

Selective Perfluoro- and Polyfluoroarylation of Meldrum's Acid

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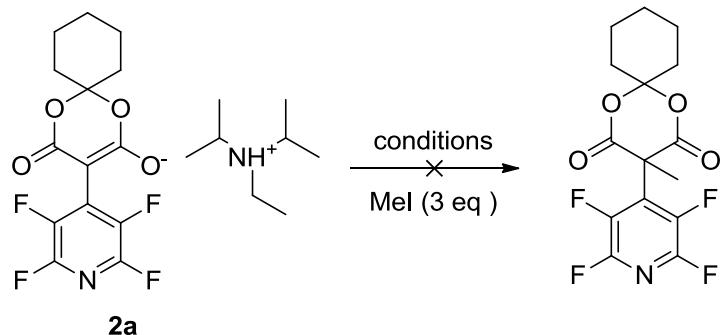
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Supporting Information

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Failed direct alkylation reaction of the adducts



Entry	Conditions	Time (h)	% Conv
1	DMF (0.1 M), K ₂ CO ₃ (3 equiv), 30 °C	3	0
2	DMF (0.1 M), K ₂ CO ₃ (3 equiv), 45 °C	17	30% conv to the decarboxylated product
3	DMF (0.1 M), K ₂ CO ₃ (3 equiv), 80 °C	15	Decarboxylated product and several byproducts formed
4	acetone (0.1 M), K ₂ CO ₃ (3 equiv), 30 °C	3	0
5	acetone (0.1 M), K ₂ CO ₃ (3 equiv), 45 °C	17	35% conv to the decarboxylated product
6	acetone (0.1 M), K ₂ CO ₃ (3 equiv), 80 °C	15	Decarboxylated product and several byproducts formed

Metathnolysis decarboxylation experiment of *N*-ethyl-*N*-isopropylpropan-2-aminium 4-oxo-3-(perfluoropyridin-4-yl)-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2a)



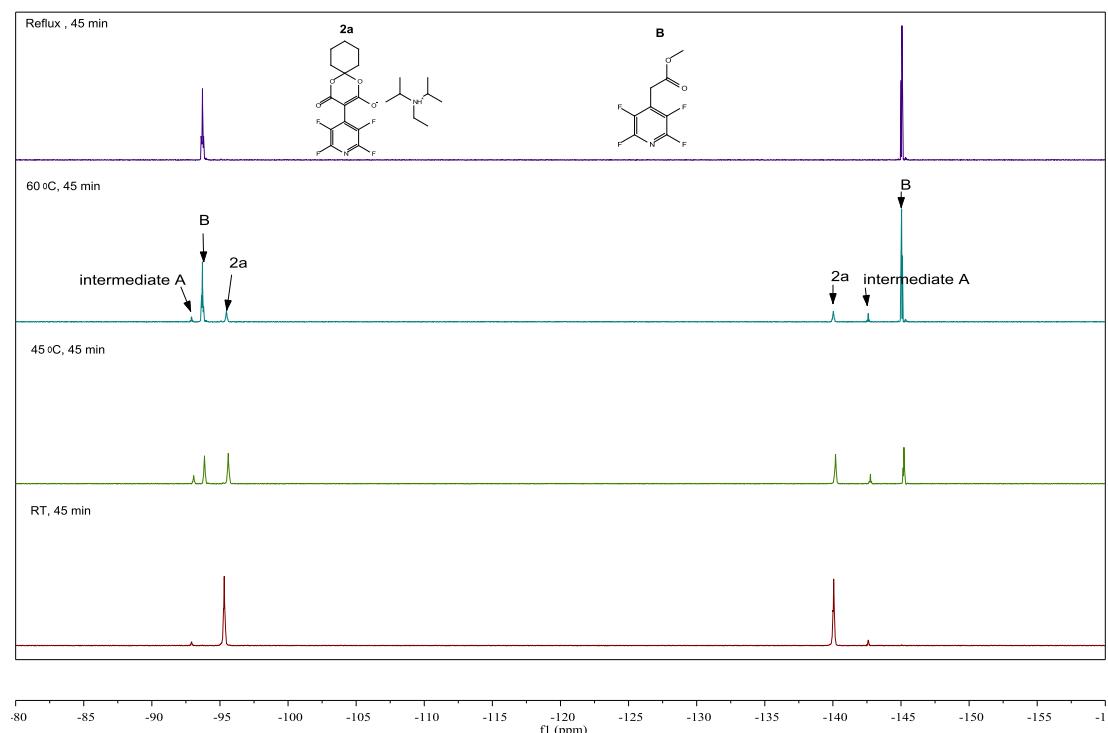
For the monitoring purposes, these reactions were carried out in NMR tubes and monitored via ¹⁹F NMR. Four NMR tubes charged with **2a** (23.1 mg, 0.05 mmol, 1.0 equiv) and HCl (36% w/v, 8.6 μL, 0.1 mmol, 2.0 equiv) and methanol (0.5 mL) were added and sealed glass capillary tubes containing C₆D₆ were placed in NMR tubes for locking purposes. Then the NMR tubes

were placed in sand baths separately and maintained at appropriate temperatures (RT, 45 °C, 60 °C and reflux). The reactions were periodically monitored by ^{19}F NMR. After the completion of the reaction, methanol was removed *in vacuo* and the resulting residue was dissolved in DCM (2 mL) and washed with deionized water (2 mL). The organic layer was dried with anhydrous MgSO_4 , filtered, concentrated *in vacuo* to obtain analytically pure compound methyl 2-(perfluoropyridin-4-yl)acetate in >99% yield as a reddish liquid. ^{19}F NMR (376 MHz, CDCl_3) δ -90.6 – -91.0 (m, 2F), -143.3 – -143.6 (m, 2F). ^1H NMR (400 MHz, CDCl_3) δ 3.86 (s, 2H), 3.77 (s, 3H). HRMS (ESI) calcd. $\text{C}_8\text{H}_5\text{F}_4\text{NO}_2$ 223.0256 observed 223.0274.

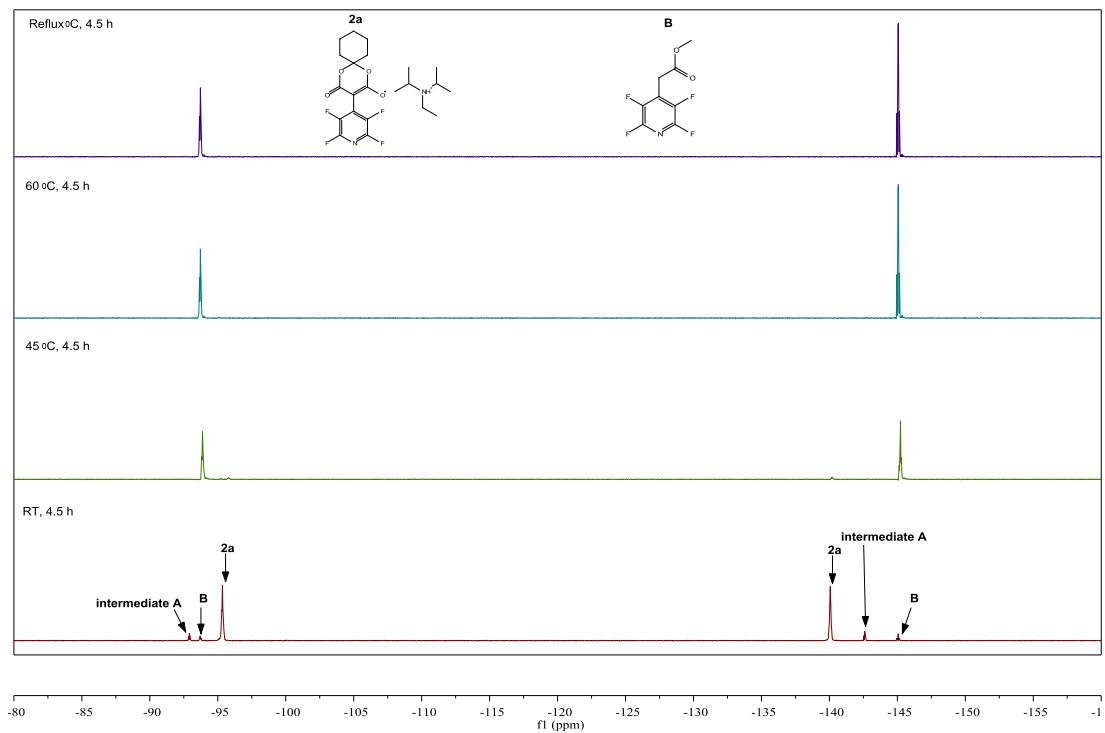
Note: Complete removal of DCM was not accomplished due to the high volatility of the product.

Comparison of the metatholysis experiment of *N*-ethyl-*N*-isopropylpropan-2-aminium 4-oxo-3-(perfluoropyridin-4-yl)-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2a) at different temperatures.

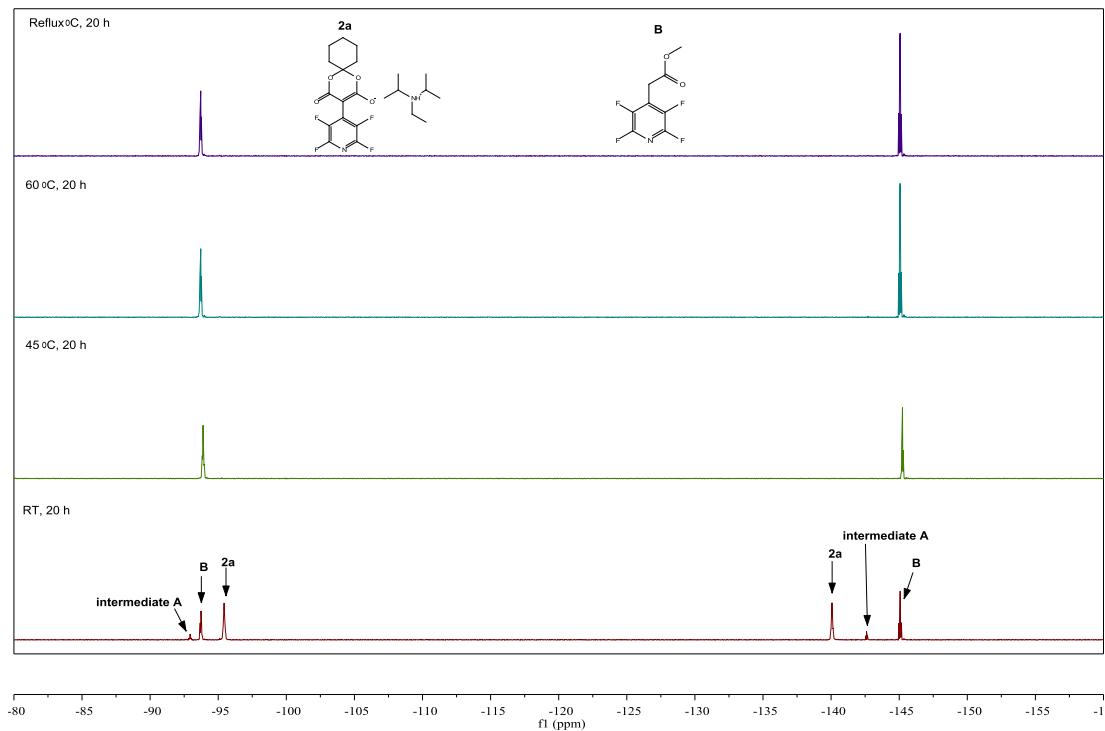
Reaction time = 45 min



Reaction time = 4.5 h



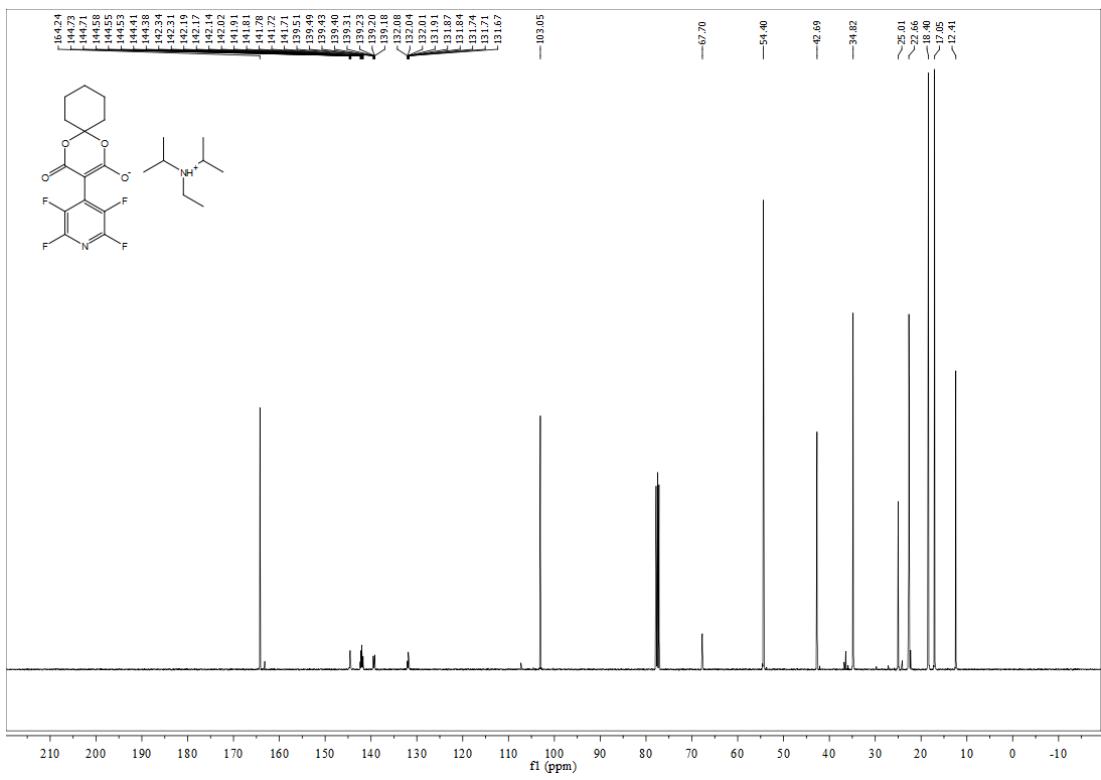
Reaction time = 20 h



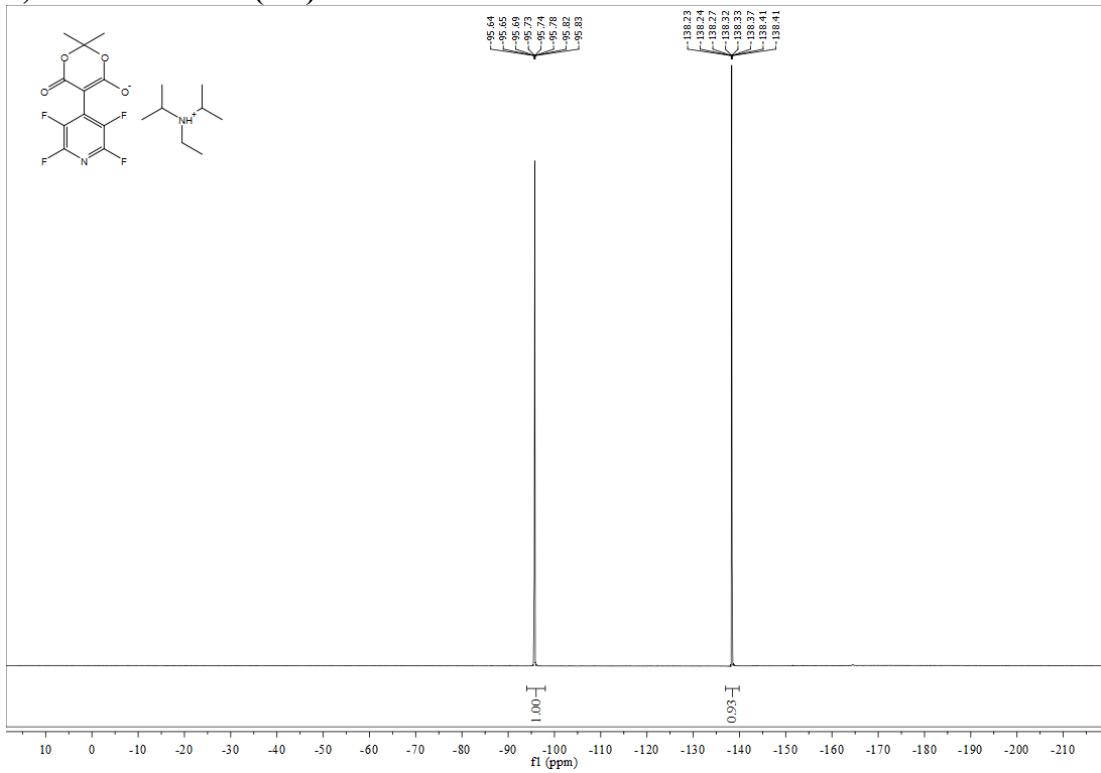
T (°C)	Time	2a %	Intermediate A %	B %
RT	45 min	97	3	0
	1.5 h	87	7	6
	20 h	60	5	35
45	45 min	51	9	40
	1.5 h	5	0	95
	20 h	0	0	100
60	45 min	17	4	66
	1.5 h	0	0	100
Reflux	45 min	0	0	100

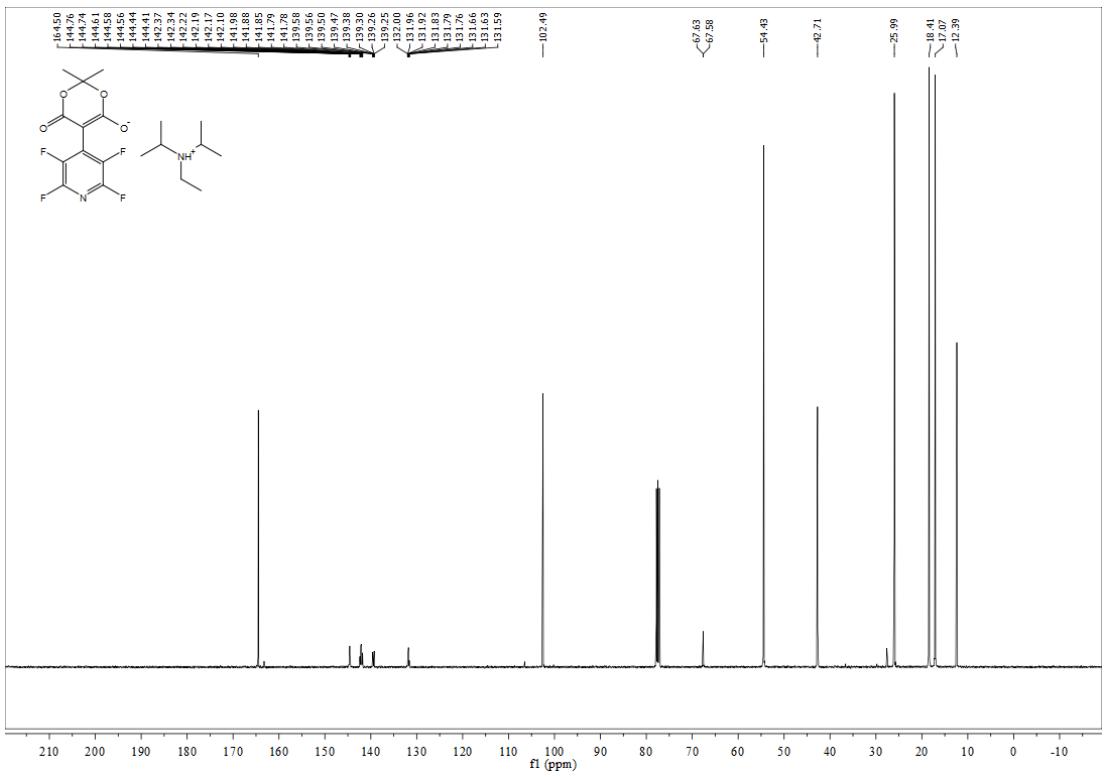
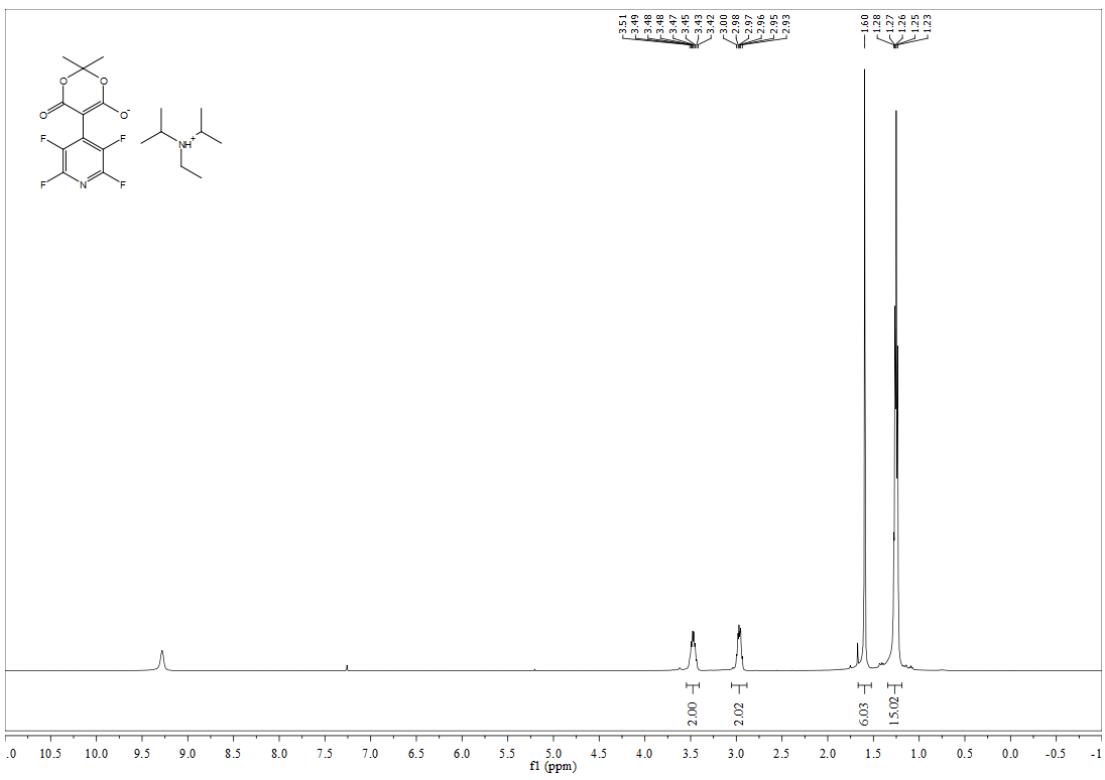
***N*-ethyl-*N*-isopropylpropan-2-aminium
dioxaspiro[5.5]undec-2-en-2-olate (2a)**



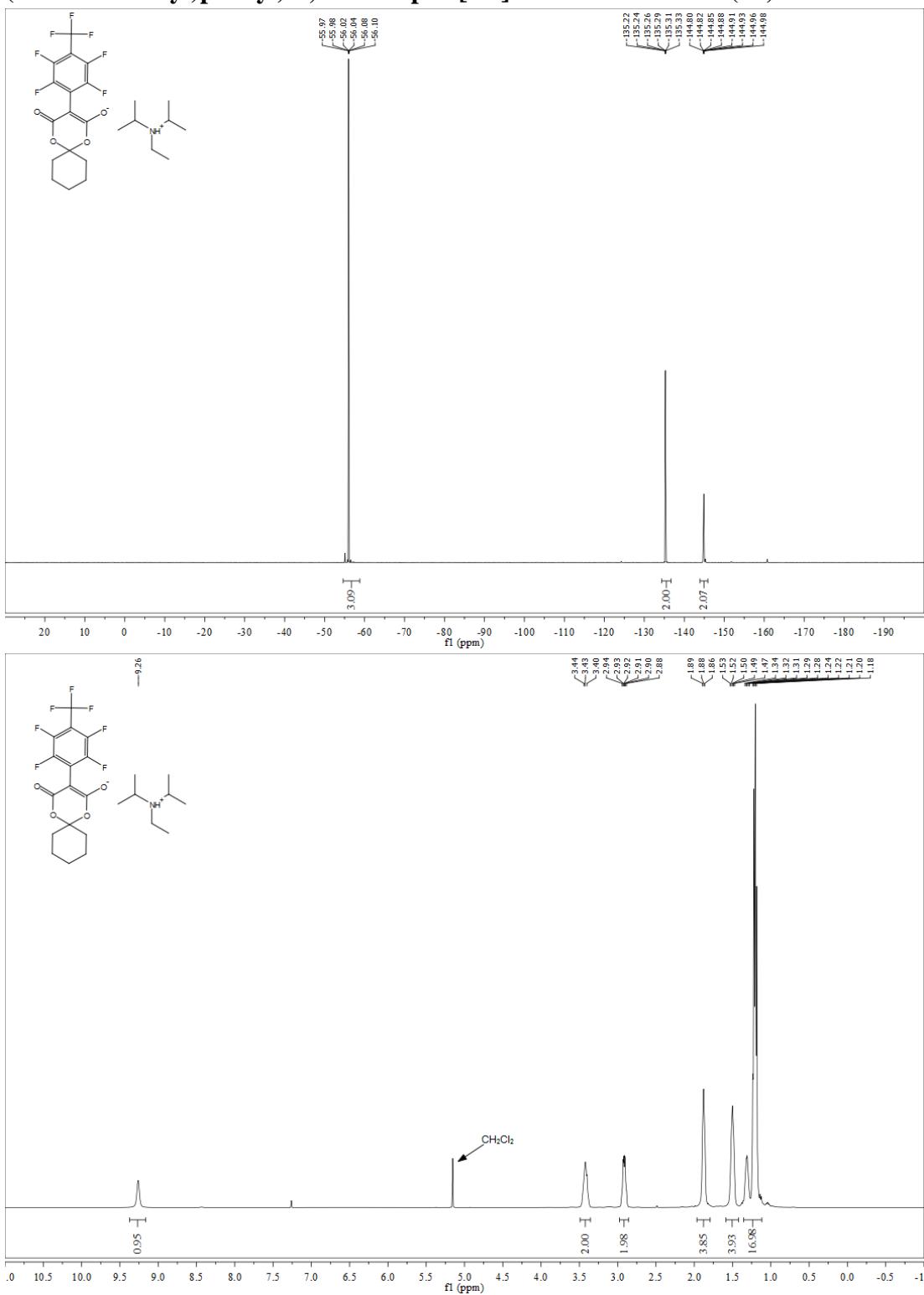


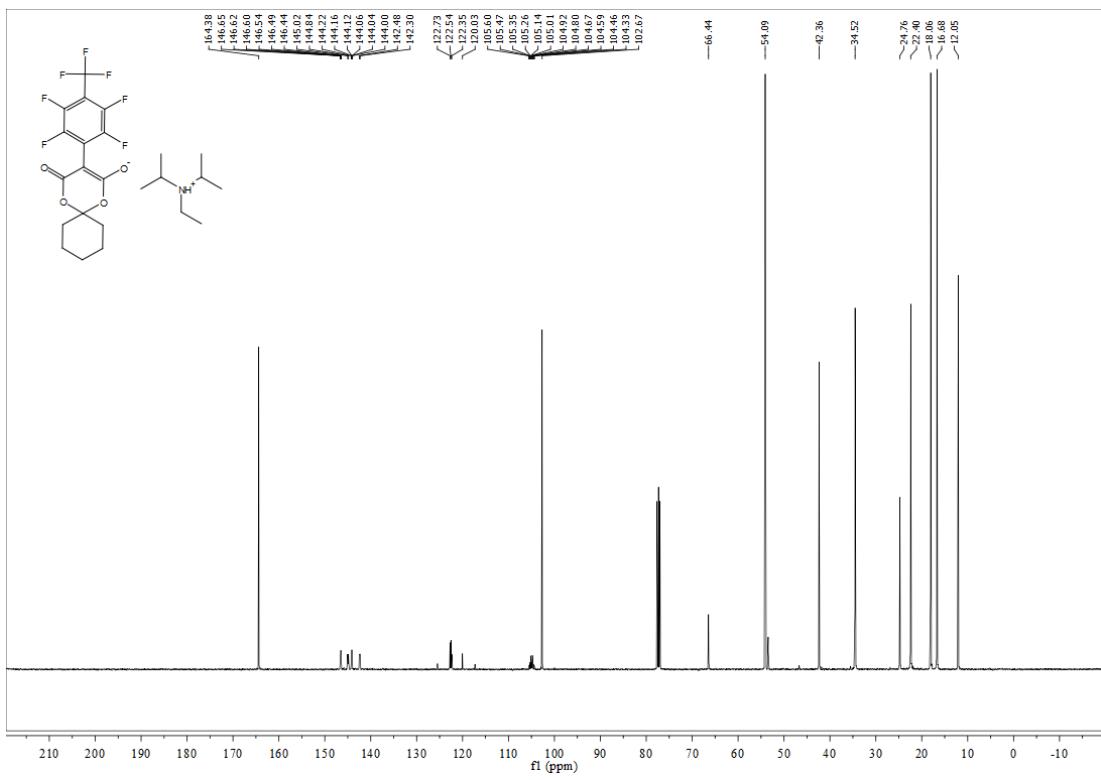
***N*-ethyl-*N*-isopropylpropan-2-aminium 2,2-dimethyl-4-oxo-5-(perfluoropyridin-4-yl)-4*H*-1,3-dioxin-6-olate (2a')**



