

(Supporting Information)

**Highly Diastereo- and Enantioselective Organocatalytic Synthesis of
Trifluoromethylated Erythritols Based on the in situ Generation of
Unstable Trifluoroacetaldehyde**

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Kubota[†]

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1193, Japan

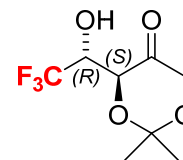
[‡] Division of Instrumental Analysis, Life Science Research Center, Gifu University, 1-1 Yanagido,
Gifu 501-1193, Japan

E-mail funabiki@gifu-u.ac.jp

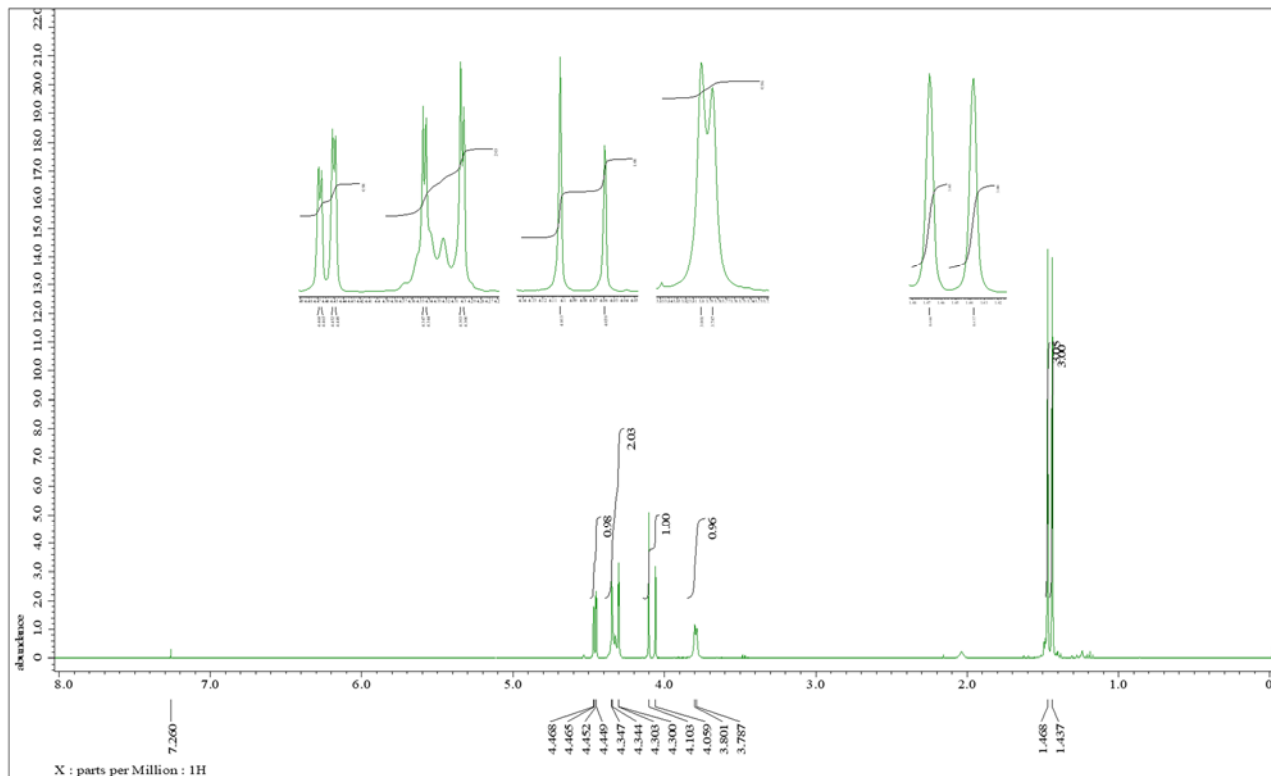
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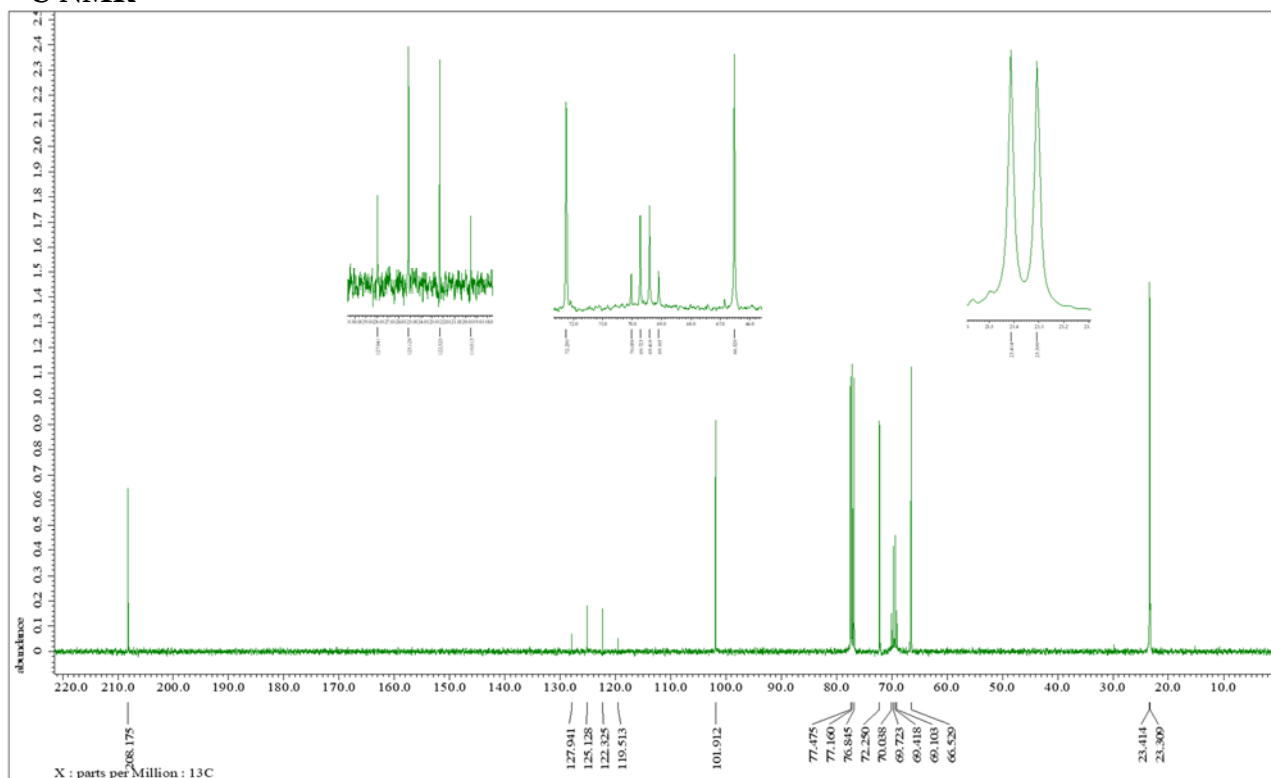
(S)-2,2-Dimethyl-4-((R)-2,2,2-trifluoro-1-hydroxyethyl)-1,3-dioxan-5-one
(anti-4a)



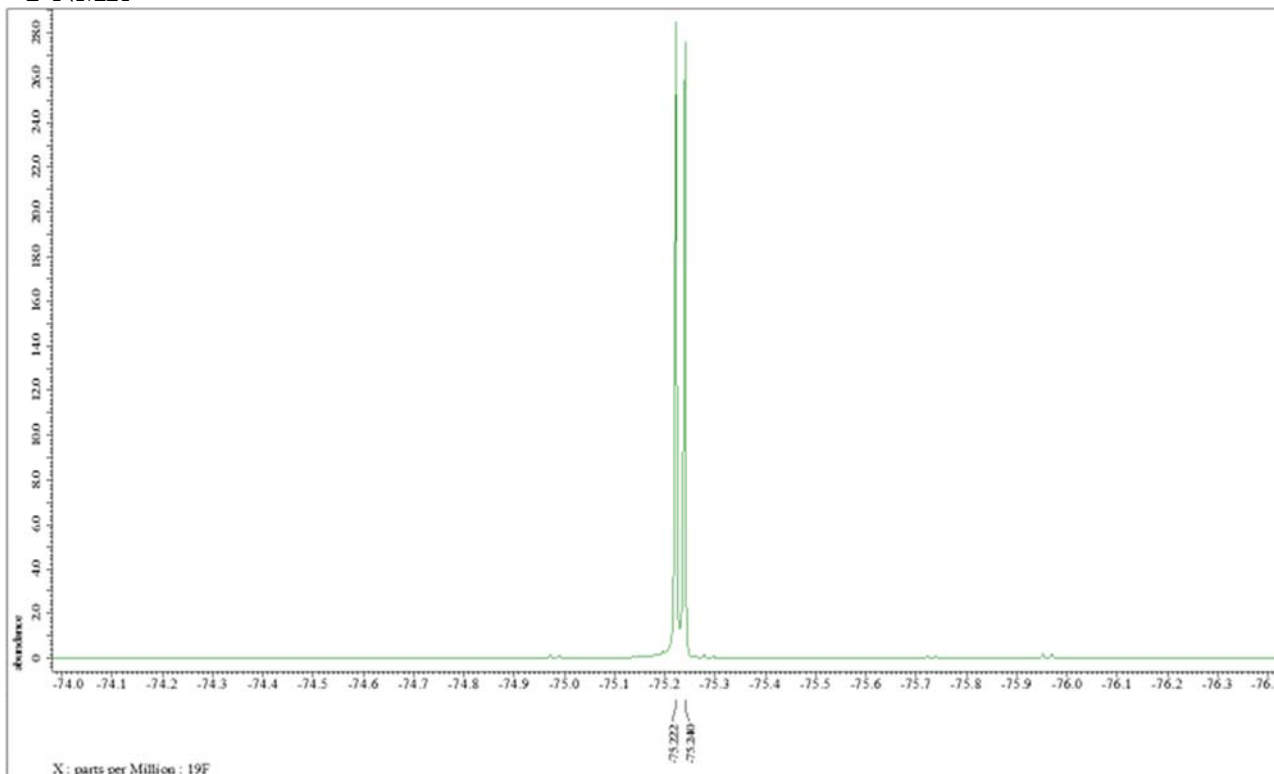
¹H NMR



¹³C NMR



¹⁹F NMR



HRMS

Elemental Composition Report

Single Mass Analysis

Tolerance = 100.0 PPM / DBE: min = -10.0, max = 100.0

Element prediction: Off

Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions

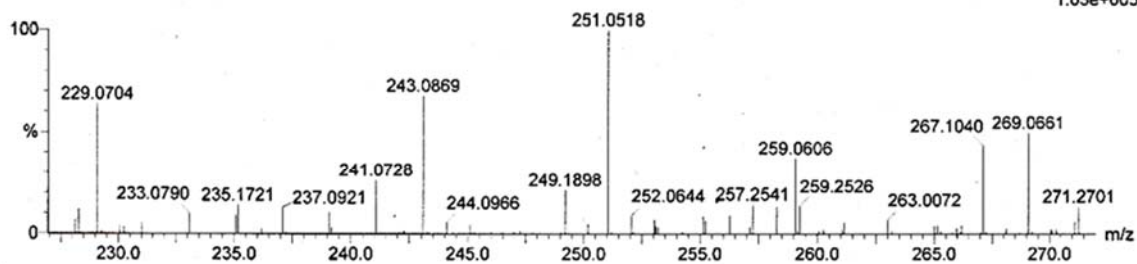
5 formula(e) evaluated with 1 results within limits (all results (up to 1000) for each mass)

Elements Used:

