Supplementary Material (ESI) for Green Chemistry
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Supporting Information

Gold-catalyzed intramolecular hydroamination of terminal alkynes in aqueous media: efficient and regioselective synthesis of indole-1-carboxamides

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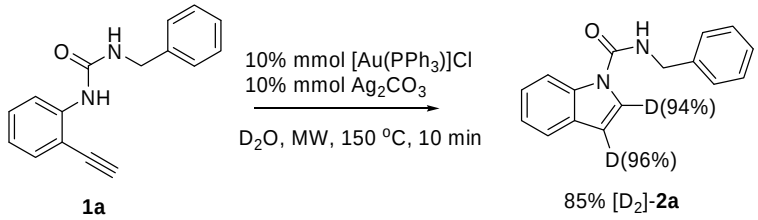
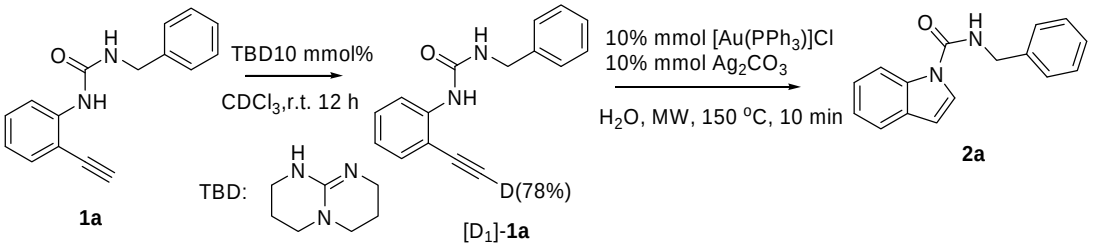
Experiment Section

Procedure for the Isotope Studies.



1a 85% [D_2]-**2a**

Labeling studies with deuterated solvents. A mixture of N'-benzyl N-(2-alkynylphenyl)ureas **1a** (0.1 mmol), [Au(PPh_3)]Cl (0.01 mmol) and Ag_2CO_3 (0.01 mmol) was stirred in D_2O (2 mL) under Ar atmosphere. The vial was sealed and the mixture was then irradiated for 10 min at 150 °C. After the reaction was cooled to ambient temperature, the crude reaction mixture was extracted three times with EA (15 mL × 3). The combined organic phase was wash with saturated $NaHCO_3$ solution, brine, dried with Na_2SO_4 and concentrated. The residue was purified by column chromatography on combiflash to provide the desired product.4,5-bideuterated compound [D_2]-**2a,** which was analyzed using ^{1}H NMR spectroscopy to determine the content of the deuterium incorporation. δ (300 MHz, $CDCl_3$, ppm): 4.670 (d, J = 6.0 Hz, 2H, CH_2 of Bn), 5.882 (br, s, 1H, NH), 6.625 (s, 0.04H, C5-H), 7.208-7.266 (m, 1H), 7.322-7.424 (m, 6H), 7.462 (s, 0.06H, C4-H), 7.610 (d, J = 8.4 Hz, 1H, ArH), 8.110 (d, J = 7.8 Hz, 1H, ArH); LC-MS: *m/z* 253 $[M + H]^+$ 100%



1a [D_1]-**1a** **2a**

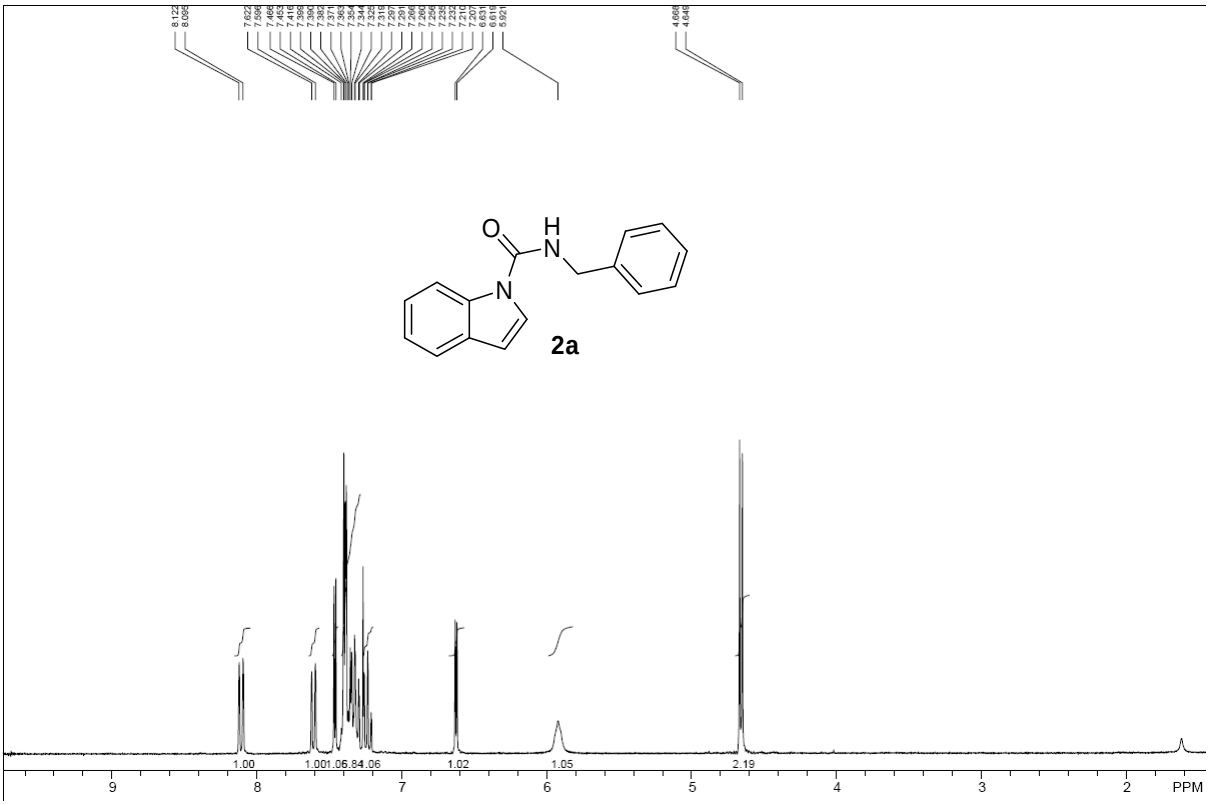
Labeling studies with deuterated starting materials. Deuterated N'-benzyl N-(2-alkynylphenyl)ureas [D_1]-**1a** was prepared in 85% yield with 78% deuterium incorporation at the terminal alkynyl site according to the method reported in ref S(1). A mixture of deuterated N'-benzyl N-(2-alkynylphenyl)ureas [D_1]-**1a** (0.1 mmol), [Au(PPh_3)]Cl (0.01 mmol) and Ag_2CO_3 (0.01 mmol) was stirred in H_2O (2 mL) under Ar atmosphere. The vial was sealed and the mixture was then irradiated for 10 min at 150 °C. After the reaction was cooled to ambient temperature, the crude reaction mixture was extracted three times with

EA (15 mL × 3). The combined organic phase was wash with saturated $NaHCO_3$ solution, brine, dried with Na_2SO_4 and concentrated. The residue was purified by column chromatography on combiflash to provide the desired product. **2a,** which was analyzed using ^1H NMR spectroscopy to determine the content of the deuterium incorporation.

[D_1]-**1a**: ^1H NMR δ (300 MHz, $CDCl_3$, ppm): 3.337 (s, 0.22 H, C≡C-H), 4.470 (d, J = 5.4 Hz, 2H, CH_2 of Bn), 5.173 (br, 1H), 6.962 (t, J = 8.1 Hz, 1H), 7.069 (br, 1H), 7.303-7.424 (m, 7H), 8.160 (d, J = 8.4 Hz, 1H); LC-MS *m/z* 252 100%, 251 35% $[M + H]^+$.

Referemces:

[S1] Sabot, C.; Kumar, K. A.; Antherume, C.; Mioskowski, C. *J. Org. Chem.* **2007**, *72*, 5001-5007.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H
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N
2a
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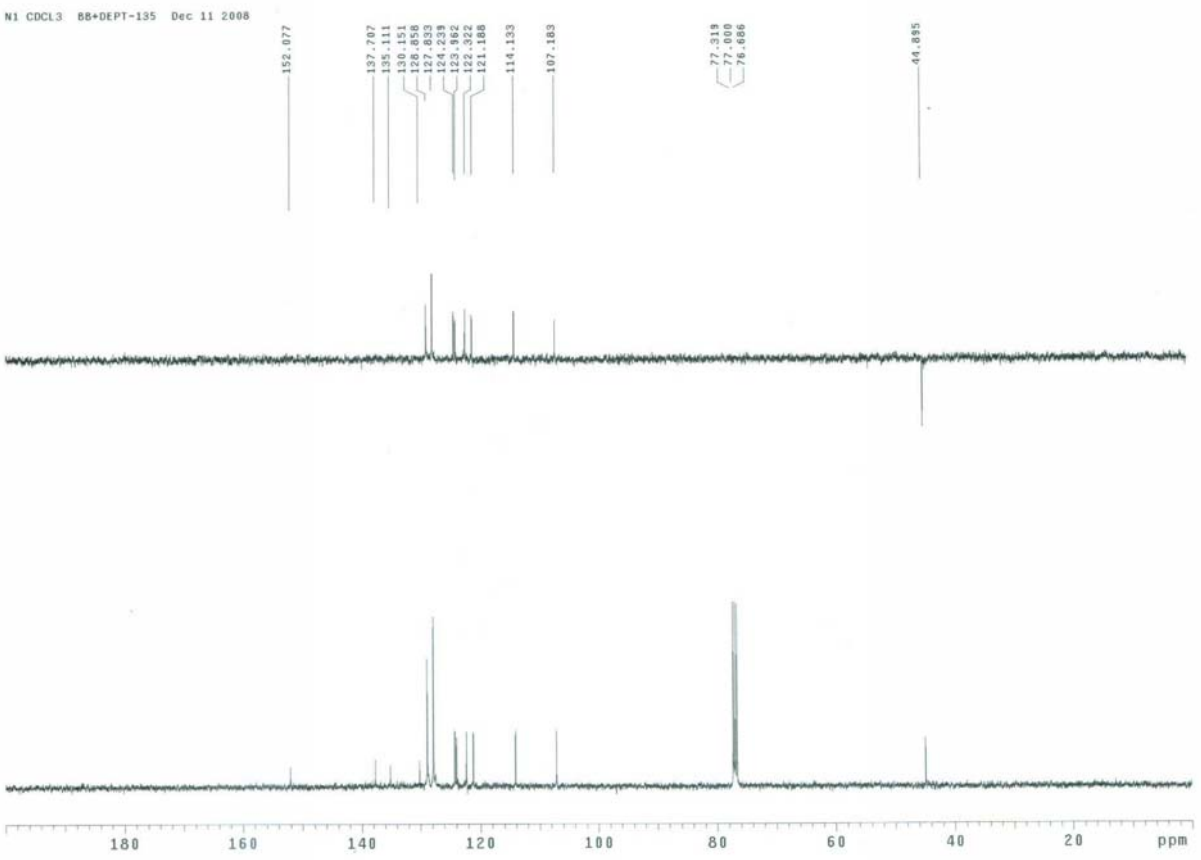
7
6
5
4
3
2
PPM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122.322
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77.000
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120
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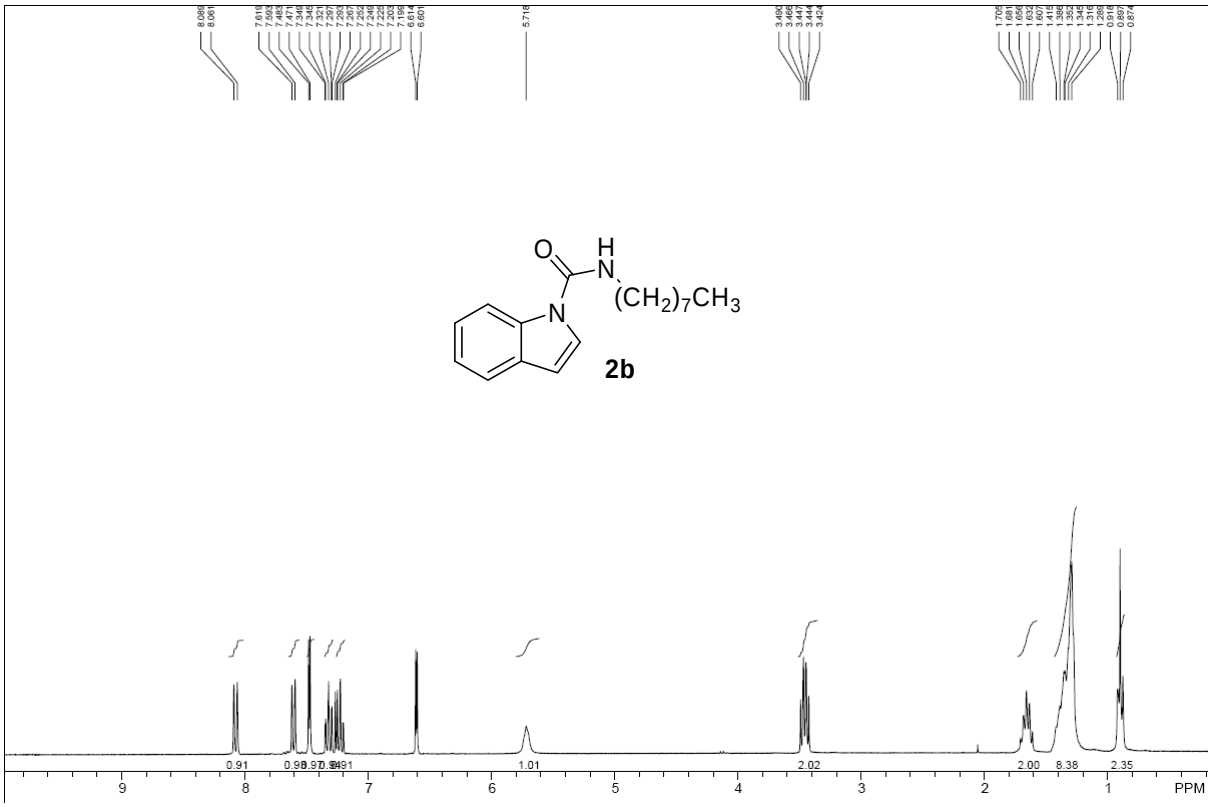
80
60
40
20
ppm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7.252
7.240
7.203
7.195
6.614
6.601
5.716
3.490
3.466
3.447
3.444
3.424
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1.681
1.656
1.652
1.607
1.415
1.386
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1.345
1.316
1.298
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0.897
0.874
O
H
N
(CH2)7CH3
N
2b
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7
6
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3
2
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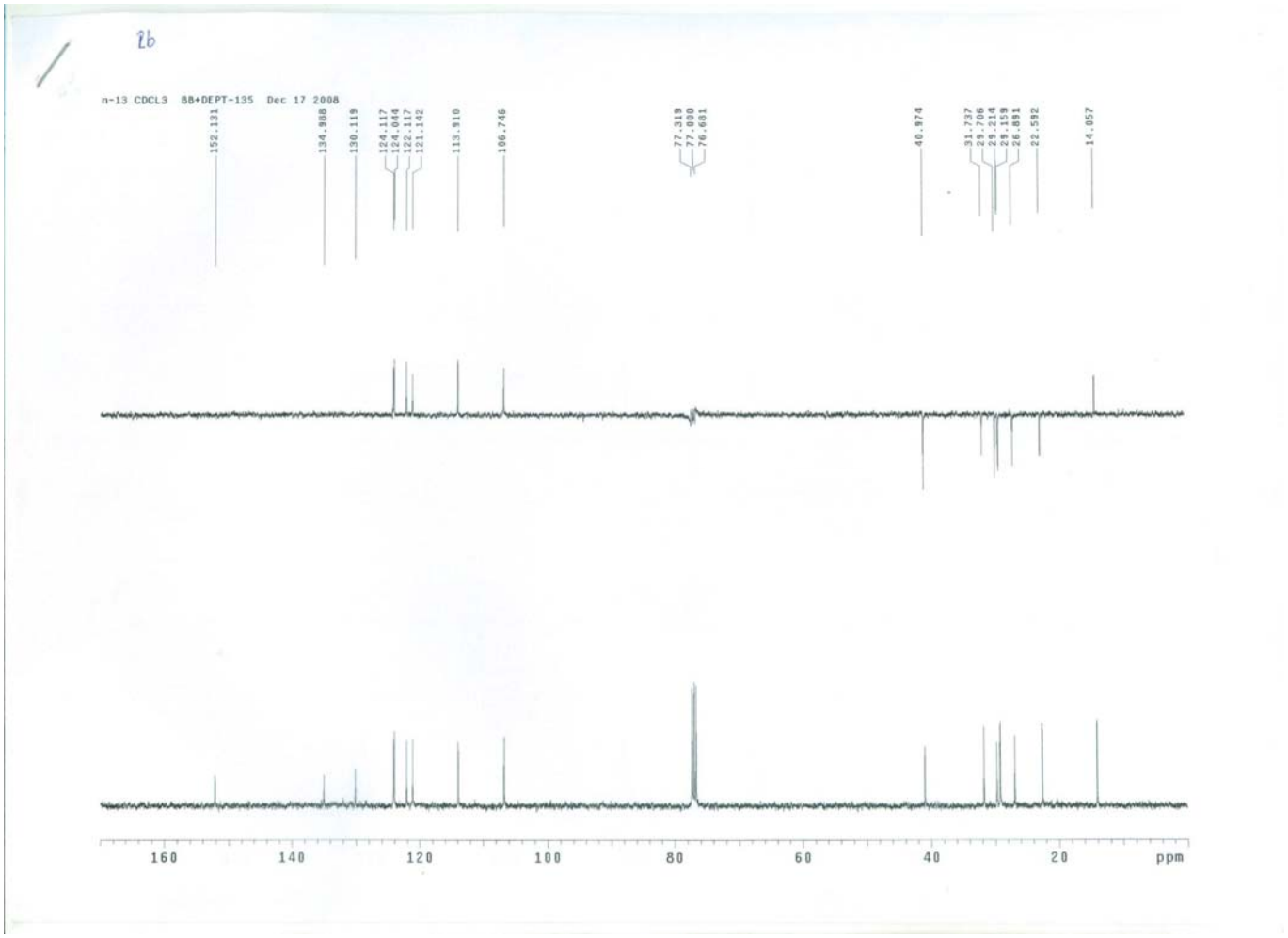
PPM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121.142
113.910
106.746
77.319
77.000
76.681
40.974
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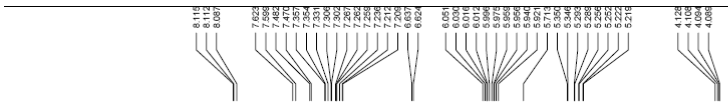

