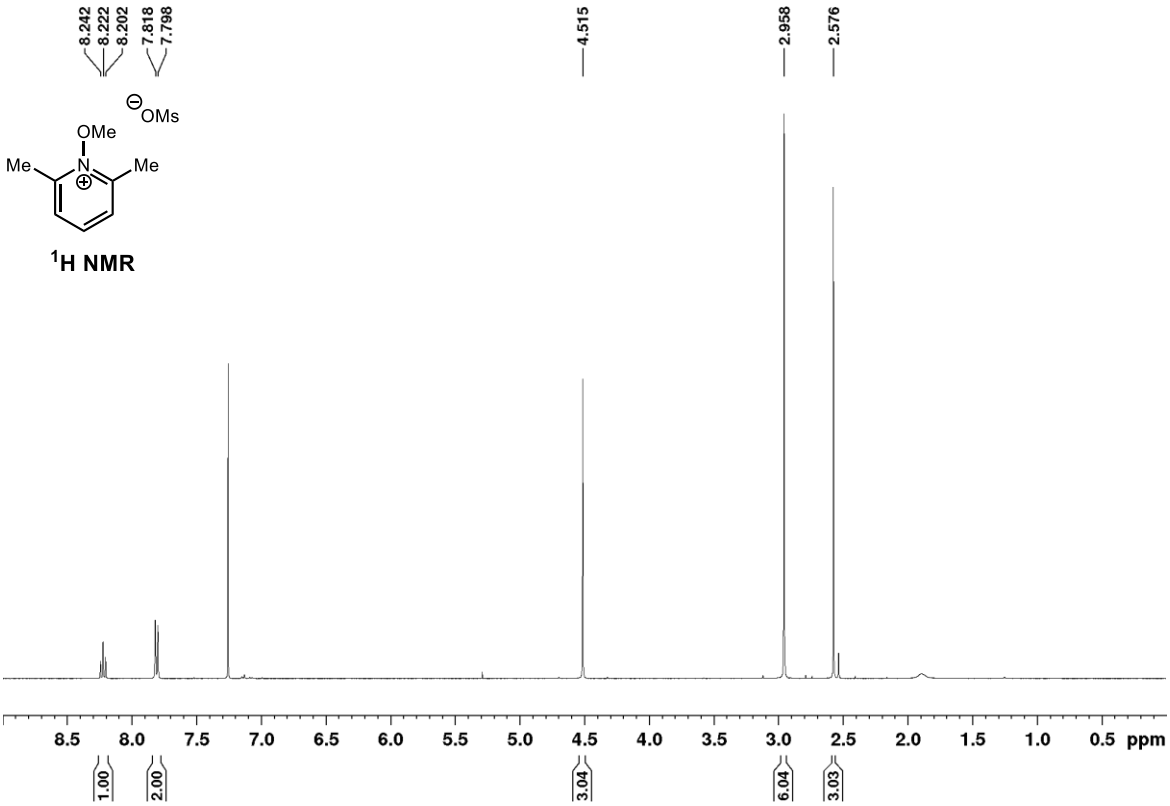
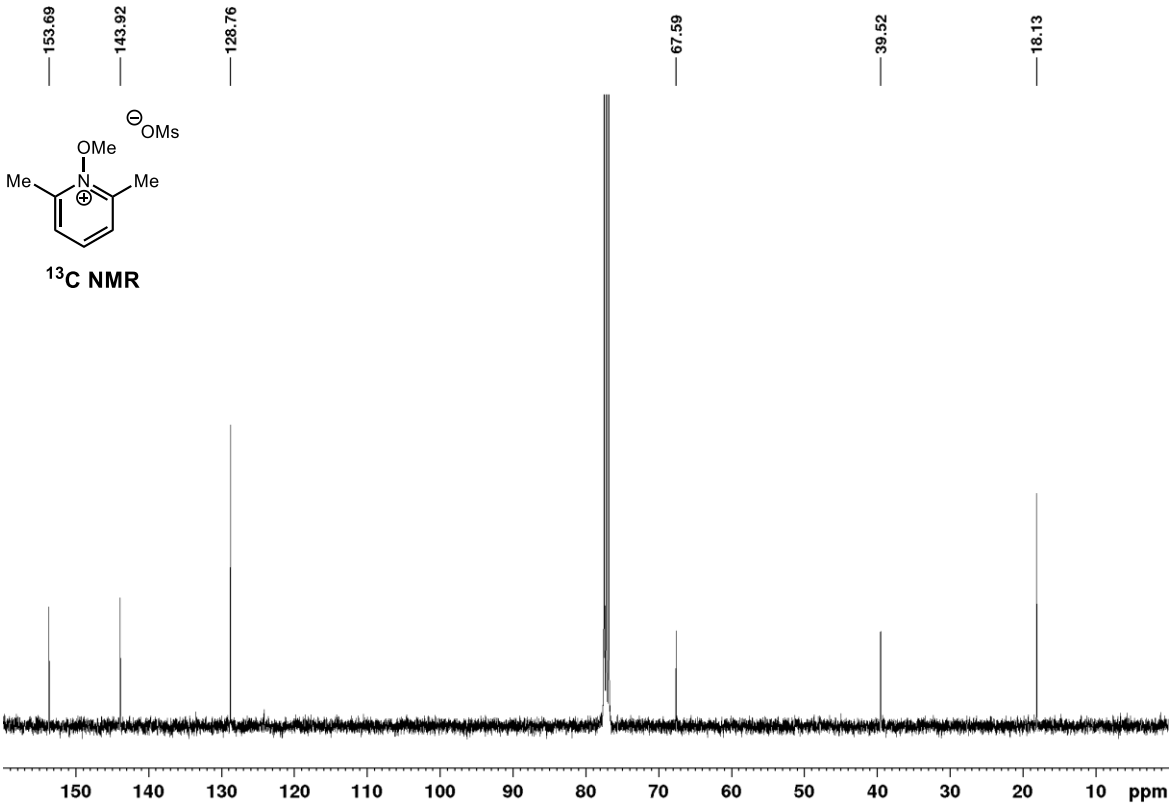
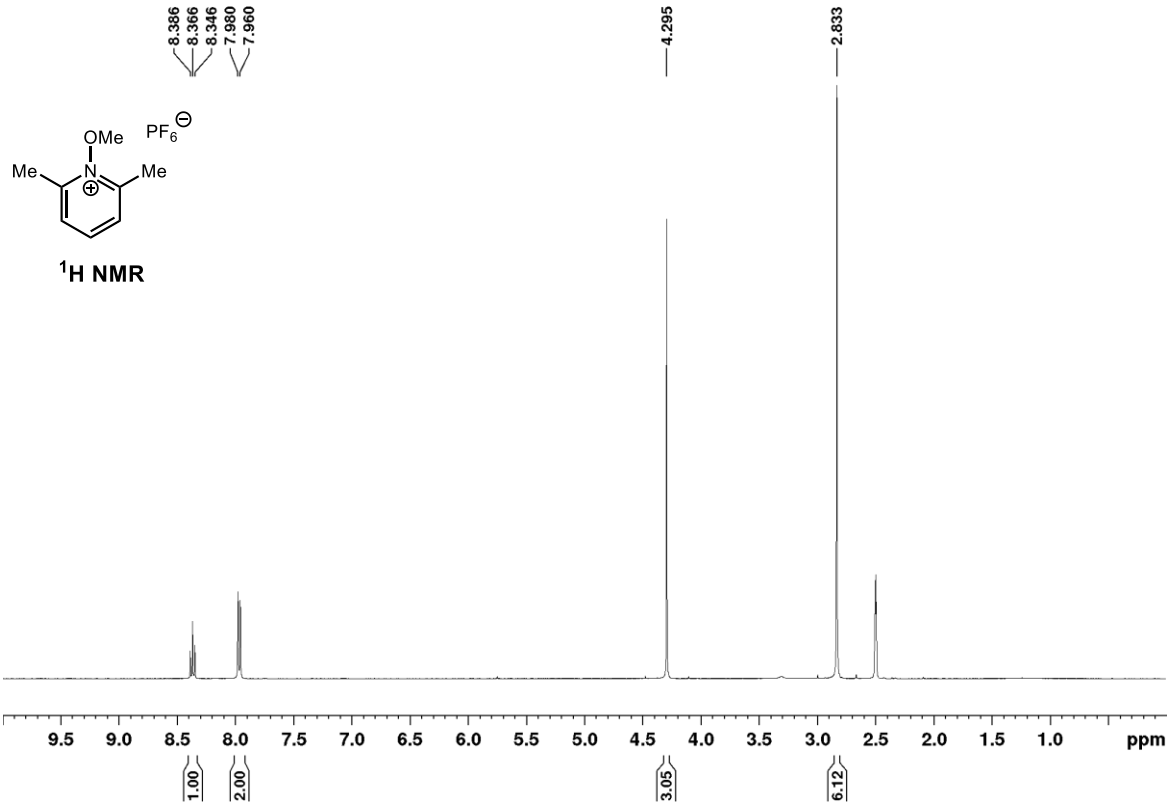
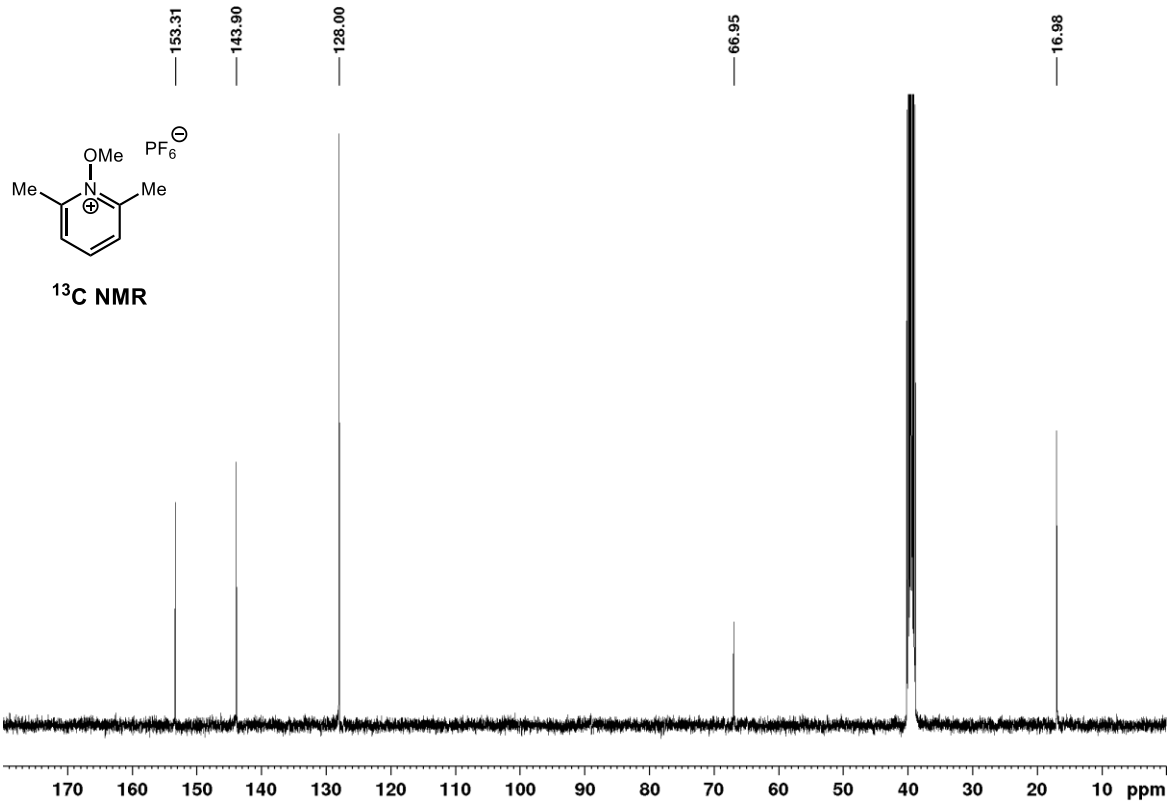
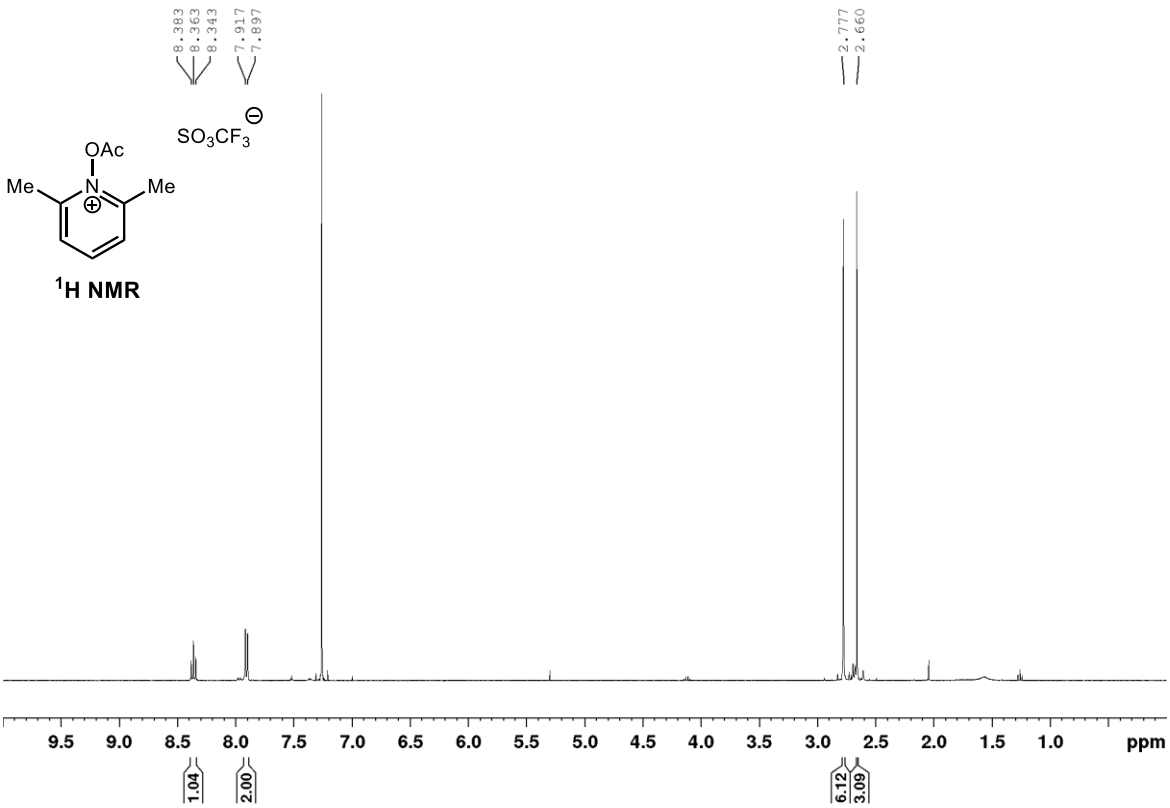
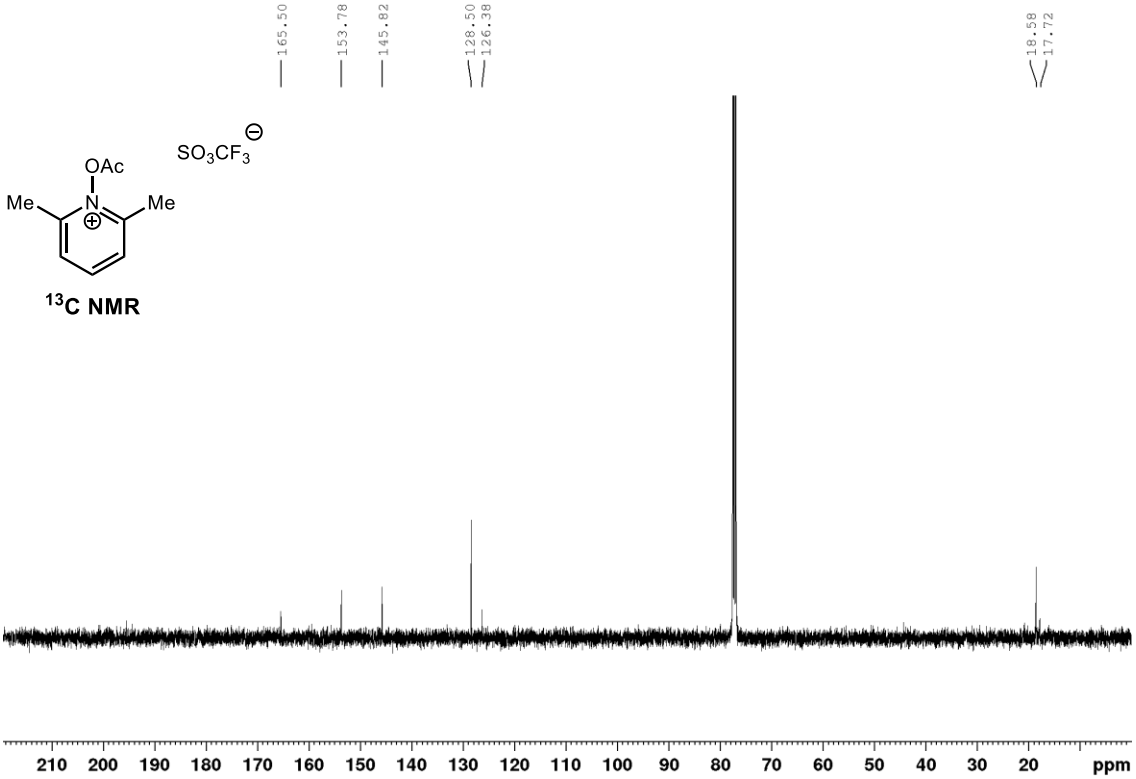

8.242
8.222
8.202
7.818
7.798
4.515
2.958
2.576
OMs
OMe
Me
N
Me
1H NMR
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.00
2.00
3.04
6.04
3.03

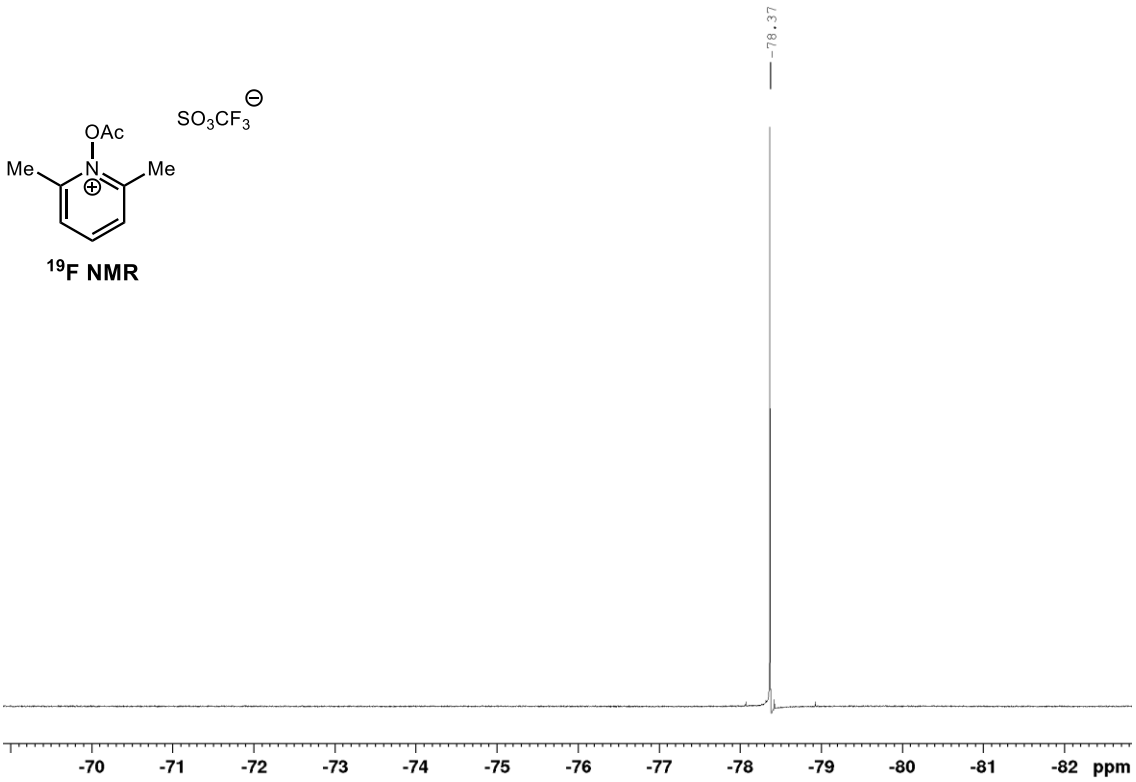

153.69
143.92
128.76
67.59
39.52
18.13
OMs
OMe
Me
N
Me
13C NMR
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


8.386
8.366
8.346
7.980
7.960
4.295
2.833
OMe
PF6
Me
N
Me
1H NMR
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 ppm
1.00
2.00
3.05
6.12

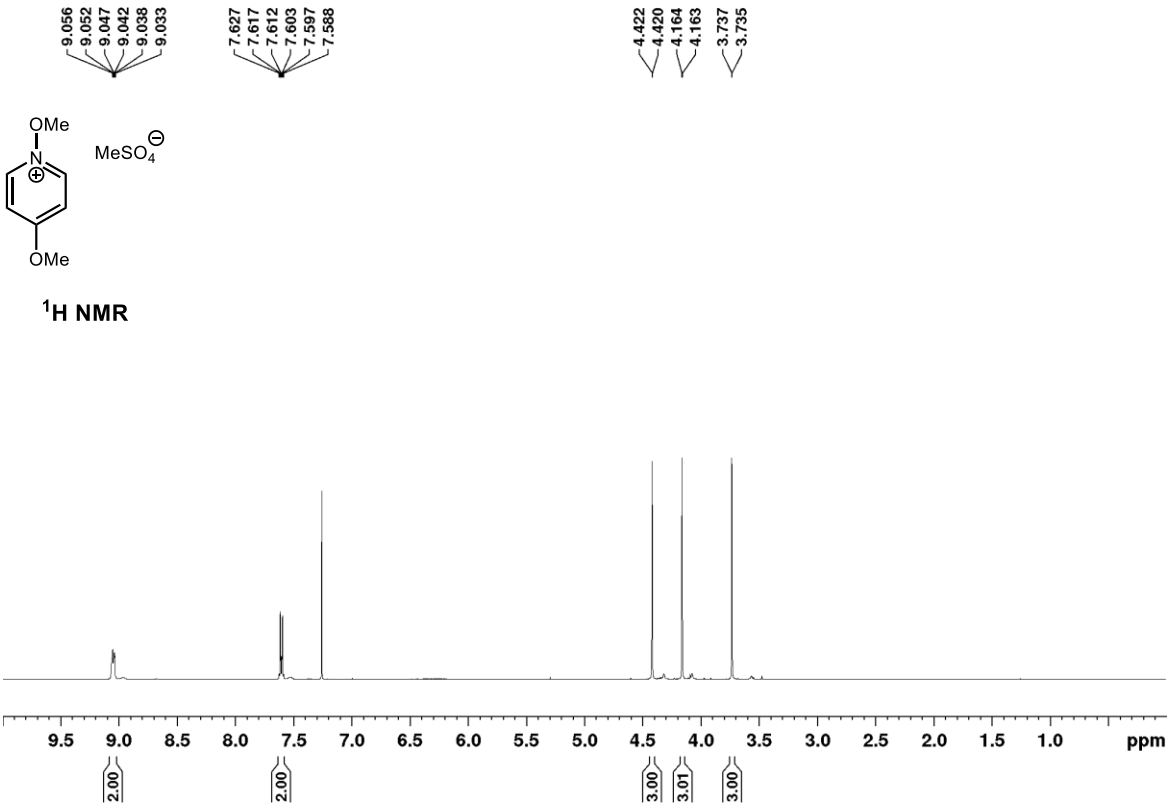

153.31
143.90
128.00
66.95
16.98
OMe
PF6
Me
N
Me
13C NMR
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


8.383
8.363
8.343
7.917
7.897
2.777
2.660
SO3CF3
OAc
Me
N
Me
1H NMR
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 ppm
1.04
2.00
6.12
3.09

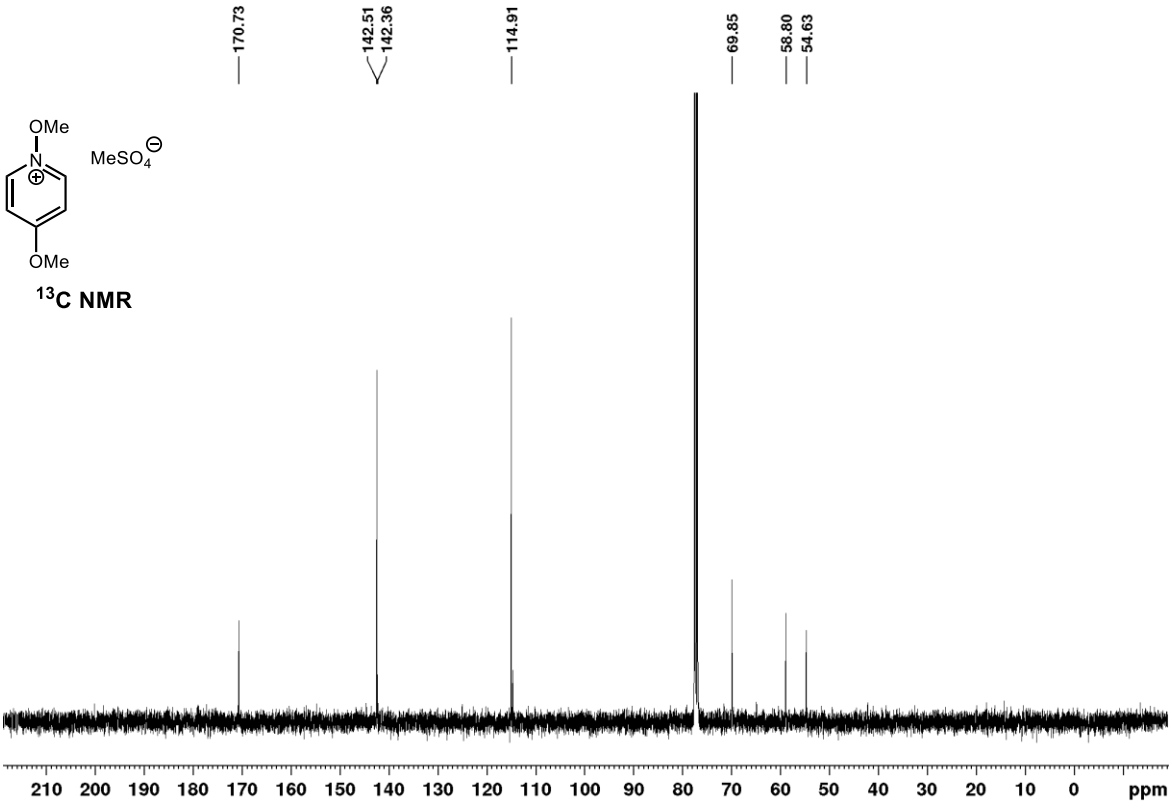

165.50
153.78
145.82
128.50
126.38
18.58
17.72
SO3CF3
OAc
Me
N
Me
13C NMR
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 ppm

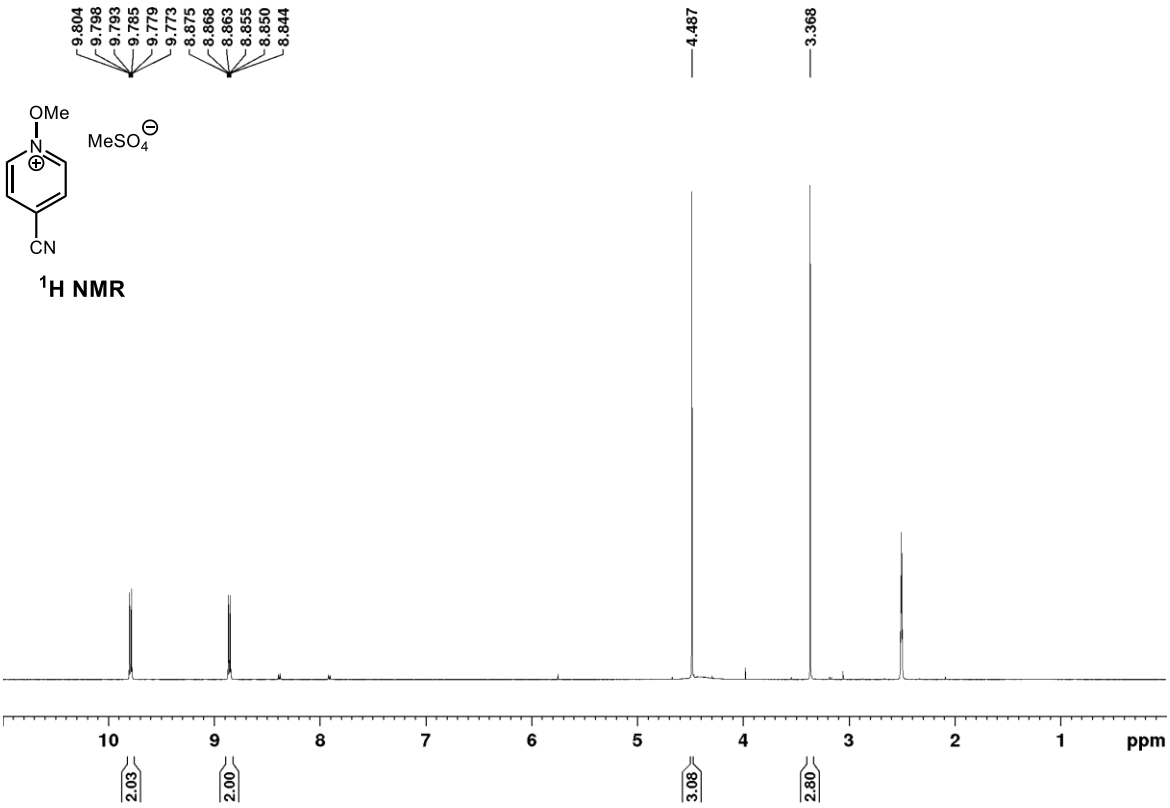


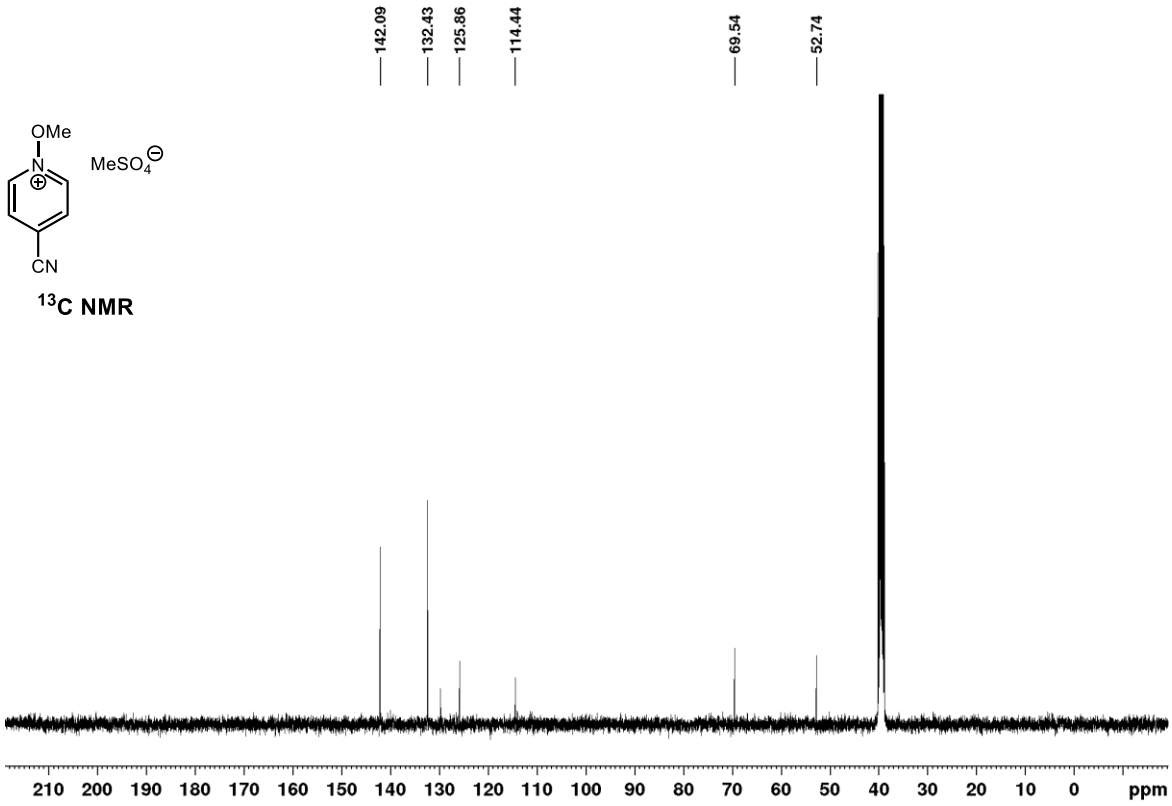
^{19}F NMR

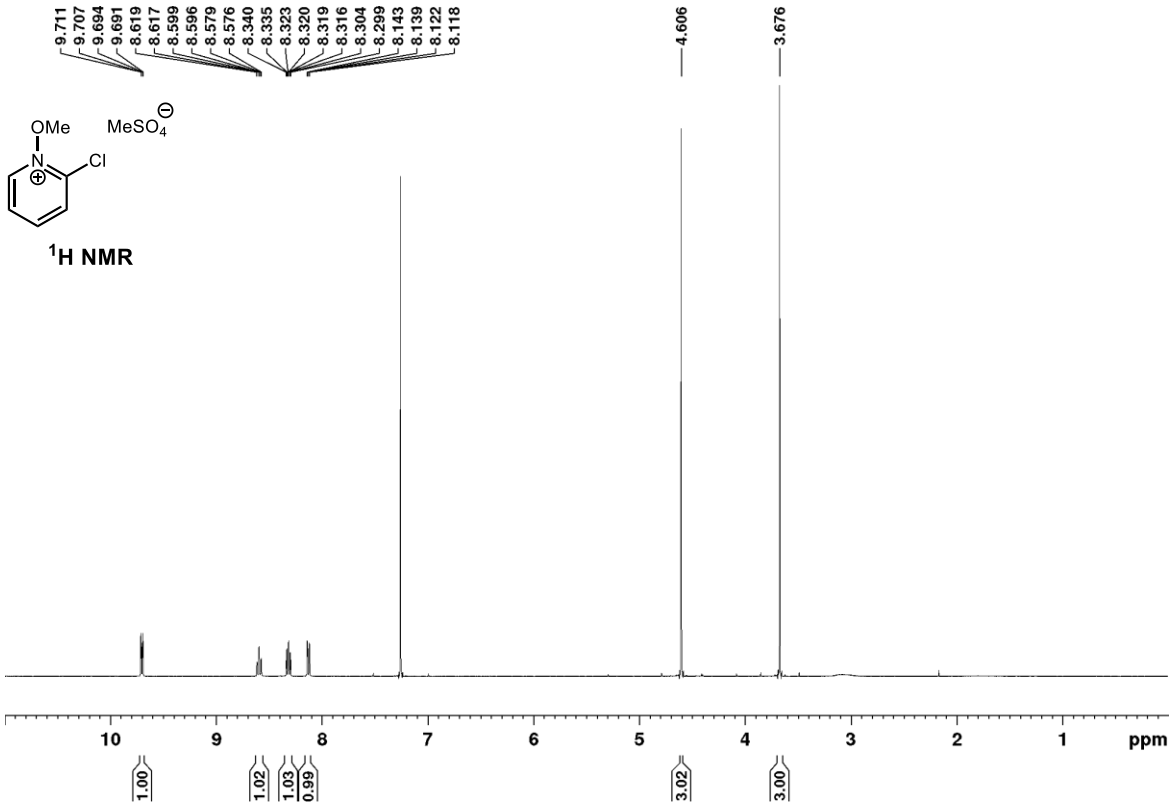


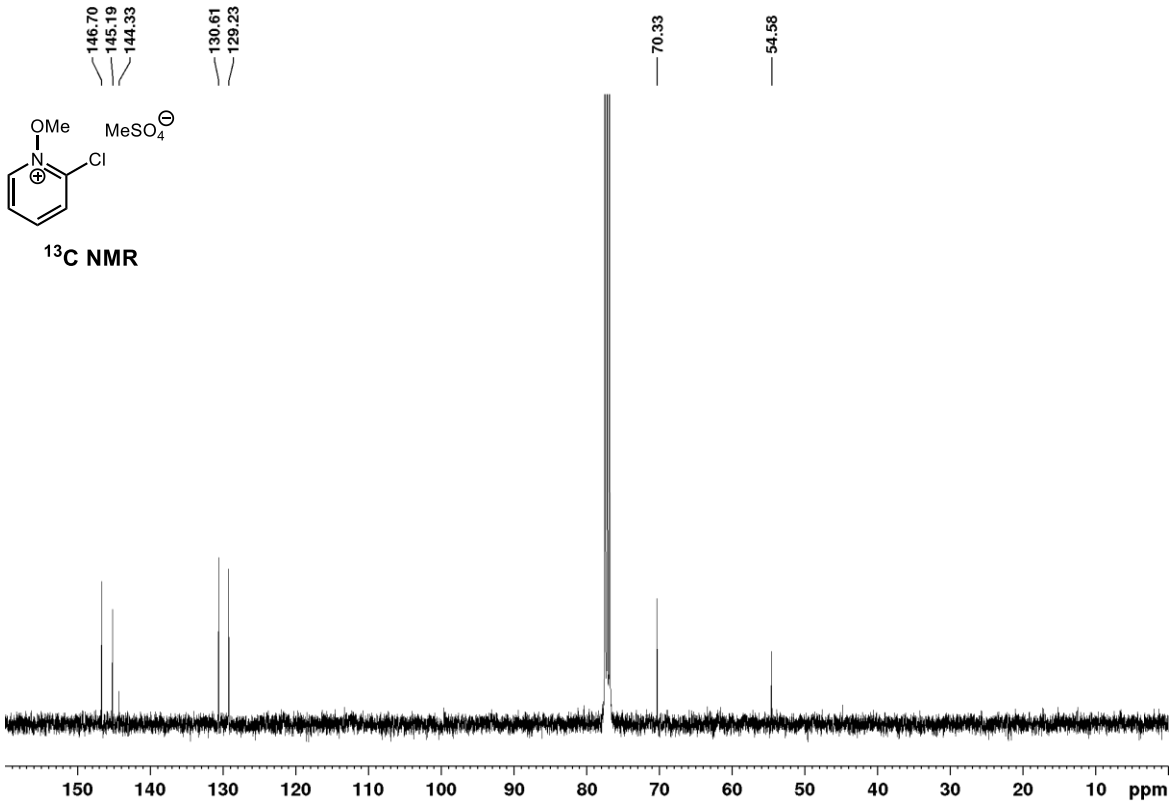
^{1}H NMR

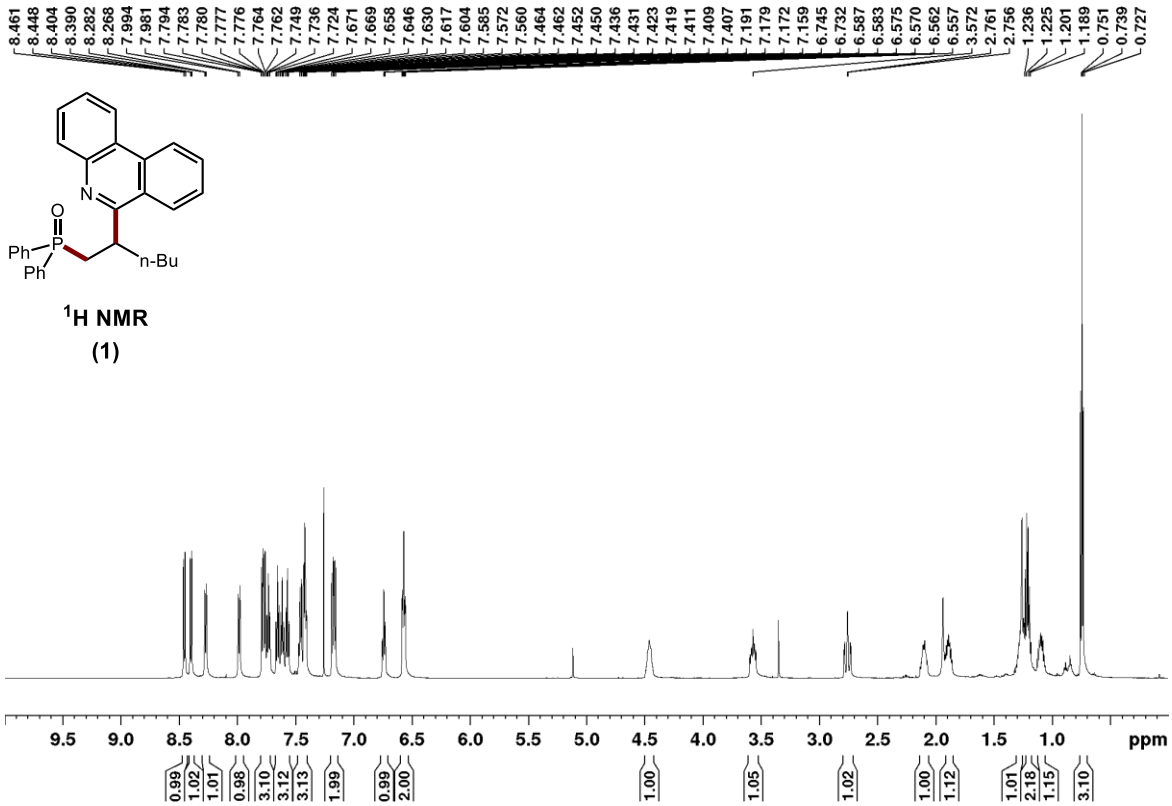

170.73
142.51
142.36
114.91
69.85
58.80
54.63
OMe
N
MeSO4
OMe
13C NMR
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

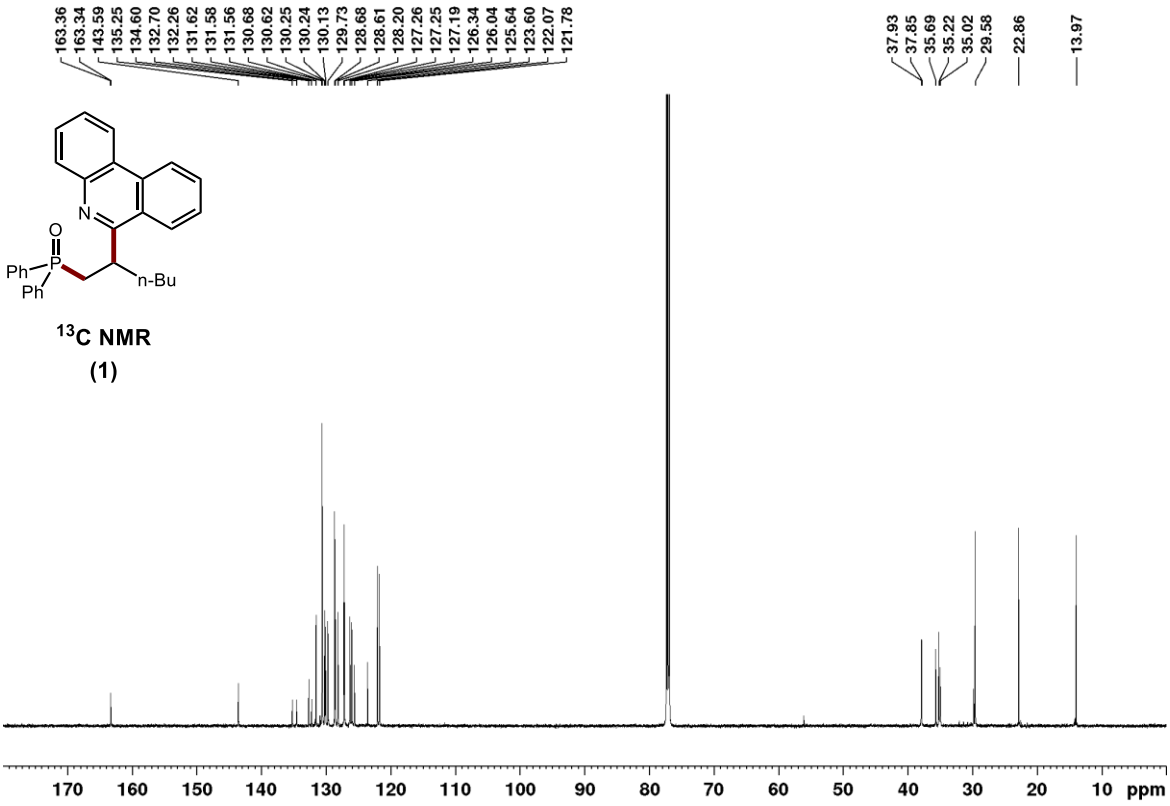

9.804
9.798
9.793
9.785
9.779
9.773
8.875
8.868
8.863
8.855
8.850
8.844
4.487
3.368
OMe
N
MeSO4
CN
1H NMR
10 9 8 7 6 5 4 3 2 1 ppm
2.03
2.00
3.08
2.80


142.09
132.43
125.86
114.44
69.54
52.74
OMe
MeSO4
CN
13C NMR
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


9.711
9.707
9.694
9.691
8.619
8.617
8.599
8.596
8.579
8.576
8.340
8.335
8.323
8.320
8.319
8.316
8.304
8.299
8.143
8.139
8.122
8.118
4.606
3.676
OMe
MeSO4
Cl
1H NMR
10 9 8 7 6 5 4 3 2 1 ppm
1.00
1.02
1.03
0.99
3.02
3.00

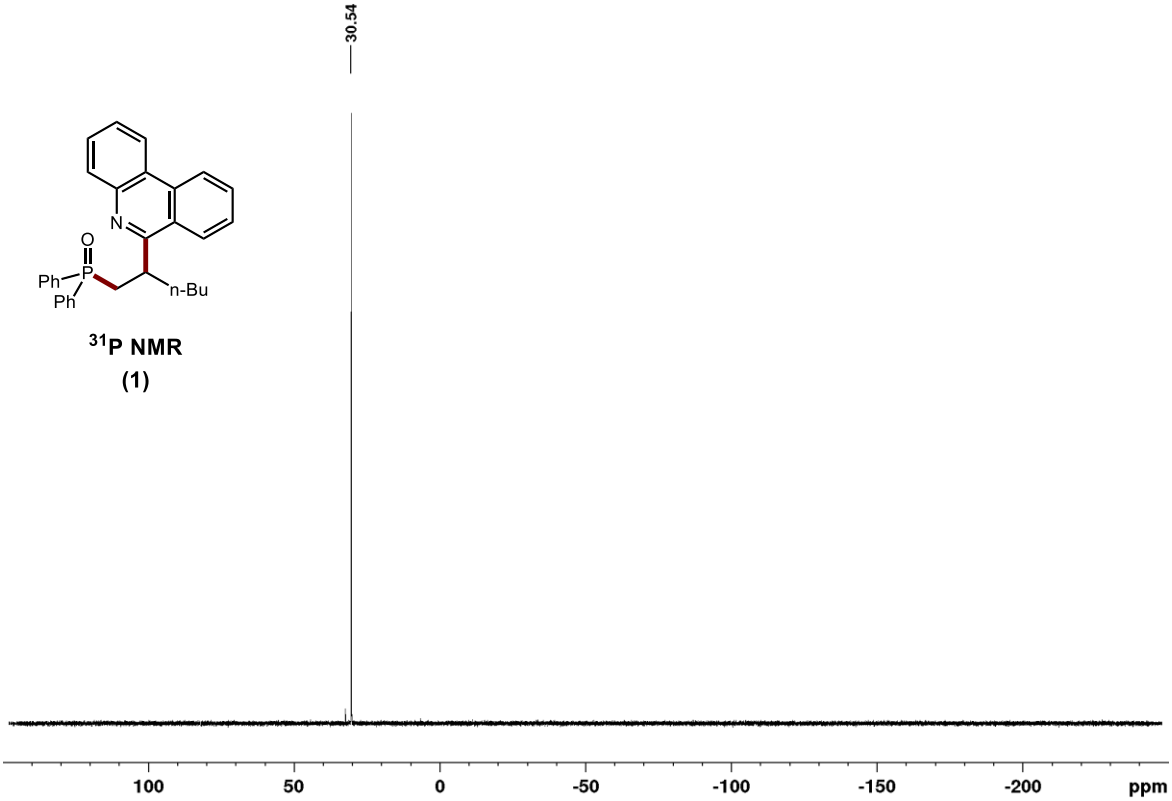

146.70
145.19
144.33
130.61
129.23
70.33
54.58
OMe
MeSO4
Cl
N
13C NMR
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


8.461 8.448 8.404 8.390 8.282 8.268 7.994 7.981 7.794 7.783 7.780 7.777 7.776 7.764 7.762 7.749 7.736 7.724 7.671 7.669 7.658 7.646 7.630 7.617 7.604 7.585 7.572 7.560 7.464 7.462 7.452 7.450 7.436 7.431 7.423 7.419 7.411 7.409 7.407 7.191 7.179 7.172 7.159 6.745 6.732 6.587 6.583 6.575 6.570 6.562 6.557 3.572 2.761 2.756 1.236 1.225 1.201 1.189 0.751 0.739 0.727
N
O
P
Ph
Ph
n-Bu
1H NMR
(1)
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 ppm
0.99 1.02 1.01 0.98 3.10 3.12 3.13 1.99 0.99 2.00 1.00 1.05 1.02 1.00 1.12 1.01 2.18 1.15 3.10



