Supplementary Materials

Three-component condensation of β-ketonitriles, 4-fluorobenzaldehyde and secondary cyclic amines

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*General Procedure for Preparation of α-arylidenenitriles **4a**–**c**,**e**–**o** and products **7a**,**b**, **9***

A mixture of the nitrile **1**, **5** or **8** (1 mmol), 4-fluorobenzaldehyde **2** (124 mg, 1 mmol) and cyclic secondary amine **3** (2 mmol) in 3 mL of acetonitrile was heated at boiling and stirring for 6 h. The reaction mixture was cooled to –30 °C, the precipitate formed was filtered off and washed with ice-cold methanol. In the cases where there was no precipitation, the reaction mixture was concentrated under reduced pressure and the residue was purified by recrystallization.

(*E*)-2-Benzoyl-3-[4-(pyrrolidin-1-yl)phenyl]acrylonitrile (4a): 223 mg (74% yield). Orange crystals, mp 156–157 °C. IR (ATR, cm^{-1}): 2955, 2924, 2866, 2191, 1643, 1605, 1551, 1504, 1447, 1404, 1366, 1346, 1277, 1231, 1180, 1165, 1115, 1057, 1034, 964, 934, 860, 822, 795, 710, 694. ^{1}H NMR ($CDCl_3$): 2.04–2.08 (m, 4H, $2CH_2$), 3.40–3.44 (m, 4H, $2CH_2N$), 6.59 (d, 2H, *J* = 8.9 Hz, Ar), 7.45–7.49 (m, 2H, Ar), 7.53–7.57 (m, 1H, Ar), 7.82 (d, 2H, *J* = 8.9 Hz, Ar), 7.96–8.00 (m, 3H, Ar, CH=CCN). ^{13}C NMR ($CDCl_3$): 25.4 ($2CH_2$), 48.0 ($2CH_2$), 101.0 (CCN), 112.3 (2CH), 119.5 (C), 119.7 (C), 128.4 (2CH), 129.0 (2CH), 132.2 (CH), 134.9 (2CH), 137.6 (C), 151.8 (C–N), 155.9 (CH=CCN), 190.3 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{20}H_{19}N_2O$: 303.1497, found 303.1496.

(*E*)-2-Benzoyl-3-[4-(piperidin-1-yl)phenyl]acrylonitrile (4b): 218 mg (69% yield). Yellow crystals, mp 126–127 °C (MeOH). IR (ATR, cm^{-1}): 2916, 2828, 2207, 1659, 1597, 1543, 1504, 1439, 1393, 1354, 1315, 1273, 1246, 1227, 1188, 1169, 1108, 1122, 1080, 1018, 999, 972, 953, 918, 818, 795, 714, 706, 691. ^{1}H NMR ($CDCl_3$): 1.68 (br. s, 6H, $3CH_2$), 3.47 (br. s, 4H, $2CH_2N$), 6.87 (d, 2H, *J* = 8.9 Hz, Ar), 7.45–7.50 (m, 2H, Ar), 7.54–7.59 (m, 1H, Ar), 7.83 (d, 2H, *J* = 8.2 Hz, Ar), 7.94–7.98 (m, 3H, Ar, CH=CCN). ^{13}C NMR ($CDCl_3$): 24.4 (CH_2), 25.4 ($2CH_2$), 48.4 ($2CH_2N$), 102.3 (CCN), 113.5 (2CH), 119.1 (C), 120.6 (C), 128.5 (2CH), 129.1 (2CH), 132.5 (CH), 134.7 (2CH), 137.3 (C), 154.1 (C–N), 155.5 (CH=CCN), 190.2 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{21}H_{21}N_2O$: 317.1654, found 317.1659.

(*E*)-2-Benzoyl-3-(4-morpholinophenyl)acrylonitrile (4c): 223 mg (70% yield). Orange crystals, mp 156–157 °C. IR (ATR, cm^{-1}): 2203, 1647, 1609, 1547, 1504, 1439, 1396, 1358, 1273, 1254, 1231, 1188, 1111, 1049, 1026, 949, 926, 810, 791, 694, 683. ^{1}H NMR ($CDCl_3$): 3.37–3.40 (m, 4H, $2CH_2N$), 3.83–3.86 (m, 4H, $2CH_2O$), 6.89 (d, 2H, *J* = 8.9 Hz, Ar), 7.46–7.51 (m, 2H, Ar), 7.55–7.60 (m, 1H, Ar), 7.83 (d, 2H, *J* = 8.2 Hz, Ar), 7.98–8.01 (m, 3H, Ar, CH=CCN). ^{13}C NMR ($CDCl_3$): 46.9 ($2CH_2N$), 66.5 ($2CH_2O$), 104.0 (CCN), 113.6 (2CH), 118.6 (C), 122.0 (C), 128.6 (2CH), 129.1 (2CH), 132.8 (CH), 134.2 (2CH), 137.0 (C), 154.3 (C–N), 155.4 (CH=CCN), 189.9 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{20}H_{19}N_2O_2$: 319.1447, found 319.1441.

(*E*)-2-Benzoyl-3-[4-(6-methoxy-1,3,4,9-tetrahydro-2*H*-pyrido[3,4-*b*]indol-2-yl)phenyl]acrylonitrile (4d). A mixture of benzoylacetonitrile (145 mg, 1 mmol), 4-fluorobenzaldehyde (124 mg, 1 mmol) and 6-methoxy-2,3,4,9-tetrahydro-1*H*-pyrido[3,4-*b*]indole (405 mg, 2 mmol) in 10 mL of acetonitrile was heated at boiling and stirring for 8 h. The reaction mixture was cooled to room temperature, and the precipitate formed was filtered off. The mother liquor was evaporated under reduced pressure, 2 mL of methanol was added to the residue, and the mixture was cooled to –30 °C. The precipitate that formed was filtered off, dissolved on heating in dichloroethane, and the product was precipitated from the solution by adding an equal amount of methanol. After keeping the mixture at –30 °C for 1 h, the product precipitate was filtered off and washed with ice-cold methanol. Yield 75% (325 mg). Orange crystals, mp 225–226 °C. IR (ATR, cm^{-1}): 3314, 2199, 1639, 1612, 1593, 1551, 1516, 1485, 1447, 1400, 1366, 1331, 1315, 1285, 1258, 1215, 1196, 1180, 1126, 1111, 1030, 957, 914, 822, 791, 706, 694, 660, 625. ^{1}H NMR (DMSO-d_6): 2.78 (br. s, 2H, CH_2), 3.71 (s, 3H, CH_3O), 3.87–3.90 (m, 2H, CH_2), 4.66 (s, 2H, CH_2N), 6.65 (dd, 1H, *J* = 8.7, 2.3 Hz, Ar), 6.89 (d, 1H, *J* = 2.3 Hz, Ar), 7.14–7.20 (m, 3H, Ar), 7.52 (t, 2H, *J* =

7.6 Hz, Ar), 7.60–7.64 (m, 1H, Ar), 7.73 (d, 2H, *J* = 7.1 Hz, Ar), 7.94 (s, 1H, CH=CCN), 8.00 (d, 2H, *J* = 8.9 Hz, Ar), 10.68 (s, 1H, NH). ^{13}C NMR (DMSO-d_6): 21.2 (CH_2), 45.5 (CH_2N), 45.6 (CH_2N), 55.9 (CH_3O), 100.4 (CH), 102.5 (CCN), 107.5 (C), 111.0 (CH), 112.2 (CH), 114.1 (2CH), 119.1 (C), 120.4 (C), 127.3 (C), 129.1 (2CH), 129.3 (2CH), 131.7 (C), 132.4 (C), 133.0 (CH), 134.7 (2CH), 137.5 (C), 153.7 (C), 154.5 (C), 155.8 (CH=CCN), 190.7 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{28}H_{24}N_3O_2$: 434.1869, found 434.1862.

(*E*)-4,4-Dimethyl-3-oxo-2-[4-(pyrrolidin-1-yl)benzylidene]pentanenitrile (4e): 195 mg (69% yield). Orange crystals, mp 146–147 °C (MeOH). IR (ATR, cm^{-1}): 2199, 1663, 1597, 1543, 1497, 1462, 1439, 1389, 1366, 1346, 1304, 1273, 1196, 1142, 1119, 1061, 1034, 980, 934, 829, 802, 748, 725. ^{1}H NMR ($CDCl_3$): 1.39 (s, 9H, *t*-Bu), 2.02–2.05 (m, 4H, $2CH_2$), 3.36–3.40 (m, 4H, $2CH_2N$), 6.54 (d, 2H, *J* = 8.9 Hz, Ar), 7.95 (d, 2H, *J* = 8.9 Hz, Ar), 8.14 (s, 1H, CH=CCN). ^{13}C NMR ($CDCl_3$): 25.5 ($2CH_2$), 26.8 ($3CH_3$), 44.3 (CMe_3), 47.9 ($2CH_2N$), 98.0 (CCN), 112.0 (2CH), 119.8 (C), 121.0 (C), 134.8 (2CH), 151.3 (C–N), 156.4 (CH=CCN), 199.1 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{18}H_{23}N_2O$: 283.1810, found 283.1814.

(*E*)-4,4-Dimethyl-3-oxo-2-[4-(piperidin-1-yl)benzylidene]pentanenitrile (4f): 210 mg (68% yield). Yellow crystals, mp 132–133 °C (MeOH). IR (ATR, cm^{-1}): 2974, 2936, 2855, 2203, 1663, 1597, 1535, 1497, 1435, 1366, 1273, 1238, 1200, 1150, 1119, 1057, 1034, 980, 918, 829, 806, 752, 733. ^{1}H NMR ($CDCl_3$): 1.39 (s, 9H, *t*-Bu), 1.67 (br. s, 6H, $3CH_2$), 3.41–3.45 (m, 4H, $2CH_2N$), 6.85 (d, 2H, *J* = 8.9 Hz, Ar), 7.95 (d, 2H, *J* = 8.9 Hz, Ar), 8.13 (s, 1H, CH=CCN). ^{13}C NMR ($CDCl_3$): 24.4 (CH_2), 25.4 ($2CH_2$), 26.8 ($3CH_3$), 44.4 (CMe_3), 48.3 ($2CH_2N$), 99.5 (CCN), 113.4 (2CH), 120.6 (CN), 120.9 (C), 134.6 (2CH), 154.0 (C–N), 155.9 (CH=CCN), 199.0 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{19}H_{25}N_2O$: 297.1967, found 297.1964.

(*E*)-4,4-Dimethyl-2-(4-morpholinobenzylidene)-3-oxopentanenitrile (4g): 188 mg (63% yield). Yellow crystals, mp 120–121 °C (MeOH). IR (ATR, cm^{-1}): 2199, 1670, 1601, 1551, 1535, 1508, 1474, 1454, 1435, 1389, 1362, 1312, 1273, 1250, 1238, 1200, 1150, 1107, 1053, 980, 926, 818, 725, 706. ^{1}H NMR ($CDCl_3$): 1.40 (s, 9H, *t*-Bu), 3.35–3.38 (m, 4H, $2CH_2N$), 3.84–3.87 (m, 4H, $2CH_2O$), 6.90 (d, 2H, *J* = 8.9 Hz, Ar), 7.97 (d, 2H, *J* = 8.9 Hz, Ar), 8.14 (s, 1H, CH=CCN). ^{13}C NMR ($CDCl_3$): 26.7 ($3CH_3$), 44.5 (CMe_3), 47.3 ($2CH_2N$), 66.4 ($2CH_2O$), 101.5 (CCN), 113.8 (2CH), 120.0 (C), 122.8 (C), 134.1 (2CH), 153.8 (C–N), 155.8 (CH=CCN), 198.7 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{18}H_{23}N_2O_2$: 299.1760, found 299.1760.

Ethyl (*E*)-4-[4-(2-cyano-4,4-dimethyl-3-oxopent-1-en-1-yl)phenyl]piperazine-1-carboxylate (4h): 247 mg (67% yield). Yellow crystals, mp 128–129 °C (MeOH). IR (ATR, cm^{-1}): 2207, 1697, 1670, 1605, 1551, 1508, 1431, 1385, 1366, 1288, 1231, 1200, 1150, 1123, 1053, 1034, 984, 914, 810, 768. ^{1}H NMR ($CDCl_3$): 1.26 (t, 3H, *J* = 7.1 Hz, CH_2CH_3), 1.38 (s, 9H, *t*-Bu), 3.39–3.42 (m, 4H, $2CH_2N$), 3.61–3.64 (m, 4H, $2CH_2N$), 4.15 (q, 2H, *J* = 7.1 Hz, CH_2CH_3), 6.87 (d, 2H, *J* = 8.9 Hz, Ar), 7.96 (d, 2H, *J* = 8.9 Hz, Ar), 8.13 (s, 1H, CH=CCN). ^{13}C NMR ($CDCl_3$): 14.7 (CH_2CH_3), 26.7 ($3CH_3$), 43.1 ($2CH_2N$), 44.5 (CMe_3), 46.9 ($2CH_2N$), 61.8 (CH_2CH_3), 101.3 (CCN), 114.0 (2CH), 120.0 (C), 122.4 (C), 134.2 (2CH), 153.6 (C–N), 155.5 (CO_2Et), 155.8 (CH=CCN), 198.7 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{21}H_{28}N_3O_3$: 370.2131, found 370.2128.

(*E*)-2-(Adamantane-1-carbonyl)-3-[4-(pyrrolidin-1-yl)phenyl]acrylonitrile (4i): 270 mg (75% yield). Orange crystals, mp 150–151 °C. IR (ATR, cm^{-1}): 2901, 2847, 2199, 1663, 1605, 1547, 1504, 1477, 1443, 1396, 1342, 1180, 1161, 1099, 988, 964, 934, 914, 818, 791. ^{1}H NMR ($CDCl_3$): 1.72–1.80 (m, 6H, $CH_{2\ Ad}$), 2.02–2.06 (m, 4H, $2CH_2$), 2.09 (br. s, 3H, CH_{Ad}), 2.13 (br. s, 6H, $CH_{2\ Ad}$), 3.39 (t, 4H, *J* = 6.6 Hz, $2CH_2N$), 6.54 (d, 2H, *J* = 8.9 Hz, Ar), 7.94 (d, 2H, *J* = 8.9 Hz, Ar), 8.10 (s, 1H, CH=CCN). ^{13}C NMR ($CDCl_3$): 25.5 ($2CH_2$), 28.3 ($3CH_{Ad}$), 36.6 ($3CH_{2\ Ad}$), 37.7 ($3CH_{2\ Ad}$), 47.0 (C_{Ad}), 47.8 ($2CH_2N$), 98.1 (CCN), 111.9 (2CH), 119.9 (C), 121.2 (C), 134.7

(2CH), 151.2 (C–N), 156.4 (CH=CCN), 198.4 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{24}H_{29}N_2O$: 361.2280, found 361.2277.

(*E*)-2-(1*H*-Pyrrole-2-carbonyl)-3-[4-(pyrrolidin-1-yl)phenyl]acrylonitrile (4j): 248 mg (85% yield). Red crystals, mp 249–251 °C (DMF). IR (ATR, cm^{-1}): 3271, 2199, 1601, 1497, 1474, 1447, 1396, 1366, 1346, 1315, 1246, 1227, 1184, 1153, 1119, 1045, 991, 961, 903, 845, 806, 752. ^{1}H NMR (DMSO-d_6): 1.85–2.00 (m, 4H, $2CH_2$), 3.25–3.45 (m, 4H, $2CH_2N$), 6.24 (s, 1H, $H_{pyrrole}$), 6.63 (d, 2H, *J* = 8.9 Hz, Ar), 7.15 (s, 1H, $H_{pyrrole}$), 7.27 (s, 1H, $H_{pyrrole}$), 7.94 (d, 2H, *J* = 8.9 Hz, Ar), 8.10 (s, 1H, CH=CCN), 11.98 (s, 1H, NH). ^{13}C NMR (DMSO-d_6): 25.4 ($2CH_2$), 48.0 ($2CH_2N$), 99.0 (CCN), 110.8 (CH), 112.6 (2CH), 118.1 (CH), 119.4 (C), 120.7 (C), 126.9 (CH), 130.3 (C), 134.5 (2CH), 151.5 (C–N), 154.2 (CH=CCN), 175.6 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{18}H_{18}N_3O$: 292.1450, found 292.1449.

(*E*)-2-(1*H*-Indole-3-carbonyl)-3-[4-(pyrrolidin-1-yl)phenyl]acrylonitrile (4k): 270 mg (79% yield). Red crystals, mp 251–253 °C. IR (ATR, cm^{-1}): 3400–2700, 2201, 1595, 1578, 1497, 1485, 1454, 1443, 1424, 1402, 1356, 1310, 1234, 1159, 1142, 1105, 1055, 1032, 1013, 957, 918, 814, 752. ^{1}H NMR (DMSO-d_6): 1.91–1.95 (m, 4H, $2CH_2$), 3.38–3.42 (m, 4H, $2CH_2N$), 6.64 (d, 2H, *J* = 8.9 Hz, Ar), 7.17–7.25 (m, 2H, Ar), 7.50 (d, 1H, *J* = 7.1 Hz, Ar), 7.95 (d, 2H, *J* = 8.9 Hz, Ar), 8.08 (s, 1H, CH=CCN), 8.15 (dd, 1H, *J* = 6.9, 1.6 Hz, Ar), 8.38 (s, 1H, H_{indole}-2), 12.05 (br. s, 1H, NH). ^{13}C NMR (DMSO-d_6): 25.4 ($2CH_2$), 48.0 ($2CH_2N$), 101.8 (CCN), 112.5 (2CH), 112.8 (CH), 114.7 (C), 119.5 (C), 120.8 (C), 122.1 (CH), 122.5 (CH), 123.7 (CH), 127.0 (C), 134.1 (2CH), 134.4 (C), 136.9 (CH), 151.3 (C–N), 153.5 (CH=CCN), 182.0 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{22}H_{20}N_3O$: 342.1606, found 342.1601.

(*E*)-2-(1-Methyl-1*H*-indole-3-carbonyl)-3-[4-(pyrrolidin-1-yl)phenyl]acrylonitrile (4l): 295 mg (83% yield). Red crystals, mp 245–246 °C. IR (ATR, cm^{-1}): 2191, 1605, 1551, 1508, 1458, 1408, 1385, 1350, 1258, 1219, 1165, 1099, 961, 903, 810, 752. ^{1}H NMR ($CDCl_3$): 2.02–2.08 (m, 4H, $2CH_2$), 3.38–3.42 (m, 4H, $2CH_2N$), 3.87 (s, 3H, CH_3), 6.58 (d, *J* = 8.9 Hz, 2H, Ar), 7.31–7.38 (m, 3H, Ar), 8.00 (d, *J* = 8.9 Hz, 2H, Ar), 8.25 (s, 1H, CH=CCN), 8.41 (s, 1H, H_{indole}-2), 8.44–8.48 (m, 1H, Ar). ^{13}C NMR ($CDCl_3$): 25.5 ($2CH_2$), 33.8 (CH_3), 47.8 ($2CH_2N$), 100.9 (CCN), 109.7 (CH), 111.9 (2CH), 114.9 (C), 120.1 (C), 121.7 (C), 122.9 (CH), 123.2 (CH), 123.7 (CH), 128.0 (C), 134.3 (2CH), 136.3 (CH), 137.1 (C), 151.0 (C–N), 154.5 (CH=CCN), 180.3 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{23}H_{22}N_3O$: 356.1763, found 356.1758.

(*E*)-2-(1-Benzyl-1*H*-indole-3-carbonyl)-3-[4-(pyrrolidin-1-yl)phenyl]acrylonitrile (4m): 390 mg (90% yield). Red-orange crystals, mp 208–209 °C. IR (ATR, cm^{-1}): 2195, 1605, 1504, 1477, 1462, 1443, 1408, 1369, 1335, 1308, 1227, 1192, 1165, 1096, 1042, 961, 903, 814, 772, 737, 698. ^{1}H NMR ($CDCl_3$): 2.01–2.06 (m, 4H, $2CH_2$), 3.37–3.41 (m, 4H, $2CH_2N$), 5.38 (s, 2H, CH_2Ph), 6.57 (d, 2H, *J* = 8.9 Гц, Ar), 7.17–7.20 (m, 2H, Ar), 7.23–7.35 (m, 6H, Ar), 7.98 (d, *J* = 8.9 Hz, 2H, Ar), 8.24 (s, 1H, CH=CCN), 8.47 (d, *J* = 8.2 Hz, 1H, Ar), 8.49 (s, 1H, H_{indole}-2). ^{13}C NMR ($CDCl_3$): 25.5 ($2CH_2$), 47.8 ($2CH_2N$), 51.1 (CH_2Ph), 100.9 (CCN), 110.4 (CH), 111.9 (2CH), 115.3 (C), 116.5 (C), 120.0 (C), 121.6 (C), 123.0 (CH), 123.3 (CH), 123.8 (CH), 127.1 (2CH), 128.16 (C), 128.25 (CH), 129.1 (2CH), 134.4 (2CH), 135.8 (CH), 136.6 (C), 151.1 (C–N), 154.5 (CH=CCN), 180.6 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{29}H_{26}N_3O$: 432.2076, found 432.2080.

(*E*)-3-[4-(Piperidin-1-yl)phenyl]-2-(2,3,4,9-tetrahydro-1*H*-carbazole-9-carbonyl)acrylonitrile (4n): 290 mg (71% yield). Yellow crystals, mp198–199 °C. IR (ATR, cm^{-1}): 2943, 2847, 2195, 1663, 1609, 1566, 1516, 1439, 1396, 1354, 1319, 1269, 1242, 1184, 1126, 1057, 1022, 957, 930, 918, 883, 860, 814, 752, 733. ^{1}H NMR ($CDCl_3$): 1.69 (br. s, 6H, $3CH_2$), 1.87 (br. s, 4H, $2CH_2$), 2.69 (br. s, 2H, CH_2), 2.90 (br. s, 2H, CH_2), 3.44–3.49 (m, 4H, $2CH_2$), 6.86 (d,

2H, *J* = 9.1 Hz, Ar), 7.17–7.22 (m, 2H, Ar), 7.40–7.44 (m, 1H, Ar), 7.64–7.69 (m, 1H, Ar), 7.75 (s, 1H, CH=CCN), 7.93 (d, 2H, *J* = 9.1 Hz, Ar). ^{13}C NMR ($CDCl_3$): 21.2 (CH_2), 22.4 (CH_2), 23.6 (CH_2), 24.4 (CH_2), 25.1 (CH_2), 25.5 ($2CH_2$), 48.2 ($2CH_2N$), 99.2 (CCN), 113.3 (2CH), 114.2 (CH), 117.7 (C), 117.9 (C), 118.1 (CH), 120.2 (C), 122.8 (CH), 123.4 (CH), 130.1 (C), 134.4 (2CH), 135.7 (C), 136.1 (C), 154.3 (C–N), 154.8 (CH=CCN), 164.5 (C=O). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{27}H_{28}N_3O$: 410.2232, found 410.2227.

(*E*)-2-Cyano-*N*-(2-nitrophenyl)-3-[4-(pyrrolidin-1-yl)phenyl]acrylamide (4o): 260 mg (72% yield). Red crystals, mp 254–255 °C. IR (ATR, cm^{-1}): 3283, 2967, 2859, 2199, 1670, 1609, 1585, 1555, 1543, 1516, 1493, 1447, 1400, 1327, 1157, 961, 826, 783, 737, 679. ^{1}H NMR (DMSO-d_6): 1.95 (br. s, 4H, $2CH_2$), 3.30–3.35 (m, 4H, $2CH_2N$), 6.68 (d, 2H, *J* = 8.7 Hz, Ar), 7.35(t, 1H, *J* = 7.6 Hz, Ar), 7.73 (t, 1H, *J* = 7.6 Hz, Ar), 7.92 (d, 2H, *J* = 8.7 Hz, Ar), 8.02–8.06 (m, 2H, Ar), 8.10 (s, 1H, CH=CCN), 10.62 (br. s, 1H, NH). ^{13}C NMR spectroscopy of was hindered due to its poor solubility in common solvents. HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{20}H_{19}N_4O_3$: 363.1457, found 363.1450.

2-(6-Amino-1,3-dimethyl-2,4-dioxo-1,2,3,4-tetrahydropyrimidine-5-carbonyl)-3-(4-fluorophenyl)-3-(pyrrolidin-1-yl)acrylonitrile (7a): 278 mg (70% yield). Light-yellow crystals, mp 234–235 °C. IR (ATR, cm^{-1}): 3200–2400, 2203, 1697, 1643, 1601, 1562, 15001, 1462, 1396, 1366, 1281, 1258, 1231, 1192, 1157, 1107, 1065, 1042, 880, 849, 810, 752. ^{1}H NMR (DMSO-d_6): 1.82–1.86 (m, 4H, CH_2), 3.11 (s, 3H, CH_3), 3.12–3.16 (m, 4H, CH_2N), 3.42 (s, 3H, CH_3), 7.23–7.28 (m, 2H, Ar), 7.83–7.88 (m, 2H, Ar), 9.23 (br. s, 2H, NH_2). ^{13}C NMR (DMSO-d_6): 24.4 ($2CH_2$), 27.7 (CH_3), 29.9 (CH_3), 45.4 ($2CH_2N$), 96.8 (C), 99.0 (C), 115.4 (d, 2CH, $^2J_{CF}$ = 21.0 Hz), 119.8 (C), 131.3 (d, 2CH, $^3J_{CF}$ = 8.6 Hz), 135.6 (d, C, $^4J_{CF}$ = 2.9 Hz), 151.6 (C), 154.8 (C), 161.3 (C), 162.4 (C), 163.4 (d, C–F, $^1J_{CF}$ = 246.0 Hz), 176.3 (C=O). ^{19}F NMR (DMSO-d_6): –111.5 (s, 1F). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{20}H_{21}FN_5O_3$: 398.1628, found 398.1624.

