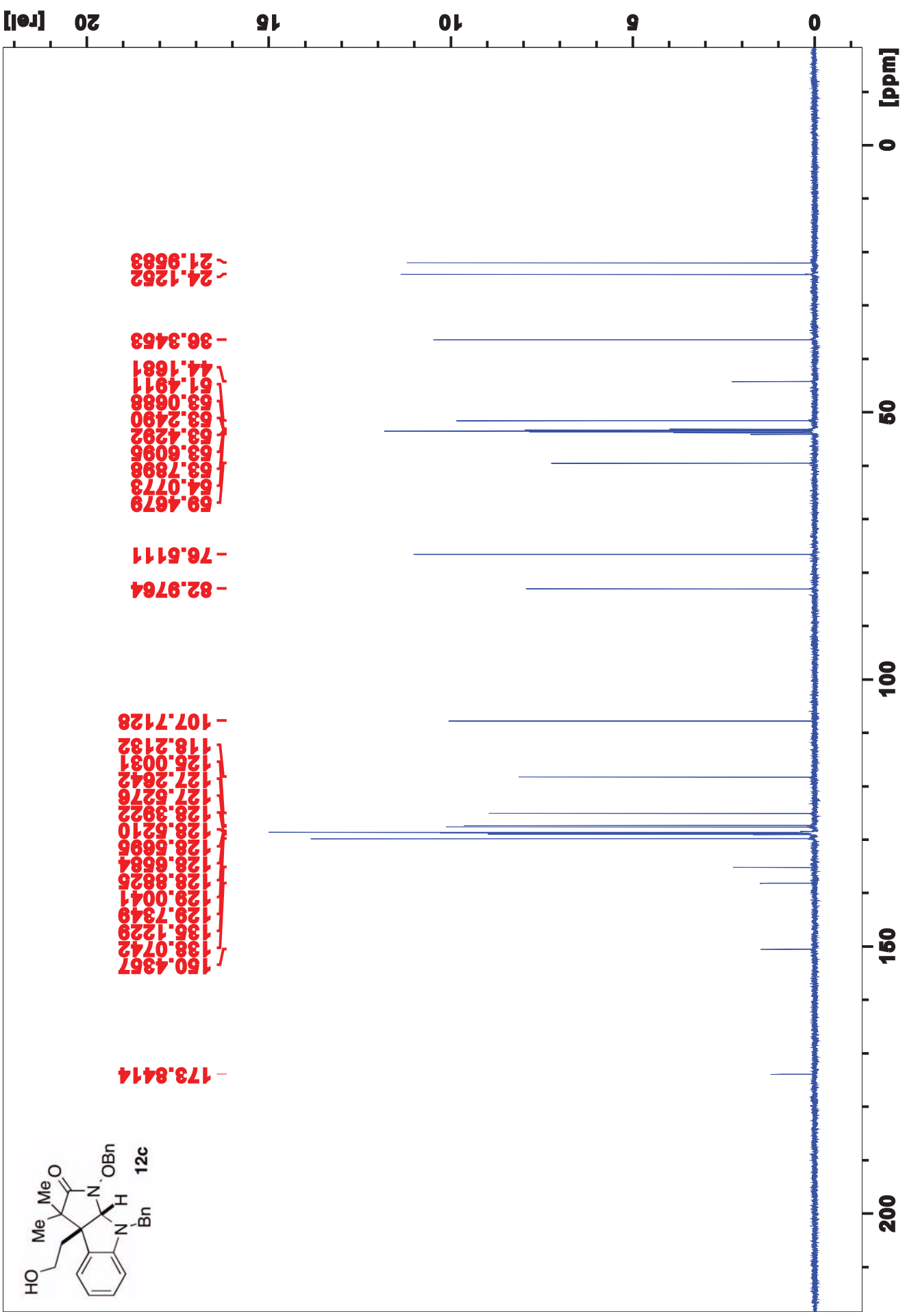

12a
Me
Me
O
N
OBn
H
N
Bn
7.2580
7.2528
7.2498
7.2464
7.2406
7.2282
7.2191
7.2161
7.1925
7.1809
7.1696
7.1677
6.9492
6.9474
6.9362
6.9346
6.9236
6.9217
6.9135
6.9012
6.6160
6.6150
6.6037
6.6027
6.5914
6.5906
6.2606
6.2373
6.2347
6.2239
6.2224
6.2207
4.9832
4.9667
4.8166
4.7981
4.6447
4.6168
4.3761
4.3483
1.5181
1.1264
1.1033
0.9629
9.8440
2.0420
0.9984
1.0000
1.0290
1.0422
2.0434
1.0451
3.0982
3.0440
[ppm]
[rel]

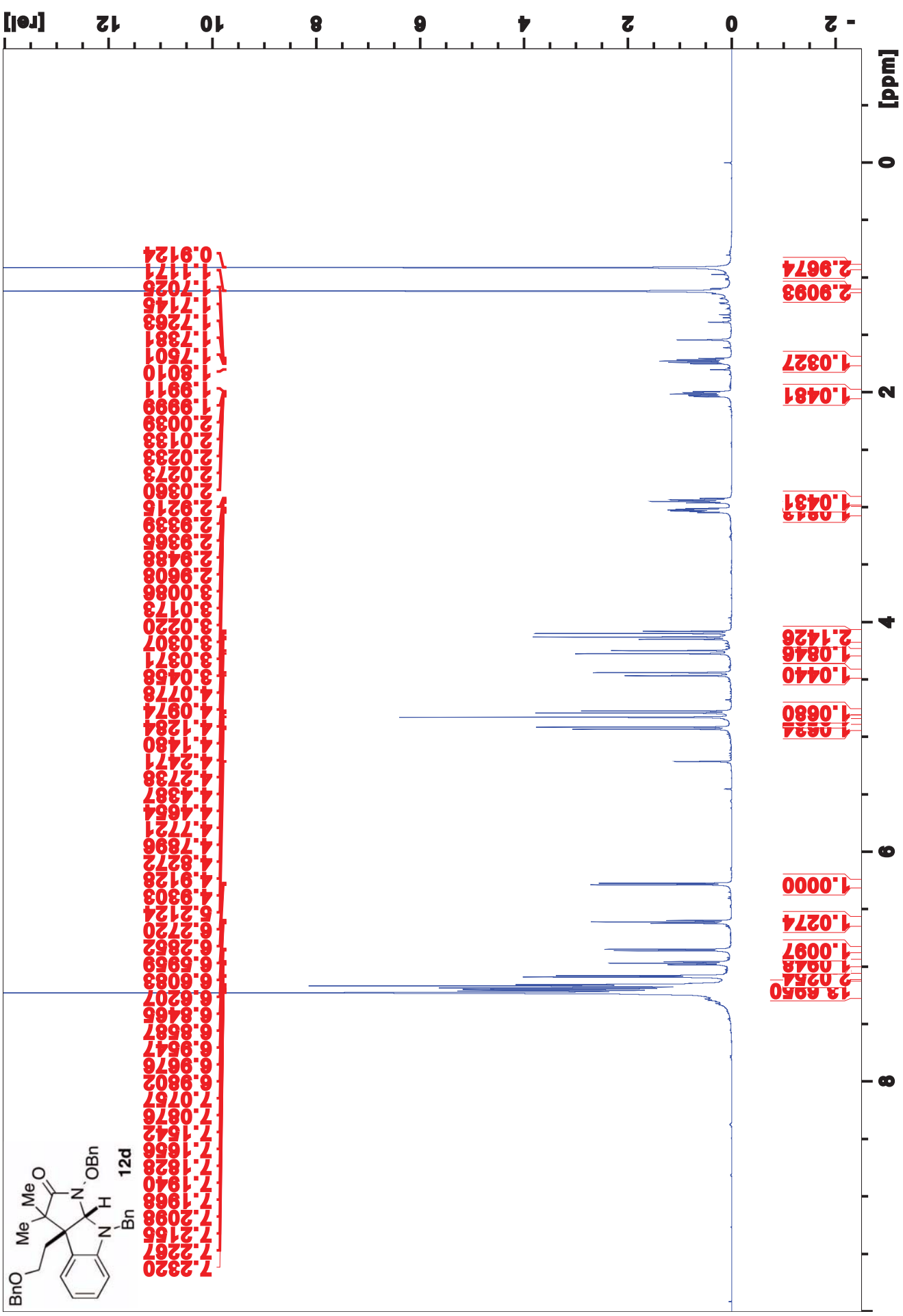
174.1024
149.7992
138.3411
136.1447
132.3180
129.6700
128.8896
128.6627
128.5068
128.3361
127.1661
127.1422
124.2746
118.2072
107.4660
86.0018
76.7637
63.8327
63.7967
63.6163
63.4360
63.2646
63.0741
61.6903
43.5623
24.1682
21.7192
21.6738
[rel]
20
15
10
5
0
[ppm]
0
50
100
150
200
12a
Me
Me
O
N
OBn
H
N
Bn
Me

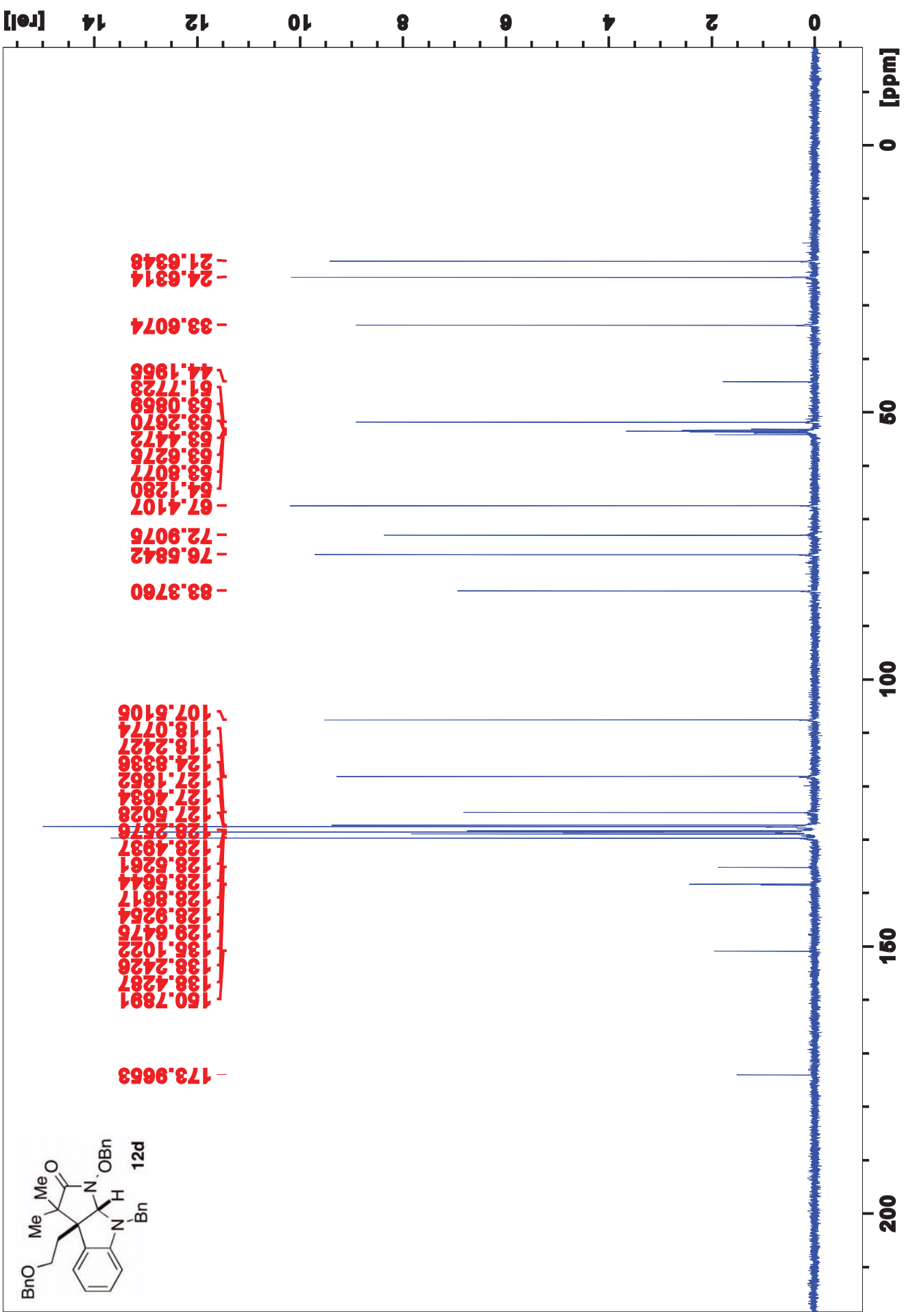

12b
EtO
Me
Me
O
N
OBn
H
N
Bn
O
[ppm]
0.9787
1.0308
1.9027
0.9608
0.9685
1.2181
0.9336
1.0171
1.0000
1.0060
0.9917
1.0473
6.0264
3.1139

[ppm]
0
50
100
150
200
[rel]
0
5
10
15
20
173.8060
170.1661
161.0632
136.6328
135.0648
129.6660
128.9264
128.8596
128.7439
128.6360
128.4776
127.1919
127.0982
124.3884
118.0194
107.3611
84.6937
76.6408
60.4483
53.8098
53.6292
53.4487
53.2683
53.1965
53.0879
52.7886
43.9799
39.0606
25.3616
23.7045
21.3383
13.7317
12b
EtO
Me
Me
O
O
N
OBn
H
N
Bn


[ppm]
[rel]
HO
Me
Me
O
N
OBn
H
N
Bn
12c
0.9603
1.0936
1.1020
1.1112
1.1201
1.4961
1.6059
1.6172
1.6187
1.6295
1.6406
1.6420
1.6632
1.9087
1.9177
1.9215
1.9311
1.9409
1.9447
1.9537
3.0634
3.0604
3.0716
3.0794
3.1364
3.1441
3.1481
3.1531
3.1568
4.3564
4.3829
4.5152
4.5417
4.7916
4.8010
4.8186
4.9708
4.9884
5.2299
5.2313
5.2329
5.2438
6.3106
6.3238
6.6143
6.6269
6.6383
6.6392
6.8804
6.8815
6.8926
6.8939
6.9648
6.9667
6.9780
6.9793
6.9904
6.9924
7.1785
7.1860
7.1940
7.2061
7.2207
7.2285
7.2323
3.0913
3.3057
1.0627
1.0644
1.0498
1.0518
1.0534
0.9938
1.0448
1.0000
0.9930
1.0113
10.1267

