Supporting Information

Construction of key building blocks towards the synthesis of cortistatins

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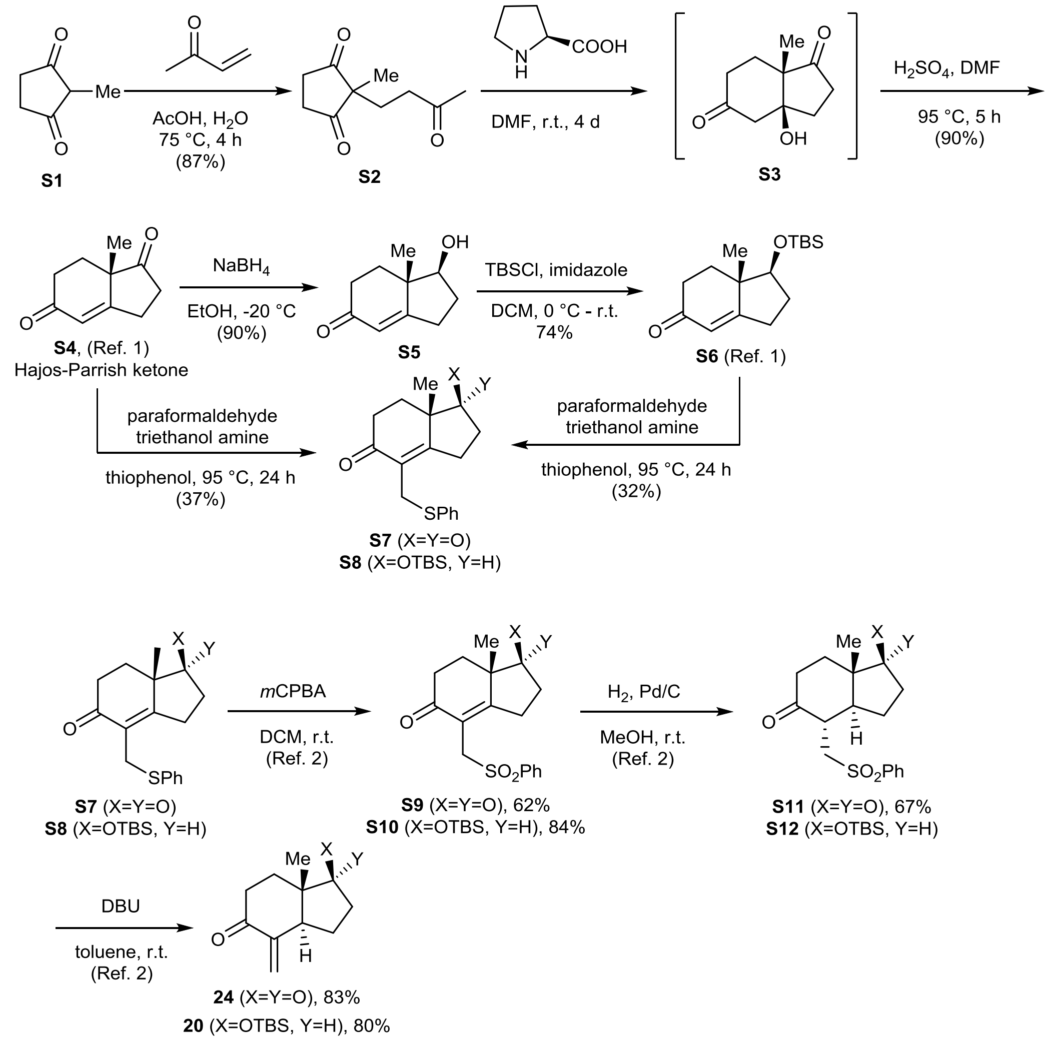
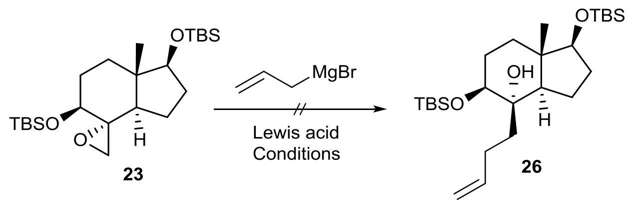
1. Experimental Details:

Preparation of enones 20 and 24:



It was observed that the hydrogenation of the sulfone **S10** leading to **S12** lacked reproducibility in our hands, as the reduced sulfone underwent facile elimination leading to the enone **20**, which was subsequently reduced once again in the same reaction medium to provide saturated products, which were of no use to our purpose. But such problems were not encountered with the hydrogenation of enedione **S9** and hence we moved forward with enedione **24**, rather than enone **20**.

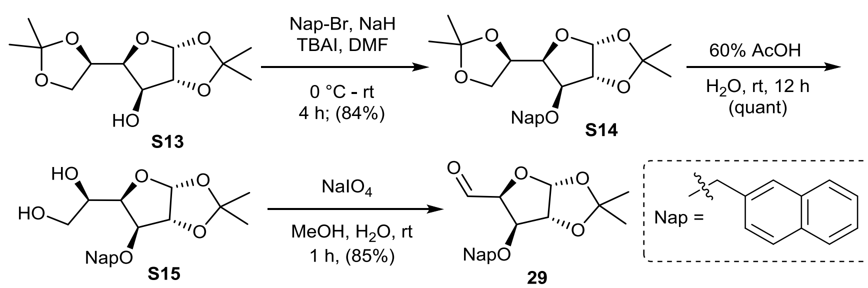
Table S1: Attempted epoxide opening



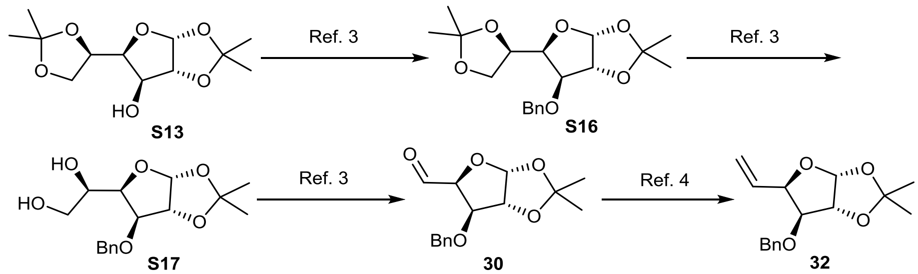
Entry	Lewis acid	Conditions	Result
1	None	Et_2O, 0 ˚C – rt	SM remained
2	$Cu(OTf)_2$	Et_2O, 0 ˚C – rt	SM remained
3	CuCN	THF, rt – reflux	SM remained
4	$CuCl_2$	LiCl, THF, rt – reflux	SM remained
5	Me_3Al	DCM, 0 ˚C – rt	SM remained

It was evident from the crystal structure of the diester **28** that the epoxide was highly hindered by the angular methyl group and this explains the difficulty faced in the epoxide opening. The nucleophile was required to attack from the direction of the axial site of the 6-membered carbocycle, where the reagents were faced with the steric hindrance of the methyl group.

Synthesis of D-glucose derived aldehydes 29 and 30:



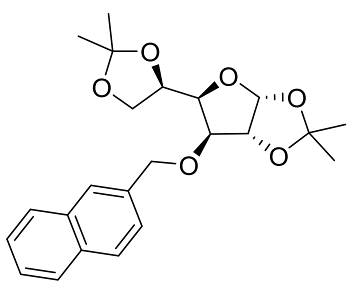
Starting from D-glucose diacetonide, the free secondary alcohol was converted into the corresponding (2-naphthyl)methyl ether, followed by hydrolysis of the primary acetonide to generate the diol **S15**. Treatment under oxidative conditions using $NaIO_4$ cleaved the diol to generate the aldehyde **29**, which was used for further transformations. Detailed procedures for the above sequence have been given in Section 3.



A similar sequence was repeated for the preparation of the corresponding benzylated aldehyde **30** as reported in literature.[3,4]

2. Experimental Procedures and Characterization of Products:

(3a*R*,5*R*,6*S*,6a*R*)-5-((*R*)-2,2-dimethyl-1,3-dioxolan-4-yl)-2,2-dimethyl-6-(naphthalen-2-ylmethoxy)tetrahydrofuro[2,3-*d*][1,3]dioxole (S14):



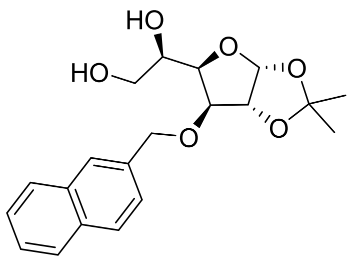
A flame-dried 2-necked round bottomed flask was charged with NaH (230 mg, 5.77 mmol, 60% in mineral oil) and anhydrous DMF (10 mL) was added. After cooling to 0 ˚C, a solution of glucose diacetonide (1 g, 3.85 mmol) in DMF (5 mL) was added in drop wise manner and the resulting solution was stirred for 1 h at the same temperature. Finally a pinch of TBAI and a solution of 2-(bromomethyl)naphthalene (1.28 g, 5.77 mmol) in DMF (5 mL) were added and the resulting mixture was stirred to room temperature for 12 hs. Finally the reaction was quenched with saturated NH_4Cl solution and work-up was done with EtOAc to obtain the crude mixture. Purification was done through silica gel column chromatography using 5% EtOAc/hexanes to obtain 1.3 g (84%) of the compound **S14** as a white solid.

R*f* : 0.70 (25% EtOAc/hexanes)

$[\alpha]^{20}_{D}$: −32.4 (*c* 0.5, CH_2Cl_2)

^{1}H NMR (400 MHz, $CDCl_3$): *δ* 7.86−7.80 (m, 4H), 7.52−7.45 (m, 3H), 5.94 (d, J = 3.7 Hz, 1H), 4.83 (ABq, $\Delta\delta_{AB}$ = 21.9 Hz, J_{AB} = 12.0 Hz, 2H), 4.64 (d, J = 3.7 Hz, 1H), 4.46−4.39 (m, 1H), 4.20−4.13 (m, 2H), 4.09 (d, *J* = 3.1 Hz, 1H), 4.04 (dd, *J* = 8.6, 5.8 Hz, 1H), 1.50 (s, 3H), 1.44 (s, 3H), 1.41 (s, 3H), 1.32 (s, 3H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 135.1, 133.3, 133.1, 128.2, 127.9, 127.7, 126.5, 126.2, 126.0, 125.7, 111.8, 109.1, 105.4, 82.7, 81.7, 81.4, 72.6, 72.5, 67.5, 26.9, 26.8, 26.3, 25.5. **IR ν (neat, cm^{-1}):** 2987, 2931, 1635, 1603, 1456, 1381, 1373, 1254, 1217, 1078, 1020, 851. **HRMS (ESI-QTOF):** *m/z* for $C_{23}H_{28}NaO_6$, $[M+Na]^+$ calcd. 423.1778, found 423.1773.

(*R*)-1-((3a*R*,5*R*,6*S*,6a*R*)-2,2-dimethyl-6-(naphthalen-2-ylmethoxy)tetrahydrofuro[2,3-*d*][1,3]dioxol-5-yl)ethane-1,2-diol (S15):



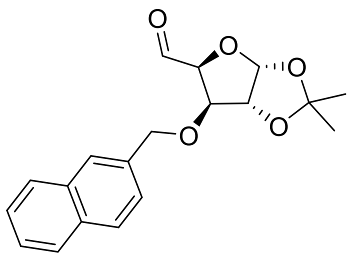
The diacetonide **S14** (1.3 g, 3.25 mmol) was dissolved in 60% AcOH (30 mL) and the resulting mixture was stirred at room temperature overnight. After complete consumption of the starting material, the acetic acid was evaporated by azeotrope formation with toluene and concentration of the organic solvents under high pressure afforded the crude diol. Purification was done through silica gel column chromatography using 60% EtOAc : hexanes as the eluent to obtain 1.17 g (quantitative yield) of the diol **S15** as a colourless liquid.

R_f : 0.10 (50% EtOAc/hexanes)

$[\alpha]^{20}_{D}$: −30.0 (*c* 2.0, CH_2Cl_2)

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.87−7.78 (m, 4H), 7.53−7.47 (m, 2H), 7.45 (dd, *J* = 8.4, 1.5 Hz, 1H), 5.96 (d, *J* = 3.8 Hz, 1H), 4.80 (ABq, $\Delta\delta_{AB}$ = 84.1 Hz, J_{AB} = 11.9 Hz, 2H), 4.67 (d, *J* = 3.8 Hz, 1H), 4.18−4.12 (m, 2H), 4.10−4.05 (m, 1H), 3.86−3.69 (m, 2H), 2.65 (bs, 1H), 2.33 (bs, 1H), 1.49 (s, 3H), 1.32 (s, 3H). **^{13}C NMR (125 MHz, $CDCl_3$):** δ 134.5, 133.2, 133.1, 128.7, 127.9, 127.8, 126.9, 126.4, 126.3, 125.5, 111.9, 105.2, 82.2, 72.0, 80.0, 72.3, 69.3, 64.4,26.8, 26.3. **IR ν (neat, cm^{-1}):** 3466, 3015, 2930, 1602, 1509, 1457, 1376, 1219, 1076, 1021. **HRMS (ESI-QTOF):** *m/z* for $C_{20}H_{24}NaO_6$, $[M+Na]^+$ calcd. 383.1465, found 383.1467.

(3a*R*,5*S*,6*S*,6a*R*)-2,2-dimethyl-6-(naphthalen-2-ylmethoxy)tetrahydrofuro[2,3-*d*][1,3]dioxole-5-carbaldehyde (29):



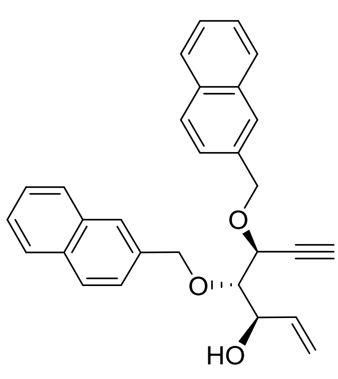
The crude diol **S15** (1.17 g, 3.25 mmol) from the previous step was dissolved in methanol (30 mL) and water (10 mL) and to this solution was added $NaIO_4$ (834 mg, 3.9 mmol) in portion wise manner at 0 ˚C. The resulting suspension was stirred to room temperature over 1 h after which the solid residues were filtered off under vacuum and the filtrate was collected. The methanol was removed and the product was extracted from the aqueous layer with dichloromethane. The combined organic layer was concentrated under vacuum to obtain the crude aldehyde. Purification was done through silica gel column chromatography using 40% EtOAc : hexanes as the eluent to obtain 900 mg (85%) of the aldehyde **29** as a colourless liquid.

R_f : 0.4 (50% EtOAc/hexanes)

$[\alpha]_D^{20}$: −81.0 (*c* 2.0, CH_2Cl_2)

^{1}H NMR (500 MHz, $CDCl_3$): *δ* 9.71 (d, *J* = 1.2 Hz, 1H), 7.84 (d, *J* = 7.7 Hz, 3H), 7.70 (s, 1H), 7.52−7.47 (m, 2H), 7.35 (dd, *J* = 8.4, 1.2 Hz, 1H), 6.15 (d, *J* = 3.5 Hz, 1H), 4.71 (ABq, $\Delta\delta_{AB}$ = 62.4 Hz, J_{AB} = 12.0 Hz, 2H), 4.69 (d, *J* = 3.5 Hz, 1H), 4.59 (dd, *J* = 3.6, 1.0 Hz, 1H), 4.39 (d, *J* = 3.8 Hz, 1H), 1.47 (s, 3H), 1.34 (s, 3H). **^{13}C NMR (125 MHz, $CDCl_3$):** *δ* 200.1, 134.2, 133.3, 133.3, 128.7, 128.1, 127.9, 127.0, 126.5, 126.4, 125.6, 112.8, 106.4, 84.8, 83.7, 82.4, 72.7, 27.2, 26.6. **IR ν (neat, cm^{-1}):** 2986, 2935, 1738, 1455, 1374, 1223, 1074, 871. **HRMS (ESI-QTOF):** *m/z* for $C_{19}H_{20}NaO_5$, $[M+Na]^+$ calcd. 351.1208, found 351.1212.

(3*R*,4*S*,5*S*)-4,5-*bis*(naphthalen-2-ylmethoxy)hept-1-en-6-yn-3-ol (S18):



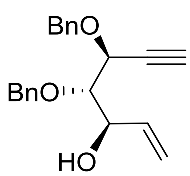
The dibromo compound **39** (50 mg, 0.086 mmol) was dissolved in dry THF (5 mL) and cooled to -78 °C and to this solution was added *n*-BuLi (0.1 mL, 1.0 M in THF, 0.1 mmol) in drop wise manner and the resulting solution was stirred for 1 h. The reaction was quenched with saturated NH_4Cl solution and work-up was done with EtOAc to obtain the crude product. Purification was done through silica gel column chromatography using 12% EtOAc/hexanes as the eluent to obtain 20 mg (54%) of the terminal alkyne as a pale yellow solid.

R_f : 0.15 (10% EtOAc/hexanes)

$[\alpha]_D^{20}$: +54.8 (*c* 1.0, CH_2Cl_2)

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.87−7.73 (m, 8H), 7.51−7.42 (m, 6H), 5.91 (ddd, J = 17.2, 10.5, 5.4 Hz, 1H), 5.34 (d, J = 17.2 Hz, 1H), 5.18 (d, J = 10.5 Hz, 1H), 4.98 (ABq, $\Delta\delta_{AB}$ = 130.6 Hz, J_{AB} = 11.3 Hz, 2H), 4.90 (ABq, $\Delta\delta_{AB}$ = 156.0 Hz, J_{AB} = 11.8 Hz, 2H), 4.54 (bs, 1H), 4.49 (dd, J = 6.7, 2.1 Hz, 1H), 3.69 (dd, J = 6.7, 3.2 Hz, 1H), 2.66 (d, J = 2.1 Hz, 1H), 2.41 (bs, 1H). **^{13}C NMR (125 MHz, $CDCl_3$):** δ 138.1, 135.6, 135.1, 133.5, 133.4, 133.3, 128.5, 128.4, 128.2, 127.9, 127.9, 127.3, 127.2, 126.4, 126.4, 126.3, 126.2, 126.2, 116.5, 83.5, 80.6, 77.0, 75.6, 72.4, 71.7, 70.7. **IR ν (KBr, cm^{-1}):** 3494, 3288, 3057, 2953, 2115, 1601, 1508, 1461, 1271, 1082, 856, 818. **HRMS (ESI-QTOF):** *m/z* for $C_{29}H_{26}NaO_3$, $[M+Na]^+$ calcd. 445.1774, found 445.1777.

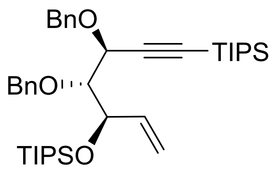
(3*R*,4*S*,5*S*)-4,5-*bis*(benzyloxy)hept-1-en-6-yn-3-ol (S19):



R_f : 0.50 (25% EtOAc/hexanes)

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40−7.26 (m, 10H), 5.88 (ddd, J = 17.1, 10.5, 5.4 Hz, 1H), 5.32 (d, J = 17.2 Hz, 1H), 5.18 (d, J = 10.5 Hz, 1H), 4.80 (ABq, $\Delta\delta_{AB}$ = 112.0 Hz, J_{AB} = 11.1 Hz, 2H), 4.73 (ABq, $\Delta\delta_{AB}$ = 125.9 Hz, J_{AB} = 11.7 Hz, 2H), 4.52−4.46 (m, 1H), 4.41 (dd, J = 6.5, 2.1 Hz, 1H), 3.60 (dd, J = 6.5, 3.4 Hz, 1H), 2.62 (d, J = 2.1 Hz, 1H), 2.41 (bs, 1H). **^{13}C NMR (100 MHz, $CDCl_3$):** δ 138.1, 138.0, 137.6, 128.6, 128.5, 128.4, 128.3, 128.1, 128.0, 116.4, 83.4, 80.5, 76.6, 75.5, 72.3, 71.4, 70.5. **IR ν (neat, cm^{-1}): HRMS (ESI-QTOF):** *m/z* for $C_{21}H_{22}NaO_3$, $[M+Na]^+$ calcd. 345.1461, found 345.1471.

((3*S*,4*R*,5*R*)-3,4-*bis*(benzyloxy)-5-((triisopropylsilyl)oxy)hept-6-en-1-yn-1-yl)triisopropylsilane (S20):



Some proportion of the TMS-TIPS exchange product **S20** was also observed in some of the reaction batches which had to be carefully separated from compound **44** (eluted with 2% EtOAc : hexanes), the data for which is given below.

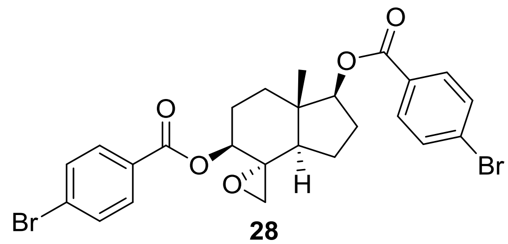
R_f : 0.8 (10% EtOAc/hexanes)

$[\alpha]^{20}_{D}$: +23.8 (c 1.0, CH_2Cl_2)

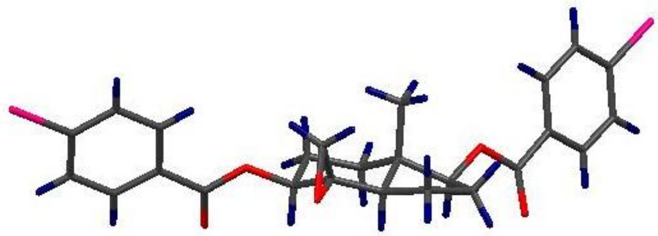
^{1}H NMR (500 MHz, $CDCl_3$): δ 7.42−7.35 (m, 4H), 7.34−7.29 (m, 4H), 7.29−7.25 (m, 2H), 6.02 (ddd, J = 17.3, 10.5, 7.1 Hz, 1H), 5.16 (d, J = 17.3 Hz, 1H), 5.06 (d, J = 10.5 Hz, 1H), 4.87 (ABq, $\Delta\delta_{AB}$ = 119.1 Hz, J_{AB} = 11.8 Hz, 2H), 4.73 (ABq, $\Delta\delta_{AB}$ = 127.6 Hz, J_{AB} = 11.7 Hz, 2H), 4.50 (d, J = 4.4 Hz, 1H), 4.47 (dd, J = 6.9, 4.7 Hz, 1H), 3.59 (t, J = 4.6 Hz, 1H), 1.18−1.07 (m, 3H), 1.12 (s, 18H), 1.03−0.95 (m, 3H), 0.99 (s, 18H). **^{13}C NMR (125 MHz, $CDCl_3$):** δ 139.2, 139.0, 138.0, 128.7, 128.4, 128.2, 127.9, 127.7, 127.4, 115.7, 105.6, 88.4, 85.0, 75.1, 74.7, 70.9, 68.7, 18.8, 18.2, 18.2, 12.6, 11.4. **IR ν (neat, cm^{-1}): HRMS (ESI-QTOF):** *m/z* for $C_{39}H_{62}NaO_3Si_2$, $[M+Na]^+$ calcd. 657.4135, found 657.4149.

3. Crystallographic Data:

Table S2. Selected crystallographic data for compound **28**:



28



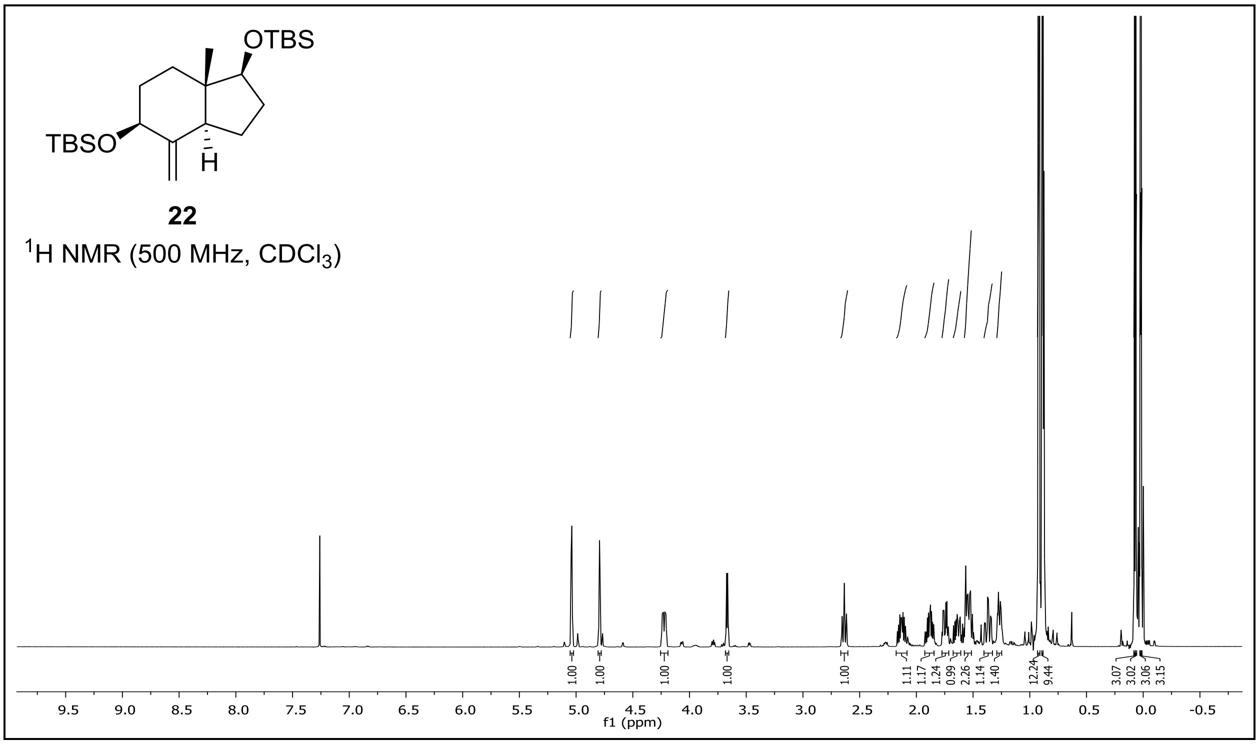
Compound	**28**
Empirical Formula	$C_{25}H_{24}Br_2O_5$
Formula Weight	540.32
Crystal System	Monoclinic
Space Group	$P2_1/c$
a (Å)	12.1083 (6)
b (Å)	18.3620 (10)
c (Å)	11.0509 (6)
α (deg)	90
β (deg)	111.208 (6)
γ (deg)	90
V (Å^3)	2290.6 (2)
Z	4
μ (mm^{-1})	3.571
T (K)	150
D_{calcd}(g cm^{-3})	1.567
F(000)	1041
θ range(deg)	2.27 to 25.00

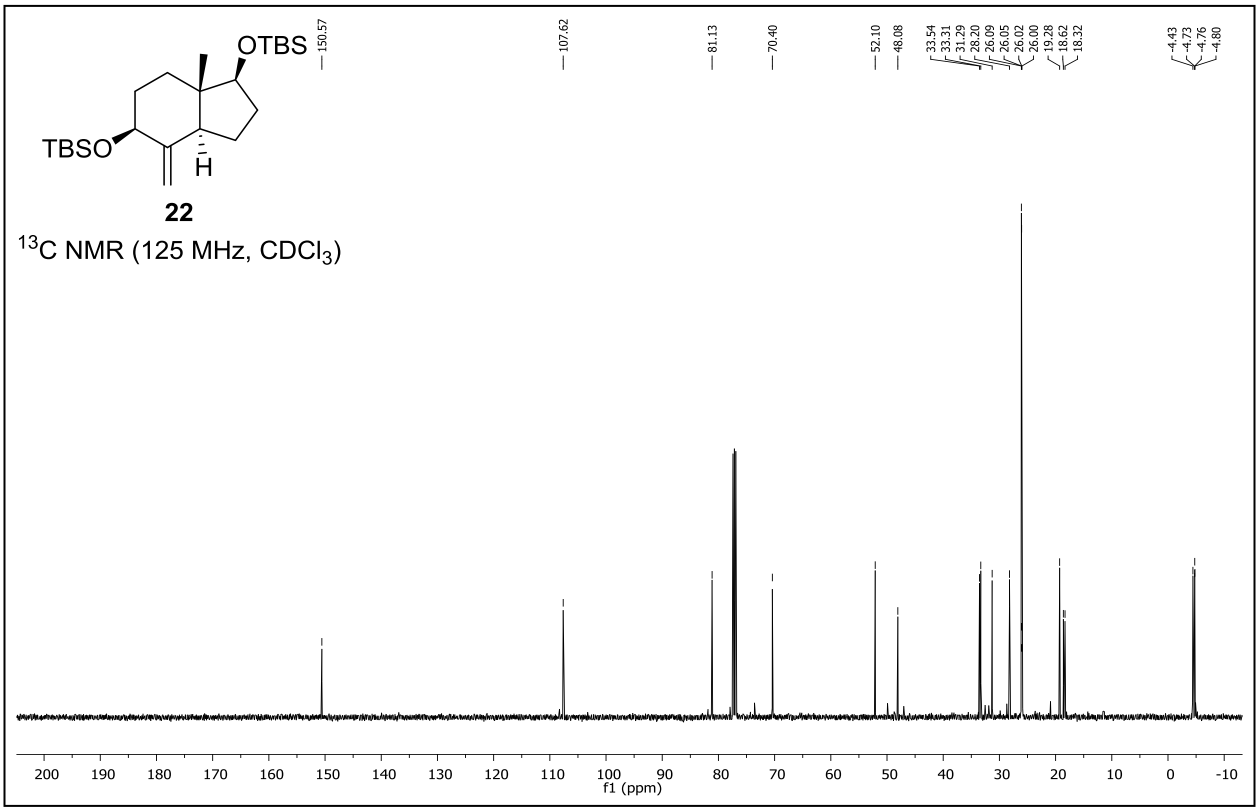
Data/Restraints/Parameters	4027/0/290
R1, wR2 [I>2σ(I)]	0.0478, 0.1159
R1, wR2(all data)	0.0703, 0.1312
GOF	0.886
Largest diff. peak/hole (e $Å^{-3}$)	0.932/-0.489

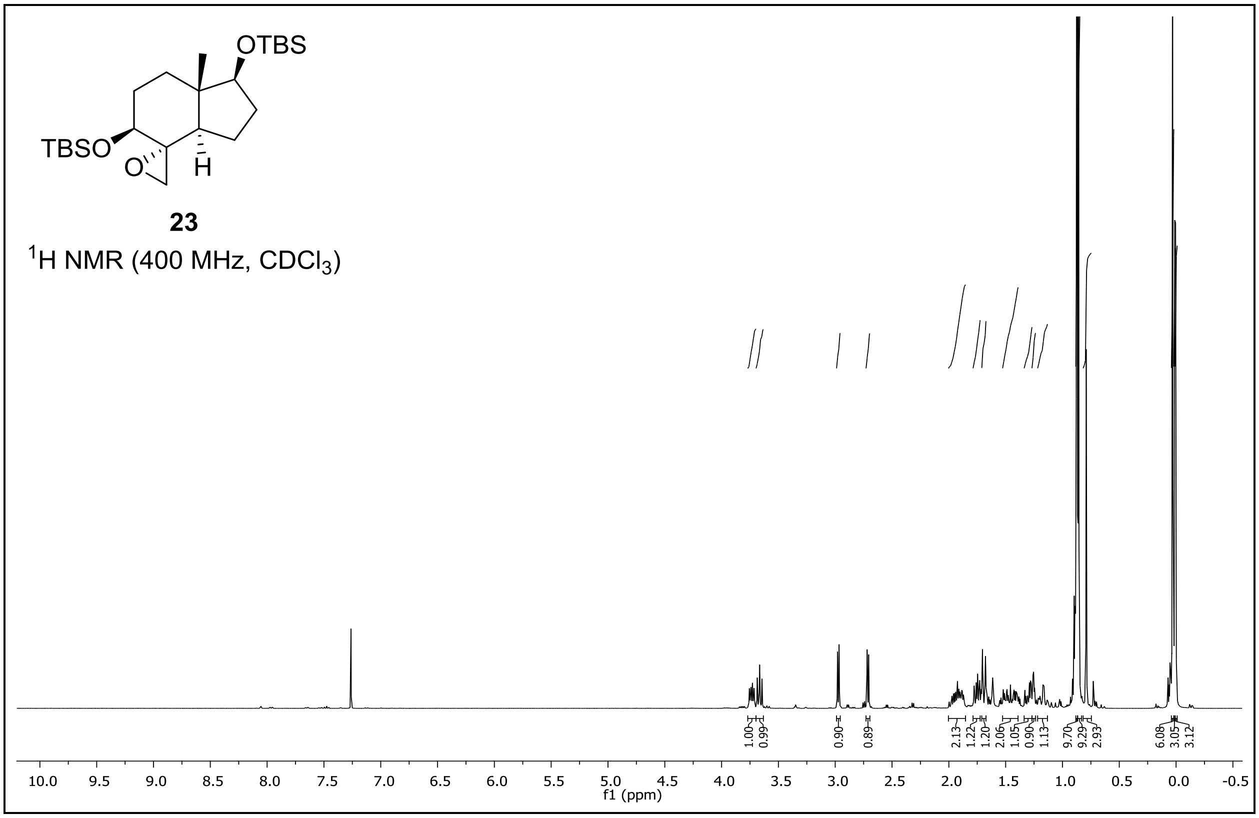
5. References:

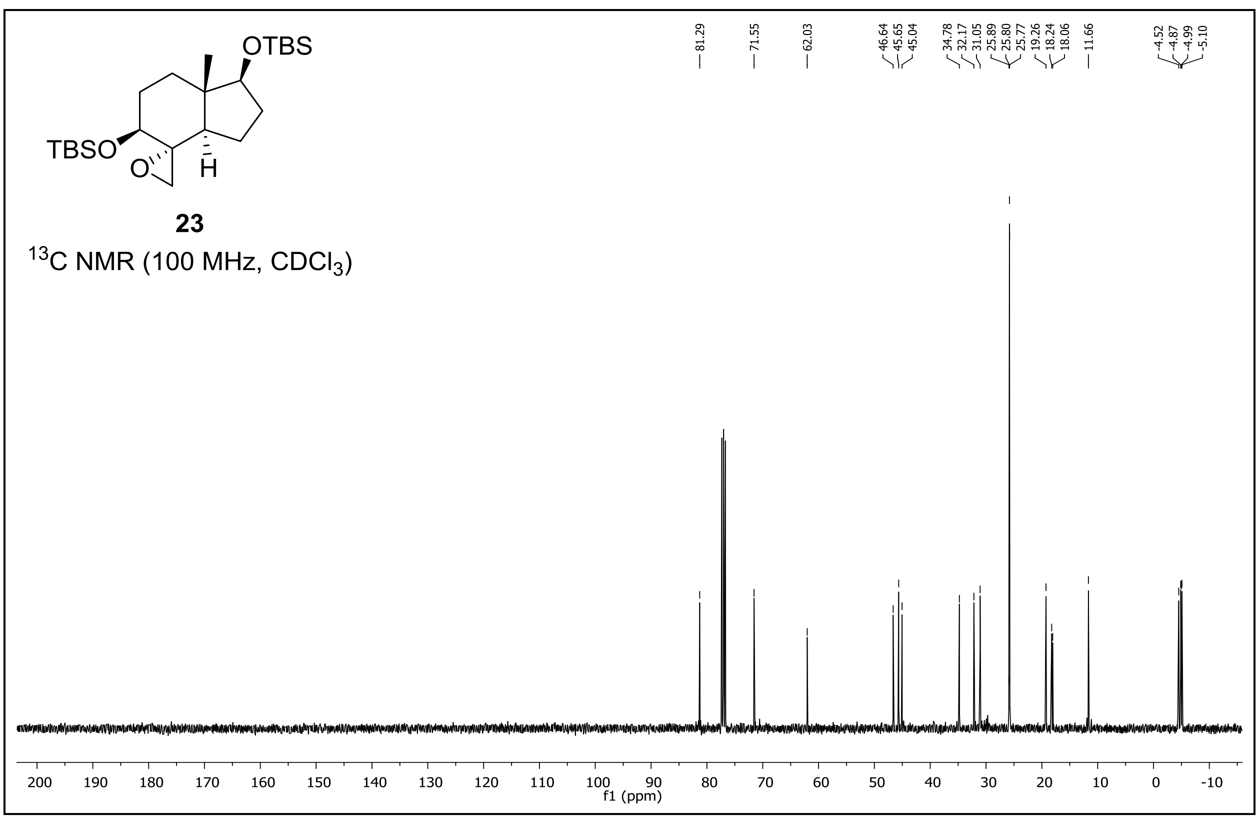
1. D. T. Hog, F. M. E. Huber, G. Jimenez-Oses, P. Mayer, K. N. Houk and D. Trauner *Chem. Eur. J.* 2015, **21**, 13646−13665.
2. Nemoto, H.; Kurobe, H.; Fukumoto, K.; Kametani, T. *J. Org. Chem.* 1986, **51**, 5311–5320.
3. R. C. Sawant, Y-J. Liao, Y-J. Lin, S. S. Badsara and S-Y. Luo *RSC Adv.* 2015, **5**, 19027−19033.
4. J. Zhang, E. Lambert, Z-F. Xu, J. Brioche, P. Remy and S. R. Piettre *J. Org. Chem.* 2019, **84**, 5245−5260.