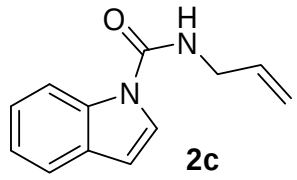

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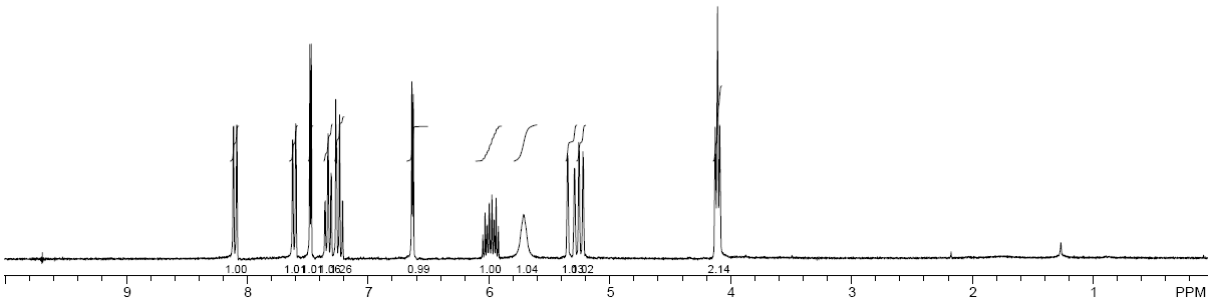
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2
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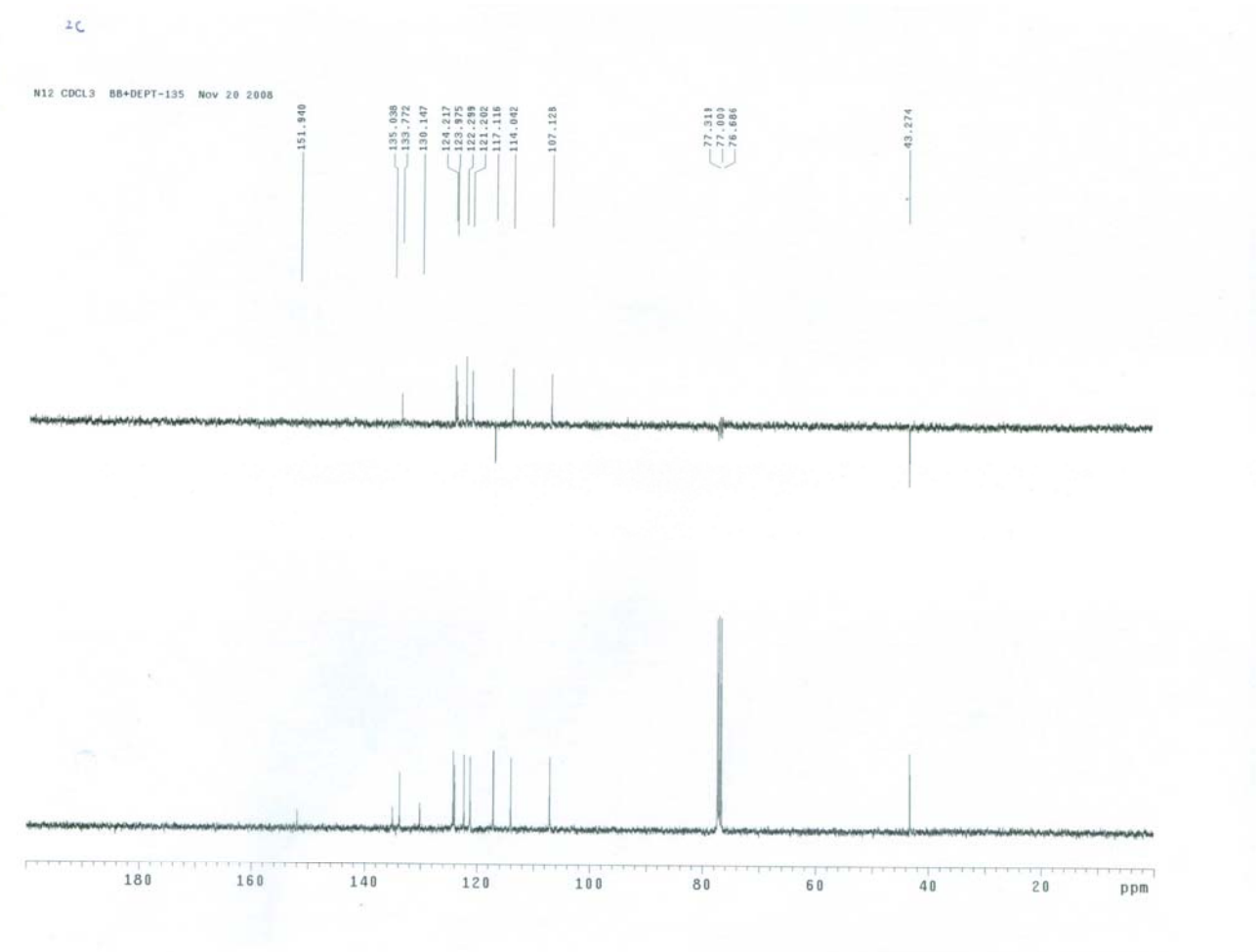
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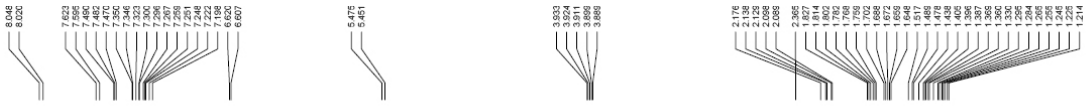