2-(6-Amino-1,3-dimethyl-2,4-dioxo-1,2,3,4-tetrahydropyrimidine-5-carbonyl)-3-(4-fluorophenyl)-3-morpholinoacrylonitrile (7b): 305 mg (74% yield). Colorless crystals, mp 229–230 °C. IR (ATR, cm^{-1}): 3200–2400, 2210, 1697, 1659, 1601, 1562, 1508, 1400, 1358, 1281, 1261, 1223, 1157, 1072, 910, 845, 810, 756. ^{1}H NMR (DMSO-d_6): 3.09 (s, 3H, CH_3), 3.11–3.14 (m, 4H, CH_2N), 3.40 (s, 3H, CH_3), 3.78–3.81 (m, 4H, CH_2O), 7.22–7.28 (m, 2H, Ar), 7.83–7.88 (m, 2H, Ar), 9.38 (br. s, 2H, NH_2). ^{13}C NMR (DMSO-d_6): 27.7 (CH_3), 29.9 (CH_3), 43.6 ($2CH_2N$), 64.0 ($2CH_2O$), 96.8 (C), 98.9 (C), 115.4 (d, 2CH, $^2J_{CF}$ = 21.9 Hz), 119.7 (C), 131.3 (d, 2CH, $^3J_{CF}$ = 8.6 Hz), 135.5 (d, C, $^4J_{CF}$ = 2.9 Hz), 151.5 (C), 154.7 (C), 161.4 (C), 162.4 (C), 163.4 (d, C–F, $^1J_{CF}$ = 246.0 Hz), 176.3 (C=O). ^{19}F NMR (DMSO-d_6): –111.5 (s, 1F). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{20}H_{21}FN_5O_4$: 414.1578, found 414.1579.

1-(4-Fluorophenyl)-9-oxo-3-(pyrrolidin-1-yl)-9*H*-indeno[2,1-*c*]pyridine-4-carbonitrile (9): 250 mg (68% yield). The product was purified by column chromatography (eluent CCl_4/CH_2Cl_2, 1:1) followed by recrystallization from ethanol. Yellow crystals, mp 228–229 °C. IR (ATR, cm^{-1}): 2978, 2882, 2203, 1701, 1597, 1558, 1528, 1497, 1458, 1335, 1242, 1227, 1200, 1153, 1003, 872, 841, 806, 756, 660. ^{1}H NMR ($CDCl_3$): 2.03 (br. s, 4H, $2CH_2$), 3.97 (br. s, 4H, $2CH_2N$), 7.10–7.14 (m, 2H, Ar), 7.50 (t, 1H, *J* = 7.3 Hz, Ar), 7.57 (t, 1H, *J* = 7.6 Hz, Ar), 7.68 (d, 1H, *J* = 7.3 Hz, Ar), 7.93–7.97 (m, 2H, Ar), 8.38 (d, 1H, *J* = 7.6 Hz, Ar). ^{13}C NMR ($CDCl_3$): 25.6 (br. signal, $2CH_2$), 50.0 ($2CH_2N$), 82.5 (CCN), 114.2 (C), 114.7 (d, 2CH, $^2J_{CF}$ = 21.9 Hz), 118.0 (C), 123.5 (CH), 123.7 (CH), 132.2 (CH), 132.3 (d, 2CH, $^3J_{CF}$ = 8.6 Hz), 132.8 (d, C, $^4J_{CF}$ = 2.9 Hz), 134.1 (CH), 135.8 (C), 137.3 (C), 157.3 (C), 158.7 (C), 160.4 (C), 164.4 (d, C–F, $^1J_{CF}$ = 248.9 Hz), 188.0 (C=O). ^{19}F NMR (DMSO-d_6): –109.8 (s, 1F). HRMS (ESI) *m/z*: $[M + H]^+$ calcd. for $C_{23}H_{17}FN_3O$: 370.1356, found 370.1354.

Reaction of α-arylidene-β-ketonitriles 4g,i with methylene active nitriles. To a mixture of the α-arylidene-β-ketonitrile **4g** or **4i** (1 mmol) and methylene active nitrile (ethyl cyanoacetate or malononitrile, 1 mmol) in 5 mL of ethanol one drop of piperidine was added and the obtained solution was heated at reflux temperature for 15 min. The reaction mixture was cooled to –30 °C, the precipitate formed was filtered off and washed with ice-cold methanol to give products **10a**,**b**.

Ethyl (*E*)-2-cyano-3-(4-morpholinophenyl)acrylate (10a): 235 mg (82% yield). Yellow crystals, mp 156–157 °C (lit mp 155–157 °C [Pourshojaei, Y.; Eskandari, K.; Elhami, E.; Asadipour, A. Molybdenum Oxide Nanoparticles as Recyclable Heterogeneous Catalyst for Synthesis of Arylidene Ethyl Cyanoacetates. *J. Nanosci. Nanotechnol*. **2019**, *19*, 5965–5973.]). ^{1}H NMR (DMSO-d_6): 1.25 (t, 3H, *J* = 7.1 Hz, C<u>H</u>$_3$CH$_2$), 3.35–3.39 (m, 4H, 2CH$_2$N), 3.67–3.70 (m, 4H, 2CH$_2$O), 4.23 (q, 2H, *J* = 7.1 Hz, CH$_3$C<u>H</u>$_2$), 7.03 (d, 2H, *J* = 8.9 Hz, Ar), 7.93 (d, 2H, *J* = 8.9 Hz, Ar), 8.11 (s, 1H, CH=CCN). ^{13}C NMR (DMSO-d_6): 14.6 (<u>C</u>H$_3$CH$_2$O), 46.8 (2CH$_2$N), 62.2 (CH$_3$<u>C</u>H$_2$O), 66.3 (2CH$_2$O), 94.8 (<u>C</u>CN), 113.8 (2CH), 117.6 (CN), 120.9 (C), 134.1 (2CH), 154.62 (C–N), 154.66 (<u>C</u>H=CCN), 163.6 (C=O). HRMS (ESI) *m/z*: [M + H]$^+$ calcd. for C$_{16}$H$_{19}$N$_2$O$_3$: 287.1396, found 287.1399.

2-[4-(Pyrrolidin-1-yl)benzylidene]malononitrile (10b): 178 mg (80% yield). Yellow crystals, mp 154–156 °C (lit mp 156 °C [Brunskill, J.S.A.; Vas, A.De&G.M.F. A Concurrent Knoevenagel and Aromatic Nucleophilic Substitution Reaction. *Synth. Commun*. **1978**, *8*, 1–7.]). ^{1}H NMR (CDCl$_3$): 2.04–2.13 (m, 4H, 2CH$_2$N), 3.40–3.48 (m, 4H, 2CH$_2$N), 6.55 (d, 2H, *J* = 8.9 Hz, Ar), 7.38 (s, 1H, CH=CCN), 7.76 (d, 2H, *J* = 8.9 Hz, Ar). ^{13}C NMR (CDCl$_3$): 25.4 (2CH$_2$), 48.0 (2CH$_2$N), 70.8 (<u>C</u>CN), 112.2 (2CH), 115.3 (CN), 116.4 (CN), 119.2 (C), 134.1 (2CH), 152.0 (C–N), 158.1 (<u>C</u>H=CCN). HRMS (ESI) *m/z*: [M + H]$^+$ calcd. for C$_{14}$H$_{14}$N$_3$: 224.1188, found 224.1185.

***trans*-5-(4-Methoxybenzoyl)-2-phenyl-4-[4-(piperidin-1-yl)phenyl]-4,5-dihydrofuran-3-carbonitrile (12).** To a mixture of the α-arylidene-β-ketonitrile **4b** (200 mg, 0.63 mmol) and pyridinium salt **11** (195 mg, 0.63 mmol) in 5 mL of acetonitrile triethylamine (0.09 mL, 0.63 mmol) was added and the obtained solution was boiled under an argon atmosphere for 5 h. The reaction mixture was concentrated under reduced pressure and the residue was purified by recrystallization from methanol. Yield 220 mg (76%). Colorless crystals, mp 116–118 °C. IR (ATR, cm^{-1}): 2940, 2205 (CN), 1686 (C=O), 1630, 1599, 1574, 1512, 1493, 1449, 1423, 1387, 1371, 1258, 1236, 1209, 1175, 1121, 1074, 1051, 1024, 993, 949, 914, 887, 829, 804, 766, 692. ^{1}H NMR (CDCl$_3$): 1.55–1.62 (m, 2H, CH$_2$), 1.67–1.74 (m, 4H, 2CH$_2$), 3.16–3.20 (m, 4H, 2CH$_2$), 3.88 (s, 3H, MeO), 4.59 (d, 1H, *J* = 5.7 Hz, H-4), 5.84 (d, 1H, *J* = 5.7 Hz, H-5), 6.94 (d, 4H, *J* = 8.9 Hz, Ar), 7.19 (d, 2H, *J* = 8.9 Hz, Ar), 7.44–7.52 (m, 3H, Ar), 7.89 (d, 2H, *J* = 8.9 Hz, Ar), 8.05 (dd, 2H, *J* = 8.9, 1.6 Hz, Ar). ^{13}C NMR (CDCl$_3$): 24.4 (CH$_2$), 25.9 (2CH$_2$), 50.3 (2CH$_2$N), 52.5 (MeO), 55.7 (CH-4), 85.6 (<u>C</u>–CN), 89.6 (CH-5), 114.3 (2CH), 116.80 (CN), 116.84 (2CH), 126.5 (C), 127.5 (2CH), 127.6 (C), 128.5 (2CH), 128.8 (2CH), 129.3 (C), 131.6 (2CH), 131.8 (CH), 152.2 (C), 164.4 (C), 166.1 (C), 191.3 (C=O). HRMS (ESI) *m/z*: [M + H]$^+$ calcd. for C$_{30}$H$_{29}$N$_2$O$_3$: 465.2178, found 465.2170.

