

Supporting Information

Catalyst-free four-component domino synthetic approach toward versatile multicyclic spirooxindole pyran scaffolds

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Experimental Section

General remarks:

The nitroketene dithioacetals, isatin derivatives, various amines, various active methylene compounds and solvents were obtained from Sigma Aldrich and Fluka Co. which used without further purification. IR spectra: Bruker Tensor 27 spectrometer. NMR spectra: Bruker DRX-300 Avance instrument (300 MHz for ^1H and 75.4 MHz for ^{13}C) with $\text{DMSO-}d_6$ as solvents. Chemical shifts are expressed in parts per million (ppm), and coupling constant (J) are reported in hertz (Hz). Mass spectra: Agilent 5975C VL MSD with Triple-Axis detector operating at an ionization potential of 70 eV. Elemental analyses for C, H and N: Heraeus CHNO-Rapid analyzer. Melting points: electrothermal 9100 apparatus.

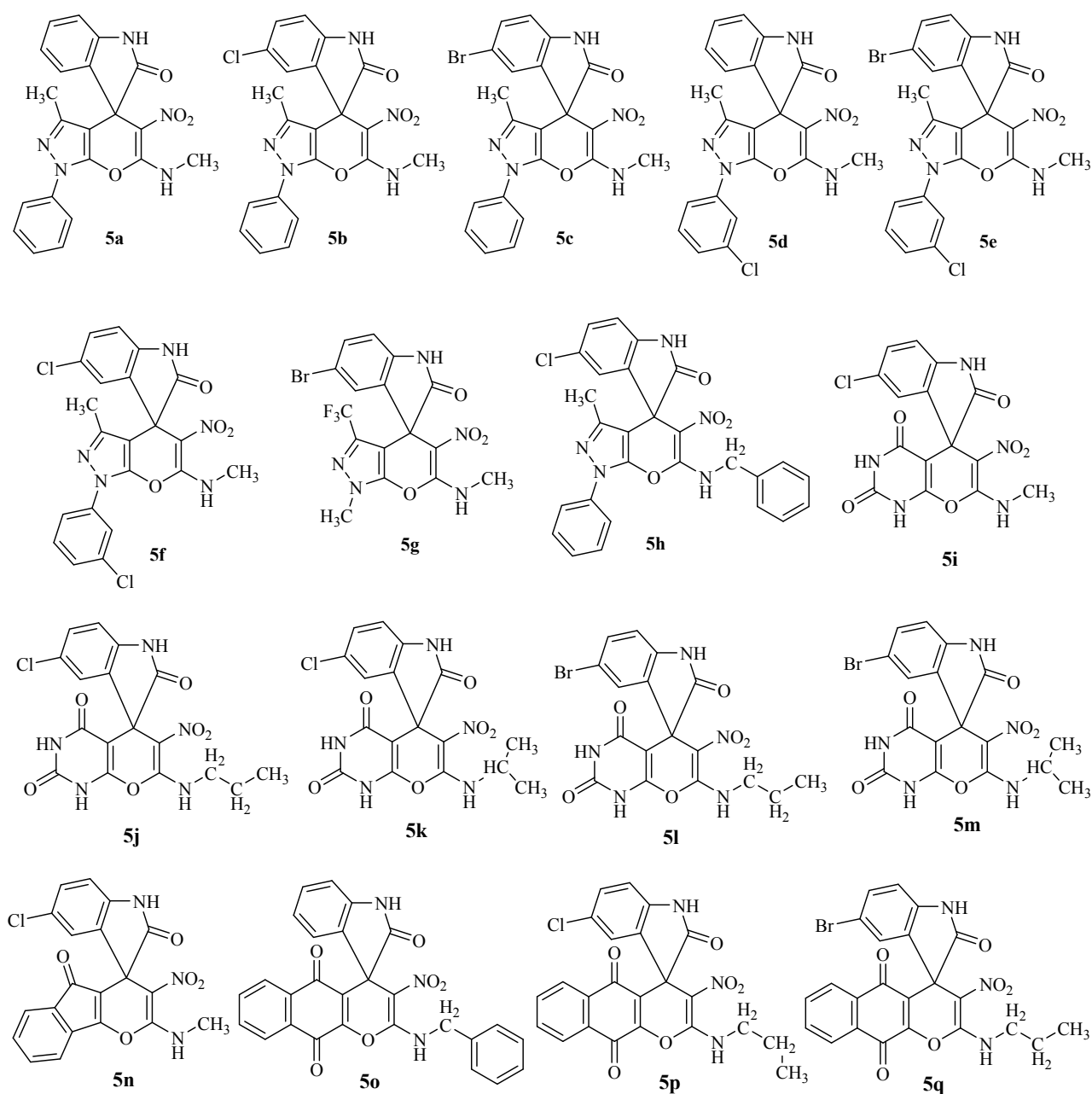
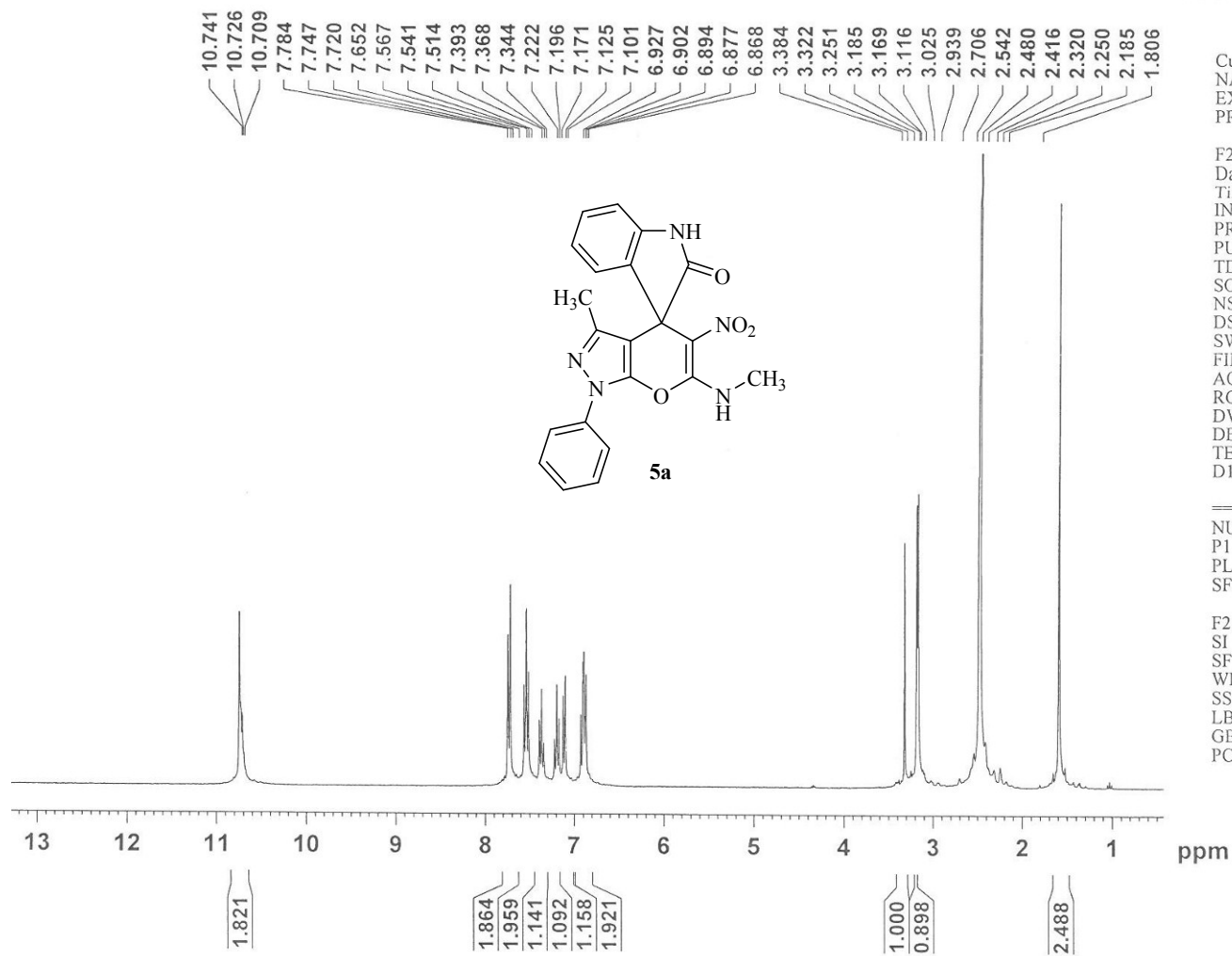


FIGURE 1. Structure of all products 5a-q.



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PROCNO 1

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TE 300.0 K
D1 6.00000000 sec

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PL1 3.00 dB
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LB 0.30 Hz
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¹H NMR of 5a



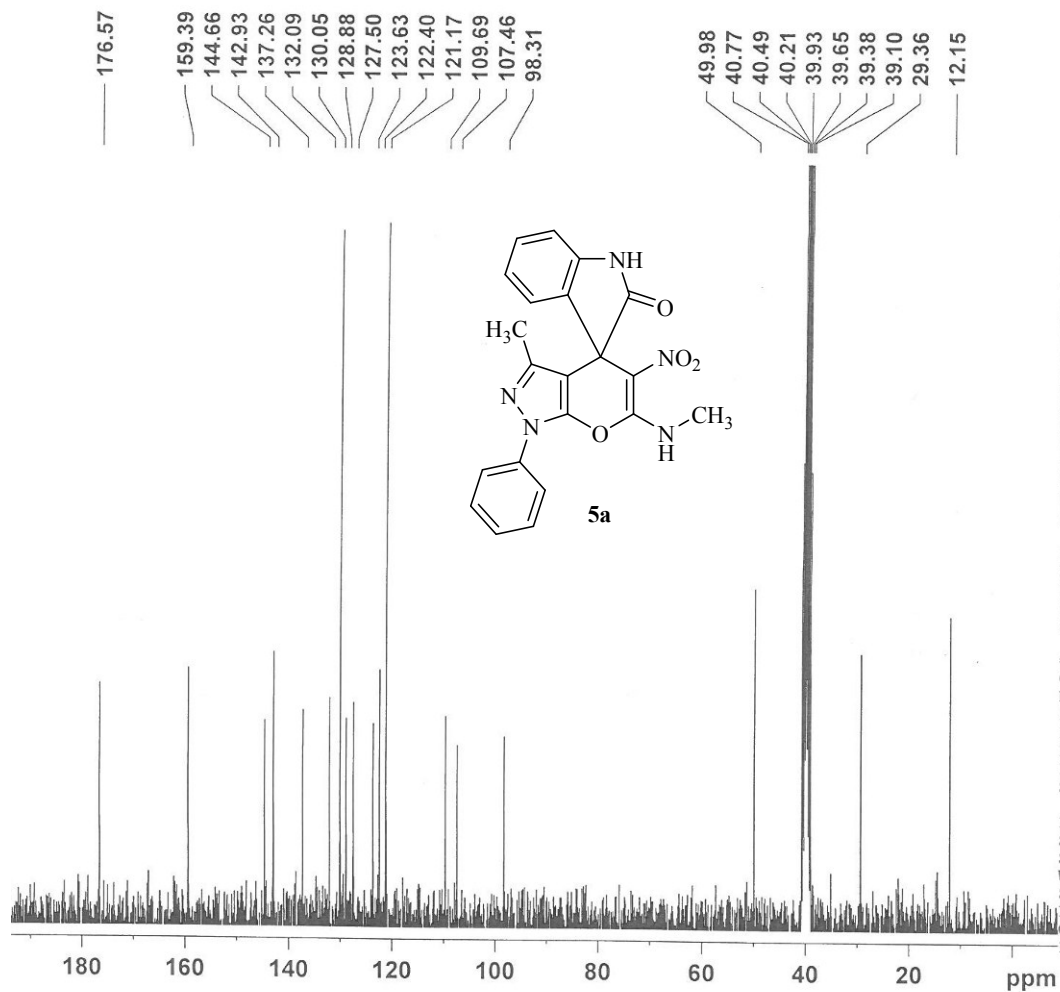
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FIDRES 0.274439 Hz
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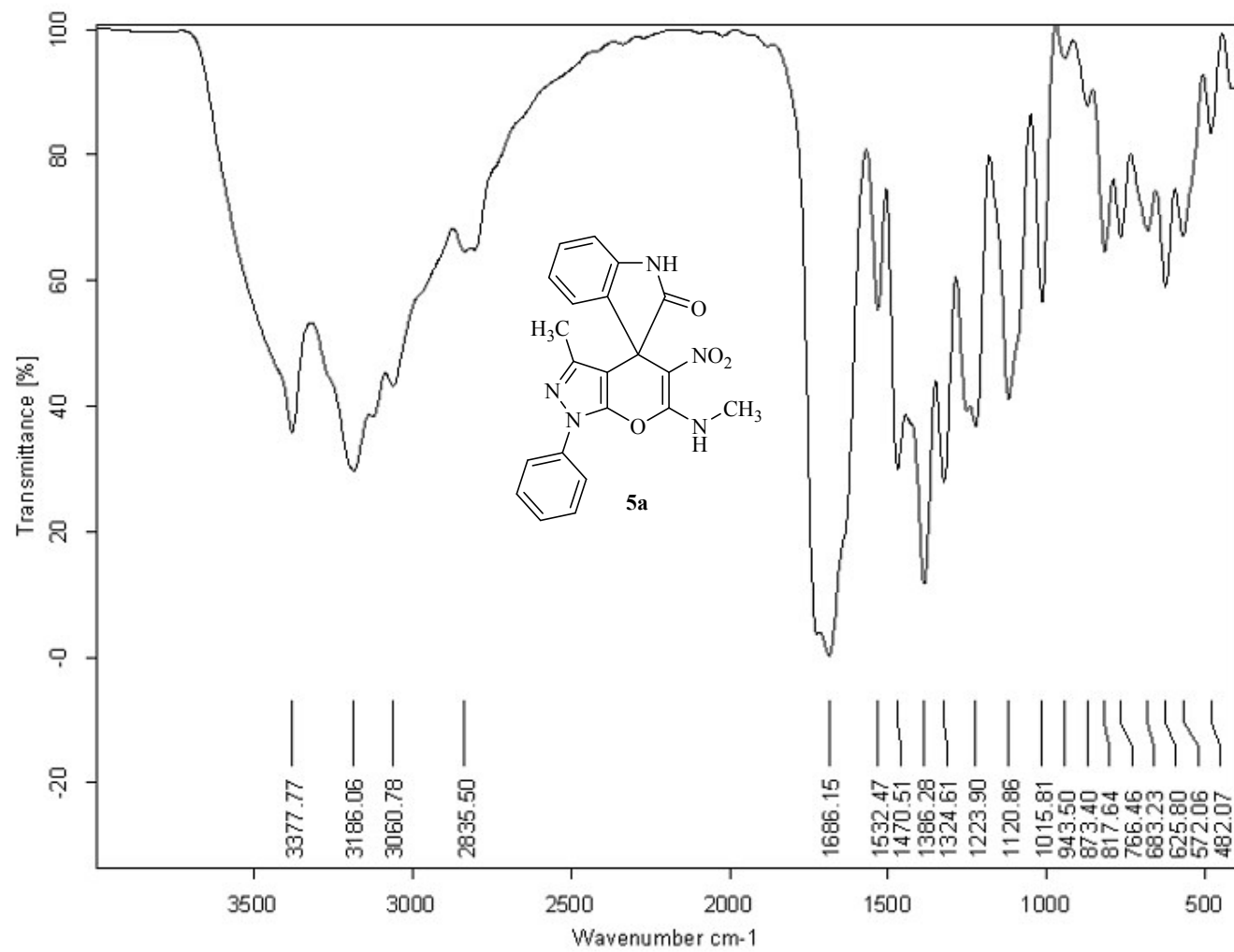
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SFO1 75.4099117 MHz

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PL13 23.00 dB
SFO2 299.8711995 MHz

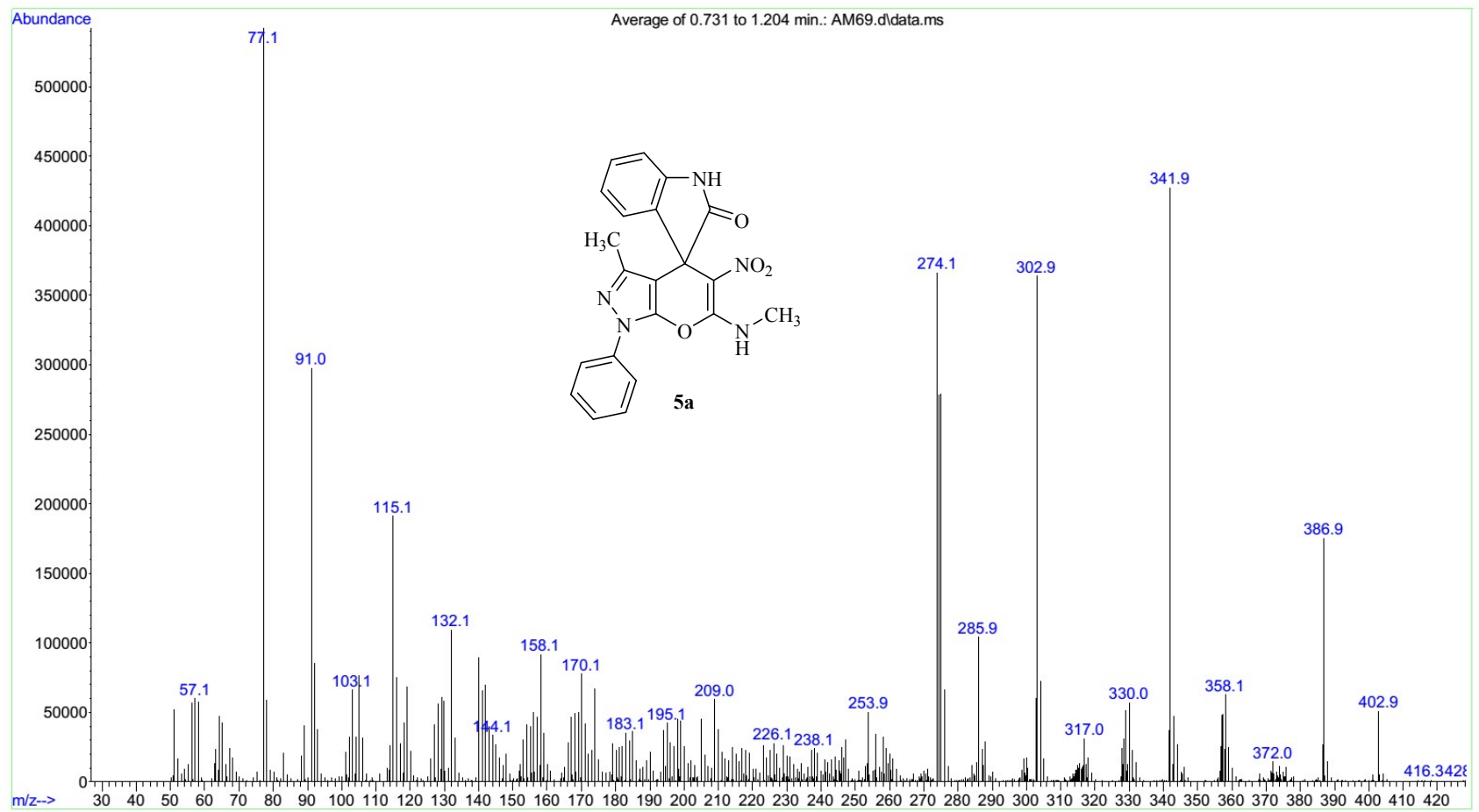
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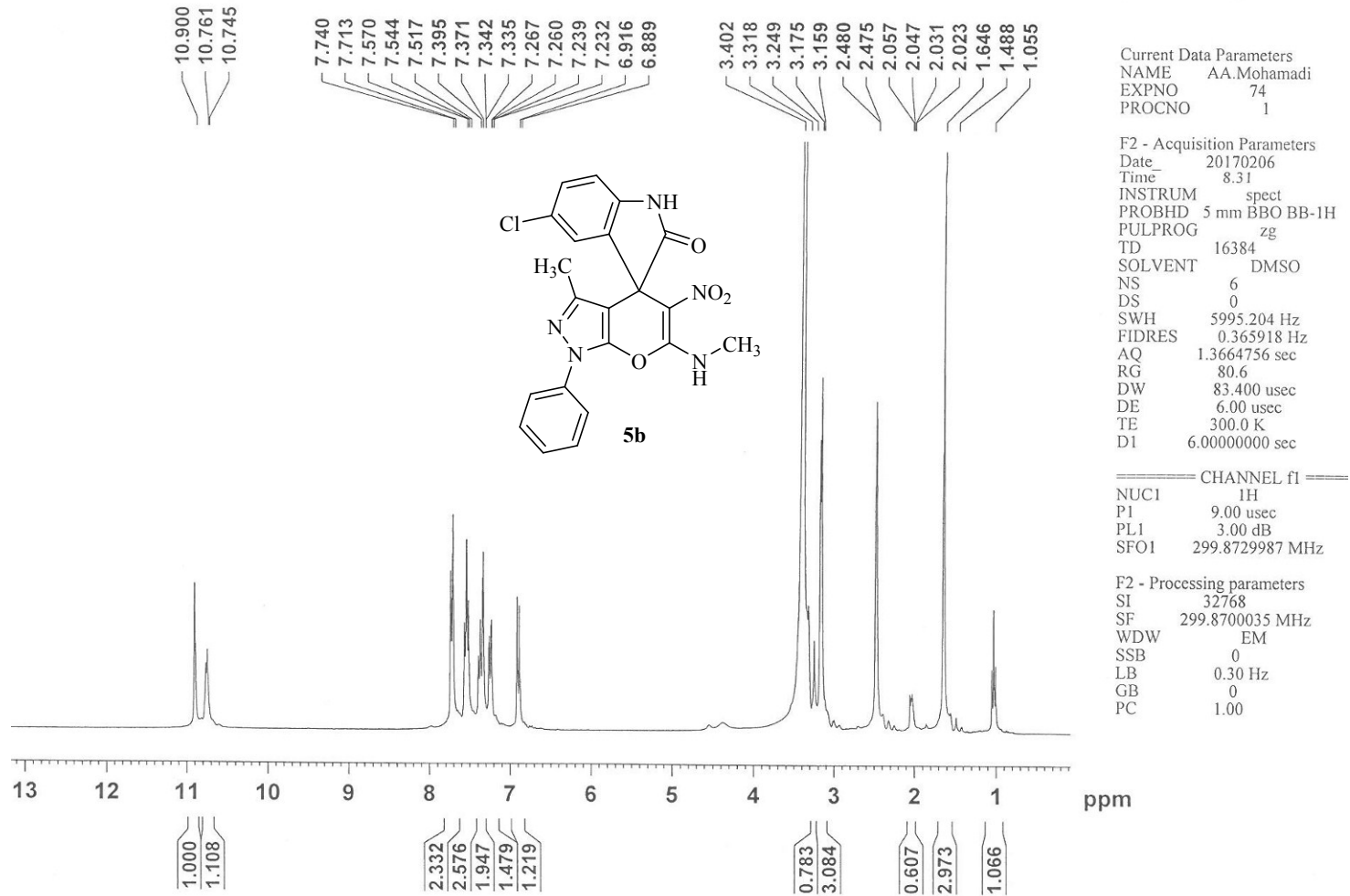
¹³C NMR of 5a



