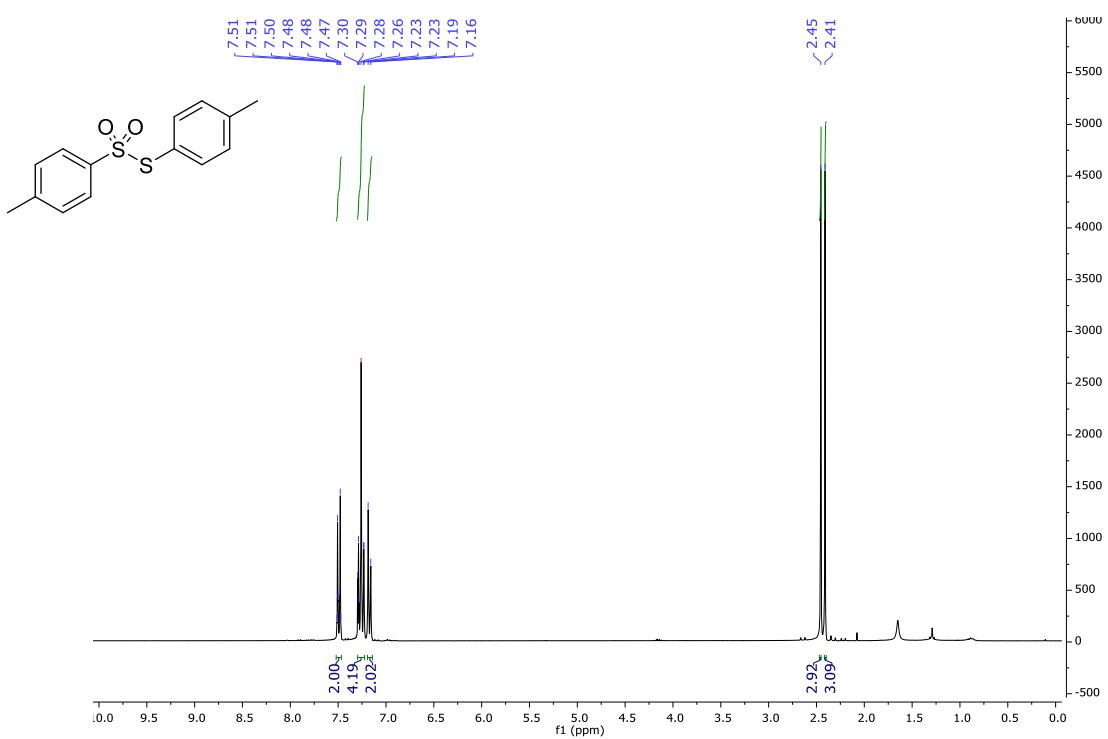


# **Supporting Information**

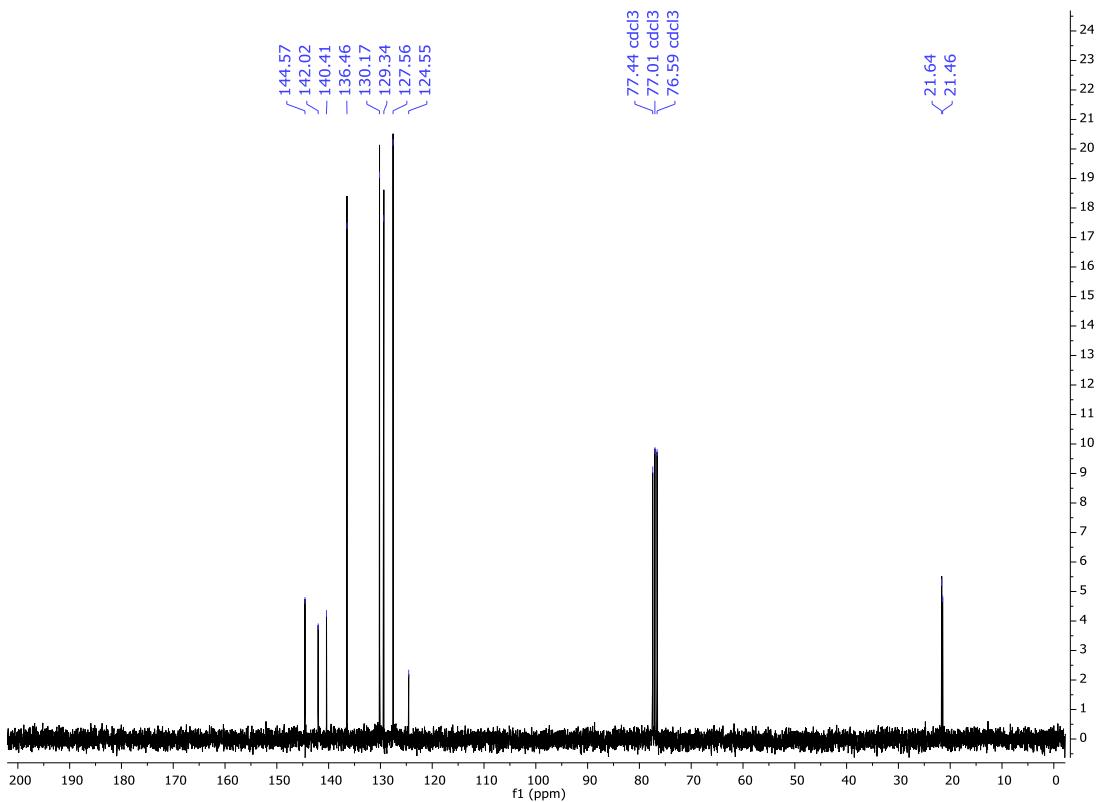
## **Unusual Application for Phosphonium Salts and Phosphoranes: Synthesis of Chalcogenides**

Igor M. R. Moura, Arisson Tranquilino, Barbara G. Sátiro, Ricardo O. Silva, Diogo de Oliveira-Silva, Roberta A. Oliveira\* and Paulo H. Menezes\*

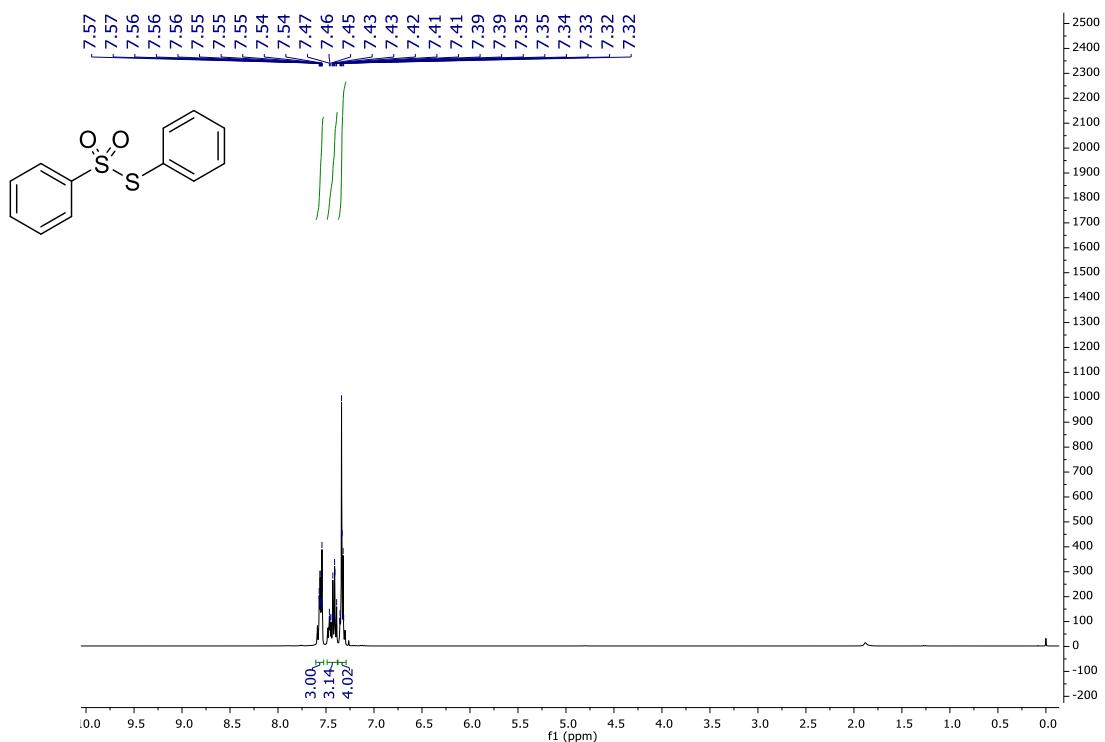
1. Spectra .....	S2
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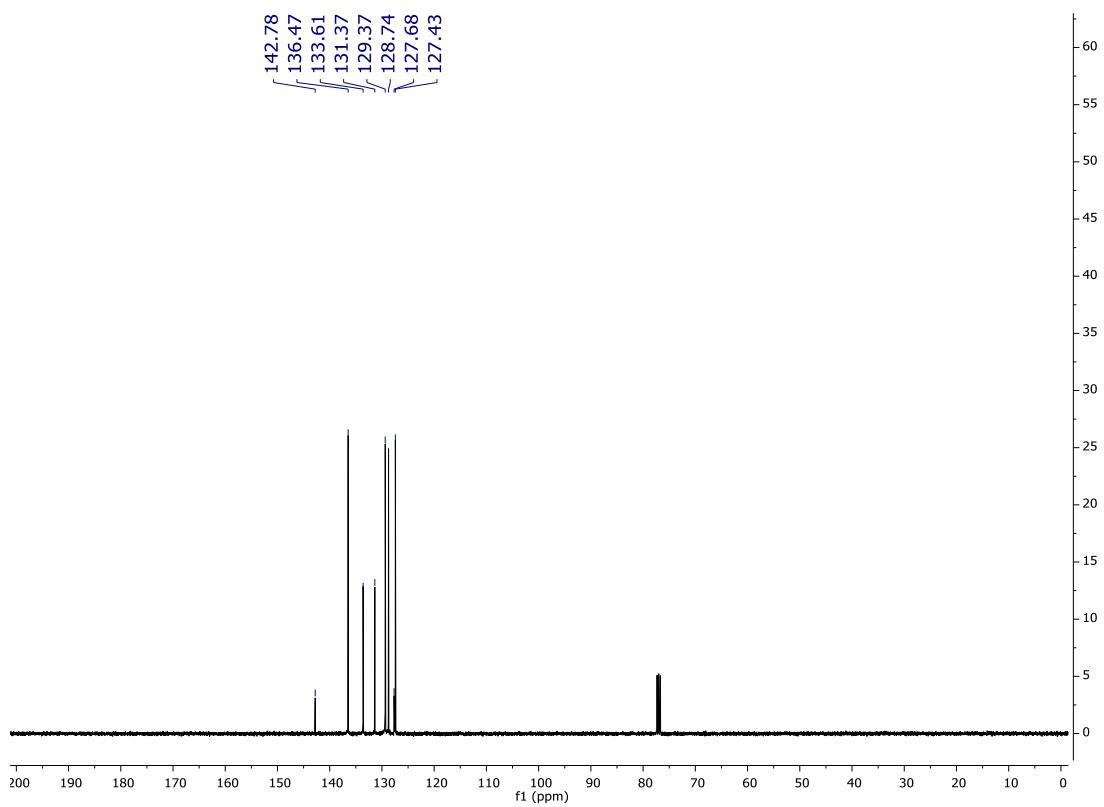
$^1\text{H}$  NMR spectrum (300 MHz,  $\text{CDCl}_3$ ) of compound **1a**



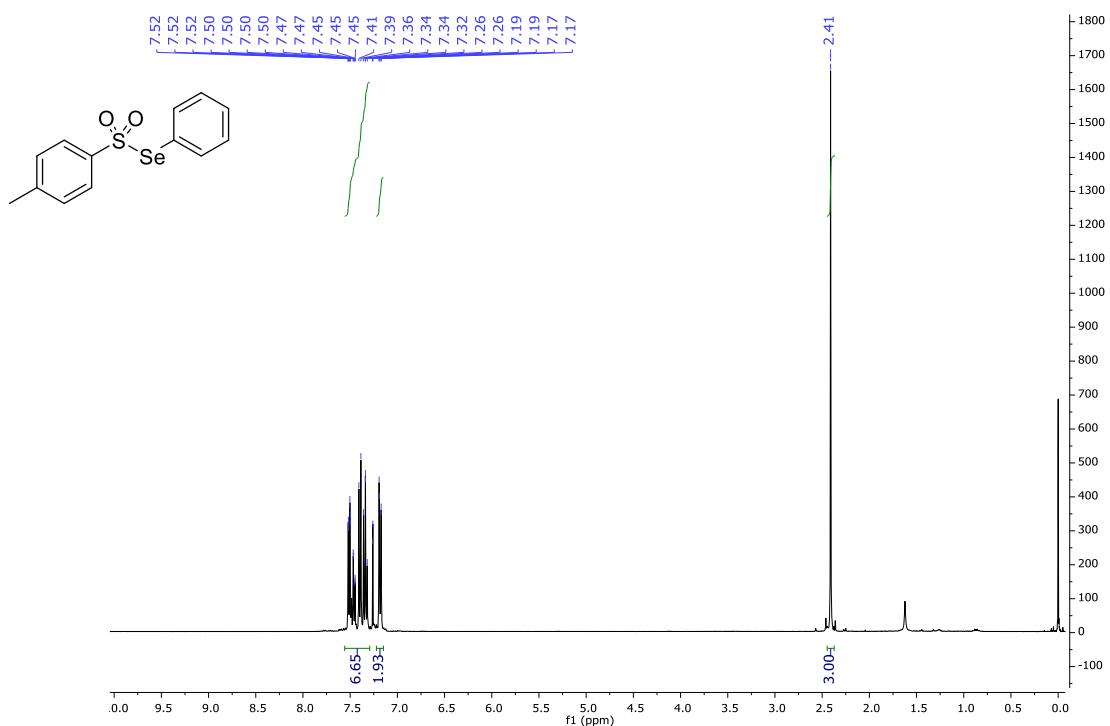
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **1a**



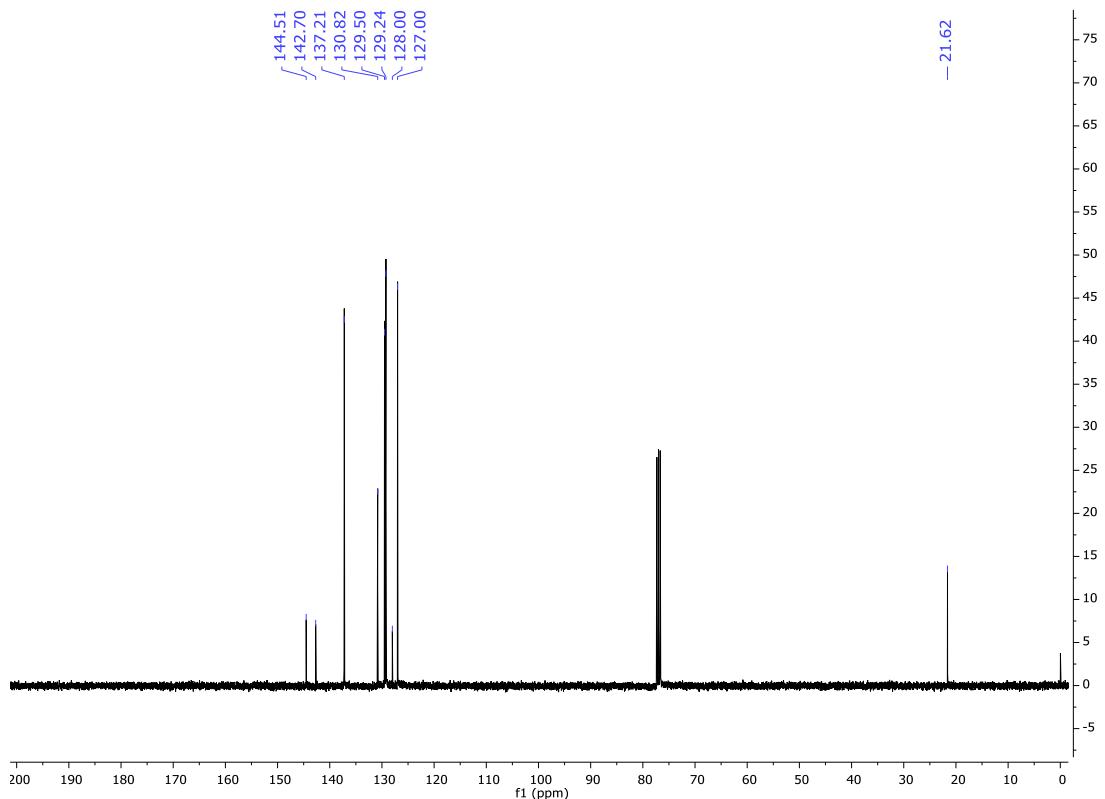
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **1b**



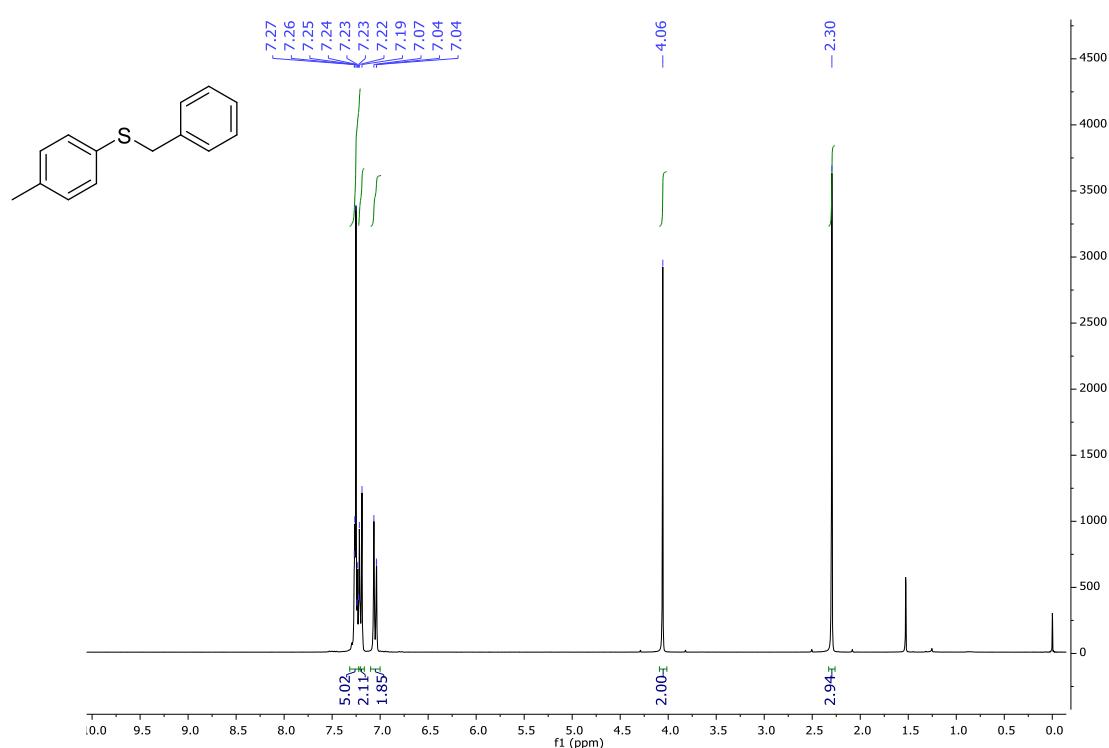
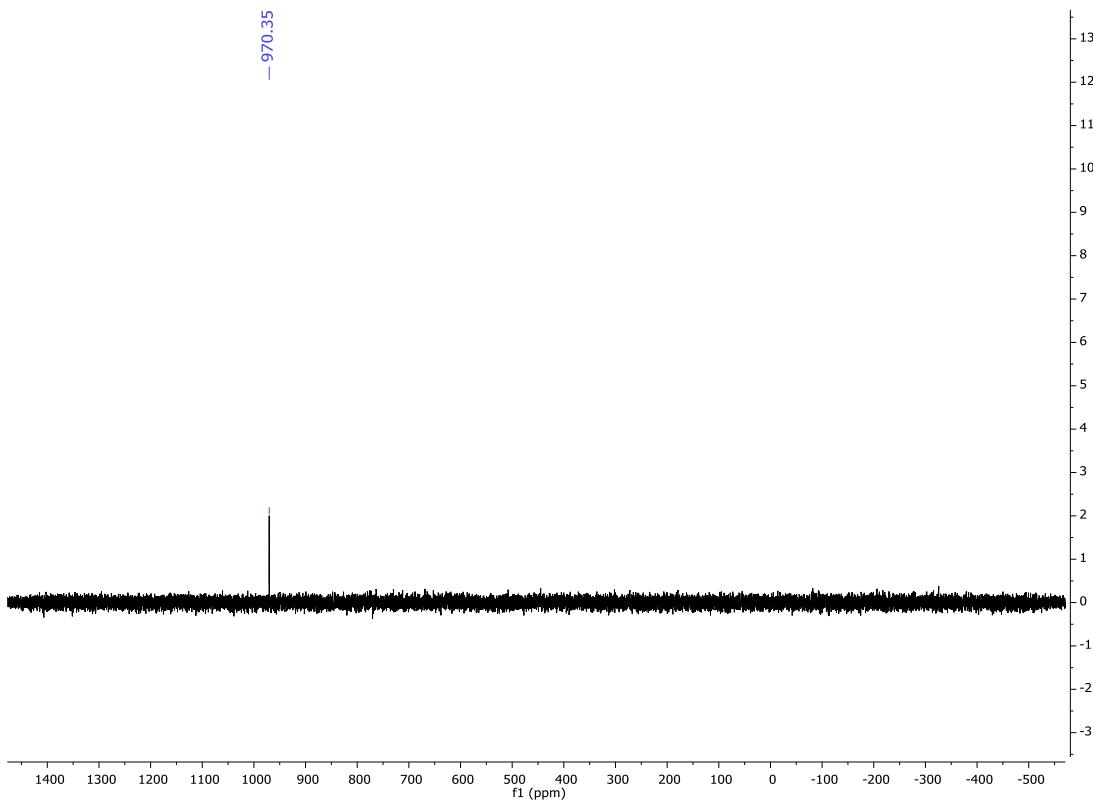
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **1b**

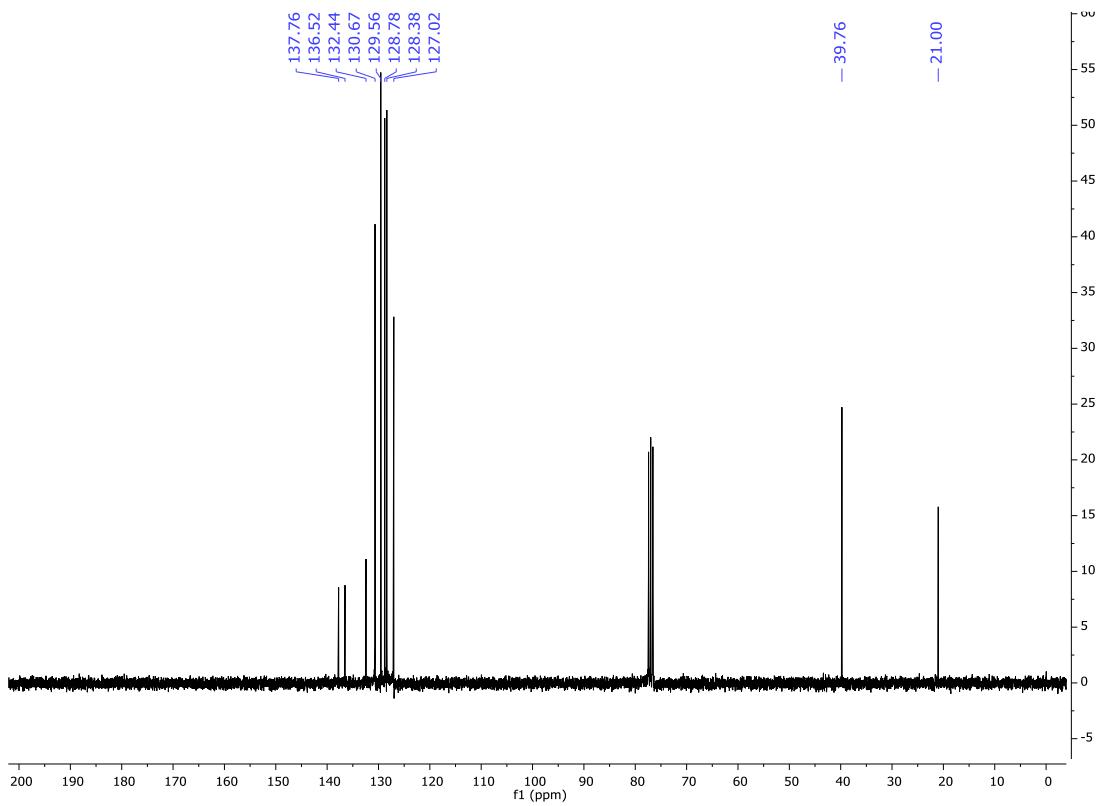


$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **1c**

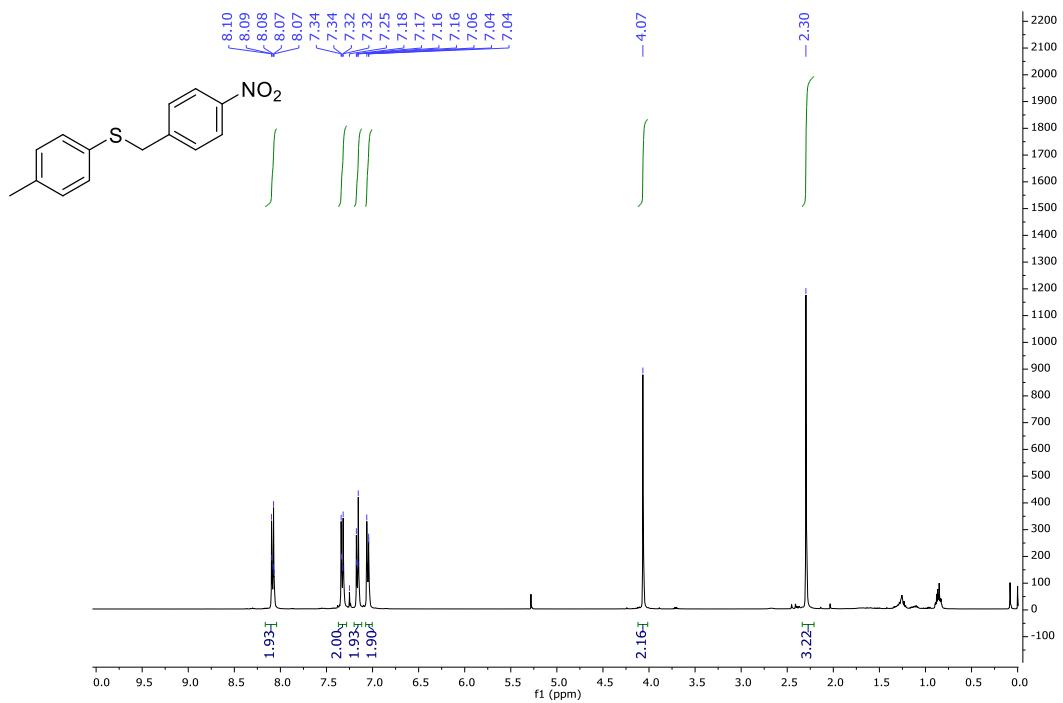


$^{13}\text{C}\{\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **1c**

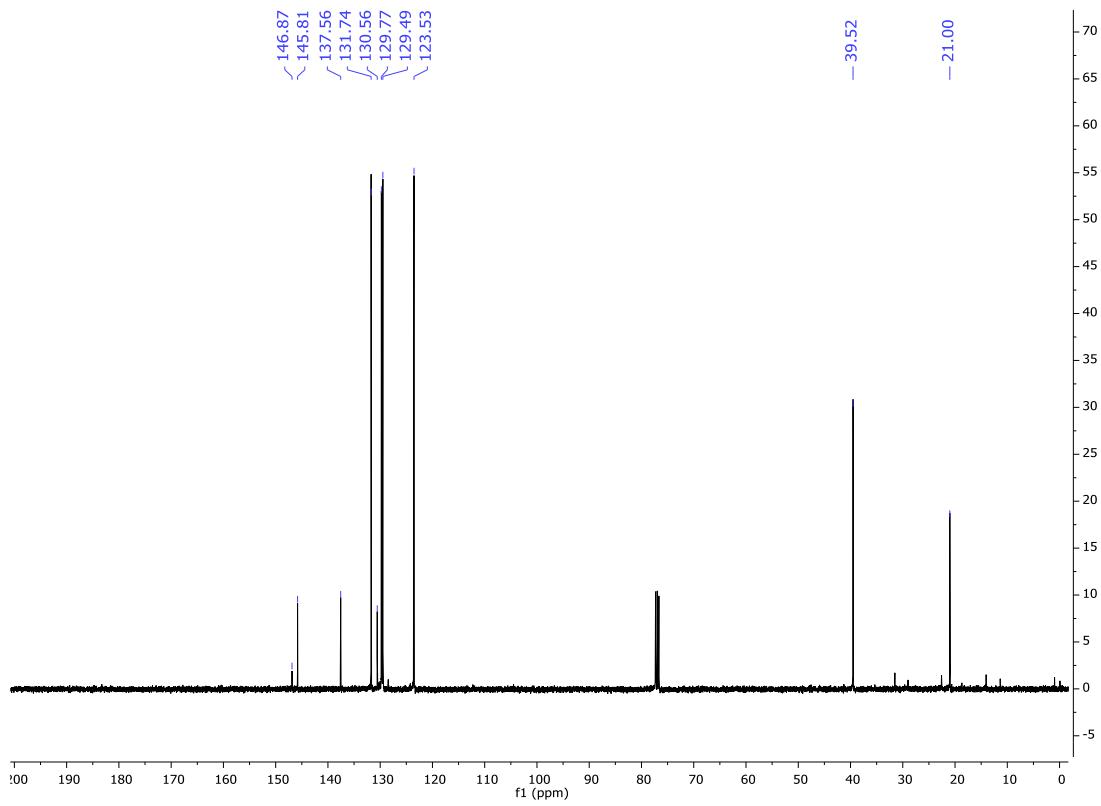




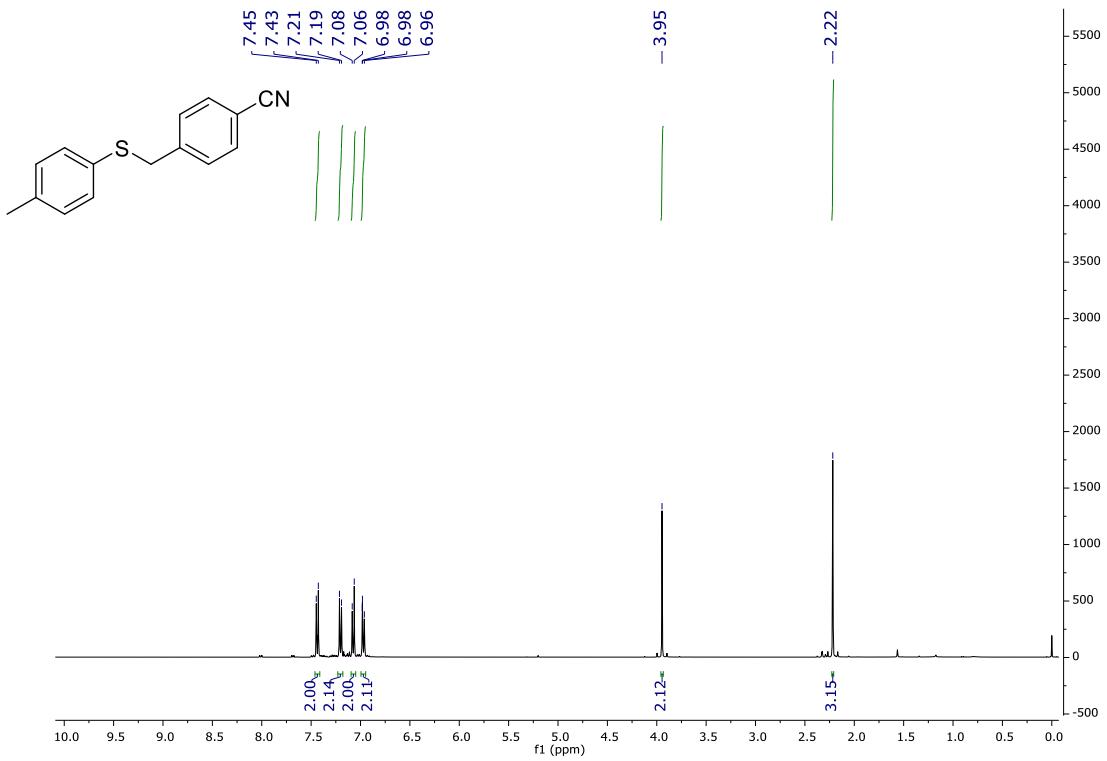
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **3a**



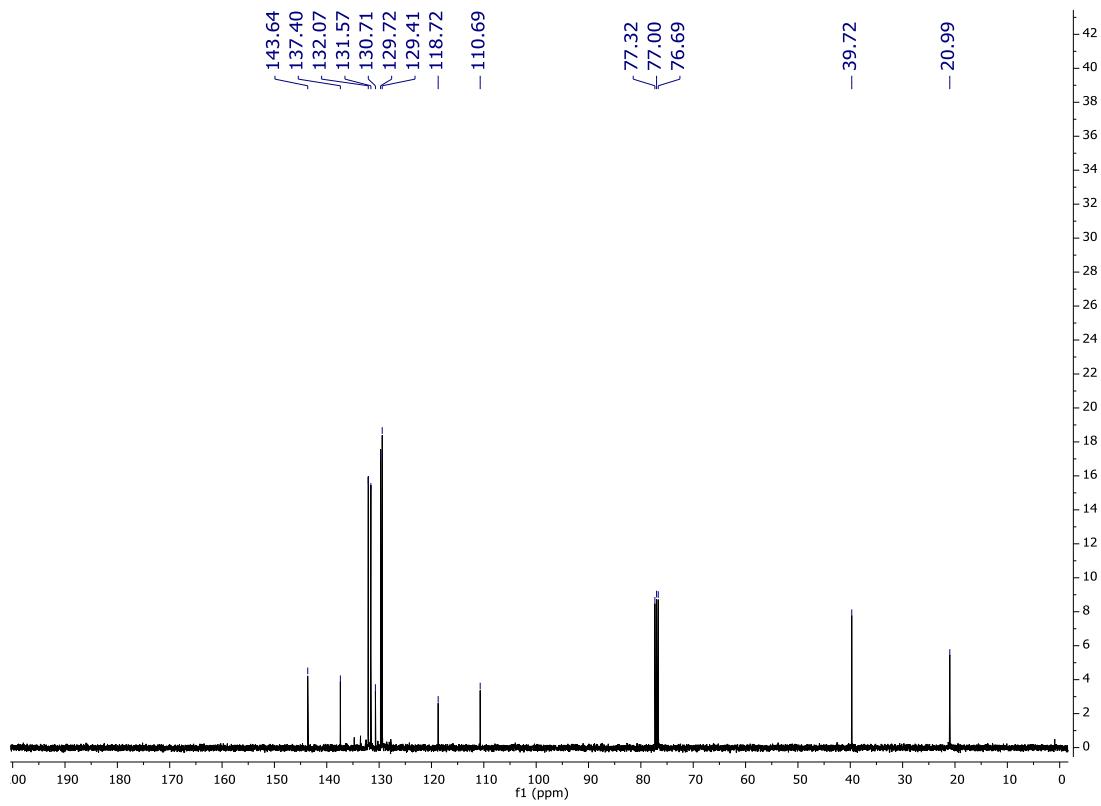
$^1\text{H}$  NMR spectrum (300 MHz,  $\text{CDCl}_3$ ) of compound **3b**



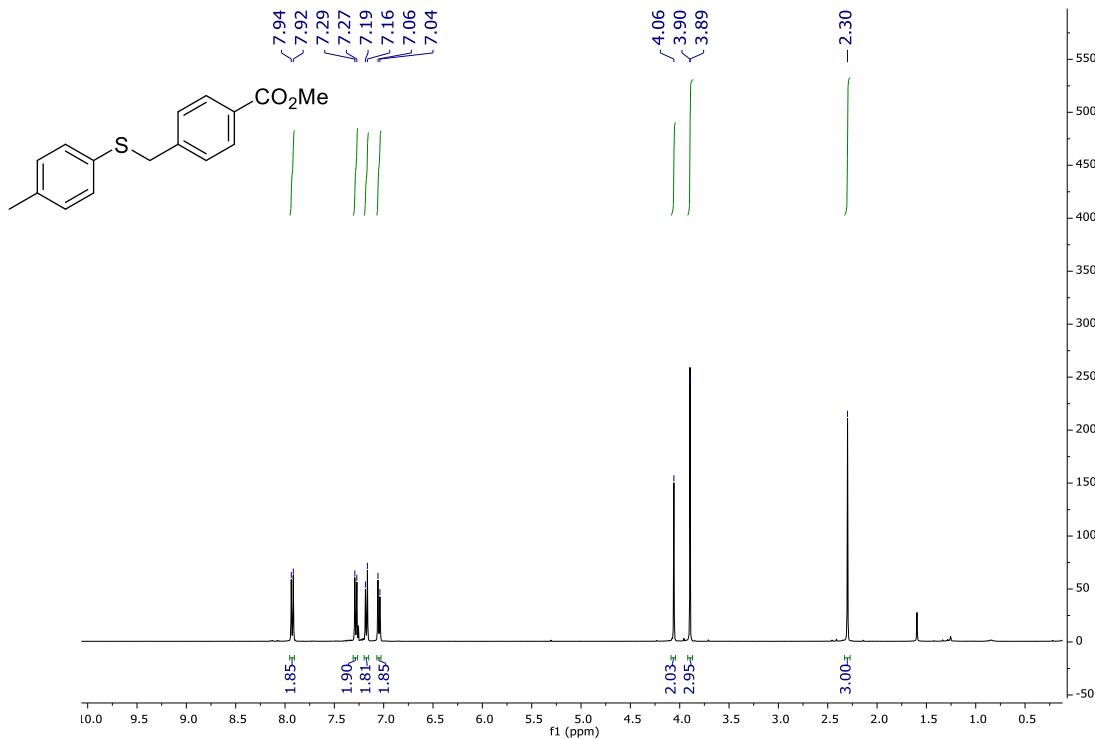
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **3b**



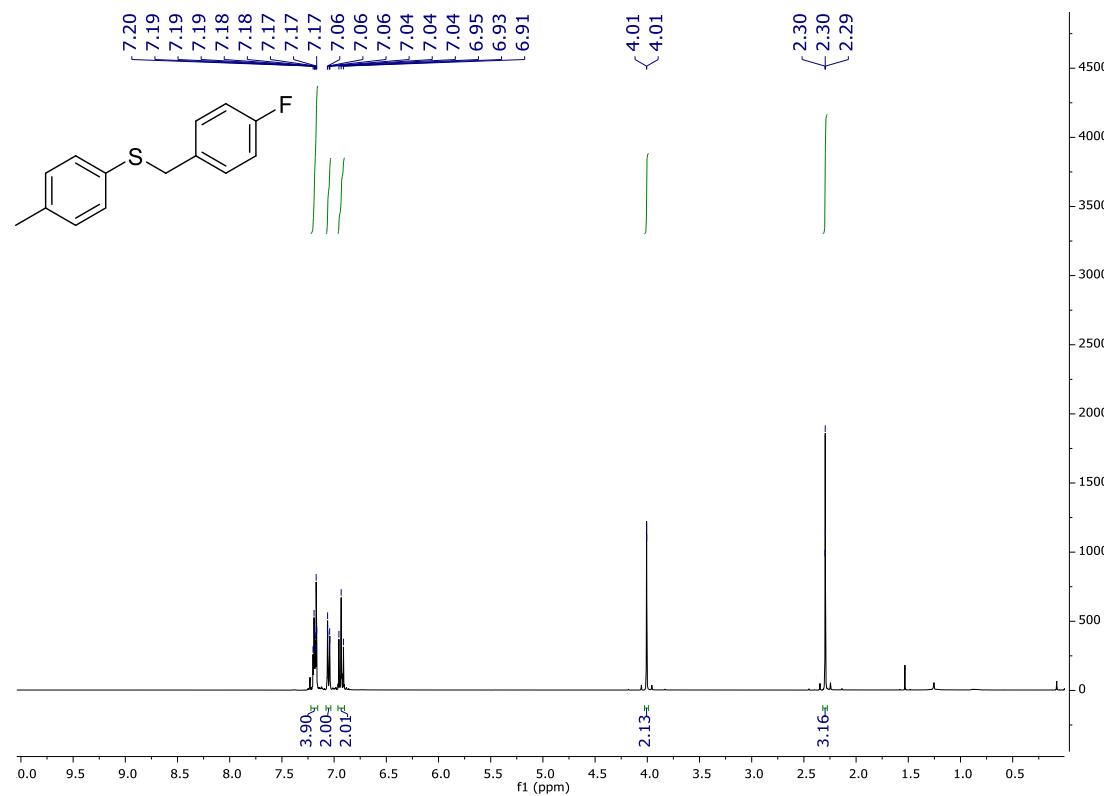
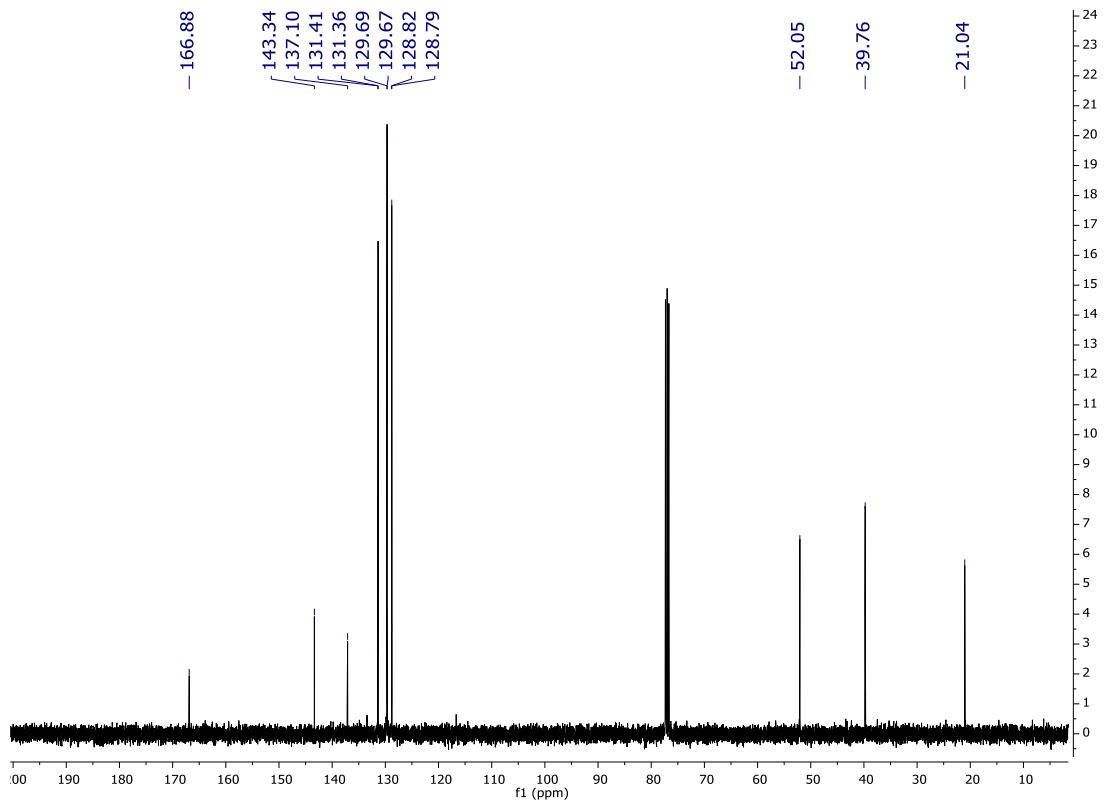
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **3c**

