Supporting Information

Stereodivergent Access to Enantioenriched Epoxy Alcohols with Three Stereogenic Centers via Ruthenium-Catalyzed Transfer Hydrogenation

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I. General Information

Commercially available materials purchased from Meryer, Aladdin, and Adamas were used as received; unless otherwise noted, all reactions and manipulations involving air- and moisture-sensitive compounds were performed using standard Schlenk techniques. Catalyst **C** was synthesized using the same procedures as shown in the literature (*J. Am. Chem. Soc.* **2011**, *133*, 14960–14963). All solvents were purified and dried using normal procedures. Proton nuclear magnetic resonance (^{1}H NMR) spectra were recorded on a Bruker AVANCE III HD400 (400 MHz) spectrometer. Chemical shifts were recorded in parts per million (ppm, δ) relative to tetramethylsilane (δ = 0.00 ppm) or chloroform (δ = 7.26 ppm). ^{1}H NMR splitting

patterns are designated as singlet (s), doublet (d), triplet (t), quartet (q), dd (doublet of doublets), m (multiplet), and etc. All first-order splitting patterns were assigned on the basis of the appearance of the multiplet. Splitting patterns that could not be easily interpreted are designated as multiplet (m) or broad (br). Carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on a Bruker AVANCE III HD400 (100 MHz) spectrometer. High resolution mass spectral analysis (HRMS) was performed on Thermo Fisher Scientific LTQ FT Ultra mass spectrometer. The determination of ee was performed via chiral HPLC analysis using Shimadzu LC-20AD HPLC workstation. X-ray crystallography analysis was performed on Agilent SuperNova X-ray diffractionmeter. Optical rotations were measured using a 1 mL cell with a 5 dm path length on an INESA SGW-1 polarimeter and are reported as follows: $[\alpha]^{rt}_{D}$ (cin g per 100 mL solvent). Analytical thin-layer chromatography (TLC) was carried out on WFH-203 F254 pre-coated silica gel plate (0.2 mm thickness). Visualization was performed using a UV lamp or 2,4-dinitrophenylhydrazine or potassium permanganate stain.

II. X-ray crystallographic analysis

X-ray crystallographic analysis of 3i

Method for single crystal cultivation: a solid sample (10–20 mg) was dissolved in $CHCl_3$ (100–200 μL) in a vial at room temperature, and MeOH (300–600 μL) was added into the above solution slowly while keeping the sample all dissolved. Then vial was sealed with a piece of parafilm and stayed quietly for several days to allow the slow evaporation of the solution until a single crystal was obtained.

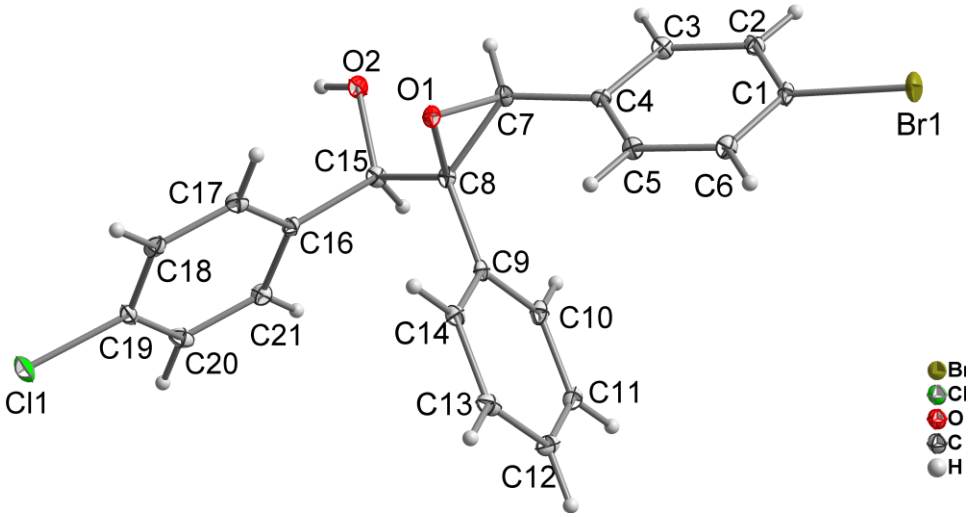
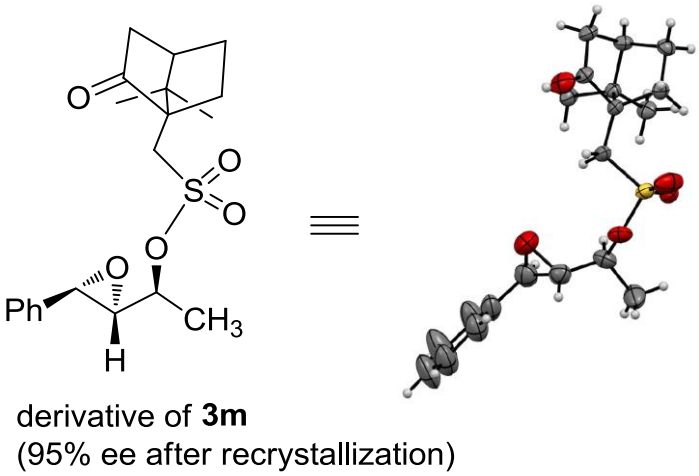


Table S1. Crystal data and structure refinement for data of compound 3i:

Identification code	3i
Empirical formula	$C_{21}H_{16}BrClO_2$
Formula weight	415.70
Temperature/K	100.(2)
Crystal system	monoclinic
Space group	$P2_1$
a/Å	8.3009(2)
b/Å	10.9773(3)
c/Å	9.7497(3)
α/°	90
β/°	91.1200(10)
γ/°	90
Volume/Å^3	888.24(4)
Z	2
ρ_{calc}g/cm^3	1.554
μ/mm^{-1}	2.476
F(000)	420.0
Crystal size/mm^3	0.200 × 0.200 × 0.200
Radiation	? (λ = 0.71073)
2Θ range for data collection/°	6.16 to 55.02
Index ranges	$-10 \leq h \leq 10$, $-14 \leq k \leq 14$, $-12 \leq l \leq 12$
Reflections collected	18512
Independent reflections	3988 [R_{int} = 0.0339, R_{sigma} = 0.0392]
Data/restraints/parameters	3988/1/228
Goodness-of-fit on F^2	1.052

Final R indexes [I>=2σ (I)]	R_1 = 0.0196, wR_2 = 0.0473
Final R indexes [all data]	R_1 = 0.0201, wR_2 = 0.0474
Largest diff. peak/hole / e Å^{-3}	0.48/-0.34
Flack parameter	0.046(3)

X-ray crystallographic analysis of 3m derivative (CCDC 2002835):



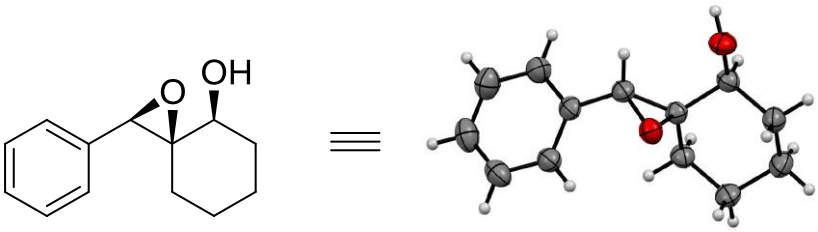
derivative of **3m**
(95% ee after recrystallization)

Table S2. Crystal data and structure refinement for data of 3m derivative:

Identification code	3m derivative
Empirical formula	$C_{20}H_{26}NO_5S$
Formula weight	380.48
Temperature/K	230(2)
Crystal system	monoclinic
Space group	$P2_1$
a/Å	6.7030(5)
b/Å	8.4049(6)
c/Å	17.5344(14)
α/°	90
β/°	98.188(3)
γ/°	90
Volume/Å^3	977.78(13)
Z	2
ρ_{calc}g/cm^3	1.292
μ/mm^{-1}	0.193
F(000)	408.0
Crystal size/mm^3	0.1 ×0.1 ×0.1
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	6.14 to 57.43

Index ranges	$-9 \le h \le 9, -11 \le k \le 11, -23 \le l \le 23$
Reflections collected	27886
Independent reflections	5054 [R_{int} = 0.0333, R_{sigma} = 0.0248]
Data/restraints/parameters	5054/1/238
Goodness-of-fit on F^2	1.002
Final R indexes [I>=2σ (I)]	R_1 = 0.0410, wR_2 = 0.1159
Final R indexes [all data]	R_1 = 0.0466, wR_2 = 0.1218
Largest diff. peak/hole / e $Å^{-3}$	0.47/-0.20
Flack parameter	0.05(2)

X-ray crystallographic analysis of 2n (CCDC 2002834):



2n
(>99% ee)

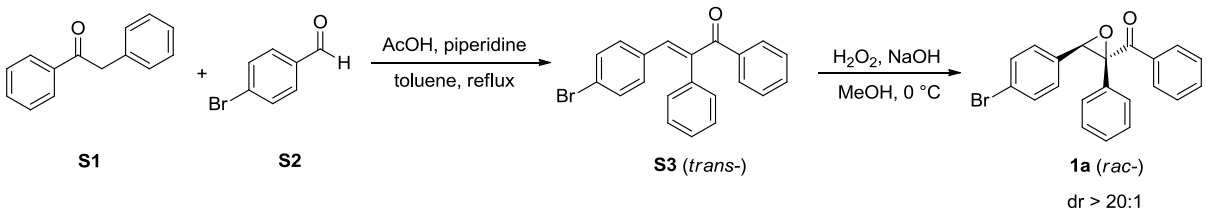
Table S3. Crystal data and structure refinement for data of 2n

Identification code	2n
Empirical formula	$C_{13}H_{16}O_2$
Formula weight	204.26
Temperature/K	293(2)
Crystal system	orthorhombic
Space group	$P2_12_12_1$
a/Å	5.5579(2)
b/Å	7.7831(2)
c/Å	25.2947(7)
α/°	90
β/°	90
γ/°	90
Volume/$Å^3$	1094.19(6)
Z	4
ρ_{calc}g/cm^3	1.240
μ/mm^{-1}	0.653
F(000)	440.0
Crystal size/mm^3	0.15 × 0.1 × 0.1
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	11.896 to 144.114
Index ranges	$-2 \le h \le 6, -9 \le k \le 8, -30 \le l \le 31$
Reflections collected	3096

Independent reflections	1887 [R_{int} = 0.0128, R_{sigma} = 0.0176]
Data/restraints/parameters	1887/0/139
Goodness-of-fit on F^2	1.072
Final R indexes [I>=2σ (I)]	R_1 = 0.0312, wR_2 = 0.0801
Final R indexes [all data]	R_1 = 0.0322, wR_2 = 0.0810
Largest diff. peak/hole / e $Å^{-3}$	0.18/-0.12
Flack parameter	-0.04(11)

III. General procedures for the preparation of substrates

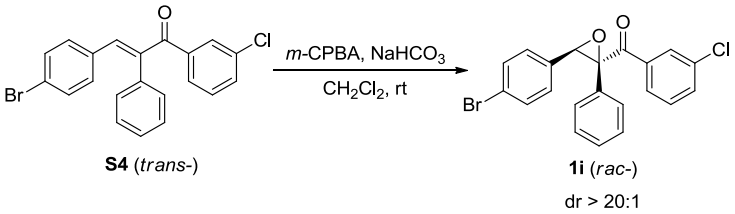
1. Typical procedure for the synthesis of substrates 1a–1h and 1l :



A solution of 1,2-diphenylethan-1-one **S1** (3.92 g, 20.0 mmol), 4-bromobenzaldehyde **S2** (3.68 g, 20.0 mmol), AcOH (1.0 mL) and piperidine (0.4 mL) in 50 mL toluene was refluxed overnight using a Dean-stark apparatus. After cooling to room temperature, the reaction was quenched by the addition of saturated aqueous $NaHCO_3$ solution (10 mL). The aqueous layer was extracted with ethyl acetate (3 x 100 mL) and the combined organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 50:1) to afford product **S3** (2.61 g, 36% yield).

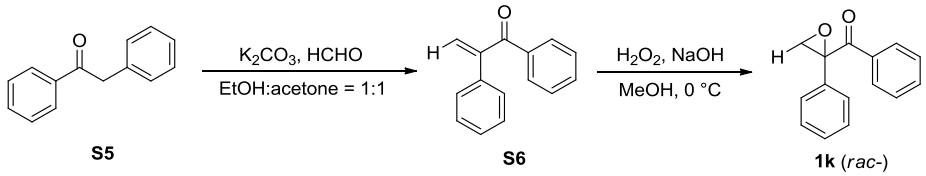
A solution of **S3** (0.51 g, 1.41 mmol) in 30 mL MeOH was added H_2O_2 (0.8 mL, 30% in water) dropwised at 0 ˚C. Then under this temperature, 0.8 mL aqueous NaOH solution (6 N) was slowly added into reaction mixture. The reaction suspension was monitored by TLC until no **S3** remained. Then the reaction was quenched with aqueous $Na_2S_2O_3$ solution, and then extracted with ethyl acetate (3 x 30 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 30:1) to afford product **1a** (0.45 g, 84% yield).

2. Typical procedure for the synthesis of substrate 1i :



A solution of methyl **S4** (0.40 g, 1.0 mmol) and 3-chloroperoxybenzoic acid (0.52 g, 3.0 mmol) in 10 mL CH_2Cl_2 were stirred for 2 h at room temperature. Then the reaction was quenched with aqueous $Na_2S_2O_3$ solution and extracted with ethyl acetate (3 x 20 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 50:1) to afford product **1i** (0.28 g, 68% yield).

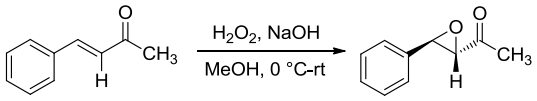
3. Typical procedure for the synthesis of substrate 1k:



1,2-Diphenylethan-1-one **S5** (2.0 g, 10.0 mmol) and K_2CO_3 (1.48 g, 10.7 mmol) were added in 50 mL EtOH:acetone (v:v = 1:1). Then formaldehyde (1.5 mL, 18.0 mmol) was added at room temperature. After 4 h, the aqueous layer was extracted with ethyl acetate (3 x 50 mL) and the combined organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 50:1) to afford product **S6** (0.61 g, 29% yield).

A solution of **S6** (0.6 g, 2.9 mmol) in 30 mL MeOH was added H_2O_2 (3.0 mL, 30% in water) dropwised at 0 ˚C. Then under this temperature, 3.0 mL aqueous NaOH solution (6 N) was slowly added into reaction mixture. The reaction suspension was monitored by TLC until no **S6** remained. Then the reaction was quenched with aqueous $Na_2S_3O_2$ solution, and then extracted with ethyl acetate (3 x 30 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 30:1) to afford product **1k** (0.48 g, 74% yield).

4. Typical procedure for the synthesis of substrate 1m:

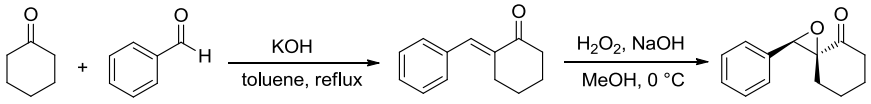


S7 (*trans*-) **1m** (*rac*-)

dr > 20:1

A solution of **S7** (1.88 g, 12.9 mmol) in 20 mL MeOH was added H_2O_2 (4.0 mL, 30% in water) dropwised at 0 ˚C. Then under this temperature, 3.8 mL aqueous NaOH solution (2 N) was slowly added into reaction mixture. The reaction suspension was slowly warmed to room temperature and monitored by TLC until no **S7** remained. Then the reaction was quenched with aqueous $Na_2S_3O_2$ solution, and then extracted with ethyl acetate (3 x 60 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 40:1) to afford product **1m** (1.42 g, 68% yield).

5. Typical procedure for the synthesis of substrate 1n:



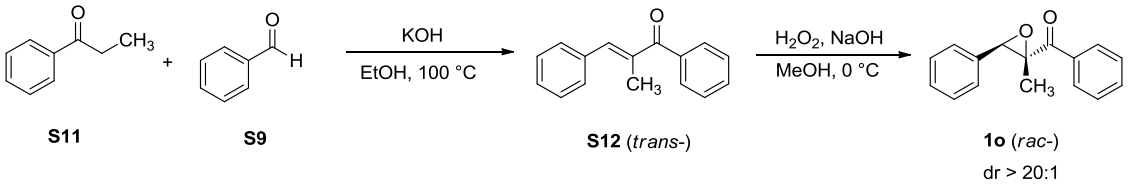
S8 **S9** **S10** (*trans*-) **1n** (*rac*-)

dr > 20:1

A solution of cyclohexanone **S8** (7.36 g, 75.0 mmol) and benzaldehyde **S9** (5.3 g, 50.0 mmol) in 50 mL aqueous KOH solution (1 N) was heated to reflux for 3 h. After cooling to room temperature, the aqueous layer was extracted with ethyl acetate (3 × 120 mL) and the combined organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 30:1) to afford product **S10** (5.58 g, 60% yield).

A solution of **S10** (2.49 g, 13.4 mmol) in 35 mL MeOH was added H_2O_2 (5.0 mL, 30% in water) dropwised at room temperature. Then under this temperature, 2.5 mL aqueous NaOH solution (6 N) was slowly added into reaction mixture. The reaction suspension was monitored by TLC until no **S10** remained. Then the reaction was quenched with aqueous $Na_2S_3O_2$ solution, and then extracted with ethyl acetate (3 x 100 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 50:1) to afford product **1n** (1.30 g, 48% yield).

6. Typical procedure for the synthesis of substrate 1o:

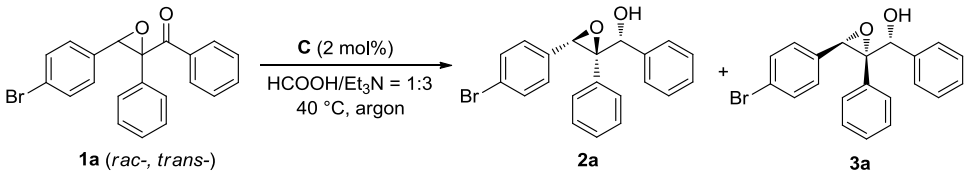


S11 **S9** **S12** (*trans*-) **1o** (*rac*-)
dr > 20:1

A solution of propiophenone **S11** (4.02 g, 30.0 mmol), benzaldehyde **S9** (6.36 g, 60.0 mmol), 60 mL aqueous KOH solution (0.1 N) and EtOH (60 mL) was stirred at room temperature for 3 d. After cooling to room temperature, the aqueous layer was extracted with ethyl acetate (3 x 150 mL) and the combined organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 30:1) to afford product **S12** (4.19 g, 63% yield).

A solution of **S12** (3.00 g, 13.5 mmol) in 60 mL MeOH was added H_2O_2 (6.0 mL, 30% in water) dropwised at room temperature. Then under this temperature, 3.0 mL aqueous NaOH solution (6 N) was slowly added into reaction mixture. The reaction suspension was monitored by TLC until no **S12** remained. Then the reaction was quenched with aqueous $Na_2S_3O_2$ solution, and then extracted with ethyl acetate (3 x 100 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 50:1) to afford product **1o** (1.90 g, 59% yield).

IV. Typical procedure for the transfer hydrogenation:

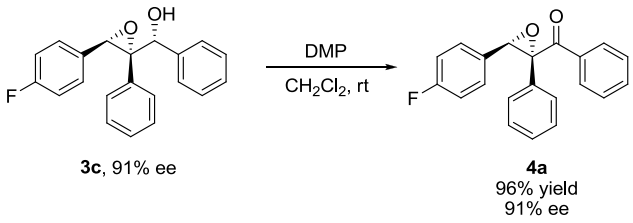


1a (*rac-, trans*-) **2a** **3a**

A mixture of epoxy ketone **1a** (75.6 mg, 0.2 mmol) and the Ru catalyst (2.5 mg, 2 mol%) in 1.0 mL formic acid/triethylamine (v:v = 1:3) mixture was stirred at 40 ℃ under argon atmosphere. After completion of the reaction as indicated by TLC, it was extracted with ethyl acetate (3 x 10 mL) and the organic extract was dried over anhydrous Na_2SO_4 followed by the removal of solvent in a rotary evaporator. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 20:1) to afford product **2a** (35.1 mg, 46% yield) and **3a** (34.2 mg, 45% yield).

V. Procedures for derivatizations of products

1. Synthesis of compound 4a:

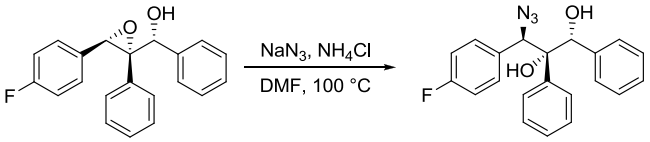


3c, 91% ee

4a
96% yield
91% ee

A solution of **3c** (17.0 mg, 0.05 mmol) and Dess-Martin periodine (61.0 mg, 0.09 mmol) in 5.0 mL dry CH_2Cl_2 was stirred at room temperature under argon atmosphere. The reaction suspension was monitored by TLC until no **3c** remained. Then the reaction mixture was extracted with ethyl acetate (3 x 10 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 5:1) to afford product **4a** (15.3 mg, 96% yield).

2. Synthesis of compound 4b*:*

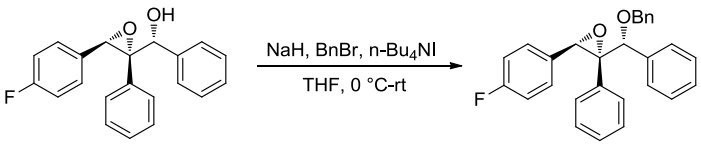


3c, 91% ee

4b
98% yield
> 20:1 dr, 91% ee

To a round-bottomed flask equiped with a dropping funnel, a condenser, and a magnetic stirrer was added **3c** (10.0 mg, 0.03 mmol), NaN_3 (4.0 mg, 0.06 mmol), NH_4Cl (3.3 mg, 0.06 mmol) and 0.4 mL DMF. The reaction mixture was heated to 100 ℃ and stirred continuously for 8 h in an over-dried pressure-tight reaction tube. Then the mixture was extracted with CH_2Cl_2 (3 x 10 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 10:1) to afford product **4b** (10.7 mg, 98% yield).

3. Synthesis of compound 4c*:*

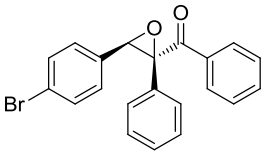


3c, 91% ee

4c
88% yield
96% ee

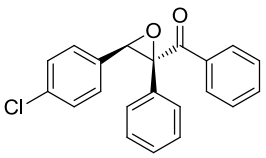
To a round-bottomed flask equipped with a dropping funnel, a condenser, and a magnetic stirrer was added **3c** (17.0 mg, 0.05 mmol), NaH (4.0 mg, 0.13 mmol) and 5.0 mL THF at 0 ℃ under argon atmophere. After stirring for 40 min, BnBr (25.9 mg, 0.15 mmol) and n-Bu_4NI (9.2 mg, 0.005 mmol) were added into the reaction mixture at 0 ℃. The the reaction resulting solution was slowly warm to room temperature and then stirred for additional 3 h. Then the reaction was quenched with aqueous saturated NH_4Cl solution, and then extracted with ethyl acetate (3 x 10 mL). The combined organic layer was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by chromatography (petroleum ether/ethyl acetate, v:v = 20:1) to afford product **4c** (18.0 mg, 88% yield).

VI. Characterizations of new compounds



1a (*rac*-)

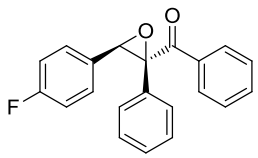
(3-(4-bromophenyl)-2-phenyloxiran-2-yl)(phenyl)methanone (1a): White solid, mp 149–150 ˚C, 0.45 g, 84% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.14–8.11 (m, 2H), 7.57–7.53 (m, 1H), 7.46–7.43 (m, 4H), 7.32–7.28 (m, 2H), 7.23–7.16 (m, 3H), 7.08–7.05 (m, 2H), 4.47 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.0, 133.99, 133.95, 132.5, 131.7, 131.2, 130.0, 128.7, 128.6, 128.5, 128.4, 127.5, 122.3, 71.3, 62.6; HRMS (ESI, m/z): calcd. for $C_{21}H_{15}O_2BrH^+$ 379.0328, found 379.0322; IR (KBr thin film, cm^{-1}): ν 3007, 2989, 1689, 1592, 1448, 1260, 1183, 1007, 1010, 780, 760, 641.



1b (*rac*-)

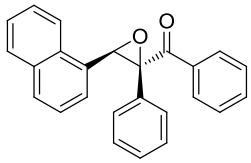
(3-(4-chlorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanone (1b): White solid, mp 100–101 ˚C, 0.28 g, 60% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10–8.07 (m, 2H), 7.52–7.47 (m, 1H), 7.41–7.37 (m, 4H), 7.20–7.05 (m, 7H), 4.44 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.9, 134.0, 133.9, 132.0, 131.7, 129.9, 128.6, 128.5, 128.3, 128.2, 128.1, 127.5, 71.3, 62.5;

HRMS (ESI, m/z): calcd. for $C_{21}H_{15}O_2ClH^+$ 335.0833, found 335.0837; IR (KBr thin film, cm^{-1}): ν 3060, 1689, 1609, 1578, 1501, 1495, 1181, 1087, 1013, 817, 746, 698.



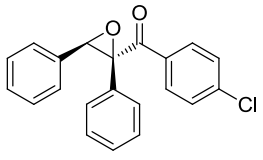
1c (*rac*-)

(3-(4-fluorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanone (1c): White solid, mp 93–94 °C, 0.34 g, 76% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15–8.12 (m, 2H), 7.57–7.53 (m, 1H), 7.46–7.43 (m, 4H), 7.23–7.14 (m, 5H), 6.88–6.84 (m, 2H), 4.50 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.2, 162.6 (d, *J* = 245.4 Hz), 134.1, 133.9, 131.8, 130.0, 129.2 (d, *J* = 2.5 Hz), 128.7, 128.54, 128.48, 128.3, 127.6, 115.1 (d, *J* = 21.7 Hz), 71.3, 62.6; HRMS (ESI, m/z): calcd. for $C_{21}H_{15}O_2FH^+$ 319.1129, found 319.1131; IR (KBr thin film, cm^{-1}): ν 3037, 1687, 1601, 1582, 1510, 1446, 1275, 1187, 1031, 838, 775, 698.



1d (*rac*-)

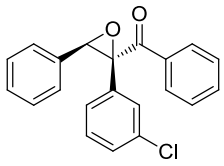
(3-(naphthalen-1-yl)-2-phenyloxiran-2-yl)(phenyl)methanone (1d): Yellow solid, mp 109–110°C, 0.25 g, 51% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.38–8.36 (m, 1H), 8.20–8.16 (m, 2H), 7.75 (d, *J* = 8.2 Hz, 1H), 7.65 (d, *J* = 8.2 Hz, 1H), 7.61–7.54 (m, 2H), 7.50–7.41 (m, 6H), 7.34–7.30 (m, 1H), 7.05–6.98 (m, 3H), 5.05 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.4, 134.1, 134.0, 133.0, 132.1, 130.9, 130.2, 129.3, 128.7, 128.5, 128.3, 128.2, 128.0, 126.7, 126.5, 126.0, 124.9, 124.6, 123.6, 70.7, 63.2; HRMS (ESI, m/z): calcd. for $C_{25}H_{18}O_2H^+$ 351.1380, found 351.1381; IR (KBr thin film, cm^{-1}): ν 2983, 1681, 1599, 1517, 1457, 1392, 1275, 1266, 1181, 1019, 855, 698.



1e (*rac*-)

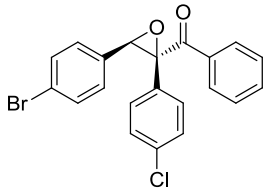
(4-chlorophenyl)(2,3-diphenyloxiran-2-yl)methanone (1e): White solid, mp 114–115 °C, 0.38 g, 80% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.10–8.07 (m, 2H), 7.42–7.40 (m, 4H), 7.21–7.15 (m, 8H), 4.51 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.2, 140.4, 133.2, 132.5,

131.7, 131.4, 129.0, 128.5, 128.3, 128.2, 128.0, 127.5, 126.8, 71.2, 63.2; HRMS (ESI, m/z): calcd. for $C_{21}H_{15}ClO_2H^+$ 335.0833, found 335.0834; IR (KBr thin film, cm^{-1}): ν 3063, 3001, 1683, 1583, 1450, 1280, 1178, 1019, 845, 766, 752, 701.



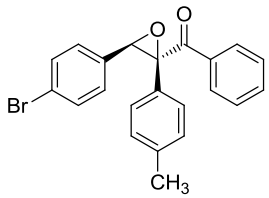
1f (*rac*-)

(3-chlorophenyl)(2,3-diphenyloxiran-2-yl)methanone (1f): Yellow solid, mp 68–69 °C, 0.33 g, 70% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.14–8.11 (m, 2H), 7.59–7.55 (m, 1H), 7.48–7.45 (m, 3H), 7.34–7.32 (m, 1H), 7.22–7.17 (m, 5H), 7.14–7.10 (m, 2H), 4.52 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.8, 134.22, 134.18, 134.1, 133.9, 132.9, 130.0, 129.5, 128.73, 128.65, 128.3, 128.1, 127.7, 126.7, 125.8, 70.7, 63.3; HRMS (ESI, m/z): calcd. for $C_{21}H_{15}O_2H^+$ 335.0833, found 335.0835; IR (KBr thin film, cm^{-1}): ν 3074, 1680, 1598, 1478, 1283, 1178, 1084, 1022, 857, 769, 755, 695.



1g (*rac*-)

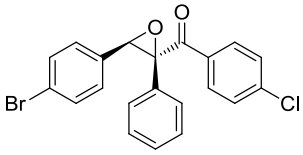
(3-(4-bromophenyl)-2-(4-chlorophenyl)oxiran-2-yl)(phenyl)methanone (1g): White solid, mp 91–92 °C, 0.30 g, 51% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.11–8.08 (m, 2H),7.58–7.55 (m, 1H), 7.47–7.43 (m, 2H), 7.39–7.36 (m, 2H), 7.34–7.31 (m, 2H), 7.20–7.17 (m, 2H), 7.06–7.02 (m, 2H), 4.46 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.7, 134.7, 134.1, 133.8, 132.1, 131.4, 130.3, 129.9, 128.9, 128.73, 128.71, 128.3, 122.5, 70.8, 62.7; HRMS (ESI, m/z): calcd. for $C_{21}H_{14}O_2ClBrH^+$ 412.9938, found 412.9942; IR (KBr thin film, cm^{-1}): ν 2938, 1677, 1604, 1498, 1450, 1319, 1280, 1175, 1019, 772, 749, 695.



1h (*rac*-)

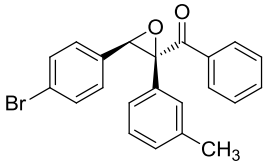
(3-(4-bromophenyl)-2-(*p*-tolyl)oxiran-2-yl)(phenyl)methanone (1h): Colourless liquid, 0.49 g, 89% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15–8.12 (m, 2H), 7.55–7.51 (m, 1H),

7.45–7.41 (m, 2H), 7.35–7.30 (m, 4H), 7.10–7.07 (m, 2H), 7.03–7.01 (m, 2H), 4.47 (s, 1H), 2.22 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.1, 138.4, 134.1, 133.9, 132.7, 131.2, 130.0, 129.2, 128.64, 128.60, 128.5, 127.4, 122.2, 71.4, 62.6, 21.3; HRMS (ESI, m/z): calcd. for $C_{22}H_{17}O_2BrH^+$ 393.0485, found 393.0488; IR (KBr thin film, cm^{-1}): ν 2989, 1686, 1601, 1541, 1493, 1444, 1277, 1186, 1076, 888, 772, 698.



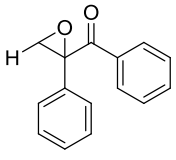
1i (*rac*-)

(3-(4-bromophenyl)-2-phenyloxiran-2-yl)(4-chlorophenyl)methanone (1i): White solid, mp 154–155 °C, 0.28 g, 68% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.08–8.05 (m, 2H), 7.42–7.40 (m, 4H), 7.31–7.28 (m, 2H), 7.24–7.17 (m, 3H), 7.06–7.03 (m, 2H), 4.46 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 189.9, 136.6, 128.3, 127.4, 127.3, 125.1, 124.8, 124.53, 124.47, 123.5, 118.4, 67.3, 58.7; HRMS (ESI, m/z): calcd. for $C_{21}H_{14}O_2ClBrH^+$ 412.9938, found 412.9941; IR (KBr thin film, cm^{-1}): ν 3011, 2989, 1691, 1592, 1487, 1277, 1175, 1101, 1007, 766, 749, 695.



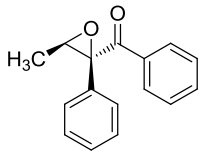
1j (*rac*-)

(3-(4-bromophenyl)-2-(*m*-tolyl)oxiran-2-yl)(phenyl)methanone (1j): Yellow solid, mp 77–78 °C, 0.41 g, 74% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.13–8.10 (m, 2H), 7.55–7.52 (m, 1H), 7.45–7.42 (m, 2H), 7.32–7.30 (m, 4H), 7.08–7.06 (m, 2H), 7.02–7.00 (m, 2H), 4.44 (s, 1H), 2.22 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.0, 138.1, 134.0, 133.9, 132.6, 131.5, 131.1, 130.0, 129.4, 128.7, 128.5, 128.3, 128.0, 124.5, 122.2, 71.4, 62.7, 21.5; HRMS (ESI, m/z): calcd. for $C_{22}H_{17}O_2BrH^+$ 393.0486, found 393.0488; IR (KBr thin film, cm^{-1}): ν 2955, 2856, 1683, 1541, 1450, 1374, 1269, 1175, 1022, 894, 763, 761, 707.



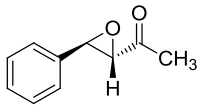
1k (*rac*-)

phenyl(2-phenyloxiran-2-yl)methanone (1k): Yellow solid, mp 68–69 °C, 0.48 g, 74% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04–8.02 (m, 2H), 7.54–7.50 (m, 1H), 7.47–7.43 (m, 2H), 7.42–7.29 (m, 5H), 3.39 (d, *J* = 5.3 Hz, 1H), 3.07 (d, *J* = 5.3 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 194.8, 135.7, 134.4, 133.9, 130.1, 128.9, 128.7, 128.6, 125.5, 63.3, 55.2; HRMS (ESI, m/z): calcd. for $C_{15}H_{12}O_2H^+$ 225.0910, found 225.0909; IR (KBr thin film, cm^{-1}): ν 2986, 1683, 1606, 1581, 1487, 1453, 1277, 1172, 1010, 854, 769, 704.



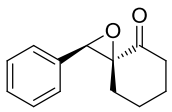
1l (*rac*-)

(3-methyl-2-phenyloxiran-2-yl)(phenyl)methanone (1l): Colourless liquid, 0.24 g, 71% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.05–8.02 (m, 2H), 7.57–7.55 (m, 2H), 7.51–7.47 (m, 1H), 7.40–7.35 (m, 4H), 7.32–7.29 (m, 1H), 3.58 (q, *J* = 5.4 Hz, 1H), 1.14 (d, *J* = 5.4 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.7, 134.3, 133.7, 133.3, 130.0, 128.6, 128.5, 128.4, 126.9, 68.7, 59.3, 13.5; HRMS (ESI, m/z): calcd. for $C_{16}H_{14}O_2H^+$ 239.1067, found 239.1068; IR (KBr thin film, cm^{-1}): ν 2932, 1729, 1680, 1584, 1502, 1380, 1277, 1260, 1184, 1056, 851, 701.



1m (*rac*-)

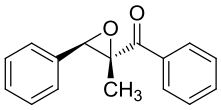
1-(3-phenyloxiran-2-yl)ethan-1-one (1m): White solid, mp 38–39 °C, 1.42 g, 68% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.37–7.32 (m, 3H), 7.27–7.24 (m, 2H), 3.99 (d, *J* = 1.8 Hz, 1H), 3.48–3.47 (m, 1H), 2.17 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 204.3, 135.1, 129.1, 128.8, 125.8, 63.6, 57.9, 24.9; HRMS (ESI, m/z): calcd. for $C_{10}H_{10}O_2H^+$ 163.0754, found 163.0753; IR (KBr thin film, cm^{-1}): ν 2997, 1721, 1489, 1460, 1366, 1281, 1250, 1187, 1090, 886, 752, 698.



1n (*rac*-)

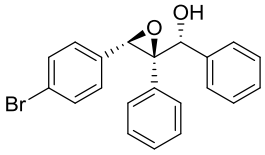
2-phenyl-1-oxaspiro[2.5]octan-4-one (1n): White solid, mp 110–111 °C, 1.30 g, 48% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.38–7.31 (m, 3H), 7.30–7.28 (m, 2H), 4.04 (s, 1H), 2.73–2.68 (m, 1H), 2.45–2.38 (m, 1H), 2.03–1.99 (m, 1H), 1.93 (td, *J* = 13.2, 4.2 Hz, 1H), 1.82–1.73 (m,

2H), 1.63–1.58 (m, 1H), 1.47–1.39 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 206.7, 133.6, 128.4, 126.8, 126.7, 66.1, 64.2, 42.0, 27.5, 24.8, 23.5; HRMS (ESI, m/z): calcd. for $C_{13}H_{14}O_2H^+$ 203.1067, found 203.1066; IR (KBr thin film, cm^{-1}): ν 2861, 1713, 1647, 1457, 1423, 1321, 1278, 1156, 1065, 886, 758, 704.



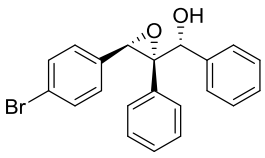
1o (*rac*-)

(2-methyl-3-phenyloxiran-2-yl)(phenyl)methanone (1o): Colourless liquid, 1.90 g, 59% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06–8.04 (m, 2H), 7.61–7.57 (m, 1H), 7.51–7.47 (m, 2H), 7.43–7.34 (m, 5H), 4.16 (s, 1H), 1.43 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 198.3, 134.4, 133.9, 133.6, 129.4, 128.7, 128.5, 128.4, 126.7, 66.6, 61.7, 14.5; HRMS (ESI, m/z): calcd. for $C_{16}H_{14}O_2H^+$ 239.1067, found 239.1069; IR (KBr thin film, cm^{-1}): ν 3003, 2929, 1687, 1599, 1585, 1500, 1451, 1281, 1184, 977, 755, 698.



2a

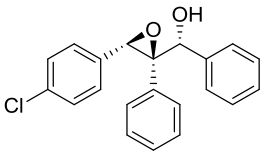
(*R*)-((2*R*,3*S*)-3-(4-bromophenyl)-2-phenyloxiran-2-yl)(phenyl)methanol (2a): Colourless liquid, 35.1 mg, 46% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.29–7.27 (m, 3H), 7.22–7.18 (m, 4H), 7.15–7.11 (m, 1H), 7.06–7.03 (m, 2H), 6.82–6.79 (m, 2H), 6.75–6.72 (m, 2H), 4.98 (s, 1H), 4.61 (s, 1H), 2.81 (d, *J* = 1.7 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.5, 133.9, 133.1, 130.9, 129.2, 128.5, 128.3, 128.0, 127.7, 127.6, 121.7, 76.3, 71.8, 60.0; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2BrNa^+$ 403.0304, found 403.0308; $[\alpha]_D^{25}$: 15.9 (c 0.7, $CHCl_3$); HPLC analysis: 90% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 18.4 min, R_t (minor) = 24.8 min; IR (KBr thin film, cm^{-1}): ν 3062, 3031, 2852, 1595, 1489, 1454, 1391, 1193, 1068, 1010, 757, 699.



3a

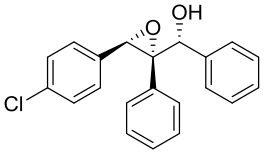
(*R*)-((2*S*,3*R*)-3-(4-bromophenyl)-2-phenyloxiran-2-yl)(phenyl)methanol (3a): White solid, mp 131–133 °C, 34.2 mg, 45% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.24–7.17 (m, 7H),

7.08–7.00 (m, 3H), 6.87–6.81 (m, 4H), 5.04 (d, *J* = 6.8 Hz, 1H), 4.62 (s, 1H), 2.38 (d, *J* = 6.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 139.6, 134.1, 133.3, 130.9, 128.7, 128.4, 128.3, 128.2, 127.7, 127.6, 127.0, 121.6, 76.3, 71.7, 61.0; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2BrNa^+$ 403.0304, found 403.0303; $[\alpha]_D^{25}$: +42.6 (c 0.8, $CHCl_3$); HPLC analysis: 98% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 39.2 min, R_t (minor) = 22.1 min; IR (KBr thin film, cm^{-1}): ν 3065, 2928, 2849, 1599, 1492, 1448, 1397, 1189, 1065, 1008, 765, 695.



2b

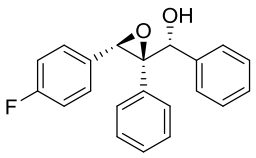
(*R*)-((2*R*,3*S*)-3-(4-chlorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanol (2b): Colourless liquid, 29.0 mg, 43% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31–7.27 (m, 3H), 7.23–7.19 (m, 2H), 7.16–7.11 (m, 1H), 7.08–7.03 (m, 4H), 6.90–6.86 (m, 2H), 6.77–6.74 (m, 2H), 4.99 (d, *J* = 0.9 Hz, 1H), 4.63 (s, 1H), 2.86 (d, *J* = 1.7 Hz, 1H); ^{13}C NMR (150 MHz, CDCl3) δ 138.6, 133.5, 133.4, 133.2, 129.2, 128.7, 128.5, 128.3, 128.02, 127.96, 127.6, 127.0, 76.3, 71.8, 60.0; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2ClNa^+$ 359.0809, found 359.0811; $[\alpha]_D^{25}$: –7.6 (c 0.8, $CHCl_3$); HPLC analysis: 90% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 11.4 min, R_t (minor) = 14.7 min; IR (KBr thin film, cm^{-1}): ν 3059, 2929, 2857, 1600, 1491, 1451, 1265, 1195, 1086, 1013, 766, 692.



3b

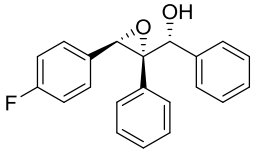
(*R*)-((2*S*,3*R*)-3-(4-chlorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanol (3b): White solid, mp 128–130 °C, 26.9 mg, 40% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.26–7.19 (m, 5H), 7.07–7.01 (m, 5H), 6.93–6.90 (m, 2H), 6.86–6.83 (m, 2H), 5.04 (s, 1H), 4.64 (s, 1H), 2.55 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 139.7, 133.6, 133.41, 133.37, 128.7, 128.4, 128.2, 127.99, 127.96, 127.7, 127.6, 127.0, 76.4, 71.8, 60.9; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2ClNa^+$ 359.0809, found 359.0810; $[\alpha]_D^{25}$: +26.5 (c 0.7, $CHCl_3$); HPLC analysis: 91% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 21.7 min, R_t

(minor) = 12.8 min; IR (KBr thin film, cm^{-1}): ν 3063, 2925, 2854, 1601, 1493, 1454, 1261, 1193, 1091, 1016, 763, 697.



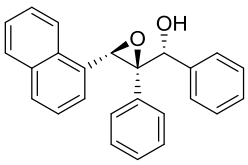
2c

(*R*)-((2*R*,3*S*)-3-(4-fluorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanol (2c): Colourless liquid, 28.5 mg, 44% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30–7.27 (m, 3H), 7.22–7.19 (m, 2H), 7.15–7.11 (m, 1H), 7.06–7.03 (m, 2H), 6.92–6.89 (m, 2H), 6.79–6.74 (m, 4H), 4.99 (s, 1H), 4.65 (s, 1H), 2.97 (d, *J* = 9.5 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 162.3 (d, *J* = 245.6 Hz), 138.7, 133.3, 130.6, 129.3, 128.5, 128.3, 128.0, 127.7, 127.6, 114.8 (d, *J* = 21.5 Hz), 76.3 (t, *J* = 6.9 Hz), 71.7, 60.1; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2FNa^+$ 343.1105, found 343.1107; $[\alpha]_D^{25}$: –8.2 (c 0.5, $CHCl_3$); HPLC analysis: 89% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 14.4 min, R_t (minor) = 17.8 min; IR (KBr thin film, cm^{-1}): ν 3055, 2925, 2869, 1605, 1497, 1452, 1268, 1199, 1085, 1007, 768, 687.



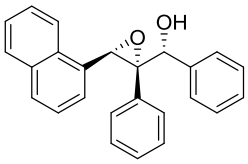
3c

(*R*)-((2*S*,3*R*)-3-(4-fluorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanol (3c): White solid, mp 85–87 °C, 28.8 mg, 45% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28–7.20 (m, 5H), 7.07–7.00 (m, 3H), 6.97–6.93 (m, 2H), 6.86–6.84 (m, 2H), 6.79–6.75 (m, 2H), 5.05 (d, *J* = 6.3 Hz, 1H), 4.65 (s, 1H), 2.43 (d, *J* = 6.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4 (d, *J* = 244.5 Hz), 139.9, 130.8 (d, *J* = 3.0 Hz), 129.4, 128.9, 128.5, 128.4, 128.3 (d, *J* = 2.4 Hz), 127.74, 127.66, 127.1, 114.9 (d, *J* = 21.6 Hz), 76.6, 71.7, 61.1; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2FNa^+$ 343.1105, found 343.1107; $[\alpha]_D^{25}$: +27.7 (c 0.3, $CHCl_3$); HPLC analysis: 91% *ee* (Chiralcel AD-H, 10:90 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 10.1 min, R_t (minor) = 7.2 min; IR (KBr thin film, cm^{-1}): ν 3057, 2929, 2861, 1602, 1499, 1456, 1269, 1194, 1088, 1011, 771, 684.



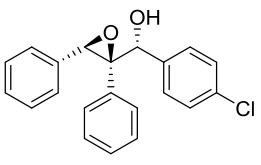
2d

(*R*)-((2*R*,3*S*)-3-(naphthalen-1-yl)-2-phenyloxiran-2-yl)(phenyl)methanol (2d): Yellow liquid, 38.9 mg, 55% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.5 Hz, 1H), 7.79–7.76 (m, 1H), 7.58 (d, *J* = 7.8 Hz, 1H), 7.52–7.44 (m, 2H), 7.38–7.32 (m, 5H), 7.14 (t, *J* = 7.6 Hz, 1H), 7.10–7.07 (m, 1H), 7.03–6.99 (m, 1H), 6.92 (t, *J* = 7.8 Hz, 2H), 6.81–6.79 (m, 2H), 5.20 (d, *J* = 2.0 Hz, 1H), 5.06 (s, 1H), 3.07 (d, *J* = 2.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.8, 133.8, 133.0, 130.9, 130.7, 128.8, 128.7, 128.5, 128.3, 127.8, 127.4, 126.2, 125.7, 125.2, 125.1, 124.0, 123.9, 122.8, 76.4, 71.9, 59.4; HRMS (ESI, m/z): calcd. for $C_{25}H_{20}O_2Na^+$ 375.1356, found 375.1354; $[\alpha]_D^{25}$: 79.1 (c 1.9, $CHCl_3$); HPLC analysis: 74% *ee* (Chiralcel AD-H, 10:90 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 8.5 min, R_t (minor) = 21.0 min; IR (KBr thin film, cm^{-1}): ν 2986, 1571, 1457, 1332, 1278, 1258, 1224, 1071, 937, 852, 775, 667.



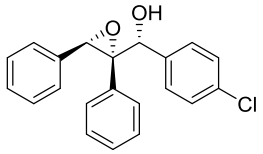
3d

(*R*)-((2*S*,3*R*)-3-(naphthalen-1-yl)-2-phenyloxiran-2-yl)(phenyl)methanol (3d): White solid, mp 86–87 °C, 25.9 mg, 37% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.15–8.13 (m, 1H), 7.78–7.76 (m, 1H), 7.58–7.54 (m, 2H), 7.49–7.45 (m, 1H), 7.34–7.25 (m, 5H), 7.17–7.13 (m, 2H), 6.92–6.84 (m, 5H), 5.31 (d, *J* = 6.8 Hz, 1H), 5.20 (s, 1H), 2.55 (d, *J* = 6.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 139.9, 134.1, 133.0, 130.9, 130.8, 128.8, 128.4, 128.3, 127.9, 127.6, 127.33, 127.26, 126.2, 125.7, 125.1, 123.9, 122.9, 76.2, 71.4, 60.1; HRMS (ESI, m/z): calcd. for $C_{25}H_{20}O_2Na^+$ 375.1356, found 375.1357; $[\alpha]_D^{25}$: +158.1 (c 0.6, $CHCl_3$); HPLC analysis: 65% *ee* (Chiralcel AD-H, 10:90 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 15.8 min, R_t (minor) = 10.0 min; IR (KBr thin film, cm^{-1}): ν 3040, 1539, 1525, 1508, 1460, 1338, 1275, 1090, 900, 838, 775, 707.



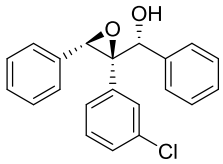
2e

(*R*)-(4-chlorophenyl)((2*R*,3*S*)-2,3-diphenyloxiran-2-yl)methanol (2e): Colourless liquid, 28.3 mg, 42% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.26–7.24 (m, 2H), 7.15–7.03 (m, 8H), 6.91 (dd, *J* = 7.5, 1.5 Hz, 2H), 6.76–6.74 (m, 2H), 4.97 (d, *J* = 1.4 Hz, 1H), 4.62 (s, 1H), 2.91 (d, *J* = 1.7 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 137.3, 134.5, 134.1, 133.1, 129.3, 128.9, 128.5, 128.0, 127.8, 127.6, 126.7, 75.8, 71.5, 60.4; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2ClNa^+$ 359.0809, found 359.0812; $[\alpha]_D^{25}$: –8.8 (c 0.5, $CHCl_3$); HPLC analysis: 83% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 19.1 min, R_t (minor) = 25.3 min; IR (KBr thin film, cm^{-1}): ν 3061, 2931, 2861, 1599, 1492, 1458, 1264, 1195, 1092, 1013, 765, 682.



3e

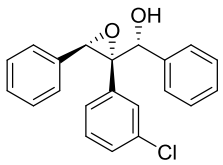
(*R*)-(4-chlorophenyl)((2*S*,3*R*)-2,3-diphenyloxiran-2-yl)methanol (3e): White semi-solid, 25.7 mg, 38% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.23–7.20 (m, 2H), 7.16–7.13 (m, 2H), 7.09–7.01 (m, 6H), 6.98–6.96 (m, 2H), 6.86–6.83 (m, 2H), 5.03 (d, *J* = 6.8 Hz, 1H), 4.64 (s, 1H), 2.50 (d, *J* = 6.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.3, 134.6, 133.9, 133.3, 128.7, 128.5, 128.4, 127.8, 127.70, 127.66, 127.6, 126.6, 75.9, 71.4, 61.7; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2ClNa^+$ 359.0809, found 359.0810; $[\alpha]_D^{25}$: +26.2 (c 0.5, $CHCl_3$); HPLC analysis: 98% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 37.5 min, R_t (minor) = 21.5 min; IR (KBr thin film, cm^{-1}): ν 3057, 2932, 2866, 1597, 1493, 1459, 1261, 1199, 1087, 1015, 759, 681.



2f

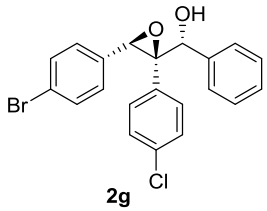
(*R*)-(3-chlorophenyl)((2*R*,3*S*)-2,3-diphenyloxiran-2-yl)methanol (2f): Colourless liquid, 29.1 mg, 43% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32–7.30 (m, 3H), 7.26–7.21 (m, 2H), 7.13–7.07 (m, 4H), 6.97–6.88 (m, 4H), 6.49 (d, *J* = 7.6 Hz, 1H), 4.96 (s, 1H), 4.68 (s, 1H), 2.87 (d, *J* = 6.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.3, 135.7, 134.2, 133.4, 129.2, 128.62, 128.59, 128.4, 128.0, 127.9, 127.8, 127.6, 127.4, 126.5, 76.2, 71.0, 60.6; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2ClNa^+$ 359.0809, found 359.0811; $[\alpha]_D^{25}$: –19.4 (c 2.1, $CHCl_3$); HPLC analysis: 80% *ee* (Chiralcel AD-H, 1.5:98.5 ^{i}PrOH/Hexane, 1 mL/min, 220

nm), R_t (major) = 25.3 min, R_t (minor) = 34.7 min; IR (KBr thin film, cm^{-1}): ν 3058, 3027, 2869, 1598, 1501, 1451, 1267, 1199, 1095, 1005, 765, 689.



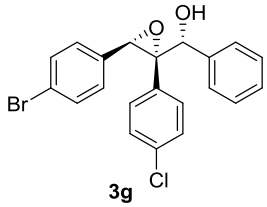
3f

(*R*)-(3-chlorophenyl)((2*S*,3*R*)-2,3-diphenyloxiran-2-yl)methanol (3f): White semi-solid, 25.6 mg, 38% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29–7.22 (m, 5H), 7.13–7.10 (m, 3H), 7.04–6.98 (m, 3H), 6.94–6.90 (m, 2H), 6.88 (d, *J* = 7.6 Hz, 1H), 5.04 (d, *J* = 6.5 Hz, 1H), 4.68 (s, 1H), 2.51 (d, *J* = 6.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.3, 135.7, 134.3, 133.3, 128.9, 128.6, 128.4, 128.3, 127.84, 127.75, 127.7, 126.9, 126.8, 126.4, 76.4, 71.1, 61.7; HRMS (ESI, m/z): calcd. for $C_{21}H_{17}O_2ClNa^+$ 359.0809, found 359.0808; $[\alpha]_D^{25}$: +19.0 (c 0.5, $CHCl_3$); HPLC analysis: 90% *ee* (Chiralcel AD-H, 1.5:98.5 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 51.0 min, R_t (minor) = 38.5 min; IR (KBr thin film, cm^{-1}): ν 3059, 2931, 2868, 1598, 1500, 1455, 1268, 1195, 1097, 1007, 766, 692.



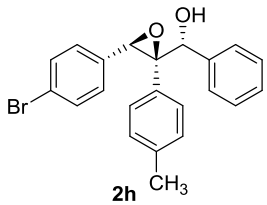
2g

(*R*)-((2*R*,3*S*)-3-(4-bromophenyl)-2-(4-chlorophenyl)oxiran-2-yl)(phenyl)methanol (2g): Colourless liquid, 37.5 mg, 45% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32–7.29 (m, 3H), 7.26–7.22 (m, 2H), 7.21–7.18 (m, 2H), 7.03 (d, *J* = 8.6 Hz, 2H), 6.83–6.80 (m, 2H), 6.69–6.66 (m, 2H), 4.94 (s, 1H), 4.63 (s, 1H), 2.74 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.1, 134.1, 134.0, 133.3, 131.1, 128.70, 128.65, 128.6, 128.4, 128.0, 127.9, 121.9, 75.8, 71.6, 61.1; HRMS (ESI, m/z): calcd. for $C_{21}H_{16}O_2ClBrNa^+$ 436.9914, found 436.9916; $[\alpha]_D^{25}$: –6.1 (c 0.5, $CHCl_3$); HPLC analysis: 87% *ee* (Chiralcel AD-H, 4:96 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 14.4 min, R_t (minor) = 23.0 min; IR (KBr thin film, cm^{-1}): ν 3063, 2935, 2866, 1601, 1493, 1449, 1270, 1197, 1089, 1009, 759, 681.



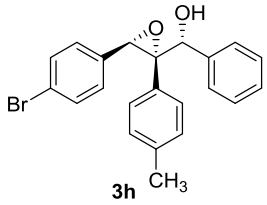
3g

(*R*)-((2*S*,3*R*)-3-(4-bromophenyl)-2-(4-chlorophenyl)oxiran-2-yl)(phenyl)methanol (3g): White solid, 123–126 °C, 24.9 mg, 30% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29–7.19 (m, 7H), 7.10–7.01 (m, 3H), 6.88–6.84 (m, 3H), 5.05 (d, *J* = 6.6 Hz, 1H), 4.63 (s, 1H), 2.40 (d, *J* = 6.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.6, 134.1, 133.3, 130.9, 128.6, 128.3, 128.22, 128.16, 127.64, 127.56, 127.0, 121.6, 76.3, 71.6, 60.9; HRMS (ESI, m/z): calcd. for $C_{21}H_{16}O_2ClBrNa^+$ 436.9914, found 436.9915; $[\alpha]_D^{25}$: +28.3 (c 0.6, $CHCl_3$); HPLC analysis: 93% *ee* (Chiralcel AD-H, 4:96 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 27.9 min, R_t (minor) = 17.6 min; IR (KBr thin film, cm^{-1}): ν 3066, 2929, 2863, 1603, 1495, 1451, 1268, 1199, 1093, 1015, 761, 683.



2h

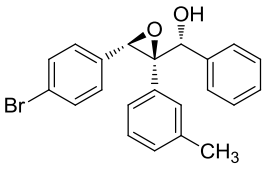
(*R*)-((2*R*,3*S*)-3-(4-bromophenyl)-2-(*p*-tolyl)oxiran-2-yl)(phenyl)methanol (2h): Colourless liquid, 32.5 mg, 41% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30–7.28 (m, 3H), 7.23–7.19 (m, 4H), 6.88–6.81 (m, 4H), 6.63 (d, *J* = 8.0 Hz, 2H), 4.97 (d, *J* = 1.1 Hz, 1H), 4.58 (s, 1H), 2.80 (d, *J* = 1.7 Hz, 1H), 2.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.6, 137.7, 134.0, 131.0, 130.9, 130.0, 129.0 128.37, 128.35, 128.2, 127.6, 121.6, 76.3, 71.6, 59.9, 21.2; HRMS (ESI, m/z): calcd. for $C_{22}H_{19}O_2BrNa^+$ 417.0461, found 417.0463; $[\alpha]_D^{25}$: –14.3 (c 0.5, $CHCl_3$); HPLC analysis: 88% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 19.1 min, R_t (minor) = 23.8 min; IR (KBr thin film, cm^{-1}): ν 3061, 2936, 2865, 1599, 1497, 1459, 1264, 1201, 1097, 1011, 761, 688.



3h

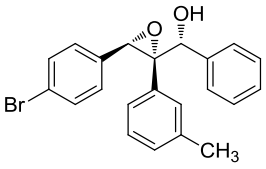
(*R*)-((2*S*,3*R*)-3-(4-bromophenyl)-2-(*p*-tolyl)oxiran-2-yl)(phenyl)methanol (3h): White solid, mp 114–116 °C, 31.7 mg, 40% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26–7.20 (m, 7H), 6.88–6.82 (m, 4H), 6.73 (d, *J* = 8.0 Hz, 2H), 5.02 (d, *J* = 6.7 Hz, 1H), 4.59 (s, 1H), 2.36 (d, *J* = 6.8 Hz, 1H), 2.19 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.7, 137.3, 134.2, 130.8, 130.1, 128.4, 128.29, 128.28, 128.25, 128.1, 127.0, 121.5, 76.4, 71.5, 60.9, 21.2; HRMS (ESI, m/z): calcd. for $C_{22}H_{19}O_2BrNa^+$ 417.0461, found 417.0463; $[\alpha]_D^{25}$: +28.6 (c 0.9, $CHCl_3$); HPLC

analysis: 97% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 32.6 min, R_t (minor) = 20.8 min; IR (KBr thin film, cm^{-1}): ν 3060, 2938, 2862, 1601, 1499, 1463, 1261, 1200, 1095, 1013, 763, 671.



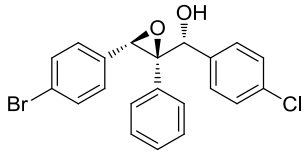
2i

(*R*)-((2*R*,3*S*)-3-(4-bromophenyl)-2-(*m*-tolyl)oxiran-2-yl)(phenyl)methanol (2i): Colourless liquid, 30.7 mg, 39% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29–7.20 (m, 7H), 6.96–6.88 (m, 2H), 6.82 (d, *J* = 7.5 Hz, 2H), 6.66 (s, 1H), 6.42 (d, *J* = 7.2 Hz, 1H), 4.98 (s, 1H), 4.57 (s, 1H), 2.79 (s, 1H), 2.15 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.5, 137.2, 133.9, 132.9, 130.8, 129.7, 128.7, 128.4, 128.3, 128.1, 127.6, 127.3, 126.2, 121.6, 76.2, 71.7, 59.9, 21.2; HRMS (ESI, m/z): calcd. for $C_{22}H_{19}O_2BrNa^+$ 417.0461, found 417.0464; $[\alpha]_D^{25}$: –31.0 (c 0.5, $CHCl_3$); HPLC analysis: 92% *ee* (Chiralcel AD-H, 1:99 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 41.7 min, R_t (minor) = 49.0 min; IR (KBr thin film, cm^{-1}): ν 3059, 2931, 2861, 1600, 1496, 1460, 1263, 1201, 1098, 1009, 799, 705.