IR of 5a



Mass of 5a





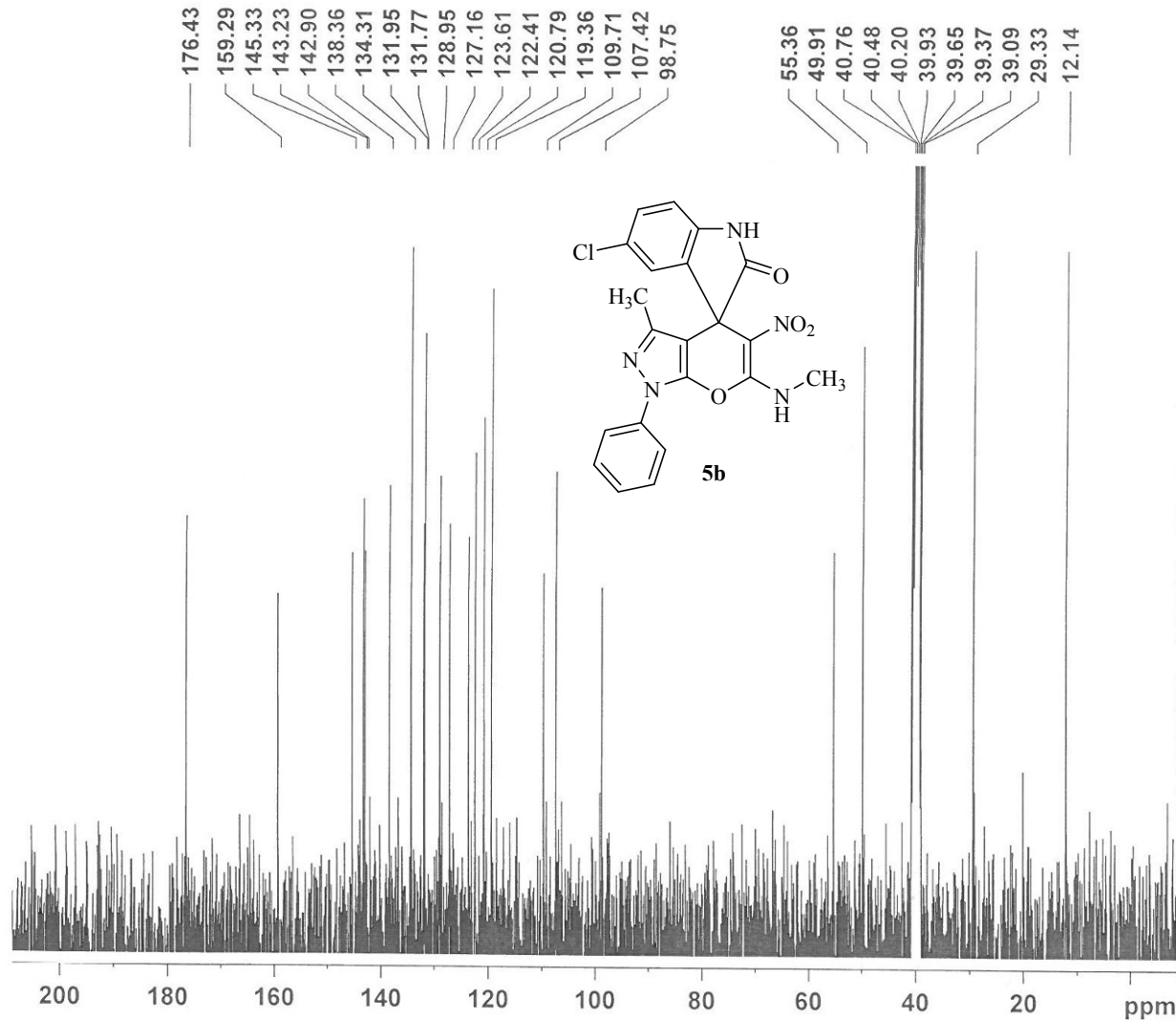
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SOLVENT DMSO
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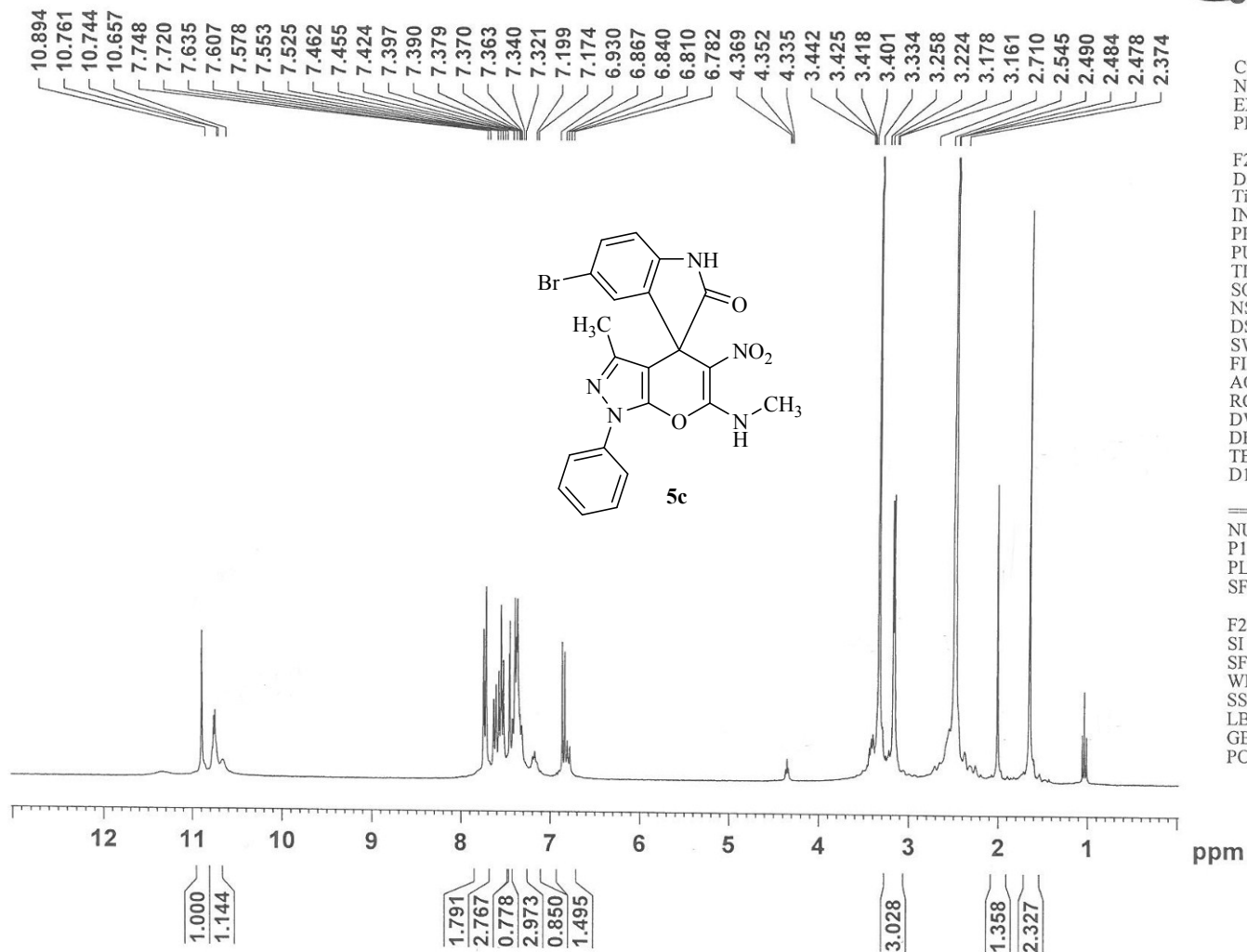
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NUC2 1H
PCPD2 80.00 usec
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PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

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¹³C NMR of 5b



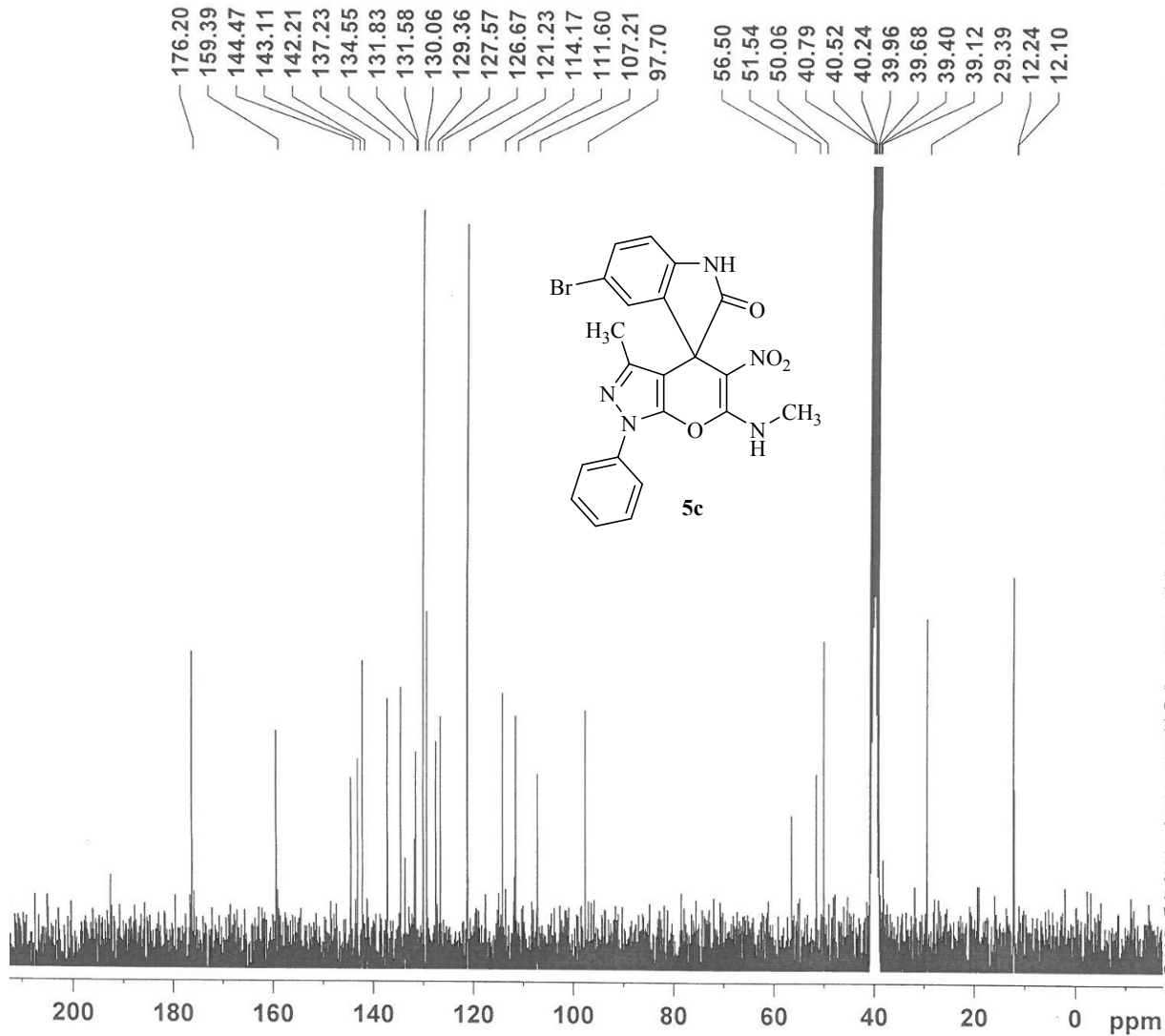
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SOLVENT DMSO
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SWH 6172.839 Hz
FIDRES 0.376760 Hz
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DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

CHANNEL f1
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PL1 3.00 dB
SFO1 299.8729987 MHz

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PC 1.00

¹H NMR of 5c



Current Data Parameters
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EXPNO 75
PROCNO 1

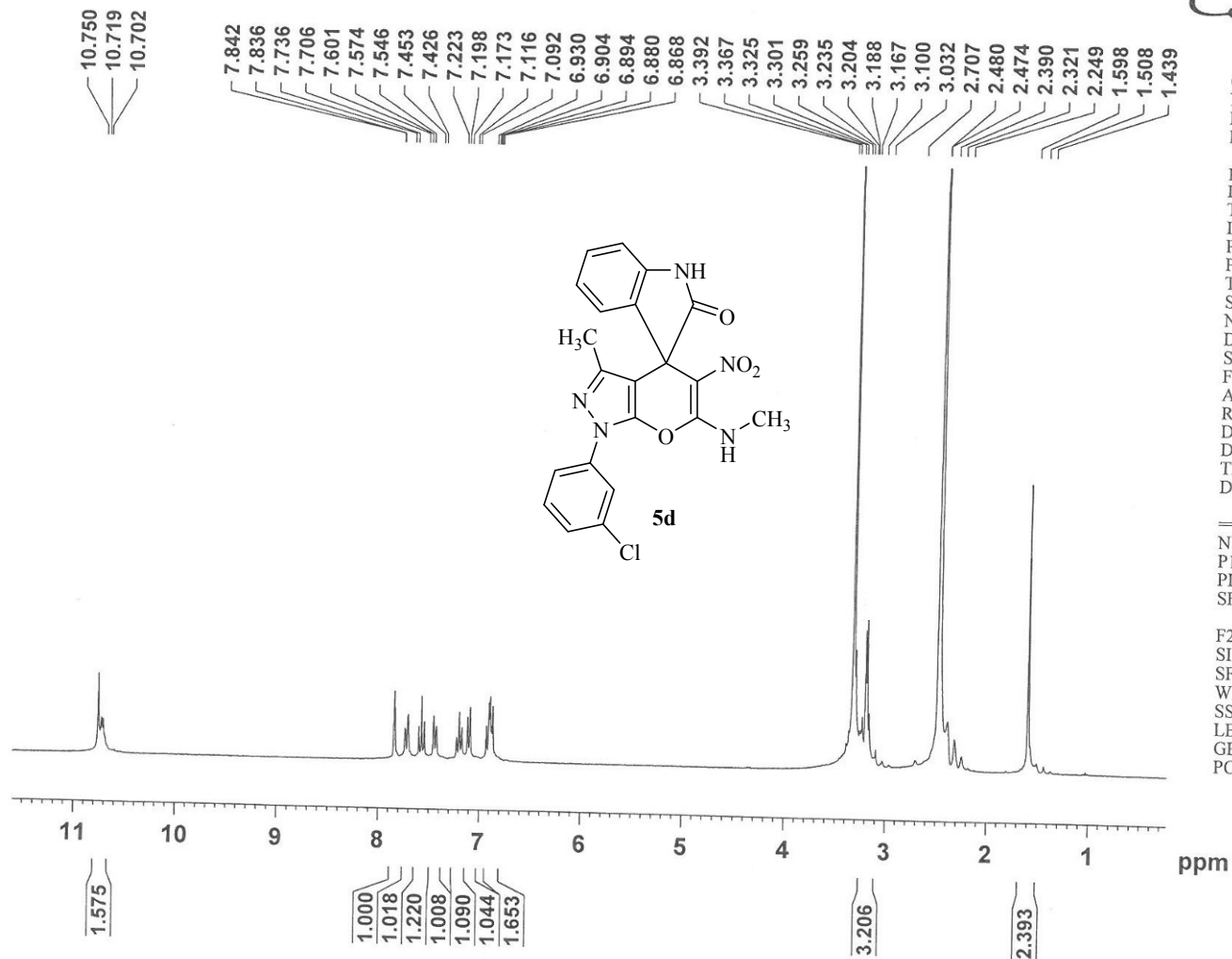
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NS 2000
DS 0
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FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.00000000 sec
d11 0.03000000 sec
d12 0.00002000 sec

==== CHANNEL f1 =====
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P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

==== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

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SF 75.4023710 MHz
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LB 1.00 Hz
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PC 1.40

¹³C NMR of 5c



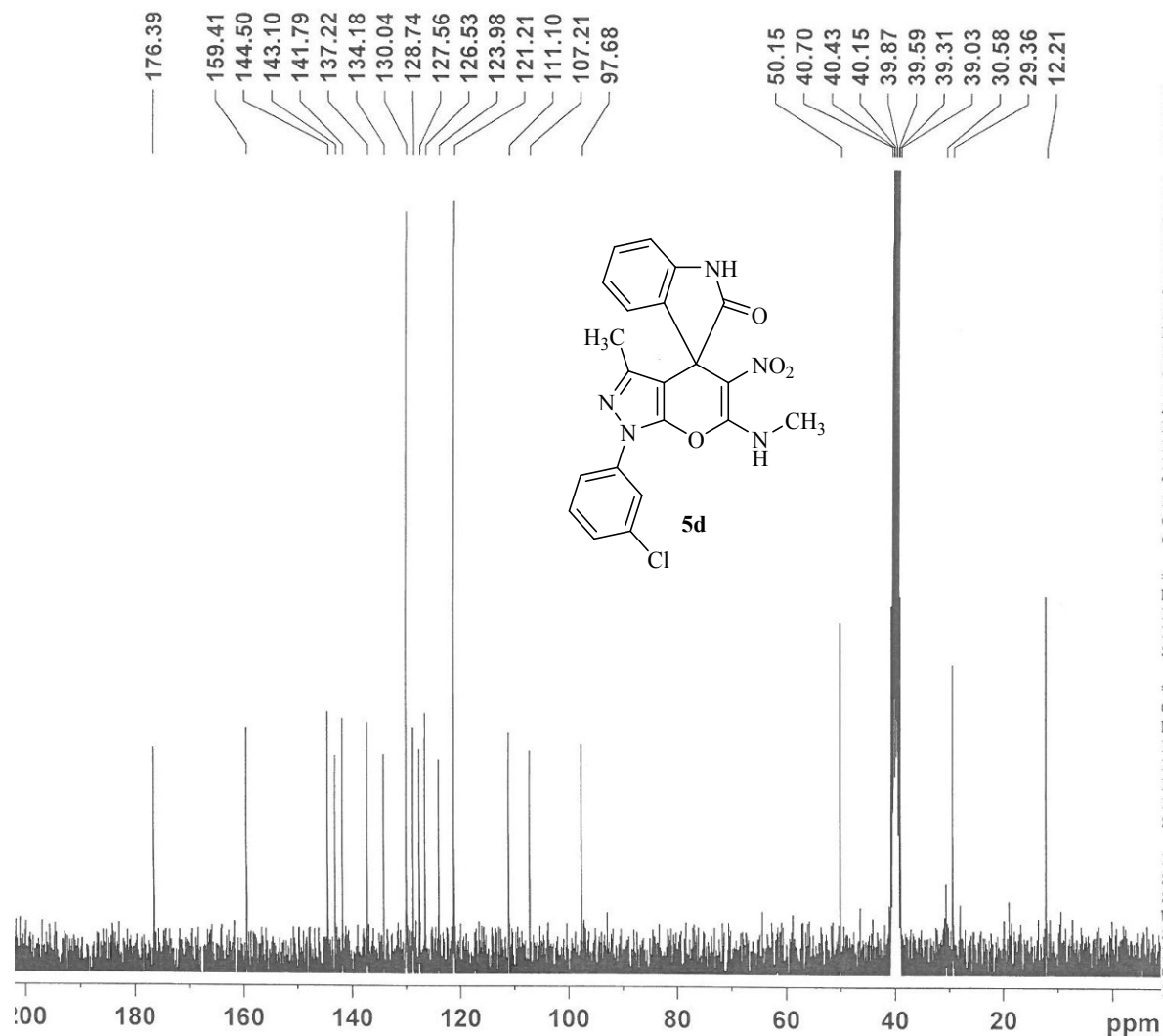
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EXPNO 21
PROCNO 1

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PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 362
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

CHANNEL f1
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
WDW EM
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LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of 5d



Current Data Parameters
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EXPNO 64
PROCNO 1

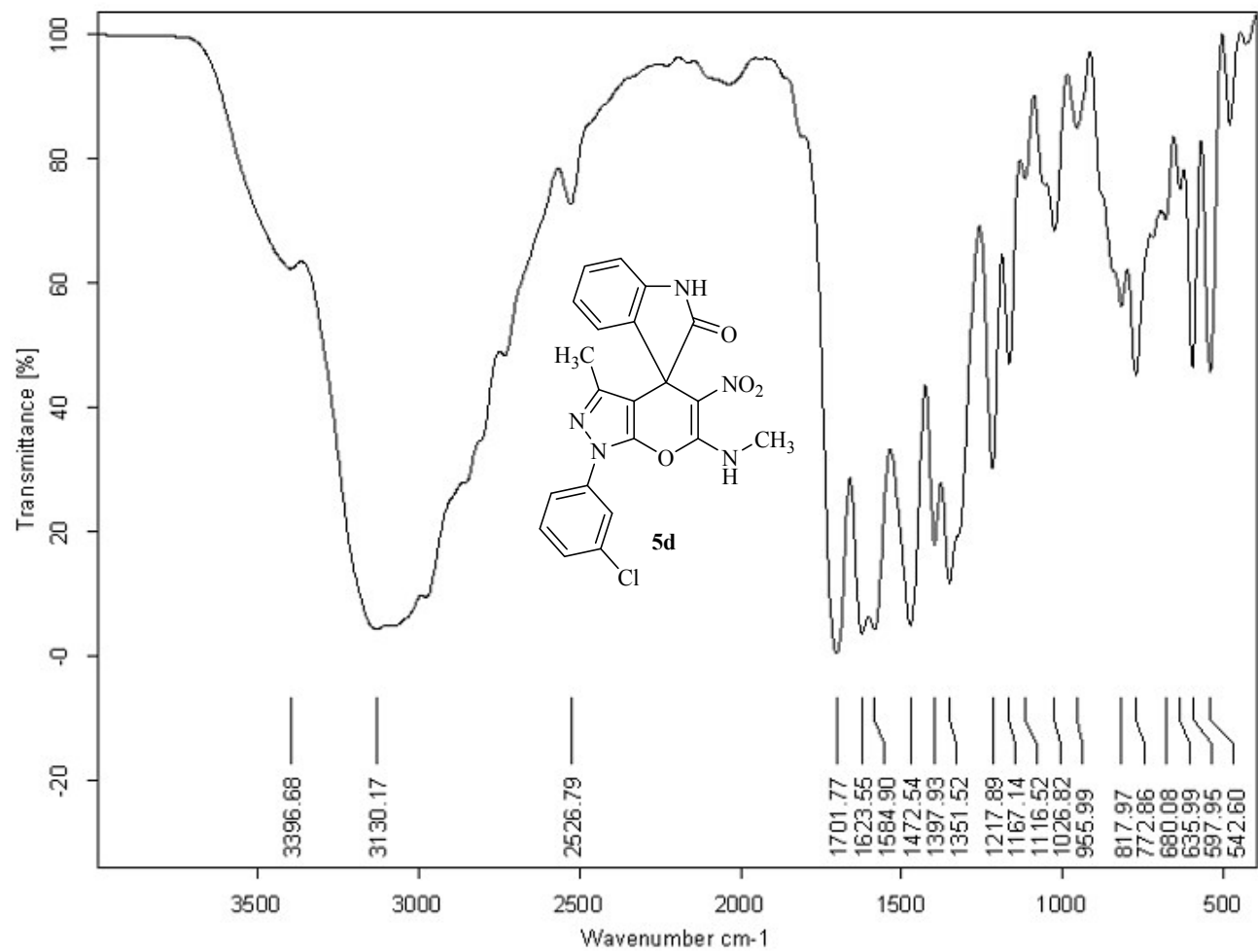
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Time_ 10.49
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 500
DS 0
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.00000000 sec
d11 0.03000000 sec
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PL1 -6.00 dB
SFO1 75.4099117 MHz

