SUPPORTING INFORMATION

Structure-Property Relationships Studies of 3-acyl Substituted Furans: the serendipity identification and characterization of a new non-classic hydrogen bond donor moiety

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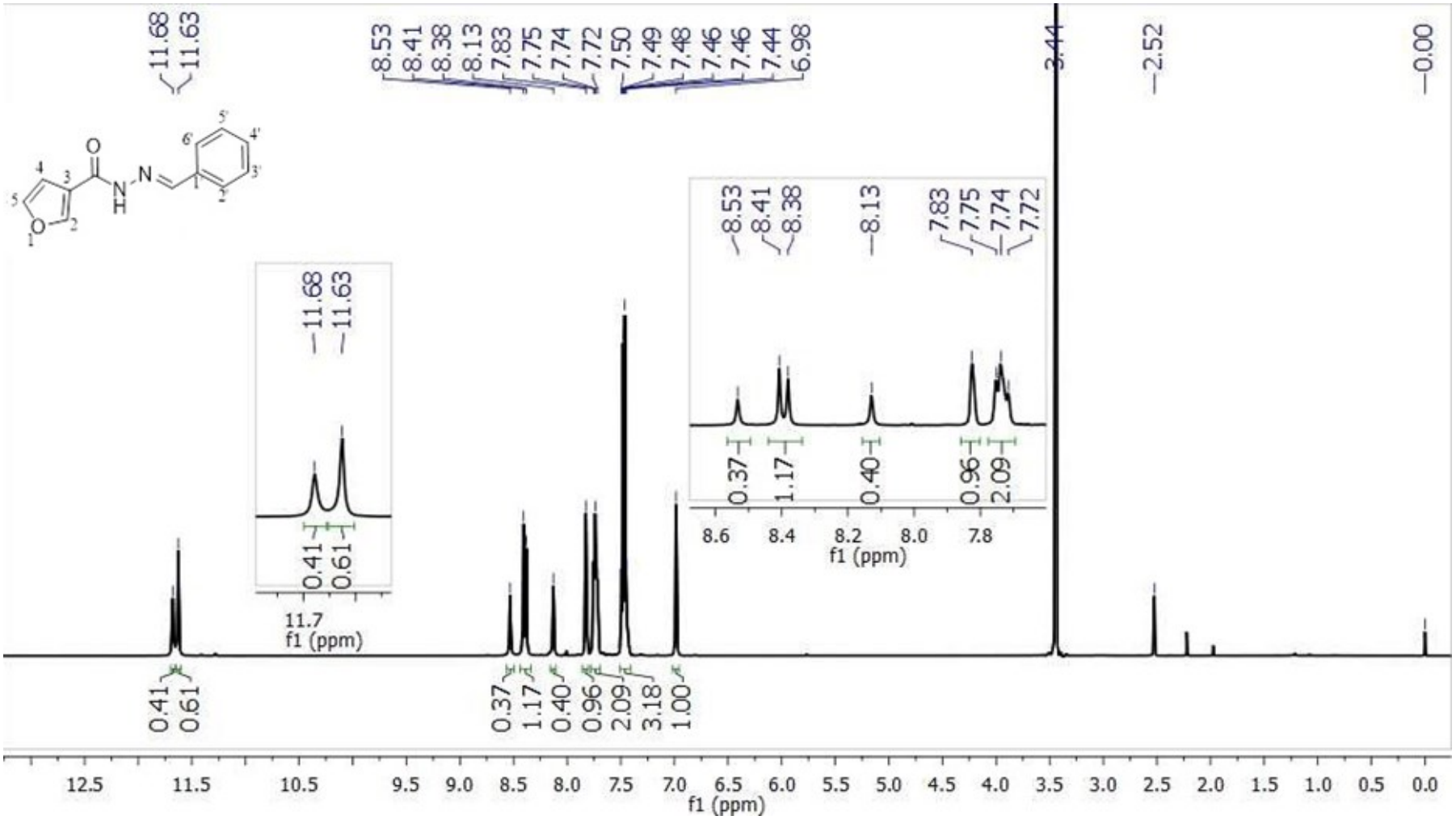
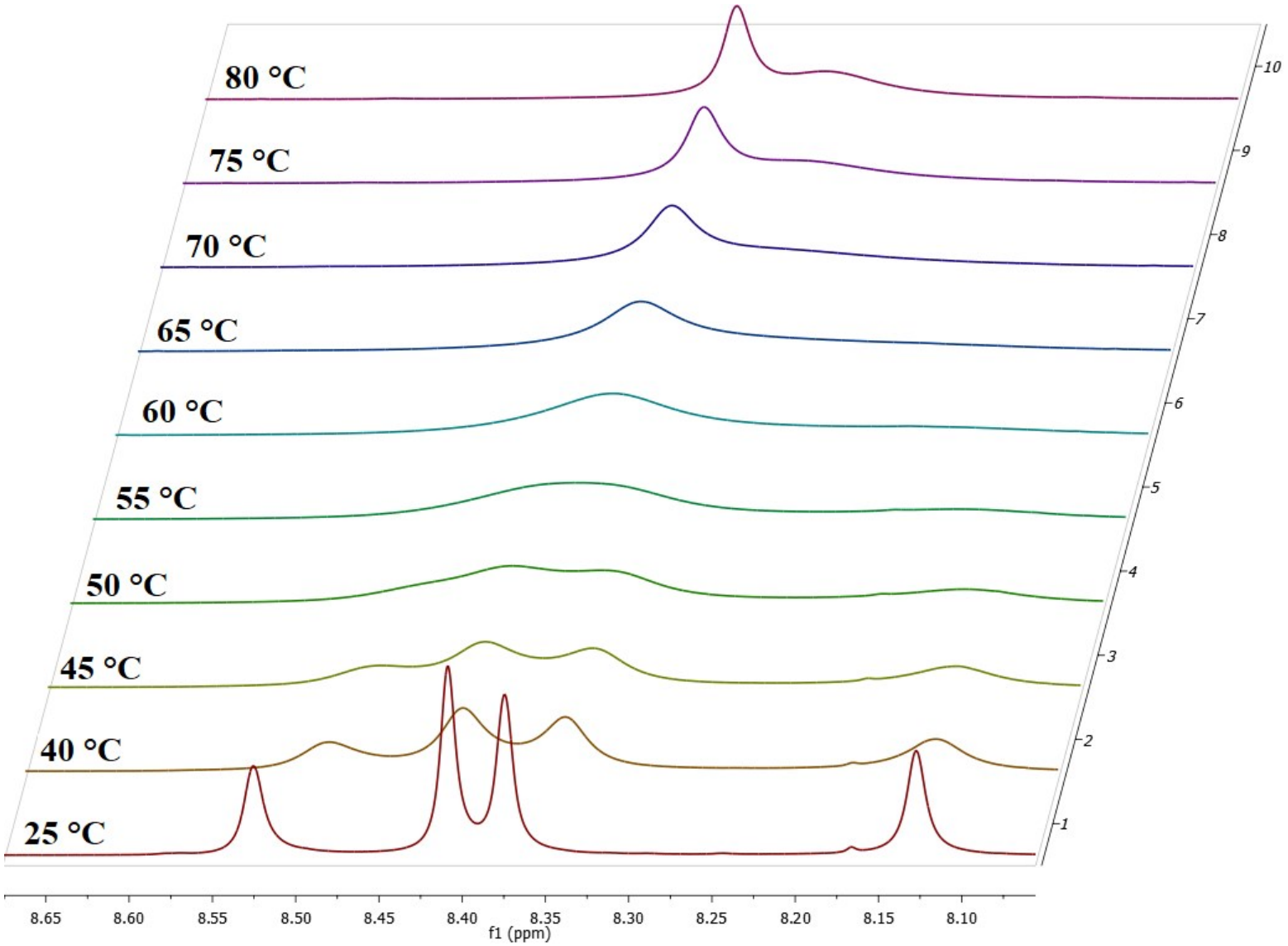
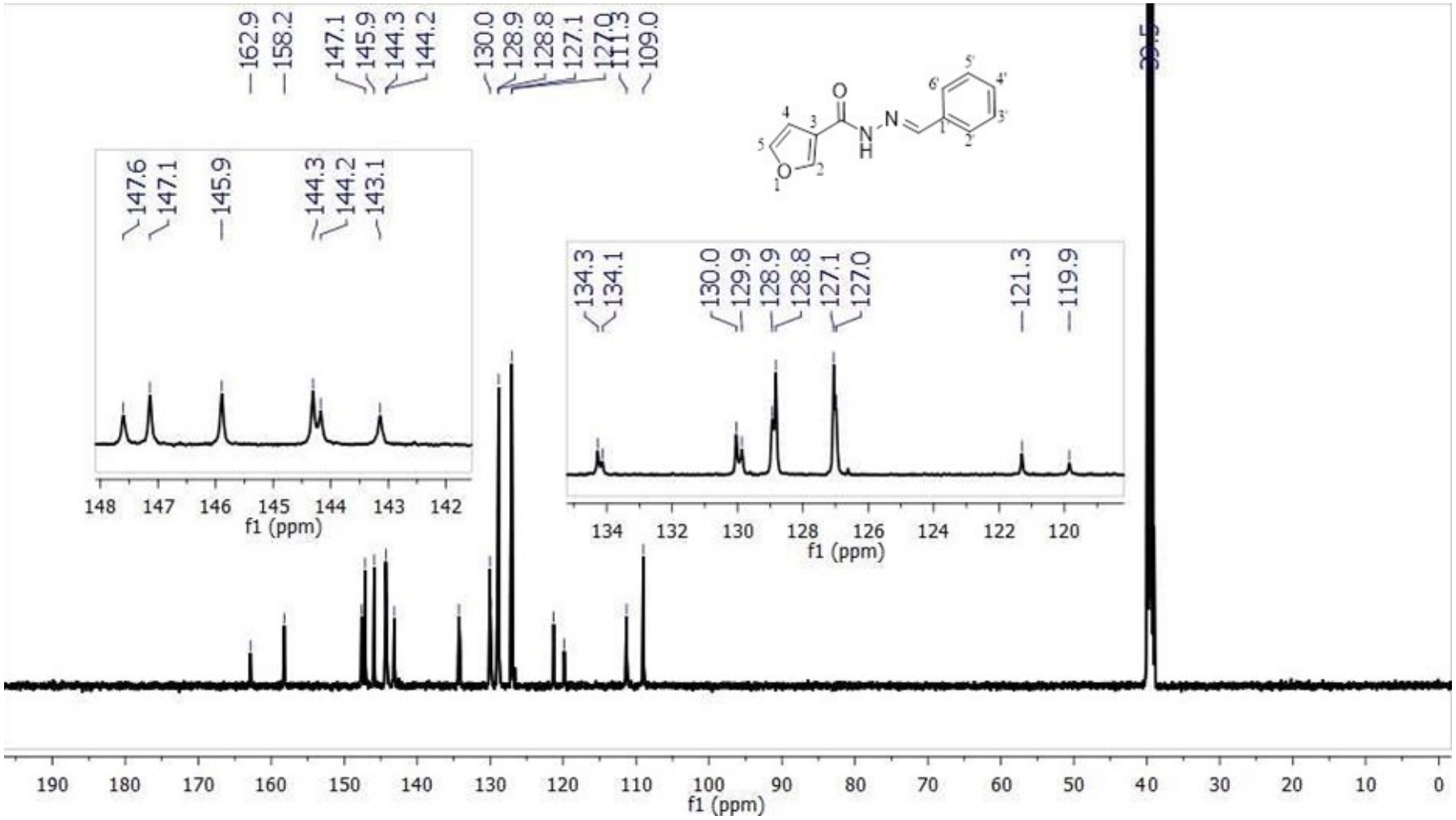
SPECTRAL DATA



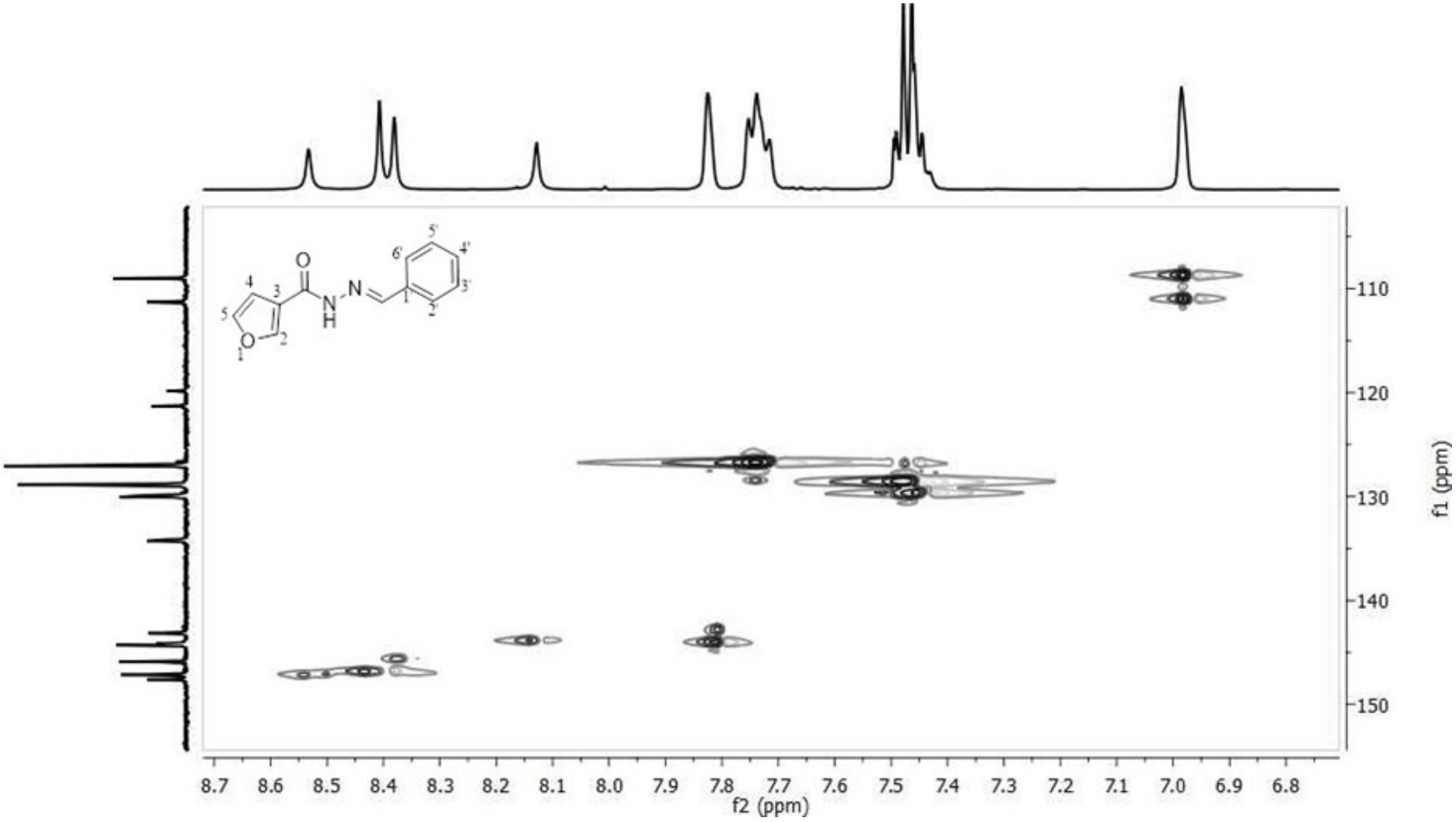
Spectrum 1 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **2** at 25ºC.



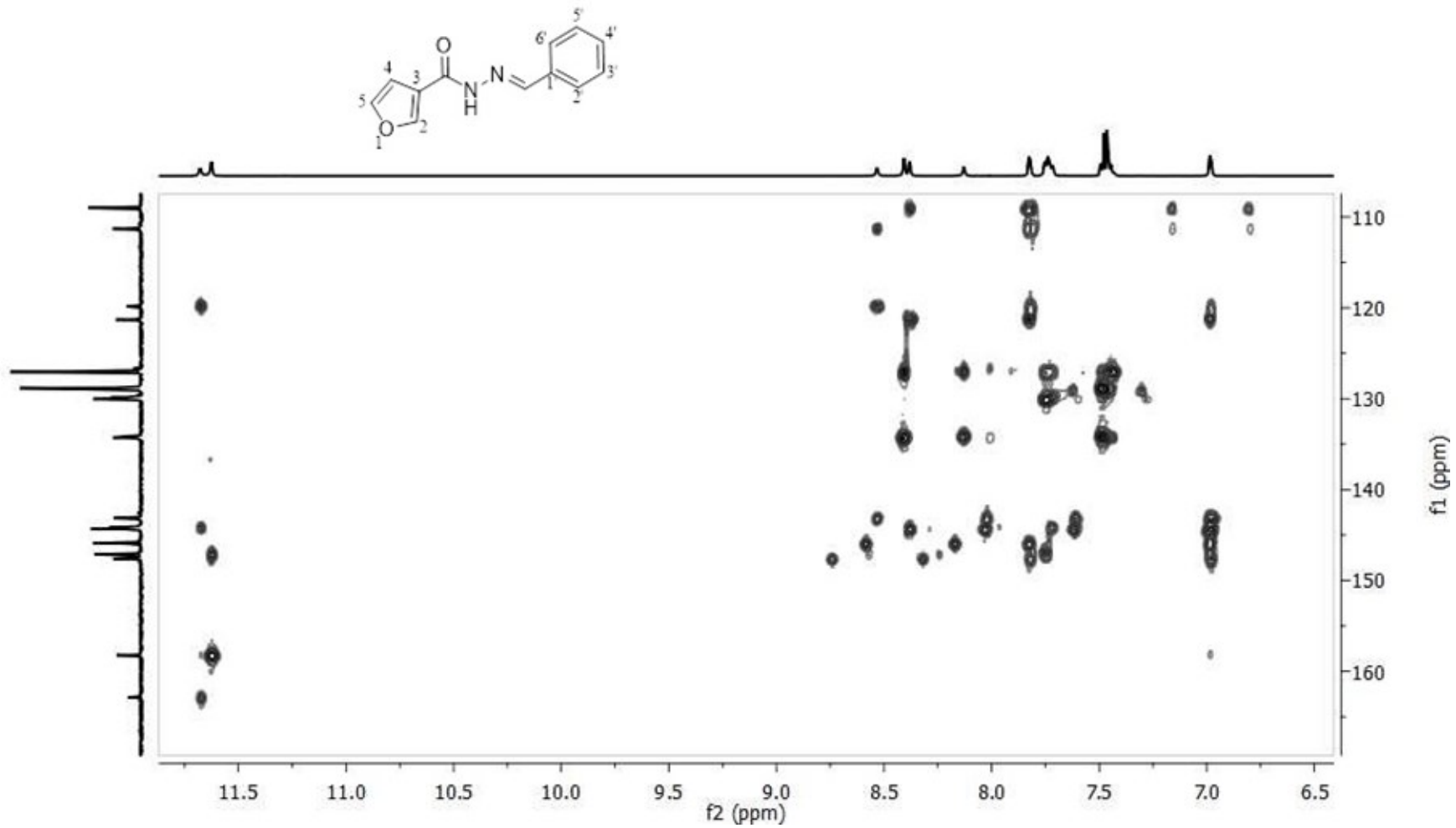
Spectrum 2 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **2**.



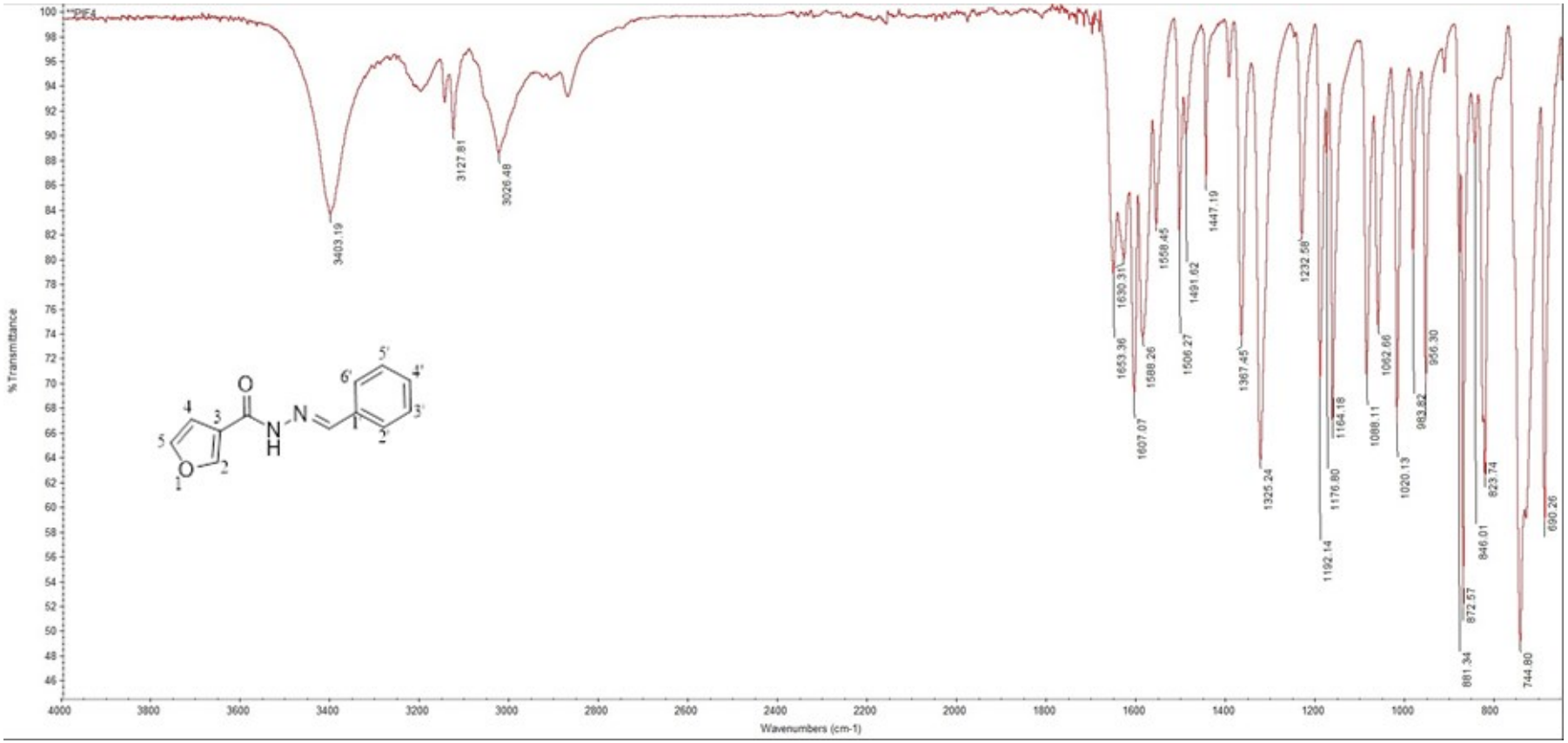
Spectrum 3 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **2** at 25ºC.



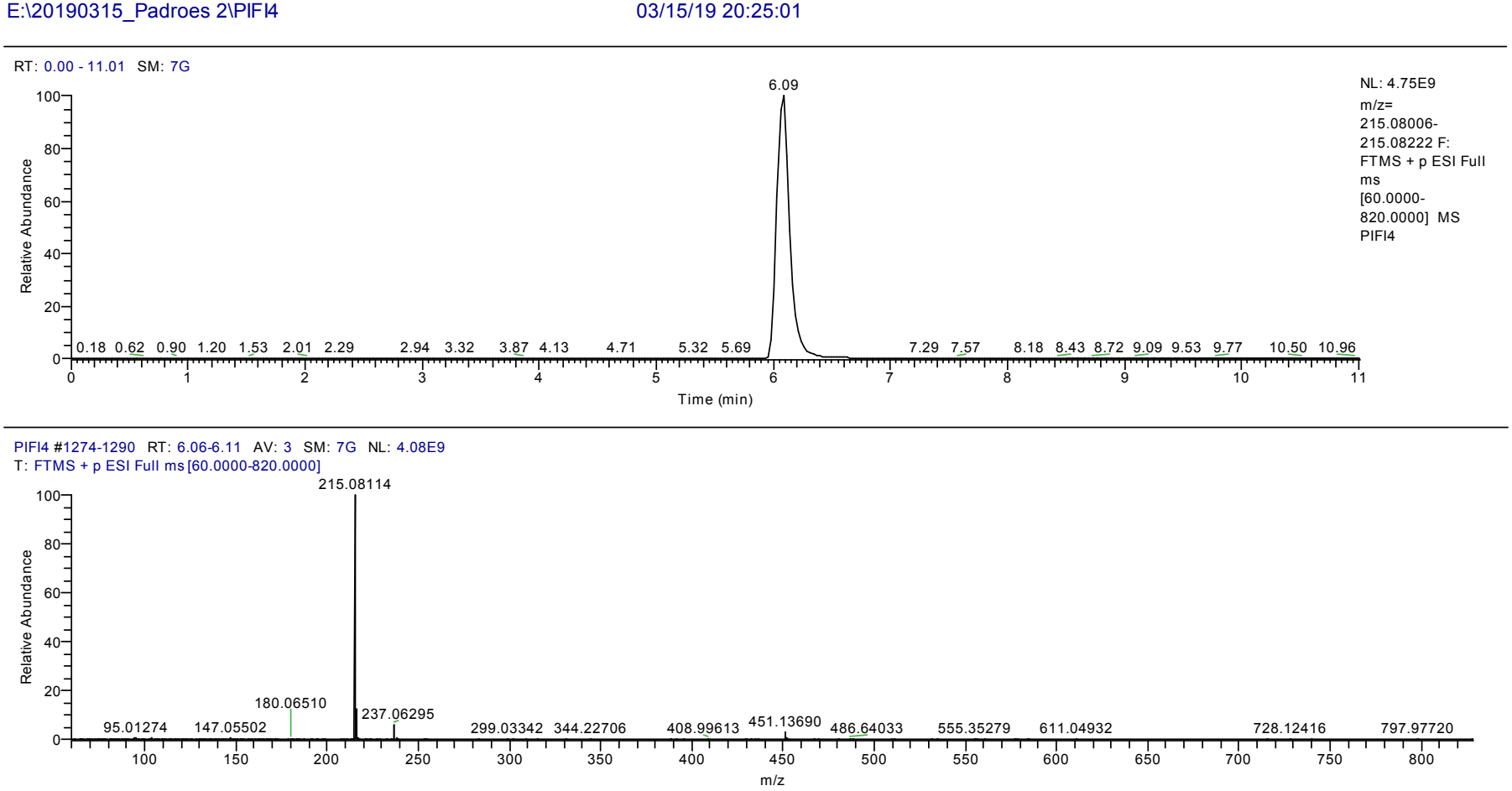
Spectrum 4 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **2** at 25ºC.



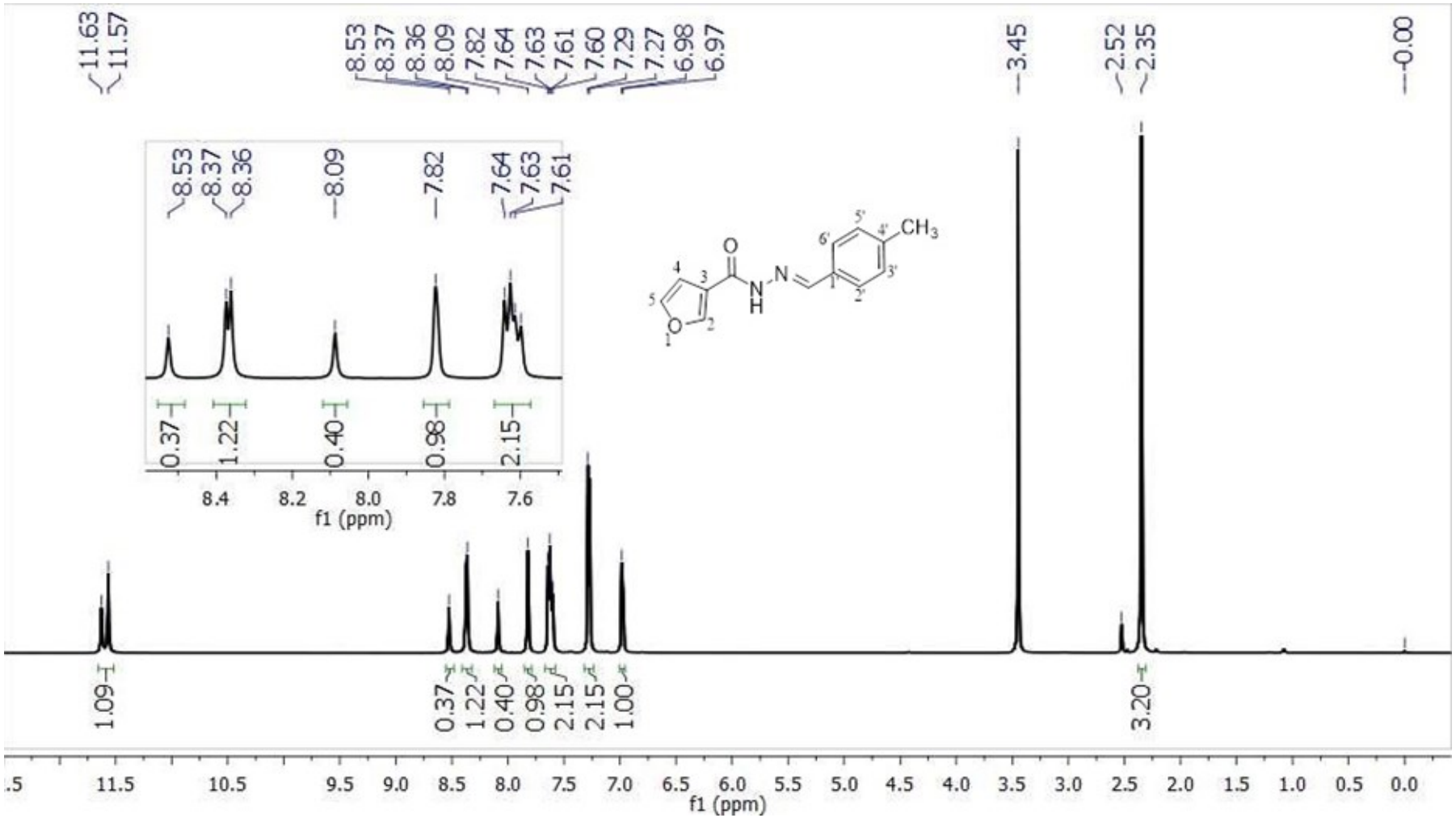
Spectrum 5 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **2** at 25ºC.



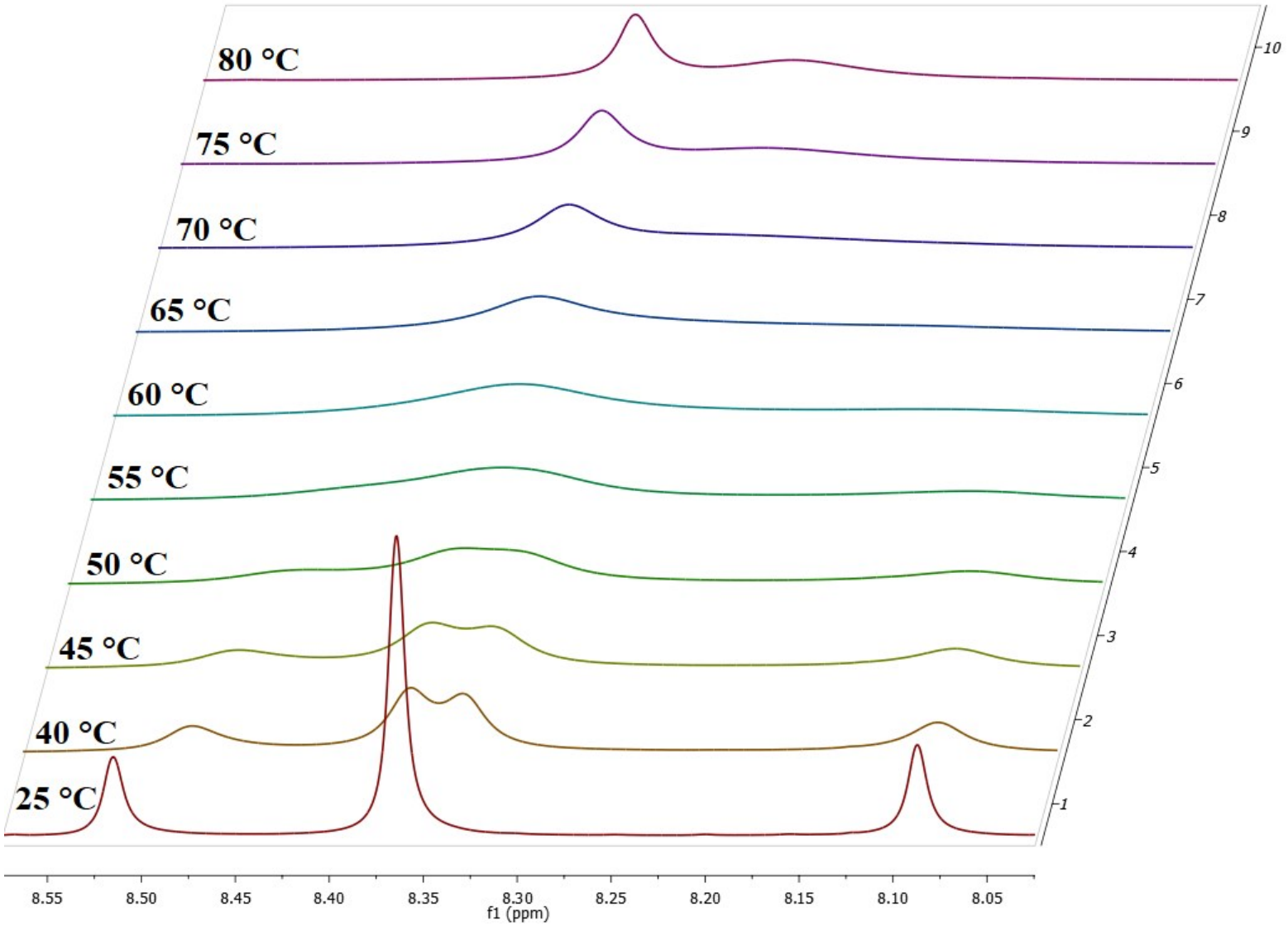
Spectrum 6 – Infrared spectrum (ATR) of compound **2**.