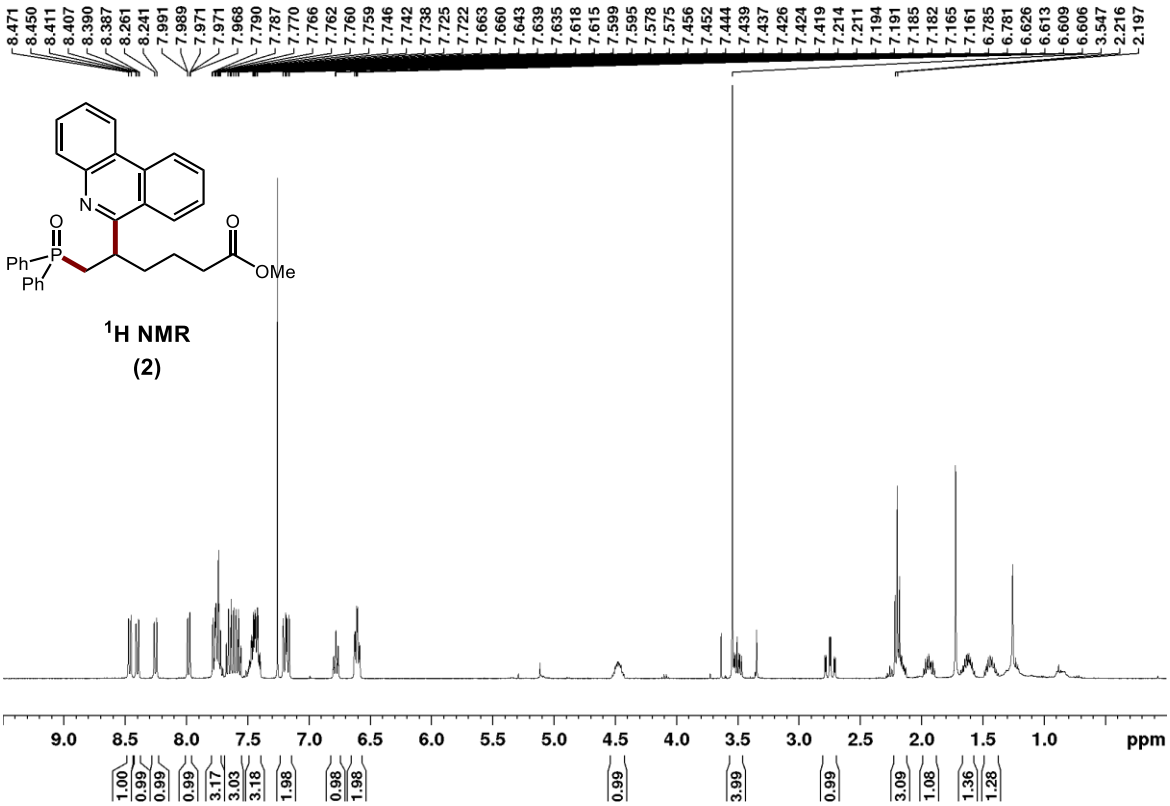
^{13}C NMR

(1)



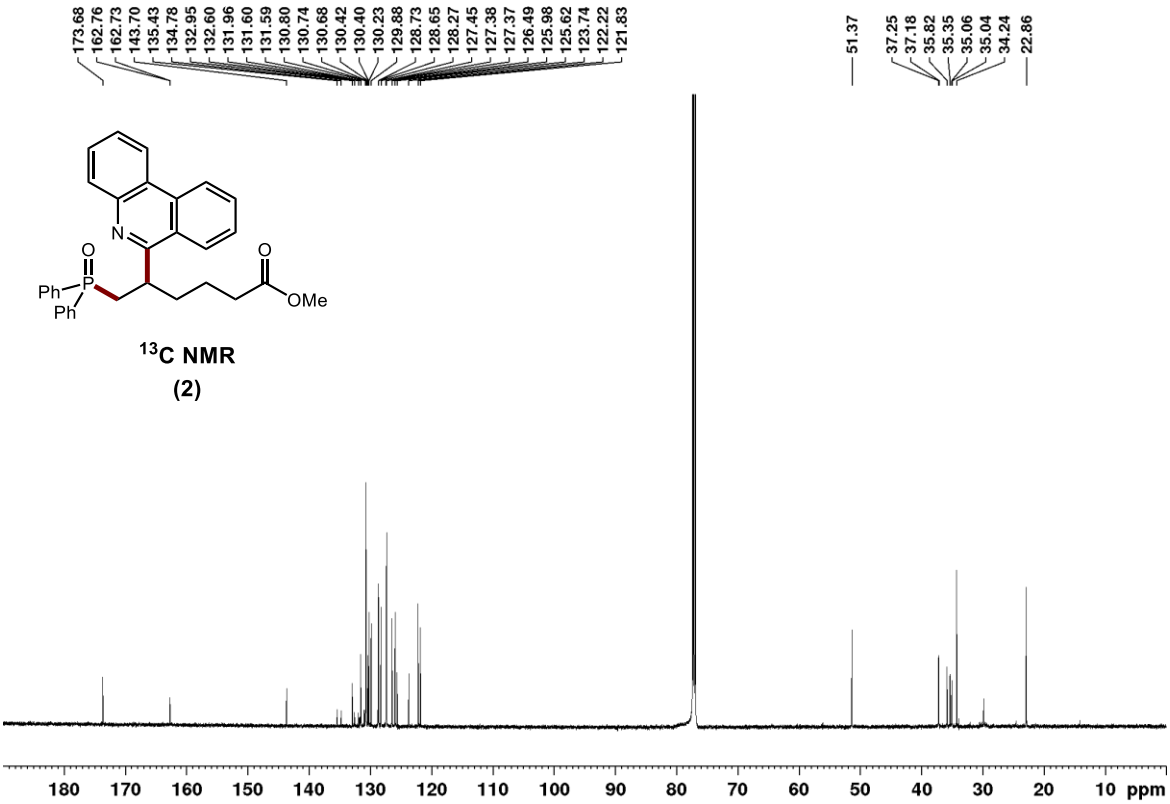
^{31}P NMR

(1)



^{1}H NMR

(2)

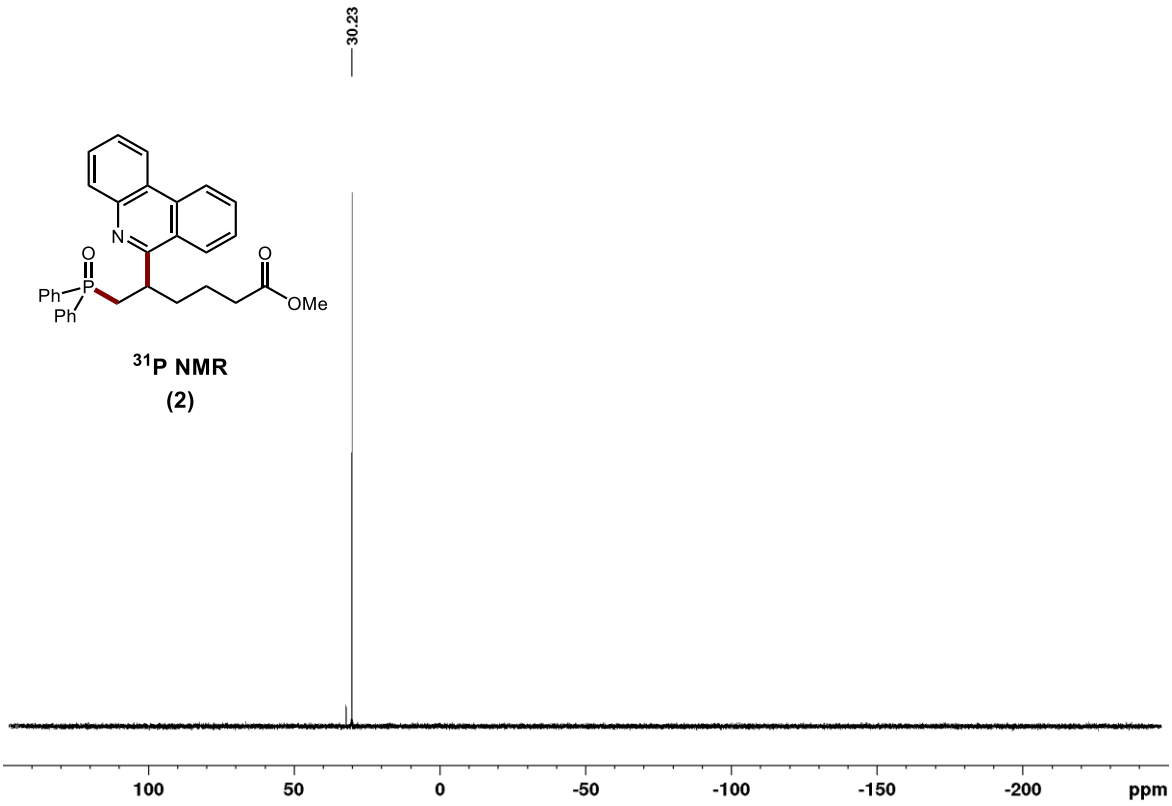


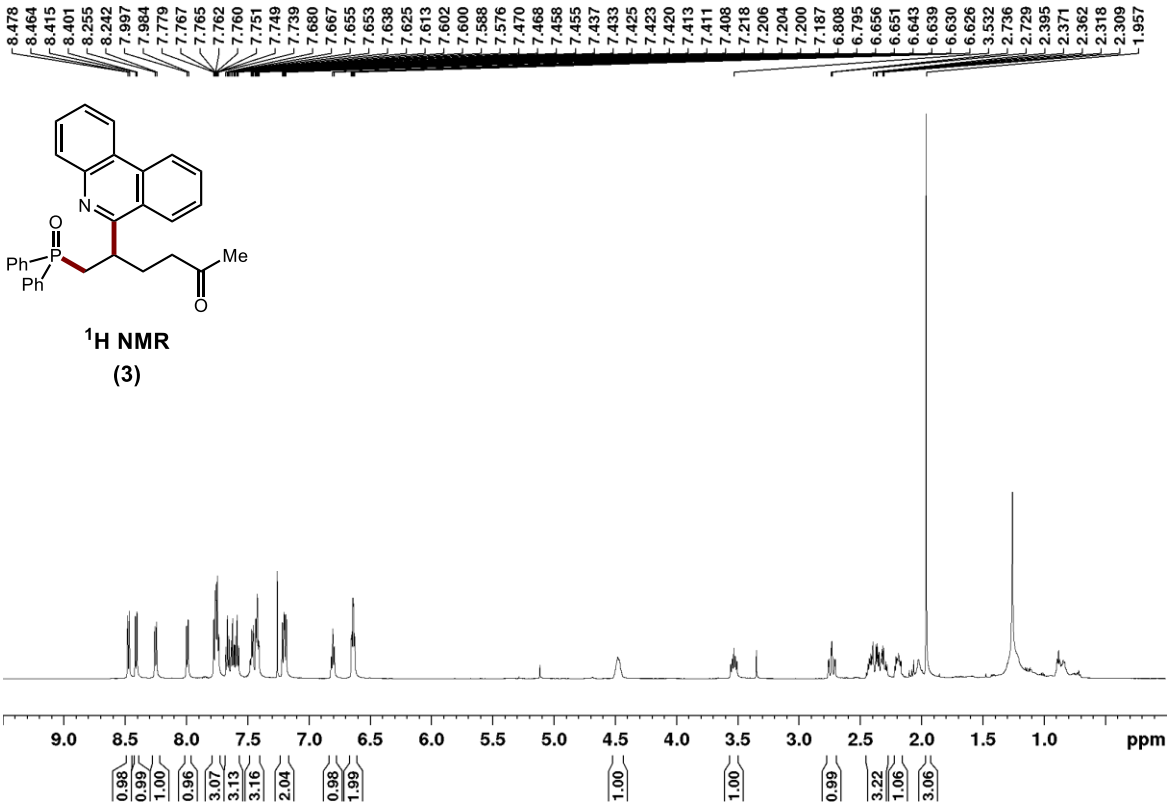
^{13}C NMR

(2)

^{31}P NMR

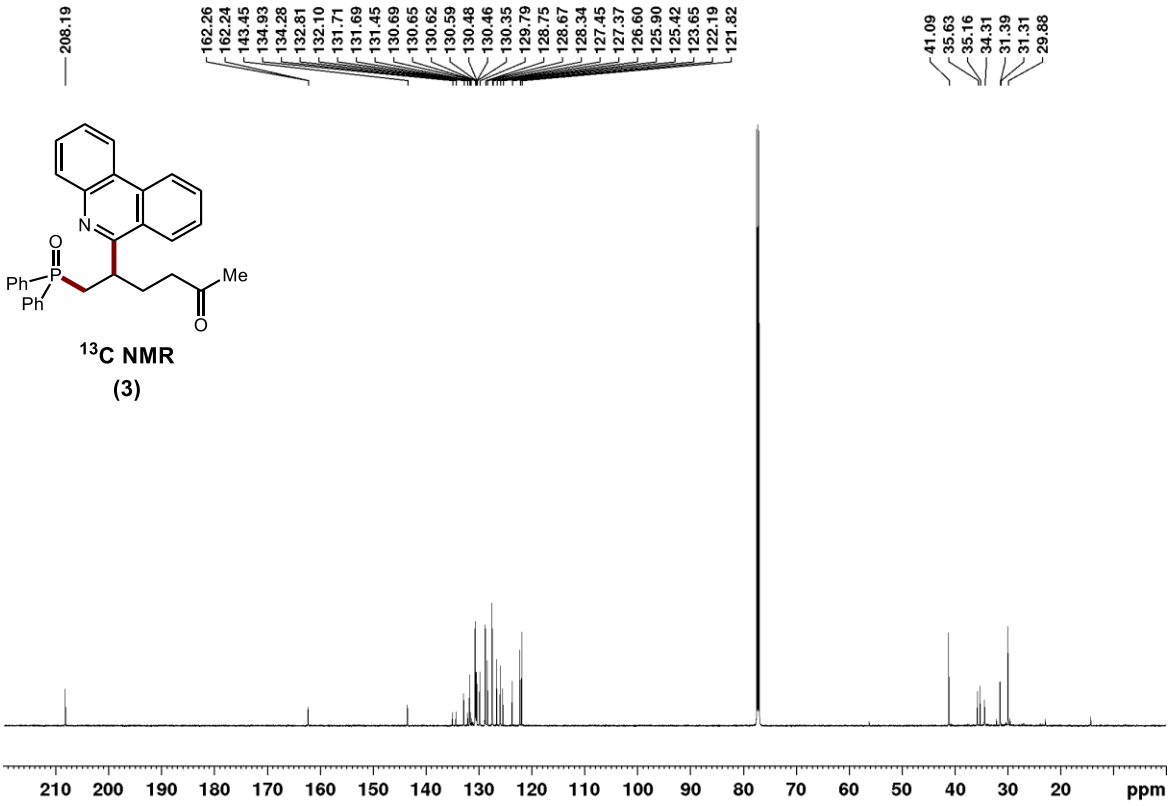
(2)





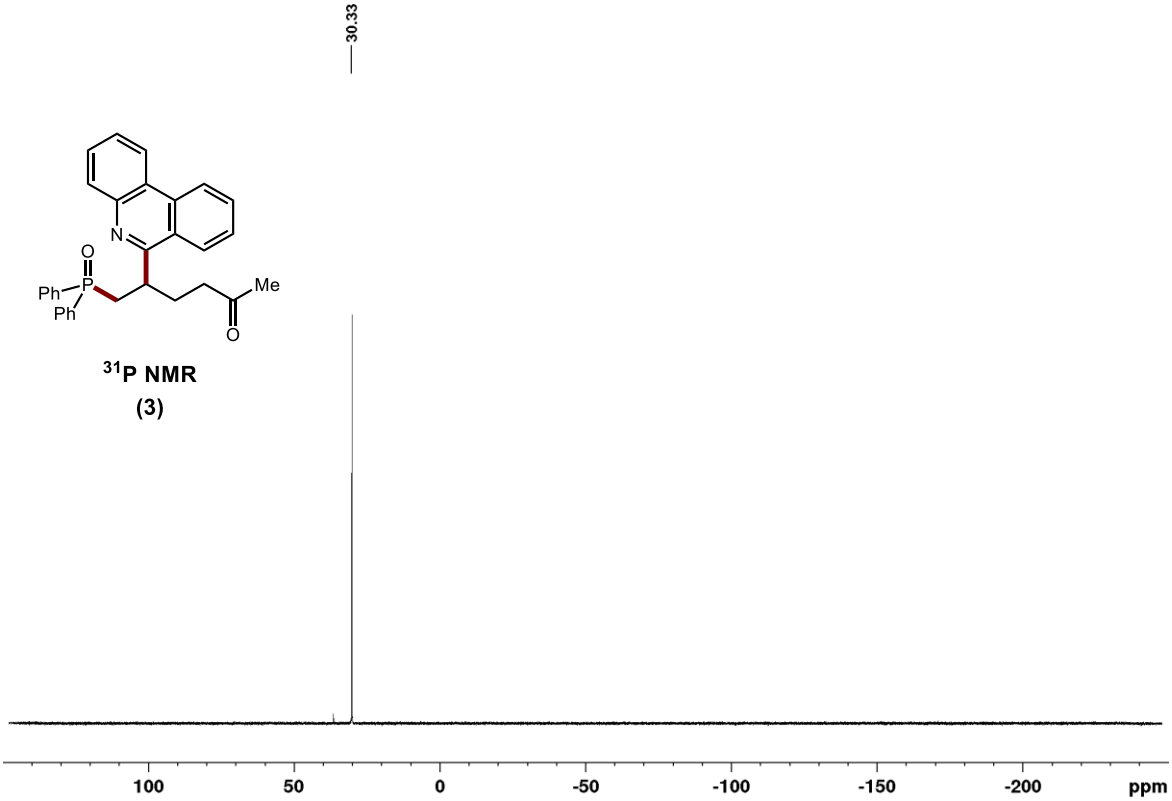
^{1}H NMR

(3)



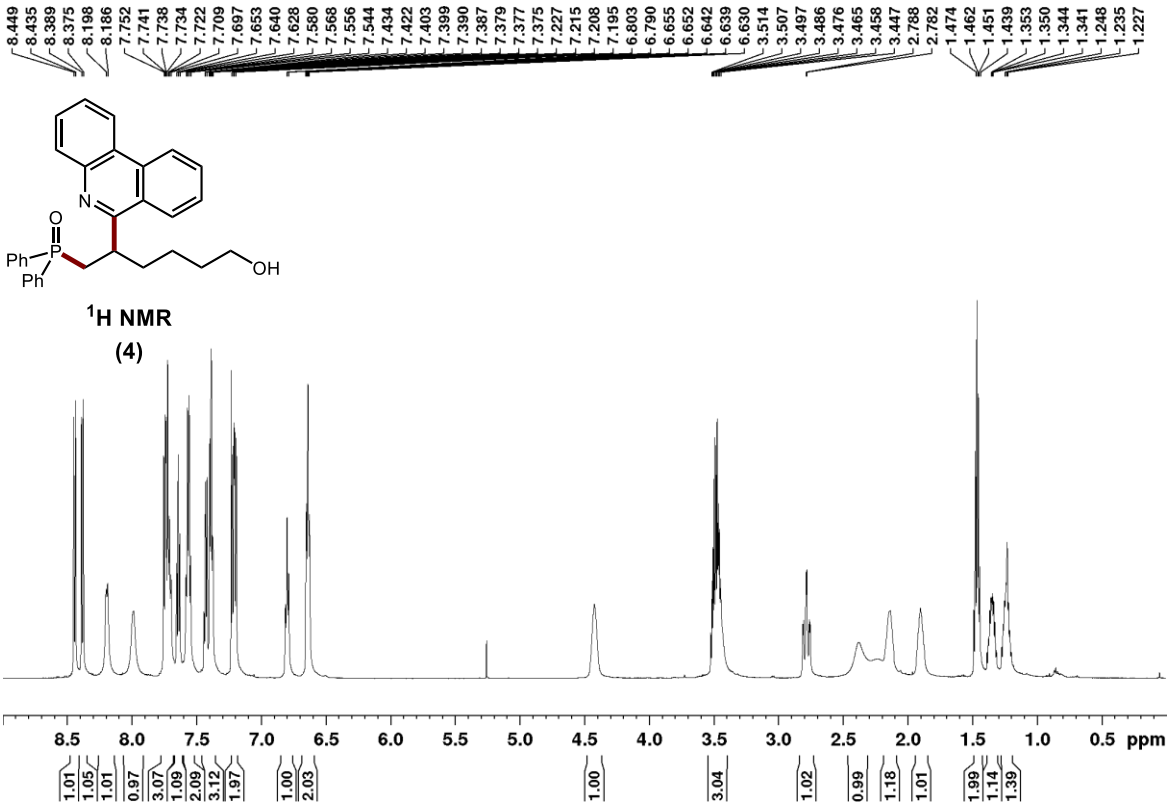
^{13}C NMR

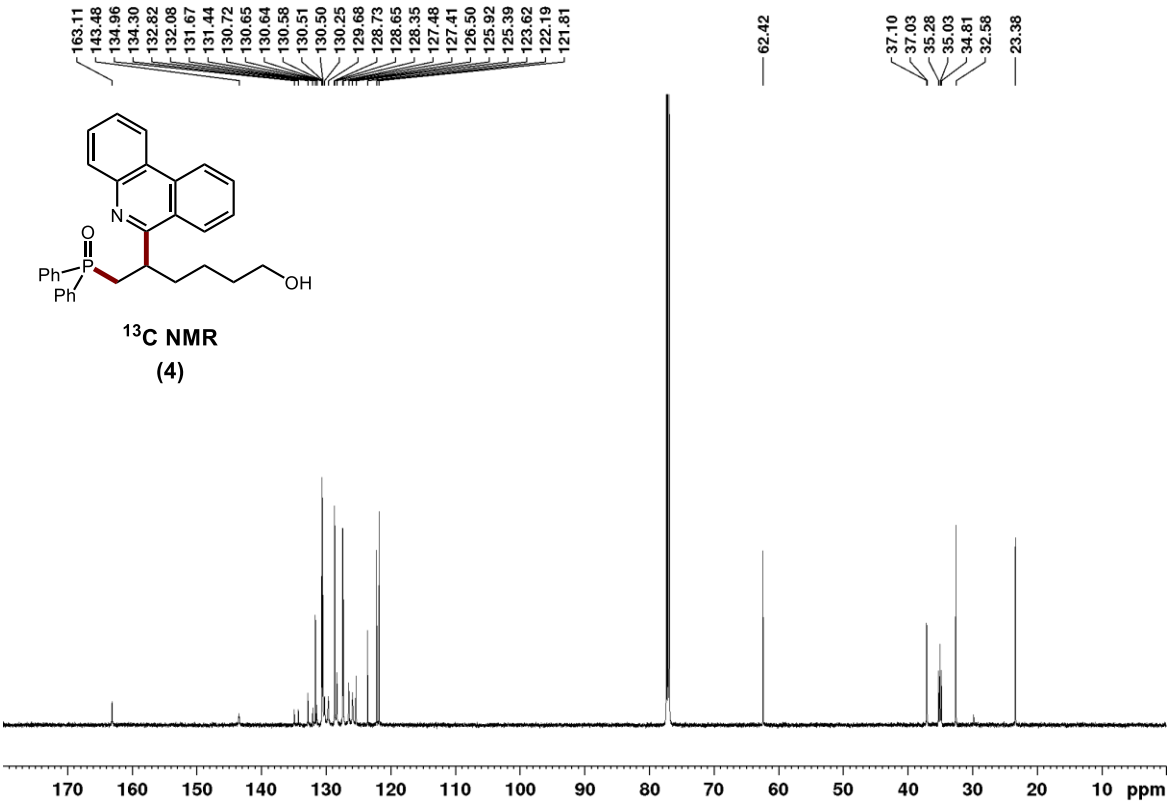
(3)



^{31}P NMR

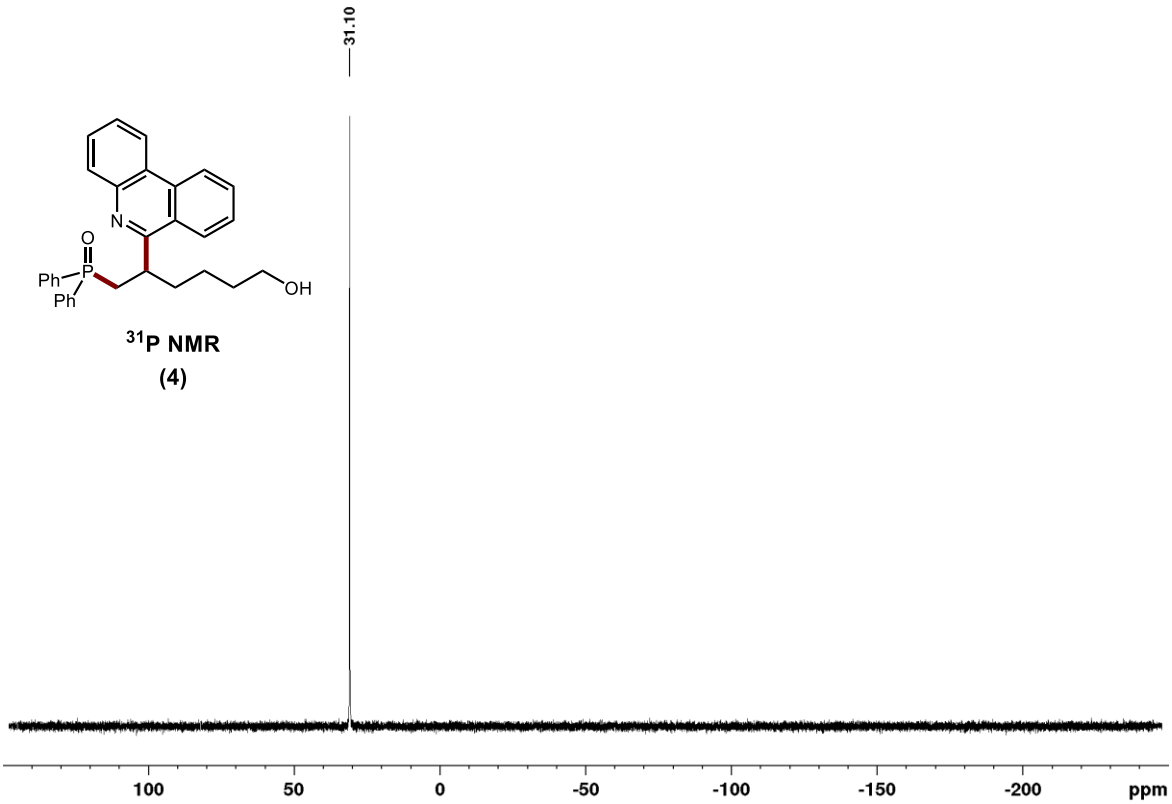
(3)

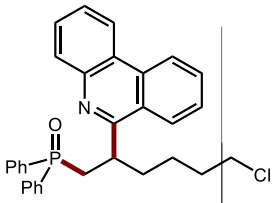

8.449 8.435 8.389 8.375 8.198 8.186 7.752 7.741 7.738 7.734 7.722 7.709 7.697 7.653 7.640 7.628 7.580 7.568 7.556 7.544 7.434 7.422 7.403 7.399 7.390 7.387 7.379 7.377 7.375 7.227 7.215 7.208 7.195 6.803 6.790 6.655 6.652 6.642 6.639 6.630 3.514 3.507 3.497 3.486 3.476 3.465 3.458 3.447 2.788 2.782 1.474 1.462 1.451 1.439 1.353 1.350 1.344 1.341 1.248 1.235 1.227
N
O
Ph
P
Ph
OH
1H NMR
(4)
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 ppm
1.01 1.05 1.01 0.97 3.07 1.09 2.09 3.12 1.97 1.00 2.03 1.00 3.04 1.02 0.99 1.18 1.01 1.99 1.14 1.39


163.11 143.48 134.96 134.30 132.82 132.08 131.67 131.44 130.72 130.65 130.64 130.58 130.51 130.50 130.25 129.68 128.73 128.65 128.35 127.48 127.41 126.50 125.92 125.39 123.62 122.19 121.81
62.42
37.10 37.03 35.28 35.03 34.81 32.58
23.38
N
O
Ph
P
Ph
OH
13C NMR
(4)
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

^{31}P NMR

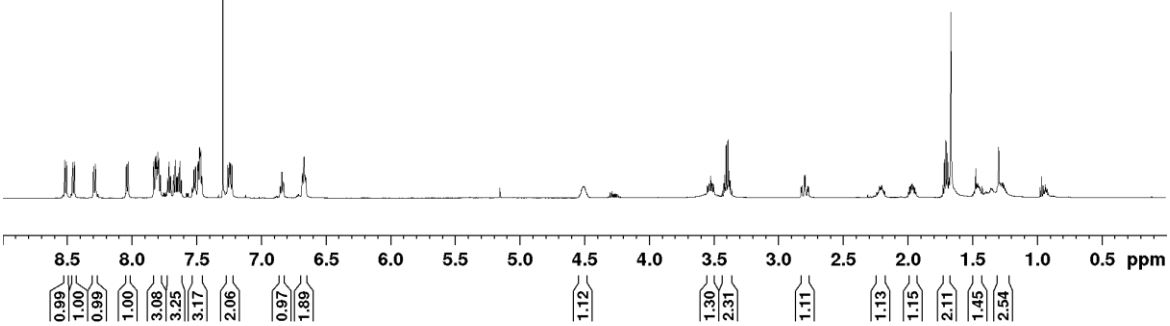
(4)

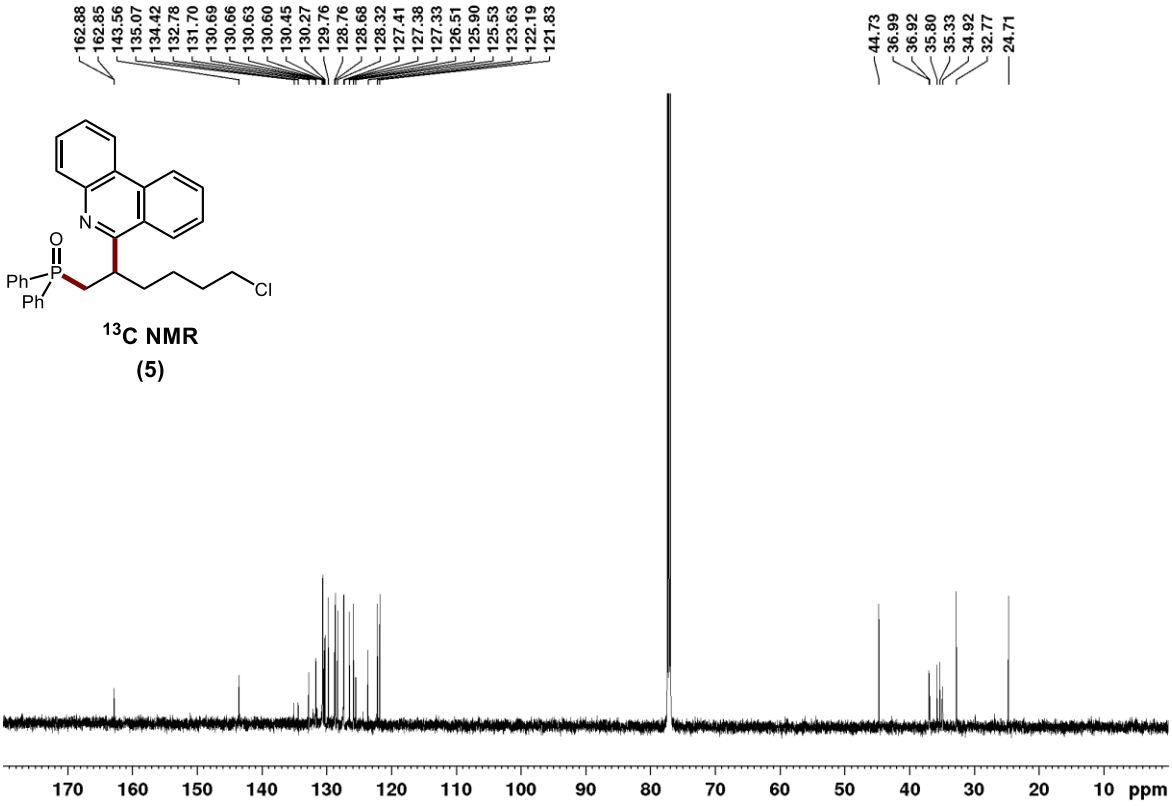




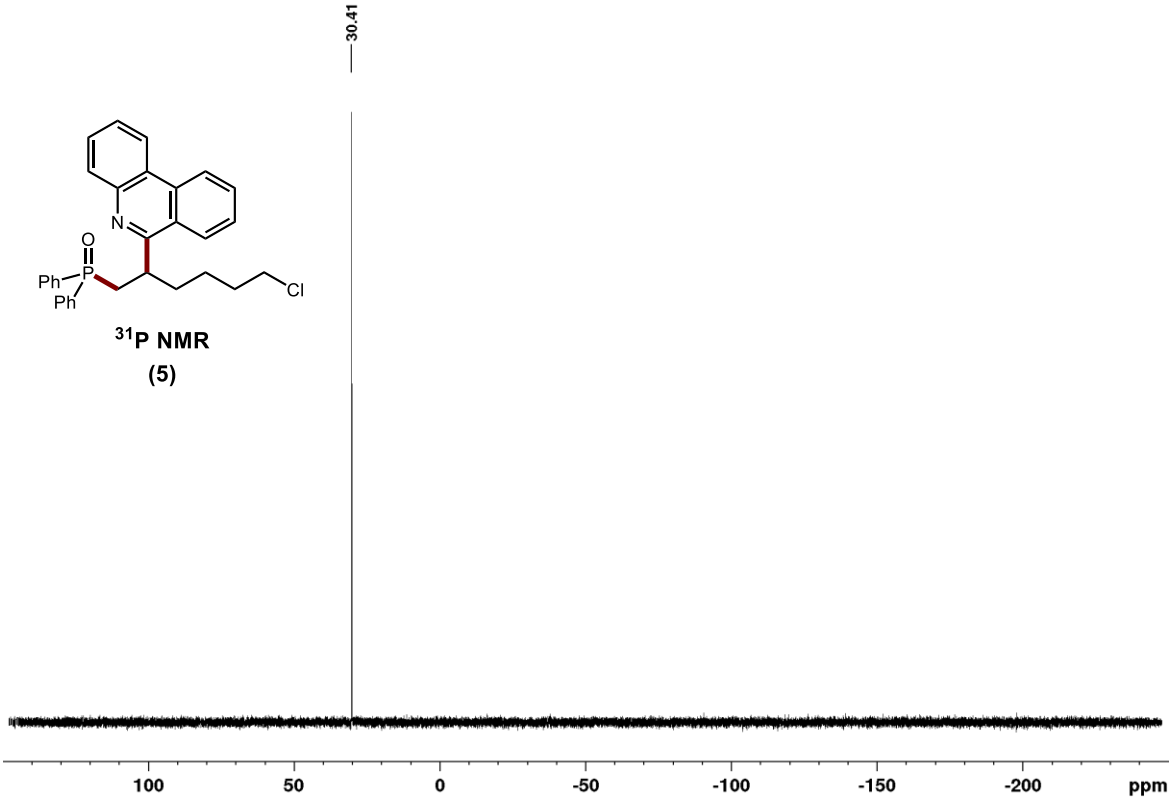
^{1}H NMR

(5)

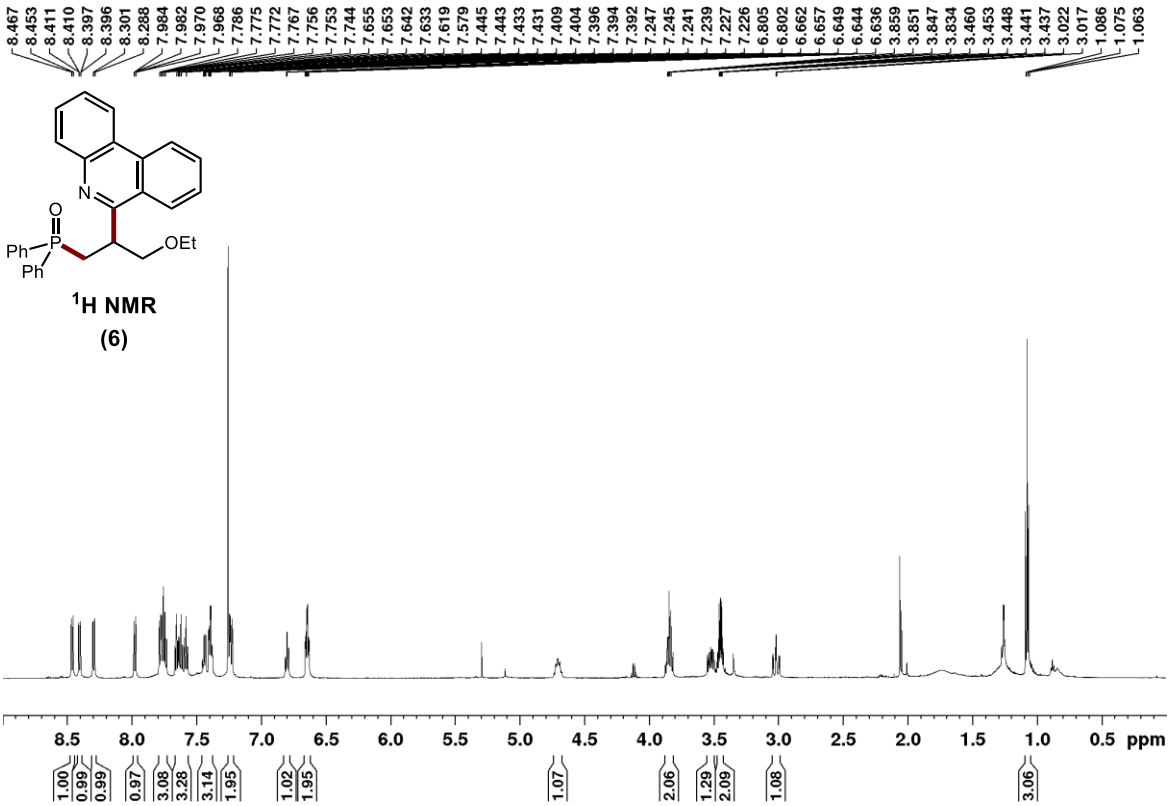




^{13}C NMR
(5)

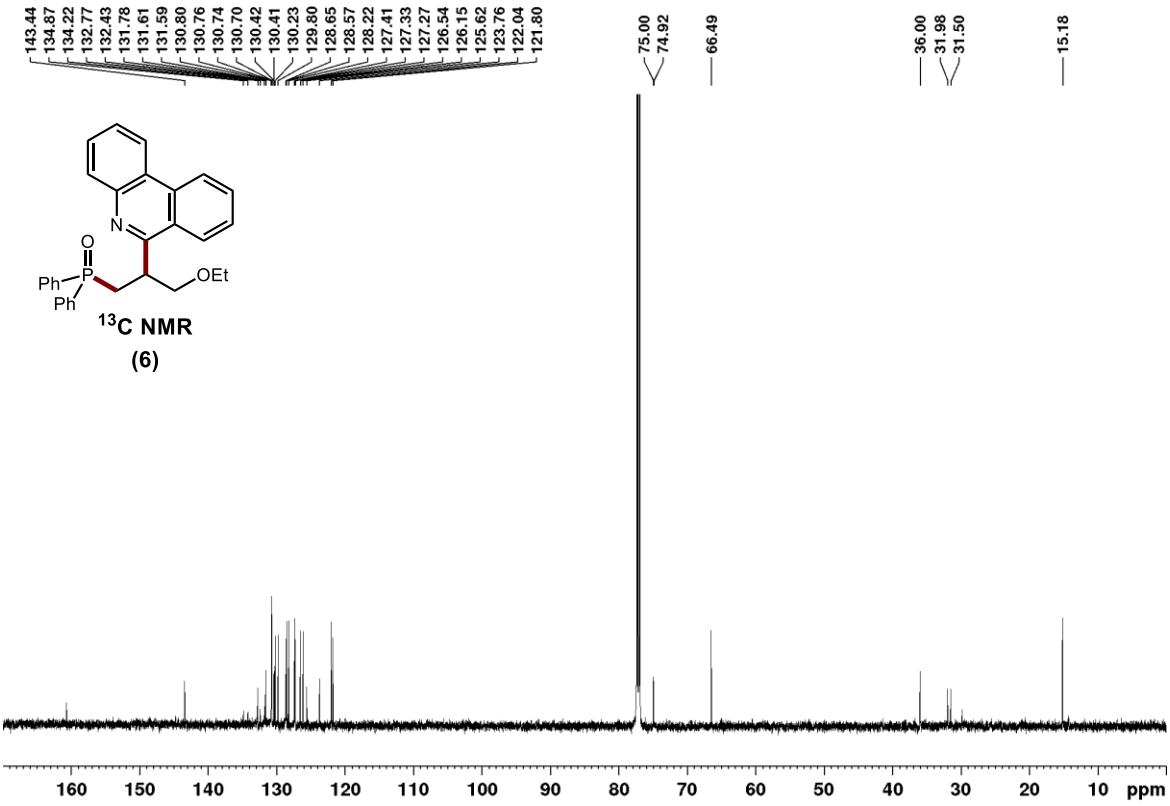


^{31}P NMR
(5)



^{1}H NMR

(6)

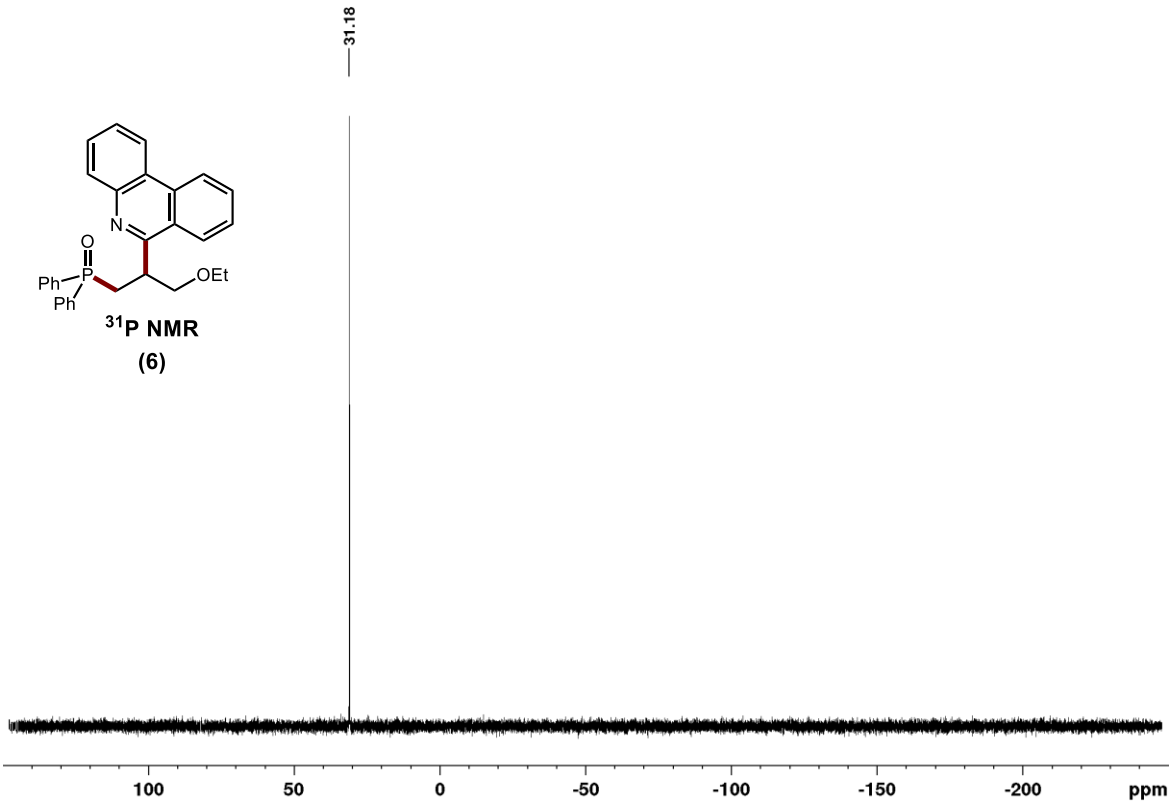


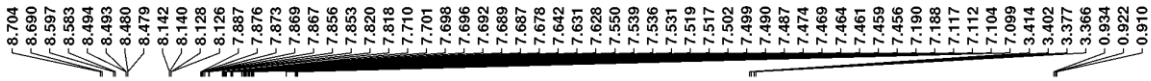
^{13}C NMR

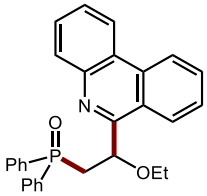
(6)

^{31}P NMR

(6)

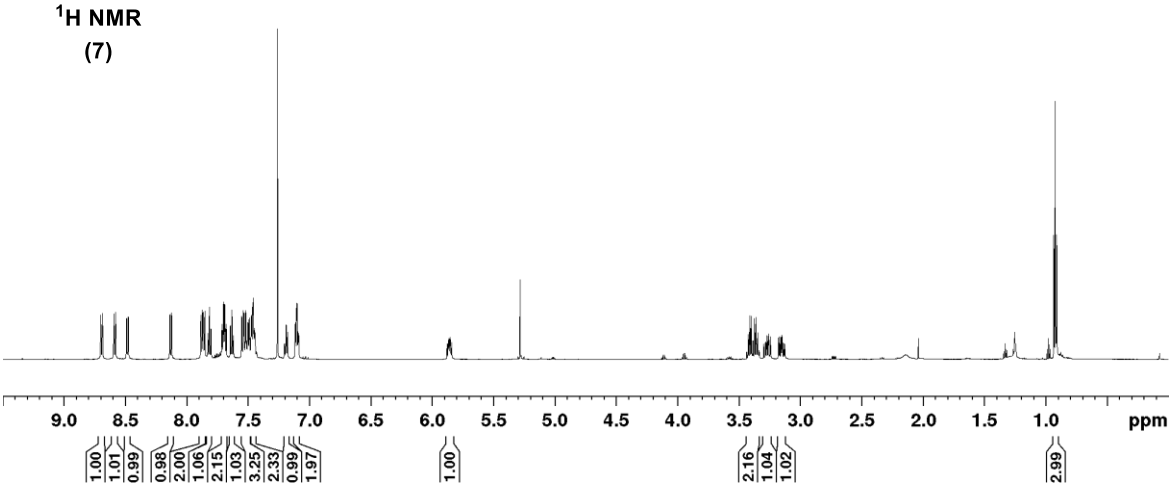


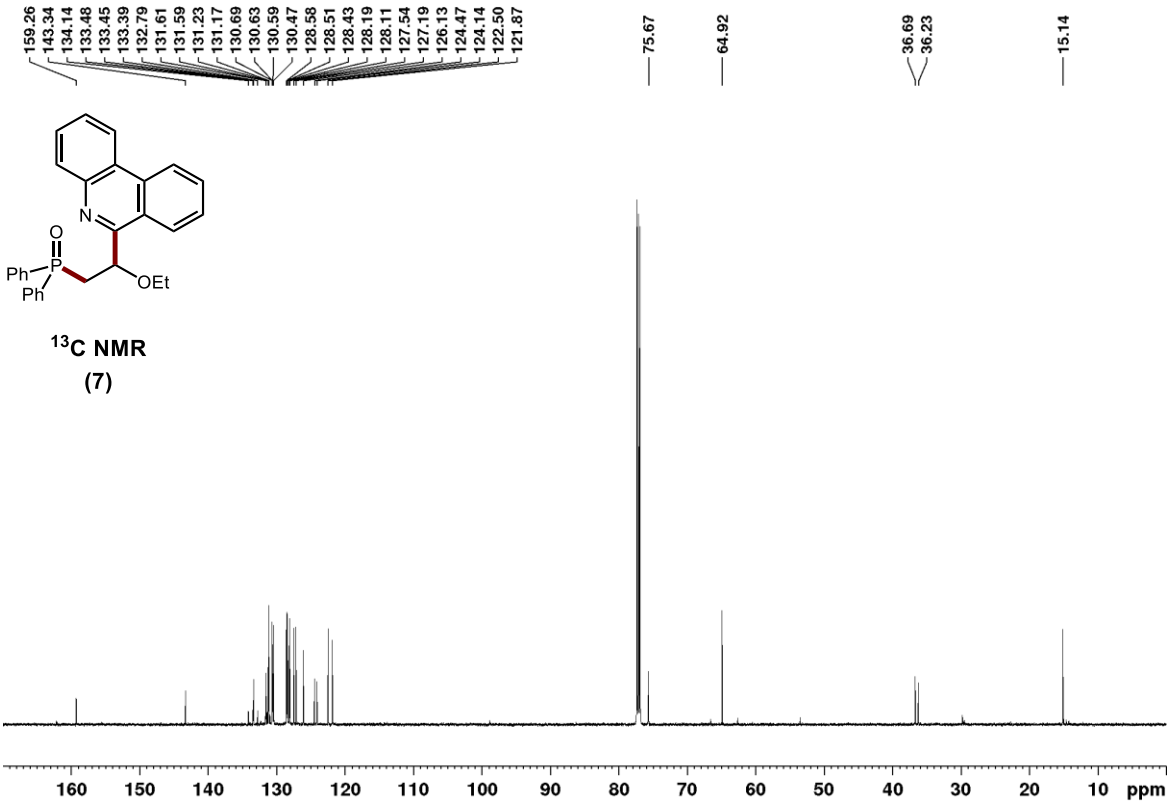




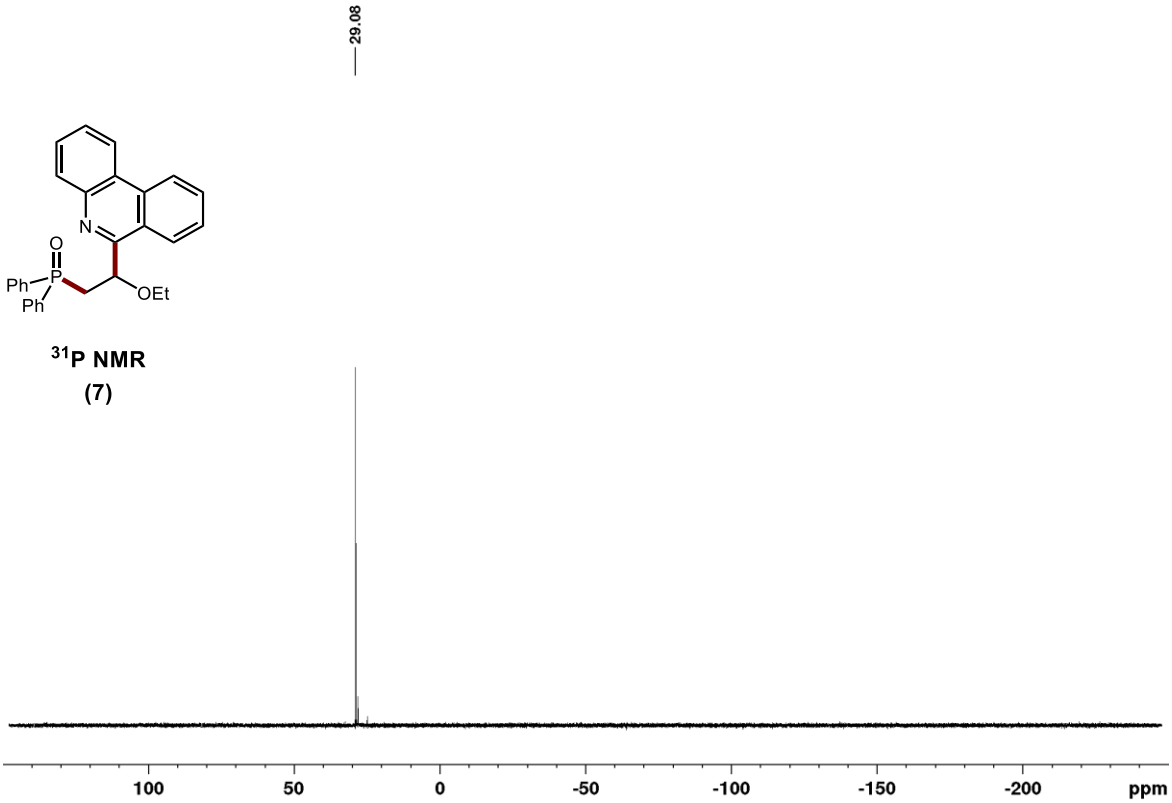
^{1}H NMR

(7)