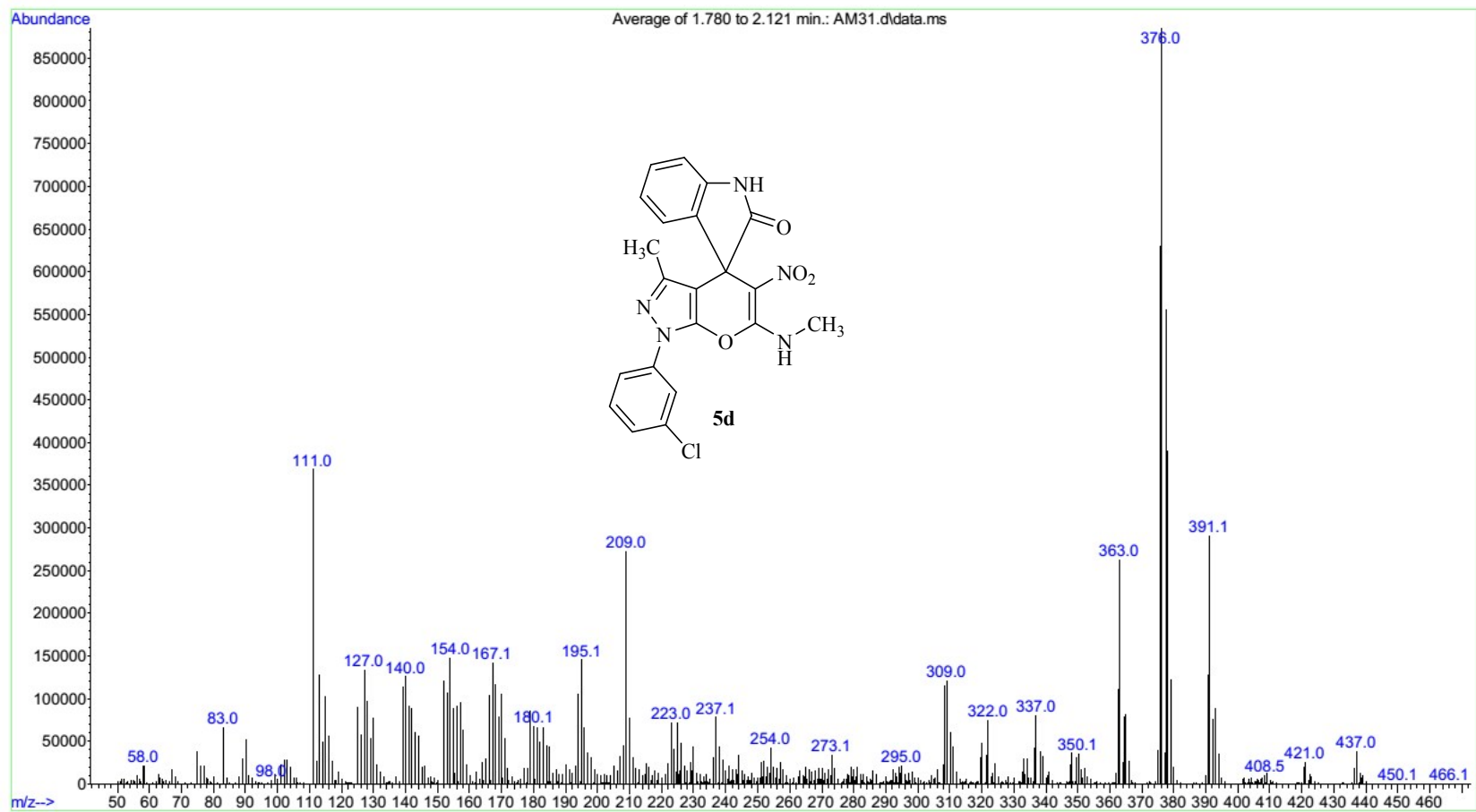
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NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
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F2 - Processing parameters
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SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

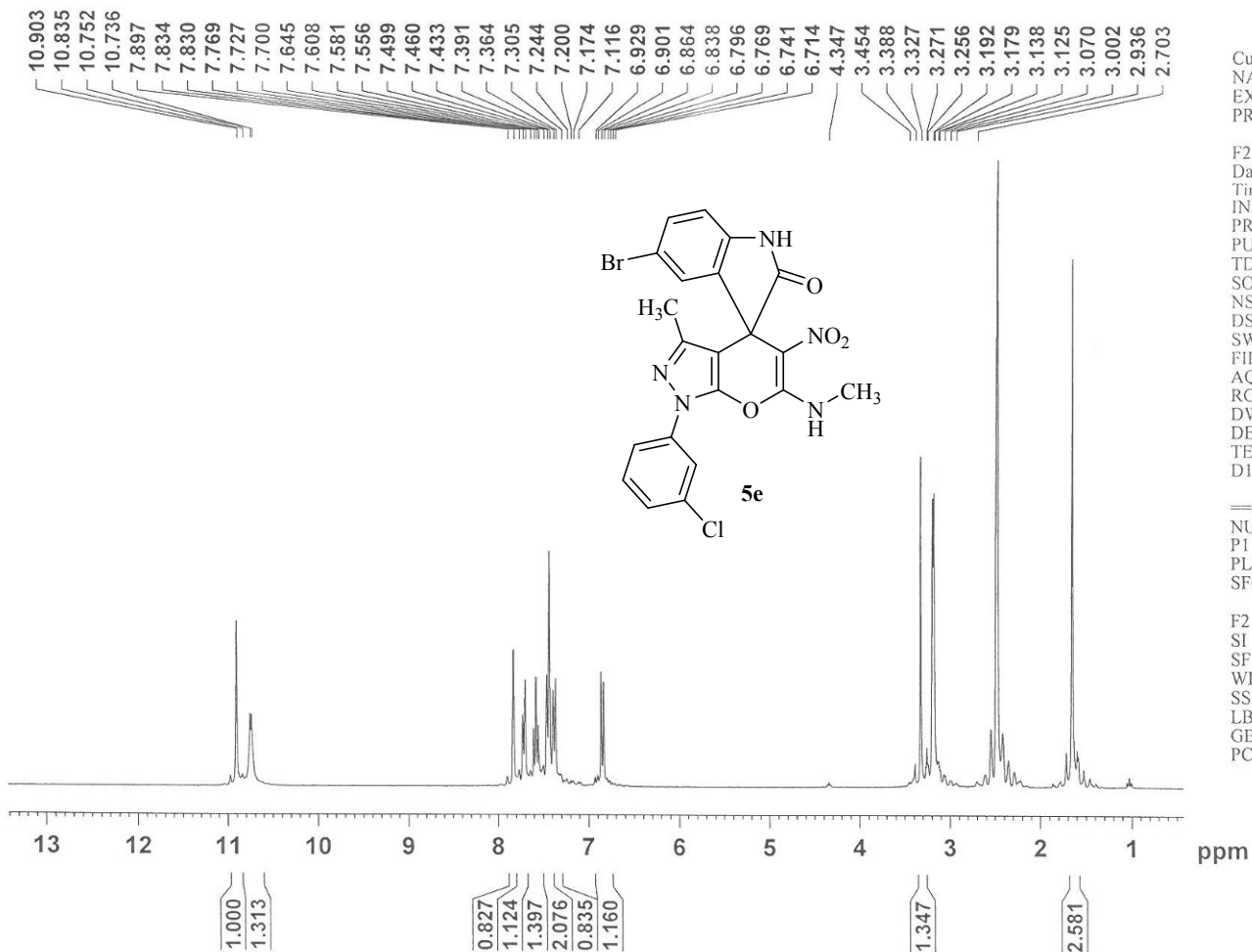
¹³C NMR of 5d



IR of 5d



Mass of 5d



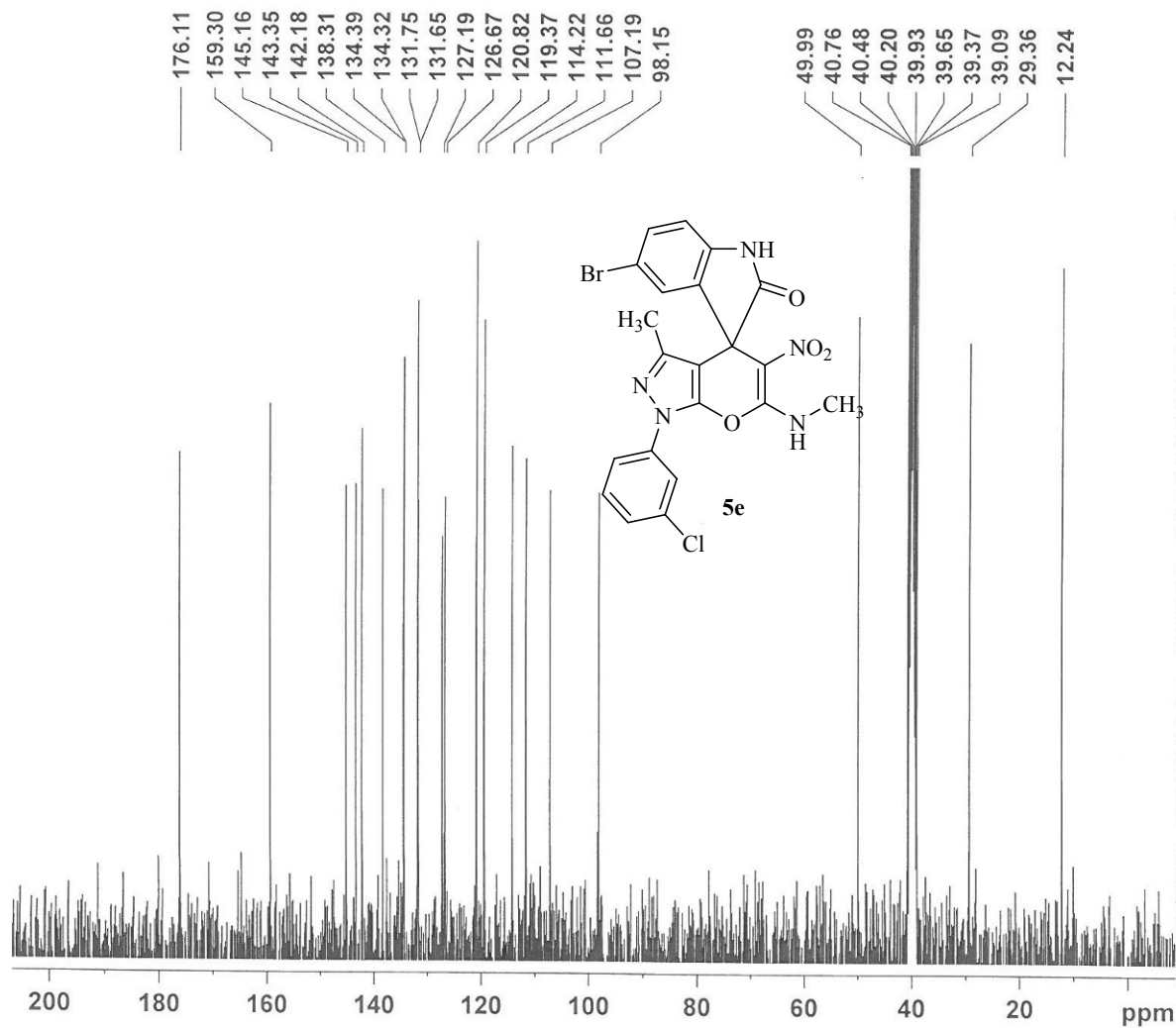
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PROCNO 1

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PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 256
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

===== CHANNEL f1 =====
NUC1 1H
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PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
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GB 0
PC 1.00

¹H NMR of 5e



Current Data Parameters
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EXPNO 65
PROCNO 1

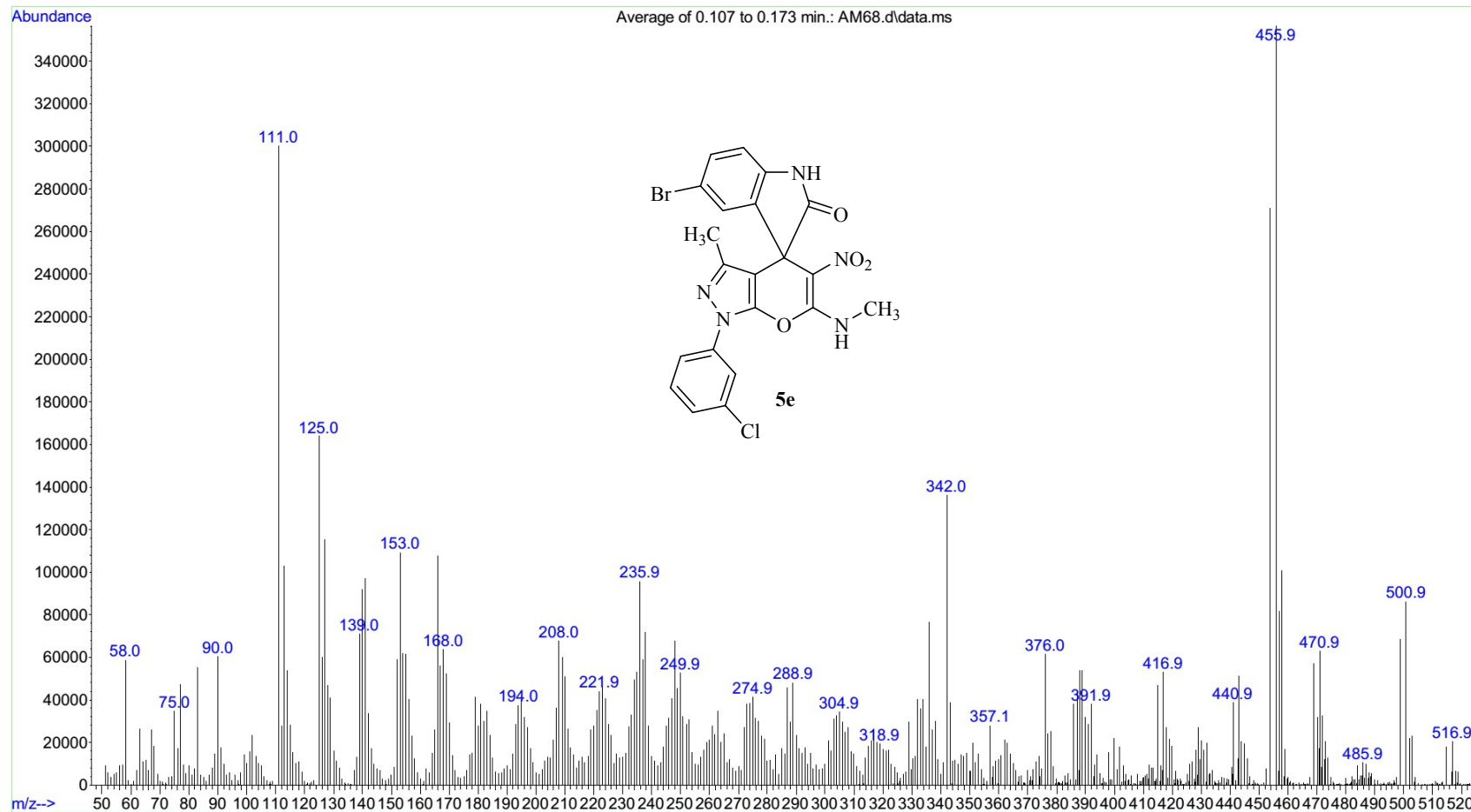
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FIDRES 0.274439 Hz
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RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.00000000 sec
d11 0.03000000 sec
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==== CHANNEL f1 =====
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PL1 -6.00 dB
SFO1 75.4099117 MHz

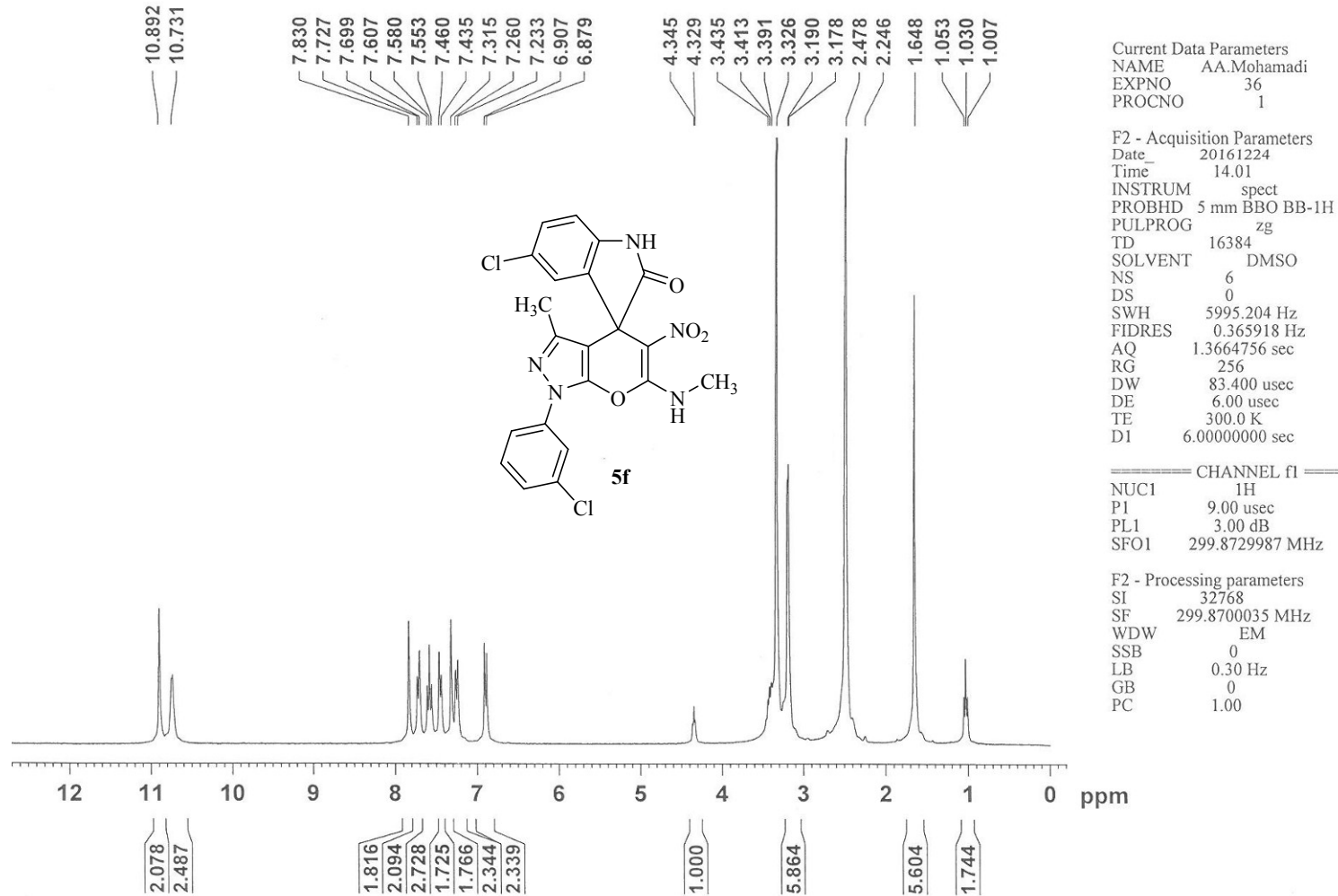
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NUC2 1H
PCPD2 80.00 usec
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PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