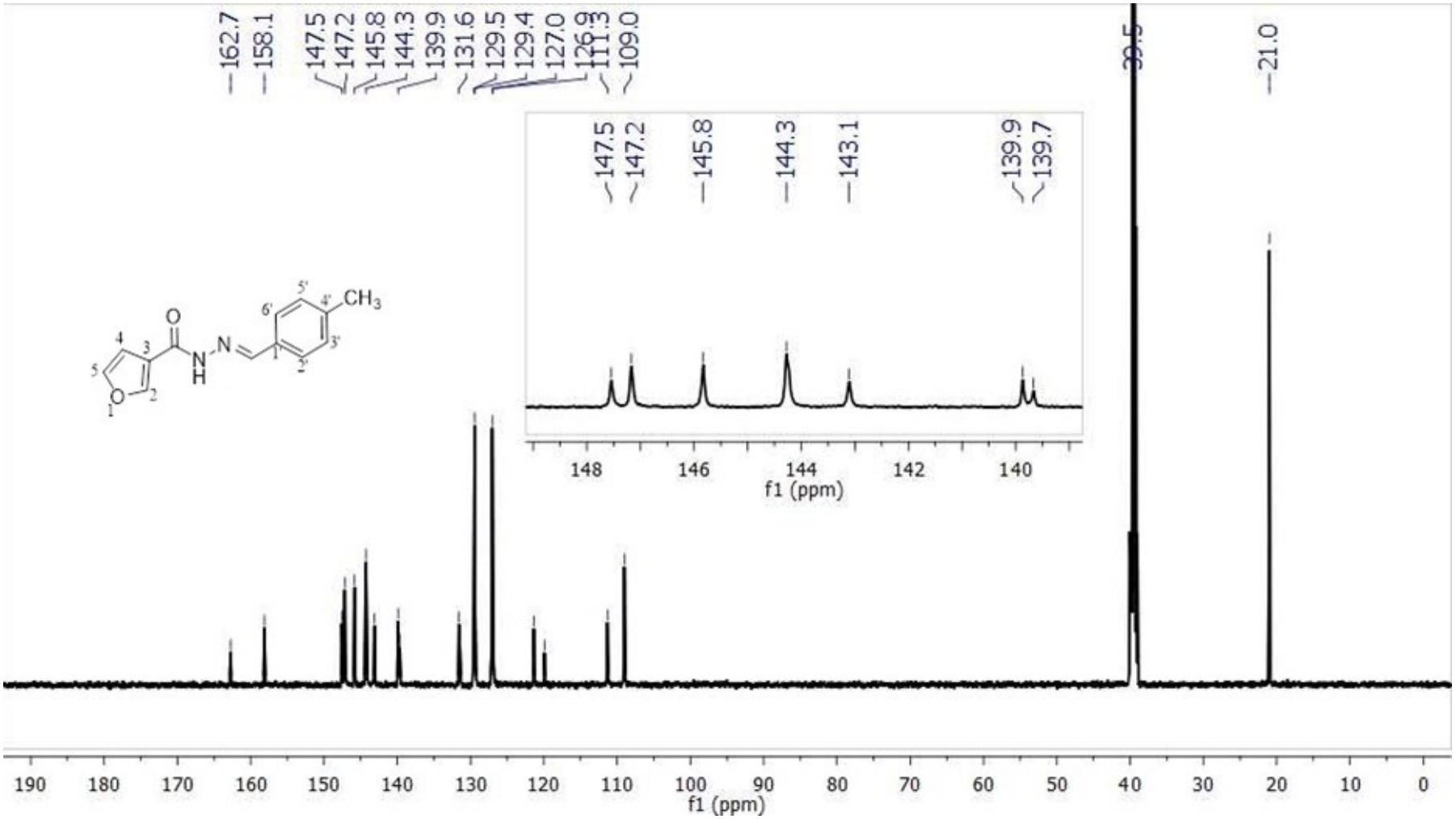
Spectrum 7 – High resolution mass spectrometry ($[M + H]^+$) of compound **2**.



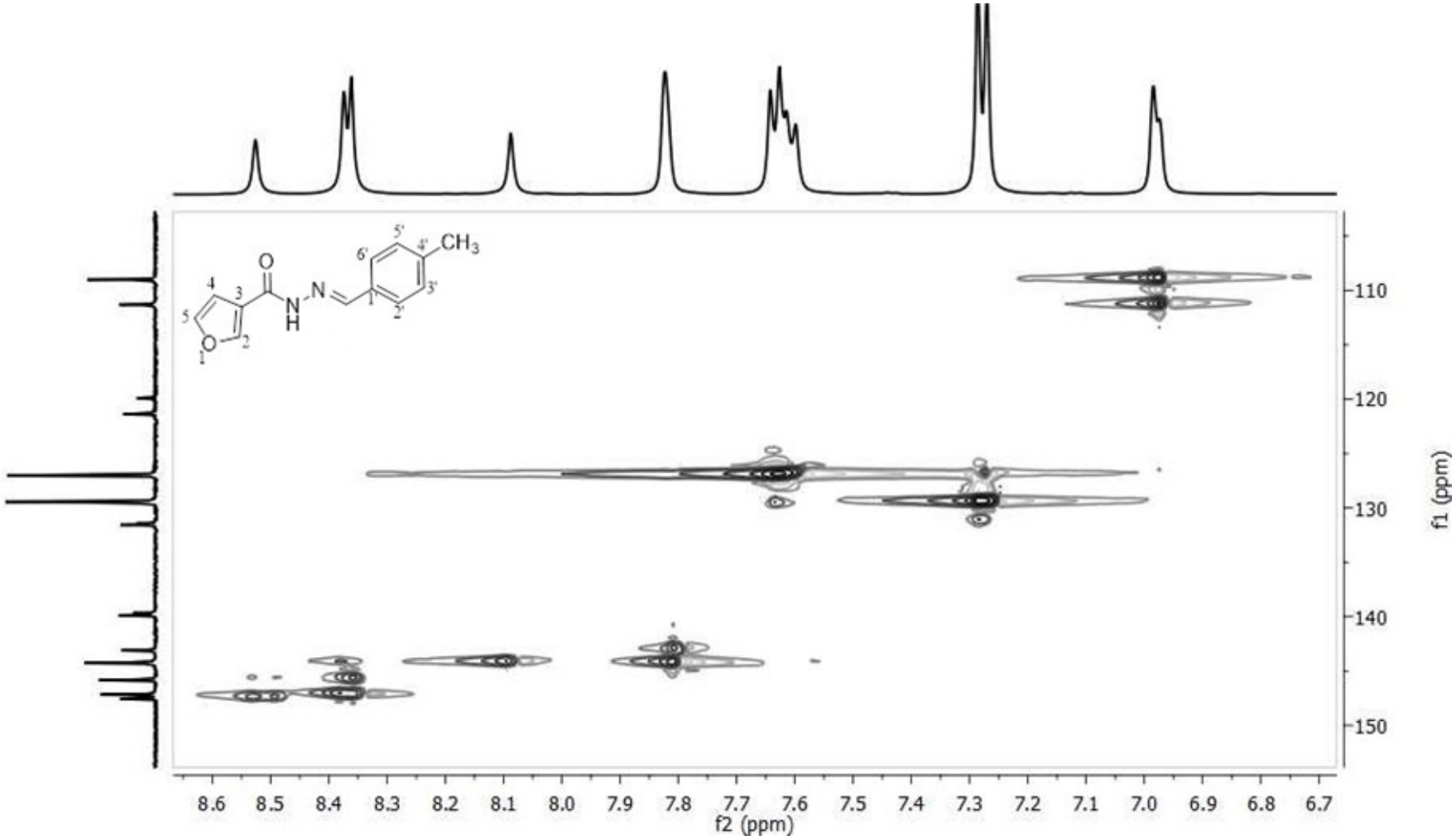
Spectrum 8 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **3** at 25ºC.



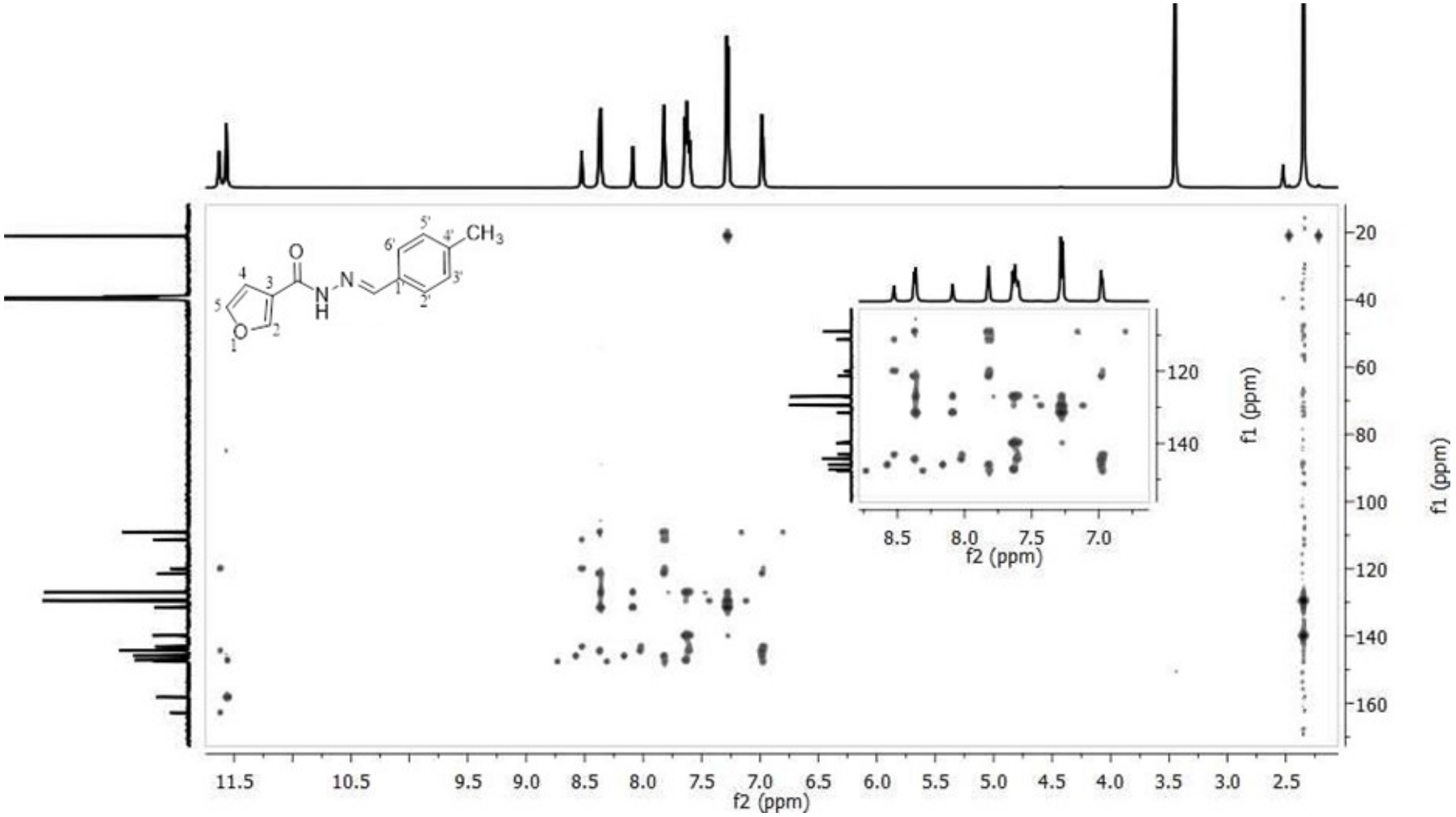
Spectrum 9 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **3**.



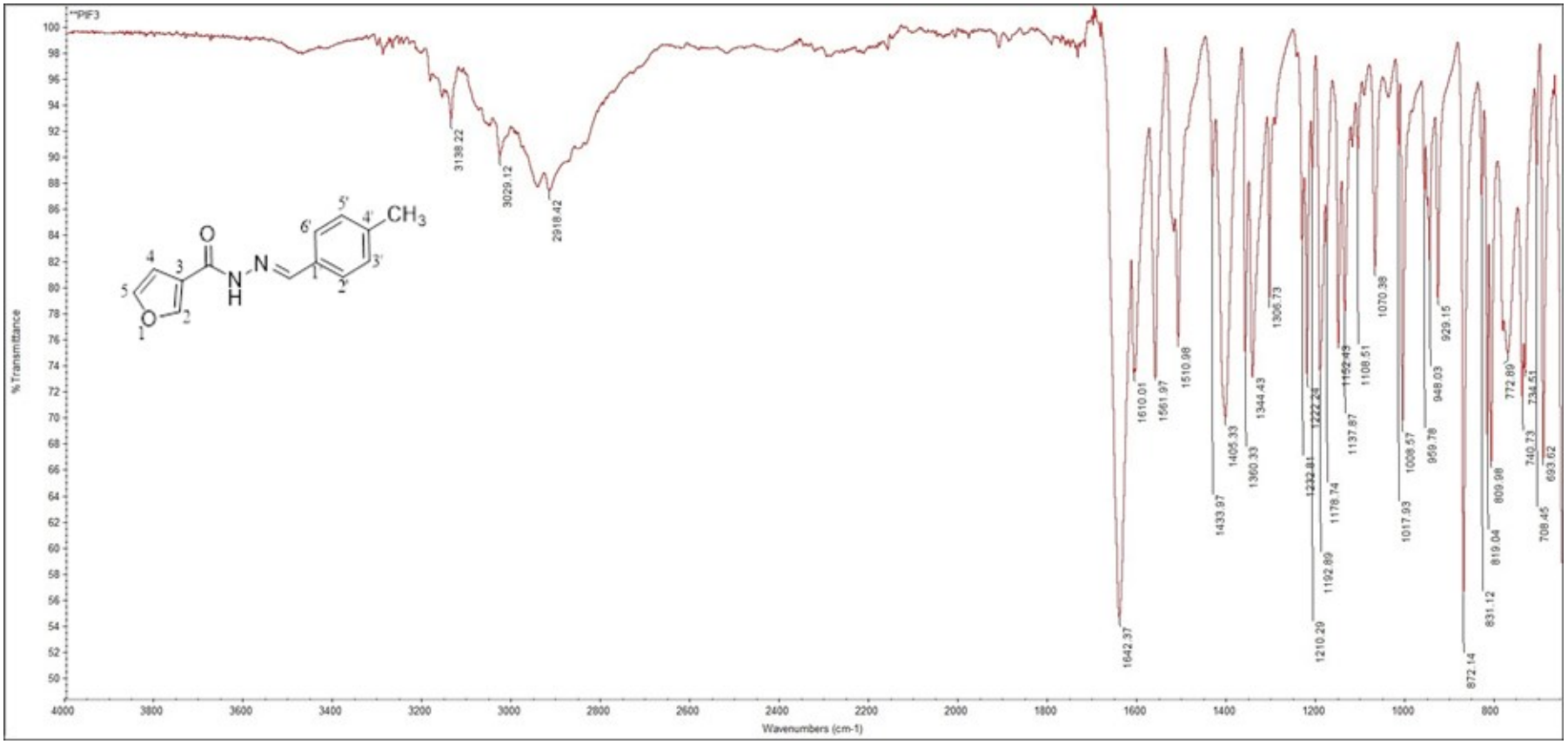
Spectrum 10 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **3** at 25ºC.



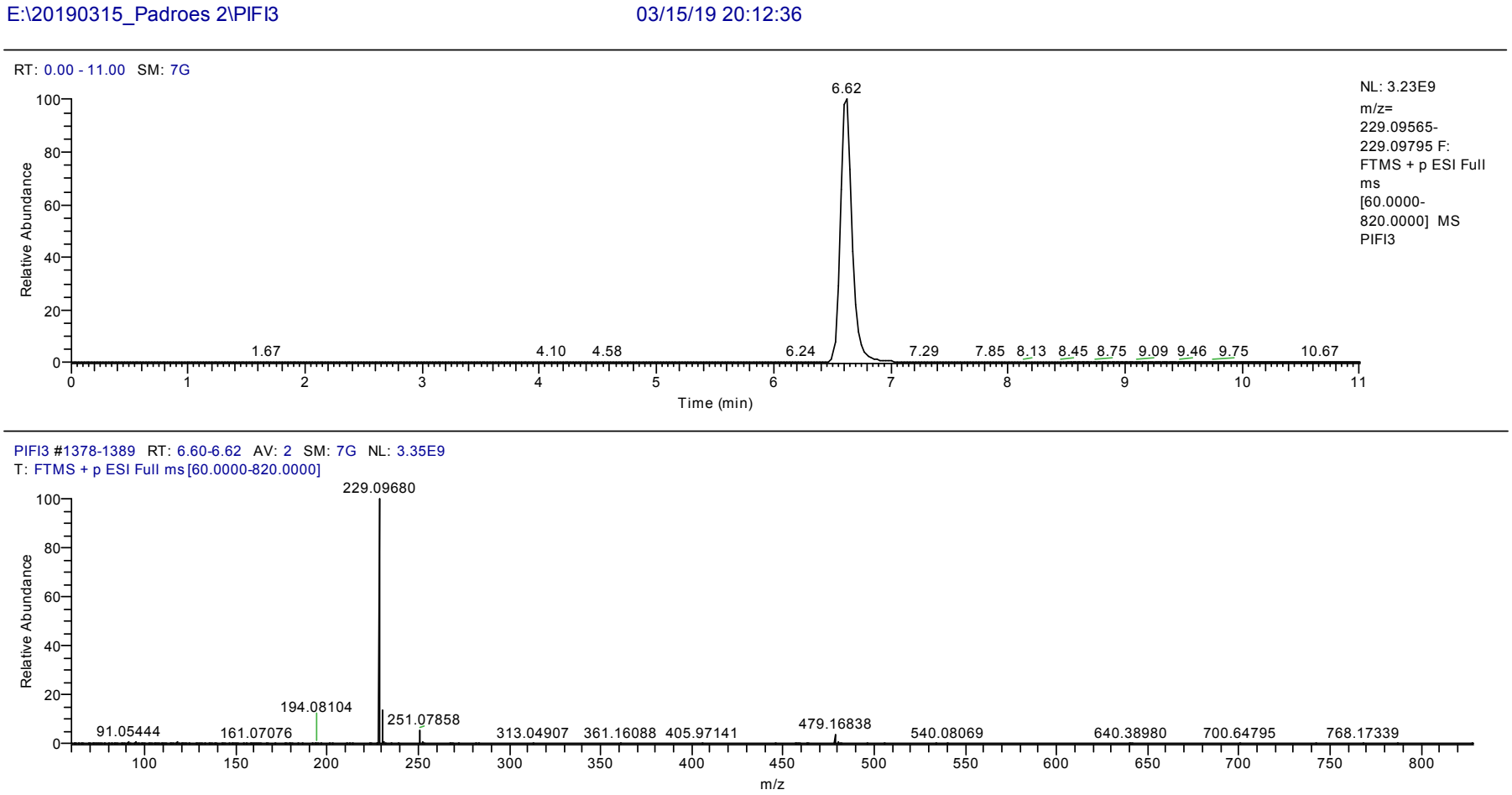
Spectrum 11 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **3** at 25ºC.



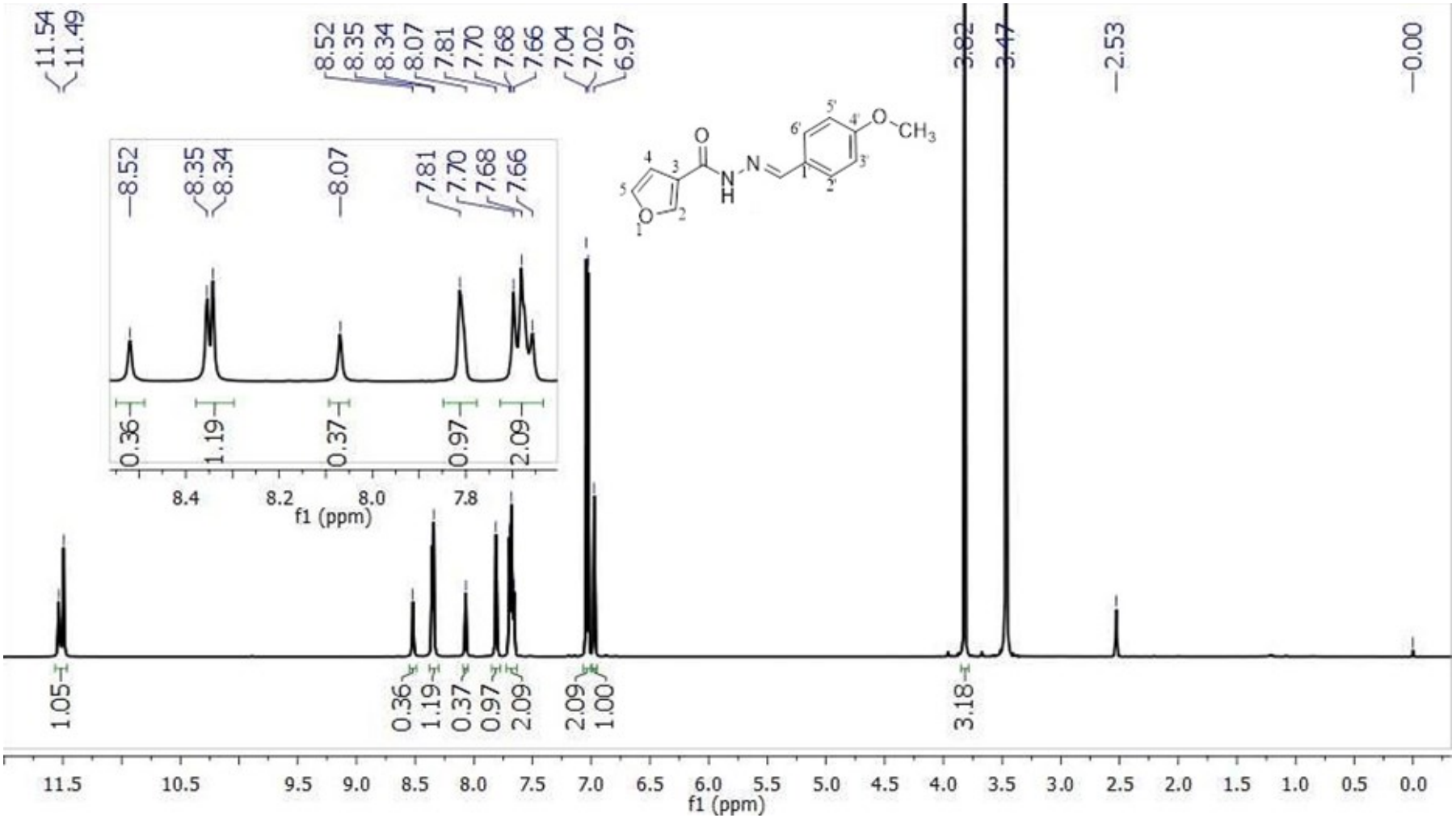
Spectrum 12 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **3** at 25ºC.



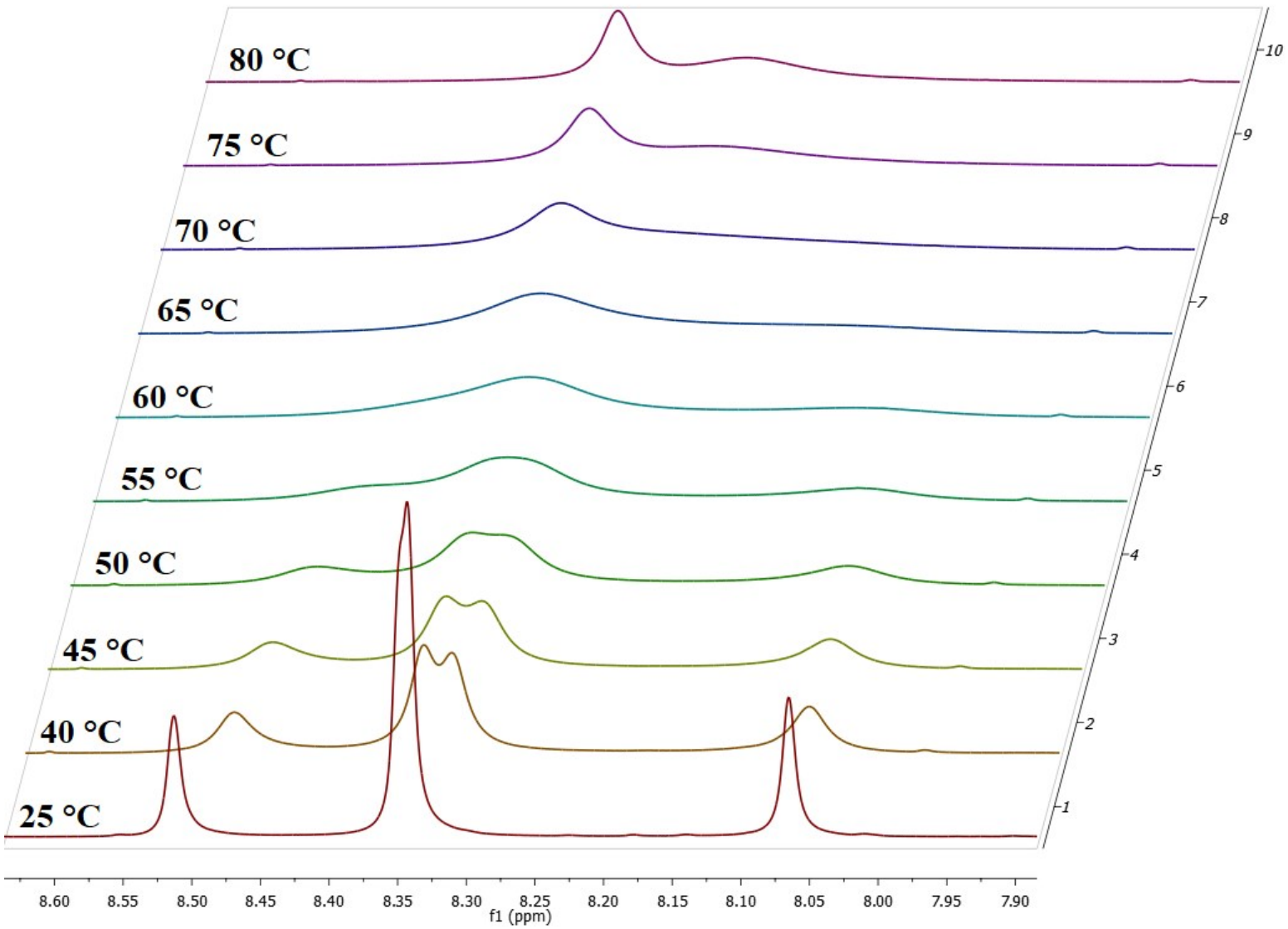
Spectrum 13 – Infrared spectrum (ATR) of compound **3**.



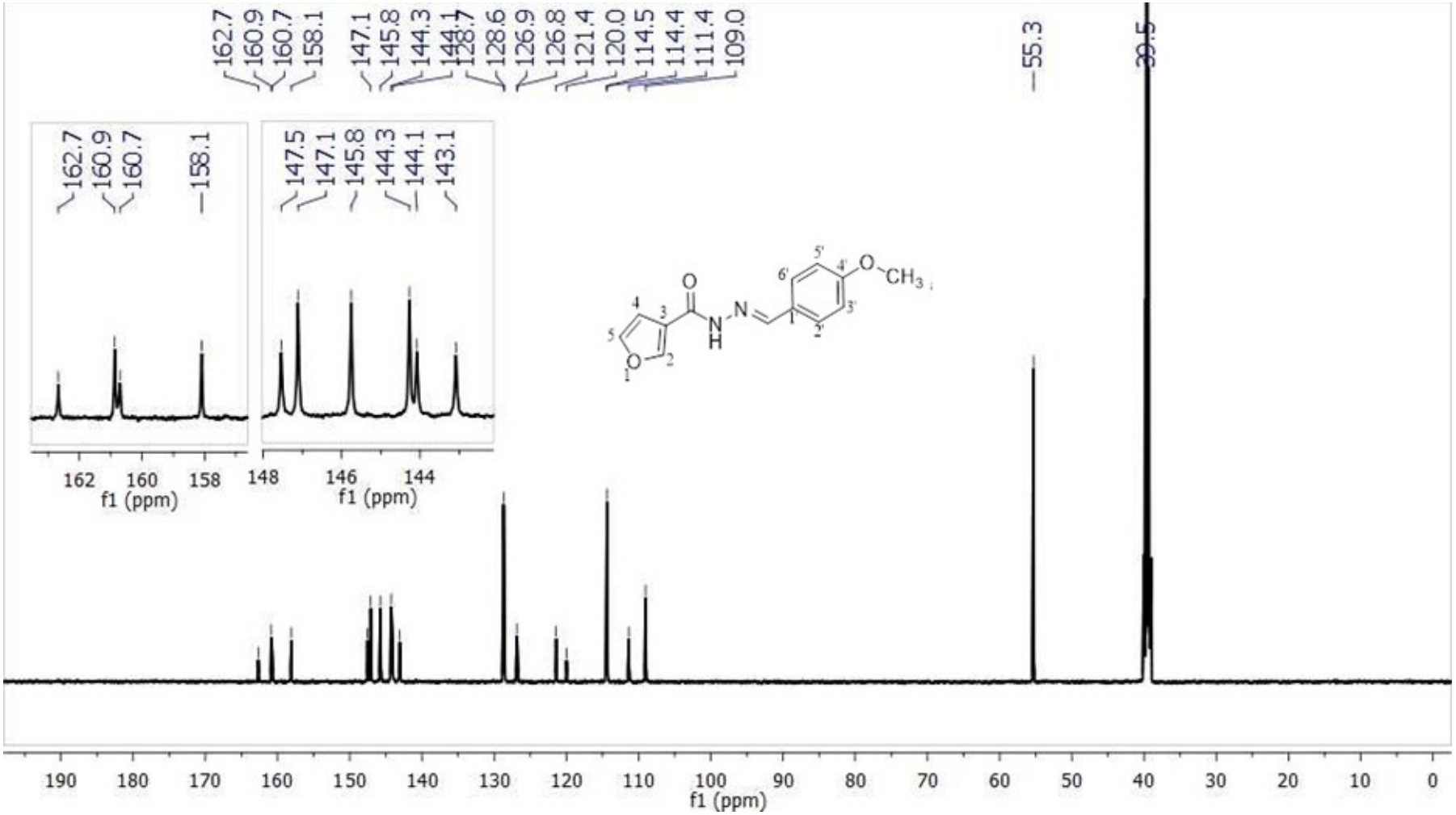
Spectrum 14 – High resolution mass spectrometry ($[M + H]^+$) of compound **3**.



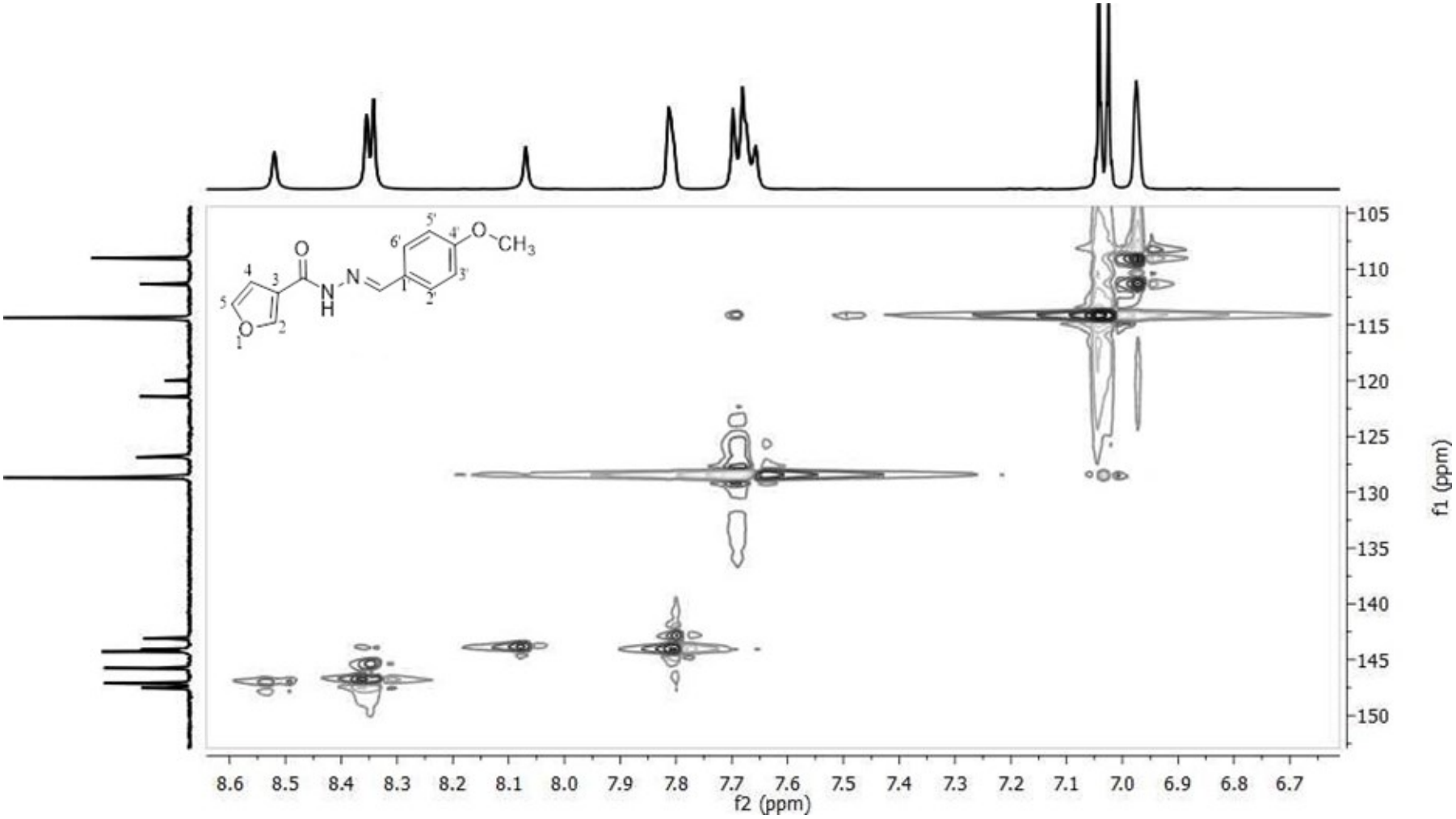
Spectrum 15 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **4** at 25ºC.