C: 8-8 H: 11-12 O: 4-4 Na: 0-1 14N: 0-2 19F: 3-3

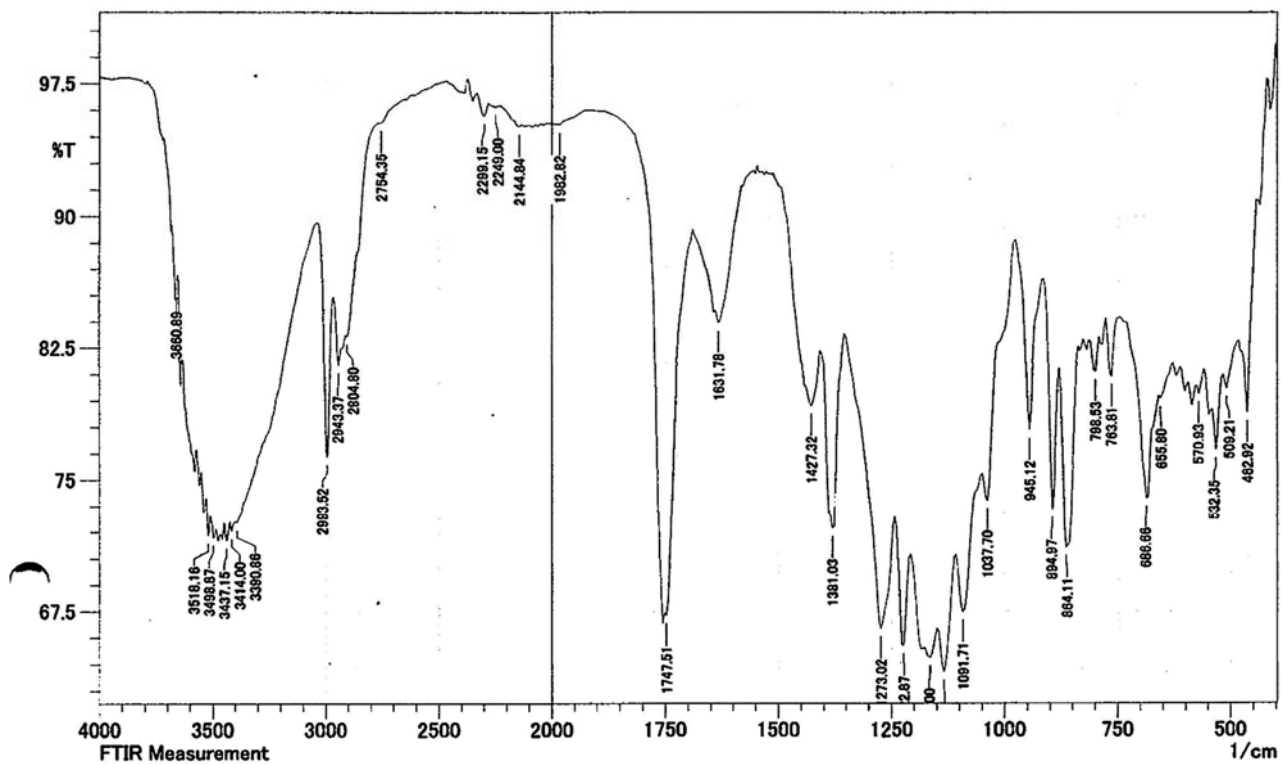
20190708p-1 24 (0.842)

1: TOF MS ES+

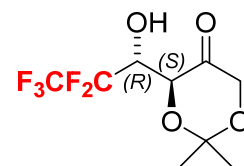


Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
229.0704	229.0688	1.6	7.0	1.5	299.4	0.0	C8 H12 O4 19F3

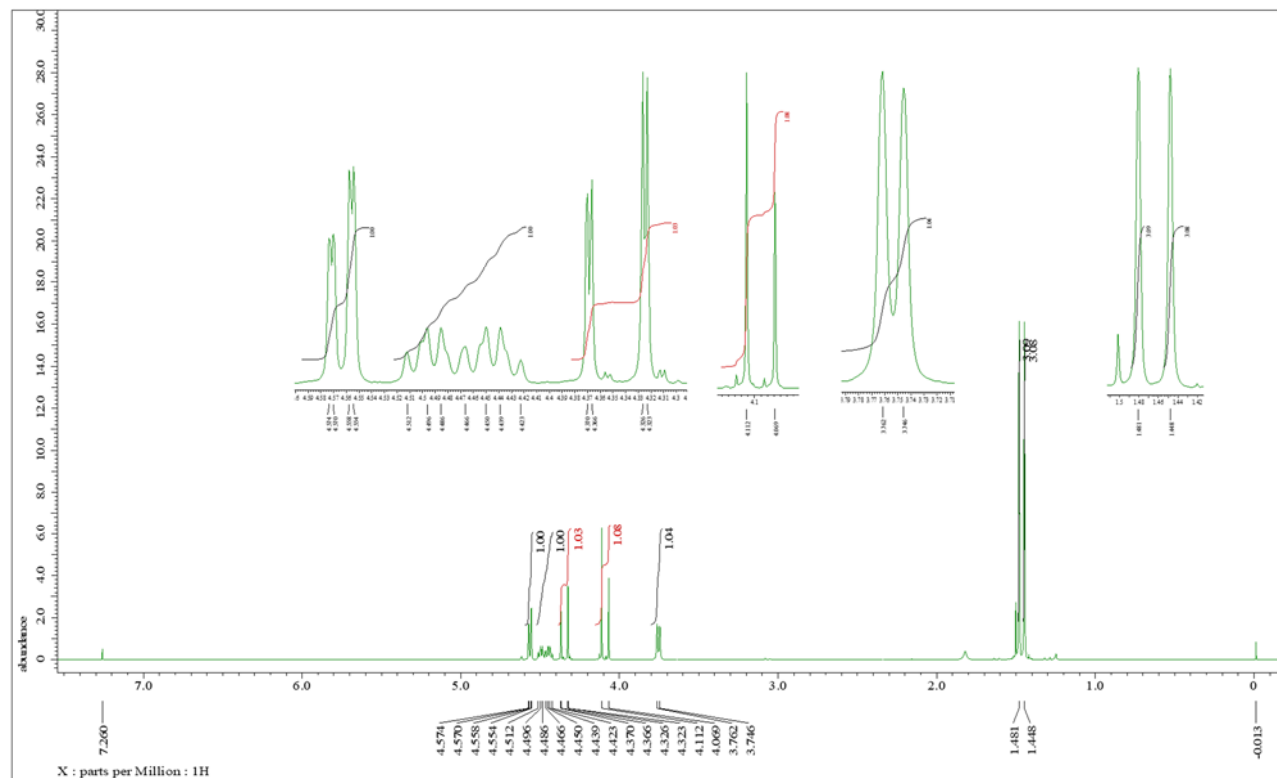
IR



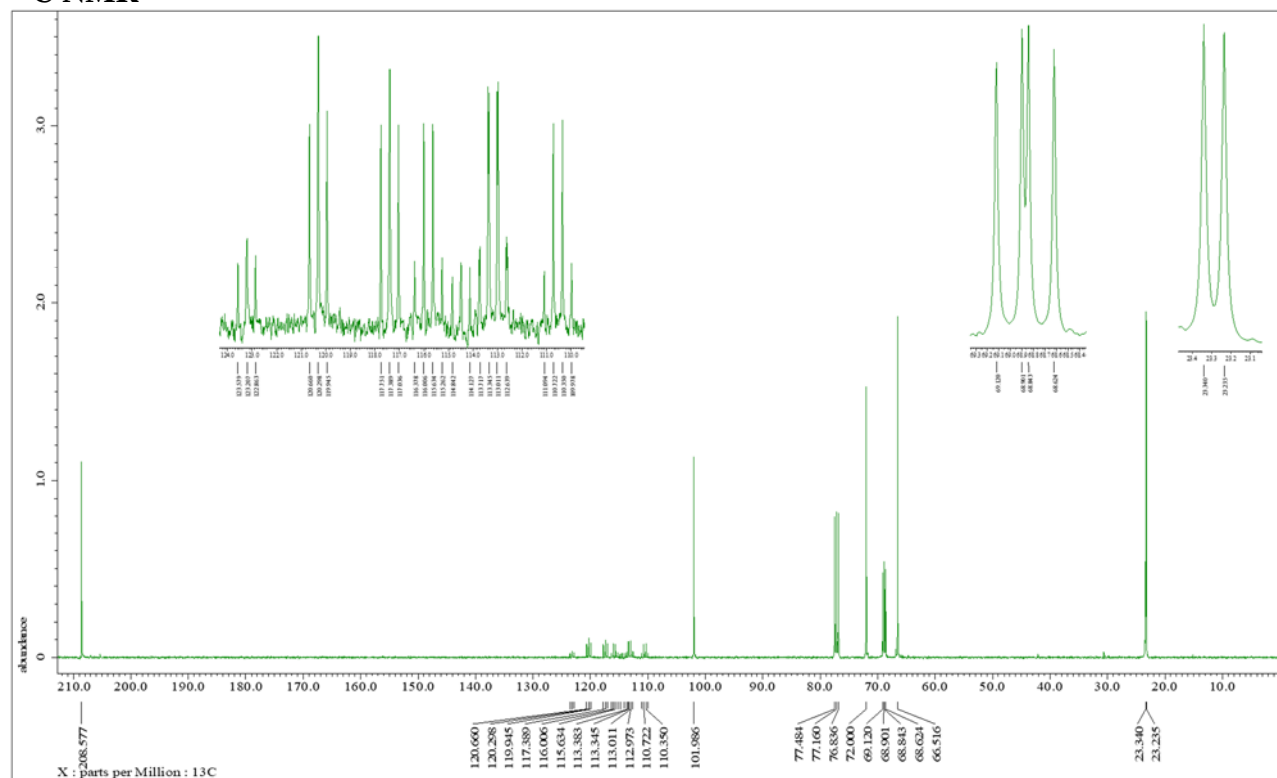
(S)-2,2-Dimethyl-4-((R)-2,2,3,3,3-pentafluoro-1-hydroxypropyl)-1,3-dioxan-5-one (anti-4b)



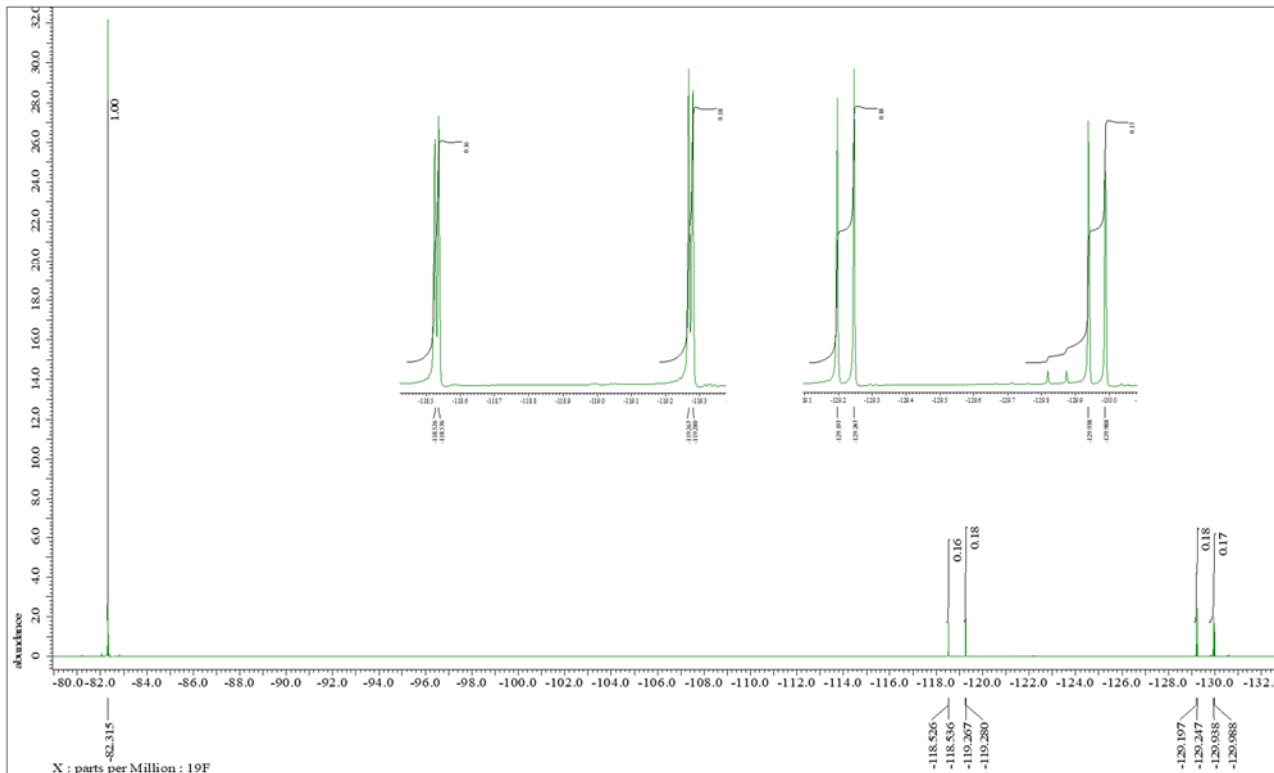
¹H NMR



¹³C NMR



¹⁹F NMR



HRMS

Elemental Composition Report

Single Mass Analysis

Tolerance = 100.0 PPM / DBE: min = -10.0, max = 100.0

Element prediction: Off

Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions

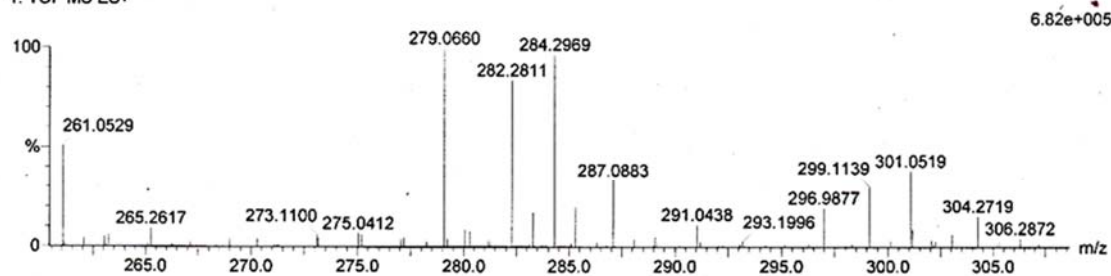
5 formula(e) evaluated with 1 results within limits (all results (up to 1000) for each mass)

