

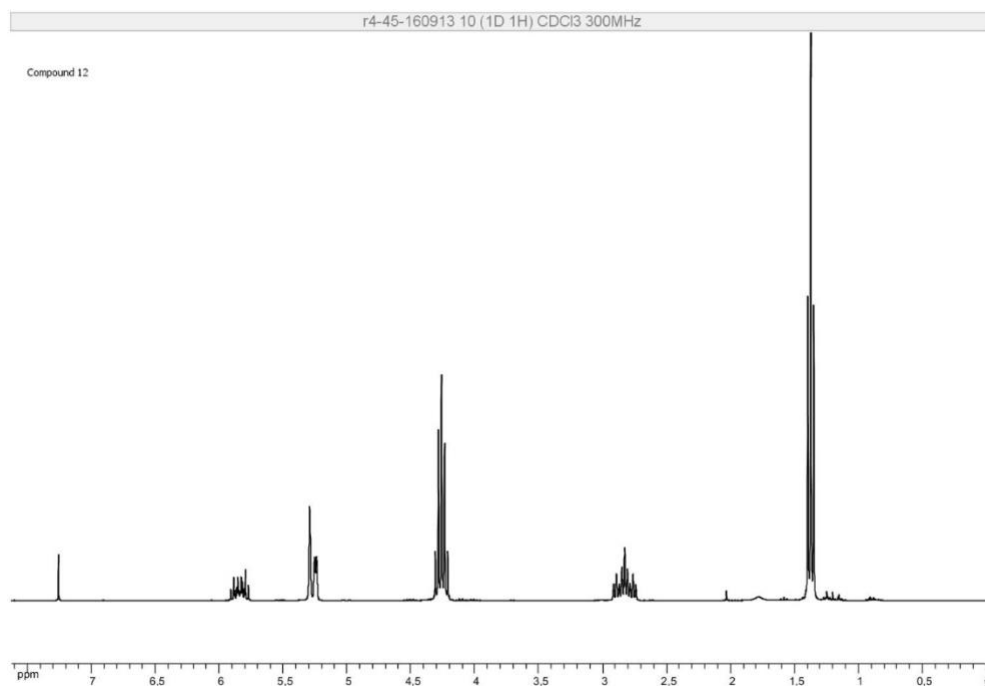
## **$\alpha,\alpha$ -Difluorophosphonohydroxamic acid derivatives among the best antibacterial fosmidomycin analogues**

Aurore Dreneau, Fanny S. Krebs, Mathilde Munier, Chheng Ngov, Denis Tritsch, Didier Lièvremon, Michel Rohmer and Catherine Grosdemange-Billiard\*

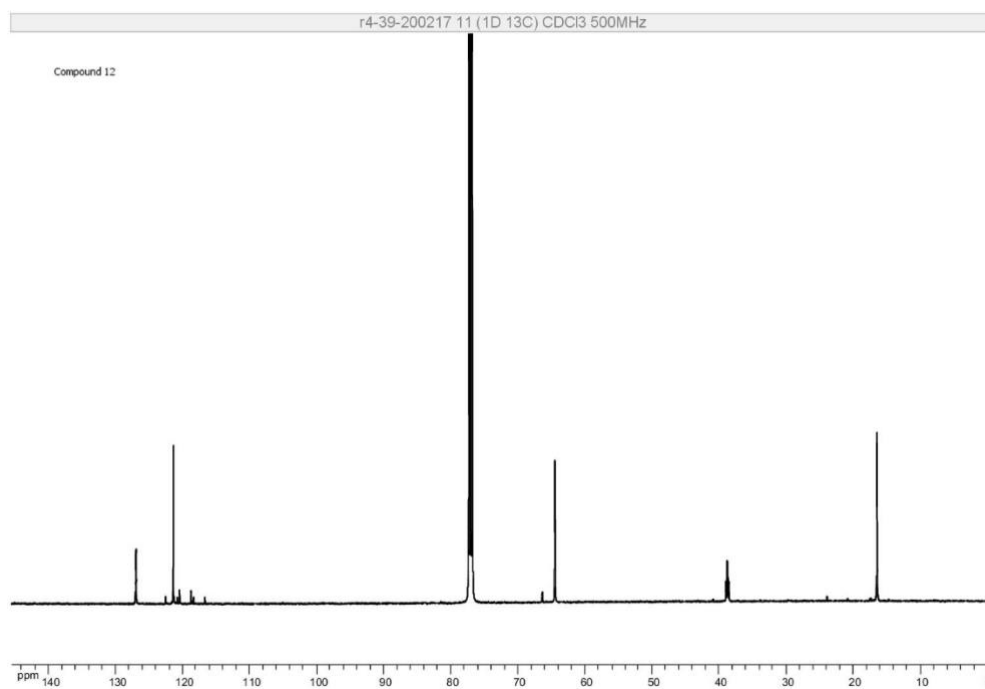
Laboratoire de Chimie et Biochimie de Molécules Bioactives – Université de Strasbourg/CNRS, UMR 7177, Institut Le Bel, 4 rue Blaise Pascal, 67081 Strasbourg, France

$^1\text{H}$ ,  $^{13}\text{C}$ ,  $^{31}\text{P}$ ,  $^{19}\text{F}$  NMR spectra

Compound <b>12</b>	2
Compound <b>13</b>	4
Compound <b>14</b>	5
Compound <b>15a</b>	7
Compound <b>15b</b>	9
Compound <b>16a</b>	11
Compound <b>16b</b>	13
Compound <b>17</b>	15
Compound <b>18</b>	17
Compound <b>19a</b>	19
Compound <b>19b</b>	21
Compound <b>20a</b>	23
Compound <b>20b</b>	25
Compound <b>9b</b>	27
Compound <b>10a</b>	29
Compound <b>10b</b>	31

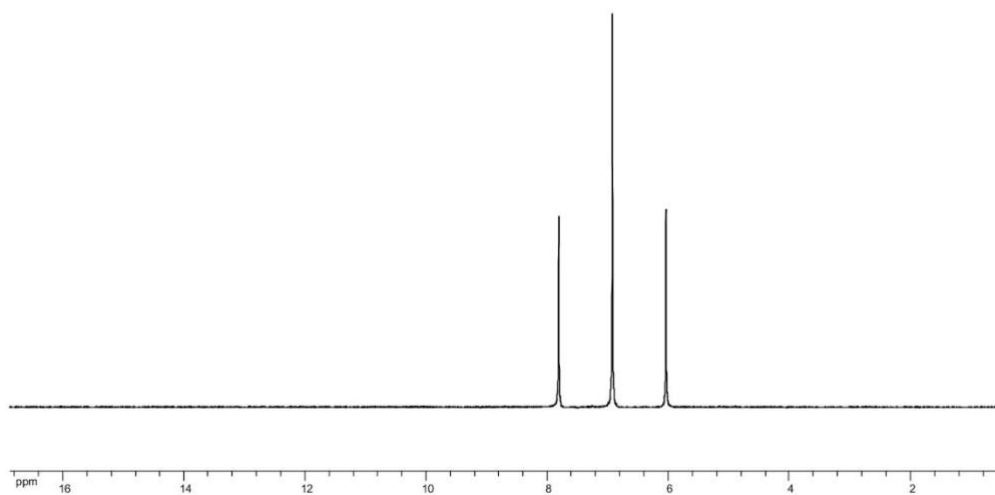


Compound **19b**



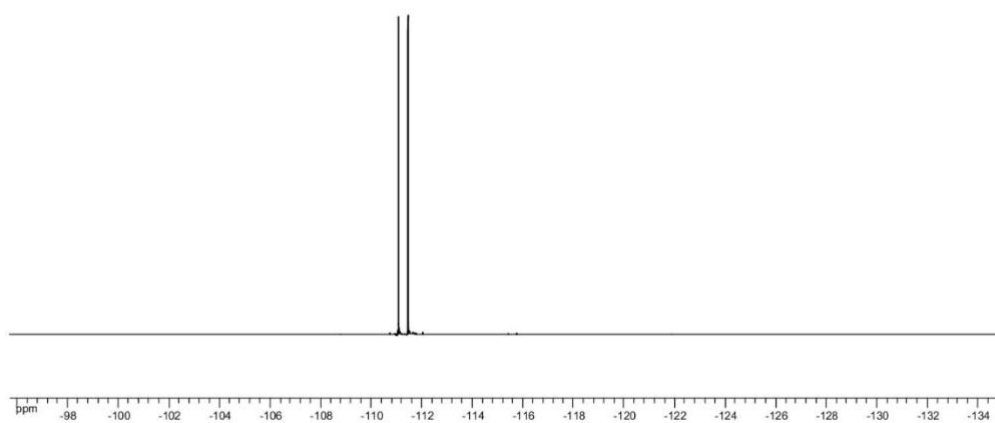
r4-39-200217-31P 10 (1D 31P) CDCl3 300MHz

Compound 12

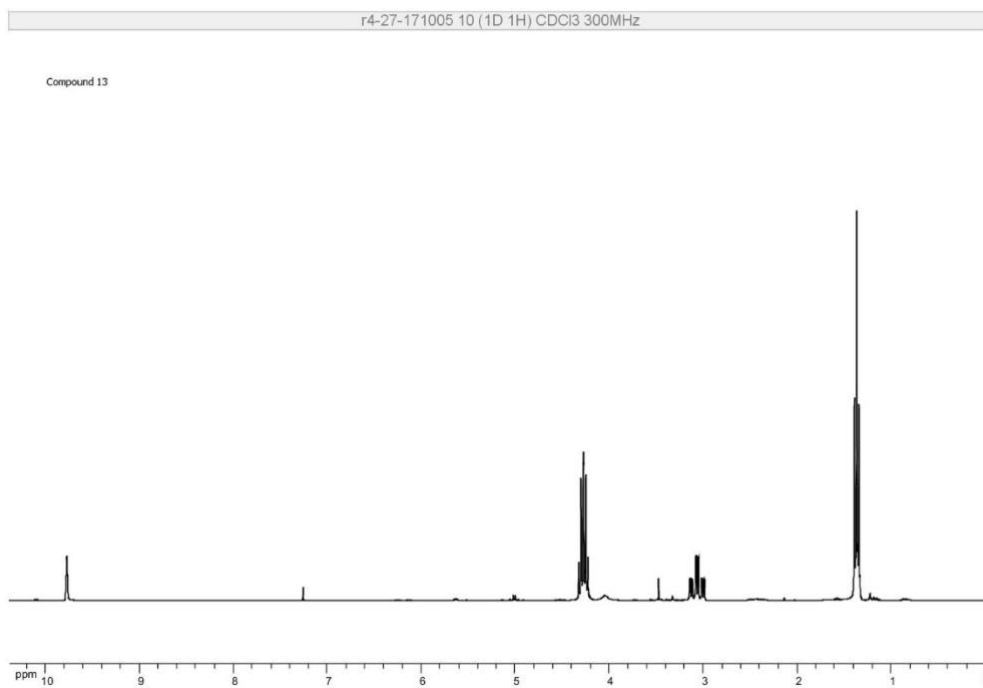


r4-39-200217-19F 10 (1D 19F) CDCl3 300MHz

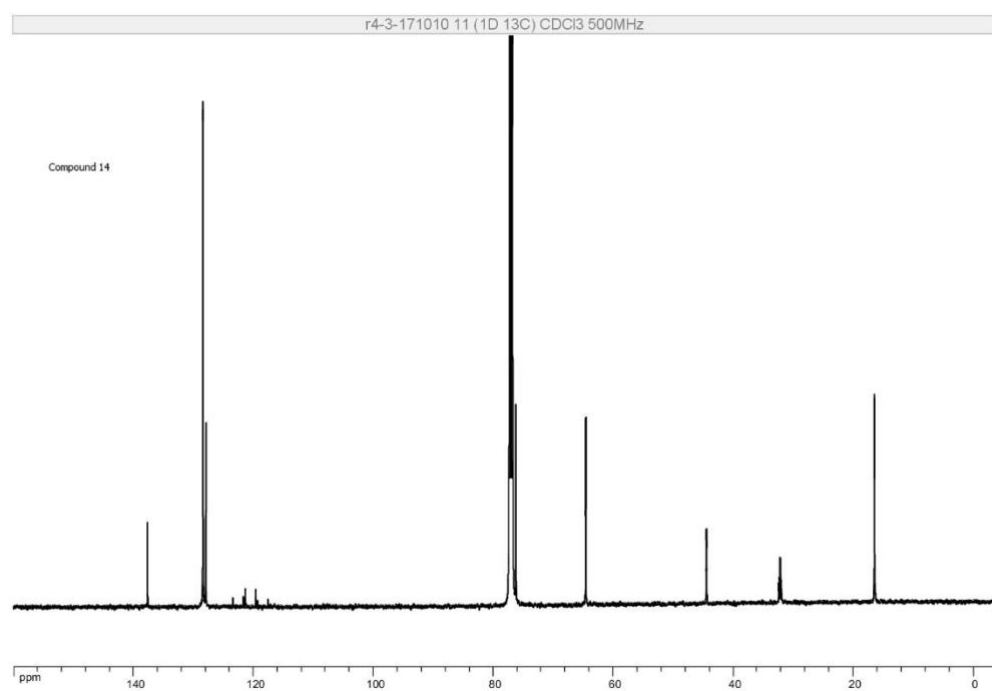
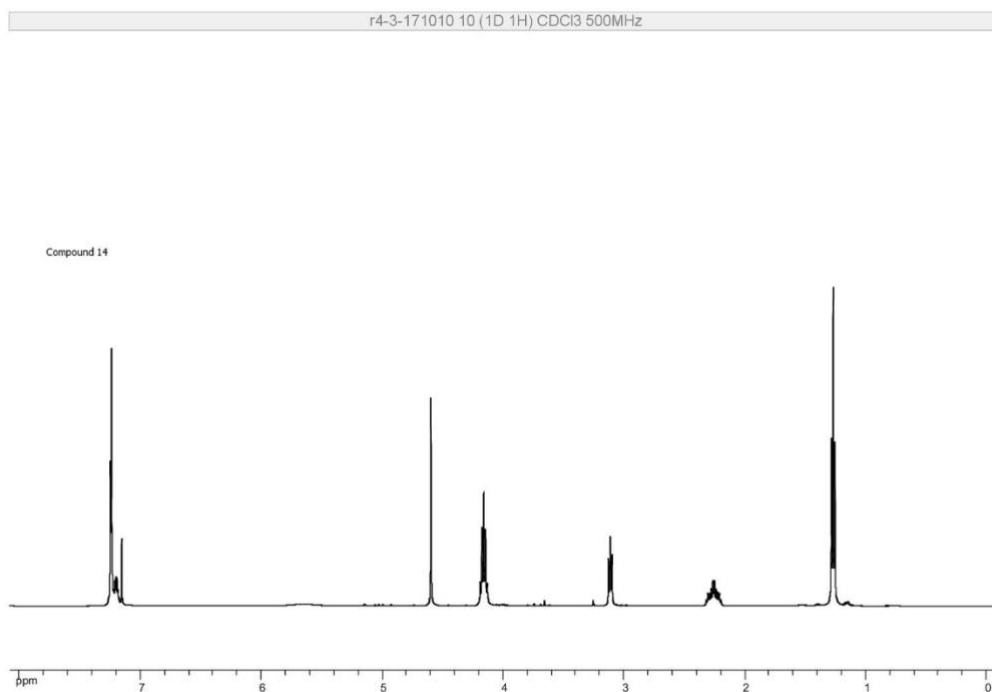
Compound 12



