Supporting information for

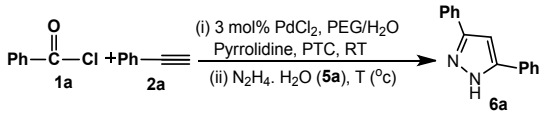
One-pot regioselective synthesis of pyrazoles and isoxazoles in PEG-400/water by a Cu-free nano-Pd catalyzed sequential acyl Sonogashira coupling-intramolecuar cyclization

Narasimha Swamy Thirukovela,[a] Ramesh Balaboina,[a] Vinayak Botla,[b] Ravinder Vadde[a*]
Sreekantha Babu Jonnalagadda[c*] and Chandra Sekhar Vasam[d*]

[a] Department of Chemistry, Kakatiya University, Warangal, T.S. India; email ; ravichemkuc@gmail.com
[b] IICT, Hyderabad, India; email. vinnu.chemistry@gmail.com
[c] School of Physics and Chemistry, University of Kwazulu-Natal, Westville Compus, Chiltern Hills, Durban-4000, South Africa. E-mail: jonnalagaddas@ukzn.ac.za
[d] Department of Pharmaceutical Chemistry, Telangana University, Warangal, T.S. India; email : csvasam@telanganauniversity.ac.in

Table of contents	**Page No**

Table S1. Optimization of reaction conditions for the one-pot synthesis of **6a**



Entry	PTC	PEG-polymer	N_2H_4. H_2O (eq)	Temp (^oC) Step-i/step-ii	Time (hrs) Step-i/step-ii	Yield(%)[b]
1	cetyltrimethylammonium bromide	PEG-400	2	RT/60	4/3	42
2	triethylbenzylammonium bromide	PEG-400	2	RT/60	4/3	35
3	tetrabutylammonium iodide	PEG-400	2	RT/60	2.5/3	73
4	tetrabutylammonium bromide	PEG-400	2	RT/60	2.5/3	87
5	tetrabutylammonium bromide	PEG-200	2	RT/60	2.5/3	83
6	tetrabutylammonium bromide	PEG-600	2	RT/60	2.5/3	87
7	tetrabutylammonium bromide	PEG-400	2	RT/RT	2.5/14	41
8	tetrabutylammonium bromide	PEG-400	2	RT/45	2.5/7	64
9	tetrabutylammonium bromide	PEG-400	1	RT/60	2.5/3	58

[a] Reaction conditions: [a] Step i **: 1a** (1.2 mmol), **2a** (1 mmol), pyrrolidine (2.0 mmol), PTC (0.3 mmol) 6 mL of PEG/H_2O (2 : 1); Step 2: (**4a**) 2 mmol. [b] Isolated yields after column chromatography.

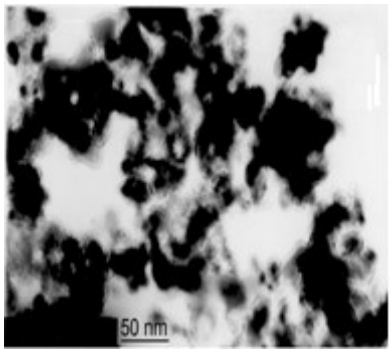


Figure S1. TEM image of unevenly distributed *in situ* PdNPs obtained from (a) Pd-NHC (3a)/PTC system during the synthesis of **6a** after 1st catalytic cycle

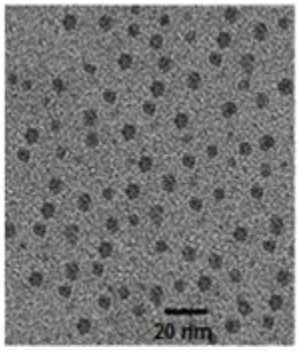


Figure S2. TEM image of well dispersed *in situ* PdNPs obtained from $PdCl_2$/PEG-400 systems during the synthesis of **6a** after 1st catalytic cycle

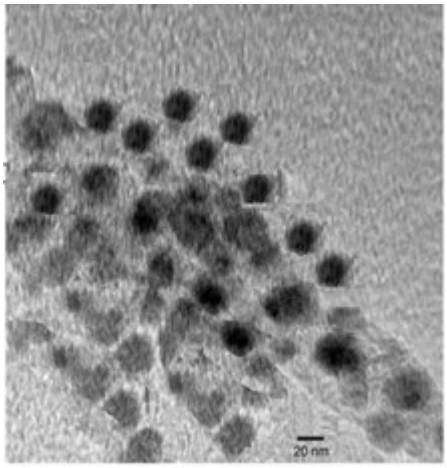
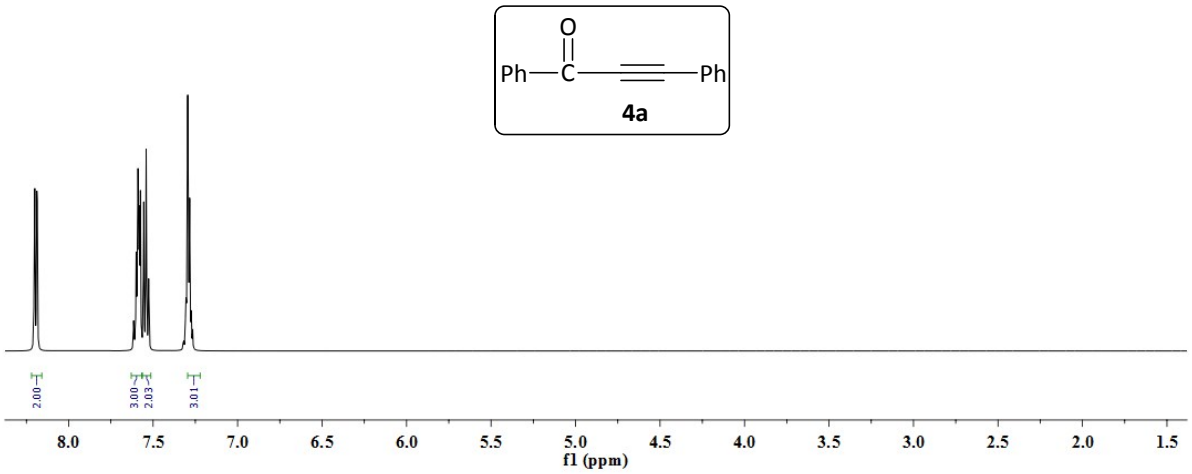
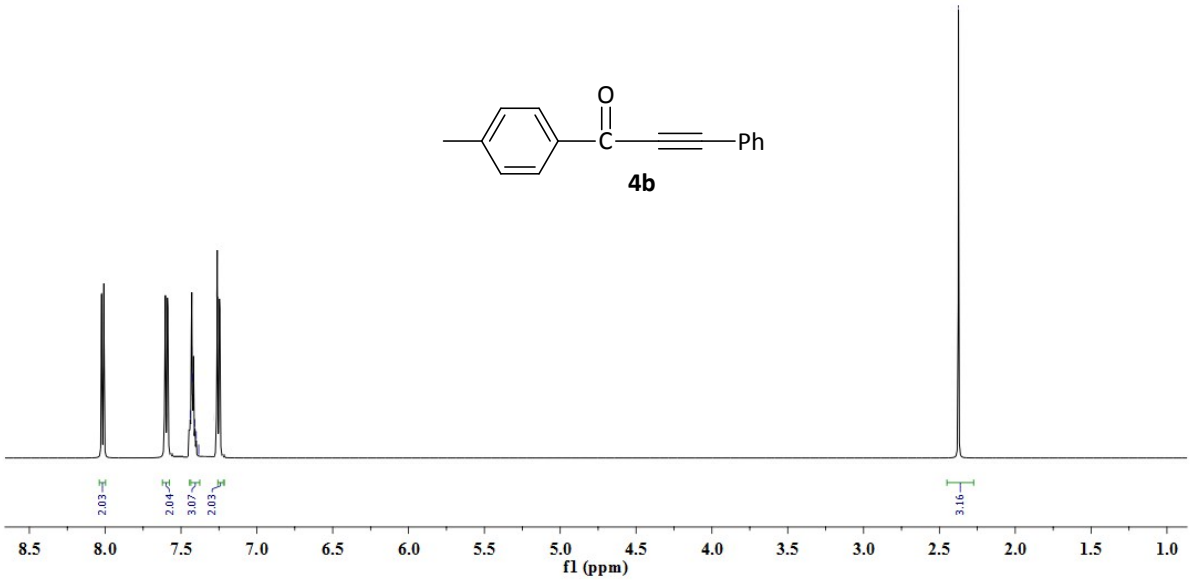
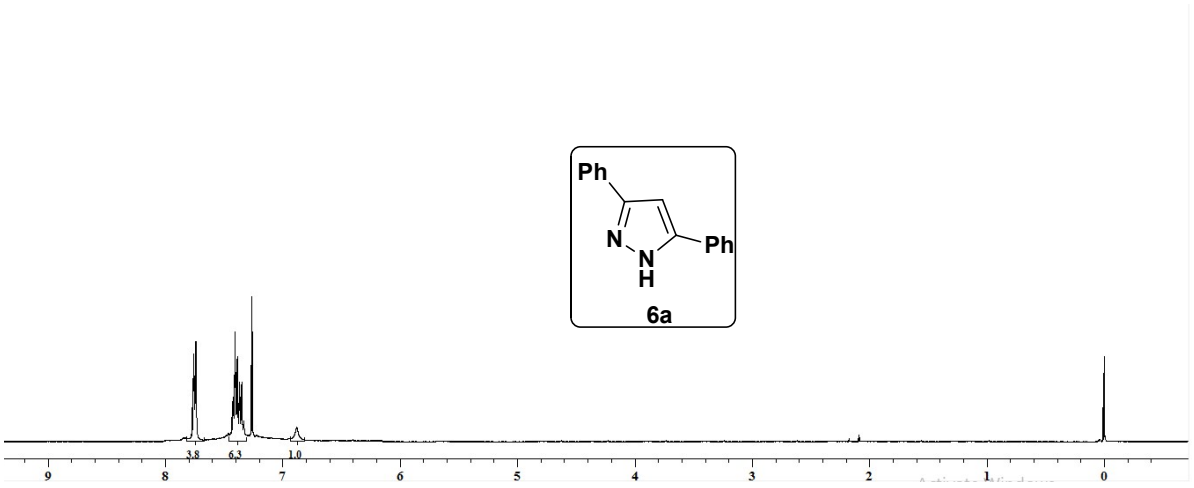
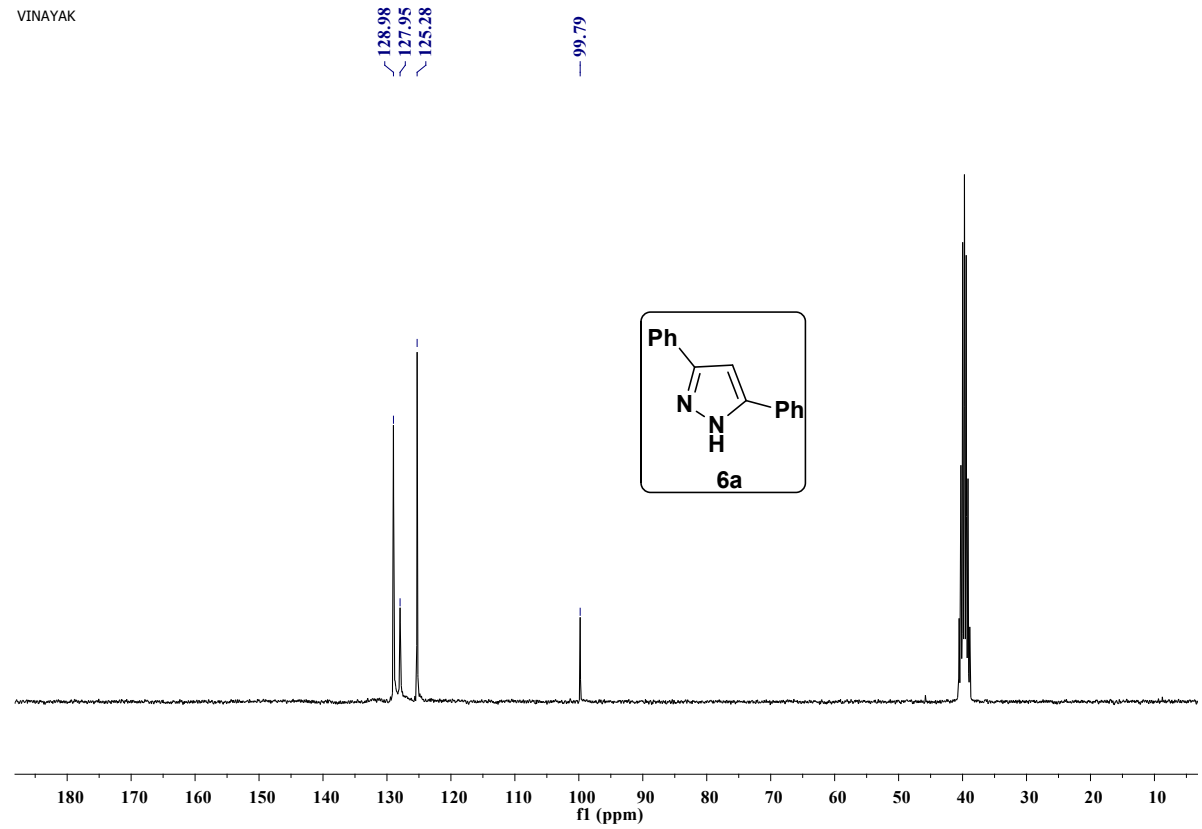


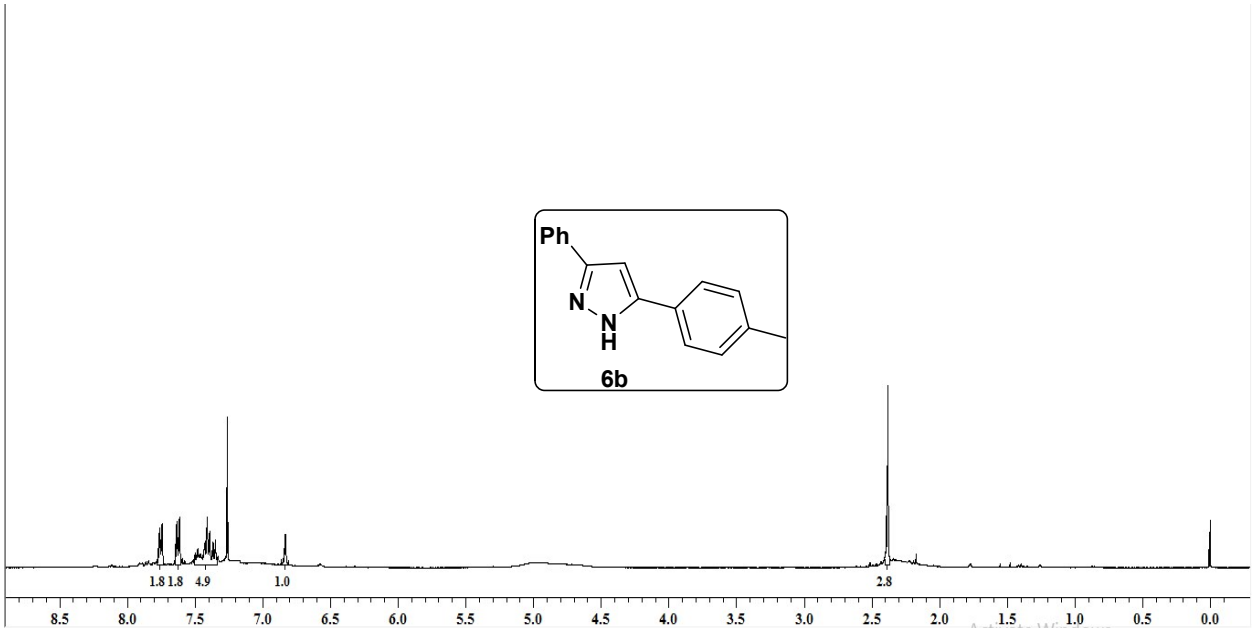
Figure S3. TEM image of *in situ* formed PEG-PdNPs during the synthesis of **6l** after 6th catalytic cycle.

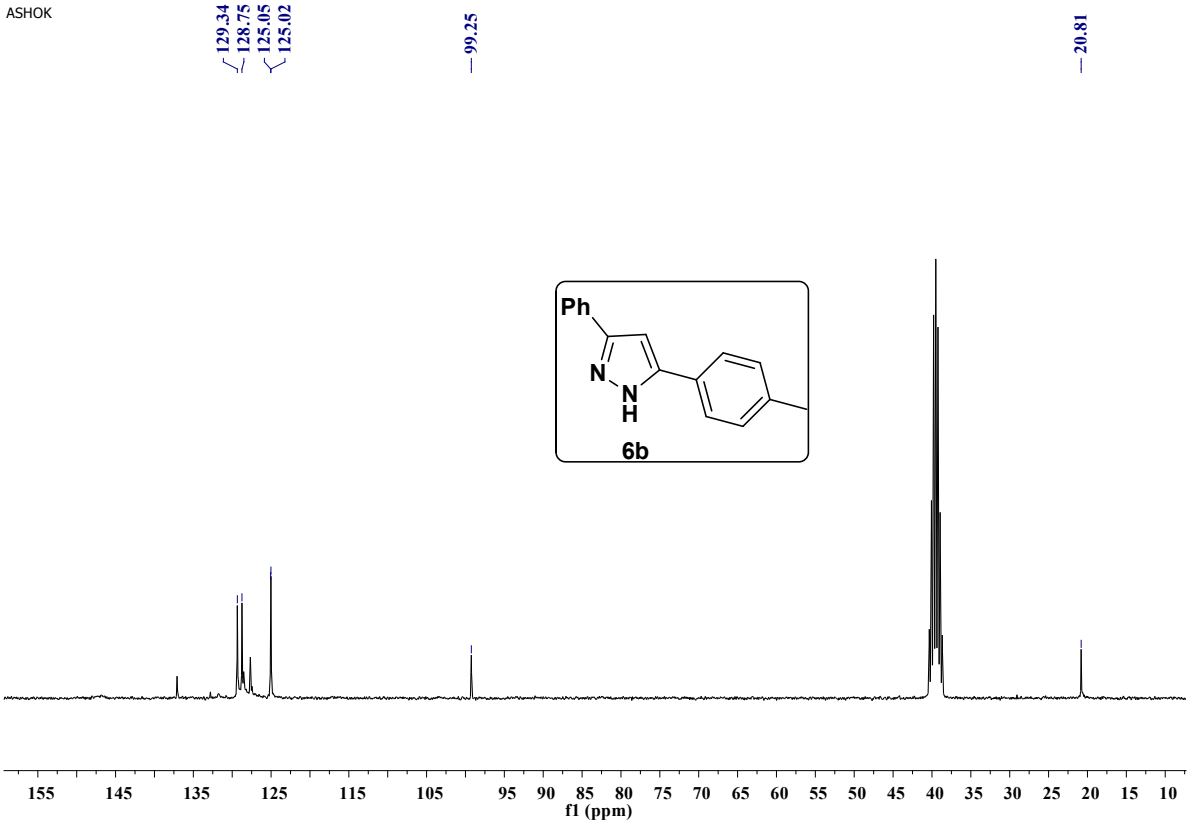

O
Ph
C
Ph
4a
2.00
3.00
2.03
3.01
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
f1 (ppm)

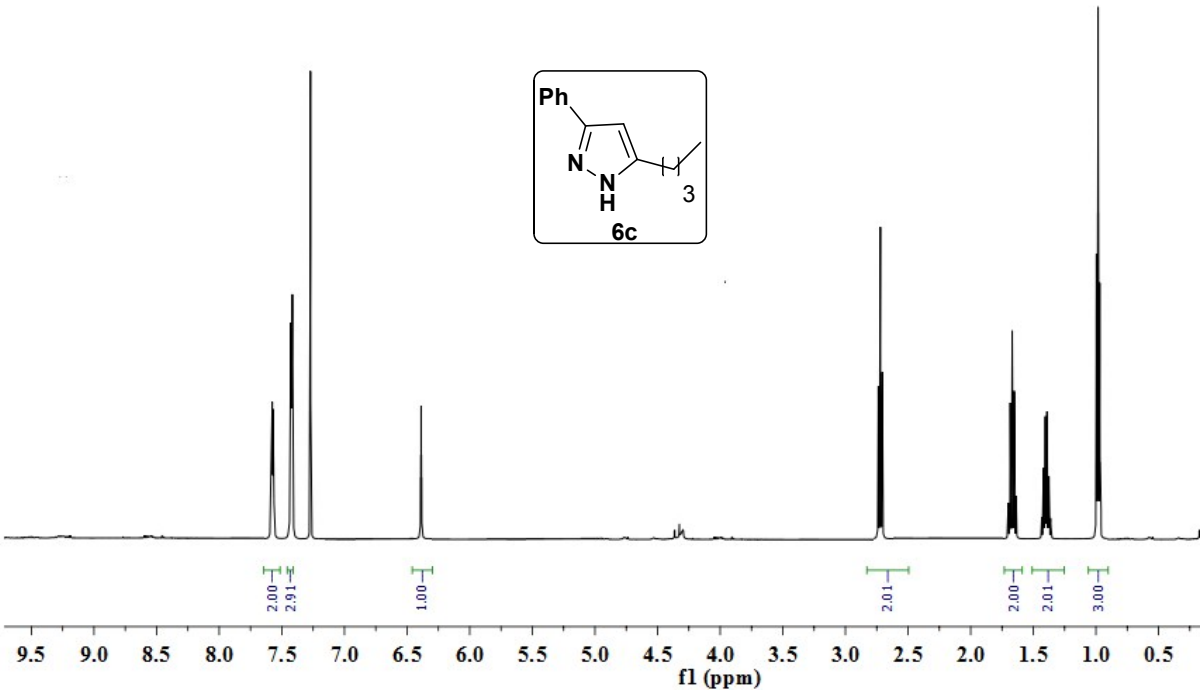

O
C
Ph
4b
2.03
2.04
3.07
2.03
3.16
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)