Elements Used:

C: 9-9 H: 11-12 14N: 0-2 O: 4-4 19F: 5-5 Na: 0-1

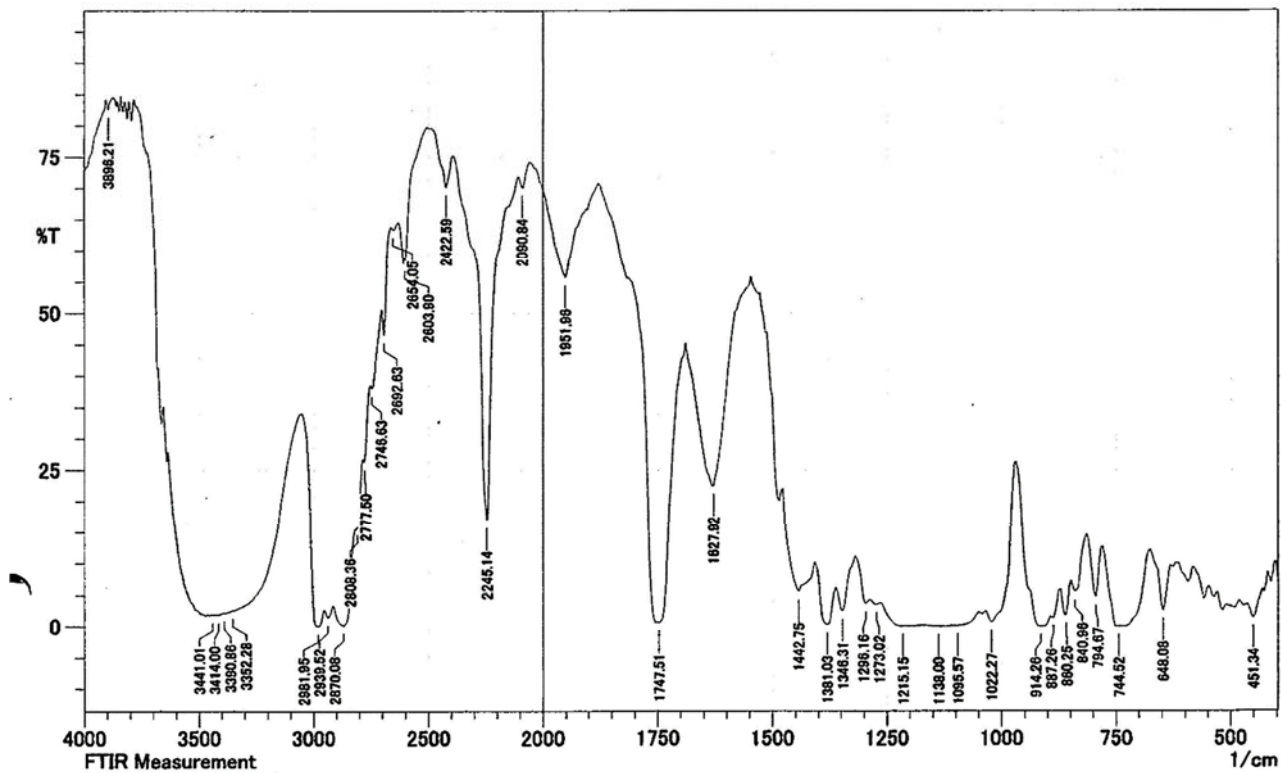
20190708p-4 10 (0.353)

1: TOF MS ES+

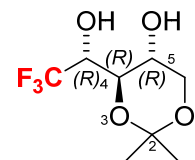


Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
279.0660	279.0656	0.4	1.4	1.5	431.6	0.0	C9 H12 O4 19F5

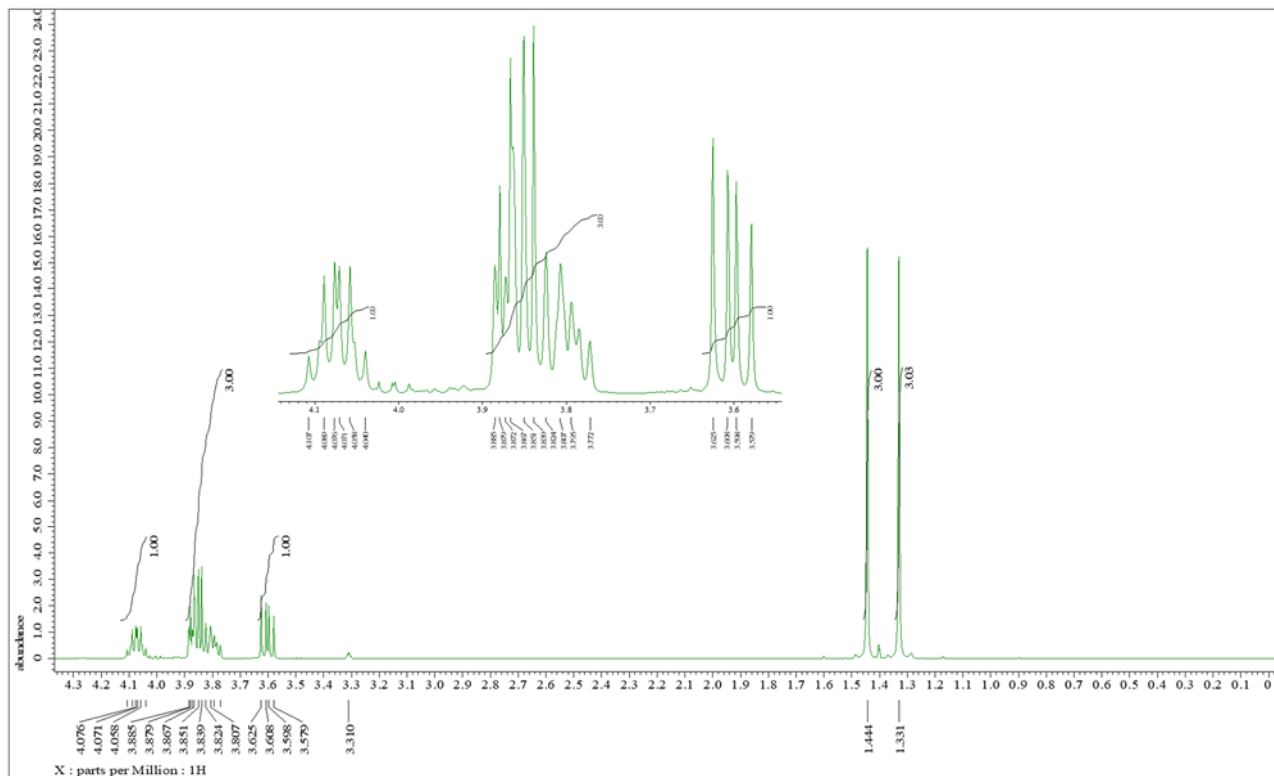
IR



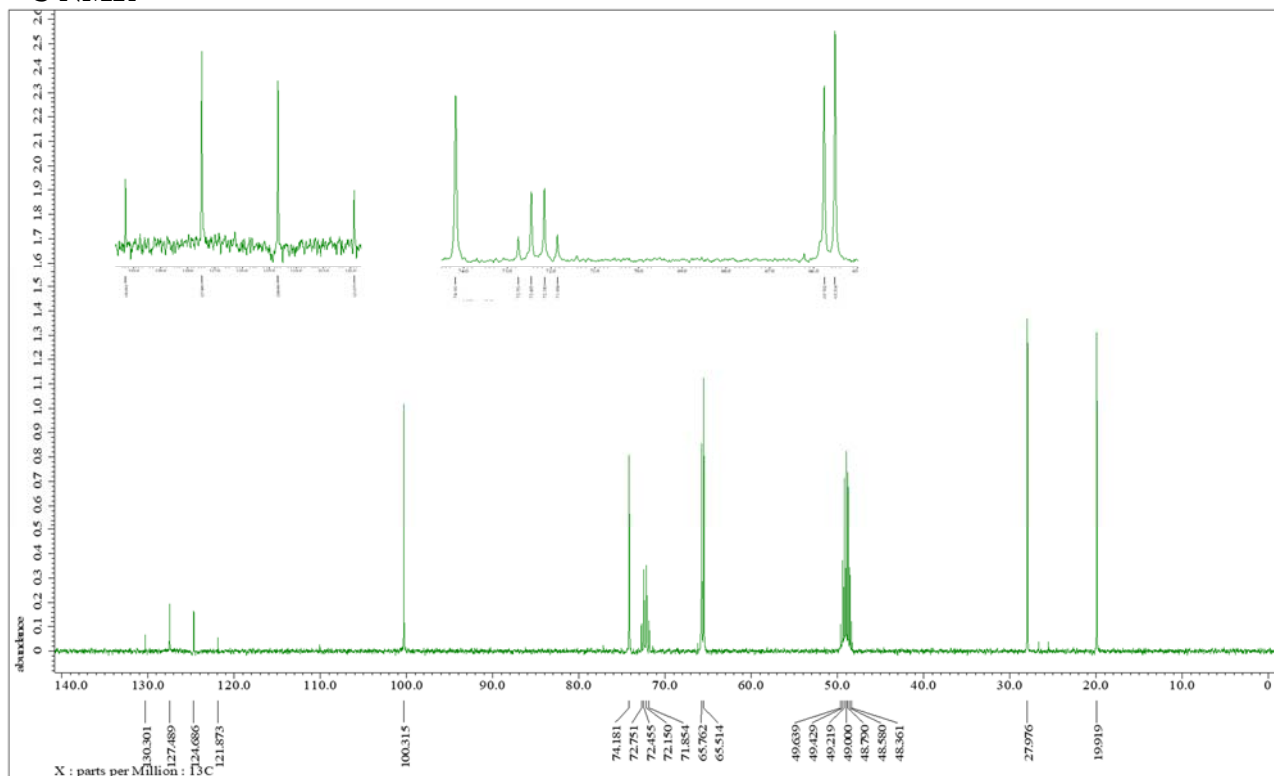
(4*R*,5*R*)-2,2-Dimethyl-4-((*R*)-2,2,2-trifluoro-1-hydroxyethyl)-1,3-dioxan-5-ol
((5*R*)-5a)