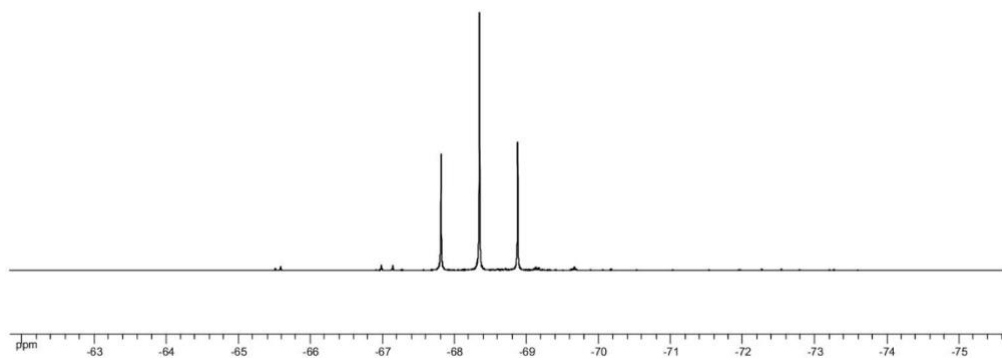
Compound **13**



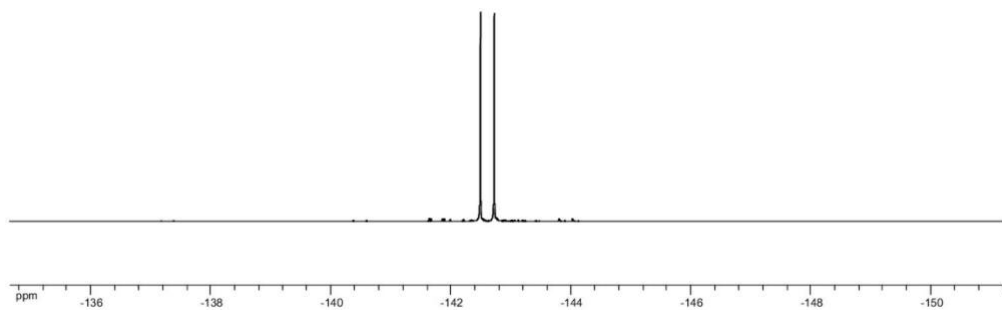
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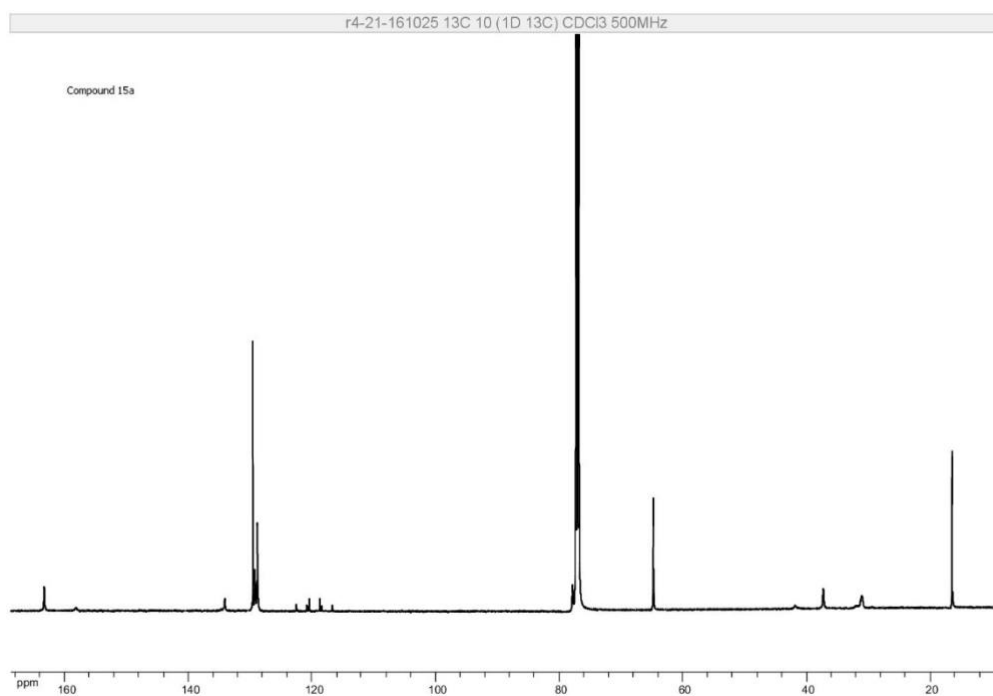
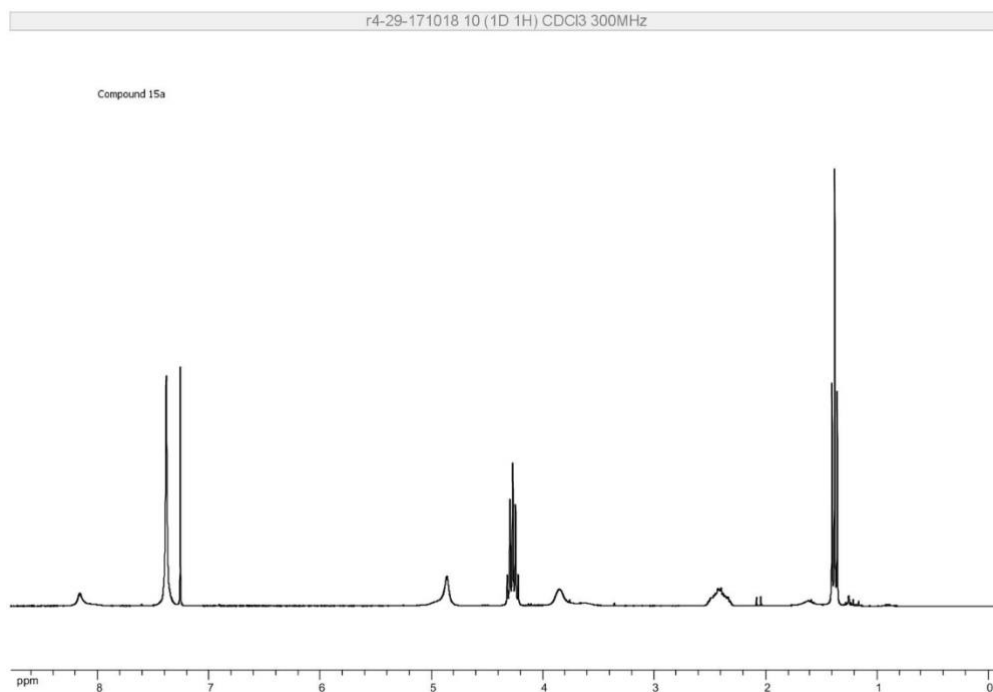
Compound 14



Compound 14

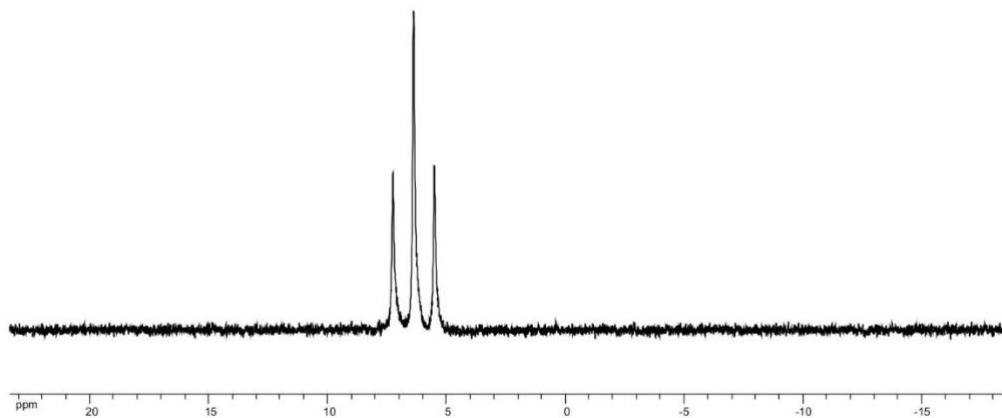


Compound **15a**



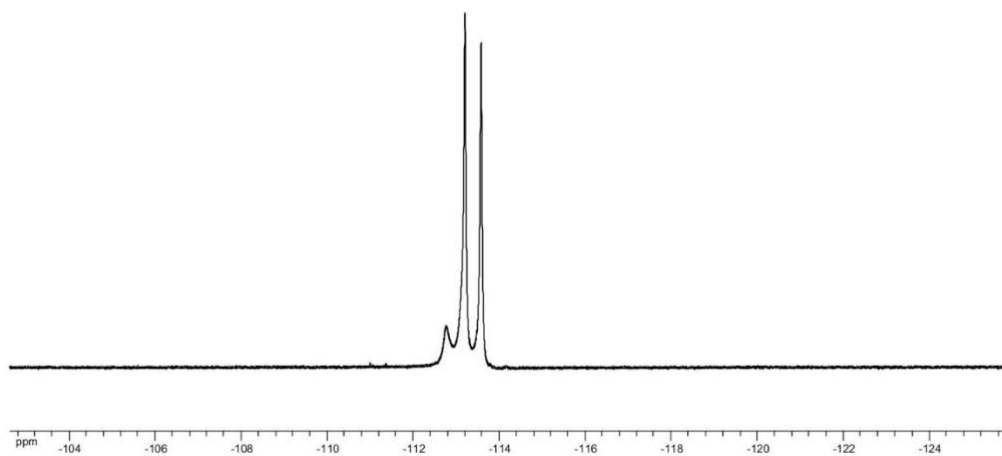
r4-21-161025-31P 10 (1D 31P) CDCl3 300MHz

Compound 15a



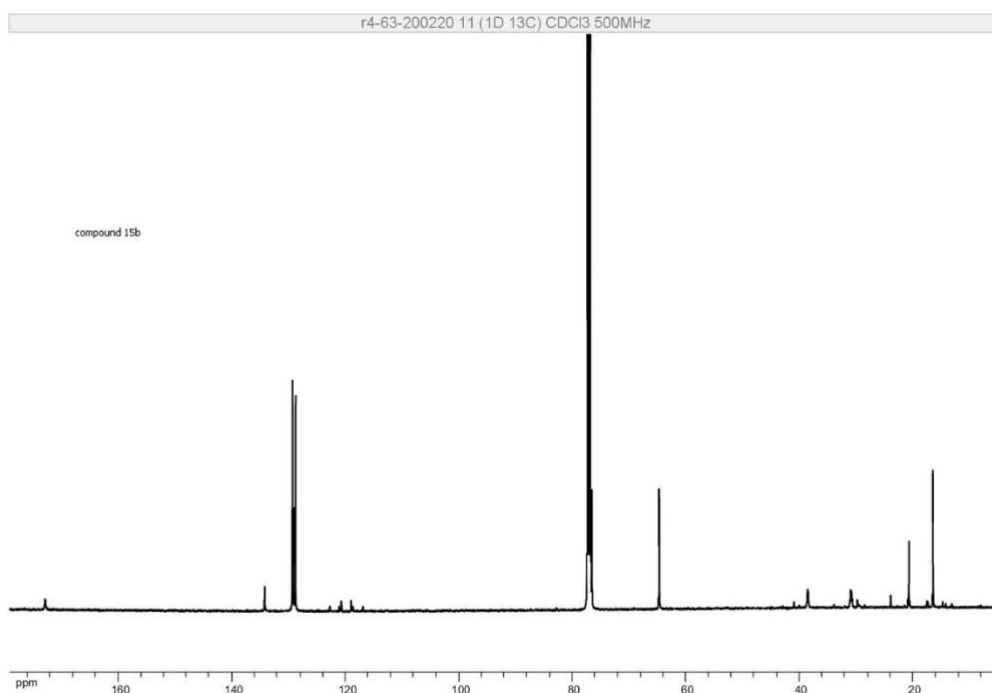
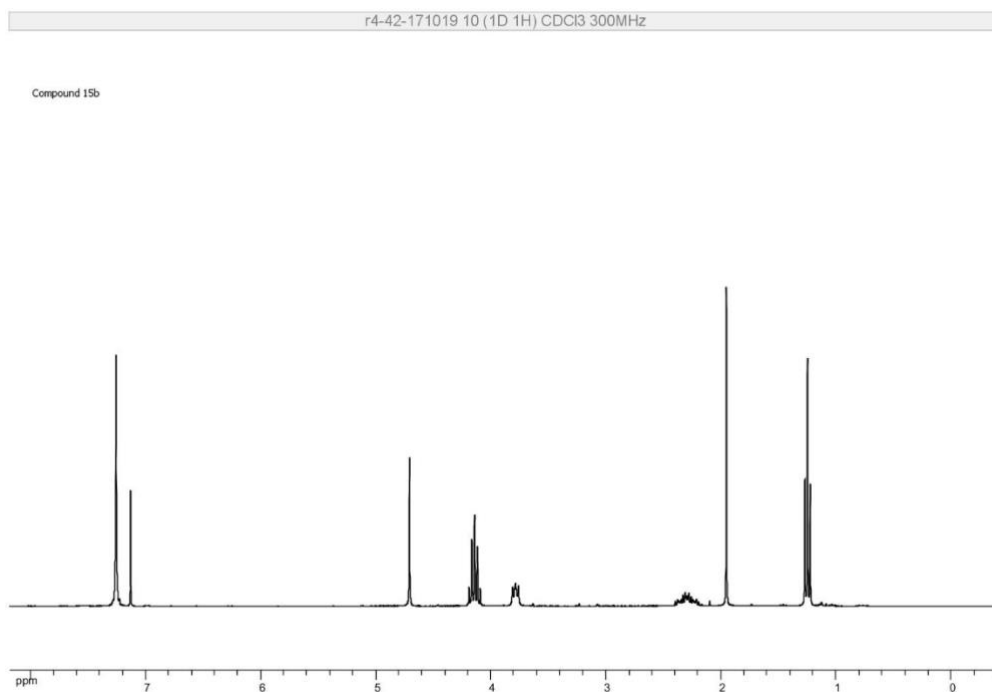
r4-21-161025-19F 10 (1D 19F) CDCl3 300MHz

