

Synthesis and biological evaluation of highly functionalized dispiro heterocycles

Anshu Dandia* Anuj K. Jain, Ashok K. Laxkar

Center for Advance Studies, Department of Chemistry

University of Rajasthan, Jaipur-302004, India

Email: dranshudandia@yahoo.co.in, jain_anuj04@yahoo.com

Tel.: +91 9414073436; fax: +91 141 2609549

Table of contents

General Experimental Methods.....	2
Experimental procedure for synthesis of compounds 4(a-k).....	2
Characterization data of compounds 4(a-k).....	3-9
¹ H and ¹³ C NMR spectra of the compounds	10-28
Single crystal X-ray of compound (4a).....	29

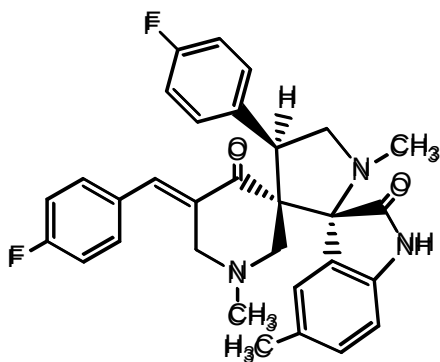
Experimental

The melting points of all compounds were determined on a Toshniwal apparatus. The purity of compounds was checked on thin layers of silica Gel-G coated glass plates and n-hexane: ethyl acetate (8:2) as eluent. IR spectra were recorded on a Shimadzu FT IR-8400S spectrophotometer using KBr pellets. ^1H , and ^{13}C spectra were recorded in DMSO- d_6 using TMS as an internal standard on a Bruker Avance II 400 spectrophotometer at 400 and 100 MHz respectively. Mass spectrums of representative compounds were recorded on JEOL-AccuTOF JMS-T100LC Mass spectrometer at 70 eV. Elemental microanalyses were carried out on a Carlo-Erba 1108 CHN analyzer. Single crystal X-ray diffraction was performed on a Bruker Kappa Apex II instrument.

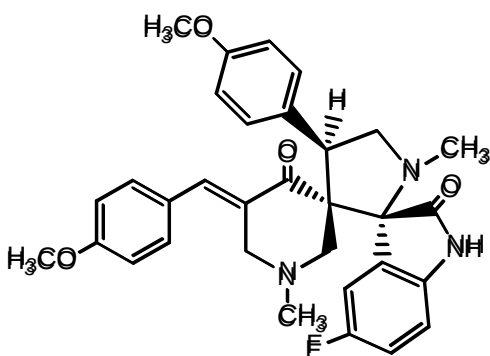
General procedure for the Synthesis of dispiro [3*H*-indole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione derivatives (4a-k)

A dry 50 mL flask was charged with substituted isatin **1** (2.0 mmol), sarcosine **2** (2.0 mmol), and 1-methyl-3,5-bis[(*E*)-arylidene]piperidin-4-one **3** (2.0 mmol), in methanol (10 mL). The reaction mixture was stirred at refluxing temperature for appropriate time (Table 1). After completion of the reaction, as indicated by TLC, the reaction mixture was cooled at room temperature. The solid precipitate was filtered, washed with methanol, dried and recrystallized from ethanol to furnish pure dispiro[3*H*-indole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione derivatives with absolute chemo and regioselectivity.

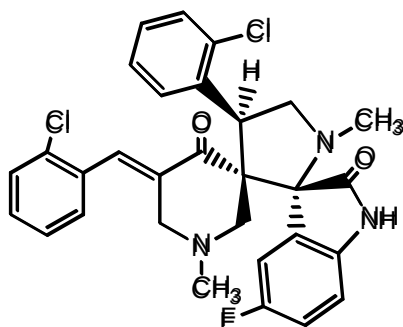
Spectral data of compounds 4



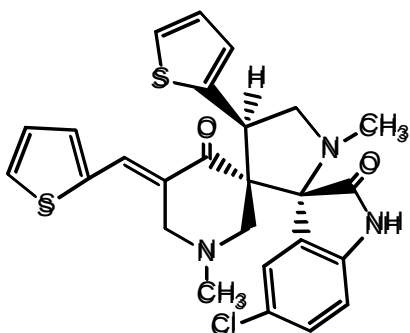
1',1''-Dimethyl-4'-(4-fluorophenyl)-5'-[(4-fluorophenyl)methylene]-dispiro[5-(3H)-methylindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1H),4''-dione (4a). White solid; M.p: 230-232 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1680, 1708, 3248; ^1H NMR (400 MHz, $\text{DMSO}-d_6$): 1.59 (d, 1H, $J=12.6$ Hz, 2''-CH₂), 1.97 (s, 6H, 1'-N-CH₃ and 1''-N-CH₃), 2.24 (s, 3H, CH₃), 3.02 (dd, 1H, $J=2.5$, Hz, 6''-CH₂), 3.12-3.22 (m, 3H, 2''-CH₂, 6''-CH₂ and 5'-CH₂), 3.73-3.77 (m, 1H, 5'-CH₂), 4.60-4.64 (dd, 1H, $J=7.20$ Hz, 7.20 Hz, 4'-CH), 6.45–7.34 (m, 11H, Ar-H), 6.68 (s, 1H, C=CH), 10.22 (s, 1H, NH); ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): 20.76, 34.10, 44.17, 44.56, 56.16, 56.69, 57.11, 64.56, 74.91, 108.35, 115.41, 115.62, 126.89, 127.54, 128.63, 129.22, 130.72, 130.79, 131.00, 131.03, 132.10, 132.18, 133.31, 134.50, 134.52, 135.07, 140.86, 159.84, 160.79, 176.46, 197.83; MS m/z : 514.0 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{31}\text{H}_{29}\text{F}_2\text{N}_3\text{O}_2$: C, 72.50; H, 5.69; N, 8.18. Found: C, 72.57; H, 5.62; N, 8.14.



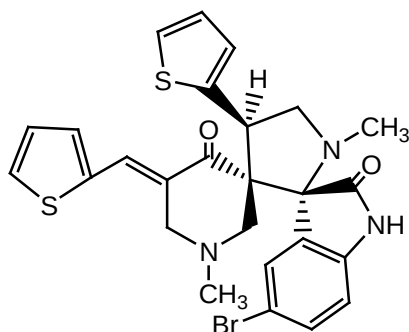
1',1''-Dimethyl-4'-(4-methoxyphenyl)-5''-[(4-methoxyphenyl)methylene]-dispiro[5-(3*H*)-fluoroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione (4b). Yellow solid; M.p: 260-262 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1676, 1706, 3251; ^1H NMR (400 MHz, $\text{DMSO}-d_6$): 1.58 (d, 1H, $J=12.4$ Hz, 2''-CH₂), 1.98 (s, 3H, 1'-N-CH₃), 2.00 (s, 3H, 1''-N-CH₃), 3.02 (dd, 1H, $J=2.4$ Hz, 6''-CH₂), 3.12-3.17 (m, 2H, 2''-CH₂ and 6''-CH₂), 3.71 (d, 1H, 5'-CH₂), 3.73 (3H, s, OCH₃), 3.76 (3H, s, OCH₃), 3.77-3.81 (m, 1H, 5'-CH₂), 4.57 (dd, 1H, $J=7.2$ Hz, 4'-CH), 6.54–7.56 (m, 11H, Ar-H), 6.83 (s, 1H, C=CH), 10.36 (s, 1H, NH); ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): 34.12, 44.12, 44.62, 55.22, 55.27, 56.20, 56.54, 56.87, 64.94, 75.23, 108.61, 113.64, 113.98, 114.11, 114.28, 114.52, 126.86, 127.22, 129.01, 129.82, 129.93, 130.99, 131.62, 131.97, 132.37, 134.22, 136.74, 139.55, 158.01, 159.96, 176.57, 197.62; MS m/z : 542.0 $[\text{M}+\text{H}]^+$; Analysis calcd for $\text{C}_{32}\text{H}_{32}\text{FN}_3\text{O}_4$: C, 70.96; H, 5.96; N, 7.76. Found: C, 70.84; H, 5.90; N, 7.74.



4'-(2-chlorophenyl)-5''-[(2-chlorophenyl)methylene]-1',1''-dimethyldispiro[5-(3*H*)-fluoroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione (4c). White solid; M.p: 227-229 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1682, 1705, 3246; ^1H NMR (300 MHz, $\text{DMSO}-d_6$): 1.59 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 1.99 (s, 6H, 1'-N-CH₃, 1''-N-CH₃), 3.01-3.26 (m, 5H, 2''-CH₂, 6''-CH₂, 5'-CH₂), 3.71-3.77 (m, 1H, 5'-CH₂), 4.59 (t, 1H, $J=6.9$ Hz, 4'-CH), 6.55–7.60 (m, 11H, Ar-H), 6.92 (s, 1H, C=CH), 10.51 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO}-d_6$): 34.63, 44.46, 44.98, 56.63, 57.02, 57.43, 65.60, 75.27, 111.22, 113.00, 115.42, 115.70, 127.24, 127.95, 129.93, 131.13, 131.24, 131.66, 132.66, 132.77, 133.59, 134.60, 136.22, 143.11, 159.99, 161.01, 176.49, 198.20; MS m/z : 551.1 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{30}\text{H}_{26}\text{Cl}_2\text{FN}_3\text{O}_2$: C, 65.46; H, 4.76; N, 7.63. Found: C, 65.55; H, 4.69; N, 7.60.

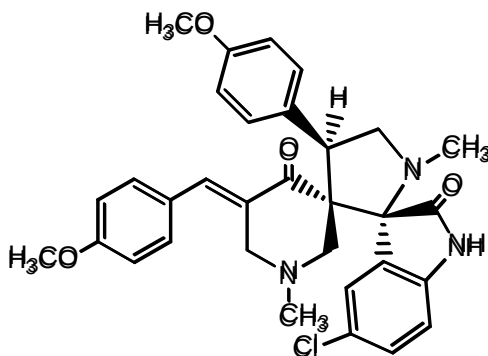


1',1''-Dimethyl-4'-(2-thienyl)-5''-[(2-thienyl)methylene]-dispiro[5-(3H)-chloroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1H),4''-dione (4d). White solid; M.p. 240-242 °C; IR (KBr) (ν_{max} , cm^{-1}): 1680, 1709, 3249; ^1H NMR (300 MHz, $\text{DMSO}-d_6$): 1.82 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 1.98 (s, 3H, 1'-N-CH₃), 2.07 (s, 3H, 1''-N-CH₃), 2.98 (d, 1H, $J=15.3$ Hz, 6''-CH₂), 3.21-3.30 (m, 3H, 2''-CH₂, 6''-CH, 5'-CH₂), 3.69-3.75 (m, 1H, 5'-CH₂), 4.83-4.89 (m, 1H, 4'-CH), 6.61–7.84 (m, 9H, Ar-H), 6.75 (s, 1H, C=CH), 10.53 (s, 1H, NH),. MS m/z : 511.2 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{26}\text{H}_{24}\text{ClN}_3\text{O}_2\text{S}_2$: C, 61.22; H, 4.74; N, 8.24. Found: C, 61.09; H, 4.78; N, 8.26.

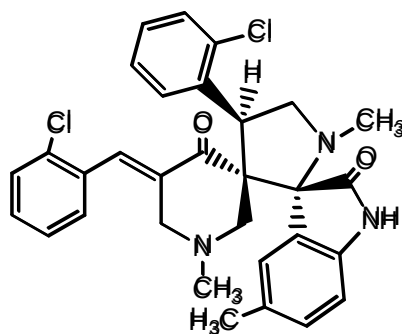


1',1''-Dimethyl-4'-(2-thienyl)-5''-[(2-thienyl)methylene]-dispiro[5-(3H)-bromoindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1H),4''-dione (4e). White solid;

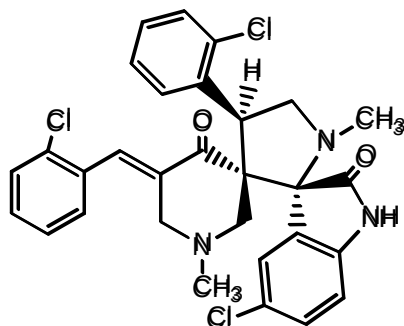
M.p: 238-240 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1676, 1706, 3246; ^1H NMR (300 MHz, $\text{DMSO-}d_6$): 1.65 (d, 1H, $J=12.1$ Hz, 2''-CH₂), 2.01 (s, 3H, 1'-N-CH₃), 2.08 (s, 3H, 1''-N-CH₃), 3.12 (d, 1H, $J=7.4$ Hz, 6''-CH₂), 3.20-3.32 (m, 3H, 2''-CH₂, 6''-CH₂, 5'-CH₂), 3.67-3.74 (m, 1H, 5'-CH₂), 4.81-4.87 (m, 1H, 4'-CH), 6.58-7.79 (m, 9H, Ar), 6.72 (1H, s, C=CH), 10.43 (s, 1H, NH); MS m/z : 554.52 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{26}\text{H}_{24}\text{BrN}_3\text{O}_2\text{S}_2$: C, 56.31; H, 4.36; N, 7.58. Found: C, 56.40; H, 4.28; N, 7.55.