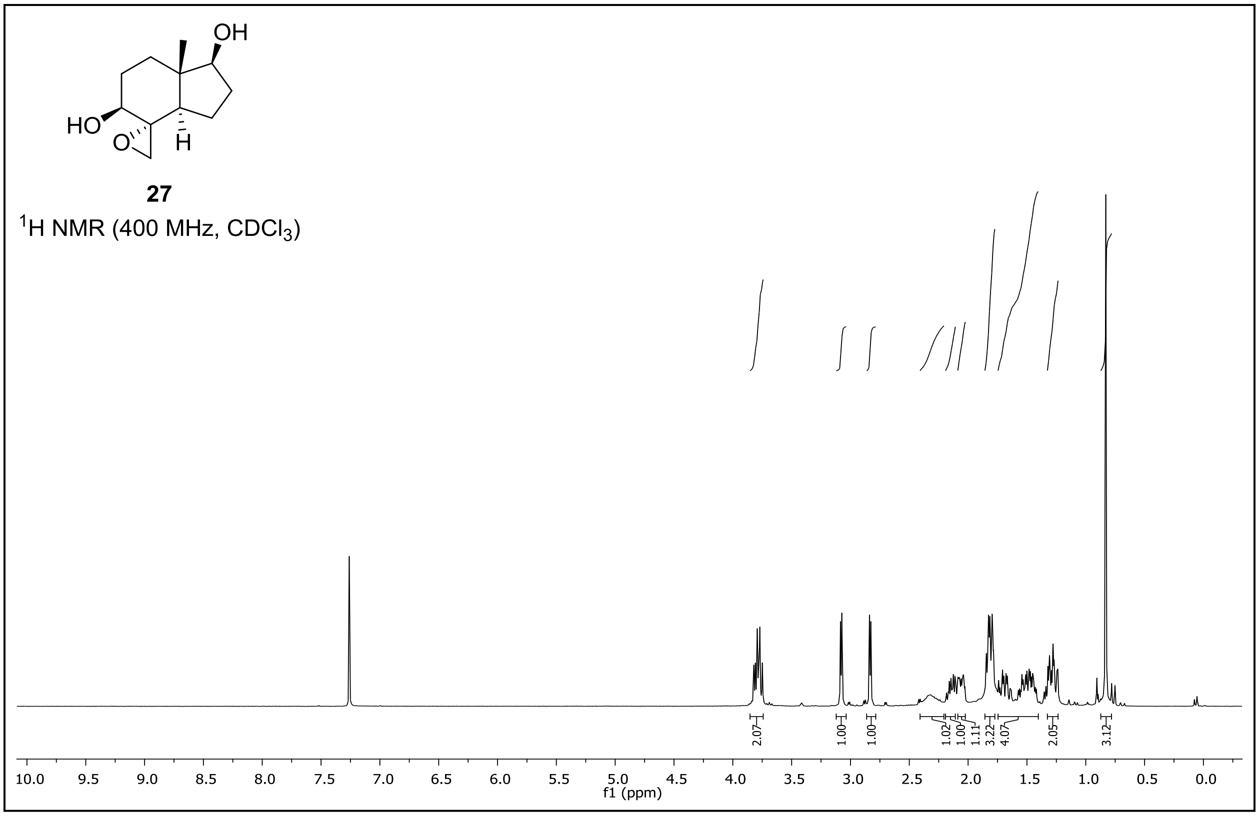
6. Spectral Data:





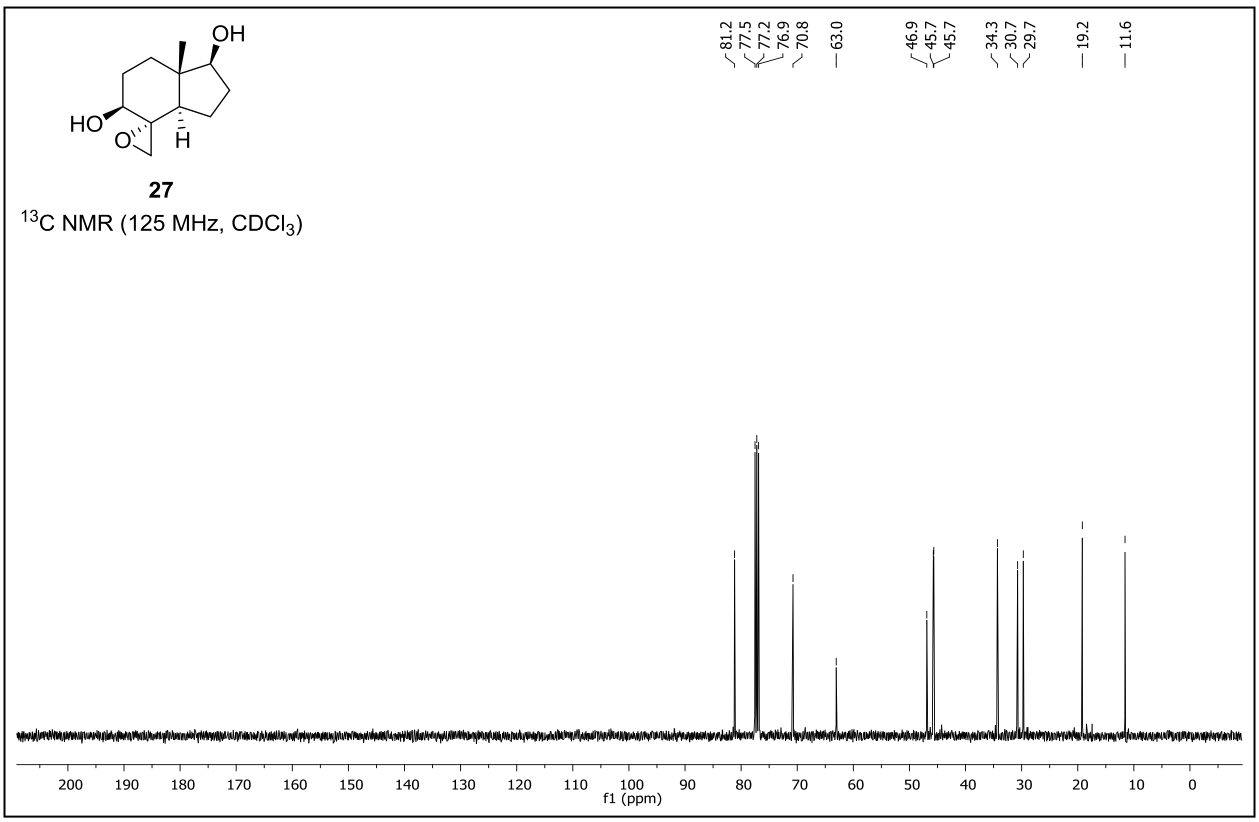

OTBS
TBSO
O
H
23
1H NMR (400 MHz, CDCl3)
1.00
0.99
0.90
0.89
2.13
1.22
1.20
2.06
1.05
0.90
1.13
9.70
9.29
2.93
6.08
3.05
3.12
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


81.29
71.55
62.03
46.64
45.65
45.04
34.78
32.17
31.05
25.89
25.80
25.77
19.26
18.24
18.06
11.66
-4.52
-4.87
-4.99
-5.10
OTBS
TBSO
O
H
23
13C NMR (100 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



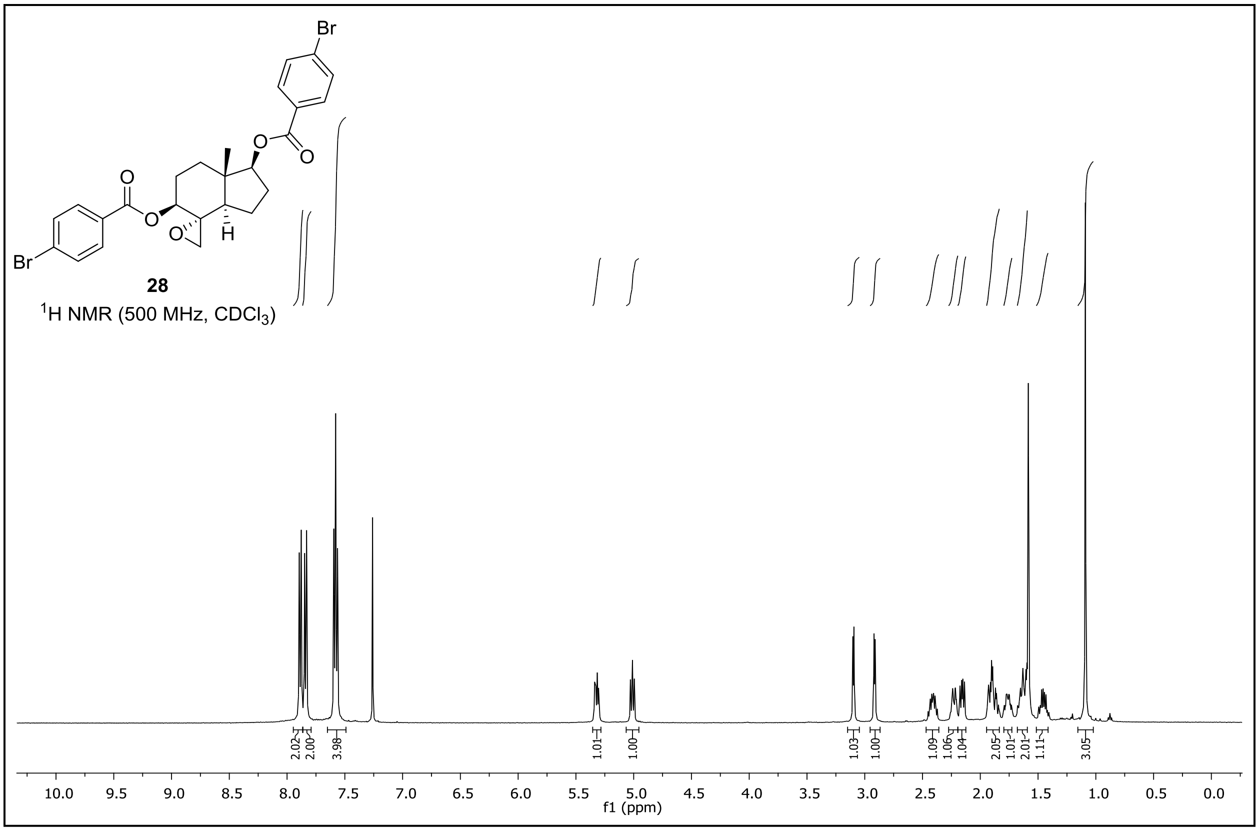
27

^{1}H NMR (400 MHz, $CDCl_3$)

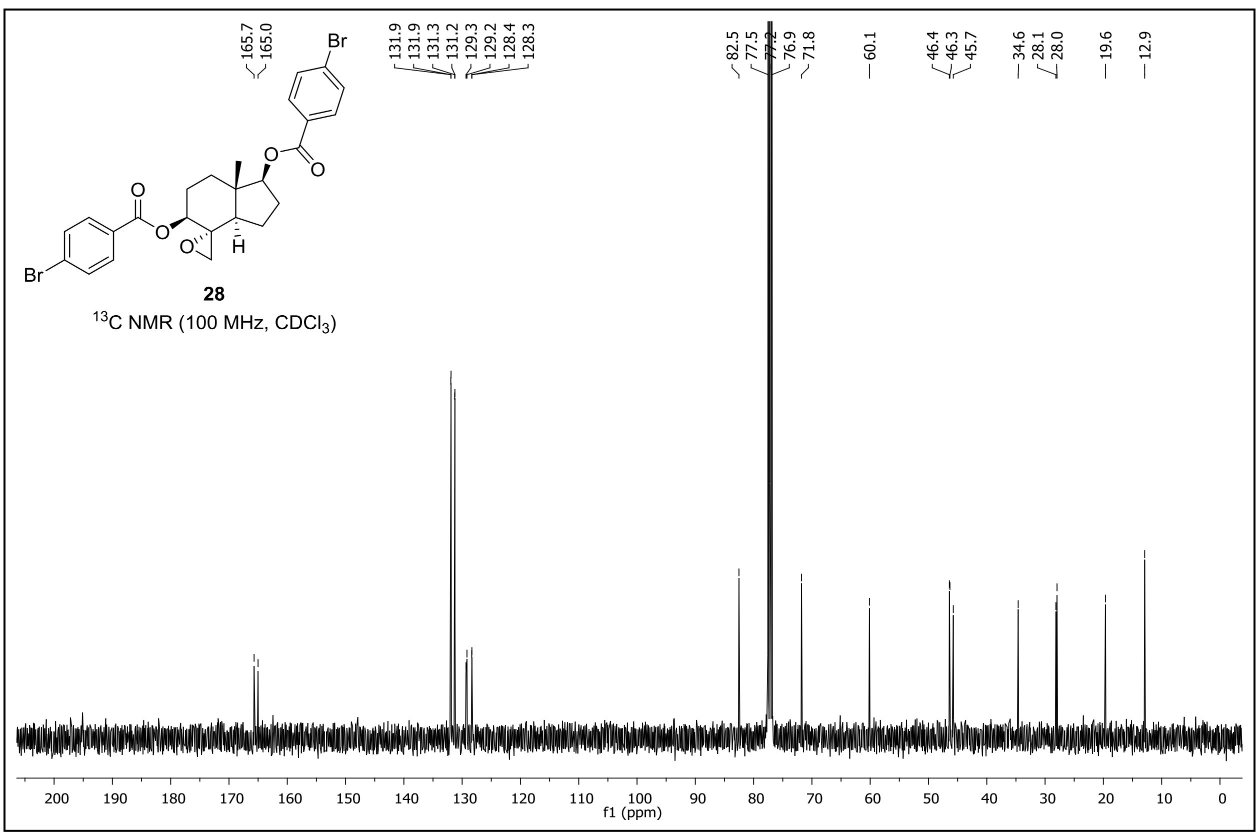


27

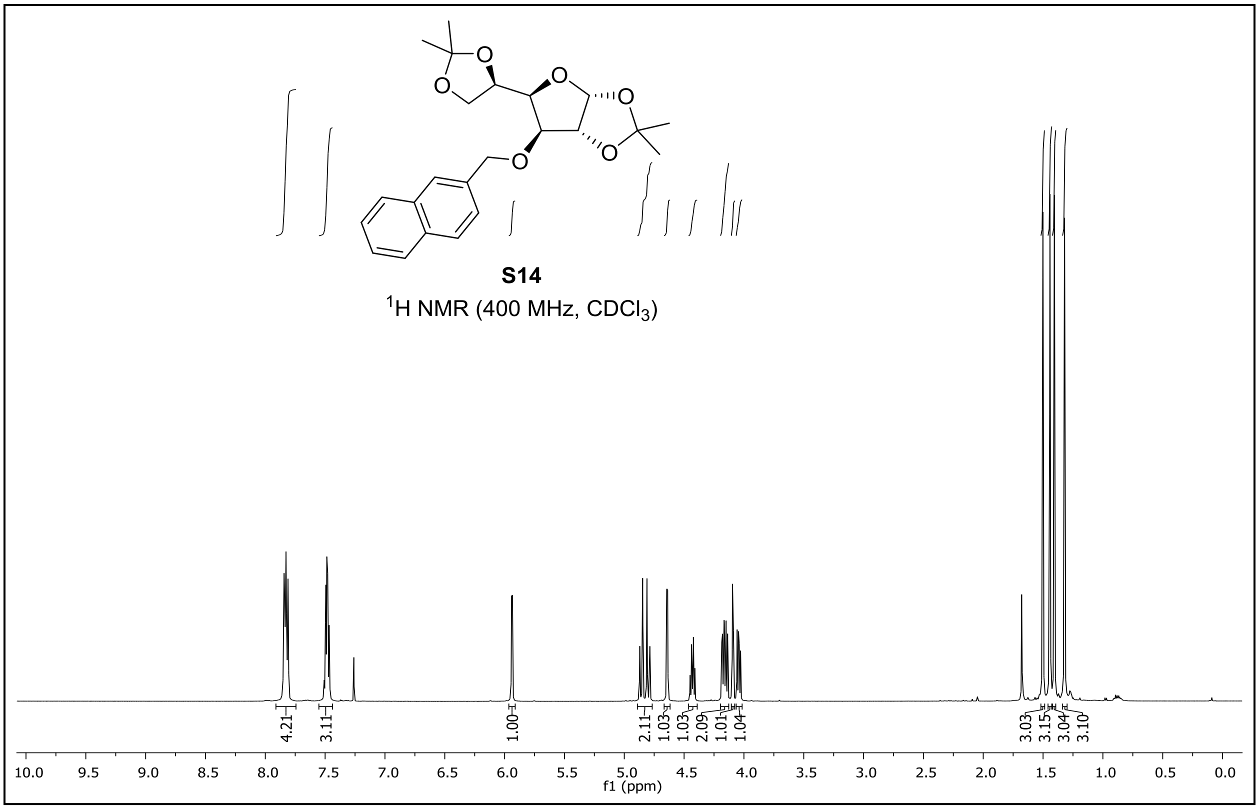
^{13}C NMR (125 MHz, $CDCl_3$)

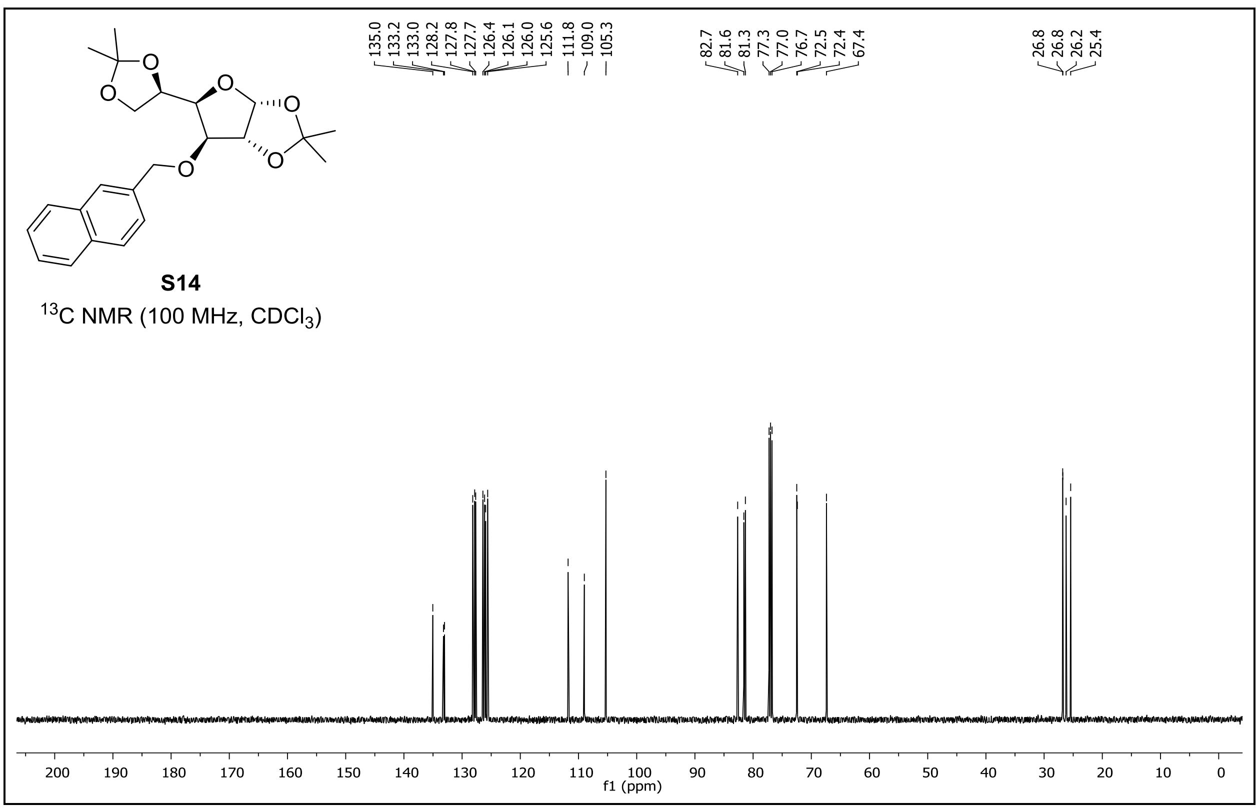


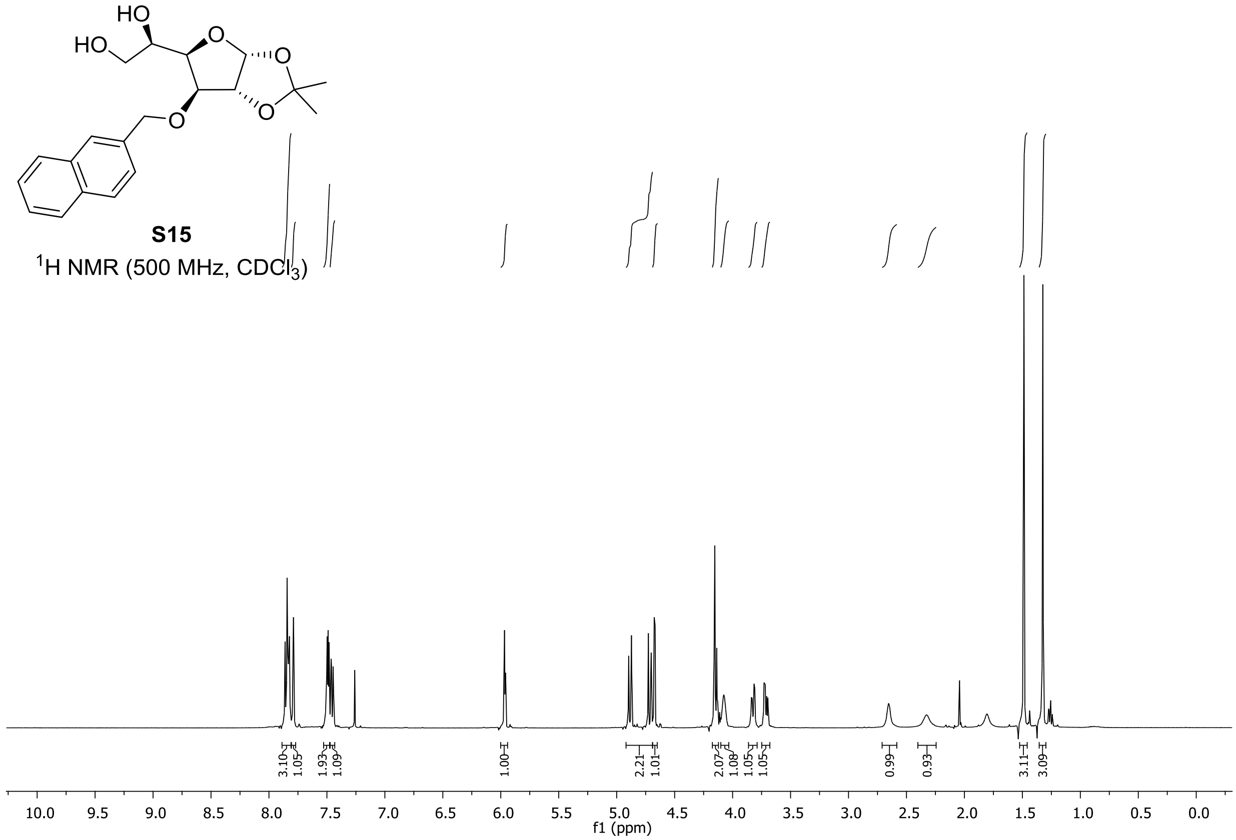
Br
O
O
O
O
H
Br
28
1H NMR (500 MHz, CDCl3)
2.02
2.00
3.98
1.01
1.00
1.03
1.00
1.09
1.06
1.04
2.05
1.01
2.01
1.11
3.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



165.7
165.0
131.9
131.9
131.3
131.2
129.3
129.2
128.4
128.3
82.5
77.5
77.2
76.9
71.8
60.1
46.4
46.3
45.7
34.6
28.1
28.0
19.6
12.9
28
13C NMR (100 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

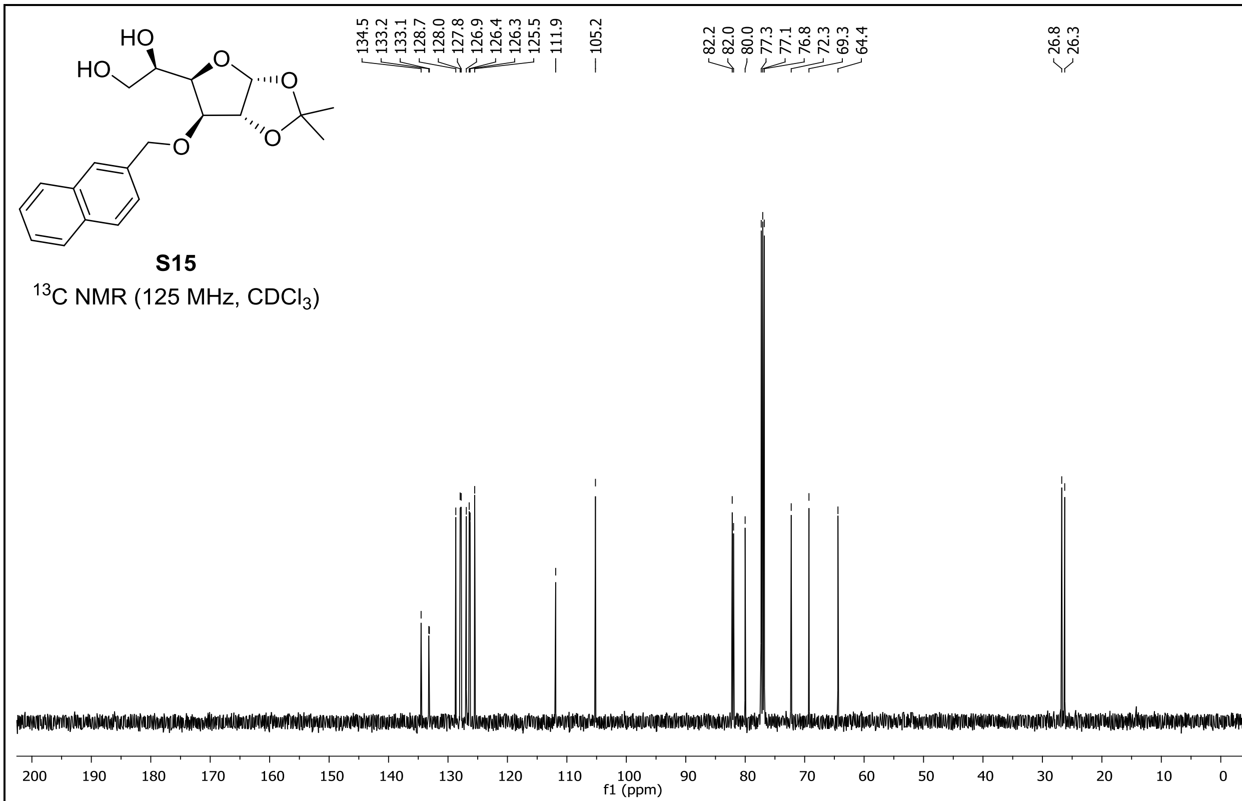

S14
^{1}H NMR (400 MHz, CDCl$_3$)
4.21 3.11 1.00 2.11 1.03 1.03 2.09 1.01 1.04 3.03 3.15 3.04 3.10
f1 (ppm)


135.0 133.2 133.0 128.2 127.8 127.7 126.4 126.1 126.0 125.6 111.8 109.0 105.3 82.7 81.6 81.3 77.3 77.0 76.7 72.5 72.4 67.4 26.8 26.8 26.2 25.4
S14
^{13}C NMR (100 MHz, CDCl$_3$)
f1 (ppm)



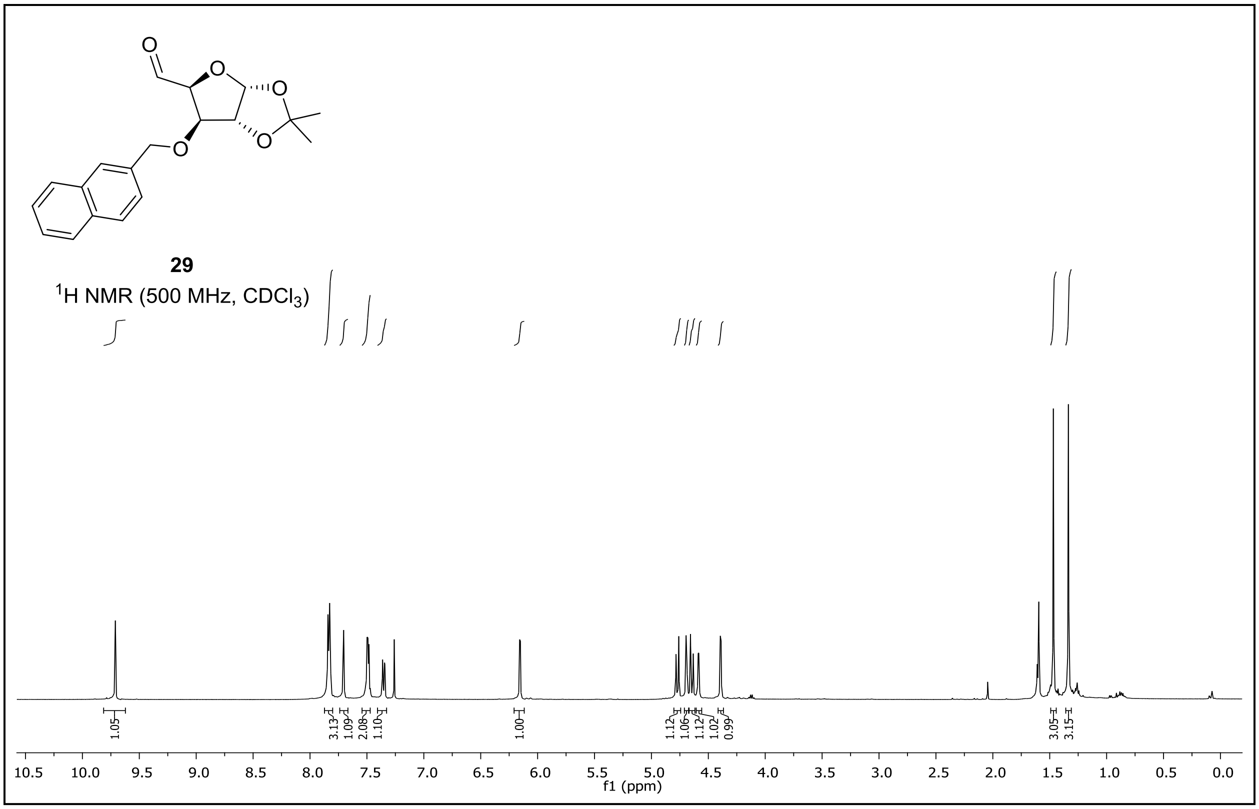
S15

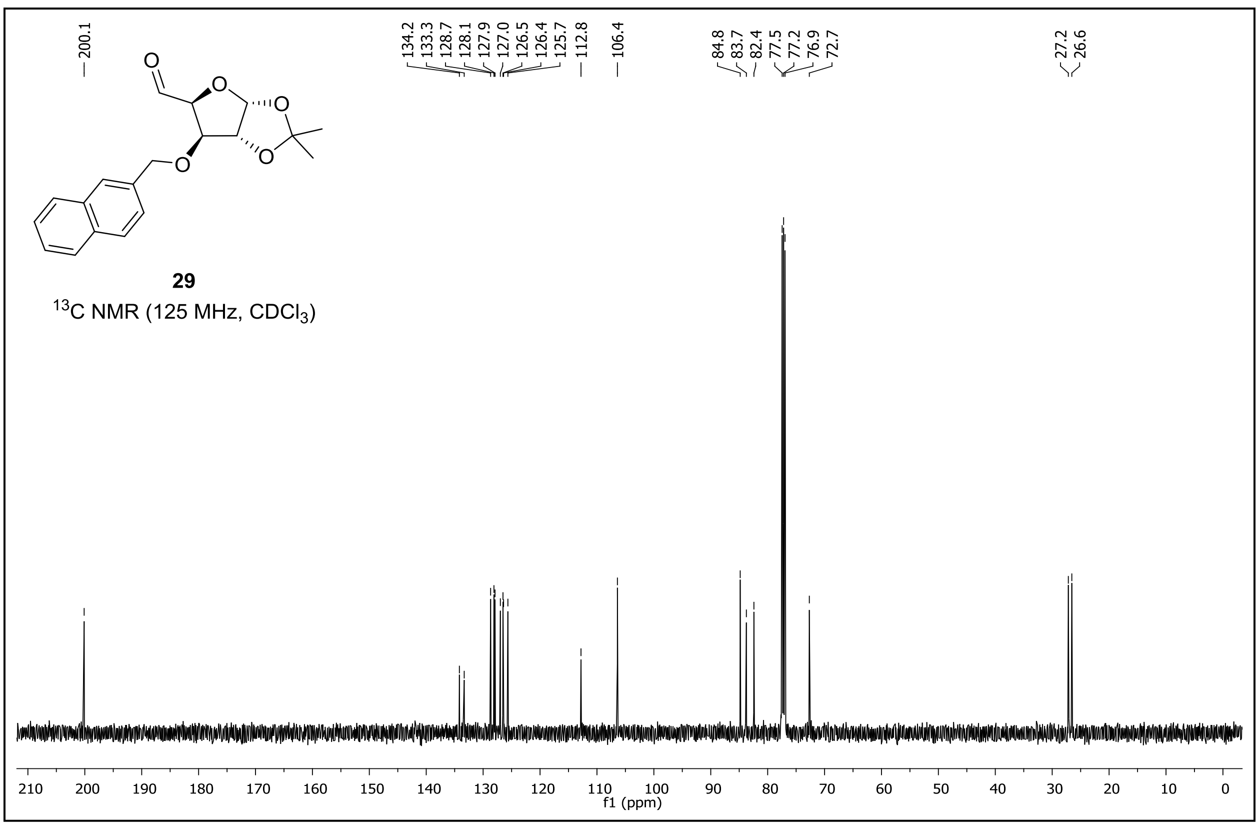
^{1}H NMR (500 MHz, $CDCl_3$)