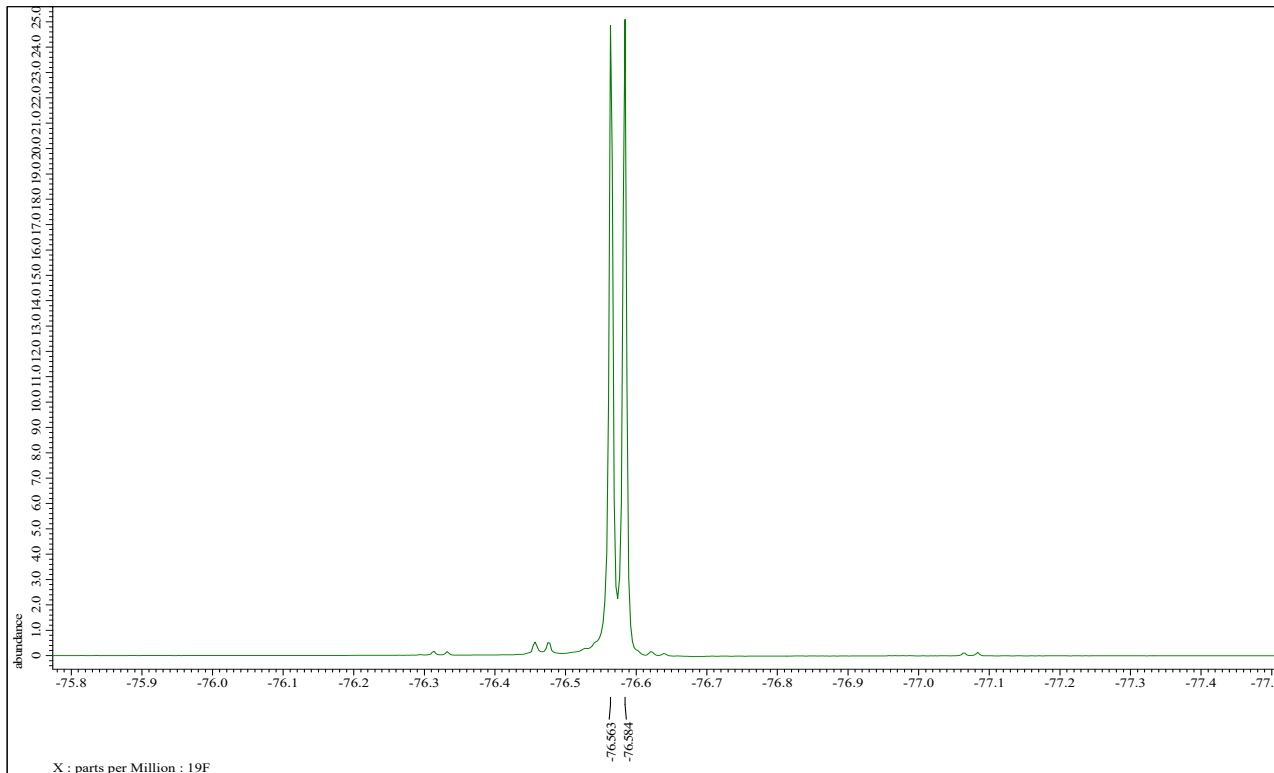
¹H NMR



¹³C NMR



¹⁹F NMR



HRMS

Elemental Composition Report

Single Mass Analysis

Tolerance = 500.0 PPM / DBE: min = -10.0, max = 100.0
 Element prediction: Off
 Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions

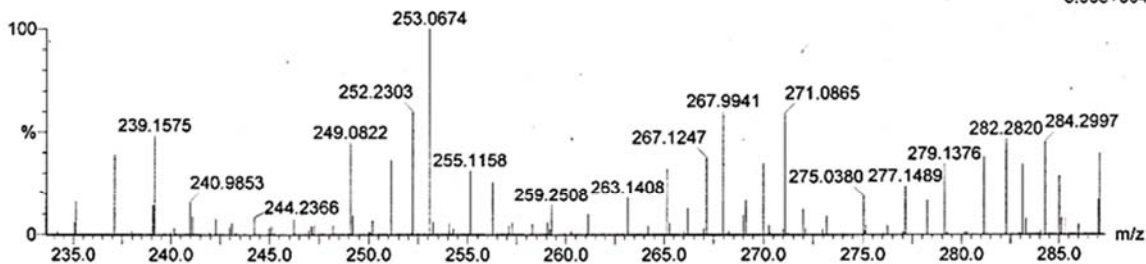
1 formula(e) evaluated with 1 results within limits (all results (up to 1000) for each mass)

Elements Used:

C: 8-8 H: 13-14 O: 4-4 F: 3-3 Na: 0-1

20190410-5 11 (0.387) Cm (11:15)

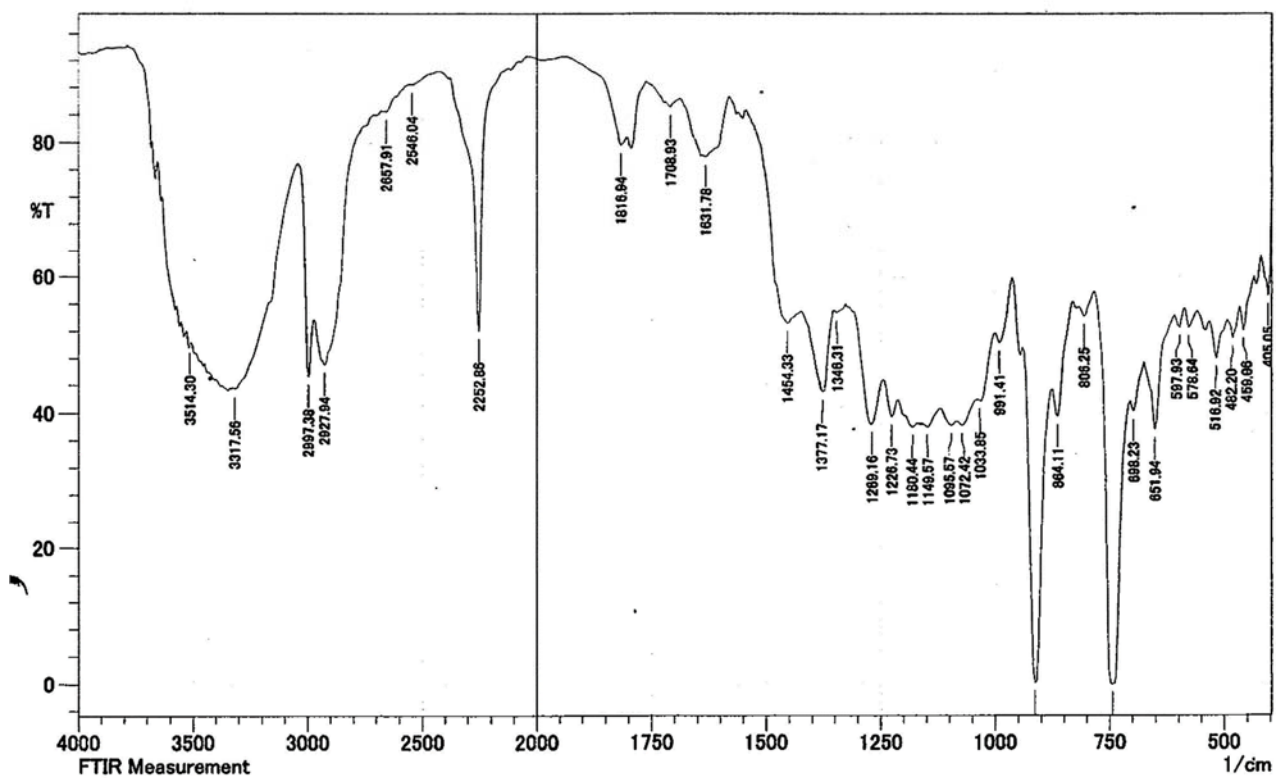
1: TOF MS ES+



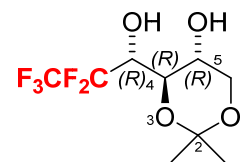
Minimum: -10.0
 Maximum: 100.0 500.0 100.0

Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
253.0674	253.0664	1.0	4.0	0.5	305.6	0.0	C8 H13 O4 F3 Na