1',1''-Dimethyl-4'-(4-methoxyphenyl)-5''-[(4-methoxyphenyl)methylene]-dispiro[5-(3H)-chloroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1H),4''-dione (4f). Yellow solid; M.p: 240-242 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1682, 1710, 3253; ^1H NMR (300 MHz, $\text{DMSO-}d_6$): 1.58 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 1.99 (s, 6H, 1'-N-CH₃, 1''-N-CH₃), 2.99 (d, 1H, $J=14.7$ Hz, 6''-CH₂), 3.13 (d, 1H, $J=8.7$ Hz, 2''-CH₂), 3.25 (d, 1H, $J=14.7$ Hz, 6''-CH₂), 3.72 (s, 3H, OCH₃), 3.75 (s, 3H, OCH₃), 3.80-3.83 (m, 2H, 5'-CH₂), 4.58 (t, 1H, $J=6.3$ Hz, 4'-CH), 6.57-7.56 (m, 11H, Ar-H), 6.80 (s, 1H, C=CH), 10.45 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): 34.23, 44.02, 44.67, 54.97, 55.28, 56.62, 56.95, 57.06, 65.10, 75.05, 110.06, 124.83, 126.79, 126.92, 127.29, 128.25, 129.37, 129.91, 131.19, 131.66, 131.98, 132.45, 134.32, 136.98, 142.26, 158.09, 160.02, 176.33, 197.74; MS m/z : 559.3 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{32}\text{H}_{32}\text{ClN}_3\text{O}_4$: C, 68.87; H, 5.78; N, 7.53. Found: C, 68.73; H, 5.82; N, 7.56.

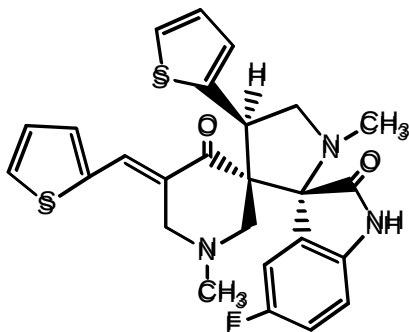


4'-(2-Chlorophenyl)-5'-[(2-chlorophenyl)methylene]-1',1''-dimethyldispiro[5-(3*H*)-methylindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione (4g). White solid; M.p: 258-260 °C; IR (KBr) (ν_{max} , cm^{-1}): 1685, 1705, 3243; ^1H NMR (300 MHz, $\text{DMSO-}d_6$): 1.70 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 1.85 (3H, s, CH₃), 1.93 (s, 3H, 1'-N-CH₃), 2.17 (s, 3H, 1''-N-CH₃), 2.91 (d, 1H, $J=12.3$ Hz, 6''-CH₂), 2.97-3.16 (m, 2H, 2''-CH₂, 5'-CH₂), 3.28 (d, 1H, $J=7.8$ Hz, 6''-CH₂), 3.79 (t, 1H, $J=8.7$ Hz, 5'-CH₂), 4.85-4.91 (m 1H, 4'-CH), 6.55-7.94 (m, 11H, Ar-H), 6.69 (s, 1H, C=CH), 10.40 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): 21.11, 34.16, 42.07, 45.08, 56.82, 57.21, 57.79, 62.76, 76.18, 108.74, 126.34, 127.02, 127.23, 127.80, 128.46, 128.81, 129.14, 129.69, 130.19, 130.60, 130.78, 132.04, 132.62, 133.69, 134.41, 134.79, 136.75, 141.13, 176.56, 196.60; MS m/z : 547.0 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{31}\text{H}_{29}\text{Cl}_2\text{N}_3\text{O}_2$: C, 68.13; H, 5.35; N, 7.69. Found: C, 67.96; H, 5.42; N, 7.71.

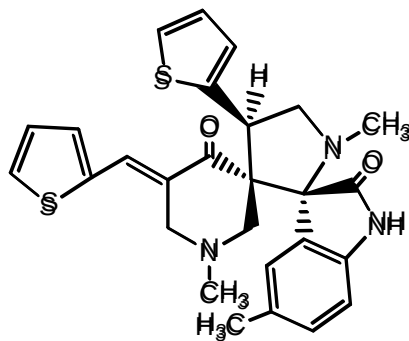


4'-(2-Chlorophenyl)-5'-[(2-chlorophenyl)methylene]-1',1''-dimethyldispiro[5-(3*H*)-chloroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione (4h). White solid; M.p: 244-246 °C; IR (KBr) (ν_{max} , cm^{-1}): 1683, 1708, 3247; ^1H NMR 300 MHz, $\text{DMSO-}d_6$): 1.70 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 1.89 (s, 3H, 1'-N-CH₃), 1.97 (s, 3H, 1''-N-CH₃), 2.95 (d, 2H, $J=12.3$ Hz, 2''-CH₂), 3.05-3.15 (m, 2H, 6''-CH₂, 5'-CH₂), 3.32 (d, 1H, $J=7.8$ Hz, 6''-CH₂), 3.77-3.83 (m, 1H, 5'-CH₂), 4.85-4.90 (m, 1H, 4'-CH), 6.69-7.90 (m, 11H, Ar-H), 6.84 (s, 1H, C=CH), 10.70 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): 34.59, 42.41, 45.40, 57.06, 57.60, 58.12, 63.74, 76.46, 110.91, 125.96, 127.40, 127.54, 128.93, 128.99, 129.65, 130.03, 130.61, 131.00, 131.09, 133.02, 133.45, 134.18, 134.49, 135.13,

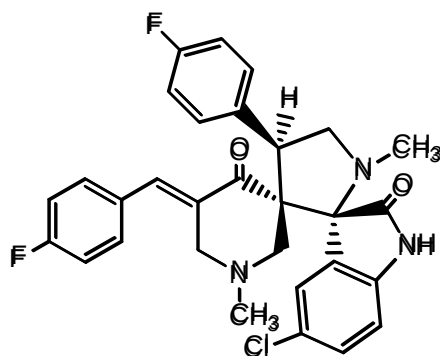
136.86, 142.86, 176.73, 196.91; MS m/z : 567.2 $[M+H]^+$; Anal. calcd for $C_{30}H_{26}Cl_3N_3O_2$: C, 63.56; H, 4.62; N, 7.41. Found: C, 63.64; H, 4.53; N, 7.37.



1',1''-Dimethyl-4'-(2-thienyl)-5''-[(2-thienyl)methylene]-dispiro[5-(3H)-fluoroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1H),4''-dione (4i). White solid; M.p: 260-262 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1679, 1711, 3251; ^1H NMR (300 MHz, $\text{DMSO}-d_6$): 1.82 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 1.97 (s, 3H, 1'-N-CH₃), 2.08 (s, 3H, 1''-N-CH₃), 2.98 (d, 1H, $J=15.6$ Hz, 6''-CH₂), 3.23-3.28 (m, 2H, 2''-CH₂, 6''-CH₂), 3.37 (d, 1H, $J=15.6$ Hz, 5'-CH₂), 3.70-3.77 (m, 1H, 5'-CH₂), 4.80-4.86 (m, 1H, 4'-CH), 6.55-7.84 (m, 9H, Ar), 6.54 (s, 1H, C=CH), 10.43 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO}-d_6$): 33.86, 44.54, 51.30, 55.38, 56.44, 57.25, 64.50, 75.16, 109.34, 124.51, 125.88, 126.97, 128.41, 128.56, 128.67, 129.46, 132.43, 134.12, 137.35, 139.69, 140.60, 155.79, 158.91, 176.34, 196.09; MS m/z : 494.1 $[M+H]^+$; Anal. calcd for $C_{26}H_{24}FN_3O_2S_2$: C, 63.26; H, 4.90; N, 8.51. Found: C, 63.15; H, 4.84; N, 8.49.

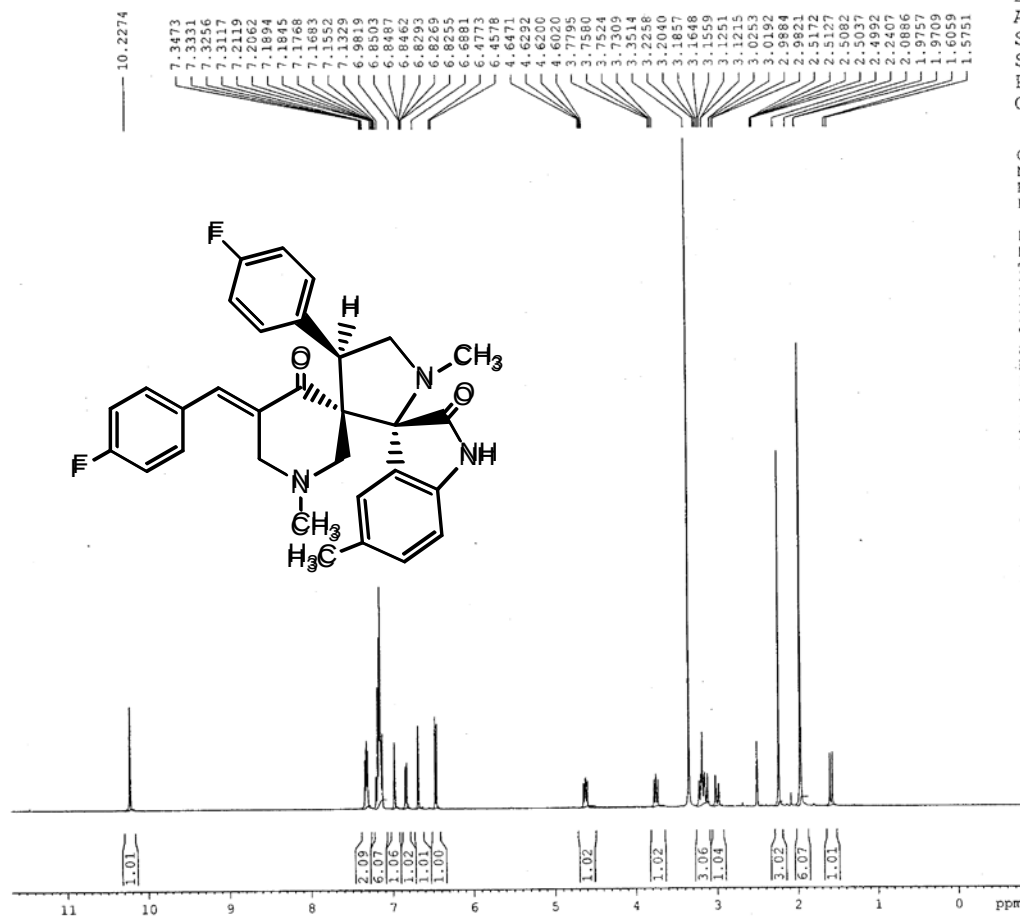


1',1''-Dimethyl-4'-(2-thienyl)-5''-[(2-thienyl)methylene]-dispiro[5-(3*H*)-methylindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione (4j). White solid; M.p: 245-247 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1677, 1706, 3245; ^1H NMR (300 MHz, $\text{DMSO-}d_6$): 1.83 (d, 1H, $J=12.0$ Hz, 2''-CH₂), 1.96 (3H, s, CH₃), 2.06 (s, 3H, 1'-N-CH₃), 2.11 (s, 3H, 1''-N-CH₃), 2.95 (d, 1H, $J=15.3$ Hz, 6''-CH₂), 3.22-3.37 (m, 3H, 2''-CH₂, 6''-CH₂, 5'-CH₂), 3.75 (t, 1H, $J=9.3$ Hz, 5'-CH₂), 4.87 (t, 1H, $J=8.4$ Hz, 4'-CH), 6.47-7.81 (m, 10H, Ar), 6.64 (s, 1H, C=CH), 10.26 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): 20.57, 34.42, 42.34, 44.64, 55.81, 56.64, 57.32, 64.03, 75.04, 108.25, 124.44, 125.91, 126.64, 126.94, 127.57, 128.36, 128.67, 128.85, 129.15, 129.48, 131.08, 131.84, 133.36, 138.09, 140.99, 176.33, 196.38; MS m/z : 490.1 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{27}\text{H}_{27}\text{N}_3\text{O}_2\text{S}_2$: C, 66.23; H, 5.56; N, 8.58. Found: C, 66.16; H, 5.51; N, 8.61.



