

An environmentally benign multi-component reaction: Regioselective synthesis of fluorinated 2-aminopyridines using diverse properties of nitro group

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Supporting Information

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X-ray Structure and Data of 4a & 5s

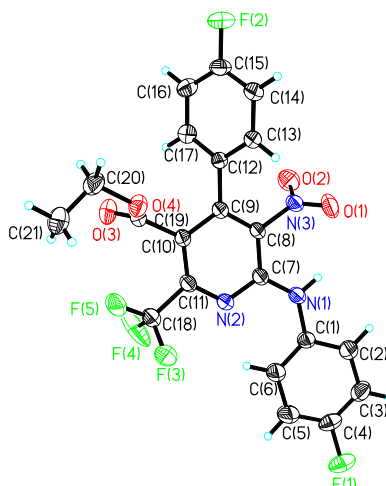


Figure S1. X-Ray crystal structure of **4a**; ellipsoids are drawn at the 30% probability level.

Table S1. Crystal data and structure refinement for **4a**

Identification code	1
Empirical formula	$C_{21}H_{14}F_5N_3O_4$
Formula weight	467.35
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system, space group	Triclinic, P -1
Unit cell dimensions	a = 8.2387(14) Å alpha = 78.884(2) deg. b = 9.1226(15) Å beta = 77.335(2) deg. c = 15.647(3) Å gamma = 63.875(2) deg.
Volume	1023.9(3) Å ³
Z, Calculated density	2, 1.516 Mg/m ³
Absorption coefficient	0.136 mm ⁻¹
F(000)	476
Crystal size	0.300 x 0.250 x 0.230 mm
Theta range for data collection	2.502 to 24.995 deg.
Limiting indices	-9 ≤ h ≤ 9, -10 ≤ k ≤ 10, -18 ≤ l ≤ 18
Reflections collected / unique	7987 / 3571 [R(int) = 0.0226]
Completeness to theta = 25.242	96.8 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.969 and 0.960
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	3571 / 0 / 300
Goodness-of-fit on F ²	1.094
Final R indices [I > 2σ(I)]	R1 = 0.0501, wR2 = 0.1497
R indices (all data)	R1 = 0.0658, wR2 = 0.1619
Extinction coefficient	0.023(5)
Largest diff. peak and hole	0.432 and -0.275 eÅ ⁻³

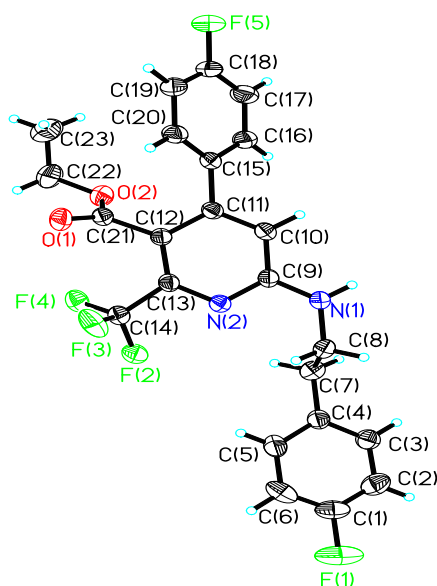


Figure S2. X-Ray crystal structure of **5s**; ellipsoids are drawn at the 30% probability level.

Table S2. Crystal data and structure refinement for **5s**

Identification code	1
Empirical formula	$C_{23}H_{19}F_5N_2O_2$
Formula weight	450.40
Temperature	293(2) K
Wavelength	0.71073 Å
Crystal system, space group	Triclinic, $P -1$
Unit cell dimensions	$a = 8.6308(16)$ Å $\alpha = 78.895(2)$ deg. $b = 9.4049(18)$ Å $\beta = 81.887(2)$ deg. $c = 13.955(3)$ Å $\gamma = 74.726(2)$ deg.
Volume	$1067.4(3)$ Å ³
Z, Calculated density	2, 1.401 Mg/m ³
Absorption coefficient	0.120 mm ⁻¹
F(000)	464
Crystal size	0.350 x 0.300 x 0.200 mm
Theta range for data collection	1.494 to 25.150 deg.
Limiting indices	$-10 \leq h \leq 10$, $-11 \leq k \leq 11$, $-16 \leq l \leq 16$
Reflections collected / unique	8534 / 3809 [R(int) = 0.0261]
Completeness to theta = 25.242	98.3 %
Absorption correction	Semi-empirical from equivalents
Max. and min. transmission	0.976 and 0.959
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	3809 / 0 / 290
Goodness-of-fit on F ²	1.022
Final R indices [I > 2σ(I)]	R1 = 0.0512, wR2 = 0.1386
R indices (all data)	R1 = 0.0861, wR2 = 0.1679
Extinction coefficient	n/a
Largest diff. peak and hole	0.383 and -0.235 e.Å ⁻³
Symmetry transformations used to generate equivalent atoms:	

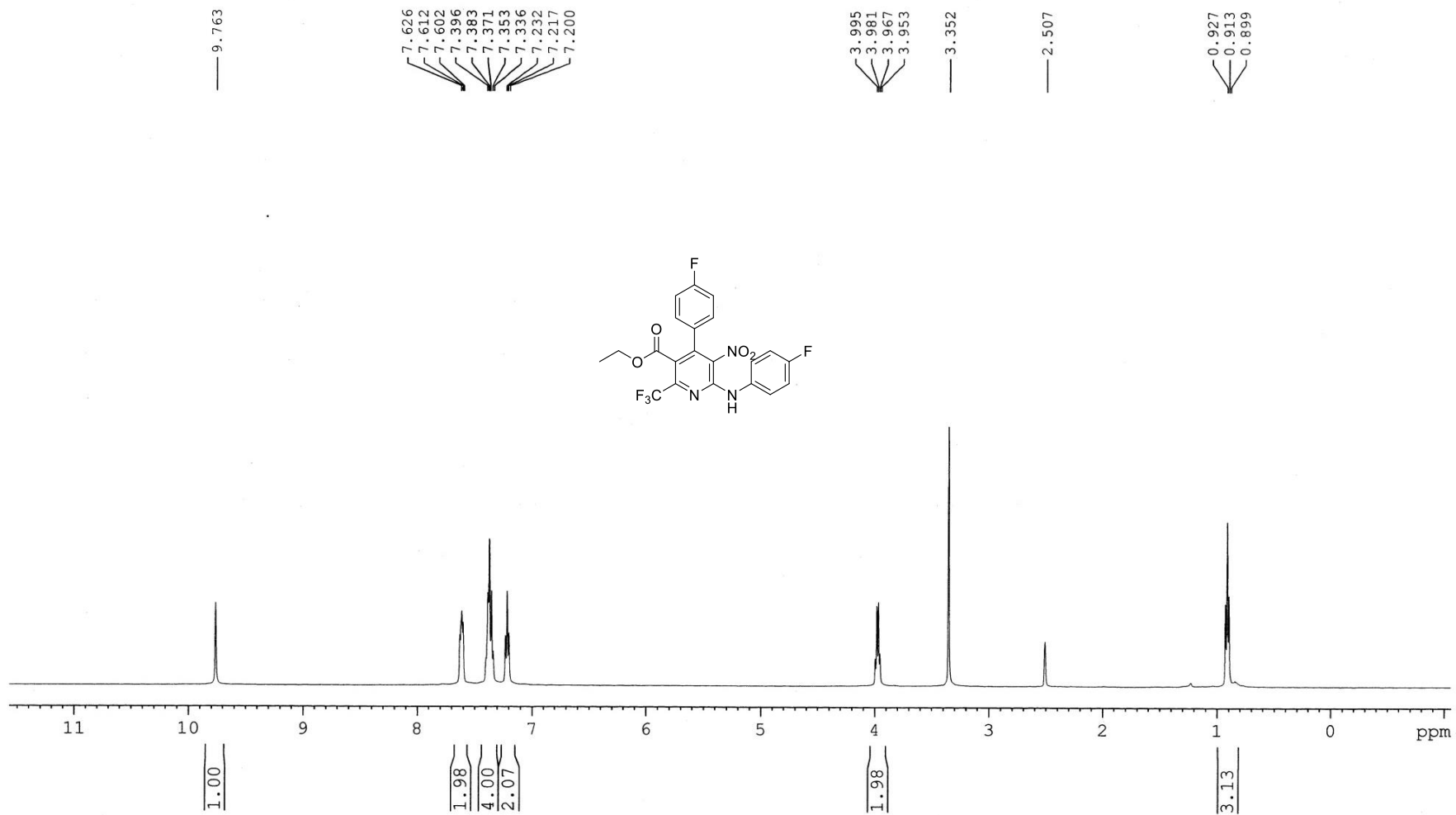
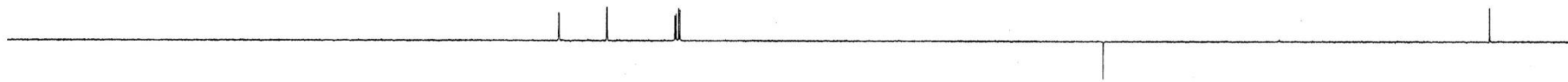


Figure S3. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4a**

DEPT135



YUNNAN UNIVERSITY AVIIHD500 DXX-3-6-1
Jun27-2017-duxuanxuan
C13CPD DMSO

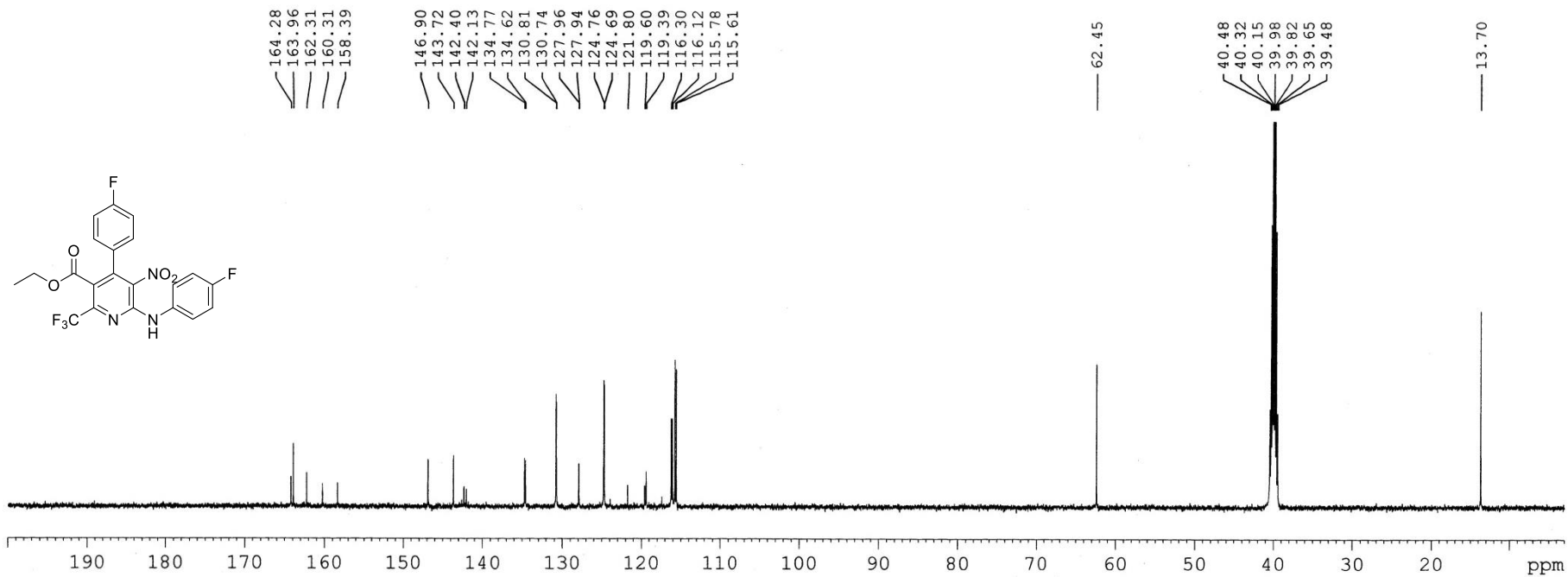


Figure S4. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4a

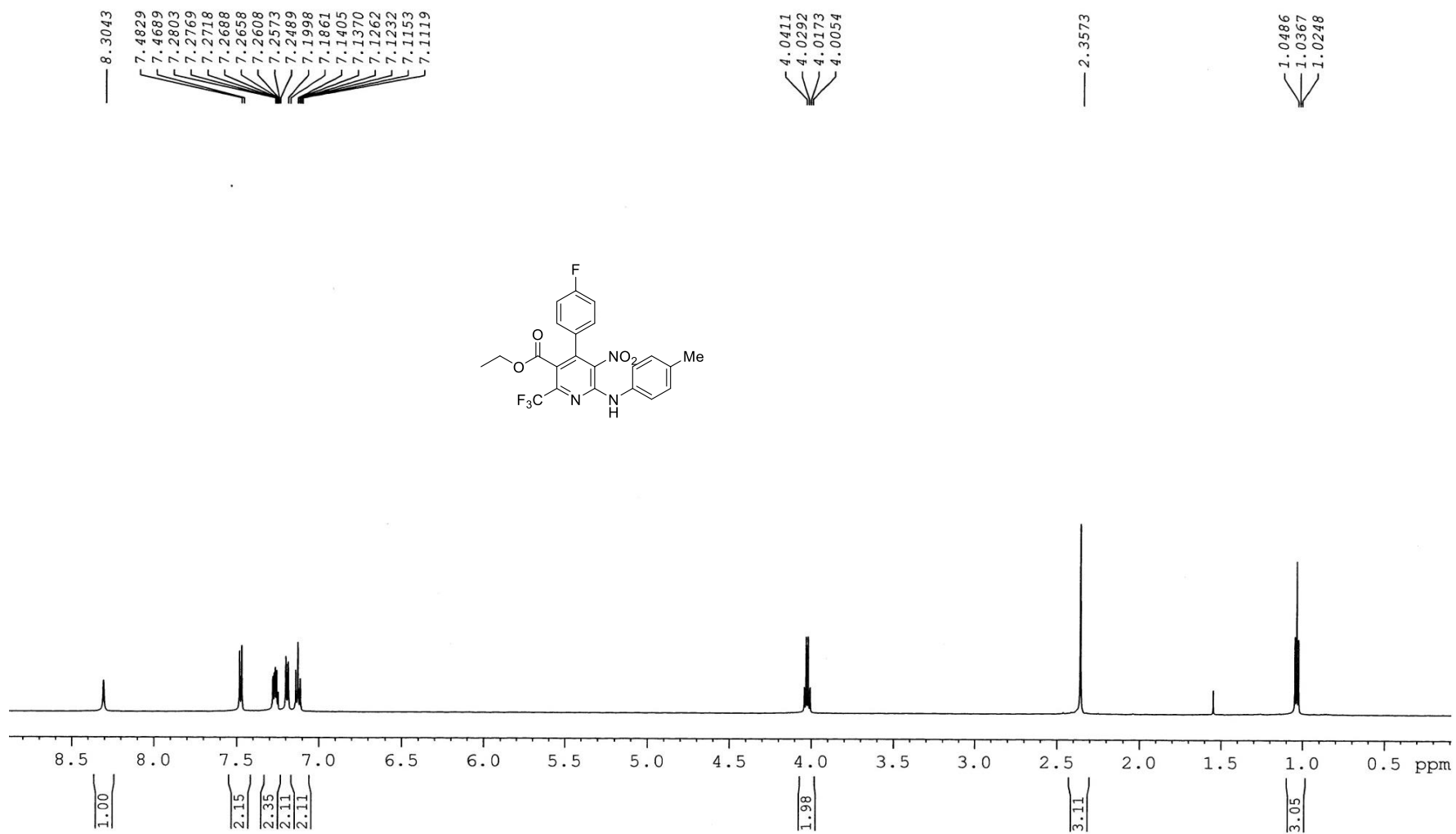
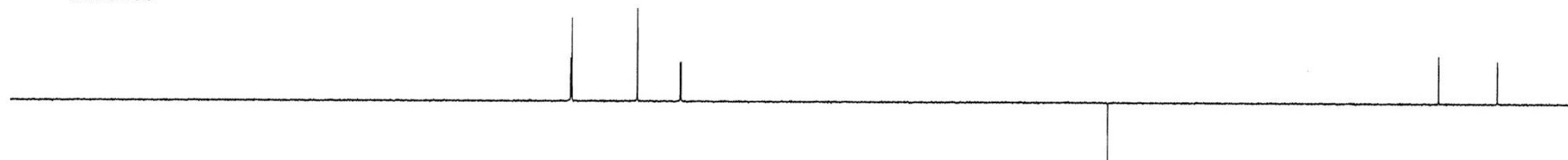


Figure S5. ¹H NMR (600 MHz, CDCl₃) spectra of compound **4b**

DEPT135



YUNNAN UNIVERSITY ASCEND AVIIIHD600 DXX-3-20-1
Sep06-2017-duxuanxuan
C13CPD CDCl3

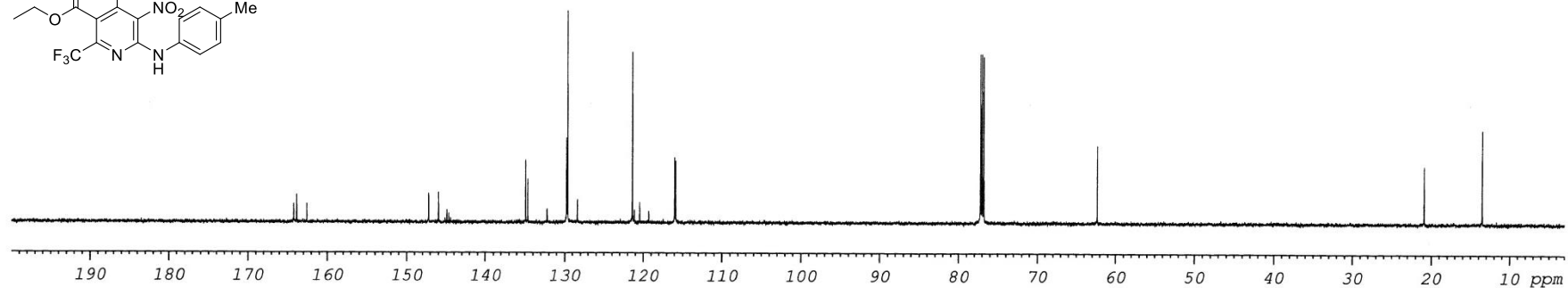
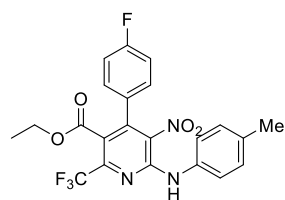