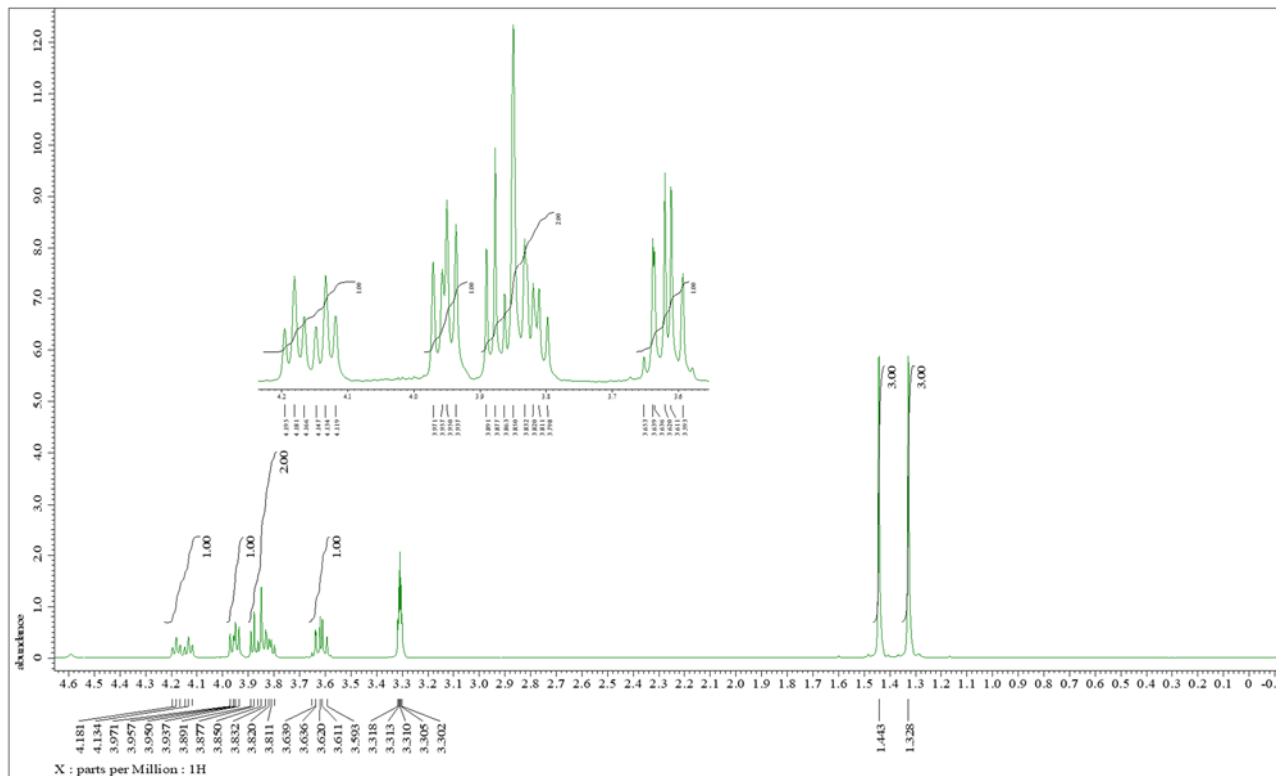
IR



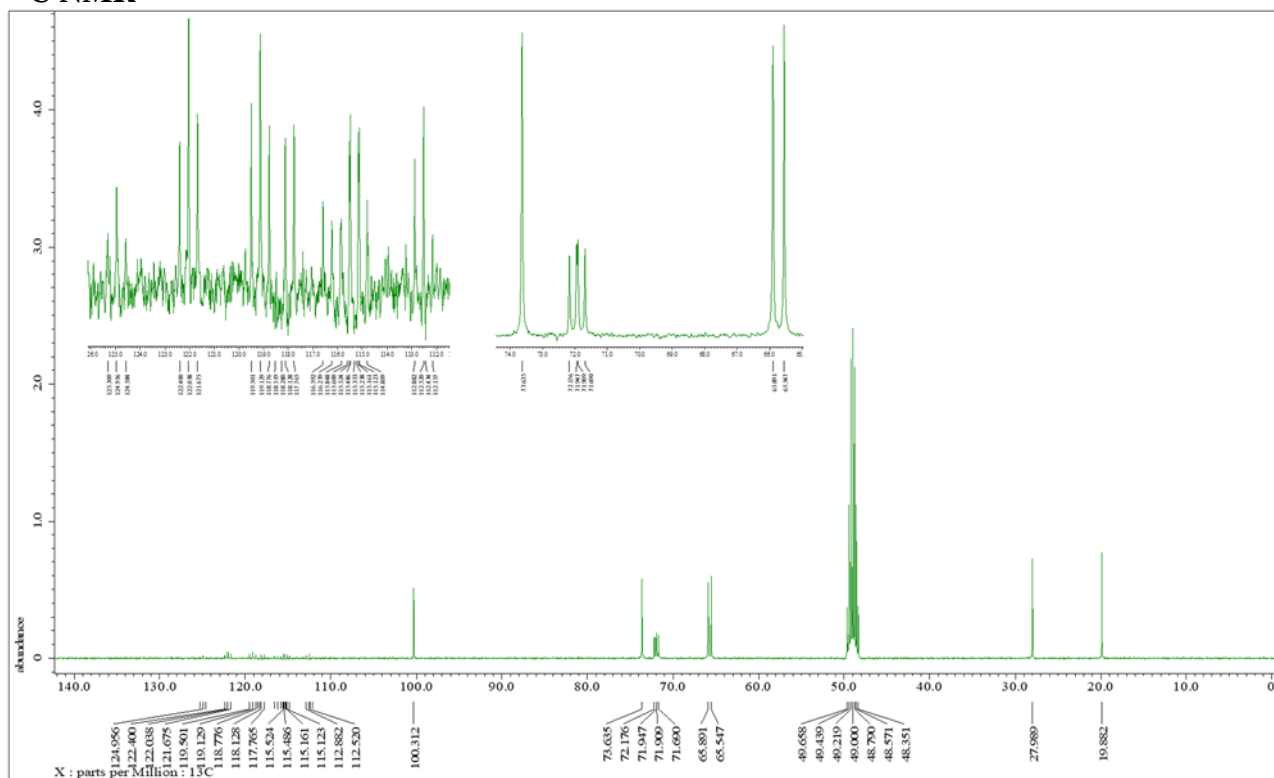
(4*R*,5*R*)-2,2-Dimethyl-4-((*R*)-2,2,3,3,3-pentafluoro-1-hydroxypropyl)-1,3-dioxan-5-ol ((5*R*)-5b)



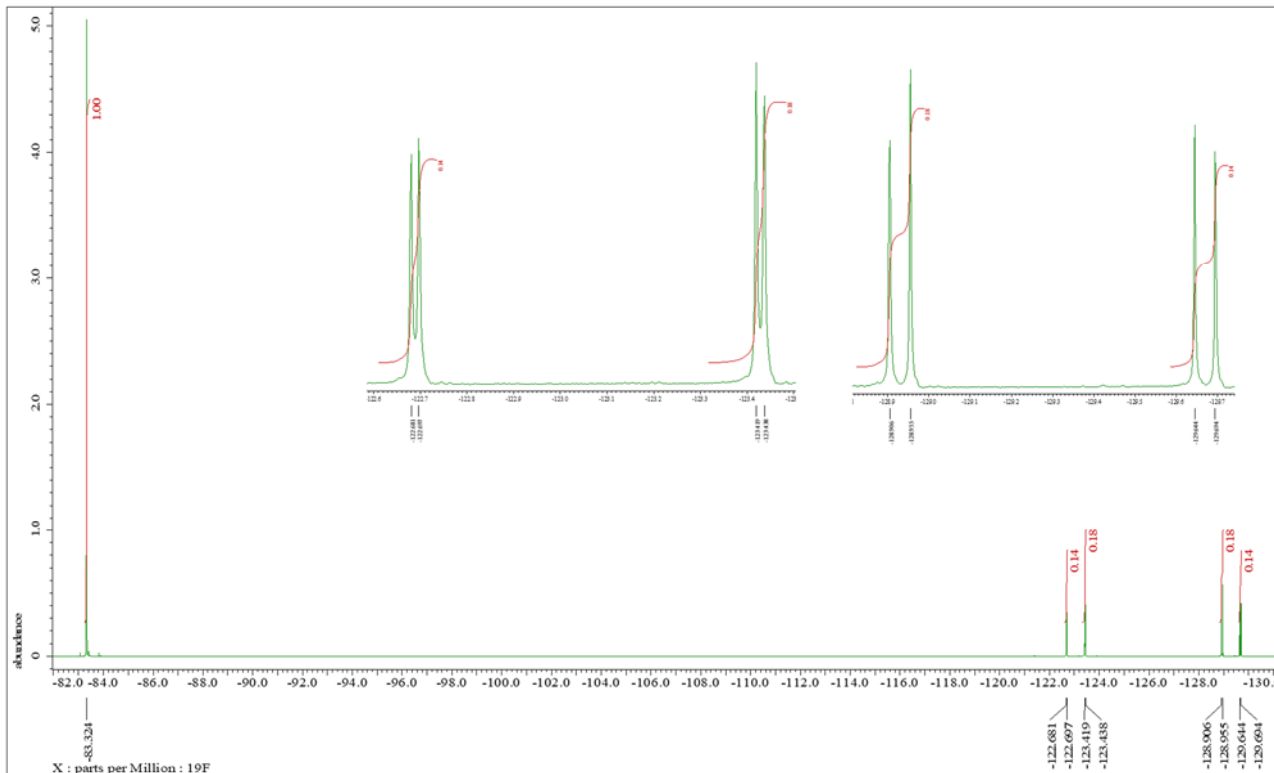
¹H NMR



¹³C NMR



¹⁹F NMR



HRMS

Elemental Composition Report

Single Mass Analysis

Tolerance = 100.0 PPM / DBE: min = -10.0, max = 100.0

Element prediction: Off

Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions

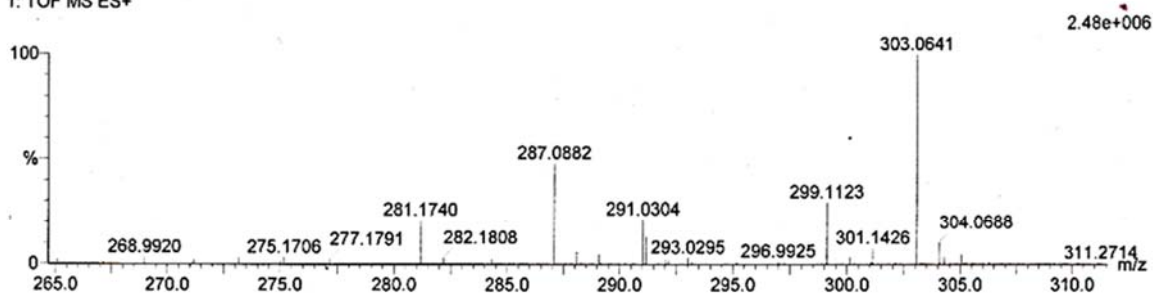
2 formula(e) evaluated with 1 results within limits (all results (up to 1000) for each mass)

Elements Used:

C: 9-9 H: 13-14 14N: 0-2 O: 4-4 19F: 5-5 Na: 0-1

20190708p-5 11 (0.387)

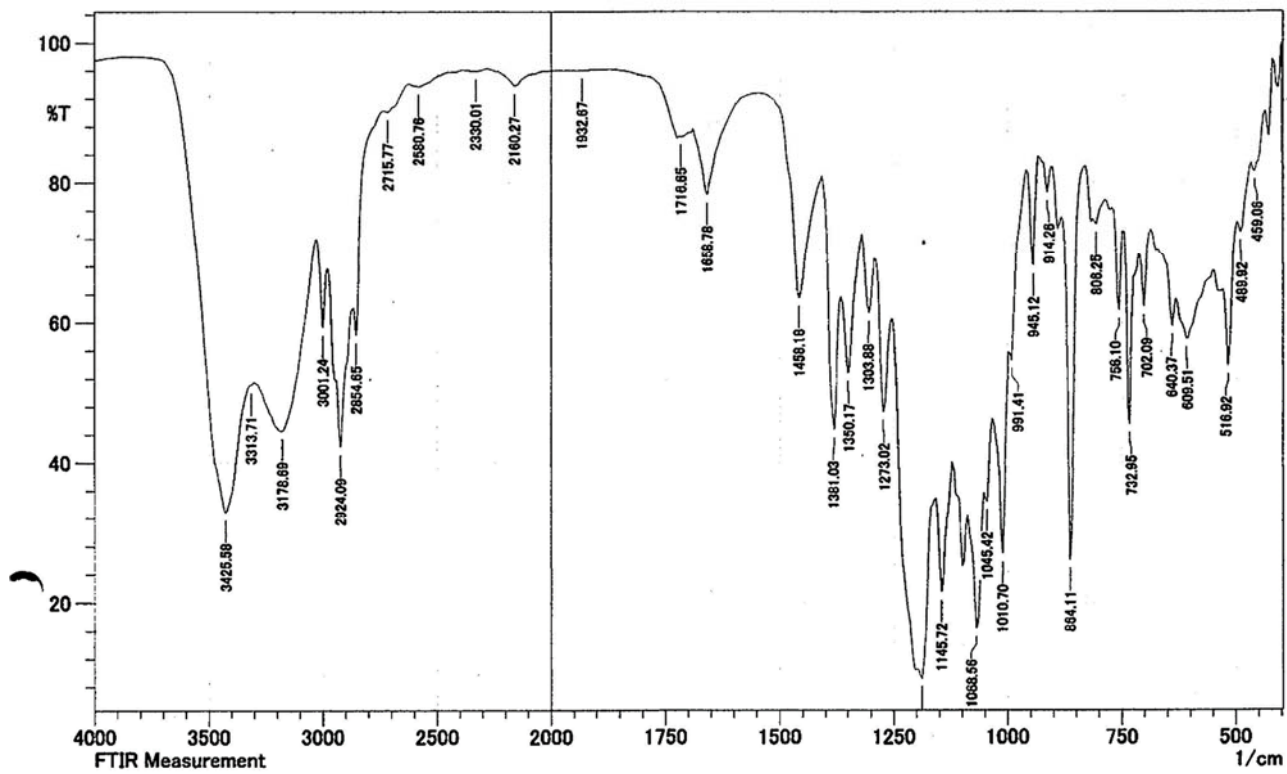
1: TOF MS ES+



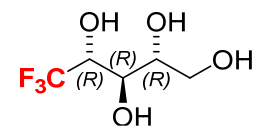
Minimum: -10.0
Maximum: 100.0 100.0 100.0

Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
303.0641	303.0632	0.9	3.0	0.5	575.4	0.0	C9 H13 O4 19F5 Na