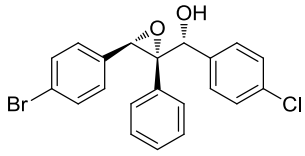
3i

(*R*)-((2*S*,3*R*)-3-(4-bromophenyl)-2-(*m*-tolyl)oxiran-2-yl)(phenyl)methanol (3i): White solid, mp 110–112 °C, 29.9 mg, 38% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27–7.20 (m, 7H), 6.93–6.85 (m, 4H), 6.69 (s, 1H), 6.61 (d, *J* = 6.7 Hz, 1H), 5.03 (d, *J* = 6.3 Hz, 1H), 4.58 (s, 1H), 2.40 (d, *J* = 6.6 Hz, 1H), 2.13 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.6, 137.1, 134.1, 133.1, 130.8, 129.2, 128.4, 128.24, 128.17, 128.1, 127.3, 126.9, 125.6, 121.5, 76.4, 71.6, 60.9, 21.2; HRMS (ESI, m/z): calcd. for $C_{22}H_{19}O_2BrNa^+$ 417.0460, found 417.0463; $[\alpha]_D^{25}$: +35.9 (c 0.6, $CHCl_3$); HPLC analysis: 90% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 26.9 min, R_t (minor) = 18.0 min; IR (KBr thin film, cm^{-1}): ν 3057, 2927, 2866, 1602, 1498, 1466, 1260, 1205, 1099, 1007, 793, 700.



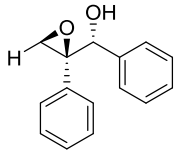
2j

(*R*)-((2*R*,3*S*)-3-(4-bromophenyl)-2-phenyloxiran-2-yl)(4-chlorophenyl)methanol (2j): Colourless liquid, 46.0 mg, 55% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.27–7.23 (m, 2H), 7.22–7.19 (m, 2H), 7.17–7.05 (m, 5H), 6.80–6.72 (m, 4H), 4.96 (d, *J* = 1.6 Hz, 1H), 4.55 (s, 1H), 2.82 (d, *J* = 1.9 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 137.1, 134.2, 133.7, 132.7, 131.0, 129.2, 128.9, 128.5, 128.3, 128.2, 127.8, 121.9, 75.7, 71.6, 59.9; HRMS (ESI, m/z): calcd. for $C_{21}H_{16}O_2ClBrNa^+$ 436.9914, found 436.9916; $[\alpha]_D^{25}$: –10.5 (c 0.5, $CHCl_3$); HPLC analysis: 54% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 22.5 min, R_t (minor) = 27.2 min; IR (KBr thin film, cm^{-1}): ν 3064, 2928, 2859, 1602, 1488, 1451, 1268, 1198, 1087, 1011, 767, 687.



3j

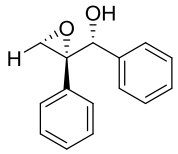
(*R*)-((2*S*,3*R*)-3-(4-bromophenyl)-2-phenyloxiran-2-yl)(4-chlorophenyl)methanol (3j): White solid, mp 122–124 °C, 30.0 mg, 36% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27–7.20 (m, 4H), 7.14 (d, *J* = 8.4 Hz, 2H), 7.10–7.03 (m, 3H), 6.88–6.84 (m, 4H), 5.04 (d, *J* = 6.8 Hz, 1H), 4.61 (s, 1H), 2.42 (d, *J* = 6.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.1, 133.9, 133.8, 133.1, 130.9, 128.50, 128.45, 128.4, 128.2, 127.8, 127.7, 121.7, 75.6, 71.4, 60.9; HRMS (ESI, m/z): calcd. for $C_{21}H_{16}O_2ClBrNa^+$ 436.9914, found 436.9918; $[\alpha]_D^{25}$: +36.4 (c 0.6, $CHCl_3$); HPLC analysis: 98% *ee* (Chiralcel AD-H, 3:97 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 41.8 min, R_t (minor) = 21.9 min; IR (KBr thin film, cm^{-1}): ν 3061, 2926, 2857, 1601, 1489, 1455, 1263, 1197, 1086, 1009, 766, 689.



2k

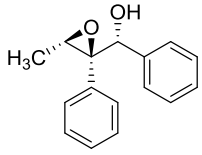
(*R*)-phenyl((*S*)-2-phenyloxiran-2-yl)methanol (2k): Colourless liquid, 19.9 mg, 44% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28–7.21 (m, 6H), 7.19–7.16 (m, 2H), 7.14–7.11 (m, 2H),

5.04 (d, *J* = 0.9 Hz, 1H), 3.39 (dd, *J* = 5.1, 0.5 Hz, 1H), 2.94 (dd, *J* = 5.1, 0.5 Hz, 1H), 2.74 (d, 1.7 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 138.9, 136.8, 128.33, 128.27, 128.14, 128.08, 127.5, 74.5, 64.3, 50.3; HRMS (ESI, m/z): calcd. for $C_{15}H_{14}O_2Na^+$ 249.0886, found 249.0888; $[\alpha]_D^{25}$: +71.5 (c 0.6, $CHCl_3$); HPLC analysis: 85% *ee* (Chiralcel AD-H, 5:95 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 15.5 min, R_t (minor) = 11.0 min; IR (KBr thin film, cm^{-1}): ν 2983, 1559, 1548, 1479, 1465, 1275, 1267, 1048, 1028, 906, 778, 673.



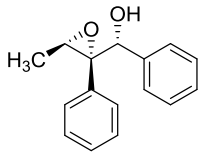
3k

(*R*)-phenyl((*R*)-2-phenyloxiran-2-yl)methanol (3k): Yellow liquid, 20.8 mg, 46% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28–7.22 (m, 5H), 7.22–7.15 (m, 5H), 5.06 (d, *J* = 7.1 Hz, 1H), 3.41 (d, *J* = 5.5 Hz, 1H), 2.80 (d, *J* = 5.5 Hz, 1H), 2.34 (d, *J* = 7.1 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 139.9, 137.0, 128.4, 128.1, 128.0, 127.8, 127.3, 127.2, 75.0, 63.5, 52.4; HRMS (ESI, m/z): calcd. for $C_{15}H_{14}O_2Na^+$ 249.0087, found 249.0088; $[\alpha]_D^{25}$: +18.0 (c 1.5, $CHCl_3$); HPLC analysis: 85% *ee* (Chiralcel AD-H, 1:99 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 27.3 min, R_t (minor) = 37.0 min; IR (KBr thin film, cm^{-1}): ν 3037, 1687, 1601, 1582, 1510, 1446, 1275, 1187, 1031, 838, 775, 698.



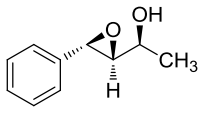
2l

(*R*)-((2*R*,3*S*)-3-methyl-2-phenyloxiran-2-yl)(phenyl)methanol (2l): White solid, mp 84–85 °C, 17.3 mg, 36% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30–7.25 (m, 3H), 7.25–7.19 (m, 3H), 7.18–7.15 (m, 2H), 6.98–6.96 (m, 2H), 4.86 (s, 1H), 3.63 (q, *J* = 5.5 Hz, 1H), 2.71 (d, *J* = 1.1 Hz, 1H), 1.03 (d, *J* = 5.5 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 139.1, 135.1, 128.4, 128.3, 128.2, 127.91, 127.88, 127.8, 76.2, 68.7, 56.4, 15.0; HRMS (ESI, m/z): calcd. for $C_{16}H_{16}O_2Na^+$ 263.1043, found 263.1040; $[\alpha]_D^{25}$: +27.8 (c 0.3, $CHCl_3$); HPLC analysis: 80% *ee* (Chiralcel AD-H, 5:95 ^{i}PrOH/Hexane, 1 mL/min, 254 nm), R_t (major) = 7.4 min, R_t (minor) = 8.7 min; IR (KBr thin film, cm^{-1}): ν 2991, 1539, 1454, 1414, 1315, 1283, 1264, 1133, 920, 897, 767, 676.



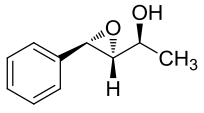
3l

(*R*)-((2*S*,3*R*)-3-methyl-2-phenyloxiran-2-yl)(phenyl)methanol (3l): White solid, mp 141–142 °C, 17.3 mg, 36% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.24–7.15 (m, 8H), 7.04–7.01 (m, 2H), 4.94 (d, *J* = 6.9 Hz, 1H), 3.68 (q, *J* = 5.5 Hz, 1H), 2.37 (d, *J* = 6.9 Hz, 1H), 1.00 (d, *J* = 5.5 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 140.2, 135.1, 128.2, 128.0, 127.9, 127.8, 127.6, 127.0, 76.1, 68.6, 57.3, 14.7; HRMS (ESI, m/z): calcd. for $C_{16}H_{16}O_2Na^+$ 263.1043, found 263.1044; $[\alpha]_D^{25}$: 12.4 (c 0.6, $CHCl_3$); HPLC analysis: 86% *ee* (Chiralcel AD-H, 0.5:99.5 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 38.4 min, R_t (minor) = 28.9 min; IR (KBr thin film, cm^{-1}): ν 2988, 1556, 1454, 1414, 1280, 1263, 1230, 1130, 1016, 894, 769, 678.



2m

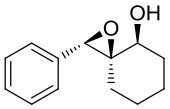
(*R*)-1-((2*R*,3*S*)-3-phenyloxiran-2-yl)ethan-1-ol (2m): Colourless liquid, 14.1 mg, 43% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36–7.26 (m, 5H), 4.12–4.08 (m, 1H), 3.94 (d, *J* = 2.2 Hz, 1H), 3.08 (dd, *J* = 2.8, 2.3 Hz, 1H), 2.17 (s, 1H), 1,31 (d, *J* = 6.5 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 137.0, 128.6, 128.4, 125.8, 65.7, 64.9, 54.8, 18.8; HRMS (ESI, m/z): calcd. for $C_{10}H_{12}O_2Na^+$ 187.0730, found 187.0729; $[\alpha]_D^{25}$: 7.4 (c 1.8, $CHCl_3$); HPLC analysis: 89% *ee* (Chiralcel AD-H, 10:90 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 5.1 min, R_t (minor) = 4.2 min; IR (KBr thin film, cm^{-1}): ν 2988, 1571, 1542, 1466, 1335, 1281, 1261, 1150, 1031, 951, 778, 681.



3m

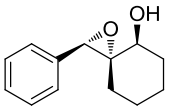
(*R*)-1-((2*S*,3*R*)-3-phenyloxiran-2-yl)ethan-1-ol (3m): Colourless liquid, 17.4 mg, 53% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36–7.33 (m, 2H), 7.32–7.29 (m, 1H), 7.29–7.25 (m, 2H), 3.86 (d, *J* = 2.1 Hz, 1H), 3.04 (dd, *J* = 4.6, 2.2 Hz, 1H), 1.96 (d, *J* = 6.0 Hz, 1H), 1.35 (d, *J* = 6.5 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 136.8, 128.6, 128.4, 125.8, 67.3, 66.4, 56.7, 20.2; HRMS (ESI, m/z): calcd. for $C_{10}H_{12}O_2Na^+$ 187.0730, found 187.0729; $[\alpha]_D^{25}$: +10.8 (c 0.3, $CHCl_3$); HPLC analysis: 56% *ee* (Chiralcel AD-H, 5:95 ^{i}PrOH/Hexane, 1 mL/min, 220

nm), R_t (major) = 11.9 min, R_t (minor) = 7.1 min; IR (KBr thin film, cm^{-1}): ν 2994, 1542, 1463, 1375, 1340, 1284, 1218, 1090, 1014, 900, 772, 701.



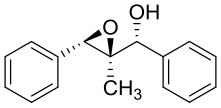
2n

(2*S*,3*R*,4*R*)-2-phenyl-1-oxaspiro[2.5]octan-4-ol (2n): Yellow solid, mp 102–103 °C, 18.8 mg, 46% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36–7.25 (m, 5H), 4.34 (s, 1H), 3.88 (ddd, *J* = 10.9, 4.3, 1.6 Hz, 1H), 2.24–2.14 (m, 2H), 1.77–1.73 (m, 1H), 1.64–1.62 (m, 1H), 1.54–1.46 (m, 2H), 1.41–1.33 (m, 2H), 1.05–0.96 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 135.8, 128.1, 127.4, 126.3, 70.6, 68.5, 58.8, 33.3, 27.1, 24.6, 23.9; HRMS (ESI, m/z): calcd. for $C_{13}H_{16}O_2Na^+$ 227.1043, found 227.1042; $[\alpha]_D^{25}$: +12.5 (c 0.8, $CHCl_3$); HPLC analysis: >99% *ee* (Chiralcel AD-H, 0.5:99.5 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 13.9 min, R_t (minor) = 17.4 min; IR (KBr thin film, cm^{-1}): ν 2983, 1539, 1463, 1420, 1278, 1264, 1221, 1019, 931, 897, 772, 693.



3n

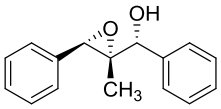
(2*R*,3*S*,4*R*)-2-phenyl-1-oxaspiro[2.5]octan-4-ol (3n): White solid, mp 64–65 °C, 20.7 mg, 51% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.35–7.32 (m, 2H), 7.29–7.26 (m, 3H), 4.30 (s, 1H), 3.73 (td, *J* = 9.1, 4.2 Hz, 1H), 2.01–1.95 (m, 1H), 1.78 (d, *J* = 8.9 Hz, 1H), 1.79–1.75 (m, 1H), 1.64–1.59 (m, 1H), 1.56–1.52 (m, 1H), 1.52–1.43 (m, 2H), 1.42–1.34 (m, 1H), 1.25–1.19 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 135.7, 128.1, 127.5, 126.4, 70.3, 67.2, 60.7, 33.9, 26.1, 23.6, 23.0; HRMS (ESI, m/z): calcd. for $C_{13}H_{16}O_2Na^+$ 227.1043, found 227.1044; $[\alpha]_D^{25}$: +8.2 (c 1.1, $CHCl_3$); HPLC analysis: 96% *ee* (Chiralcel AD-H, 0.5:99.5 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 29.5 min, R_t (minor) = 12.0 min; IR (KBr thin film, cm^{-1}): ν 2929, 1539, 1463, 1420, 1278, 1264, 1221, 1019, 931, 897, 772, 693.



2o

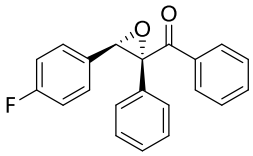
(*R*)-((2*R*,3*S*)-2-methyl-3-phenyloxiran-2-yl)(phenyl)methanol (2o): Colourless liquid, 17.3 mg, 36% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.47–7.45 (m, 2H), 7.41–7.38 (m, 2H), 7.35–

7.31 (m, 3H), 7.28–7.24 (m, 3H), 4.83 (s, 1H), 4.51 (s, 1H), 2.74 (s, 1H), 0.98 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 139.6, 135.4, 128.7, 128.5, 128.2, 127.7, 127.4, 126.4, 75.4, 66.1, 59.7, 13.7; HRMS (ESI, m/z): calcd. for $C_{16}H_{16}O_2Na^+$ 263.1043, found 263.1045; $[\alpha]_D^{25}$: 2.6 (c 1.2, $CHCl_3$); HPLC analysis: 58% *ee* (Chiralcel AD-H, 10:90 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 6.5 min, R_t (minor) = 4.8 min; IR (KBr thin film, cm^{-1}): ν 2934, 1553, 1454, 1412, 1340, 1280, 1261, 1093, 980, 852, 775, 687.



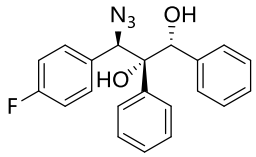
3o

(*R*)-((2*S*,3*R*)-2-methyl-3-phenyloxiran-2-yl)(phenyl)methanol (3o): White solid, mp 97–98 °C, 25.0 mg, 52% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.48–7.43 (m, 2H), 7.41–7.26 (m, 8H), 4.66 (s, 1H), 4.36 (s, 1H), 2.54 (s, 1H), 0.92 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 140.3, 135.4, 128.7, 128.3, 128.1, 127.8, 126.6, 126.5, 77.3, 66.5, 61.7, 11.9; HRMS (ESI, m/z): calcd. for $C_{16}H_{16}O_2Na^+$ 263.1043, found 263.1042; $[\alpha]_D^{25}$: +23.5 (c 0.8, $CHCl_3$); HPLC analysis: 34% *ee* (Chiralcel AD-H, 10:90 ^{i}PrOH/Hexane, 1 mL/min, 220 nm), R_t (major) = 6.4 min, R_t (minor) = 5.4 min; IR (KBr thin film, cm^{-1}): ν 2858, 1562, 1451, 1402, 1340, 1287, 1224, 1059, 928, 852, 772, 693.



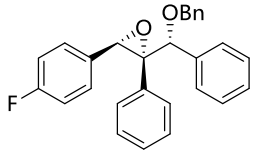
4a

((2*R*,3*R*)-3-(4-fluorophenyl)-2-phenyloxiran-2-yl)(phenyl)methanone (4a): White solid, mp 93–94 °C, 15.3 mg, 96% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.14–8.12 (m, 2H), 7.57–7.53 (m, 1H), 7.46–7.42 (m, 4H), 7.23–7.13 (m, 5H), 6.88–6.84 (m, 2H), 4.49 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 195.2, 162.6 (d, *J* = 245.4 Hz), 134.1, 133.9, 131.8, 130.0, 129.2 (d, *J* = 2.5 Hz), 128.7, 128.54, 128.48, 128.3, 127.6, 115.1 (d, *J* = 21.7 Hz), 71.3, 62.6; HRMS (ESI, m/z): calcd. for $C_{21}H_{15}O_2FH^+$ 319.1129, found 319.1132; $[\alpha]_D^{25}$: 25.0 (c 0.9, $CHCl_3$); HPLC analysis: 91% *ee* (Chiralcel AD-H, 5:95 ^{i}PrOH/Hexane, 1 mL/min), R_t (major) = 5.3 min, R_t (minor) = 4.8 min; IR (KBr thin film, cm^{-1}): ν 3037, 1687, 1601, 1582, 1510, 1446, 1275, 1187, 1031, 838, 775, 698.



4b

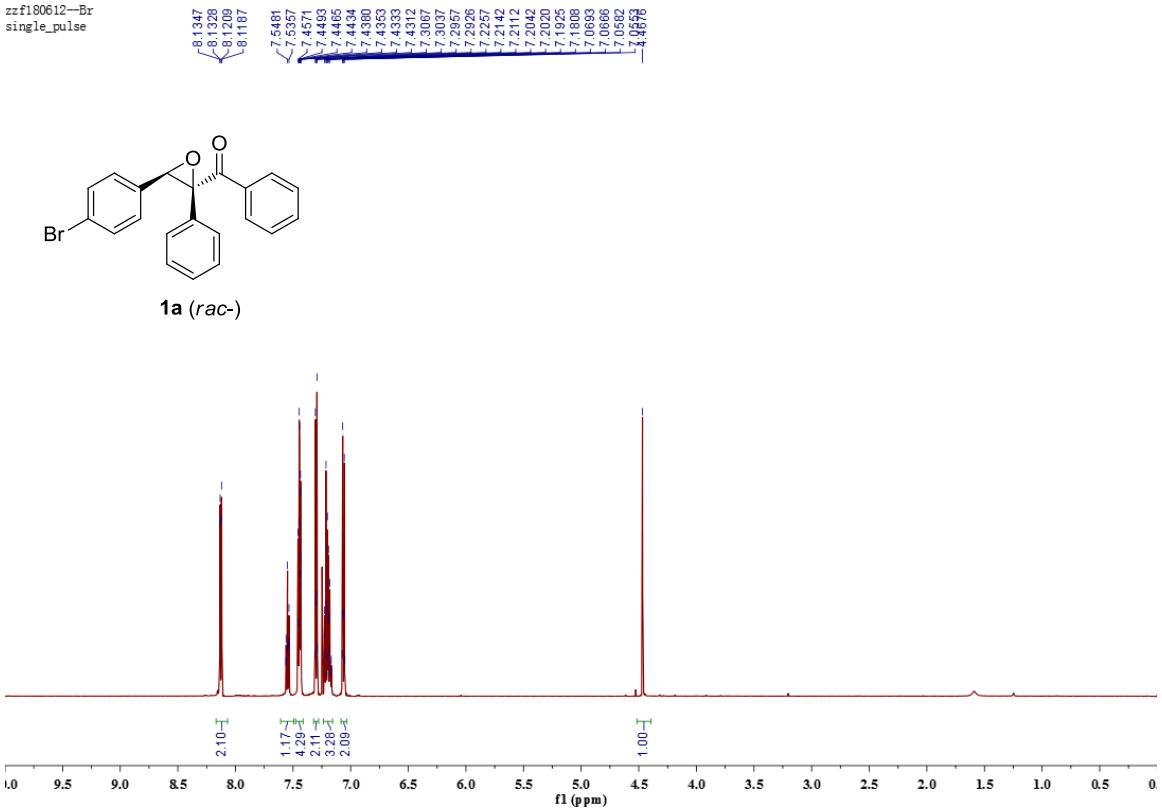
(1*R*,2*R*,3*R*)-3-azido-3-(4-fluorophenyl)-1,2-diphenylpropane-1,2-diol (4b): White solid, mp 78–79 °C, 10.7 mg, 98% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.16–7.09 (m, 10H), 6.91–6.88 (m, 2H), 6.85–6.82 (m, 2H), 5.53 (d, *J* = 3.2 Hz, 1H), 5.28 (s, 1H), 2.70 (s, 1H), 2.64 (d, *J* = 3.3 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 162.6 (d, *J* = 245.3 Hz), 139.1, 138.2, 131.3 (d, *J* = 2.4 Hz), 130.9, 130.8, 128.14, 128.07, 128.0, 127.4, 126.8 (d, *J* = 7.6 Hz), 114.7 (d, *J* = 21.3 Hz), 80.1, 76.0, 69.7; HRMS (ESI, m/z): calcd. for $C_{21}H_{18}O_2N_3Na^+$ 386.1277, found 386.1279; $[\alpha]_D^{25}$: 27.4 (c 1.1, $CHCl_3$); HPLC analysis: 91% *ee* (Chiralcel AD-H, 15:85 ^{i}PrOH/Hexane, 1 mL/min), R_t (major) = 6.6 min, R_t (minor) = 4.8 min; IR (KBr thin film, cm^{-1}): ν 2108, 1556, 1508, 1409, 1340, 1278, 1258, 1221, 1090, 772, 704, 678.

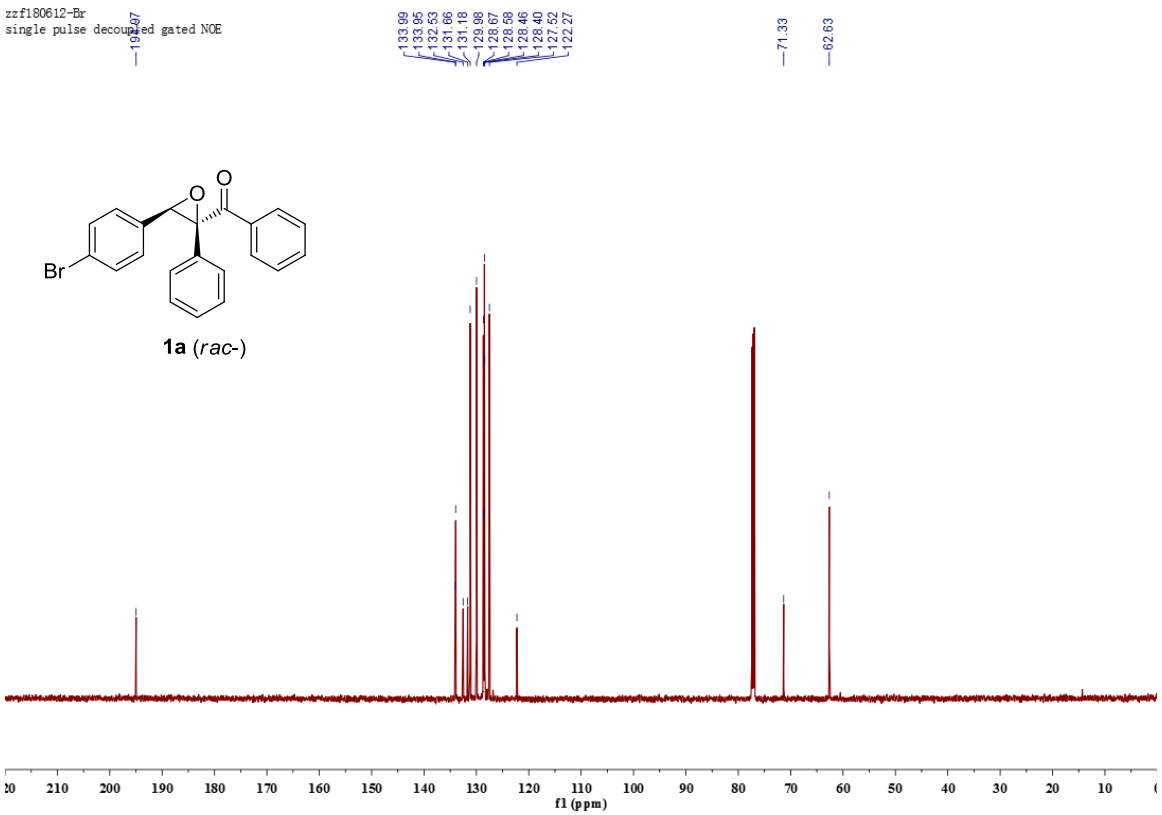


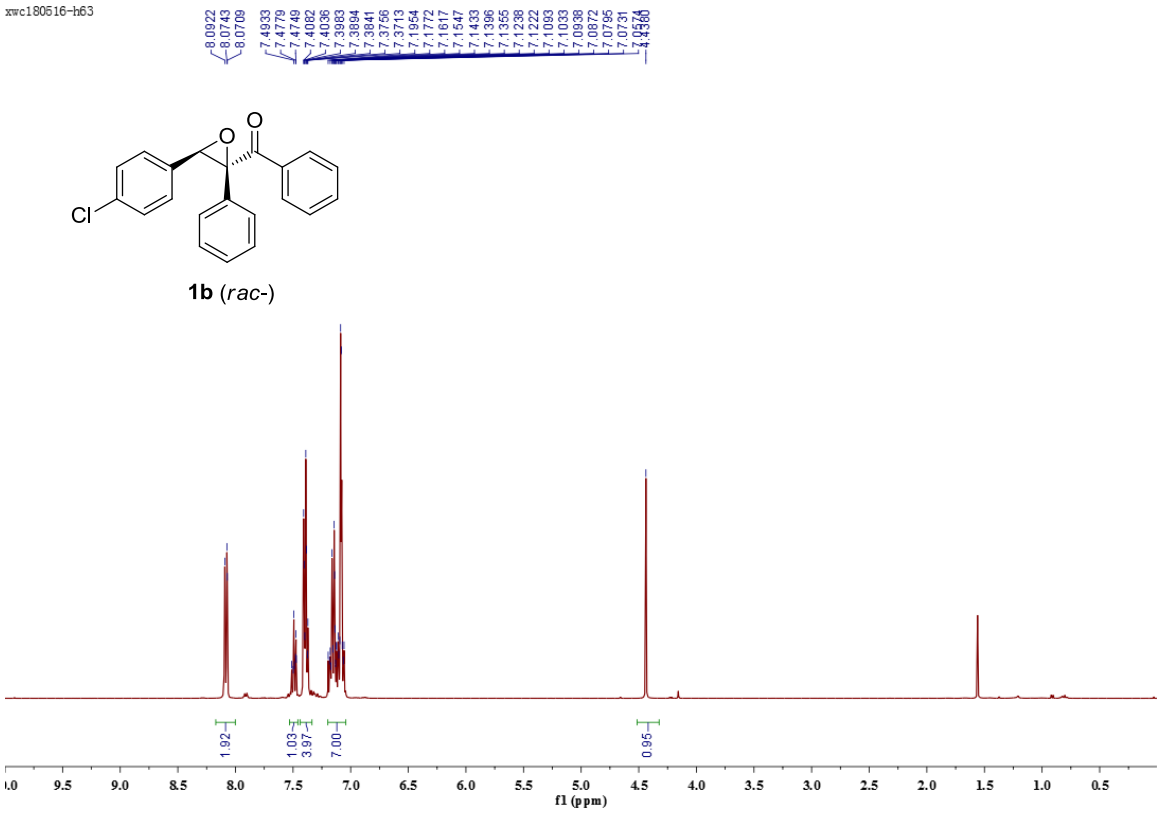
4c

(2*R*,3*R*)-2-((*R*)-(benzyloxy)(phenyl)methyl)-3-(4-fluorophenyl)-2-phenyloxirane (4c): White solid, mp 94–95 °C, 18.0 mg, 88% yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.37–7.28 (m, 8H), 7.24–7.22 (m, 2H), 7.11–7.08 (m, 1H), 7.06–7.03 (m, 2H), 6.91–6.85 (m, 4H), 6.76–6.72 (m, 2H), 4.74 (s, 1H), 4.64 (d, *J* = 12.1 Hz, 1H), 4.57 (s, 1H), 4.68 (d, *J* = 12.1 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) 162.2 (d, *J* = 244.2 Hz), 138.2, 137.3, 134.2, 131.0 (d, *J* = 2.4 Hz), 129.1, 128.5, 128.3, 128.2, 128.1, 128.0, 127.7, 127.6, 127.5, 127.4, 114.7 (d, *J* = 21.5 Hz), 83.3, 71.1, 71.0, 60.7; HRMS (ESI, m/z): calcd. for $C_{28}H_{23}FO_2H^+$ 411.1755, found 411.1756; $[\alpha]_D^{25}$: +11.4 (c 2.9, $CHCl_3$); HPLC analysis: 96% *ee* (Chiralcel AD-H, 1:99 ^{i}PrOH/Hexane, 1 mL/min), R_t (major) = 17.3 min, R_t (minor) = 5.9 min; IR (KBr thin film, cm^{-1}): ν 1618, 1565, 1537, 1451, 1394, 1335, 1281, 1264, 1099, 1025, 778, 690.

VII. ^{1}H NMR and ^{13}C NMR spectra of new compounds



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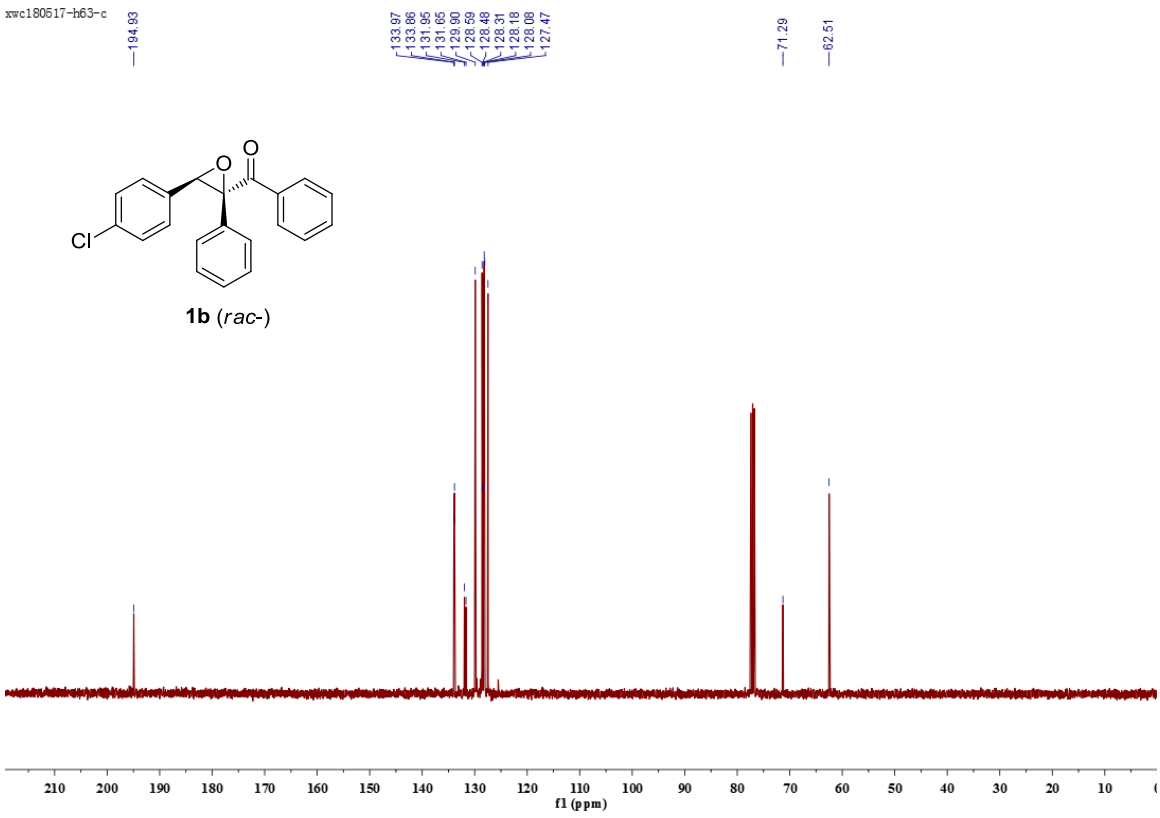
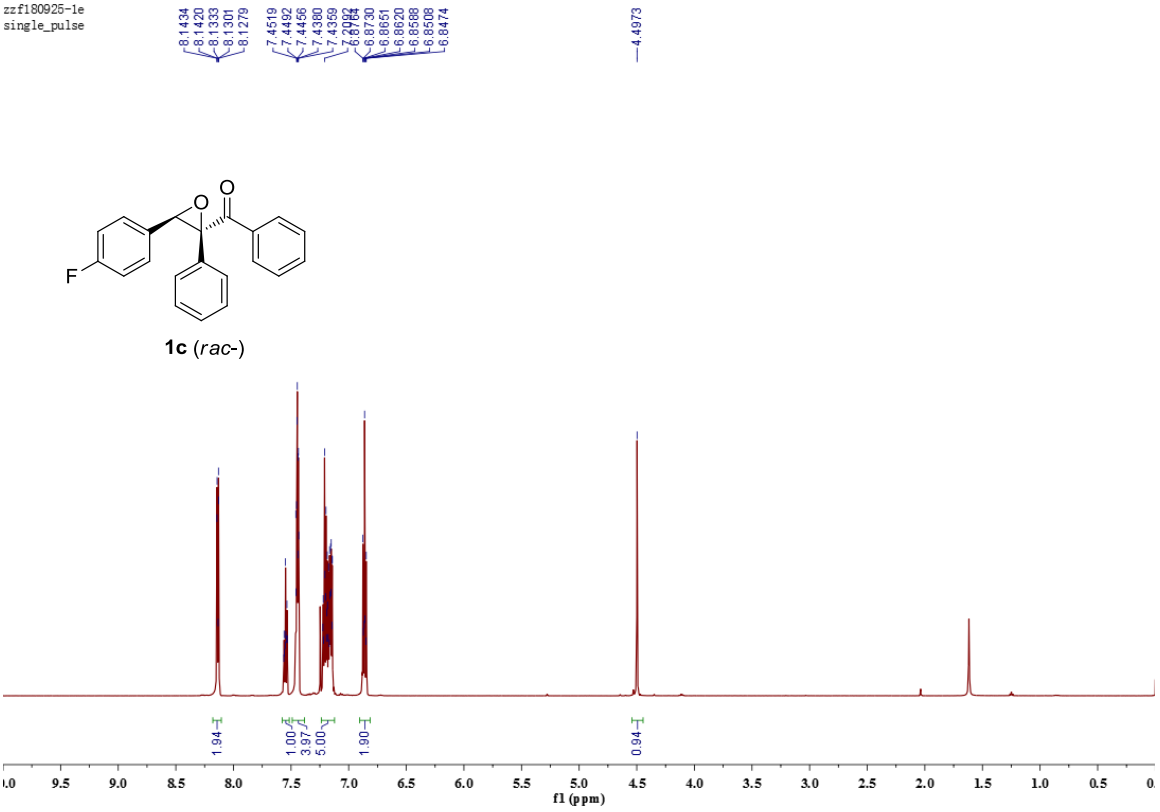
8.0743
8.0709
7.4933
7.4779
7.4749
7.4082
7.4036
7.3983
7.3894
7.3841
7.3756
7.3713
7.1954
7.1772
7.1617
7.1547
7.1433
7.1386
7.1355
7.1238
7.1222
7.1093
7.1033
7.0938
7.0872
7.0795
7.0731
4.4380
Cl
O
O
1b (rac-)
1.92
1.03
3.97
7.00
0.95
f1 (ppm)


xwc180517-h63-c
194.93
133.97
133.86
131.95
131.65
129.90
128.59
128.48
128.31
128.18
128.08
127.47
71.29
62.51
Cl
O
O
1b (rac-)
f1 (ppm)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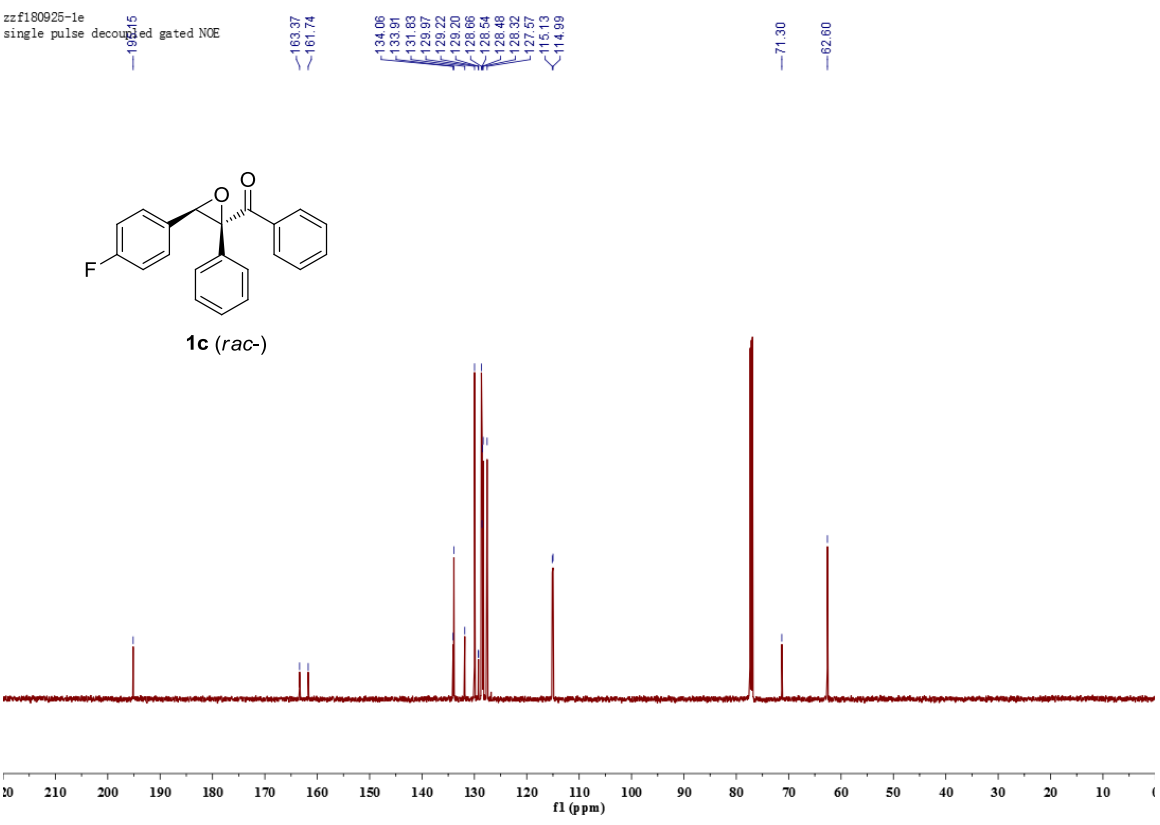
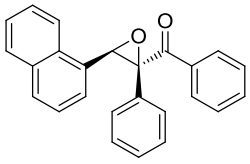
single_pulse
8.1434
8.1420
8.1333
8.1301
8.1279
7.4519
7.4492
7.4456
7.4380
7.4359
6.8784
6.8730
6.8651
6.8620
6.8588
6.8508
6.8474
4.4973
F
O
O
1.94
1.00
3.97
5.00
1.90
0.94
f1 (ppm)

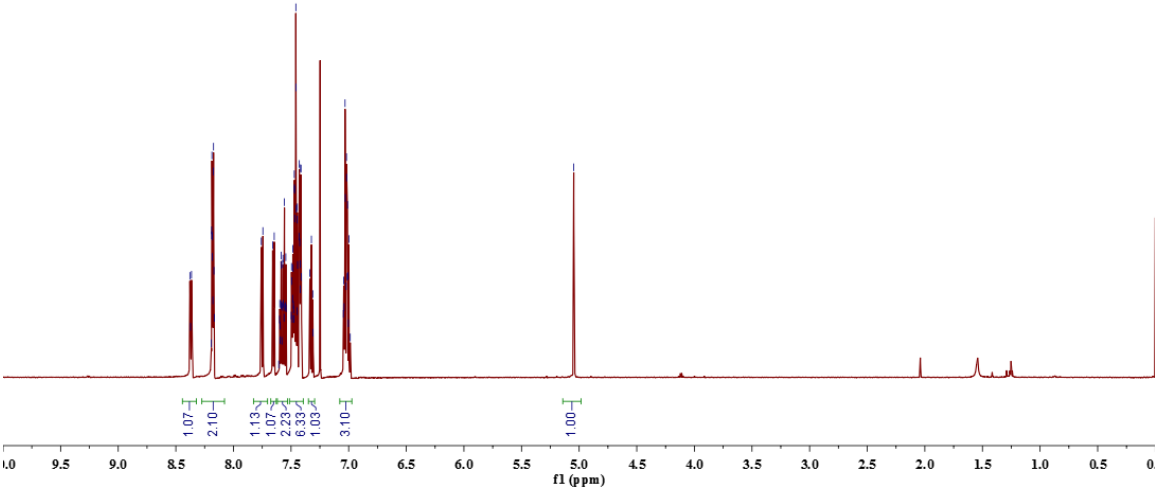
1c (*rac*-)


zzf180925-1e
single pulse decoupled gated NOE
163.37
161.74
134.06
133.91
131.83
129.97
129.22
129.20
128.66
128.54
128.48
128.32
127.57
115.13
114.99
71.30
62.60
F
O
O
f1 (ppm)

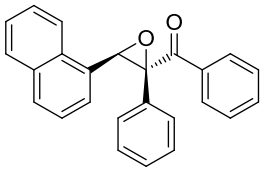
1c (*rac*-)



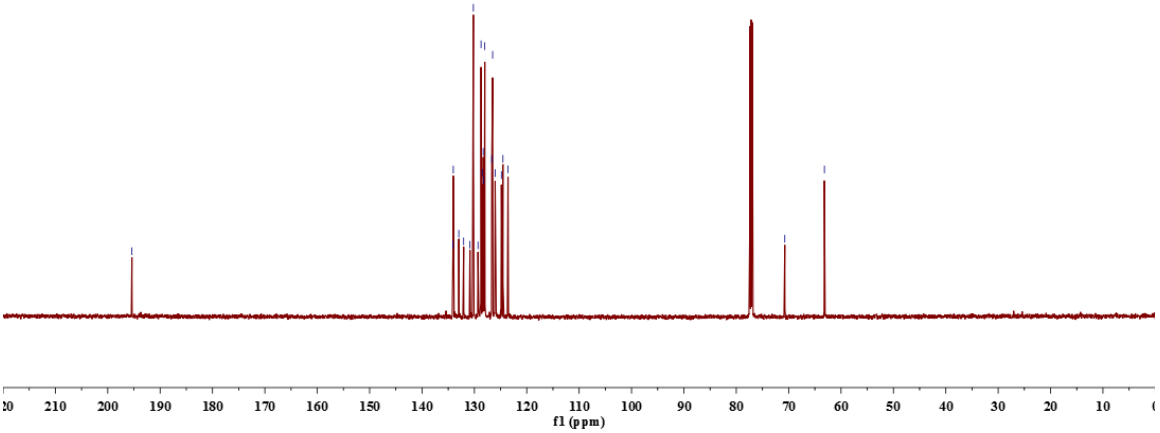
1d (*rac*-)

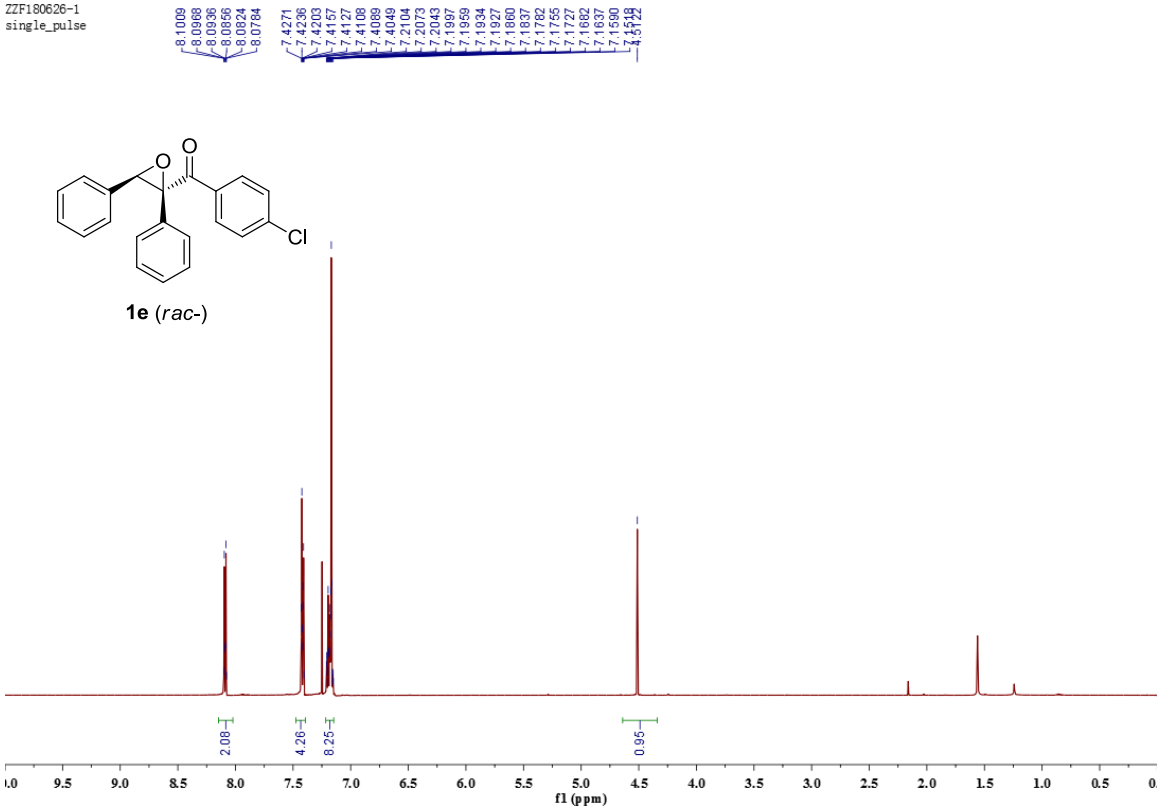

1.07
2.10
1.13
1.07
2.23
6.33
1.03
3.10
1.00
f1 (ppm)


zzf181012-3
single pulse decoupled gated NOE

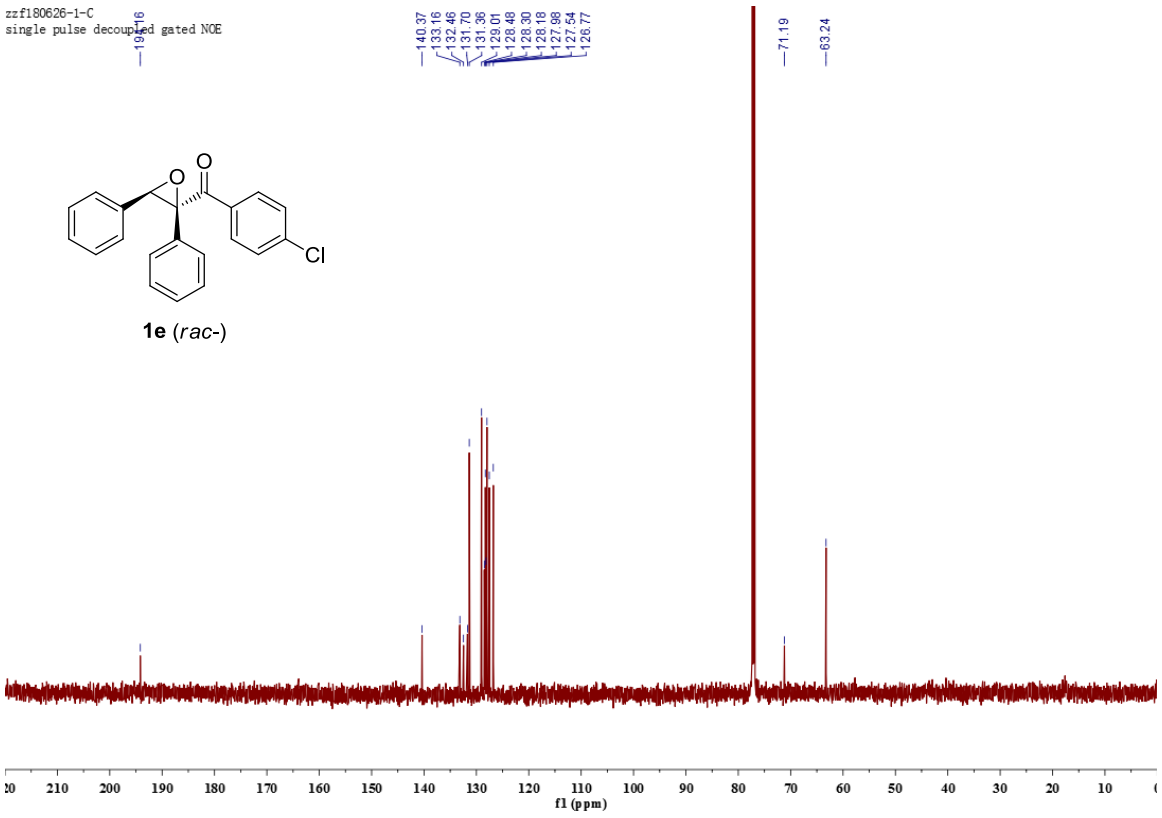


1d (*rac*-)

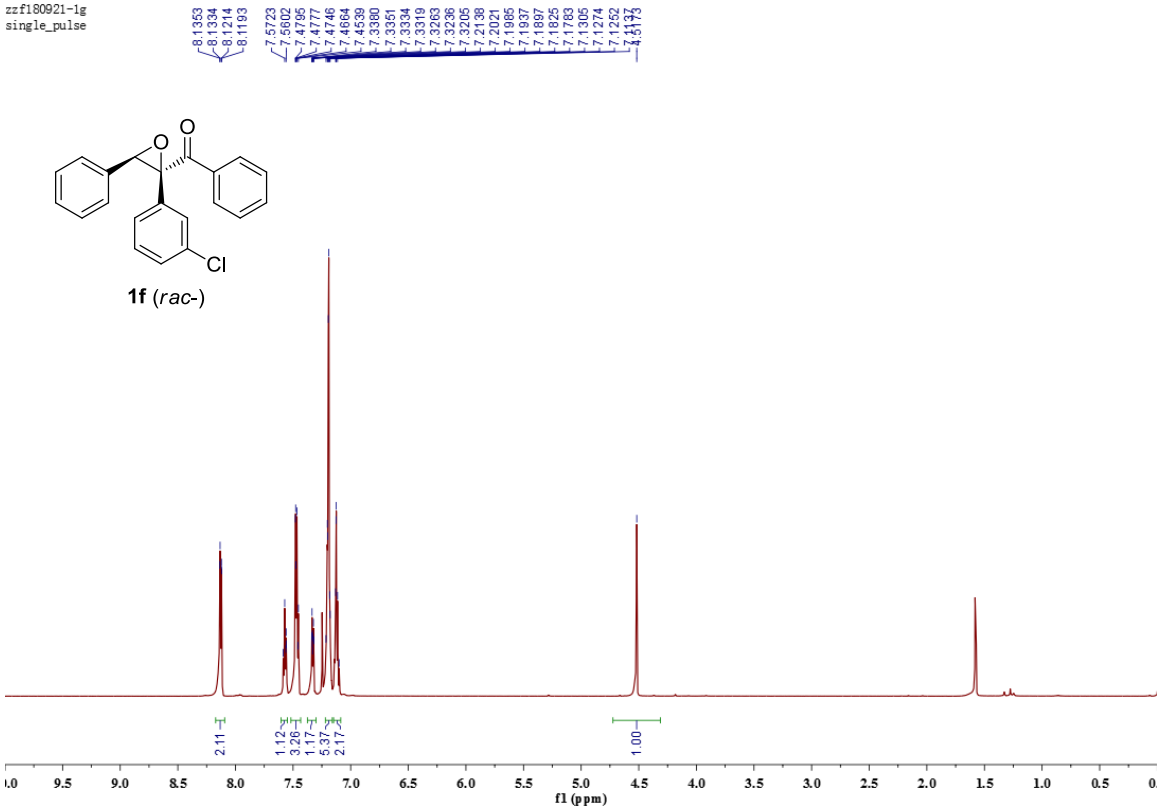

f1 (ppm)

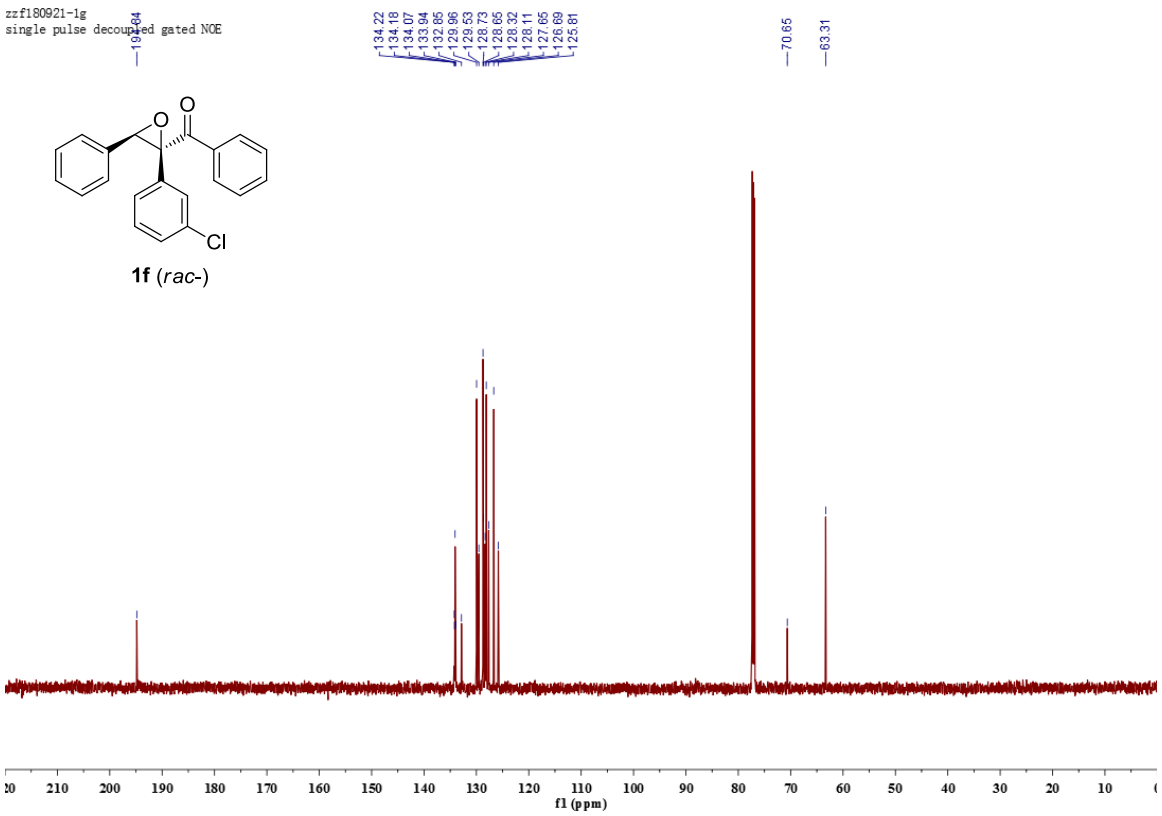

ZZF180626-1
single_pulse
8.1009
8.0968
8.0936
8.0856
8.0824
8.0784
7.4271
7.4236
7.4203
7.4157
7.4127
7.4108
7.4089
7.4049
7.2104
7.2073
7.2043
7.1997
7.1959
7.1934
7.1927
7.1860
7.1837
7.1782
7.1755
7.1727
7.1682
7.1637
7.1590
O
O
Cl
2.08
4.26
8.25
0.95
f1 (ppm)

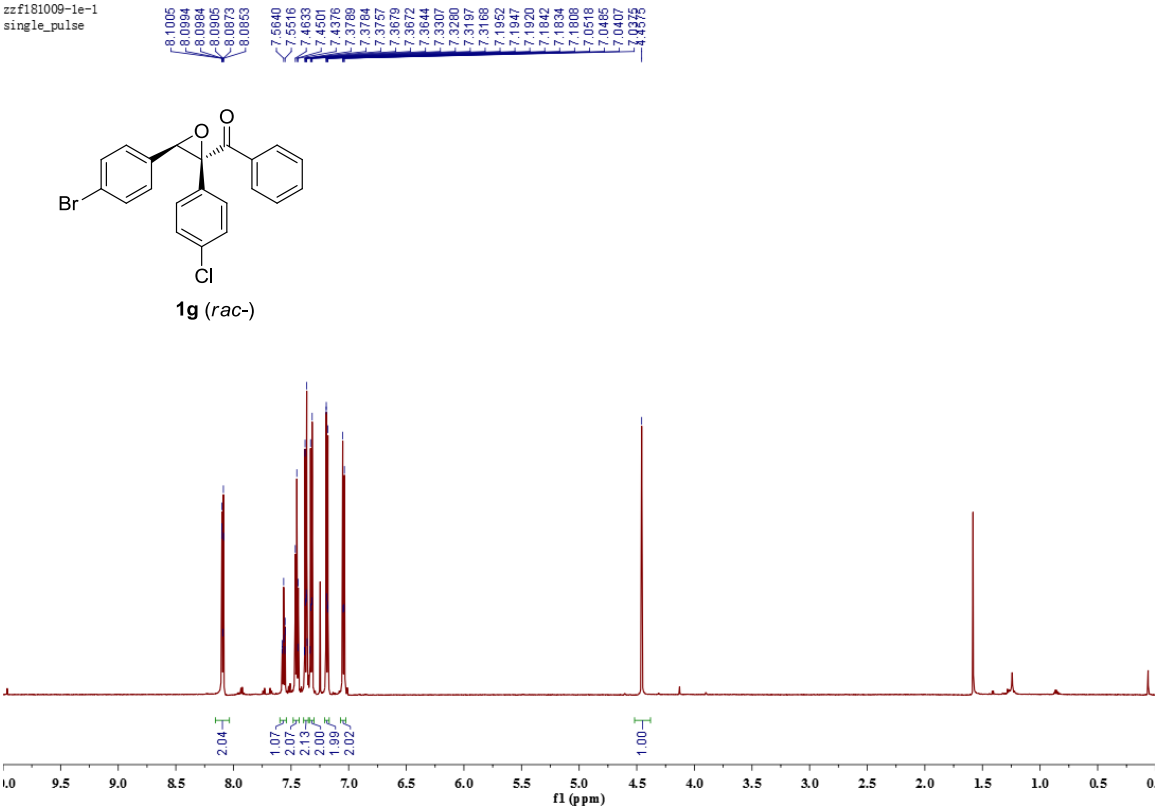
1e (*rac*-)


zzf180626-1-C
single pulse decoupled gated NOE
196.16
140.37
133.16
132.46
131.70
131.36
129.01
128.48
128.30
128.18
127.98
127.54
126.77
71.19
63.24
O
O
Cl
f1 (ppm)