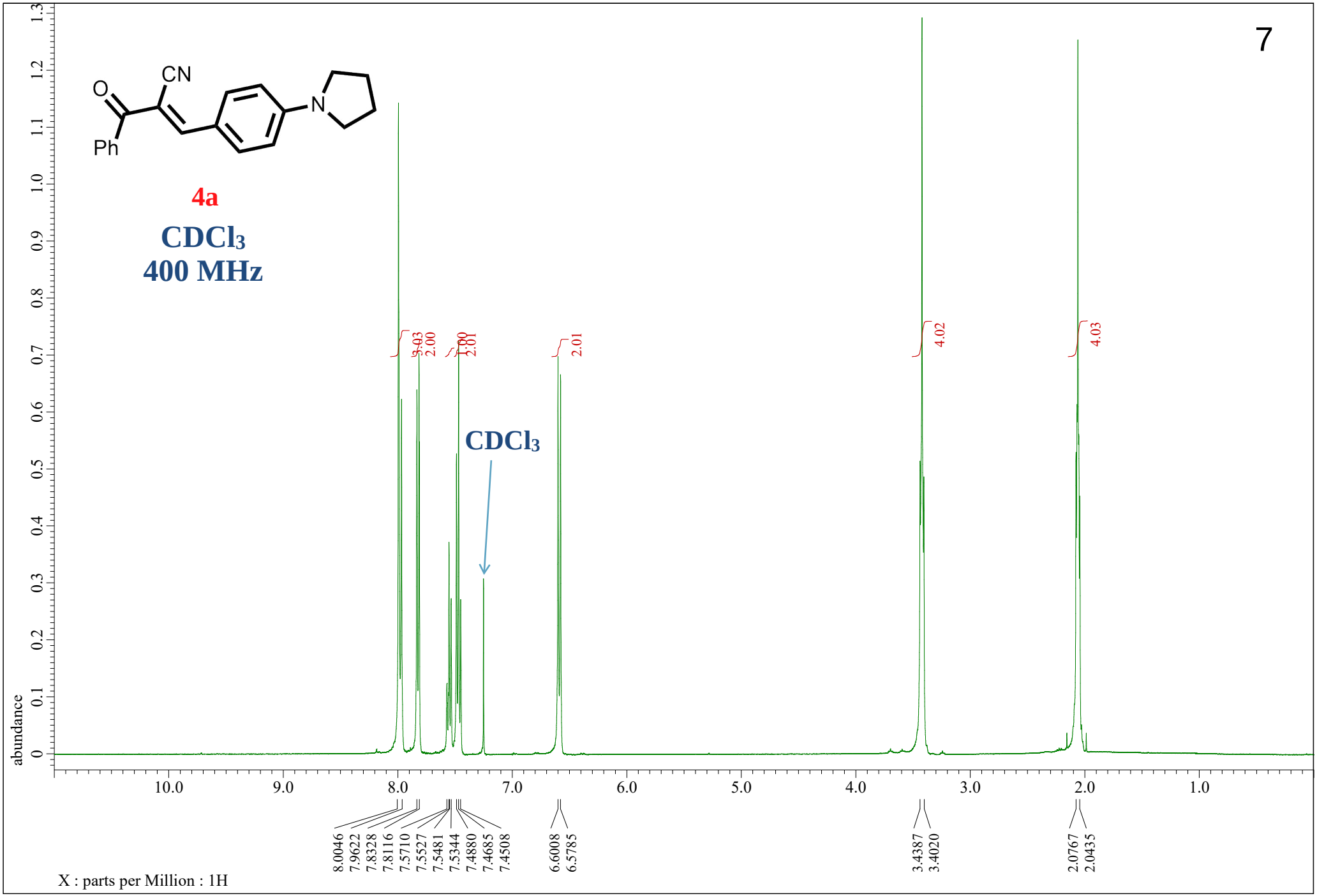

Figure S1. NMR spectra of **4a**

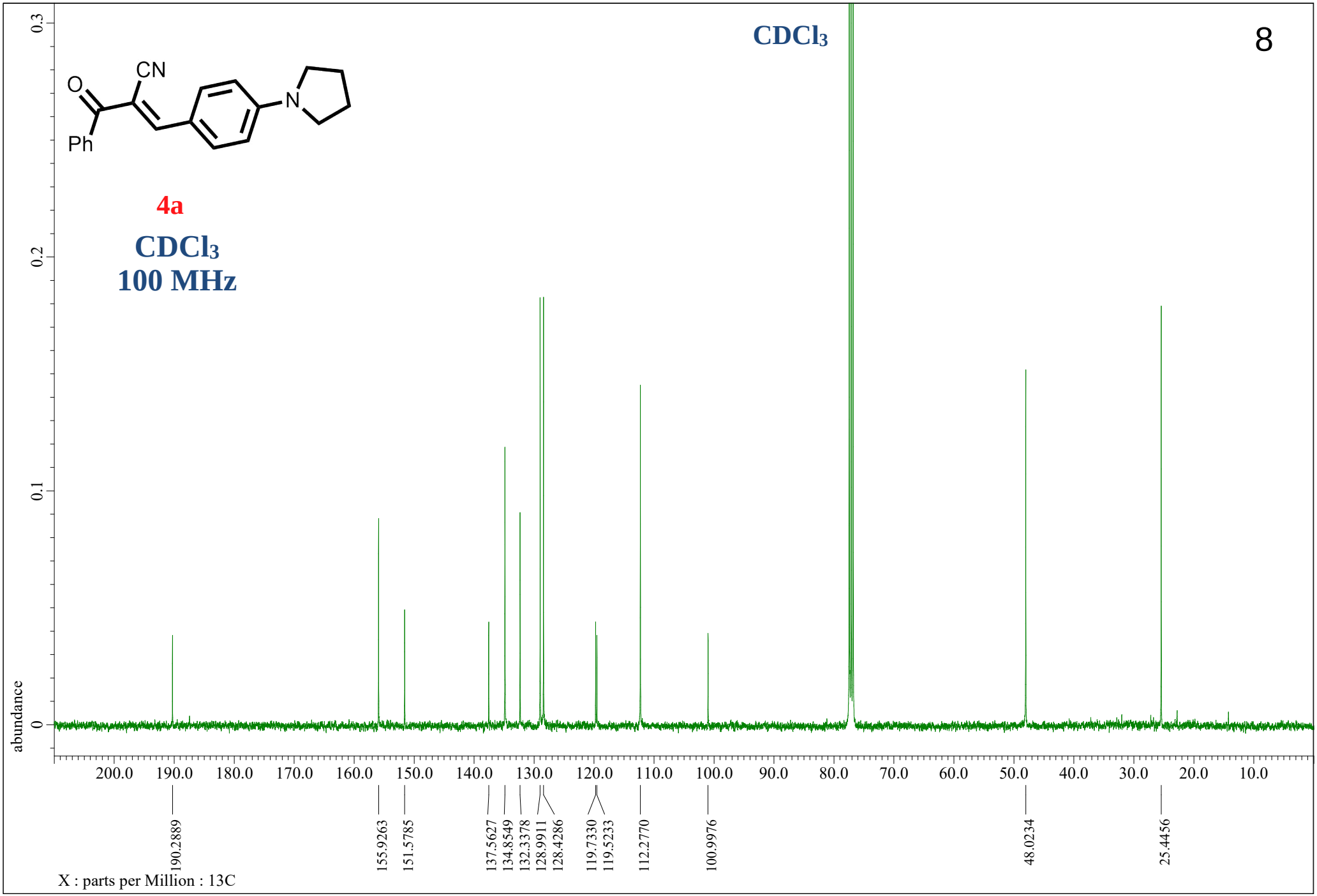

Figure S1. NMR spectra of **4a**

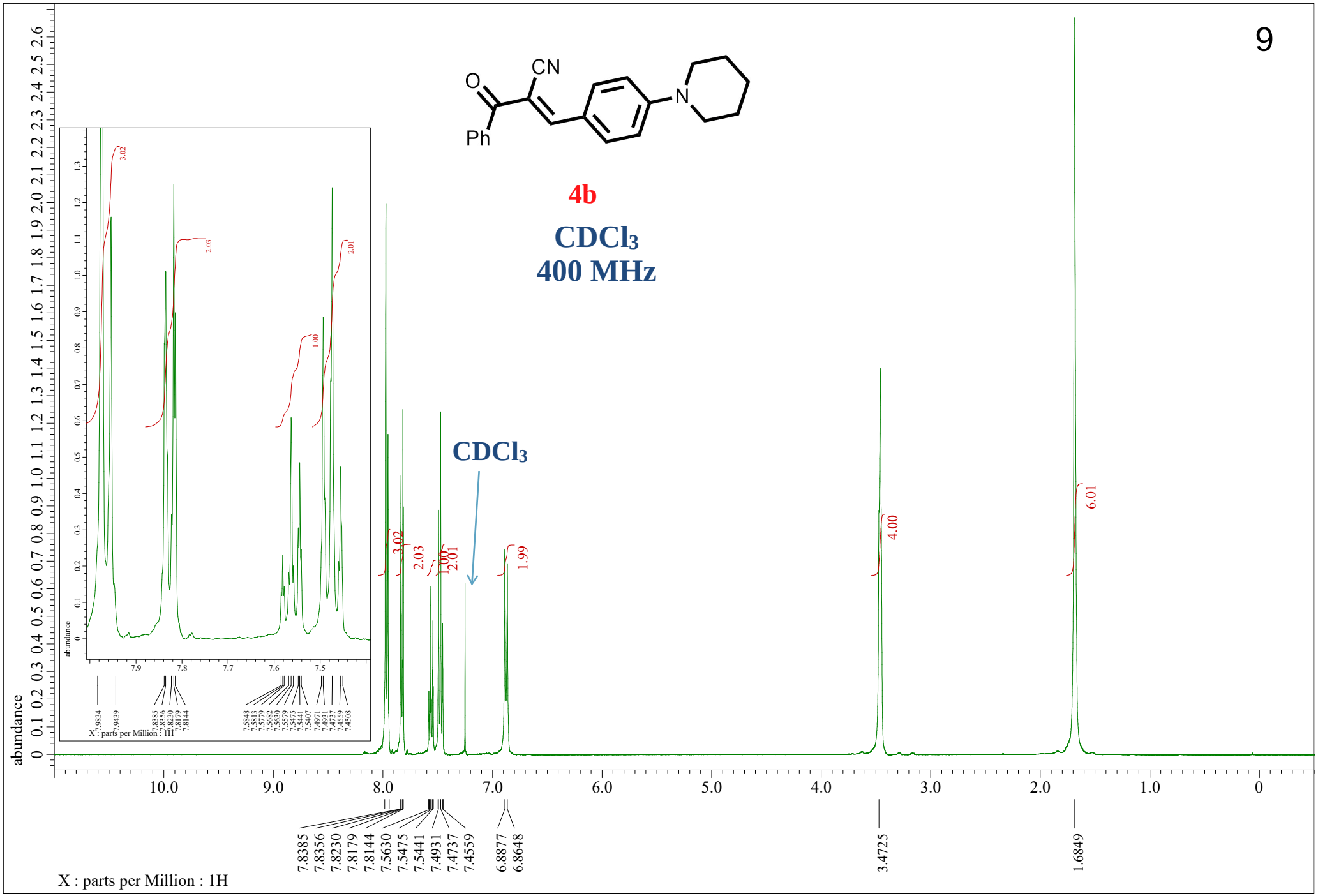

Figure S2. NMR spectra of **4b**

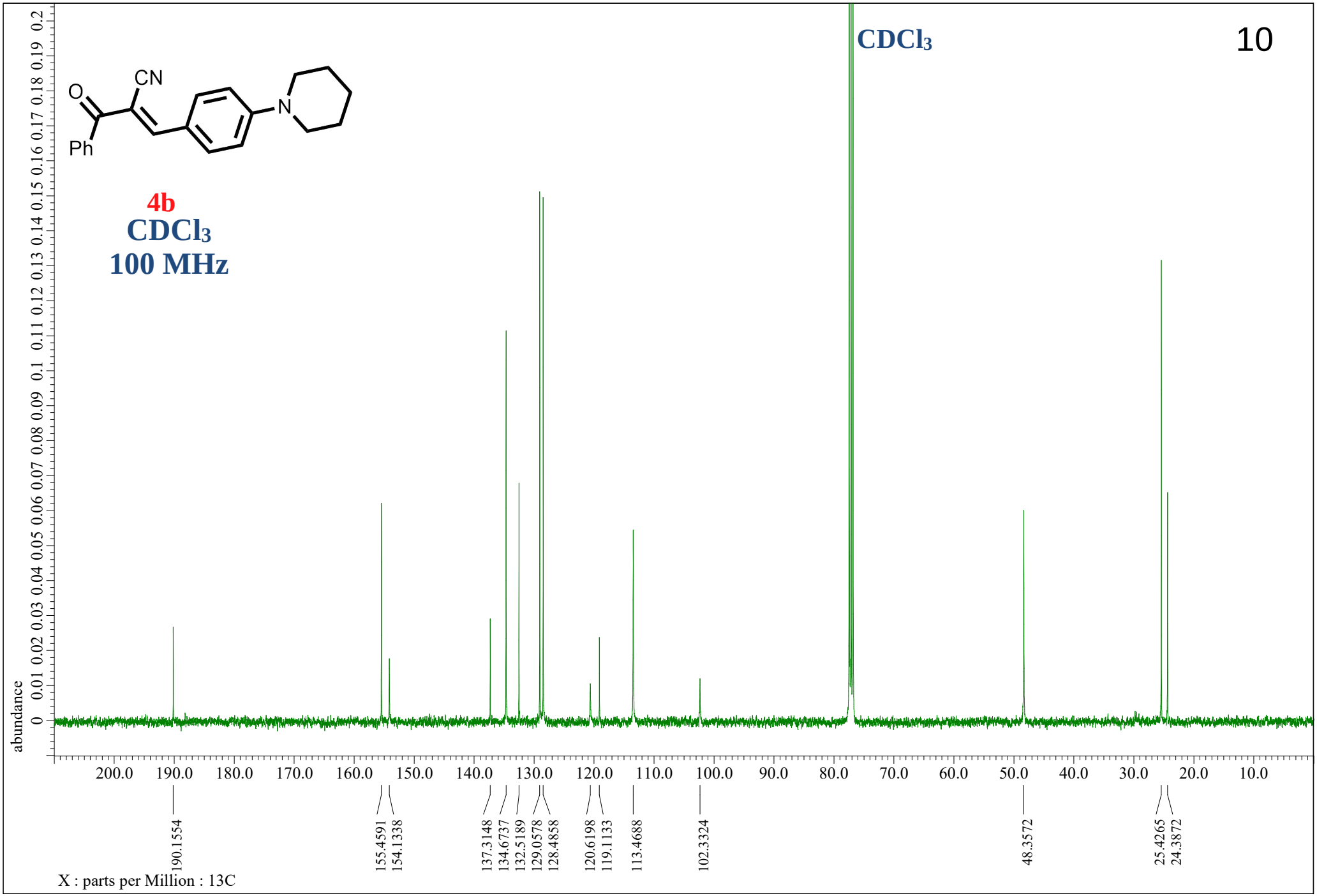

Figure S2. NMR spectra of **4b**

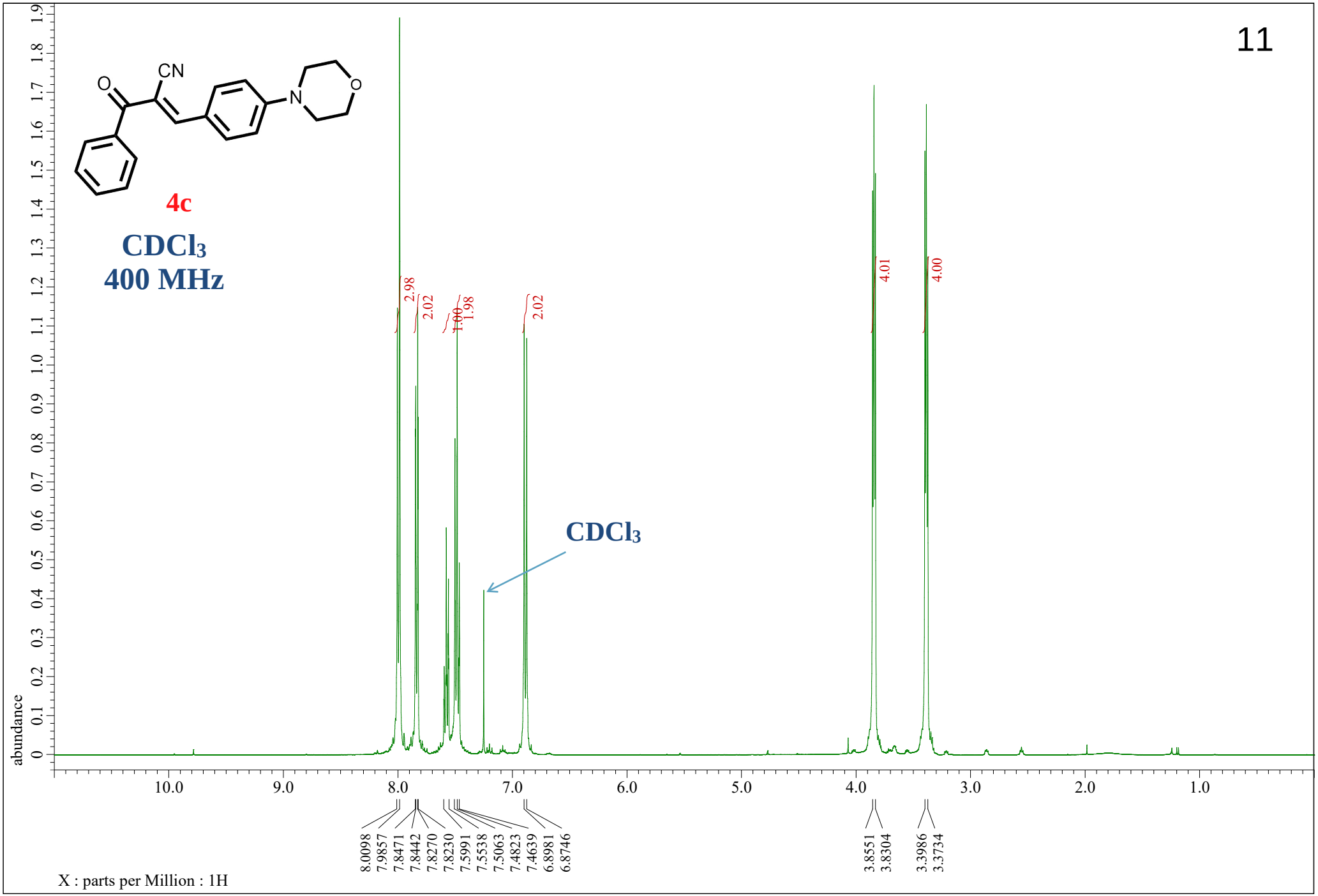

Figure S3. NMR spectra of **4c**

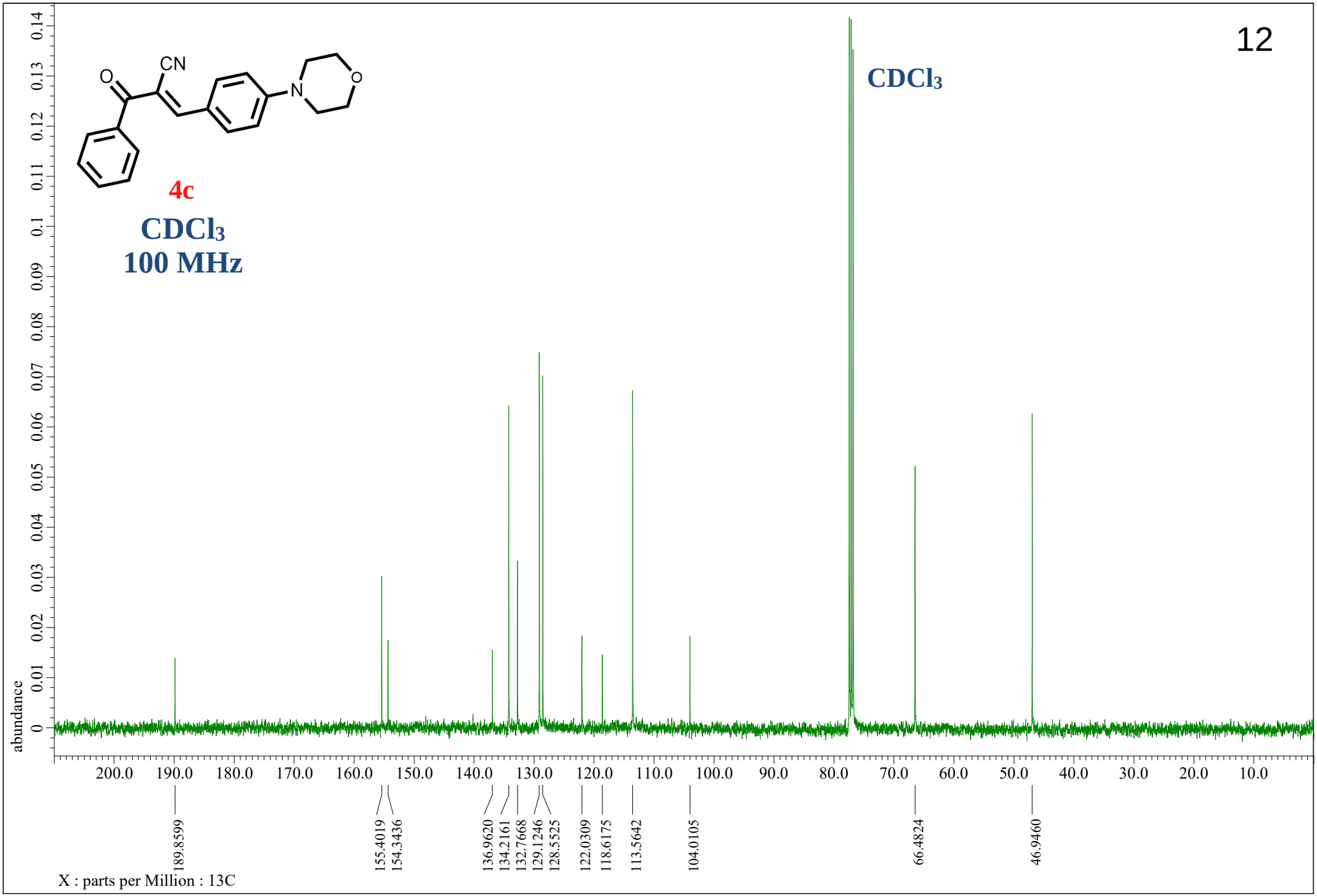

Figure S3. NMR spectra of **4c**

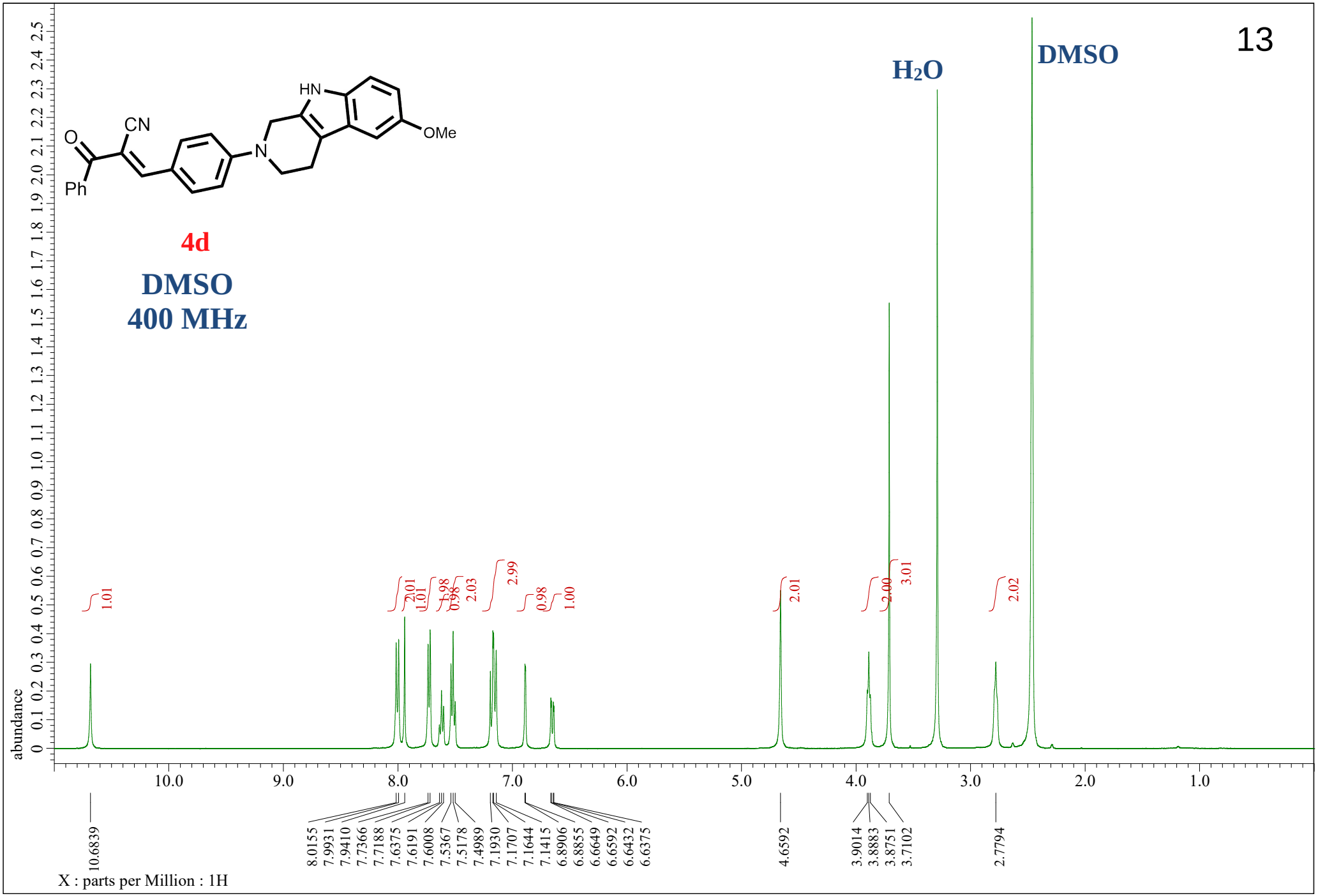

Figure S4. NMR spectra of **4d**

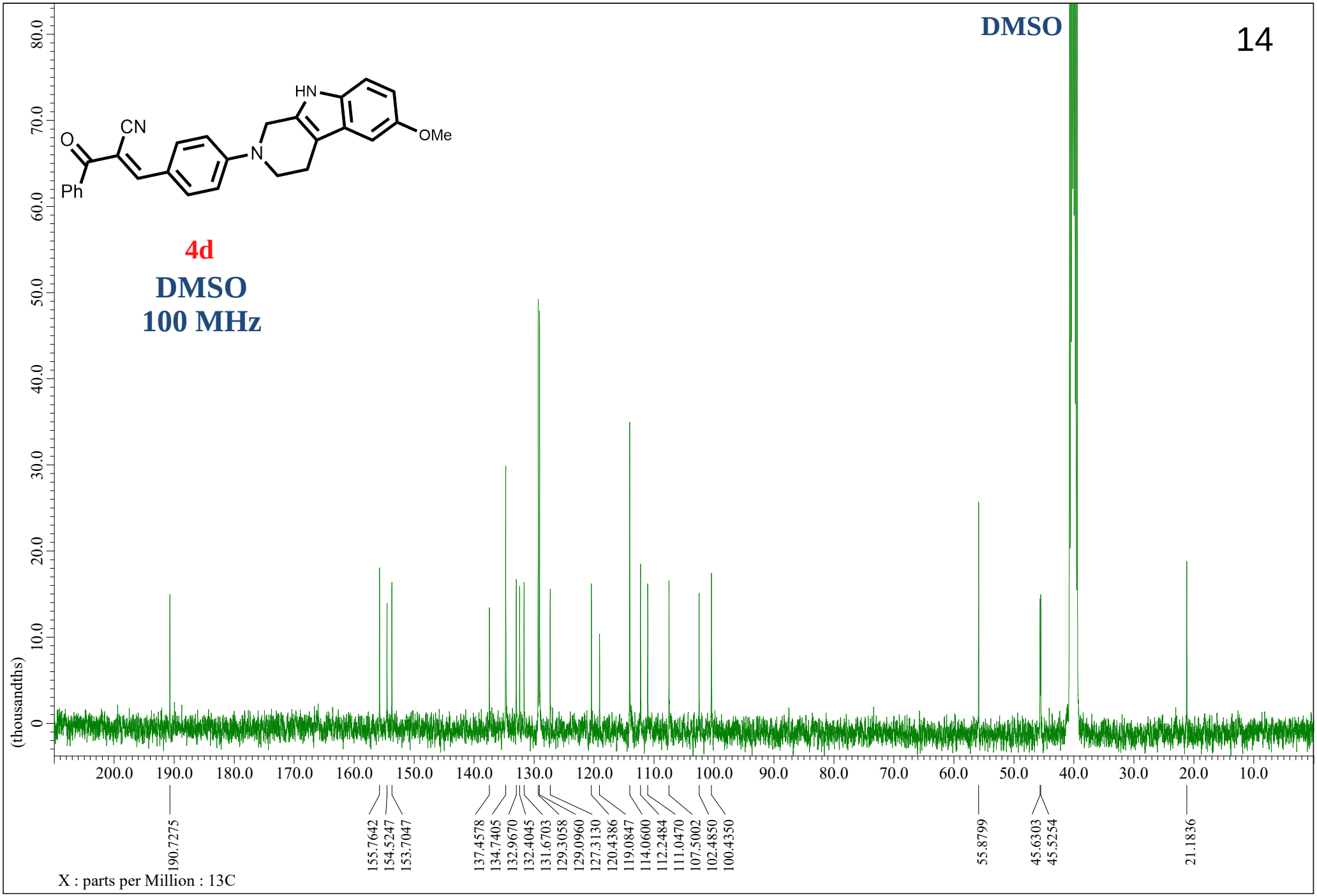