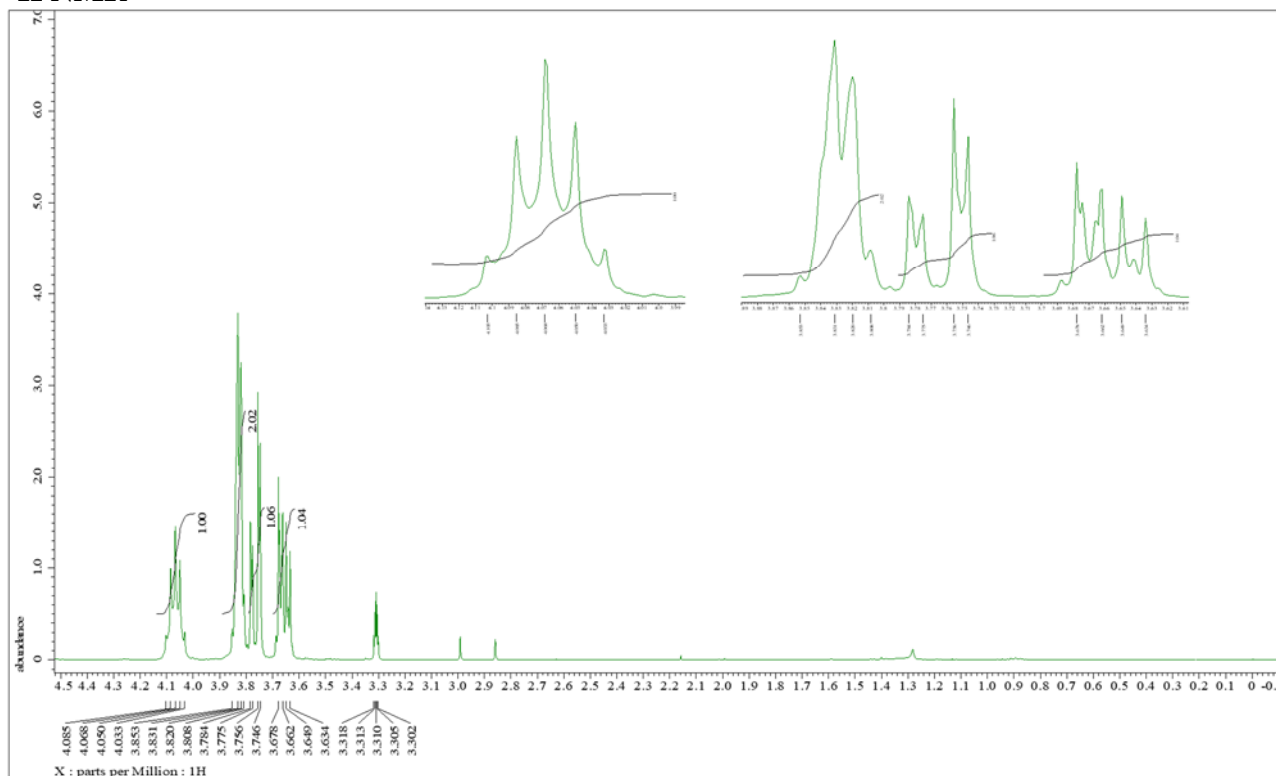
IR



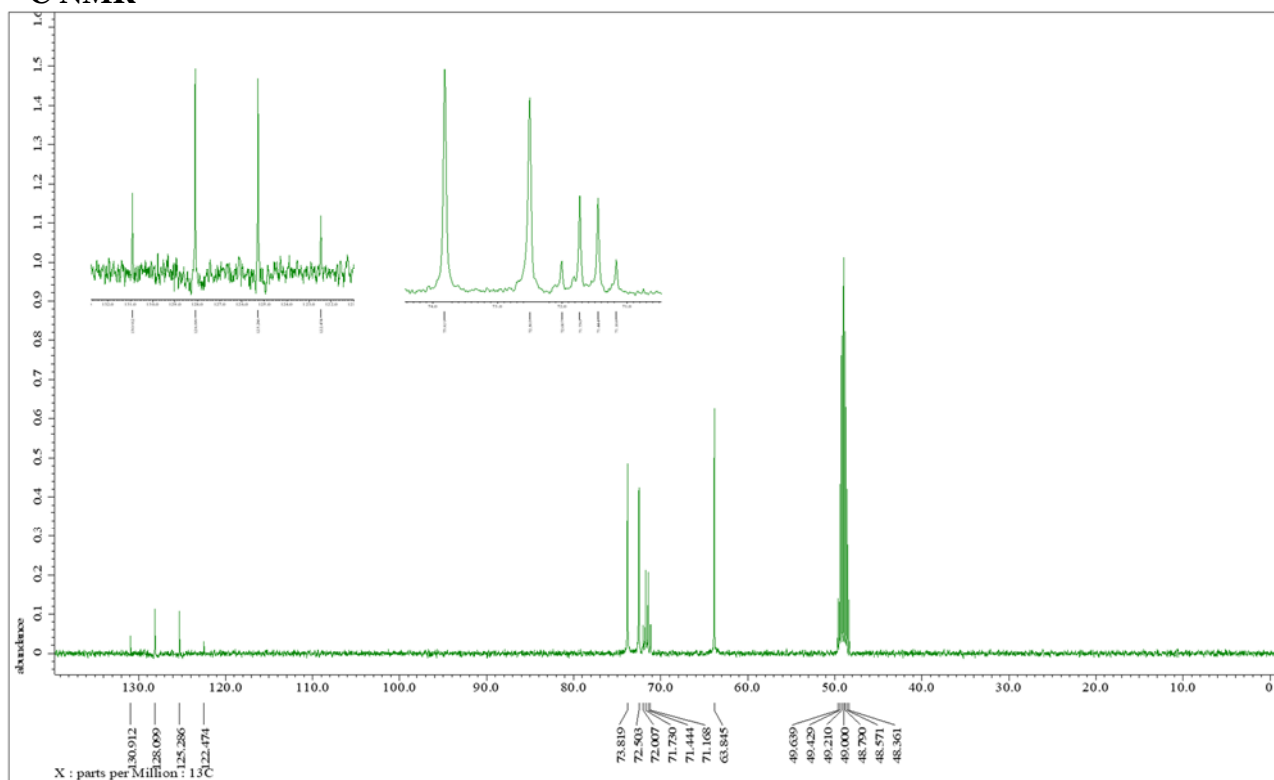
(2*R*,3*R*,4*R*)-5,5,5-Trifluoropentane-1,2,3,4-tetraol (6a)



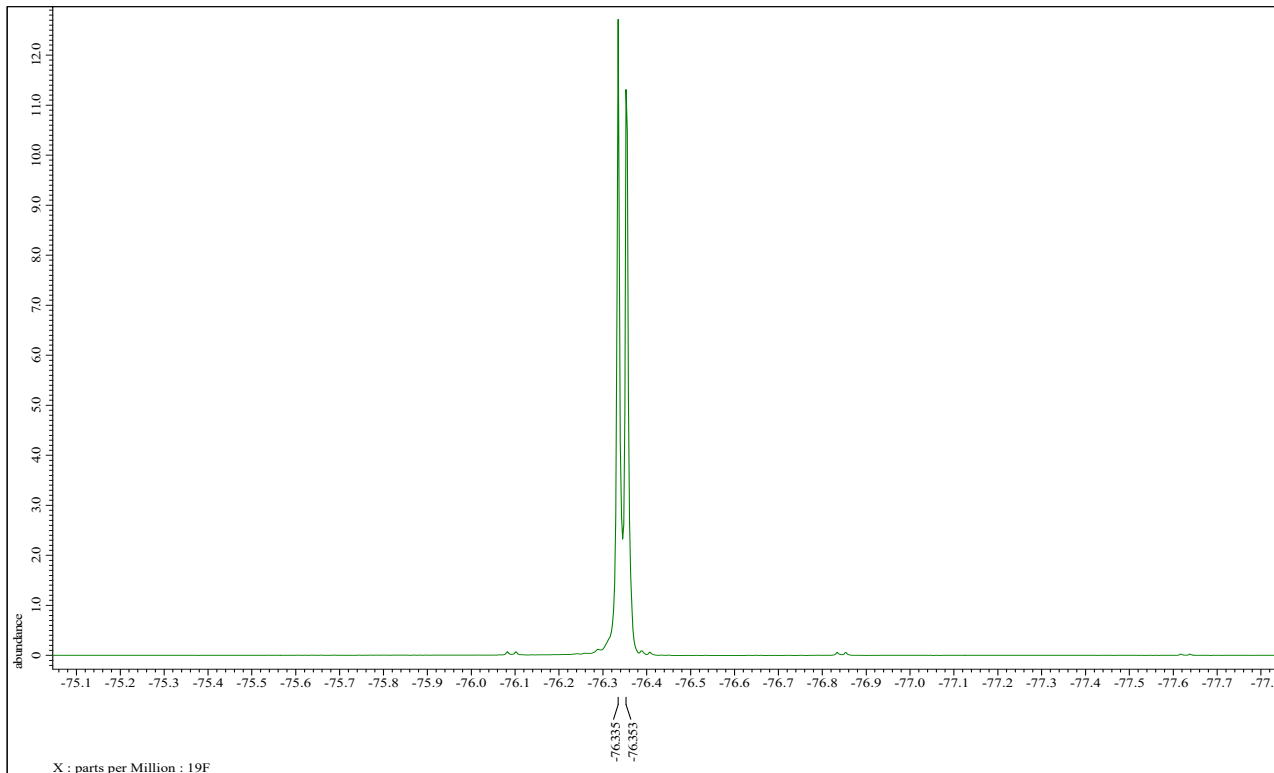
¹H NMR



¹³C NMR



¹⁹F NMR



HRMS

Elemental Composition Report

Single Mass Analysis

Tolerance = 500.0 PPM / DBE: min = -10.0, max = 100.0

Element prediction: Off

Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions

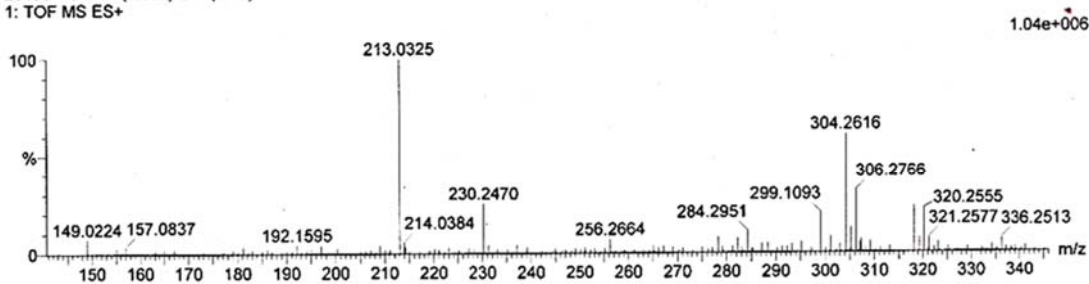
2 formula(e) evaluated with 1 results within limits (all results (up to 1000) for each mass)

Elements Used:

C: 5-5 H: 9-10 O: 4-4 F: 3-3 Na: 0-1

20190410-6 10 (0.353) Cm (9:13)

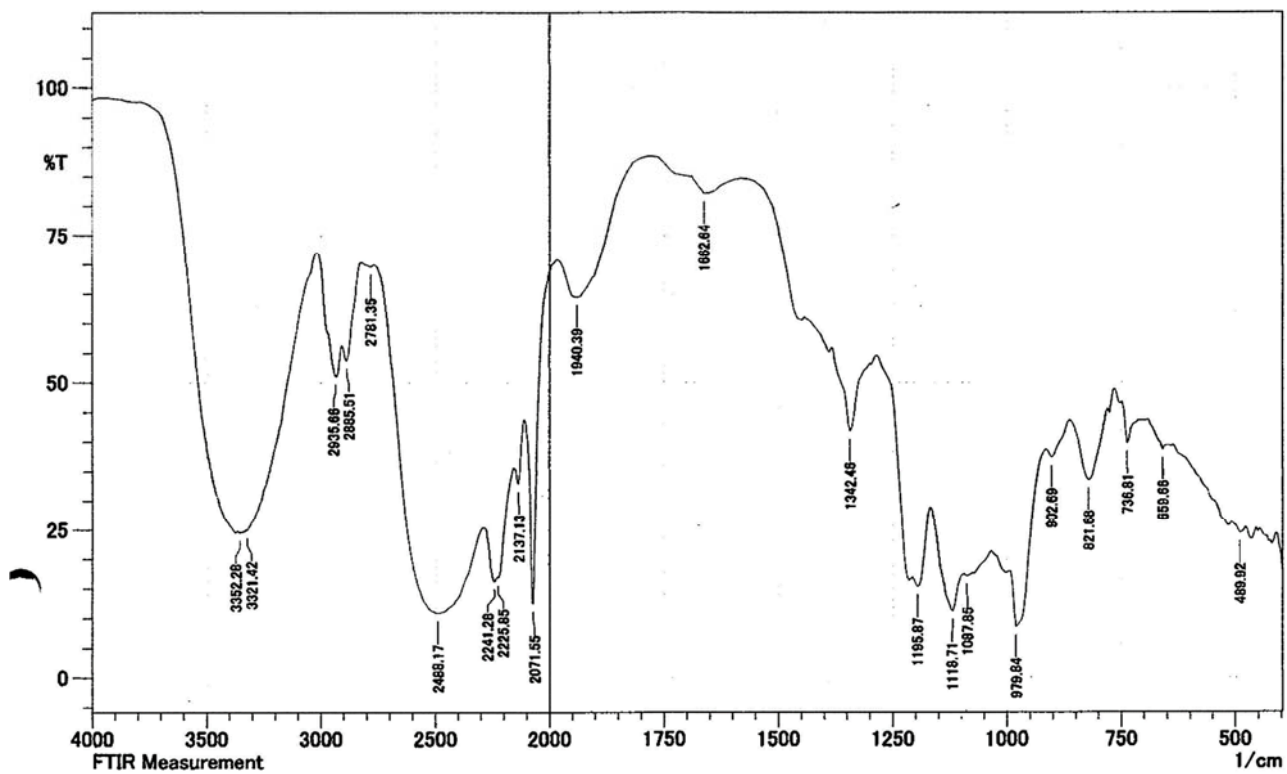
1: TOF MS ES+



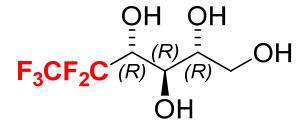
Minimum: -10.0
Maximum: 100.0 500.0 100.0

Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
213.0325	213.0351	-2.6	-12.2	-0.5	484.4	0.0	C5 H9 O4 F3 Na

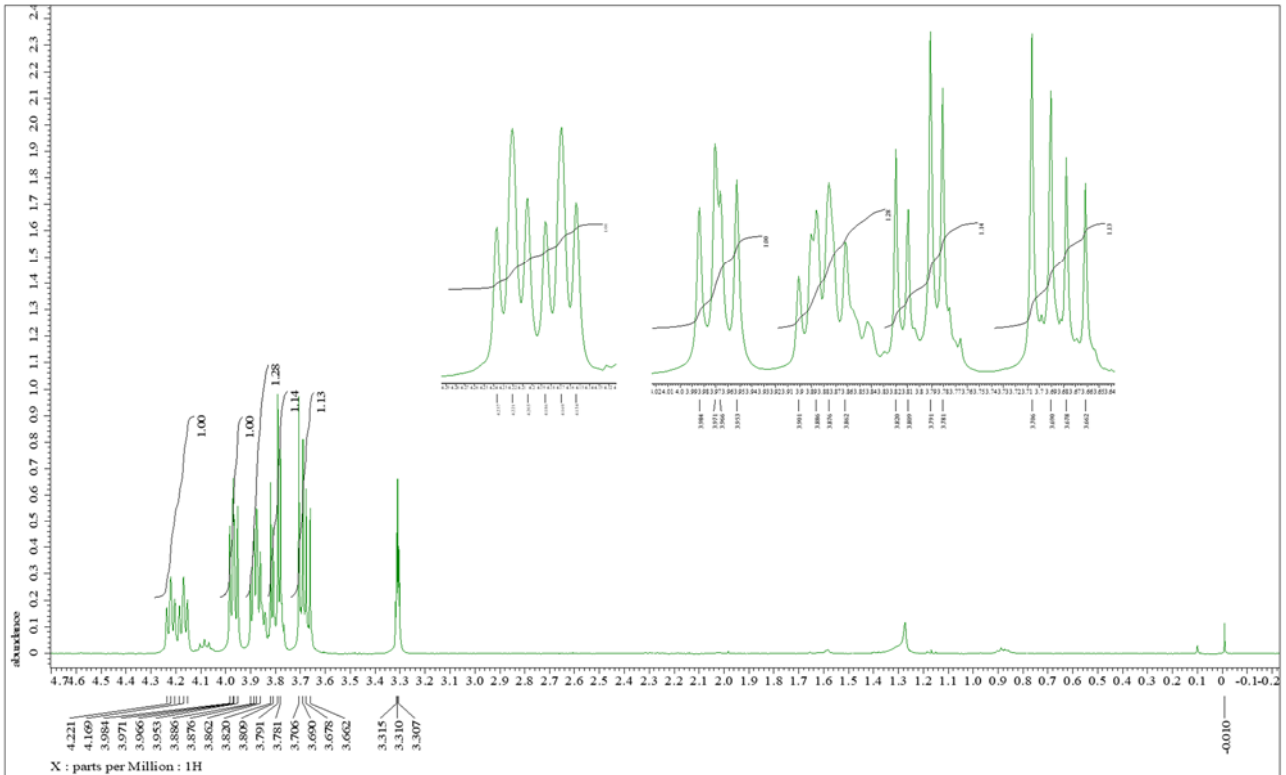
IR



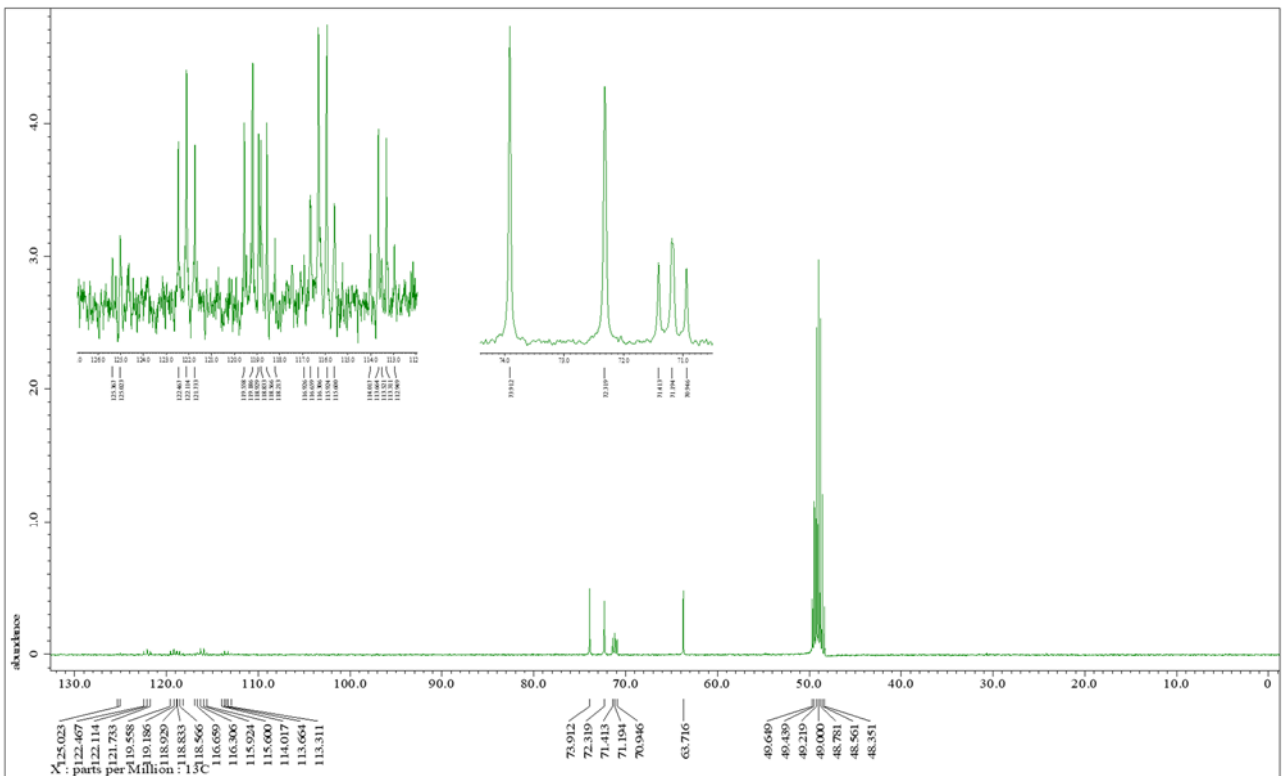
(2*R*,3*R*,4*R*)-5,5,6,6,6-Pentafluorohexane-1,2,3,4-tetraol (6b)



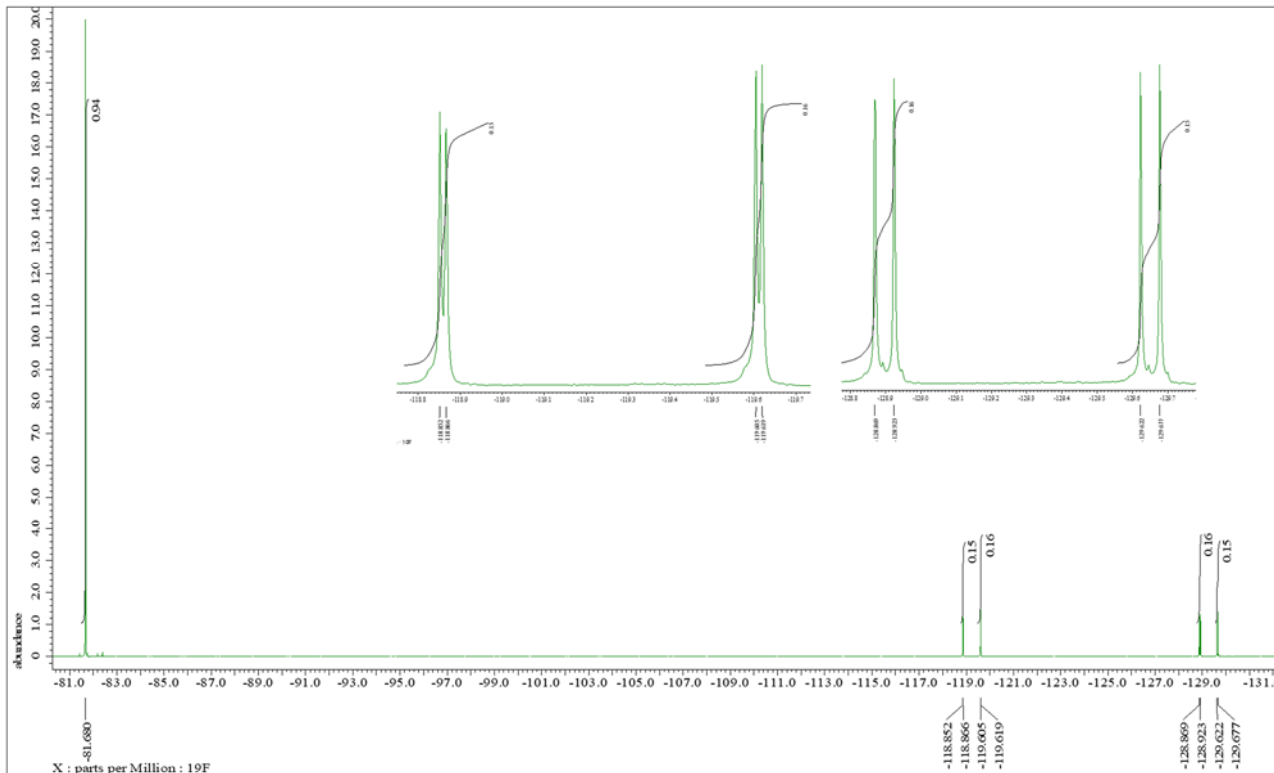
¹H NMR



¹³C NMR



¹⁹F NMR



HRMS

Elemental Composition Report

Single Mass Analysis

Tolerance = 100.0 PPM / DBE: min = -10.0, max = 100.0

Element prediction: Off

Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions

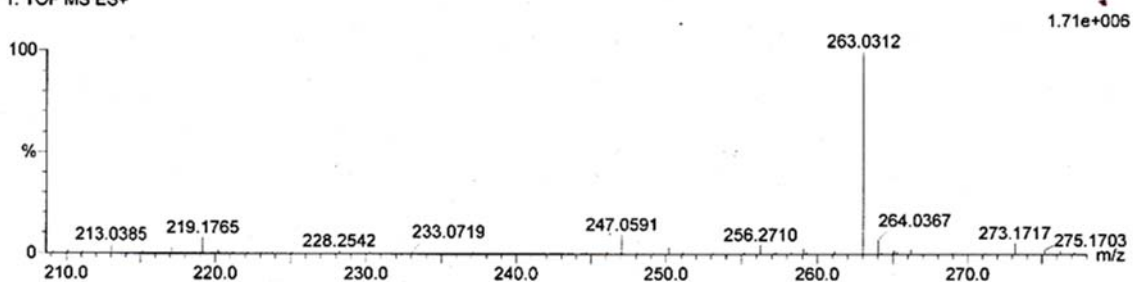
3 formula(e) evaluated with 1 results within limits (all results (up to 1000) for each mass)

Elements Used:

C: 6-6 H: 9-9 14N: 0-2 O: 4-4 19F: 5-5 Na: 0-1

20190708p-6 11 (0.387)