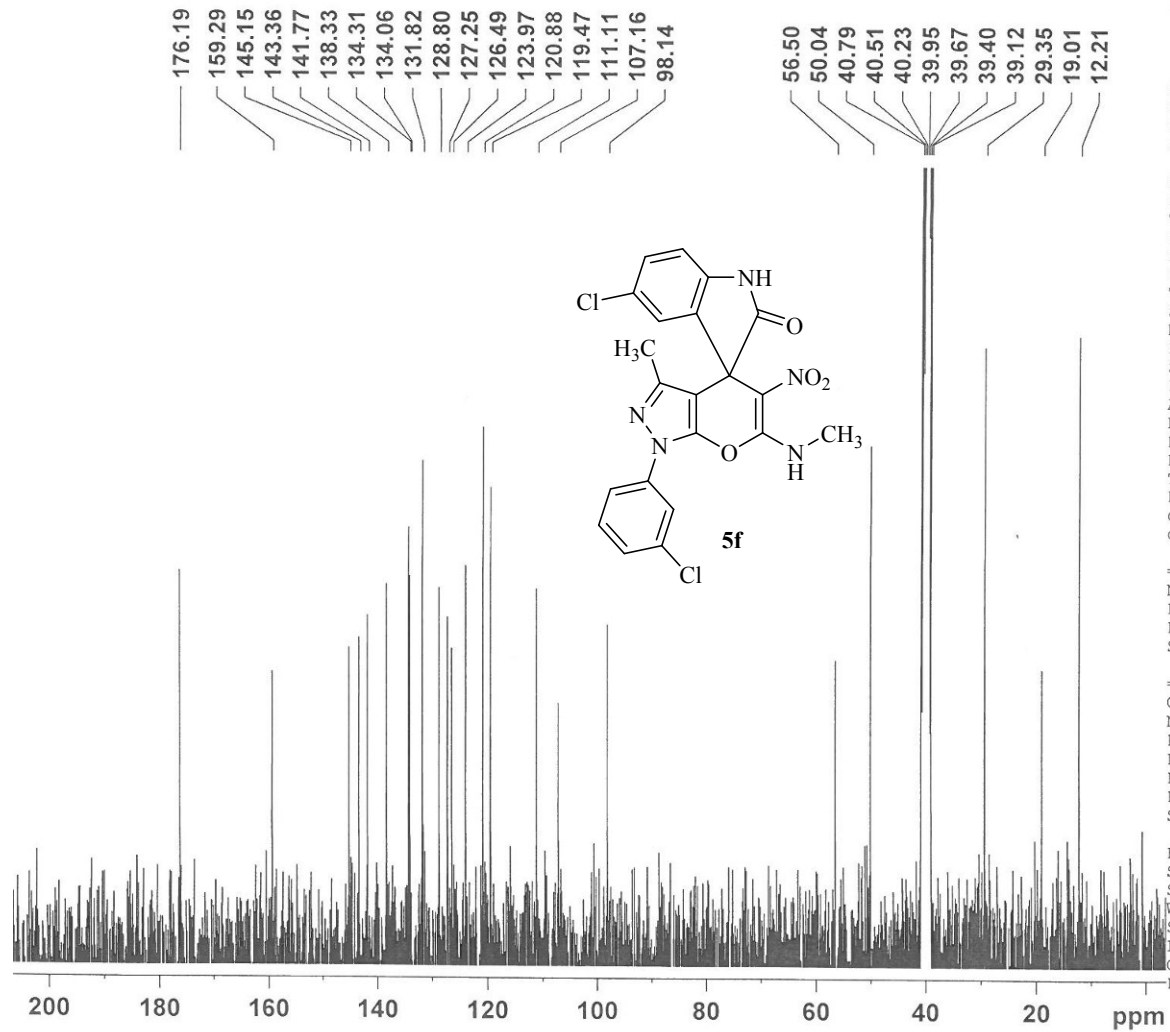
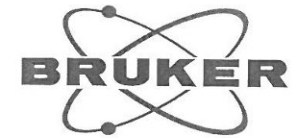
¹³C NMR of 5e



Mass of 5e



¹H NMR of 5f



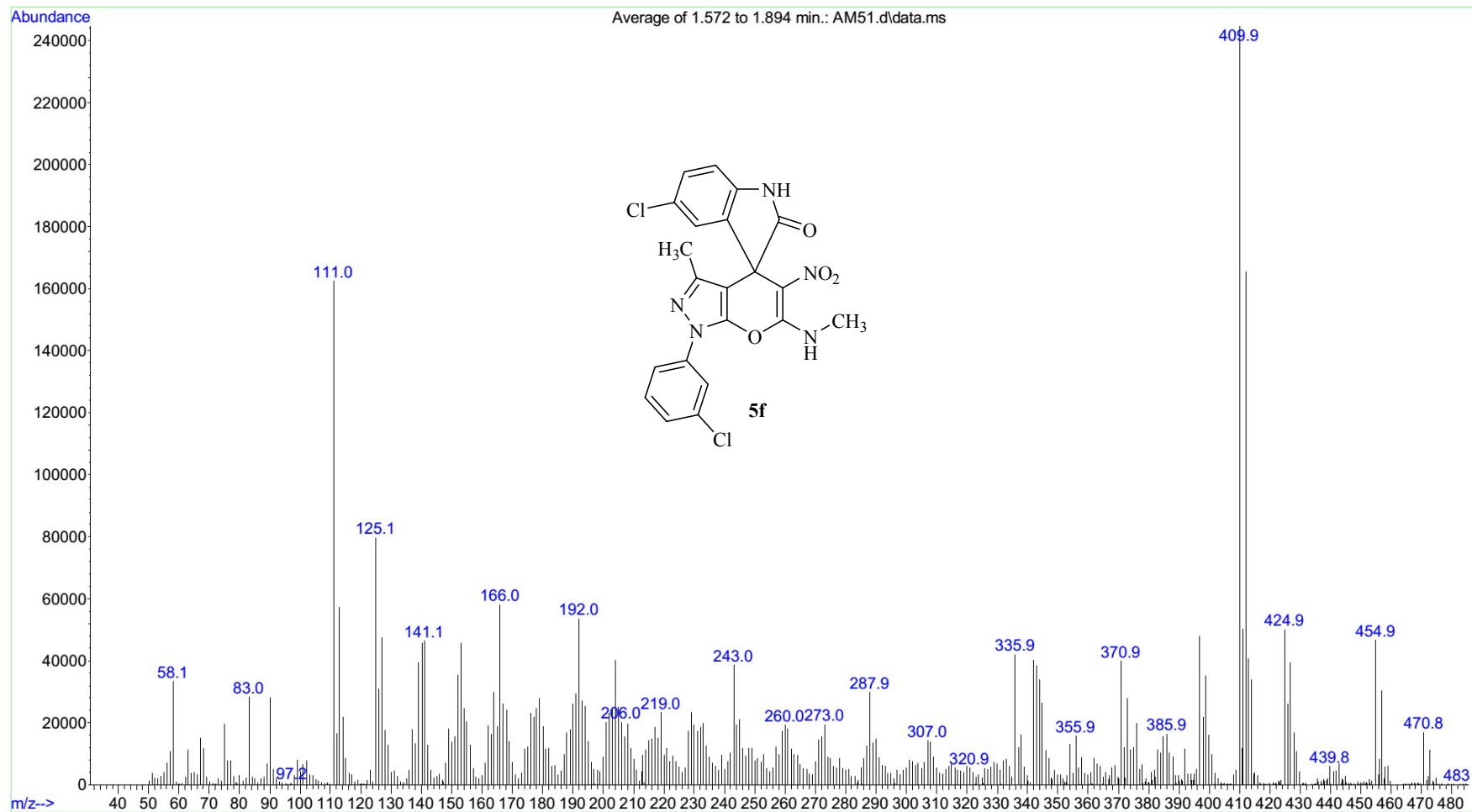
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EXPNO 39
PROCNO 1

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PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 1500
DS 0
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 4.00000000 sec
d11 0.03000000 sec
d12 0.00002000 sec

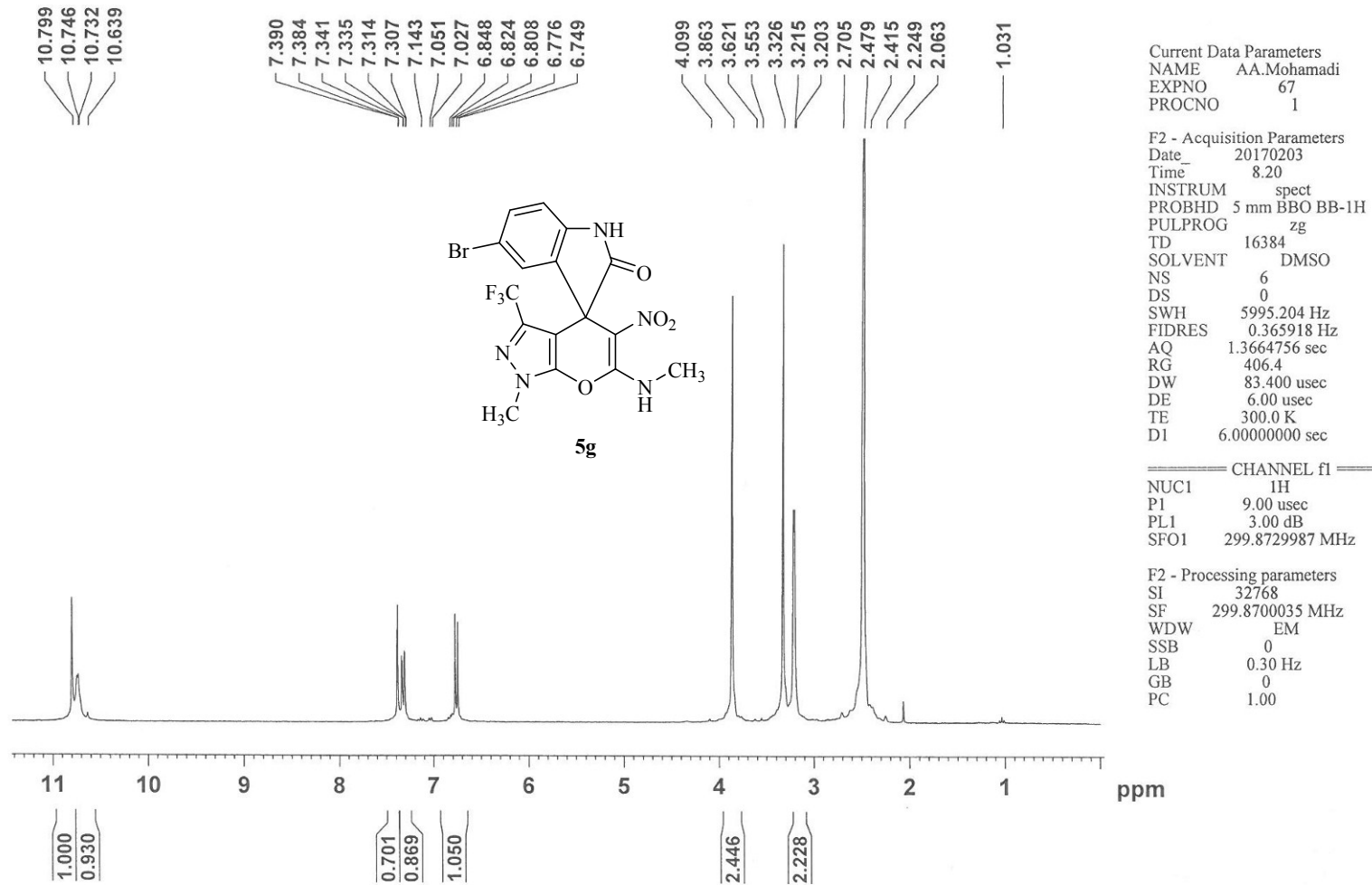
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NUC1 13C
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PL1 -6.00 dB
SFO1 75.4099117 MHz

==== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

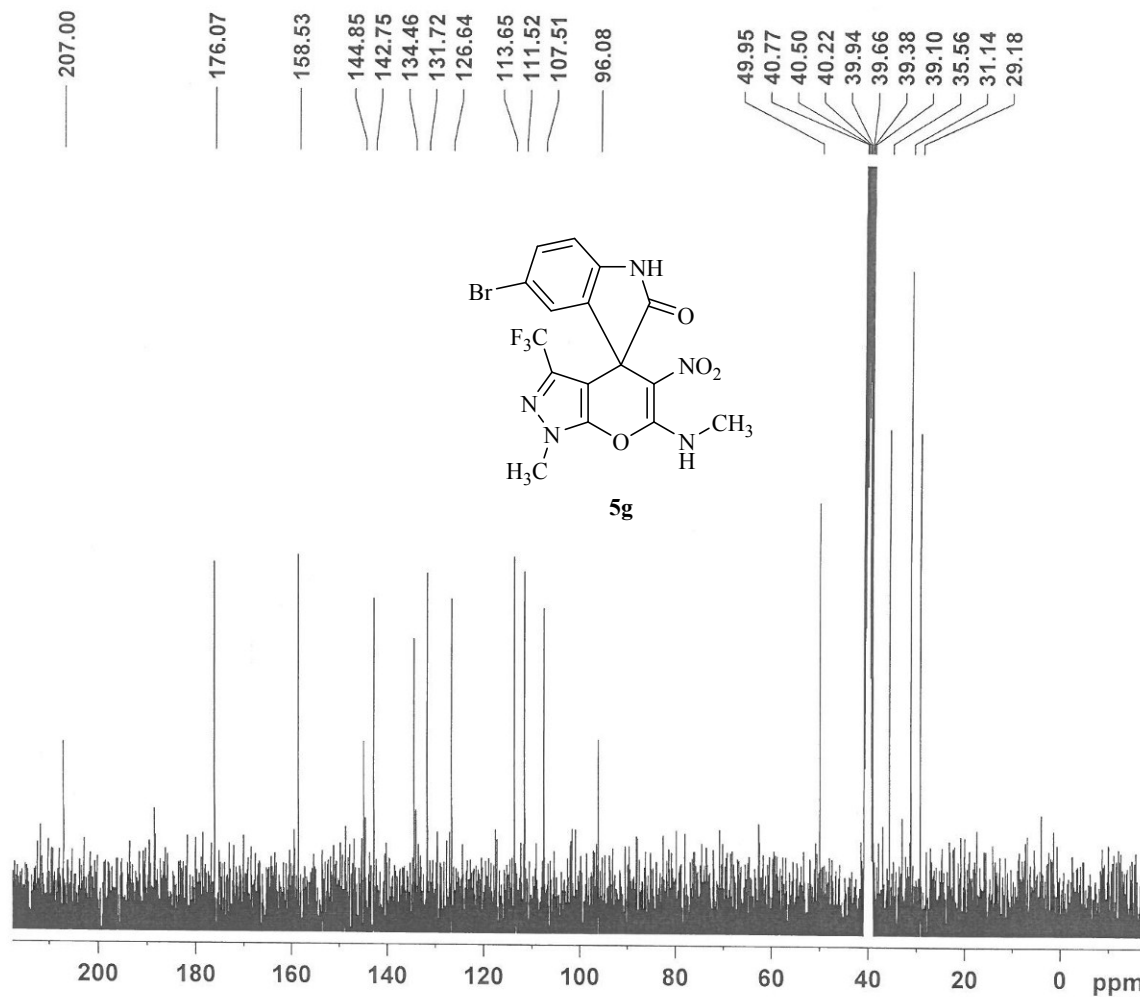
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GB 0
PC 1.40



Mass of 5f



¹H NMR of 5g



Current Data Parameters
NAME AA.Mohamadi
EXPNO 77
PROCNO 1

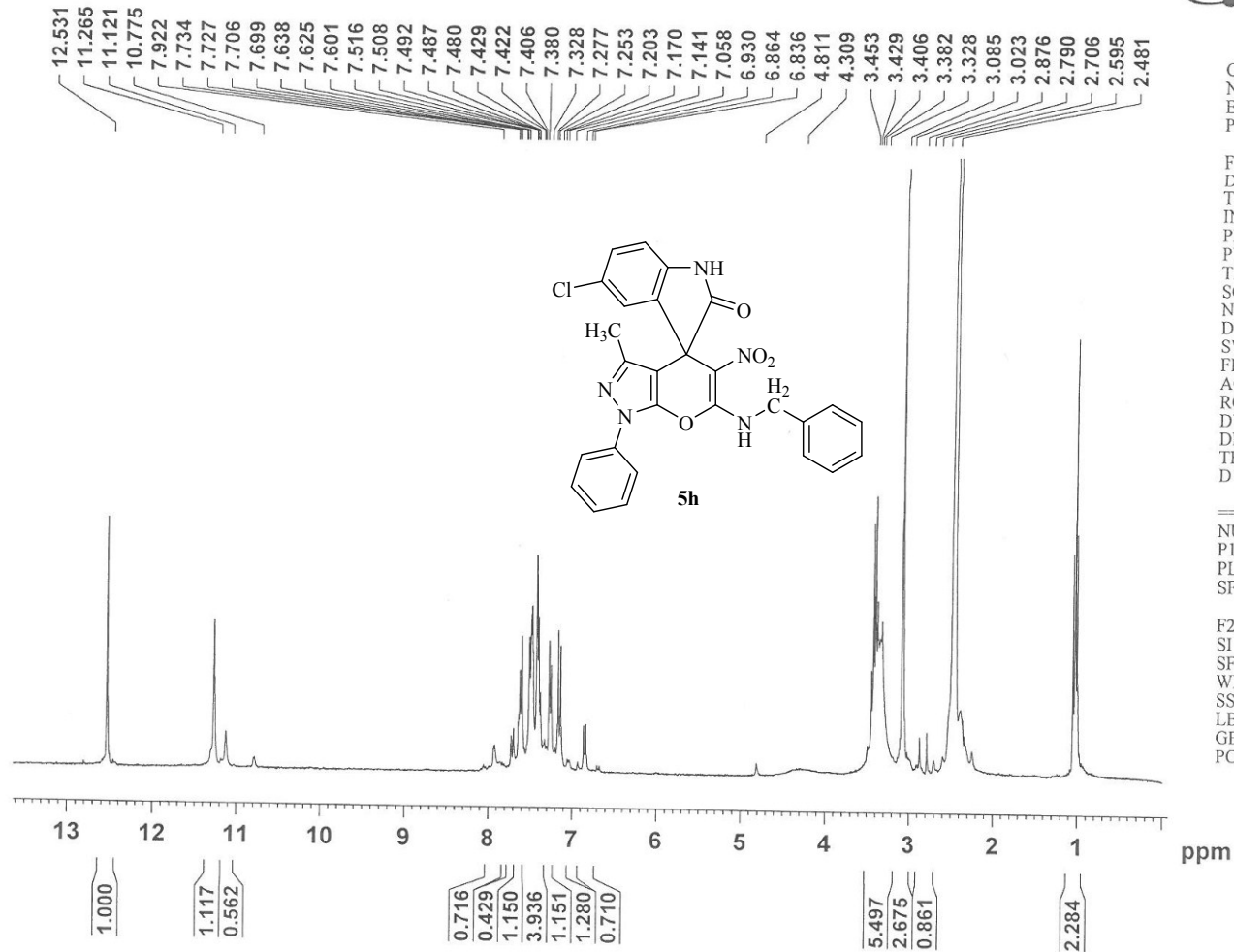
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FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.00000000 sec
d11 0.03000000 sec
d12 0.00002000 sec

==== CHANNEL f1 =====
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

==== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
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SF 75.4023710 MHz
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GB 0
PC 1.40

¹³C NMR of 5g



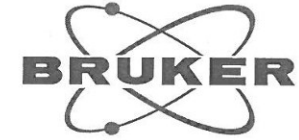
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PROCNO 1

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SOLVENT DMSO
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DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 362
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

CHANNEL f1
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

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GB 0
PC 1.00

¹H NMR of 5h



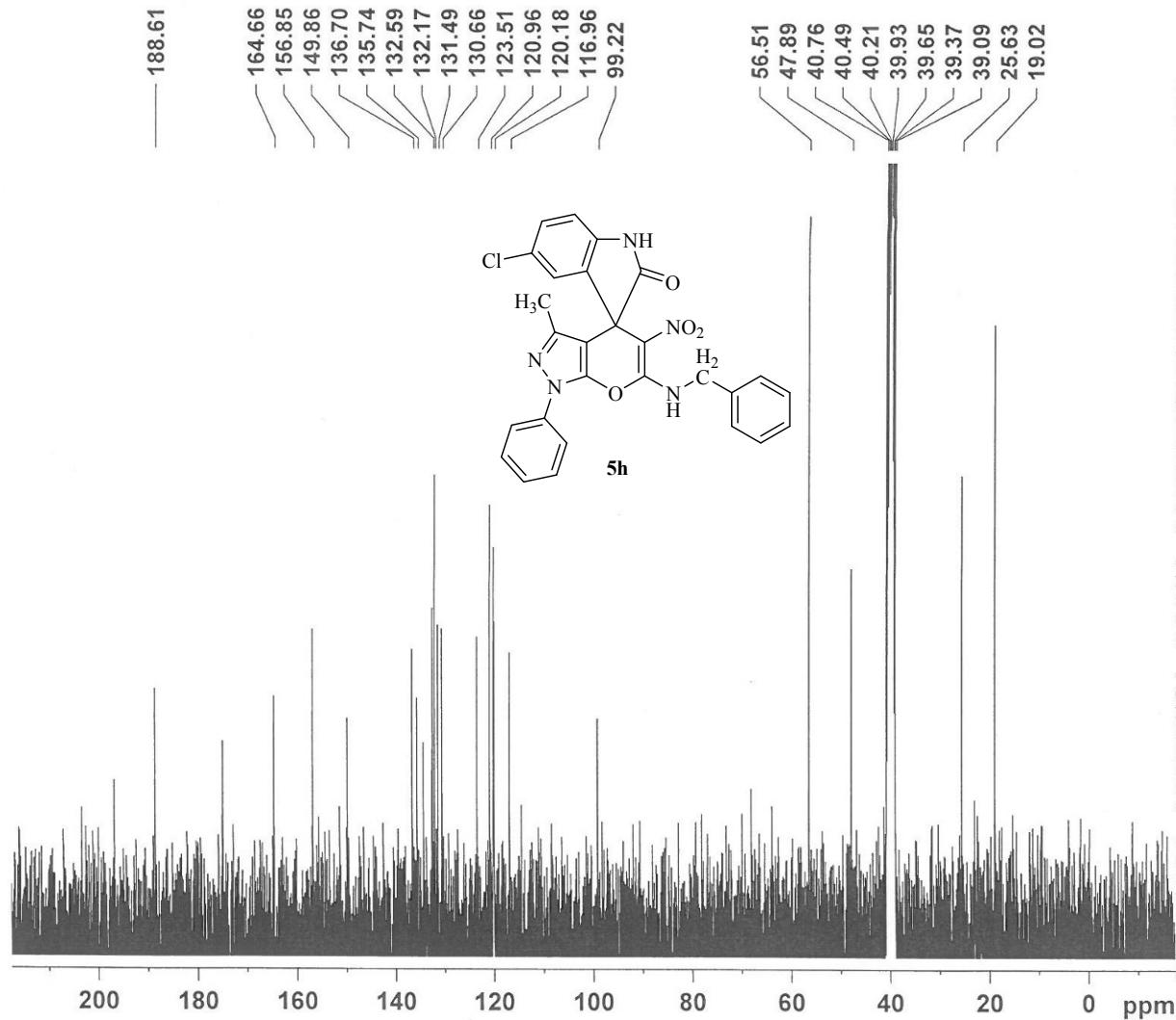
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EXPNO 82
PROCNO 1

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SOLVENT DMSO
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FIDRES 0.274439 Hz
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RG 32768
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DE 6.00 usec
TE 300.0 K
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d11 0.03000000 sec
d12 0.00002000 sec