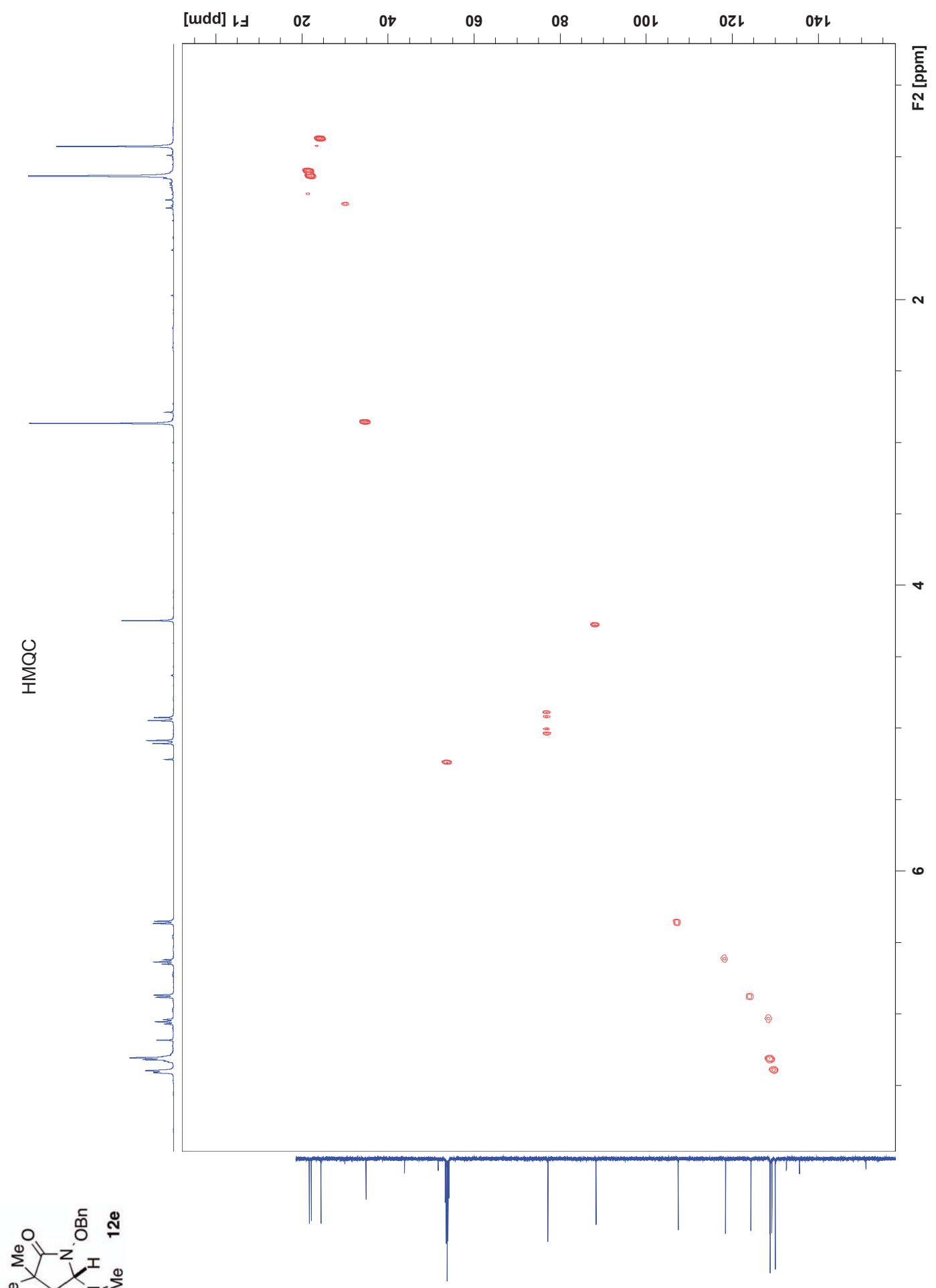

[ppm]
0
50
100
150
200
[rel]
0
5
10
15
20
173.8414
150.4357
138.0742
136.1229
129.7349
129.0041
128.8825
128.6684
128.6995
128.6210
128.3922
127.6276
127.2642
126.0031
118.2182
107.7128
82.9764
76.5111
59.4679
64.0773
63.7898
63.6096
63.4292
63.2490
63.0688
61.4911
44.1681
36.3463
24.1252
21.9583
12c
Me
Me
O
N
OBn
H
N
Bn
HO

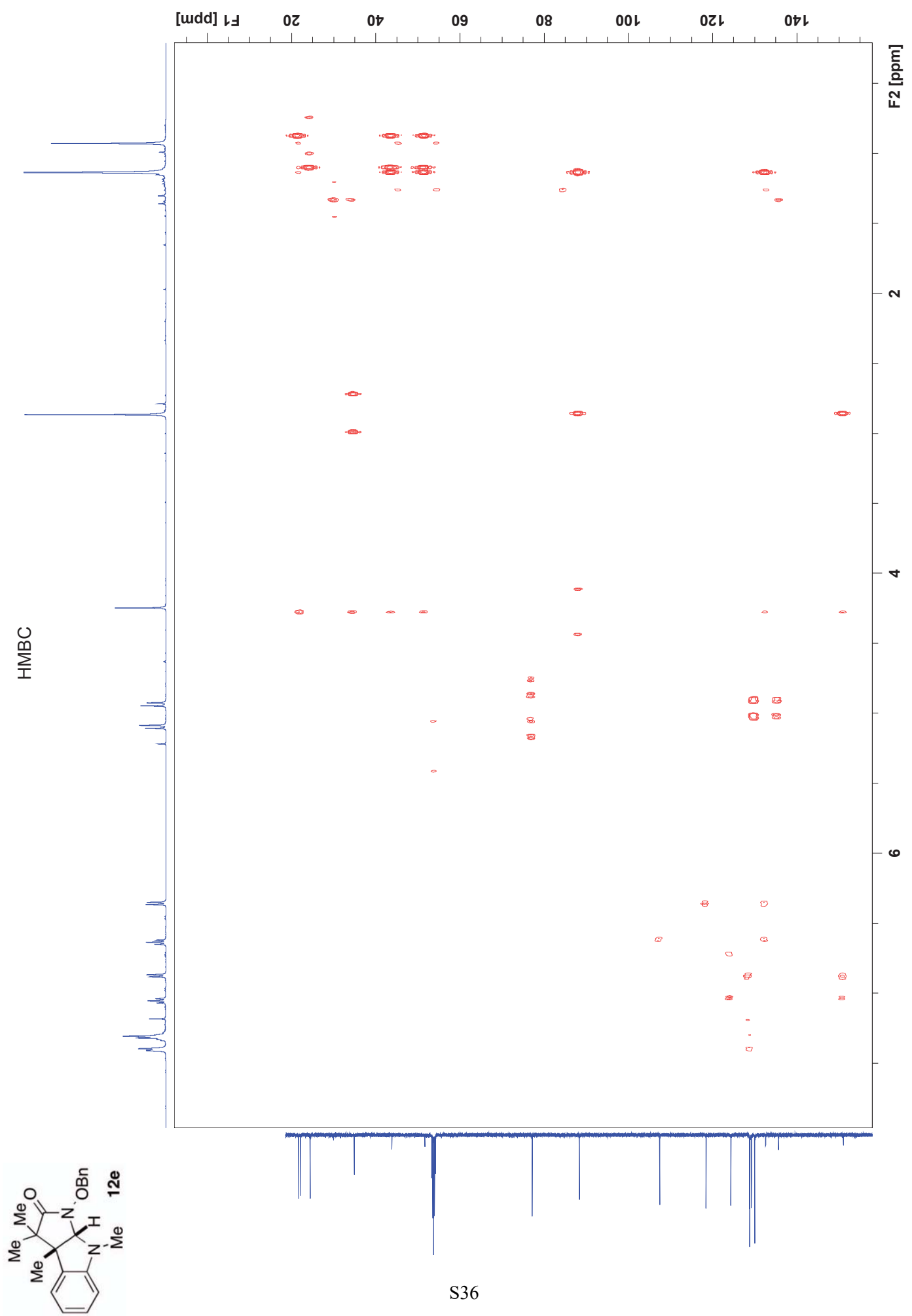

12d
BnO
Me
Me
O
OBn
N
H
N
Bn
[ppm]
0
2
4
6
8
10
12
-2
7.2320
7.2267
7.2166
7.2098
7.1968
7.1940
7.1828
7.1656
7.1642
7.0876
7.0767
6.9802
6.9676
6.9647
6.8587
6.8466
6.6207
6.6083
6.5969
6.5862
6.2720
6.2124
4.9303
4.9128
4.8272
4.7896
4.7721
4.6654
4.4387
4.2738
4.2471
4.1480
4.1264
4.0974
4.0778
3.0468
3.0371
3.0307
3.0220
3.0173
3.0086
2.9488
2.9366
2.9339
2.9216
2.0360
2.0273
2.0233
2.0133
2.0039
1.9999
1.9911
1.8010
1.7601
1.7381
1.7263
1.7146
1.7025
1.1171
0.9124
2.9674
2.9093
1.0327
1.0481
1.0431
2.1426
1.0846
1.0440
1.0680
1.0274
1.0000
1.0097
1.0048
2.0254
13.6050

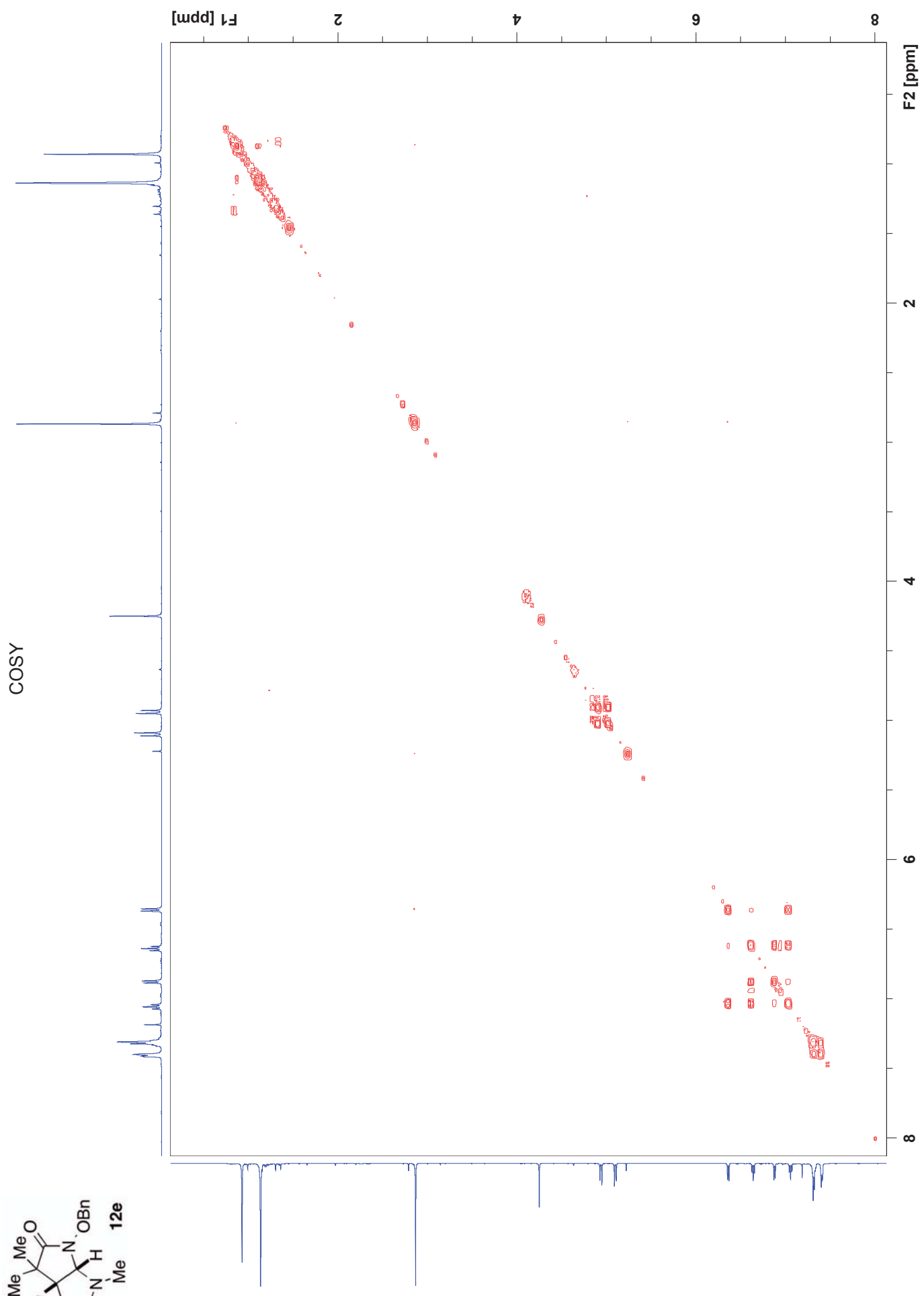

173.9663
160.7891
138.4287
138.2426
135.1022
129.6476
128.9264
128.8617
128.5644
128.0261
128.4937
128.2676
127.5028
127.4634
127.1862
124.8336
118.2427
118.0774
107.6105
83.3760
76.5842
72.9075
67.4107
64.1280
63.8077
63.6276
63.4472
63.2670
63.0869
61.7723
44.1965
33.6074
24.6314
21.6348
[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
12
14
12d
BnO
Me
Me
O
N
OBn
H
N
Bn