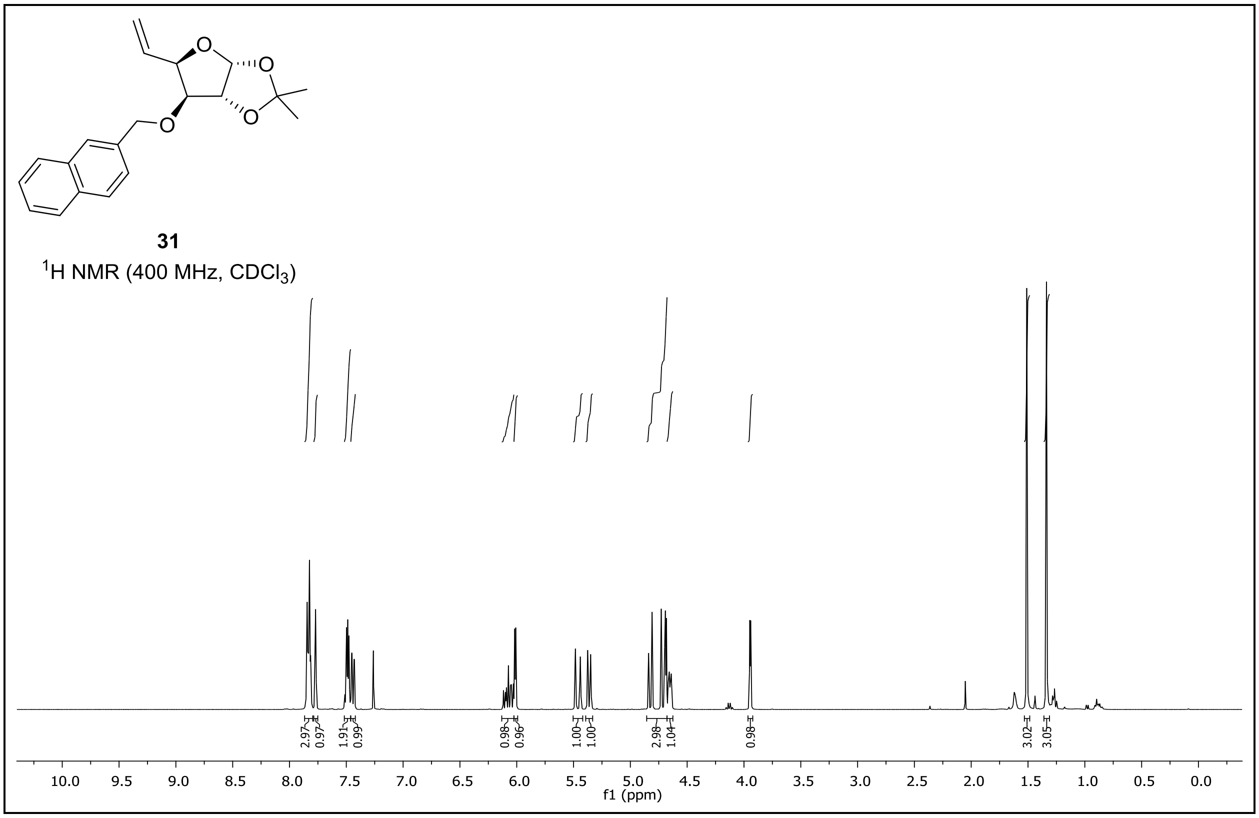


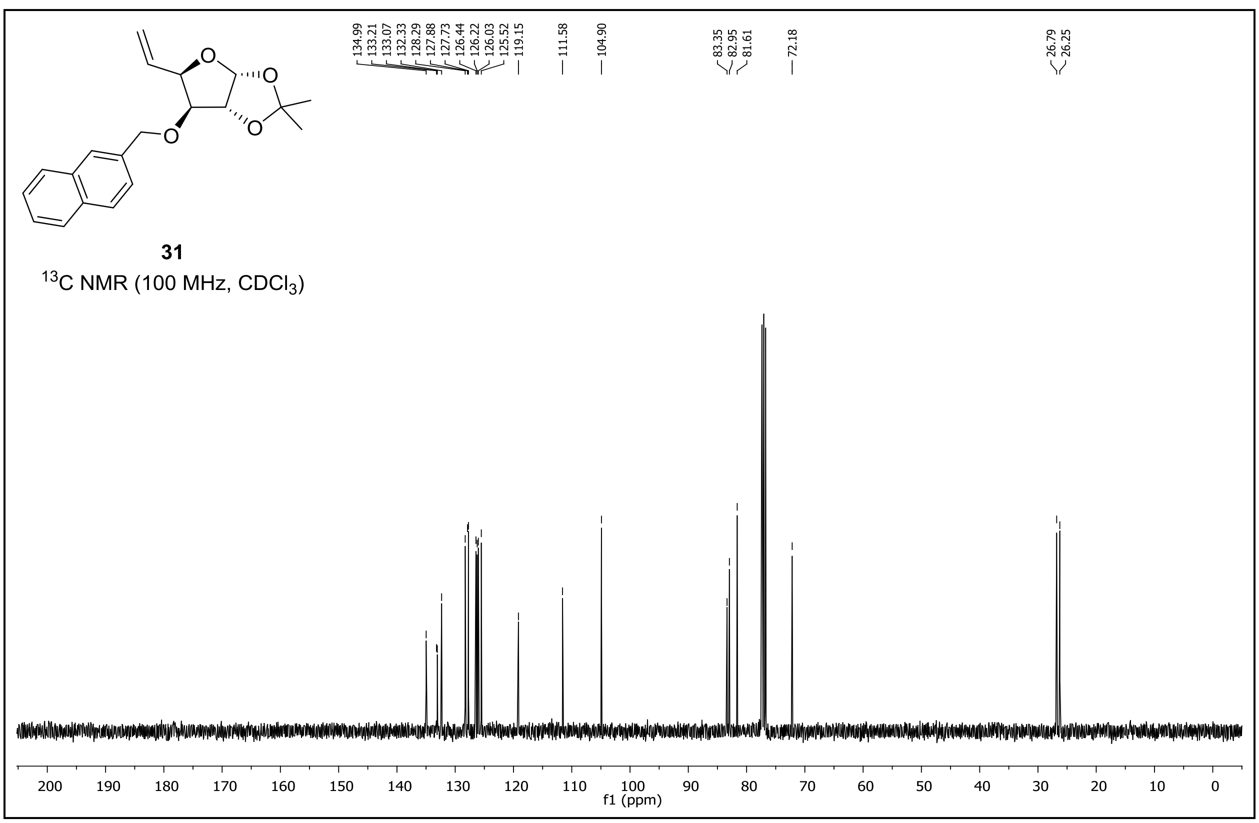
S15

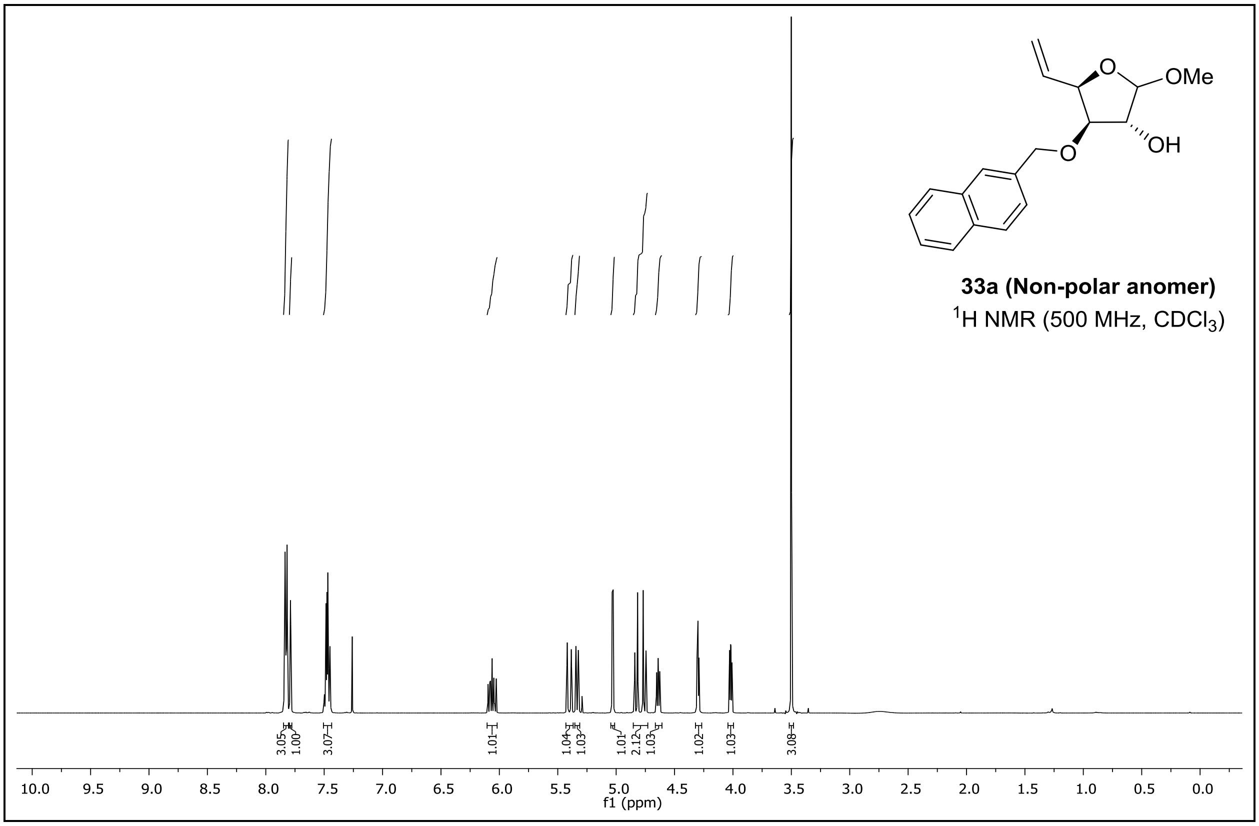
^{13}C NMR (125 MHz, $CDCl_3$)

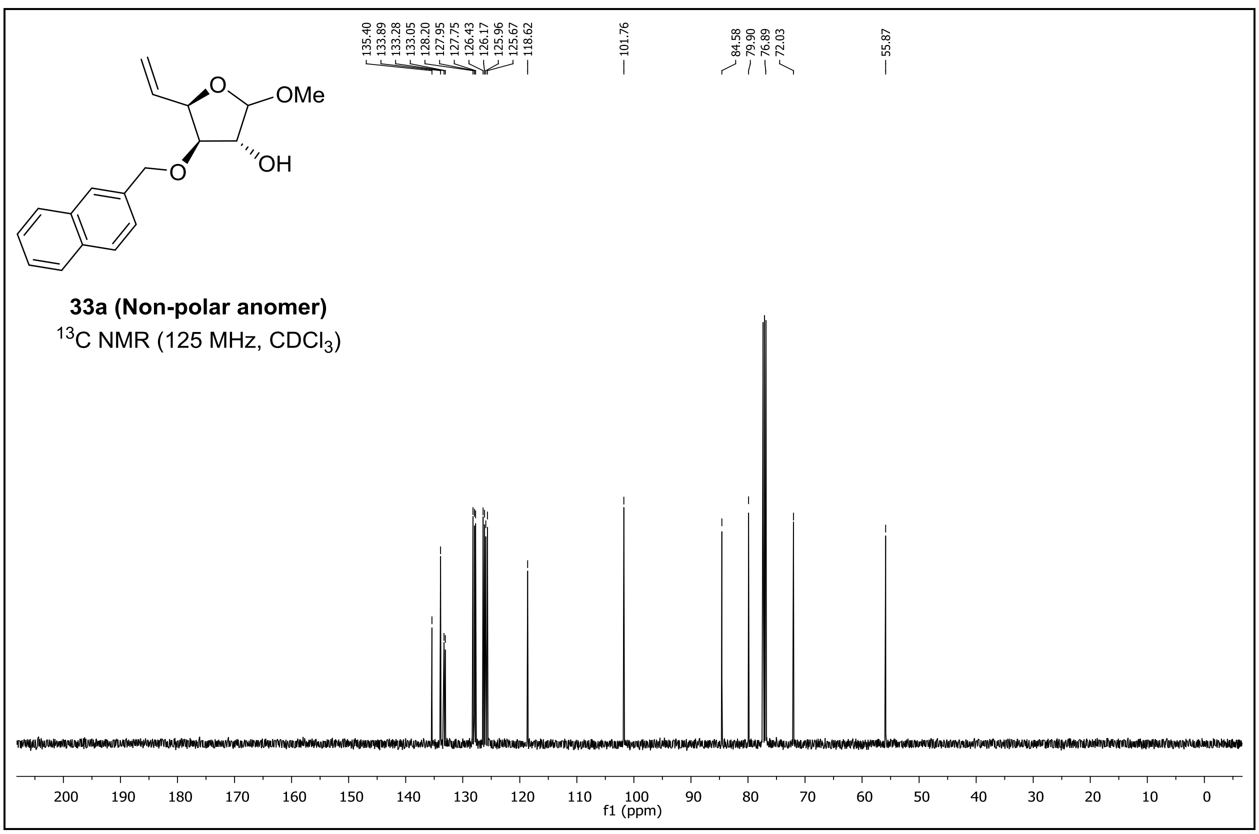

29
^{1}H NMR (500 MHz, $CDCl_3$)
1.05
3.13
1.09
2.08
1.10
1.00
1.12
1.06
1.12
1.02
0.99
3.05
3.15
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

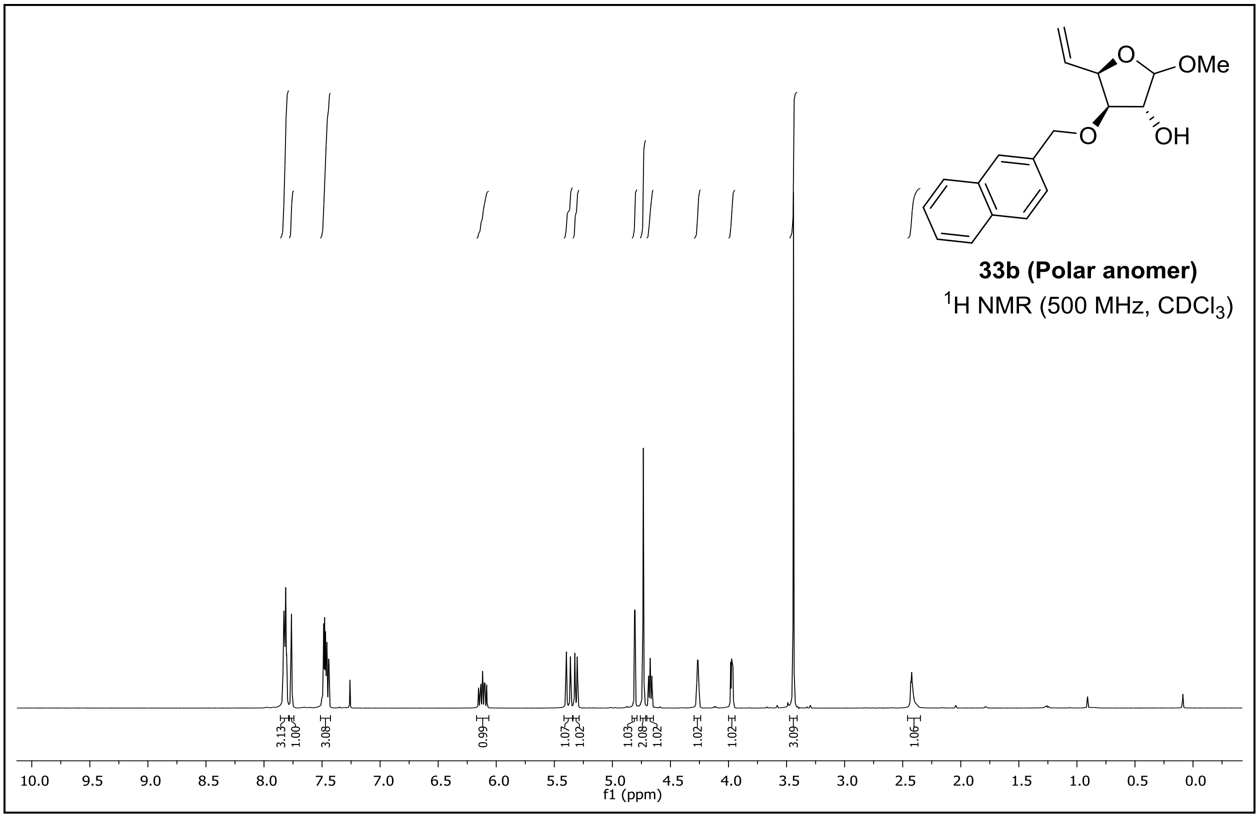

200.1
134.2
133.3
128.7
128.1
127.9
127.0
126.5
126.4
125.7
112.8
106.4
84.8
83.7
82.4
77.5
77.2
76.9
72.7
27.2
26.6
29
^{13}C NMR (125 MHz, $CDCl_3$)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

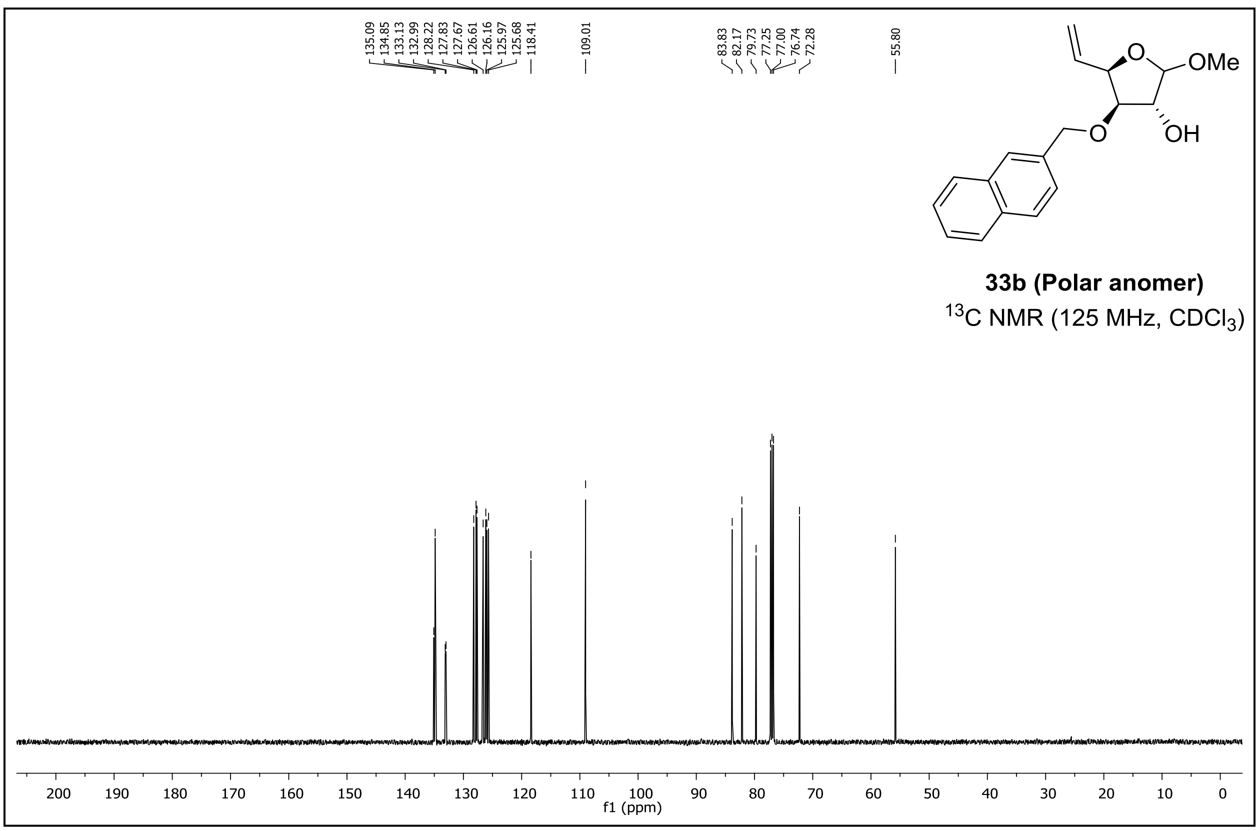

31
1H NMR (400 MHz, CDCl3)
2.97
0.97
1.91
0.99
0.98
0.96
1.00
1.00
2.98
1.04
0.98
3.02
3.05
f1 (ppm)

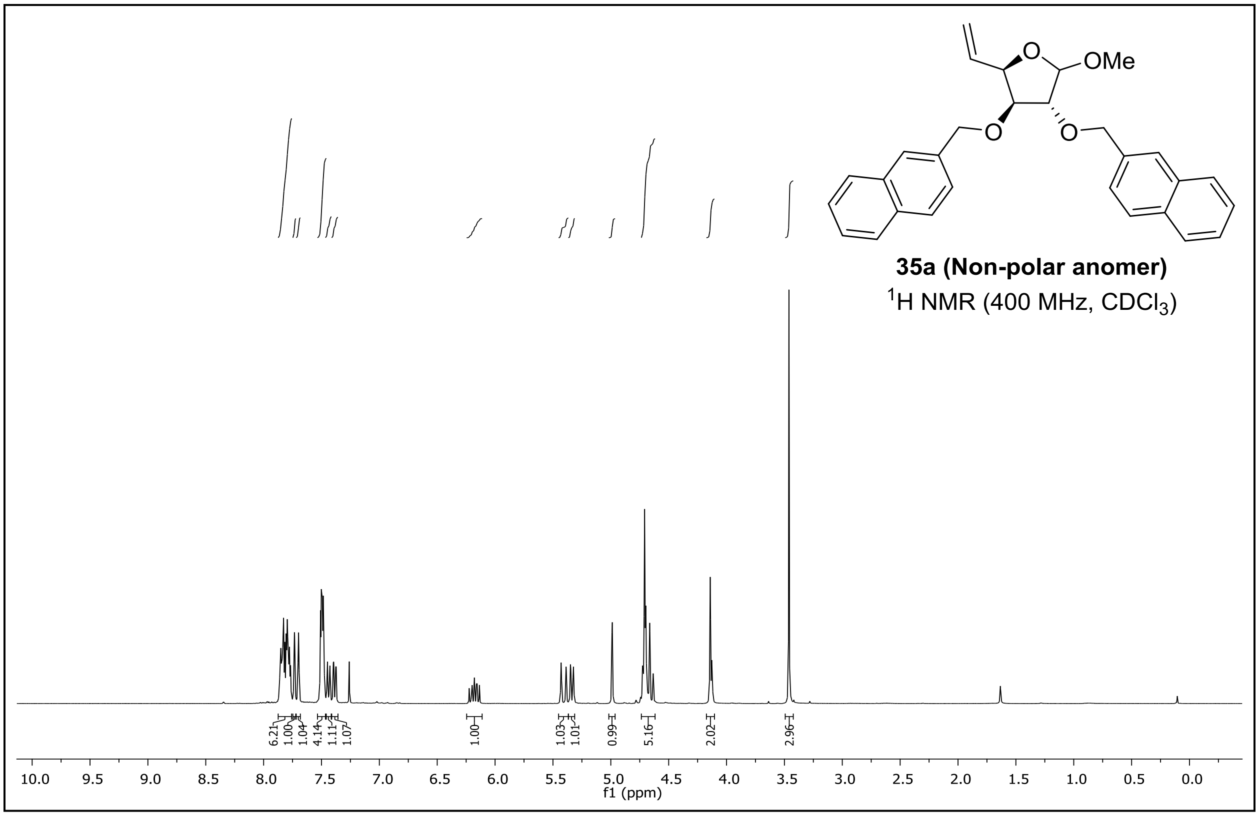

134.99
133.21
133.07
132.33
128.29
127.88
127.73
126.44
126.22
126.03
125.52
119.15
111.58
104.90
83.35
82.95
81.61
72.18
26.79
26.25
31
13C NMR (100 MHz, CDCl3)
f1 (ppm)

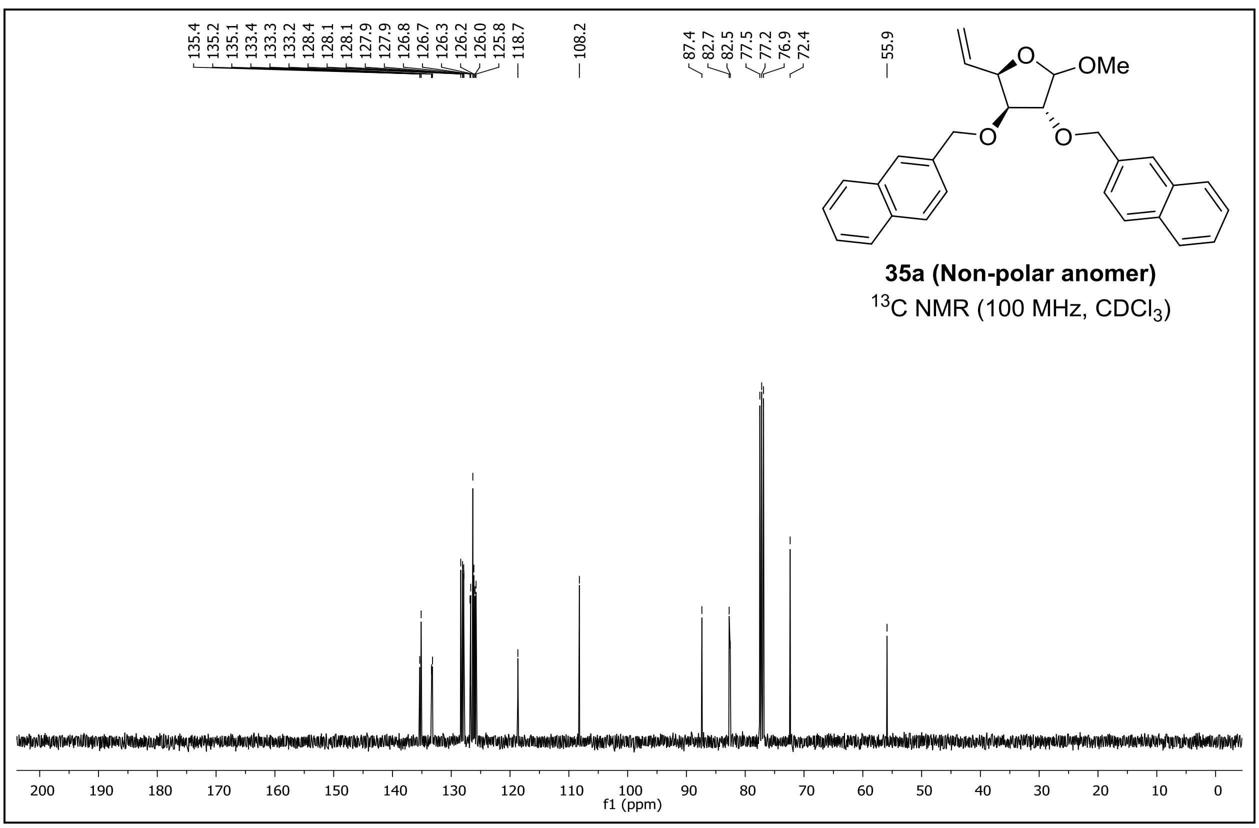

OMe
OH
O
O
33a (Non-polar anomer)
1H NMR (500 MHz, CDCl3)
f1 (ppm)

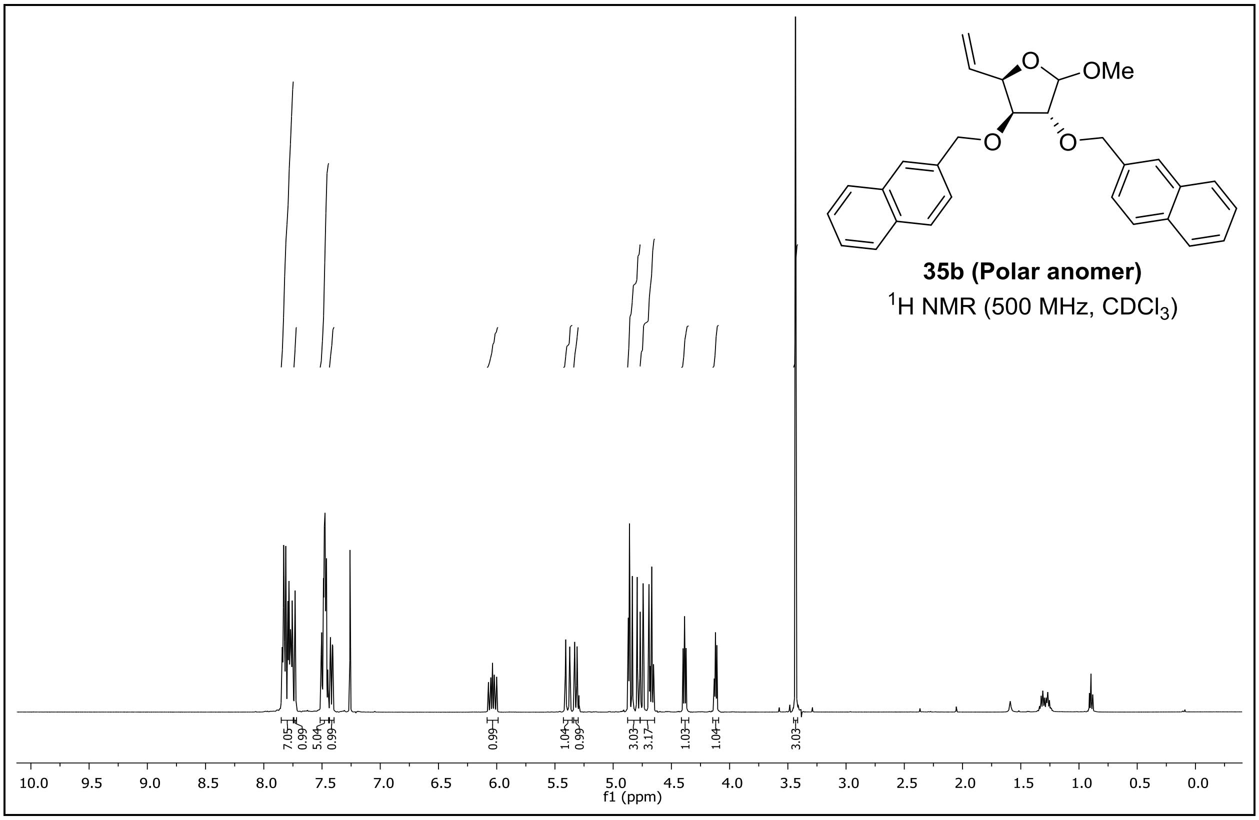

135.40
133.89
133.28
133.05
128.20
127.95
127.75
126.43
126.17
125.96
125.67
118.62
101.76
84.58
79.90
76.89
72.03
55.87
OMe
OH
33a (Non-polar anomer)
13C NMR (125 MHz, CDCl3)
f1 (ppm)

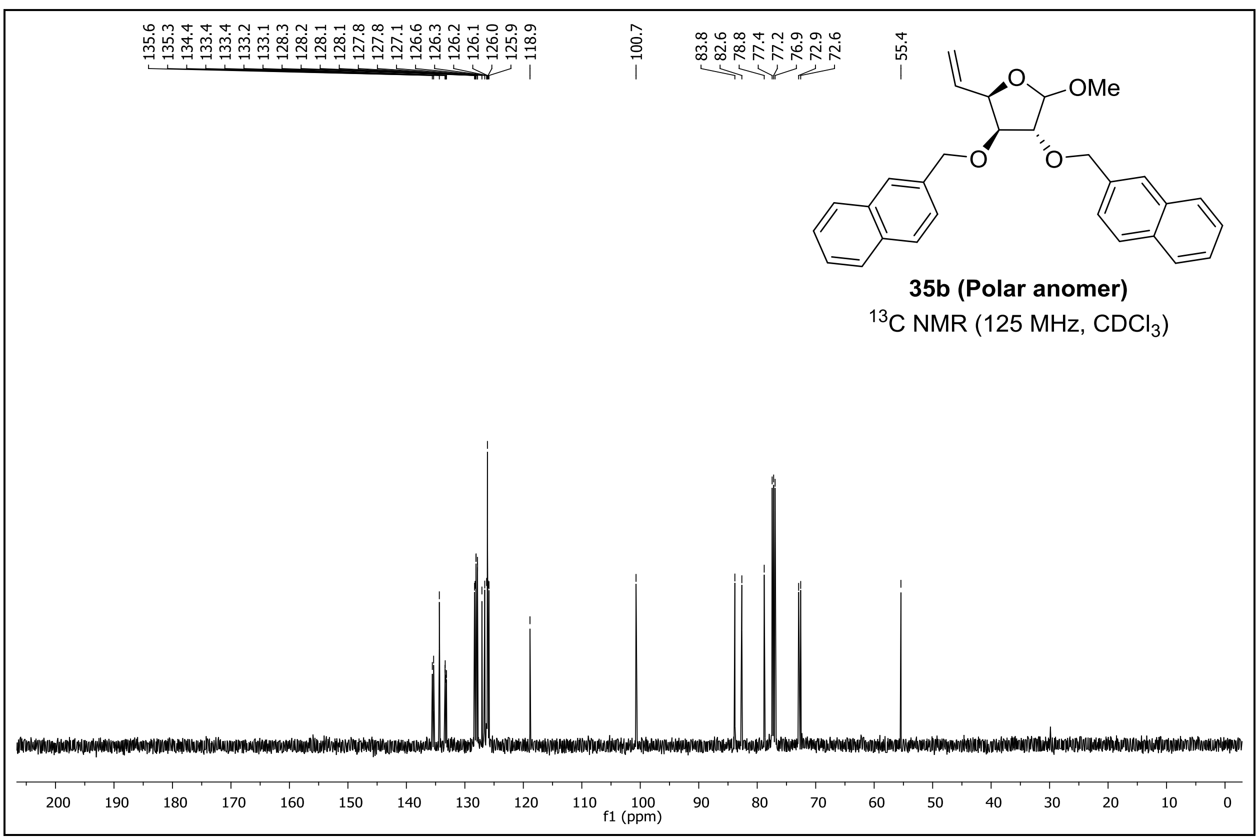

OMe
OH
O
33b (Polar anomer)
1H NMR (500 MHz, CDCl3)
f1 (ppm)

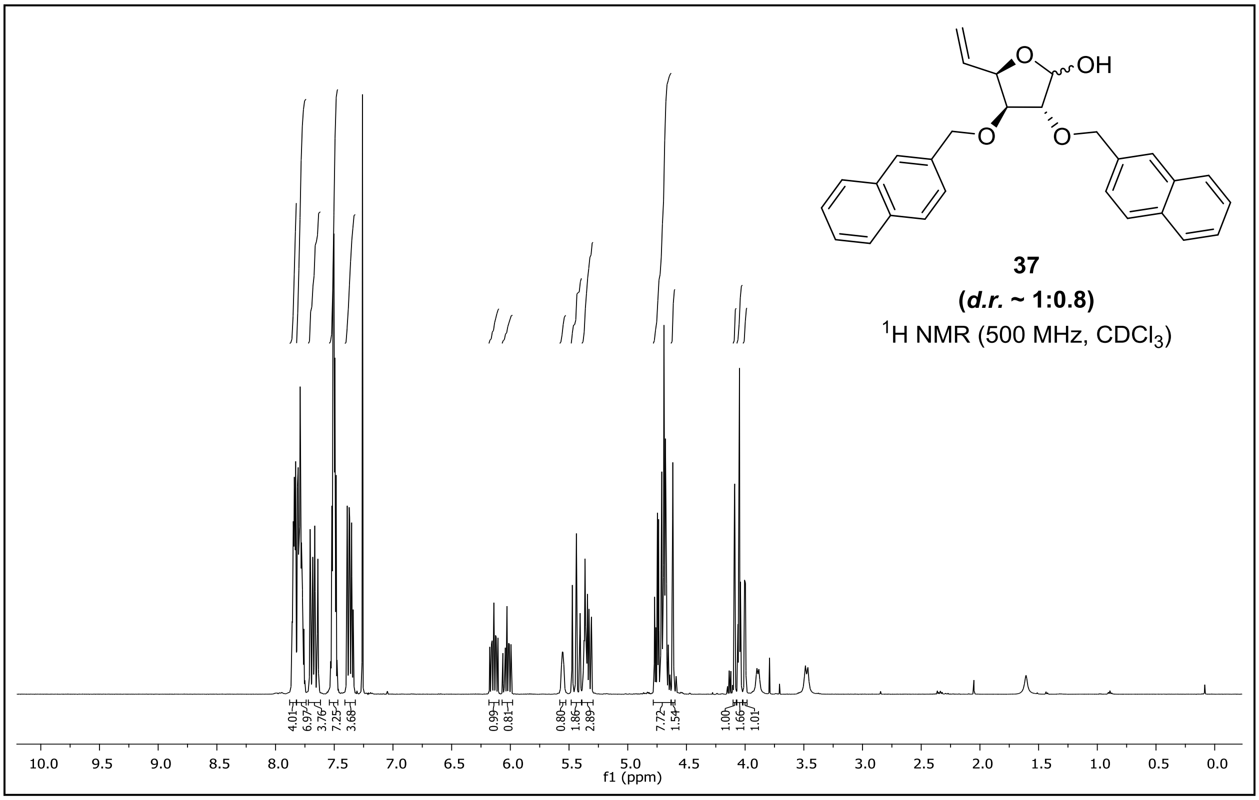

135.09
134.85
133.13
132.99
128.22
127.83
127.67
126.61
126.16
125.97
125.68
118.41
109.01
83.83
82.17
79.73
77.25
77.00
76.74
72.28
55.80
OMe
OH
O
33b (Polar anomer)
13C NMR (125 MHz, CDCl3)
f1 (ppm)