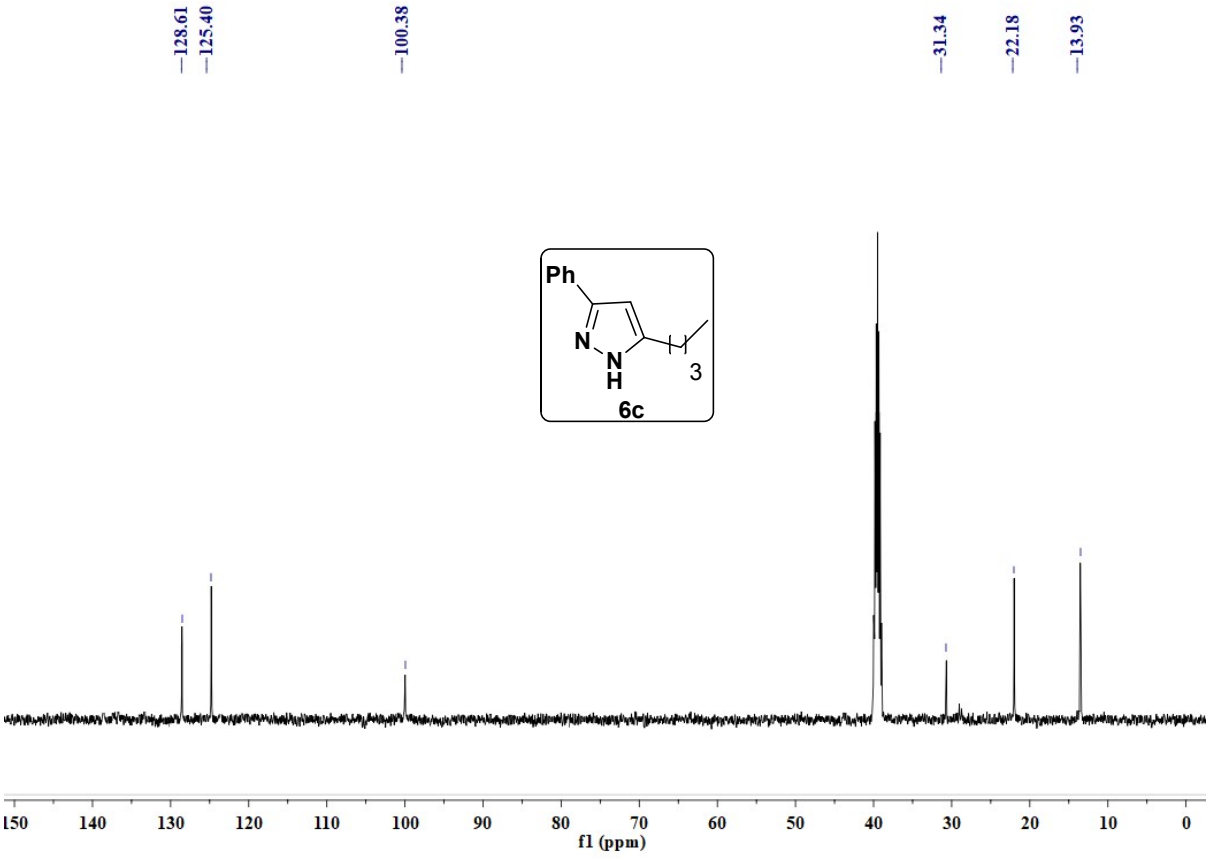

Ph
N
N
H
Ph
6a
3.8
6.3
1.0
9
8
7
6
5
4
3
2
1
0

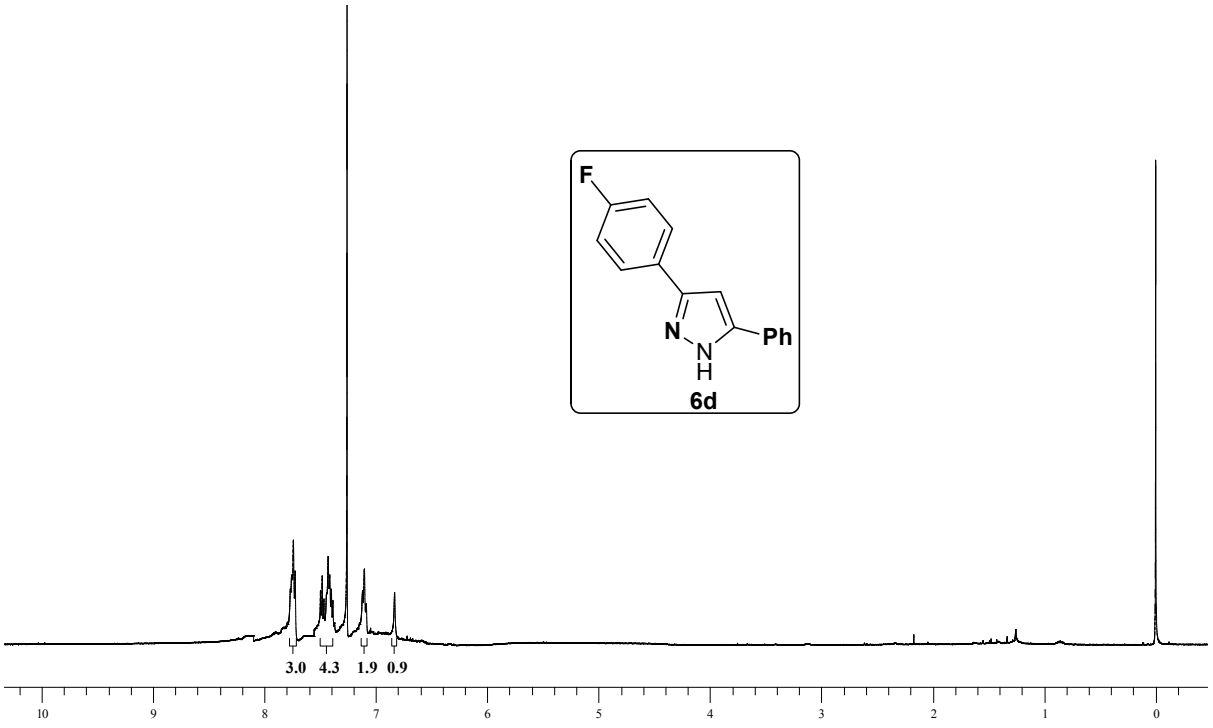

VINAYAK
128.98
127.95
125.28
99.79
Ph
N
N
H
Ph
6a
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

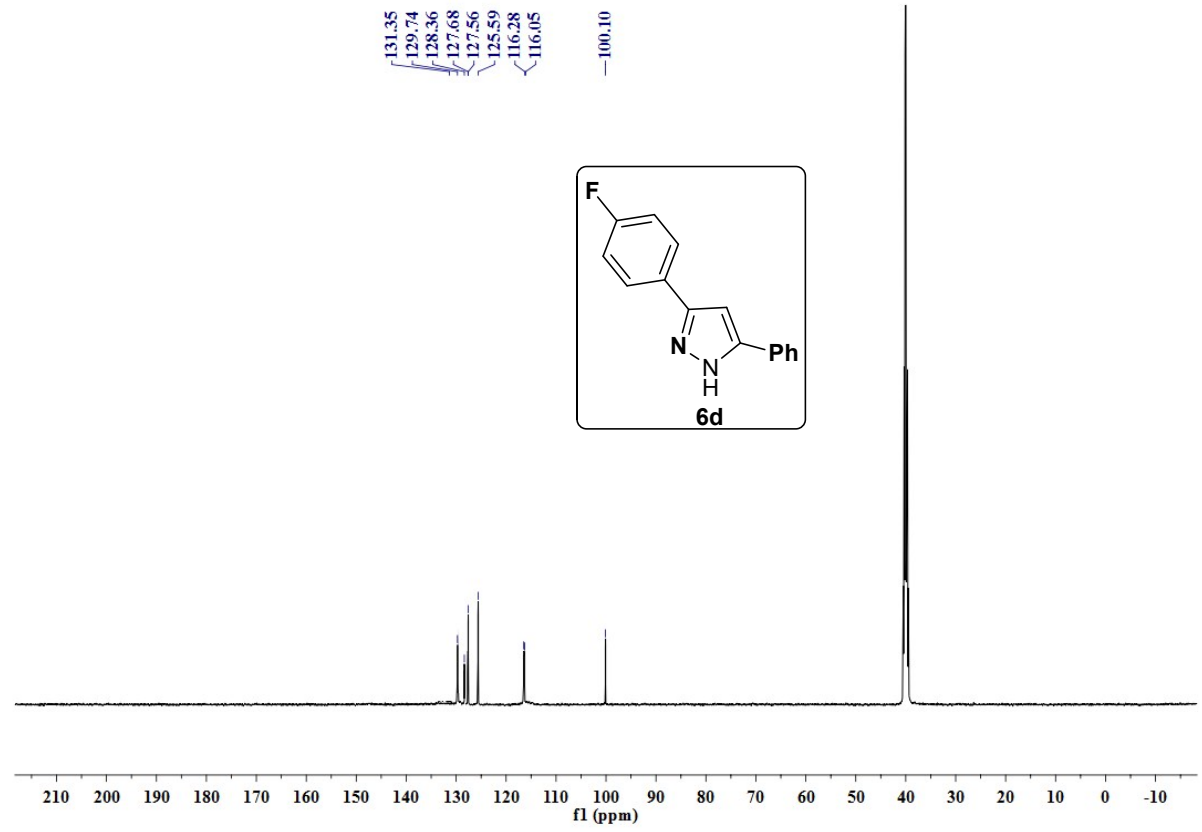

Ph
N
N
H
6b
1.8 1.8 4.9
1.0
2.8
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

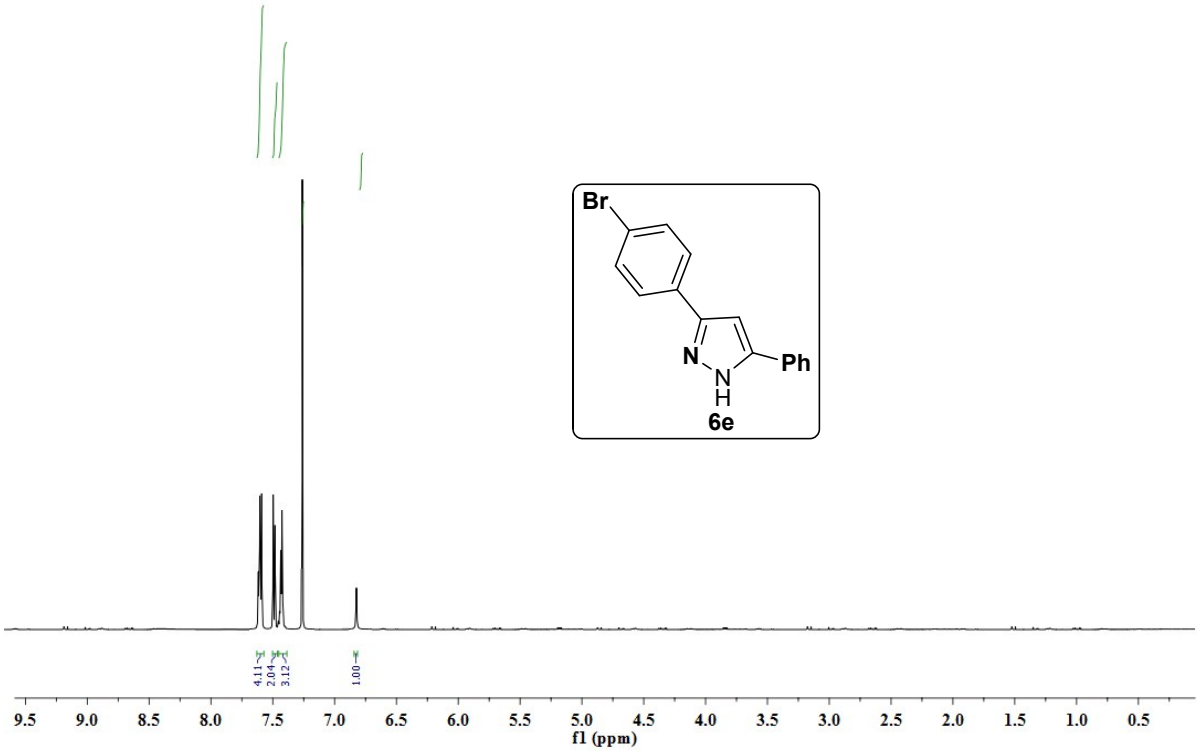

ASHOK
129.34
128.75
125.05
125.02
99.25
20.81
Ph
N
N
H
6b
155 145 135 125 115 105 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10
f1 (ppm)

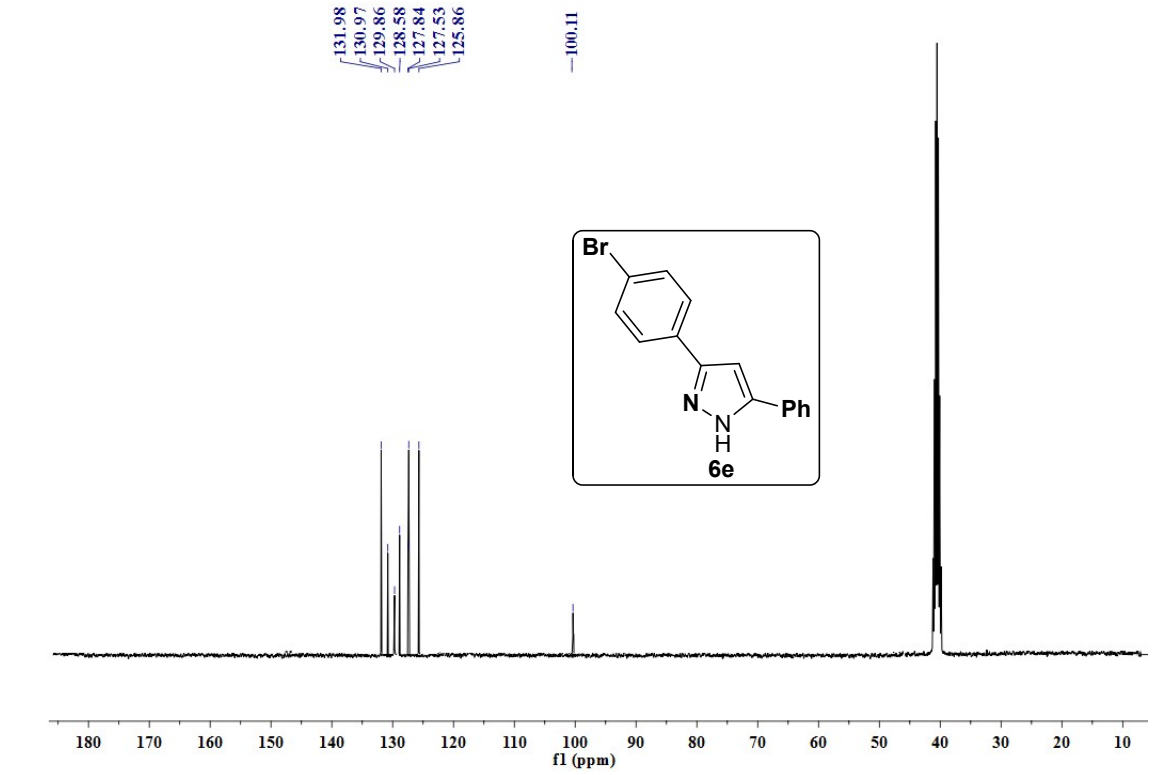

Ph
N
N
H
3
6c
2.00
2.91
1.00
2.01
2.00
2.01
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

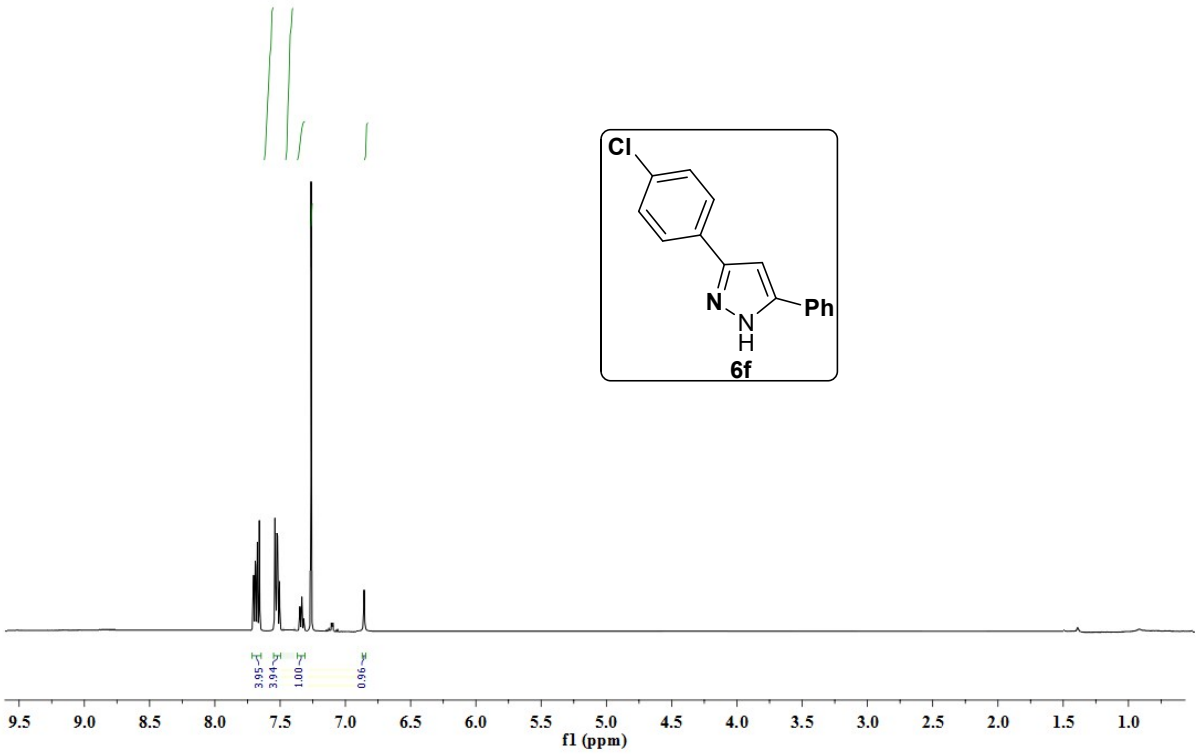

128.61
125.40
100.38
31.34
22.18
13.93
Ph
N
N
H
3
6c
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

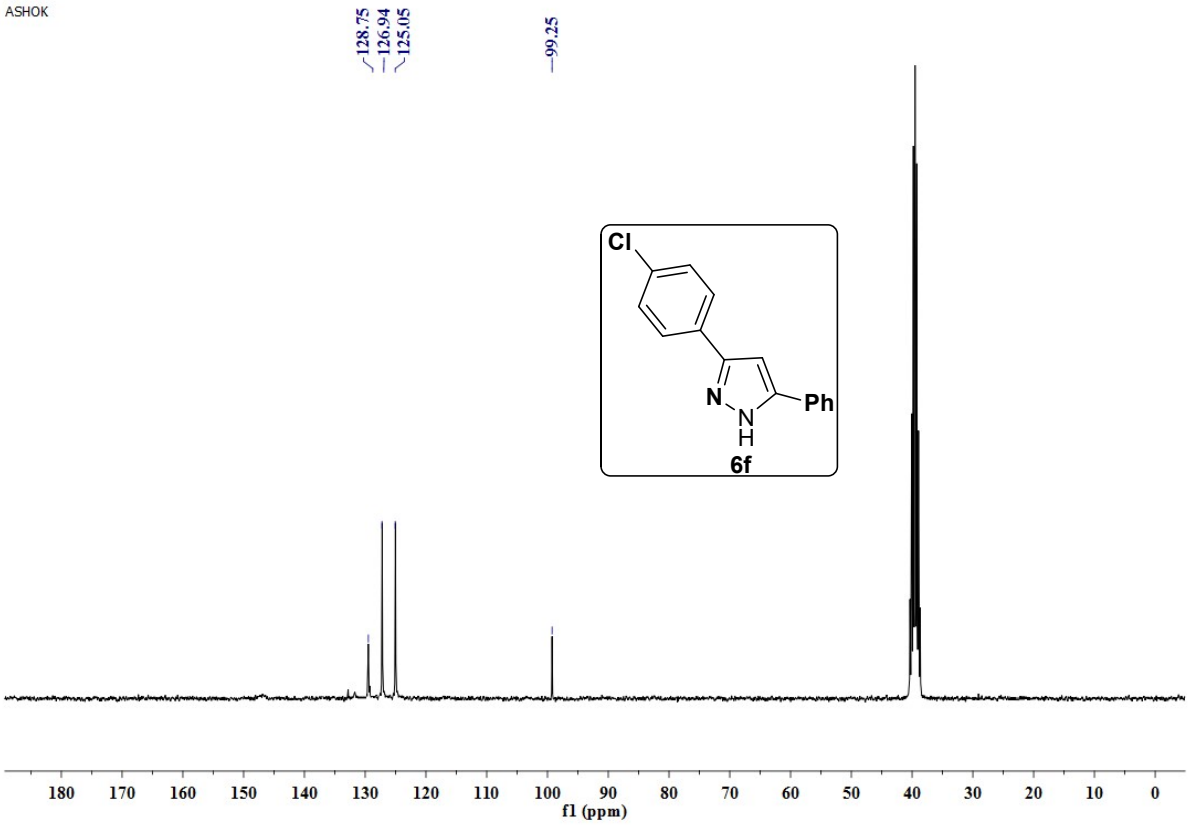

F
N
N
H
Ph
6d
3.0
4.3
1.9
0.9
10
9
8
7
6
5
4
3
2
1
0

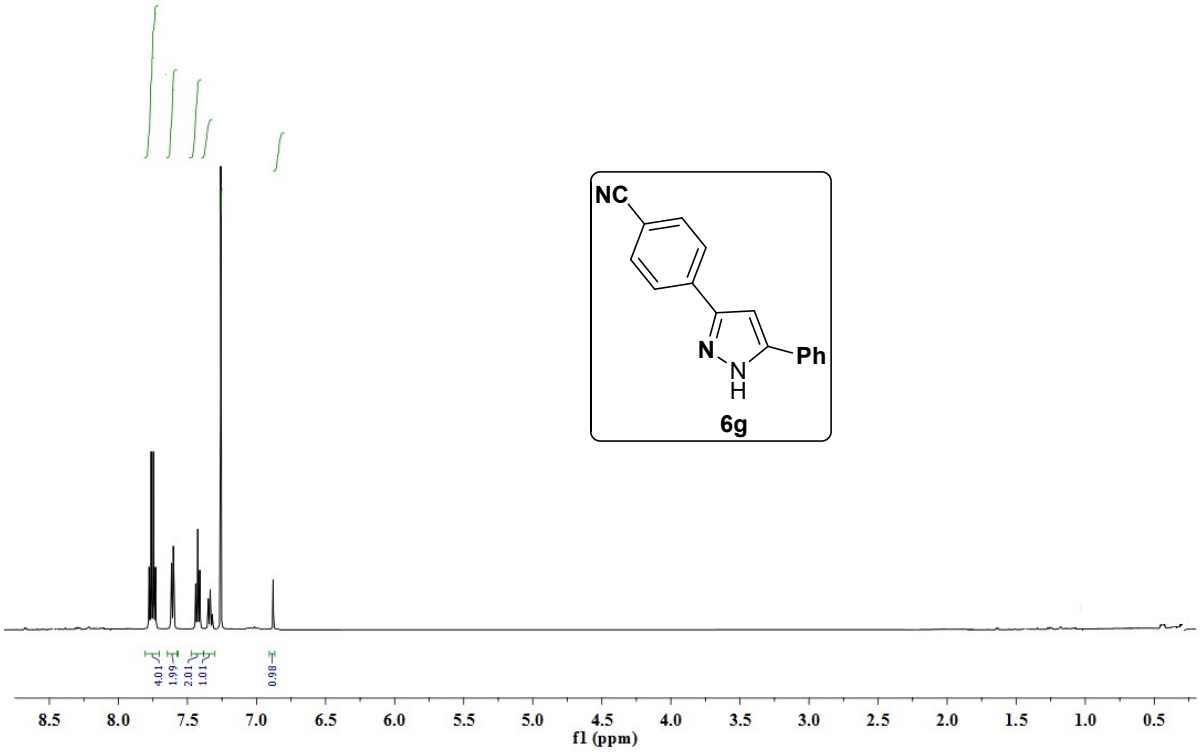

131.35
129.74
128.36
127.68
127.56
125.59
116.28
116.05
100.10
F
N
N
H
Ph
6d
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

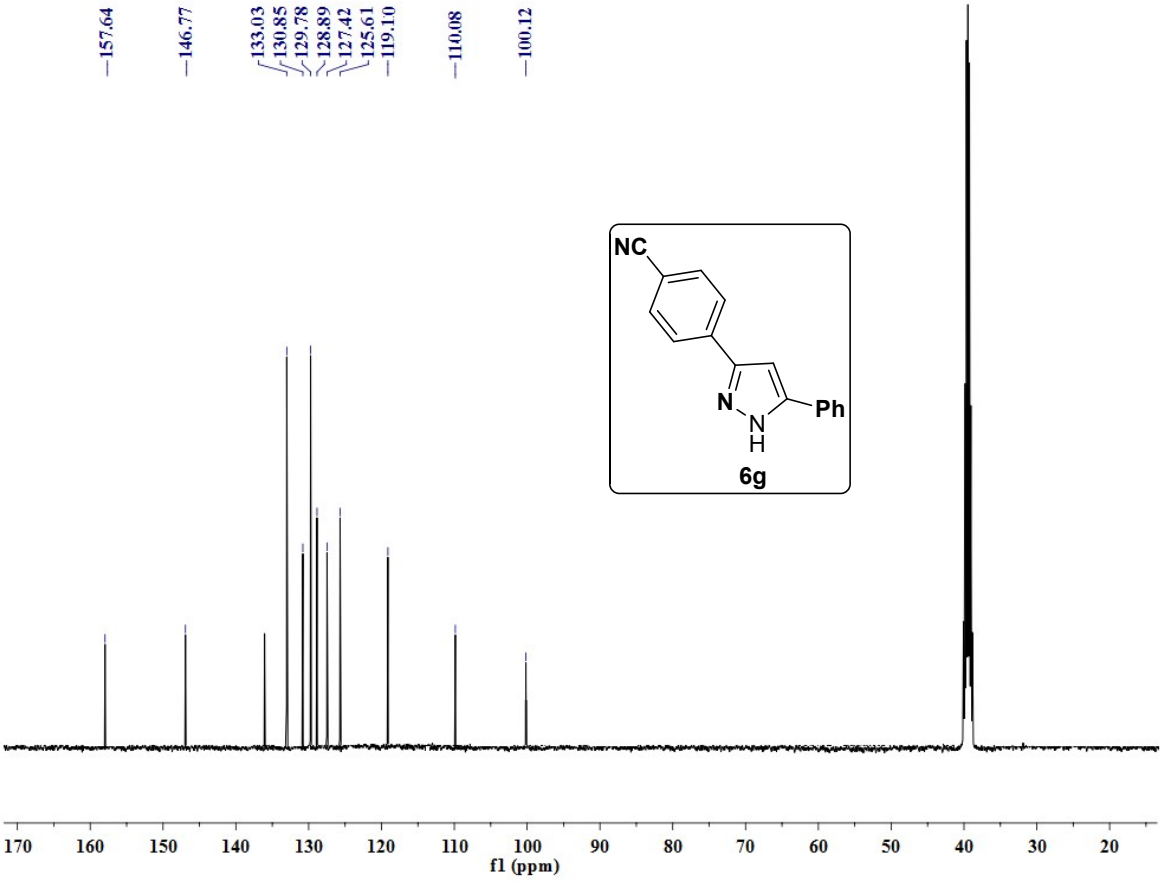

Br
N
N
H
Ph
6e
4.11
2.04
3.12
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