1',1''-Dimethyl-4'-(4-fluorophenyl)-5''-[(4-fluorophenyl)methylene]-dispiro[5-(3*H*)-chloroindole-3,2'-pyrrolidine-3',3''-piperidine]-2(1*H*),4''-dione (4k). White solid; M.p: 228-230 °C; IR (KBr) ($\nu_{\max}$, cm^{-1}): 1683, 1709, 3252; ^1H NMR (300 MHz, $\text{DMSO-}d_6$): 1.59 (d, 1H, $J=12.3$ Hz, 2''-CH₂), 2.00 (s, 6H, 1'-N-CH₃, 1''-N-CH₃), 3.02-3.21 (m, 4H, 6''-CH₂, 2''-CH₂, 5'-CH₂), 3.72-3.78 (m, 1H, 5'-CH₂), 4.65 (t, 1H, $J=6.6$ Hz, 4'-CH), 6.59-7.32 (m, 11H, Ar), 6.80 (s, 1H, C=CH), 10.53 (s, 1H, NH); ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): 34.63, 44.49, 44.99, 56.68, 57.02, 57.44, 65.56, 75.38, 110.66, 115.41, 115.69, 115.96, 116.25, 125.31, 127.20, 128.85, 129.51, 131.15, 131.25, 132.62, 132.74, 133.61, 134.66, 136.22, 142.74, 160.0, 161.01, 176.65, 198.19; MS m/z : 535.2 $[\text{M}+\text{H}]^+$; Anal. calcd for $\text{C}_{30}\text{H}_{26}\text{ClF}_2\text{N}_3\text{O}_2$: C, 67.48; H, 4.91; N, 7.87. Found: C, 67.61; H, 4.99; N, 7.84.

AQL-3



BRUKER
AVANCE II 400 NMR
Spectrometer
SAIF
Panjab University
Chandigarh

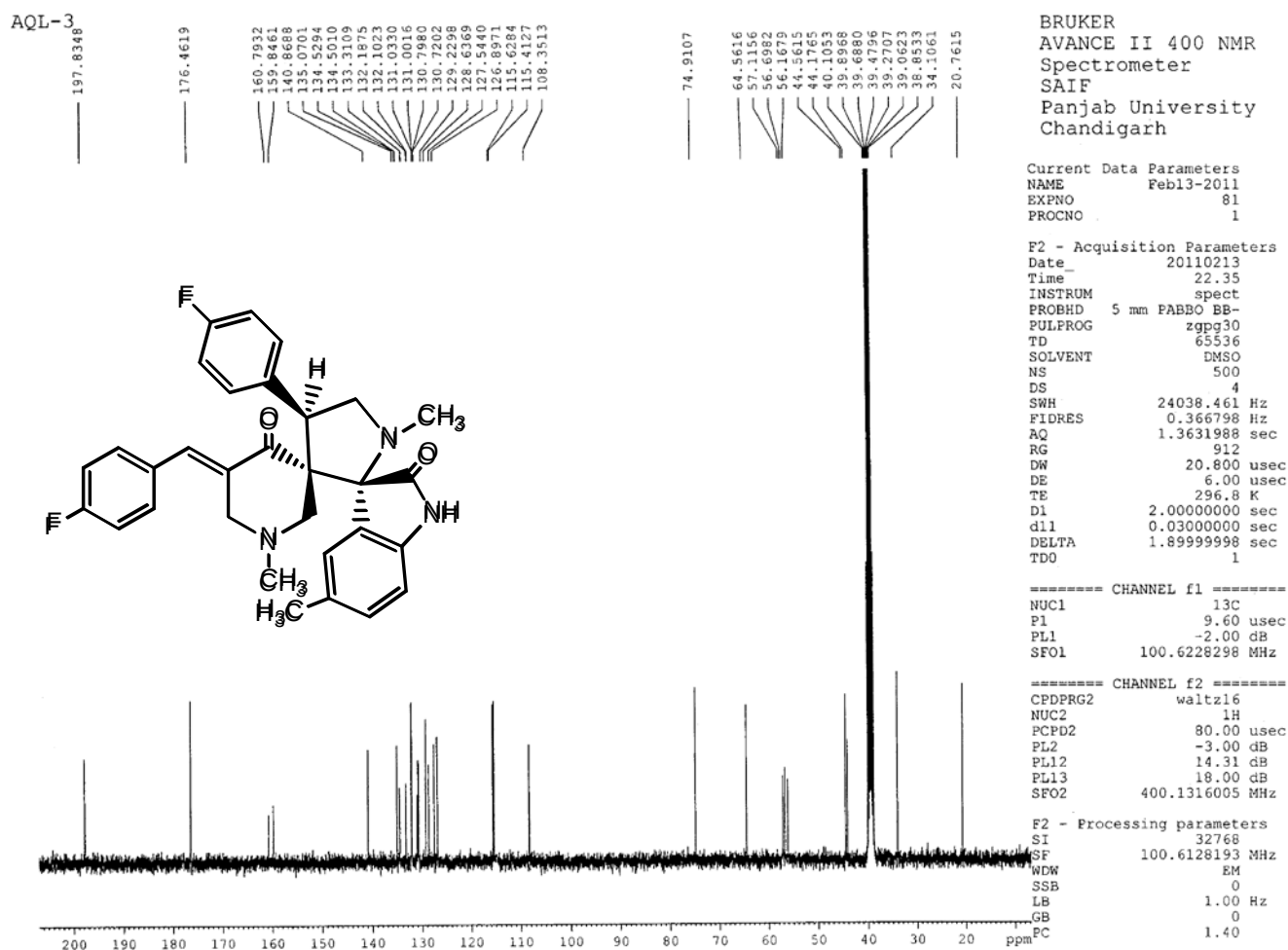
Current Data Parameters
NAME Feb13-2011
EXPNO 80
PROCNO 1

F2 - Acquisition Parameters
Date_ 20110213
Time 22.05
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
SWH 12019.230 Hz
FIDRES 0.183399 Hz
AQ 2.7263477 sec
RG 228
DW 41.600 usec
DE 6.00 usec
TE 296.3 K
D1 1.00000000 sec
TD0 1

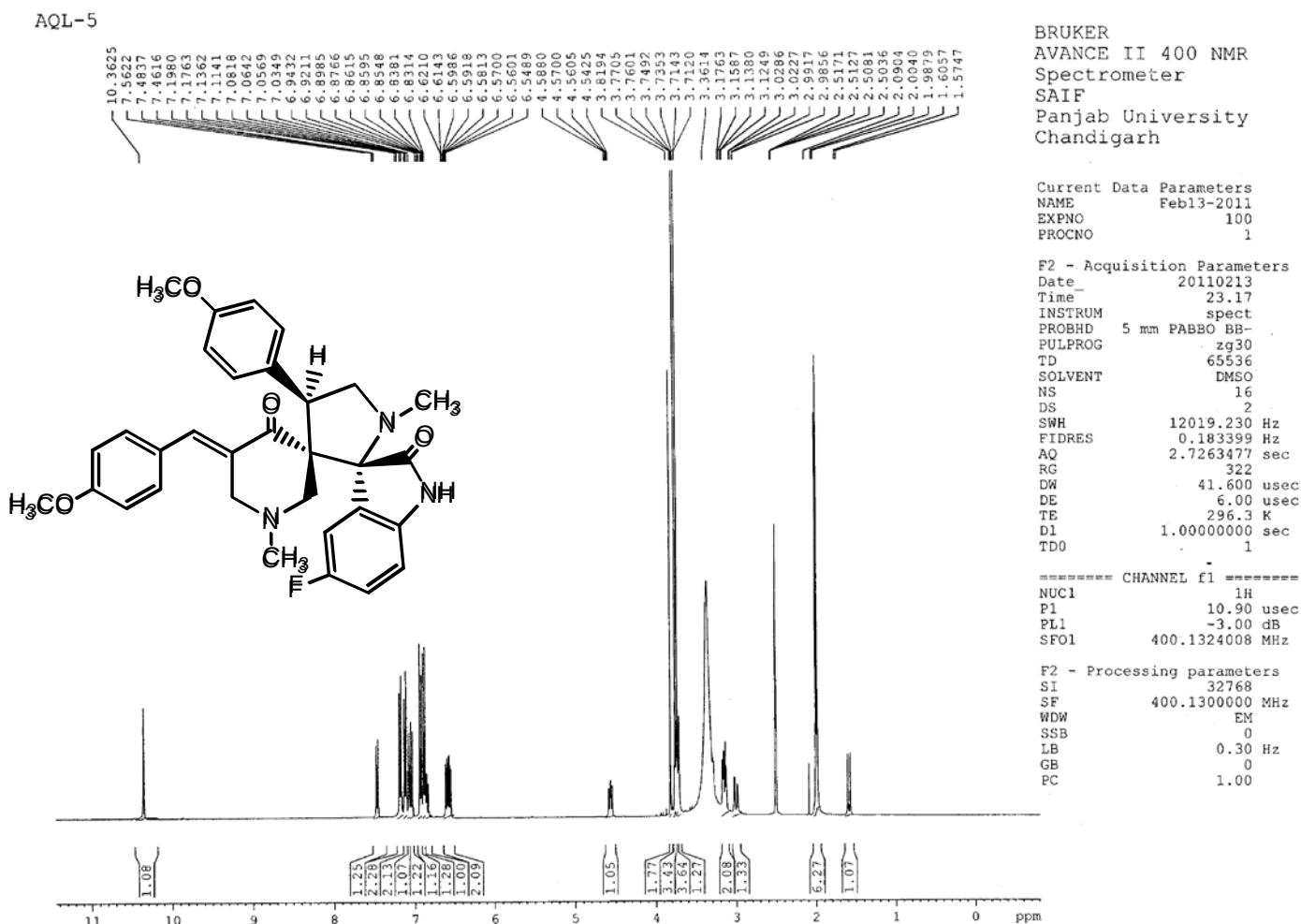
===== CHANNEL f1 =====
NUC1 1H
P1 10.90 usec
PL1 -3.00 dB
SFO1 400.1324008 MHz

F2 - Processing parameters
SI 32768
SF 400.1300000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H spectrum of 4a