OMe
35a (Non-polar anomer)
^{1}H NMR (400 MHz, CDCl$_3$)
6.21
1.00
1.04
4.14
1.11
1.07
1.00
1.03
1.01
0.99
5.16
2.02
2.96
10.0 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 0.0
f1 (ppm)

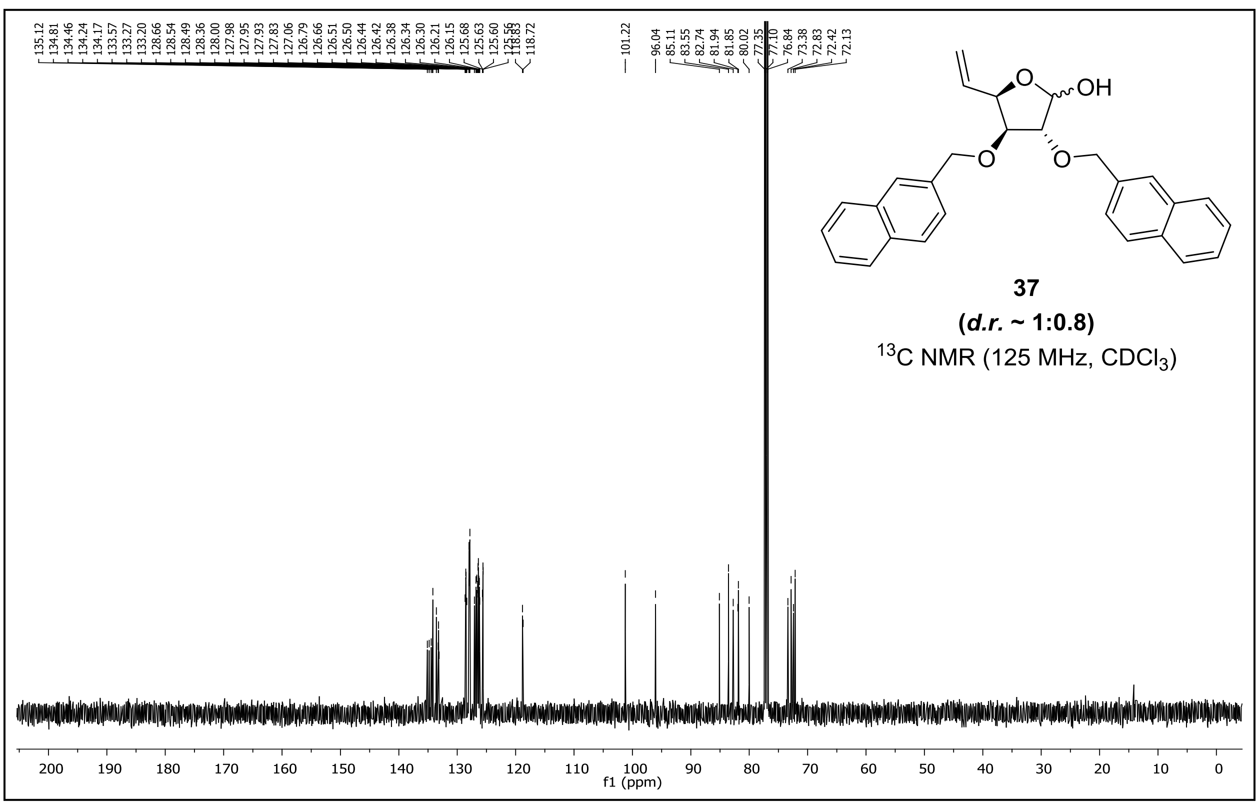

135.4
135.2
135.1
133.4
133.3
133.2
128.4
128.1
128.1
127.9
127.9
126.8
126.7
126.3
126.2
126.0
125.8
118.7
108.2
87.4
82.7
82.5
77.5
77.2
76.9
72.4
55.9
OMe
35a (Non-polar anomer)
^{13}C NMR (100 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


OMe
O
O
O
35b (Polar anomer)
1H NMR (500 MHz, CDCl3)
7.05
0.99
5.04
0.99
0.99
1.04
0.99
3.03
3.17
1.03
1.04
3.03
10.0 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 0.0
f1 (ppm)

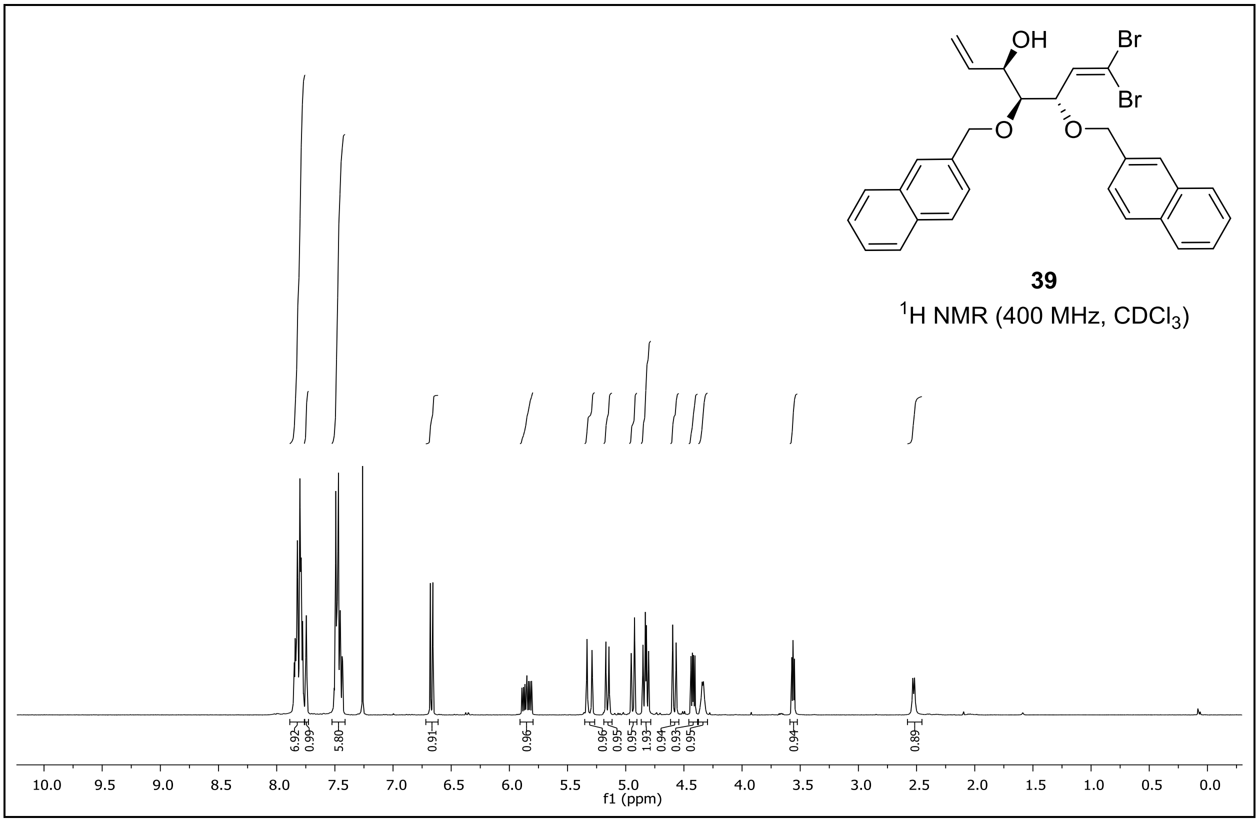

135.6
135.3
134.4
133.4
133.4
133.2
133.1
128.3
128.2
128.1
128.1
127.8
127.8
127.1
126.6
126.3
126.2
126.1
126.0
125.9
118.9
100.7
83.8
82.6
78.8
77.4
77.2
76.9
72.9
72.6
55.4
OMe
O
O
O
35b (Polar anomer)
13C NMR (125 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

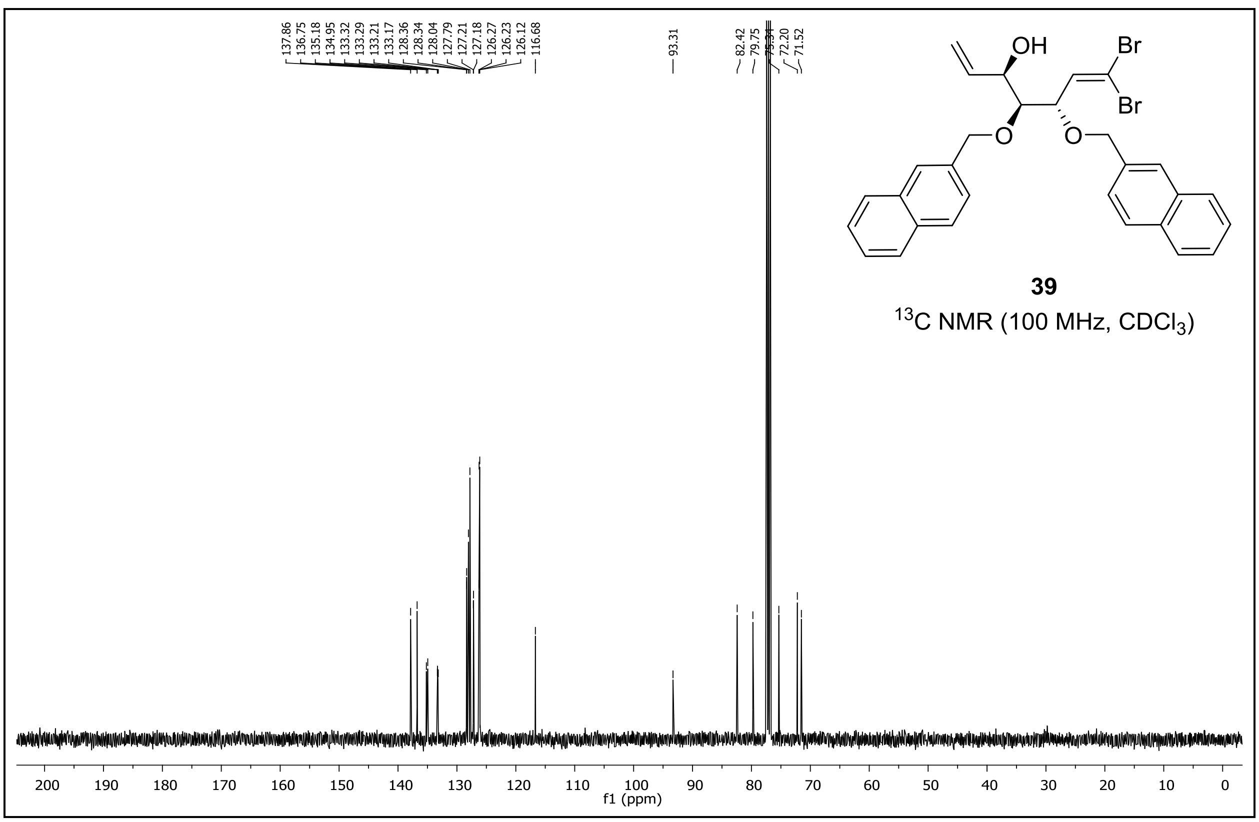


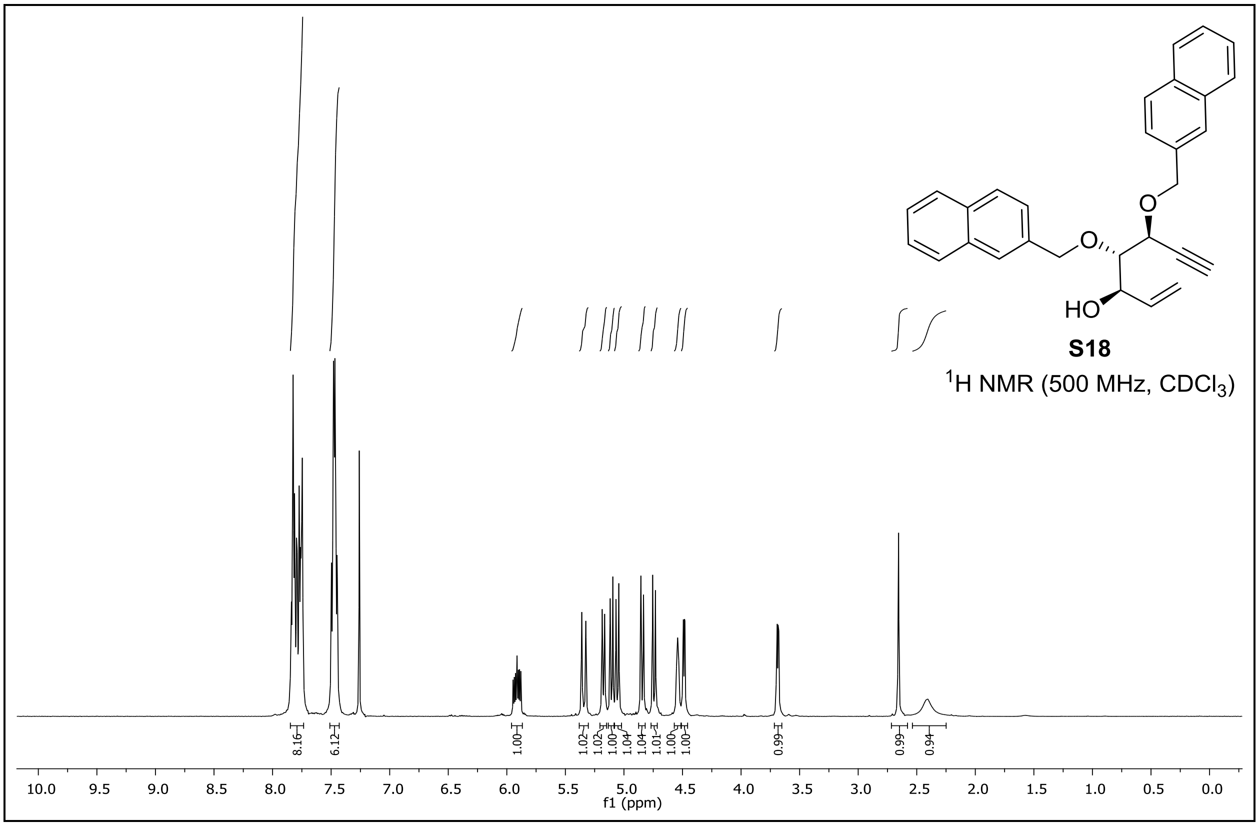
OH
O
37
(d.r. ~ 1:0.8)
¹H NMR (500 MHz, CDCl₃)
f1 (ppm)

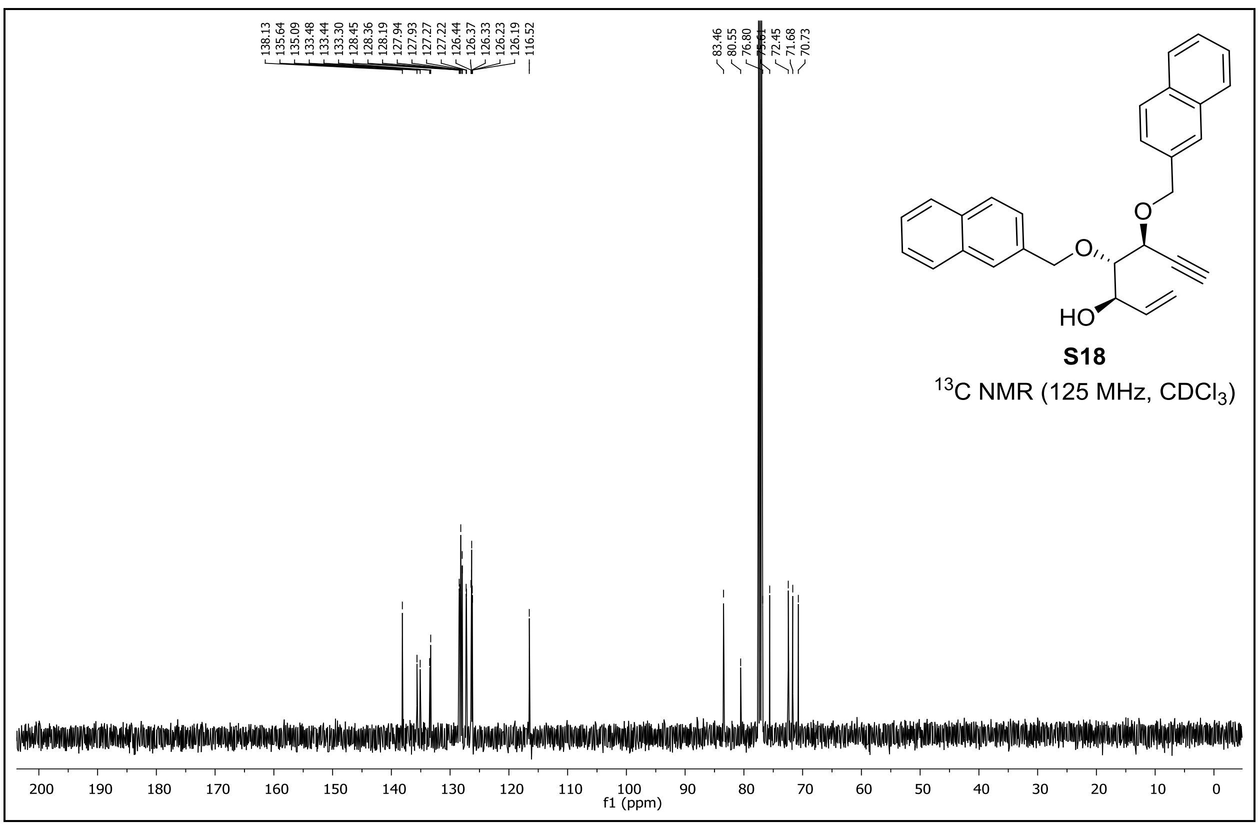


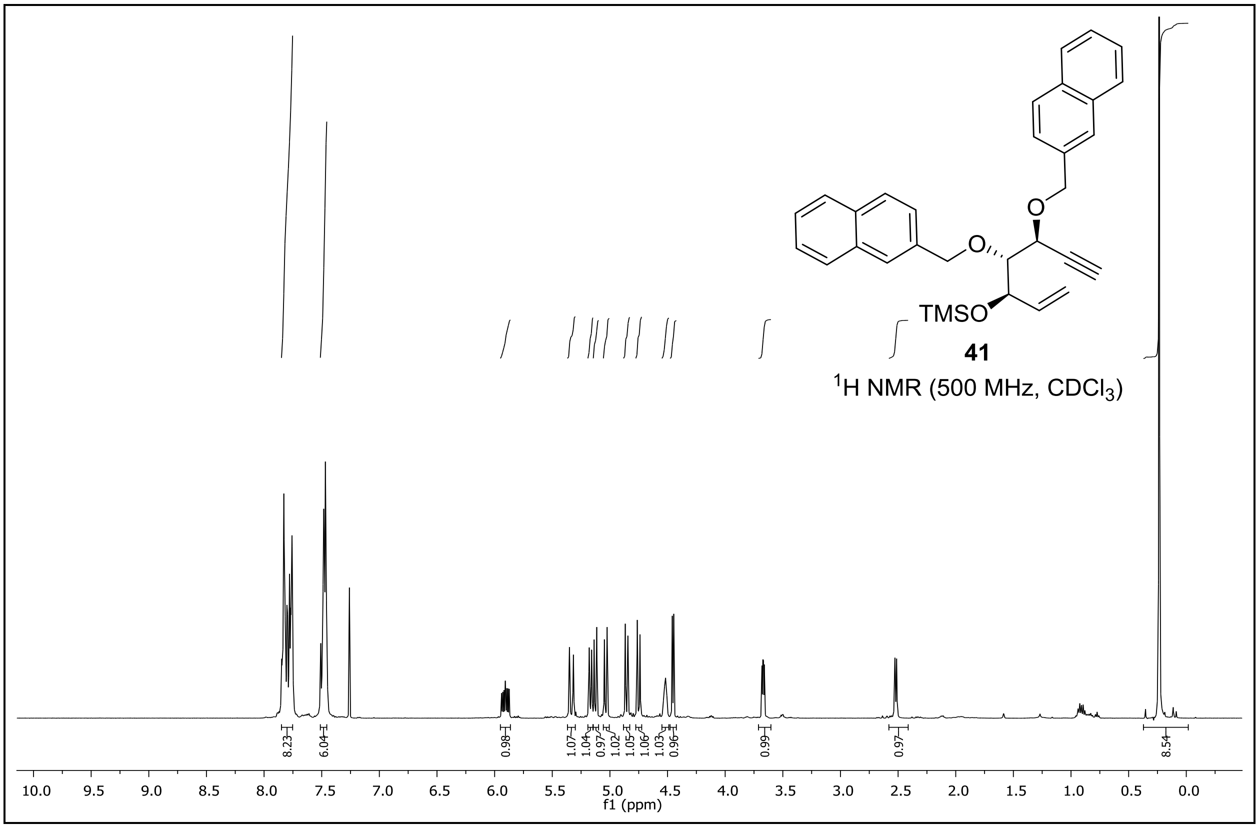
OH
O
37
(d.r. ~ 1:0.8)
¹³C NMR (125 MHz, CDCl₃)
f1 (ppm)


OH
Br
Br
O
O
39
^{1}H NMR (400 MHz, $CDCl_3$)
6.92
0.99
5.80
0.91
0.96
0.96
0.95
0.95
1.93
0.94
0.93
0.95
0.94
0.89
10.0 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 0.0
f1 (ppm)

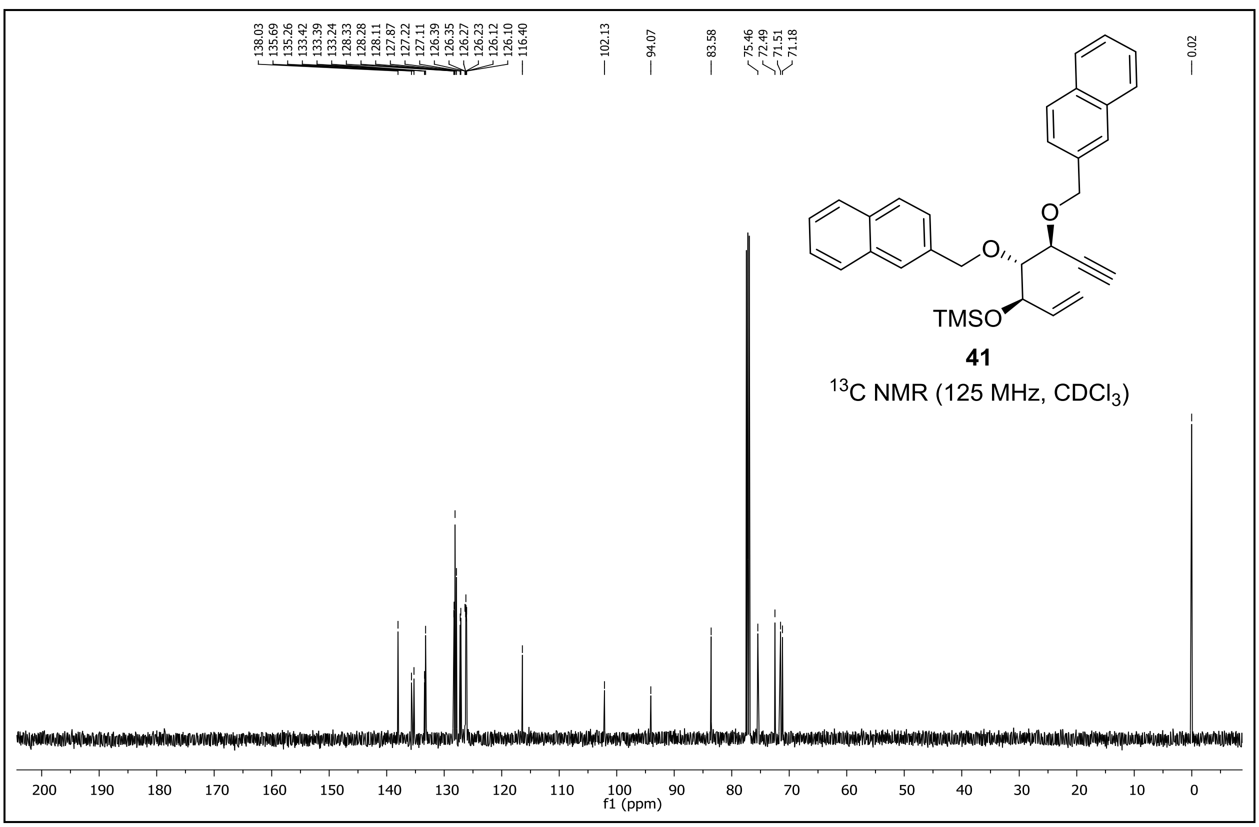

137.86
136.75
135.18
134.95
133.32
133.29
133.21
133.17
128.36
128.34
128.04
127.79
127.21
127.18
126.27
126.23
126.12
116.68
93.31
82.42
79.75
75.34
72.20
71.52
OH
Br
Br
O
O
39
^{13}C NMR (100 MHz, $CDCl_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


HO
S18
1H NMR (500 MHz, CDCl3)
f1 (ppm)

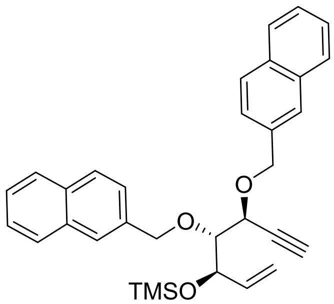

HO
S18
13C NMR (125 MHz, CDCl3)
f1 (ppm)



TMSO
41
1H NMR (500 MHz, CDCl3)
f1 (ppm)

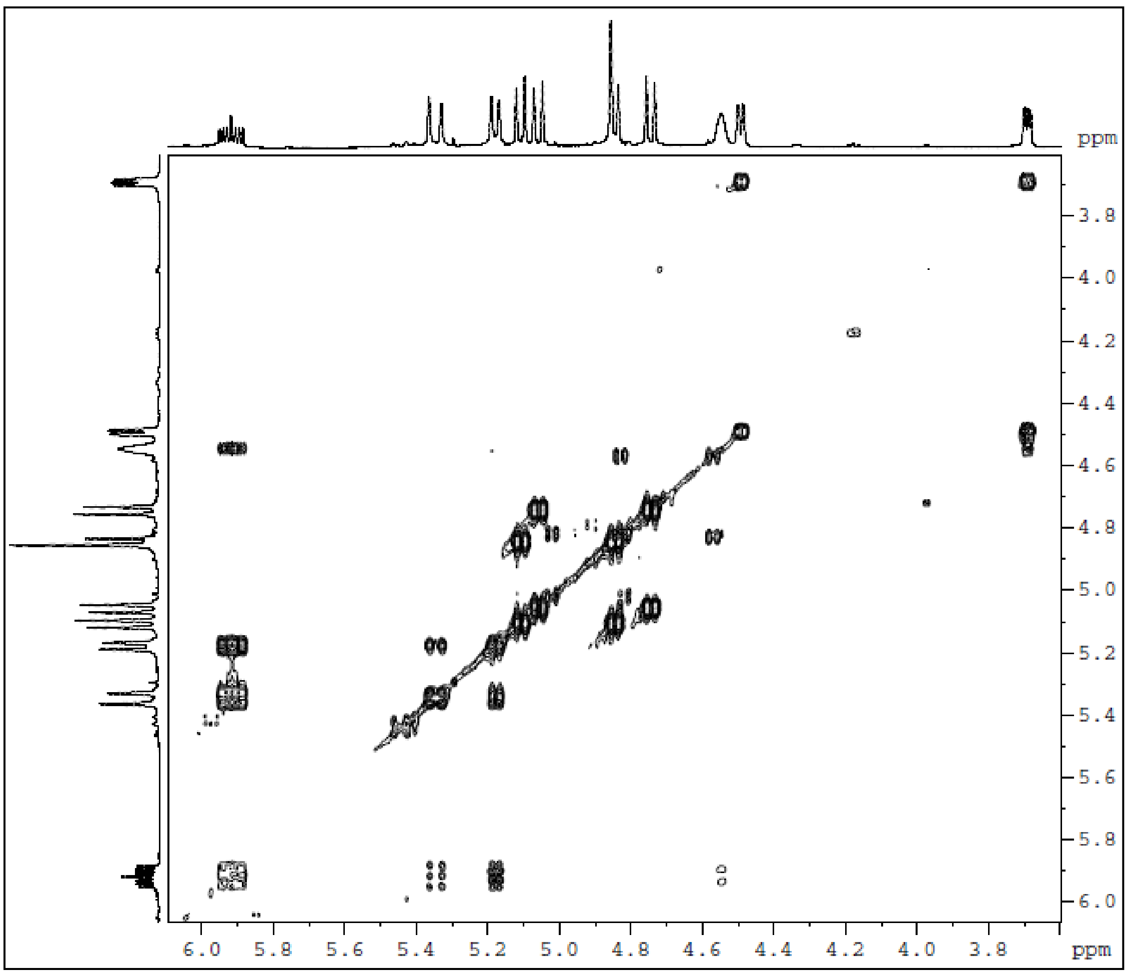


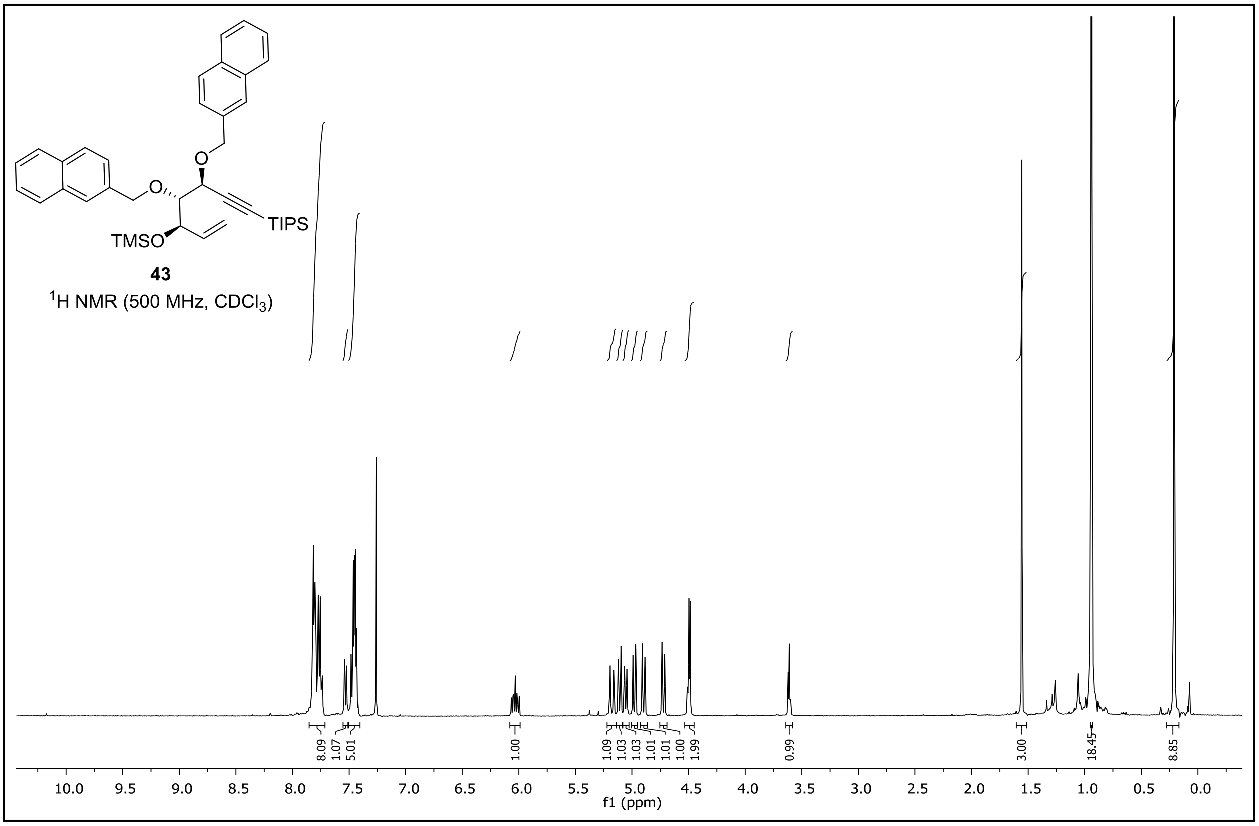
138.03
135.69
135.26
133.42
133.39
133.24
128.33
128.28
128.11
127.87
127.22
127.11
126.39
126.35
126.27
126.23
126.12
126.10
116.40
102.13
94.07
83.58
75.46
72.49
71.51
71.18
0.02
TMSO
41
13C NMR (125 MHz, CDCl3)
f1 (ppm)