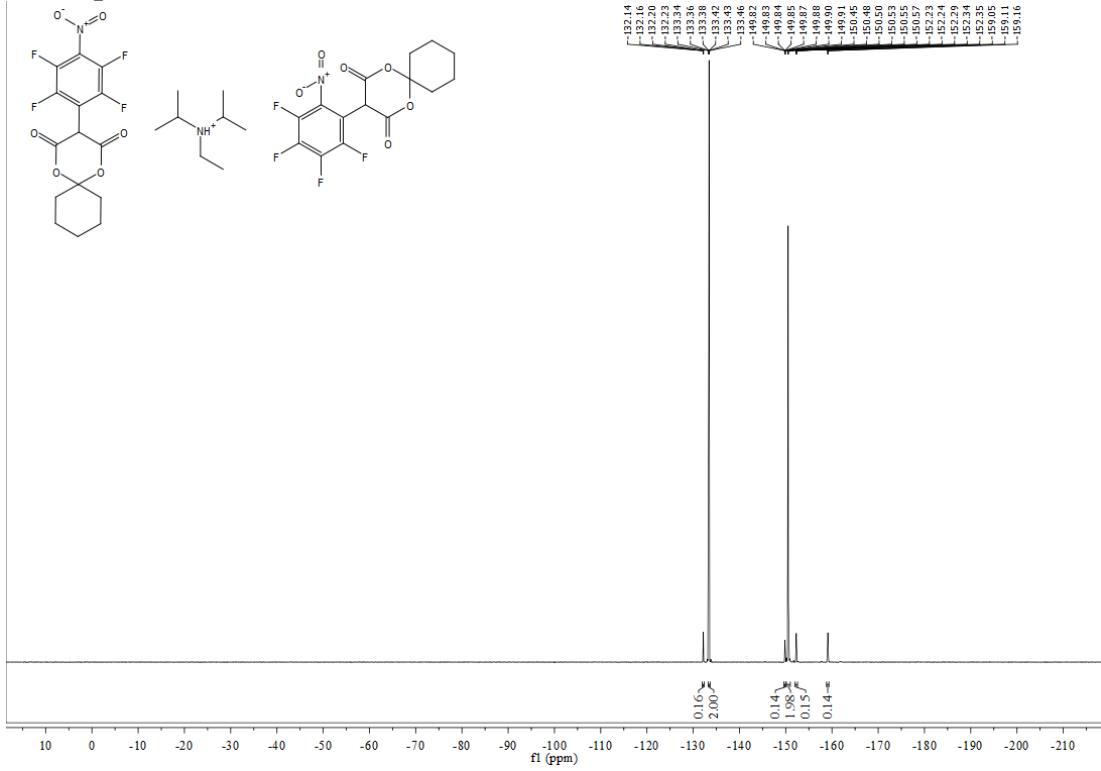


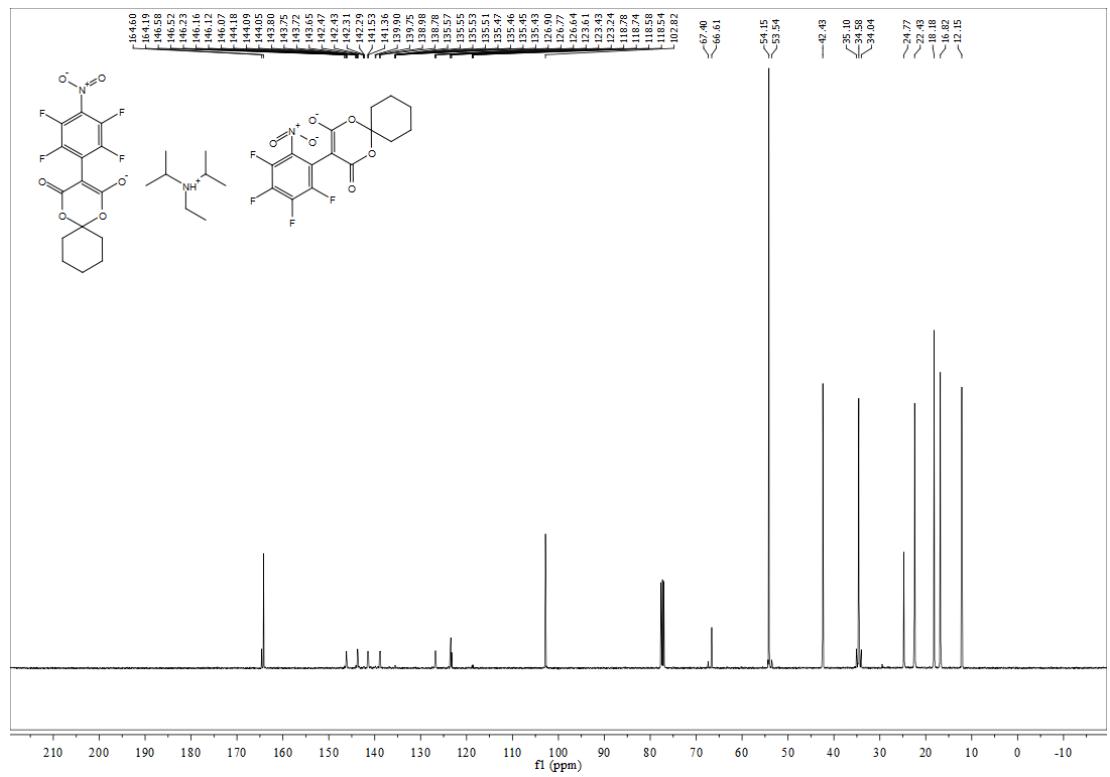
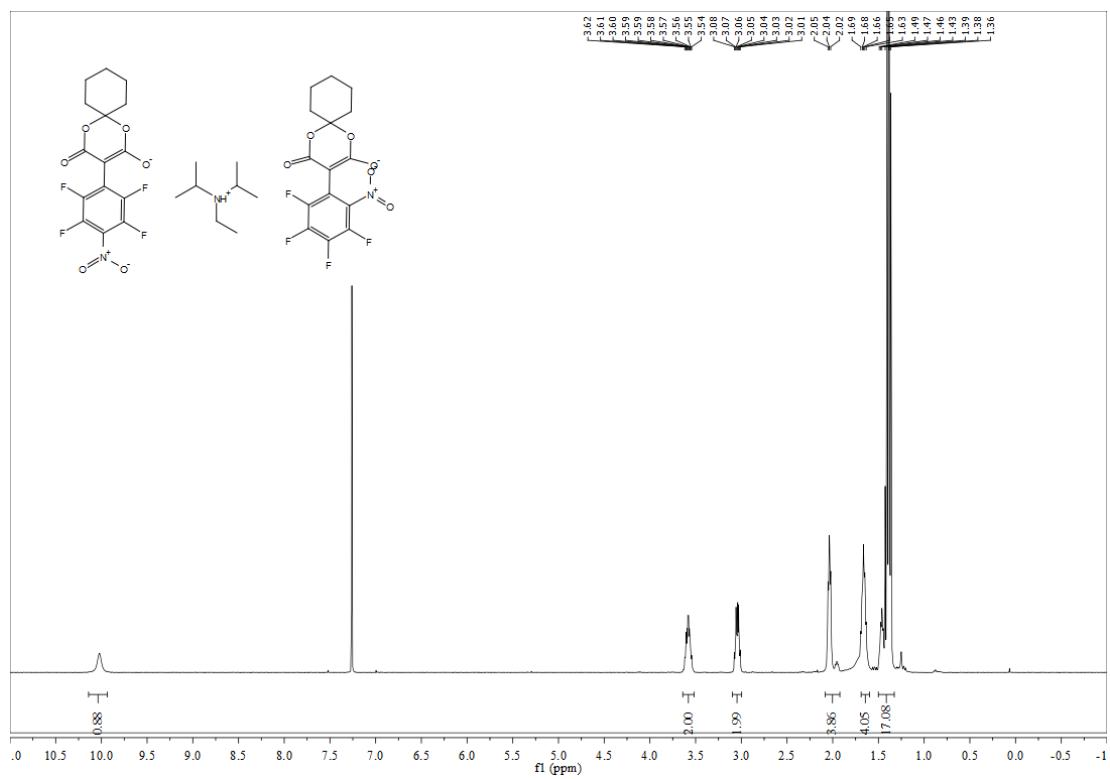
N-ethyl-N-isopropylpropan-2-aminium 4-oxo-3-(2,3,5,6-tetrafluoro-4-(trifluoromethyl)phenyl)-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2b)





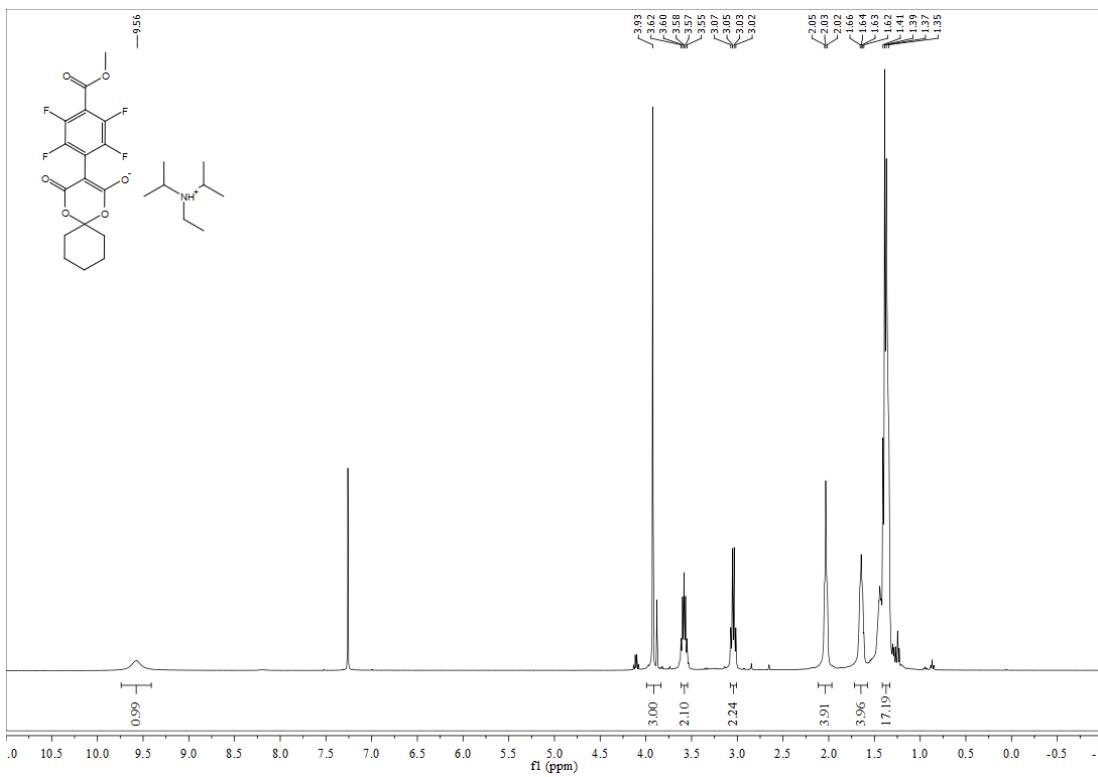
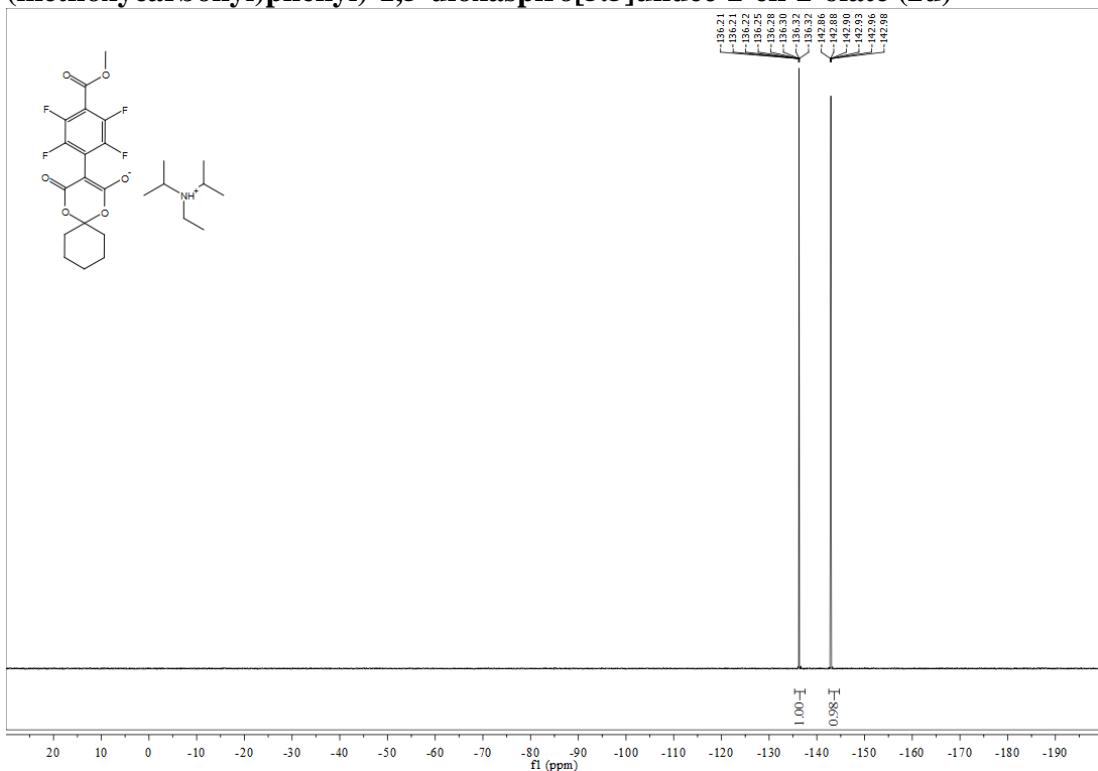
N-ethyl-N-isopropylpropan-2-aminium dioxaspiro[5.5]undec-2-en-2-olate (2c)

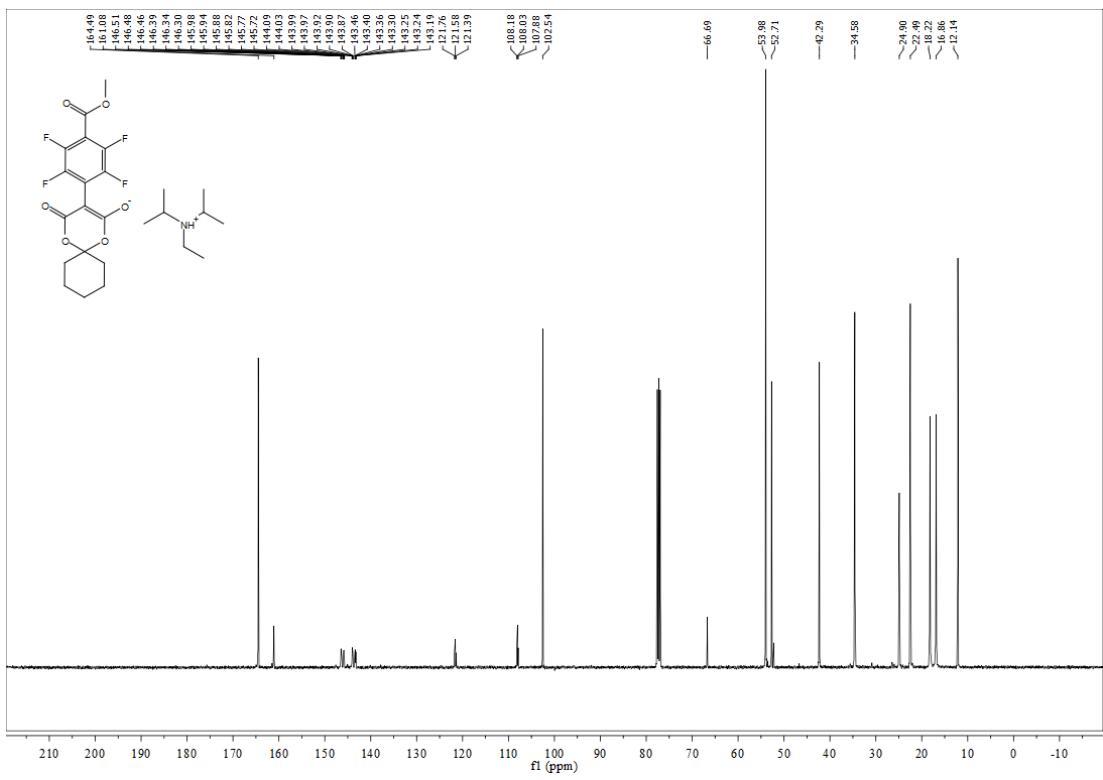




N-ethyl-*N*-isopropylpropan-2-aminium

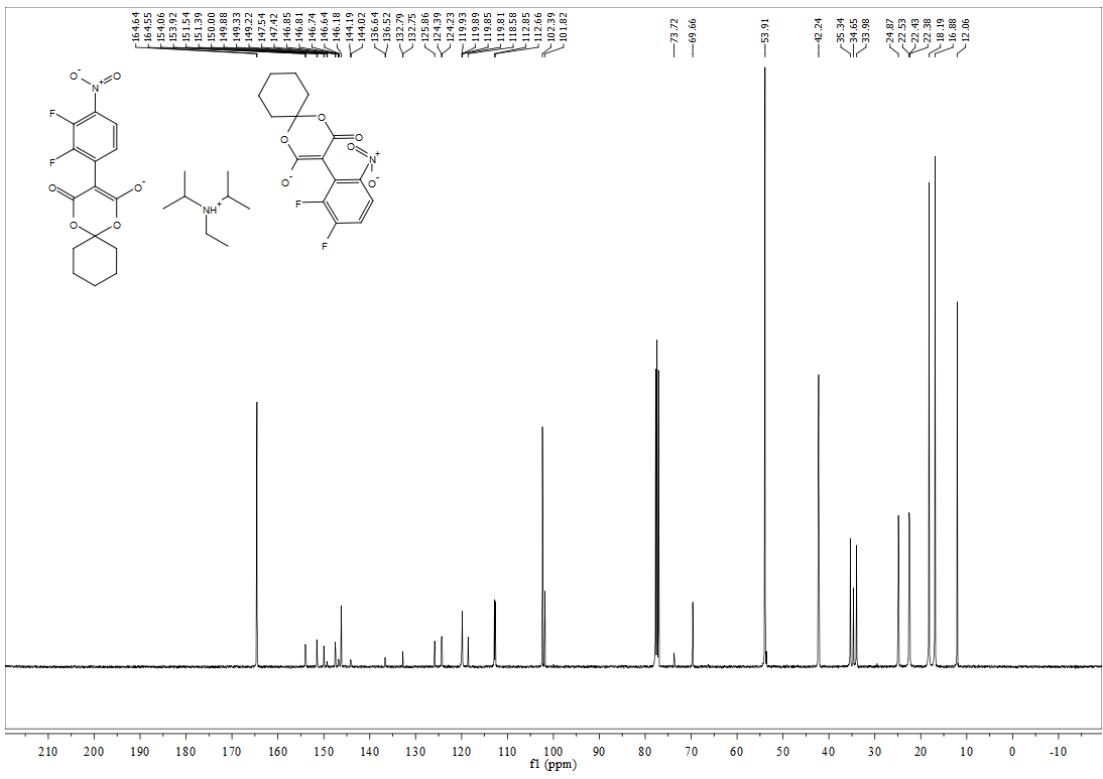
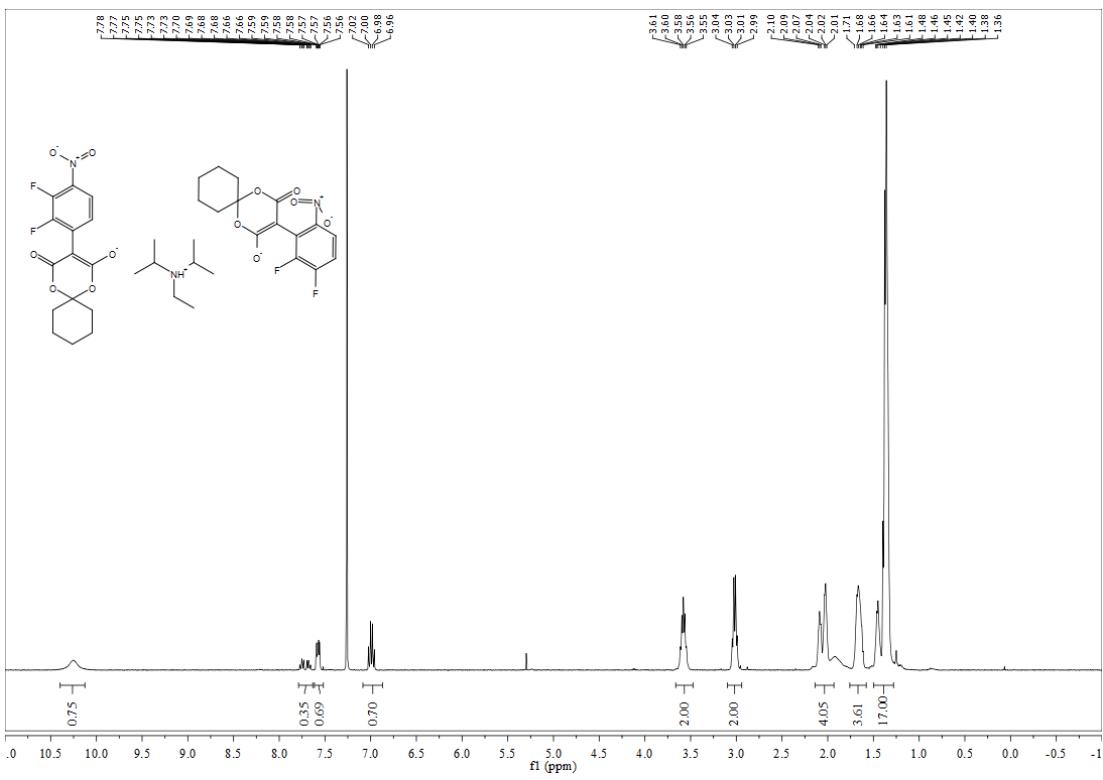
(methoxycarbonyl)phenyl)-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2d)



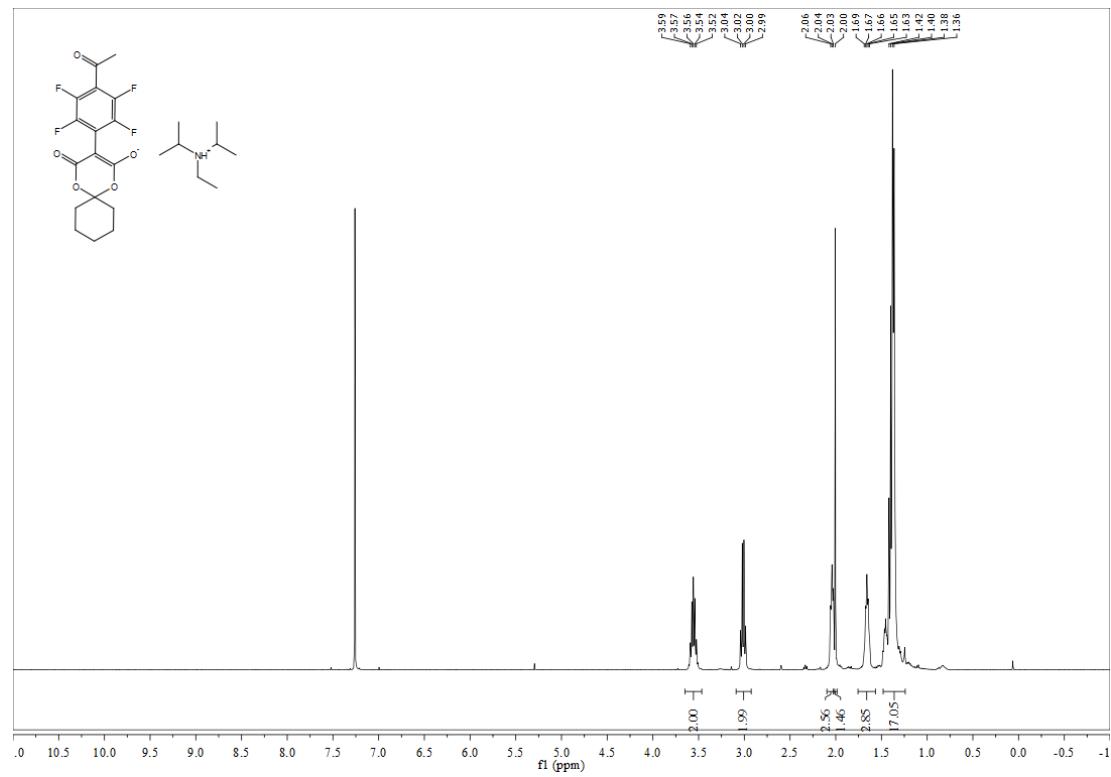
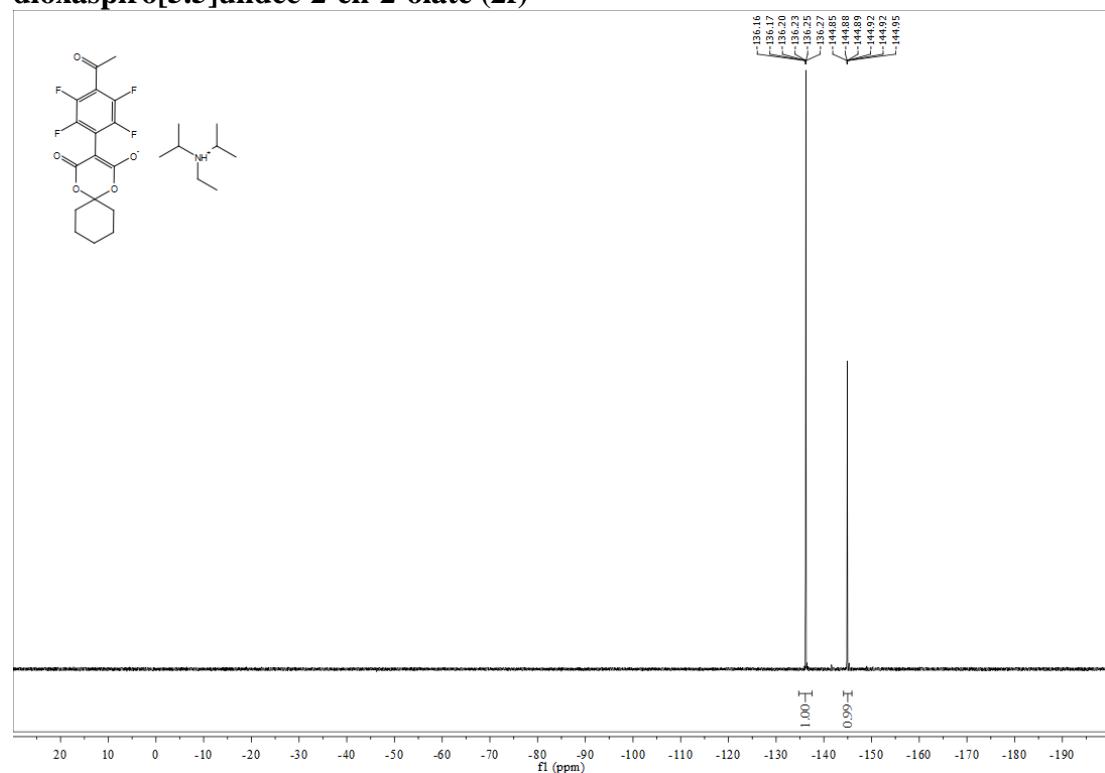