Figure S4. NMR spectra of **4d**

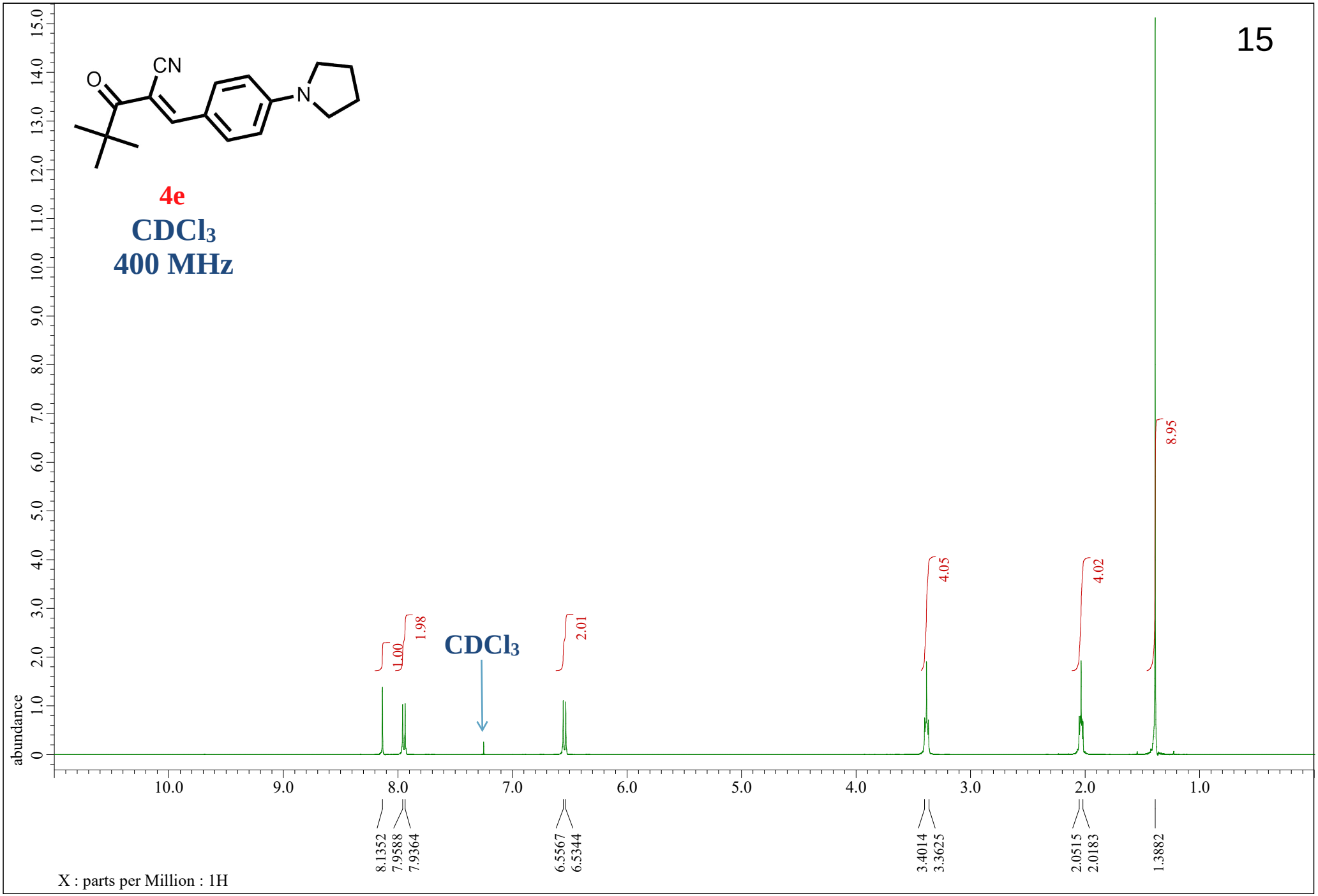

Figure S5. NMR spectra of **4e**

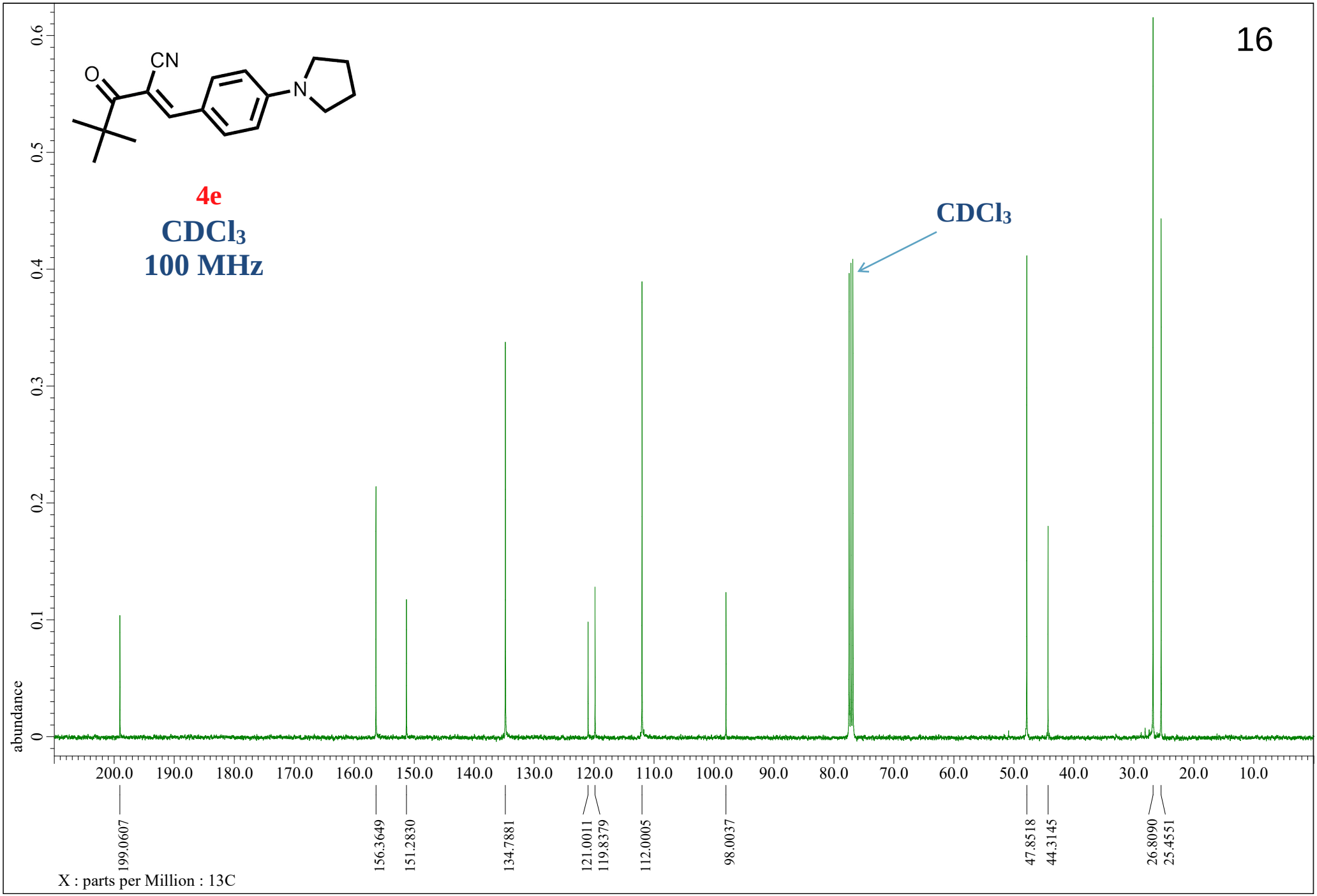

Figure S5. NMR spectra of **4e**

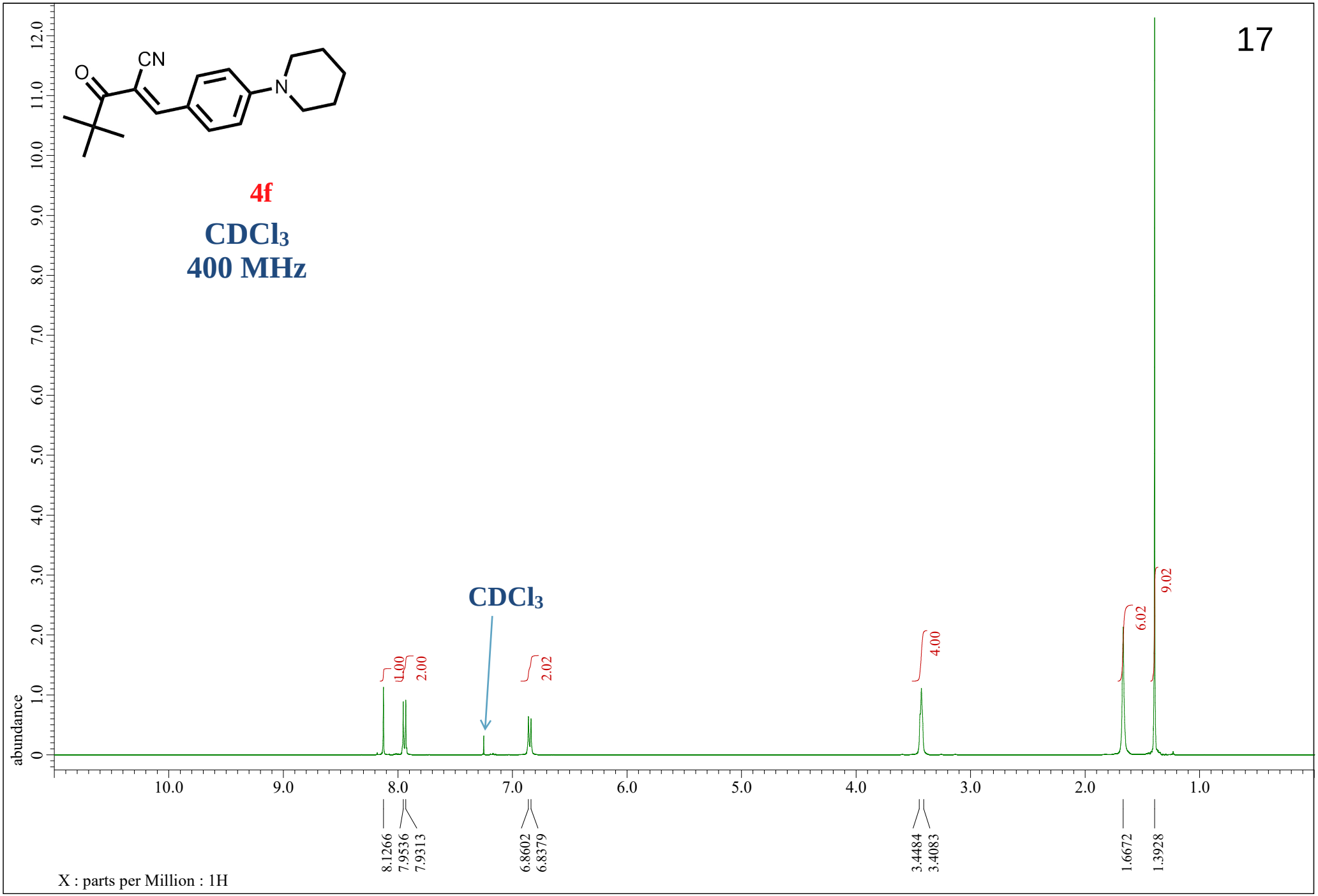

Figure S6. NMR spectra of **4f**

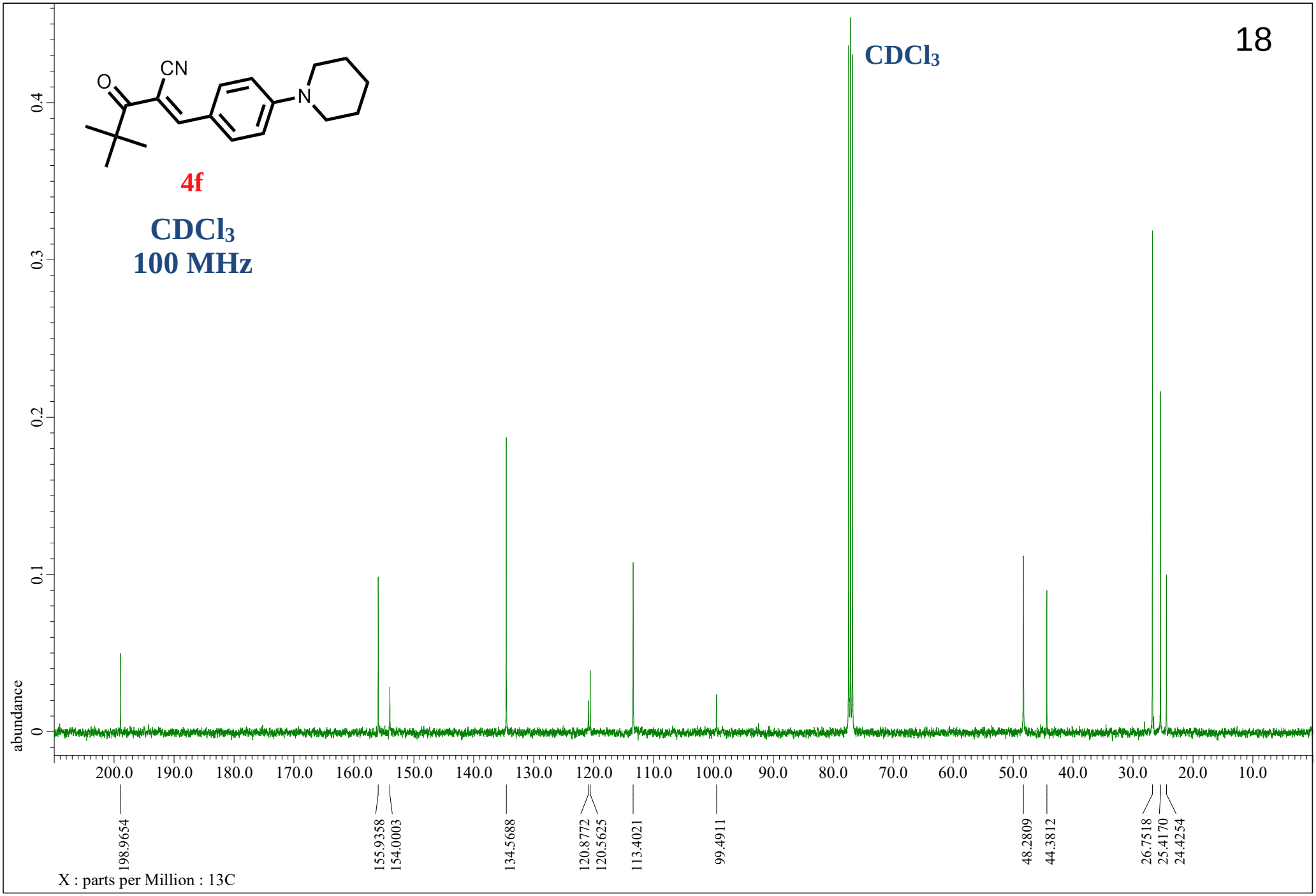

Figure S6. NMR spectra of **4f**

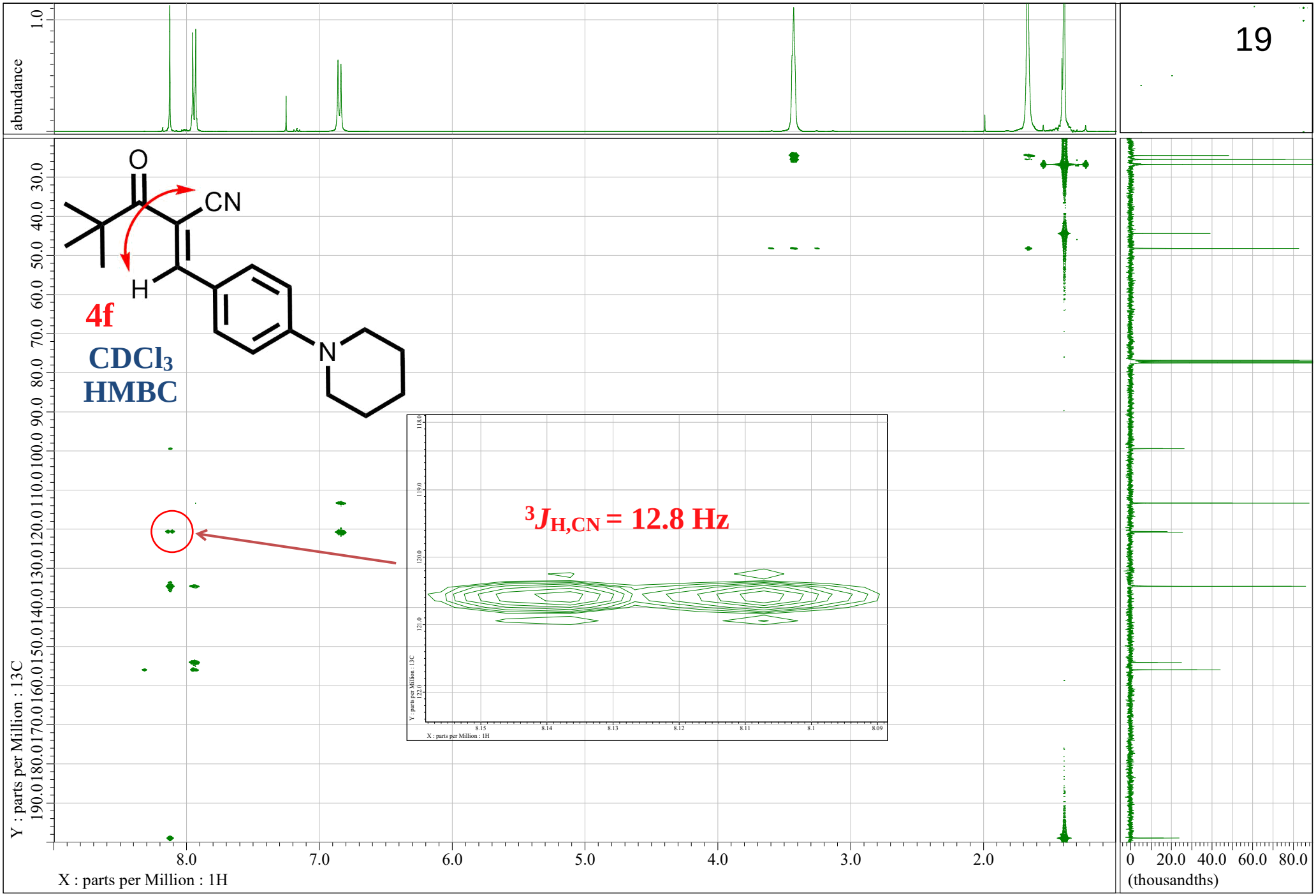

Figure S6. NMR spectra of **4f**

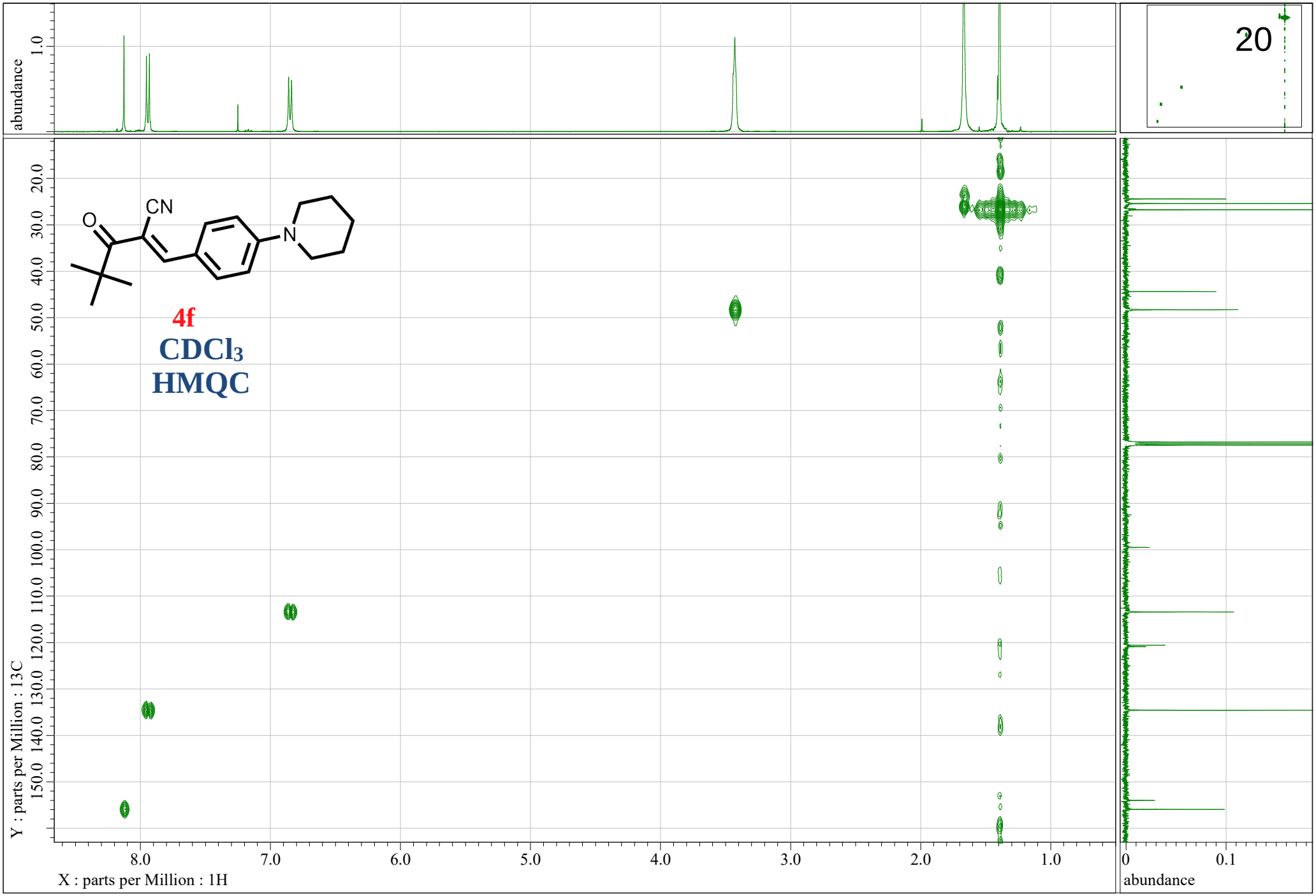

Figure S6. NMR spectra of **4f**

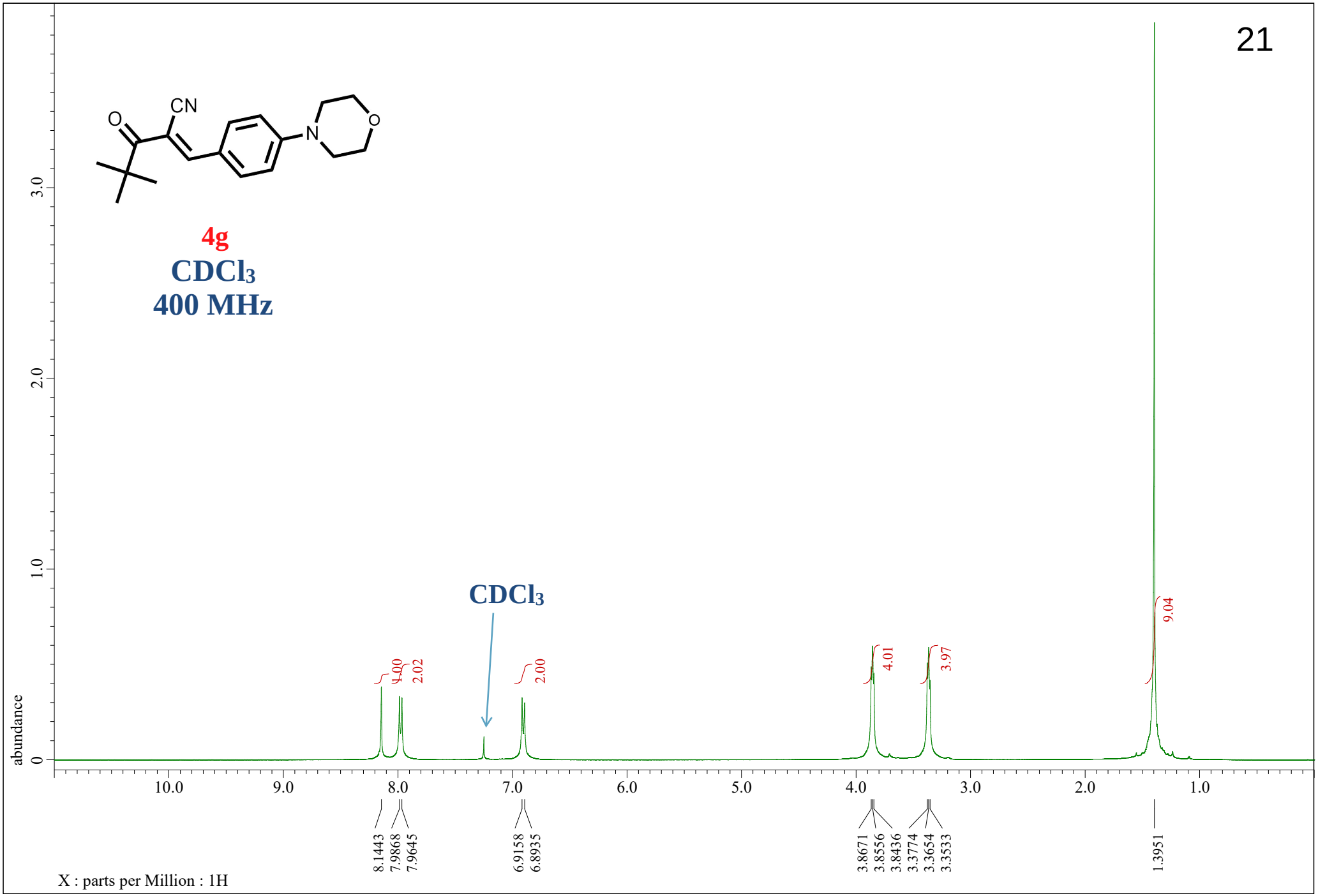

Figure S7. NMR spectra of **4g**

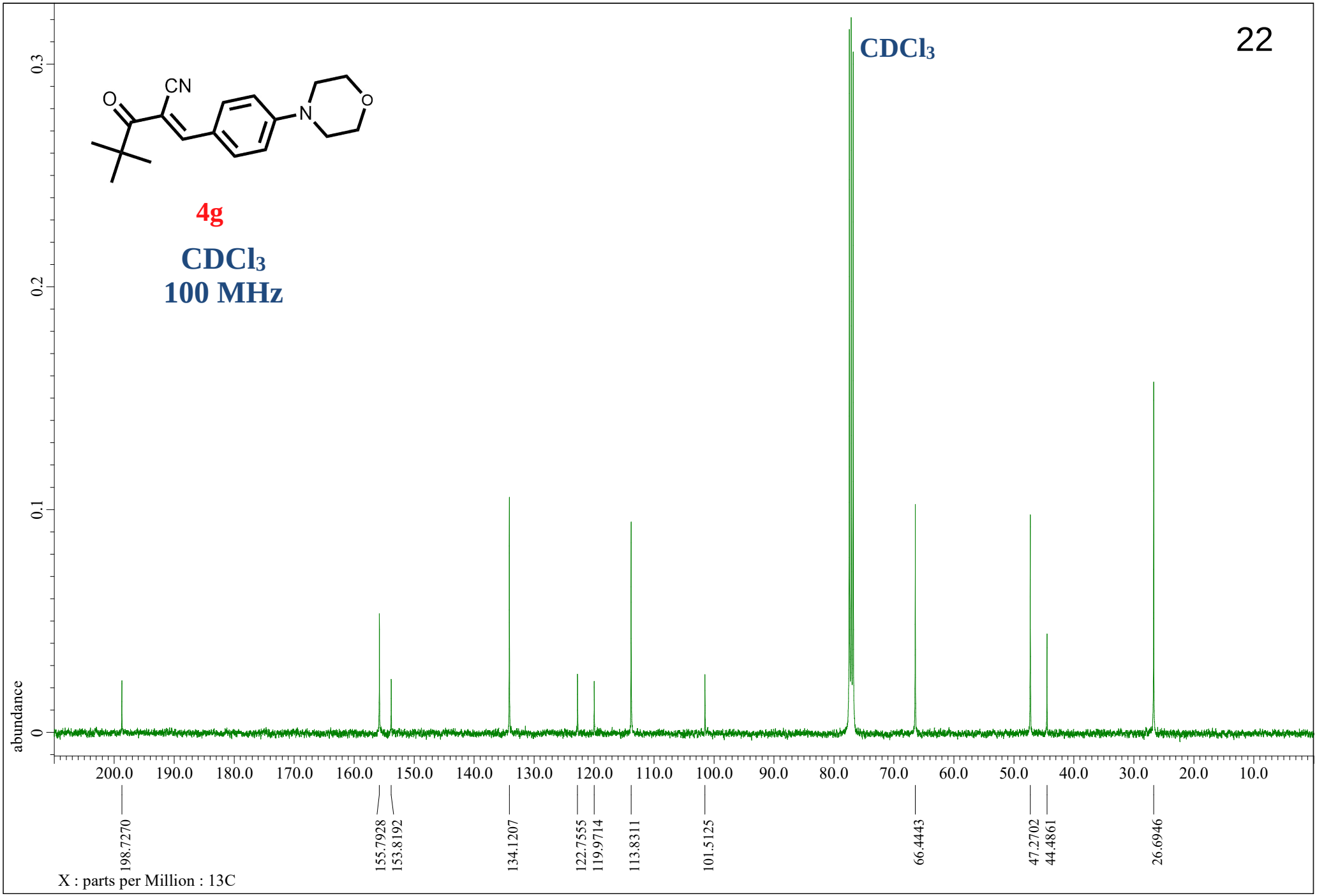

