

## Supplementary Material

### Efficient synthesis of novel bis(dihydropyrano[2,3-*c*]pyrazoles), bis(4*H*-chromenes) and bis(dihydropyrano[3,2-*c*]chromenes) with amide functionality

Amna M. Abdella,<sup>a</sup> Amr M. Abdelmoniem,<sup>a</sup> Holger Butenschön,<sup>b</sup> Ismail A. Abdelhamid,<sup>a\*</sup> and

Ahmed H. M. Elwahy<sup>a\*</sup>

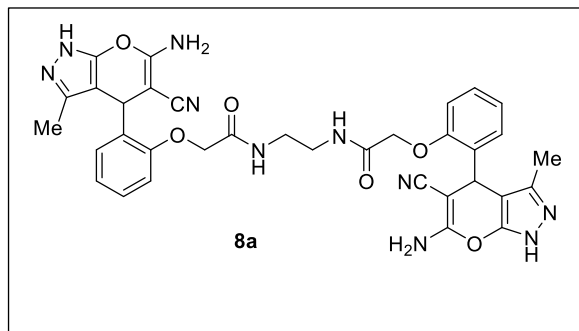
<sup>a</sup> *Department of Chemistry, Faculty of Science, Cairo University, 12613 Giza, A. R. Egypt*

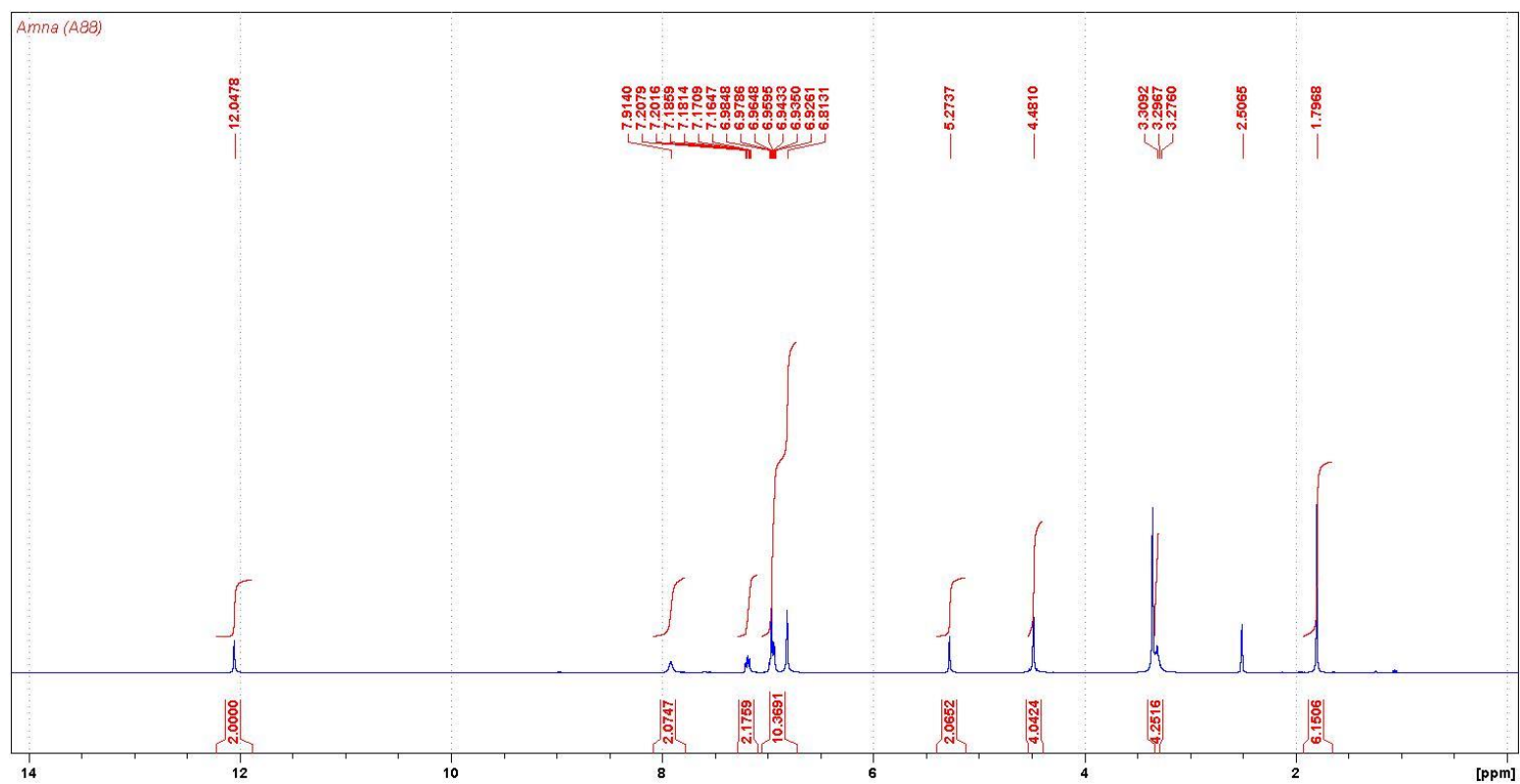
<sup>b</sup> *Institut für Organische Chemie, Leibniz Universität Hannover, Schneiderberg 1B, 30167 Hannover, Germany*

E-mail: [aelwahy@hotmail.com](mailto:aelwahy@hotmail.com) [ismail.shafy@yahoo.com](mailto:ismail.shafy@yahoo.com)

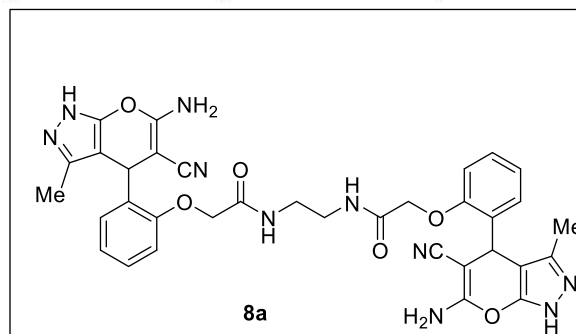
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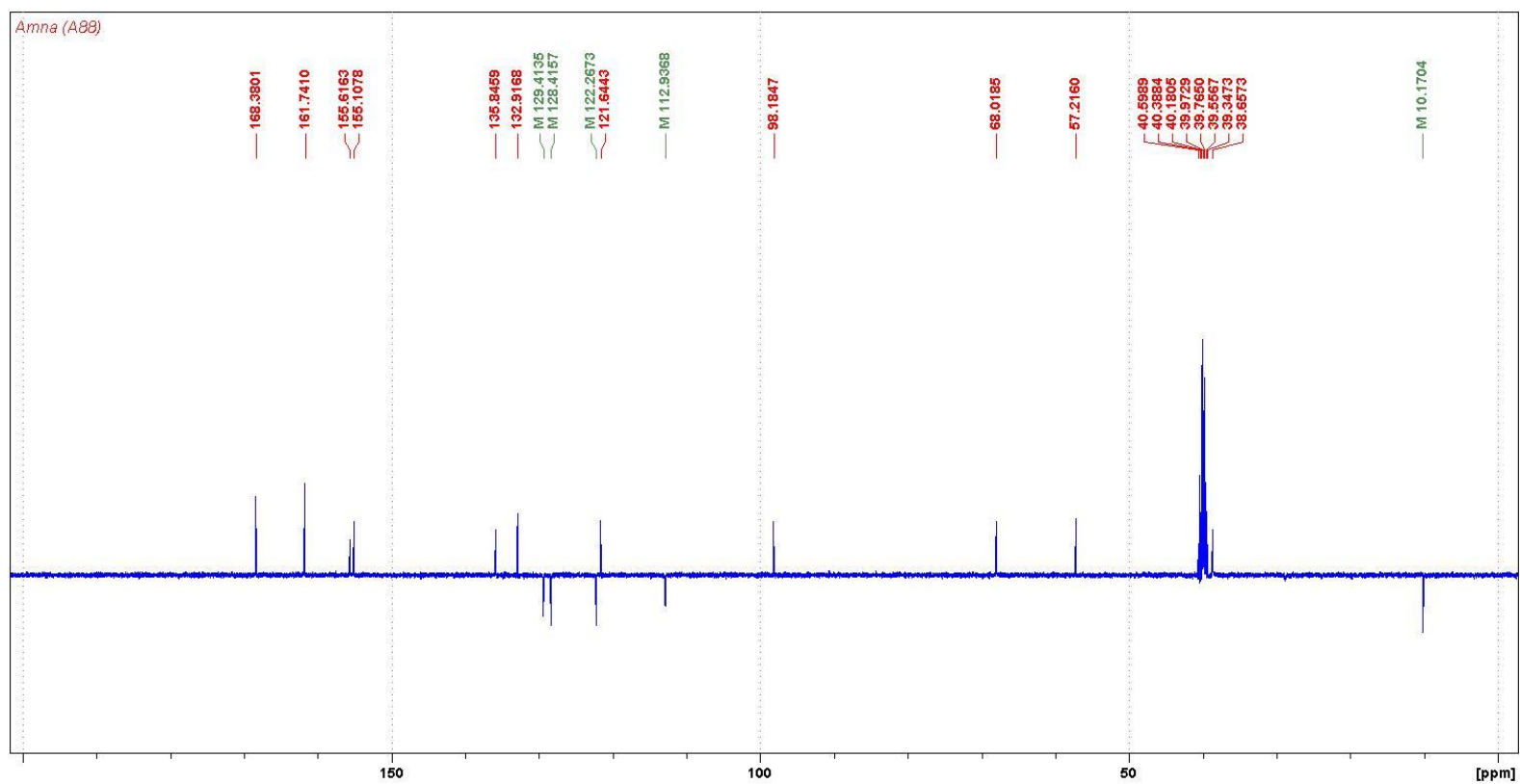
<sup>1</sup> H- and <sup>13</sup> C-NMR spectra .....	S2
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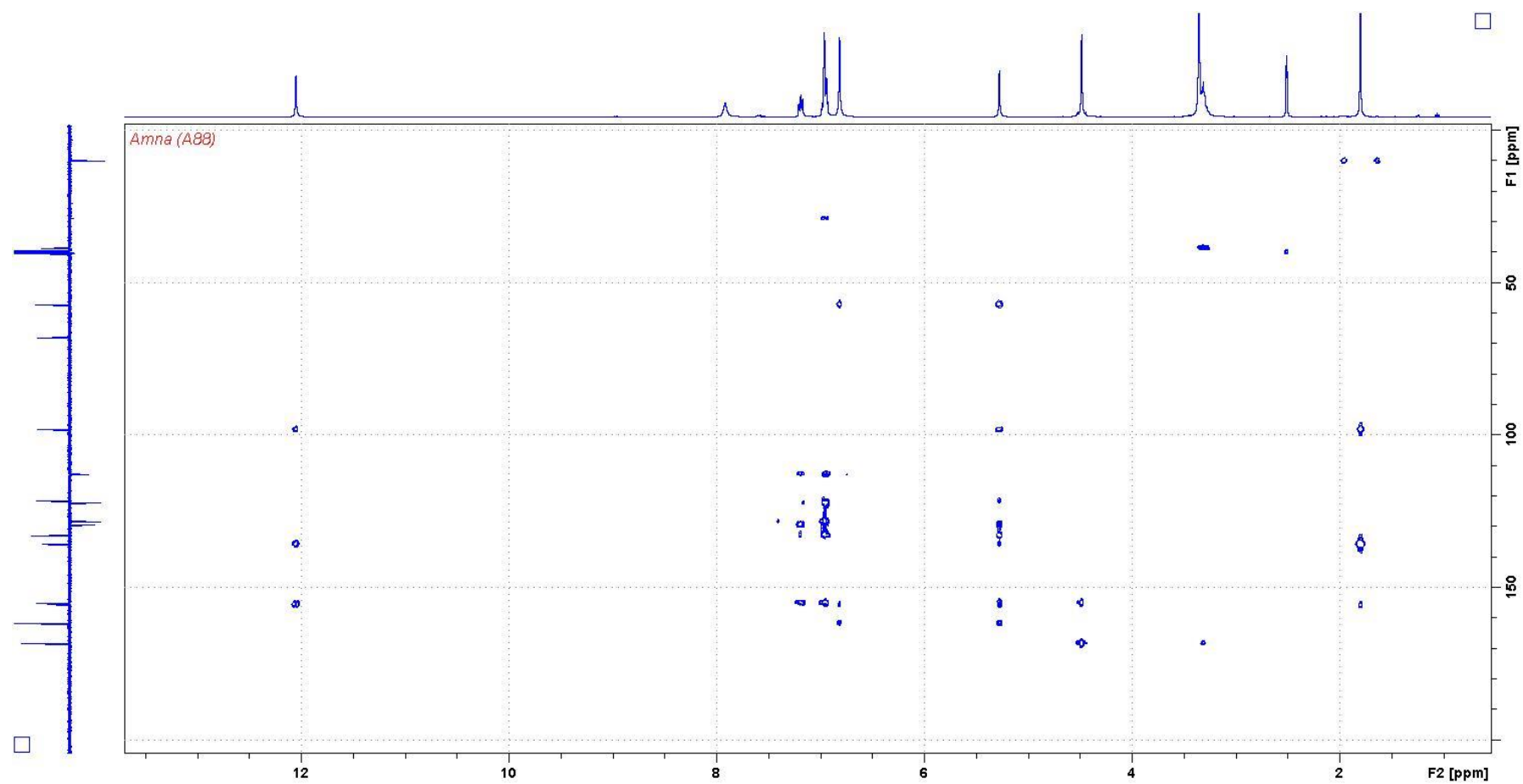
**<sup>1</sup>HNMR of compound 8a**