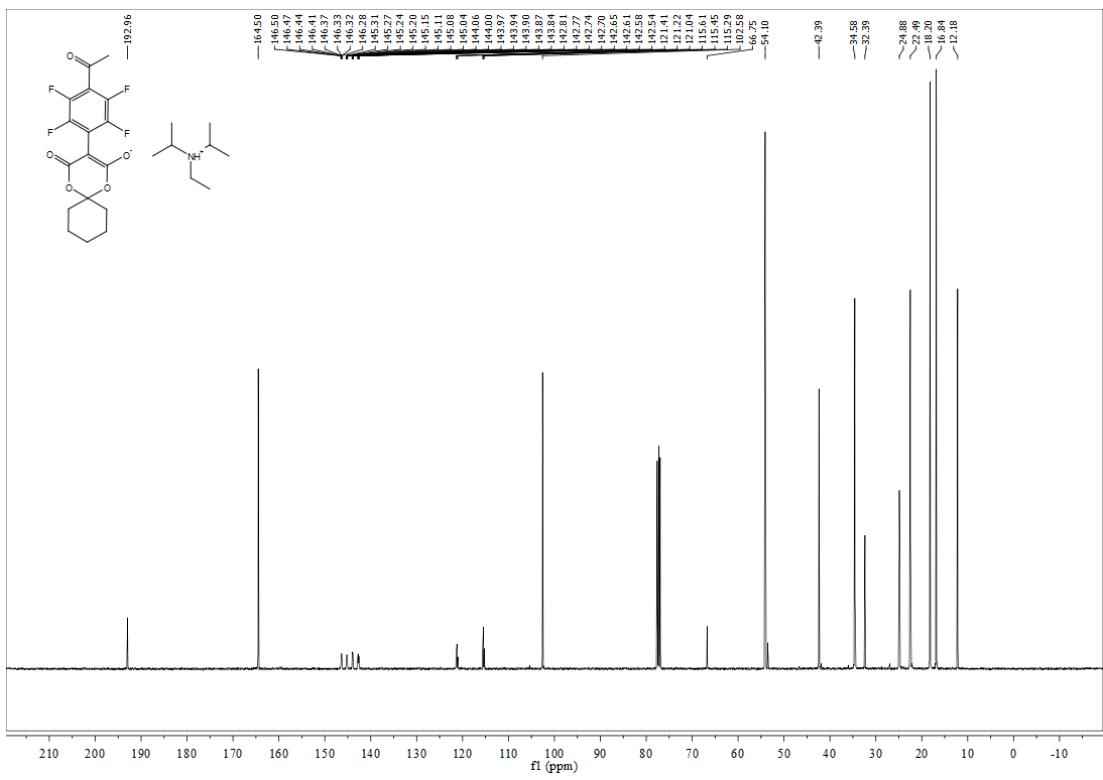
N-ethyl-N-isopropylpropan-2-aminium3-(2,3-difluoro-4-nitrophenyl)-4-oxo-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2e)





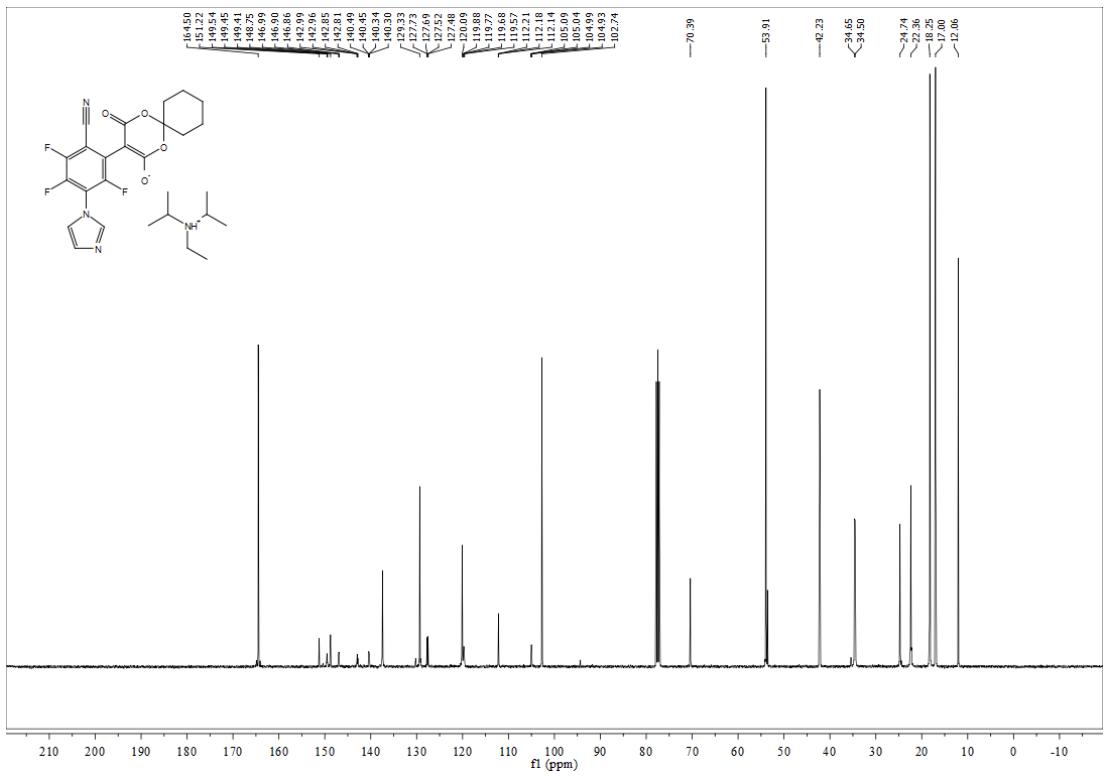
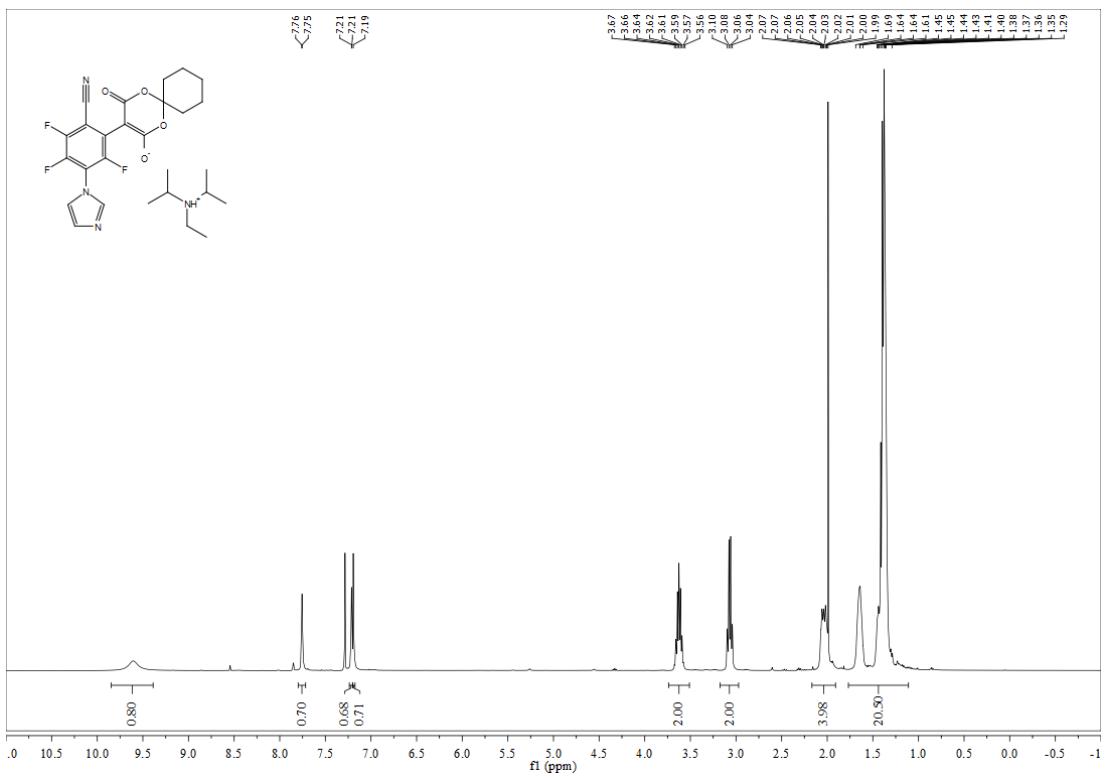
N-ethyl-*N*-isopropylpropan-2-aminium
dioxaspiro[5.5]undec-2-en-2-olate (2f)



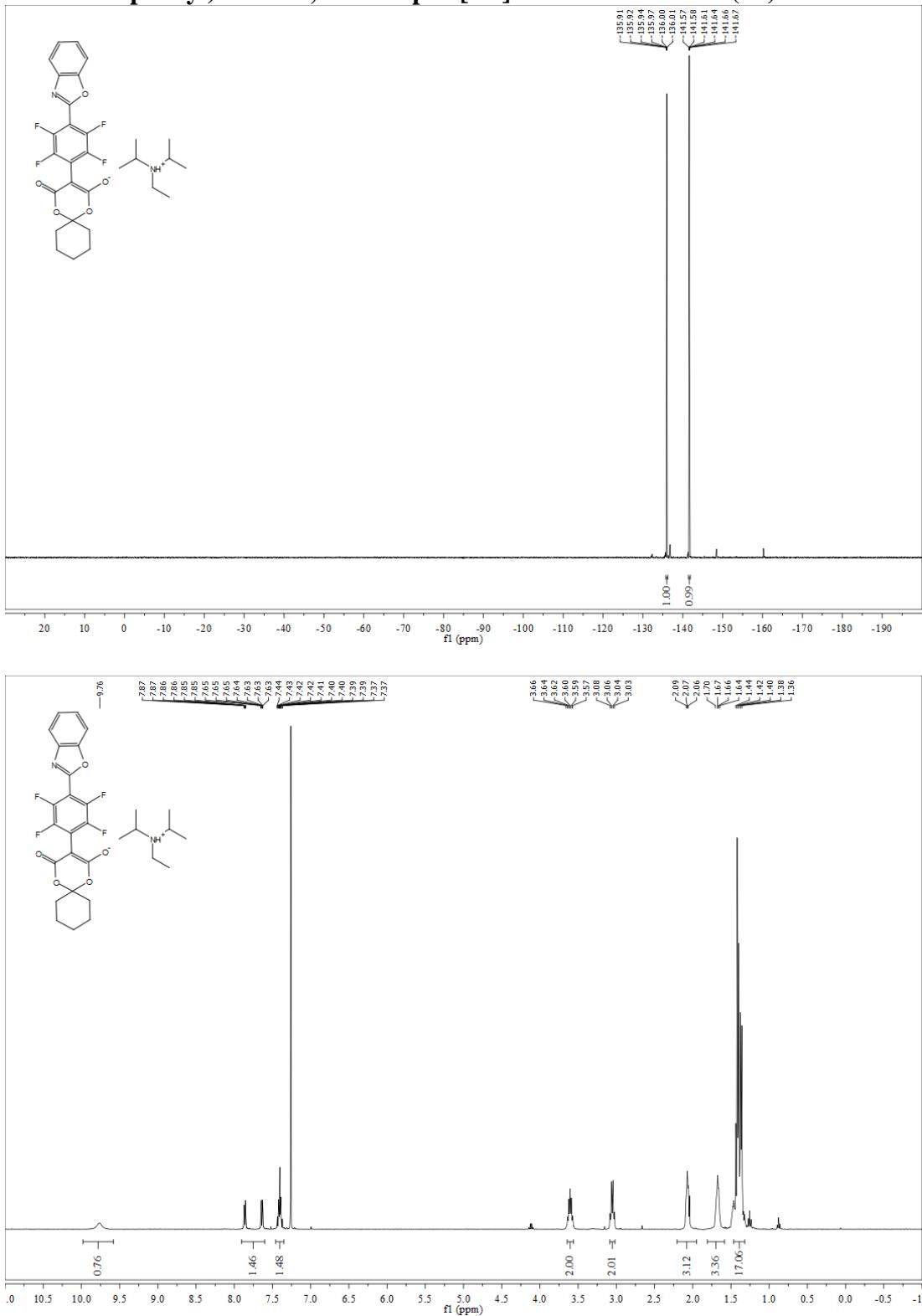


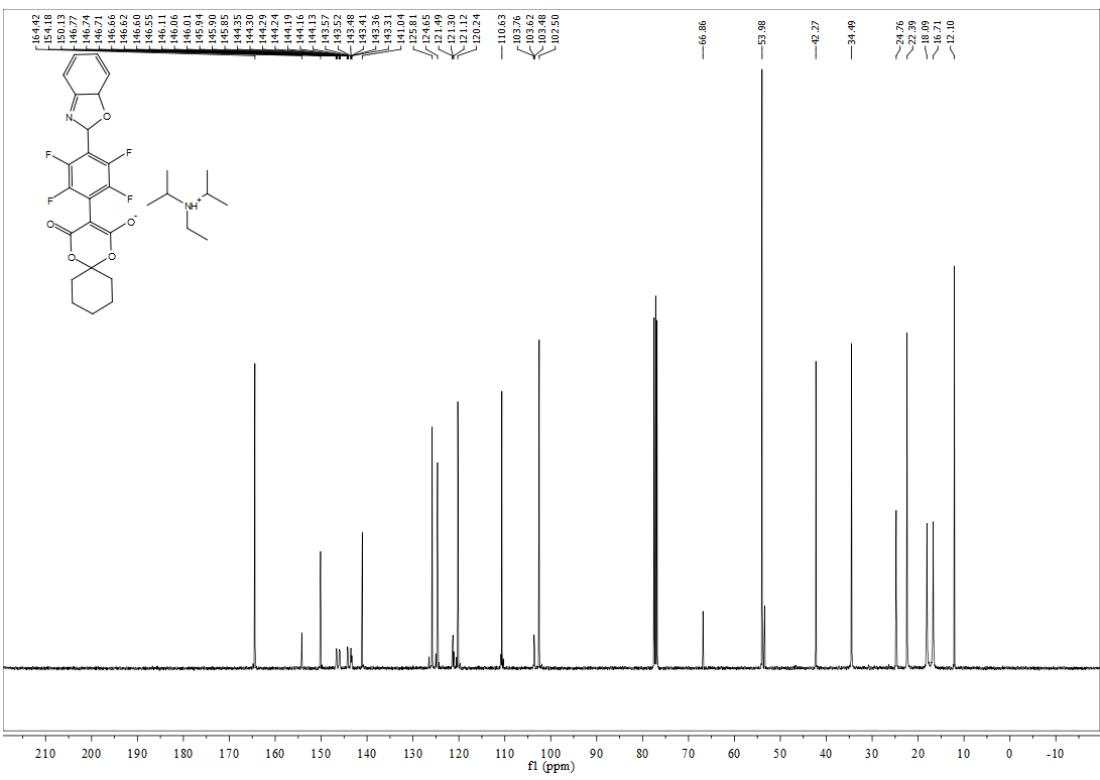
N-ethyl-*N*-isopropylpropan-2-aminium 3-(2-cyano-3,4,6-trifluoro-5-(1*H*-imidazol-1-
yl)phenyl)-4-oxo-1,5-dioxaspiro[5.5]undec-2-en-2-olate (**2g**)





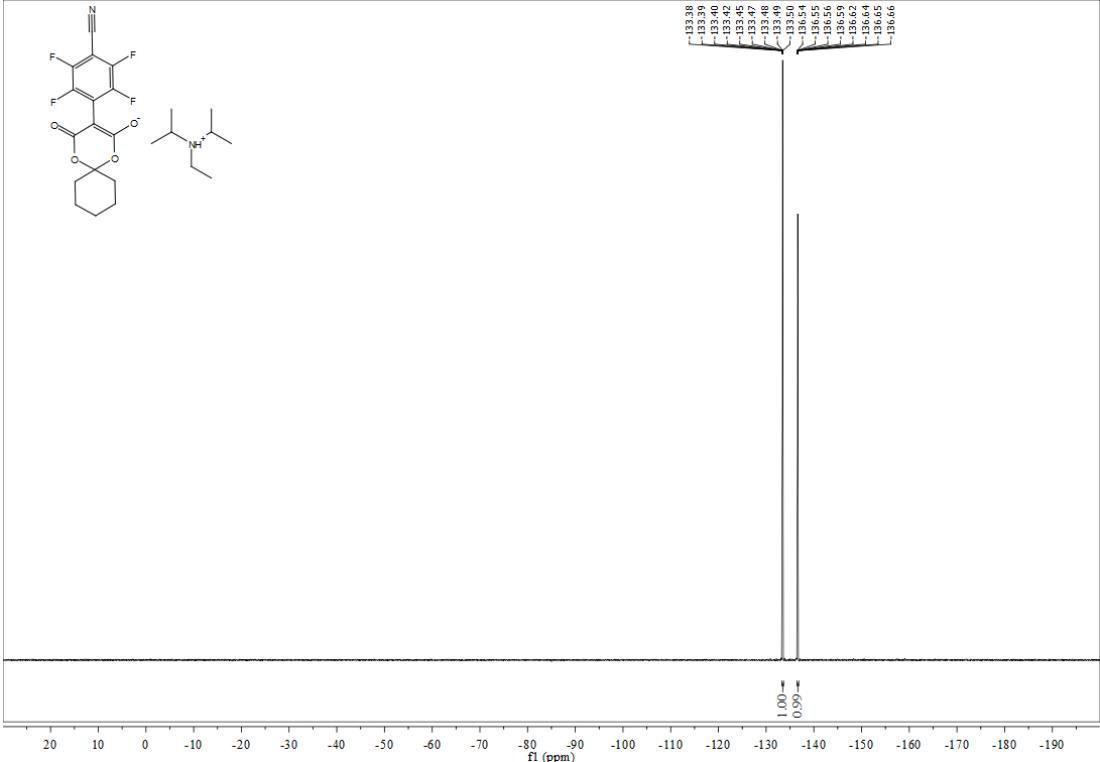
N-ethyl-*N*-isopropylpropan-2-aminium 3-(4-(2,7a-dihydrobenzo[d]oxazol-2-yl)-2,3,5,6-tetrafluorophenyl)-4-oxo-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2h)

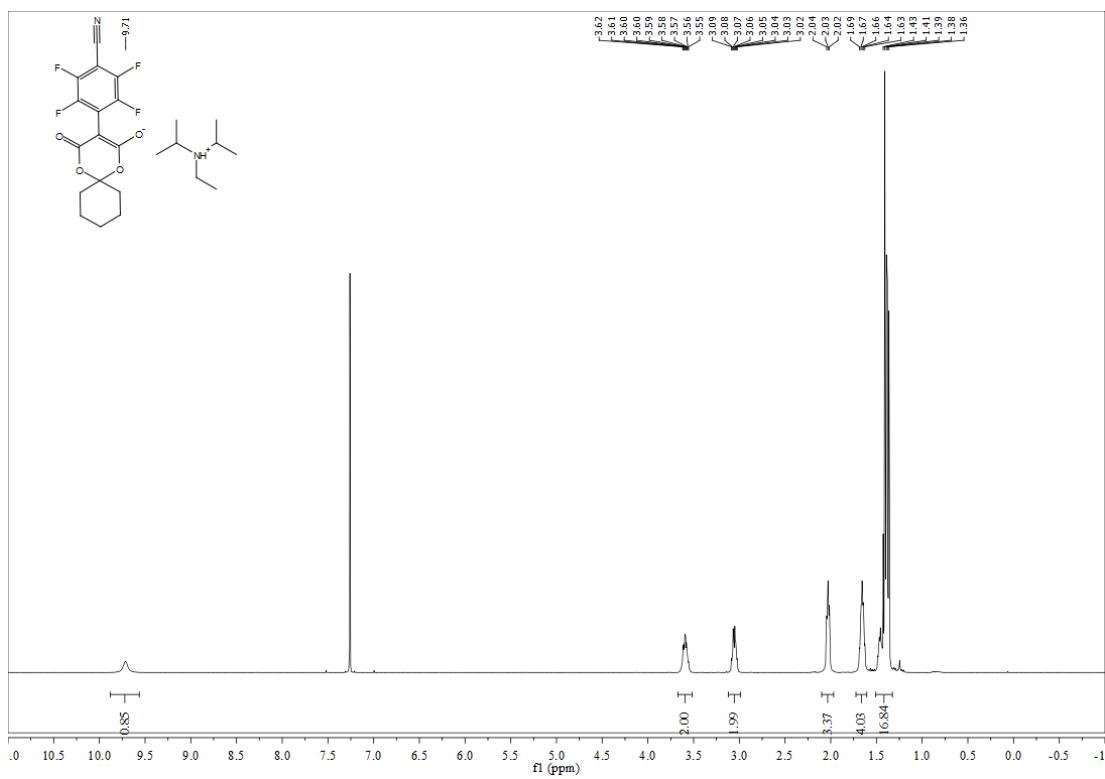




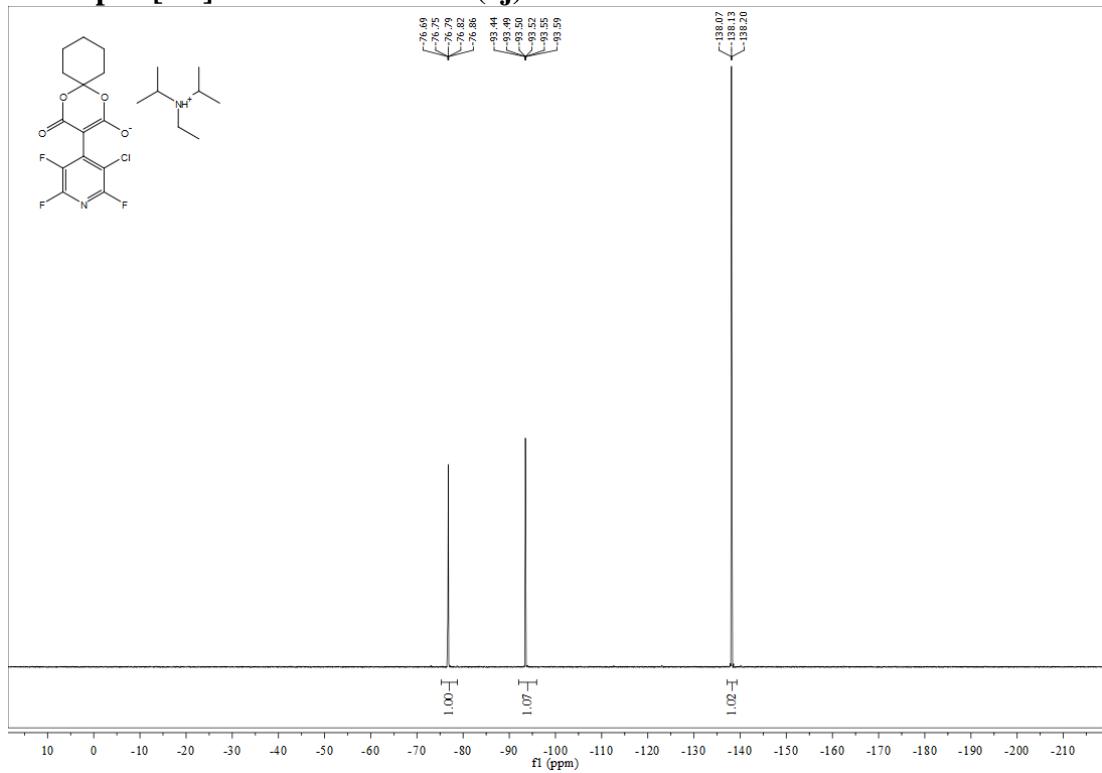
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dioxaspiro[5.5]undec-2-en-2-olate (2i)