Figure S6. ^{13}C NMR (150 MHz, CDCl_3) spectra of compound **4b**

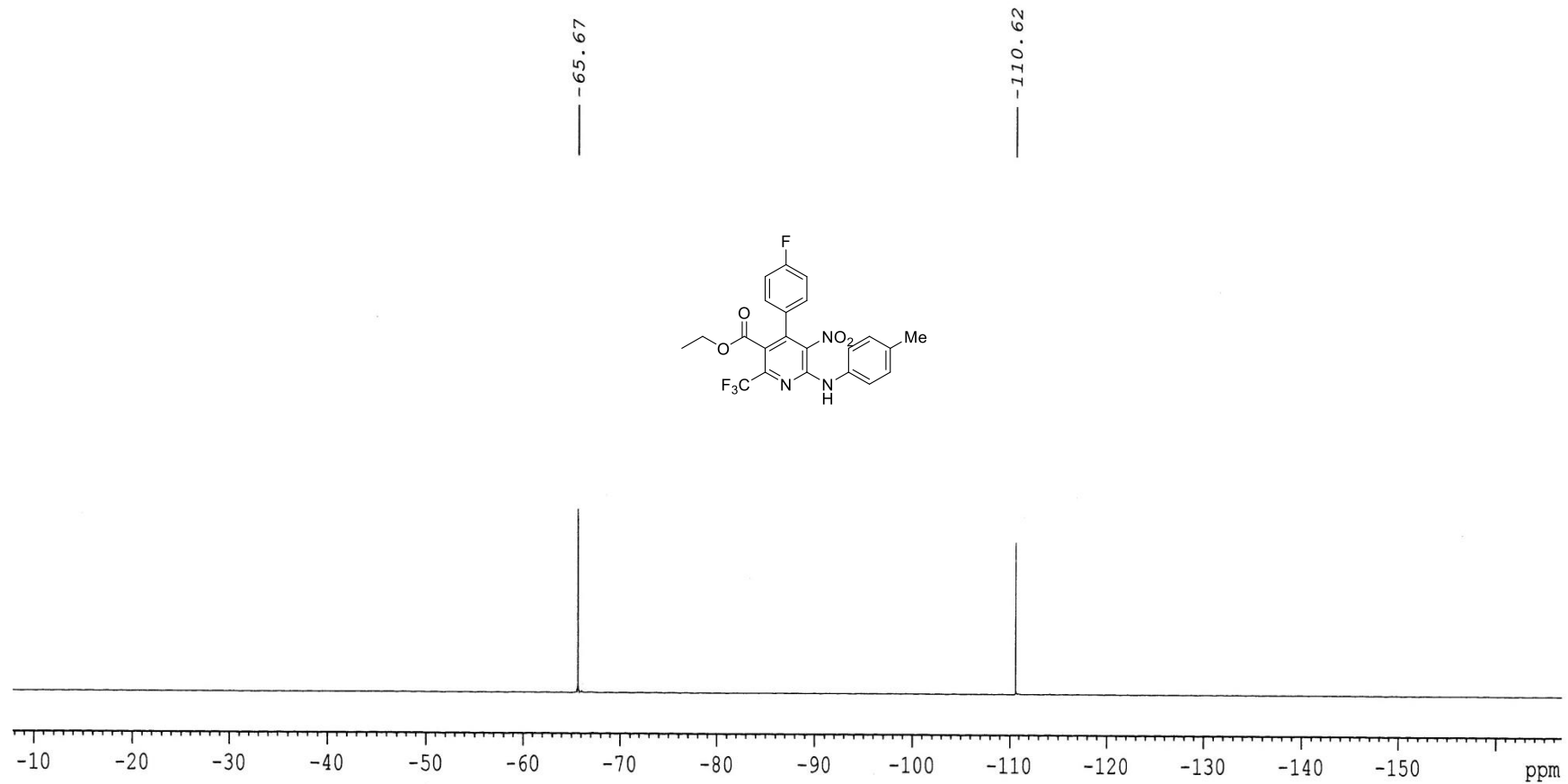


Figure S7. ^{19}F NMR (564 MHz, CDCl_3) spectra of compound **4b**

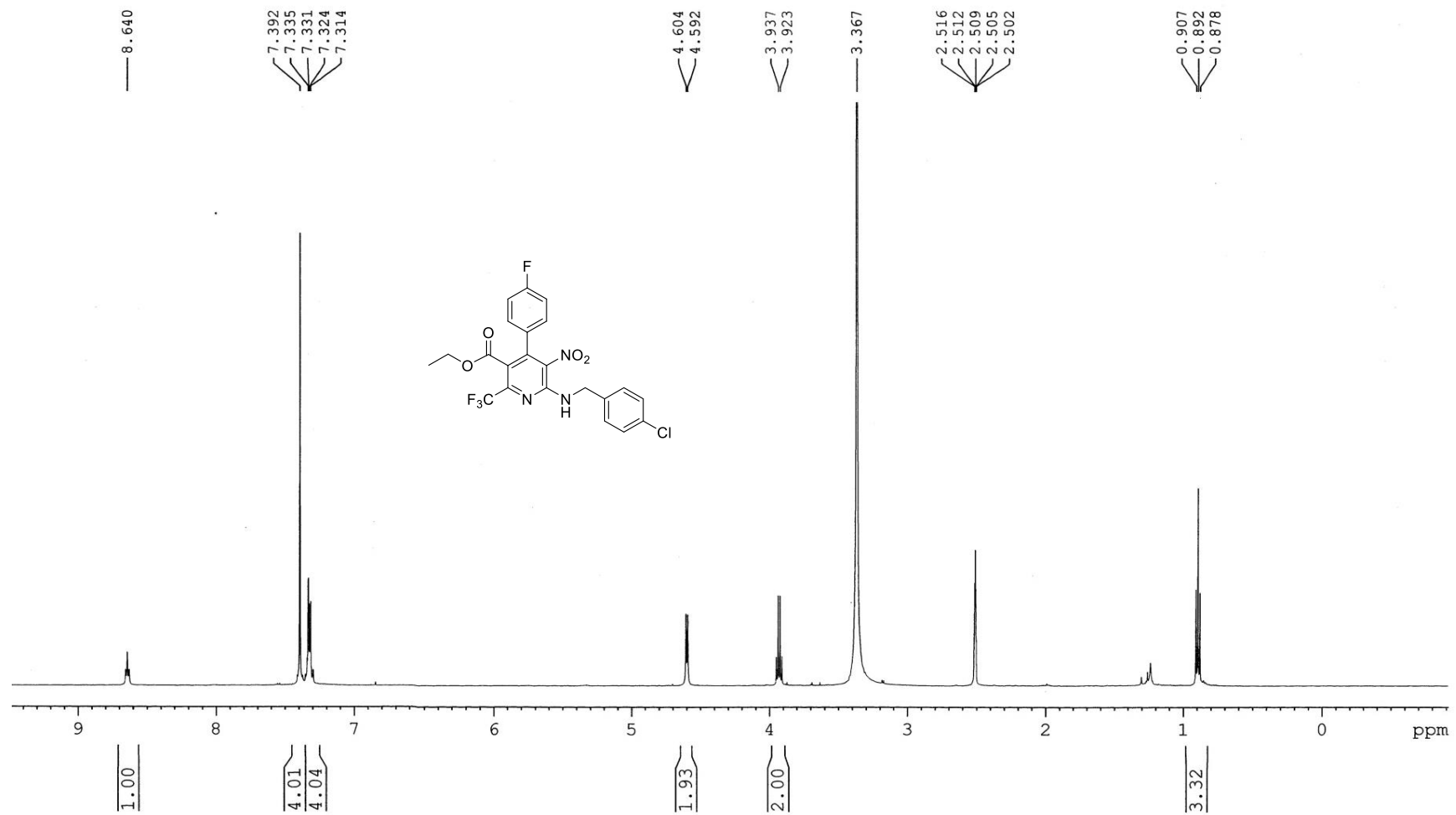


Figure S8. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4c**

DEPT135



YUNNAN UNIVERSITY AVIIIHD500 DXX3-8-1
Jun27-2017-duxuanxuan
C13CPD DMSO

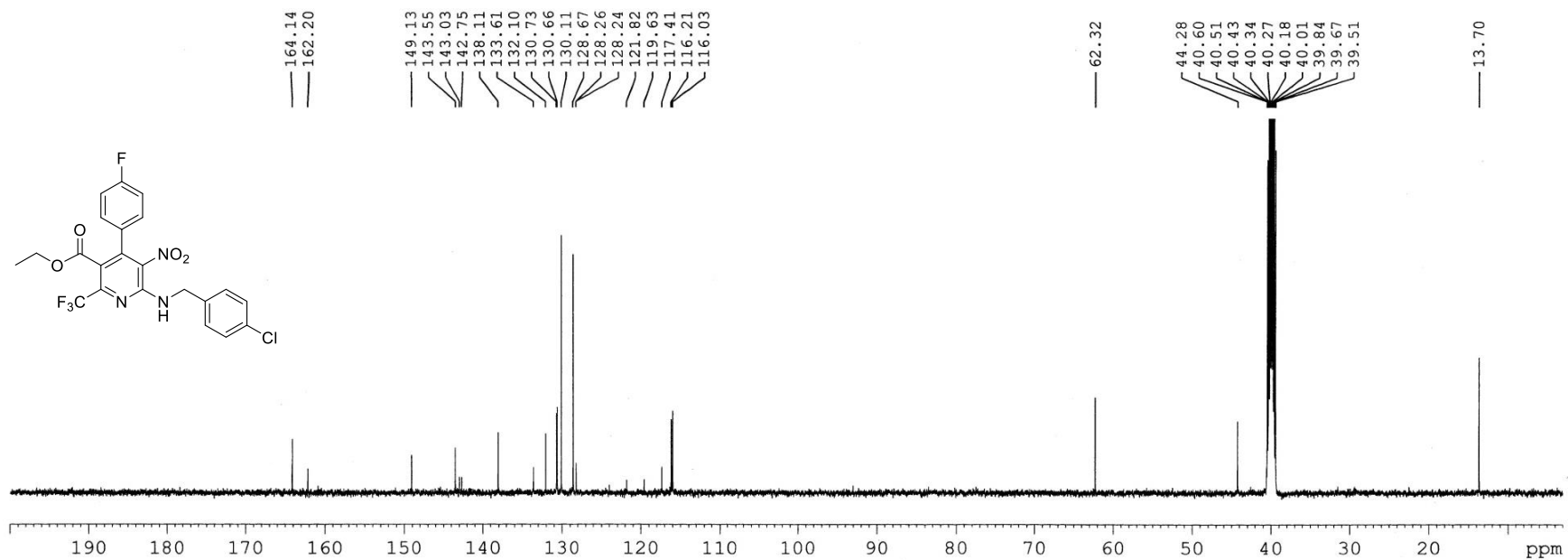


Figure S9. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4c

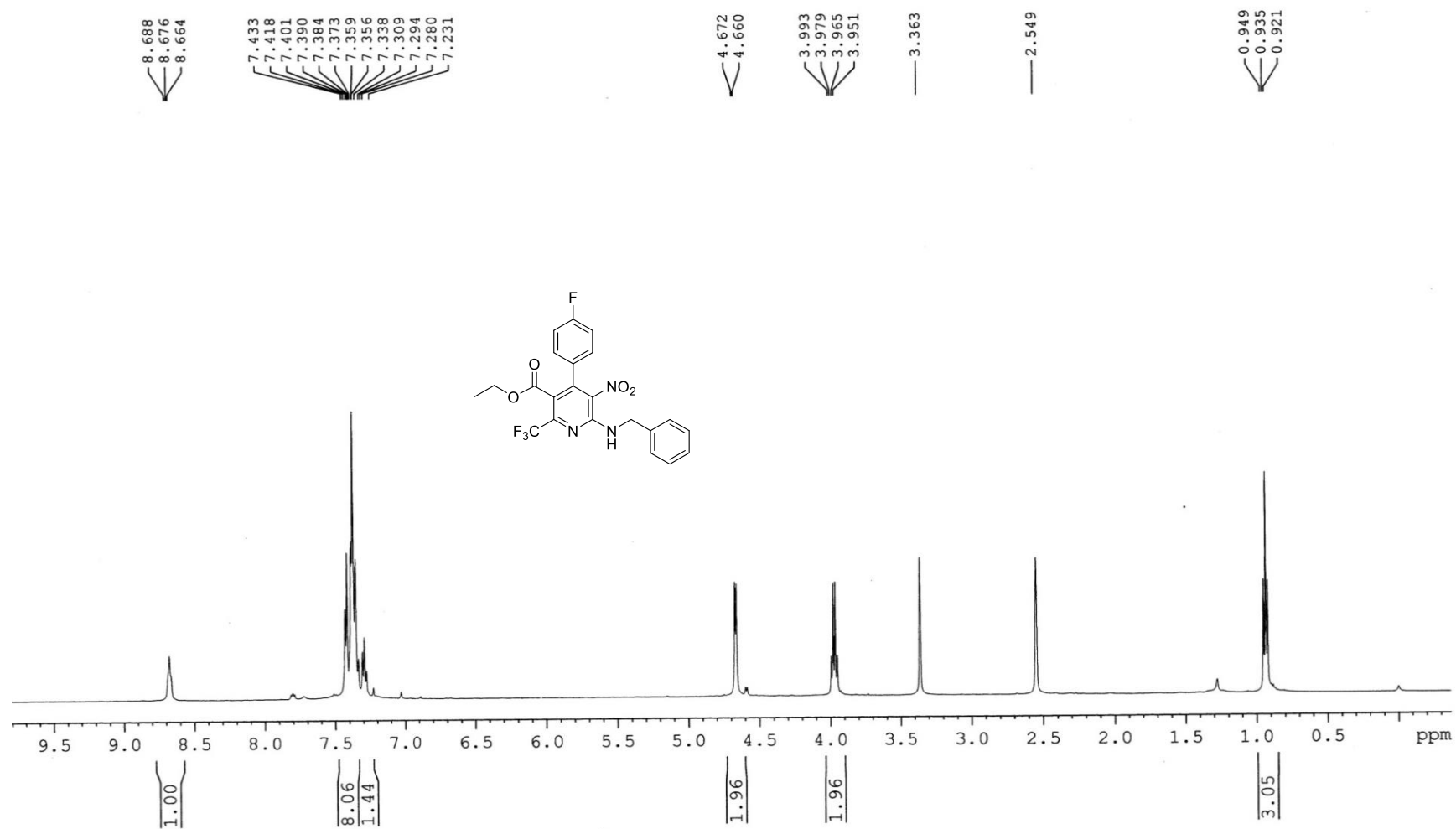


Figure S10. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4d**

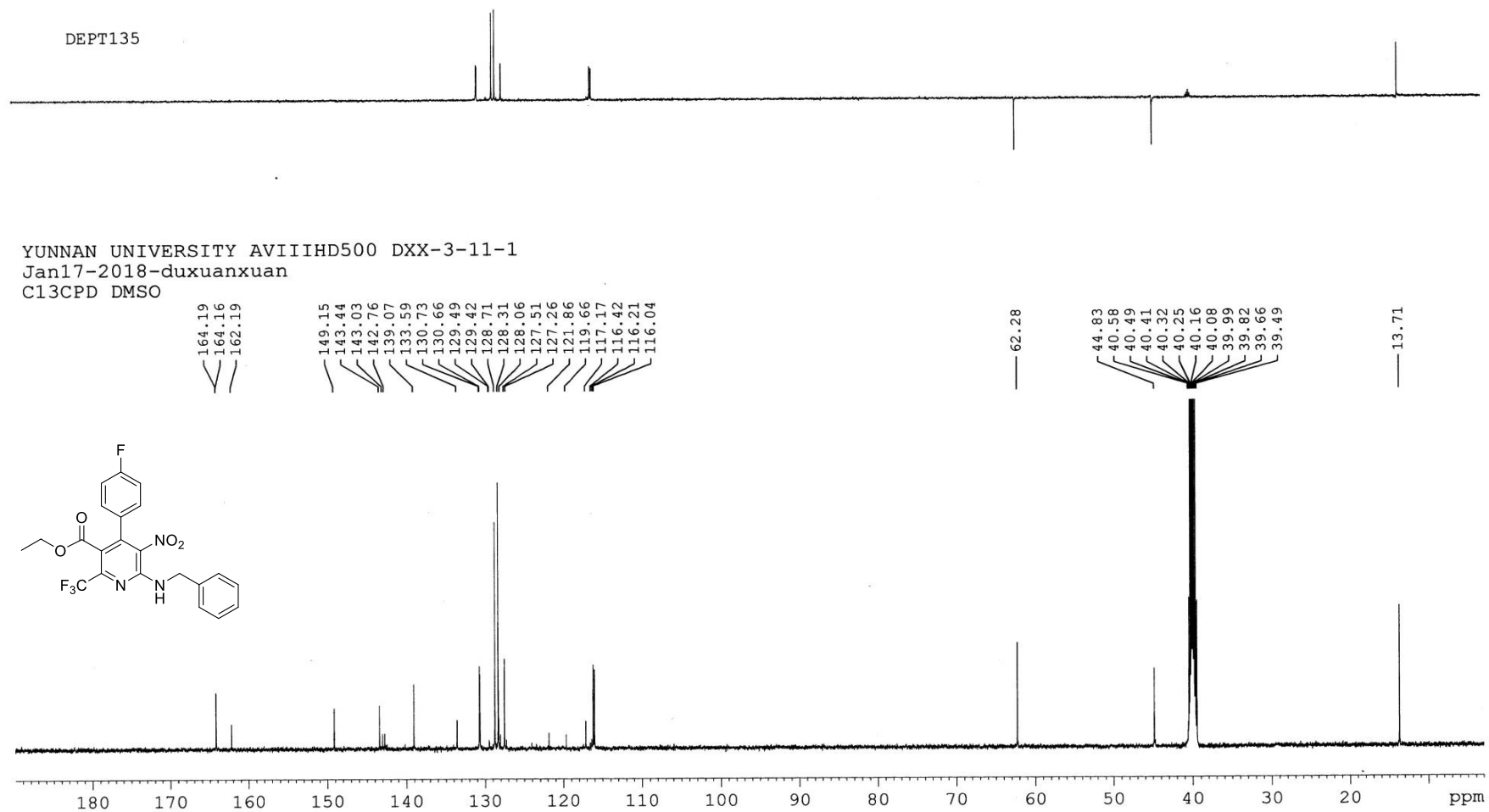


Figure S11. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **4d**

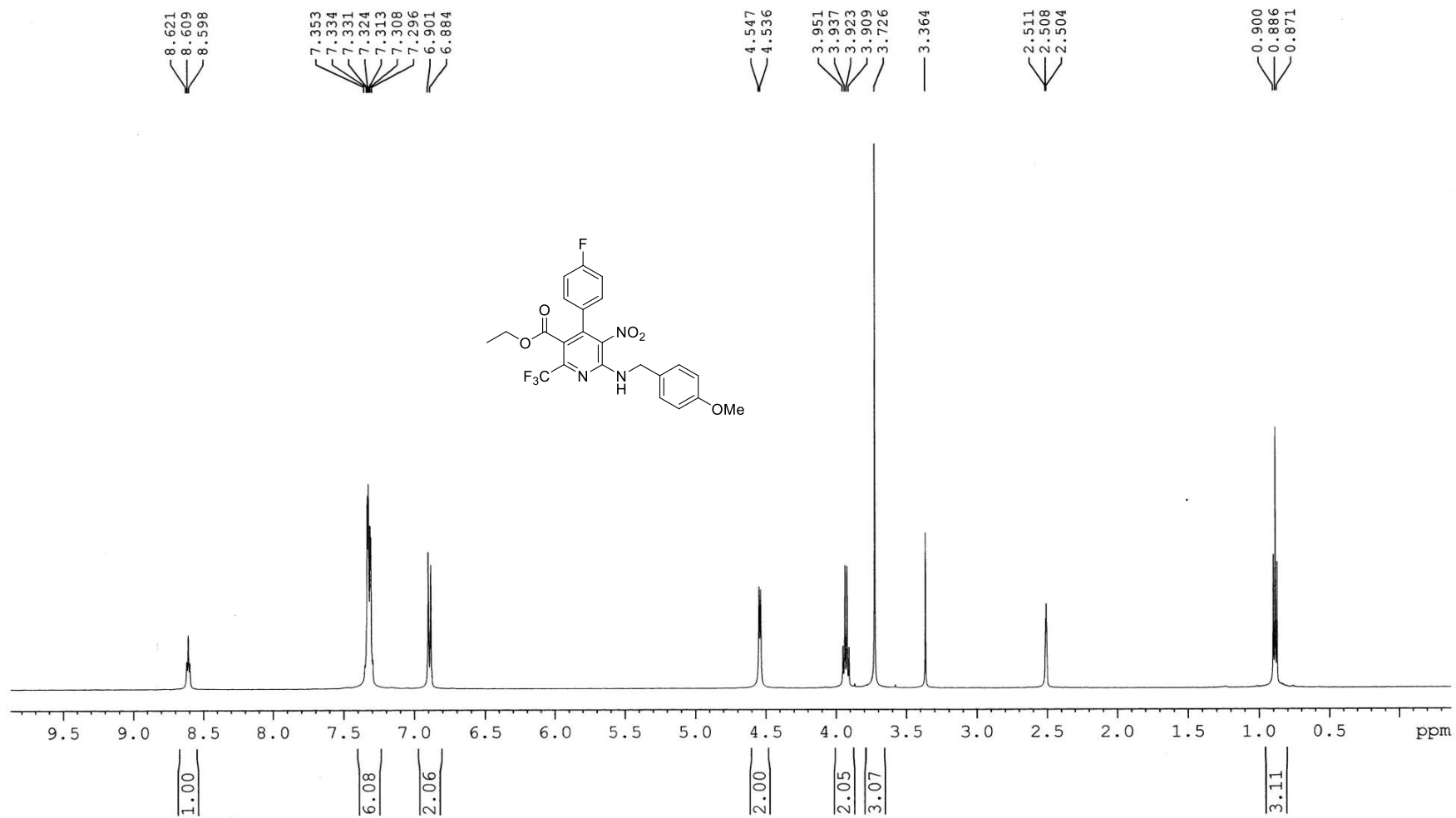


Figure S12. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **4e**

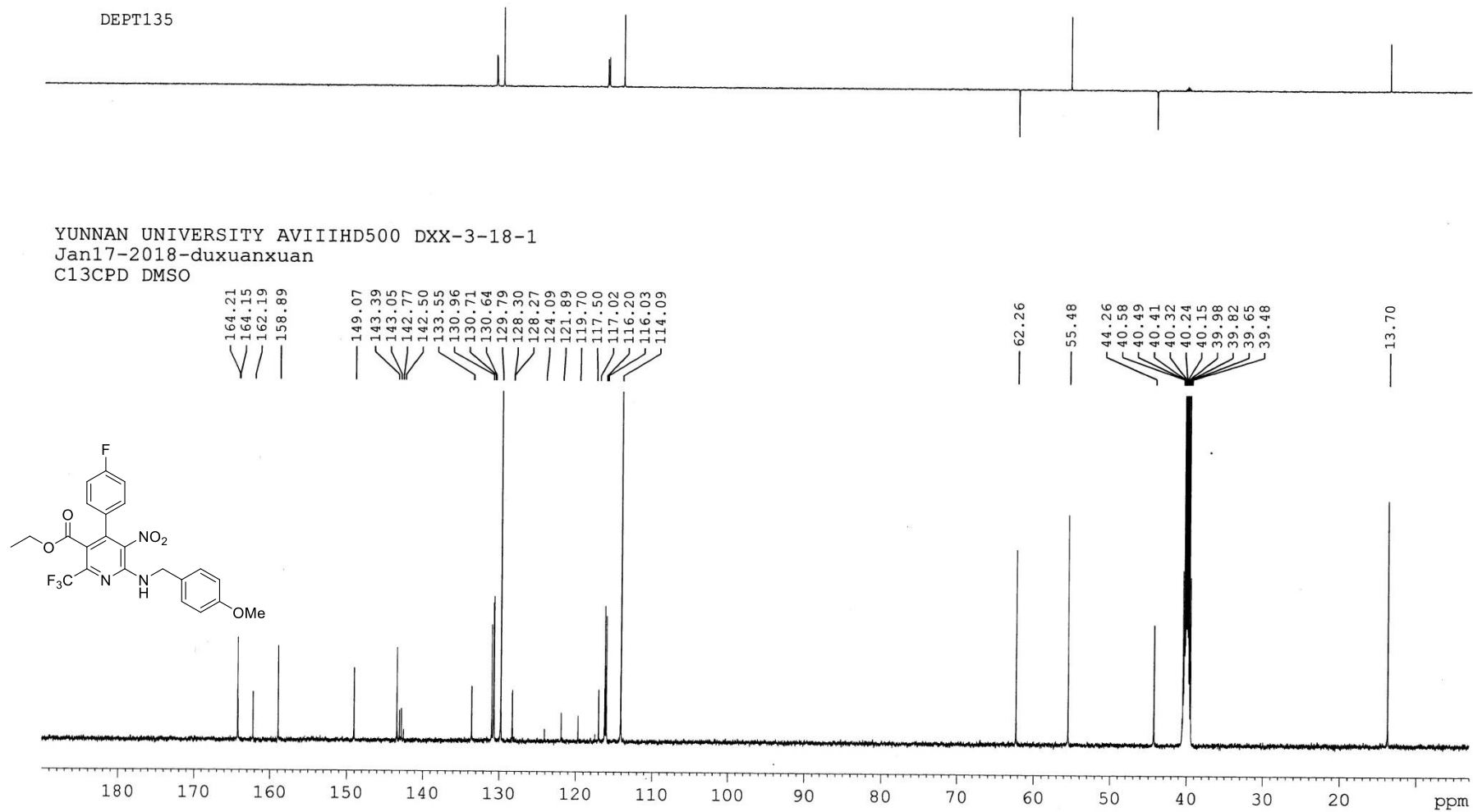


Figure S13. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4e

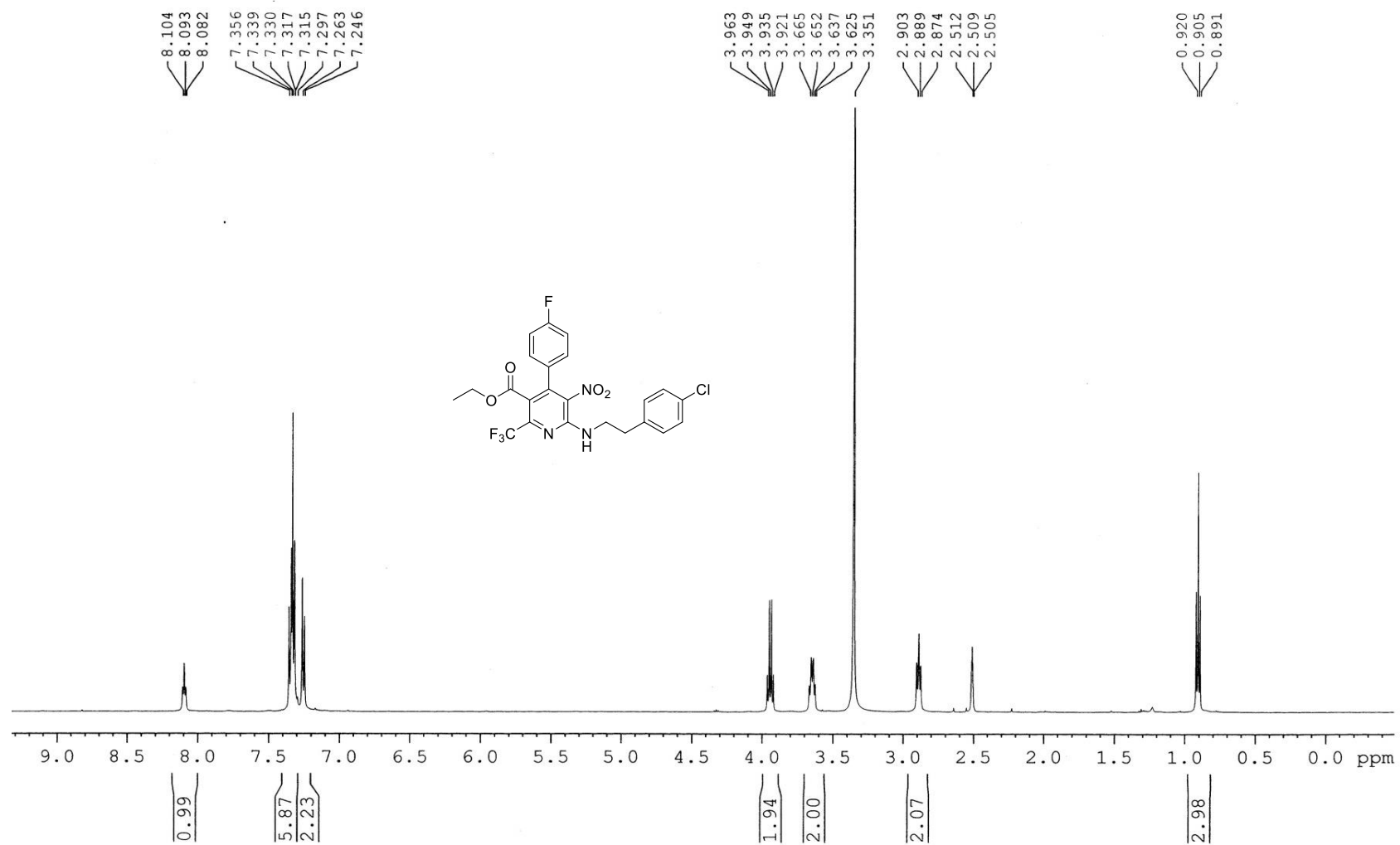


Figure S14. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **4f**

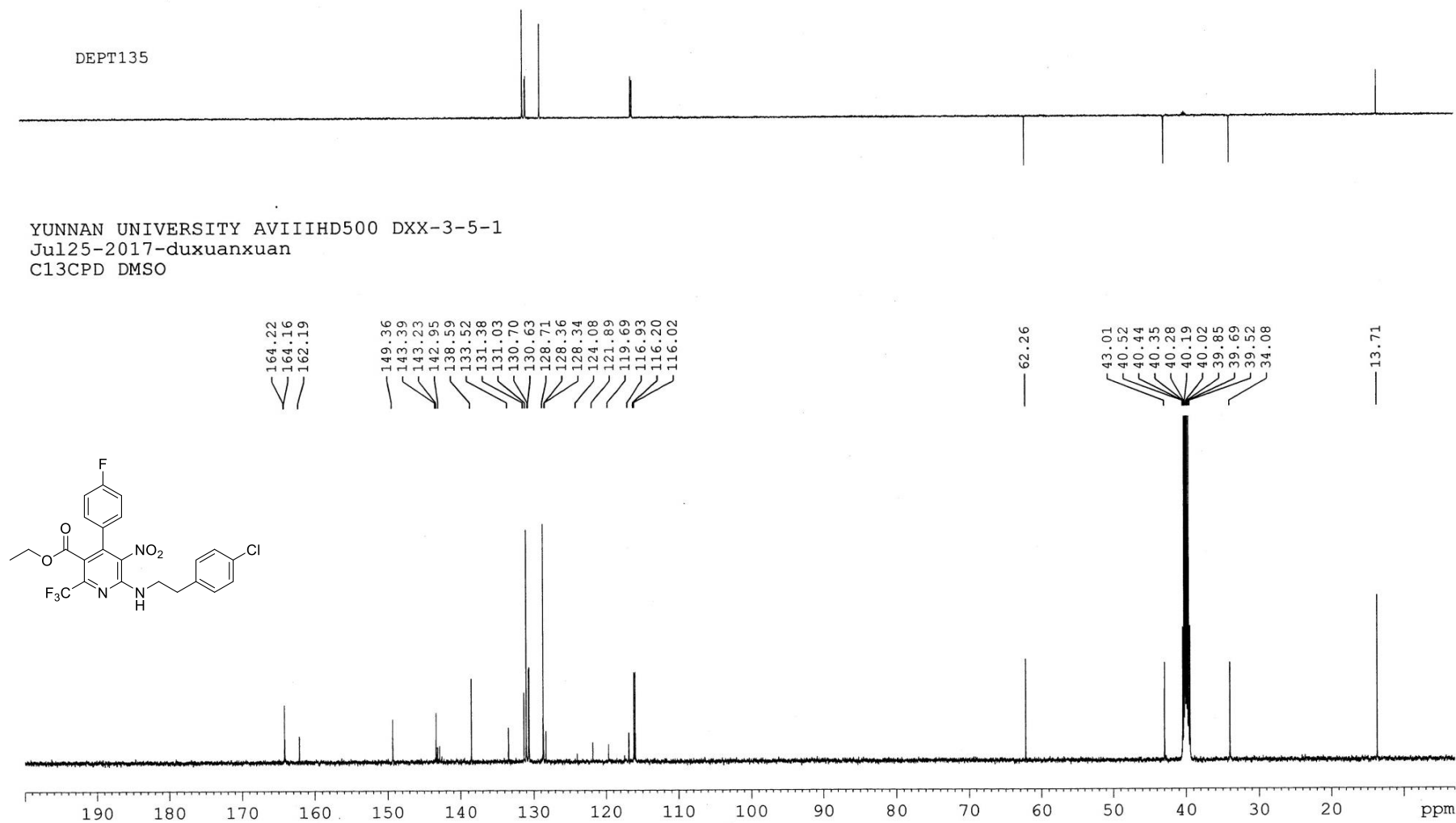


Figure S15. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound **4f**

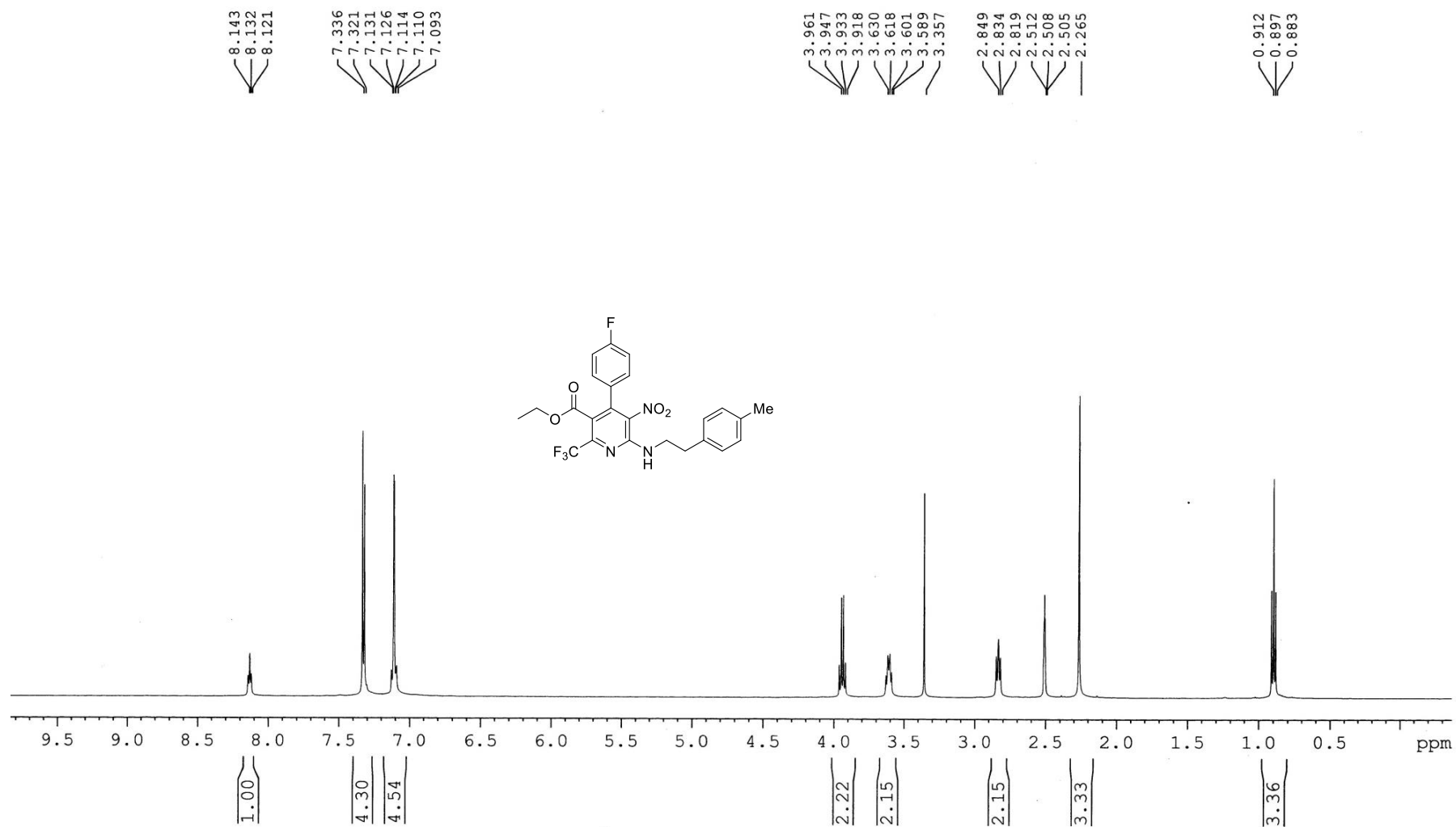


Figure S16. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **4g**

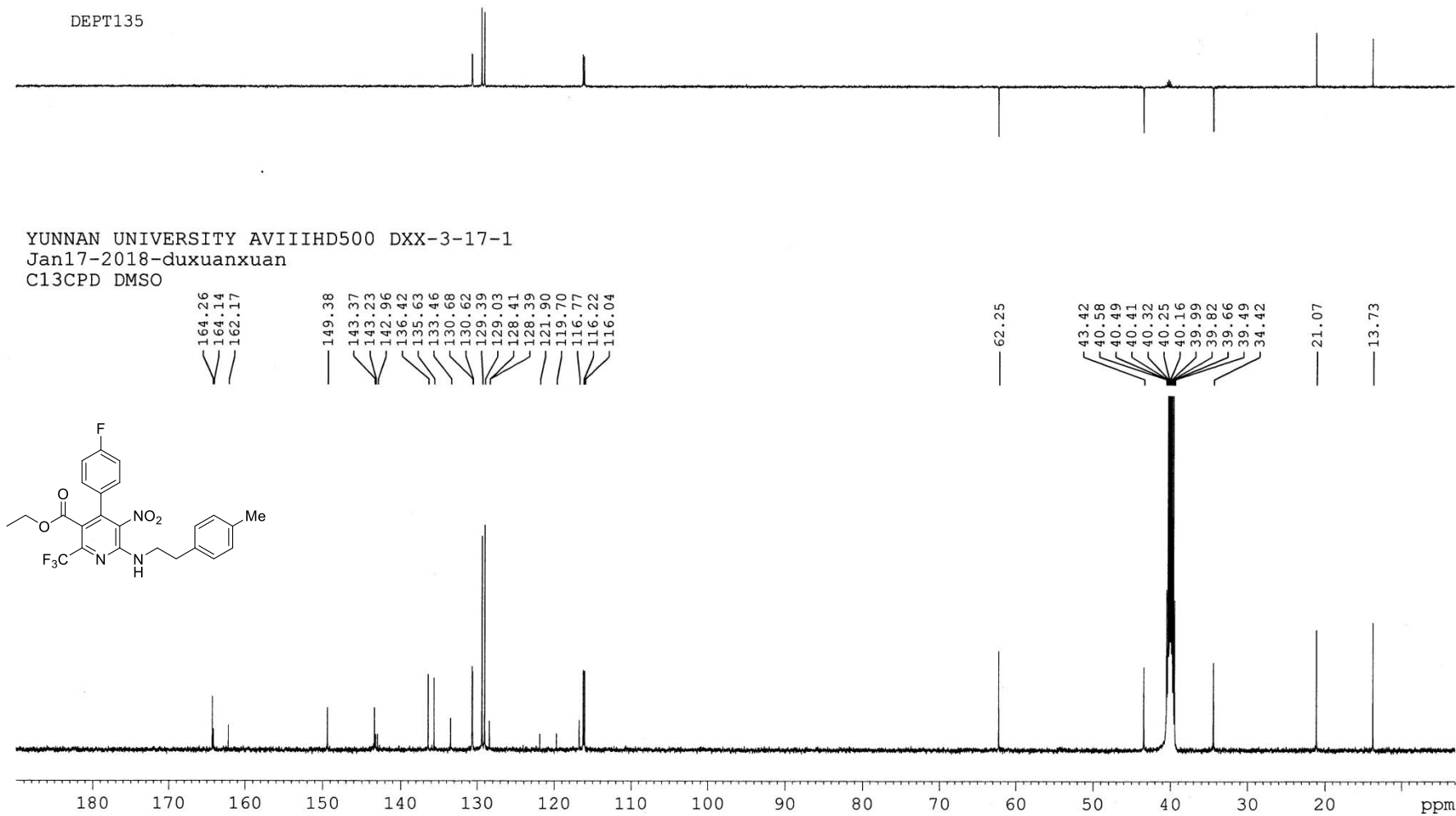


Figure S17. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4g

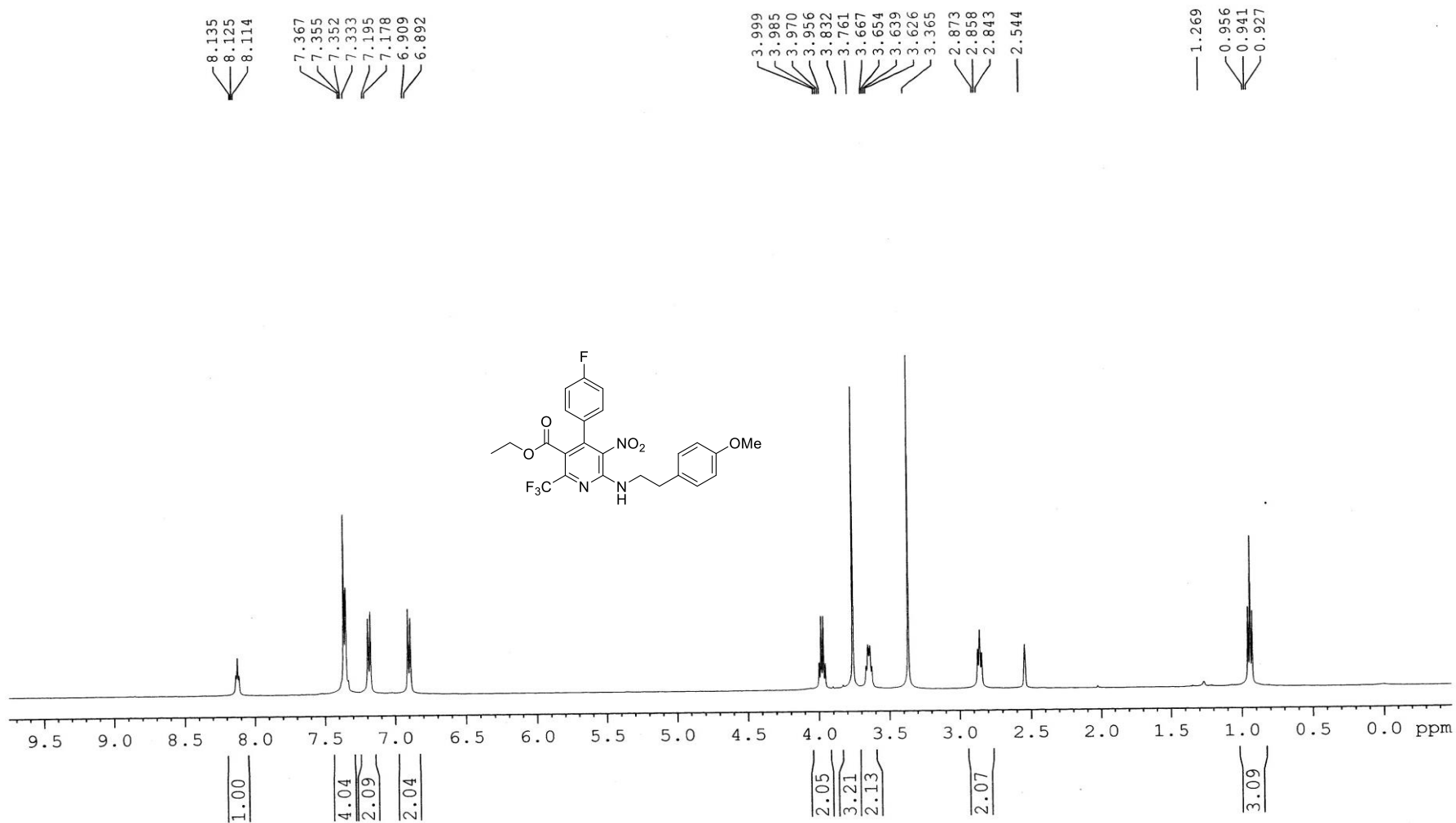
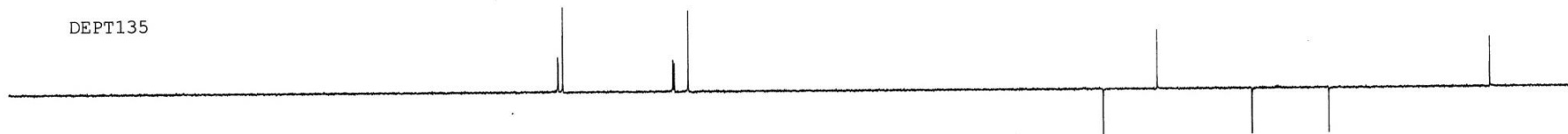


Figure S18. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4h**

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YUNNAN UNIVERSITY AVIIIHD500 DXX-3-12-1
Jun23-2017-duxuanxuan
C13CPD DMSO

164.25
164.15
162.18
158.29
149.42
143.55
143.42
143.27
143.00
133.45
131.40
130.70
130.63
130.10
128.43
128.41
124.10
121.91
119.71
116.81
116.18
116.01
114.30
62.24
55.46
43.54
40.54
40.38
40.21
40.04
39.88
39.71
39.54
33.98
13.71

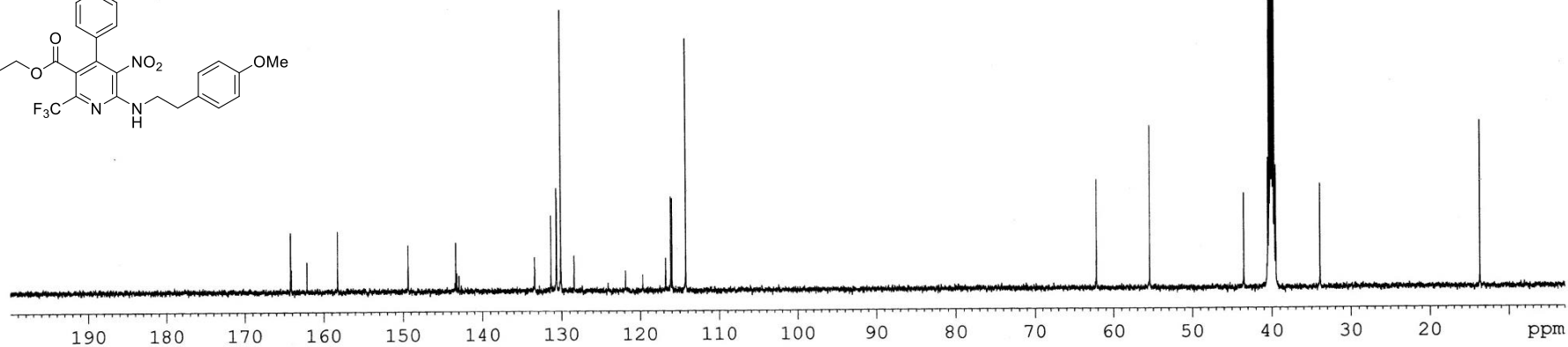
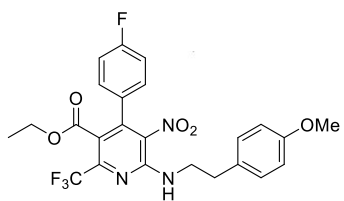


Figure S19. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 4h

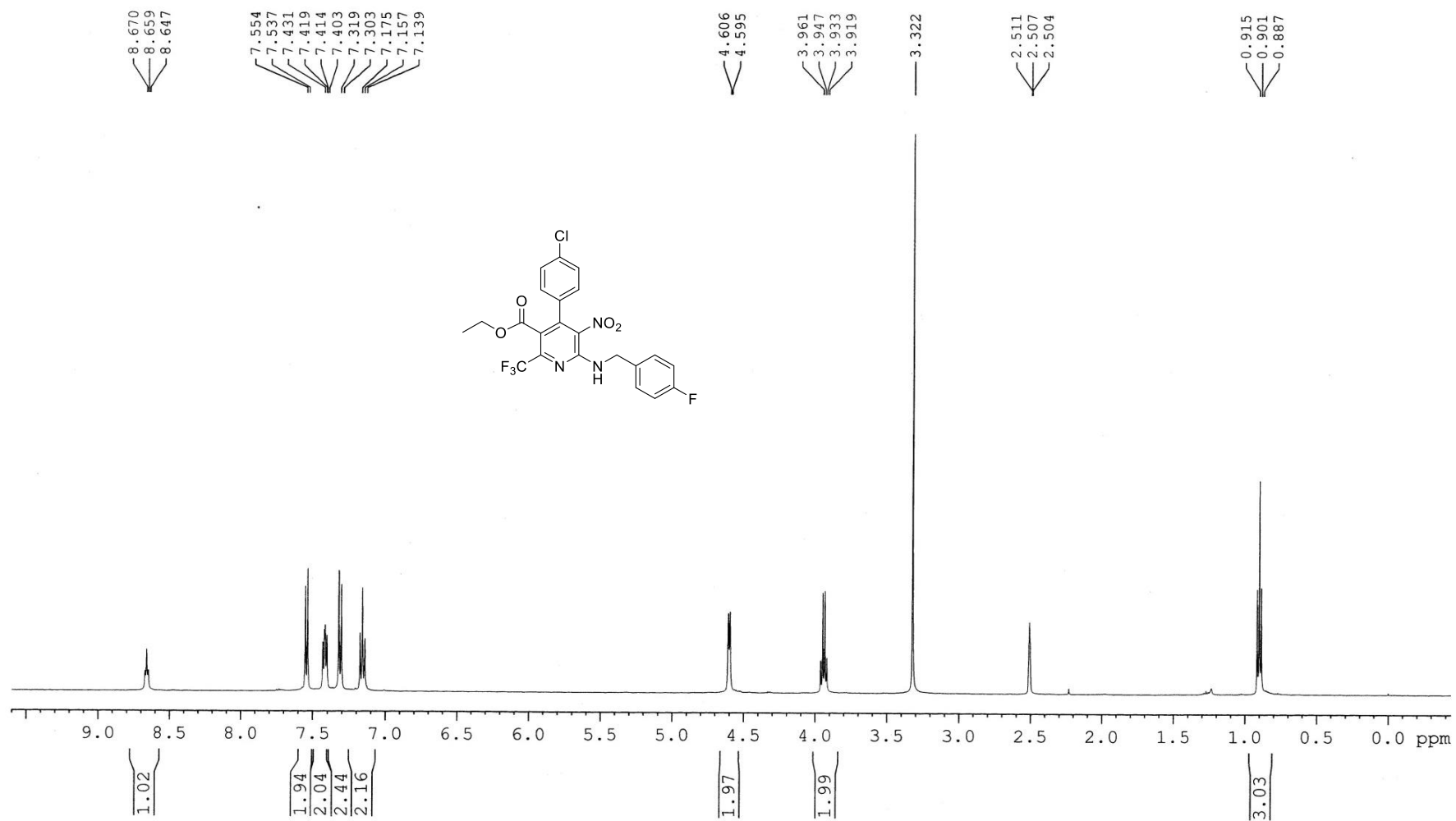
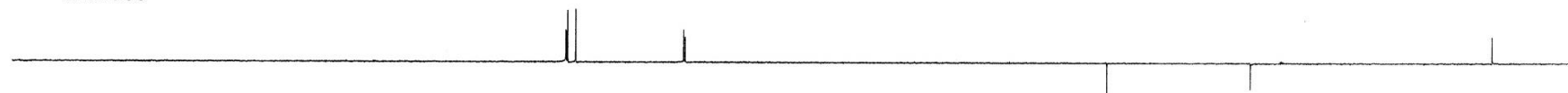


Figure S20. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4i**

DEPT135



YUNNAN UNIVERSITY AVIIHD500 DXX-3-23-1
Sep30-2017-duxuanxuan
C13CPD DMSO

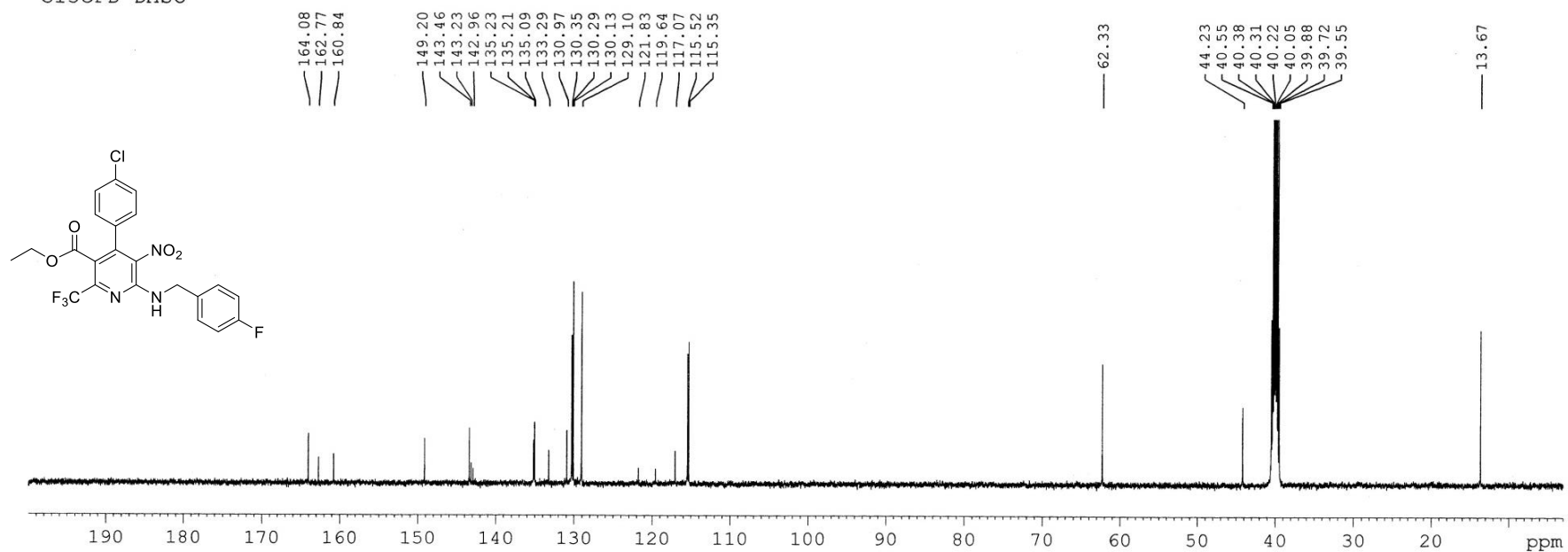


Figure S21. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4i

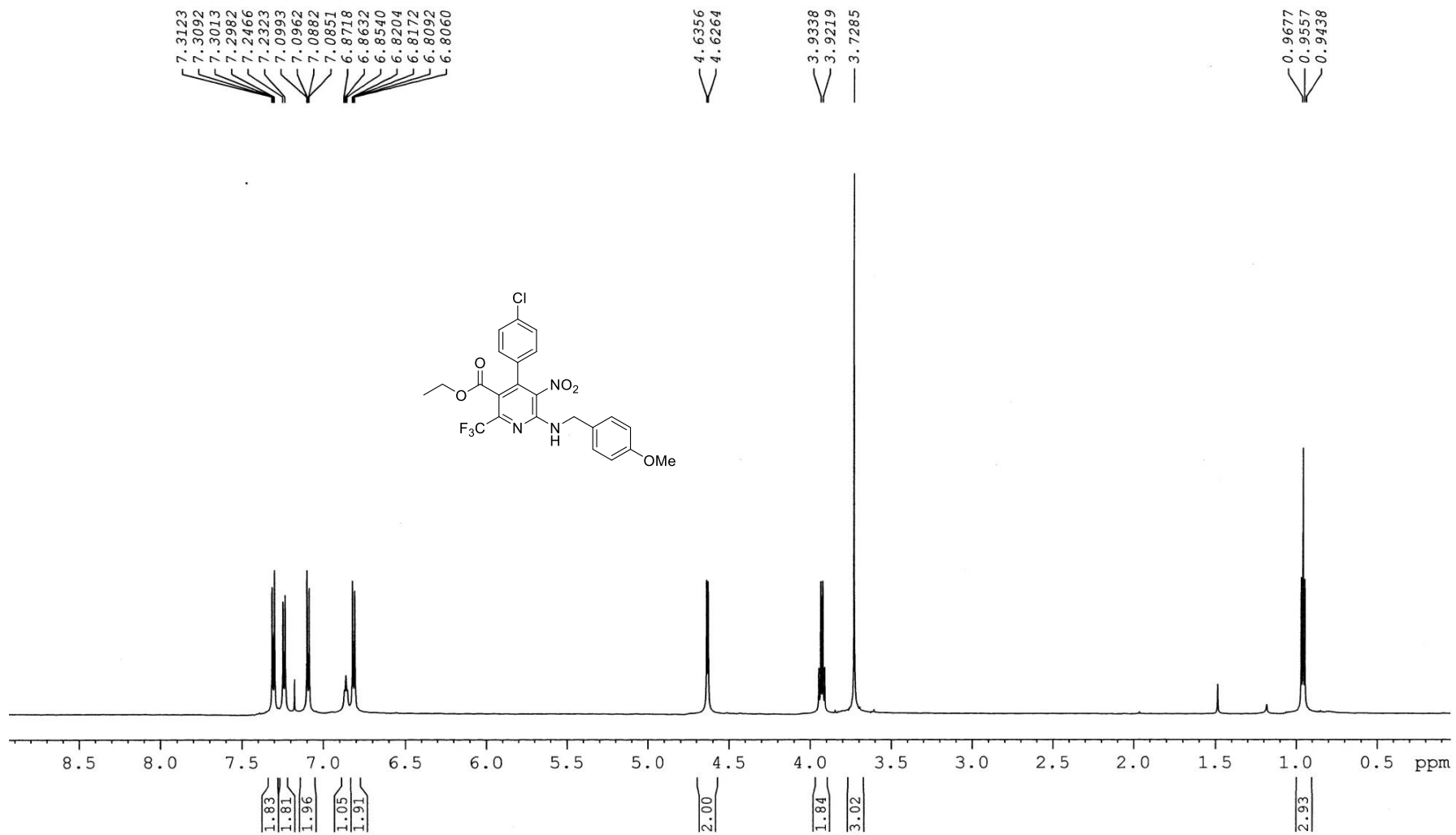
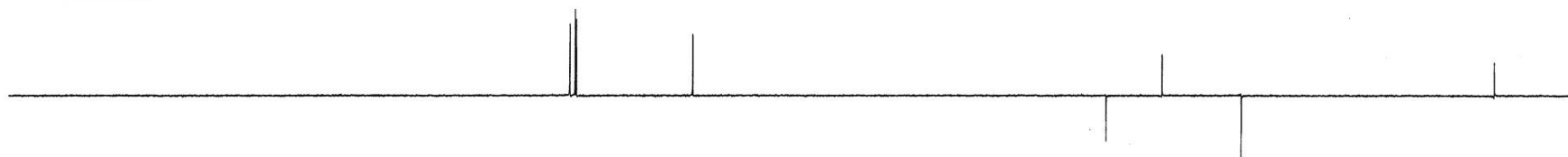


Figure S22. ^1H NMR (600 MHz, CDCl_3) spectra of compound **4j**

DEPT135



YUNNAN UNIVERSITY ASCEND AVIIIHD600 DXX-3-33-1
Sep06-2017-duxuanxuan
C13CPD CDC13