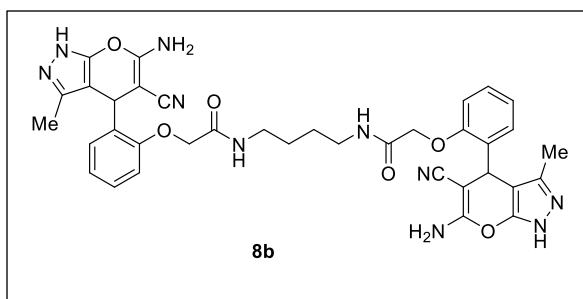
### $^{13}\text{C}$ NMR of compound 8a







HMBC of compound 8a

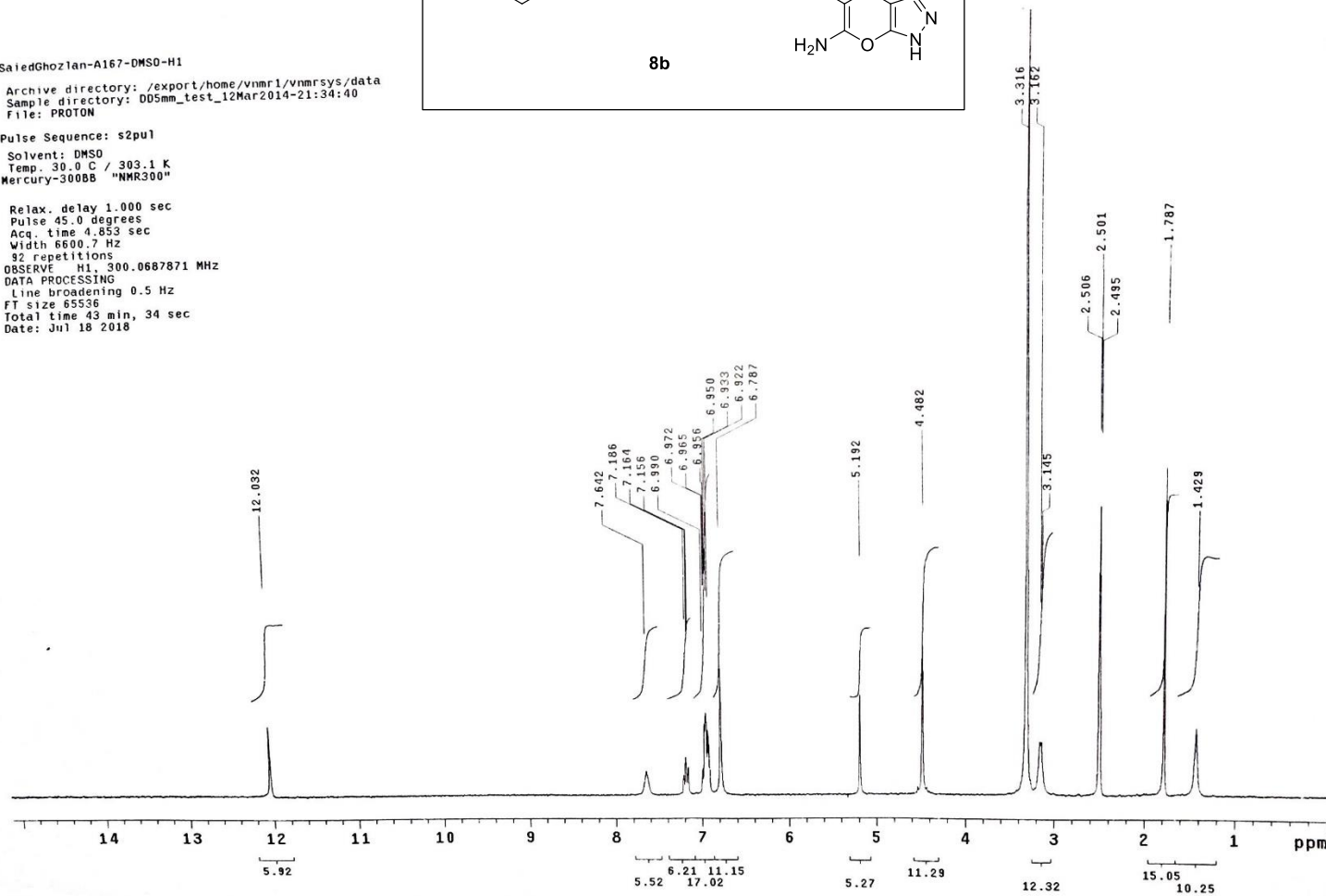


SaiedGhozlan-A167-DMSO-H1

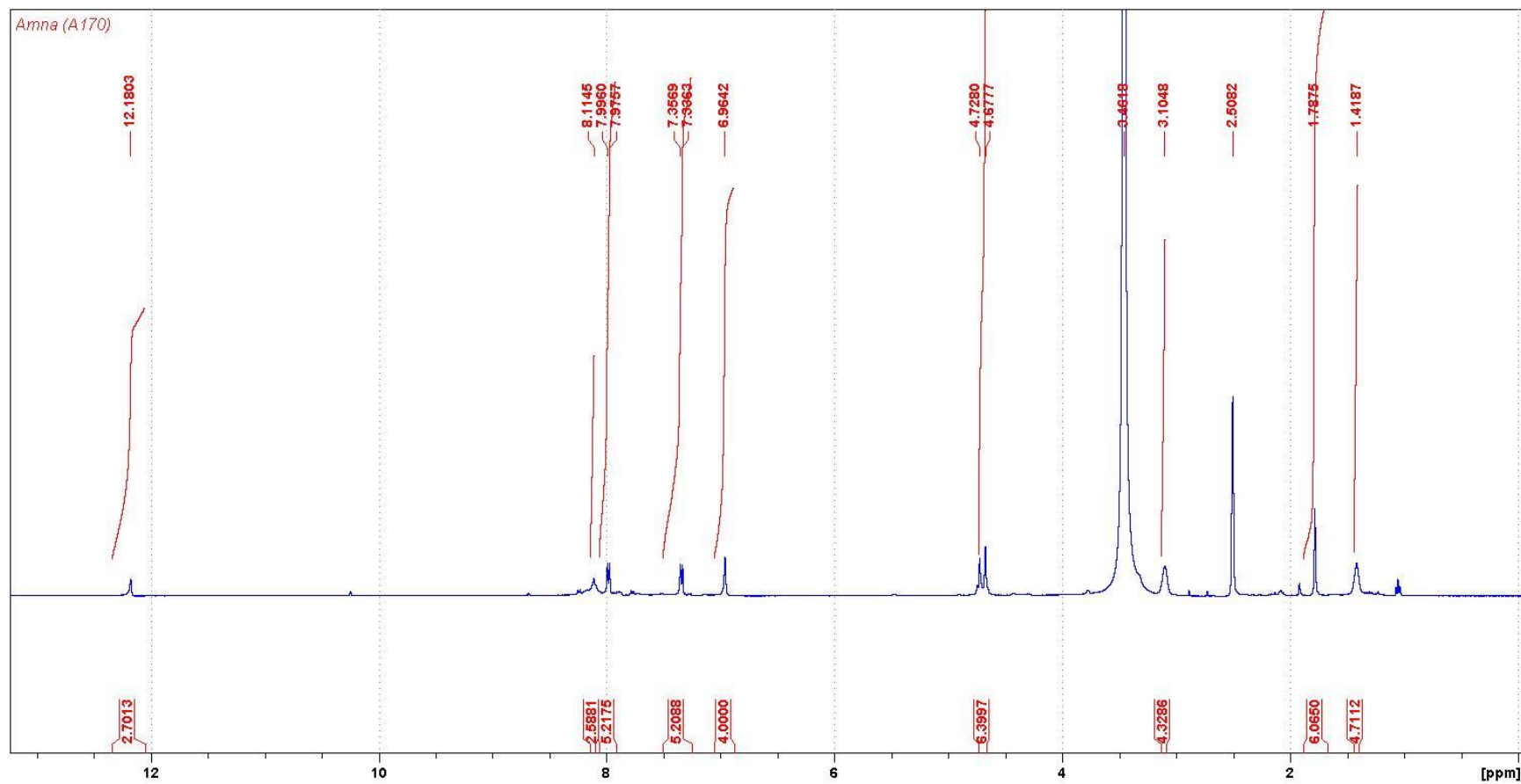
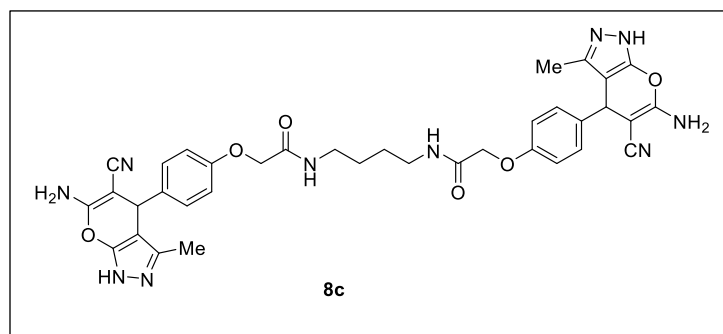
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Pulse Sequence: s2pu1  
 Solvent: DMSO  
 Temp. 30.0 C / 303.1 K  
 Mercury-300BB "NMR300"

Relax. delay 1.000 sec  
 Pulse 45.0 degrees  
 Acq. time 4.853 sec  
 Width 6600.7 Hz  
 32 repetitions  
 OBSERVE H1, 300.0687871 MHz  
 DATA PROCESSING  
 Line broadening 0.5 Hz  
 FT size 65536  
 Total time 43 min, 34 sec  
 Date: Jul 18 2018



<sup>1</sup>H NMR of compound 8b



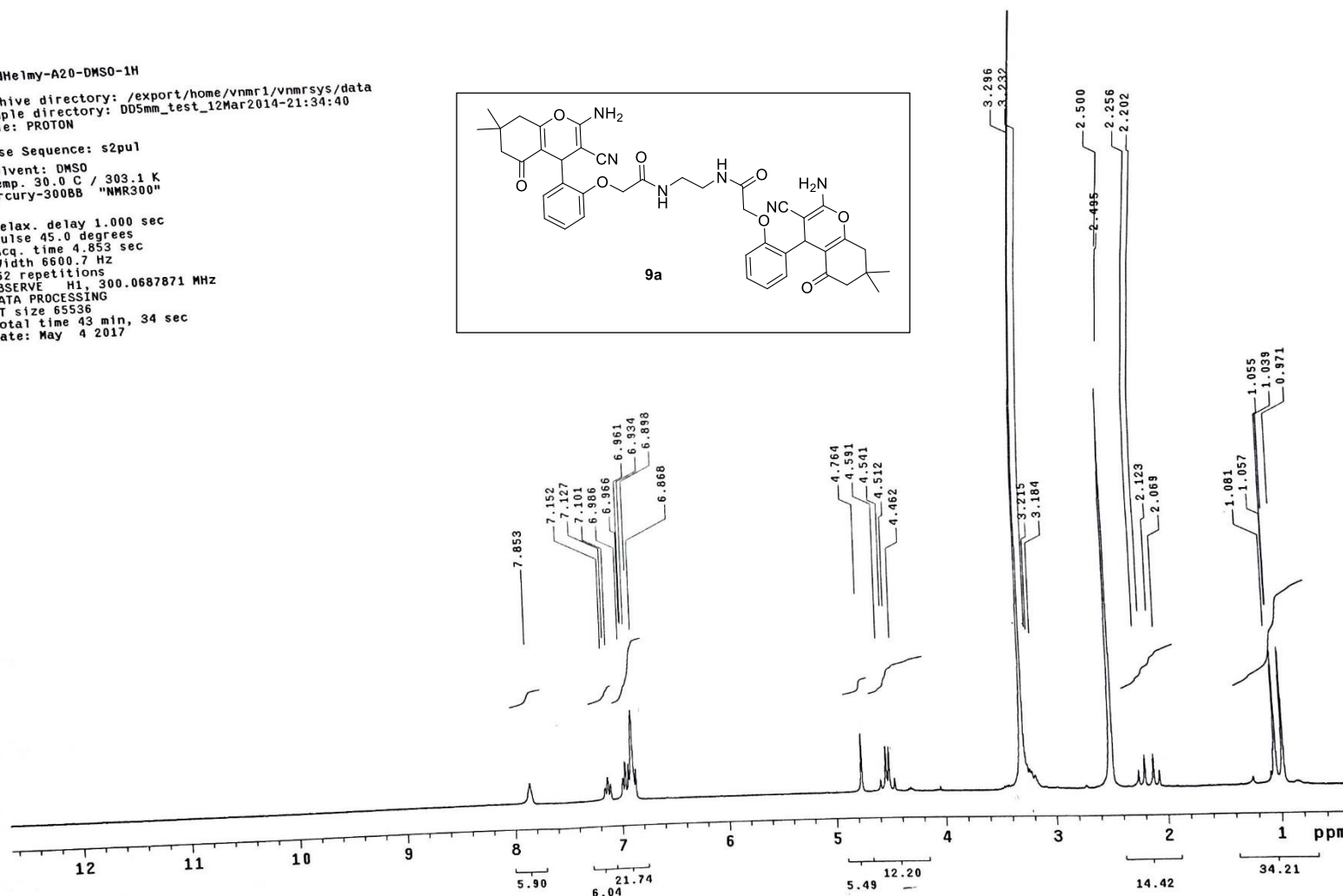
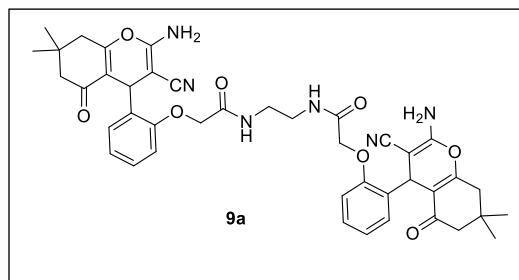
<sup>1</sup>H NMR of compound **8c**

AhmadHelmy-A20-DMSO-1H

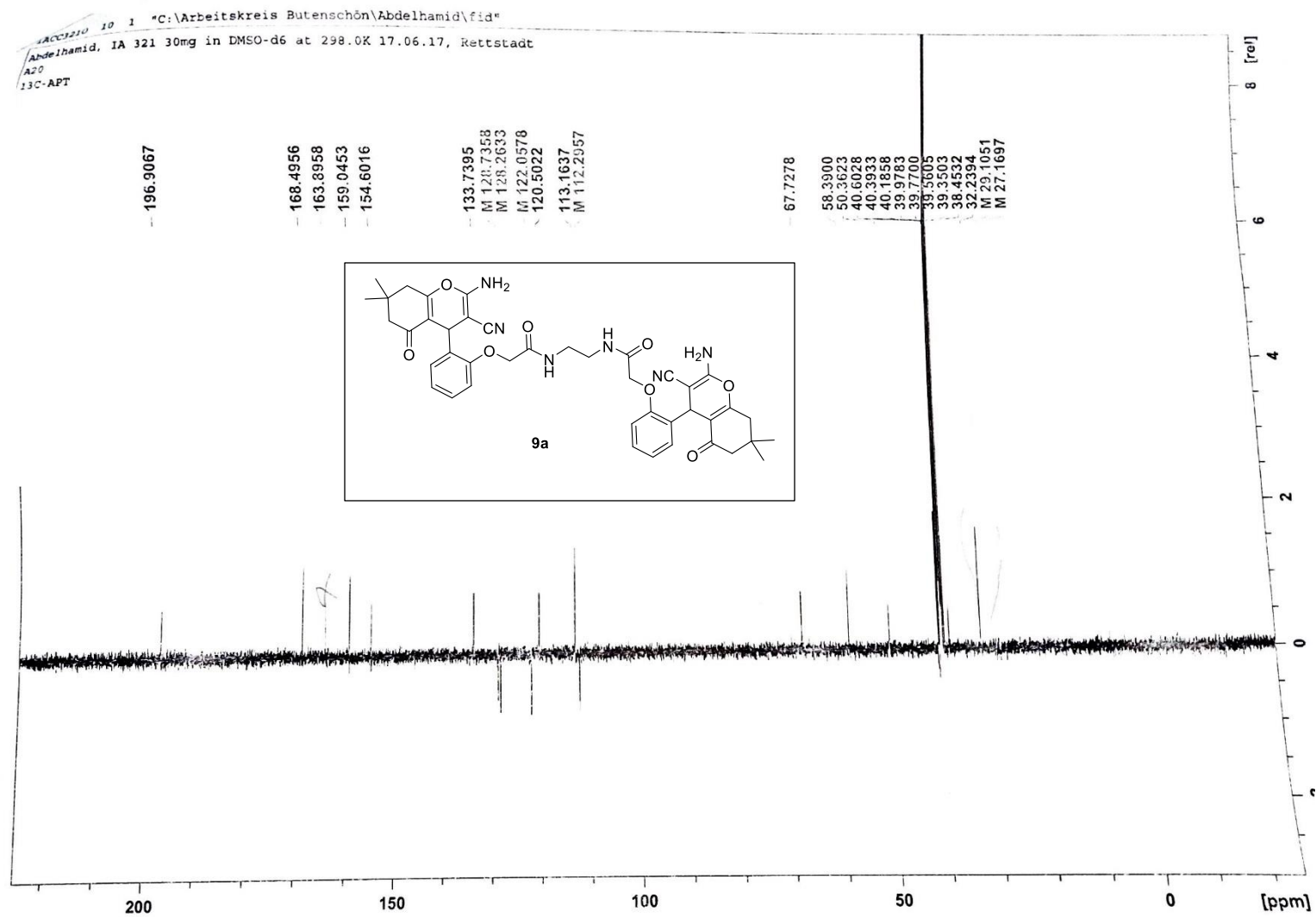
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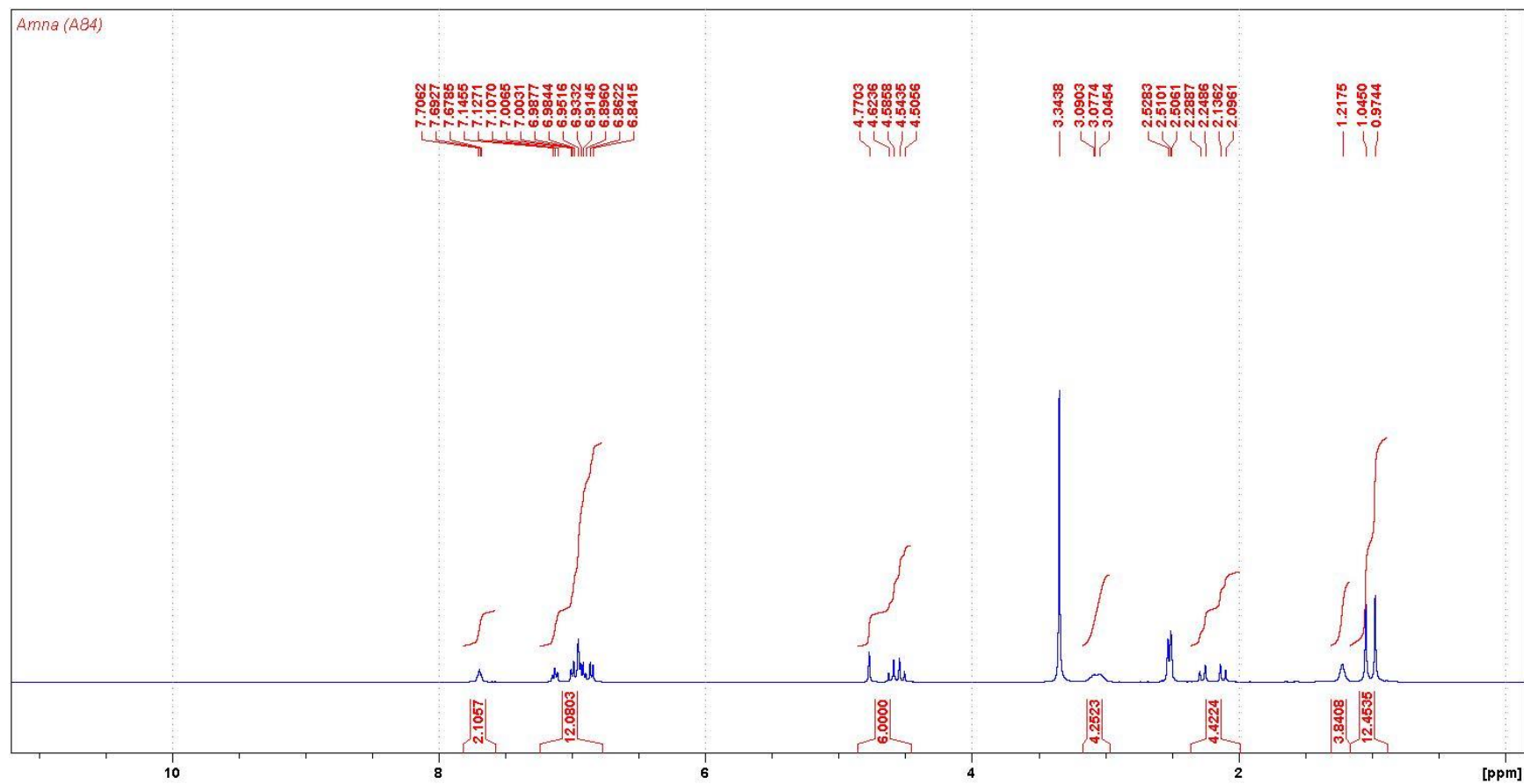
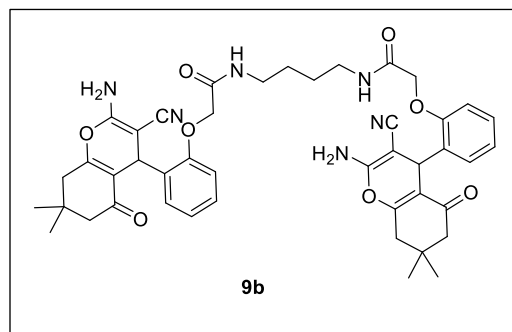
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Relax. delay 1.000 sec  
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 Acq. time 4.853 sec  
 Width 6600.7 Hz  
 62 repetitions  
 OBSERVE H1, 300.0687871 MHz  
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 Total time 43 min, 34 sec  
 Date: May 4 2017