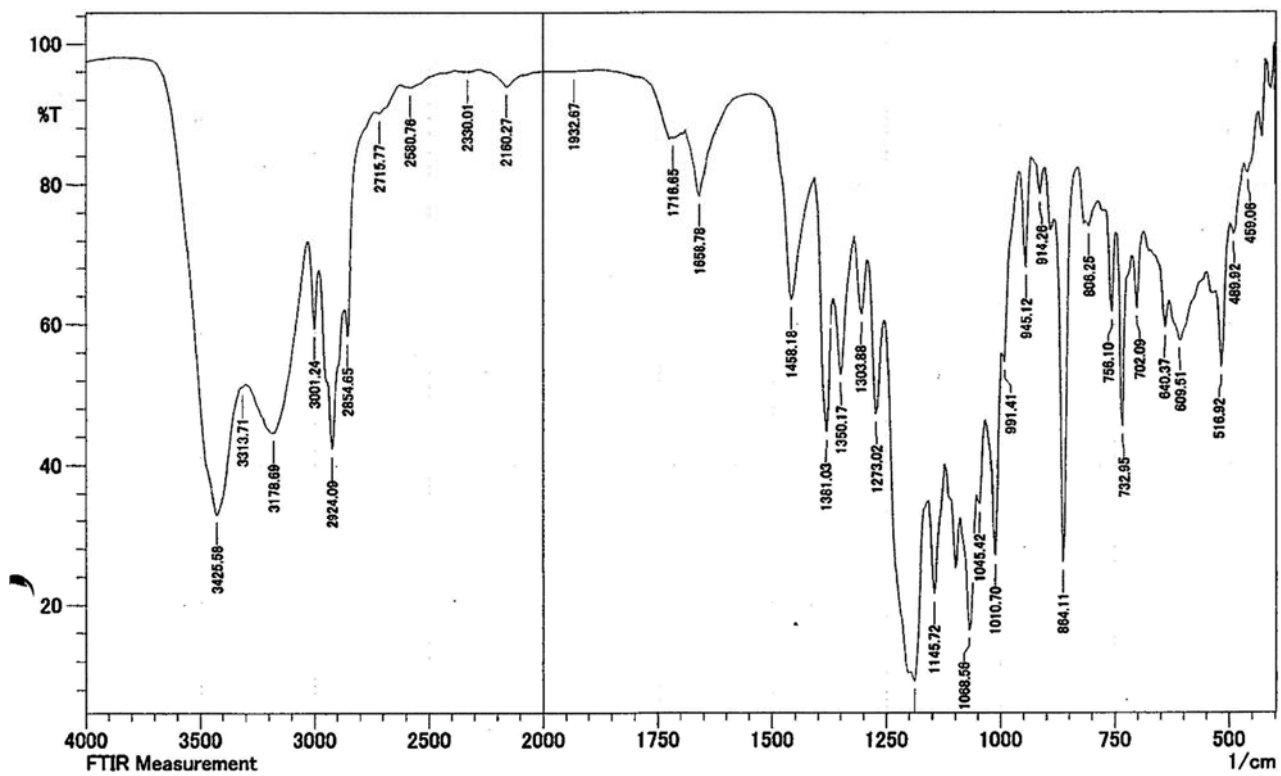
1: TOF MS ES+



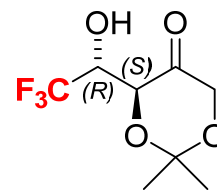
Minimum: -10.0
Maximum: 100.0

Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	i-FIT (Norm)	Formula
263.0312	263.0319	-0.7	-2.7	-0.5	533.4	0.0	C6 H9 O4 19F5 Na

IR



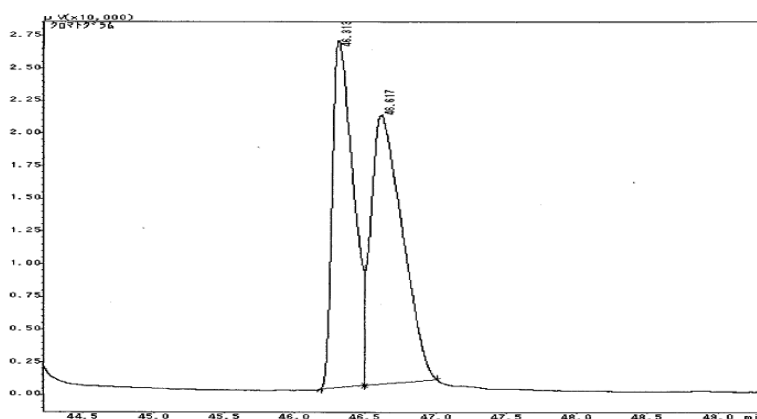
Enantiomer separation by GC



Enantiomer separation of *anti*-4a:

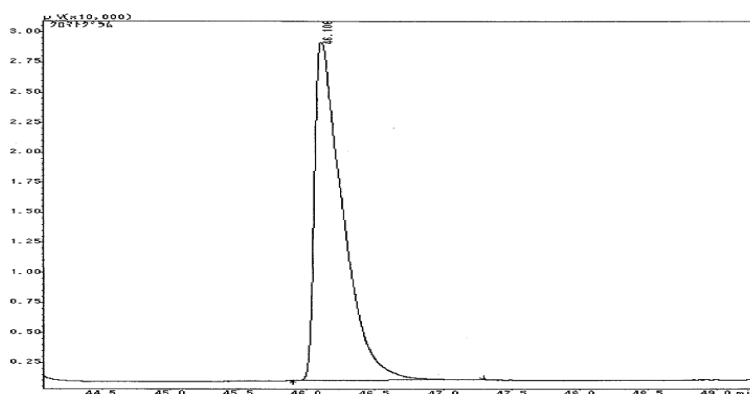
CHIRAL GC (GL Sciences InterCap CHIRAMIX column, temperature : 80-140 °C (1°C/min), muscle : 74.4 kPa, total flow : 26.0 mL/min, column flow : 0.89 mL/min, linear velocity : 25.7 cm/sec, purge flow : 3.0 mL/min, split fraction : 24.8), t₁ (major enantiomer) = 46.1 min, t₂ (minor enantiomer) = 46.6 min.

Racemate



peak	Retention time	area	height	area
1	46.313	276920	26546	46.551
2	46.617	317960	20589	53.449
total		594880	47135	

Chiral compound



peak	Retention time	area	height	area
1	46.106	402447	28164	100.000
total		402447	28164	

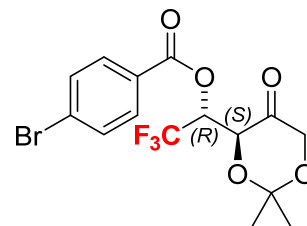
Enantiomer separation by HPLC

Enantiomer separation of ester of *anti*-4a:

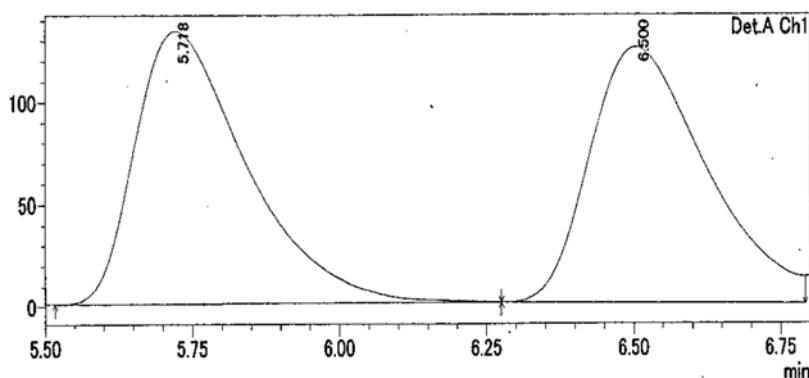
After esterification of **4a** with 4-bromobenzoyl chloride in the presence of pyridine, ee was measured in HPLC with CHIRALCEL AD-H

(Daicel, 0.46 cm ϕ x 25cmL) column on a SHIMADZU LC-20AT

liquid chromatograph, column temperature : 40 °C, flow solvent : hexane/*i*-PrOH = 95/5, column flow : 1.0 mL/min, detection wavelength : 237 nm, t_1 (major enantiomer) = 5.7 min, t_2 (minor enantiomer) = 6.5 min.

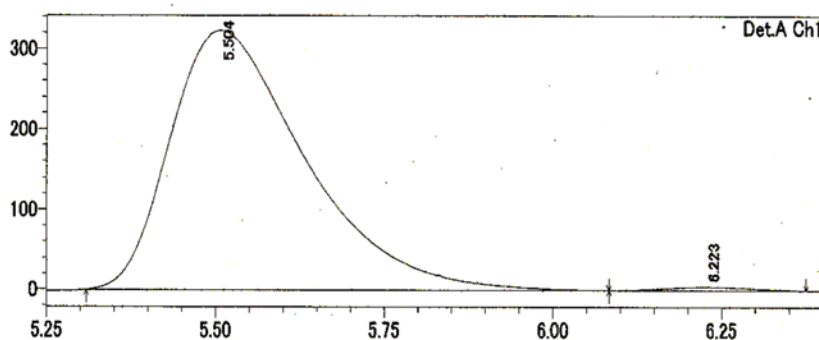


Racemate



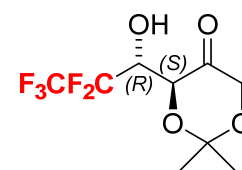
peak	Retention time	area	height	area%
1	5.718	1769454	133443	50.620
2	6.500	1726079	125155	49.380
total		3495533	258598	100.000

Chiral compound



peak	Retention time	area	height	area%
1	5.504	4500131	323800	99.170
2	6.223	37667	4051	0.830
total		4537798	327851	100.000

Enantiomer separation by GC

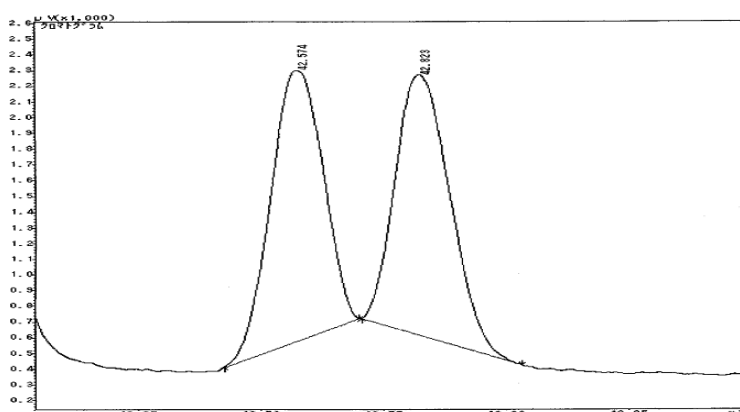


Enantiomer separation of *anti*-4b:

CHIRAL GC (GL Sciences InterCap CHIRAMIX column,

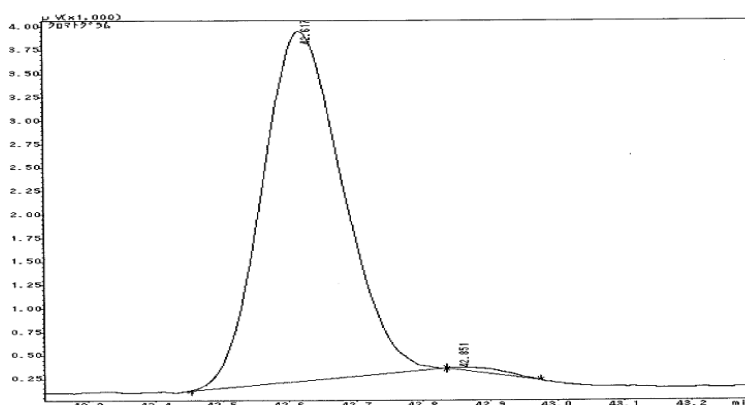
temperature : 80-140 °C (1°C/min), muscle : 89.9 kPa, total flow : 27.4 mL/min, column flow : 0.95 mL/min, linear velocity : 25.7 cm/sec, purge flow : 3.0 mL/min, split fraction : 24.8), t_1 (major enantiomer) = 42.6 min, t_2 (minor enantiomer) = 42.9 min.

Racemate



peak	Retention time	area	height	area
1	42.574	12841	1721	49.918
2	42.823	12883	1657	50.082
total		25724	3378	

Chiral compound



peak	Retention time	area	height	area
1	42.617	31243	3718	99.263
2	42.851	232	24	0.737
total		31475	3742	