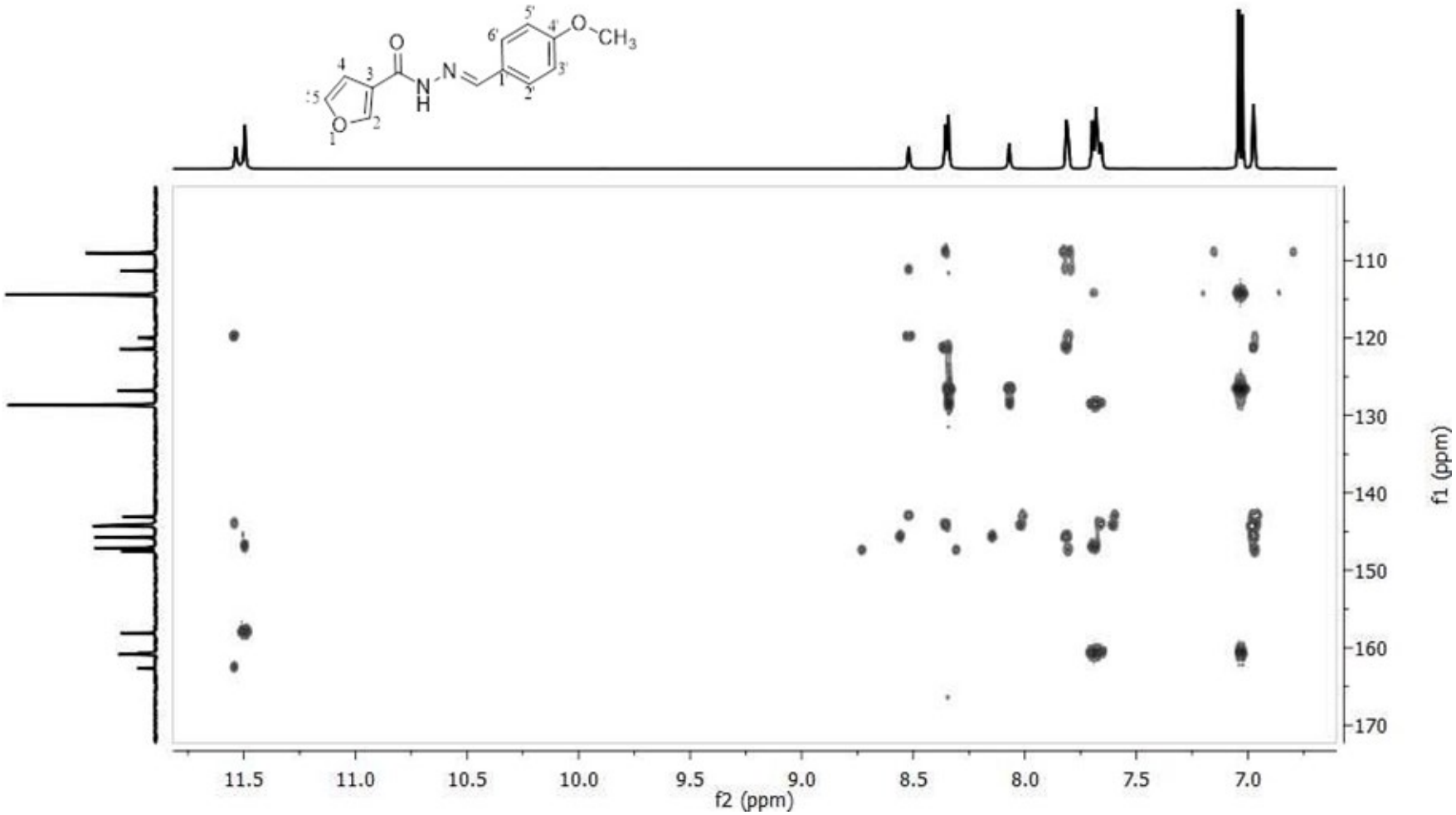
Spectrum 16 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **4**.



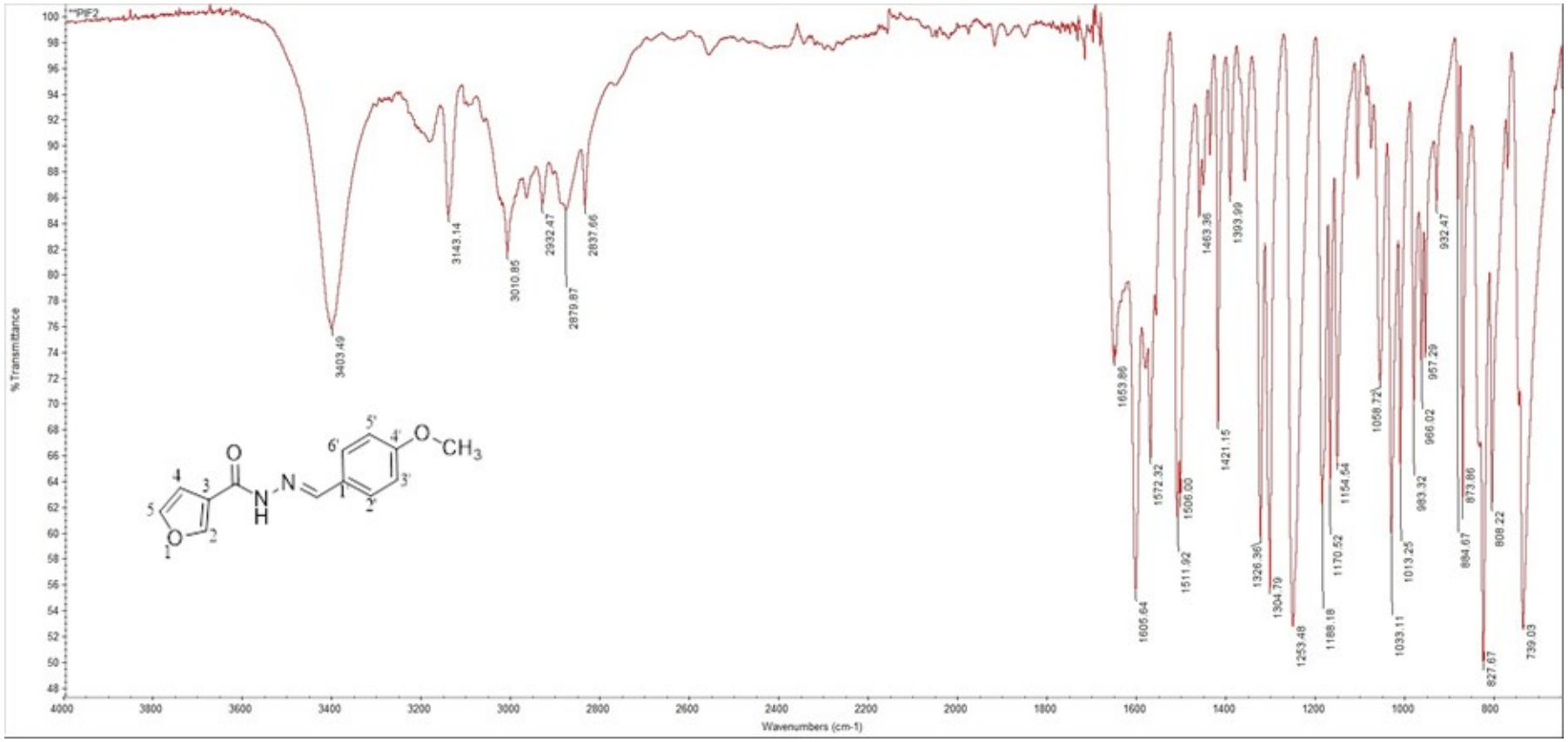
Spectrum 17 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **4** at 25ºC.



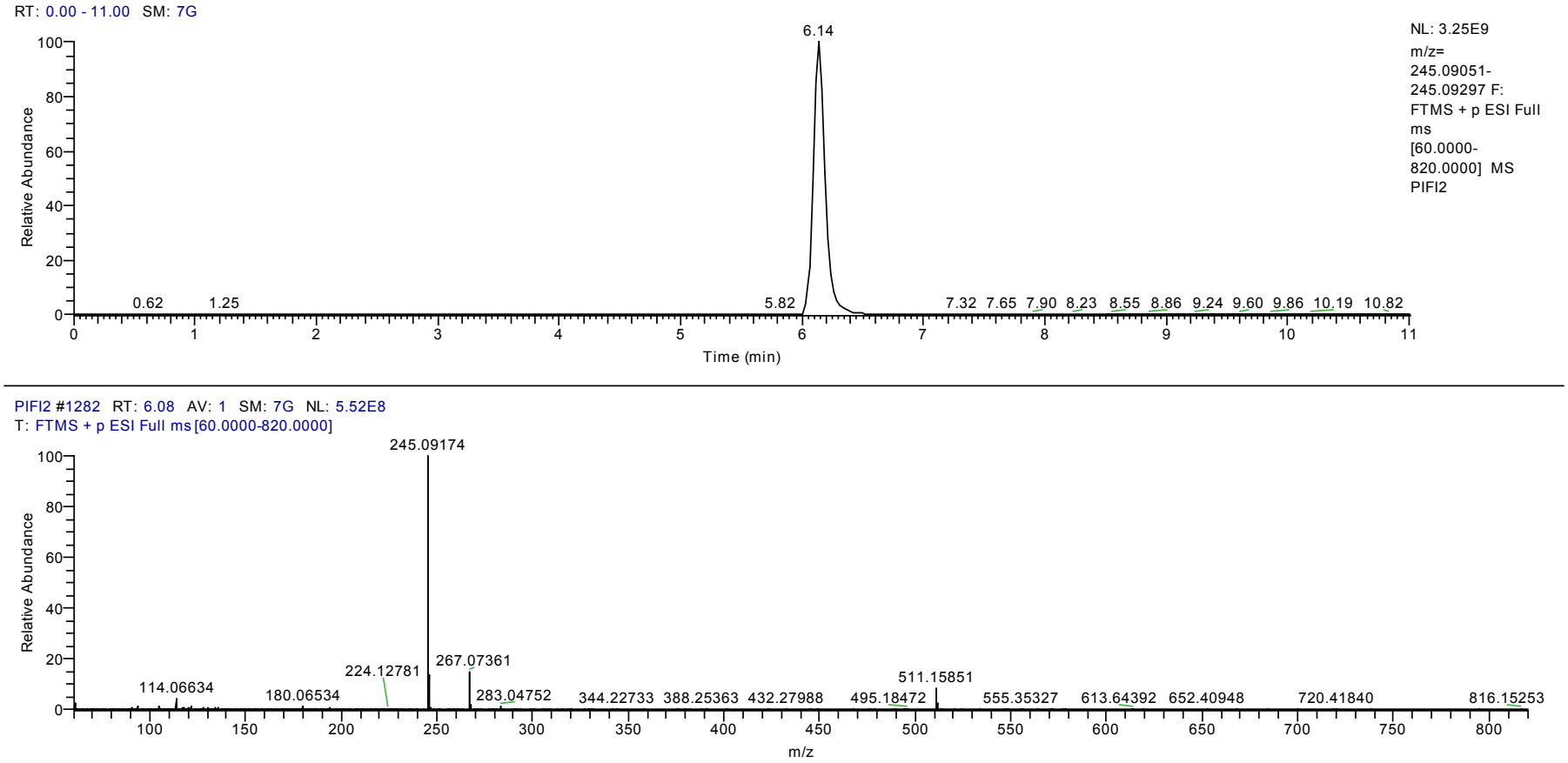
Spectrum 18 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **4** at 25ºC.



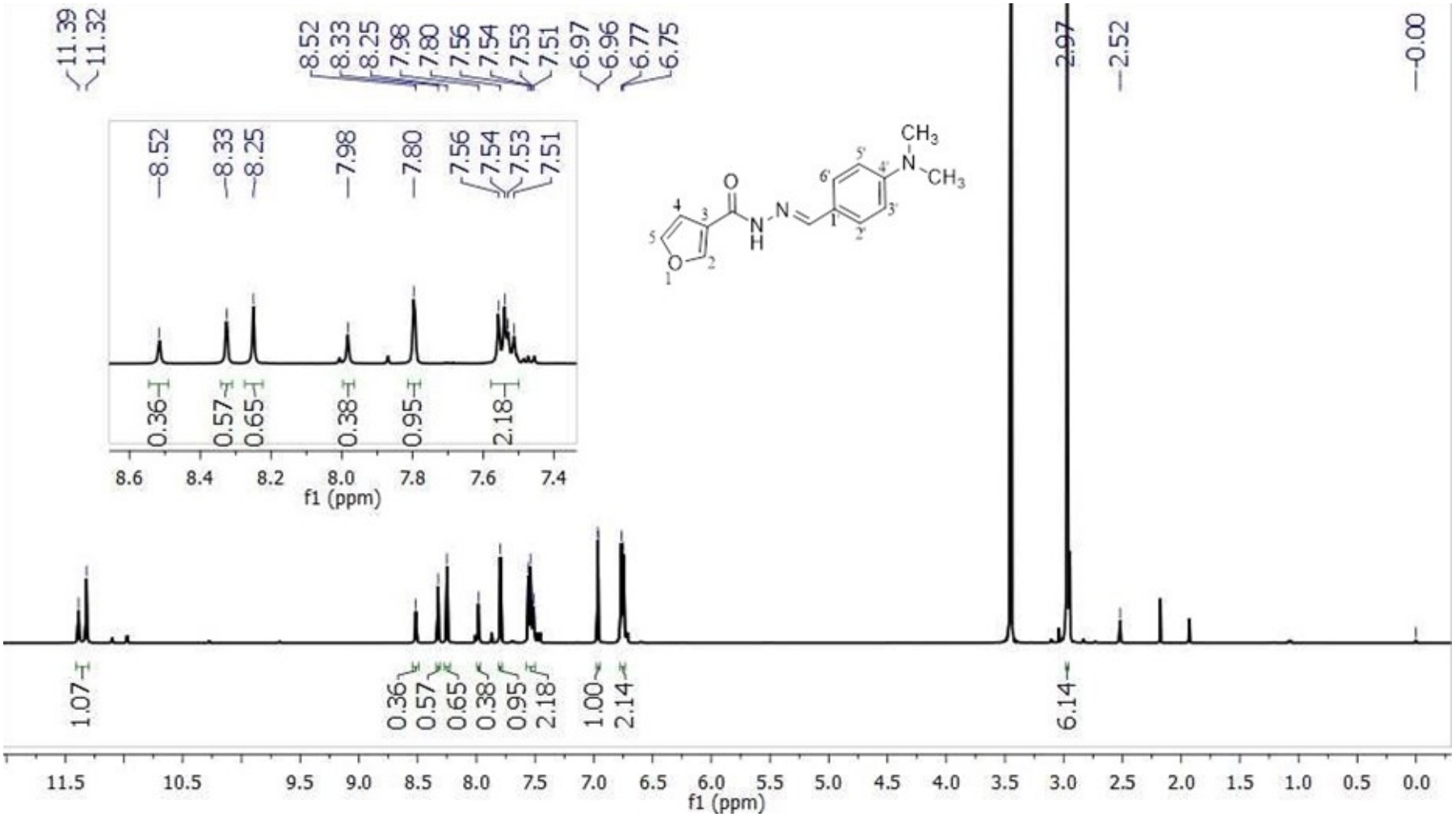
Spectrum 19 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **4** at 25ºC.



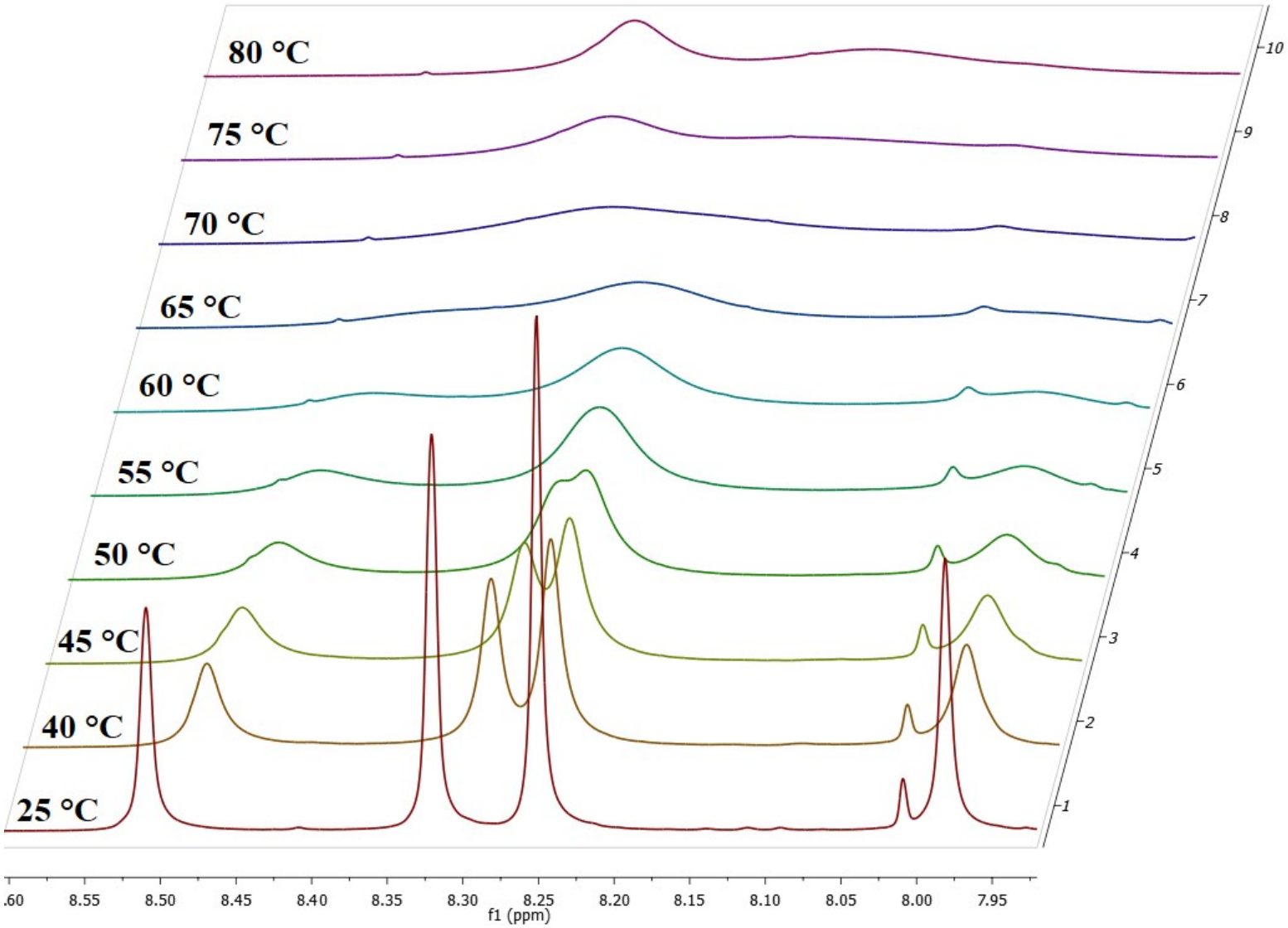
Spectrum 20 – Infrared spectrum (ATR) of compound **4**.



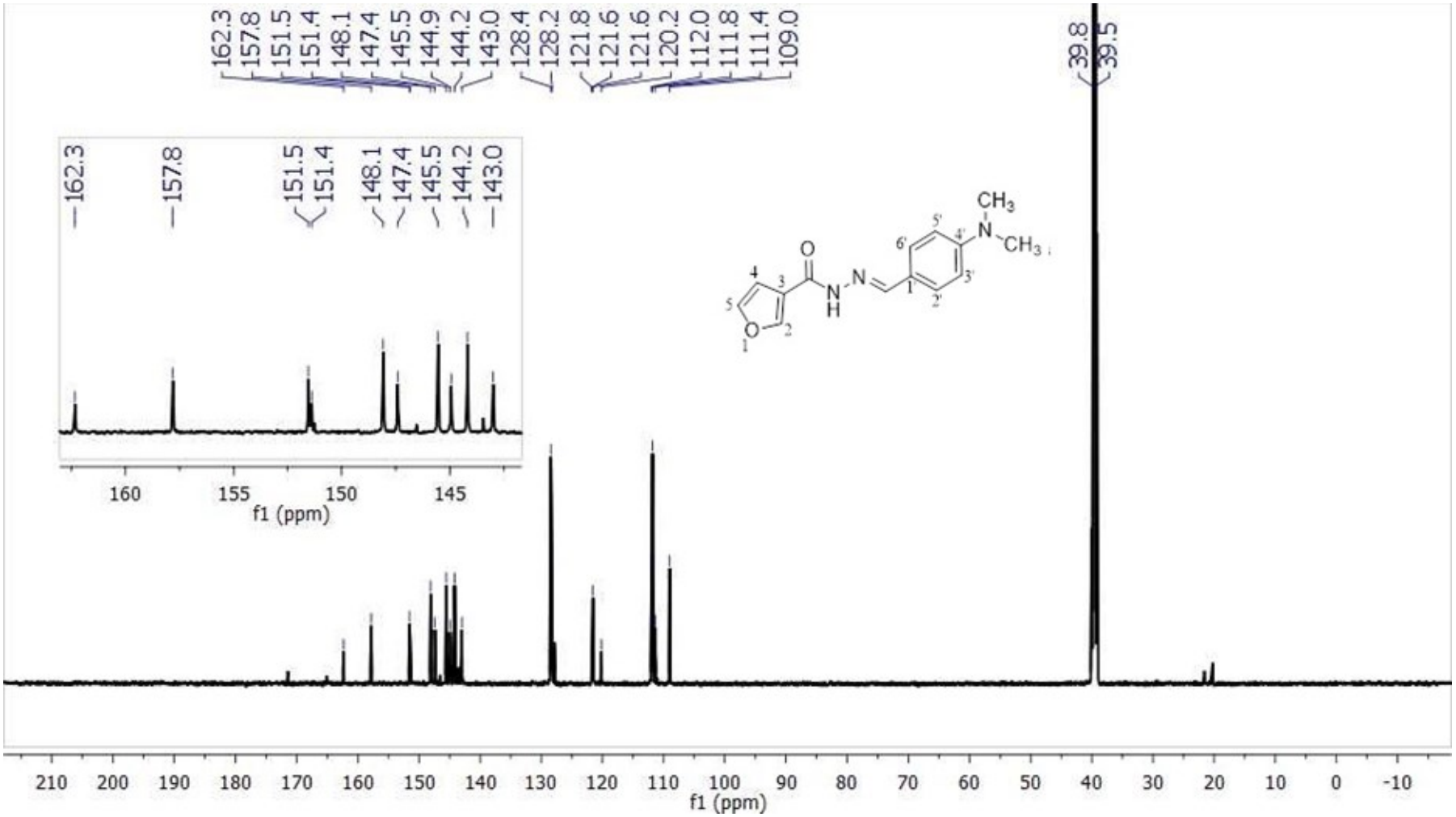
Spectrum 21 – High resolution mass spectrometry ($[M + H]^+$) of compound **4**.



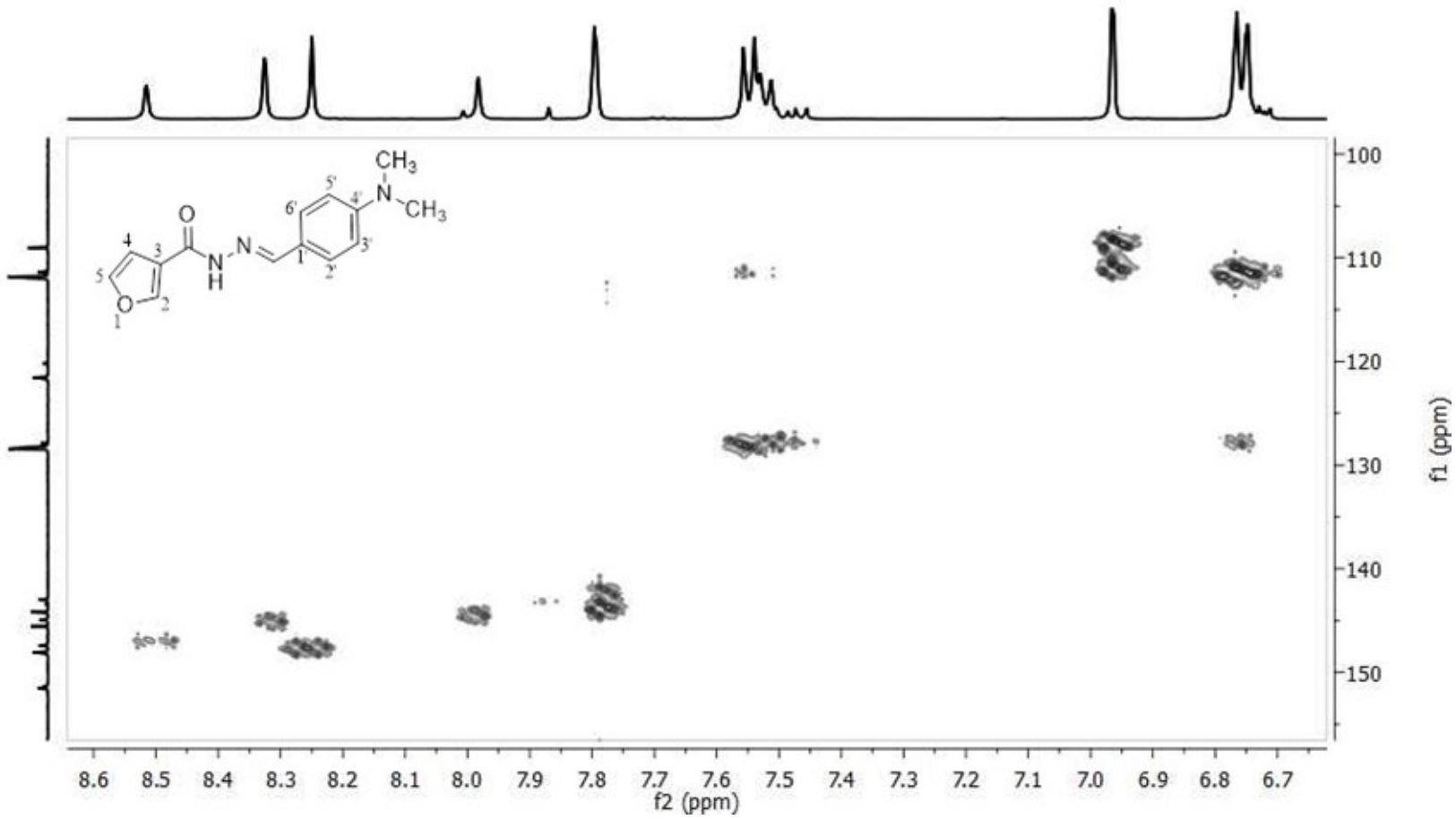
Spectrum 22 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **5** at 25ºC.



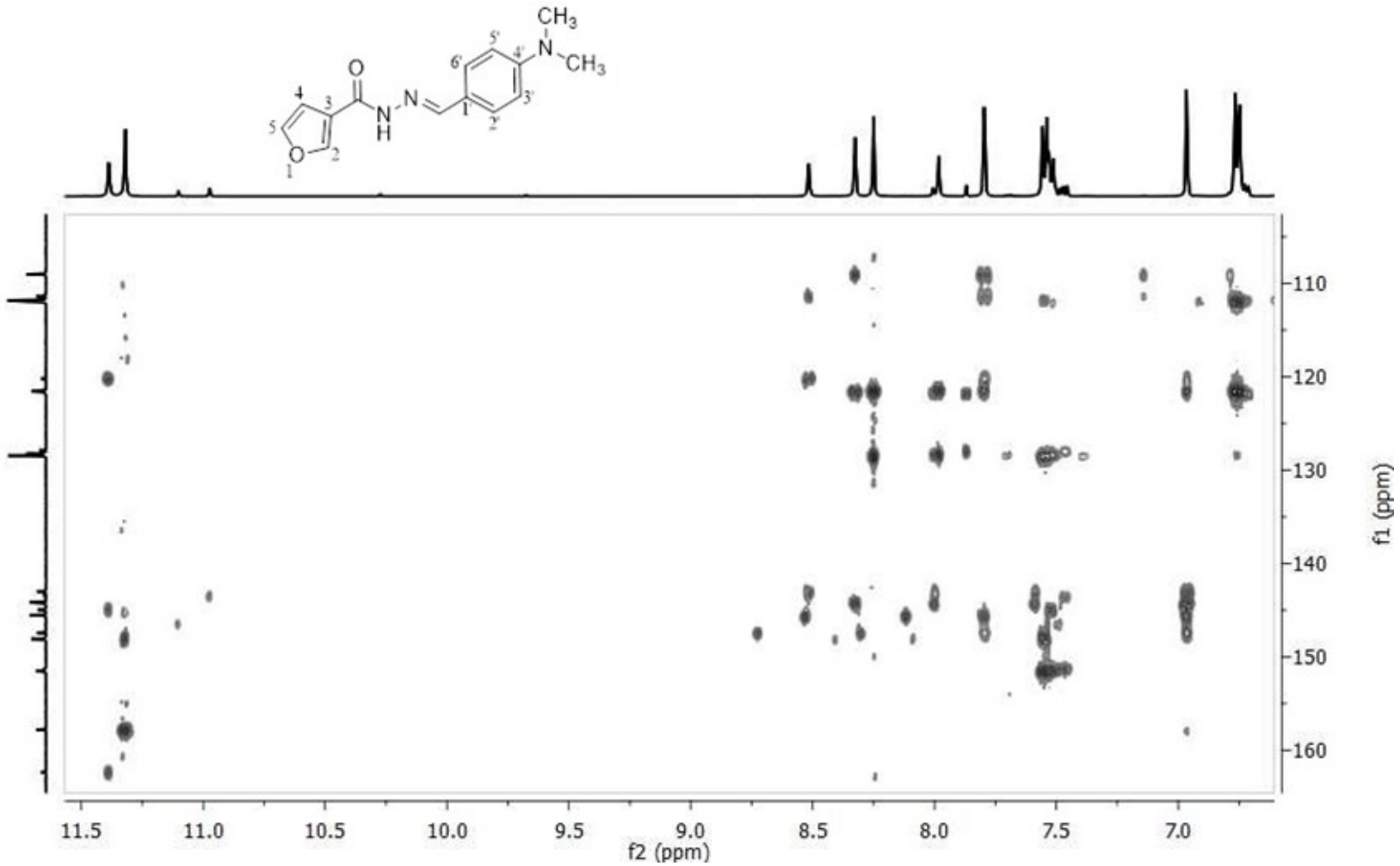
Spectrum 23 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **5**.



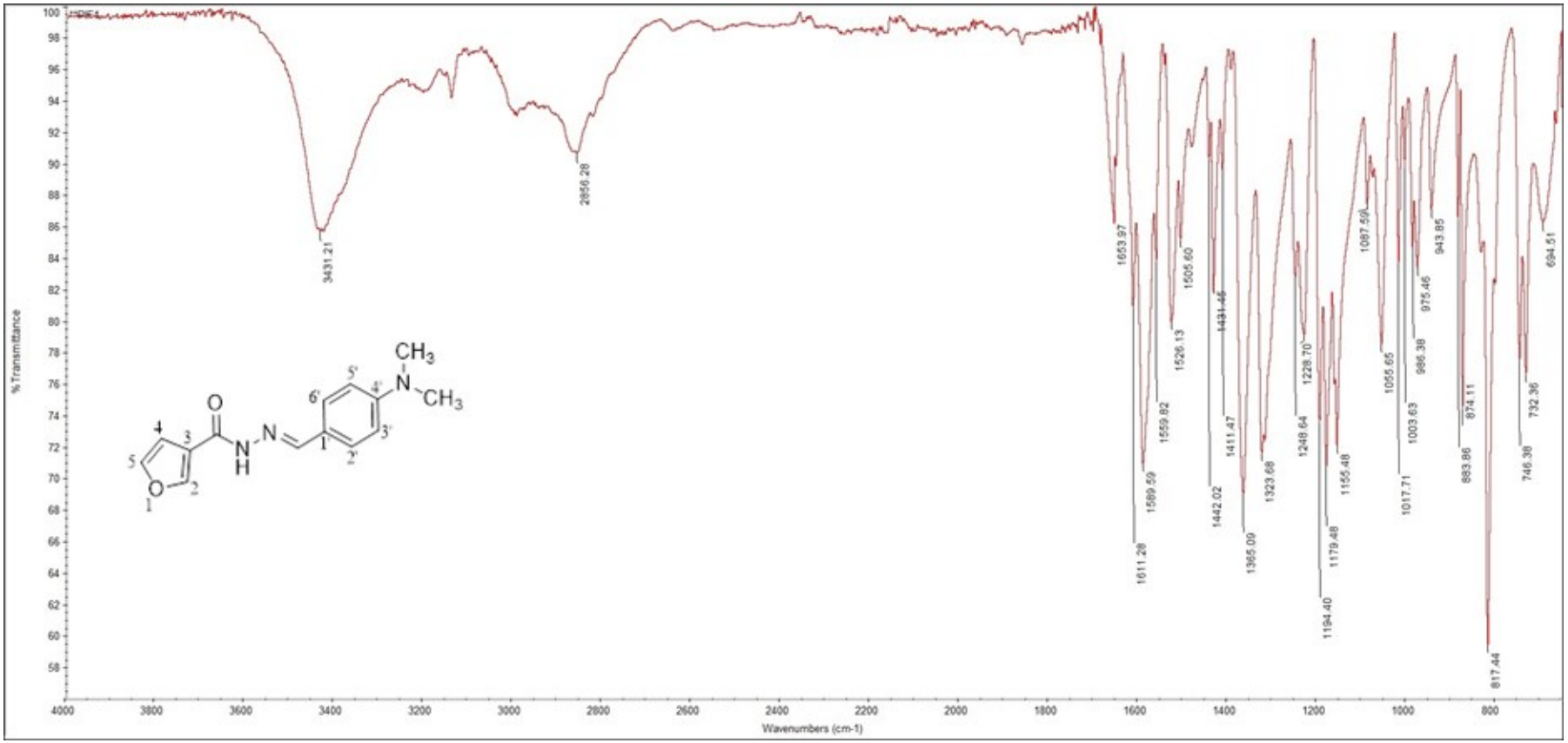
Spectrum 24 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **5** at 25ºC.