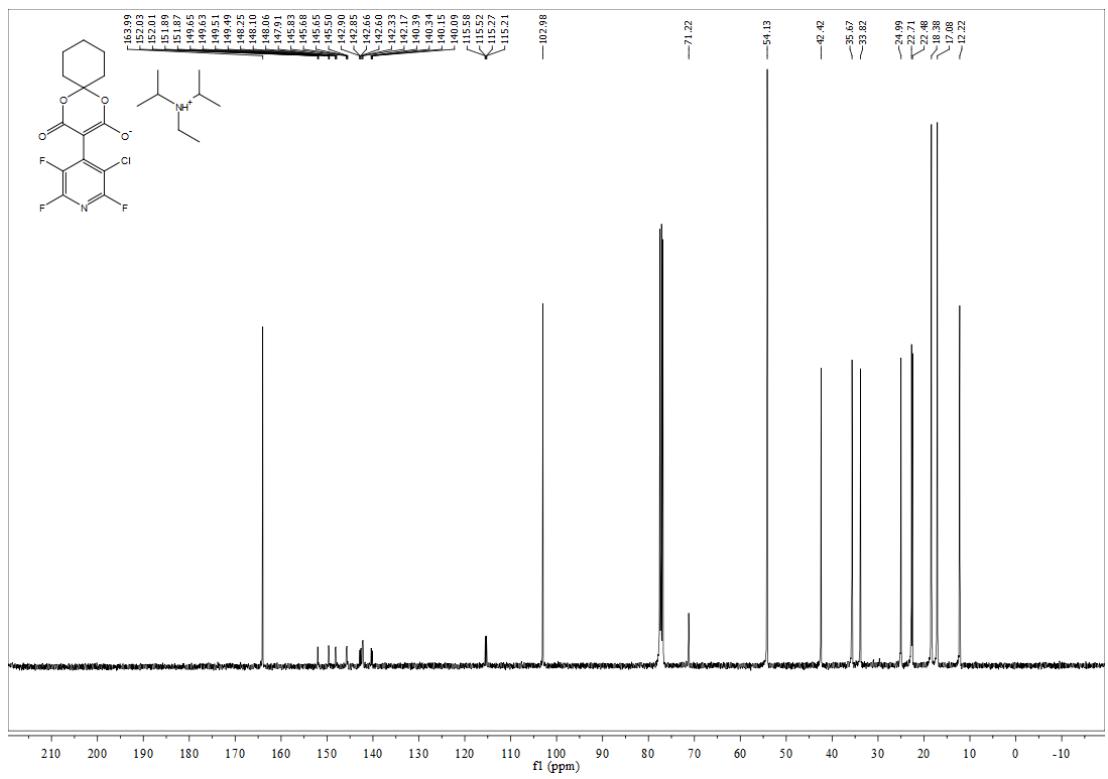
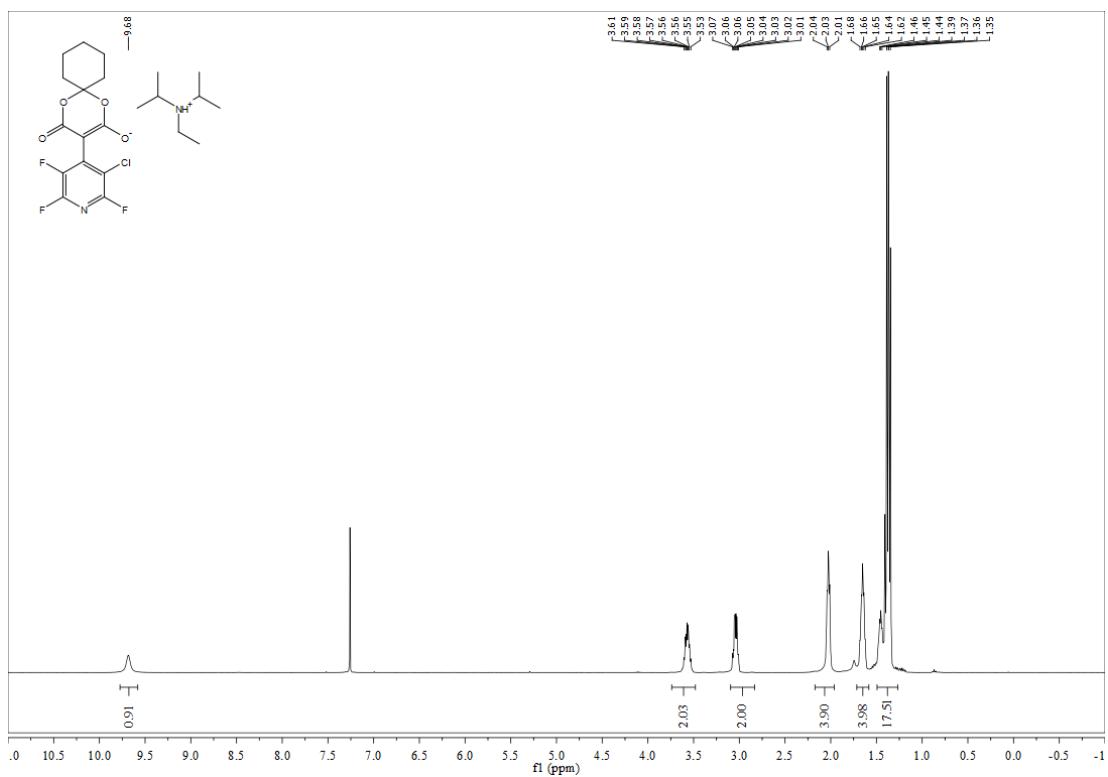
3-(4-cyano-2,3,5,6-tetrafluorophenyl)-4-oxo-1,5-



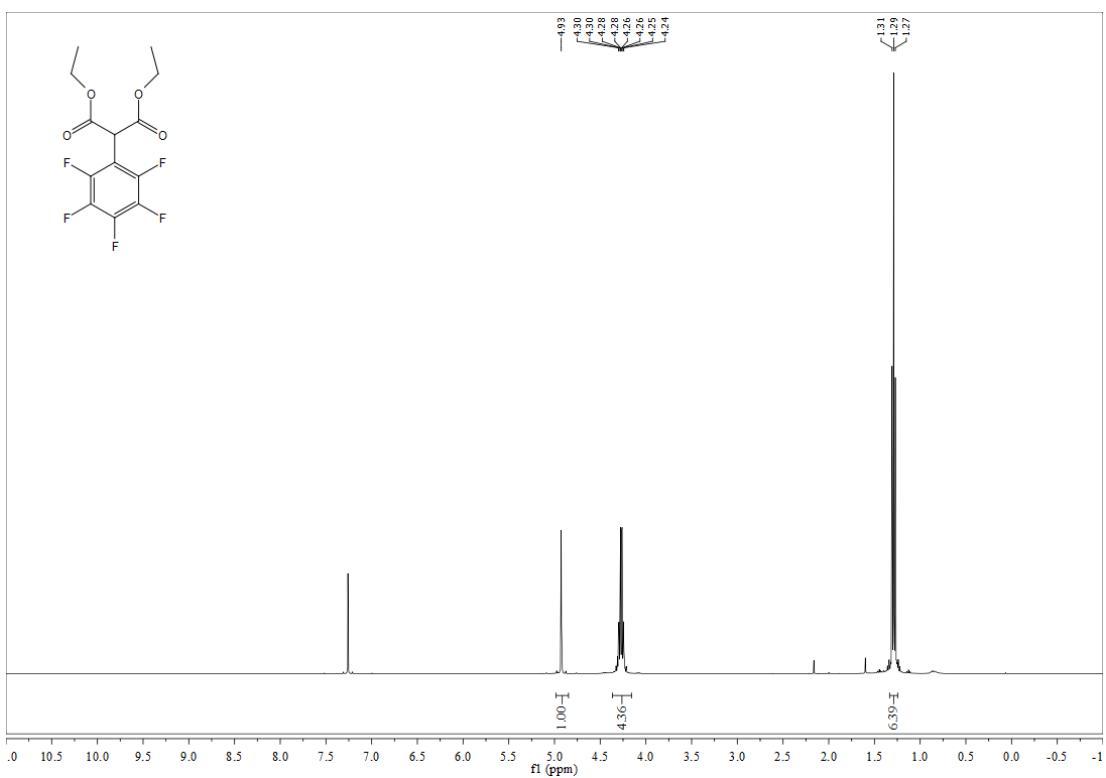
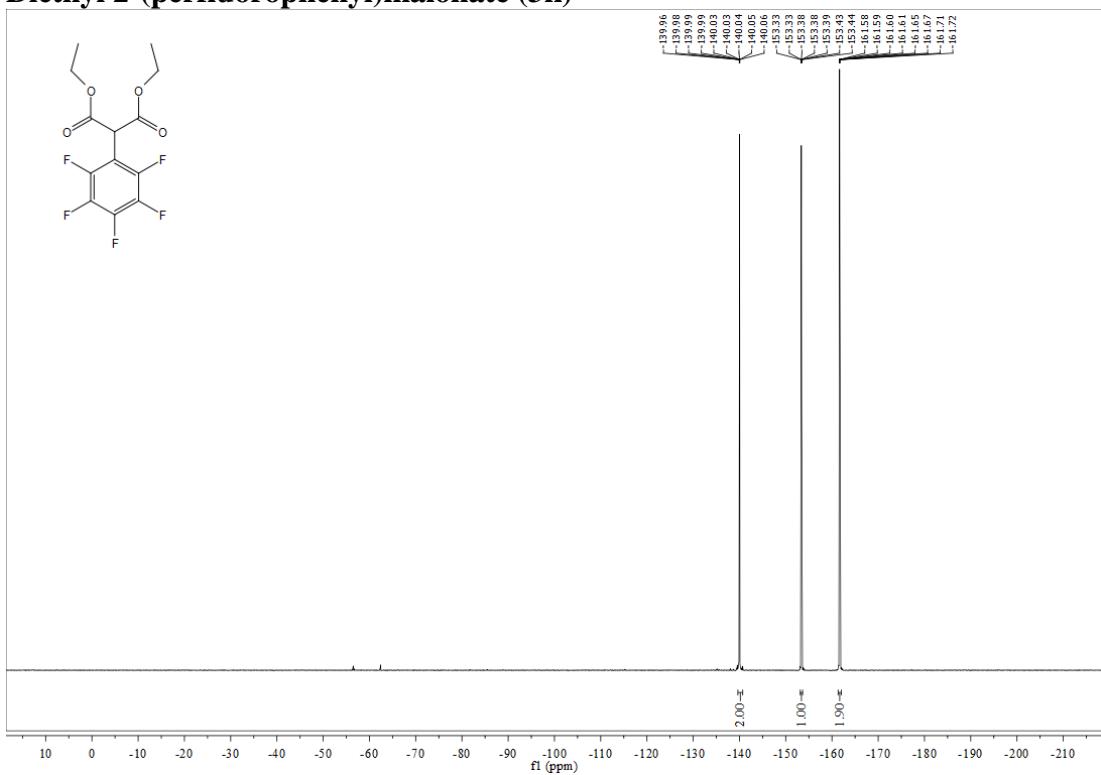


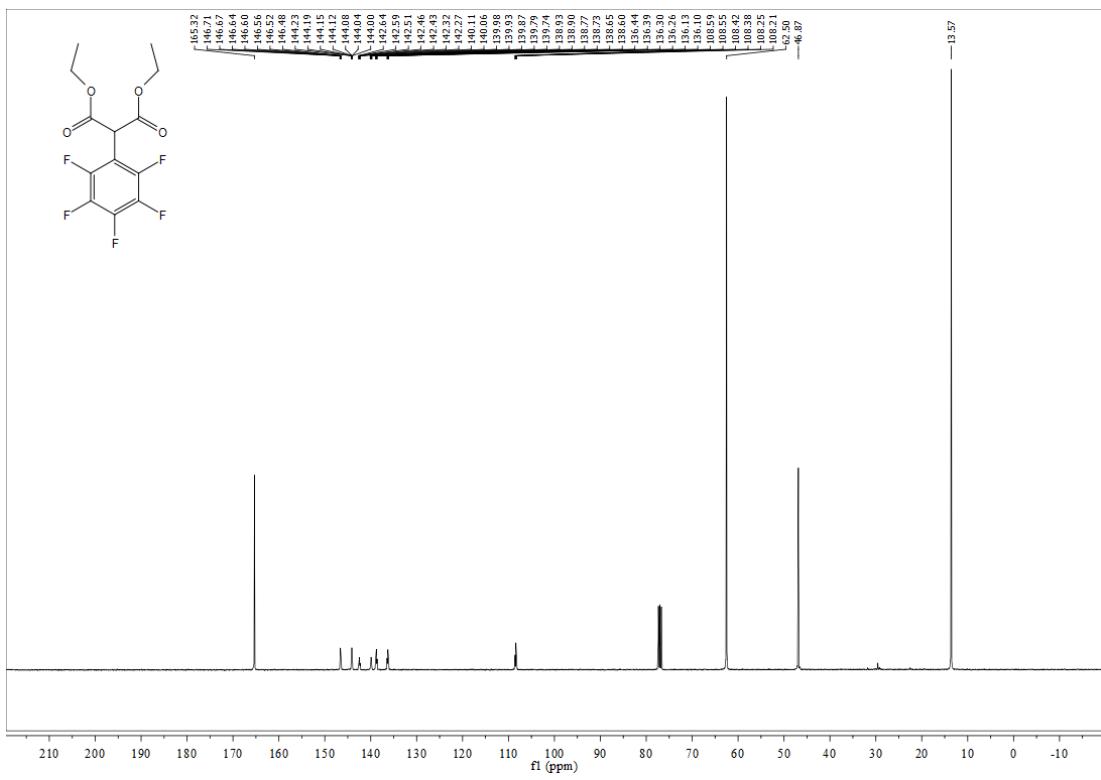
N-ethyl-*N*-isopropylpropan-2-aminium 3-(3-chloro-2,5,6-trifluoropyridin-4-yl)-4-oxo-1,5-dioxaspiro[5.5]undec-2-en-2-olate (2j)



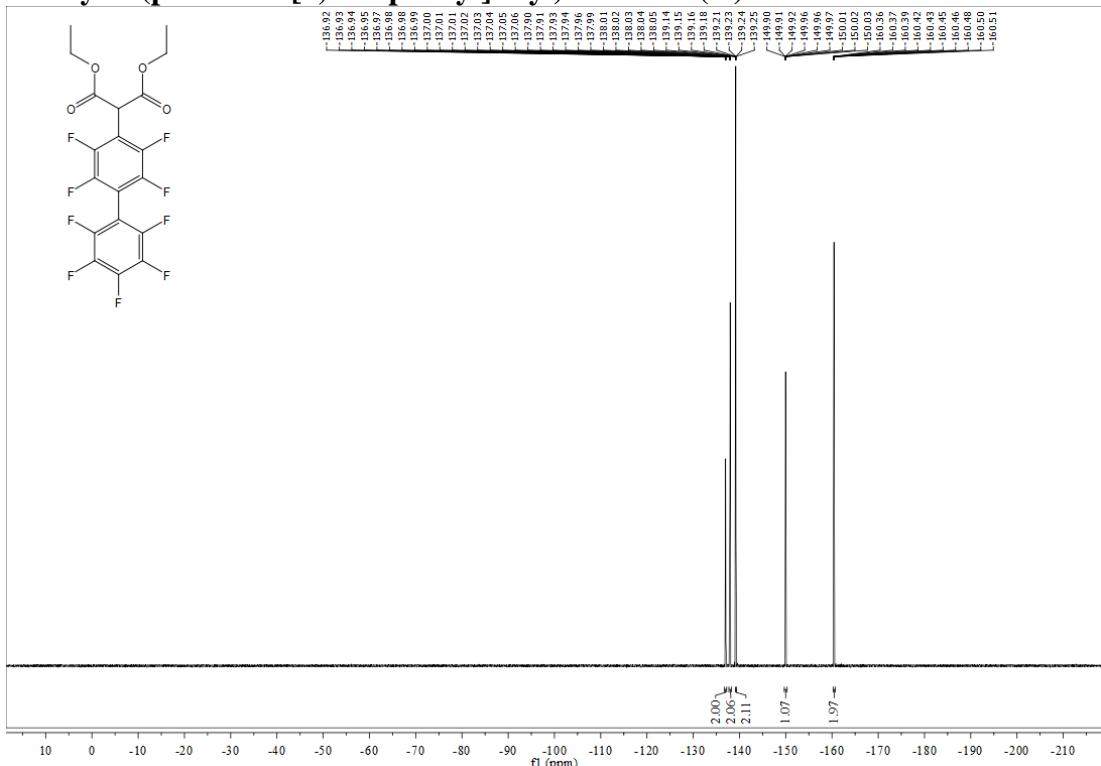


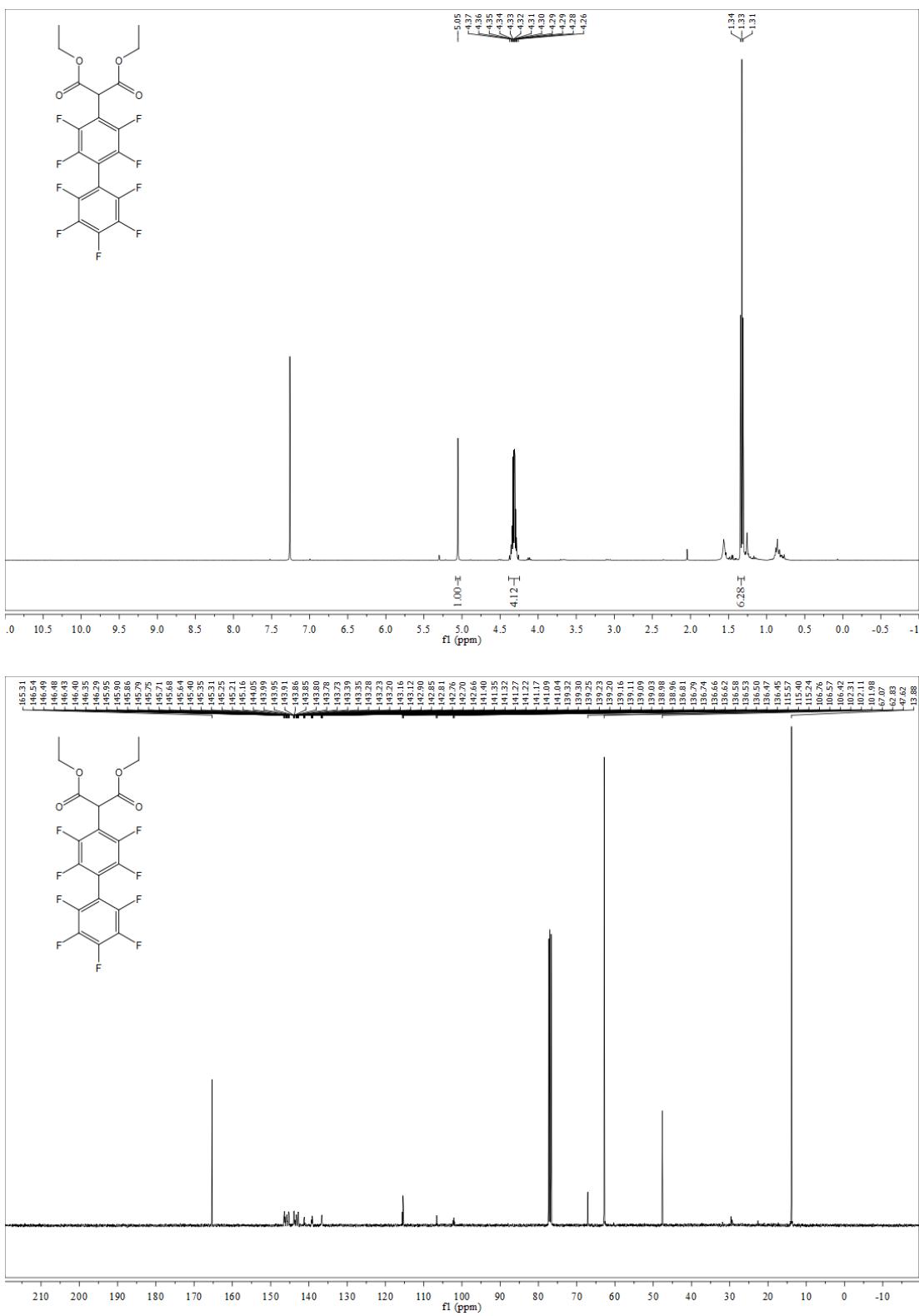
Diethyl 2-(perfluorophenyl)malonate (3k)



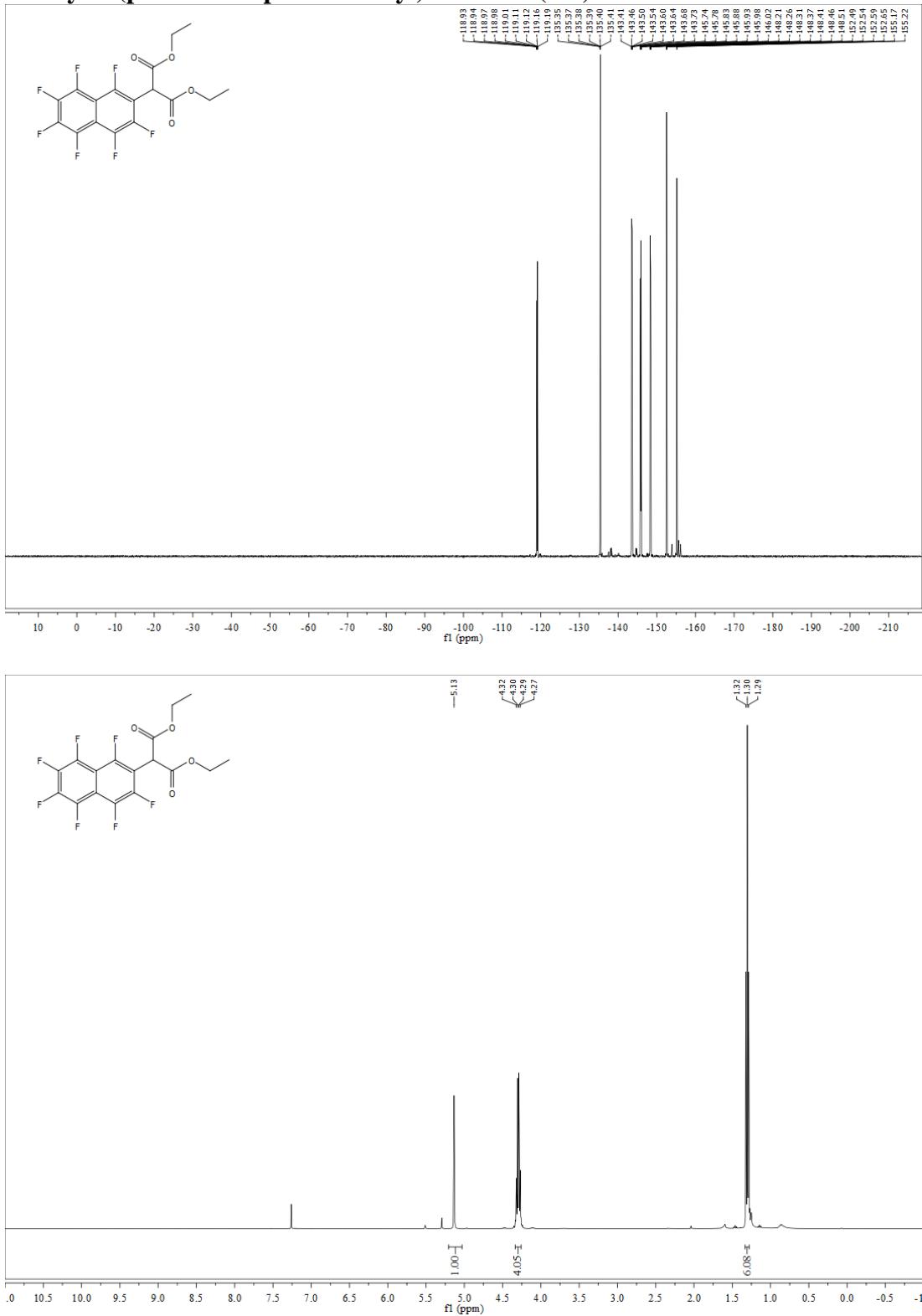


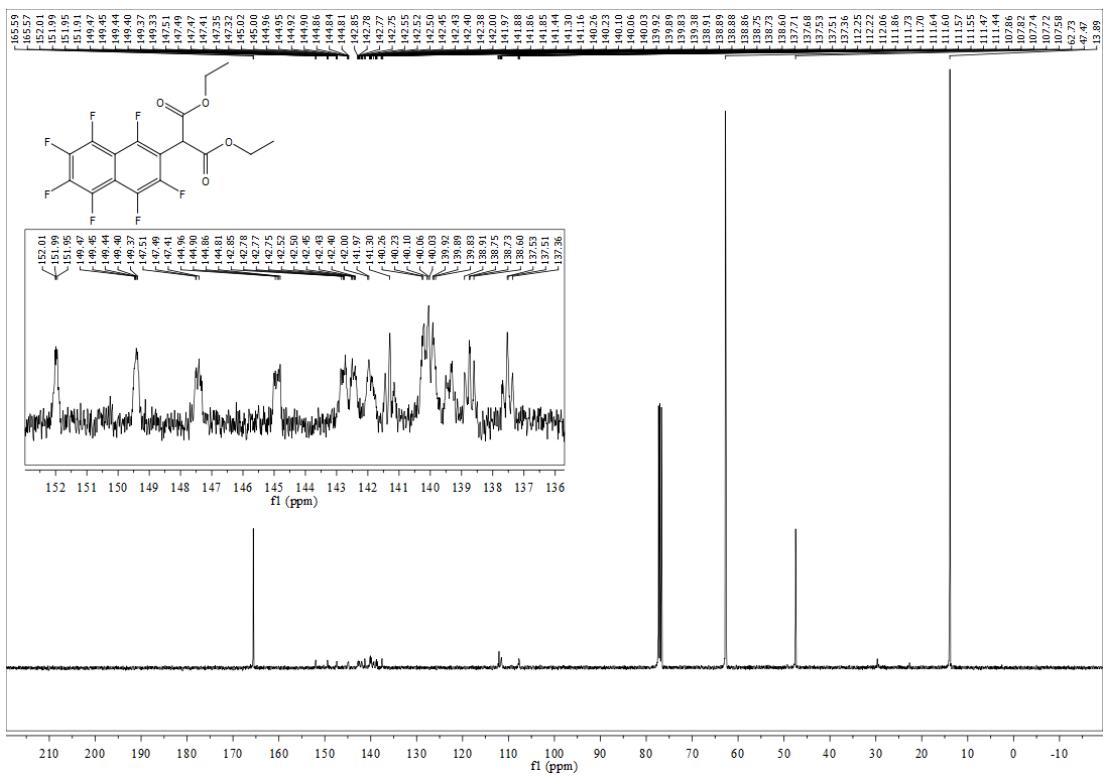
Diethyl 2-(perfluoro-[1,1'-biphenyl]-4-yl)malonate (3l)