Compound 15a



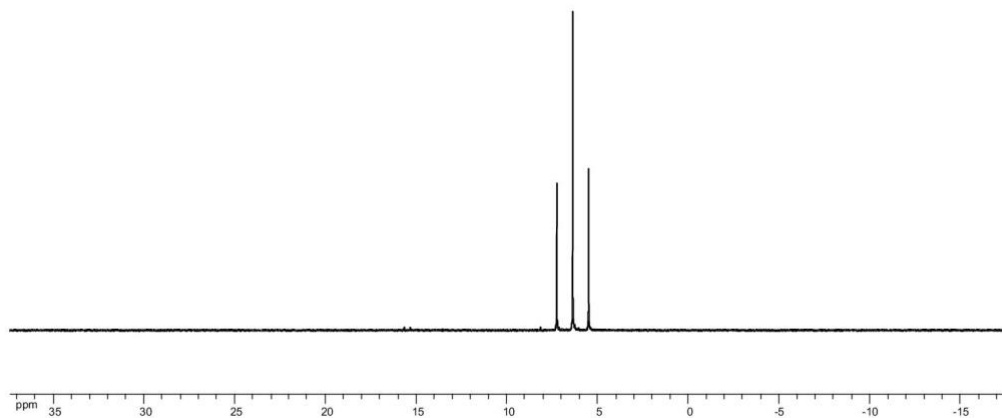


# Compound **15b**



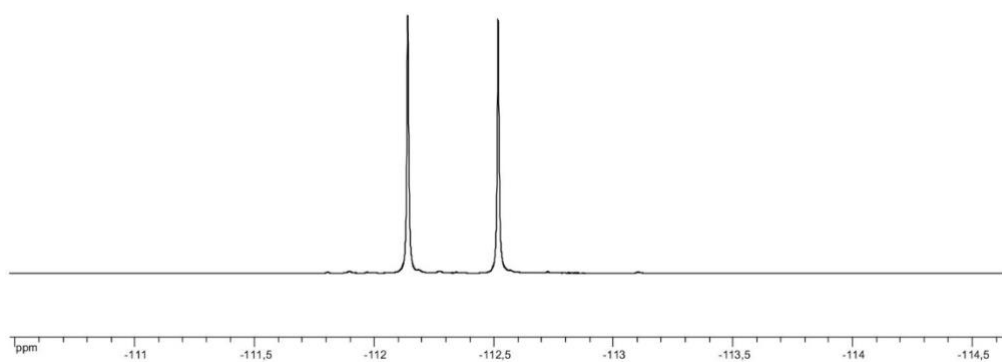
r4-63-200220-31P 10 (1D 31P) CDCl3 300MHz

Compound 15b

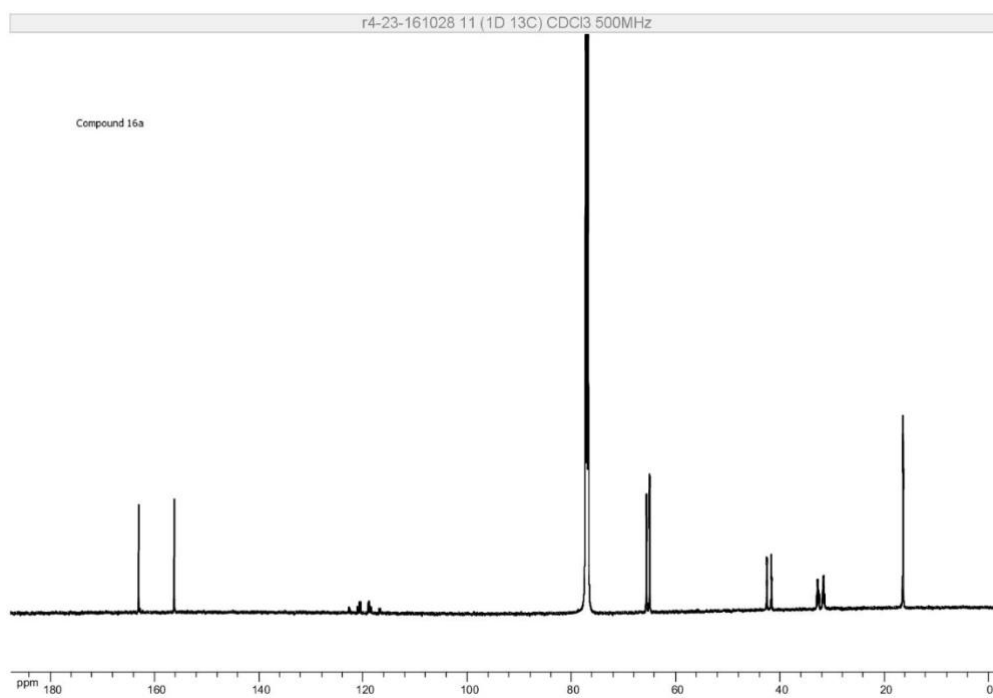
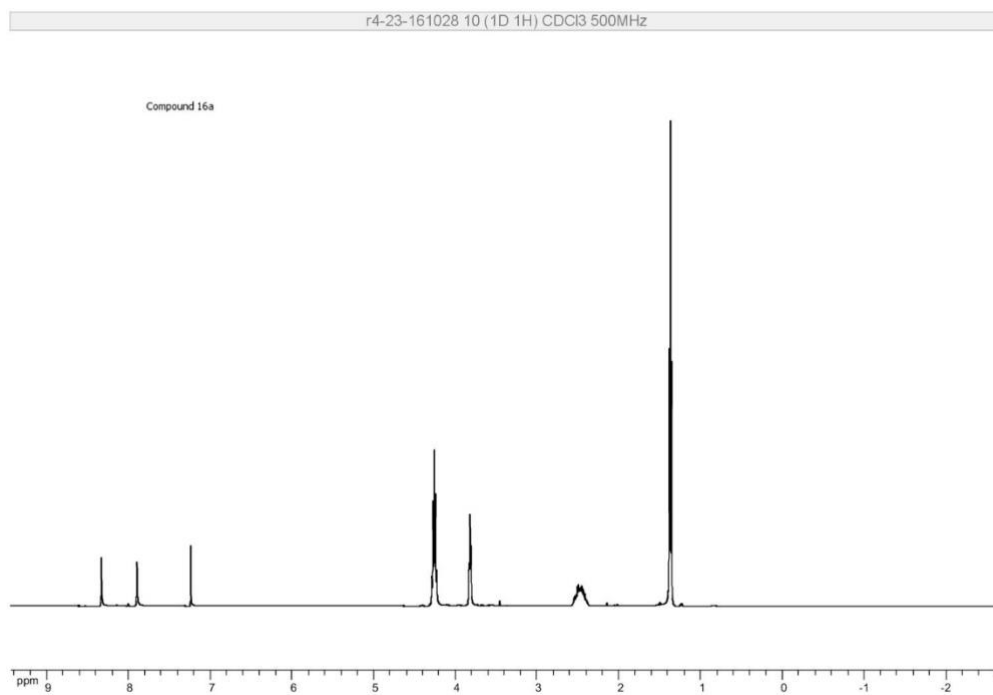


r4-63-200220-19F 10 (1D 19F) CDCl3 300MHz

Compound 15b

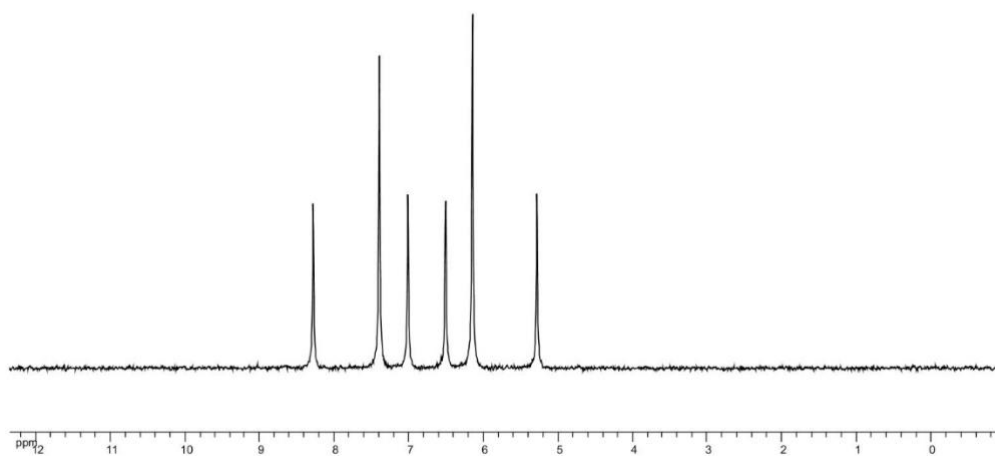


Compound **16a**



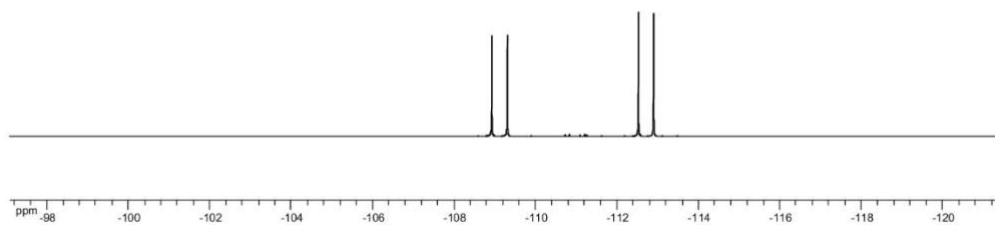
r4-23-161028-31P 10 (1D 31P) CDCl3 300MHz

Compound 16a

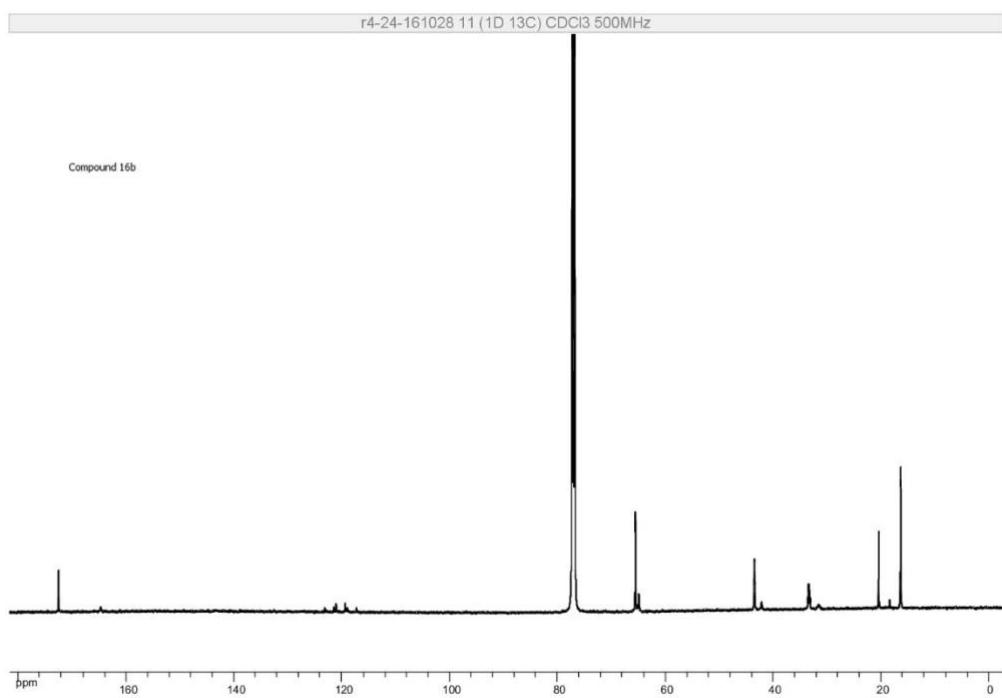
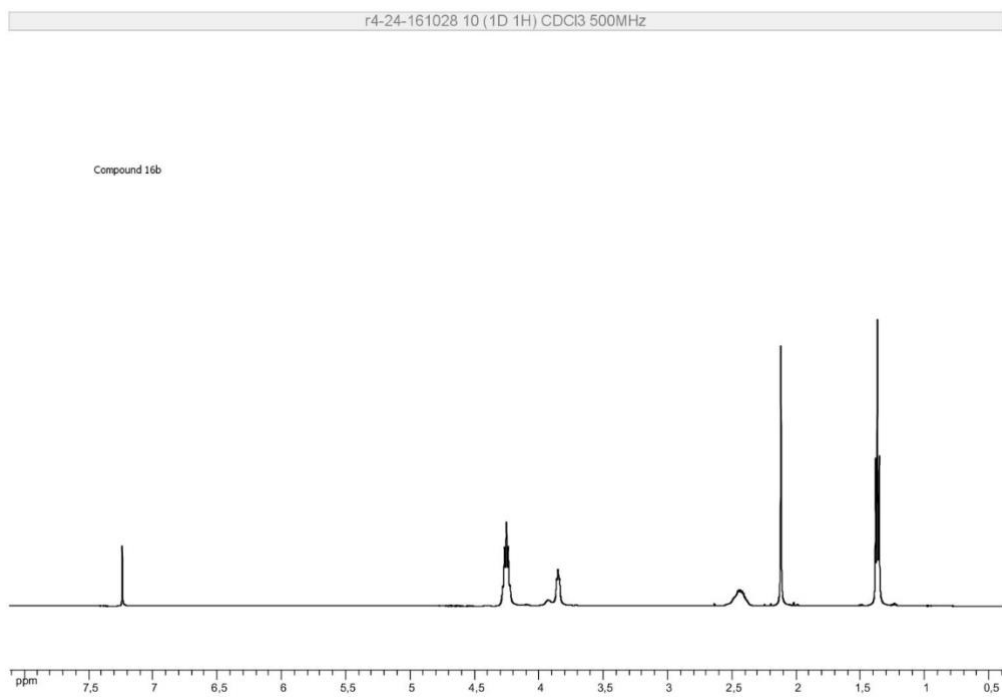