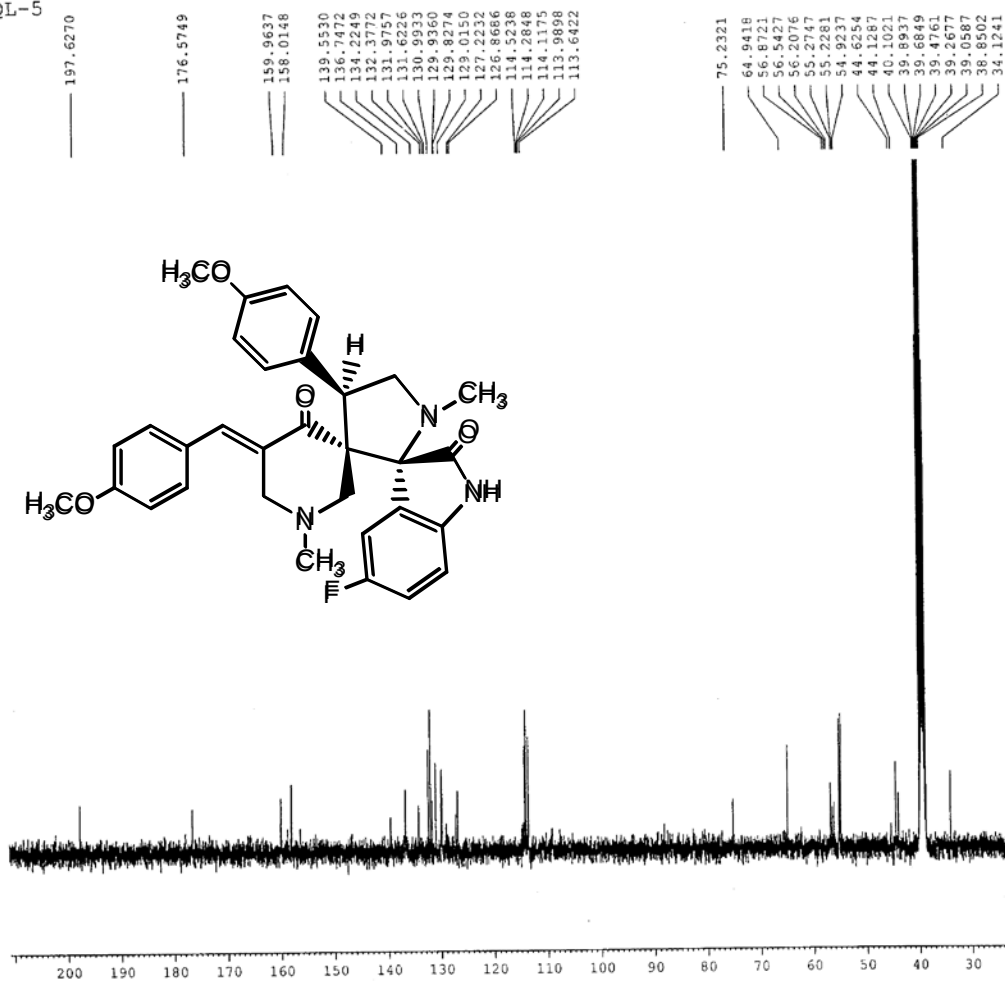


^{13}C spectrum of 4a



¹H spectrum of **4b**

AQL-5



BRUKER
AVANCE II 400 NMR
Spectrometer
SAIF
Panjab University
Chandigarh

Current Data Parameters
NAME Feb13-2011
EXPNO 101
PROCNO 1

F2 - Acquisition Parameters
Date_ 20110213
Time 23.47
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 500
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 912
DW 20.800 usec
DE 6.00 usec
TE 296.7 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999999 sec
TDO 1

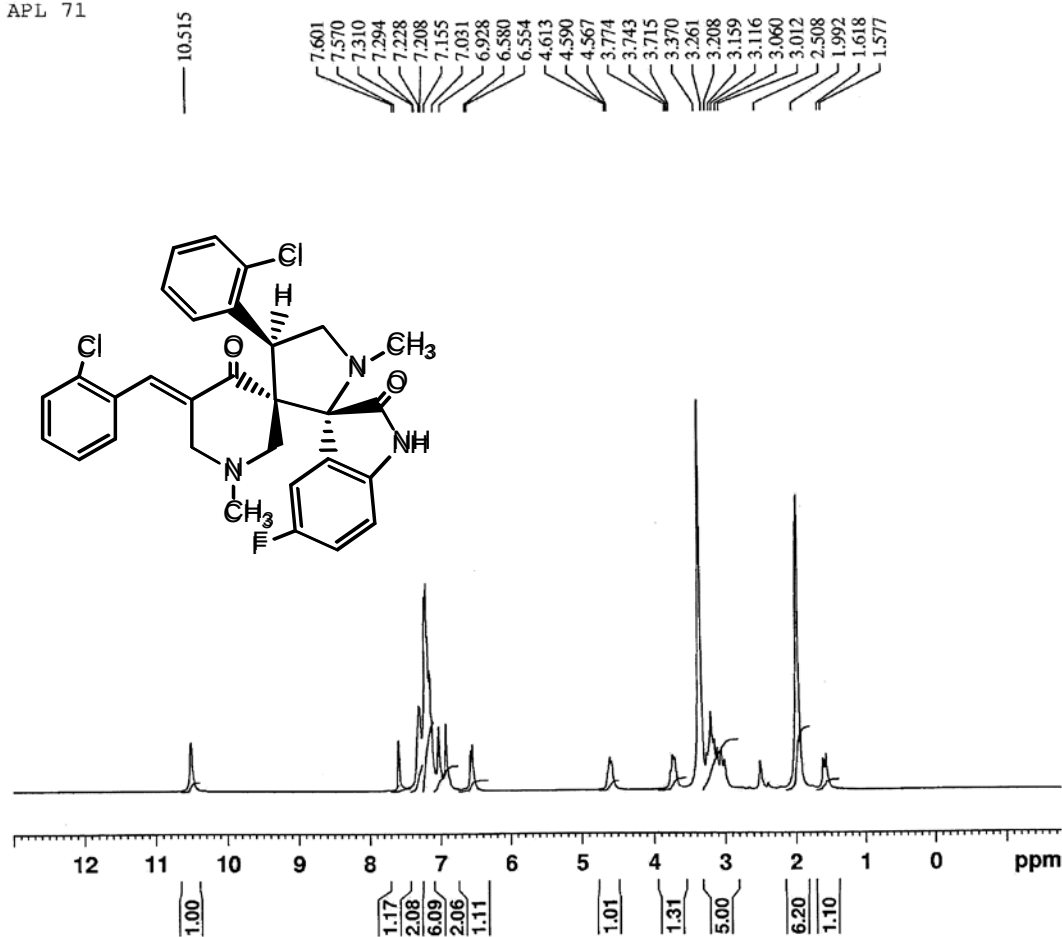
===== CHANNEL f1 =====
NUC1 13C
P1 9.60 usec
PL1 -2.00 dB
SFO1 100.6228298 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 -3.00 dB
PL12 14.31 dB
EL13 18.00 dB
SFO2 400.1316005 MHz

F2 - Processing parameters
SI 32768
SF 100.6128193 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

¹³C spectrum of 4b

APL 71



```
Current Data Parameters
NAME          feb-28-2012
EXPNO          88
PROCNO         1
```

```

F2 - Acquisition Parameters
Date_      20120228
Time       17.28
INSTRUM    av3000
PROBHD     5 mm PABBO BB-
PULPROG    zg30
TD         65536
SOLVENT     DMSO
NS          9
DS          2
SWH         6172.839 Hz
FIDRES     0.094190 Hz
AQ         5.3084660 sec
RG          90.5
DW         81.000 usec
DE         6.00 usec
TE         300.0 K
D1         1.00000000 sec
TD0         1

```

```

===== CHANNEL f1 =====
NUC1          1H
P1            10.70 usec
PL1           -2.00 dB
SFO1          300.1318534 MHz

```

```
F2 - Processing parameters
SI                      32768
SF                      300.1300000 MHz
WDW                      EM
SSB                      0
LB                      0.30 Hz
GB                      0
PC                      1.00
```

¹H spectrum of **4c**

APL71



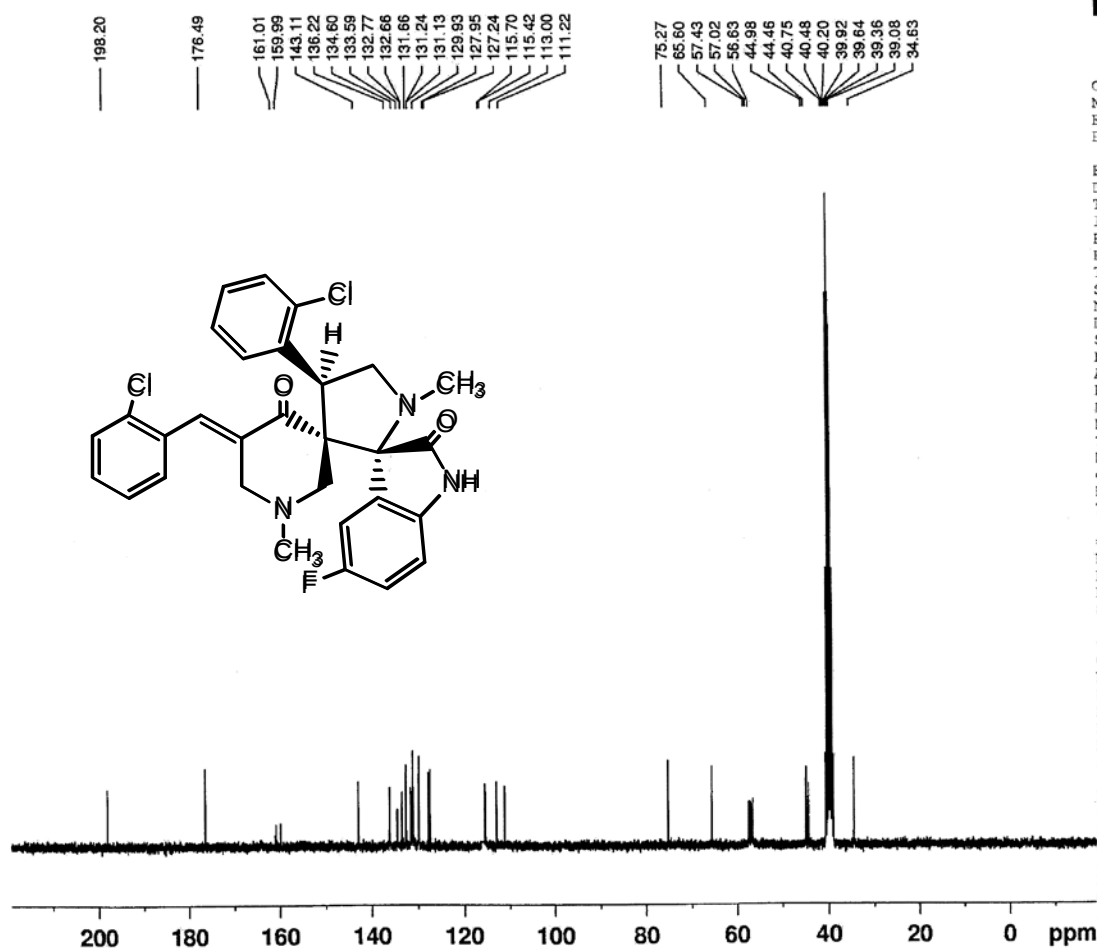
Current Data Parameters
NAME feb-28-2012
EXPNO 89
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120228
Time 17.47
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 504
DS 4
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
TD0 1

===== CHANNEL f1 =====
NUC1 13C
P1 10.10 usec
PL1 -2.00 dB
SFO1 75.4752953 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 115.00 usec
PL2 -2.00 dB
PL12 18.50 dB
PL13 22.50 dB
SFO2 300.1312005 MHz

F2 - Processing parameters
SI 32768
SF 75.4677490 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



Chemical structure of the compound is shown above the spectrum. The structure is a complex molecule featuring a thiophene ring, a thiazolidine ring, a piperidine ring, and a benzene ring with a chlorine substituent. The structure is labeled with stereochemistry (R/S) and a chlorine atom.