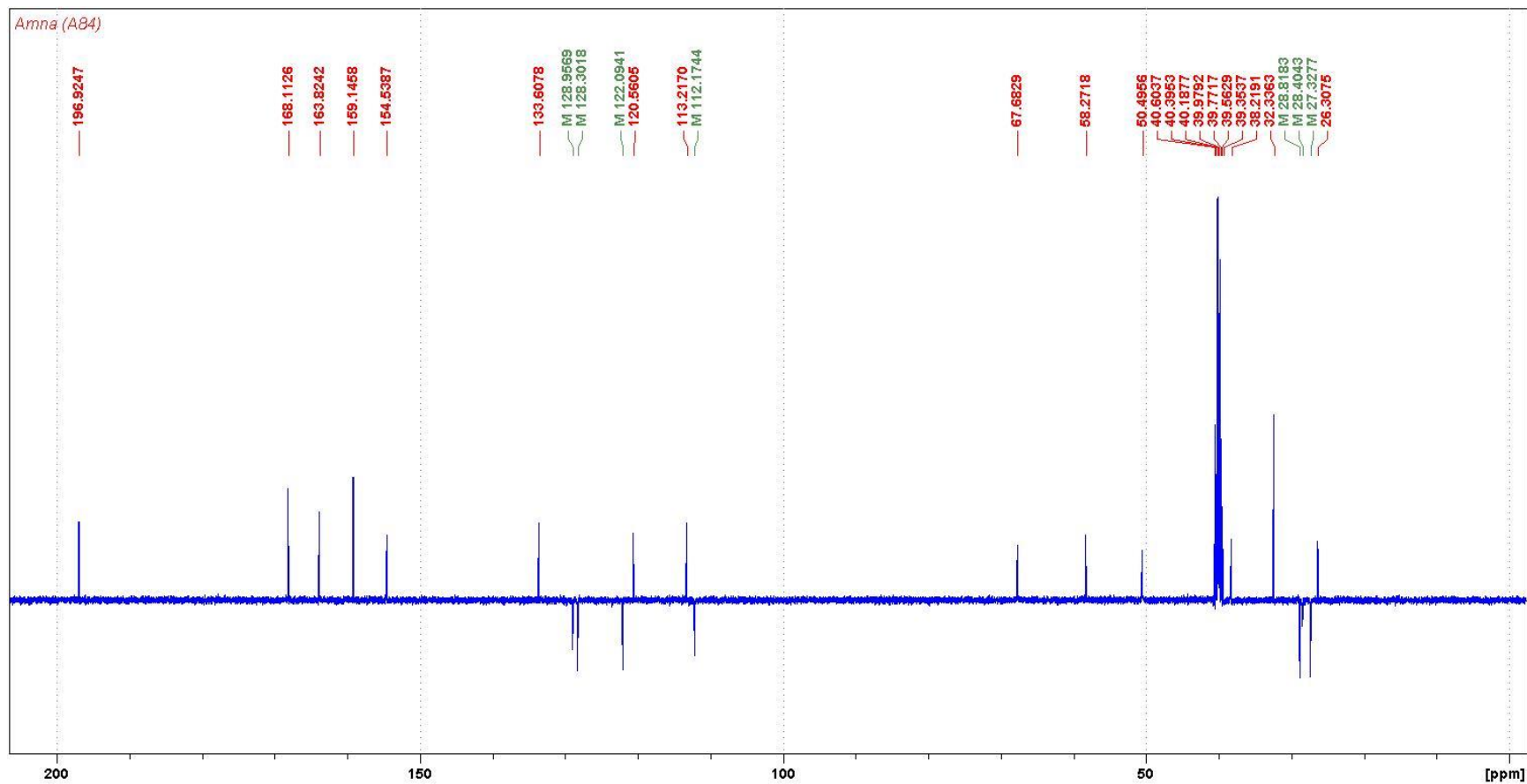
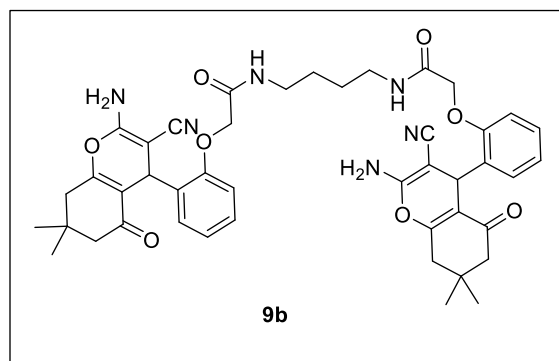




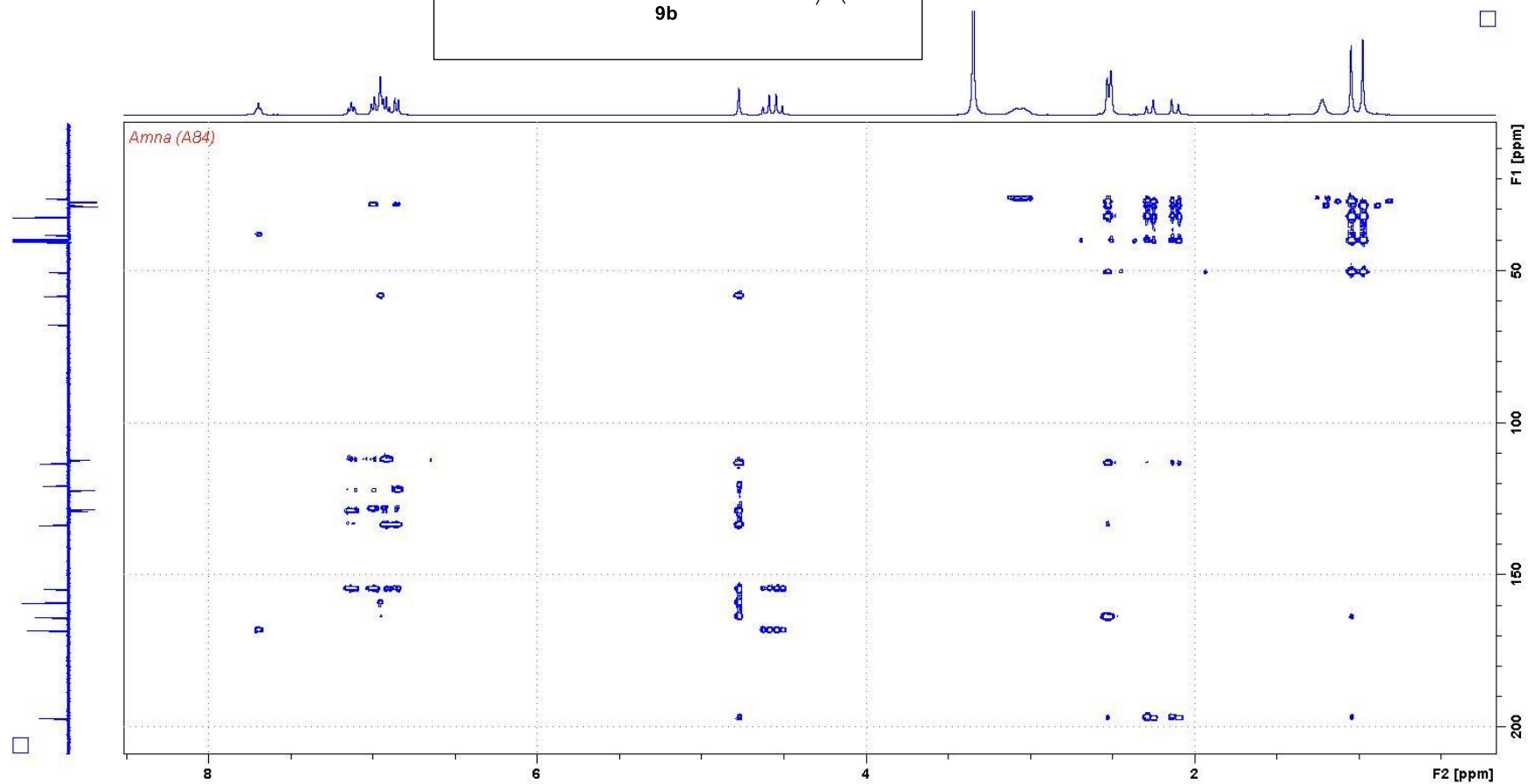
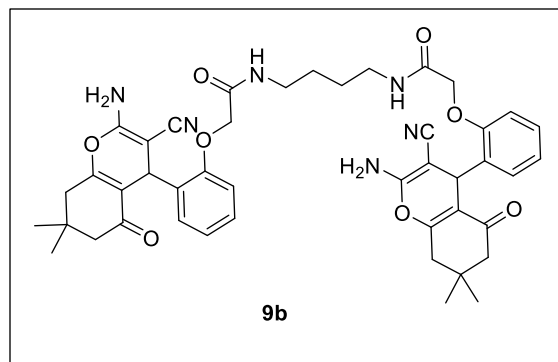




**<sup>1</sup>H NMR of compound 9b**



**<sup>13</sup>C NMR of compound 9b**

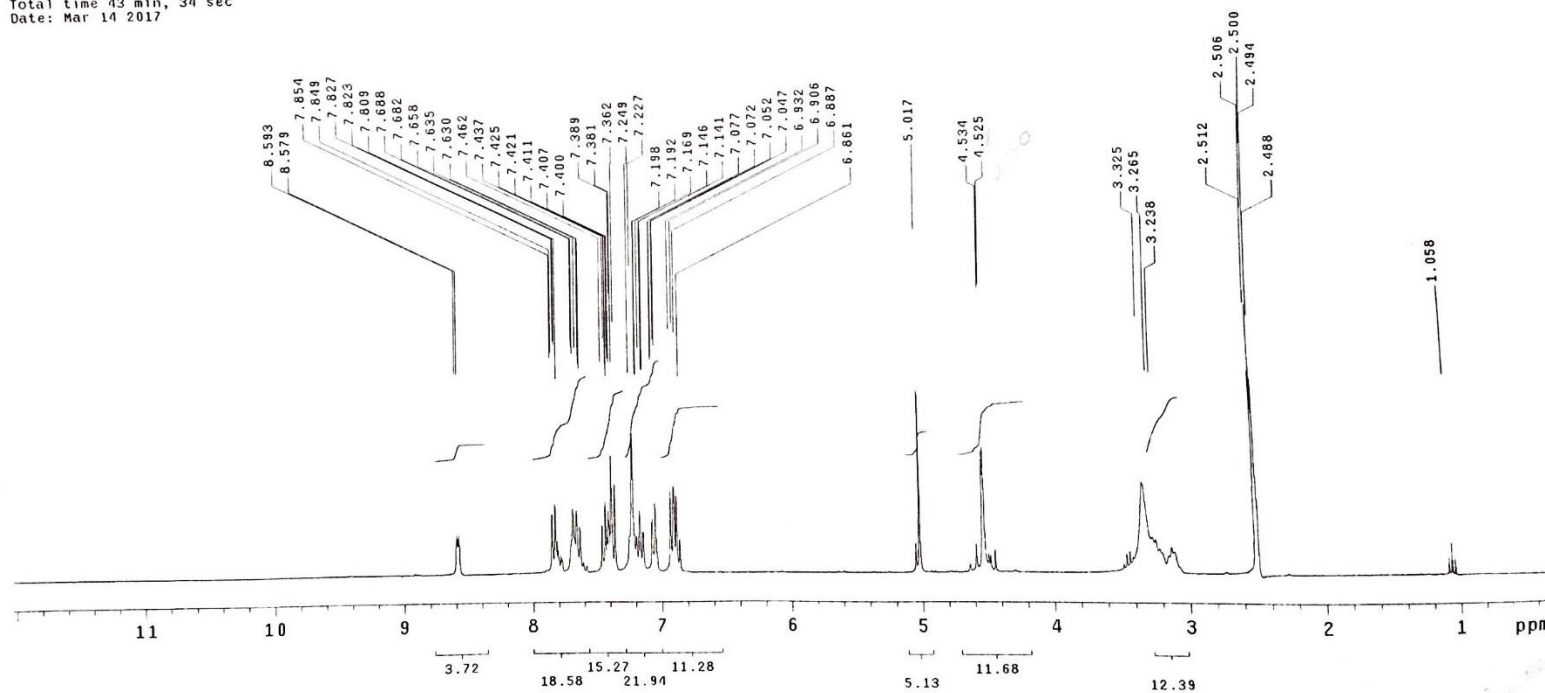
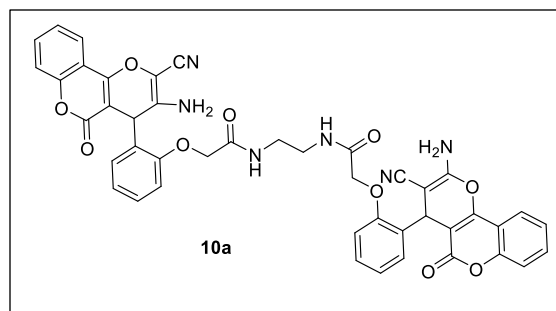