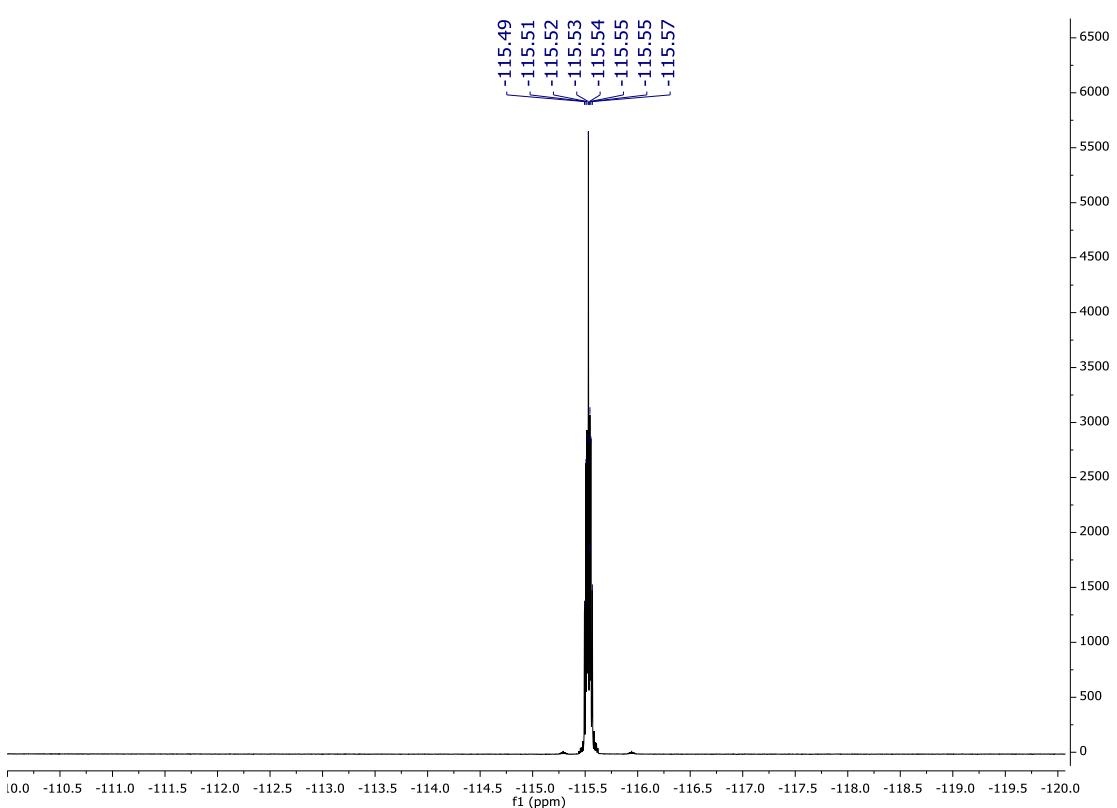
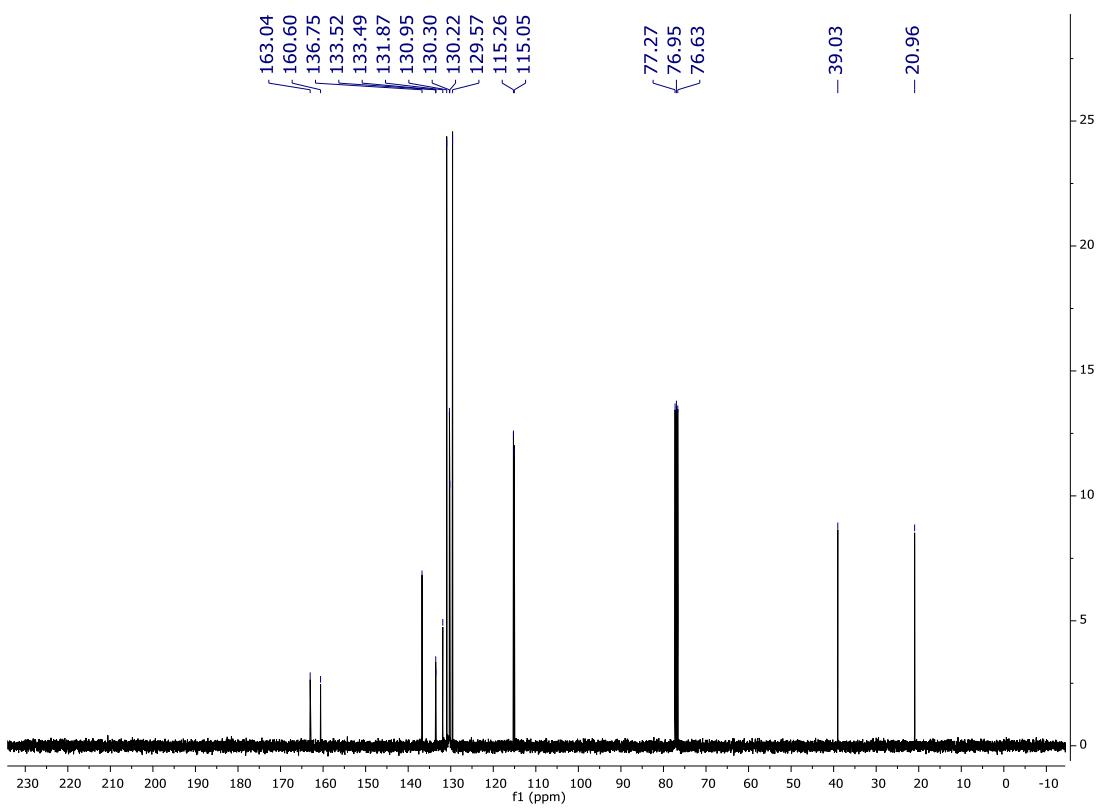


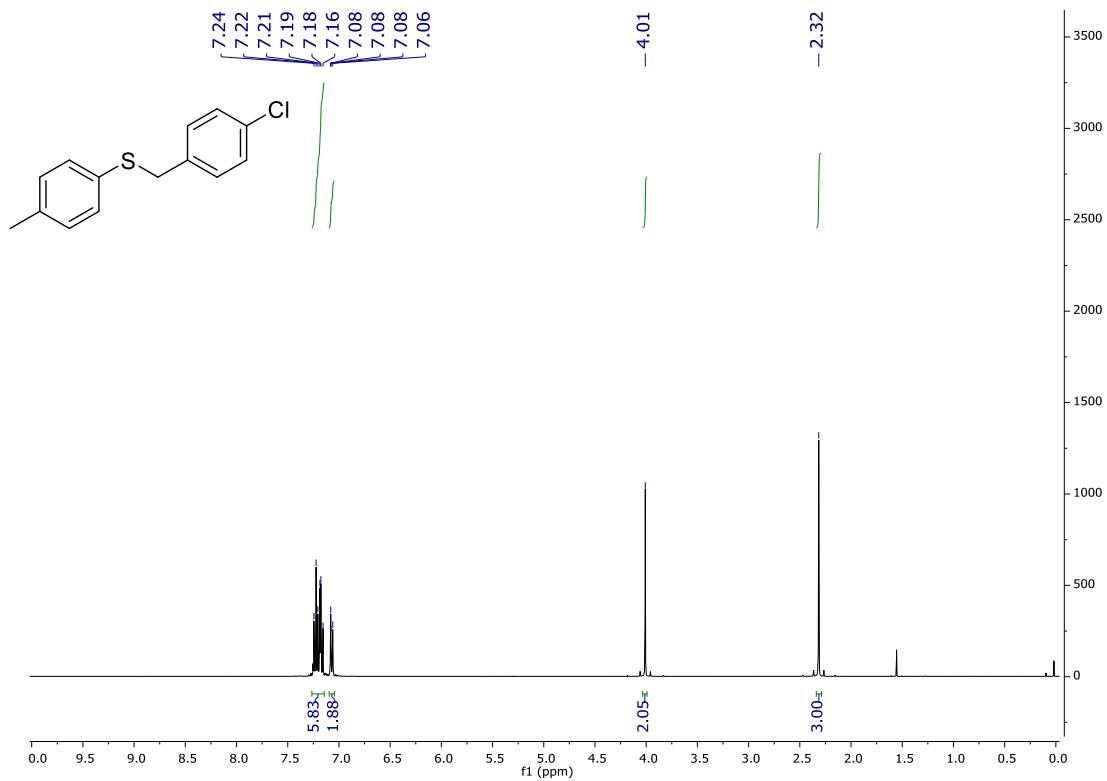
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **3c**



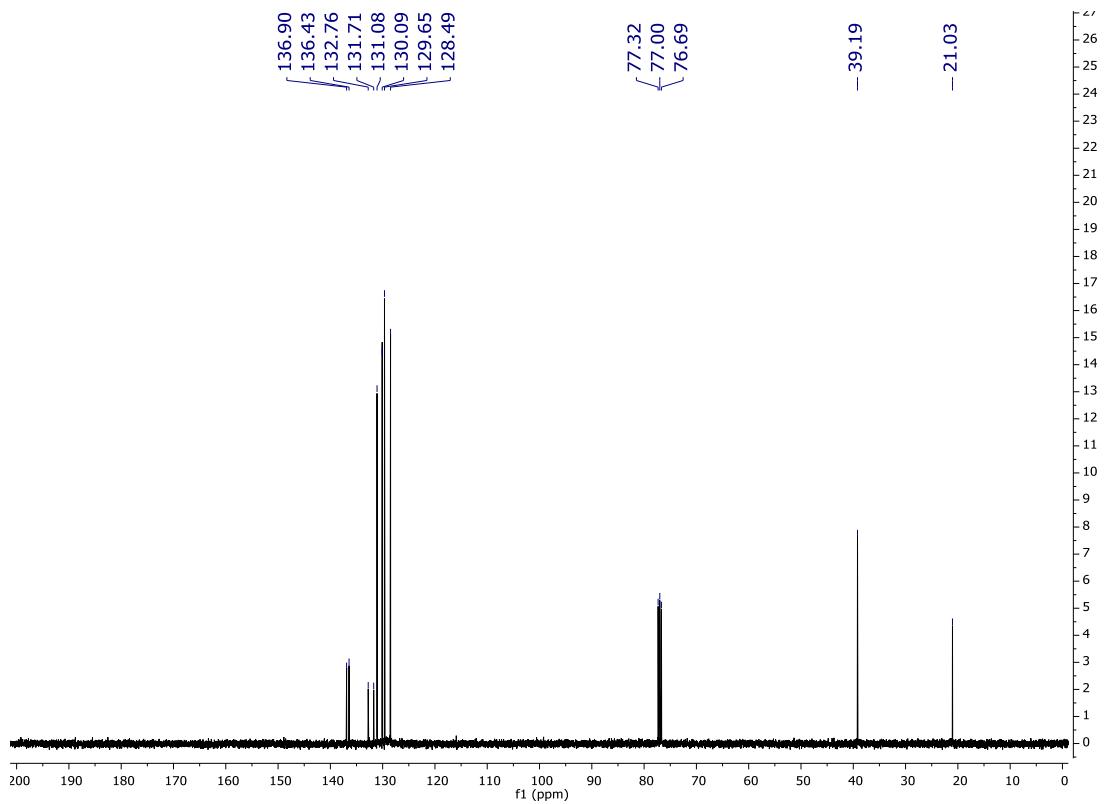
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **3d**



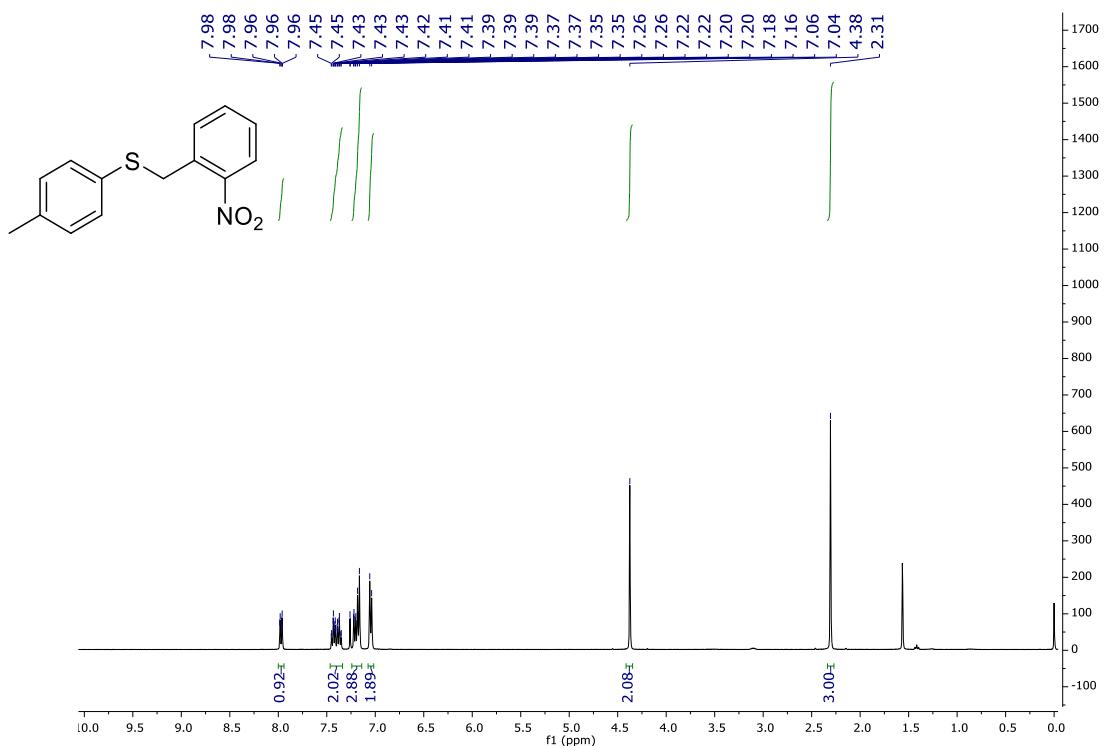




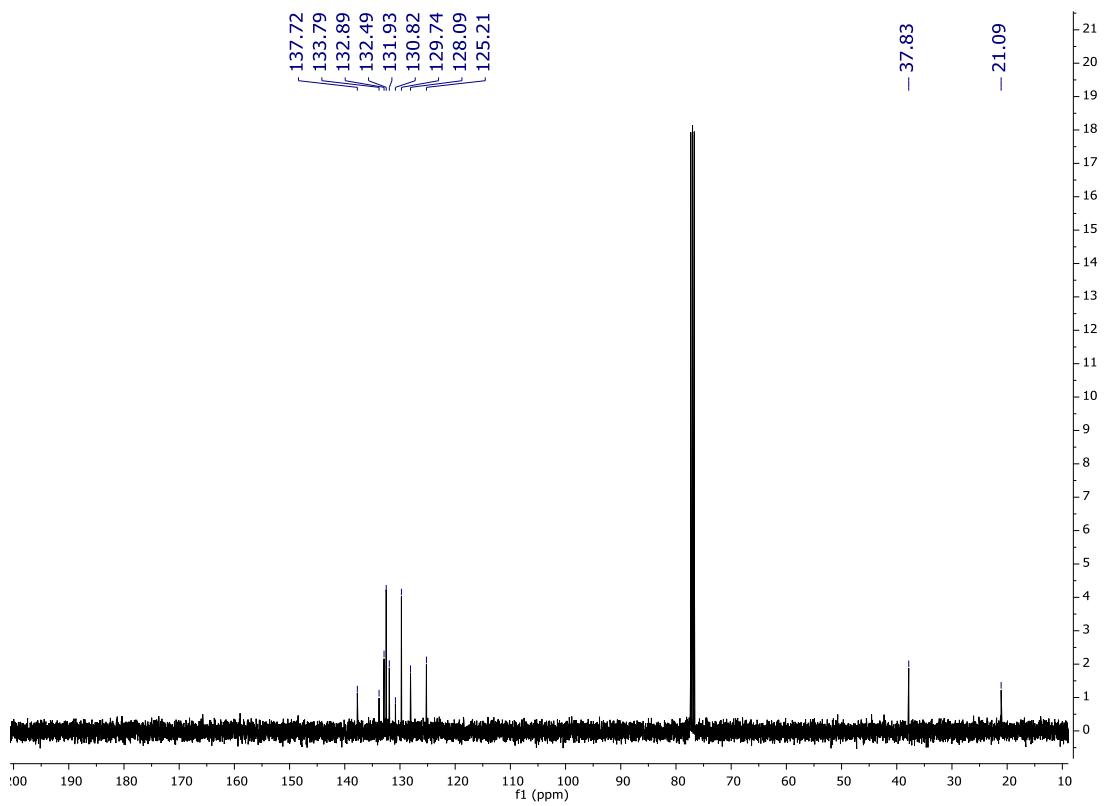
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **3f**



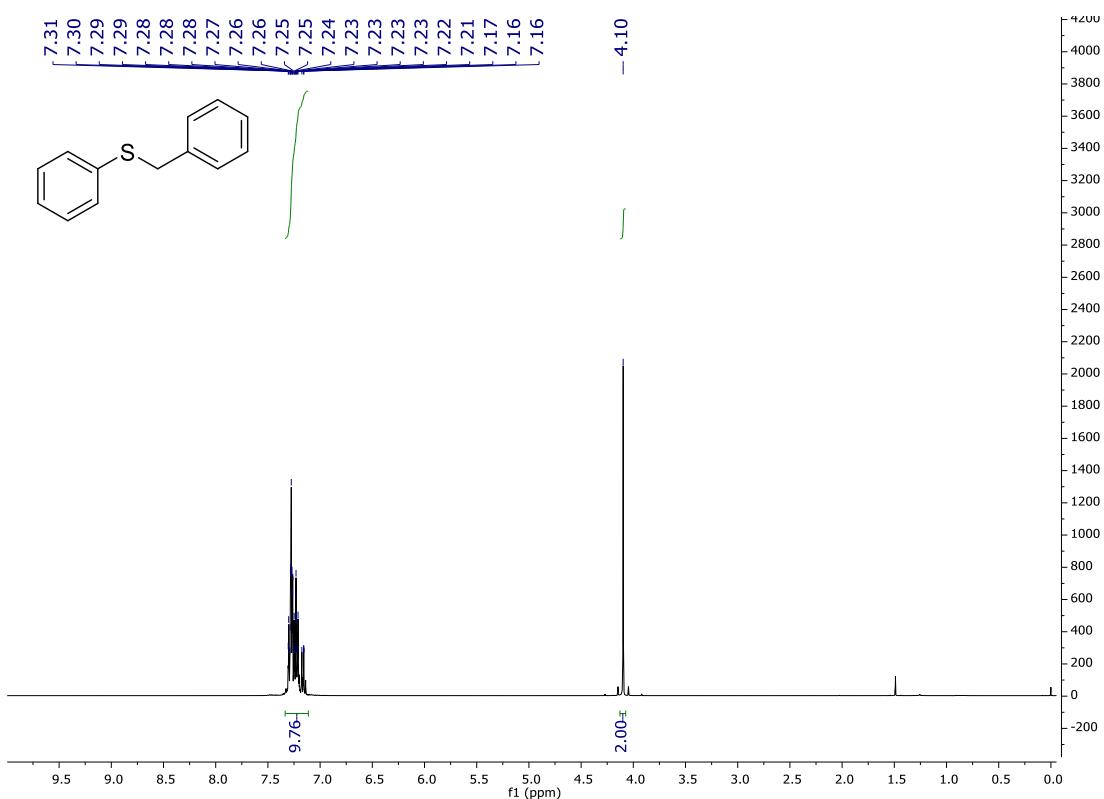
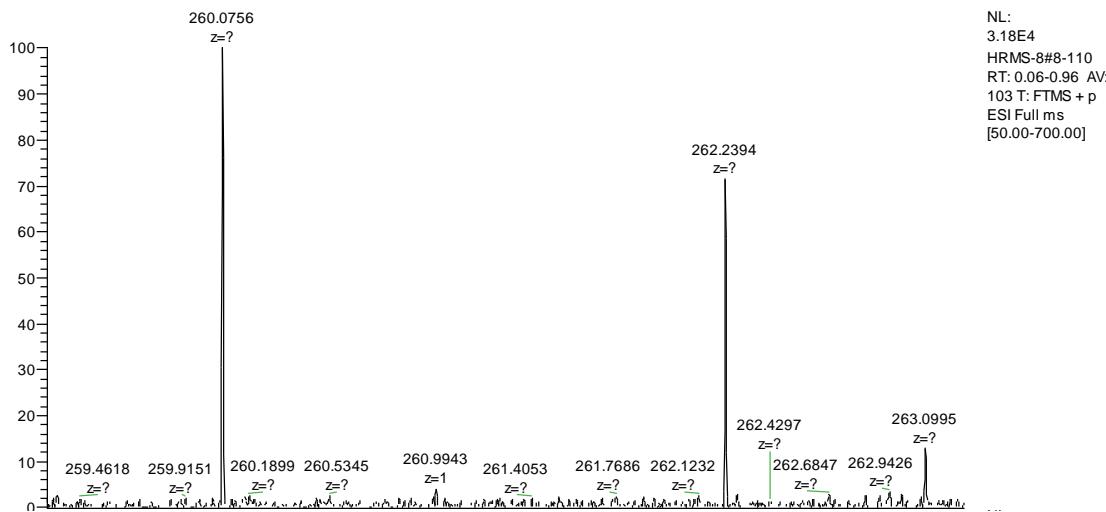
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **3f**

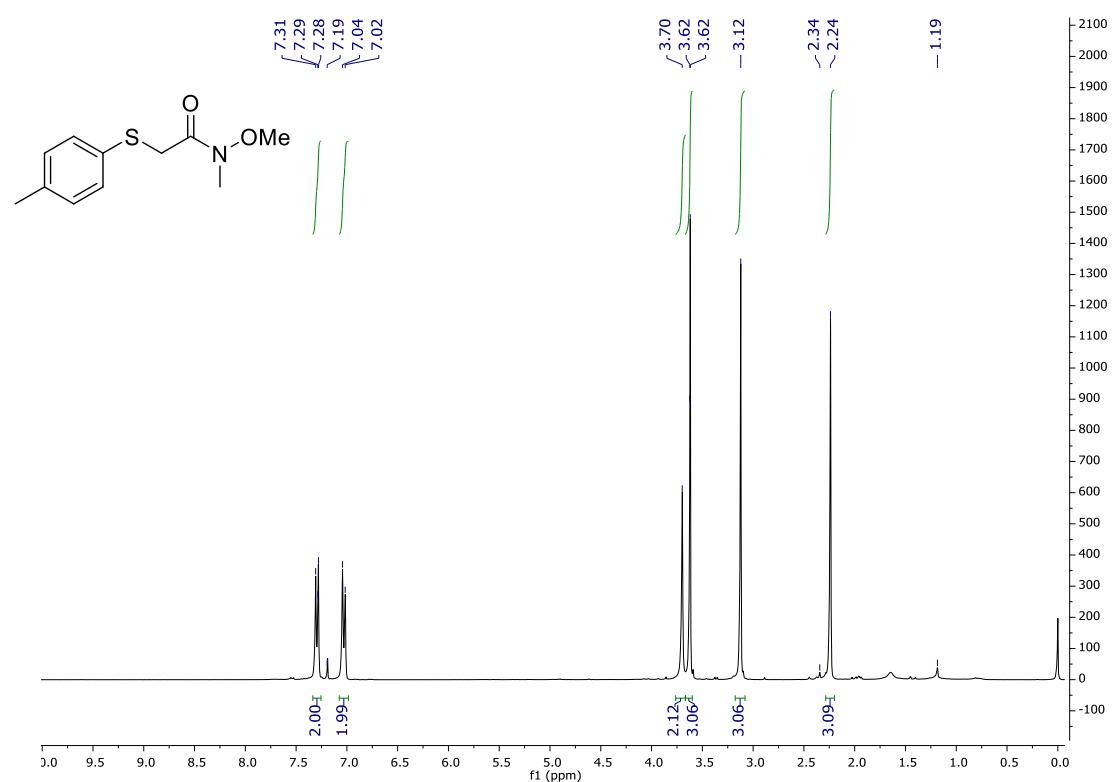
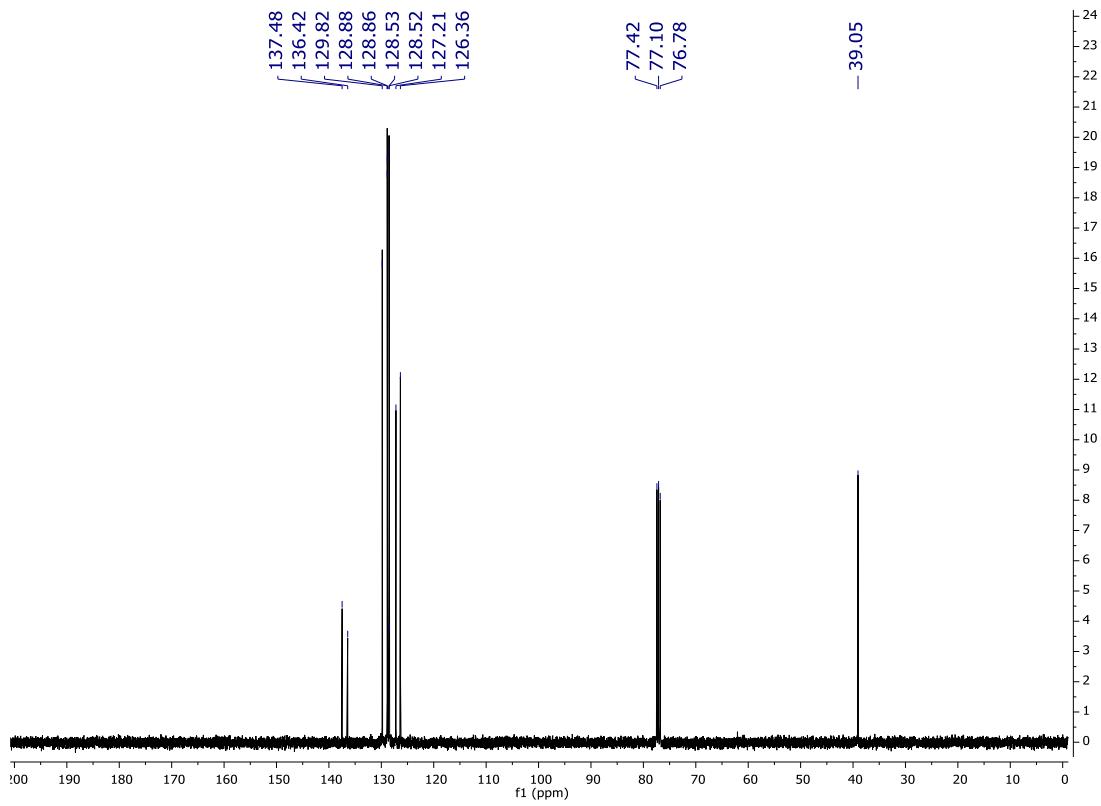


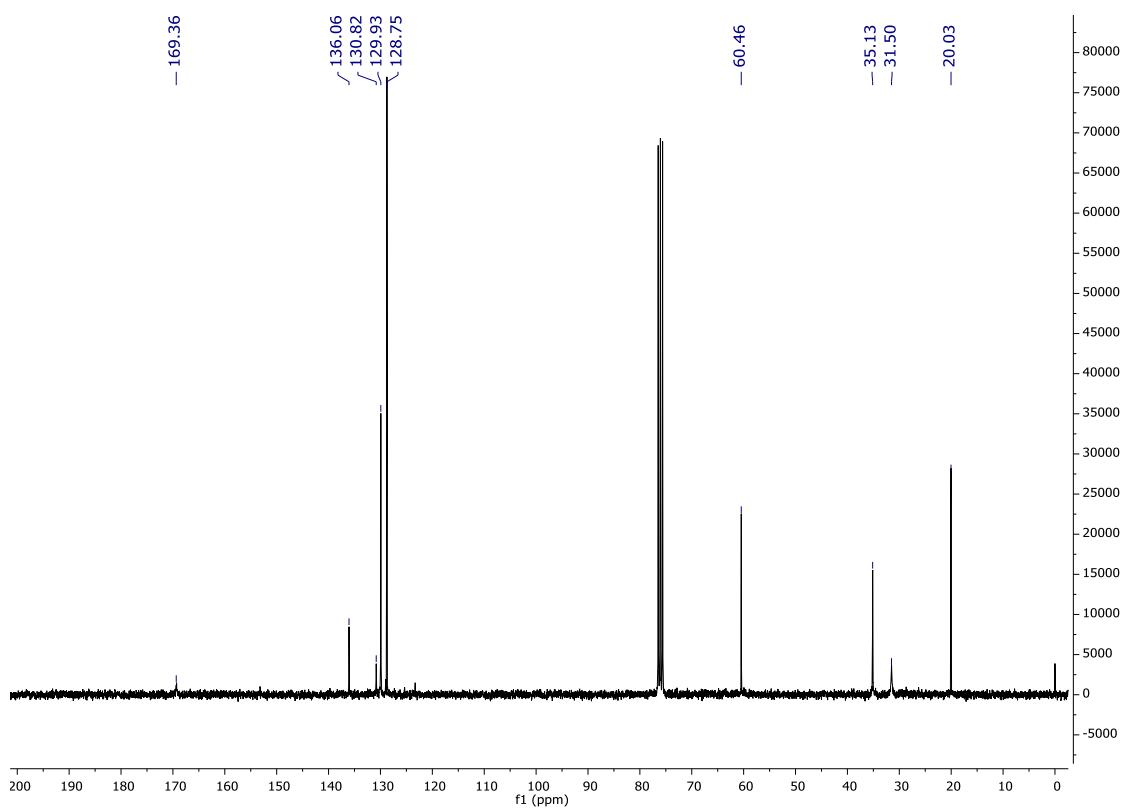
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **3g**



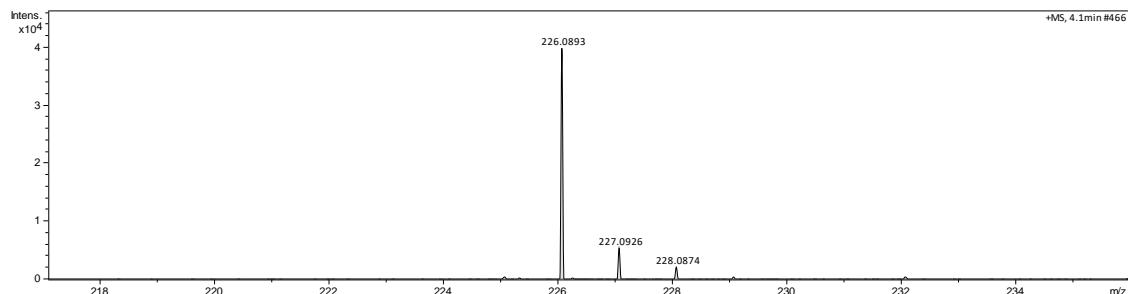
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **3g**



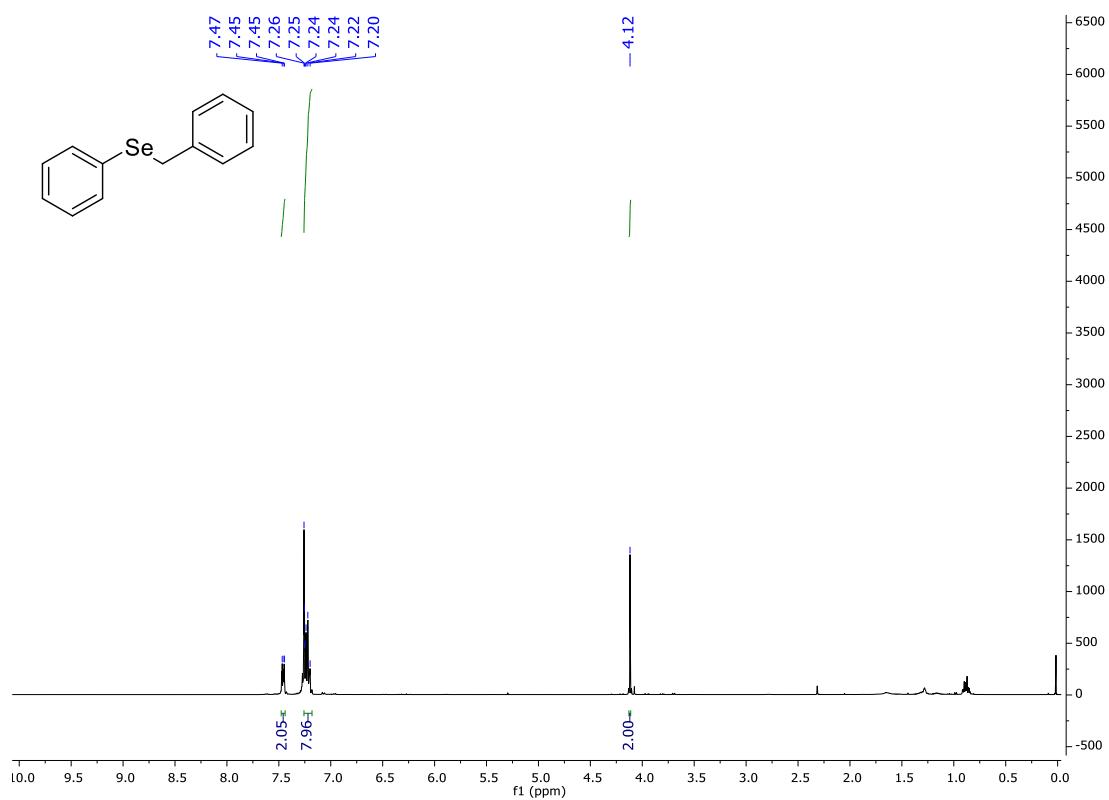




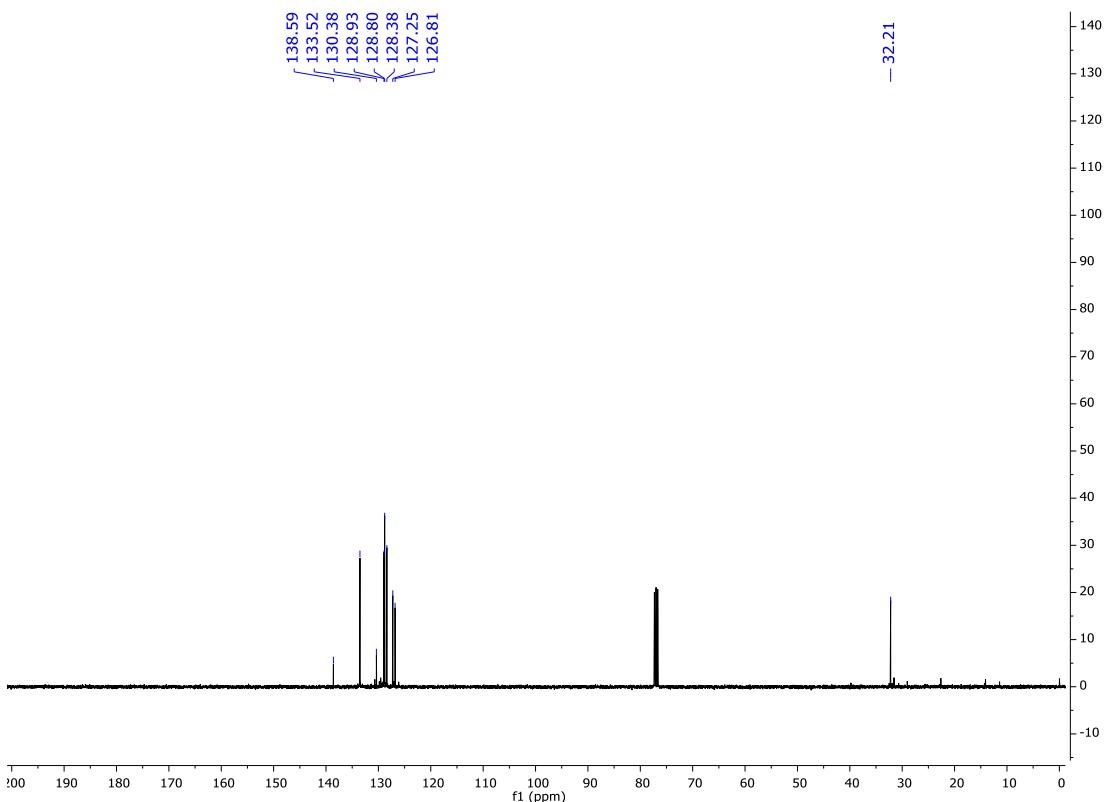
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **3m**



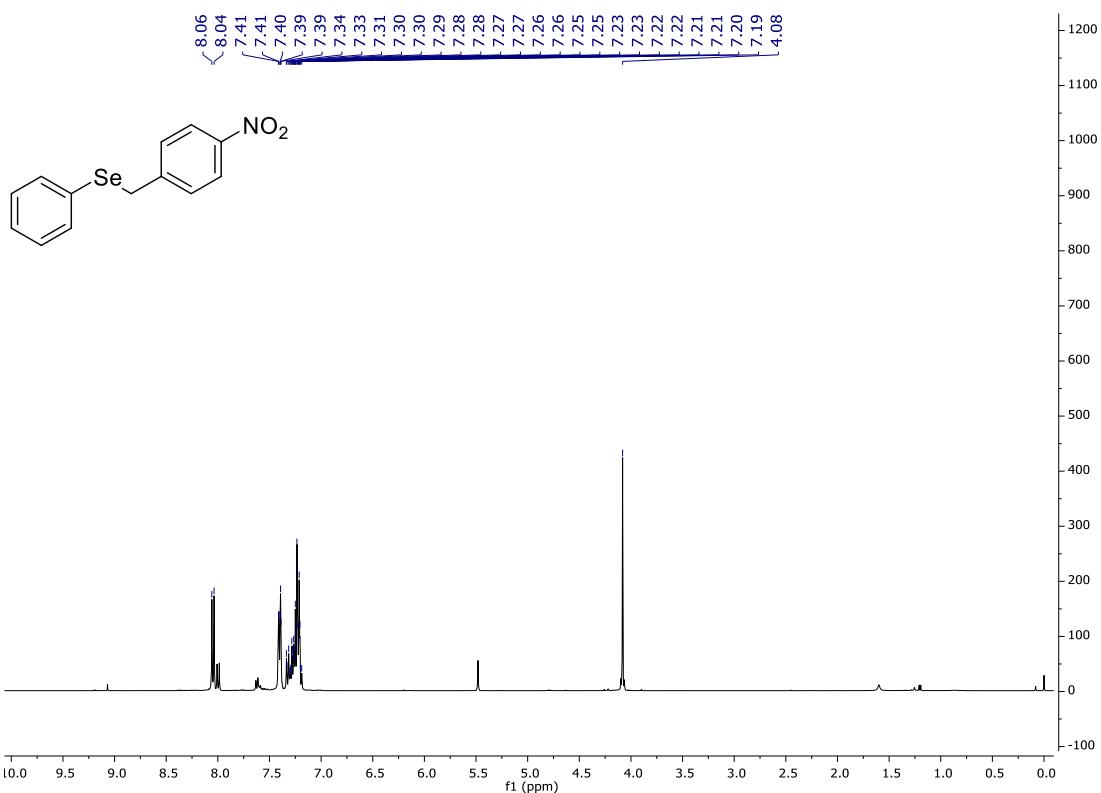
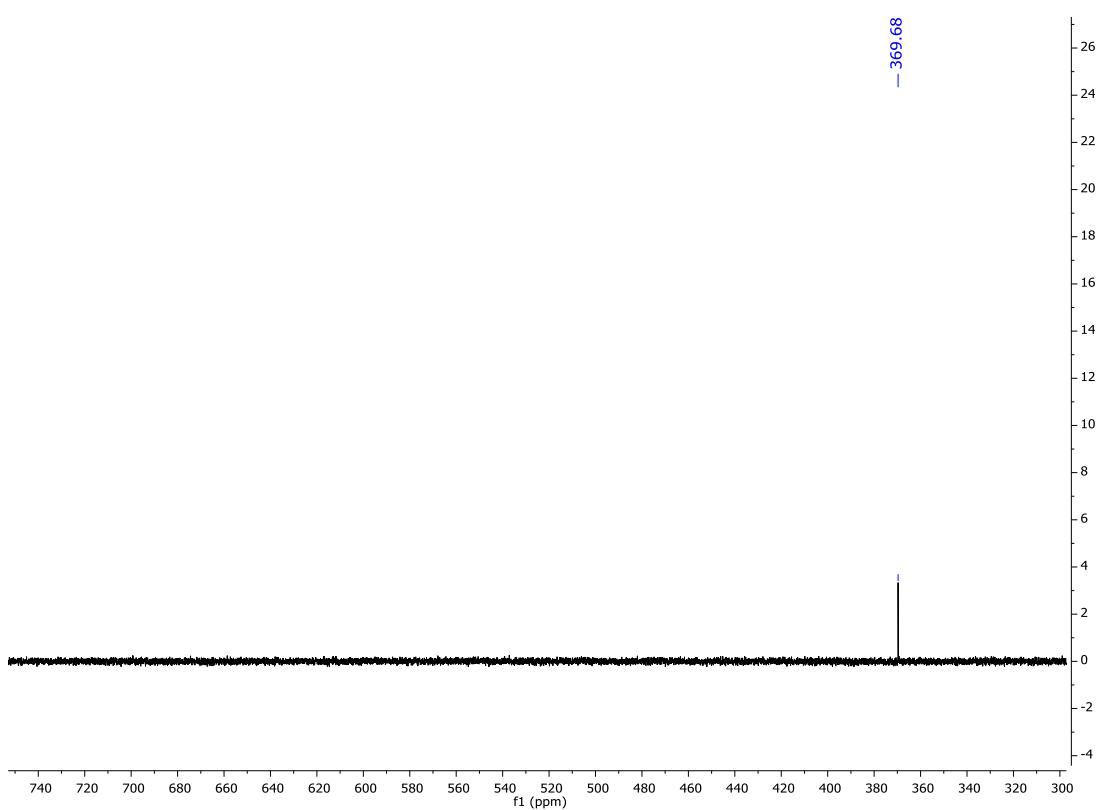
Mass spectrometry analysis of compound **3m** HRMS (ESI)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{11}\text{H}_{16}\text{NO}_2\text{S}^+$  226.0896; Found 226.0893.