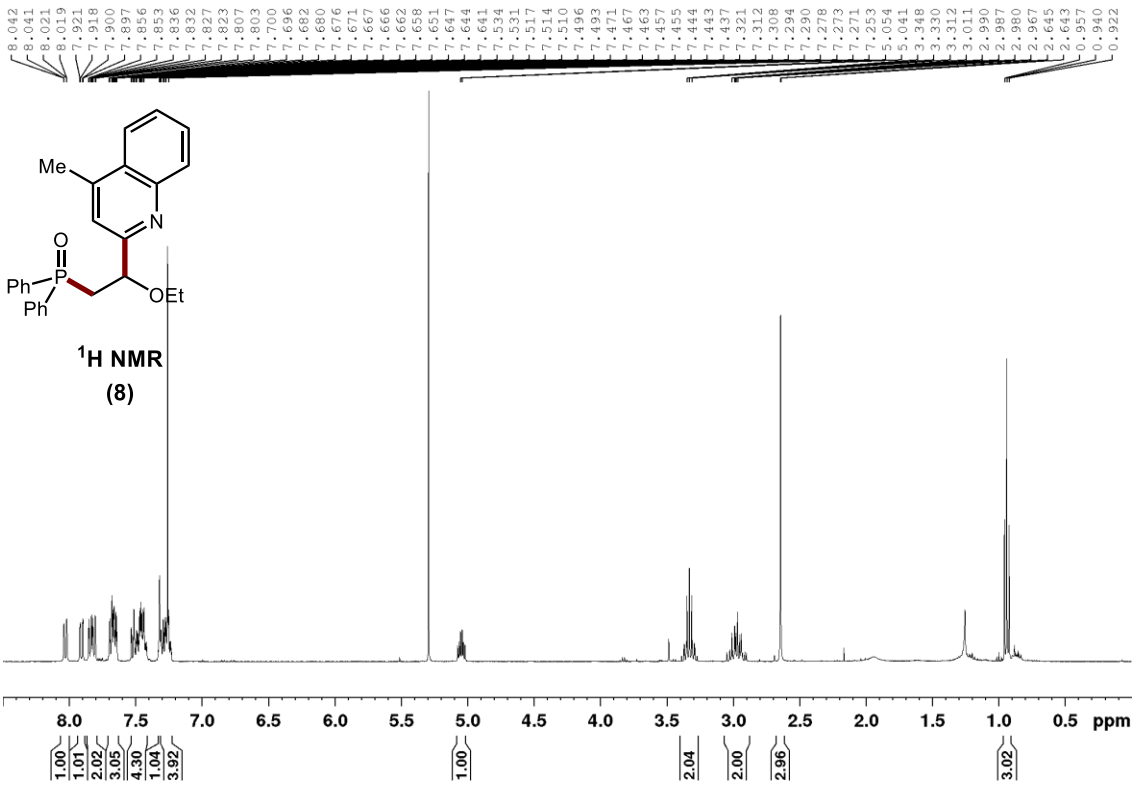




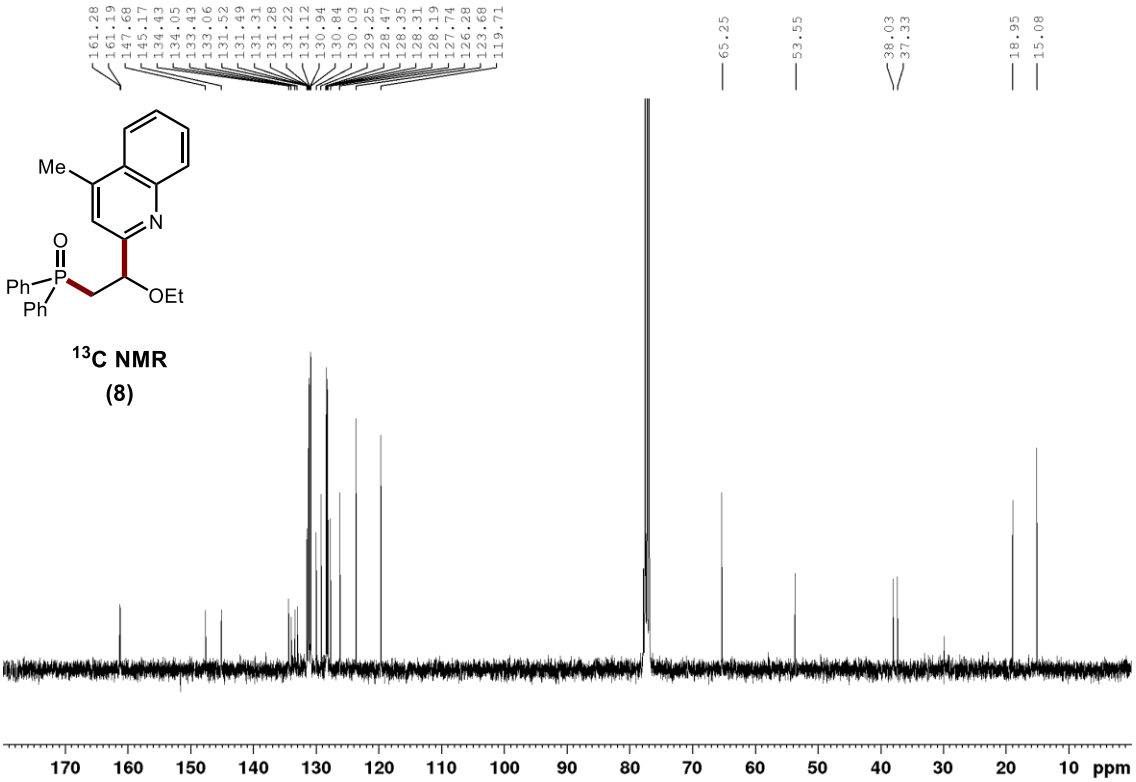
^{13}C NMR
(7)



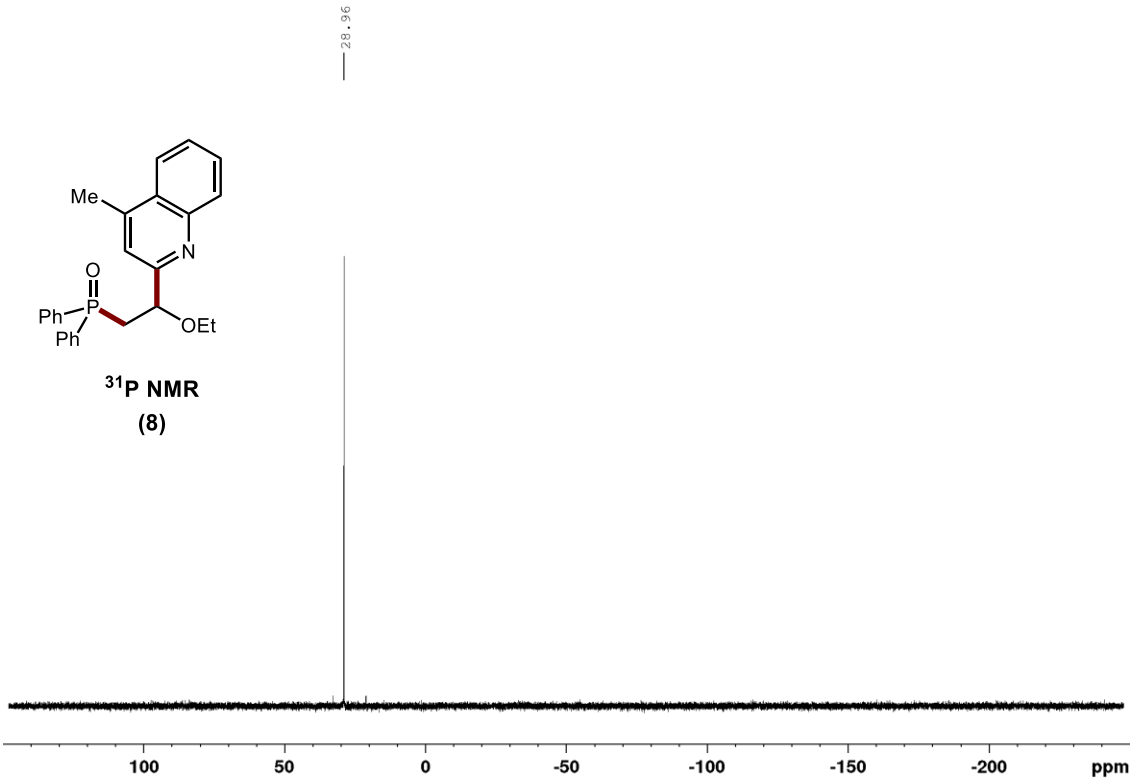
^{31}P NMR
(7)



^{1}H NMR
(8)

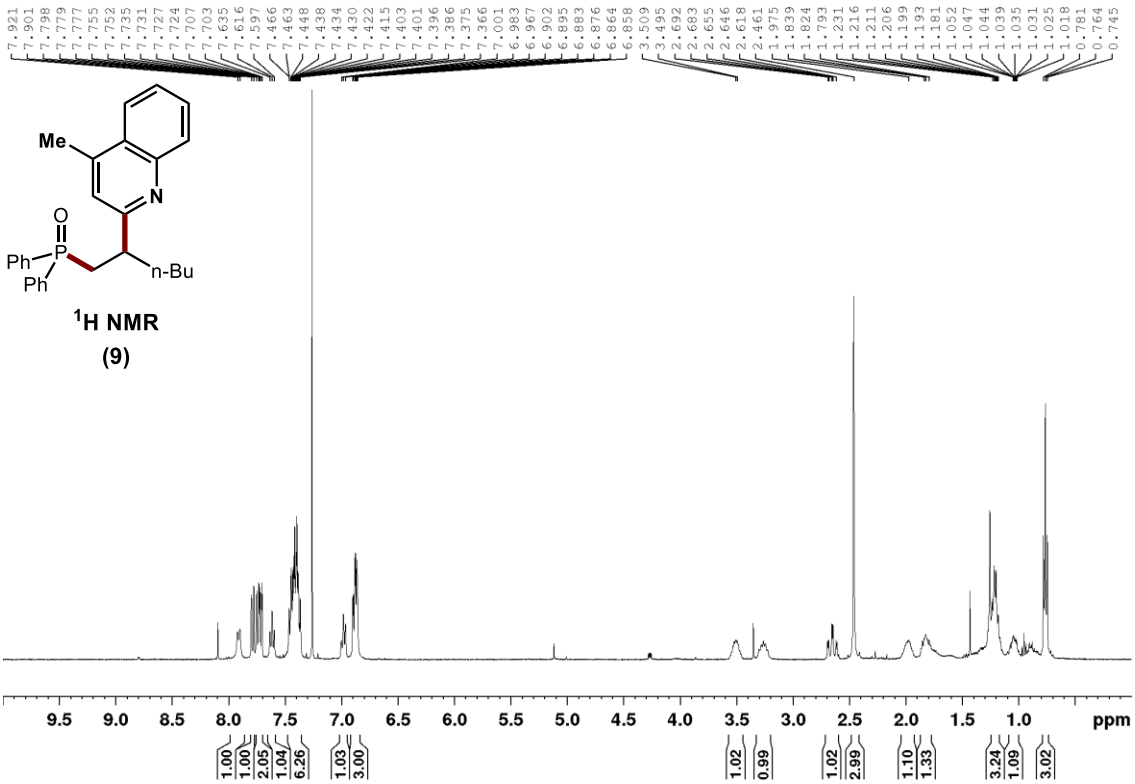


^{13}C NMR
(8)



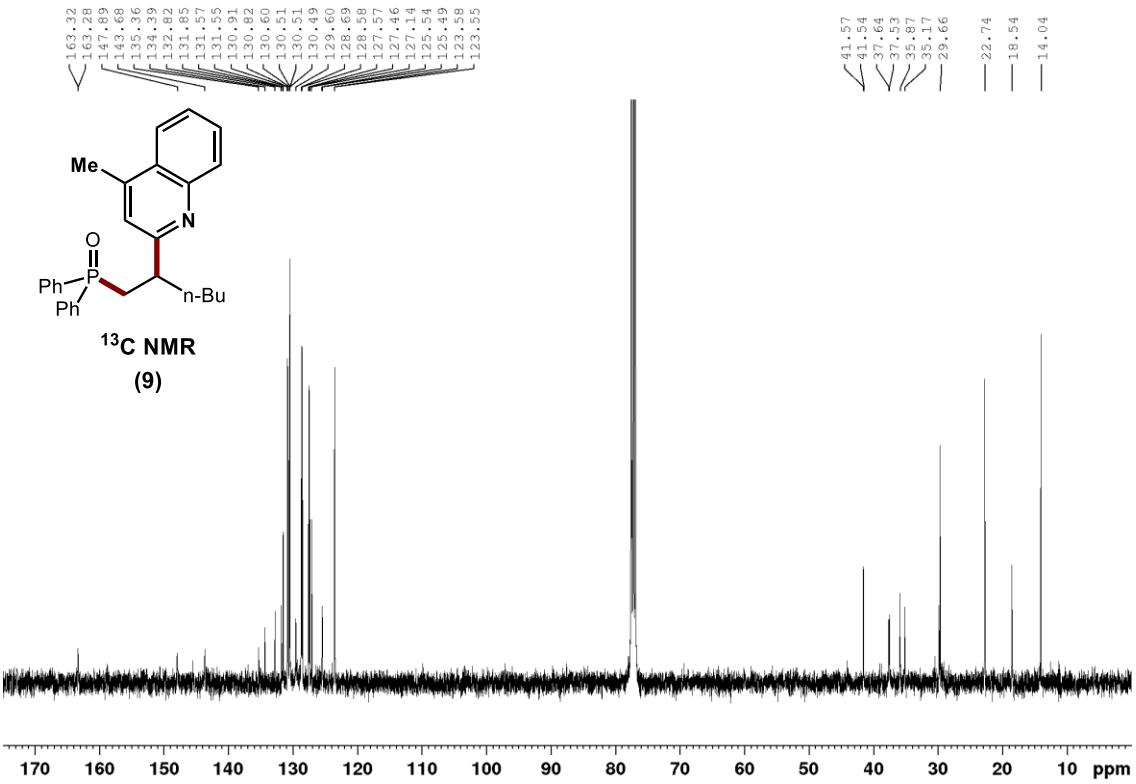
^{31}P NMR

(8)



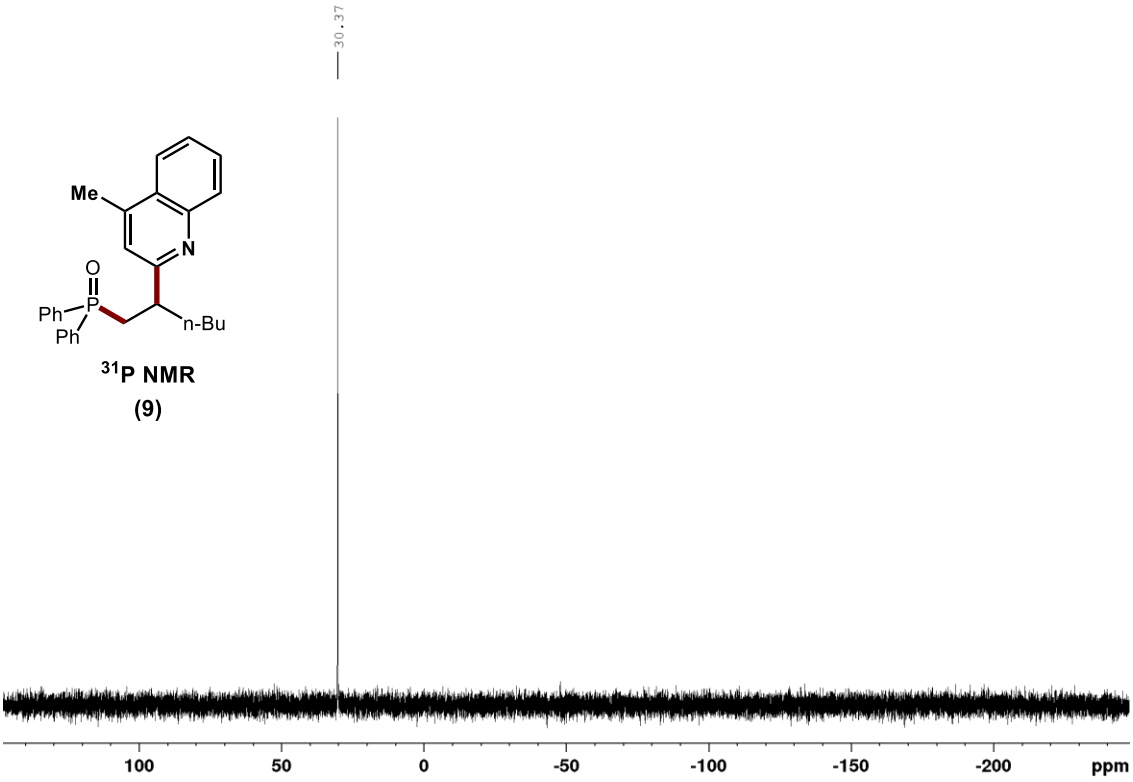
^{1}H NMR

(9)



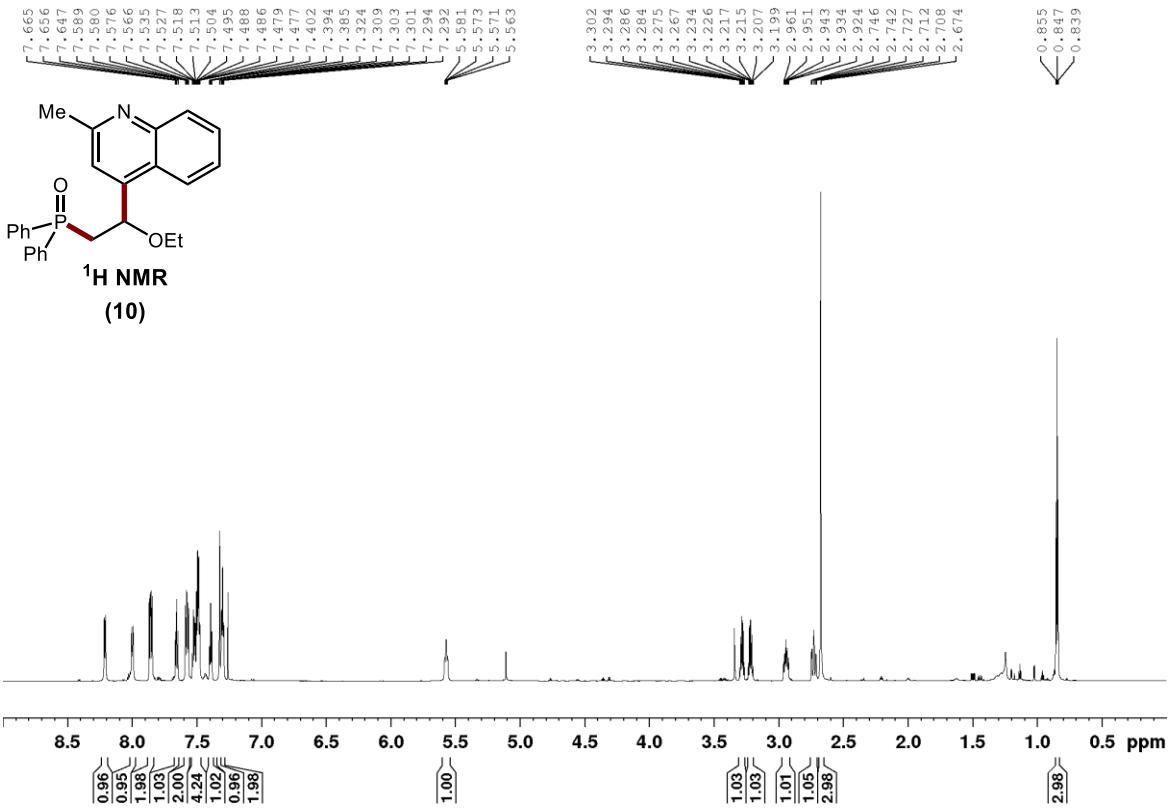
^{13}C NMR

(9)



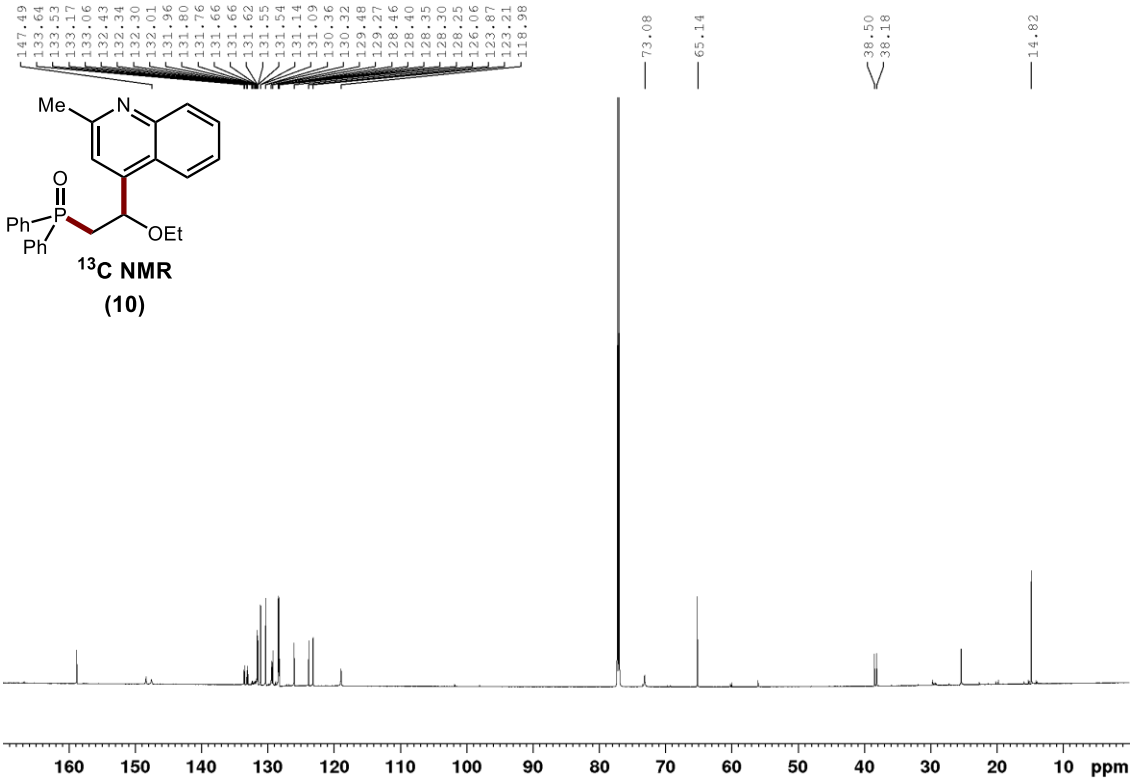
^{31}P NMR

(9)



^{1}H NMR

(10)

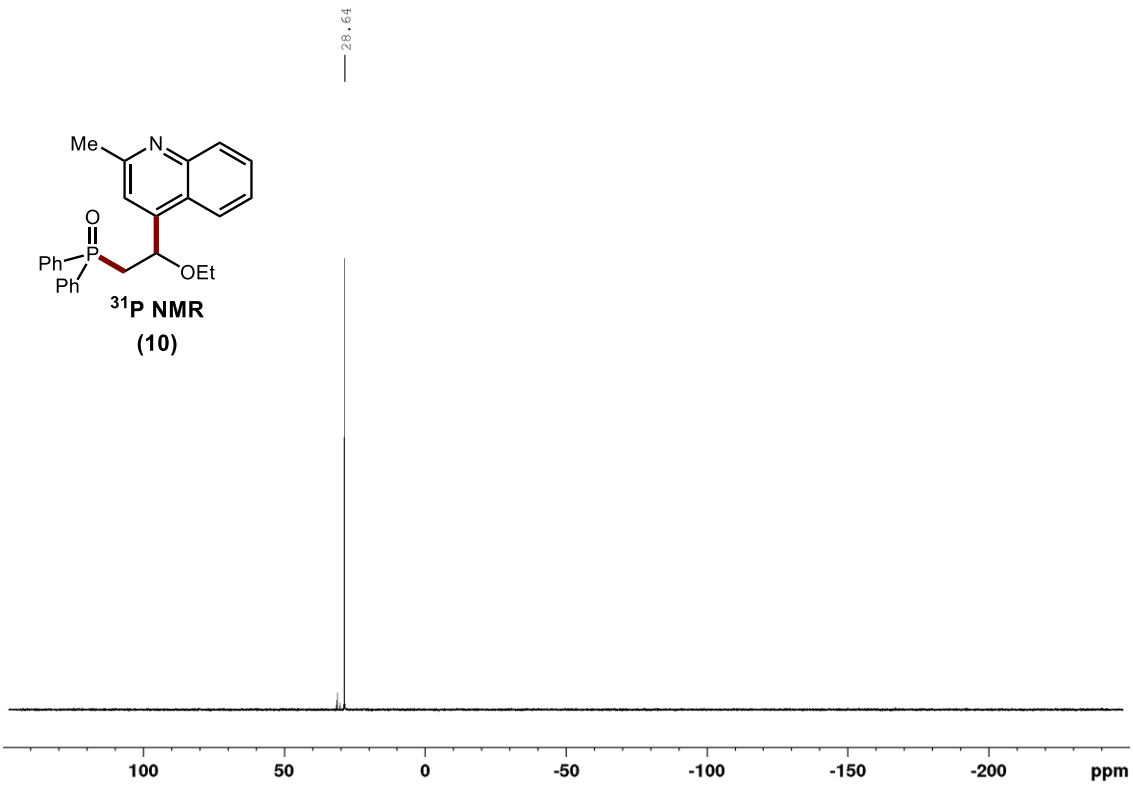


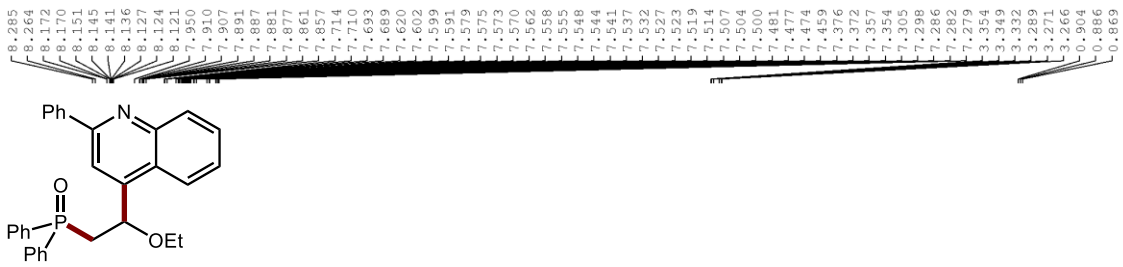
^{13}C NMR

(10)

^{31}P NMR

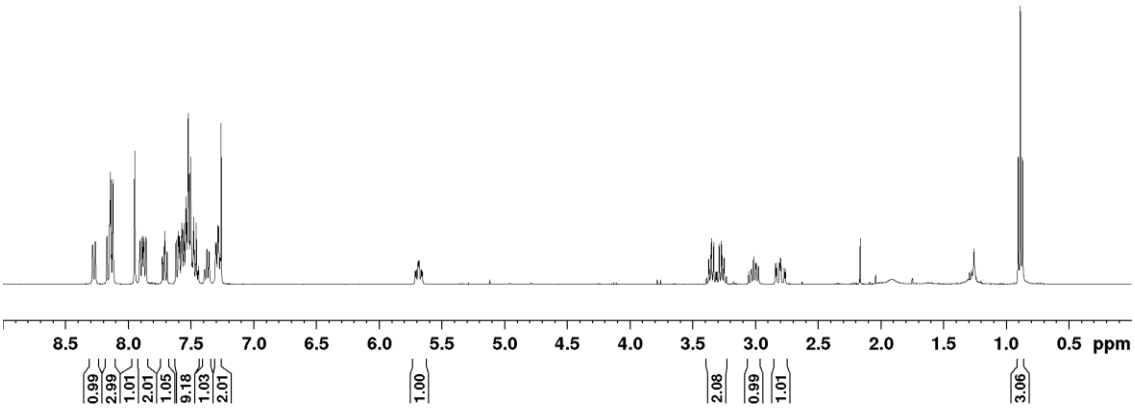
(10)

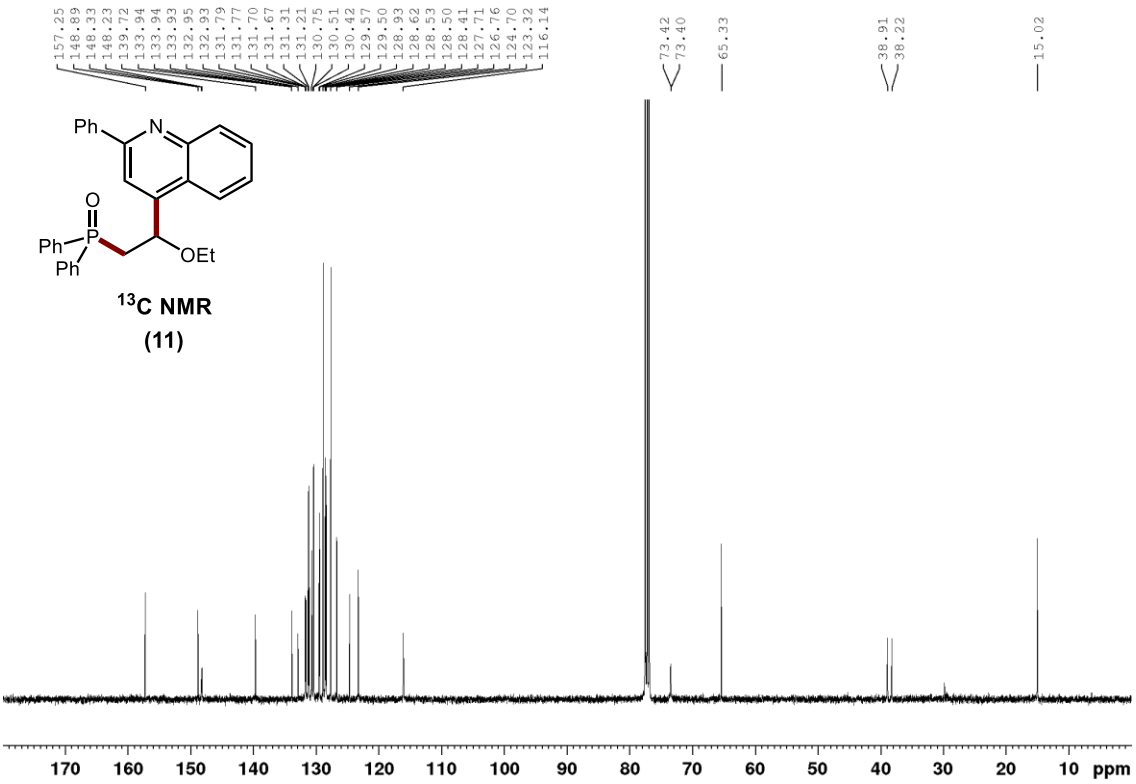




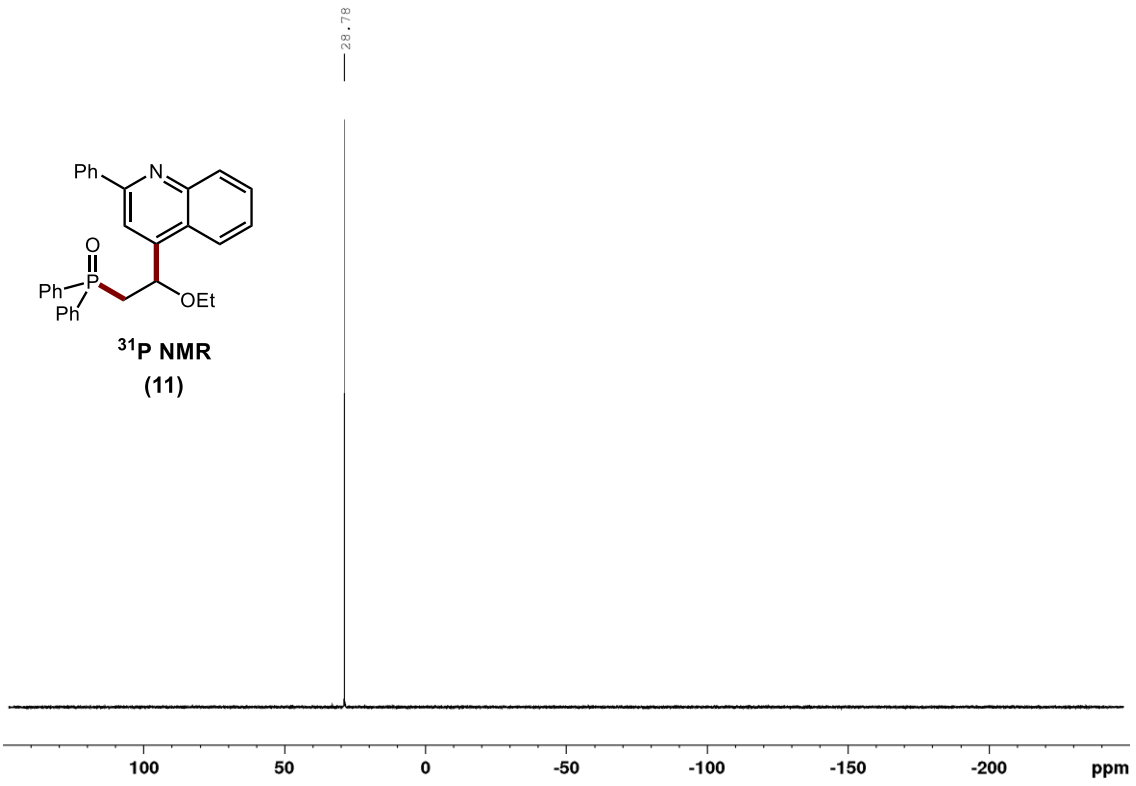
^{1}H NMR

(11)

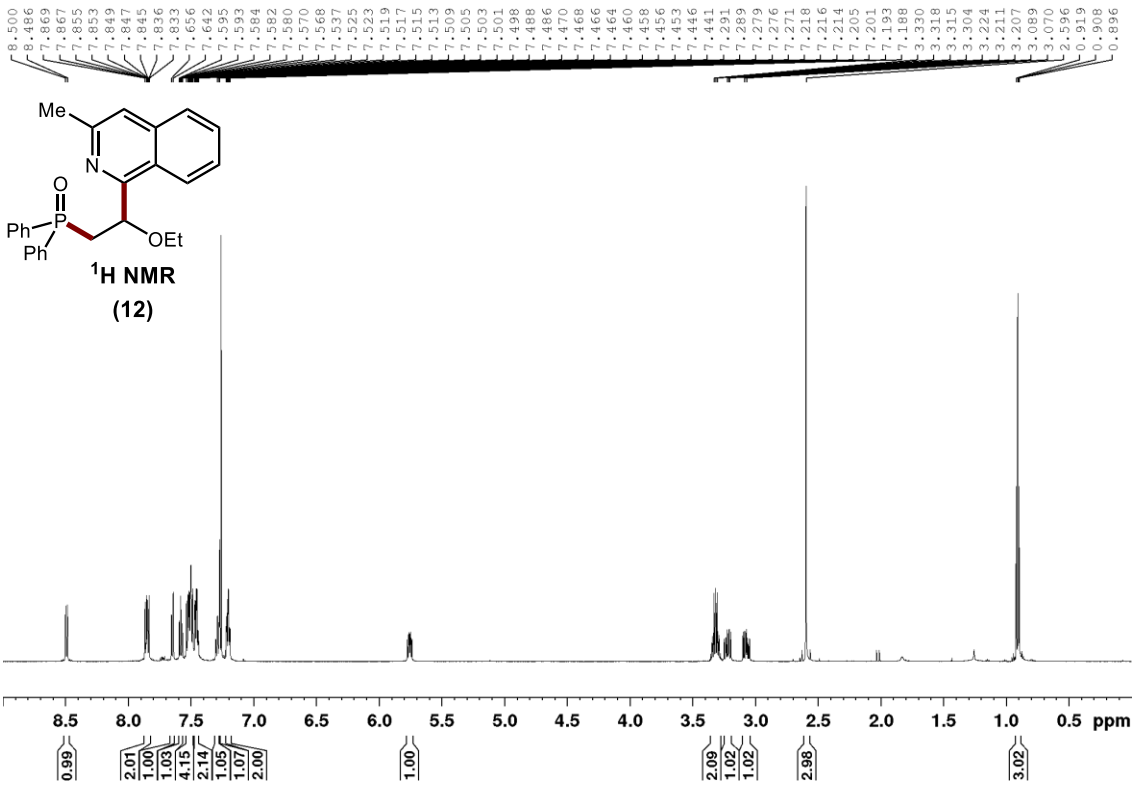




^{13}C NMR
(11)

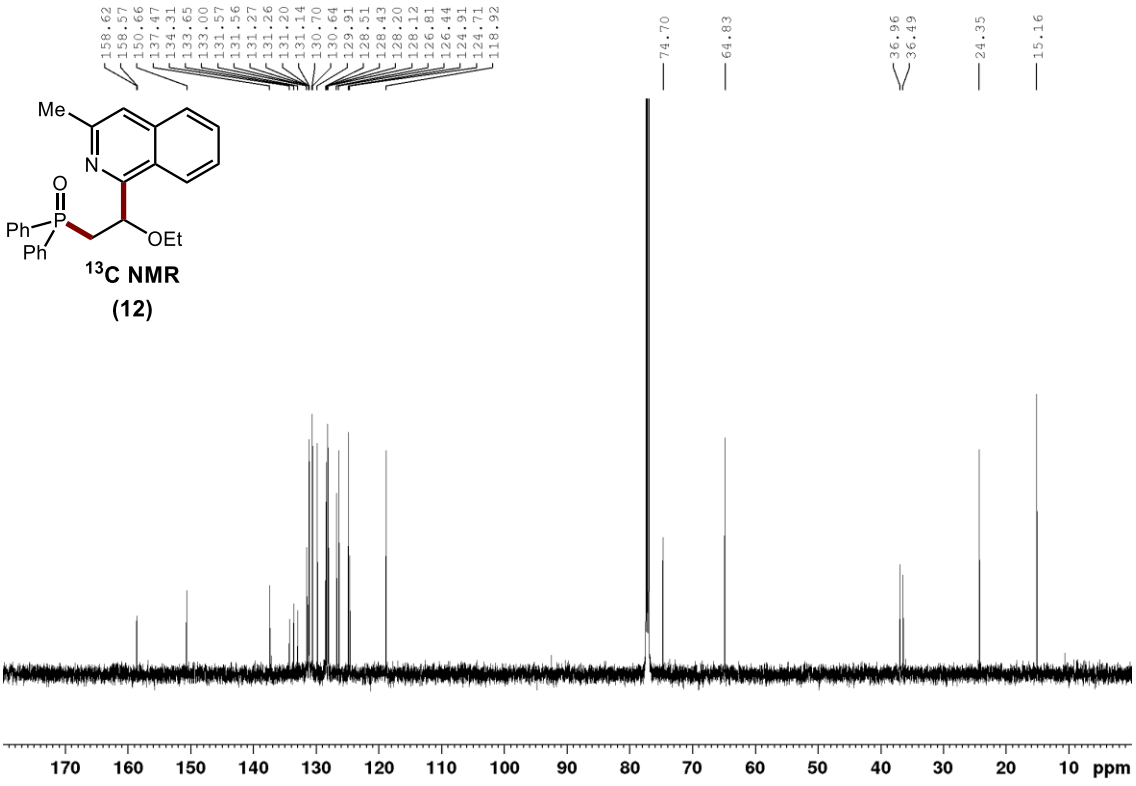


^{31}P NMR
(11)



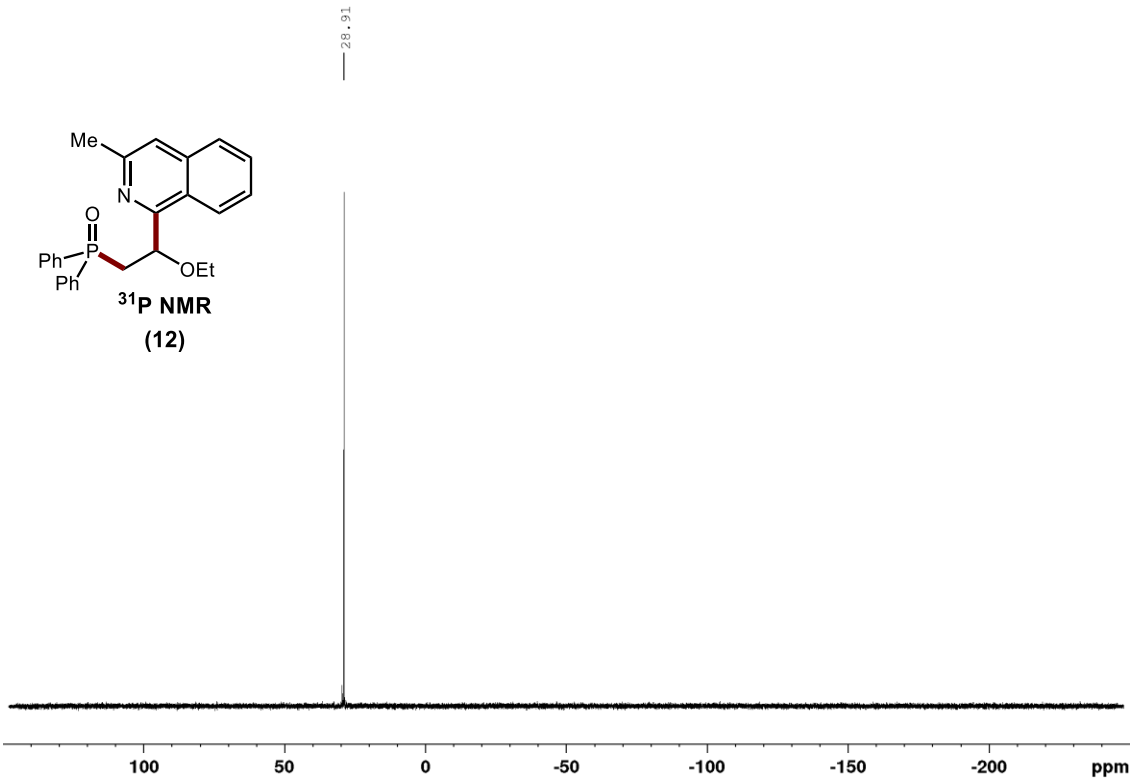
^{1}H NMR

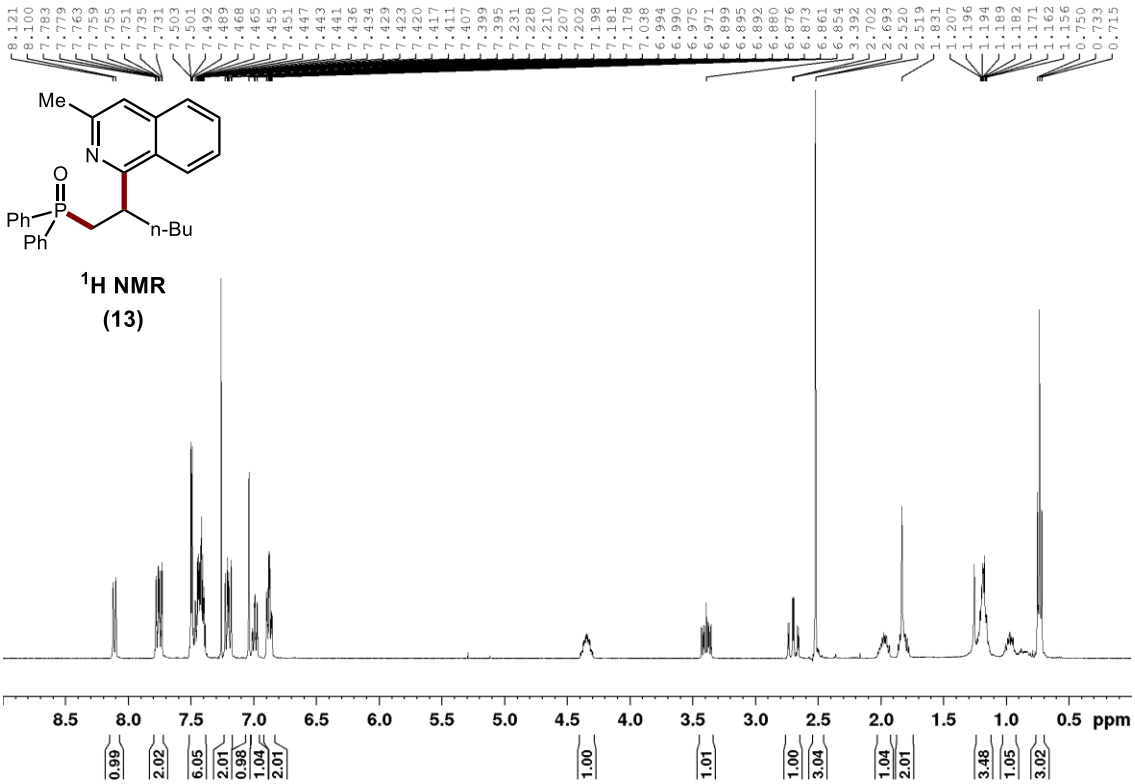
(12)