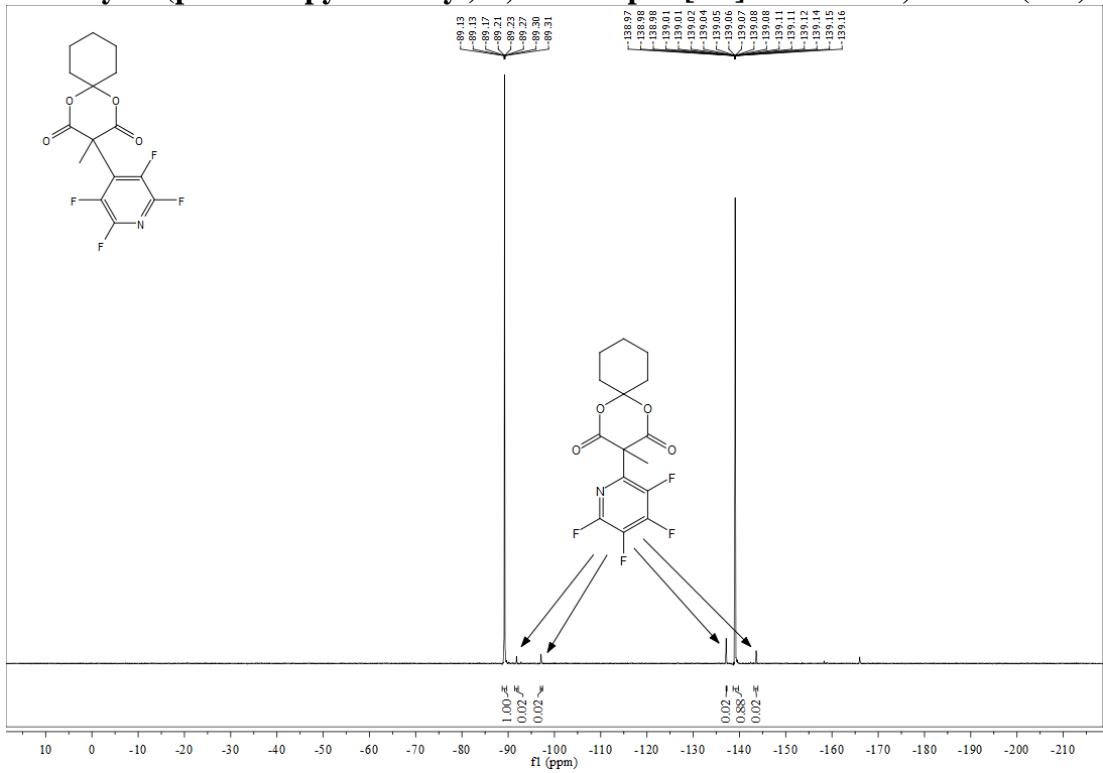


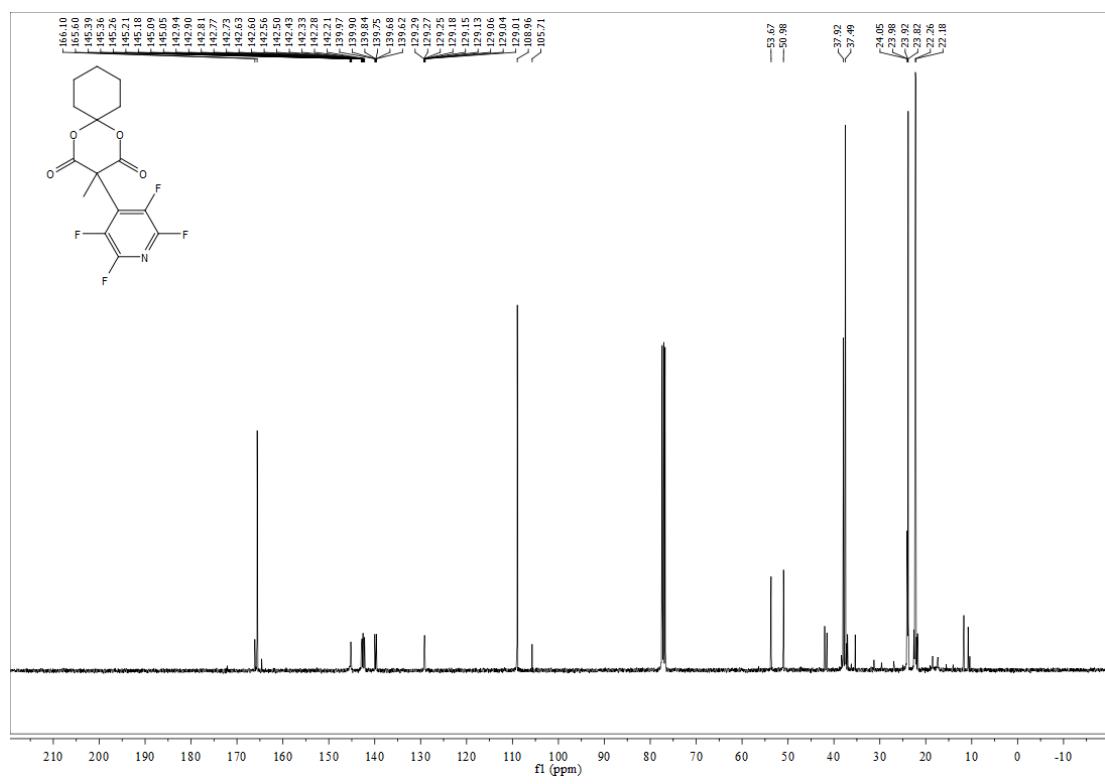
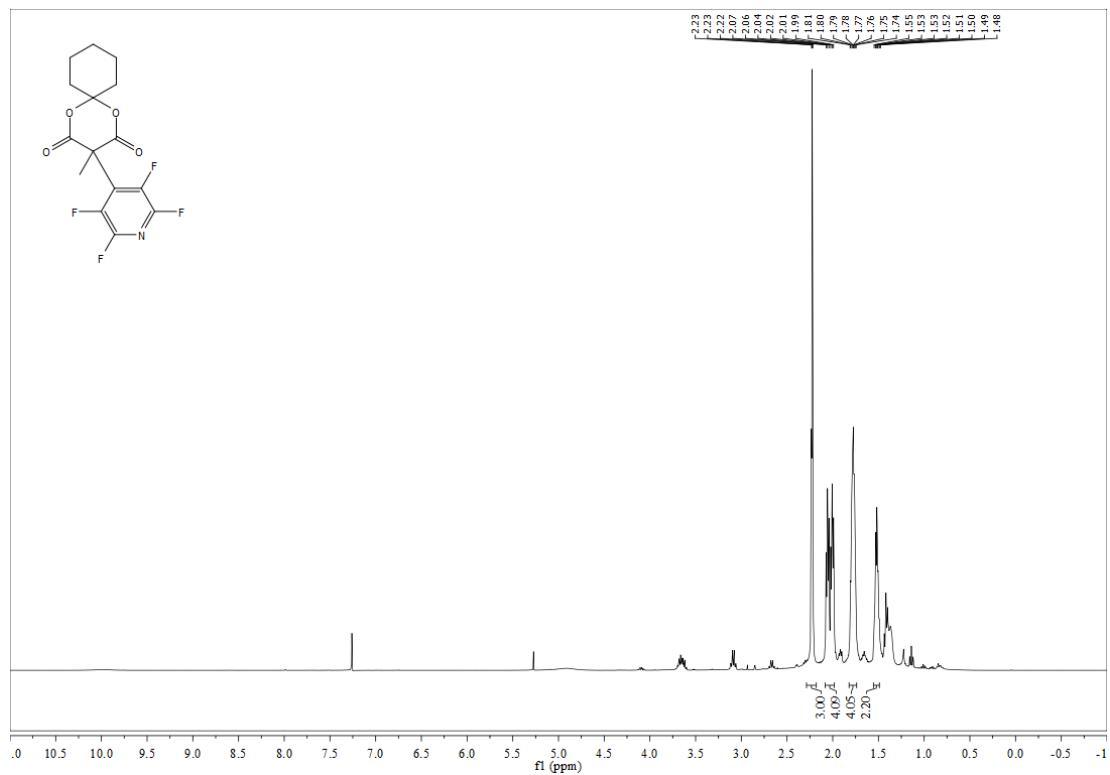
Diethyl 2-(perfluoronaphthalen-2-yl)malonate (3m)



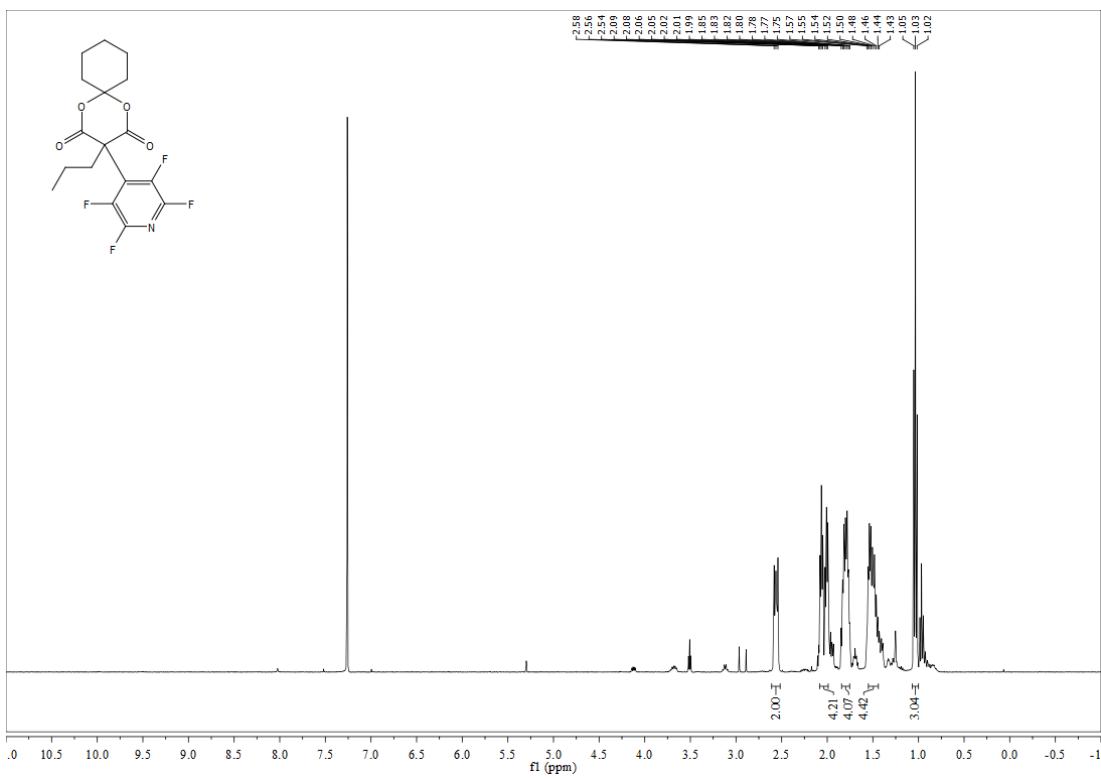
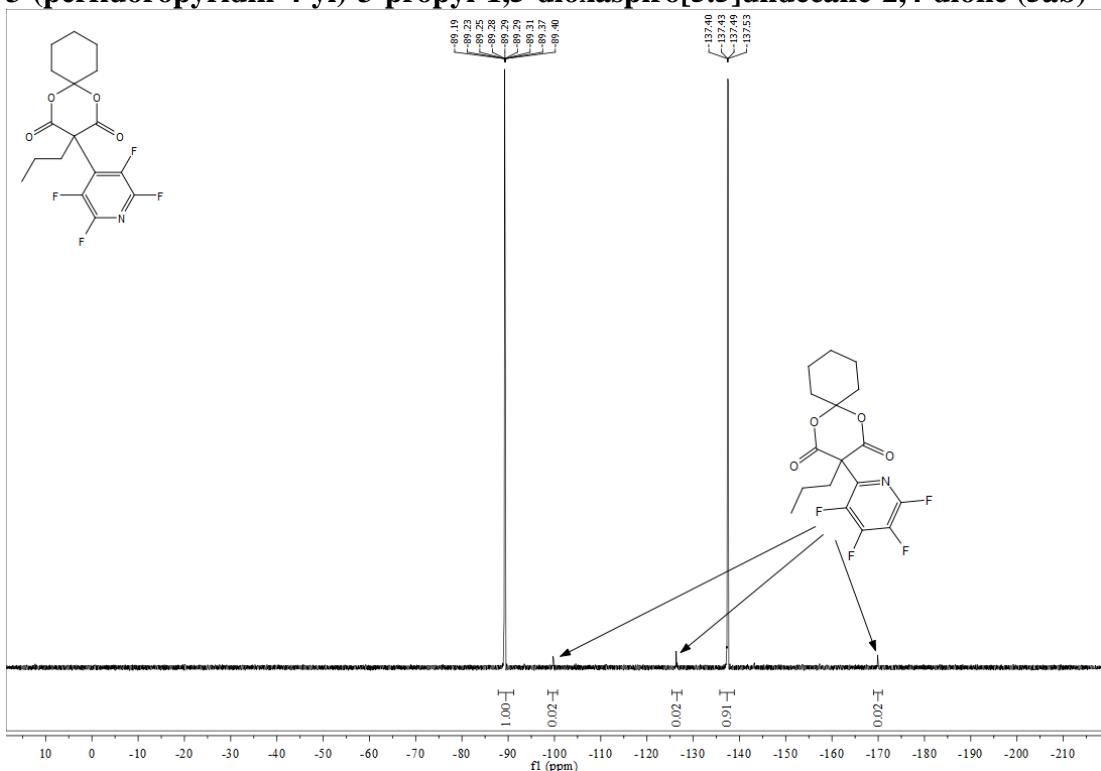


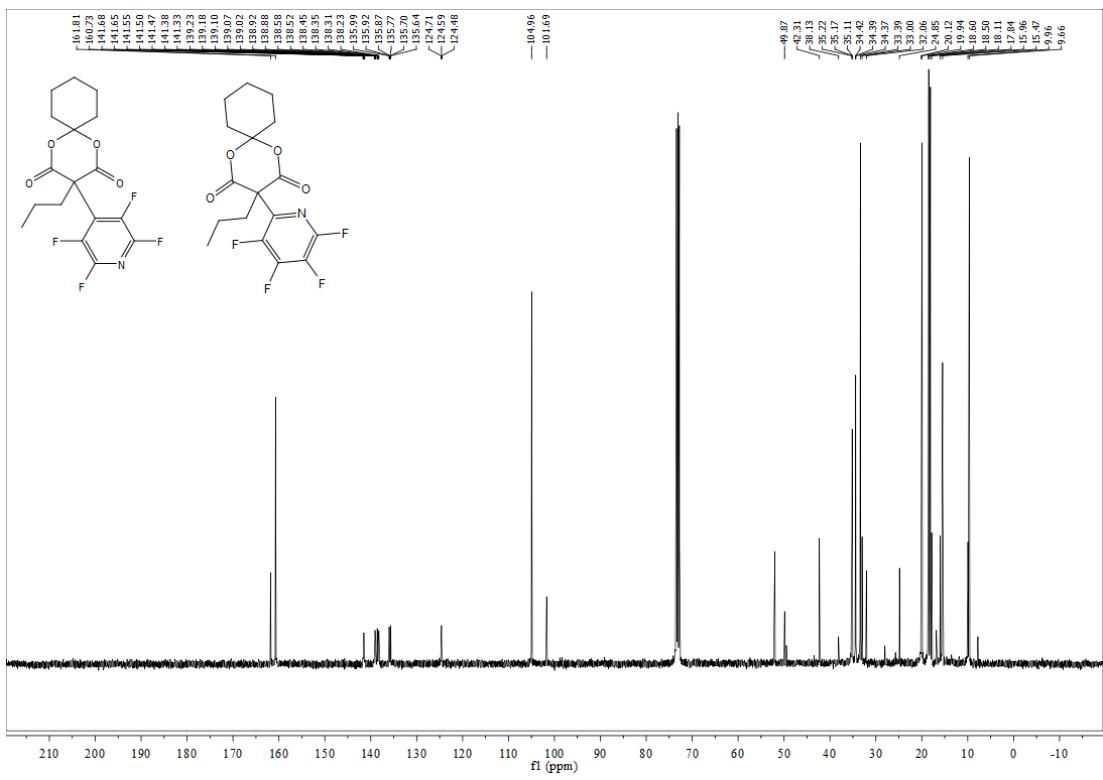
3-methyl-3-(perfluoropyridin-4-yl)-1,5-dioxaspiro[5.5]undecane-2,4-dione (5aa)



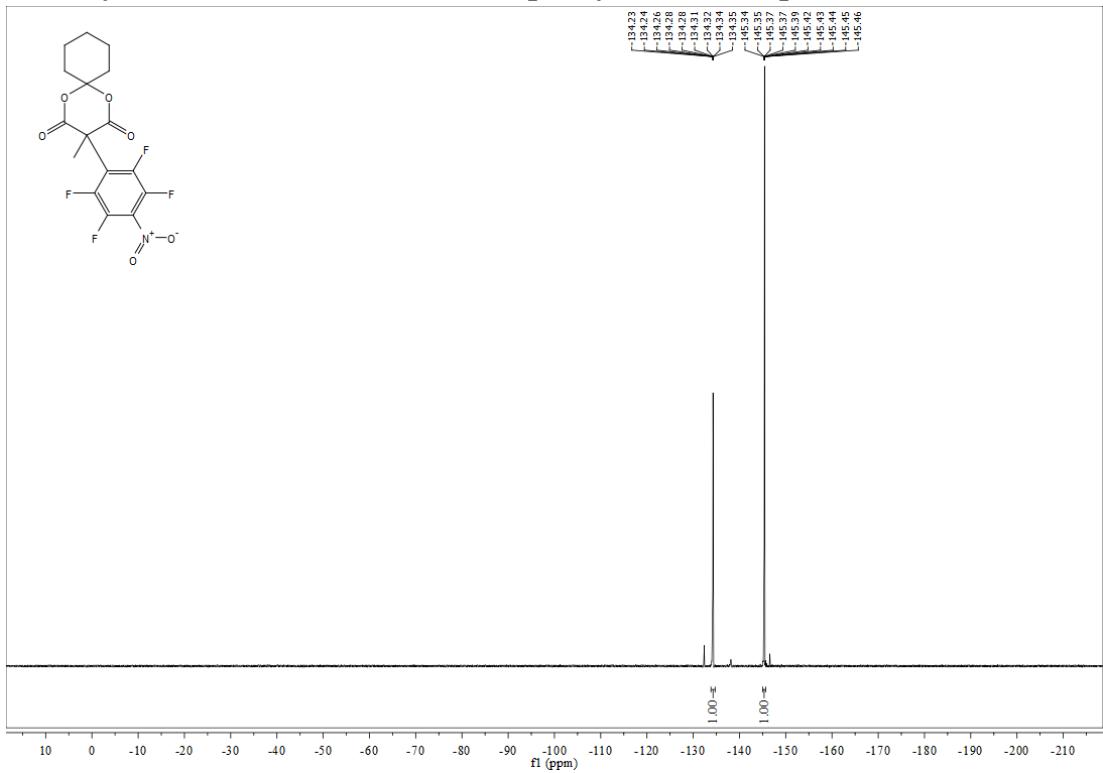


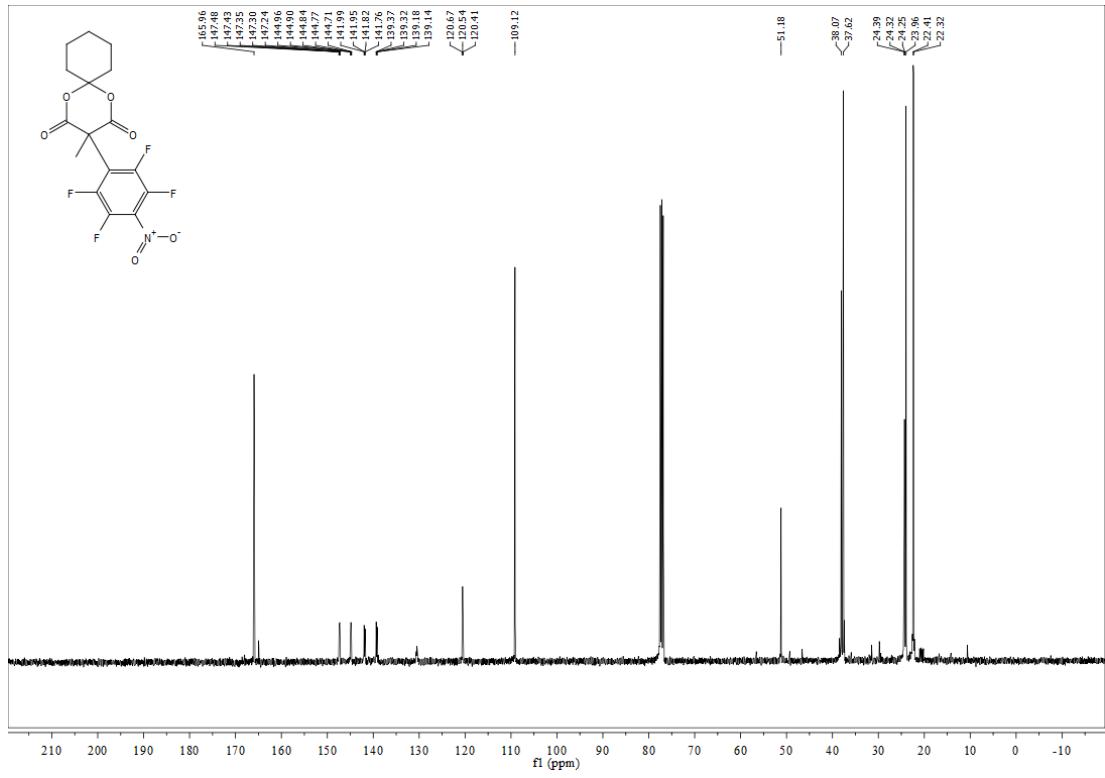
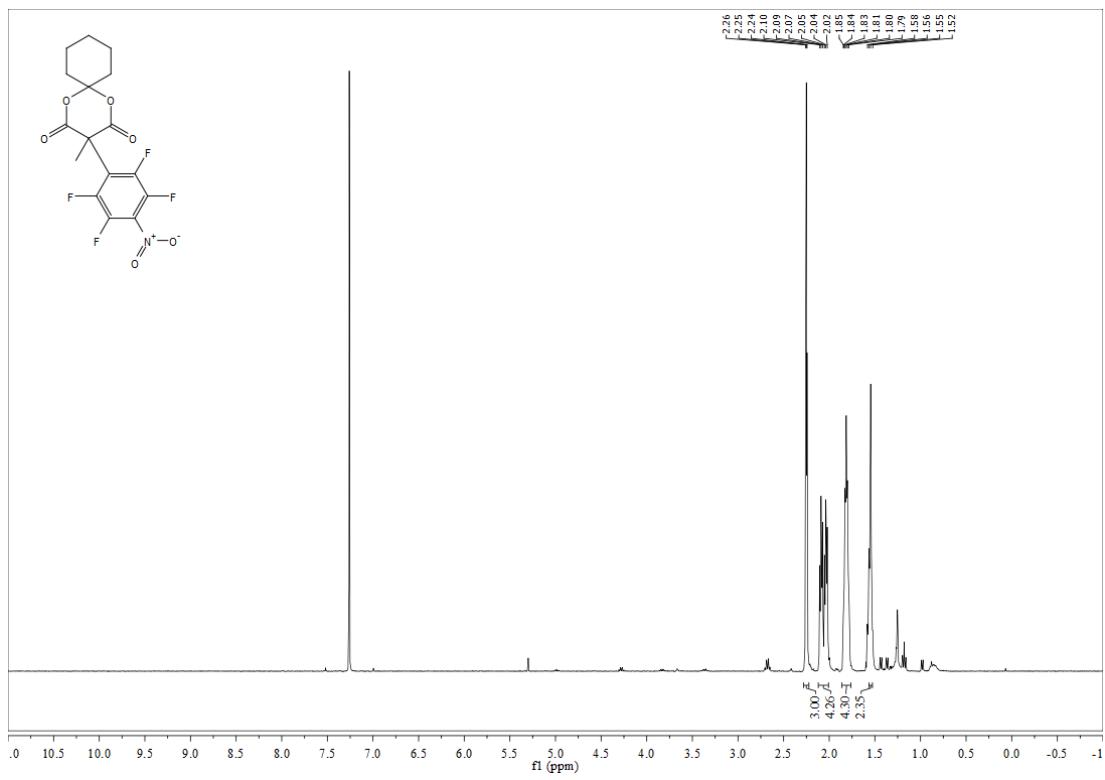
3-(perfluoropyridin-4-yl)-3-propyl-1,5-dioxaspiro[5.5]undecane-2,4-dione (5ab)



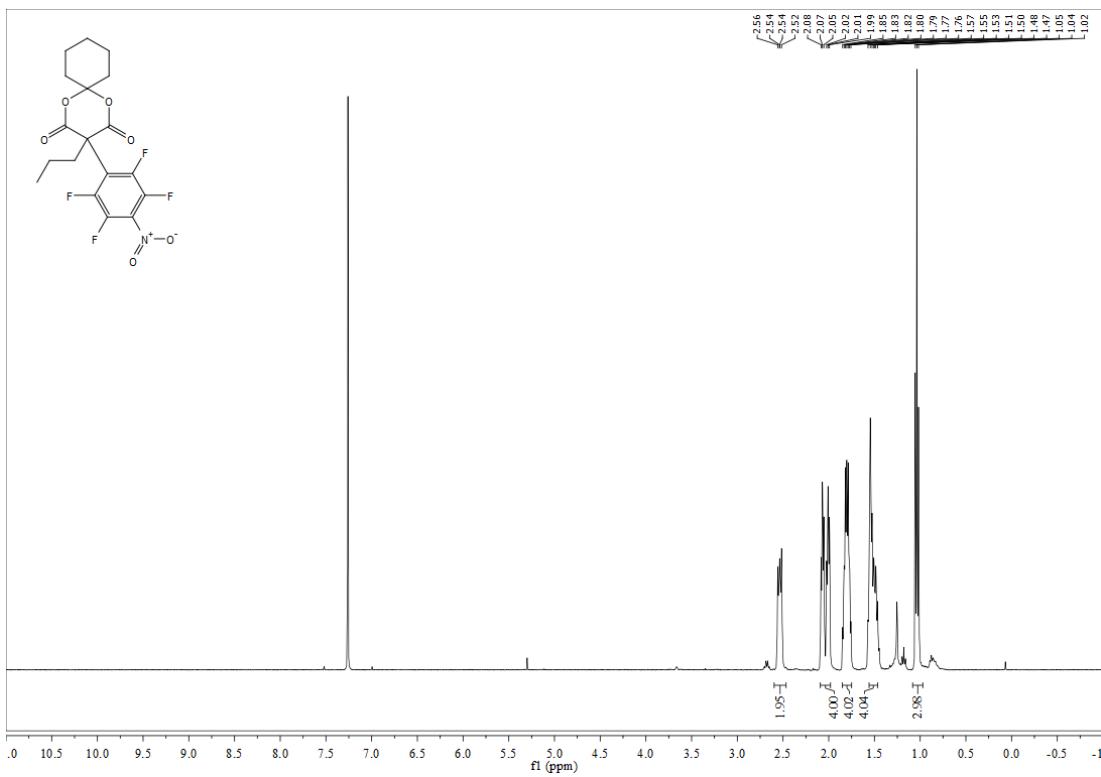
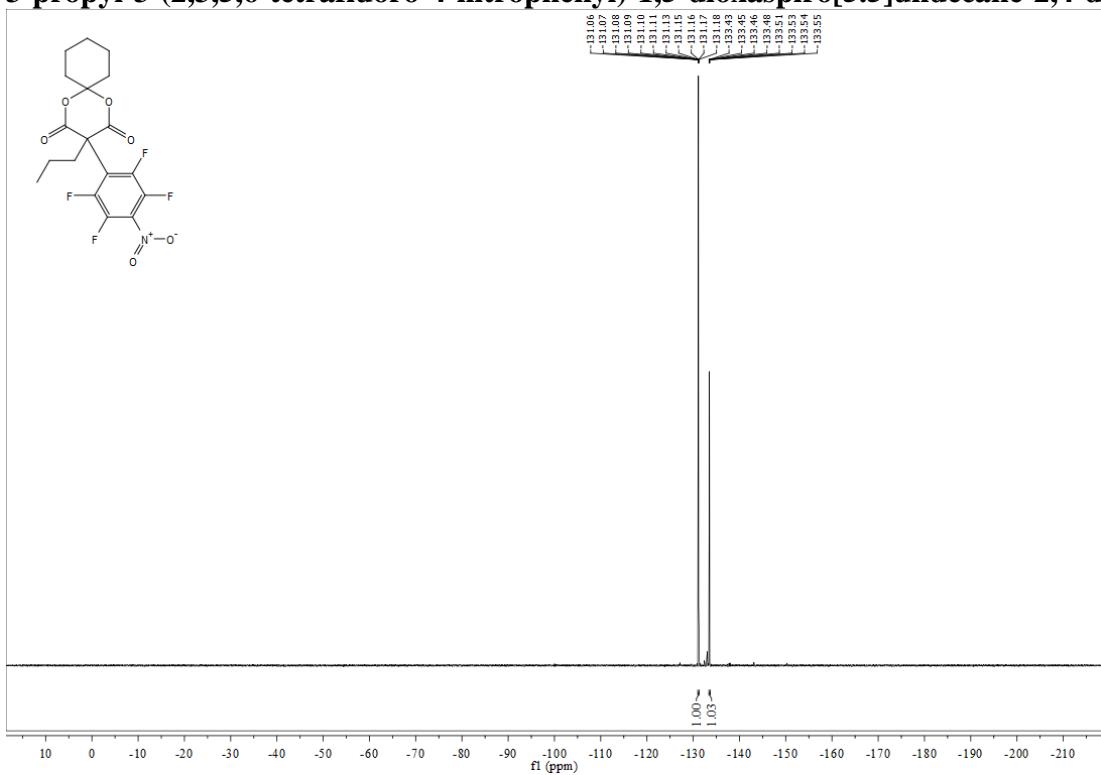