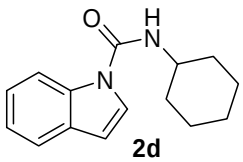

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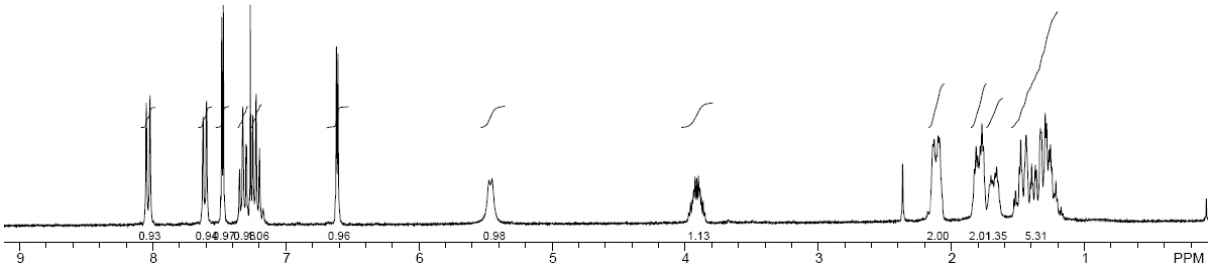
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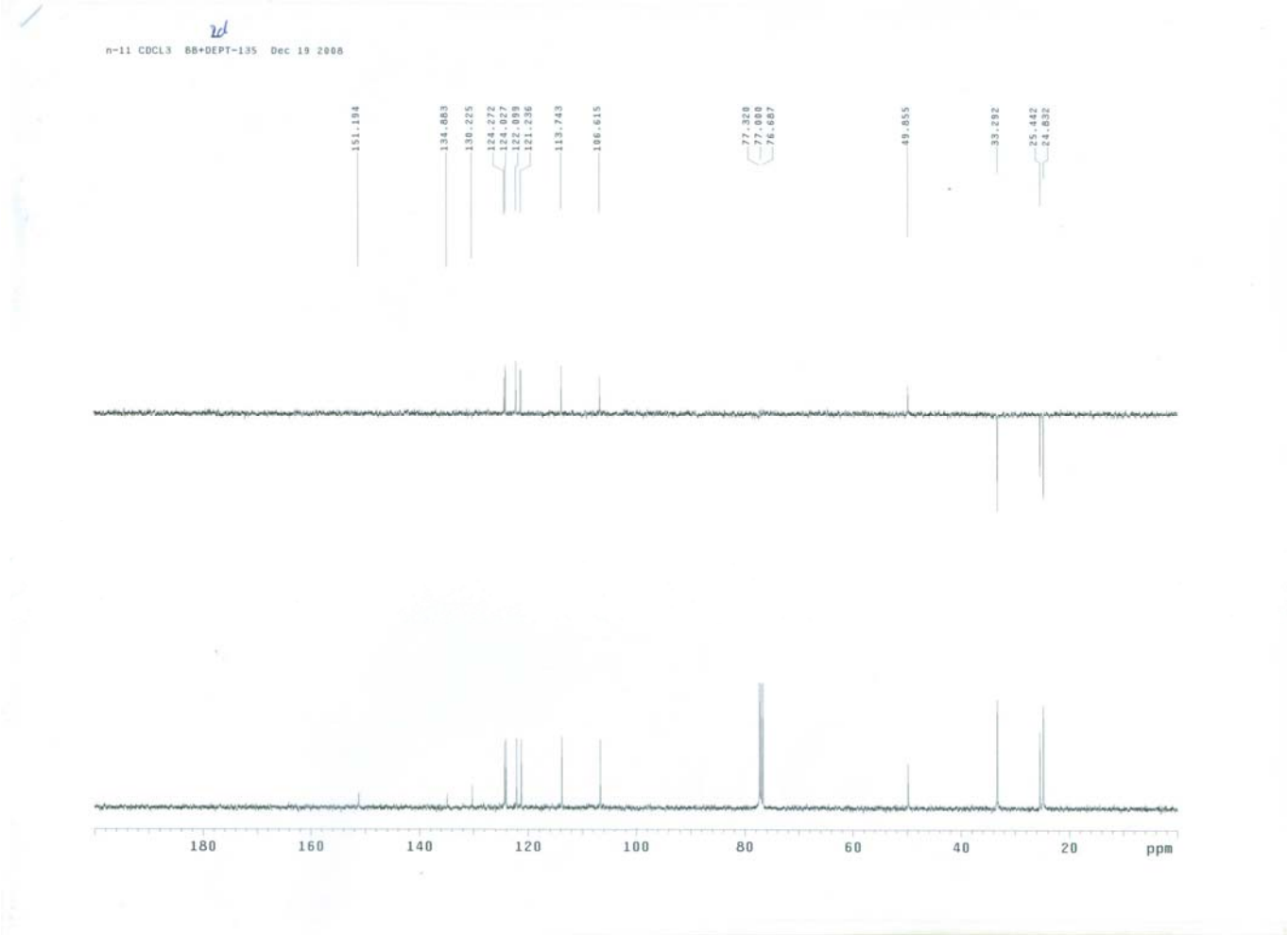
PPM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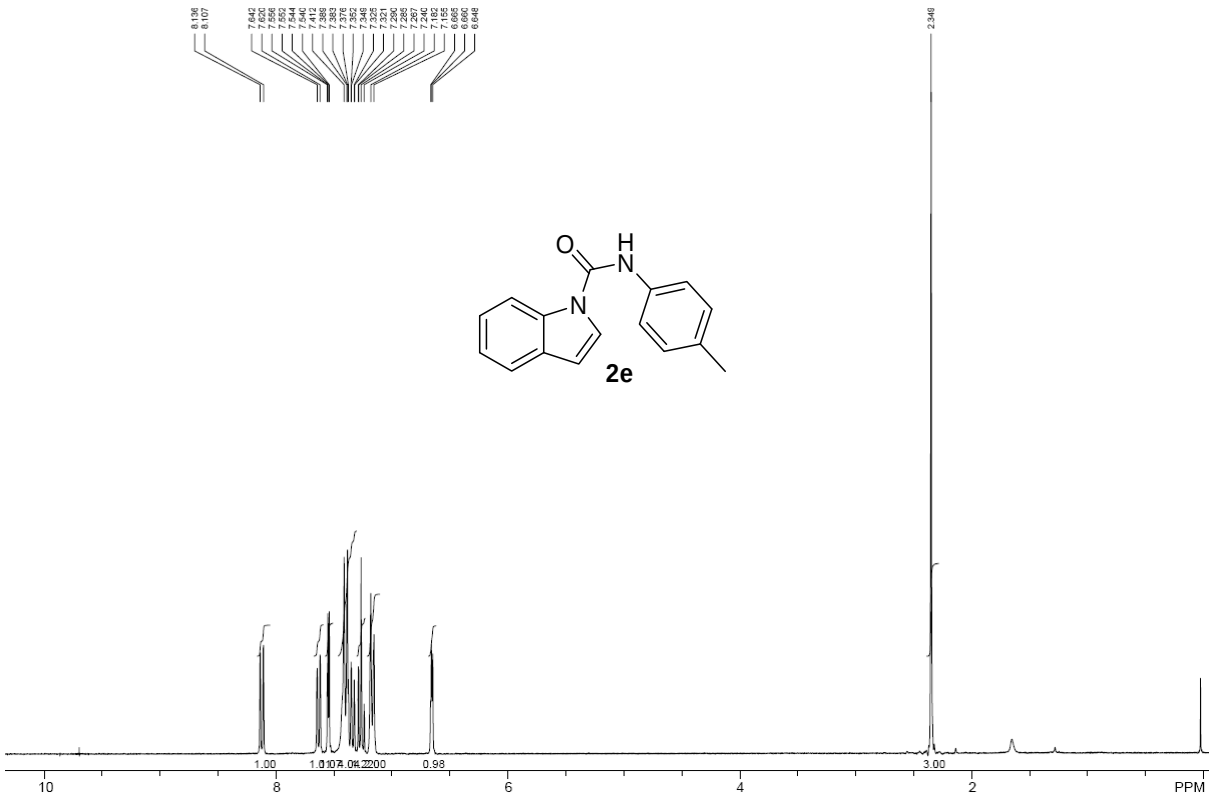
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7.335
7.321
7.290
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7.240
7.195
7.165
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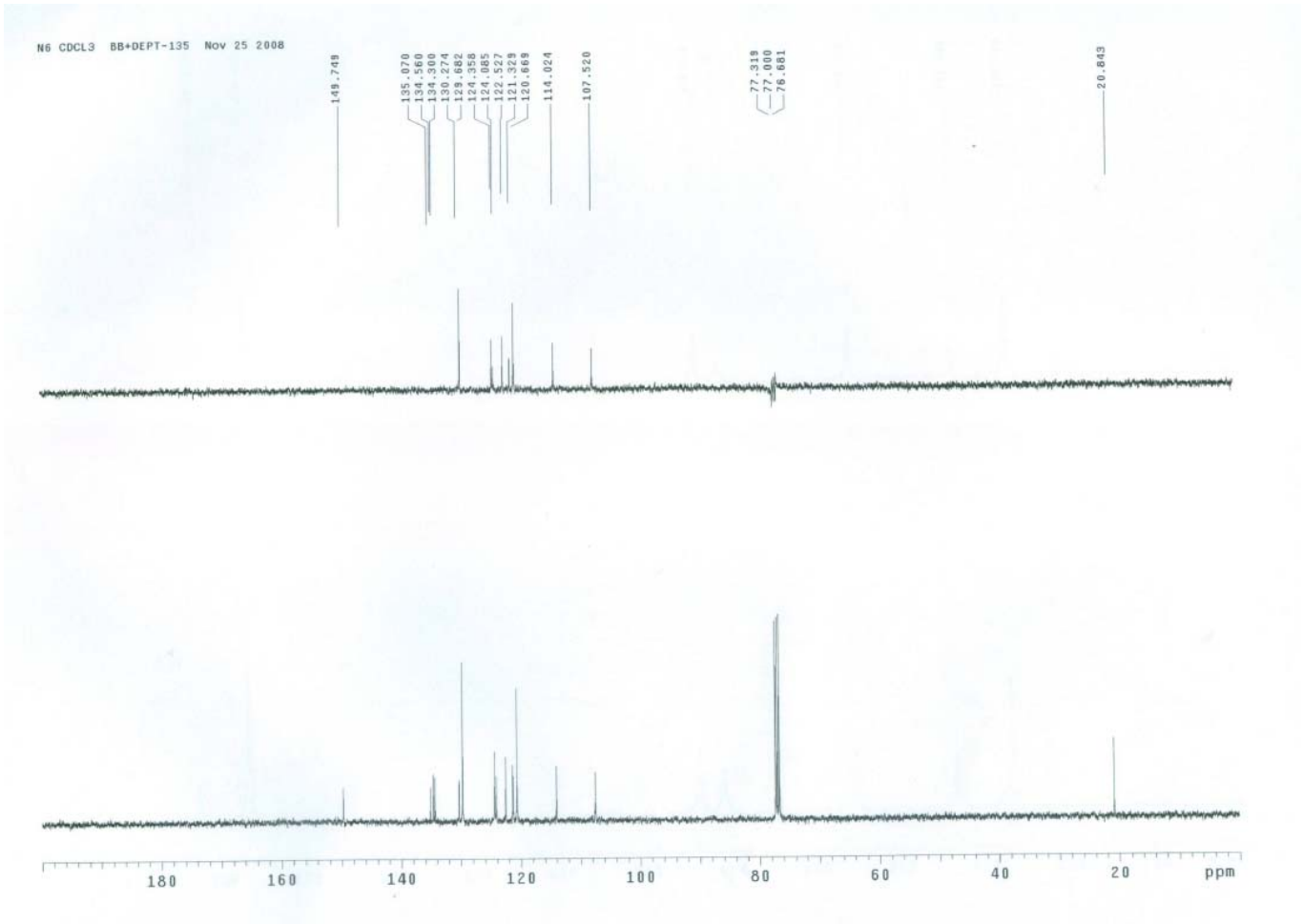
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135.070
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130.274
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120.669
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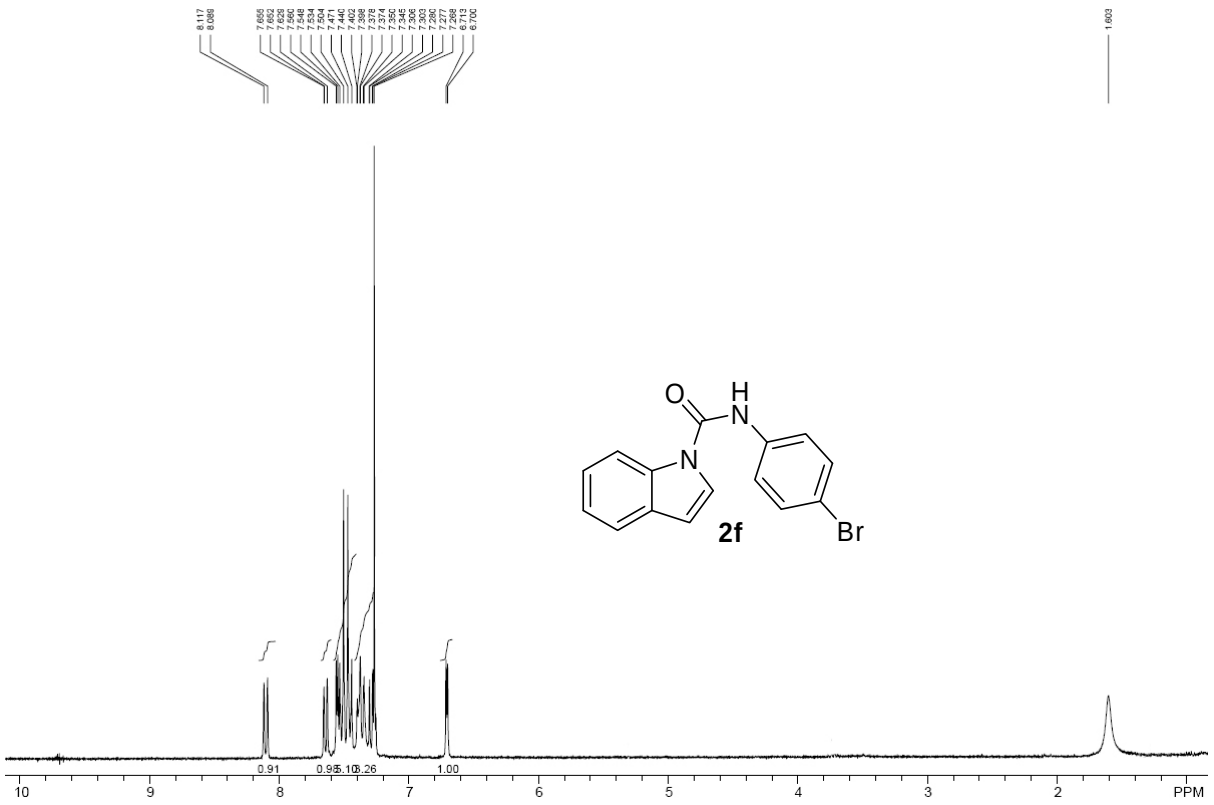
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7.398
7.378
7.374
7.350
7.345
7.306
7.303
7.280
7.277
7.267
6.713
6.700
1.603
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H
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N
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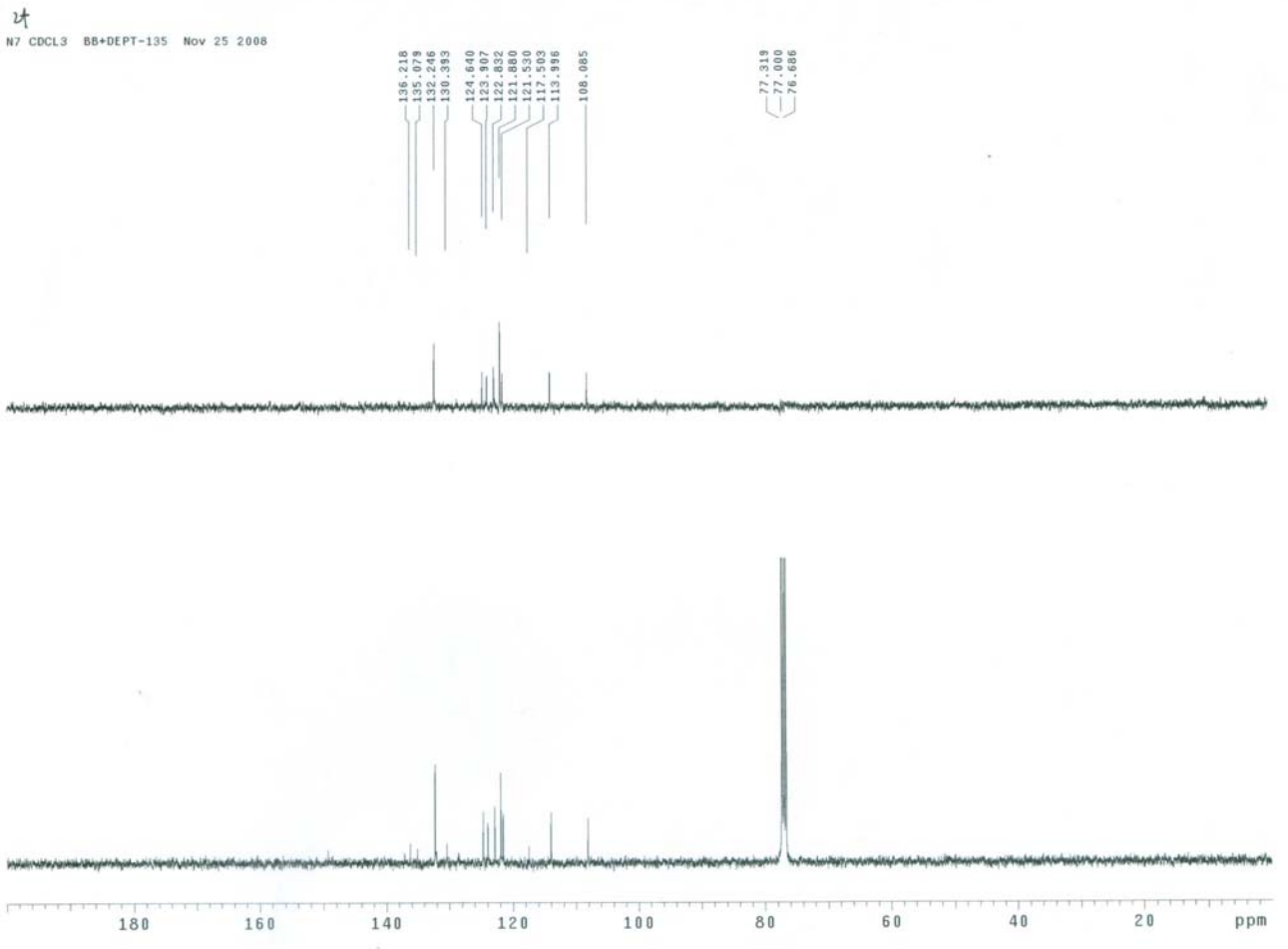
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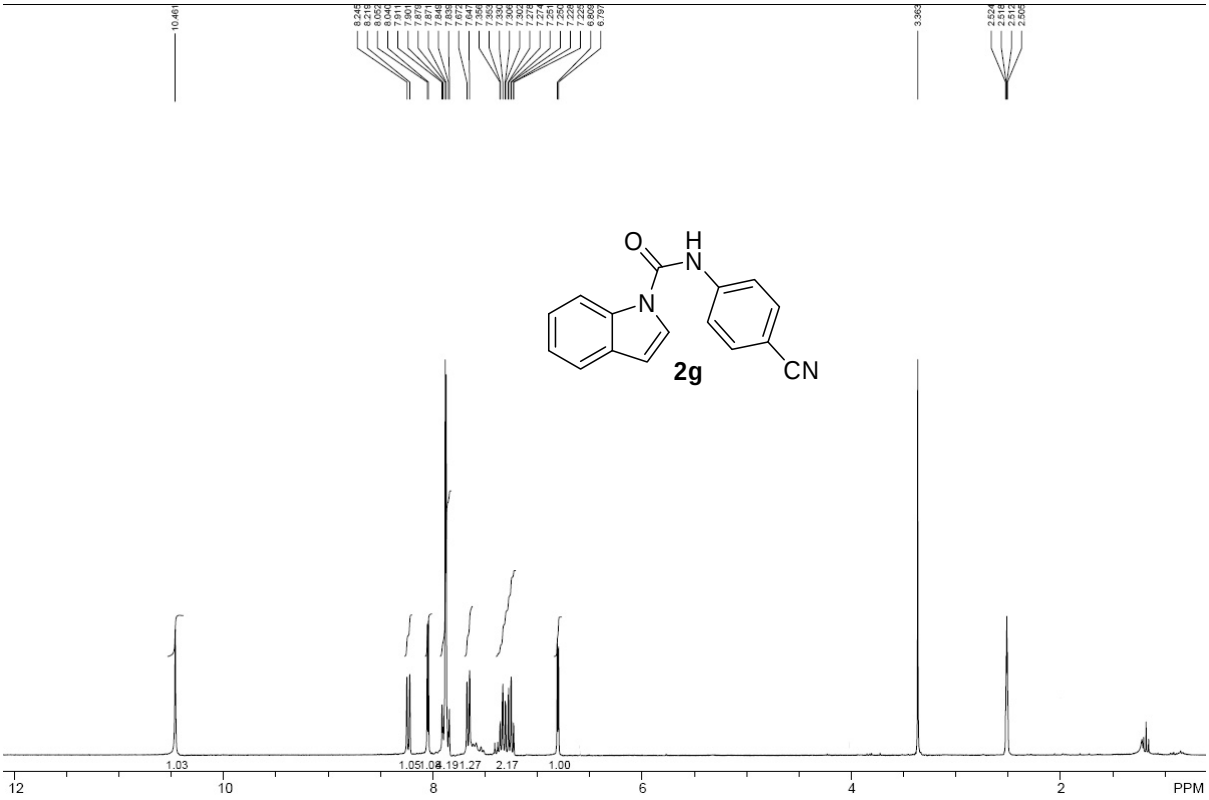
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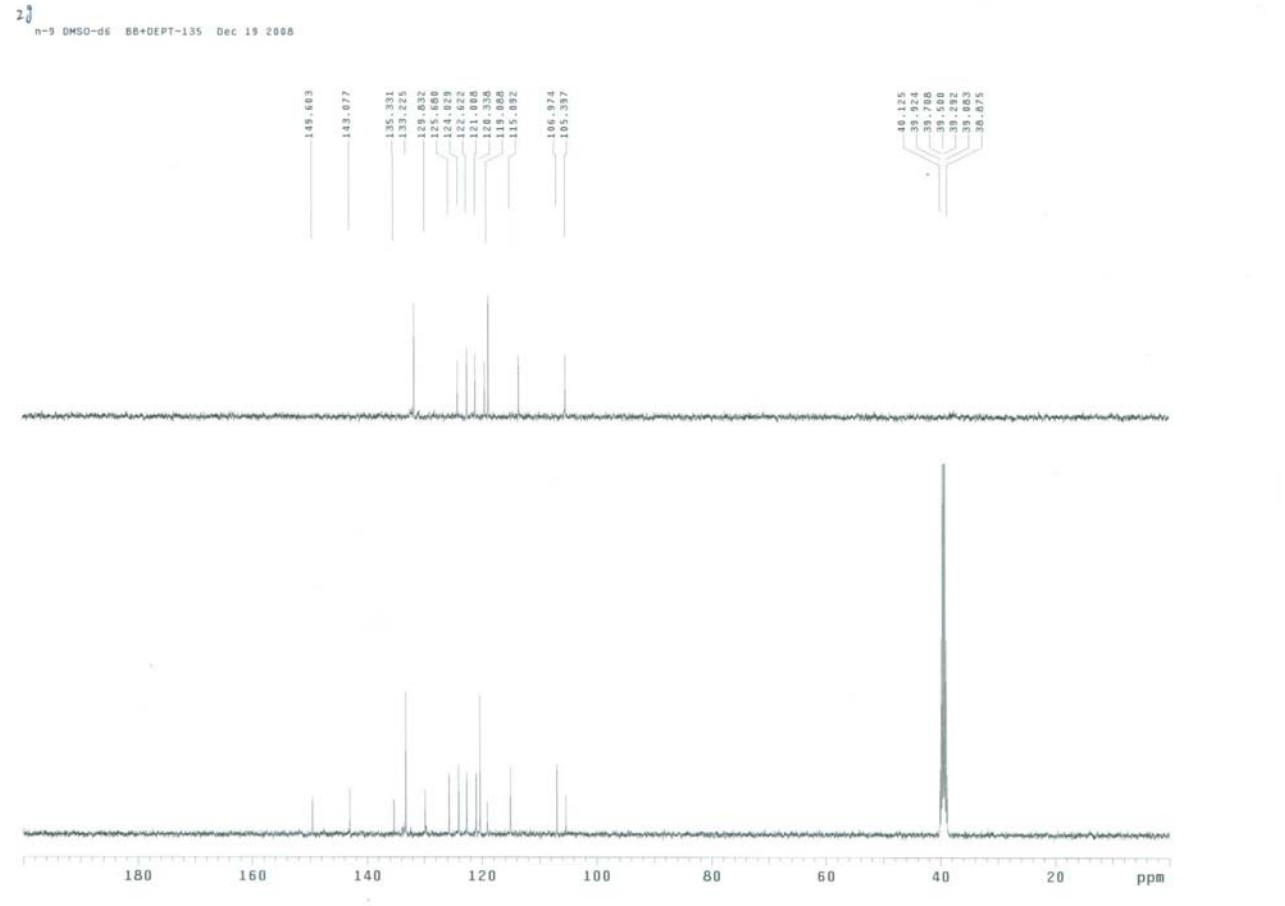
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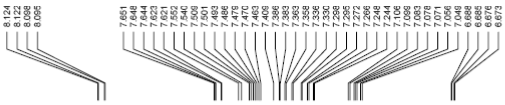