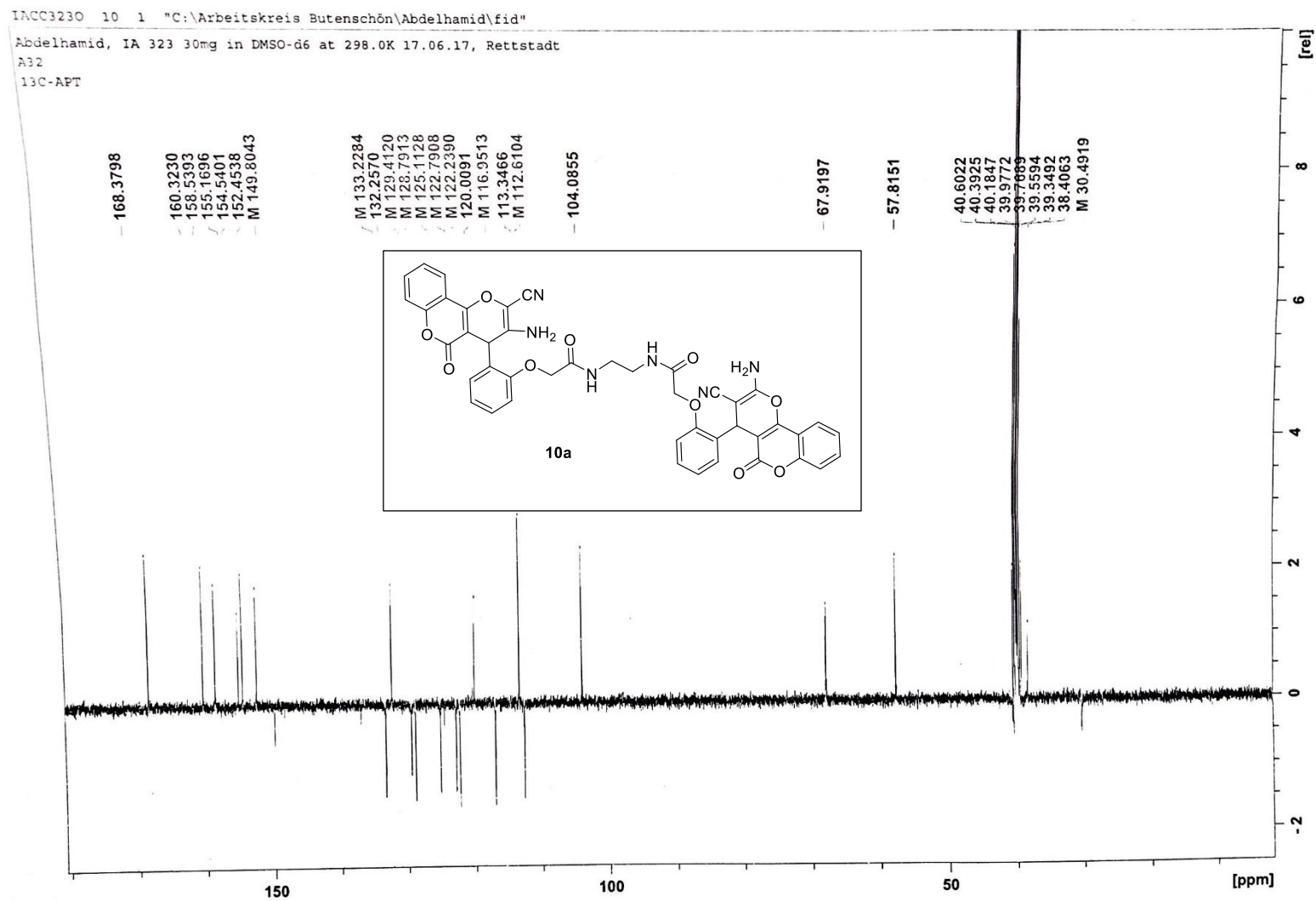
HMBC of compound 9b

AhmadHelmy-A32-DMSO-1H

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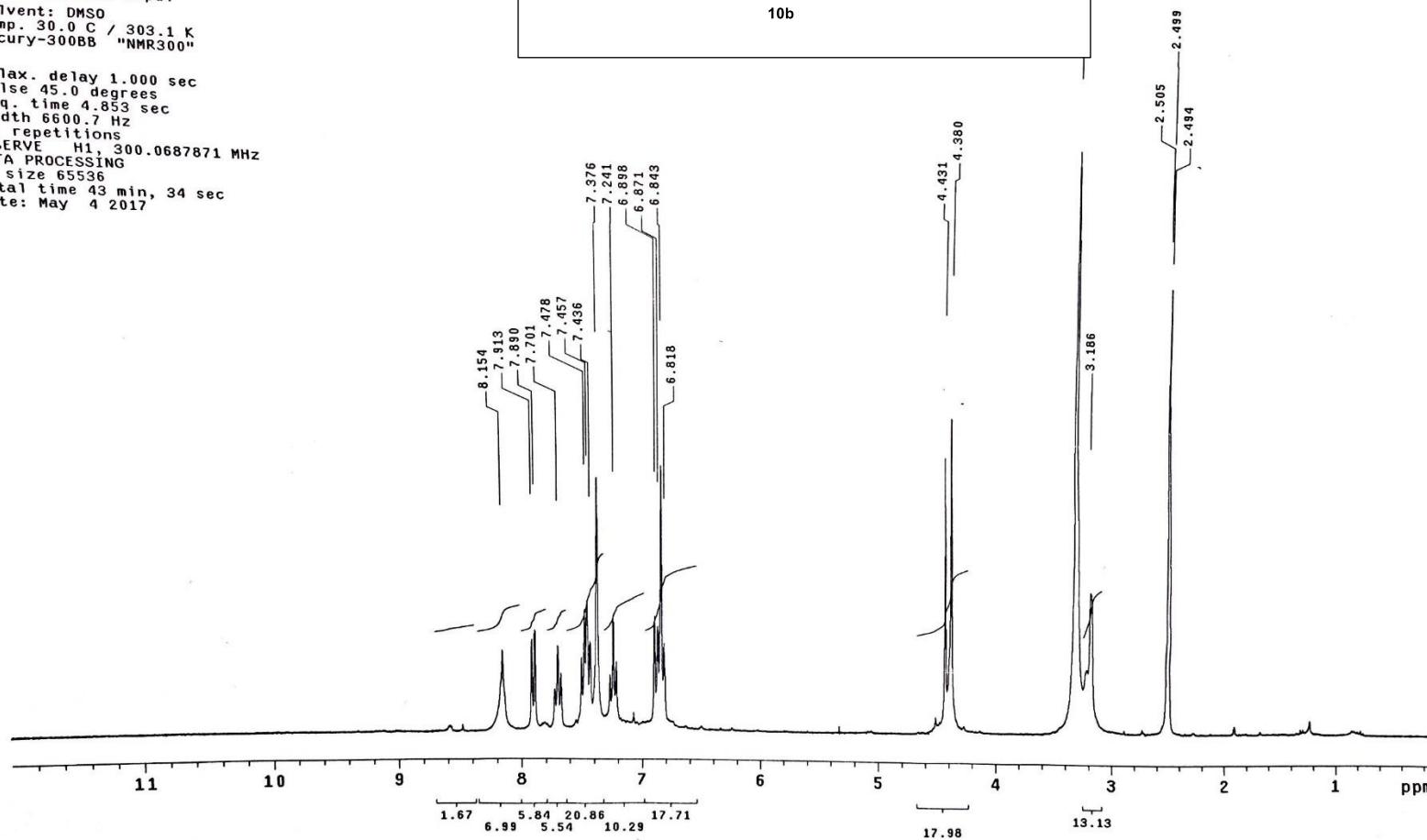
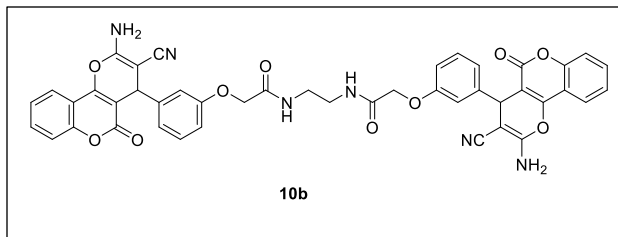
Pulse Sequence: s2pul

Solvent: DMSO  
Temp: 30.0 C / 303.1 K  
Mercury-300BB "NMR300"Relax. delay 1.000 sec  
Pulse 45.0 degrees  
Acq. time 4.853 sec  
Width 6600.7 Hz  
46 repetitions  
OBSERVE H1, 300.0687871 MHz  
DATA PROCESSING  
F1 size 65536  
Total time 43 min, 34 sec  
Date: Mar 14 2017<sup>1</sup>H NMR of compound 10a



<sup>13</sup>C NMR of compound 10a

AhmadHemy-A33-DMSO-1H

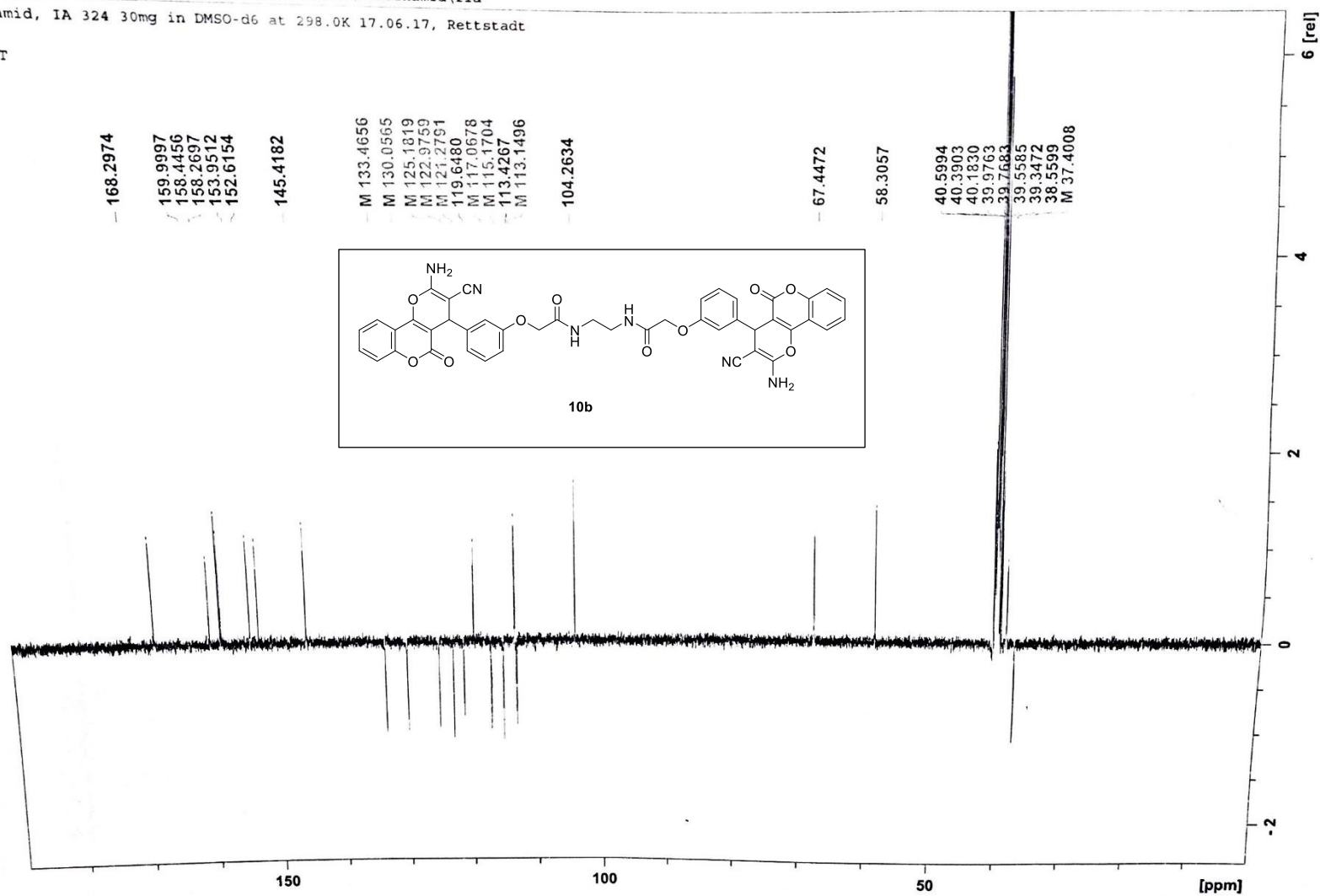
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Solvent: DMSO  
Temp. 30.0 C / 303.1 K  
Mercury-300BB "NMR300"Relax. delay 1.000 sec  
Pulse 45.0 degrees  
Acq. time 4.853 sec  
Width 6600.7 Hz  
21 repetitions  
OBSERVE H1, 300.0687871 MHz  
DATA PROCESSING  
FT size 65536  
Total time 43 min, 34 sec  
Date: May 4 2017<sup>1</sup>H NMR of compound 10b

IACC3240 10 1 "C:\Arbeitskreis Butenschön\Abdelhamid\fid"

Abdelhamid, IA 324 30mg in DMSO-d6 at 298.0K 17.06.17, Rettstadt

A33

13C-APT

<sup>13</sup>C NMR of compound 10b

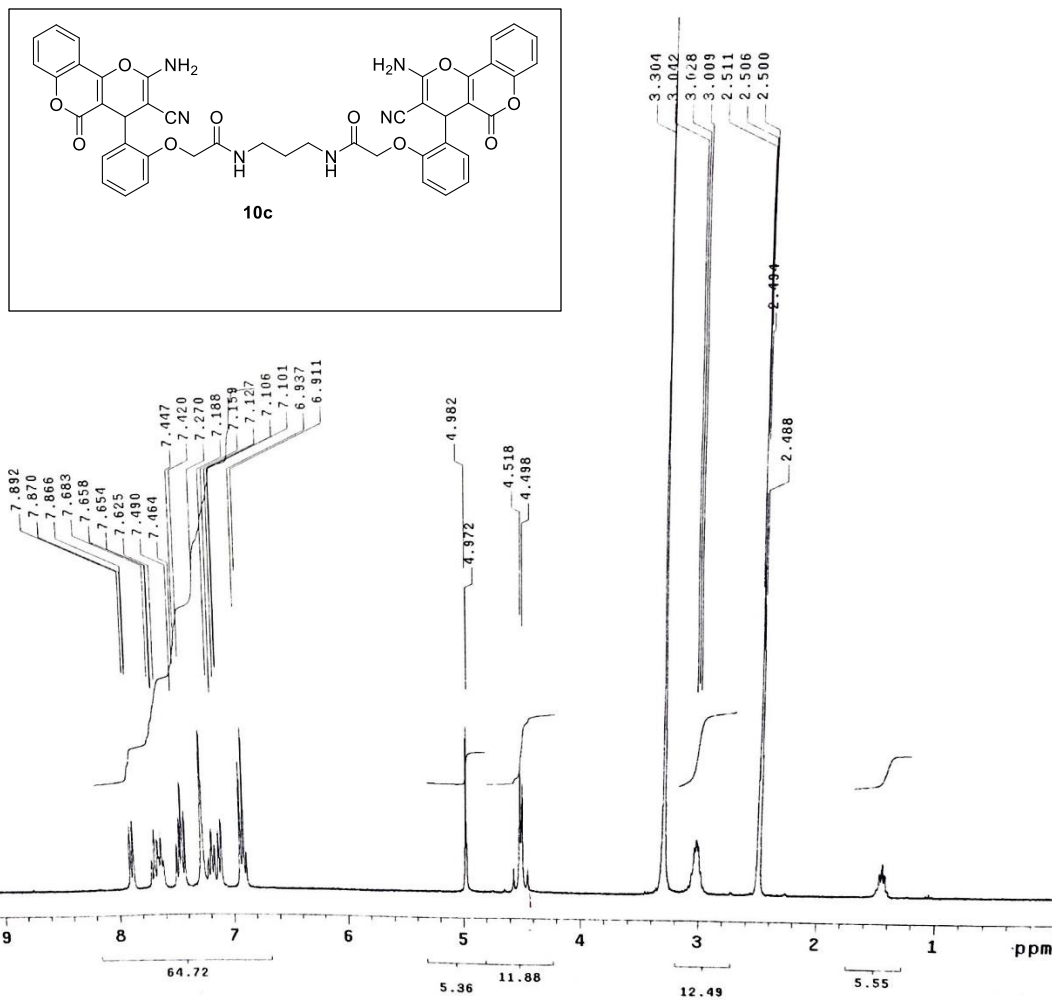


AhmedHelmy-A119-DMSO-H1

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Solvent: DMSO  
Temp. 30.0 C / 303.1 K  
Mercury-300BB "NMR300"