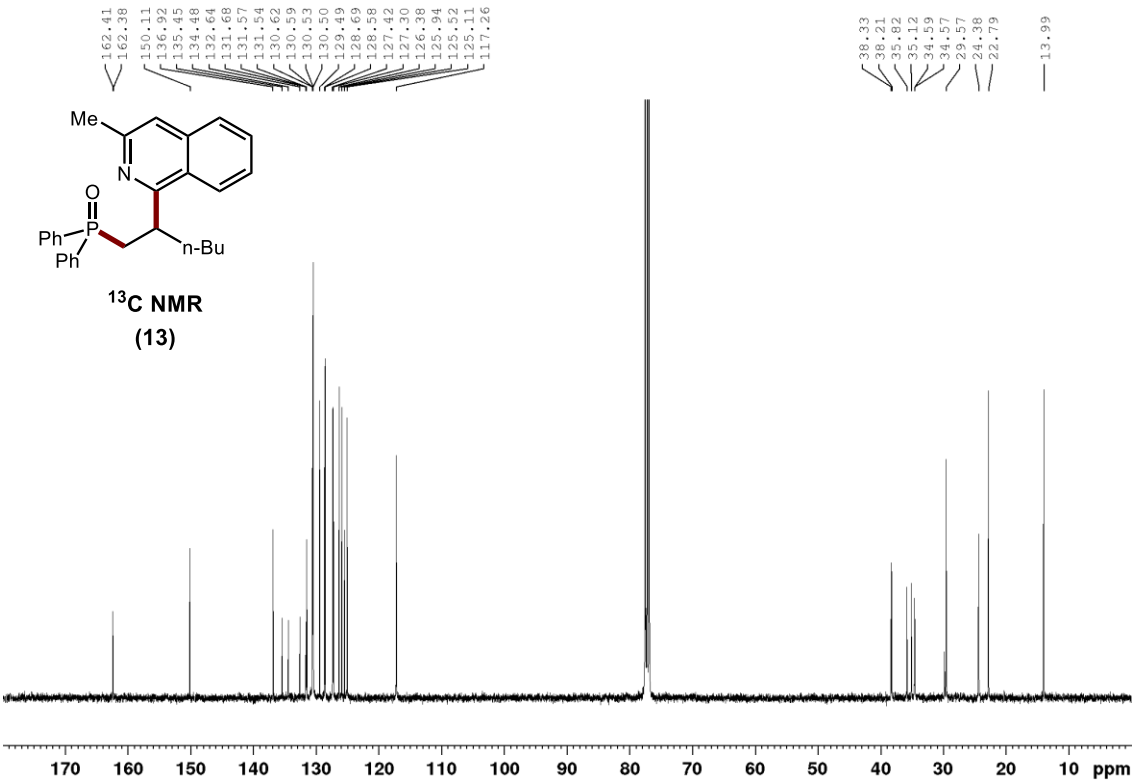


^{13}C NMR

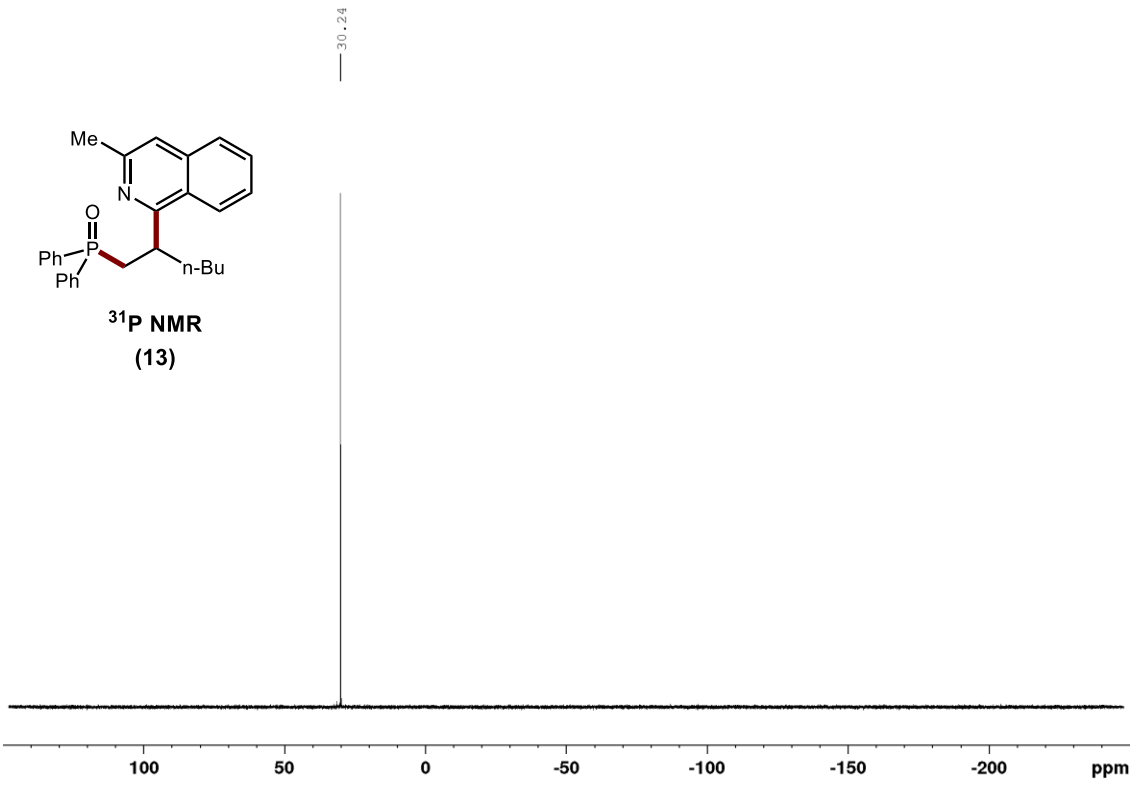
(12)


28.91
Me
N
O
Ph
P
Ph
OEt
31P NMR
(12)
100
50
0
-50
-100
-150
-200
ppm

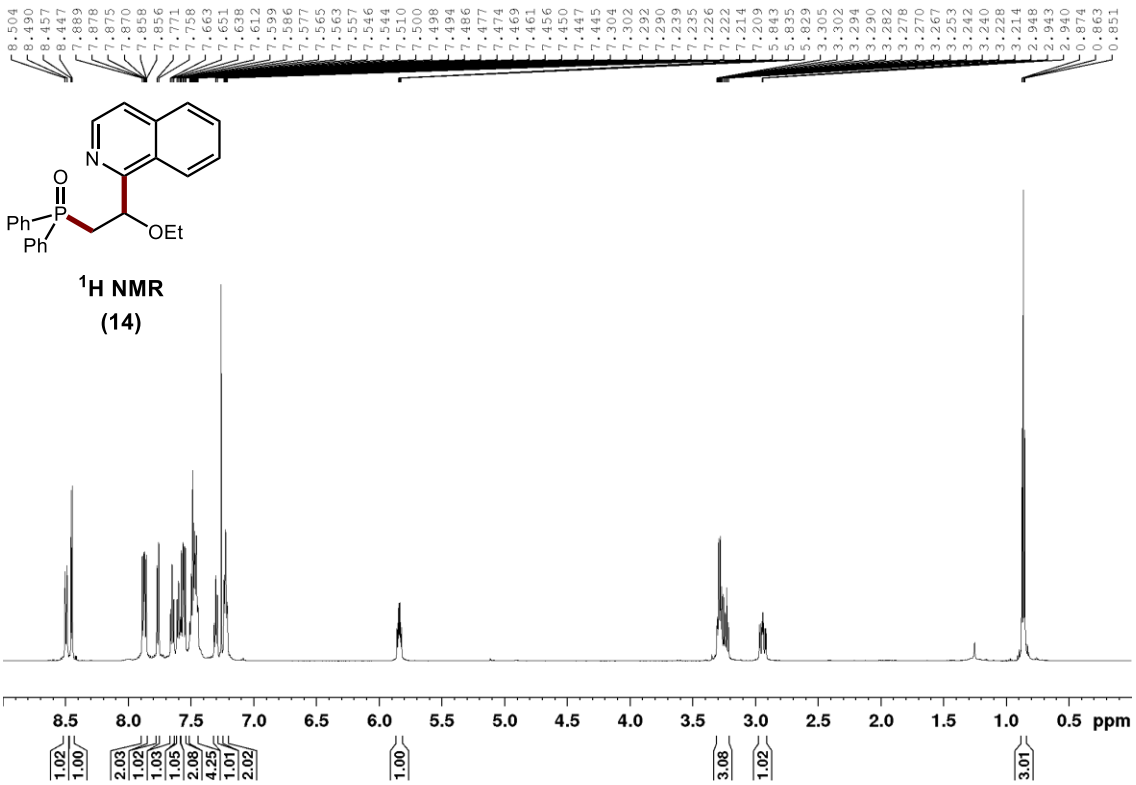

8.121
8.100
7.783
7.779
7.763
7.759
7.755
7.751
7.735
7.731
7.503
7.501
7.492
7.489
7.468
7.465
7.455
7.451
7.447
7.443
7.441
7.436
7.434
7.429
7.423
7.420
7.417
7.411
7.407
7.399
7.395
7.231
7.228
7.210
7.207
7.202
7.198
7.181
7.178
7.038
6.994
6.990
6.975
6.971
6.899
6.895
6.892
6.880
6.876
6.873
6.861
6.854
3.392
2.702
2.693
2.520
2.519
1.831
1.207
1.196
1.194
1.189
1.182
1.171
1.162
1.156
0.750
0.733
0.715
Me
N
O
Ph
P
Ph
n-Bu
1H NMR
(13)
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
ppm
0.99
2.02
6.05
2.01
0.98
1.04
2.01
1.00
1.01
1.00
3.04
1.04
2.01
3.48
1.05
3.02



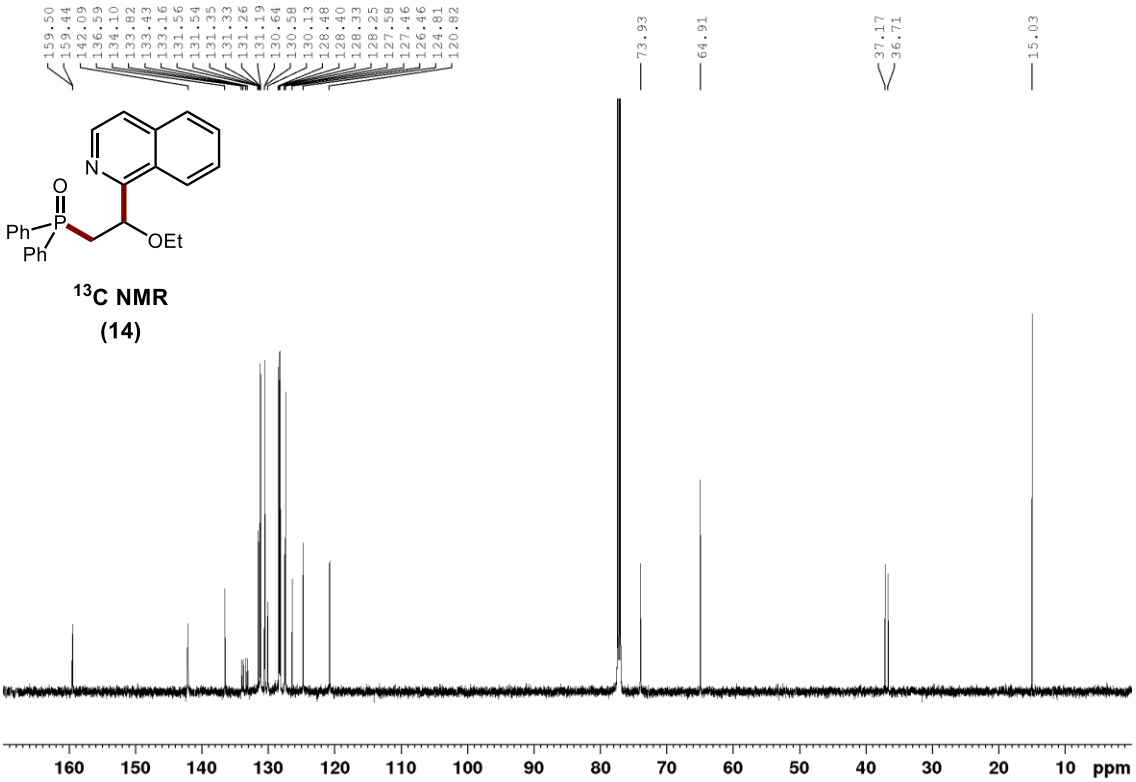
^{13}C NMR
(13)



^{31}P NMR
(13)



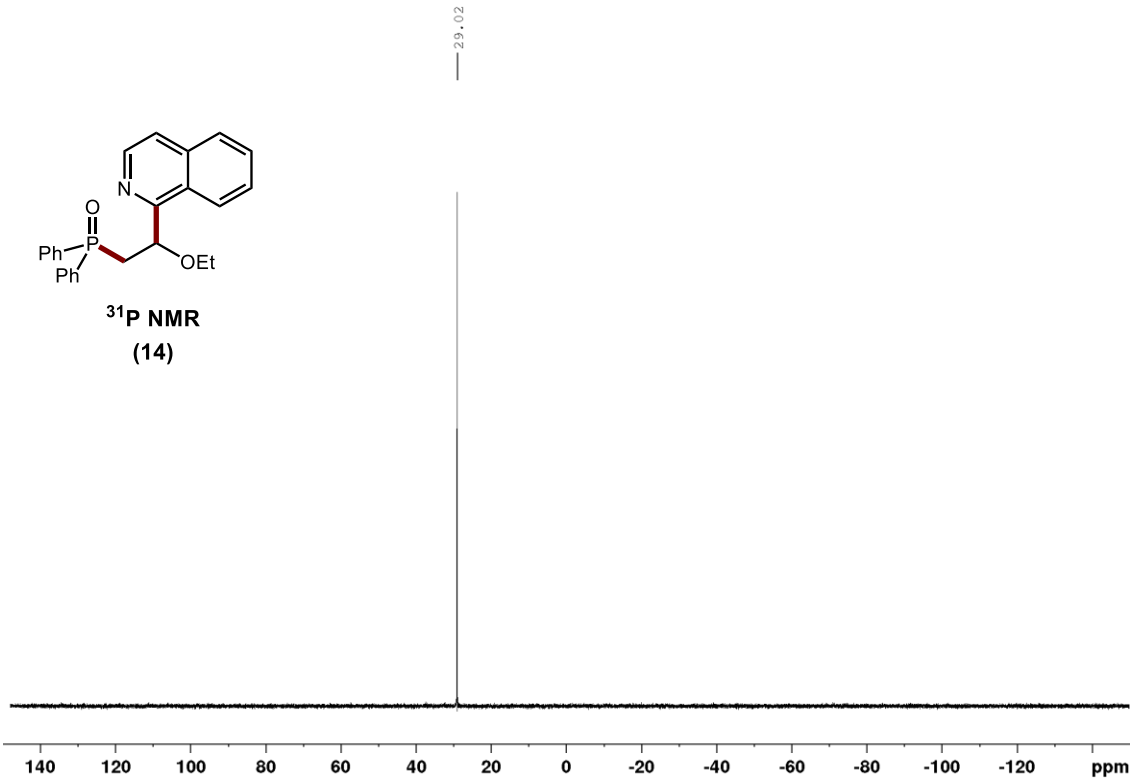
^{1}H NMR
(14)

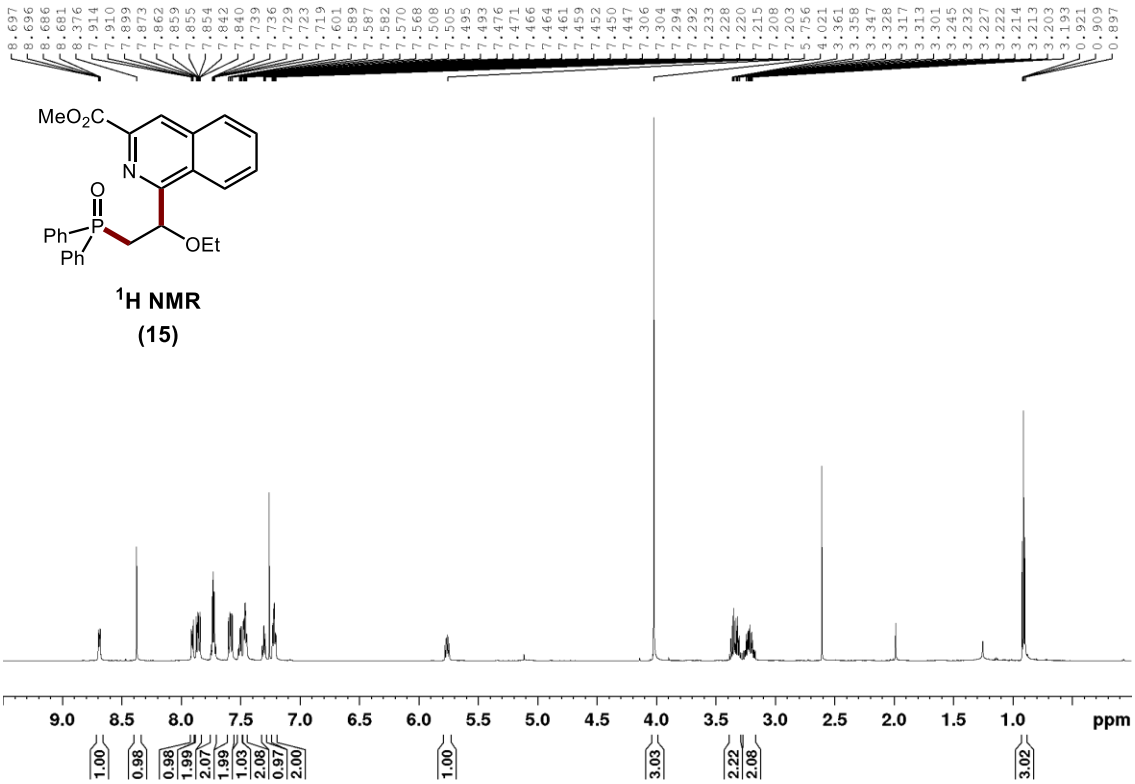


^{13}C NMR
(14)

^{31}P NMR

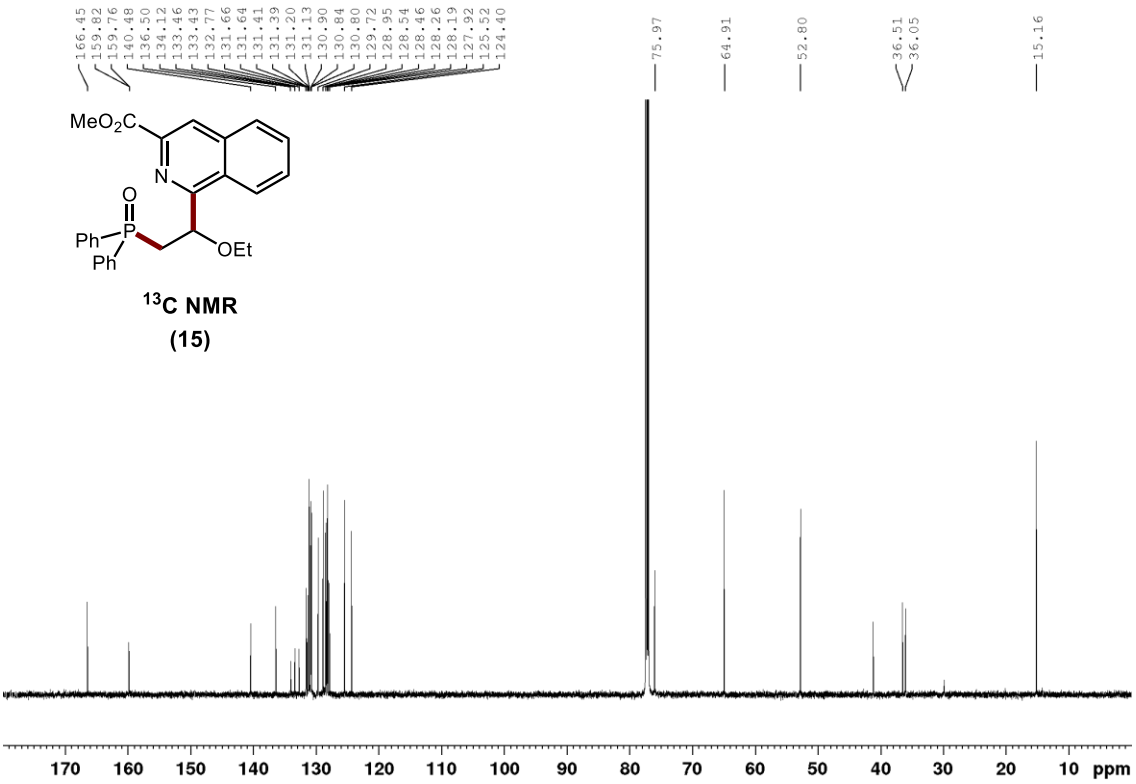
(14)





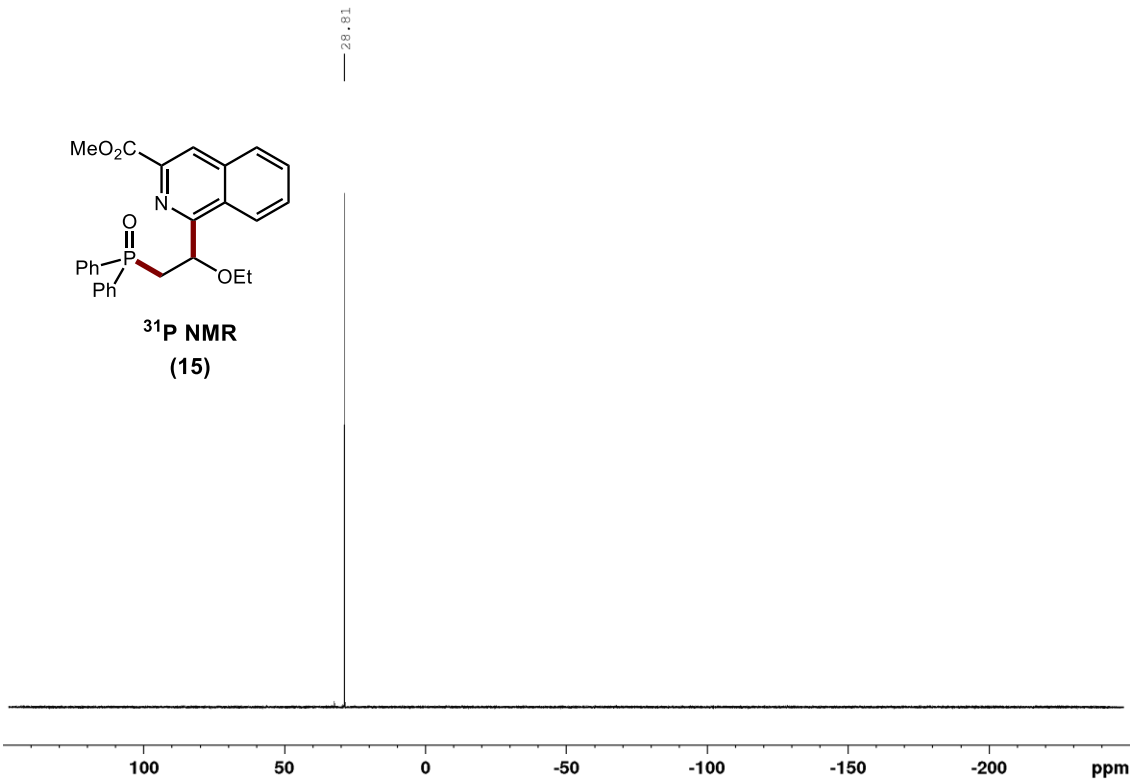
^{1}H NMR

(15)



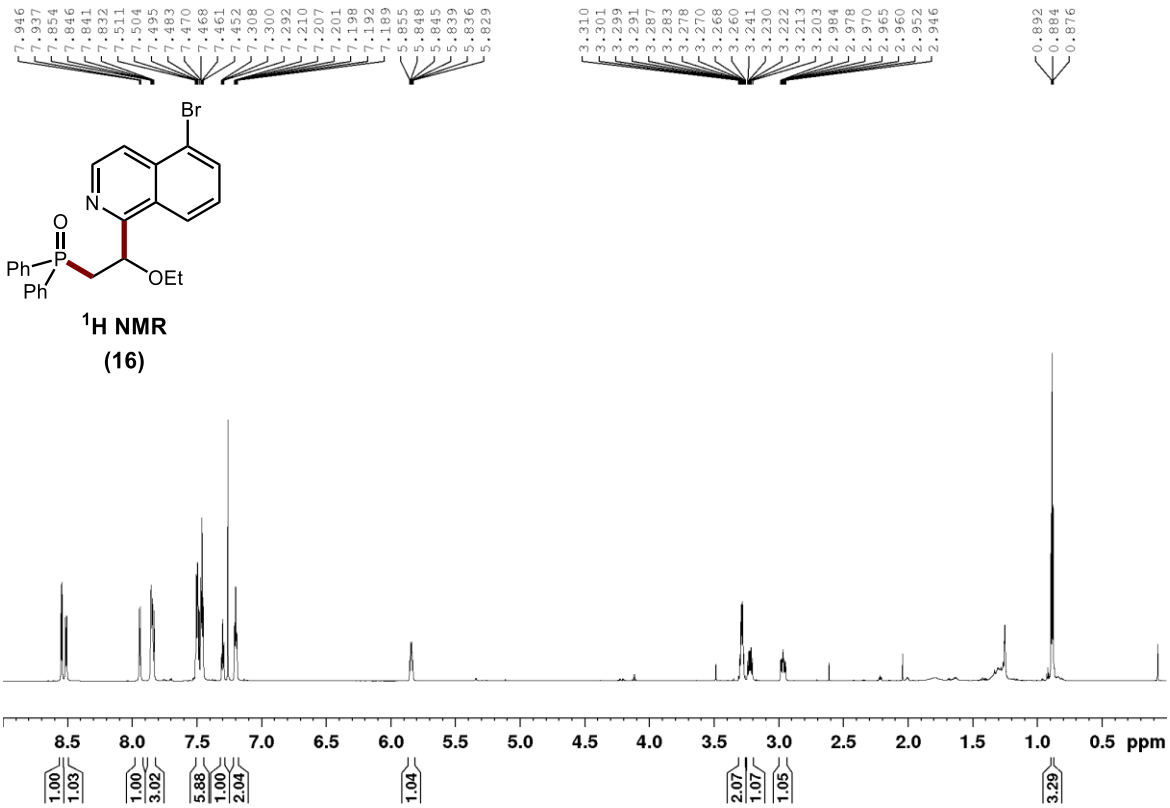
^{13}C NMR

(15)



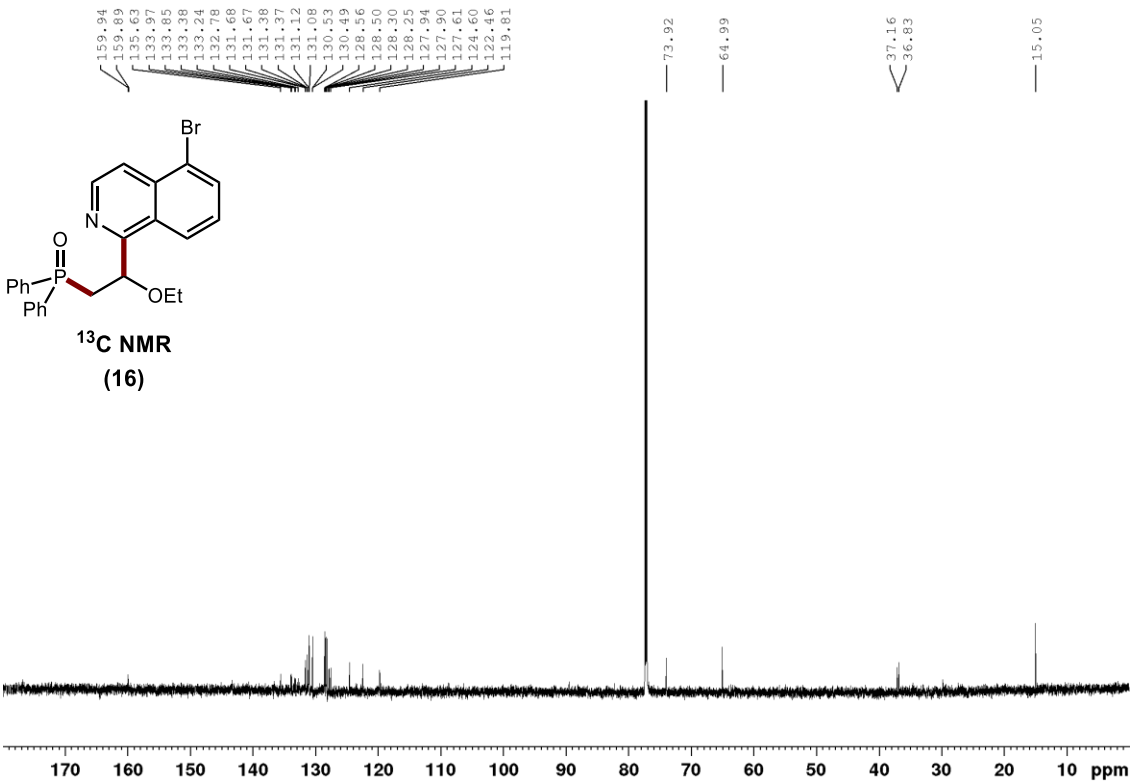
^{31}P NMR

(15)



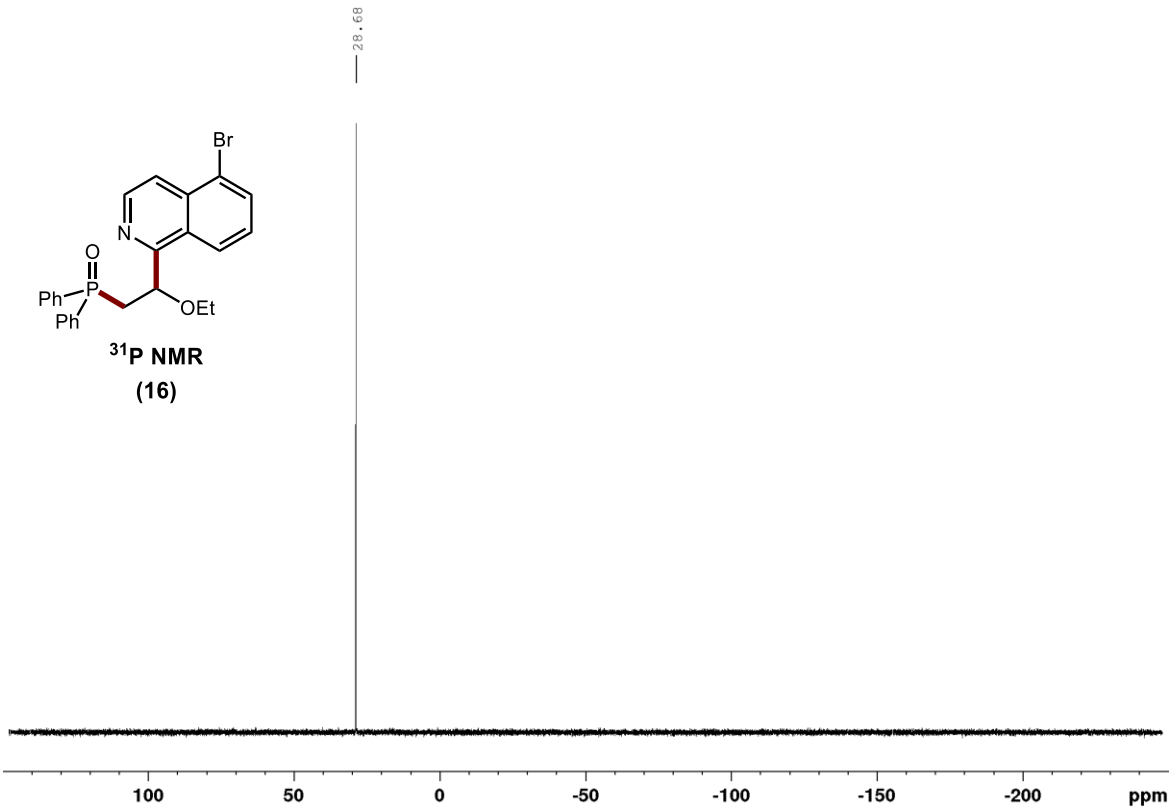
^{1}H NMR

(16)



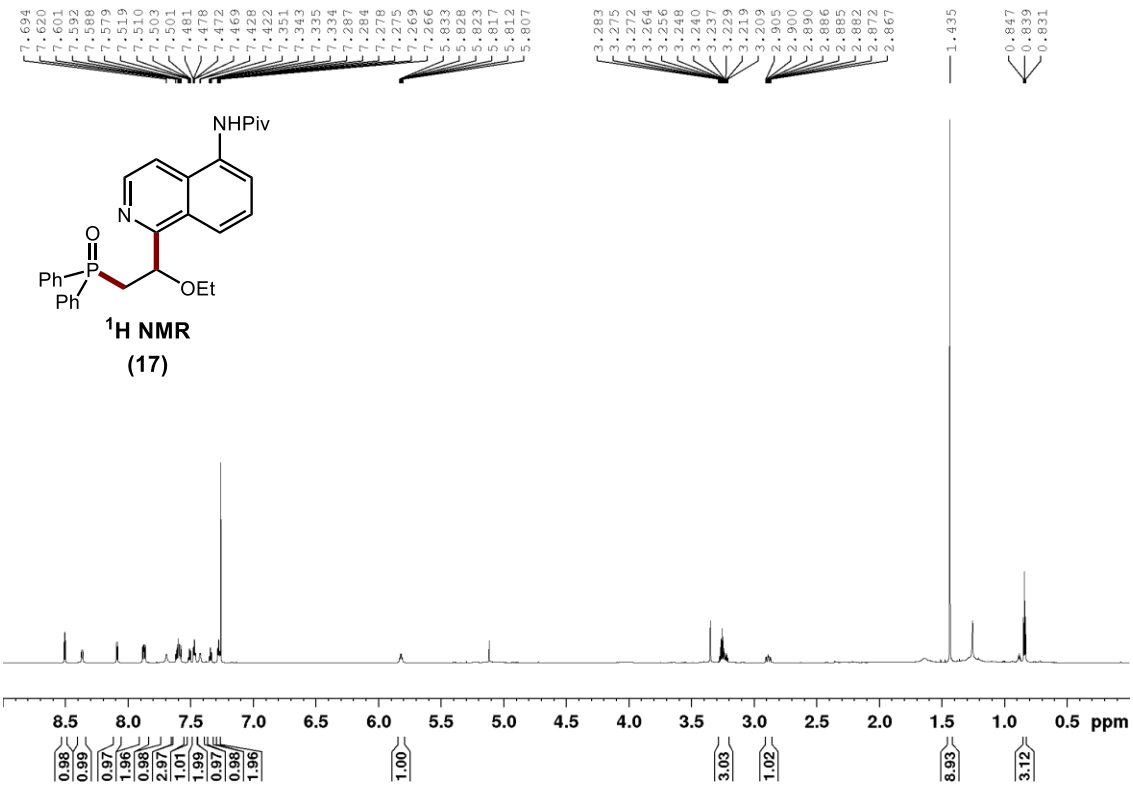
^{13}C NMR

(16)



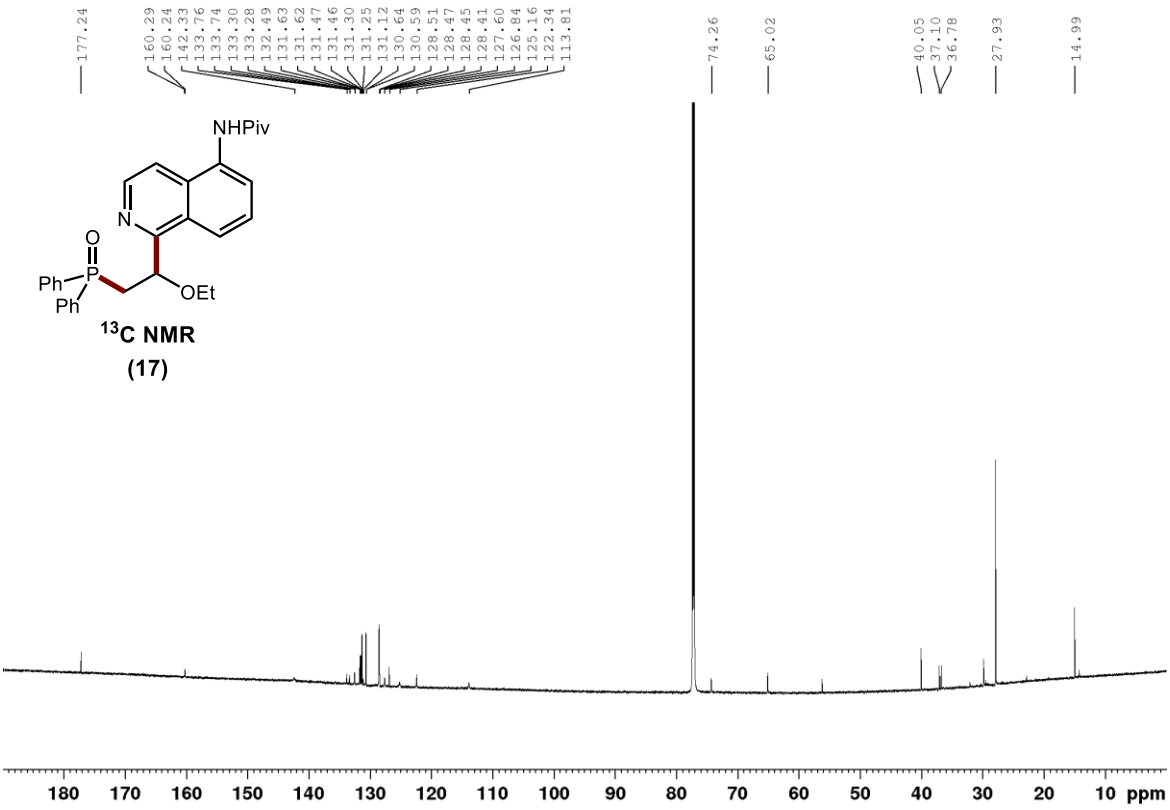
^{31}P NMR

(16)

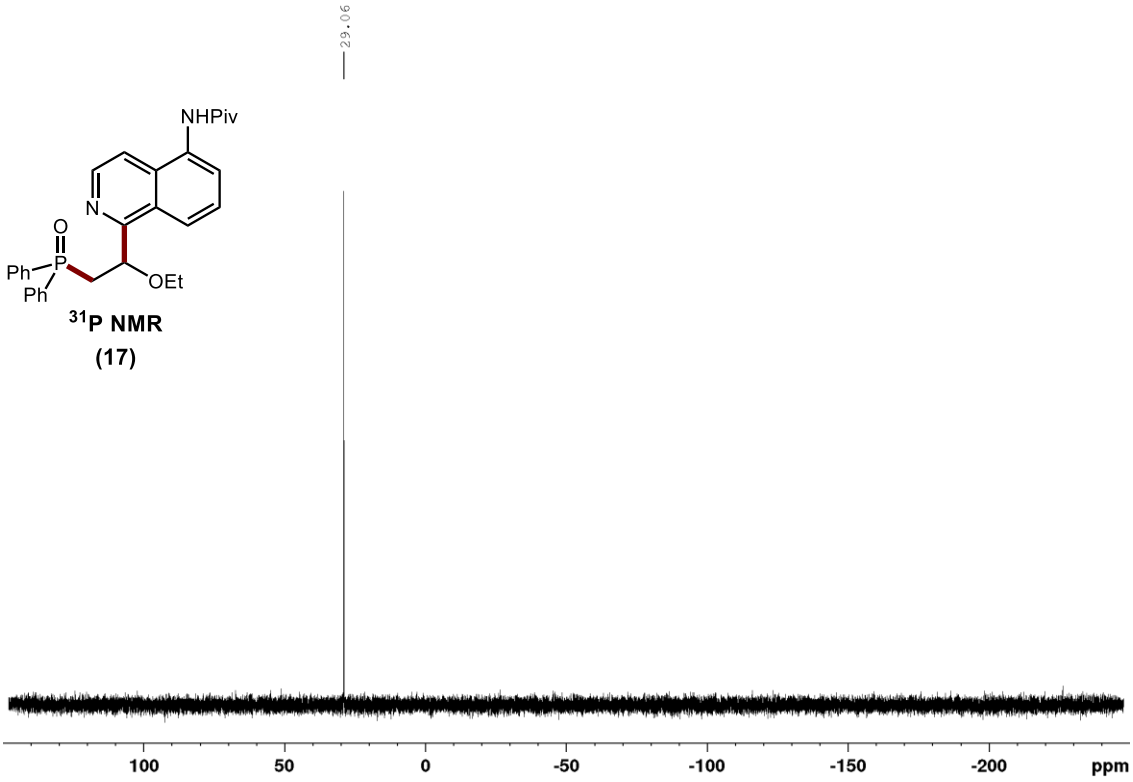


^{1}H NMR

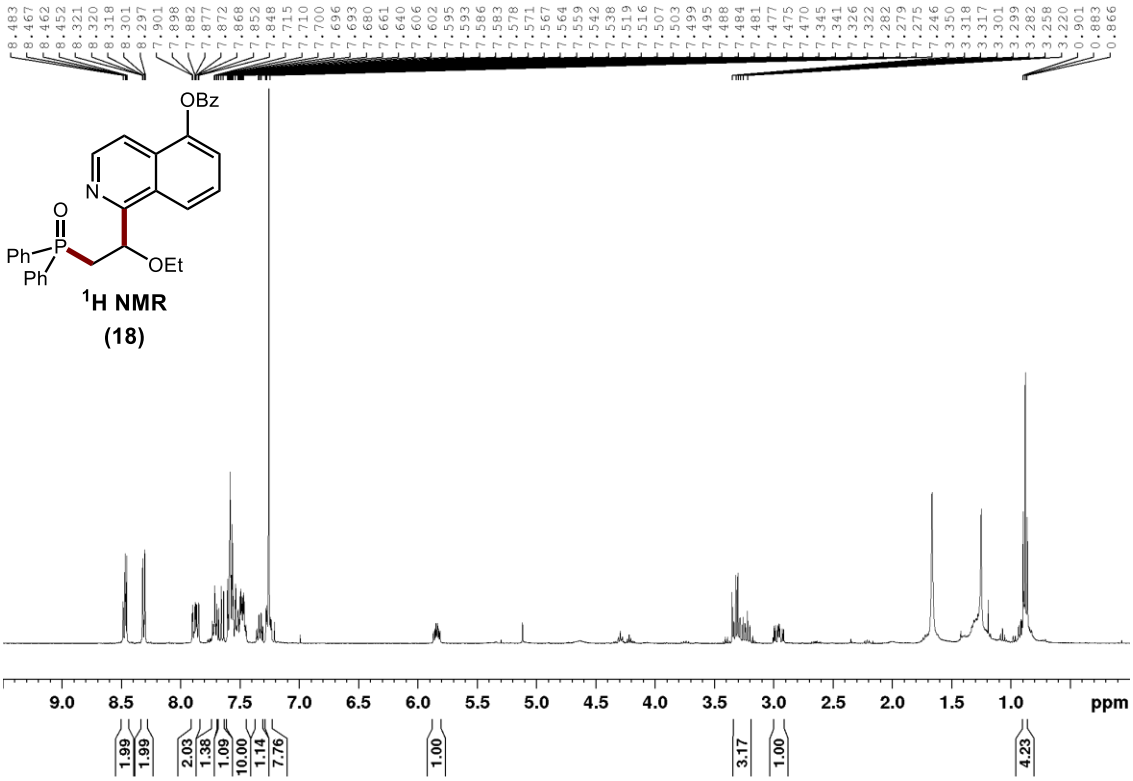
(17)



^{13}C NMR
(17)

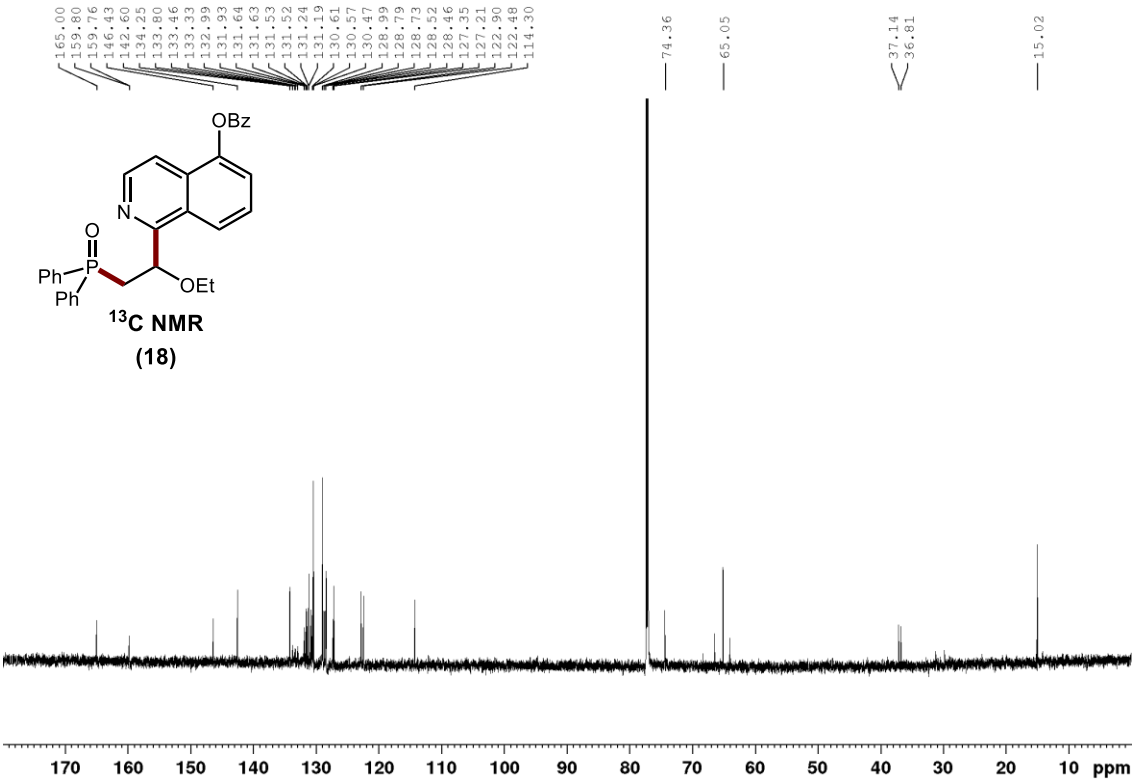


^{31}P NMR
(17)



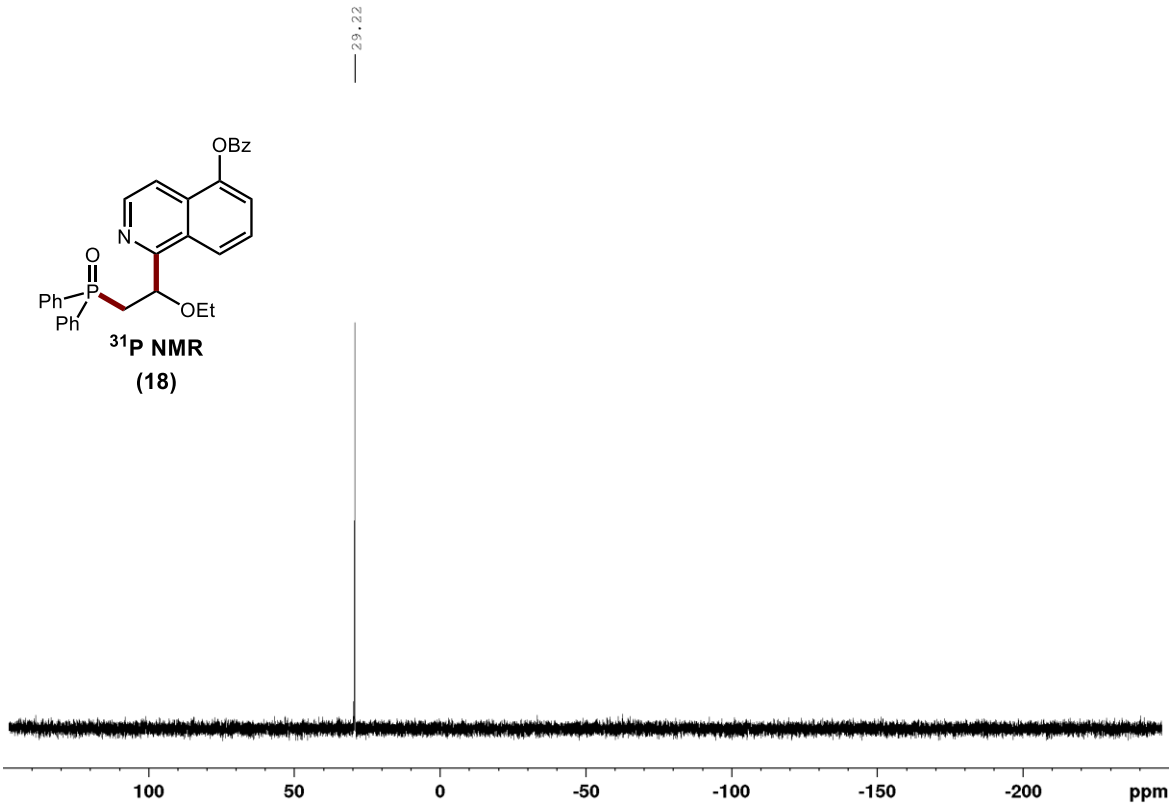
^{1}H NMR

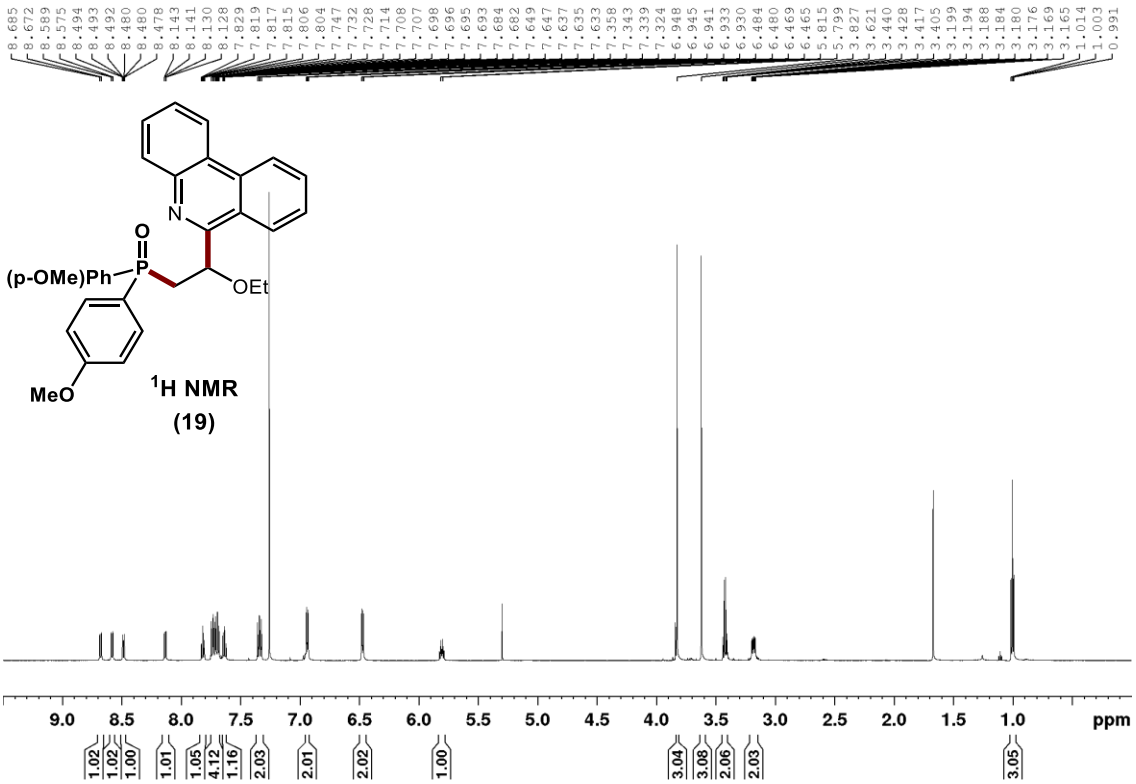
(18)