Current Data Parameters

NAME	feb-29-2012
EXPNO	1
PROCNO	1

F2 - Acquisition Parameters

Date_	20120229
Time	9.35
INSTRUM	av300
PROBHD	5 mm PABBO BB-
PULPROG	zg30
TD	65536
SOLVENT	DMSO
NS	11
DS	2
SWH	6172.839 Hz
FIDRES	0.094190 Hz
AQ	5.3084660 sec
RG	90.5
DW	81.000 usec
DE	6.00 usec
TE	300.0 K
D1	1.00000000 sec
TDO	1

===== CHANNEL f1 =====

NUC1	1H
P1	10.70 usec
PL1	-2.00 dB
SFO1	300.1318534 MHz

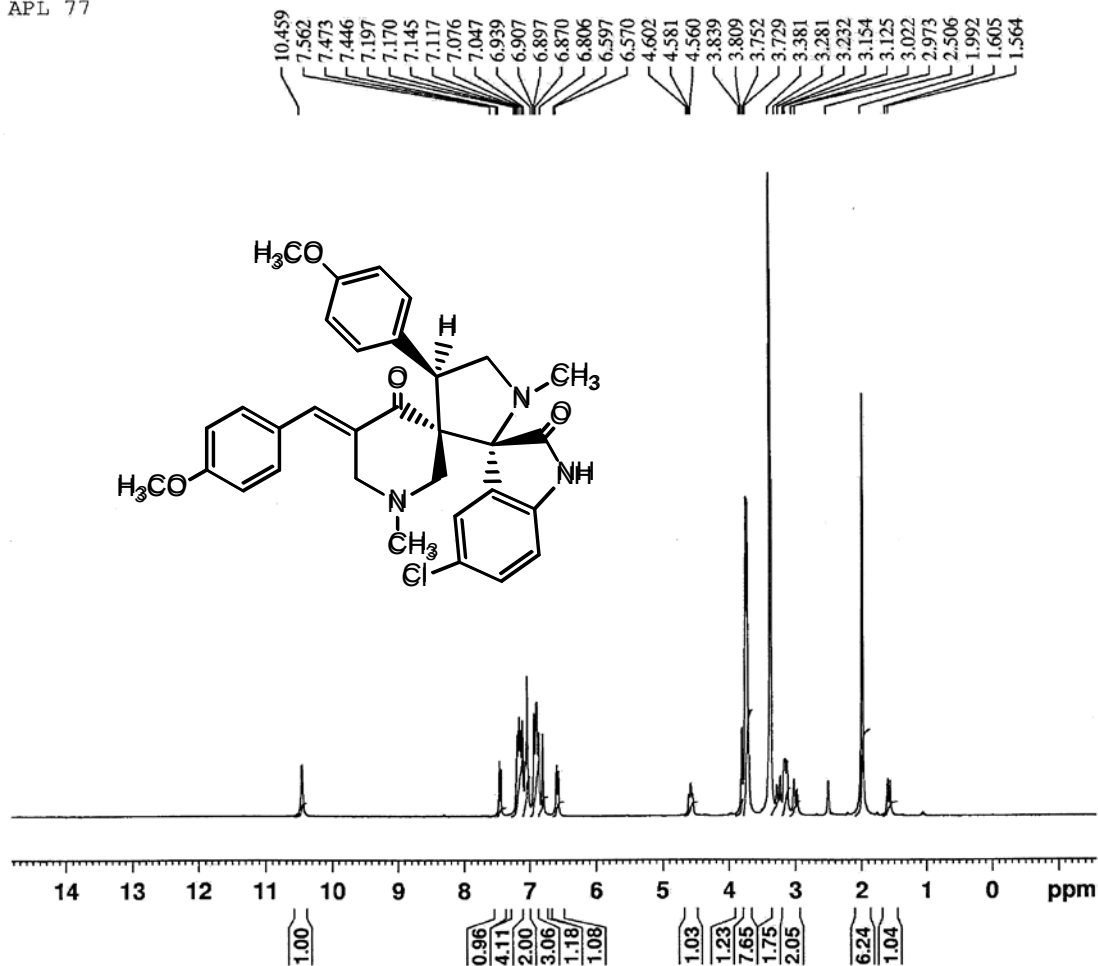
F2 - Processing parameters

SI	32768
SF	300.1300000 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00

Chemical structure of the compound is shown above the spectrum. The structure is a complex molecule featuring a thiophene ring, a thiazolidine ring, a piperidine ring, and a benzene ring with a chlorine substituent. The structure is labeled with stereochemistry (R/S) and a chlorine atom.

 ^1H spectrum of 4d

APL 77



Current Data Parameters
NAME feb-24-2012
EXPNO 13
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120224
Time 11.32
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 12
DS 2
SWH 6172.839 Hz
FIDRES 0.094190 Hz
AQ 5.3084660 sec
RG 80.6
DW 81.000 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
NUC1 1H
P1 10.70 usec
PL1 -2.00 dB
SFO1 300.1318534 MHz

F2 - Processing parameters
SI 32768
SF 300.1300000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H spectrum of **4f**

APL 77



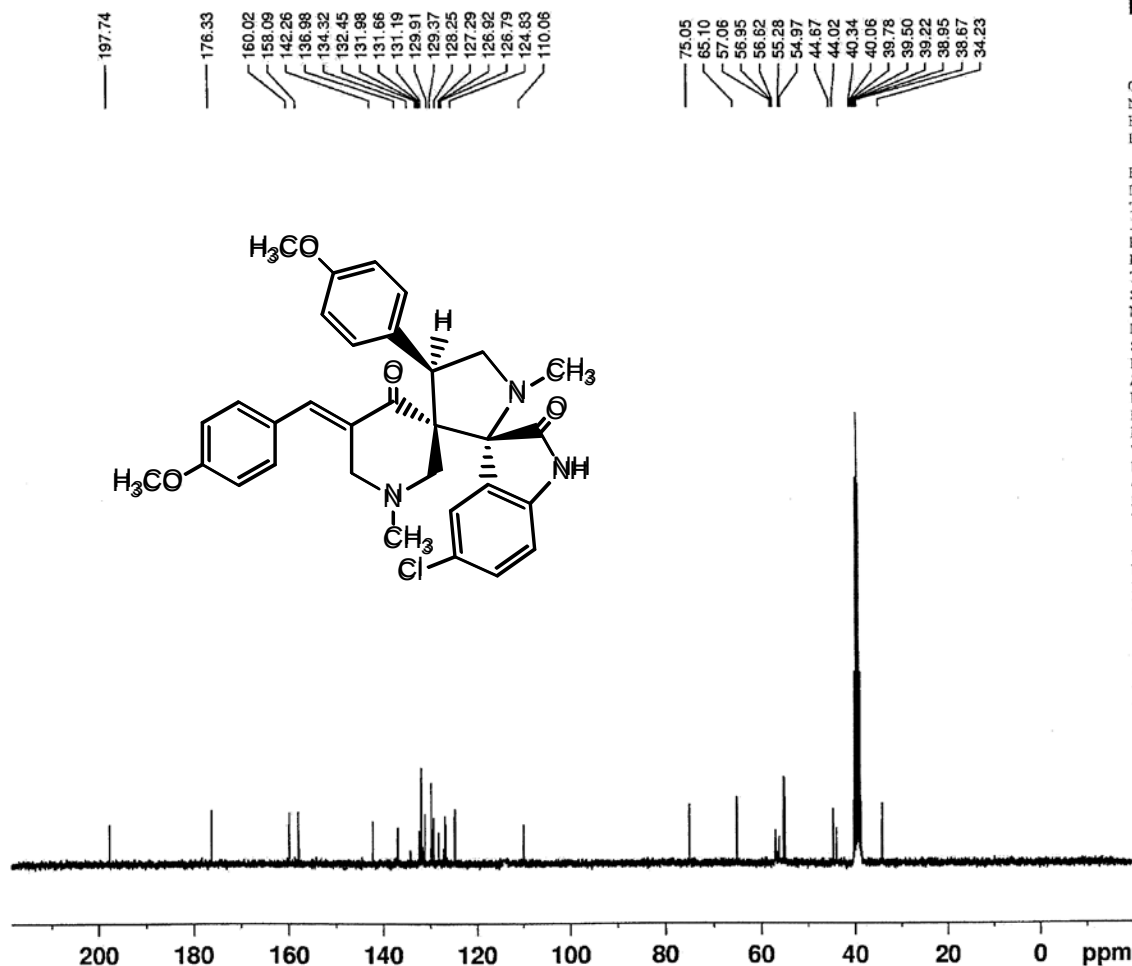
Current Data Parameters
NAME feb-24-2012
EXPNO 221
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120224
Time 13.25
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 312
DS 4
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
TDO 1

===== CHANNEL f1 =====
NUC1 13C
P1 10.10 usec
PL1 -2.00 dB
SFO1 75.4752953 MHz

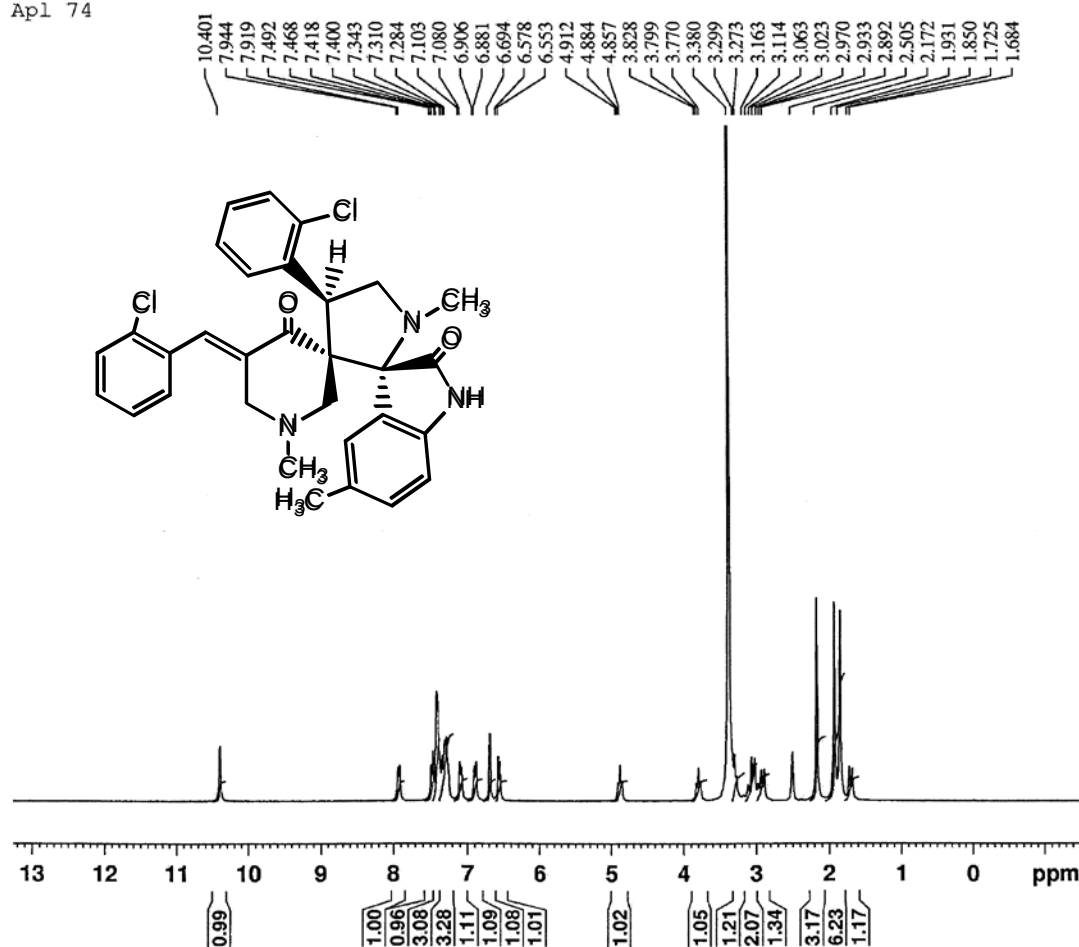
===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 115.00 usec
PL2 -2.00 dB
PL12 18.50 dB
PL13 22.50 dB
SFO2 300.1312005 MHz

F2 - Processing parameters
SI 32768
SF 75.4677809 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