Figure S7. NMR spectra of **4g**

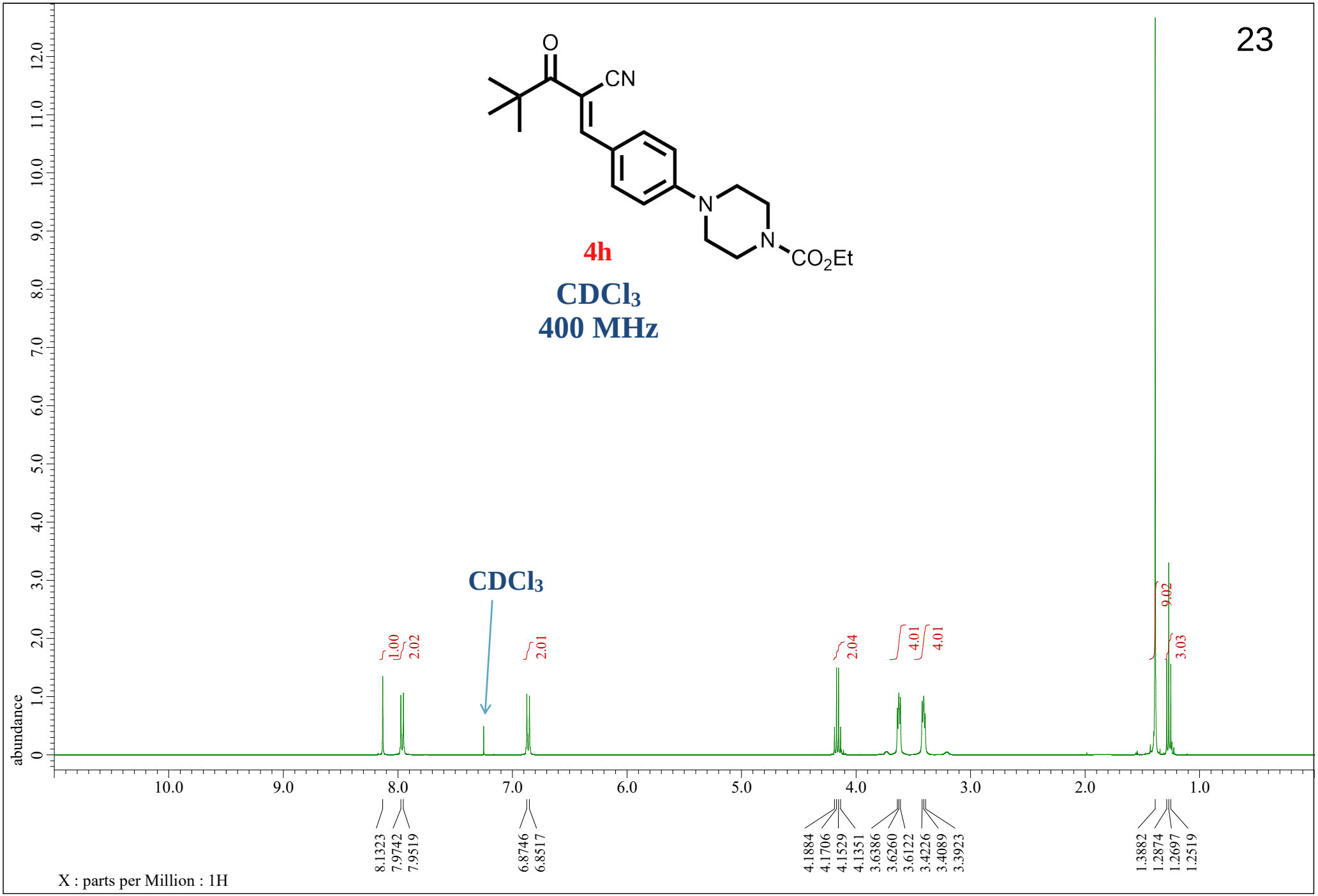

Figure S8. NMR spectra of **4h**

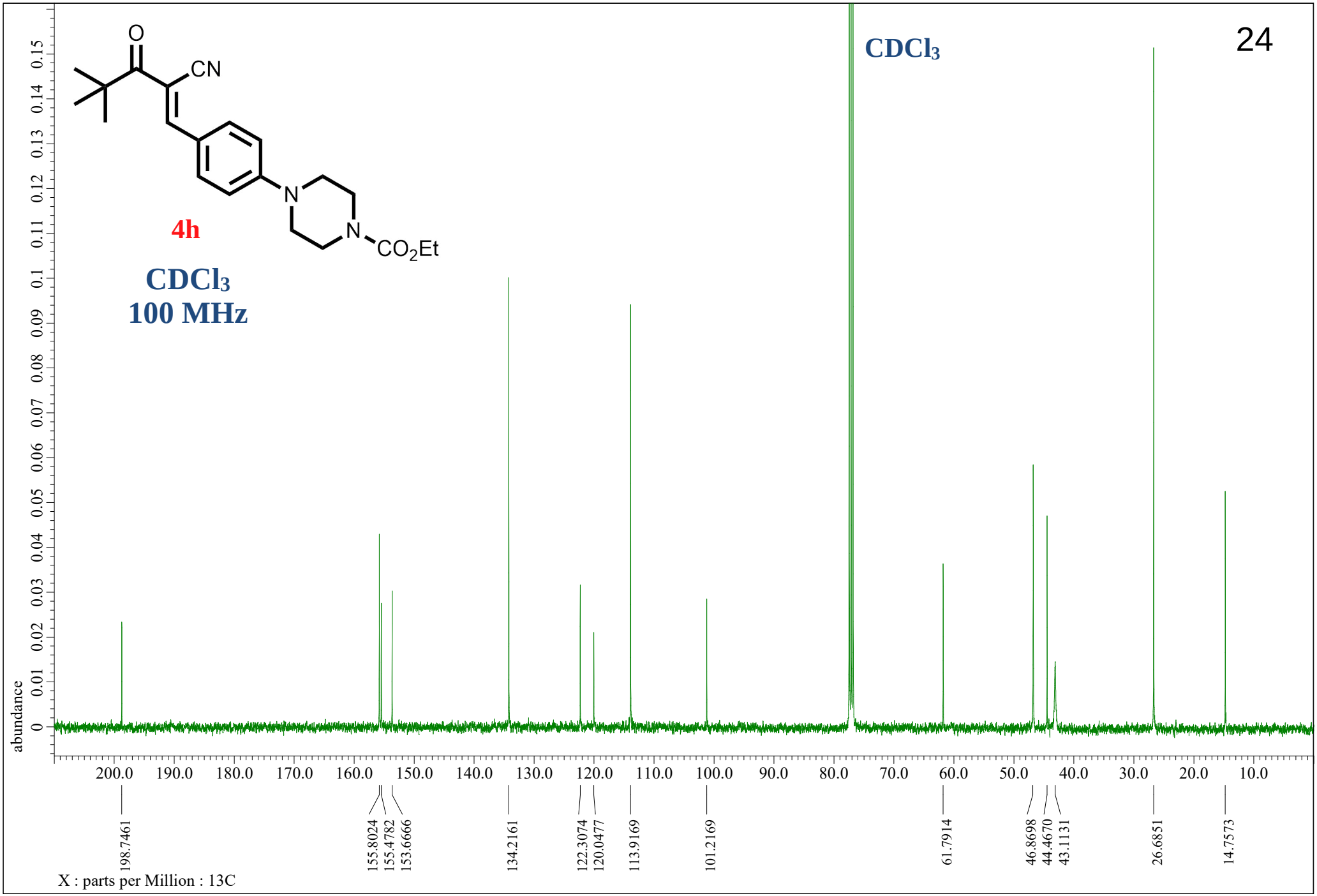

Figure S8. NMR spectra of **4h**

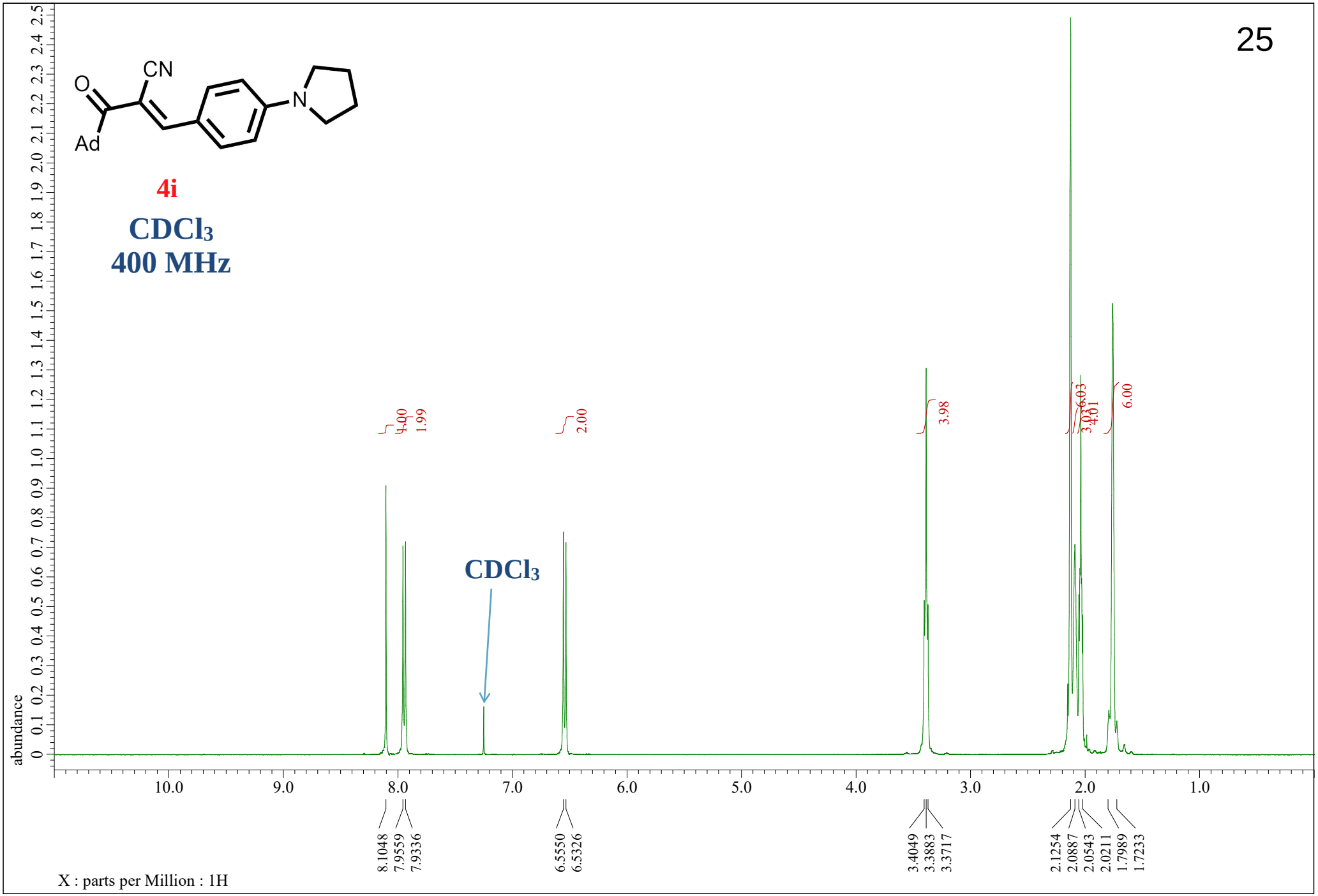

Figure S9. NMR spectra of **4i**

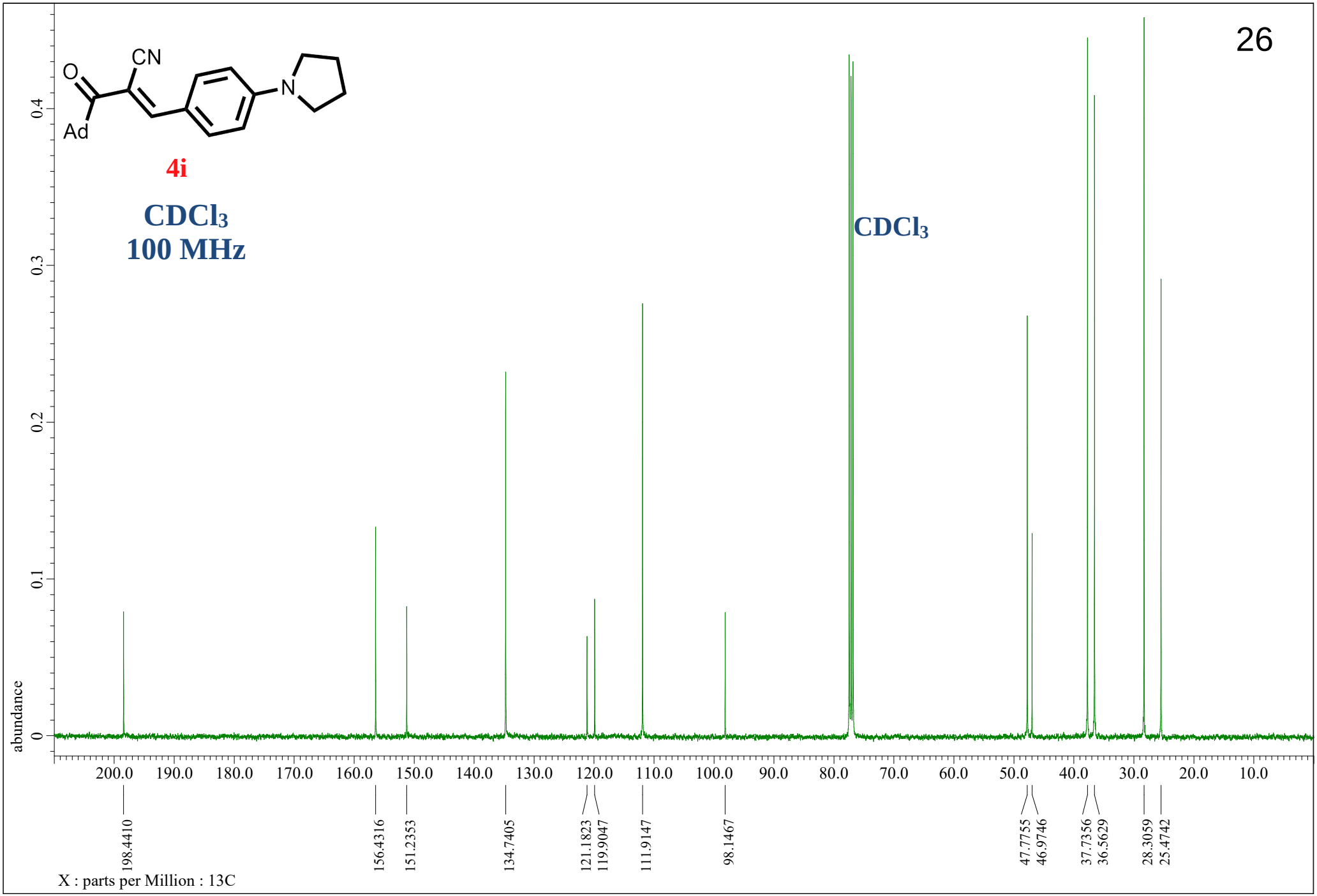

Figure S9. NMR spectra of **4i**

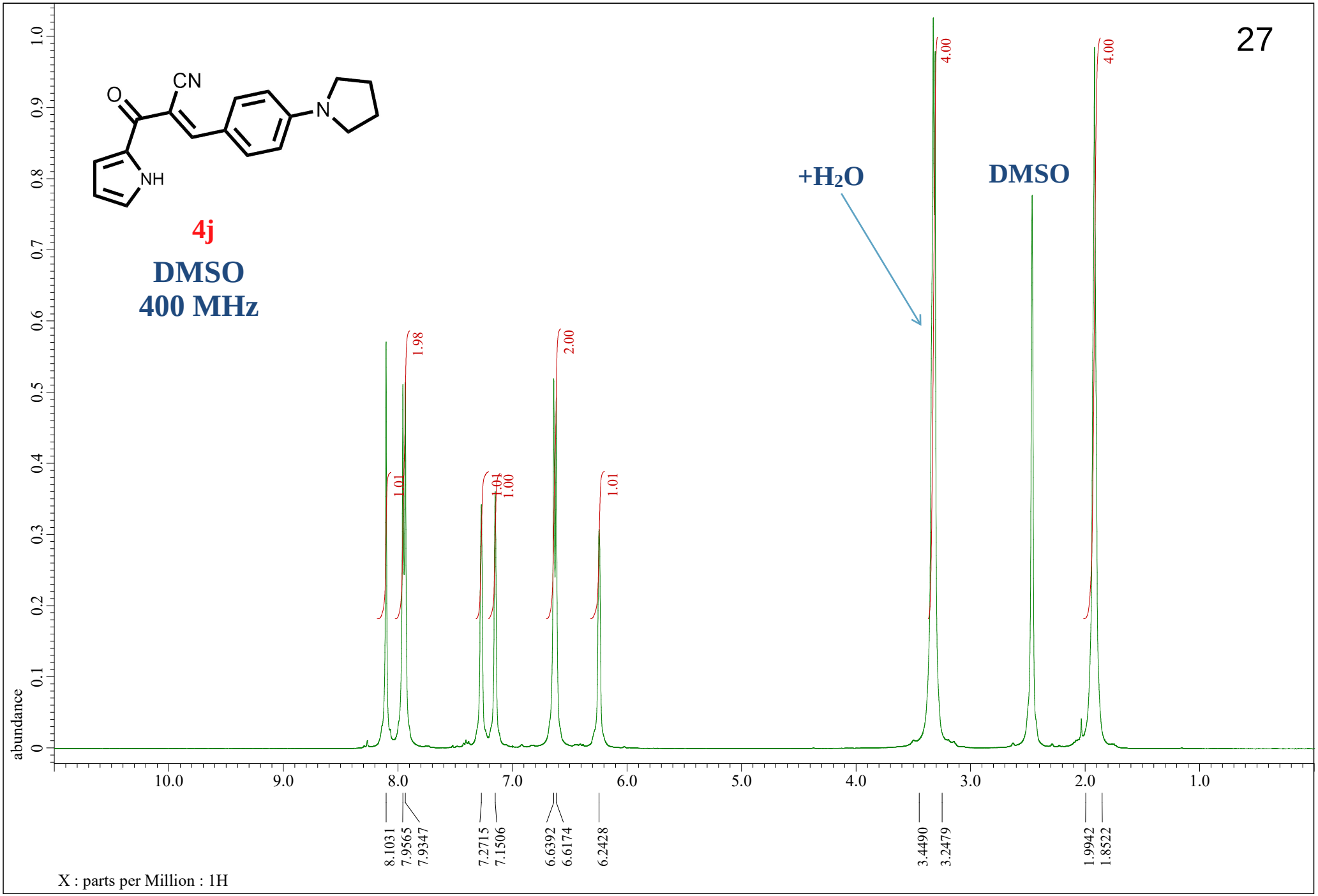

Figure S10. NMR spectra of **4j**

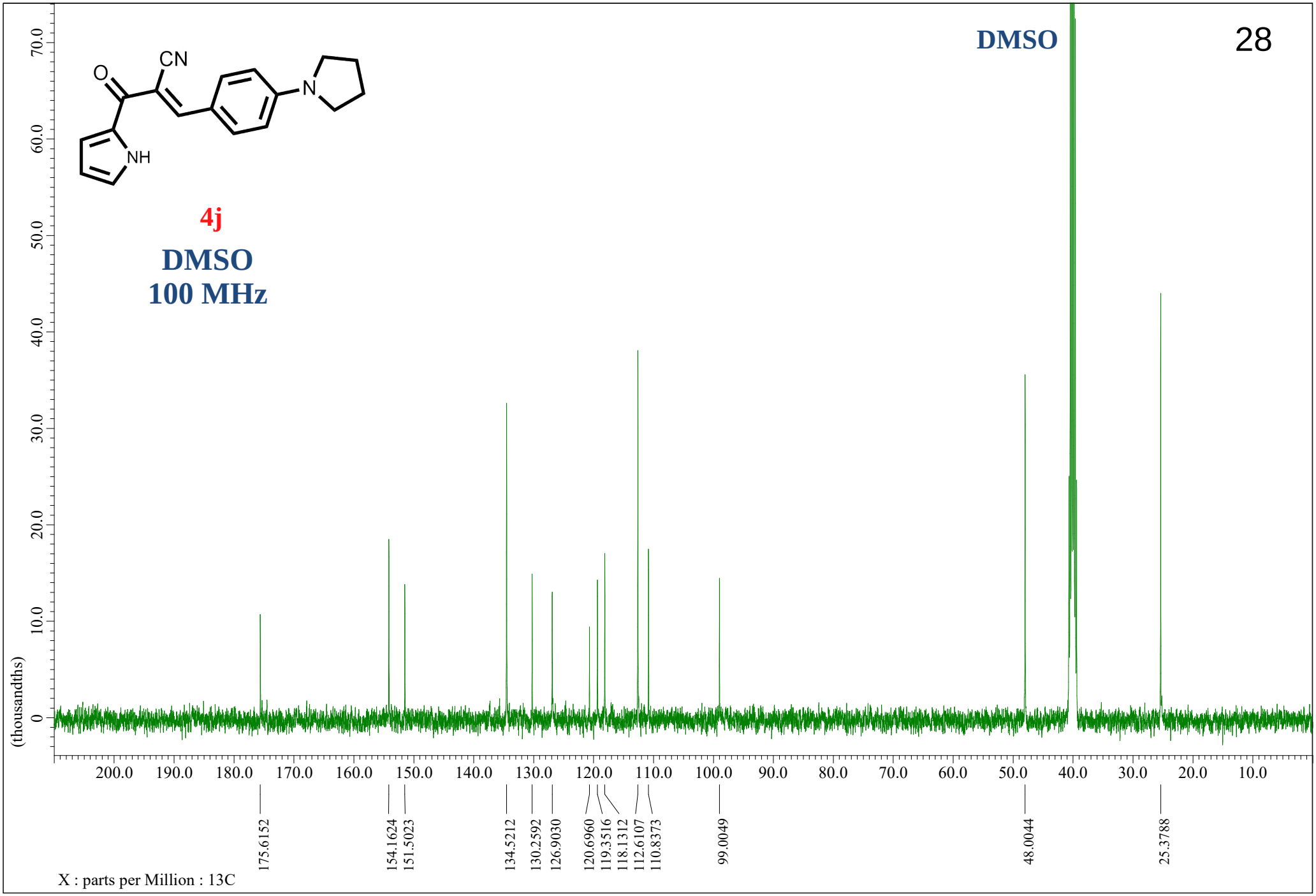

Figure S10. NMR spectra of **4j**

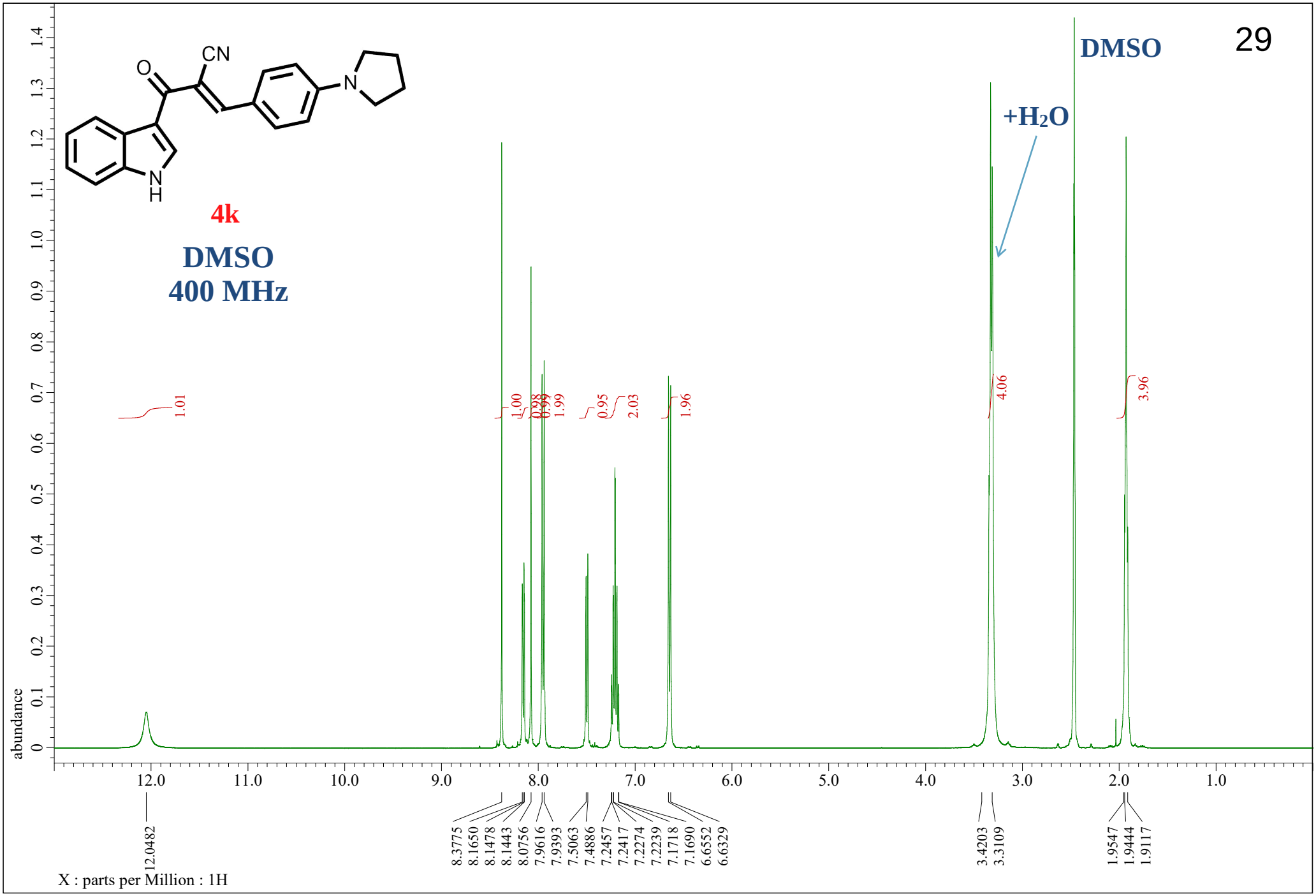

Figure S11. NMR spectra of **4k**