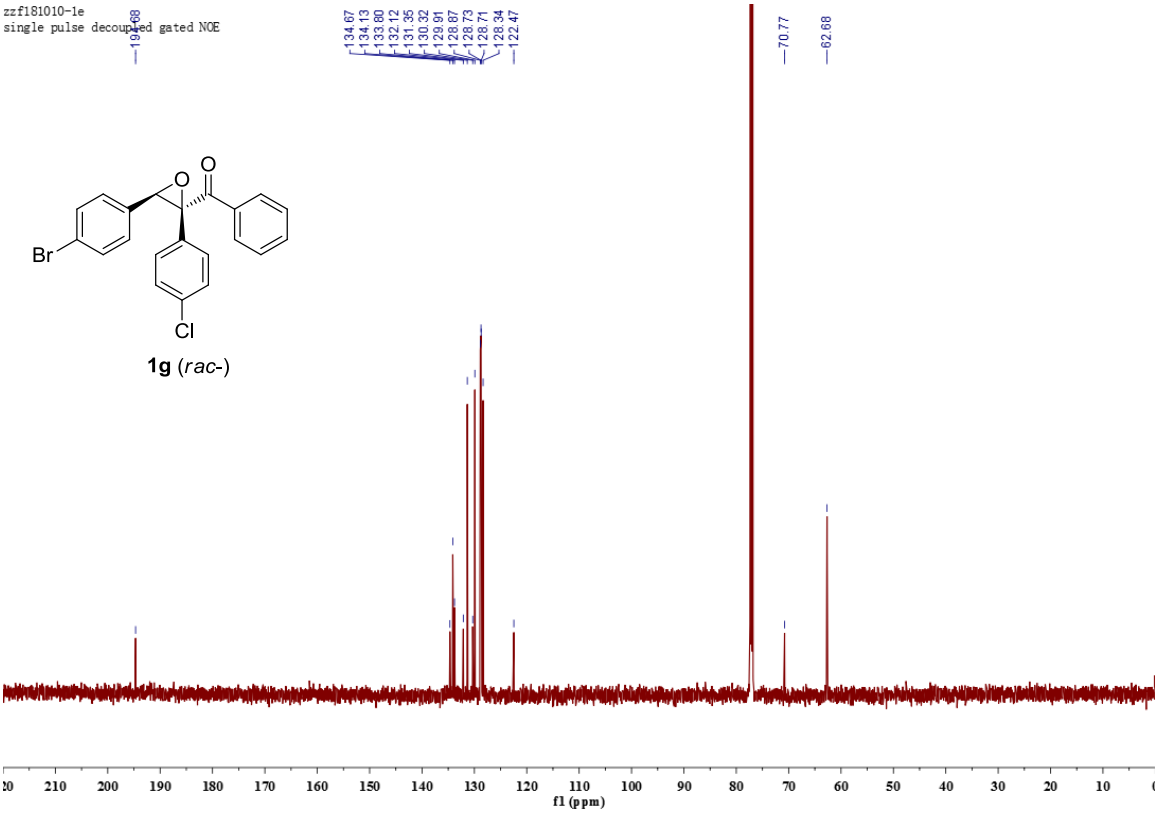
1e (*rac*-)


zzf180921-1g
single_pulse
8.1353
8.1334
8.1214
8.1193
7.5723
7.5602
7.4795
7.4777
7.4746
7.4664
7.4539
7.3380
7.3351
7.3334
7.3319
7.3263
7.3236
7.3205
7.2138
7.2021
7.1986
7.1937
7.1897
7.1825
7.1783
7.1305
7.1274
7.1252
O
O
Cl
1f (rac-)
2.11
1.12
3.26
1.17
5.37
2.17
1.00
f1 (ppm)

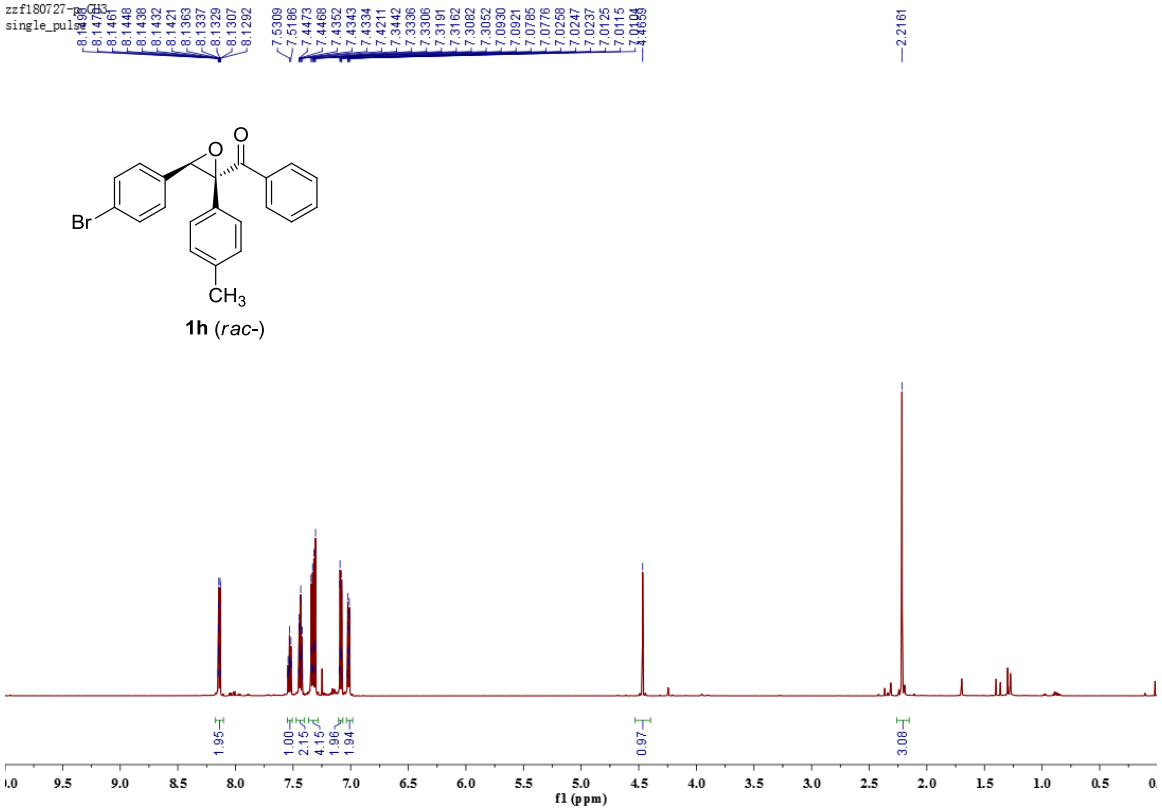

zzf180921-1g
single pulse decoupled gated NOE
134.22
134.18
134.07
133.94
132.85
129.96
129.53
128.73
128.65
128.32
128.11
127.65
126.69
125.61
70.65
63.31
O
O
Cl
1f (rac-)
f1 (ppm)


zzf181009-1e-1
single_pulse
8.1005
8.0994
8.0984
8.0905
8.0873
8.0853
7.5640
7.5516
7.4633
7.4501
7.4376
7.3789
7.3784
7.3757
7.3679
7.3672
7.3644
7.3307
7.3280
7.3197
7.3168
7.1962
7.1947
7.1920
7.1842
7.1834
7.1808
7.0518
7.0485
7.0407
4.4575
O
O
Br
Cl
2.04
1.07
2.07
2.13
2.00
1.99
2.02
1.00
f1 (ppm)

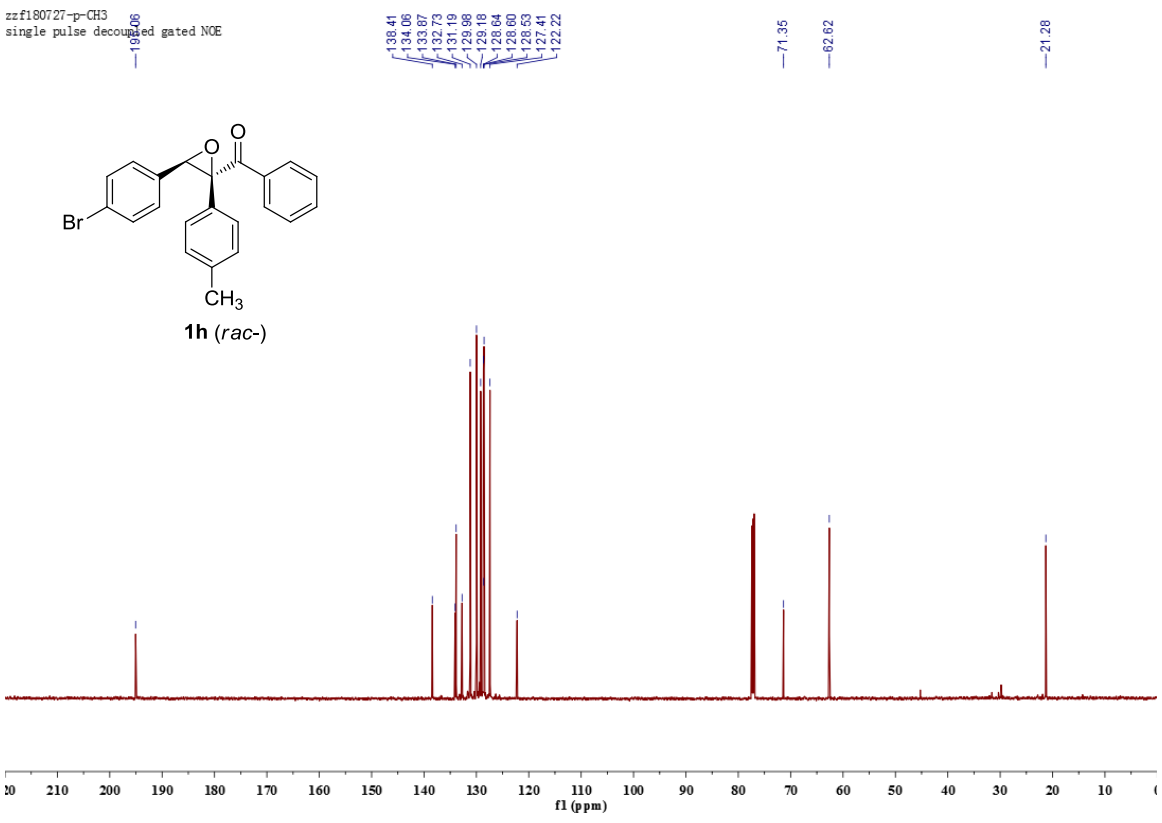
1g (*rac*-)


zzf181010-1e
single pulse decoupled gated NOE
194.68
134.67
134.13
133.80
132.12
131.35
130.32
129.91
128.87
128.73
128.71
128.34
122.47
70.77
62.68
O
O
Br
Cl
f1 (ppm)

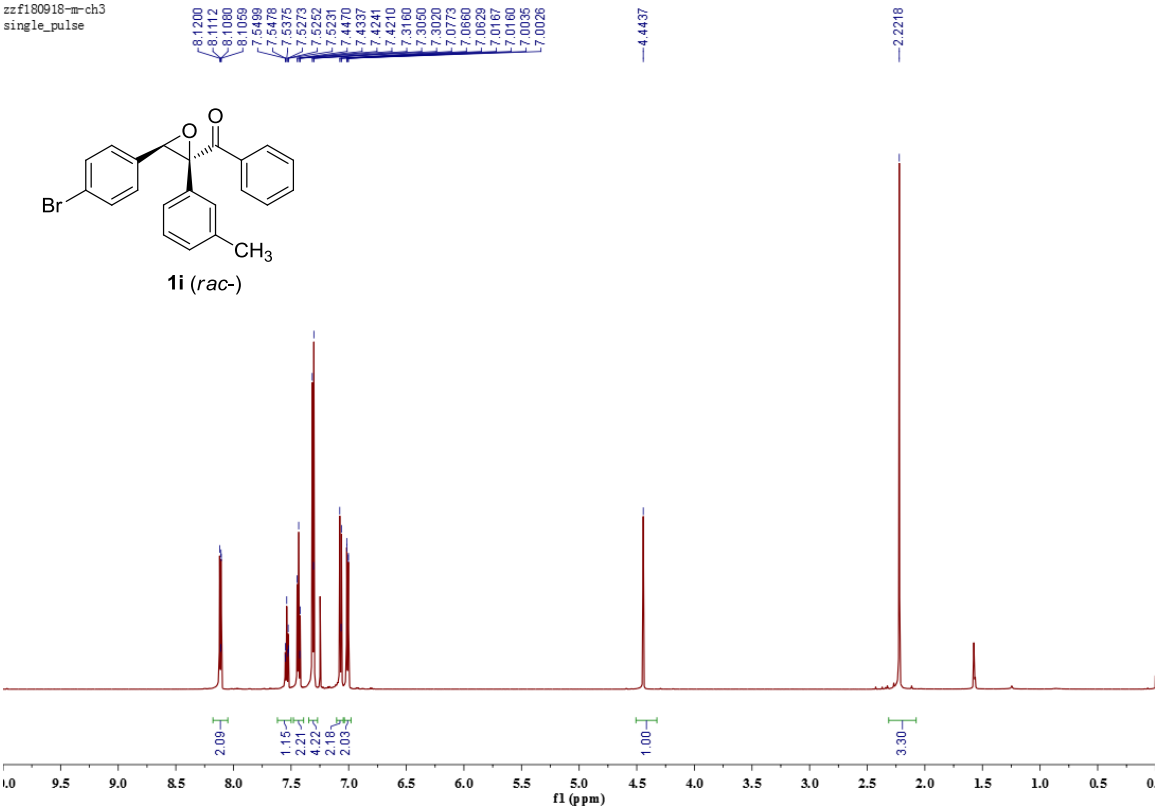
1g (*rac*-)


zzf180727-p-CH3
single_pulse
8.1467
8.1448
8.1438
8.1432
8.1421
8.1363
8.1337
8.1329
8.1307
8.1292
7.5309
7.5186
7.4473
7.4468
7.4352
7.4343
7.4334
7.4211
7.3442
7.3336
7.3306
7.3191
7.3162
7.3082
7.3052
7.0930
7.0921
7.0776
7.0765
7.0258
7.0247
7.0237
7.0125
7.0115
7.0104
4.4659
2.2161
Br
O
O
CH3
1.95
1.00
2.15
4.15
1.96
1.94
0.97
3.08
f1 (ppm)

1h (*rac*-)


zzf180727-p-CH3
single pulse decoupled gated NOE
138.41
134.06
133.87
132.73
131.19
129.98
129.18
128.64
128.60
128.53
127.41
122.22
71.35
62.62
21.28
Br
O
O
CH3
f1 (ppm)

1h (*rac*-)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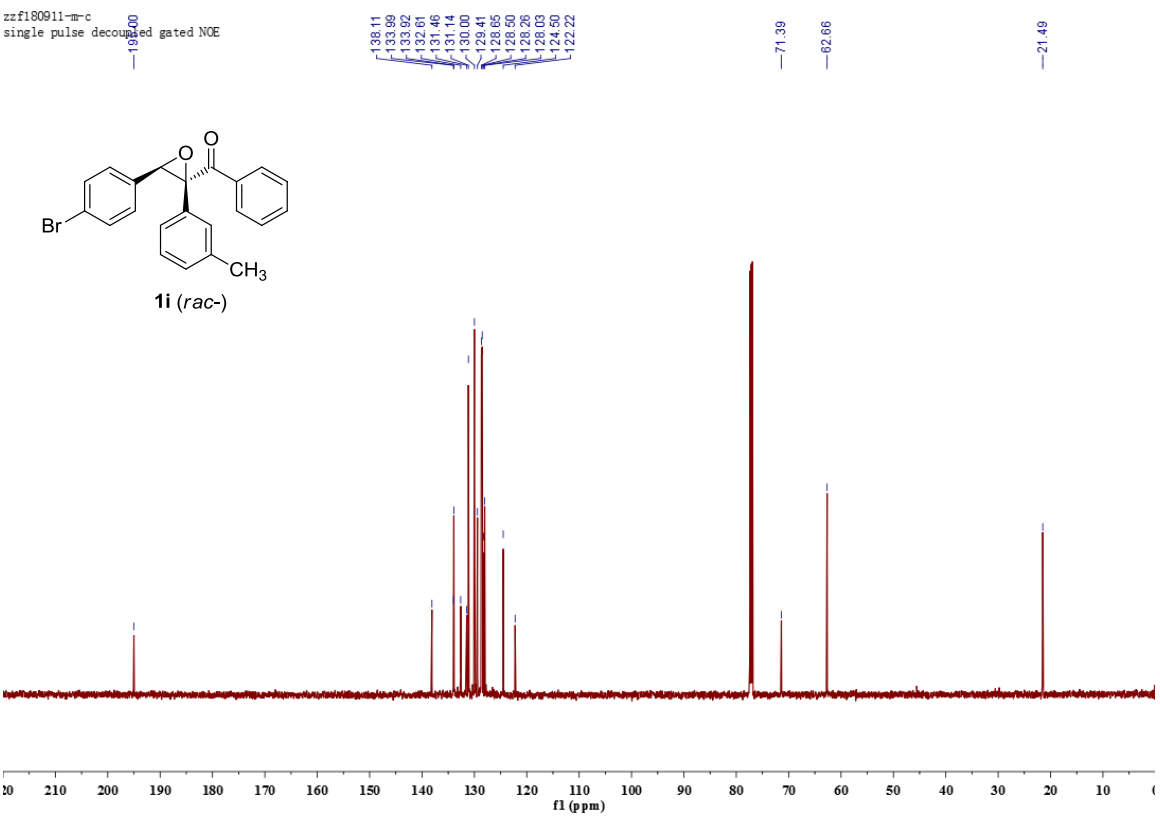
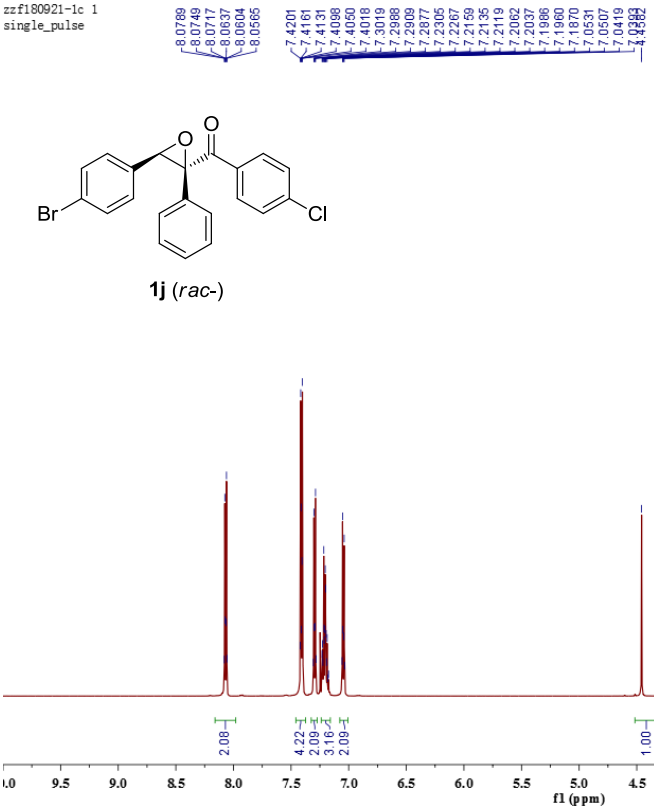
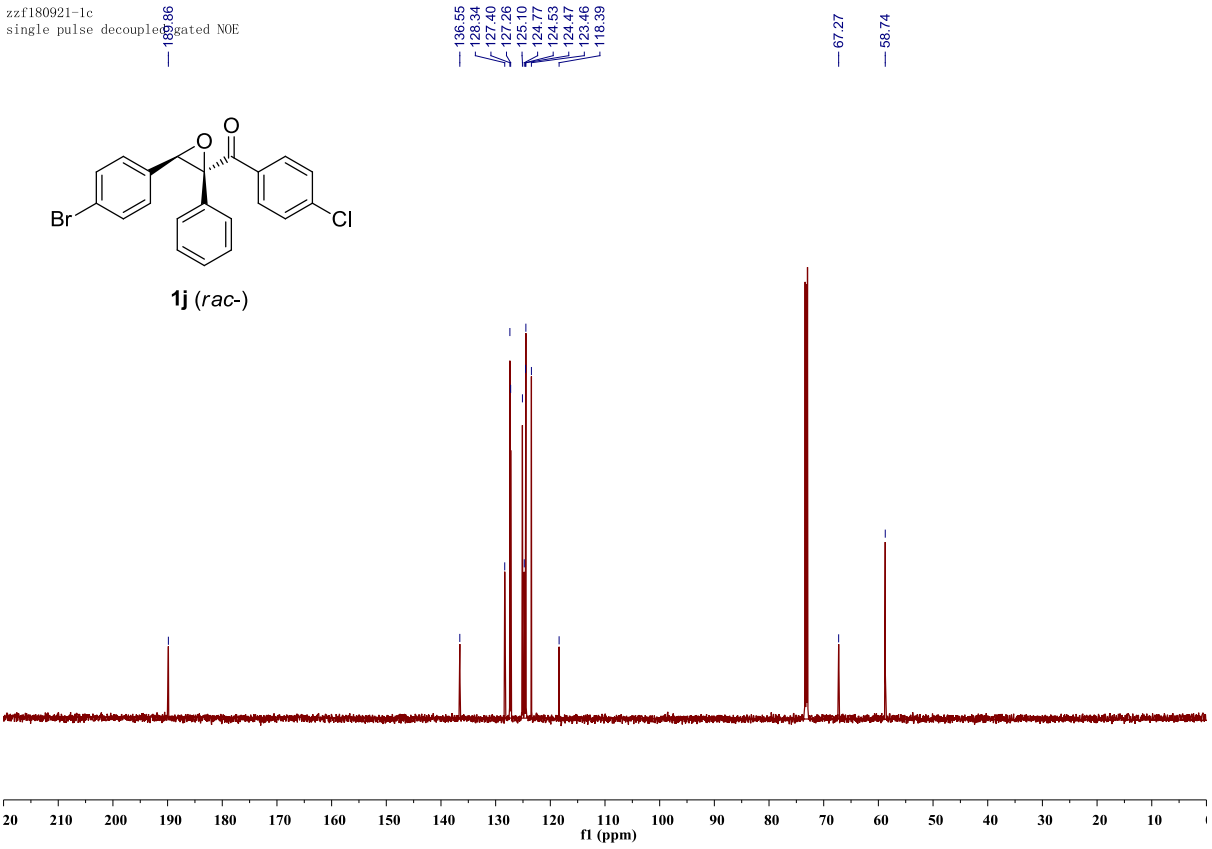
single_pulse
8.1200
8.1112
8.1080
8.1059
7.5499
7.5478
7.5375
7.5273
7.5252
7.5231
7.4470
7.4337
7.4241
7.4210
7.3160
7.3050
7.3020
7.0773
7.0660
7.0629
7.0167
7.0160
7.0035
7.0026
4.4437
2.2218
O
O
Br
CH3
1i (rac-)
2.09
1.15
2.21
4.22
2.18
2.03
1.00
3.30
f1 (ppm)


zzf180911-m-c
single pulse decoupled gated NOE
192.00
138.11
133.99
133.92
132.61
131.46
131.14
130.00
129.41
128.65
128.50
128.26
128.03
124.60
122.22
71.39
62.66
21.49
O
O
Br
CH3
1i (rac-)
f1 (ppm)


zzf180921-1c 1
single_pulse
8.0789
8.0749
8.0717
8.0637
8.0604
8.0565
7.4201
7.4161
7.4131
7.4098
7.4050
7.4018
7.3019
7.2988
7.2909
7.2877
7.2305
7.2267
7.2159
7.2135
7.2119
7.2062
7.2037
7.1986
7.1960
7.1870
7.0531
7.0507
7.0419
4.4382
O
O
Br
Cl
2.08
4.22
2.09
3.16
2.09
1.00
f1 (ppm)

1j (*rac*-)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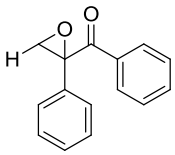
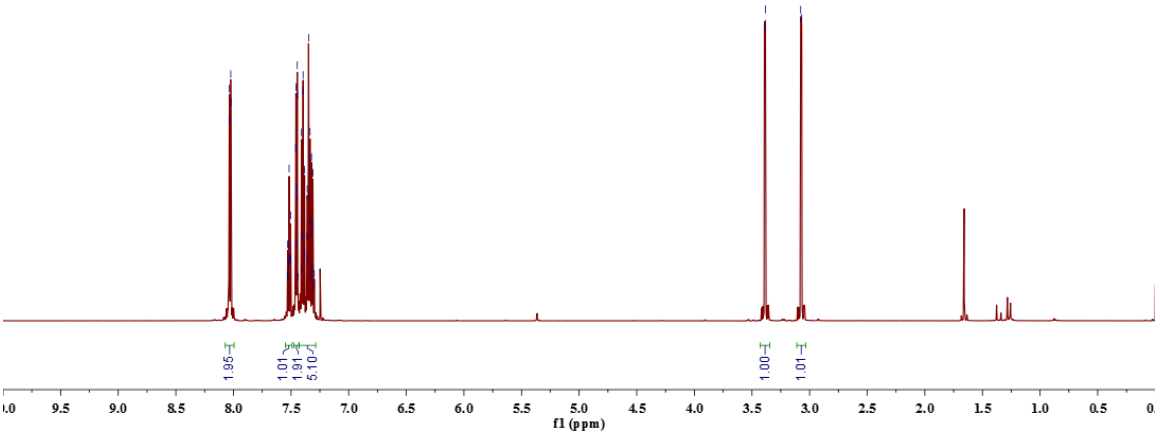
single pulse decoupled gated NOE
189.86
136.55
128.34
127.40
127.26
125.10
124.77
124.53
124.47
123.46
118.39
67.27
58.74
O
O
Br
Cl
f1 (ppm)

1j (*rac*-)

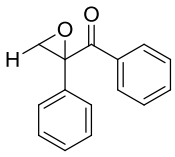

zzf180829-2H
single_pulse
8.0375
8.0355
8.0235
8.0213
7.5292
7.5183
7.5168
7.5142
7.5086
7.5045
7.5024
7.4601
7.4575
7.4541
7.4487
7.4475
7.4461
7.4439
7.4089
7.4062
7.3964
7.3954
7.3869
7.3830
7.3619
7.3593
7.3563
7.3477
7.3450
7.3376
7.3353
7.3344
7.3250
7.3225
7.3202
3.3922
3.3833
3.0777
3.0687



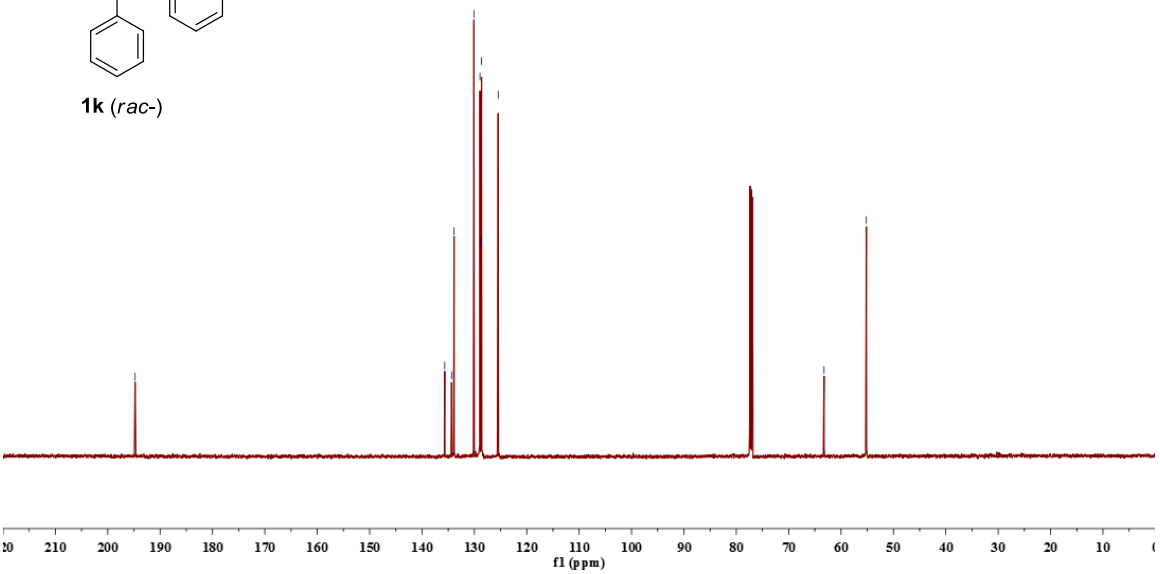
1k (*rac*-)

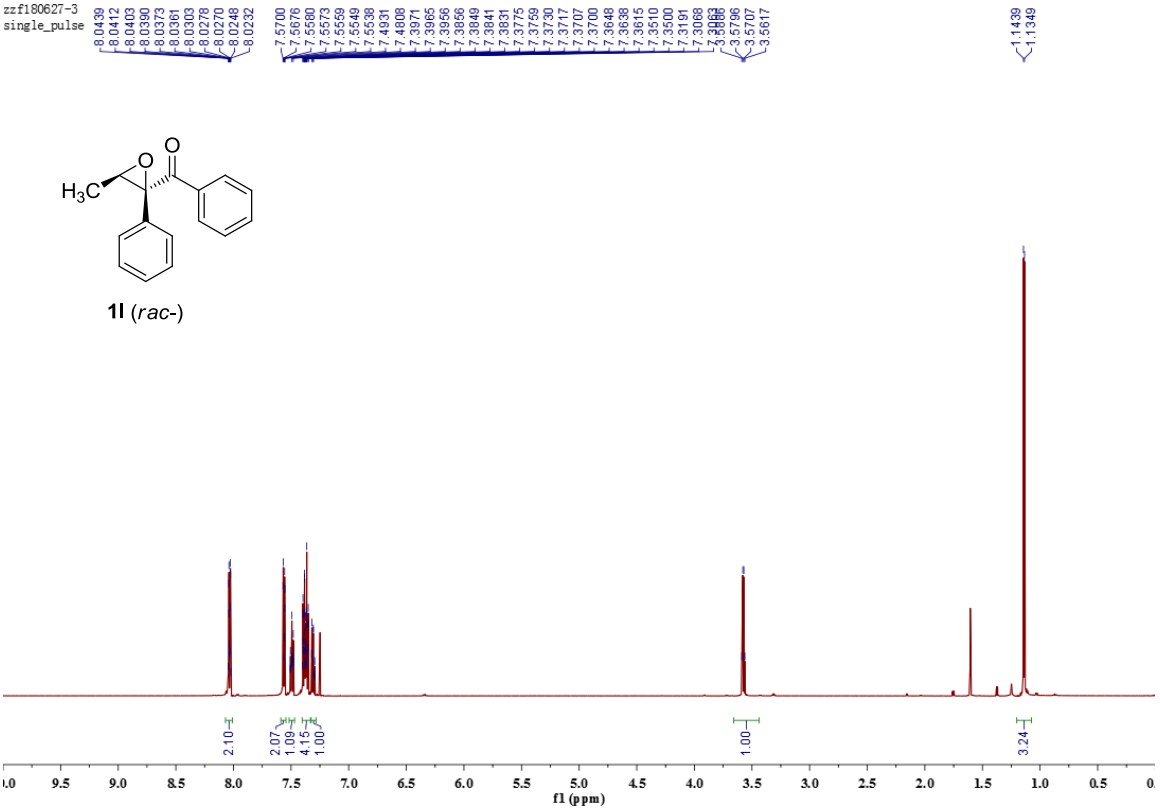

1.95
1.01
1.91
5.10
1.00
1.01
f1 (ppm)


zzf180829-2H
single pulse decoupled gated NOE
135.67
134.35
133.88
130.09
128.93
128.68
128.64
125.46
63.25
56.16



1k (*rac*-)


f1 (ppm)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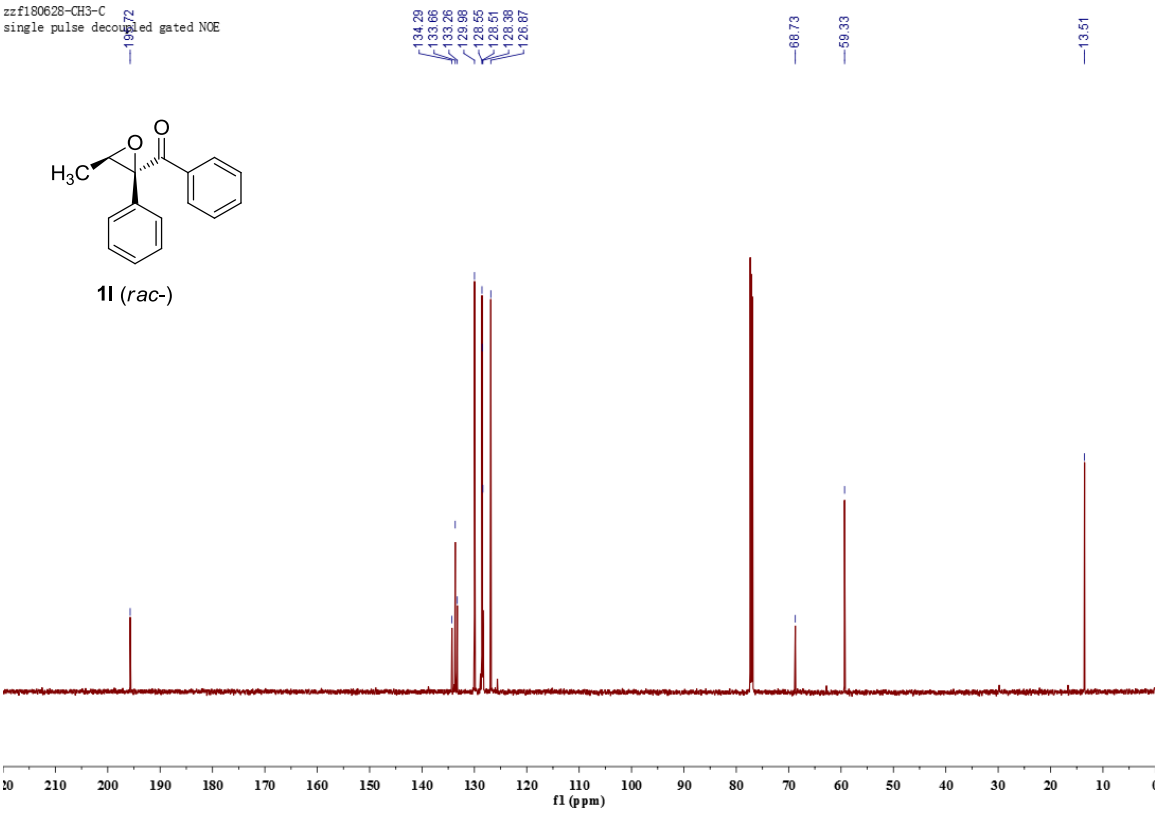
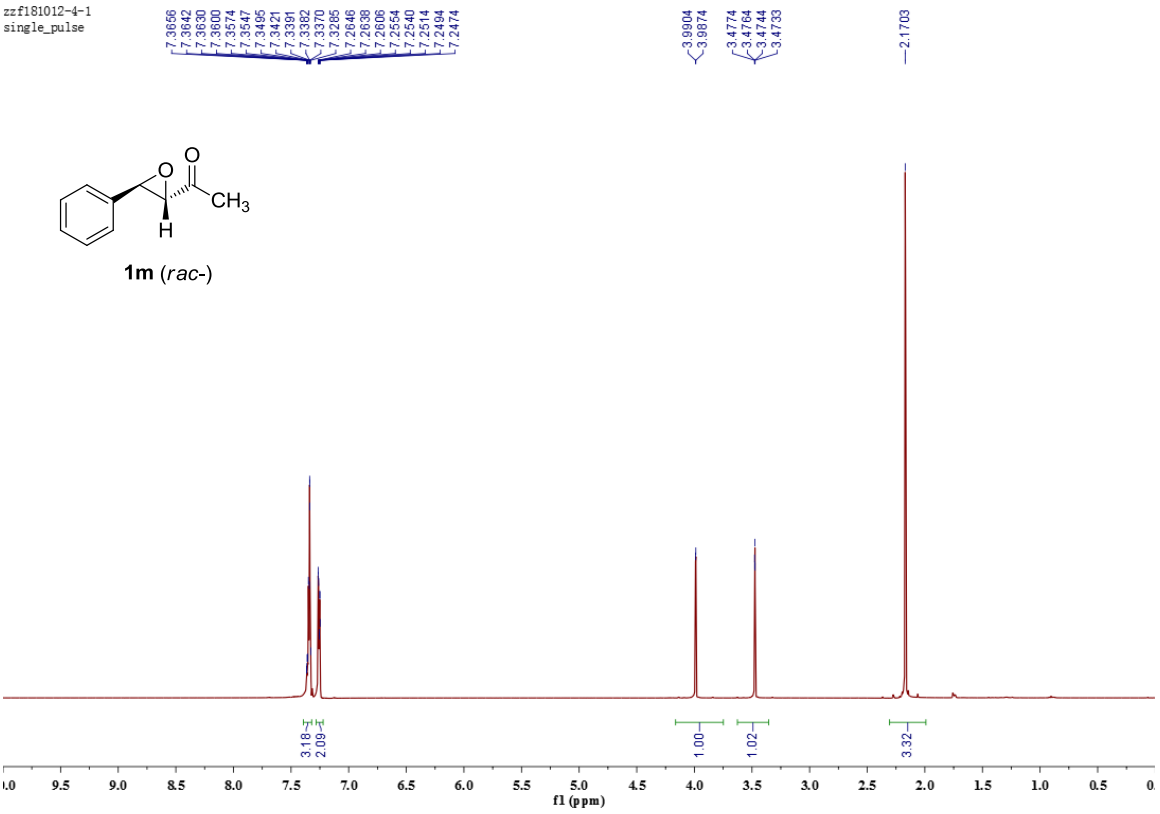
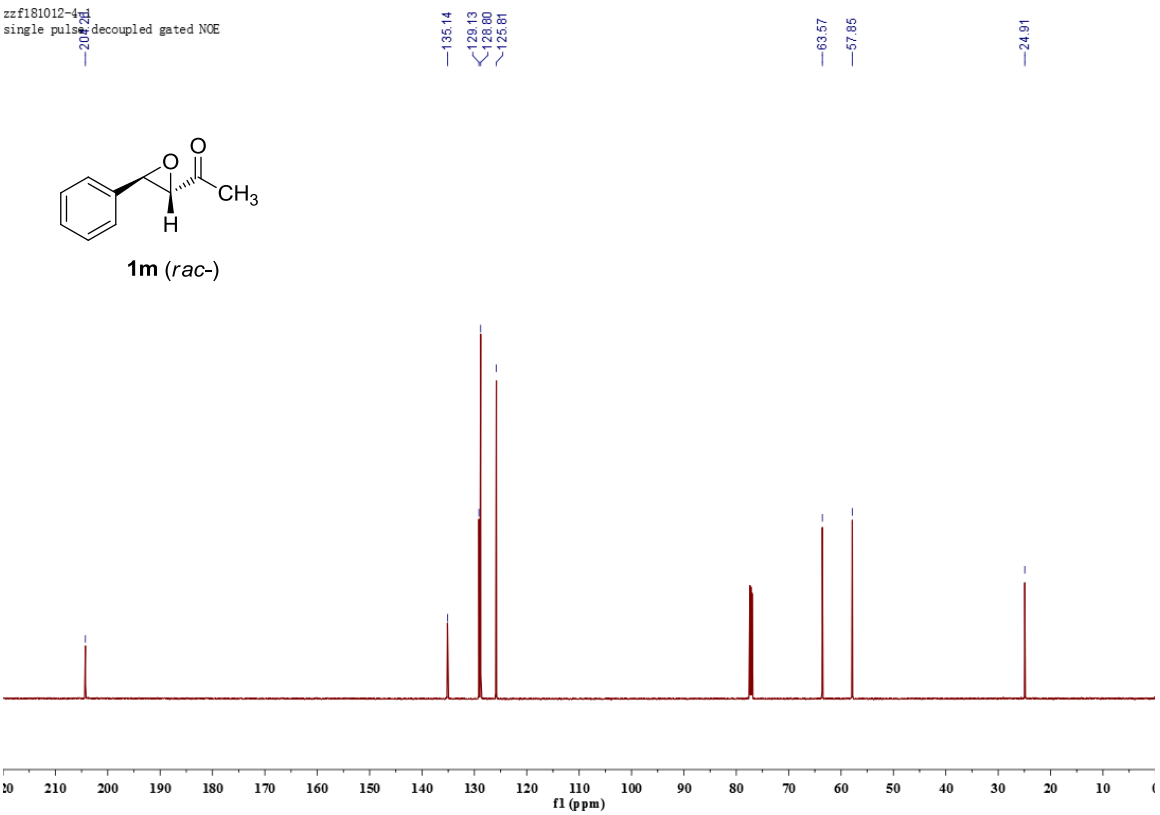
single_pulse
8.0439
8.0412
8.0403
8.0390
8.0373
8.0361
8.0303
8.0278
8.0270
8.0248
8.0232
7.5700
7.5676
7.5580
7.5573
7.5559
7.5549
7.5538
7.4931
7.4808
7.3971
7.3965
7.3956
7.3866
7.3849
7.3841
7.3831
7.3775
7.3759
7.3730
7.3717
7.3707
7.3700
7.3648
7.3638
7.3615
7.3510
7.3500
7.3191
7.3068
3.5796
3.5707
3.5617
1.1439
1.1349
H3C
O
O
1l (rac-)
2.10
2.07
1.09
4.15
1.00
1.00
3.24
f1 (ppm)

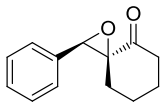

zzf180628-CH3-C
single pulse decoupled gated NOE
134.29
133.66
133.26
129.98
128.55
128.51
128.38
126.87
68.73
59.33
13.51
H3C
O
O
1l (rac-)
f1 (ppm)


zzf181012-4-1
single_pulse
7.3656
7.3642
7.3630
7.3600
7.3574
7.3547
7.3495
7.3421
7.3391
7.3362
7.3370
7.3285
7.2646
7.2638
7.2606
7.2554
7.2540
7.2514
7.2494
7.2474
3.9904
3.9874
3.4774
3.4764
3.4744
3.4733
2.1703
O
O
CH3
H
3.18
2.09
1.00
1.02
3.32
f1 (ppm)

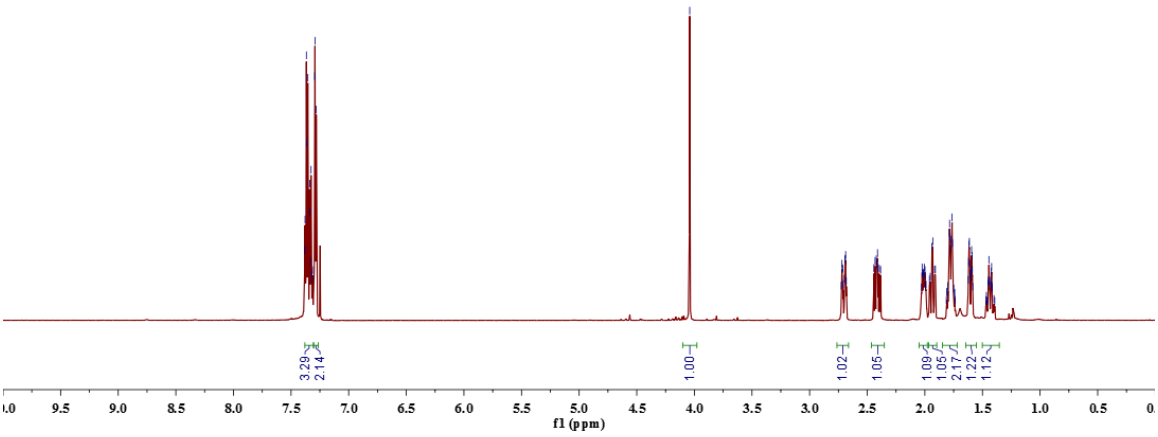
1m (*rac*-)

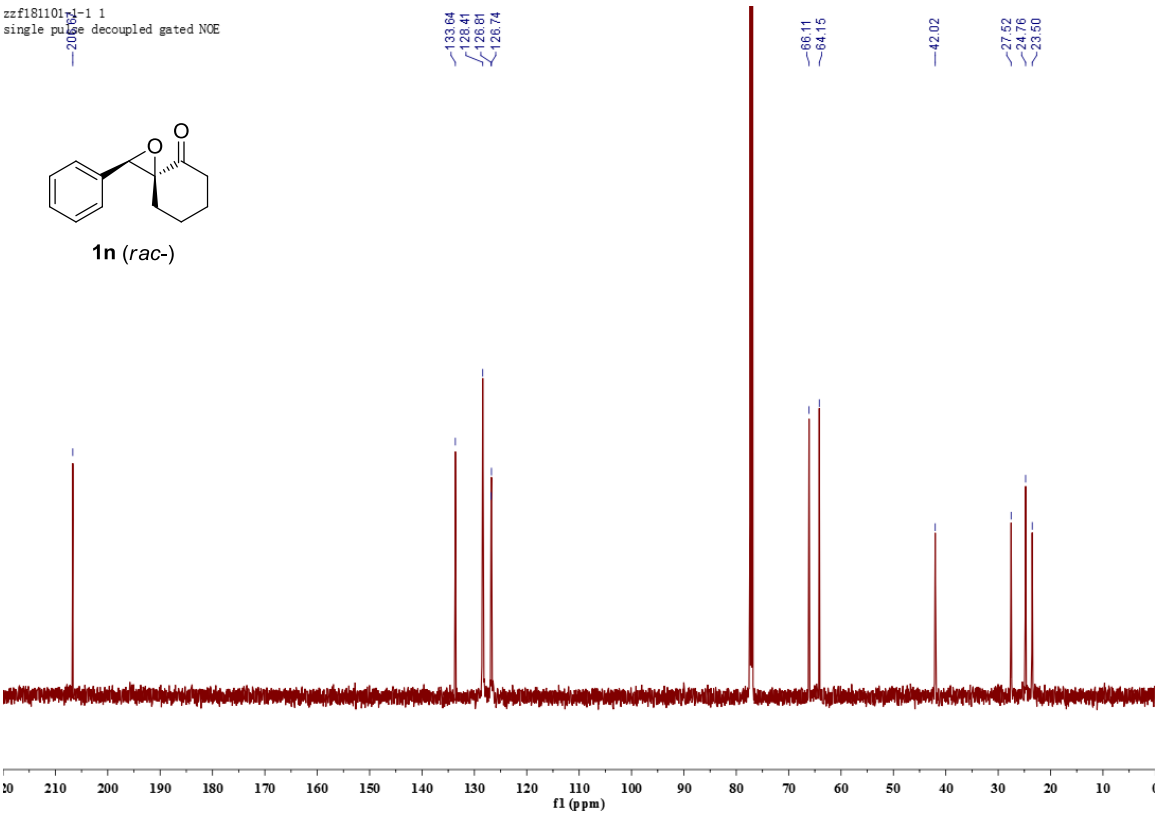

zzf181012-4-1
single_pulse_decoupled_gated_NOE
135.14
129.13
128.80
125.81
63.57
57.85
24.91
O
O
CH3
H
f1 (ppm)

1m (*rac*-)

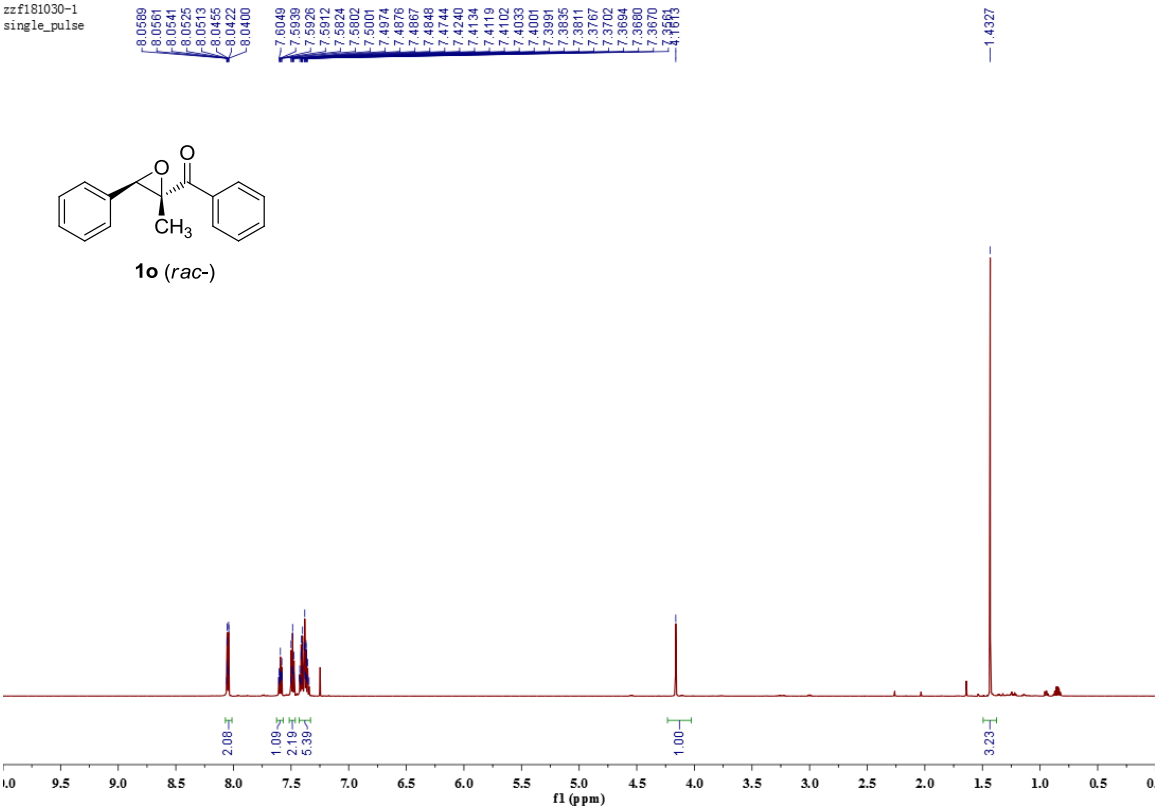


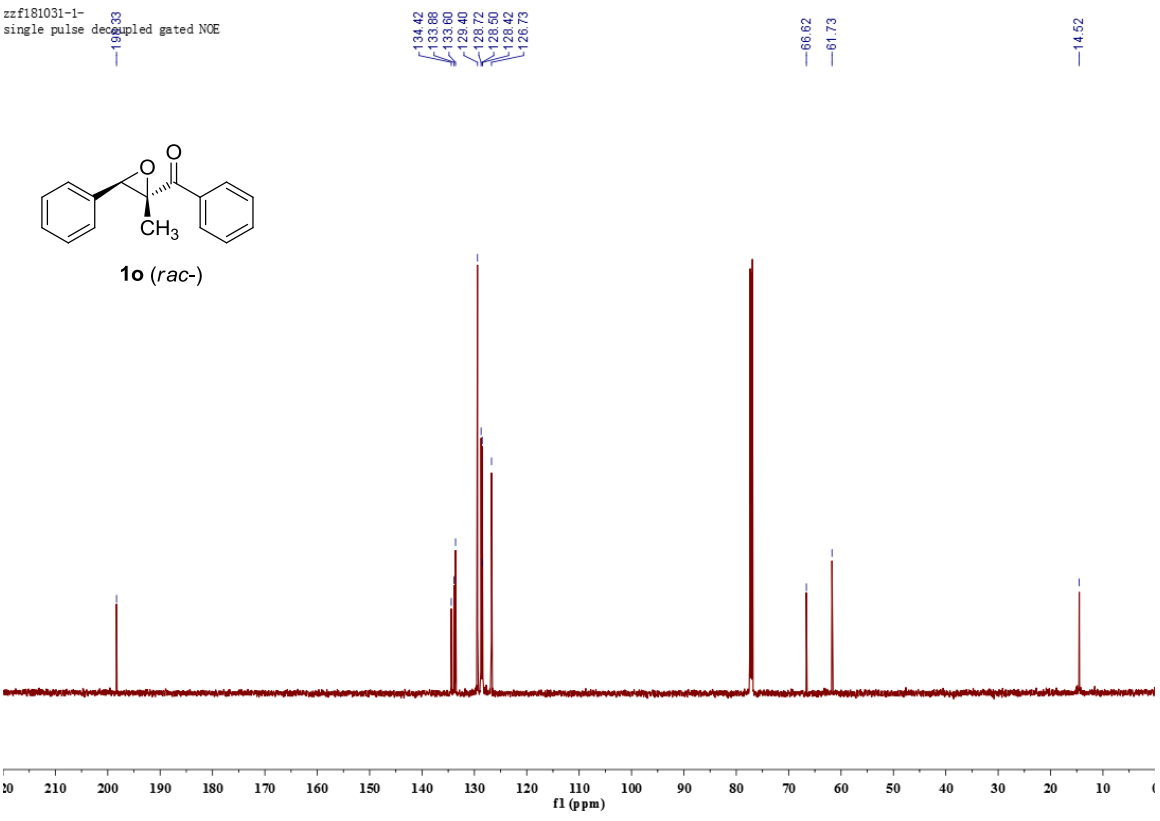
1n (*rac*-)

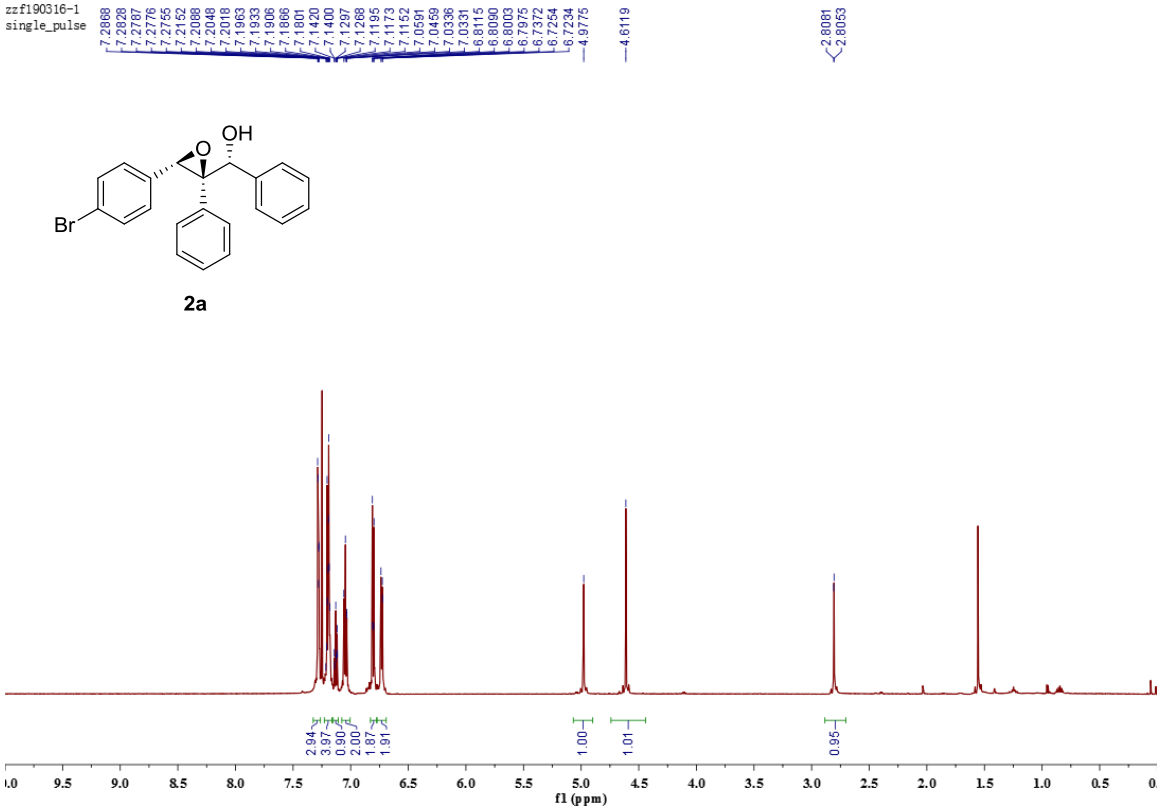

3.29
2.14
1.00
1.02
1.05
1.09
1.05
2.17
1.22
1.12
f1 (ppm)

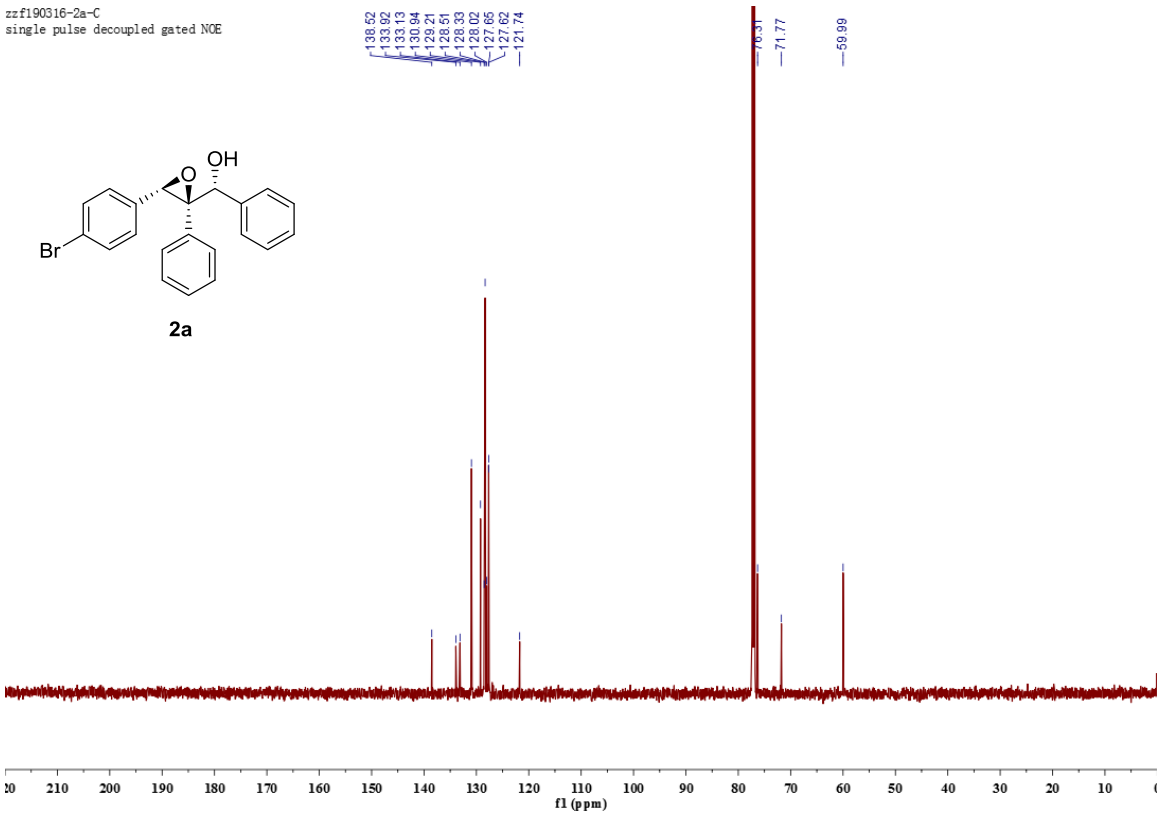

zzf181101-1 1
single pulse decoupled gated NOE
206.62
133.64
128.41
126.81
126.74
66.11
64.15
42.02
27.52
24.76
23.50
f1 (ppm)

1n (*rac*-)

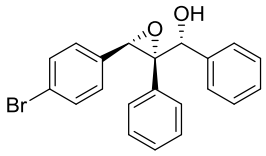

zzf181030-1
single_pulse
8.0589
8.0561
8.0541
8.0525
8.0513
8.0455
8.0422
8.0400
7.6049
7.5939
7.5926
7.5912
7.5824
7.5802
7.5001
7.4974
7.4876
7.4867
7.4848
7.4744
7.4240
7.4134
7.4119
7.4102
7.4033
7.4001
7.3991
7.3835
7.3811
7.3767
7.3702
7.3694
7.3680
7.3670
7.3561
7.3513
1.4327
O
O
CH3
1o (rac-)
2.08
1.09
2.19
5.39
1.00
3.23
f1 (ppm)


zzf181031-1-
single pulse decoupled gated NOE
196.33
134.42
133.88
133.60
129.40
128.72
128.50
128.42
126.73
66.62
61.73
14.52
O
O
CH3
1o (rac-)
f1 (ppm)

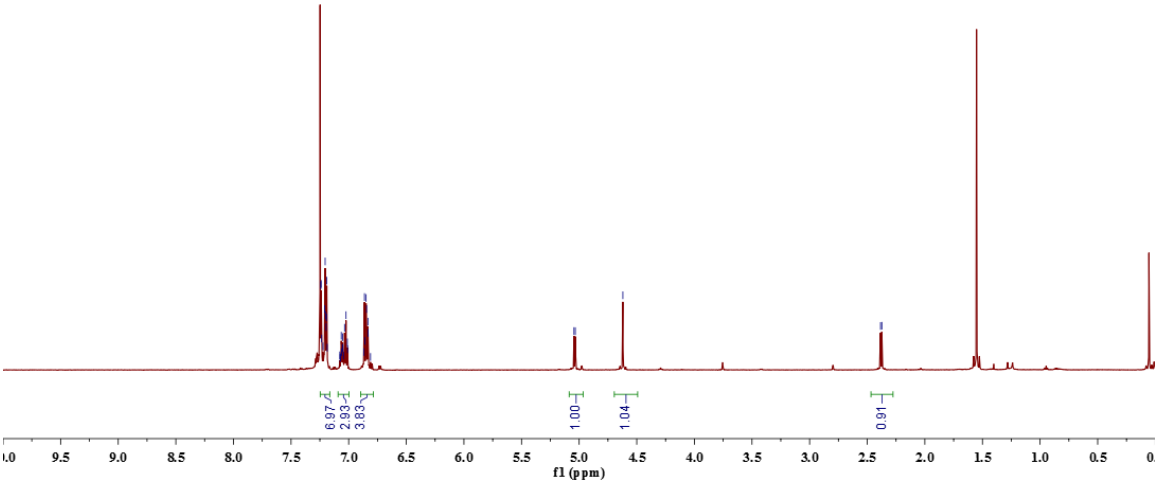

zzf190316-1
single_pulse
7.2868
7.2828
7.2787
7.2776
7.2755
7.2152
7.2088
7.2048
7.2018
7.1963
7.1933
7.1906
7.1866
7.1801
7.1420
7.1400
7.1297
7.1288
7.1195
7.1173
7.1152
7.0591
7.0459
7.0336
7.0331
6.8115
6.8090
6.8003
6.7975
6.7372
6.7254
6.7234
4.9775
4.6119
2.8081
2.8053
OH
O
Br
2a
2.94
3.97
0.90
2.00
1.87
1.91
1.00
1.01
0.95
f1 (ppm)