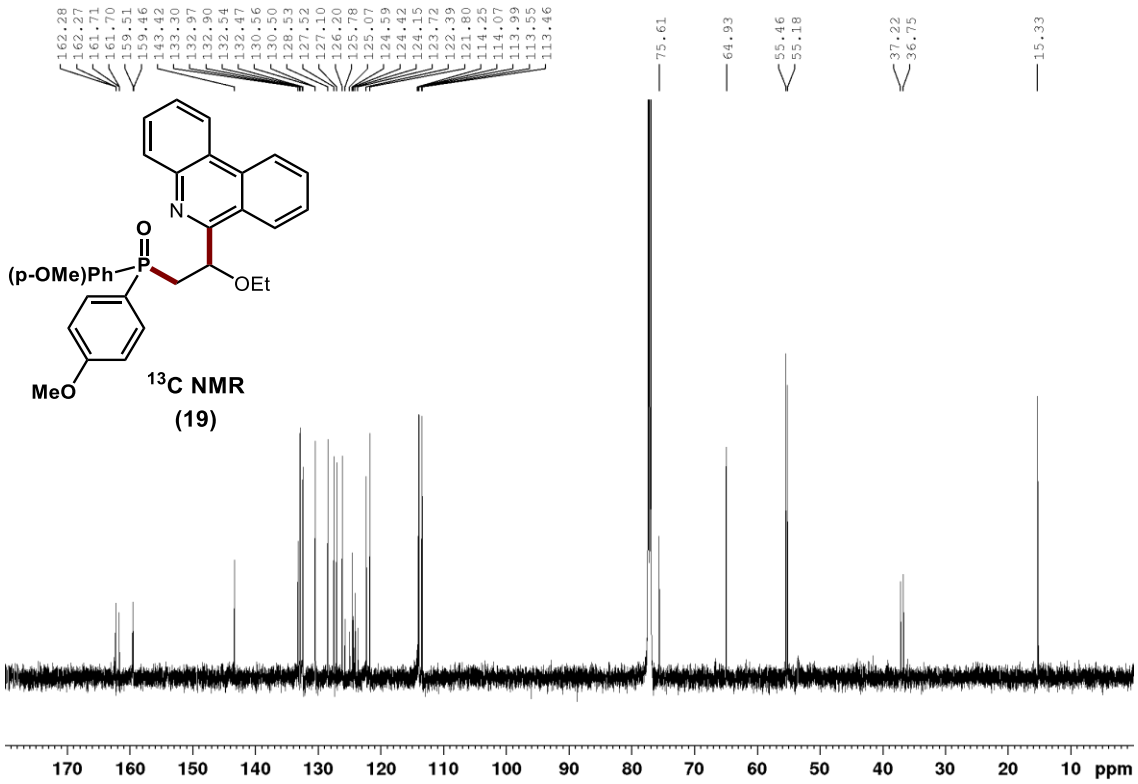


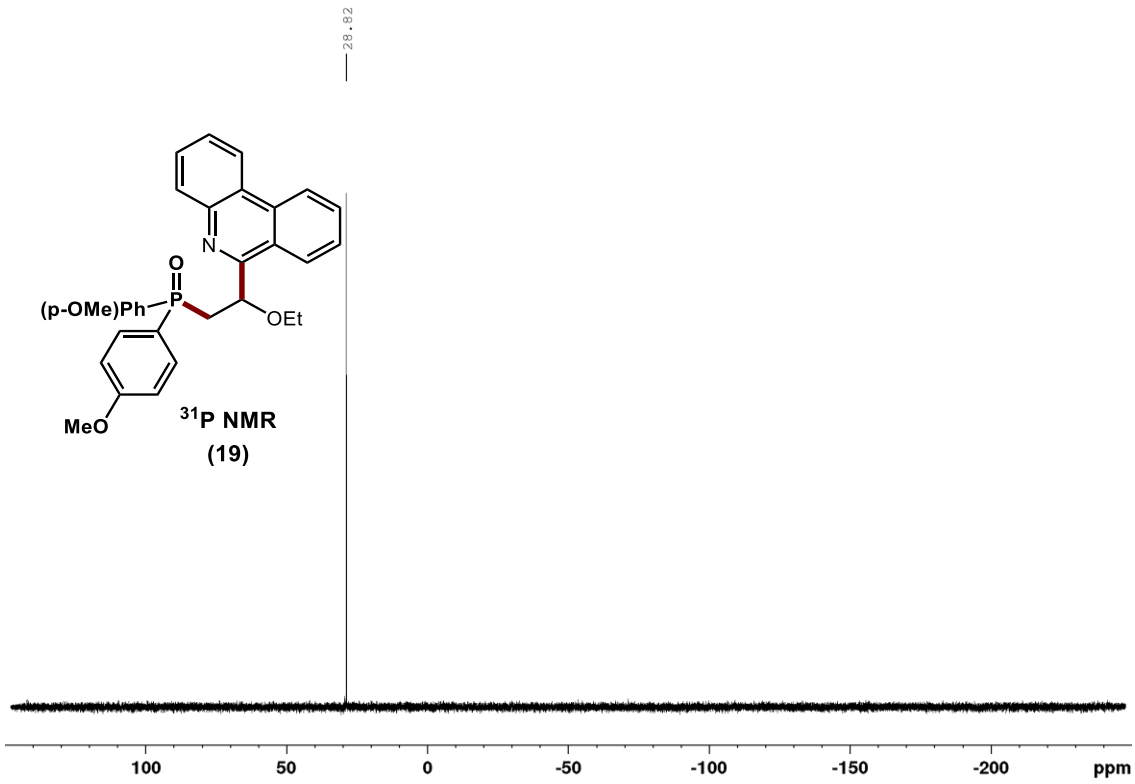
^{13}C NMR

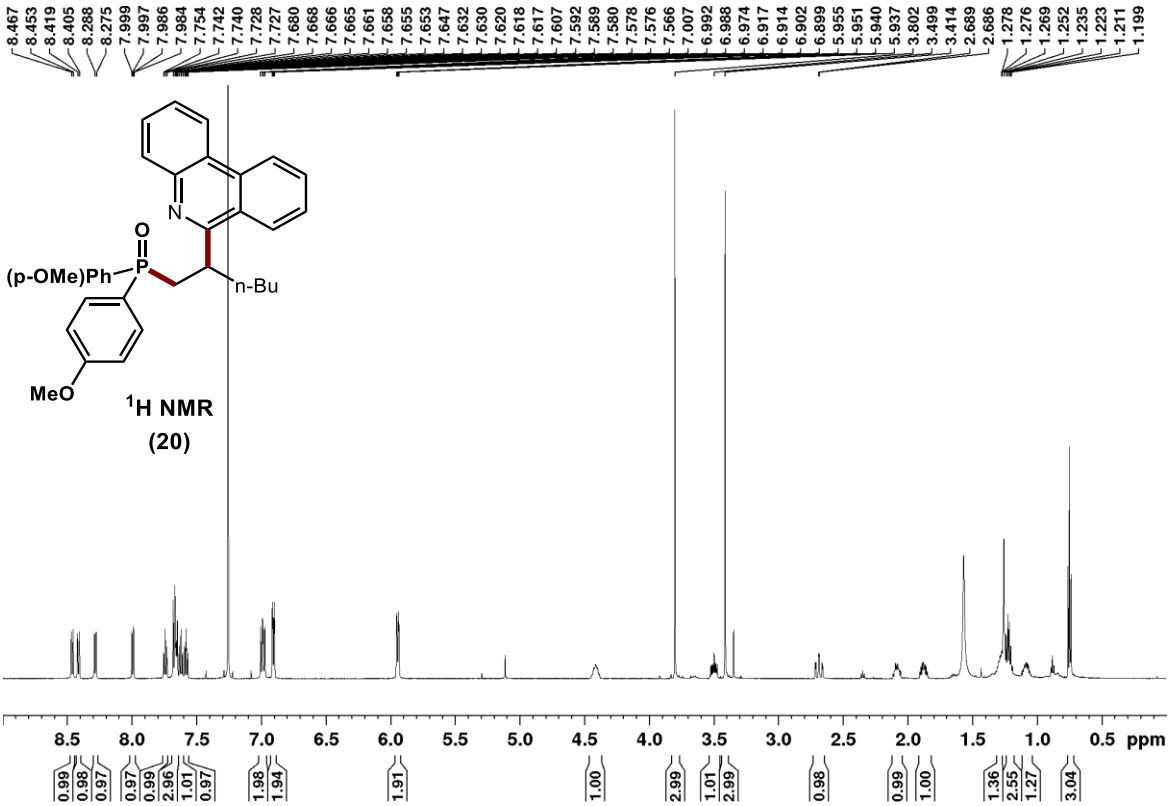
(18)

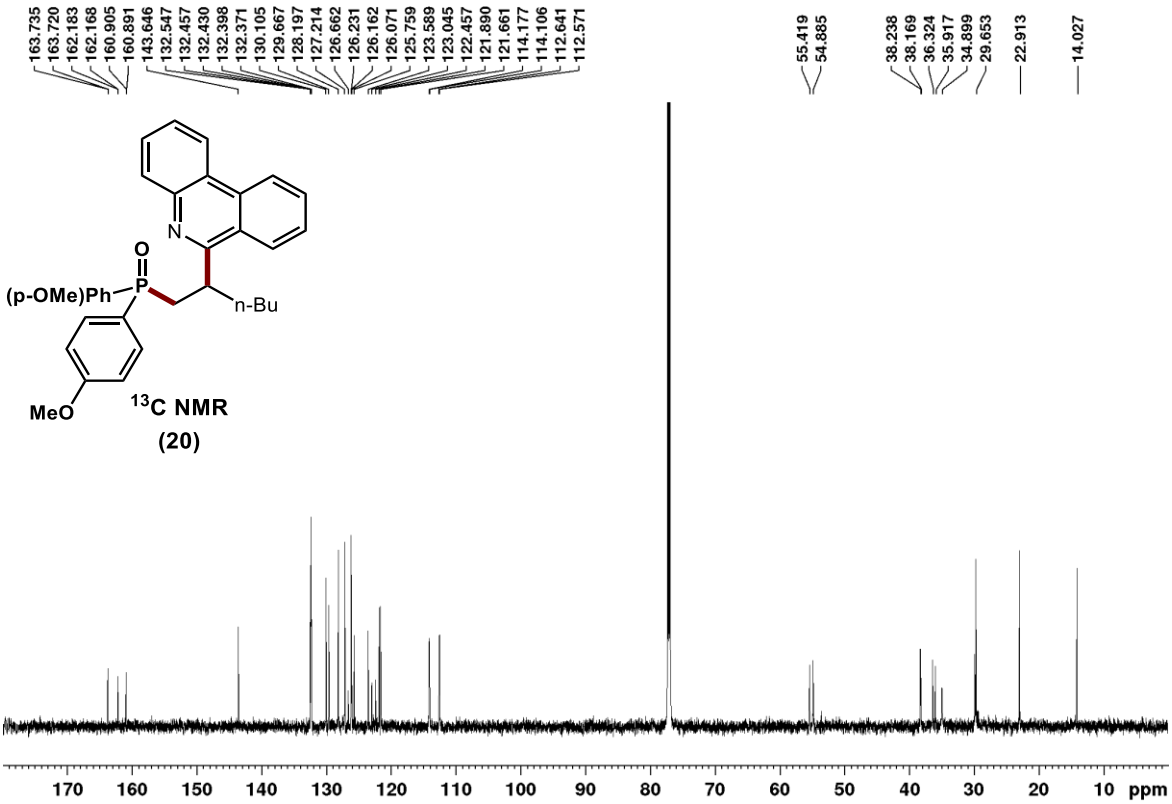

29.22
OBz
N
O
Ph
P
Ph
OEt
31P NMR
(18)
100
50
0
-50
-100
-150
-200
ppm

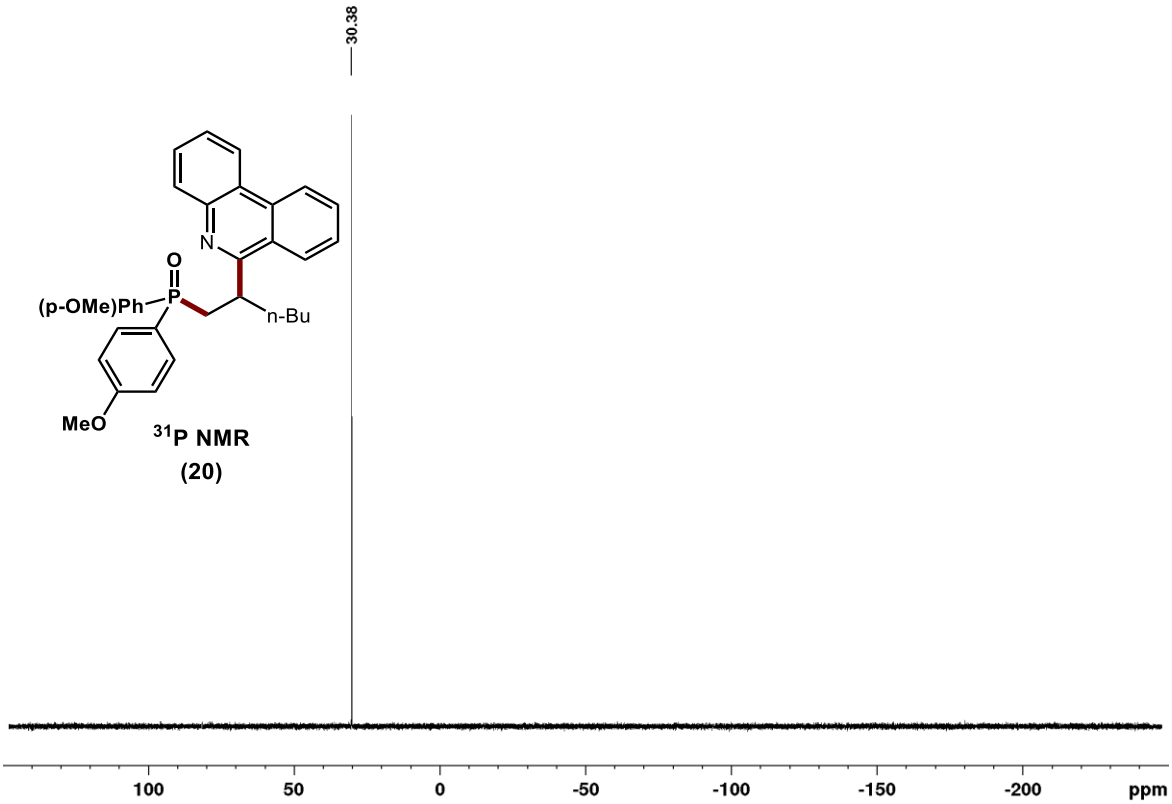

8.685
8.672
8.589
8.575
8.494
8.493
8.492
8.480
8.480
8.478
8.143
8.141
8.130
8.128
7.829
7.819
7.817
7.815
7.806
7.804
7.747
7.732
7.728
7.714
7.708
7.707
7.698
7.696
7.695
7.693
7.684
7.682
7.649
7.647
7.637
7.635
7.633
7.358
7.343
7.339
7.324
6.948
6.945
6.941
6.933
6.930
6.484
6.480
6.469
6.465
5.815
5.799
3.827
3.621
3.440
3.428
3.417
3.405
3.199
3.194
3.188
3.184
3.180
3.176
3.169
3.165
1.014
1.003
0.991
N
O
(p-OMe)Ph
P
OEt
MeO
1H NMR
(19)
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
ppm
1.02
1.02
1.00
1.01
1.05
4.12
1.16
2.03
2.01
2.02
1.00
3.04
3.08
2.06
2.03
3.05


162.28
162.27
161.71
161.70
159.51
159.46
143.42
133.30
132.97
132.90
132.54
132.47
130.56
130.50
128.53
127.52
127.10
126.20
125.78
125.07
124.59
124.42
124.15
123.72
122.39
121.80
114.25
114.07
113.99
113.55
113.46
75.61
64.93
55.46
55.18
37.22
36.75
15.33
N
O
P
(p-OMe)Ph
OEt
MeO
13C NMR
(19)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

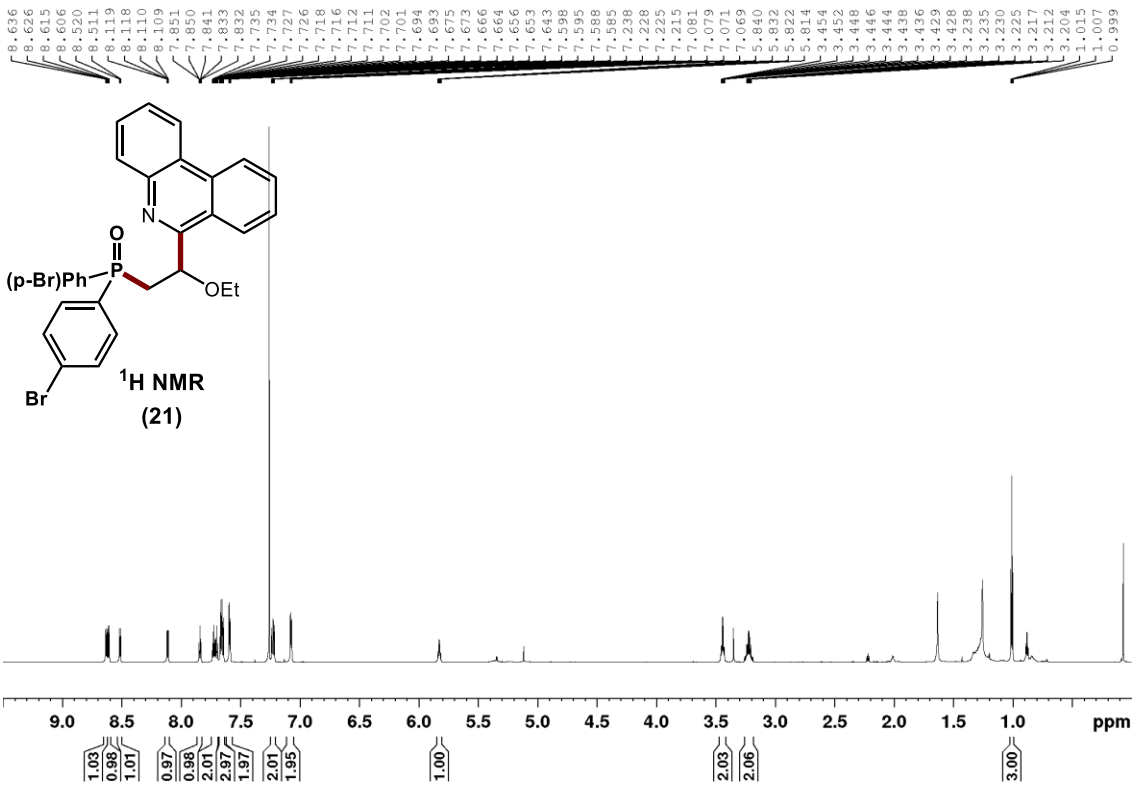

28.82
N
O
P
(p-OMe)Ph
OEt
MeO
31P NMR
(19)
100
50
0
-50
-100
-150
-200
ppm


8.467 8.453 8.419 8.405 8.288 8.275 7.999 7.997 7.986 7.984 7.754 7.742 7.740 7.728 7.727 7.680 7.668 7.666 7.665 7.661 7.658 7.655 7.653 7.647 7.632 7.630 7.620 7.618 7.617 7.607 7.592 7.589 7.580 7.578 7.576 7.566 7.007 6.992 6.988 6.974 6.917 6.914 6.902 6.899 5.955 5.951 5.940 5.937 3.802 3.499 3.414 2.689 2.686 1.278 1.276 1.269 1.252 1.235 1.223 1.211 1.199
N
O
P
(p-OMe)Ph
n-Bu
MeO
1H NMR
(20)
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 ppm
0.99 0.98 0.97 0.97 0.99 2.96 1.01 0.97 1.98 1.94 1.91 1.00 2.99 1.01 2.99 0.98 0.99 1.00 1.36 2.55 1.27 3.04

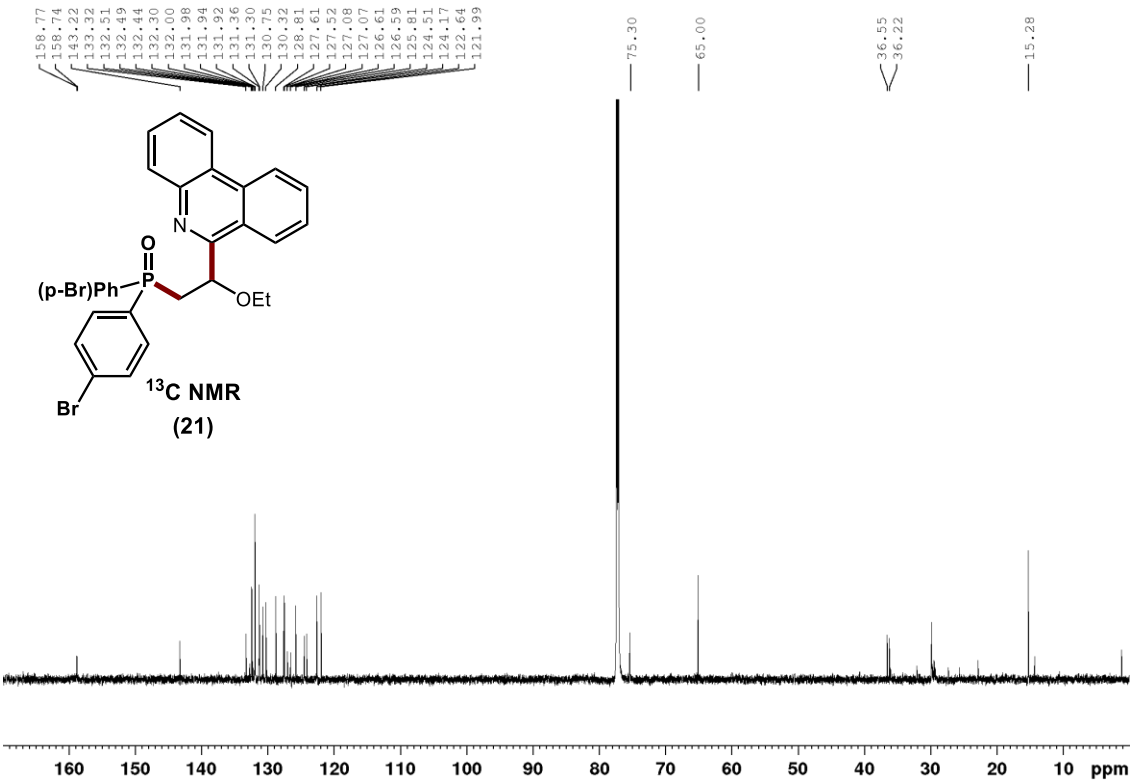

163.735 163.720 162.183 162.168 160.905 160.891 143.646 132.547 132.457 132.430 132.398 132.371 130.105 129.667 128.197 127.214 126.662 126.231 126.162 126.071 125.759 123.589 123.045 122.457 121.890 121.661 114.177 114.106 112.641 112.571
55.419 54.885
38.238 38.169 36.324 35.917 34.899 29.653
22.913
14.027
N
O
P
(p-OMe)Ph
n-Bu
MeO
13C NMR
(20)
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

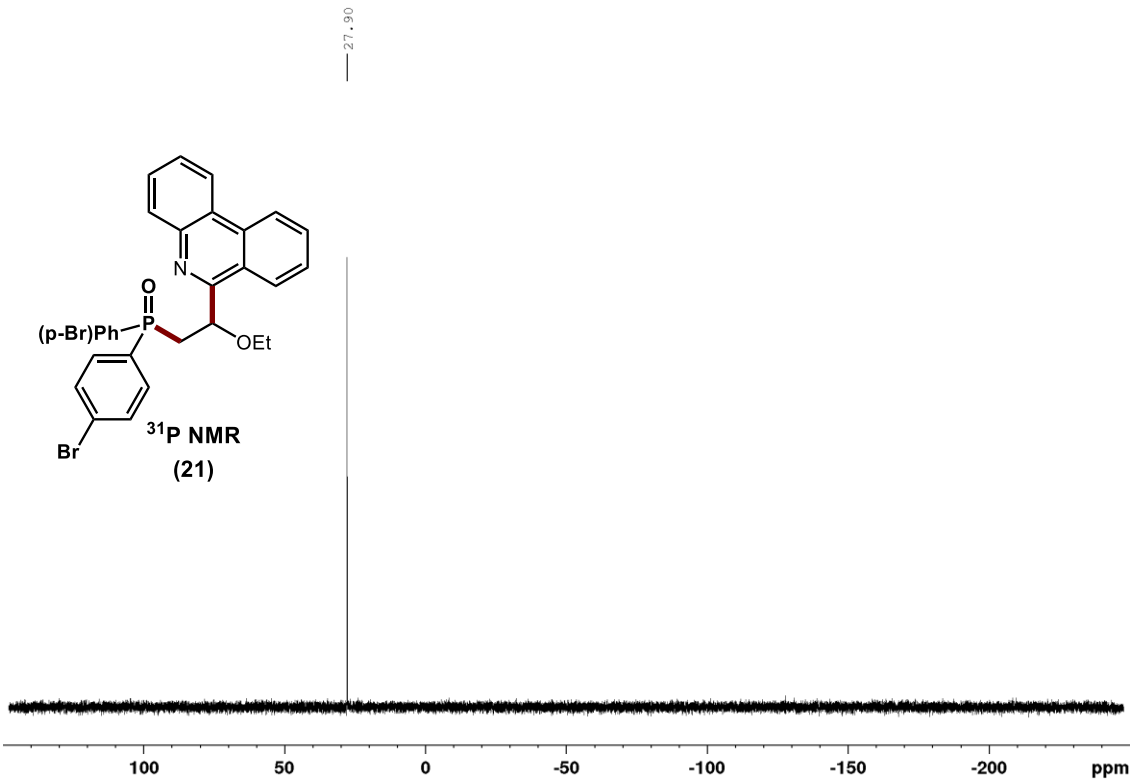


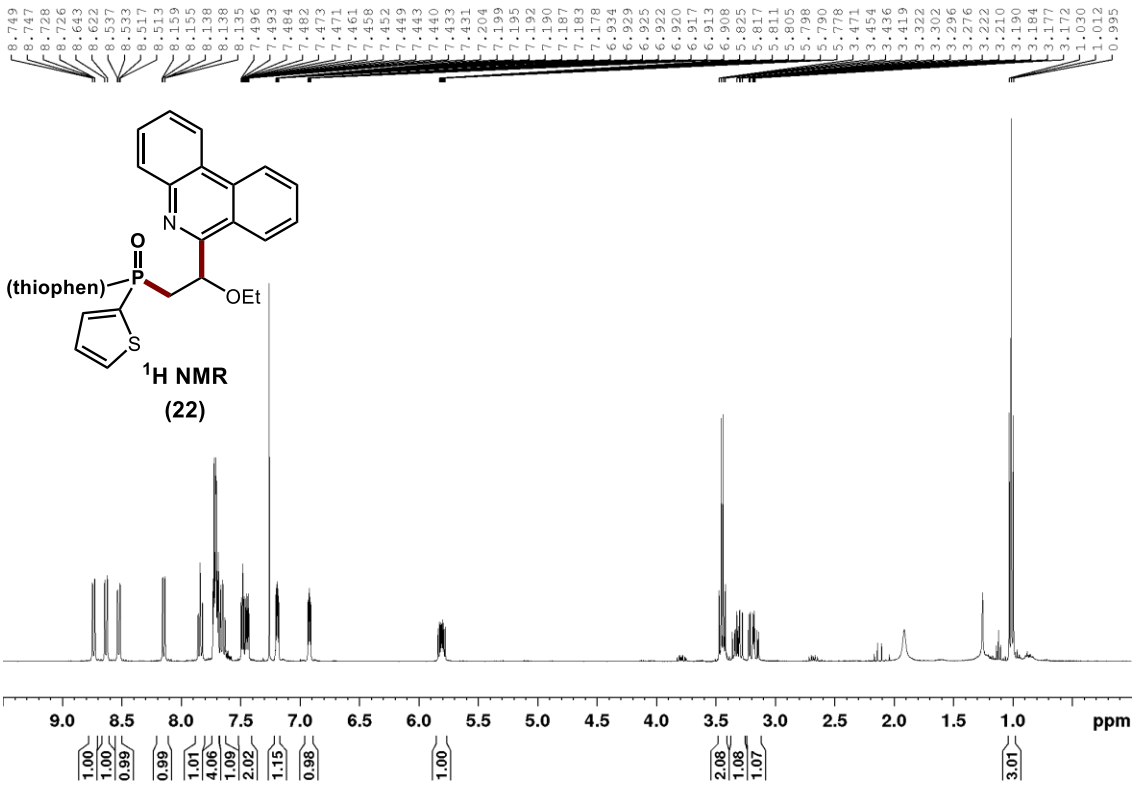
^{31}P NMR
(20)

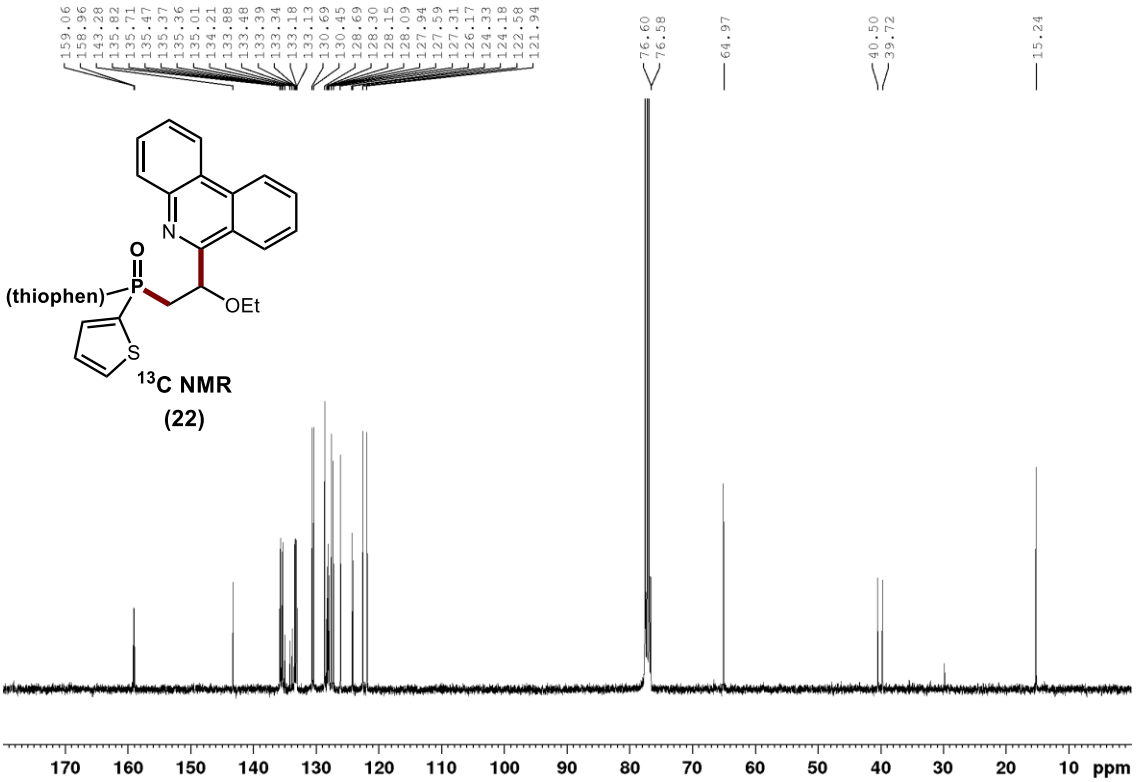


^{1}H NMR
(21)


158.77
158.74
143.22
133.32
132.51
132.49
132.44
132.30
132.00
131.98
131.94
131.92
131.36
131.30
130.75
130.32
128.81
127.61
127.52
127.08
127.07
126.61
126.59
125.81
124.51
124.17
122.64
121.99
75.30
65.00
36.55
36.22
15.28
N
O
P
(p-Br)Ph
OEt
Br
13C NMR
(21)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

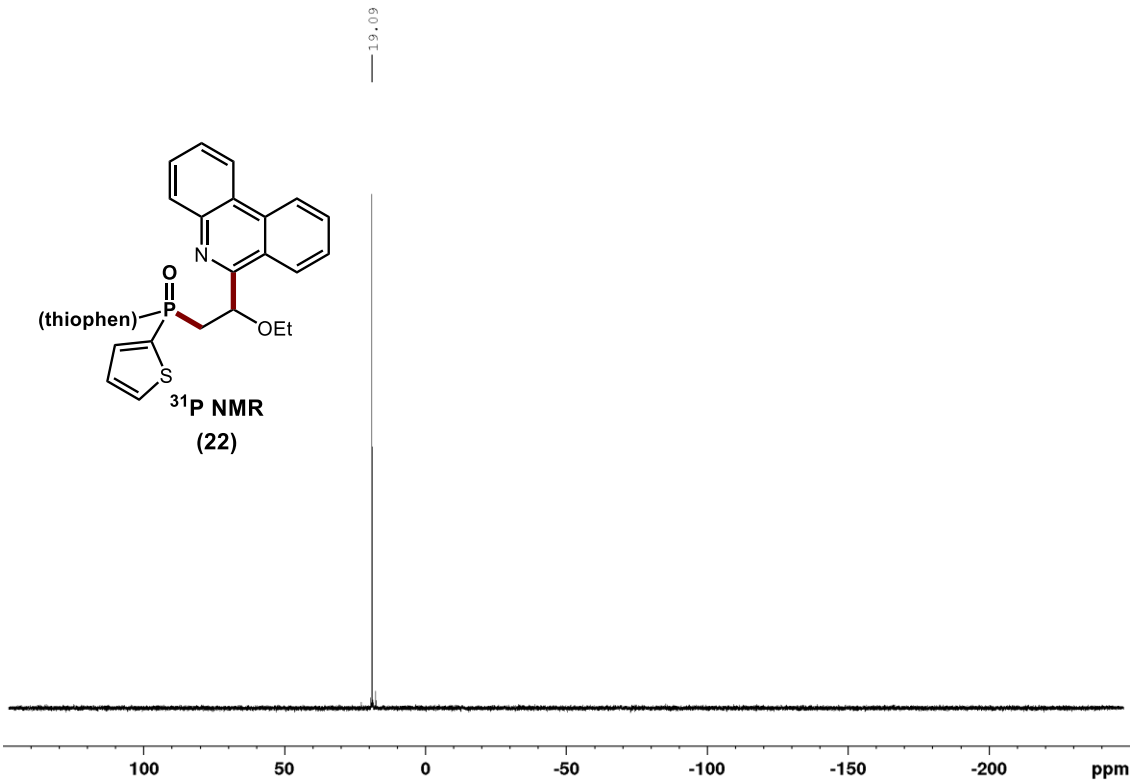

27.90
N
O
P
(p-Br)Ph
OEt
Br
31P NMR
(21)
100
50
0
-50
-100
-150
-200
ppm

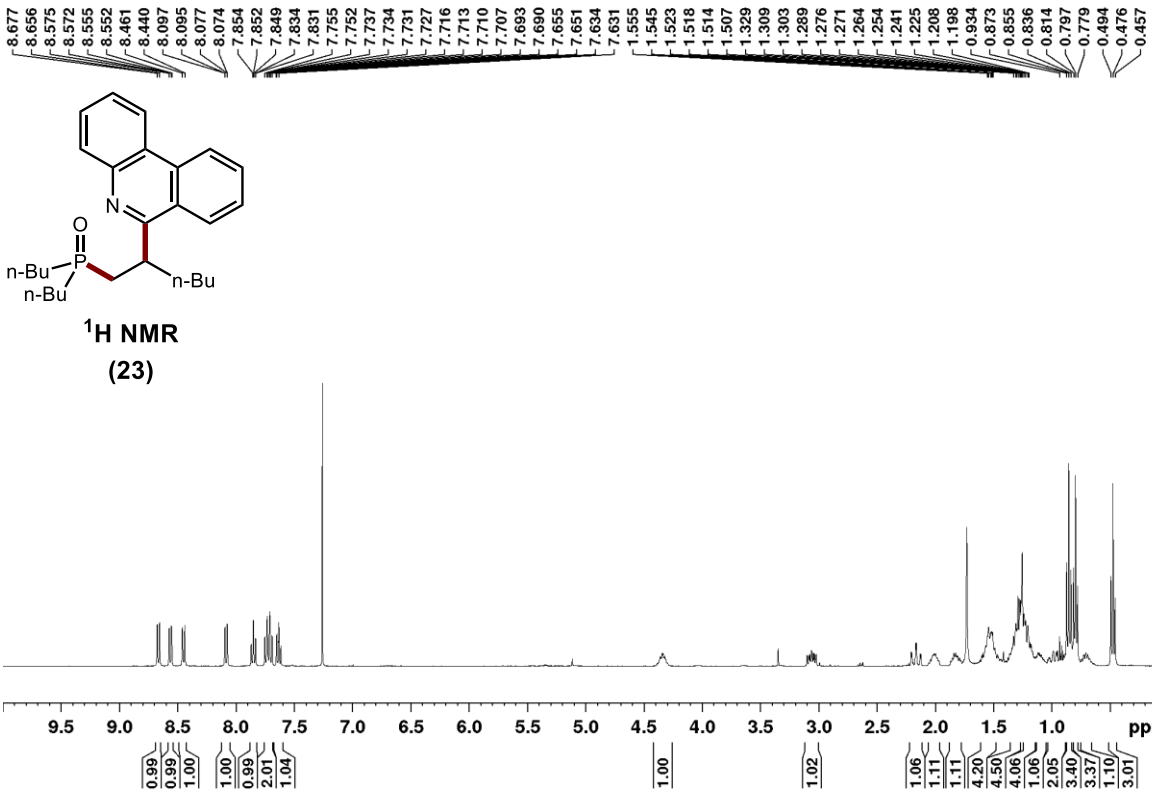

8.749 8.747 8.728 8.726 8.643 8.622 8.537 8.533 8.517 8.513 8.159 8.155 8.138 8.138 8.135 7.496 7.493 7.484 7.482 7.473 7.471 7.461 7.458 7.452 7.449 7.443 7.440 7.433 7.431 7.204 7.199 7.195 7.192 7.190 7.187 7.183 7.178 6.934 6.929 6.925 6.922 6.920 6.917 6.913 6.908 5.825 5.817 5.811 5.805 5.798 5.790 5.778 3.471 3.454 3.436 3.419 3.322 3.302 3.296 3.276 3.222 3.210 3.190 3.184 3.177 3.172 1.030 1.012 0.995
N
O
P
(thiophen)
OEt
S
^{1}H NMR
(22)
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 ppm
1.00 1.00 0.99 0.99 1.01 4.06 1.09 2.02 1.15 0.98 1.00 2.08 1.08 1.07 3.01


159.06 158.96 143.28 135.82 135.71 135.47 135.37 135.36 135.01 134.21 133.88 133.48 133.39 133.34 133.18 133.13 130.69 130.45 128.69 128.30 128.15 128.09 127.94 127.59 127.31 126.17 124.33 124.18 122.58 121.94
76.60 76.58
64.97
40.50 39.72
15.24
N
O
P
(thiophen)
OEt
S
^{13}C NMR
(22)
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

^{31}P NMR

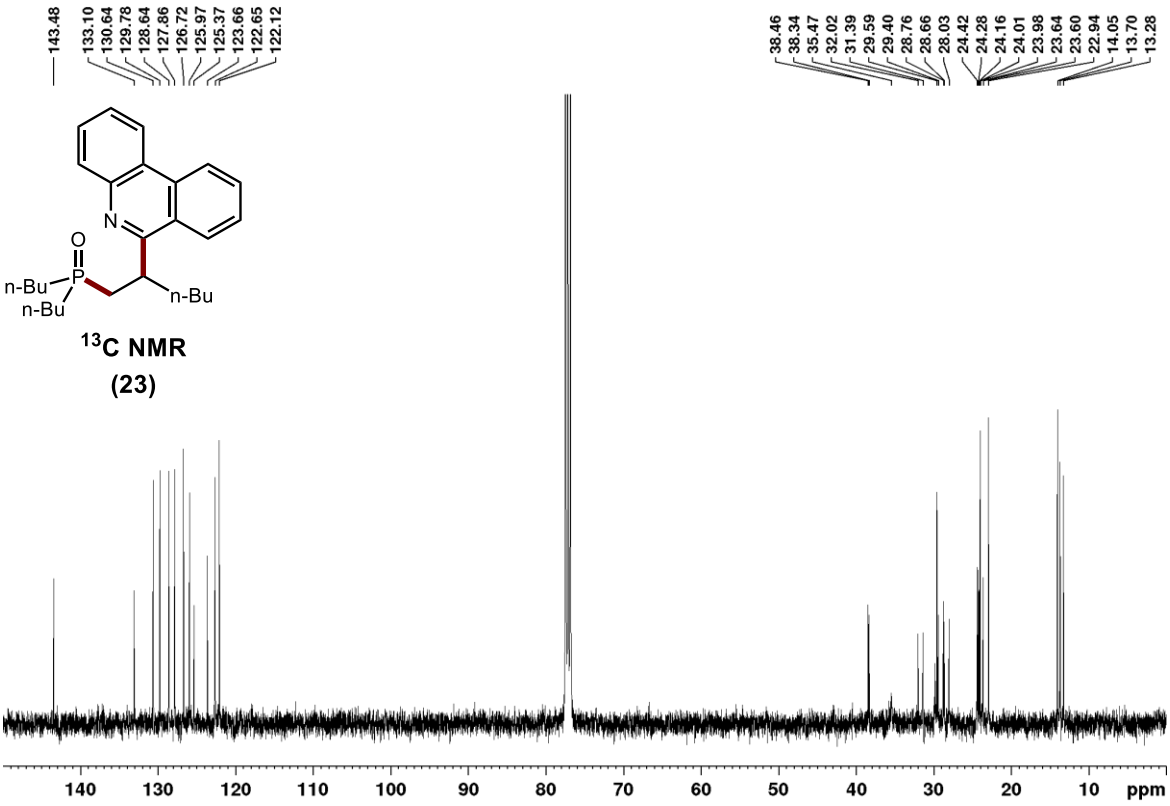
(22)





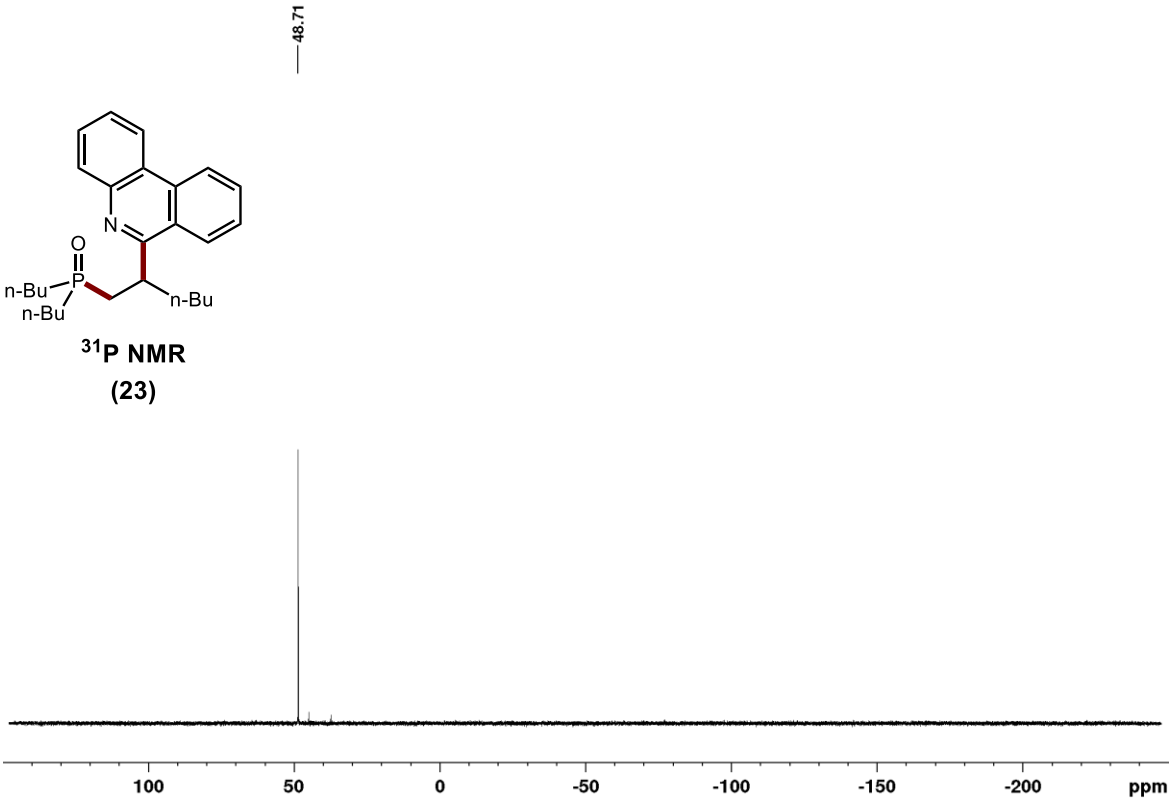
^{1}H NMR

(23)



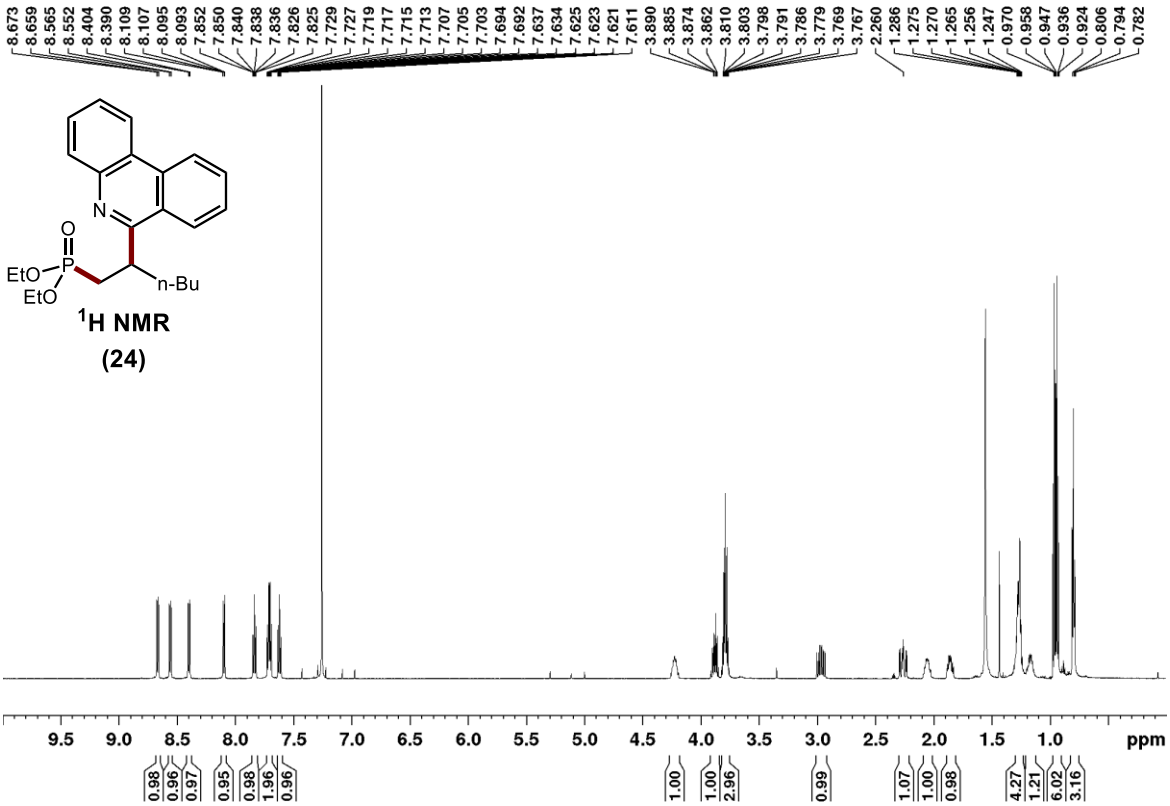
^{13}C NMR

(23)