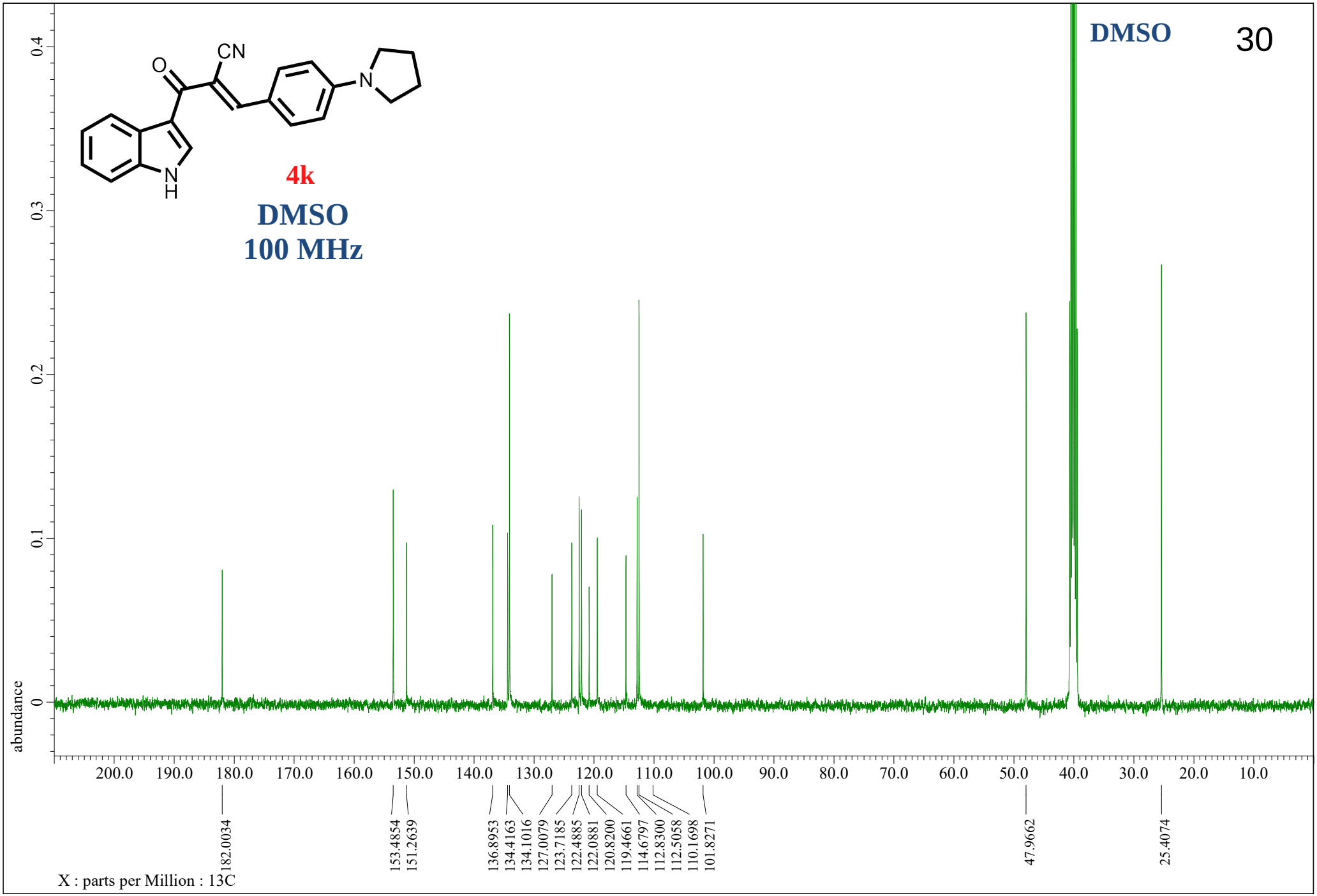

Figure S11. NMR spectra of **4k**

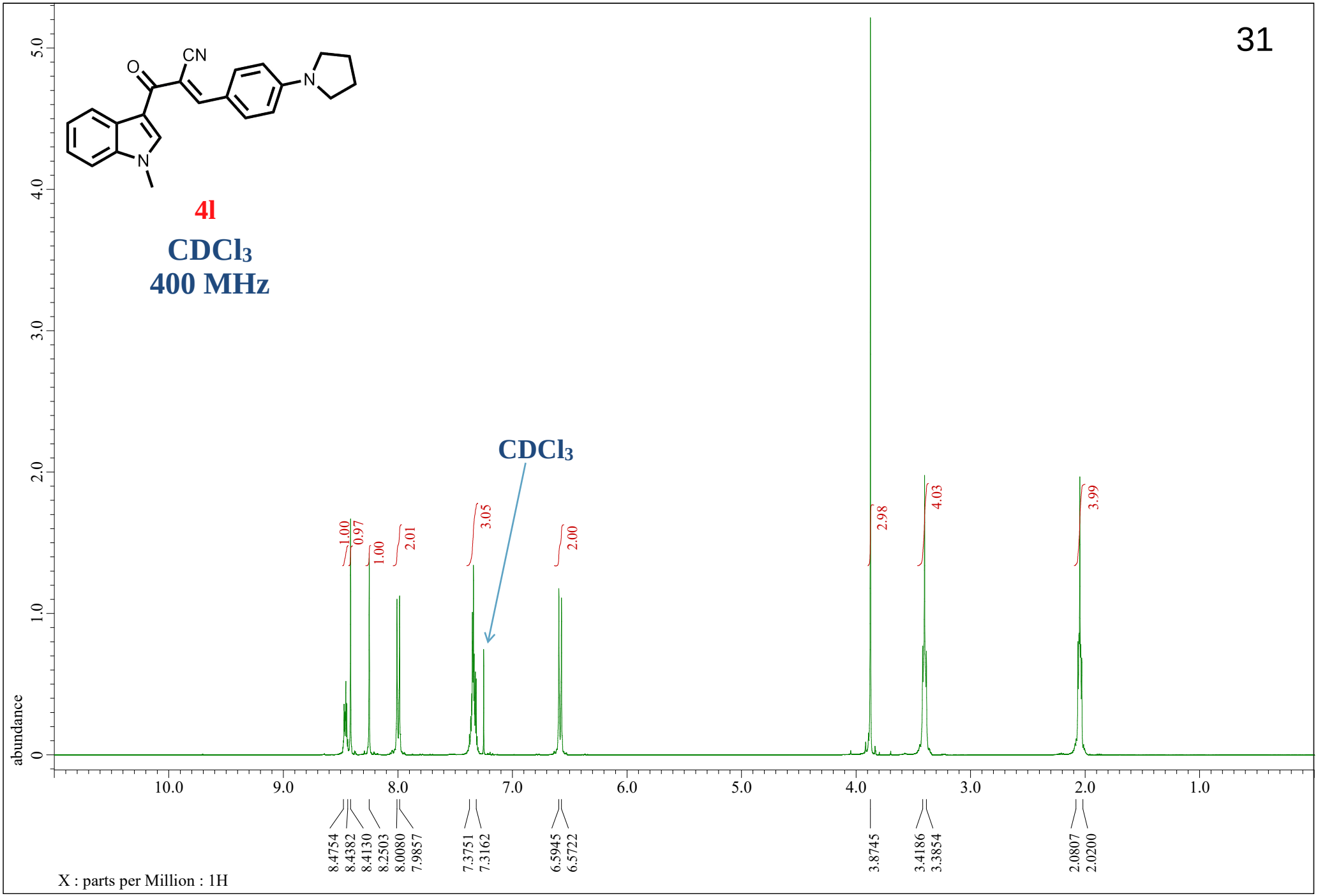

Figure S12. NMR spectra of **4l**

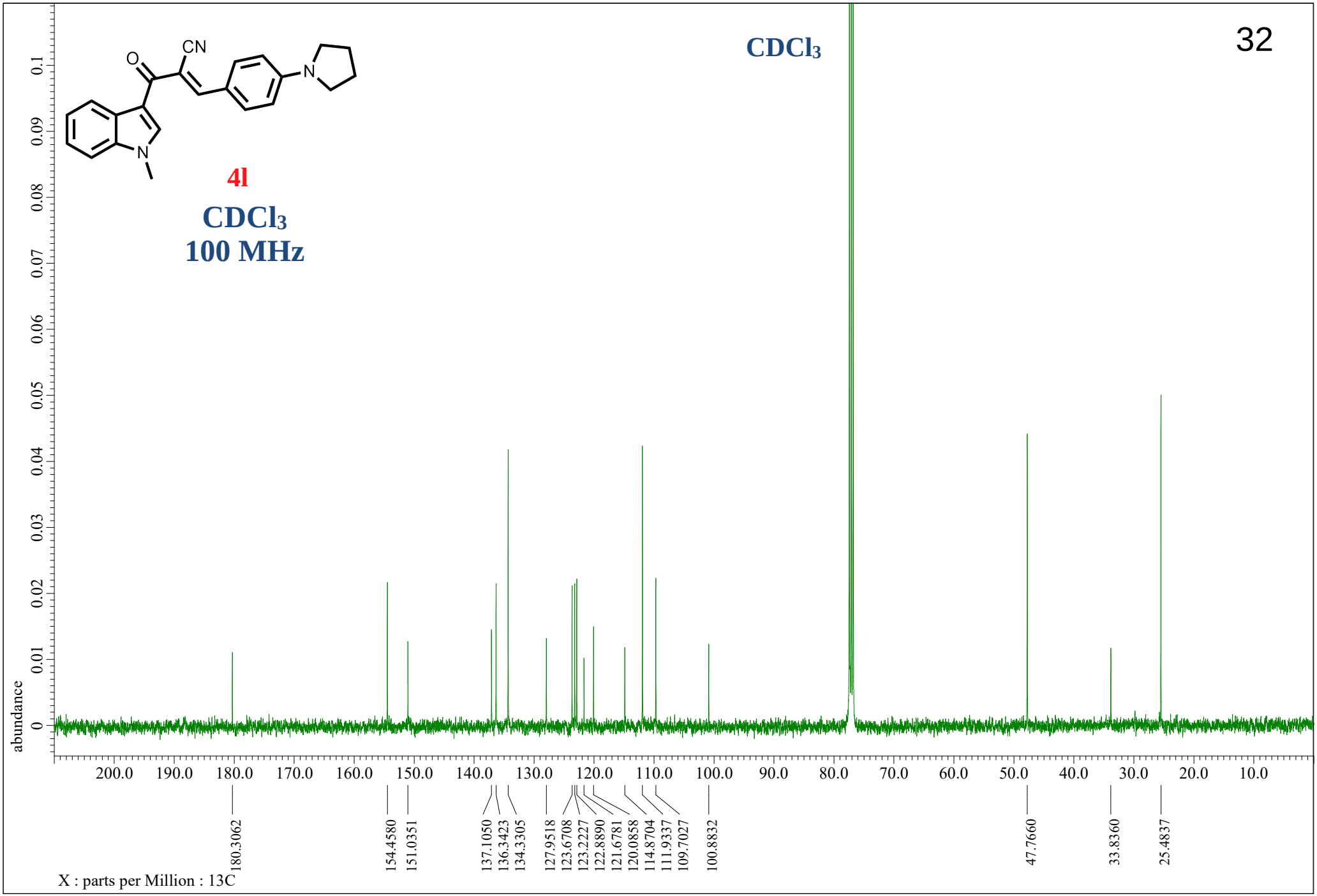

Figure S12. NMR spectra of **4l**

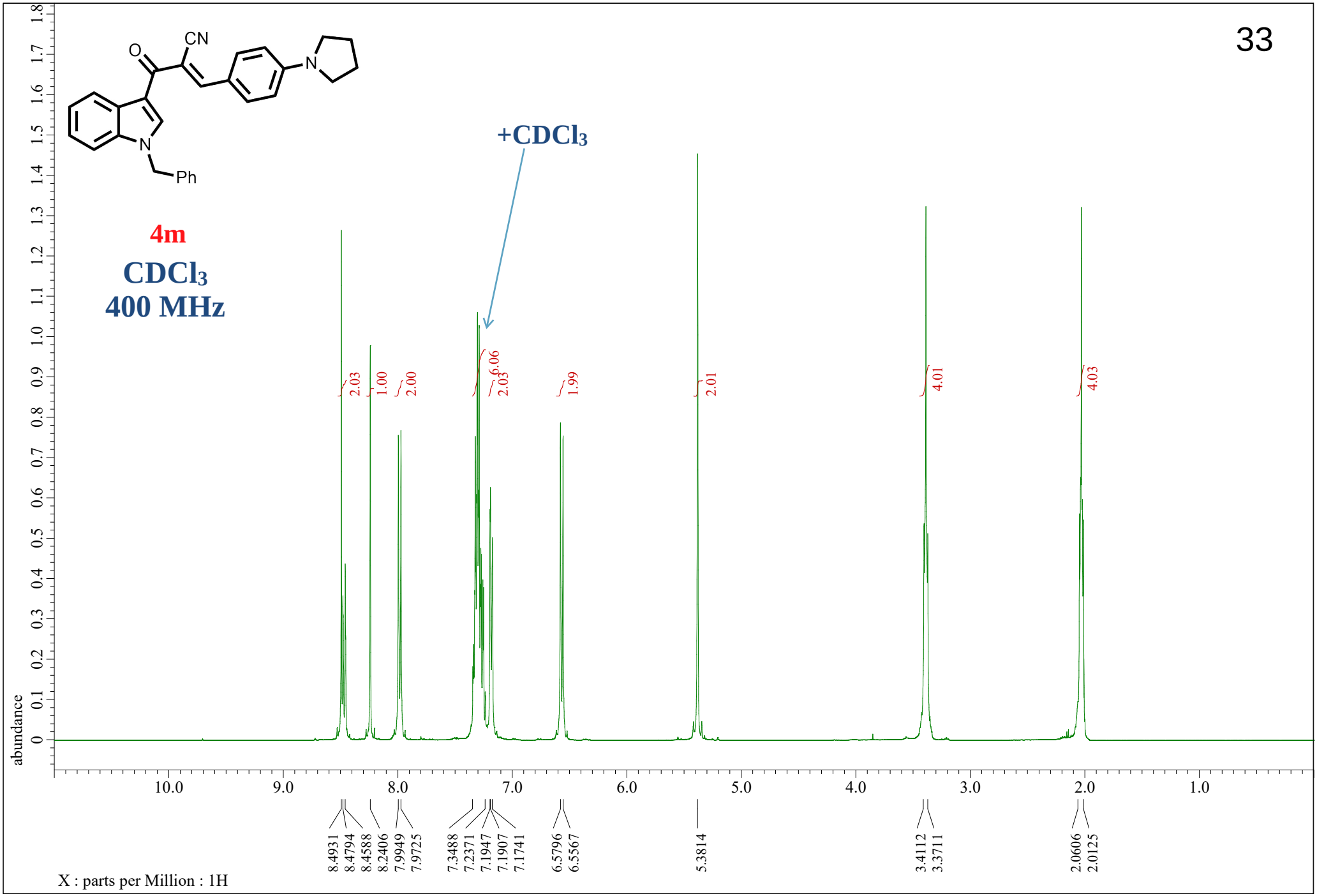

Figure S13. NMR spectra of **4m**

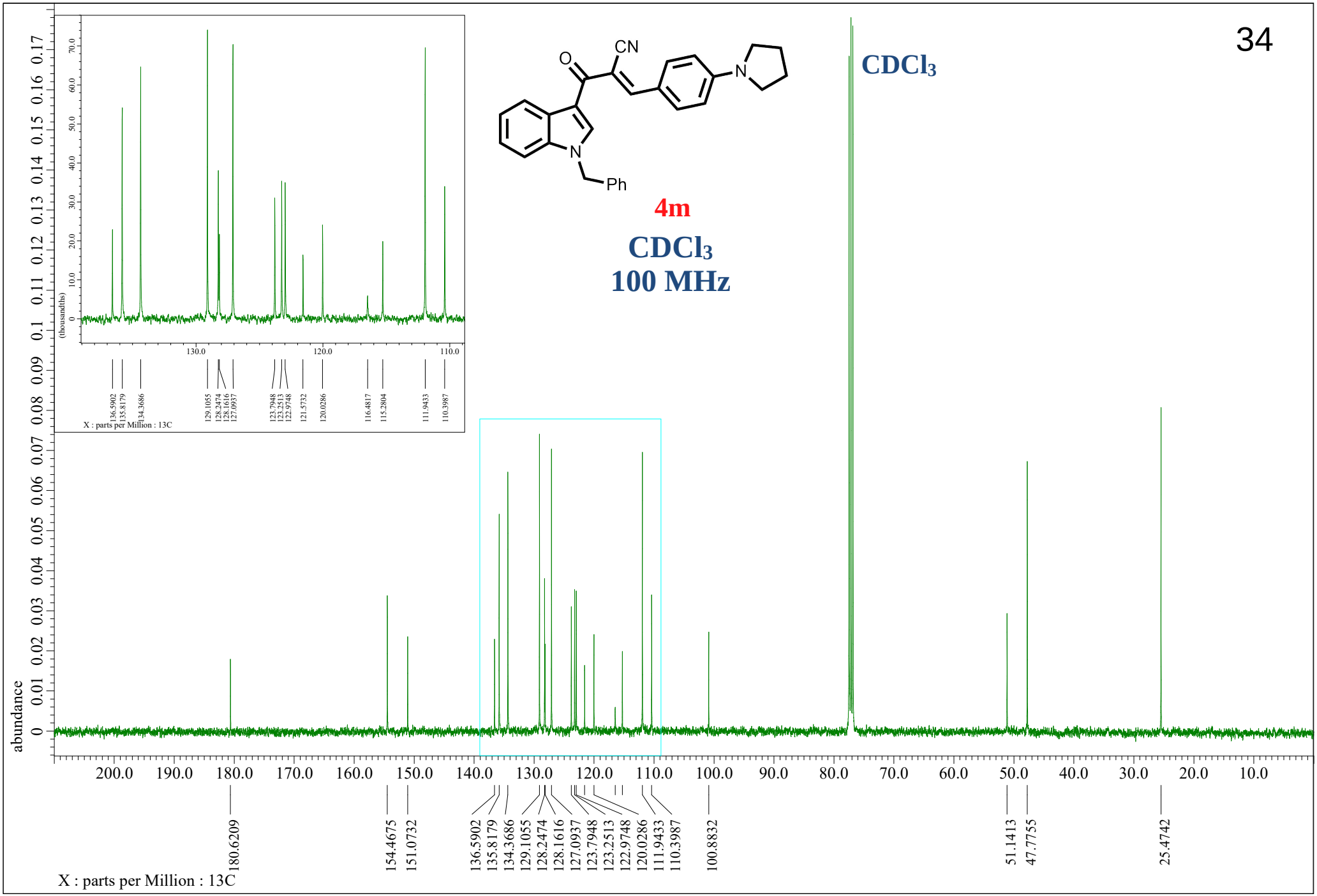

Figure S13. NMR spectra of **4m**

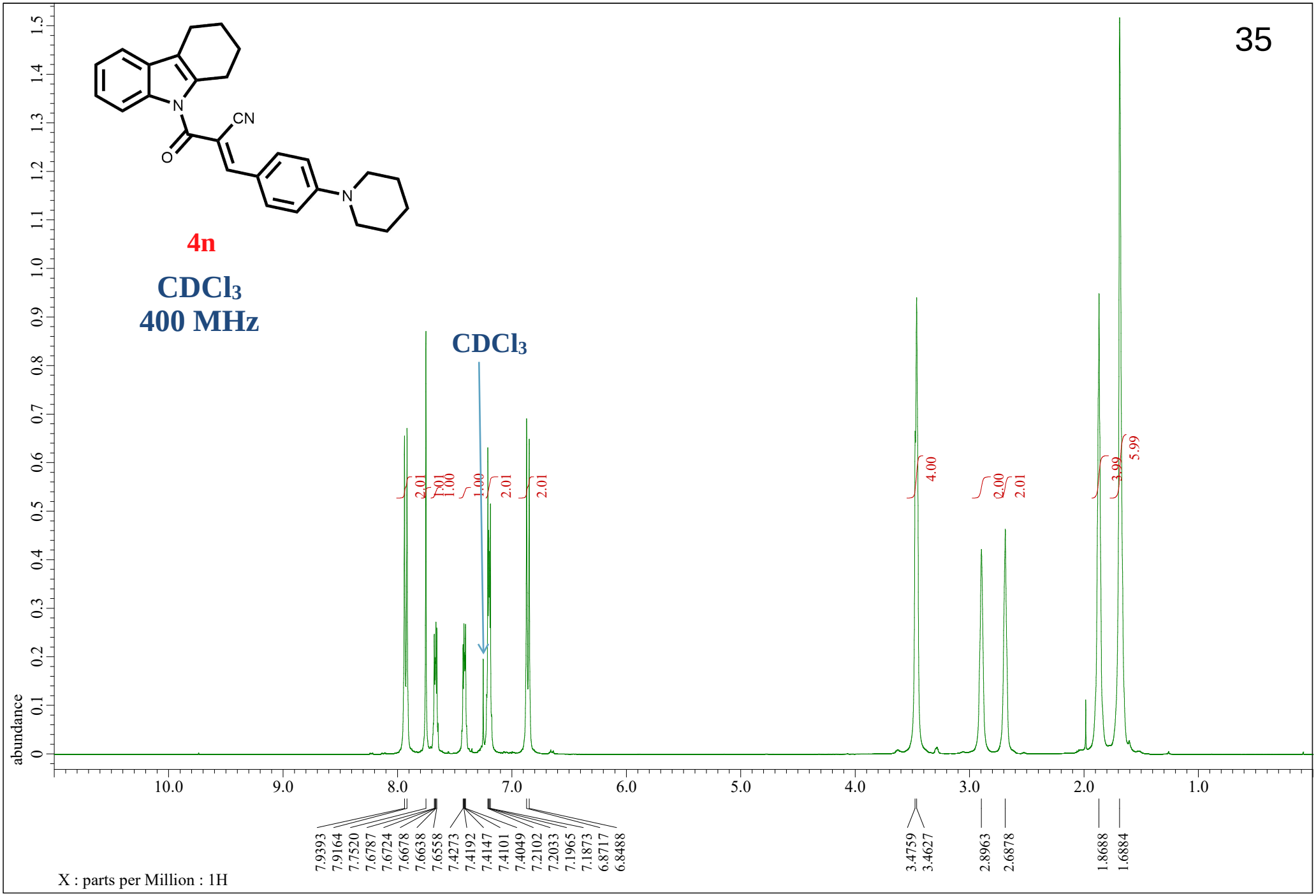

Figure S14. NMR spectra of **4n**

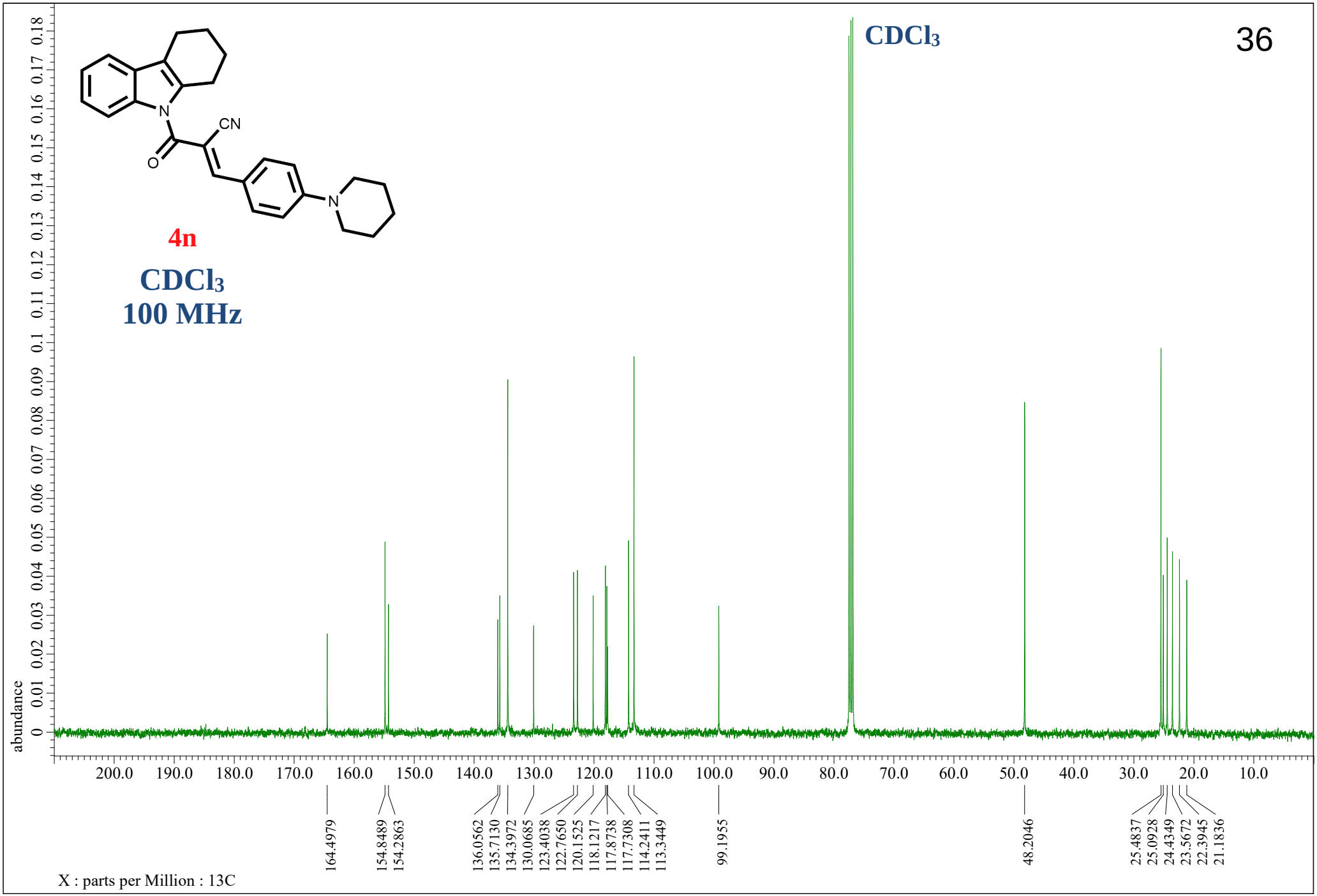

Figure S14. NMR spectra of **4n**

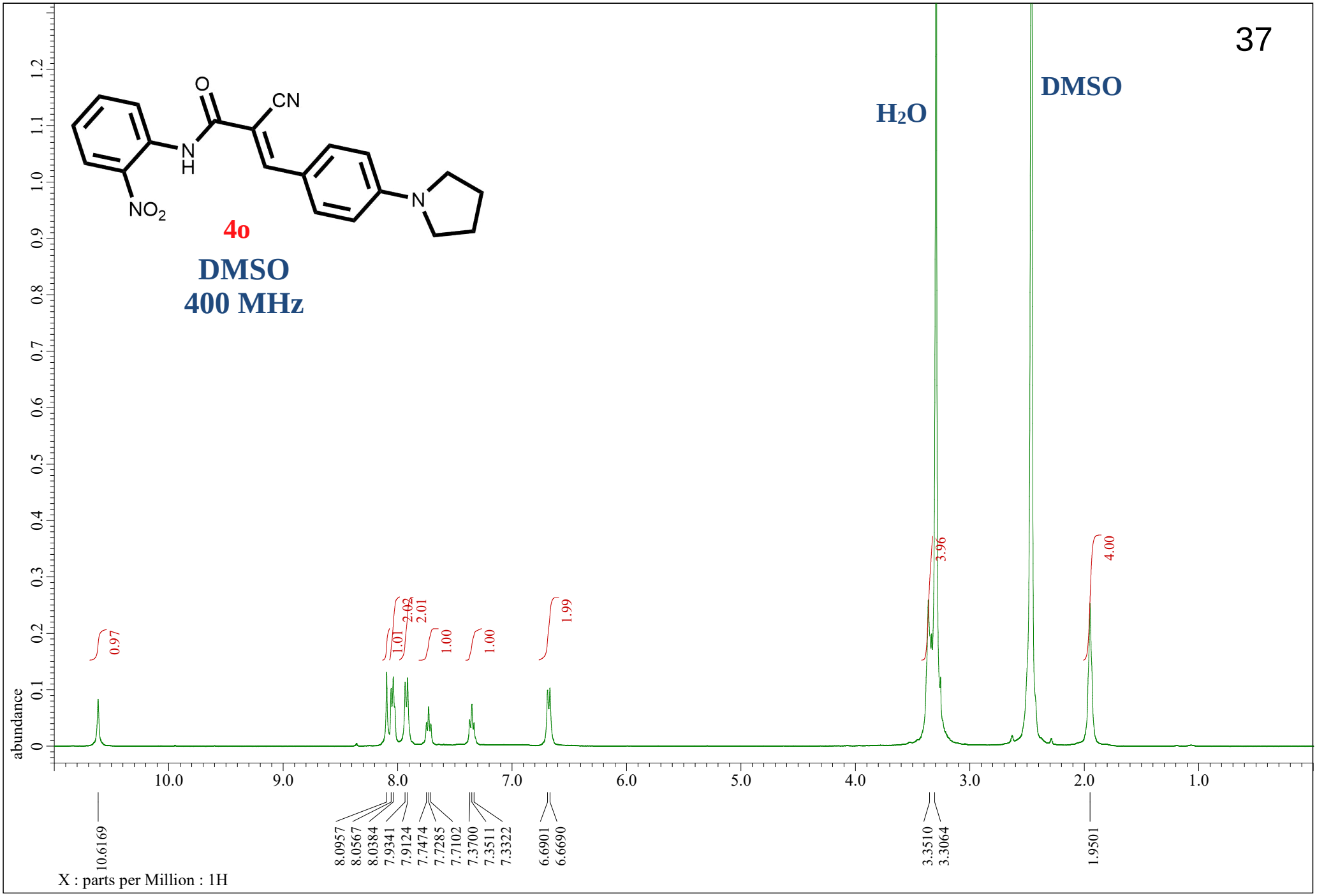