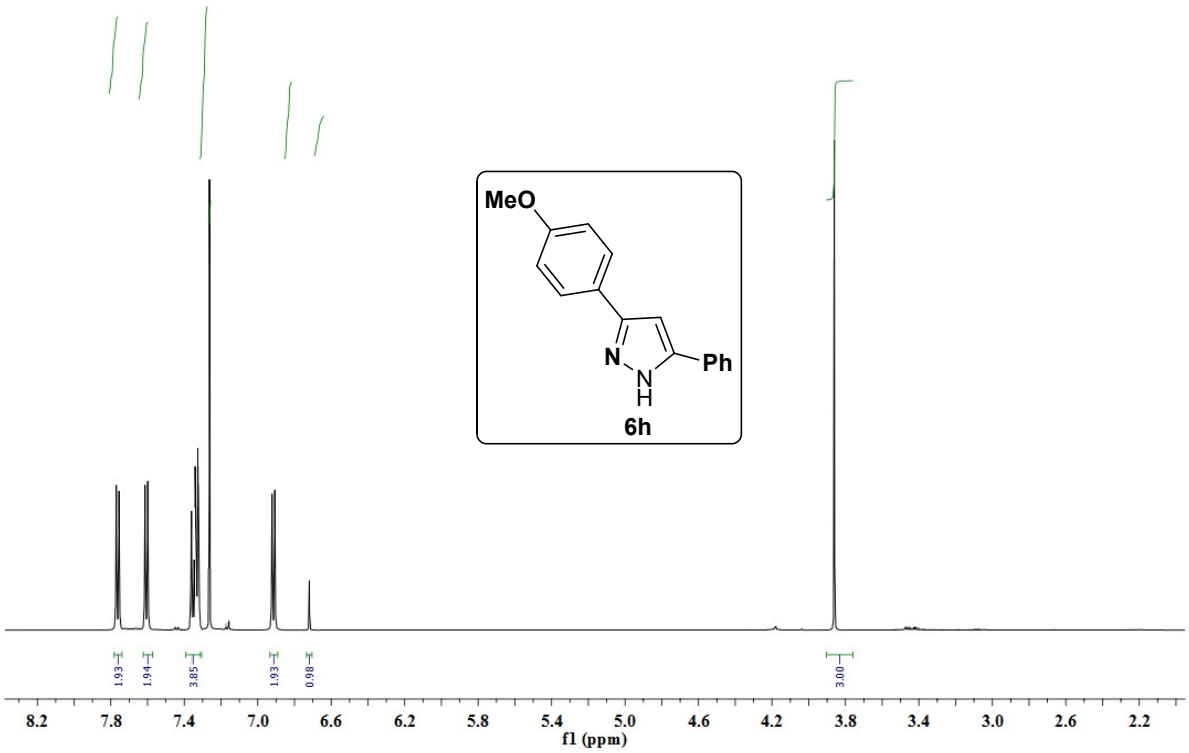

131.98
130.97
129.86
128.58
127.84
127.53
125.86
100.11
Br
N
N
H
Ph
6e
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

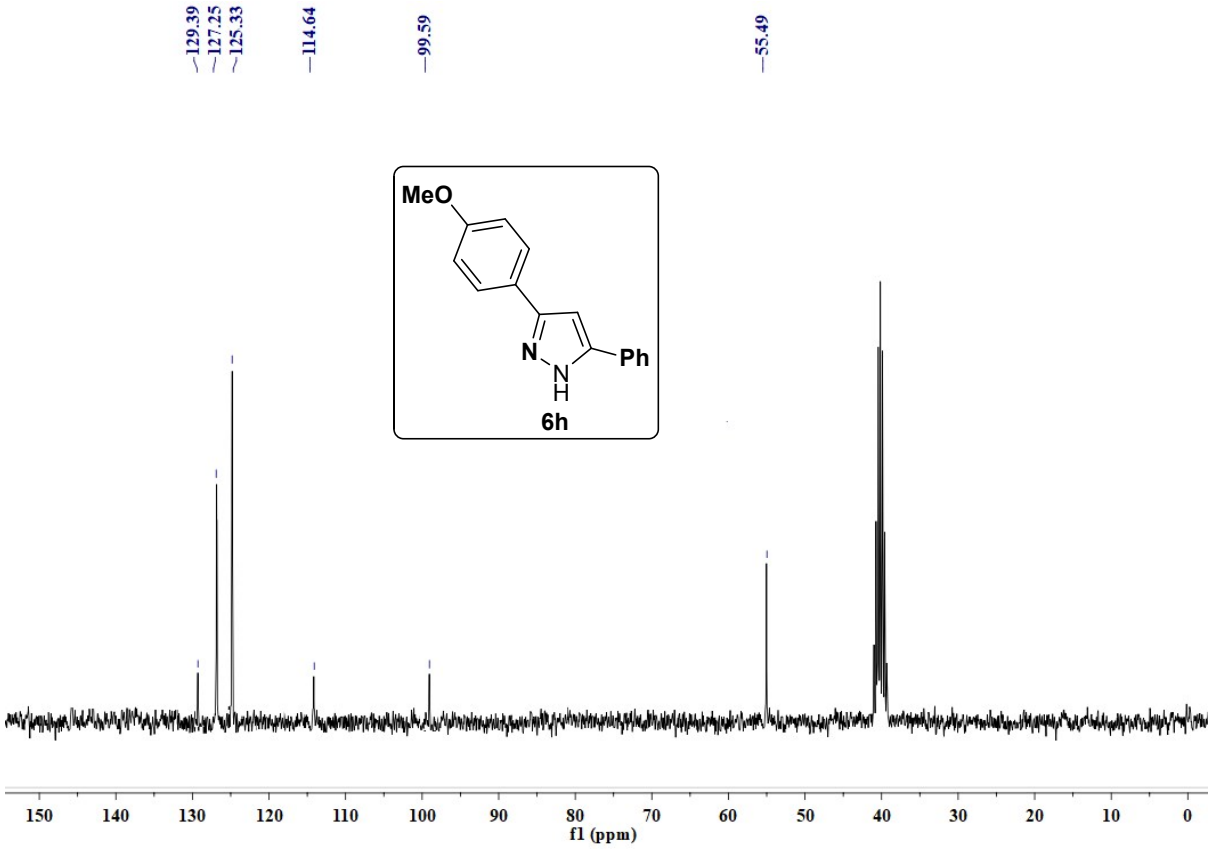

Cl
N
N
H
Ph
6f
3.95
3.94
1.00
0.96
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
f1 (ppm)

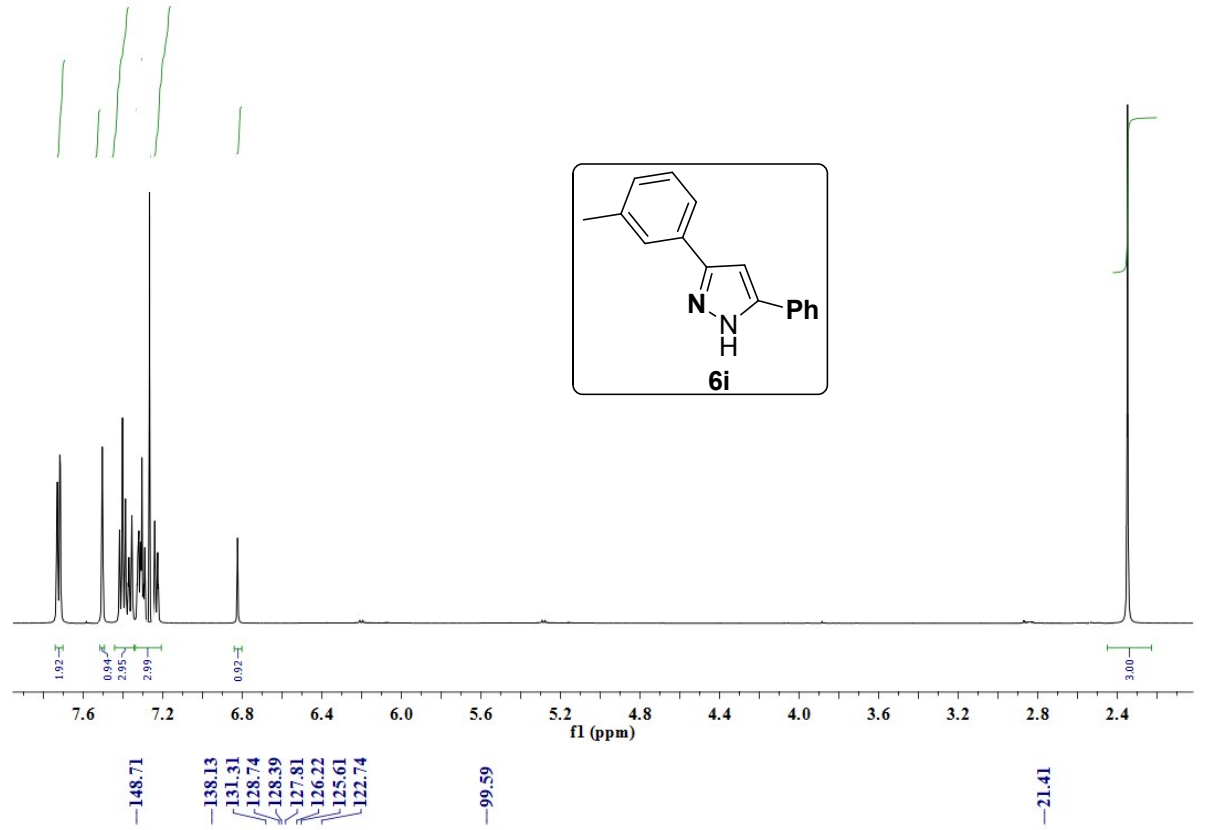

ASHOK
128.75
126.94
125.05
99.25
Cl
N
N
H
Ph
6f
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

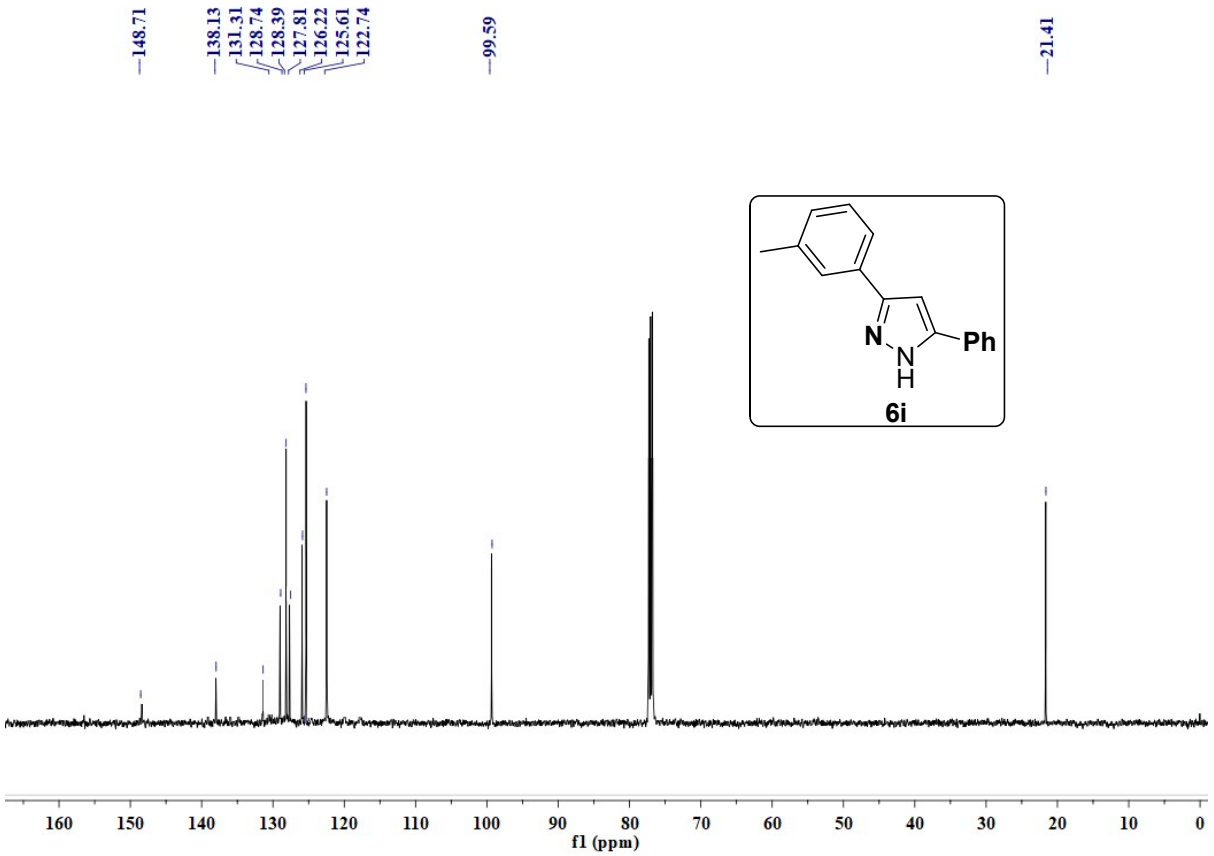

NC
N
N
H
Ph
6g
4.01
1.99
2.01
1.01
0.98
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

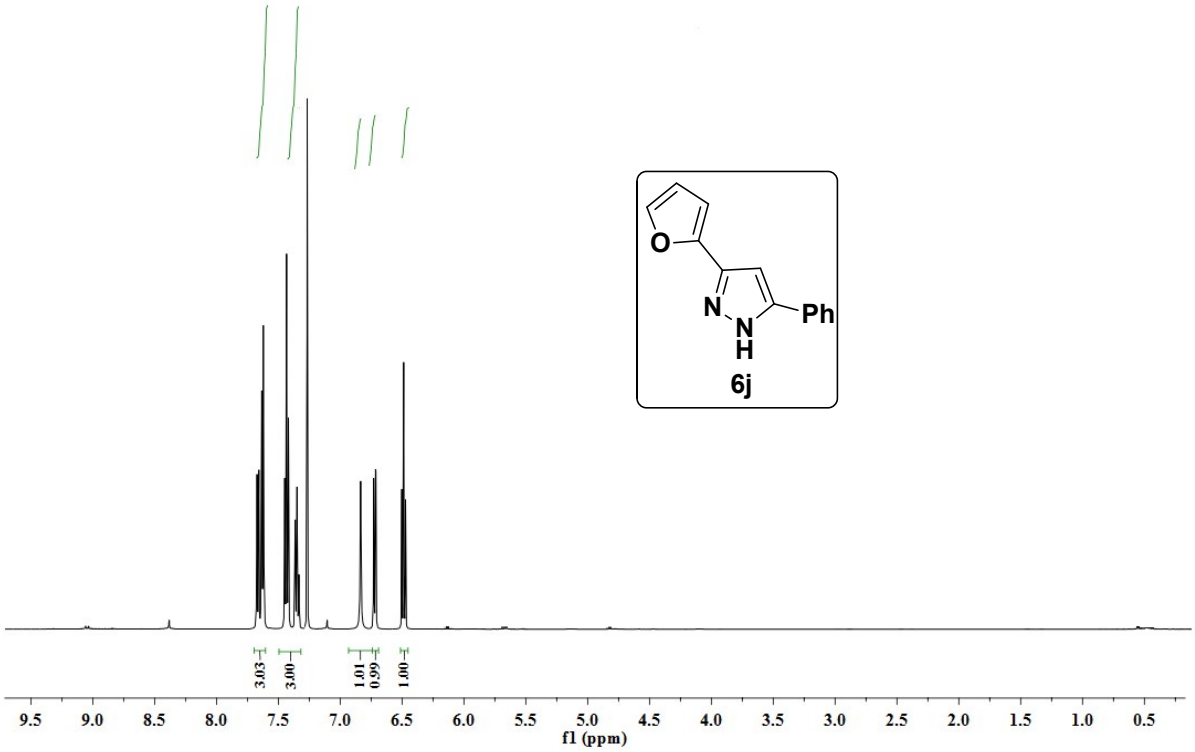

157.64
146.77
133.03
130.85
129.78
128.89
127.42
125.61
119.10
110.08
100.12
NC
N
N
H
Ph
6g
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

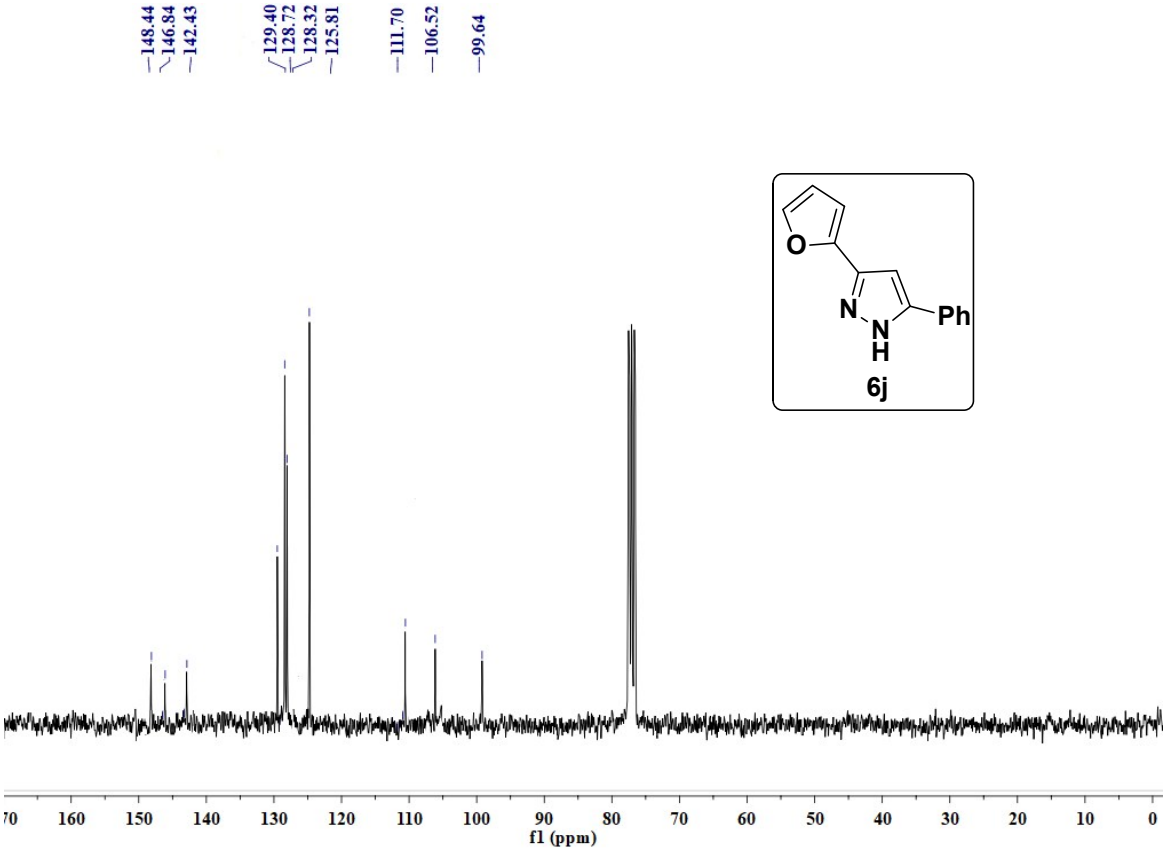

MeO
N
N
H
Ph
6h
1.93
1.94
3.85
1.93
0.98
3.00
8.2
7.8
7.4
7.0
6.6
6.2
5.8
5.4
5.0
4.6
4.2
3.8
3.4
3.0
2.6
2.2
f1 (ppm)

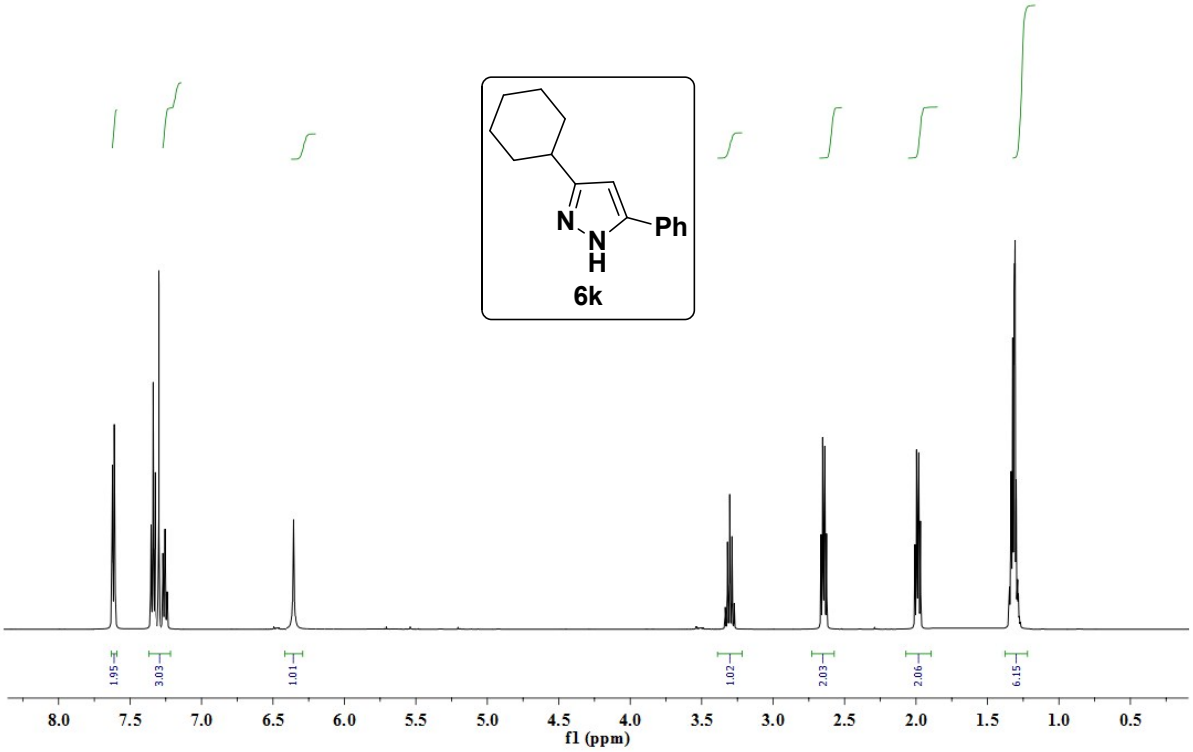

129.39
127.25
125.33
114.64
99.59
55.49
MeO
N
N
H
Ph
6h
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