Relax. delay 1.000 sec  
Pulse 45.0 degrees  
Acq. time 4.853 sec  
Width 6600.7 Hz  
18 repetitions  
OBSERVE H1, 300.0687871 MHz  
DATA PROCESSING  
FT size 65536  
Total time 43 min, 34 sec  
Date: Dec 24 2017

<sup>1</sup>H NMR of compound 10c

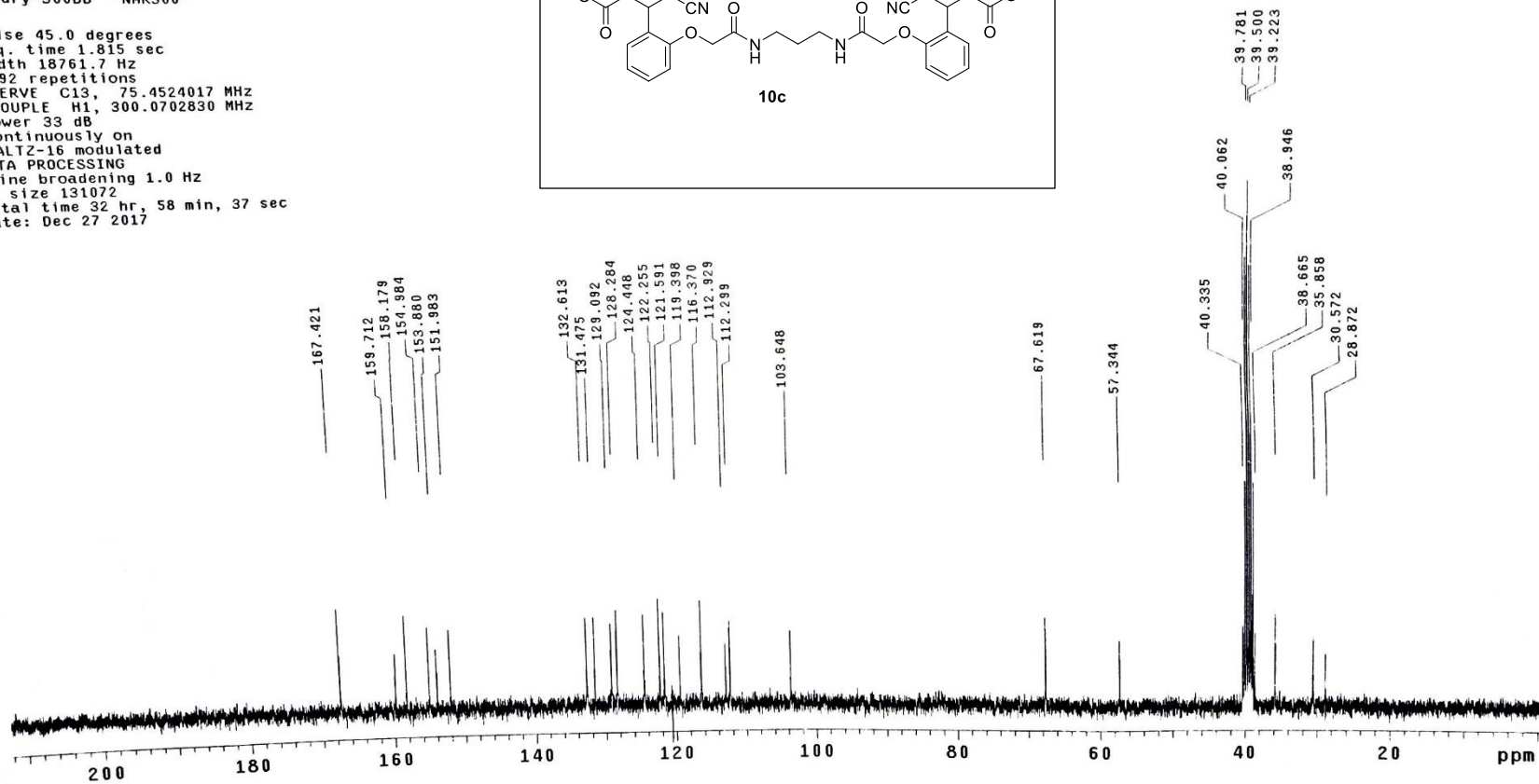
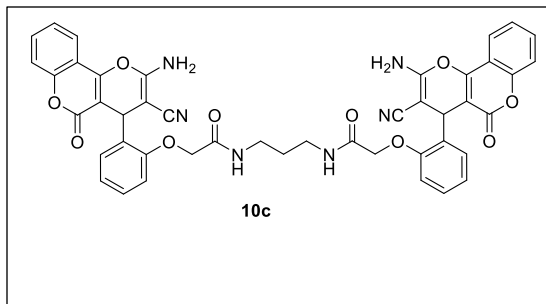
AhmedHelmy-A119-DMSO-C13

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File: PROTON

Pulse Sequence: s2pul

Solvent: DMSO  
Temp. 40.0 C / 313.1 K  
Mercury-300BB "NMR300"

Pulse 45.0 degrees  
Acq. time 1.815 sec  
Width 18761.7 Hz  
2192 repetitions  
OBSERVE C13, 75.4524017 MHz  
DECOUPLE H1, 300.0702830 MHz  
Power 33 dB  
continuously on  
WALTZ-16 modulated  
DATA PROCESSING  
Line broadening 1.0 Hz  
FT size 131072  
Total time 32 hr, 58 min, 37 sec  
Date: Dec 27 2017

<sup>13</sup>C NMR of compound 10c

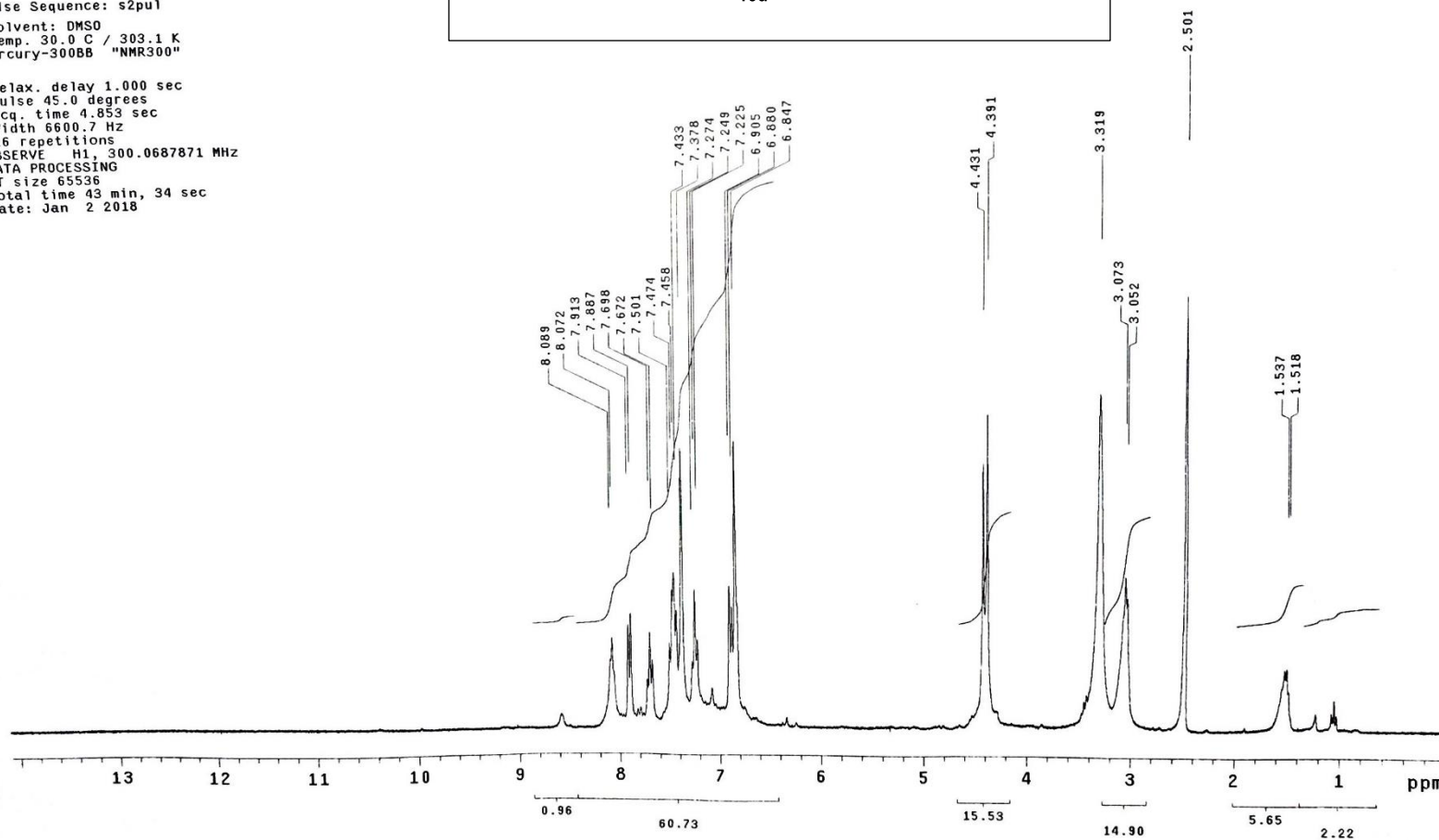
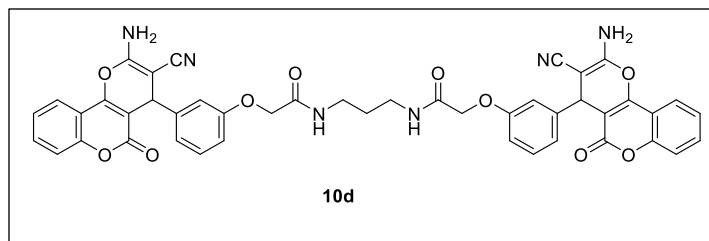
AhmedHelmy-A123-DMSO-H1

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File: PROTON

Pulse Sequence: s2pu1

Solvent: DMSO  
Temp. 30.0 C / 303.1 K  
Mercury-300BB "NMR300"

Relax. delay 1.000 sec  
Pulse 45.0 degrees  
Acq. time 4.853 sec  
Width 6600.7 Hz  
16 repetitions  
OBSERVE H1, 300.0687871 MHZ  
DATA PROCESSING  
FT size 65536  
Total time 43 min, 34 sec  
Date: Jan 2 2018

**<sup>1</sup>H NMR of compound 10d**

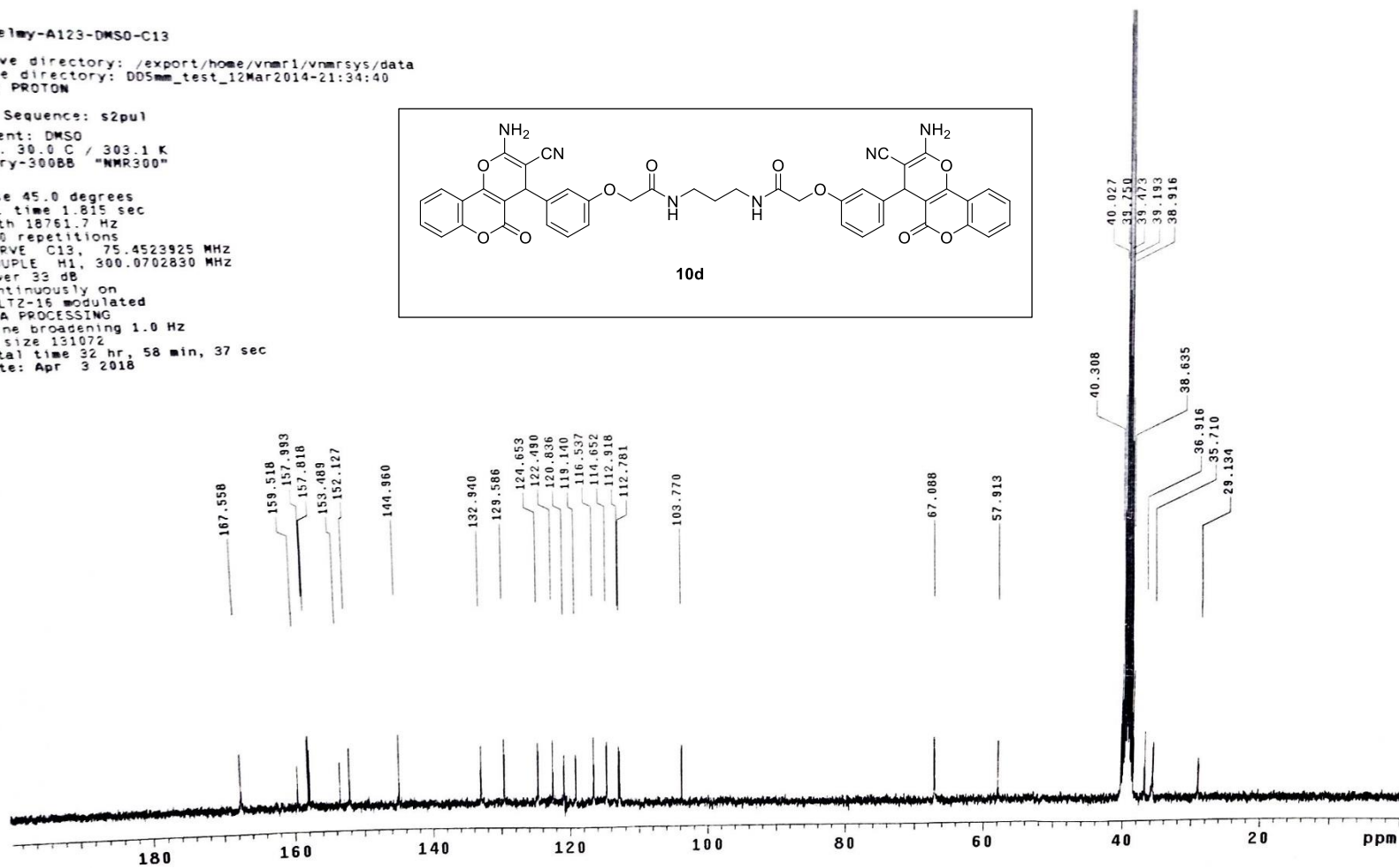
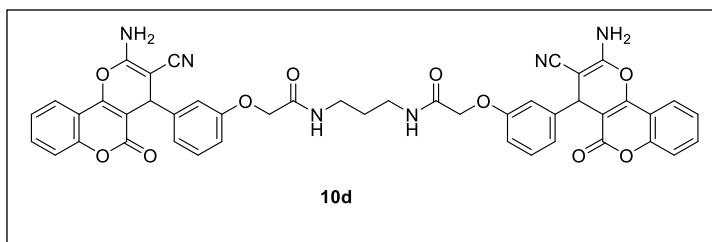
AhmedHelmy-A123-DMSO-C13