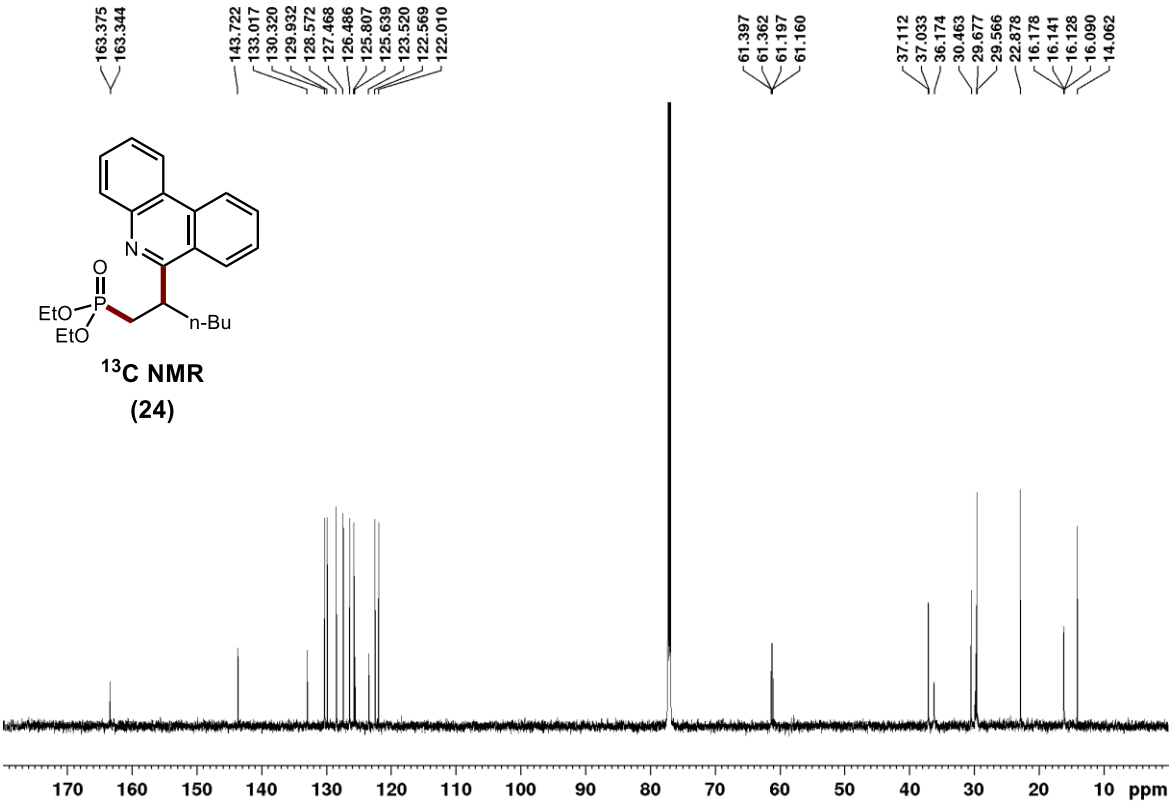
^{31}P NMR

(23)



^{1}H NMR

(24)

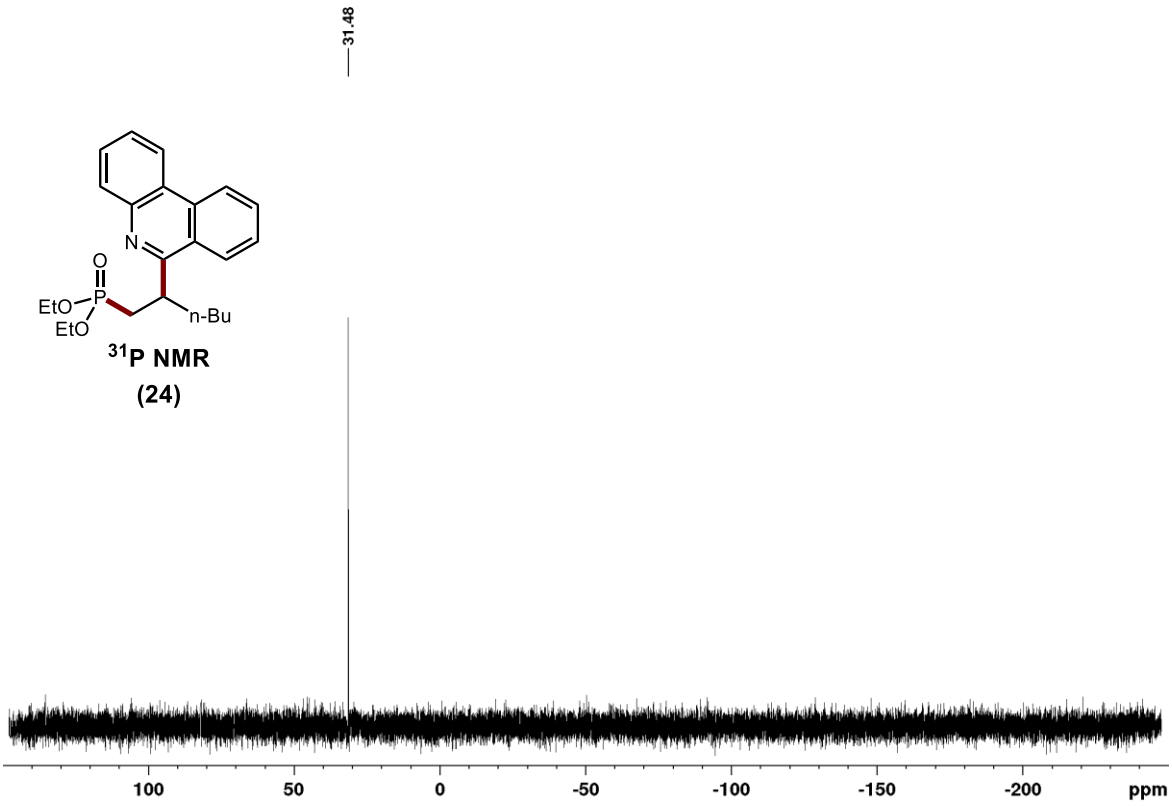


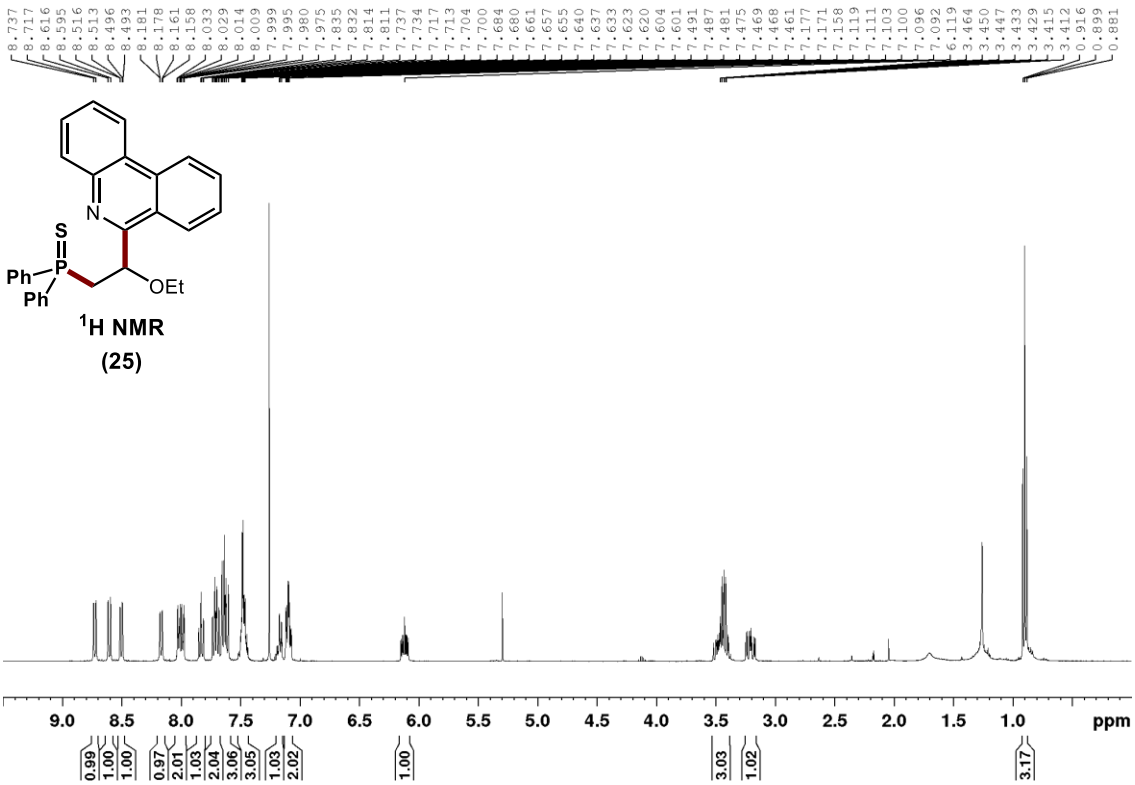
^{13}C NMR

(24)

^{31}P NMR

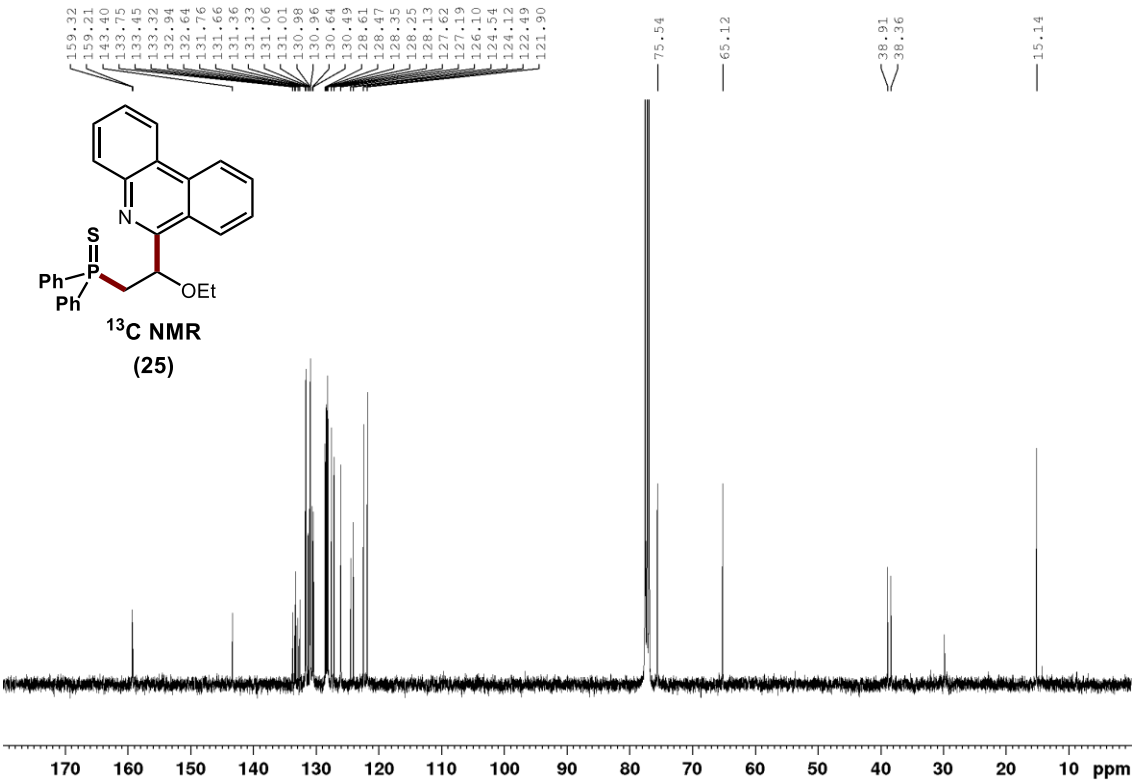
(24)





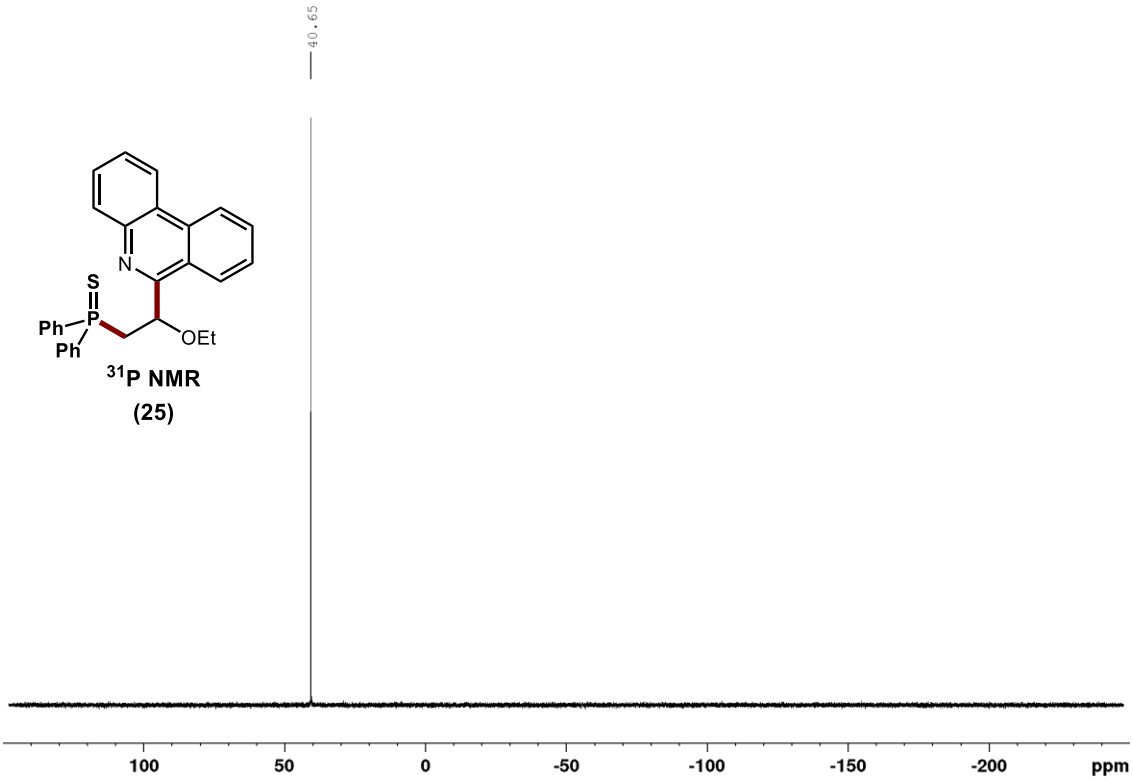
^{1}H NMR

(25)



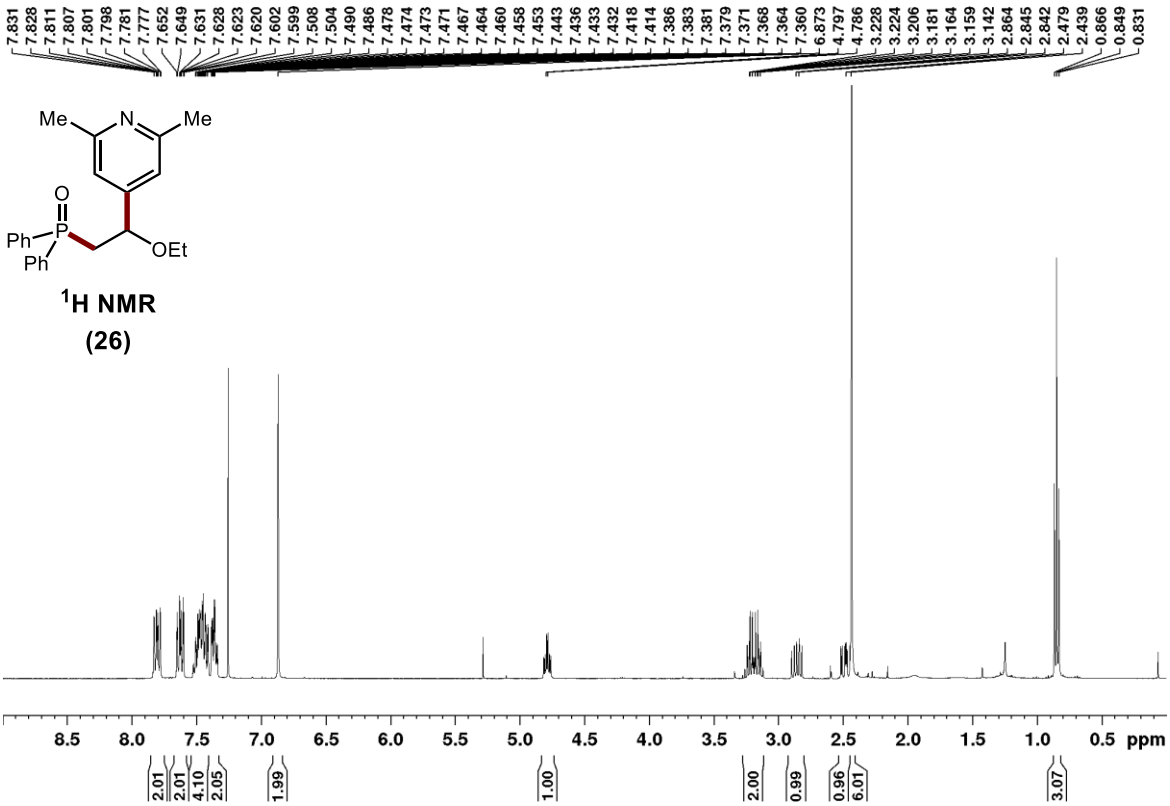
^{13}C NMR

(25)



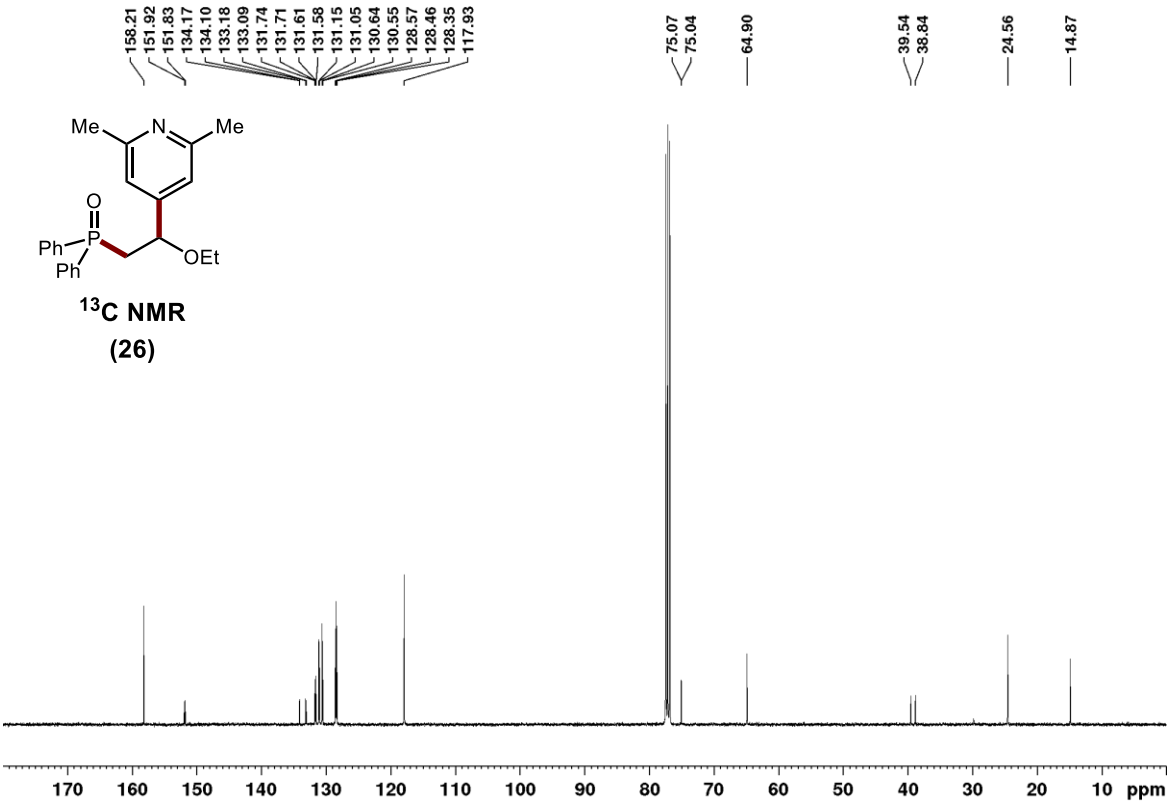
^{31}P NMR

(25)



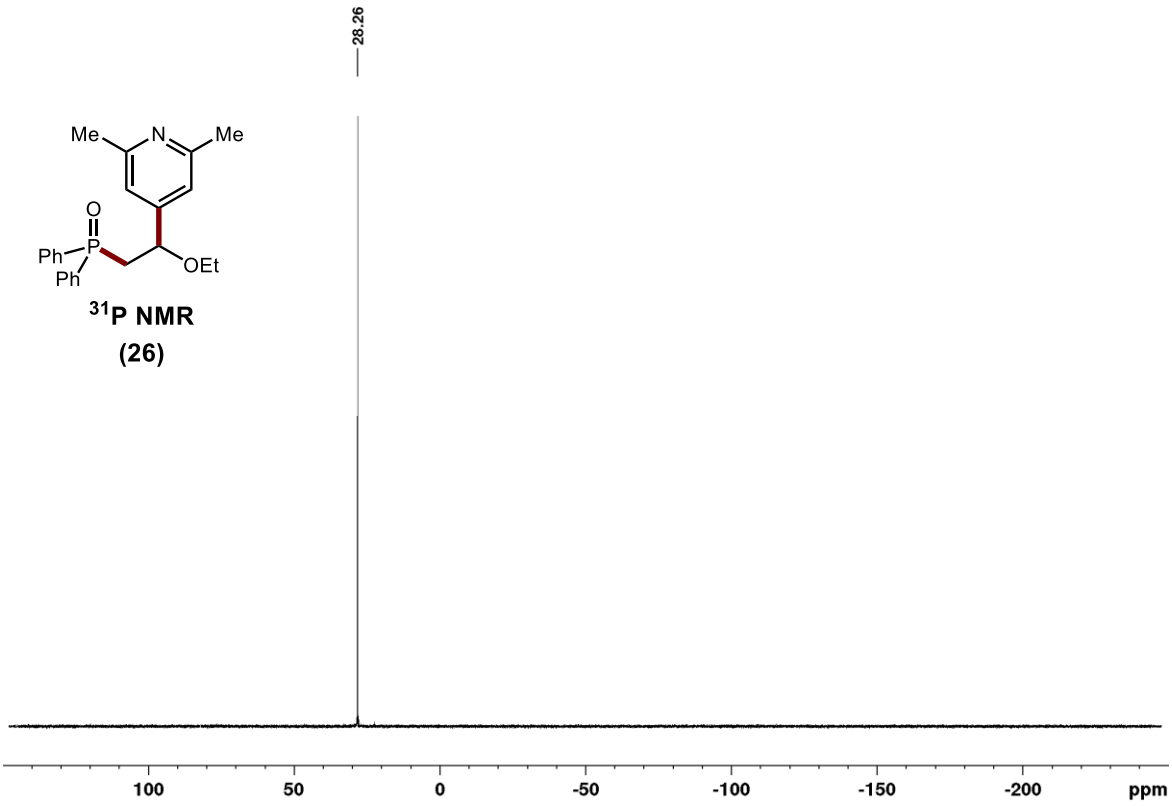
^{1}H NMR

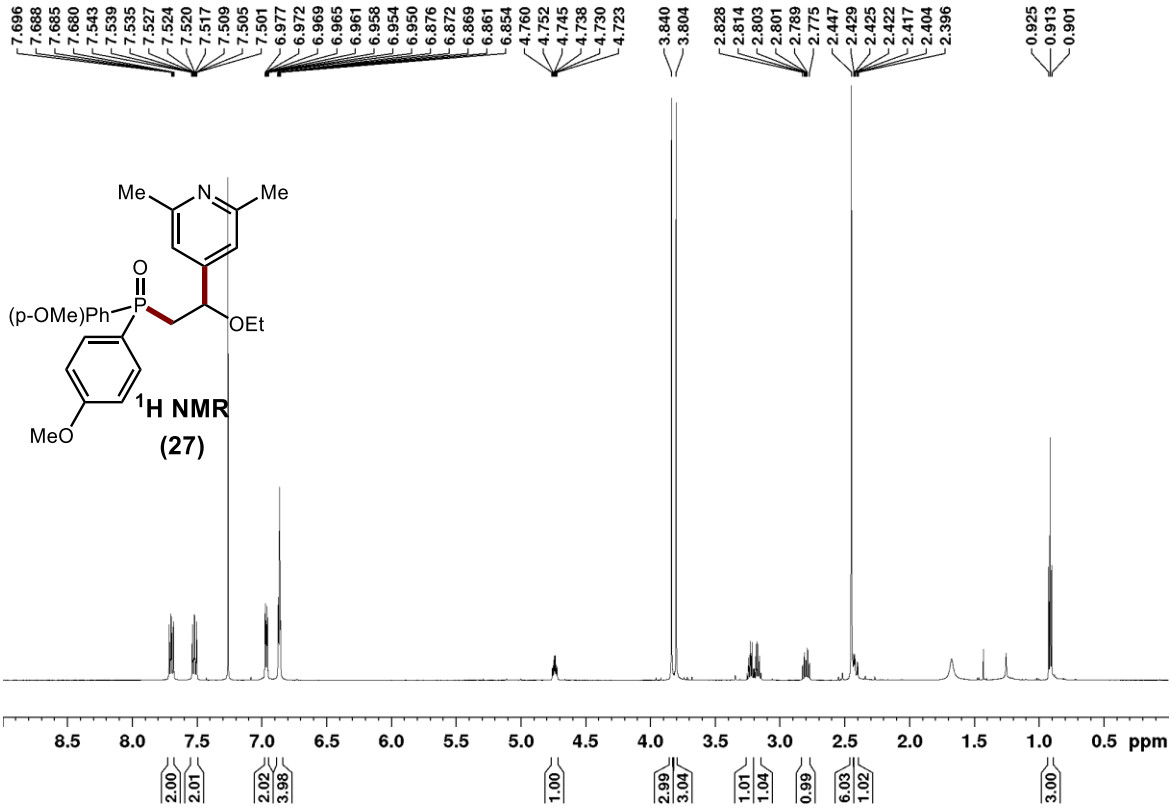
(26)

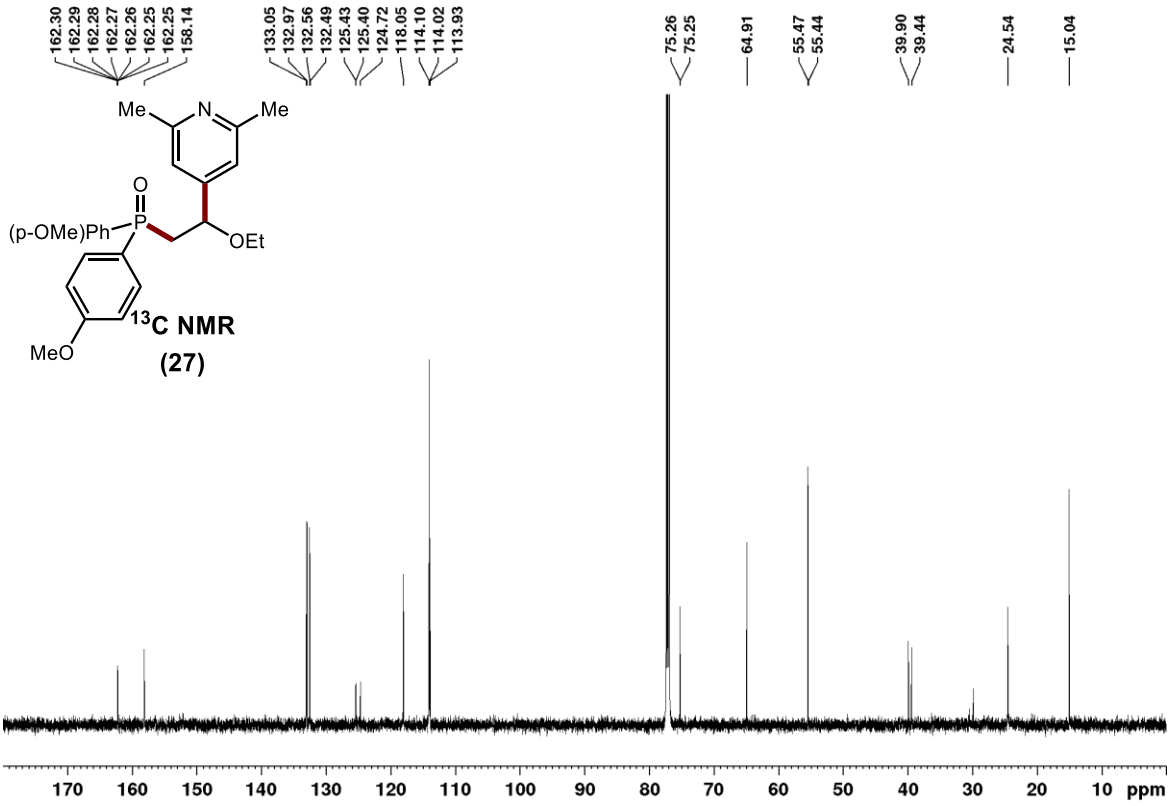


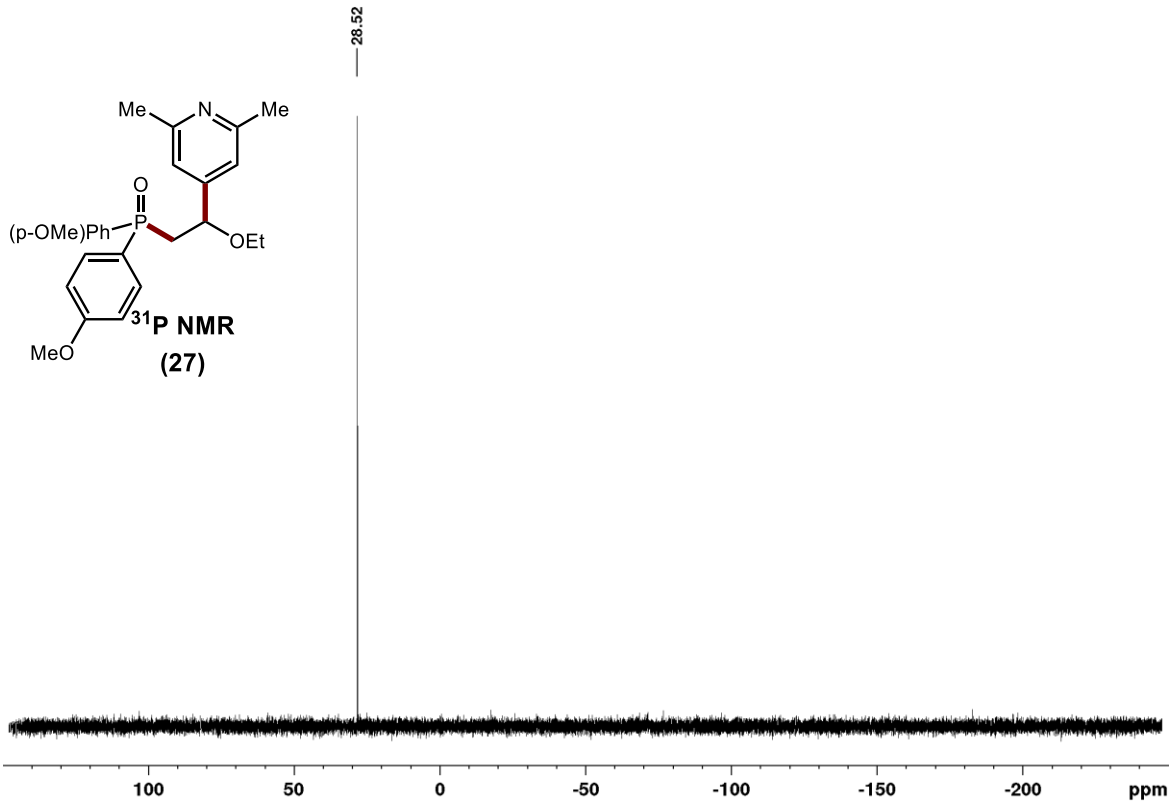
^{13}C NMR

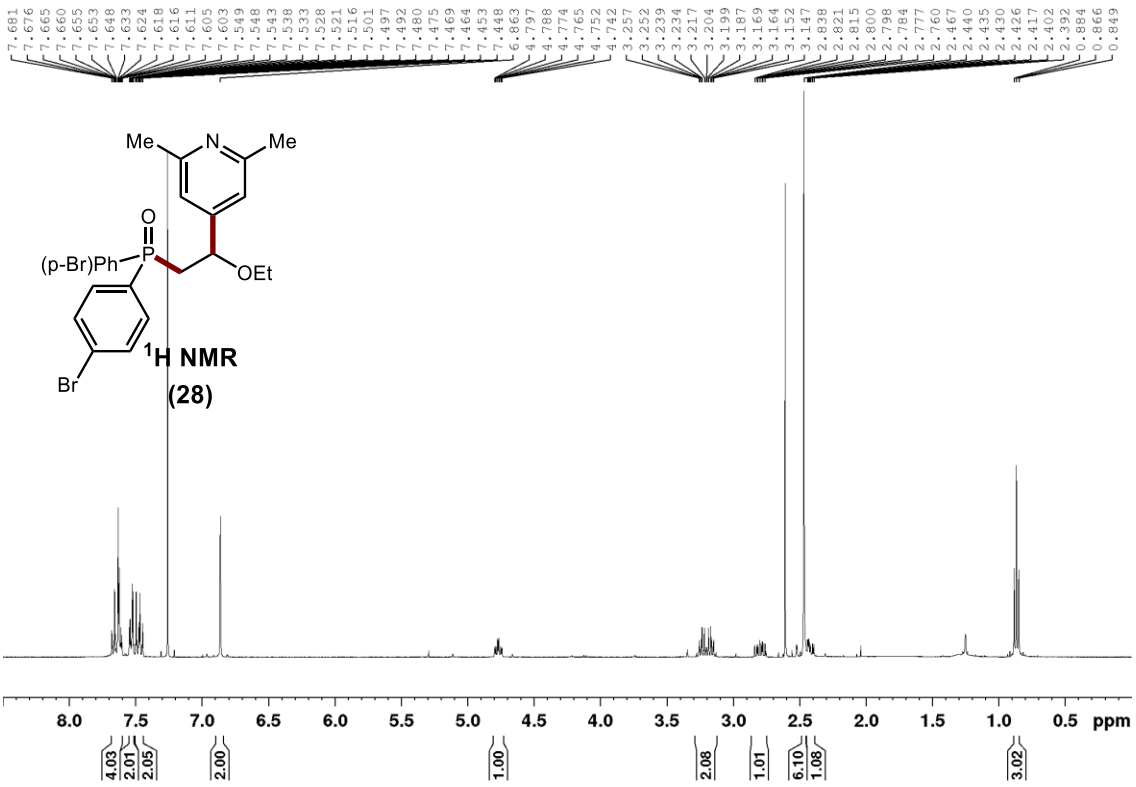
(26)

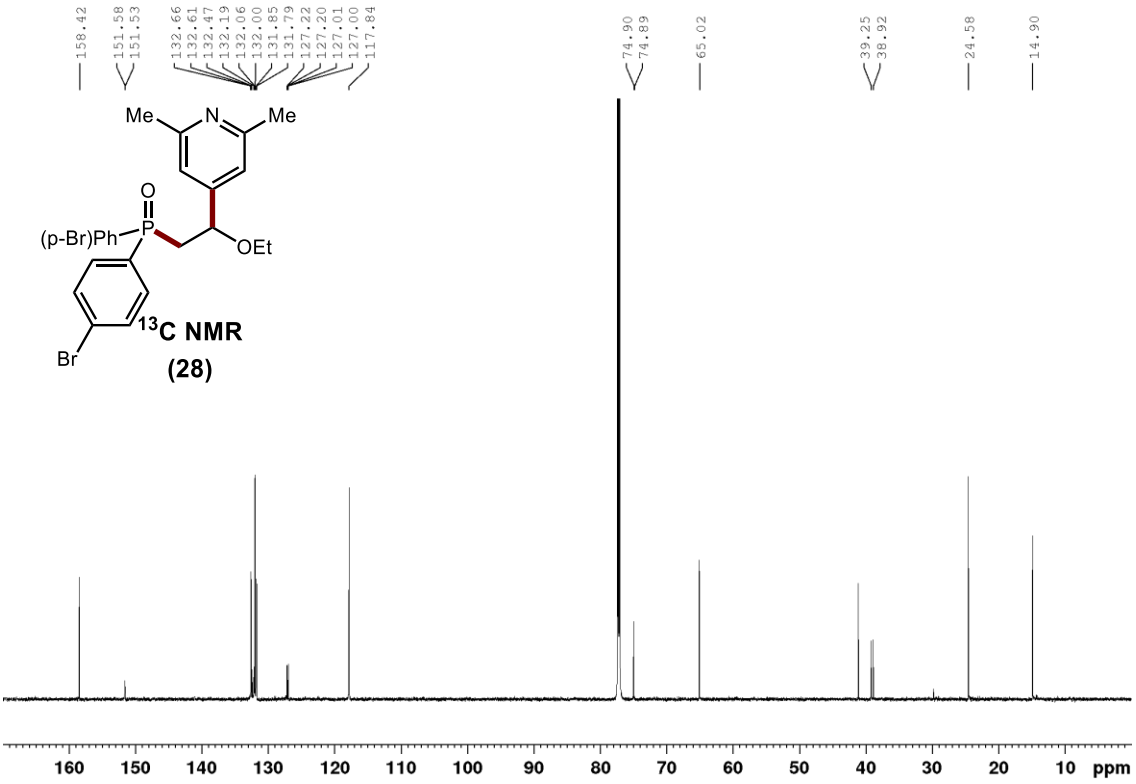

28.26
Me
N
Me
O
Ph
P
Ph
OEt
31P NMR
(26)
100
50
0
-50
-100
-150
-200
ppm

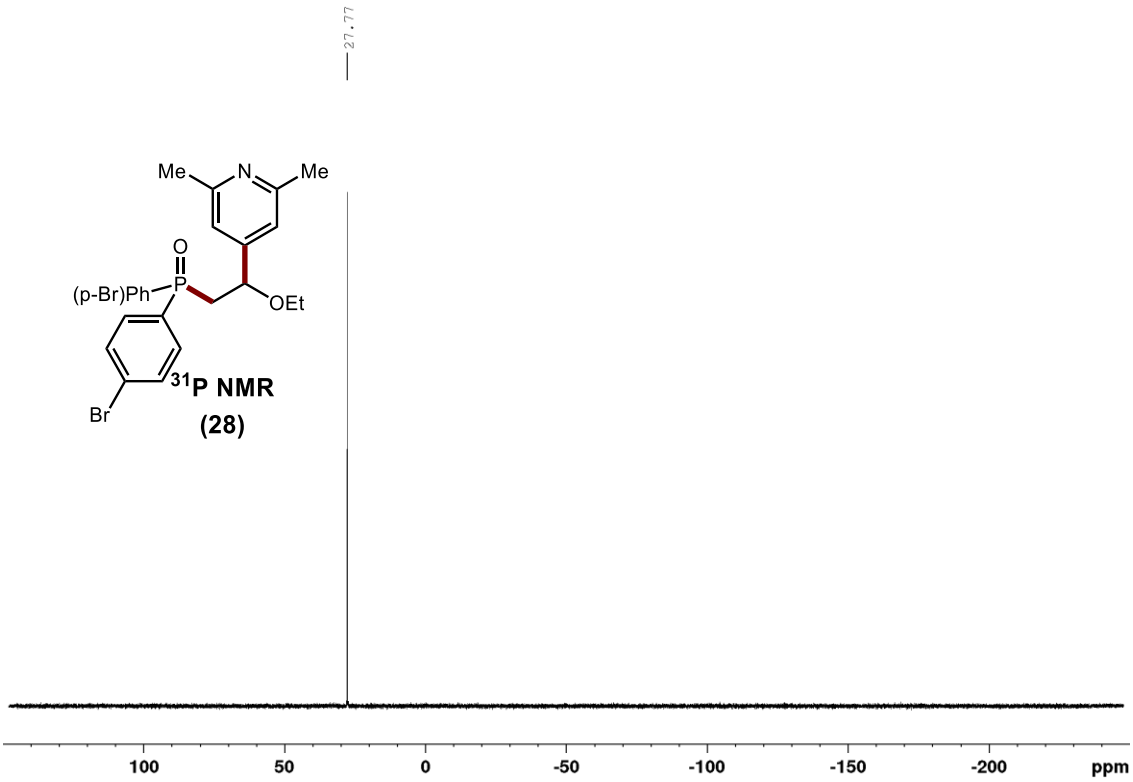

7.696
7.688
7.685
7.680
7.543
7.539
7.535
7.527
7.524
7.520
7.517
7.509
7.505
7.501
6.977
6.972
6.969
6.965
6.961
6.958
6.954
6.950
6.876
6.872
6.869
6.861
6.854
4.760
4.752
4.745
4.738
4.730
4.723
3.840
3.804
2.828
2.814
2.803
2.801
2.789
2.775
2.447
2.429
2.425
2.422
2.417
2.404
2.396
0.925
0.913
0.901
Me
N
Me
O
(p-OMe)Ph
P
OEt
MeO
1H NMR
(27)
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
ppm
2.00
2.01
2.02
3.98
1.00
2.99
3.04
1.01
1.04
0.99
6.03
1.02
3.00

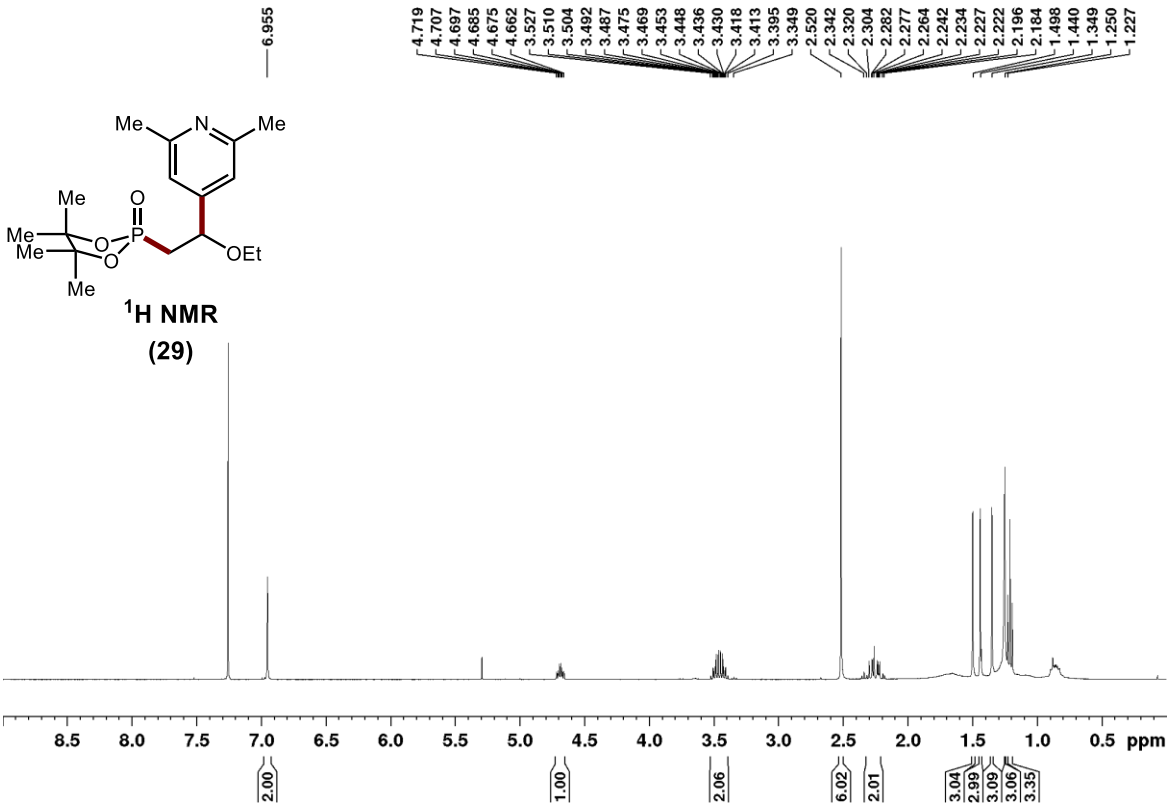

162.30
162.29
162.28
162.27
162.26
162.25
162.25
158.14
133.05
132.97
132.56
132.49
125.43
125.40
124.72
118.05
114.10
114.02
113.93
75.26
75.25
64.91
55.47
55.44
39.90
39.44
24.54
15.04
Me
N
Me
O
P
(p-OMe)Ph
OEt
MeO
13C NMR
(27)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

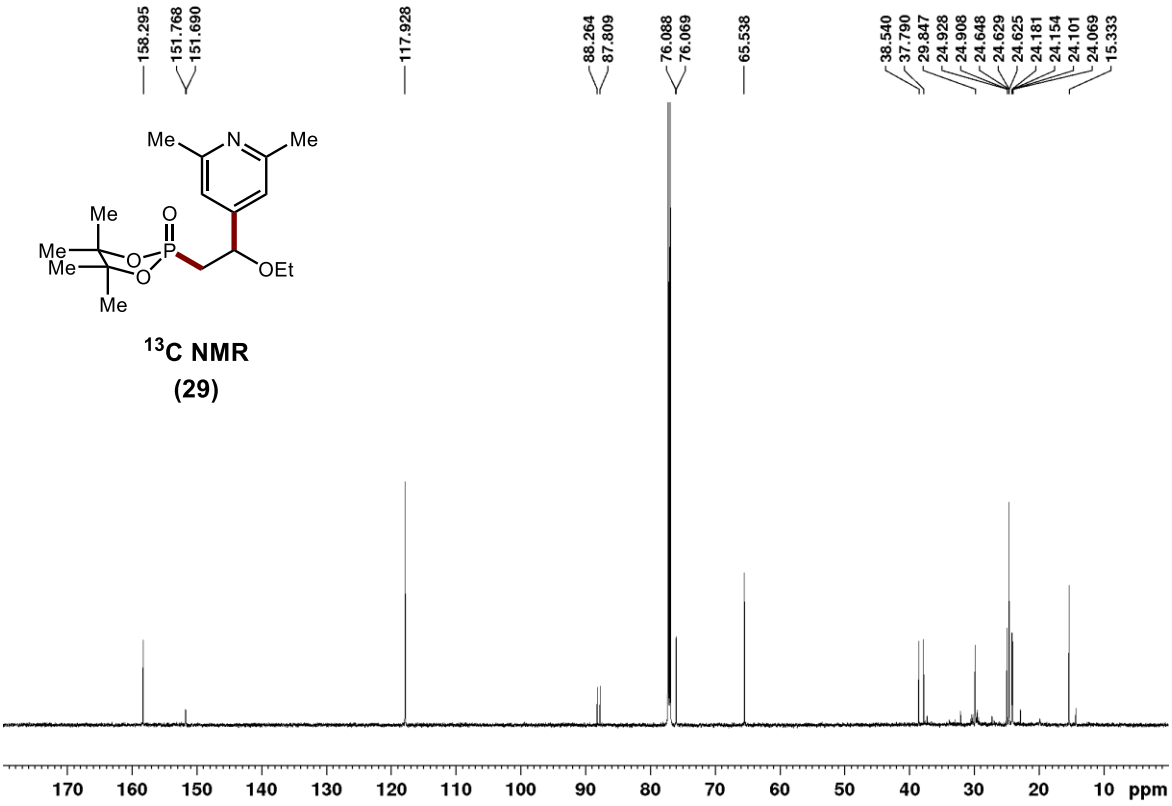

28.52
Me
N
Me
O
P
(p-OMe)Ph
OEt
MeO
31P NMR
(27)
100
50
0
-50
-100
-150
-200
ppm


Me
N
Me
O
P
(p-Br)Ph
OEt
Br
1H NMR
(28)
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 ppm
4.03
2.01
2.05
2.00
1.00
2.08
1.01
6.10
1.08
3.02