¹³C spectrum of **4f**

Apl 74



Current Data Parameters
NAME feb-24-2012
EXPNO 2
PROCNO 1

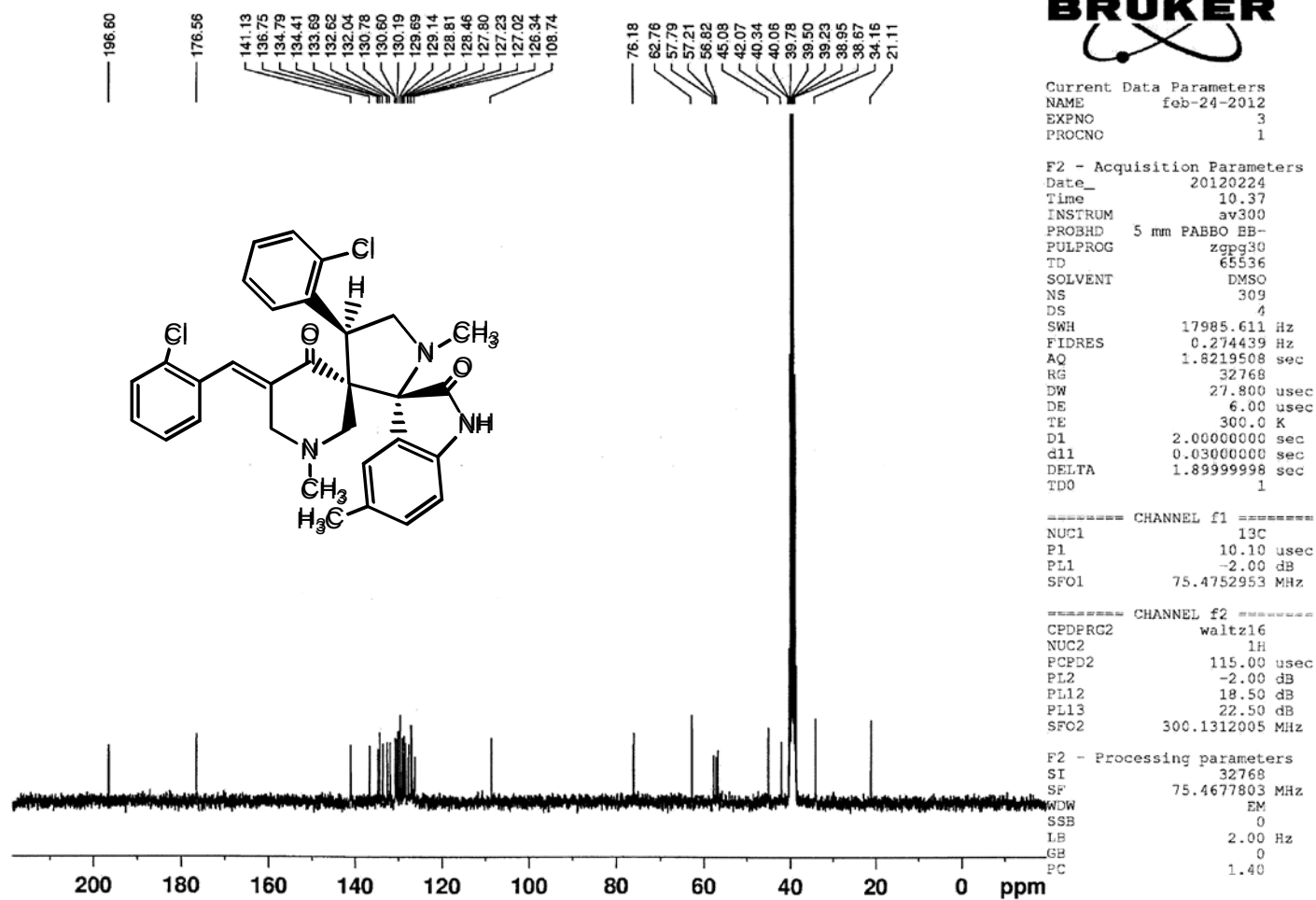
F2 - Acquisition Parameters
Date_ 20120224
Time 10.19
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 11
DS 2
SWH 6172.839 Hz
FIDRES 0.094190 Hz
AQ 5.3084660 sec
RG 80.6
DW 81.000 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
NUC1 1H
P1 10.70 usec
PL1 -2.00 dB
SFO1 300.1318534 MHz

F2 - Processing parameters
SI 32768
SF 300.1300000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

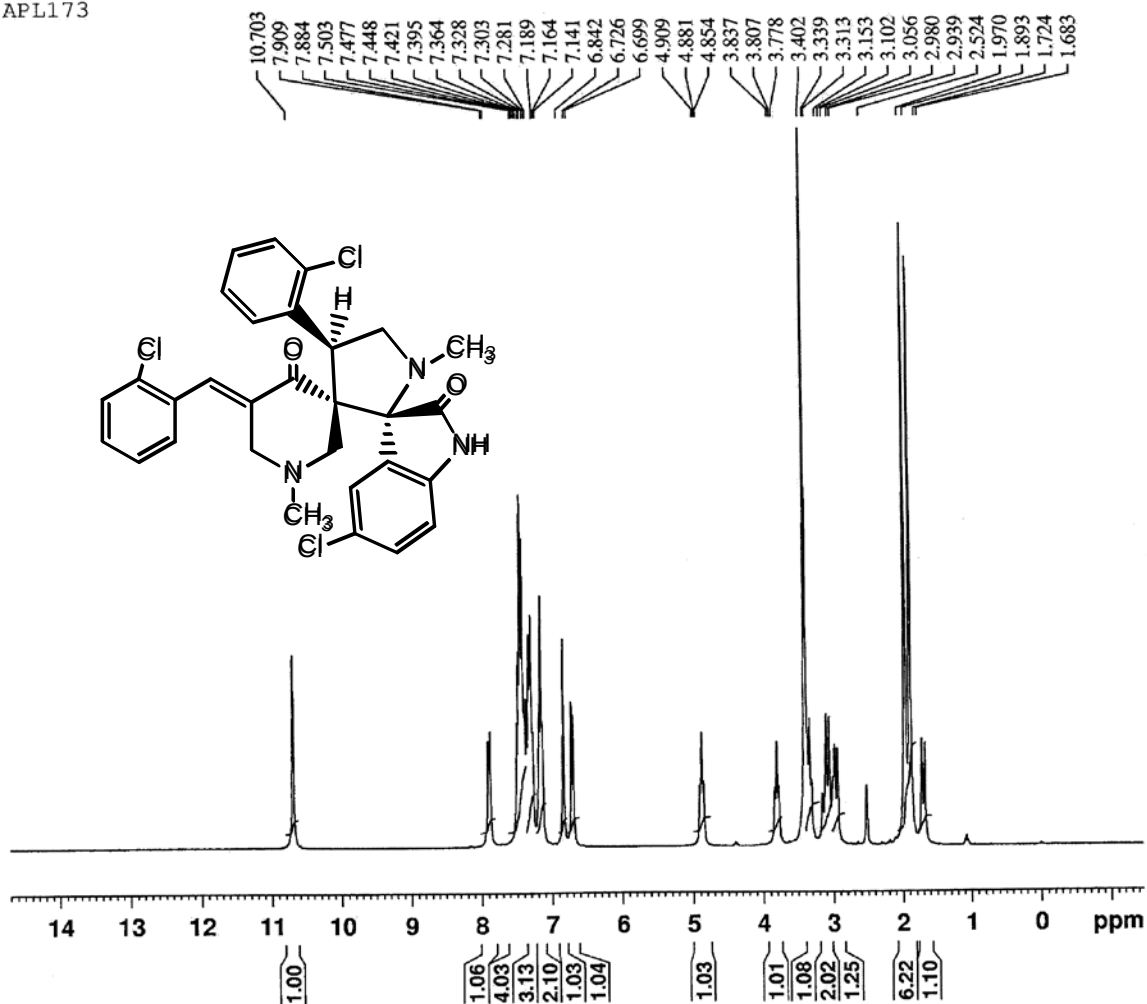
¹H spectrum of 4g

Ap1 74



¹³C spectrum of 4g

APL173



Current Data Parameters
NAME feb-27-2012
EXPNO 1
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120227
Time 9.44
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 12
DS 2
SWH 6172.839 Hz
FIDRES 0.094190 Hz
AQ 5.3084660 sec
RG 64
DW 81.000 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
NUC1 1H
P1 10.70 usec
PL1 -2.00 dB
SFO1 300.1318534 MHz

F2 - Processing parameters
SI 32768
SF 300.1299944 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H spectrum of **4h**

APL173



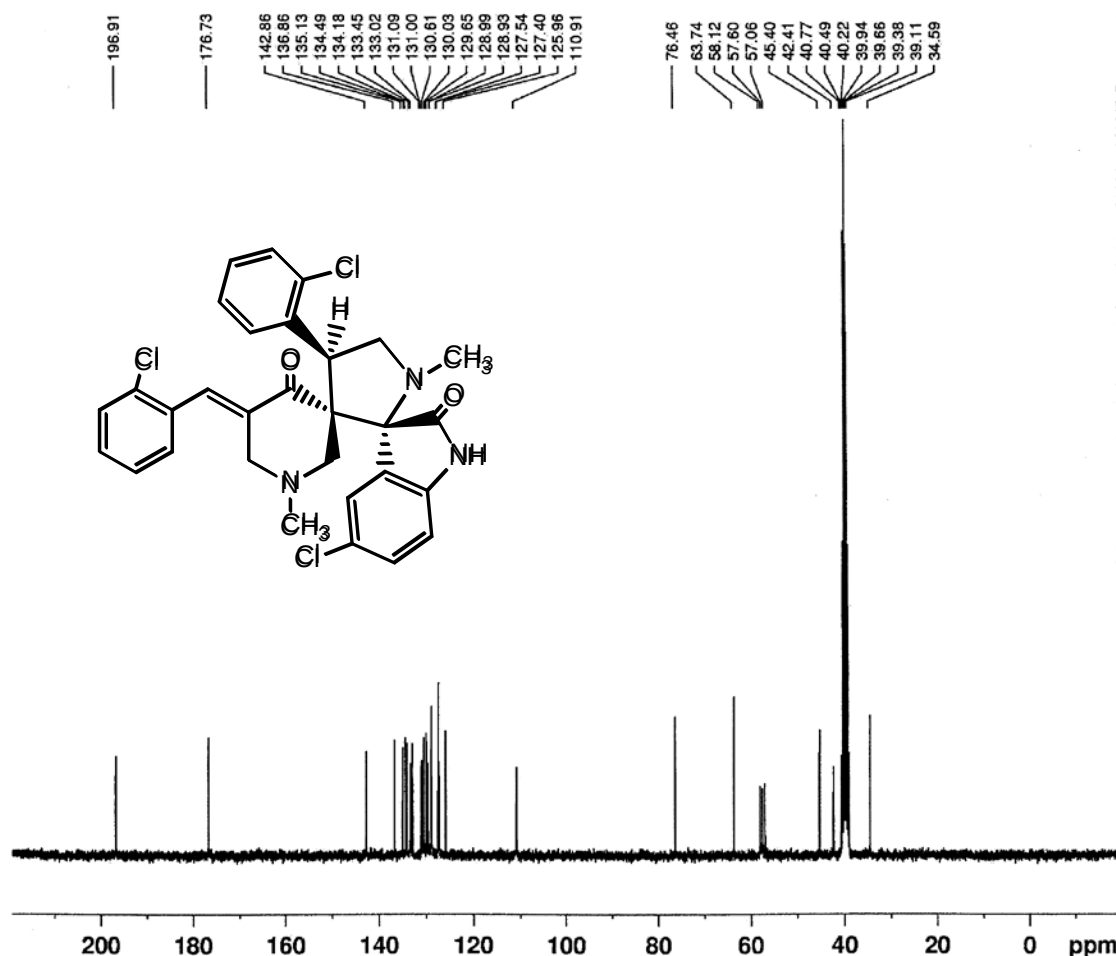
Current Data Parameters
NAME feb-27-2012
EXPNO 2
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120227
Time 9.49
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 534
DS 4
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
TD0 1