r4-23-161028-19F 10 (1D 19F) CDCl3 300MHz

Compound 16a

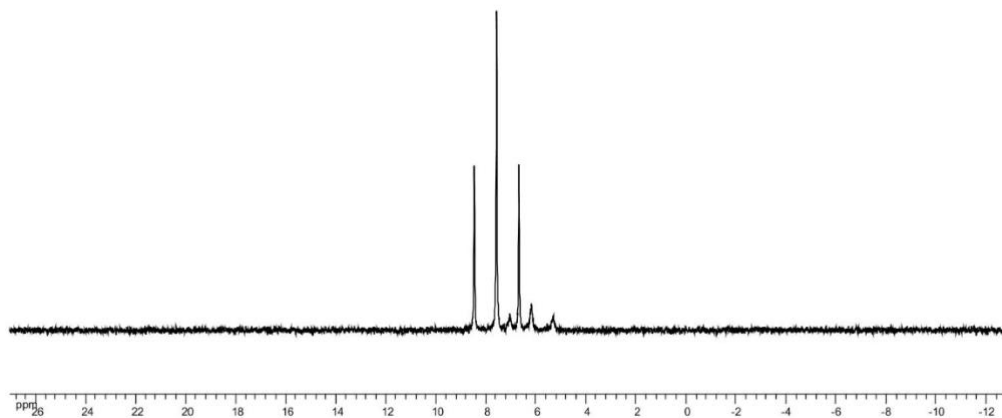


Compound **16b**



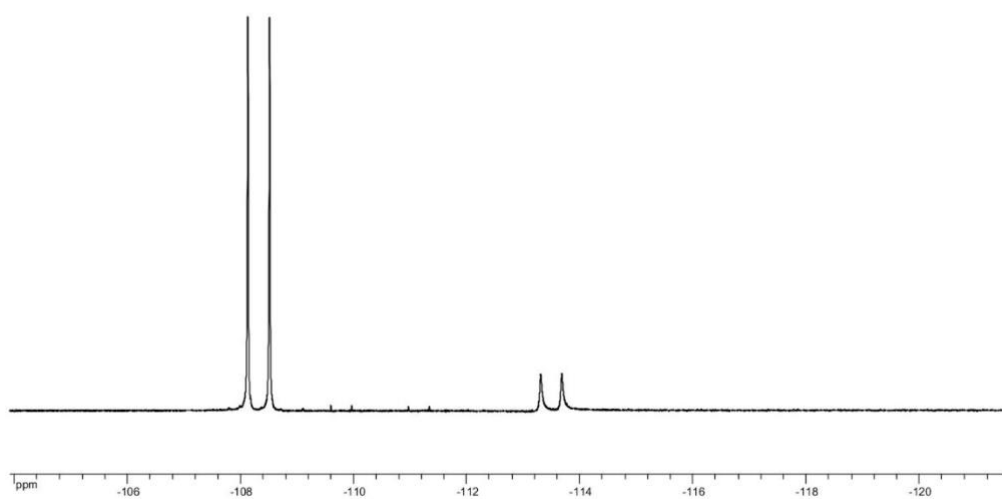
r4-24-161028-31P 10 (1D 31P) CDCl3 300MHz

Compound 16b

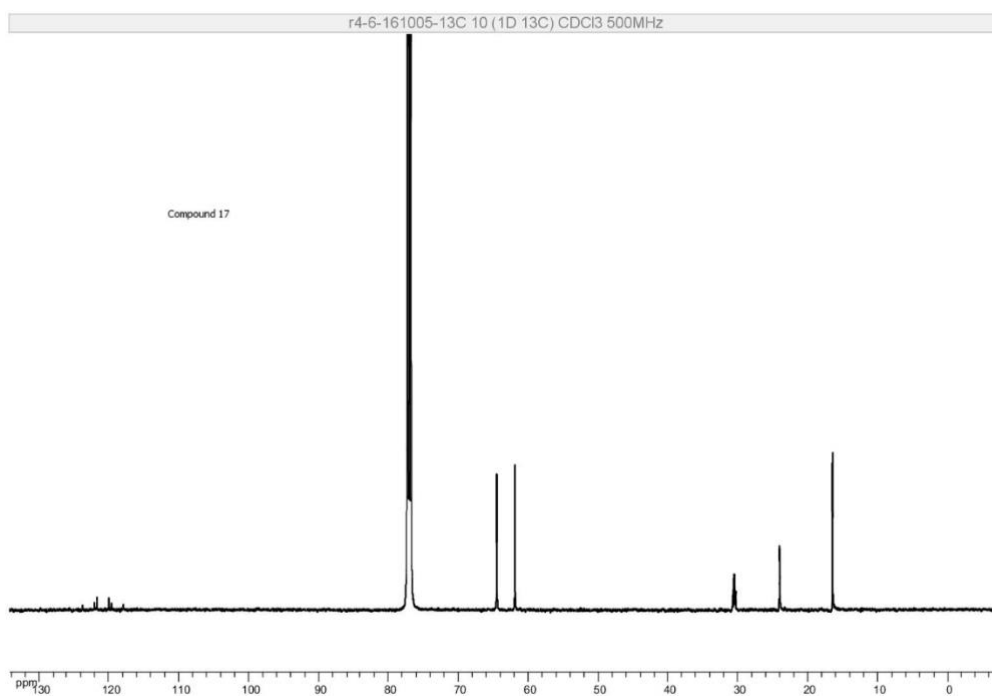
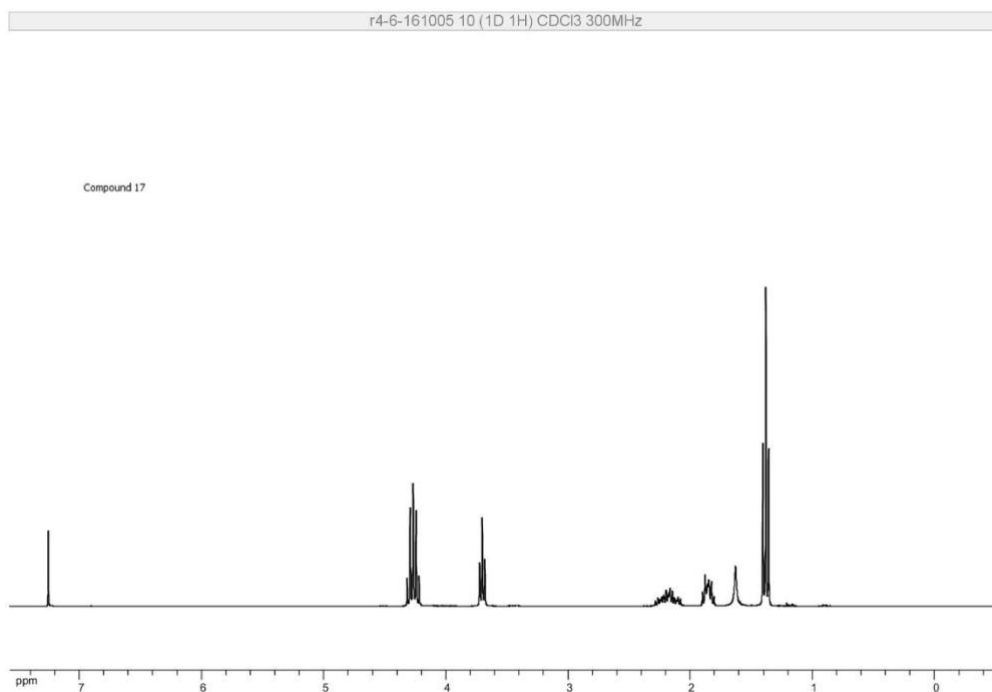


r4-24-161028-19F 10 (1D 19F) CDCl3 300MHz

Compound 16b

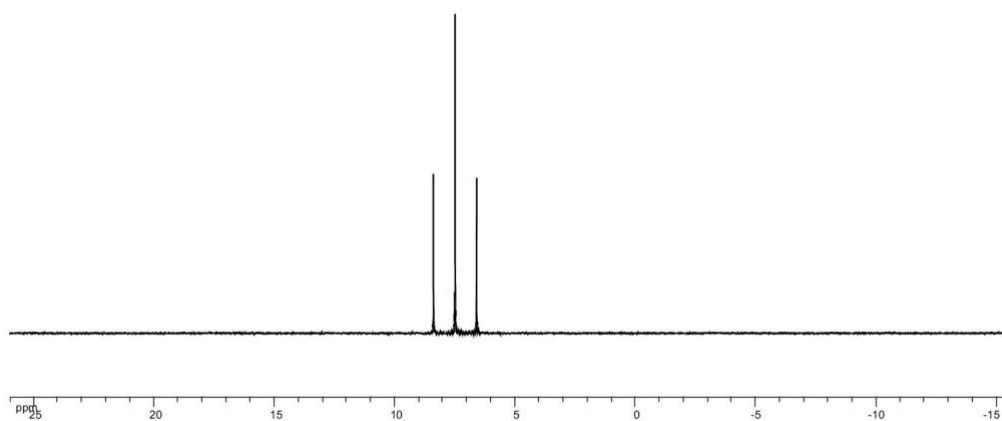


Compound **17**



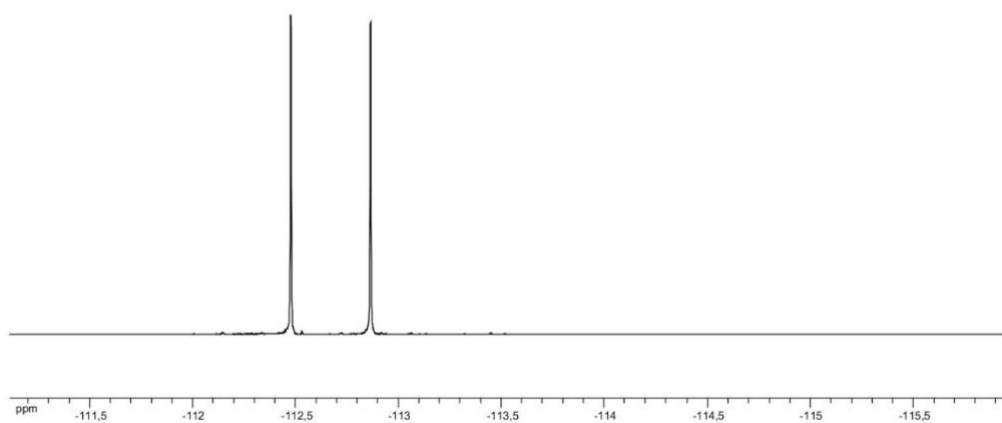
r4-6-161005 11 (1D 31P) CDCl3 300MHz

Compound 17



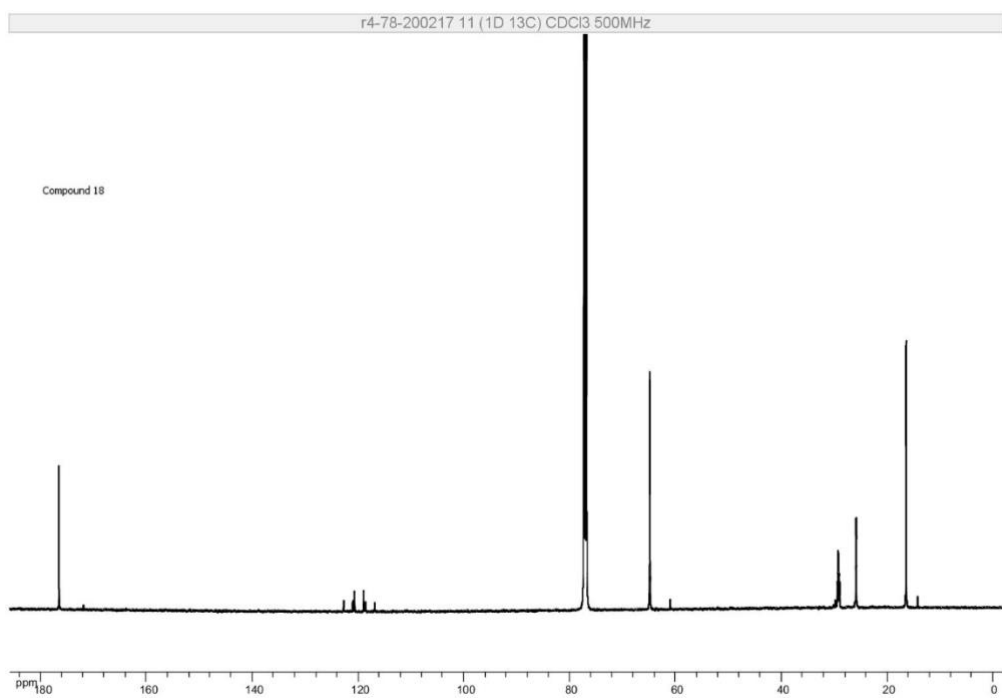
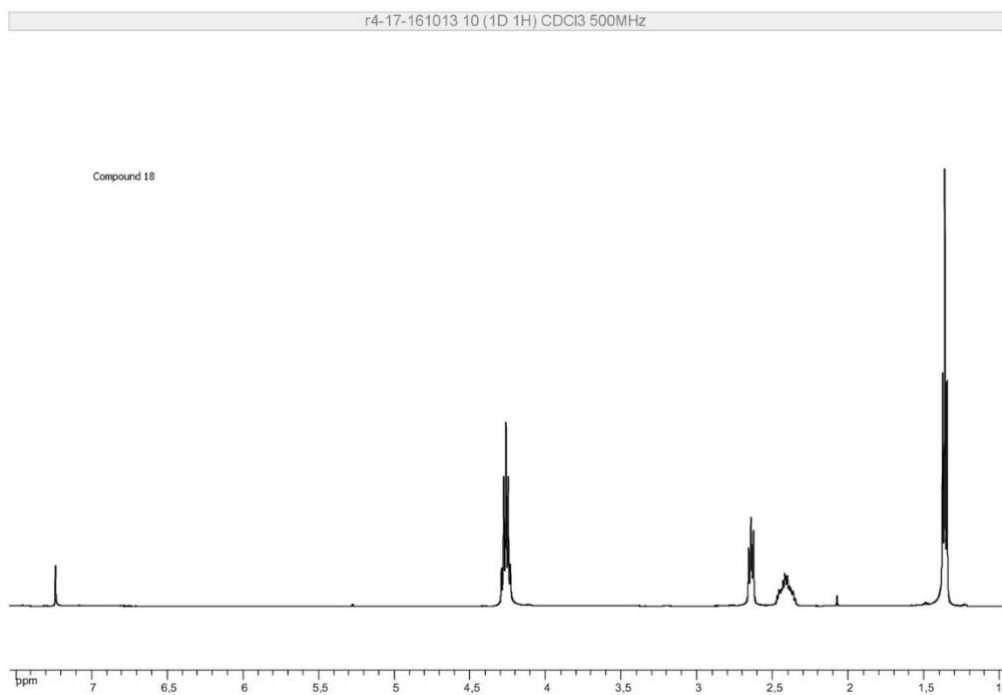
r4-6-161005 12 (1D 19F) CDCl3 300MHz