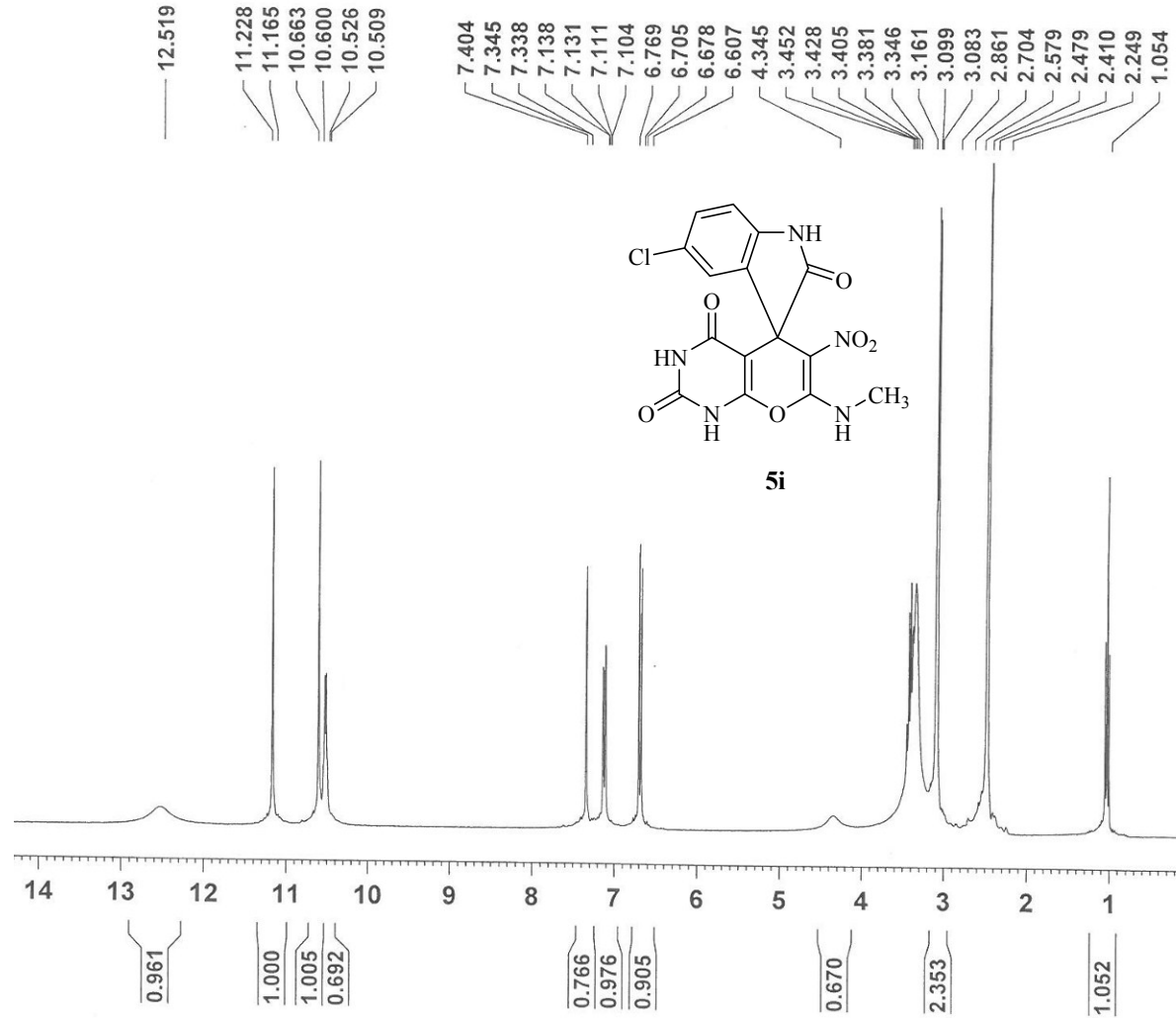
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SFO1 75.4099117 MHz

===== CHANNEL f2 =====
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NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



¹³C NMR of 5h



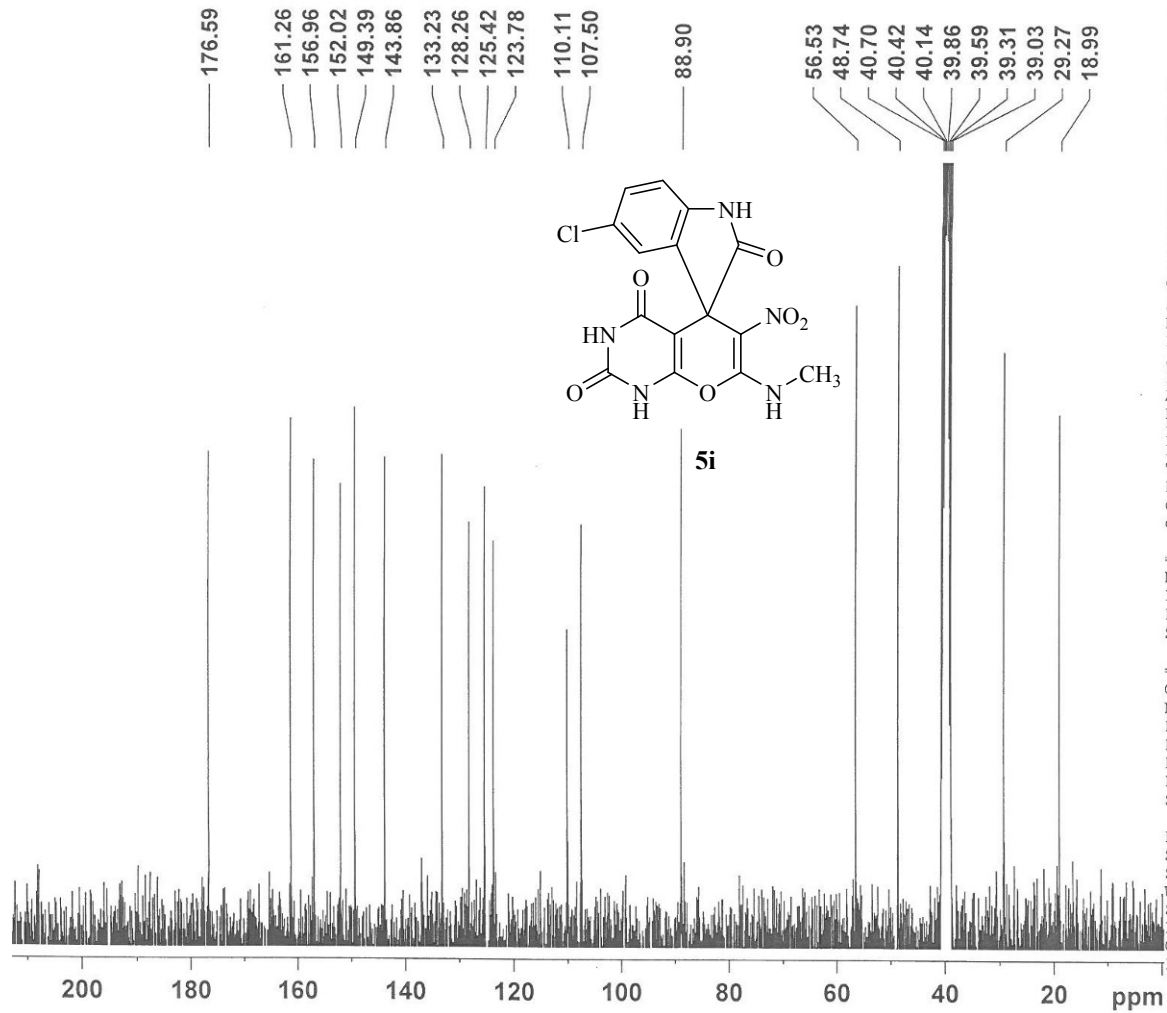
Current Data Parameters
NAME AA.Mohamadi
EXPNO 28
PROCNO 1

F2 - Acquisition Parameters
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PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 203.2
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

==== CHANNEL f1 ====
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of 5i



Current Data Parameters
NAME AA.Mohamadi
EXPNO 35
PROCNO 1

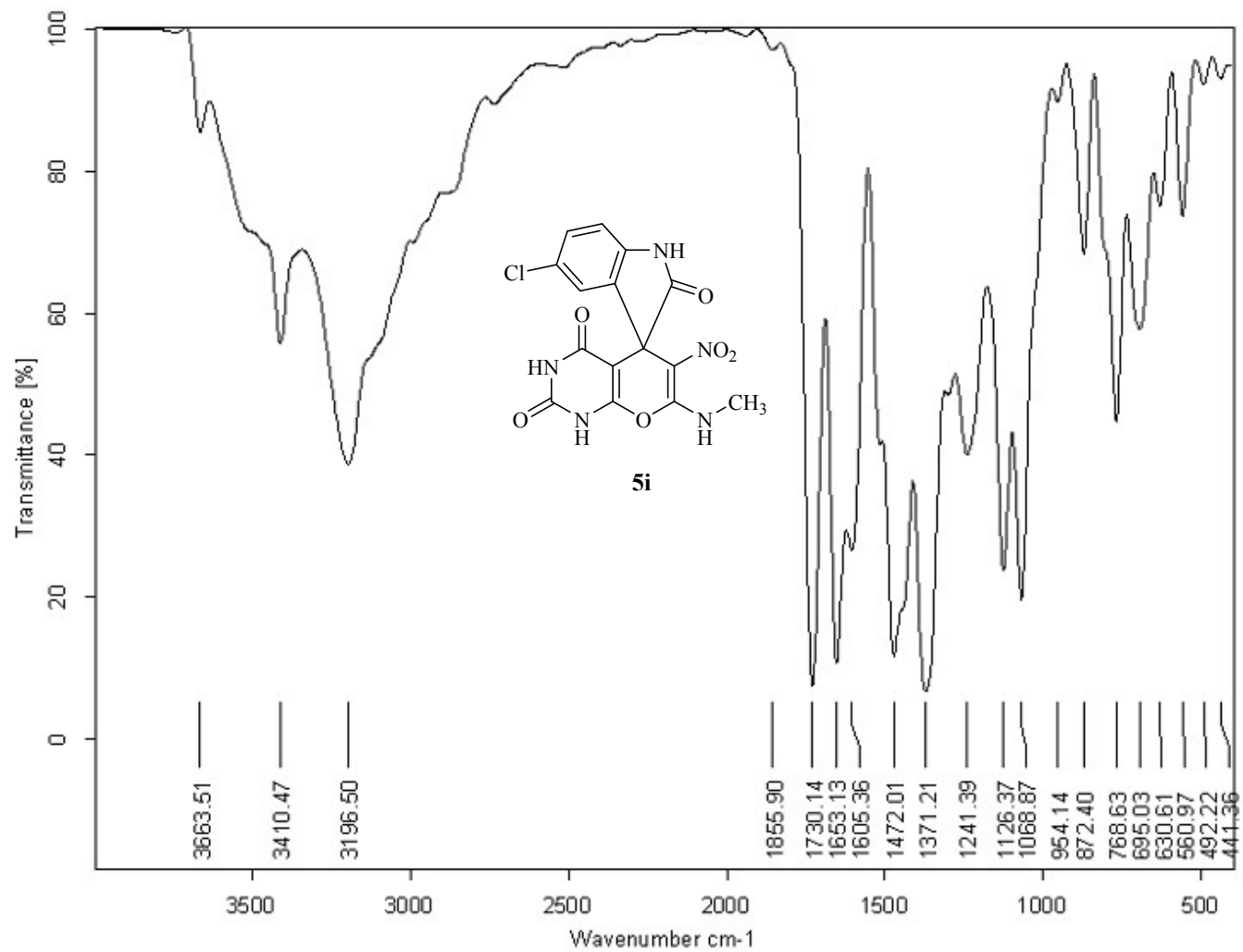
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PULPROG zgpg
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SOLVENT DMSO
NS 500
DS 0
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.0000000 sec
d11 0.0300000 sec
d12 0.0000200 sec

===== CHANNEL f1 =====
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

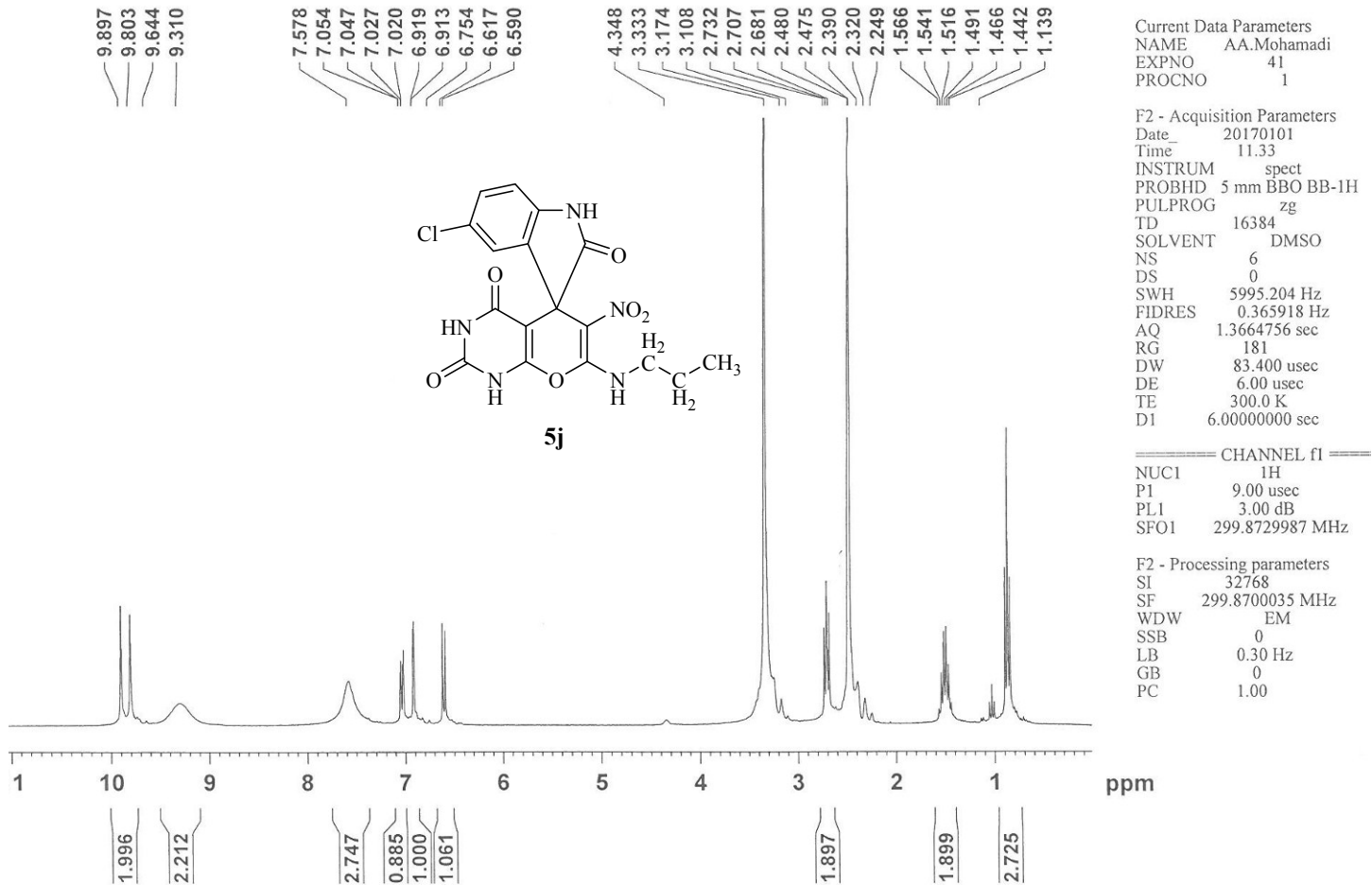
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NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
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WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

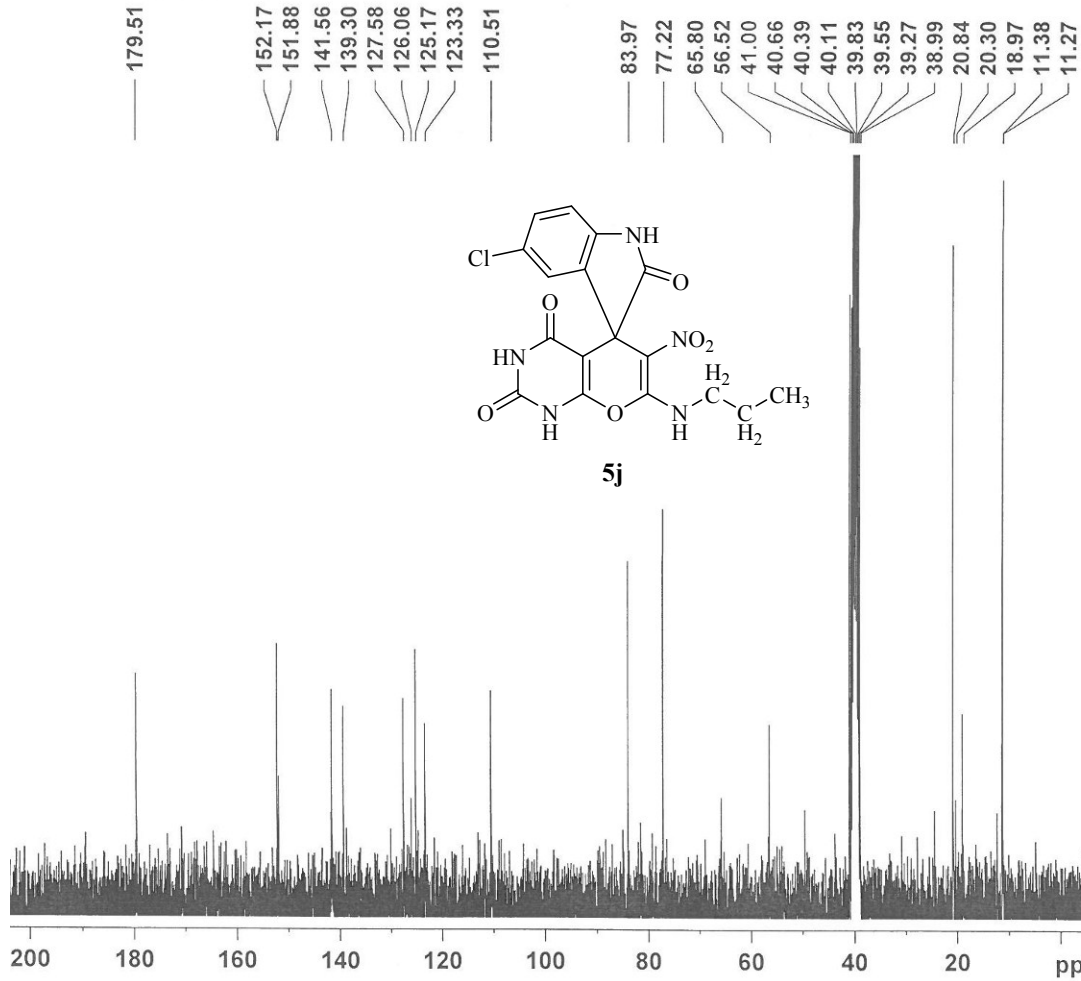
¹³C NMR of 5i



IR of 5i



¹H NMR of **5j**



Current Data Parameters
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EXPNO 44
PROCNO 1

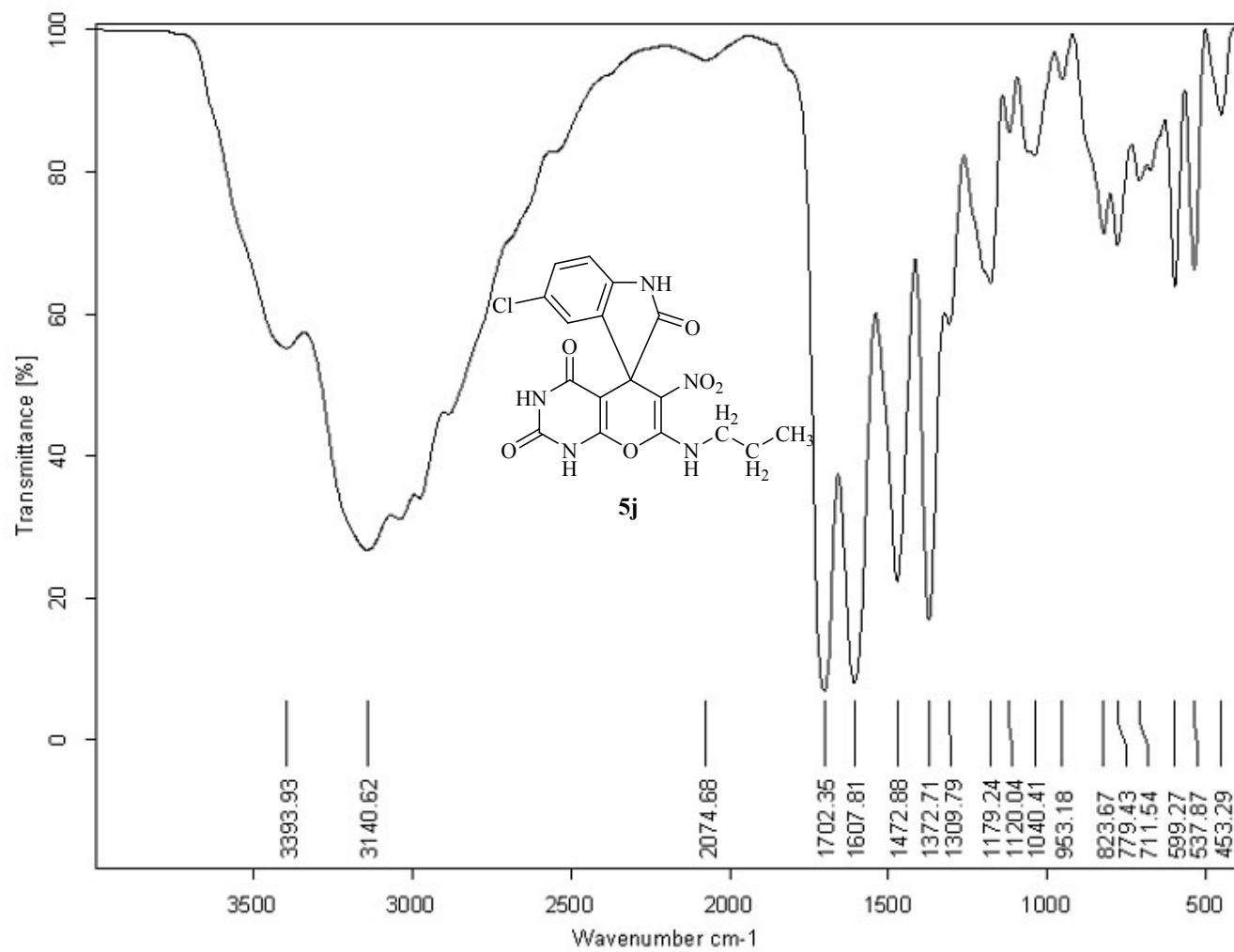
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PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 500
DS 0
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.0000000 sec
d11 0.0300000 sec
d12 0.00002000 sec