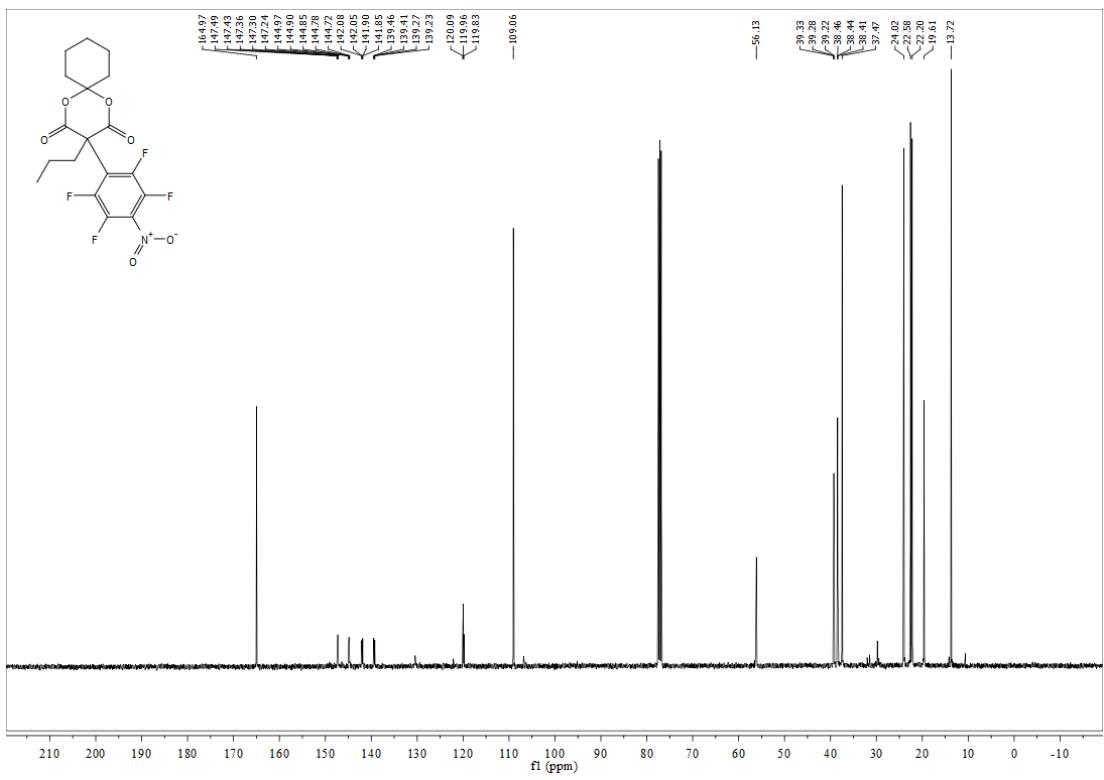
3-methyl-3-(2,3,5,6-tetrafluoro-4-nitrophenyl)-1,5-dioxaspiro[5.5]undecane-2,4-dione (5ca)



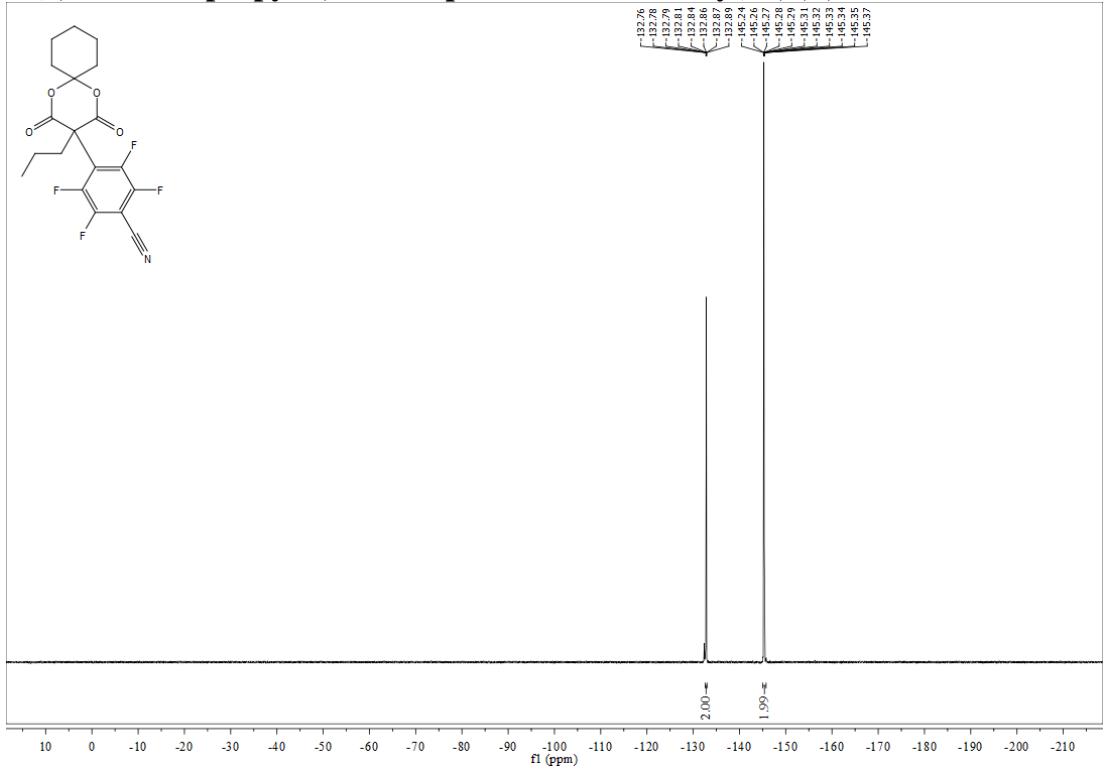


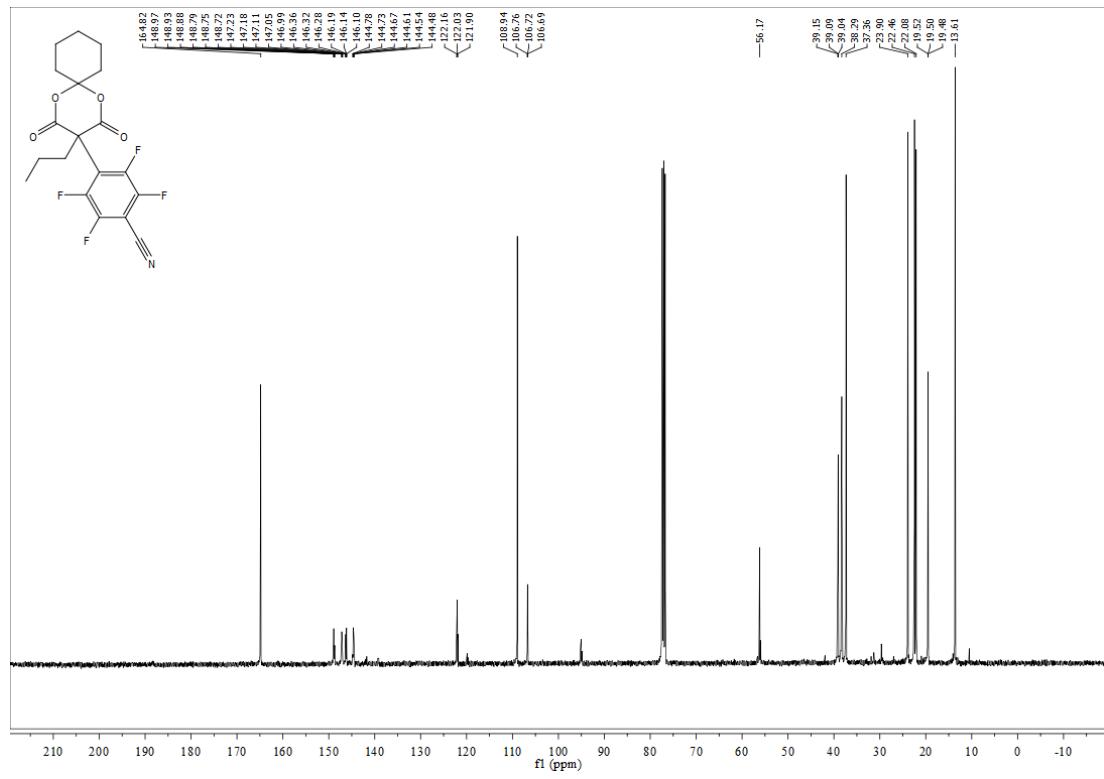
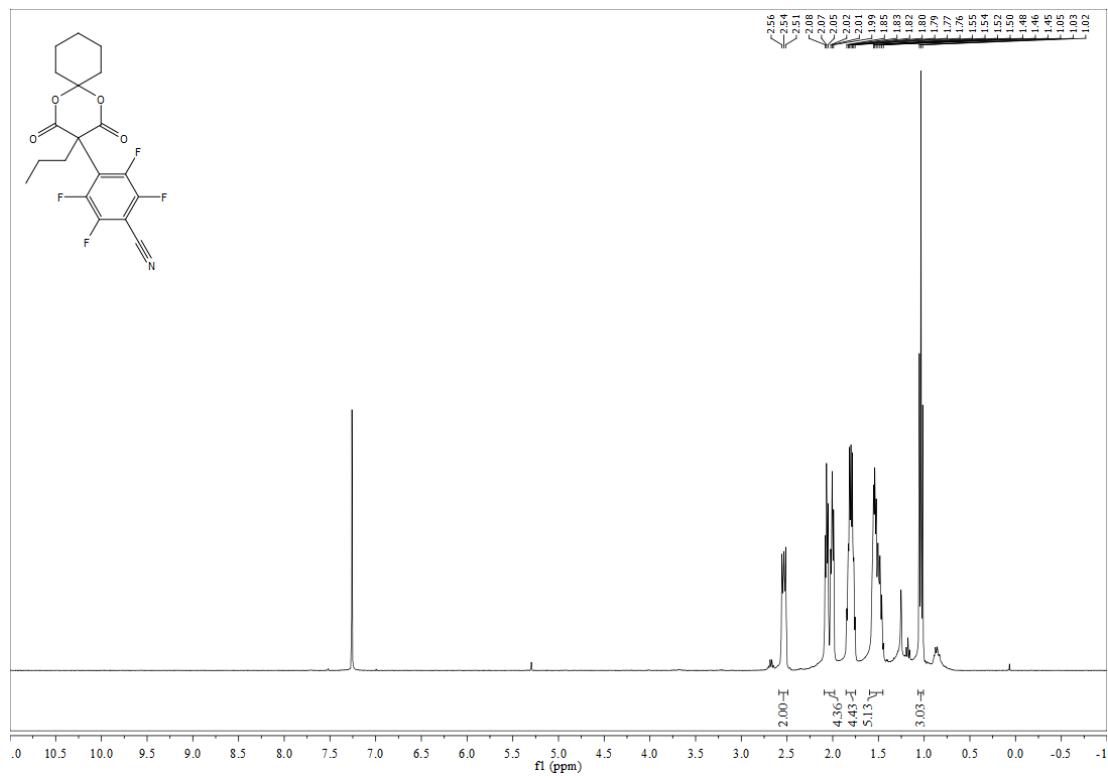
3-propyl-3-(2,3,5,6-tetrafluoro-4-nitrophenyl)-1,5-dioxaspiro[5.5]undecane-2,4-dione (5cb)



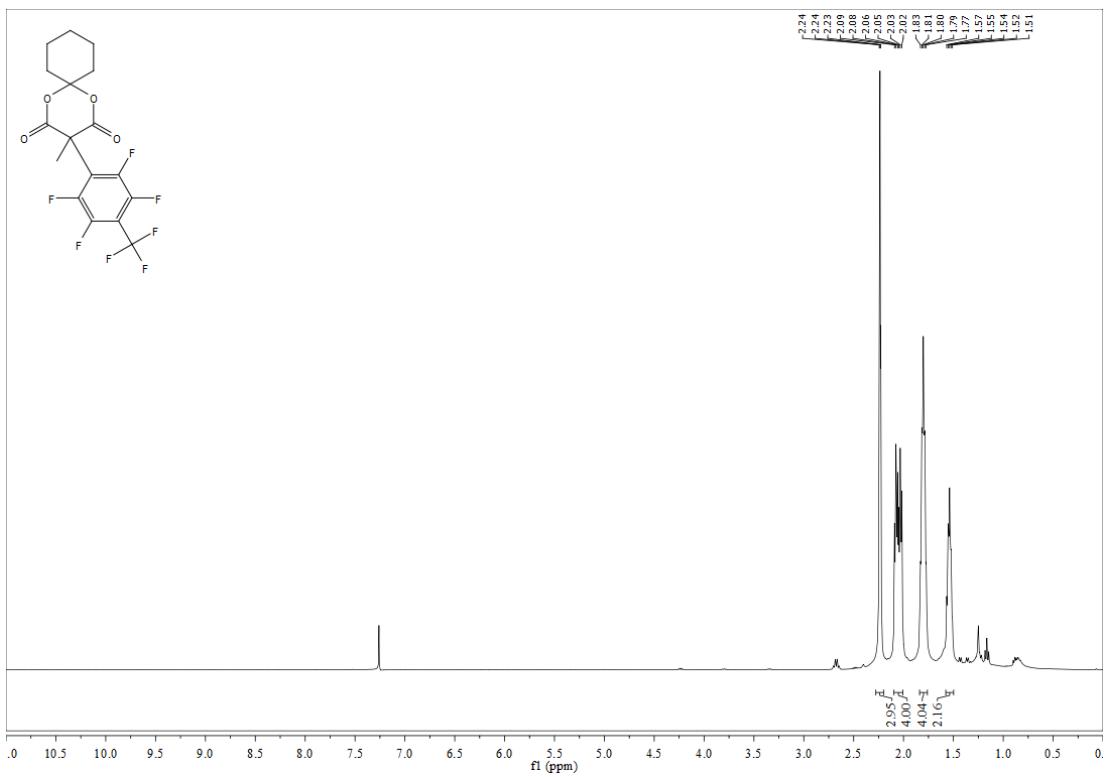
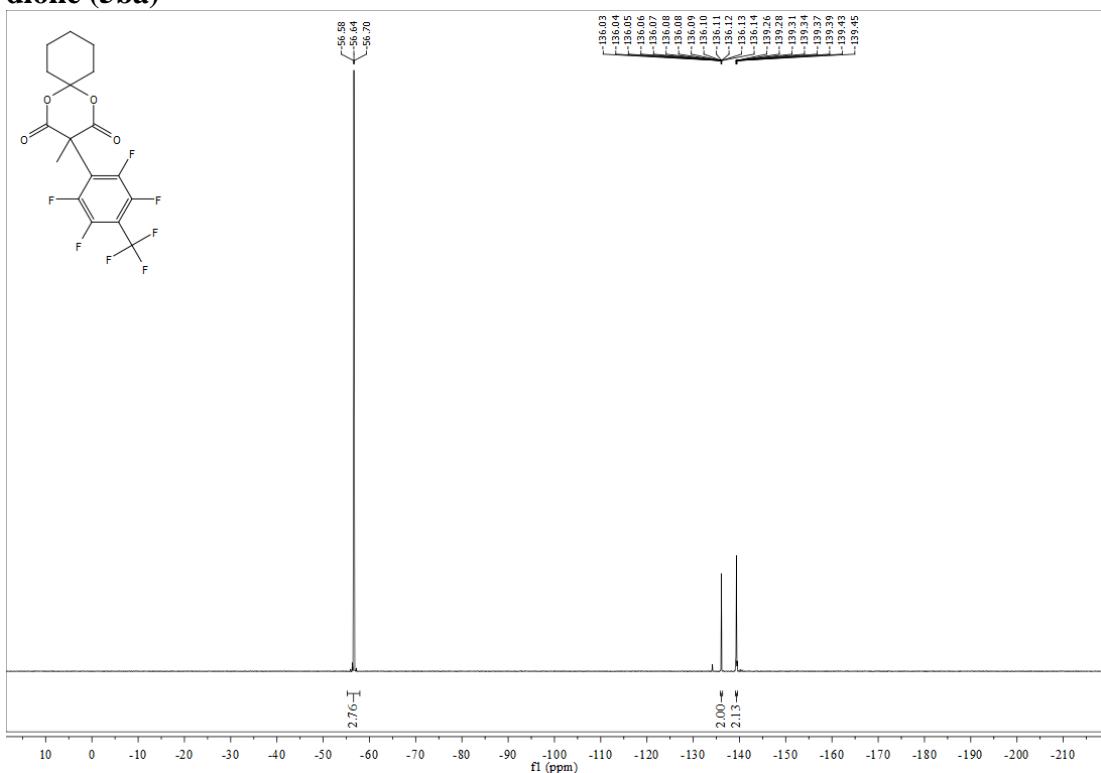


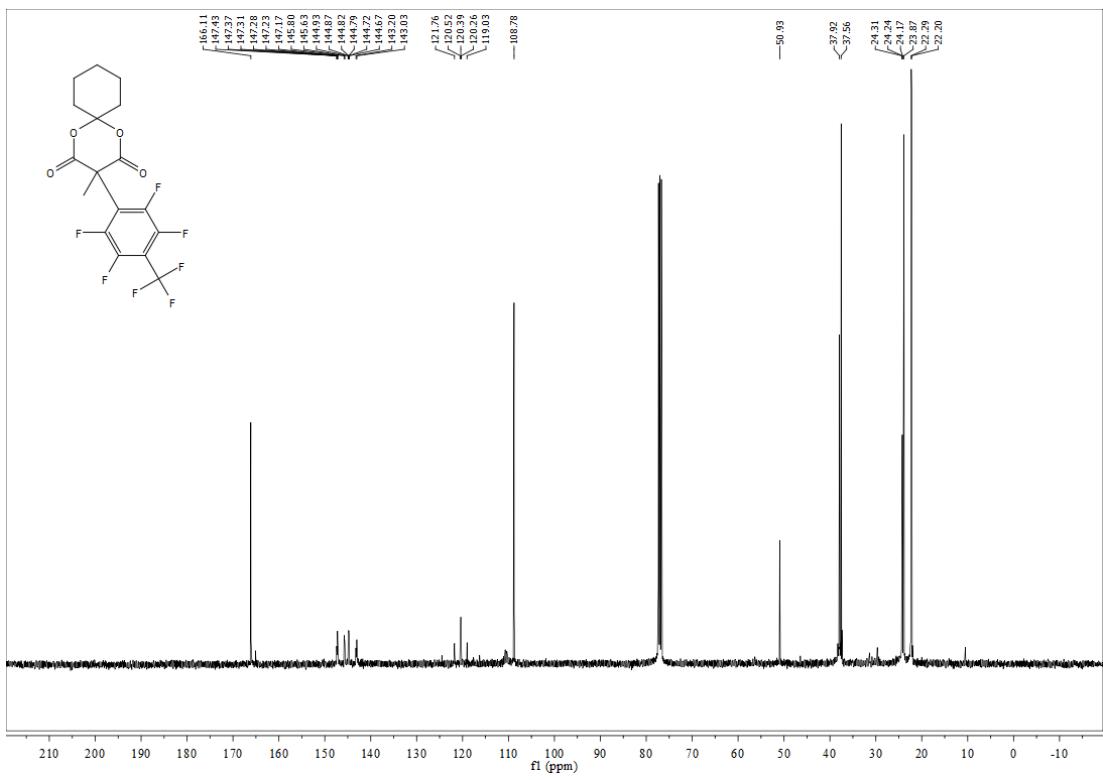
4-(2,4-dioxo-3-propyl-1,5-dioxaspiro[5.5]undecan-3-yl)-2,3,5,6-tetrafluorobenzonitrile (5ib)



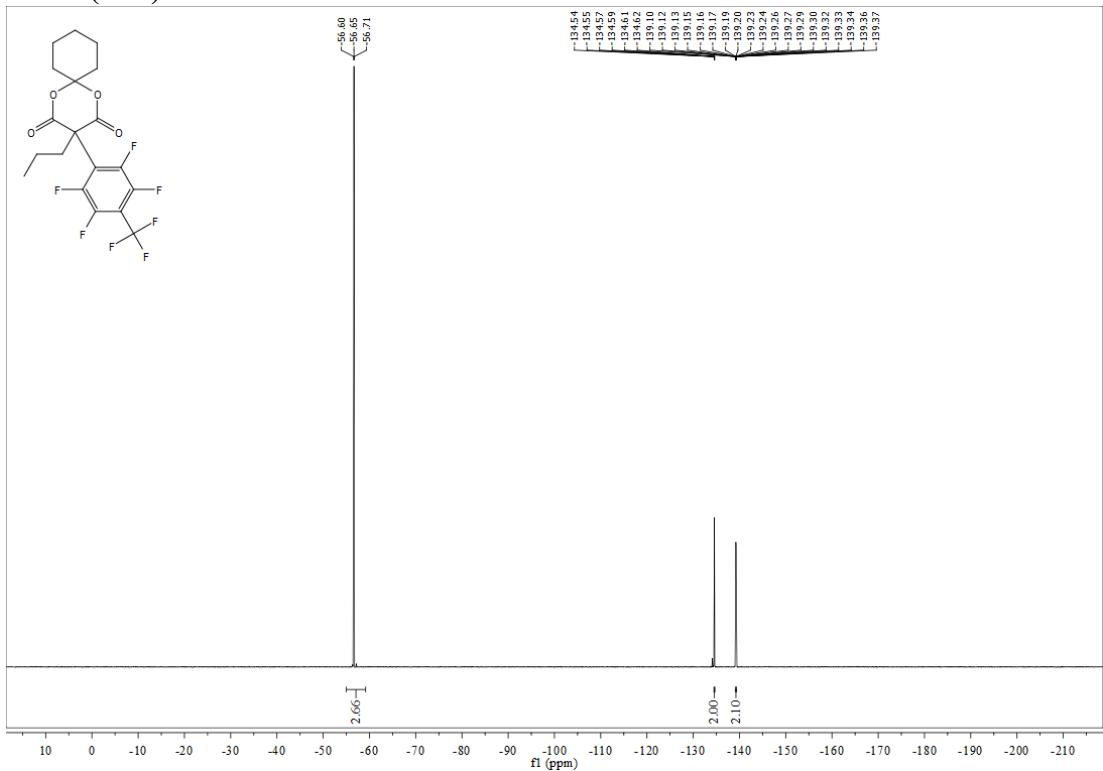


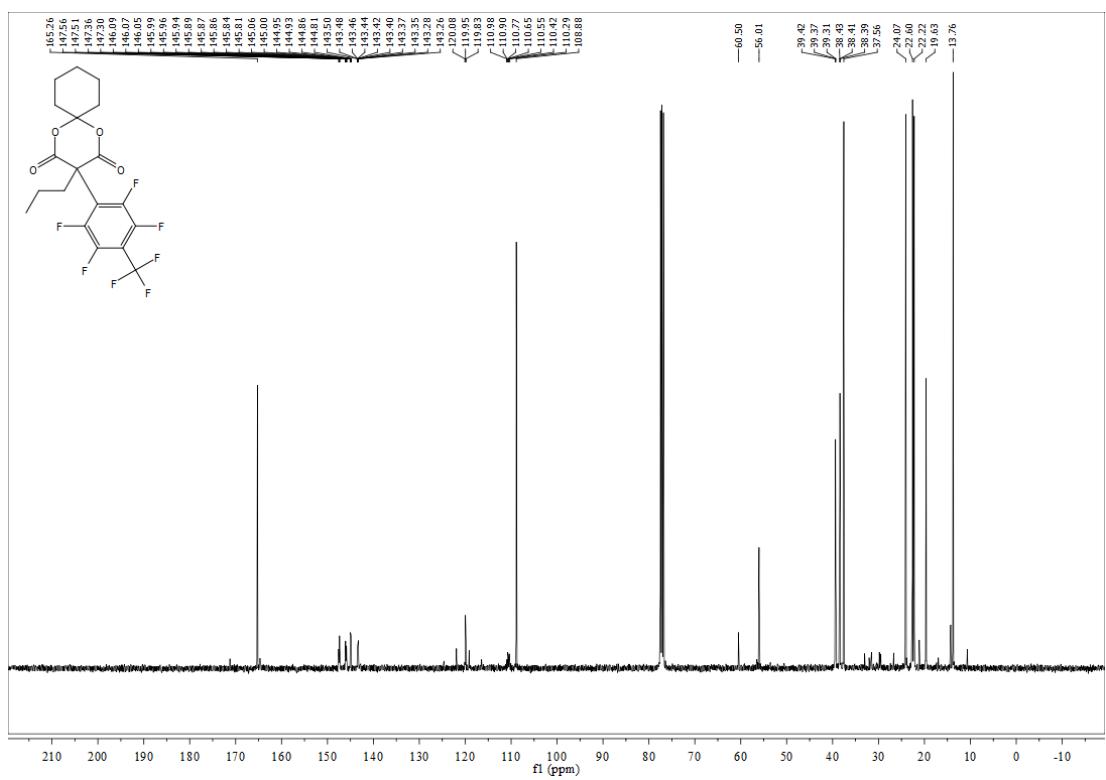
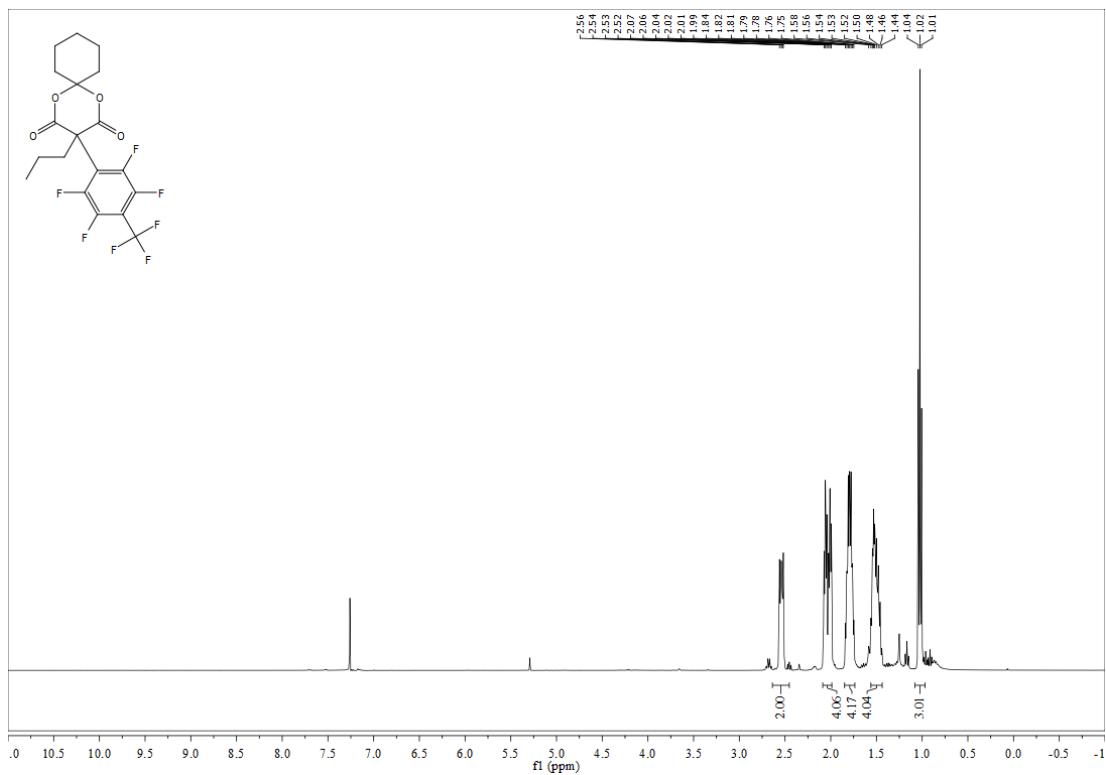
3-methyl-3-(2,3,5,6-tetrafluoro-4-(trifluoromethyl)phenyl)-1,5-dioxaspiro[5.5]undecane-2,4-dione (5ba)