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 Sample directory: D05mm\_test\_12Mar2014-21:34:40  
 File: PROTON

Pulse Sequence: s2pul

Solvent: DMSO  
 Temp. 30.0 C / 303.1 K  
 Mercury-300BB "NMR300"

Pulse 45.0 degrees  
 Acq. time 1.835 sec  
 Width 18761.7 Hz  
 2500 repetitions  
 OBSERVE C13, 75.4523925 MHz  
 DECOUPLE H1, 300.0702830 MHz  
 Power 33 dB  
 continuously on  
 WALTZ-16 modulated  
 DATA PROCESSING  
 Line broadening 1.0 Hz  
 FT size 131072  
 Total time 32 hr, 58 min, 37 sec  
 Date: Apr 3 2018

<sup>13</sup>C NMR of compound 10d

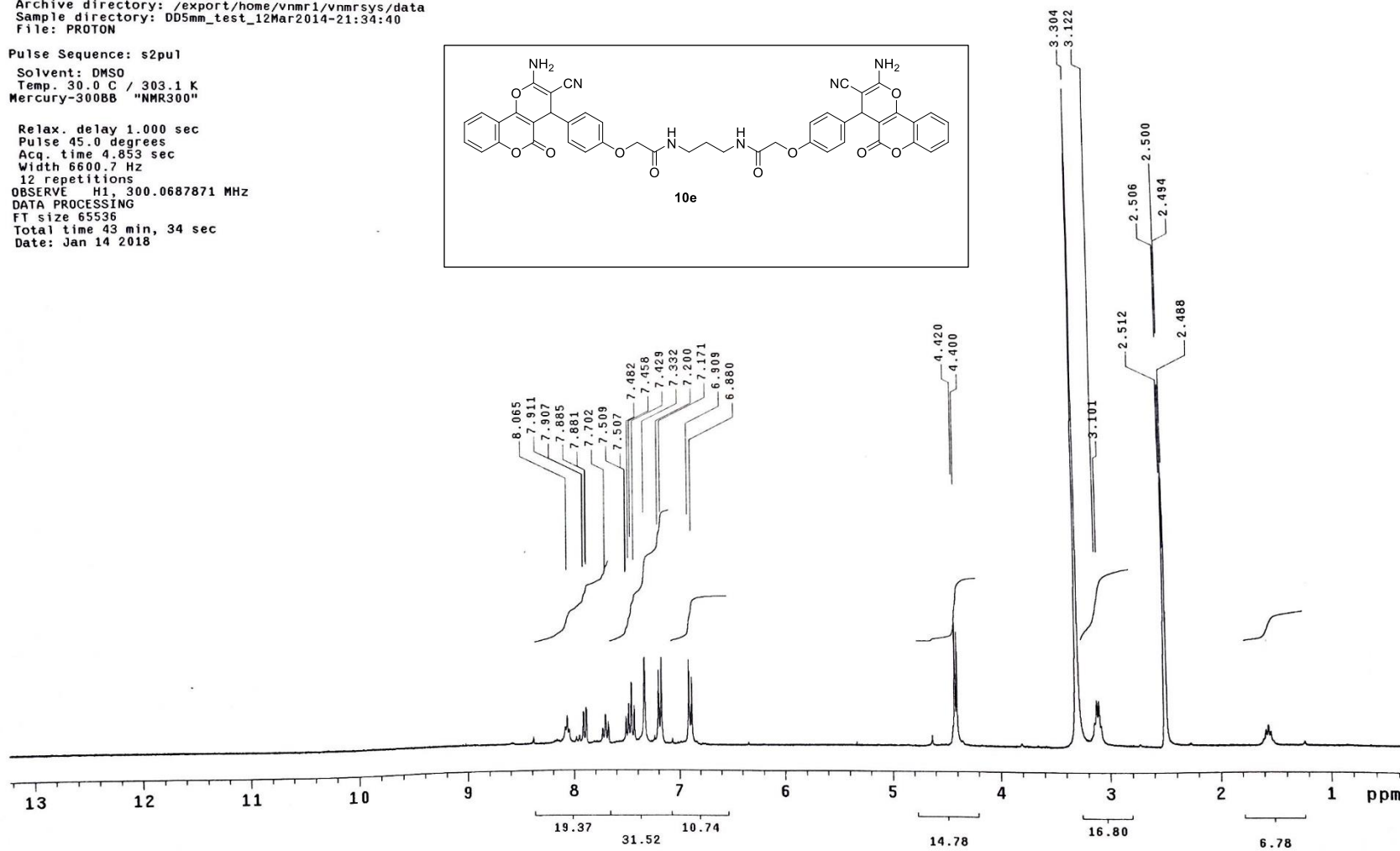
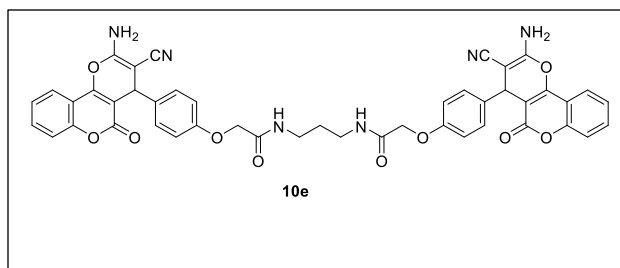
SaiedGhozlan-A126-DMSO-H1

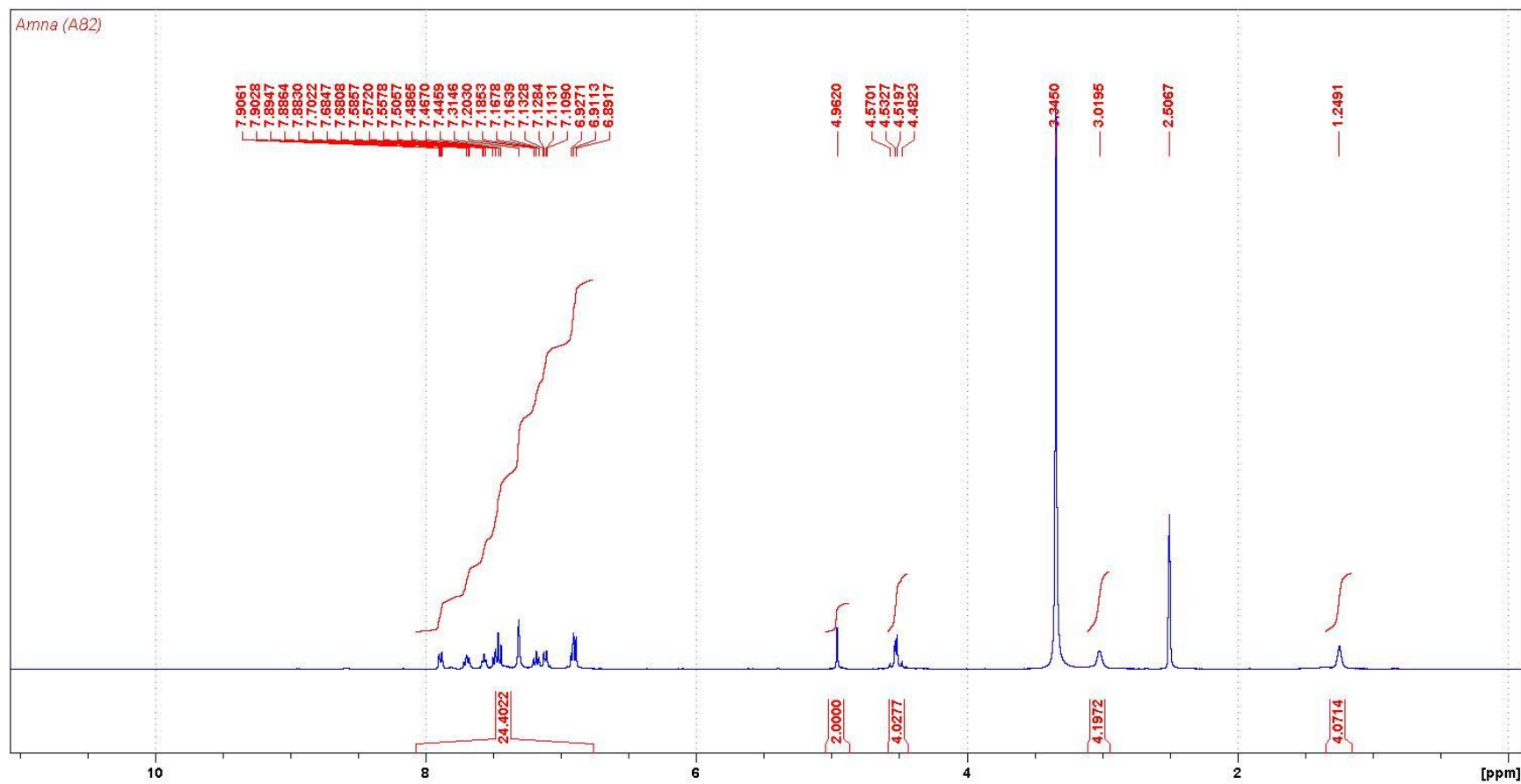
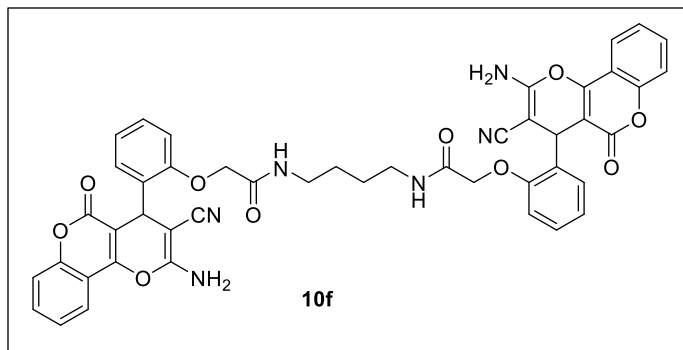
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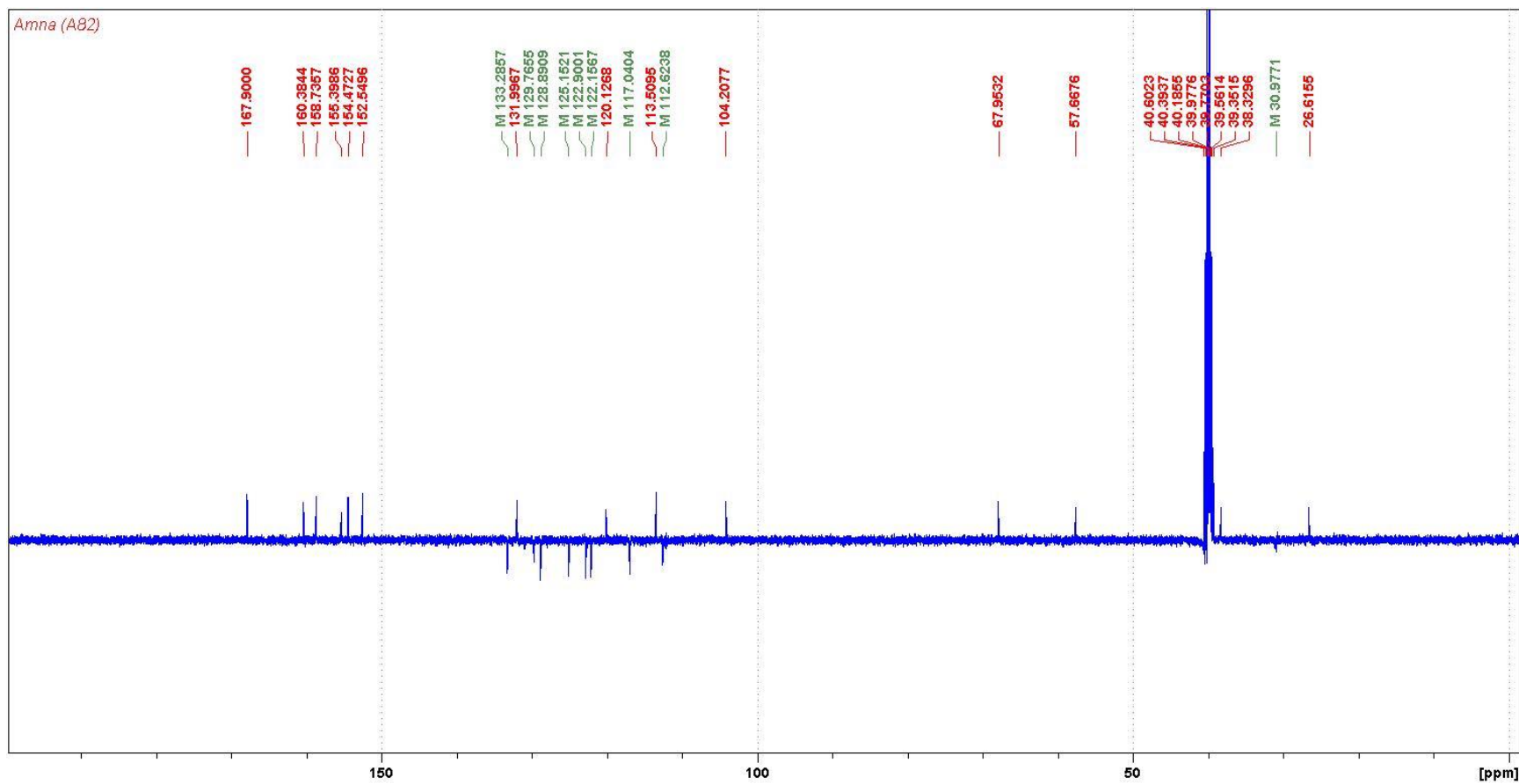
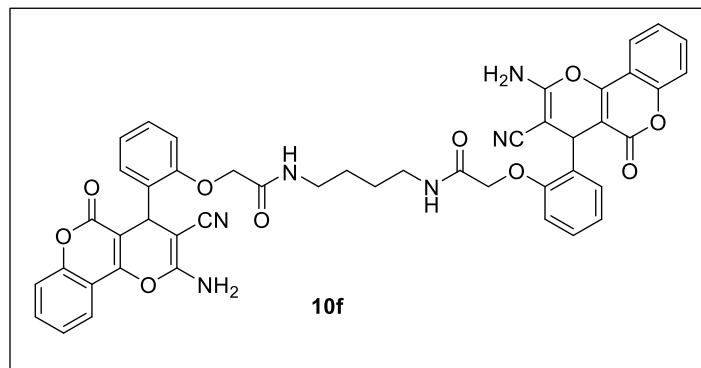
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Pulse 45.0 degrees  
Acq. time 4.853 sec  
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Date: Jan 14 2018