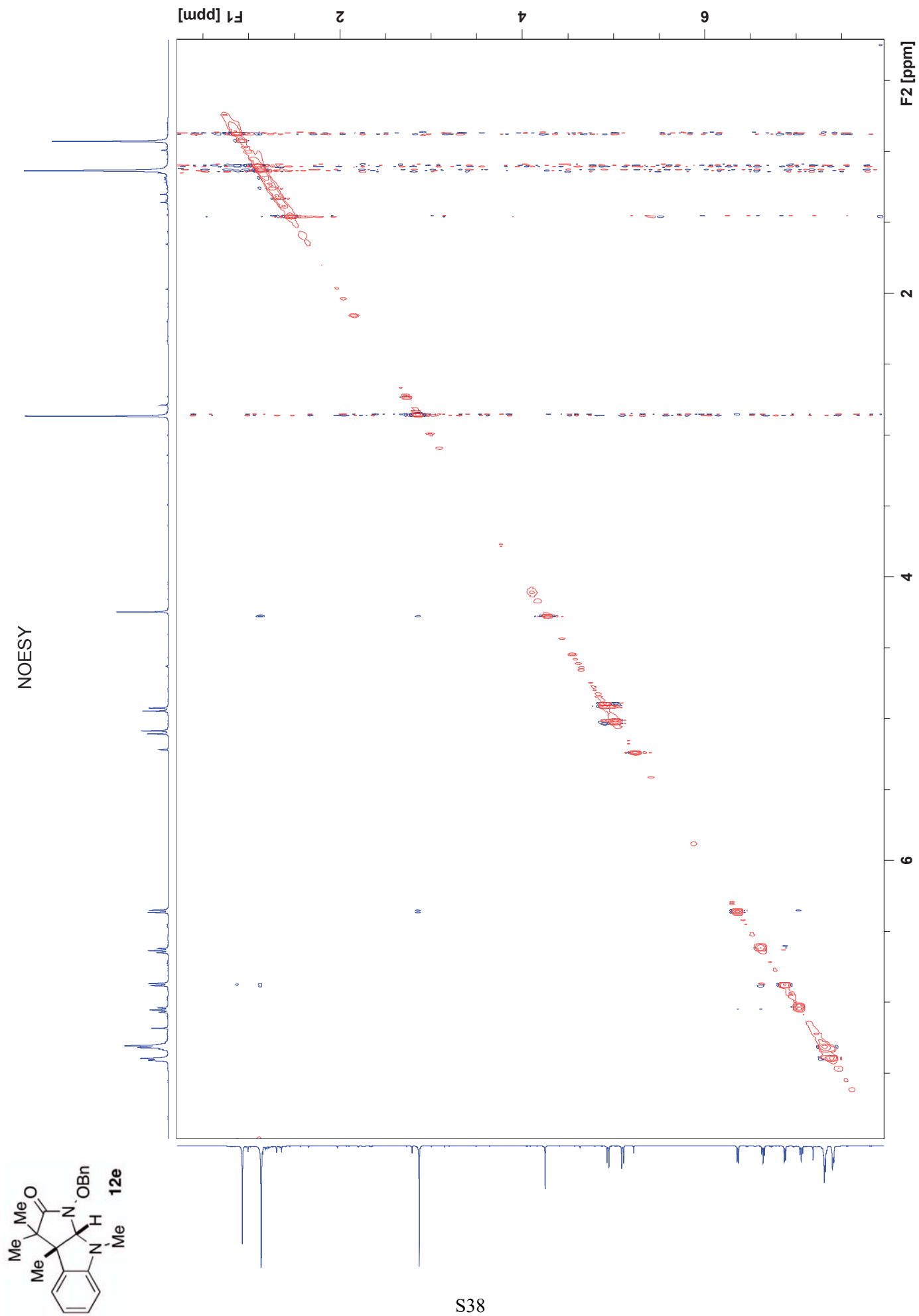
12e
Me
Me
O
N
OBn
H
N
Me
Me
7.6296
7.6266
7.6164
7.6142
7.4638
7.4591
7.4566
7.4536
7.4491
7.4366
7.4337
7.4261
7.4260
7.1743
7.1726
7.1614
7.1598
7.1488
7.1470
7.0110
6.9988
6.7642
6.7419
6.7304
6.7296
6.4928
6.4797
6.3684
6.3668
6.1601
6.1425
6.0413
6.0237
4.4057
2.9837
1.6968
1.2602
1.2278
1.0021
2.1469
2.8816
1.0660
0.9899
0.9687
1.0000
1.0666
1.0258
0.9818
3.0411
3.0167
3.1647
[ppm]

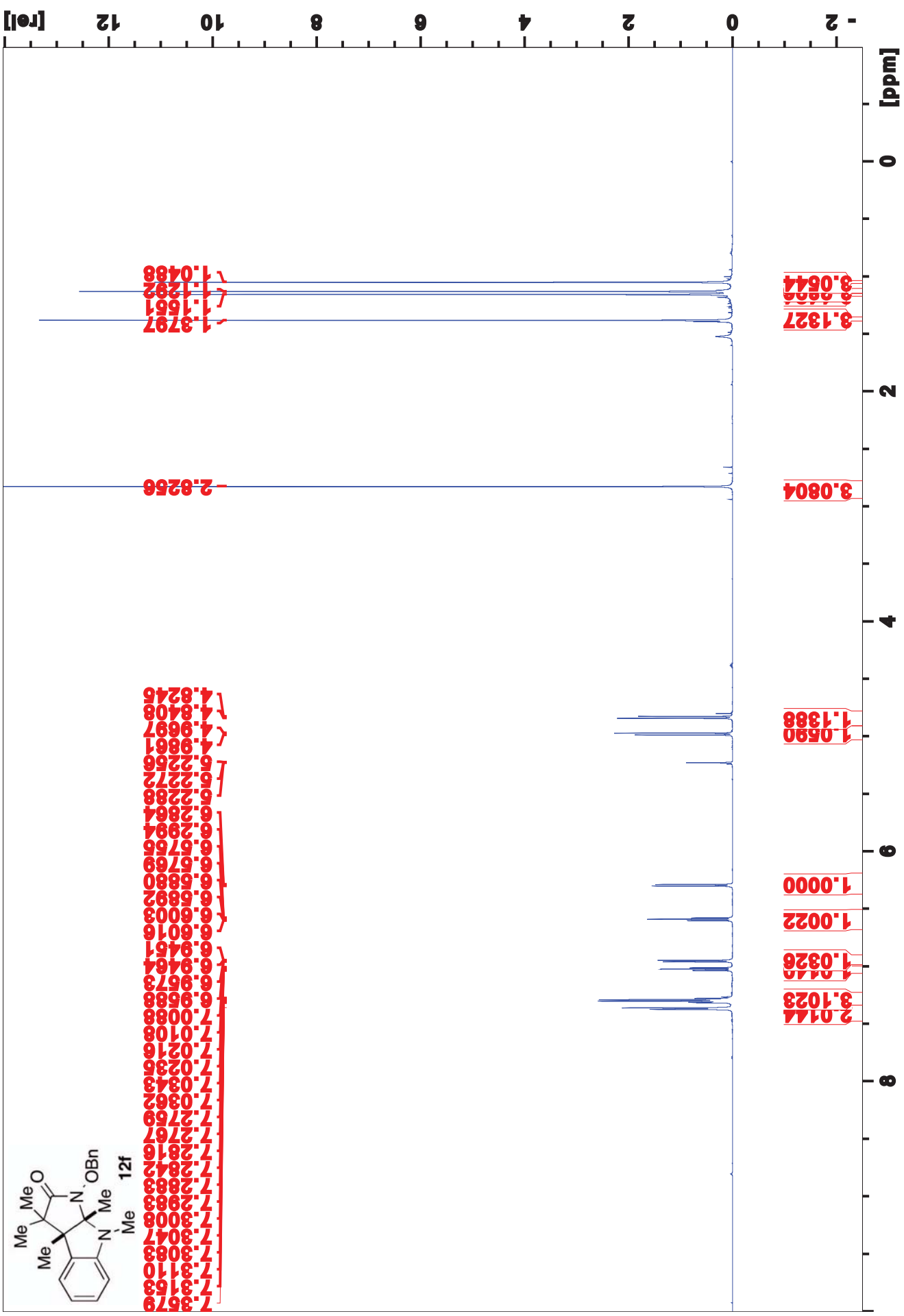
[rel]
14
12
10
8
6
4
2
0
[ppm]
0
50
100
150
200
174.1688
160.7569
135.3102
132.2937
129.6983
128.8247
128.6406
128.4068
124.0144
118.1359
107.1424
88.0757
76.8434
63.7960
63.6166
63.4362
63.2649
63.0746
61.3645
43.5102
34.6199
24.1542
21.9004
21.4438
12e
Me
O
OBn
N
H
N
Me
Me
Me


HMQC
F1 [ppm]
20
40
60
80
100
120
140
F2 [ppm]
2
4
6
Me
O
OBn
12e
Me
H
N
Me
N
Me

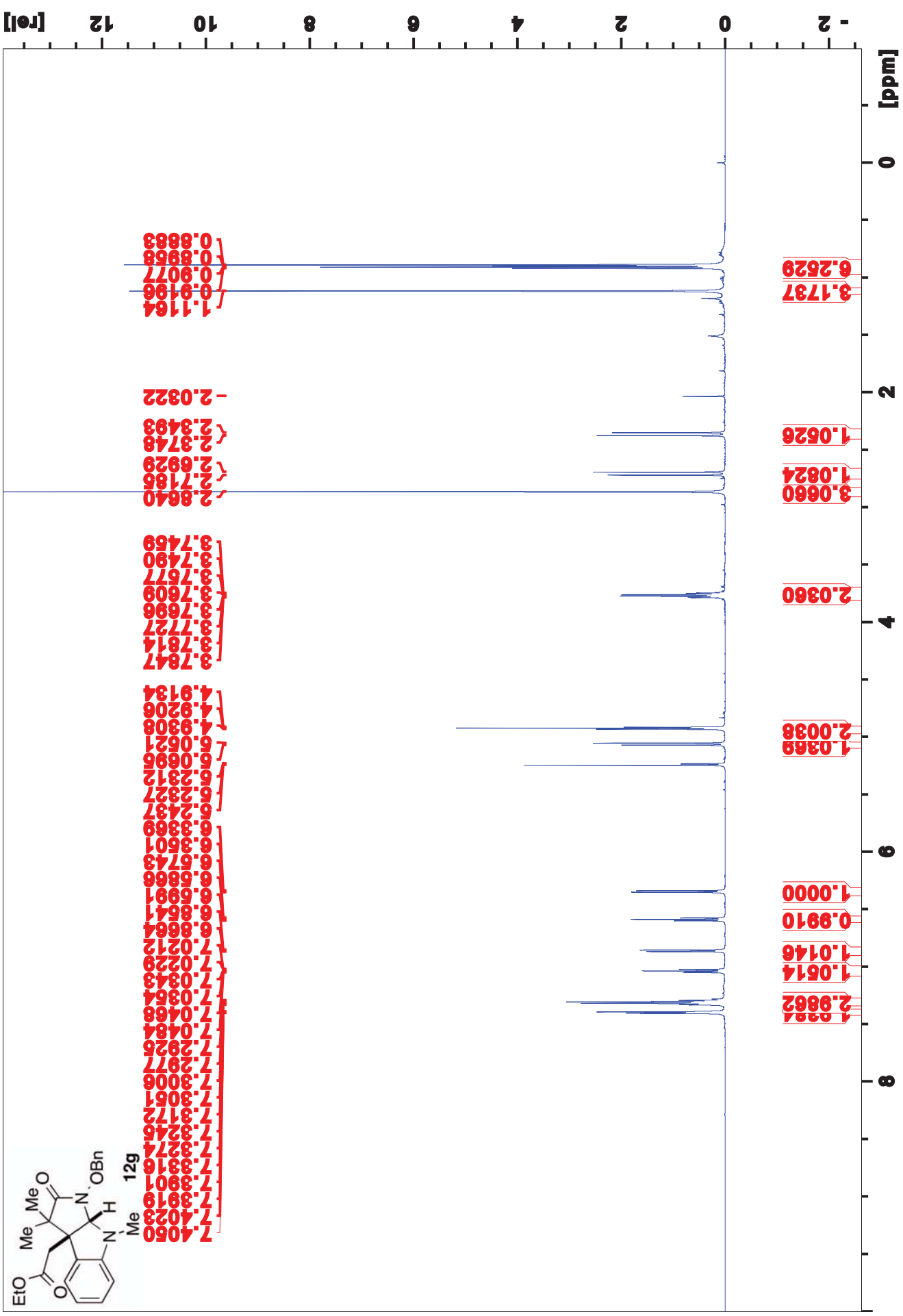

HMBC
F1 [ppm]
20
40
60
80
100
120
140
F2 [ppm]
2
4
6
Me
Me
O
N
OBn
H
N
Me
Me
12e


COSY
F1 [ppm]
F2 [ppm]
2
4
6
8
Me
Me
Me
Me
O
N
OBn
H
N
12e

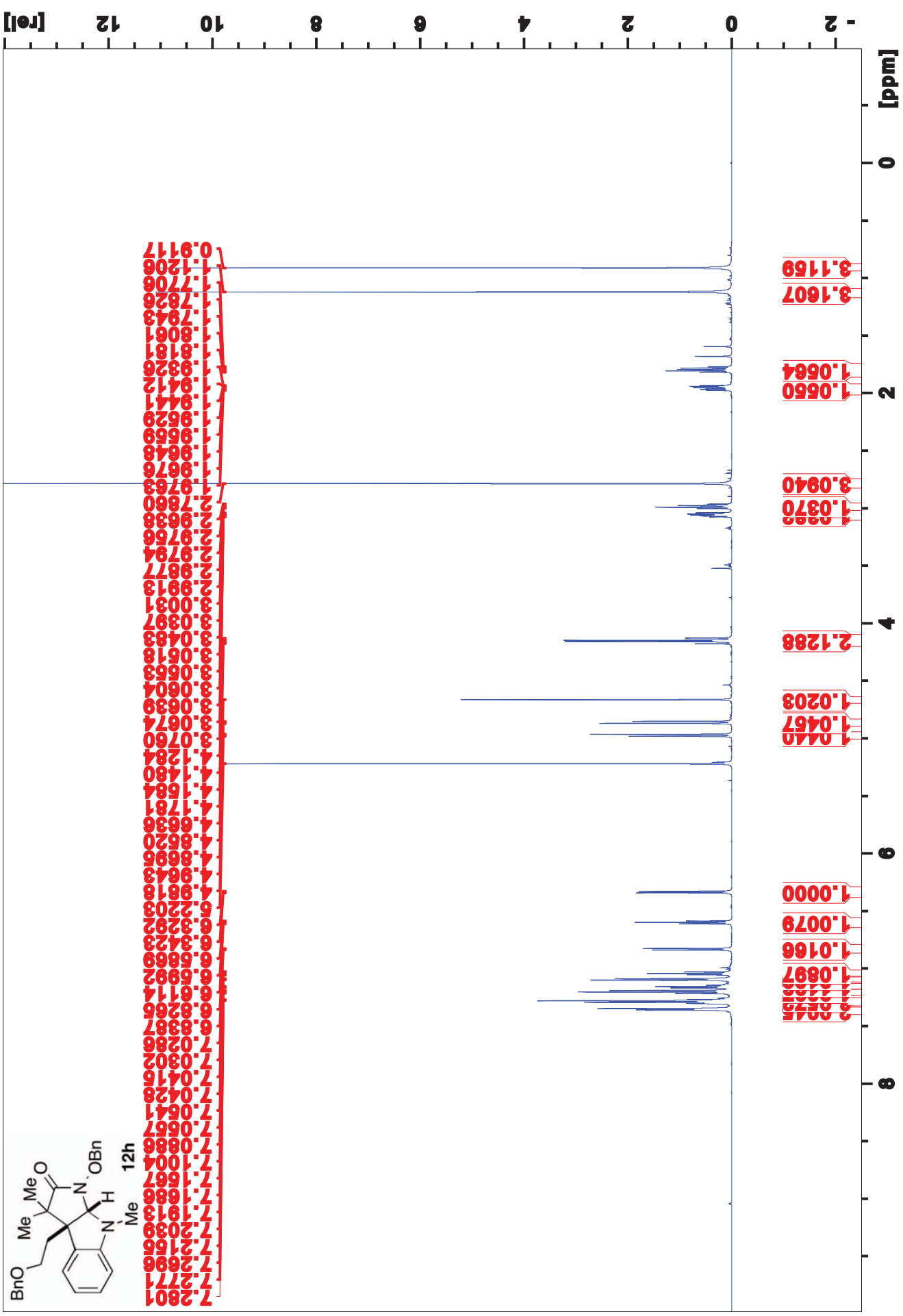

NOESY
F1 [ppm]
F2 [ppm]
2
4
6
Me
O
N
OBn
H
Me
Me
N
Me
12e


12f
Me
Me
Me
Me
Me
O
N
OBn
N
[ppm]