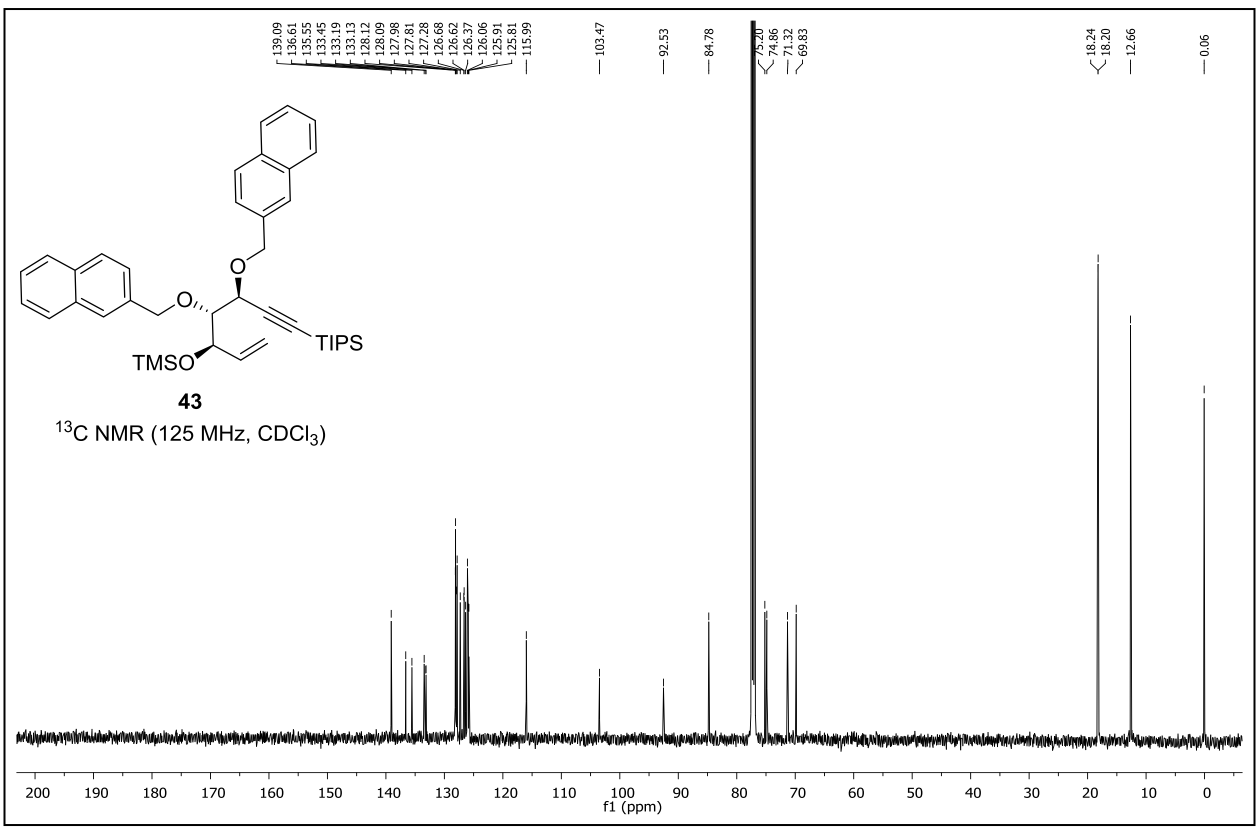


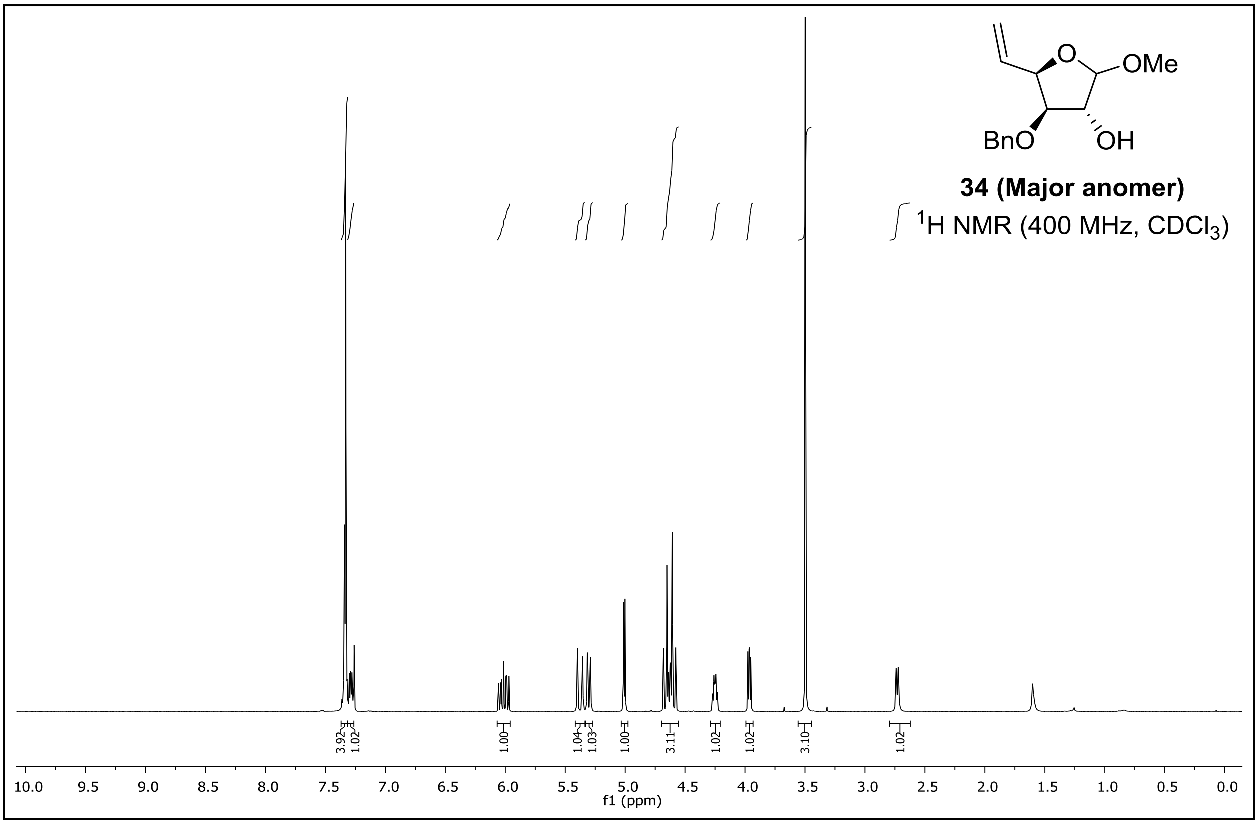
41

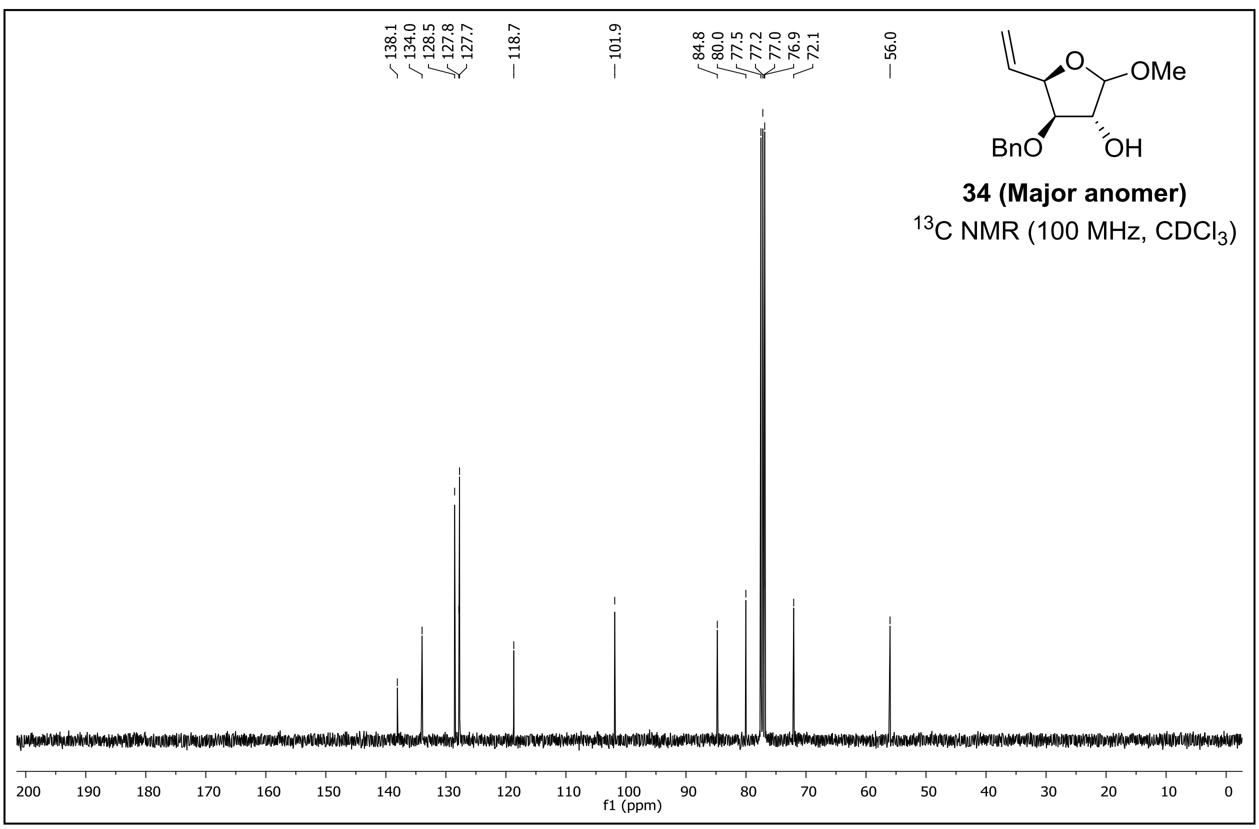
COSY (500 MHz, $CDCl_3$)

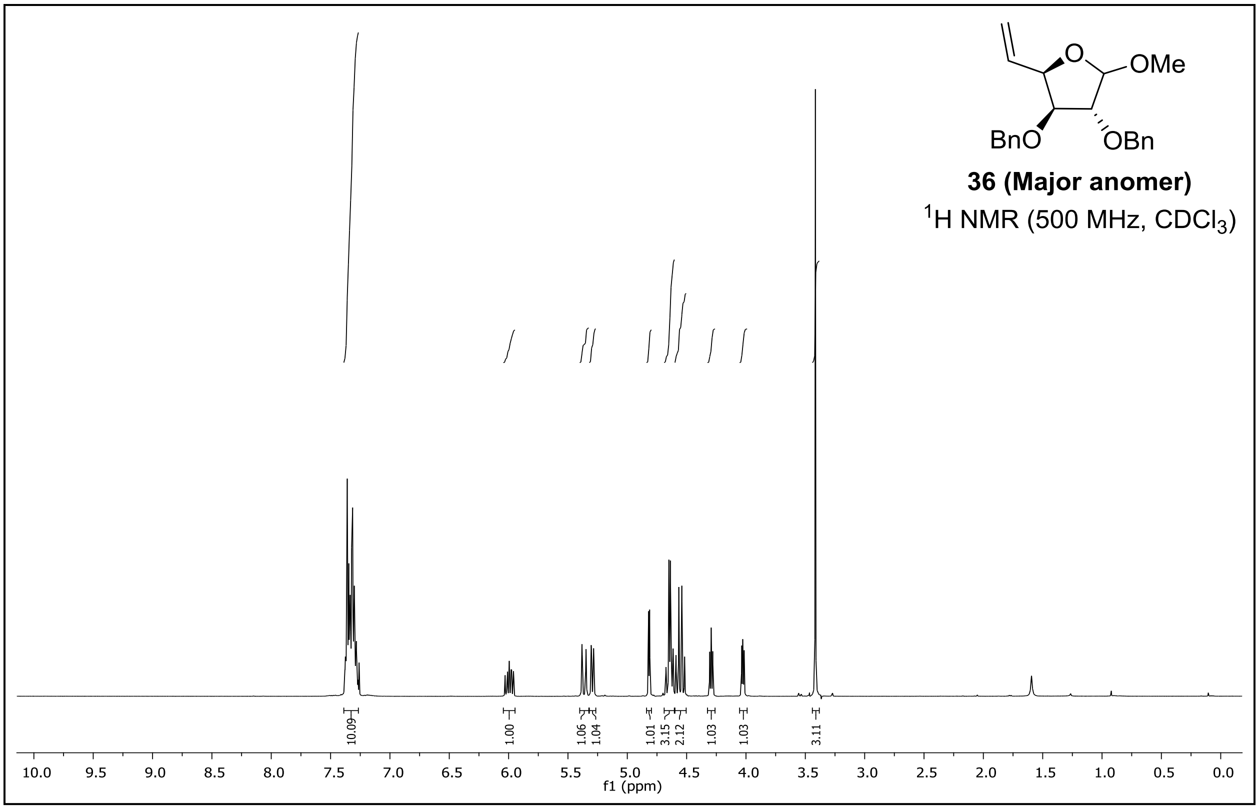


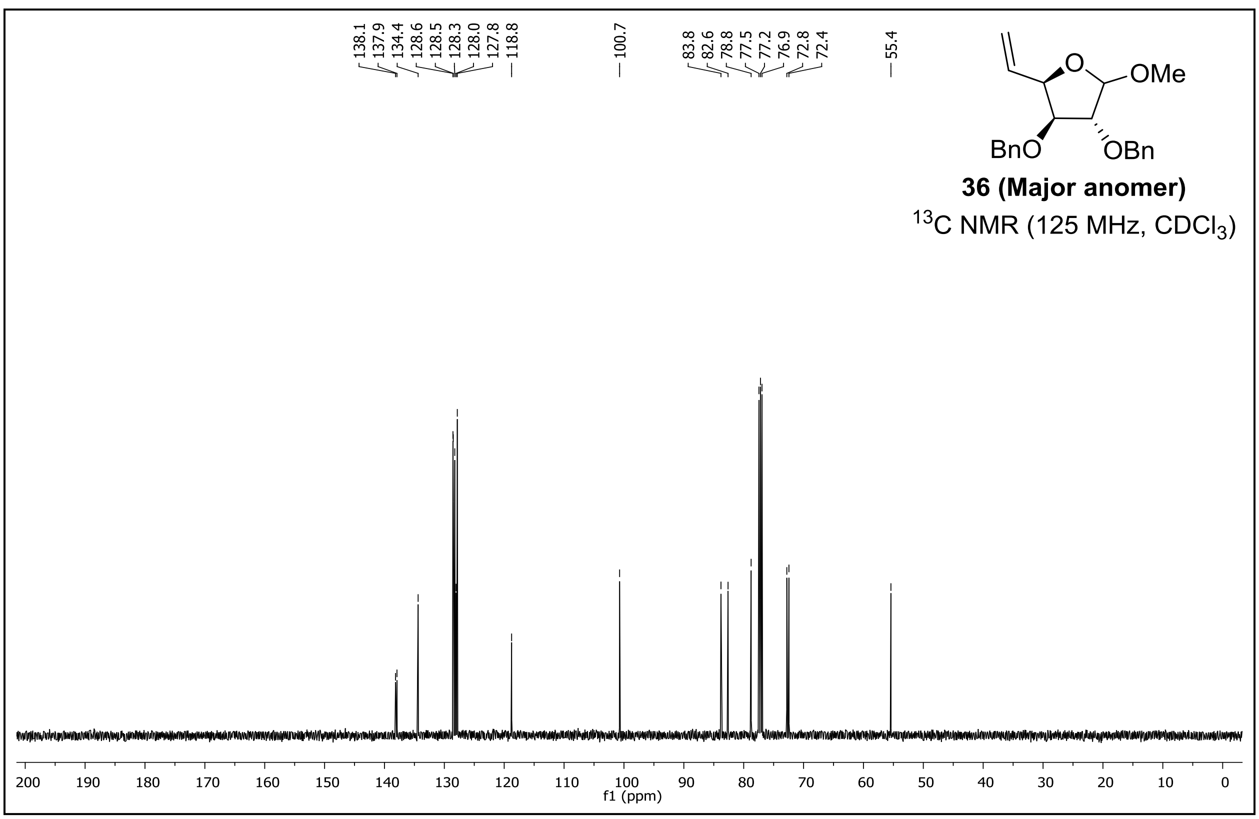

TMSO
TIPS
43
^{1}H NMR (500 MHz, CDCl$_3$)
f1 (ppm)

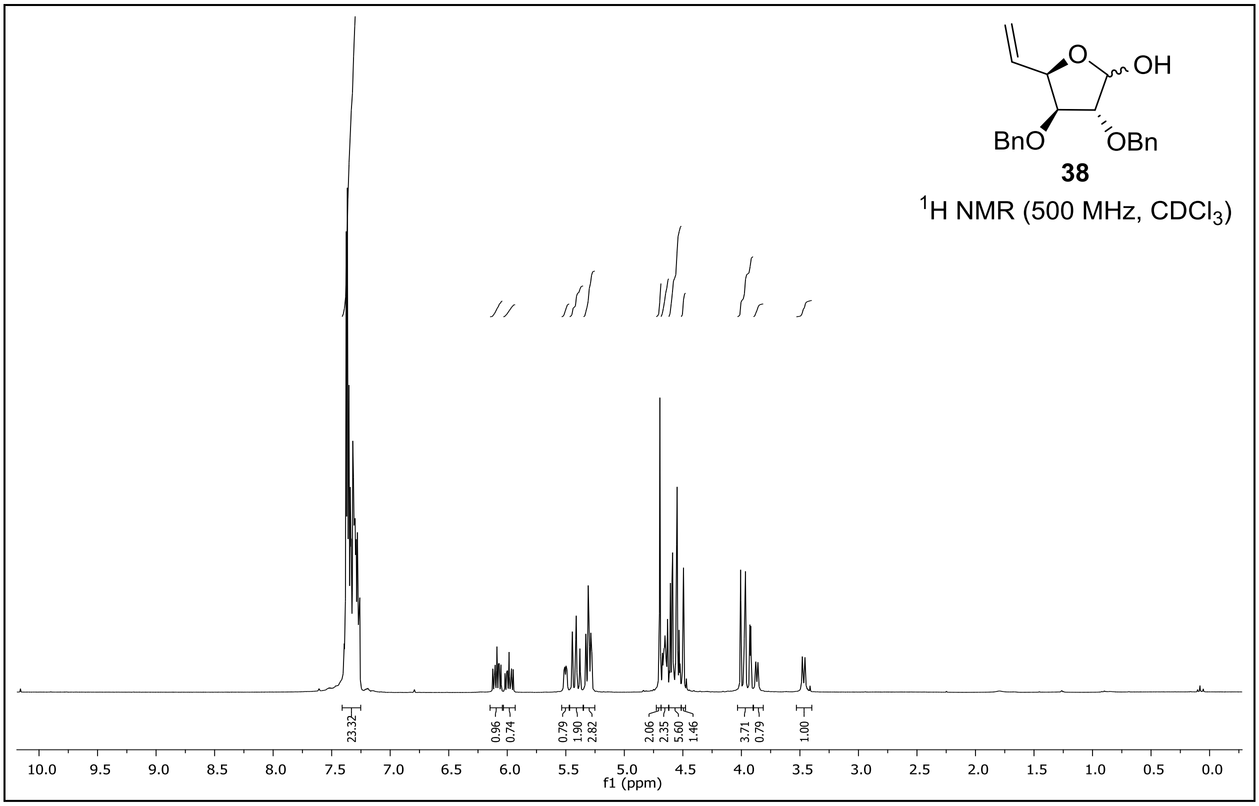

139.09
136.61
135.55
133.45
133.19
133.13
128.12
128.09
127.98
127.81
127.28
126.68
126.62
126.37
126.06
125.91
125.81
115.99
103.47
92.53
84.78
75.20
74.86
71.32
69.83
18.24
18.20
12.66
0.06
TMSO
TIPS
43
^{13}C NMR (125 MHz, CDCl$_3$)
f1 (ppm)

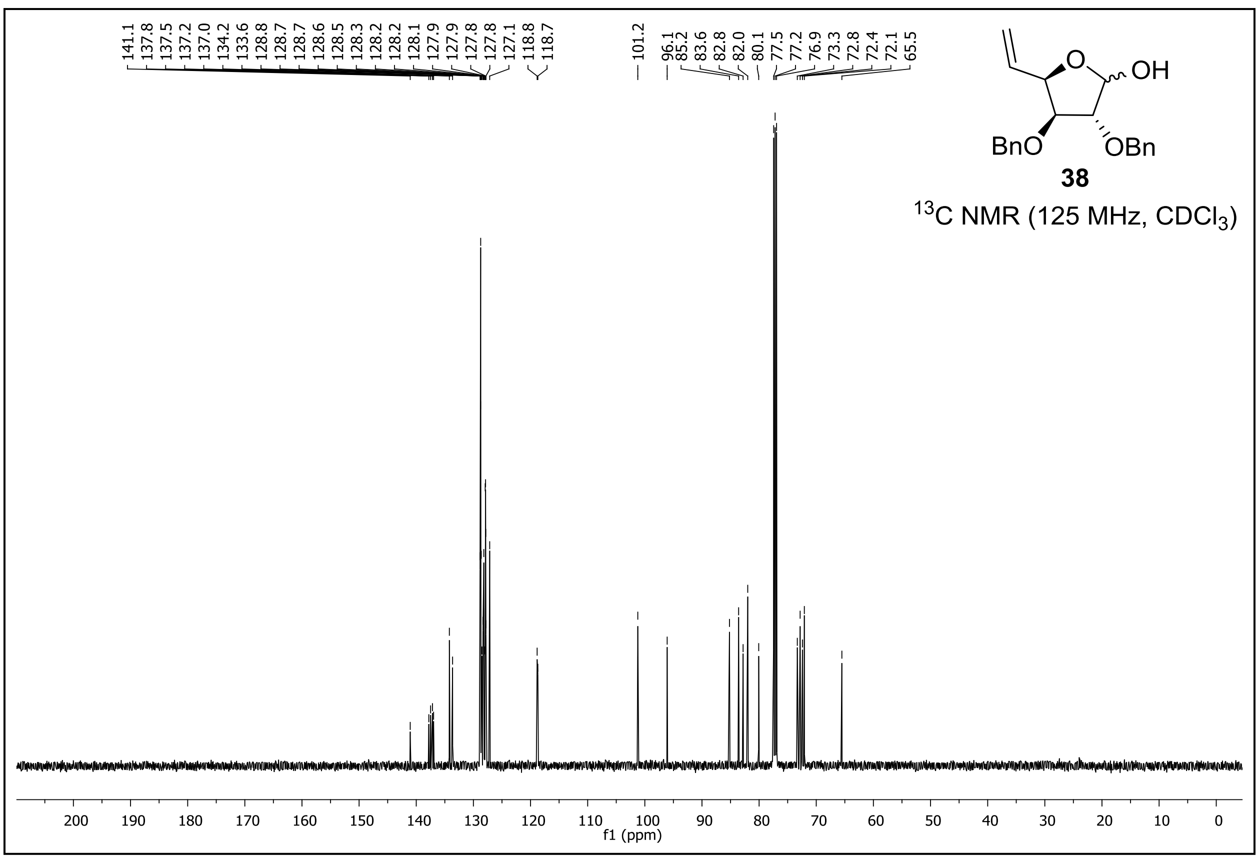

OMe
BnO
OH
34 (Major anomer)
^{1}H NMR (400 MHz, CDCl$_3$)
3.92
1.02
1.00
1.04
1.03
1.00
3.11
1.02
1.02
3.10
1.02
f1 (ppm)

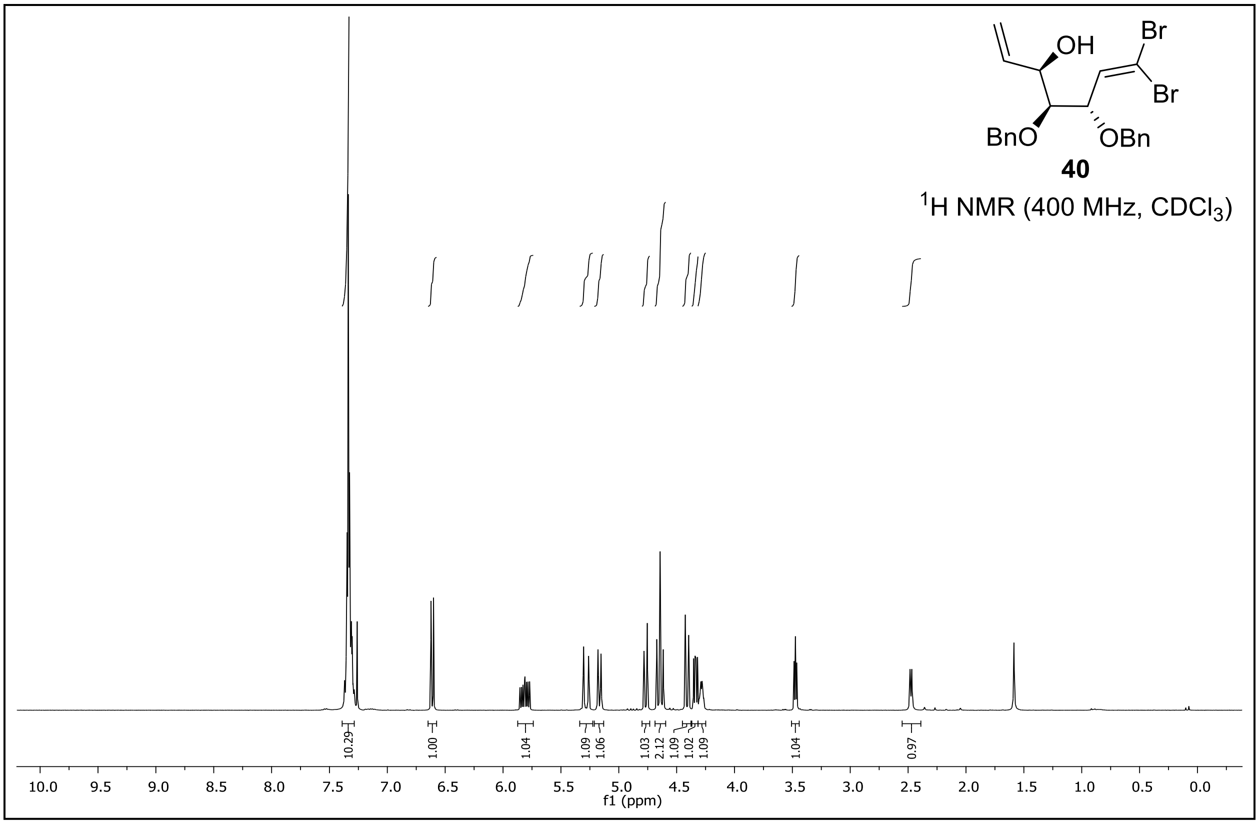

138.1
134.0
128.5
127.8
127.7
118.7
101.9
84.8
80.0
77.5
77.2
77.0
76.9
72.1
56.0
OMe
BnO
OH
34 (Major anomer)
^{13}C NMR (100 MHz, CDCl$_3$)
f1 (ppm)


OMe
BnO
OBn
36 (Major anomer)
1H NMR (500 MHz, CDCl3)
10.09
1.00
1.06
1.04
1.01
3.15
2.12
1.03
1.03
3.11
10.0 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 0.0
f1 (ppm)

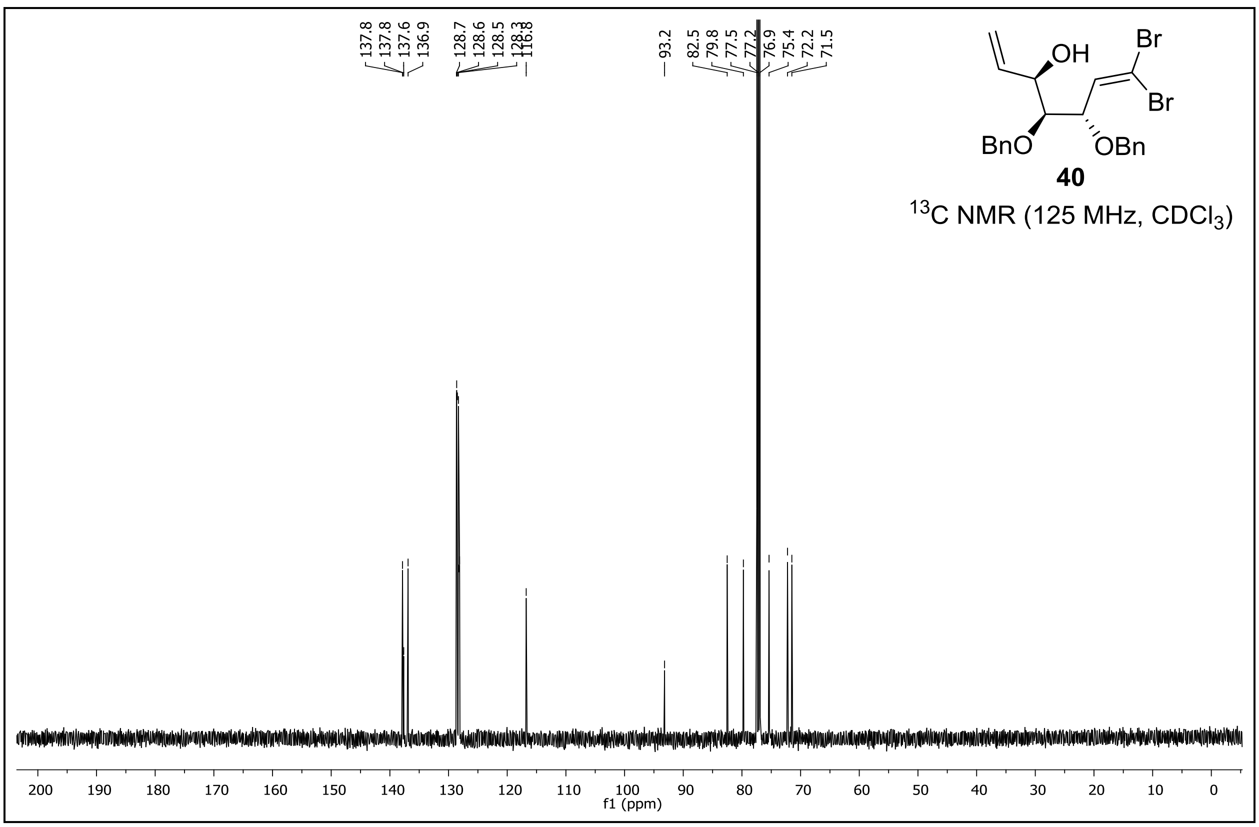

138.1
137.9
134.4
128.6
128.5
128.3
128.0
127.8
118.8
100.7
83.8
82.6
78.8
77.5
77.2
76.9
72.8
72.4
55.4
OMe
BnO
OBn
36 (Major anomer)
13C NMR (125 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


OH
BnO
OBn
38
1H NMR (500 MHz, CDCl3)
23.32
0.96
0.74
0.79
1.90
2.82
2.06
2.35
5.60
1.46
3.71
0.79
1.00
10.0 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 0.0
f1 (ppm)

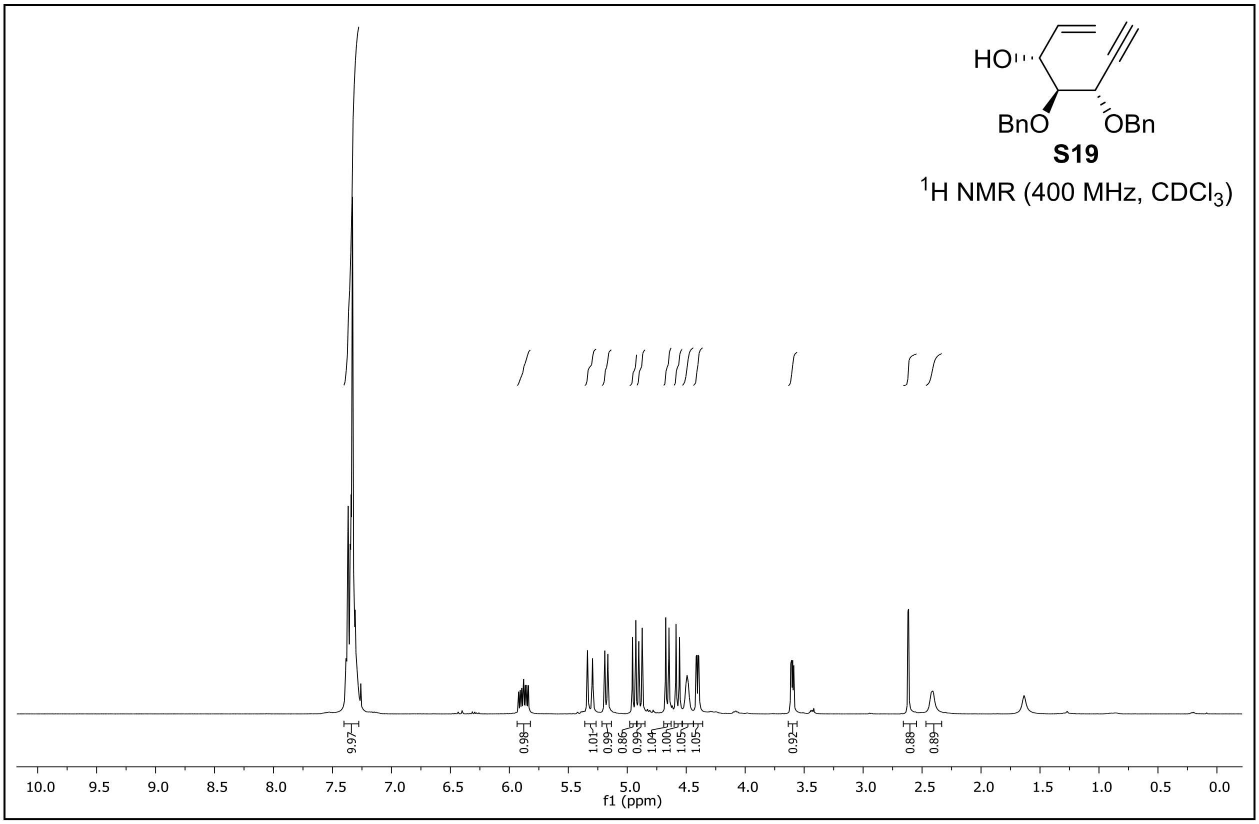

141.1 137.8 137.5 137.2 137.0 134.2 133.6 128.8 128.7 128.7 128.6 128.5 128.3 128.2 128.2 128.1 127.9 127.8 127.8 127.1 118.8 118.7
101.2
96.1 85.2 83.6 82.8 82.0 80.1 77.5 77.2 76.9 73.3 72.8 72.4 72.1 65.5
OH
BnO
OBn
38
13C NMR (125 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

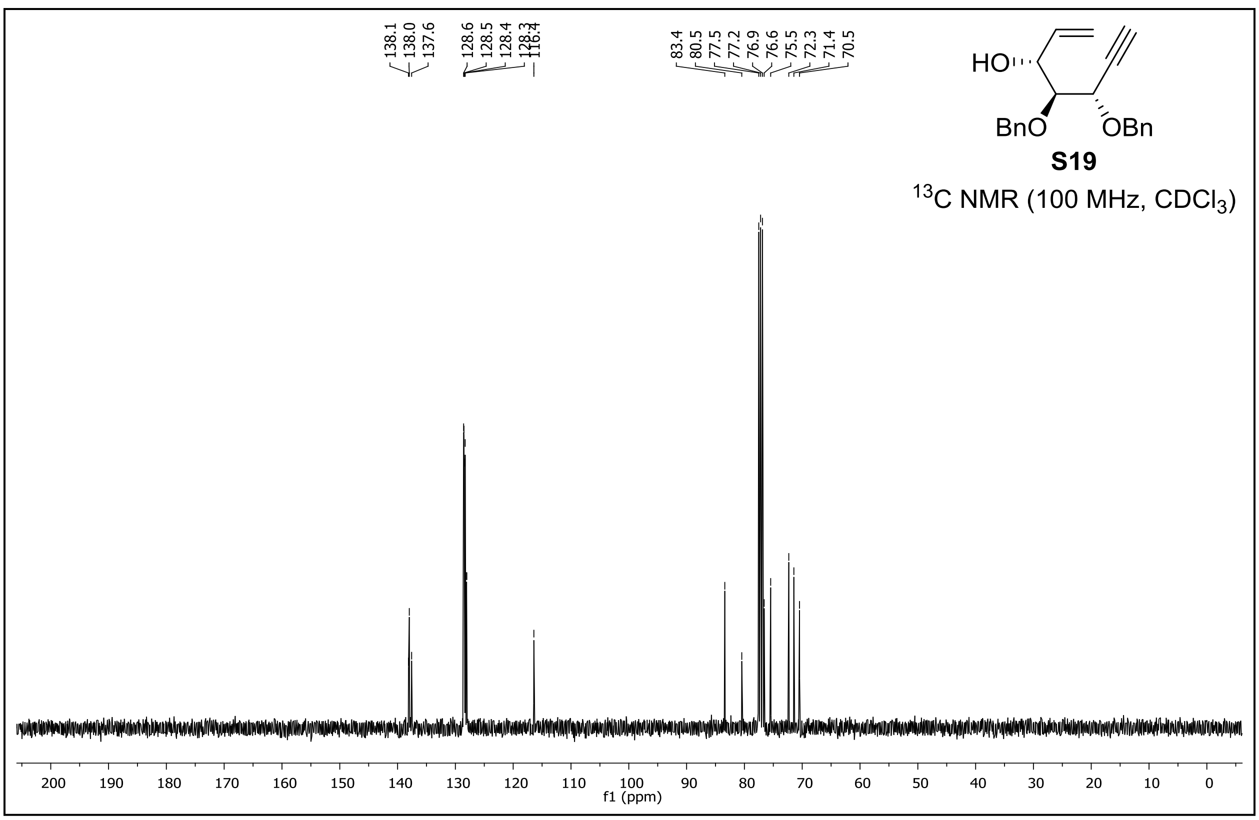


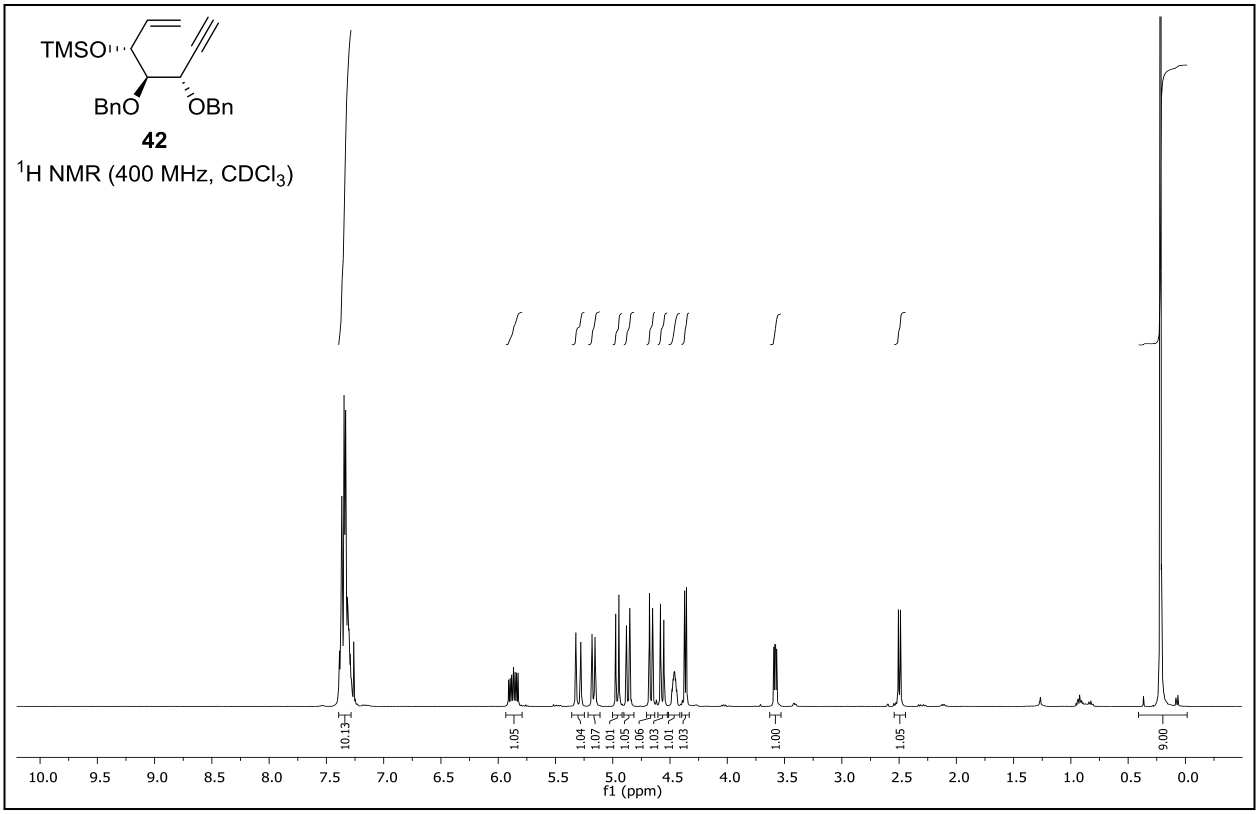
OH
Br
Br
BnO
OBn
40
^{1}H NMR (400 MHz, CDCl$_3$)
10.29
1.00
1.04
1.09
1.06
1.03
2.12
1.09
1.02
1.09
1.04
0.97
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