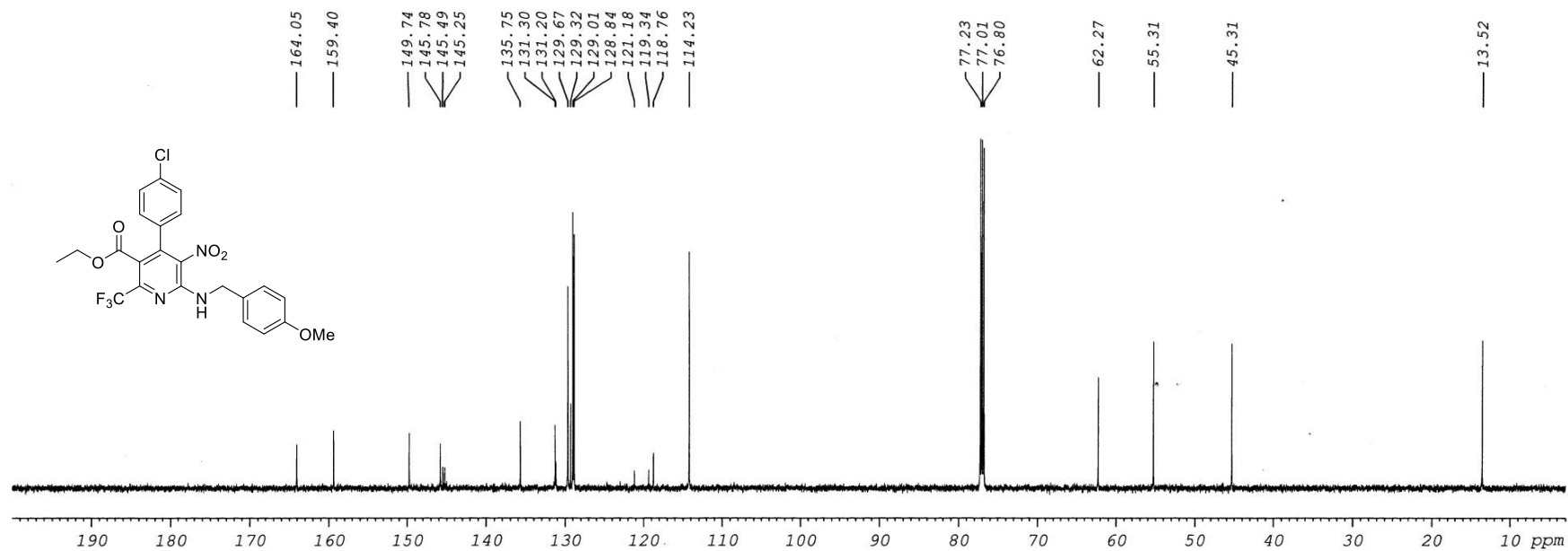


Figure S23. ^{13}C NMR (150 MHz, CDCl_3) spectra of compound 4j

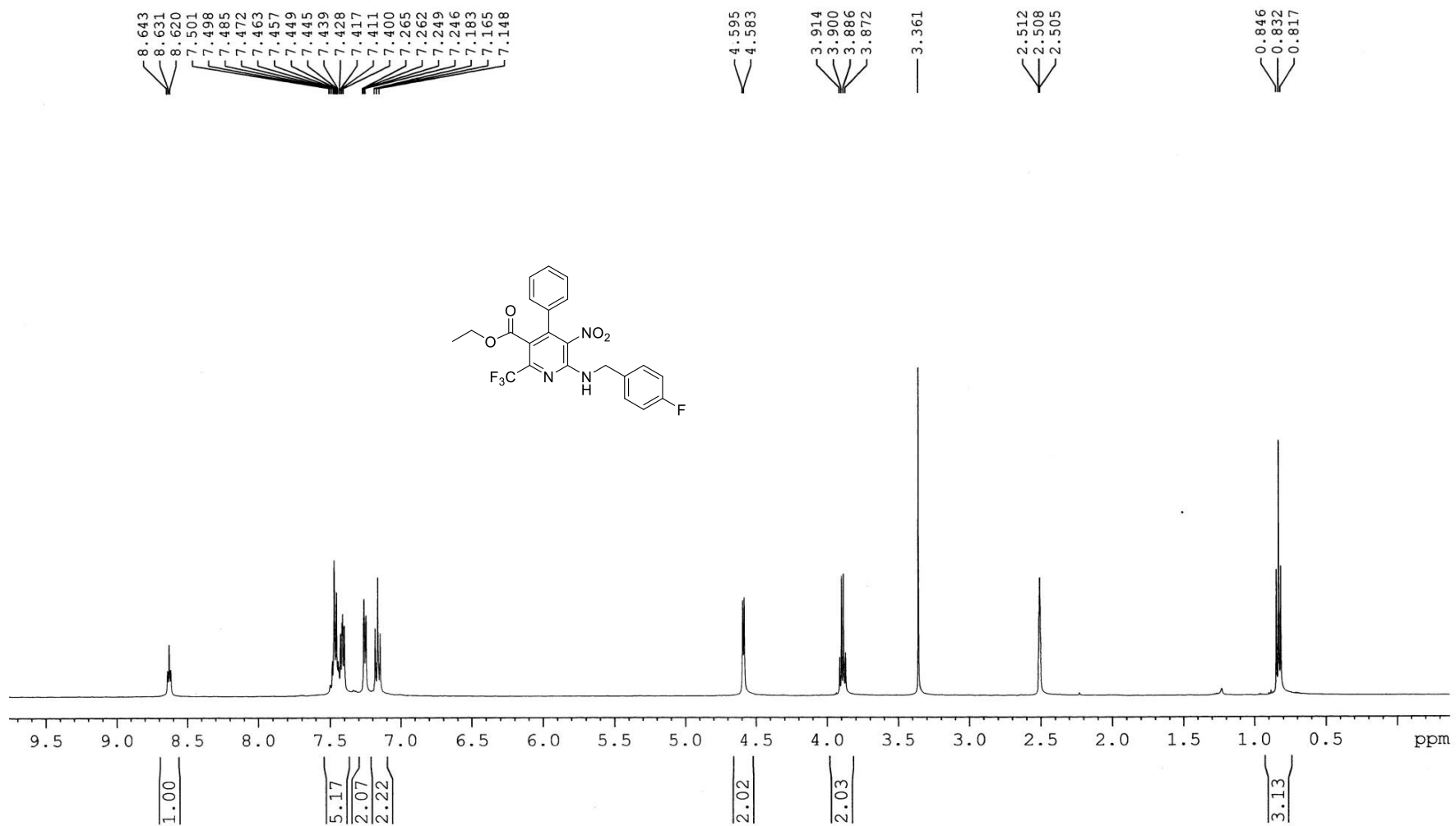


Figure S24. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **4k**

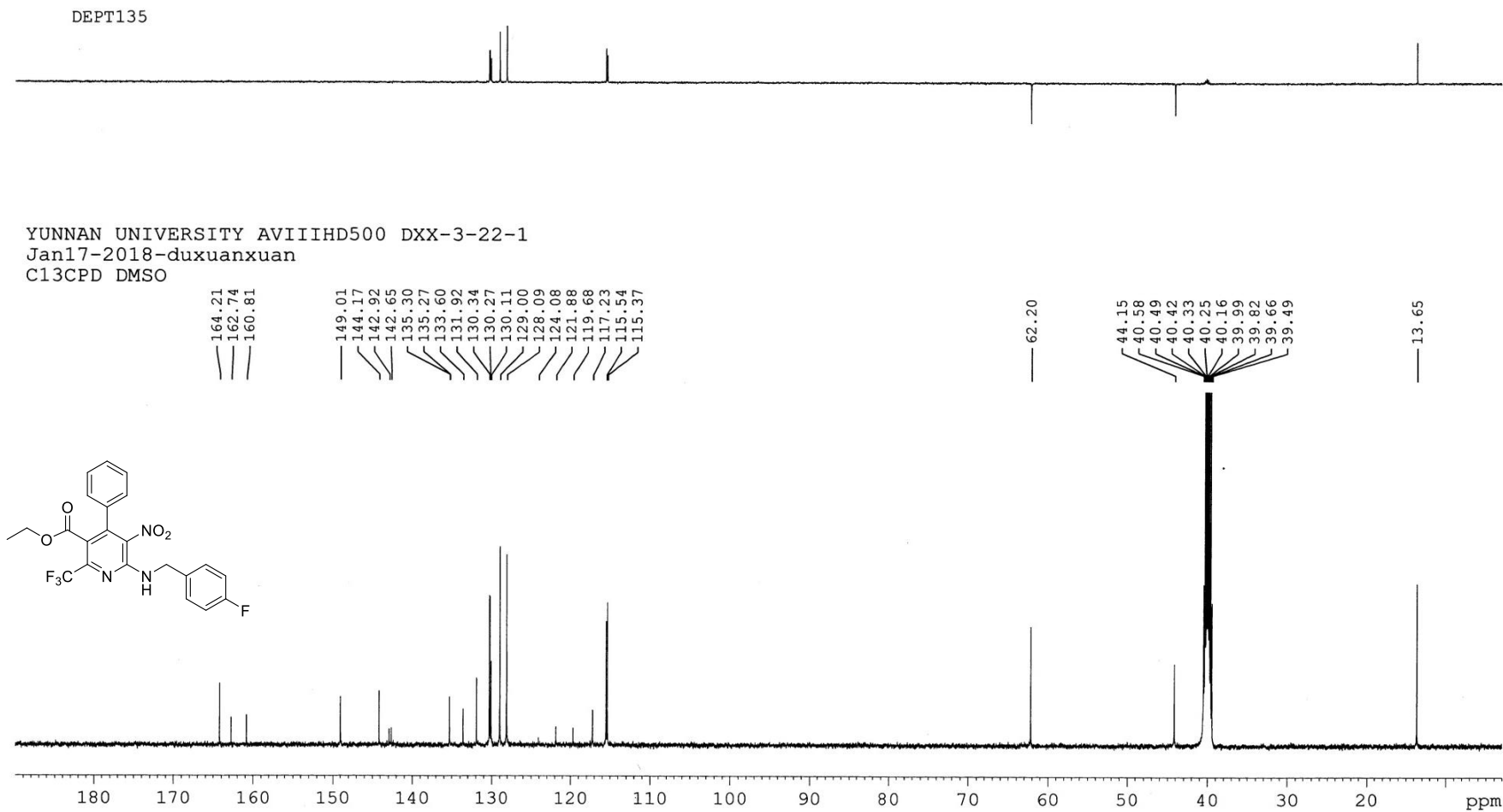


Figure S25. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **4k**

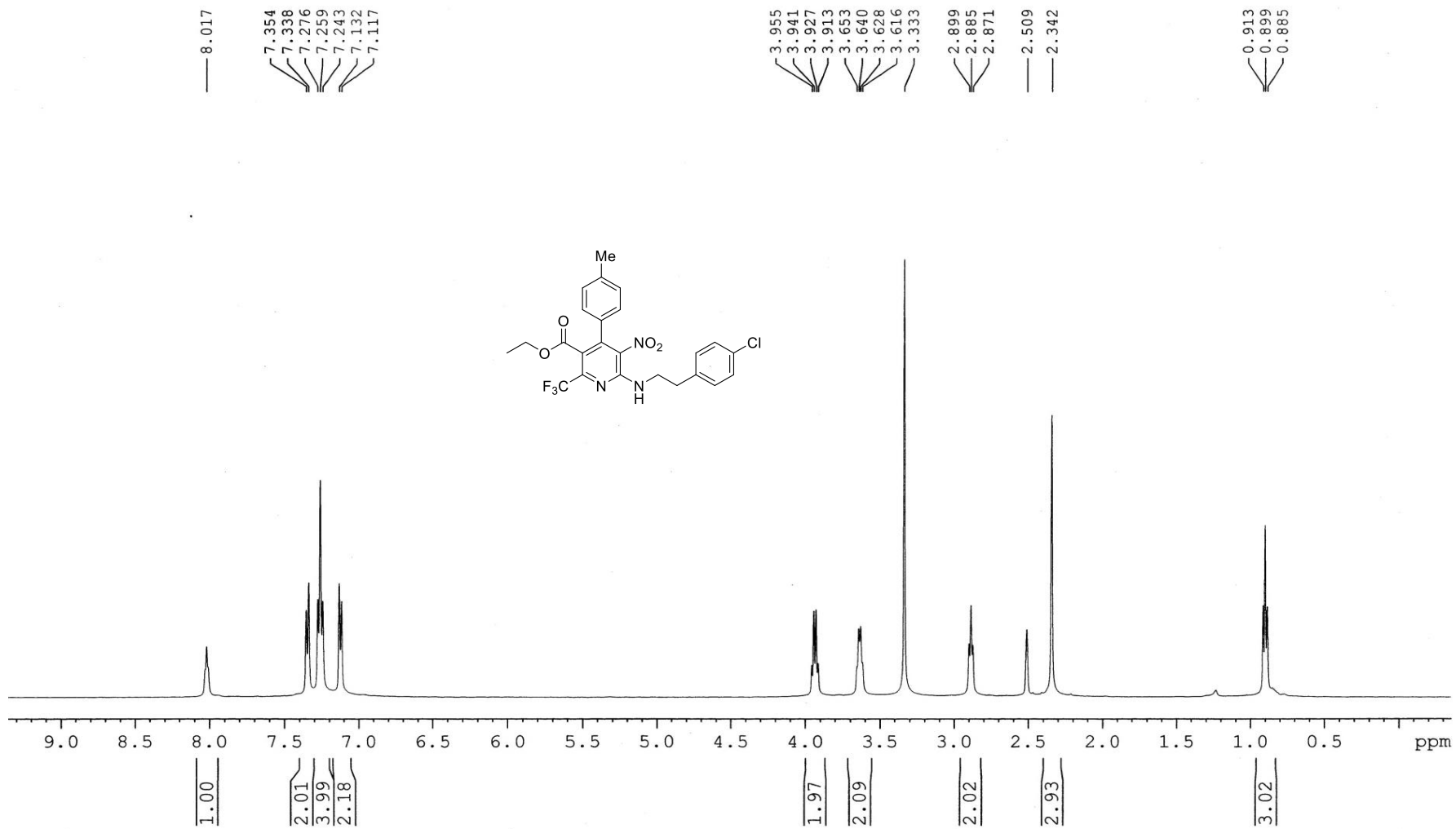
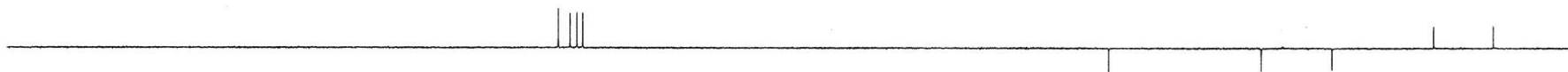