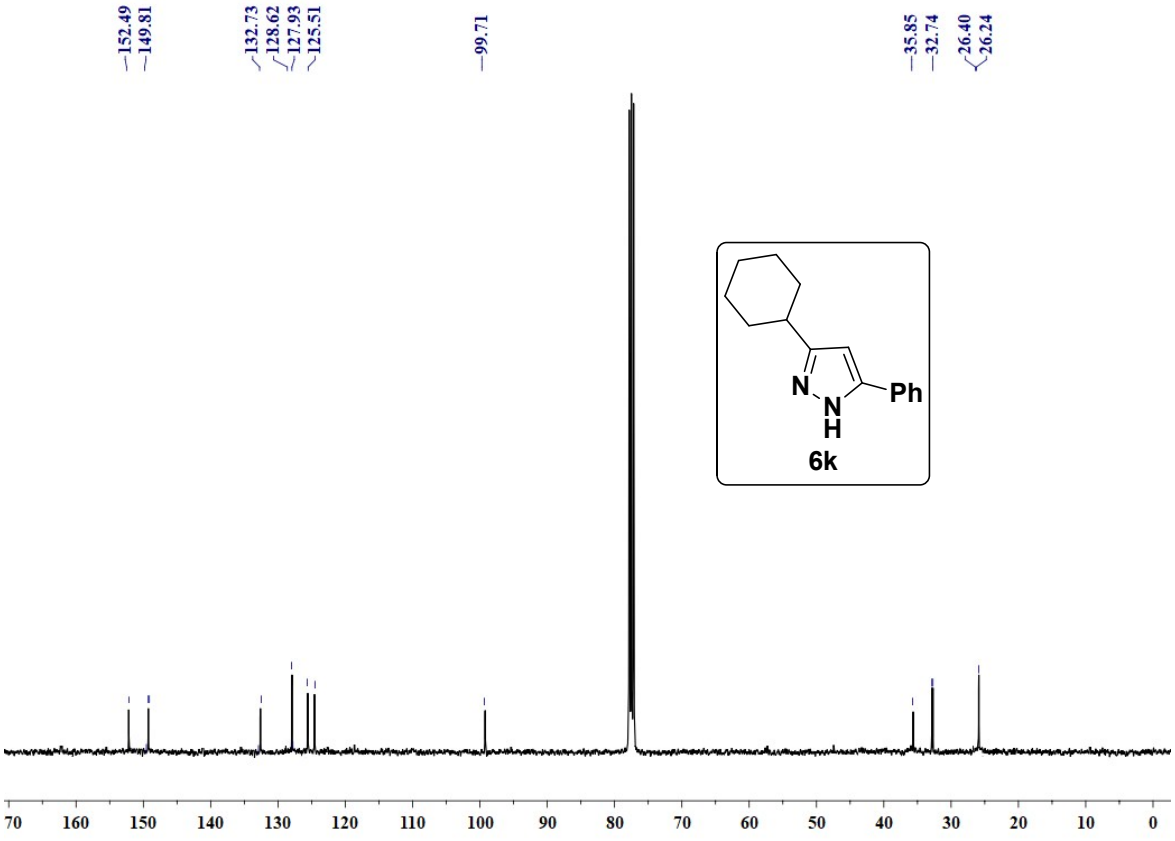

N
N
H
Ph
6i
1.92
0.94
2.95
2.99
0.92
3.00
7.6
7.2
6.8
6.4
6.0
5.6
5.2
4.8
4.4
4.0
3.6
3.2
2.8
2.4
f1 (ppm)

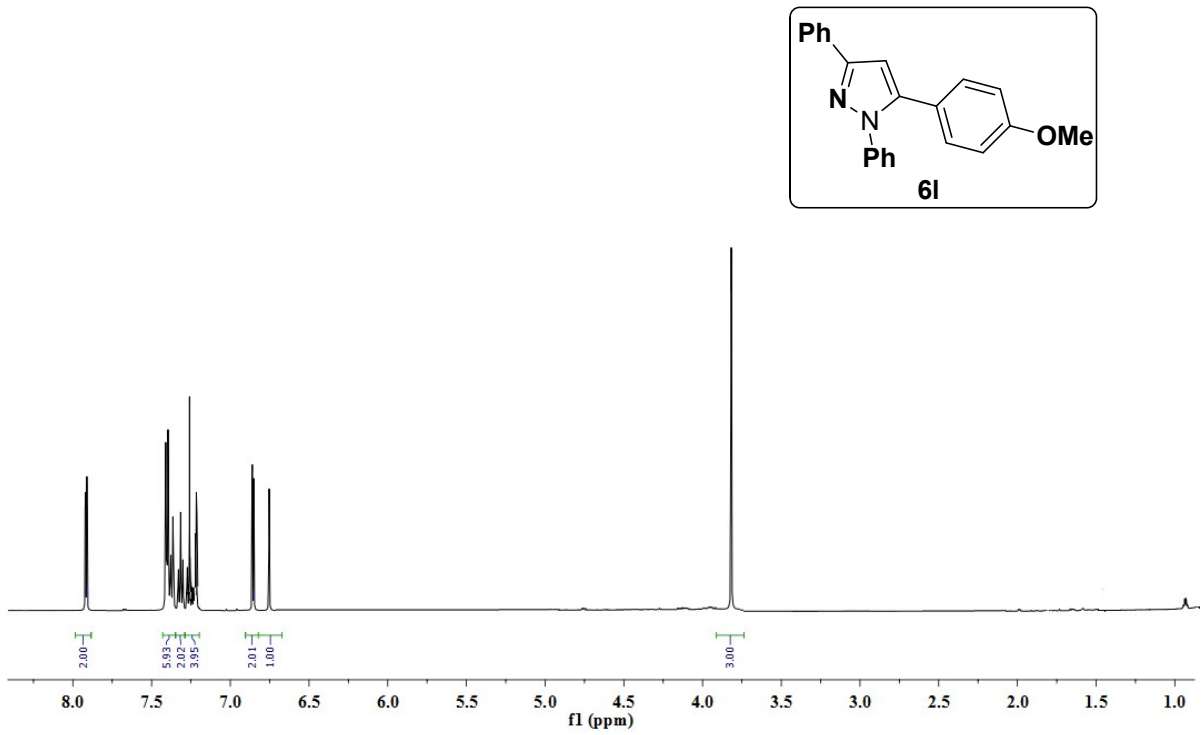

148.71
138.13
131.31
128.74
128.39
127.81
126.22
125.61
122.74
99.59
21.41
N
N
H
Ph
6i
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

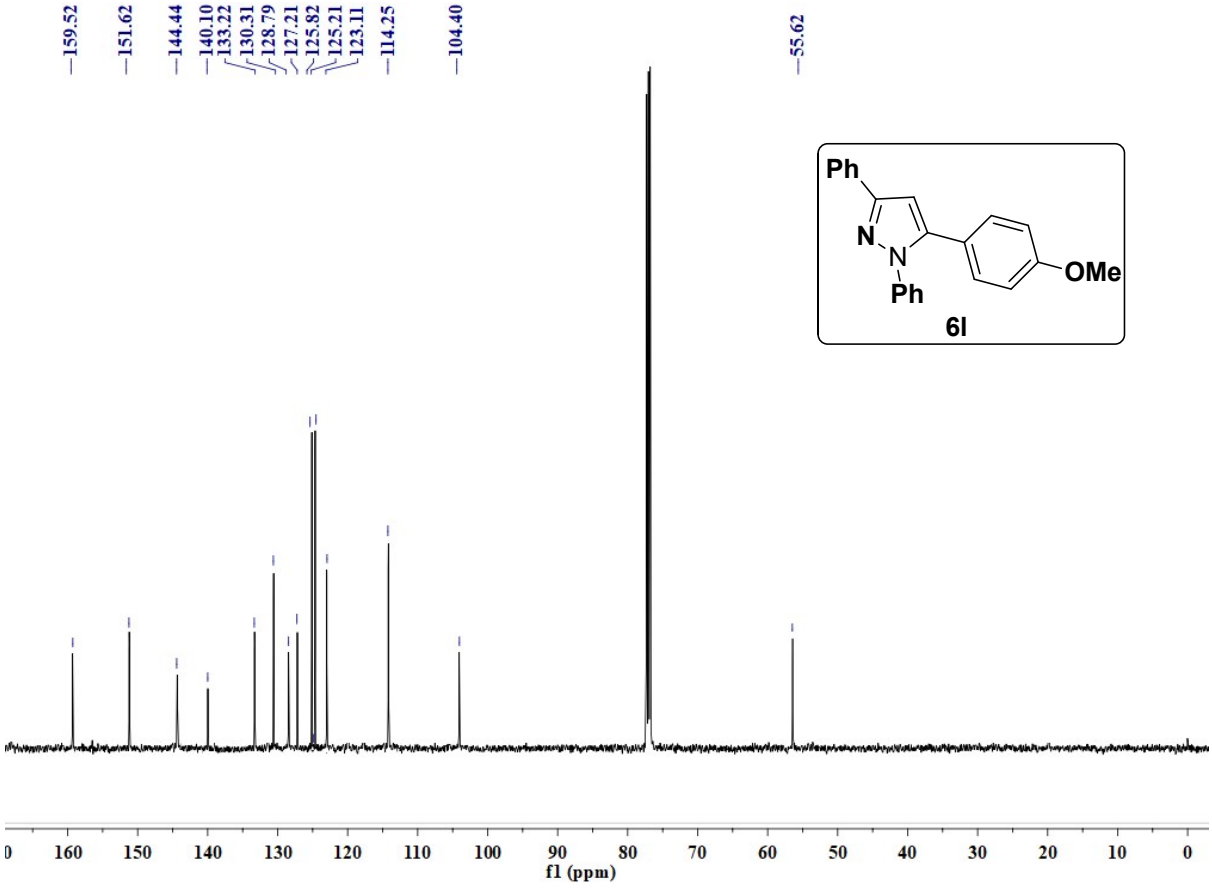

O
N
N
H
Ph
6j
3.03
3.00
1.01
0.99
1.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

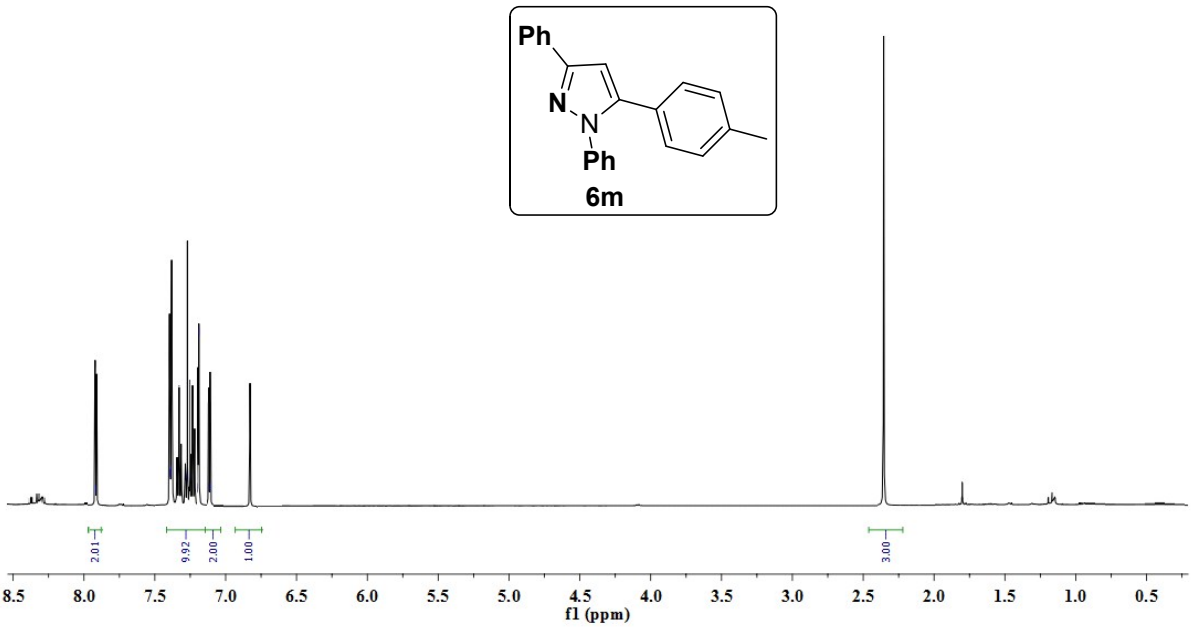

148.44
146.84
142.43
129.40
128.72
128.32
125.81
111.70
106.52
99.64
O
N
N
H
Ph
6j
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

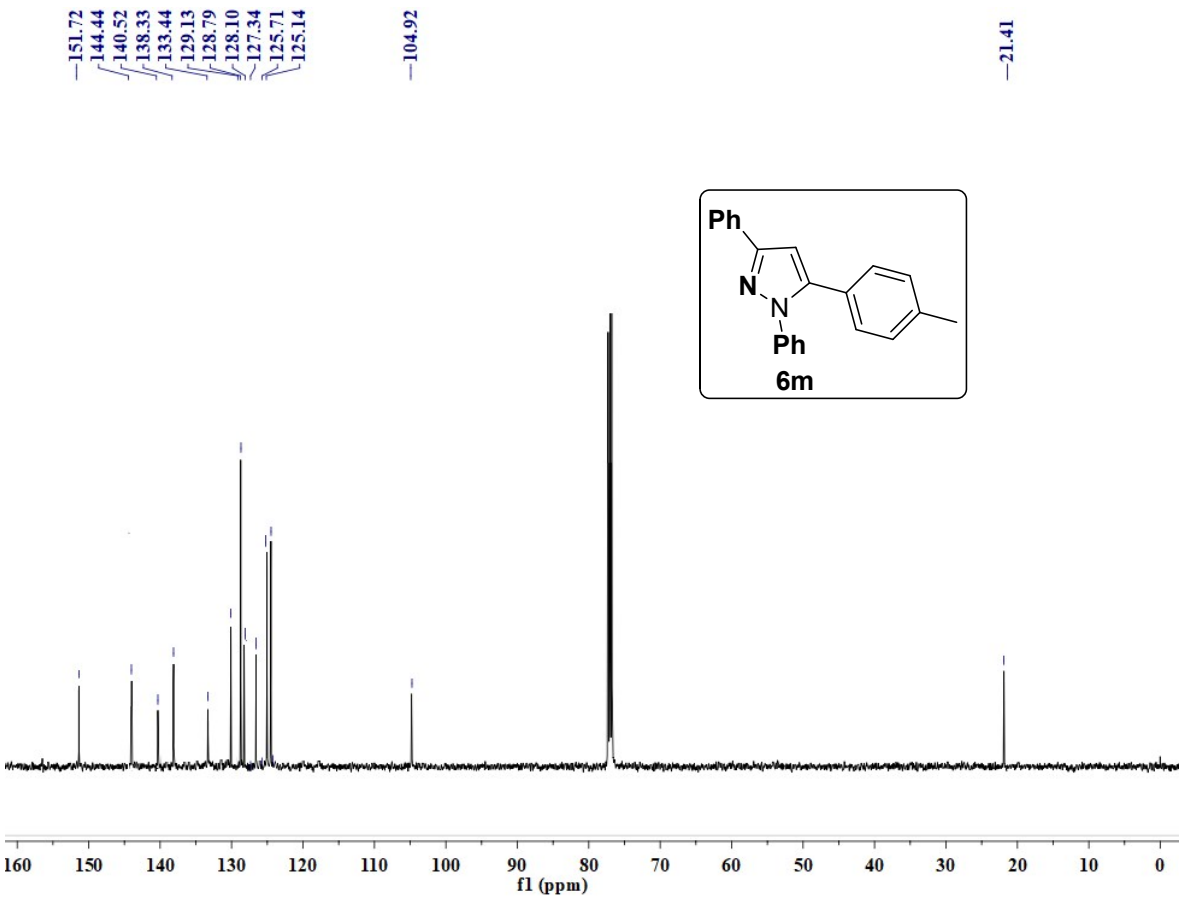

N
N
H
Ph
6k
1.95
3.03
1.01
1.02
2.03
2.06
6.15
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

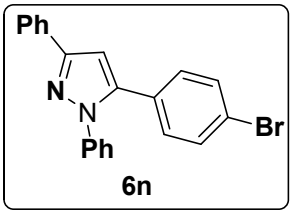

152.49
149.81
132.73
128.62
127.93
125.51
99.71
35.85
32.74
26.40
26.24
N
N
H
Ph
6k
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

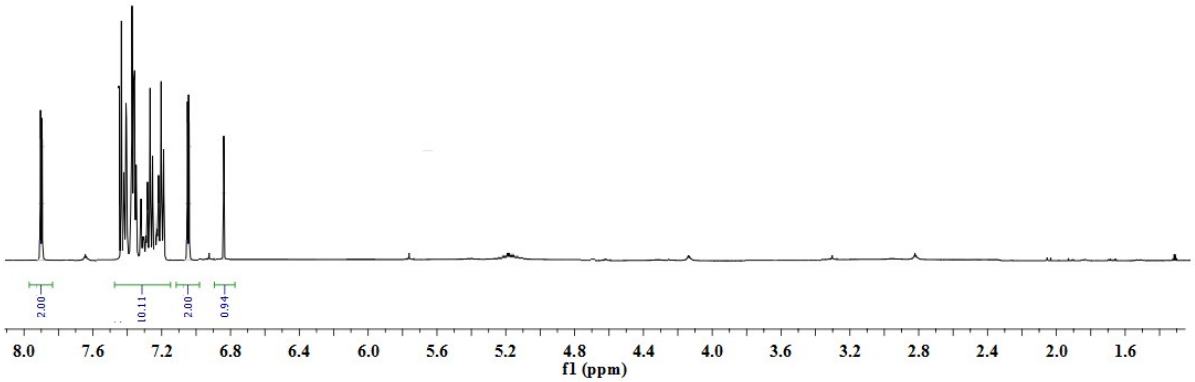

Ph
N
N
Ph
OMe
6l
2.00
5.93
2.02
3.95
2.01
1.00
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)


159.52
151.62
144.44
140.10
133.22
130.31
128.79
127.21
125.82
125.21
123.11
114.25
104.40
55.62
Ph
N
N
Ph
OMe
6l
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

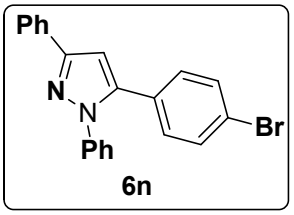

Ph
N
N
Ph
6m
2.01
9.92
2.00
1.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


151.72
144.44
140.52
138.33
133.44
129.13
128.79
128.10
127.34
125.71
125.14
104.92
21.41
Ph
N
N
Ph
6m
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

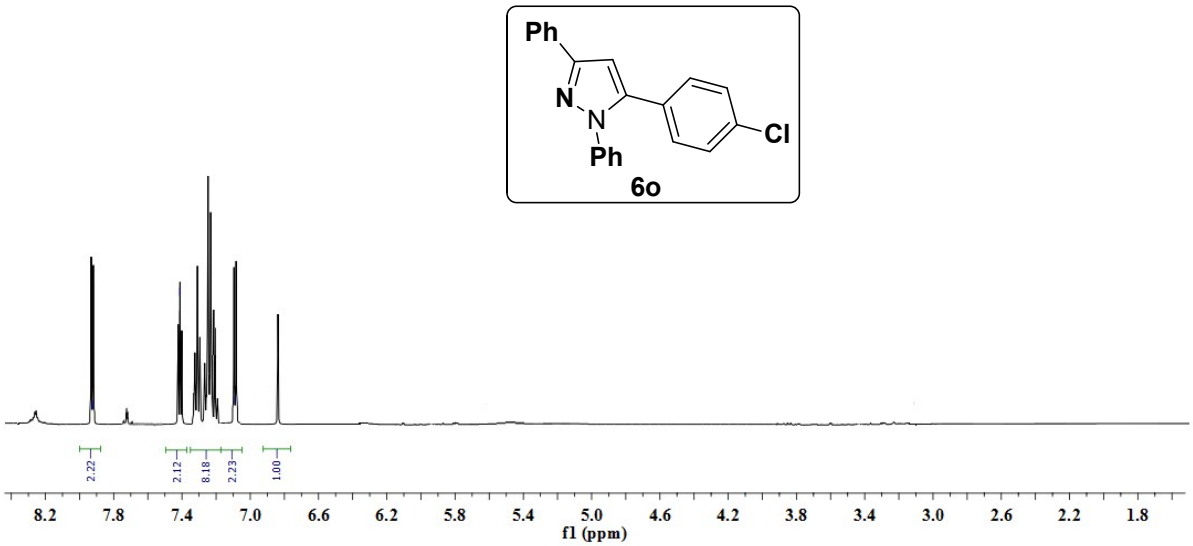

Ph
N
N
Ph
Br
6n

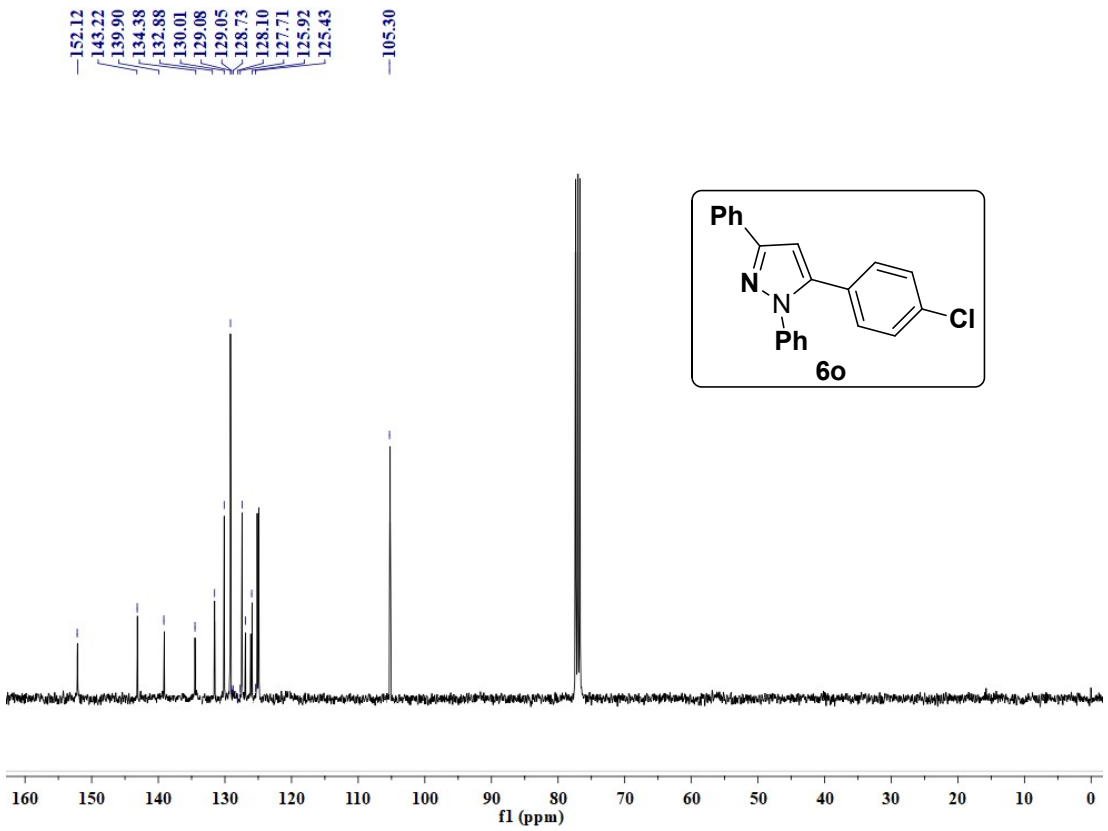

2.00
10.11
2.00
0.94
8.0
7.6
7.2
6.8
6.4
6.0
5.6
5.2
4.8
4.4
4.0
3.6
3.2
2.8
2.4
2.0
1.6
f1 (ppm)

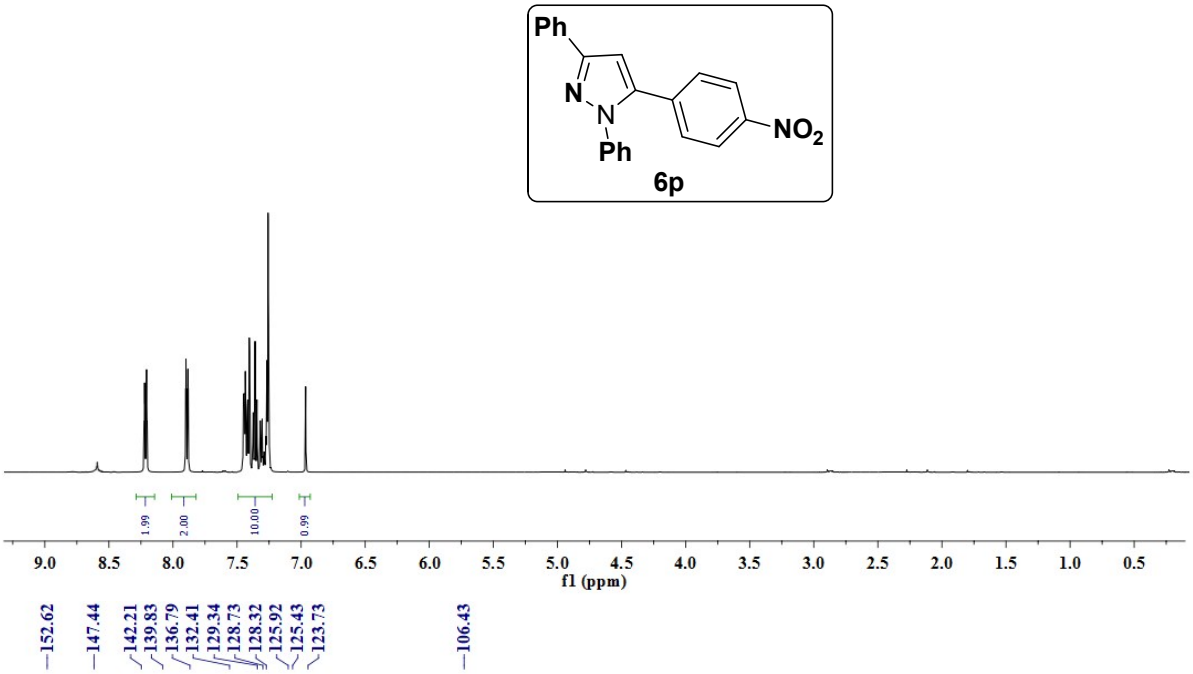

152.39
143.30
139.71
132.74
131.61
130.11
129.41
128.59
128.24
127.64
125.73
125.15
122.32
105.42