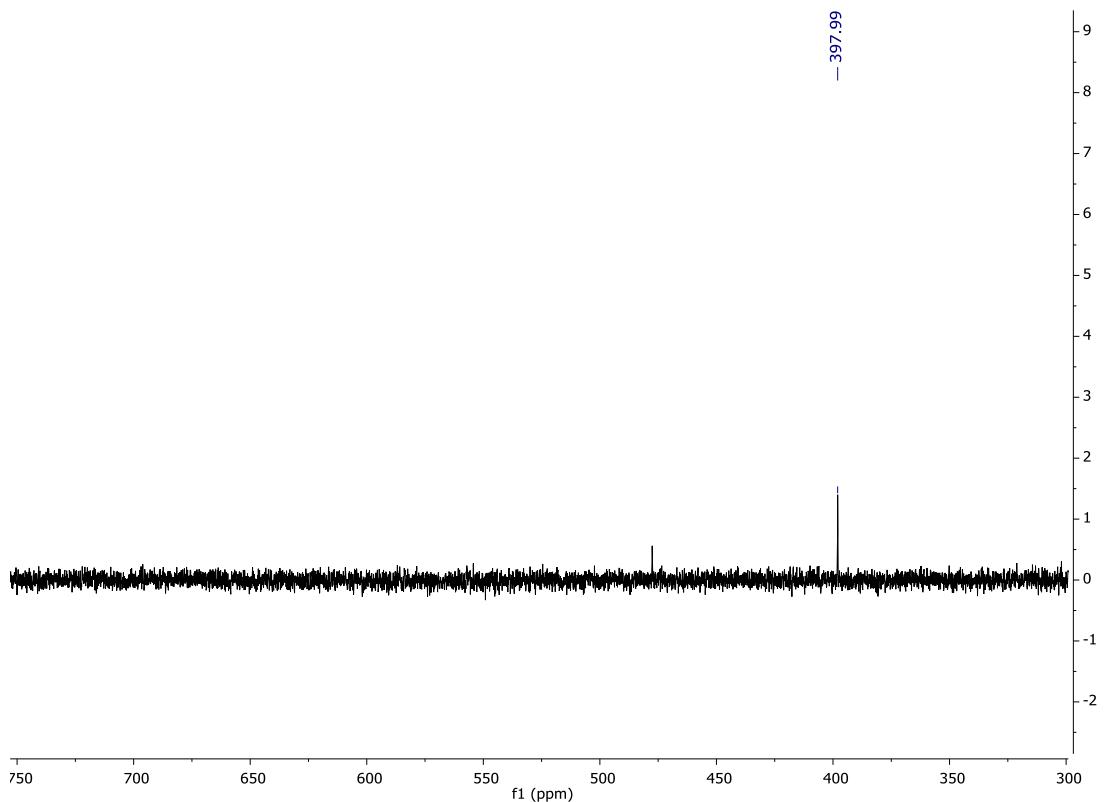
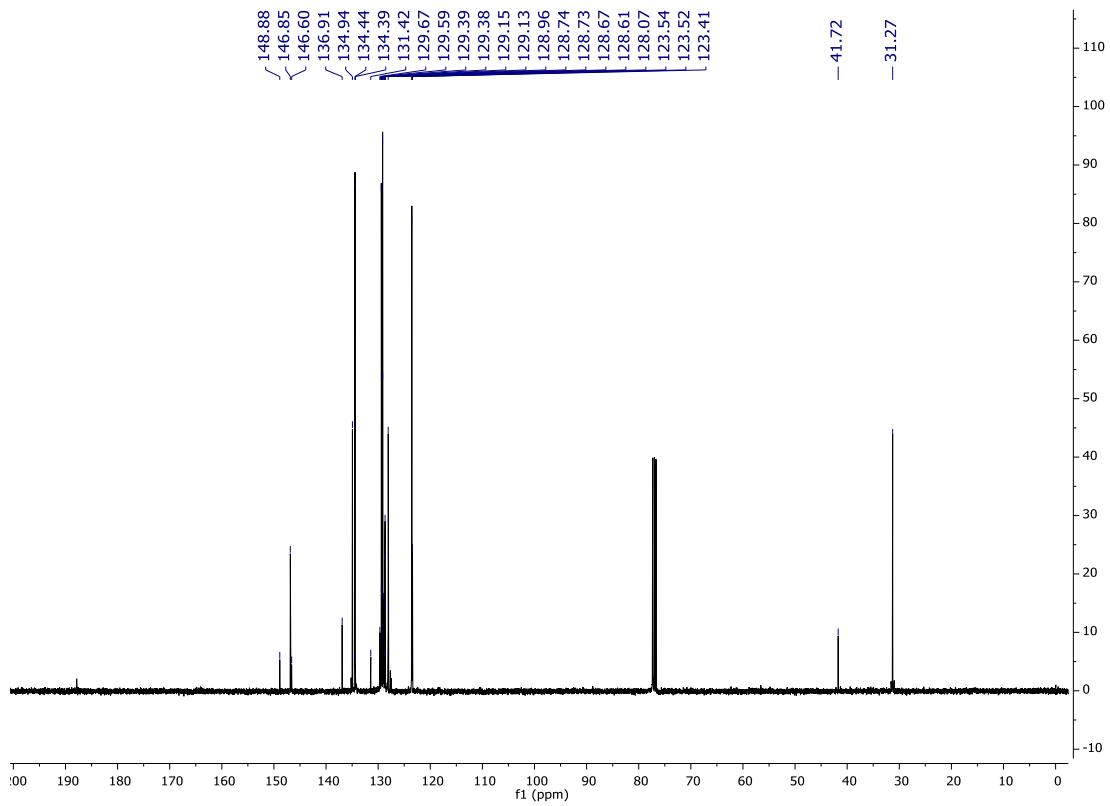
$^1\text{H}$  NMR spectrum (300 MHz,  $\text{CDCl}_3$ ) of compound **5a**



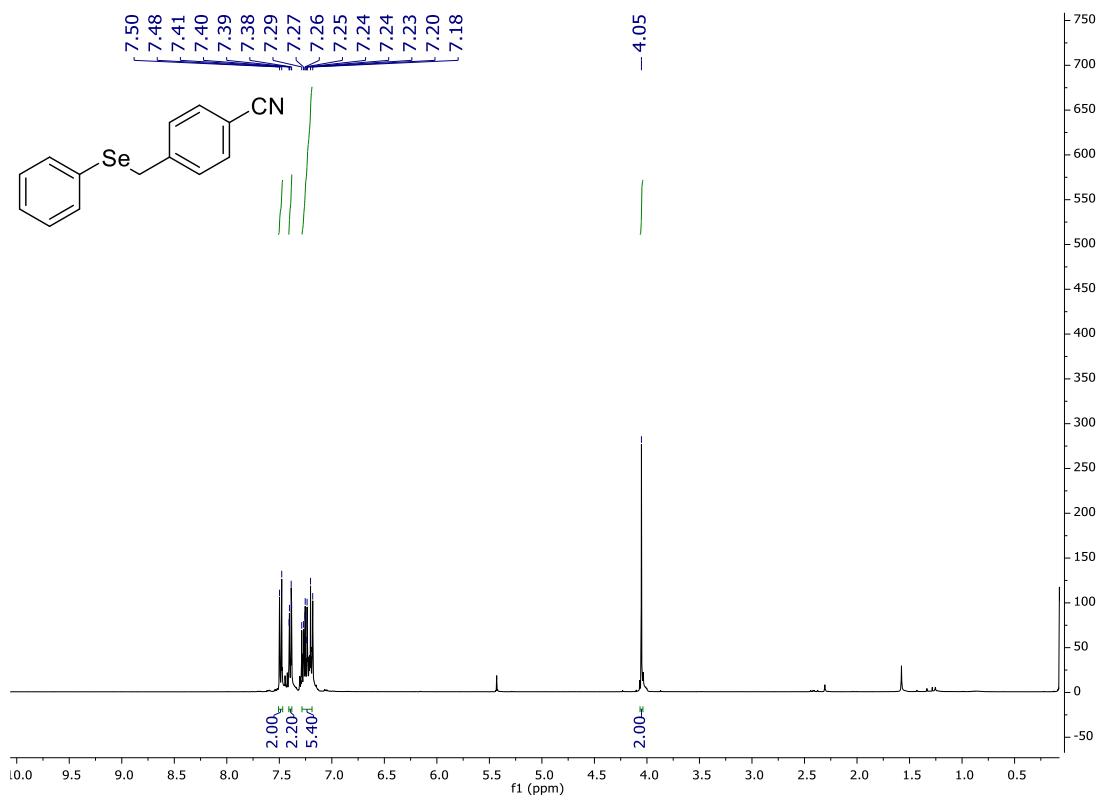
$^{13}\text{C}\{\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **5a**



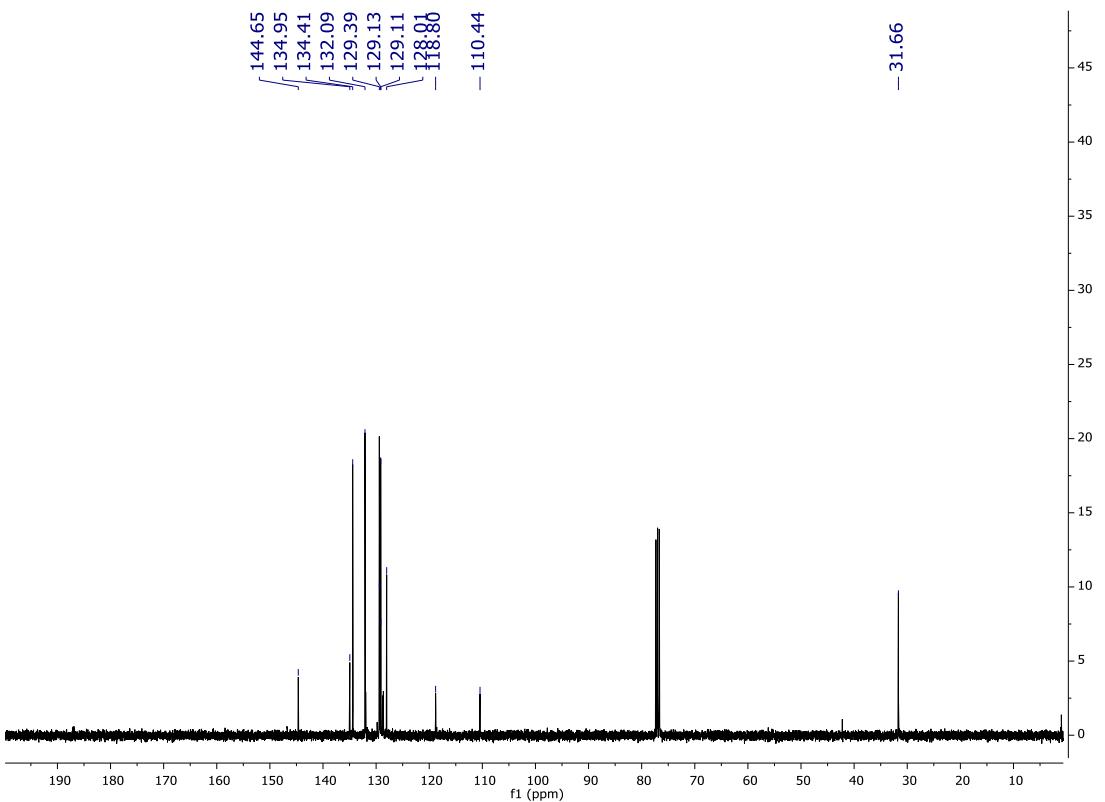
<sup>1</sup>H NMR spectrum (300 MHz, CDCl<sub>3</sub>) of compound **5b**



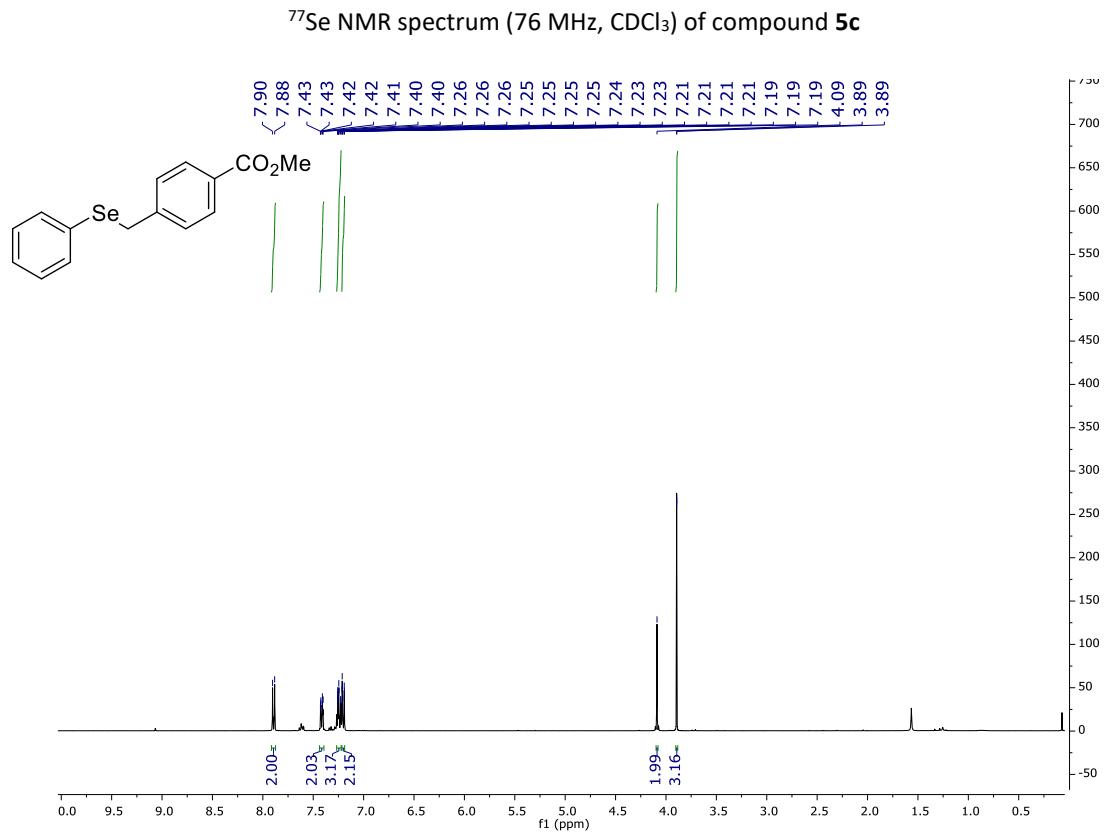
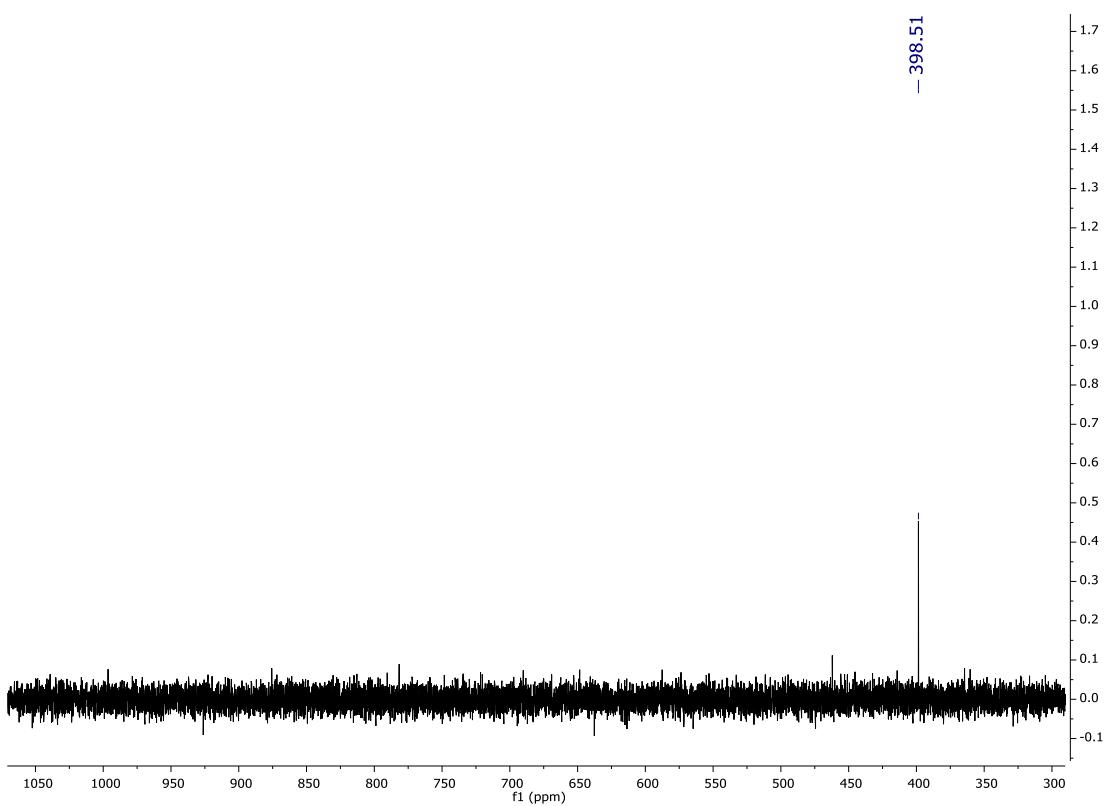
<sup>77</sup>Se NMR spectrum (57 MHz, CDCl<sub>3</sub>) of compound **5b**



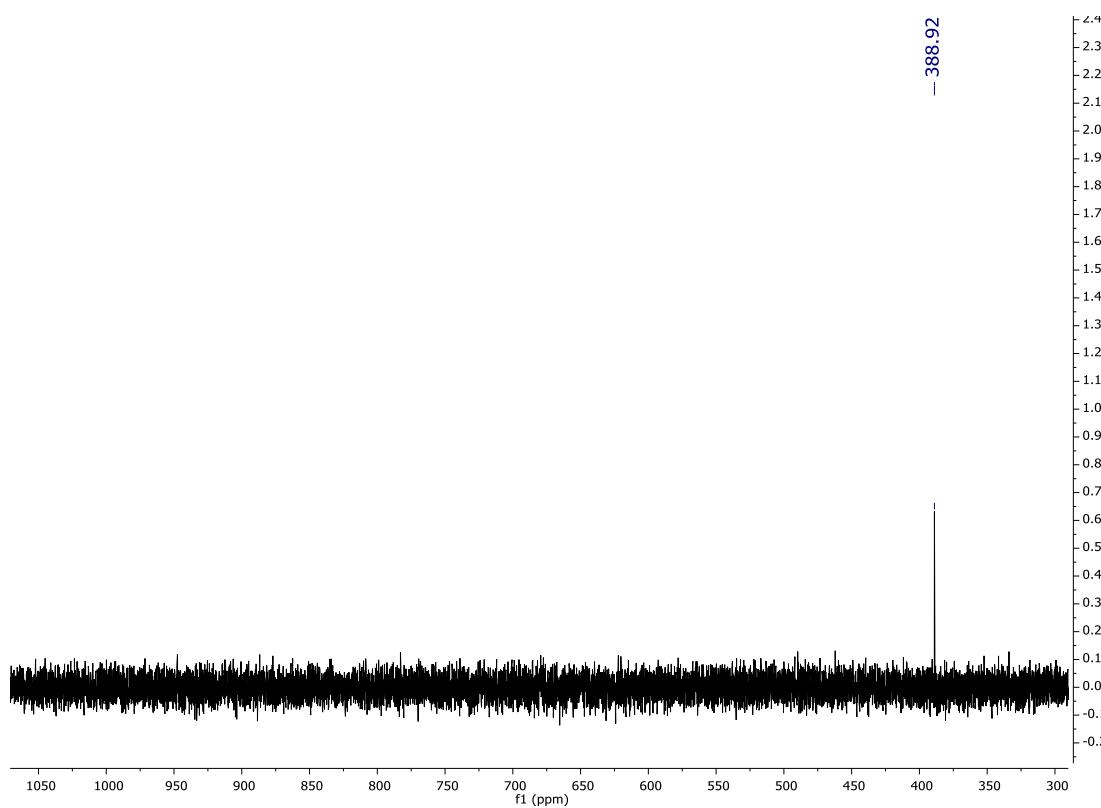
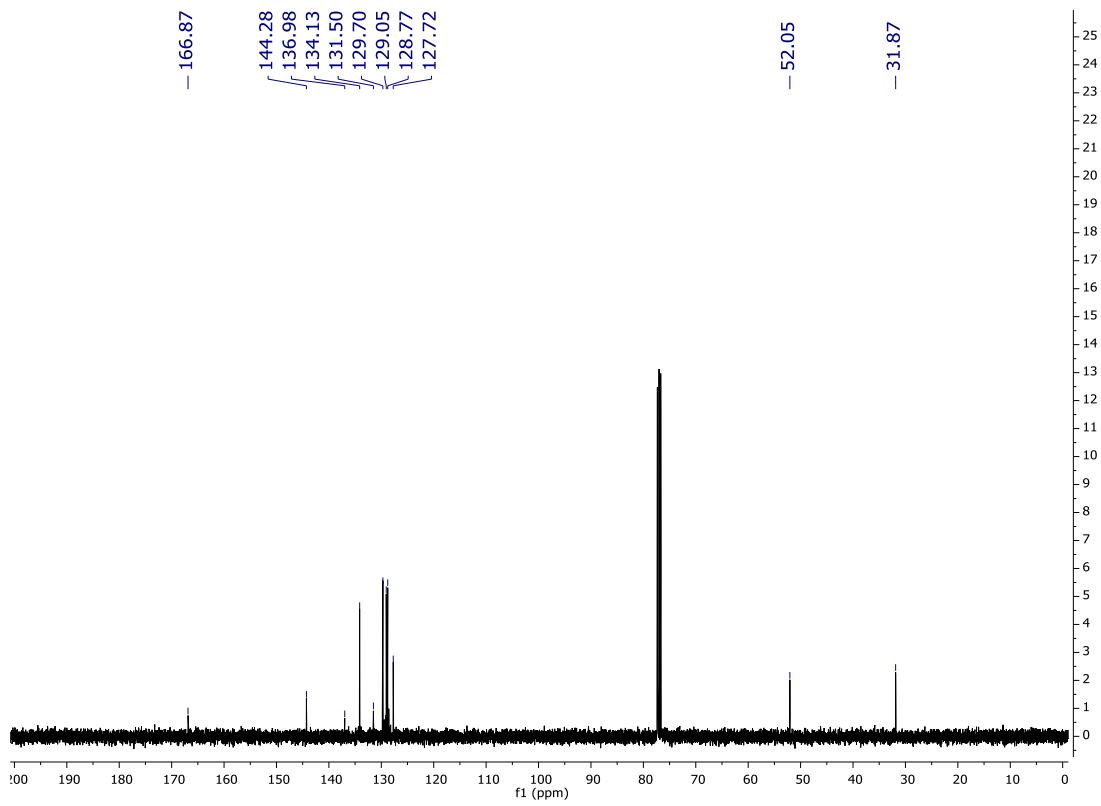
$^1\text{H}$  NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **5c**

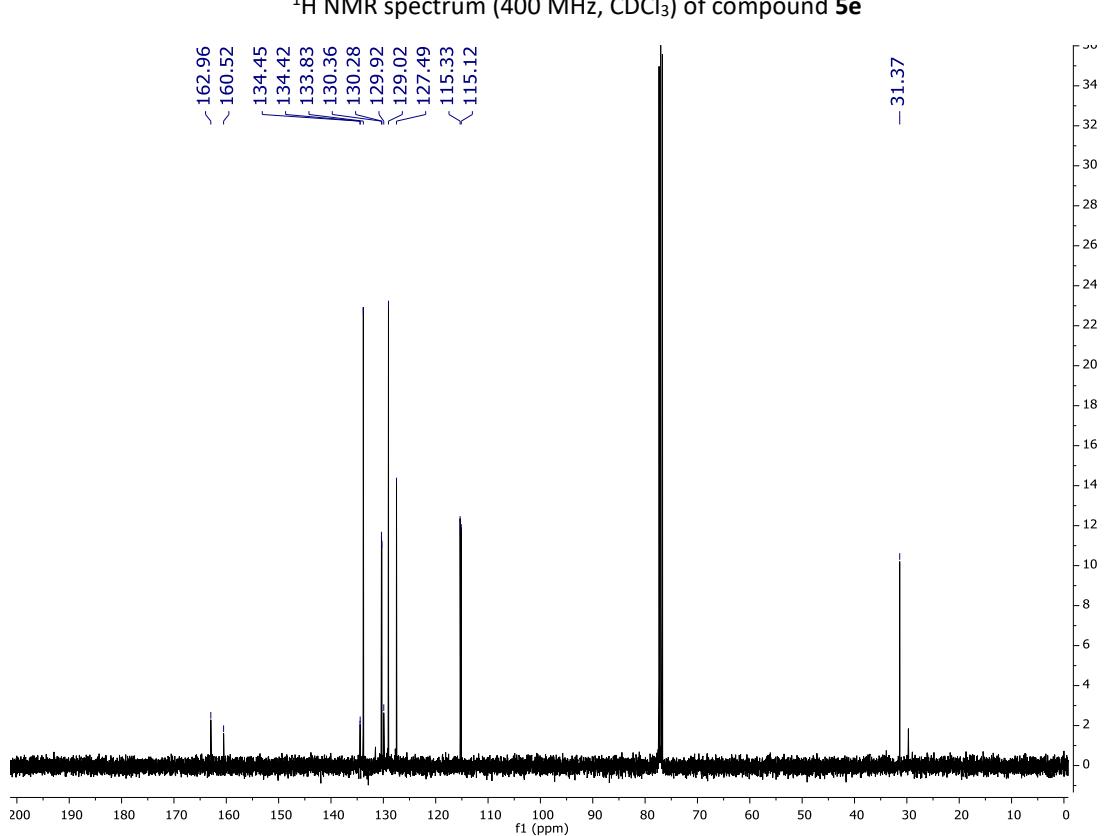
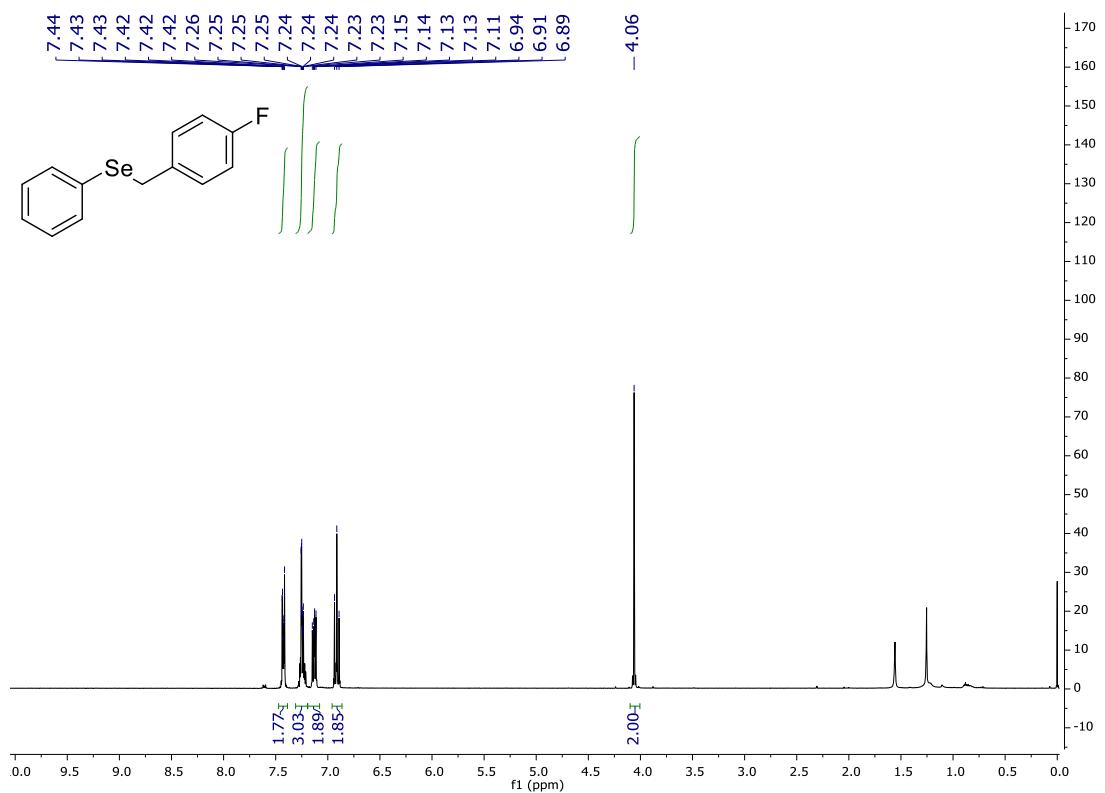


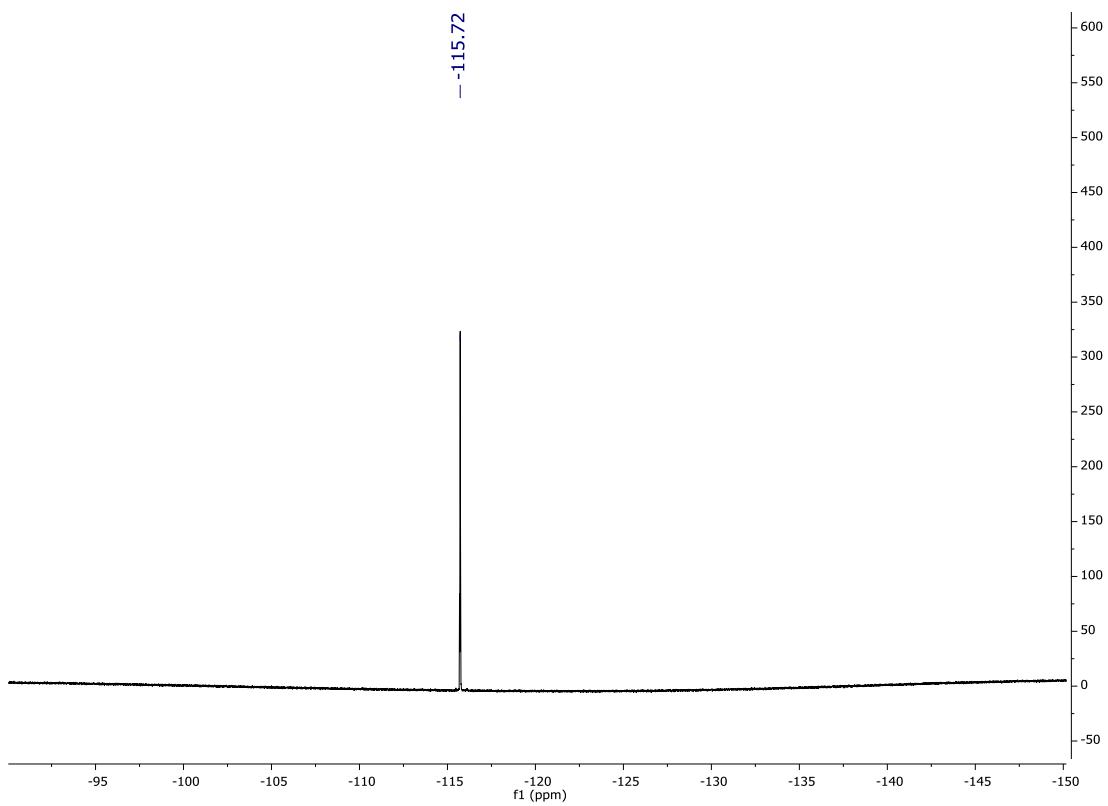
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz, CDCl<sub>3</sub>) of compound **5c**



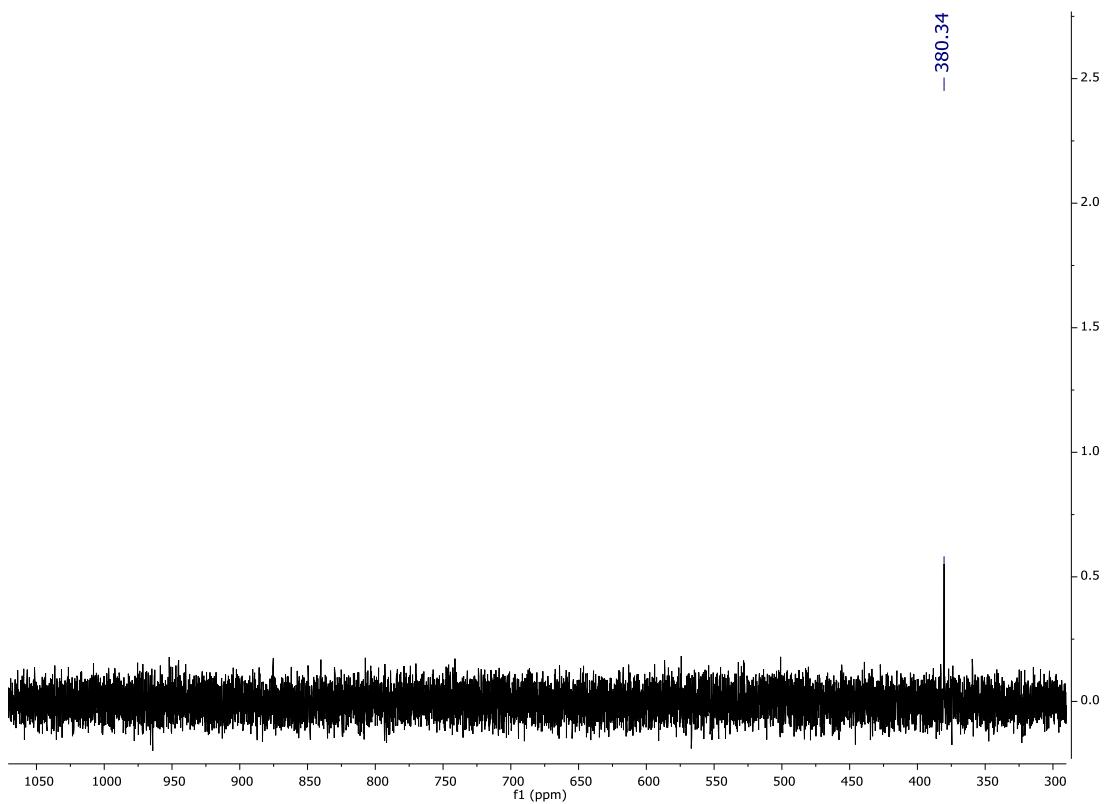
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **5d**



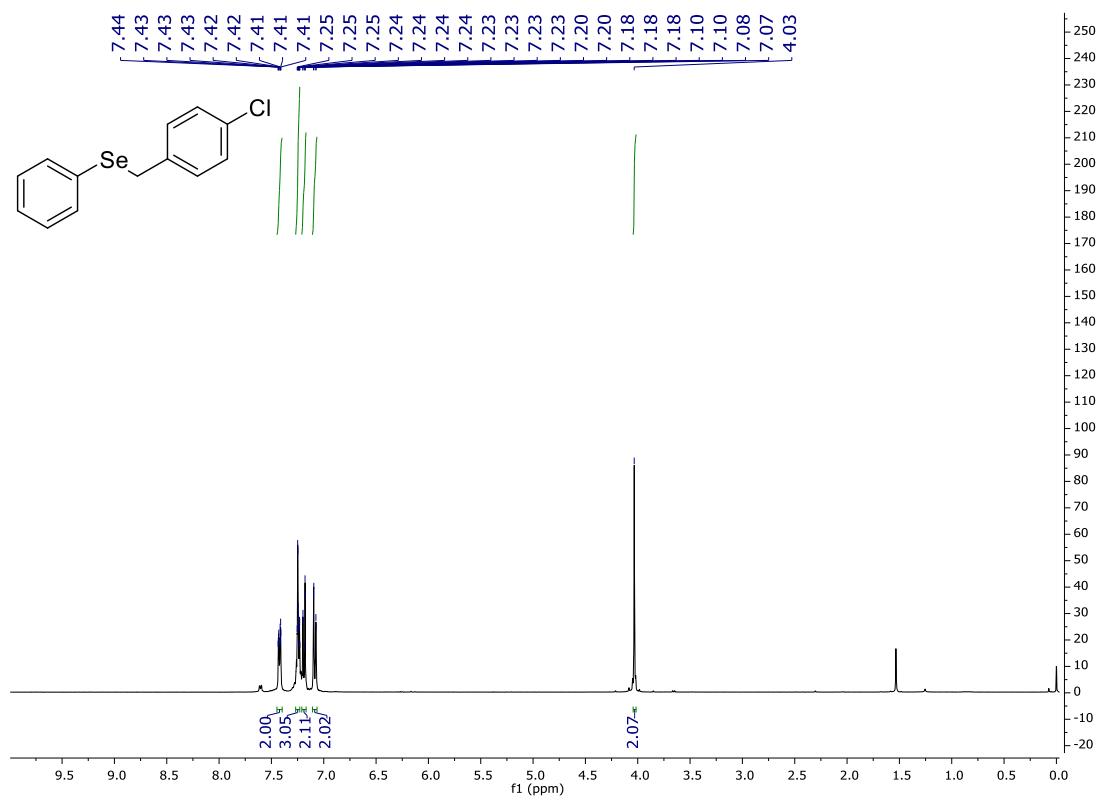




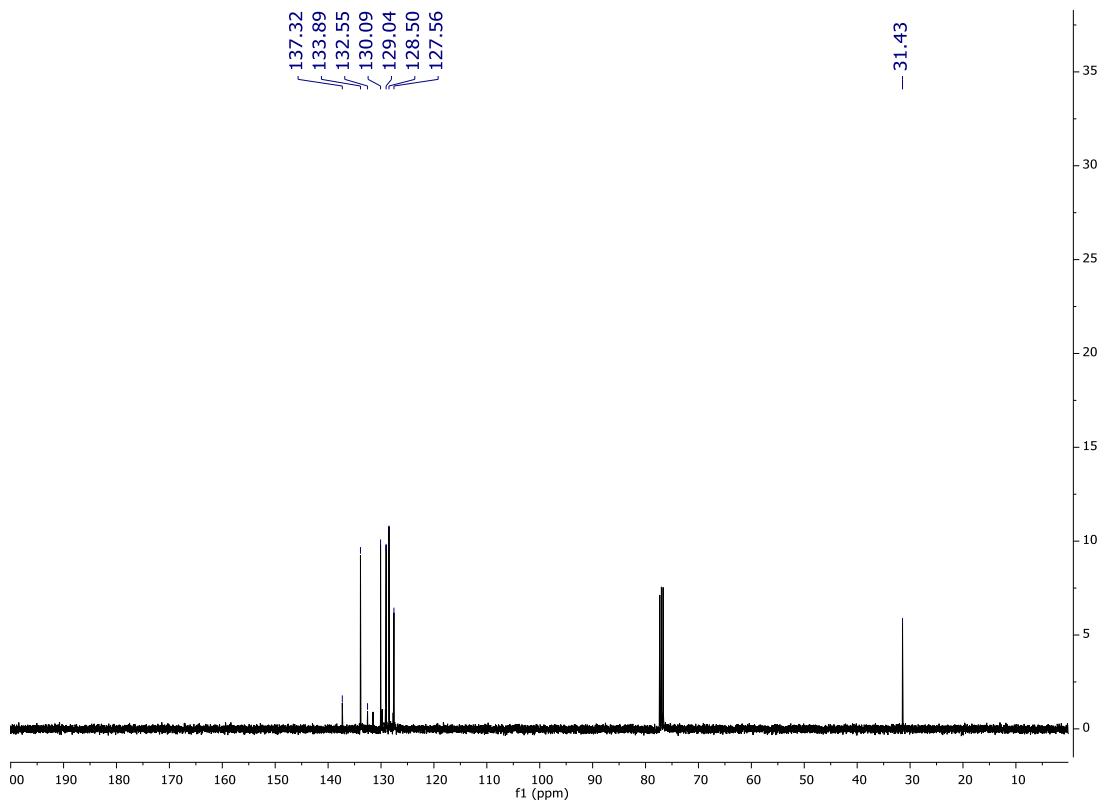
$^{19}\text{F}$  NMR spectrum (376 MHz,  $\text{CDCl}_3$ ) of compound **5e**