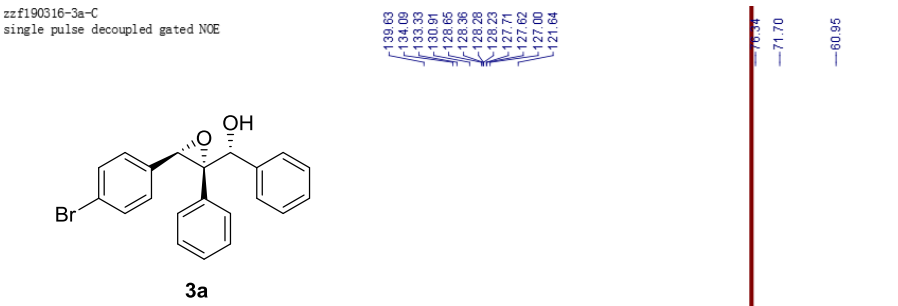

zzf190316-2a-C
single pulse decoupled gated NOE
138.52
133.92
133.13
130.94
129.21
128.51
128.33
128.02
127.65
127.62
121.74
76.31
71.77
59.99
OH
O
Br
2a
f1 (ppm)


zzf190316-3a
single_pulse


OH
O
Br

3a

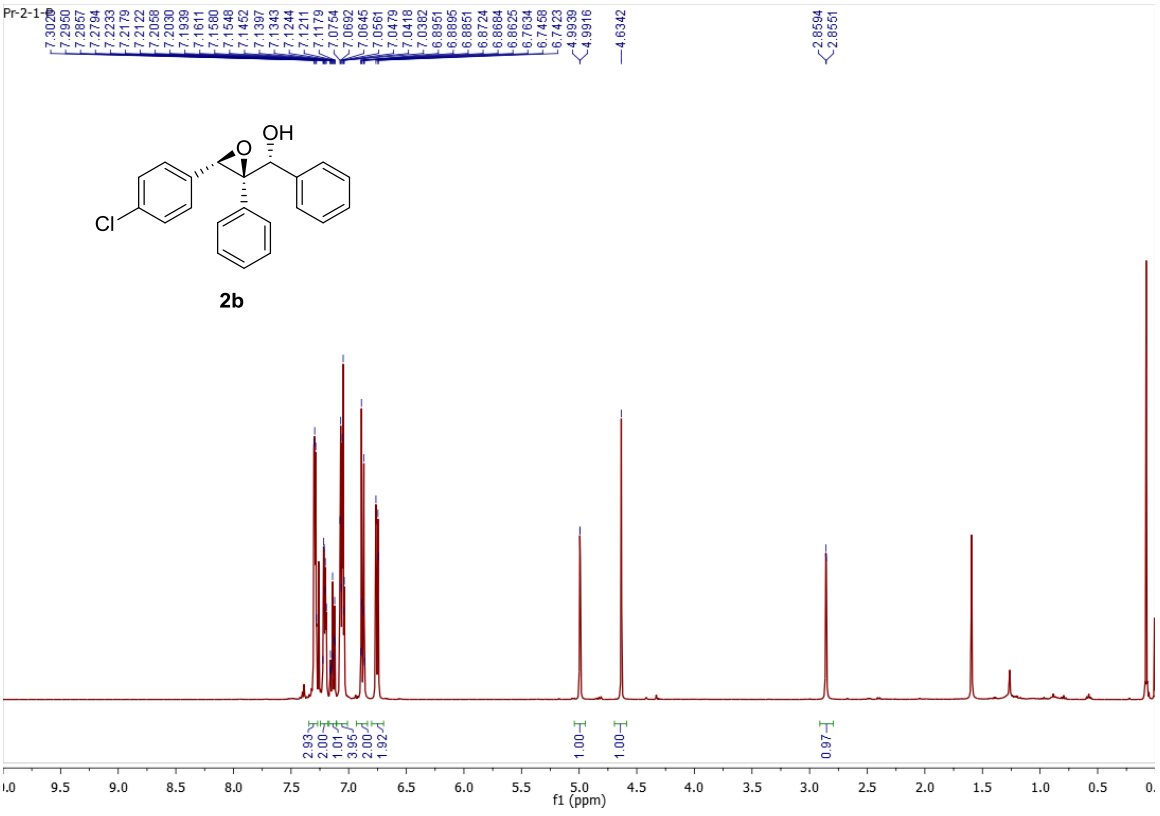

6.97
2.93
3.83
1.00
1.04
0.91
f1 (ppm)

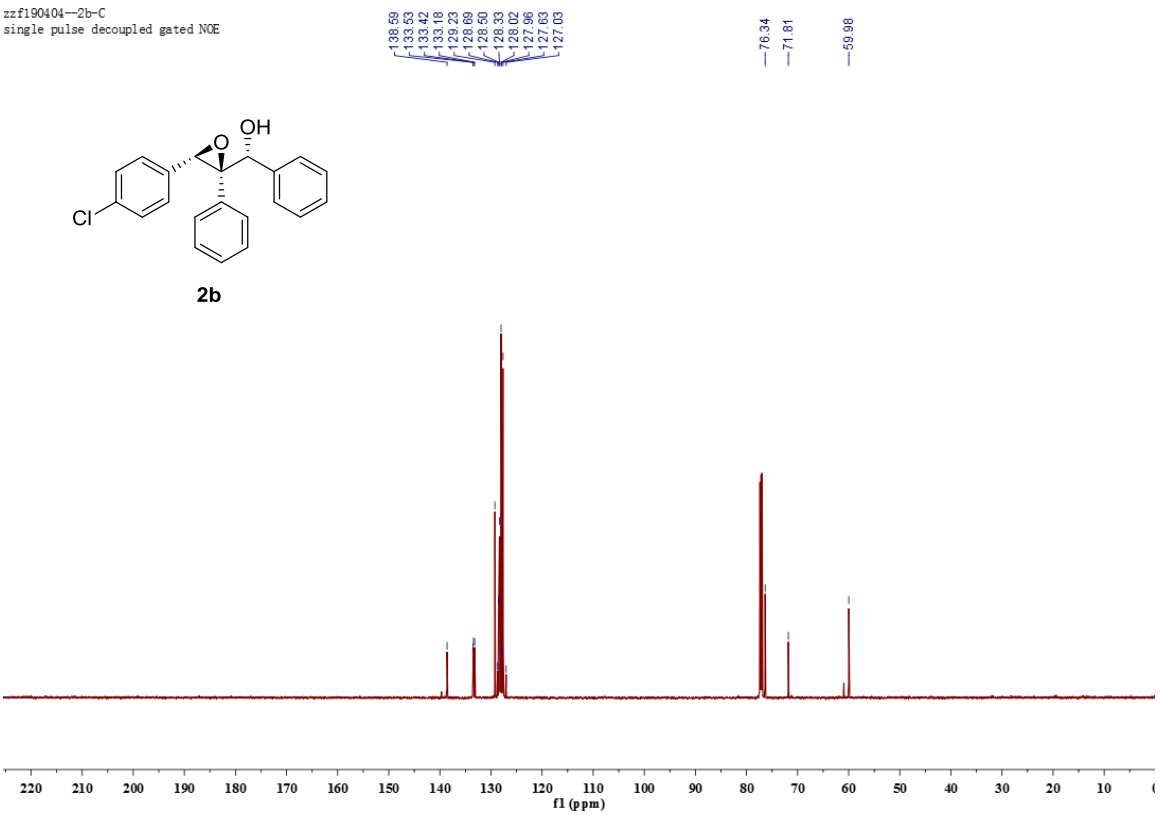

zzf190316-3a-C
single pulse decoupled gated NOE

OH
O
Br

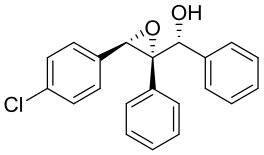
3a

f1 (ppm)

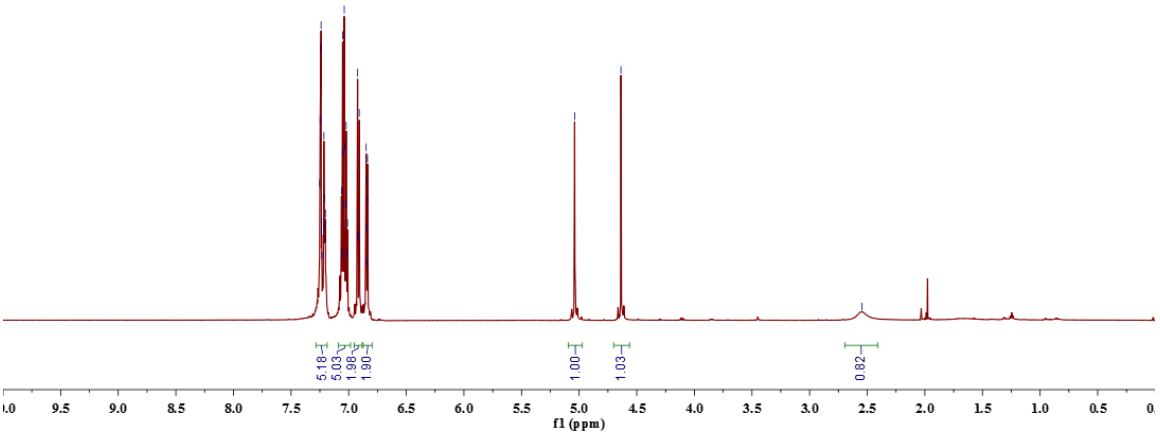

Pr-2-1-B
7.3026
7.2960
7.2857
7.2794
7.2233
7.2179
7.2122
7.2068
7.2030
7.1939
7.1611
7.1580
7.1548
7.1452
7.1397
7.1343
7.1244
7.1211
7.1179
7.0754
7.0692
7.0645
7.0561
7.0479
7.0418
7.0382
6.8951
6.8895
6.8851
6.8724
6.8684
6.8625
6.7634
6.7458
6.7423
4.9939
4.9916
4.6342
2.8594
2.8551
OH
O
Cl
2b
2.93
2.00
1.01
3.95
2.00
1.92
1.00
1.00
0.97
f1 (ppm)


zzf190404--2b-C
single pulse decoupled gated NOE
138.59
133.53
133.42
133.18
129.23
128.69
128.50
128.33
128.02
127.96
127.63
127.03
76.34
71.81
59.98
OH
O
Cl
2b
f1 (ppm)

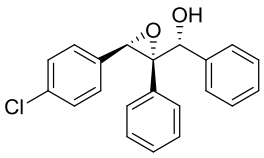

zzf190402-1--3b
single_pulse
7.4471
7.4428
7.4396
7.2358
7.2347
7.2322
7.2148
7.2098
7.2070
7.2020
7.1987
7.0629
7.0587
7.0569
7.0529
7.0508
7.0418
7.0385
7.0342
7.0240
7.0215
7.0099
7.0076
6.9225
6.9195
6.9111
6.9084
6.8502
6.8484
6.8460
6.8399
6.8369
6.8344
5.0389
4.6371
2.5468


OH
O
Cl

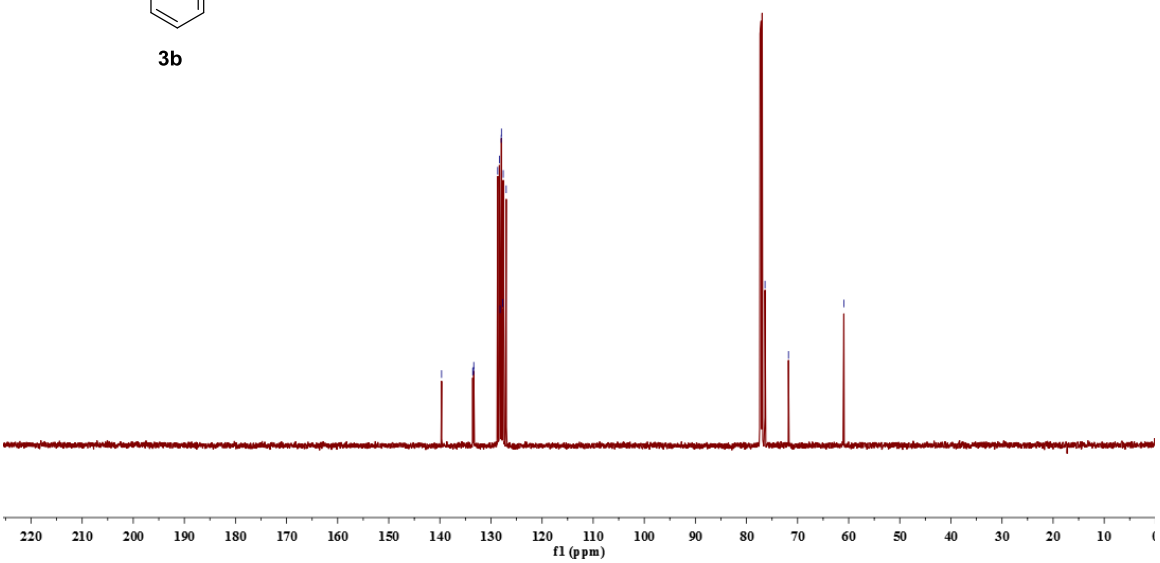
3b

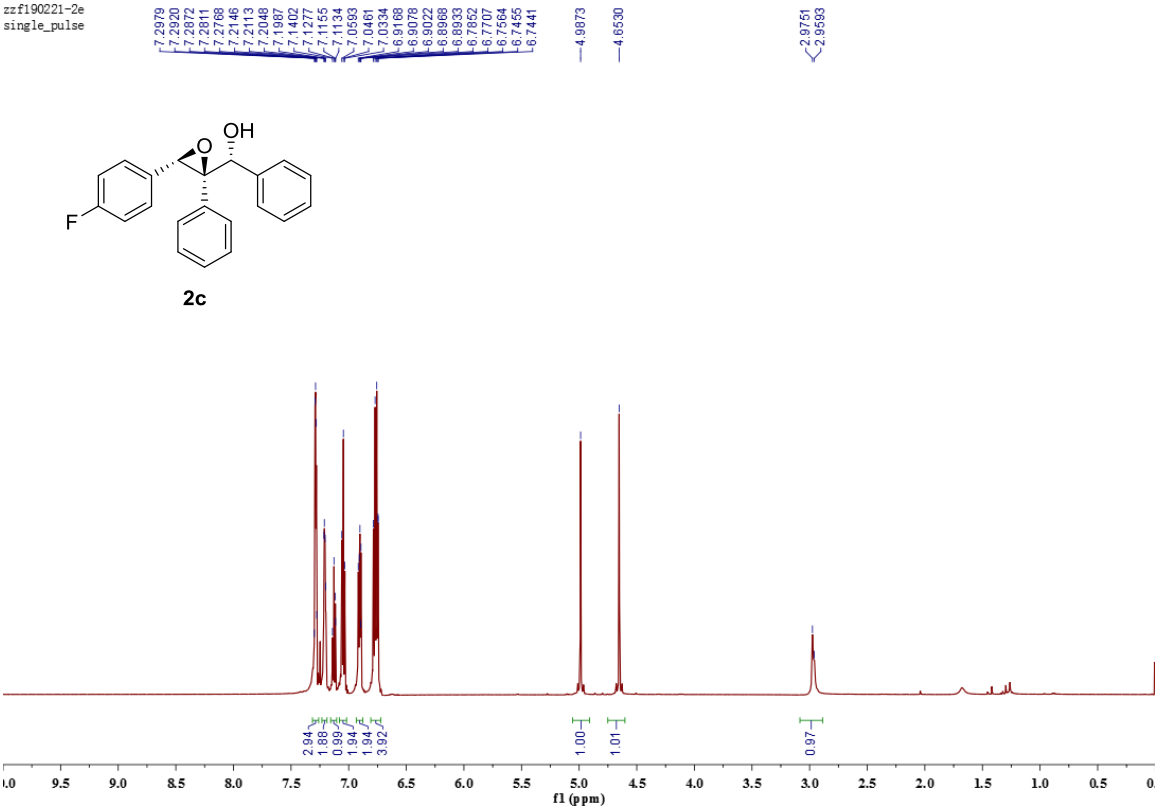

5.18
5.03
1.98
1.90
1.00
1.03
0.82
f1 (ppm)

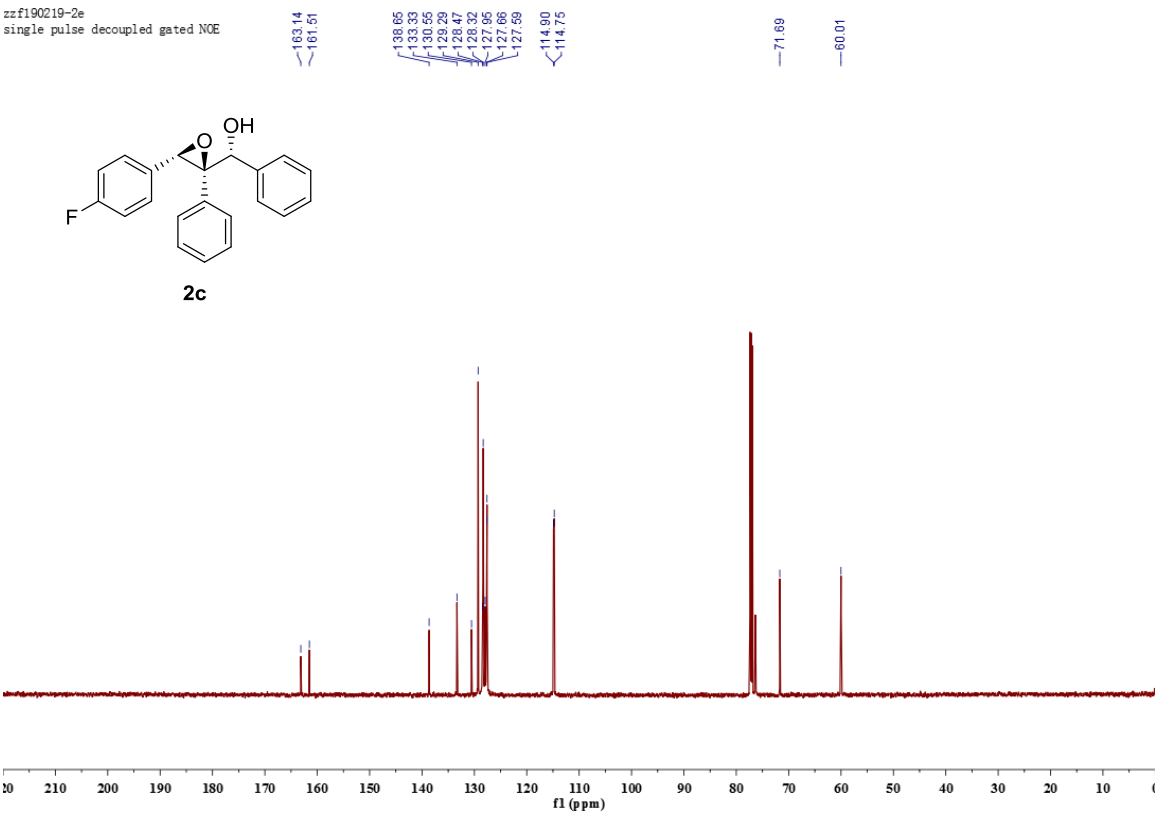

zzf190402-1--3b
single pulse decoupled gated NOE
139.66
133.57
133.41
133.37
128.68
128.35
128.21
127.99
127.96
127.69
127.60
127.02
76.37
71.78
60.94

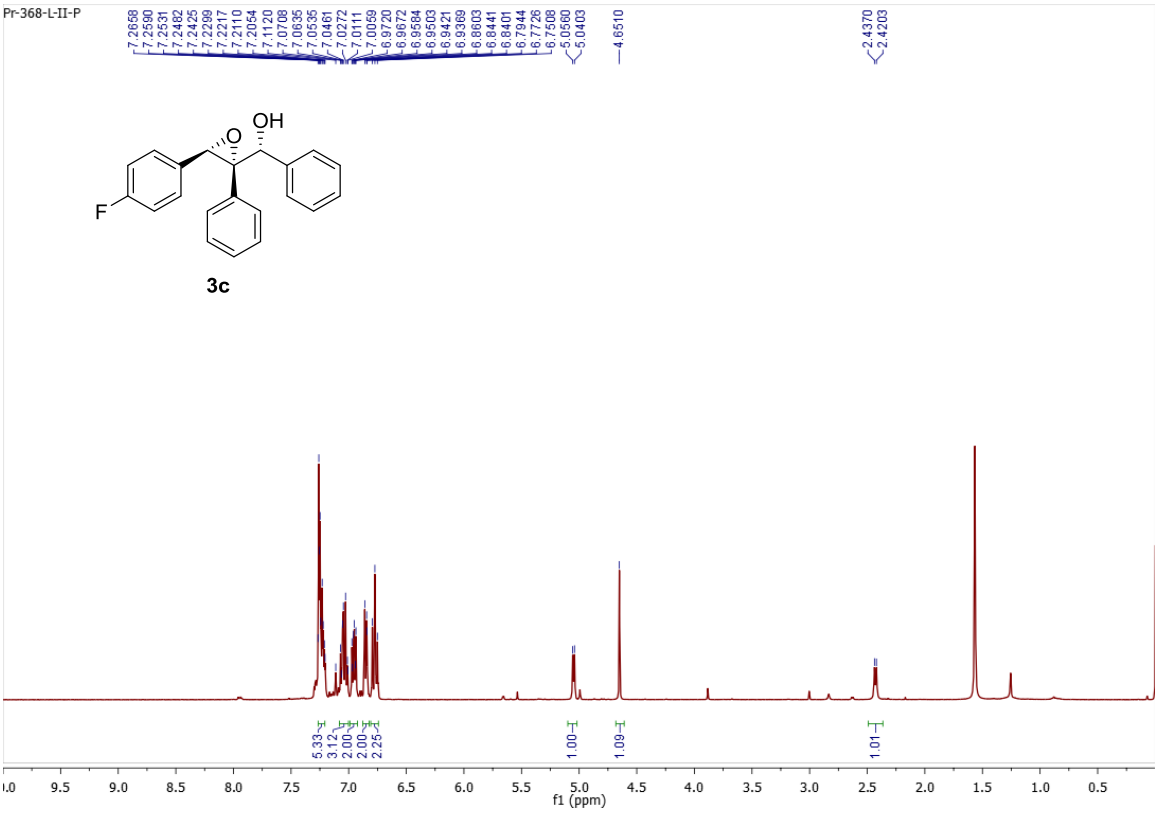

OH
O
Cl

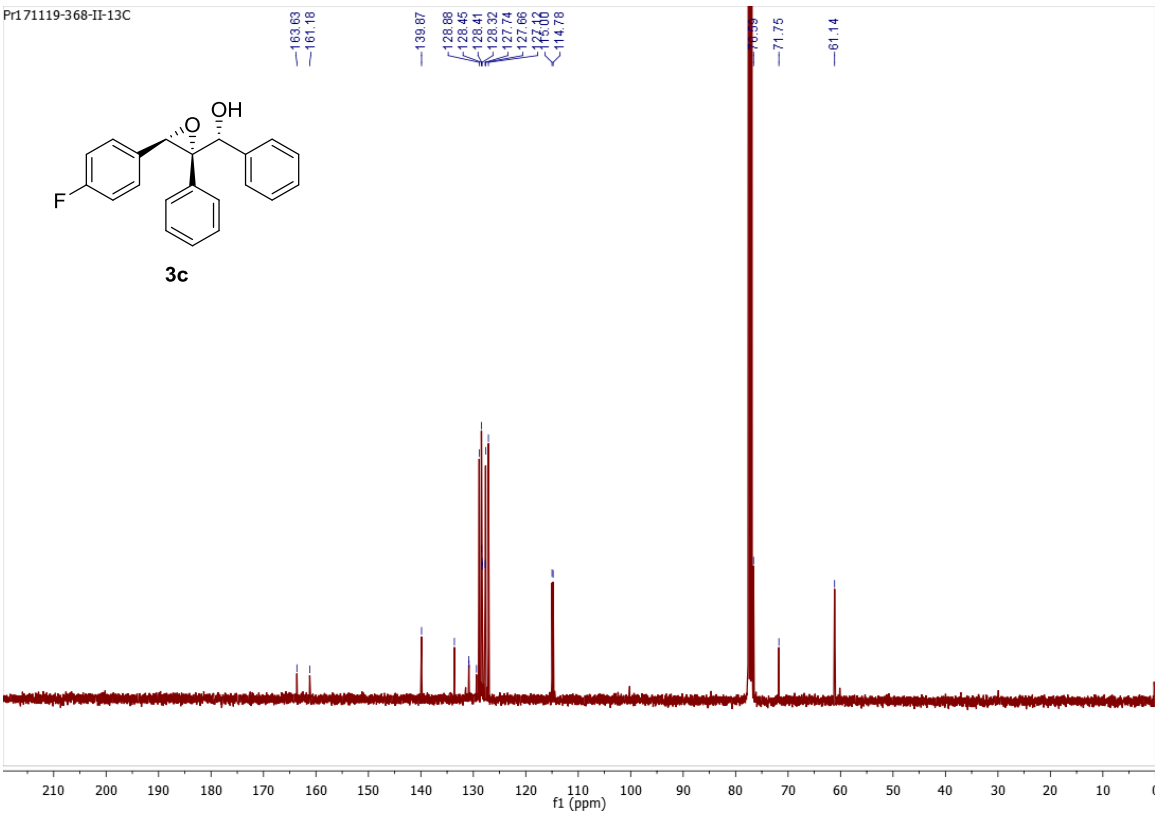
3b

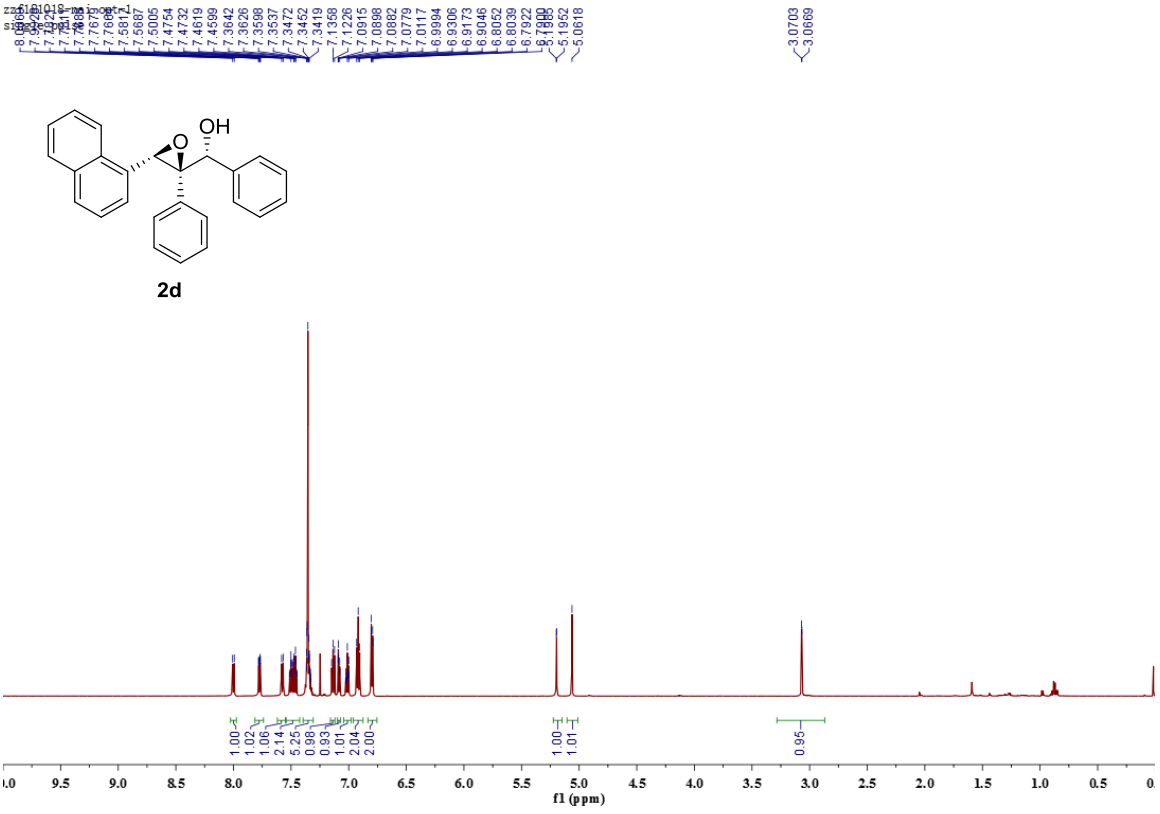

f1 (ppm)

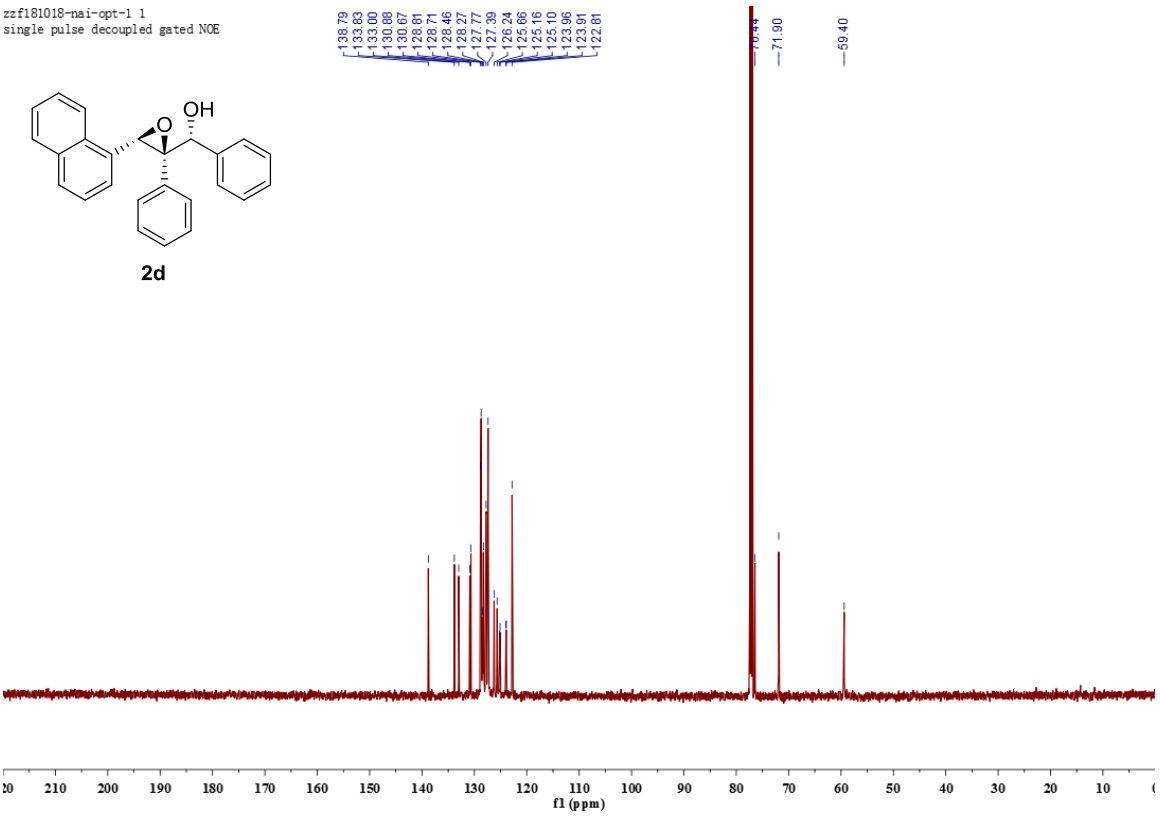

zzf190221-2e
single_pulse
7.2979
7.2920
7.2872
7.2811
7.2768
7.2146
7.2113
7.2048
7.1987
7.1402
7.1277
7.1155
7.1134
7.0593
7.0461
7.0334
6.9168
6.9078
6.9022
6.8968
6.8933
6.7852
6.7707
6.7564
6.7455
6.7441
4.9873
4.6530
2.9751
2.9593
OH
O
F
2c
2.94
1.88
0.99
1.94
1.94
3.92
1.00
1.01
0.97
f1 (ppm)

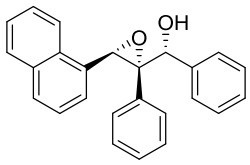

zzf190219-2e
single pulse decoupled gated NOE
163.14
161.51
138.65
133.33
130.55
129.29
128.47
128.32
127.95
127.66
127.59
114.90
114.75
71.69
60.01
OH
O
F
2c
f1 (ppm)


Pr-368-L-II-P
7.2658
7.2590
7.2531
7.2492
7.2425
7.2299
7.2217
7.2110
7.2054
7.1120
7.0708
7.0635
7.0535
7.0461
7.0272
7.0111
7.0059
6.9720
6.9672
6.9584
6.9503
6.9421
6.9369
6.8603
6.8441
6.8401
6.7944
6.7726
6.7508
5.0560
5.0403
4.6510
2.4370
2.4203
OH
O
F
3c
5.33
3.12
2.00
2.00
2.25
1.00
1.09
1.01
f1 (ppm)

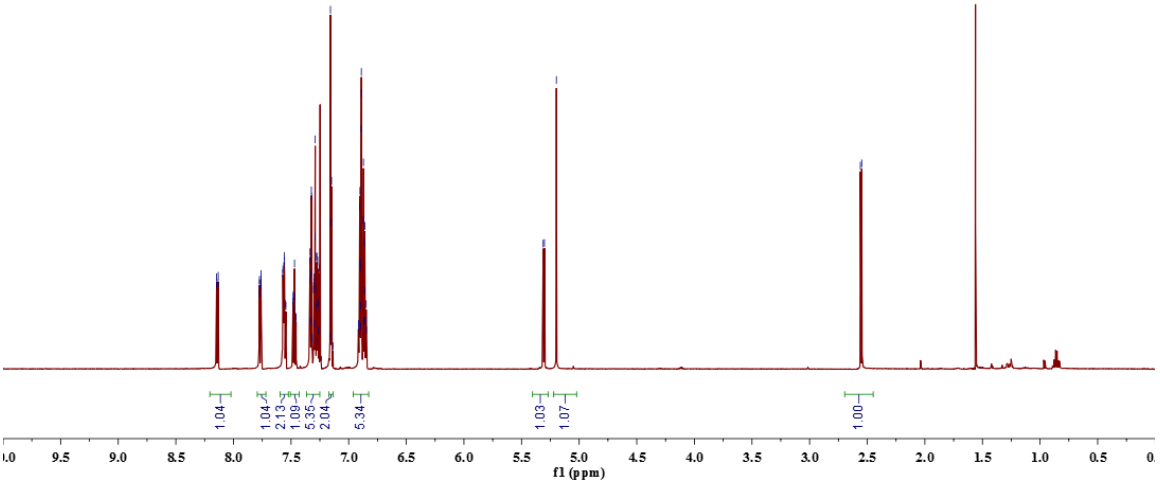

Pr171119-368-II-13C
163.63
161.18
139.87
128.88
128.45
128.41
128.32
127.74
127.66
127.42
127.00
114.78
76.99
71.75
61.14
OH
O
F
3c
f1 (ppm)


OH
O
2d
f1 (ppm)

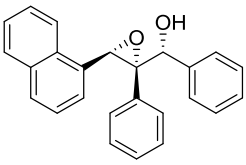

zzf181018-nai-opt-1 1
single pulse decoupled gated NOE
OH
O
2d
f1 (ppm)



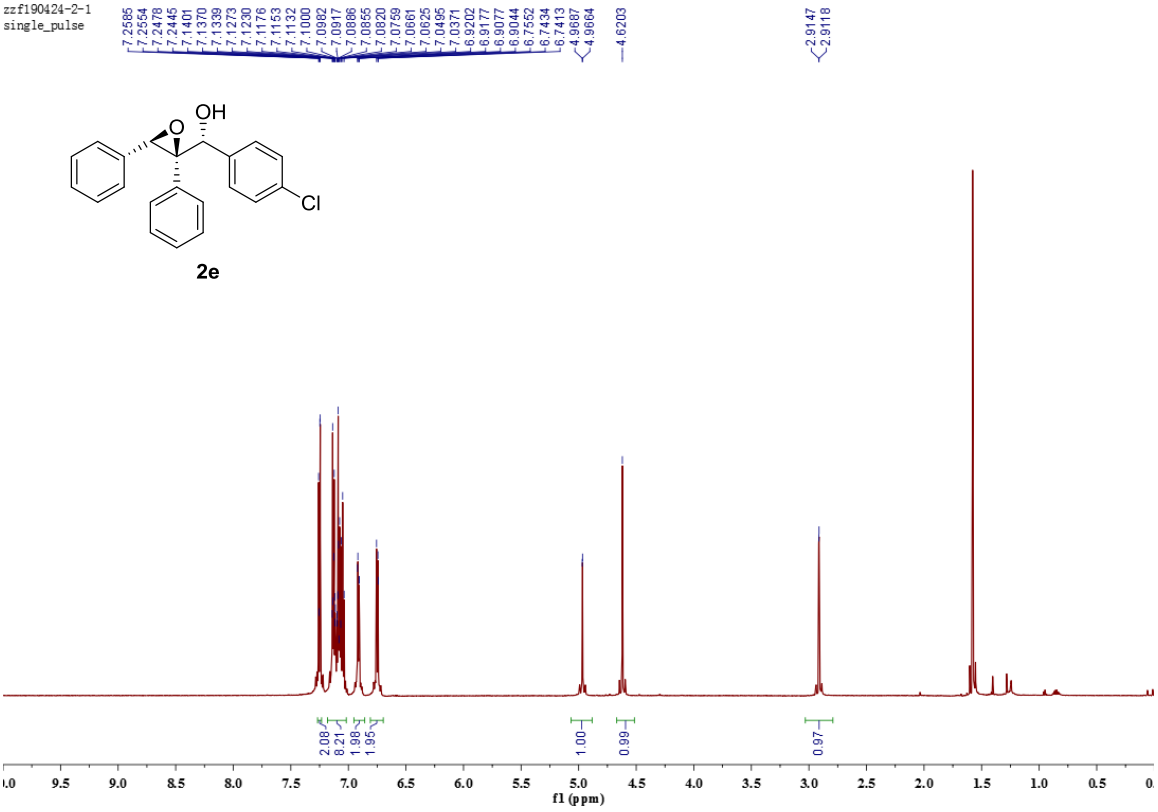
3d

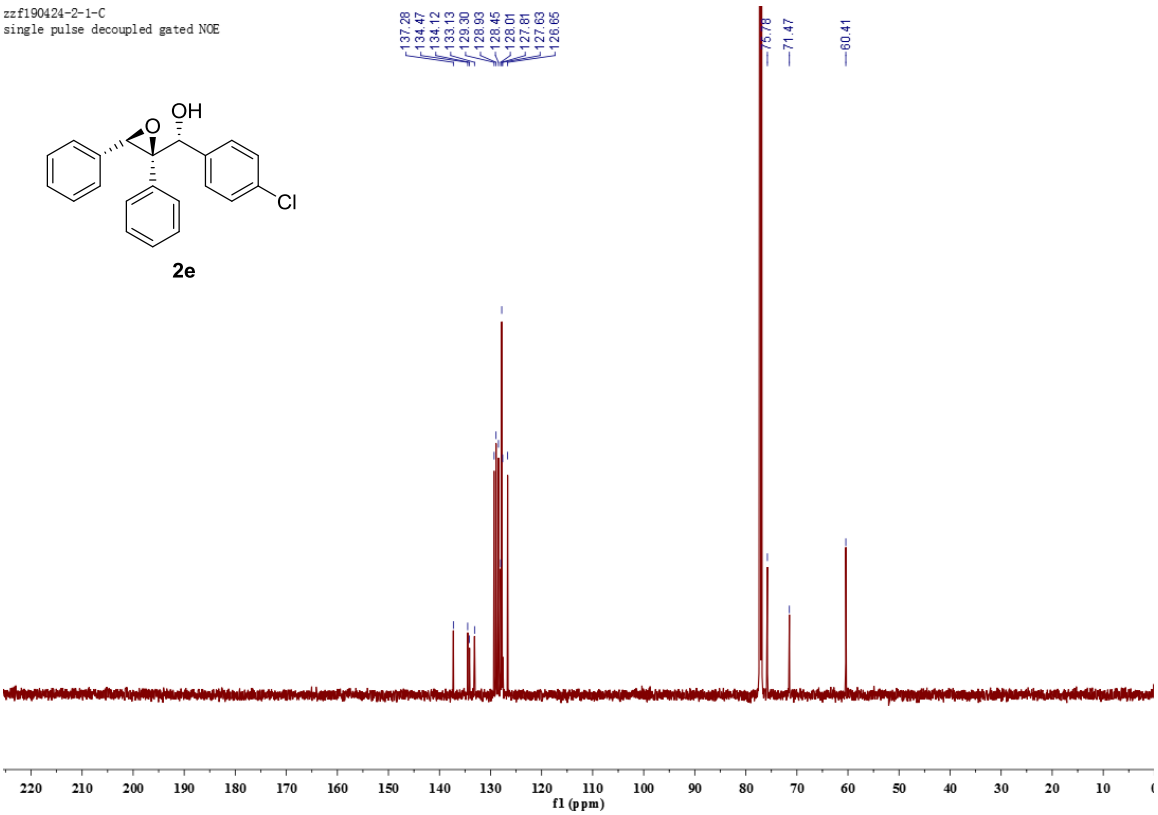


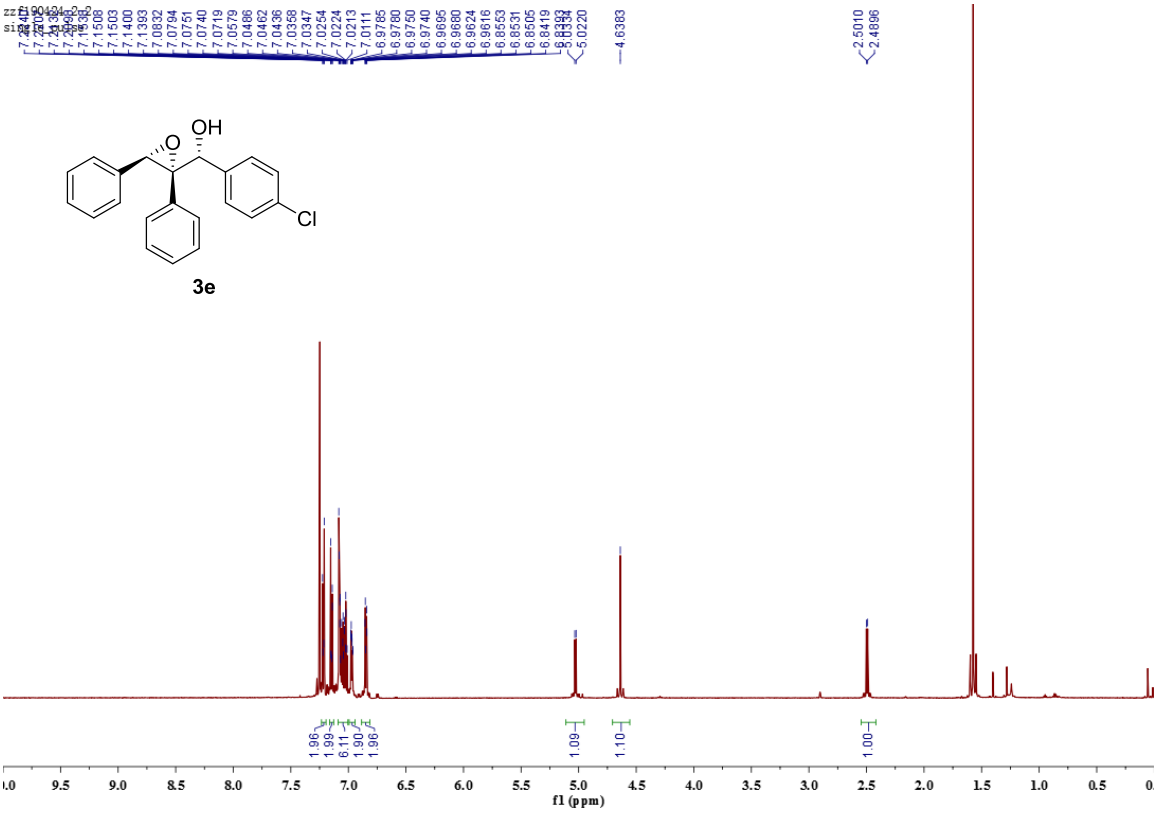
zzf181018-nai-opt--2
single pulse decoupled gated NOE

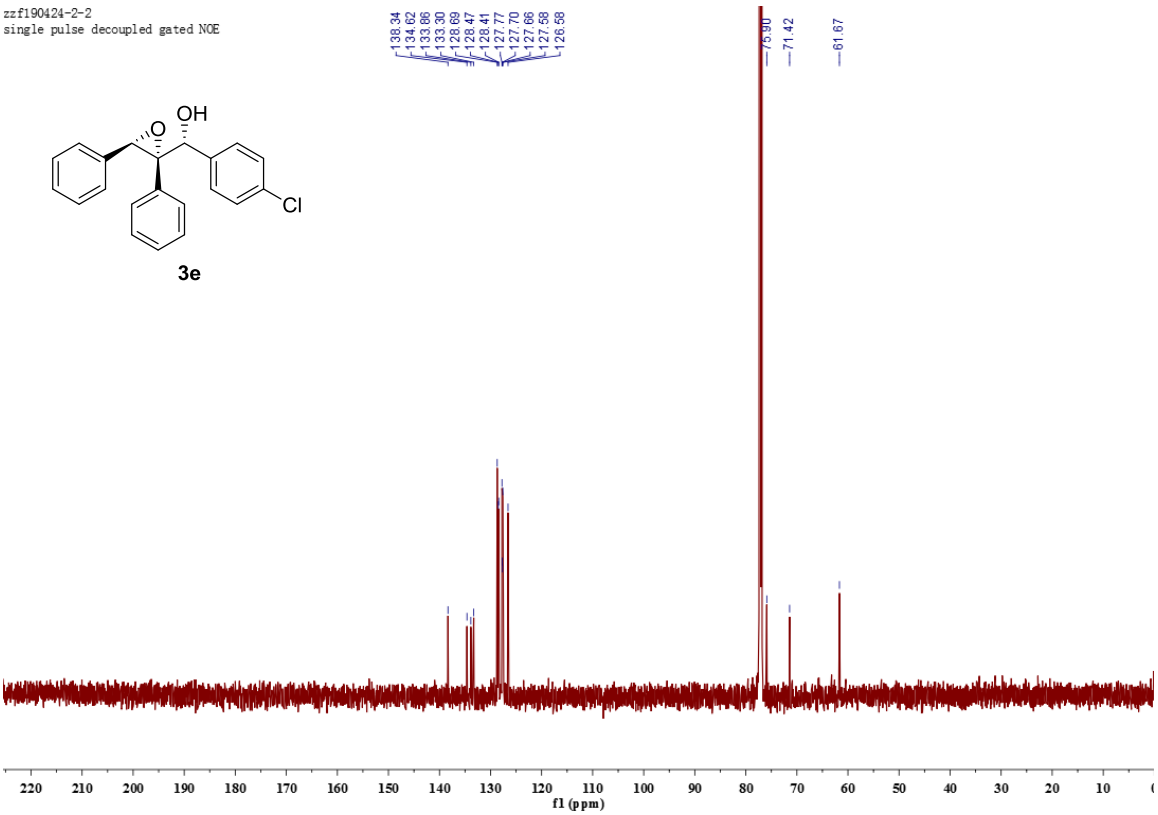


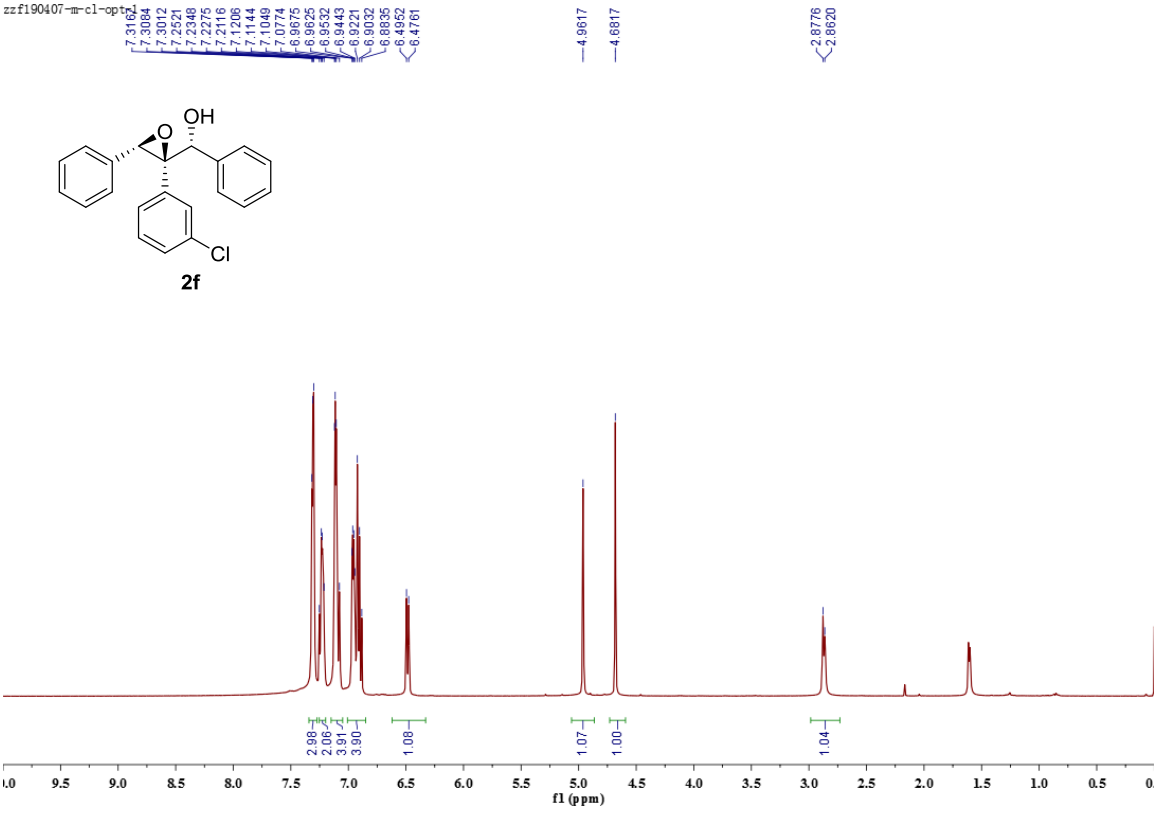
3d

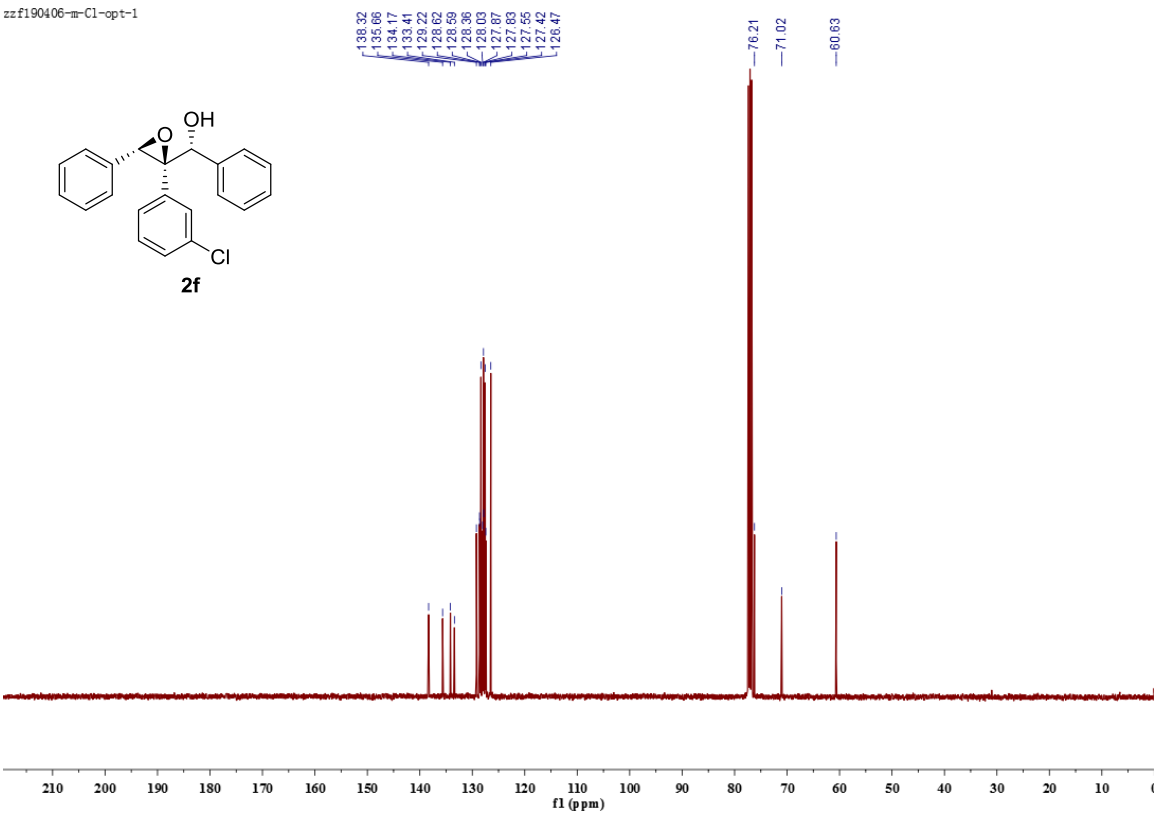

zzf190424-2-1
single_pulse
OH
O
Cl
2e
f1 (ppm)

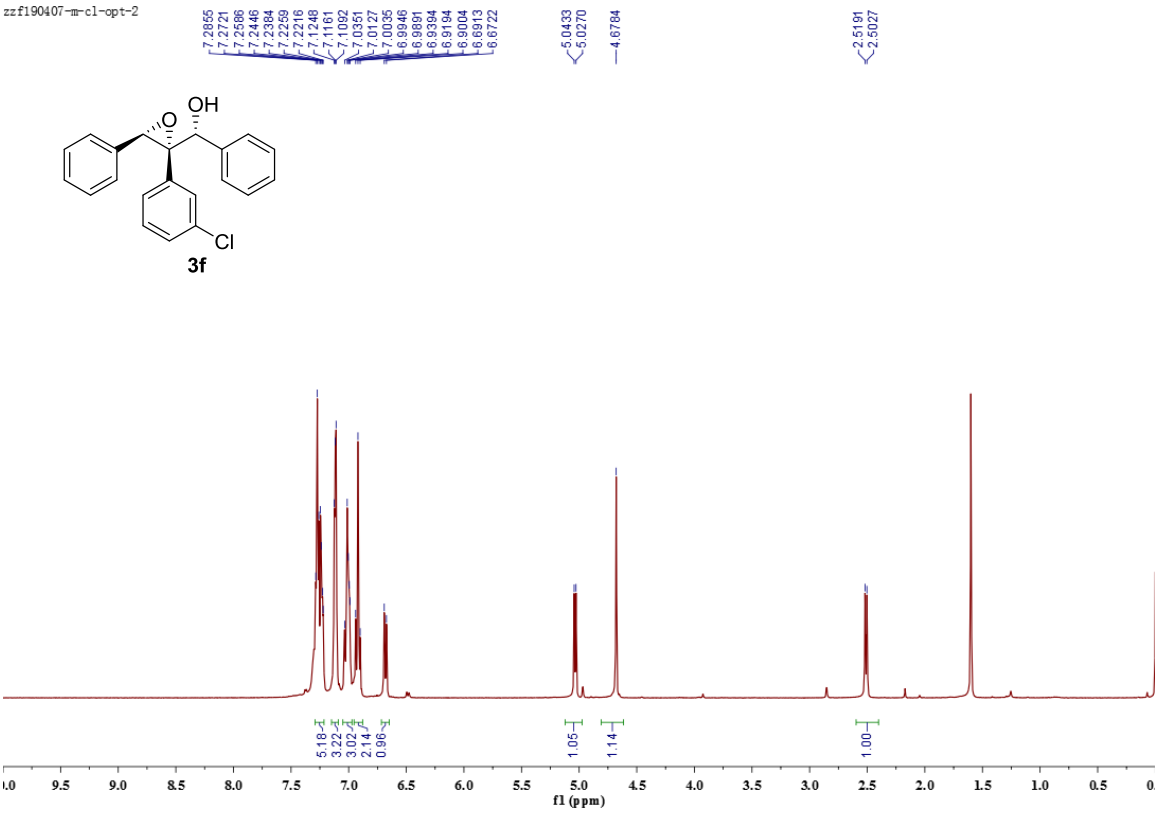

zzf190424-2-1-C
single pulse decoupled gated NOE
OH
O
Cl
2e
f1 (ppm)

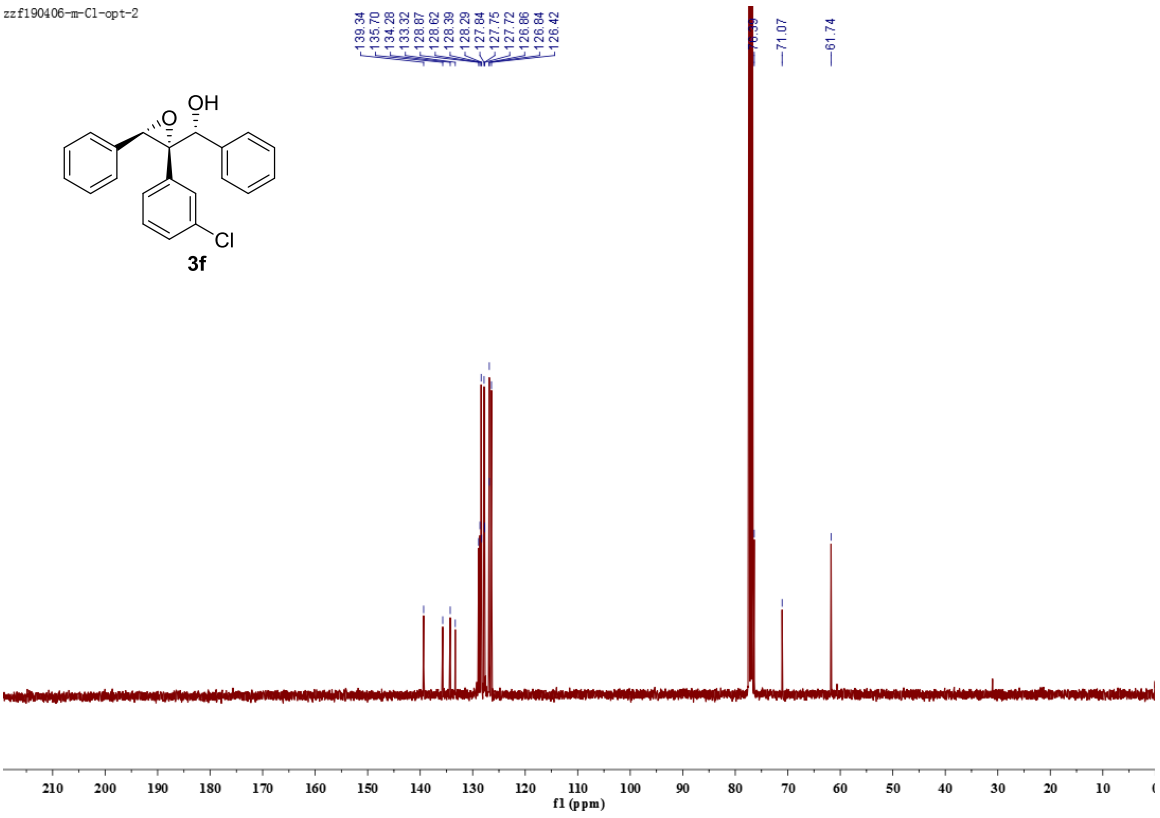

OH
O
Cl
3e
4.6383
2.5010
2.4896
1.96
1.99
6.11
1.90
1.98
1.09
1.10
1.00
f1 (ppm)

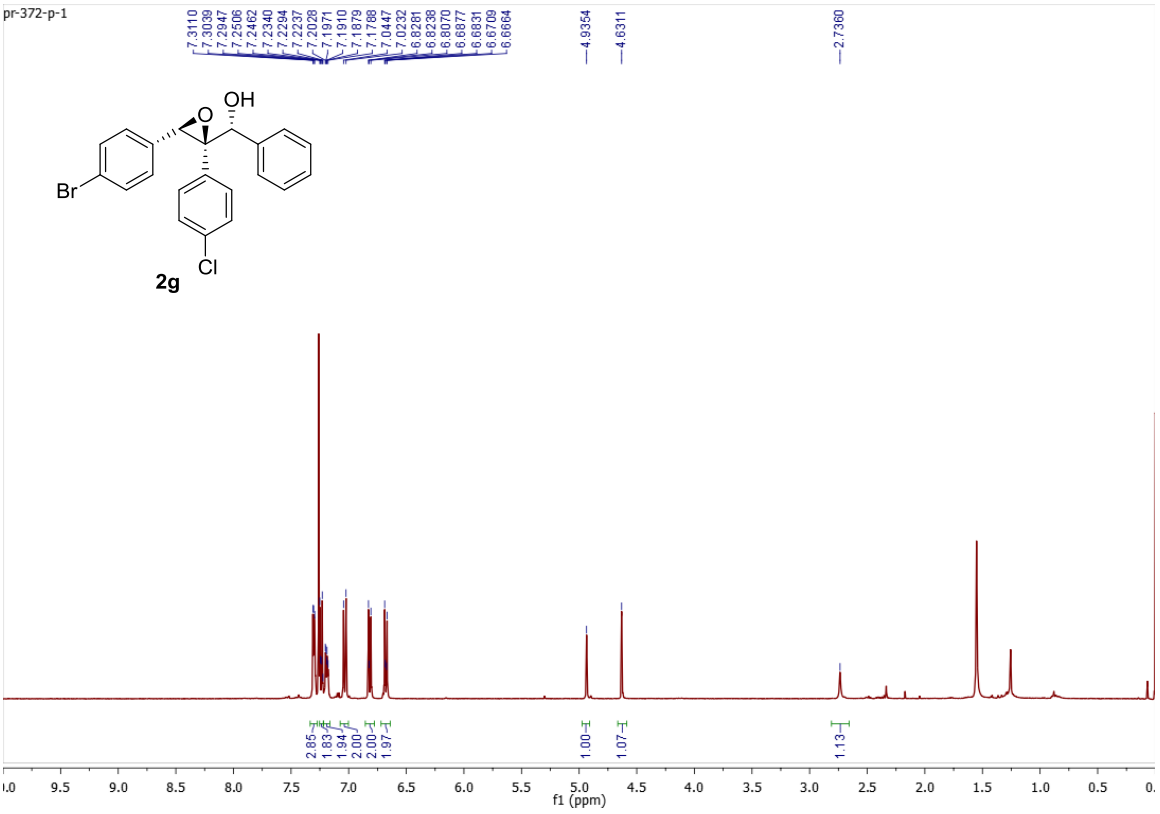

zzf190424-2-2
single pulse decoupled gated NOE
OH
O
Cl
3e
138.34
134.62
133.88
133.30
128.69
128.47
128.41
127.77
127.70
127.66
127.58
126.58
75.90
71.42
61.67
f1 (ppm)