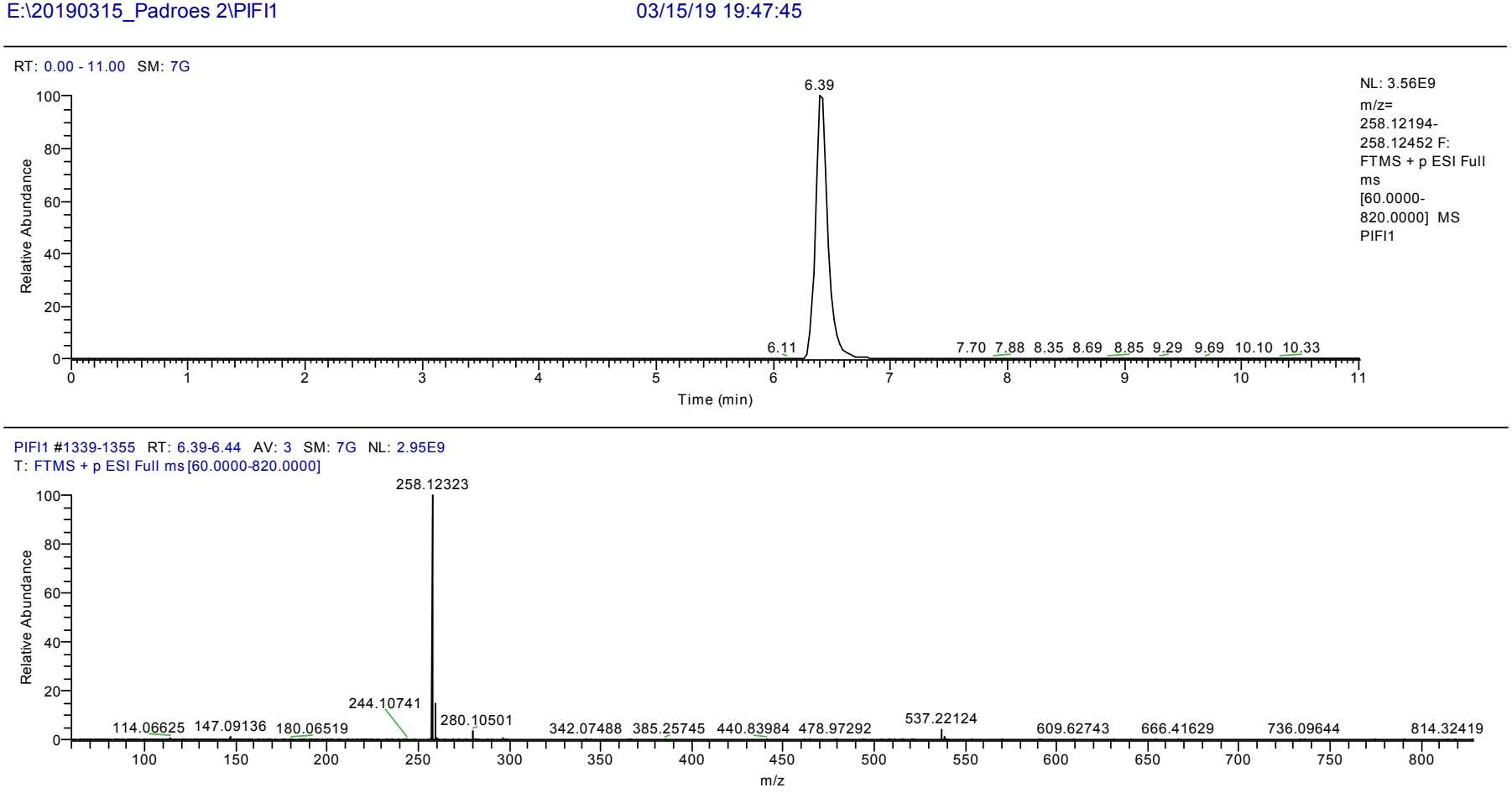
Spectrum 25 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **5** at 25ºC.



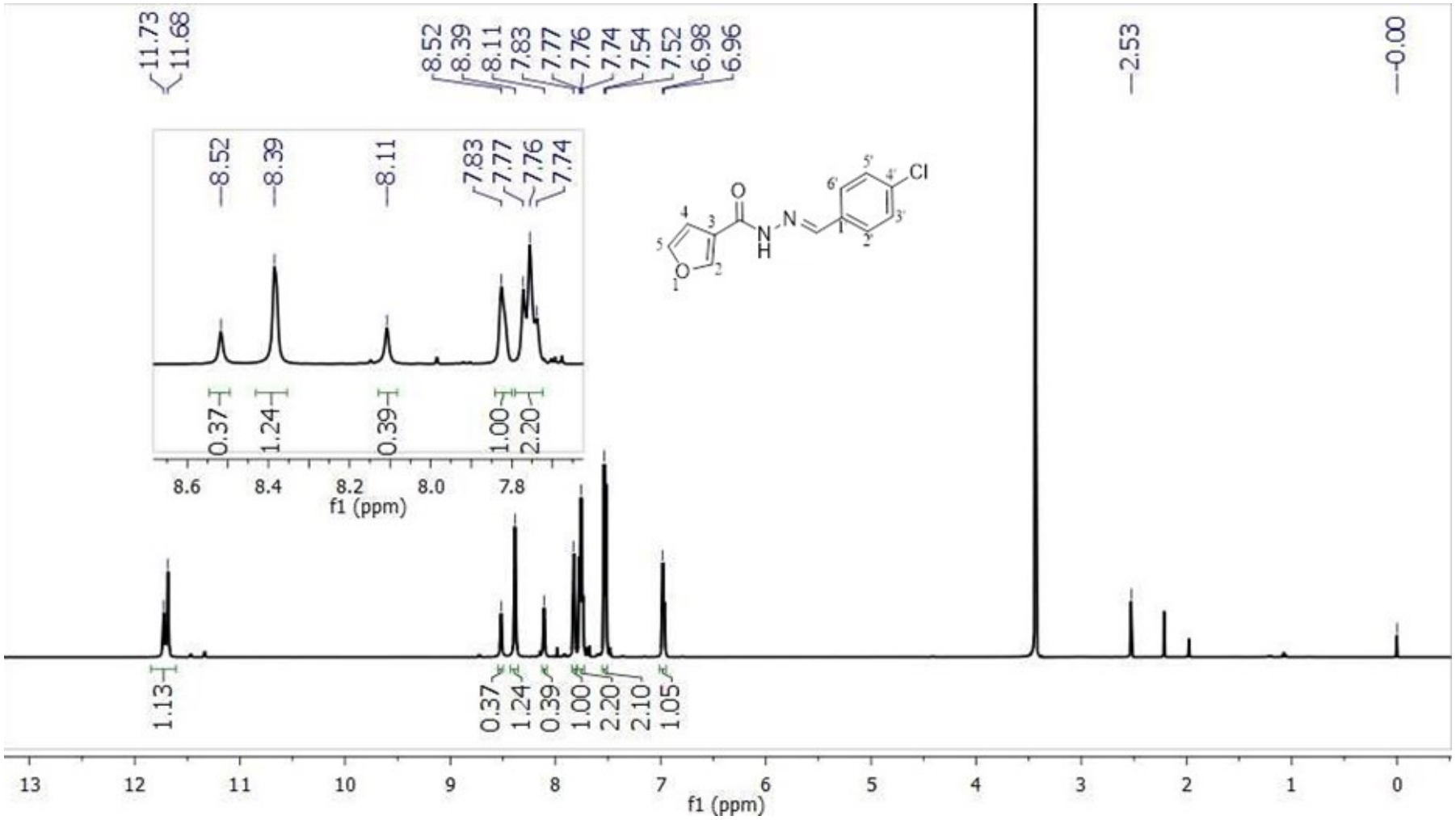
Spectrum 26 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **5** at 25ºC.



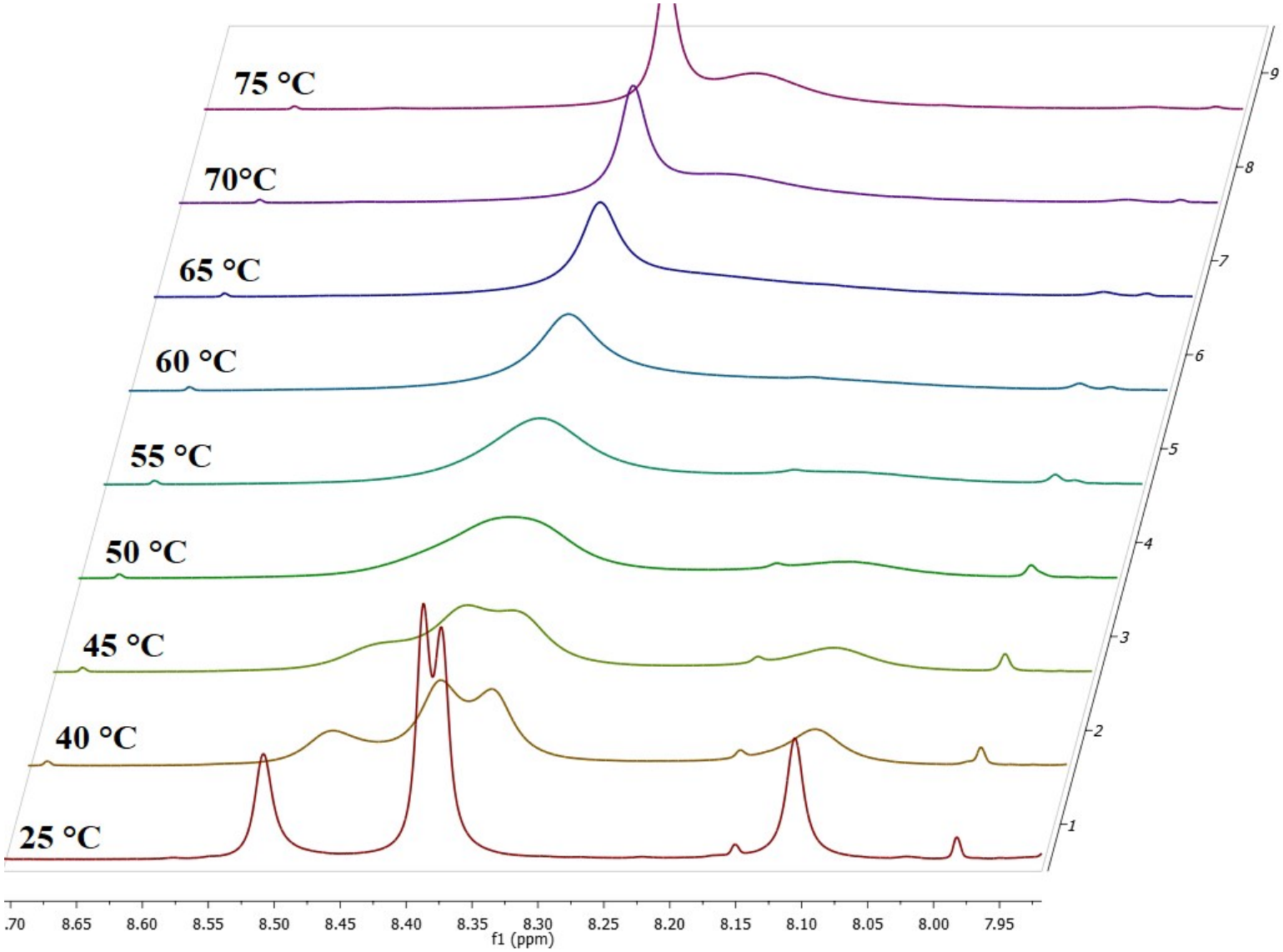
Spectrum 27 – Infrared spectrum (ATR) of compound **5**.



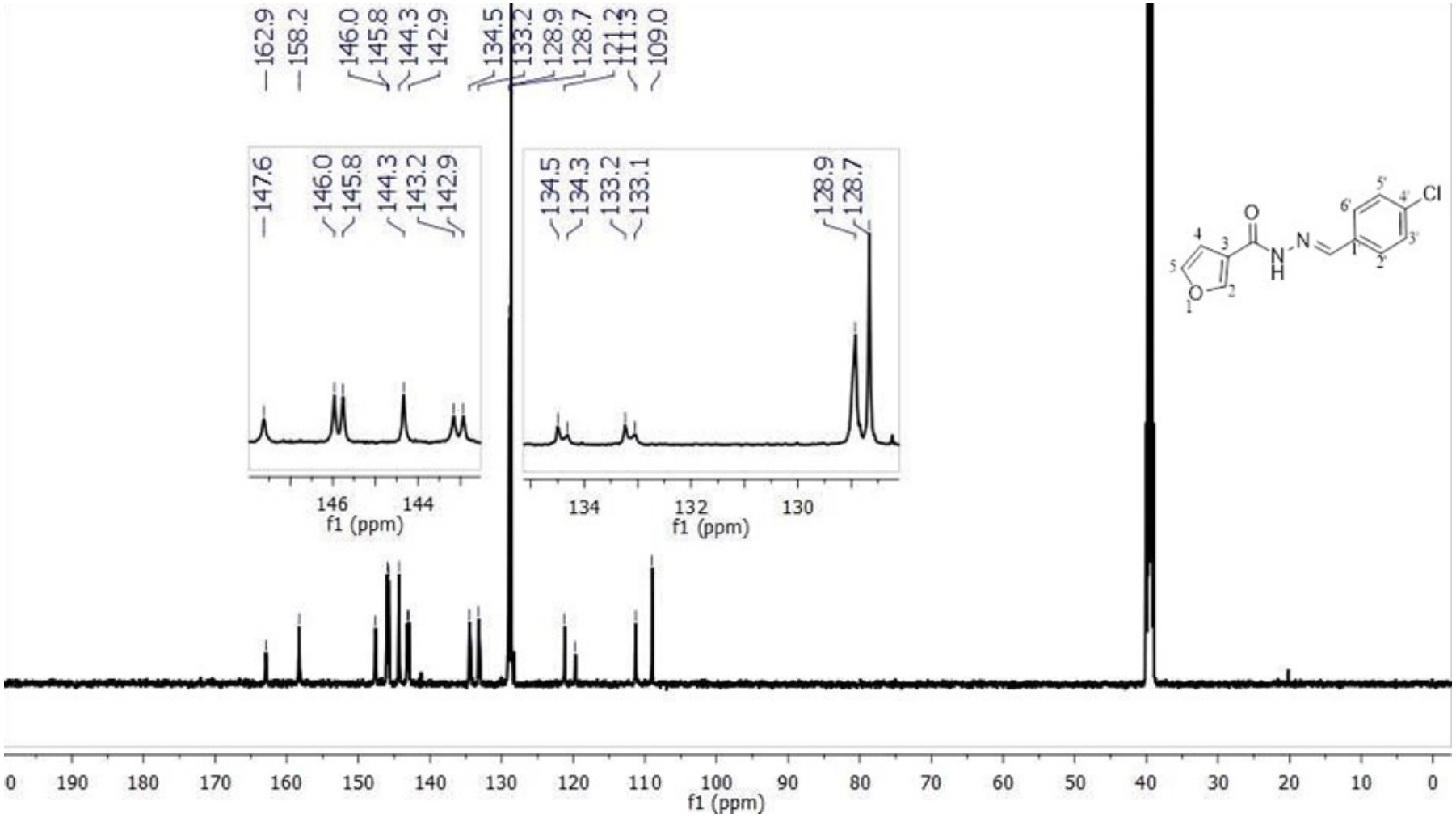
Spectrum 28 – High resolution mass spectrometry ($[M + H]^+$) of compound **5**.



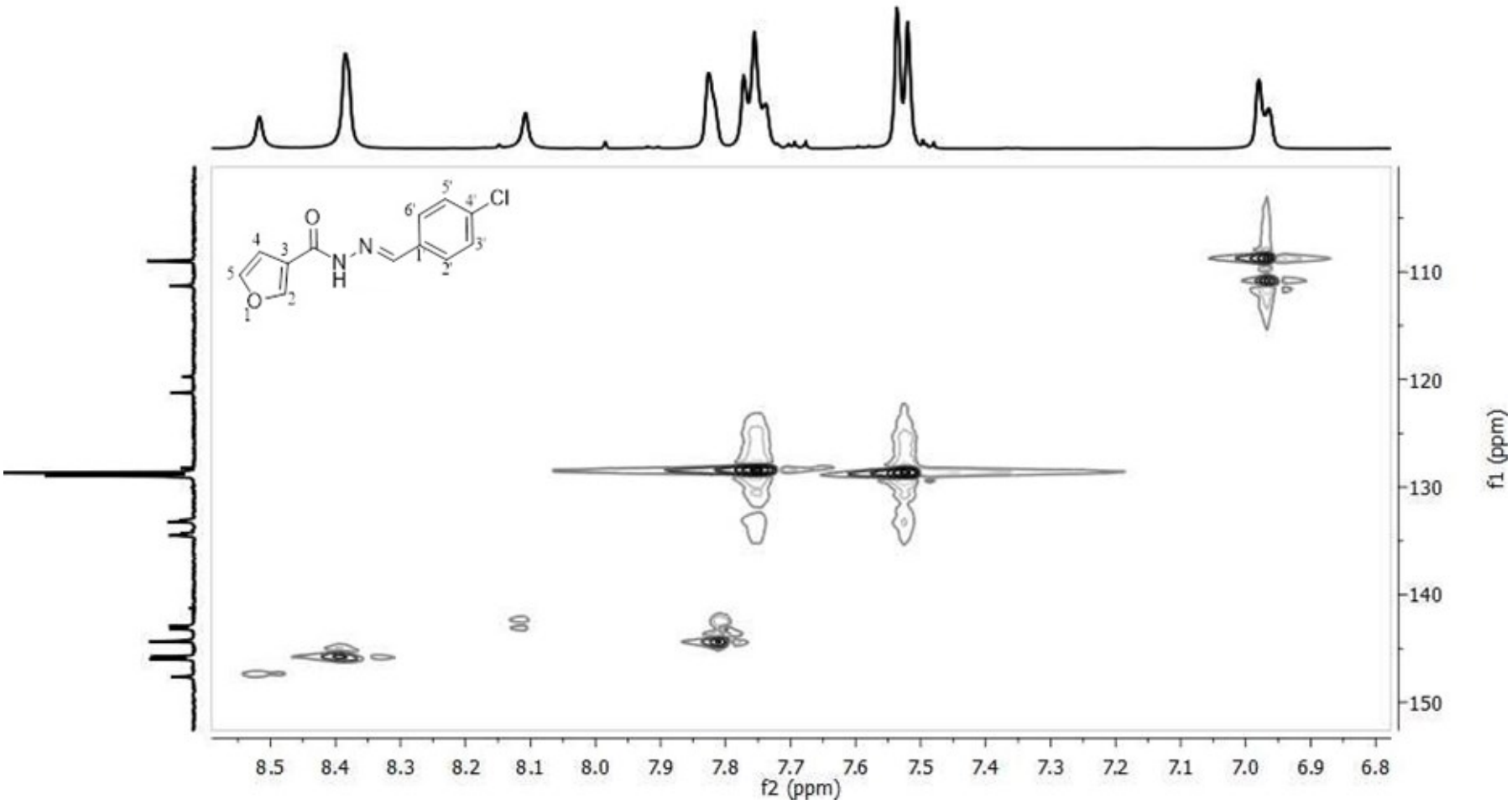
Spectrum 29 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **6** at 25ºC.



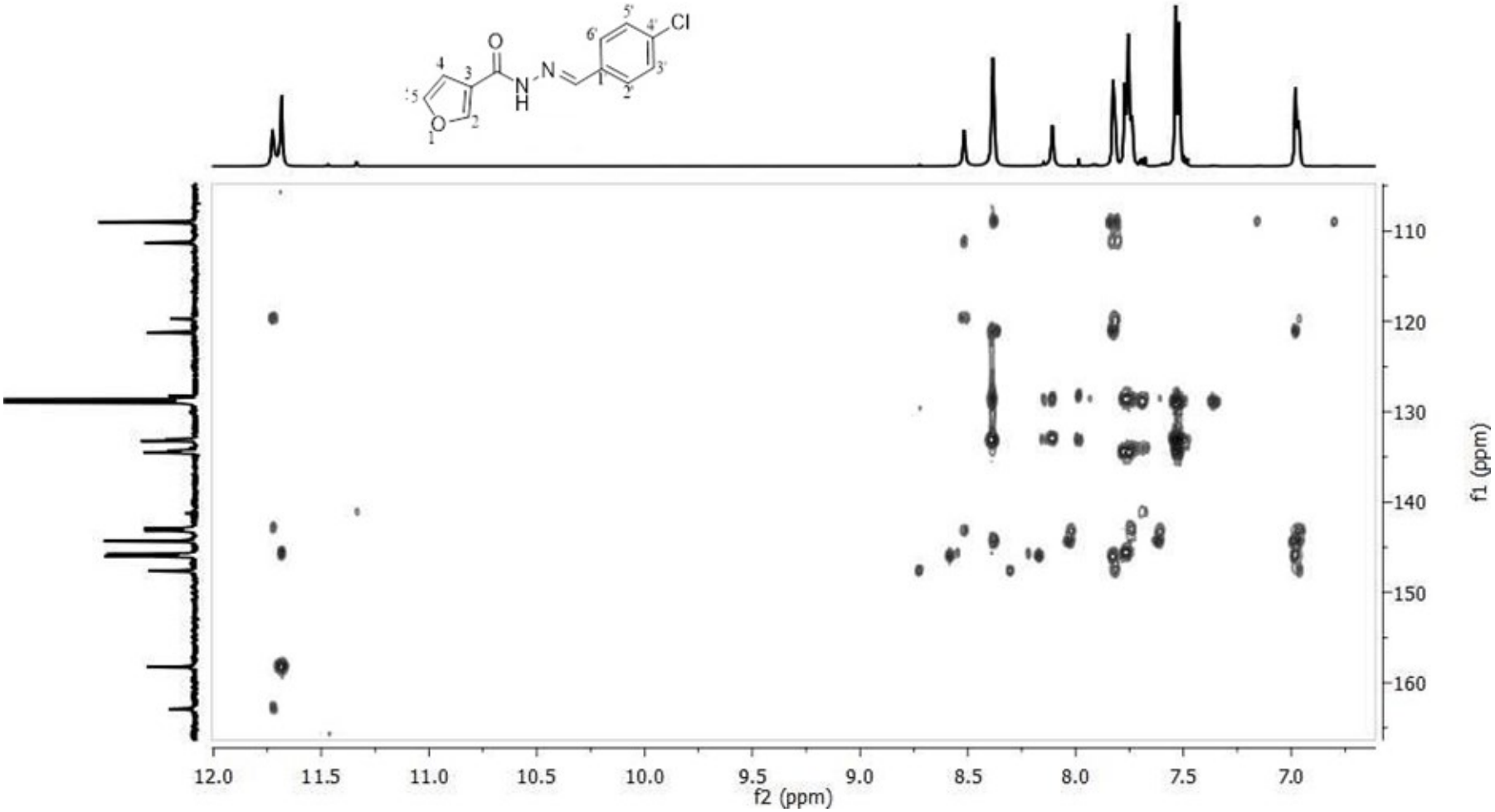
Spectrum 30 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **6**.



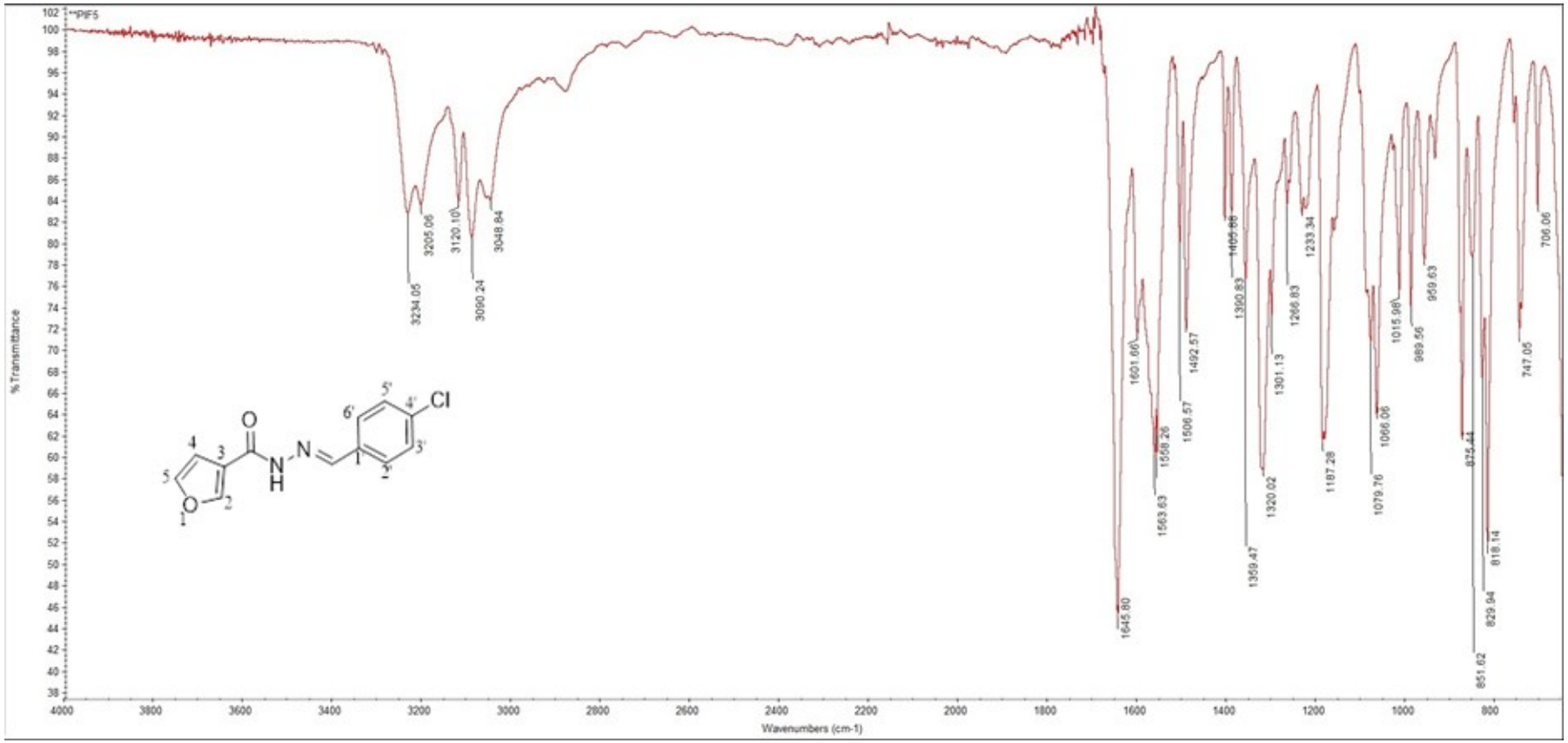
Spectrum 31 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **6** at 25ºC.



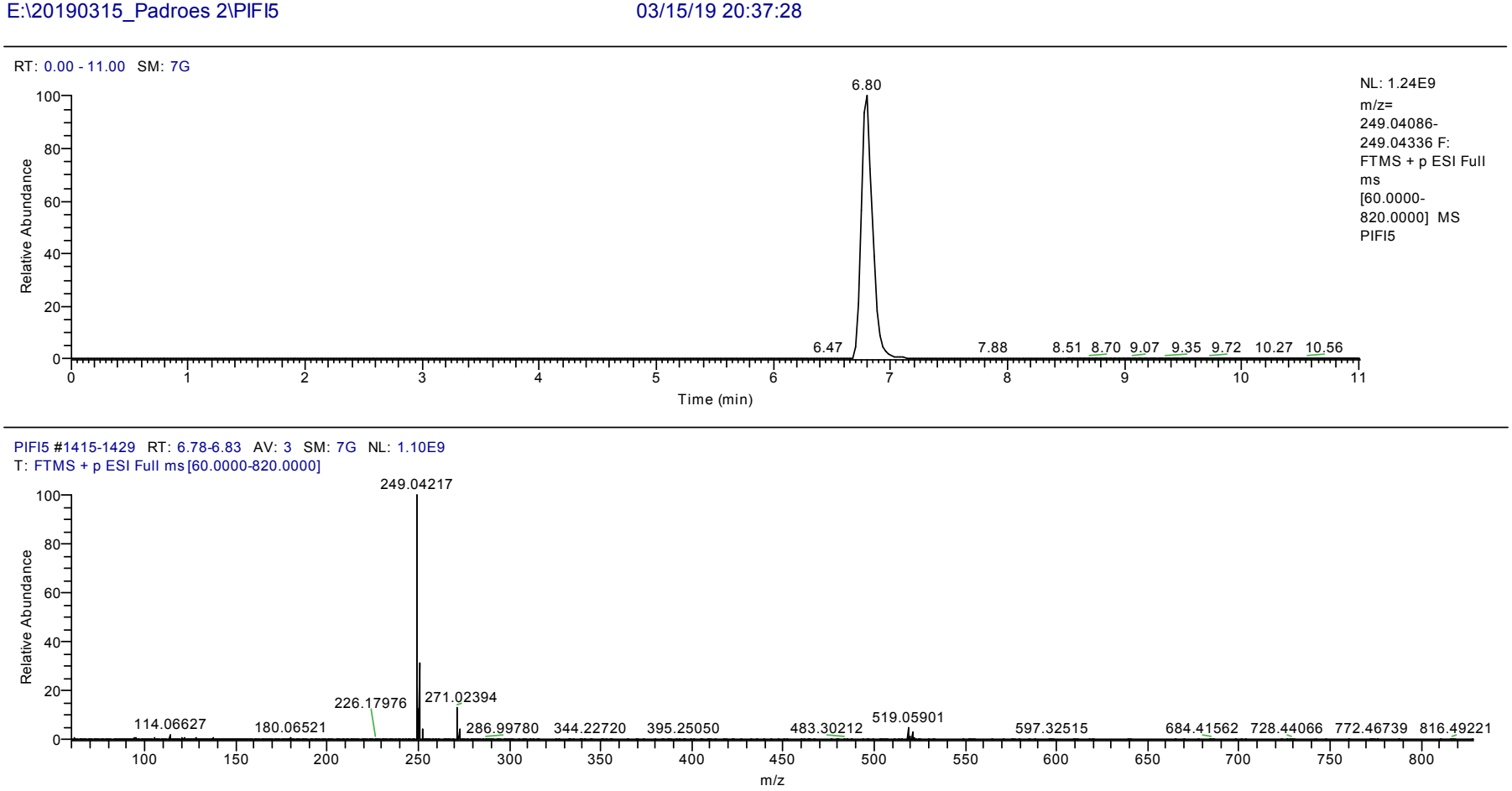
Spectrum 32 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **6** at 25ºC.



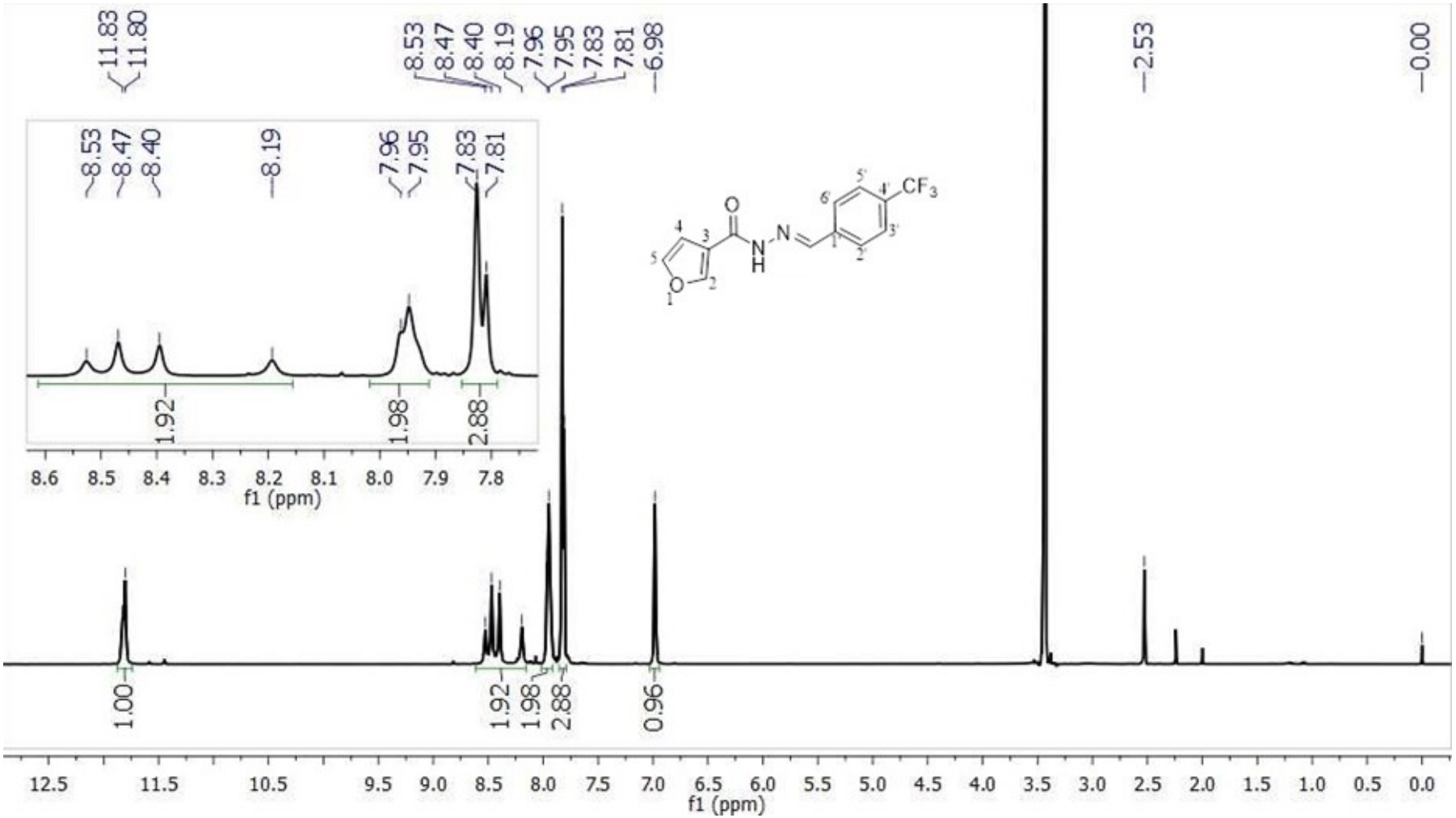
Spectrum 33 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **6** at 25ºC.