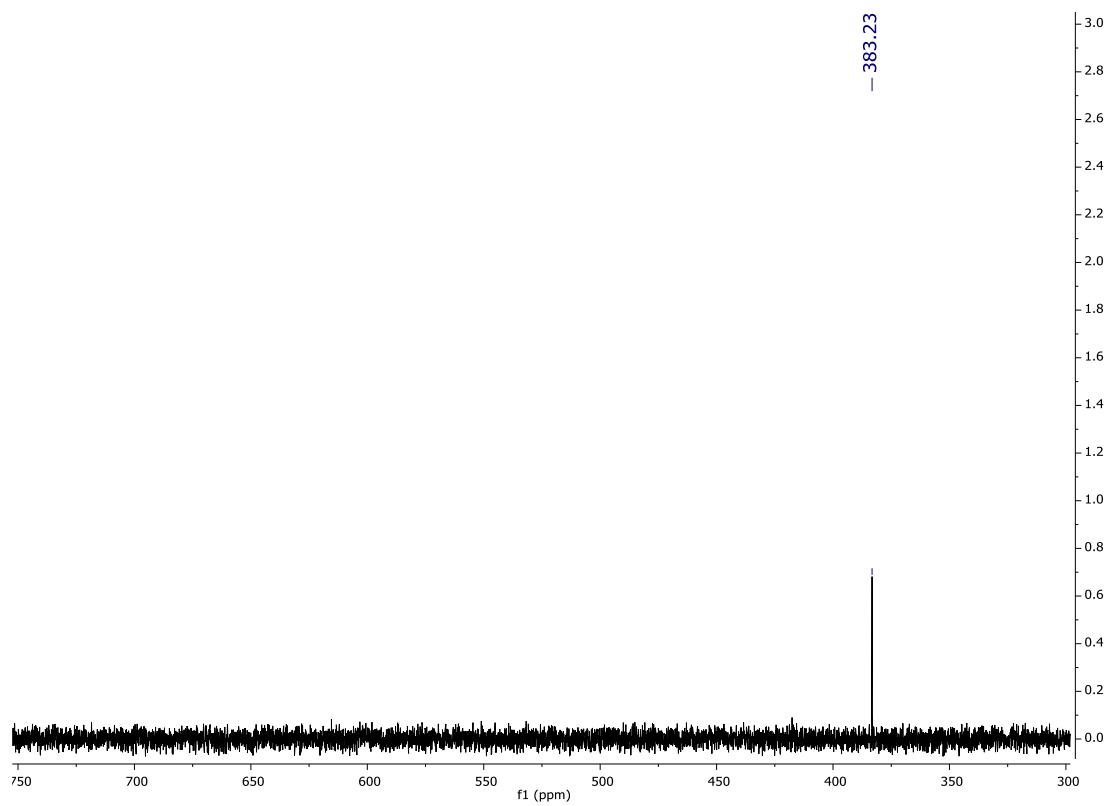
$^{77}\text{Se}$  NMR spectrum (76 MHz,  $\text{CDCl}_3$ ) of compound **5e**



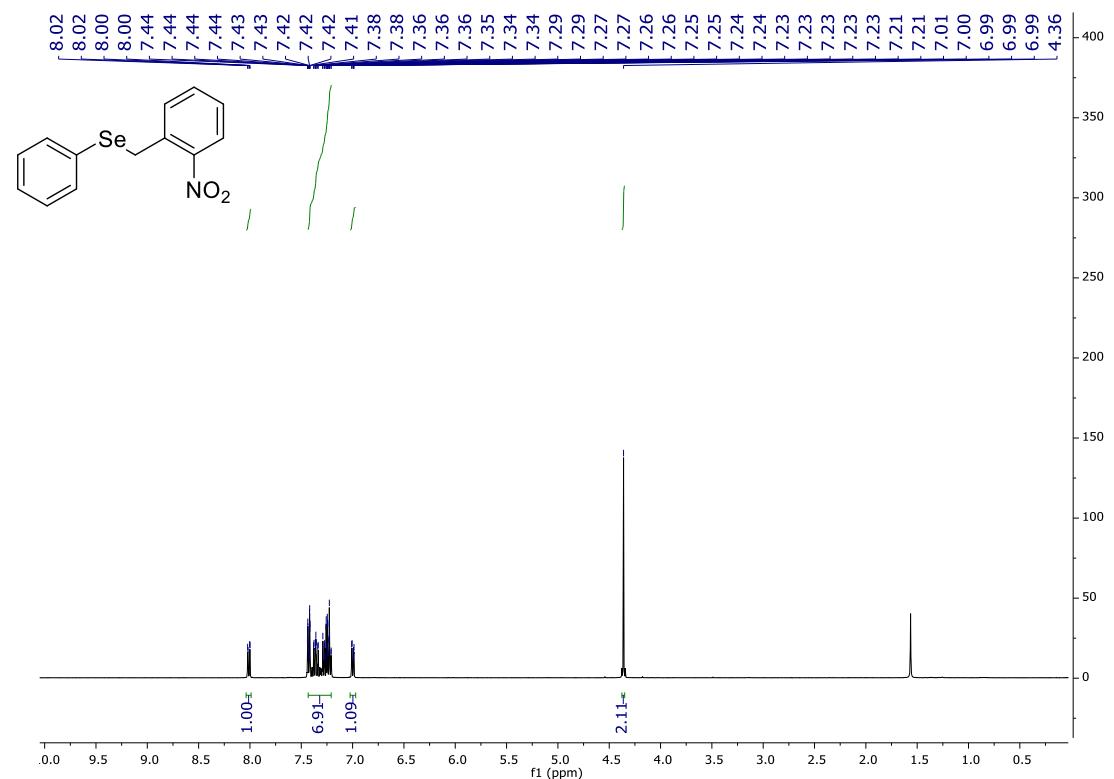
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **5f**



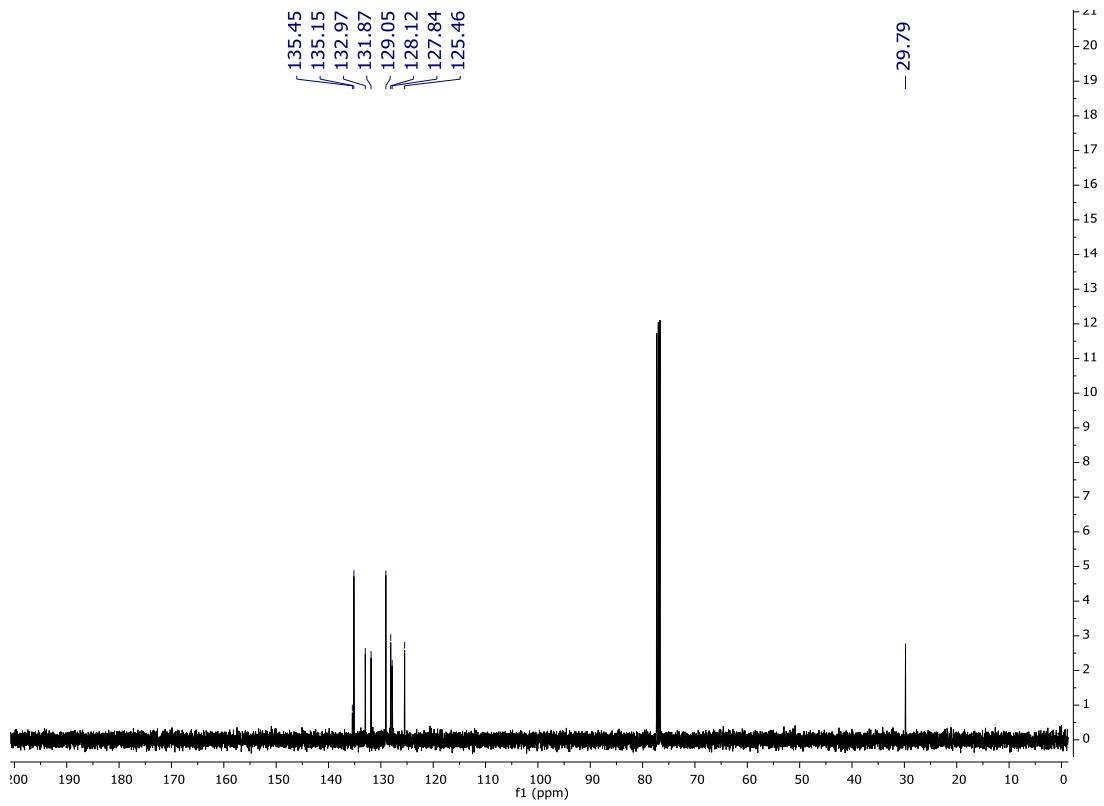
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **5f**



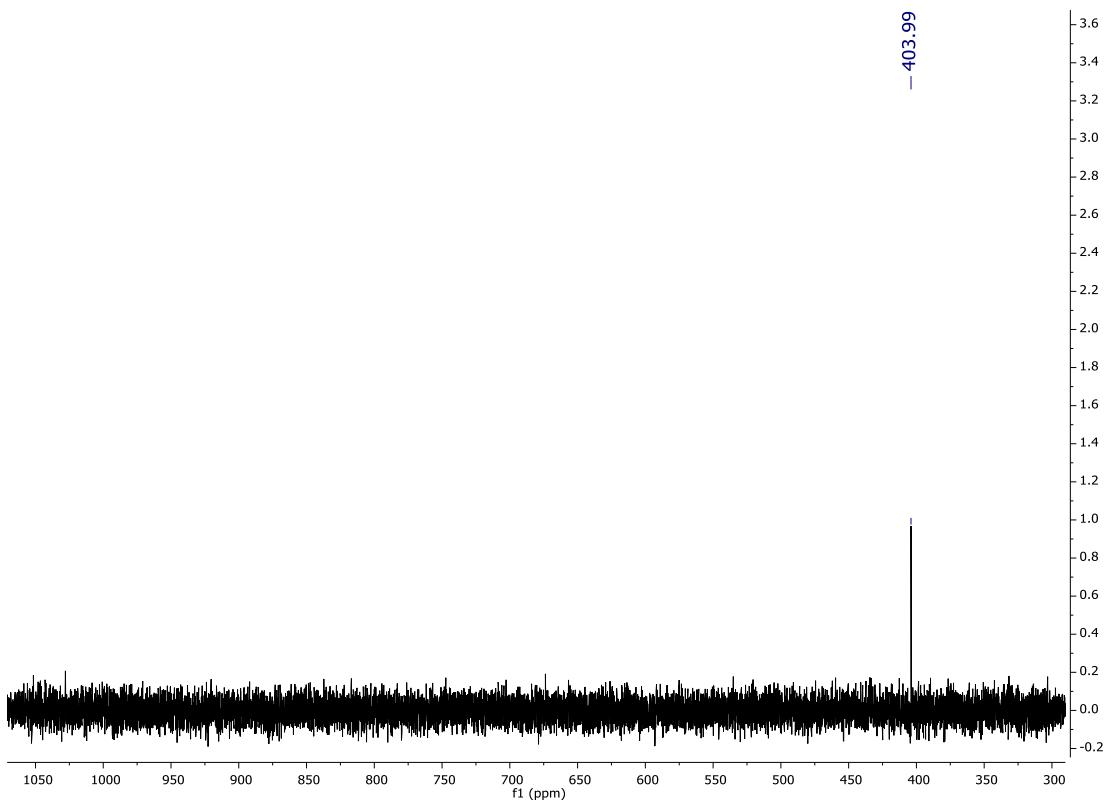
$^{77}\text{Se}$  NMR spectrum (76 MHz,  $\text{CDCl}_3$ ) of compound **5f**



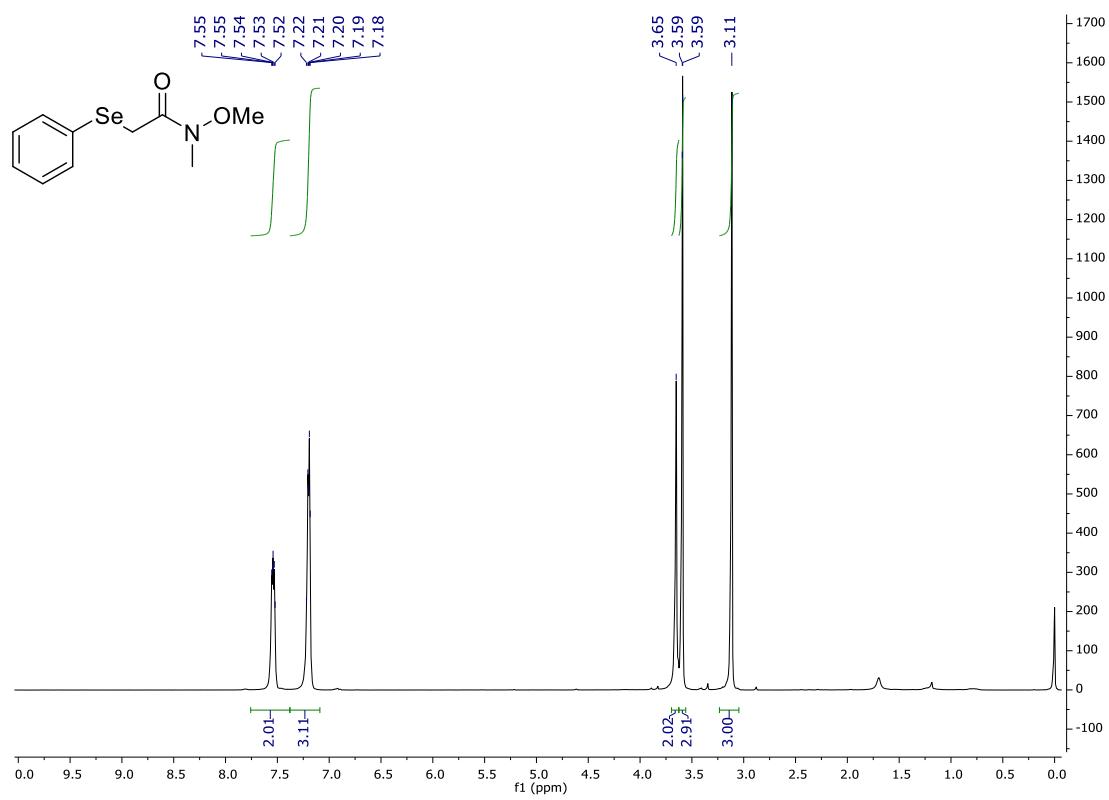
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **5g**



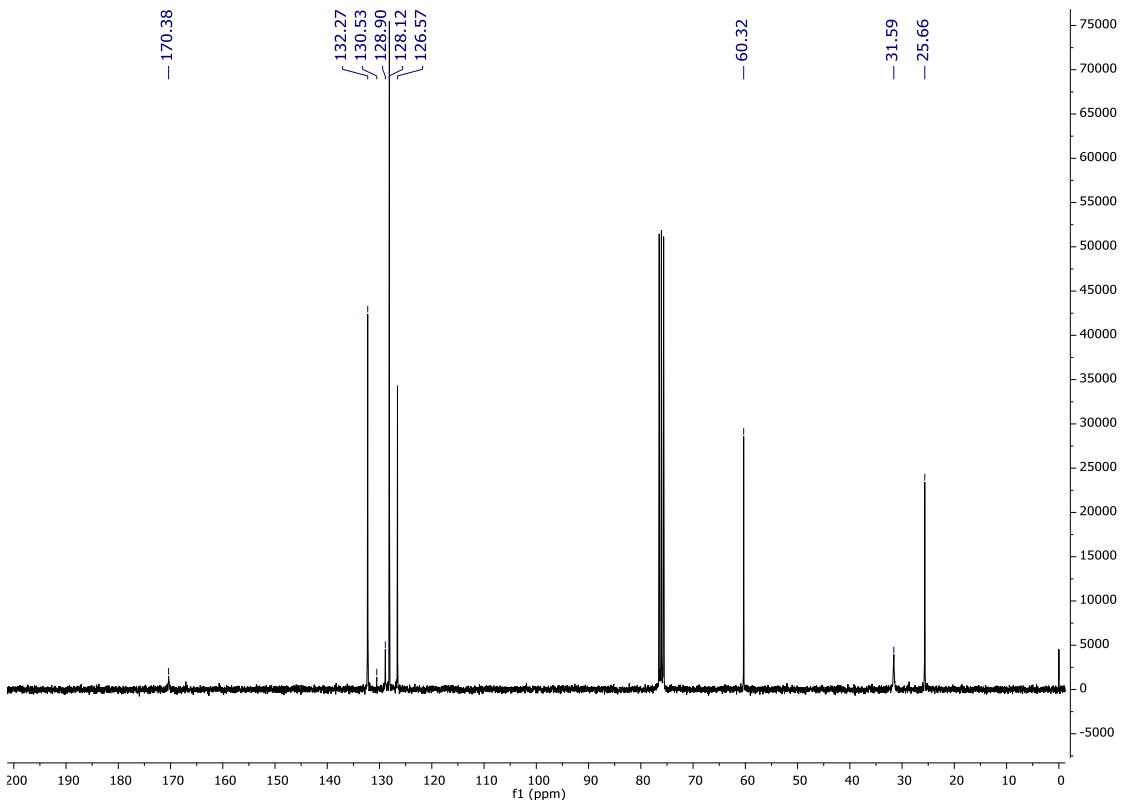
$^{13}\text{C}\{\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **5g**



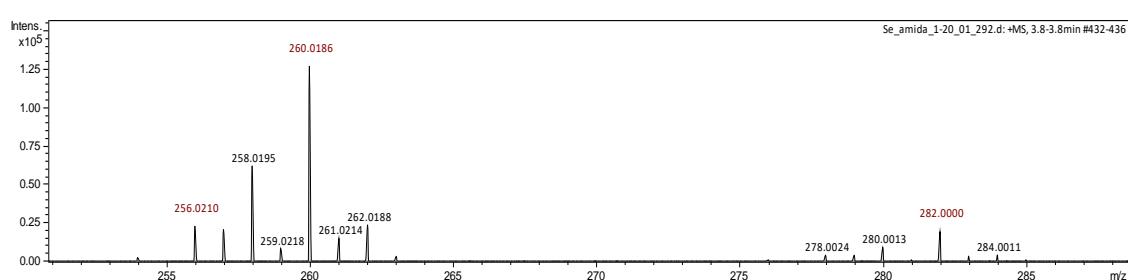
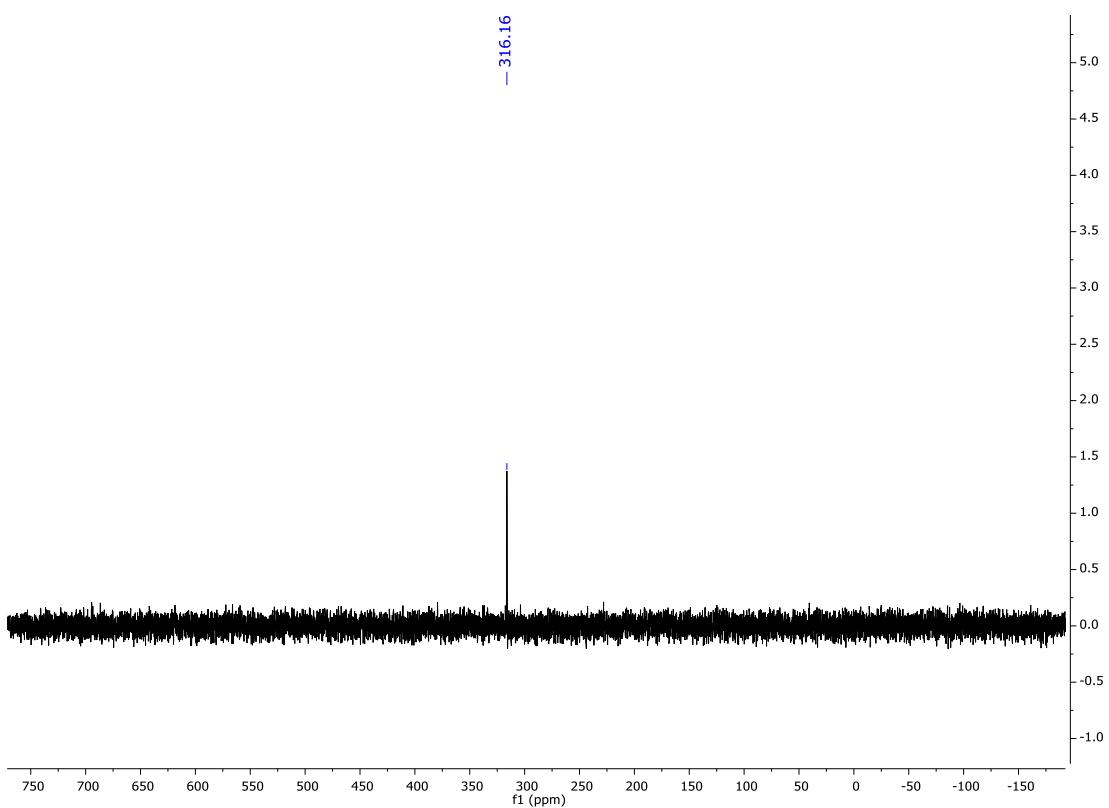
$^{77}\text{Se}$  NMR spectrum (76 MHz,  $\text{CDCl}_3$ ) of compound **5g**

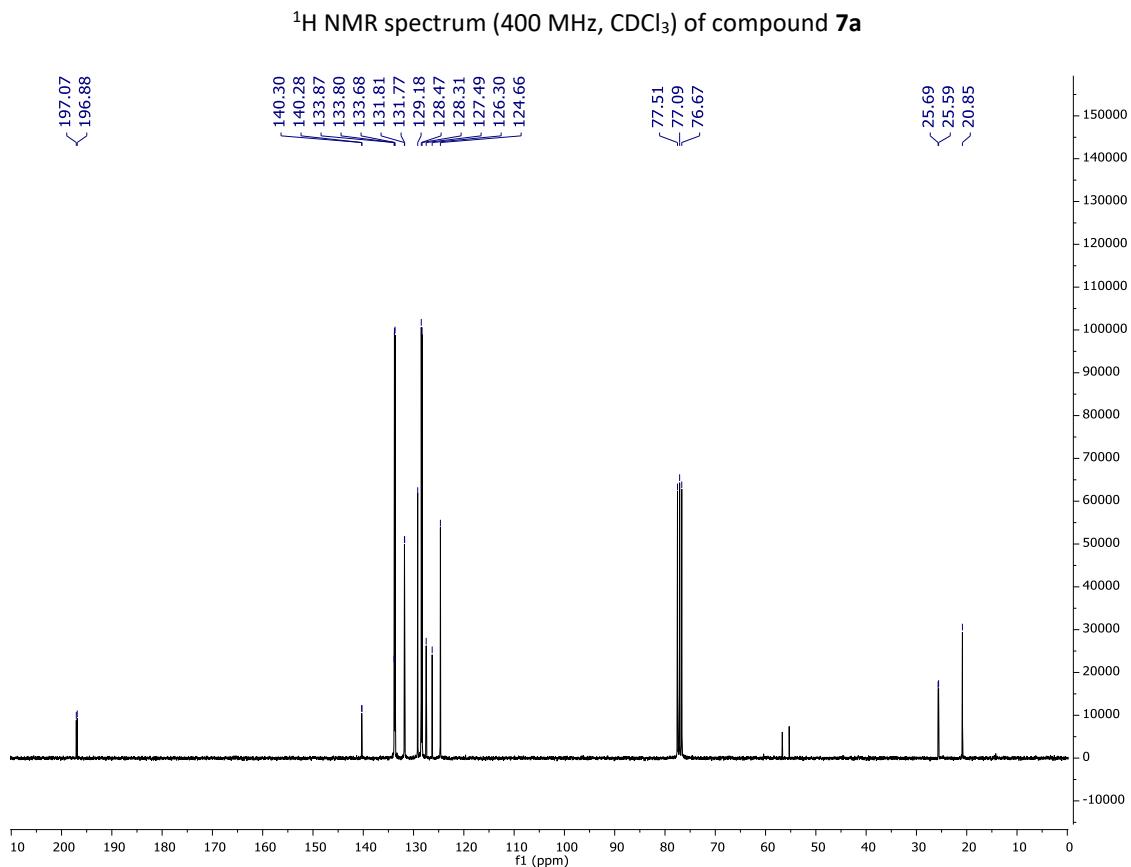
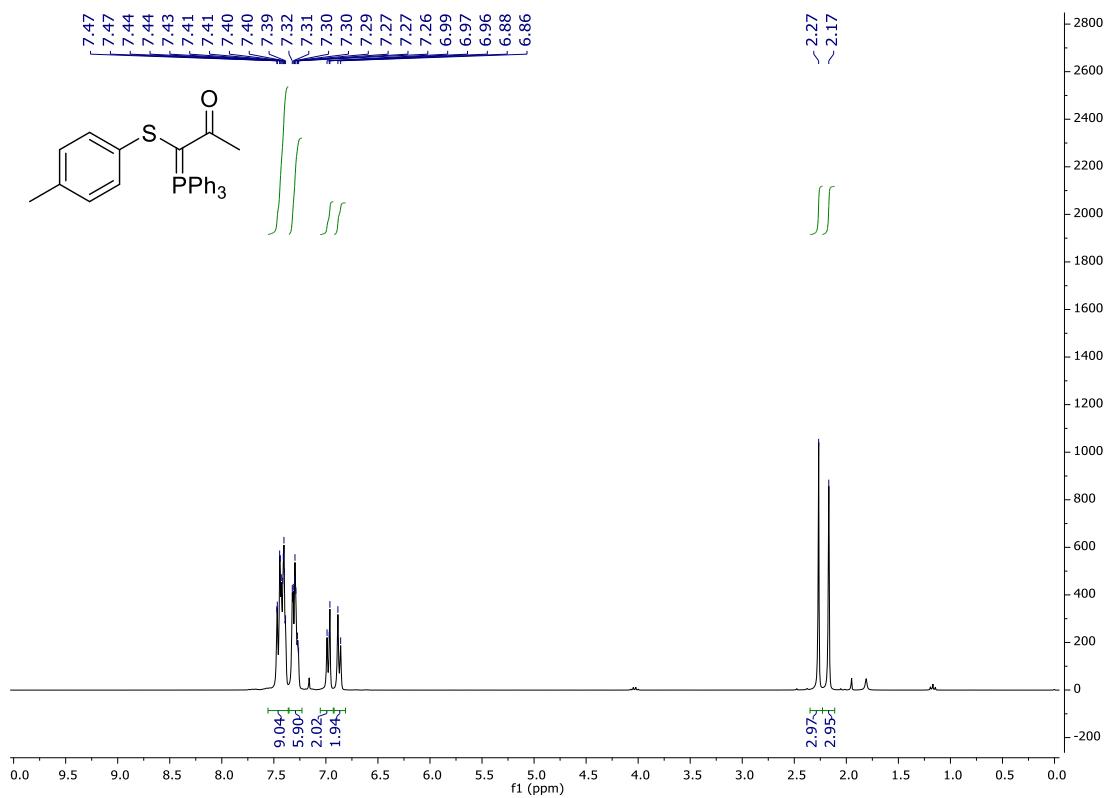


$^1\text{H}$  NMR spectrum (300 MHz,  $\text{CDCl}_3$ ) of compound **5h**

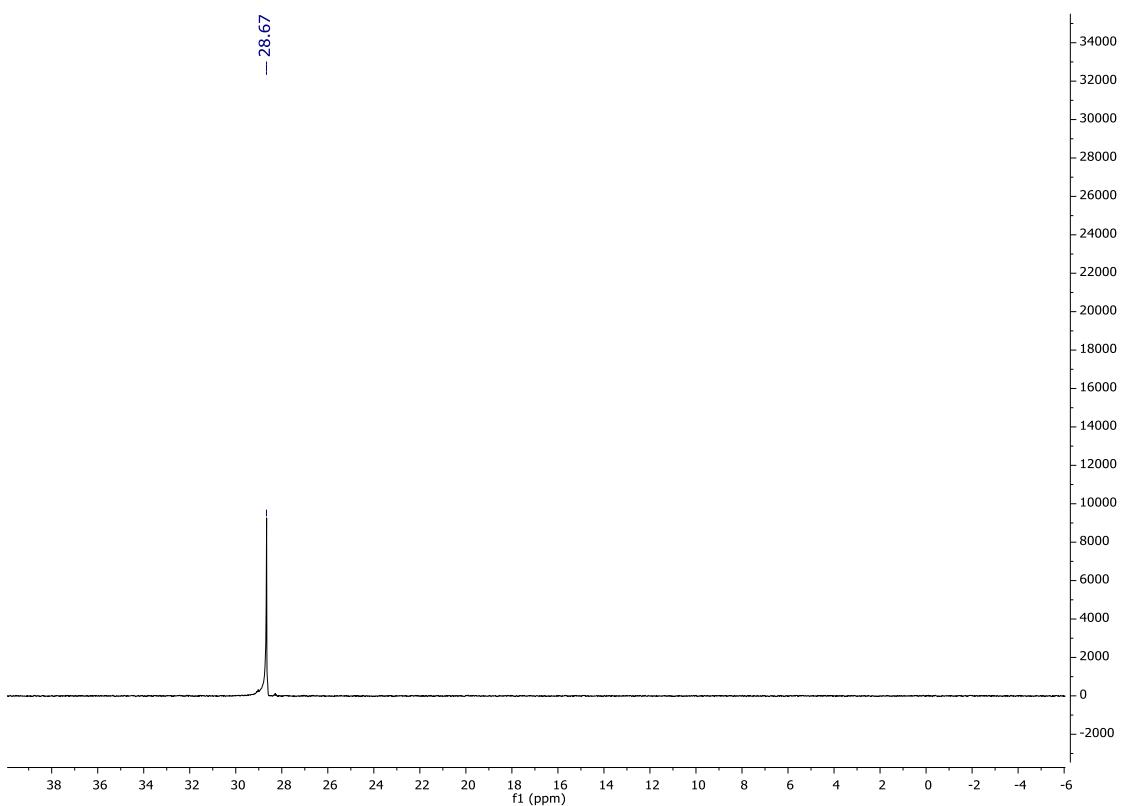


$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **5h**

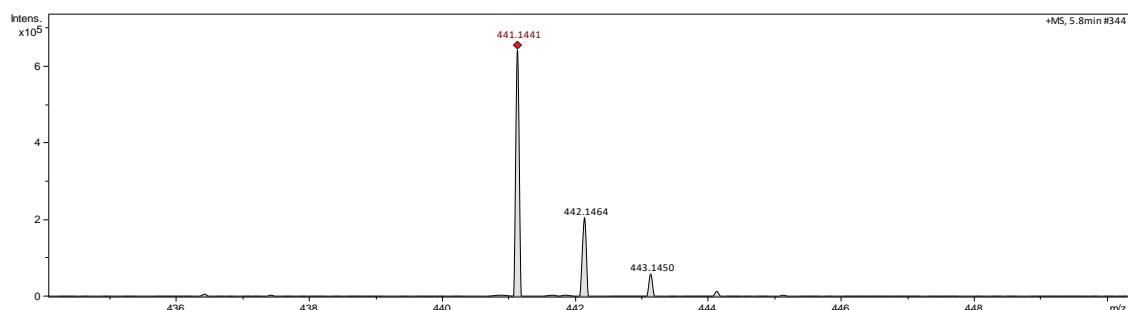




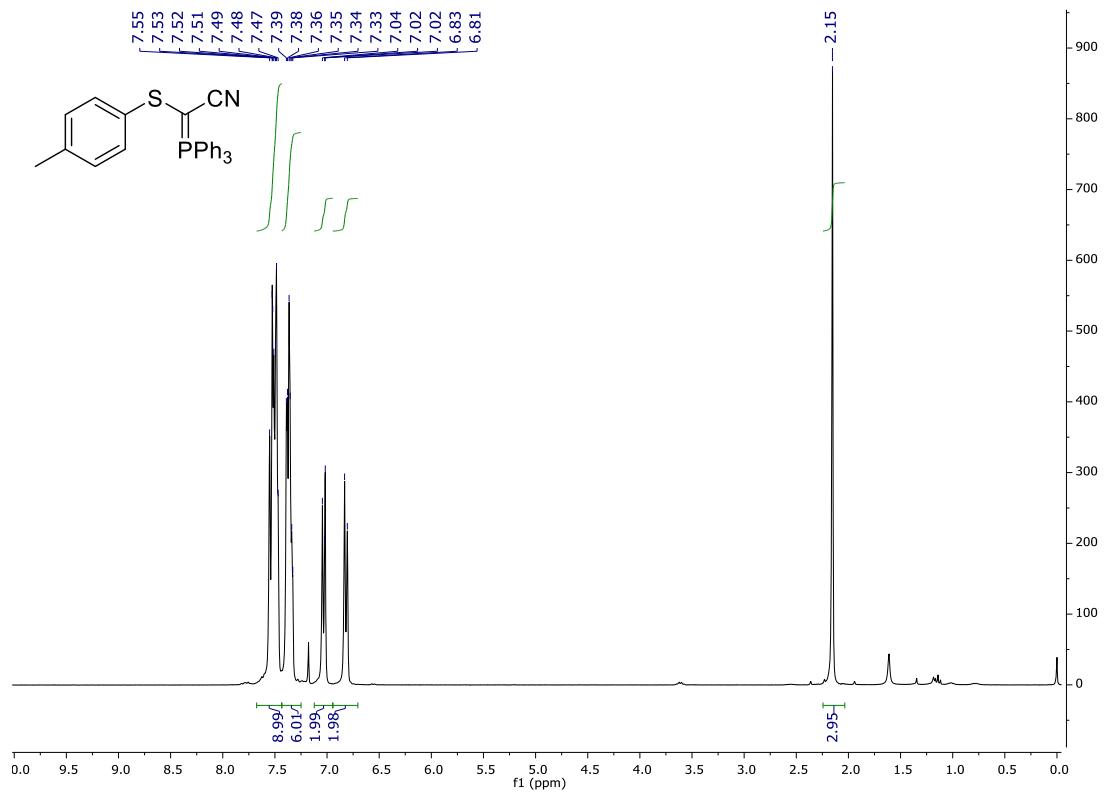
<sup>13</sup>C{<sup>1</sup>H} NMR spectrum (100 MHz, CDCl<sub>3</sub>) of compound **7a**



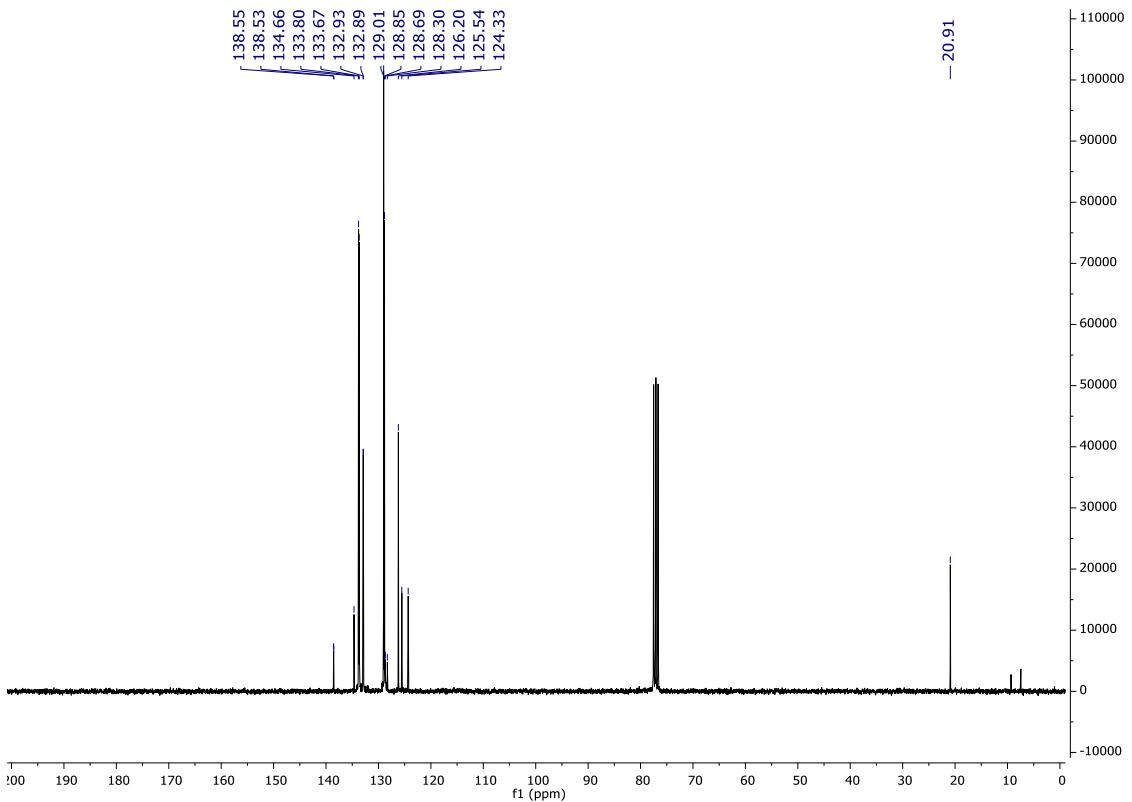
$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7a**



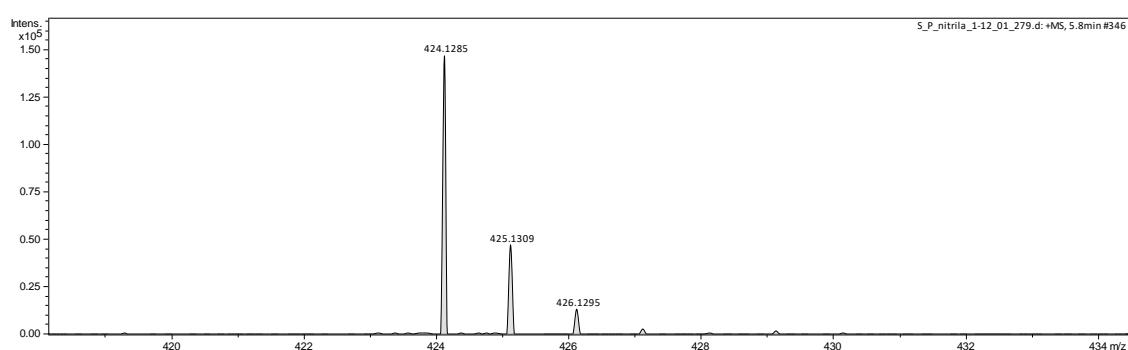
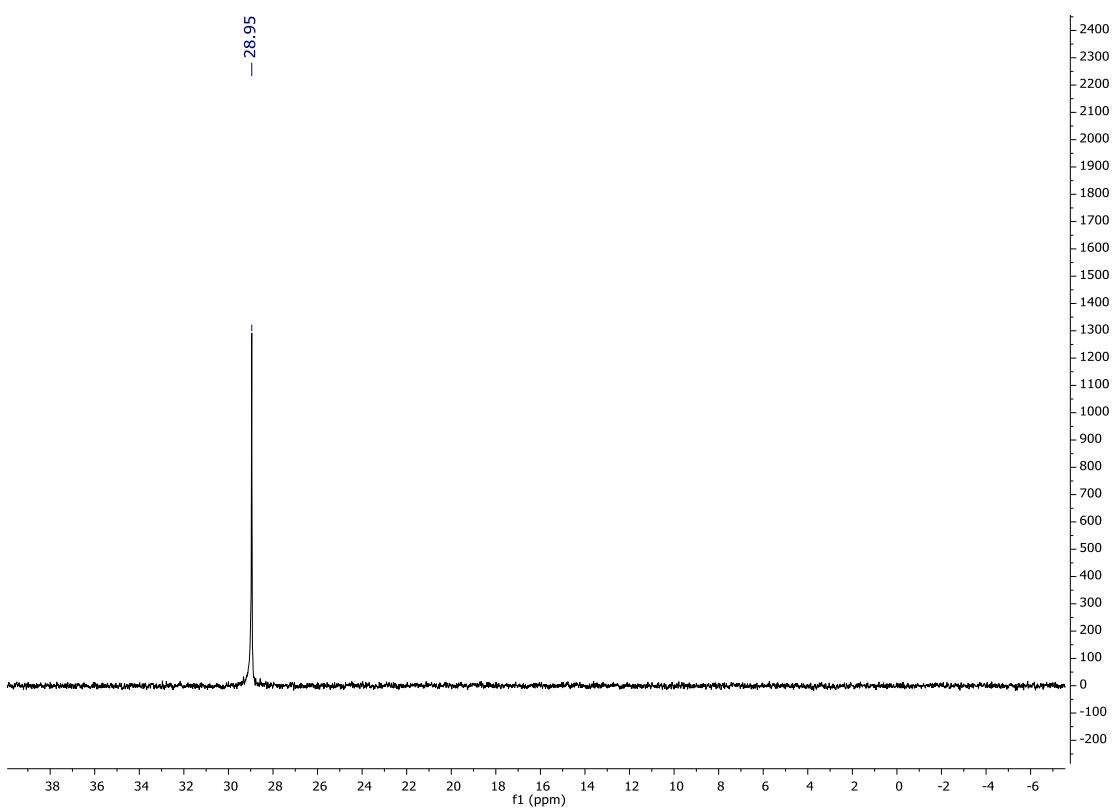
Mass spectrometry analysis of compound **7a** HRMS (ESI)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{28}\text{H}_{26}\text{OPS}^+$  441.1436;  
Found 441.1441.