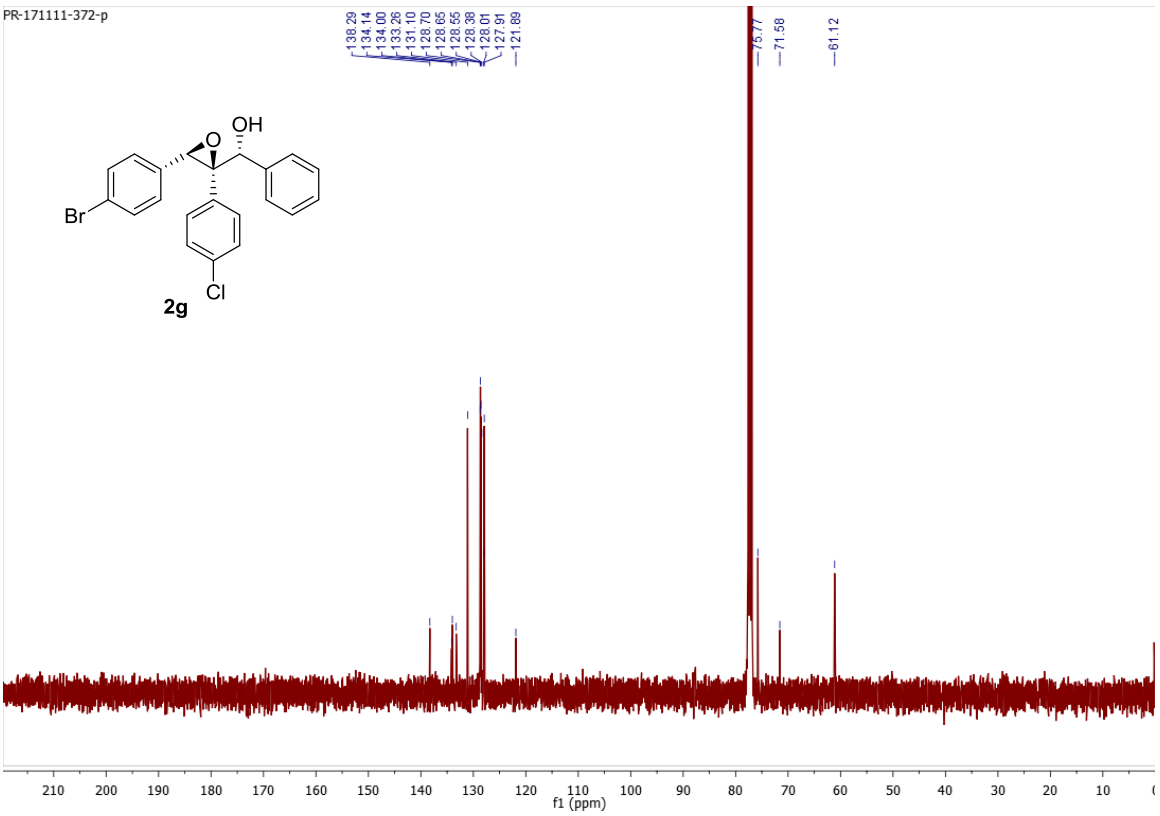

zzf190407-m-cl-opt-1
7.3162
7.3084
7.3012
7.2521
7.2348
7.2275
7.2116
7.1206
7.1144
7.1049
7.0774
6.9675
6.9625
6.9532
6.9443
6.9221
6.9032
6.8835
6.4952
6.4761
4.9617
4.6817
2.8776
2.8620
OH
O
Cl
2f
2.98
2.06
3.91
3.90
1.08
1.07
1.00
1.04
f1 (ppm)

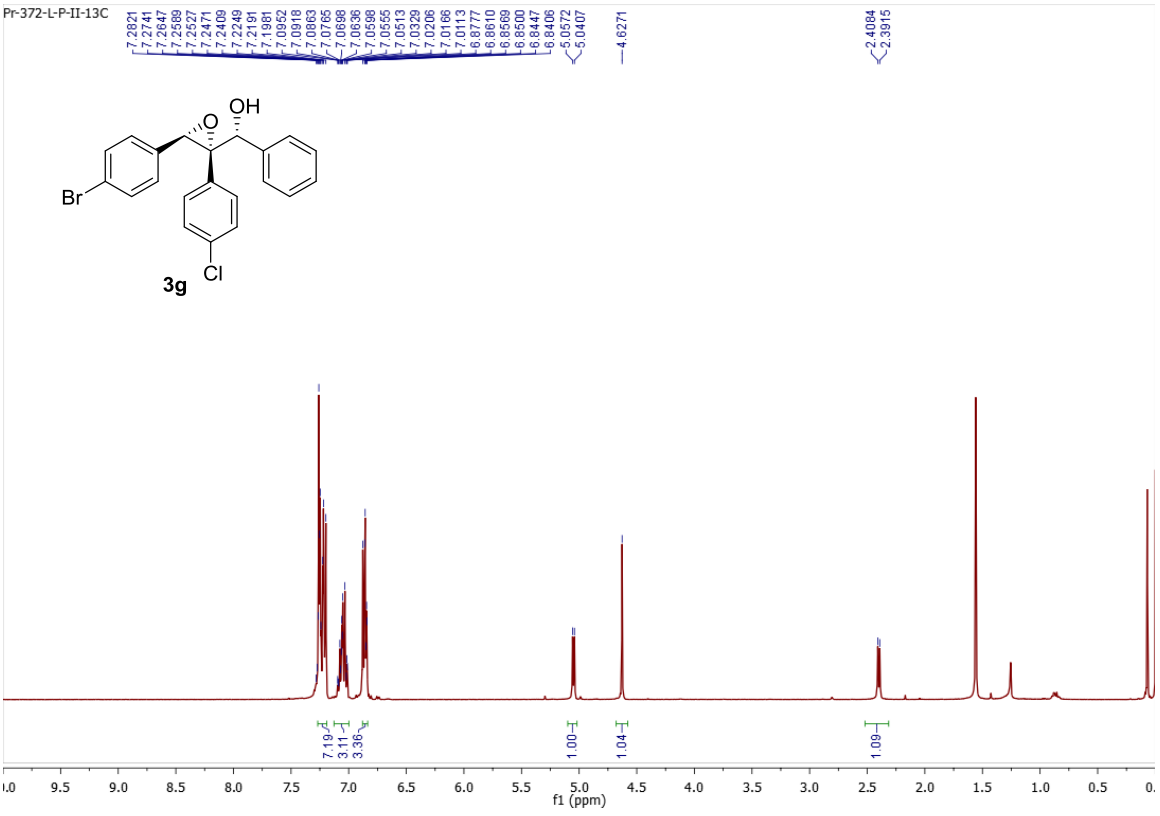

zzf190406-m-Cl-opt-1
138.32
135.66
134.17
133.41
129.22
128.62
128.59
128.36
128.03
127.87
127.83
127.55
127.42
126.47
76.21
71.02
60.63
OH
O
Cl
2f
f1 (ppm)

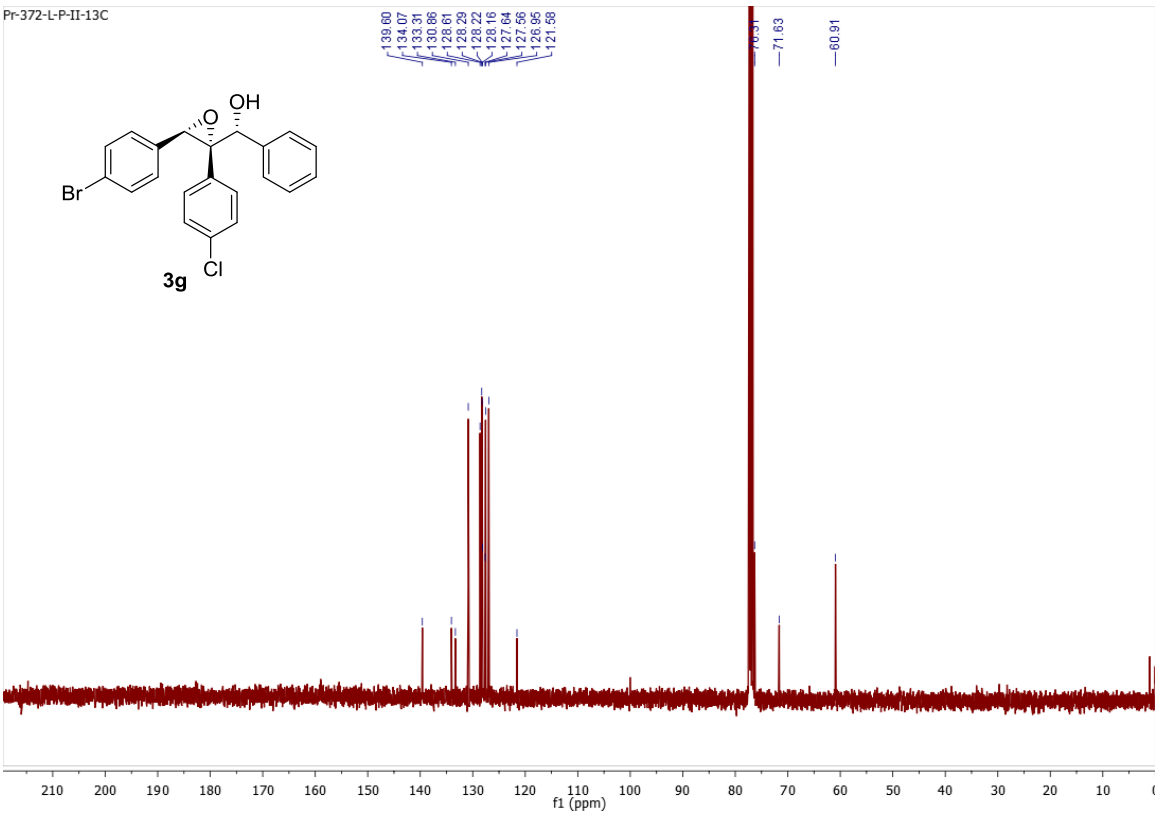

zzf190407-m-cl-opt-2
7.2855
7.2721
7.2566
7.2446
7.2384
7.2259
7.2216
7.1248
7.1161
7.1092
7.0351
7.0127
7.0035
6.9946
6.9891
6.9394
6.9194
6.9004
6.6913
6.6722
5.0433
5.0270
4.6784
2.5191
2.5027
OH
O
Cl
3f
5.18
3.22
3.02
2.14
0.96
1.05
1.14
1.00
f1 (ppm)

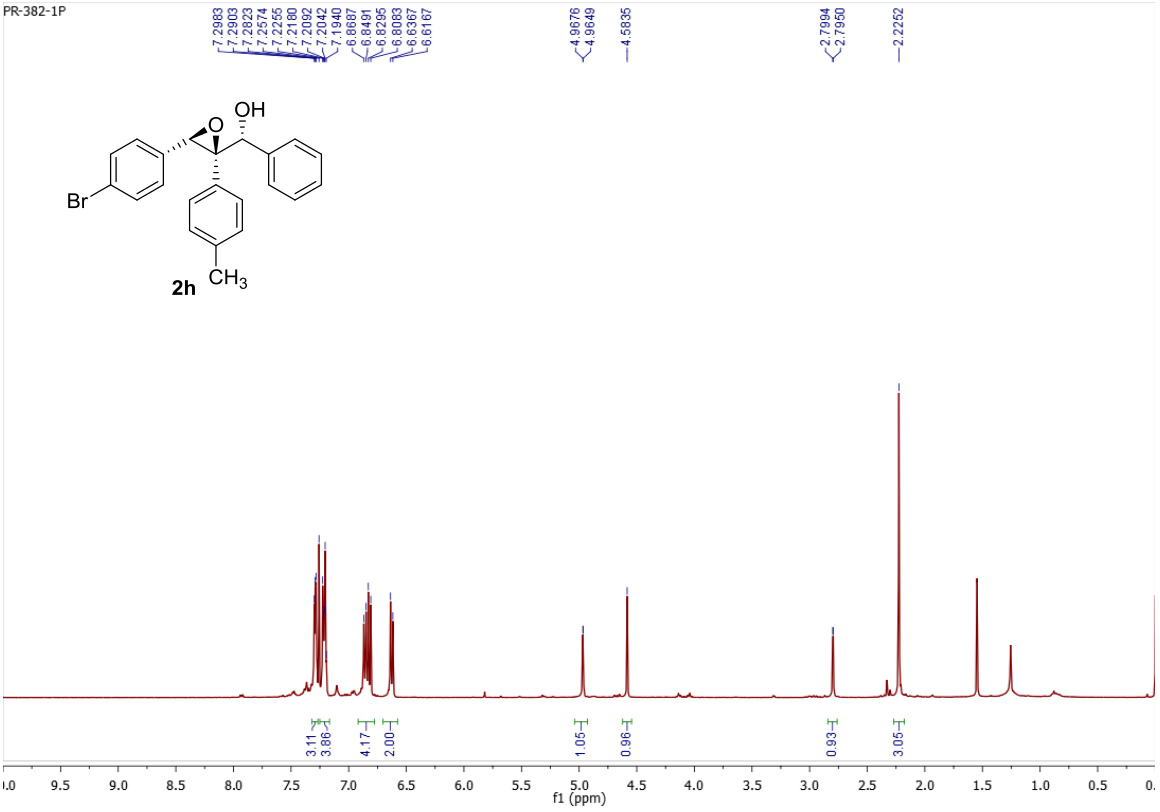

zzf190406-m-Cl-opt-2
139.34
135.70
134.28
133.32
128.87
128.62
128.39
128.29
127.84
127.75
127.72
126.86
126.64
126.42
76.39
71.07
61.74
OH
O
Cl
3f
f1 (ppm)

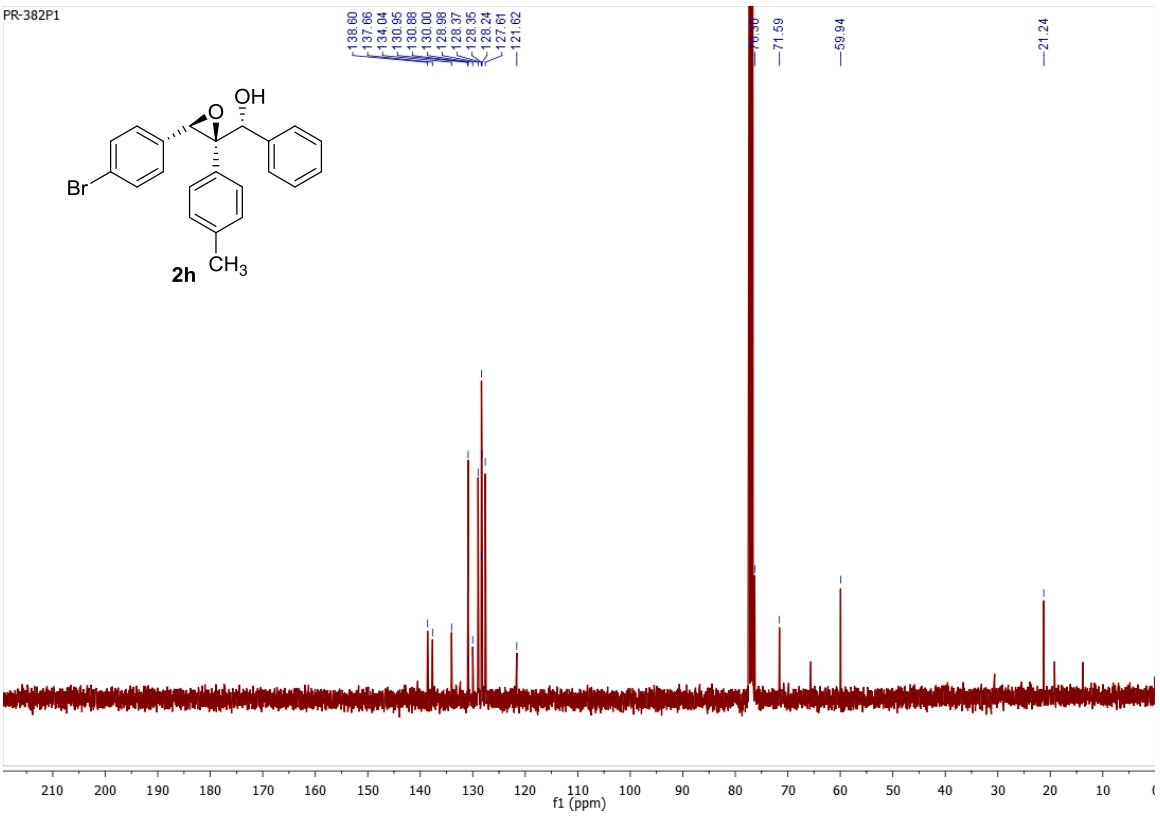

pr-372-p-1
7.3110
7.3039
7.2947
7.2506
7.2462
7.2340
7.2294
7.2237
7.2028
7.1971
7.1910
7.1879
7.1788
7.0447
7.0232
6.8261
6.8238
6.8070
6.6877
6.6831
6.6709
6.6664
4.9354
4.6311
2.7360
OH
O
Br
Cl
2g
2.85
1.83
1.94
2.00
2.00
1.97
1.00
1.07
1.13
f1 (ppm)

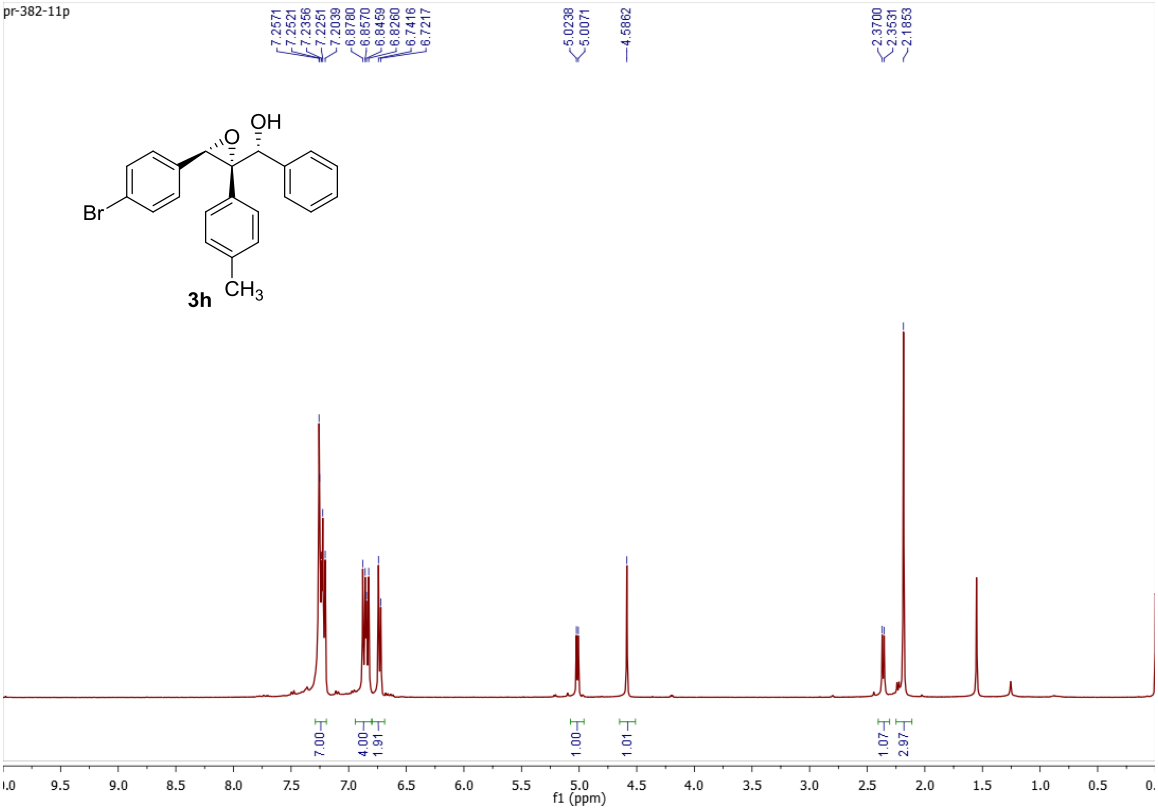

PR-171111-372-p
138.29
134.14
134.00
133.26
131.10
128.70
128.65
128.55
128.38
128.01
127.91
121.89
75.77
71.58
61.12
OH
O
Br
Cl
2g
f1 (ppm)

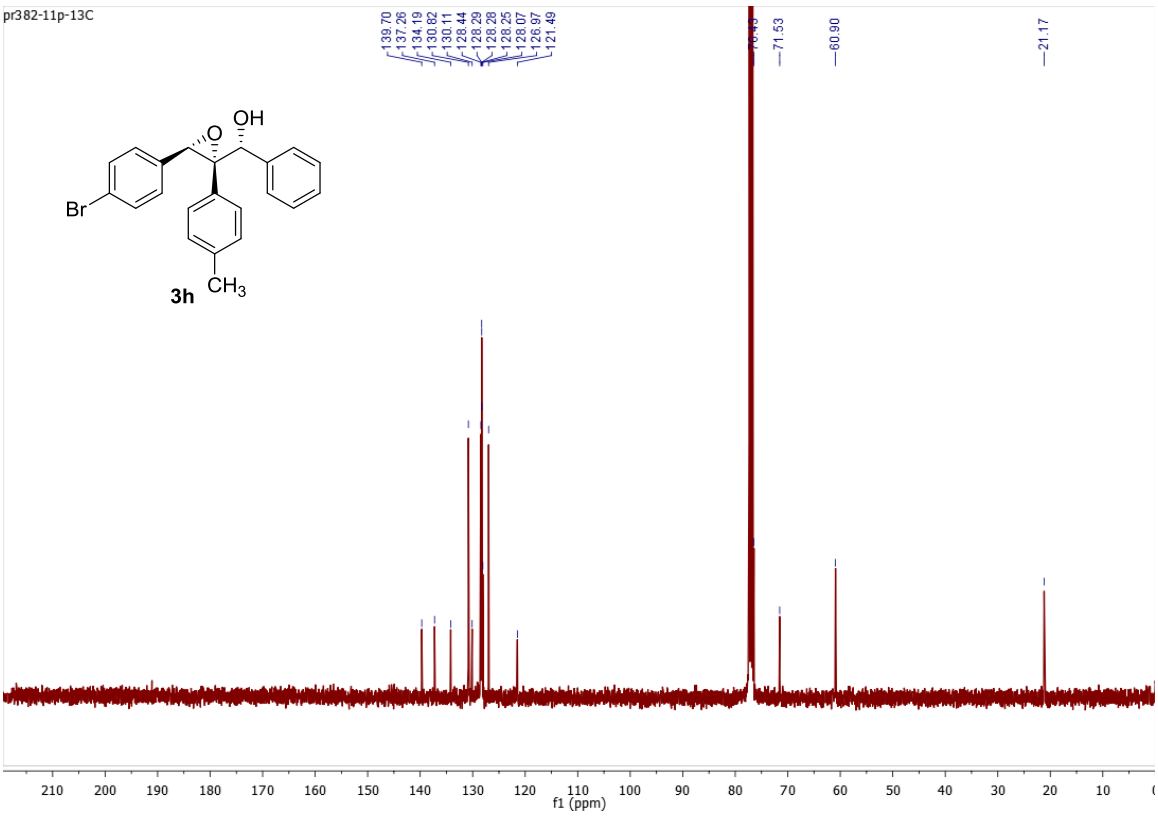

Pr-372-L-P-II-13C
7.2821
7.2741
7.2647
7.2589
7.2527
7.2471
7.2409
7.2249
7.2191
7.1981
7.0952
7.0918
7.0863
7.0765
7.0698
7.0636
7.0598
7.0555
7.0513
7.0329
7.0206
7.0166
7.0113
6.8777
6.8610
6.8569
6.8500
6.8447
6.8406
5.0572
5.0407
4.6271
2.4084
2.3915
OH
O
Br
Cl
3g
7.19
3.11
3.36
1.00
1.04
1.09
f1 (ppm)

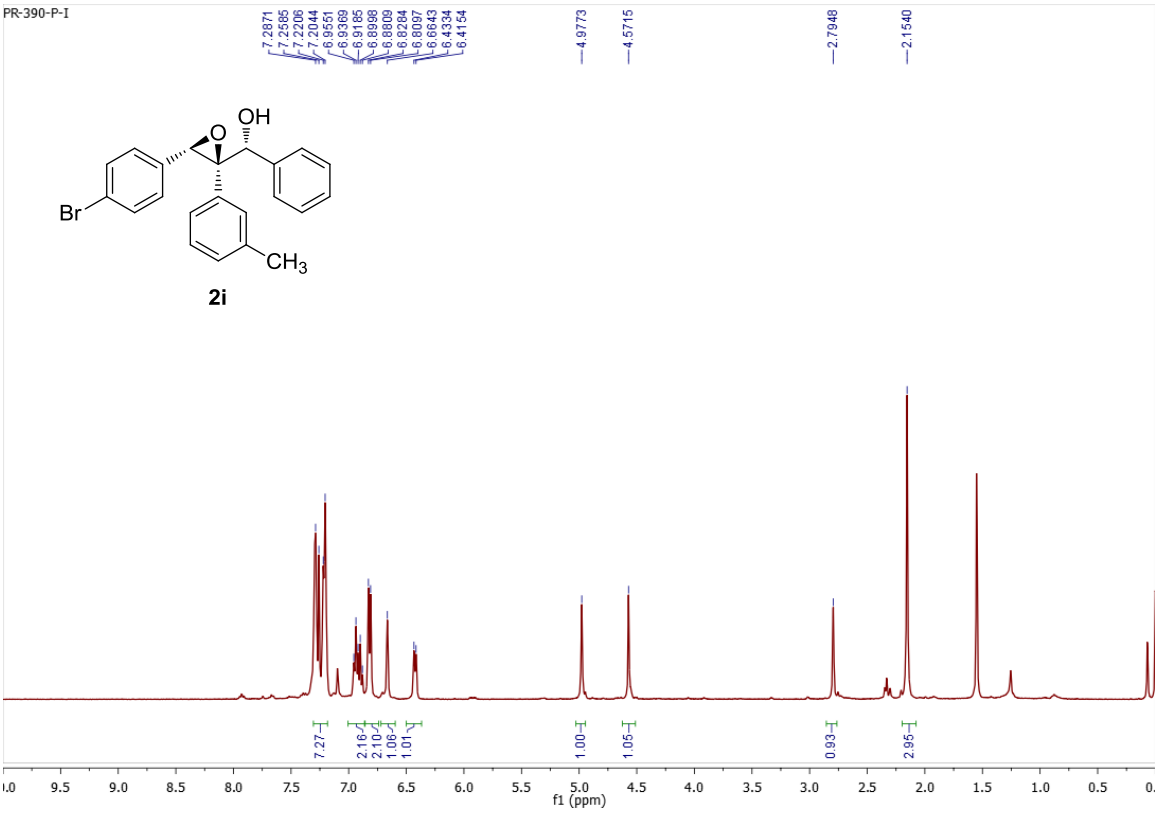

Pr-372-L-P-II-13C
139.60
134.07
133.31
130.86
128.61
128.29
128.22
128.16
127.64
127.56
126.95
121.58
76.31
71.63
60.91
OH
O
Br
Cl
3g
f1 (ppm)

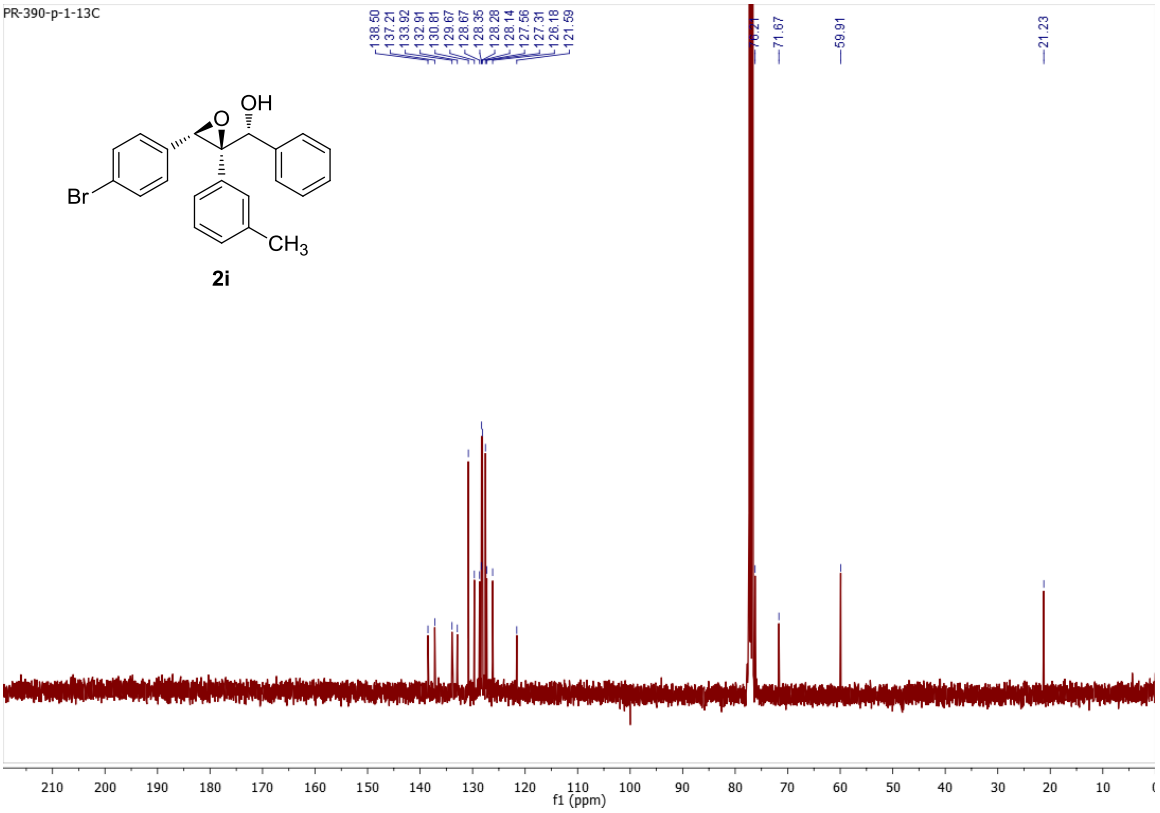

PR-382-1P
7.2983
7.2903
7.2823
7.2574
7.2255
7.2160
7.2092
7.2042
7.1940
6.8687
6.8491
6.8295
6.8083
6.6367
6.6167
4.9676
4.9649
4.5835
2.7994
2.7950
2.2252
OH
O
Br
CH3
2h
3.11
3.86
4.17
2.00
1.05
0.96
0.93
3.05
f1 (ppm)

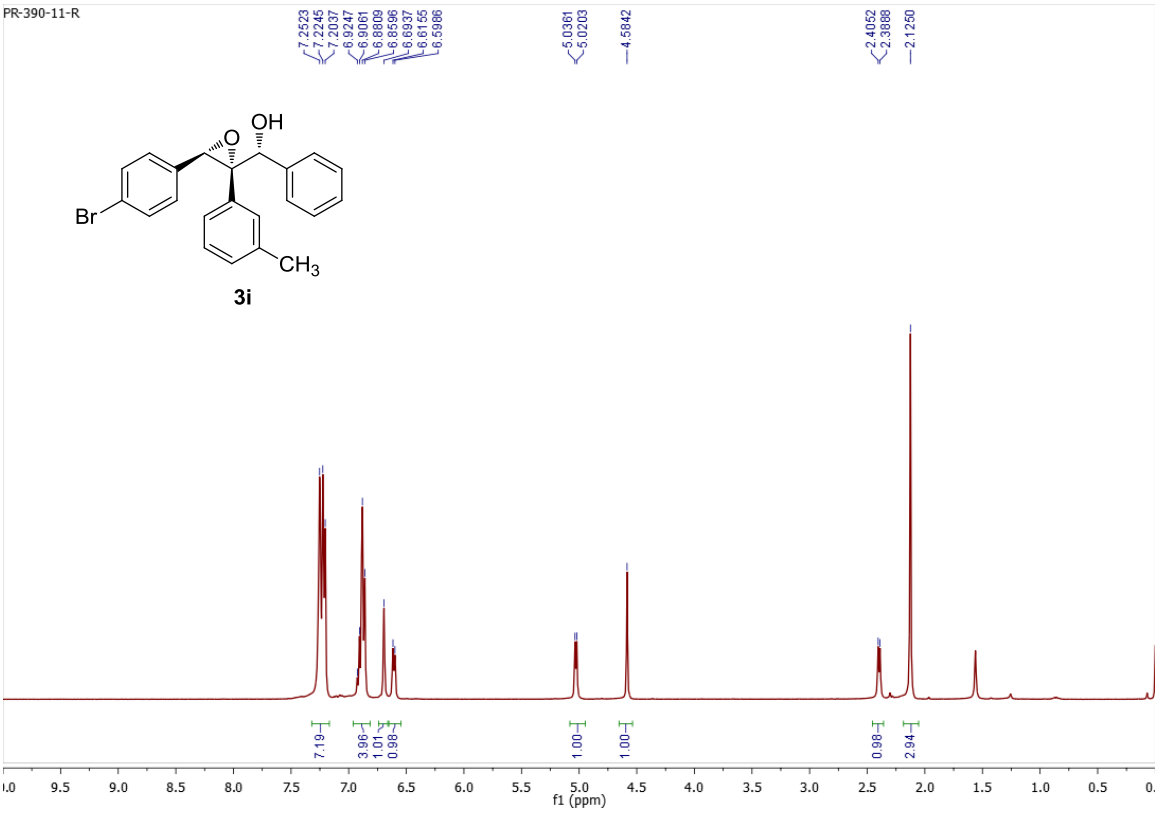

PR-382P1
138.60
137.66
134.04
130.95
130.88
130.00
128.98
128.37
128.35
128.24
127.61
121.62
71.59
59.94
21.24
OH
O
Br
CH3
2h
f1 (ppm)

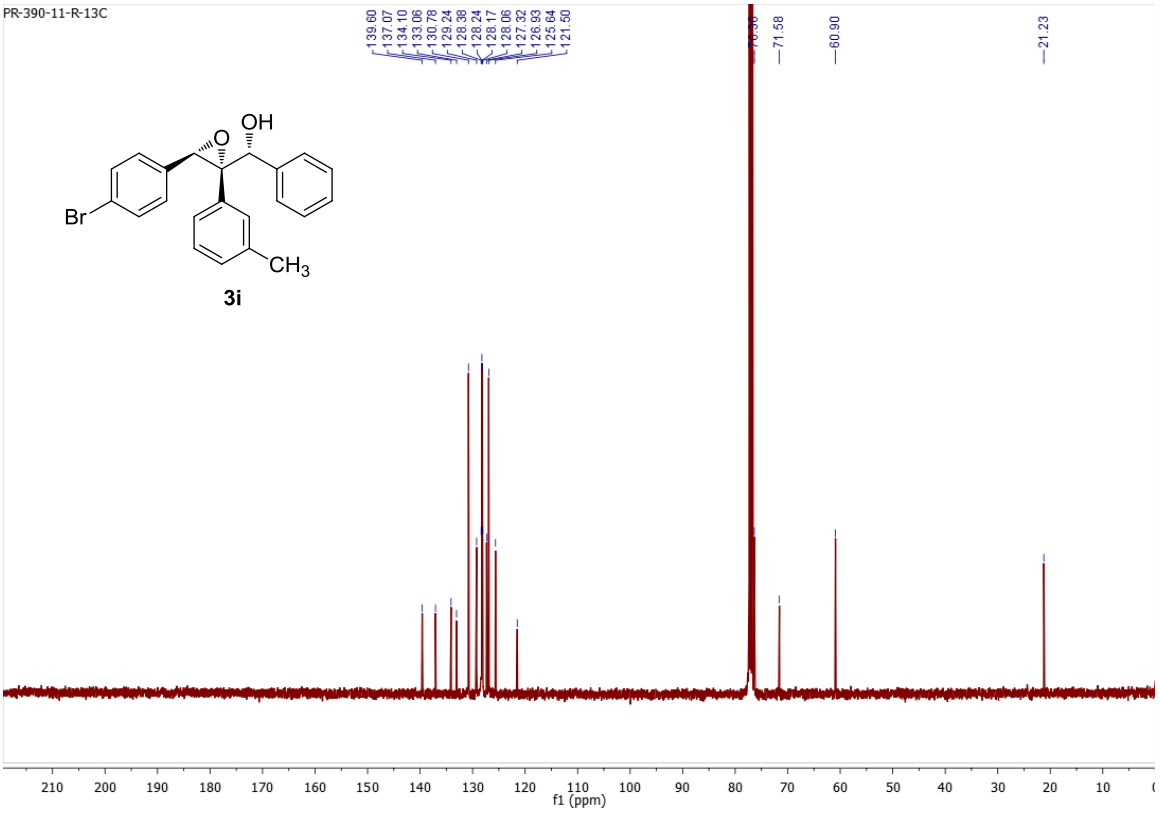

pr-382-11p
7.2571
7.2521
7.2356
7.2251
7.2039
6.8780
6.8570
6.8459
6.8260
6.7416
6.7217
5.0238
5.0071
4.5862
2.3700
2.3531
2.1853
OH
O
Br
CH3
3h
7.00
4.00
1.91
1.00
1.01
1.07
2.97
f1 (ppm)

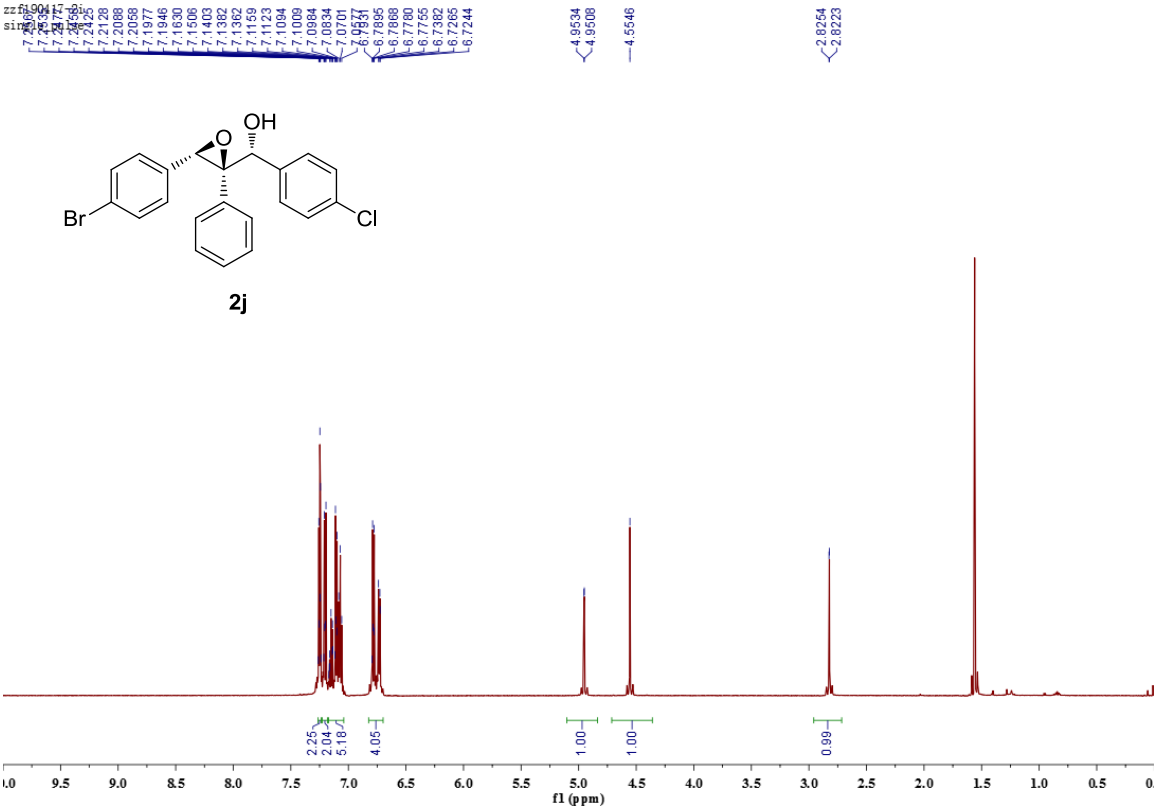

pr382-11p-13C
139.70
137.26
134.19
130.62
130.11
128.44
128.29
128.28
128.25
128.07
126.97
121.49
76.43
71.53
60.90
21.17
OH
O
Br
CH3
3h
f1 (ppm)

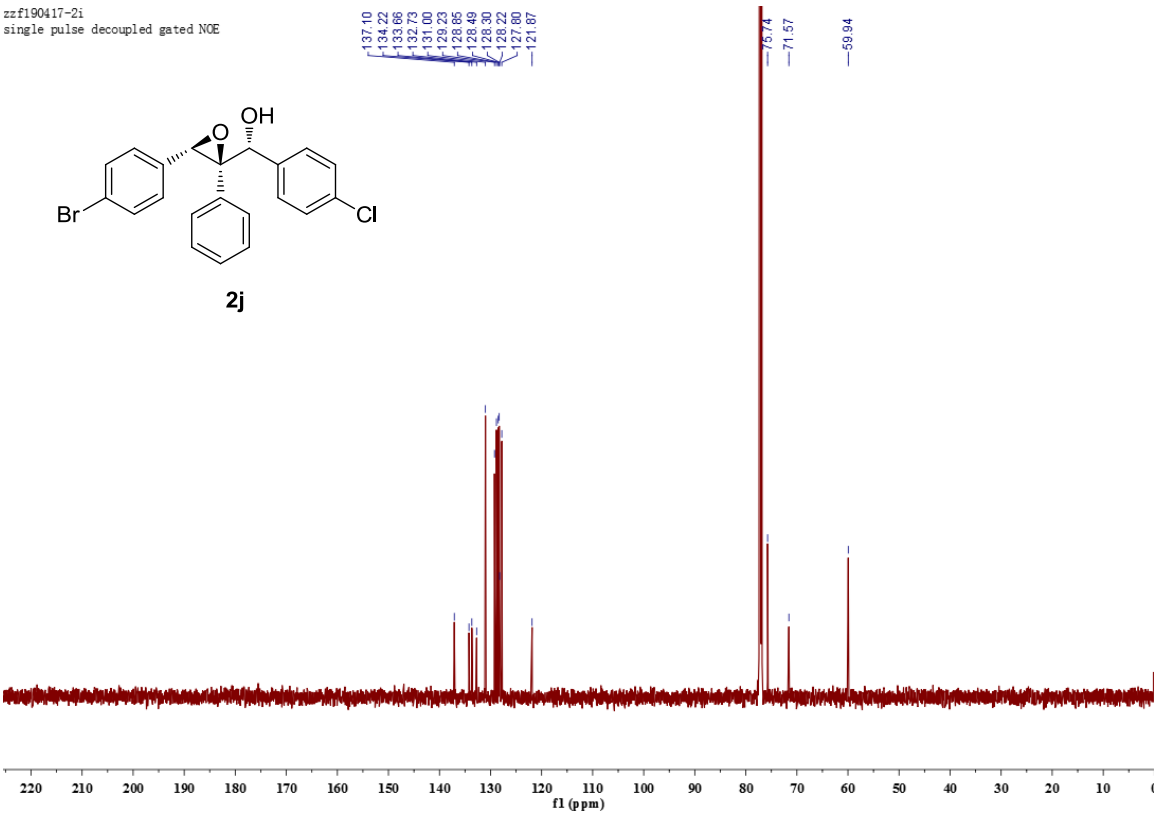

PR-390-P-I
7.2871
7.2585
7.2206
7.2044
6.9551
6.9369
6.9185
6.8998
6.8809
6.8284
6.8097
6.6643
6.4334
6.4154
4.9773
4.5715
2.7948
2.1540
OH
O
Br
CH3
2i
7.27
2.16
2.10
1.06
1.01
1.00
1.05
0.93
2.95
f1 (ppm)

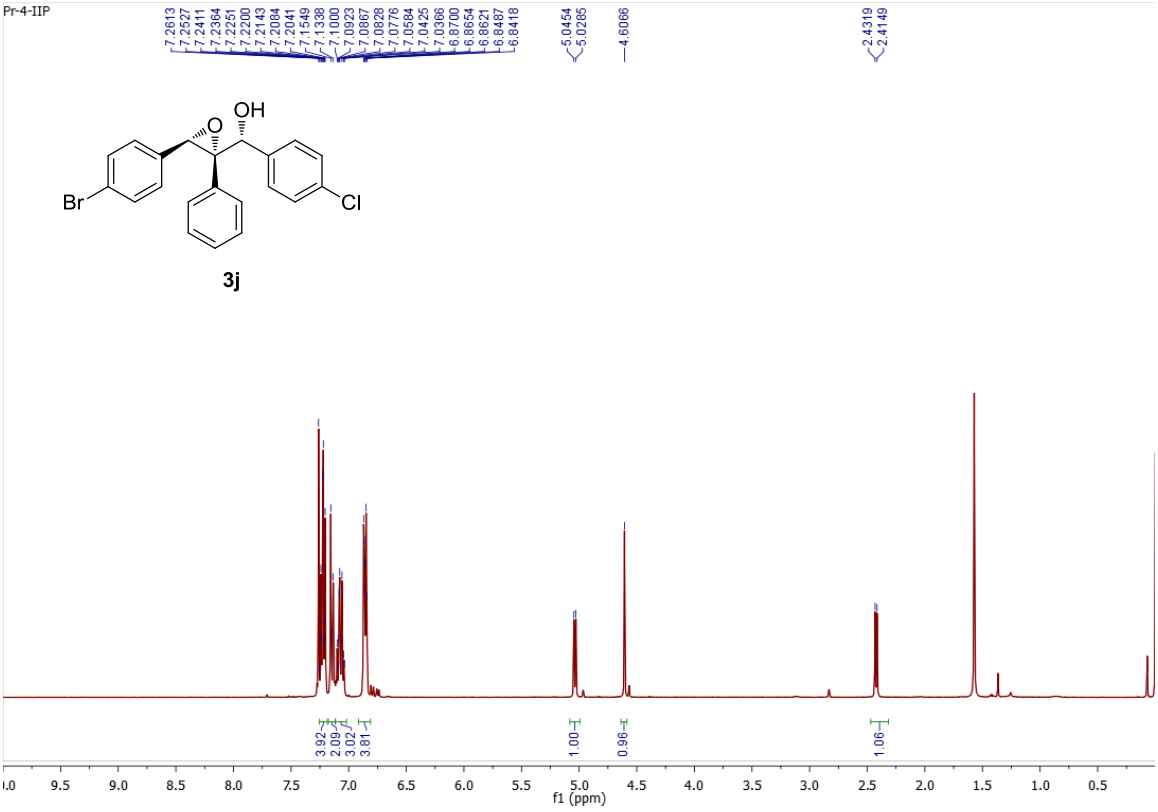

PR-390-p-1-13C
138.50
137.21
133.92
132.91
130.81
129.67
128.67
128.35
128.28
128.14
127.56
127.31
126.18
121.59
76.21
71.67
59.91
21.23
OH
O
Br
CH3
2i
f1 (ppm)

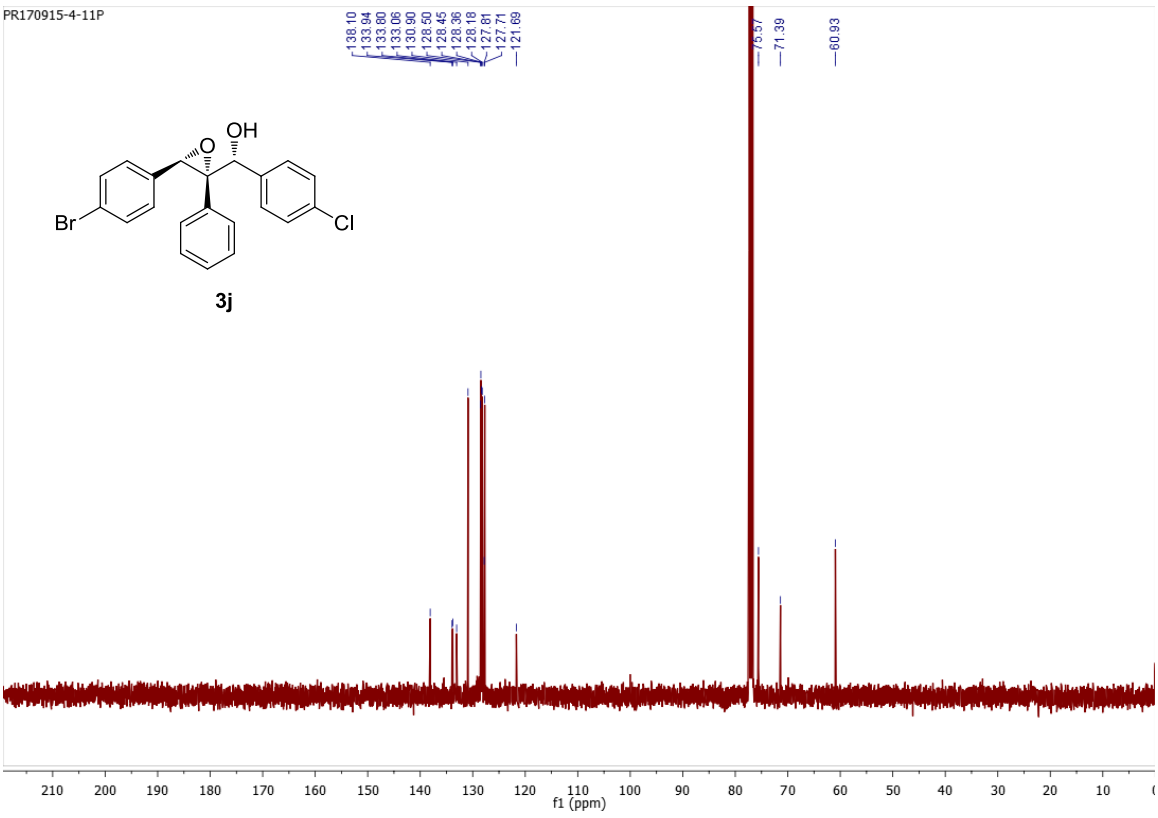

PR-390-11-R
7.2523
7.2245
7.2037
6.9247
6.9061
6.8809
6.8596
6.6937
6.6155
6.5986
5.0361
5.0203
4.5842
2.4052
2.3888
2.1250
OH
O
Br
CH3
3i
7.19
3.96
1.01
0.98
1.00
1.00
0.98
2.94
f1 (ppm)

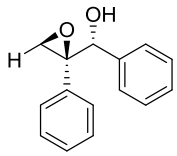

PR-390-11-R-13C
139.60
137.07
134.10
133.06
130.78
129.24
128.38
128.24
128.17
128.06
127.32
126.93
125.64
121.50
71.58
60.90
21.23
OH
O
Br
CH3
3i
f1 (ppm)


OH
O
Br
Cl
2j
f1 (ppm)

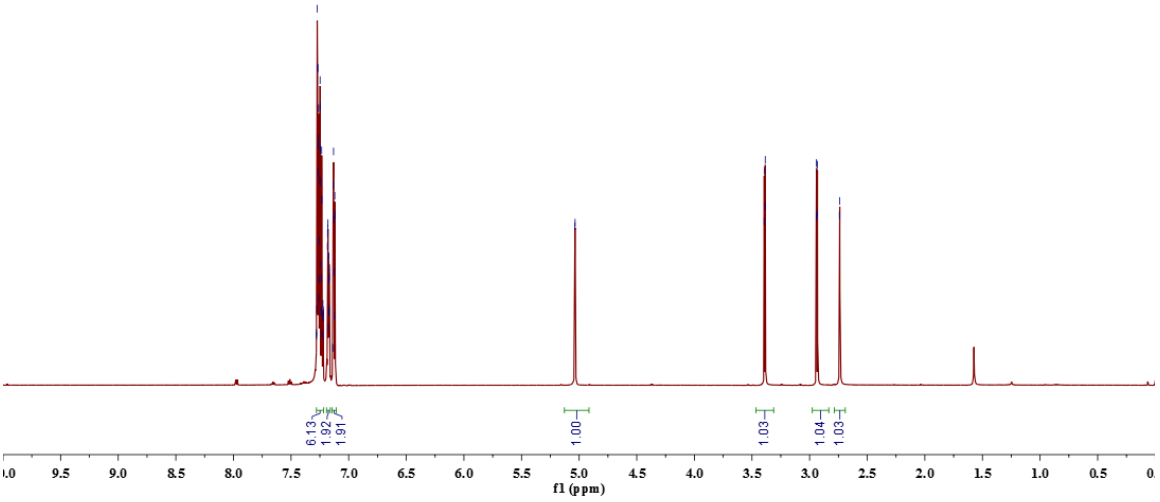

zzf190417-2i
single pulse decoupled gated NOE
OH
O
Br
Cl
2j
f1 (ppm)


Pr-4-IIP
7.2613
7.2527
7.2411
7.2364
7.2251
7.2200
7.2143
7.2084
7.2041
7.1549
7.1338
7.1000
7.0923
7.0867
7.0828
7.0776
7.0584
7.0425
7.0366
6.8700
6.8654
6.8621
6.8467
6.8418
5.0454
5.0285
4.6086
2.4319
2.4149
OH
O
Br
Cl
3j
3.92
2.09
3.02
3.81
1.00
0.96
1.06
f1 (ppm)

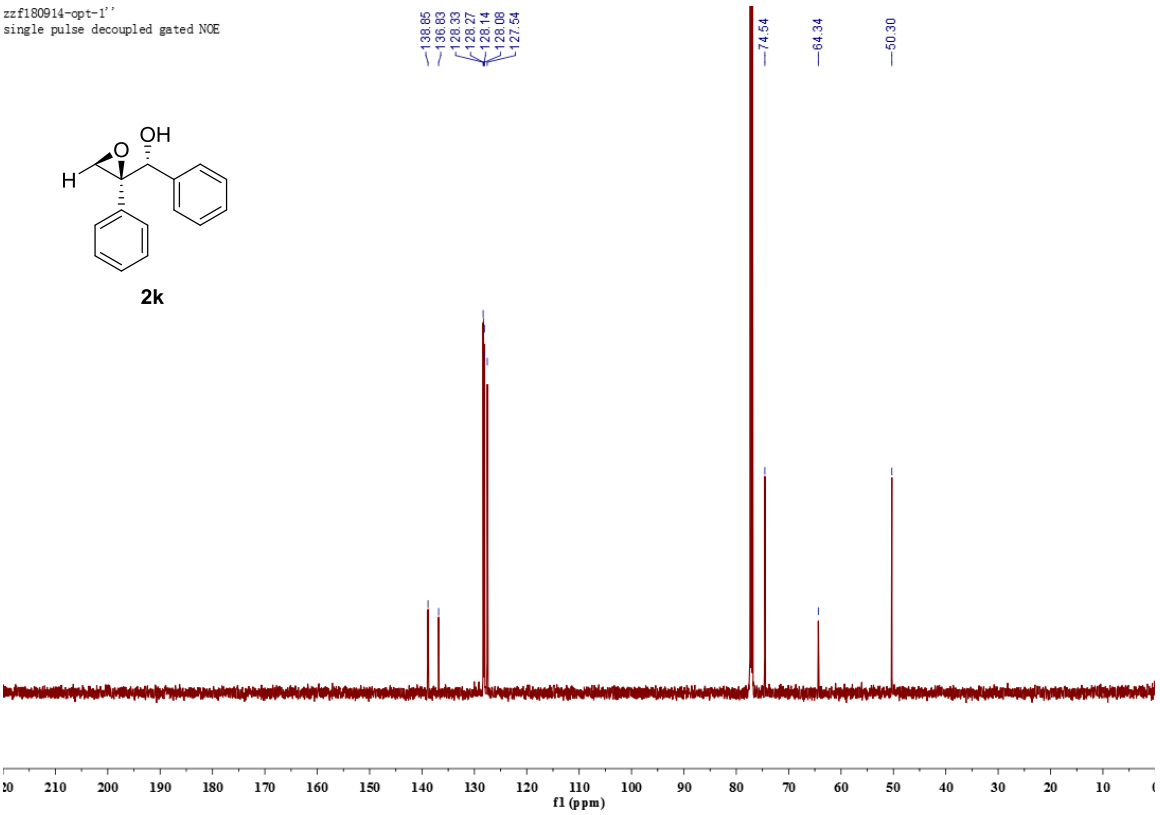

PR170915-4-11P
138.10
133.94
133.80
133.06
130.90
128.50
128.45
128.36
128.18
127.81
127.71
121.69
75.57
71.39
60.93
OH
O
Br
Cl
3j
f1 (ppm)