Figure S26. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **4I**

DEPT135



YUNNAN UNIVERSITY AVIIHD500 DXX-3-7-1
Jun27-2017-duxuanxuan
C13CPD DMSO

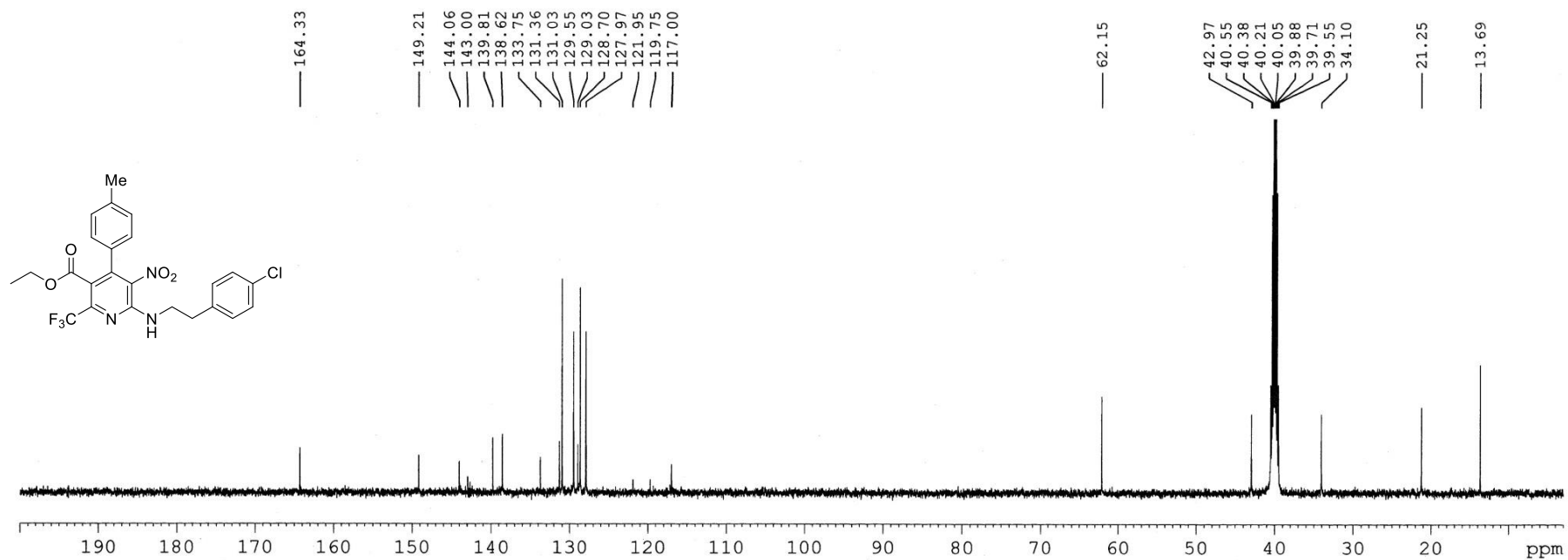


Figure S27. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4I

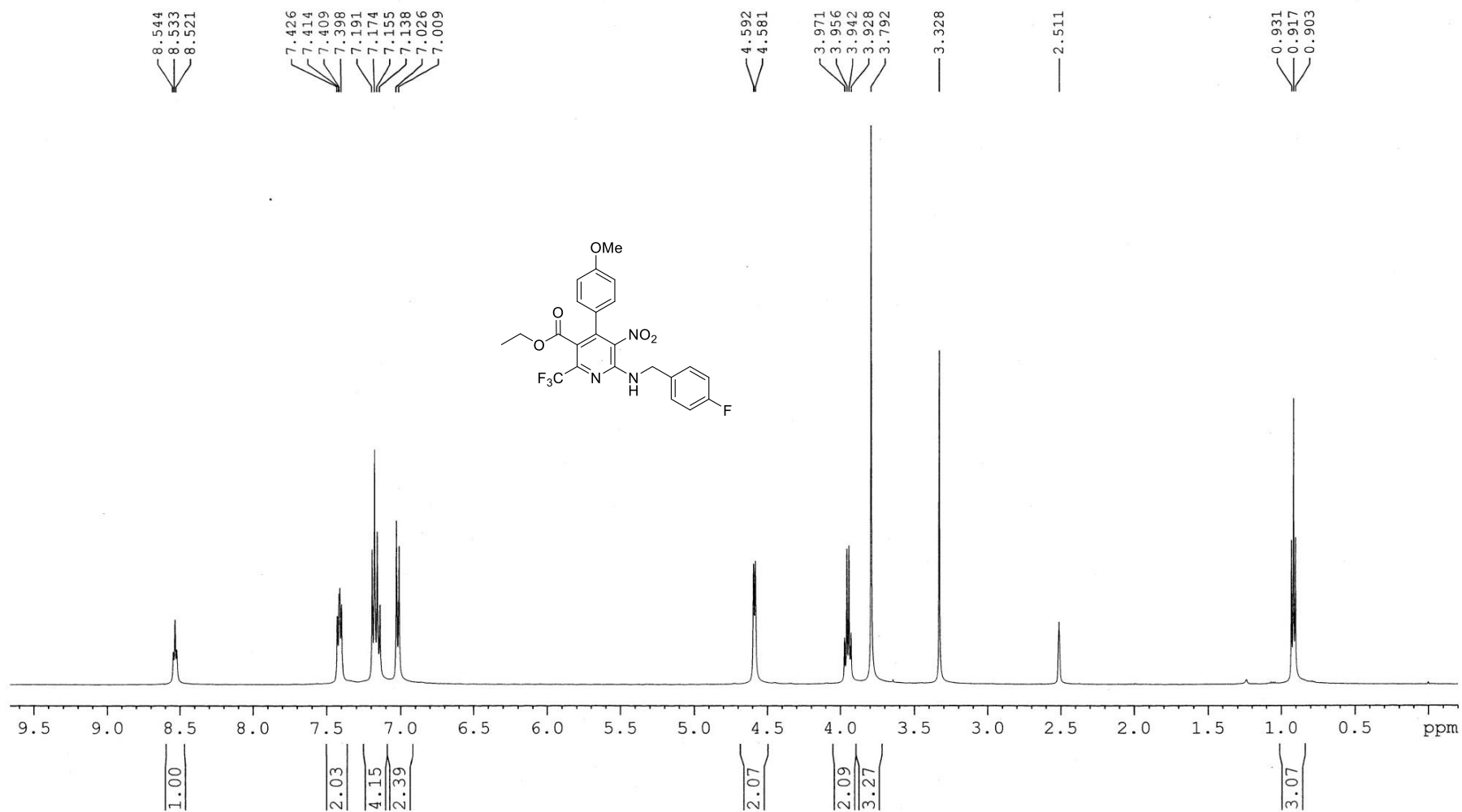


Figure S28. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4m**

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C13CPD DMSO

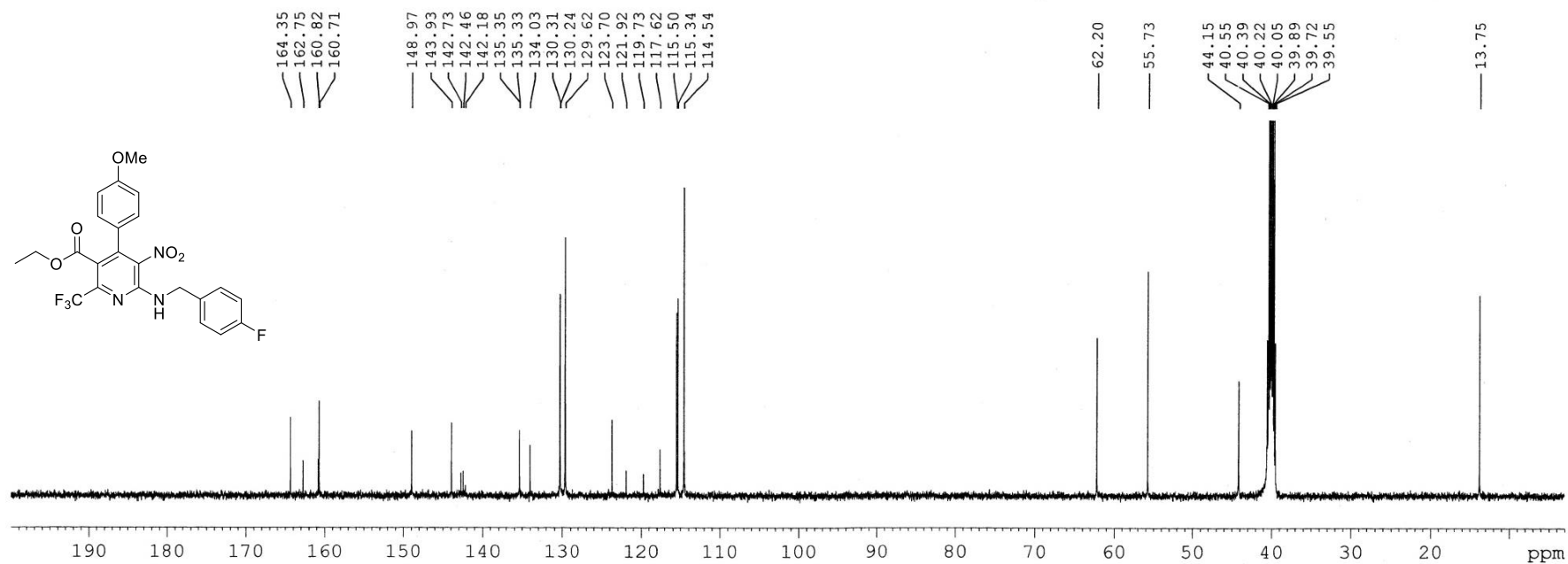


Figure S29. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 4m

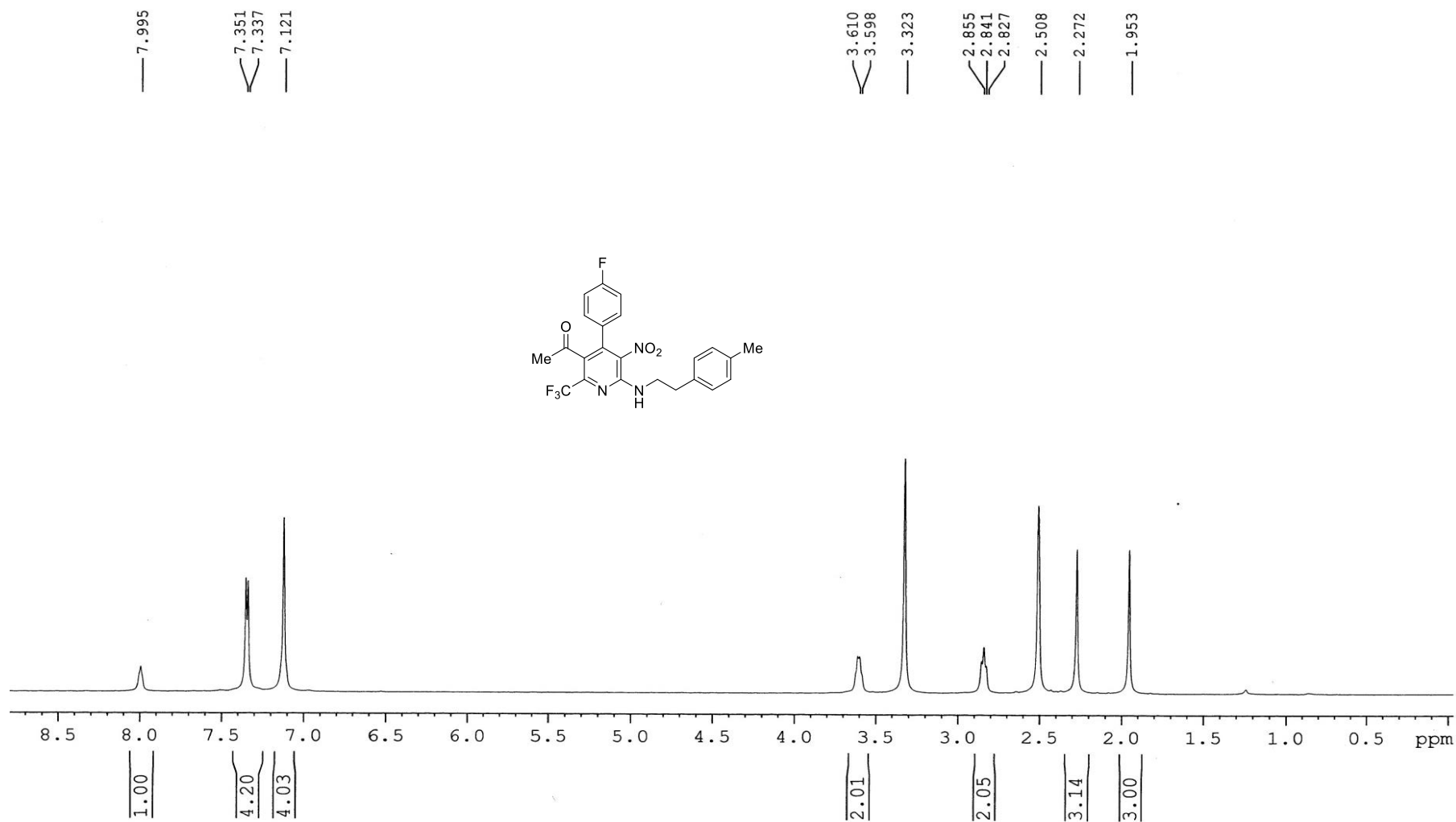


Figure S30. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **4n**

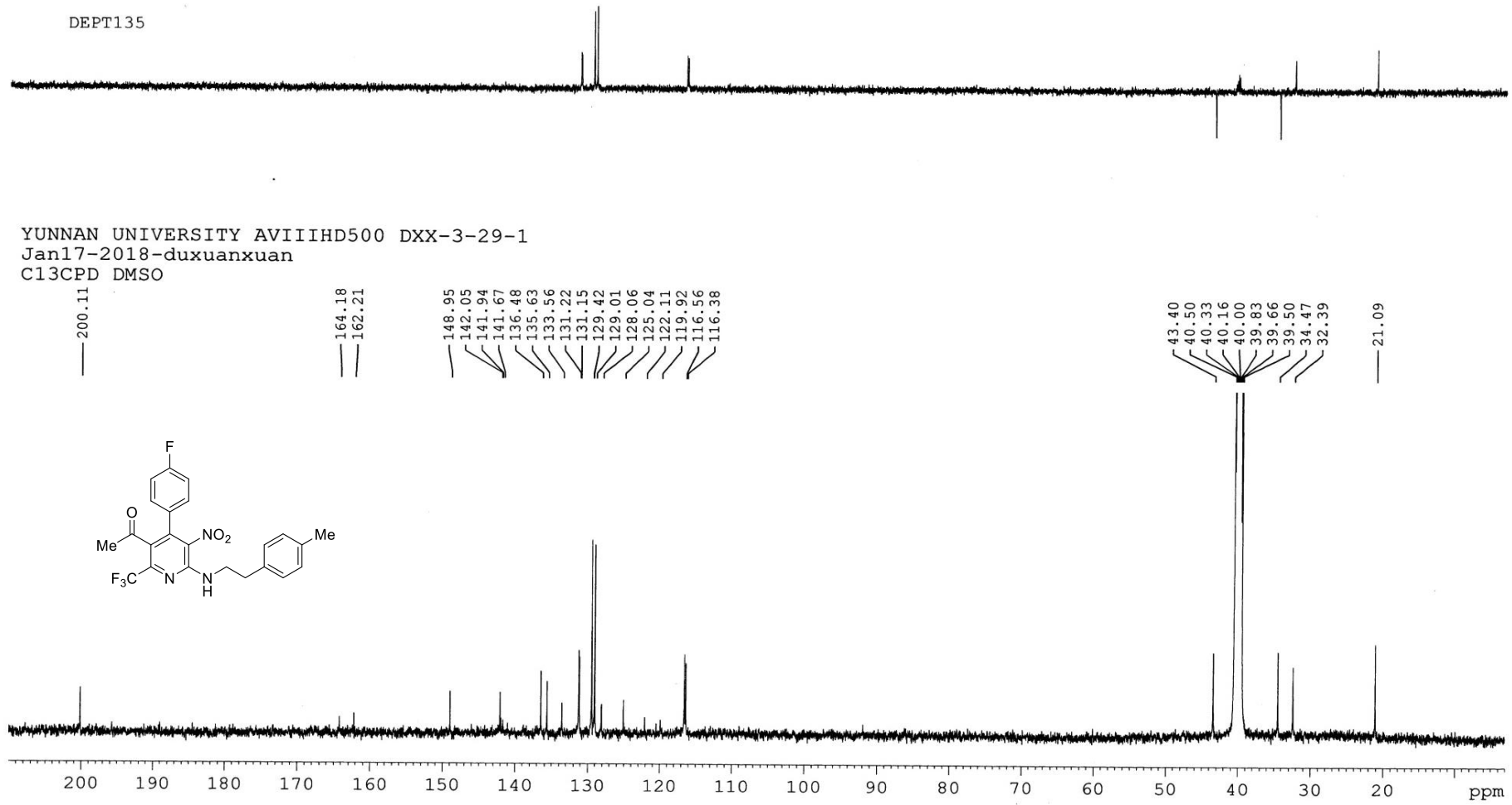


Figure S31. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 4n

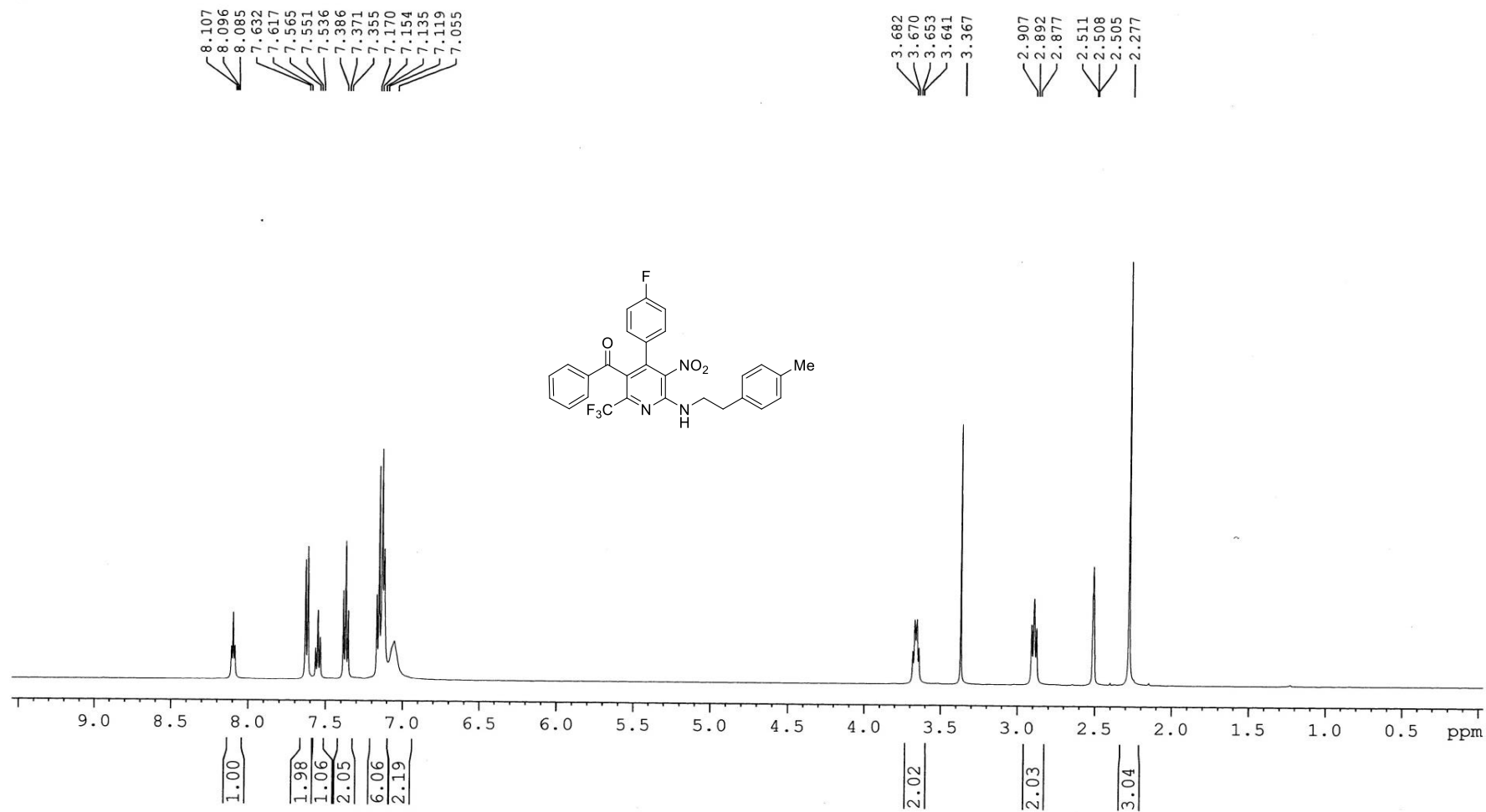


Figure S32. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4o**

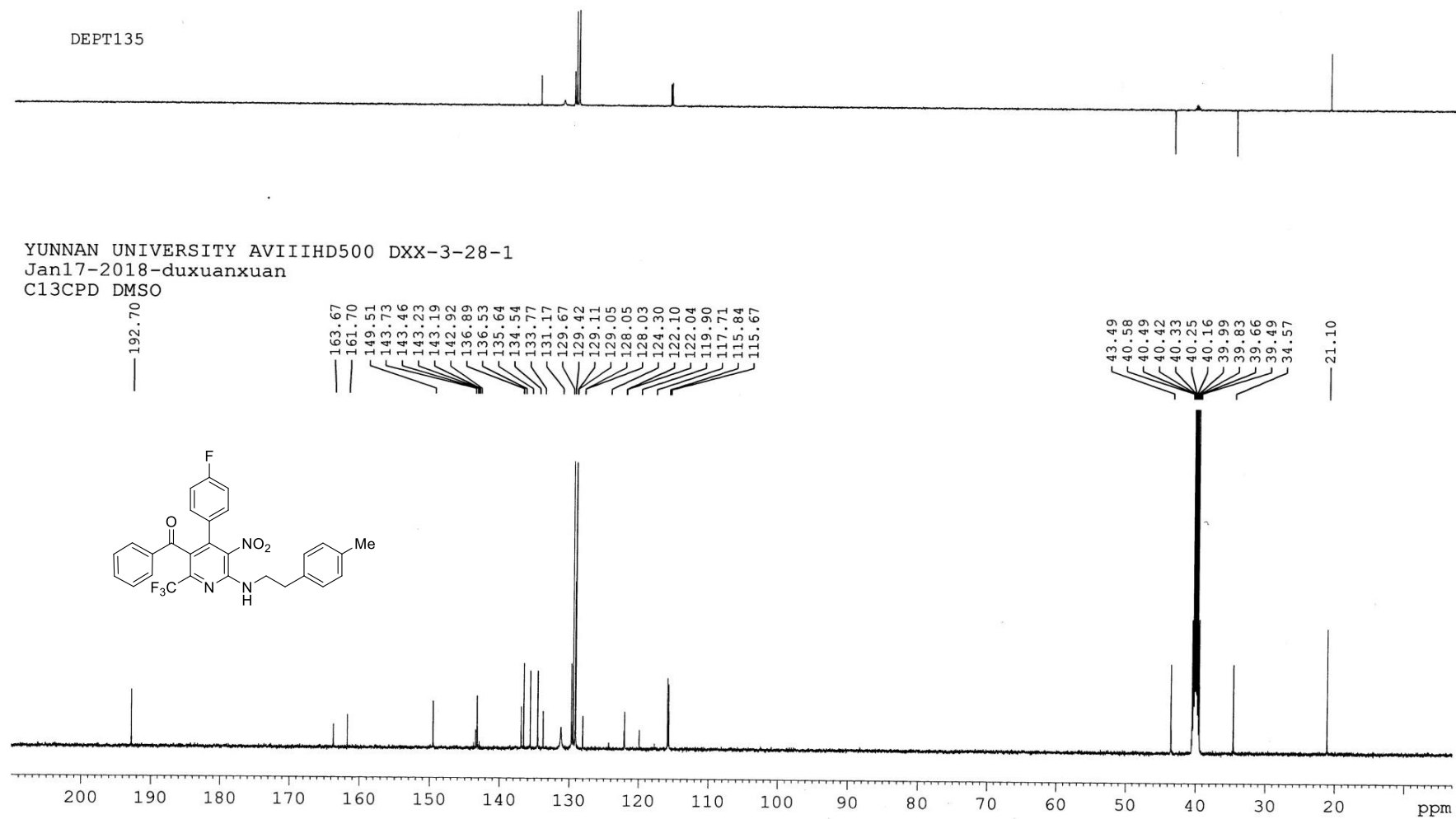


Figure S33. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **4o**

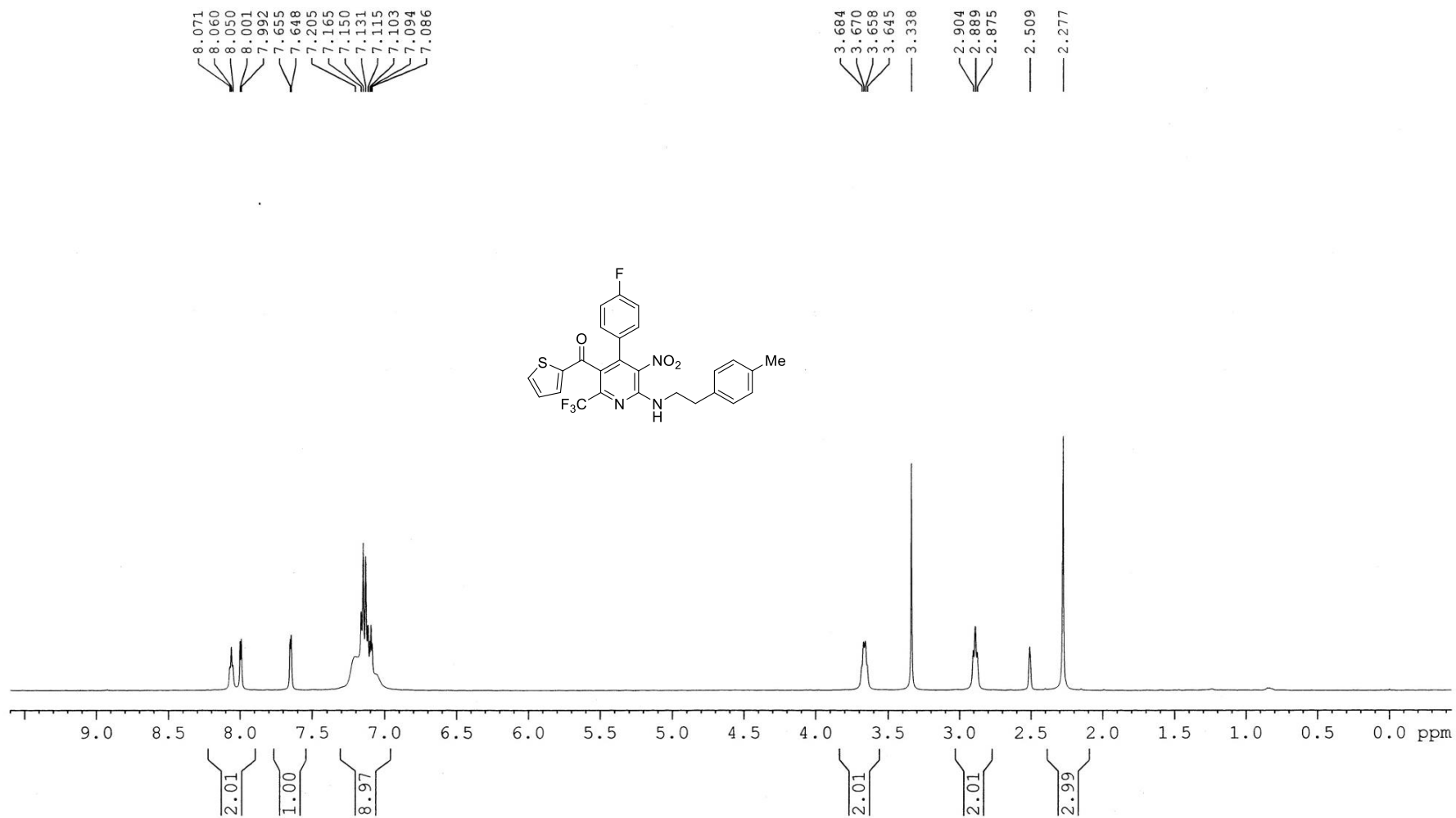


Figure S34. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **4p**



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C13CPD DMSO

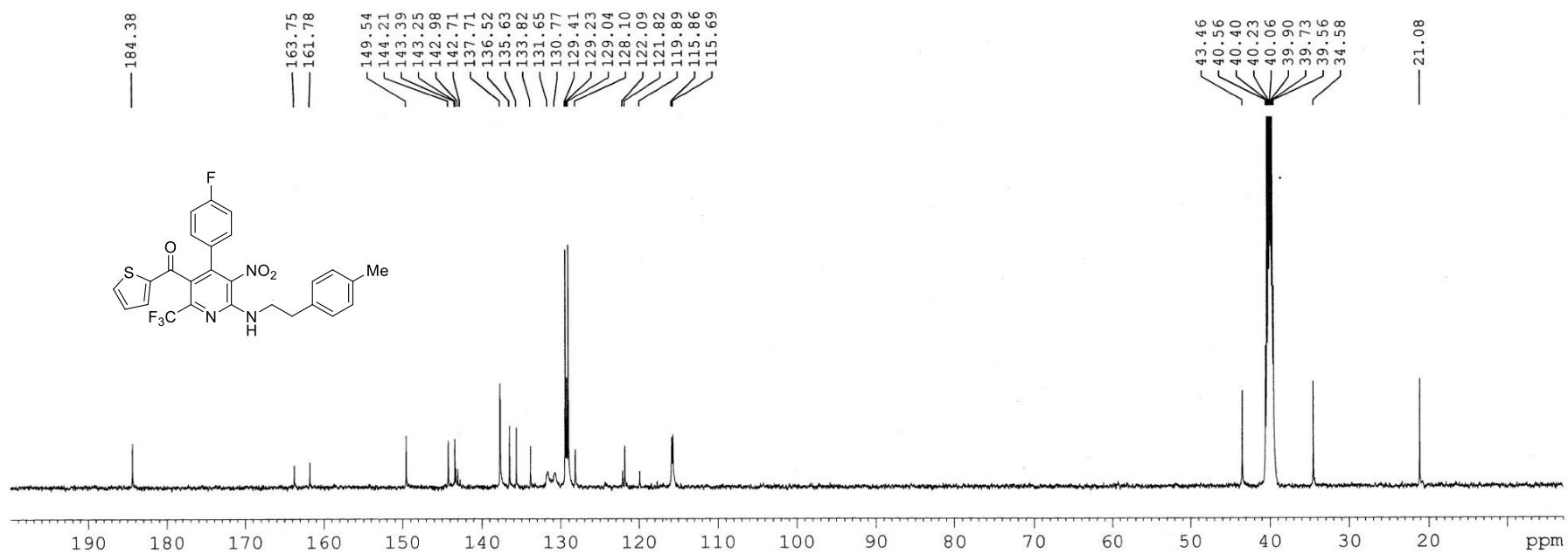


Figure S35. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **4p**

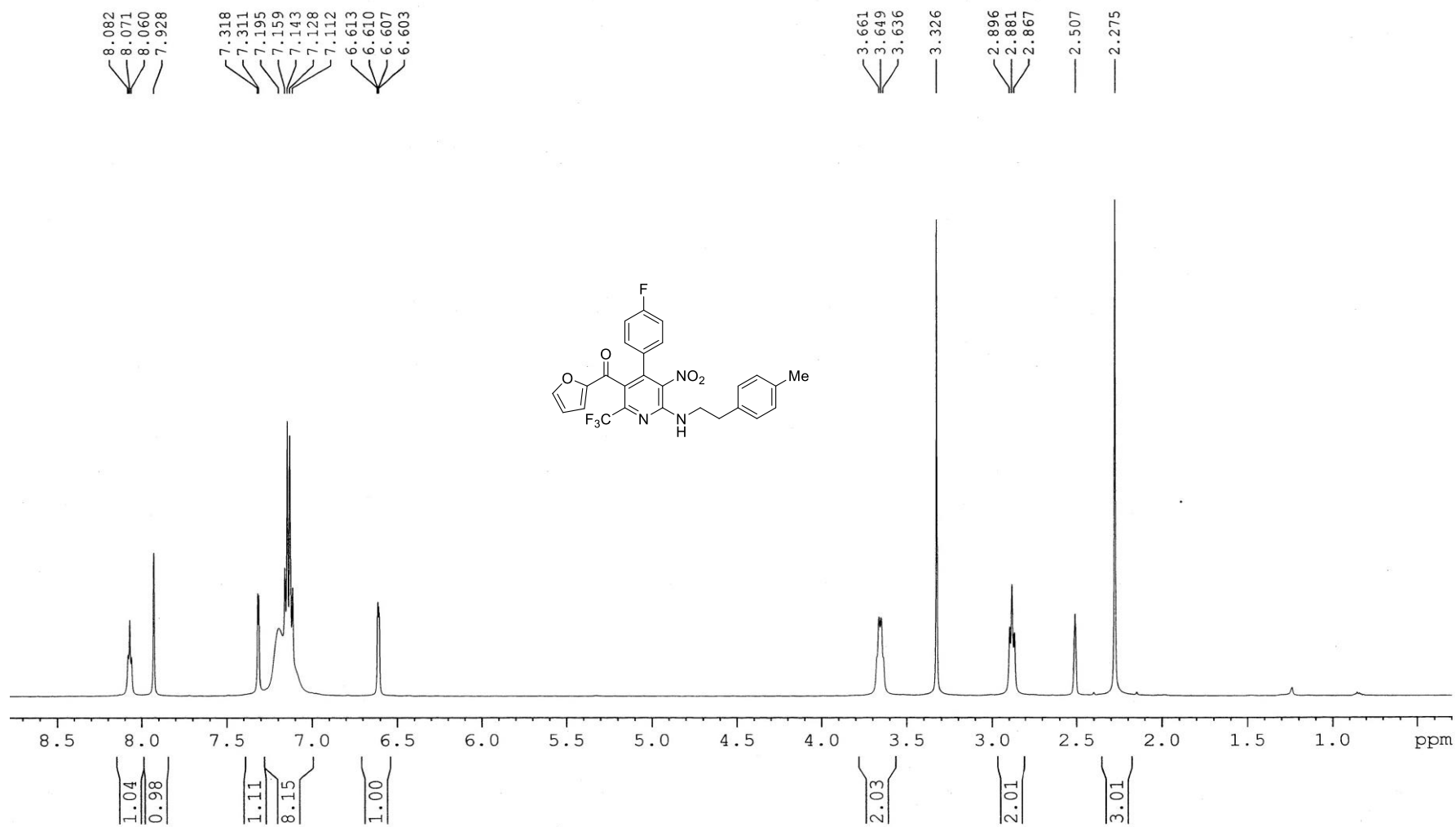


Figure S36. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound 4q

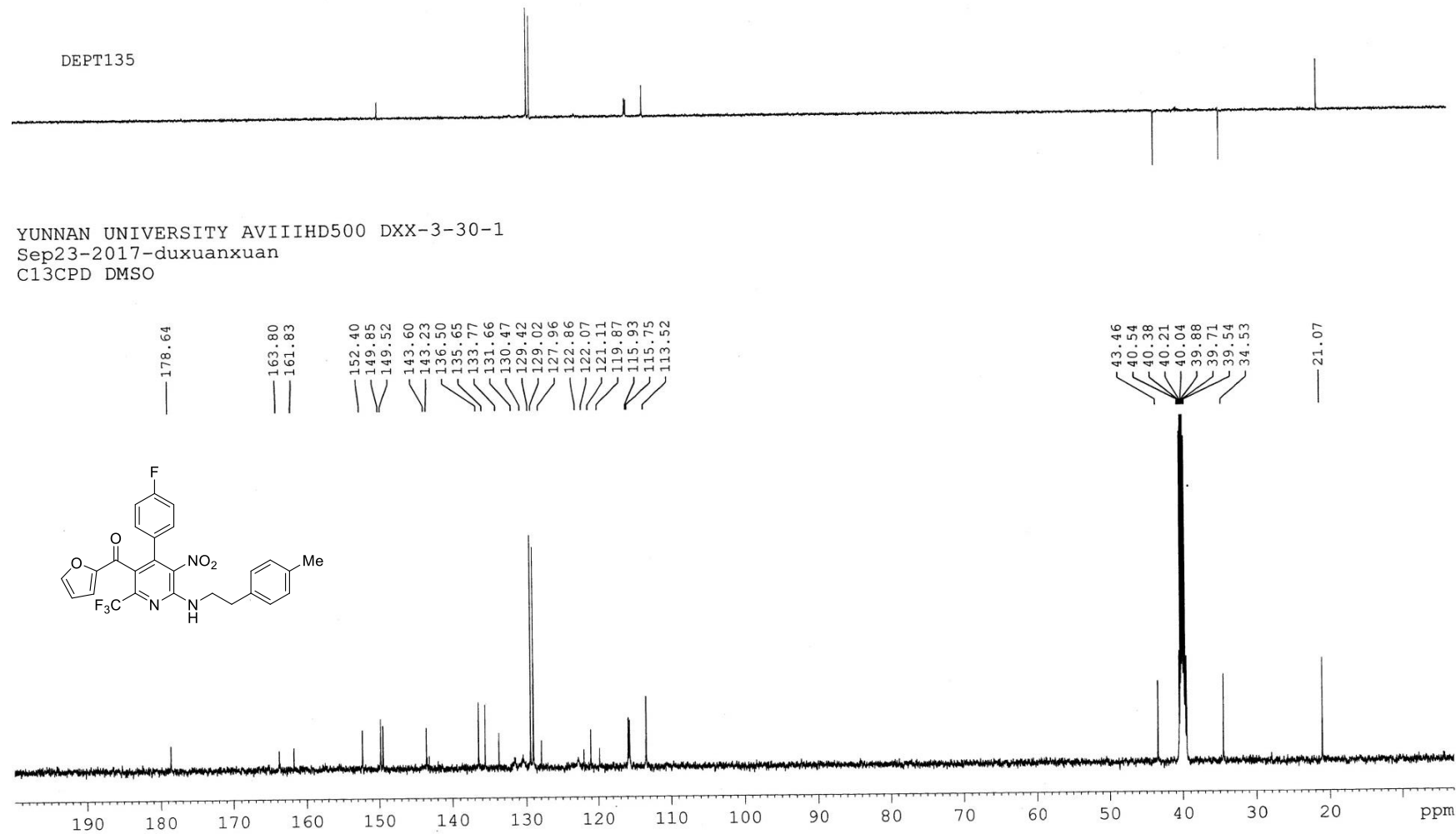


Figure S37. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 4q

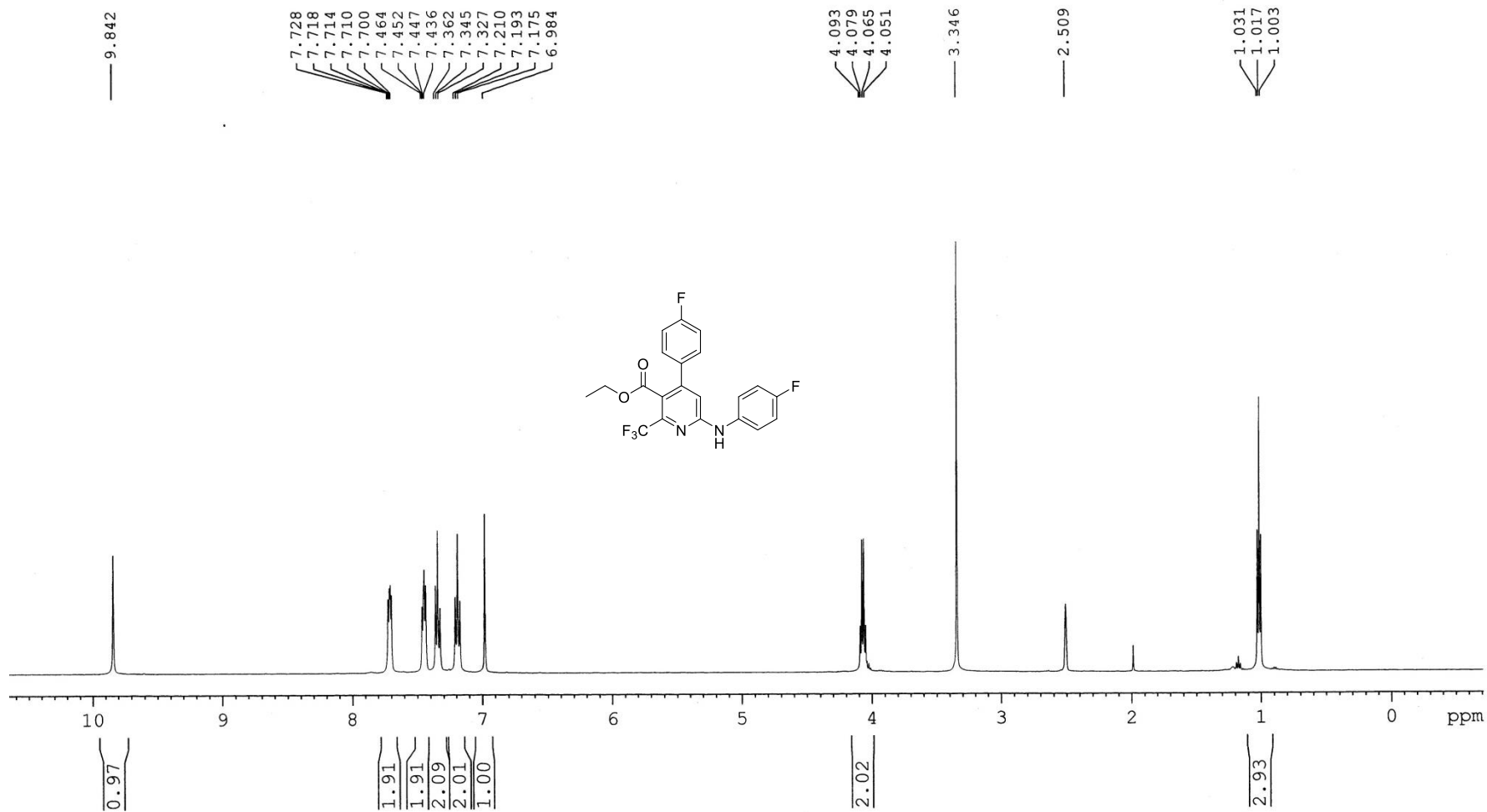
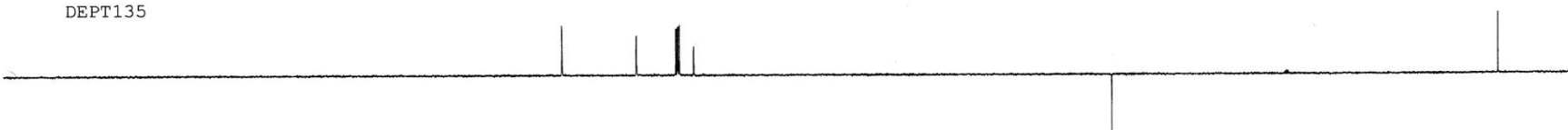


Figure S38. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5a**

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C13CPD DMSO

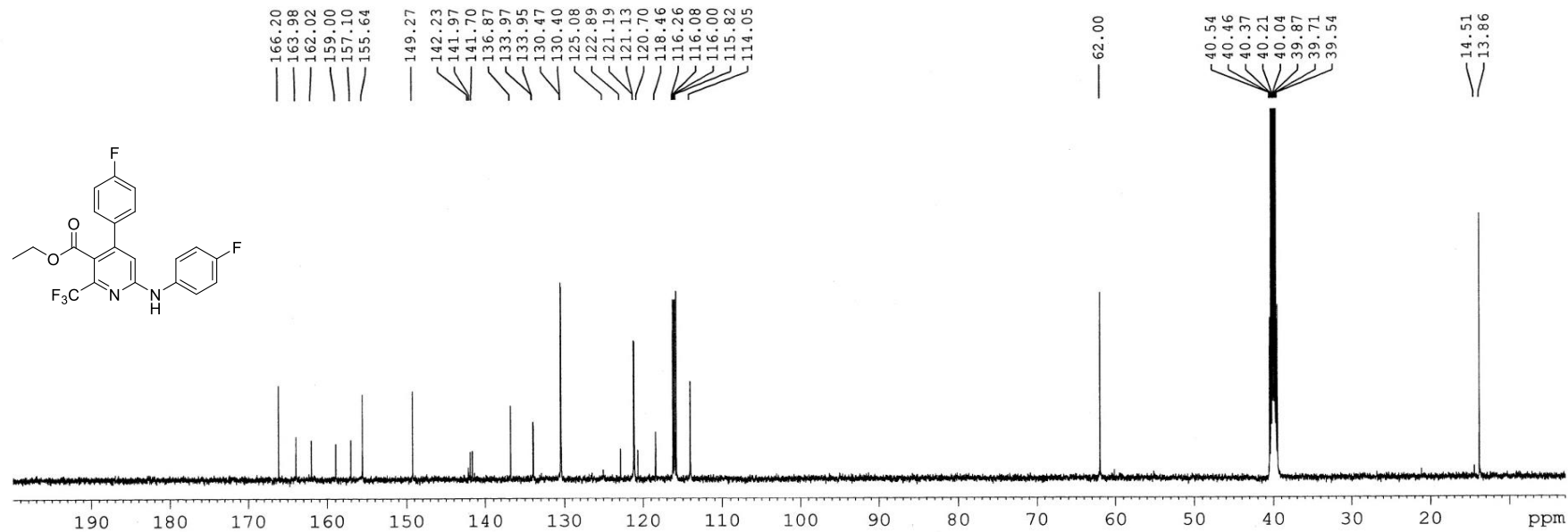


Figure S39. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 5a

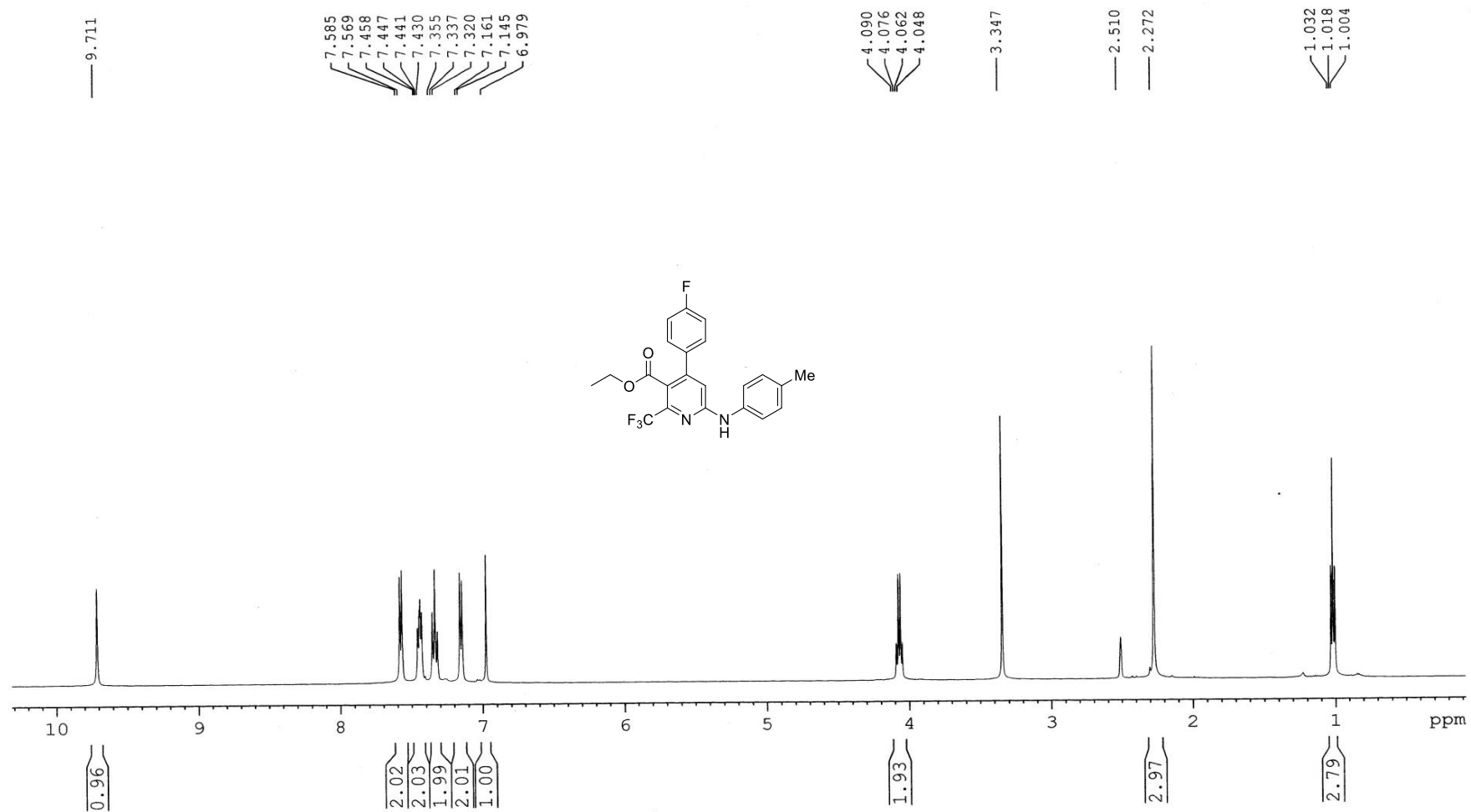


Figure S40. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **5b**

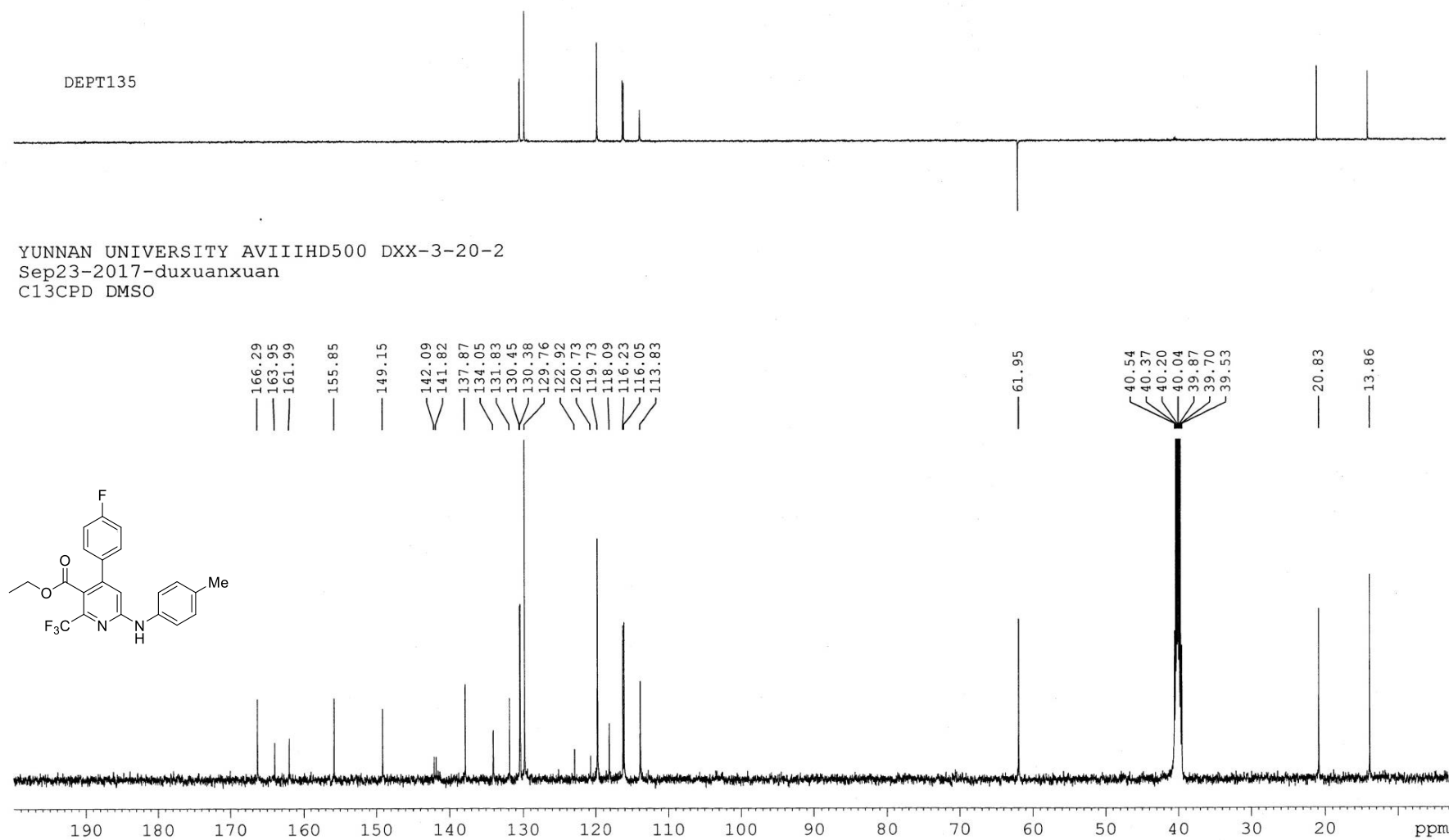


Figure S41. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **5b**

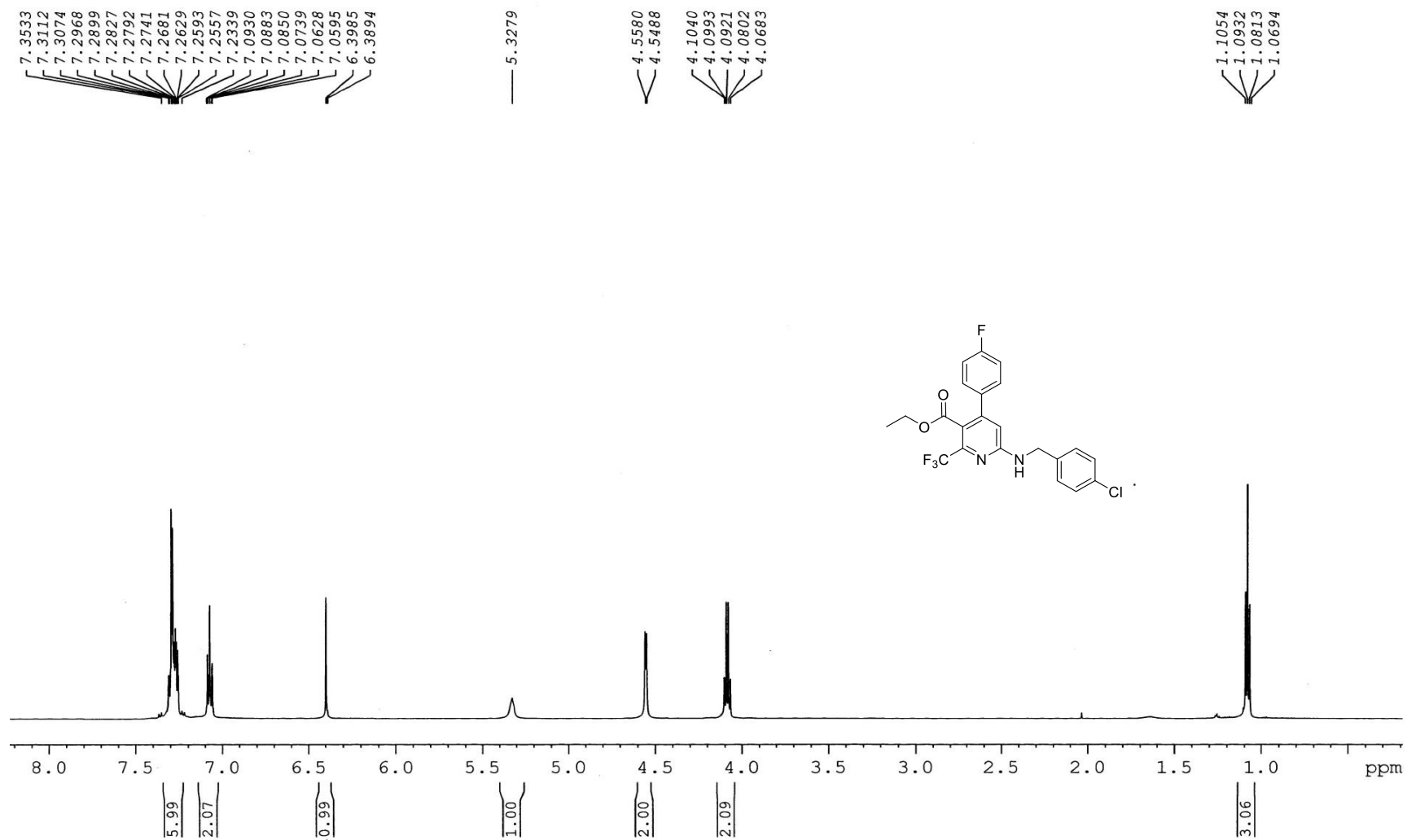
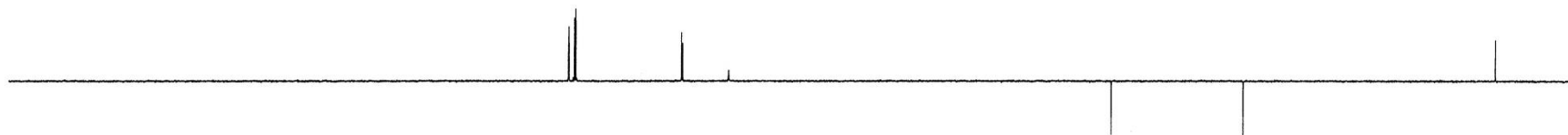


Figure S42. ¹H NMR (600 MHz, CDCl₃) spectra of compound 5c

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C13CPD CDC13

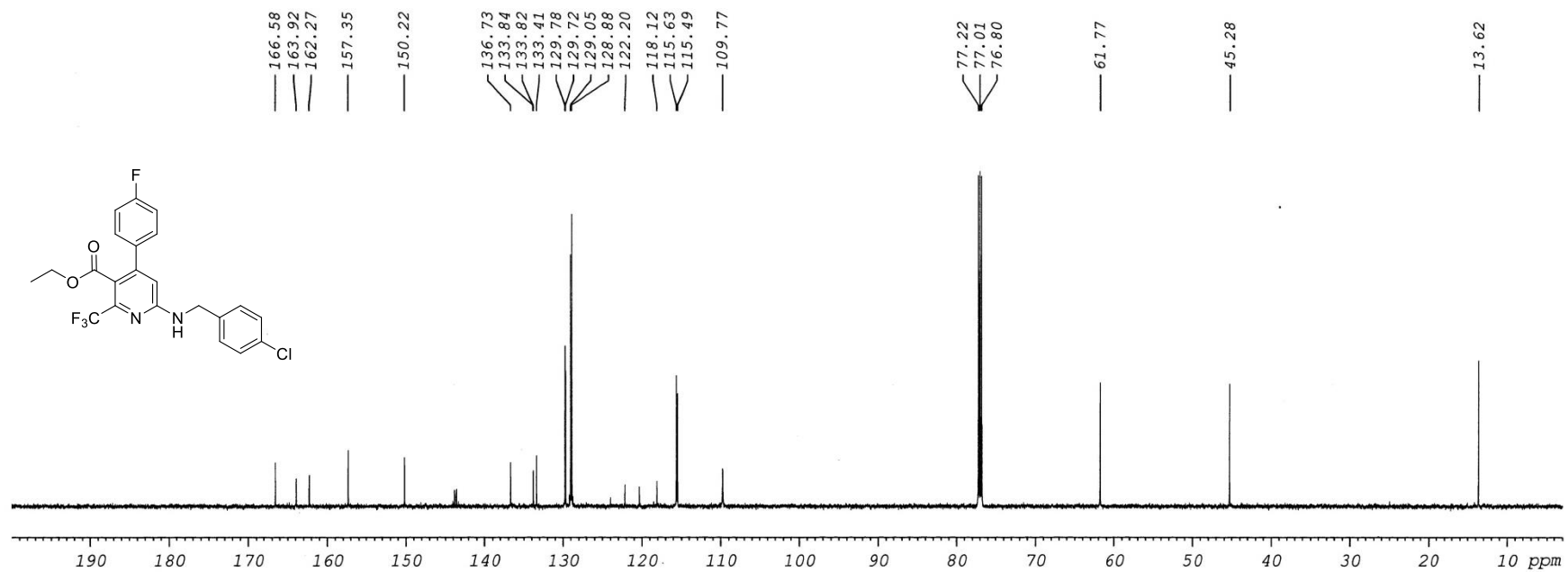


Figure S43. ^{13}C NMR (150 MHz, CDCl_3) spectra of compound 5c

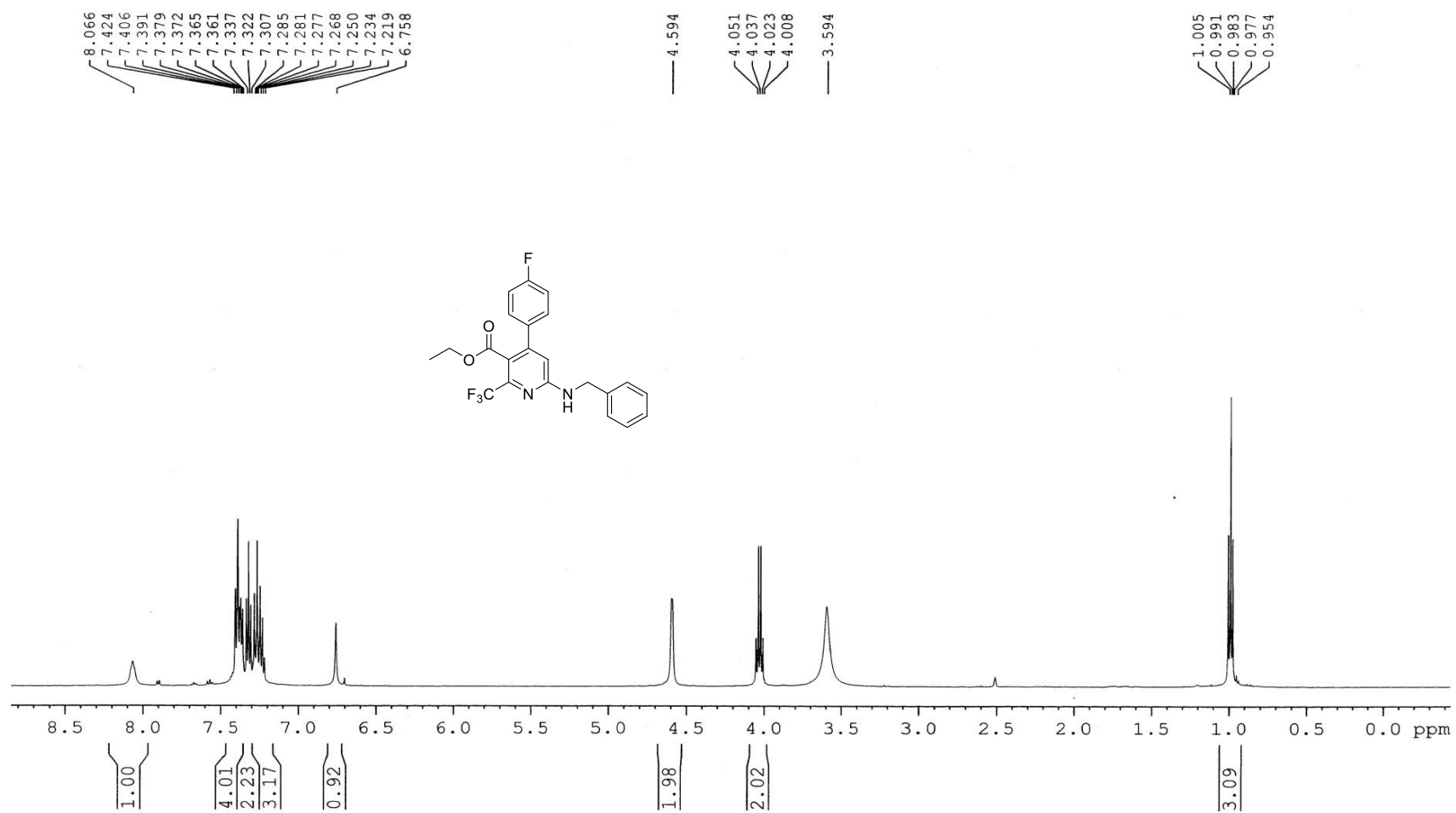
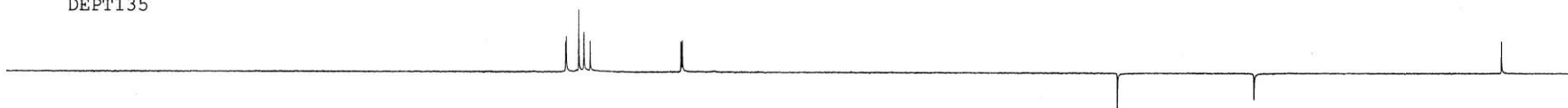


Figure S44. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5d**

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Jun27-2017-duxuanxuan
C13CPD DMSO

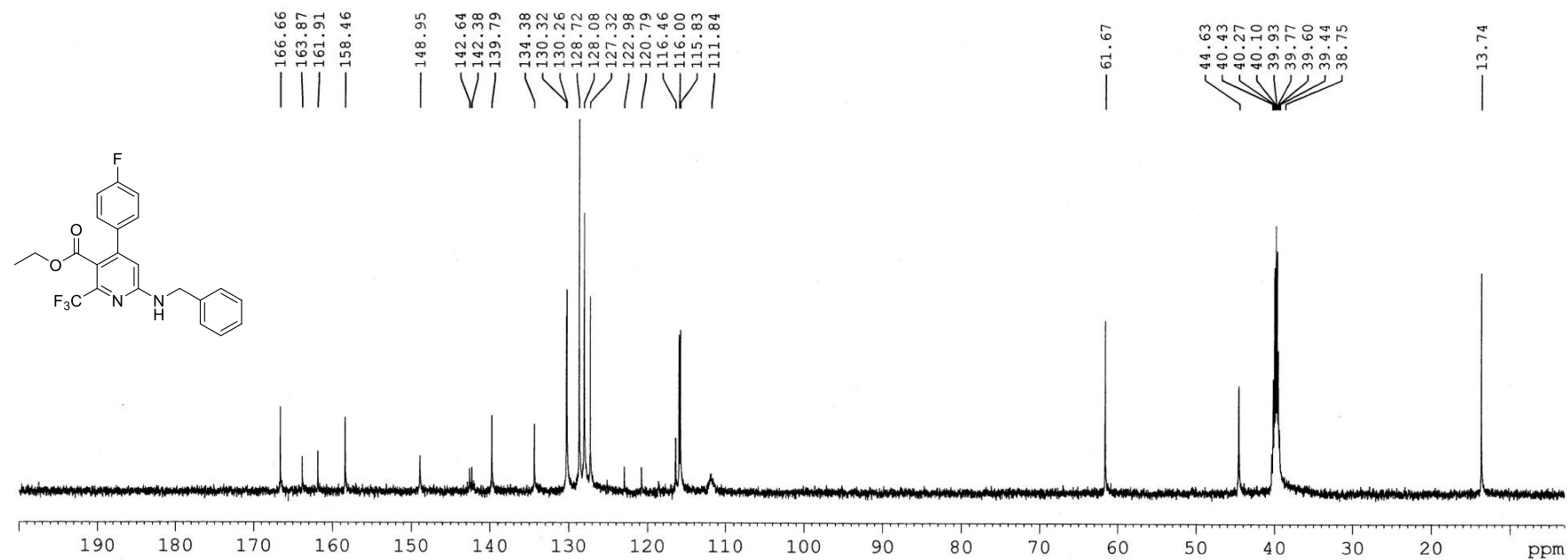


Figure S45. ¹³C NMR (125MHz, DMSO-*d*₆) spectra of compound 5d

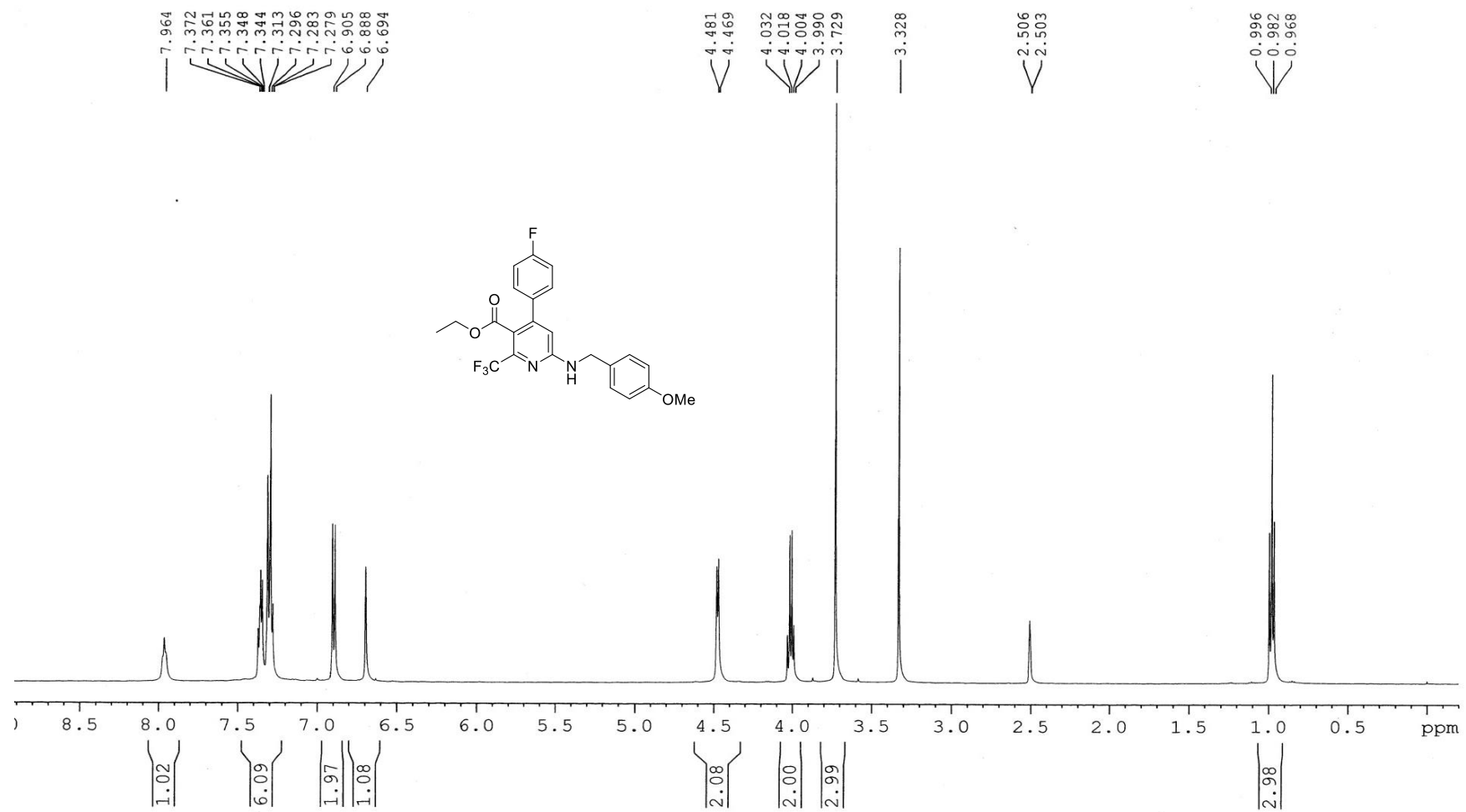
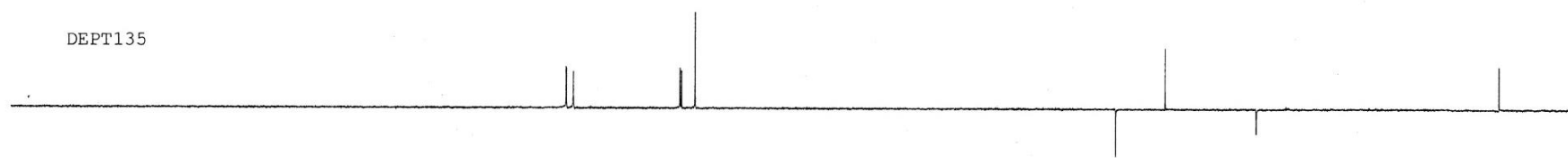