Compound 17



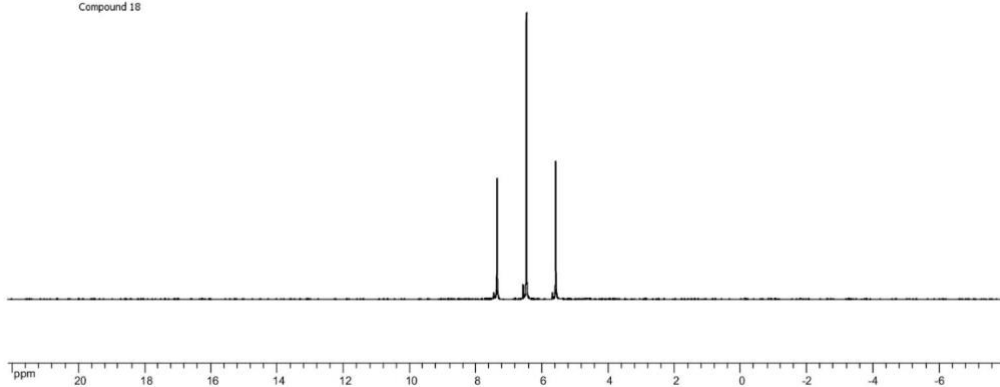


Compound **18**



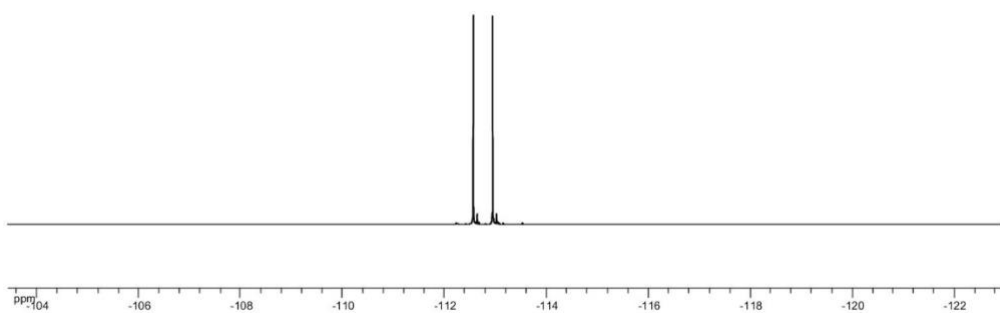
r4-78-200217-31P 10 (1D 31P) CDCl3 300MHz

Compound 18

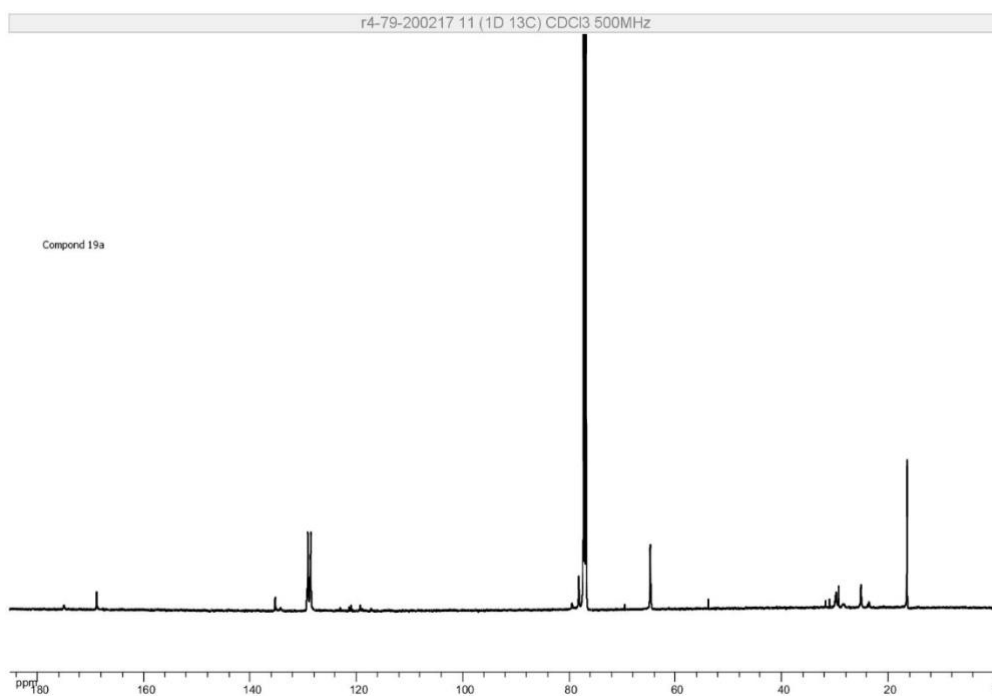
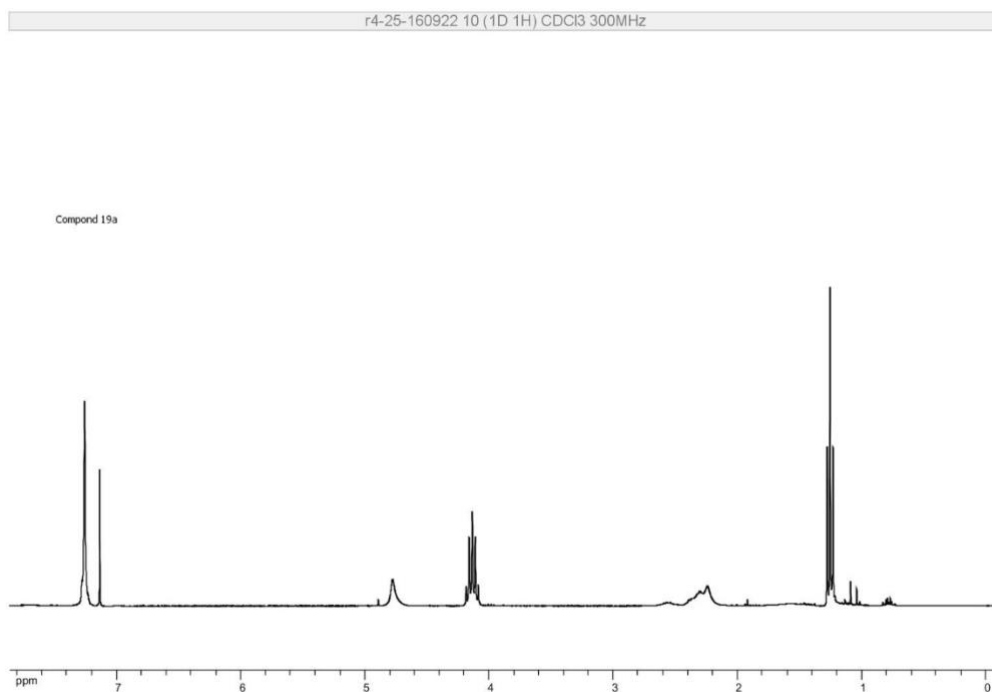


r4-78-200217-19F 10 (1D 19F) CDCl3 300MHz

Compound 18

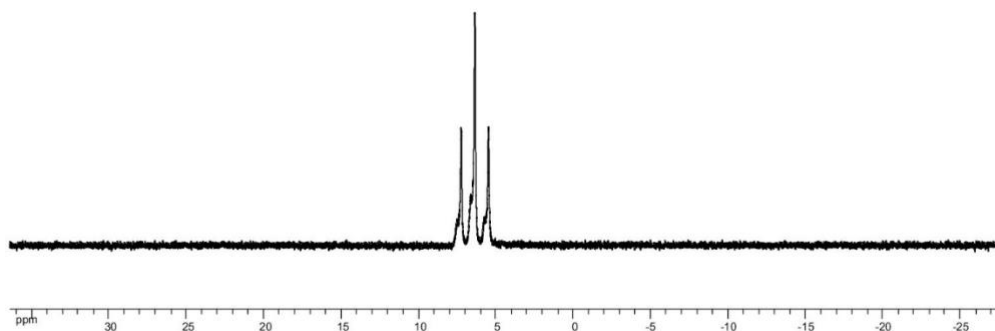


Compound **19a**



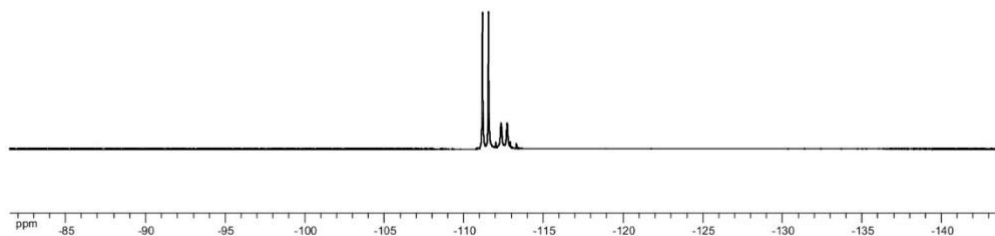
r4-79-200217-31P 10 (1D 31P) CDCl3 300MHz

Compound 19a

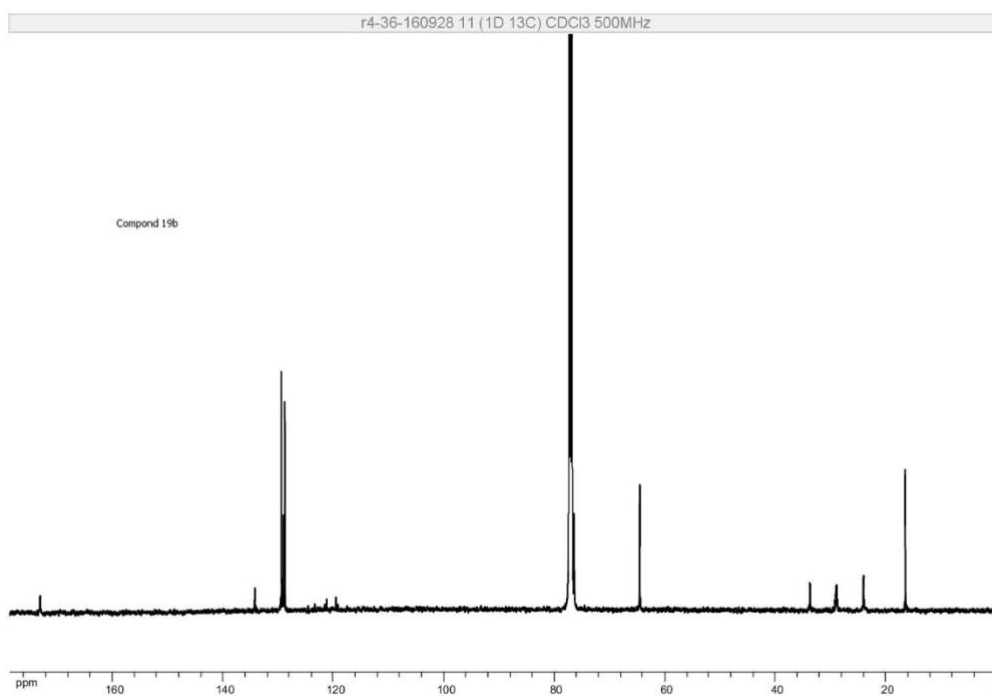
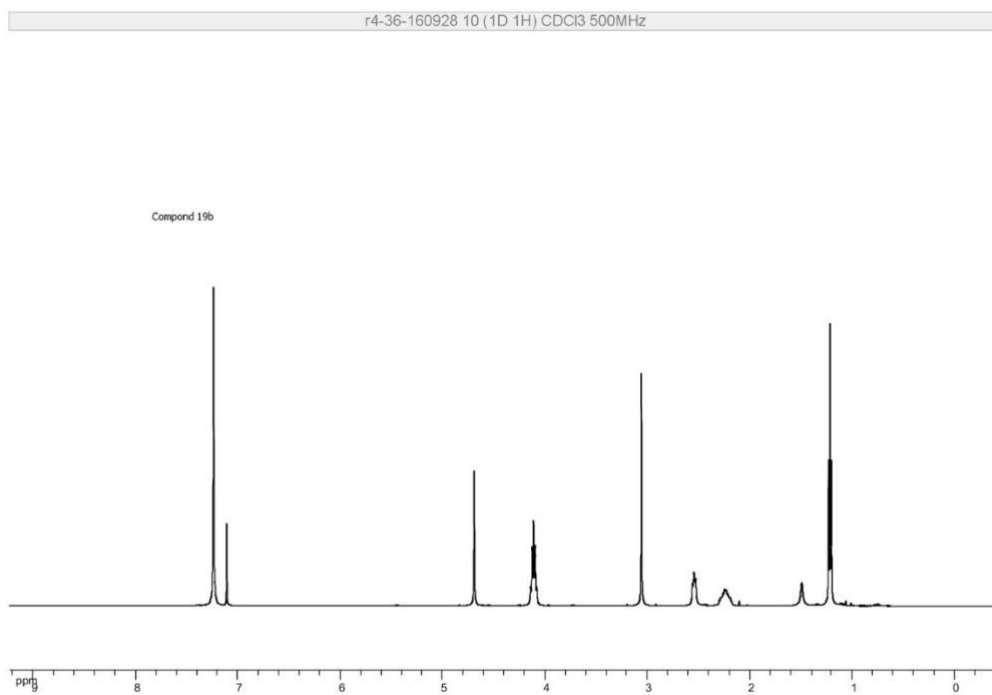


r4-79-200217-31P 11 (1D 19F) CDCl3 300MHz

Compound 19a

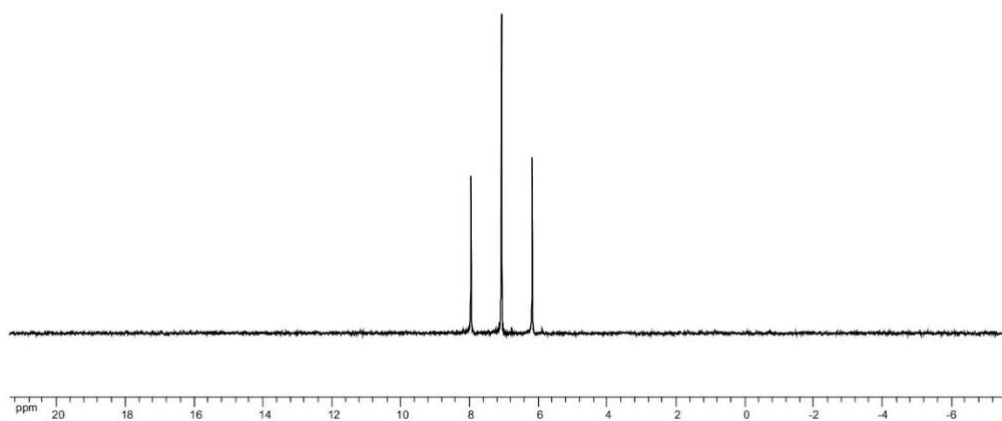


Compound **19b**



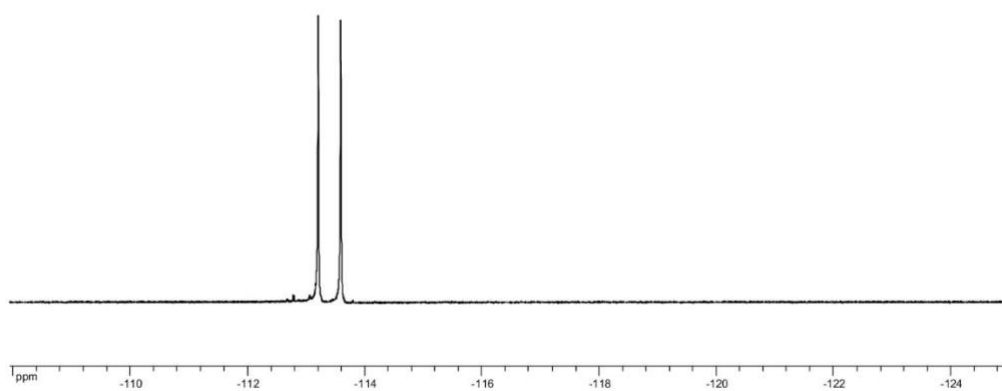
r4-36-160928-31P 10 (1D 31P) CDCl3 300MHz