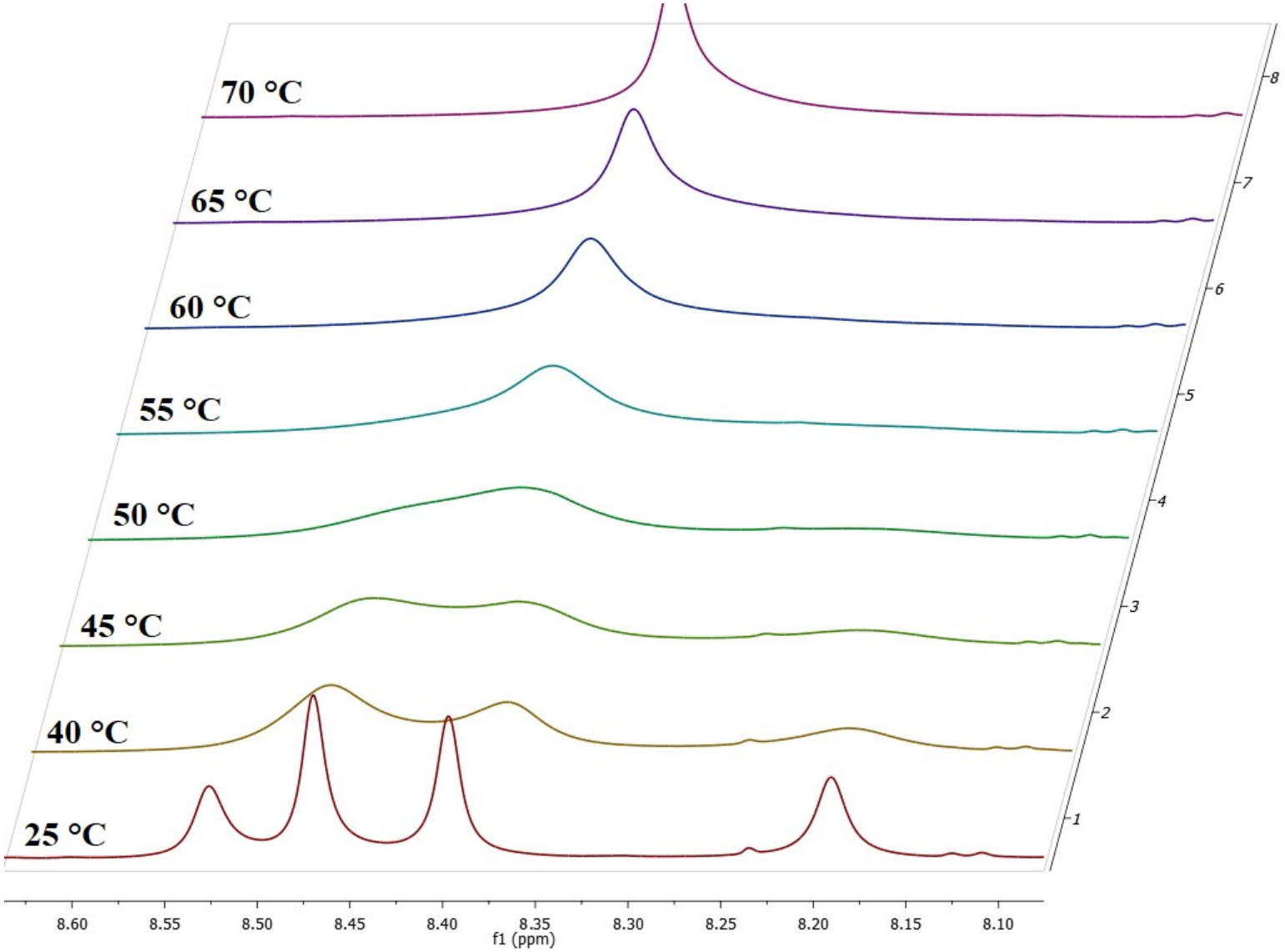
Spectrum 34 – Infrared spectrum (ATR) of compound **6**.



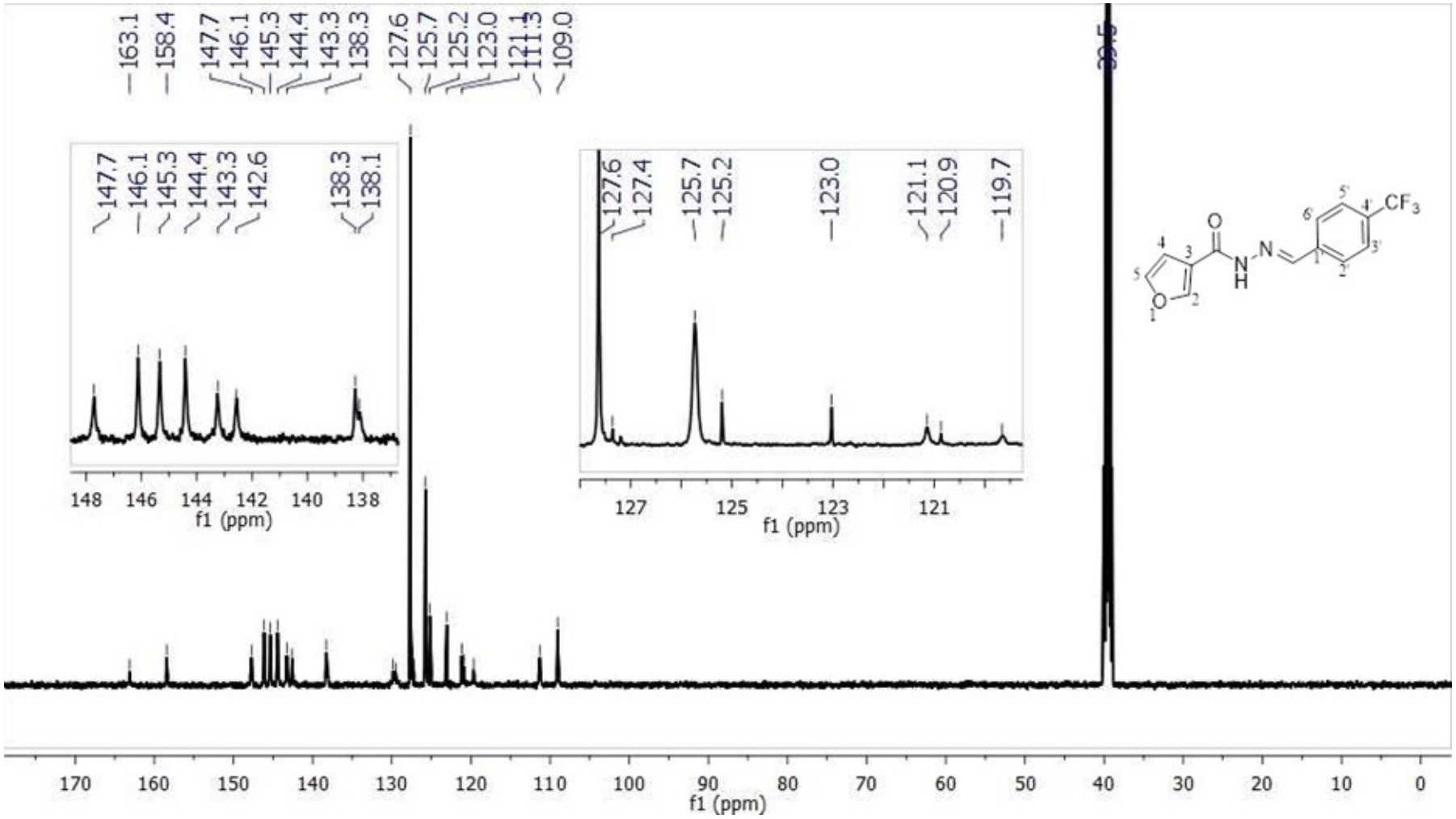
Spectrum 35 – High resolution mass spectrometry ($[M + H]^+$) of compound **6**.



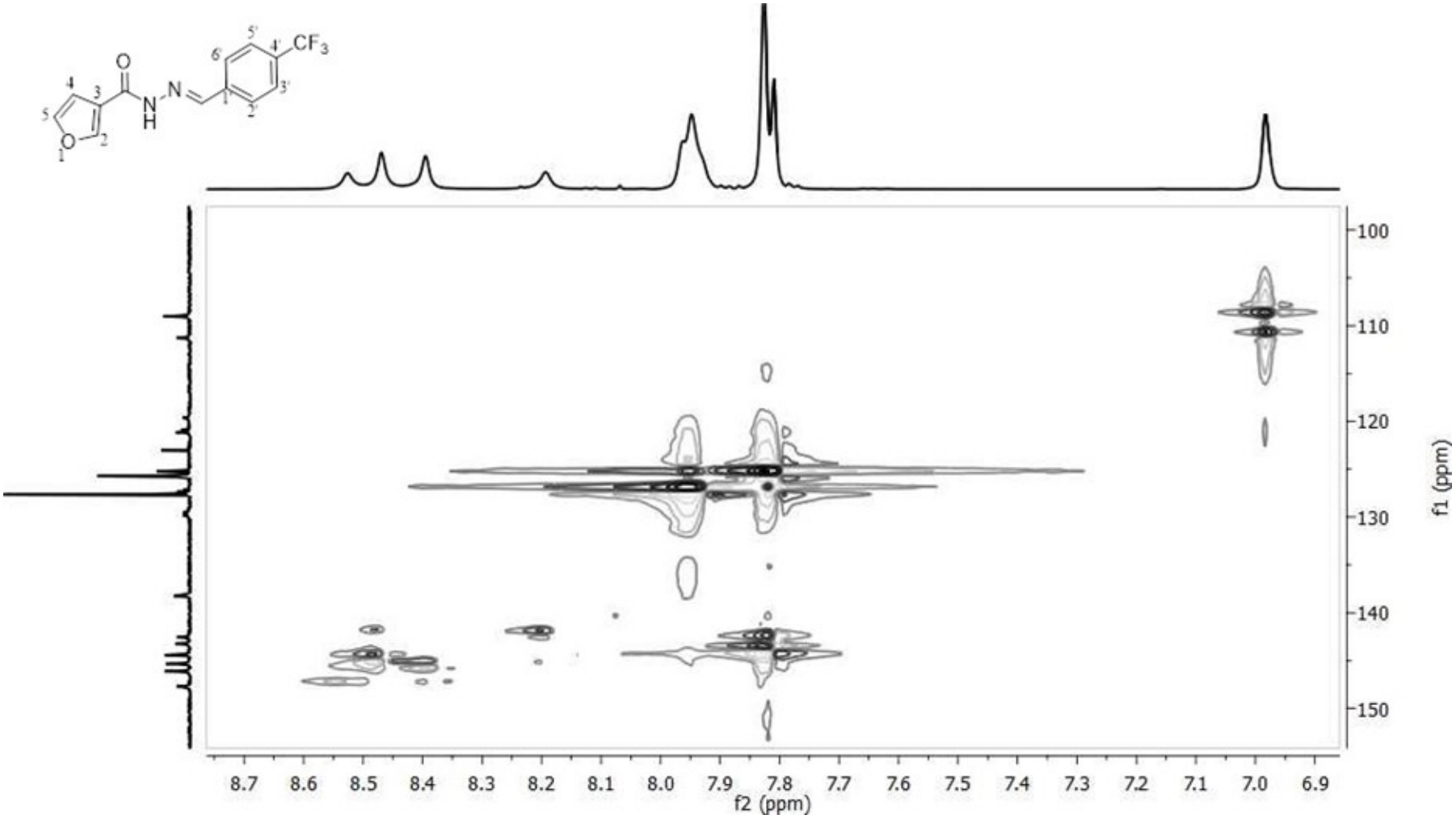
Spectrum 36 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **7** at 25ºC.



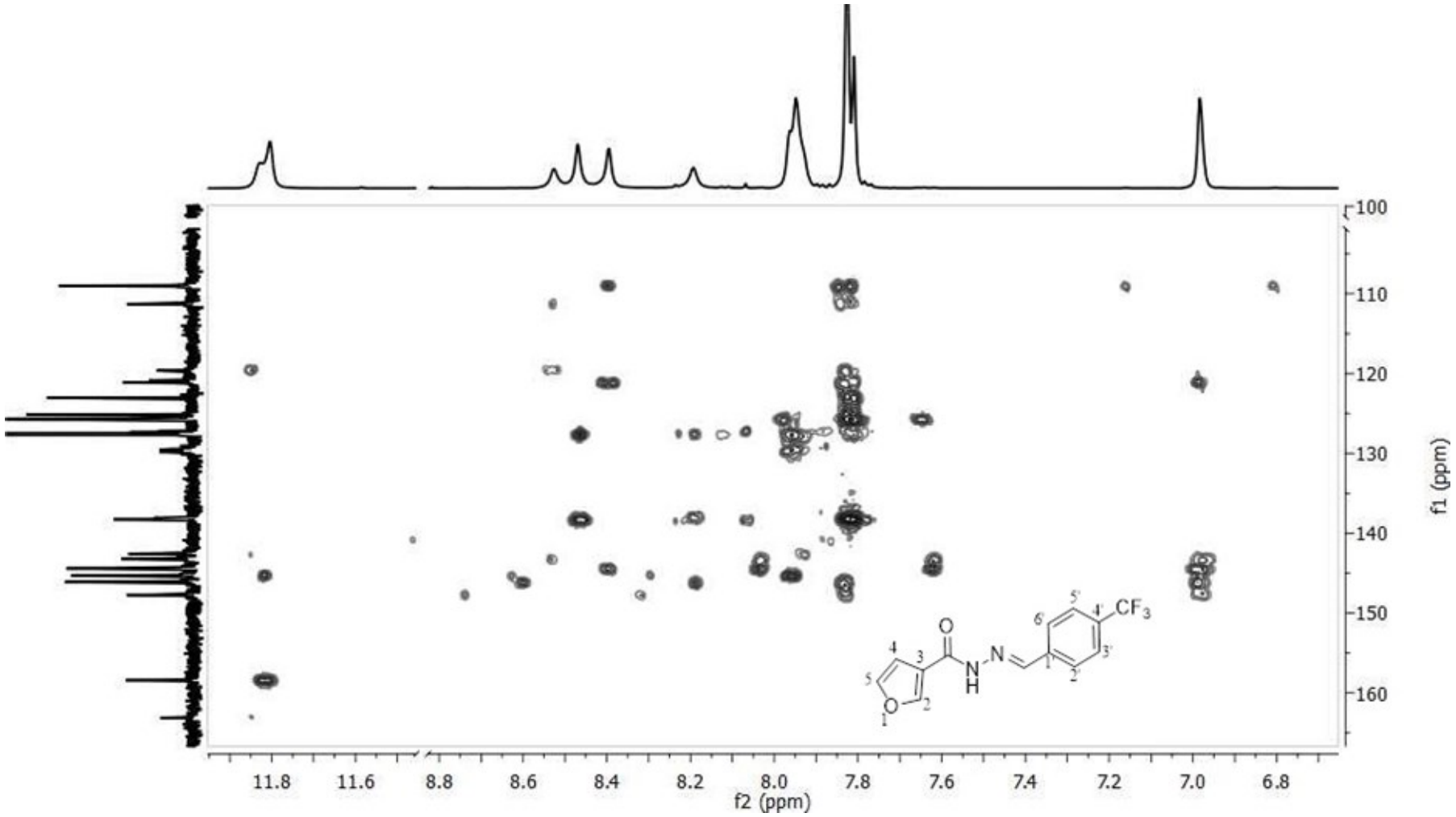
Spectrum 37 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **7**.



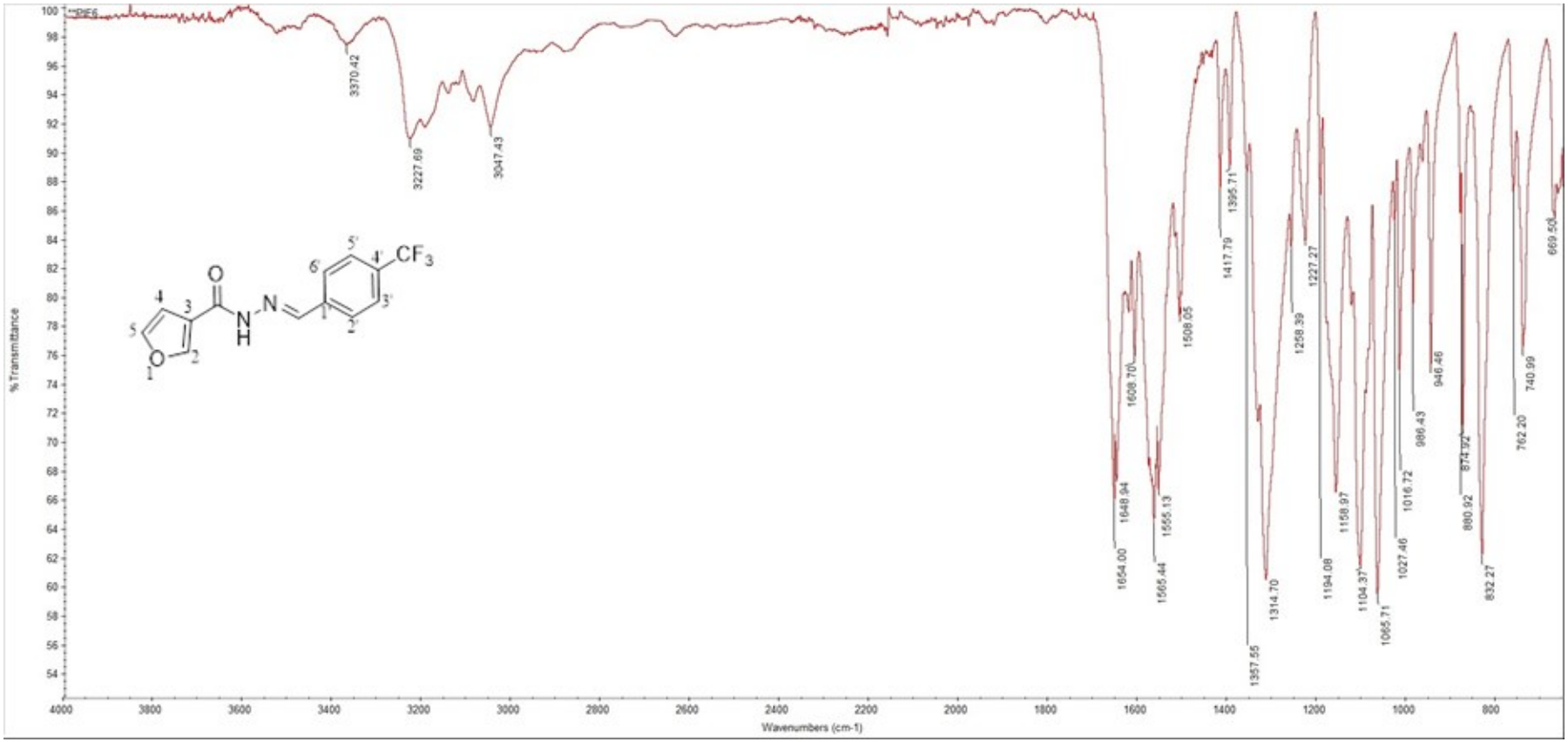
Spectrum 38 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **7** at 25ºC.



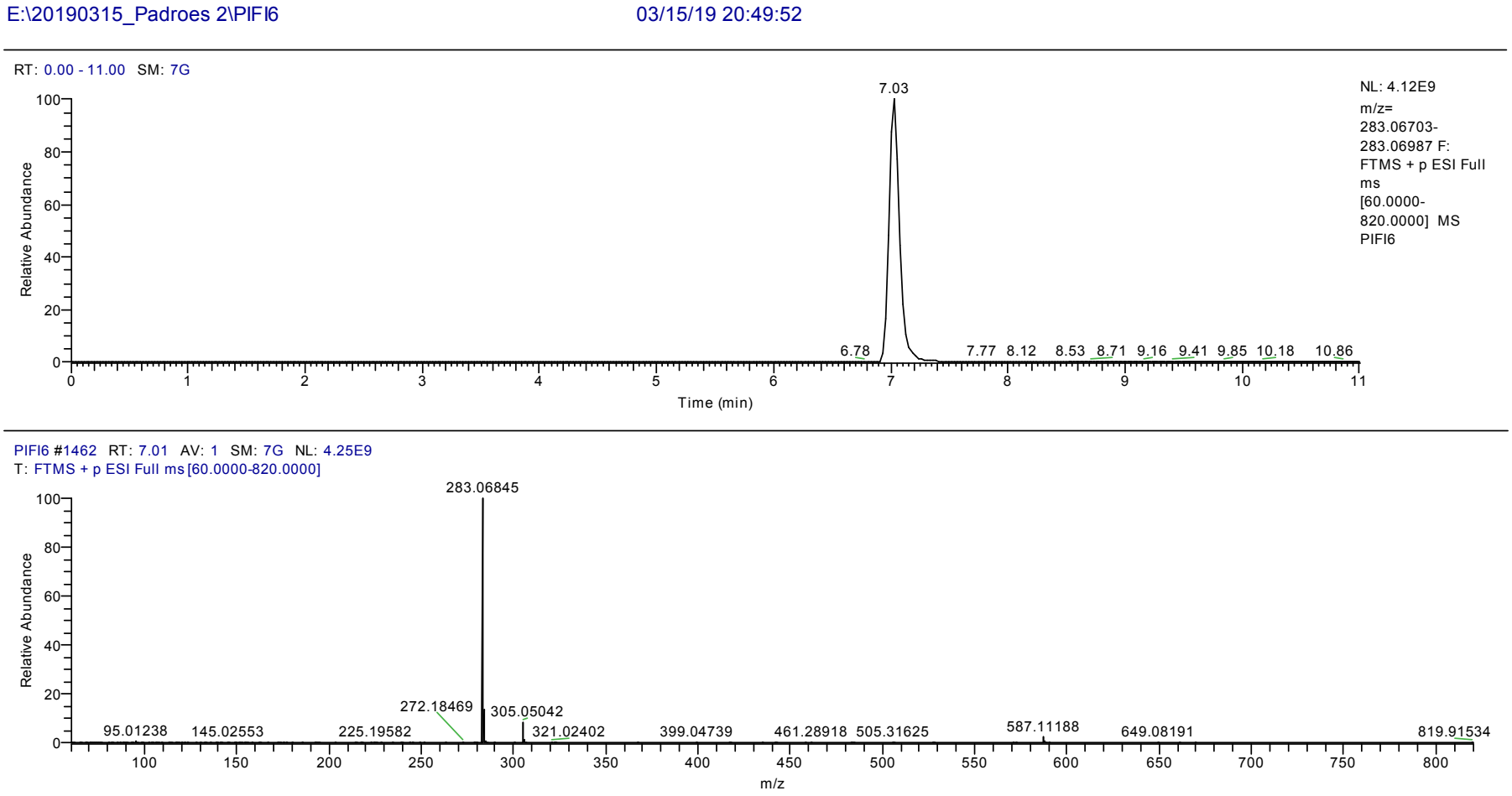
Spectrum 39 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **7** at 25ºC.



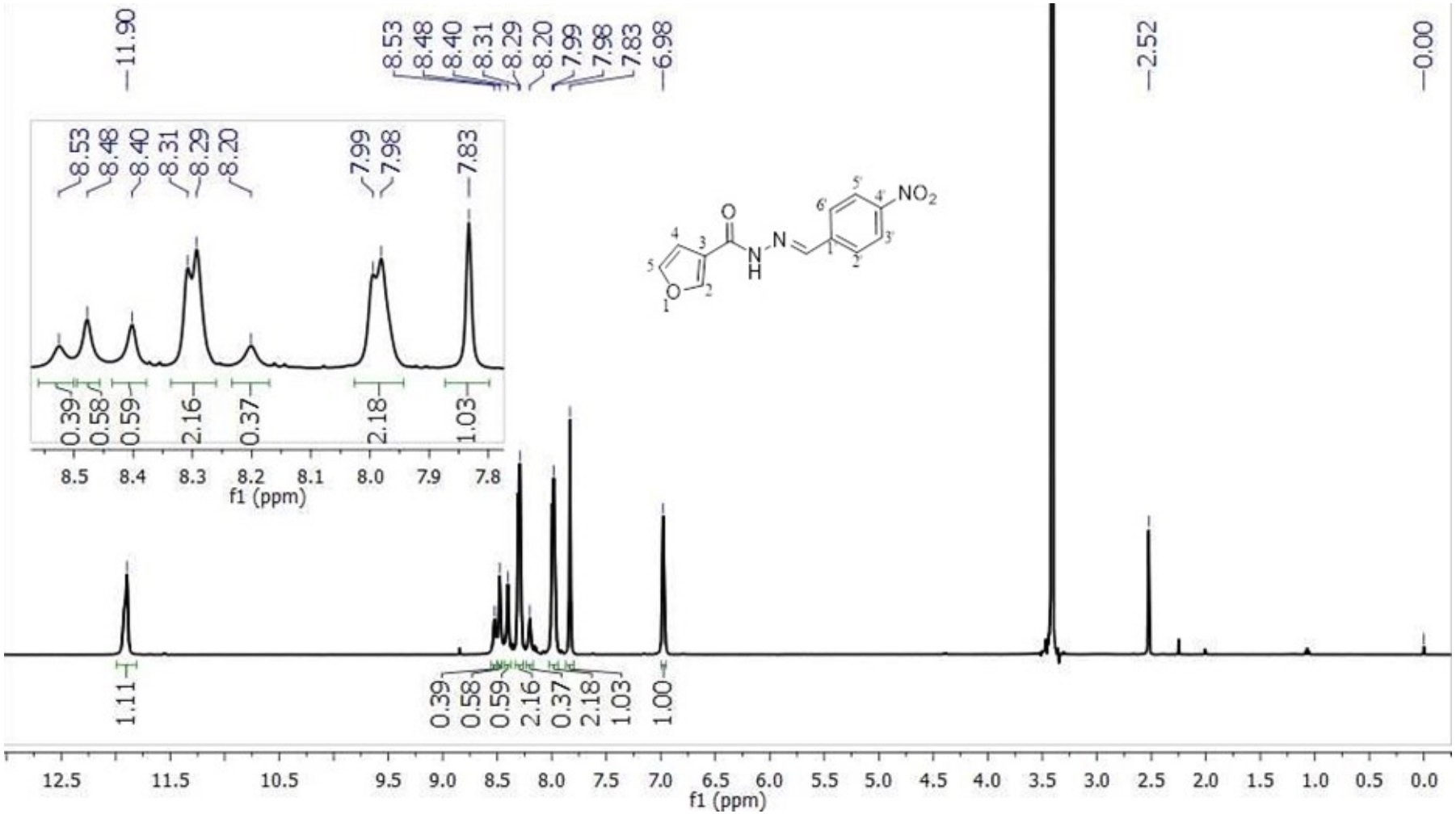
Spectrum 40 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **7** at 25ºC.



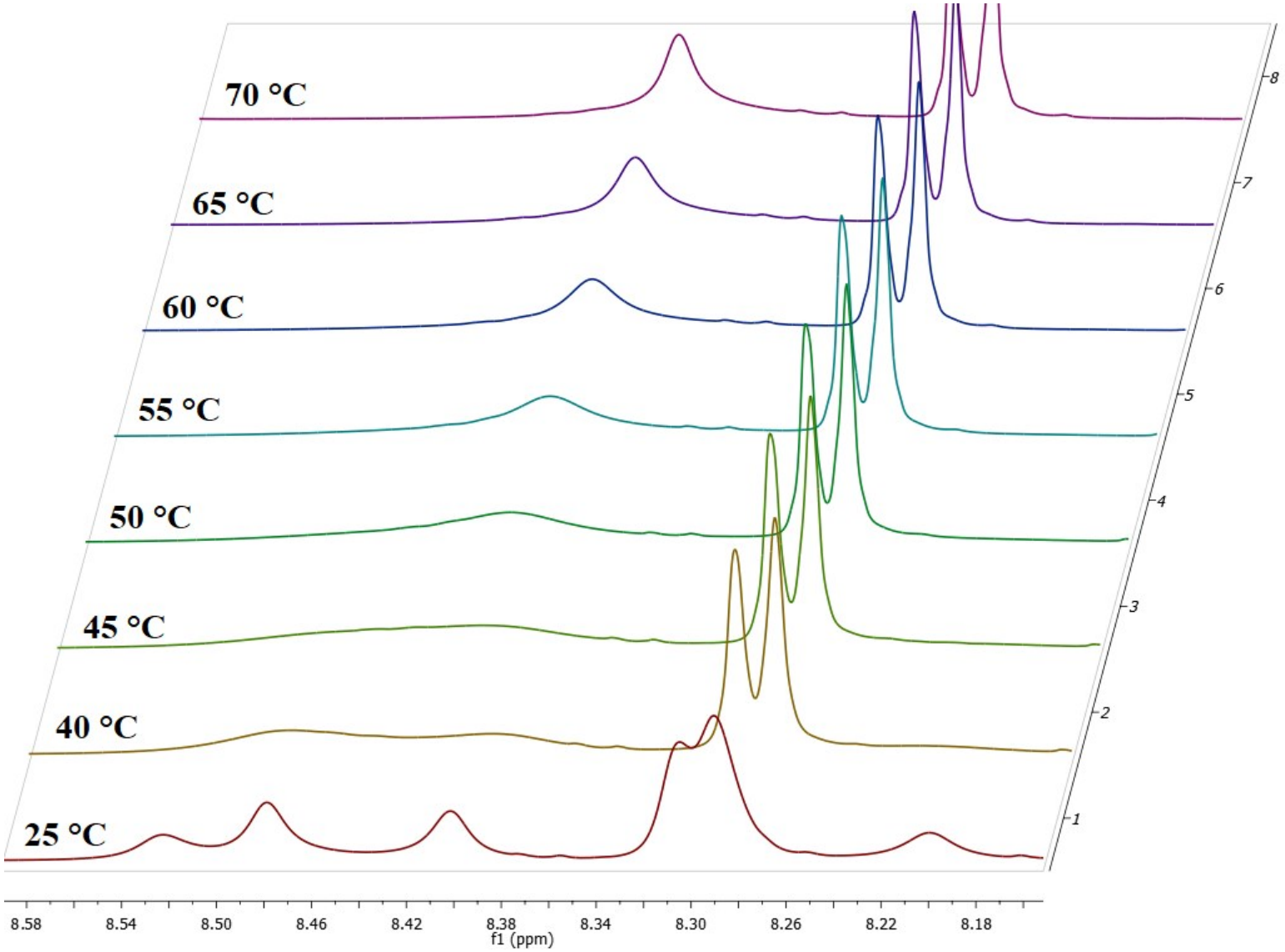
Spectrum 41 – Infrared spectrum (ATR) of compound **7**.



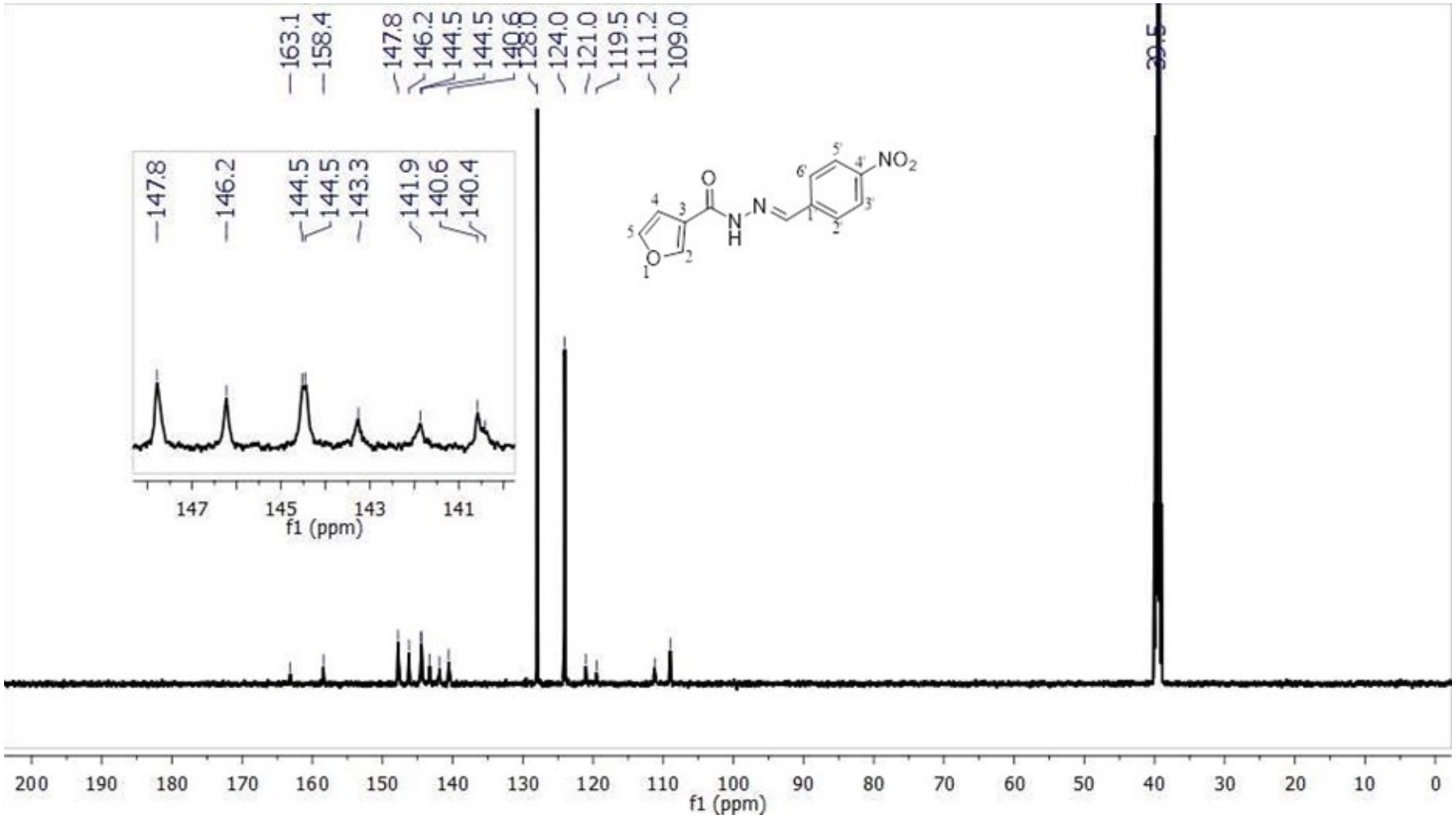
Spectrum 42 – High resolution mass spectrometry ($[M + H]^+$) of compound **7**.



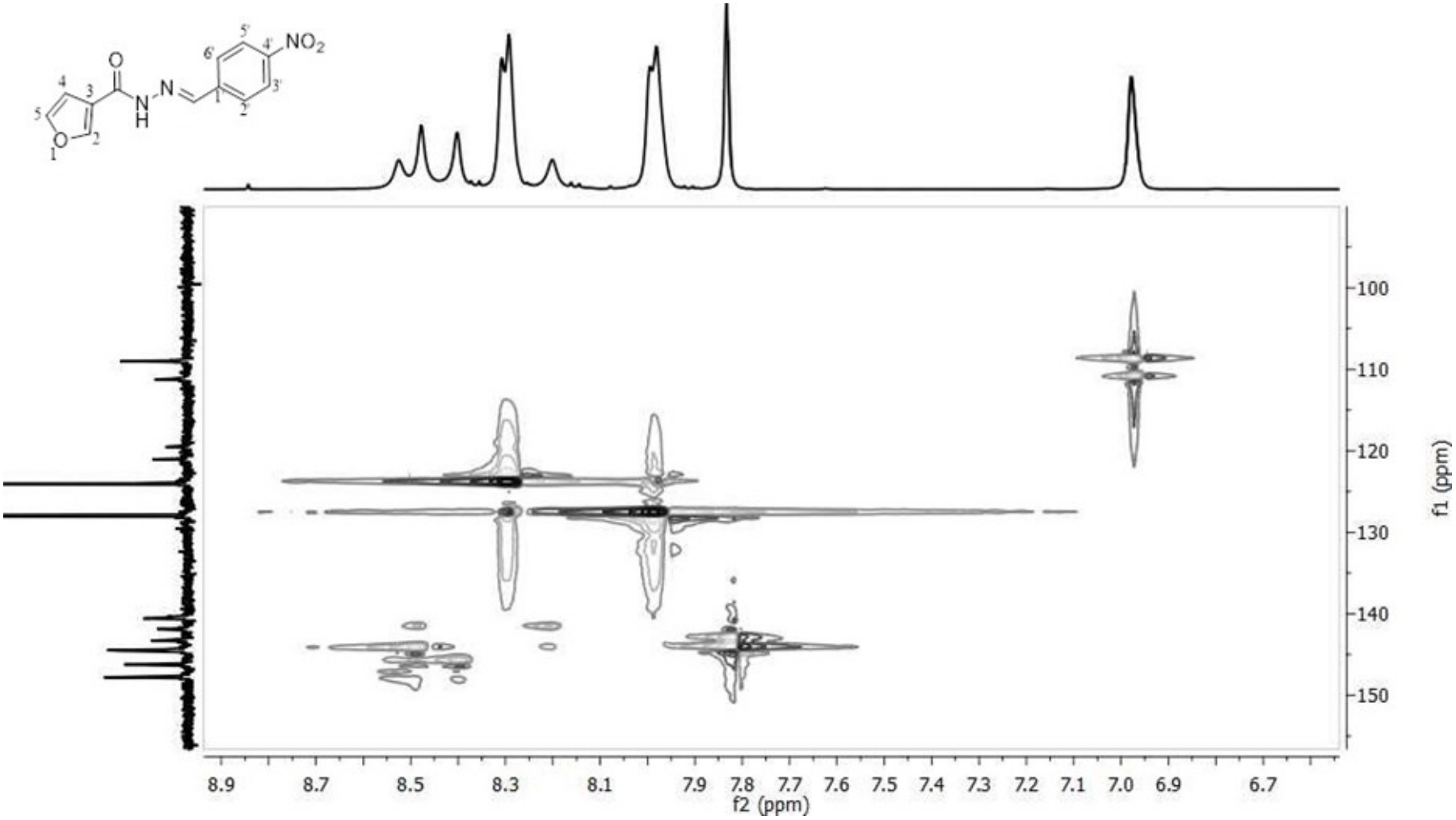
Spectrum 43 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **8** at 25ºC.