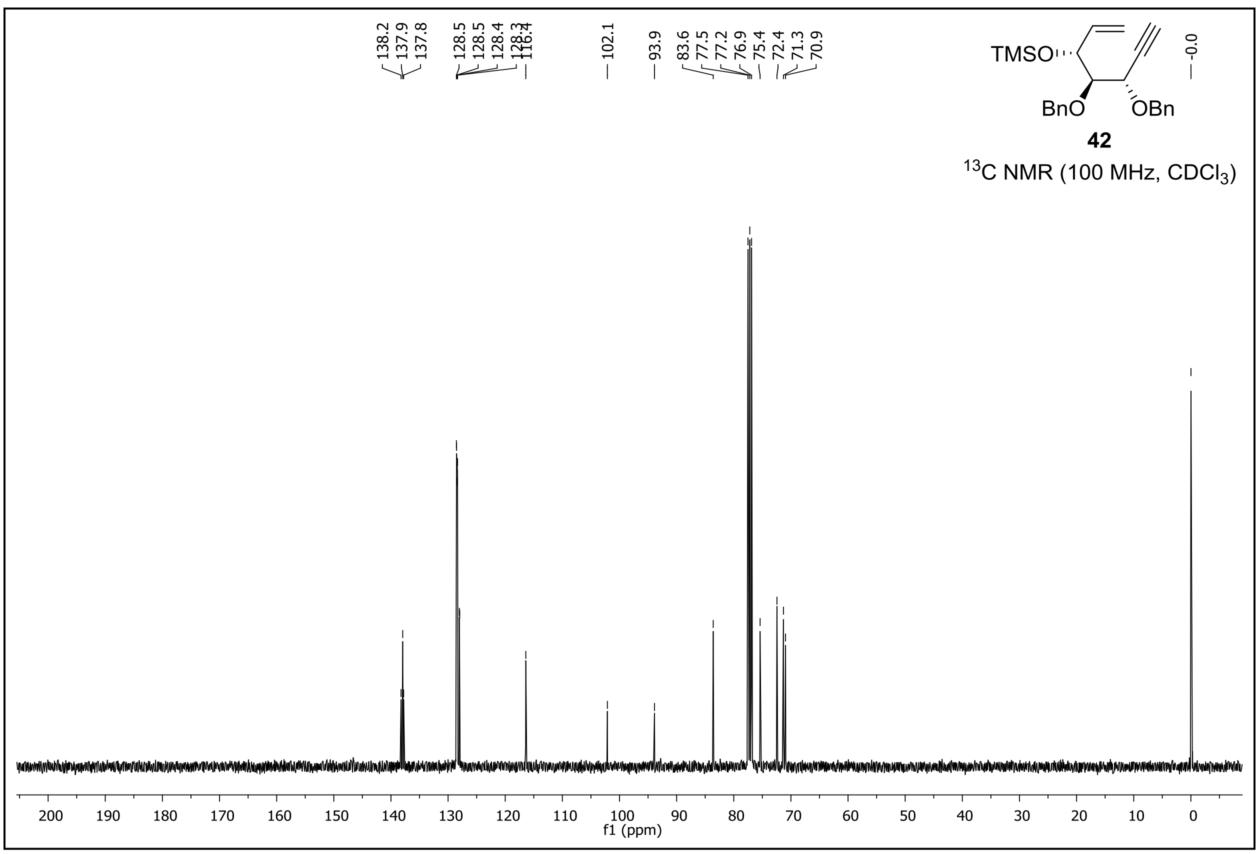


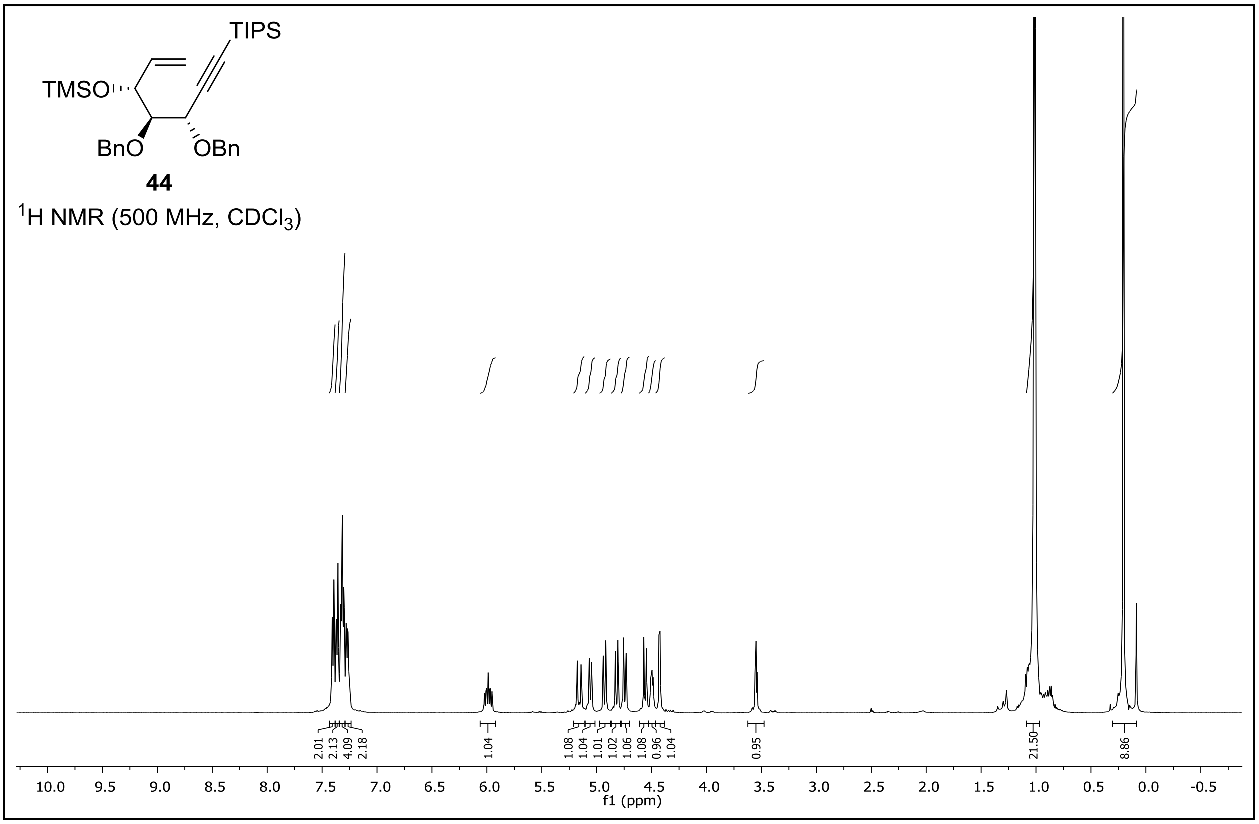
137.8
137.8
137.6
136.9
128.7
128.6
128.5
128.3
116.8
93.2
82.5
79.8
77.5
77.2
76.9
75.4
72.2
71.5
OH
Br
Br
BnO
OBn
40
^{13}C NMR (125 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

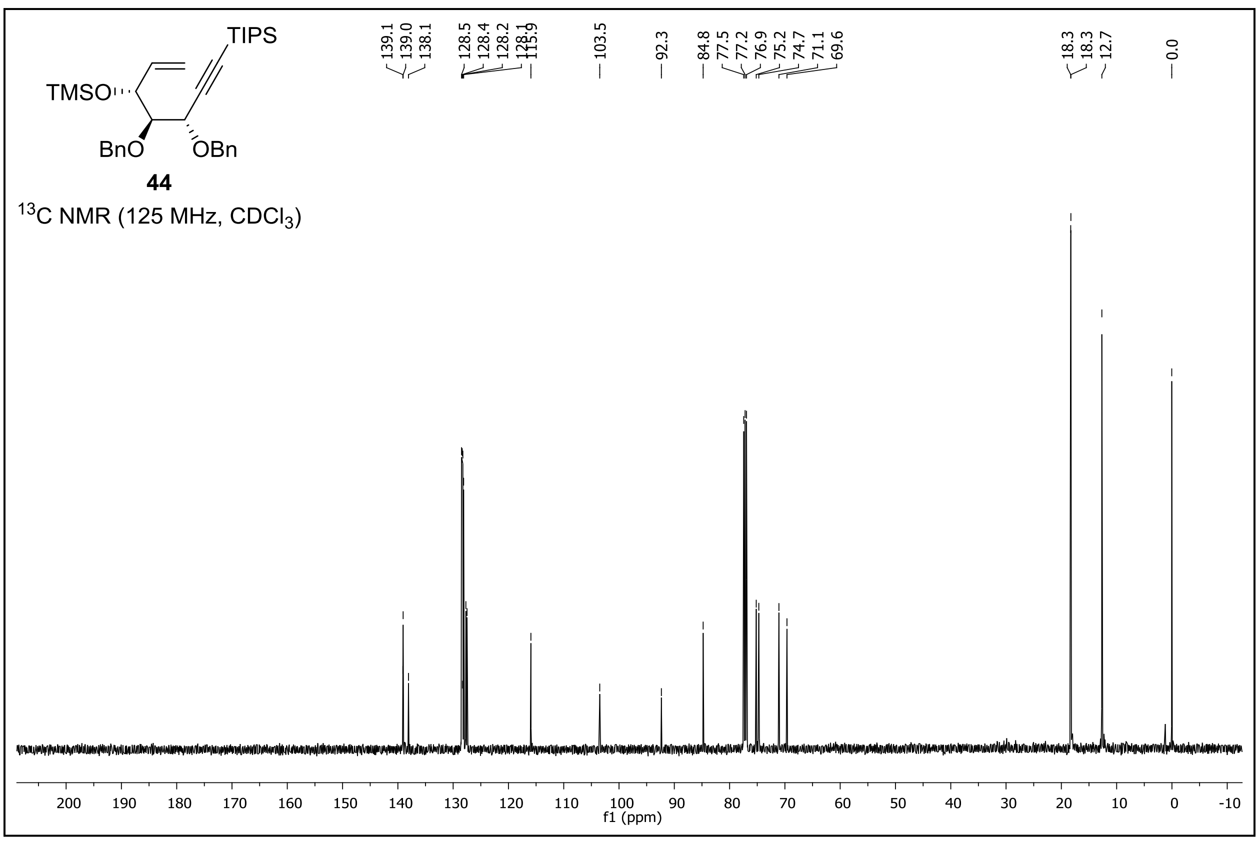

HO
BnO
OBn
S19
1H NMR (400 MHz, CDCl3)
9.97
0.98
1.01
0.99
0.86
0.99
1.04
1.00
1.05
1.05
0.92
0.88
0.89
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

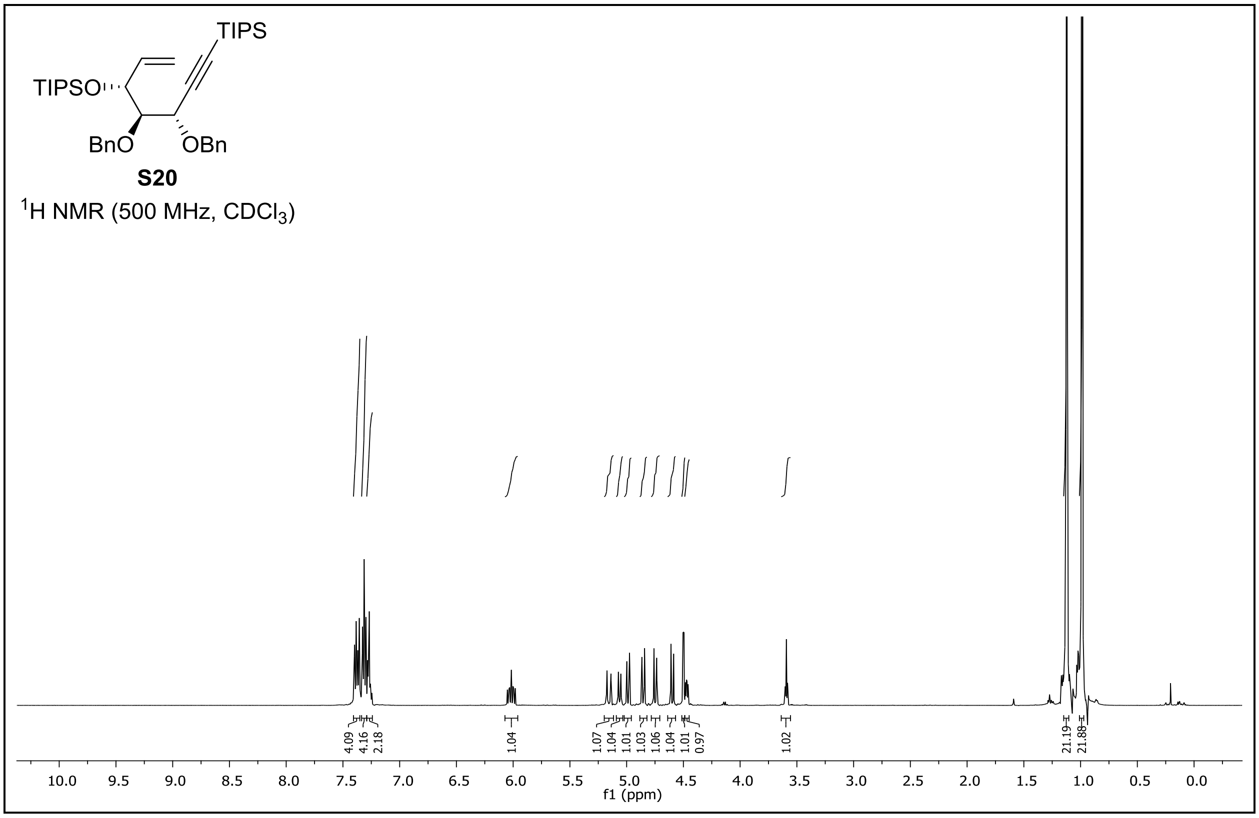

138.1
138.0
137.6
128.6
128.5
128.4
128.3
116.4
83.4
80.5
77.5
77.2
76.9
76.6
75.5
72.3
71.4
70.5
HO
BnO
OBn
S19
13C NMR (100 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

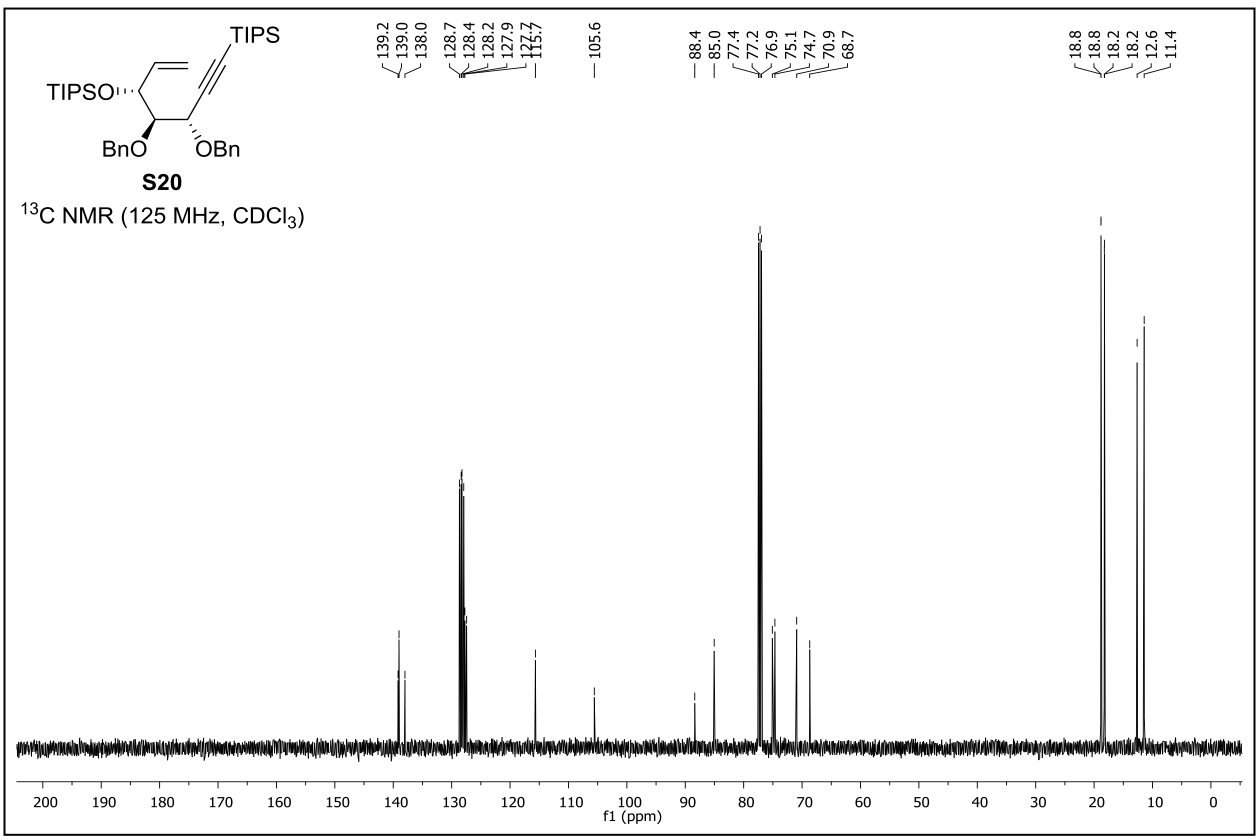

TMSO
BnO
OBn
42
1H NMR (400 MHz, CDCl3)
f1 (ppm)

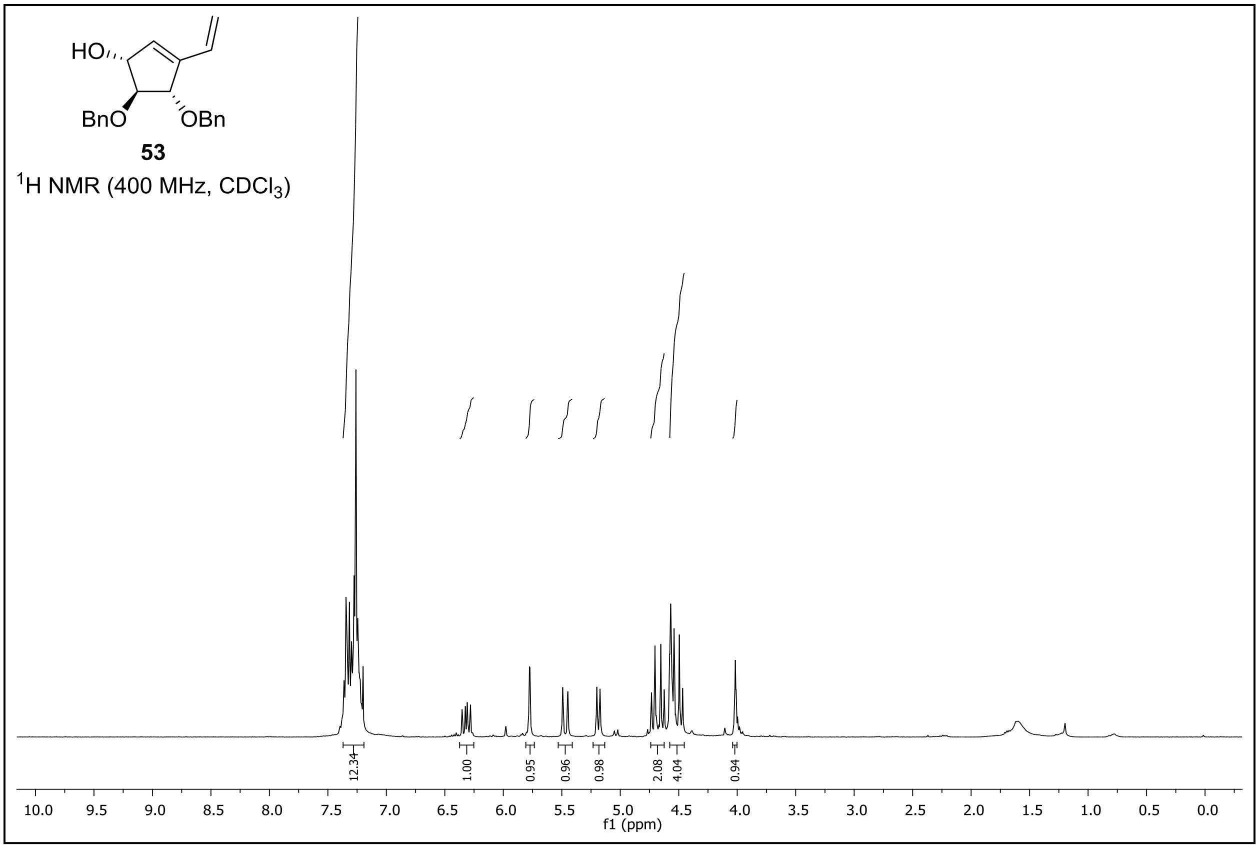

138.2
137.9
137.8
128.5
128.5
128.4
128.3
116.4
102.1
93.9
83.6
77.5
77.2
76.9
75.4
72.4
71.3
70.9
-0.0
TMSO
BnO
OBn
42
13C NMR (100 MHz, CDCl3)
f1 (ppm)

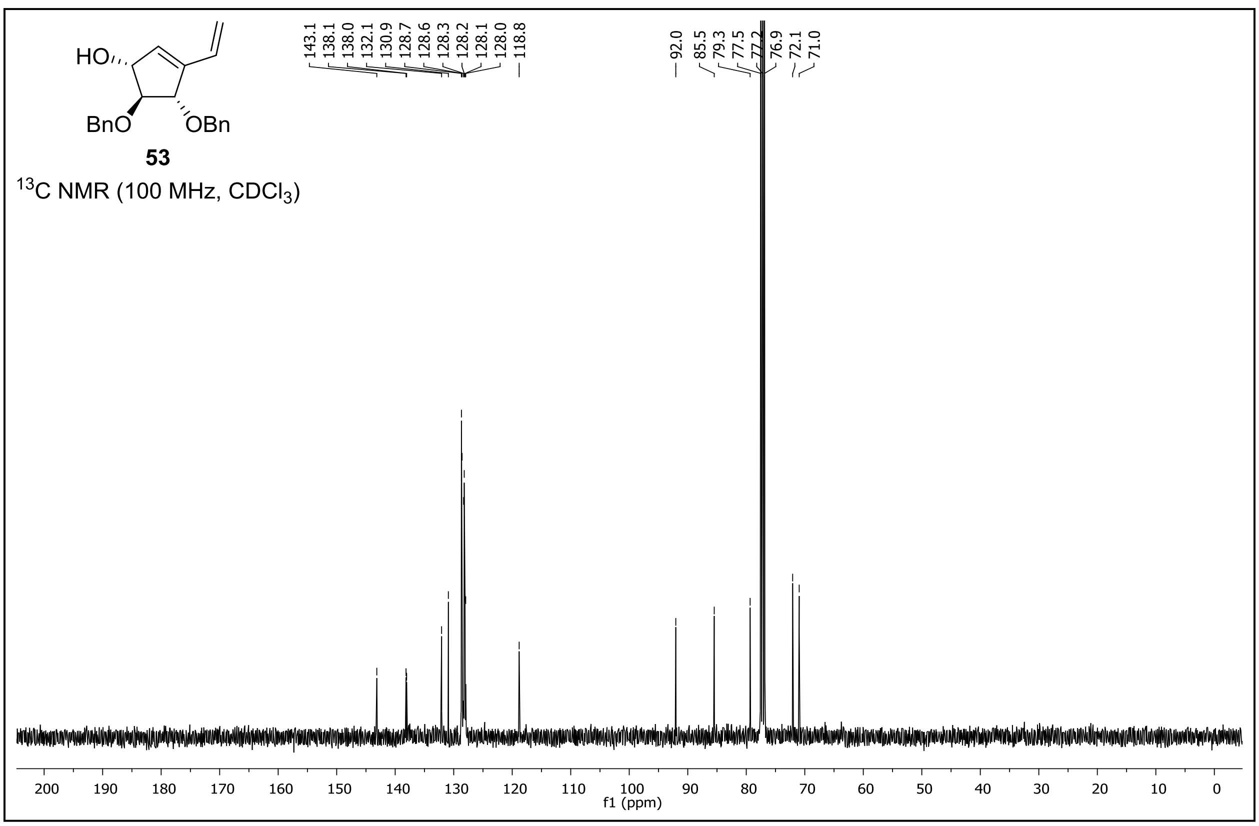

TIPS
TMSO
BnO
OBn
44
^{1}H NMR (500 MHz, CDCl$_3$)
f1 (ppm)

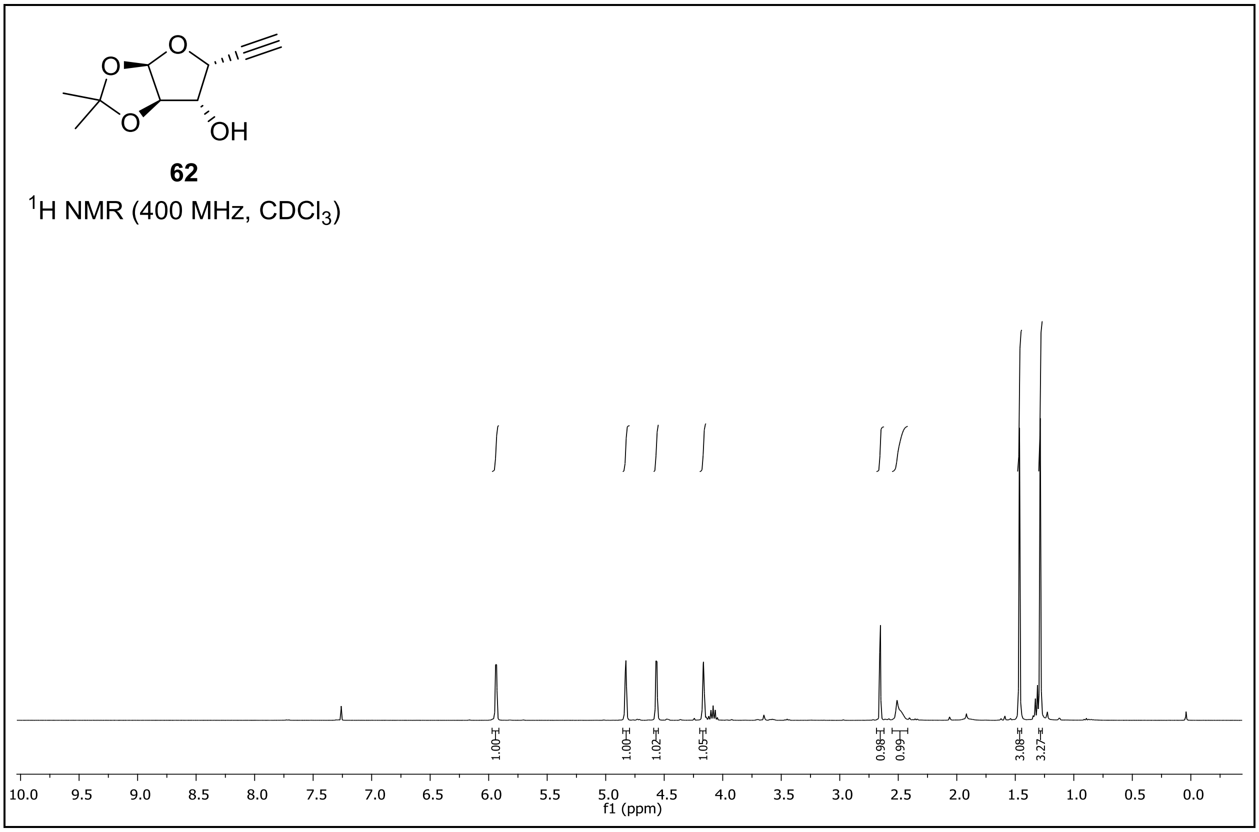

TIPS
TMSO
BnO
OBn
44
^{13}C NMR (125 MHz, CDCl$_3$)
f1 (ppm)

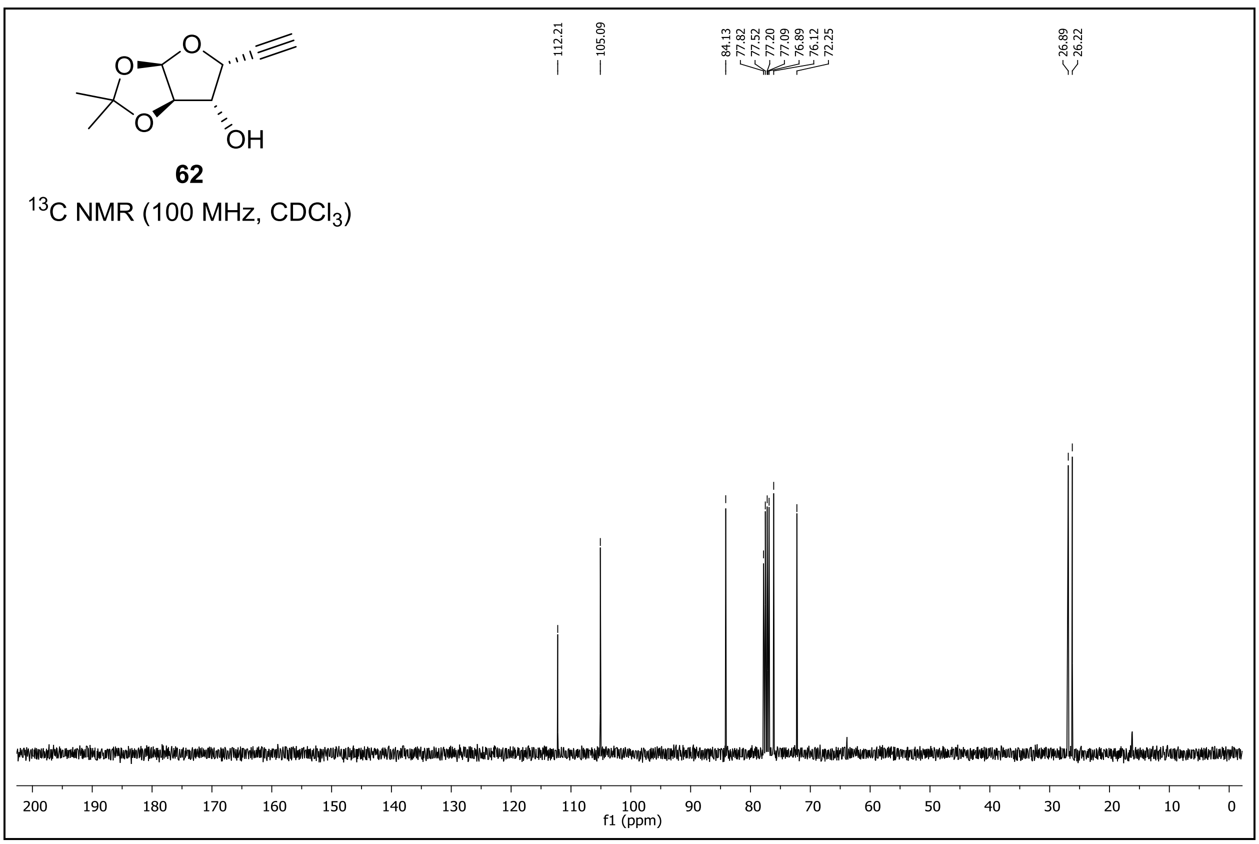

TIPS
TIPSO
BnO
OBn
S20
^{1}H NMR (500 MHz, CDCl$_3$)
f1 (ppm)

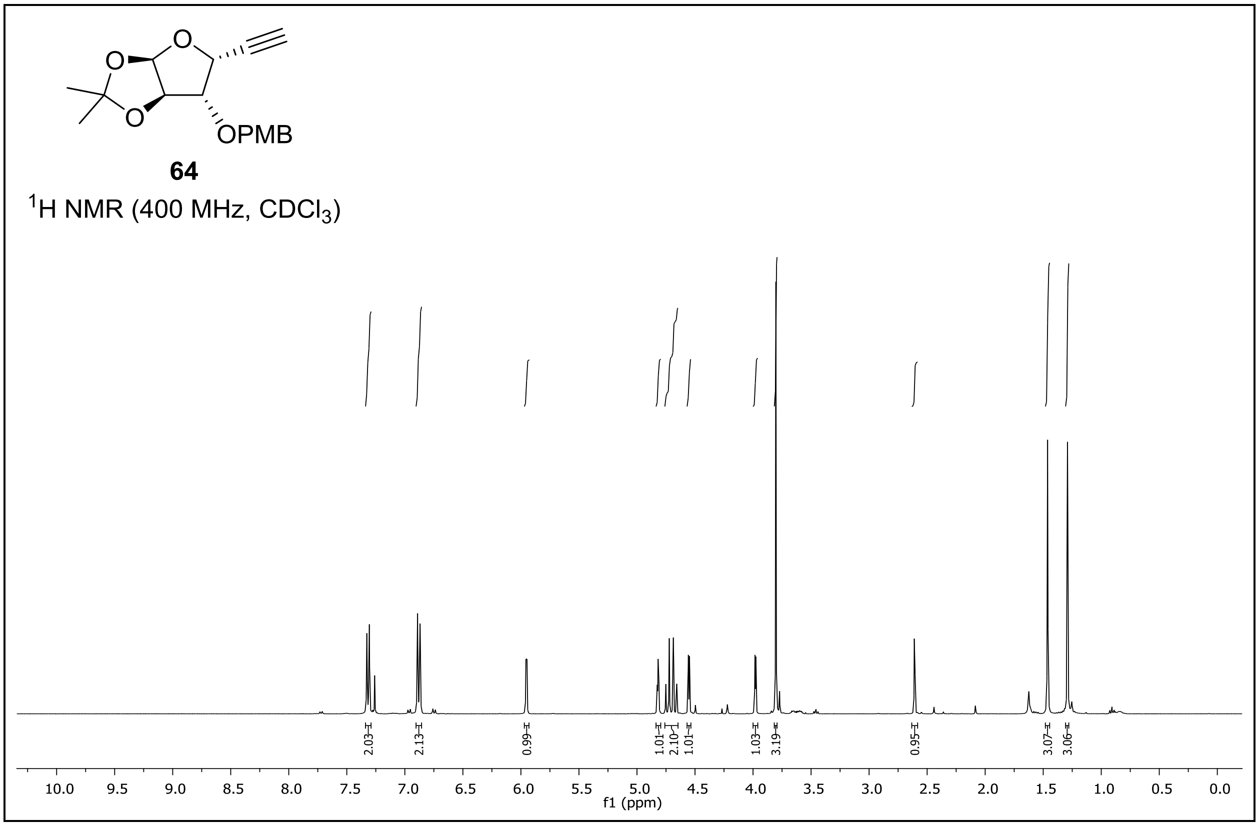

TIPS
TIPSO
BnO
OBn
S20
^{13}C NMR (125 MHz, CDCl$_3$)
139.2
139.0
138.0
128.7
128.4
128.2
127.9
127.7
115.7
105.6
88.4
85.0
77.4
77.2
76.9
75.1
74.7
70.9
68.7
18.8
18.8
18.2
18.2
12.6
11.4
f1 (ppm)