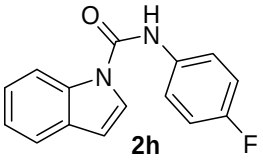

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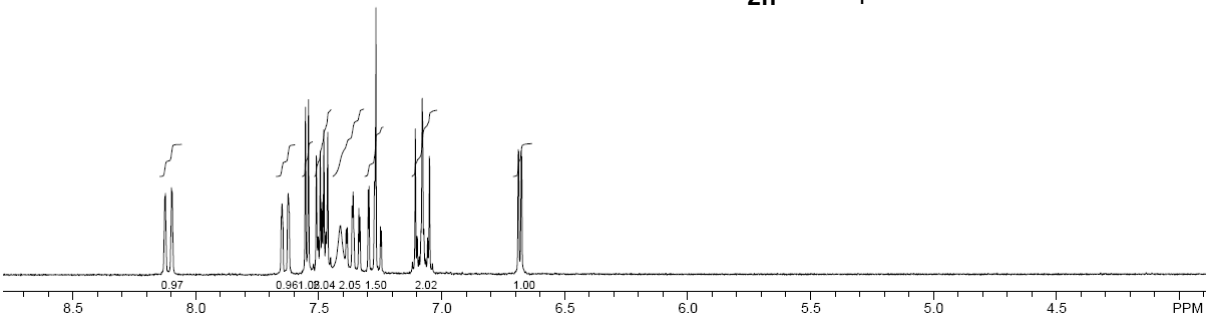
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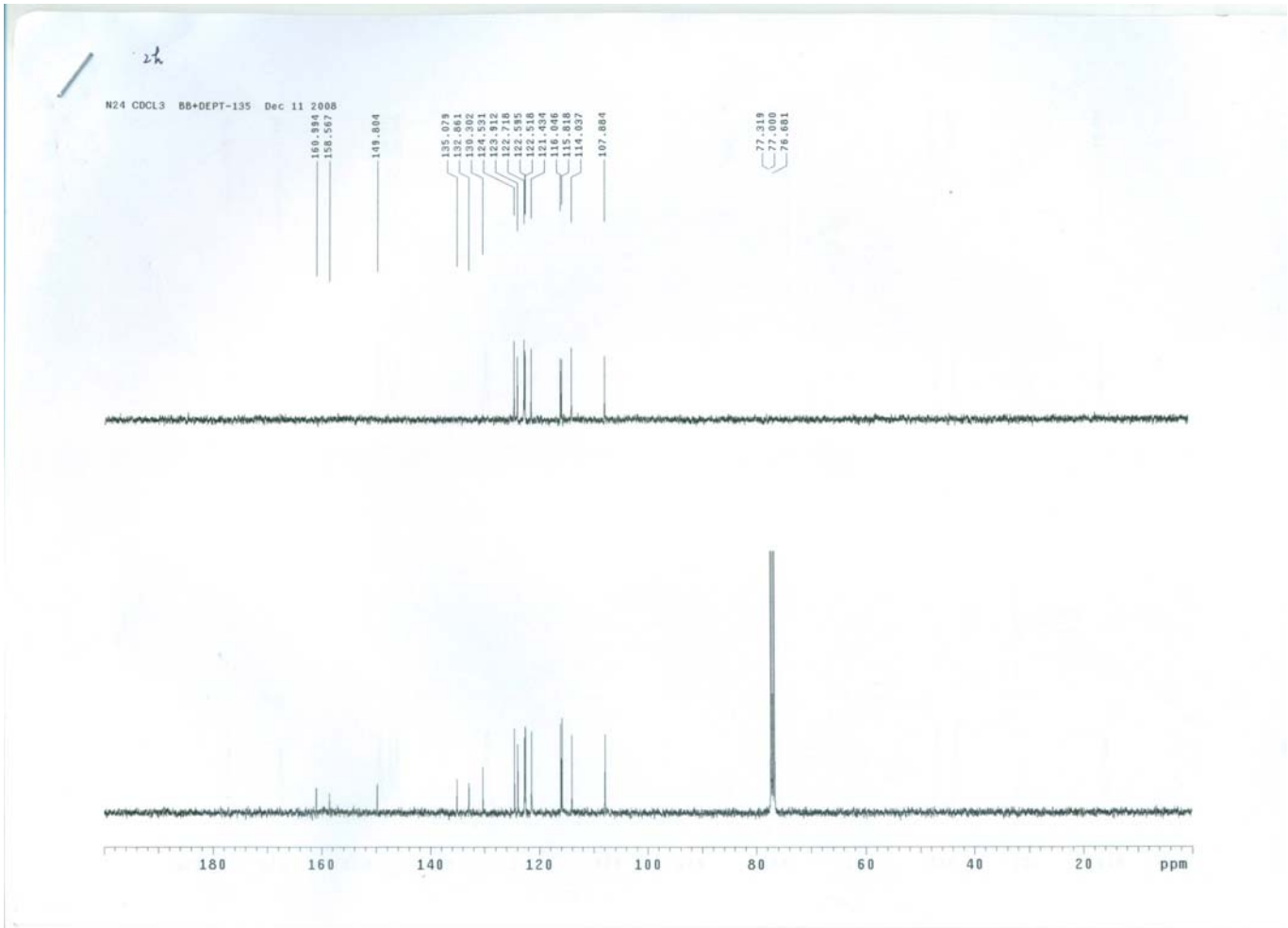
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122.538
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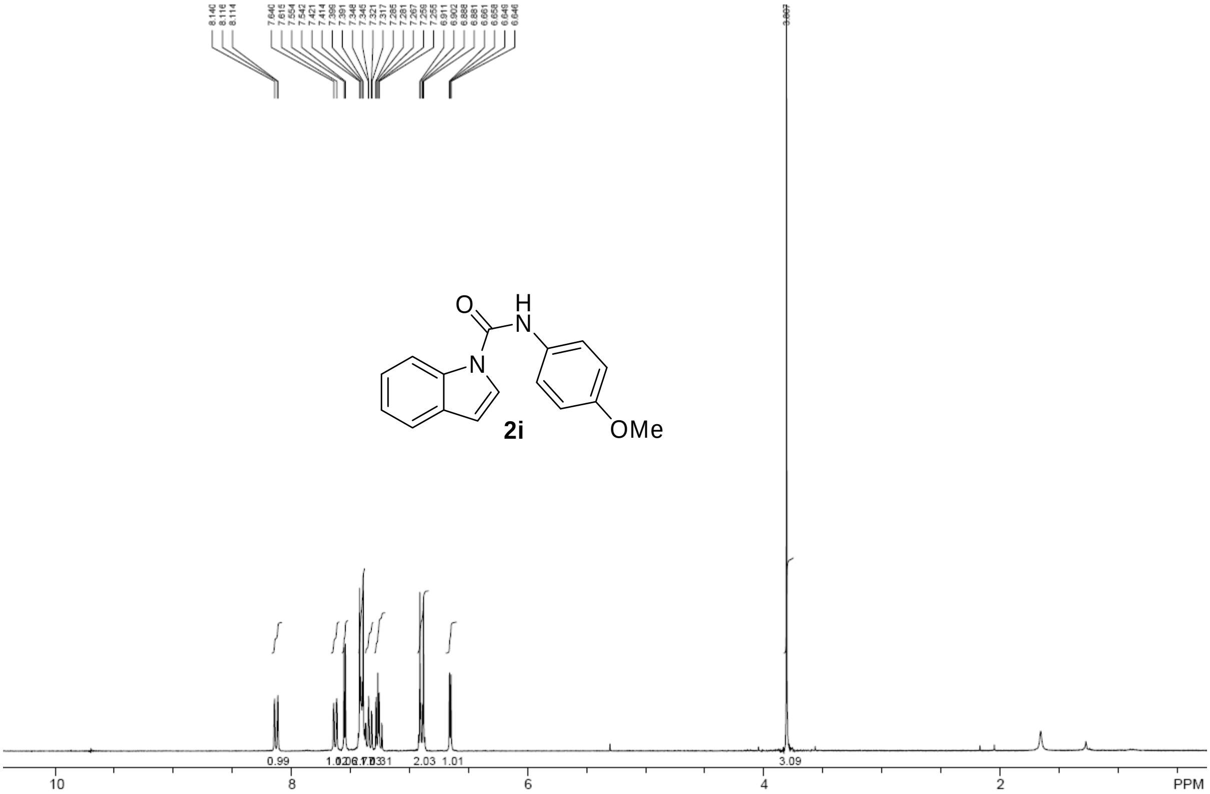
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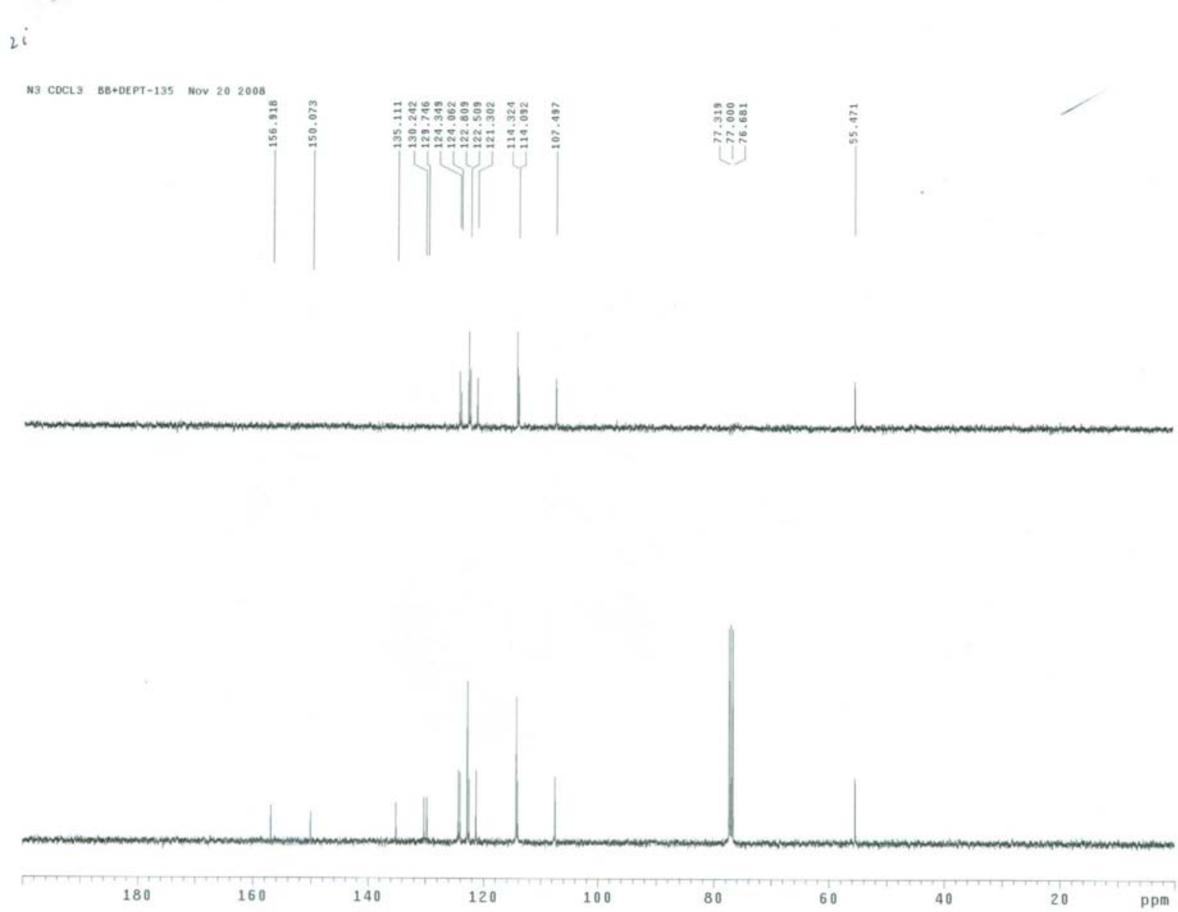
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121.302
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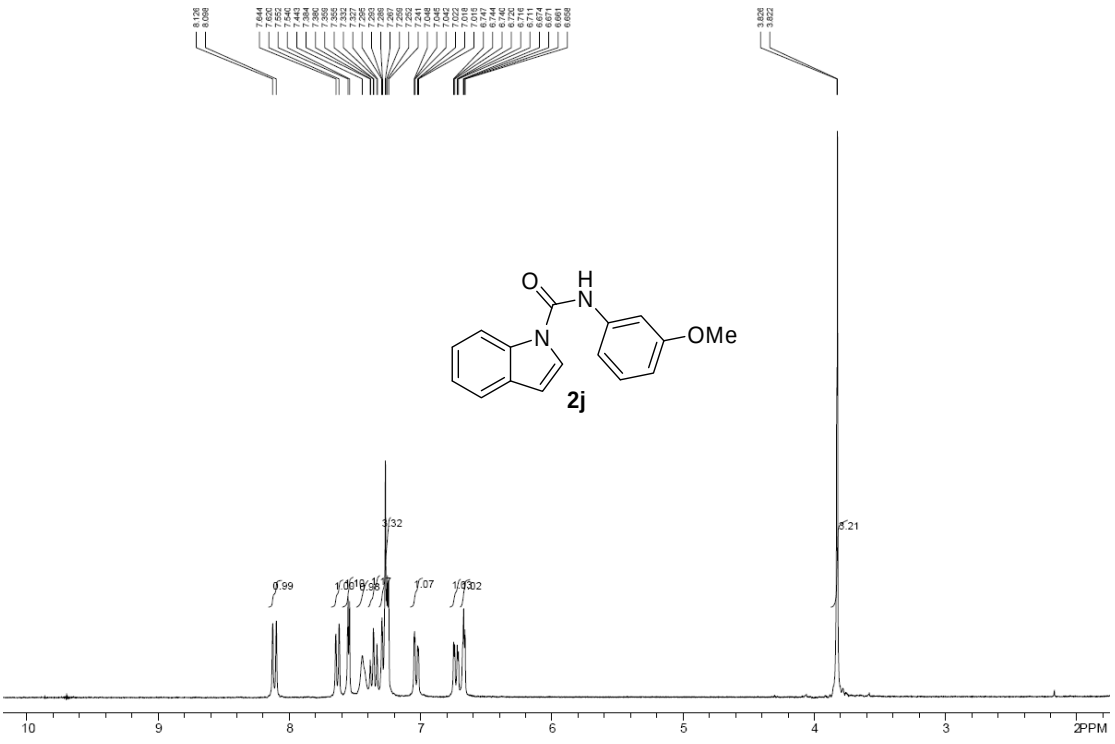
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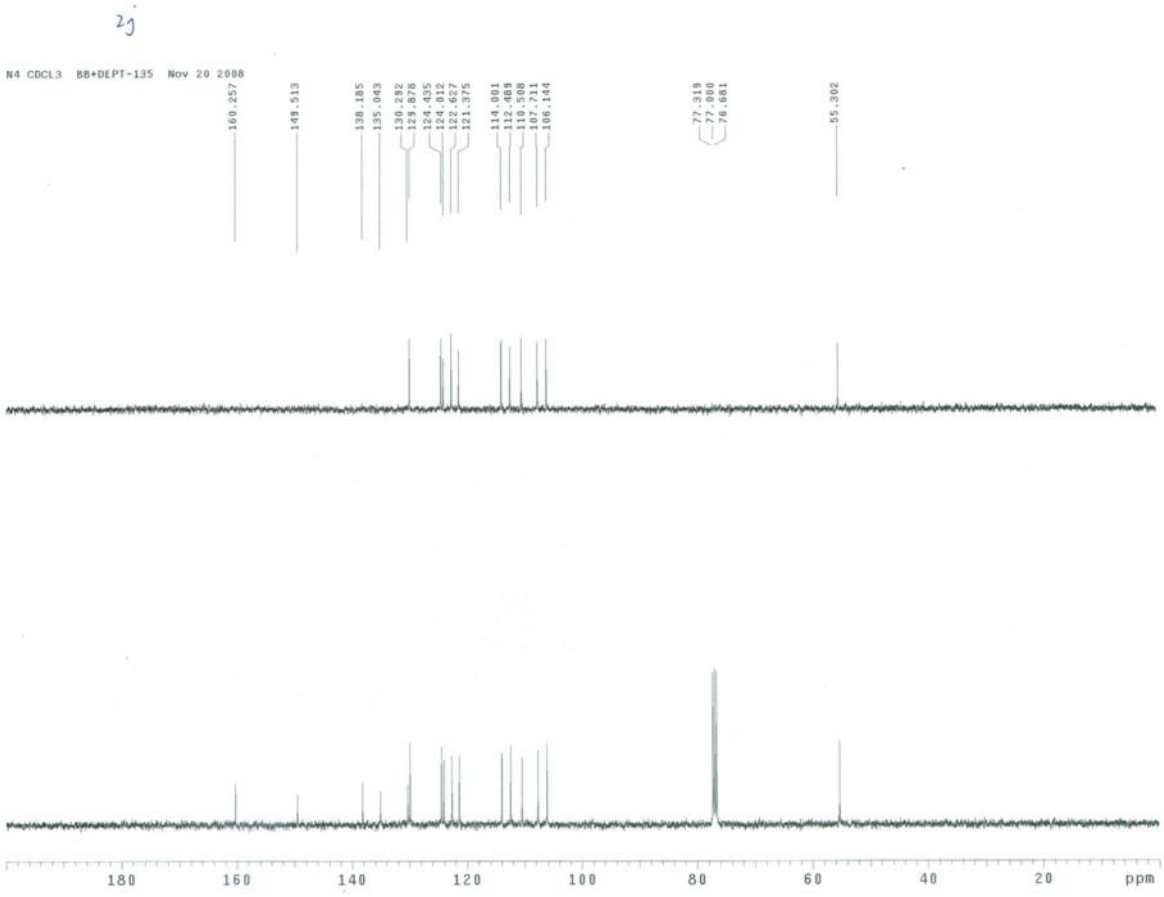