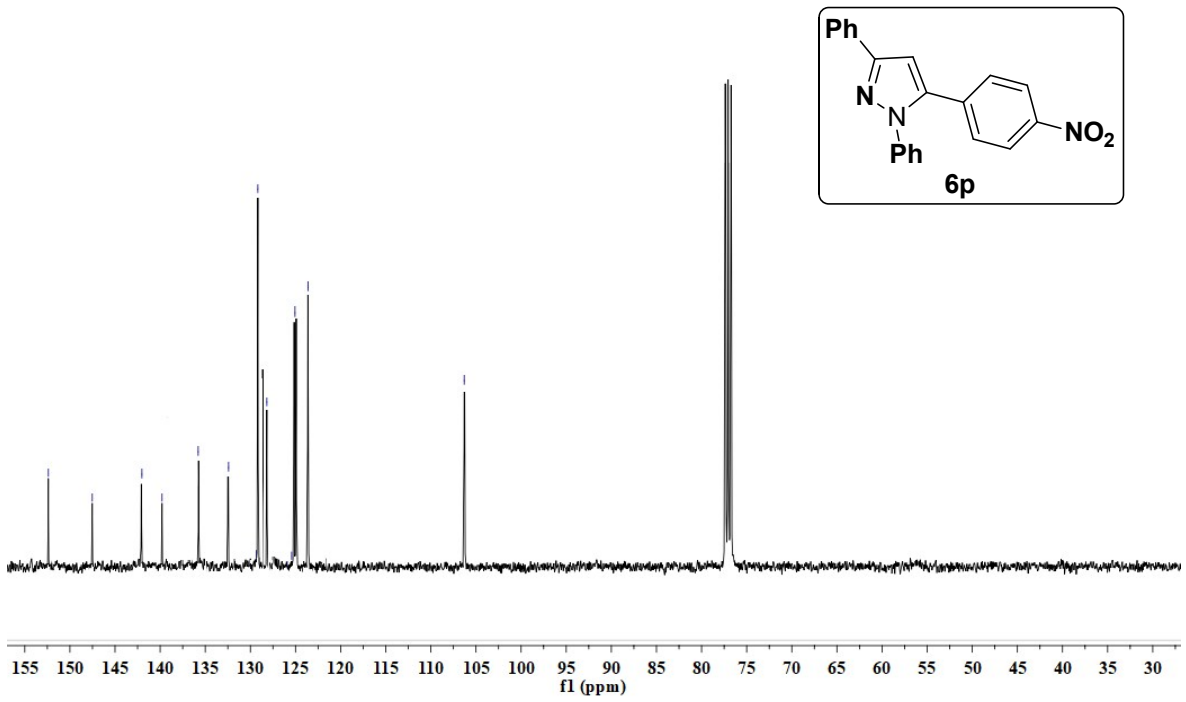

Ph
N
N
Ph
Br
6n

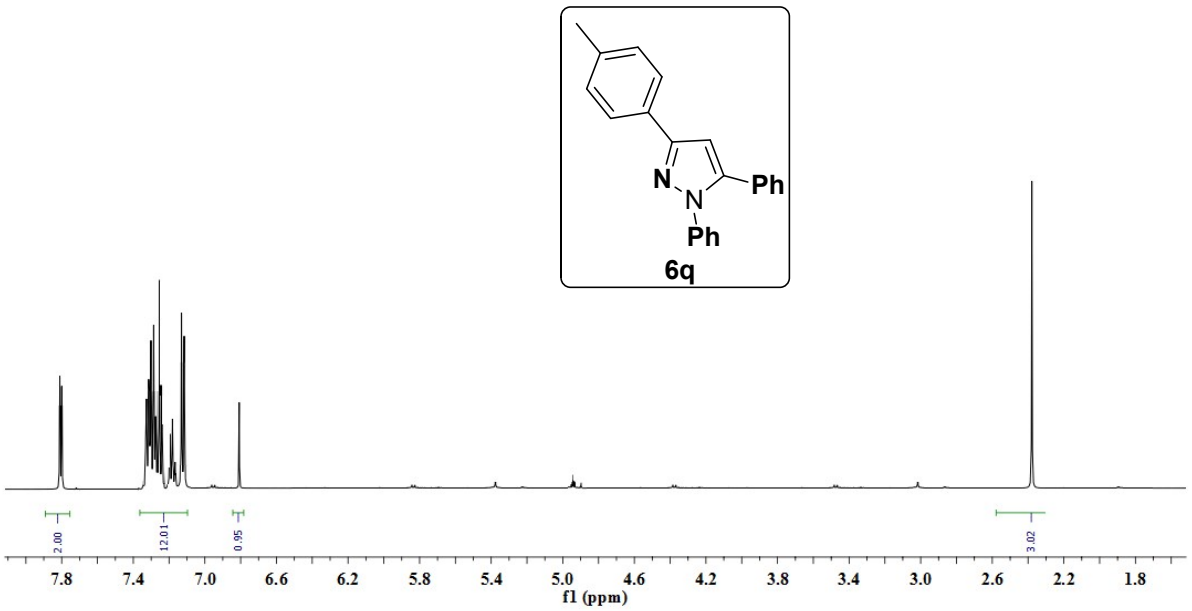
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

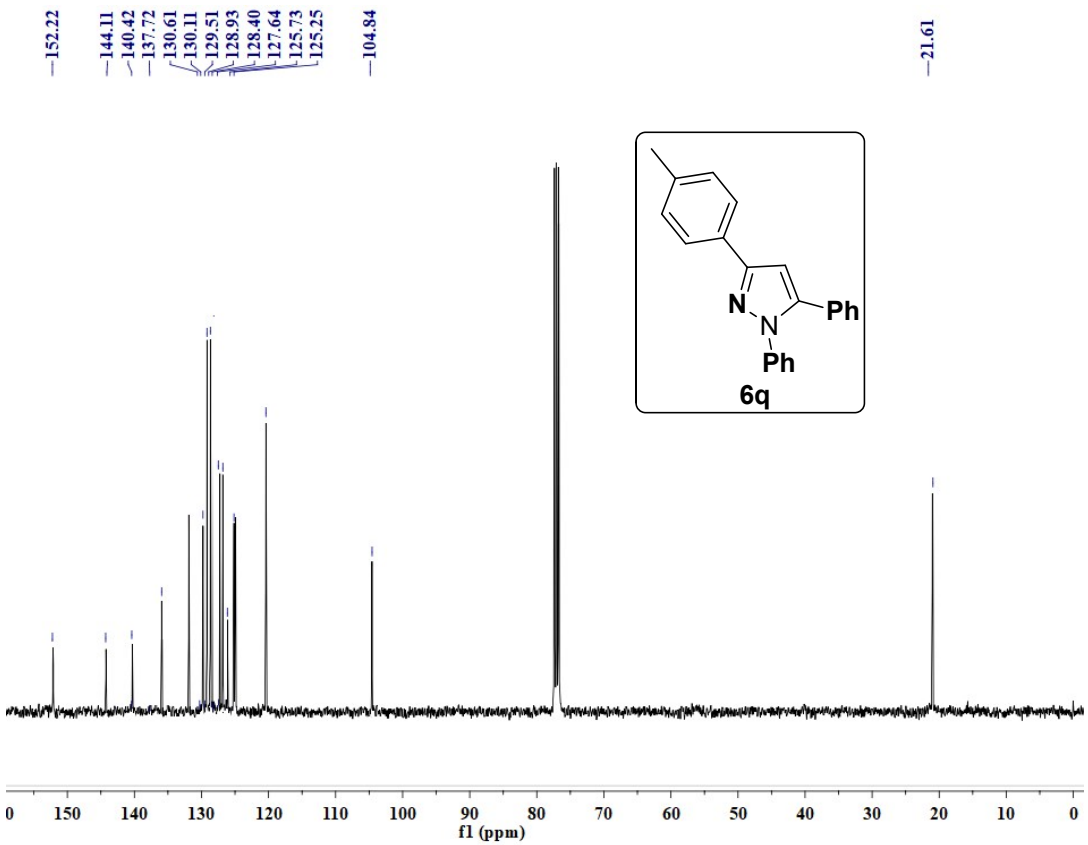

Ph
N
N
Ph
Cl
6o
2.22
2.12
8.18
2.23
1.00
8.2
7.8
7.4
7.0
6.6
6.2
5.8
5.4
5.0
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
f1 (ppm)

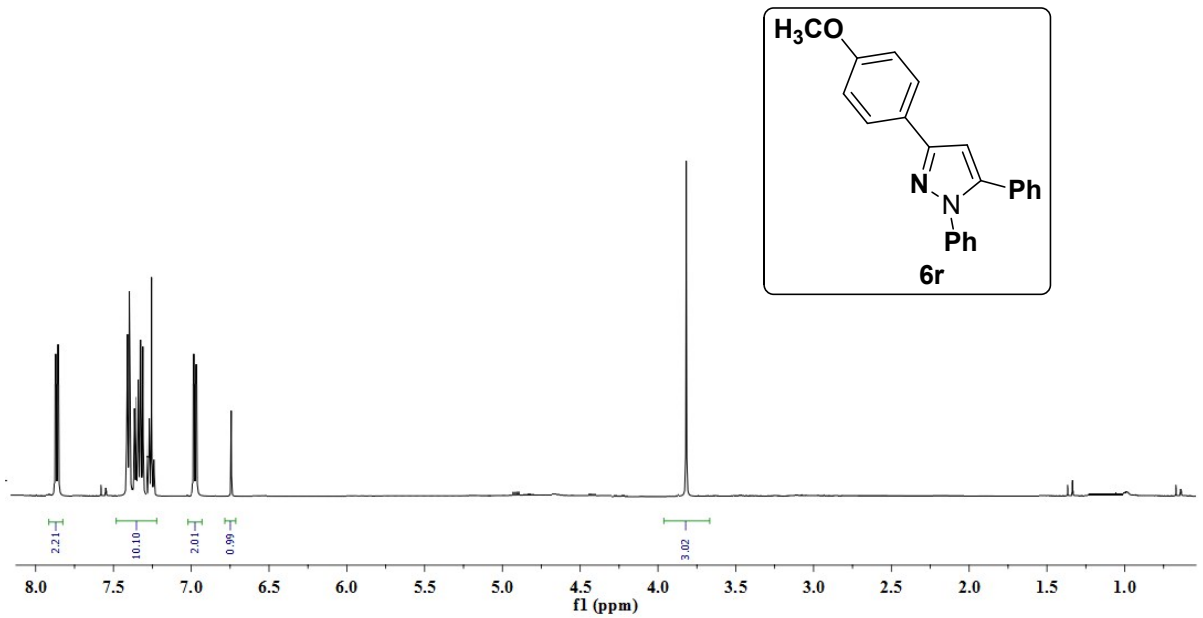

152.12
143.22
139.90
134.38
132.88
130.01
129.08
129.05
128.73
128.10
127.71
125.92
125.43
105.30
Ph
N
N
Ph
Cl
6o
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

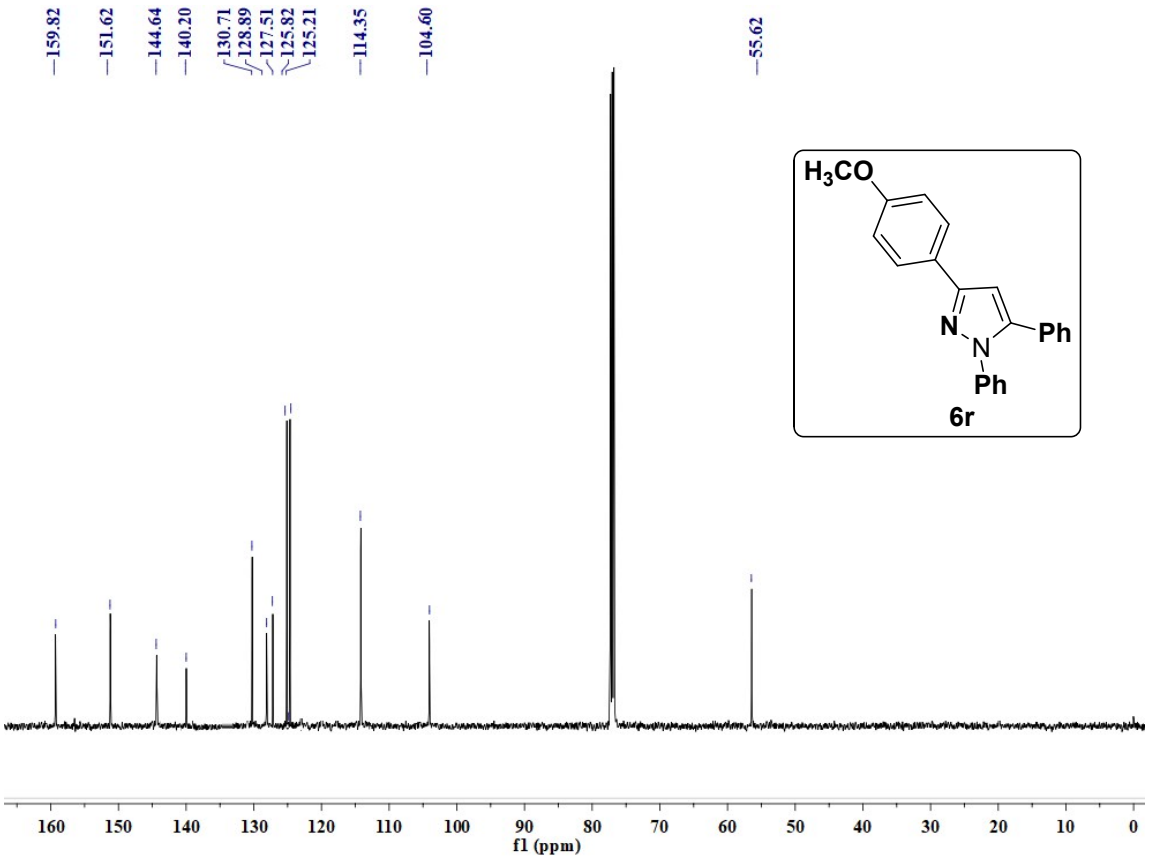

Ph
N
N
Ph
NO2
6p
1.99
2.00
10.00
0.99
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)
152.62
147.44
142.21
139.83
136.79
132.41
129.34
128.73
128.32
125.92
125.43
123.73
106.43

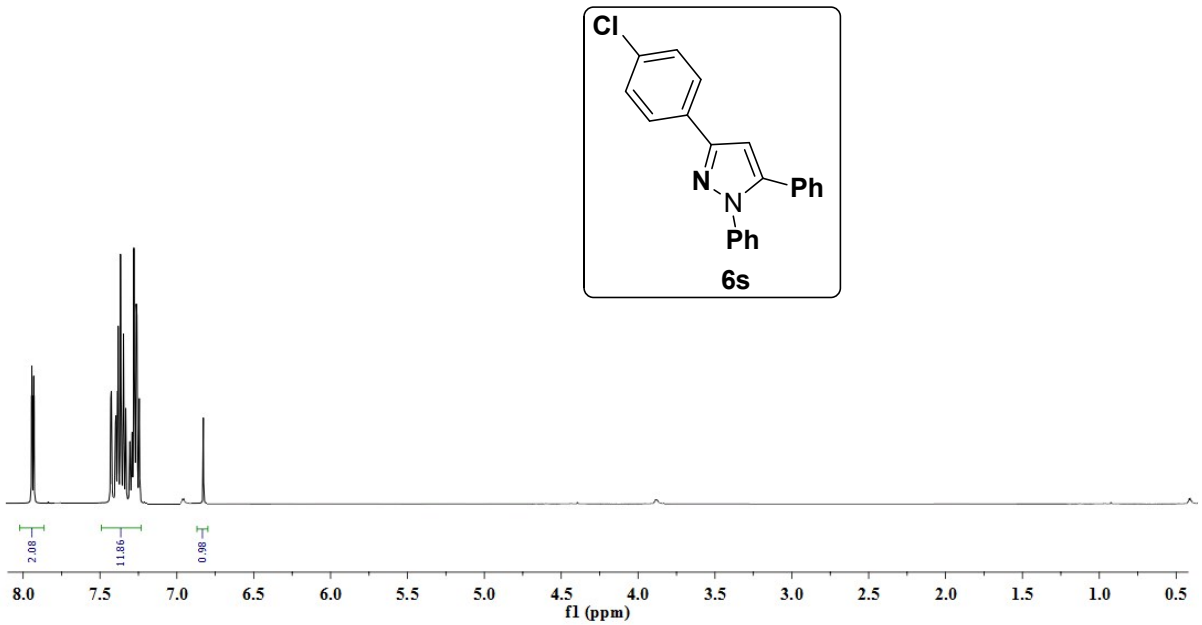

Ph
N
N
Ph
NO2
6p
155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30
f1 (ppm)

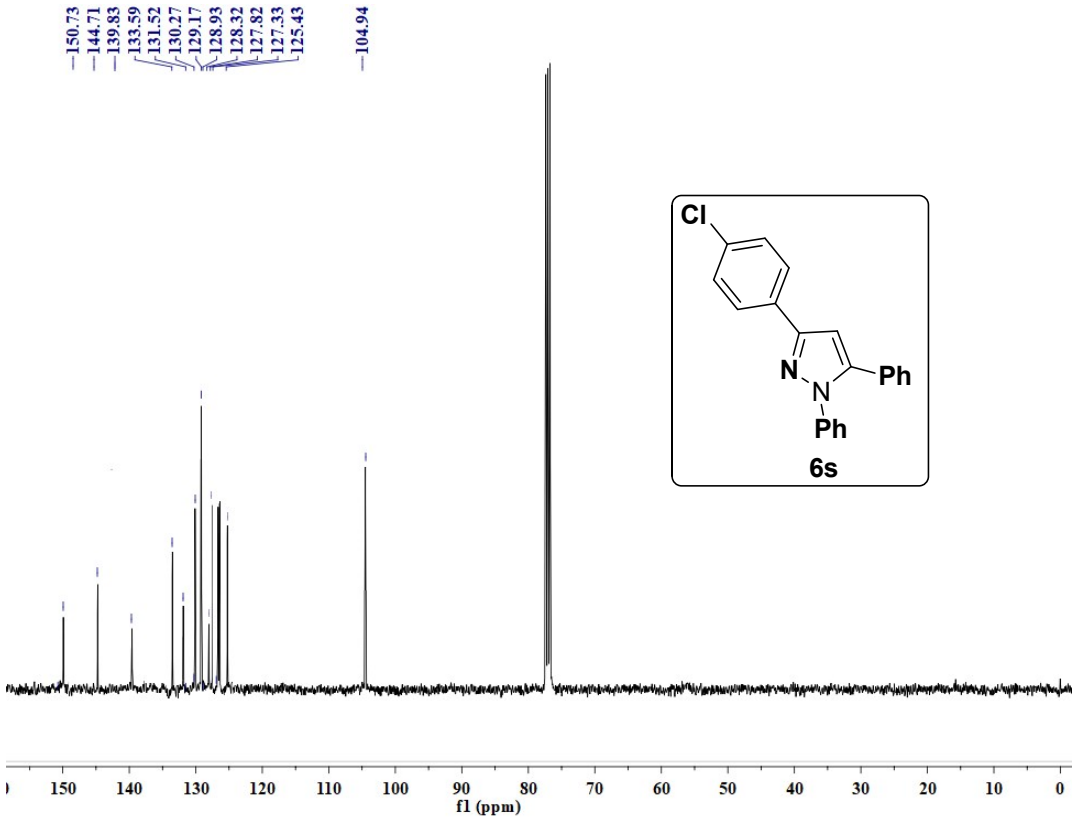

N
N
Ph
Ph
6q
2.00
12.01
0.95
3.02
7.8
7.4
7.0
6.6
6.2
5.8
5.4
5.0
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
f1 (ppm)

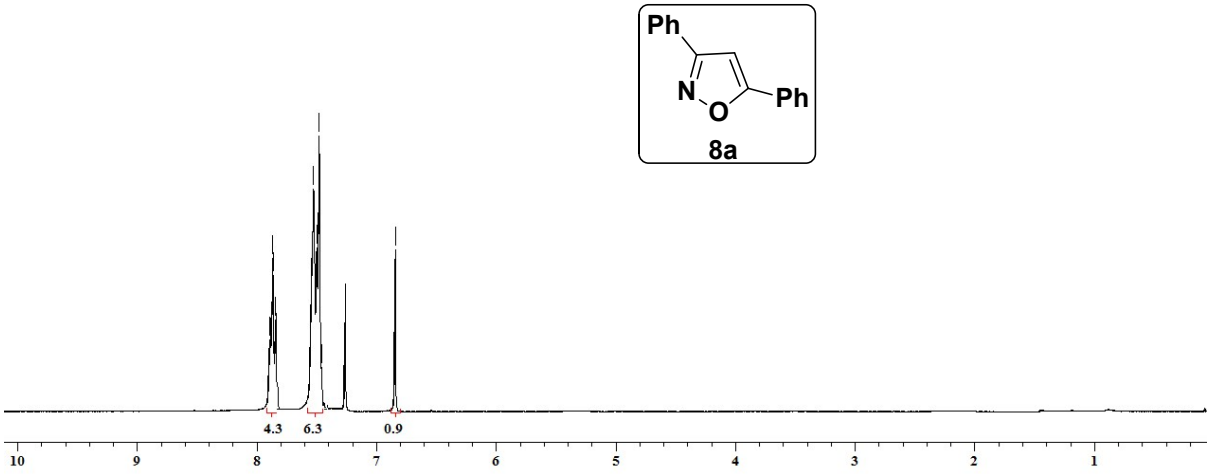

152.22
144.11
140.42
137.72
130.61
130.11
129.51
128.93
128.40
127.64
125.73
125.25
104.84
21.61
N
N
Ph
Ph
6q
0
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

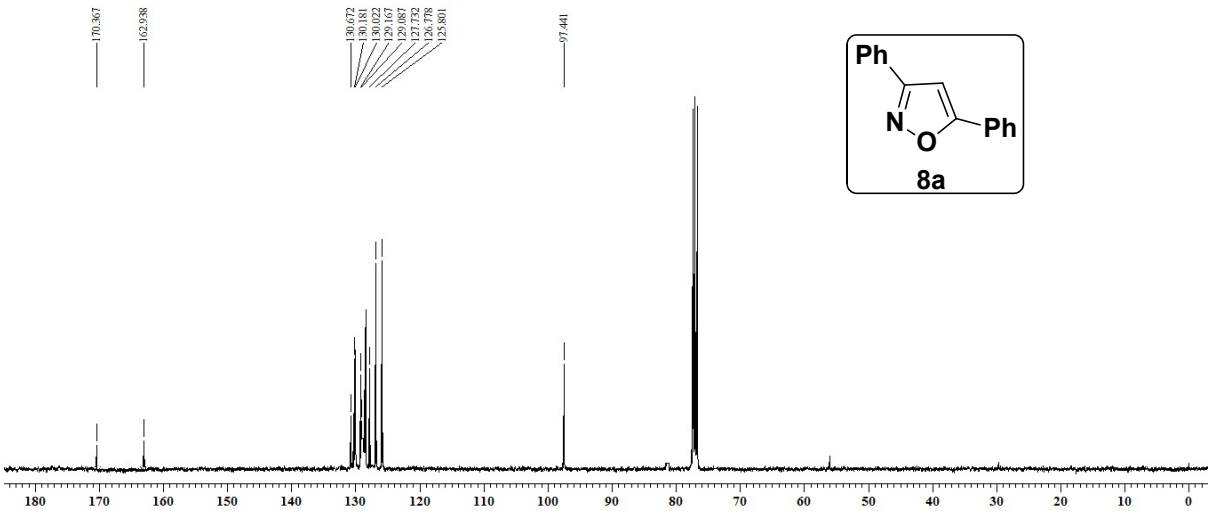

H3CO
N
N
Ph
Ph
6r
2.21
10.10
2.01
0.99
3.02
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)