=====
CHANNEL f1
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

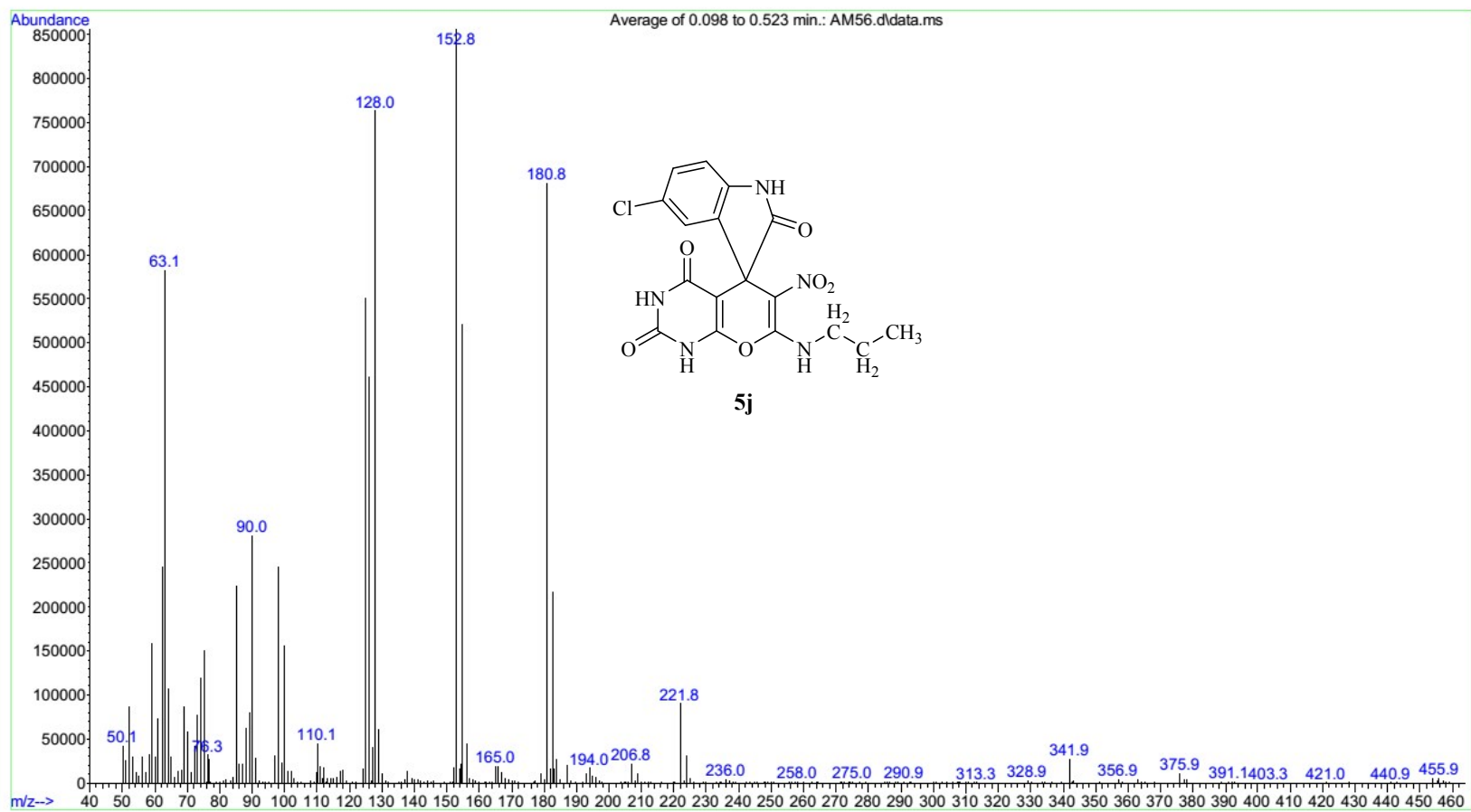
=====
CHANNEL f2
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

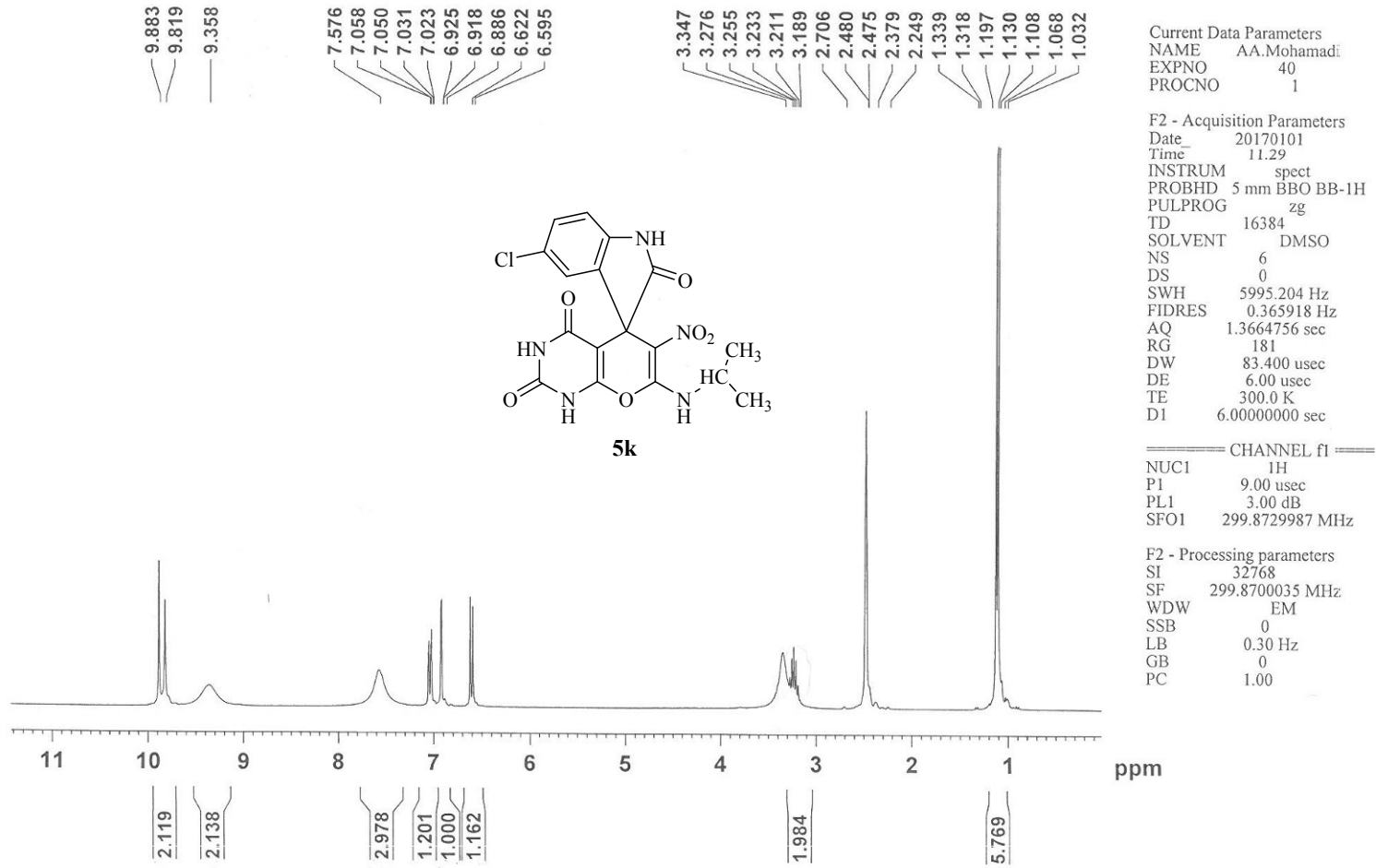
¹³C NMR of 5j



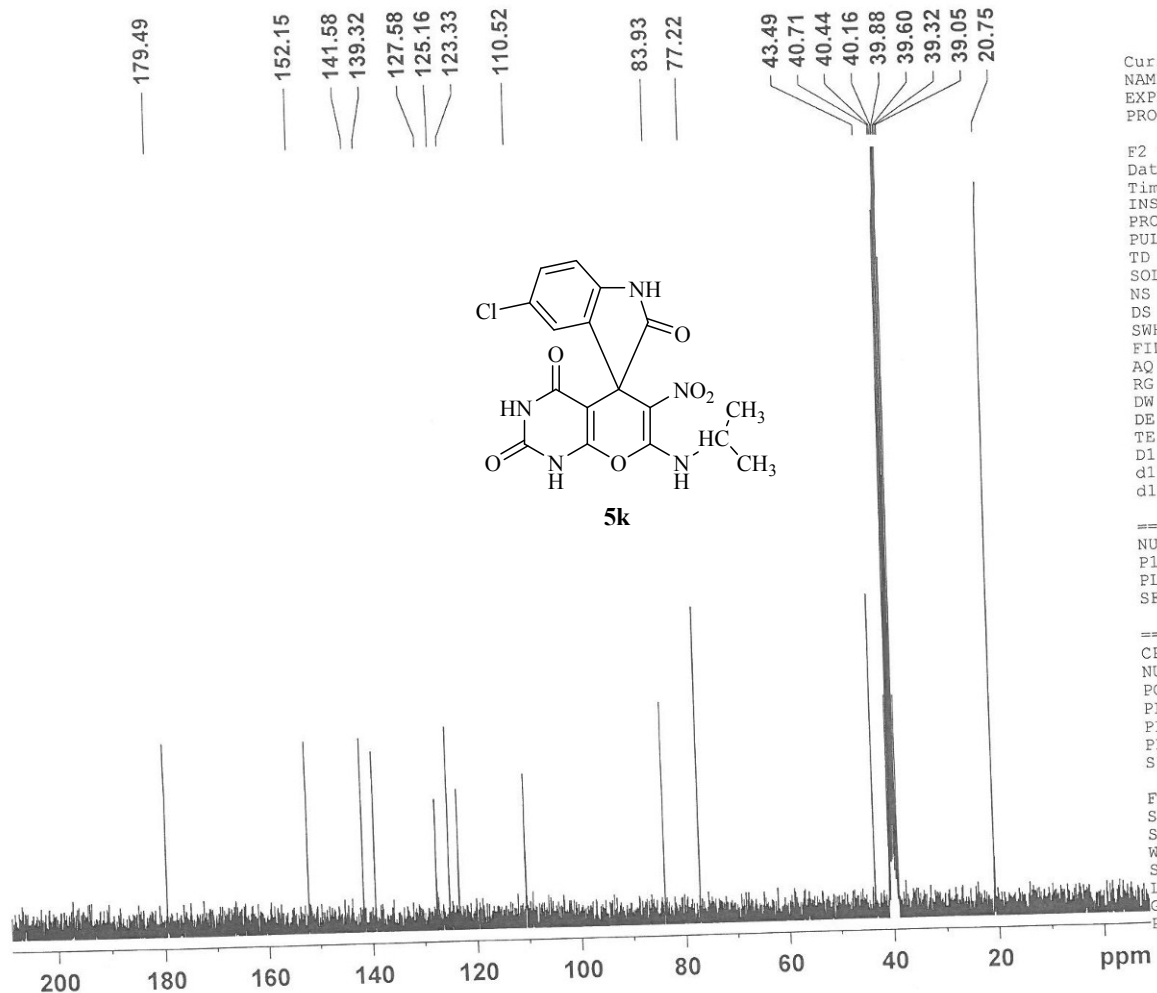
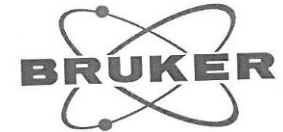
IR of 5j



Mass of **5j**



¹H NMR of 5k



Current Data Parameters
NAME AA.Mohamadi
EXPNO 43
PROCNO 1

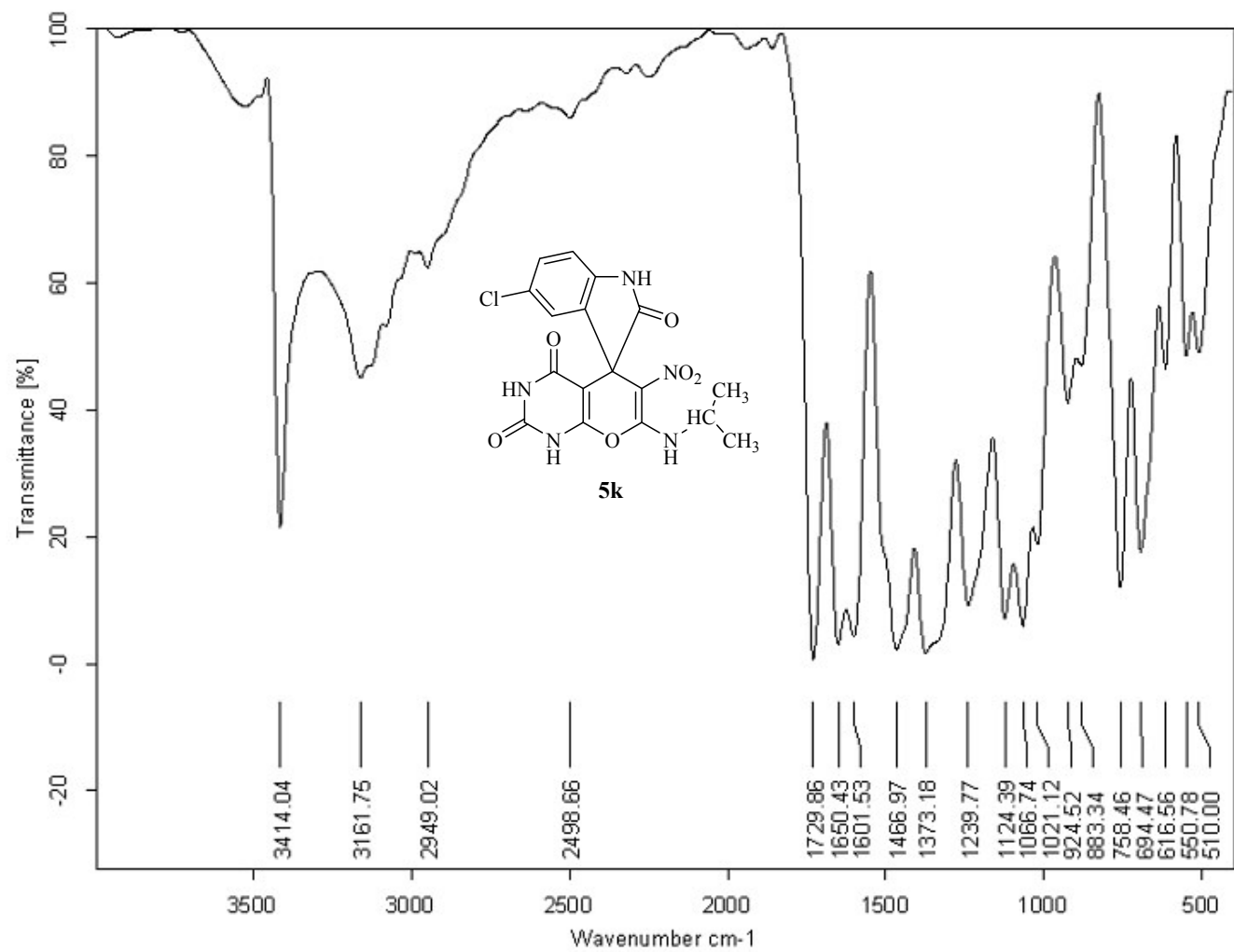
F2 - Acquisition Parameters
Date_ 20170102
Time_ 14.23
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 302
DS 0
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.0000000 sec
d11 0.0300000 sec
d12 0.0000200 sec

==== CHANNEL f1 =====
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

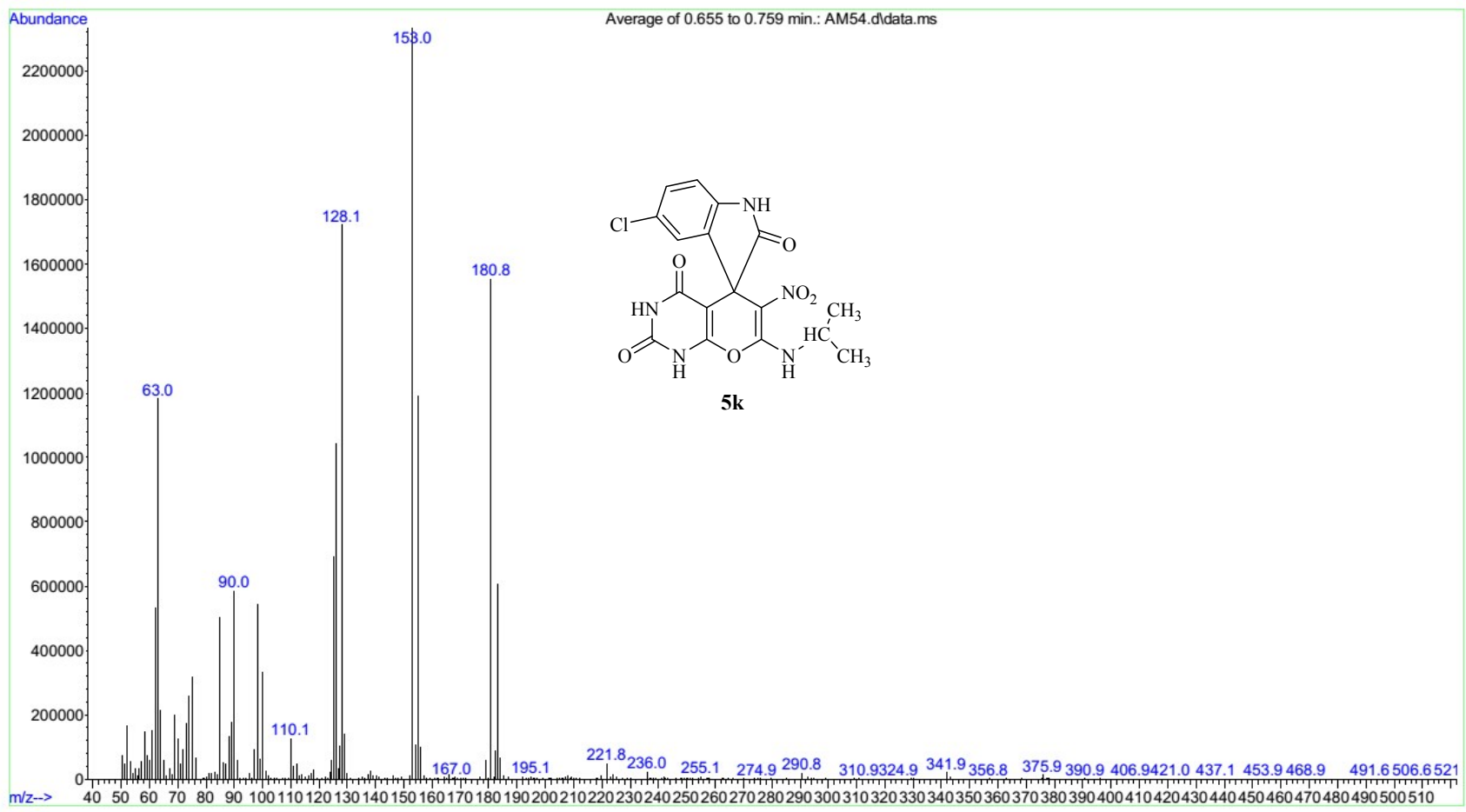
==== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDB EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