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110.508
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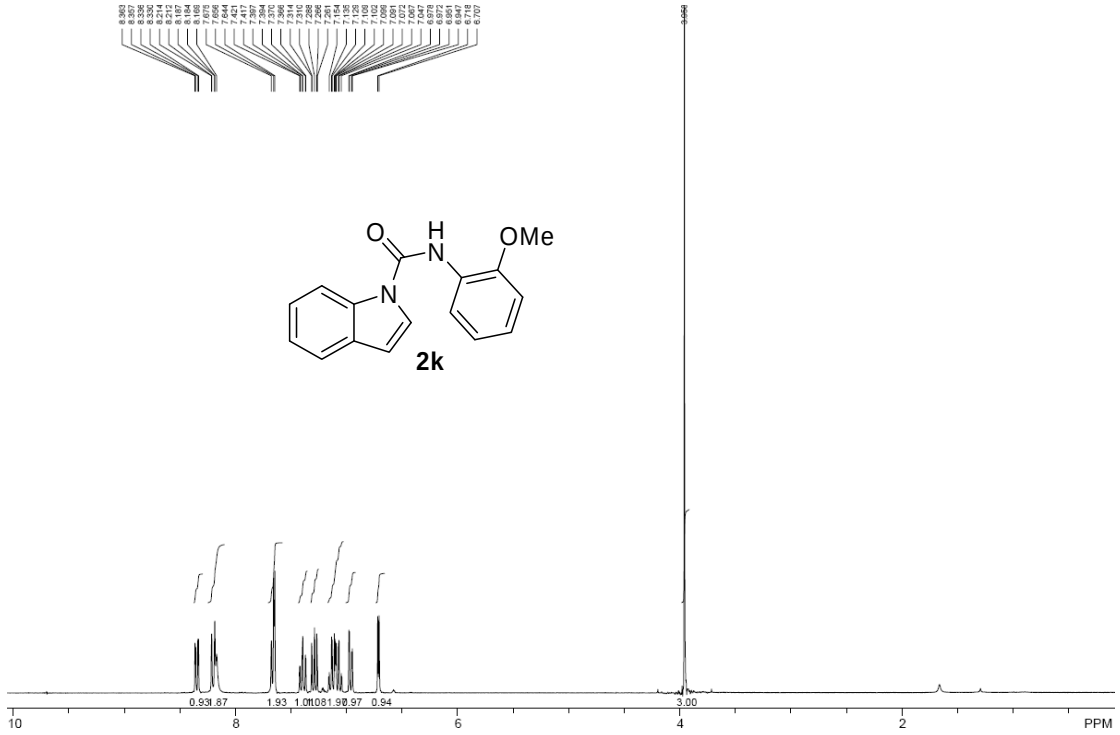
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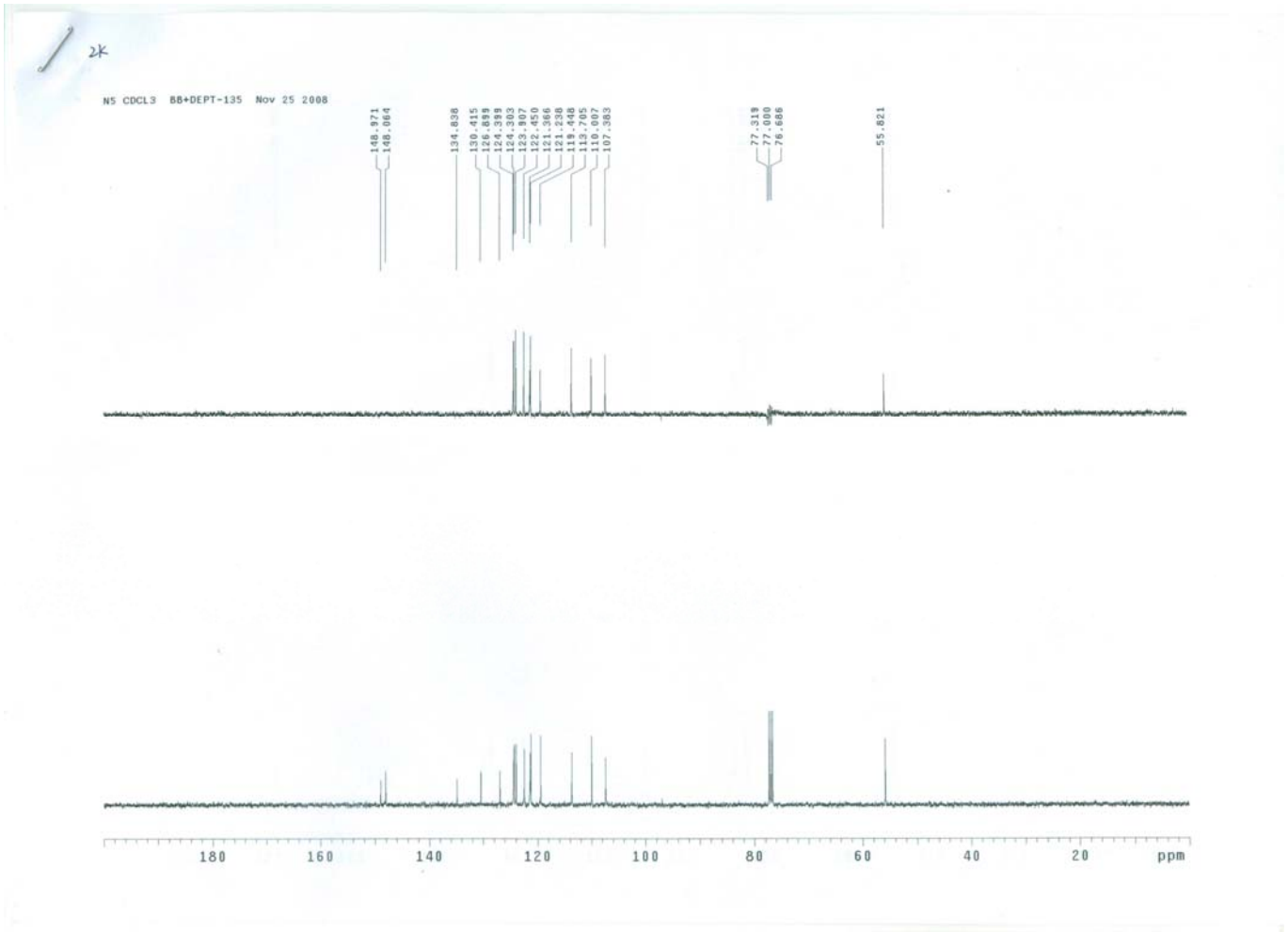
4
2
PPM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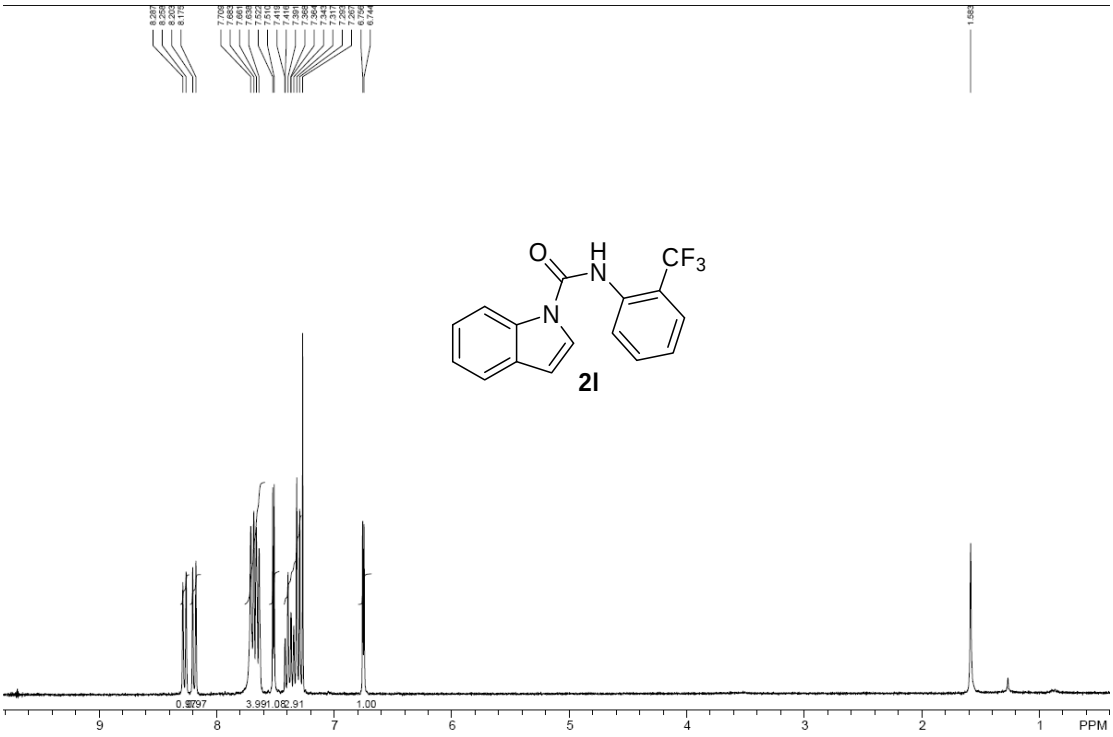
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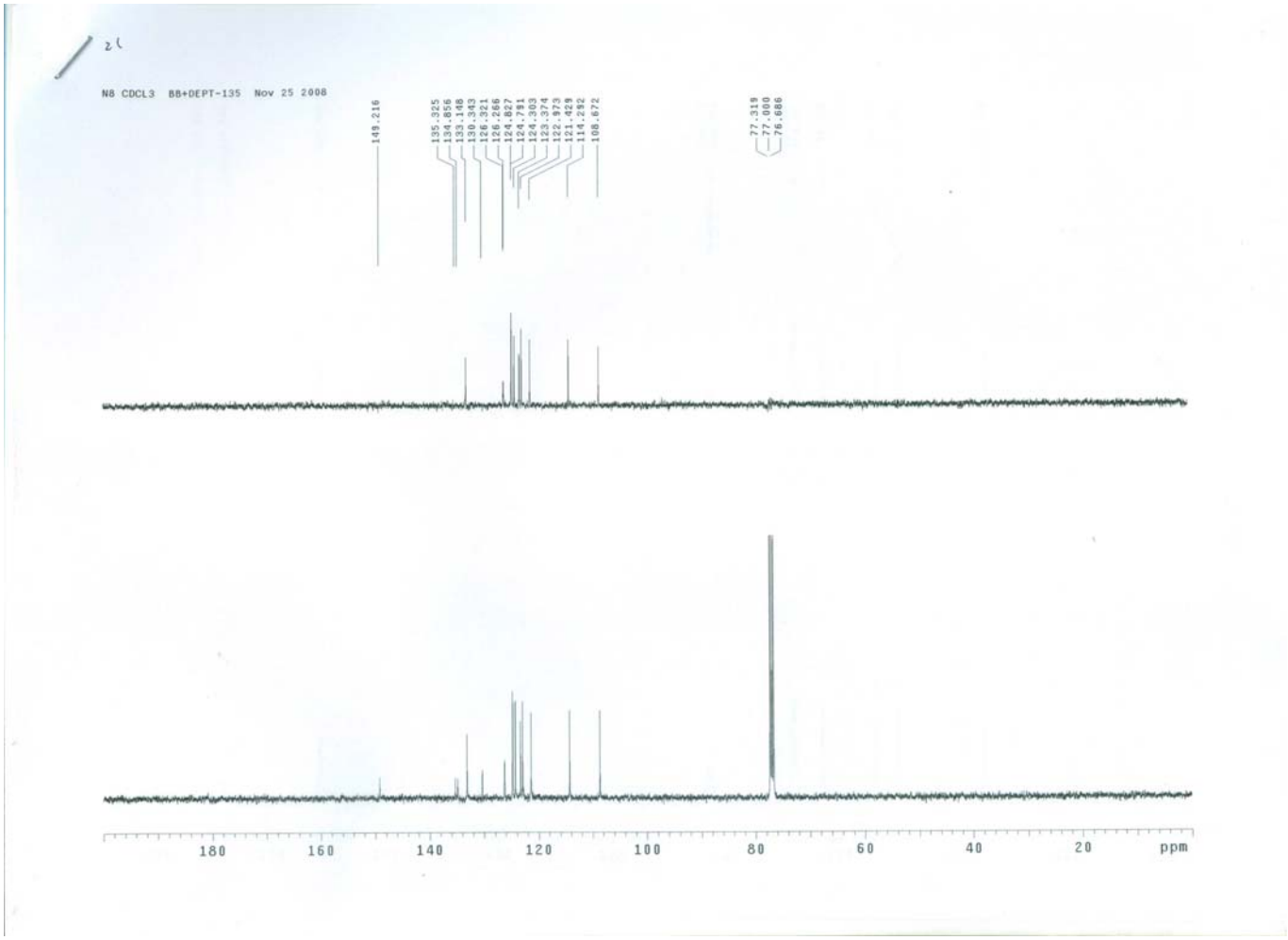
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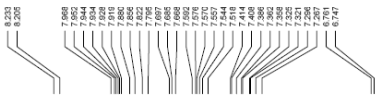
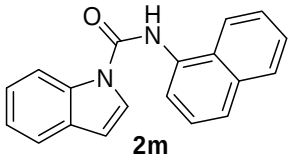
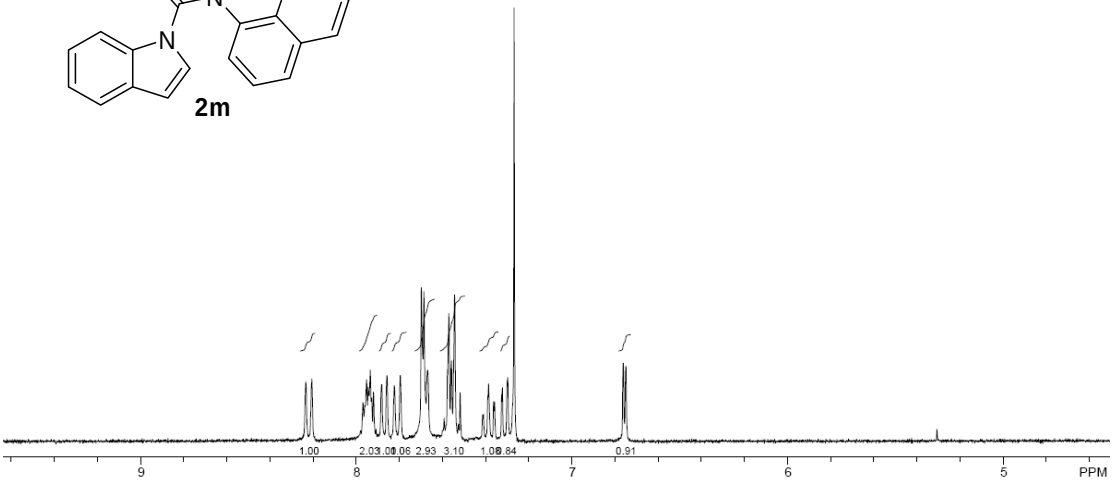
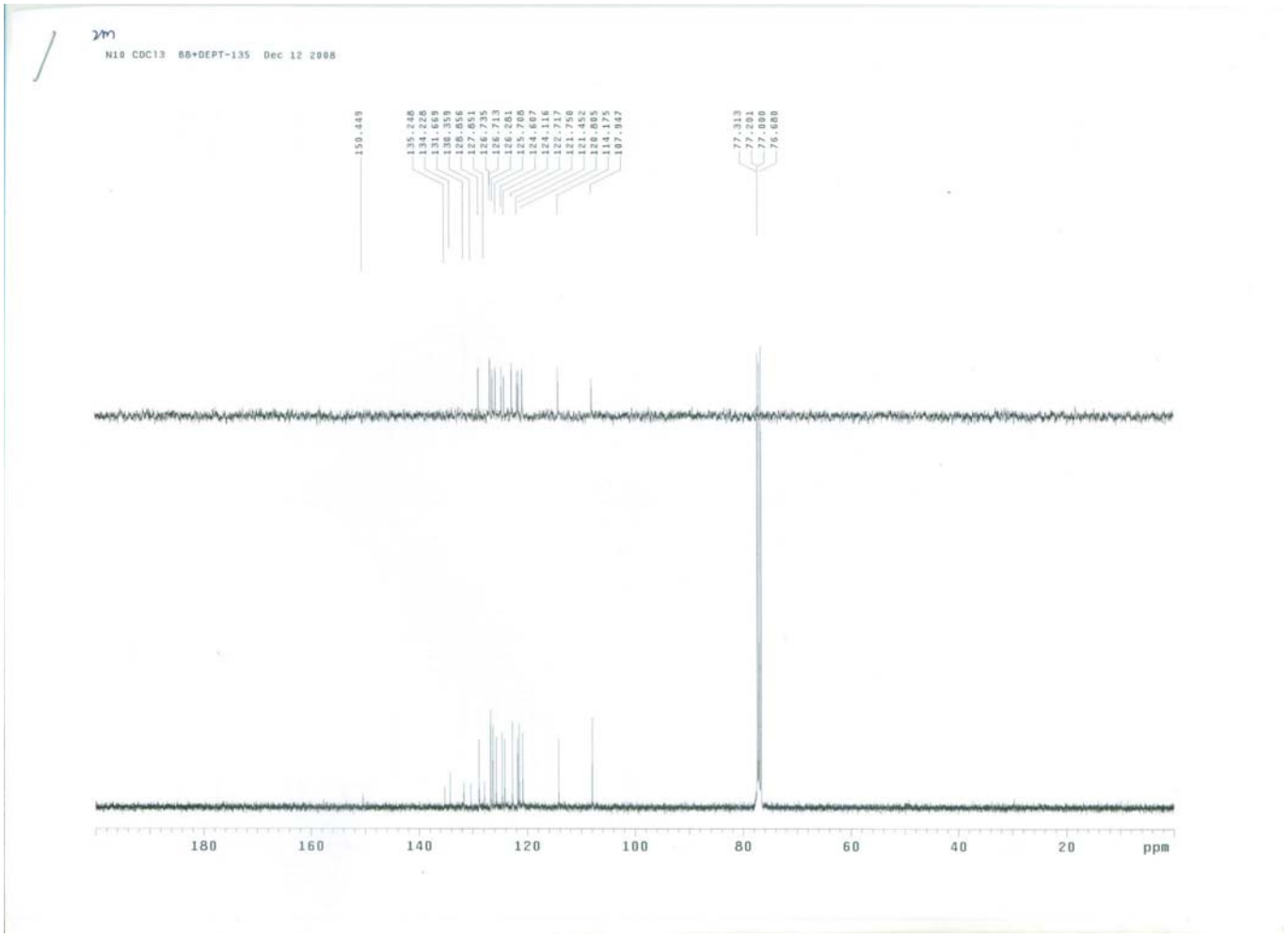
77.319
77.000
76.686
180
160
140
120
100
80
60
40
20
ppm