Figure S15. NMR spectra of **4o**

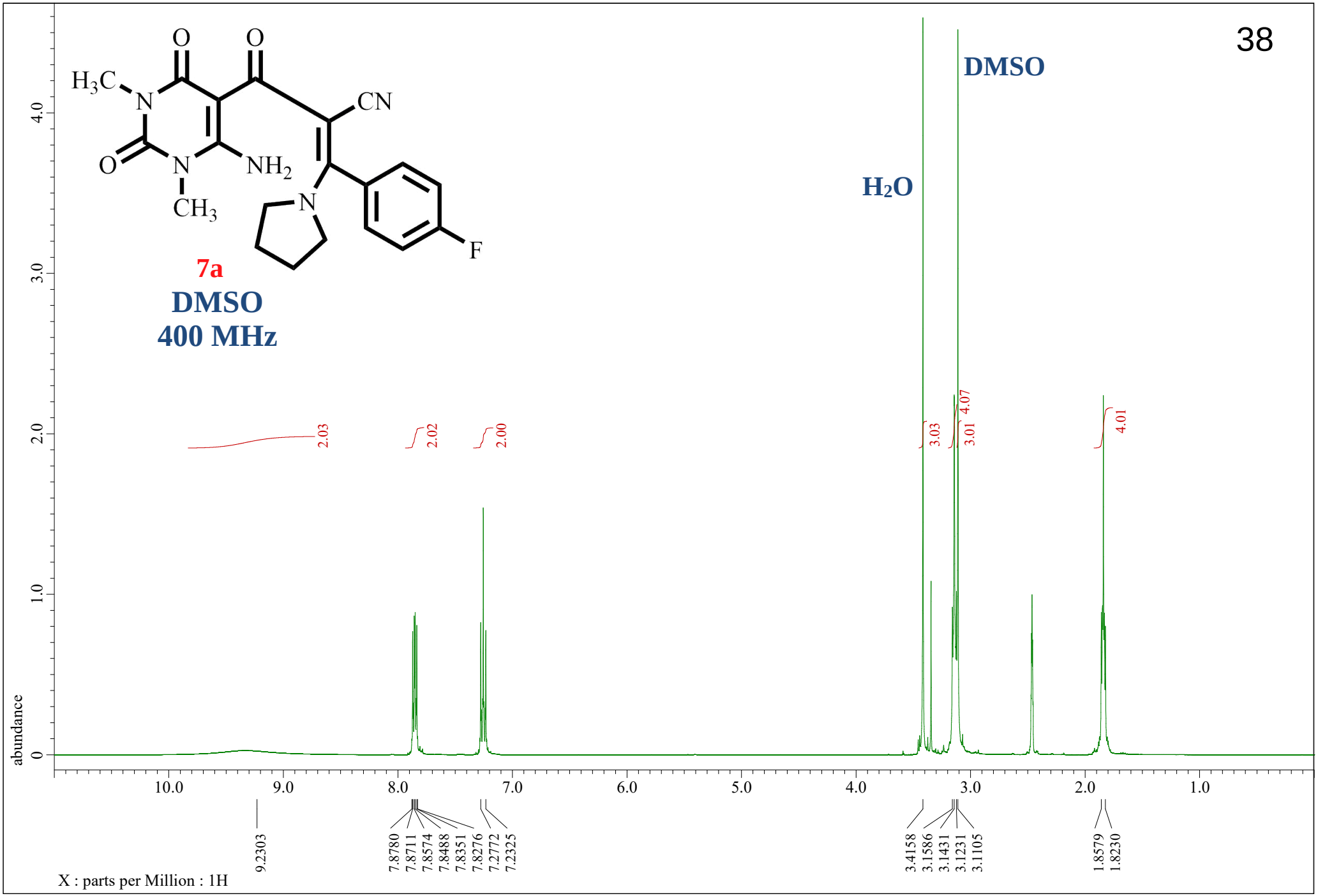

Figure S16. NMR spectra of **7a**

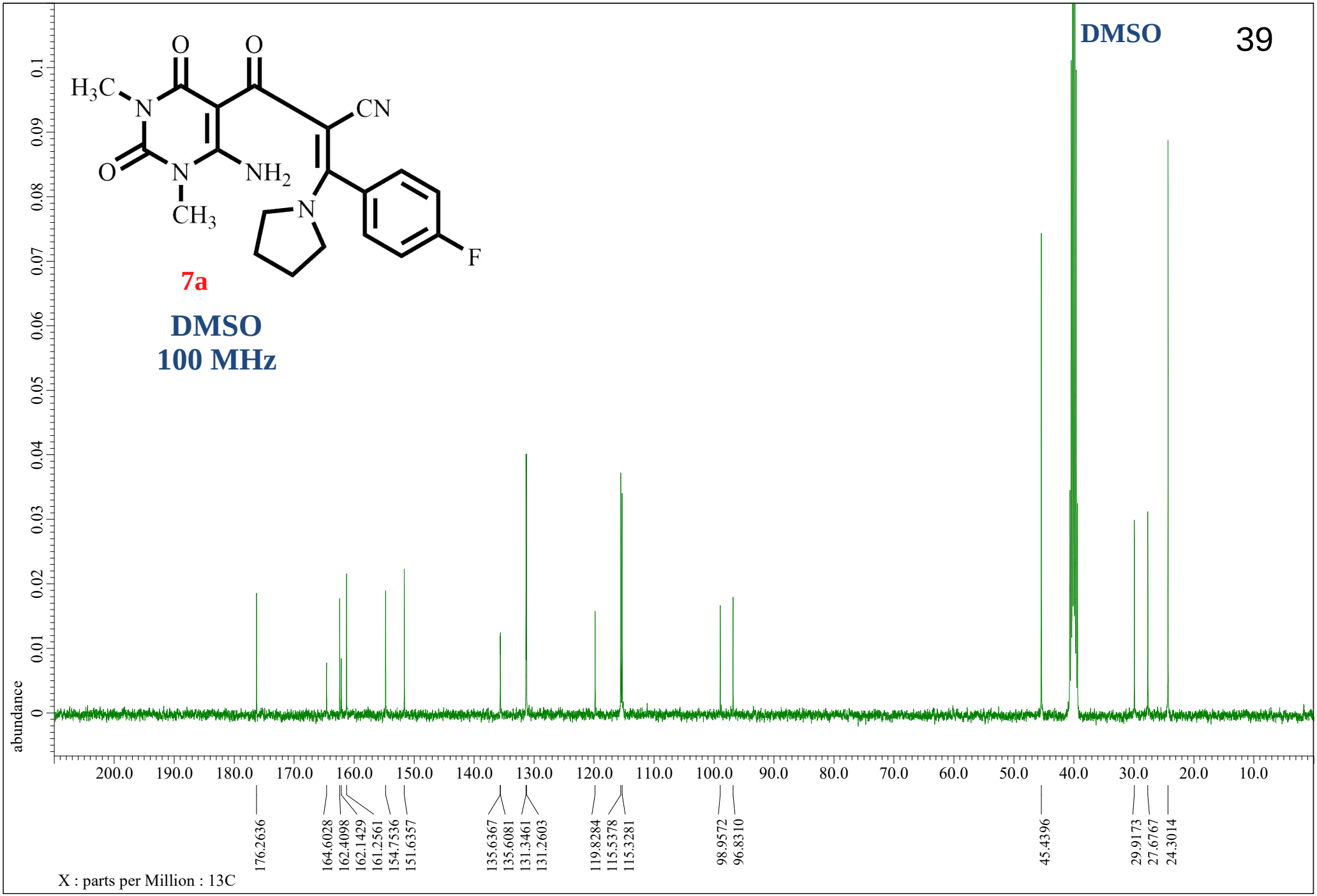

Figure S16. NMR spectra of **7a**

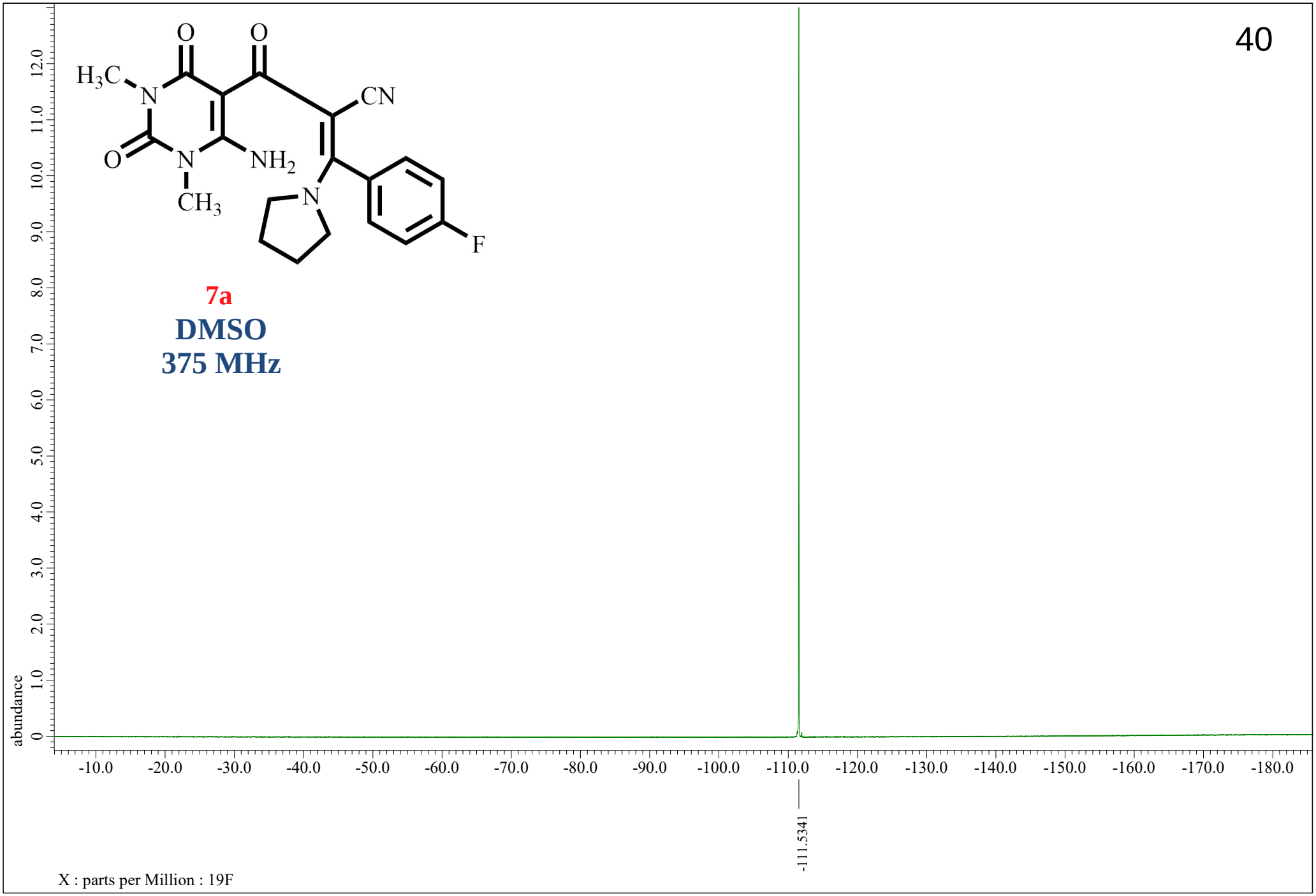

Figure S16. NMR spectra of **7a**

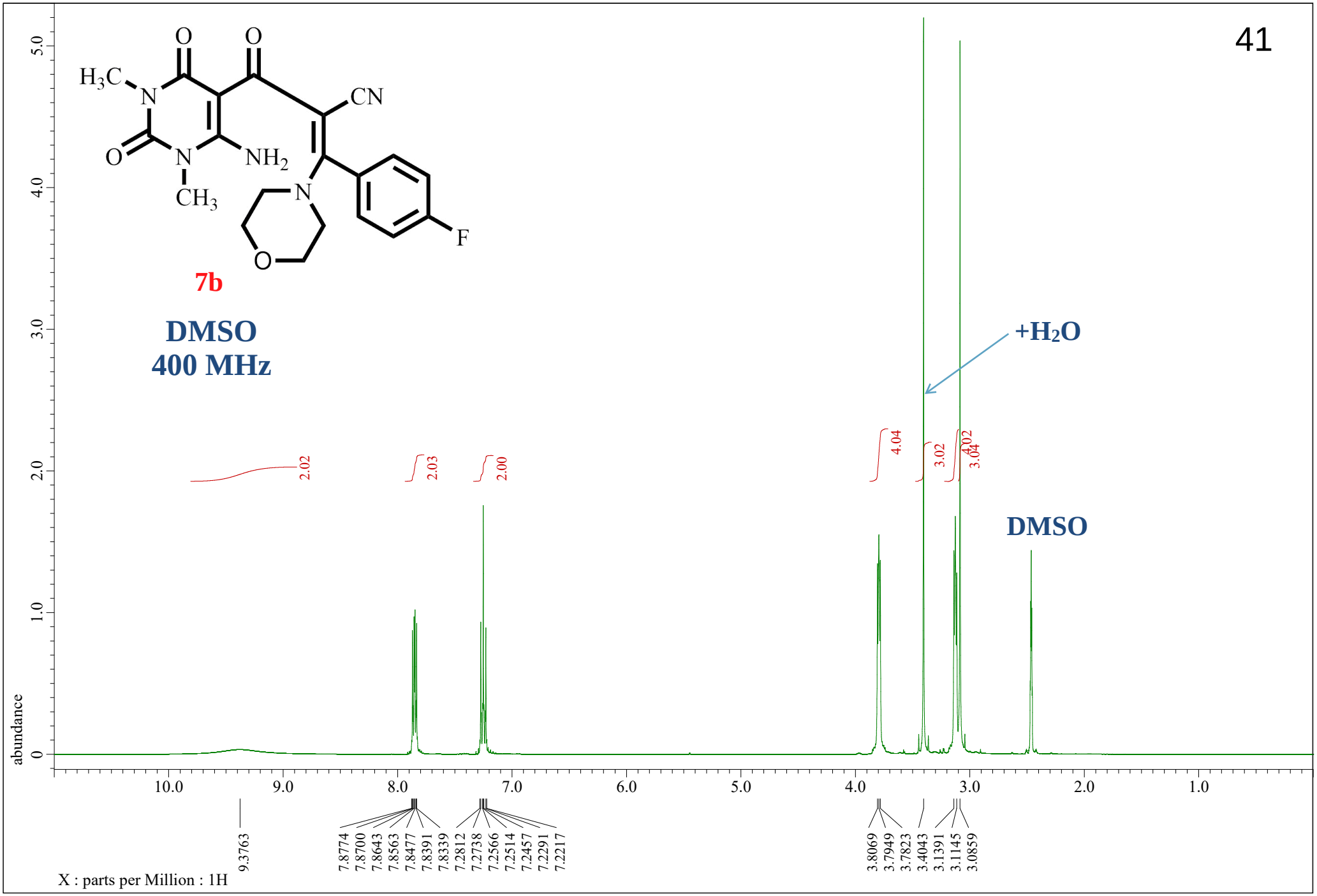

Figure S17. NMR spectra of **7b**

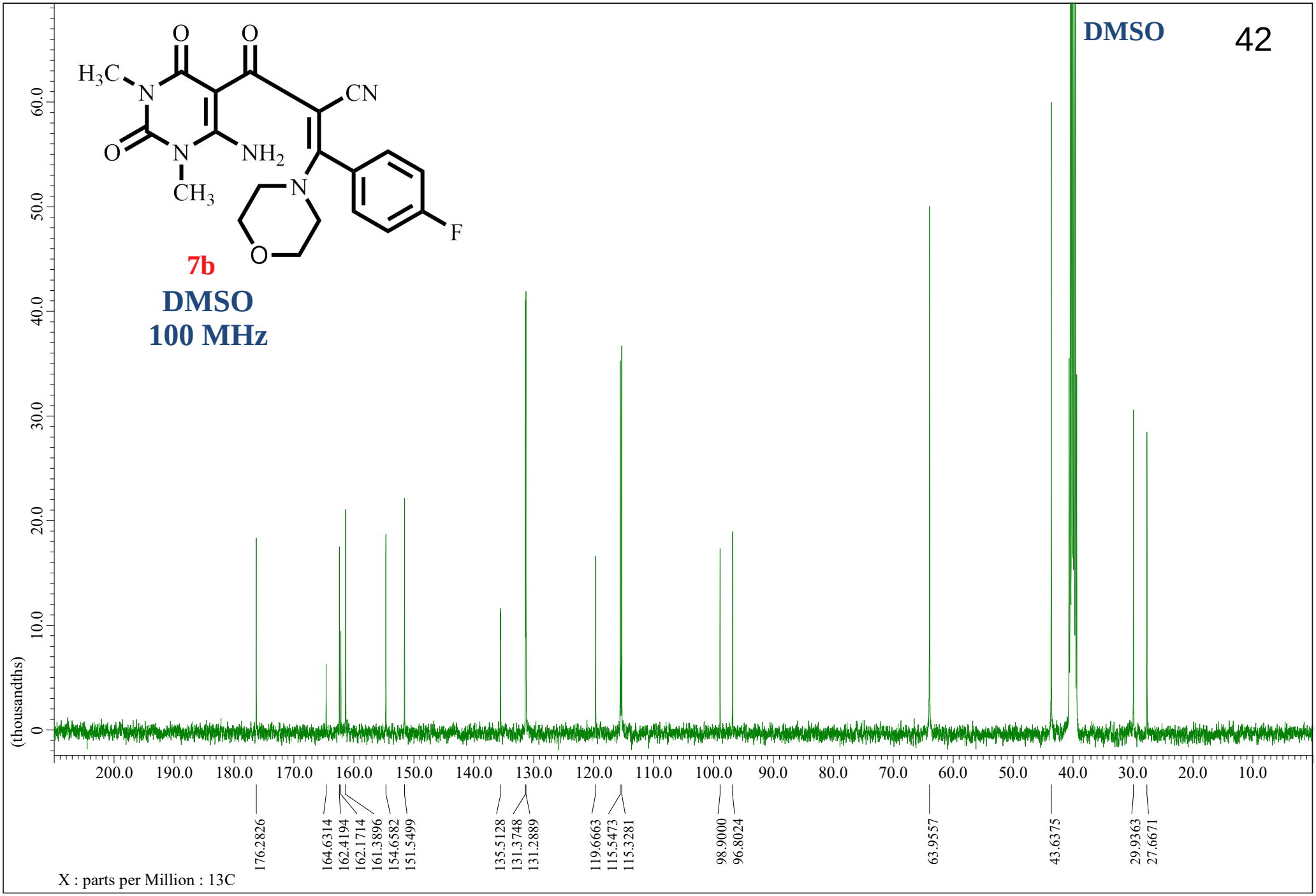

Figure S17. NMR spectra of **7b**

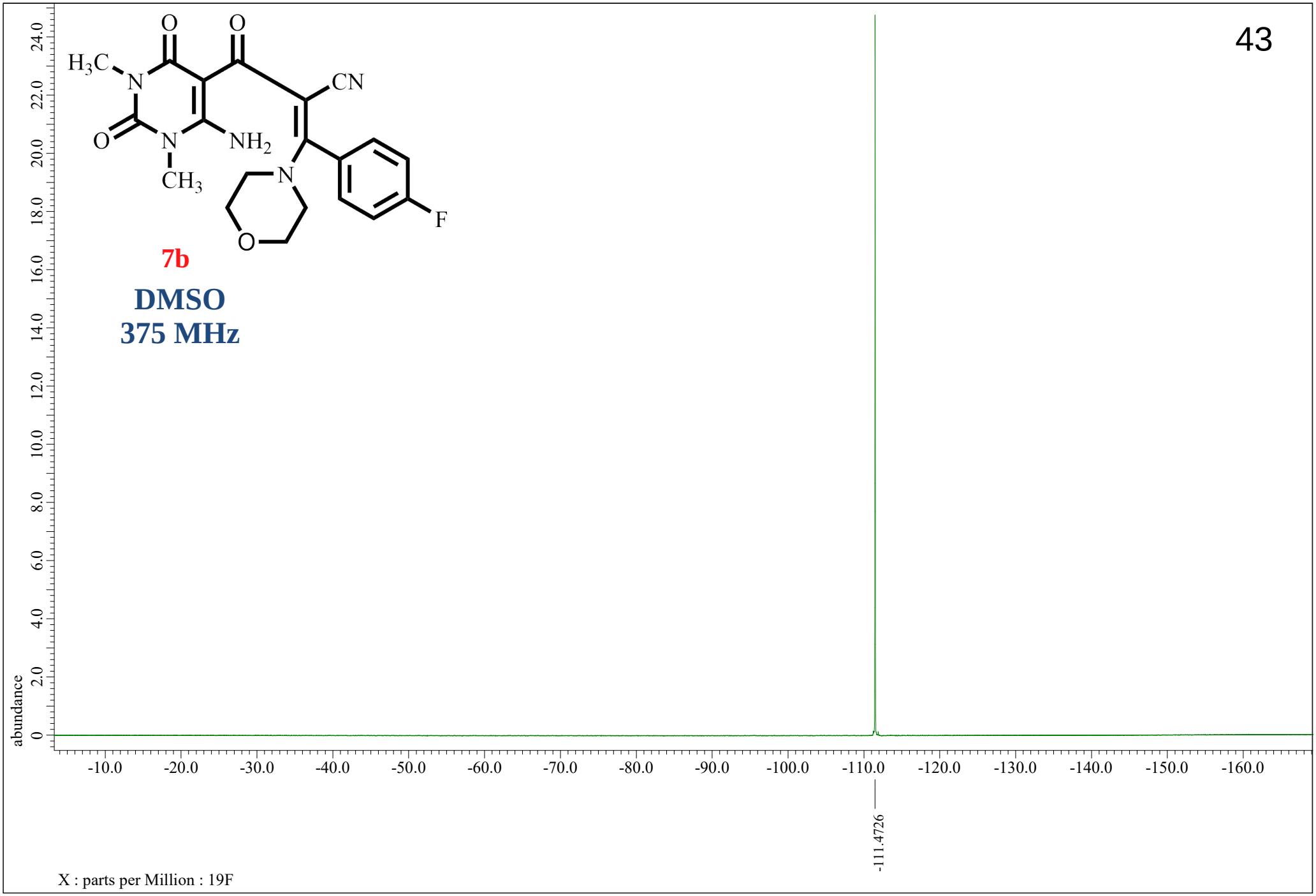

Figure S17. NMR spectra of **7b**

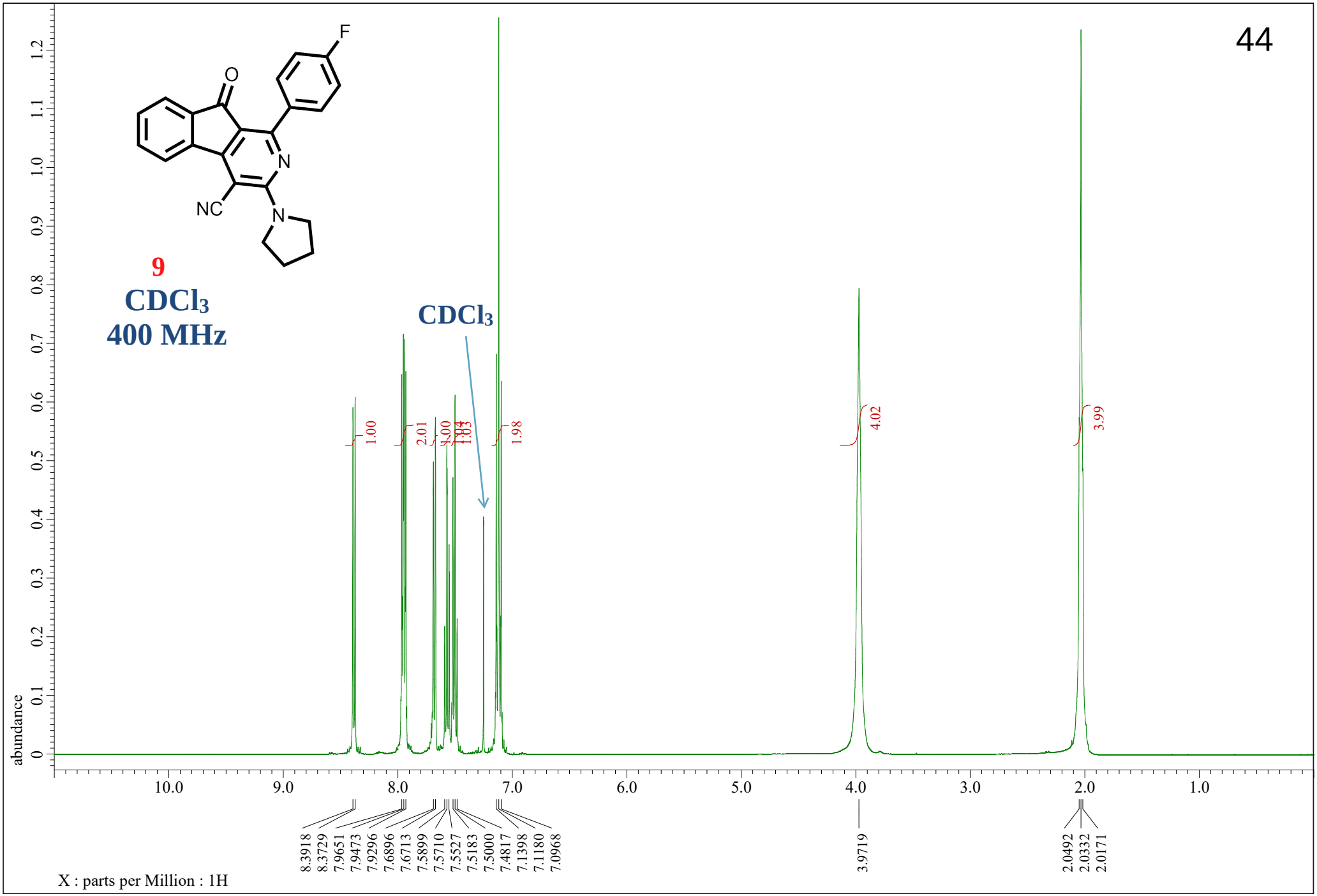

Figure S18. NMR spectra of **9**

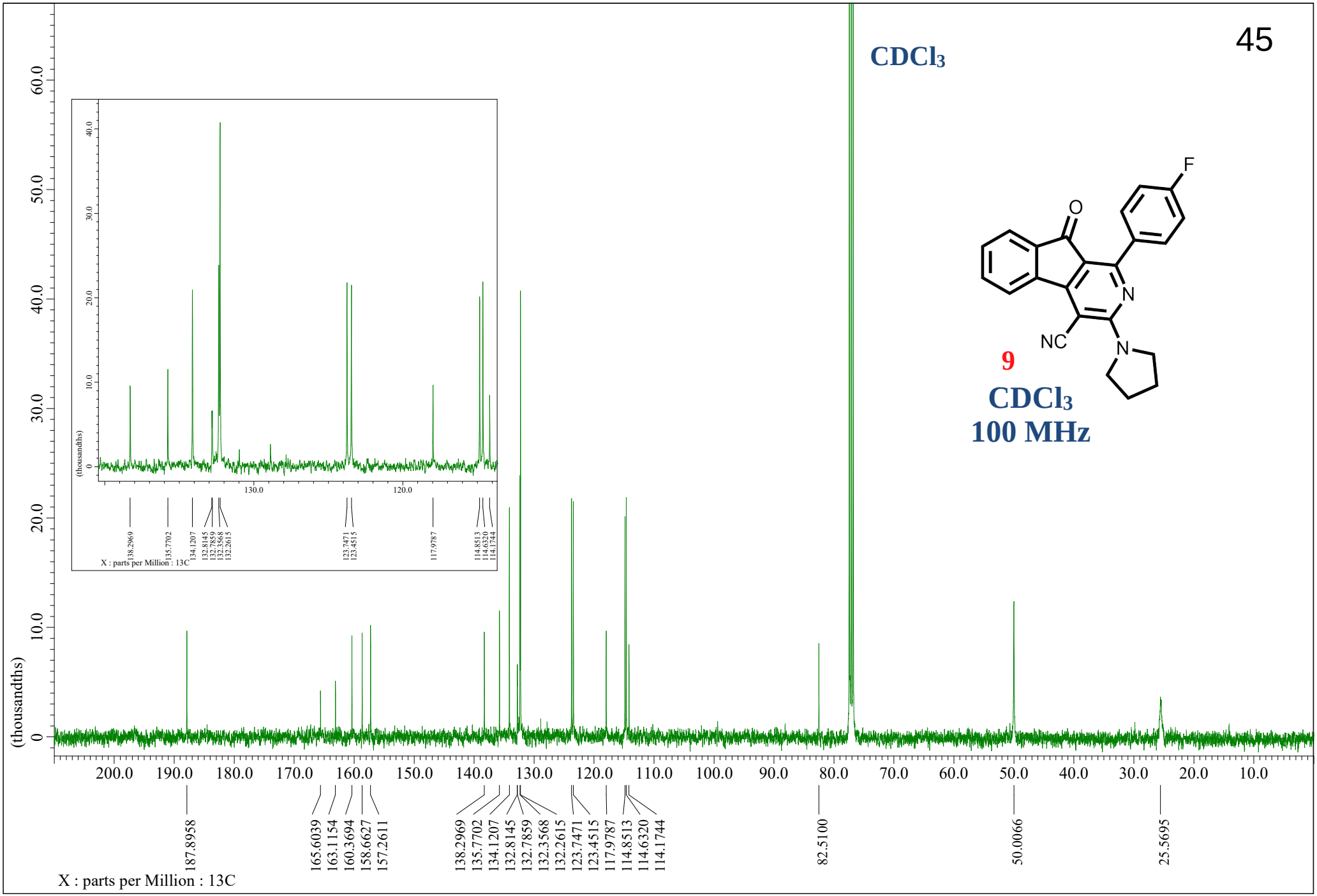