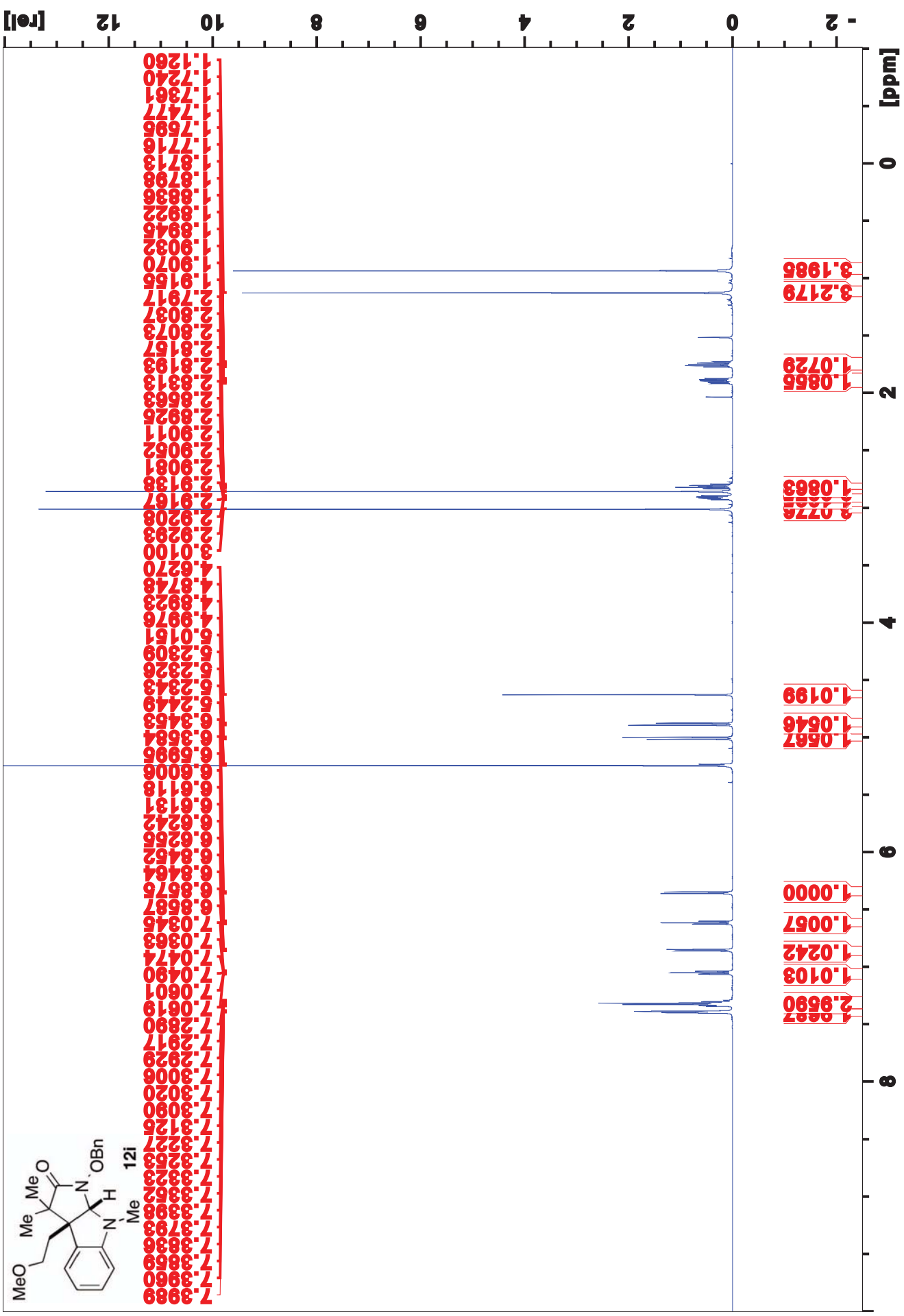
16.0604
18.3383
22.6880
23.9461
29.3832
43.2009
53.0702
53.2605
53.4305
53.6106
53.7908
53.8322
77.4283
78.2011
87.7669
105.9808
117.3844
125.0828
128.3098
128.4496
128.6800
129.3085
132.2184
135.2745
149.0262
173.7567
12f
Me
Me
Me
Me
Me
O
N
OBn
[ppm]
[rel]


12g
EtO
Me
Me
Me
OBn
[ppm]
6.2629
3.1737
1.0526
1.0824
3.0660
2.0360
1.0369
2.0038
1.0000
0.9910
1.0146
1.0614
2.9862

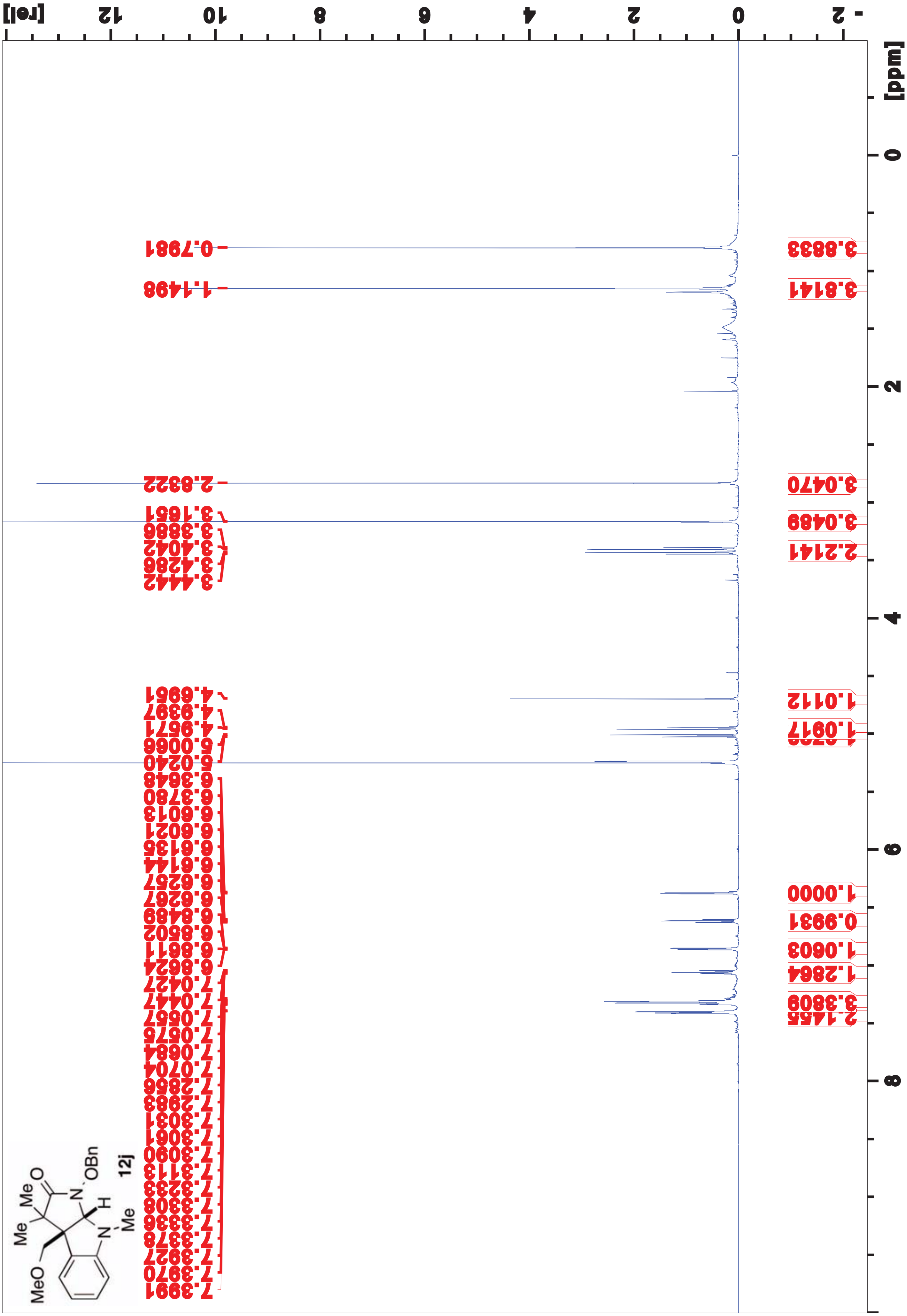
13.6763
21.6848
24.9779
34.9941
39.2861
43.8621
53.0682
53.1230
53.2483
53.4287
53.6090
53.7894
60.3831
76.8418
86.6938
107.1362
117.7813
124.6212
128.6210
128.6162
128.8249
128.9030
129.6841
135.2102
161.6121
170.1806
173.4673
[ppm]
[rel]
12g
OBn
Me
Me
Me
EtO
O
O
N
N
H

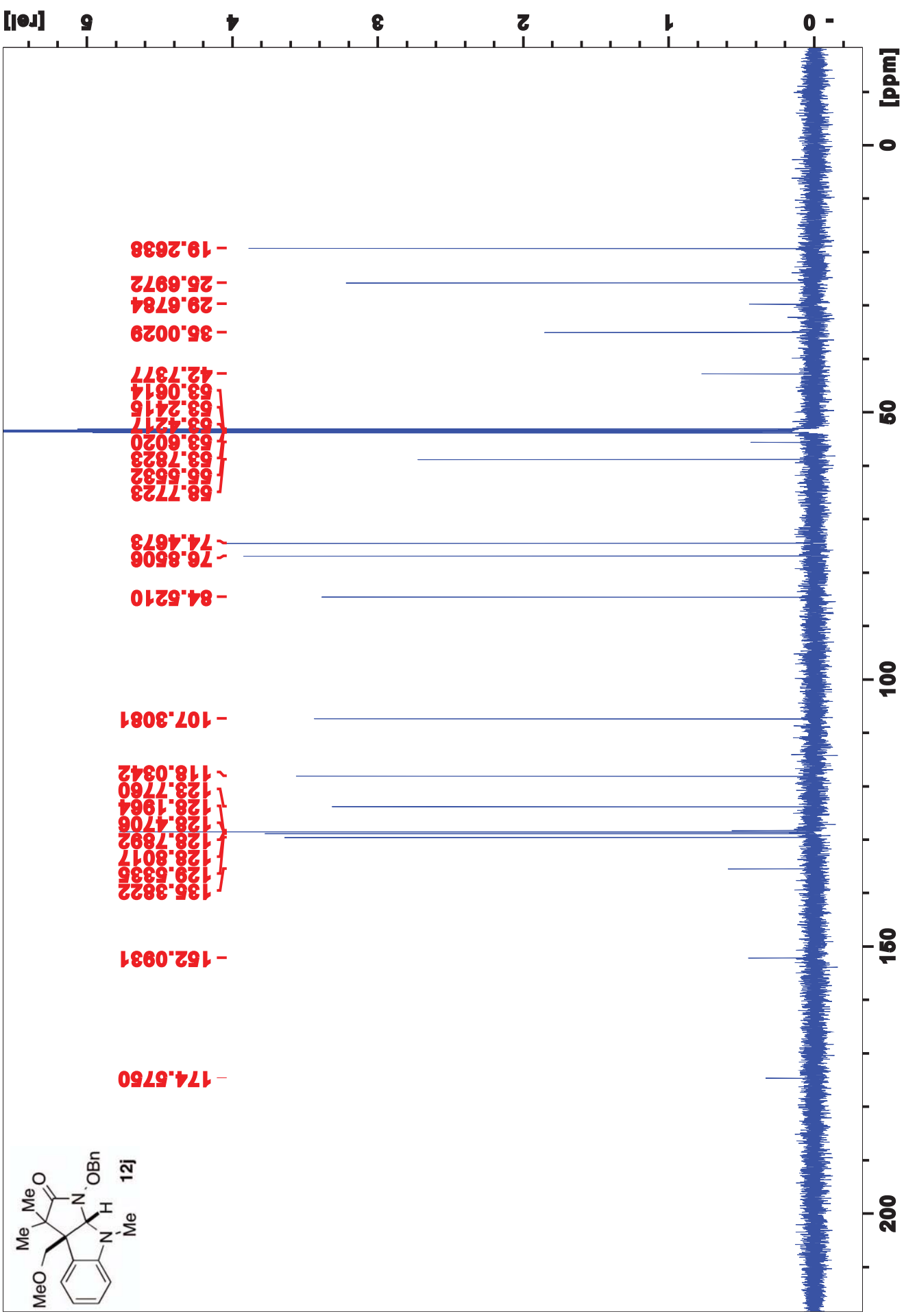

12h
BnO
Me
Me
O
N
OBn
H
N
Me
[ppm]
[rel]
3.1159
3.1607
1.0564
1.0550
3.0940
1.0370
2.1288
1.0203
1.0467
1.0000
1.0079
1.0166
1.0897