Figure S46. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5e**

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Sep23-2017-duxuanxuan
C13CPD DMSO

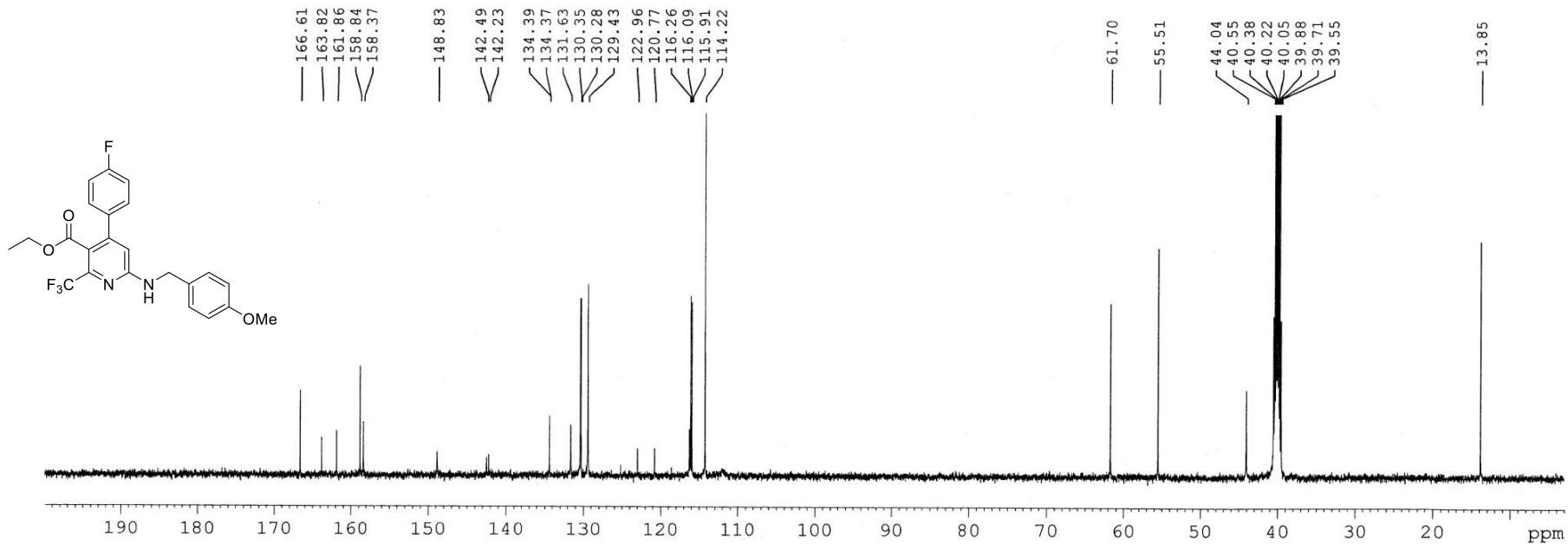


Figure S47. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 5e

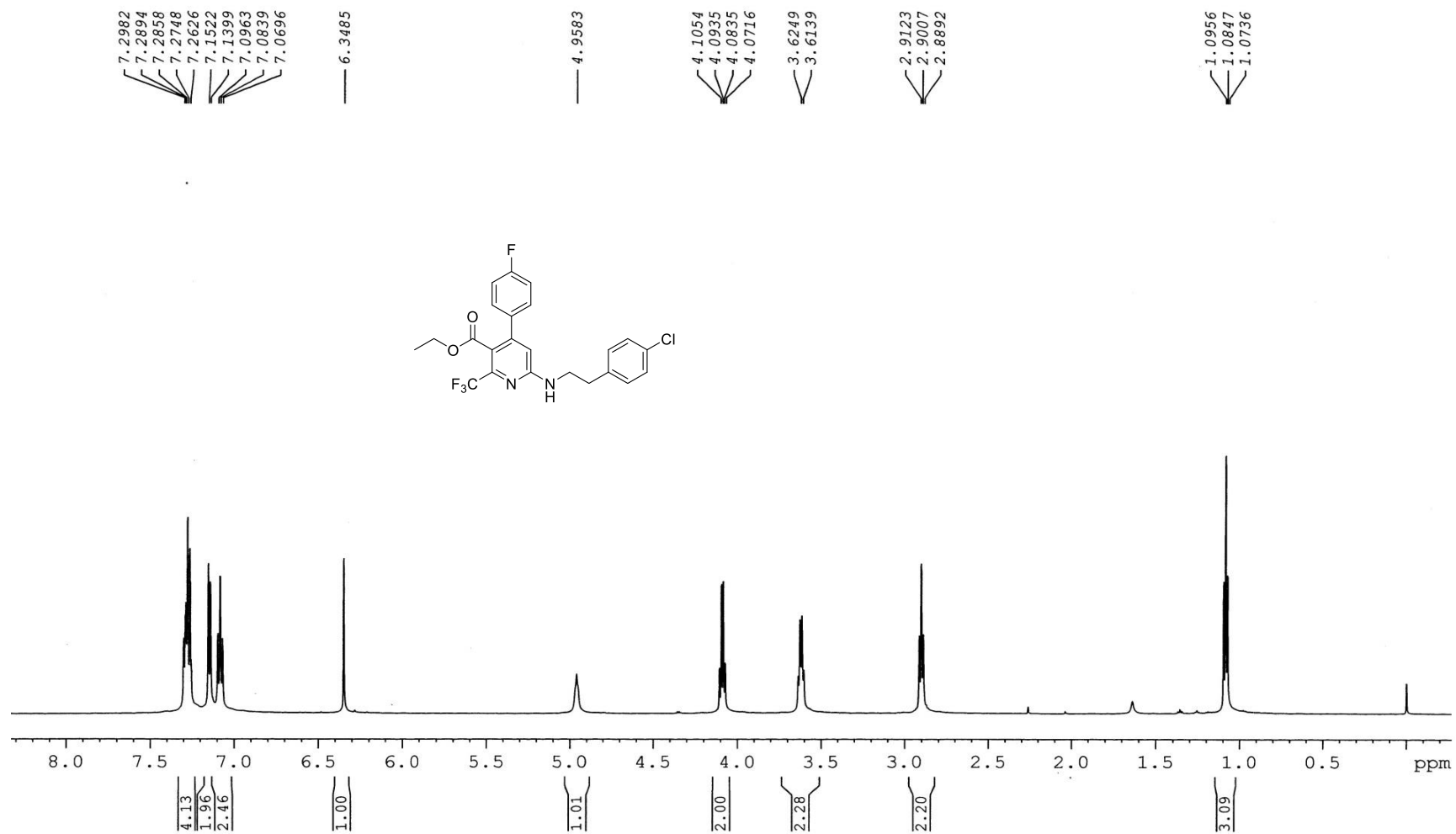
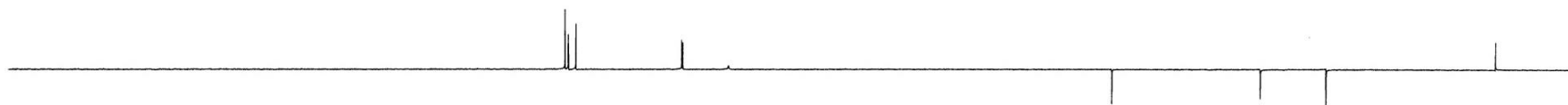


Figure S48. ¹H NMR (600 MHz, CDCl₃) spectra of compound **5f**

DEPT135



YUNNAN UNIVERSITY ASCEND AVIIIHD600 DXX -3-5-2
Sep07-2017-duxuanxuan
C13CPD CDCl3

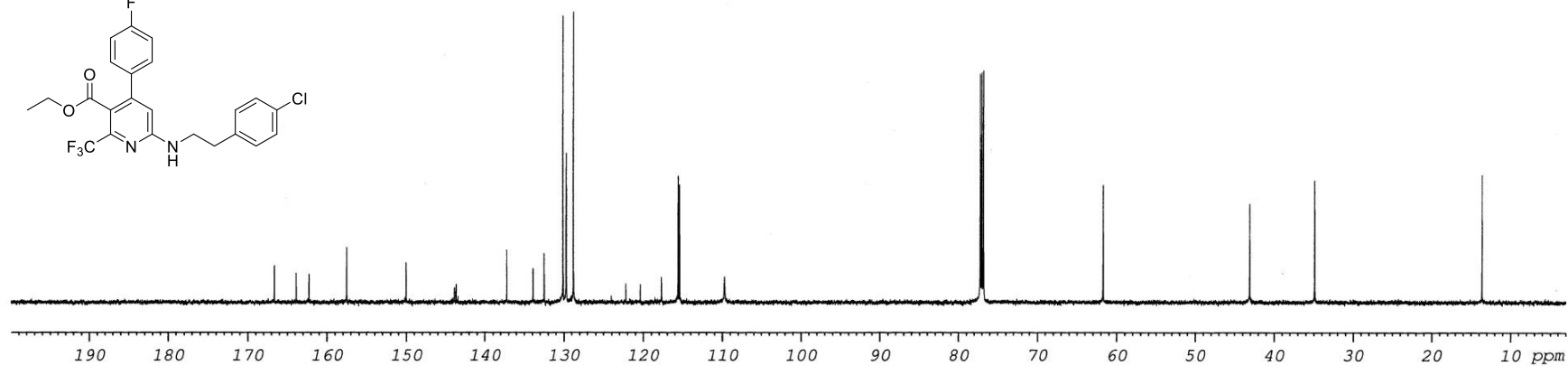
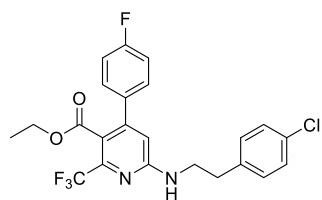


Figure S49. ^{13}C NMR (150 MHz, CDCl_3) spectra of compound **5f**

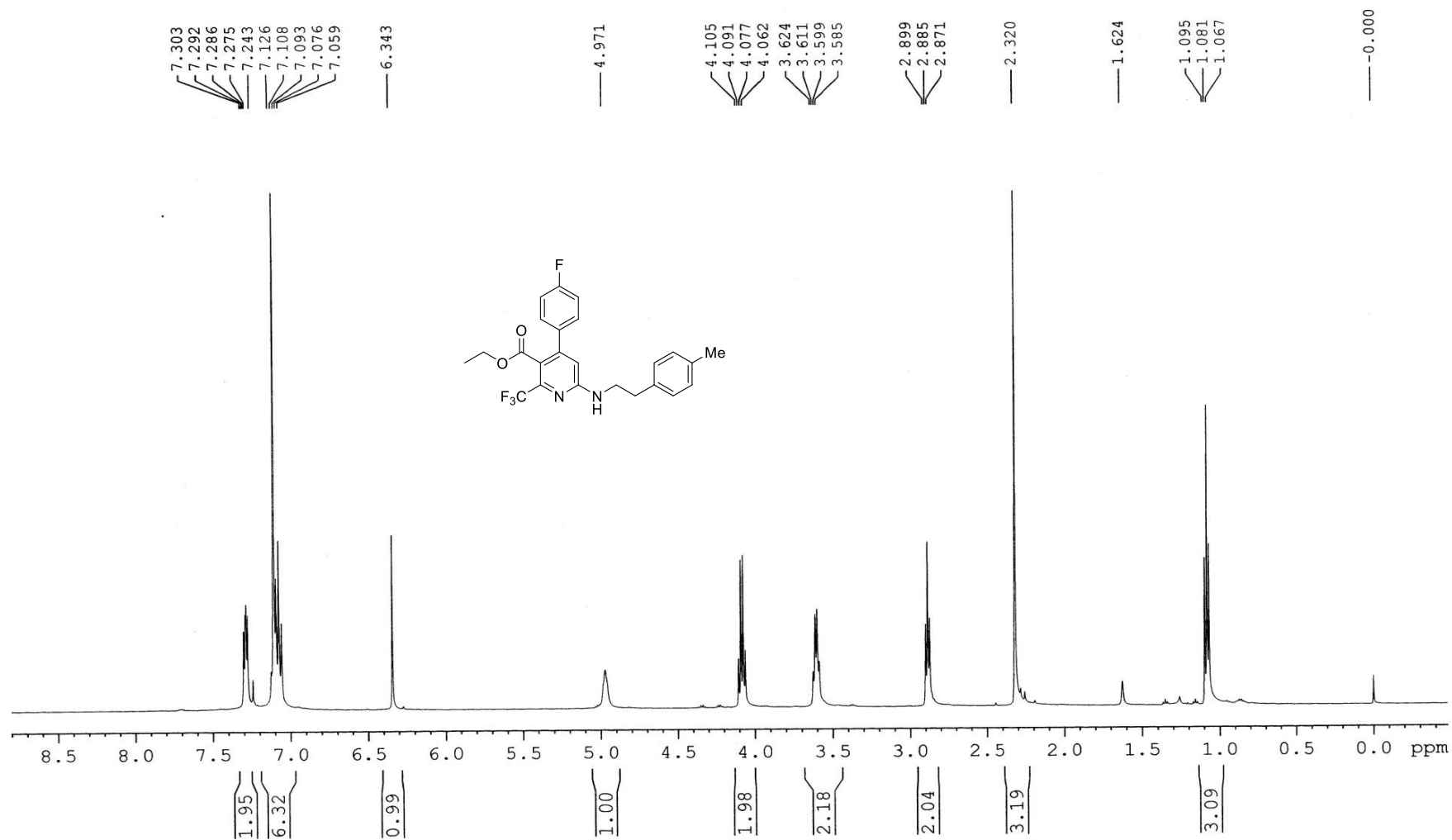


Figure S50. ^1H NMR (500 MHz, CDCl_3) spectra of compound **5g**

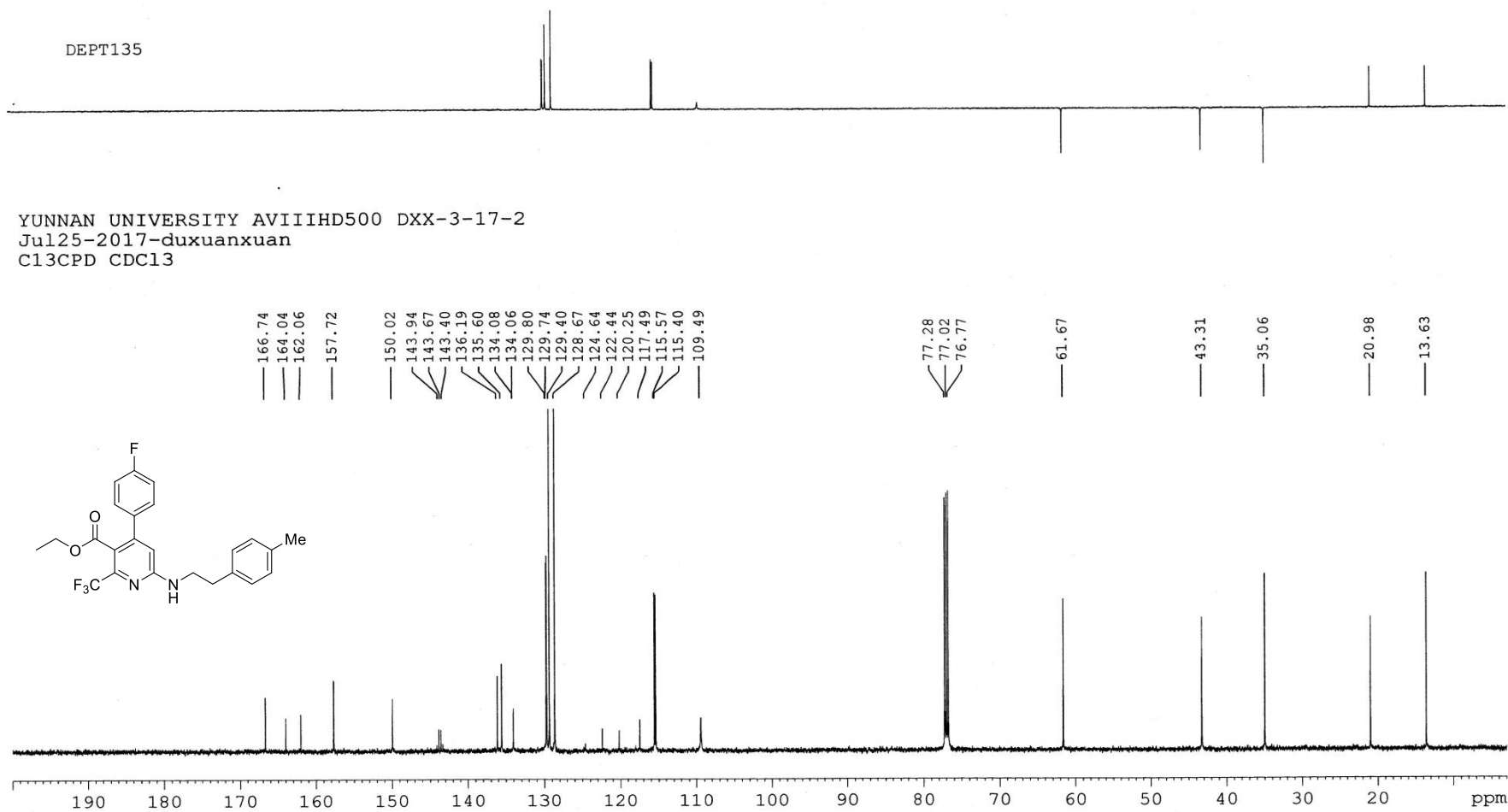


Figure S51. ^{13}C NMR (125 MHz, CDCl_3) spectra of compound **5g**

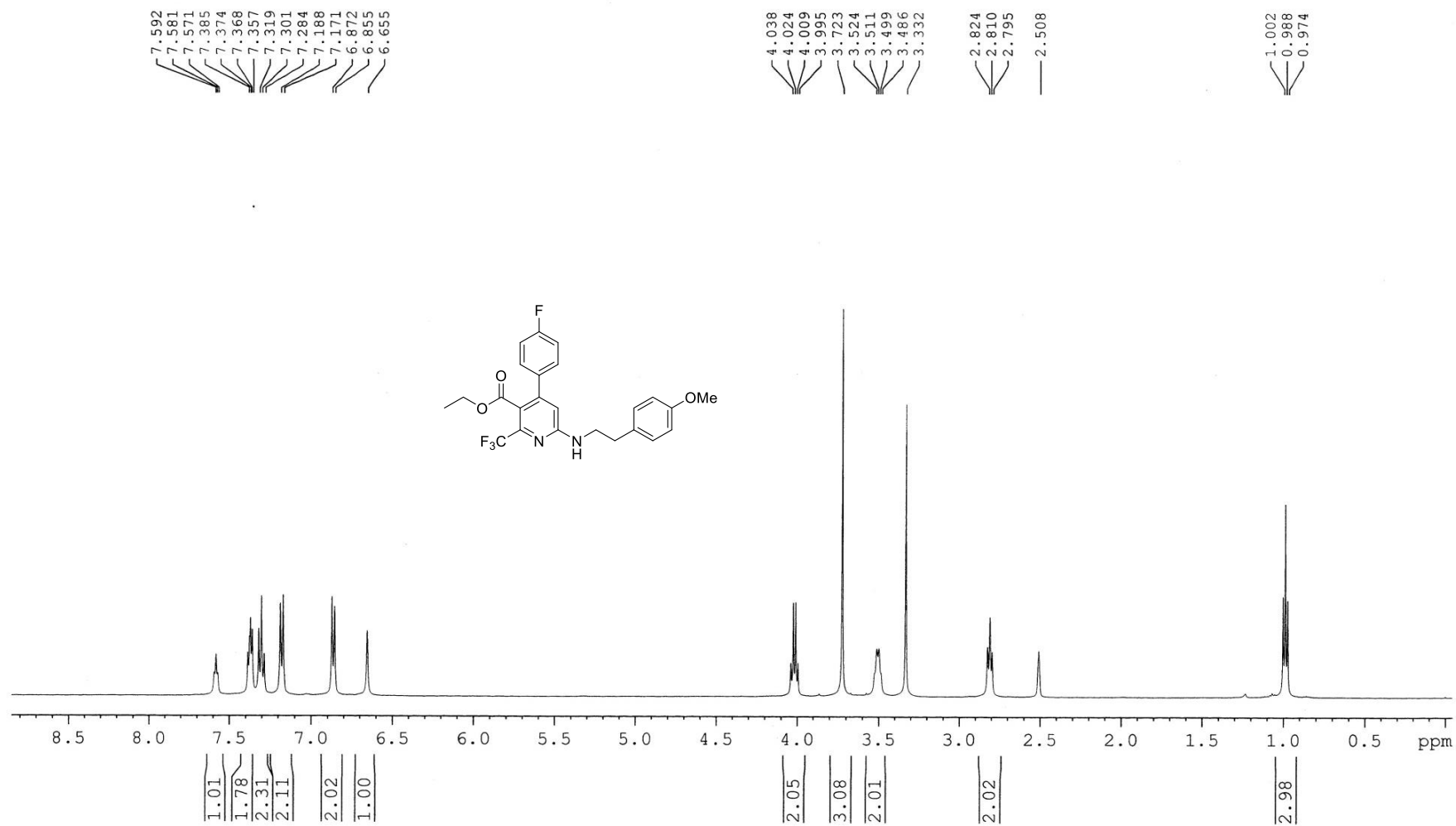
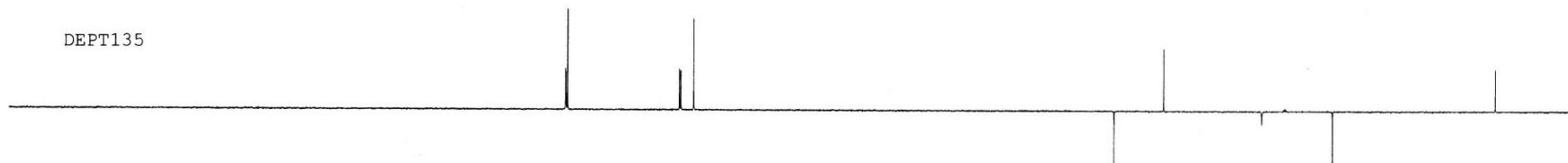


Figure S52. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5h**

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Sep30-2017-duxuanxuan
C13CPD DMSO

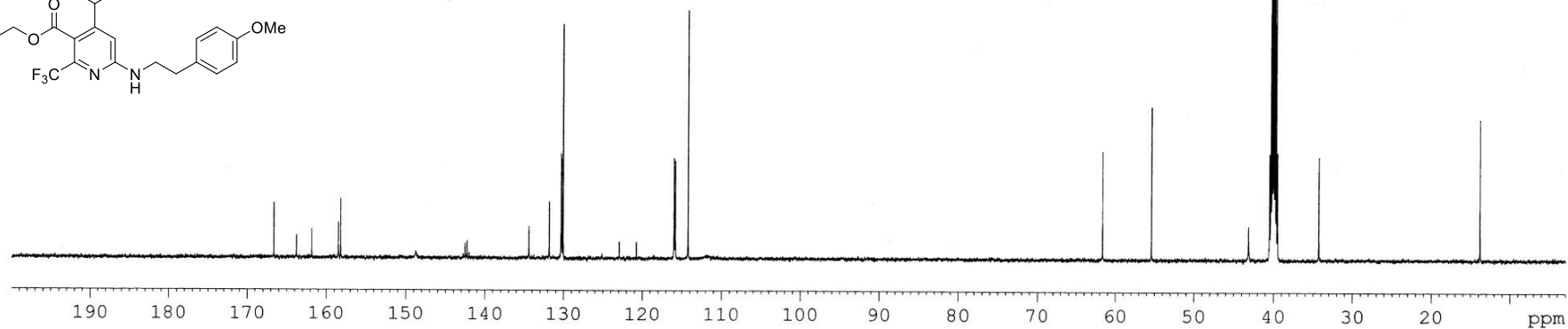
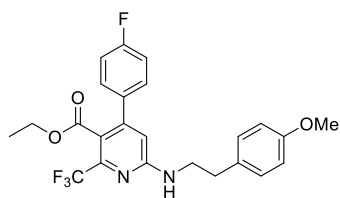


Figure S53. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 5h

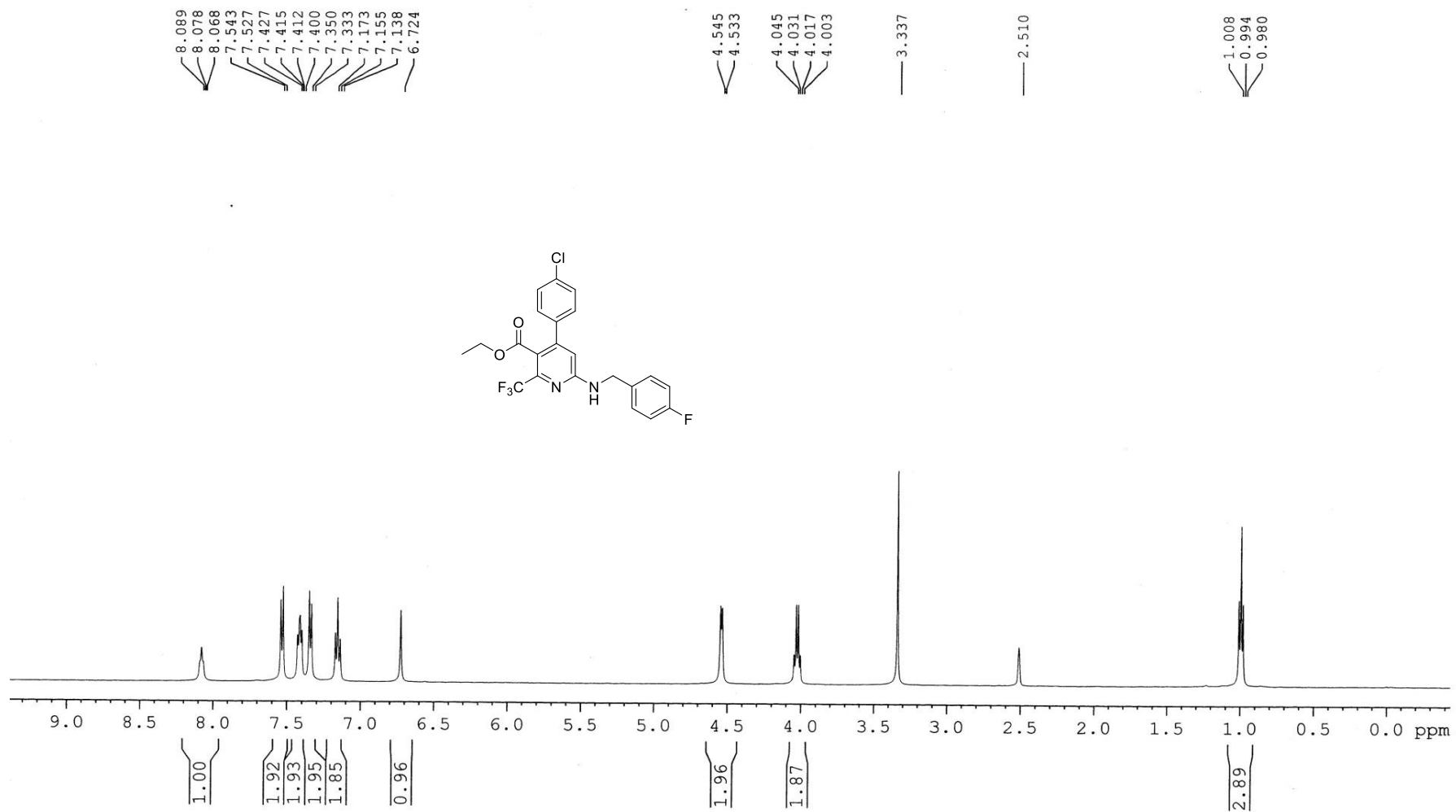


Figure S54. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5i**

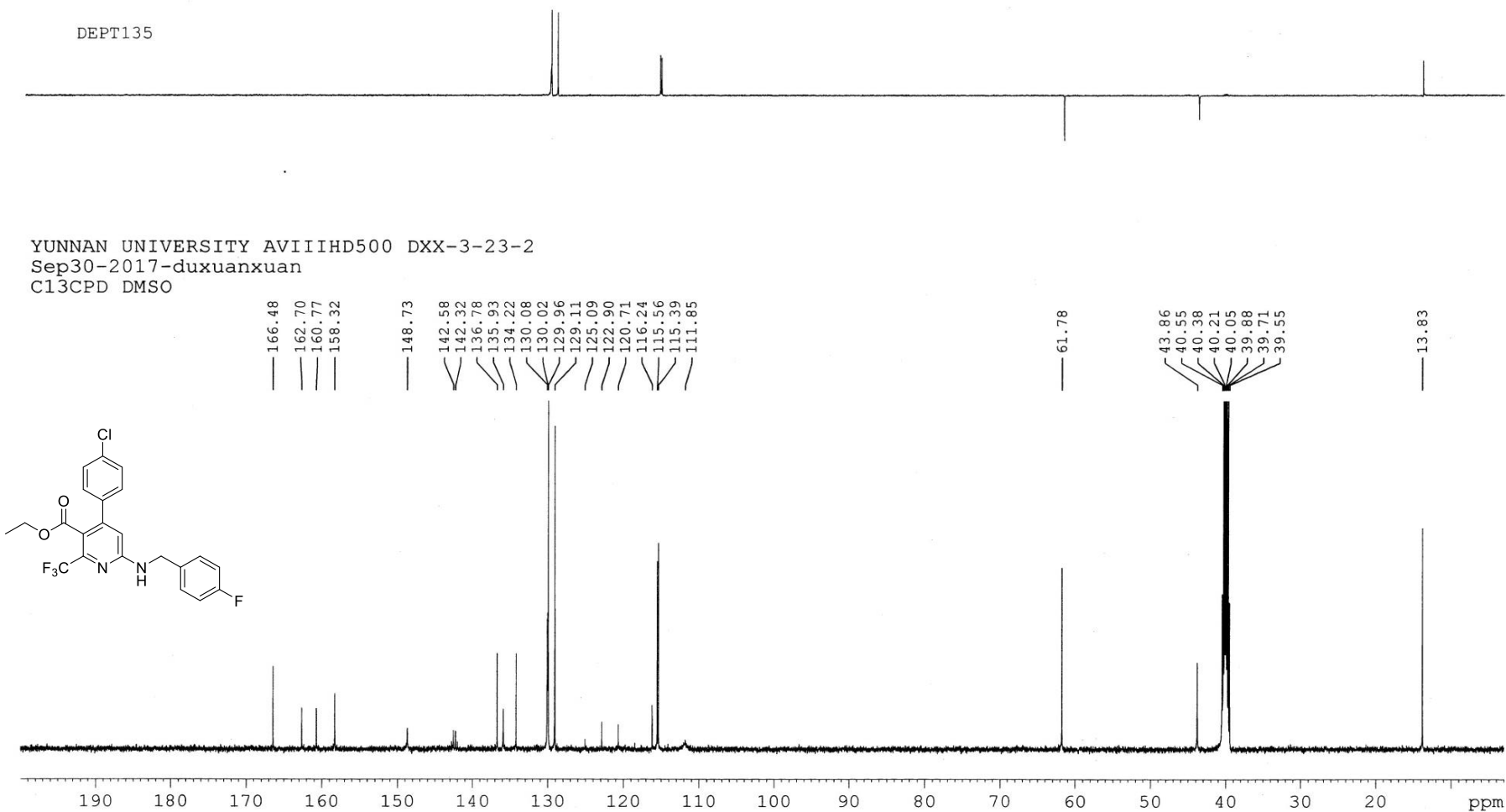


Figure S55. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **5i**

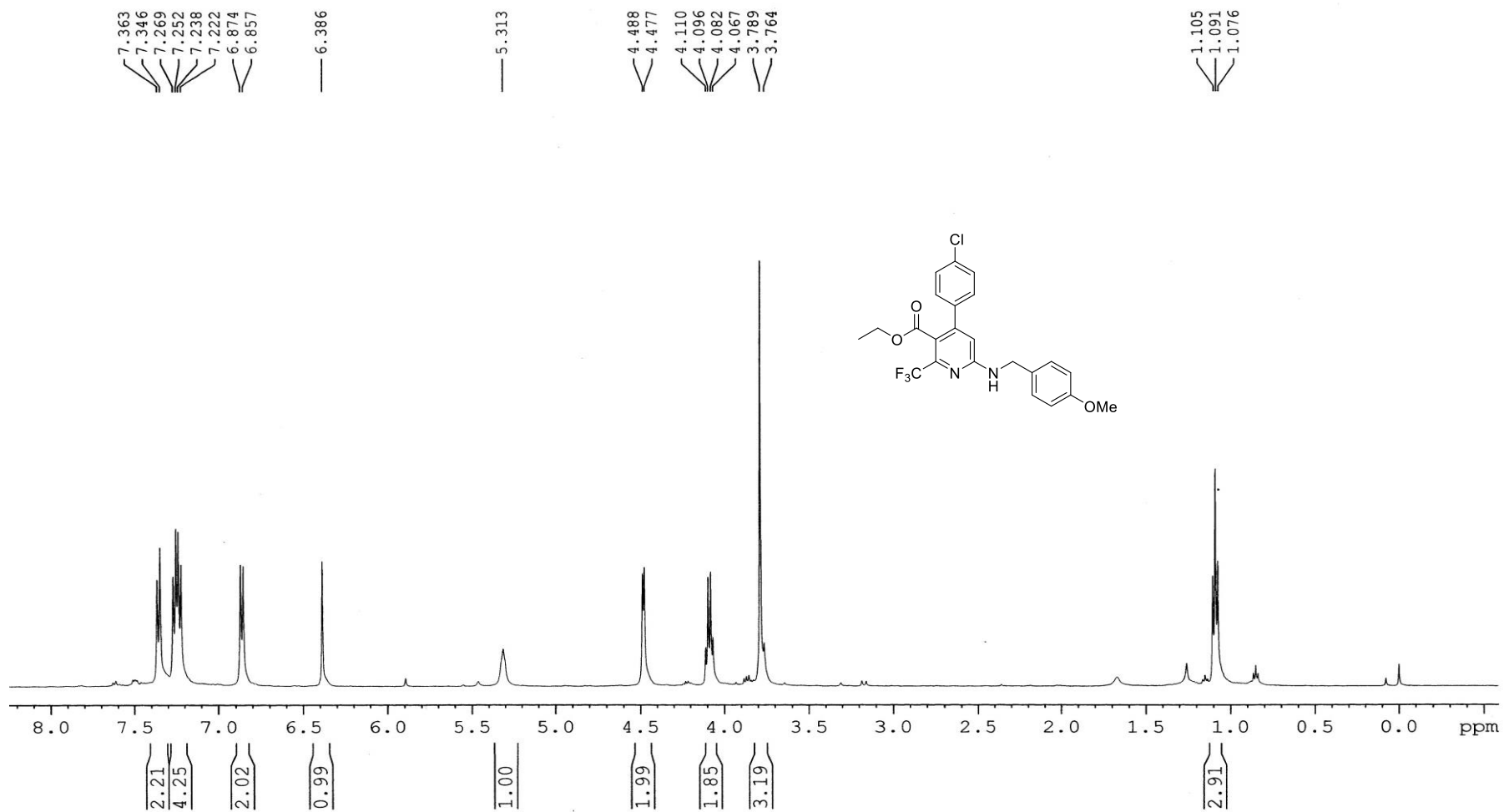


Figure S56. ¹H NMR (500 MHz, CDCl₃) spectra of compound **5j**

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Sep13-2017-duxuanxuan
C13CPD CDC13

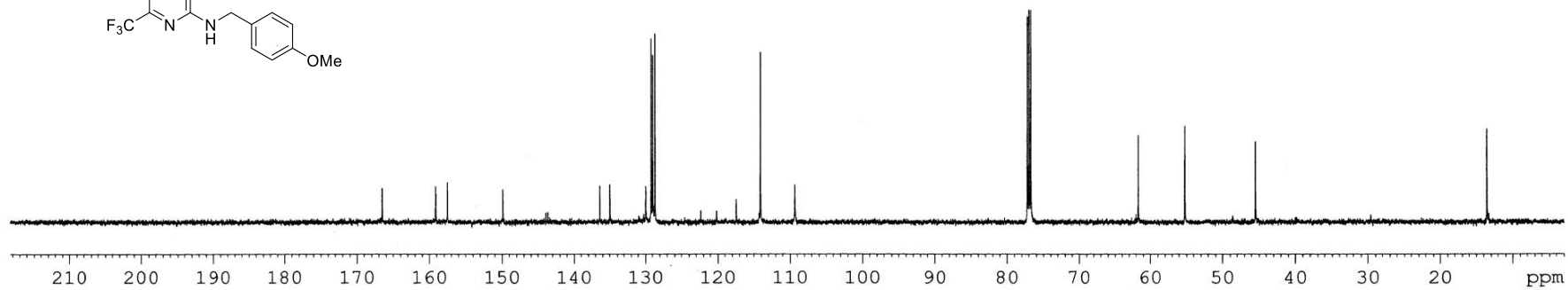
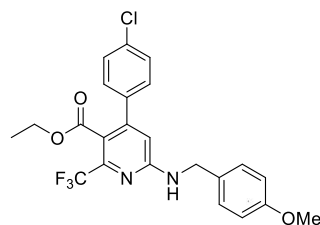


Figure S57. ¹³C NMR (125 MHz, CDCl₃) spectra of compound 5j

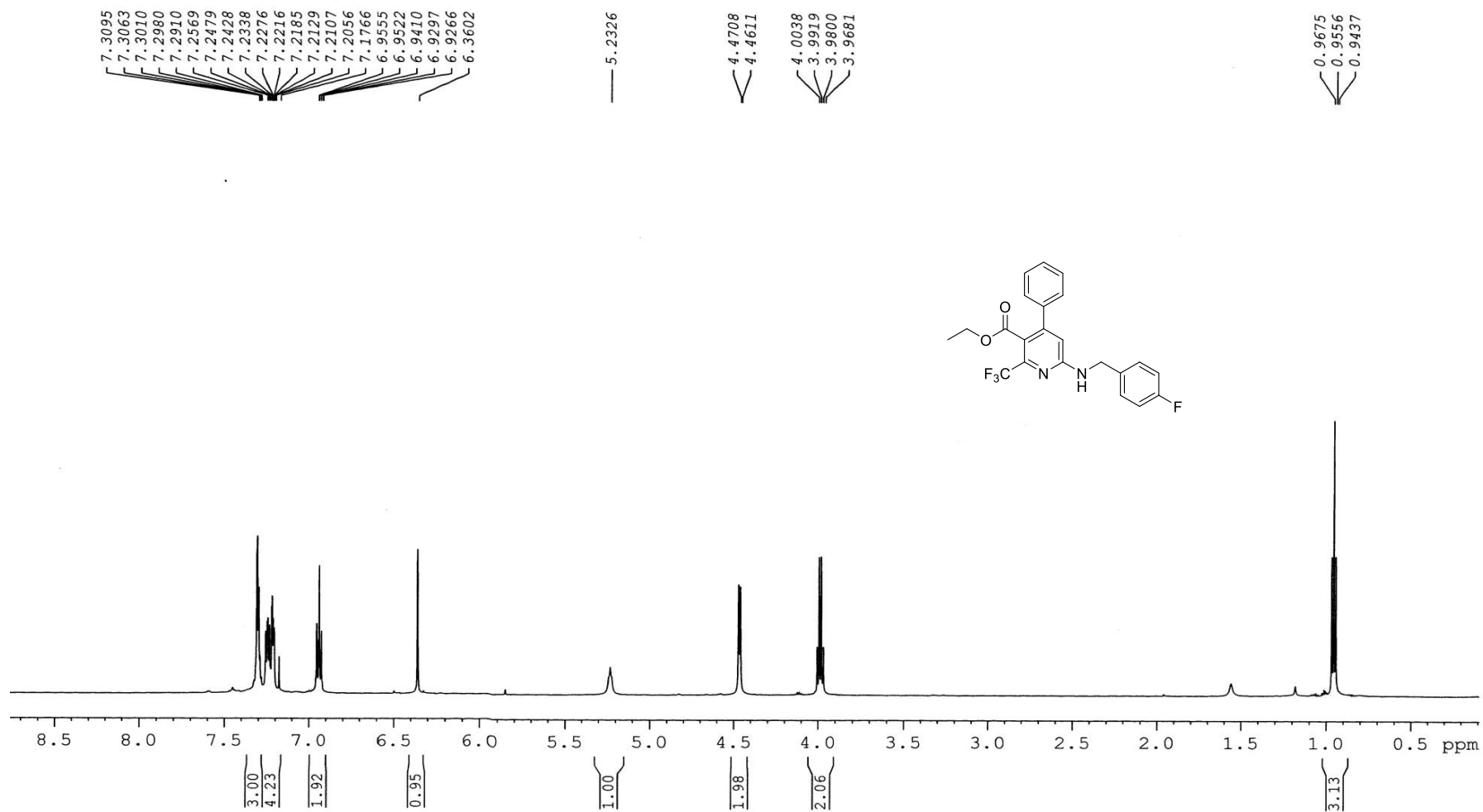
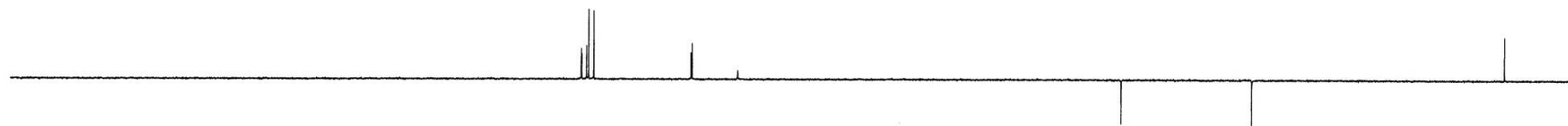