Compound 19b

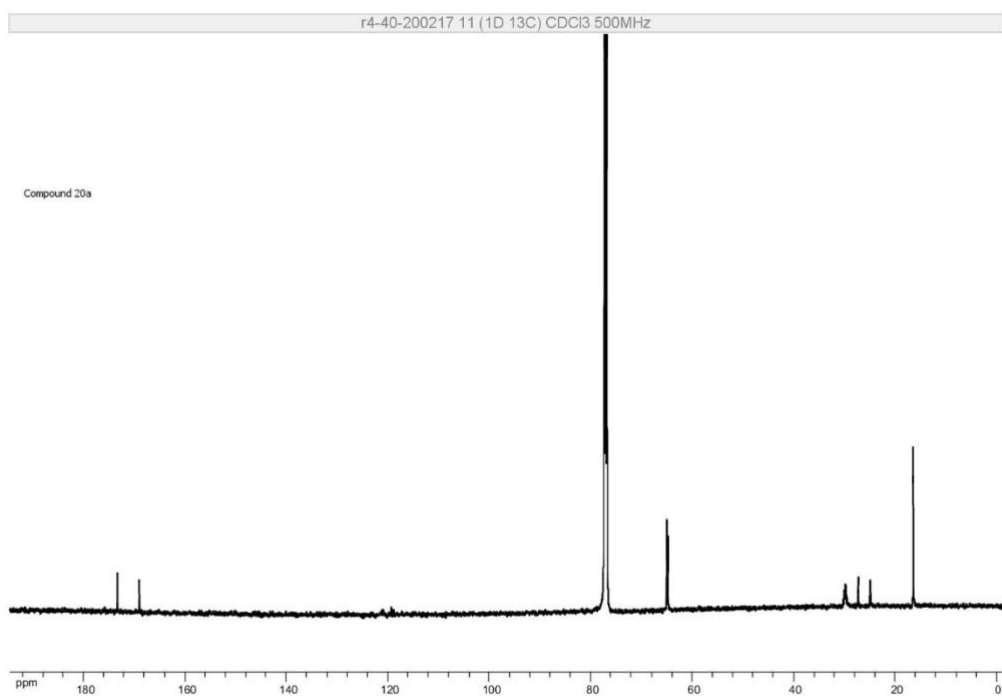
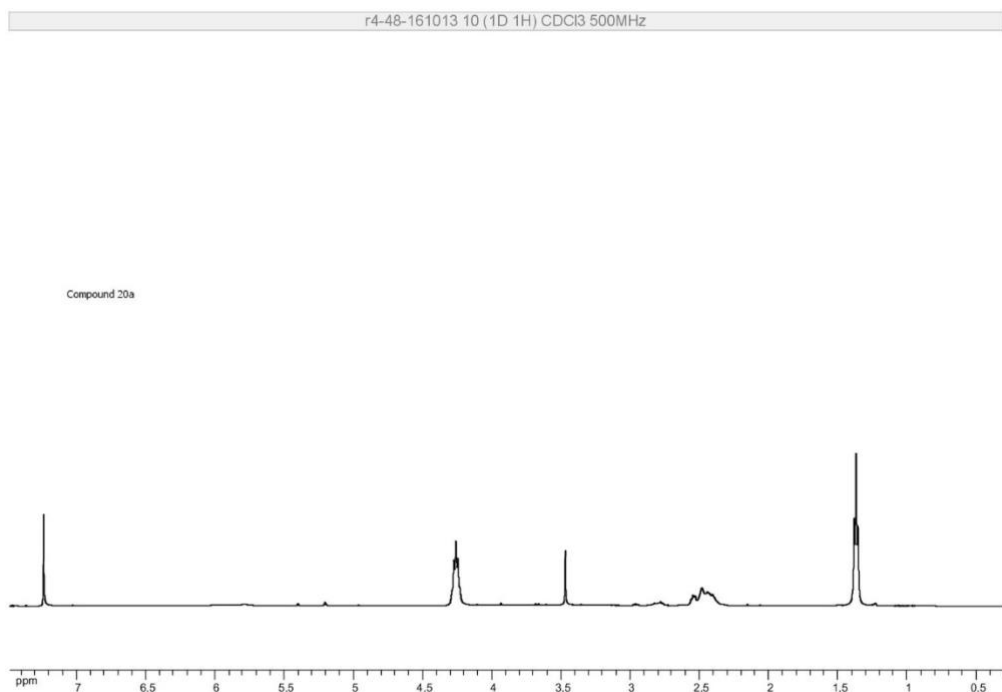


r4-36-160928-19F 10 (1D 19F) CDCl3 300MHz

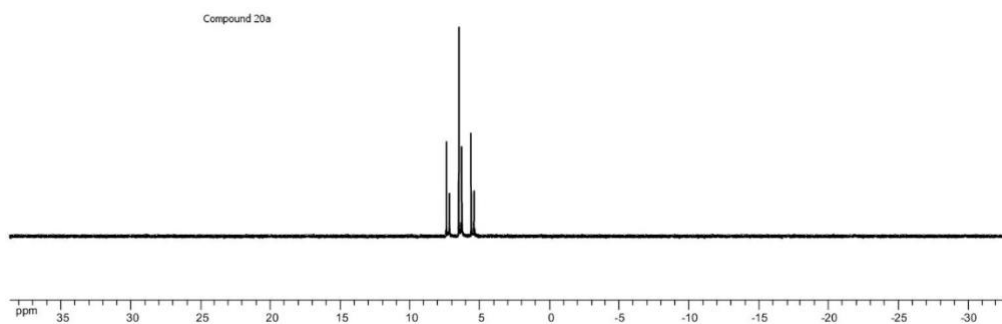
Compound 19b



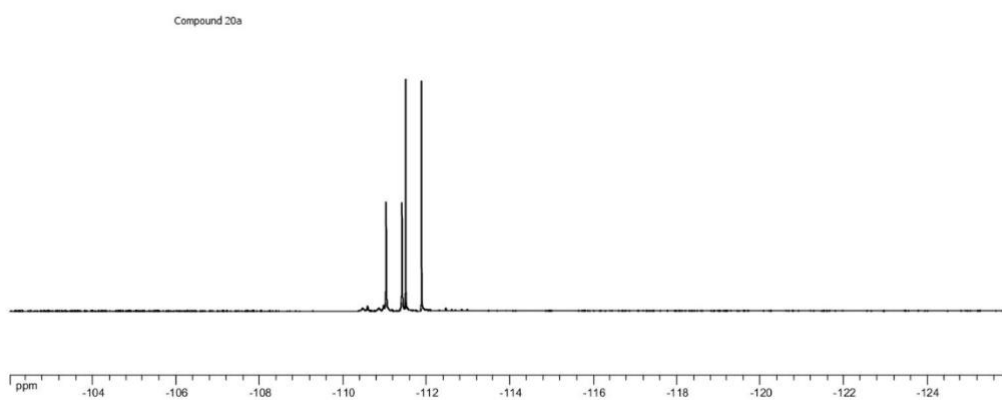
Compound **20a**



r4-40-200217-31P 10 (1D 31P) CDCl3 300MHz

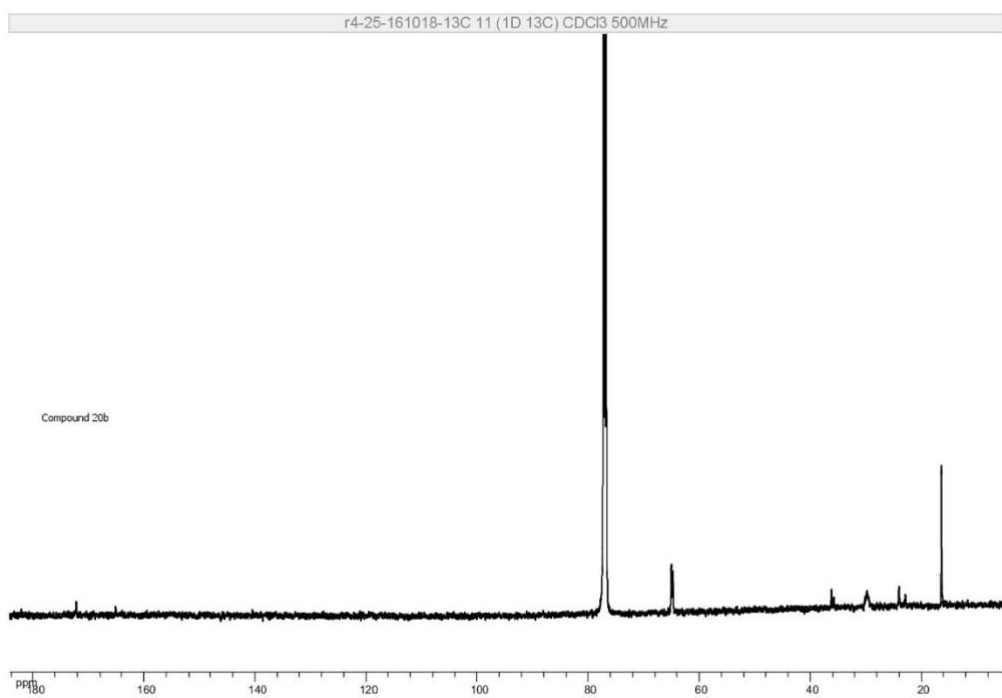
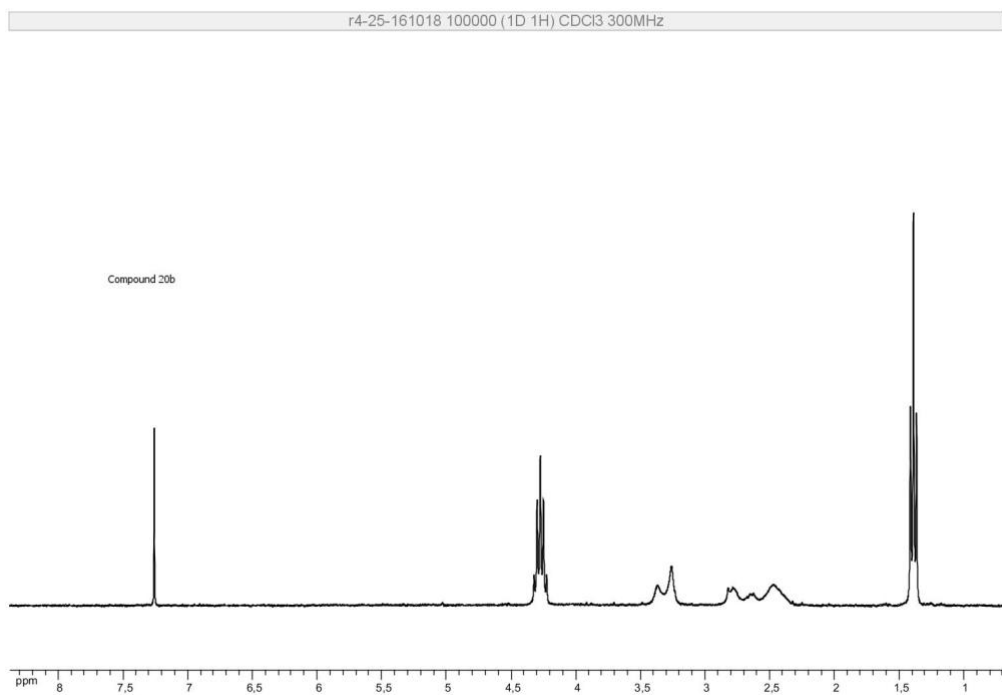