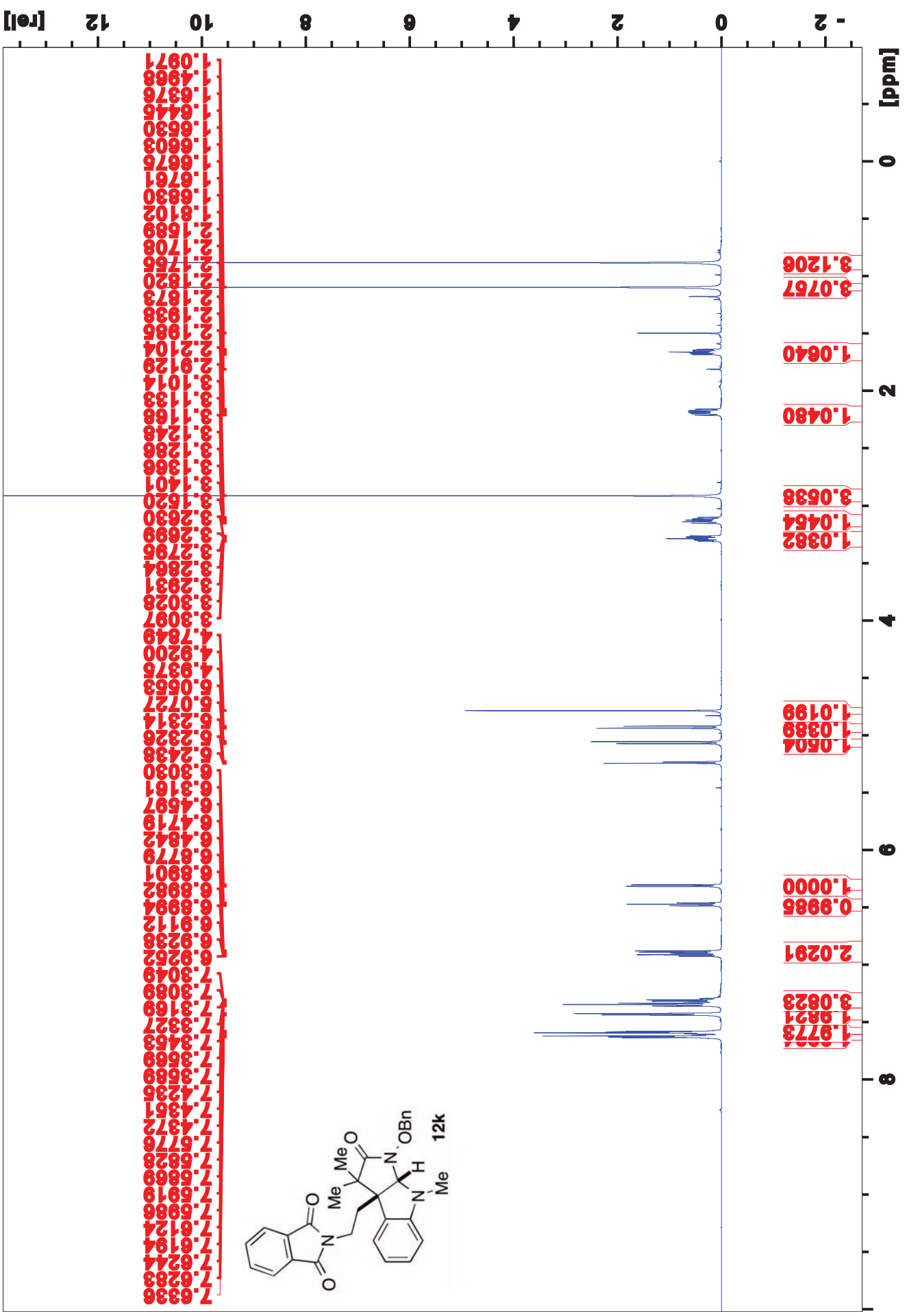
22.2110
24.1189
33.6602
34.3881
44.0602
63.0922
63.2723
63.4624
63.6326
63.8127
63.8613
64.2679
67.3684
72.9332
76.7400
86.1202
107.0192
117.8316
124.9693
127.4448
127.4737
128.2466
128.6479
128.6660
128.8966
129.0681
129.6472
136.3232
136.4471
151.3013
173.7270
12h
BnO
Me
Me
O
N
OBn
H
N
Me
[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
12
14


12i
MeO
Me
Me
O
N
OBn
H
N
Me
[ppm]
[rel]
3.1986
3.2179
1.0729
1.0865
1.0863
1.0199
1.0546
1.0567
1.0000
1.0057
1.0242
1.0103
2.9590
1.0567

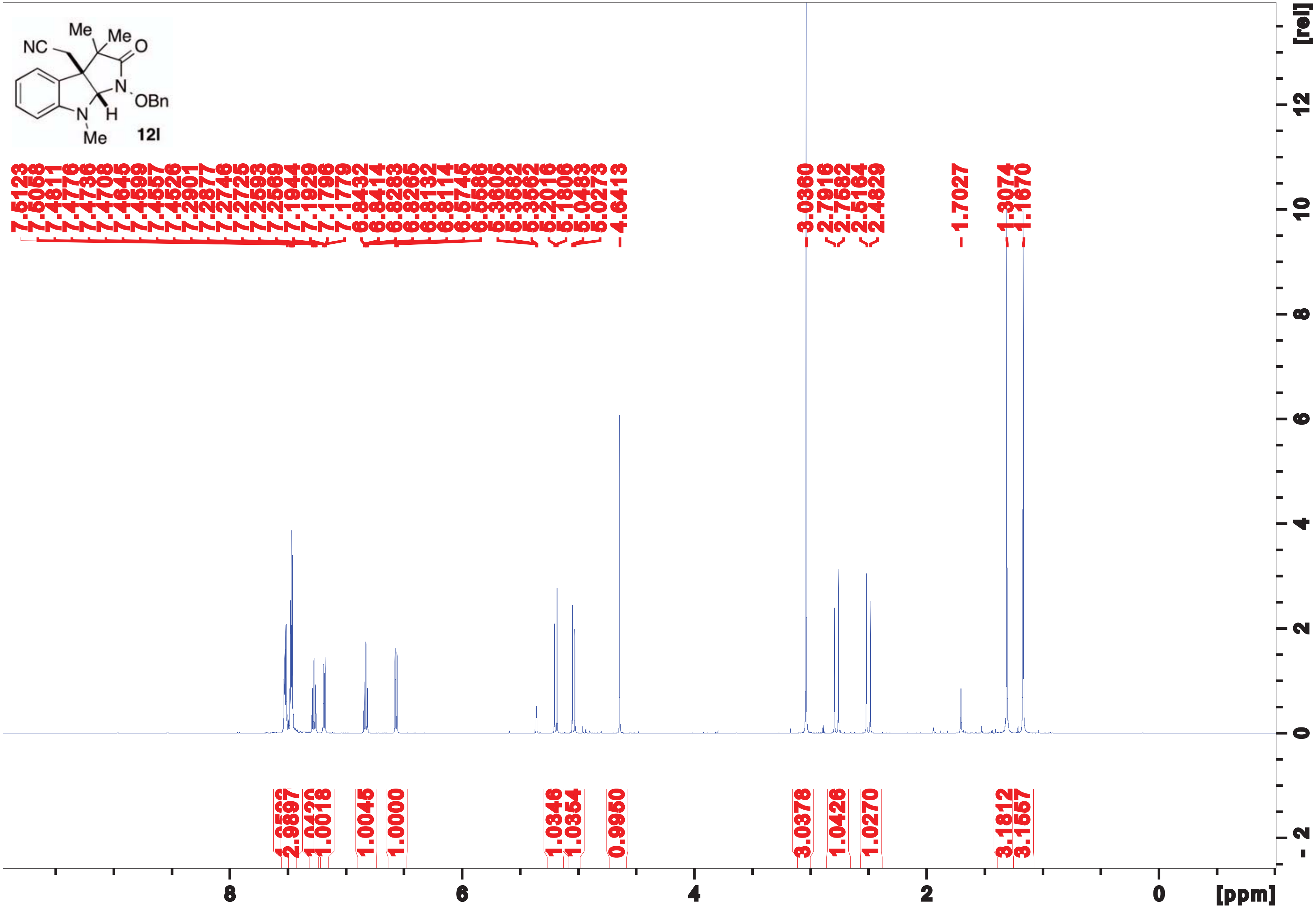
[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
12
14
173.6699
161.2028
135.3481
129.6194
129.1504
128.8742
128.6312
128.6426
125.0101
117.8029
107.0123
86.0564
76.7724
69.4041
68.2825
64.2148
63.8265
63.7890
63.6086
63.4281
63.2479
63.0676
43.9807
34.4316
33.6167
23.9878
22.2979
MeO
Me
Me
O
N
OBn
H
N
Me
12i



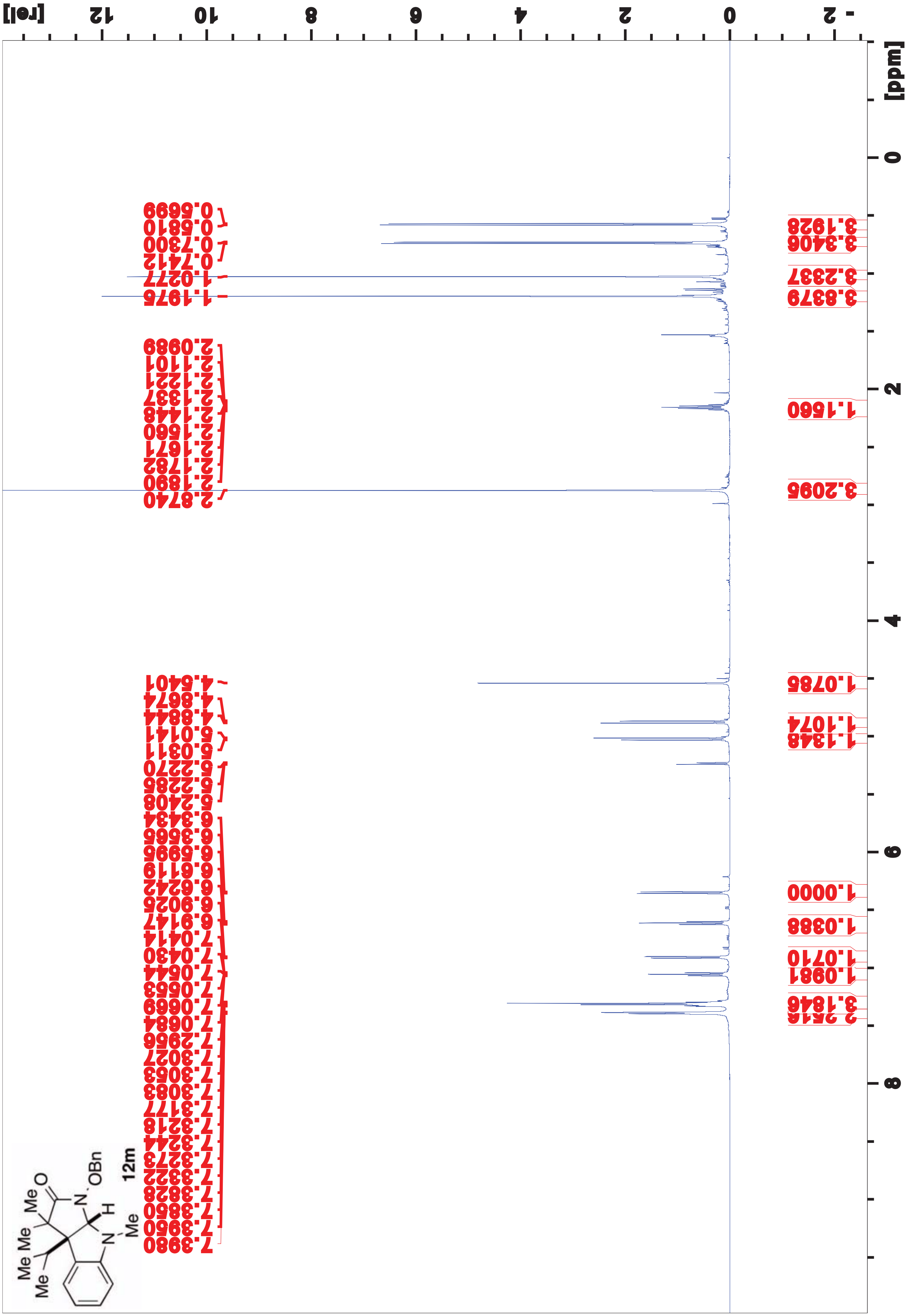

19.2638
25.6972
29.6784
35.0029
42.7377
63.0614
63.2416
63.4217
63.6020
63.7823
65.6632
68.7723
74.4673
76.8606
84.6210
107.3081
118.0342
123.7760
128.1964
128.4706
128.7892
128.8017
129.6336
135.3822
152.0931
174.6760
12j
Me
O
Me
N
OBn
H
N
Me
MeO
[rel]
6
4
3
2
1
0
[ppm]
0
50
100
150
200