Figure S58. ¹H NMR (600 MHz, CDCl₃) spectra of compound **5k**

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YUNNAN UNIVERSITY ASCEND AVIIIHD600 DXX-3-22-2
Sep06-2017-duxuanxuan
C13CPD CDC13

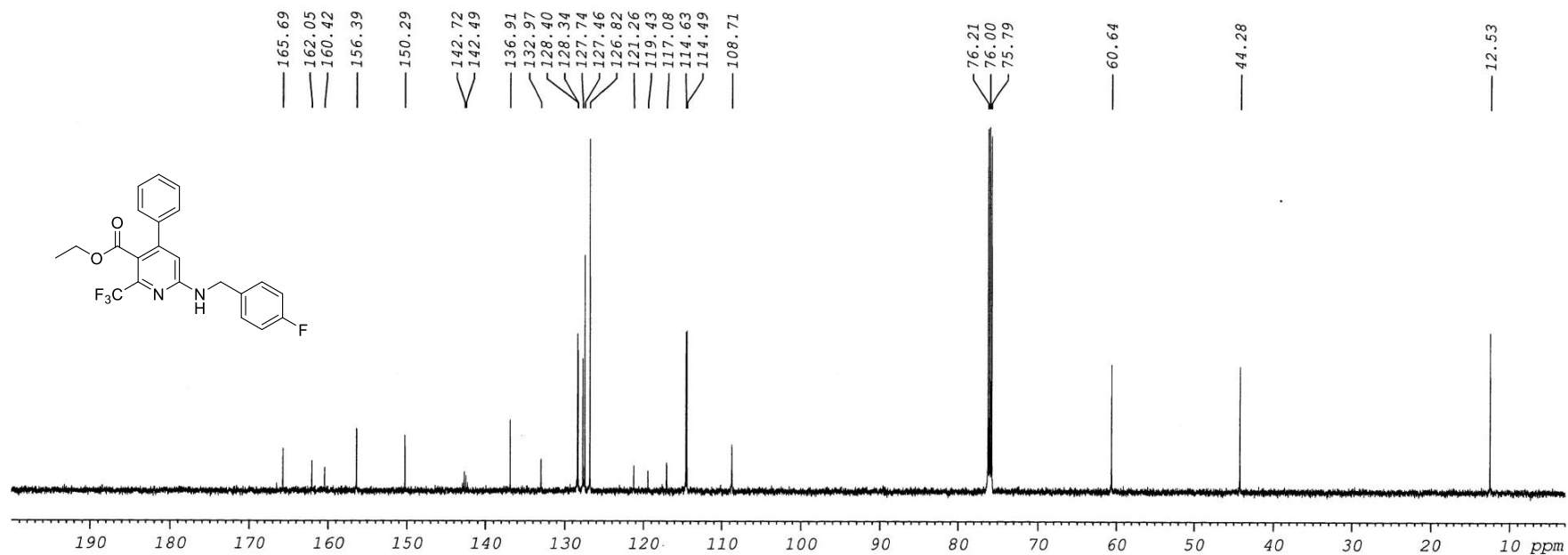


Figure S59. ¹³C NMR (150 MHz, CDCl₃) spectra of compound 5k

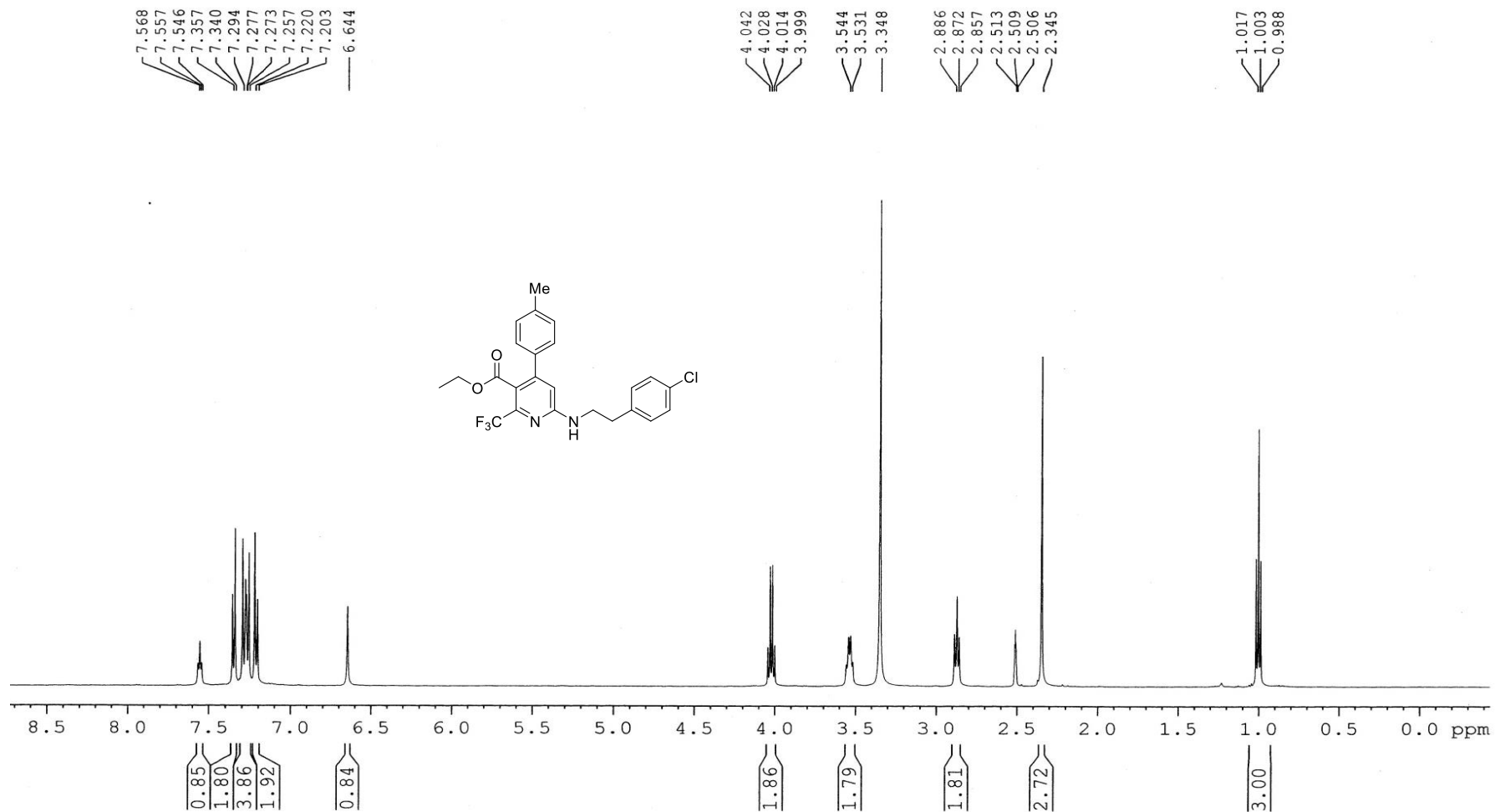


Figure S60. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **5I**

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Jun27-2017-duxuanxuan
C13CPD DMSO

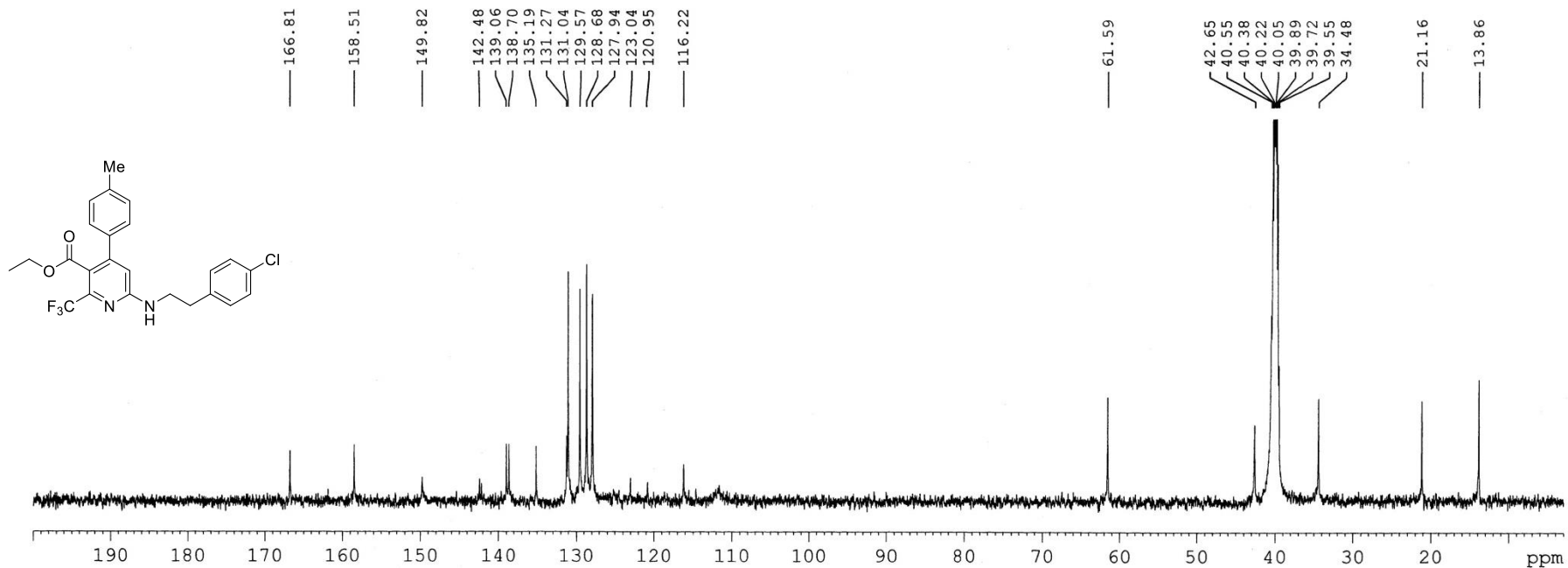


Figure S61. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **51**

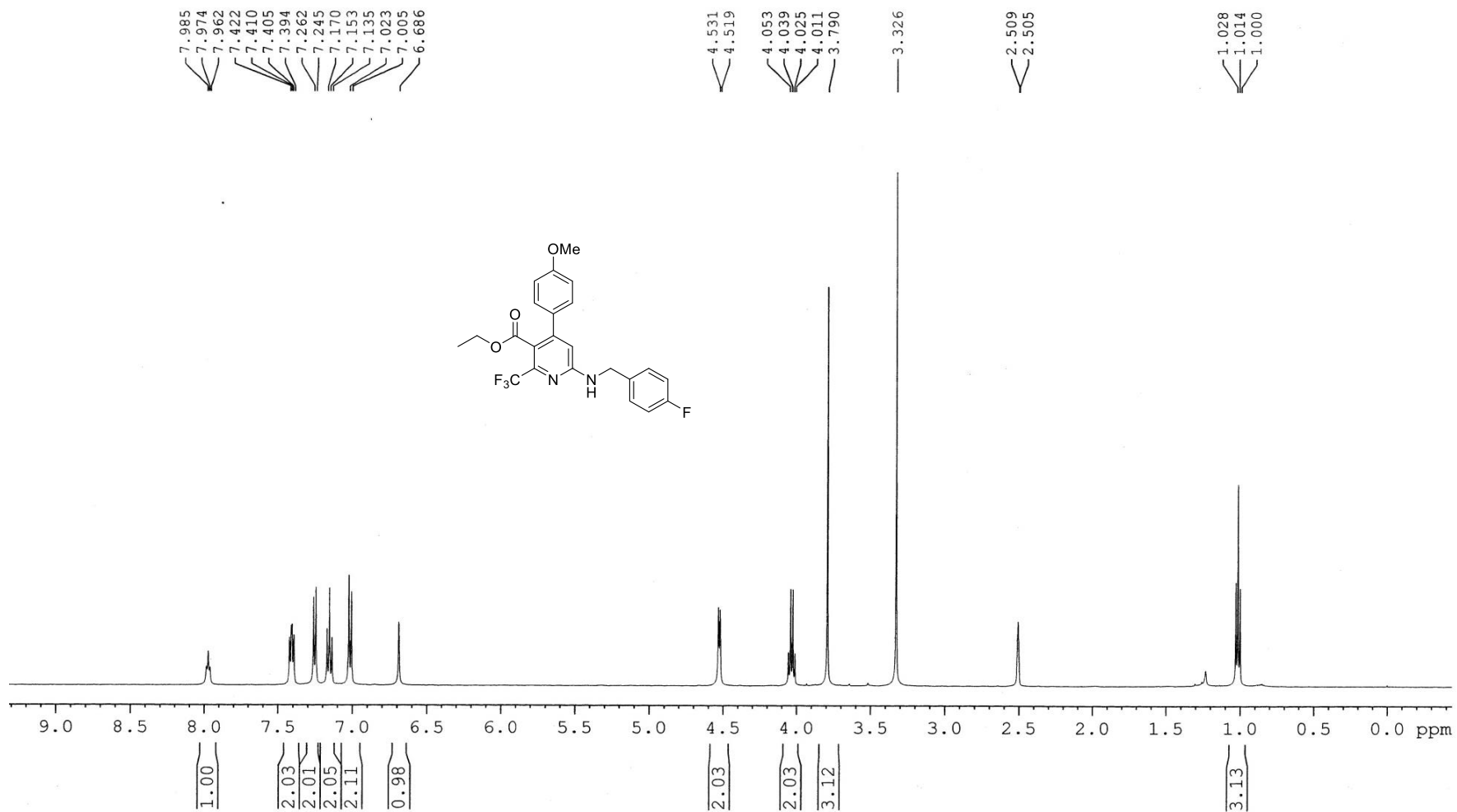


Figure S62. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5m**

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Sep30-2017-duxuanxuan
C13CPD DMSO