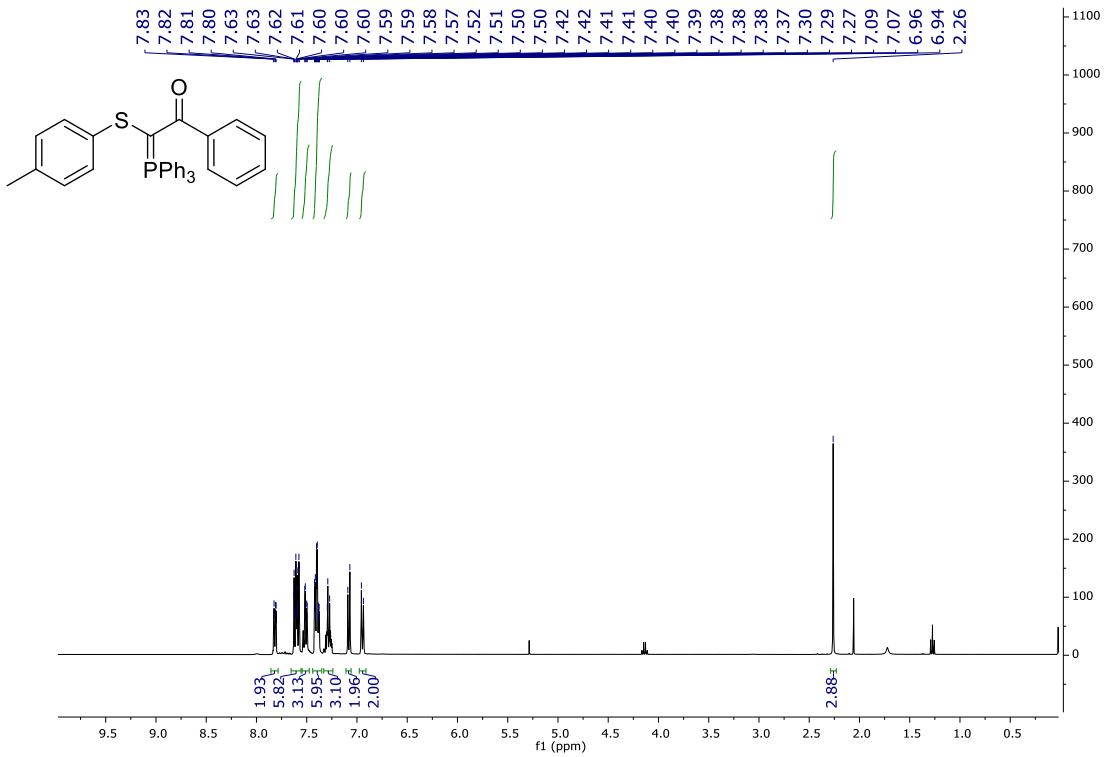
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **7b**



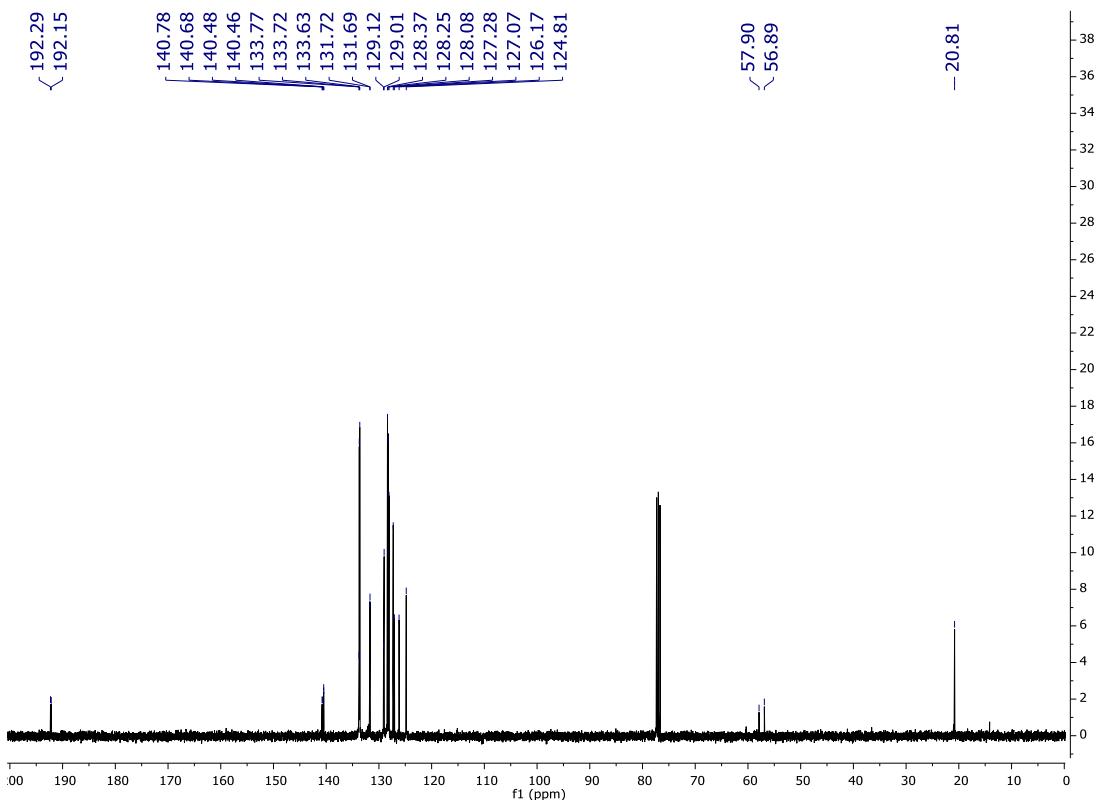
$^{13}\text{C}\{\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **7b**



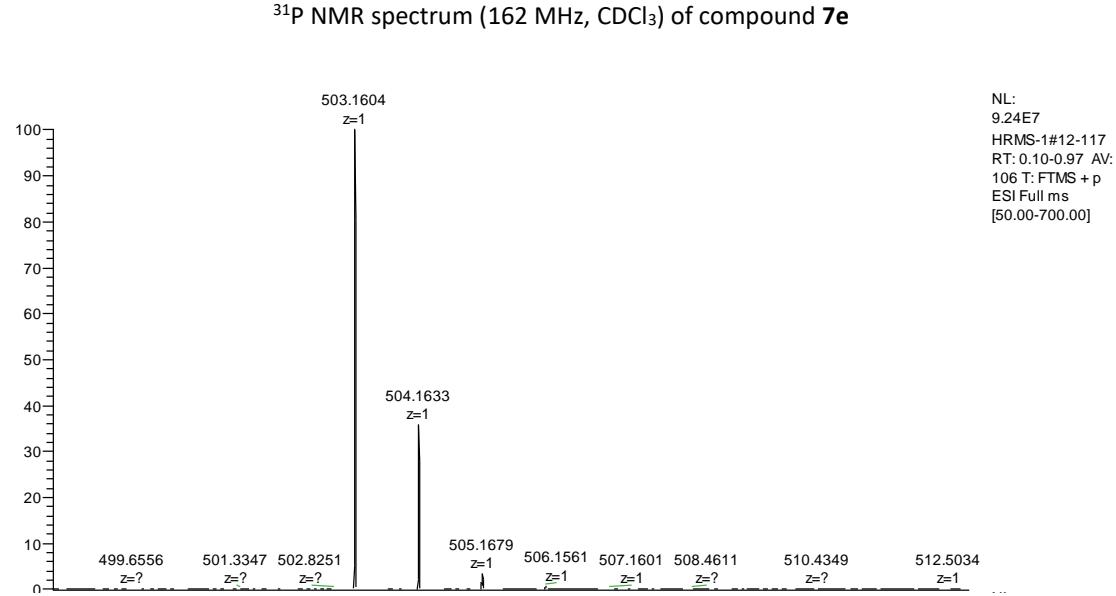
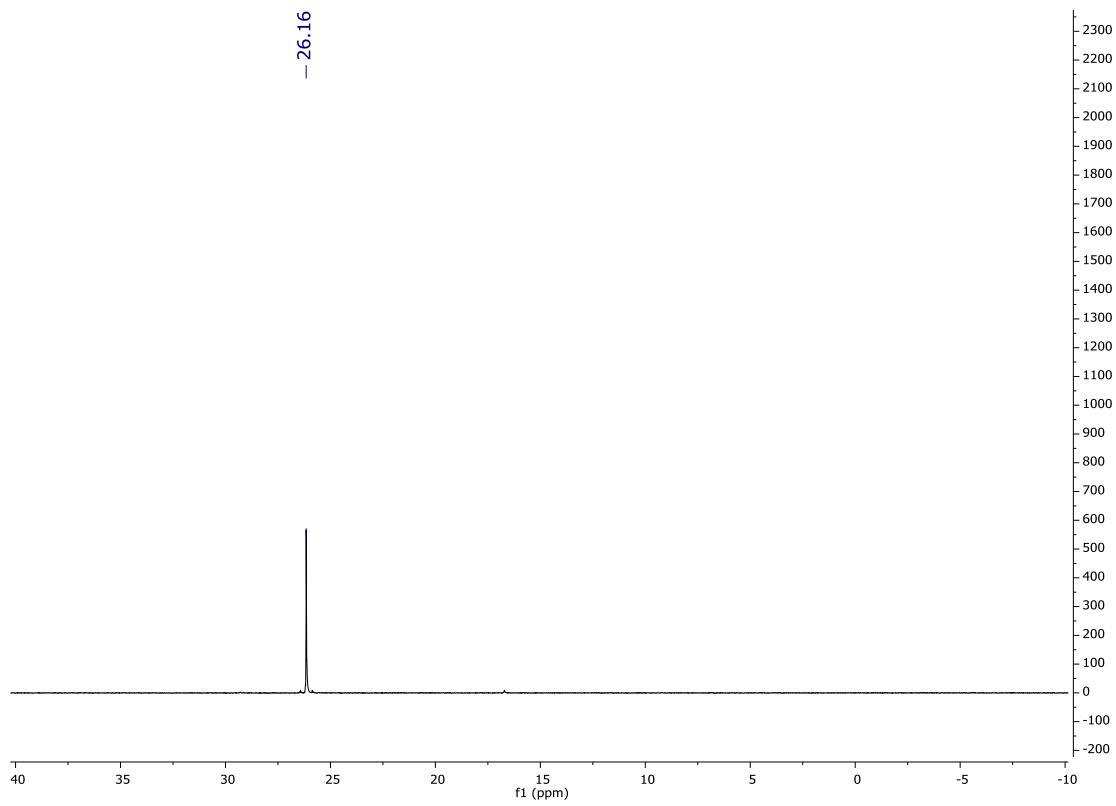
Mass spectrometry analysis of compound **7b** HRMS (ESI) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>27</sub>H<sub>23</sub>NPS<sup>+</sup> 424.1283;  
Found 424.1285.



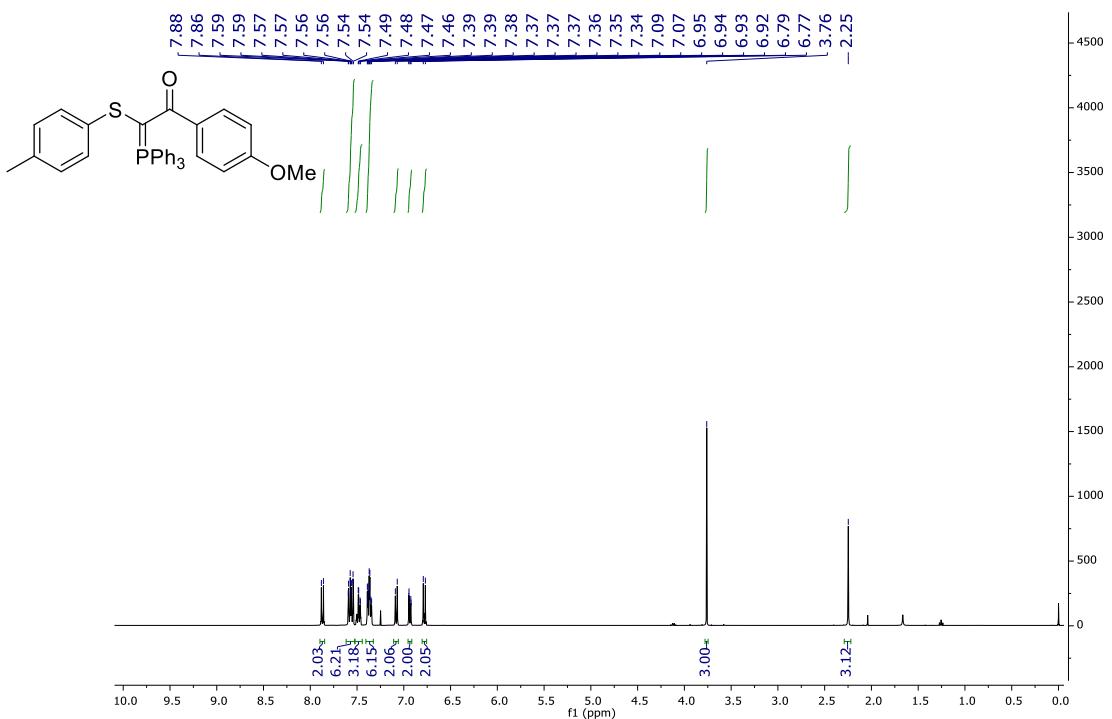
<sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 7e



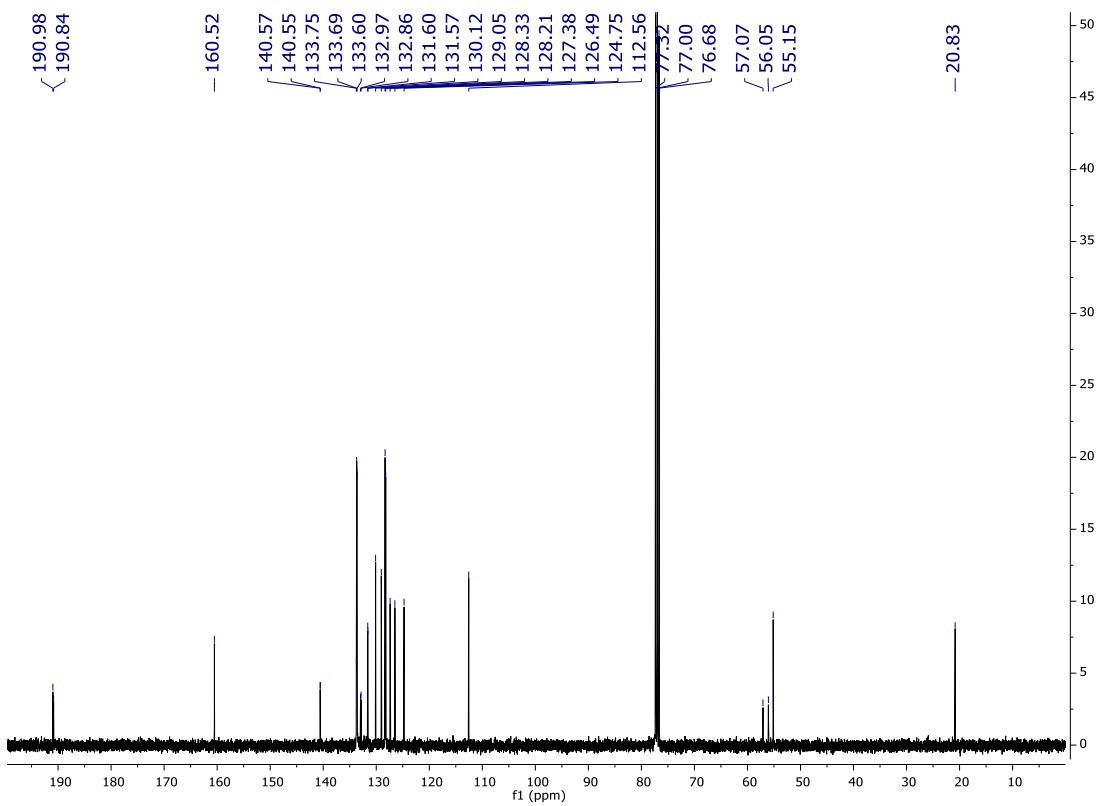
<sup>13</sup>C{<sup>1</sup>H} NMR spectrum (100 MHz, CDCl<sub>3</sub>) of compound **7e**



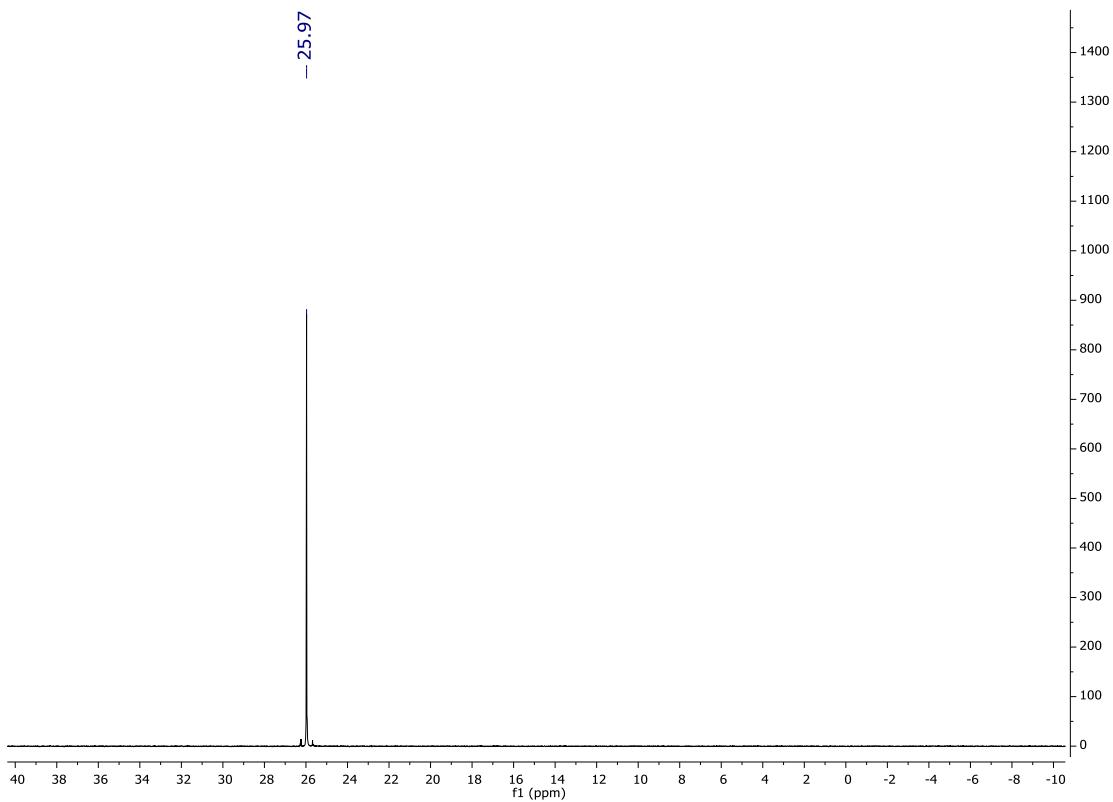
Mass spectrometry analysis of compound **7e** HRMS (ESI)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{33}\text{H}_{28}\text{OPS}^+$  503.1593;  
Found 503.1604.



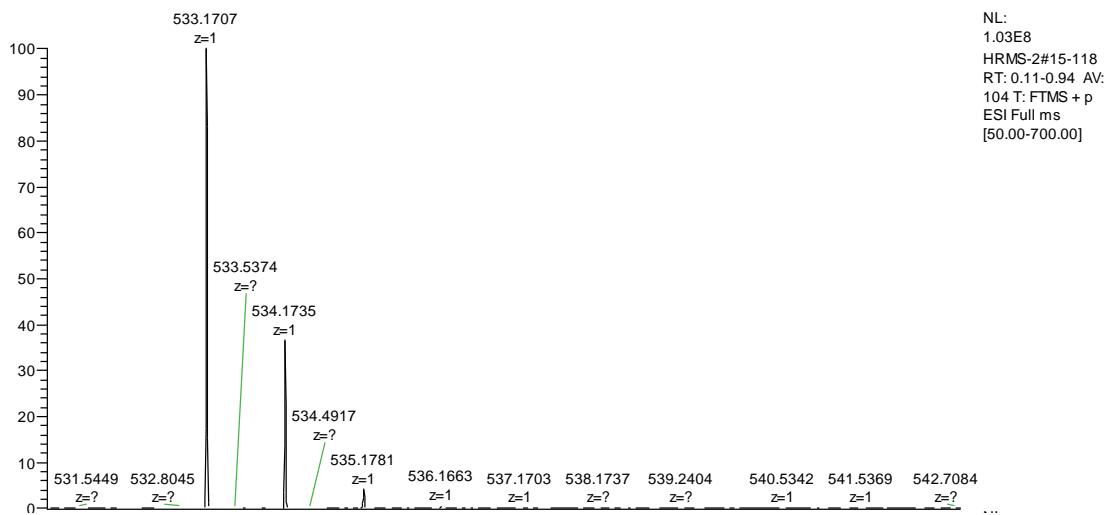
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **7f**



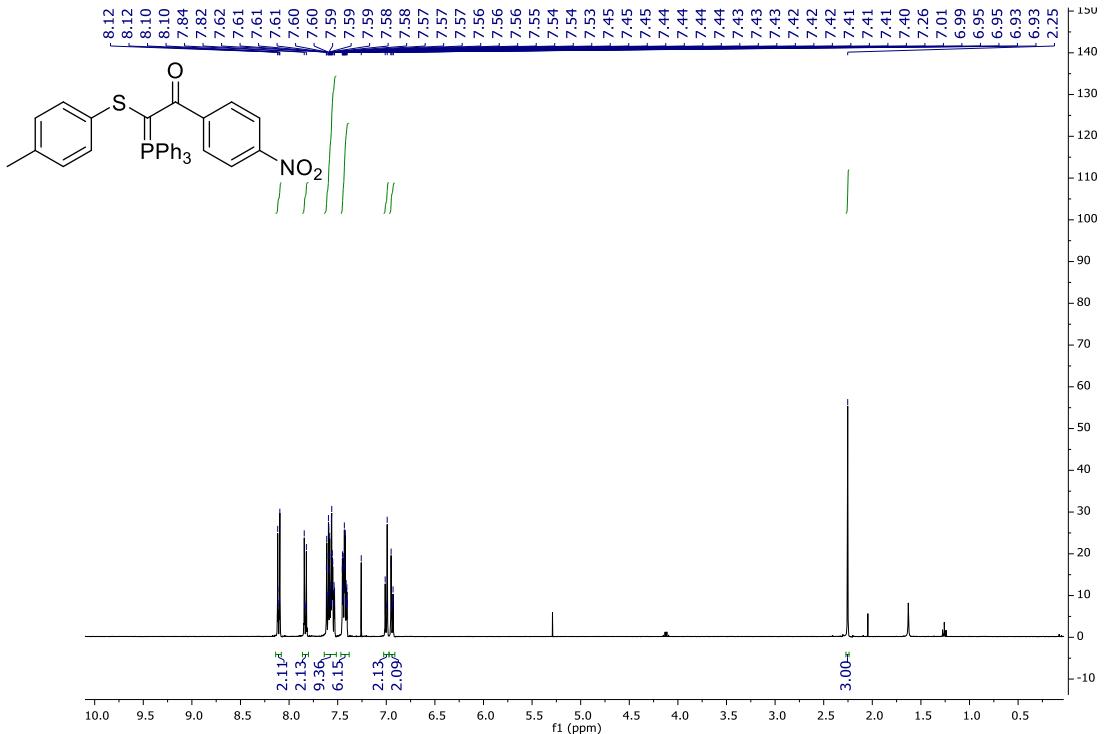
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **7f**



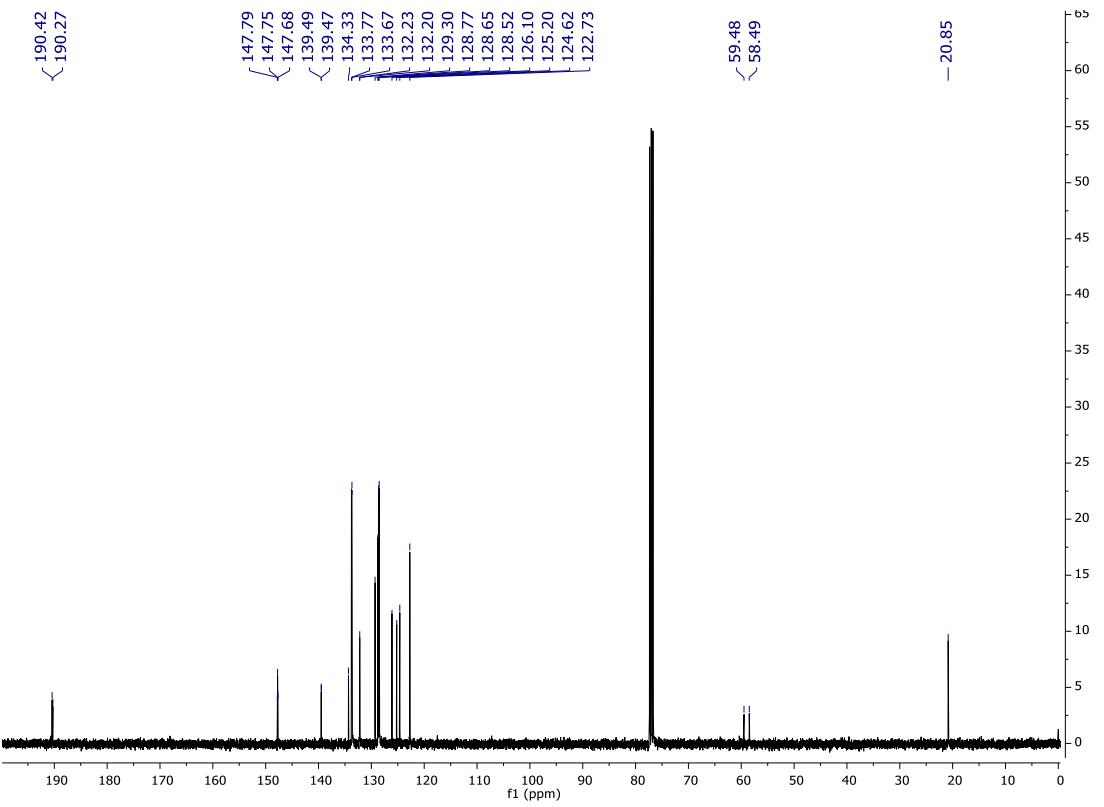
$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7f**



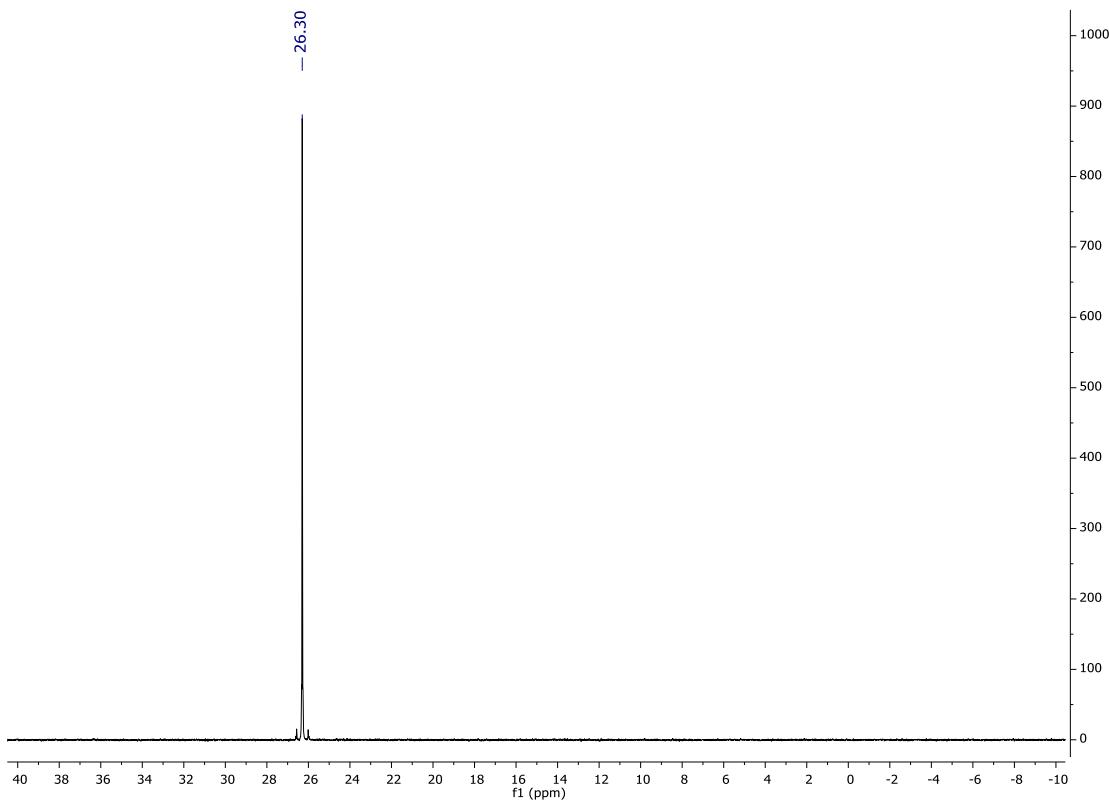
Mass spectrometry analysis of compound **7e** HRMS (ESI)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{34}\text{H}_{30}\text{O}_2\text{PS}^+$  533.1699;  
Found 533.1707.



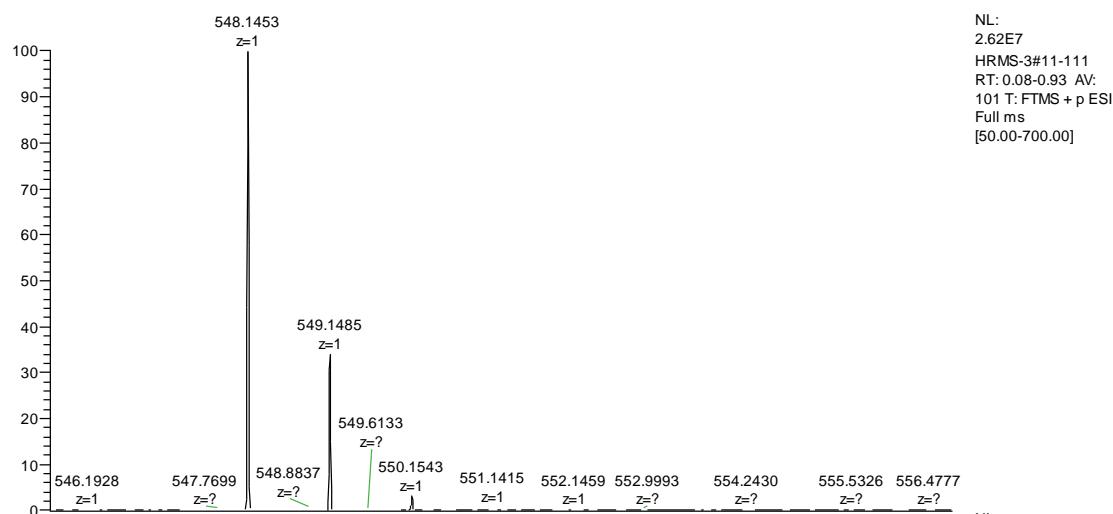
<sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound **7g**



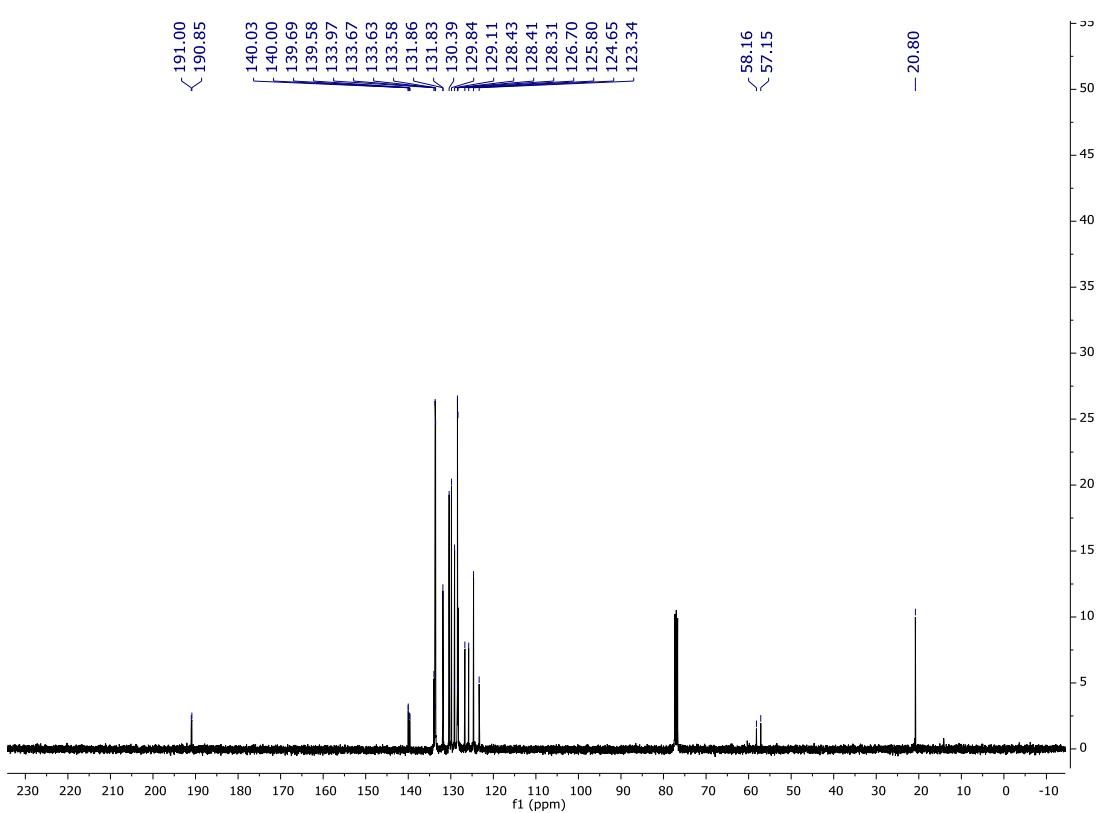
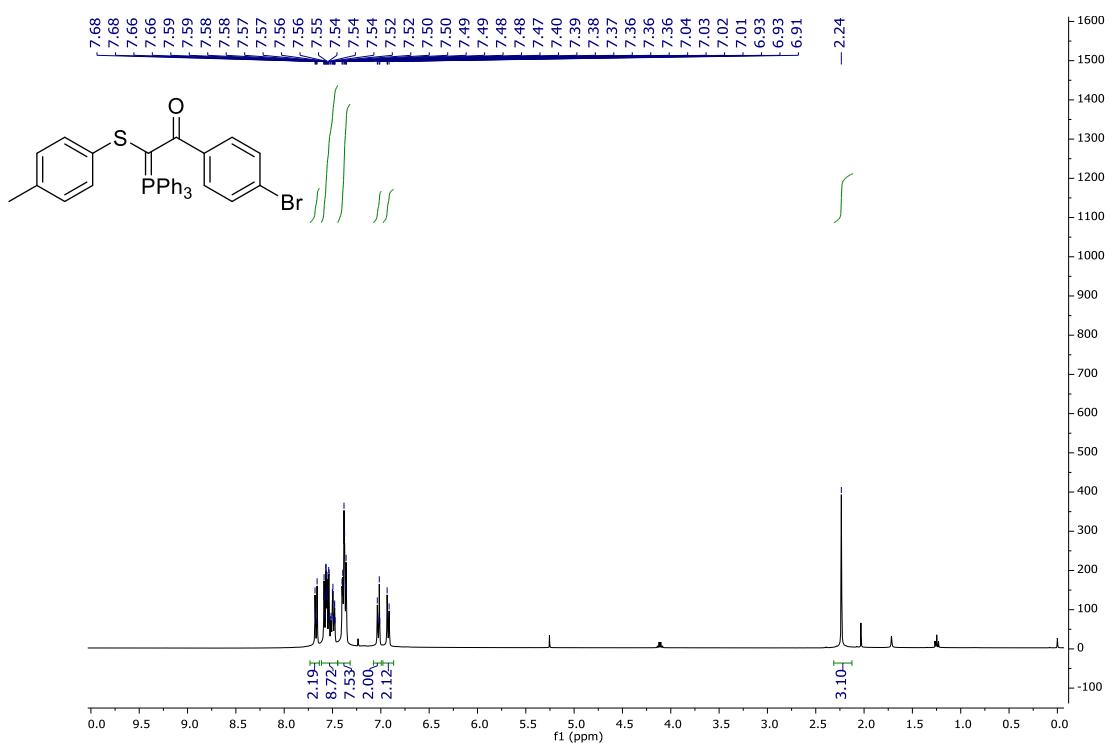
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **7g**

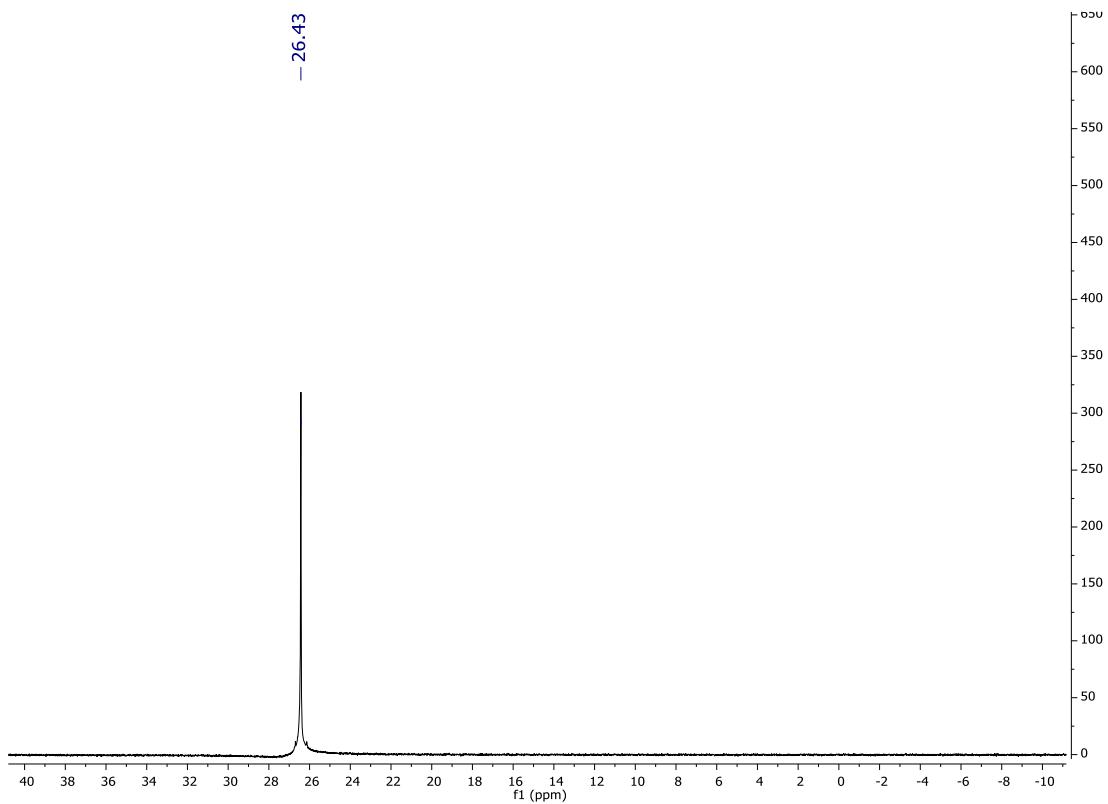


<sup>31</sup>P NMR spectrum (162 MHz, CDCl<sub>3</sub>) of compound **7g**

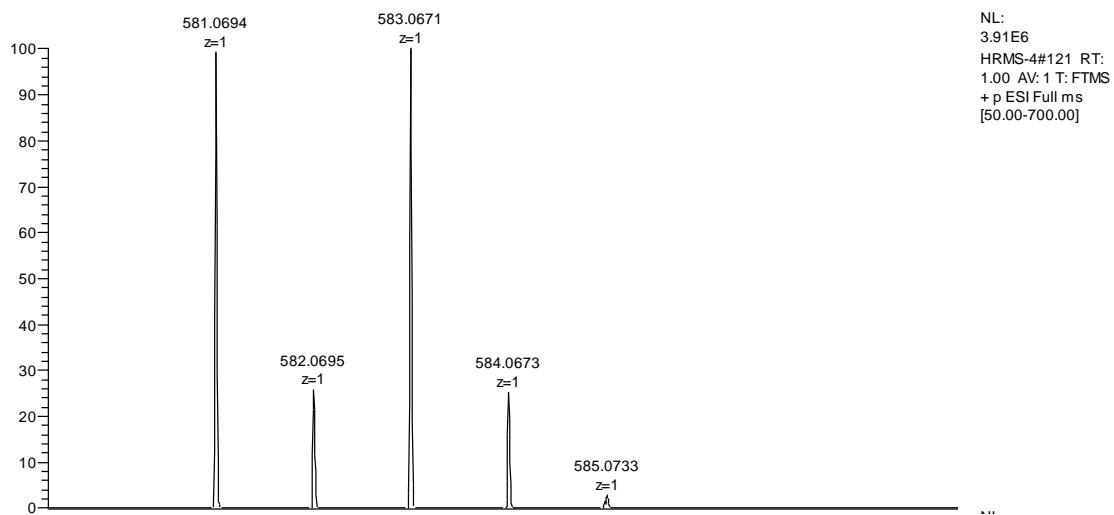


Mass spectrometry analysis of compound **7g** HRMS (ESI) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>33</sub>H<sub>27</sub>NO<sub>3</sub>PS<sup>+</sup> 548.1444;  
Found 548.1453.