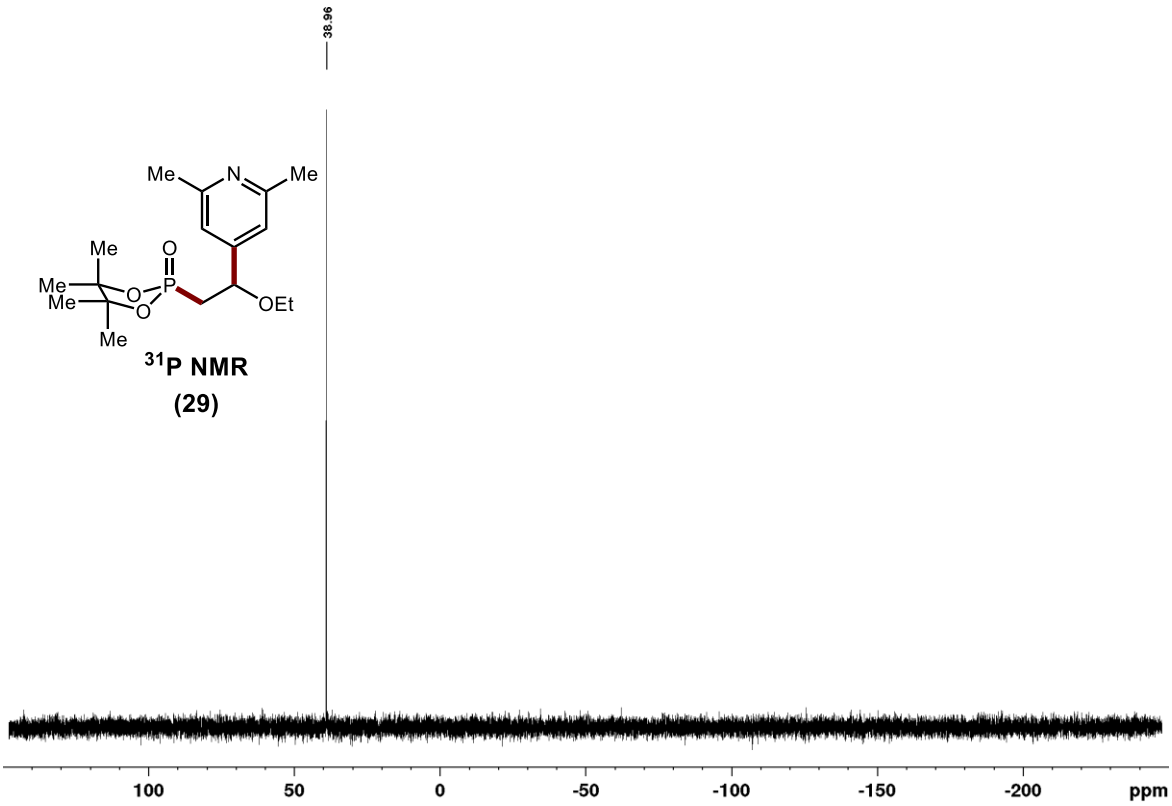

158.42
151.58
151.53
132.66
132.61
132.47
132.19
132.06
132.00
131.85
131.79
127.22
127.20
127.01
127.00
117.84
74.90
74.89
65.02
39.25
38.92
24.58
14.90
Me
N
Me
O
P
(p-Br)Ph
OEt
Br
13C NMR
(28)
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


27.77
Me
N
Me
O
P
(p-Br)Ph
OEt
Br
31P NMR
(28)
100
50
0
-50
-100
-150
-200
ppm

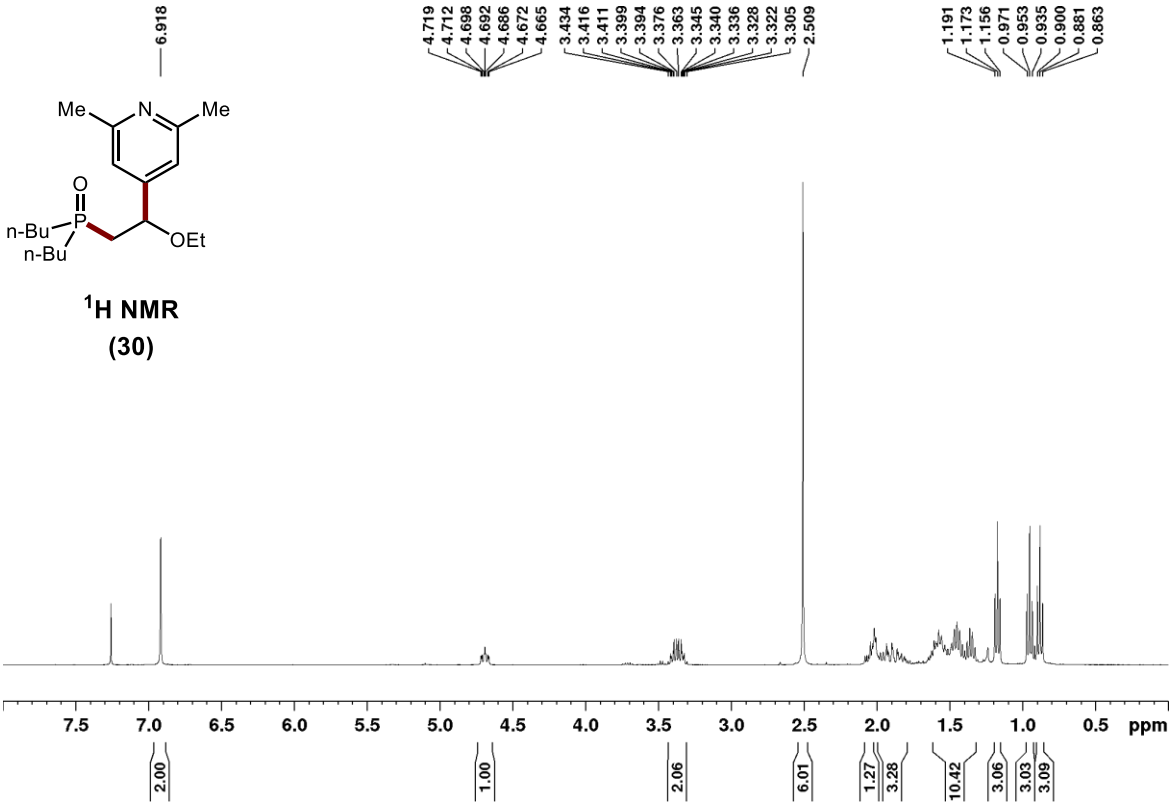

6.955
4.719
4.707
4.697
4.685
4.675
4.662
3.527
3.510
3.504
3.492
3.487
3.475
3.469
3.453
3.448
3.436
3.430
3.418
3.413
3.395
3.349
2.520
2.342
2.320
2.304
2.282
2.277
2.264
2.242
2.234
2.227
2.222
2.196
2.184
1.498
1.440
1.349
1.250
1.227
Me
N
Me
Me
O
P
Me
Me
O
O
OEt
Me
1H NMR
(29)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
1.00
2.06
6.02
2.01
3.04
2.99
3.09
3.06
3.35



^{13}C NMR
(29)

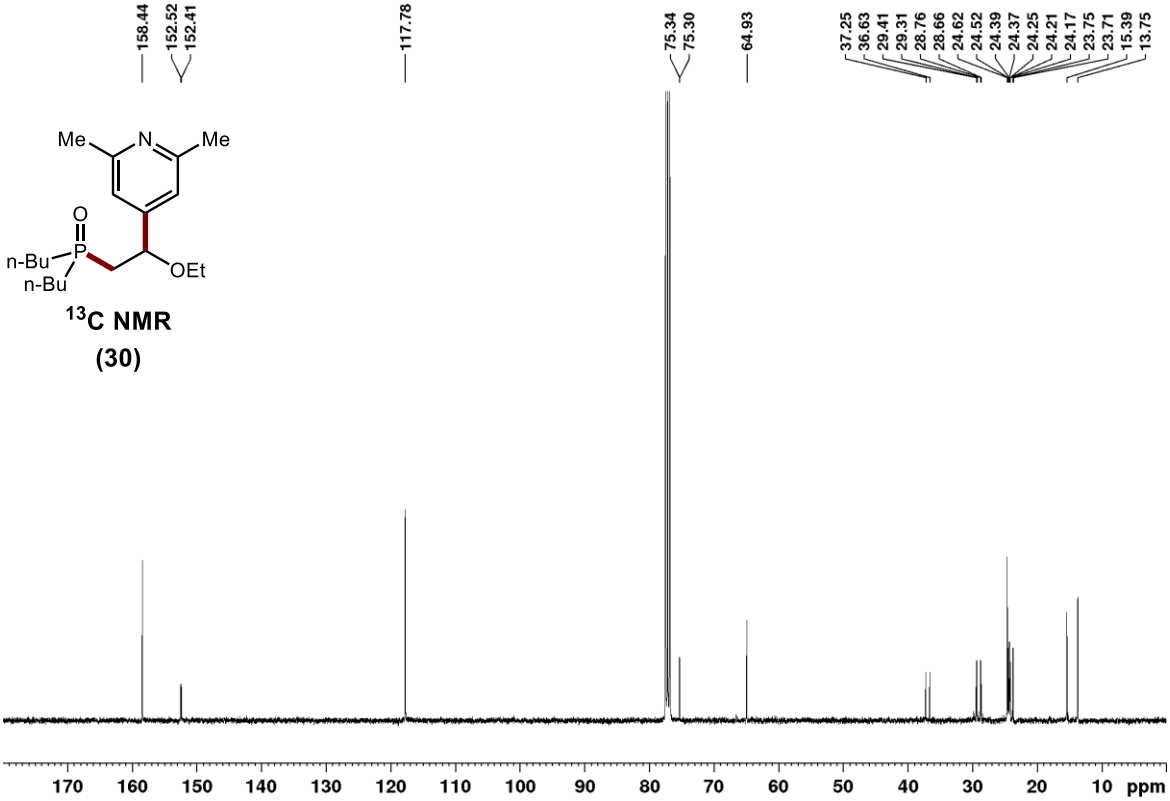


^{31}P NMR
(29)



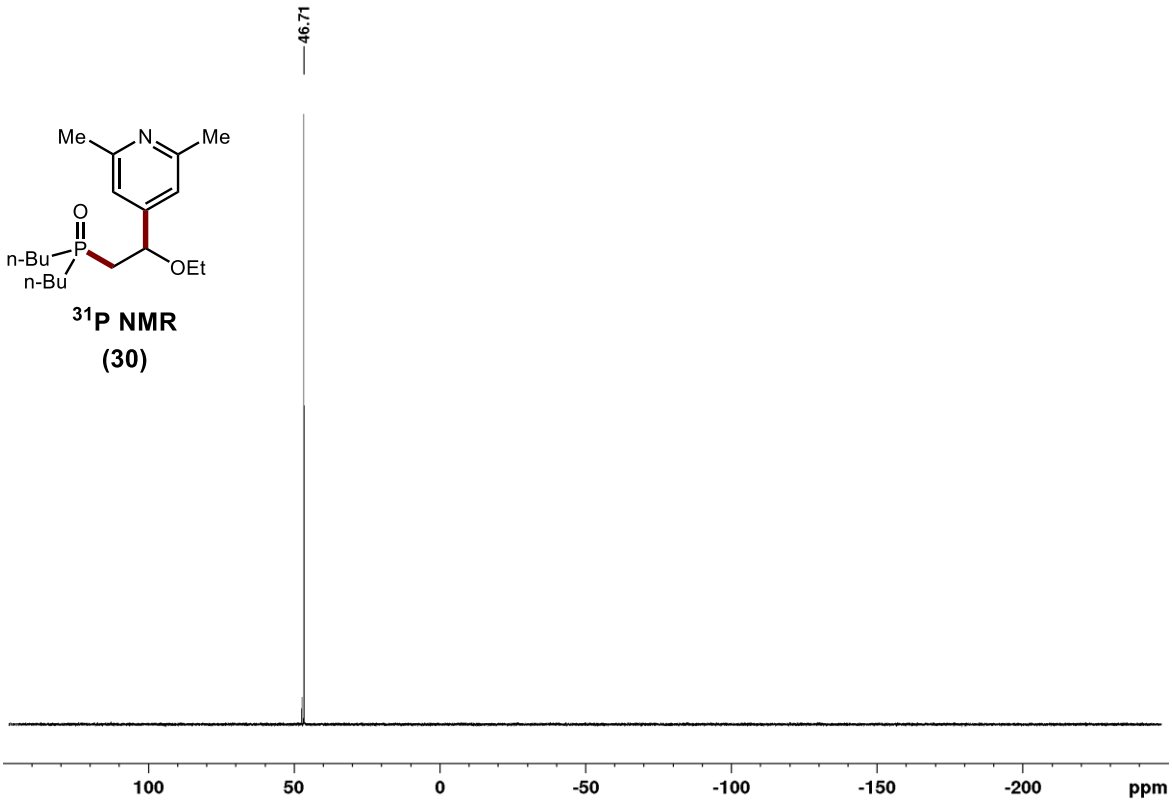
^{1}H NMR

(30)



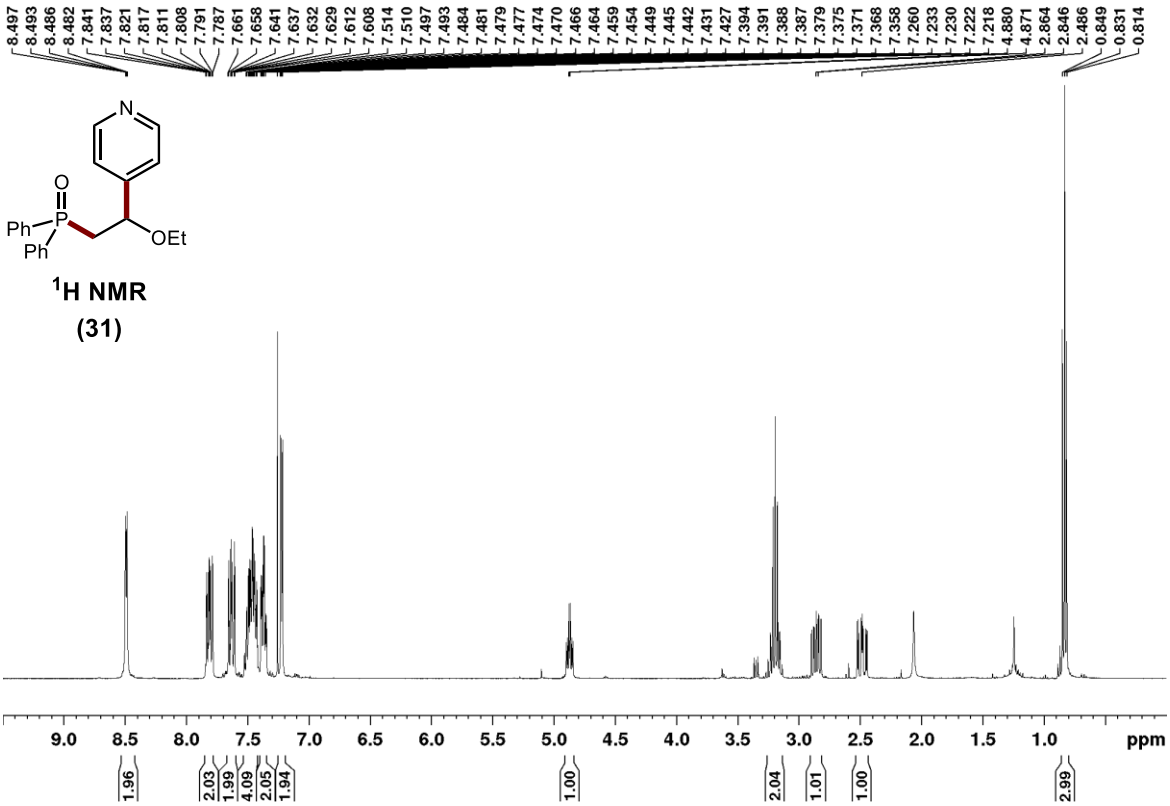
^{13}C NMR

(30)



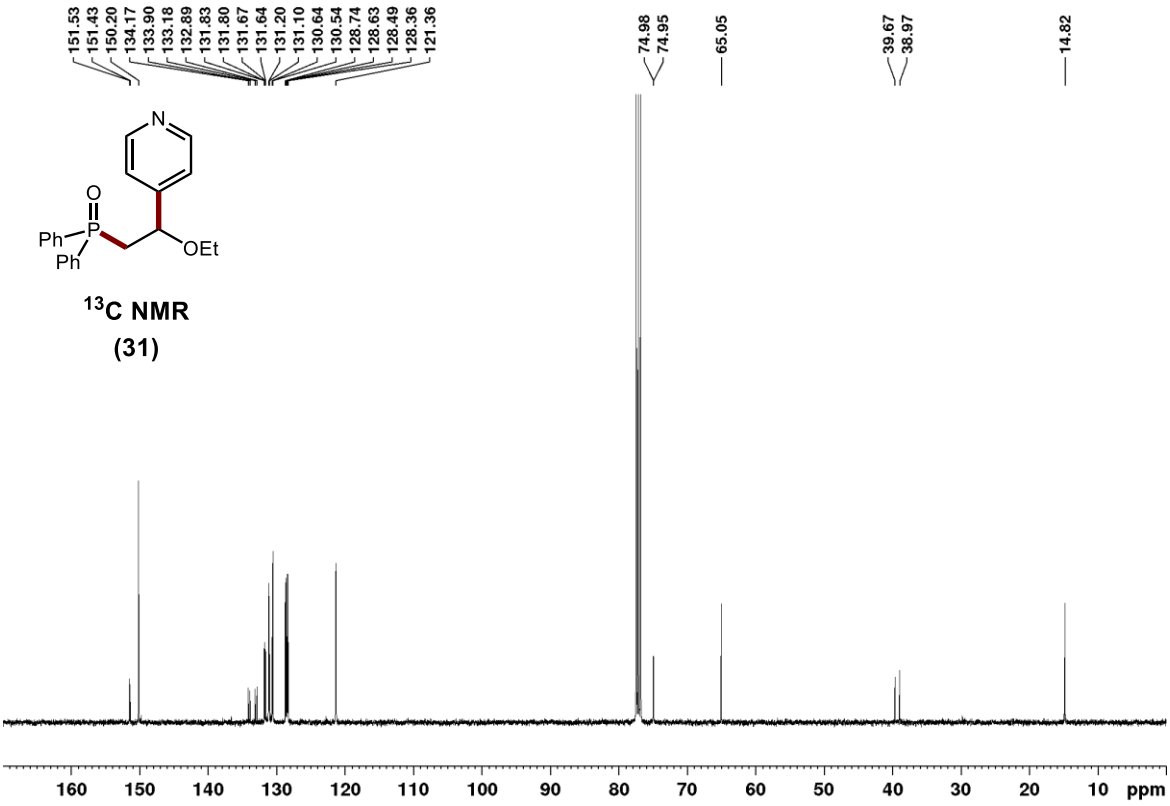
^{31}P NMR

(30)

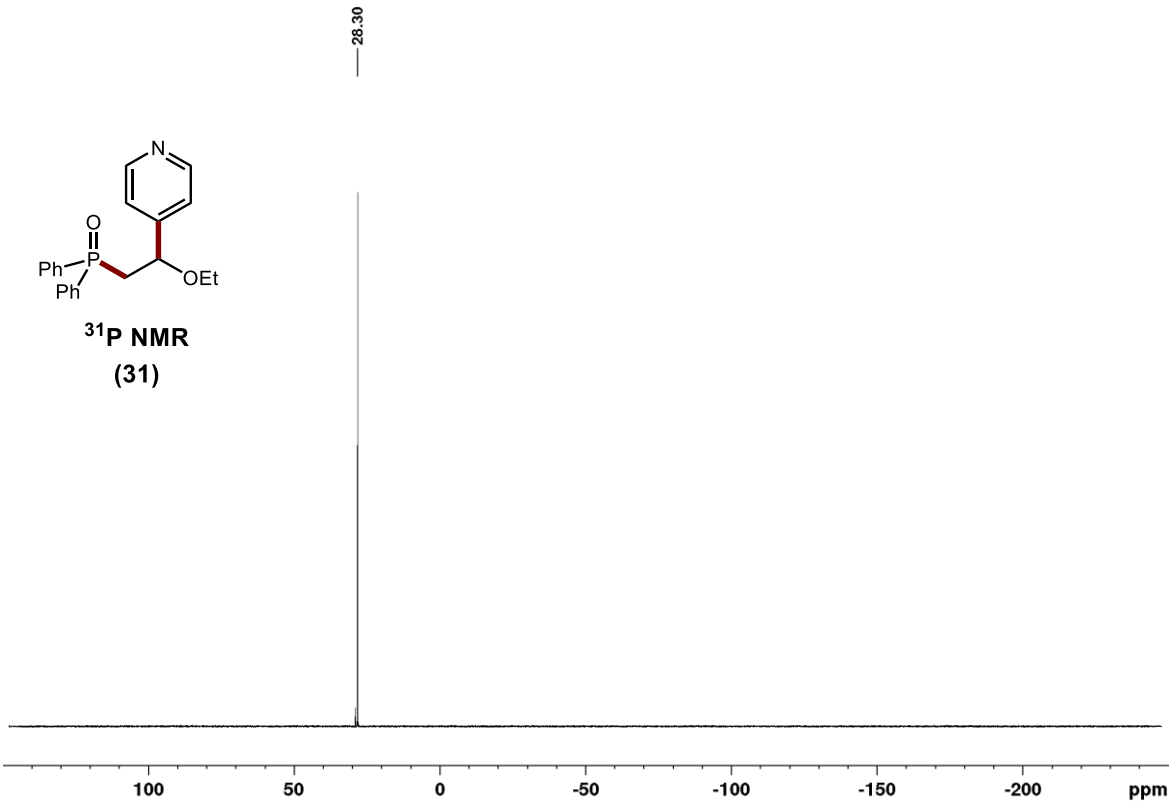


^{1}H NMR

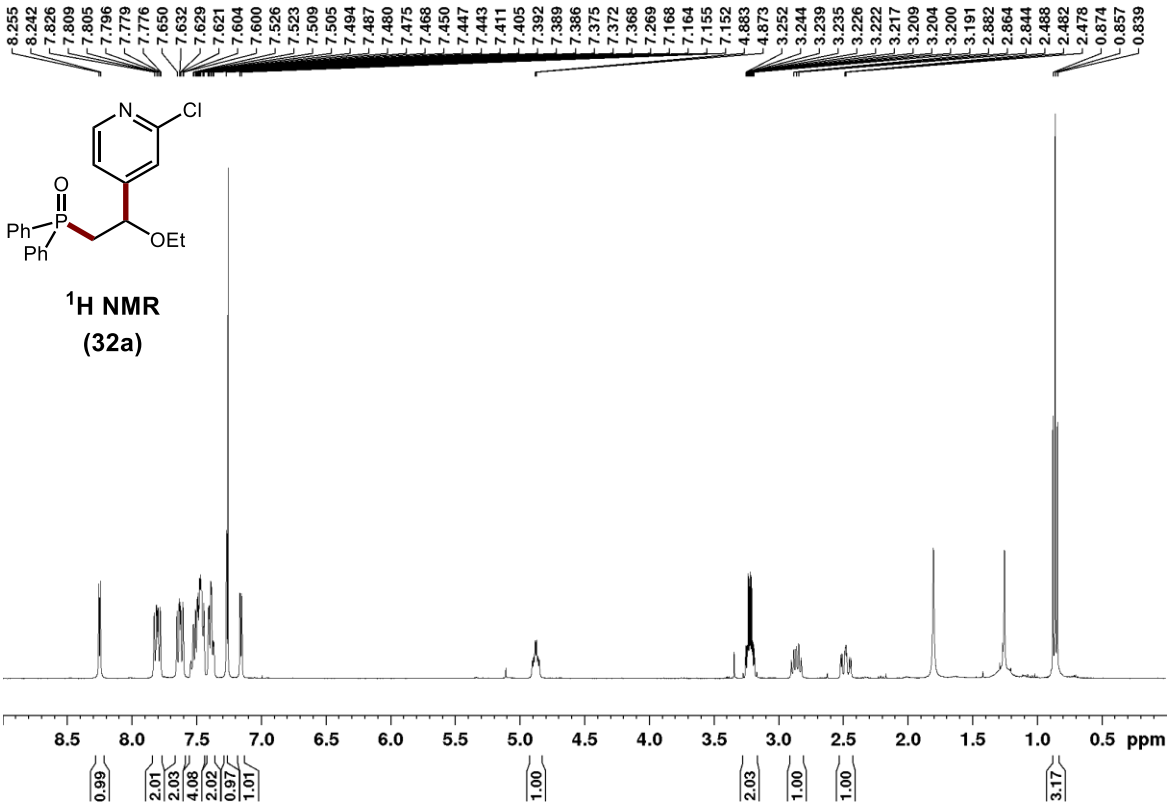
(31)



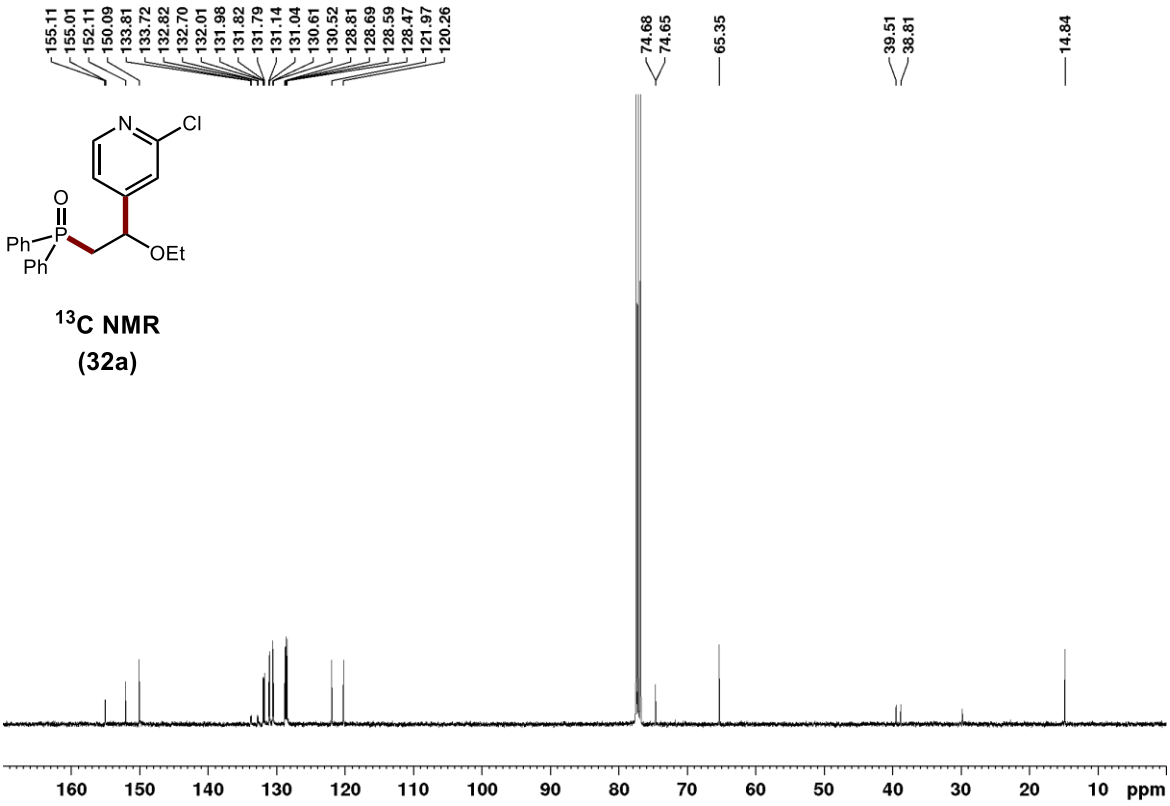
^{13}C NMR
(31)



^{31}P NMR
(31)



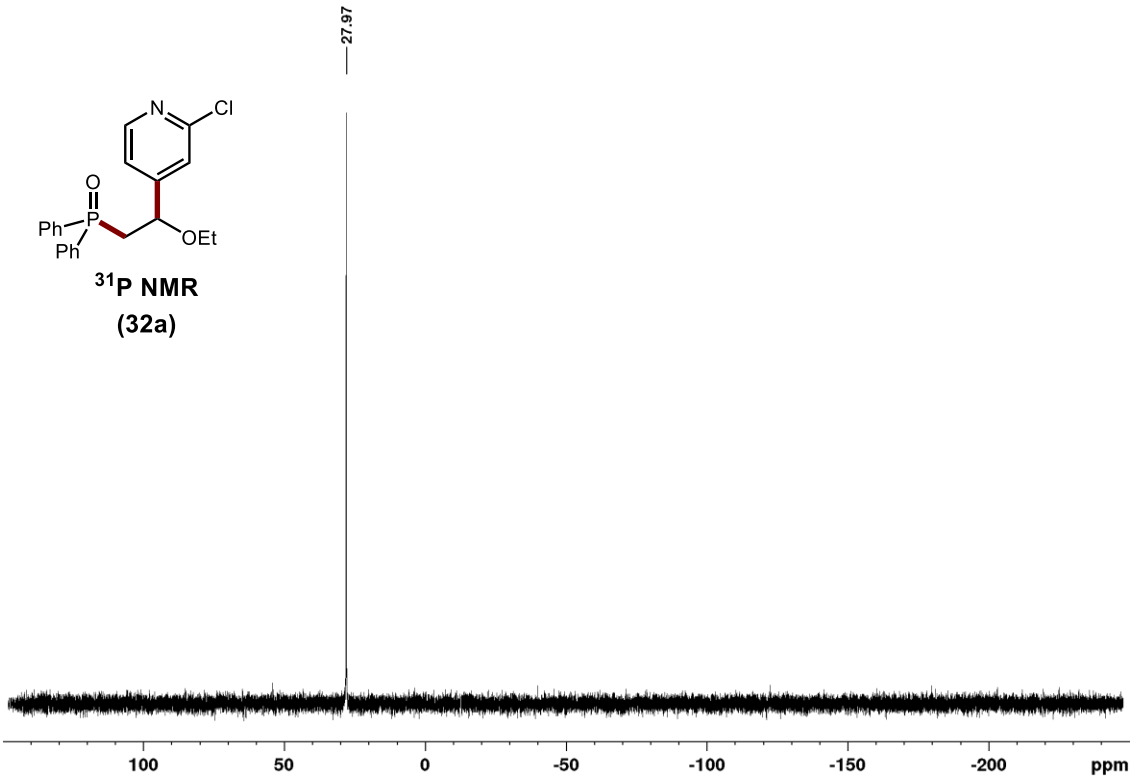
^{1}H NMR
(32a)

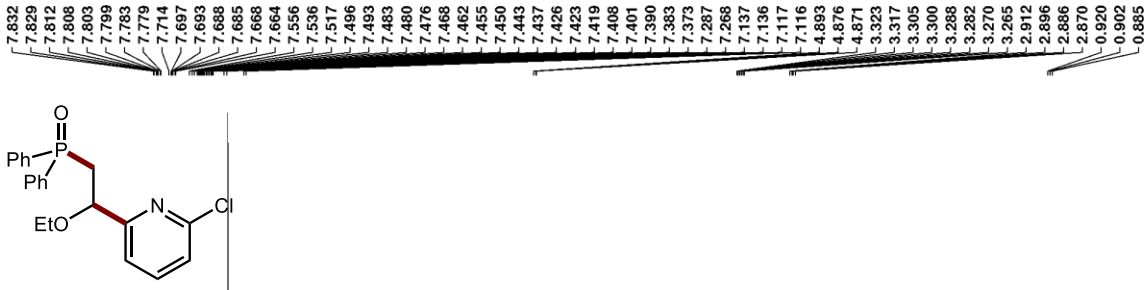


^{13}C NMR
(32a)

^{31}P NMR

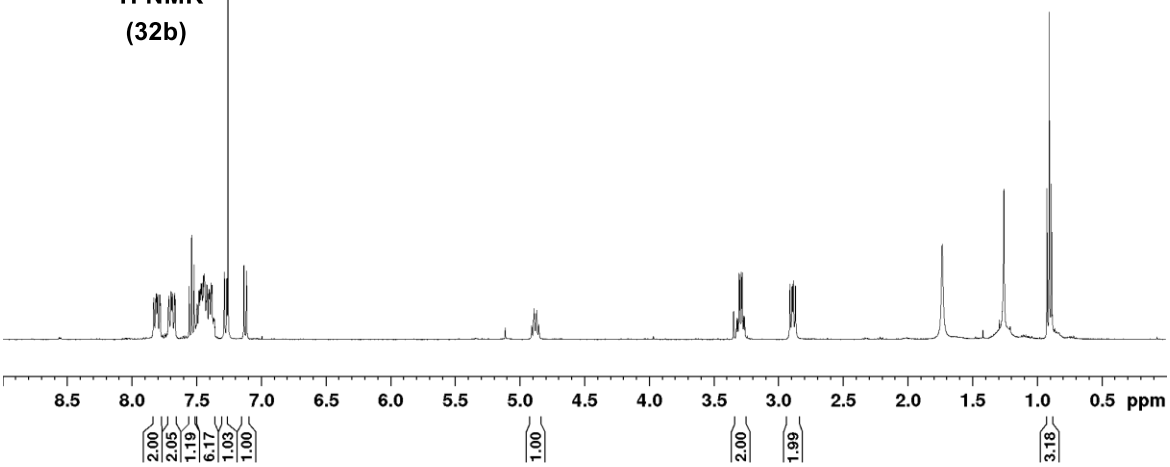
(32a)

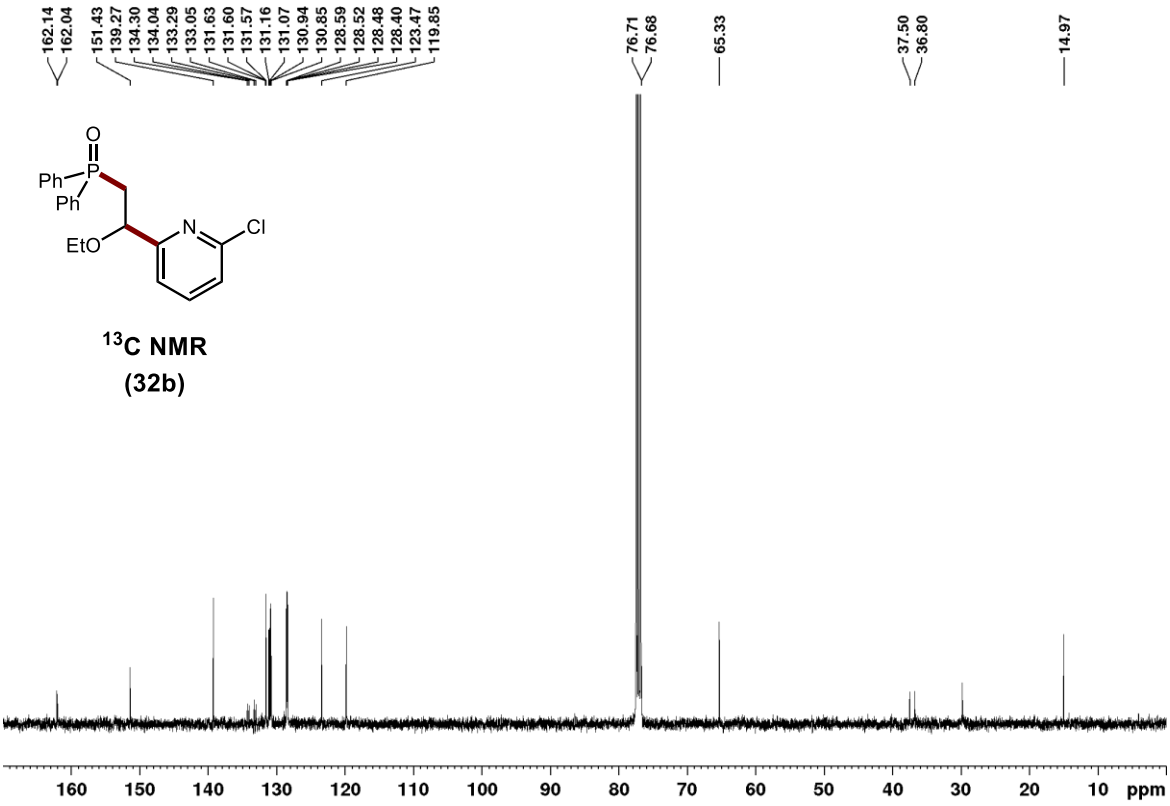




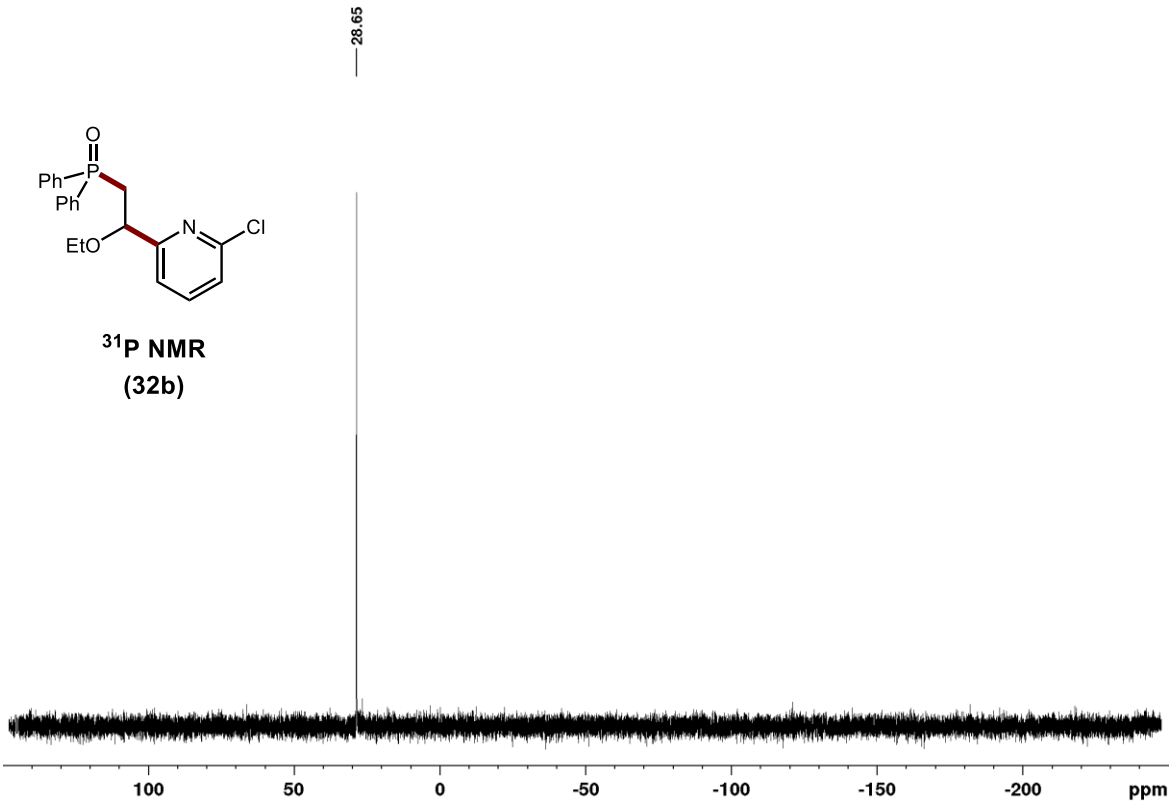
^{1}H NMR

(32b)

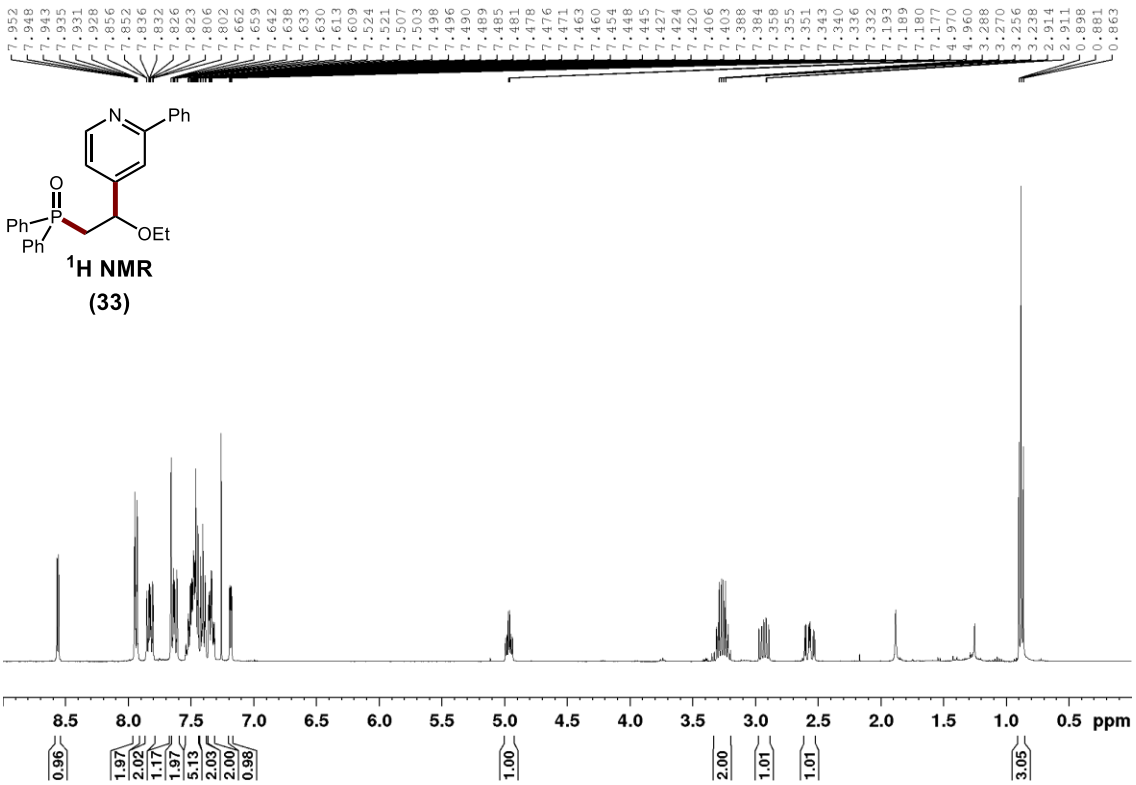


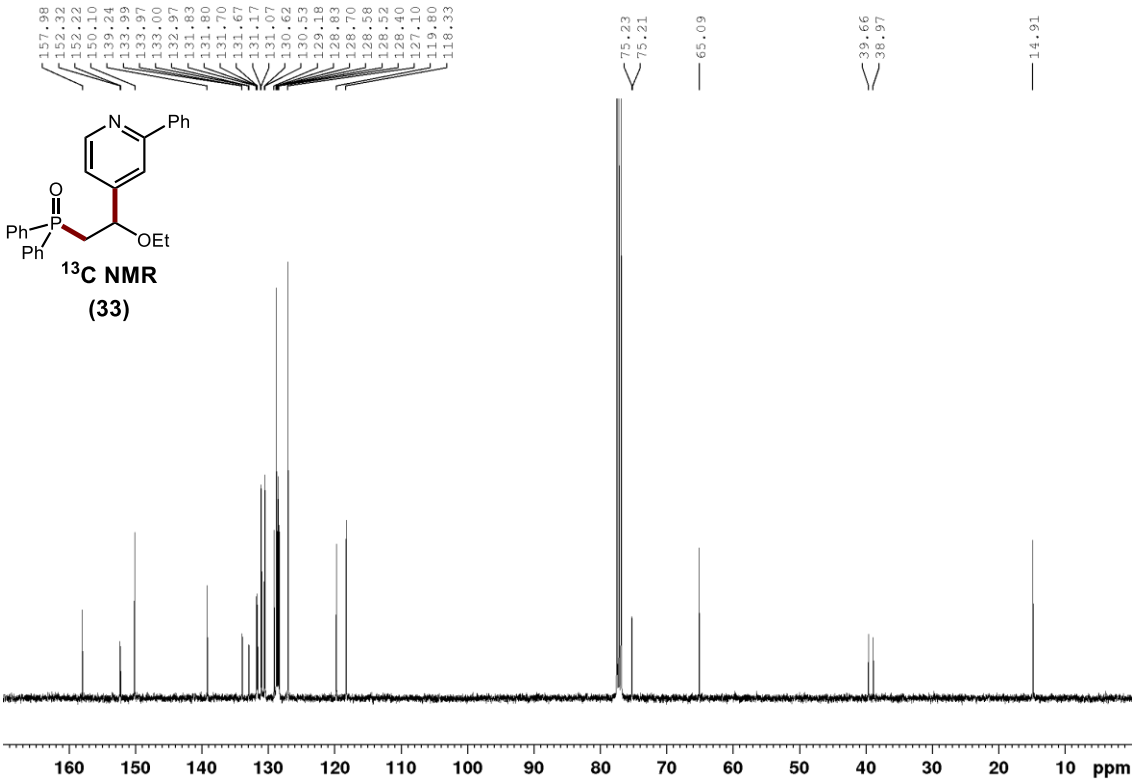


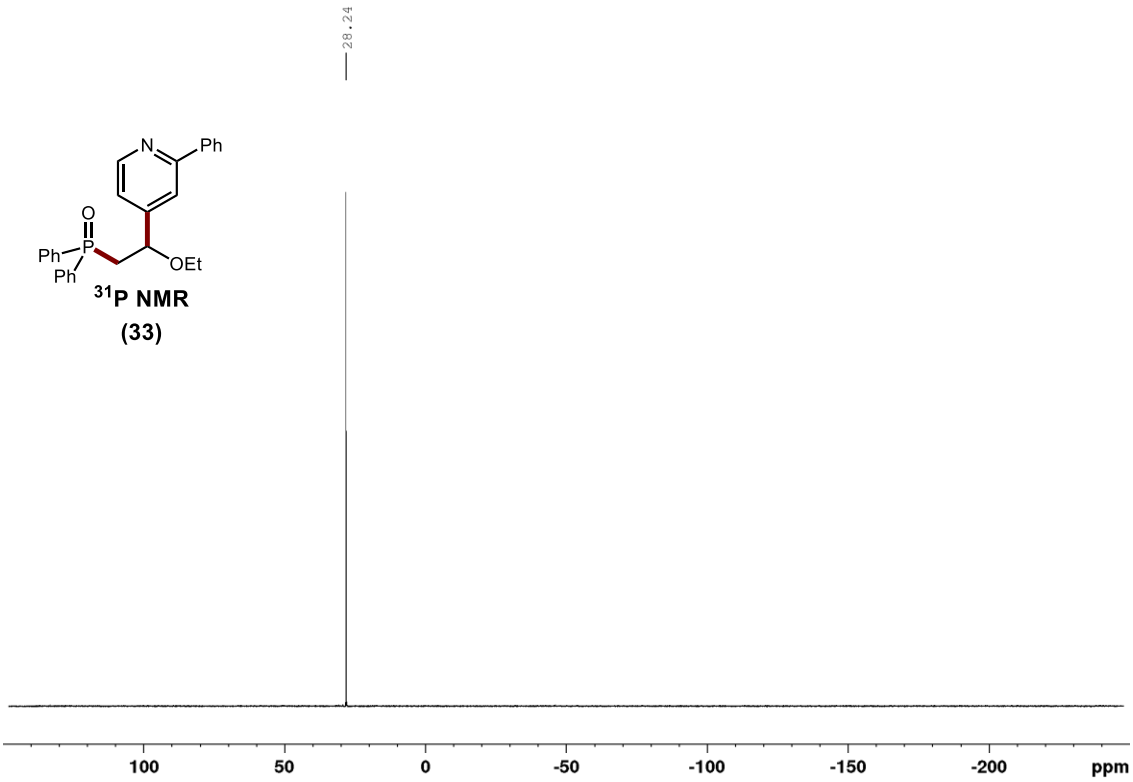
^{13}C NMR
(32b)



^{31}P NMR
(32b)

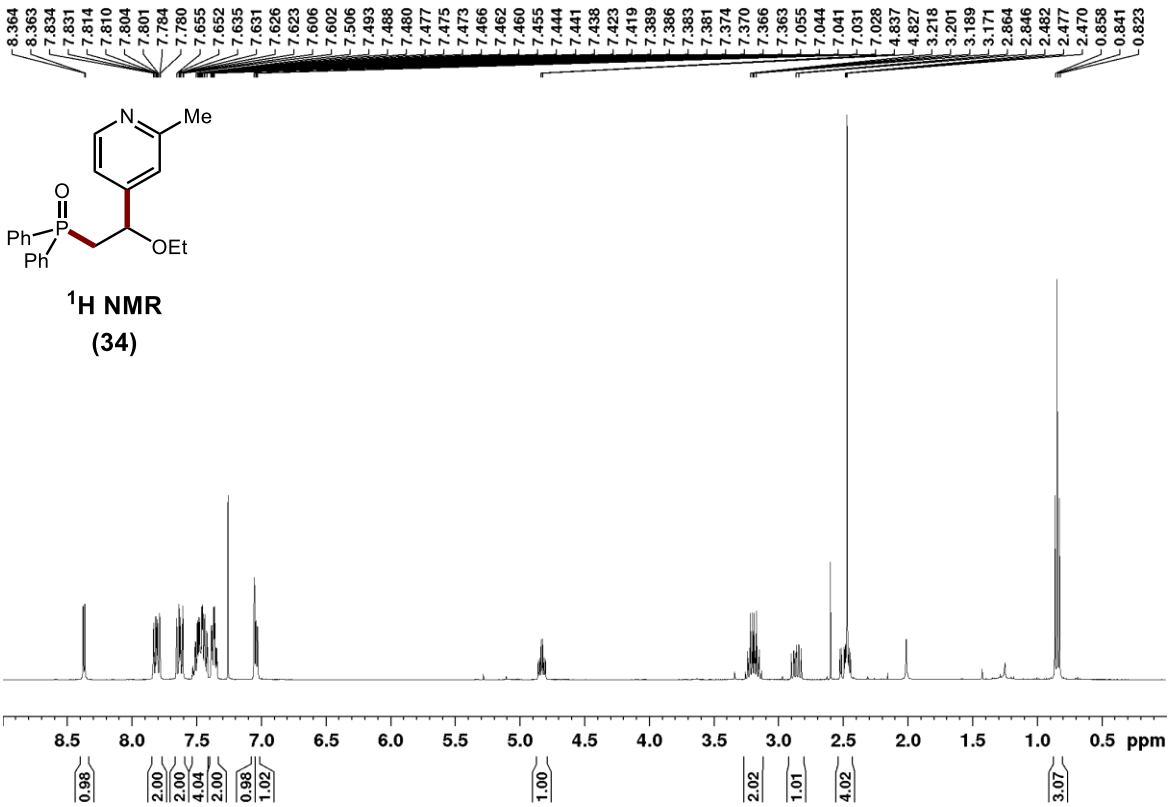

7.952 7.948 7.943 7.935 7.931 7.928 7.856 7.852 7.836 7.832 7.826 7.823 7.806 7.802 7.662 7.659 7.642 7.638 7.633 7.630 7.613 7.609 7.524 7.521 7.507 7.503 7.498 7.496 7.490 7.489 7.485 7.481 7.478 7.476 7.471 7.463 7.460 7.454 7.448 7.445 7.427 7.424 7.420 7.406 7.403 7.388 7.384 7.358 7.355 7.351 7.343 7.340 7.336 7.332 7.193 7.189 7.180 7.177 4.970 4.960 3.288 3.270 3.256 3.238 2.914 2.911 0.898 0.881 0.863
N
Ph
O
P
Ph
Ph
OEt
1H NMR
(33)
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 ppm
0.96
1.97
2.02
1.17
1.97
5.13
2.03
2.00
0.98
1.00
2.00
1.01
1.01
3.05