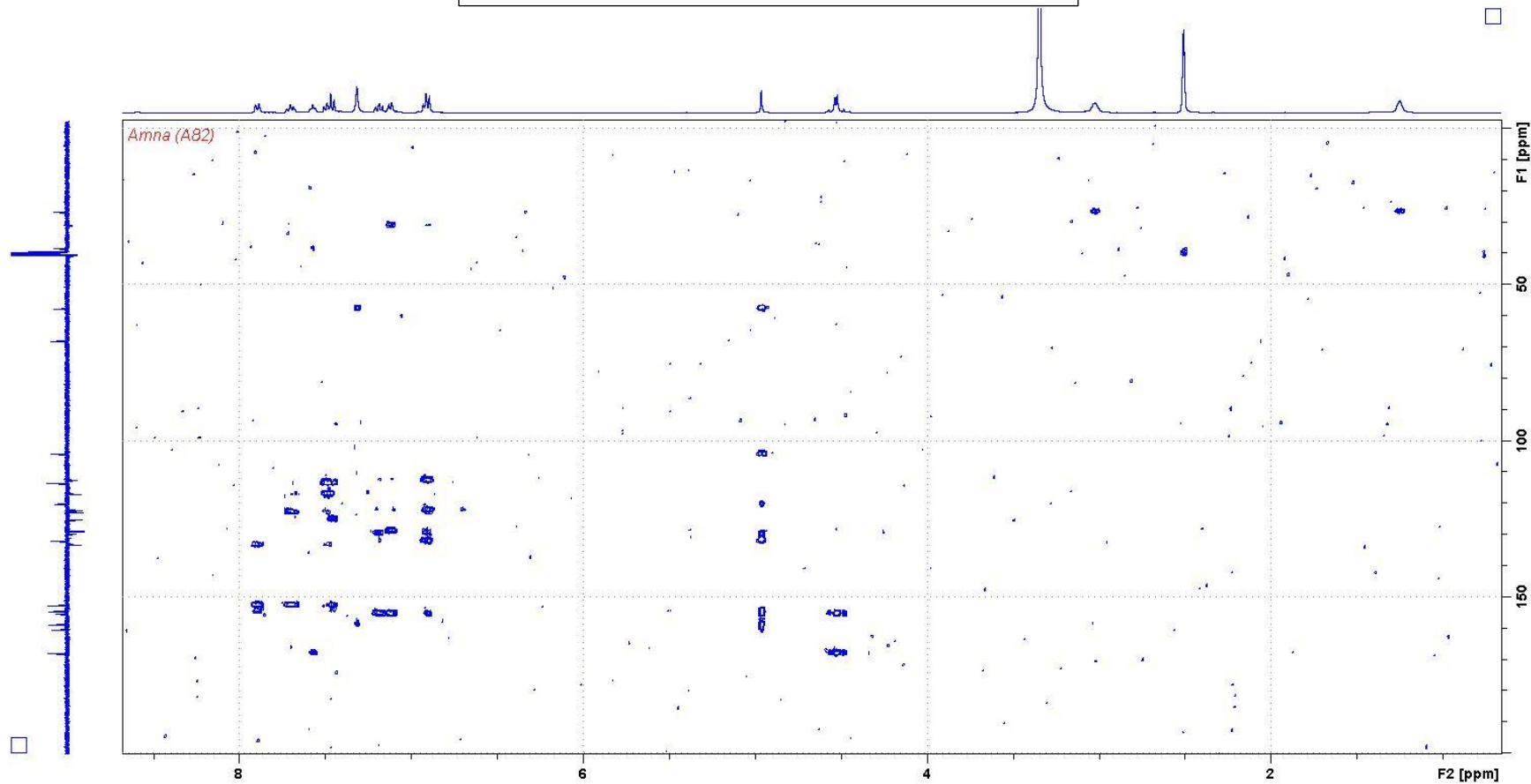
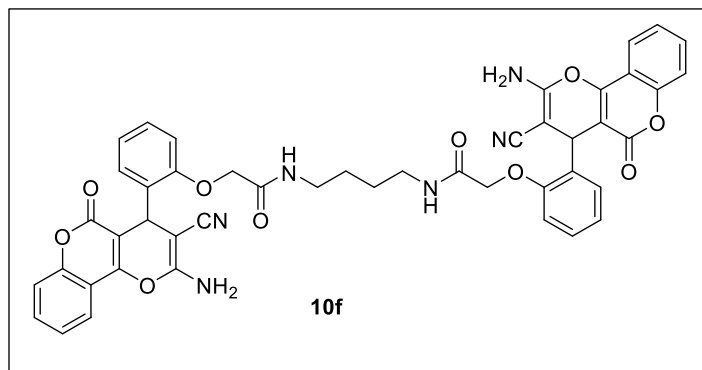
 $^1\text{H}$  NMR of compound 10e



<sup>1</sup>H NMR of compound 10f



<sup>13</sup>C NMR of compound 10f



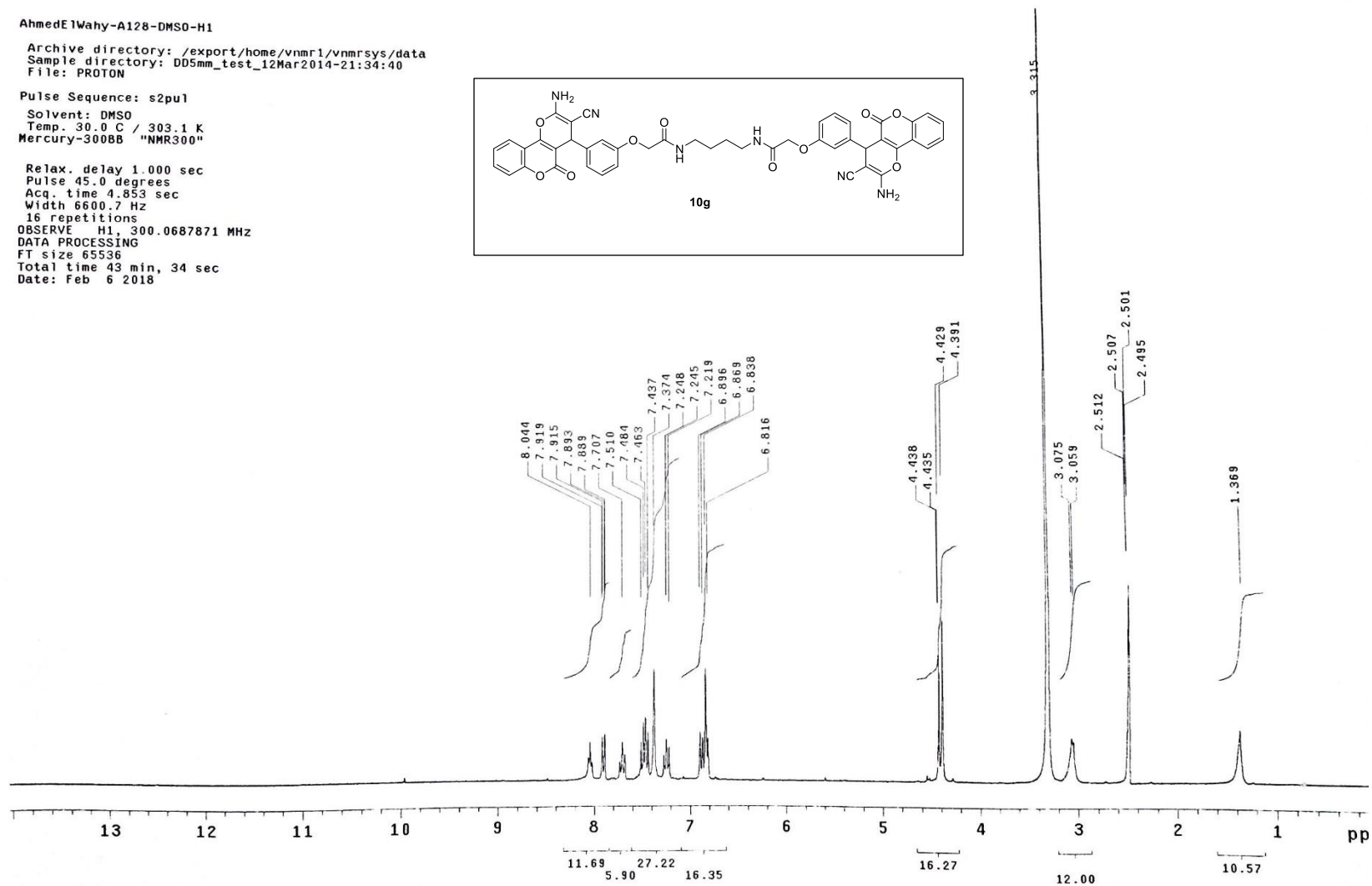
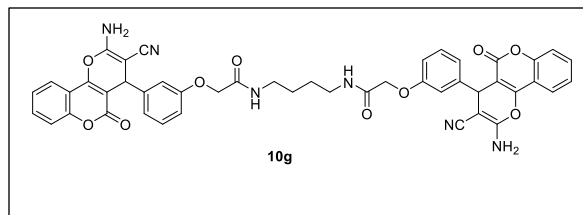
HMBC NMR of compound 10f



AhmedE1Wahy-A128-DMSO-H1

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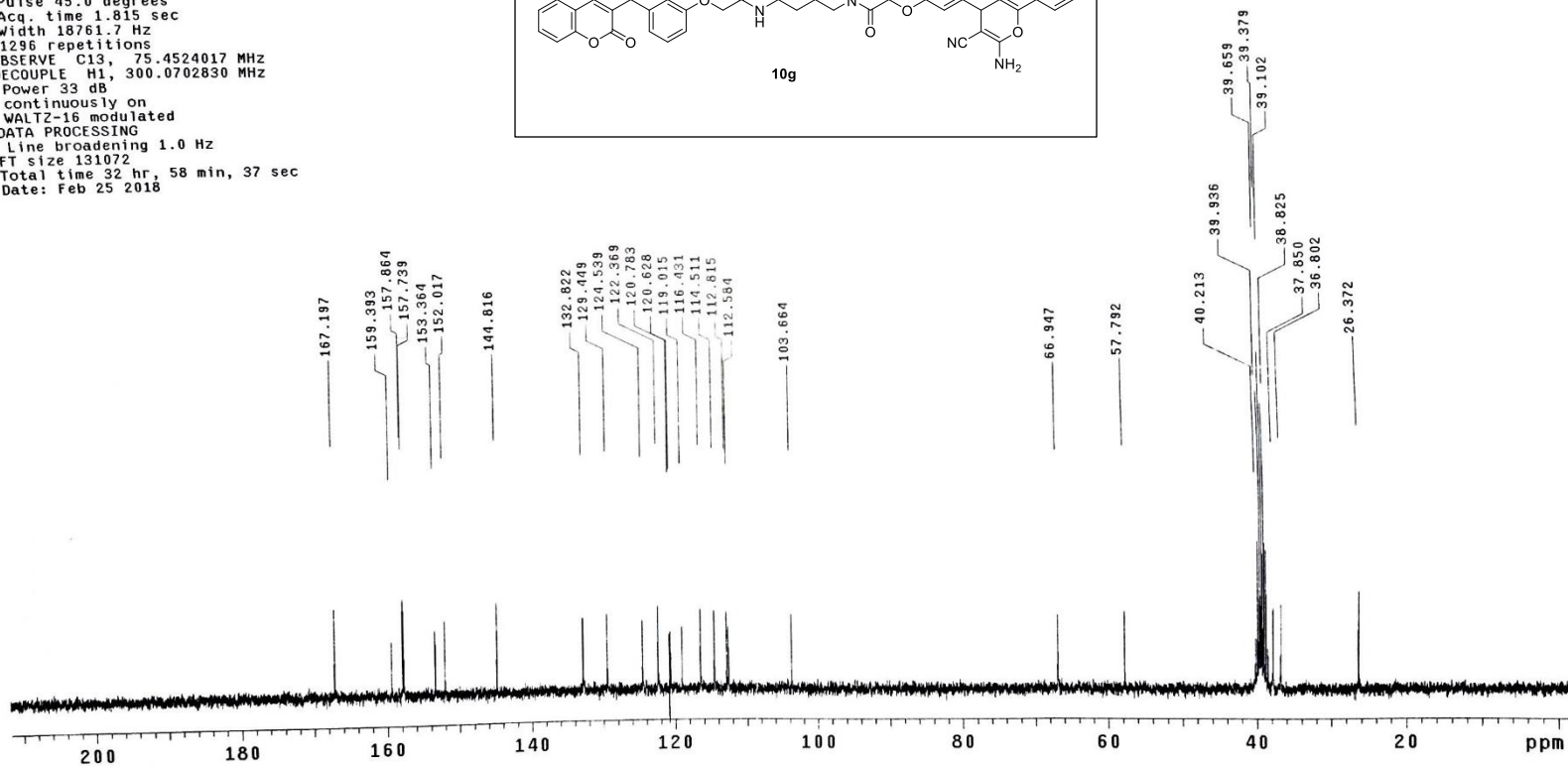
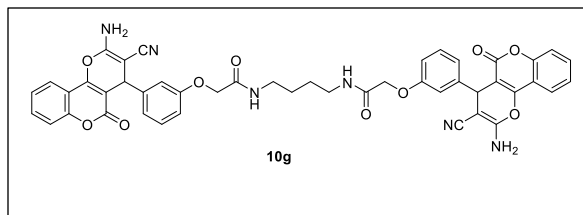
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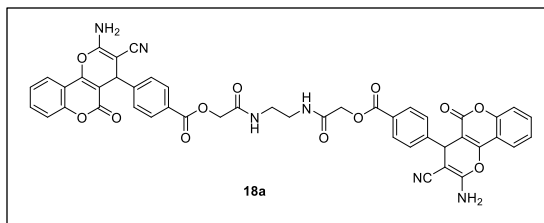
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Temp. 30.0 C / 303.1 K  
Mercury-300BB "NMR300"Relax. delay 1.000 sec  
Pulse 45.0 degrees  
Acq. time 4.853 sec  
Width 6600.7 Hz  
16 repetitions  
OBSERVE H1, 300.0687871 MHz  
DATA PROCESSING  
FT size 65536  
Total time 43 min, 34 sec  
Date: Feb 6 2018 $^1\text{H}$  NMR of compound 10g

AhmedHelmy-A128-DMSO-C13

Archive directory: /export/home/vnmr1/vnmrsys/data  
Sample directory: DD5mm\_test\_12Mar2014-21:34:40  
File: PROTON

Pulse Sequence: s2pu1

Solvent: DMSO  
Temp. 30.0 C / 303.1 K  
Mercury-300BB "NMR300"Pulse 45.0 degrees  
Acq. time 1.815 sec  
Width 18761.7 Hz  
1296 repetitions  
OBSERVE C13, 75.4524017 MHz  
DECOUPLE H1, 300.0702830 MHz  
Power 33 dB  
continuously on  
WALTZ-16 modulated  
DATA PROCESSING  
Line broadening 1.0 Hz  
FT size 131072  
Total time 32 hr, 58 min, 37 sec  
Date: Feb 25 2018 $^{13}\text{C}$  NMR of compound 10g