Figure S18. NMR spectra of **9**

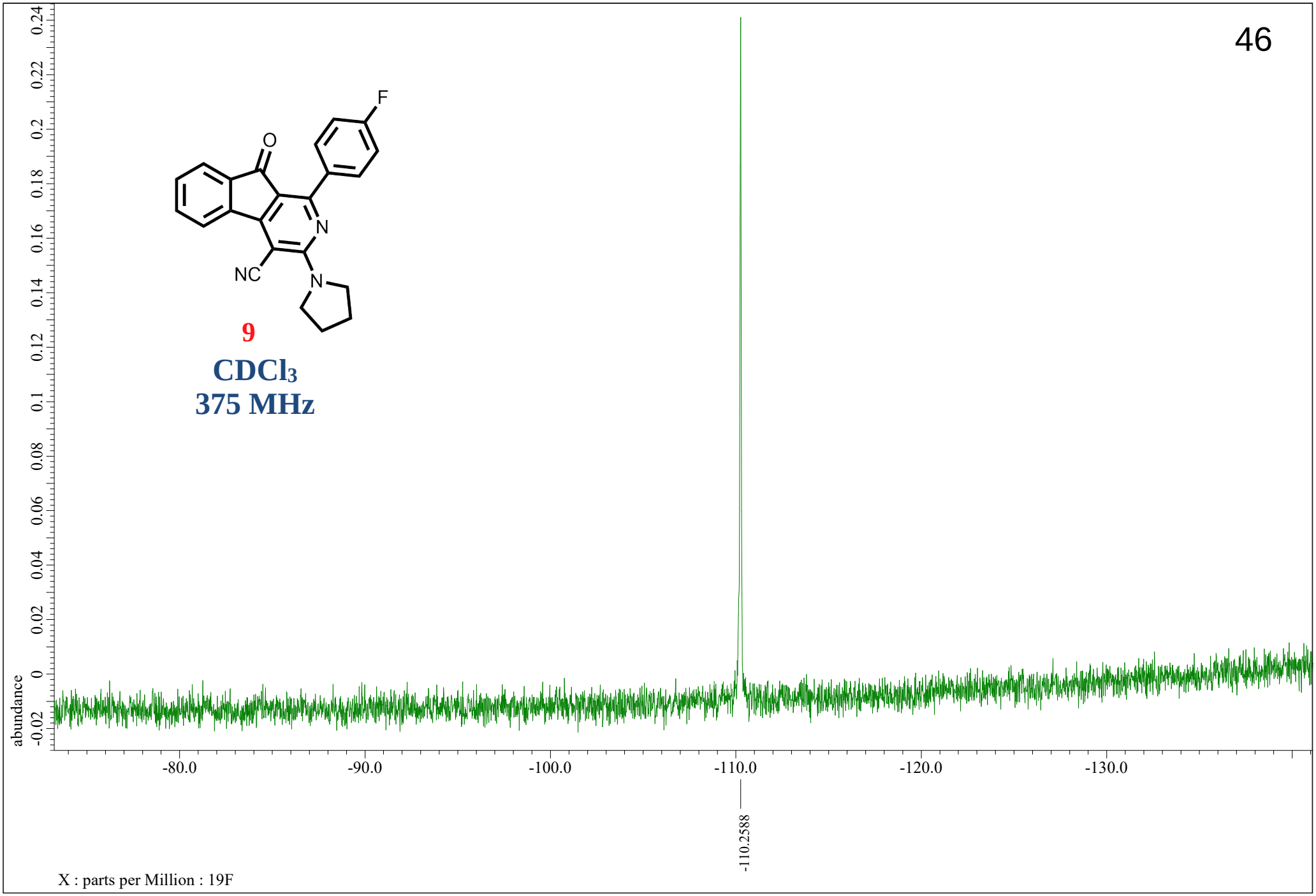

Figure S18. NMR spectra of **9**

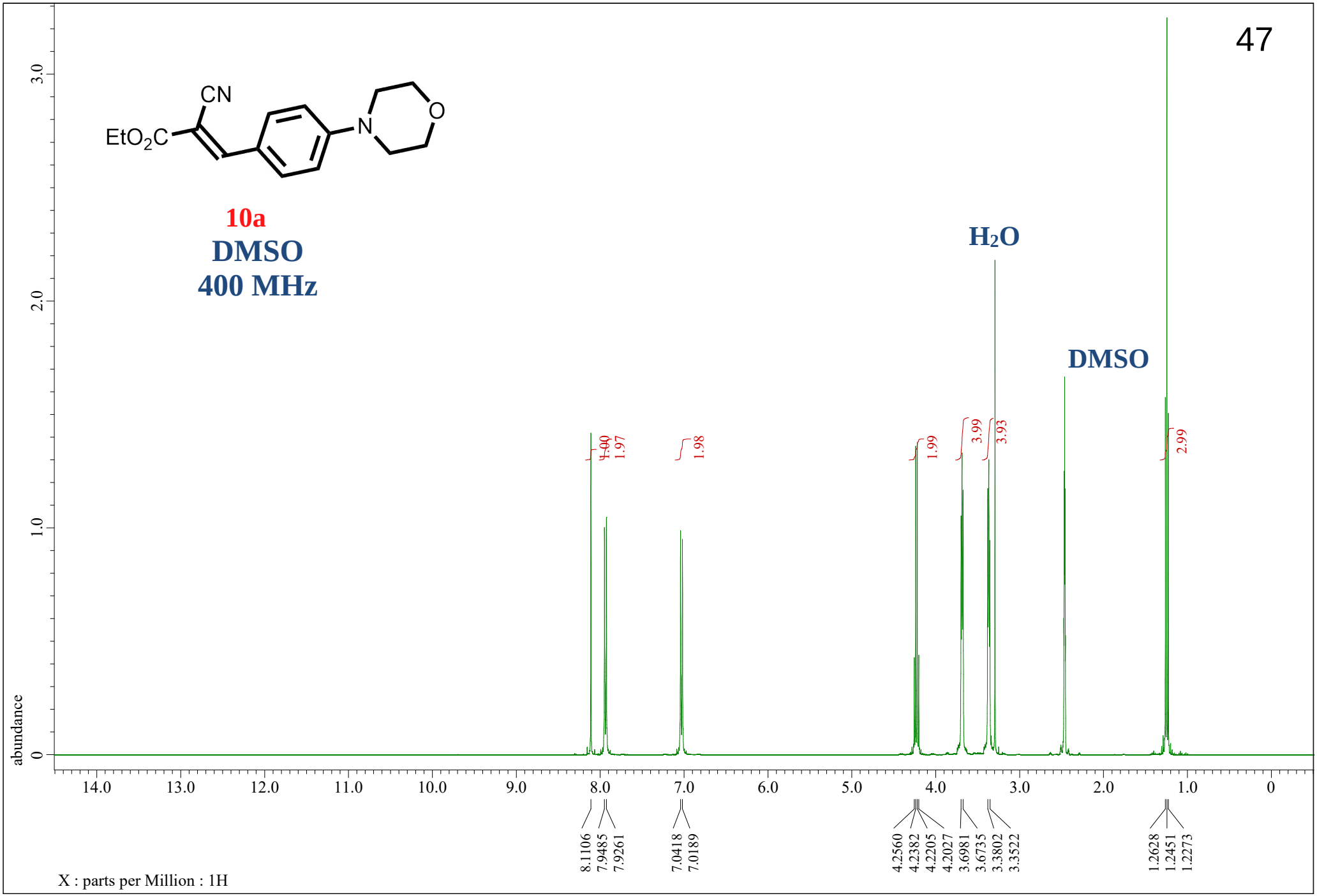

Figure S19. NMR spectra of **10a**

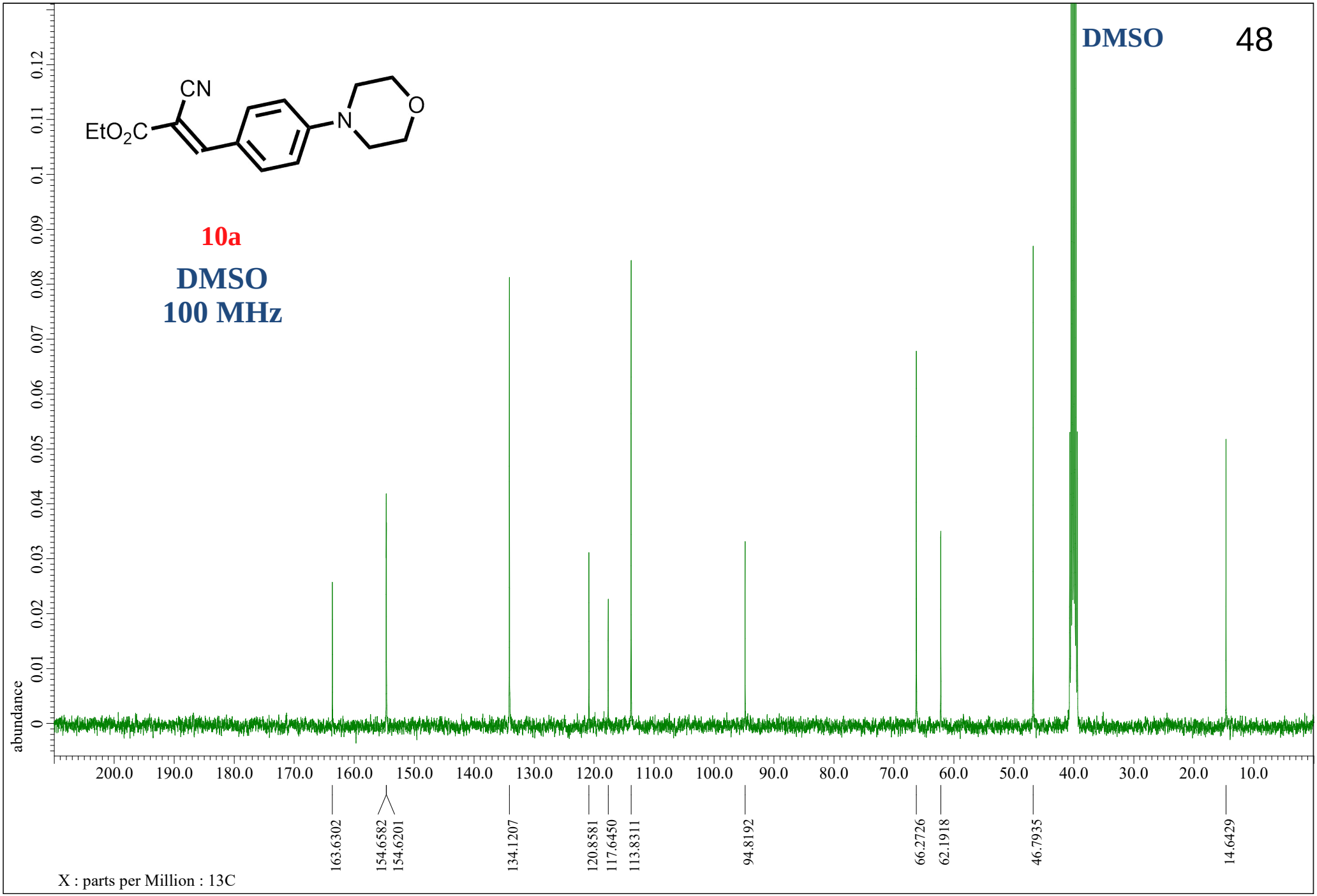

Figure S19. NMR spectra of **10a**

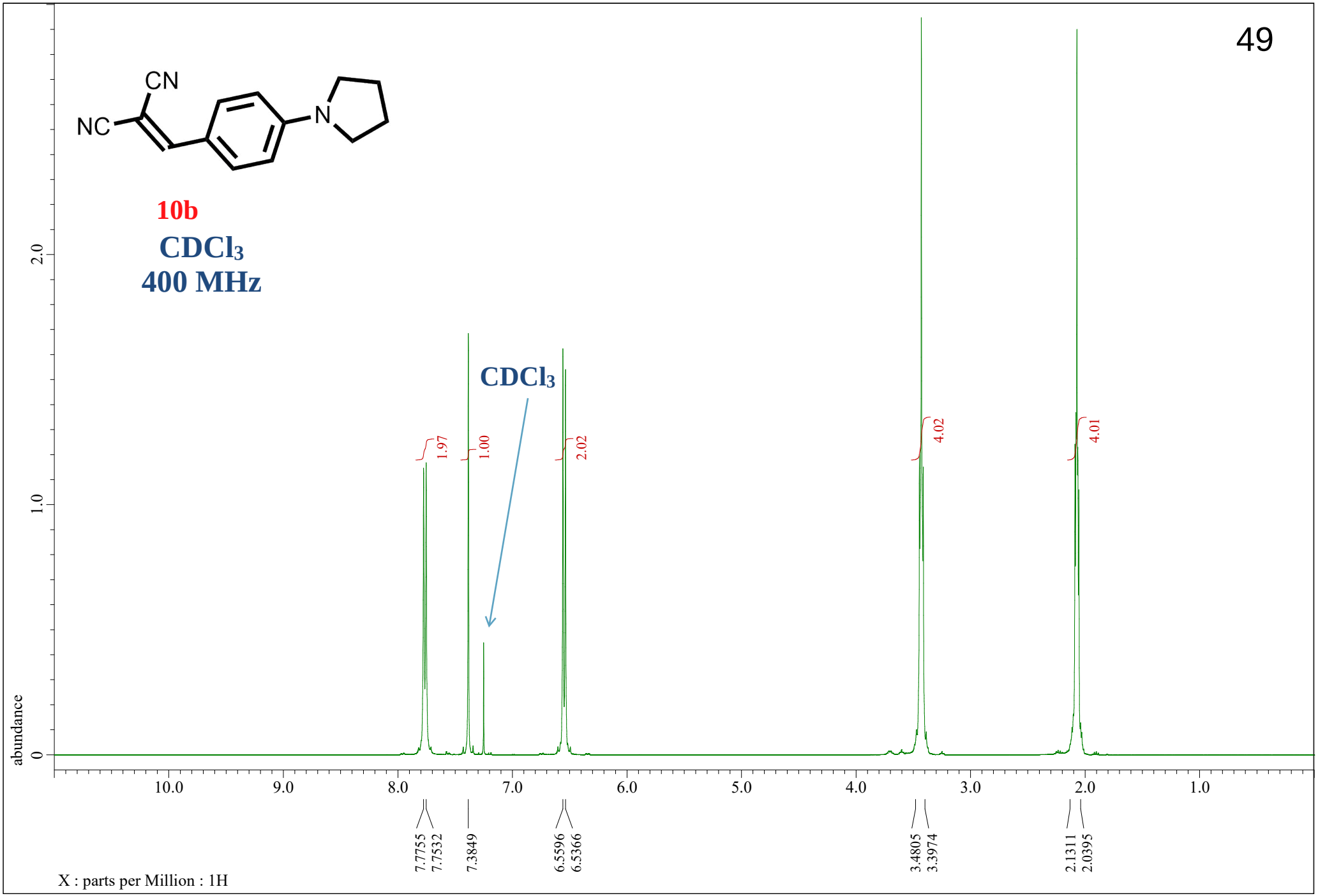

Figure S20. NMR spectra of **10b**

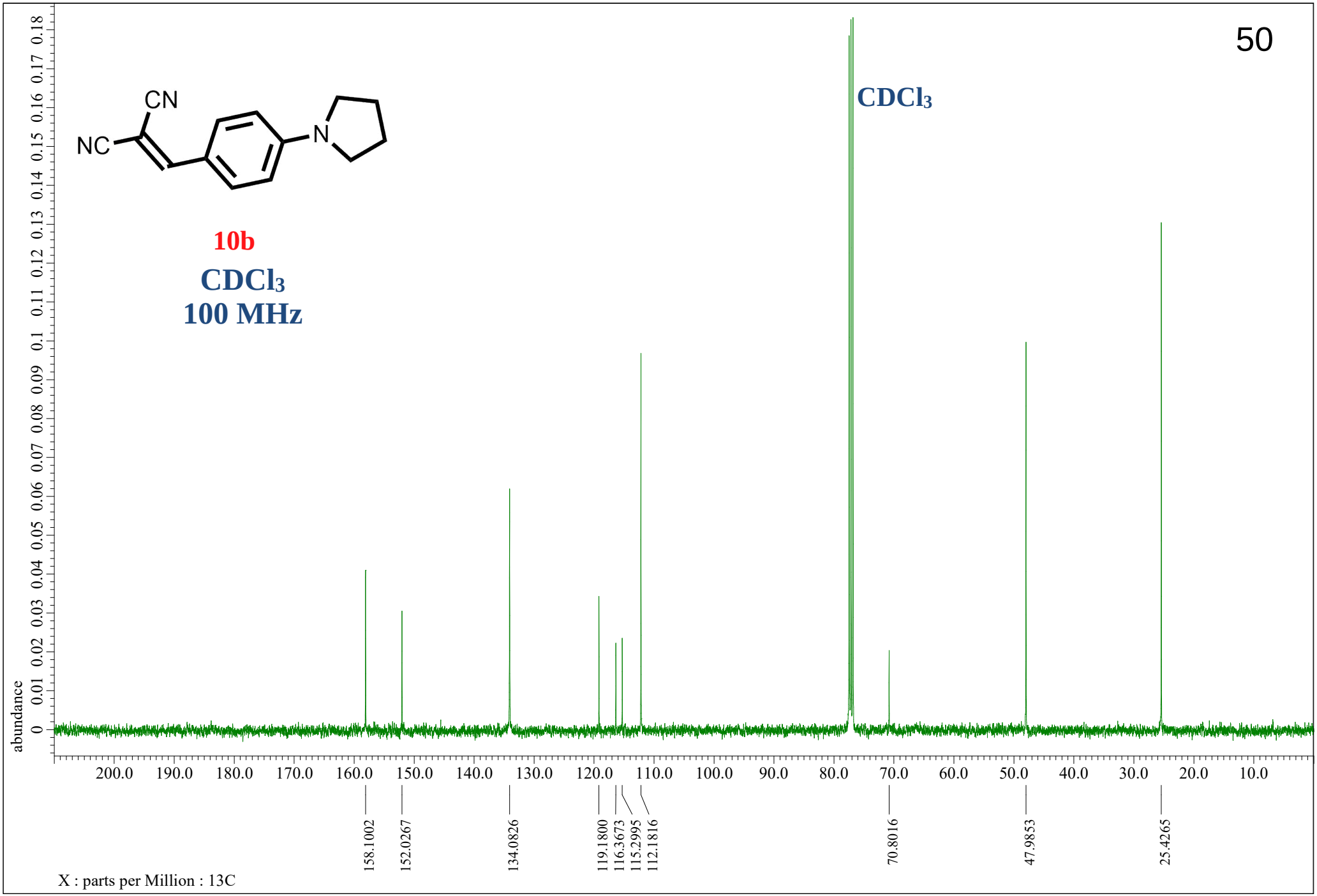

Figure S20. NMR spectra of **10b**

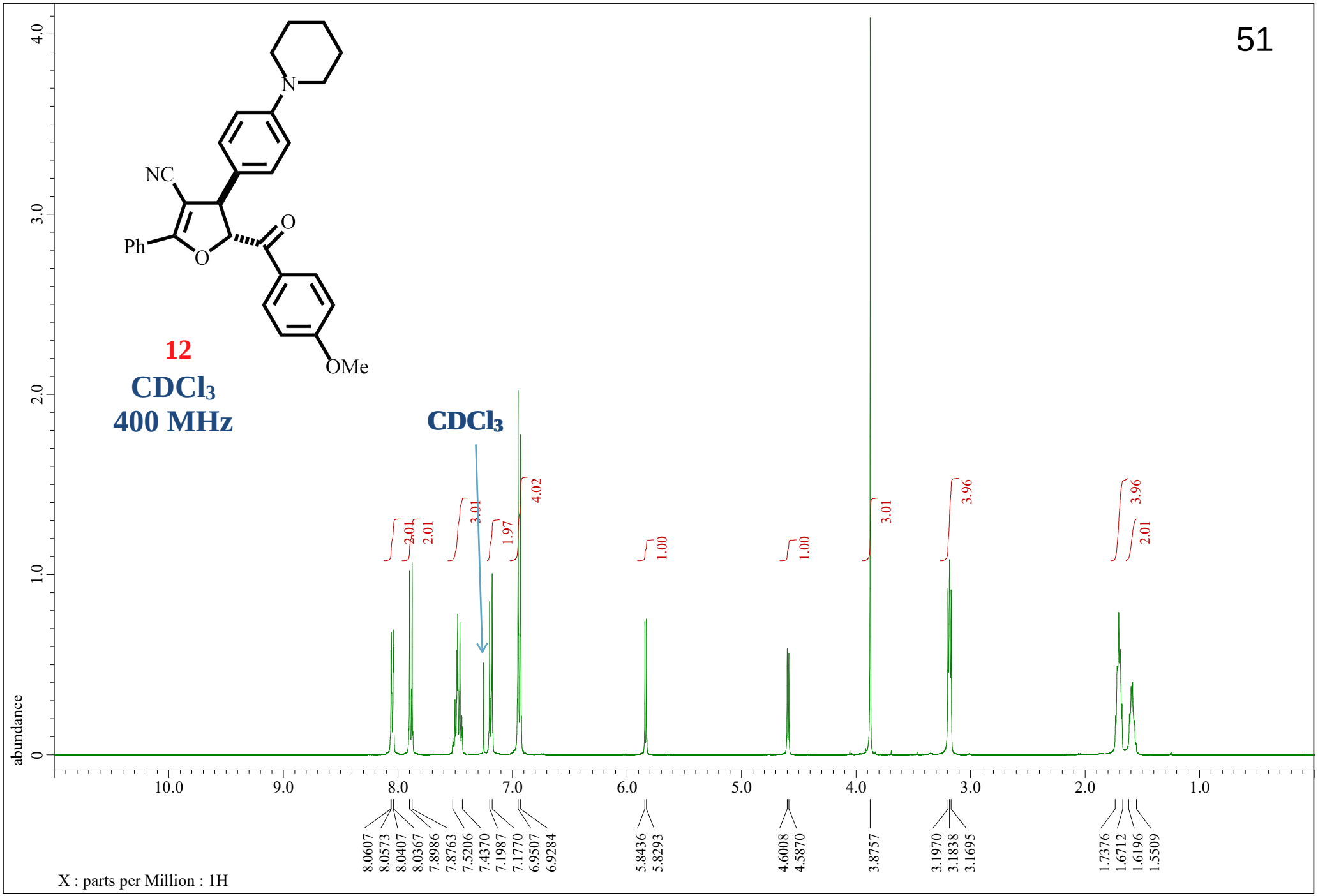

Figure S21. NMR spectra of **12**

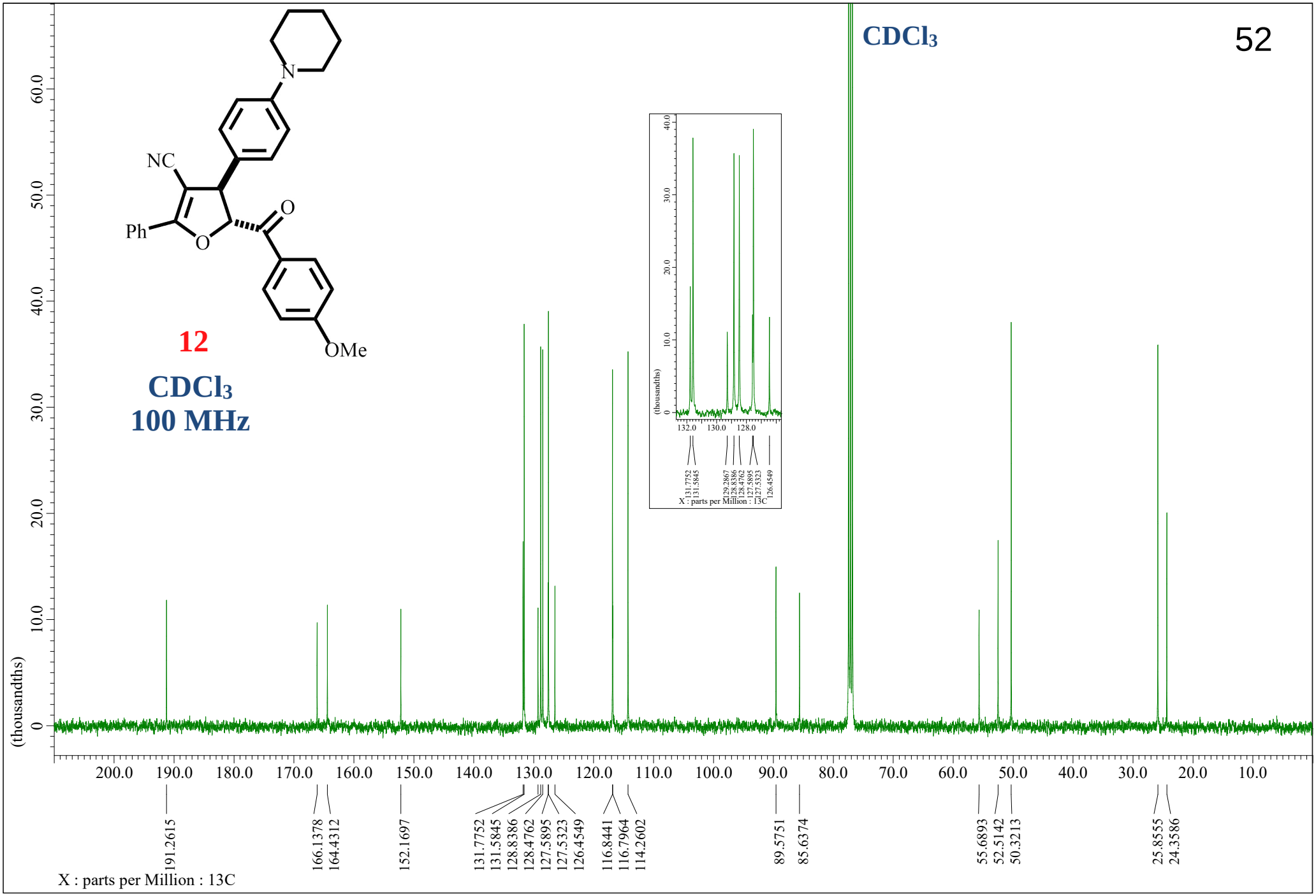

Figure S21. NMR spectra of **12**