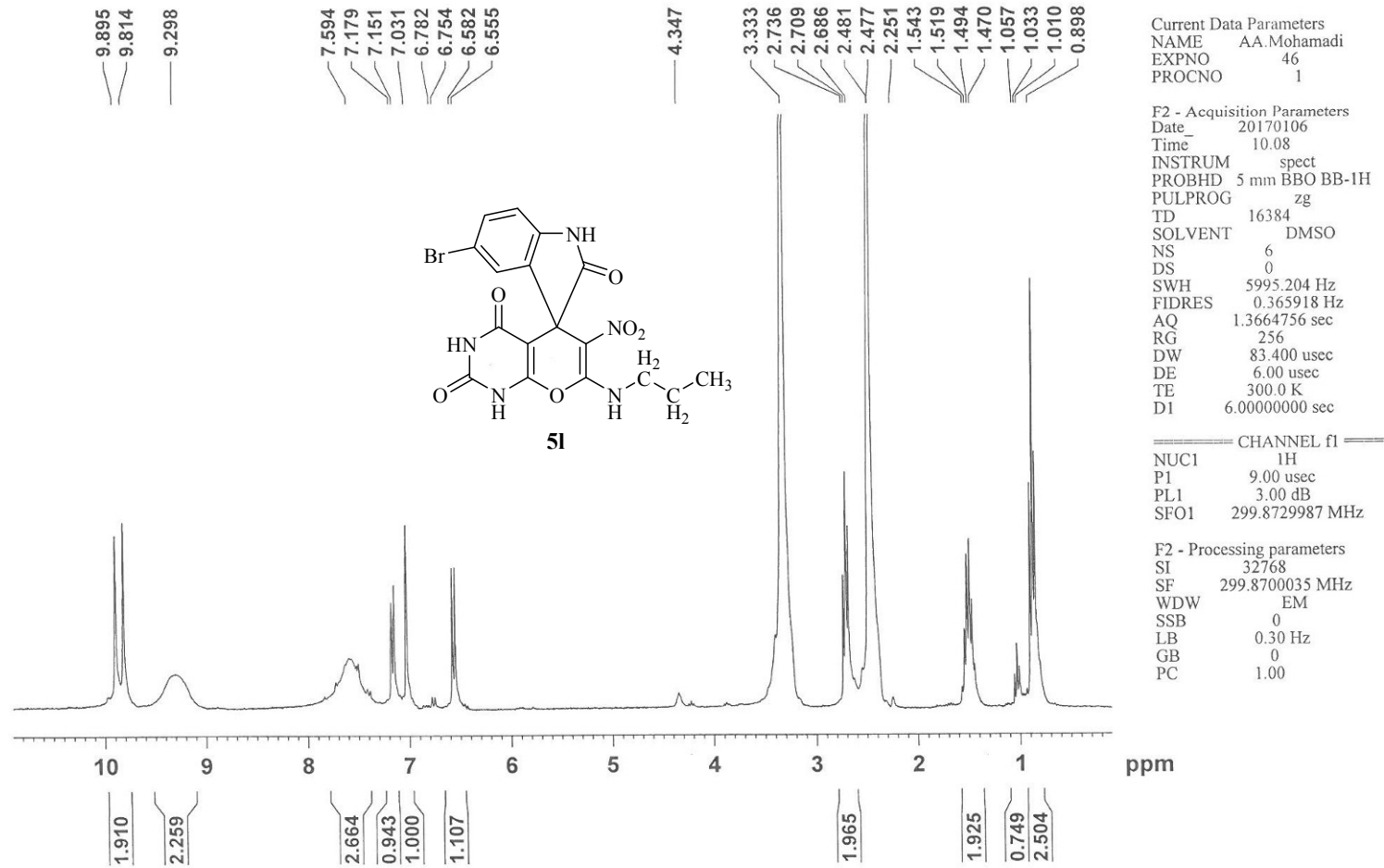
¹³C NMR of 5k



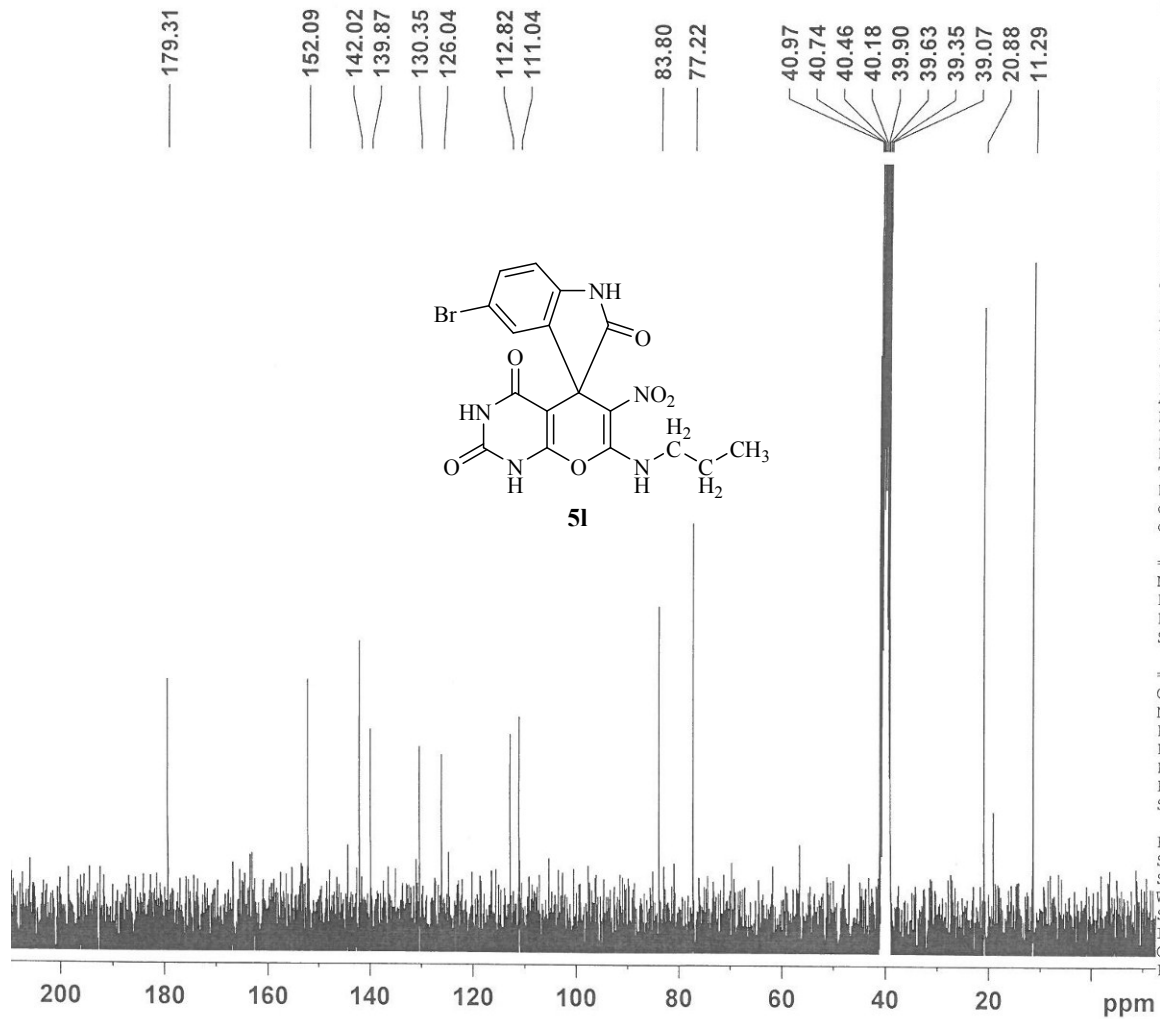
IR of 5k



Mass of 5k



¹H NMR of 51



Current Data Parameters
NAME AA.Mohamadi
EXPNO 72
PROCNO 1

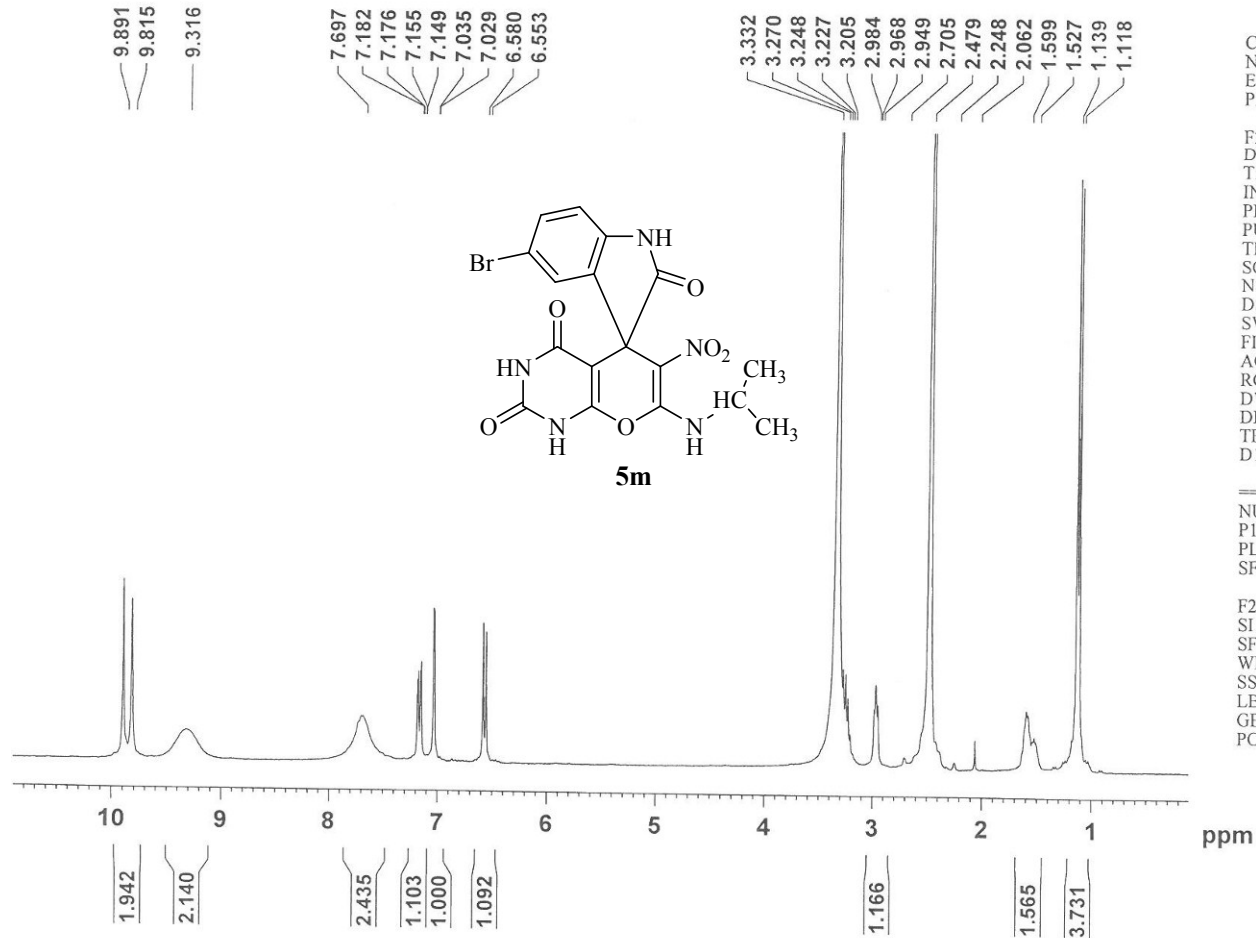
F2 - Acquisition Parameters
Date_ 20170204
Time 13.25
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 1500
DS 0
SWH 17985.611 Hz
FIDRES 0.274439 Hz
AQ 1.8219508 sec
RG 32768
DW 27.800 usec
DE 6.00 usec
TE 300.0 K
D1 4.00000000 sec
d11 0.03000000 sec
d12 0.00002000 sec

=====
CHANNEL f1
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

=====
CHANNEL f2
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

¹³C NMR of 51



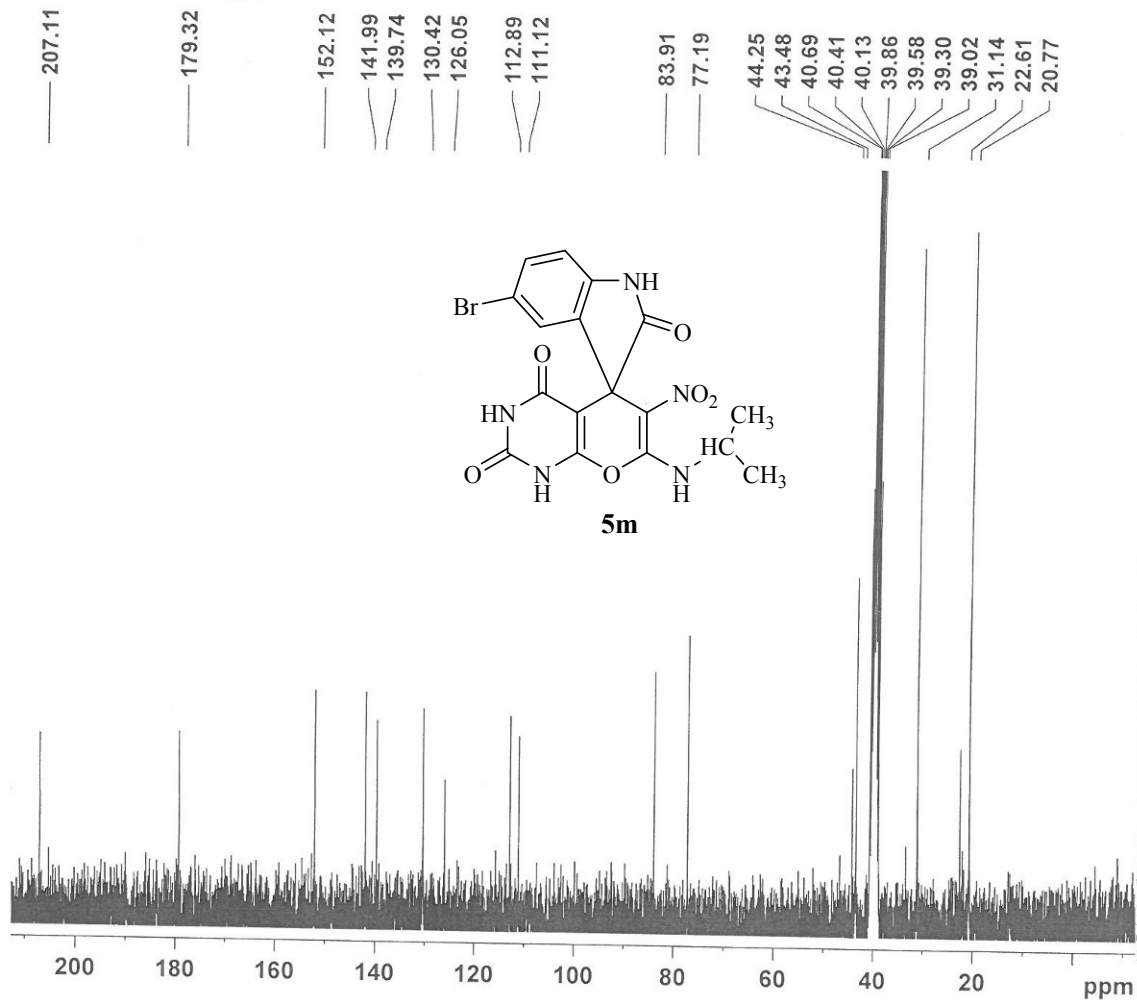
Current Data Parameters
NAME AA.Mohamadi
EXPNO 47
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170106
Time 10.12
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 256
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

===== CHANNEL f1 =====
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of 5m



Current Data Parameters
 NAME AA.Mohamadi
 EXPNO 73
 PROCNO 1

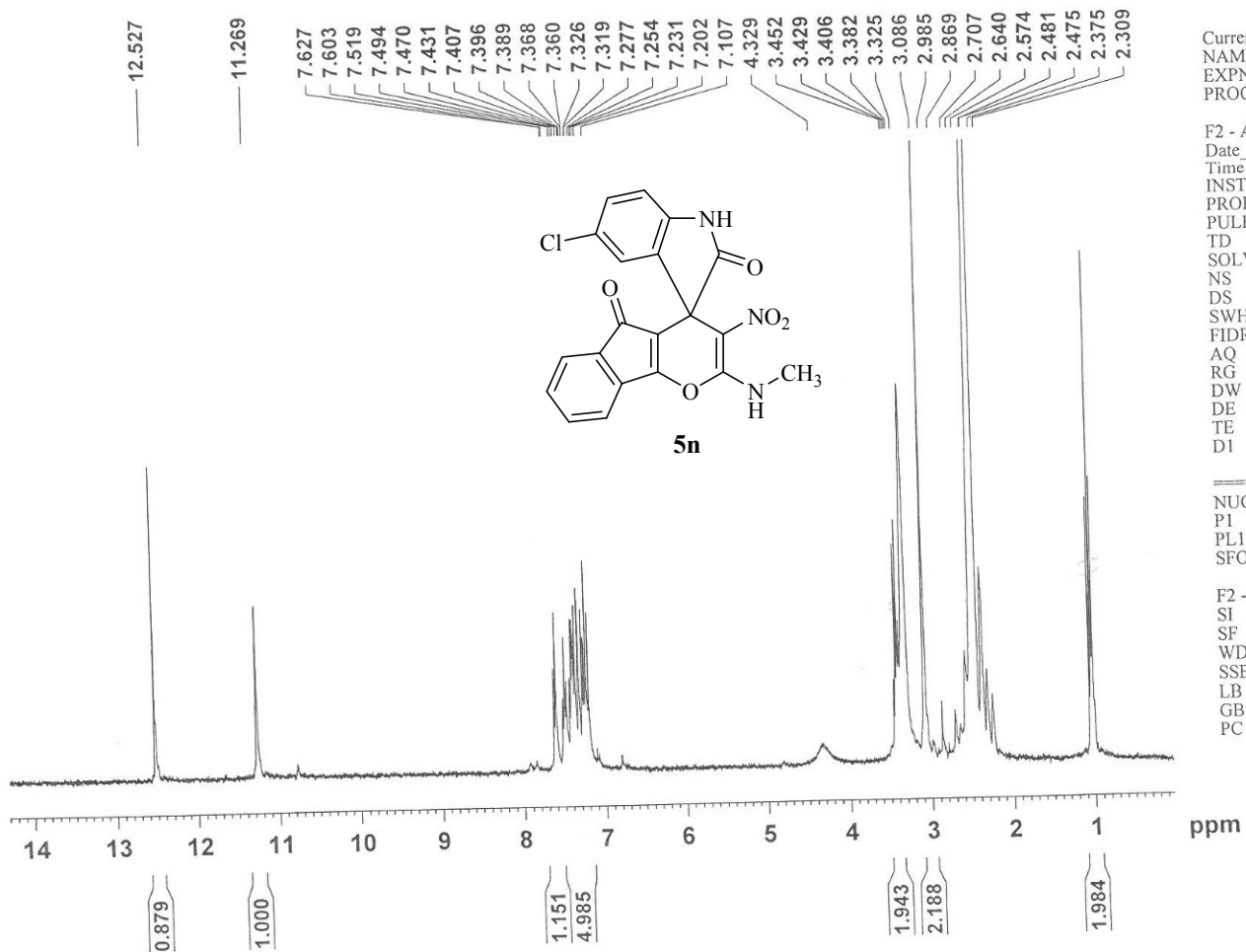
F2 - Acquisition Parameters
 Date_ 20170204
 Time 10.56
 INSTRUM spect
 PROBHD 5 mm BBO BB-1H
 PULPROG zgpg
 TD 65536
 SOLVENT DMSO
 NS 670
 DS 0
 SWH 17985.611 Hz
 FIDRES 0.274439 Hz
 AQ 1.8219508 sec
 RG 32768
 DW 27.800 usec
 DE 6.00 usec
 TE 300.0 K
 D1 4.0000000 sec
 d11 0.0300000 sec
 d12 0.0000200 sec

===== CHANNEL f1 =====
 NUC1 13C
 P1 14.00 usec
 PL1 -6.00 dB
 SFO1 75.4099117 MHz

===== CHANNEL f2 =====
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 80.00 usec
 PL2 3.00 dB
 PL12 23.00 dB
 PL13 23.00 dB
 SFO2 299.8711995 MHz

F2 - Processing parameters
 SI 32768
 SF 75.4023710 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

¹³C NMR of 5m



Current Data Parameters
NAME AA.Mohamadi
EXPNO 59
PROCNO 1

F2 - Acquisition Parameters
Date 20170127
Time 14.39
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 645.1
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

==== CHANNEL f1 ====
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of 5n



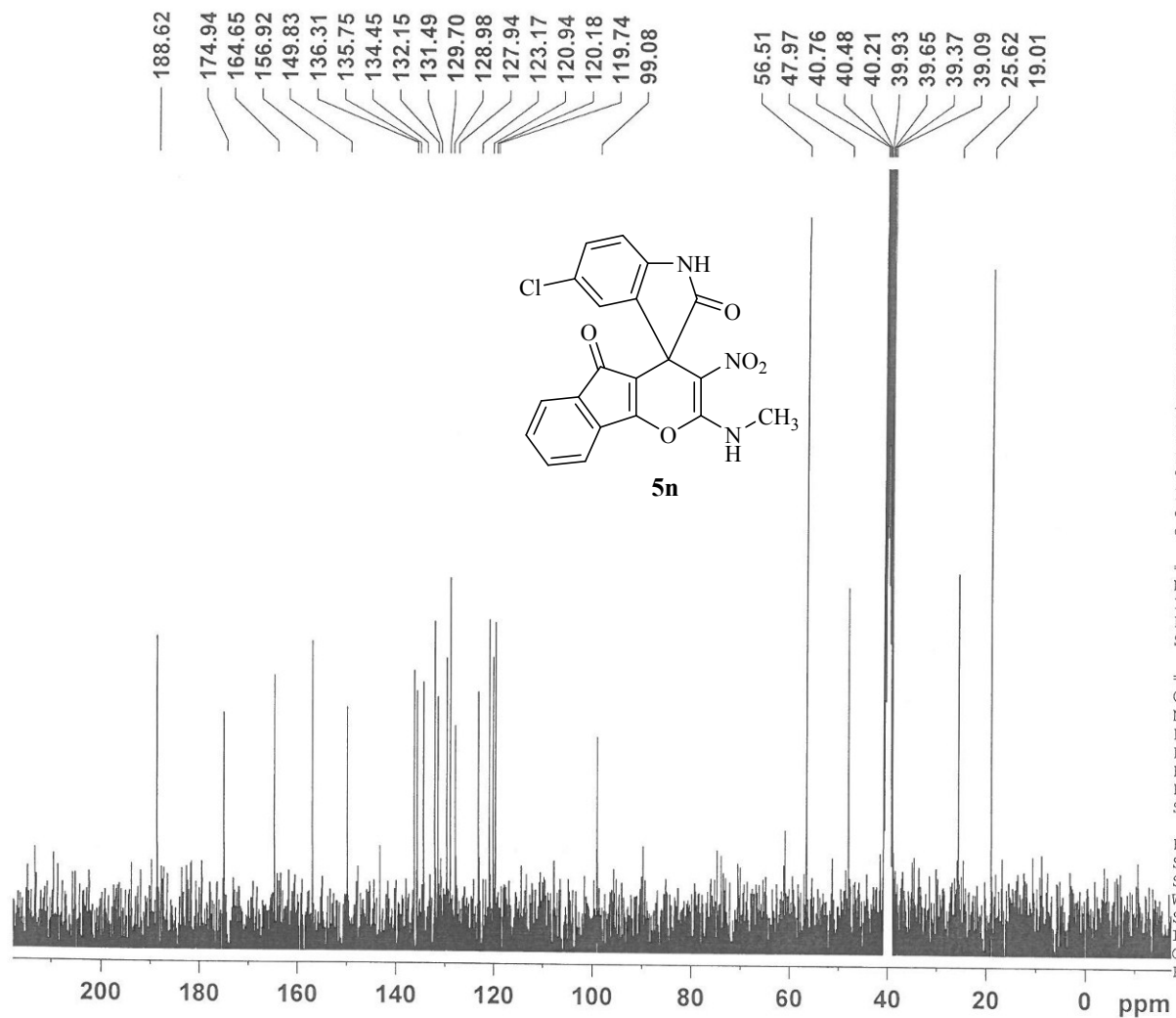
Current Data Parameters
NAME AA.Mohamadi
EXPNO 81
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170217
Time 11.54
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 1040
DS 0
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 4.00000000 sec
d11 0.03000000 sec
d12 0.00002000 sec