157.98 152.32 152.22 150.10 139.24 133.99 133.97 133.00 132.97 131.83 131.80 131.70 131.67 131.17 131.07 130.62 130.53 129.18 128.83 128.70 128.58 128.52 128.40 127.10 119.80 118.33
75.23 75.21
65.09
39.66 38.97
14.91
N
Ph
O
P
Ph
Ph
OEt
13C NMR
(33)
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm



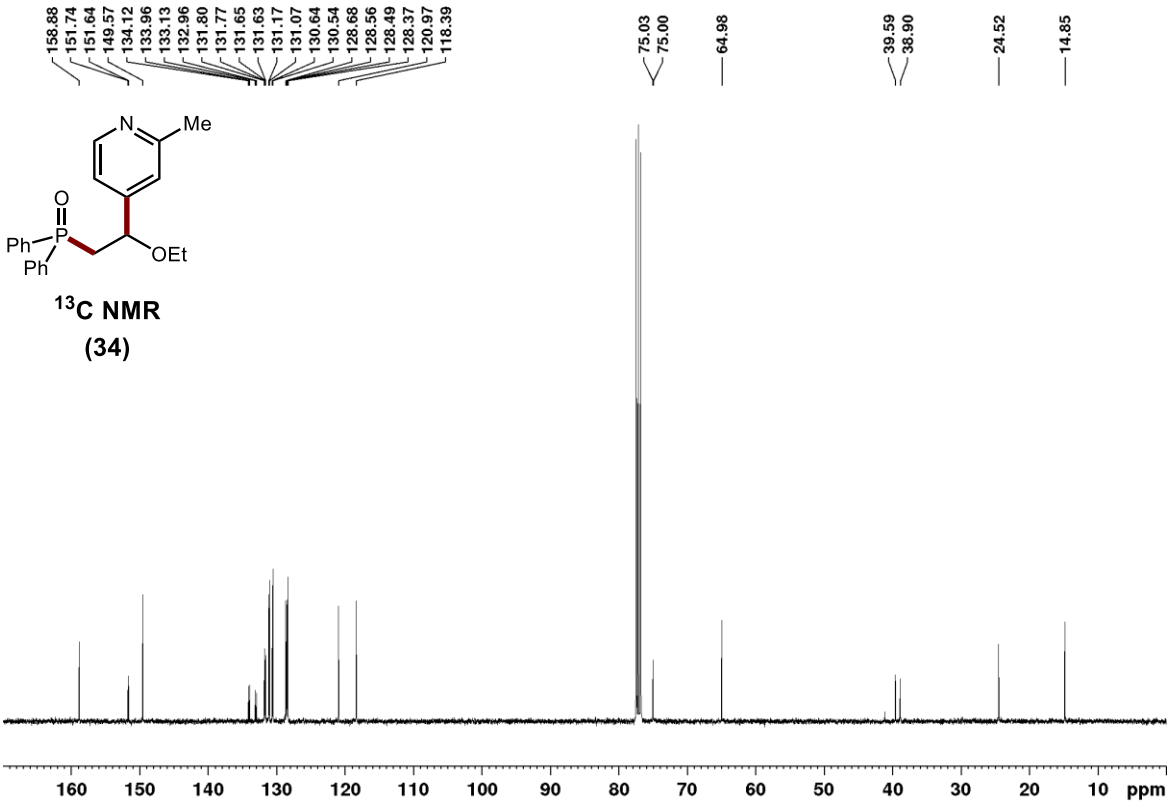
^{31}P NMR

(33)

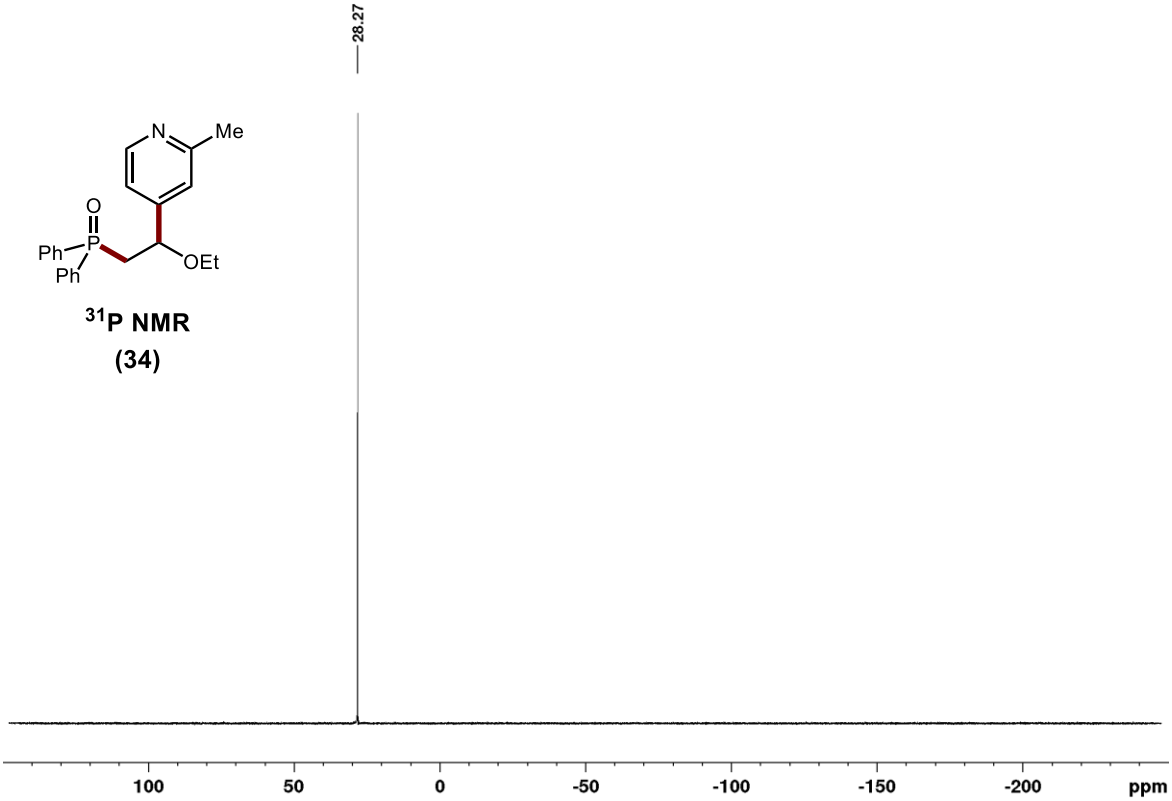


^{1}H NMR

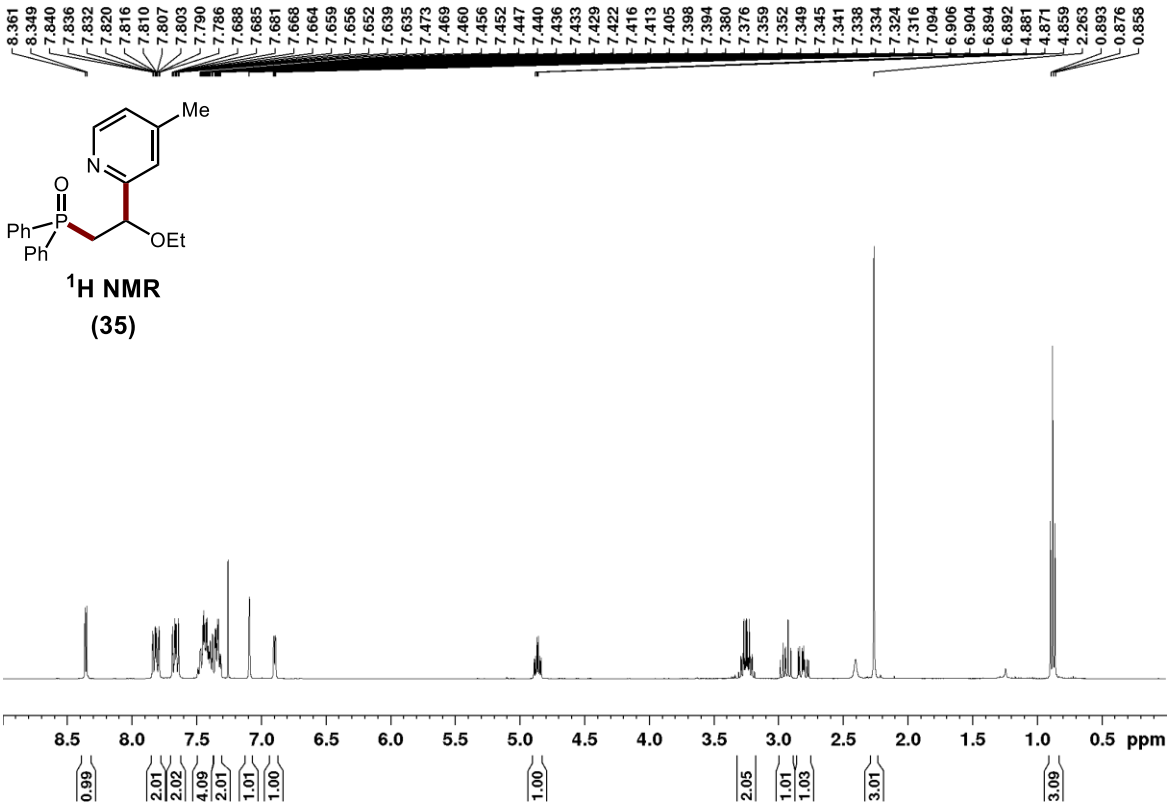
(34)



^{13}C NMR
(34)

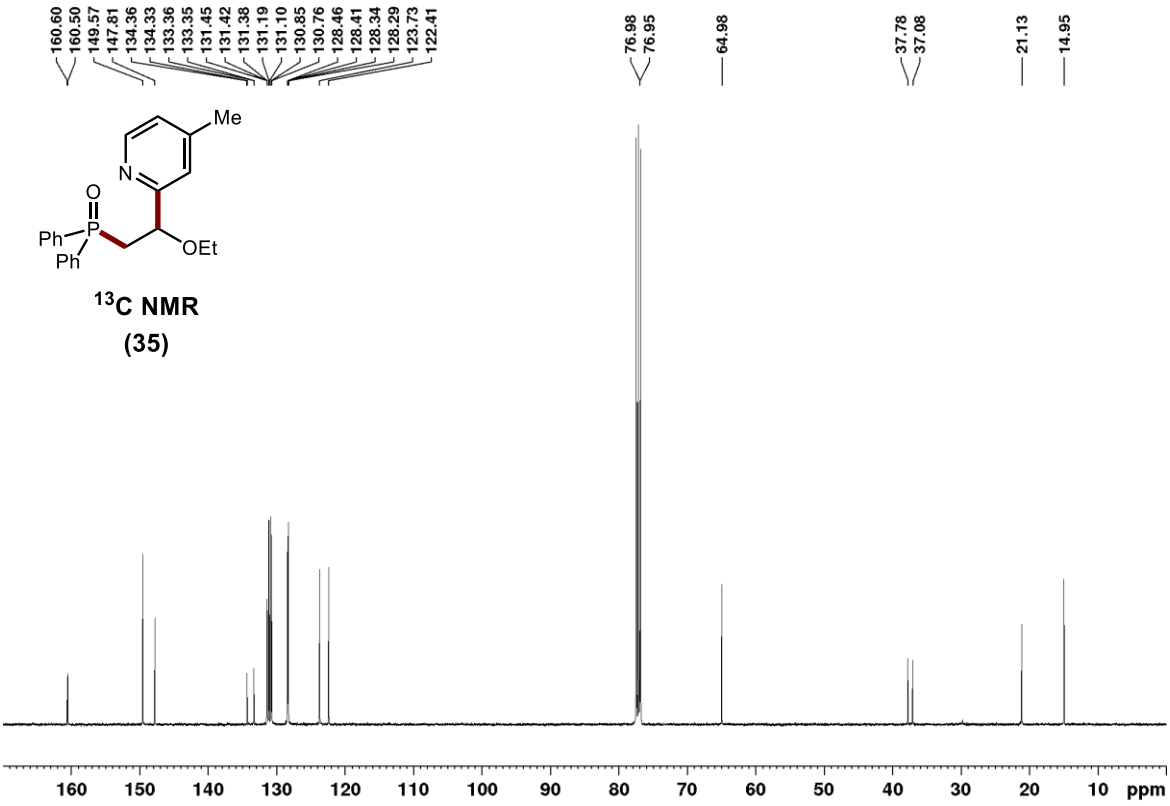


^{31}P NMR
(34)



^{1}H NMR

(35)

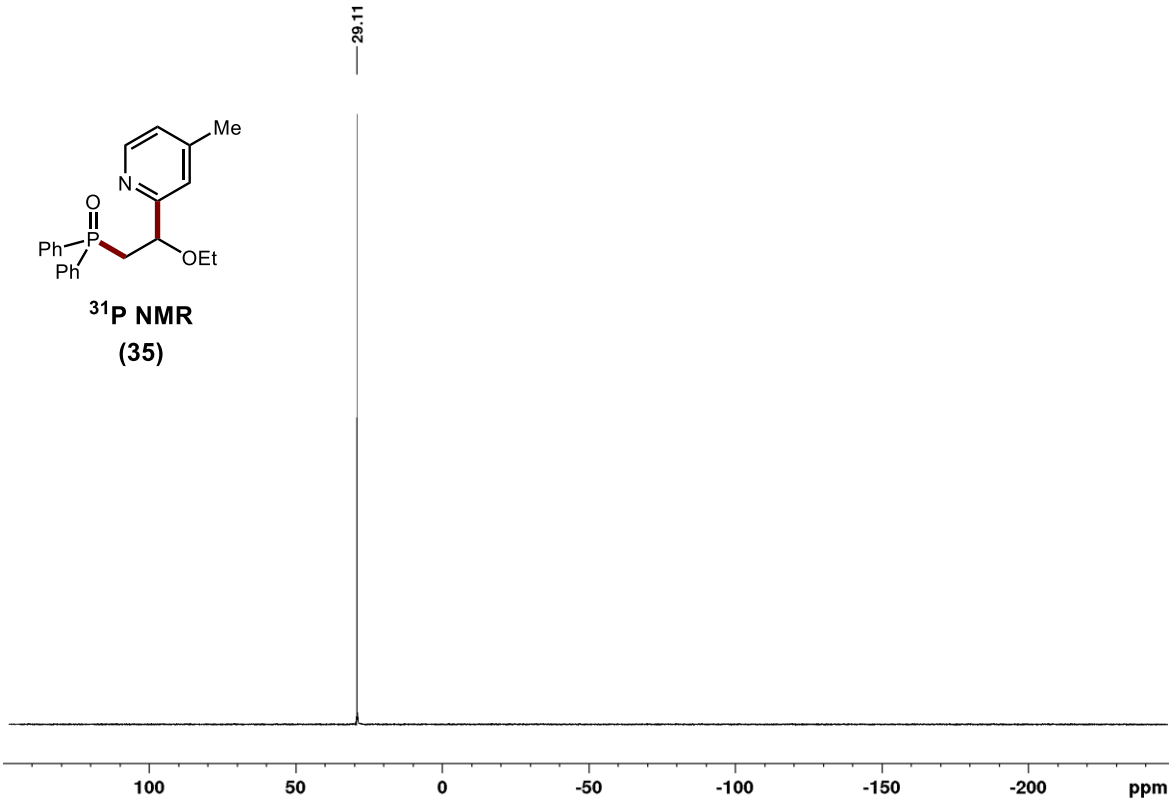


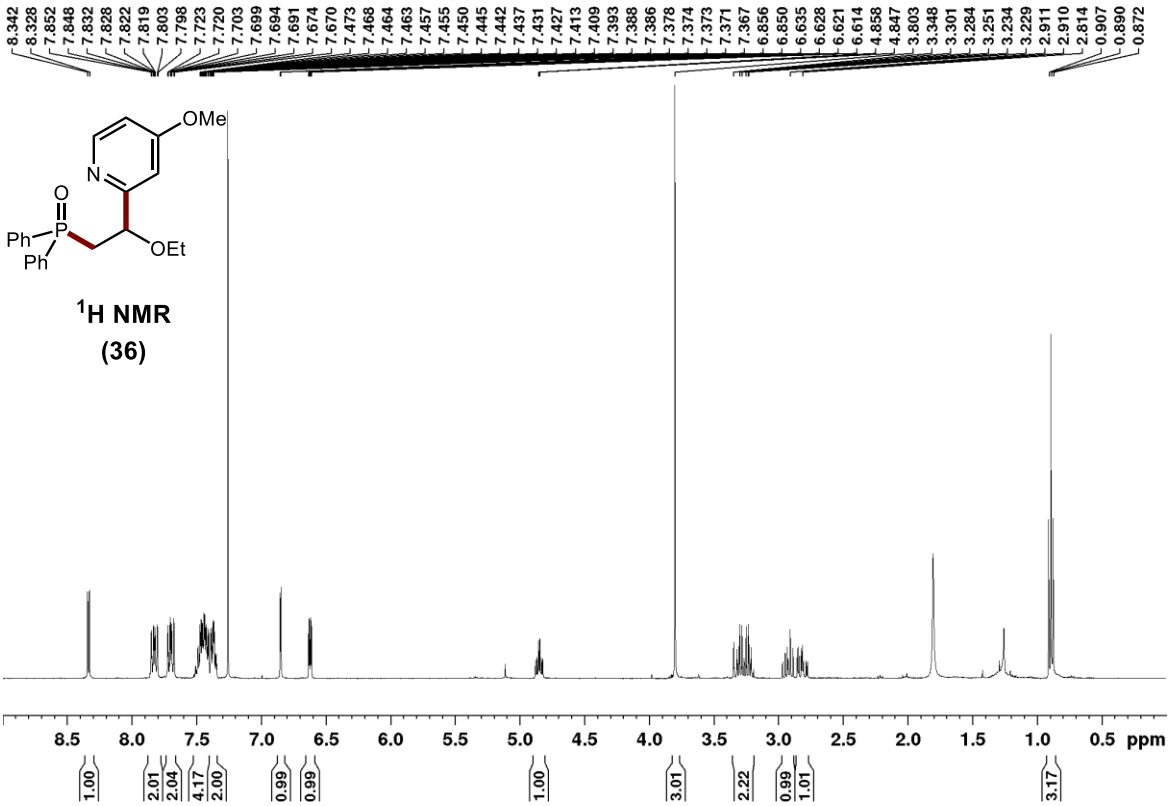
^{13}C NMR

(35)

^{31}P NMR

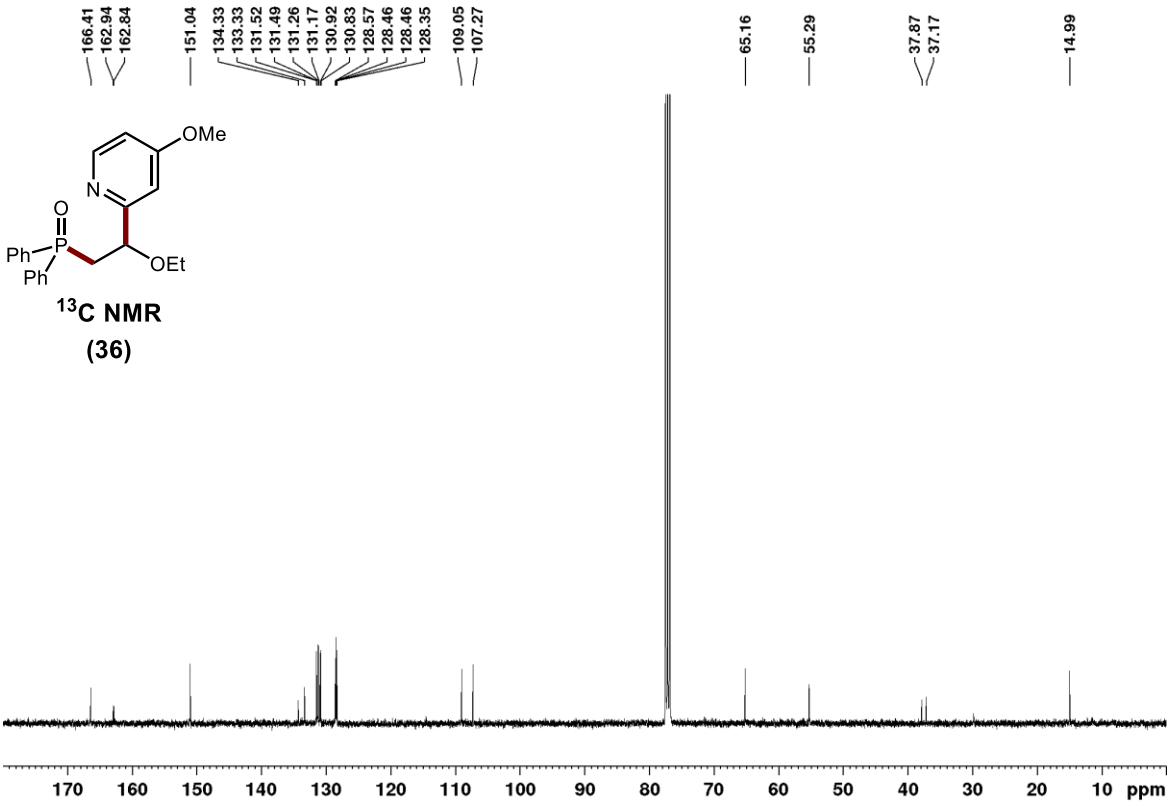
(35)



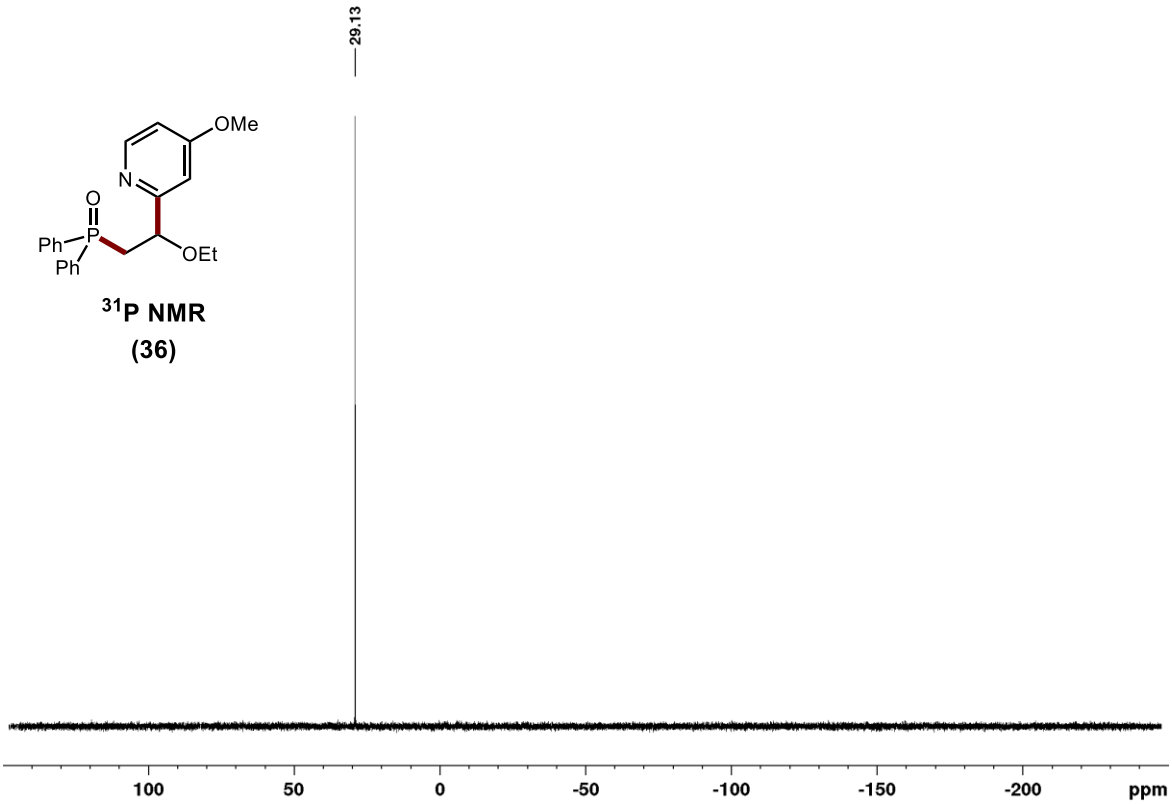


^{1}H NMR

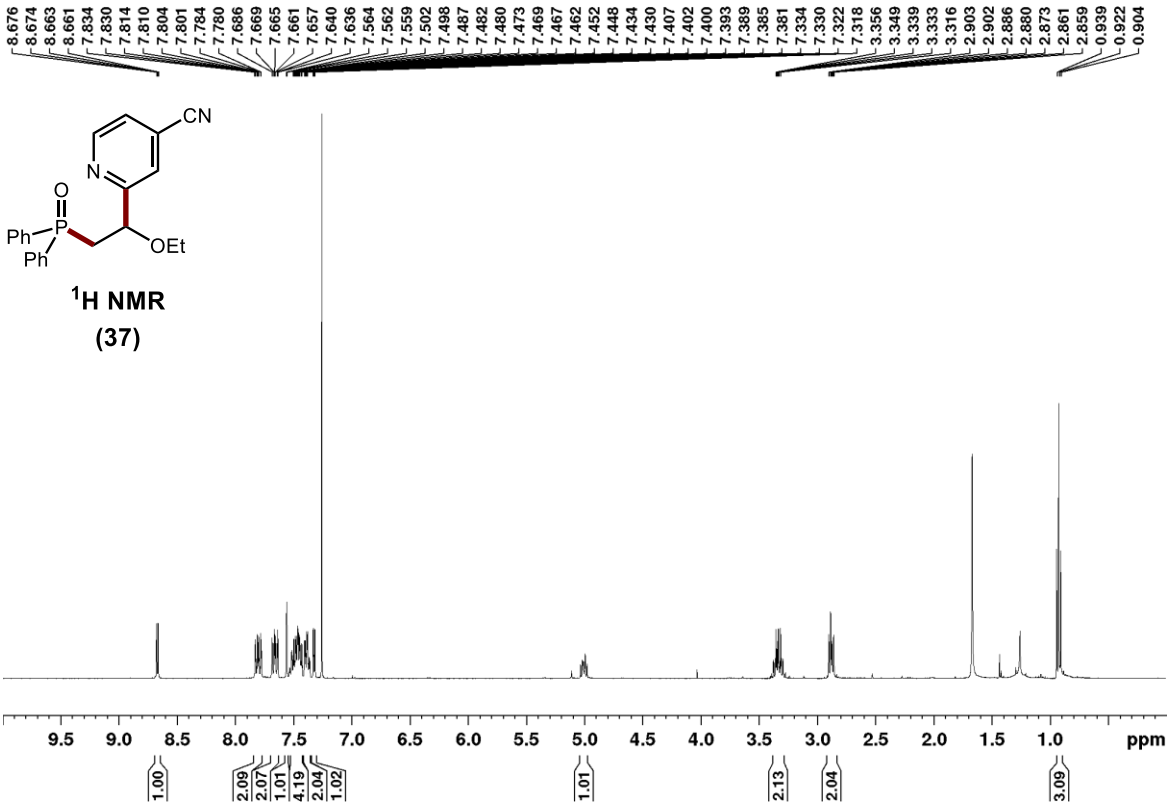
(36)



^{13}C NMR
(36)

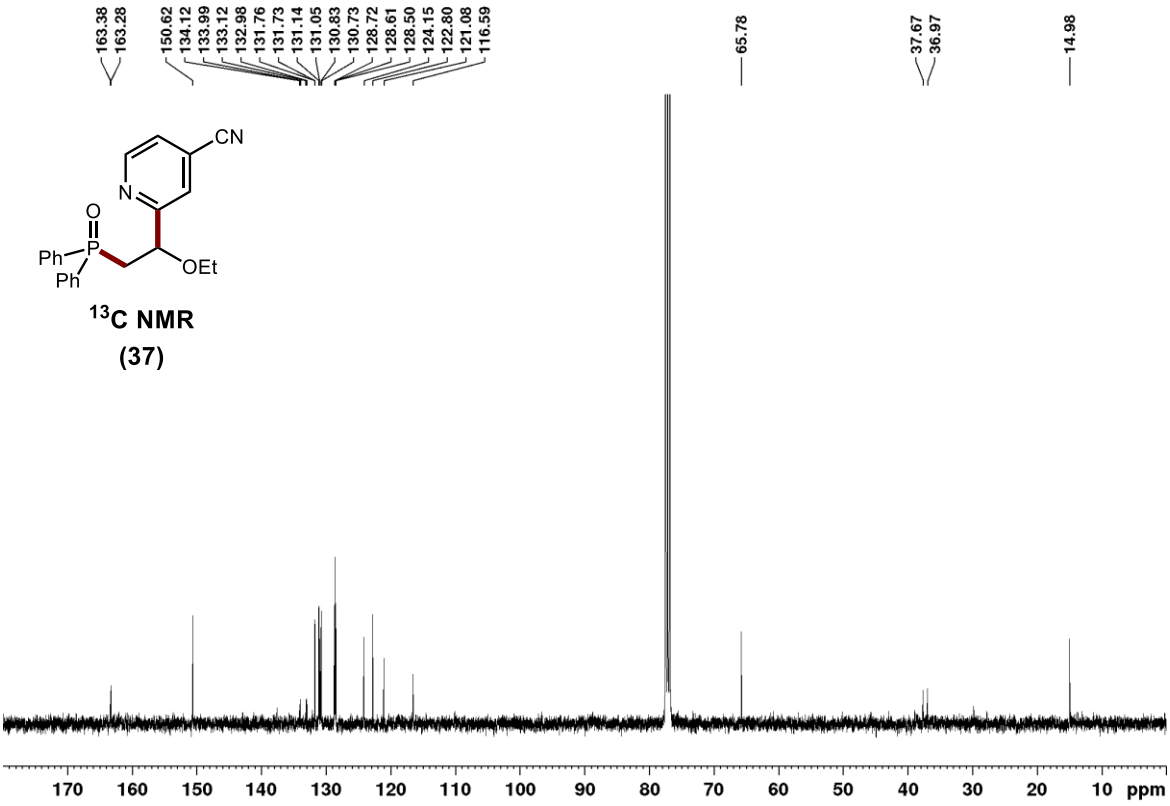


^{31}P NMR
(36)



^{1}H NMR

(37)

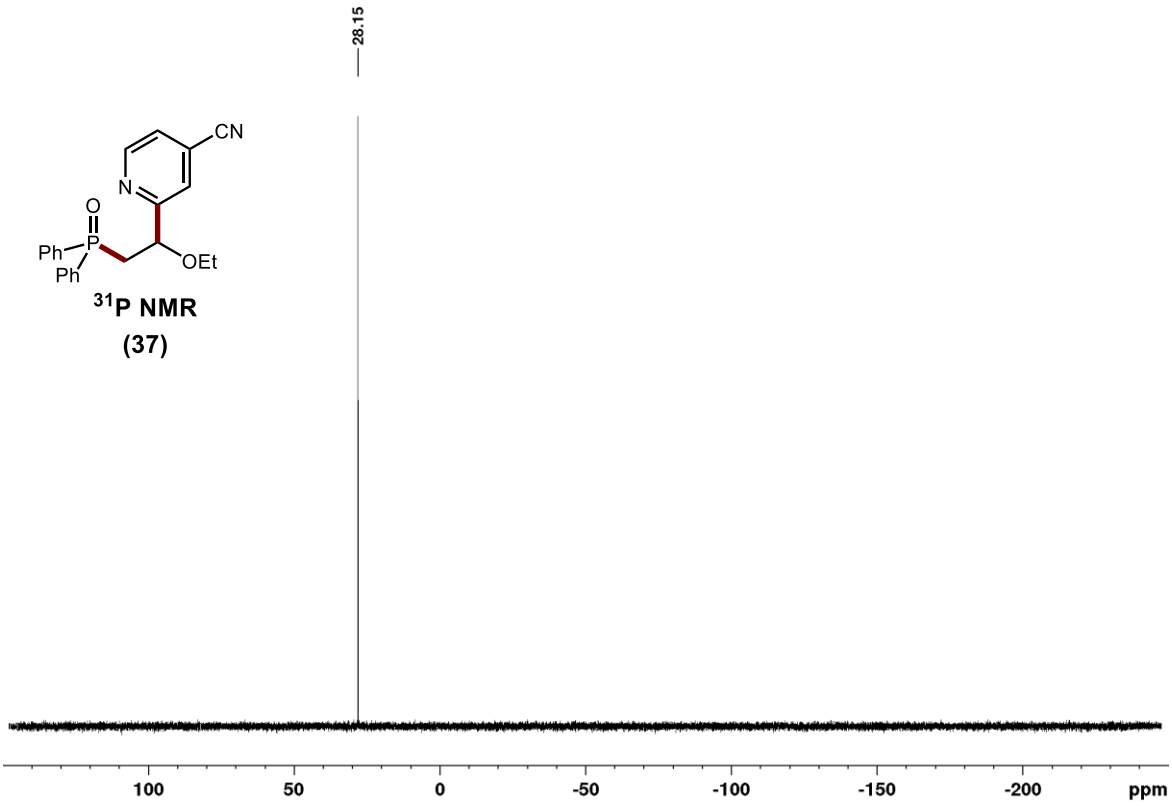


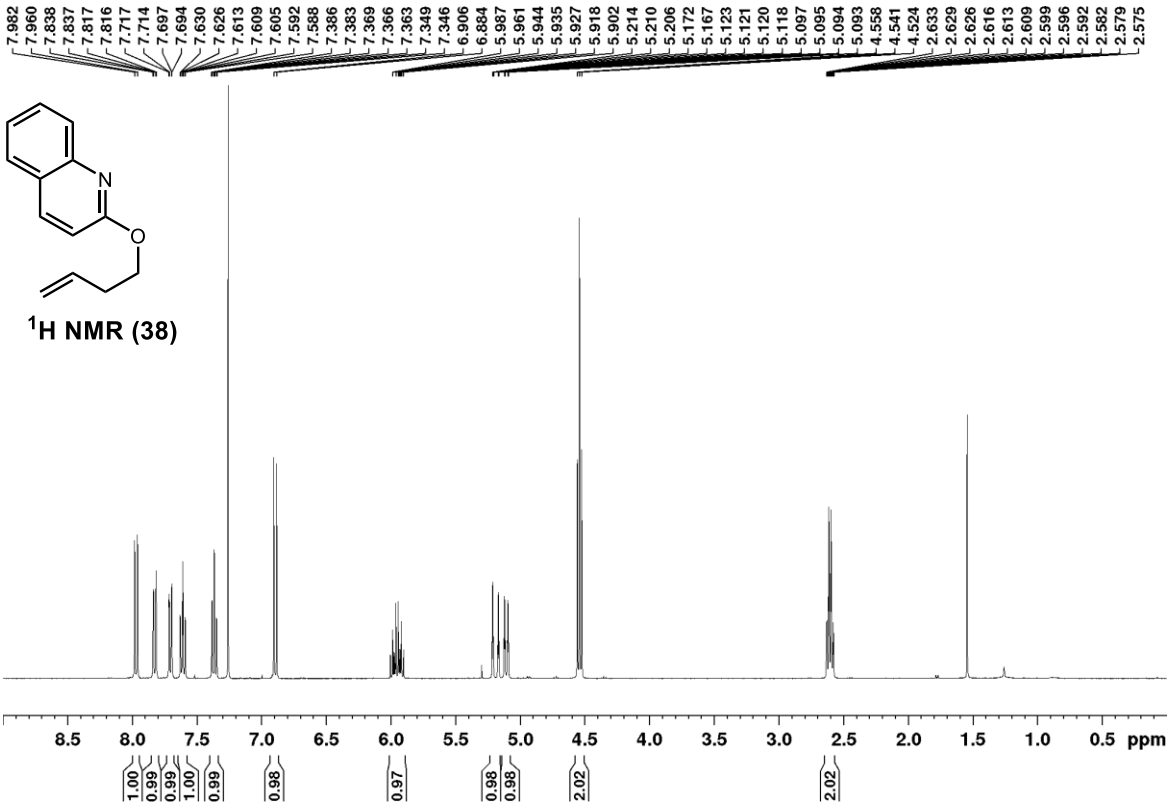
^{13}C NMR

(37)

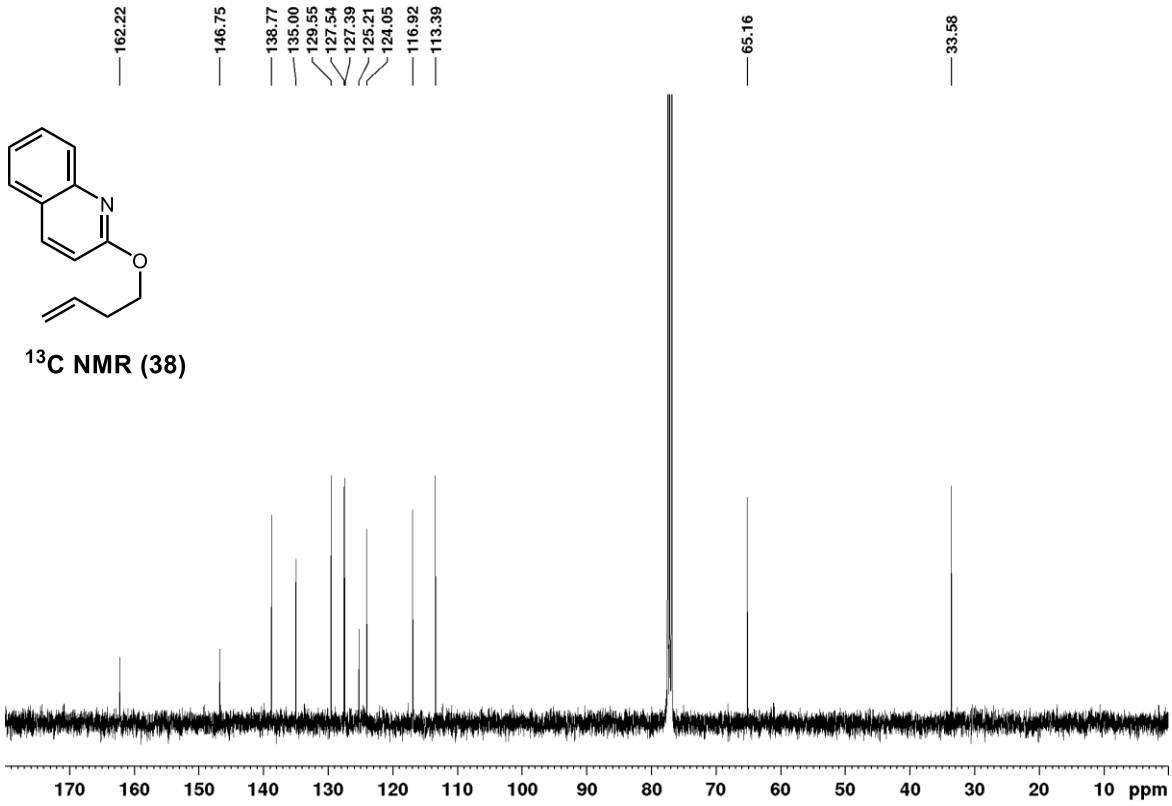
^{31}P NMR

(37)

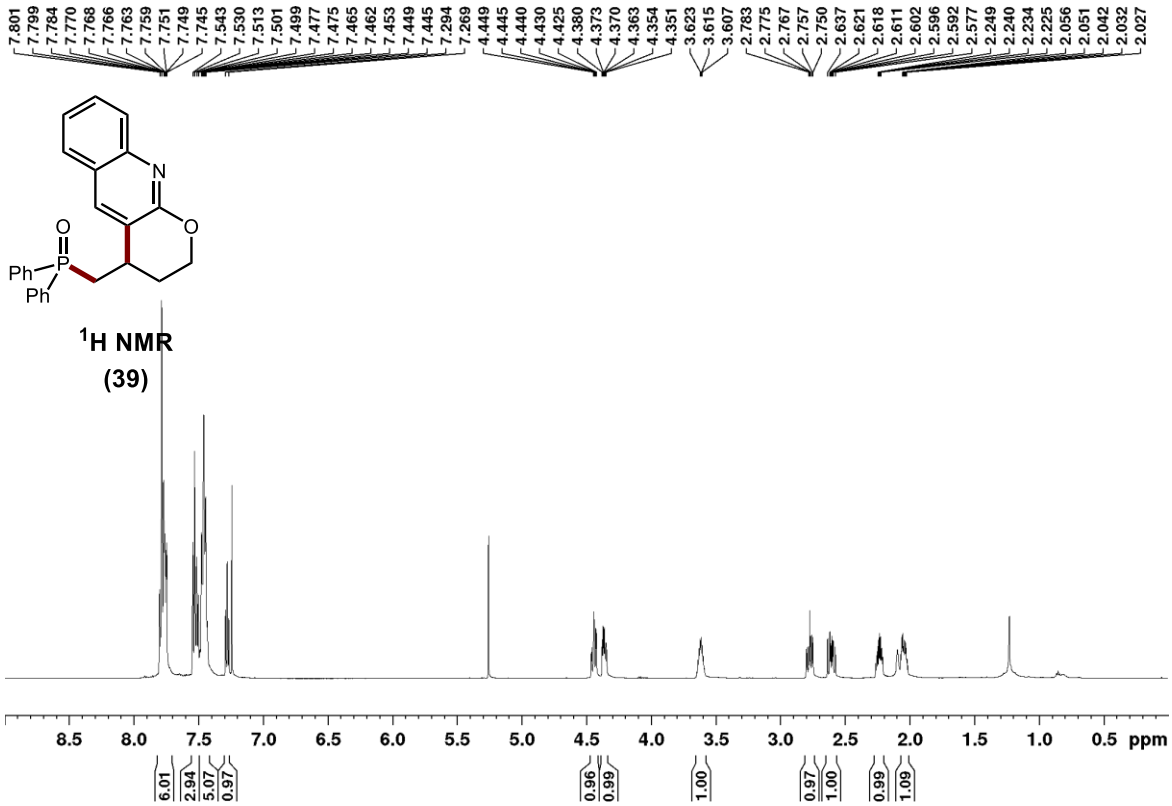




^{1}H NMR (38)

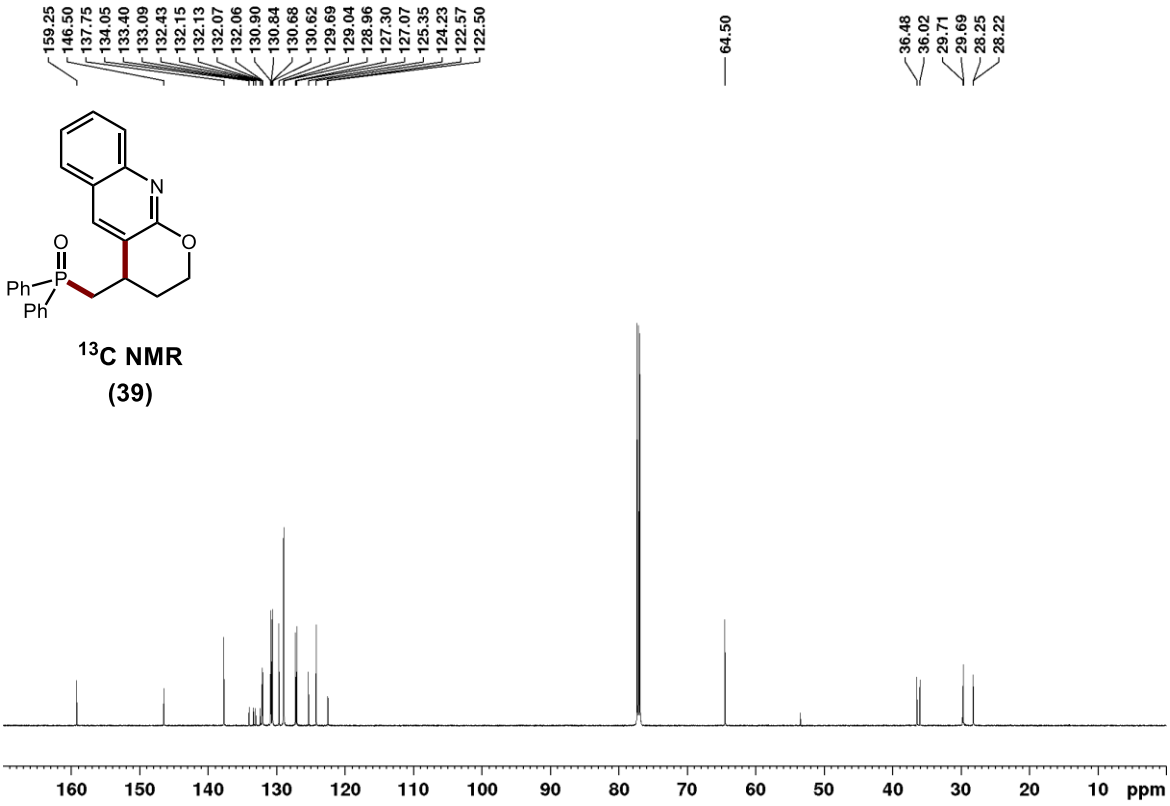


^{13}C NMR (38)

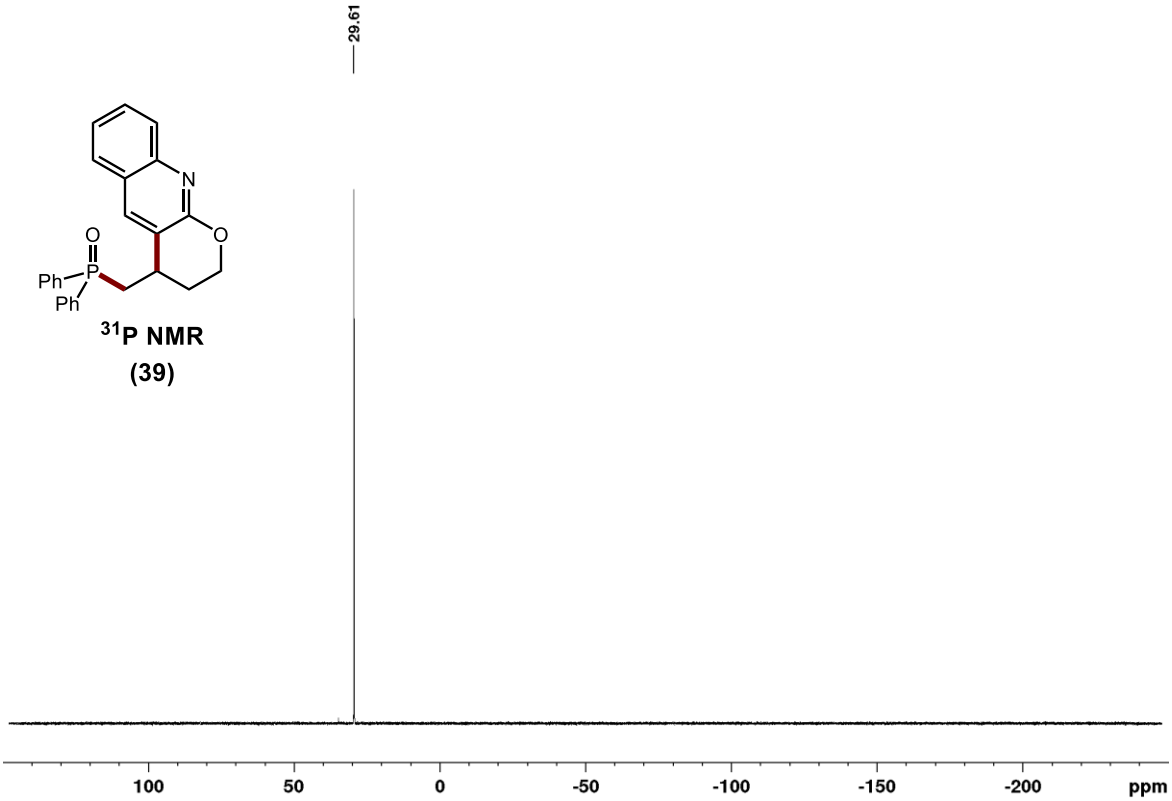


^{1}H NMR

(39)



^{13}C NMR
(39)



^{31}P NMR
(39)