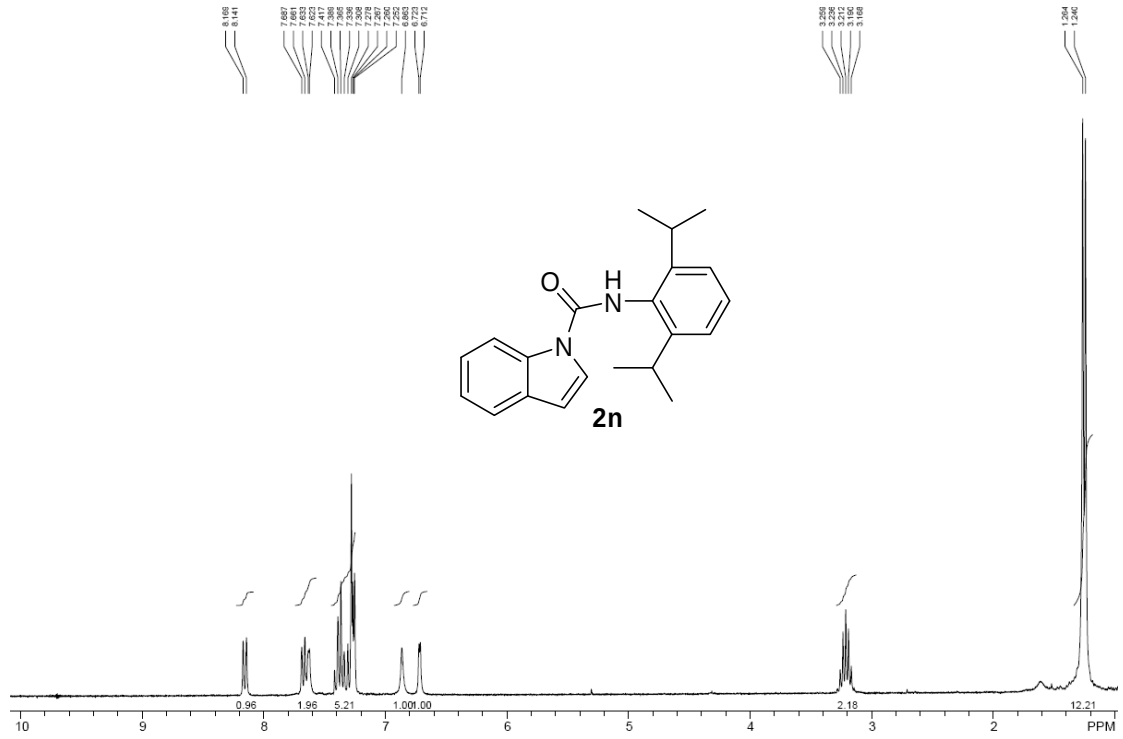




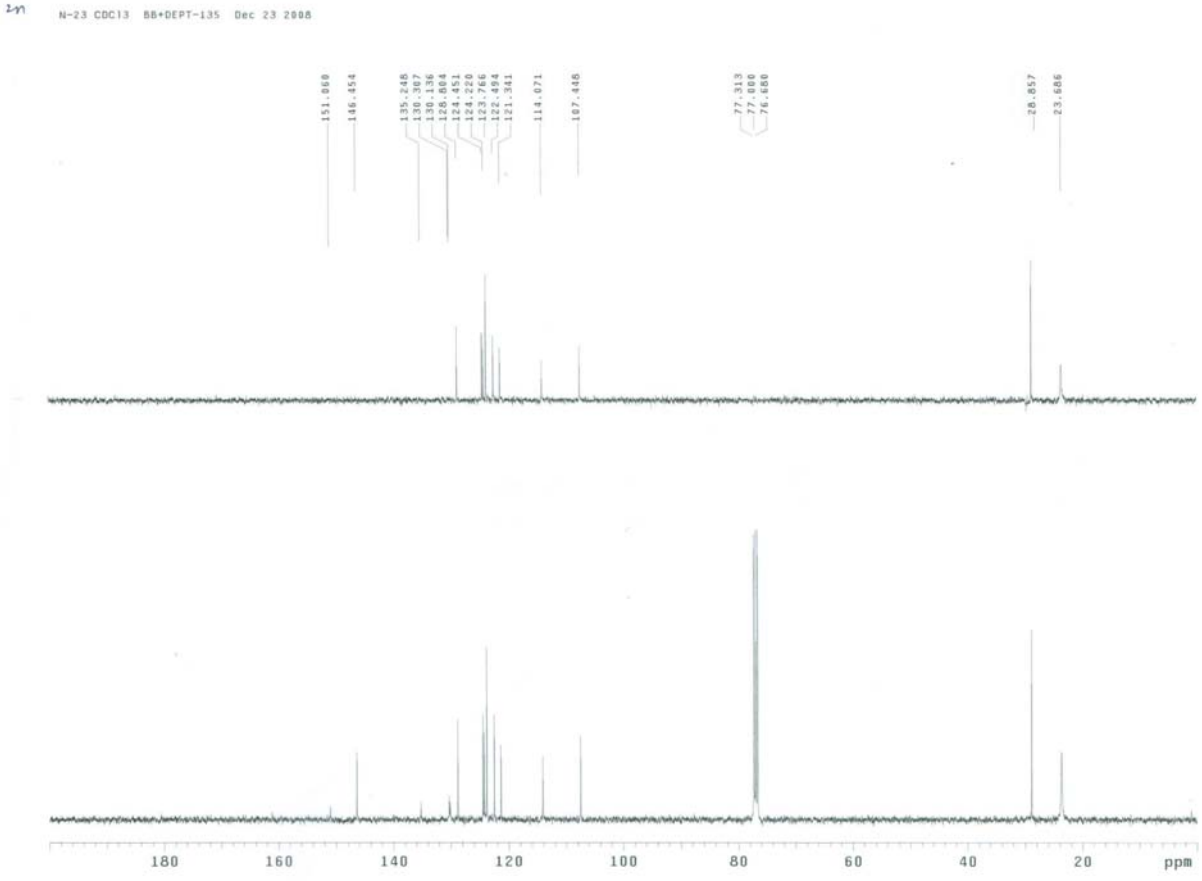
2m

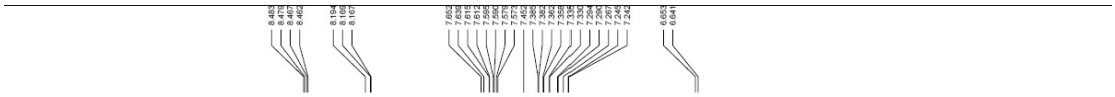

1.00
2.03
3.00
1.06
2.93
3.10
1.08
0.84
0.91
9
8
7
6
5
PPM

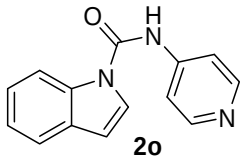

2m
N10 CDCl3 BB+DEPT-135 Dec 12 2008
150.449
135.248
134.228
131.669
130.359
128.856
127.651
126.735
126.713
126.261
125.705
124.607
124.116
122.717
121.756
121.432
120.805
114.175
107.947
77.313
77.201
77.000
76.680
180
160
140
120
100
80
60
40
20
ppm


8.166
8.141
7.687
7.681
7.633
7.623
7.417
7.396
7.388
7.306
7.298
7.287
7.285
6.863
6.773
6.713
3.258
3.236
3.212
3.192
3.168
1.264
1.240
O
H
N
N
0.96
1.96
5.21
1.00
1.00
2.18
12.21
10
9
8
7
6
5
4
3
2
PPM