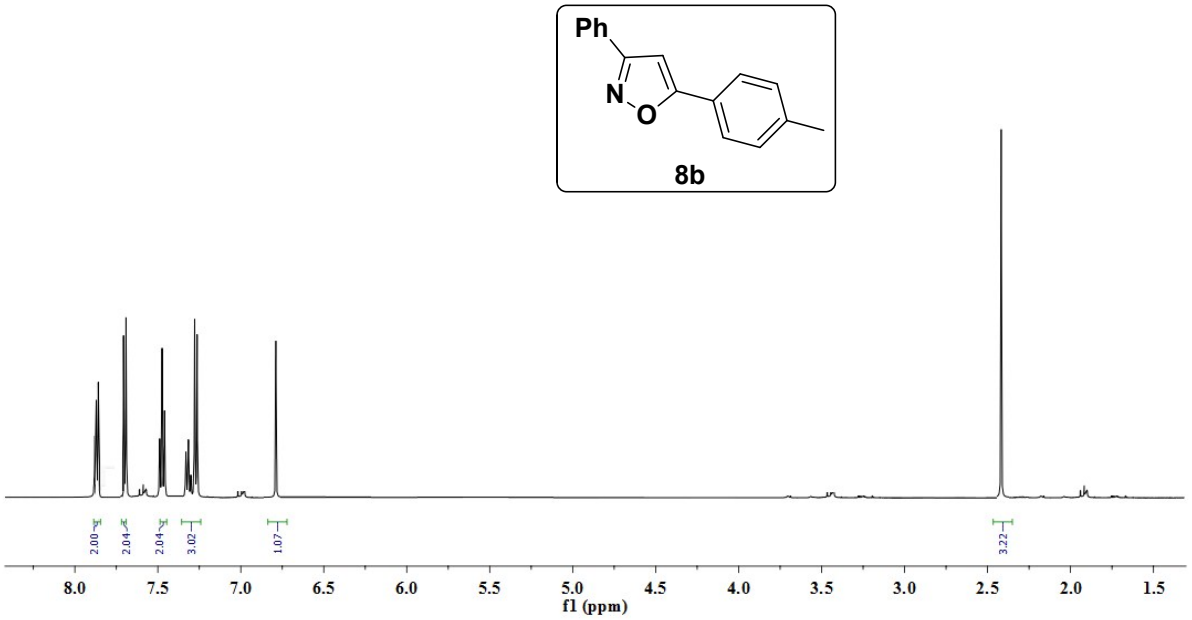

159.82
151.62
144.64
140.20
130.71
128.89
127.51
125.82
125.21
114.35
104.60
55.62
H3CO
N
N
Ph
Ph
6r
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

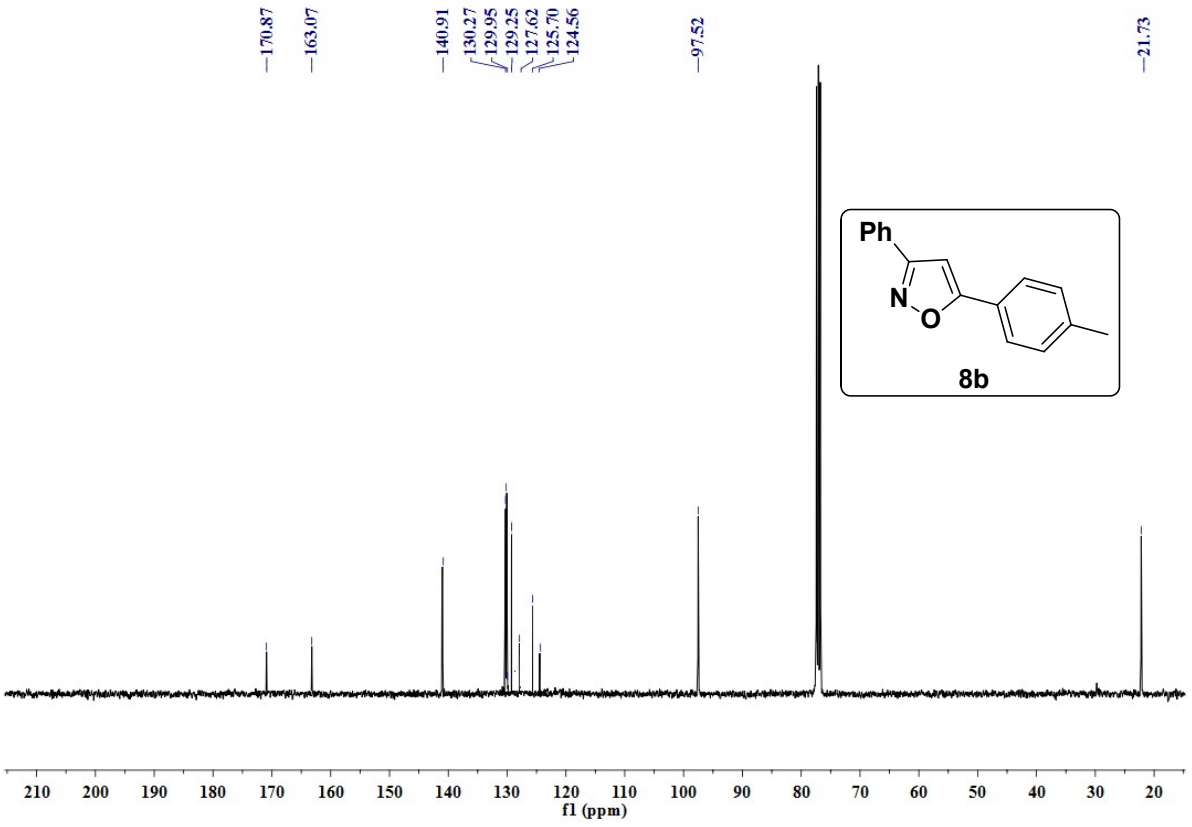

Cl
N
N
Ph
Ph
6s
2.08
11.86
0.98
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

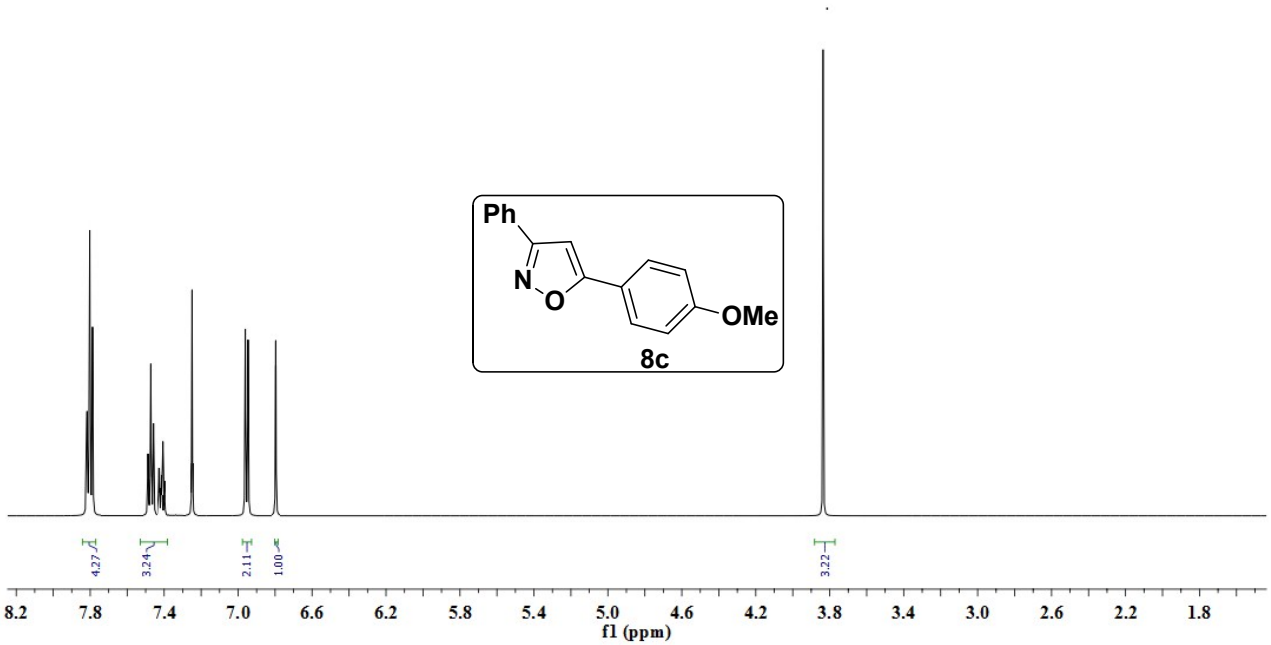

150.73
144.71
139.83
133.59
131.52
130.27
129.17
128.93
128.32
127.82
127.33
125.43
104.94
Cl
N
N
Ph
Ph
6s
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

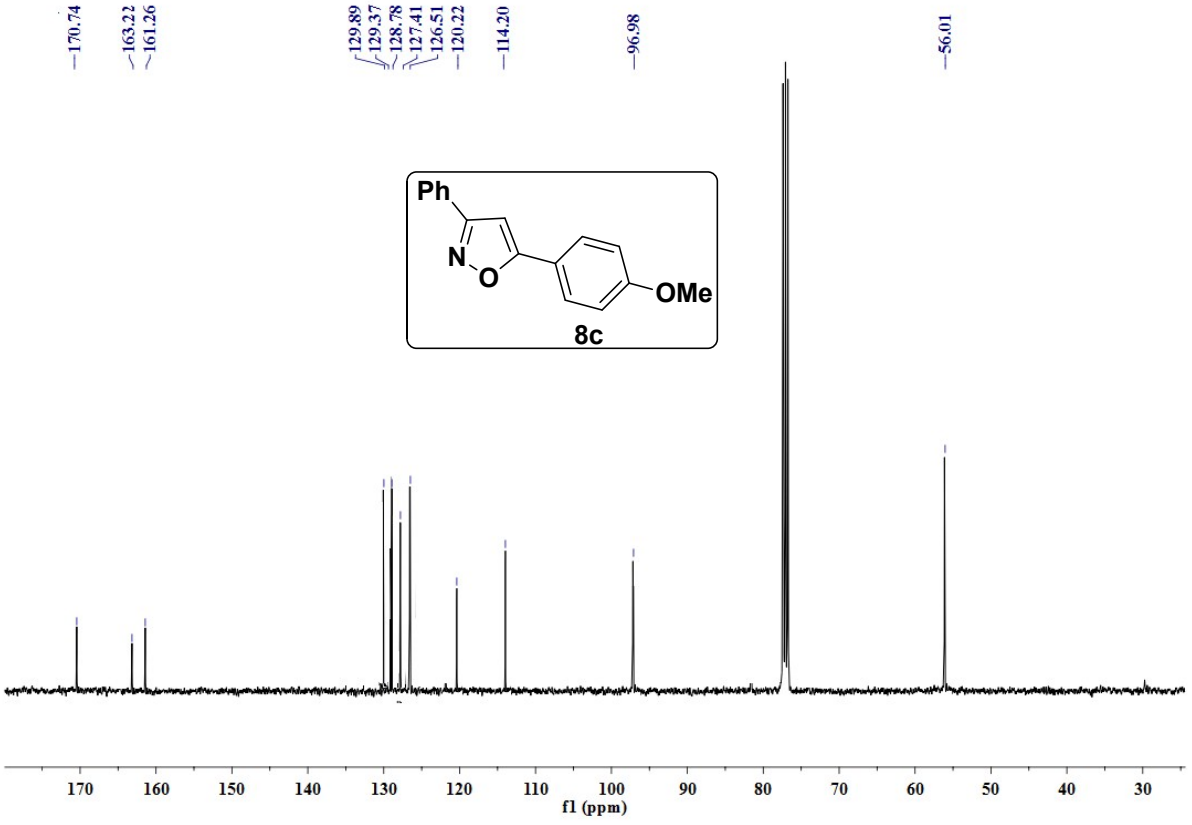

Ph
N
O
Ph
8a
4.3
6.3
0.9
10
9
8
7
6
5
4
3
2
1

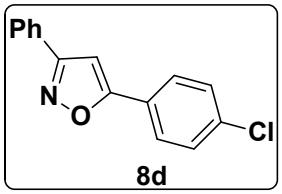

170.367
162.938
130.672
130.181
130.022
129.167
129.087
127.732
126.778
125.801
97.441
Ph
N
O
Ph
8a
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

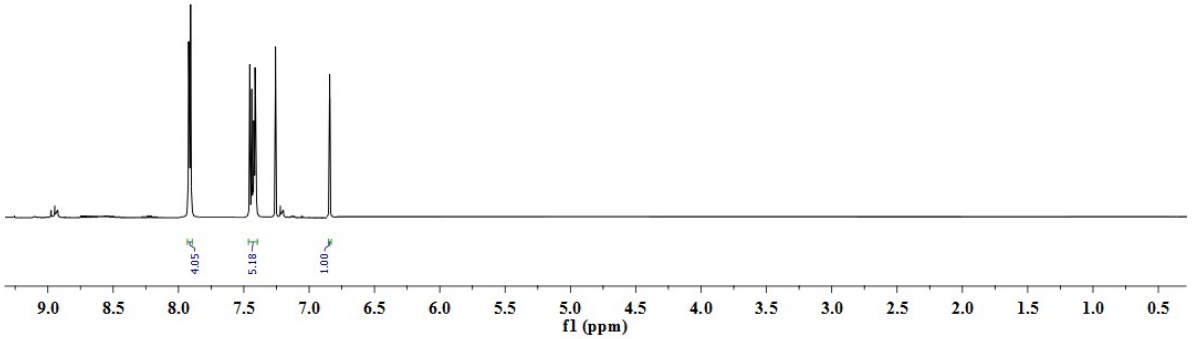

Ph
N
O
8b
2.00
2.04
2.04
3.02
1.07
3.22
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
f1 (ppm)

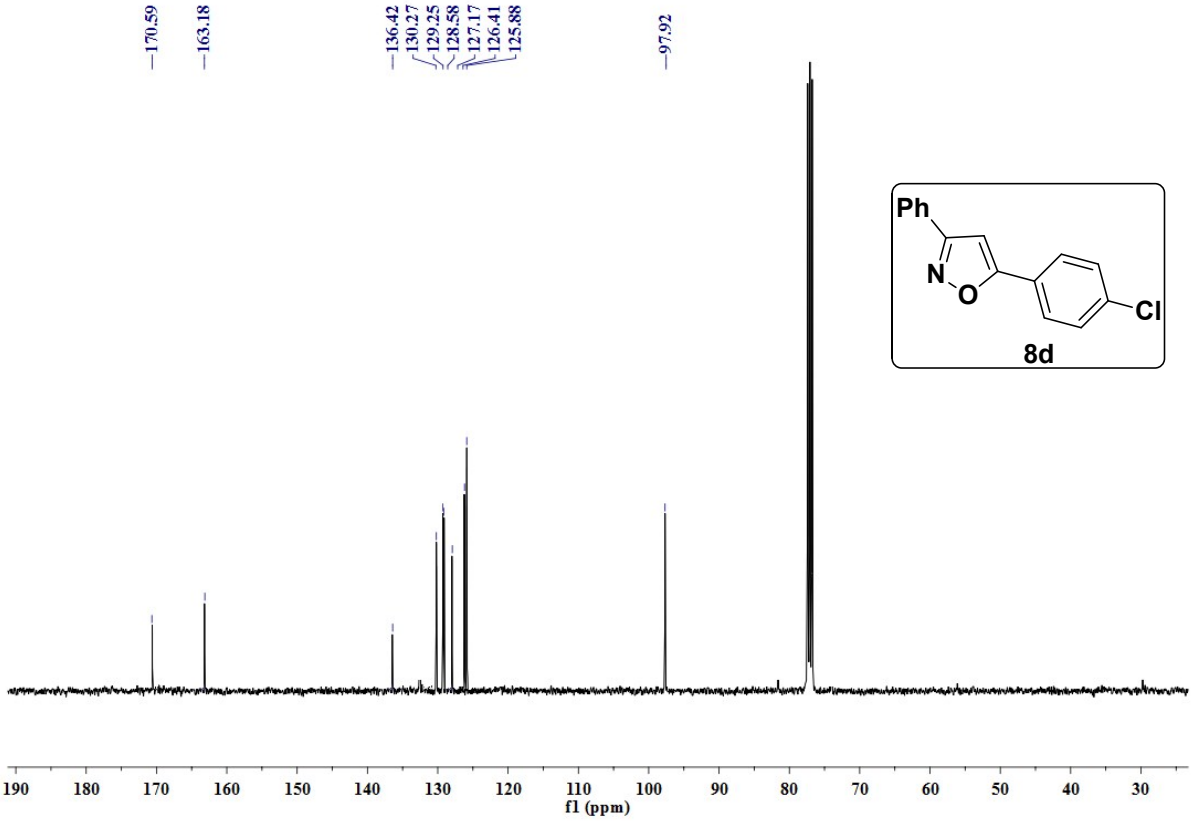

170.87
163.07
140.91
130.27
129.95
129.25
127.62
125.70
124.56
97.52
21.73
Ph
N
O
8b
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

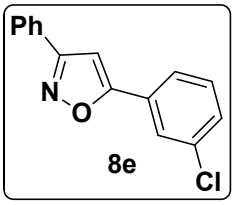

Ph
N
O
OMe
8c
4.27
3.24
2.11
1.00
3.22
8.2
7.8
7.4
7.0
6.6
6.2
5.8
5.4
5.0
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
f1 (ppm)

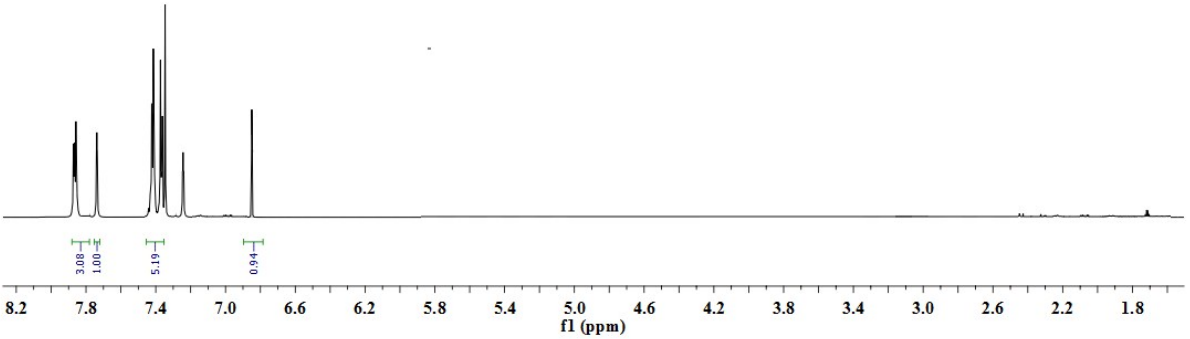

170.74
163.22
161.26
129.89
129.37
128.78
127.41
126.51
120.22
114.20
96.98
56.01
Ph
N
O
OMe
8c
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
f1 (ppm)

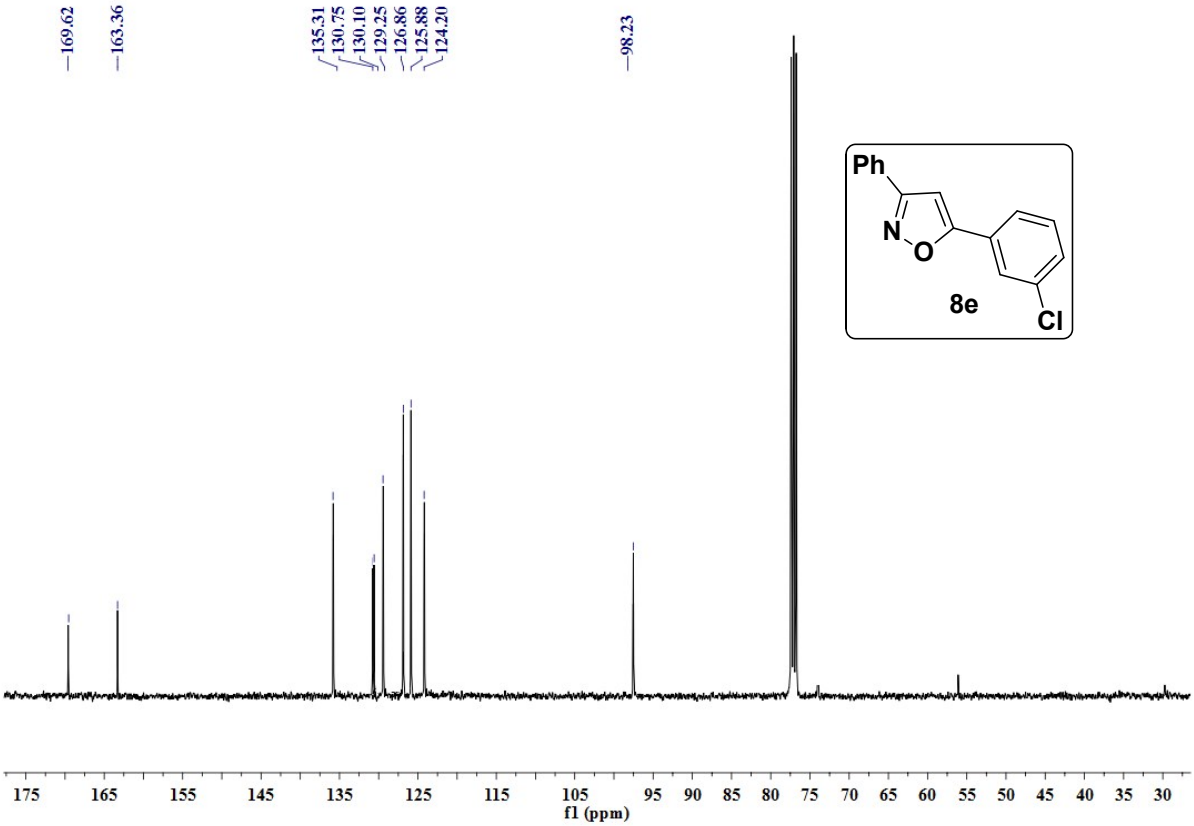

Ph
N
O
Cl
8d

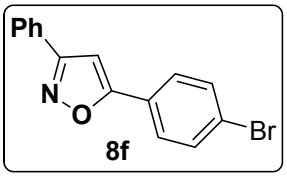

4.05
5.18
1.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

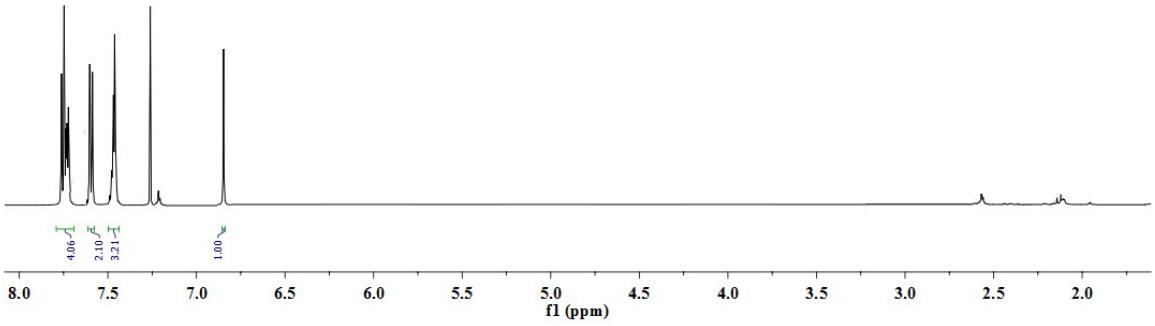

170.59
163.18
136.42
130.27
129.25
128.58
127.17
126.41
125.88
97.92
Ph
N
O
Cl
8d
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
f1 (ppm)