HO
BnO
OBn
53
1H NMR (400 MHz, CDCl3)
12.34
1.00
0.95
0.96
0.98
2.08
4.04
0.94
10.0 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 0.0
f1 (ppm)


HO
BnO
OBn
53
13C NMR (100 MHz, CDCl3)
143.1
138.1
138.0
132.1
130.9
128.7
128.6
128.3
128.2
128.1
128.0
118.8
92.0
85.5
79.3
77.5
77.2
76.9
72.1
71.0
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

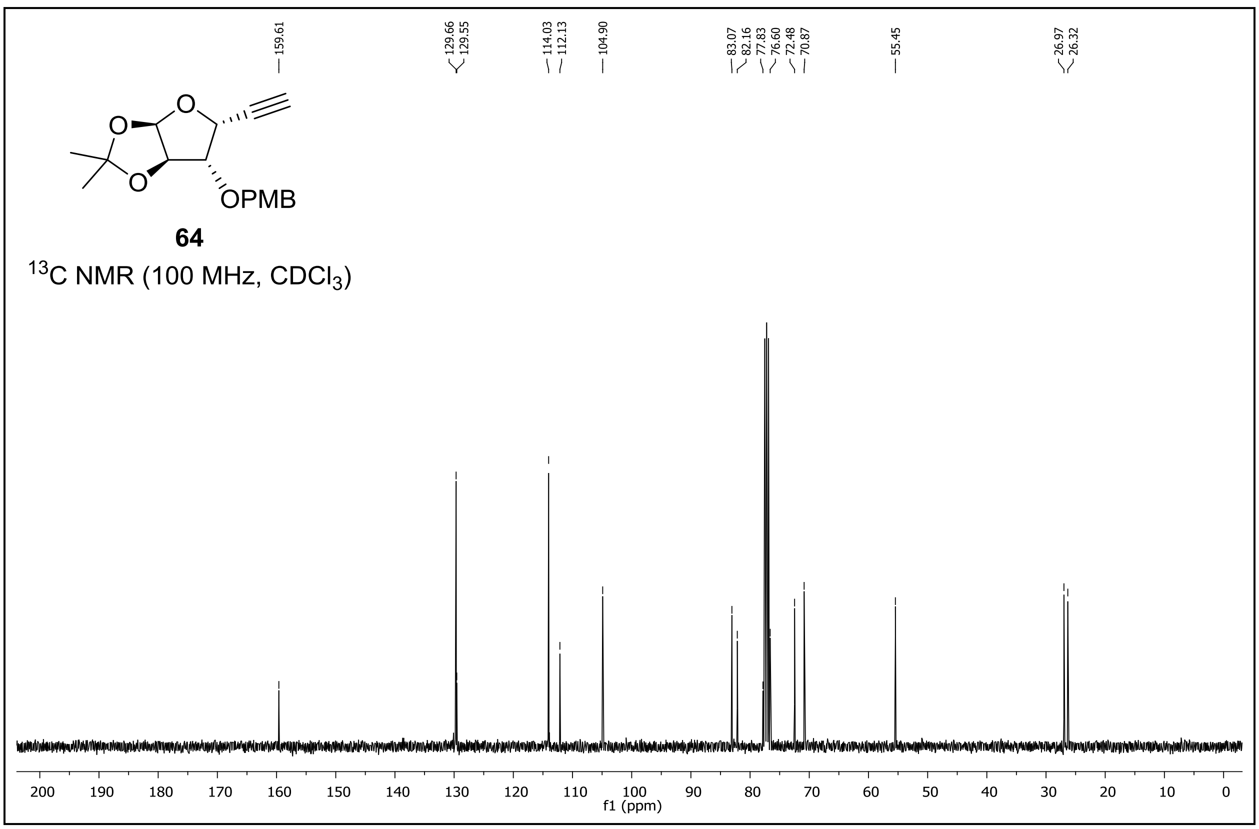

62
^{1}H NMR (400 MHz, CDCl$_3$)
1.00 1.00 1.02 1.05 0.98 0.99 3.08 3.27
f1 (ppm)


62
^{13}C NMR (100 MHz, CDCl$_3$)
112.21
105.09
84.13 77.82 77.52 77.20 77.09 76.89 76.12 72.25
26.89 26.22
f1 (ppm)



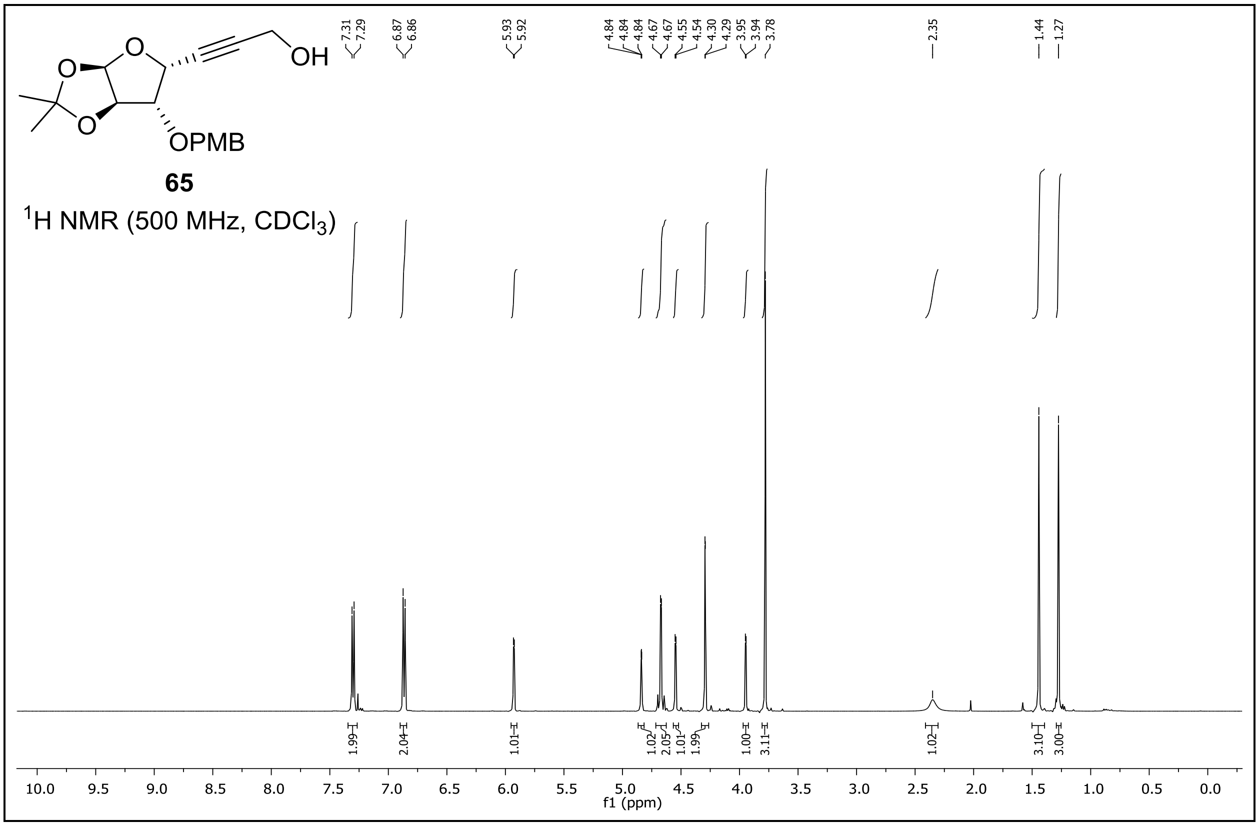
64

^{1}H NMR (400 MHz, $CDCl_3$)

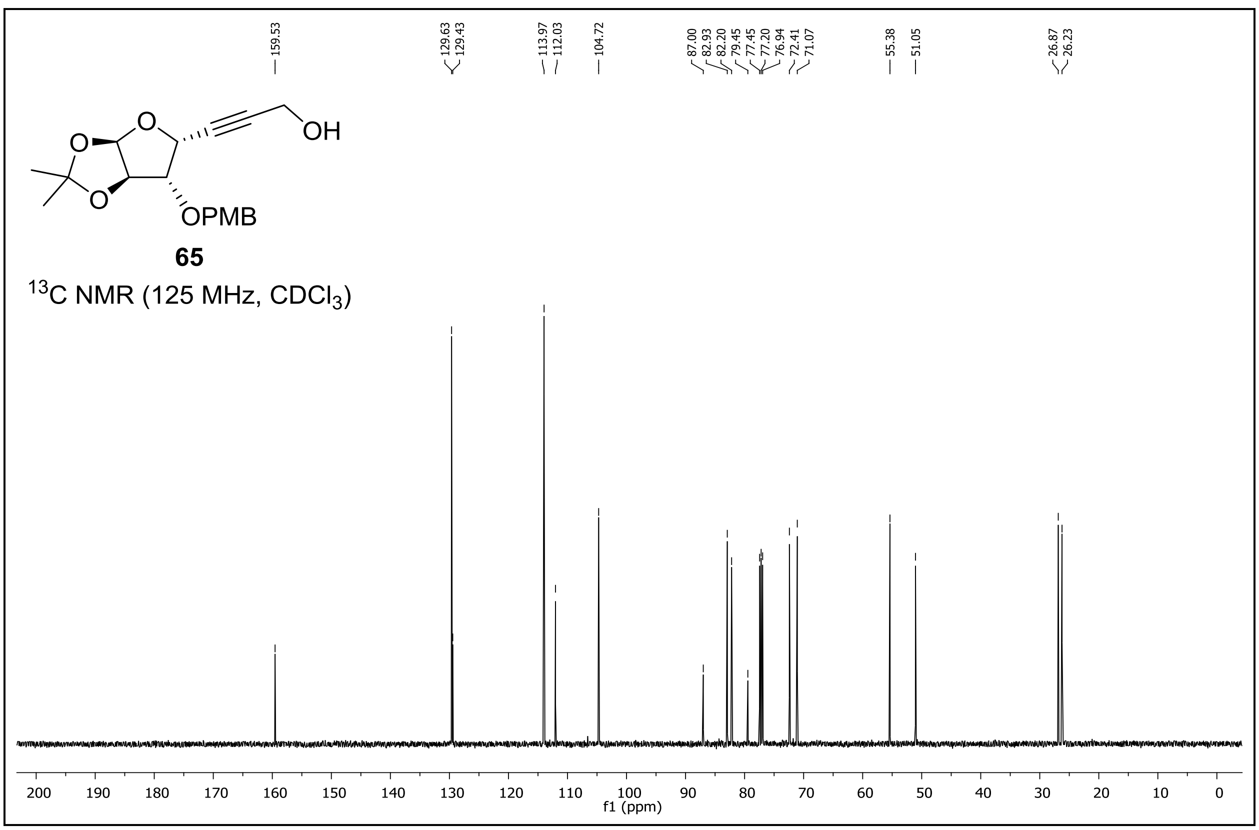


64

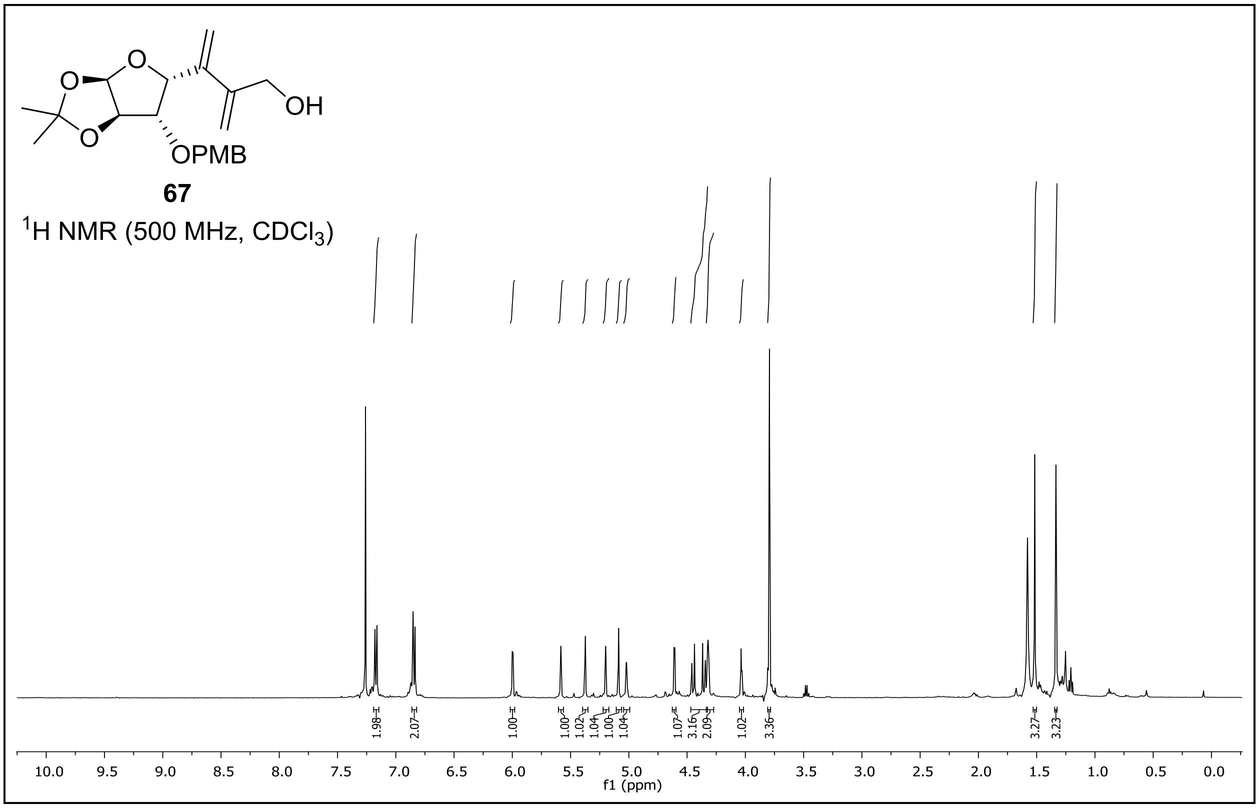
^{13}C NMR (100 MHz, $CDCl_3$)

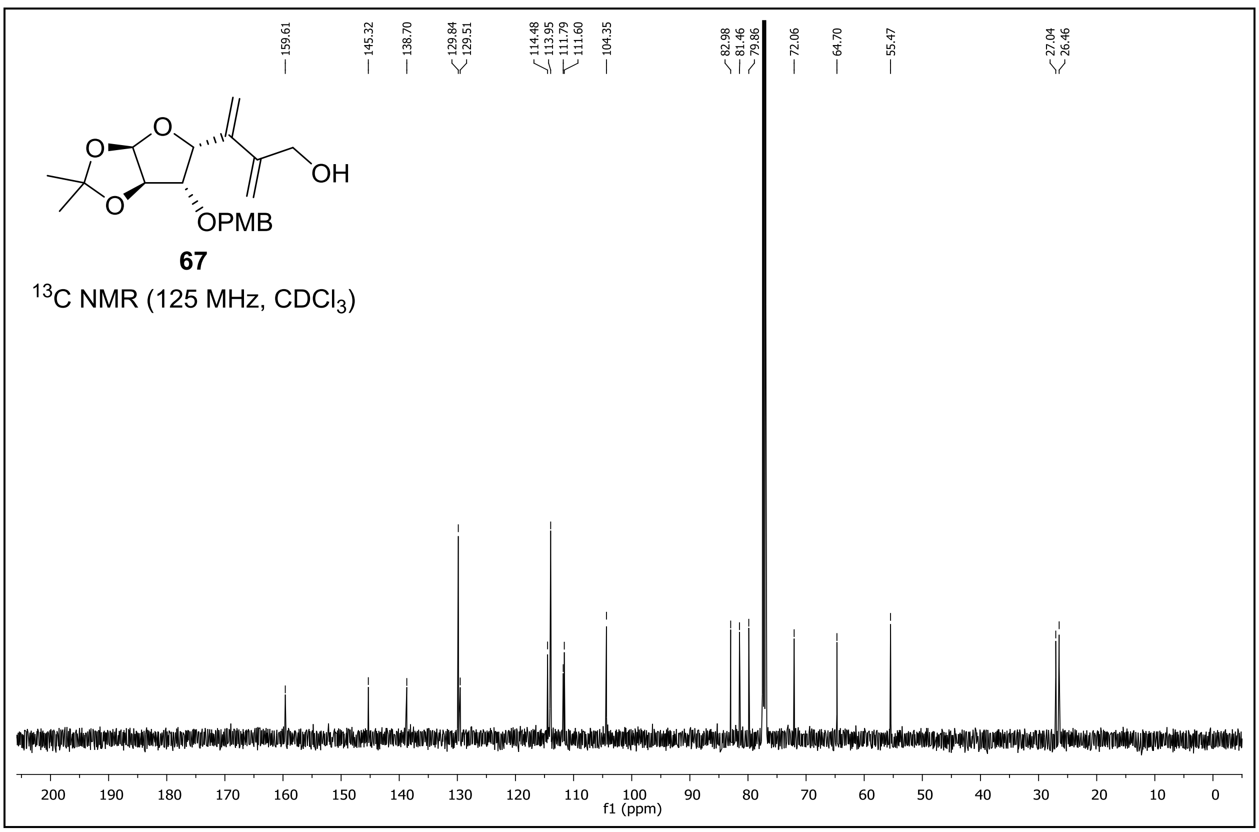


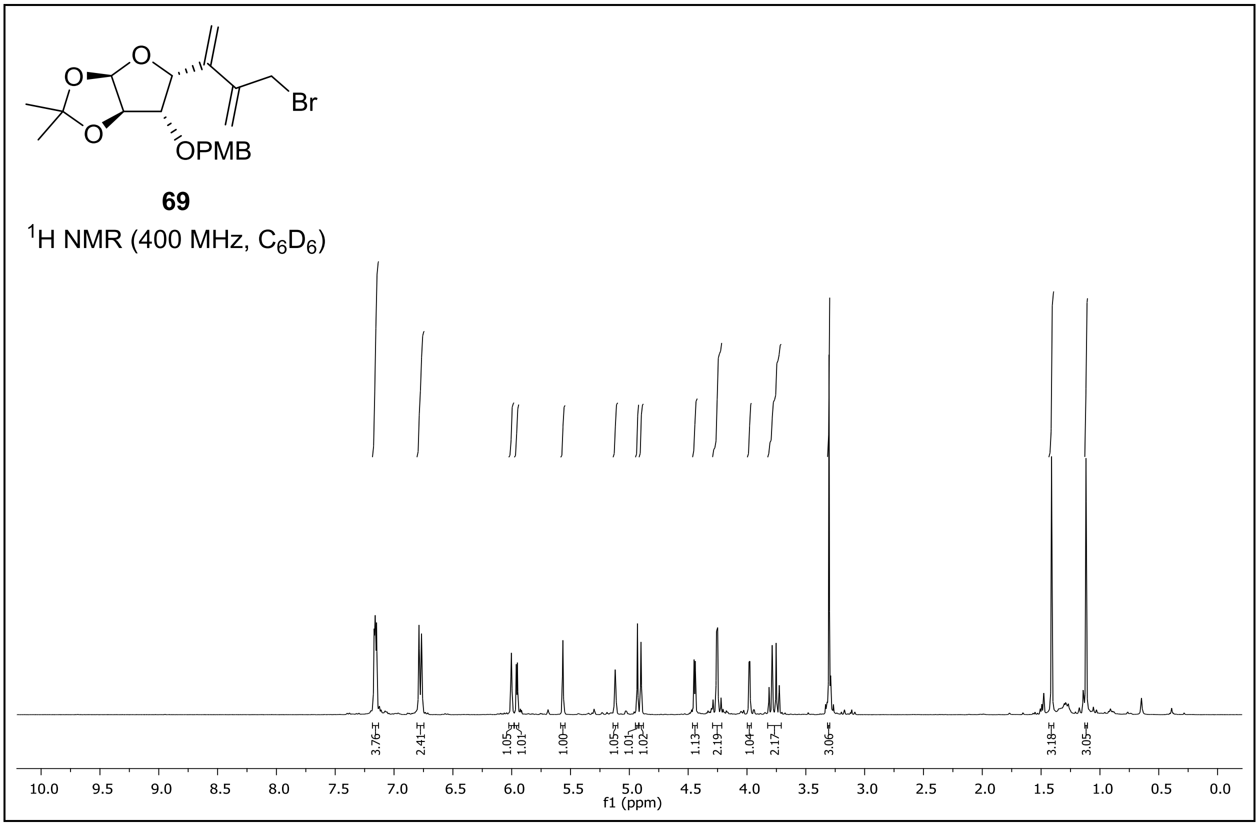
OH
OPMB
65
1H NMR (500 MHz, CDCl3)
7.31 7.29 6.87 6.86 5.93 5.92 4.84 4.84 4.84 4.67 4.67 4.55 4.54 4.30 4.29 3.95 3.94 3.78 2.35 1.44 1.27
1.99 2.04 1.01 1.02 2.05 1.01 1.99 1.00 3.11 1.02 3.10 3.00
f1 (ppm)

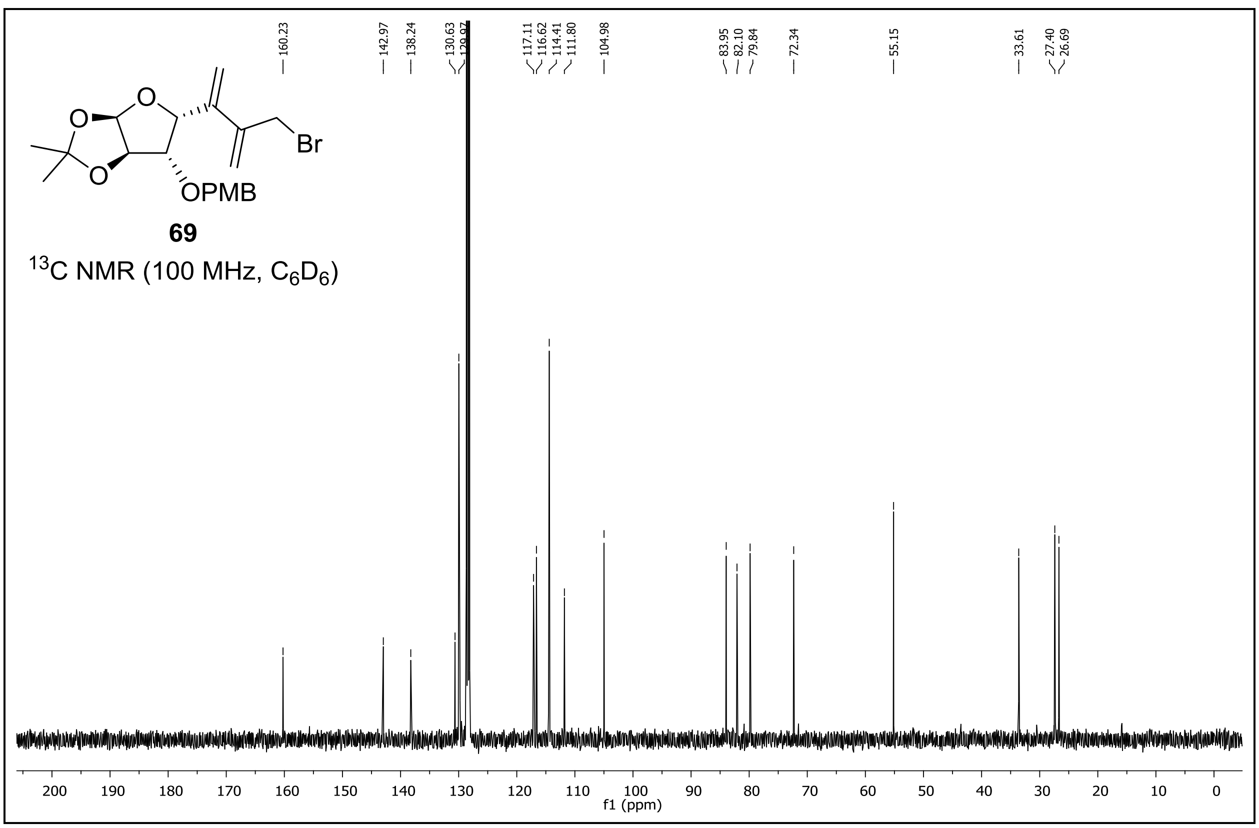


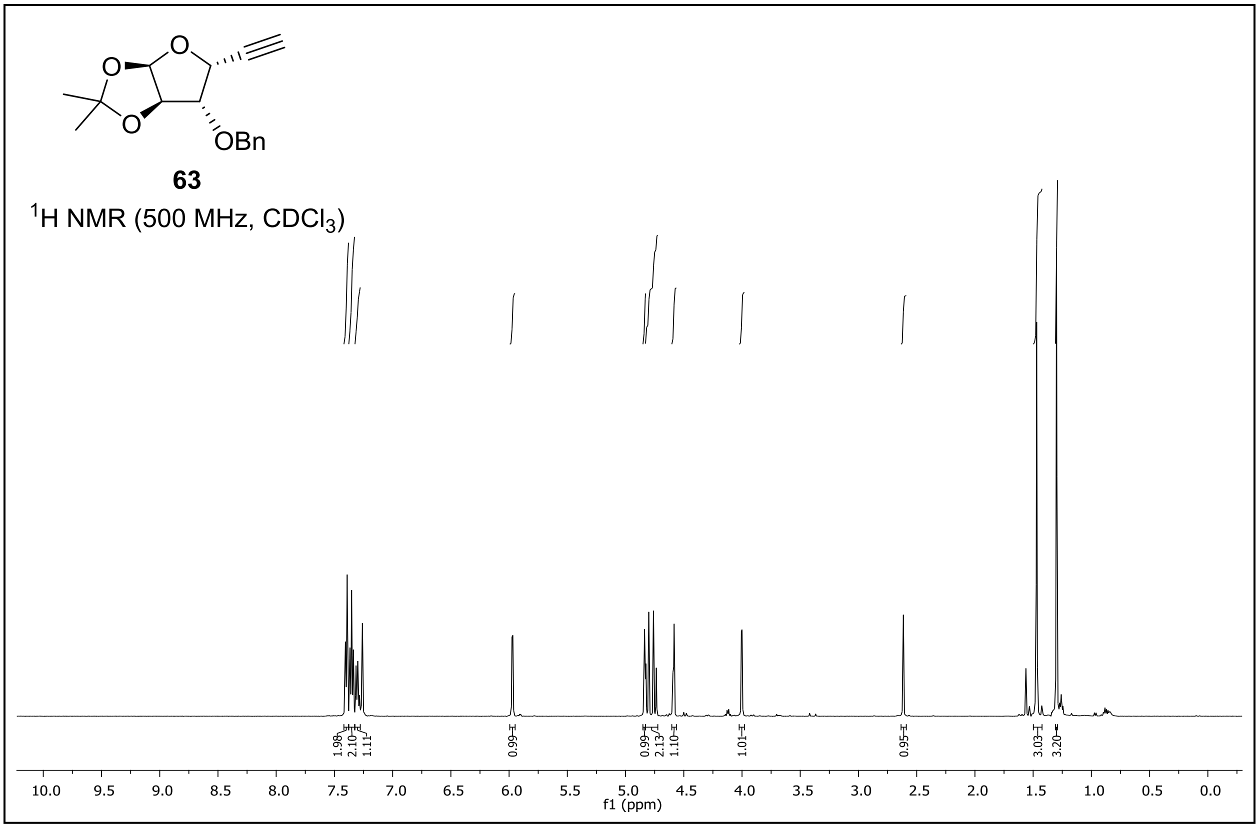
OH
OPMB
65
13C NMR (125 MHz, CDCl3)
159.53 129.63 129.43 113.97 112.03 104.72 87.00 82.93 82.20 79.45 77.45 77.20 76.94 72.41 71.07 55.38 51.05 26.87 26.23
f1 (ppm)

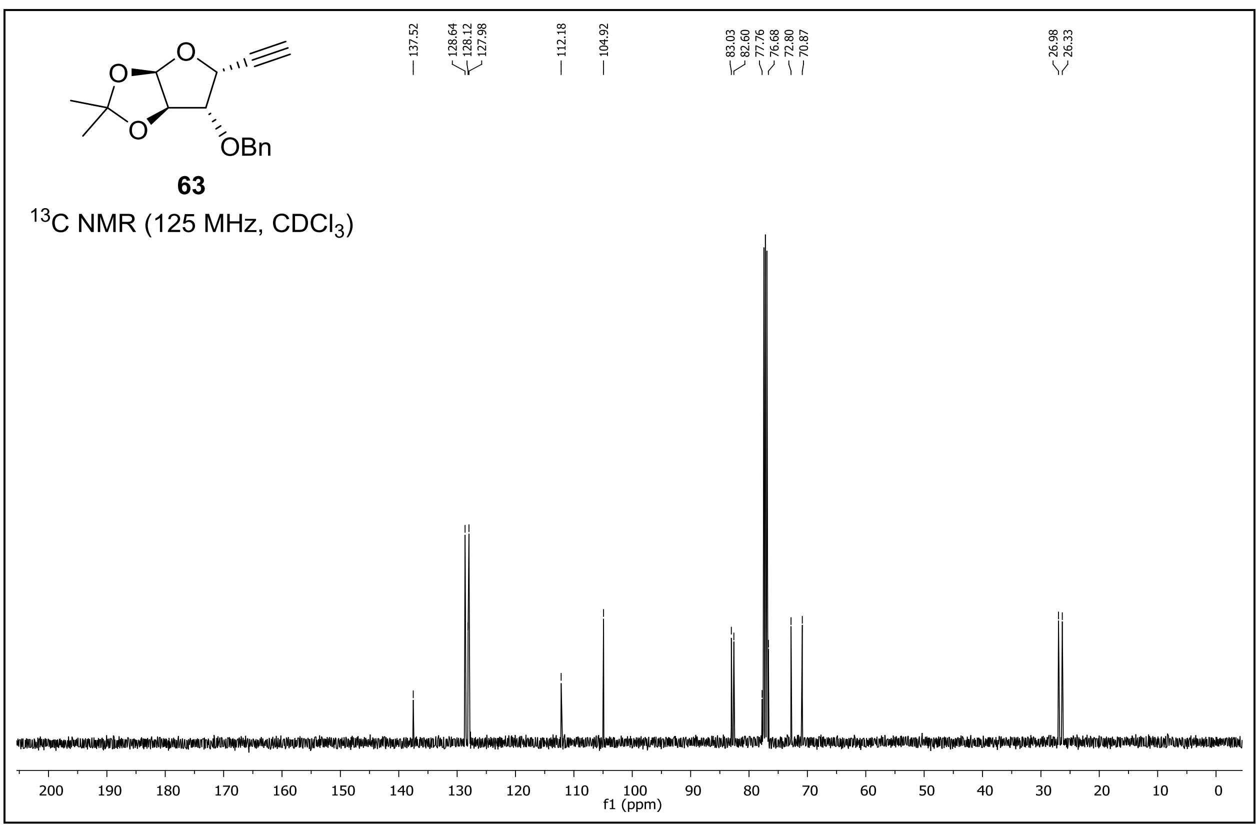

OH
OPMB
67
^{1}H NMR (500 MHz, CDCl$_3$)
1.98
2.07
1.00
1.00
1.02
1.04
1.00
1.04
1.07
3.16
2.09
1.02
3.36
3.27
3.23
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

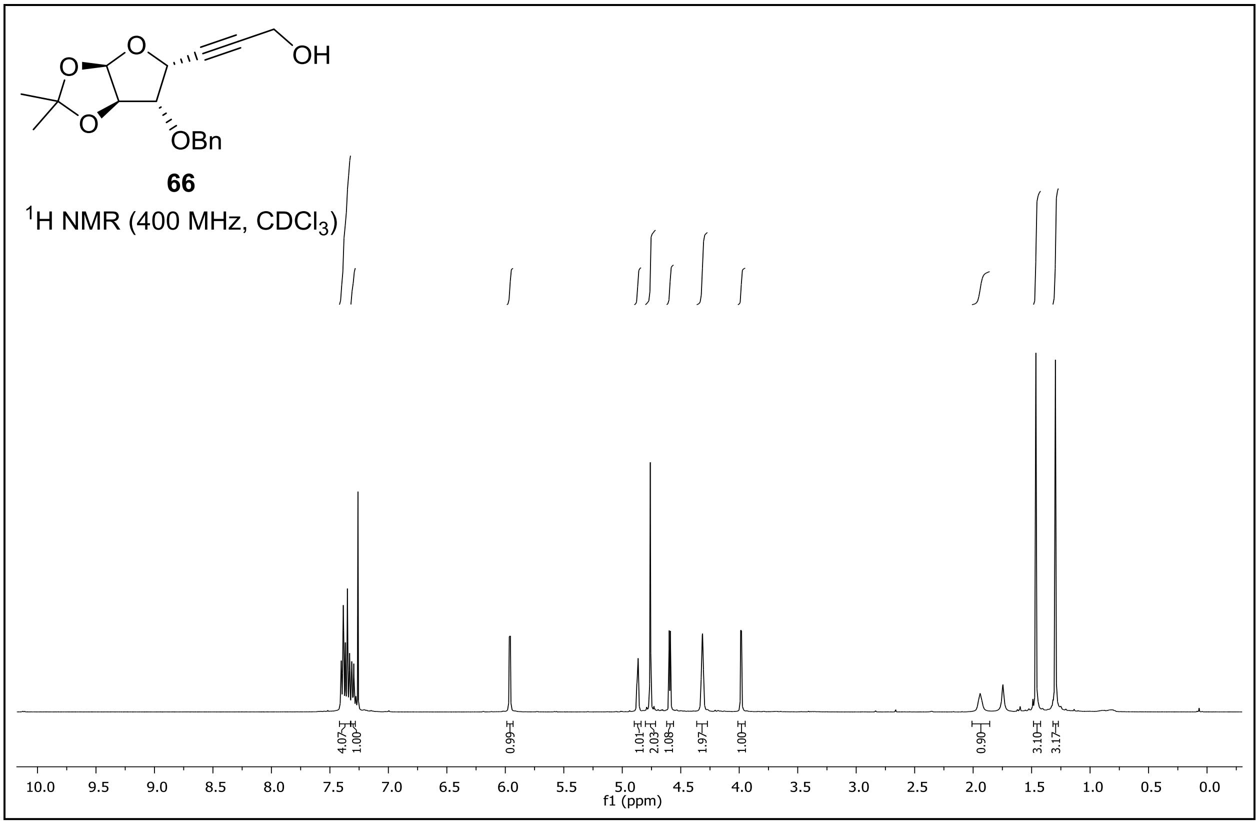

159.61
145.32
138.70
129.84
129.51
114.48
113.95
111.79
111.60
104.35
82.98
81.46
79.86
72.06
64.70
55.47
27.04
26.46
OH
OPMB
67
^{13}C NMR (125 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