r4-40-200217-19F 10 (1D 19F) CDCl3 300MHz

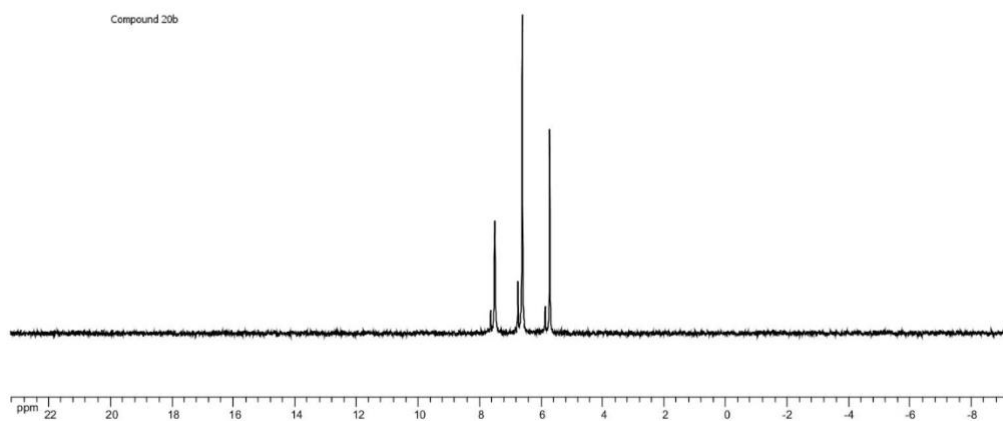




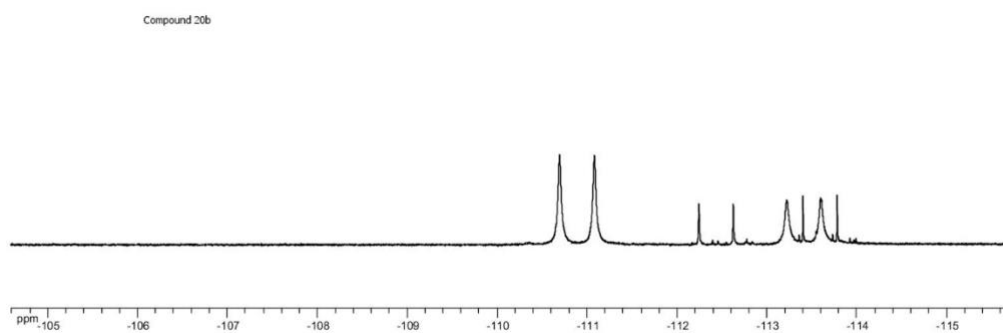
Compound **20b**



r4-25-161018 11 (1D 31P) CDCl3 300MHz



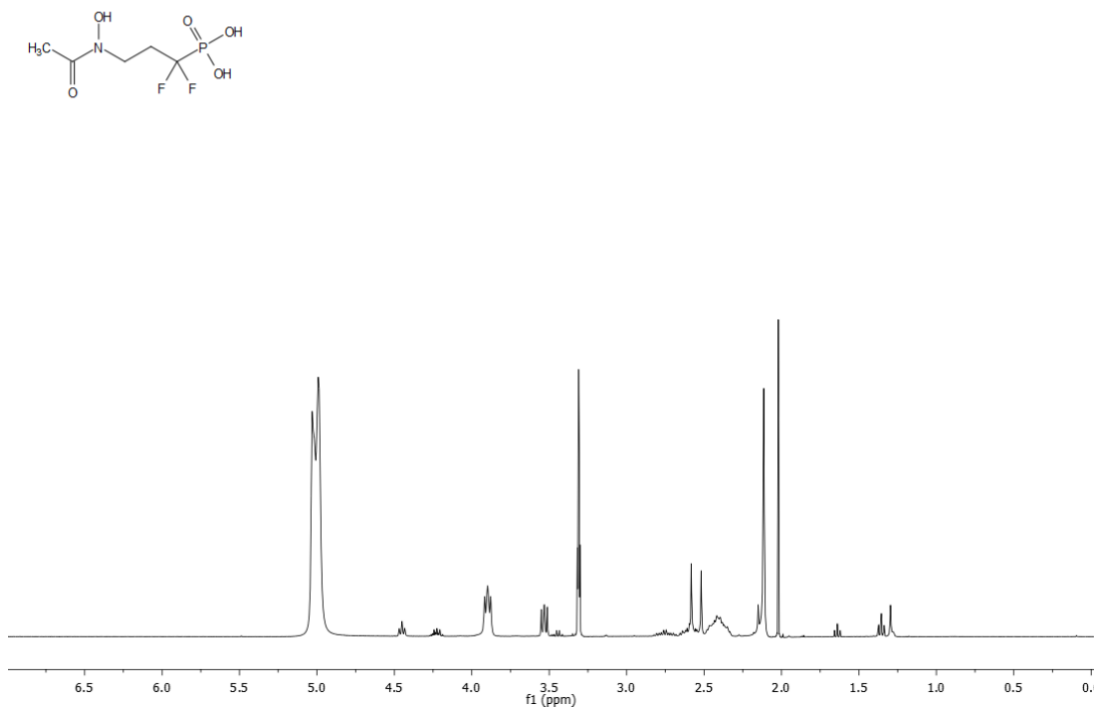
r4-25-161018 12 (1D 19F) CDCl3 300MHz



# Compound **9b**

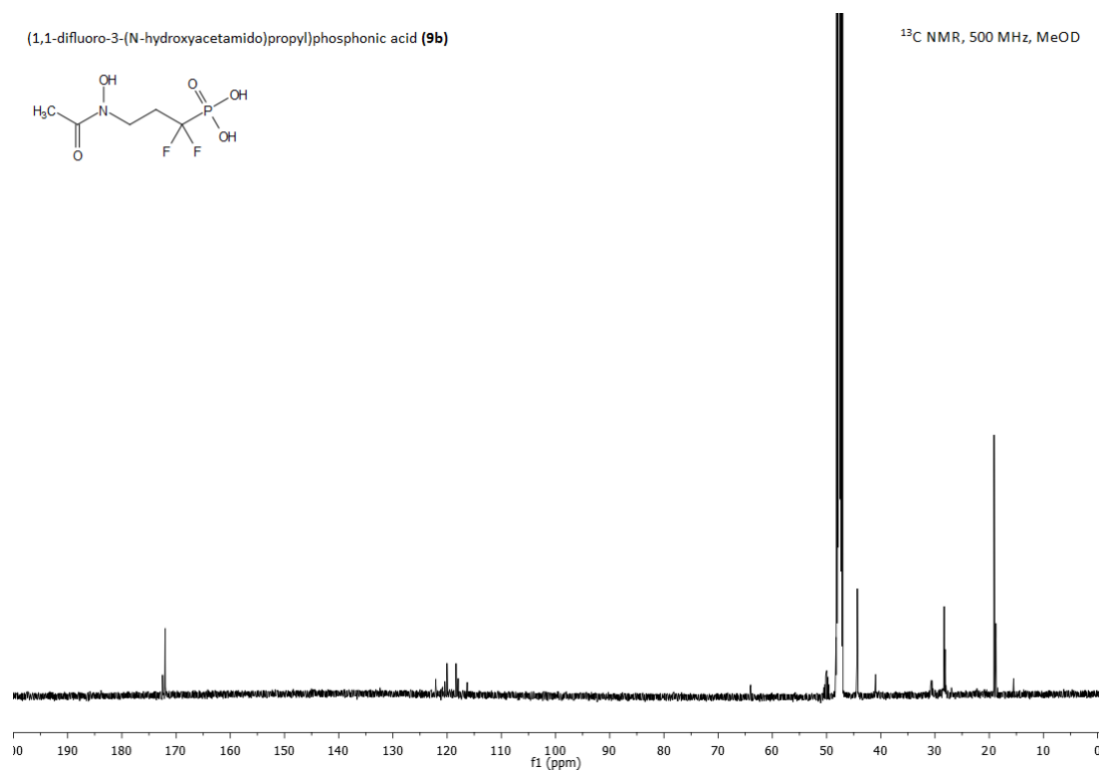
(1,1-difluoro-3-(N-hydroxyacetamido)propyl)phosphonic acid (**9b**)

$^1\text{H}$  NMR, 400 MHz, MeOD



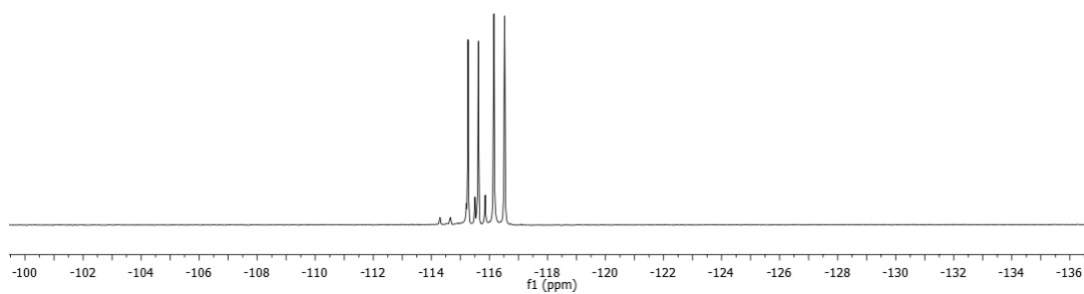
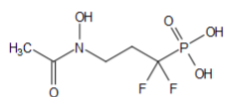
(1,1-difluoro-3-(N-hydroxyacetamido)propyl)phosphonic acid (**9b**)

$^{13}\text{C}$  NMR, 500 MHz, MeOD



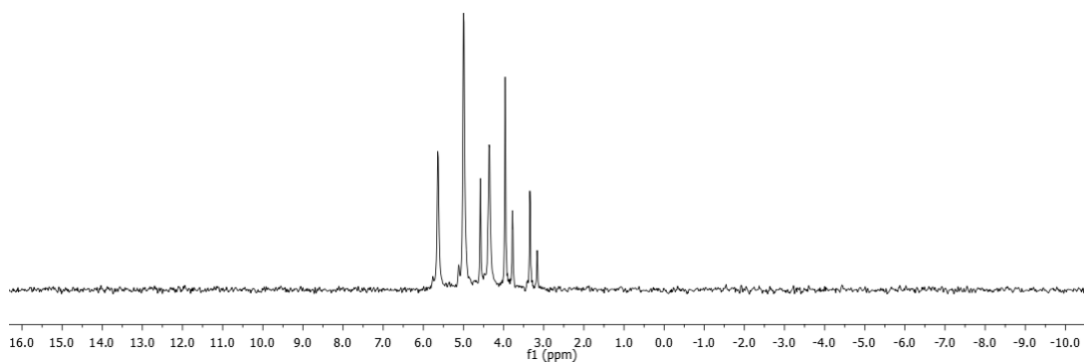
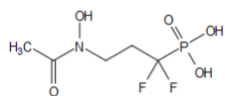
(1,1-difluoro-3-(N-hydroxyacetamido)propyl)phosphonic acid (**9b**)

$^{19}\text{F}$  NMR, 282 MHz, MeOD



(1,1-difluoro-3-(N-hydroxyacetamido)propyl)phosphonic acid (**9b**)

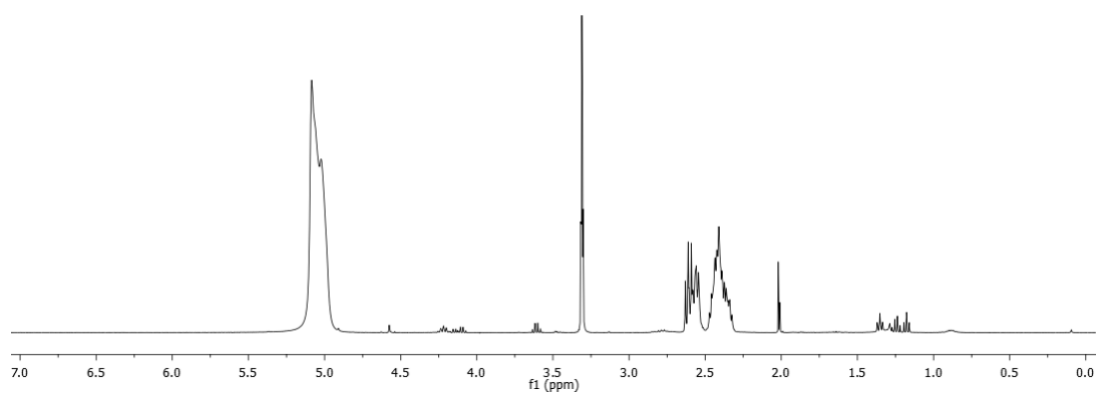
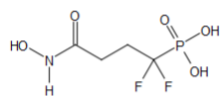
$^{31}\text{P}$  NMR, 162 MHz, MeOD



# Compound **10a**

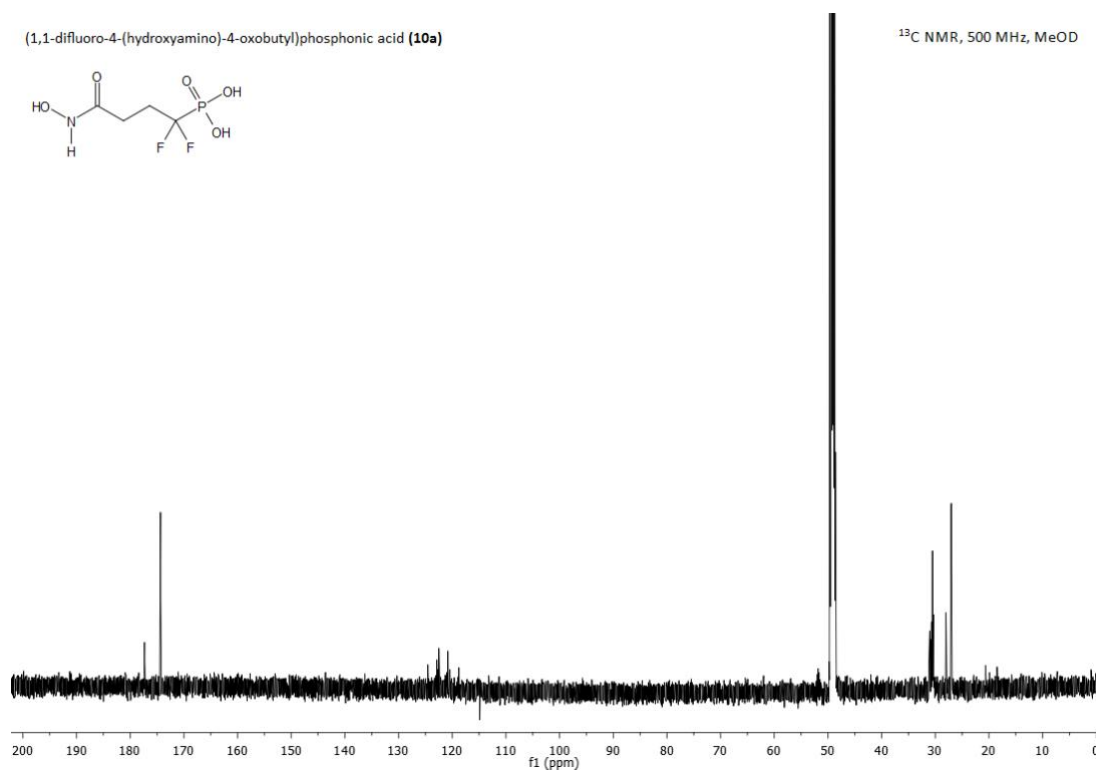
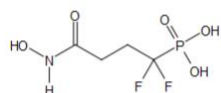
(1,1-difluoro-4-(hydroxyamino)-4-oxobutyl)phosphonic acid (**10a**)