===== CHANNEL f1 =====
NUC1 13C
P1 10.10 usec
PL1 -2.00 dB
SFO1 75.4752953 MHz

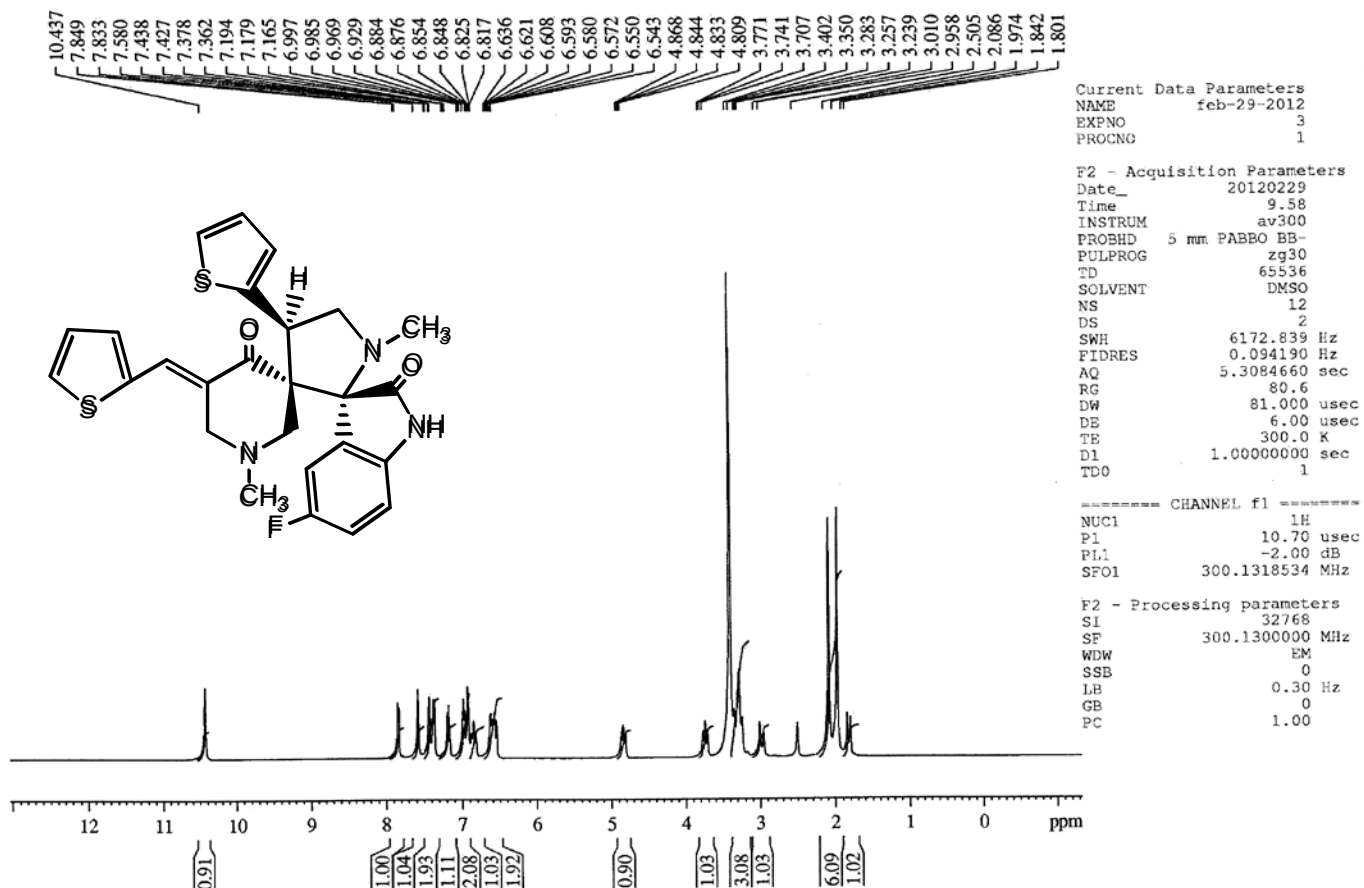
===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 115.00 usec
PL2 -2.00 dB
PL12 18.50 dB
PL13 22.50 dB
SFO2 300.1312005 MHz

F2 - Processing parameters
SI 32768
SF 75.4677490 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



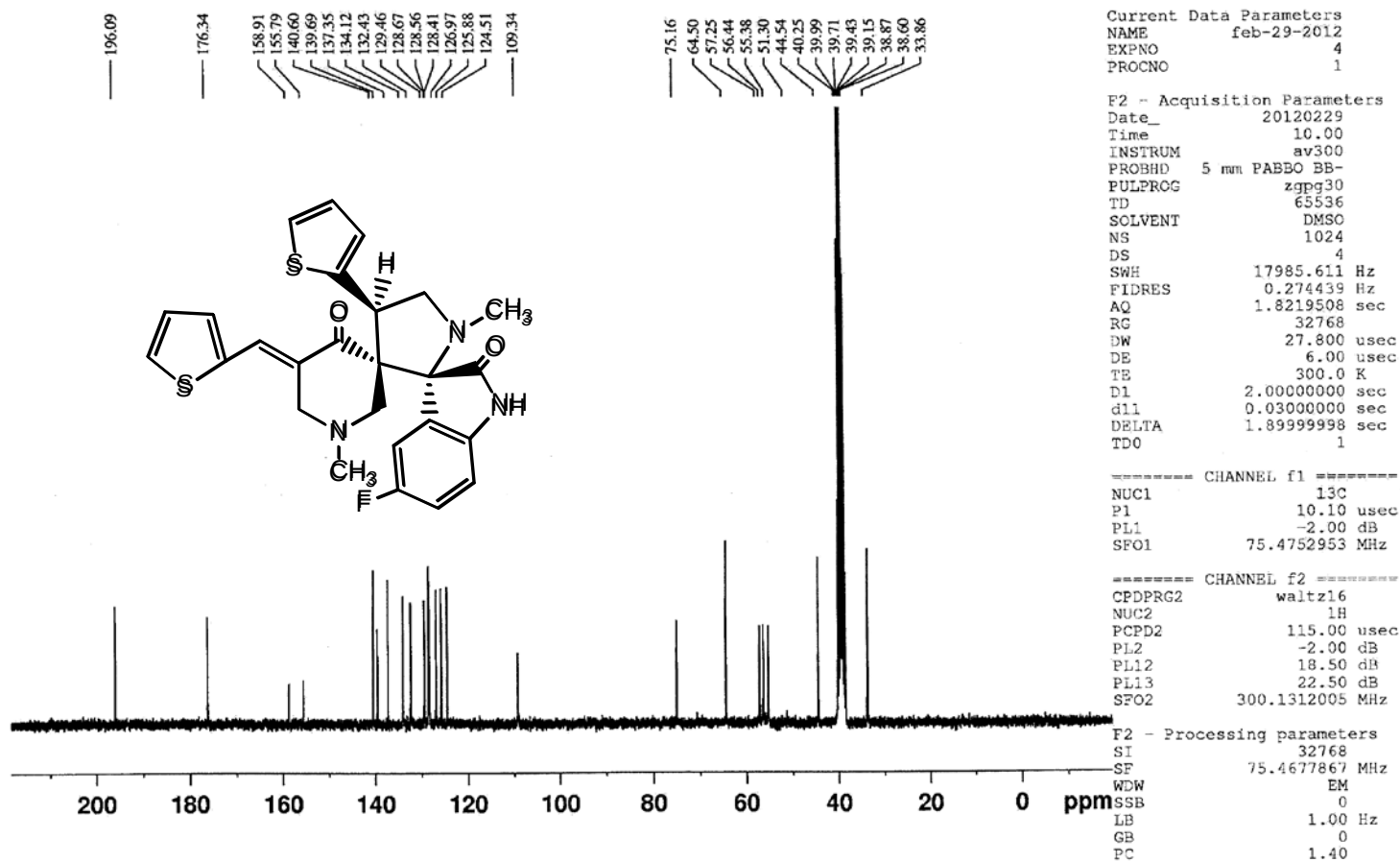
^{13}C spectrum of 4h

APL75



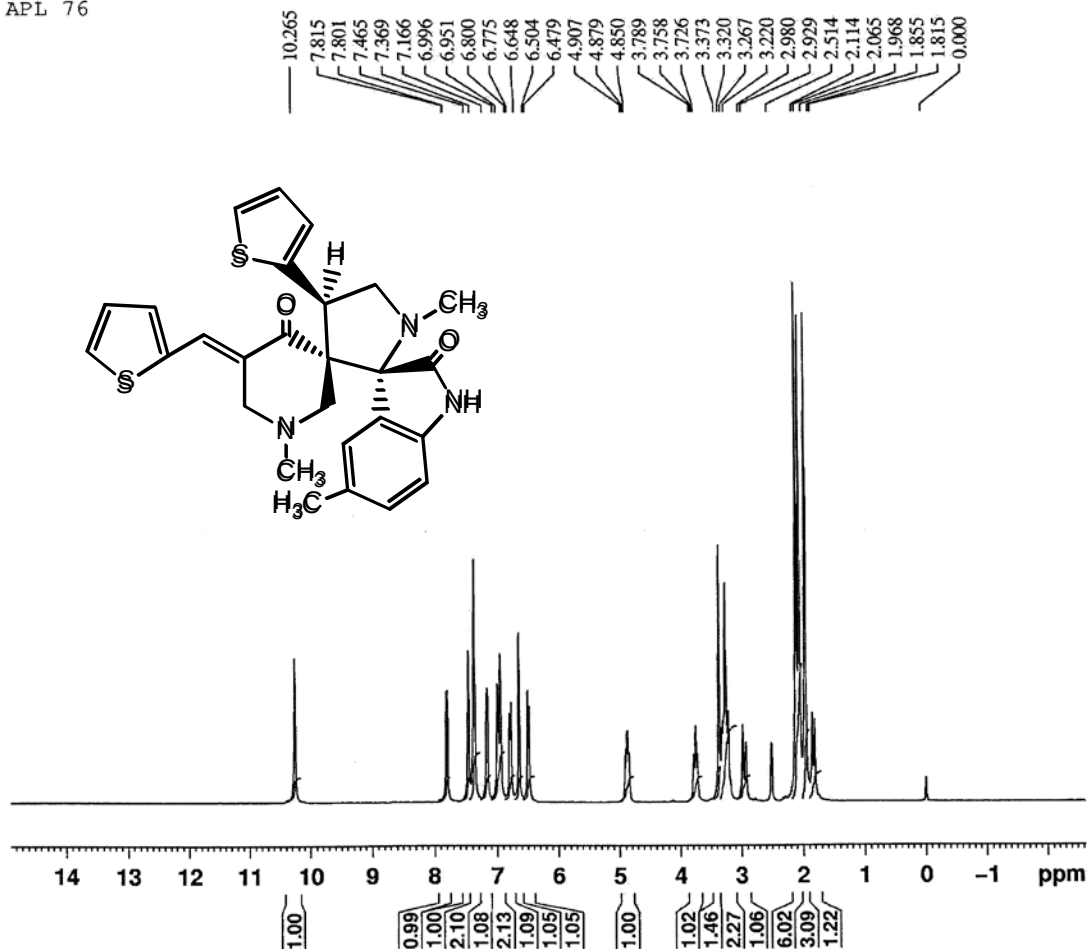
¹H spectrum of **4i**

APL75



¹³C spectrum of 4i

APL 76



Current Data Parameters
NAME feb-24-2012
EXPNO 15
PROCNO 1

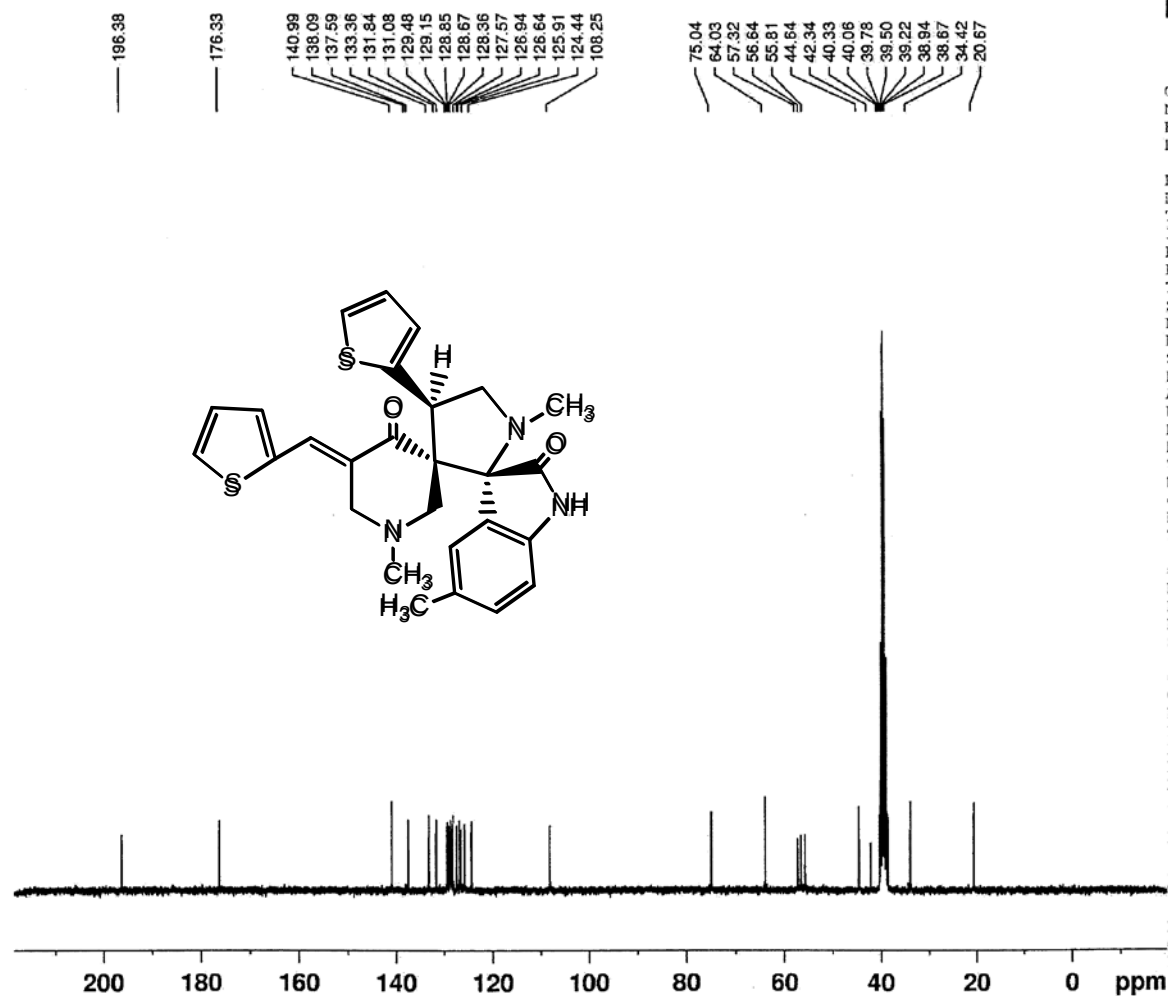
F2 - Acquisition Parameters
Date_ 20120224
Time 11.41
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
SWH 6172.839 Hz
FIDRES 0.094190 Hz
AQ 5.3084660 sec
RG 90.5
DW 81.000 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TDO 1