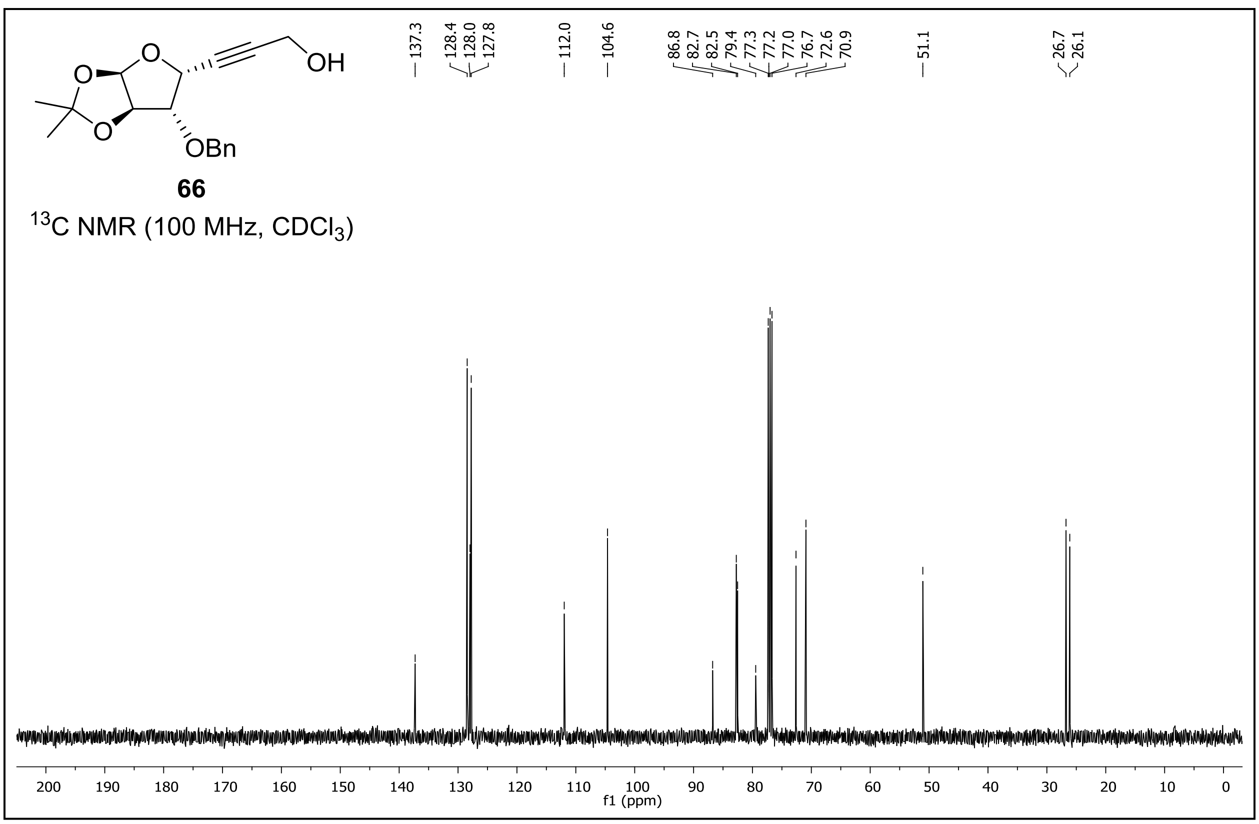

Br
OPMB
69
¹H NMR (400 MHz, C6D6)
f1 (ppm)

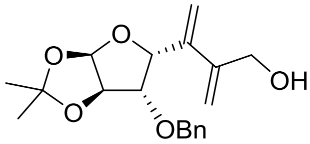

160.23
142.97
138.24
130.63
129.97
117.11
116.62
114.41
111.80
104.98
83.95
82.10
79.84
72.34
55.15
33.61
27.40
26.69
Br
OPMB
69
¹³C NMR (100 MHz, C6D6)
f1 (ppm)


O
O
O
OBn
63
1H NMR (500 MHz, CDCl3)
1.98
2.10
1.11
0.99
0.99
2.13
1.10
1.01
0.95
3.03
3.20
10.0 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 0.0
f1 (ppm)


O
O
O
OBn
63
13C NMR (125 MHz, CDCl3)
137.52
128.64
128.12
127.98
112.18
104.92
83.03
82.60
77.76
76.68
72.80
70.87
26.98
26.33
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

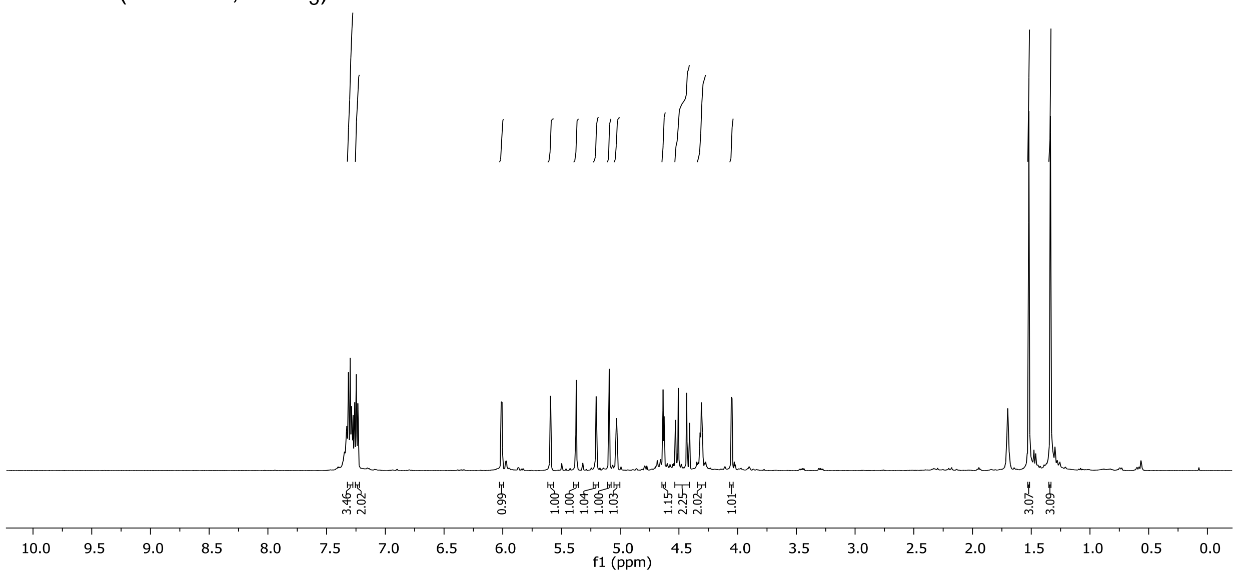

OH
O
O
O
OBn
66
1H NMR (400 MHz, CDCl3)
f1 (ppm)

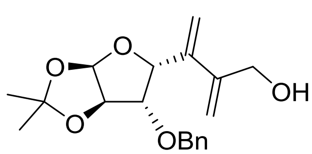

OH
O
O
O
OBn
66
13C NMR (100 MHz, CDCl3)
137.3
128.4
128.0
127.8
112.0
104.6
86.8
82.7
82.5
79.4
77.3
77.2
77.0
76.7
72.6
70.9
51.1
26.7
26.1
f1 (ppm)



68

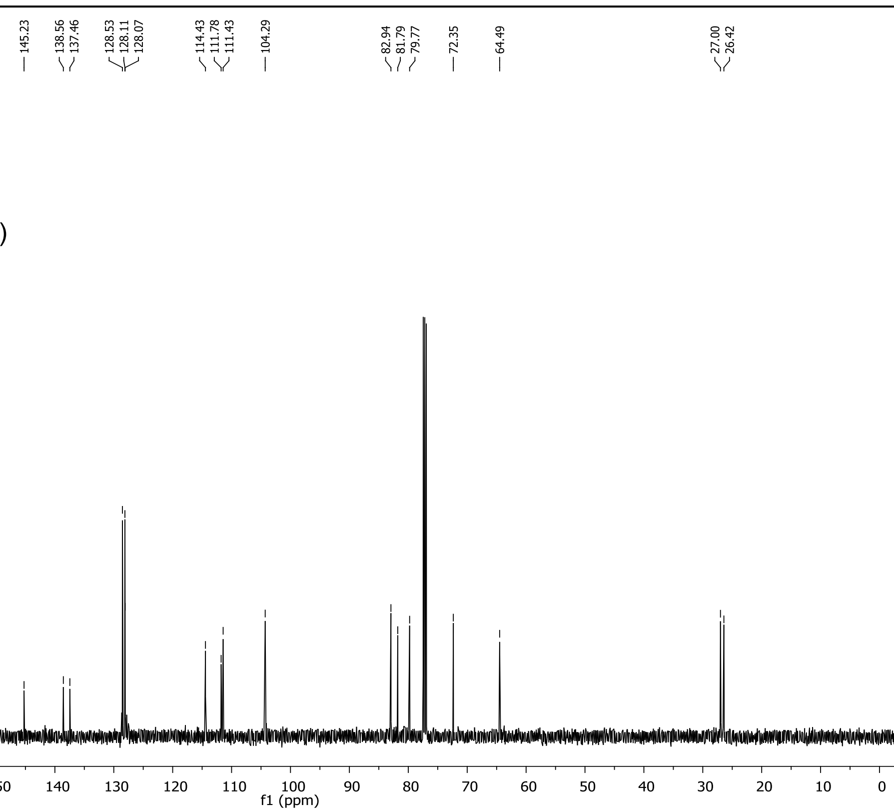
^{1}H NMR (500 MHz, $CDCl_3$)

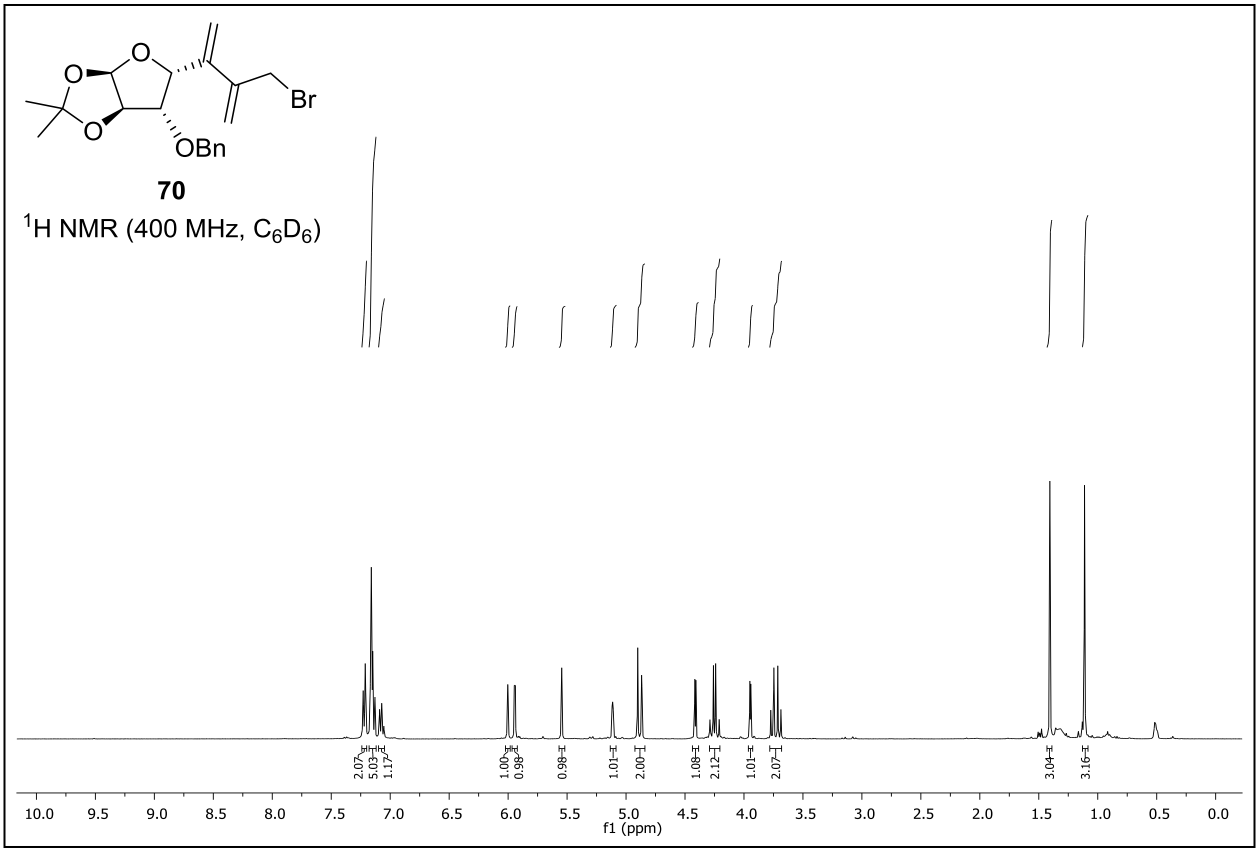


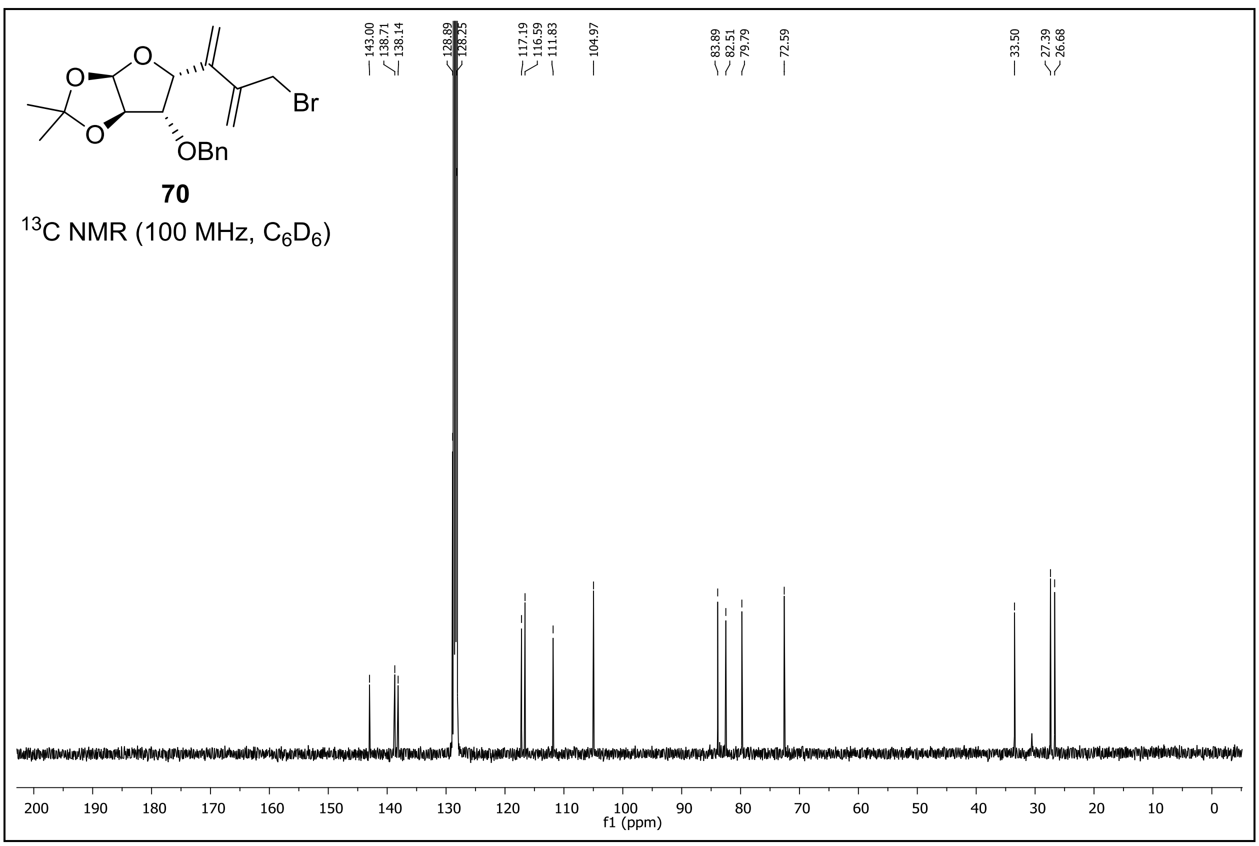


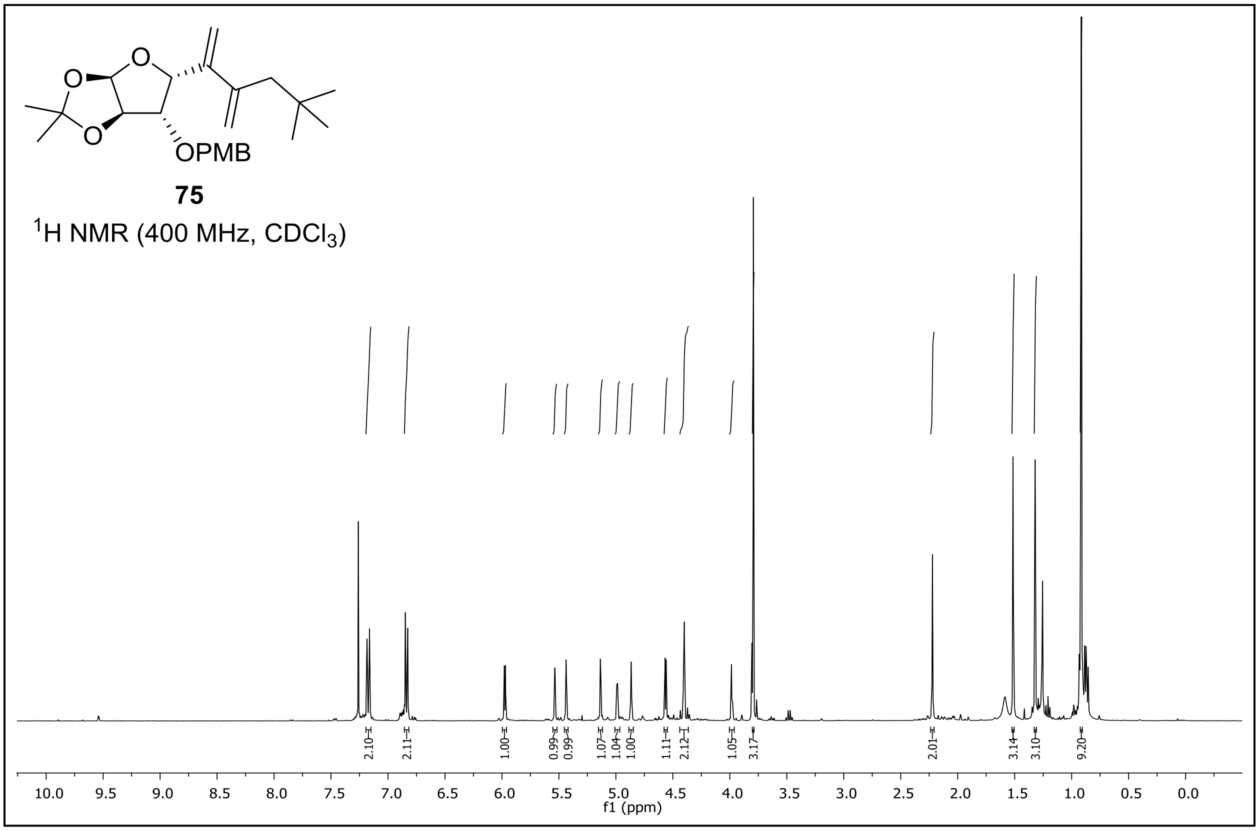
68

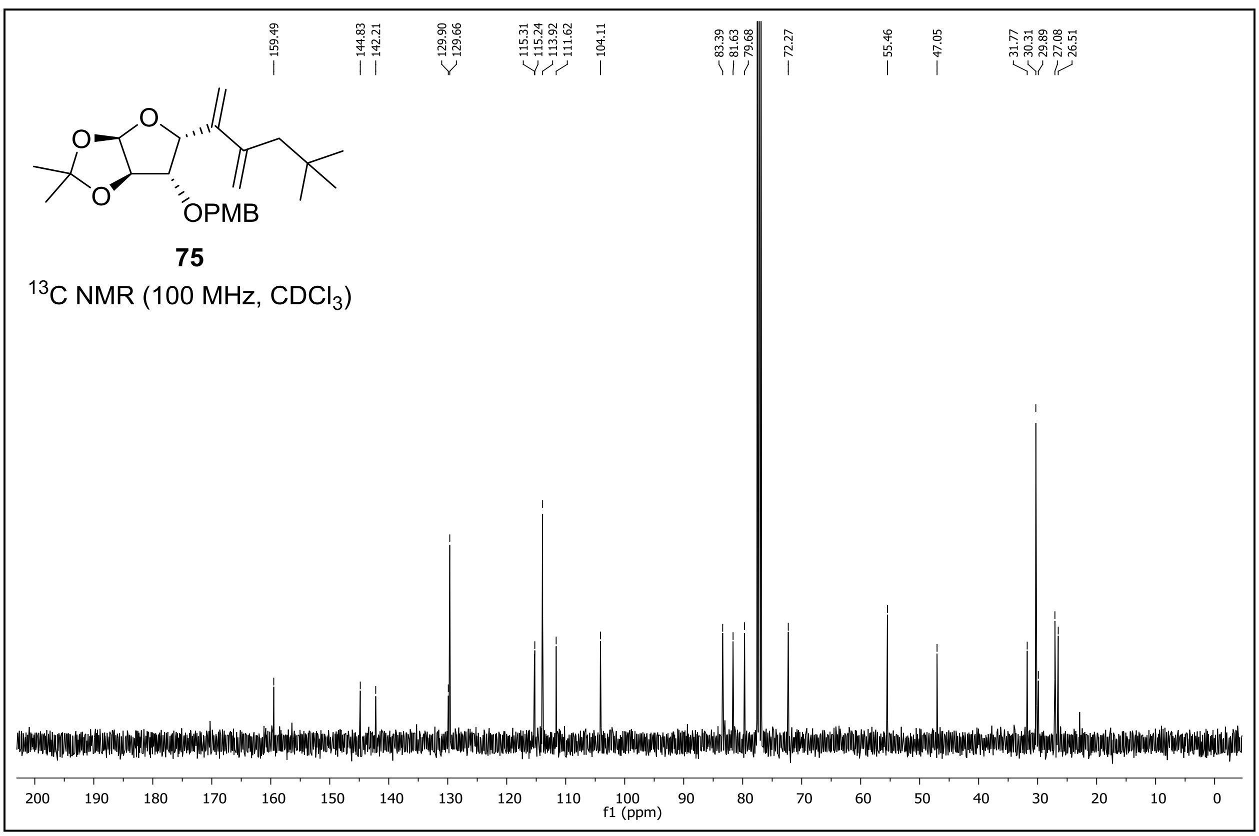
^{13}C NMR (125 MHz, $CDCl_3$)

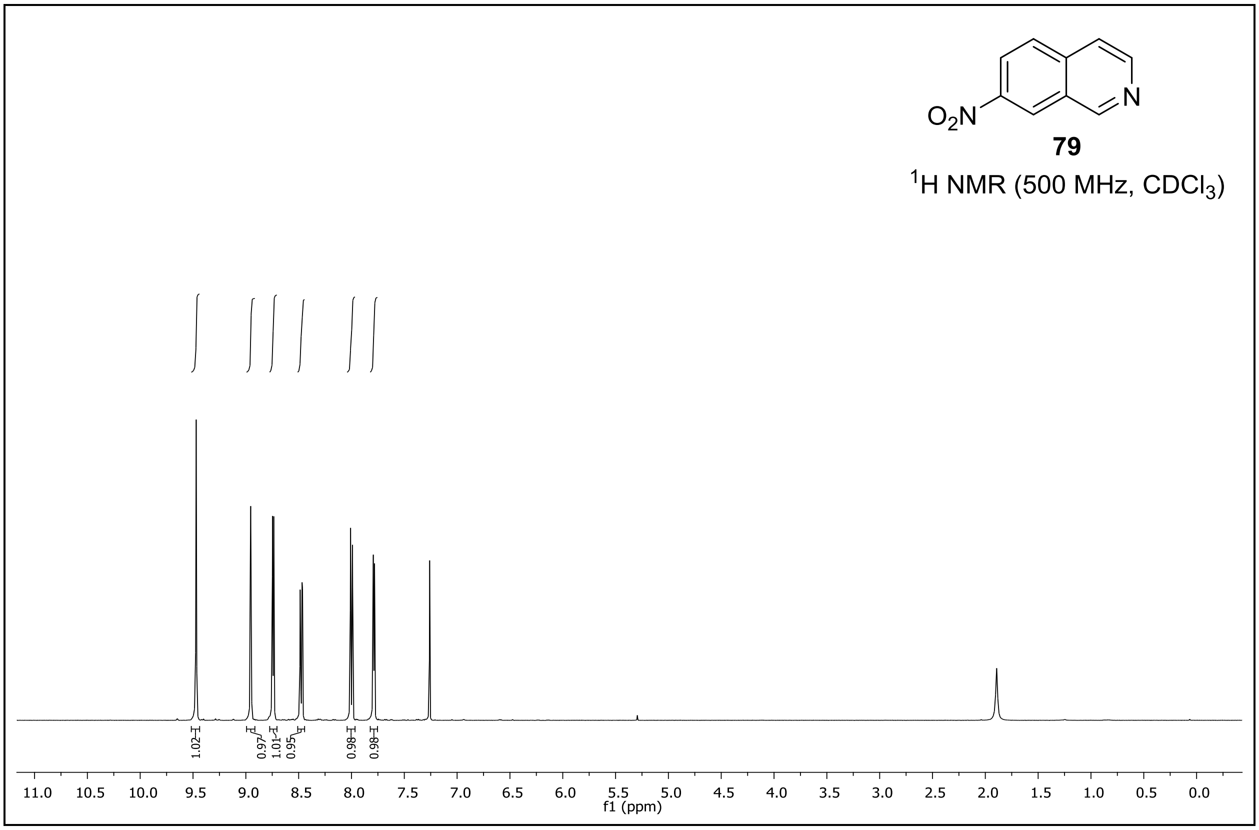


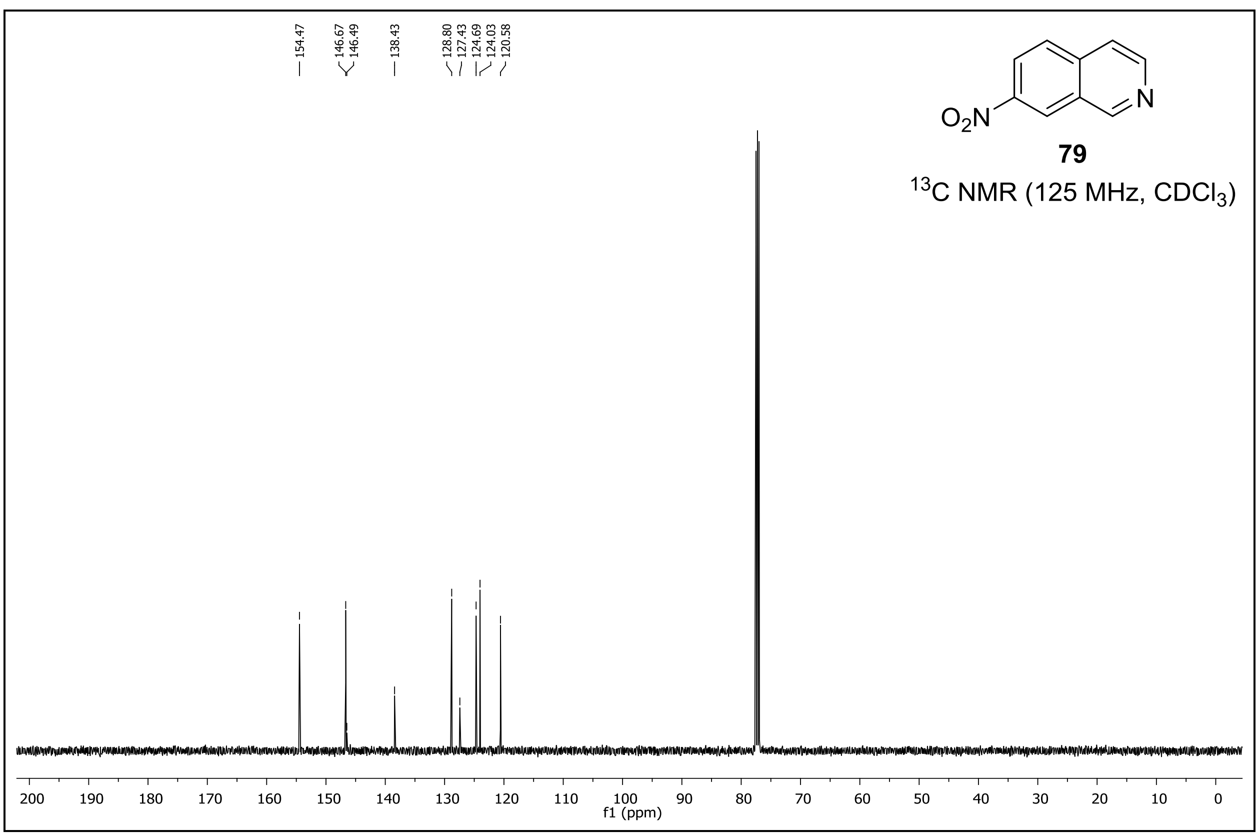

O
O
O
Br
OBn
70
1H NMR (400 MHz, C6D6)
2.07
5.03
1.17
1.00
0.98
0.98
1.01
2.00
1.08
2.12
1.01
2.07
3.04
3.16
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

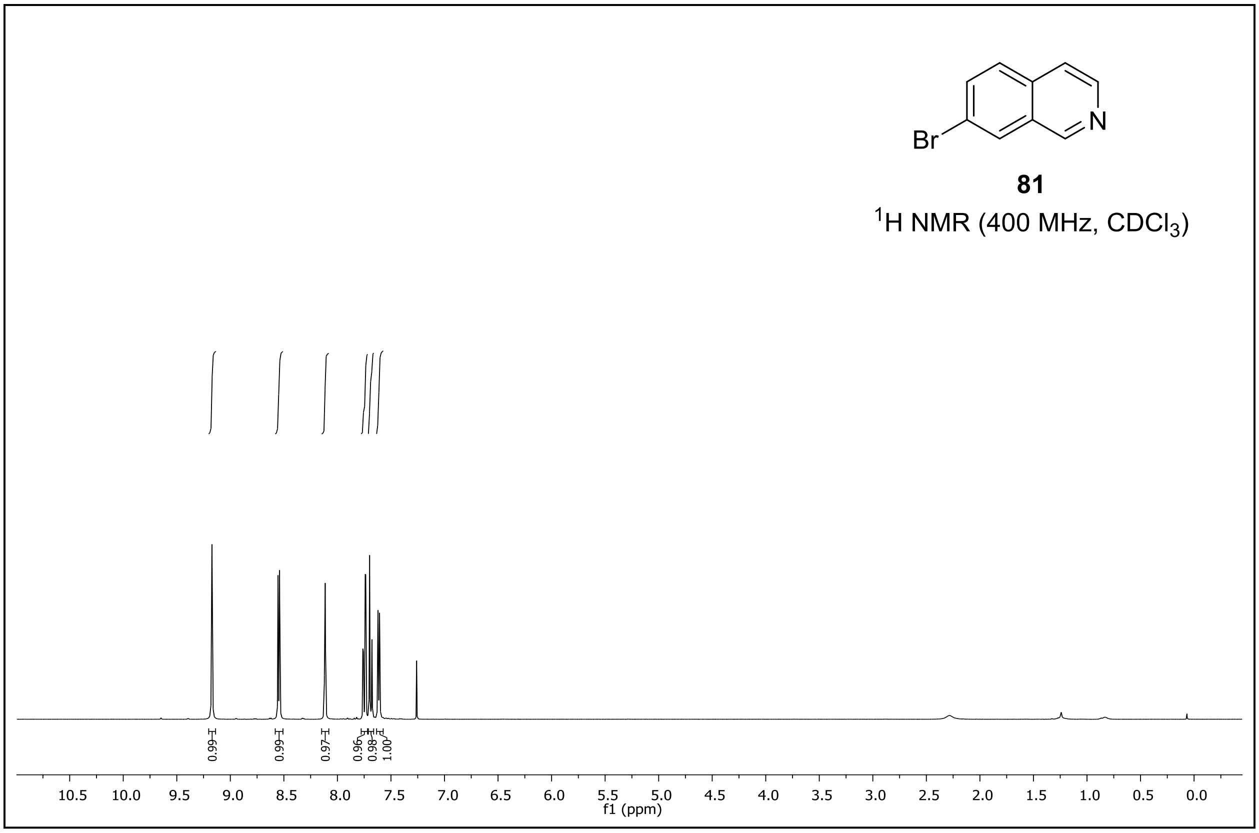

143.00
138.71
138.14
128.89
128.25
117.19
116.59
111.83
104.97
83.89
82.51
79.79
72.59
33.50
27.39
26.68
O
O
O
Br
OBn
70
13C NMR (100 MHz, C6D6)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

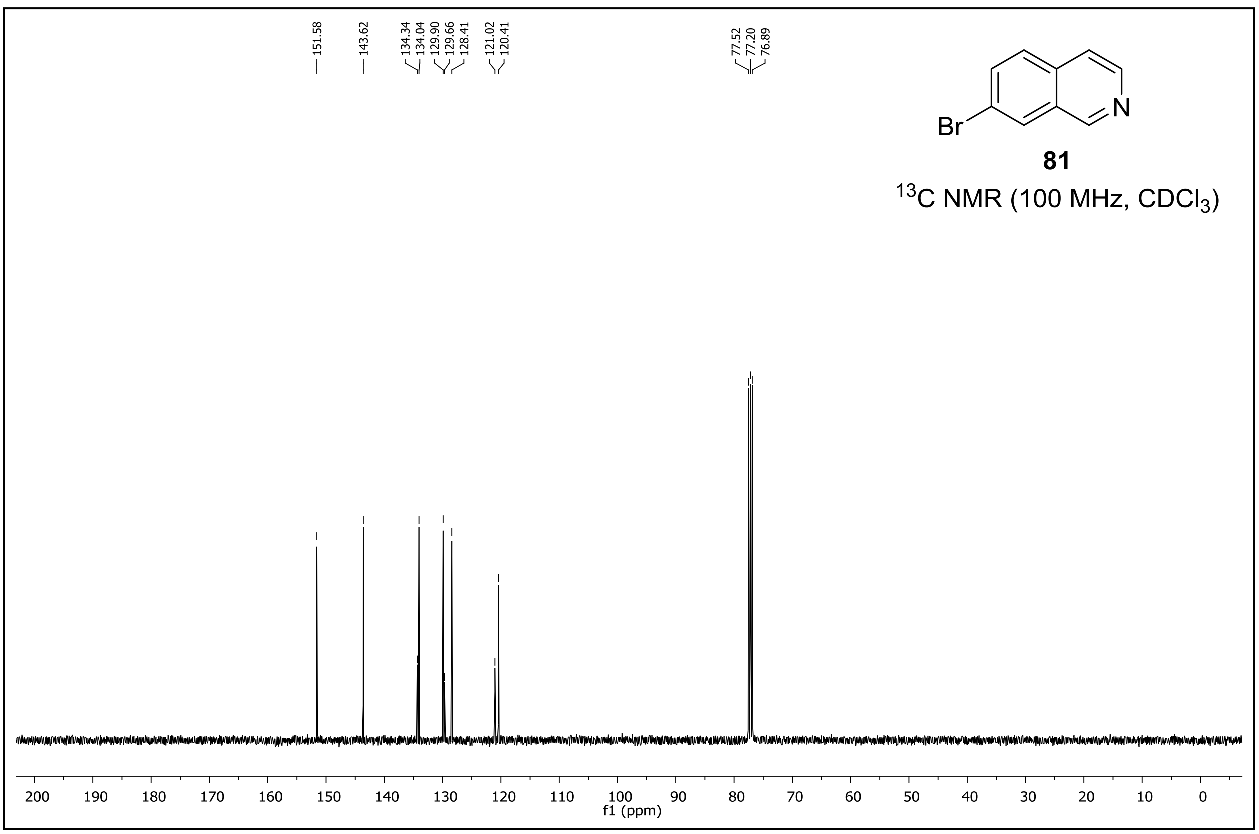

OPMB
75
^{1}H NMR (400 MHz, CDCl$_3$)
2.10 2.11 1.00 0.99 0.99 1.07 1.04 1.00 1.11 2.12 1.05 3.17 2.01 3.14 3.10 9.20
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


159.49
144.83 142.21
129.90 129.66
115.31 115.24 113.92 111.62
104.11
83.39 81.63 79.68
72.27
55.46
47.05
31.77 30.31 29.89 27.08 26.51
OPMB
75
^{13}C NMR (100 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


O2N
N
79
1H NMR (500 MHz, CDCl3)
1.02
0.97
1.01
0.95
0.98
0.98
11.0 10.5 10.0 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 0.0
f1 (ppm)


154.47
146.67
146.49
138.43
128.80
127.43
124.69
124.03
120.58
O2N
N
79
13C NMR (125 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Br
N
81
1H NMR (400 MHz, CDCl3)
0.99
0.99
0.97
0.96
0.98
1.00
10.5 10.0 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 0.0
f1 (ppm)


151.58
143.62
134.34
134.04
129.90
129.66
128.41
121.02
120.41
77.52
77.20
76.89
Br
N
81
13C NMR (100 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)