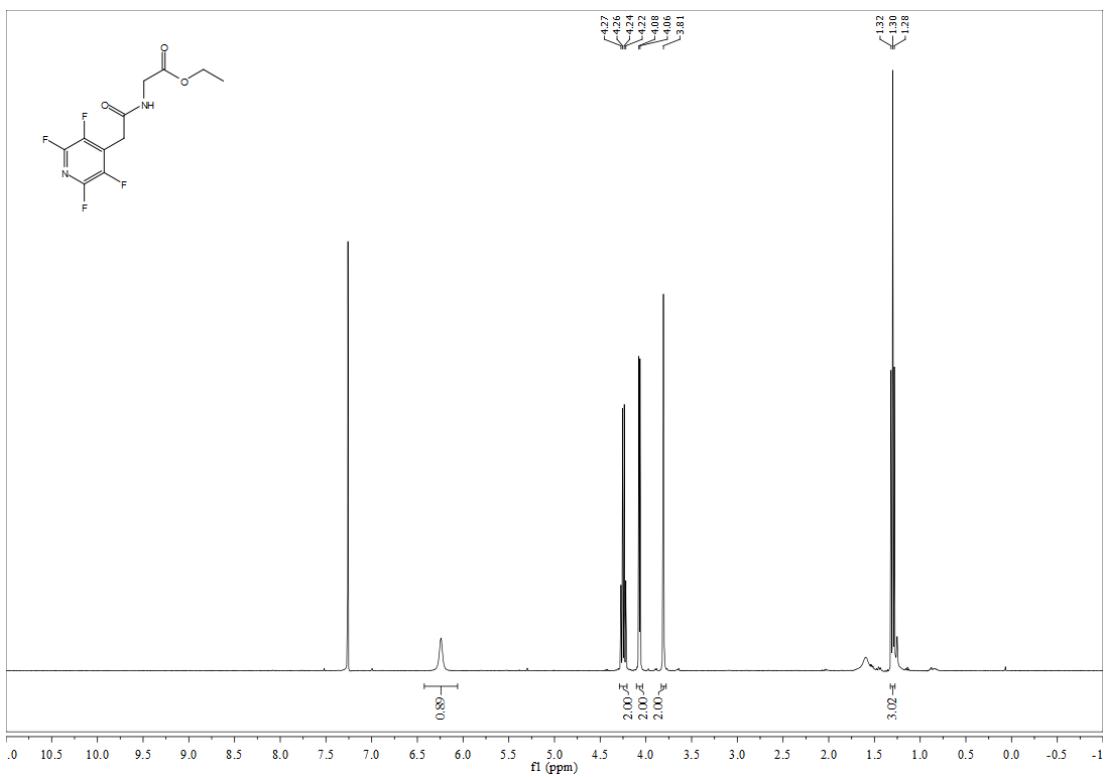
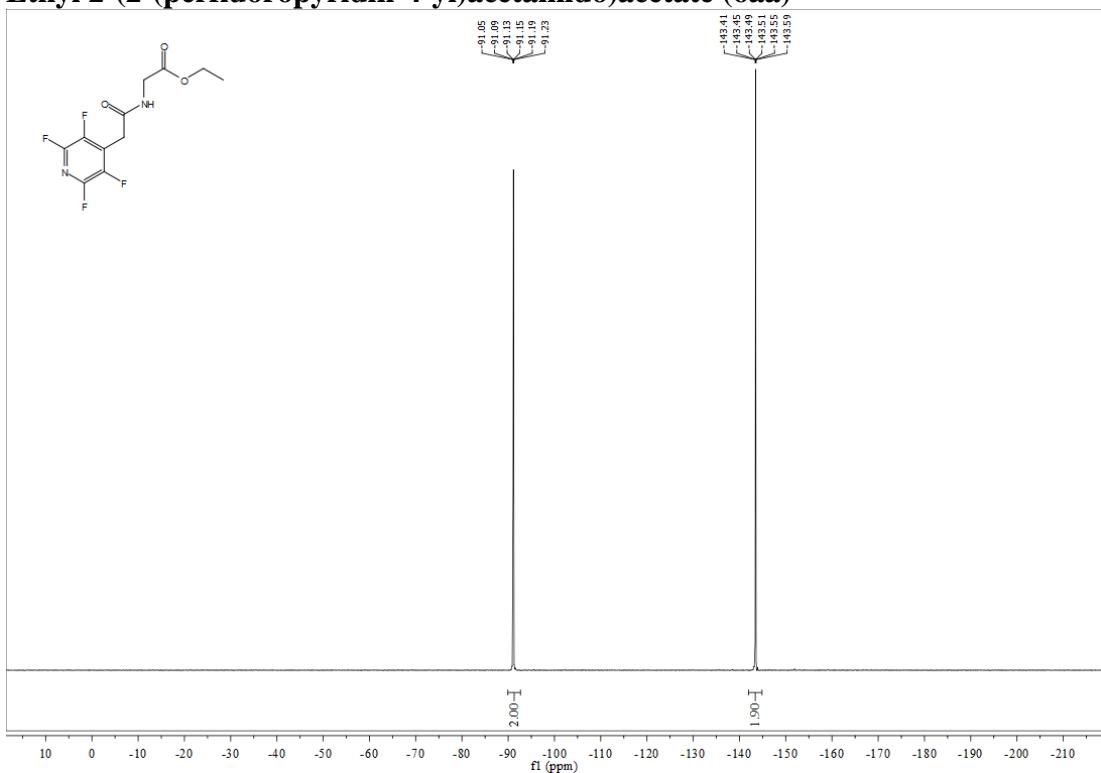


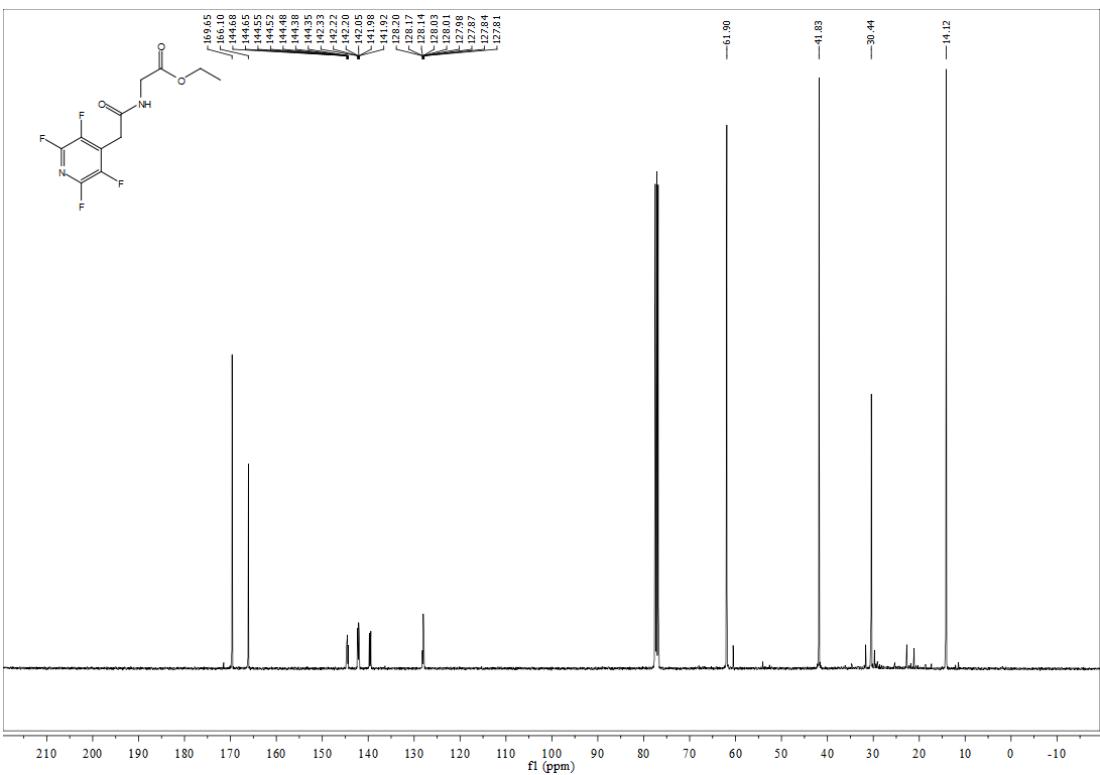
3-propyl-3-(2,3,5,6-tetrafluoro-4-(trifluoromethyl)phenyl)-1,5-dioxaspiro[5.5]undecane-2,4-dione (5bb)



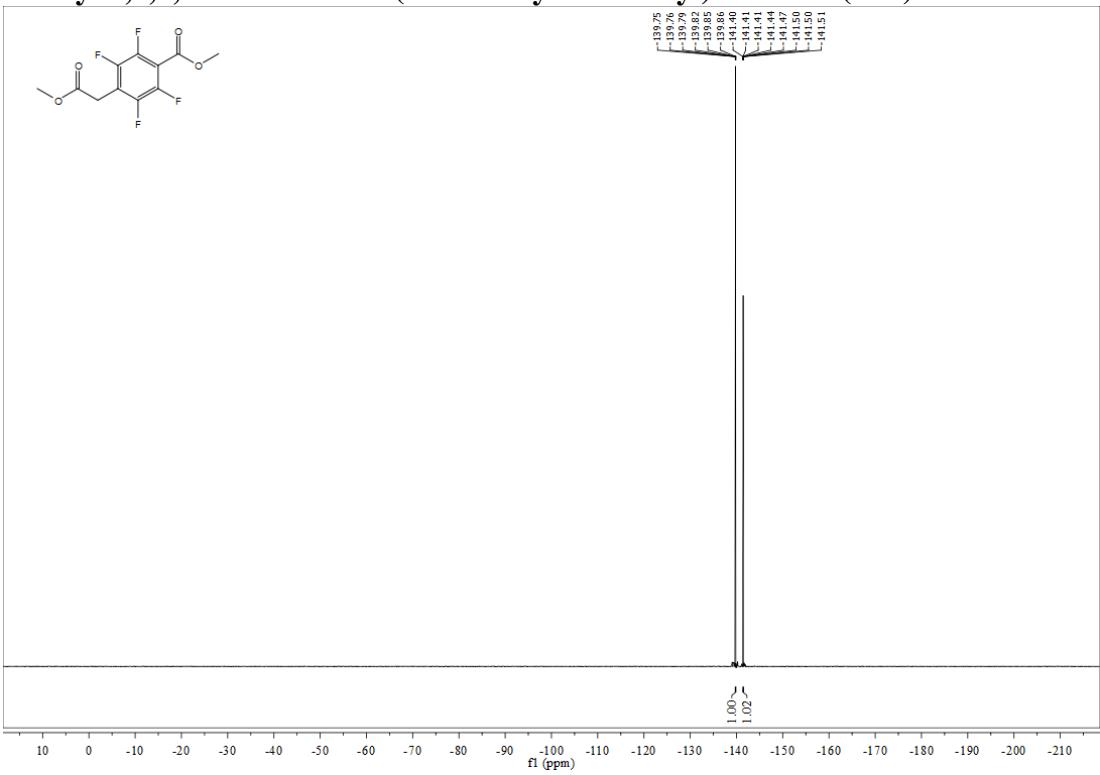


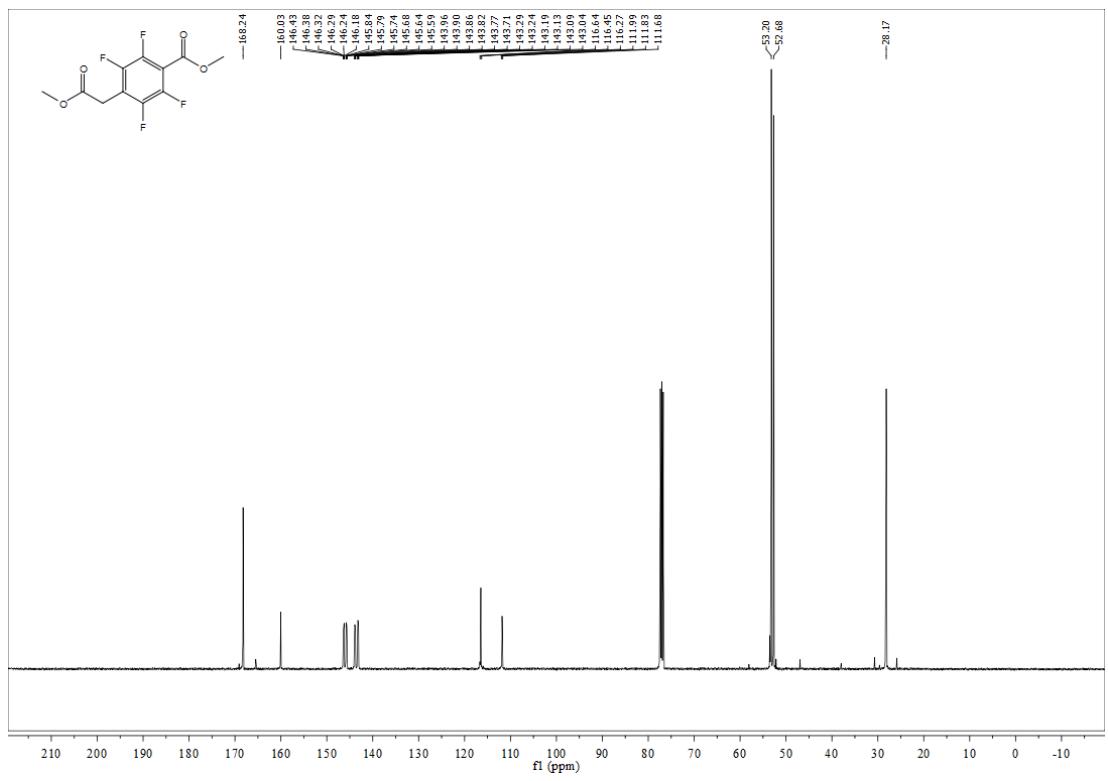
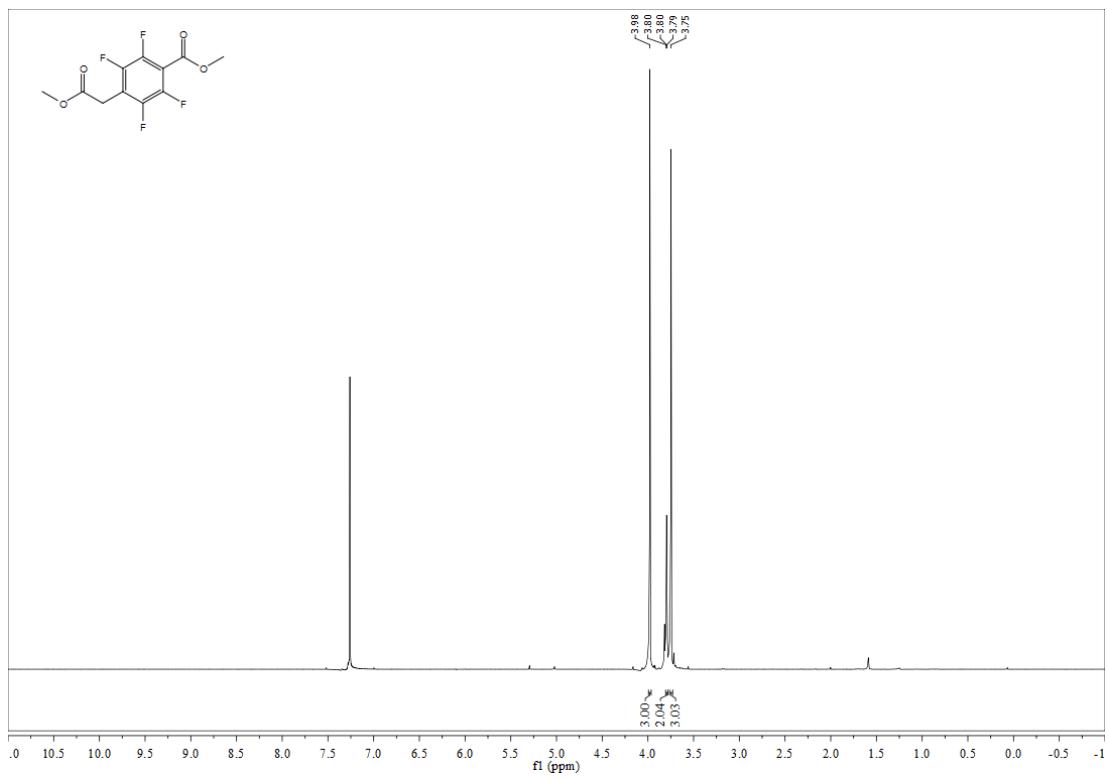
Ethyl 2-(2-(perfluoropyridin-4-yl)acetamido)acetate (6aa)



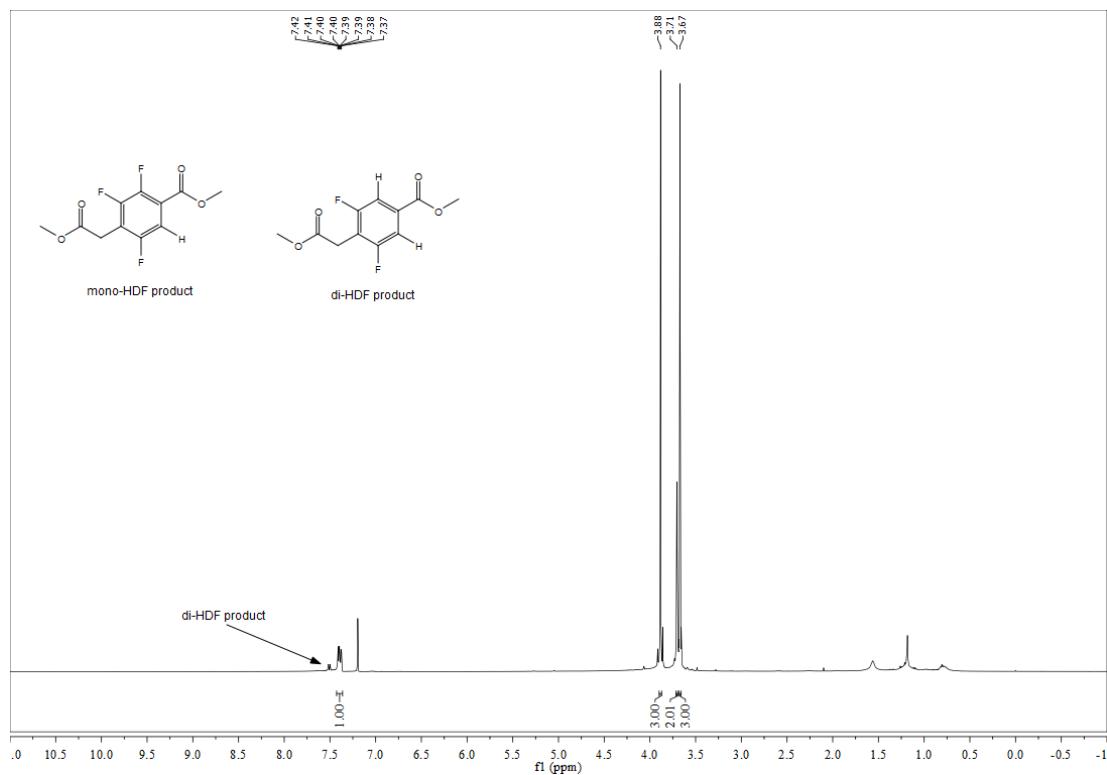
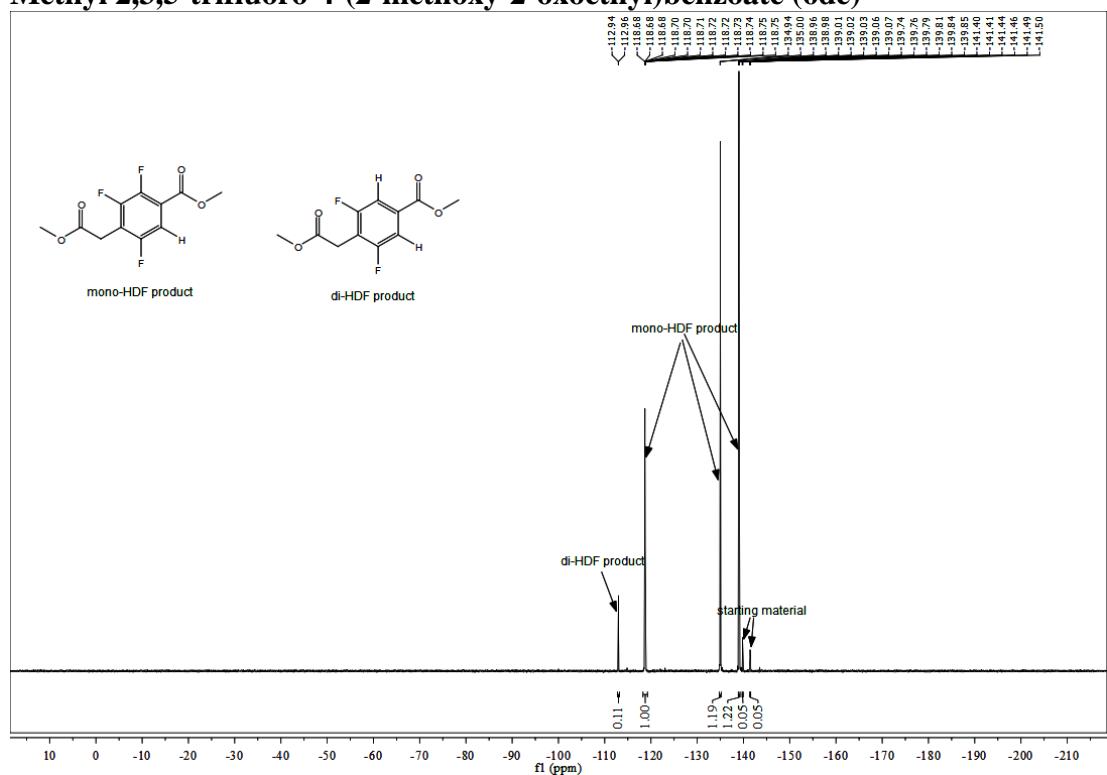


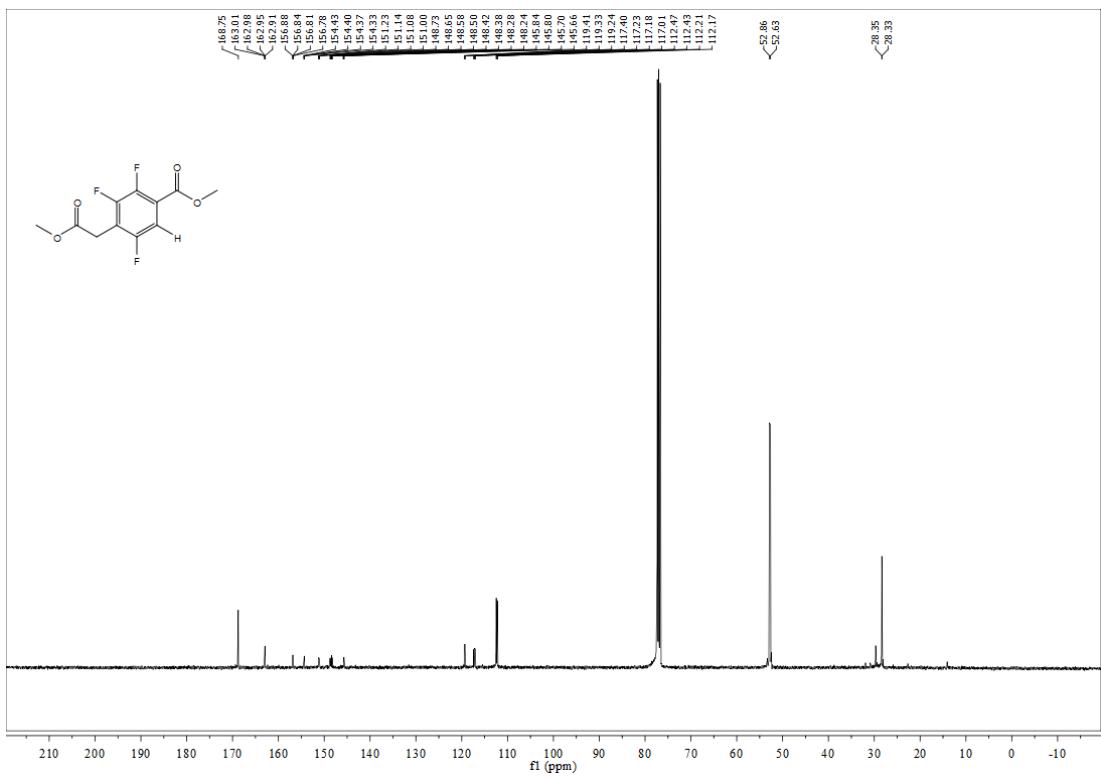
Methyl 2,3,5,6-tetrafluoro-4-(2-methoxy-2-oxoethyl)benzoate (6dd)