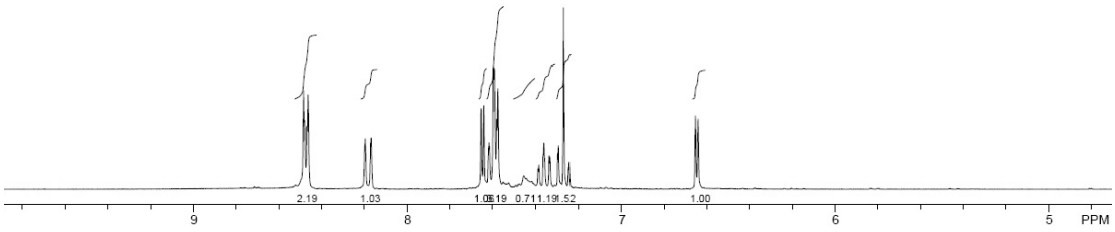
2n

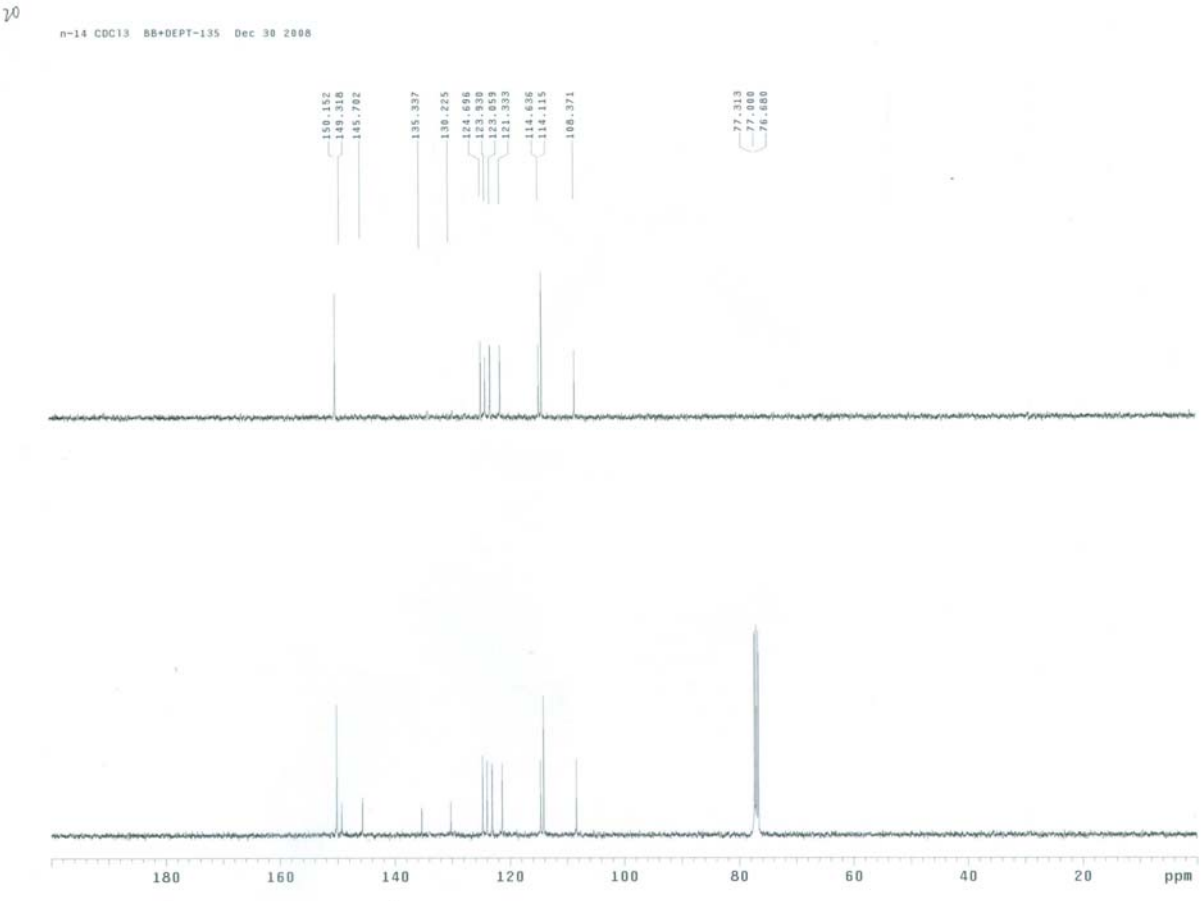

2n
N-23 CDCl3 BB+DEPT-135 Dec 23 2008
151.869
146.454
135.248
130.307
130.136
128.804
124.451
124.220
123.766
122.494
121.341
114.071
107.446
77.313
77.000
76.686
28.857
23.686
180
160
140
120
100
80
60
40
20
ppm

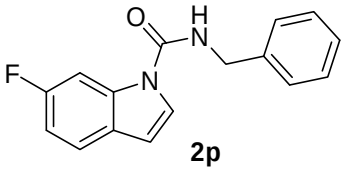




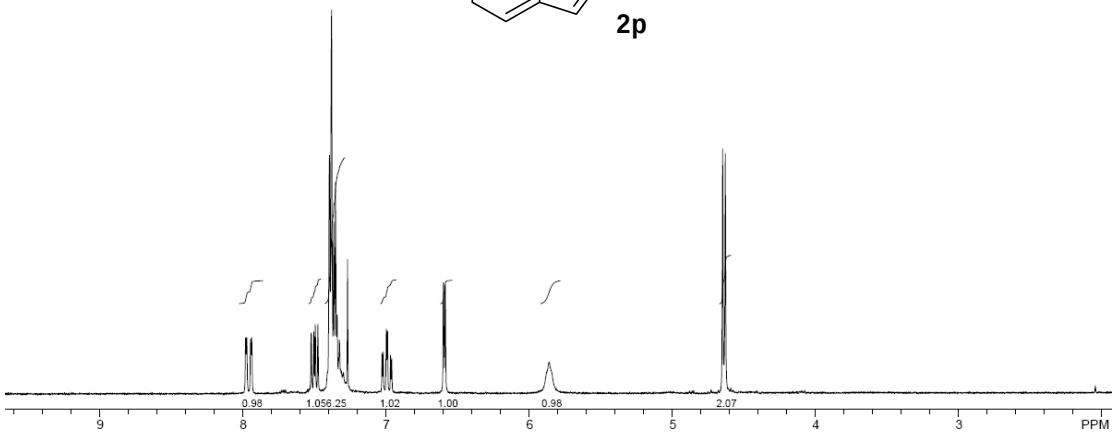
2o

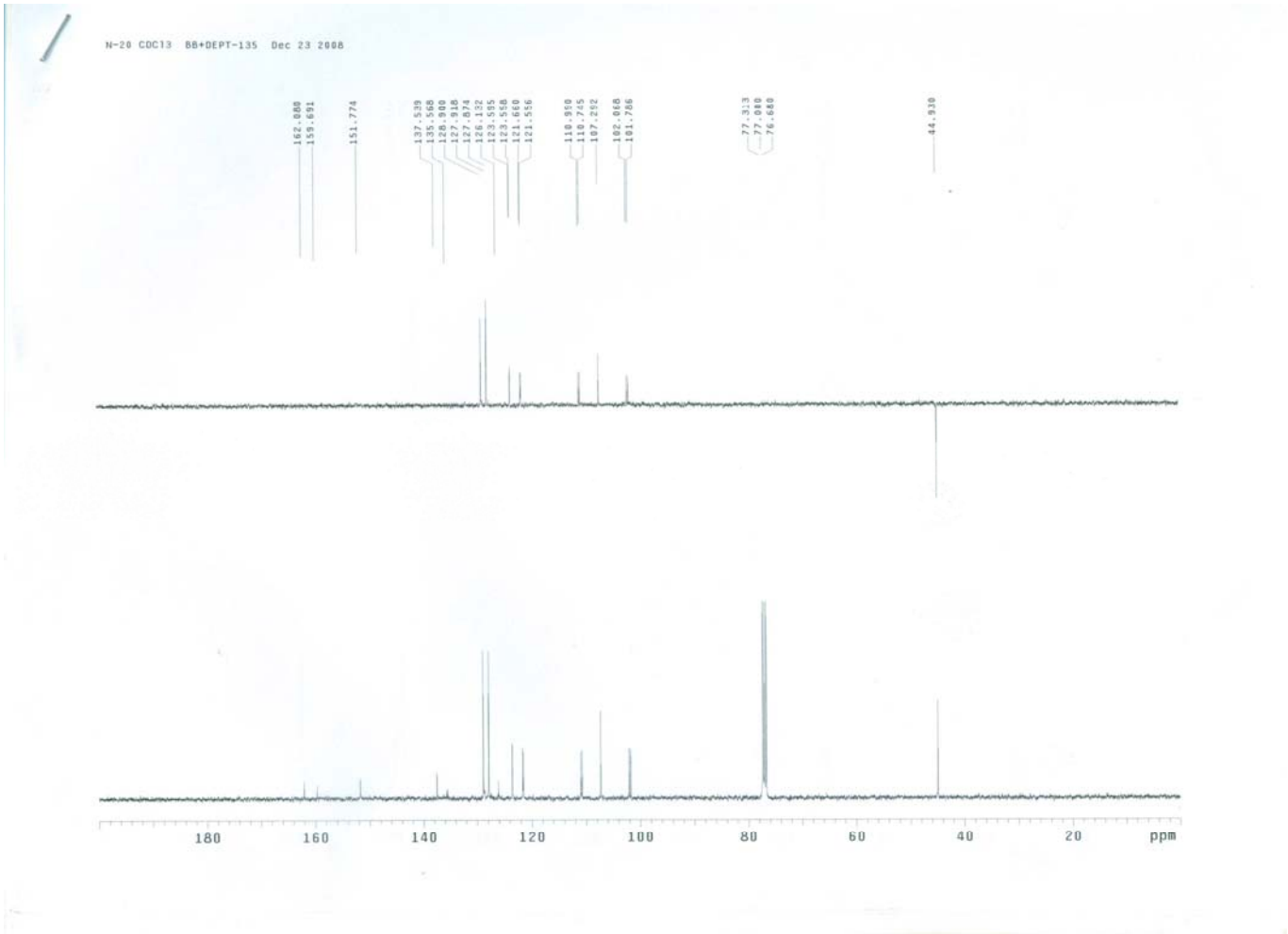

2.19
1.03
1.00
9
8
7
6
5
PPM


2o
n-14 CDCl3 BB+DEPT-135 Dec 30 2008
150.152
149.316
145.702
135.337
130.225
124.696
123.958
123.695
121.333
114.636
114.115
108.371
77.313
77.000
76.680
180
160
140
120
100
80
60
40
20
ppm

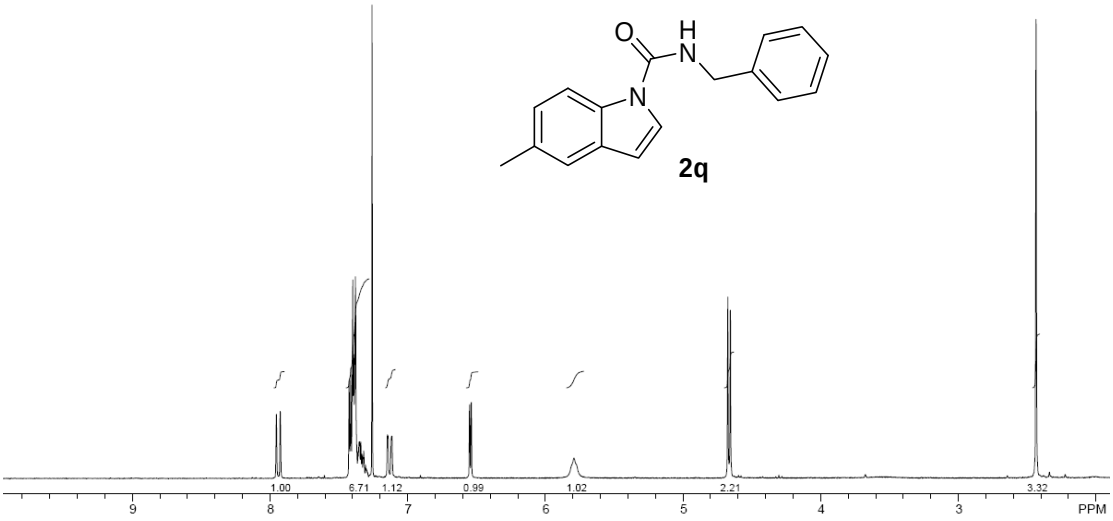

O
H
N
F
N

2p

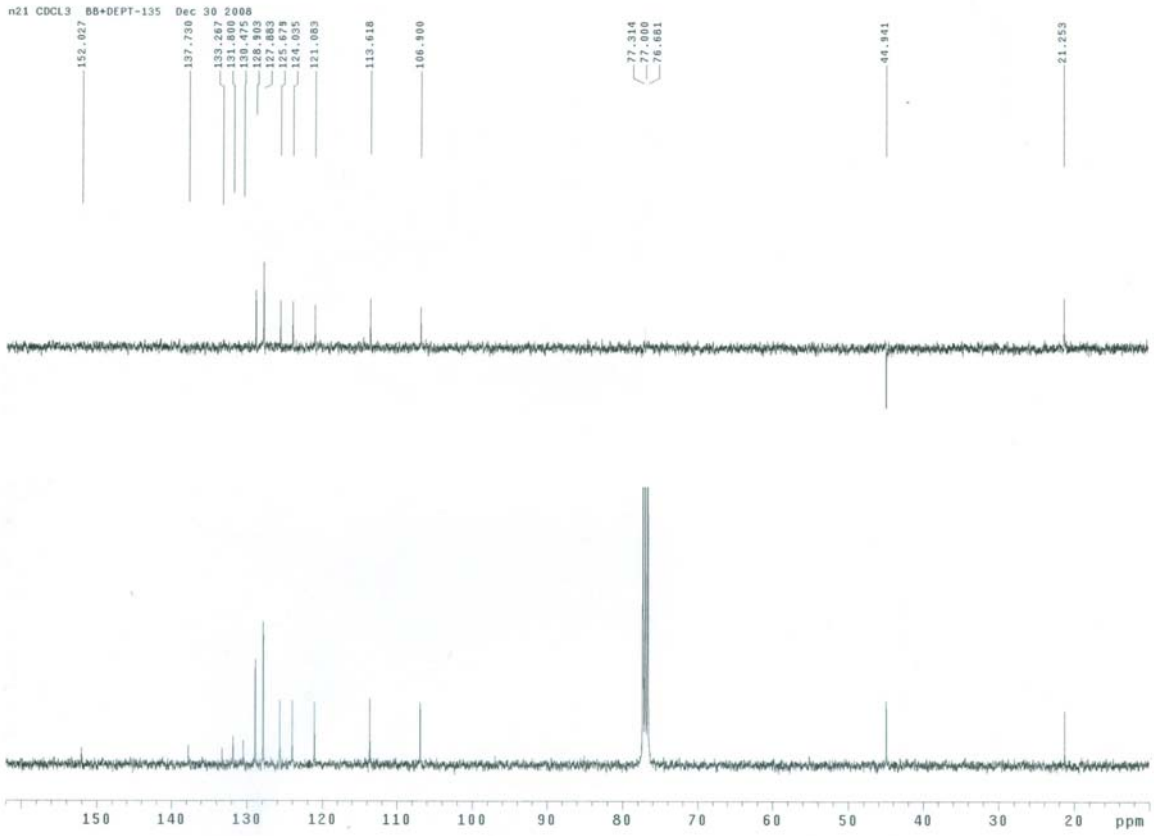

0.98
1.056.25
1.02
1.00
0.98
2.07
9
8
7
6
5
4
3
PPM

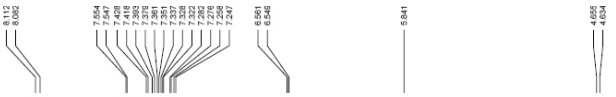

N-20 CDC13 BB+DEPT-135 Dec 23 2008
162.080
159.691
151.774
137.539
135.568
128.900
127.918
127.874
126.132
123.555
123.508
121.660
121.556
110.950
110.745
107.292
102.068
101.766
77.313
77.000
76.680
44.930
180
160
140
120
100
80
60
40
20
ppm

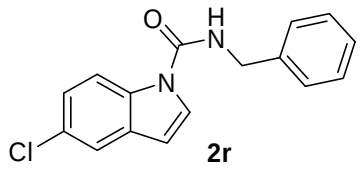

7.953
7.924
7.423
7.413
7.398
7.391
7.378
7.365
7.353
7.348
7.335
7.331
7.318
7.294
7.146
7.140
7.118
7.113
6.548
6.538
5.791
4.674
4.666
2.466