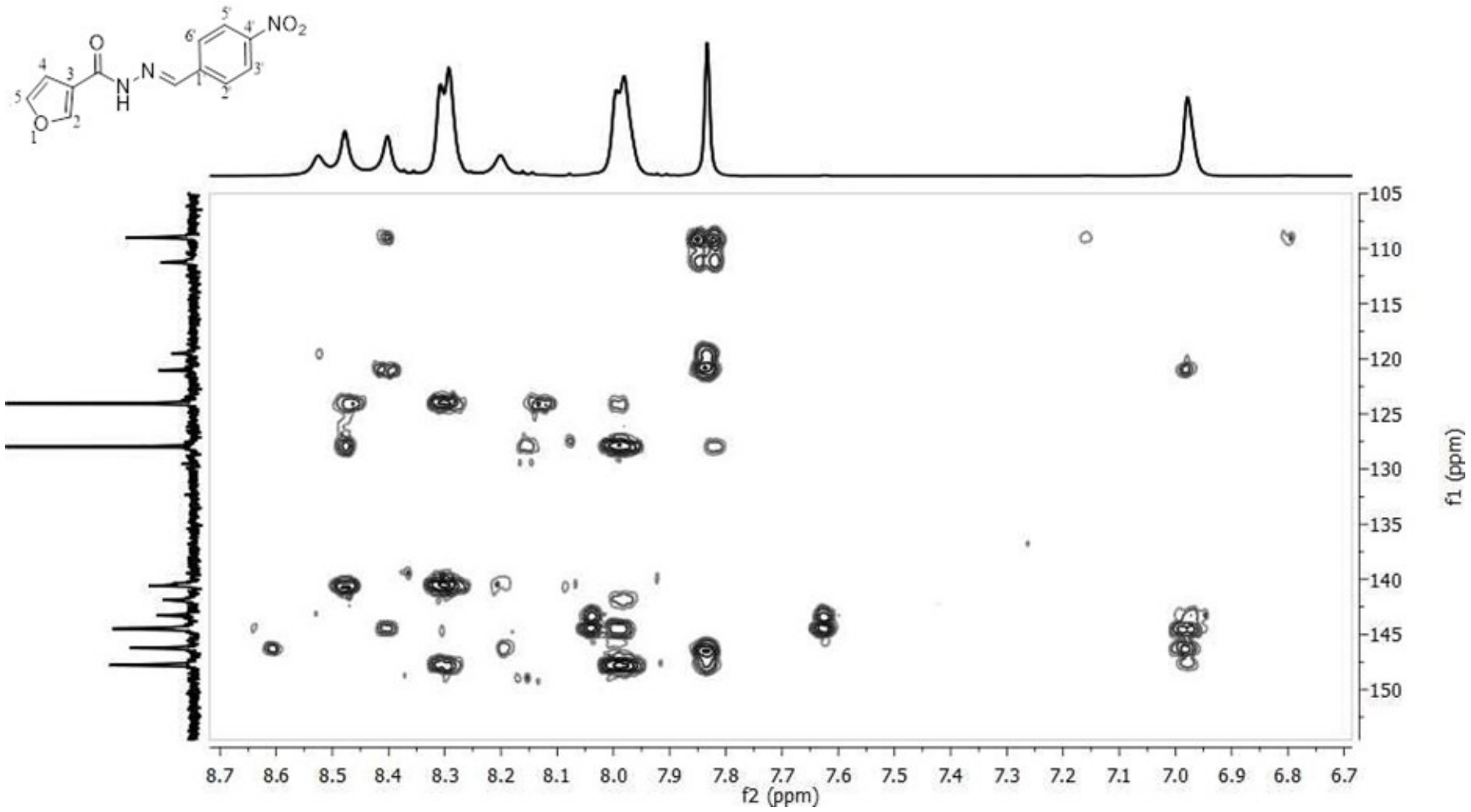
Spectrum 44 – Dynamic ^{1}H NMR (500 MHz, DMSO-d_6) of compound **8**.



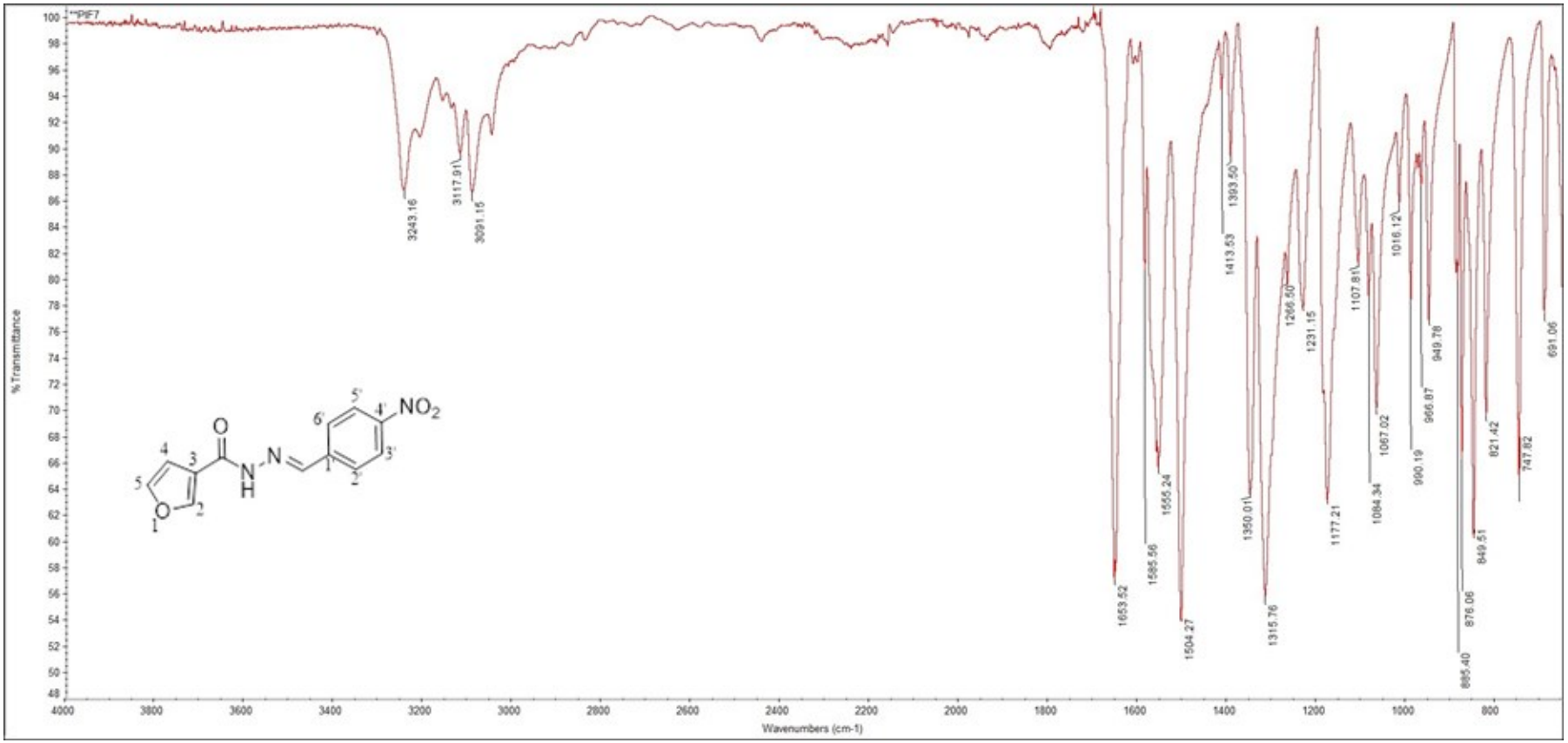
Spectrum 45 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **8** at 25ºC.



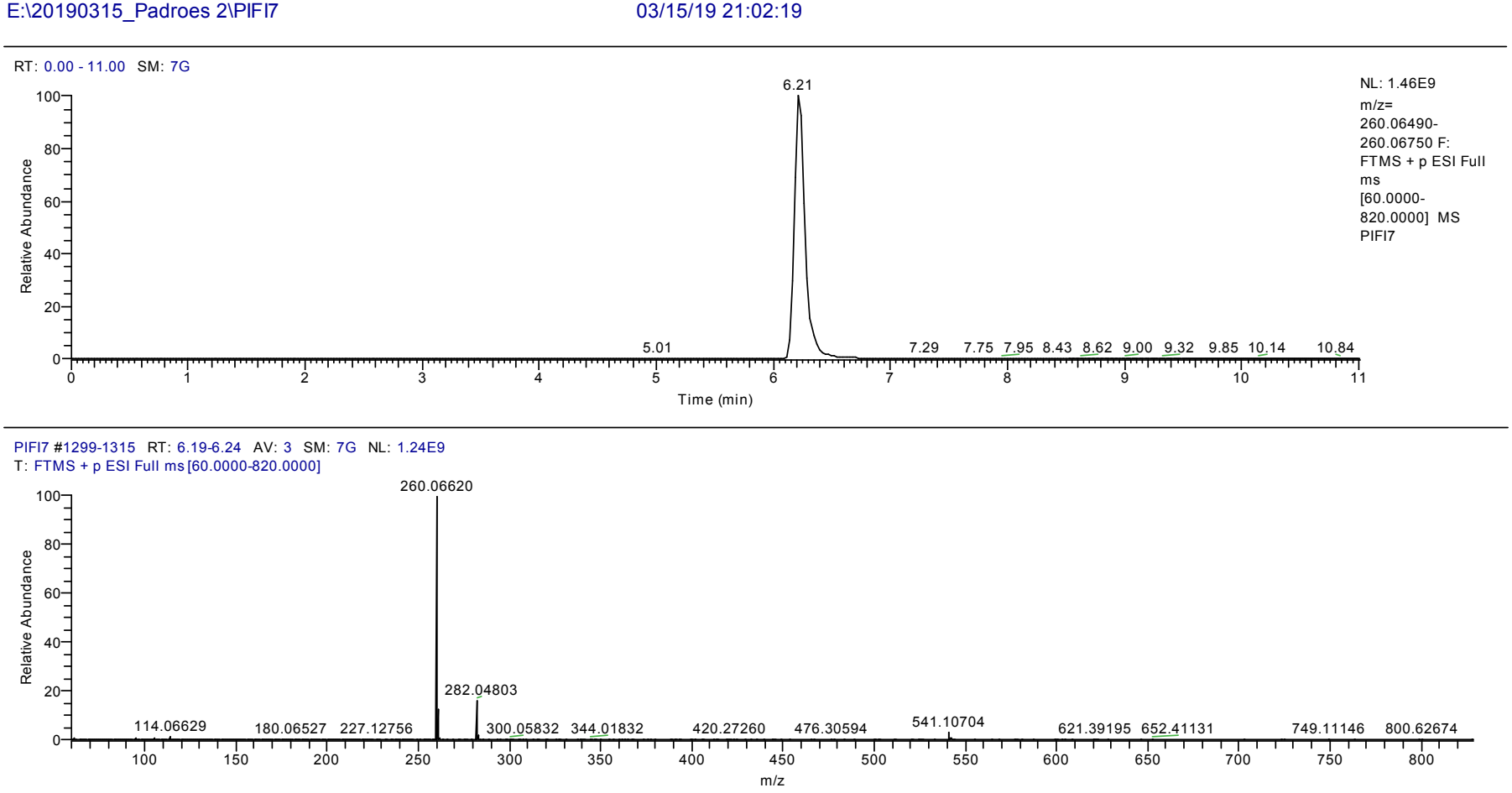
Spectrum 46 – HSQC spectrum (500 MHz, DMSO-d_6) of compound **8** at 25ºC.



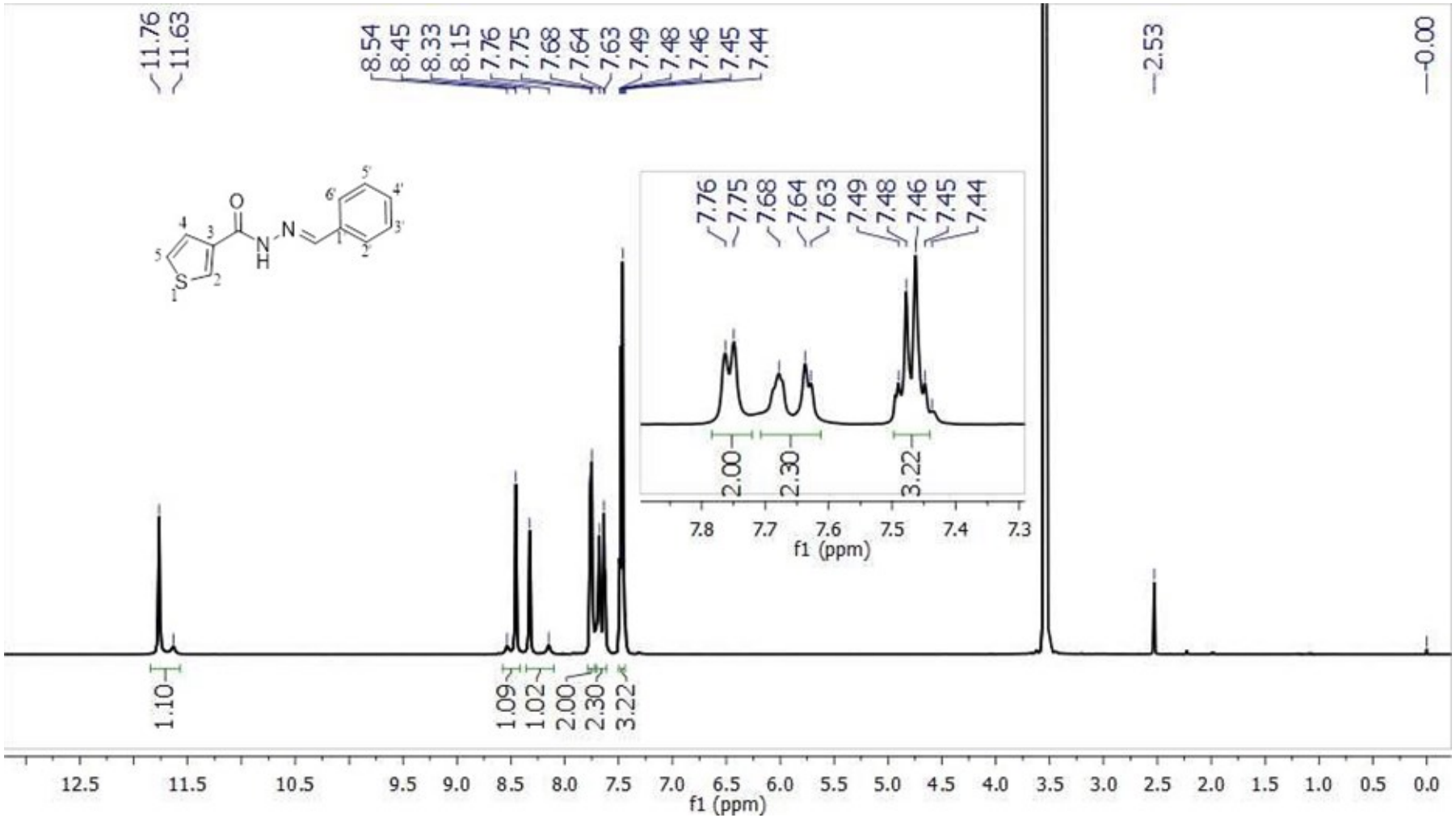
Spectrum 47 – HMBC spectrum (500 MHz, DMSO-d_6) of compound **8** at 25ºC.



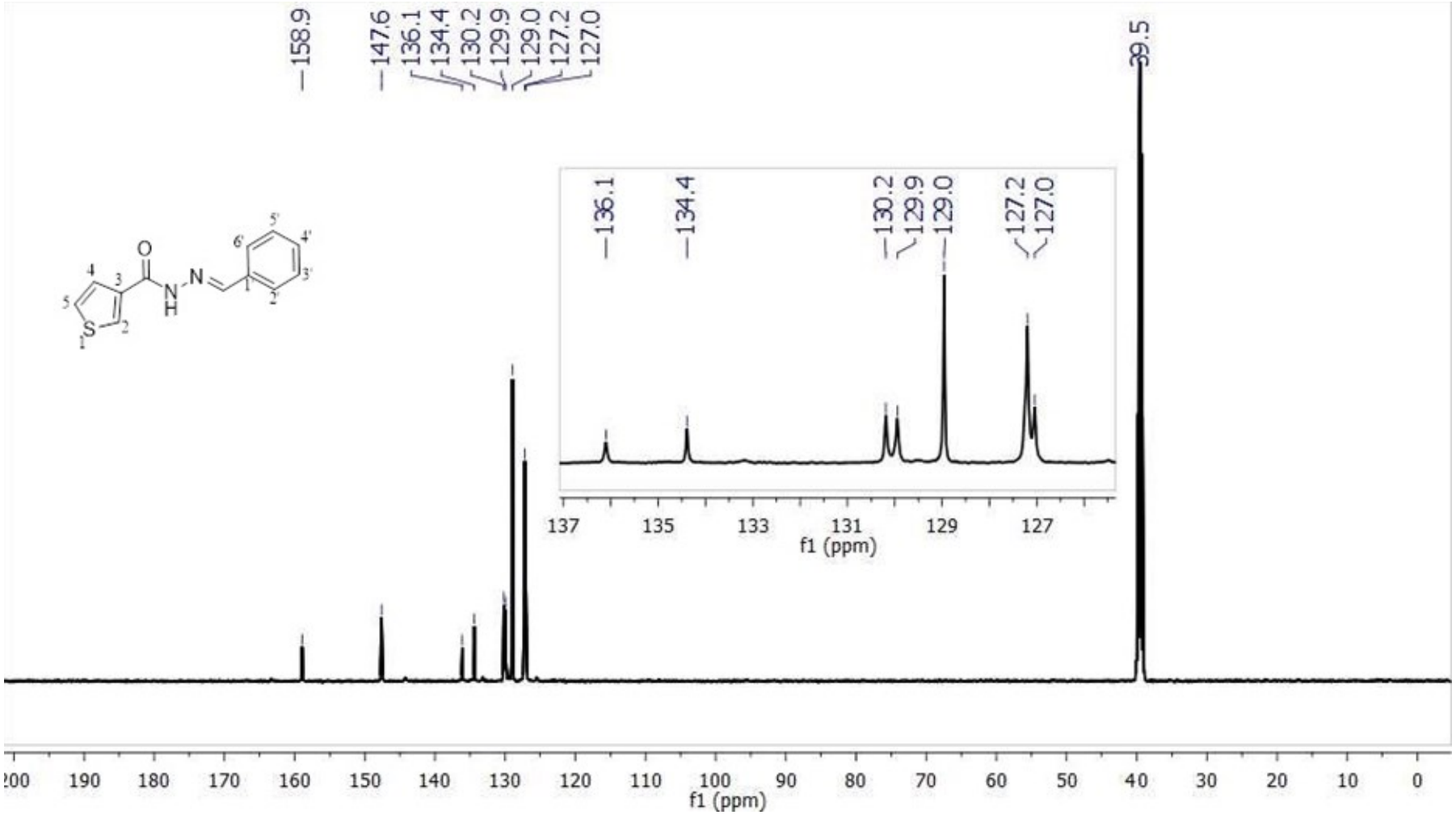
Spectrum 48 – Infrared spectrum (ATR) of compound **8**.



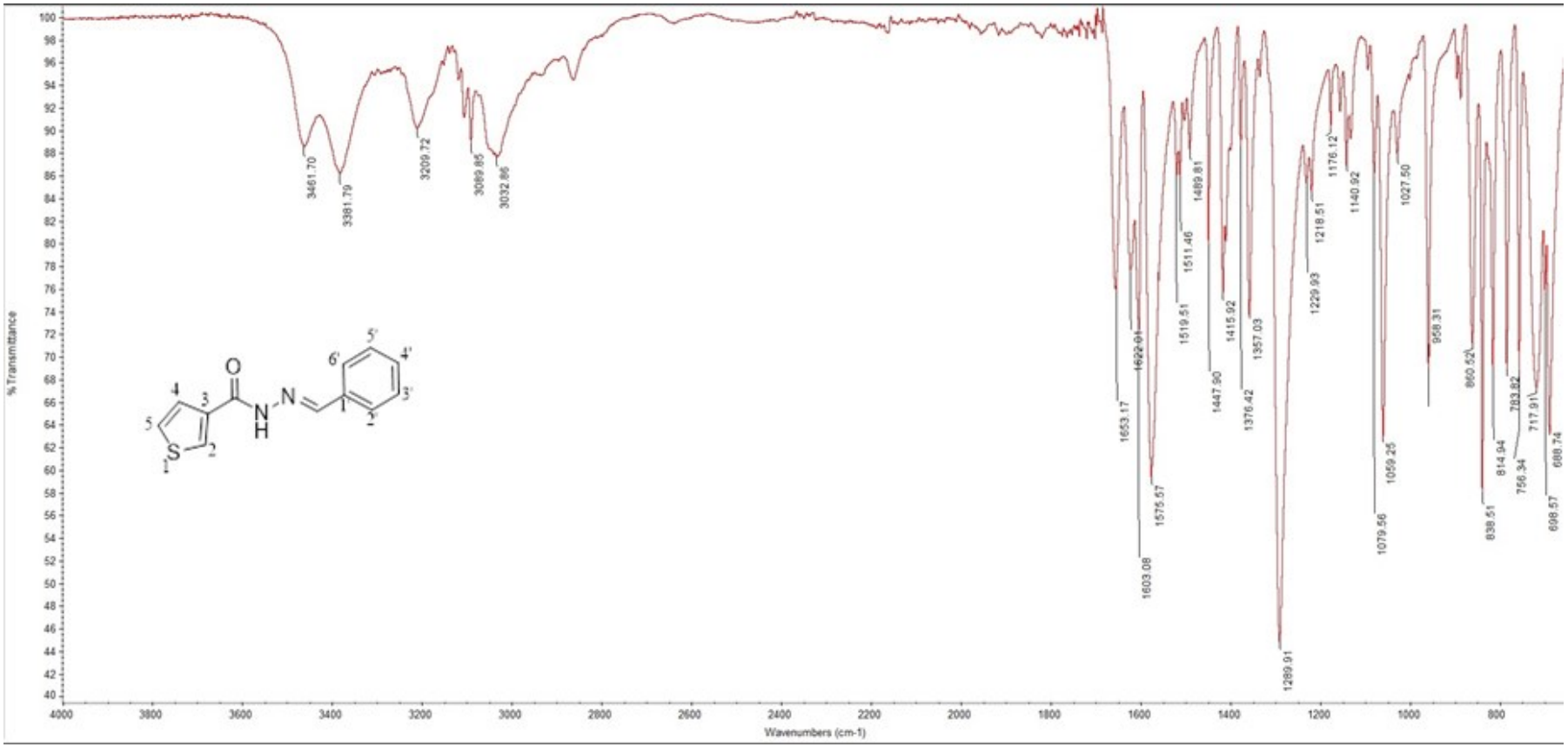
Spectrum 49 – High resolution mass spectrometry ($[M + H]^+$) of compound **8**.



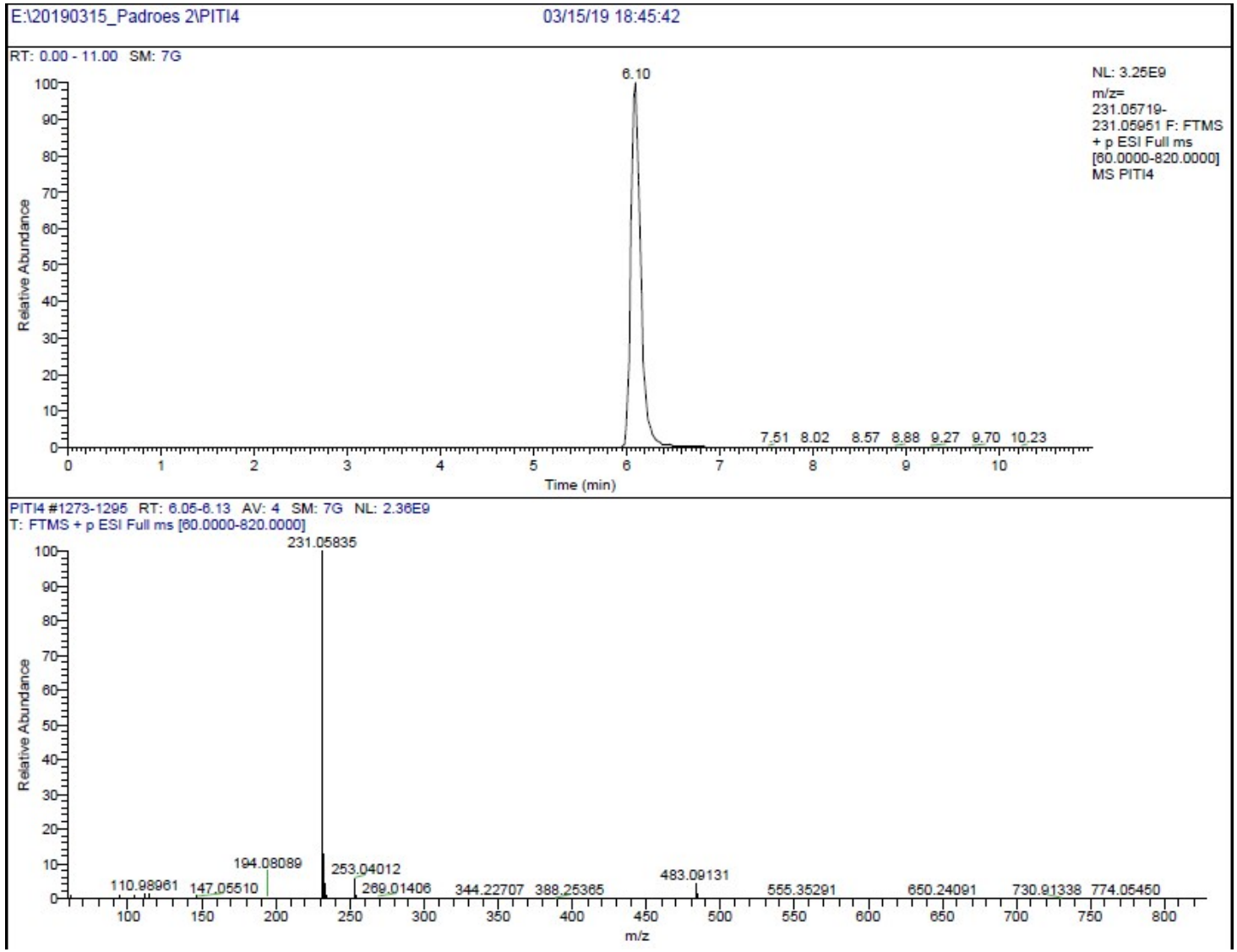
Spectrum 50 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **9** at 25ºC.



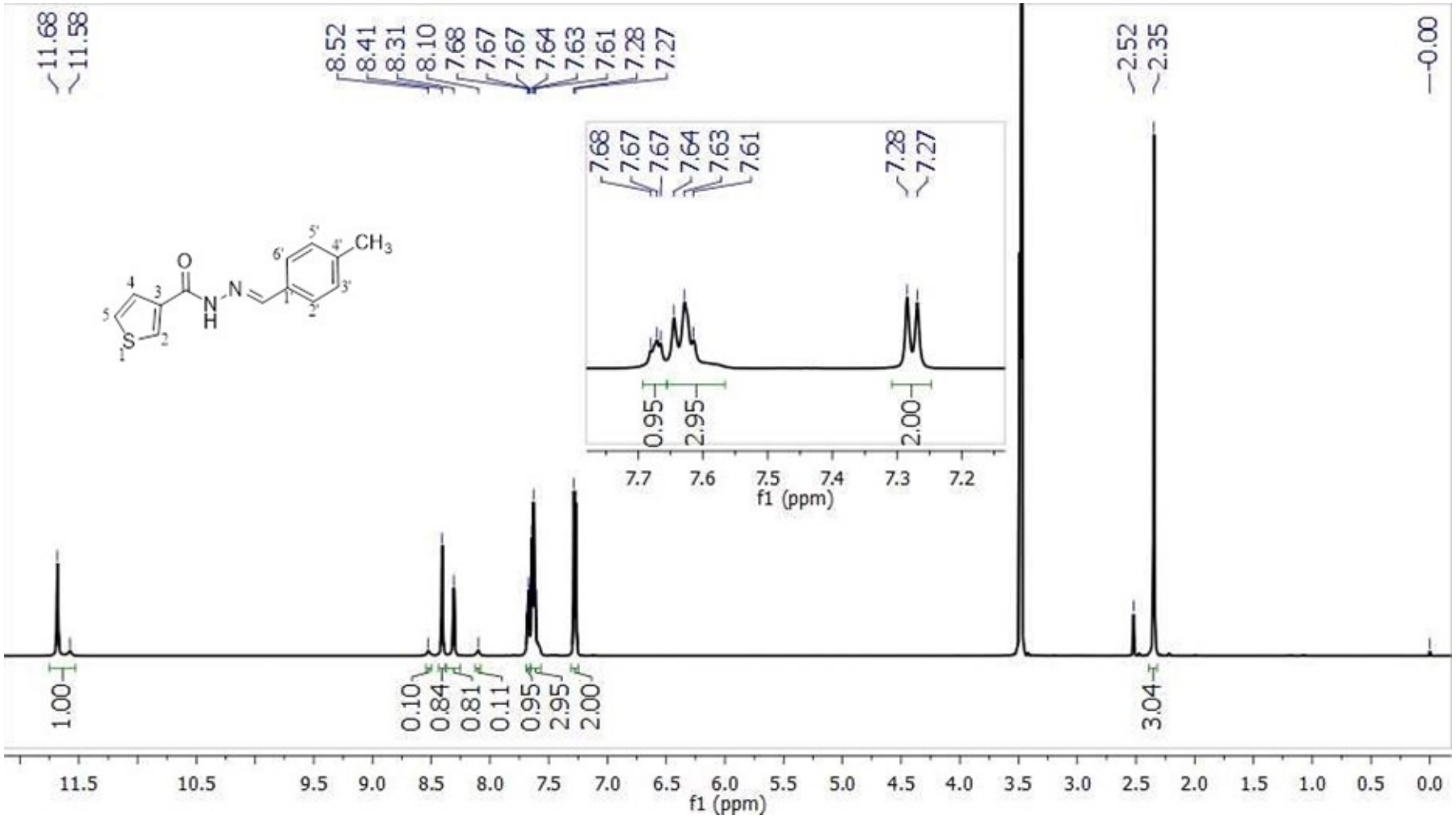
Spectrum 51 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **9** at 25ºC.



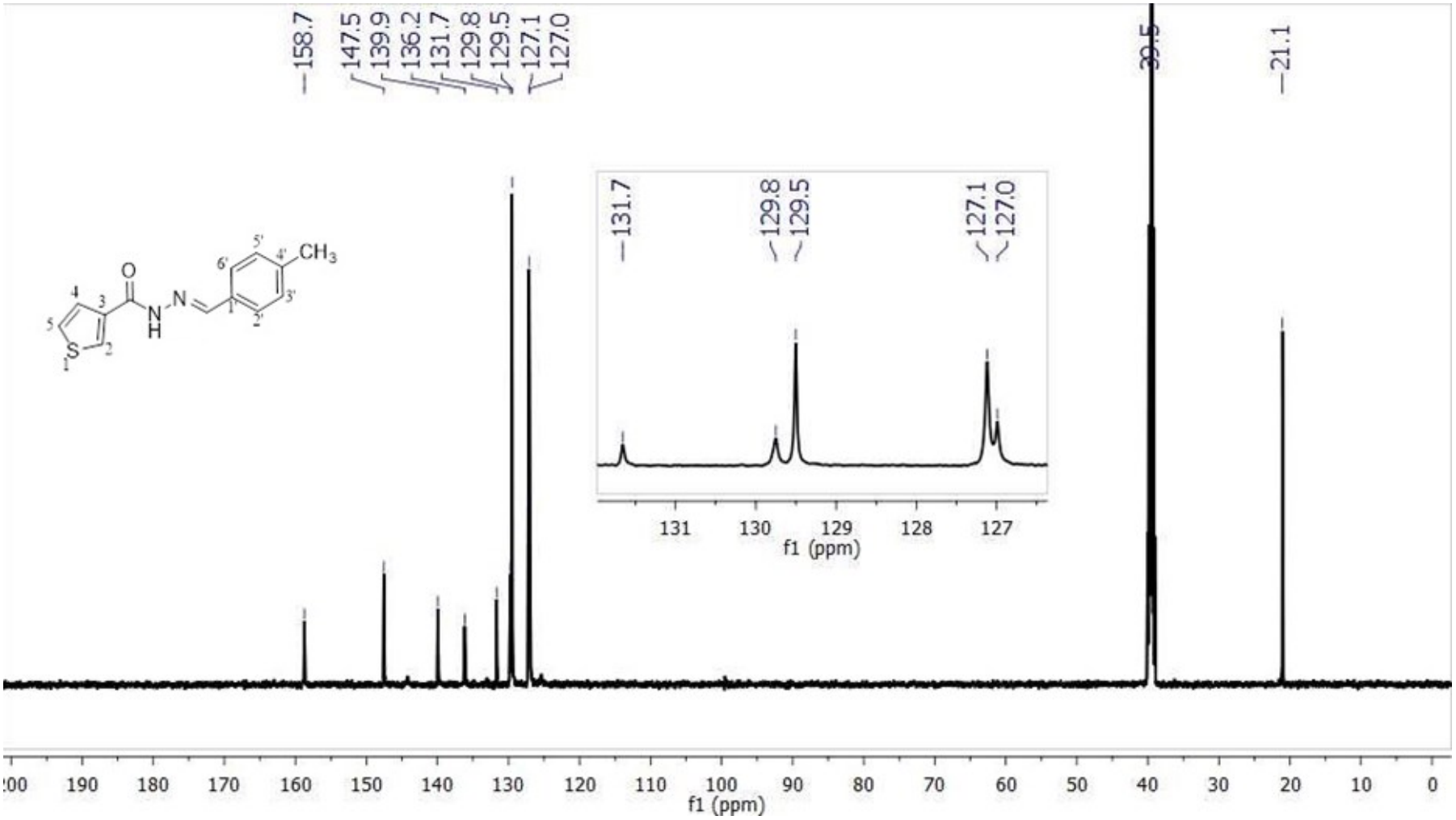
Spectrum 52 – Infrared spectrum (ATR) of compound **9**.