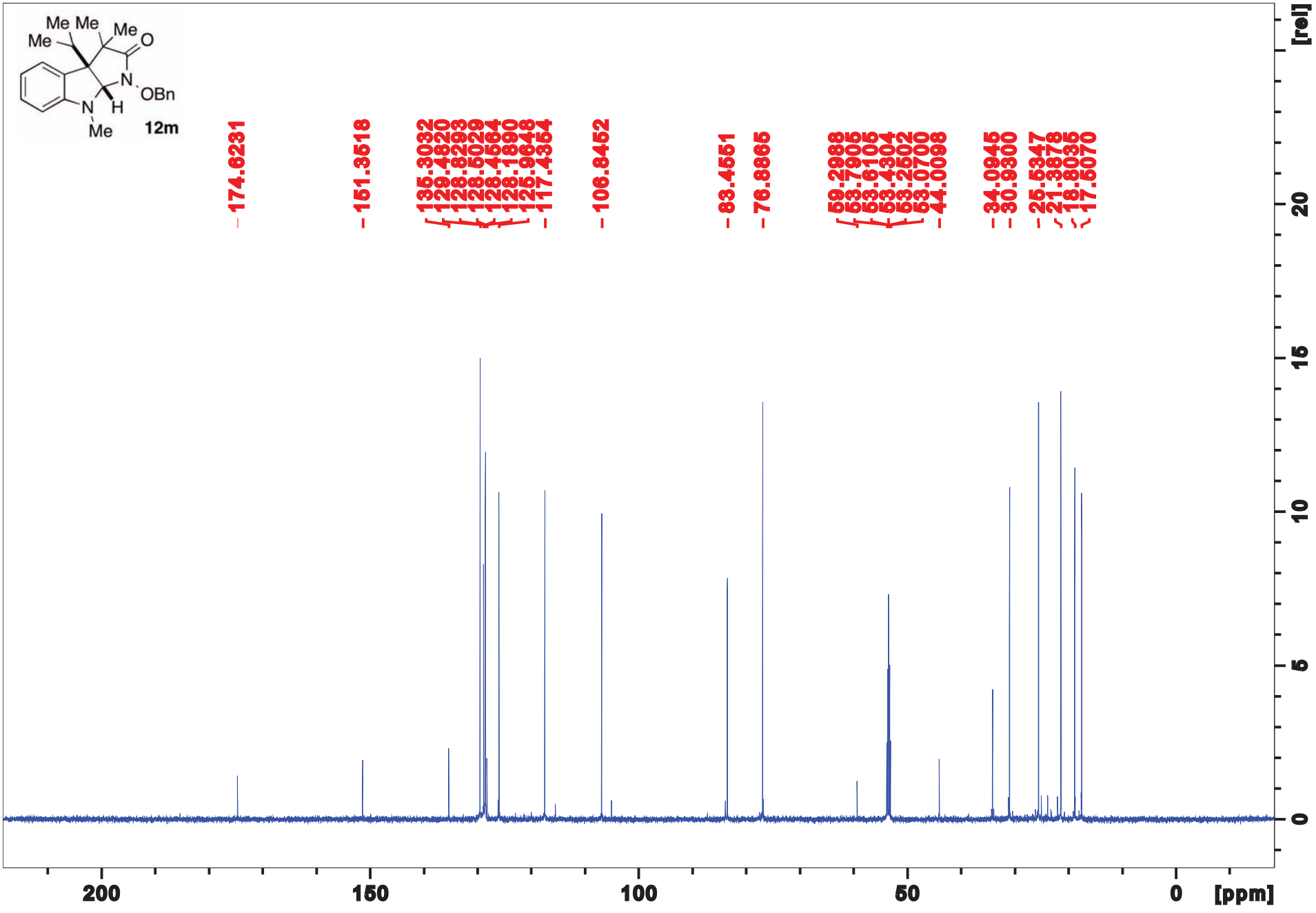

12k
Me
Me
O
N
OBn
H
N
Me
O
O
N
O

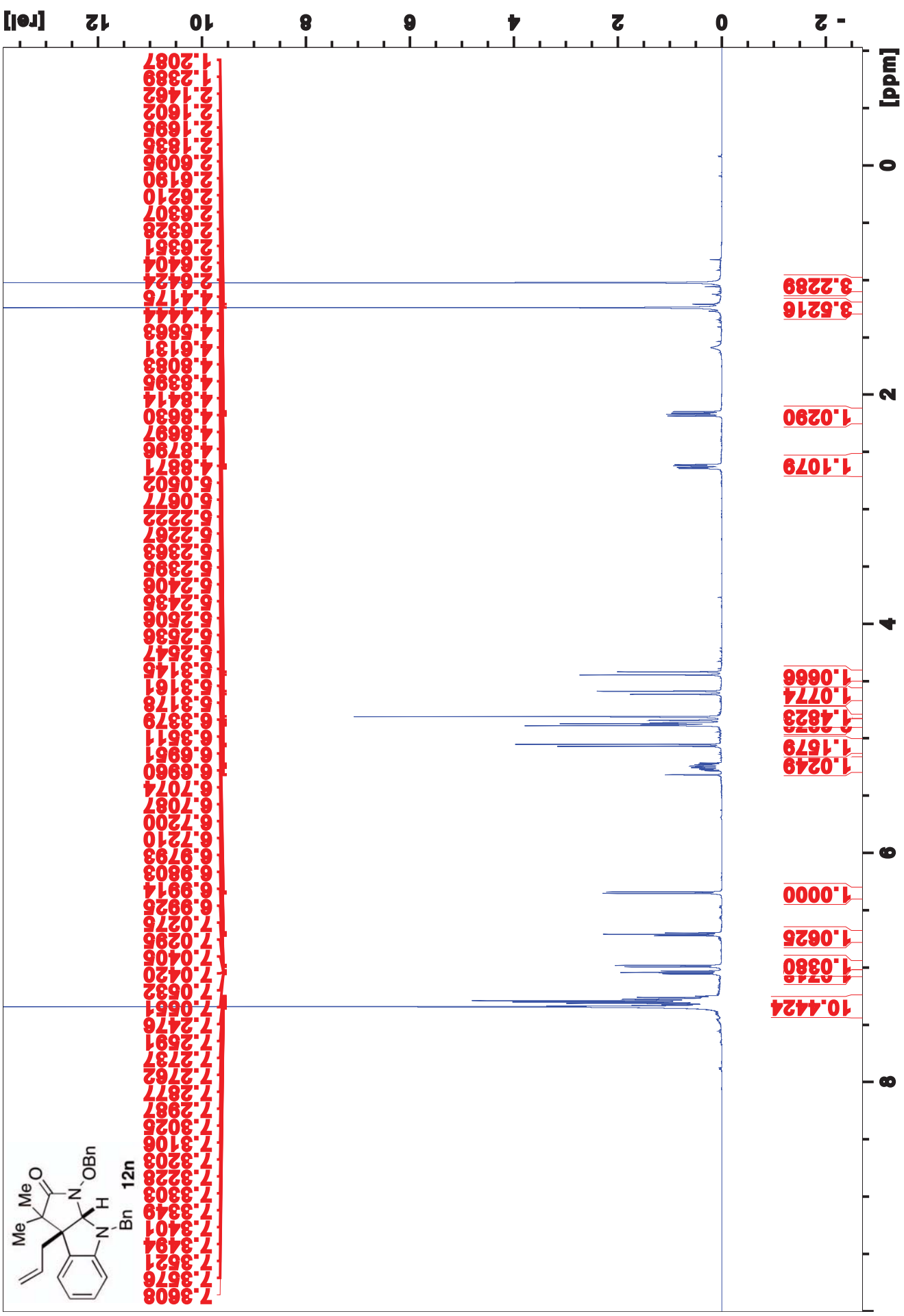
[rel]
15
10
5
0
[ppm]
0
50
100
150
200
173.6626
167.7897
161.1547
135.2363
133.7712
132.0316
129.6907
128.9699
128.6714
128.6170
128.1096
124.5766
122.8297
118.0670
107.2076
84.3681
76.8340
64.0830
63.7909
63.6109
63.4308
63.2606
63.0706
44.2479
34.2877
34.2431
31.6002
24.1906
21.6107
12k
OBn
Me
Me
Me
H
N
N
O
O
O
O


NC
Me
Me
O
N
OBn
N
H
Me
12l
7.5123
7.5058
7.4811
7.4776
7.4736
7.4708
7.4645
7.4599
7.4557
7.4526
7.2901
7.2877
7.2746
7.2725
7.2593
7.2569
7.1944
7.1929
7.1796
7.1779
6.8432
6.8414
6.8283
6.8265
6.8132
6.8114
6.5745
6.5586
5.3605
5.3582
5.3562
5.2016
5.1806
5.0483
5.0273
4.6413
3.0360
2.7916
2.7582
2.5164
2.4829
1.7027
1.3074
1.1670
2.9897
1.0018
1.0045
1.0000
1.0346
1.0354
0.9950
3.0378
1.0426
1.0270
3.1812
3.1557
[rel]
[ppm]

[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
12
14
172.4432
160.4869
134.8792
129.8365
129.7062
129.1696
128.6306
127.4456
124.7669
118.6402
116.8807
107.7869
86.0909
76.9886
63.7613
63.6808
63.4005
63.2201
63.0398
62.7863
43.4473
34.2028
24.0686
23.9200
21.8677
Me
Me
O
N
OBn
H
N
Me
NC
12l


12m
OBn
[ppm]
[rel]
0.5699
0.6810
0.7300
0.7412
1.0277
1.1975
2.0989
2.1101
2.1221
2.1337
2.1448
2.1560
2.1671
2.1782
2.1890
2.8740
4.6401
4.8674
4.8844
5.0141
5.0311
5.2270
5.2285
5.2408
6.3434
6.3665
6.5995
6.6119
6.6242
6.9025
6.9147
7.0414
7.0430
7.0644
7.0653
7.0669
7.0684
7.2956
7.3027
7.3063
7.3083
7.3177
7.3218
7.3244
7.3273
7.3322
7.3828
7.3850
7.3950
7.3980
3.1928
3.3406
3.2337
3.8879
1.1560
3.2095
1.0785
1.1074
1.1348
1.0000
1.0388
1.0710
1.0981
3.1846

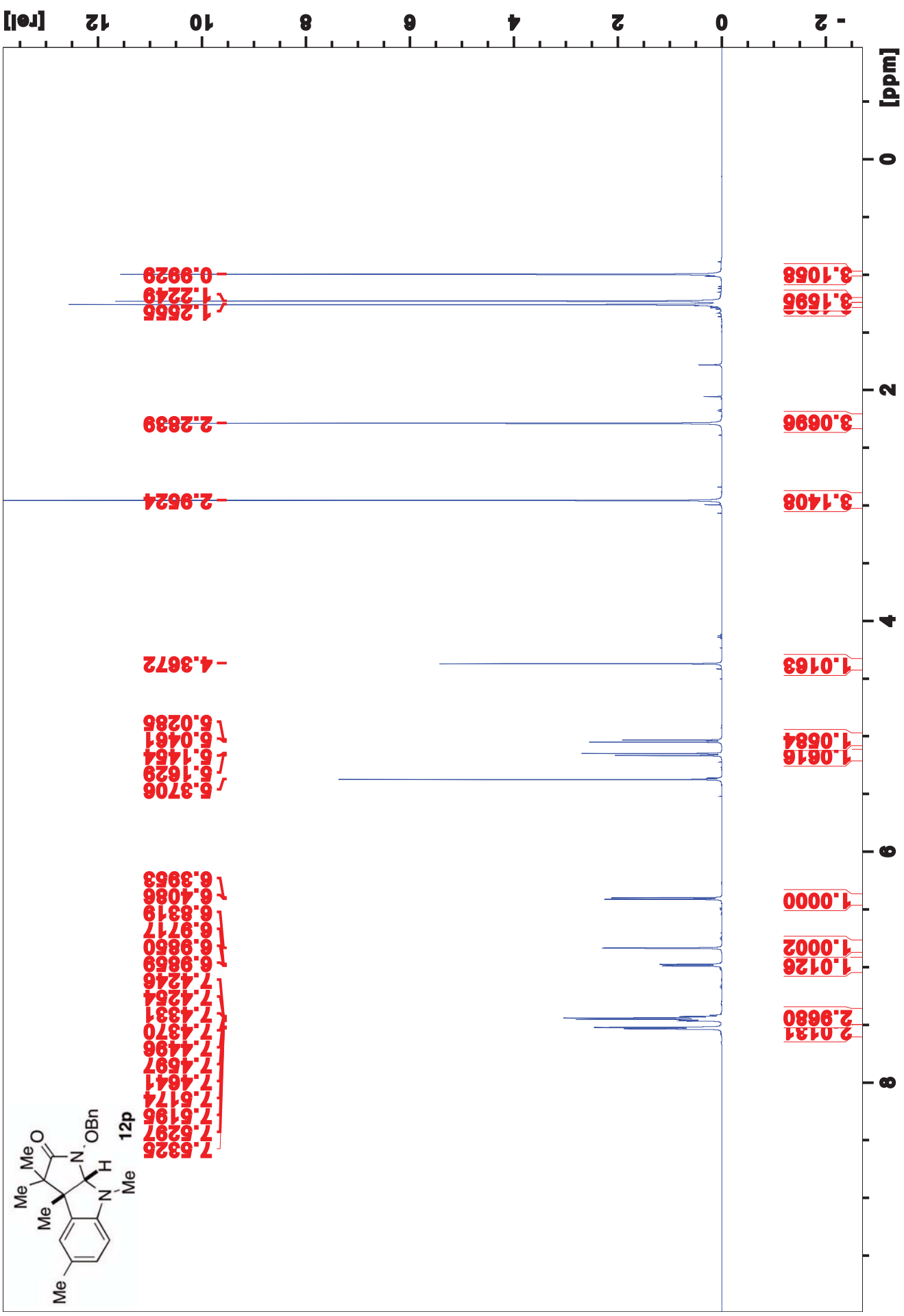

Me Me
Me
Me
O
N
OBn
N
H
Me
12m
174.6231
151.3518
135.3032
129.4620
128.8293
128.5029
128.4564
128.1890
125.9648
117.4354
106.8452
83.4551
76.8865
59.2988
53.7905
53.6105
53.4304
53.2502
53.0700
44.0098
34.0945
30.9300
25.5347
21.3878
18.8035
17.5070
[rel]
0
5
10
15
20
200
150
100
50
0
[ppm]


12n
Me
Me
O
N
OBn
H
N
Bn
10.4424
3.2289
3.5216
1.0290
1.1079
1.0249
1.1679
1.4823
1.0774
1.0666
1.0380
1.0625
1.0000
[ppm]