O
H
N
N
2q
1.00
6.71
1.12
0.99
1.02
2.21
3.32
9
8
7
6
5
4
3
PPM

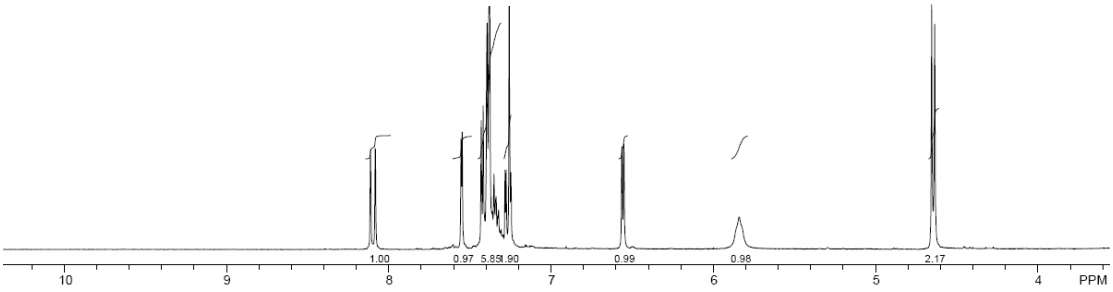
2q

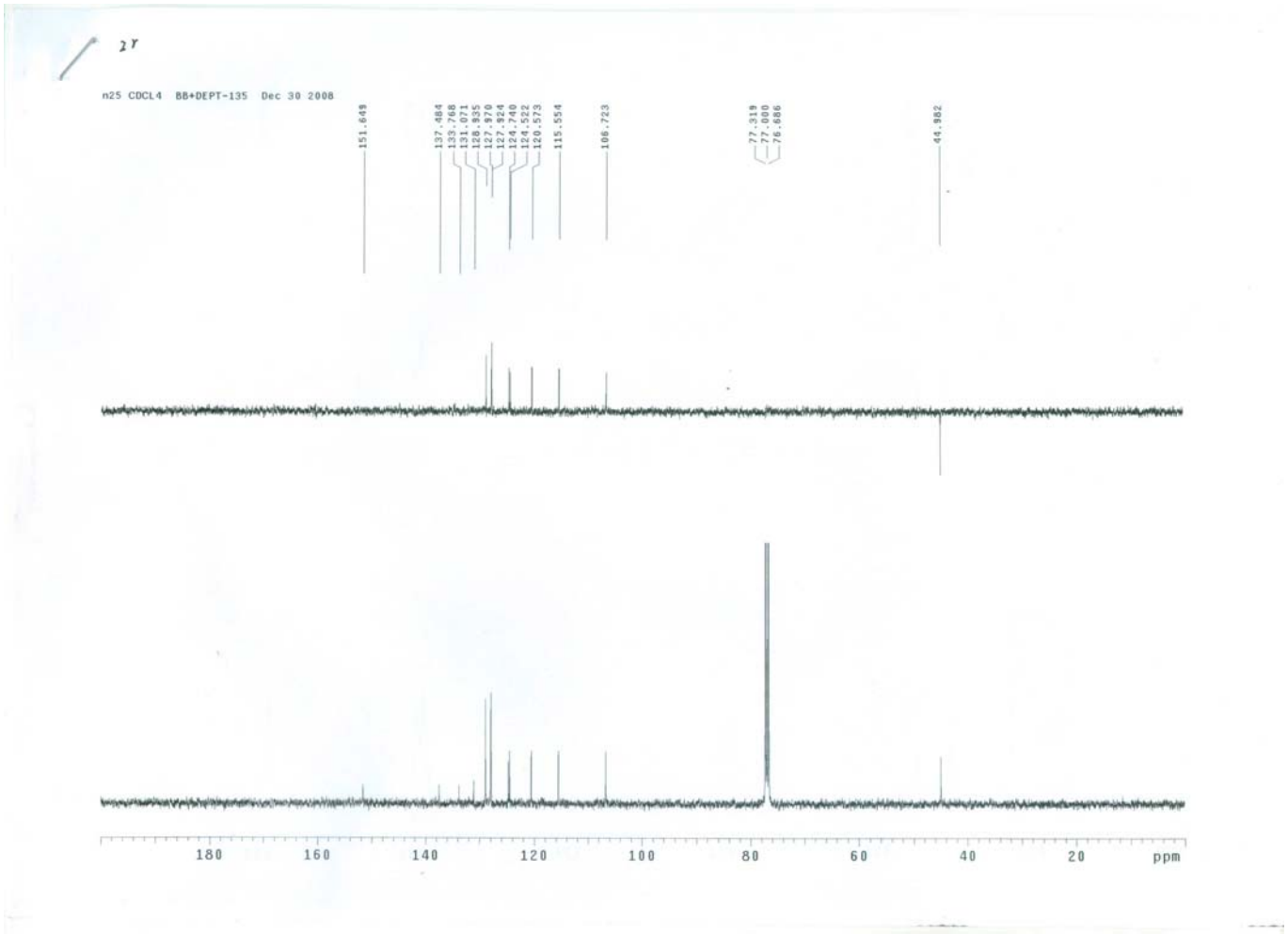

n21 CDCL3 BB+DEPT-135 Dec 30 2008
152.027
137.730
133.267
131.800
130.475
128.903
127.883
125.679
124.035
121.083
113.618
106.900
77.314
77.000
76.681
44.941
21.253
150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

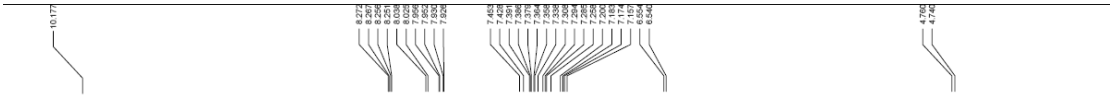


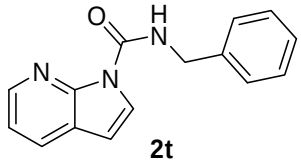

O
H
N
N
Cl

2r

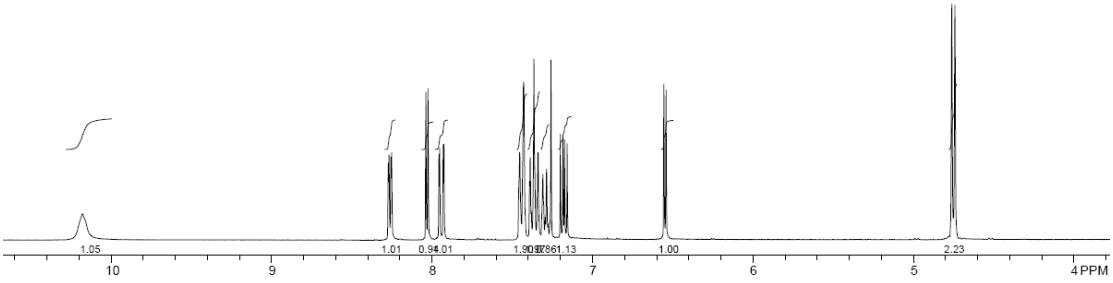

1.00
0.97
5.85
1.90
0.99
0.98
2.17
10
9
8
7
6
5
4
PPM

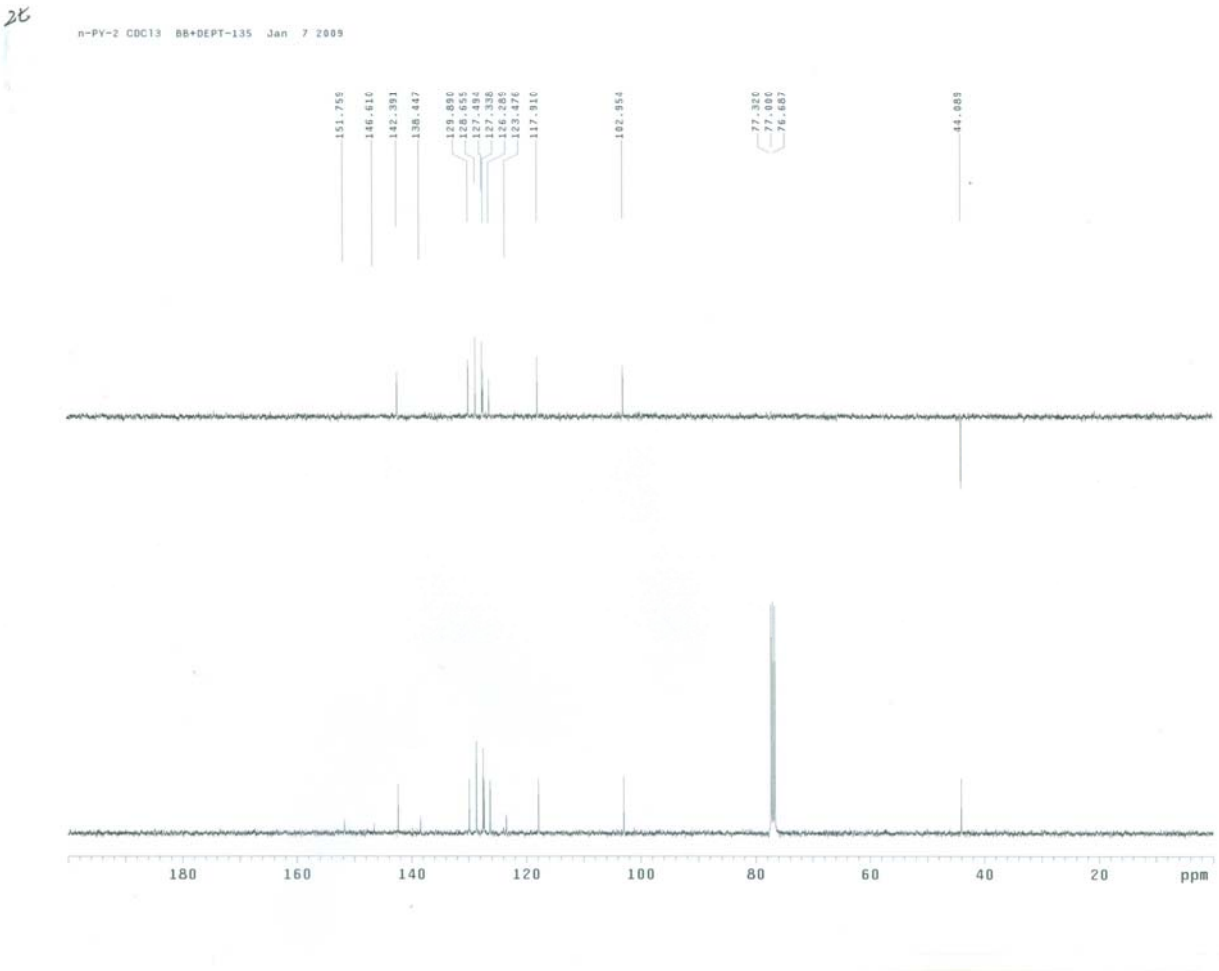

2r
n25 CDCL4 BB+DEPT-135 Dec 30 2008
151.649
137.484
133.768
131.371
129.835
127.976
127.824
124.740
124.522
120.573
115.554
106.723
77.319
77.000
76.686
44.982
180
160
140
120
100
80
60
40
20
ppm

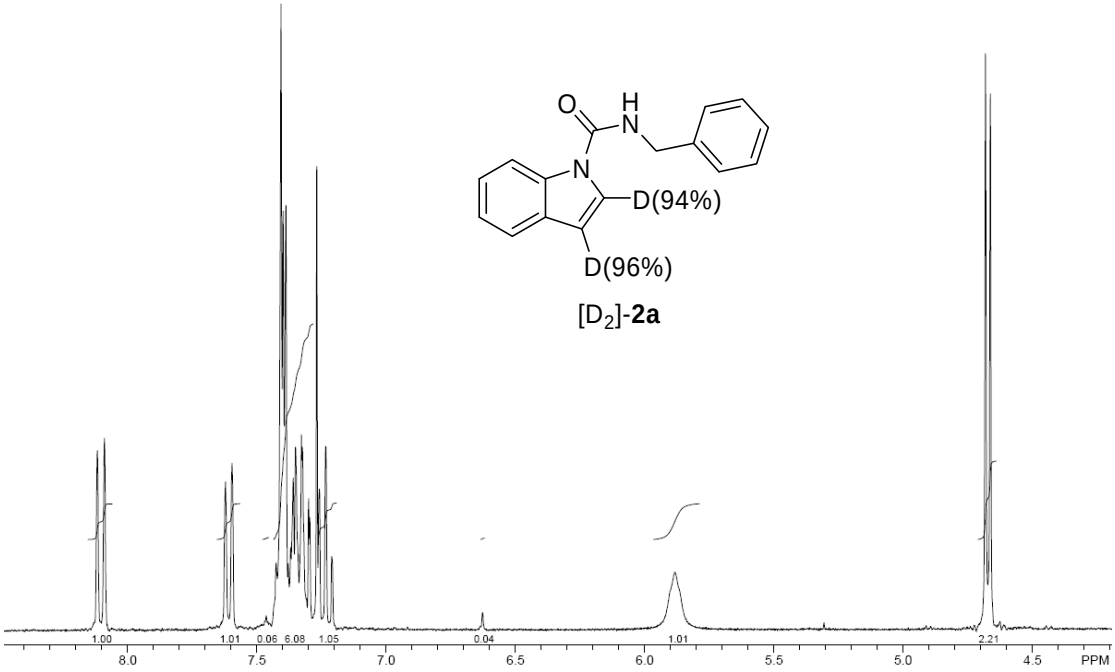




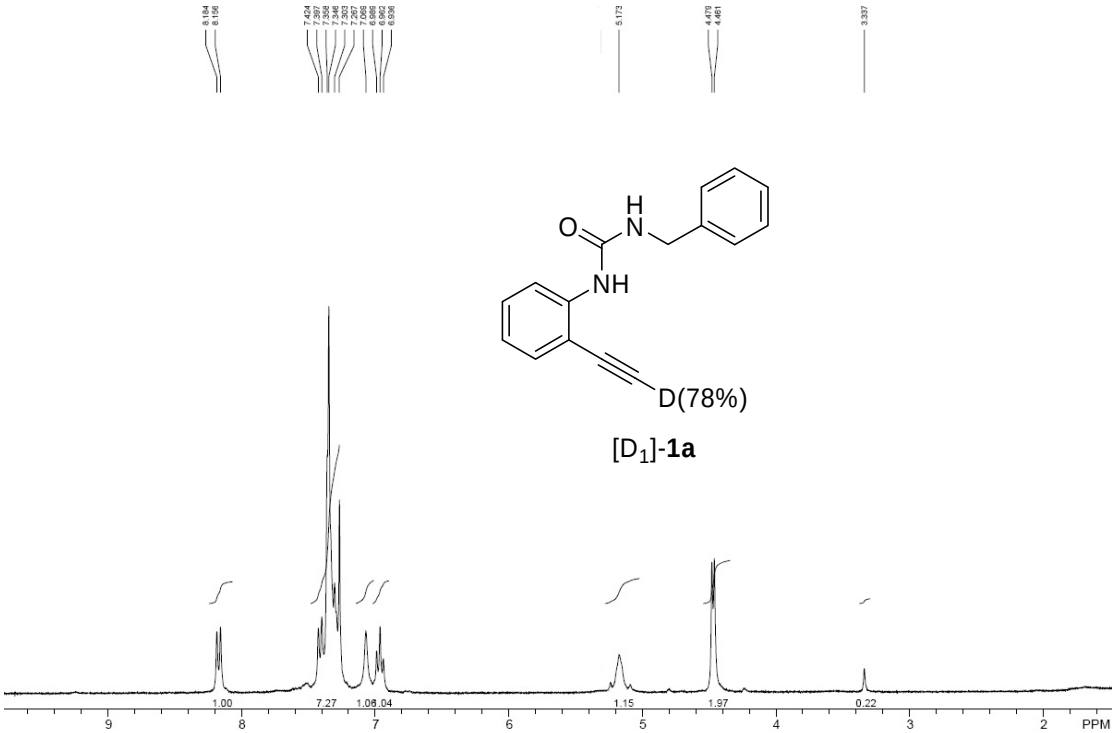
2t


1.05
1.01
0.94
4.01
1.00
2.23
10
9
8
7
6
5
4 PPM


2t
n-PY-2 CDCl3 BB+DEPT-135 Jan 7 2009
151.755
146.610
142.391
138.447
129.890
128.655
127.494
127.338
126.286
123.476
117.910
102.954
77.320
77.000
76.687
44.089
180
160
140
120
100
80
60
40
20
ppm


O
H
N
N
D(94%)
D(96%)
1.00
1.01
0.06
6.08
1.05
0.04
1.01
2.21
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
PPM

[D_2]-**2a**


O
H
N
NH
D(78%)
1.00
7.27
1.08
1.04
1.15
1.97
0.22
9
8
7
6
5
4
3
2
PPM

[D_1]-**1a**