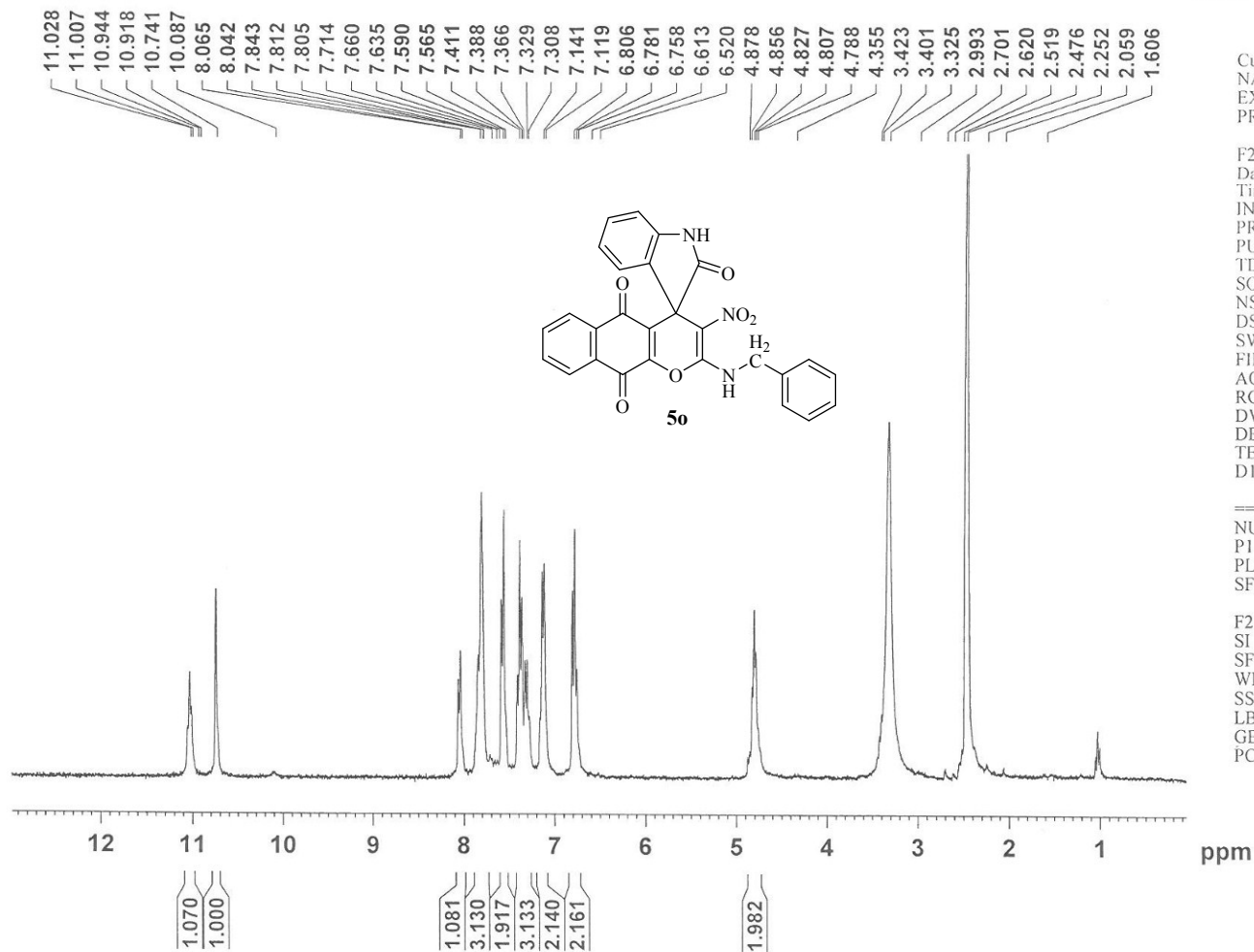
=====
CHANNEL f1
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

=====
CHANNEL f2
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



¹³C NMR of 5n



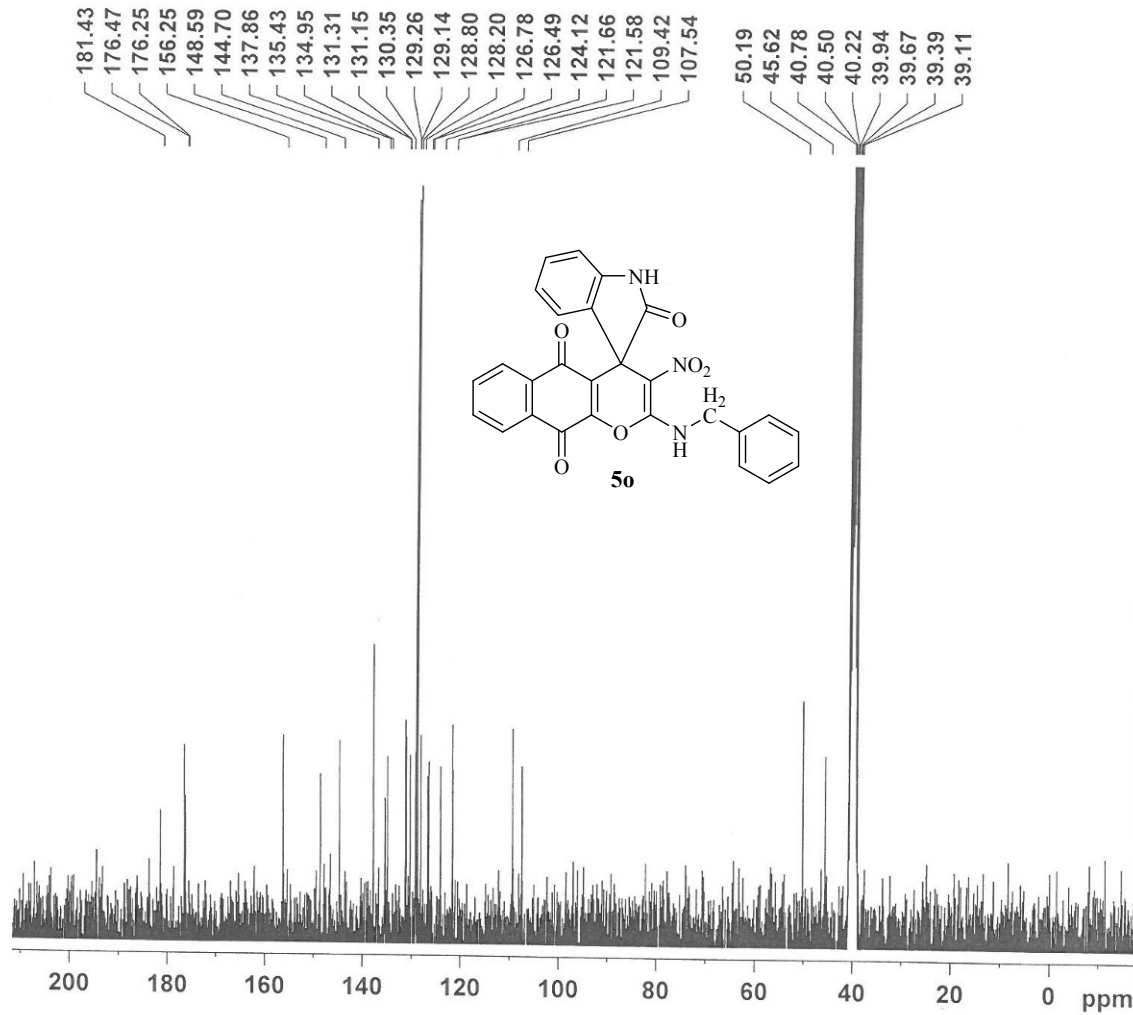
Current Data Parameters
NAME AA.Mohamadi
EXPNO 83
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170219
Time 11.58
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 812.7
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

==== CHANNEL f1 ====
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of **5o**



Current Data Parameters
NAME AA.Mohamadi
EXPNO 86
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170302
Time_ 14.27
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 2500
DS 0
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 4.00000000 sec
d11 0.03000000 sec
d12 0.00002000 sec

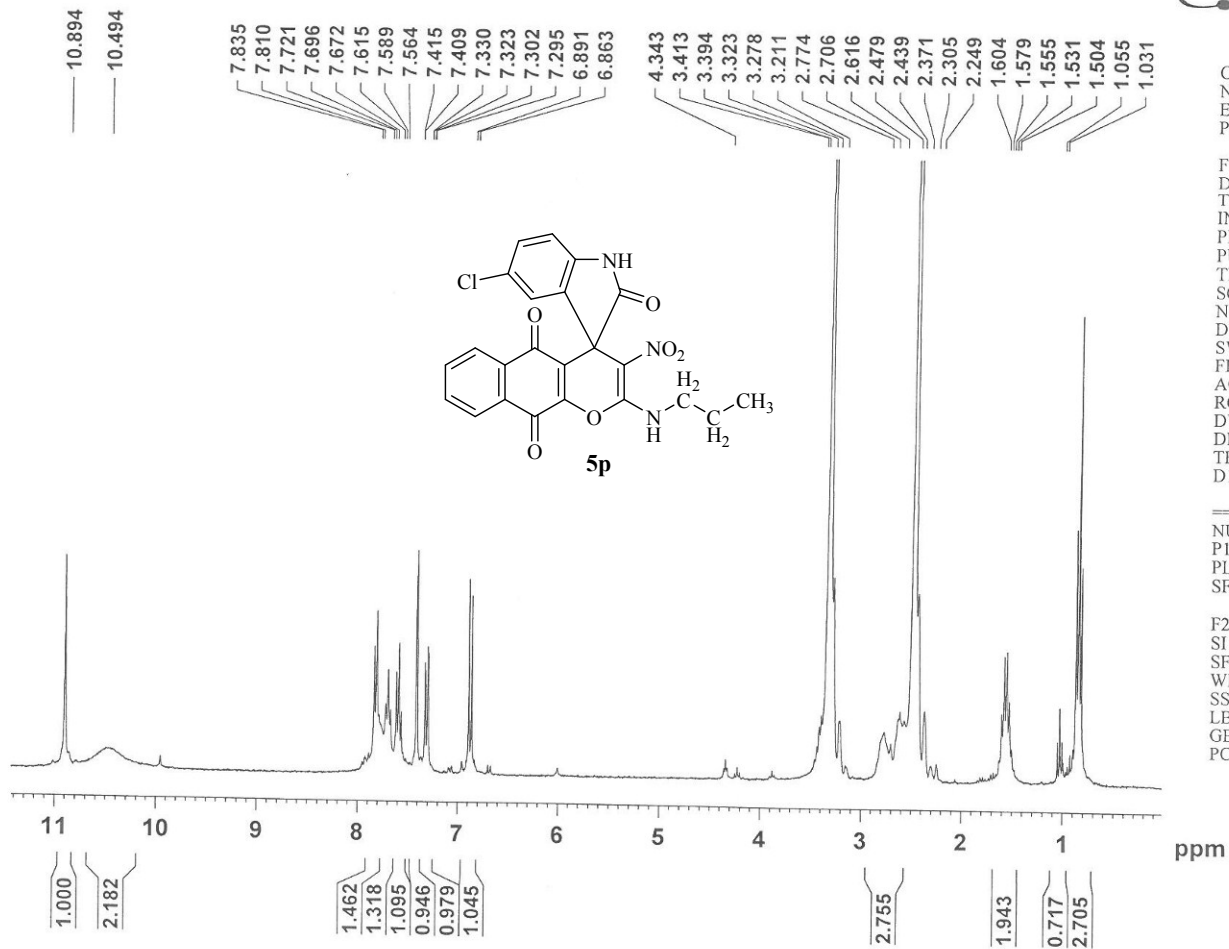
===== CHANNEL f1 =====
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

1D NMR plot parameters
CX 20.00 cm
CY 233.22 cm
F1P 219.271 ppm
F1 16533.52 Hz
F2P -19.258 ppm
F2 -1452.10 Hz
PPMCM 11.92642 ppm/cm
HZCM 899.28064 Hz/cm

¹³C NMR of 5o



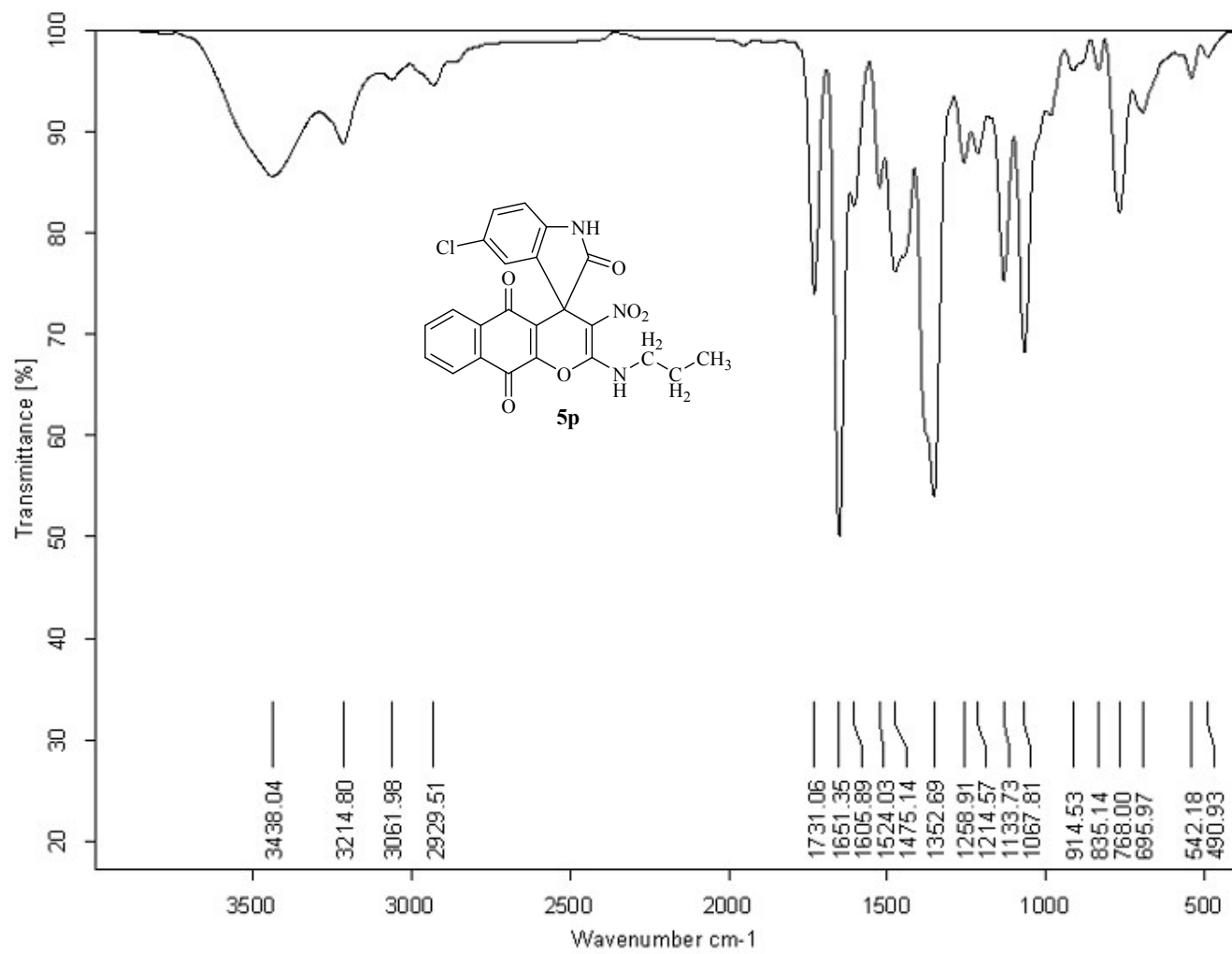
Current Data Parameters
NAME AA.Mohamadi
EXPNO 42
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170101
Time 14.58
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zg
TD 16384
SOLVENT DMSO
NS 6
DS 0
SWH 5995.204 Hz
FIDRES 0.365918 Hz
AQ 1.3664756 sec
RG 287.4
DW 83.400 usec
DE 6.00 usec
TE 300.0 K
D1 6.00000000 sec

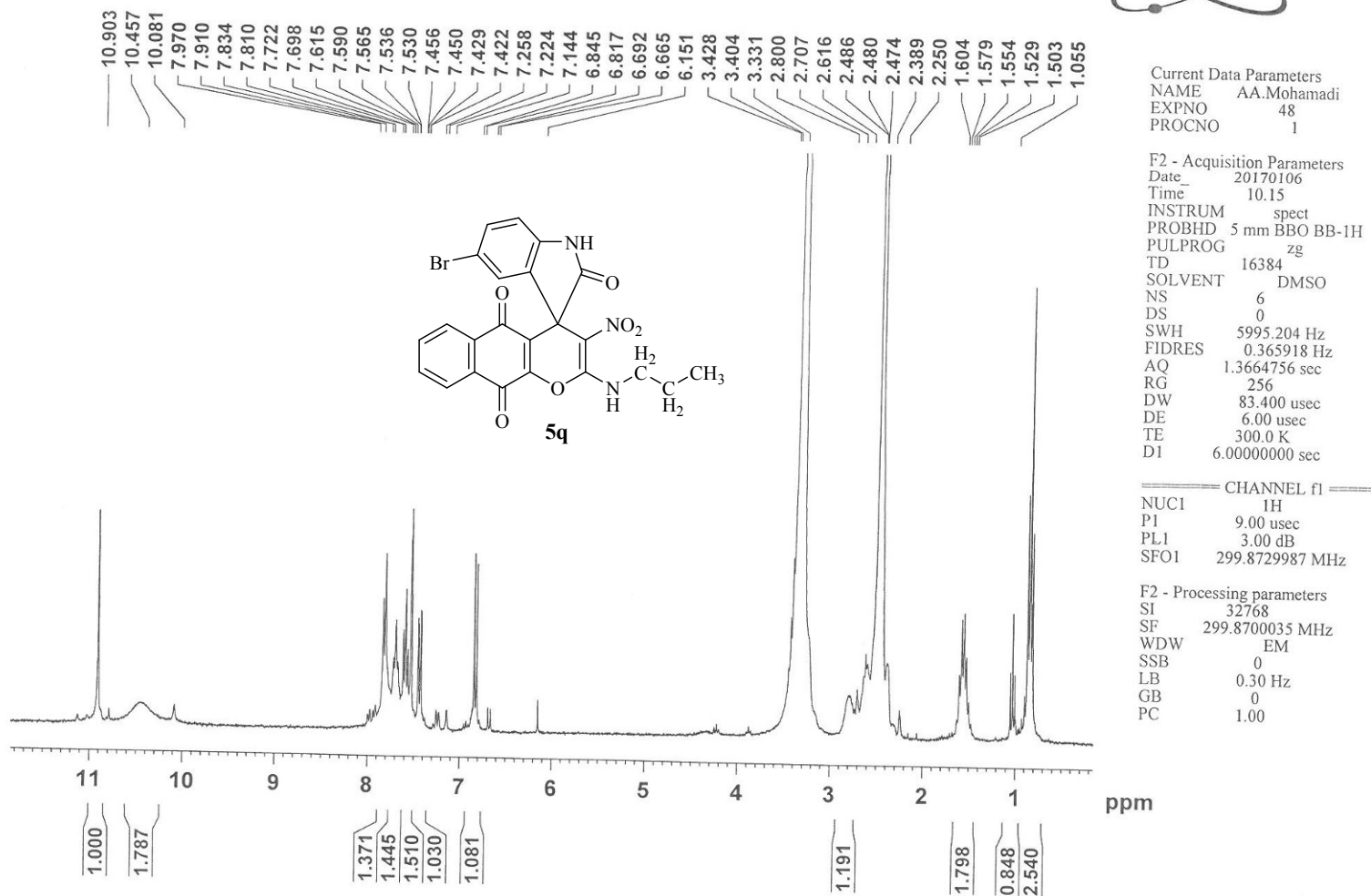
===== CHANNEL f1 =====
NUC1 1H
P1 9.00 usec
PL1 3.00 dB
SFO1 299.8729987 MHz

F2 - Processing parameters
SI 32768
SF 299.8700035 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

¹H NMR of 5p



IR of 5p



¹H NMR of **5q**



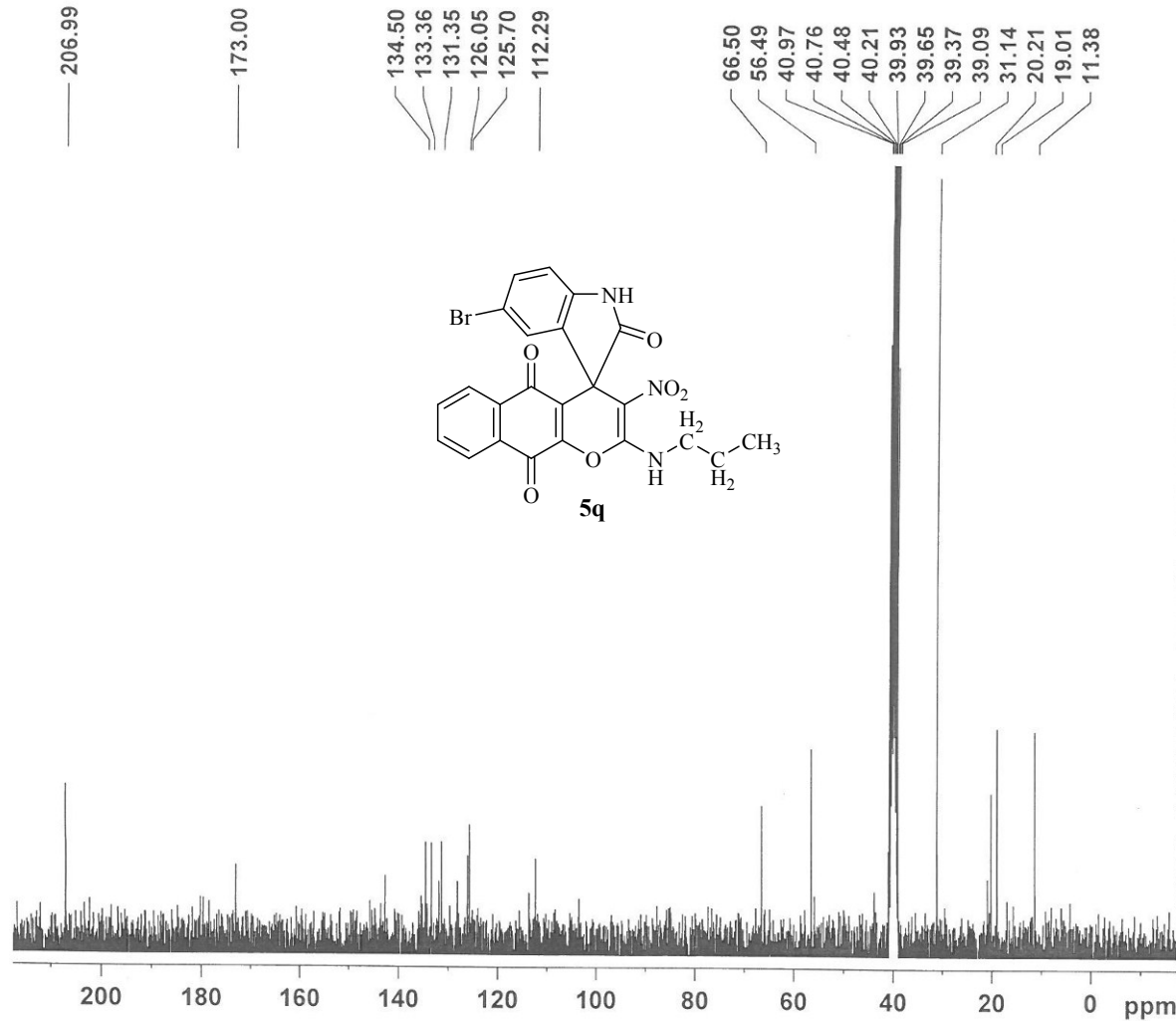
Current Data Parameters
NAME AA.Mohamadi
EXPNO 80
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170217
Time_ 9.54
INSTRUM spect
PROBHD 5 mm BBO BB-1H
PULPROG zgpg
TD 65536
SOLVENT DMSO
NS 1000
DS 0
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 4.0000000 sec
d11 0.0300000 sec
d12 0.0000200 sec

===== CHANNEL f1 =====
NUC1 13C
P1 14.00 usec
PL1 -6.00 dB
SFO1 75.4099117 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 3.00 dB
PL12 23.00 dB
PL13 23.00 dB
SFO2 299.8711995 MHz

F2 - Processing parameters
SI 32768
SF 75.4023710 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



¹³C NMR of 5q