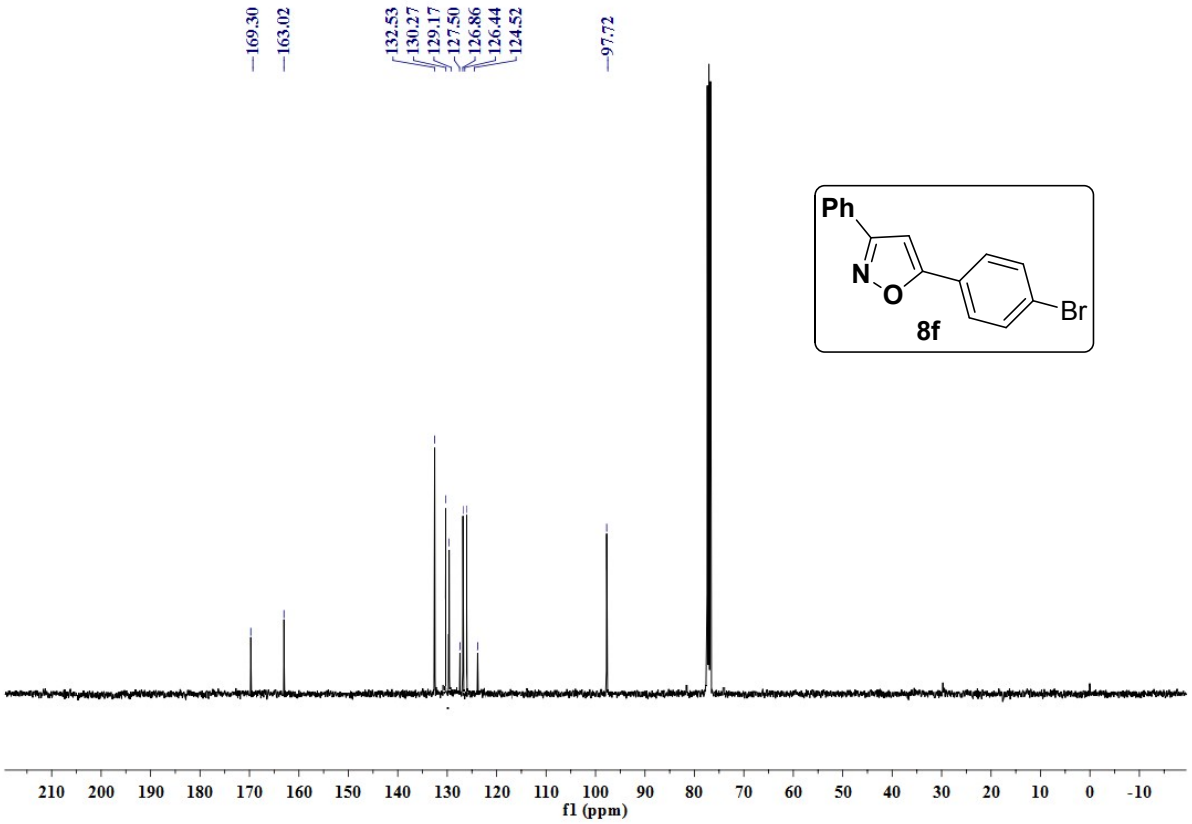

Ph
N
O
8e
Cl

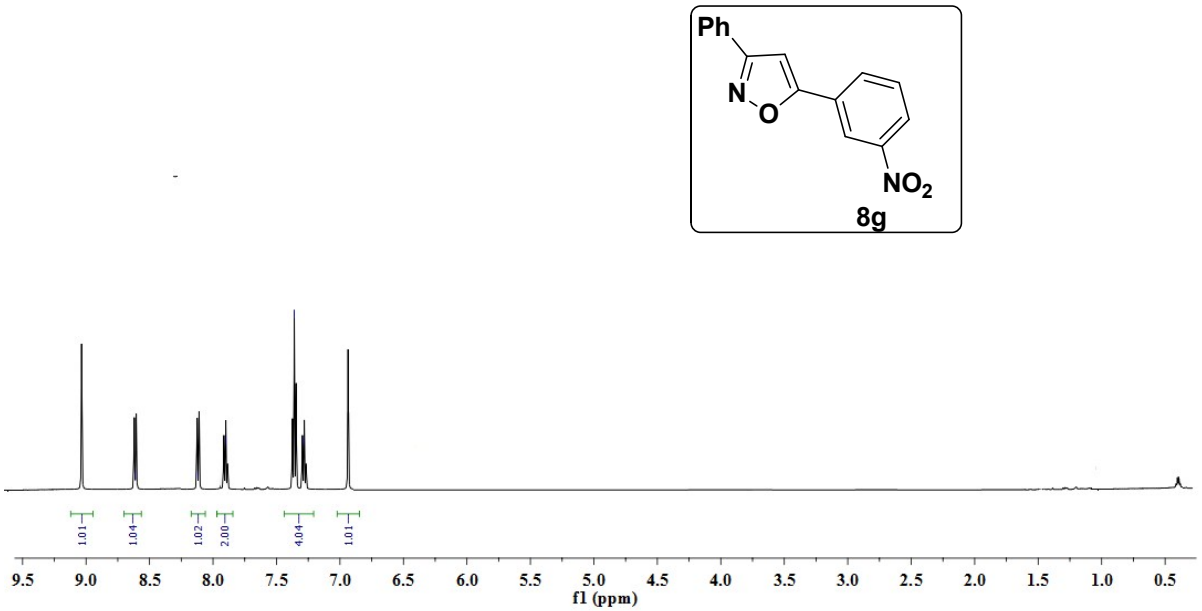

3.08
1.00
5.19
0.94
8.2
7.8
7.4
7.0
6.6
6.2
5.8
5.4
5.0
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
f1 (ppm)

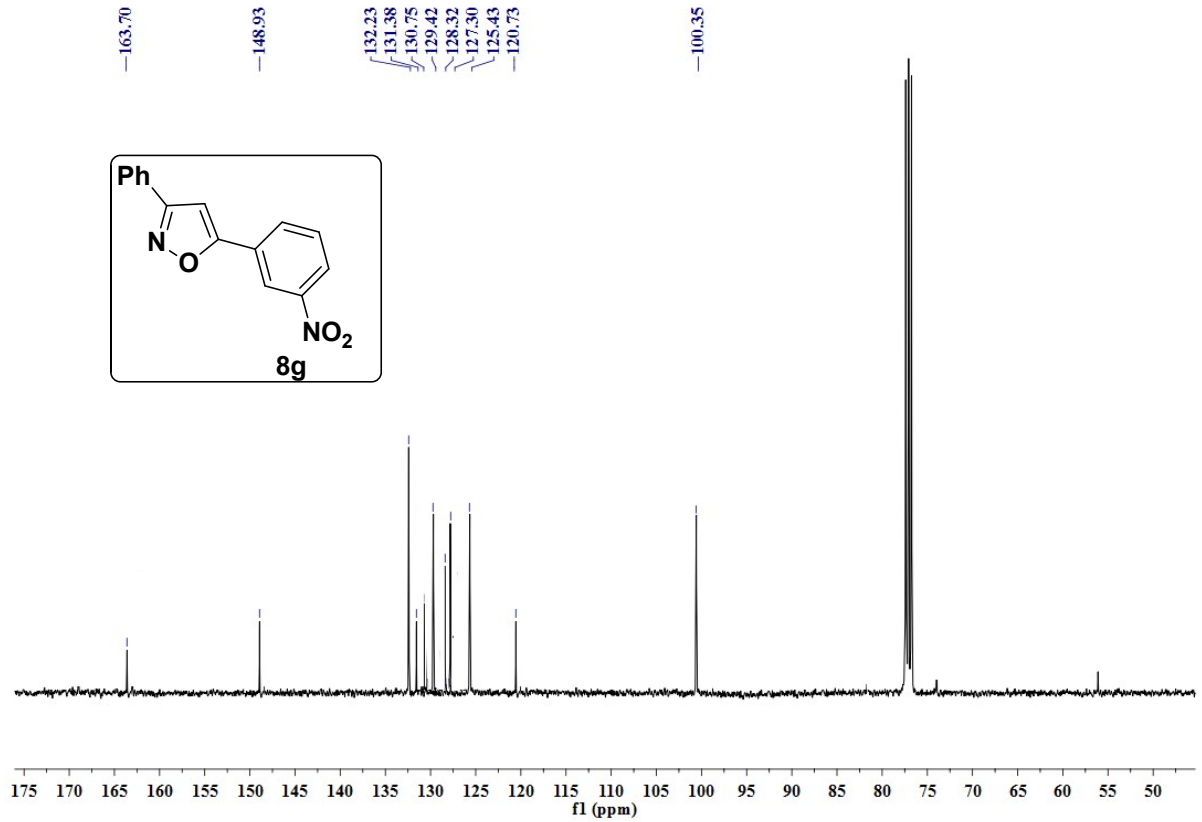

169.62
163.36
135.31
130.75
130.10
129.25
126.86
125.88
124.20
98.23
Ph
N
O
8e
Cl
175
165
155
145
135
125
115
105
95
90
85
80
75
70
65
60
55
50
45
40
35
30
f1 (ppm)

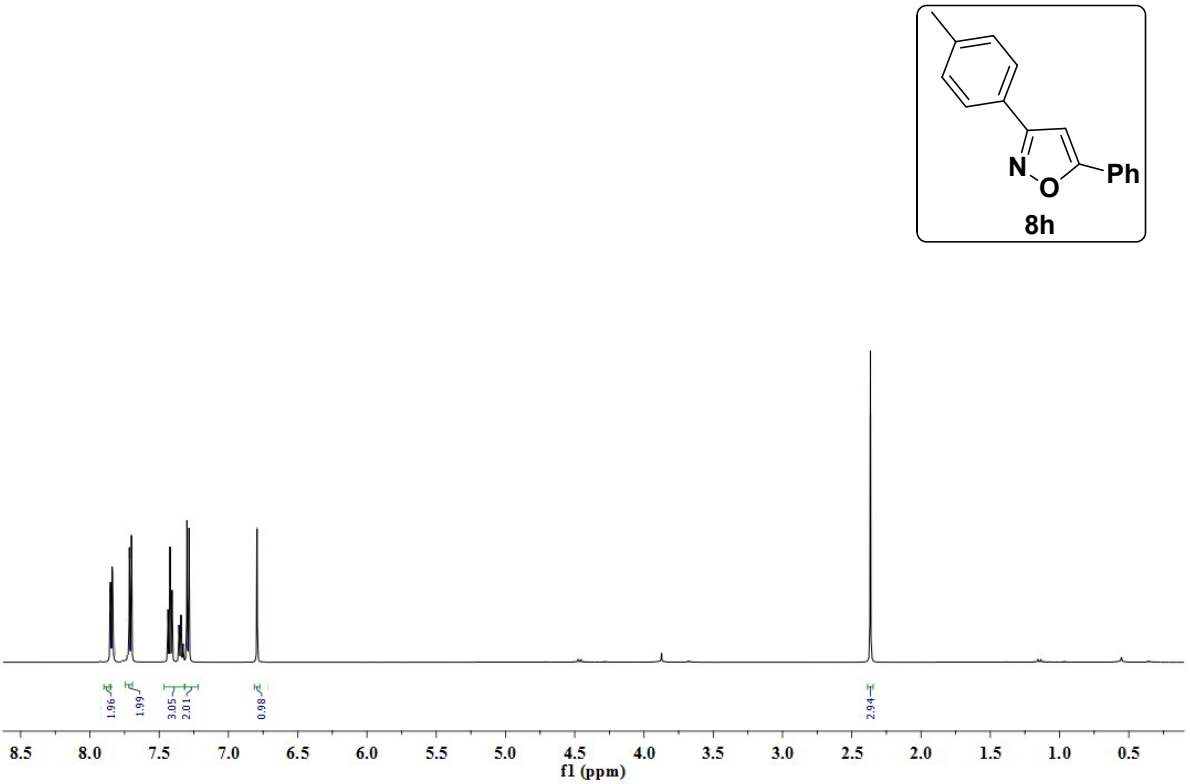

Ph
N
O
Br
8f

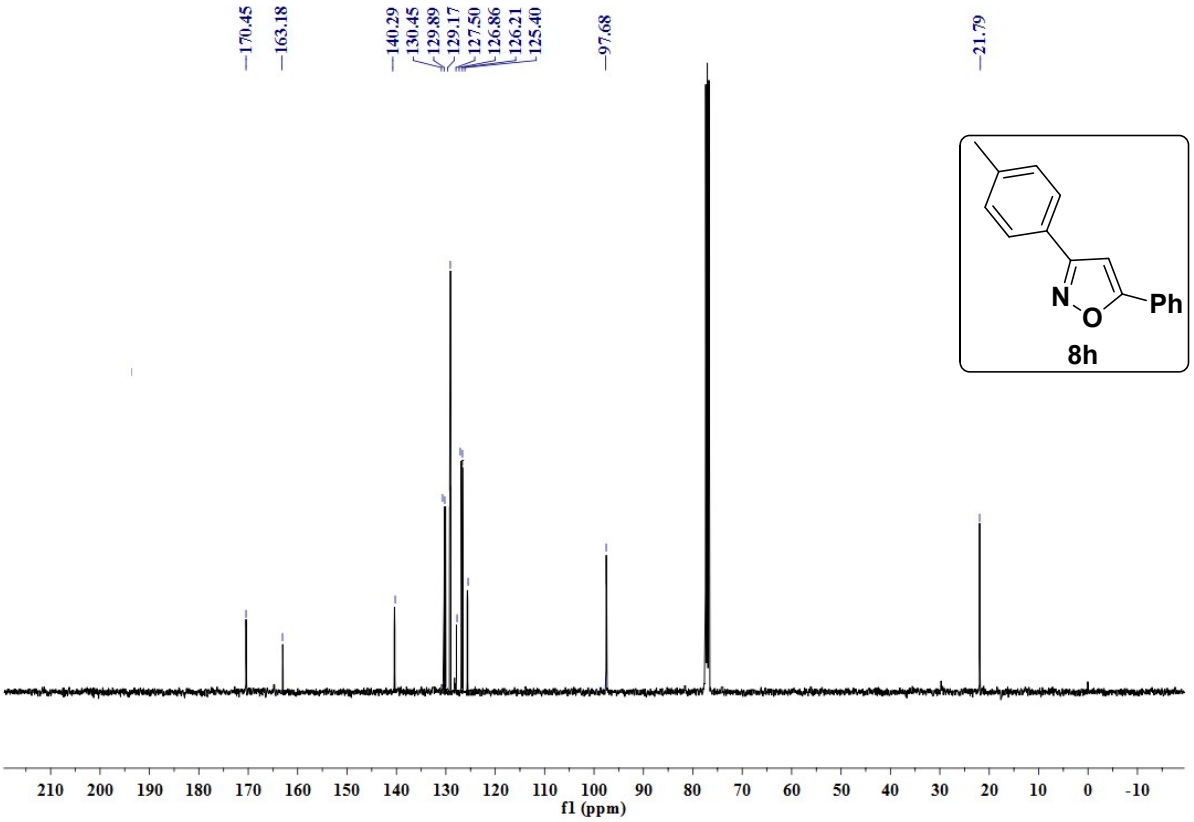

4.06
2.10
3.21
1.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
f1 (ppm)

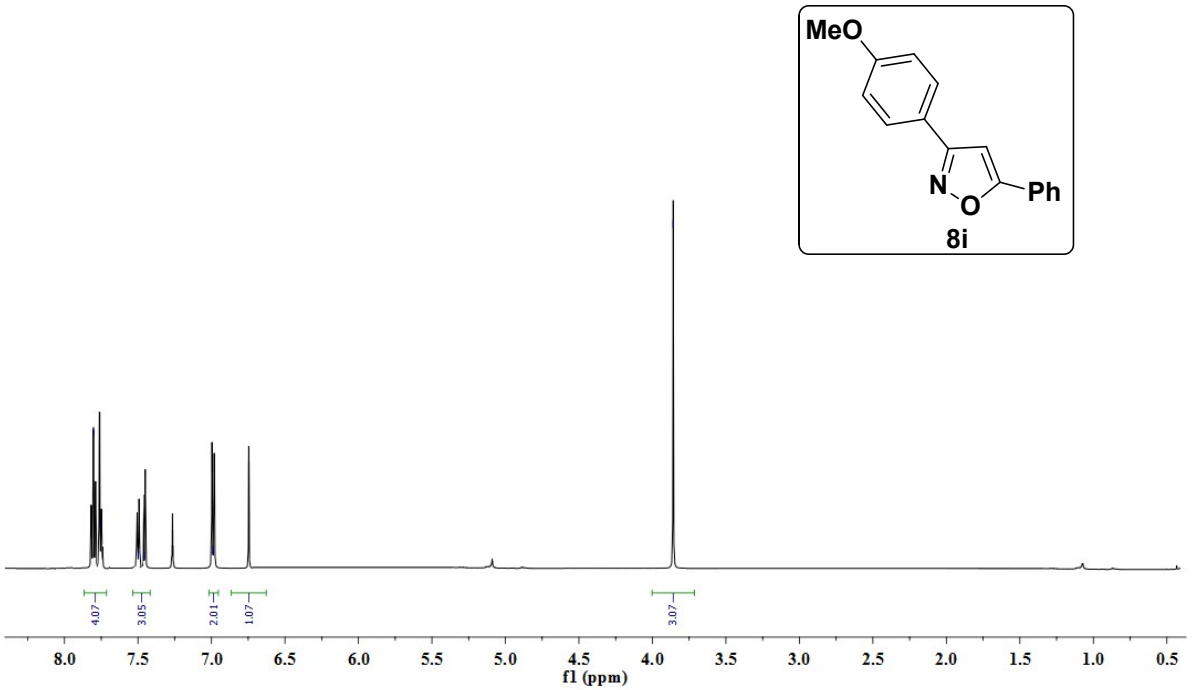

169.30
163.02
132.53
130.27
129.17
127.50
126.86
126.44
124.52
97.72
Ph
N
O
Br
8f
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

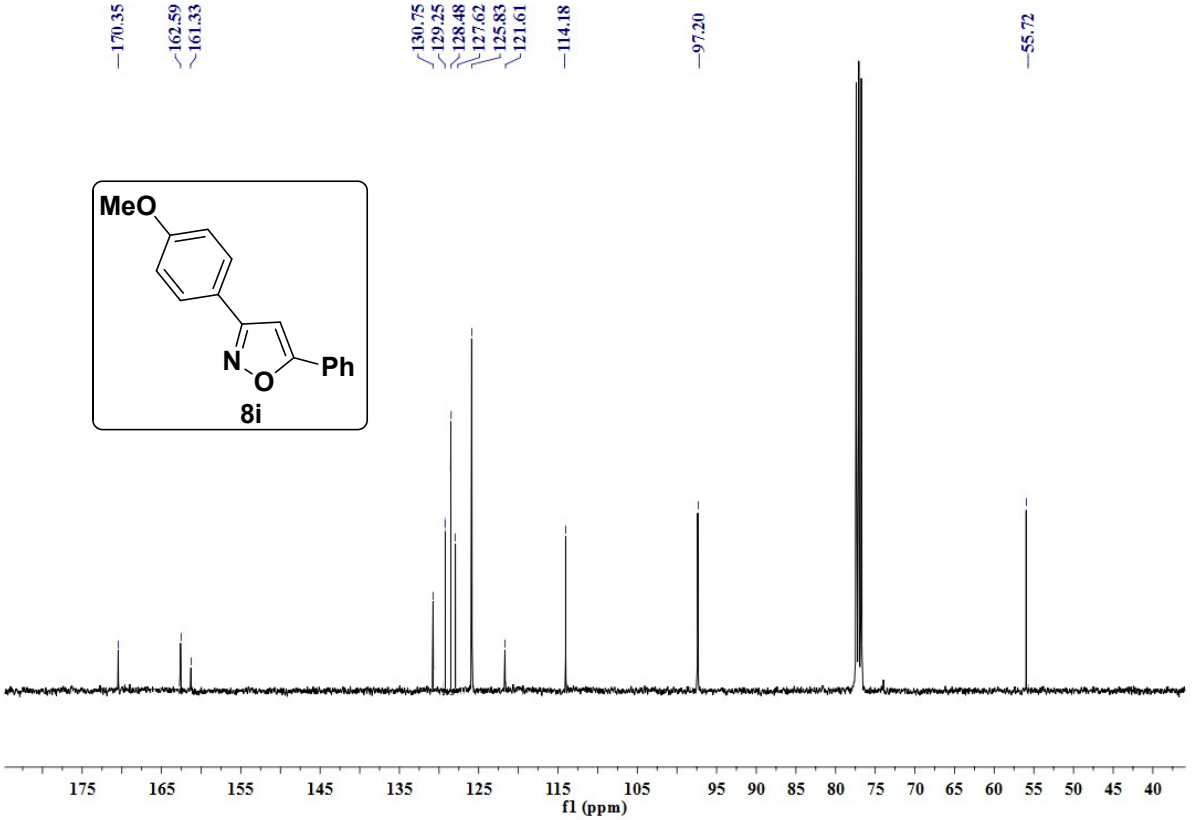

Ph
N
O
NO2
8g
1.01
1.04
1.02
2.00
4.04
1.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

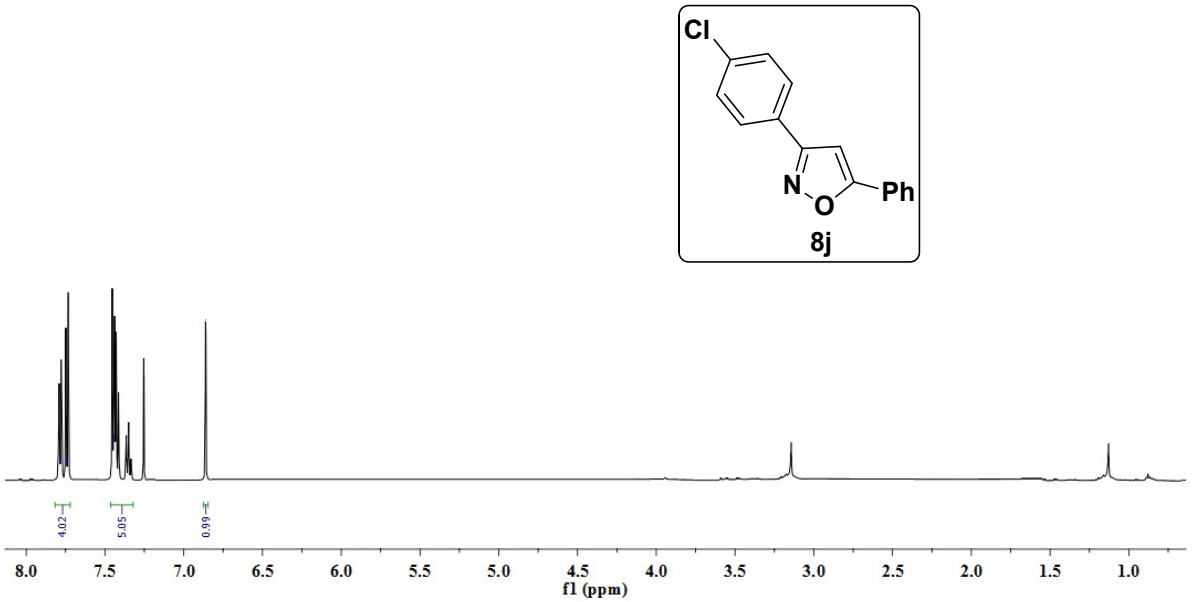

163.70
148.93
132.23
131.38
130.75
129.42
128.32
127.30
125.43
120.73
100.35
Ph
N
O
NO2
8g
175 170 165 160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55 50
f1 (ppm)

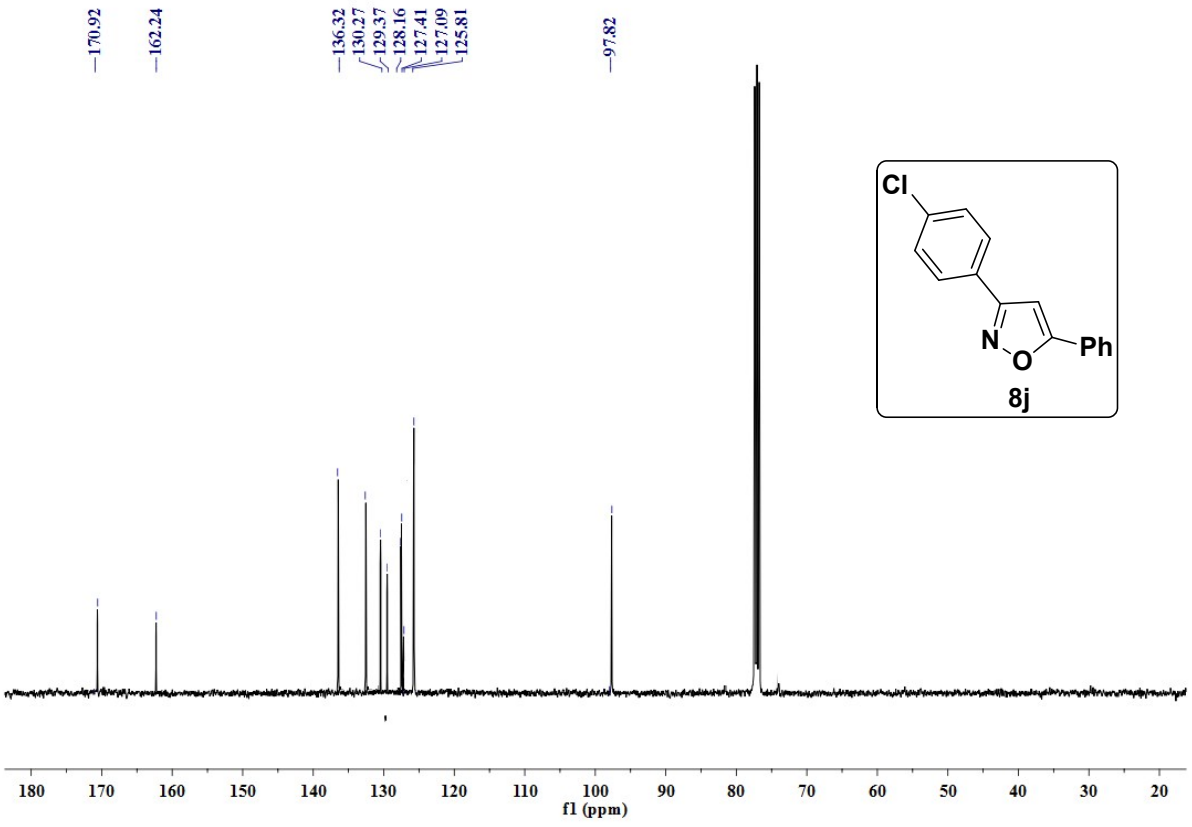

N
O
Ph
8h
1.96
1.99
3.05
2.01
0.98
2.94
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)