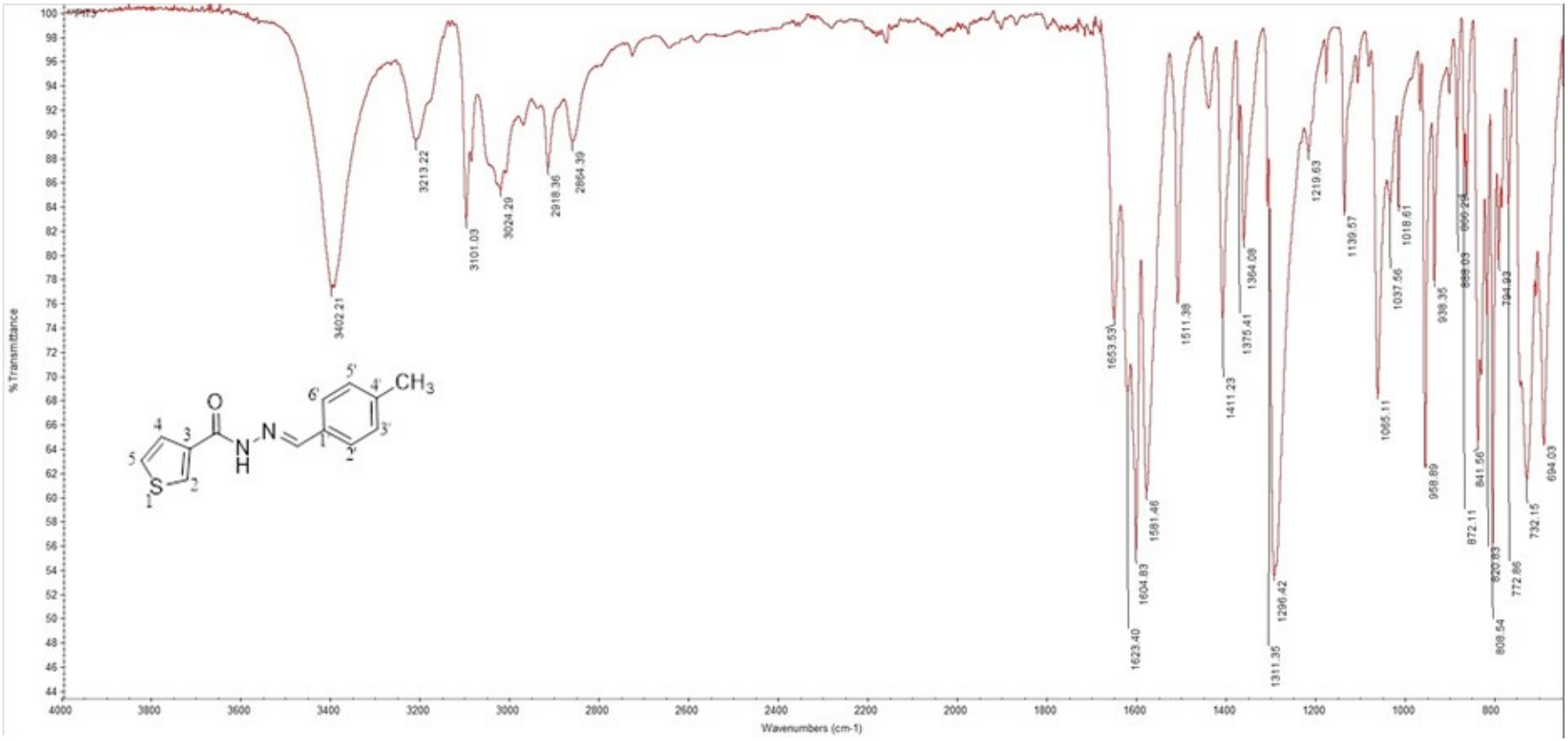
Spectrum 53 – High resolution mass spectrometry ($[M + H]^+$) of compound **9**.



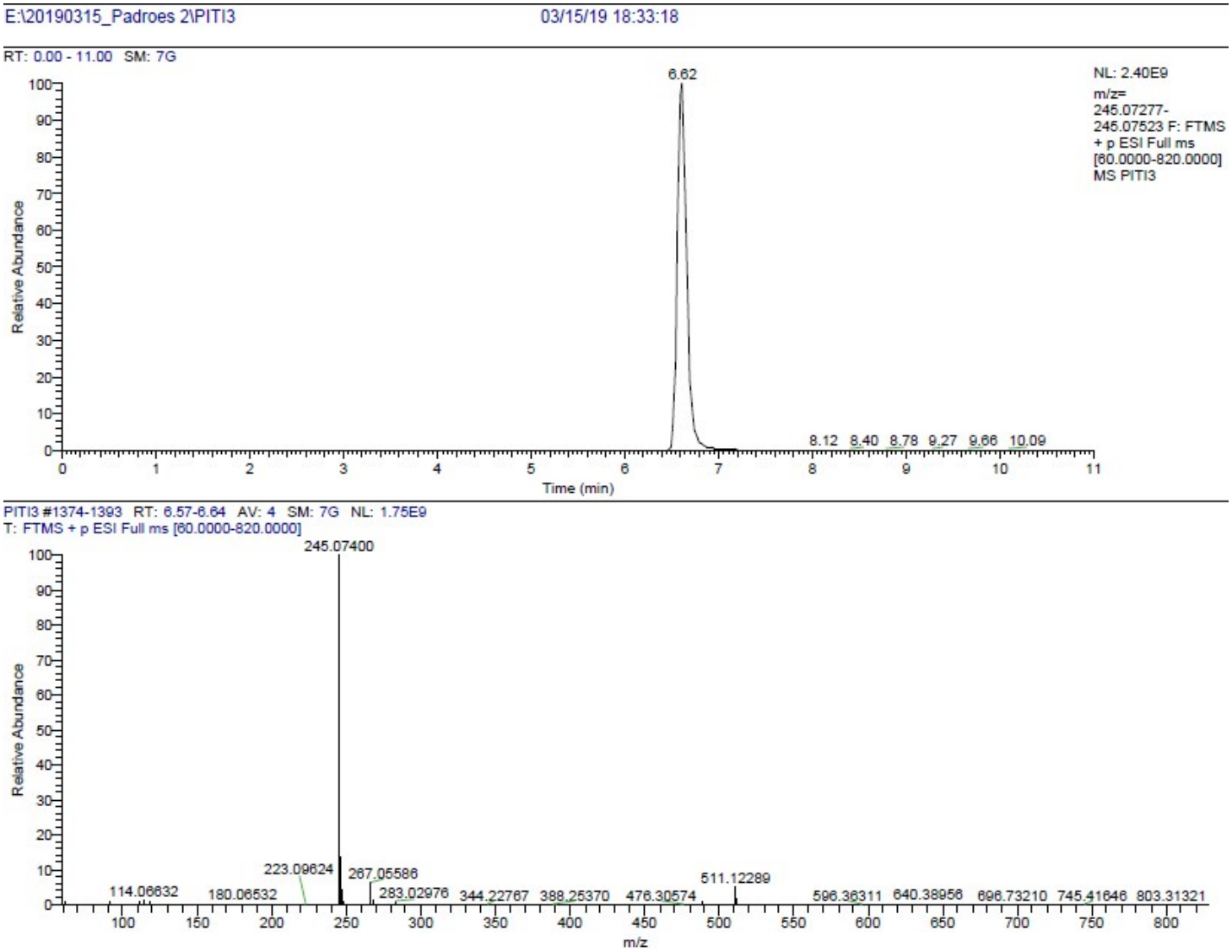
Spectrum 54 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **10** at 25ºC.



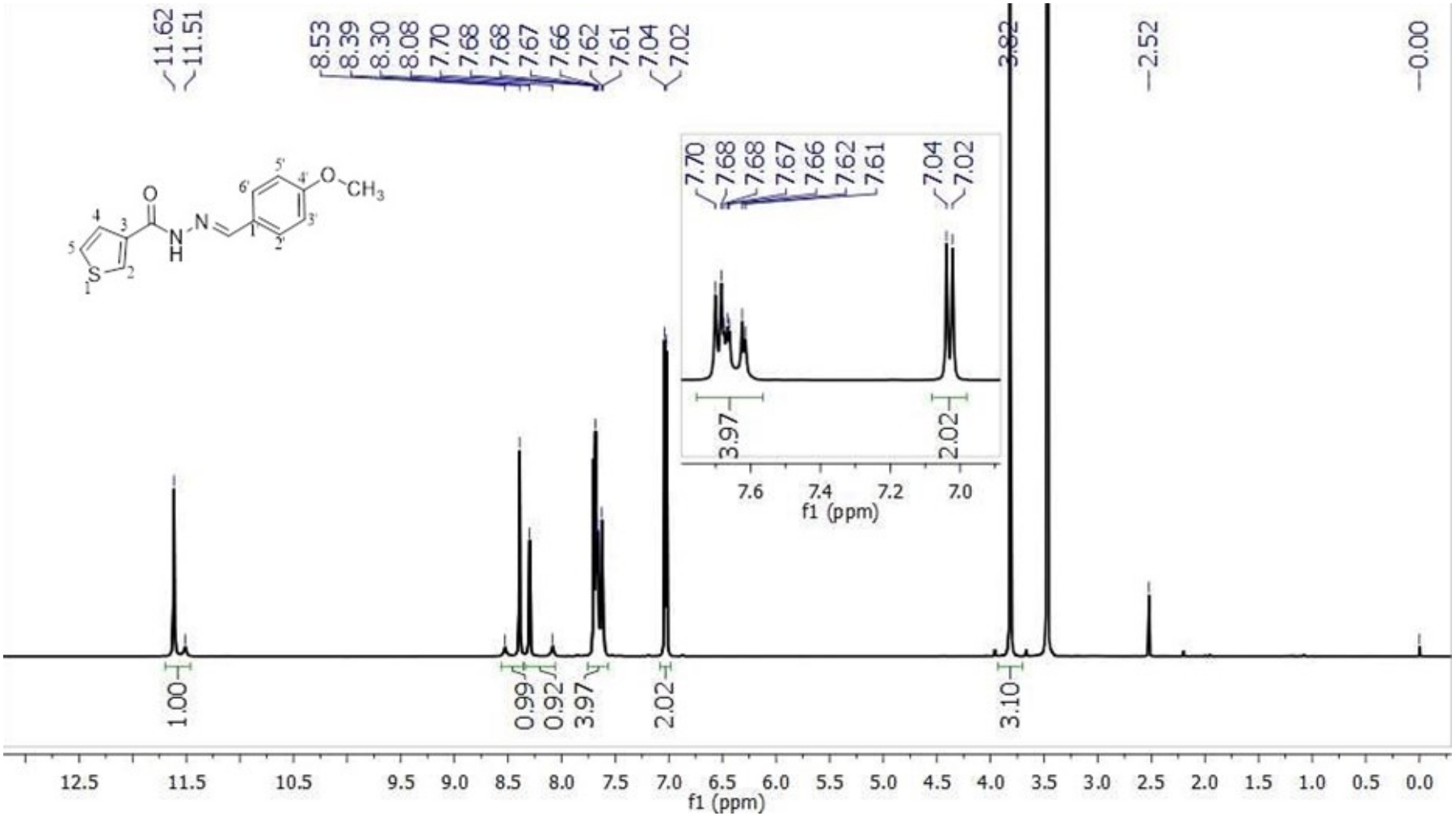
Spectrum 55 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **10** at 25ºC.



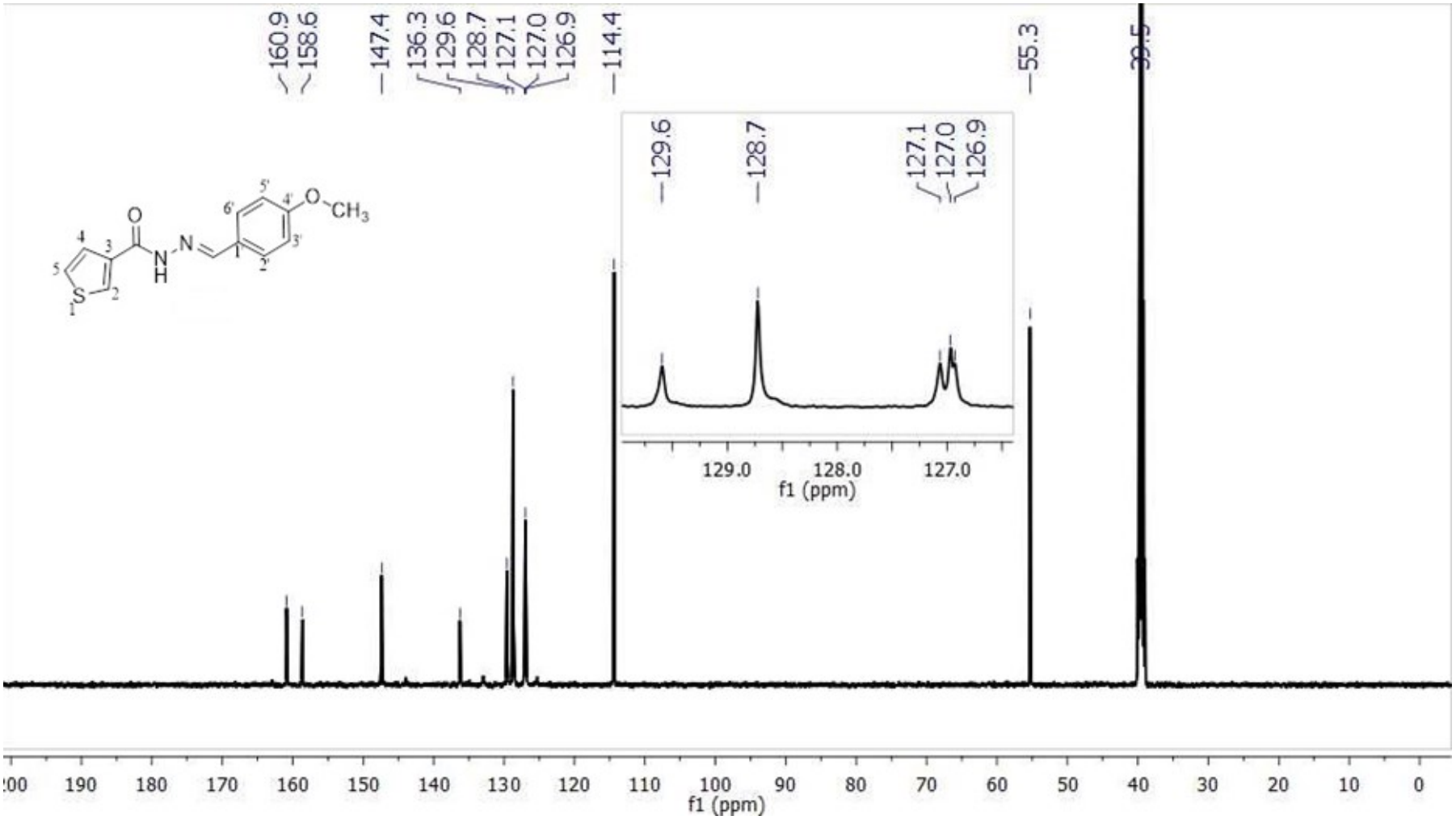
Spectrum 56 – Infrared spectrum (ATR) of compound **10**.



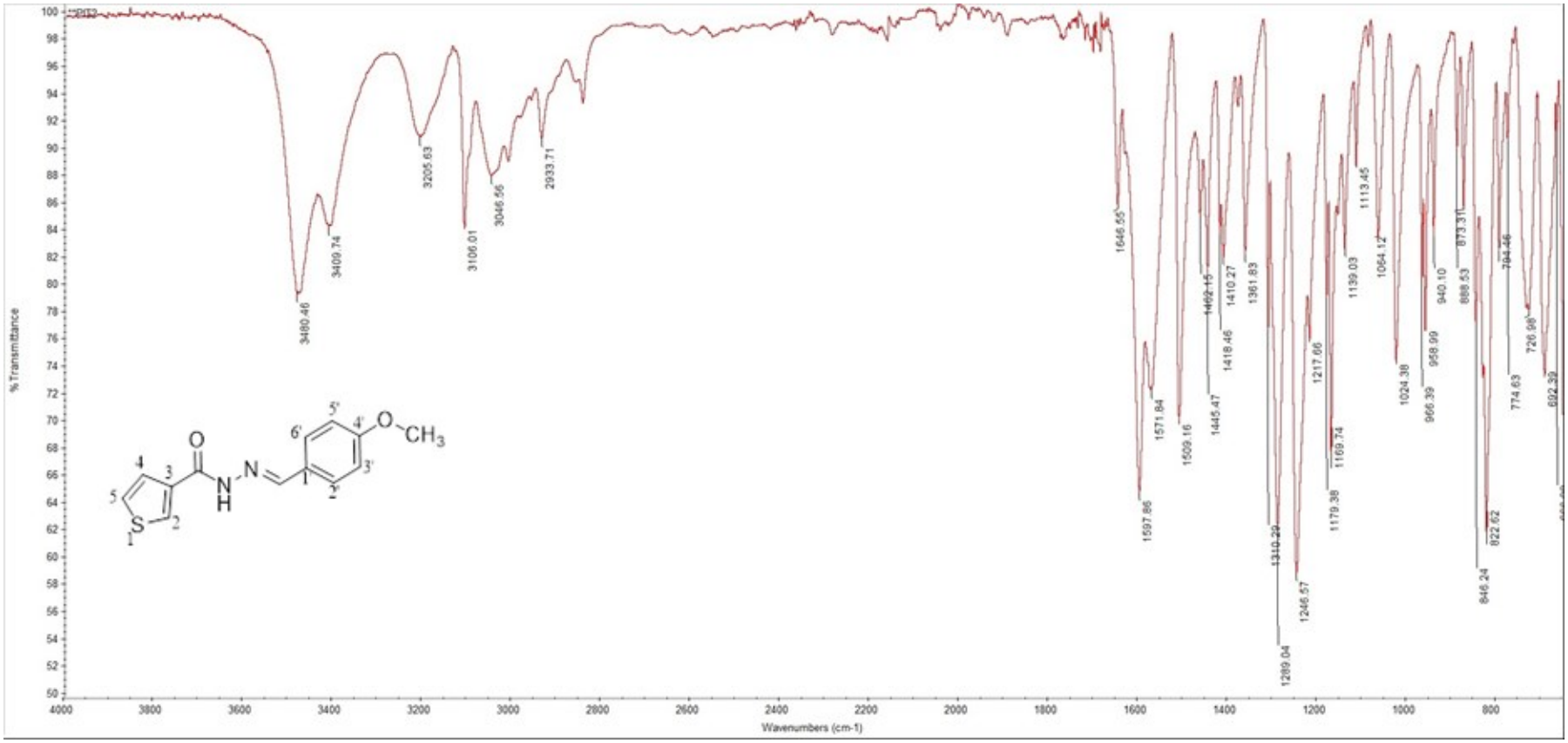
Spectrum 57 – High resolution mass spectrometry ($[M + H]^+$) of compound **10**.



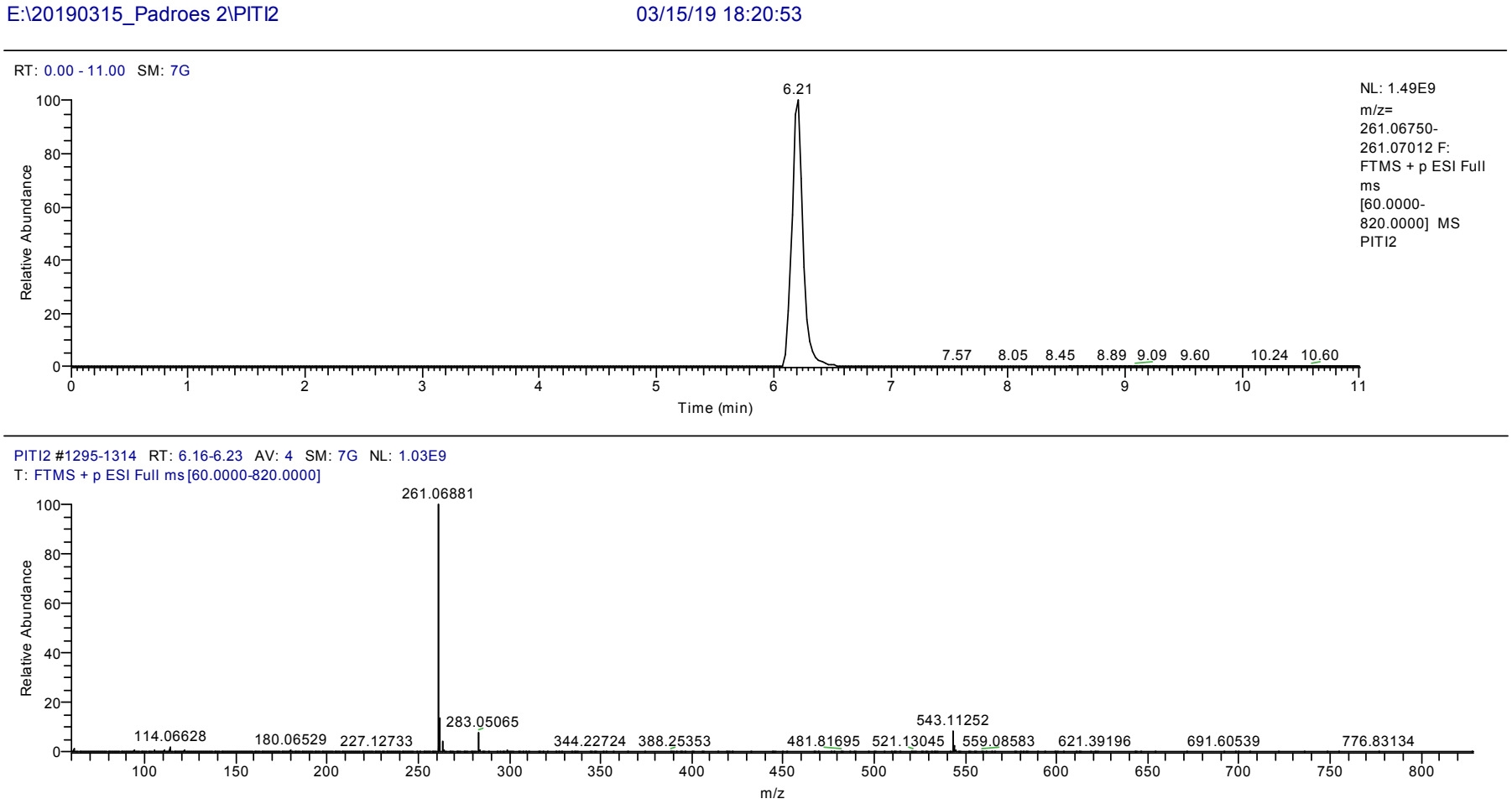
Spectrum 58 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **11** at 25ºC.



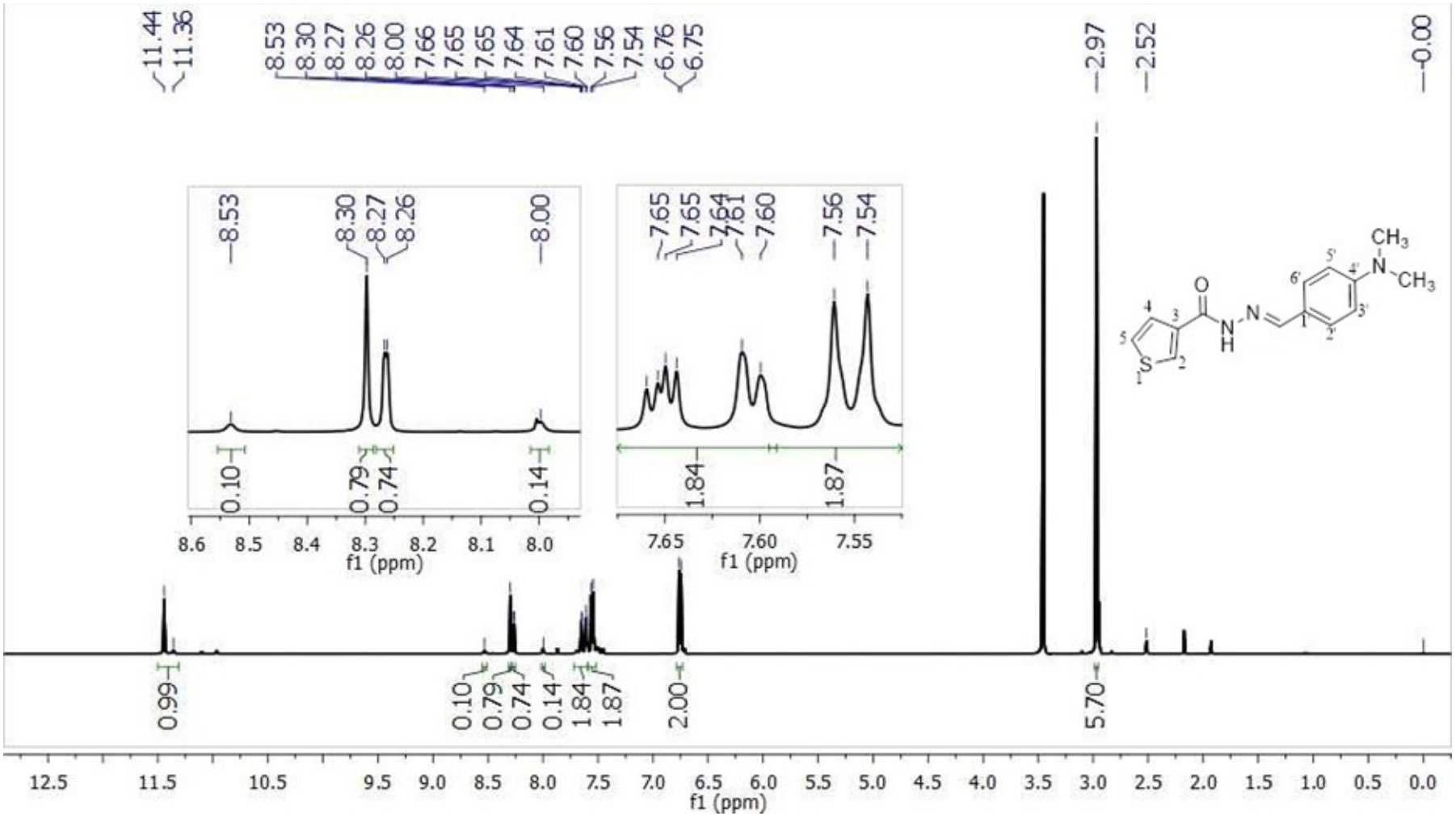
Spectrum 59 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **11** at 25ºC.



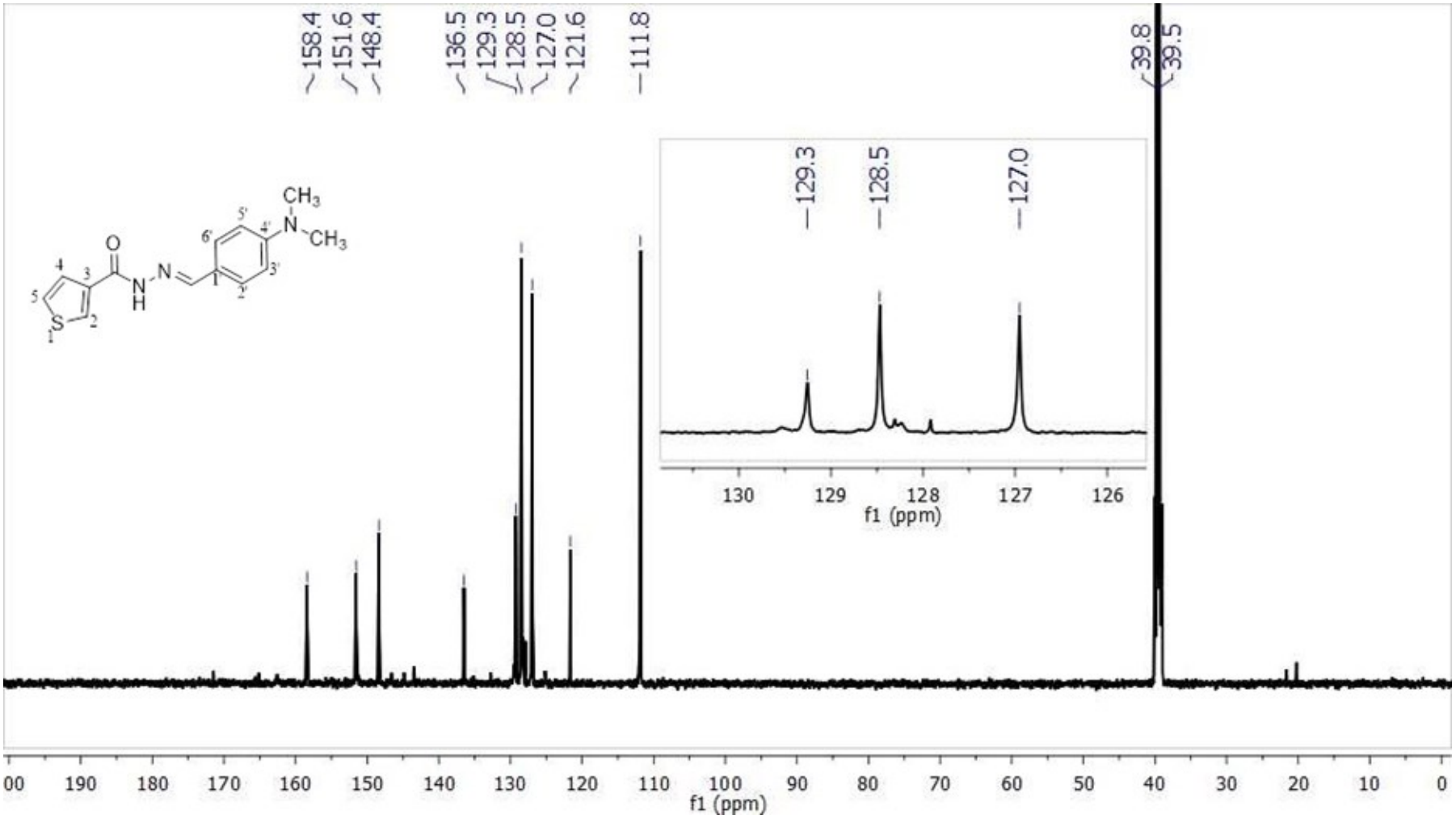
Spectrum 60 – Infrared spectrum (ATR) of compound **11**.



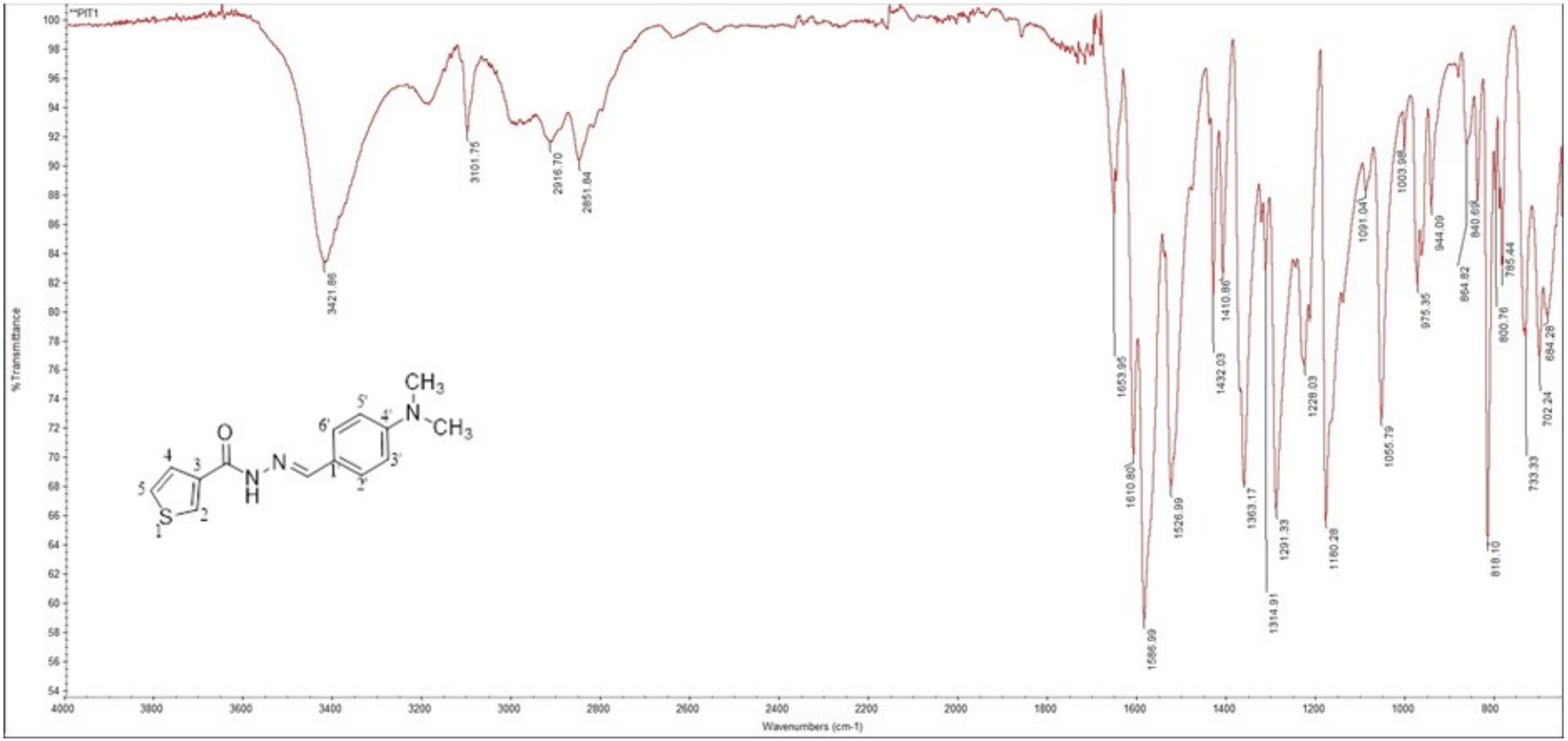
Spectrum 61 – High resolution mass spectrometry ($[M + H]^+$) of compound **11**.