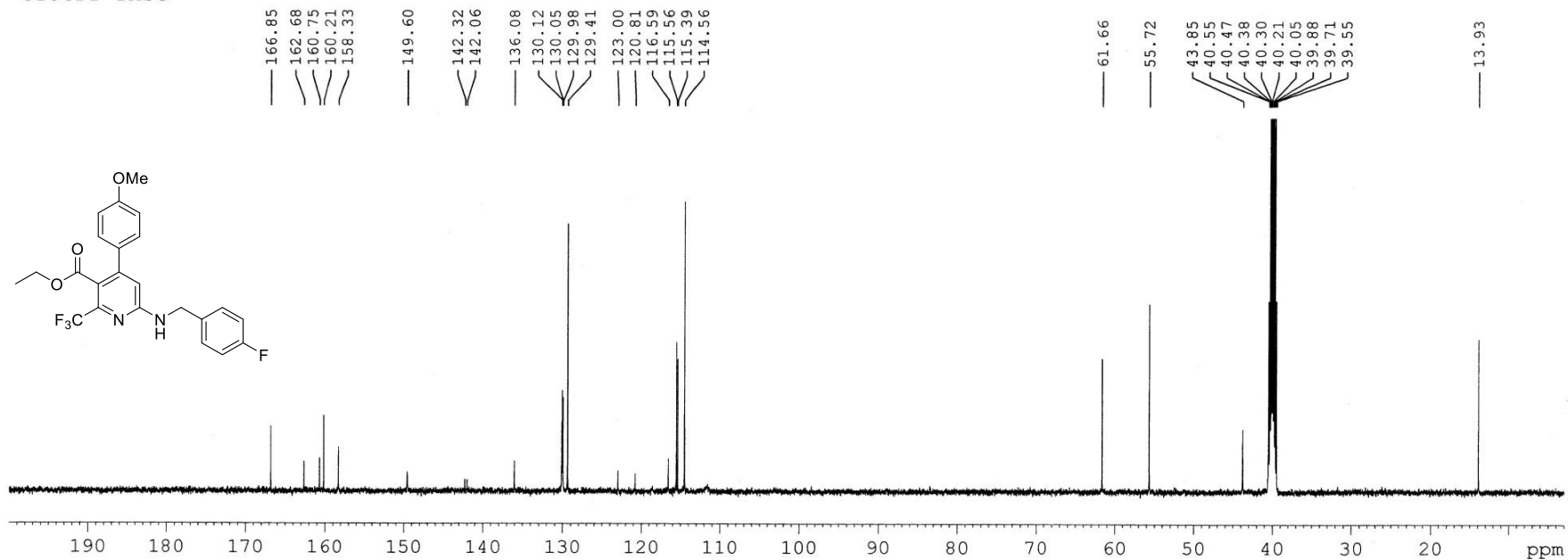


Figure S63. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound 5m

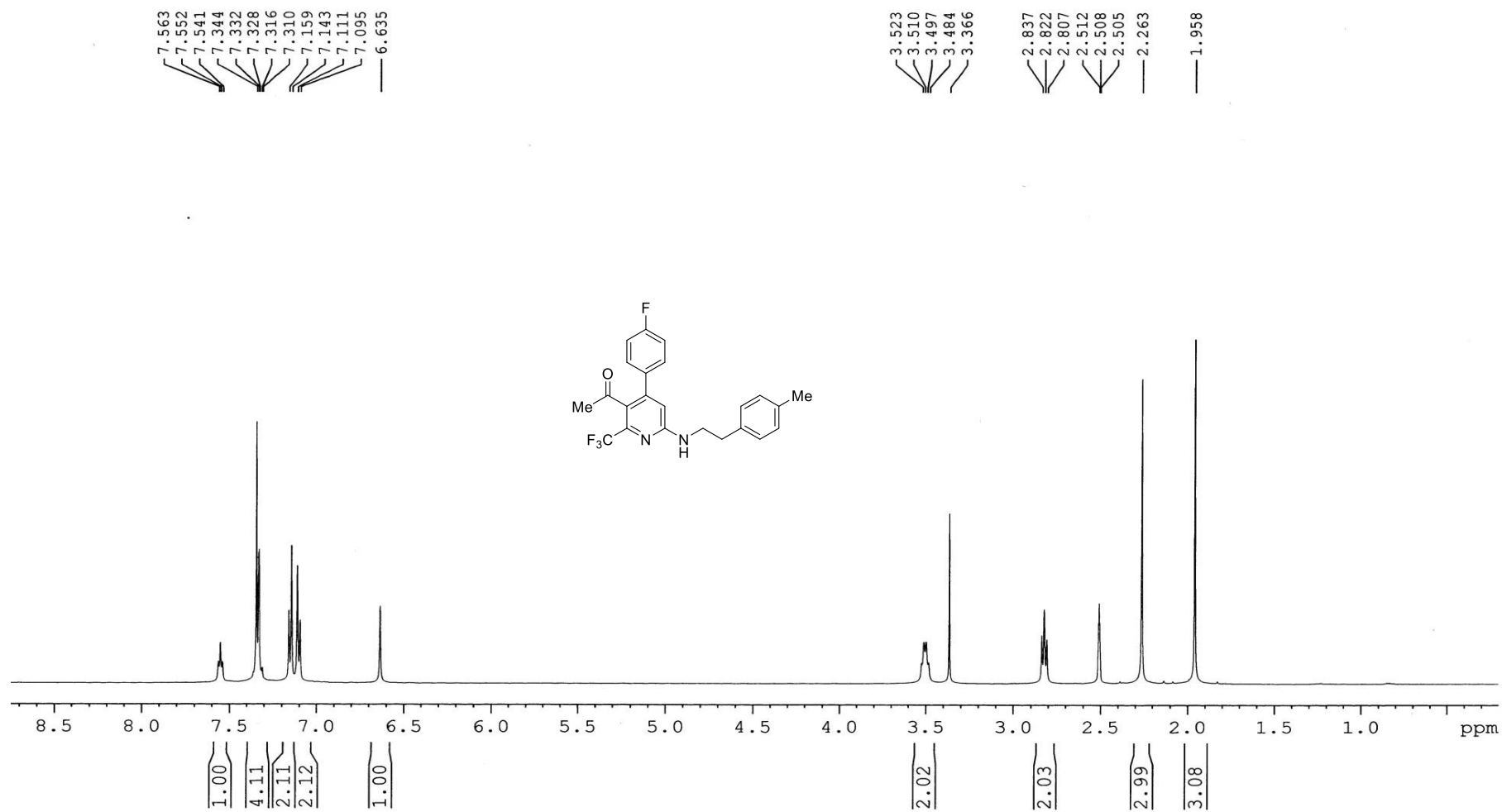


Figure S64. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5n**

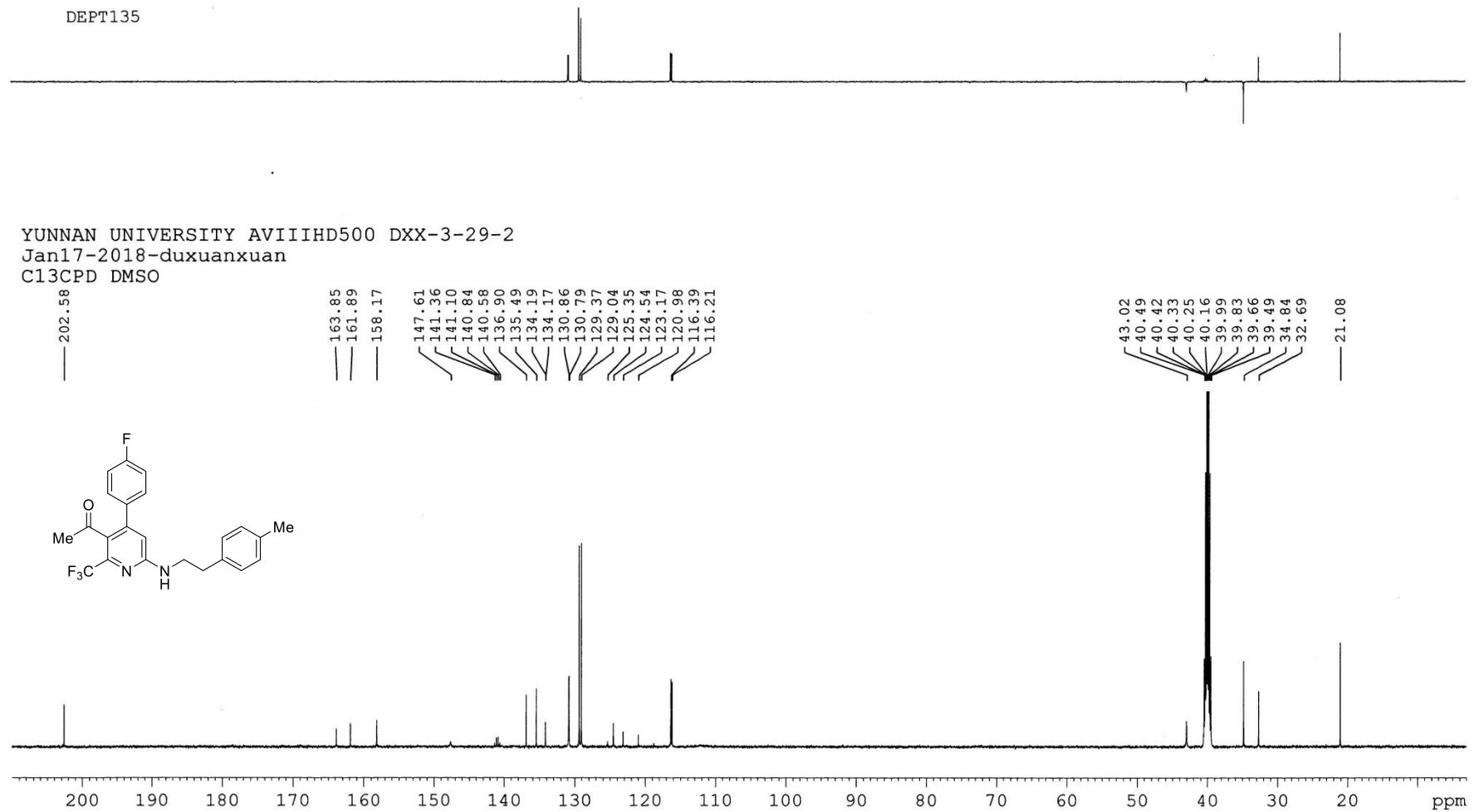


Figure S65. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound **5n**

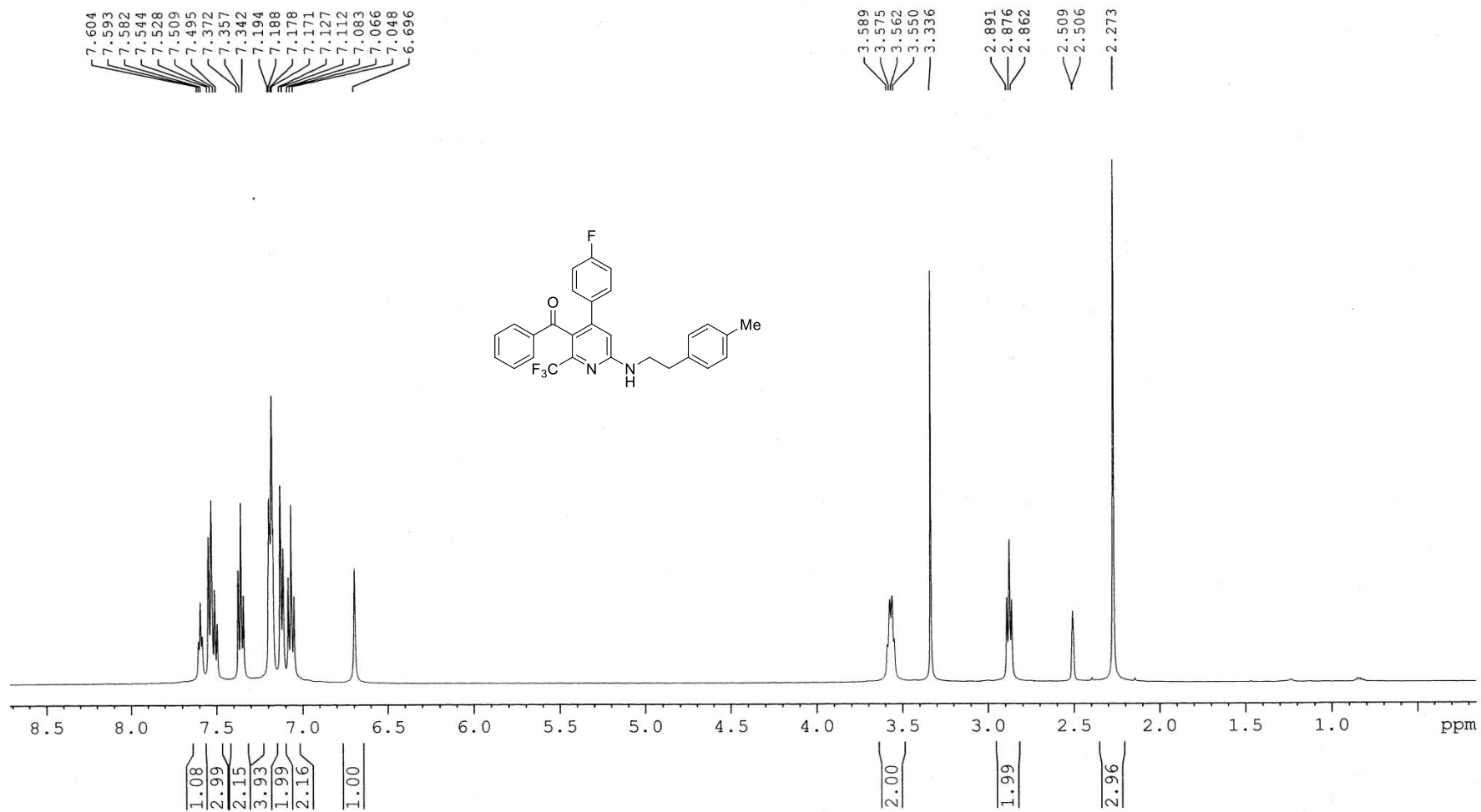


Figure S66. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5o**

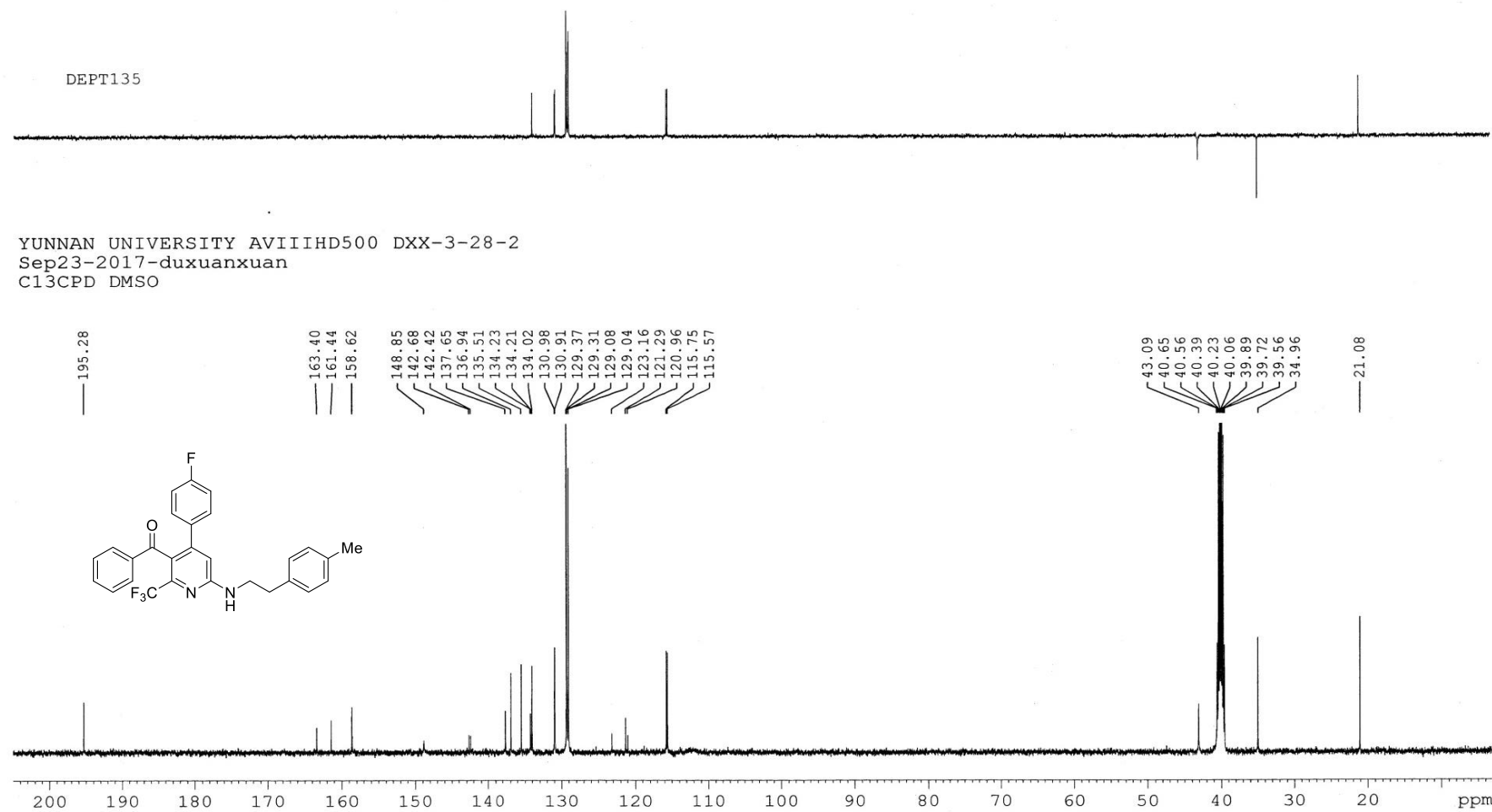


Figure S67. ^{13}C NMR (125 MHz, DMSO- d_6) spectra of compound **50**

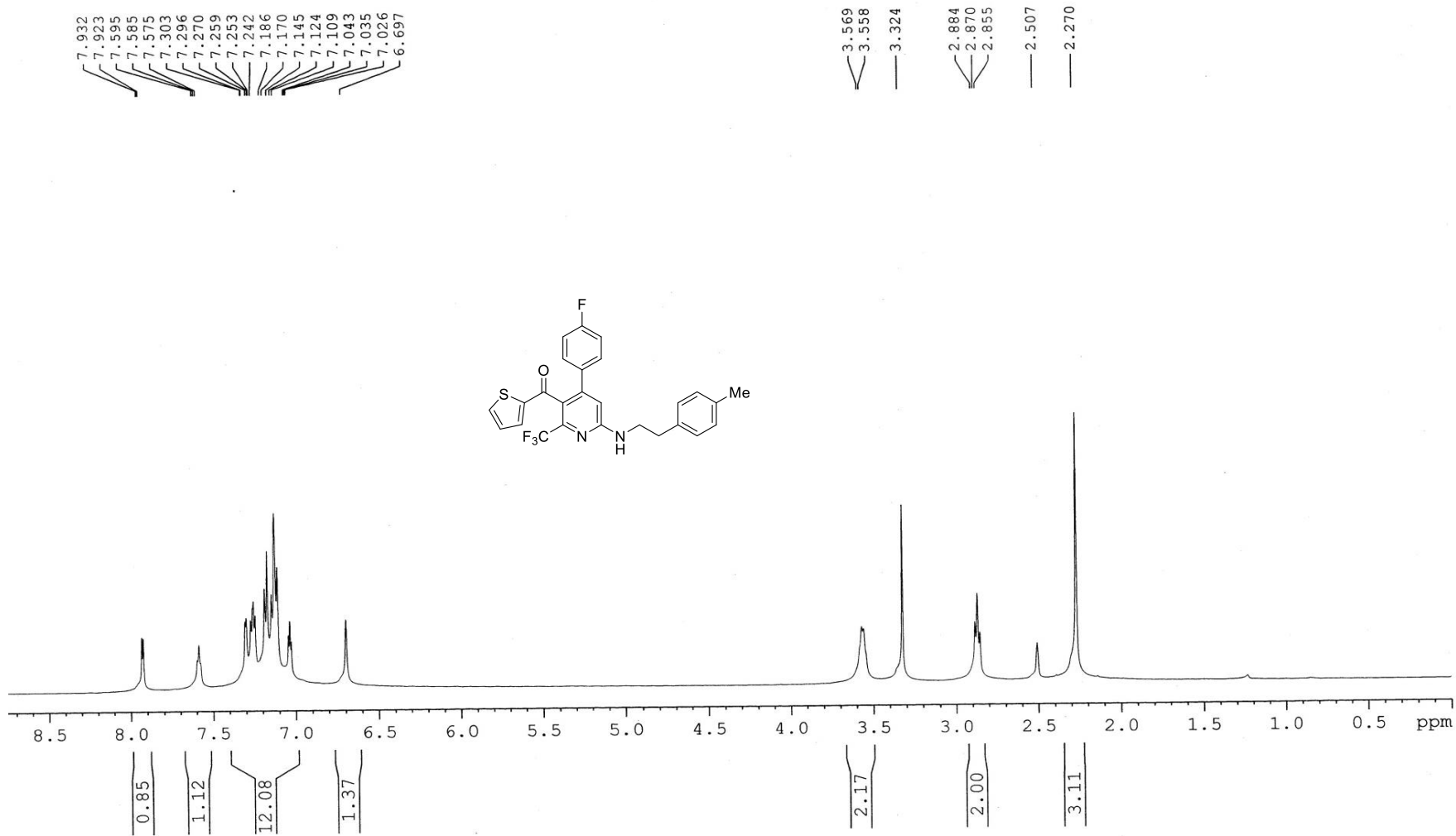


Figure S68. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound **5p**

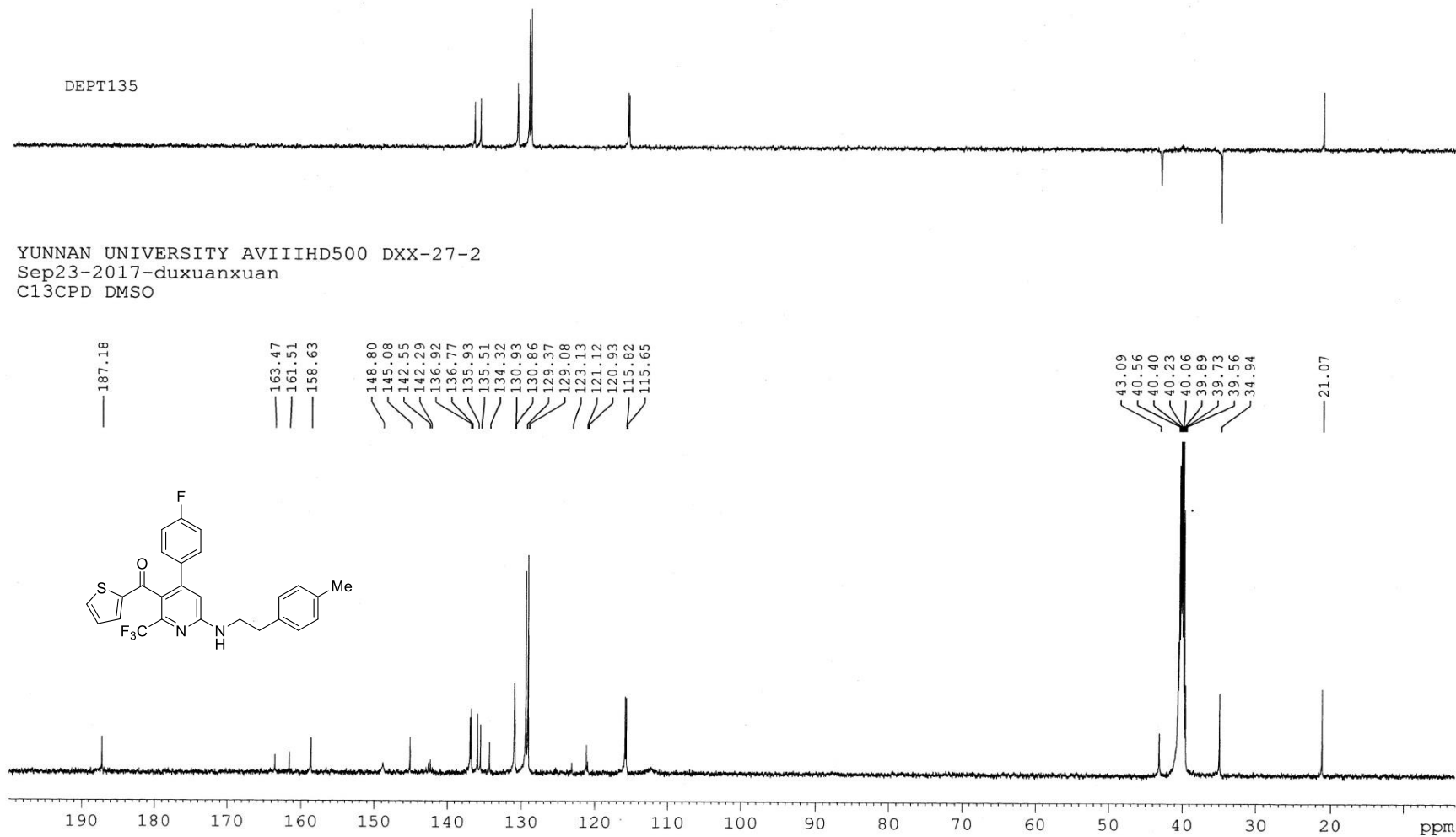


Figure S69. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **5p**

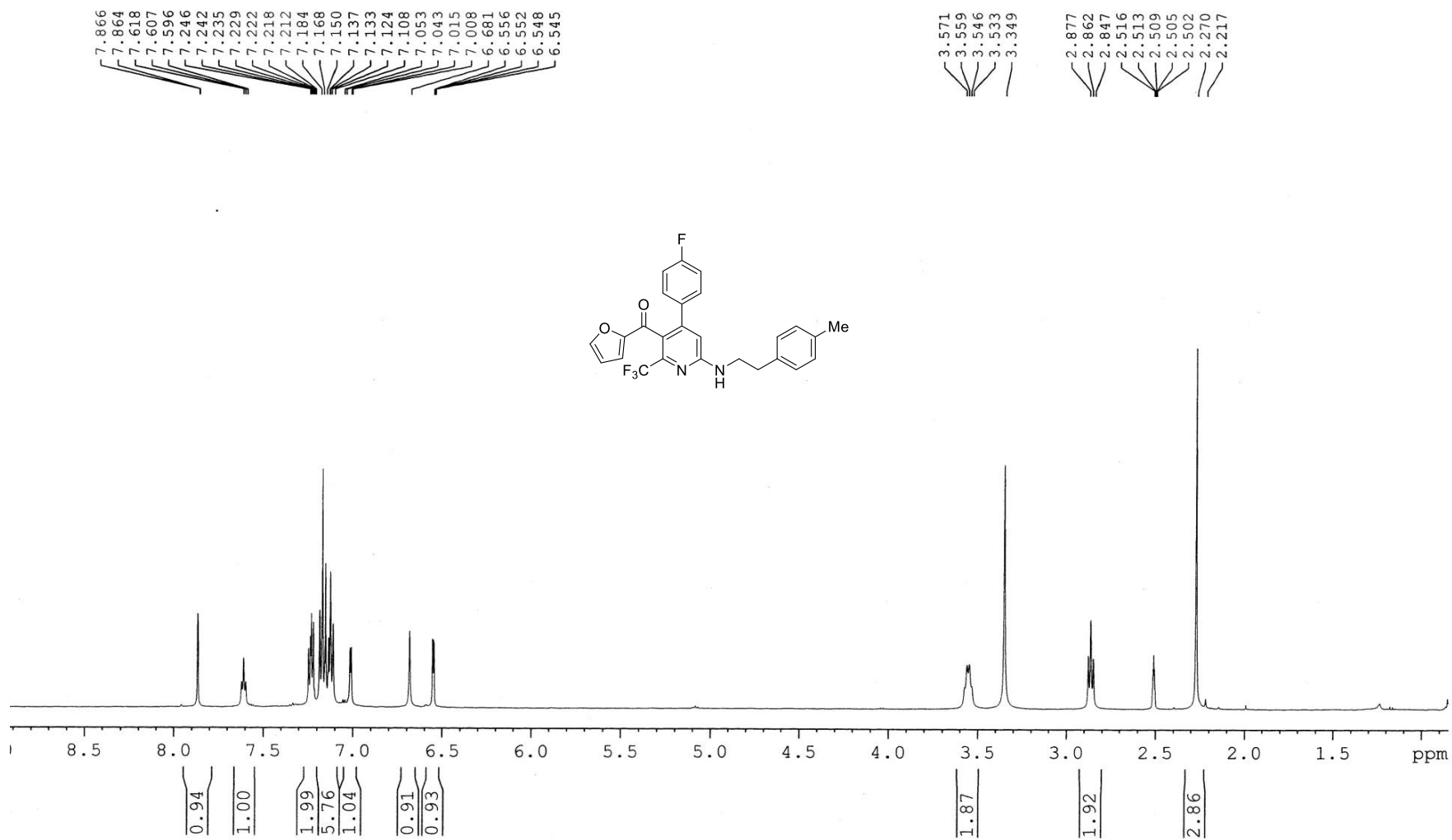


Figure S70. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5q**

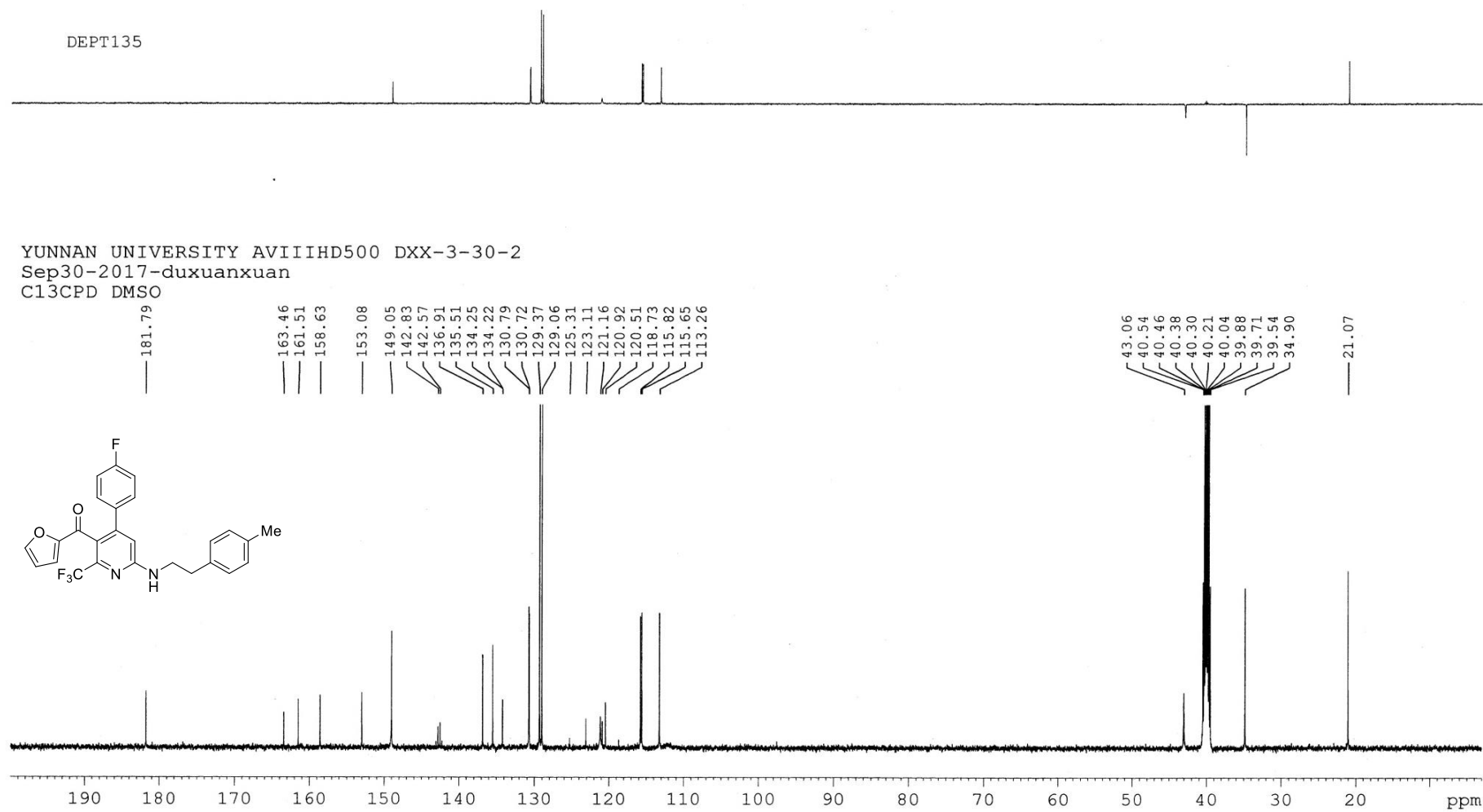


Figure S71. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **5q**

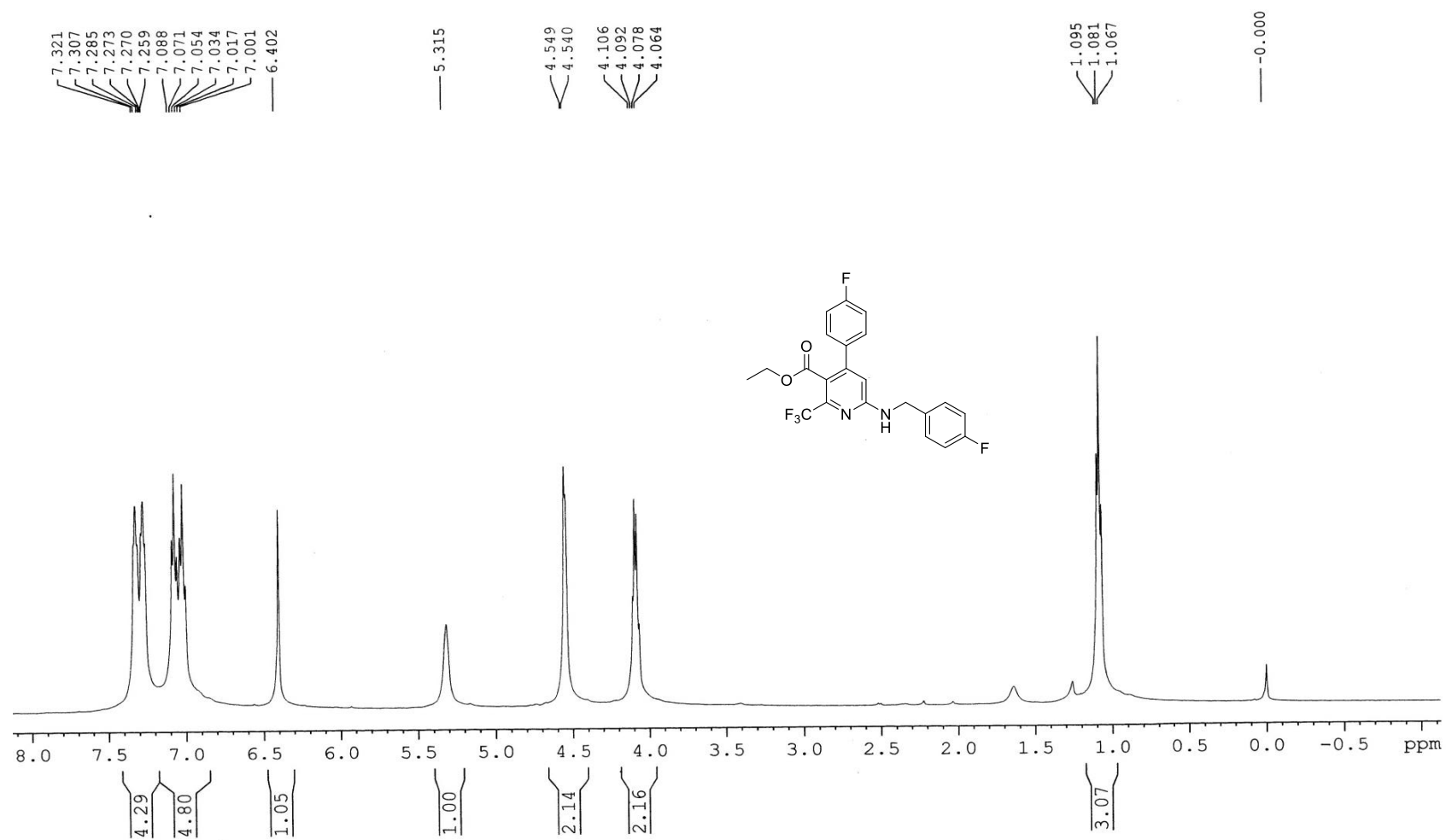
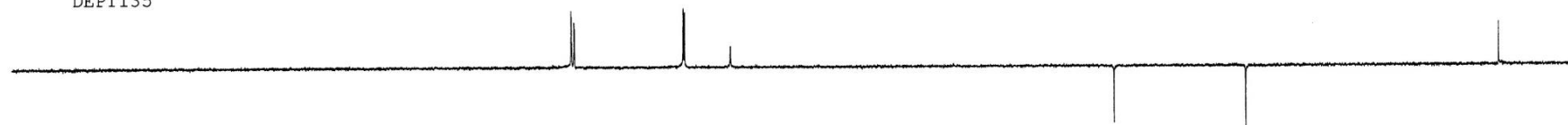


Figure S72. ^1H NMR (500 MHz, CDCl_3) spectra of compound **5r**

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Jul26-2017-duxuanxuan
C13CPD CDCl3

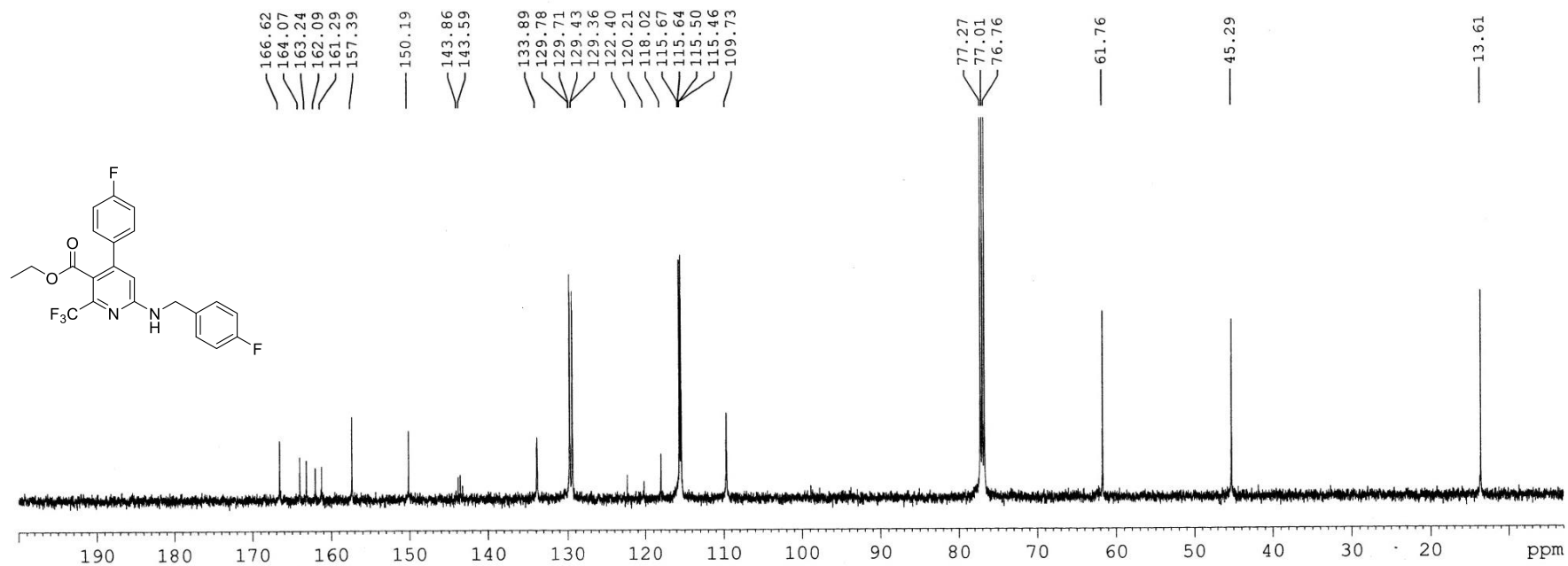


Figure S73. ^{13}C NMR (125 MHz, CDCl_3) spectra of compound 5r

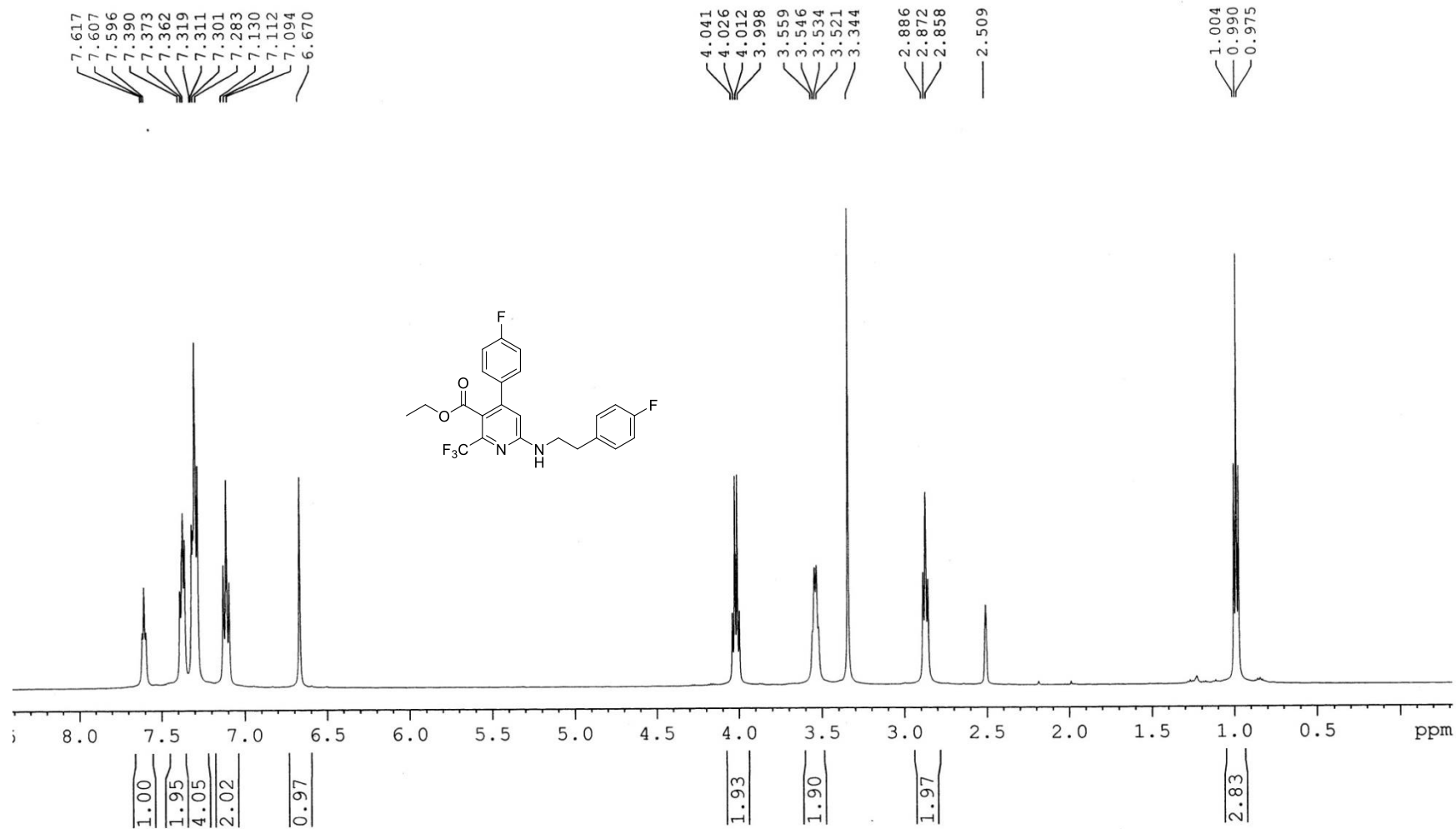


Figure S74. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound 5s

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YUNNAN UNIVERSITY AVIIIHD500 DXX-3-2-2
Jun23-2017-duxuanxuan
C13CPD DMSO

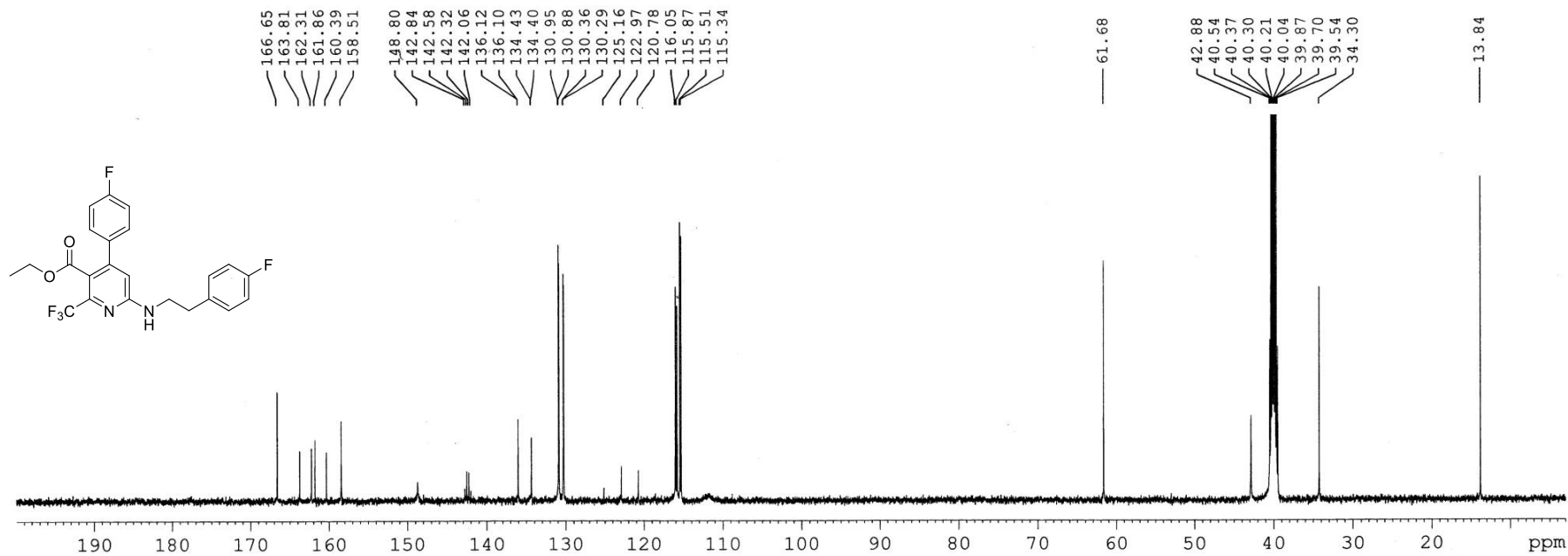


Figure S75. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 5s

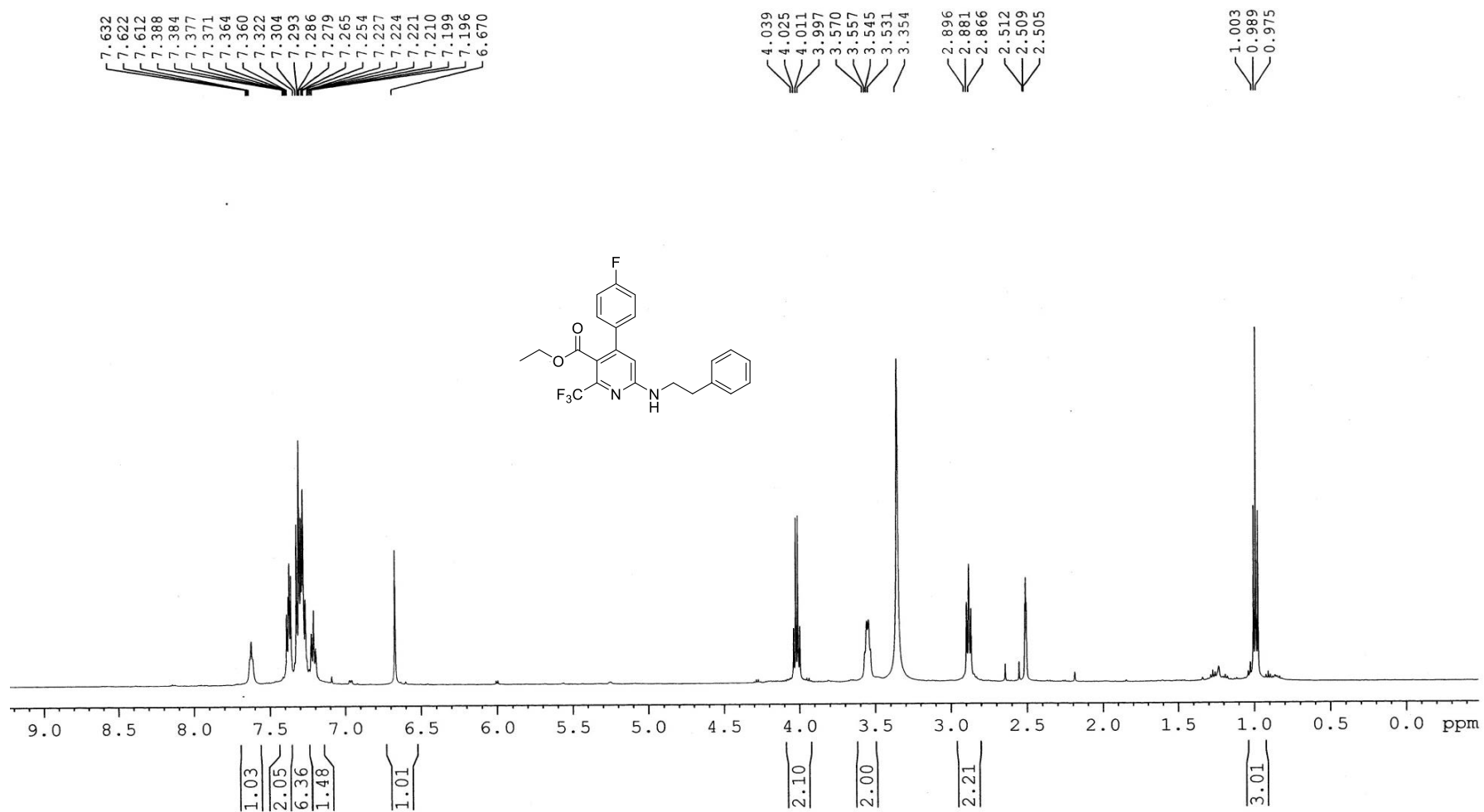


Figure S76. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5t**

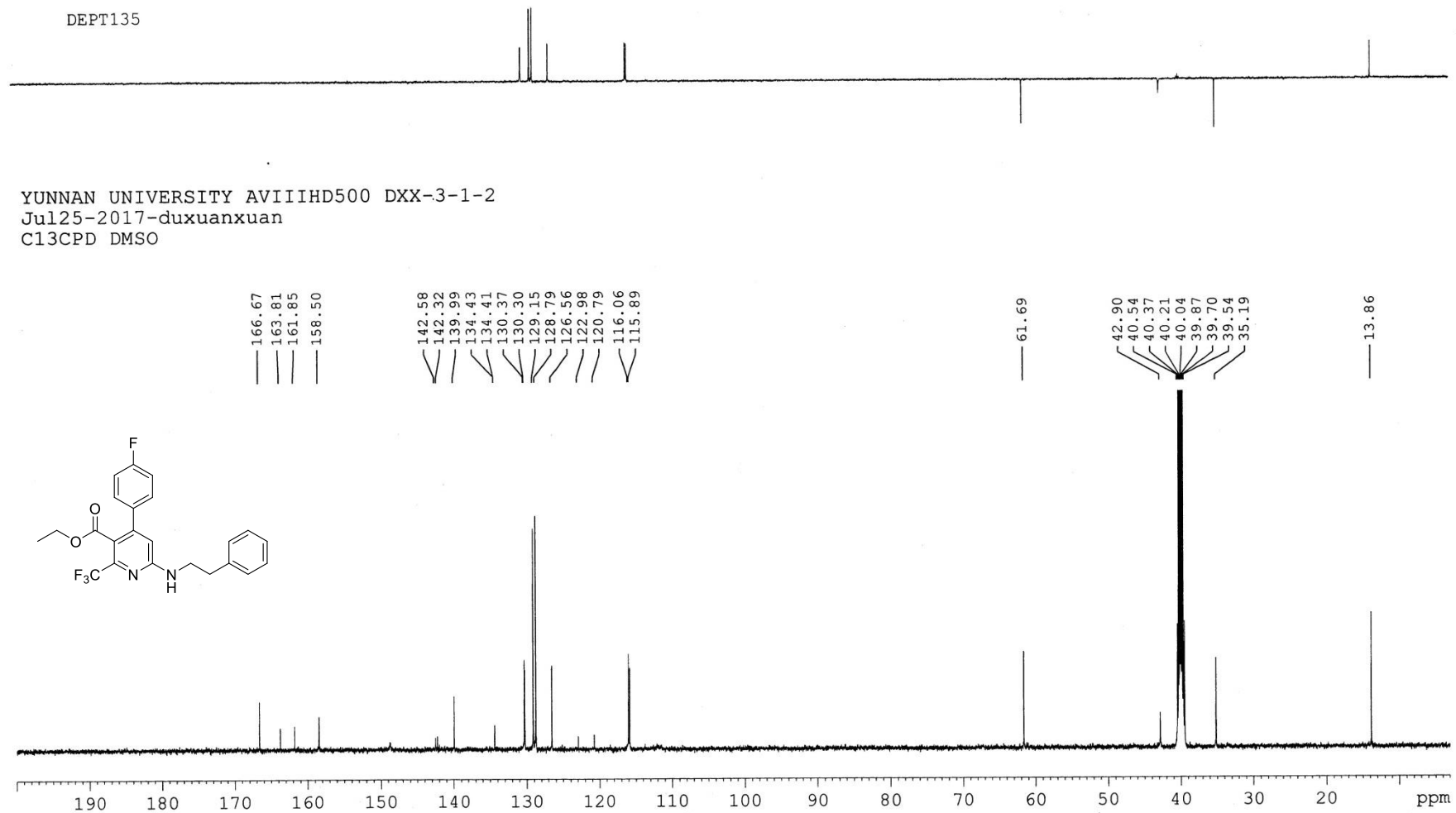


Figure S77. ¹³C NMR (125 MHz, DMSO-*d*₆) spectra of compound **5t**

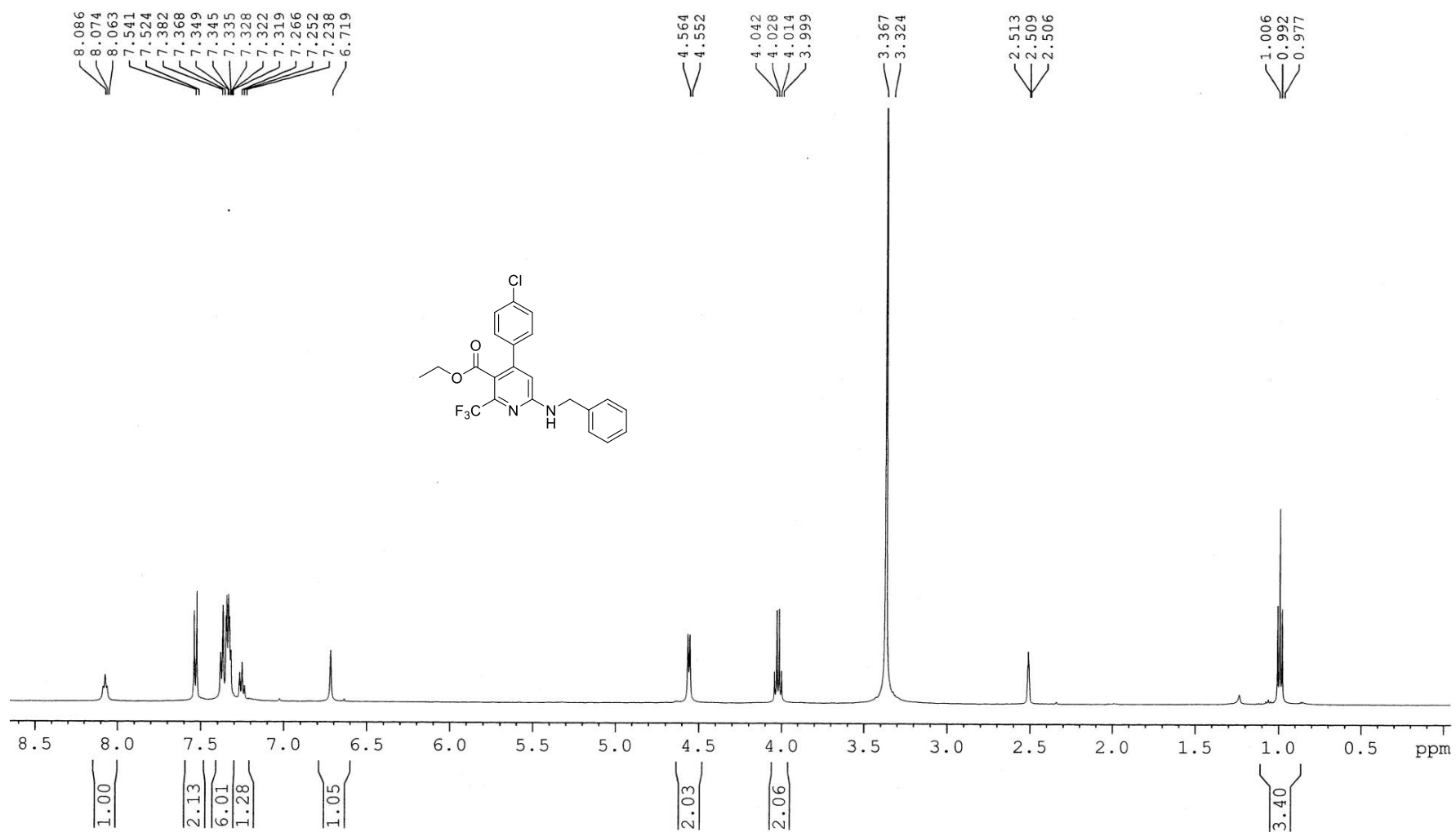


Figure S78. ¹H NMR (500 MHz, DMSO-*d*₆) spectra of compound **5u**

DEPT135



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Sep30-2017-duxuanxuan
C13CPD DMSO

166.51 158.43 148.70 142.60 142.34 139.72 136.80 134.20 129.95 128.11 128.79 128.08 127.39 122.90 120.71 116.14 61.79 44.57 40.52 40.44 40.35 40.18 40.01 39.85 39.68 39.51 13.84

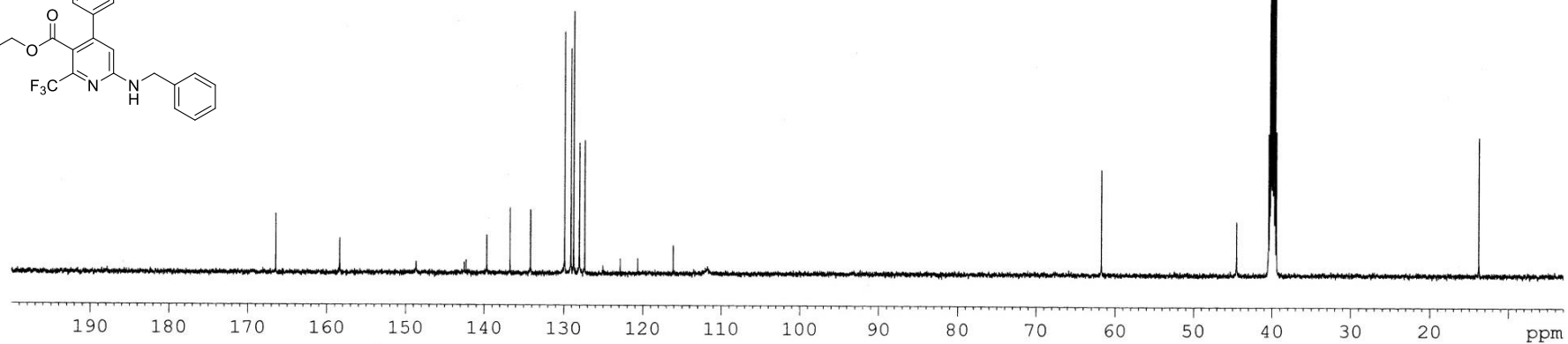
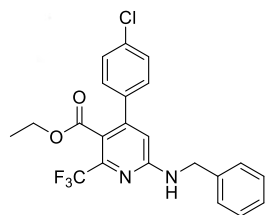


Figure S79. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound **5u**

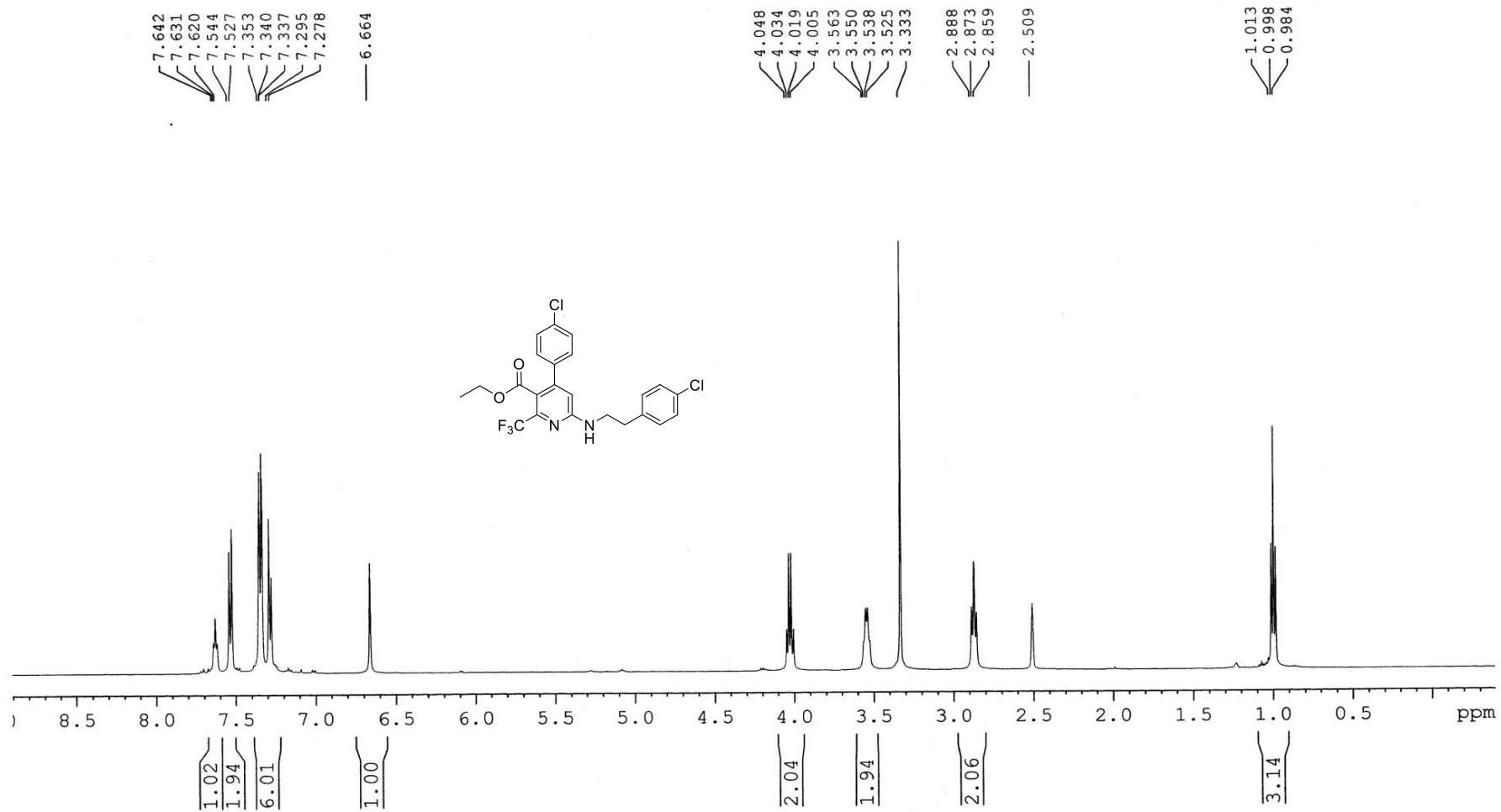


Figure S80. ^1H NMR (500 MHz, $\text{DMSO-}d_6$) spectra of compound 5v

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Jun23-2017-duxuanxuan
C13CPD DMSO