$^1\text{H}$  NMR, 400 MHz, MeOD



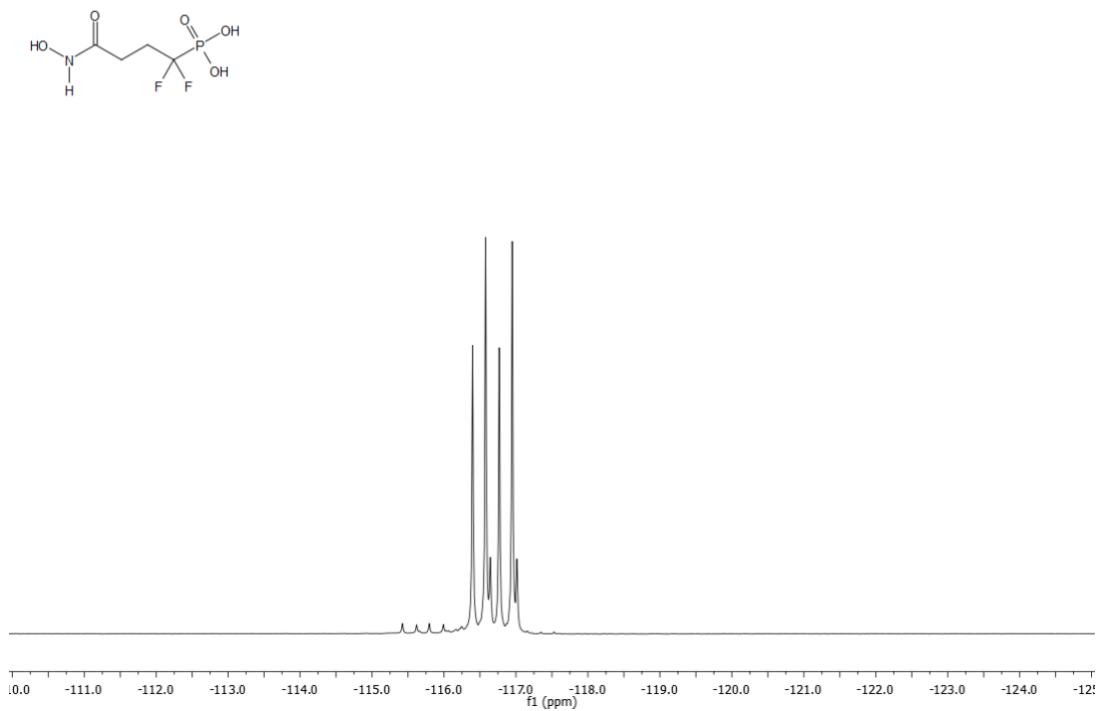
(1,1-difluoro-4-(hydroxyamino)-4-oxobutyl)phosphonic acid (**10a**)

$^{13}\text{C}$  NMR, 500 MHz, MeOD



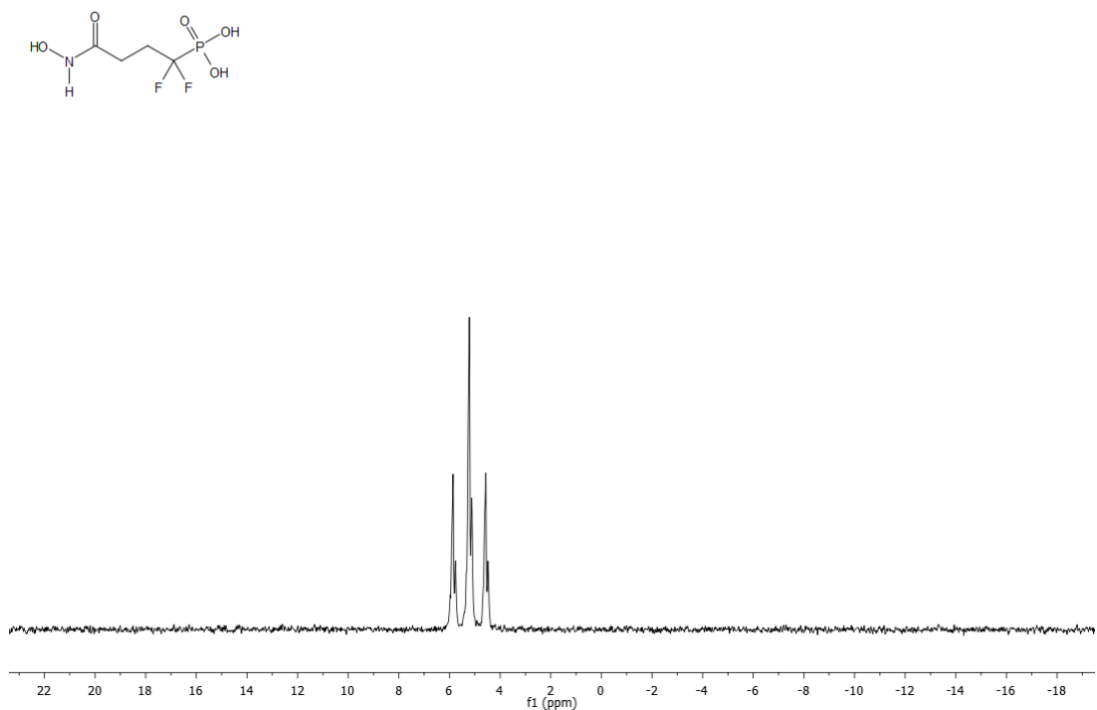
(1,1-difluoro-4-(hydroxyamino)-4-oxobutyl)phosphonic acid (**10a**)

$^{19}\text{F}$  NMR, 282 MHz, MeOD



(1,1-difluoro-4-(hydroxyamino)-4-oxobutyl)phosphonic acid (**10a**)

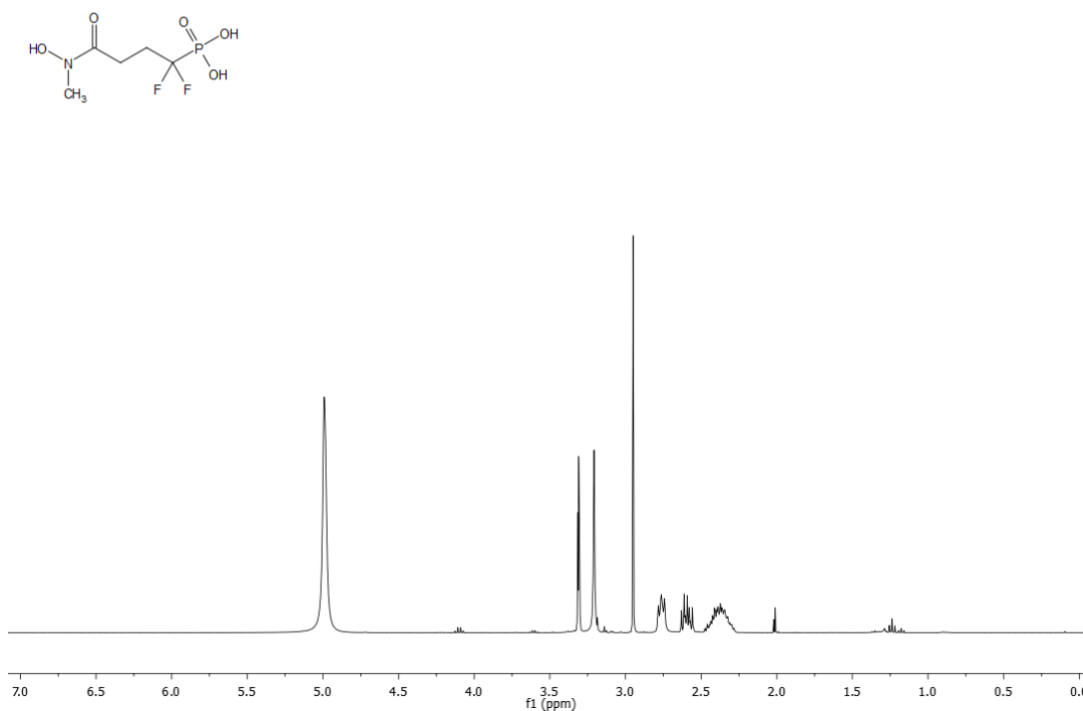
$^{31}\text{P}$  NMR, 162 MHz, MeOD



## Compound **10b**

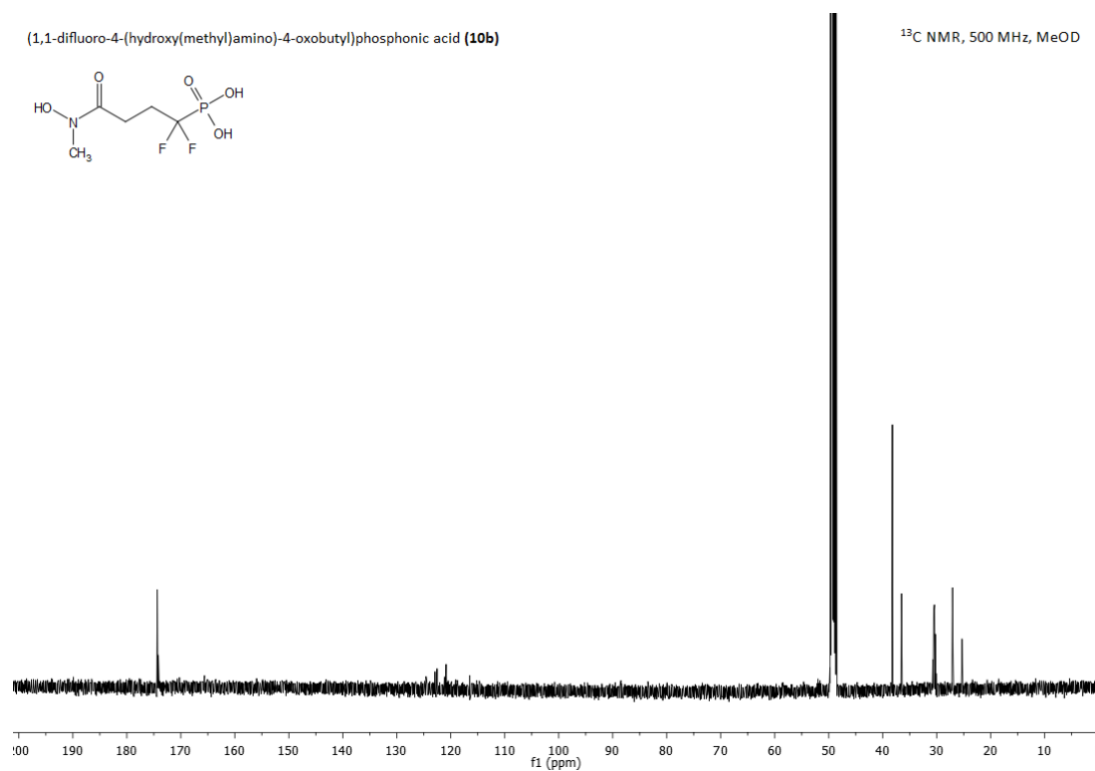
(1,1-difluoro-4-(hydroxy(methyl)amino)-4-oxobutyl)phosphonic acid (**10b**)

$^1\text{H}$  NMR, 400 MHz, MeOD



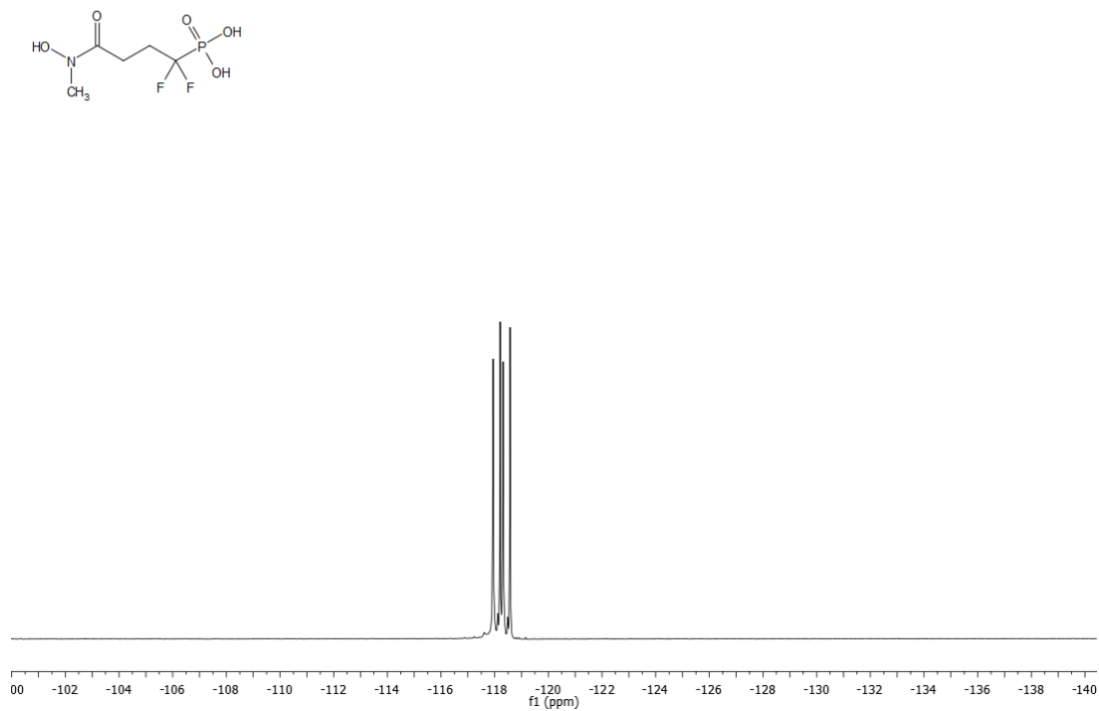
(1,1-difluoro-4-(hydroxy(methyl)amino)-4-oxobutyl)phosphonic acid (**10b**)

$^{13}\text{C}$  NMR, 500 MHz, MeOD



(1,1-difluoro-4-(hydroxy(methyl)amino)-4-oxobutyl)phosphonic acid (**10b**)

$^{19}\text{F}$  NMR, 282 MHz, MeOD



(1,1-difluoro-4-(hydroxy(methyl)amino)-4-oxobutyl)phosphonic acid (**10b**)

$^{31}\text{P}$  NMR, 162 MHz, MeOD