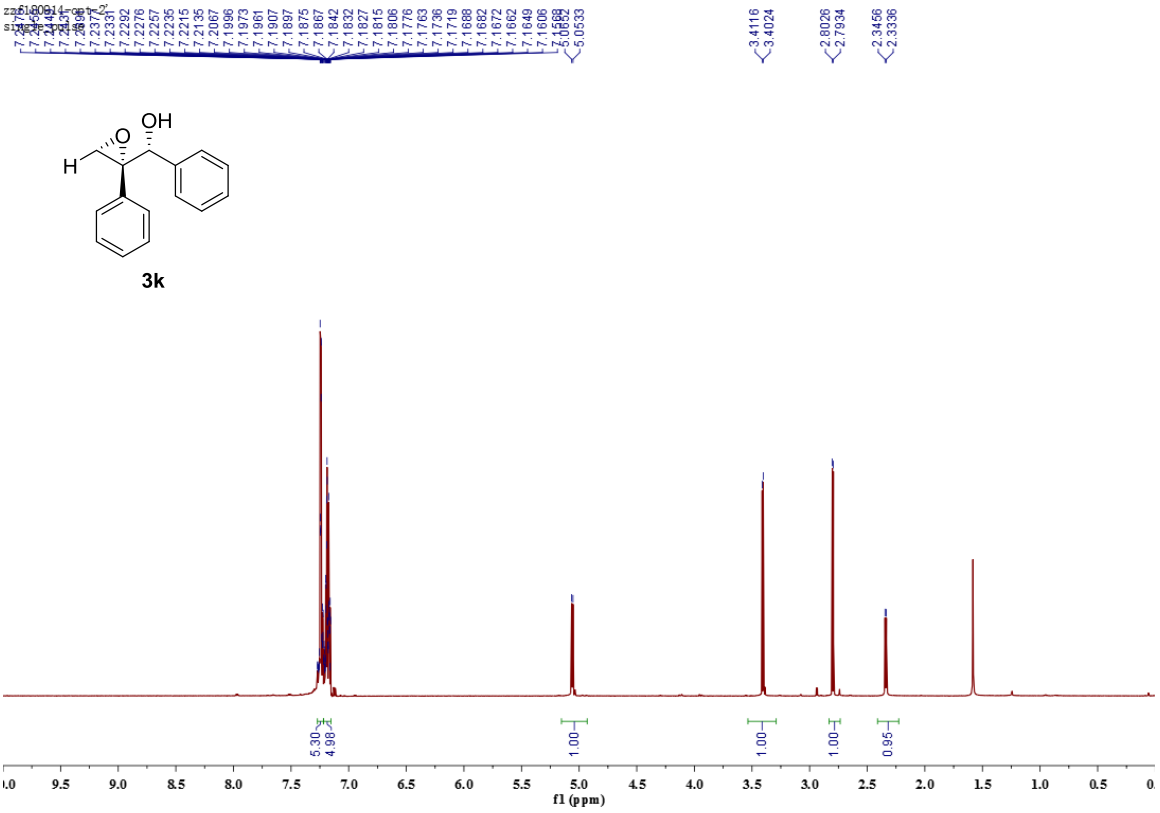
2k

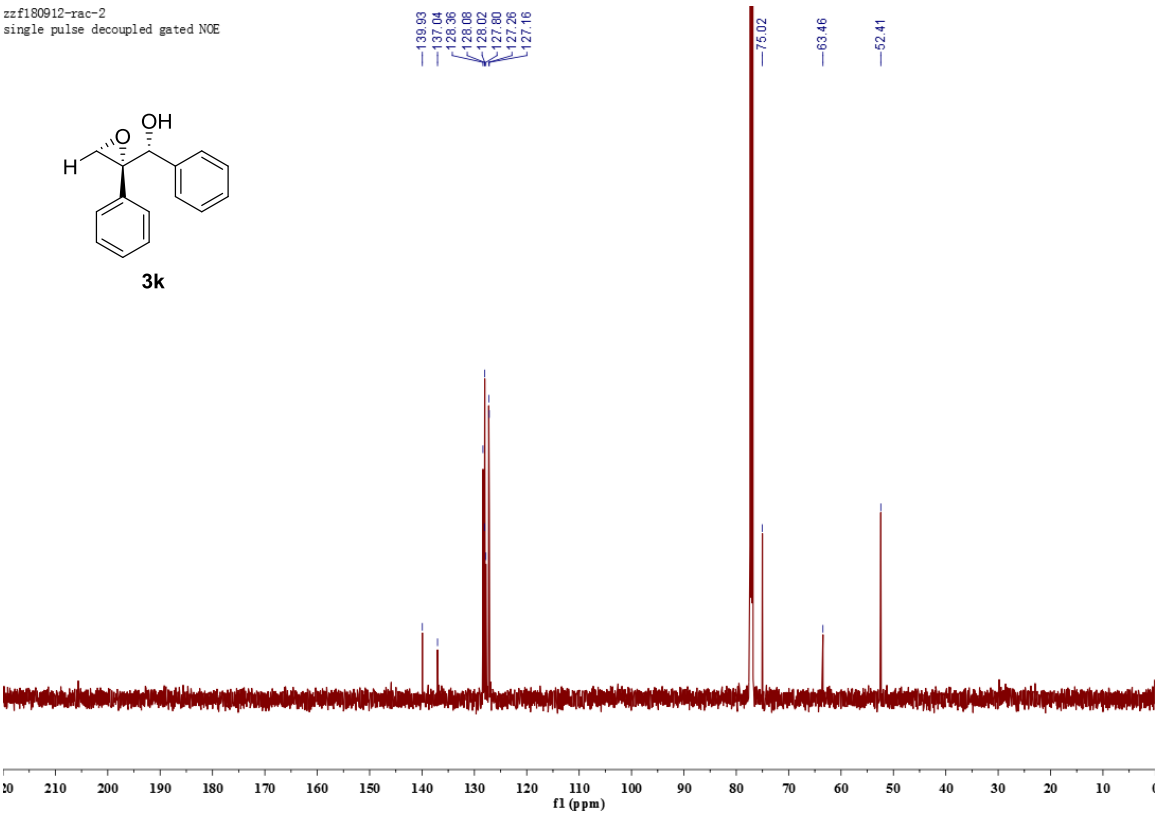


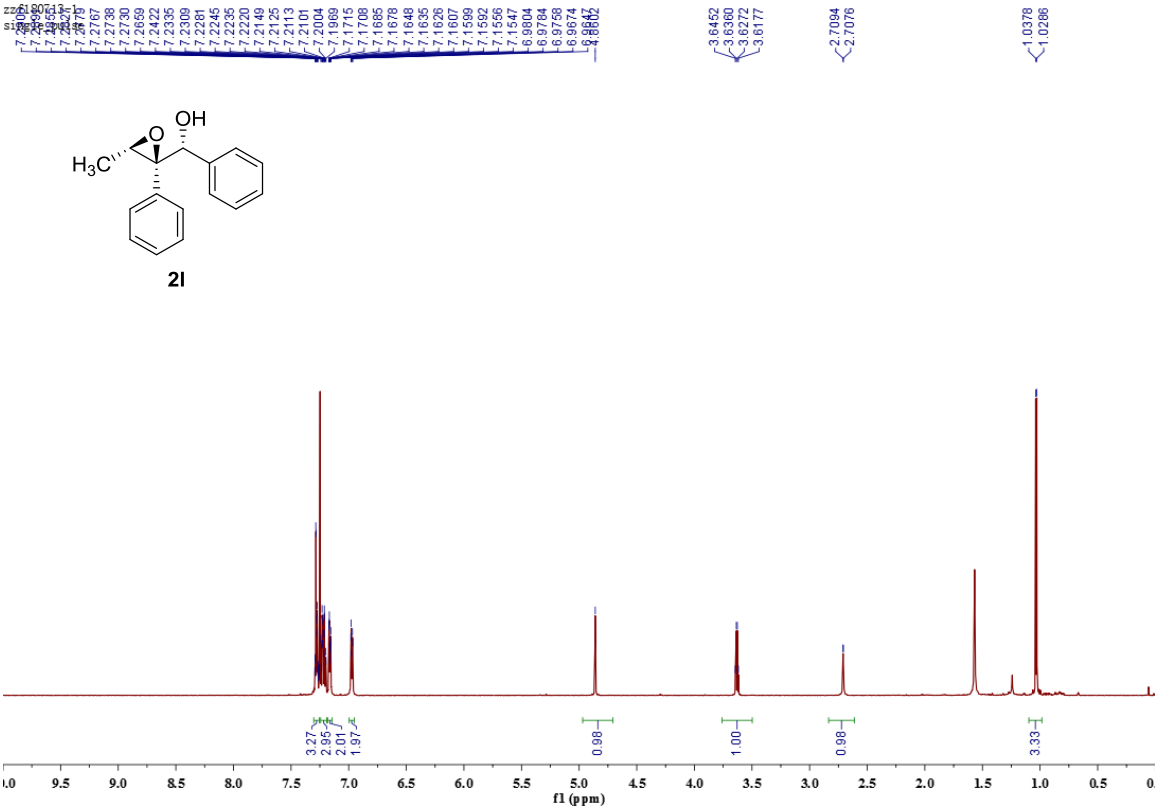
zzf180914-opt-1''
single pulse decoupled gated NOE

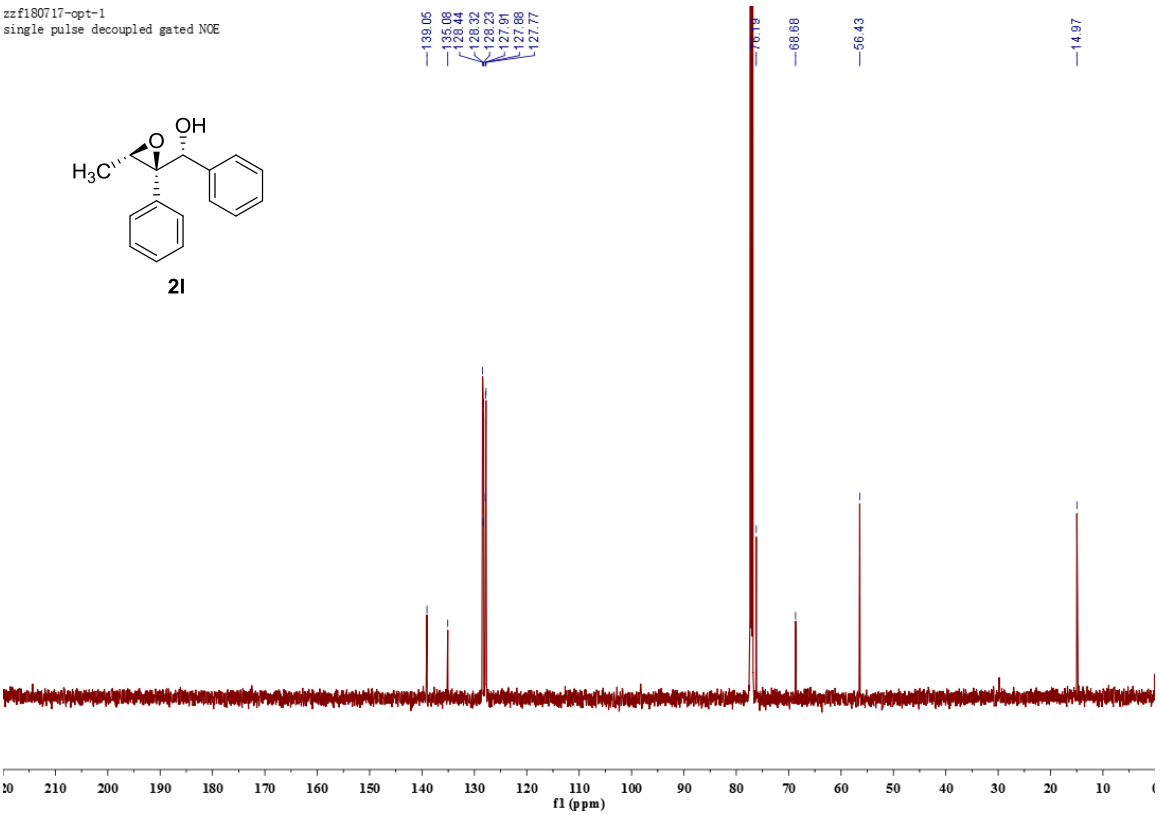


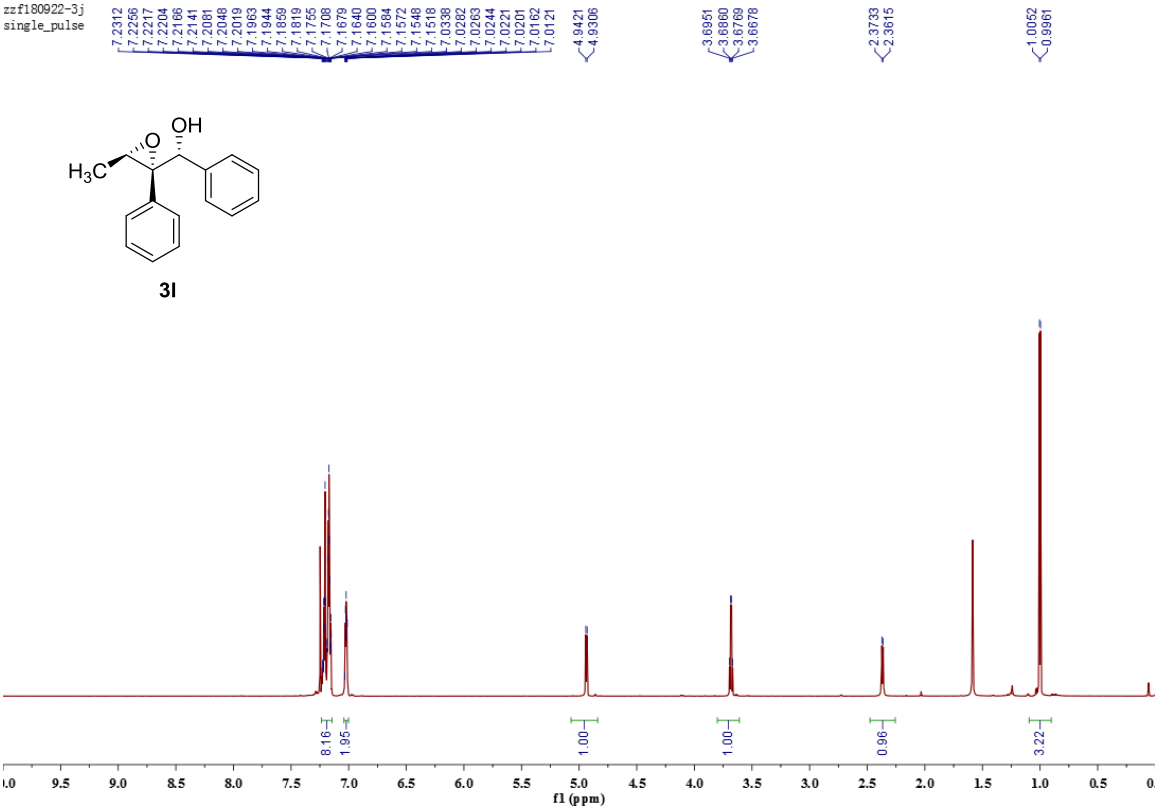
2k

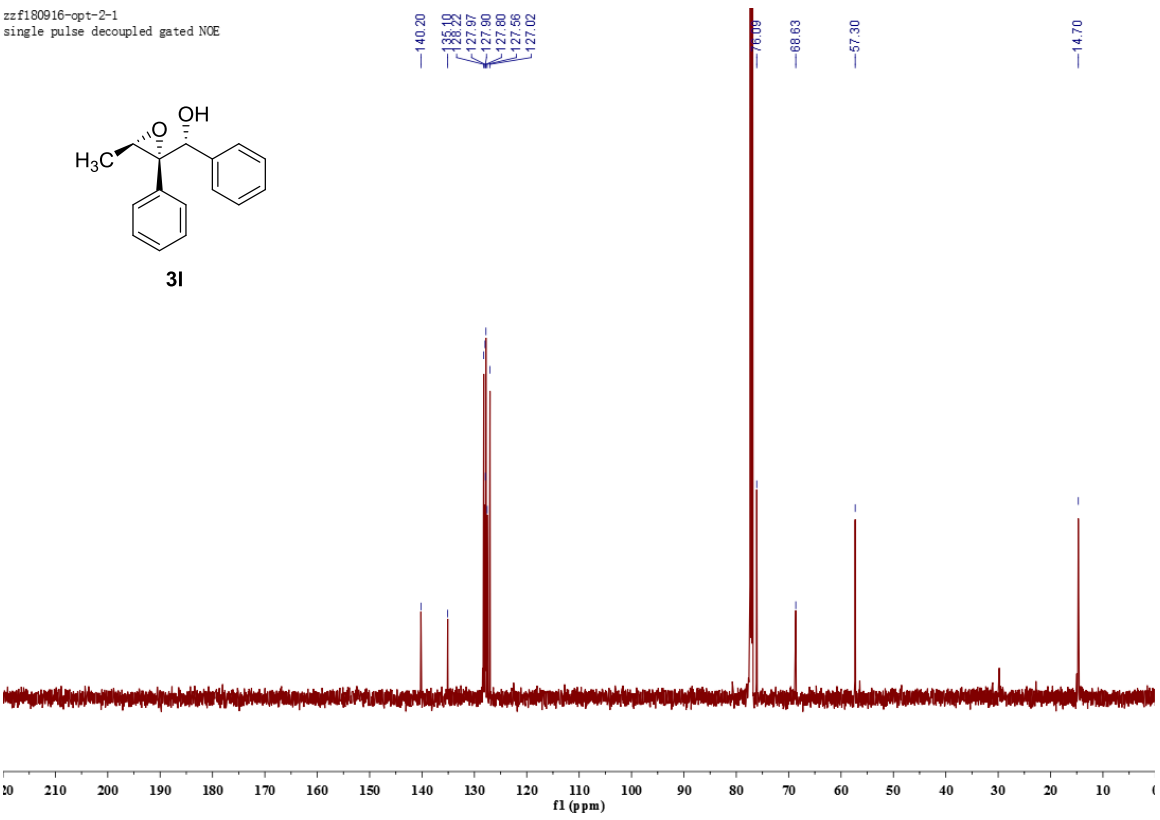

OH
O
H
3k
5.30
4.98
1.00
1.00
1.00
0.95
f1 (ppm)

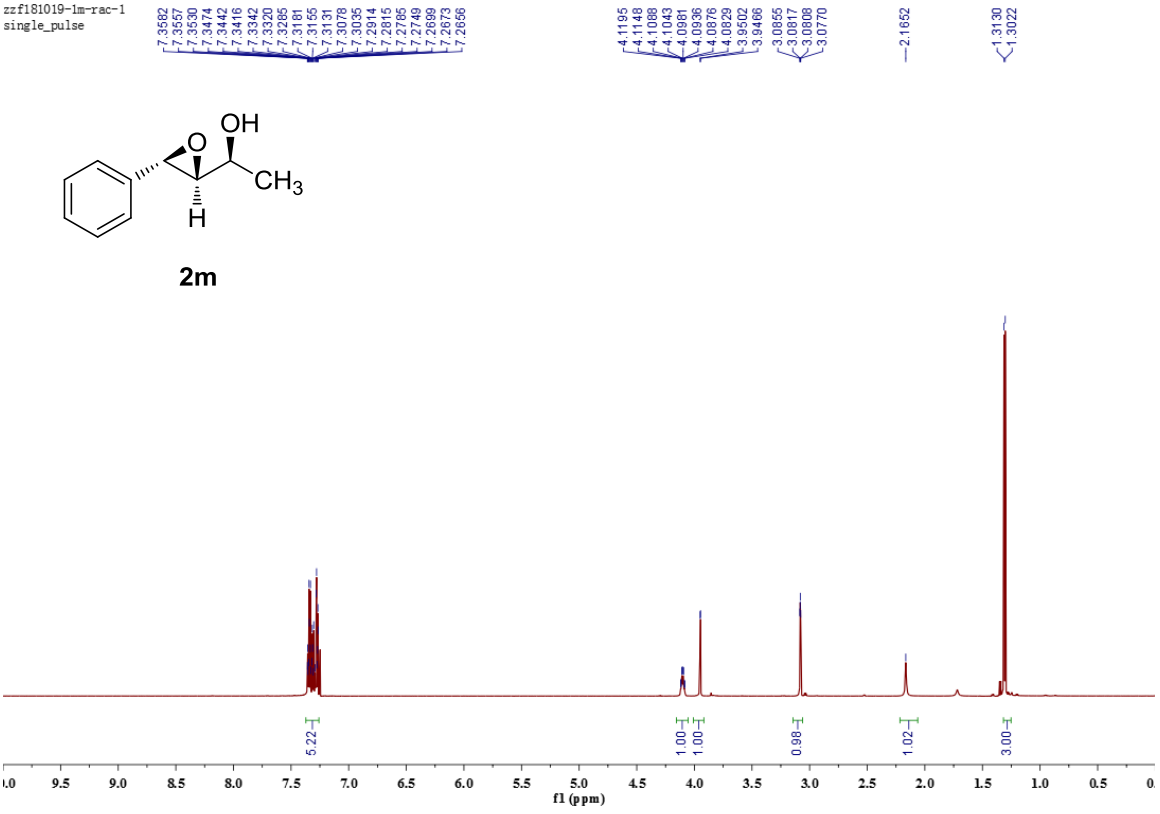

zzf180912-rac-2
single pulse decoupled gated NOE
OH
O
H
3k
139.93
137.04
128.36
128.08
128.02
127.80
127.26
127.16
75.02
63.46
52.41
f1 (ppm)

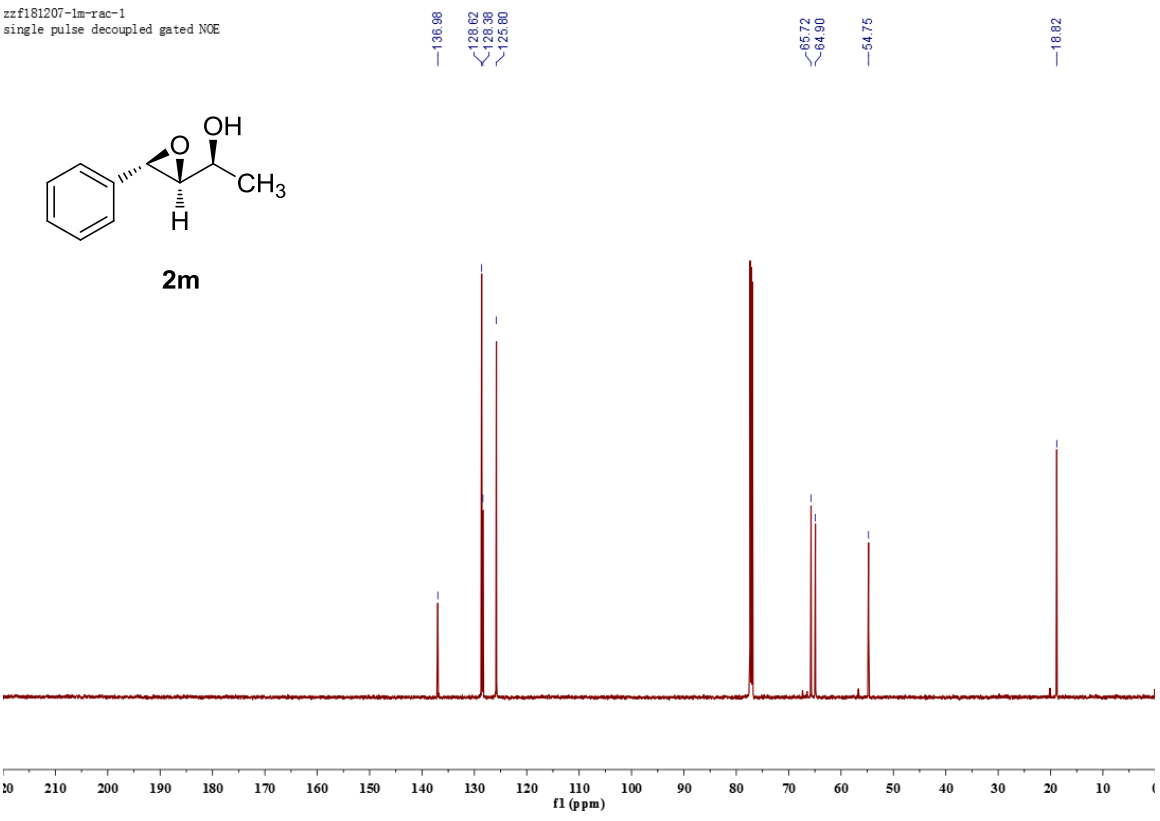

OH
O
H3C
2l
3.27
2.95
2.01
1.97
0.98
1.00
0.98
3.33
f1 (ppm)

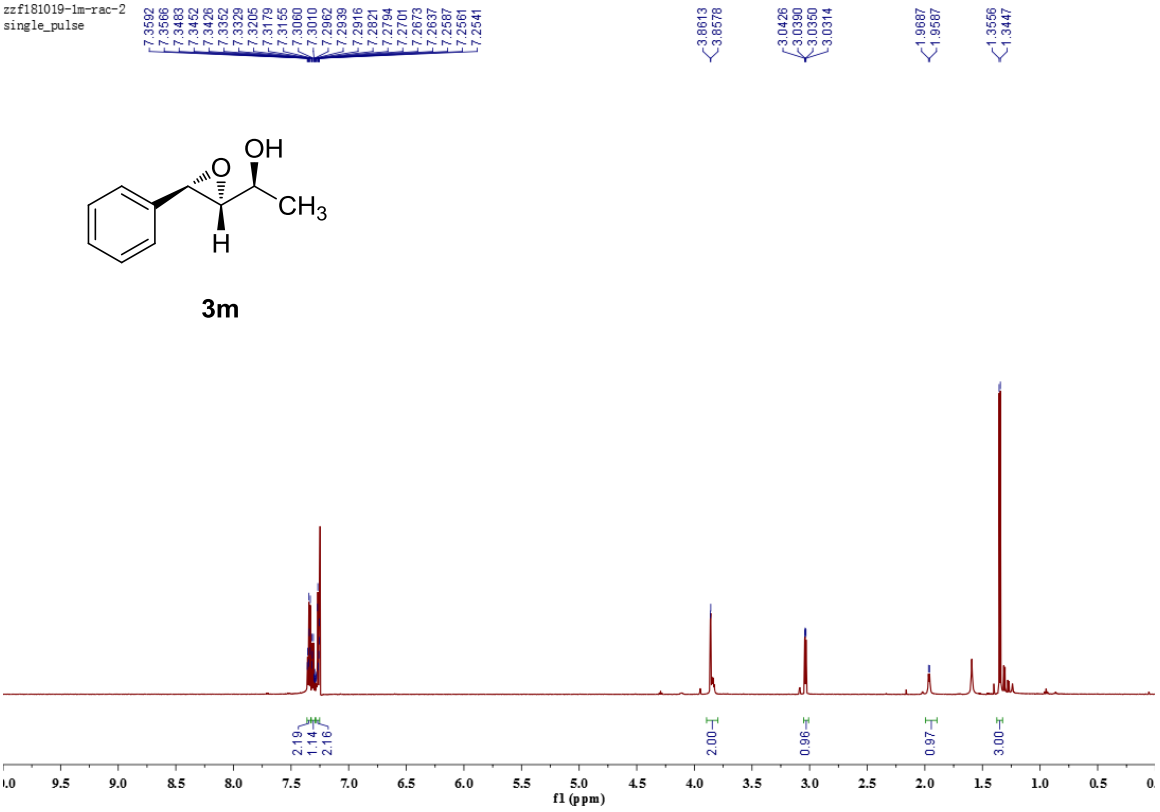

zzf180717-opt-1
single pulse decoupled gated NOE
OH
O
H3C
2l
139.05
135.08
128.44
128.32
128.23
127.91
127.88
127.77
76.19
68.68
56.43
14.97
f1 (ppm)


zzf180922-3j
single_pulse
7.2312
7.2256
7.2217
7.2204
7.2166
7.2141
7.2081
7.2048
7.2019
7.1963
7.1944
7.1859
7.1819
7.1755
7.1708
7.1679
7.1640
7.1600
7.1584
7.1572
7.1548
7.1518
7.0338
7.0282
7.0263
7.0244
7.0221
7.0201
7.0162
7.0121
4.9421
4.9306
3.6951
3.6880
3.6789
3.6678
2.3733
2.3615
1.0052
0.9961
OH
H3C
3l
8.16
1.95
1.00
1.00
0.96
3.22
f1 (ppm)

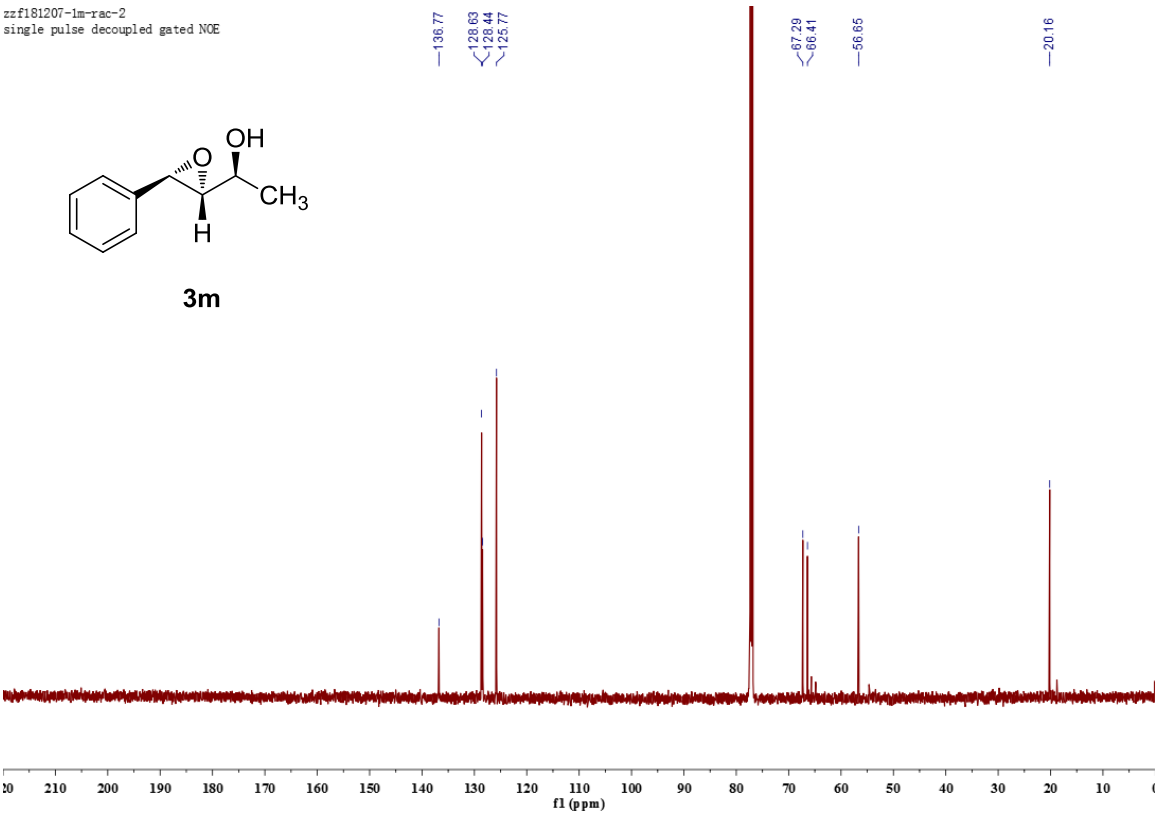

zzf180916-opt-2-1
single pulse decoupled gated NOE
140.20
135.10
128.22
127.97
127.80
127.60
127.56
127.02
76.09
68.63
57.30
14.70
OH
H3C
3l
f1 (ppm)


zzf181019-1m-rac-1
single_pulse
7.3582
7.3557
7.3530
7.3474
7.3442
7.3416
7.3342
7.3320
7.3285
7.3181
7.3155
7.3131
7.3078
7.3035
7.2914
7.2815
7.2785
7.2749
7.2699
7.2673
7.2656
4.1195
4.1148
4.1088
4.1043
4.0961
4.0936
4.0876
4.0829
3.9502
3.9466
3.0855
3.0817
3.0808
3.0770
2.1652
1.3130
1.3022
OH
O
CH3
H
2m
5.22
1.00
1.00
0.98
1.02
3.00
f1 (ppm)

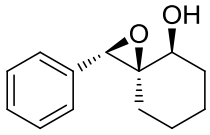

zzf181207-1m-rac-1
single pulse decoupled gated NOE
136.98
128.62
128.38
125.80
65.72
64.90
54.75
18.82
OH
O
CH3
H
2m
f1 (ppm)


zzf181019-1m-rac-2
single_pulse
7.3592
7.3566
7.3483
7.3452
7.3426
7.3352
7.3329
7.3205
7.3179
7.3155
7.3060
7.3010
7.2962
7.2939
7.2916
7.2821
7.2794
7.2701
7.2673
7.2637
7.2587
7.2561
7.2541
3.8613
3.8578
3.0426
3.0390
3.0350
3.0314
1.9687
1.9587
1.3556
1.3447
OH
O
CH3
H
2.19
1.14
2.16
2.00
0.96
0.97
3.00
f1 (ppm)

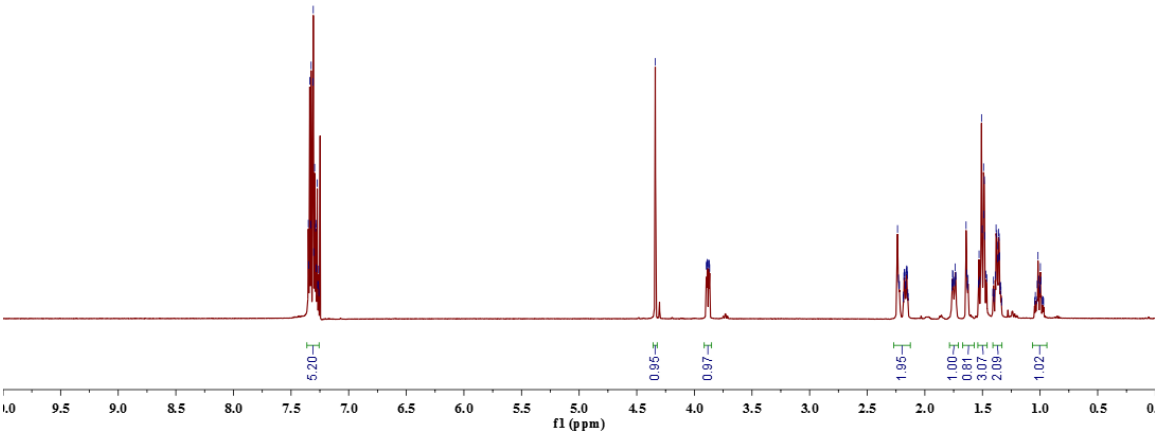
3m


zzf181207-1m-rac-2
single pulse decoupled gated NOE
136.77
128.63
128.44
125.77
67.29
66.41
56.65
20.16
OH
O
CH3
H
f1 (ppm)

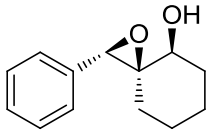
3m



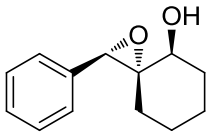
2n



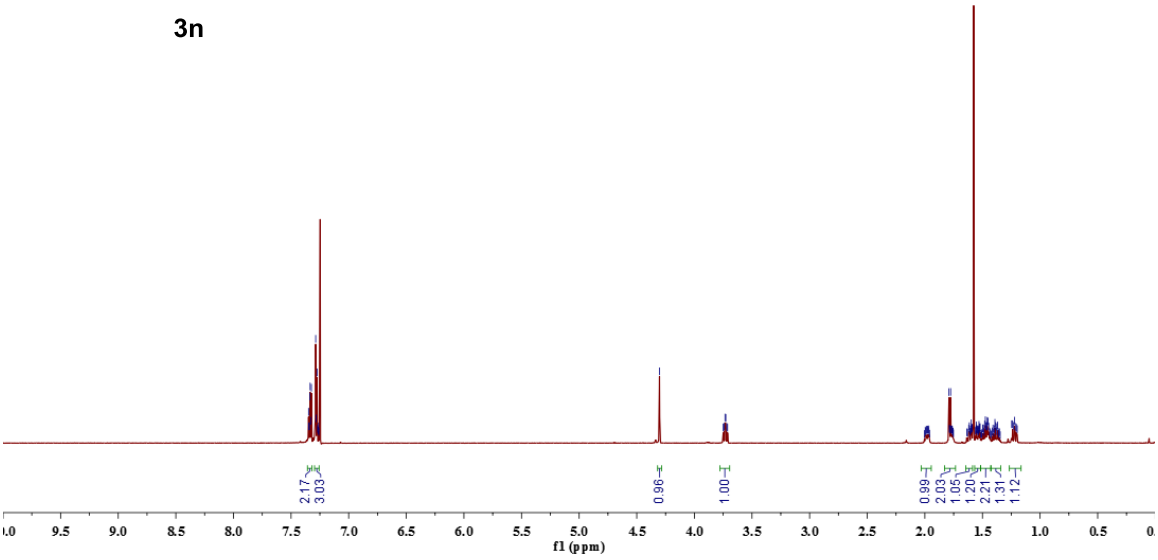
zzf181110-rac-1 -C
single pulse decoupled gated NOE

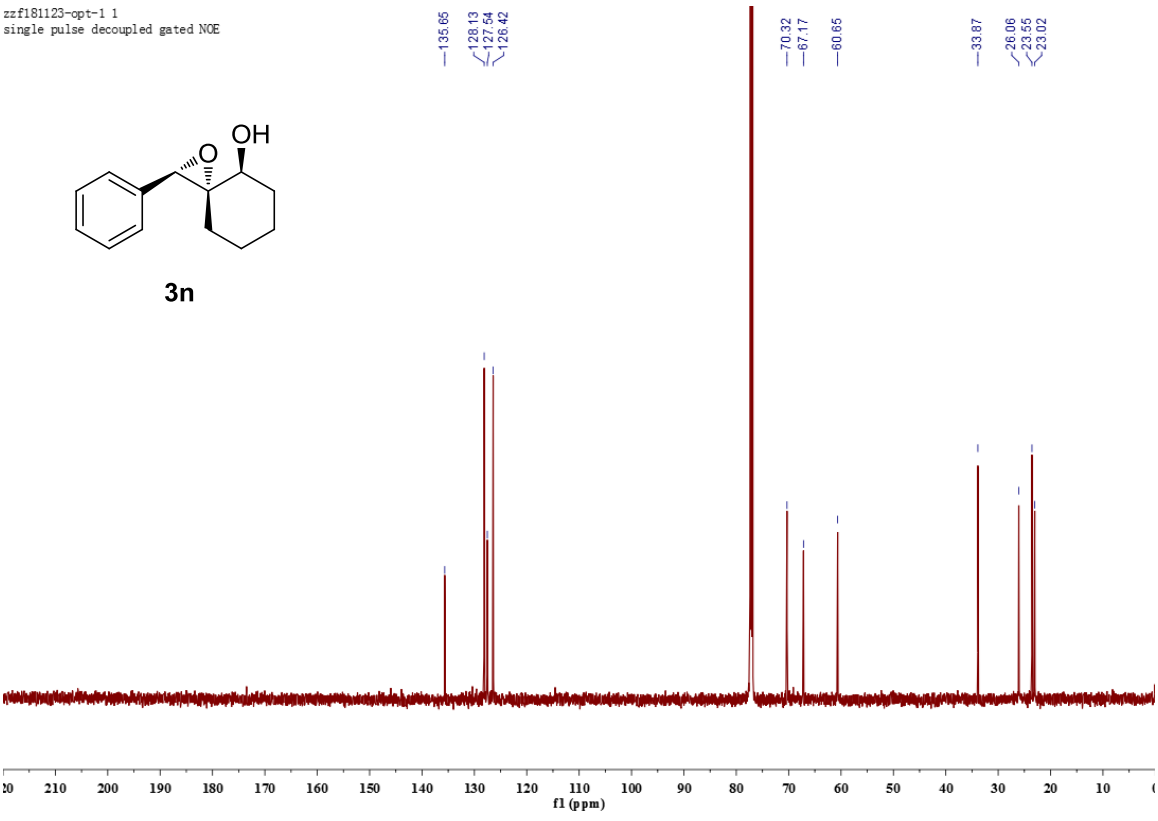


2n

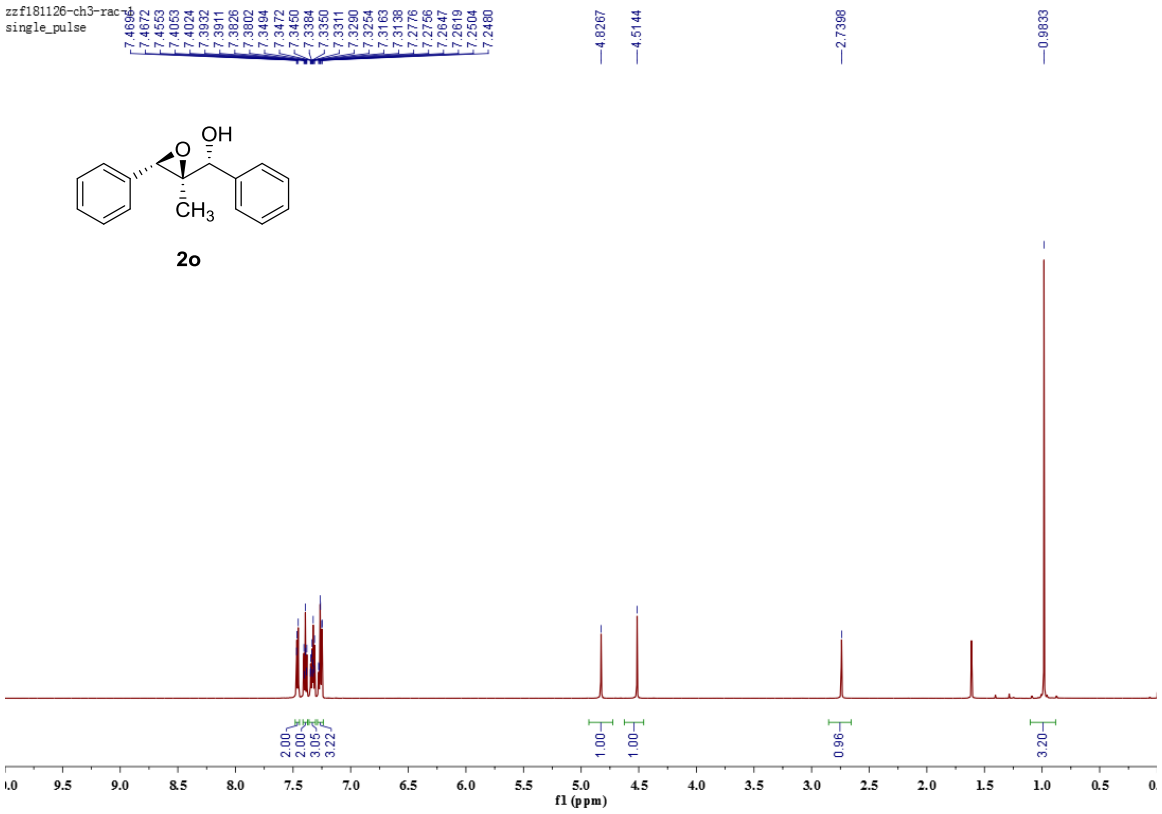


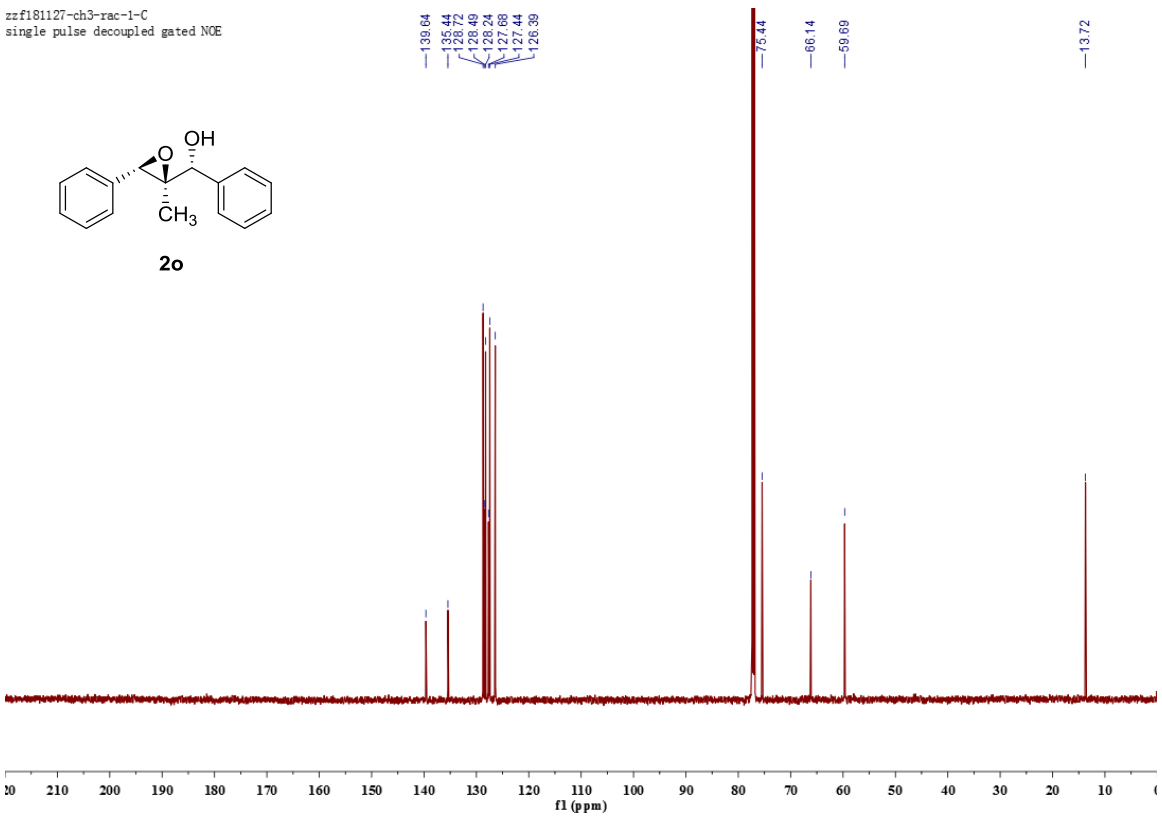
3n

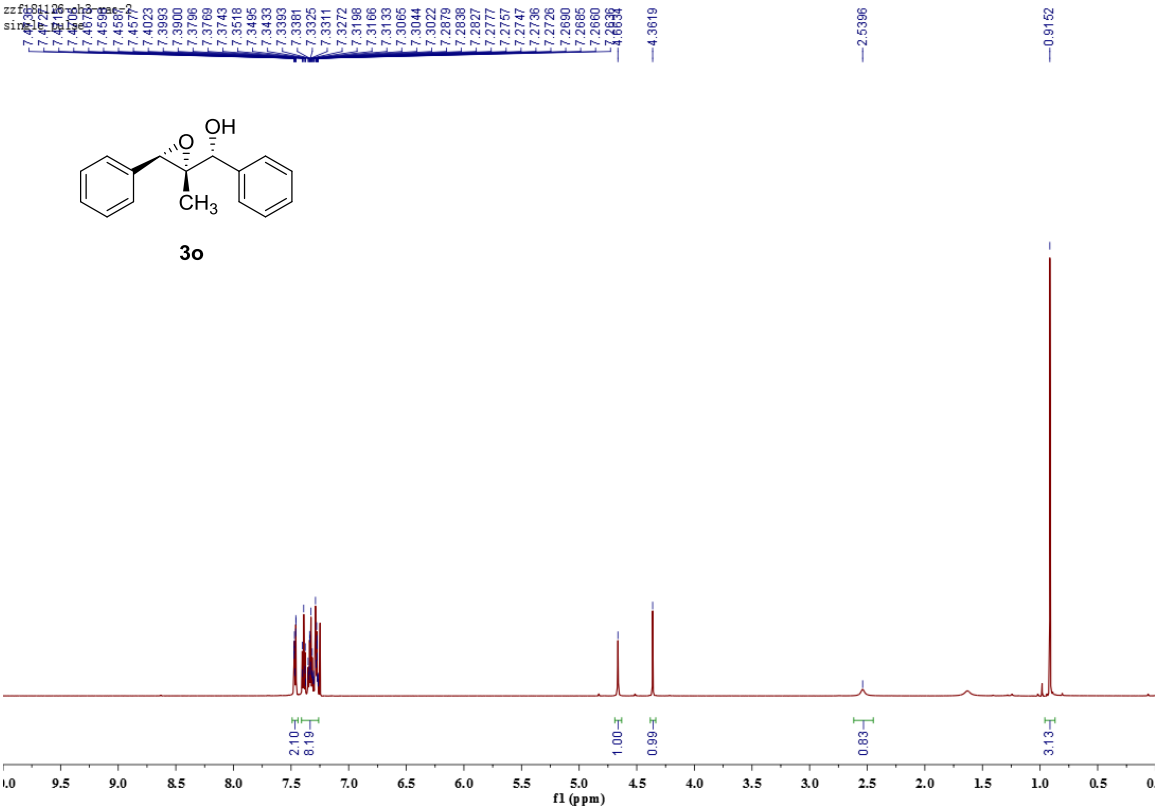

2.17
3.03
0.98
1.00
0.99
2.03
1.05
1.20
2.21
1.31
1.12
f1 (ppm)


zzf181123-opt-1 1
single pulse decoupled gated NOE
135.65
128.13
127.54
126.42
70.32
67.17
60.65
33.87
26.06
23.55
23.02
f1 (ppm)

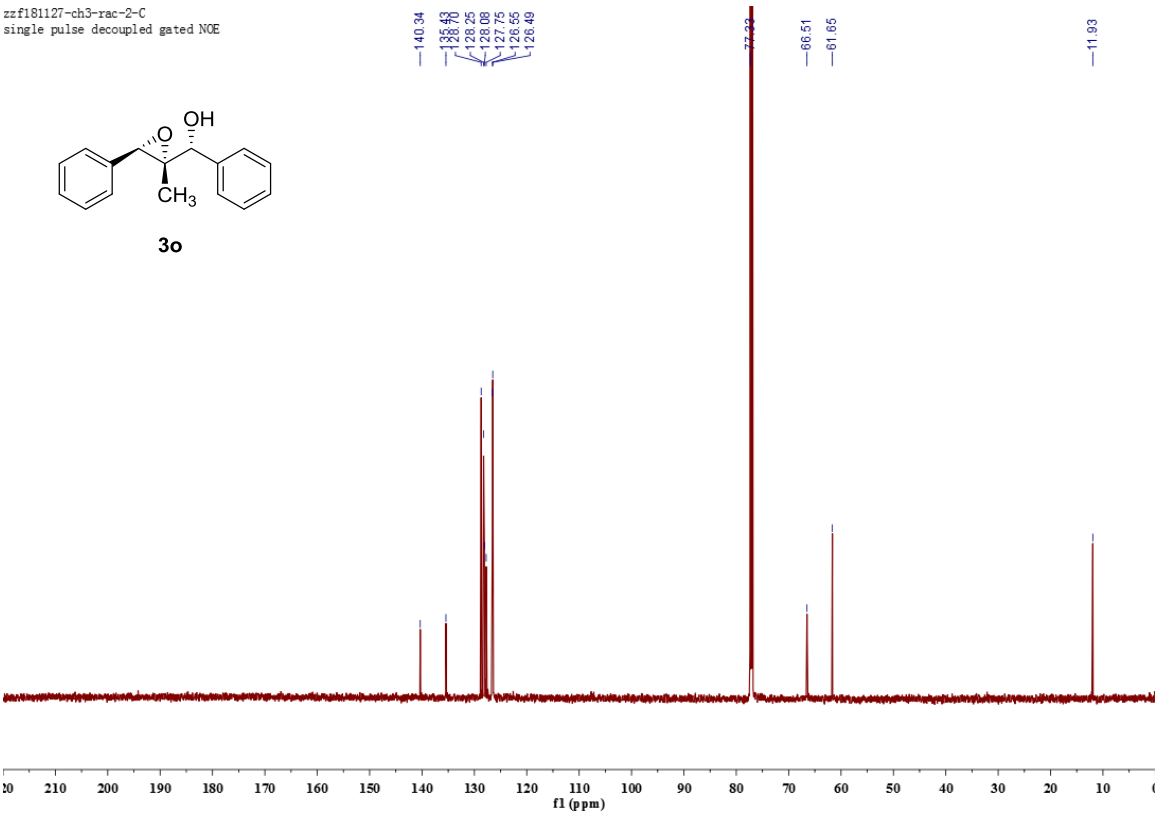
3n


zzf181126-ch3-rac-1
single_pulse
7.4696
7.4672
7.4553
7.4053
7.4024
7.3932
7.3911
7.3826
7.3802
7.3494
7.3472
7.3450
7.3384
7.3350
7.3311
7.3290
7.3254
7.3163
7.3138
7.2776
7.2756
7.2647
7.2619
7.2504
7.2480
4.8267
4.5144
2.7398
0.9833
OH
O
CH3
2o
2.00
2.00
3.05
3.22
1.00
1.00
0.96
3.20
f1 (ppm)

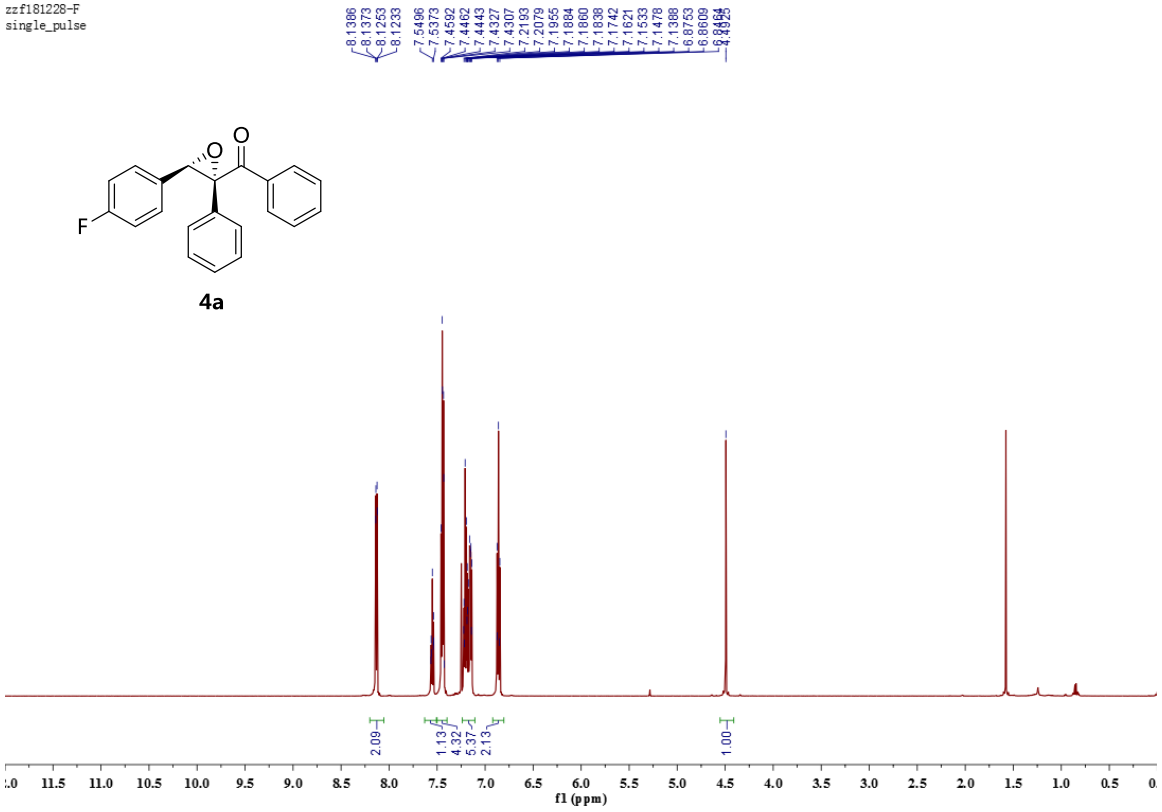

zzf181127-ch3-rac-1-C
single pulse decoupled gated NOE
139.64
135.44
128.72
128.49
128.24
127.88
127.44
126.39
75.44
66.14
59.69
13.72
OH
O
CH3
2o
f1 (ppm)

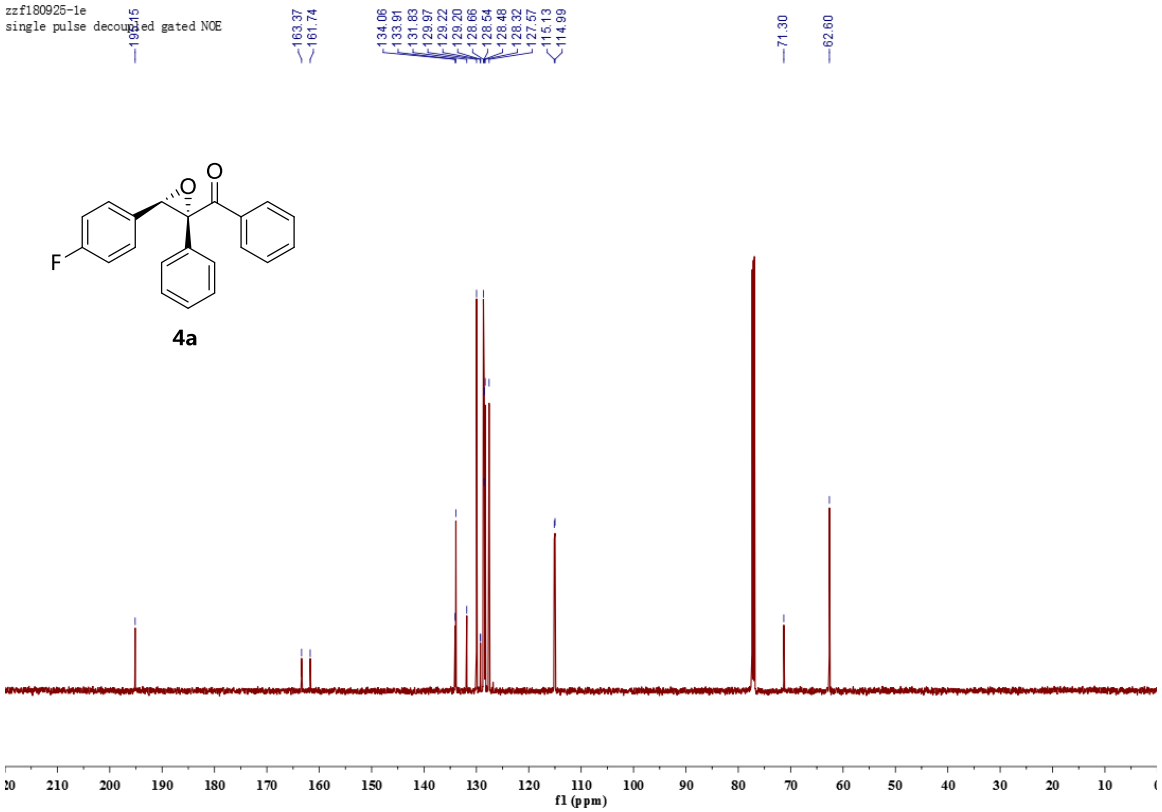

4.3619
2.5396
0.9152
OH
O
CH3
2.10
8.19
1.00
0.99
0.83
3.13
f1 (ppm)

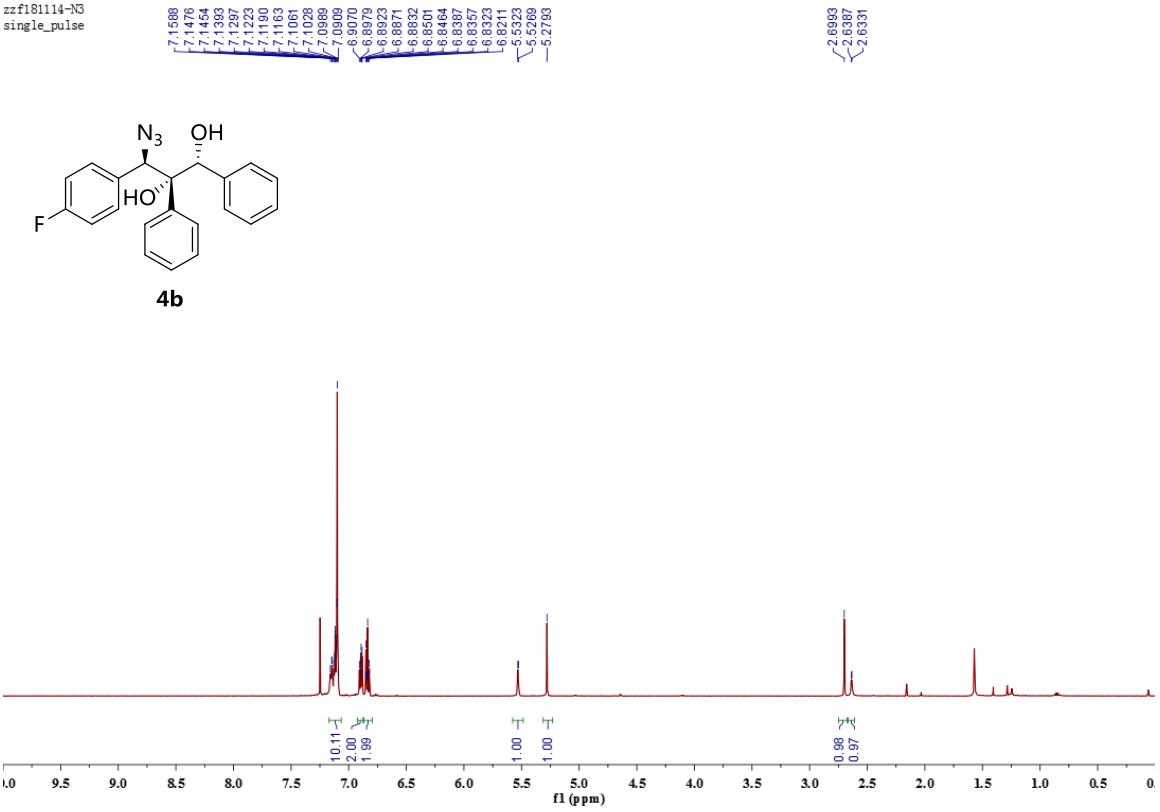
3o

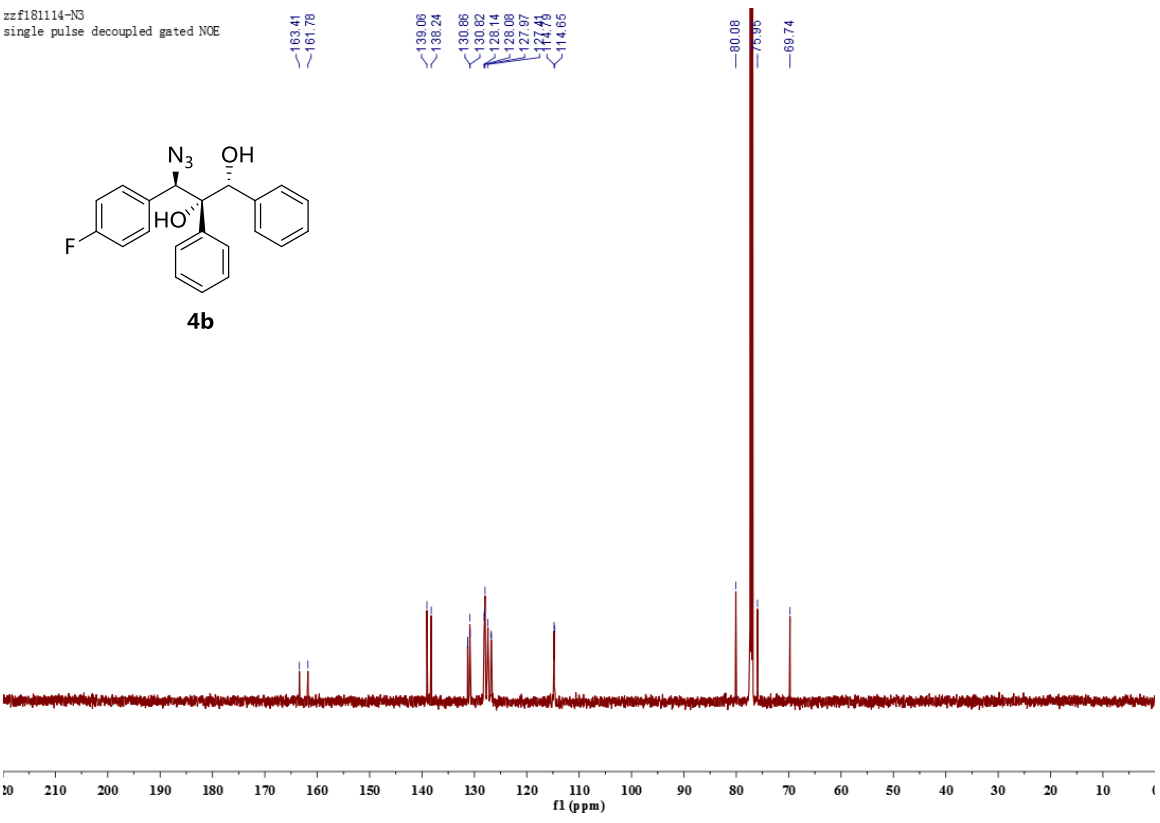

zzf181127-ch3-rac-2-C
single pulse decoupled gated NOE
140.34
135.43
128.70
128.25
128.08
127.75
126.55
126.49
77.32
66.51
61.85
11.93
OH
O
CH3
f1 (ppm)