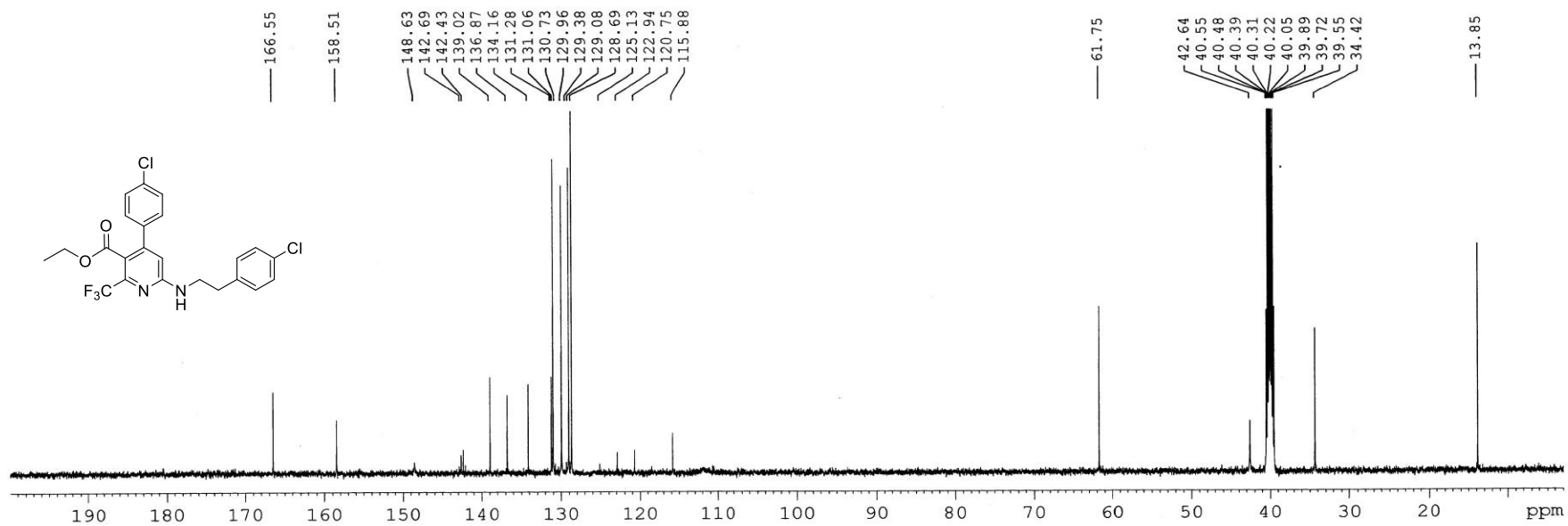


Figure S81. ^{13}C NMR (125 MHz, $\text{DMSO-}d_6$) spectra of compound 5v

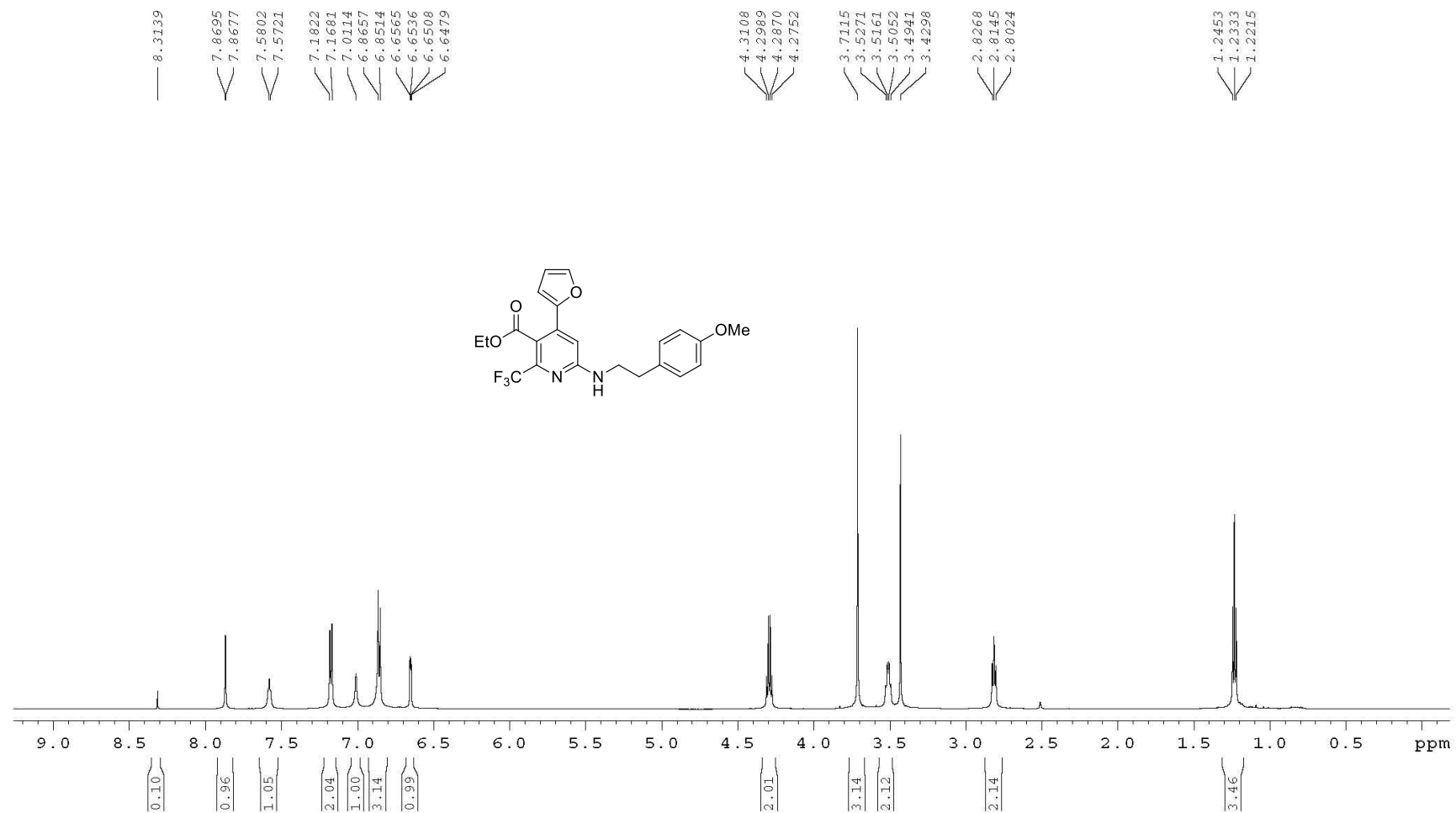
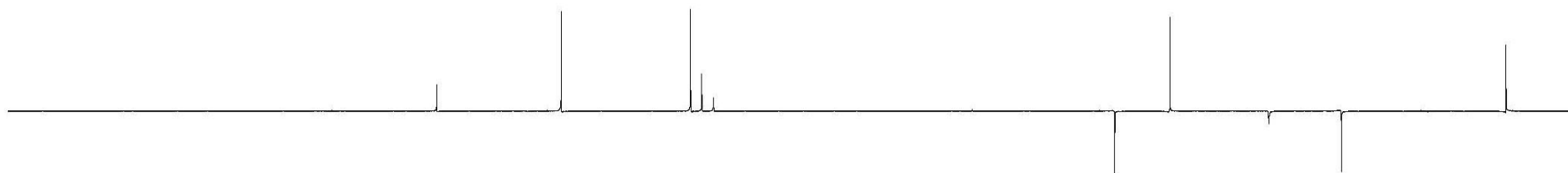


Figure S82. ¹H NMR (600 MHz, DMSO-*d*₆) spectra of compound **5w**

DEPT135



YUNNAN UNIVERSITY ASCEND AVIIIHD600 YSJ-2
Jan15-2019-ziquanxing
C13CPD DMSO

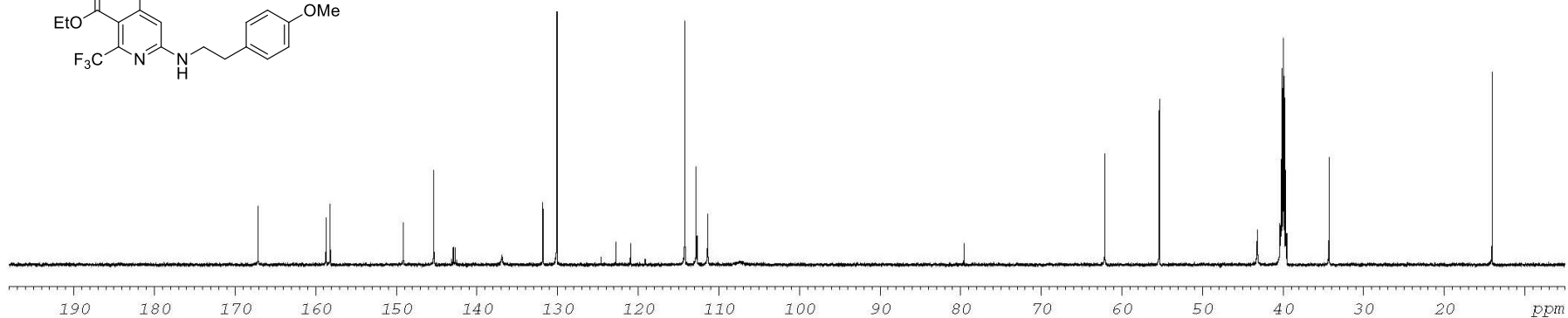
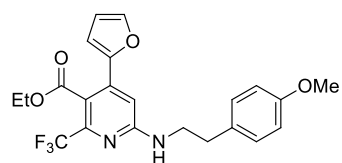


Figure S83. ^{13}C NMR (150 MHz, $\text{DMSO-}d_6$) spectra of compound **5w**

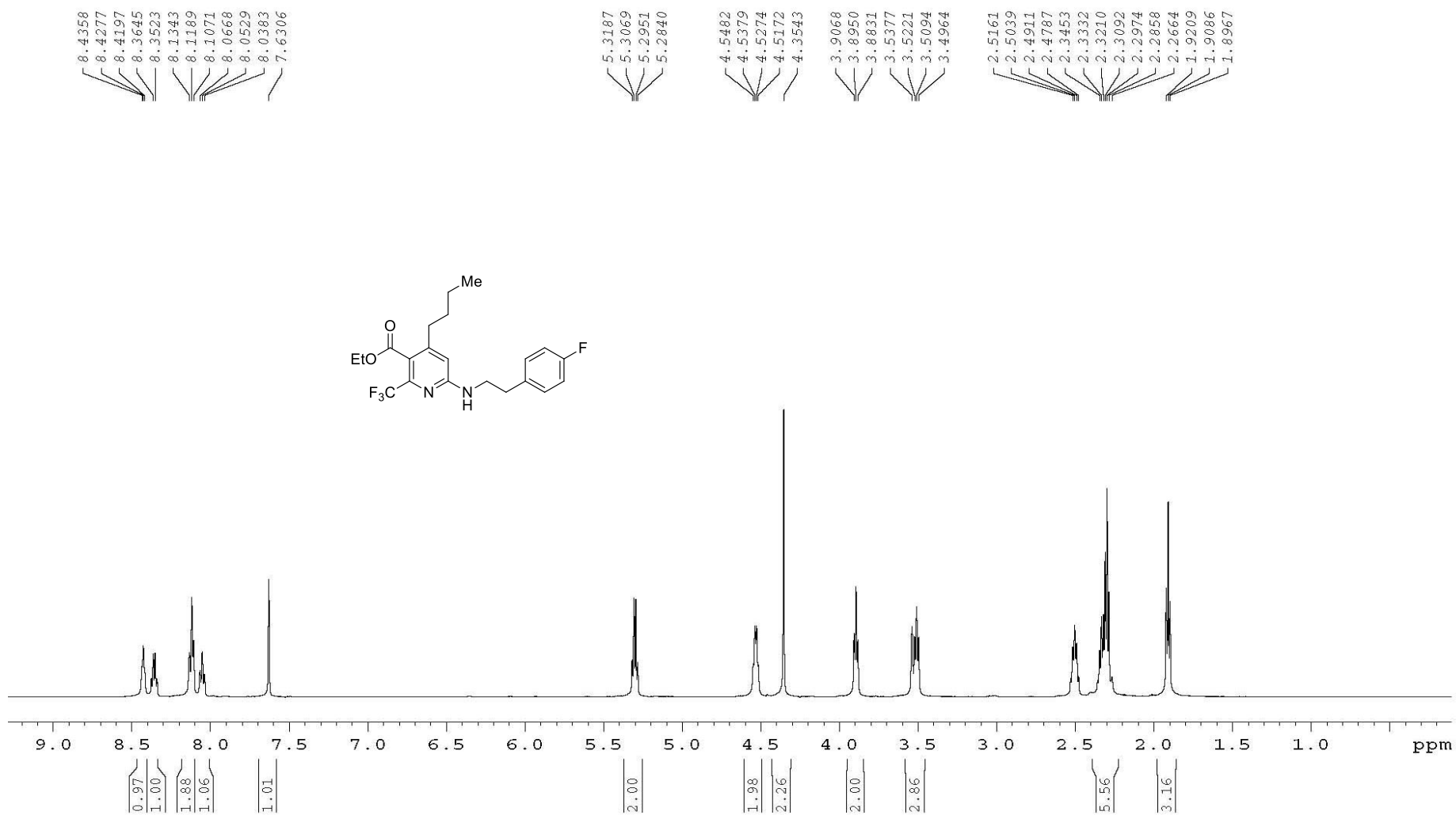


Figure S84. ¹H NMR (600 MHz, DMSO-*d*₆) spectra of compound 5x

DEPT135

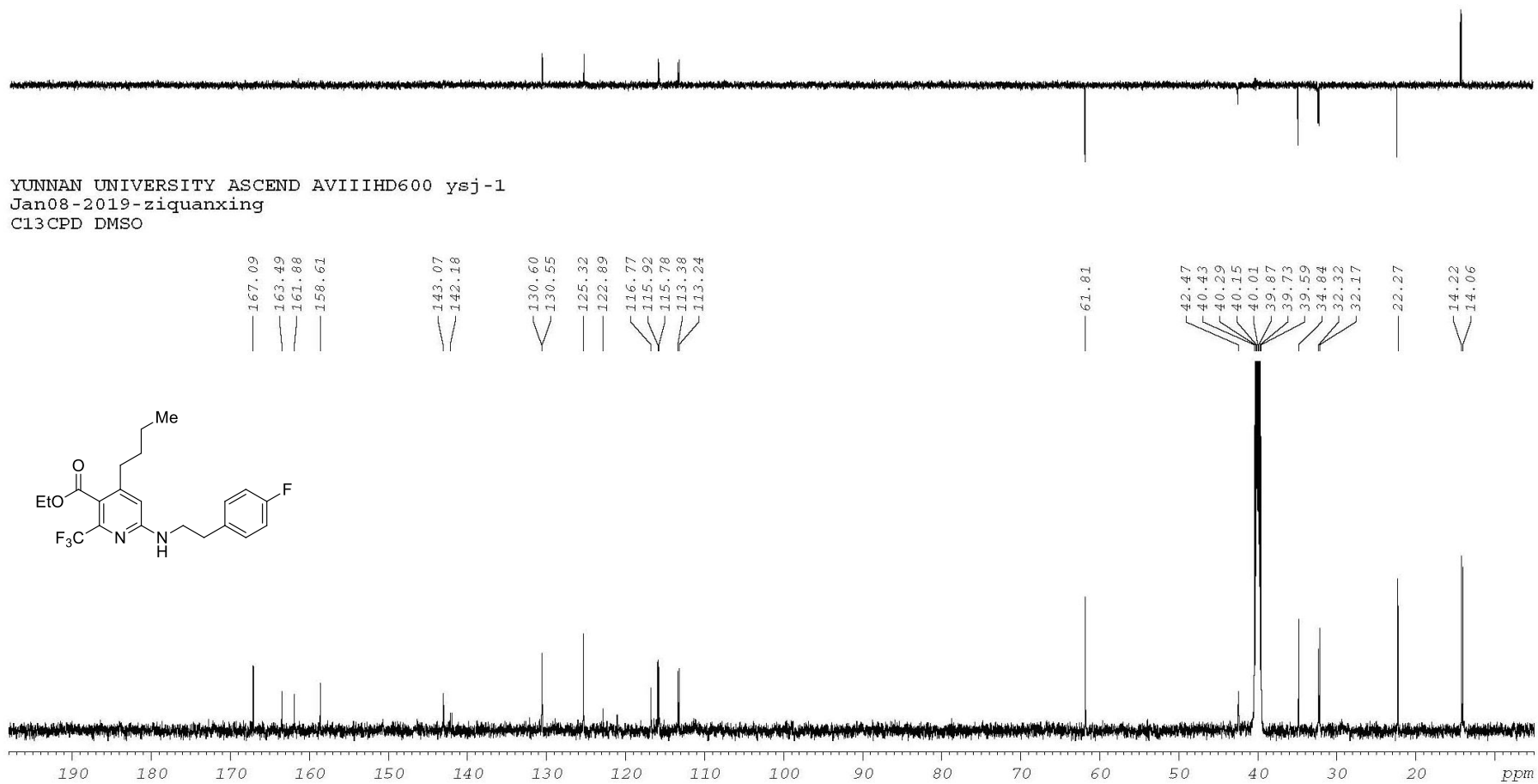


Figure S85. ^{13}C NMR (150 MHz, $\text{DMSO-}d_6$) spectra of compound 5x

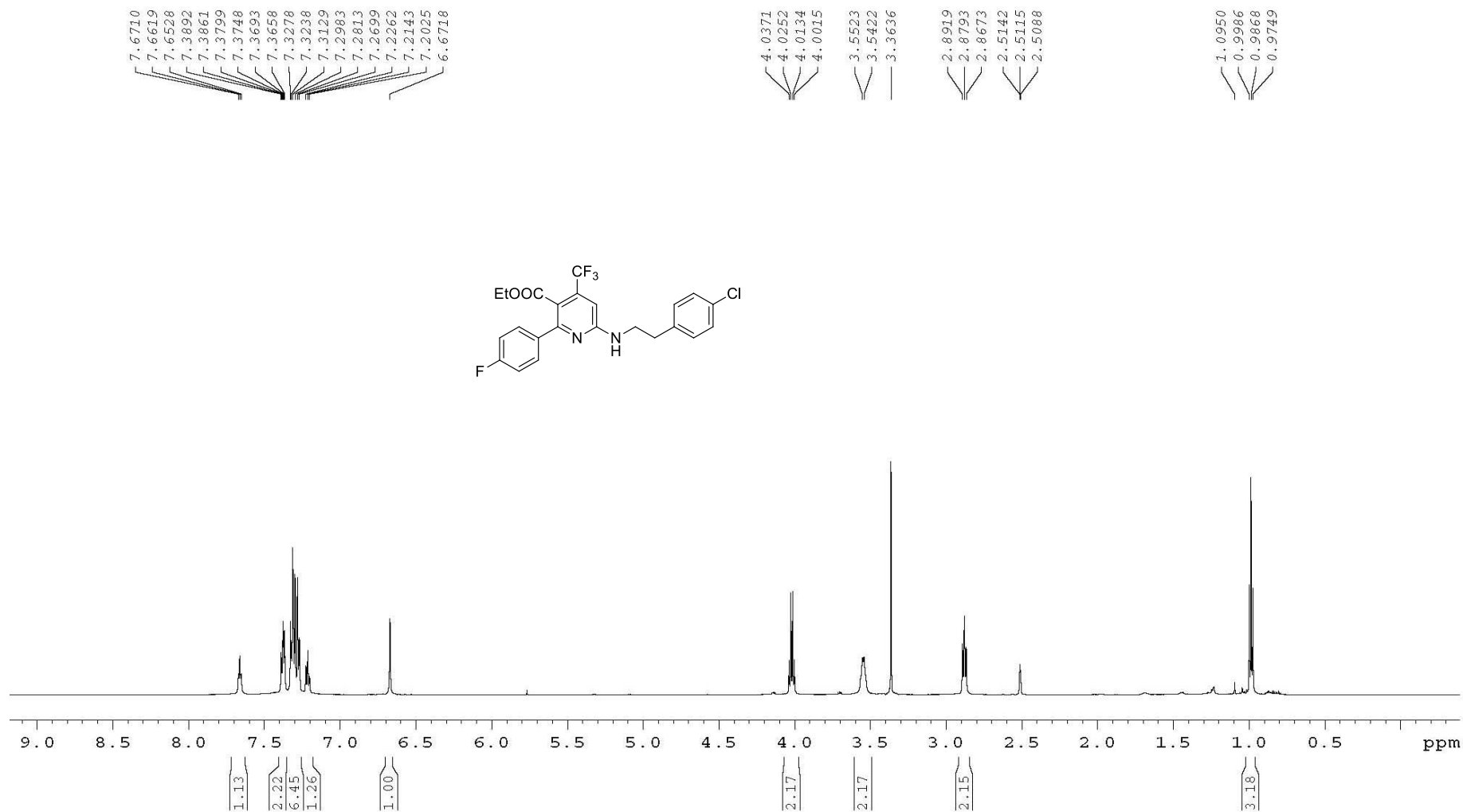
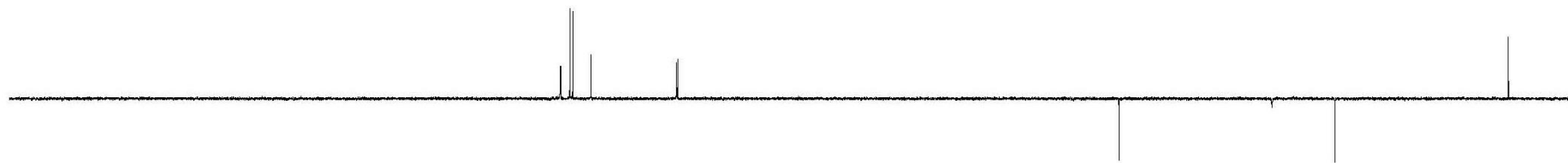


Figure S86. ^1H NMR (600 MHz, $\text{DMSO-}d_6$) spectra of compound **5f'**

DEPT135



YUNNAN UNIVERSITY ASCEND AVIIIHD600 YSJ-12
C13CPD DMSO

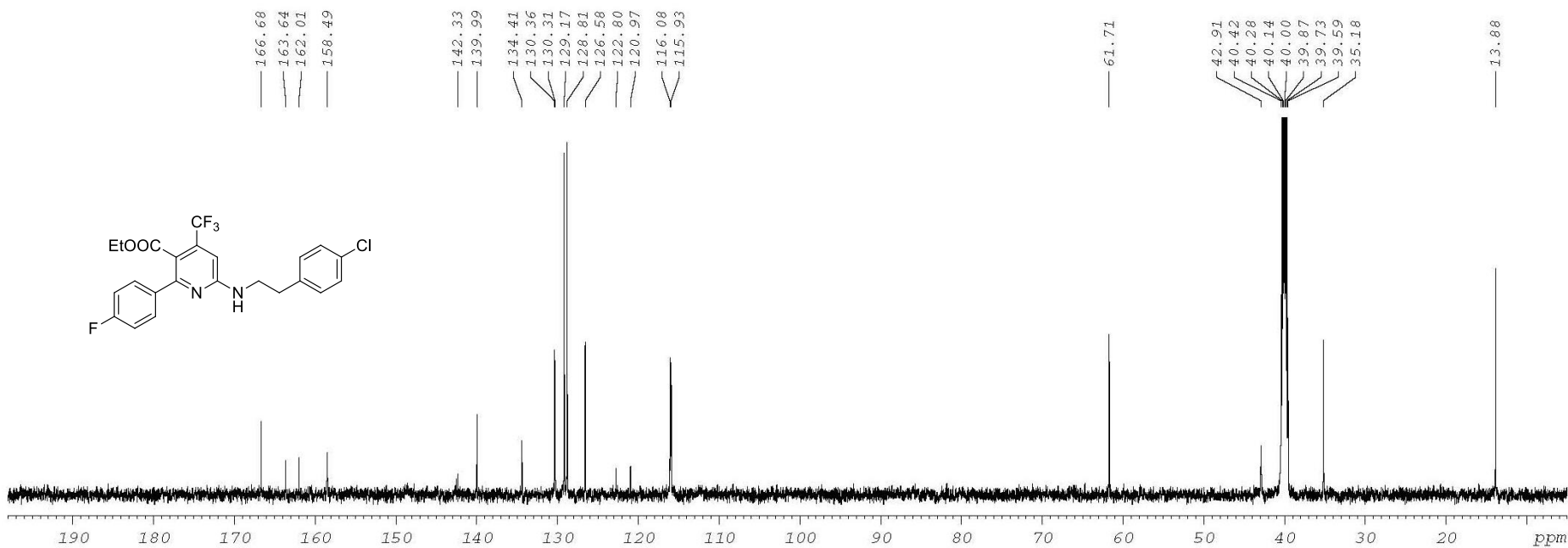
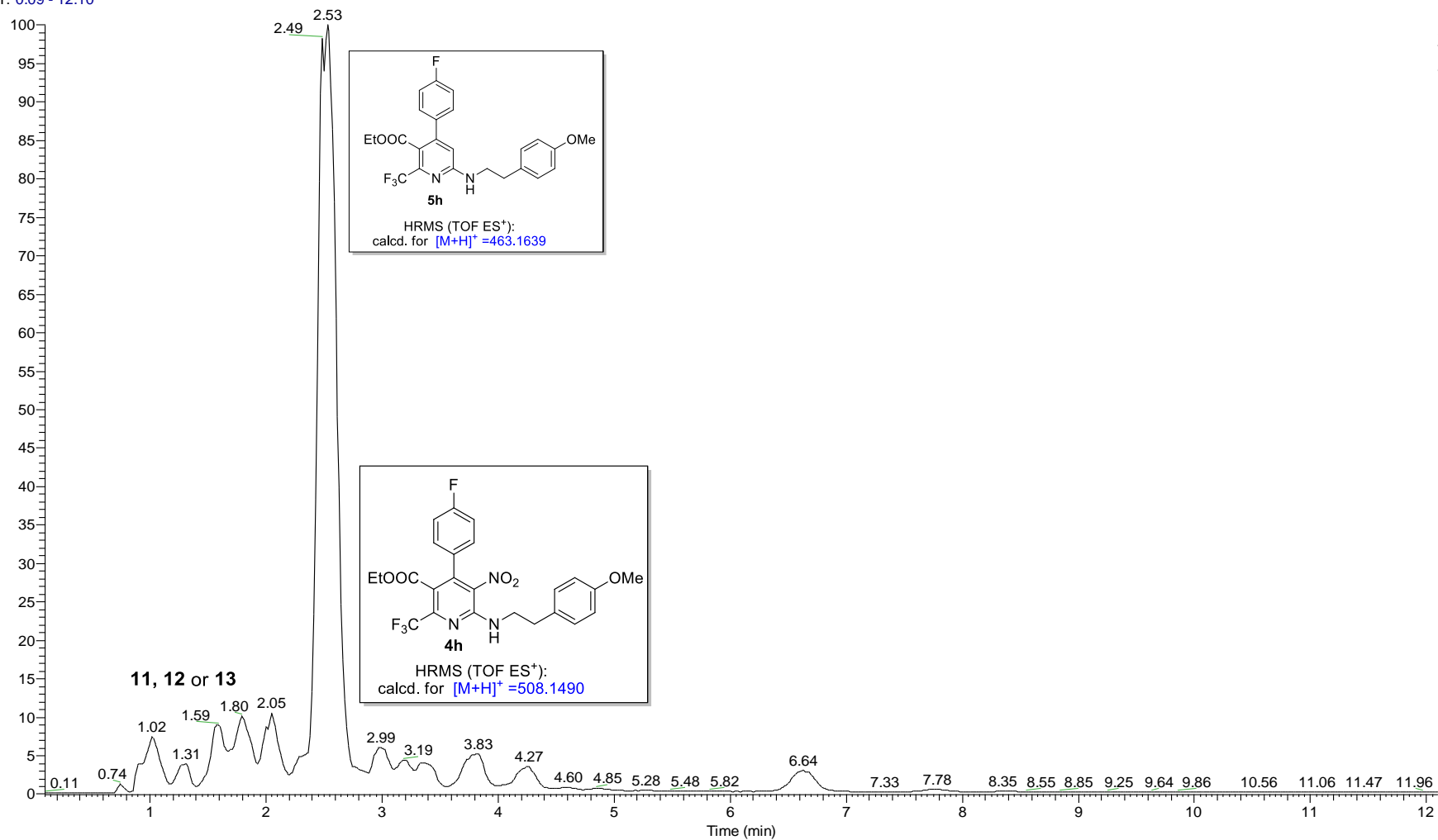


Figure S87. ¹³C NMR (150MHz, DMSO-*d*₆) spectra of compound 5f'

RT: 0.09 - 12.10



NL:
3.29E8
TIC MS
ZIQUANXIA
N-1

Figure S88. HPLC of the reaction mixture

ZIQUANXIAN-1 #66 RT: 1.33 AV: 1 NL: 2.55E6
T: FTMS + c ESI Full ms [400.00-700.00]

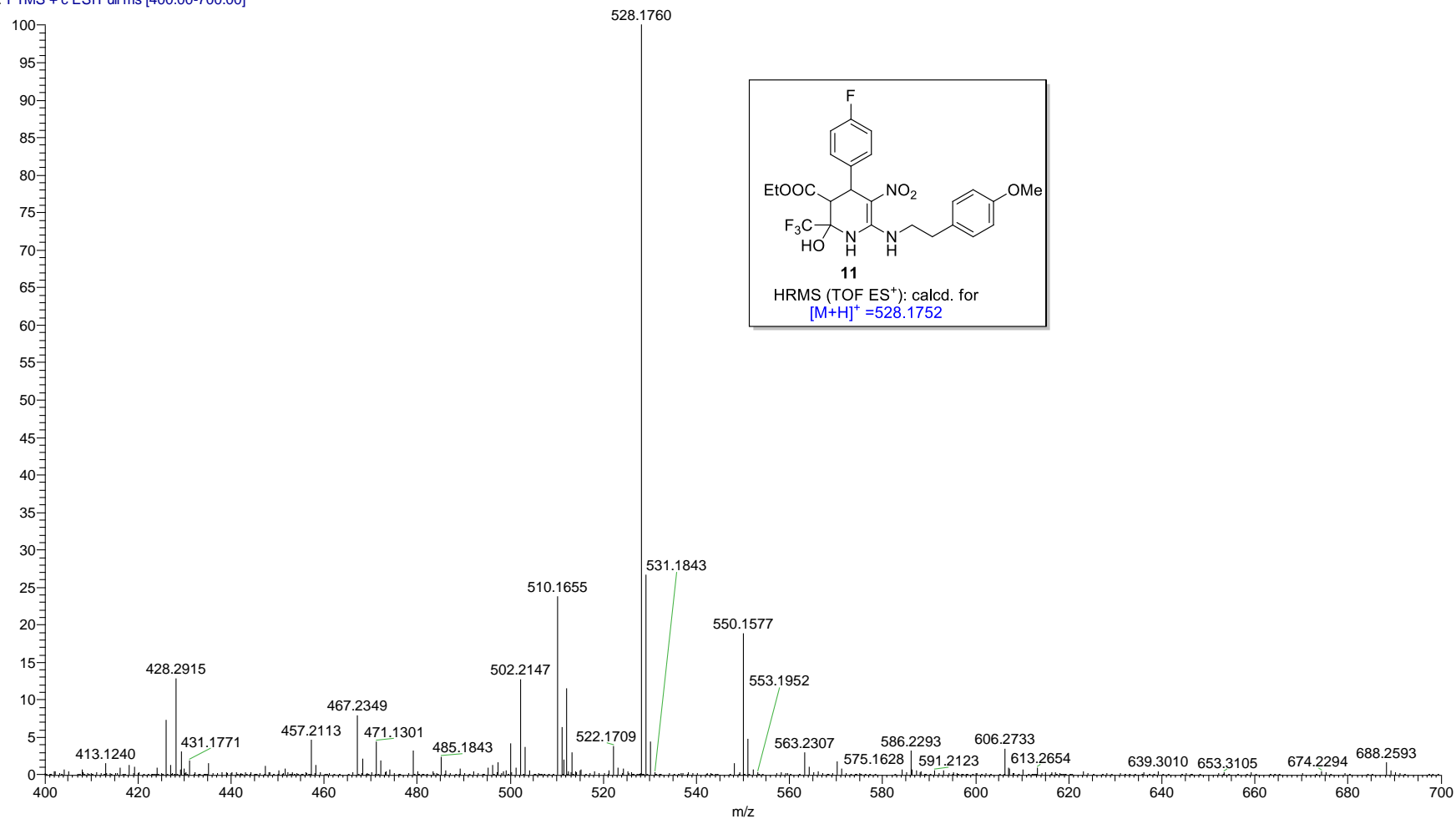


Figure S89. HRMS of intermediate 11

ZIQUANXIAN-1 #68 RT: 1.37 AV: 1 NL: 1.13E5
T: FTMS + c ESI Full ms [400.00-700.00]

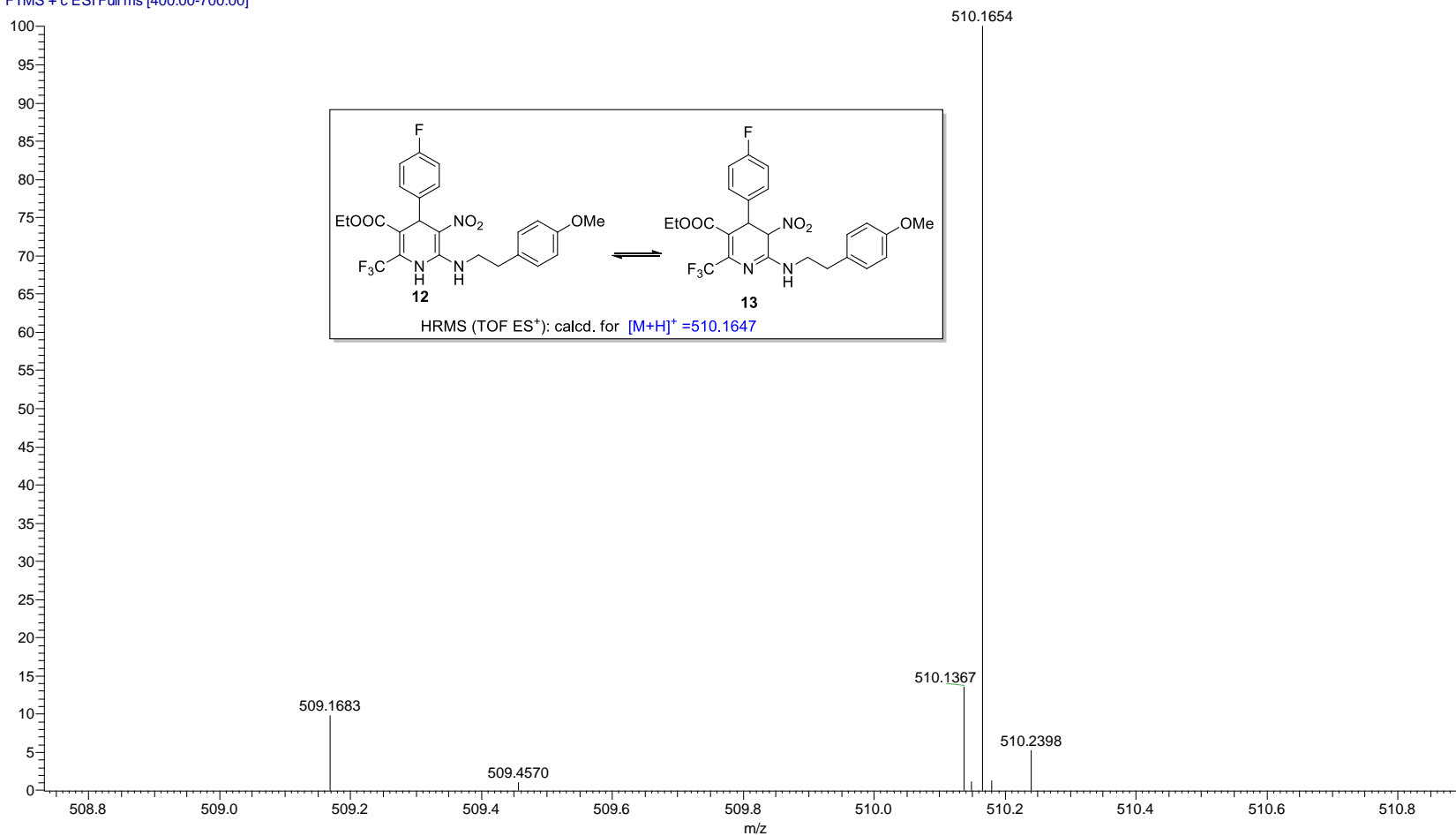


Figure S90. HRMS of intermediate 12/13

ZIQUANXIAN-1 #163 RT: 3.03 AV: 1 NL: 9.42E6
T: FTMS + c ESI Full ms [400.00-700.00]

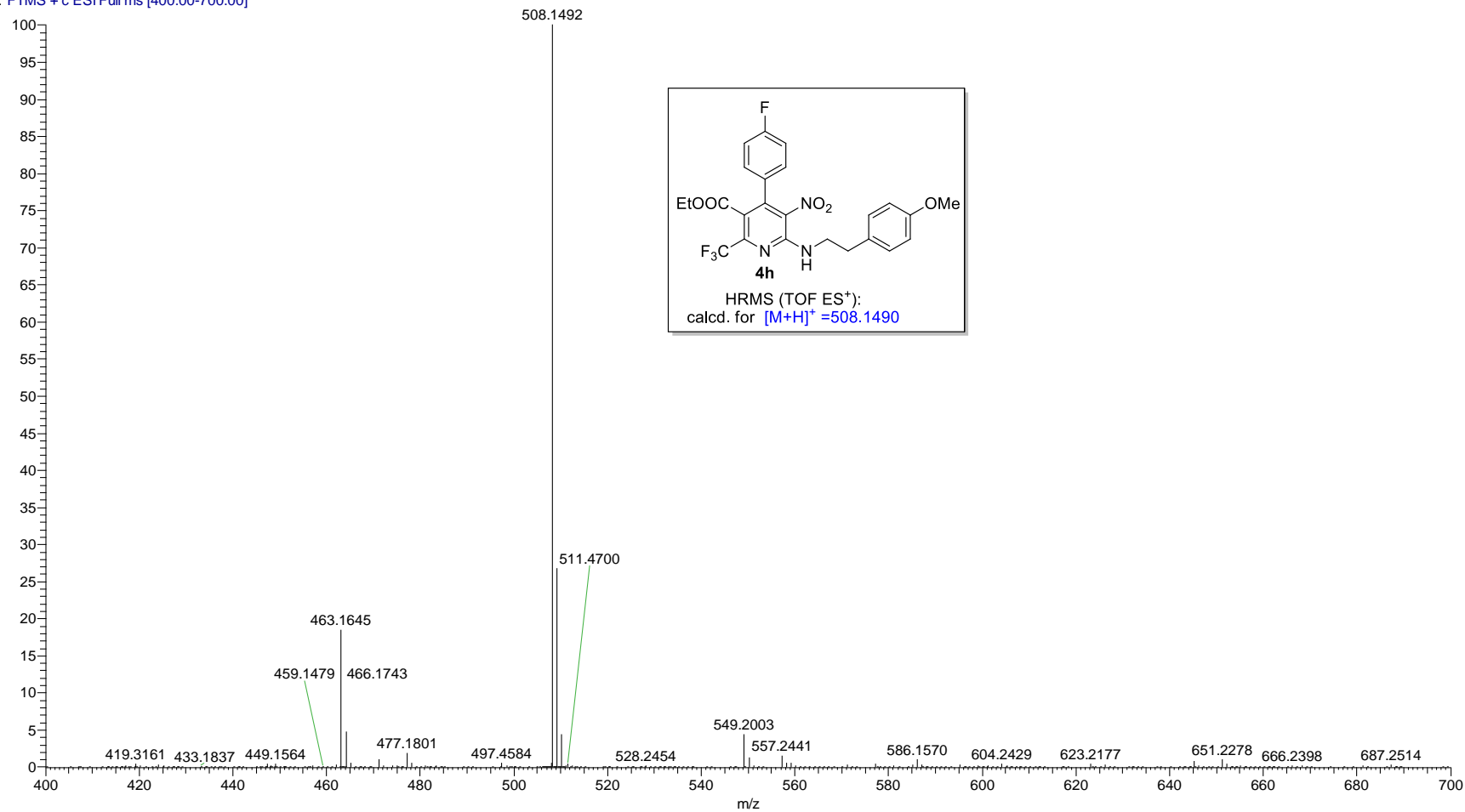


Figure S91. HRMS of compound 4h

ZIQUANXIAN-1 #133 RT: 2.50 AV: 1 NL: 2.07E8
T: FTMS + c ESI Full ms [400.00-700.00]

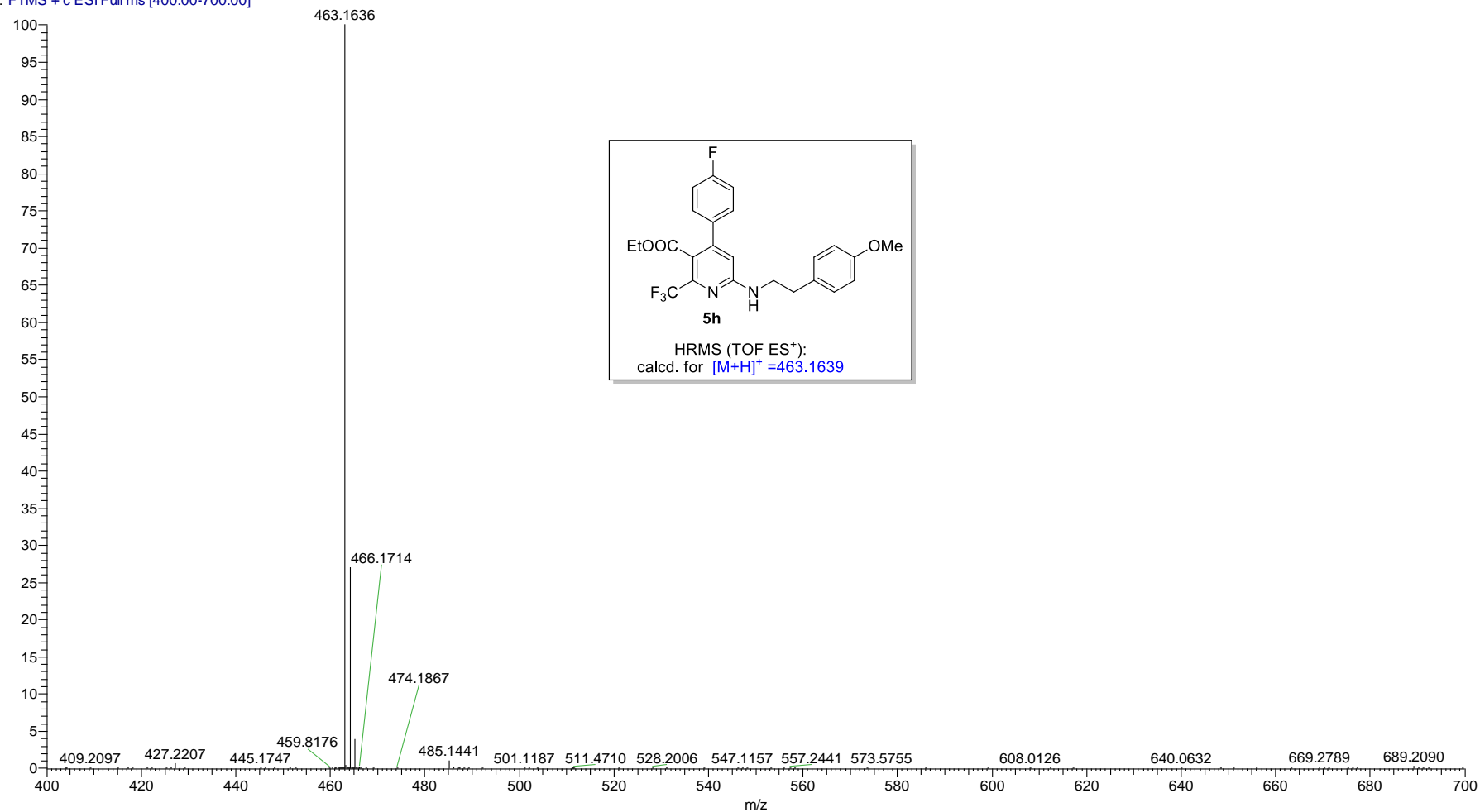


Figure S92. HRMS of compound **5h**