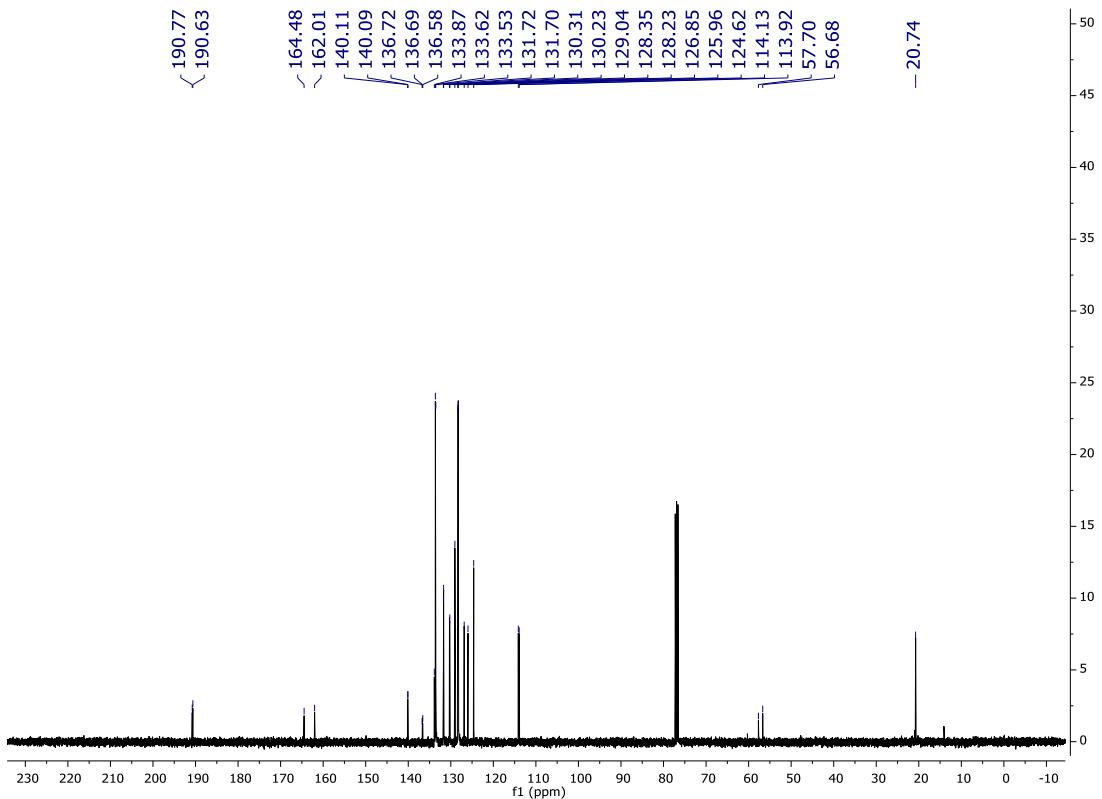
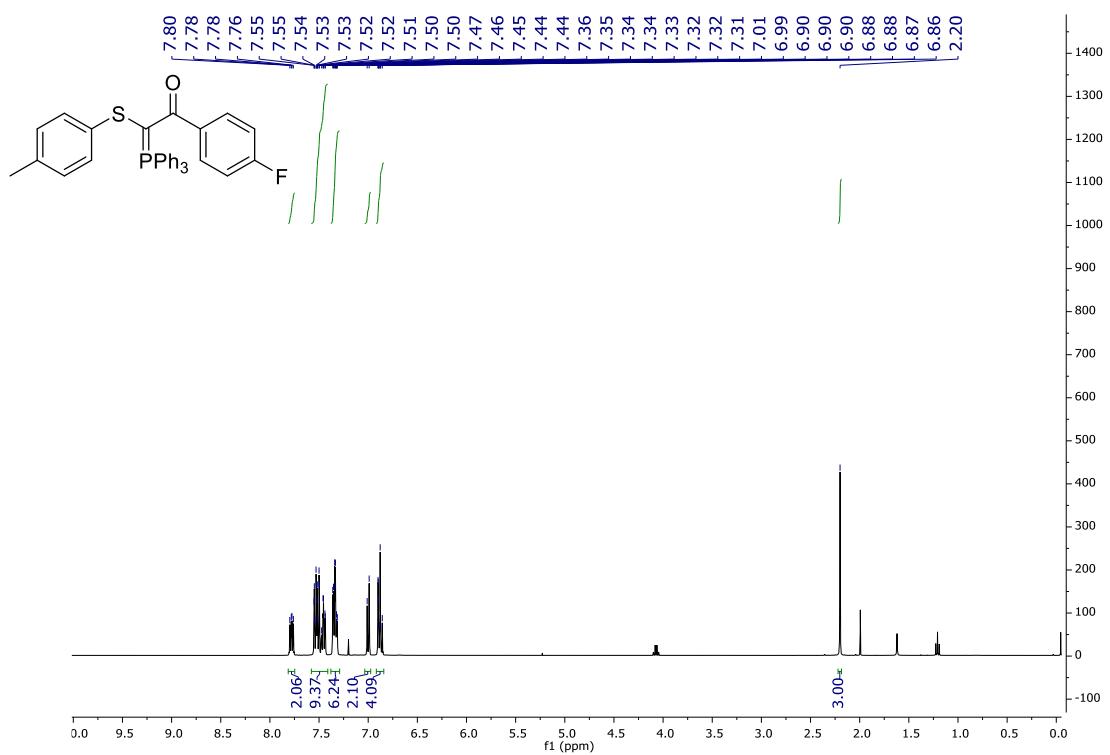


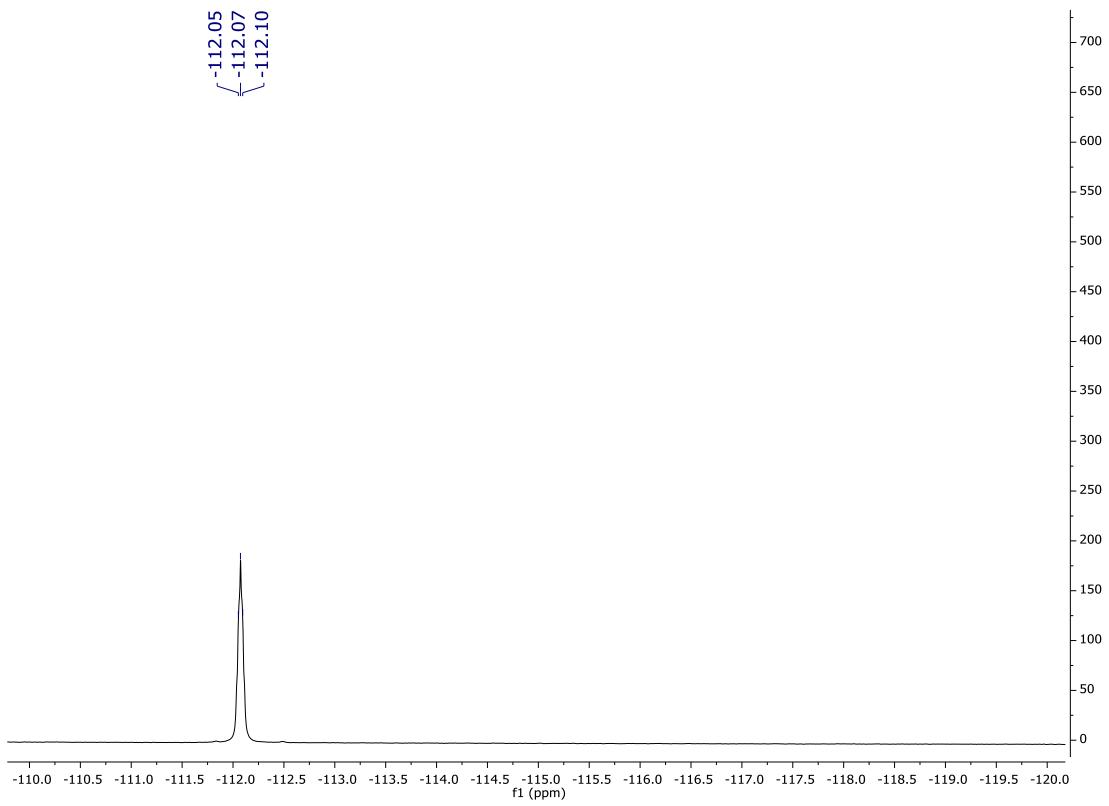


$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7h**

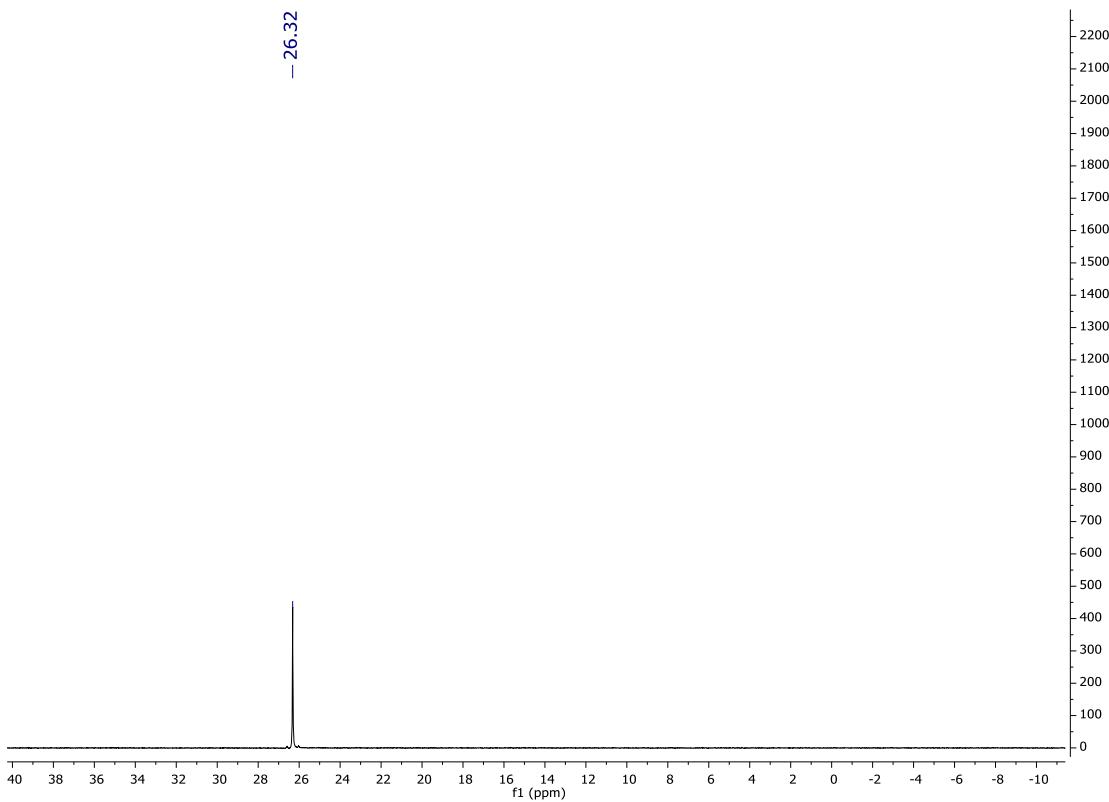


Mass spectrometry analysis of compound **7h** HRMS (ESI)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{33}\text{H}_{27}\text{BrOPS}^+$  581.0698;  
 Found 581.0694.

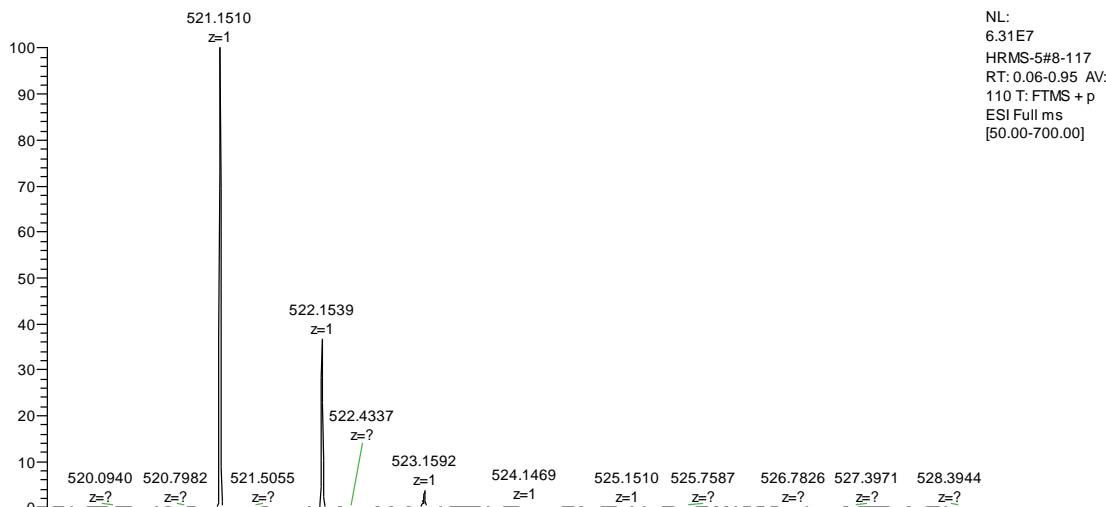




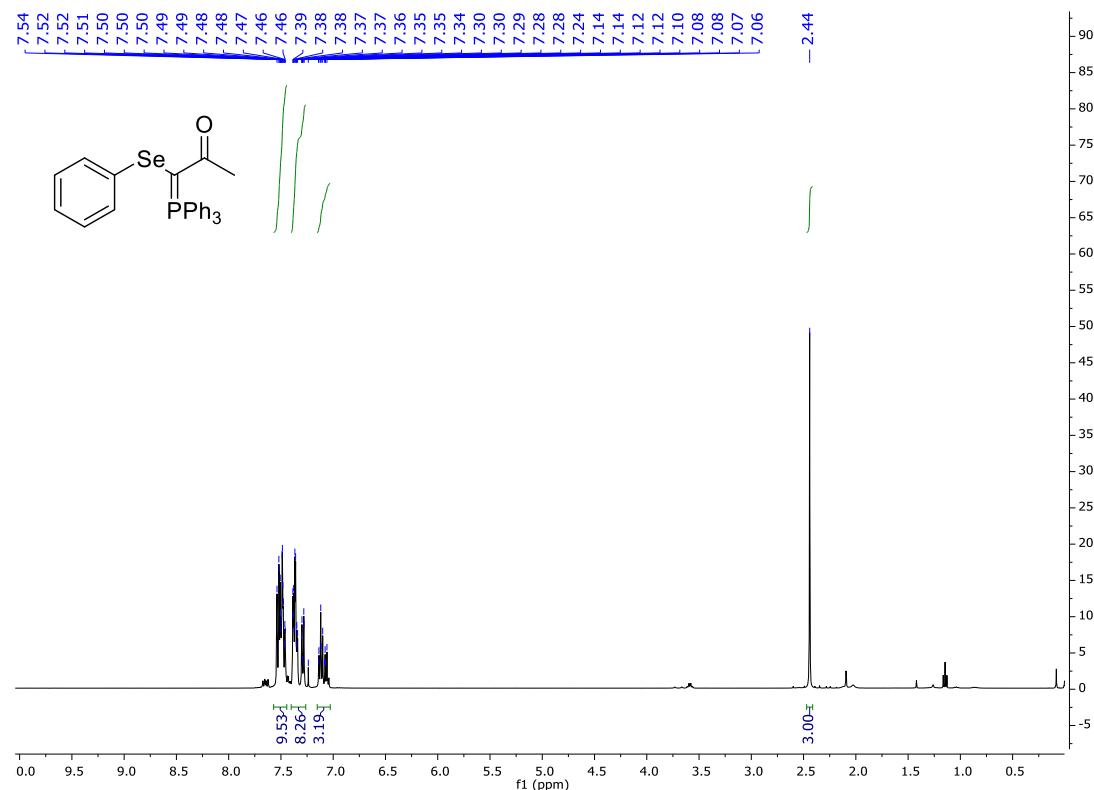
<sup>19</sup>F NMR spectrum (376 MHz, CDCl<sub>3</sub>) of compound **7i**



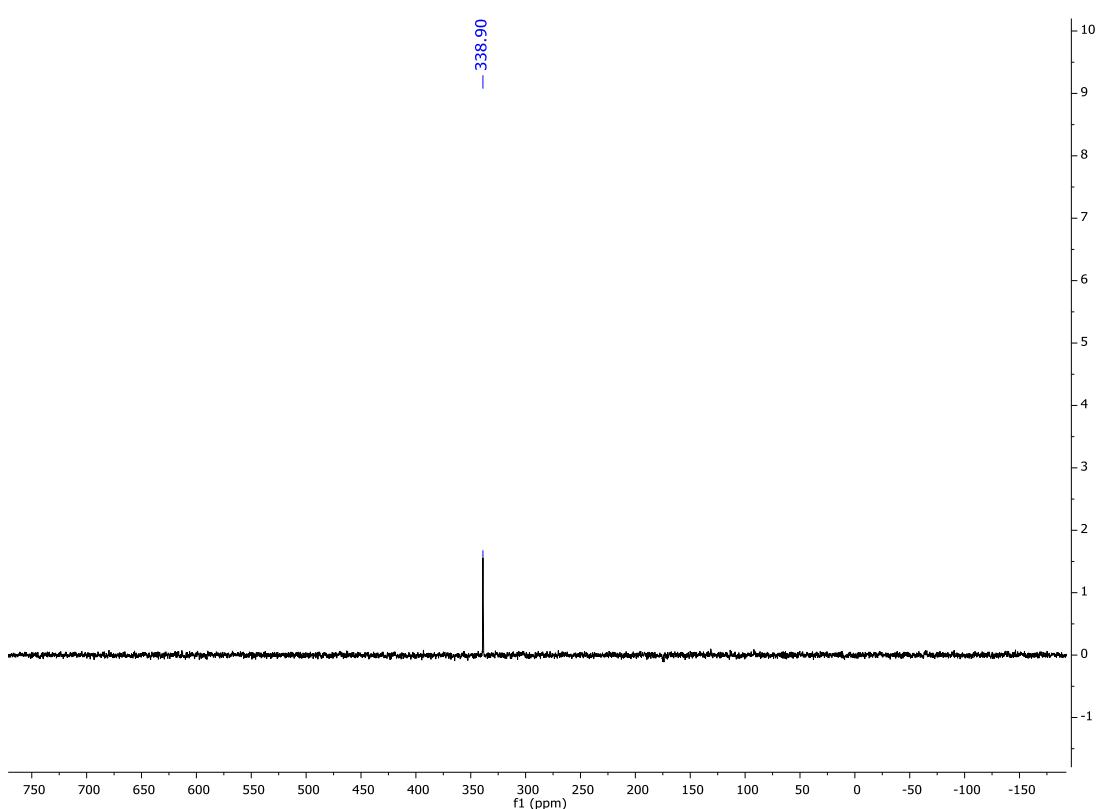
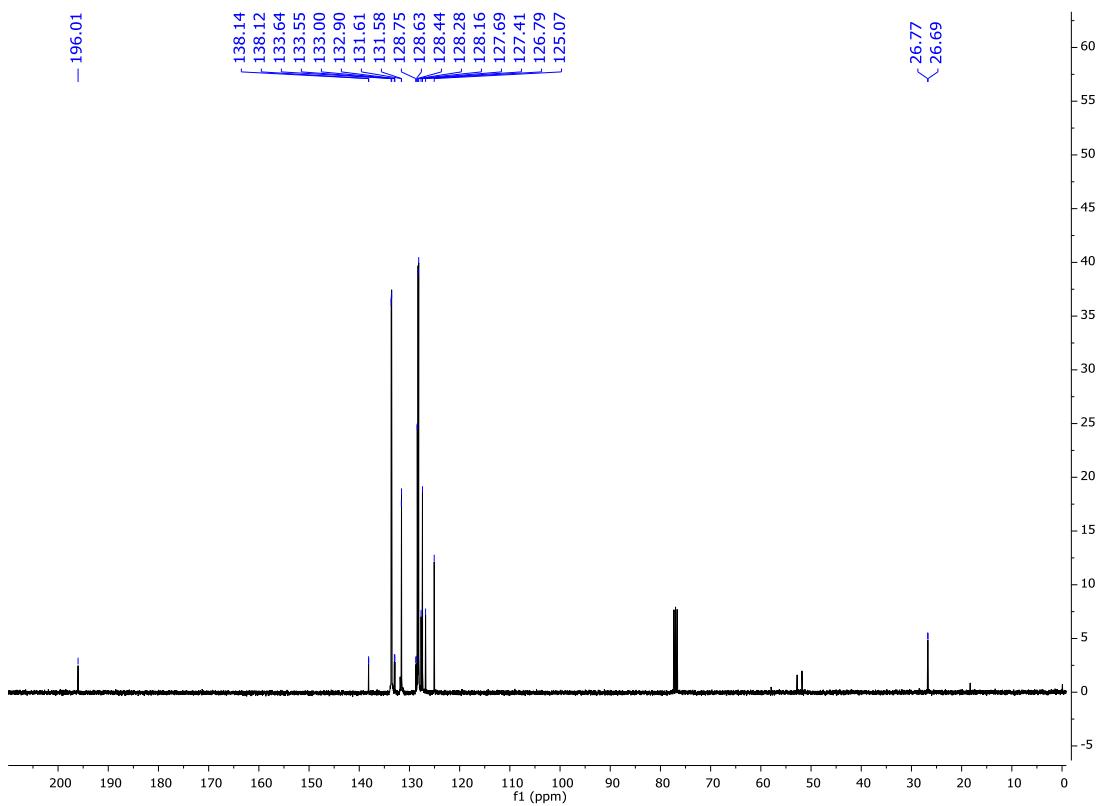
<sup>31</sup>P NMR spectrum (162 MHz, CDCl<sub>3</sub>) of compound **7i**

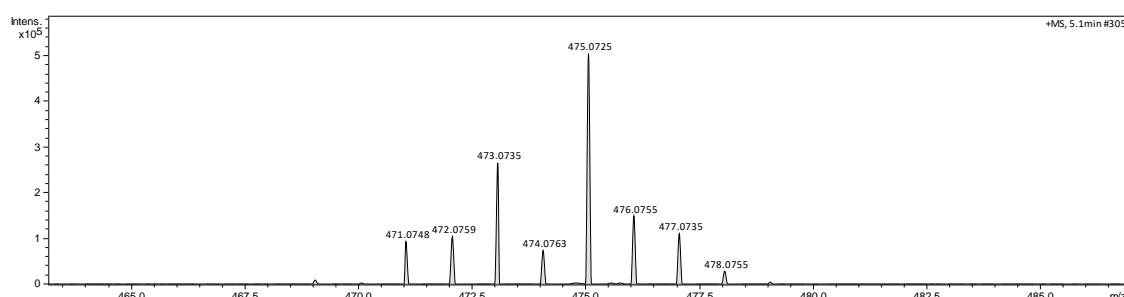
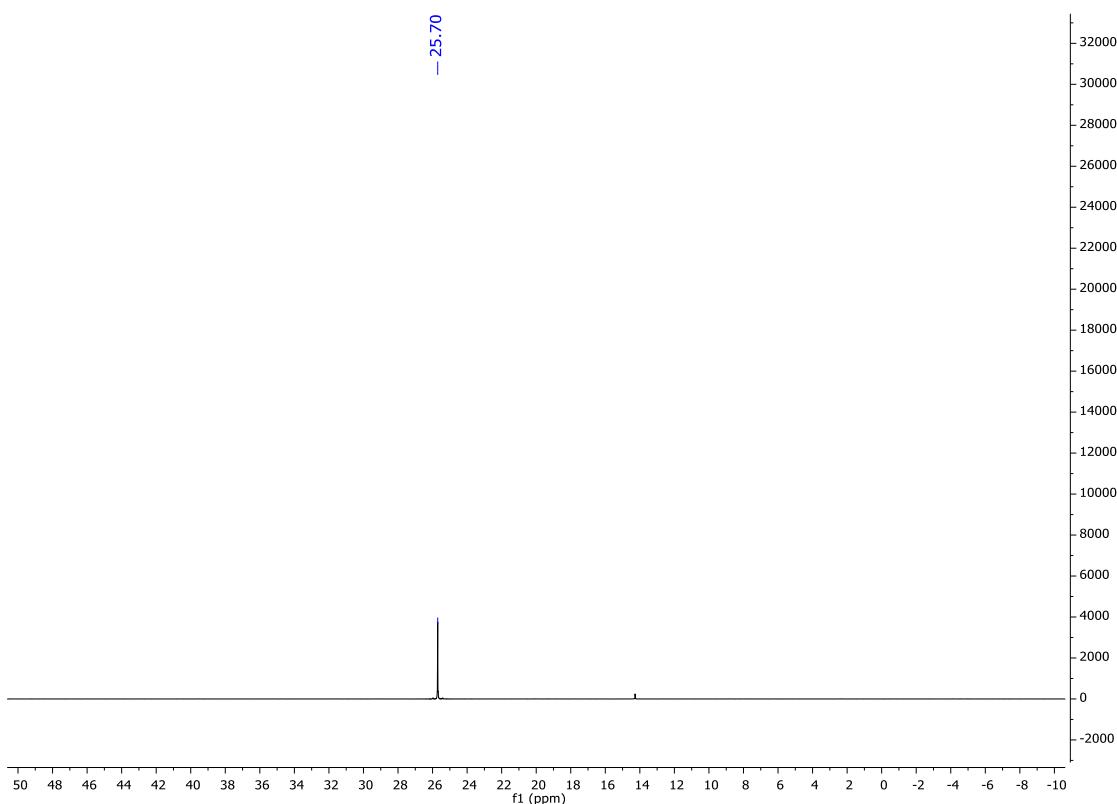


Mass spectrometry analysis of compound **7i** HRMS (ESI)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{33}H_{27}FOPS^+$  521.1499;  
 Found 521.1510.

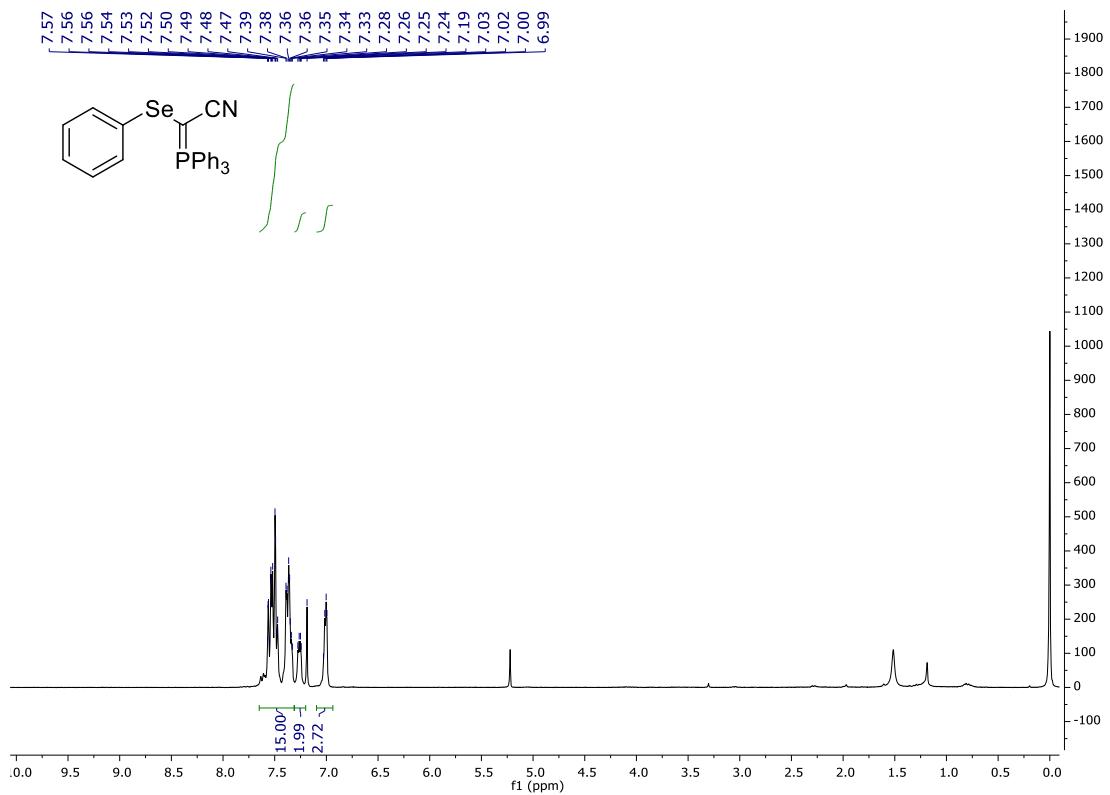


$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **7c**

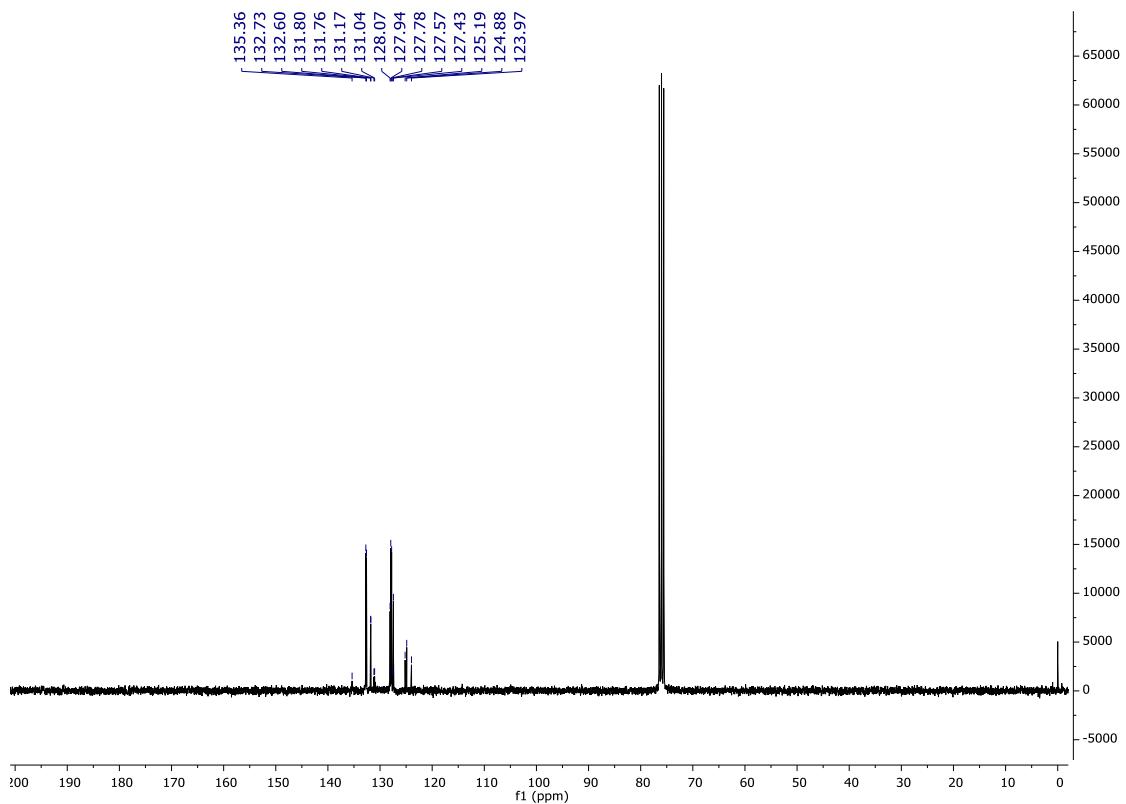




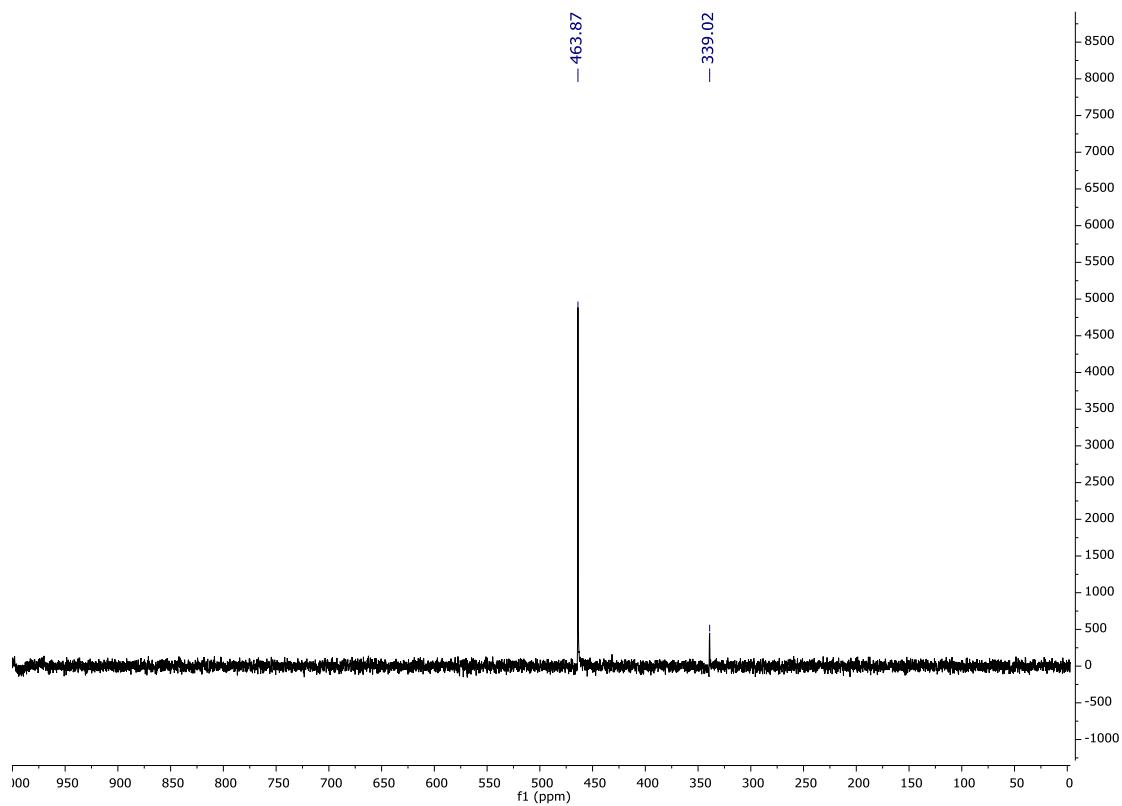
Mass spectrometry analysis of compound **7d** HRMS (ESI)  $m/z$ : [M + H]<sup>+</sup> Calcd for C<sub>27</sub>H<sub>24</sub>OPSe<sup>+</sup> 475.0725;  
Found 475.0725.