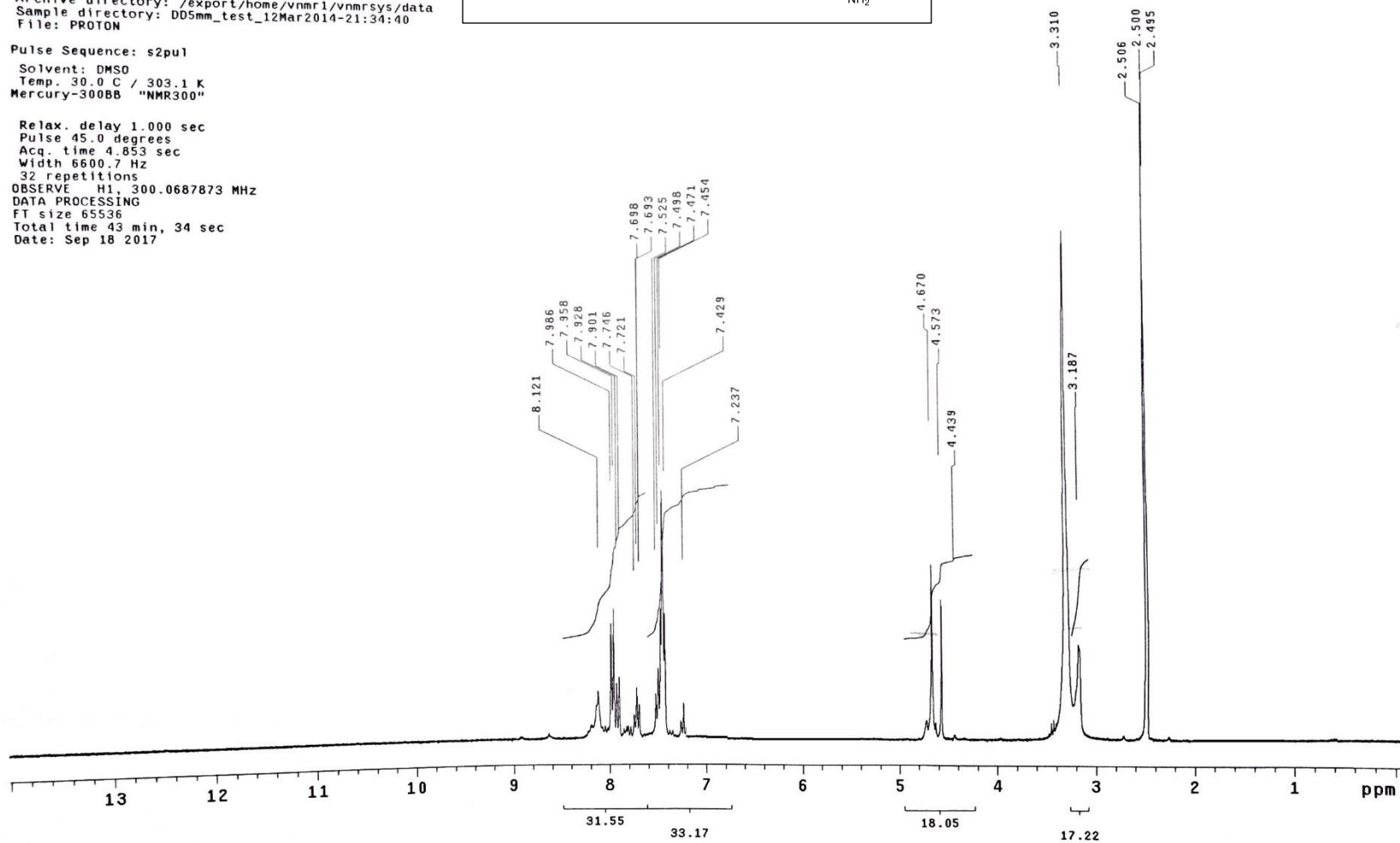


AhmedHelmy-A83-DMSO-H1

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Solvent: DMSO  
Temp. 30.0 C / 303.1 K  
Mercury-300BB "NMR300"

Relax. delay 1.000 sec  
Pulse 45.0 degrees  
Acq. time 4.853 sec  
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DATA PROCESSING  
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Total time 43 min, 34 sec  
Date: Sep 18 2017



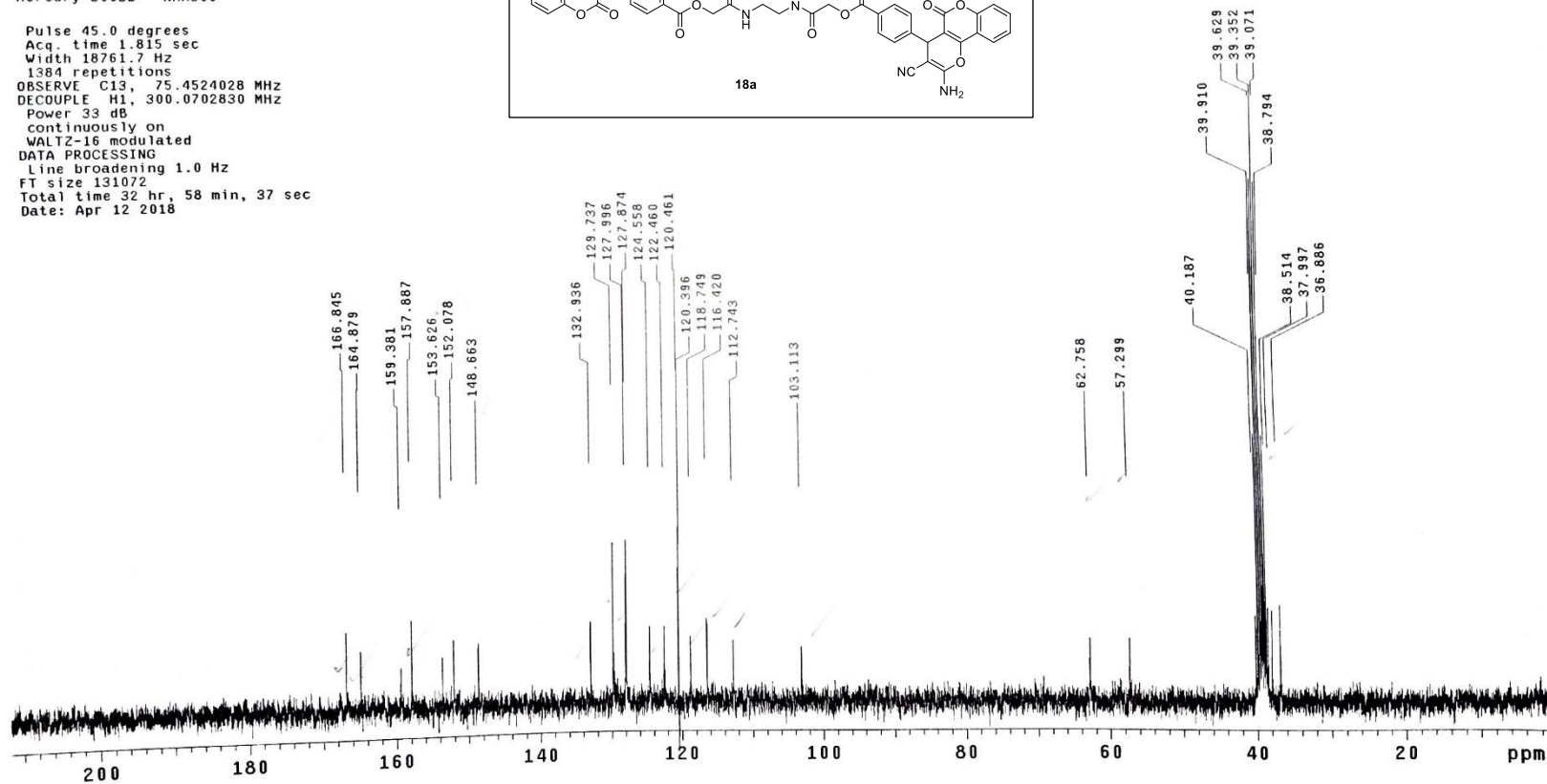
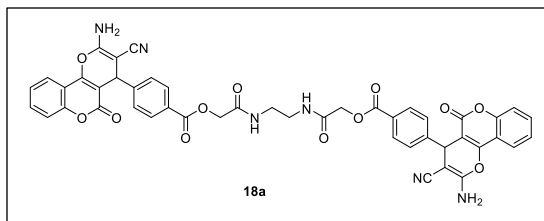
$^1\text{H}$  NMR of compound 18a

AhmedHelmy-A83-DMSO-C13

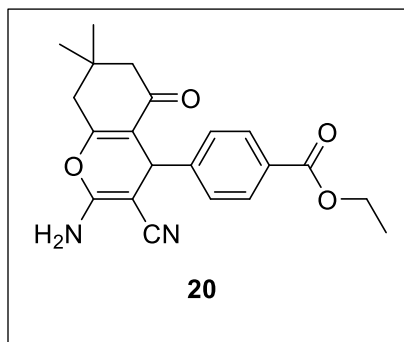
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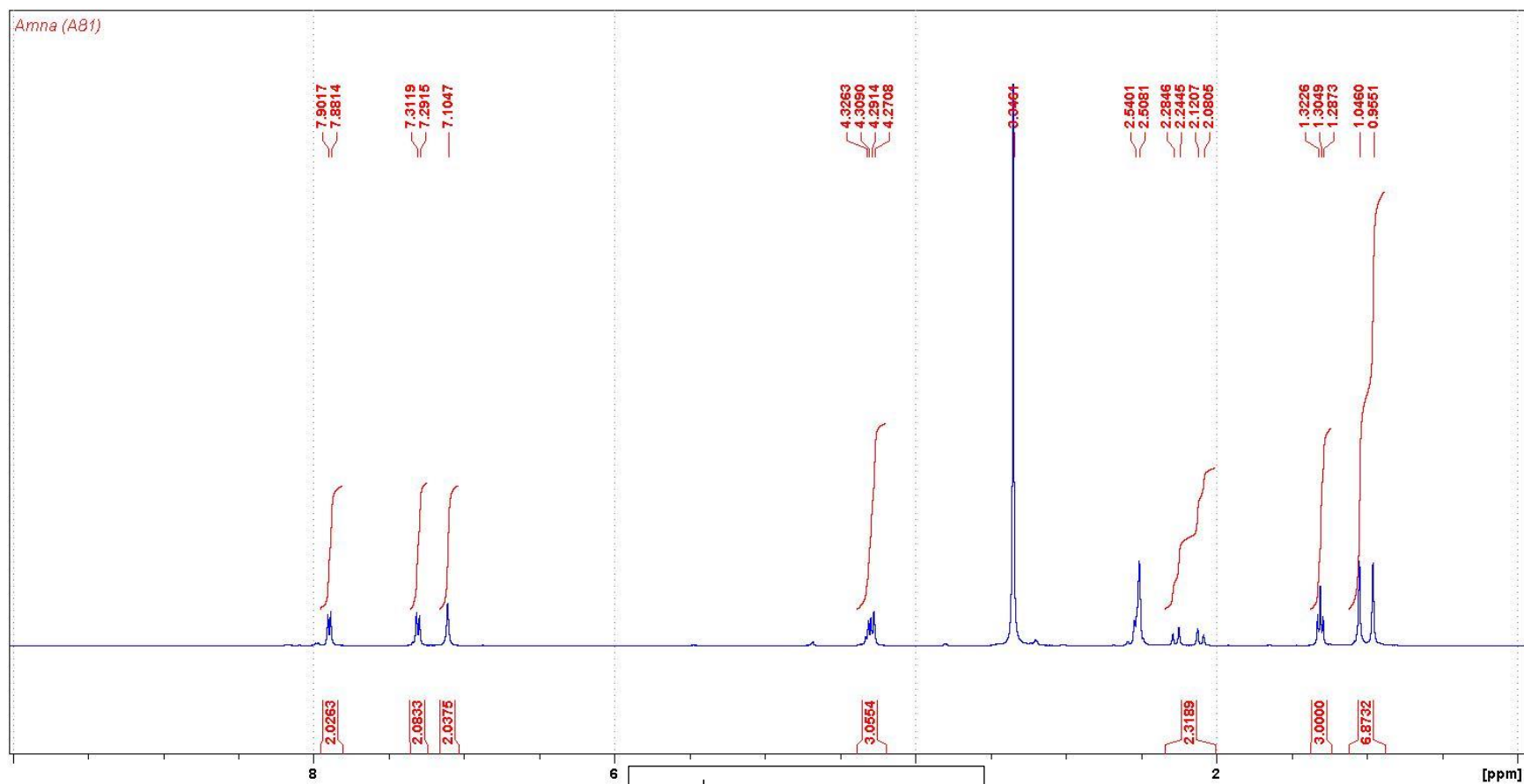
Pulse Sequence: s2pu1  
Solvent: DMSO  
Temp. 40.0 C / 313.1 K  
Mercury-300BB "NMR300"

Pulse 45.0 degrees  
Acq. time 1.815 sec  
Width 18761.7 Hz  
1384 repetitions  
OBSERVE C13, 75.4524028 MHz  
DECOUPLE H1, 300.0702830 MHz  
Power 33 dB  
continuously on  
WALTZ-16 modulated  
DATA PROCESSING  
Line broadening 1.0 Hz  
FT size 131072  
Total time 32 hr, 58 min, 37 sec  
Date: Apr 12 2018

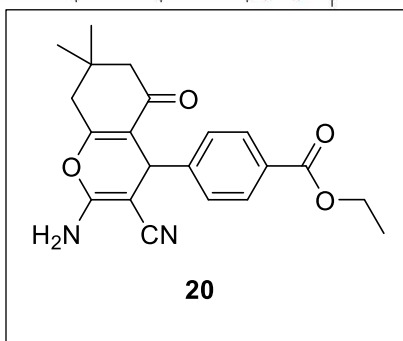


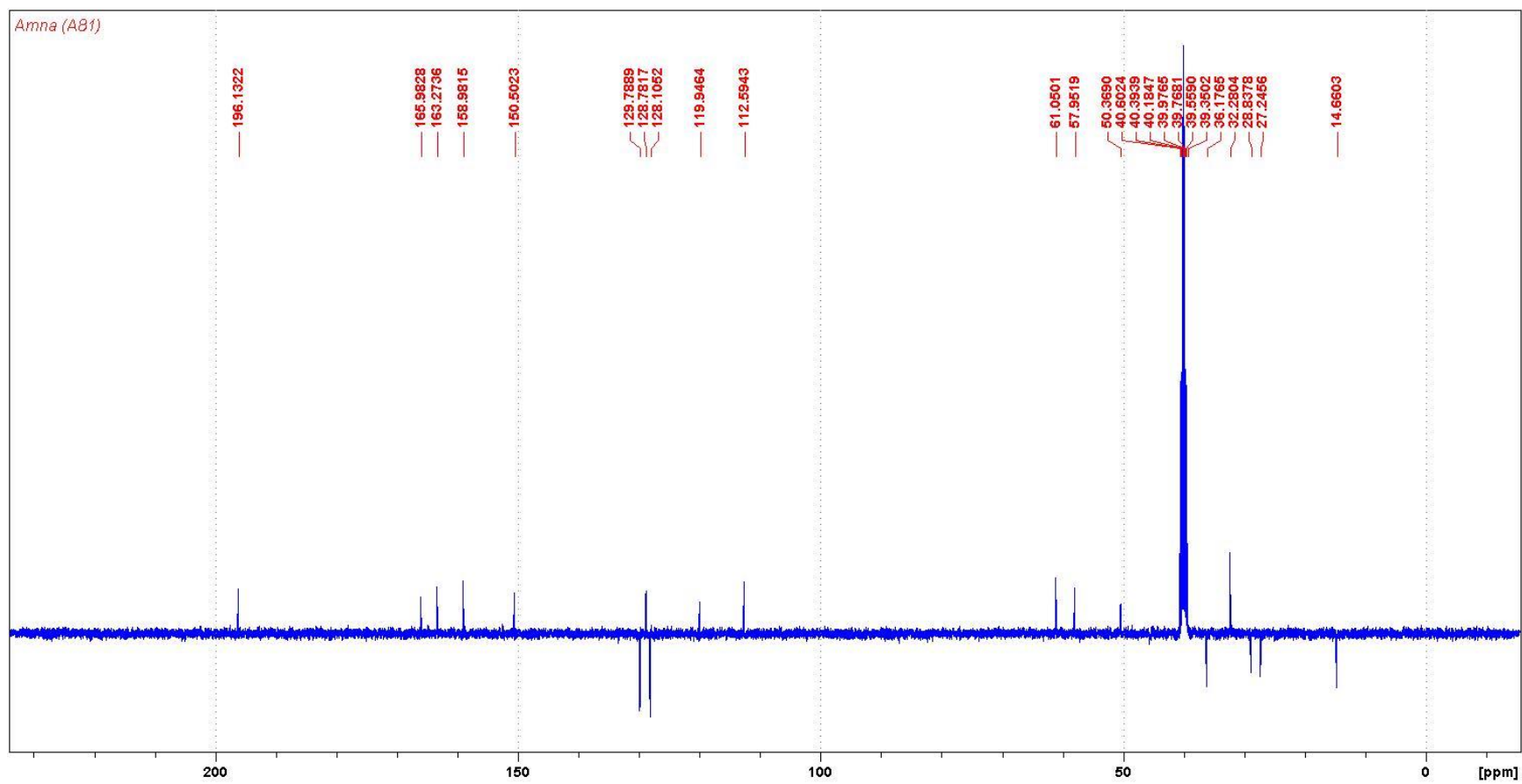
<sup>13</sup>C NMR of compound 18a





$^1\text{H}$  NMR of compound 20





**<sup>13</sup>C NMR of compound 20**