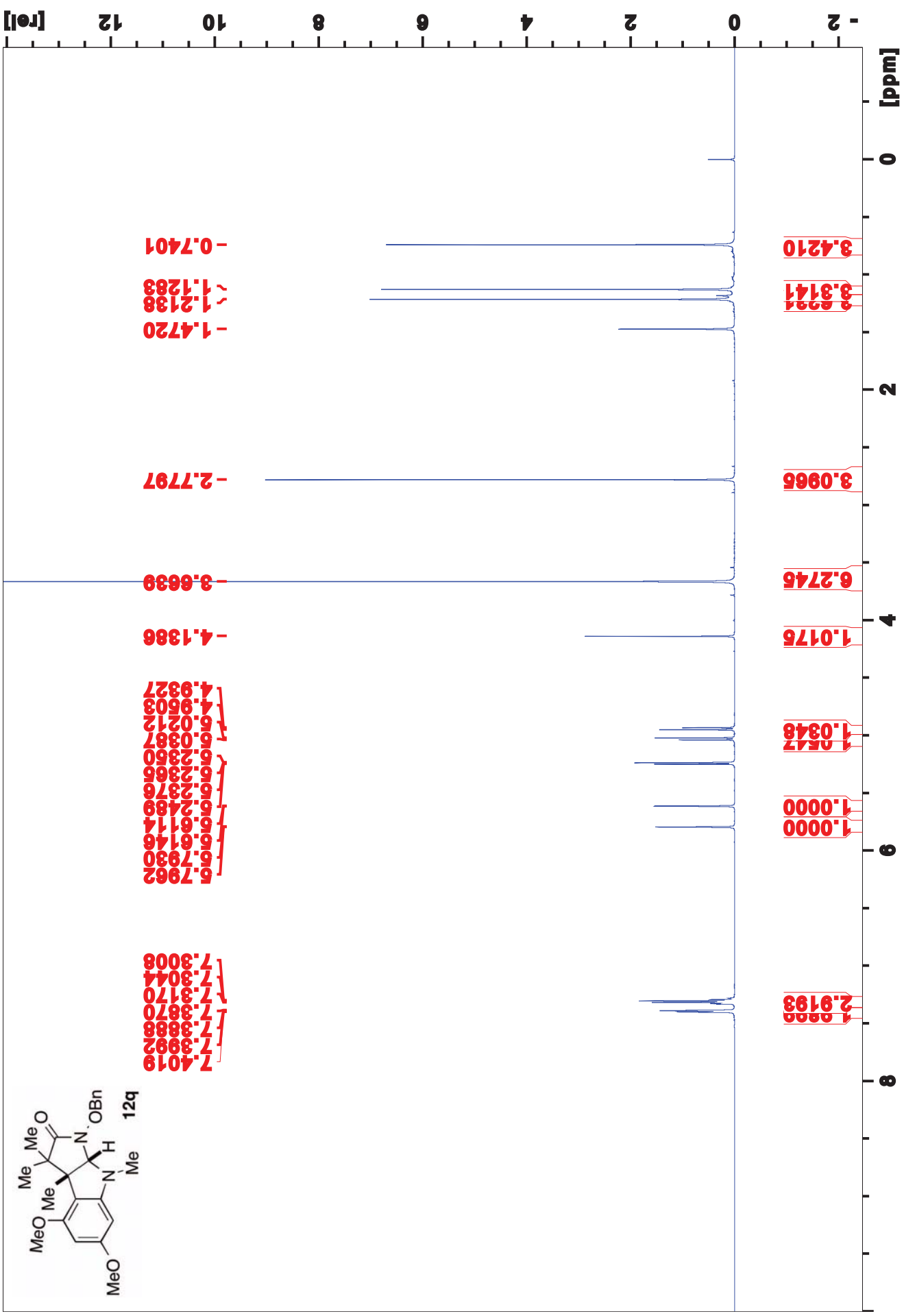
174.2278
161.0267
138.1772
135.2008
134.2330
129.6474
129.4092
128.9267
128.6716
128.5143
127.6020
127.1907
124.7743
118.6407
118.1249
107.4592
82.9954
76.6782
65.0452
63.8487
63.6686
63.4884
63.3084
63.1284
61.7959
44.0220
38.7278
25.1081
21.2000
[ppm]
0
50
100
150
200
[rel]
0
5
10
15
Me
Me
O
N
OBn
H
N
Bn
12n

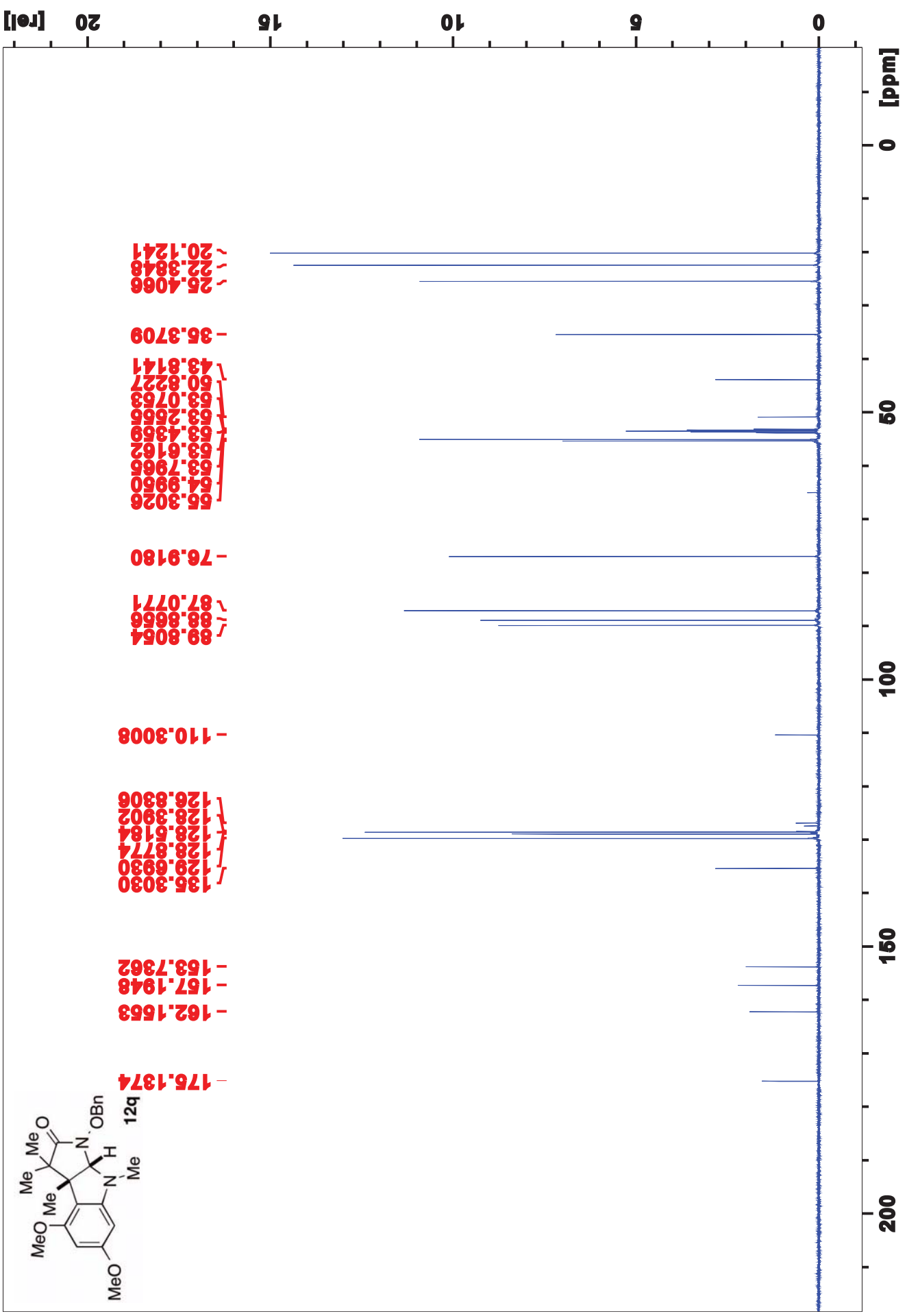
7.4710
7.4678
7.4682
7.4669
7.4094
7.4056
7.4002
7.3888
7.3802
7.2203
7.2170
7.2063
7.2031
7.0641
7.0509
6.3171
6.3082
5.3200
5.1097
4.9920
4.9867
4.9691
4.3571
2.9118
1.8883
1.1722
0.9846
2.0503
2.9139
0.9892
0.9761
1.0213
1.0647
1.0587
1.0171
3.1306
0.1063
3.2323
12o
Me
Me
Me
O
N
OBn
H
N
Me
Br
[rel]
[ppm]

21.6432
21.7836
24.1083
34.4262
43.4660
61.4319
63.1377
63.3179
63.4983
63.6786
63.8591
76.9197
87.9060
108.6386
109.6683
127.0956
128.6149
129.0606
129.7821
131.1116
134.6697
135.2222
149.7962
173.8713
[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
12
Me
Me
O
N
OBn
H
N
Me
Me
Br
12o


12p
Me
Me
Me
Me
O
N
OBn
H
N
Me
7.6325
7.6297
7.6196
7.5174
7.4641
7.4697
7.4496
7.4370
7.4331
7.4264
7.4246
6.9859
6.9850
6.9717
6.8319
6.4086
6.3963
5.3706
5.1629
5.1464
5.0461
5.0285
4.3672
2.9624
2.2839
1.2565
1.2249
0.9929
2.9181
2.9680
1.0126
1.0002
1.0000
1.0616
1.0584
1.0163
3.1408
3.0696
3.1595
3.1058
[ppm]
[rel]

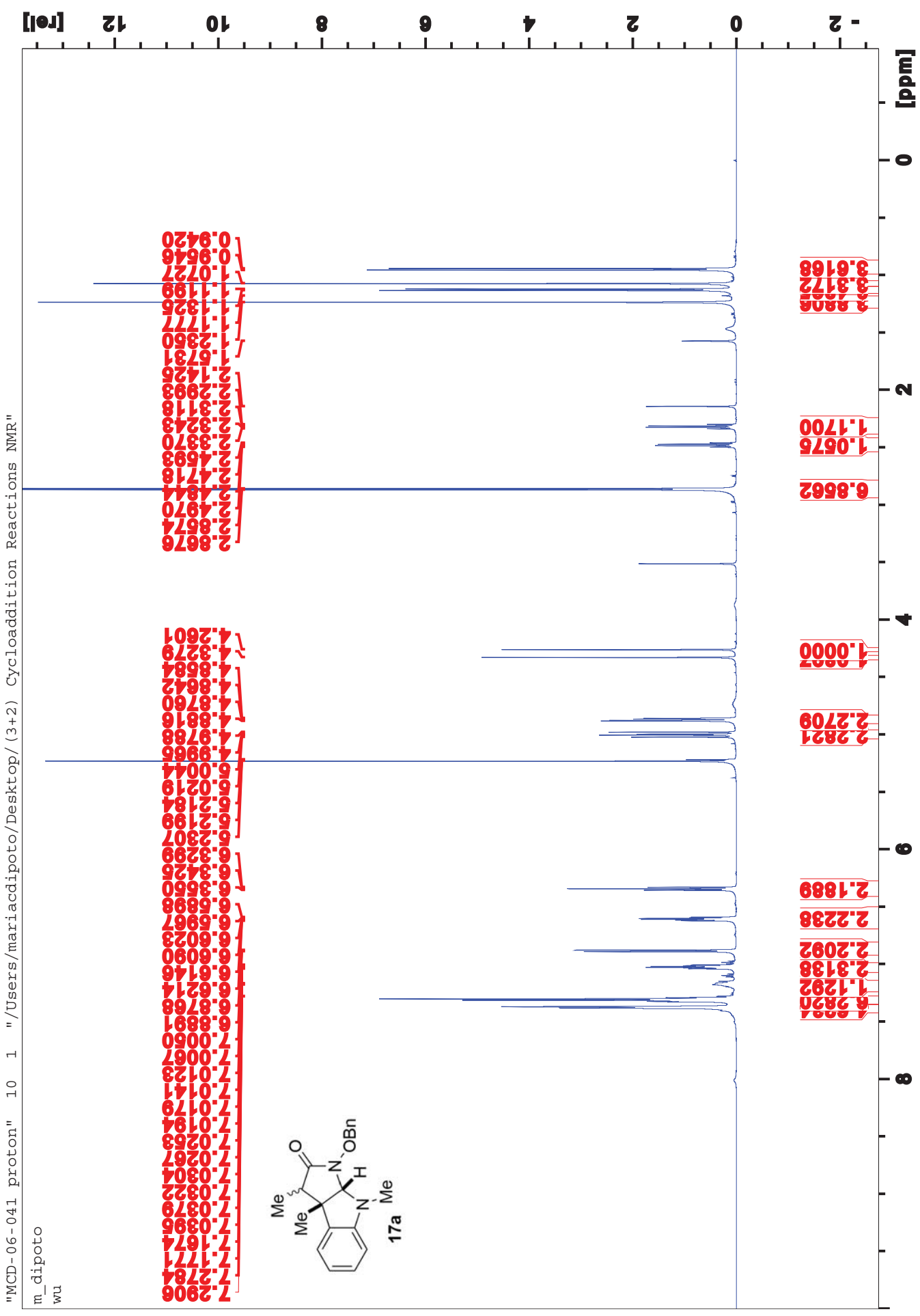
174.2405
148.8032
136.3467
132.3991
129.6776
128.8966
128.6729
128.6286
127.6606
124.7372
107.1926
88.6644
76.8576
63.8400
63.8031
63.6226
63.4423
63.2619
63.0816
61.3096
43.4965
35.1926
24.3079
22.0306
21.2008
20.5238
0
50
100
150
200
[ppm]
0
5
10
15
20
[rel]
12p
Me
Me
O
N
OBn
H
N
Me
Me
Me


12q
Me
O
N
OBn
H
N
Me
Me
Me
MeO
MeO
7.4019
7.3992
7.3868
7.3870
7.3170
7.3044
7.3008
6.7962
6.7930
6.6146
6.6114
6.2489
6.2376
6.2366
6.2360
6.0387
6.0212
4.9603
4.9327
4.1386
3.6639
2.7797
1.4720
1.2138
1.1283
0.7401
2.9193
1.0000
1.0000
1.0348
6.2746
3.0966
3.3141
3.4210
[ppm]


12q
OBn
Me
O
Me
Me
MeO
MeO
Me
N
N
H
20.1241
22.3848
25.4066
36.3709
43.8141
60.8227
63.0763
63.2665
63.4369
63.6162
63.7965
64.9860
66.3026
76.9180
87.0771
88.8656
89.8054
110.3008
126.8306
128.3902
128.6184
128.8774
129.6930
135.3030
153.7362
157.1948
162.1653
176.1374
0
50
100
150
200
[ppm]
0
5
10
15
20
[rel]

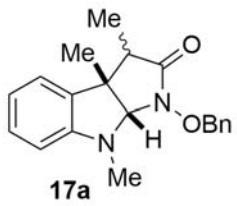
[rel]
12
10
8
6
4
2
0
-2
[ppm]
0
2
4
6
8
3.2649
3.2980
3.2860
3.1280
1.0254
1.0000
0.9952
1.0253
0.9326
1.0978
1.2453
2.7214
4.6536
4.6520
5.2438
5.2332
5.2315
5.2298
6.3456
6.3586
6.3560
6.6060
6.6072
6.6184
6.6196
6.6307
6.6318
6.9271
6.9282
6.9393
6.9404
7.0162
7.0202
7.0310
7.0328
7.0438
7.0456
7.1119
Me
Me
O
NH
H
N
Me
14

182.8579
160.6433
132.8564
128.2829
124.2586
117.9976
107.0474
84.4891
64.2963
63.7941
63.6136
63.4334
63.2629
63.0726
45.6498
32.3968
23.3371
21.7182
21.2963
14
Me
Me
O
NH
H
N
Me
Me
0
2
4
6
8
10
12
14
[rel]
0
50
100
150
200
[ppm]


"MCD-06-041 proton" 10 1 "/Users/mariacdipoto/Desktop/(3+2) Cycloaddition Reactions NMR"
m_dipoto
wu
[ppm]
[rel]
Me
Me
OBn
Me
17a