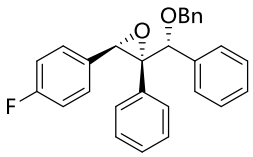
3o


zzf181228-F
single_pulse
F
O
O
4a
f1 (ppm)

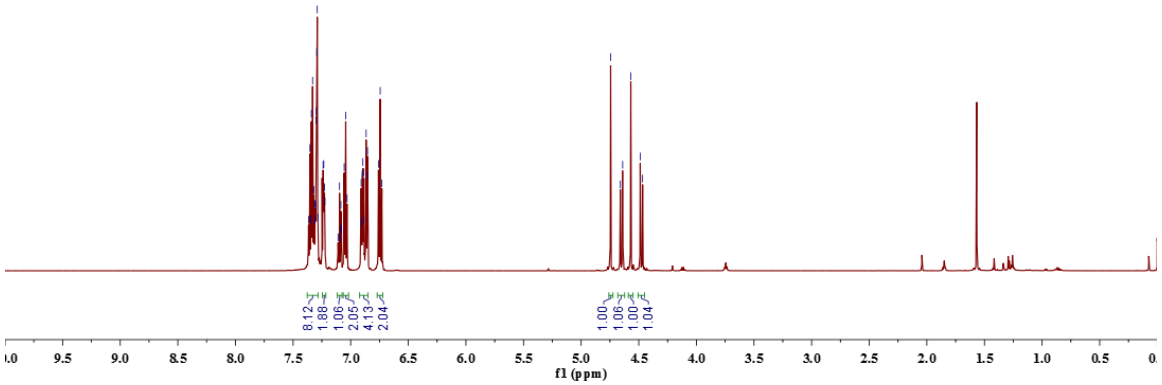

zzf180925-1e
single pulse decoupled gated NOE
F
O
O
4a
f1 (ppm)

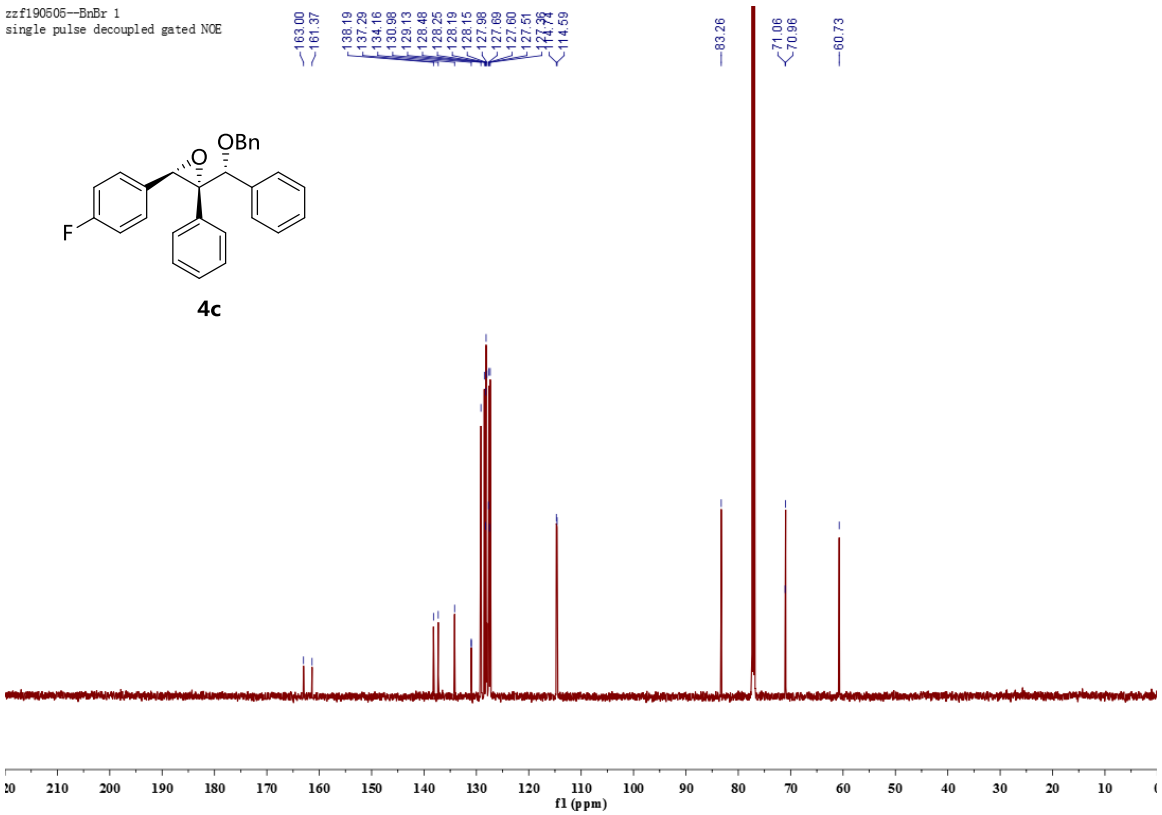

zzf181114-N3
single_pulse
7.1588
7.1476
7.1454
7.1393
7.1297
7.1223
7.1190
7.1163
7.1061
7.1028
7.0989
7.0909
6.9070
6.8979
6.8923
6.8871
6.8832
6.8501
6.8464
6.8387
6.8357
6.8323
6.8211
5.5323
5.5269
5.2793
2.6993
2.6387
2.6331
N3
OH
HO
F
4b
10.11
2.00
1.99
1.00
1.00
0.98
0.97
f1 (ppm)


zzf181114-N3
single pulse decoupled gated NOE
163.41
161.78
139.06
138.24
130.86
130.82
128.14
128.08
127.97
127.41
114.79
114.65
80.08
76.95
69.74
N3
OH
HO
F
4b
f1 (ppm)


OBn
O
F

4c


8.12
1.88
1.06
2.05
4.13
2.04
1.00
1.06
1.00
1.04
f1 (ppm)


zzf190505--BnBr 1
single pulse decoupled gated NOE
163.00
161.37
138.19
137.29
134.16
130.98
129.13
128.48
128.25
128.19
128.15
127.98
127.69
127.60
127.51
114.74
114.59
83.26
71.06
70.96
60.73
f1 (ppm)

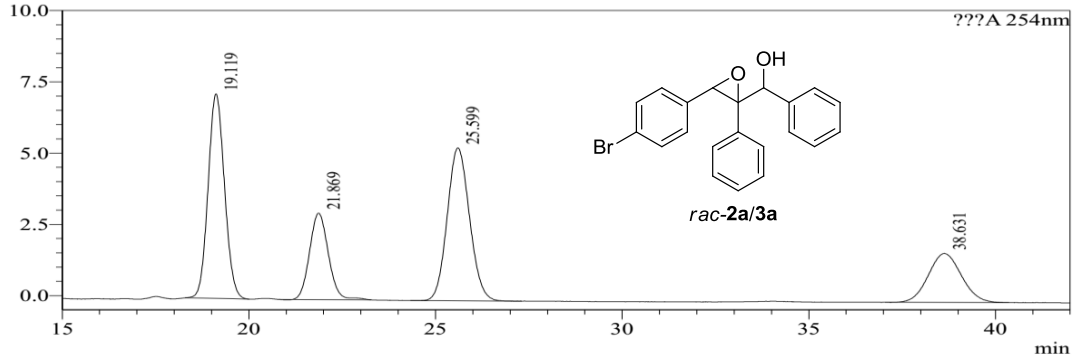
OBn
O
F

4c

VII. HPLC spectra for ee determination

<Chromatogram>

mV



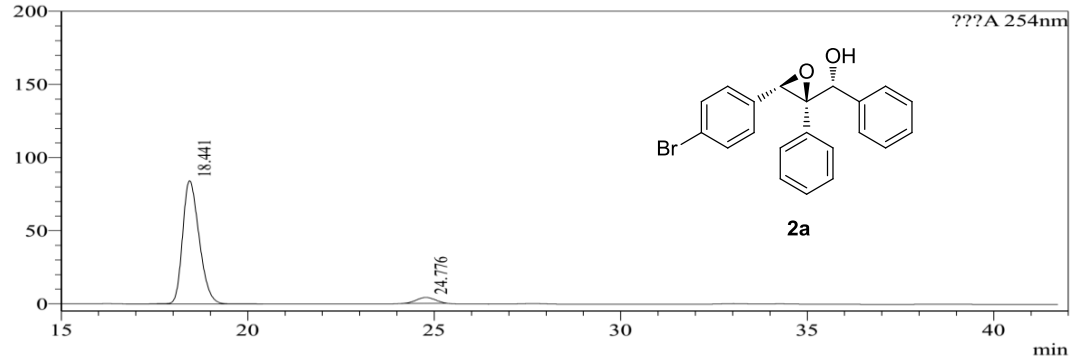
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.119	219108	7174	33.458		M	
2	21.869	106002	3029	16.187		M	
3	25.599	223470	5366	34.124		M	
4	38.631	106299	1718	16.232		M	
Total		654879	17288				

<Chromatogram>

mV



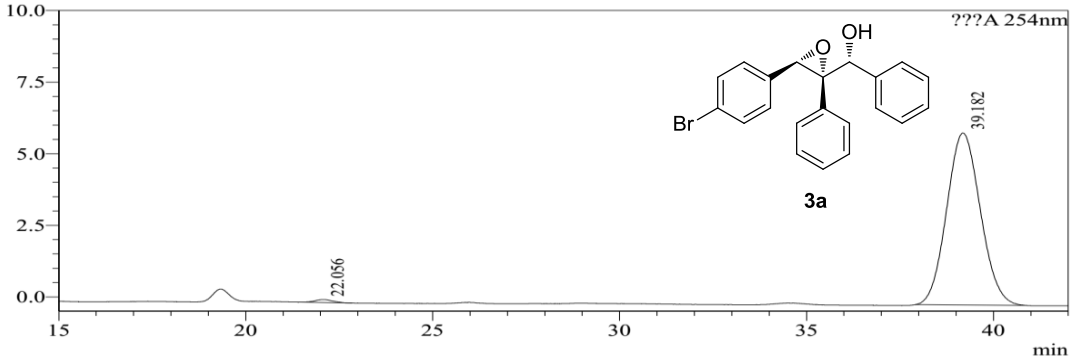
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	18.441	2611990	84313	94.853		M	
2	24.776	141732	4017	5.147		M	
Total		2753722	88330				

<Chromatogram>

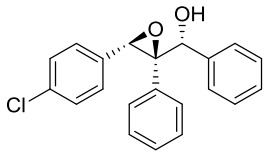
mV



<Peak Table>

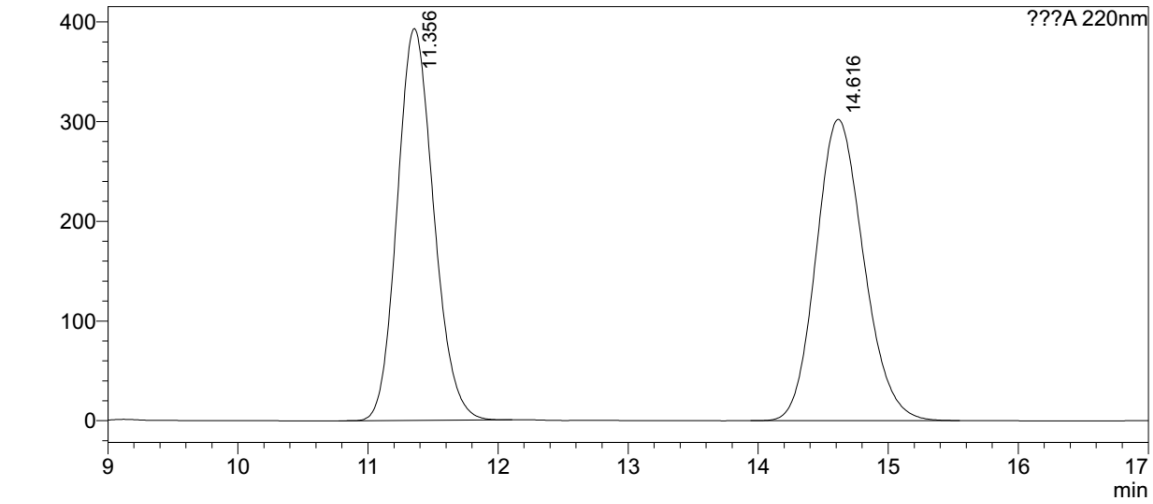
???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	22.056	3458	103	0.909		M	
2	39.182	376934	6007	99.091			
Total		380392	6110				



2b

<Chromatogram>

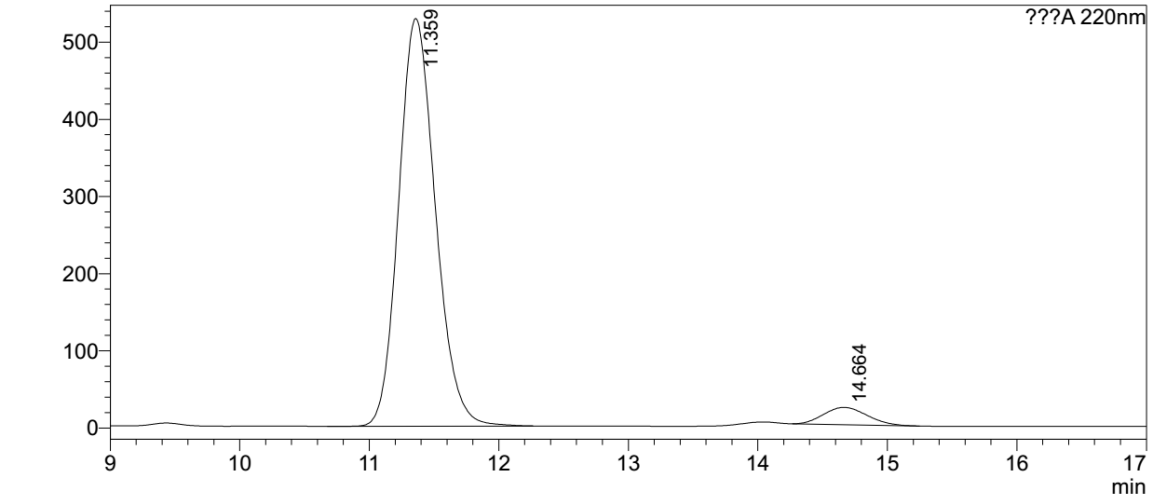


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.356	7661543	393042	49.873		M	
2	14.616	7700661	302395	50.127		M	
Total		15362205	695437				

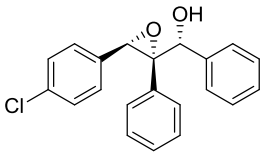
<Chromatogram>



<Peak Table>

???A 220nm

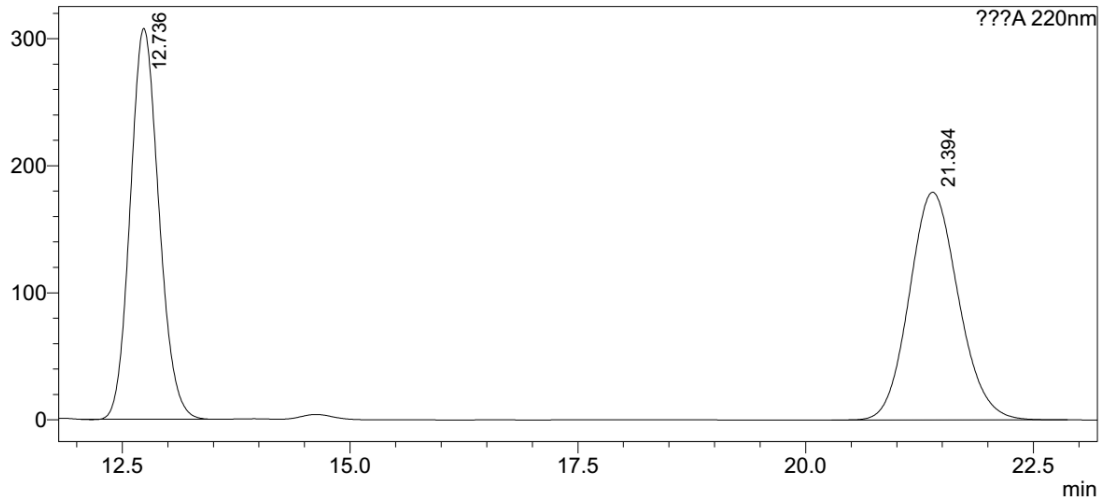
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.359	10413121	528467	95.189		M	
2	14.664	526292	22458	4.811		M	
Total		10939413	550925				



3b

<Chromatogram>

mV



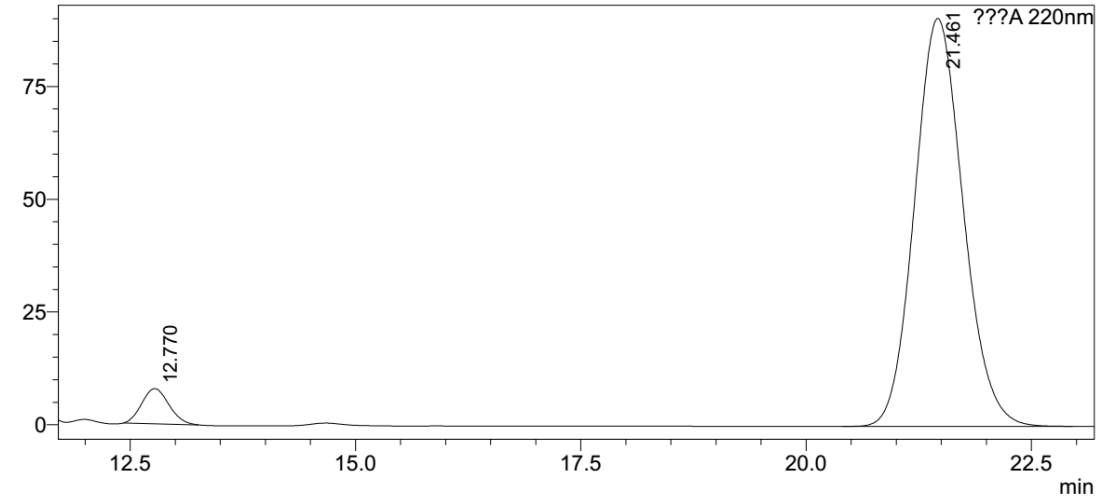
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.736	6726175	307668	50.004		M	
2	21.394	6725066	179315	49.996		M	
Total		13451241	486983				

<Chromatogram>

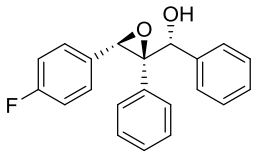
mV



<Peak Table>

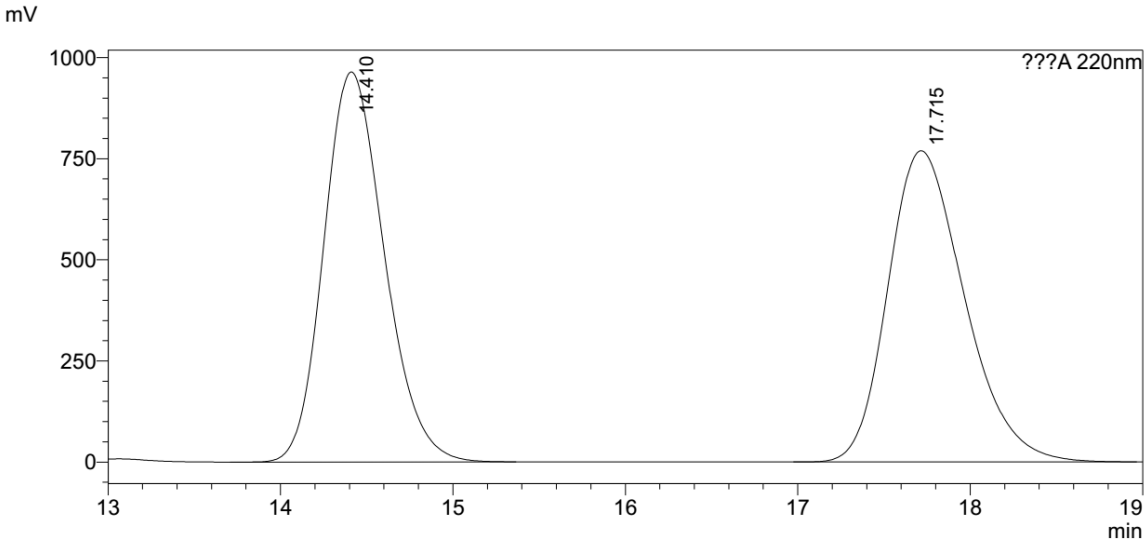
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.770	163013	7782	4.582		M	
2	21.461	3394424	90429	95.418		M	
Total		3557436	98211				



2c

<Chromatogram>

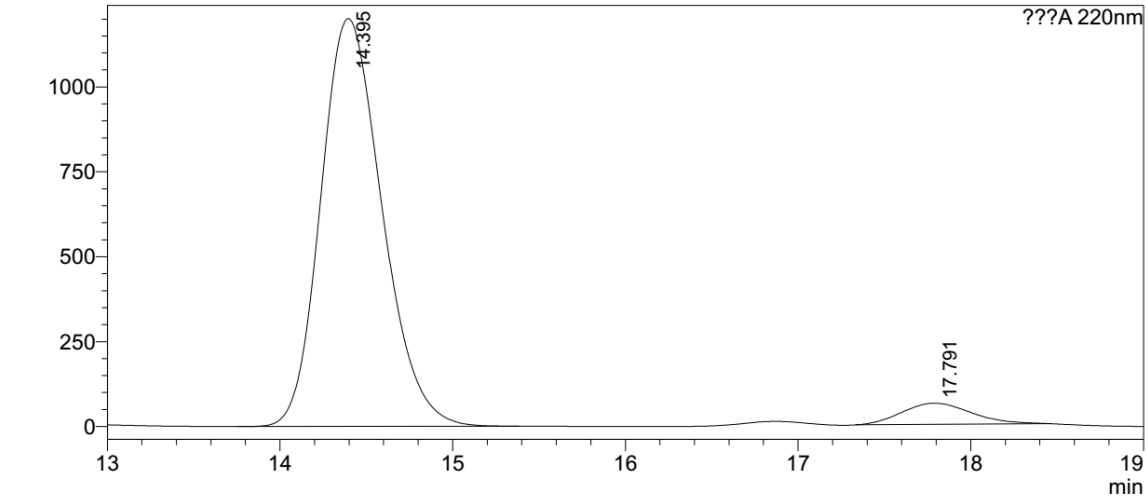


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.410	23536389	964336	49.793		M	
2	17.715	23731635	769385	50.207		M	
Total		47268024	1733721				

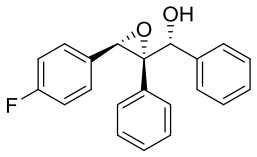
<Chromatogram>



<Peak Table>

???A 220nm

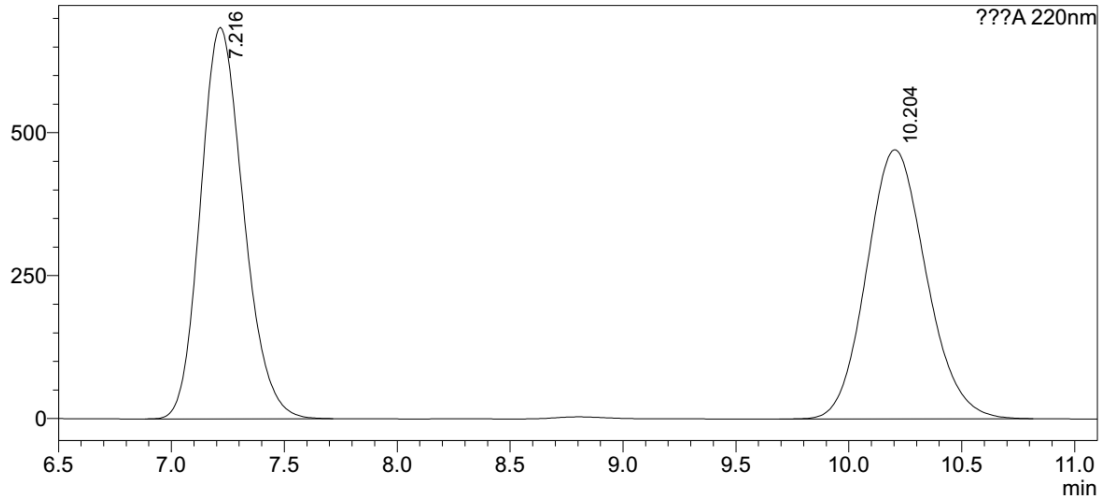
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.395	29603986	1200910	94.395		M	
2	17.791	1757831	62392	5.605		M	
Total		31361817	1263302				



3c

<Chromatogram>

mV



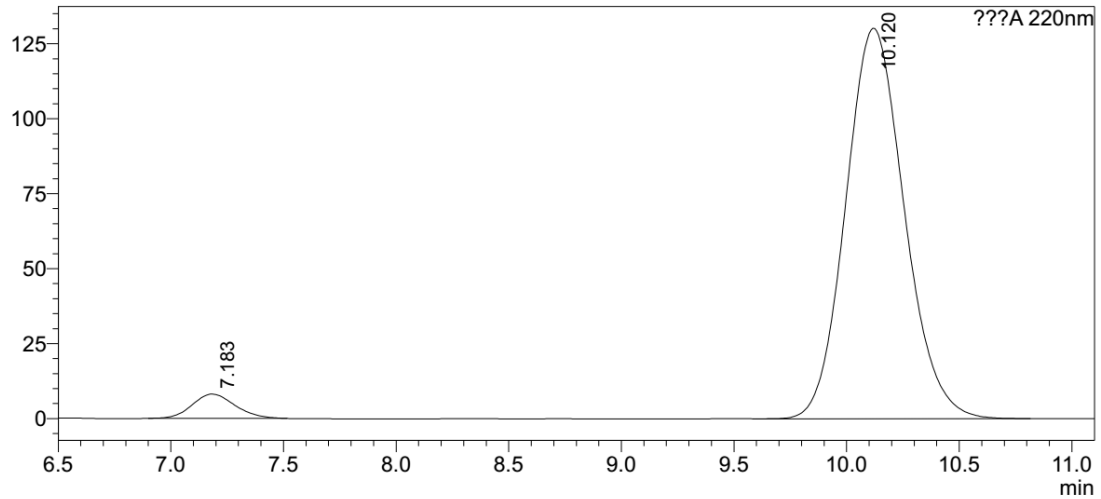
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.216	9092209	684677	51.238		M	
2	10.204	8652988	470743	48.762		M	
Total		17745197	1155420				

<Chromatogram>

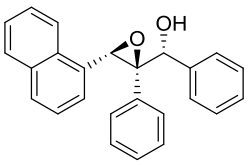
mV



<Peak Table>

???A 220nm

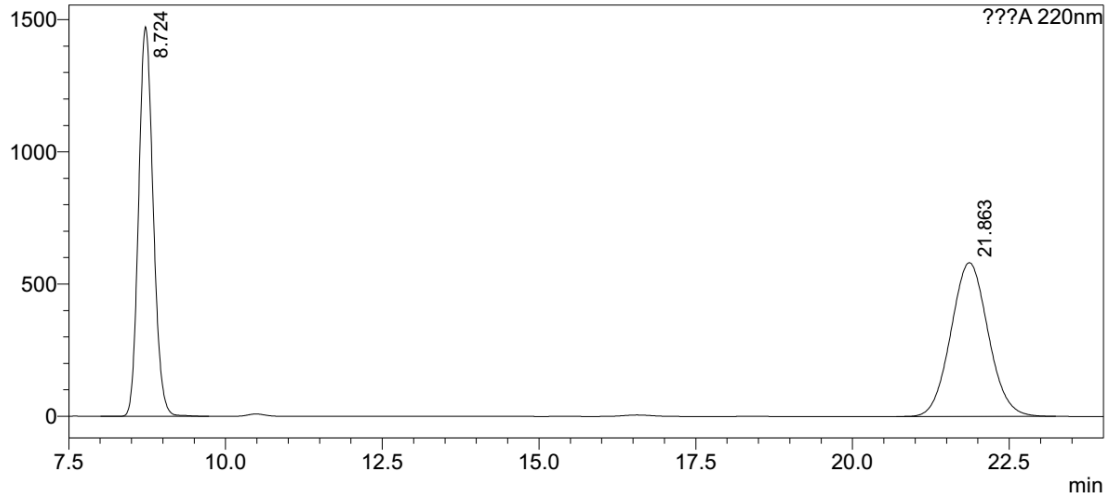
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.183	107548	8125	4.368		M	
2	10.120	2354834	130184	95.632		M	
Total		2462382	138308				



2d

<Chromatogram>

mV



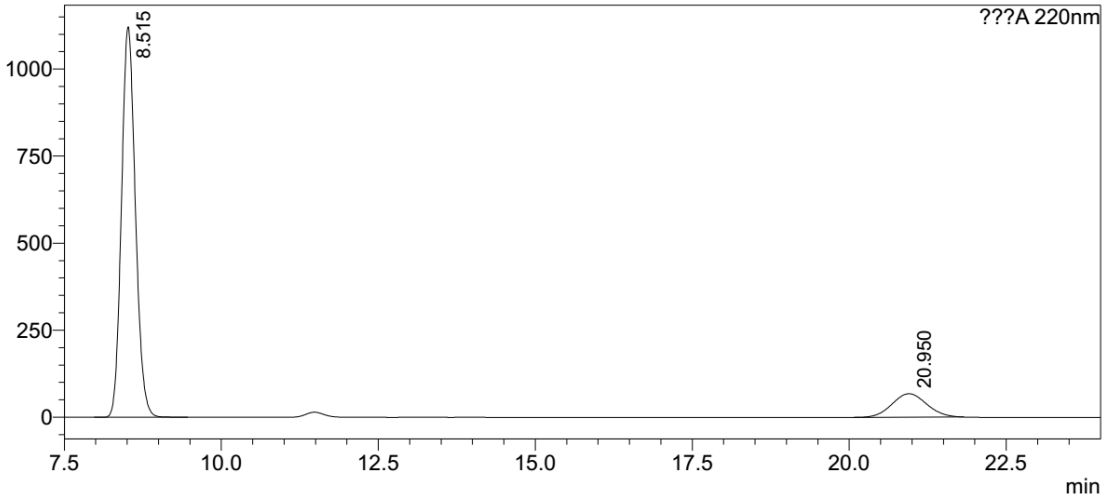
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.724	23800414	1472978	49.713		M	
2	21.863	24075627	581331	50.287		M	
Total		47876042	2054308				

<Chromatogram>

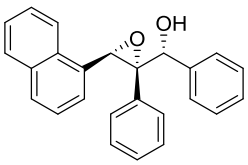
mV



<Peak Table>

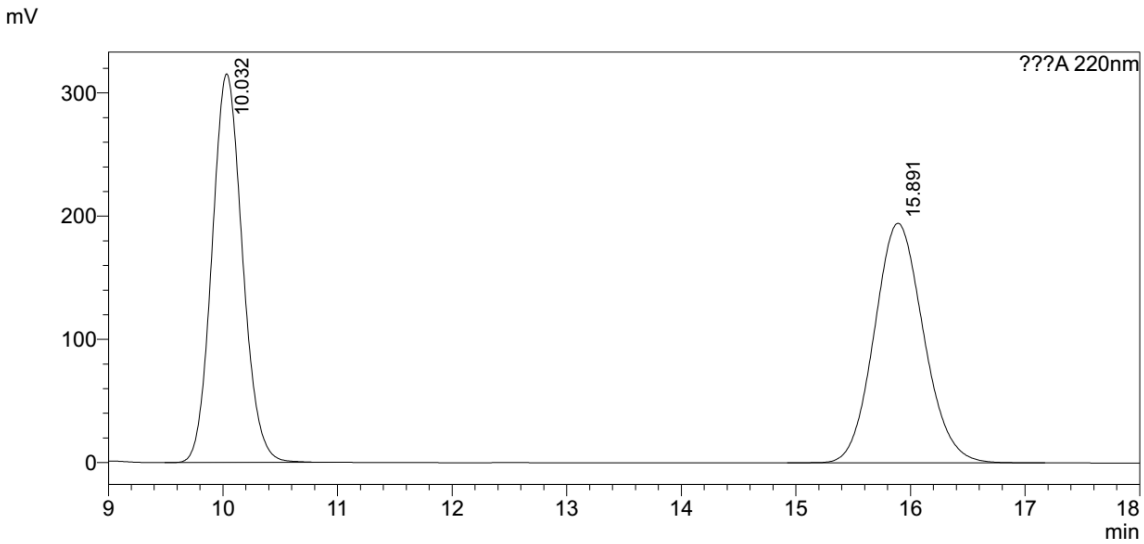
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	8.515	17326555	1120669	86.929		M	
2	20.950	2605372	67423	13.071		M	
Total		19931926	1188092				



3d

<Chromatogram>

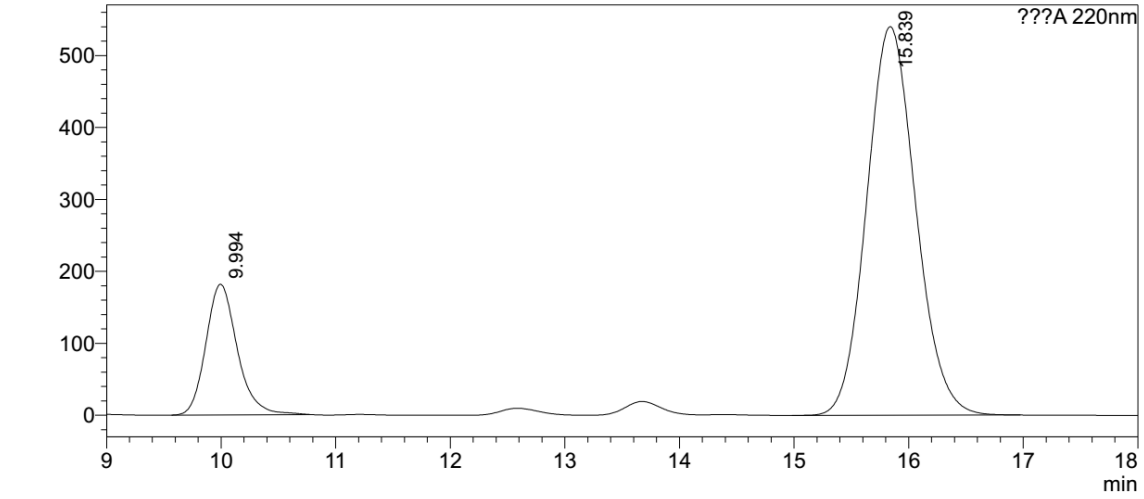


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	10.032	5822909	315519	50.092		M	
2	15.891	5801485	194483	49.908		M	
Total		11624394	510002				

<Chromatogram>



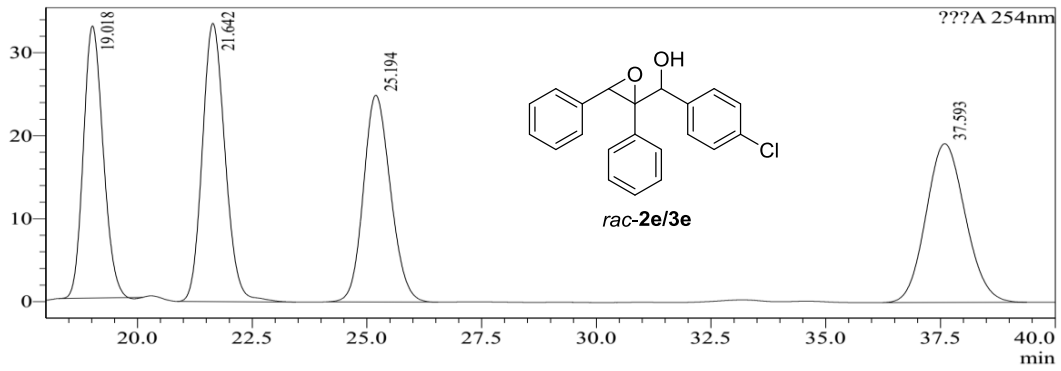
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.994	3462413	181667	17.711		M	
2	15.839	16086628	540070	82.289		M	
Total		19549040	721738				

<Chromatogram>

mV



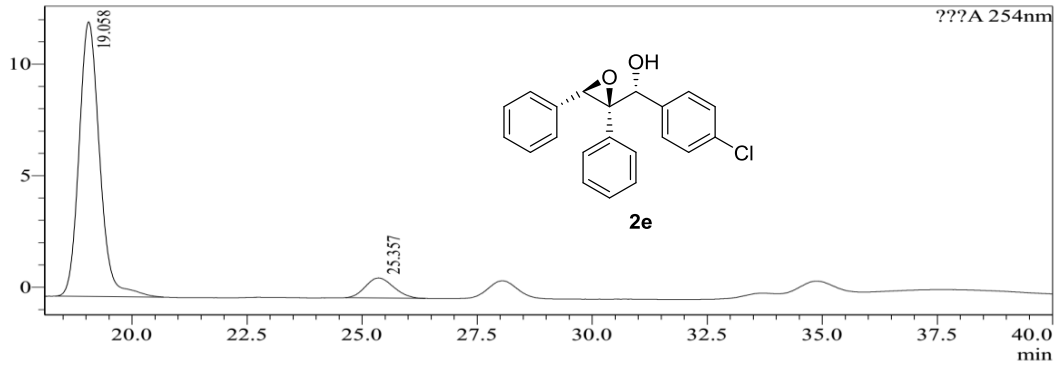
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.018	981427	32804	22.809		M	
2	21.642	1155451	33556	26.854			
3	25.194	1024659	24938	23.814			
4	37.593	1141250	19141	26.524			
Total		4302787	110439				

<Chromatogram>

mV



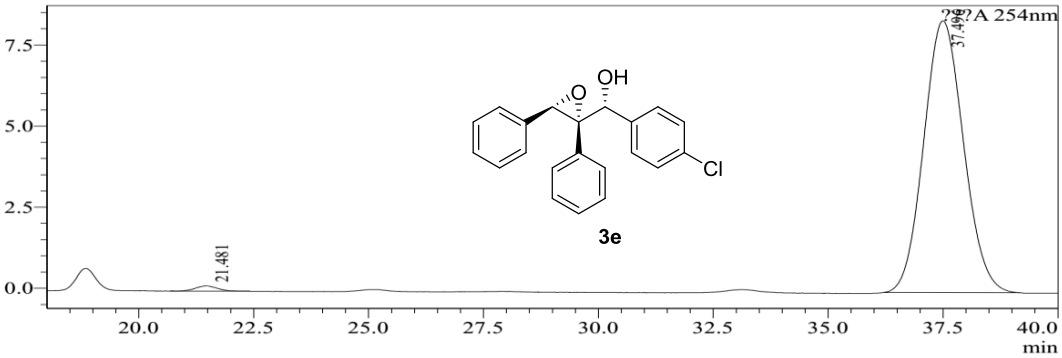
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.058	382687	12312	90.959			
2	25.357	38037	899	9.041			
Total		420724	13211				

<Chromatogram>

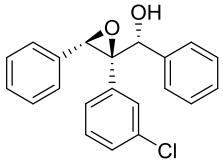
mV



<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	21.481	5251	158	1.028		M	
2	37.496	505682	8381	98.972			
Total		510933	8539				



2f

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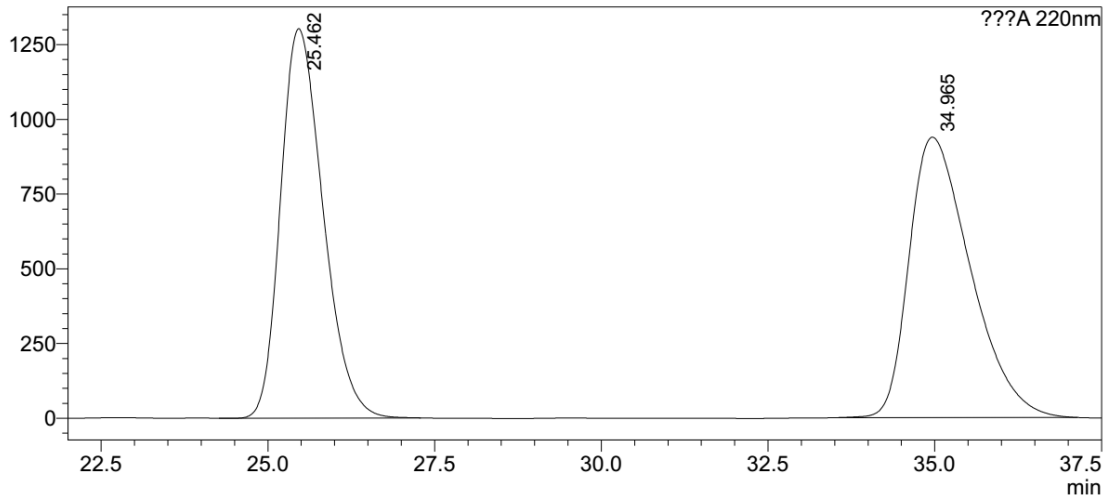
mV



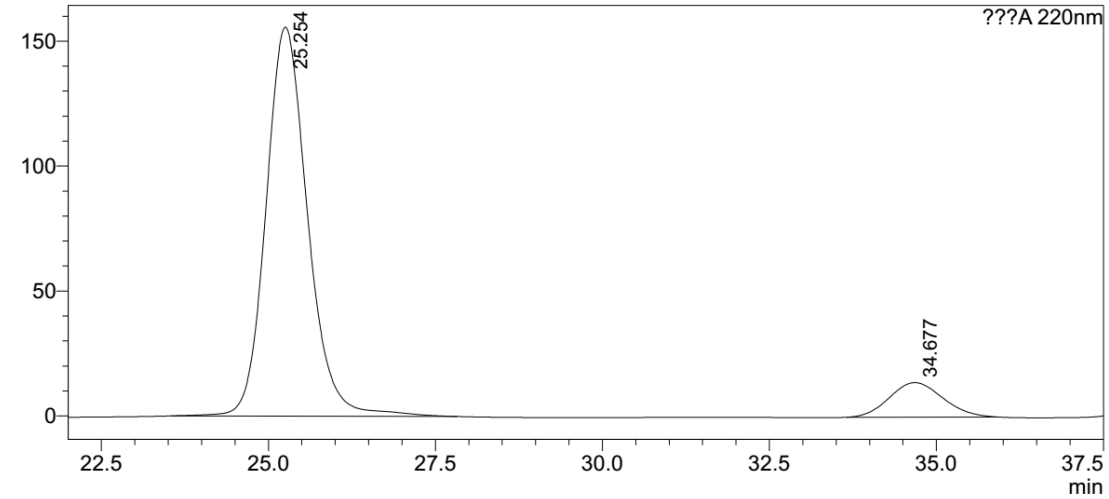
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	25.462	57744367	1302569	49.036		M	
2	34.965	60014746	938444	50.964		M	
Total		117759112	2241012				

<Chromatogram>

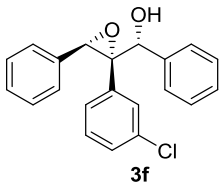
mV



<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	25.254	6761392	155664	89.775		M	
2	34.677	770085	13820	10.225		M	
Total		7531477	169484				



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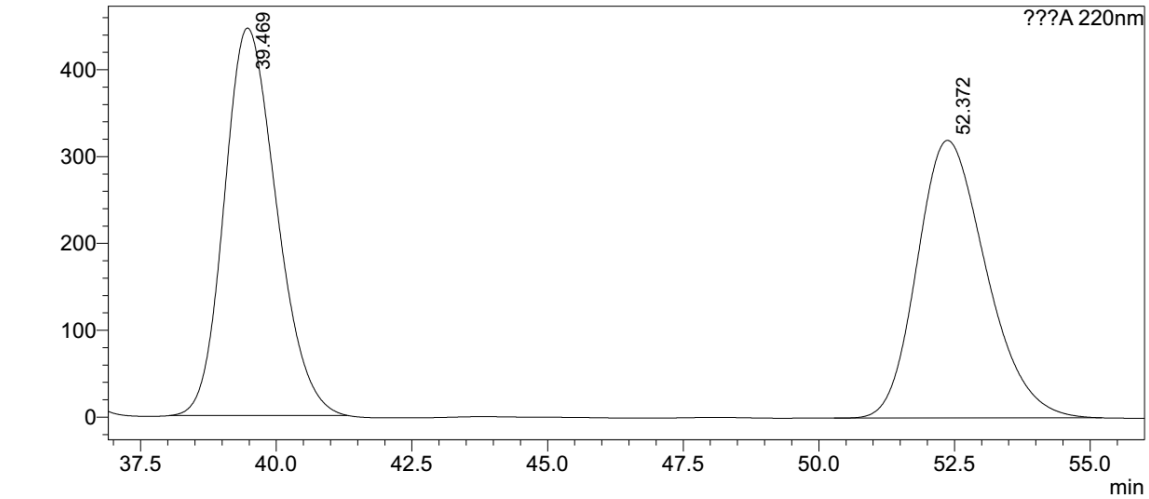
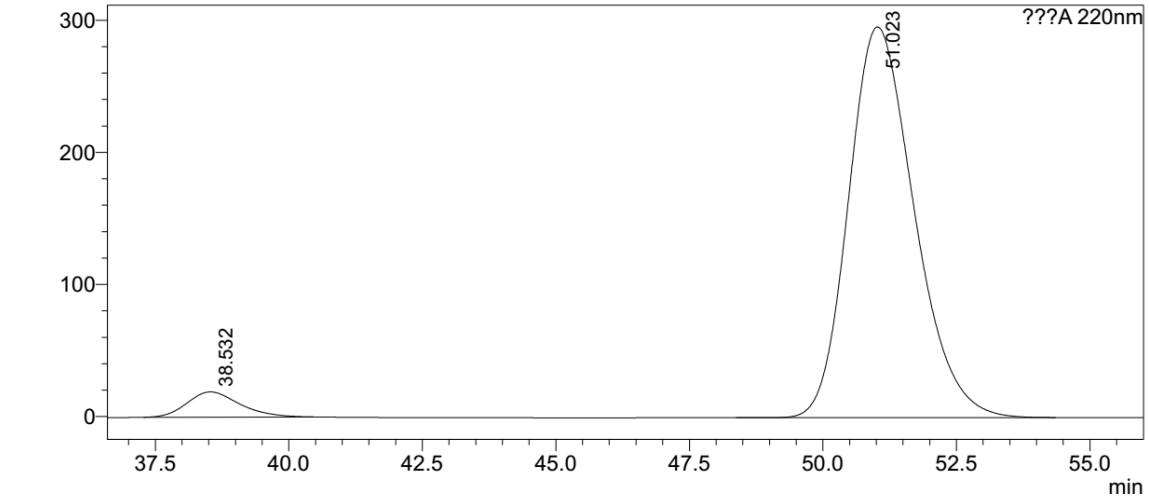


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	39.469	29934141	446051	51.426		M	
2	52.372	28273778	319583	48.574		M	
Total		58207918	765634				

<Chromatogram>



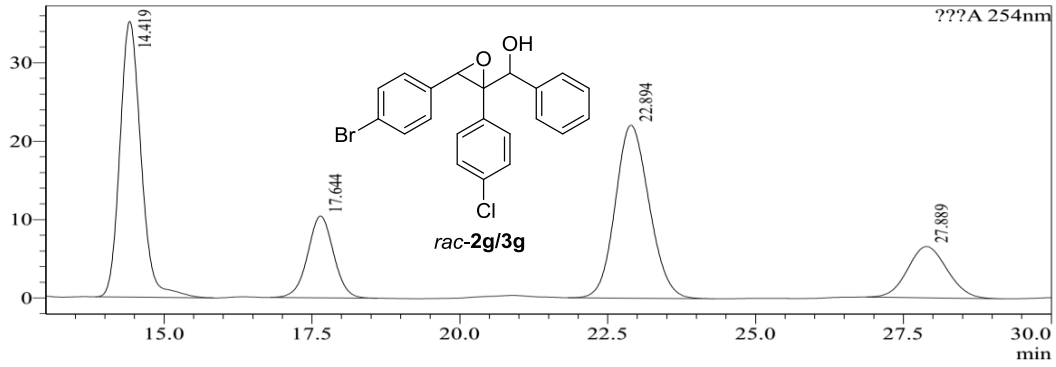
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	38.532	1308350	19095	4.922		M	
2	51.023	25273713	295687	95.078		M	
Total		26582063	314782				

<Chromatogram>

mV



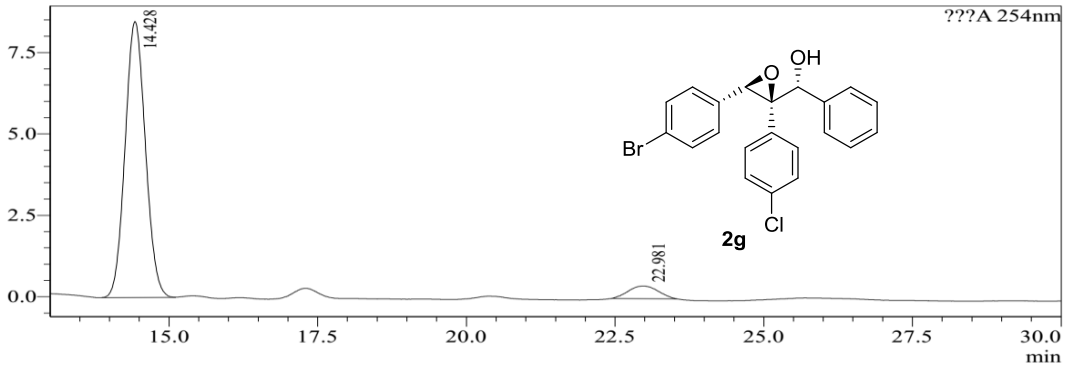
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.419	875622	35172	36.836			
2	17.644	317166	10413	13.343			
3	22.894	880474	22055	37.040			
4	27.889	303804	6533	12.781			
Total		2377066	74172				

<Chromatogram>

mV



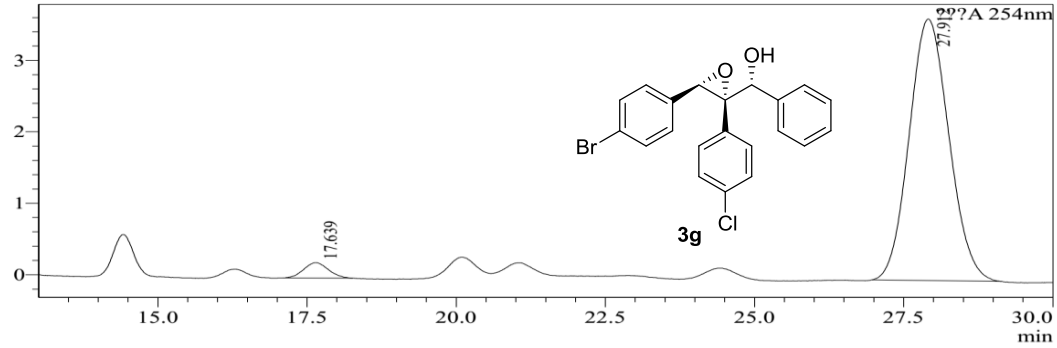
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.428	201048	8471	93.705			
2	22.981	13506	393	6.295		M	
Total		214554	8863				

<Chromatogram>

mV



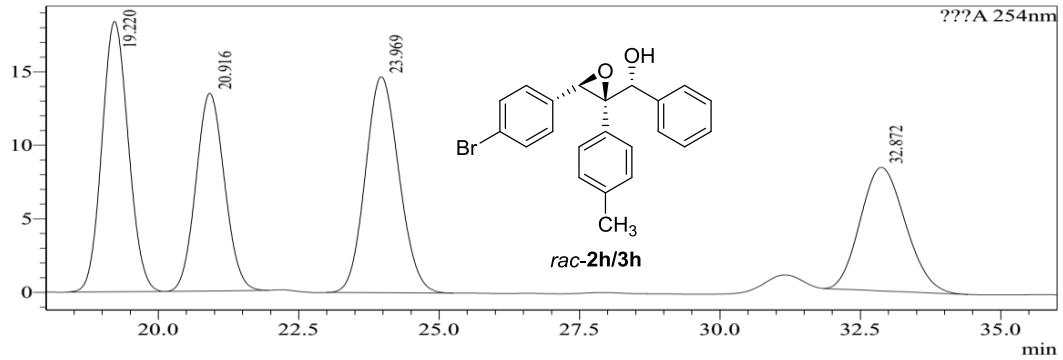
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	17.639	6123	214	3.479		M	
2	27.912	169885	3659	96.521			
Total		176007	3873				

<Chromatogram>

mV



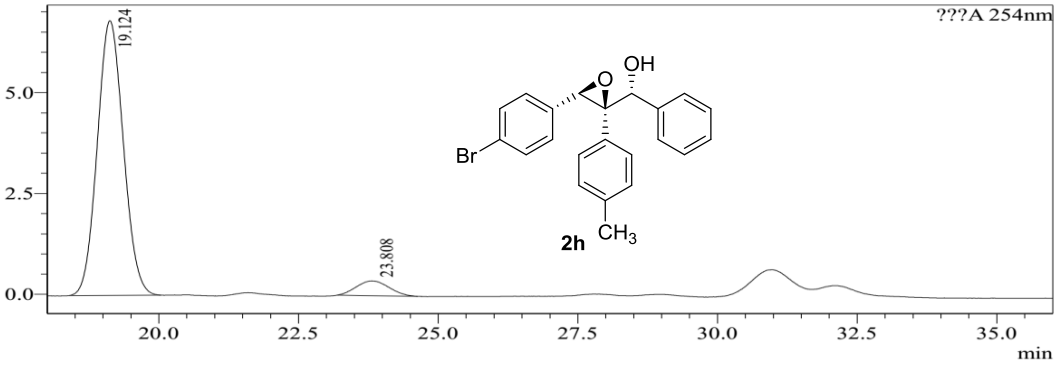
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.220	603120	18385	27.886			
2	20.916	476788	13446	22.045			
3	23.969	612659	14686	28.327			
4	32.872	470223	8397	21.742			
Total		2162790	54913				

<Chromatogram>

mV



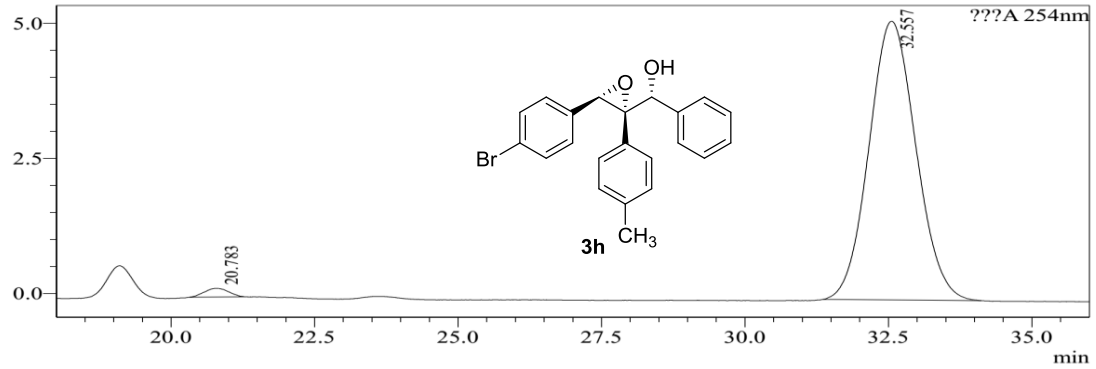
<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.124	221151	6808	93.788			
2	23.808	14648	364	6.212			
Total		235800	7172				

<Chromatogram>

mV

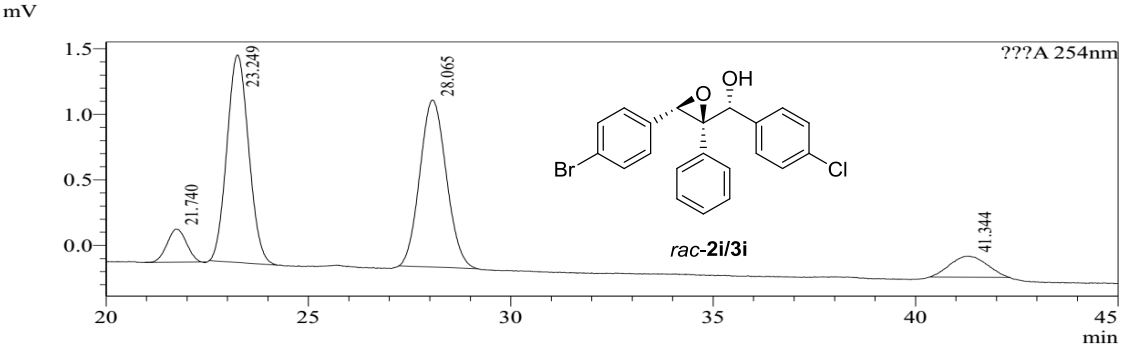


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	20.783	4816	163	1.612			
2	32.557	293866	5162	98.388			
Total		298682	5325				

<Chromatogram>

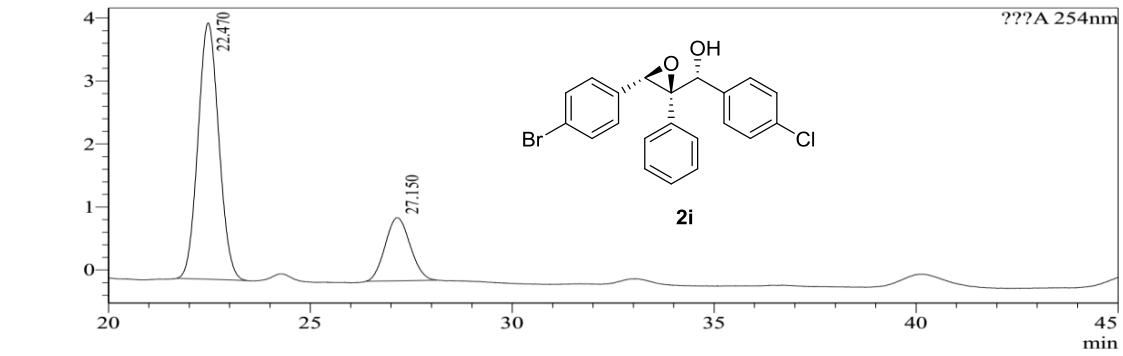


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	21.740	8387	252	6.165		M	
2	23.249	59322	1586	43.606			
3	28.065	58108	1276	42.713			
4	41.344	10226	162	7.517		M	
Total		136043	3275				

<Chromatogram>



<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	22.470	145827	4068	77.236			
2	27.150	42979	1002	22.764			
Total		188806	5069				

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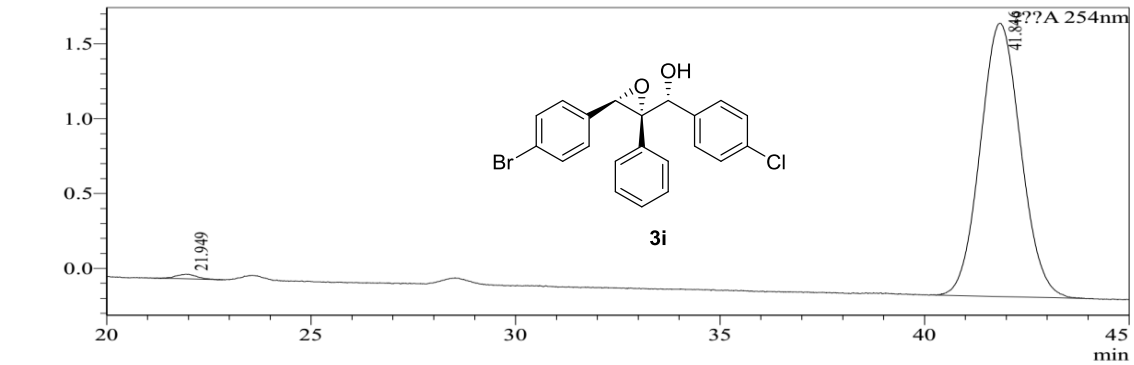
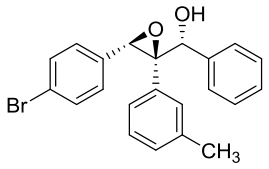


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	21.949	1113	31	0.879		M	
2	41.846	125601	1827	99.121		M	
Total		126715	1858				