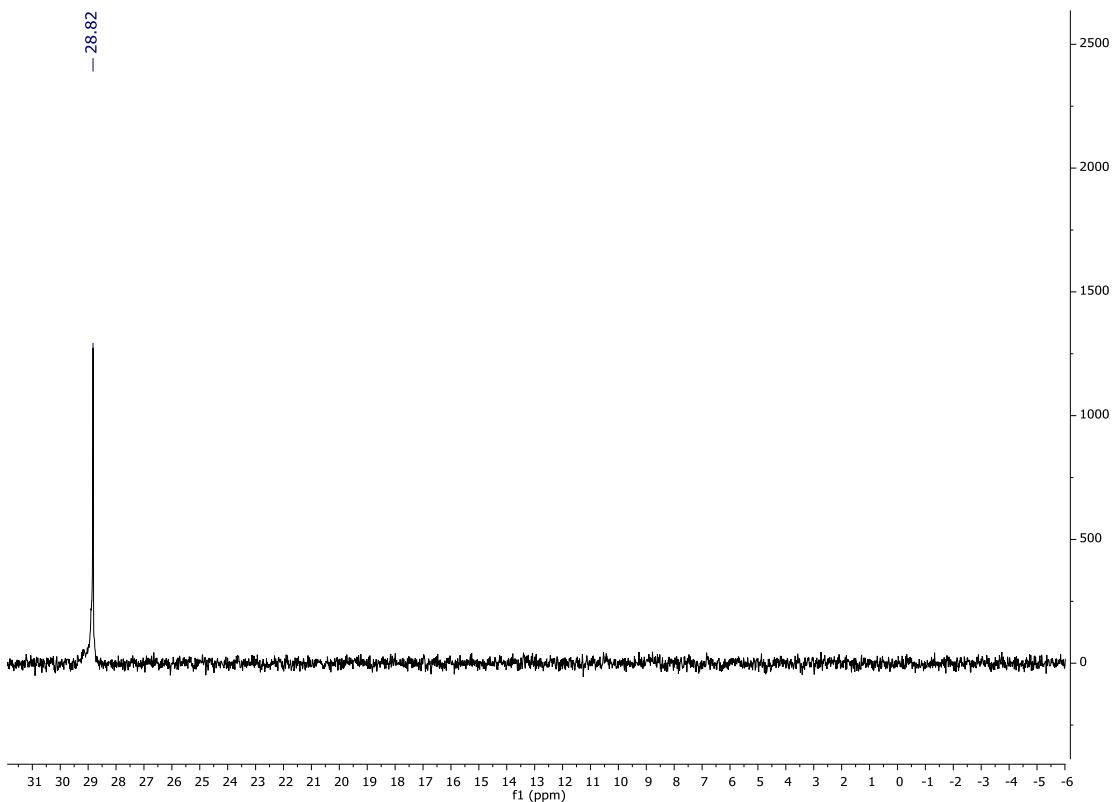
$^1\text{H}$  NMR spectrum (300 MHz,  $\text{CDCl}_3$ ) of compound **7d**



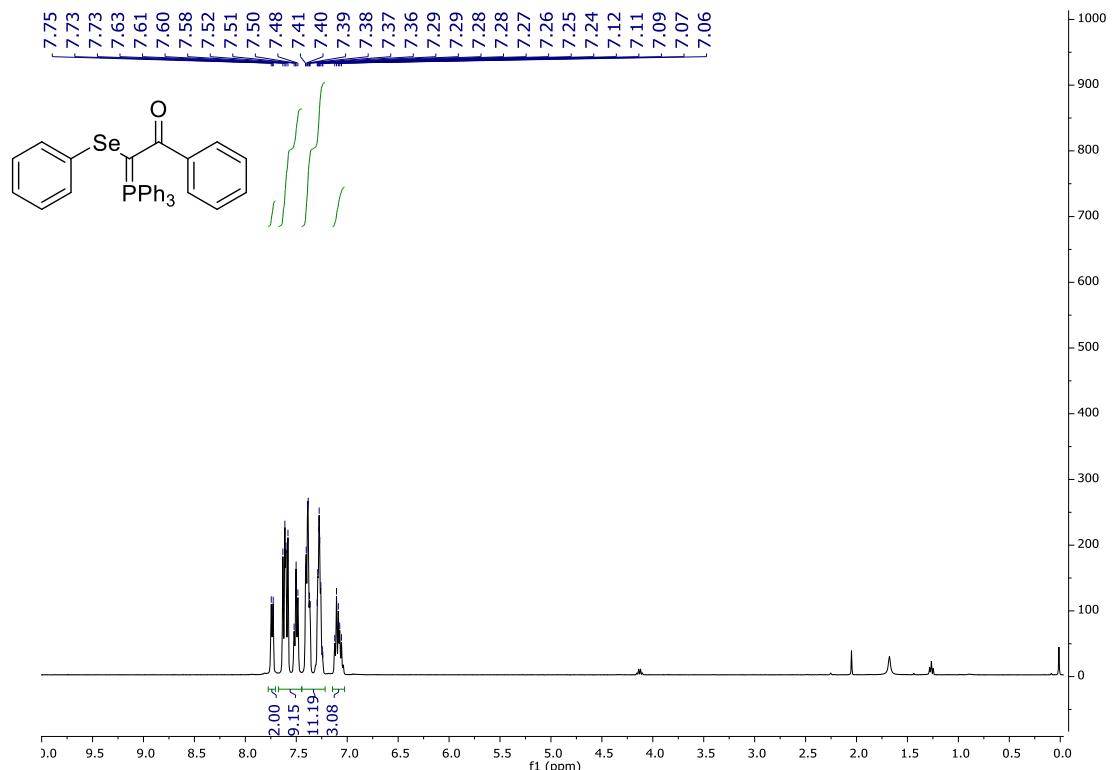
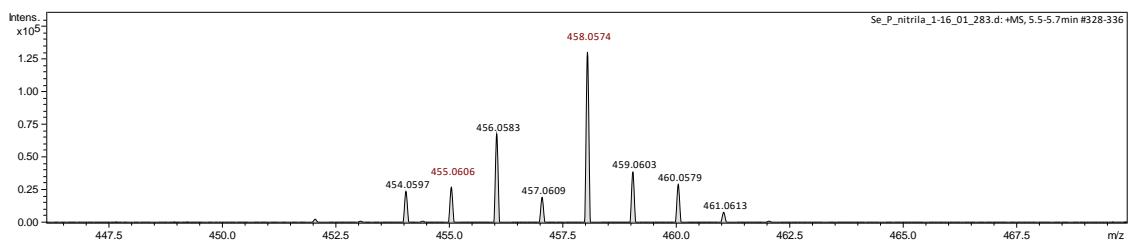
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (75 MHz,  $\text{CDCl}_3$ ) of compound **7d**

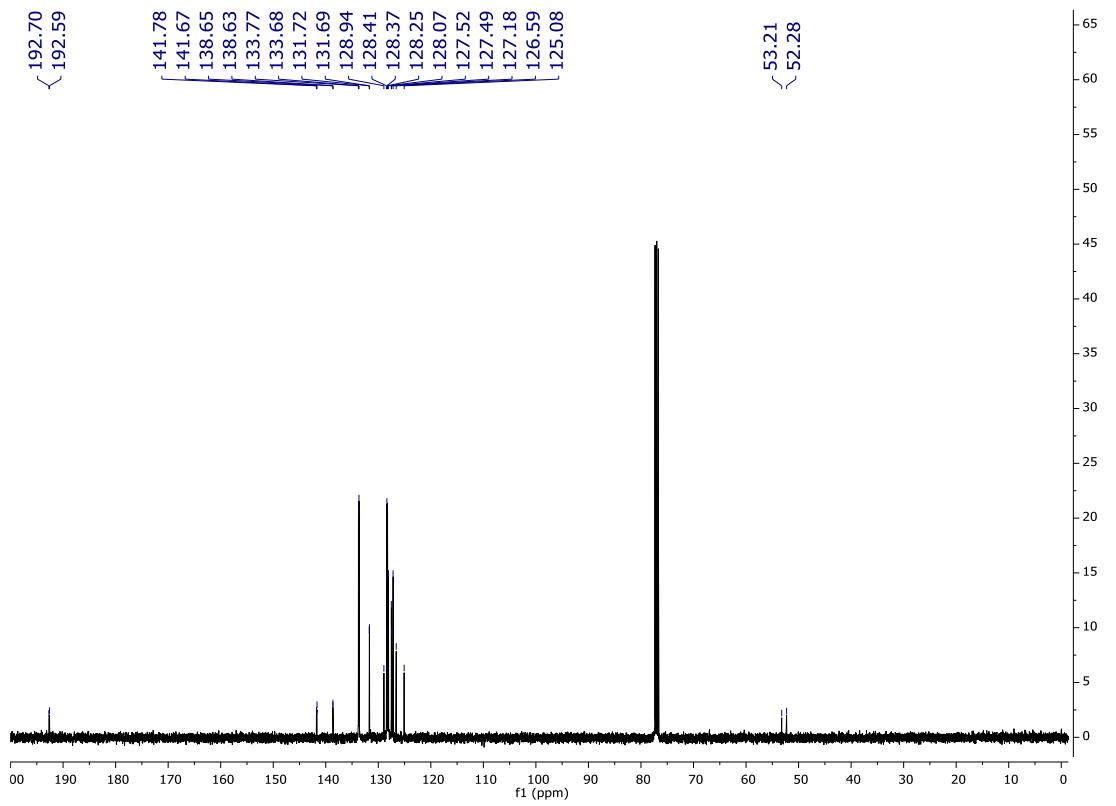


$^{77}\text{Se}$  NMR spectrum (57 MHz,  $\text{CDCl}_3$ ) of compound **7d**

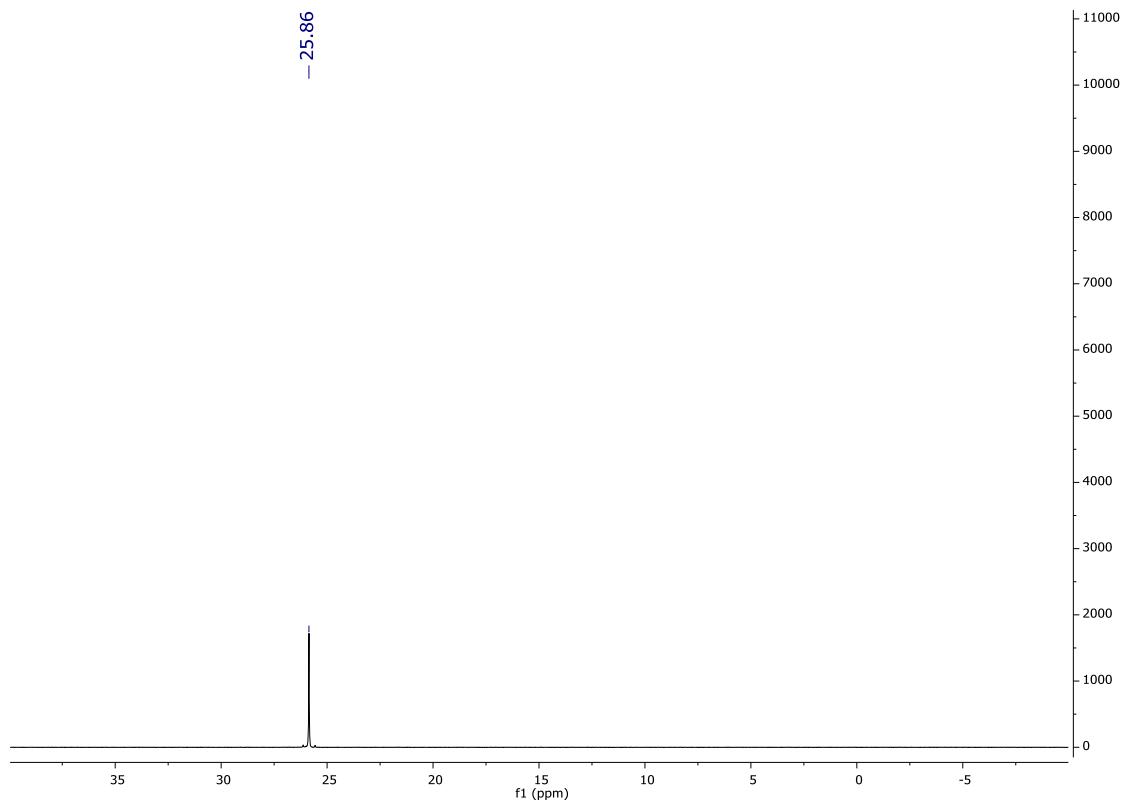


$^{31}\text{P}$  NMR spectrum (121 MHz,  $\text{CDCl}_3$ ) of compound **7d**

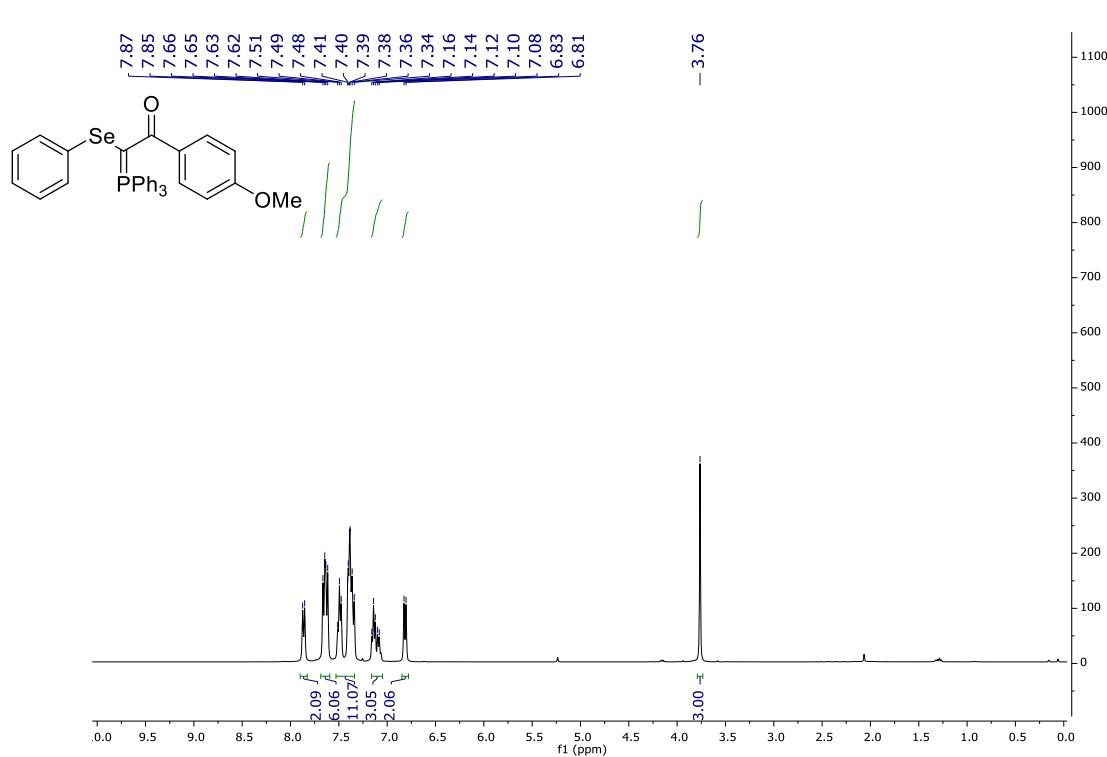
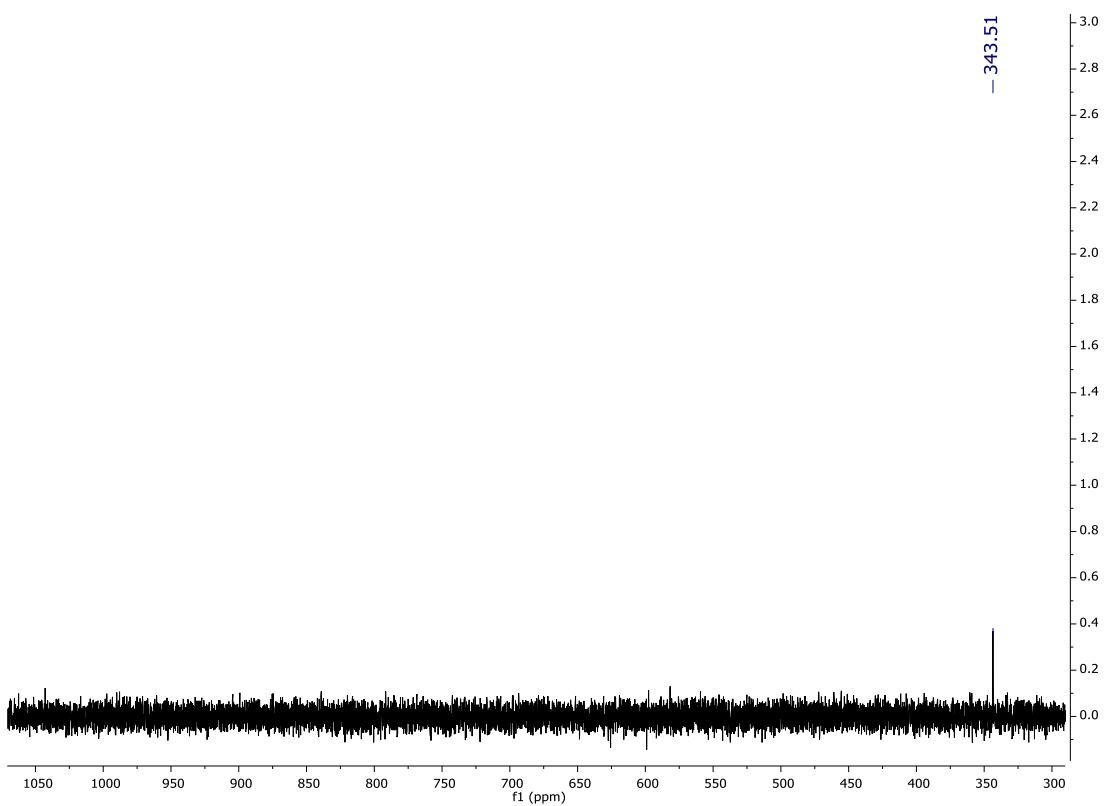


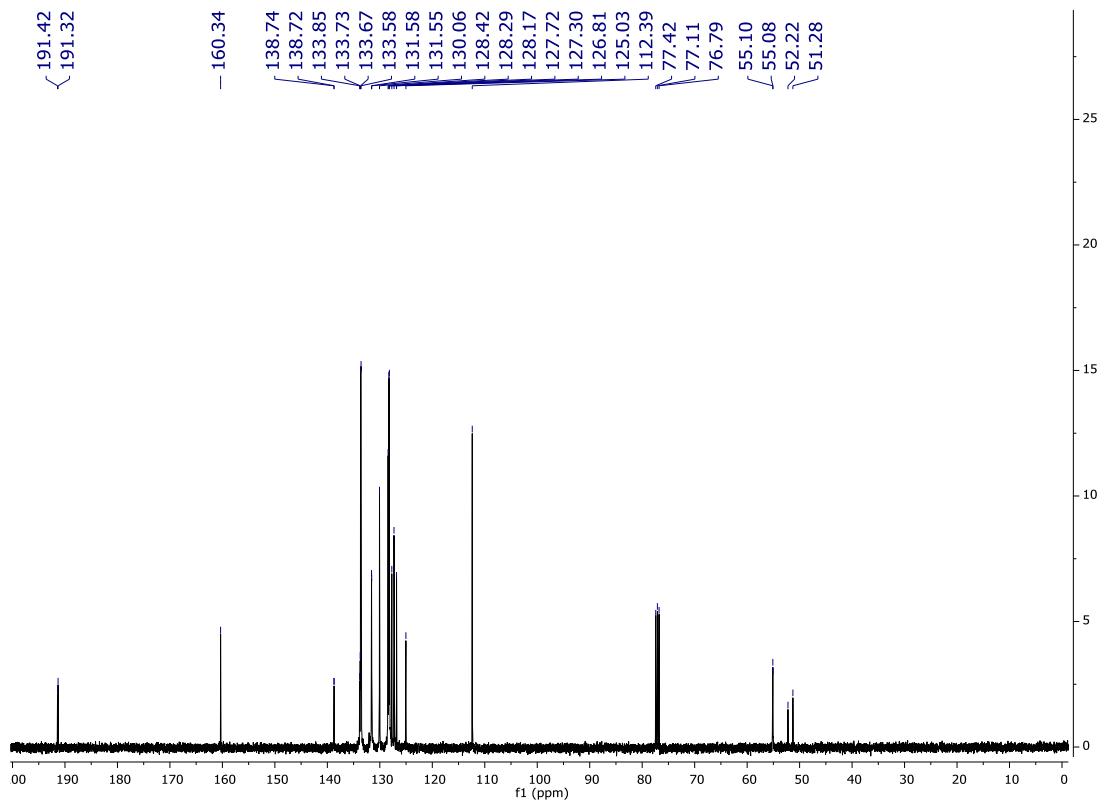


$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **7j**

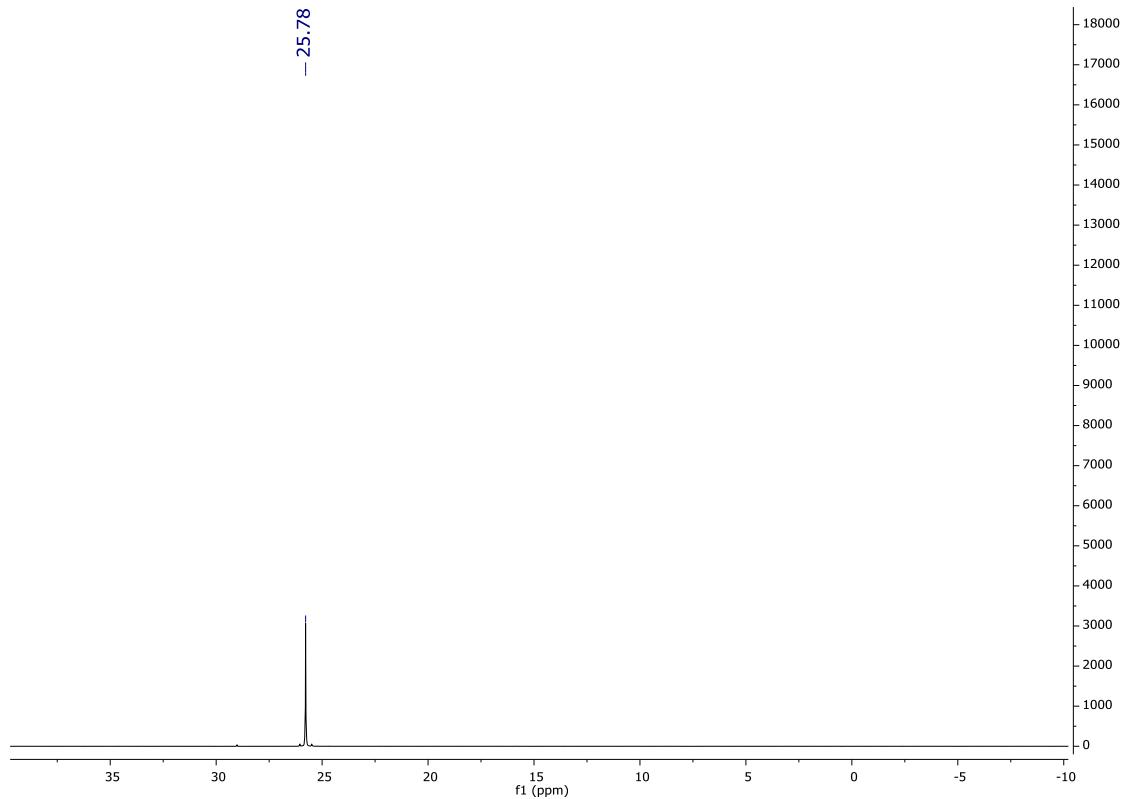


$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7j**

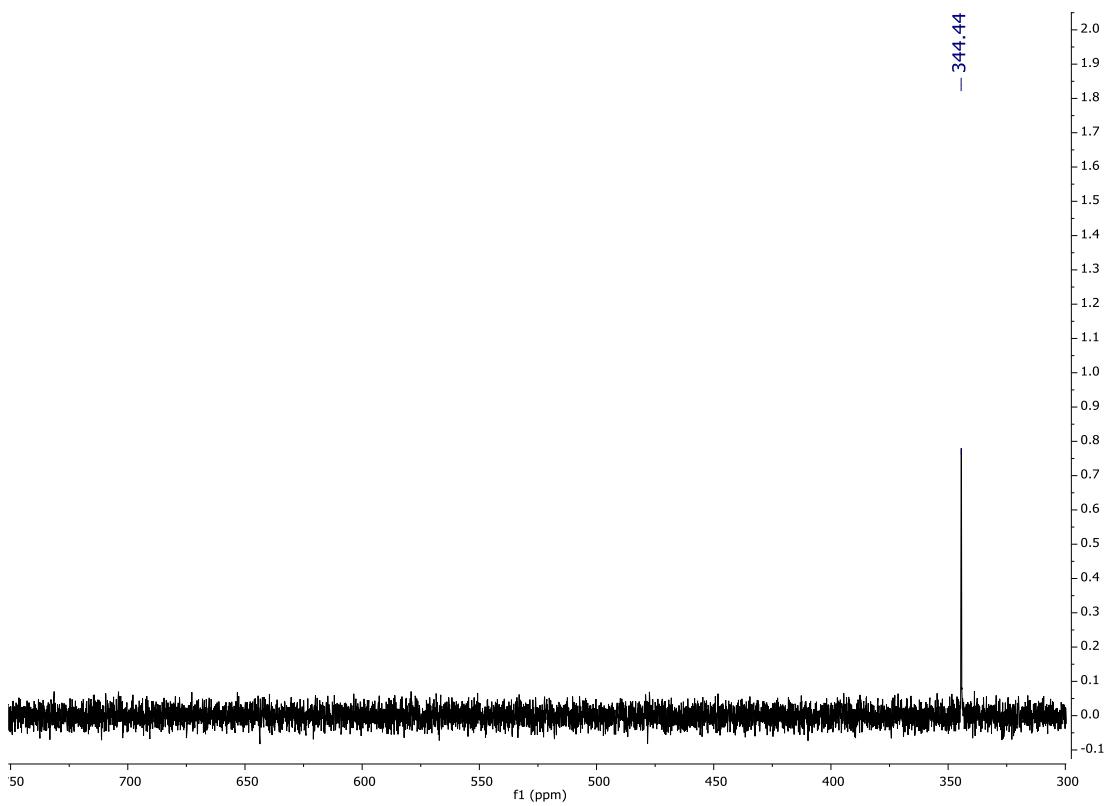




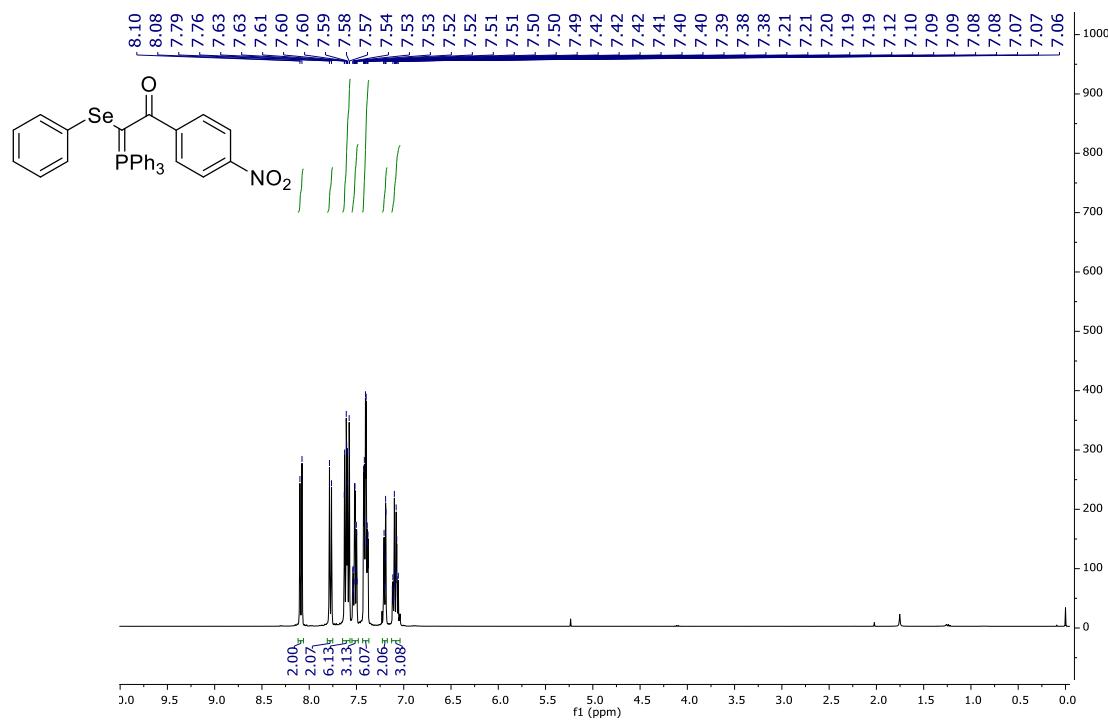
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **7k**



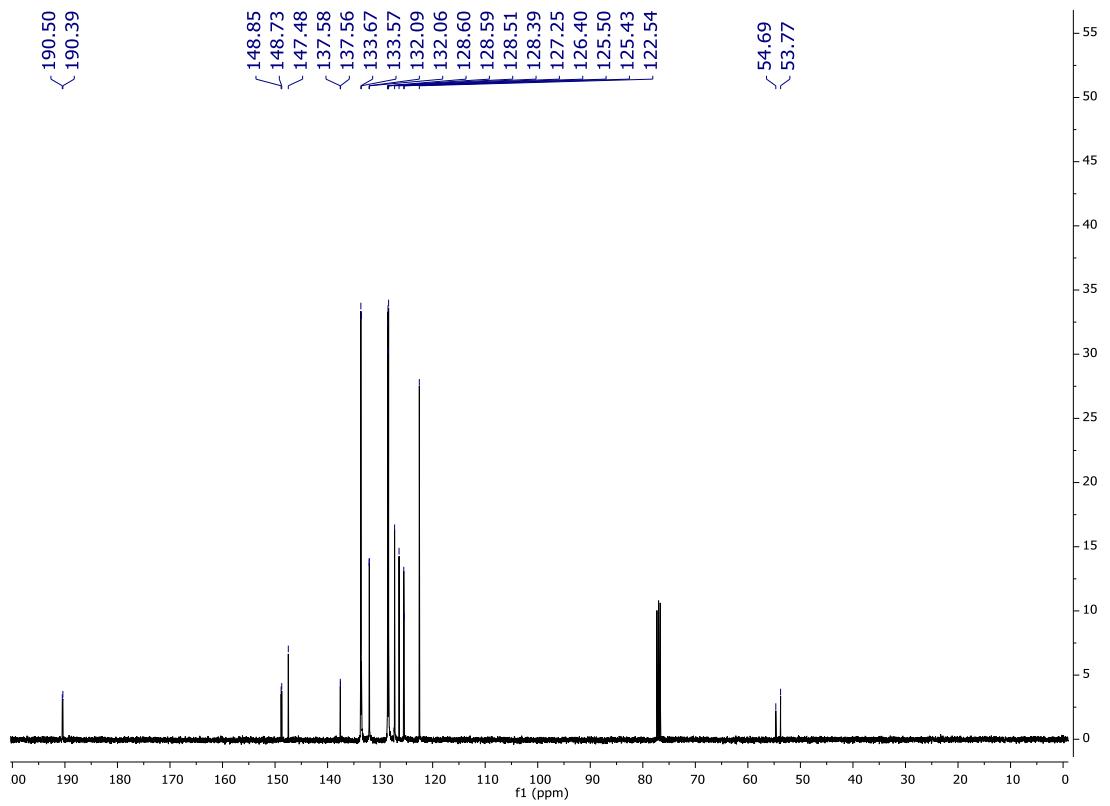
$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7k**



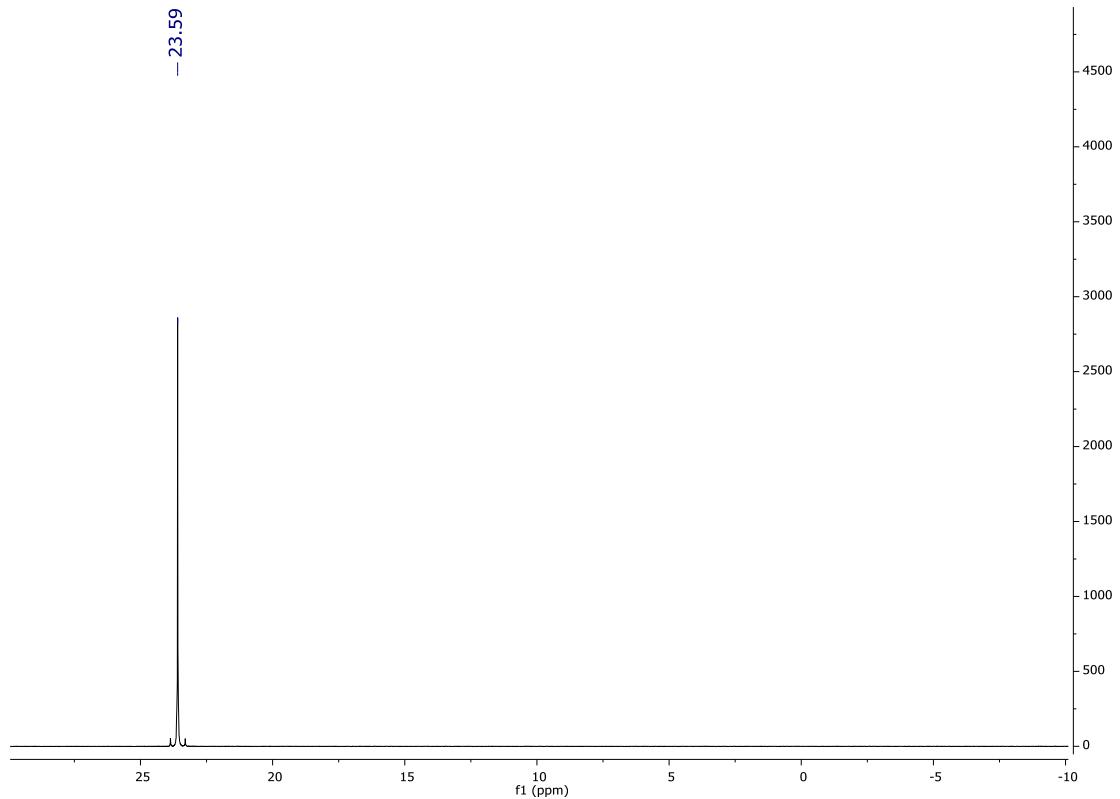
$^{77}\text{Se}$  NMR spectrum (76 MHz,  $\text{CDCl}_3$ ) of compound **7k**



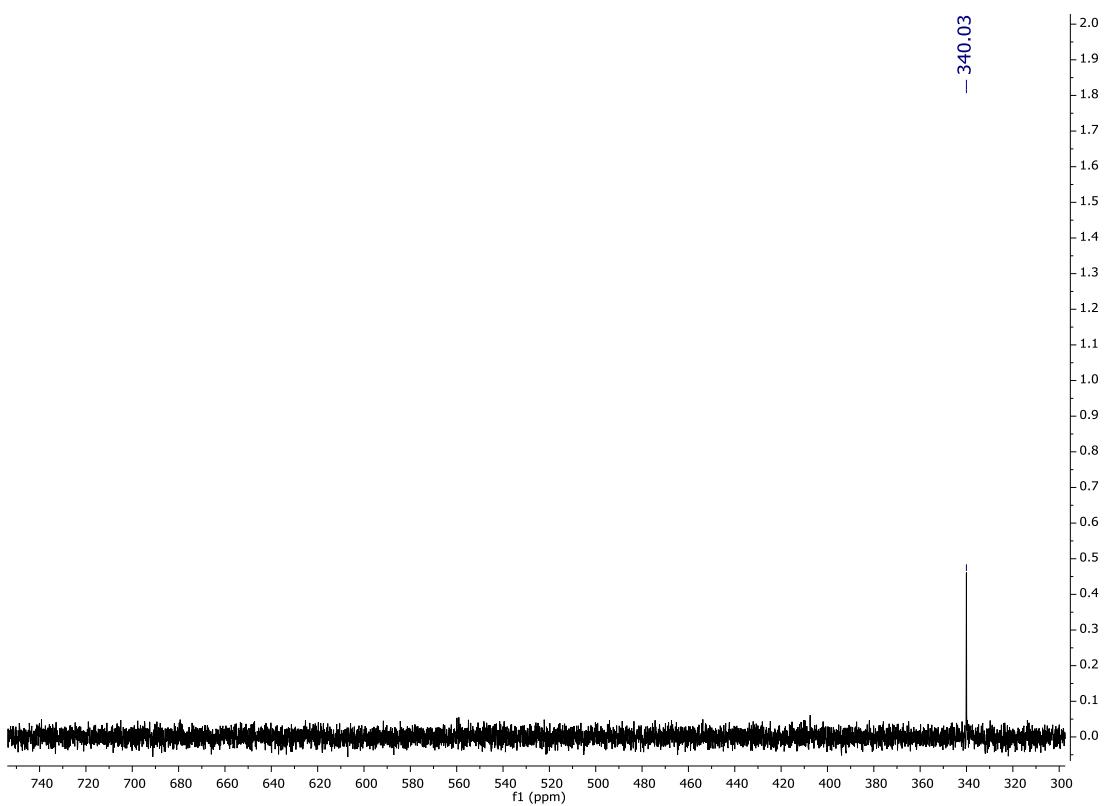
$^1\text{H}$  NMR spectrum (400 MHz,  $\text{CDCl}_3$ ) of compound **7l**



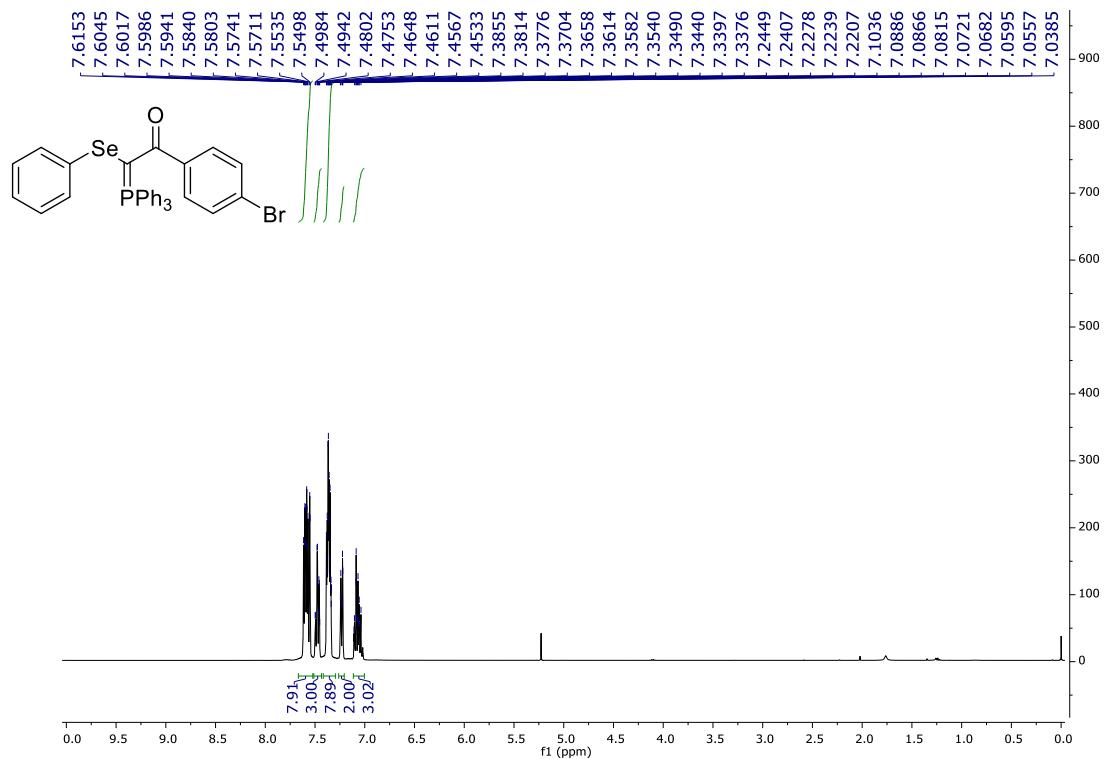
$^{13}\text{C}\{^1\text{H}\}$  NMR spectrum (100 MHz,  $\text{CDCl}_3$ ) of compound **7l**



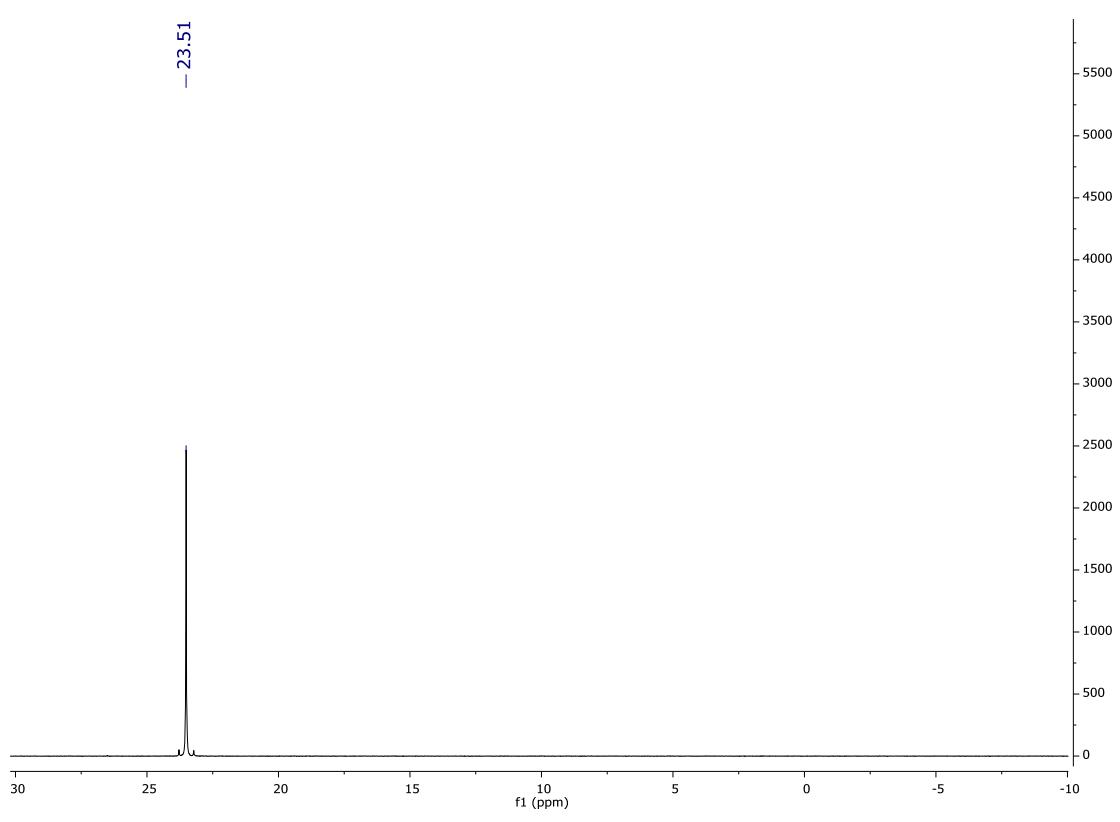
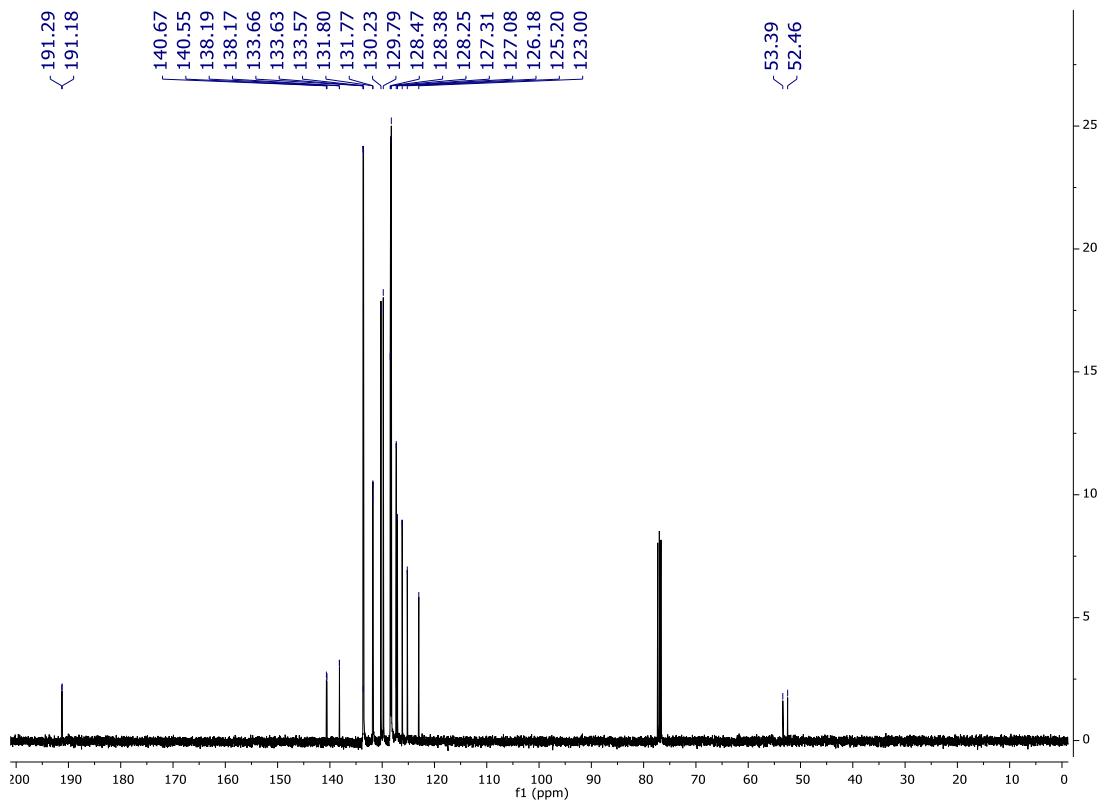
$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7l**