"MCD-06-041 carbon" 11 1 "/Users/mariacdipoto/Desktop/(3+2) Cycloaddition Reactions NMR"

m_dipoto
wu

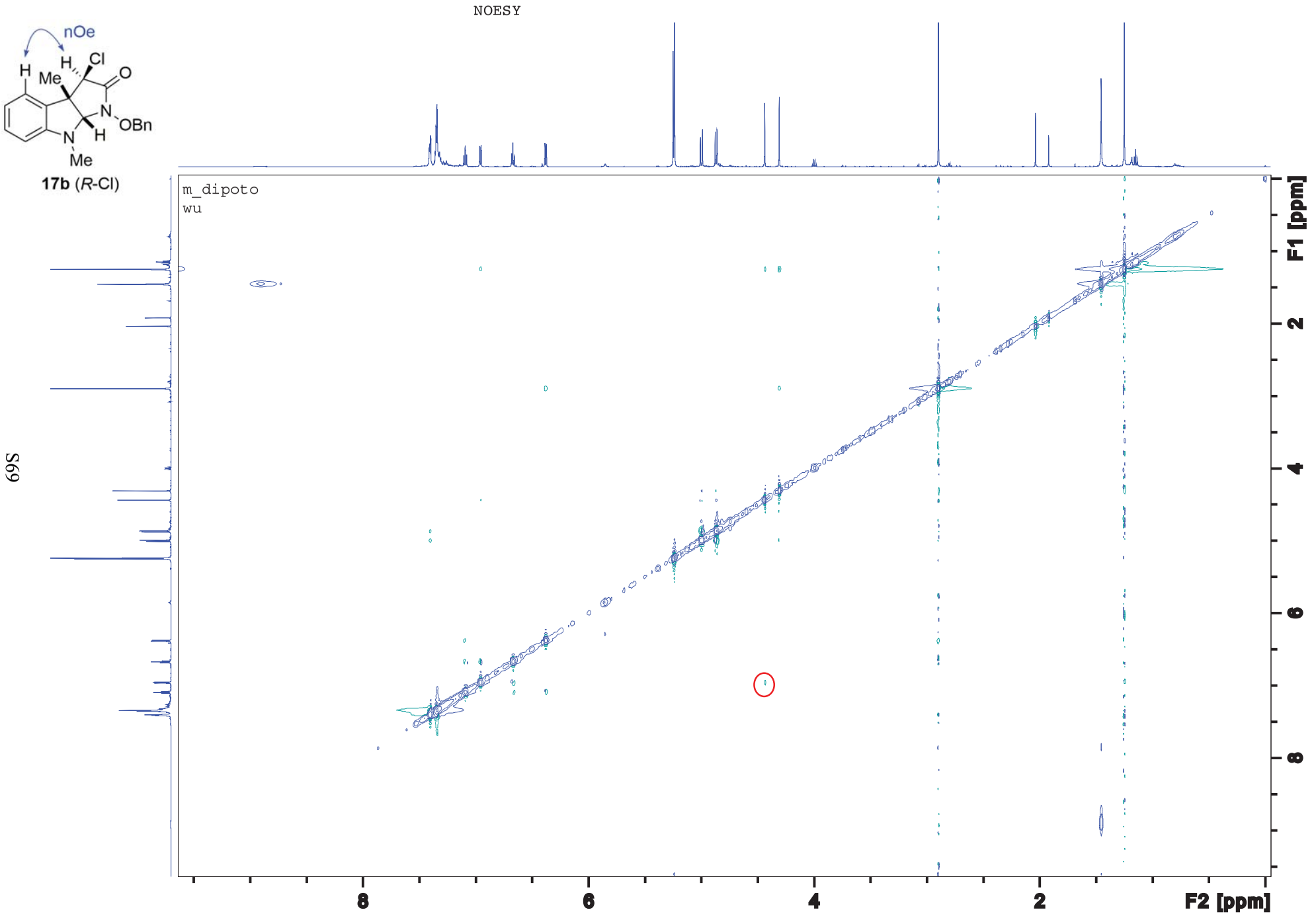


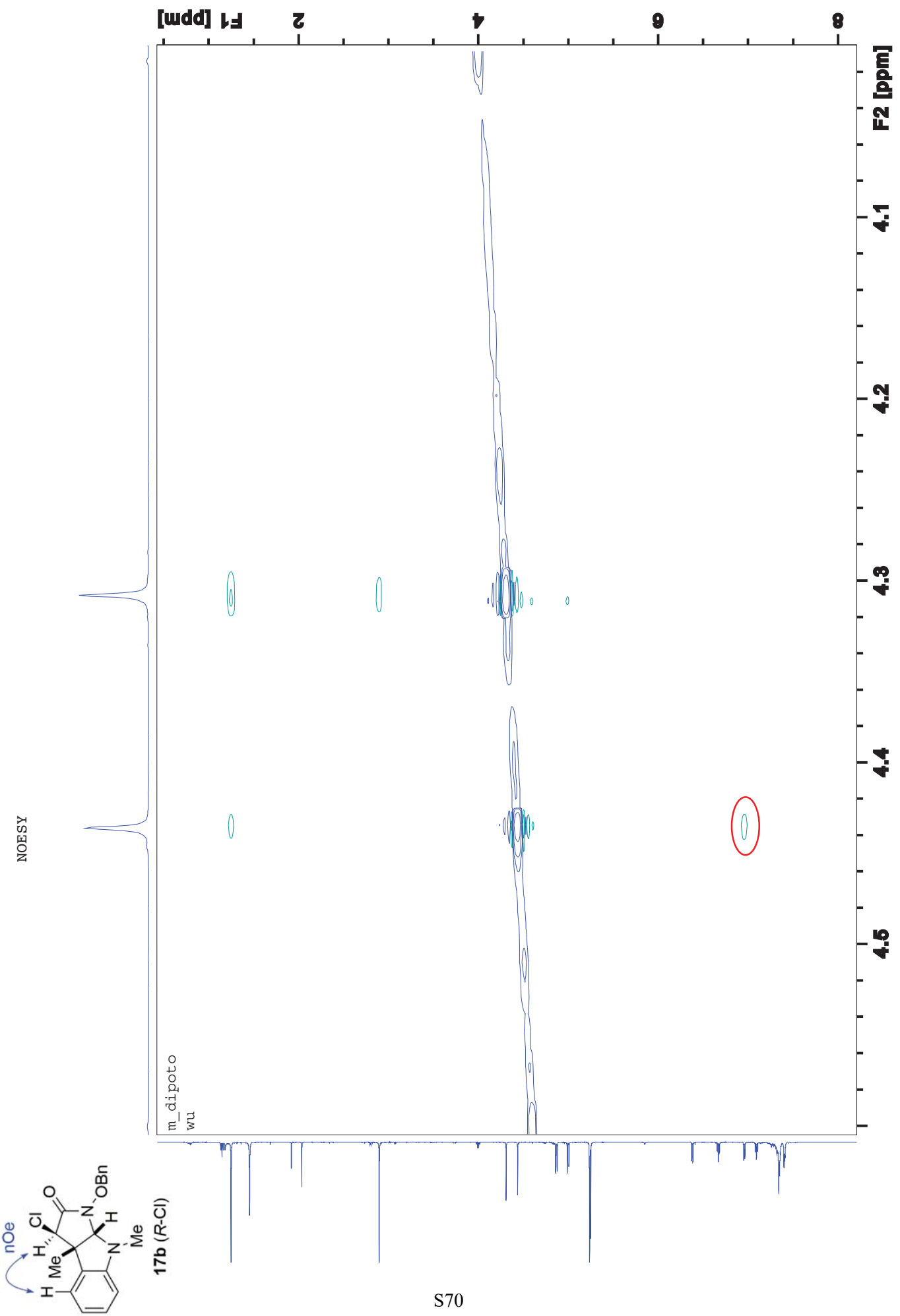
17a

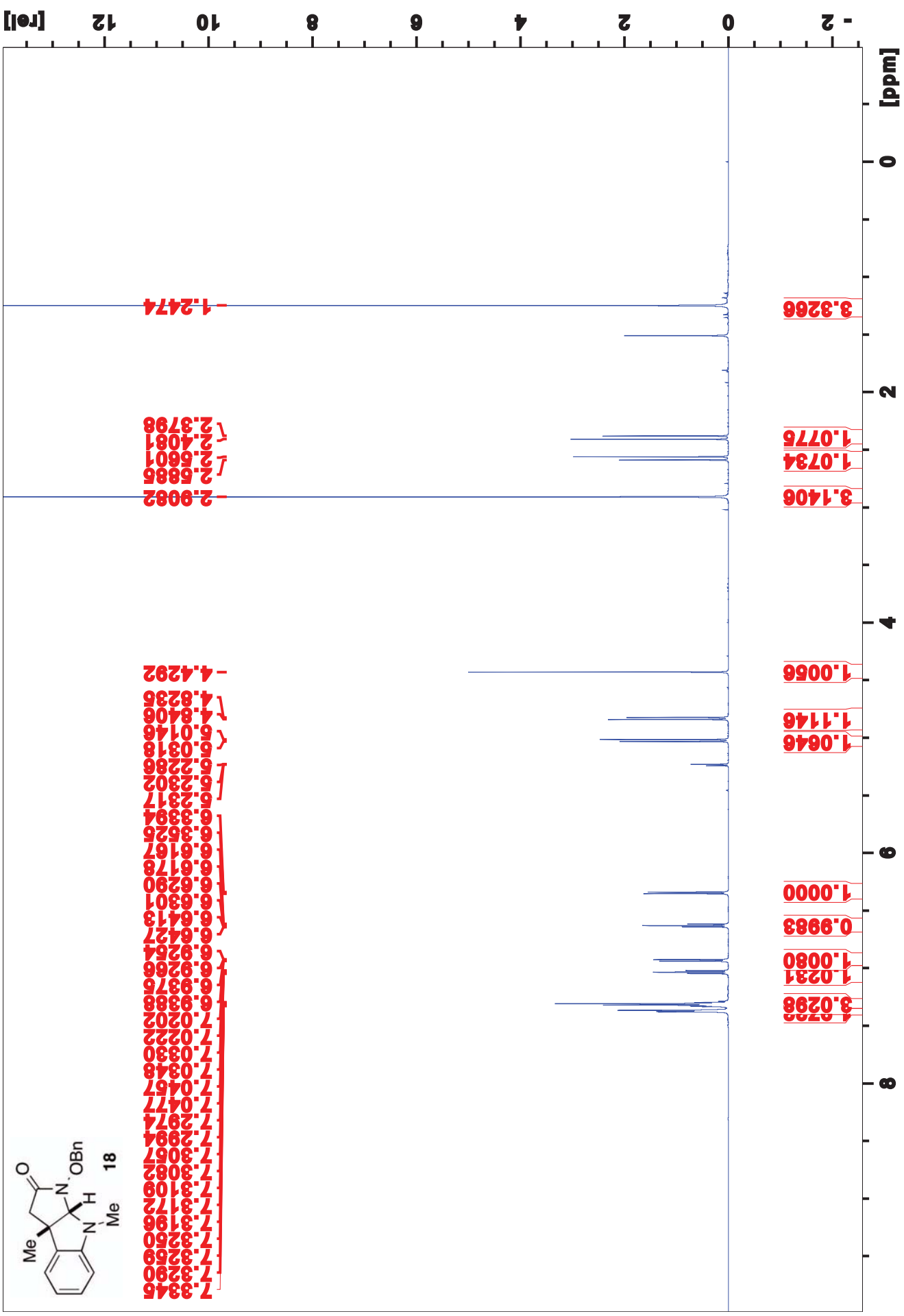
171.6847
171.5249
150.5281
149.4078
136.6847
135.3247
130.8787
129.7116
129.6611
129.1064
128.9413
128.9028
128.5820
128.5290
128.4063
128.4065
124.6508
121.8588
118.3870
117.8476
108.8934
107.1148
107.0031
88.1026
87.9694
76.9070
53.8414
53.8036
53.6241
53.4433
53.2623
53.0826
48.0622
47.2268
44.2288
43.3364
34.3501
34.1133
26.6827
19.6528
15.4679
13.7161
11.4261

[ppm]
12
10
8
6
4
2
0
-2
7.6230
7.6164
7.6106
7.6074
7.4609
7.4548
7.4527
7.4473
7.4437
7.2829
7.2011
7.1998
7.1881
7.1871
7.1766
7.1742
7.0431
7.0309
6.7828
6.7706
6.7682
6.4576
6.4444
5.3199
5.1692
5.1509
5.0041
4.9868
4.5668
4.3068
2.9870
1.3468
1.0410
1.0696
0.9843
0.9837
3.0269
3.3607
1.0017
0.9876
1.0104
1.0116
2.9890
4.6464
17b (R-Cl)

134.7777
130.0624
129.7813
129.2456
128.6873
122.7602
118.7810
107.4383
86.0372
76.7672
60.5632
53.8177
53.7808
53.6004
53.4200
53.2396
53.0593
33.1967
29.6742
29.3467
20.8629
13.8613
[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
17b (R-Cl)


NOESY
nOe
H
H
Cl
Me
O
N
OBn
N
H
Me
17b (R-Cl)
m_dipoto
wu
F1 [ppm]
F2 [ppm]
2
4
6
8
8
6
4
2


NOESY
m_dipoto
wu
F1 [ppm]
F2 [ppm]
2
4
6
8
4.1
4.2
4.3
4.4
4.5
nOe
Cl
H
Me
H
O
N
OBn
H
N
Me
17b (R-Cl)


[ppm]
12
10
8
6
4
2
0
-2
7.3465
7.3290
7.3269
7.3260
7.3196
7.3172
7.3109
7.3082
7.3057
7.2994
7.2974
7.0477
7.0467
7.0348
7.0330
7.0222
7.0202
6.9388
6.9375
6.9266
6.9264
6.6427
6.6413
6.6301
6.6290
6.6178
6.6167
6.3625
6.3394
6.2317
6.2302
6.2286
6.0318
6.0146
4.8406
4.8235
4.4292
2.9082
2.6886
2.6601
2.4081
2.3798
1.2474
3.3266
1.0776
1.0734
3.1406
1.0056
1.1146
1.0646
1.0000
0.9983
1.0231
1.0080
3.0298
Me
Me
OBn
H
N
N
O
18

[ppm]
0
50
100
150
200
[rel]
0
2
4
6
8
10
12
14
25.9865
33.6298
41.4113
43.7493
63.0716
63.2621
63.4323
63.6126
63.7928
76.8678
88.0093
106.9327
118.3690
122.1794
128.6646
128.6672
128.8977
129.6045
135.1260
135.2167
149.0066
166.5863
Me
N
H
N
O
OBn
Me
18