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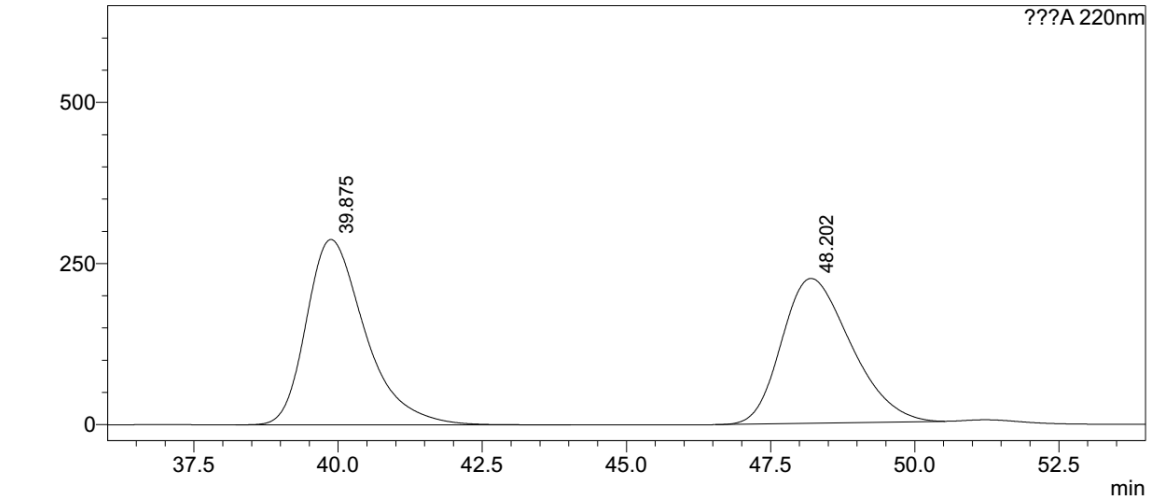

<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	39.875	20404430	287560	52.076			
2	48.202	18777345	224728	47.924			
Total		39181775	512287				

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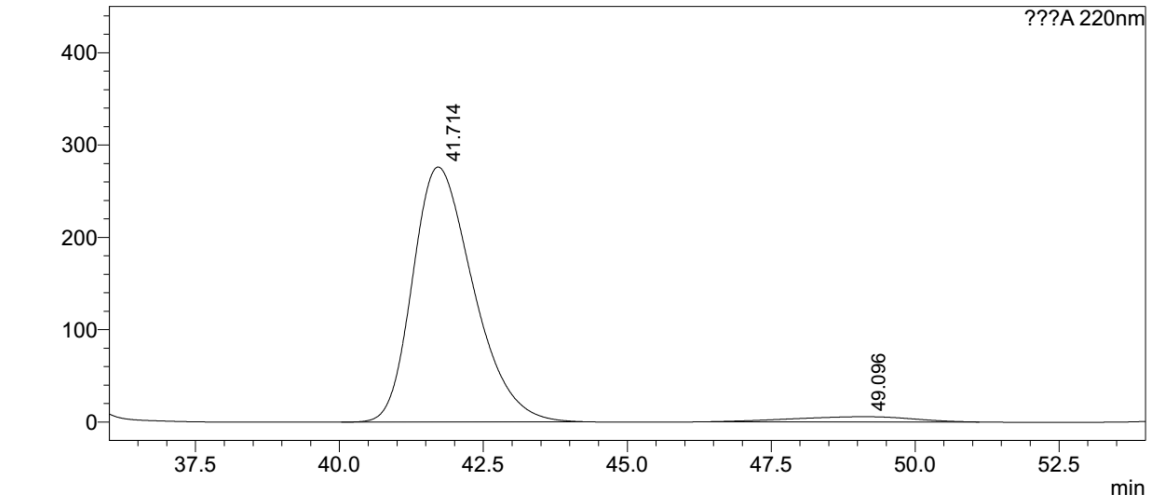
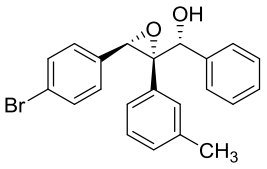


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	41.714	20269361	276178	96.054		M	
2	49.096	832691	5711	3.946		M	
Total		21102052	281889				



3j

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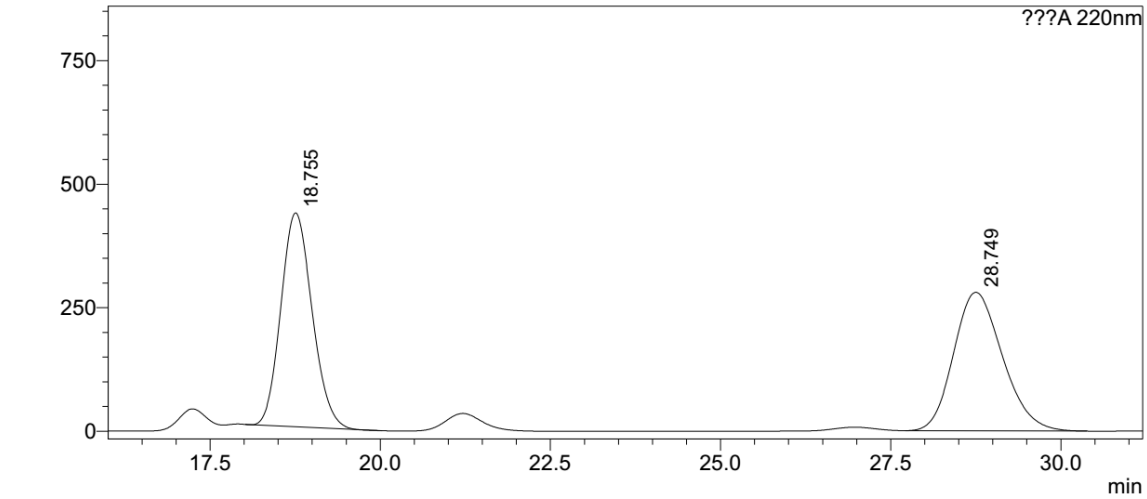

<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	18.755	13835624	432832	49.684		M	
2	28.749	14011471	280440	50.316		M	
Total		27847095	713272				

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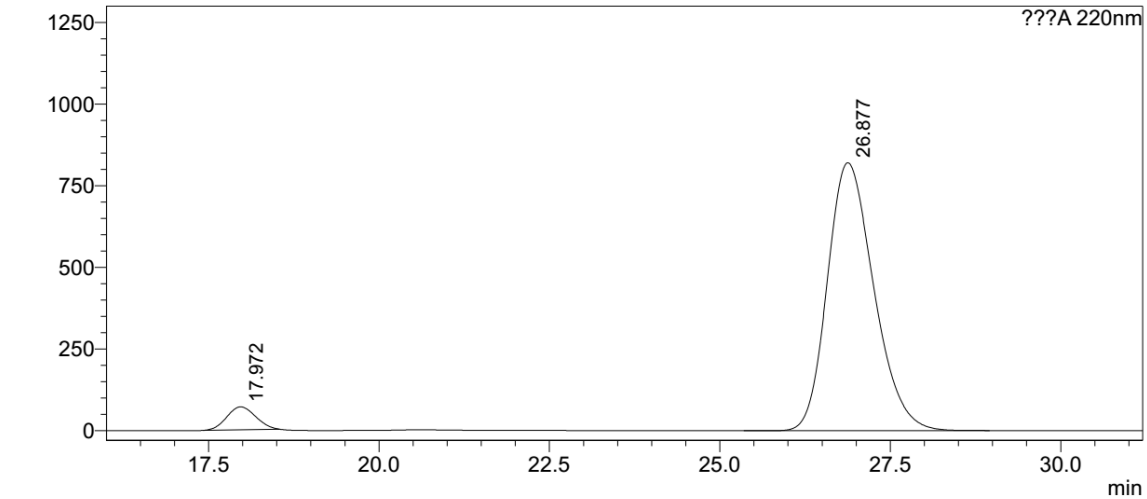
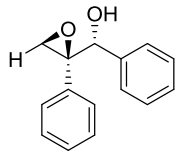


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	17.972	2070804	70290	5.063		M	
2	26.877	38830202	820576	94.937		M	
Total		40901006	890865				



2k

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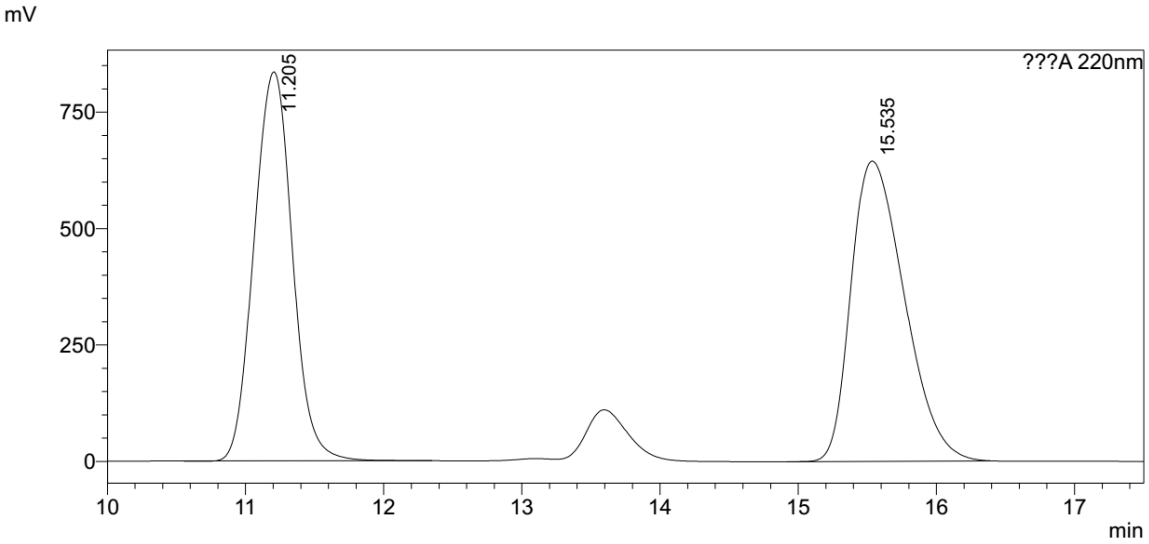

<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.205	16114237	835303	48.170		M	
2	15.535	17338726	645002	51.830		M	
Total		33452963	1480305				

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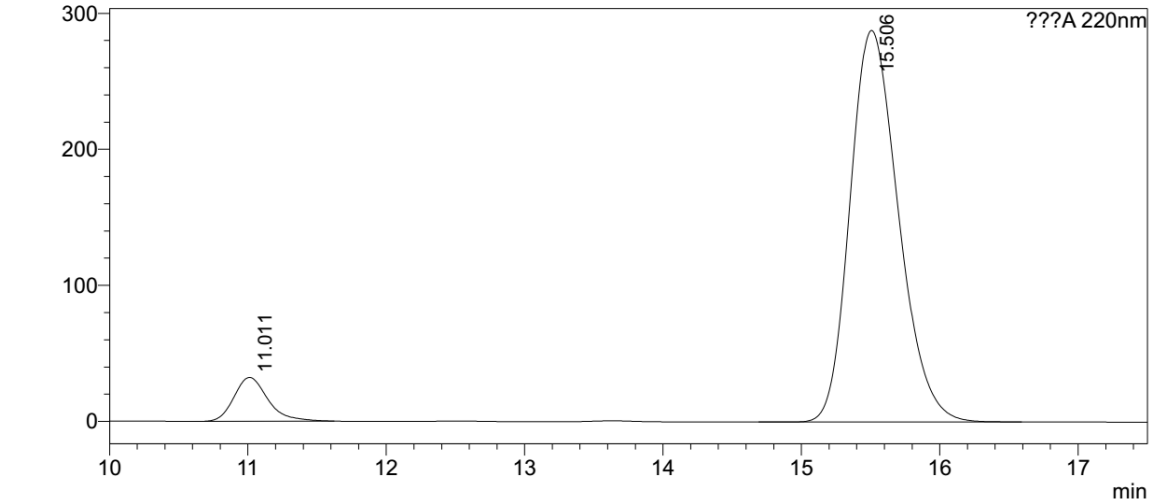
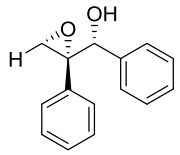


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.011	548169	32192	7.270		M	
2	15.506	6992472	287787	92.730		M	
Total		7540640	319979				



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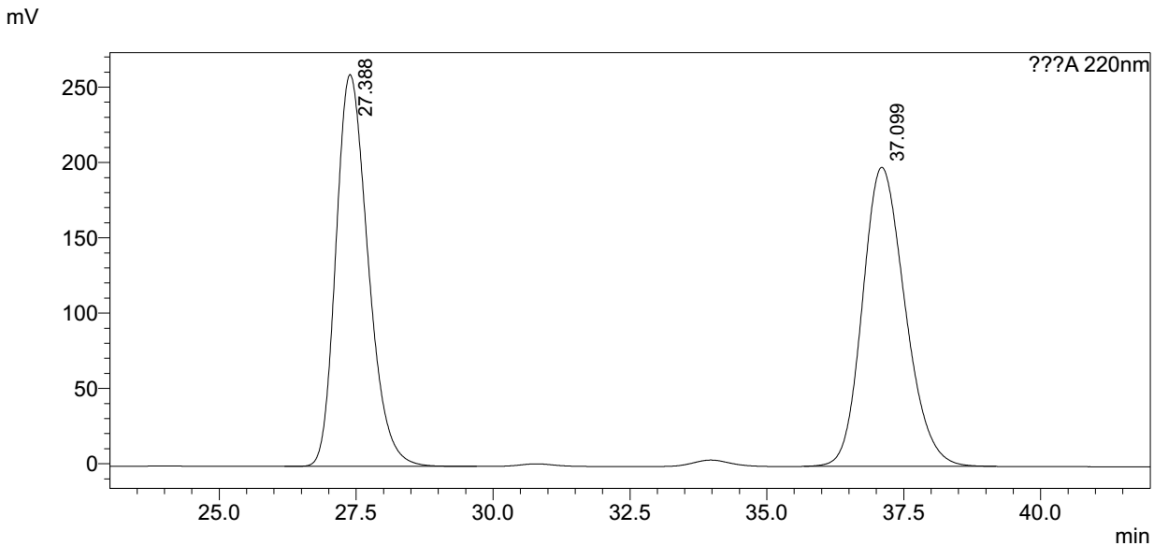

<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	27.388	10616895	260055	49.690		M	
2	37.099	10749440	198544	50.310		M	
Total		21366335	458599				

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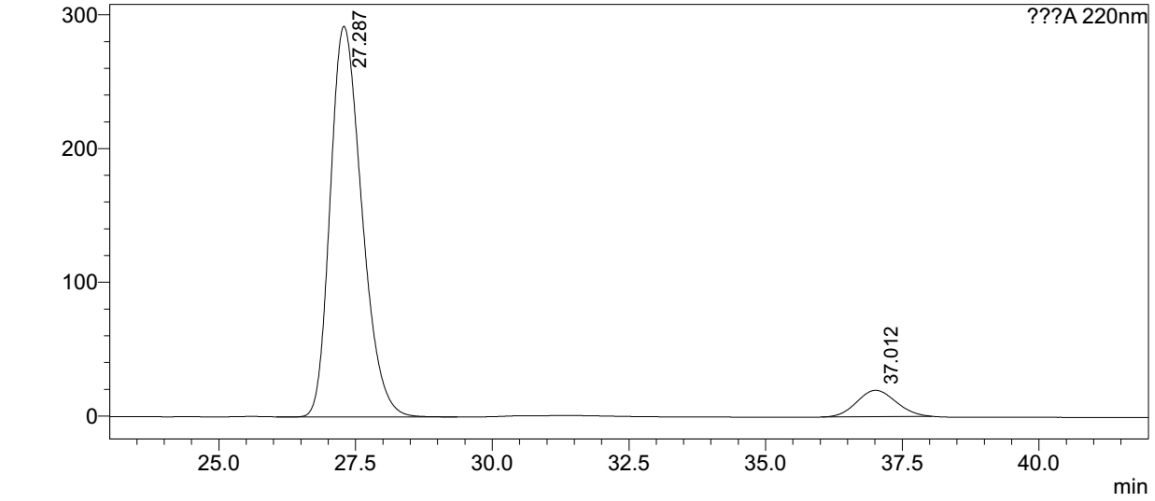
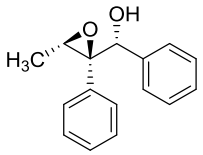


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	27.287	11733996	292015	92.267		M	
2	37.012	983381	19680	7.733		M	
Total		12717377	311695				



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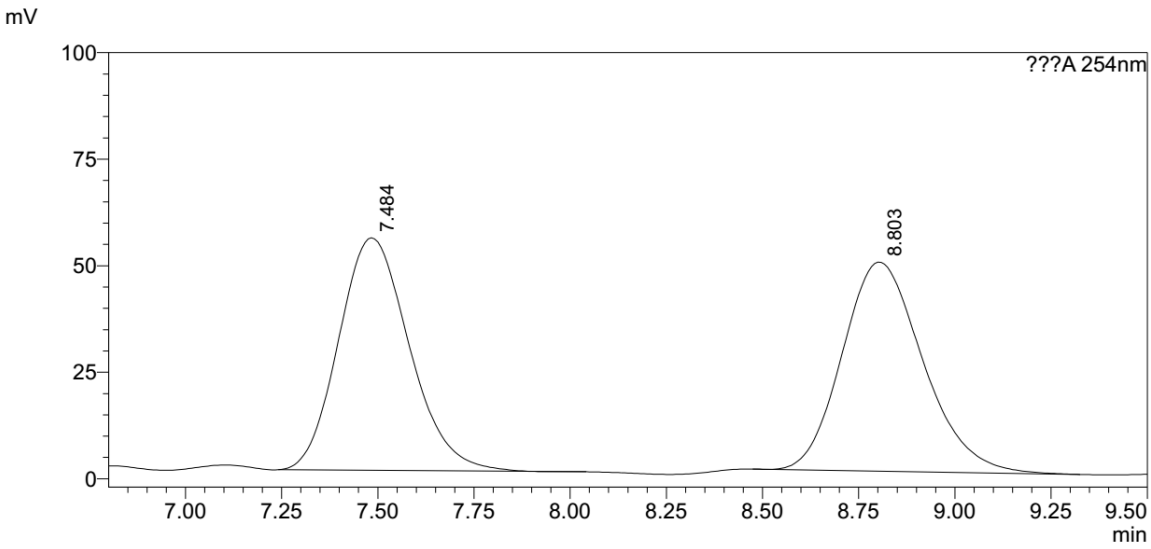
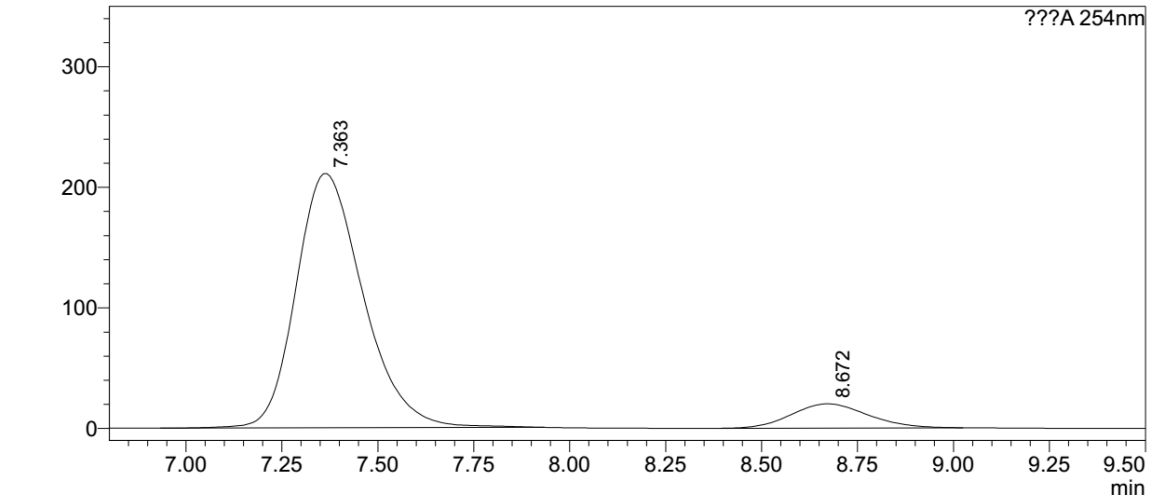


<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.484	697049	54608	49.371		M	
2	8.803	714817	49051	50.629		M	
Total		1411867	103659				

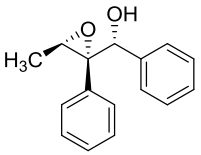
<Chromatogram>



<Peak Table>

???A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.363	2570132	210869	90.231		M	
2	8.672	278272	20066	9.769		M	
Total		2848404	230936				



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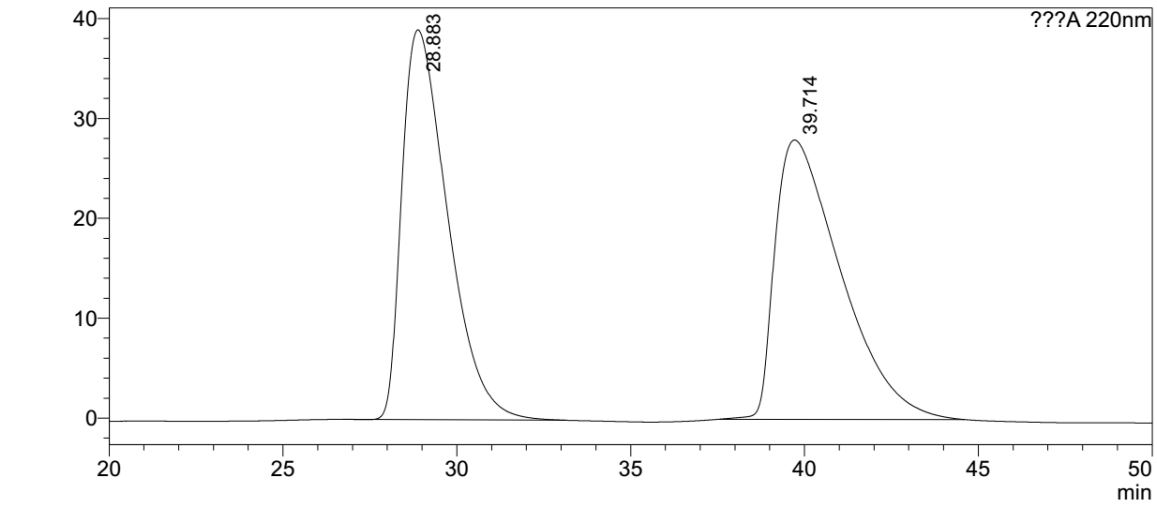
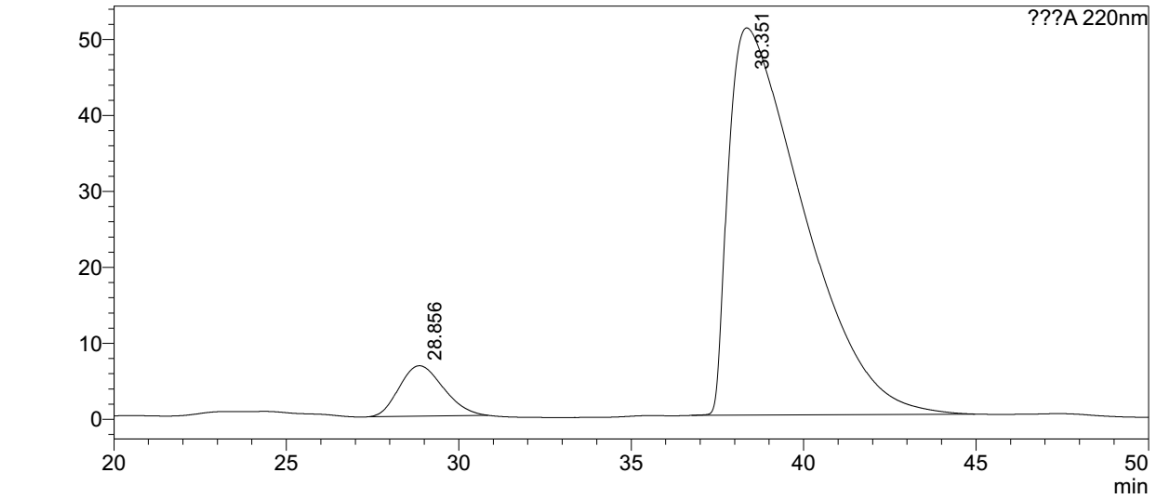


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	28.883	3573822	39014	49.220		M	
2	39.714	3687094	27959	50.780		M	
Total		7260916	66974				

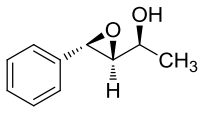
<Chromatogram>



<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	28.856	590073	6636	7.100		M	
2	38.351	7720300	50974	92.900		M	
Total		8310373	57610				



2m

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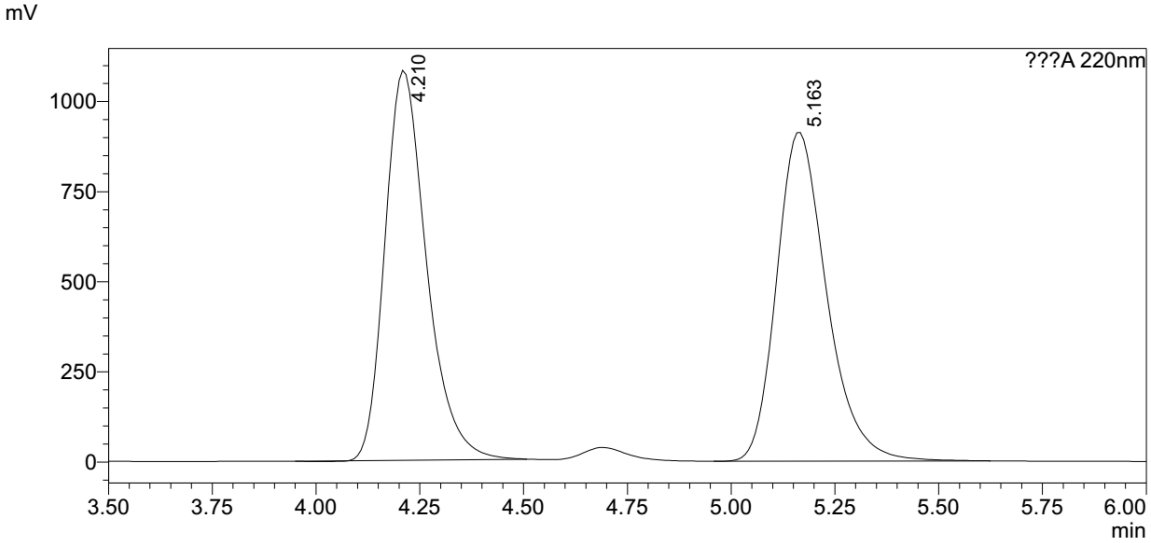
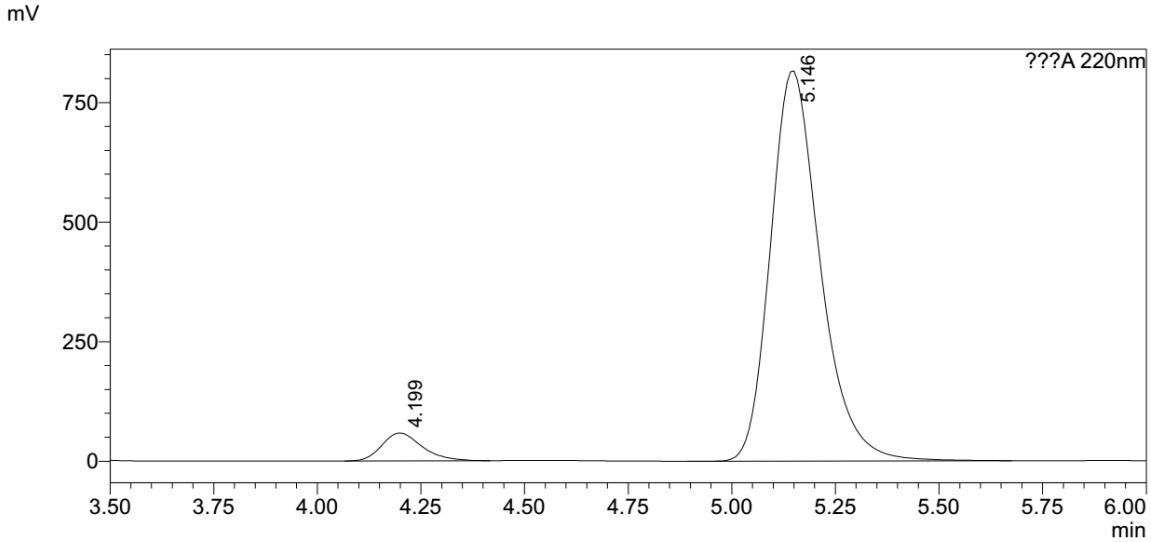


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.210	7538431	1081872	49.575		M	
2	5.163	7667550	912086	50.425		M	
Total		15205981	1993958				

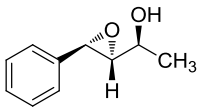
<Chromatogram>



<Peak Table>

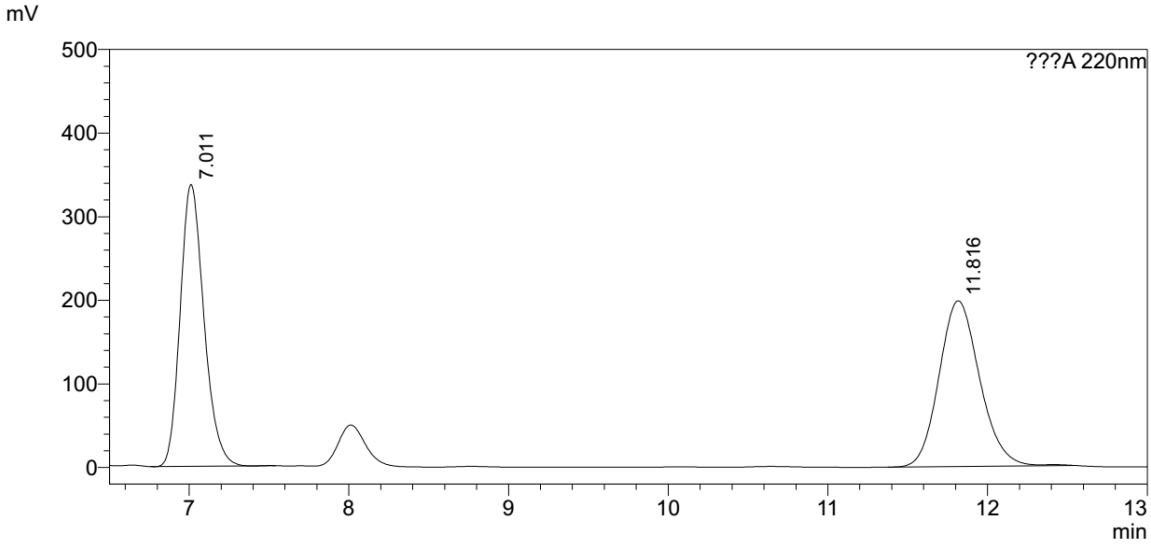
???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.199	393238	58406	5.463		M	
2	5.146	6804981	815677	94.537		M	
Total		7198219	874083				



3m

<Chromatogram>

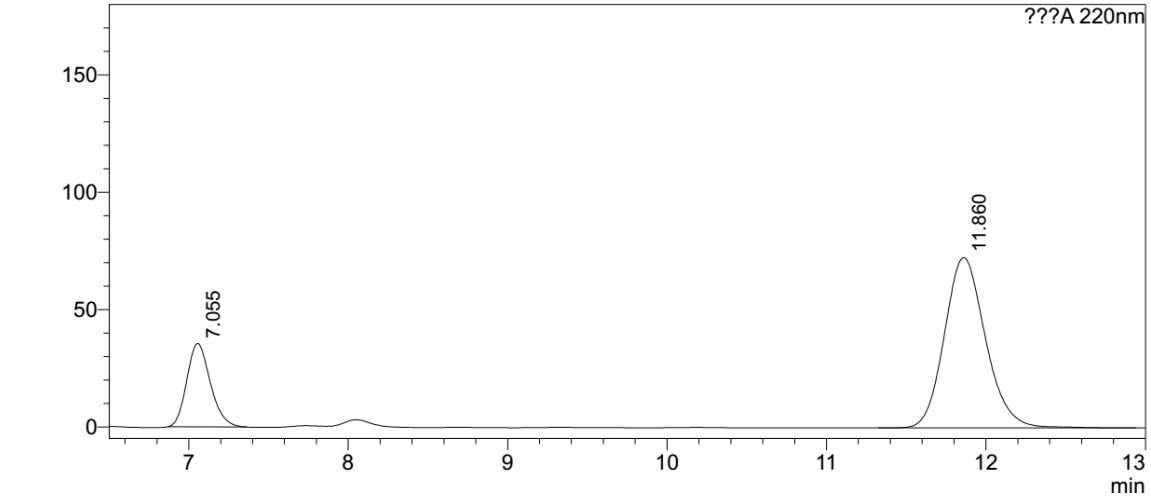


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.011	3491036	337124	49.858		M	
2	11.816	3510986	198381	50.142		M	
Total		7002022	535504				

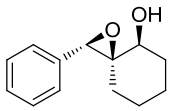
<Chromatogram>



<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	7.055	366306	35547	21.965		M	
2	11.860	1301407	72614	78.035			
Total		1667713	108161				



2n

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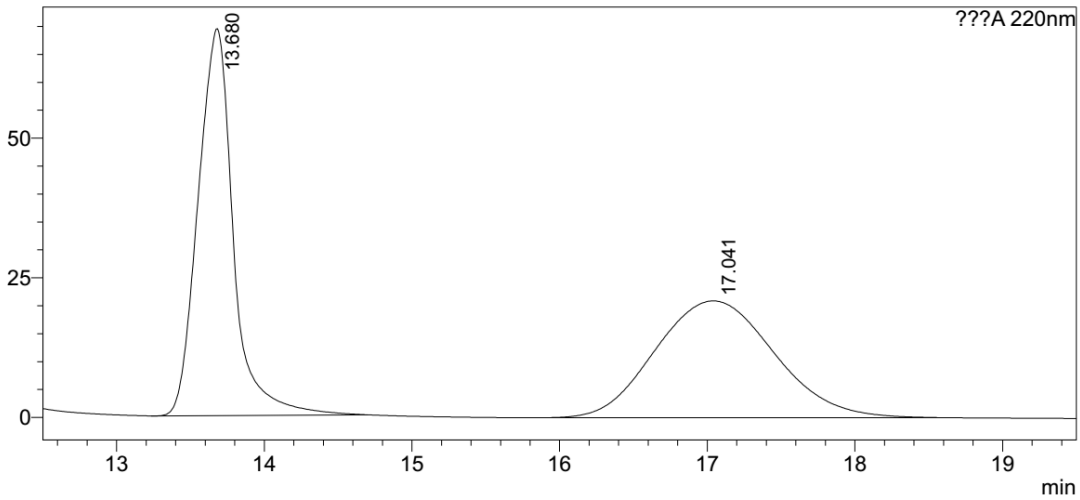
mV



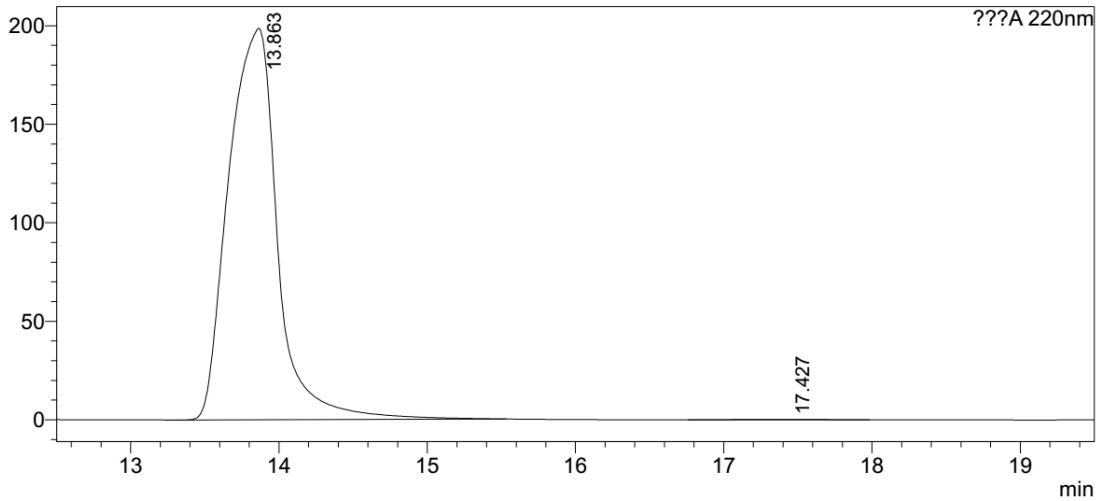
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.680	1151598	69235	49.602		M	
2	17.041	1170093	20895	50.398		M	
Total		2321691	90129				

<Chromatogram>

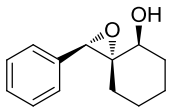
mV



<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.863	4561836	198555	99.867		M	
2	17.427	6059	143	0.133		M	
Total		4567894	198699				



3n

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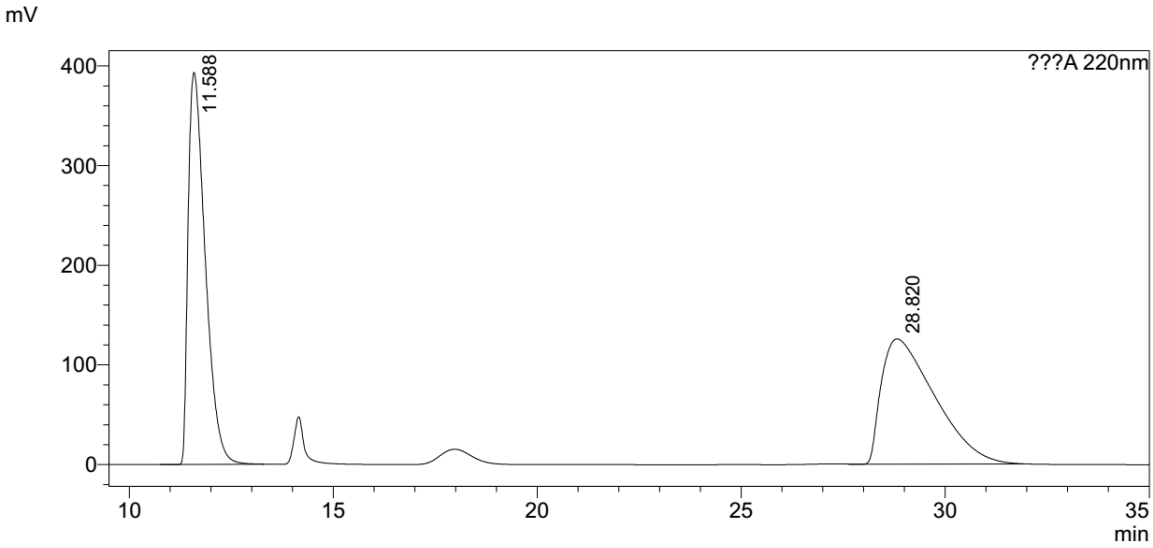
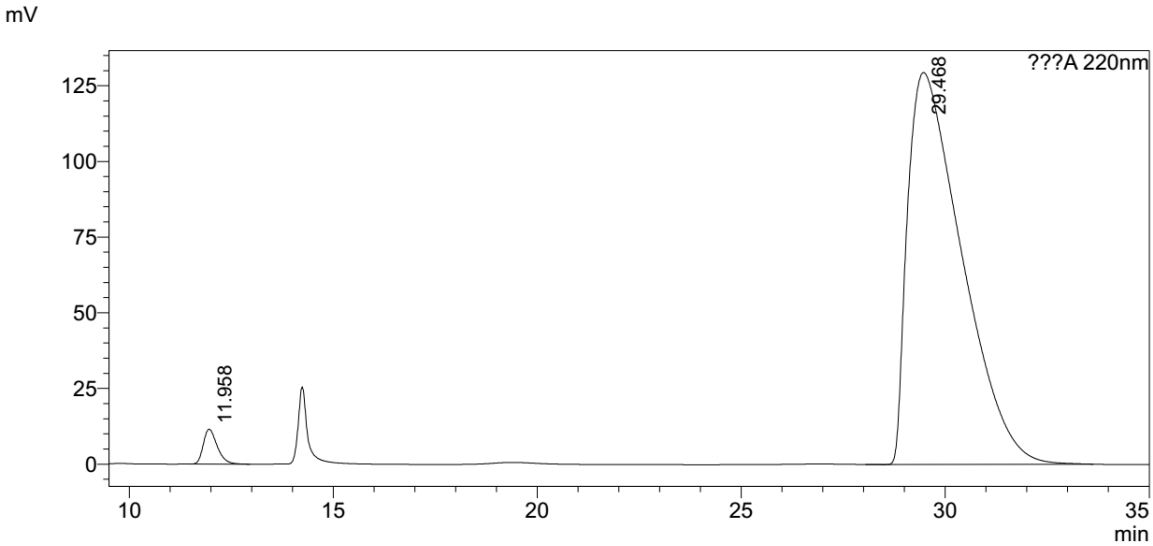


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.588	11464522	393238	50.065		M	
2	28.820	11434849	125601	49.935		M	
Total		22899370	518839				

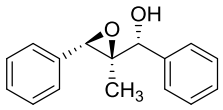
<Chromatogram>



<Peak Table>

???A 220nm

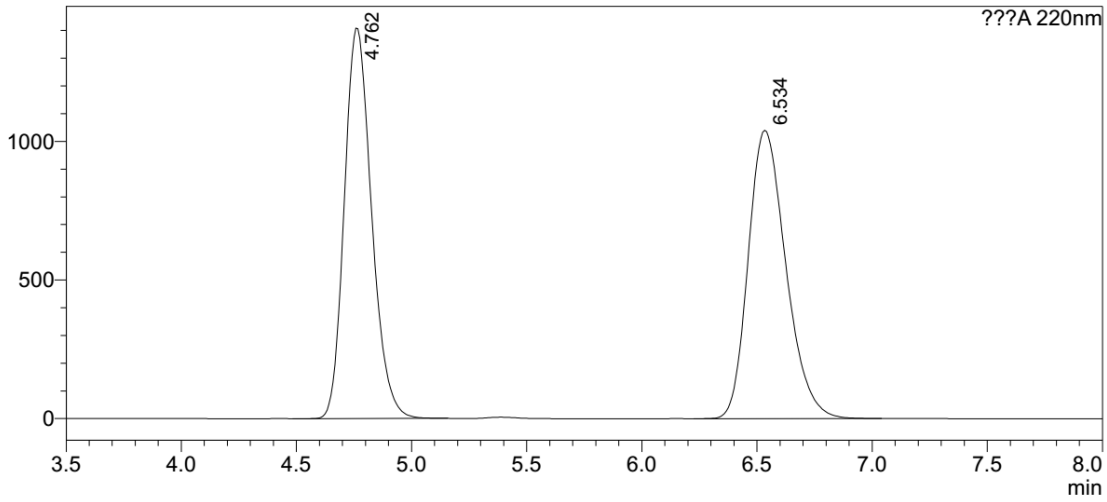
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	11.958	273358	11547	2.234		M	
2	29.468	11960304	129475	97.766		M	
Total		12233663	141022				



2o

<Chromatogram>

mV



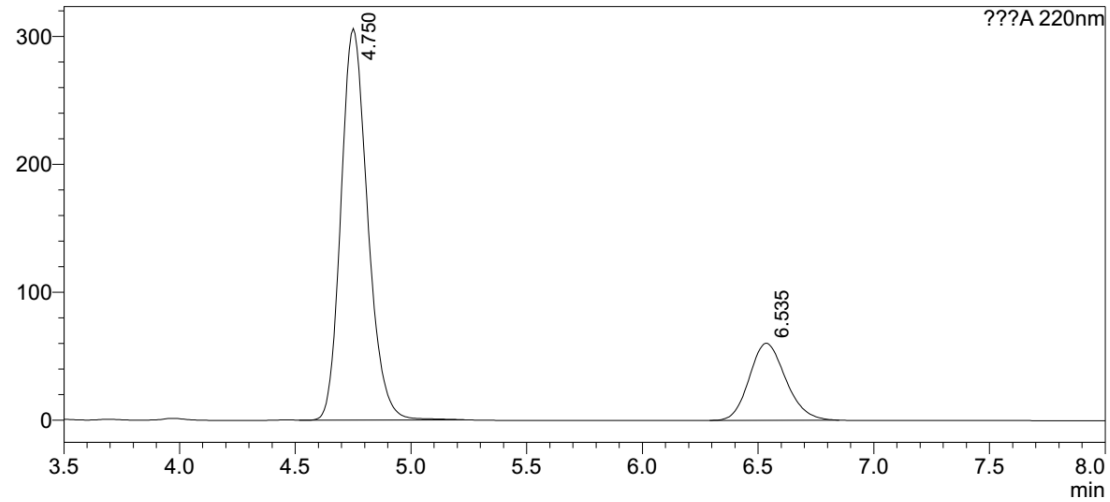
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.762	11584056	1408050	49.473		M	
2	6.534	11830890	1040408	50.527		M	
Total		23414946	2448458				

<Chromatogram>

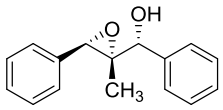
mV



<Peak Table>

???A 220nm

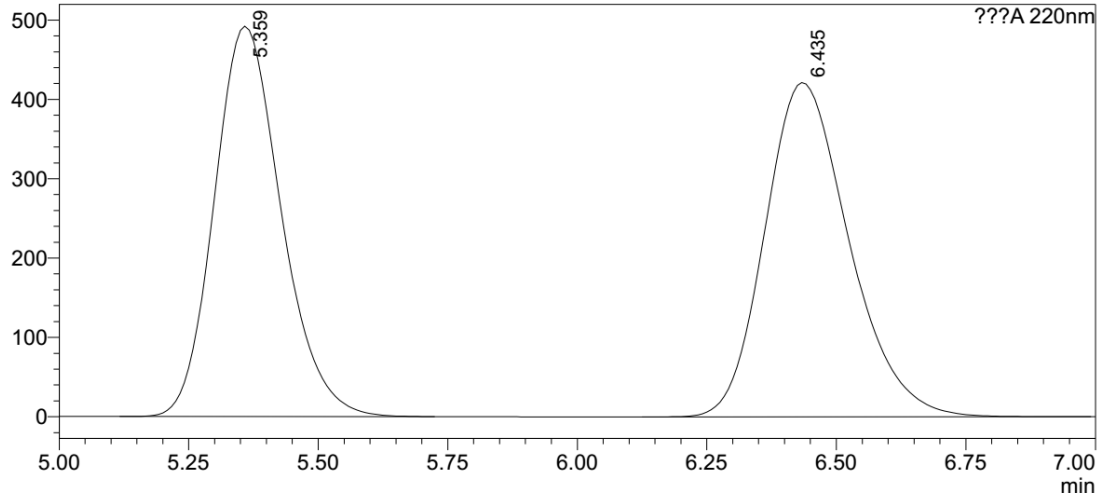
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.750	2456863	306036	78.847		M	
2	6.535	659114	60188	21.153		M	
Total		3115977	366224				



3o

<Chromatogram>

mV



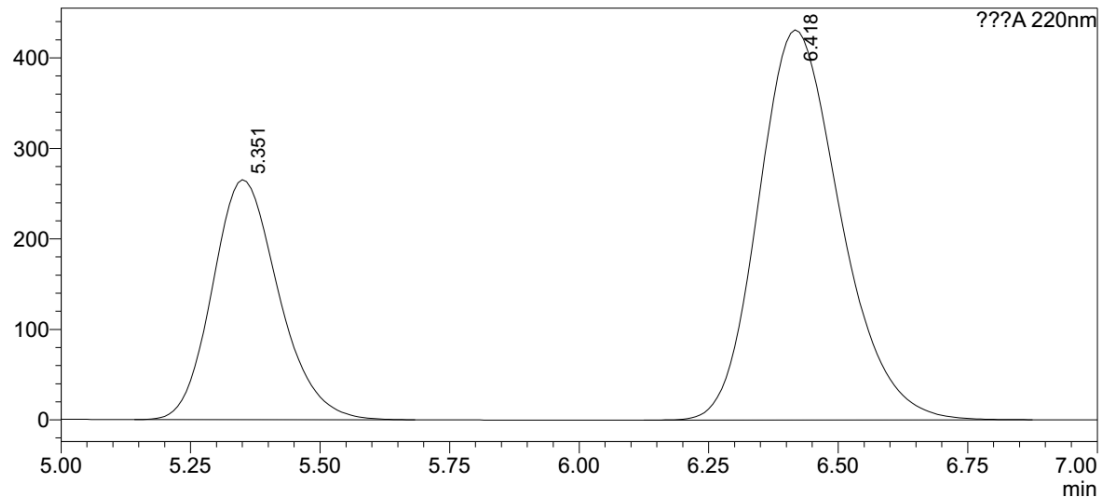
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.359	4419728	491923	48.160		M	
2	6.435	4757391	421444	51.840		M	
Total		9177119	913367				

<Chromatogram>

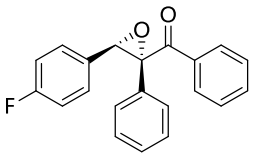
mV



<Peak Table>

???A 220nm

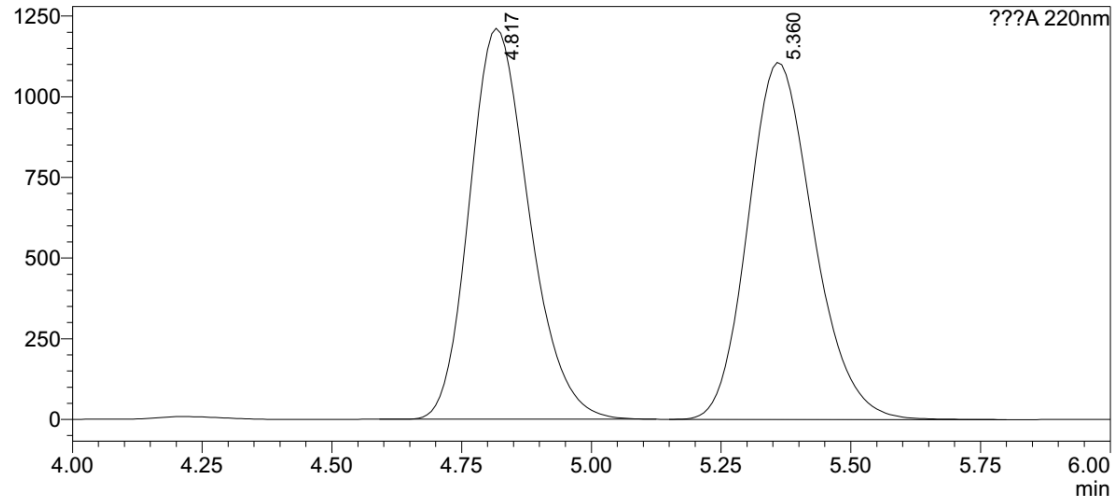
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.351	2355898	265133	33.205		M	
2	6.418	4739036	430937	66.795		M	
Total		7094935	696070				



4a

<Chromatogram>

mV



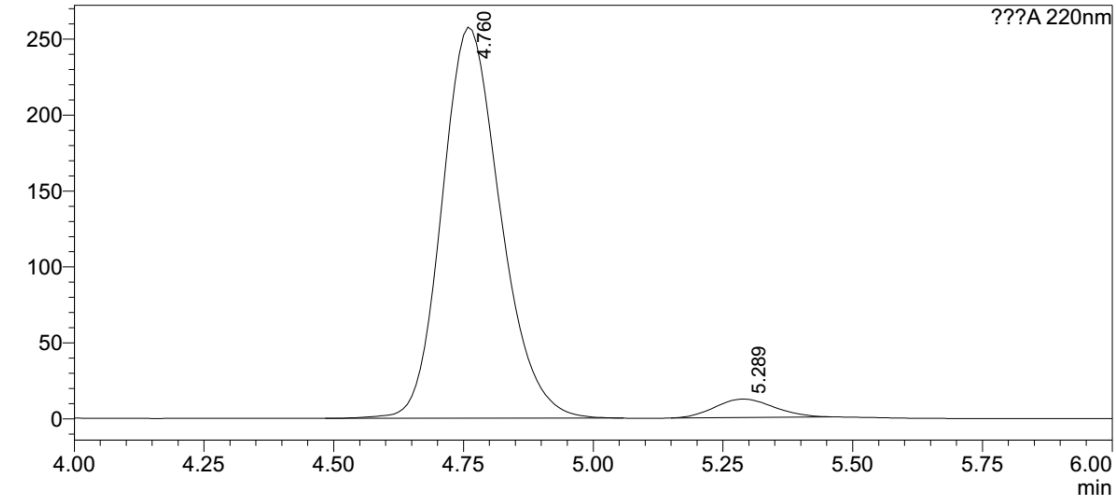
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.817	9673166	1210970	49.857		M	
2	5.360	9728479	1106487	50.143		M	
Total		19401645	2317458				

<Chromatogram>

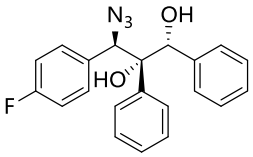
mV



<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.760	2019342	257525	95.454		M	
2	5.289	96178	12095	4.546		M	
Total		2115520	269621				



4b

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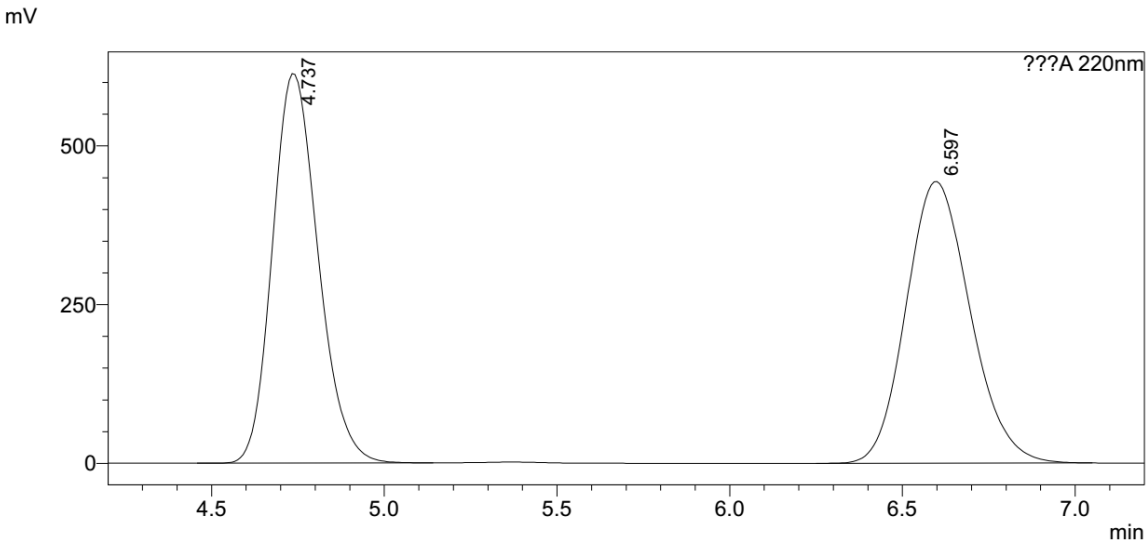
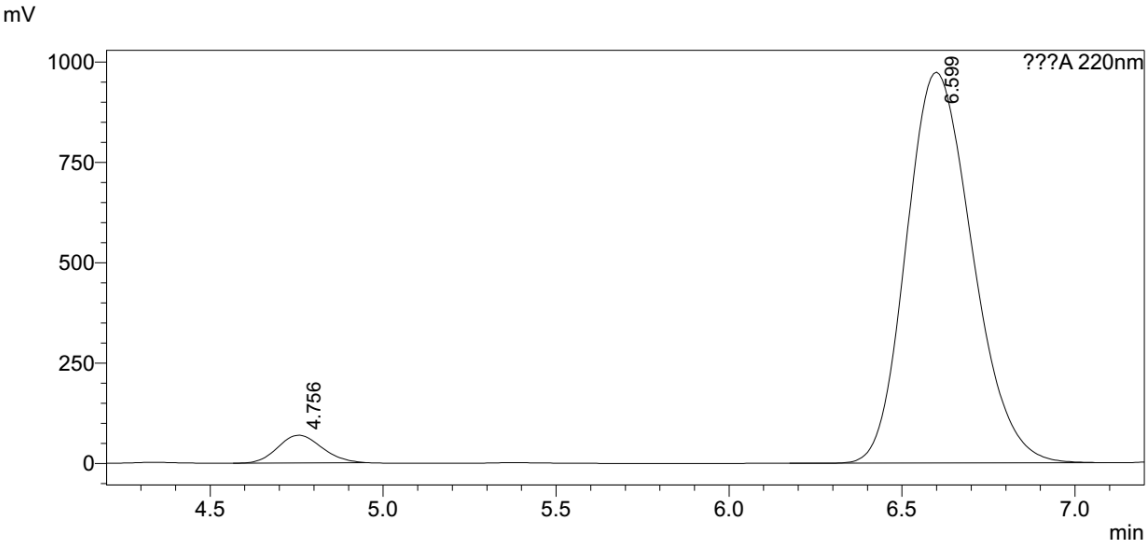


<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.737	5641559	613379	49.617		M	
2	6.597	5728681	443735	50.383		M	
Total		11370240	1057113				

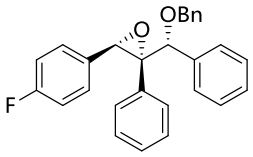
<Chromatogram>



<Peak Table>

???A 220nm

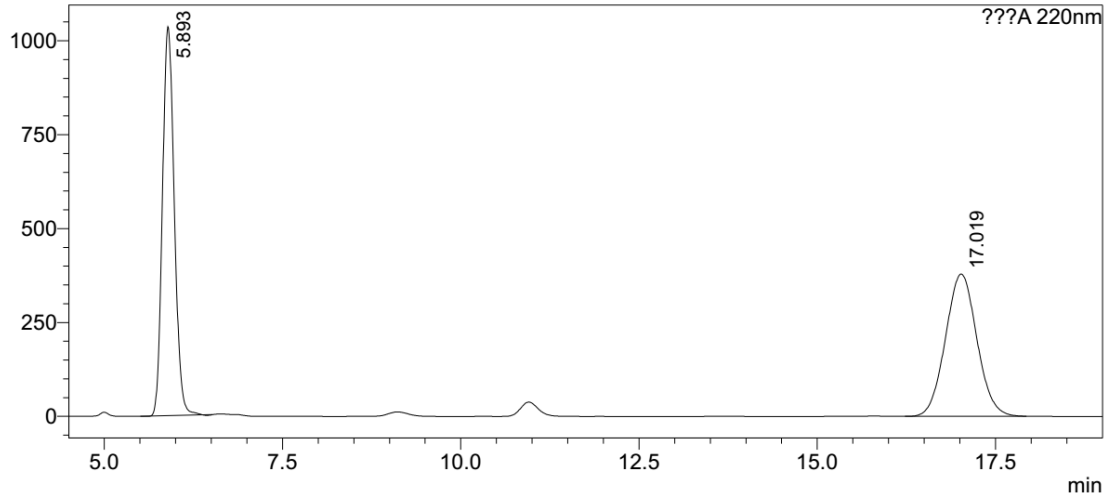
Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.756	616656	69211	4.558		M	
2	6.599	12912716	973132	95.442		M	
Total		13529372	1042343				



4c

<Chromatogram>

mV



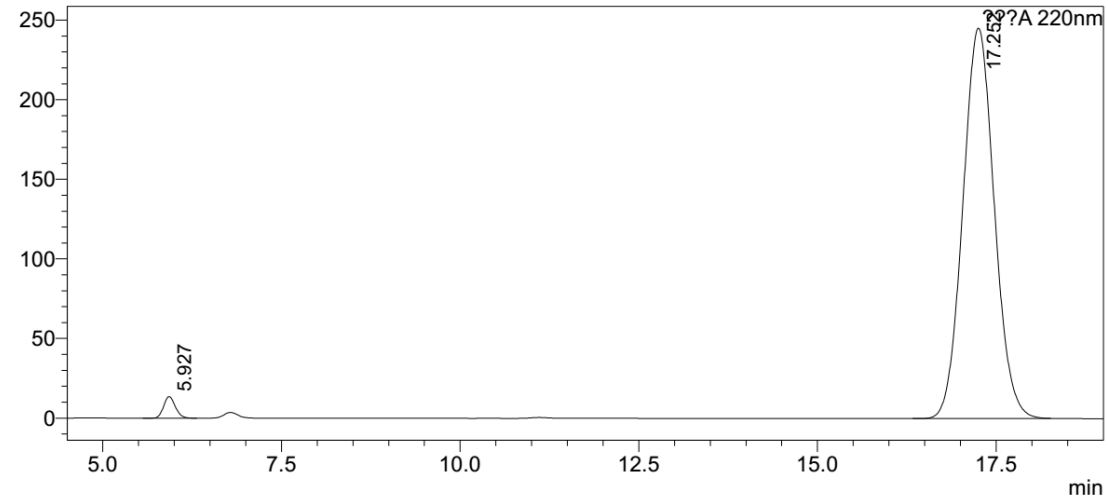
<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.893	11954597	1035126	50.712		M	
2	17.019	11618916	379086	49.288		M	
Total		23573513	1414212				

<Chromatogram>

mV



<Peak Table>

???A 220nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.927	154224	13520	2.014		M	
2	17.252	7503371	245188	97.986		M	
Total		7657594	258707				