CHANNEL f1
NUC1 1H
P1 10.70 usec
PL1 -2.00 dB
SFO1 300.1318534 MHz

F2 - Processing parameters
SI 32768
SF 300.1299977 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H spectrum of 4j

APL 76



Current Data Parameters
NAME feb-24-2012
EXPNO 16
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120224
Time 11.58
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 733
DS 4
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
TD0 1

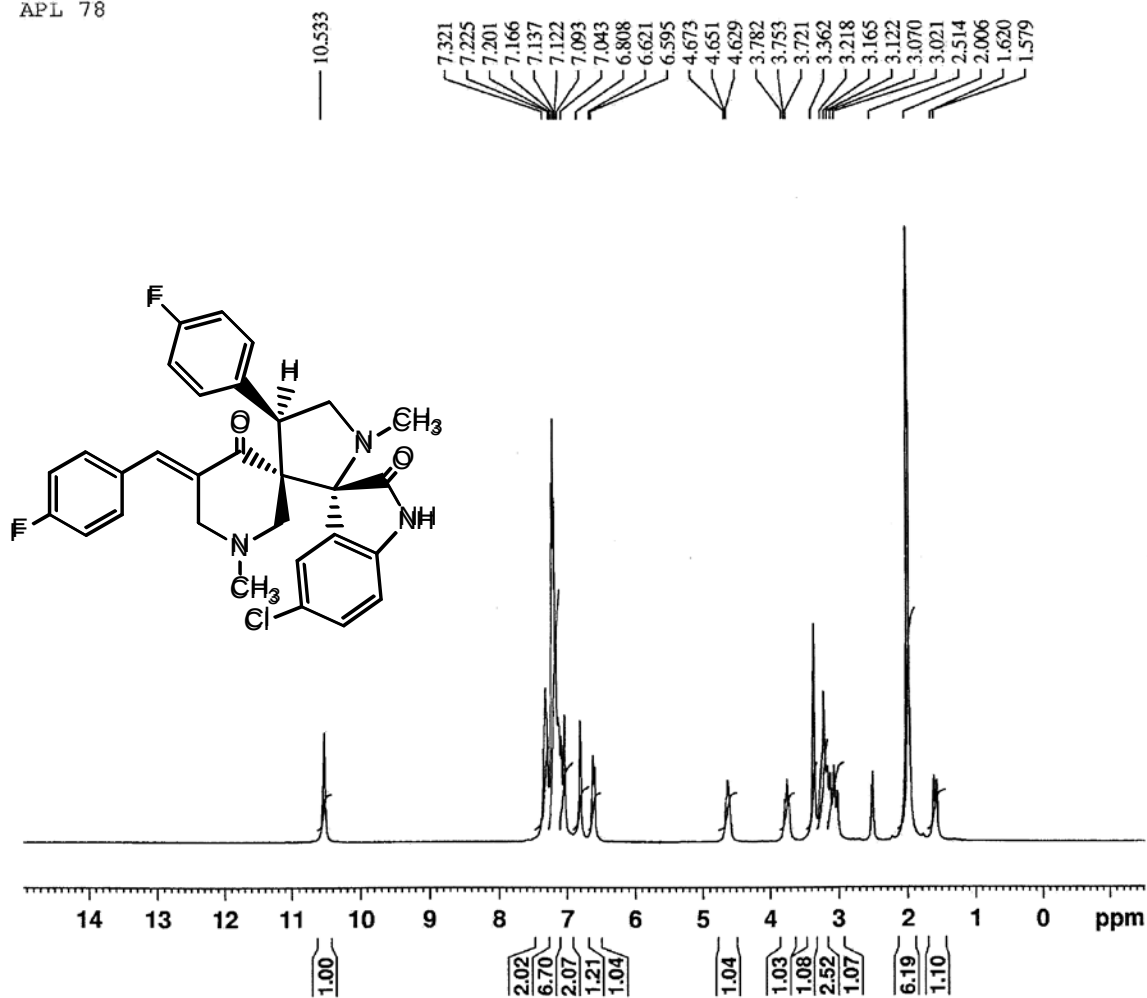
===== CHANNEL f1 =====
NUC1 13C
P1 10.10 usec
PL1 -2.00 dB
SFO1 75.4752953 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 115.00 usec
PL2 -2.00 dB
PL12 18.50 dB
PL13 22.50 dB
SFO2 300.1312005 MHz

F2 - Processing parameters
SI 32768
SF 75.4677839 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

¹³C spectrum of 4j

APL 78



Current Data Parameters
NAME feb-24-2012
EXPNO 14
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120224
Time 11.37
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
SWH 6172.839 Hz
FIDRES 0.094190 Hz
AQ 5.3084660 sec
RG 101.6
DW 81.000 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
NUC1 1H
P1 10.70 usec
PL1 -2.00 dB
SFO1 300.1318534 MHz

F2 - Processing parameters
SI 32768
SF 300.1299974 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

^1H spectrum of **4k**

APL78



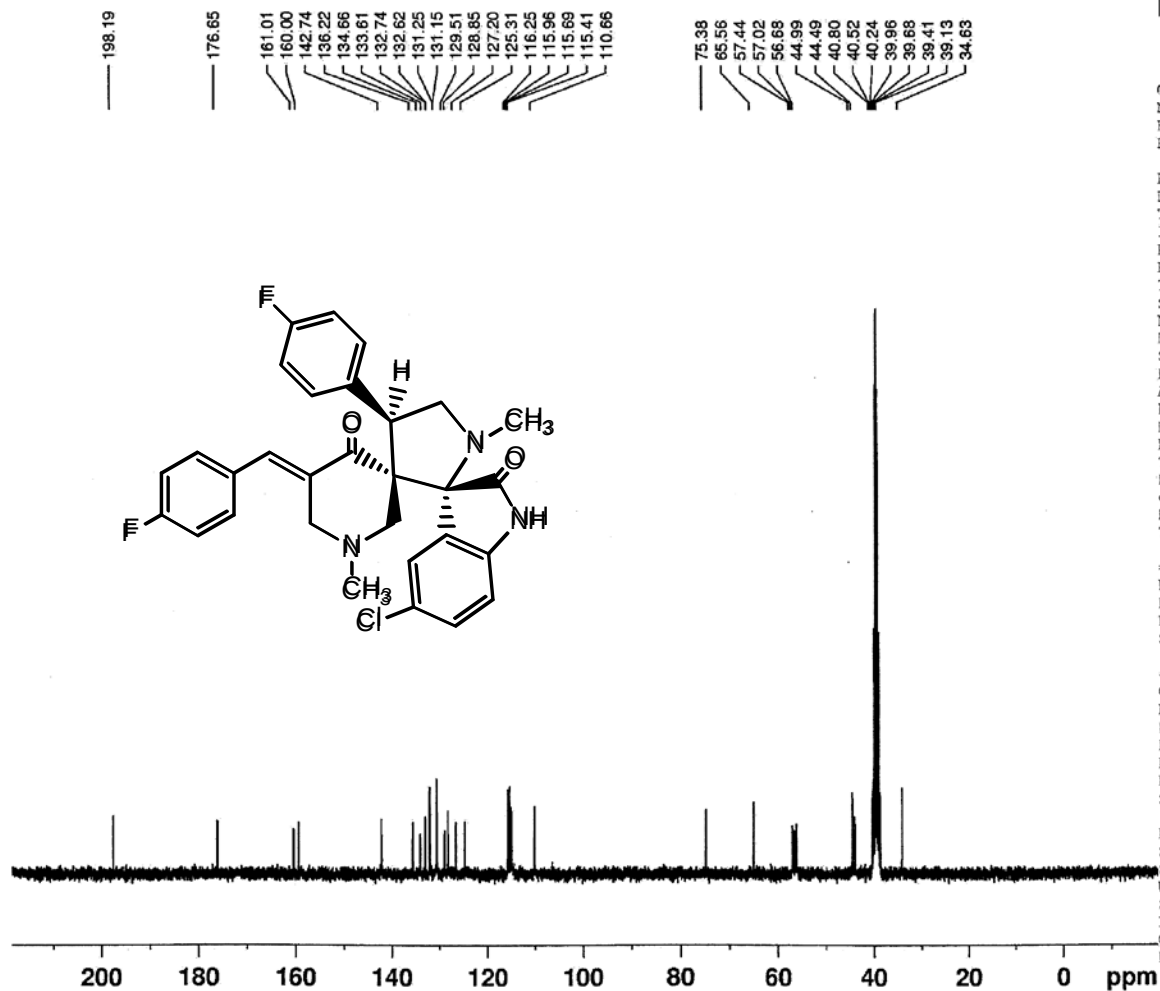
Current Data Parameters
NAME feb-24-2012
EXPNO 49
PROCNO 1

F2 - Acquisition Parameters
Date_ 20120224
Time 17.06
INSTRUM av300
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 301
DS 4
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
TD0 1

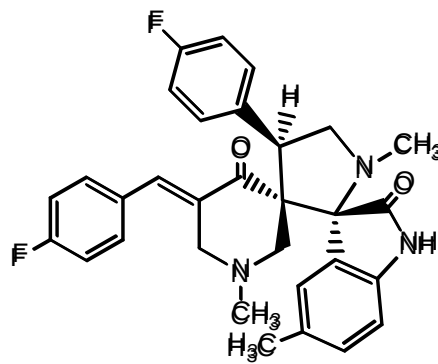
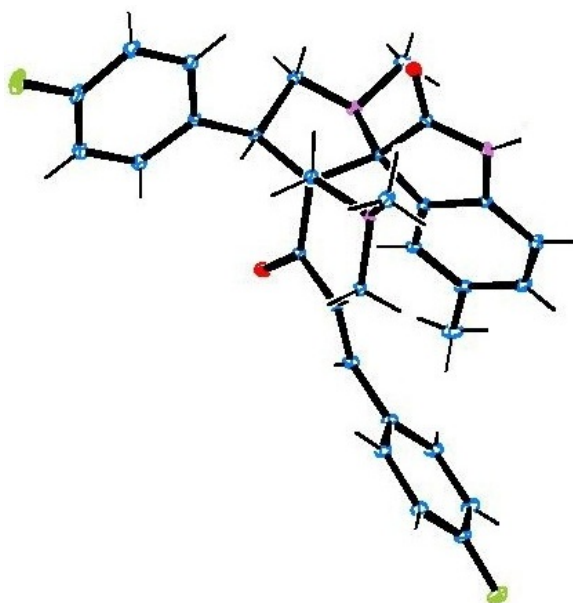
===== CHANNEL f1 =====
NUC1 13C
P1 10.10 usec
PL1 -2.00 dB
SFO1 75.4752953 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 115.00 usec
PL2 -2.00 dB
PL12 18.50 dB
PL13 22.50 dB
SFO2 300.1312005 MHz

F2 - Processing parameters
SI 32768
SF 75.4677838 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



^{13}C spectrum of 4k



ORTEP diagram of compounds **4a** ((CCDC 883122))