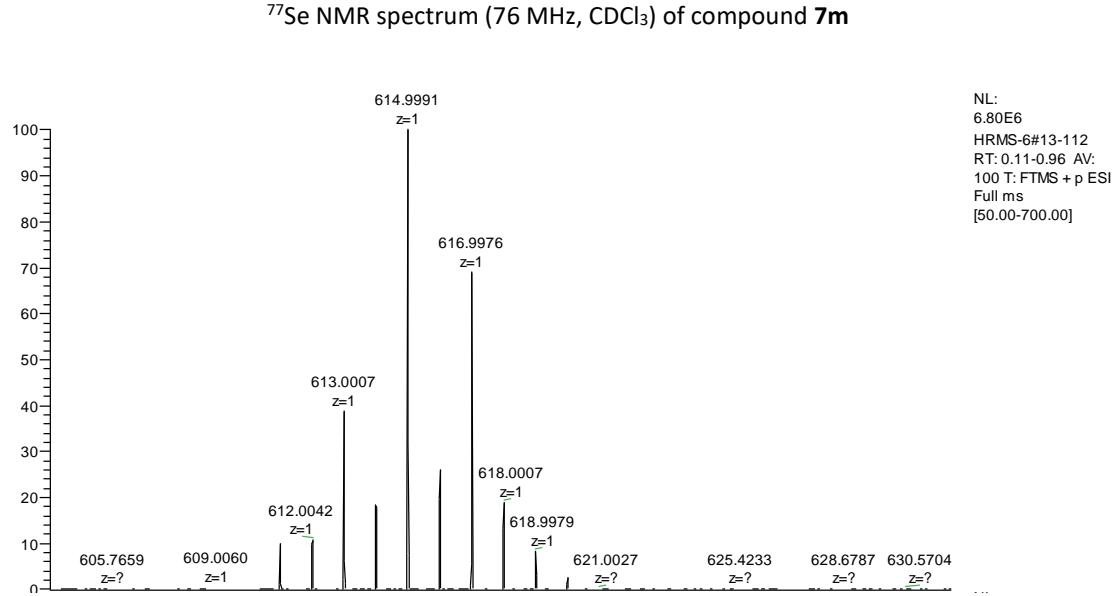
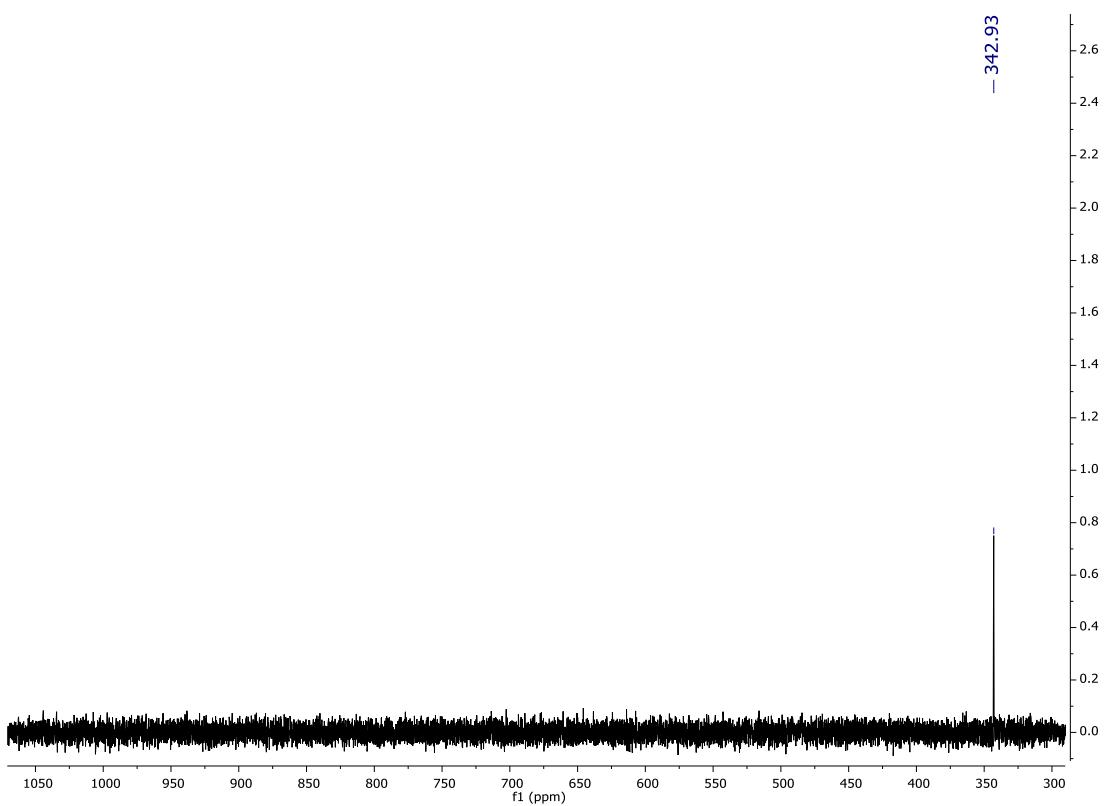


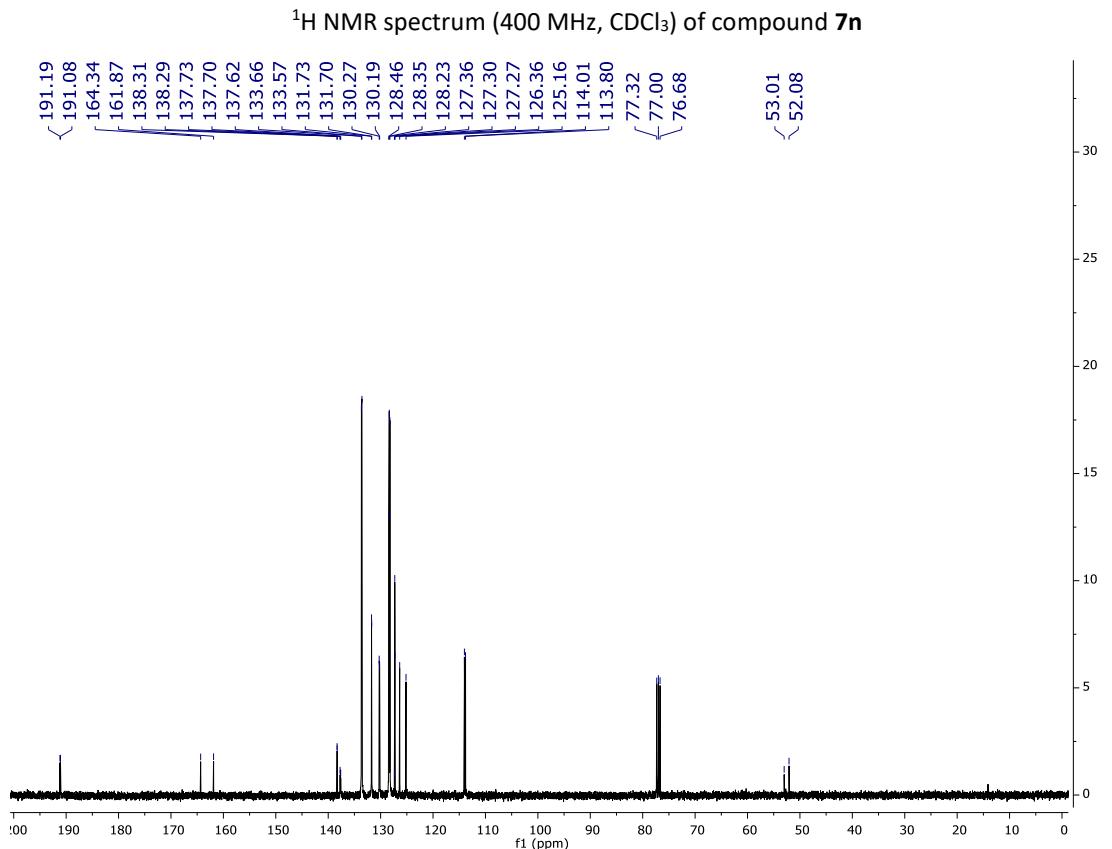
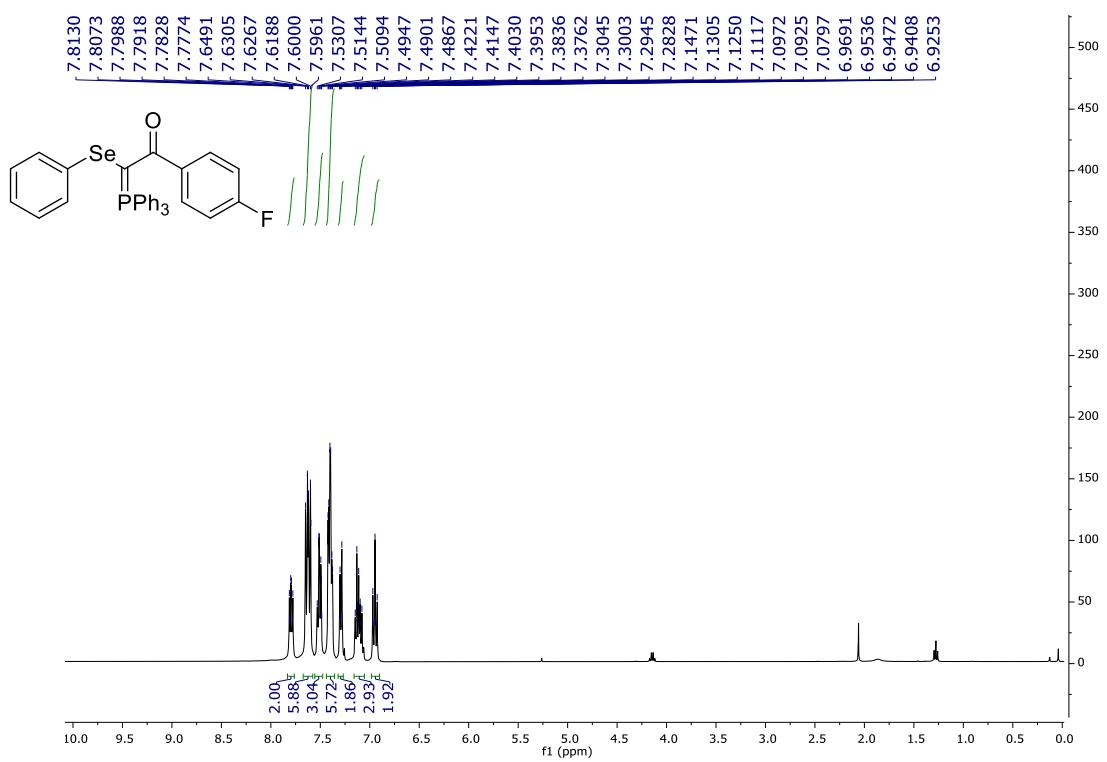
<sup>77</sup>Se NMR spectrum (76 MHz, CDCl<sub>3</sub>) of compound 7I



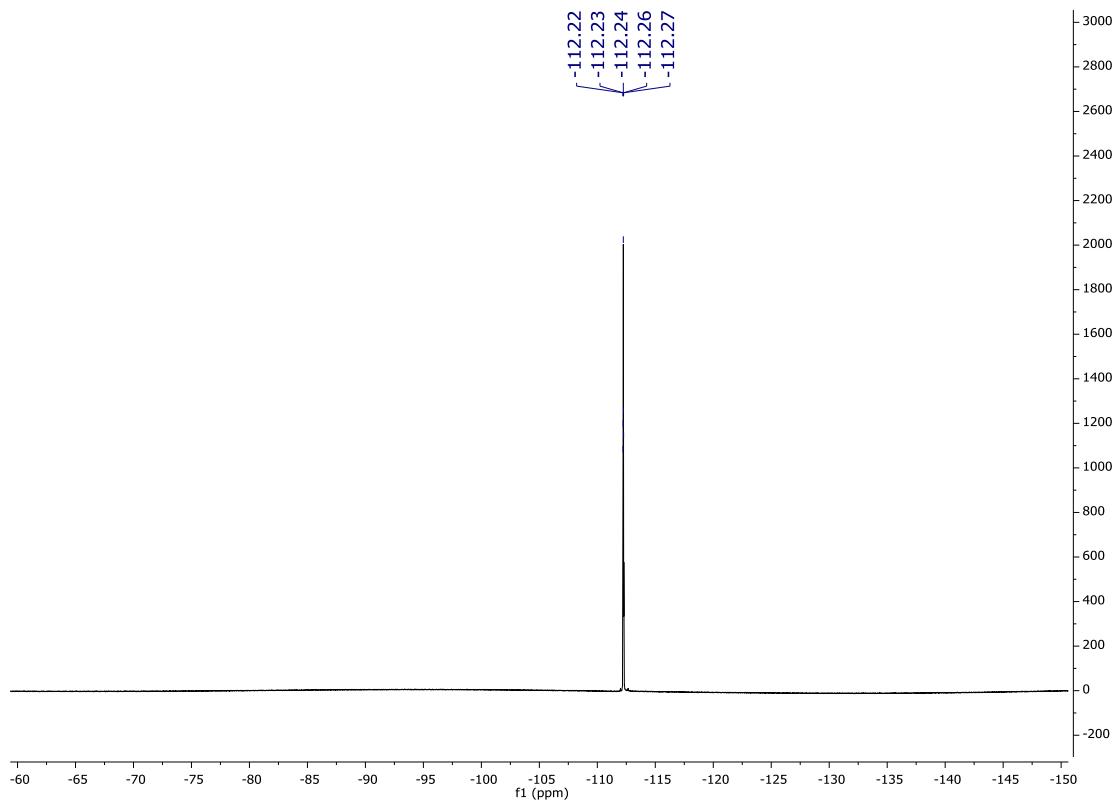
<sup>1</sup>H NMR spectrum (400 MHz, CDCl<sub>3</sub>) of compound 7m



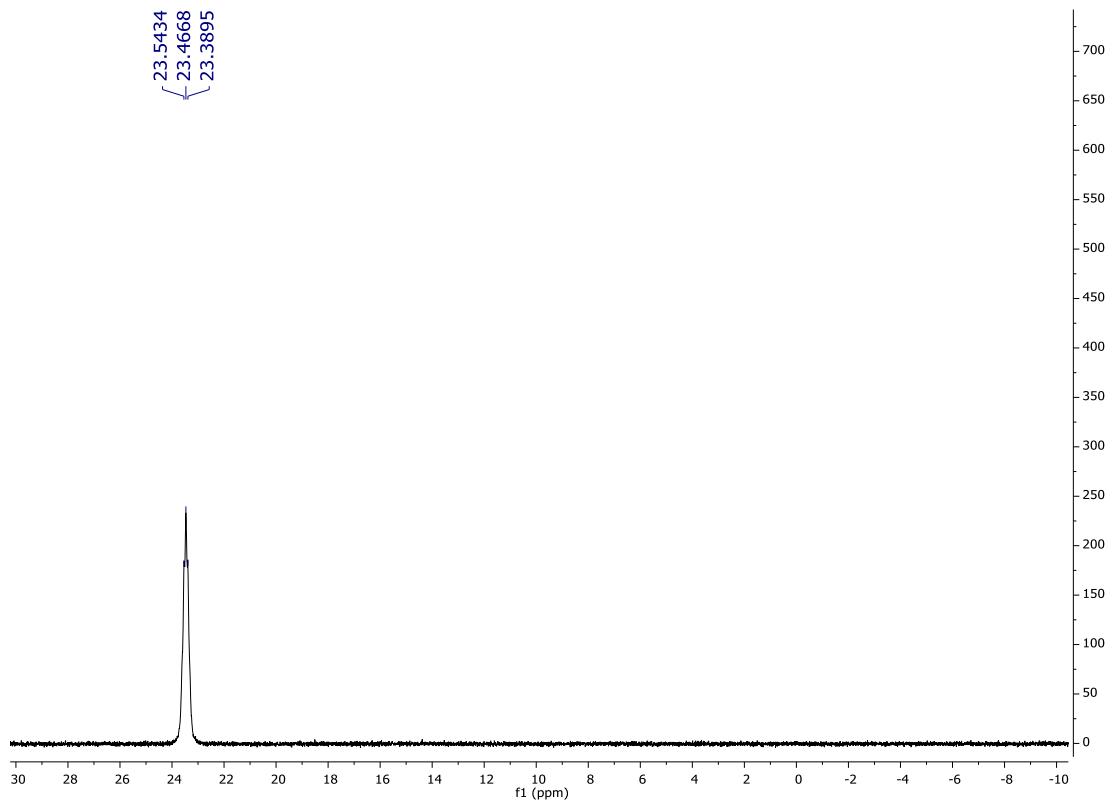




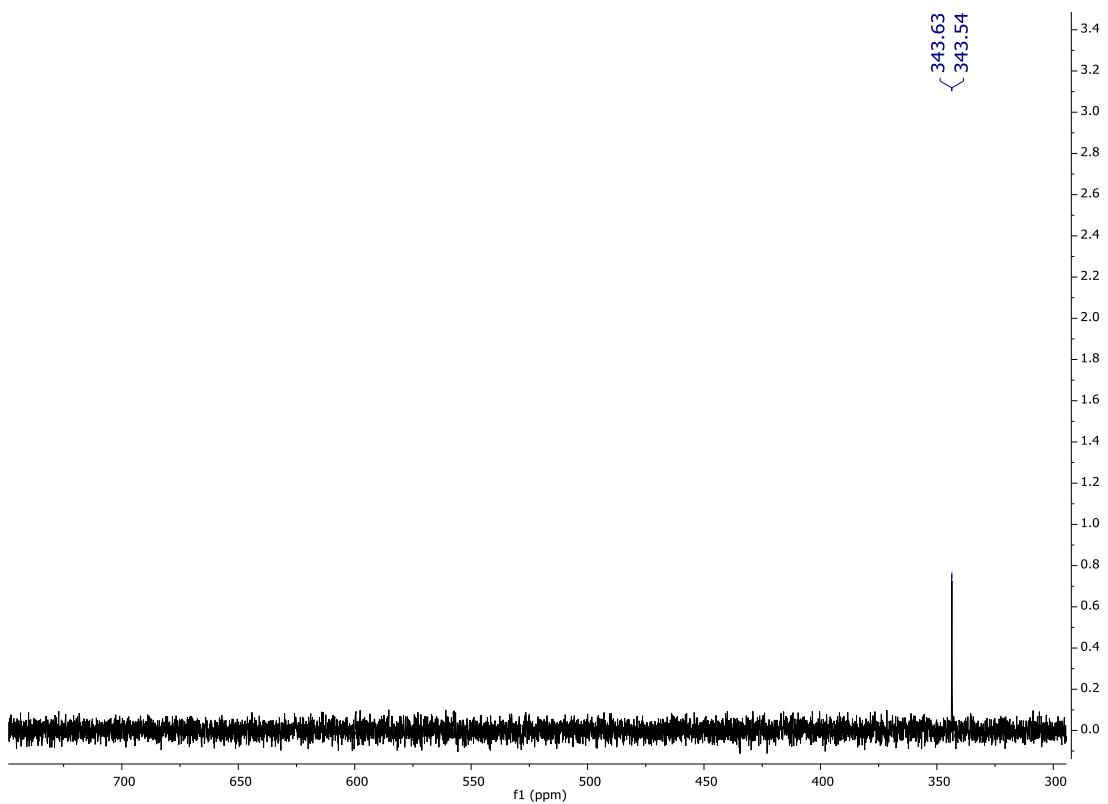
<sup>13</sup>C{<sup>1</sup>H} NMR spectrum (100 MHz, CDCl<sub>3</sub>) of compound **7n**



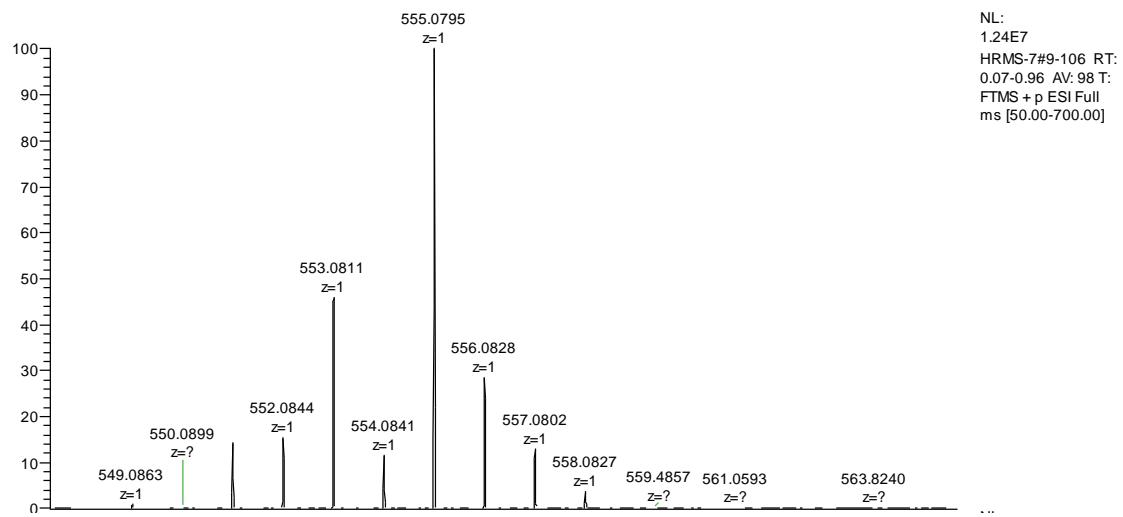
$^{19}\text{F}$  NMR spectrum (376 MHz,  $\text{CDCl}_3$ ) of compound **7n**



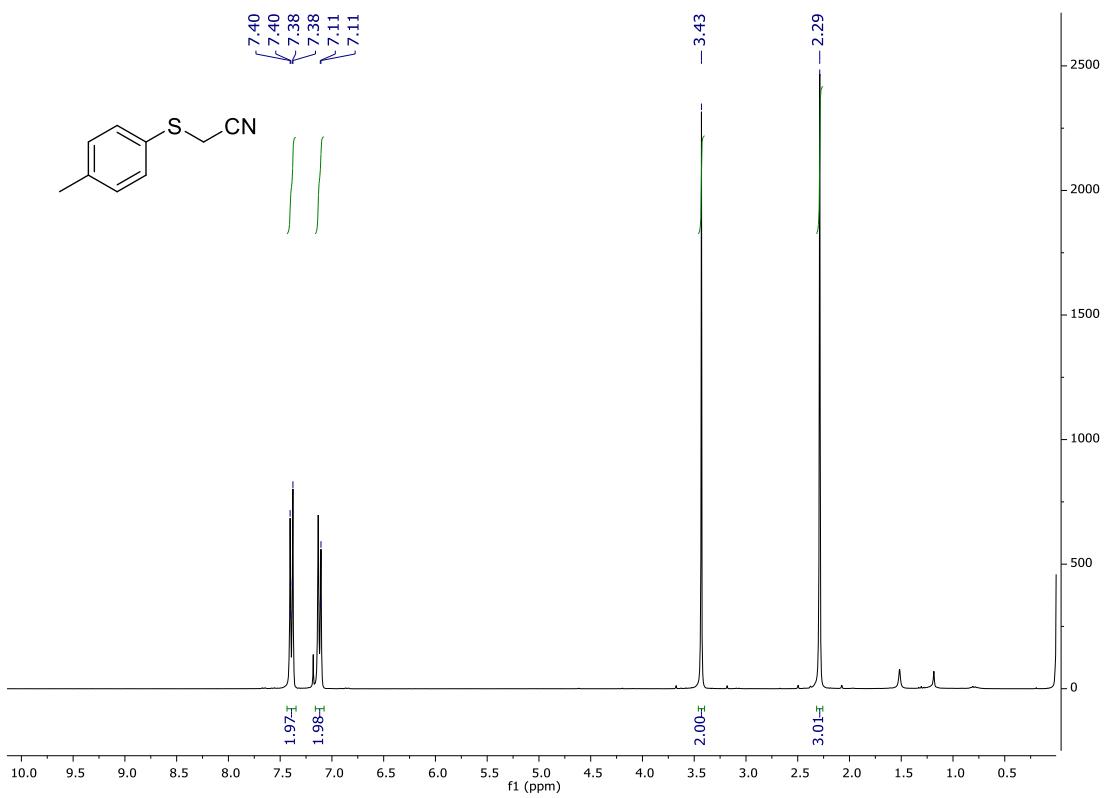
$^{31}\text{P}$  NMR spectrum (162 MHz,  $\text{CDCl}_3$ ) of compound **7n**



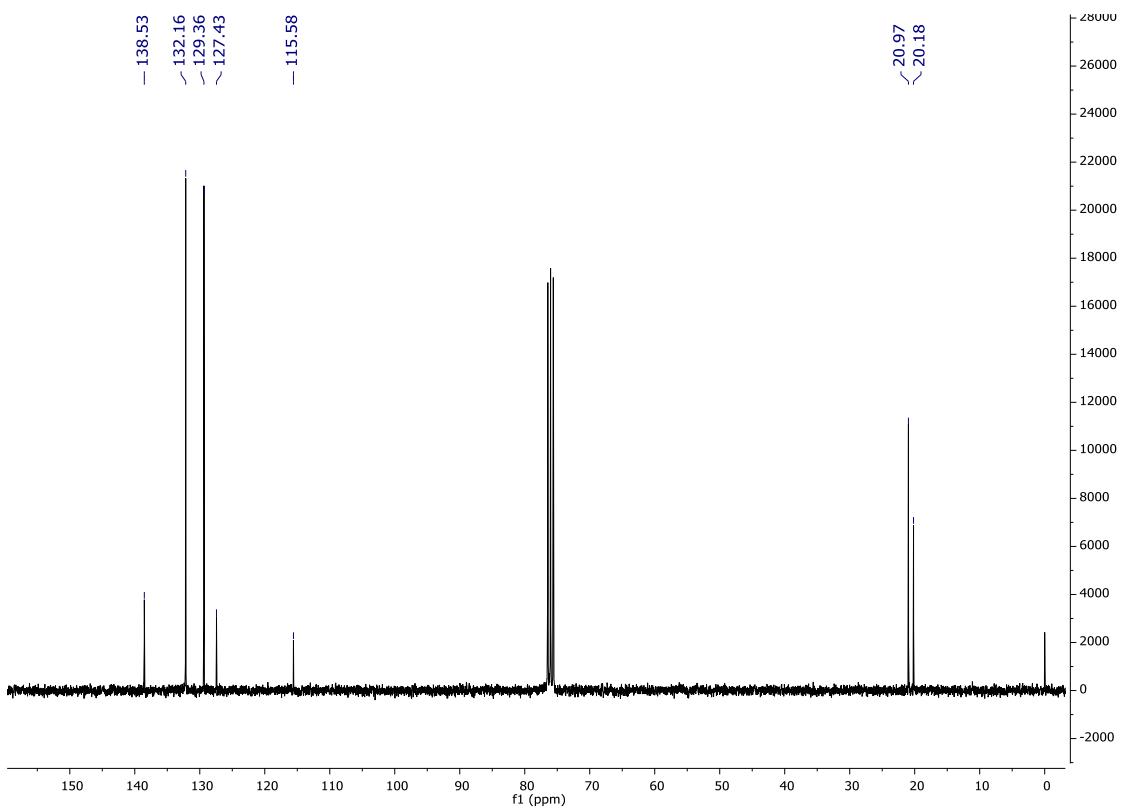
$^{77}\text{Se}$  NMR spectrum (76 MHz,  $\text{CDCl}_3$ ) of compound **7n**



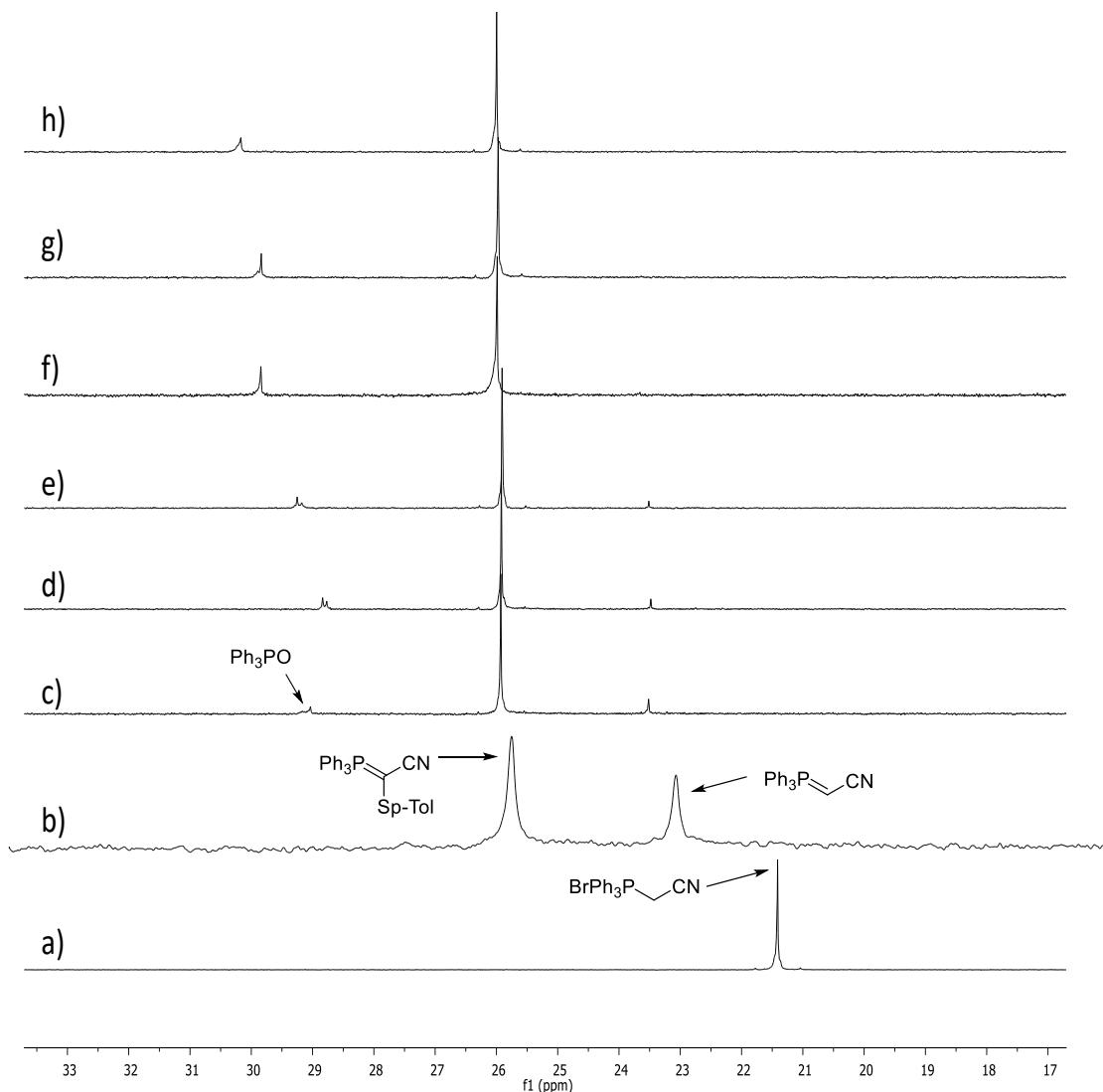
Mass spectrometry analysis of compound **7n** HRMS (ESI)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{32}\text{H}_{25}\text{FOPSe}^+$  555.0787;  
Found 555.0795.



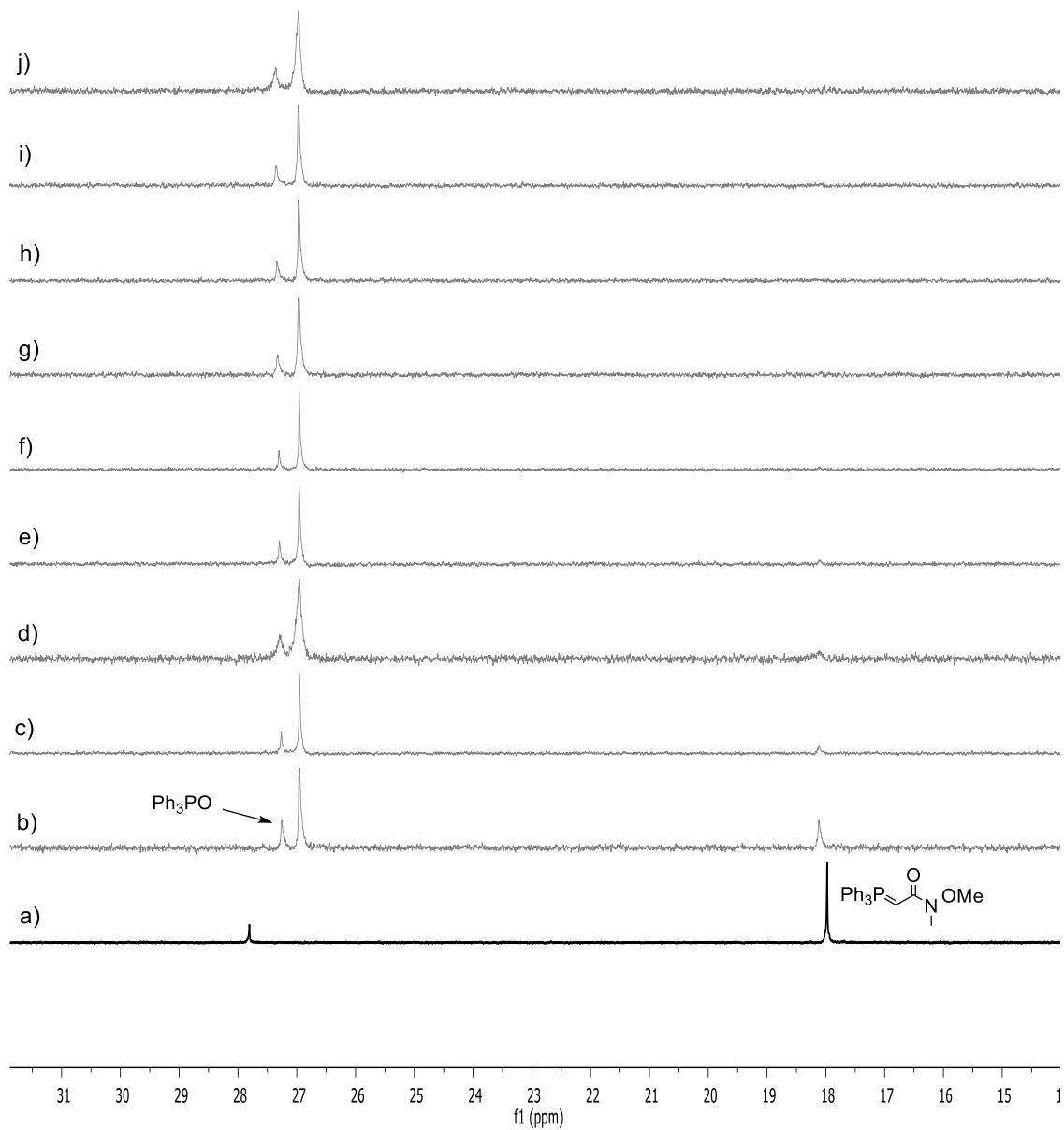
<sup>1</sup>H NMR spectrum (300 MHz, CDCl<sub>3</sub>) of compound **3n**



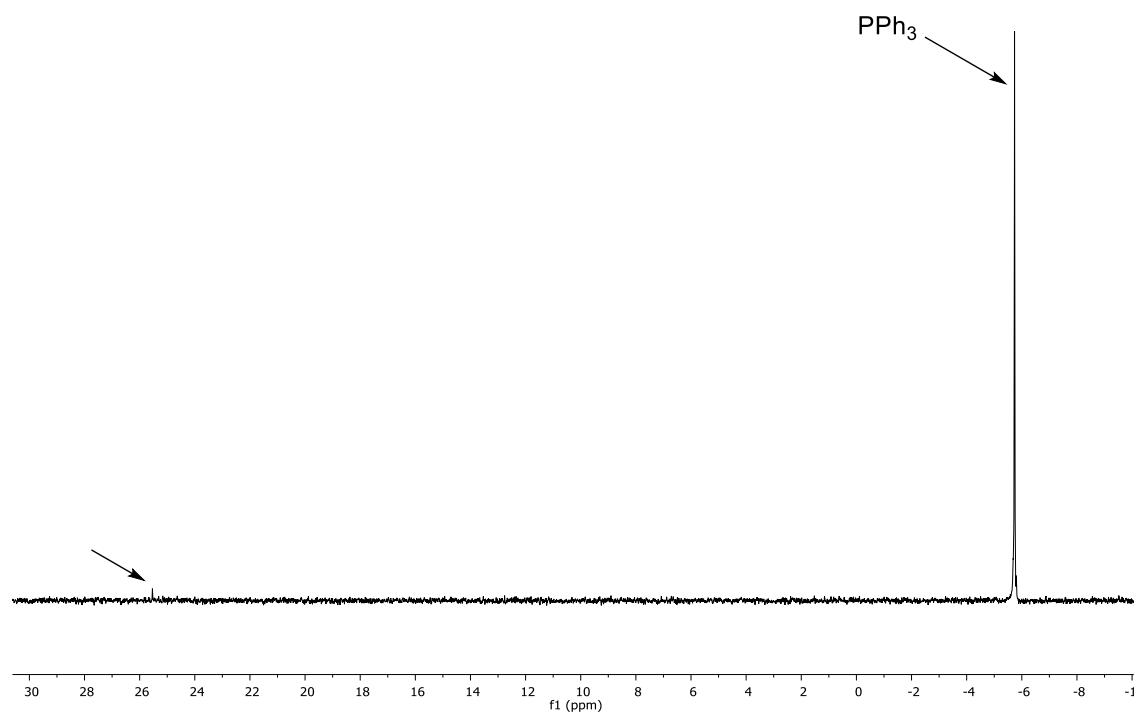
<sup>13</sup>C{<sup>1</sup>H} NMR spectrum (75 MHz, CDCl<sub>3</sub>) of compound **3n**



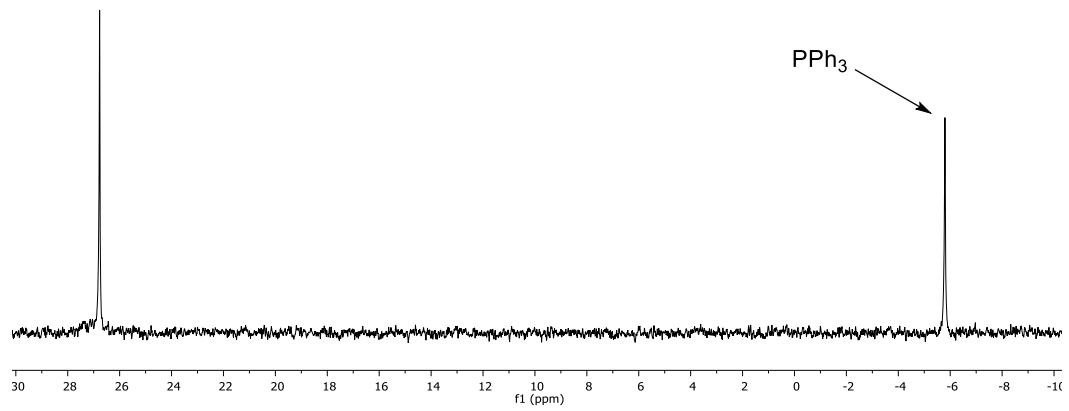
**Figure S1:**  $^{31}\text{P}$  NMR (121 MHz,  $\text{CH}_2\text{Cl}_2$ ) spectra for the synthesis of phosphorane **7b**; a) 0 min.; b) addition of triethylamine, c) after 10 min. reaction, d) after 20 min. reaction; e) after 40 min. reaction; f) after 60 min. reaction; g) after 70 min. reaction; and h) after 80 min. reaction.



**Figure S2:**  $^{31}\text{P}$  NMR (161 MHz,  $\text{CH}_2\text{Cl}_2$ ) spectra from the reaction of the phosphorane derived from Weinreb amide, **6c**; a) 0 min.; b) addition of  $\text{Et}_3\text{N}$  and thiosulfonate **1a**, c) after 5 min. reaction, d) after 10 min. reaction; e) after 15 min. reaction; f) after 20 min. reaction; g) after 25 min. reaction; h) after 30 min. reaction; i) after 35 min. reaction; and j) after 40 min. reaction.



**Figure S3:**  $^{31}\text{P}$  NMR (161 MHz,  $\text{CH}_2\text{Cl}_2$ ) spectrum from the reaction of triphenylphosphine (1 equiv.) and sodium *p*-toluenesulfinate (1 equiv.).



**Figure S4:**  $^{31}\text{P}$  NMR (161 MHz,  $\text{CH}_2\text{Cl}_2$ ) spectrum resulting from the addition of the mixture of triphenylphosphine (1 equiv.) and sodium *p*-toluenesulfinate (1 equiv.) (Figure S3) to the NMR tube containing the reaction of the phosphorane derived from Weinreb amide, **6c** after addition of  $\text{Et}_3\text{N}$  and thiosulfonate **1a** (Figure S2-j).