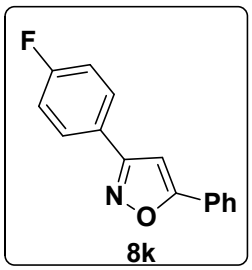

170.45
163.18
140.29
130.45
129.89
129.17
127.50
126.86
126.21
125.40
97.68
21.79
N
O
Ph
8h
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


MeO
N
O
Ph
8i
4.07
3.05
2.01
1.07
3.07
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

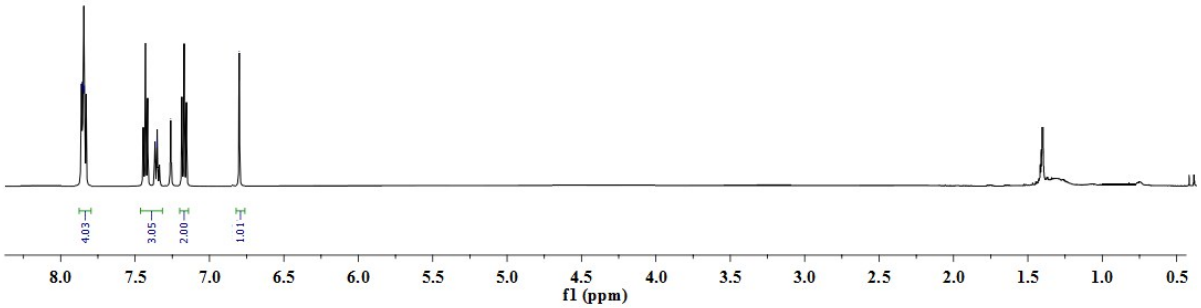

170.35
162.59
161.33
130.75
129.25
128.48
127.62
125.83
121.61
114.18
97.20
55.72
MeO
N
O
Ph
8i
175
165
155
145
135
125
115
105
95
90
85
80
75
70
65
60
55
50
45
40
f1 (ppm)

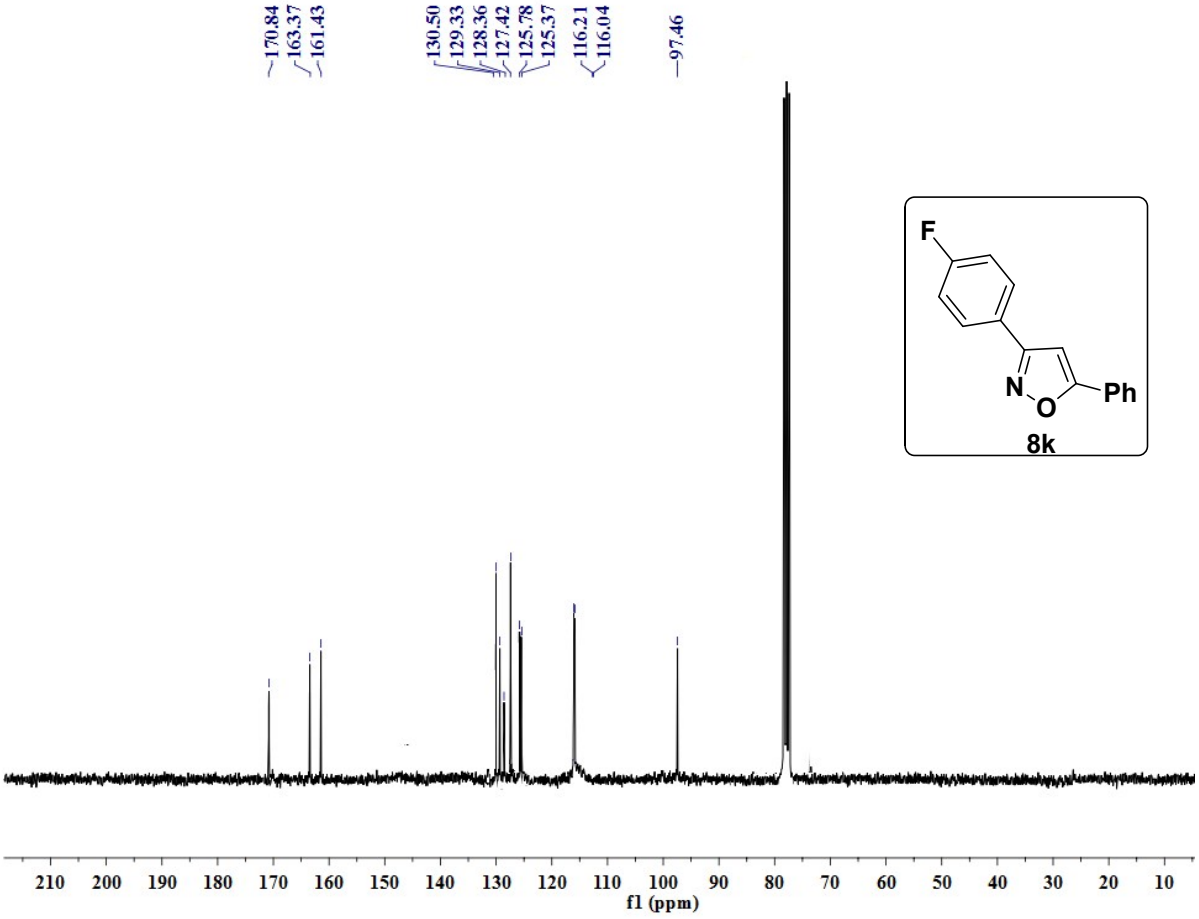

Cl
N
O
Ph
8j
4.02
5.05
0.99
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)


170.92
162.24
136.32
130.27
129.37
128.16
127.41
127.09
125.81
97.82
Cl
N
O
Ph
8j
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

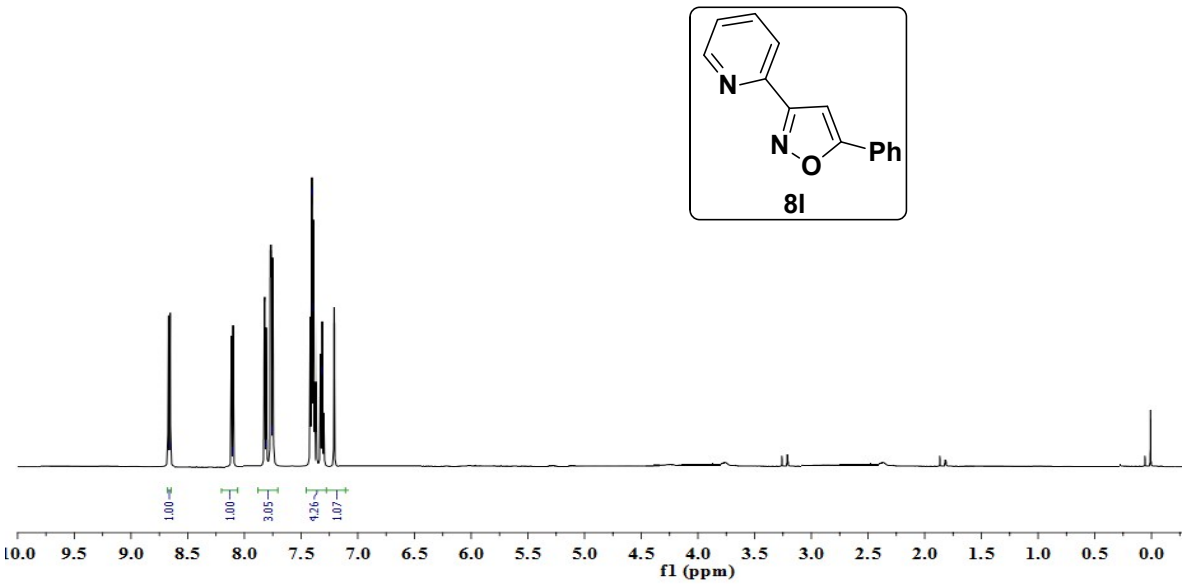

F
N
O
Ph

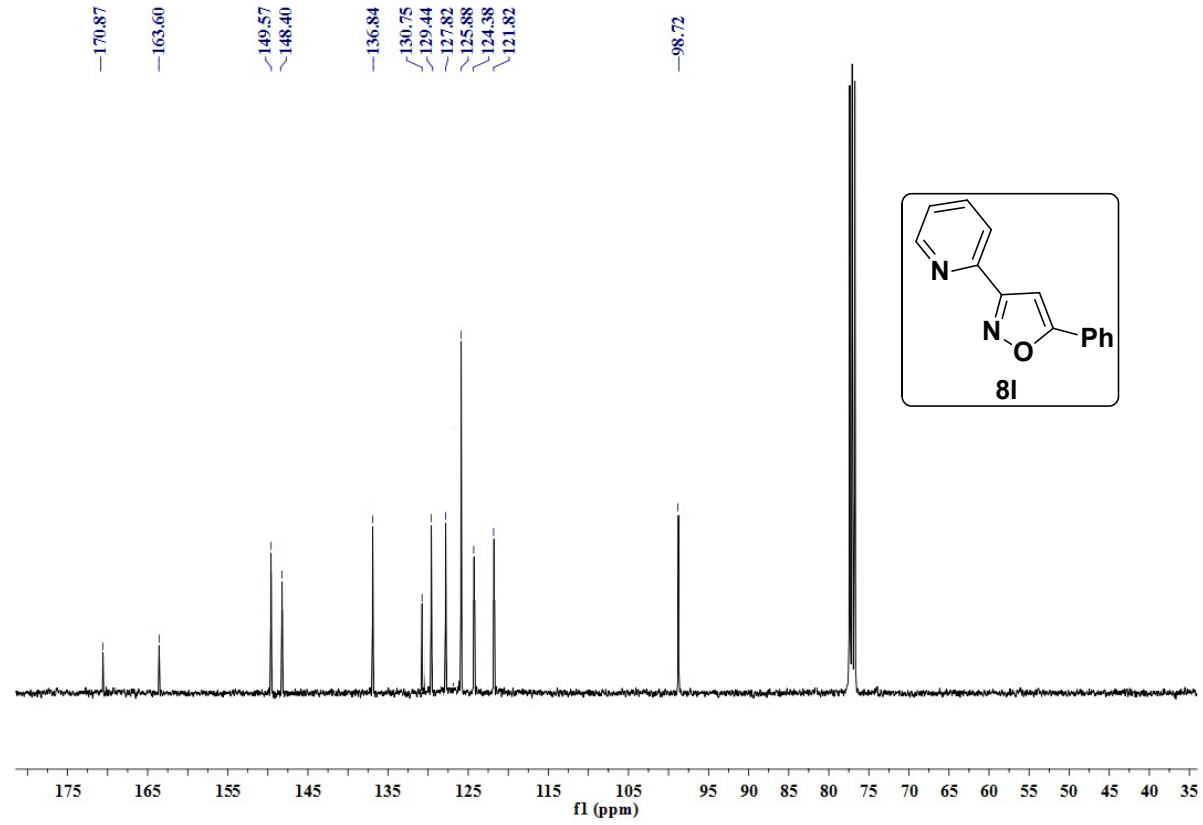
8k

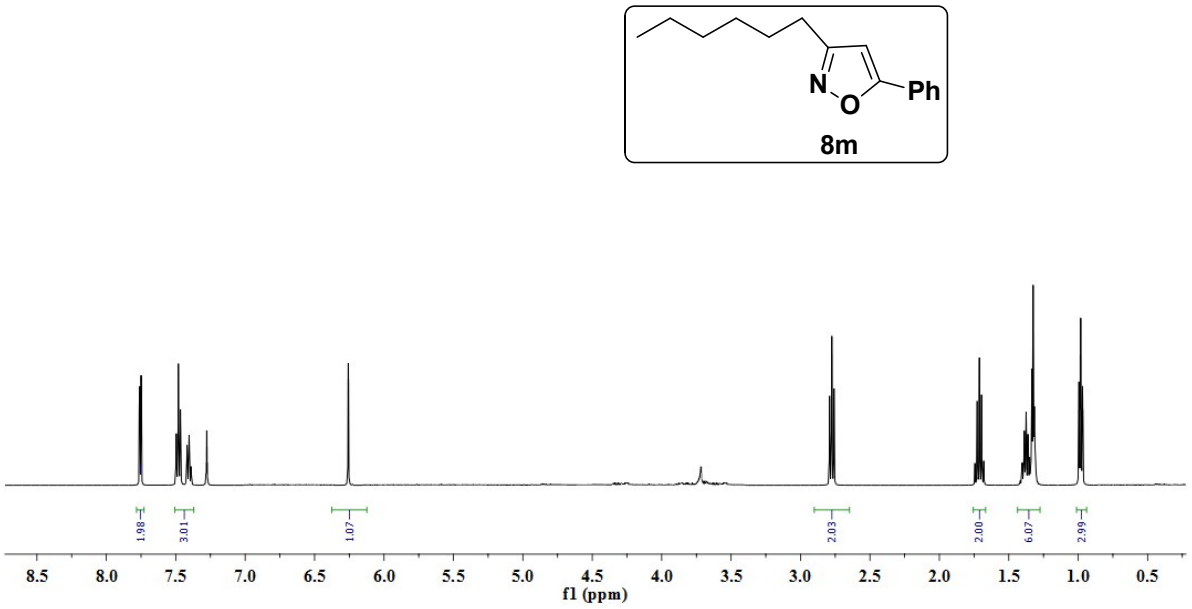

4.03
3.05
2.00
1.01
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

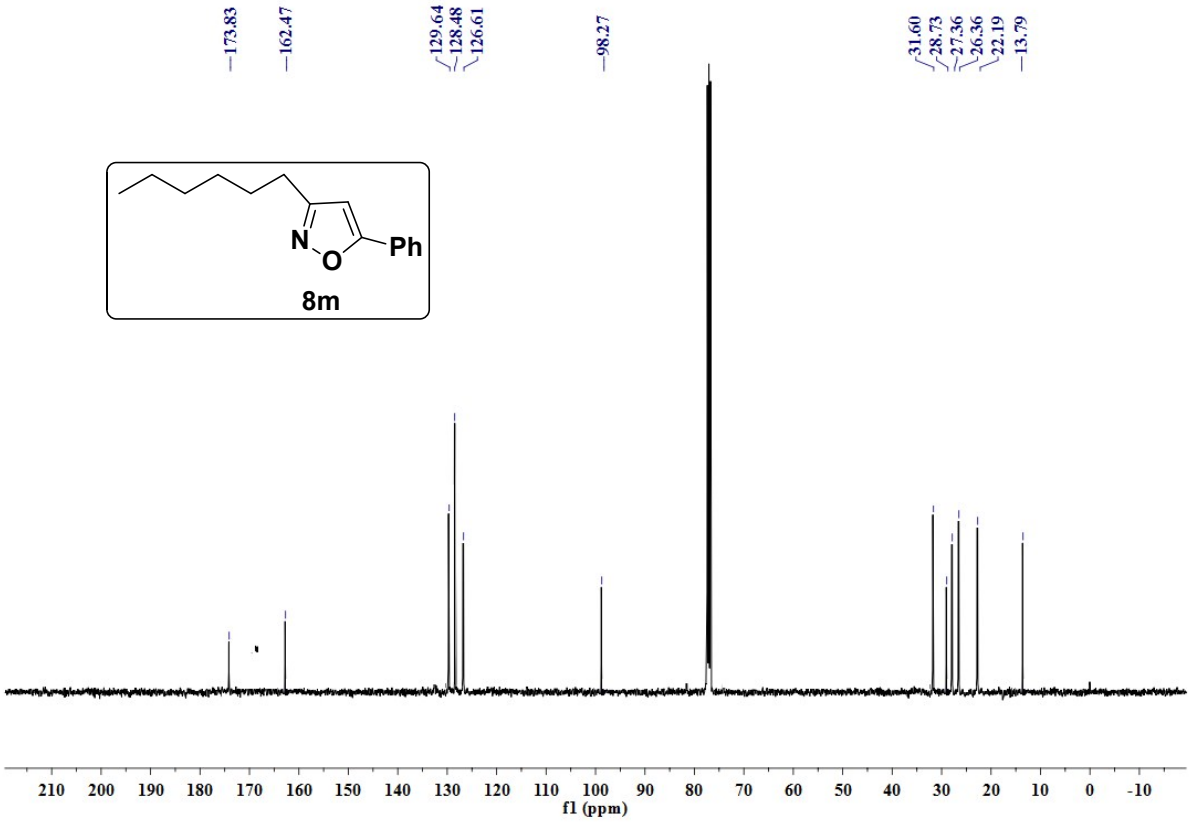

170.84
163.37
161.43
130.50
129.33
128.36
127.42
125.78
125.37
116.21
116.04
97.46
F
N
O
Ph
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

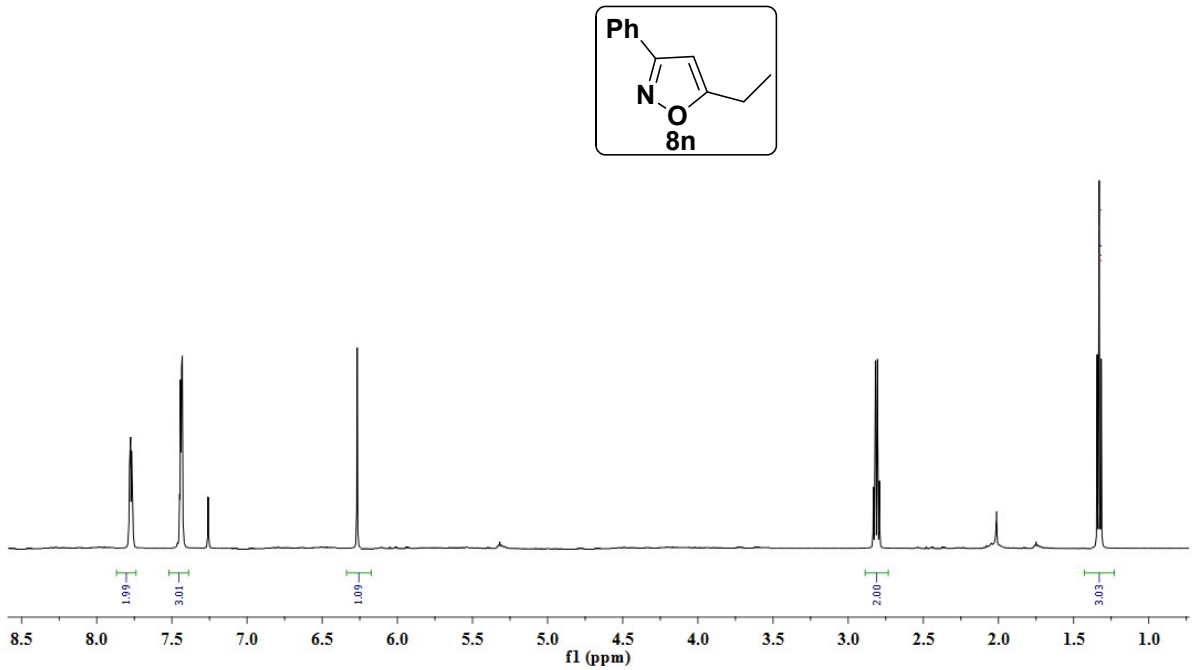
8k

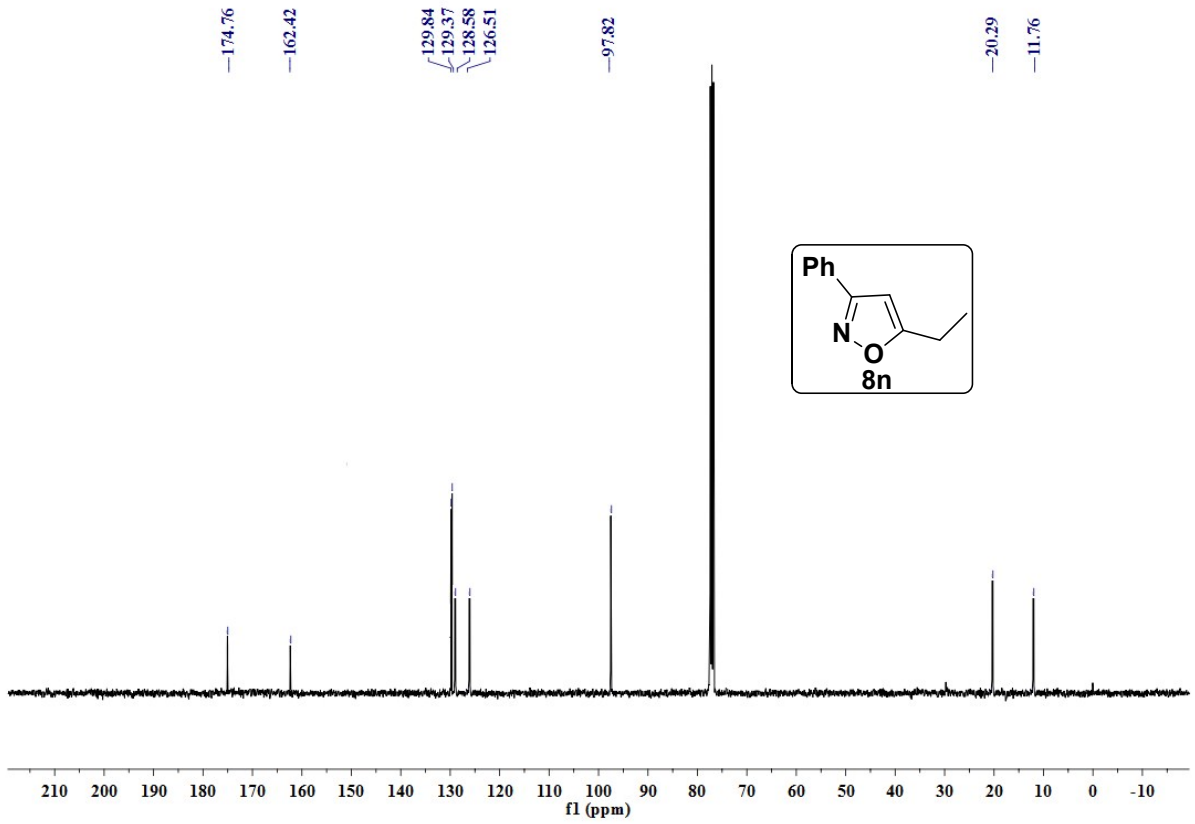

N
N
O
Ph
8l
1.00
1.00
3.05
4.26
1.07
f1 (ppm)


170.87
163.60
149.57
148.40
136.84
130.75
129.44
127.82
125.88
124.38
121.82
98.72
N
N
O
Ph
8l
f1 (ppm)


N
O
Ph
8m
1.98
3.01
1.07
2.03
2.00
6.07
2.99
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


173.83
162.47
129.64
128.48
126.61
98.27
31.60
28.73
27.36
26.36
22.19
13.79
N
O
Ph
8m
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Ph
N
O
8n
1.99
3.01
1.09
2.00
3.03
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
f1 (ppm)


174.76
162.42
129.84
129.37
128.58
126.51
97.82
20.29
11.76
Ph
N
O
8n
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)