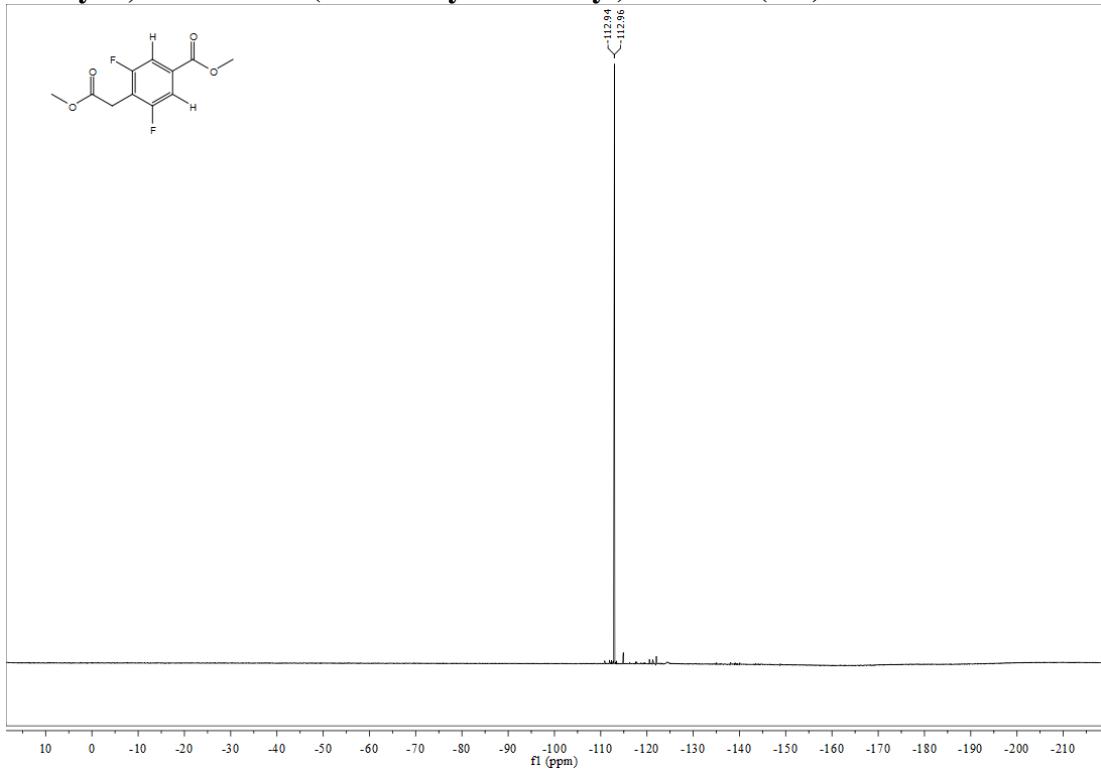


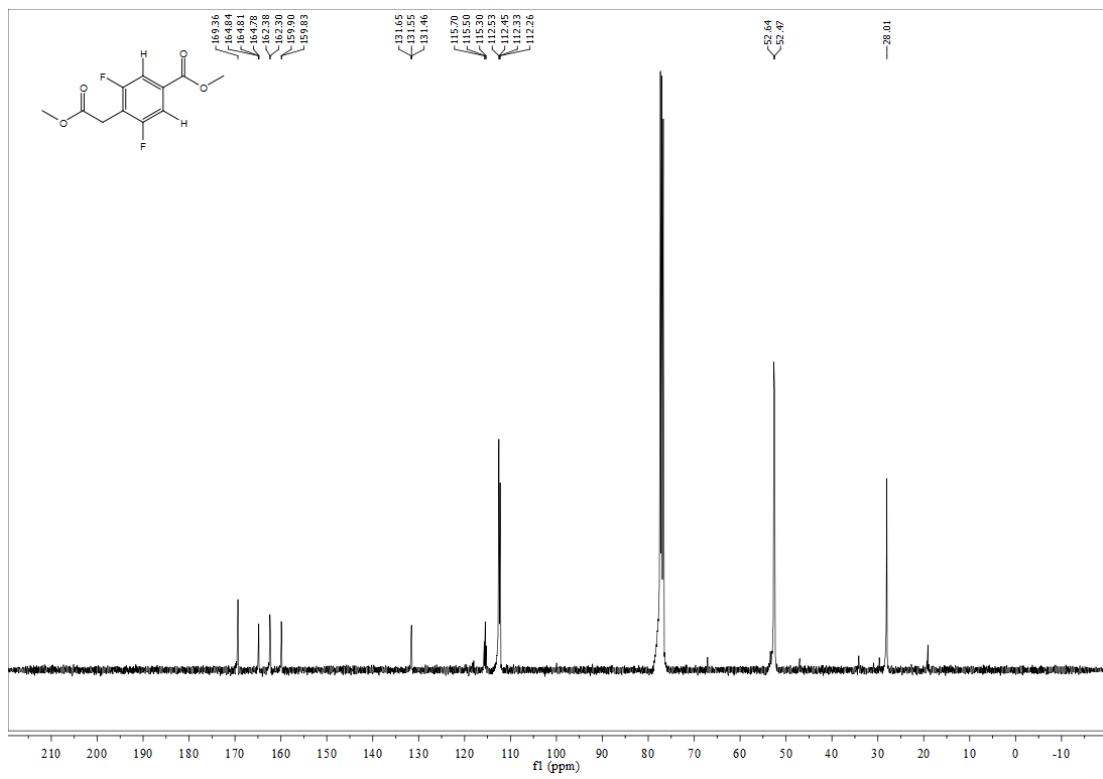
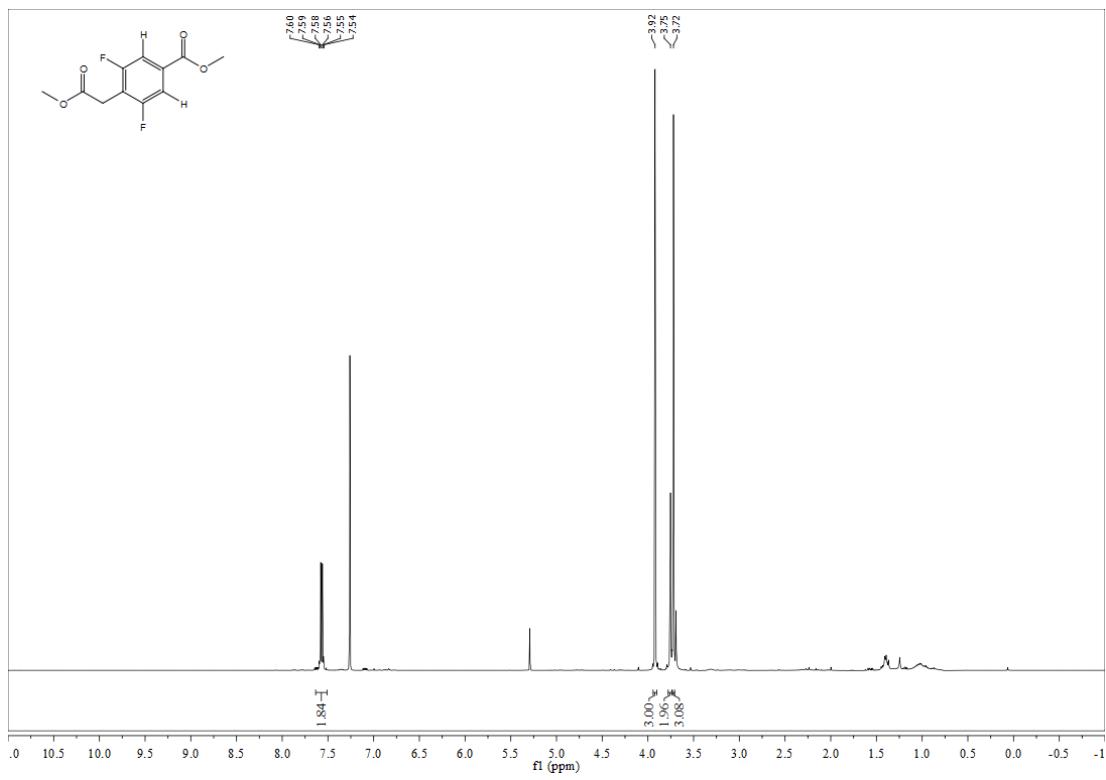
Methyl 2,3,5-trifluoro-4-(2-methoxy-2-oxoethyl)benzoate (6de)



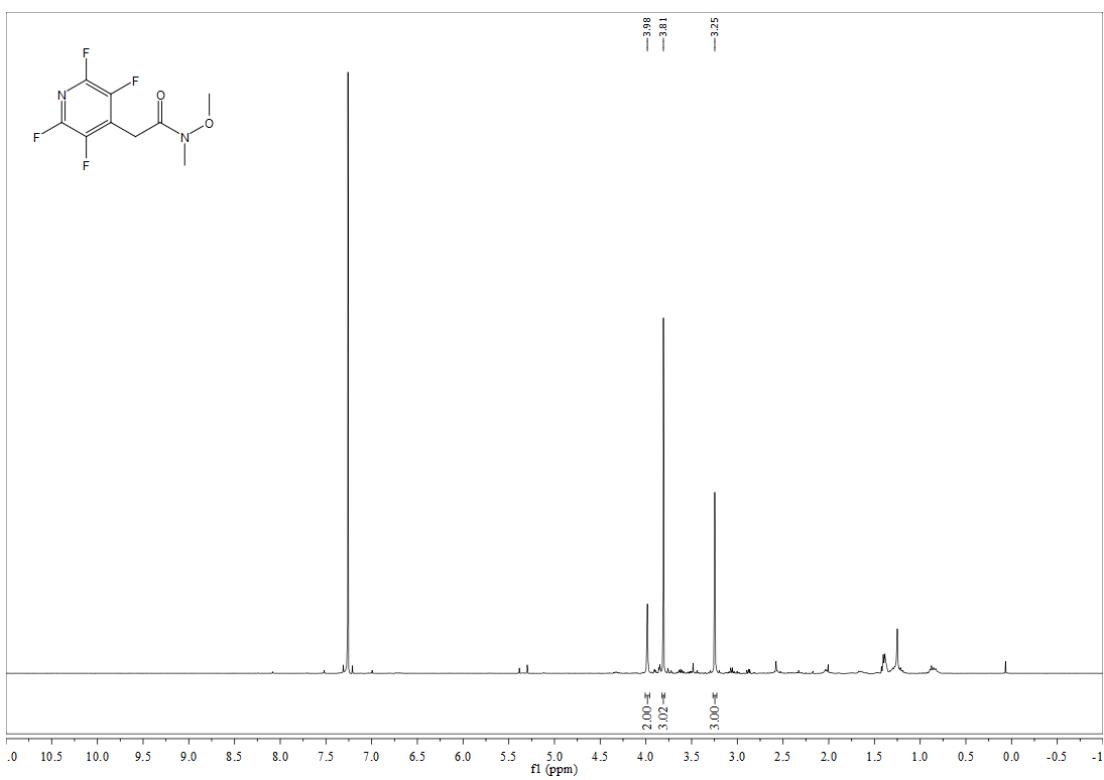
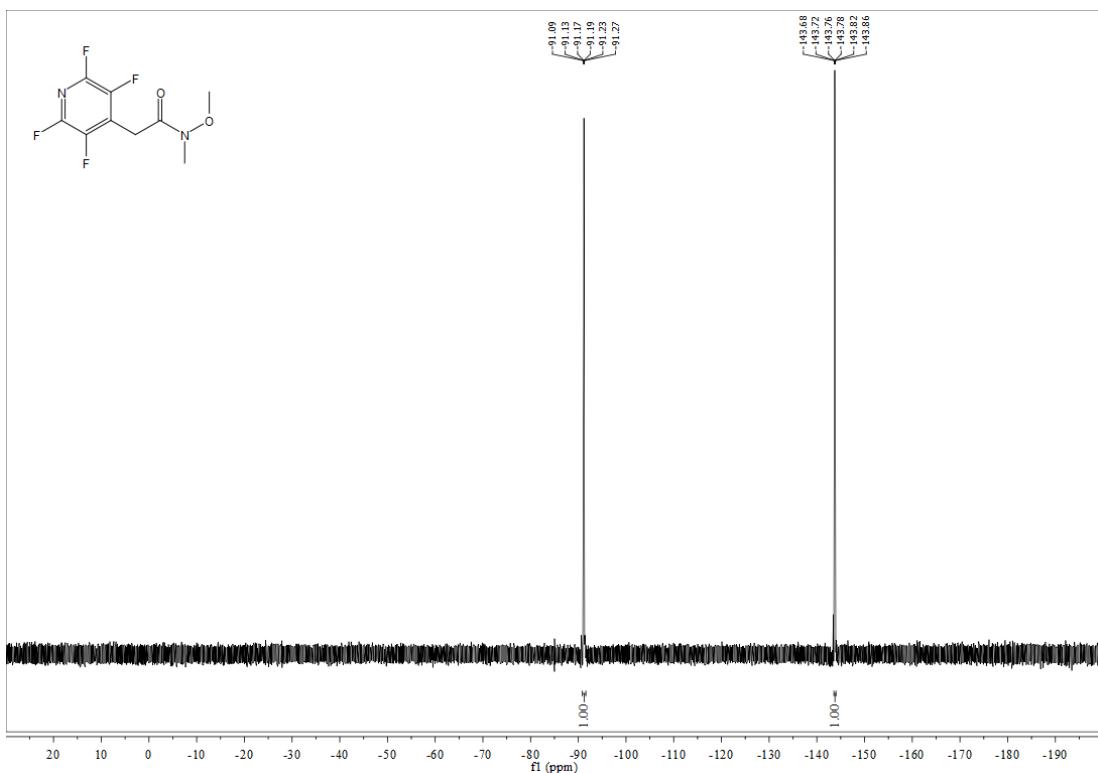


Methyl 3,5-difluoro-4-(2-methoxy-2-oxoethyl)benzoate (6df)

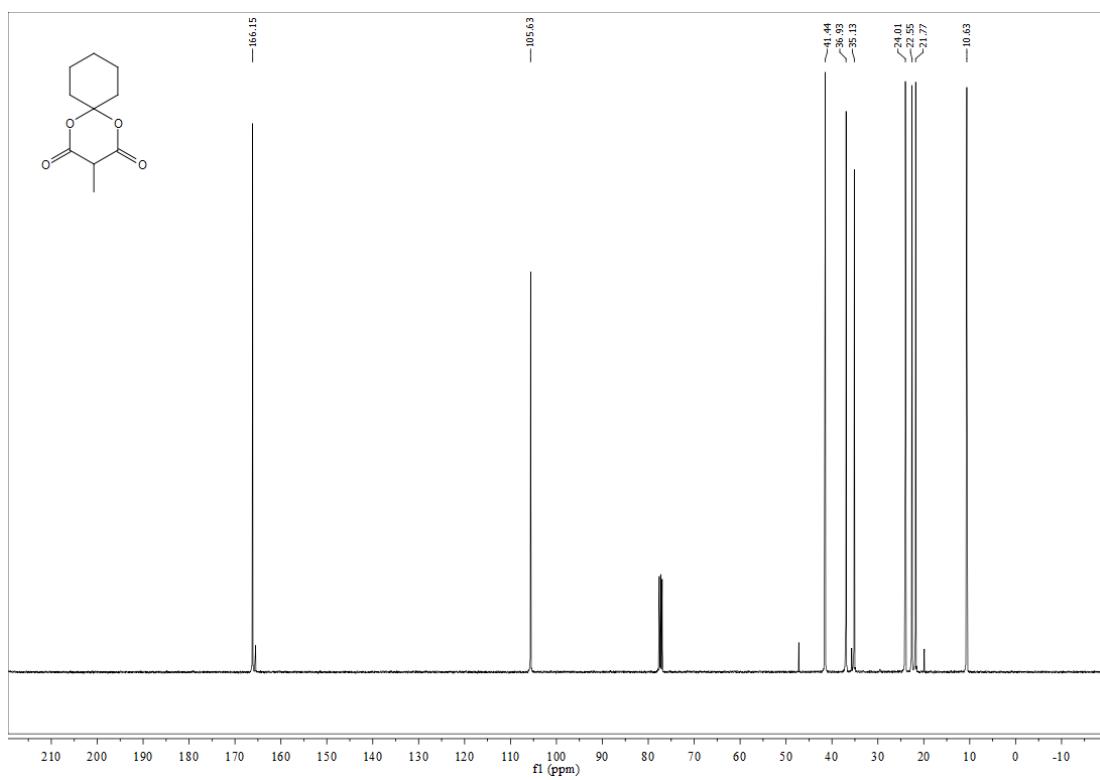
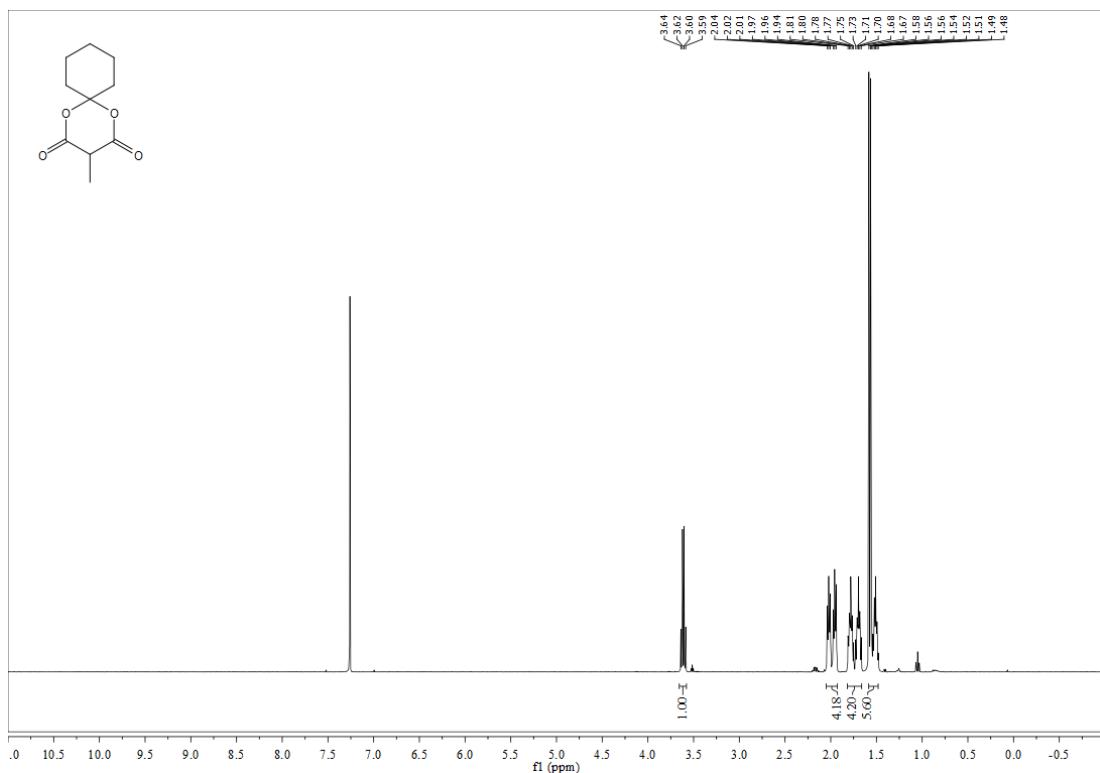




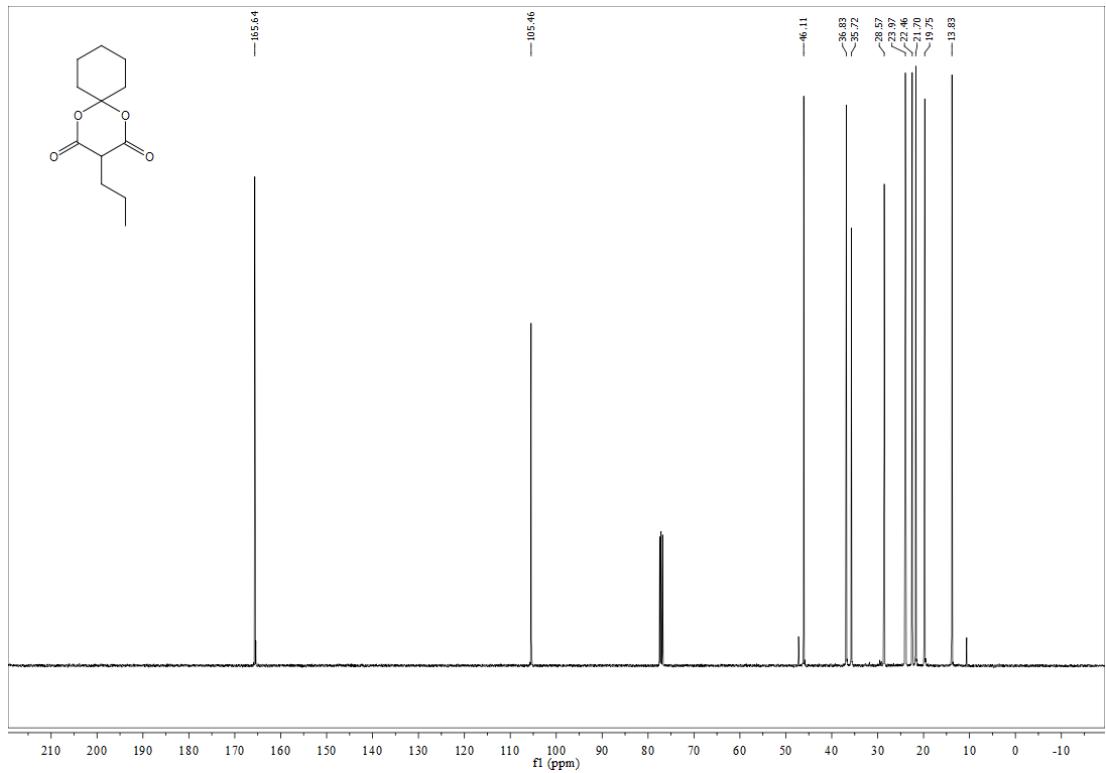
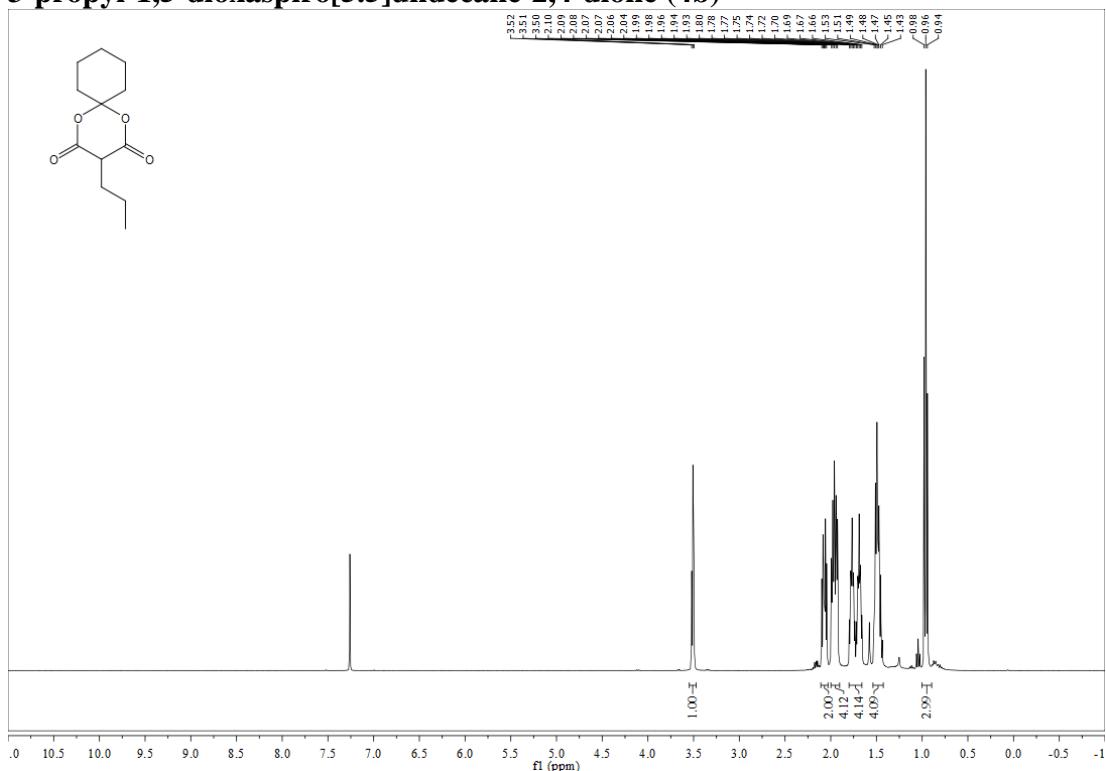
N-methoxy-N-methyl-2-(perfluoropyridin-4-yl)acetamide (6ac)



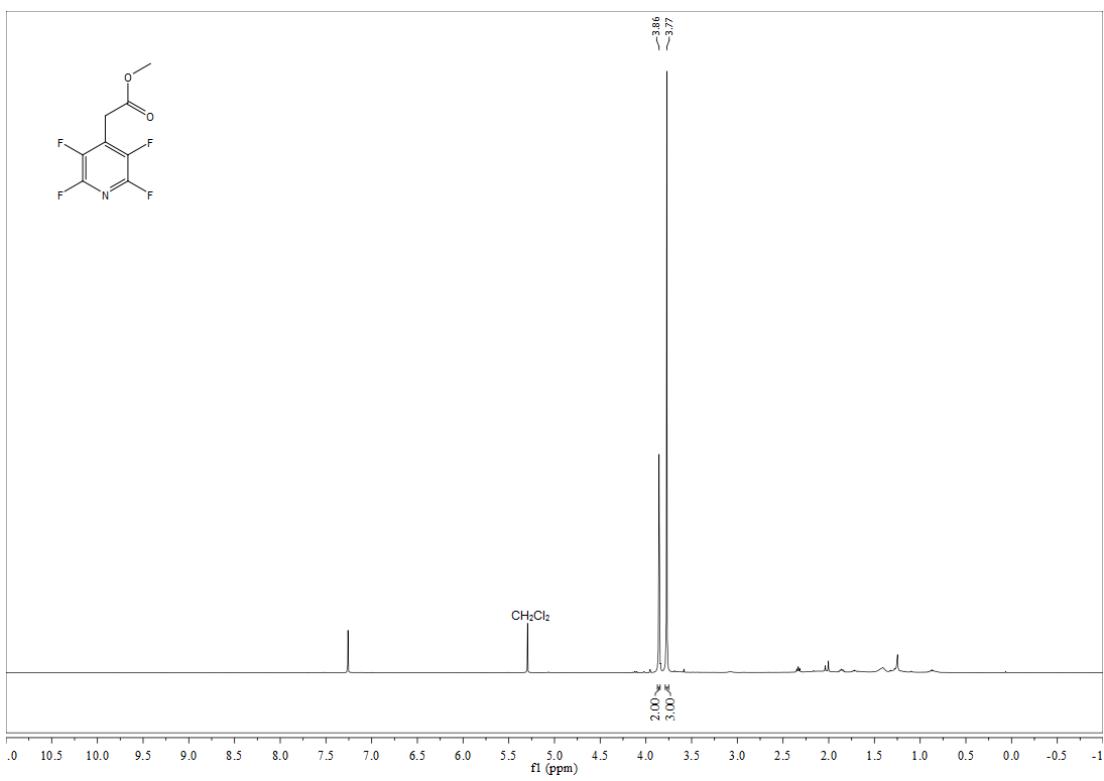
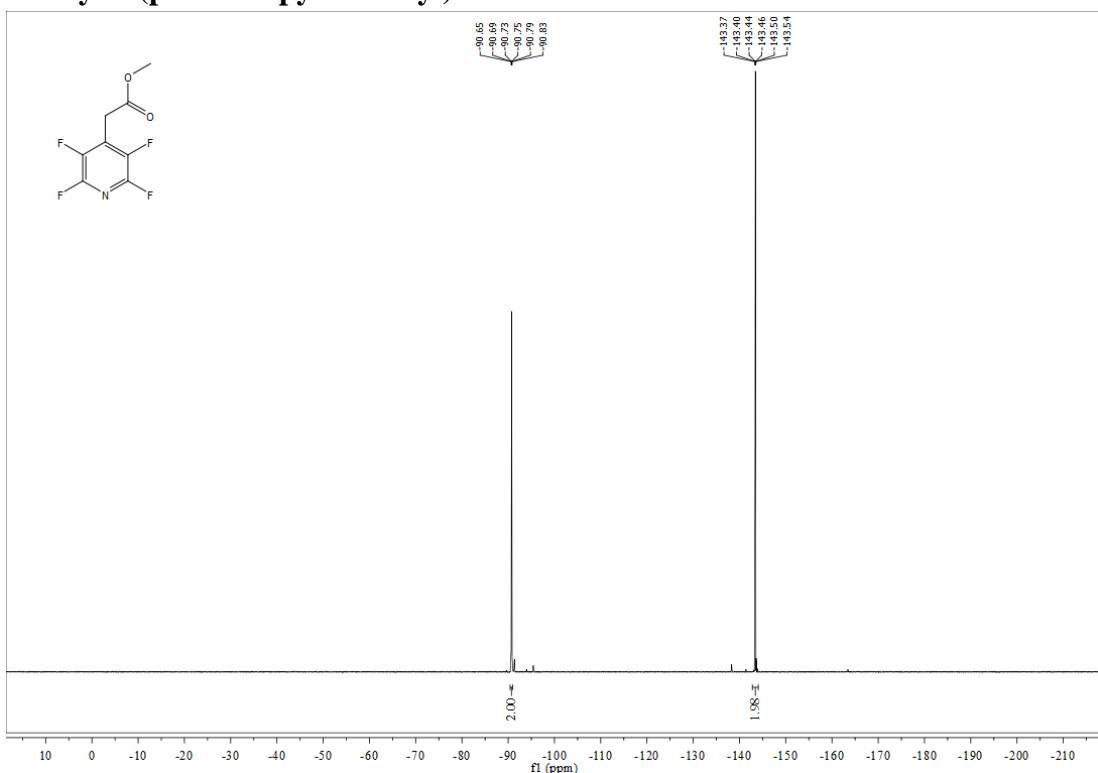
3-methyl-1,5-dioxaspiro[5.5]undecane-2,4-dione (4a)



3-propyl-1,5-dioxaspiro[5.5]undecane-2,4-dione (4b)



Methyl 2-(perfluoropyridin-4-yl)acetate



1,5-dioxaspiro[5.5]undecane-2,4-dione (Cyclohexyl-Meldrum's acid)