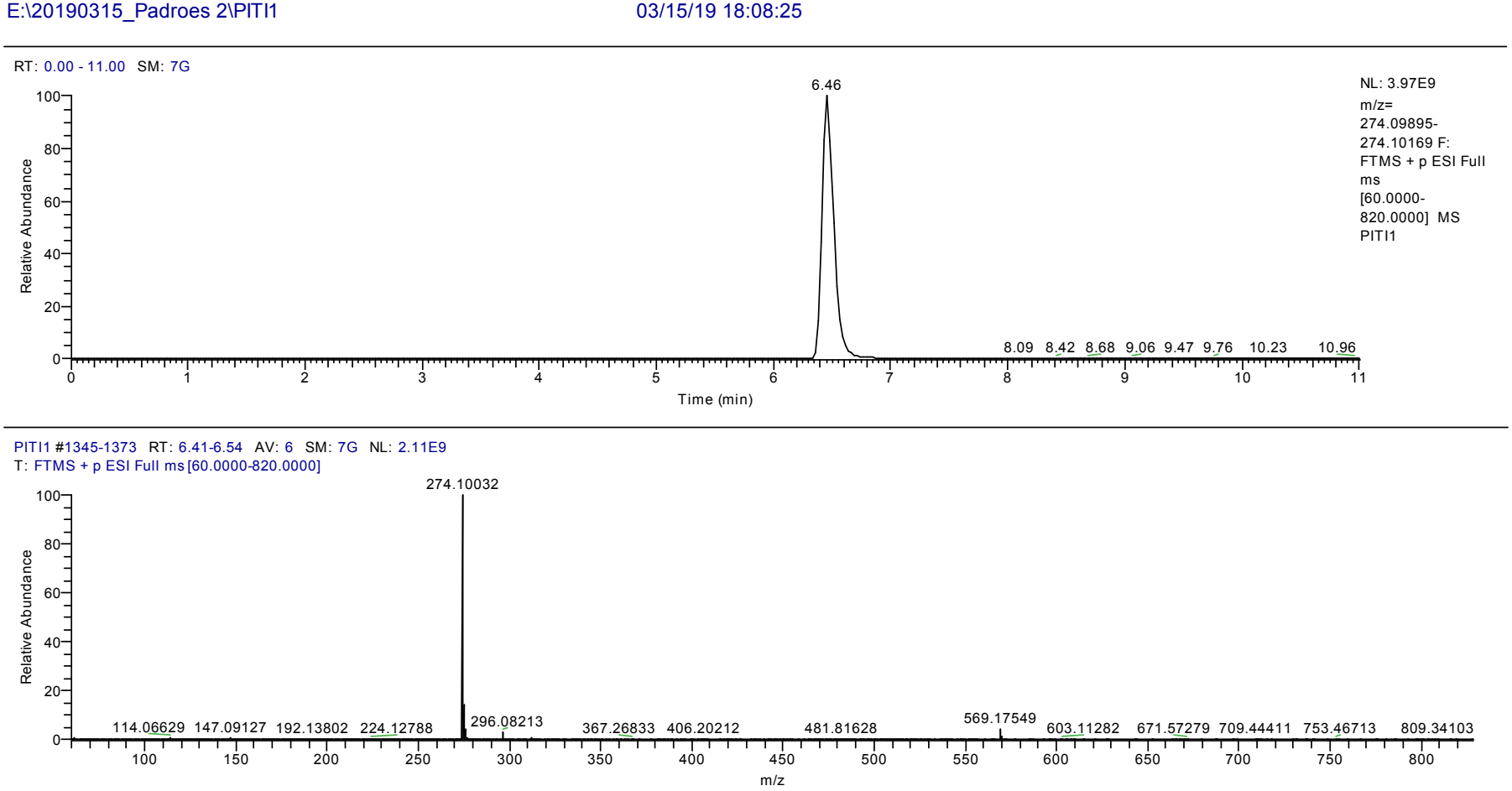
Spectrum 62 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **12** at 25ºC.



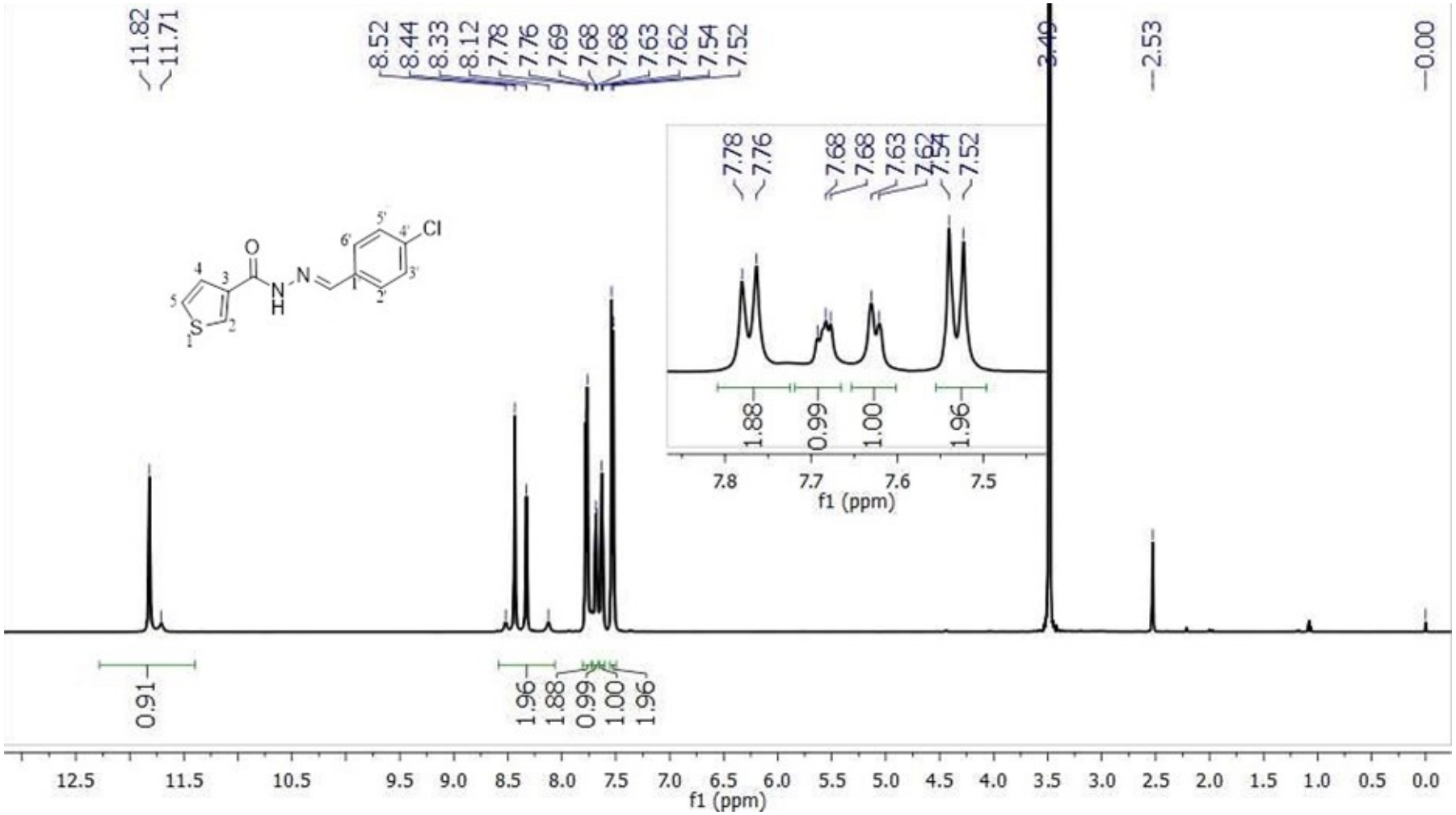
Spectrum 63 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **12** at 25ºC.



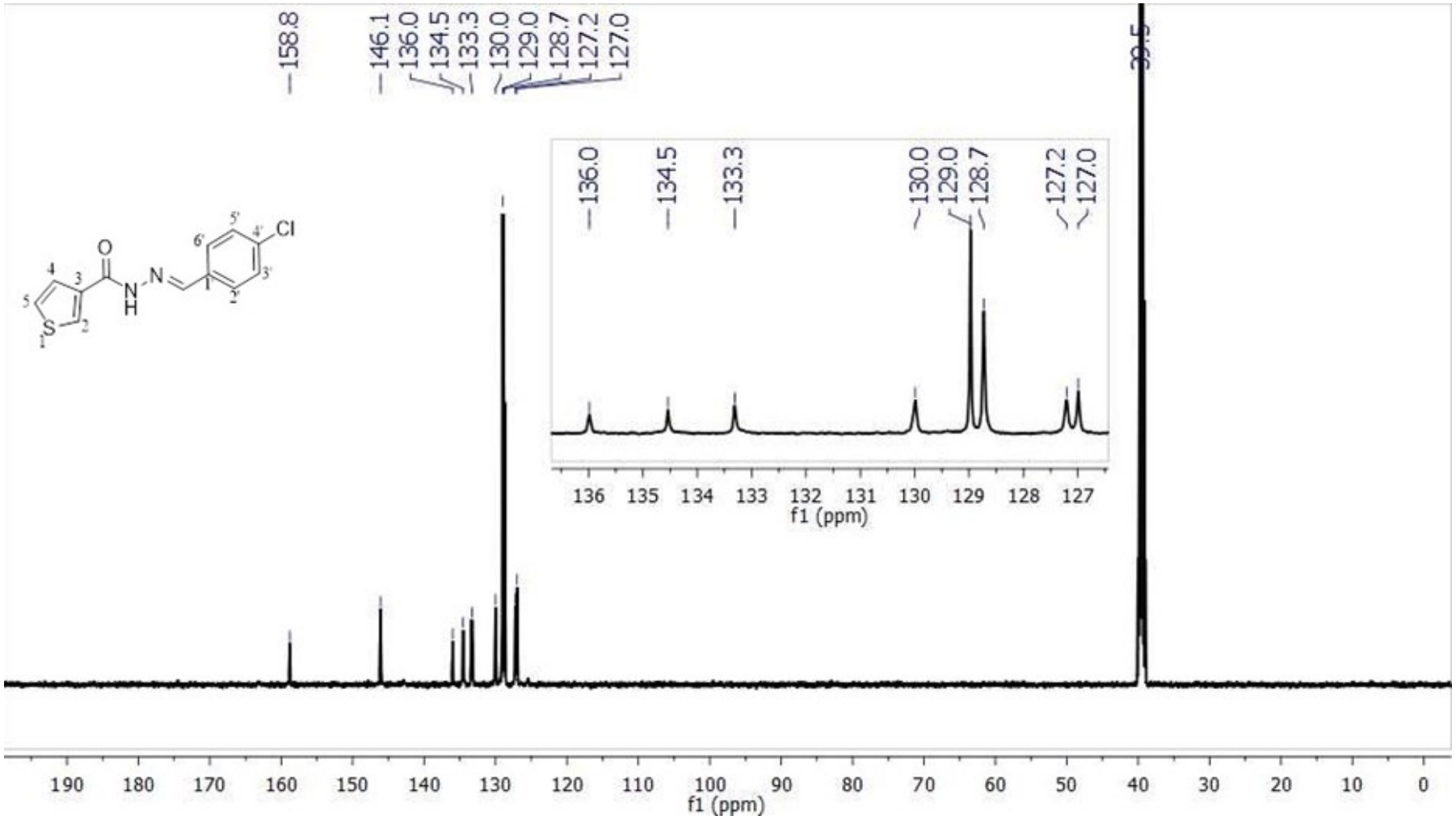
Spectrum 64 – Infrared spectrum (ATR) of compound **12**.



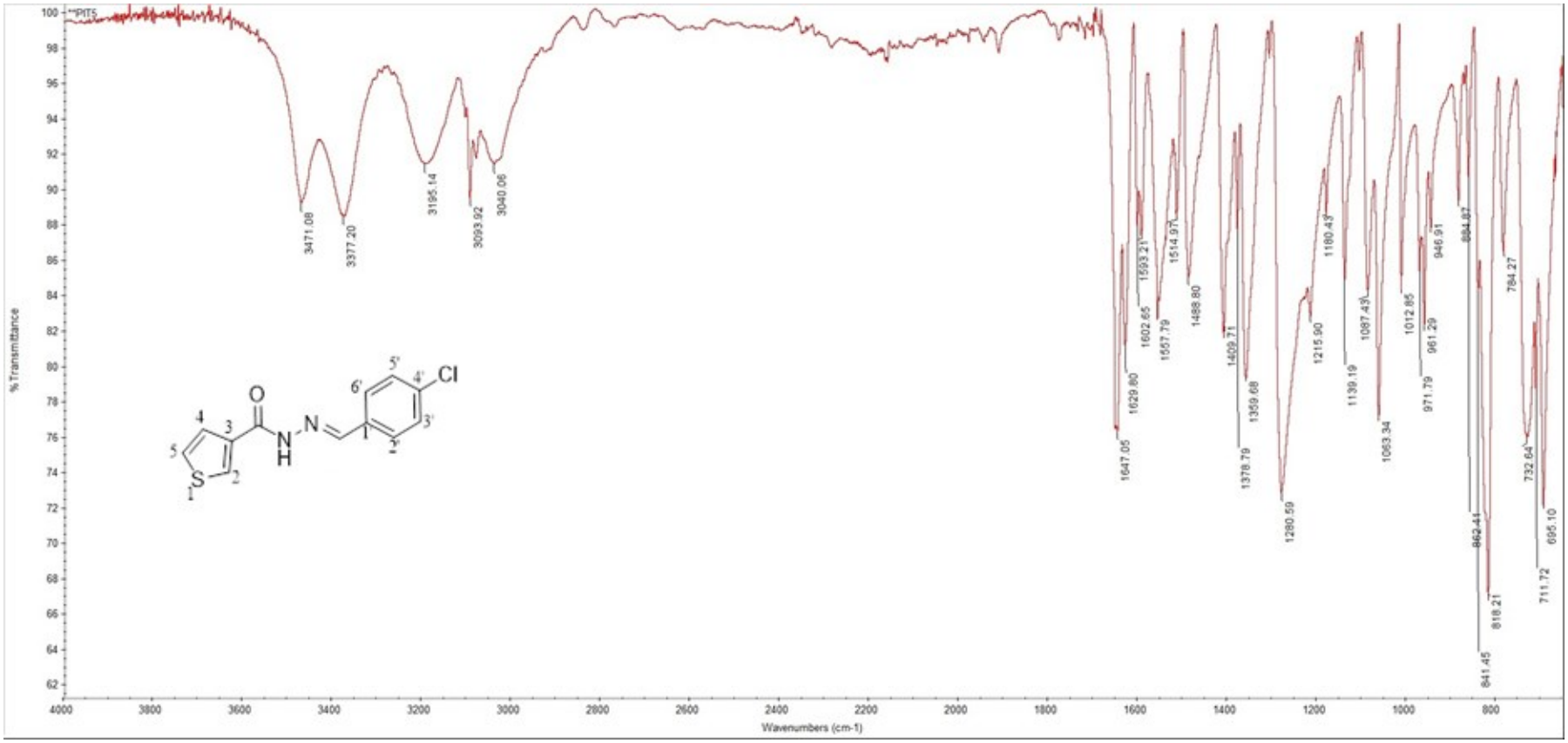
Spectrum 65 – High resolution mass spectrometry ($[M + H]^+$) of compound **12**.



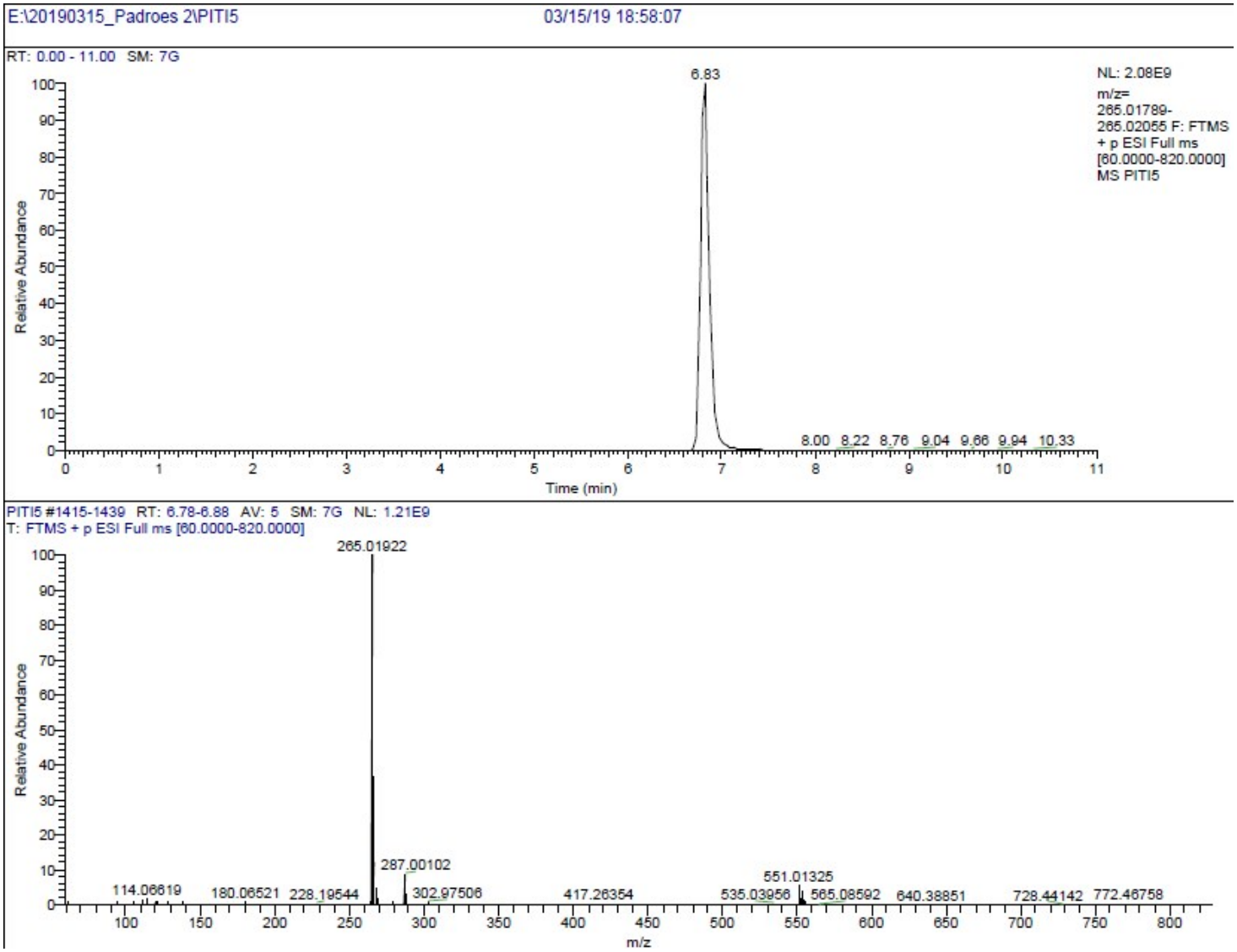
Spectrum 66 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **13** at 25ºC.



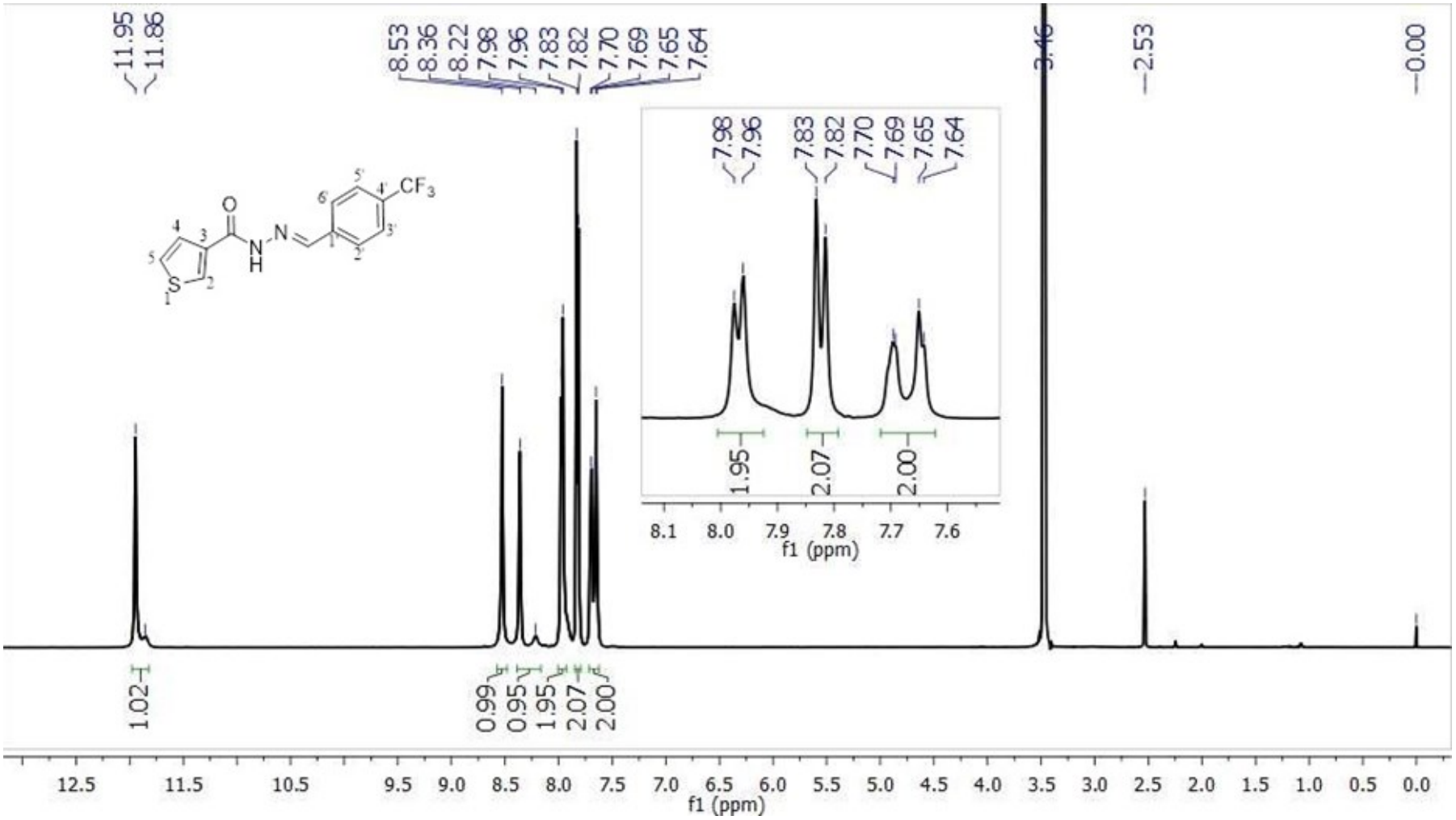
Spectrum 67 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **13** at 25ºC.



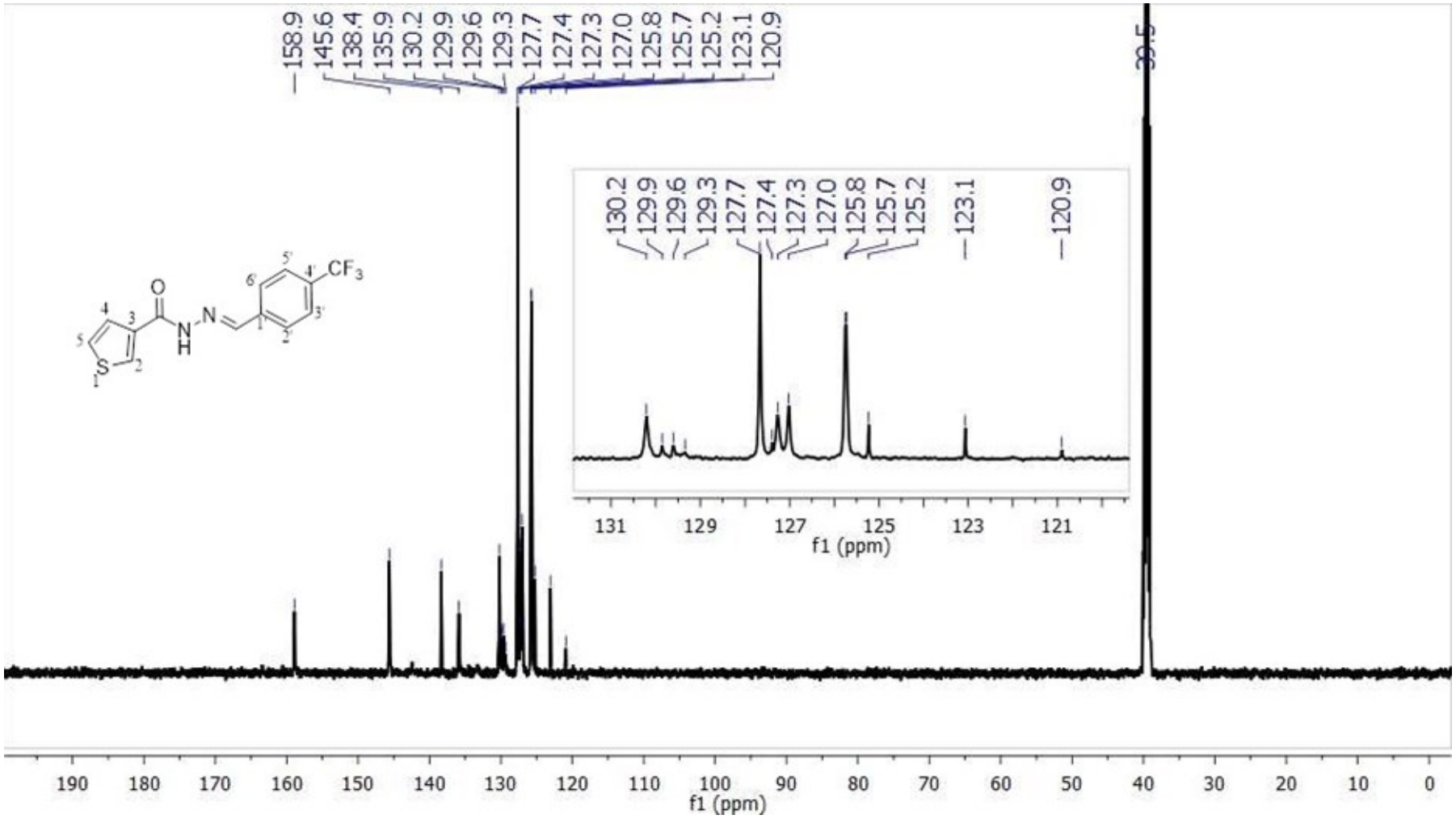
Spectrum 68 – Infrared spectrum (ATR) of compound **13**.



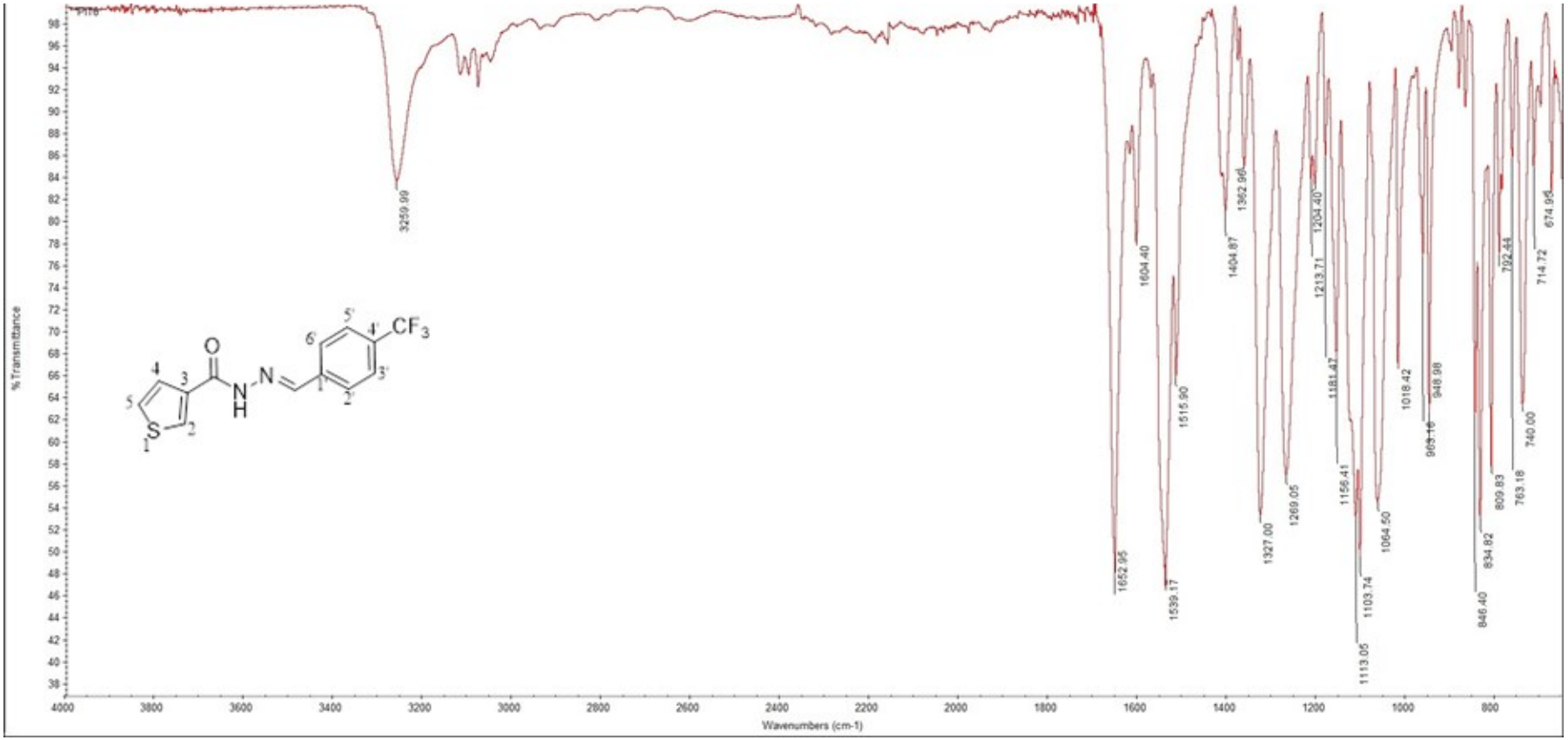
Spectrum 69 – High resolution mass spectrometry ($[M + H]^+$) of compound **13**.



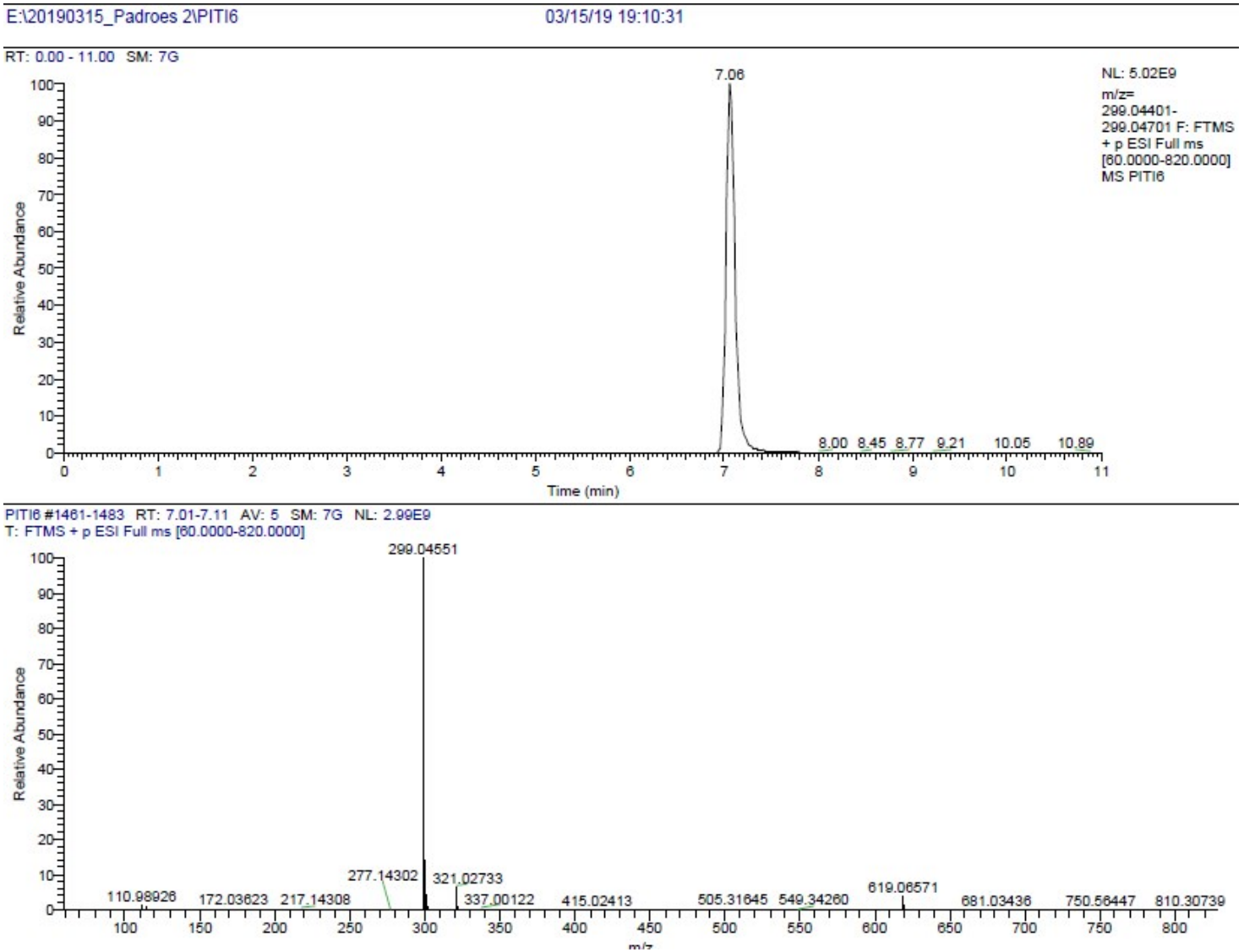
Spectrum 70 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **14** at 25ºC.



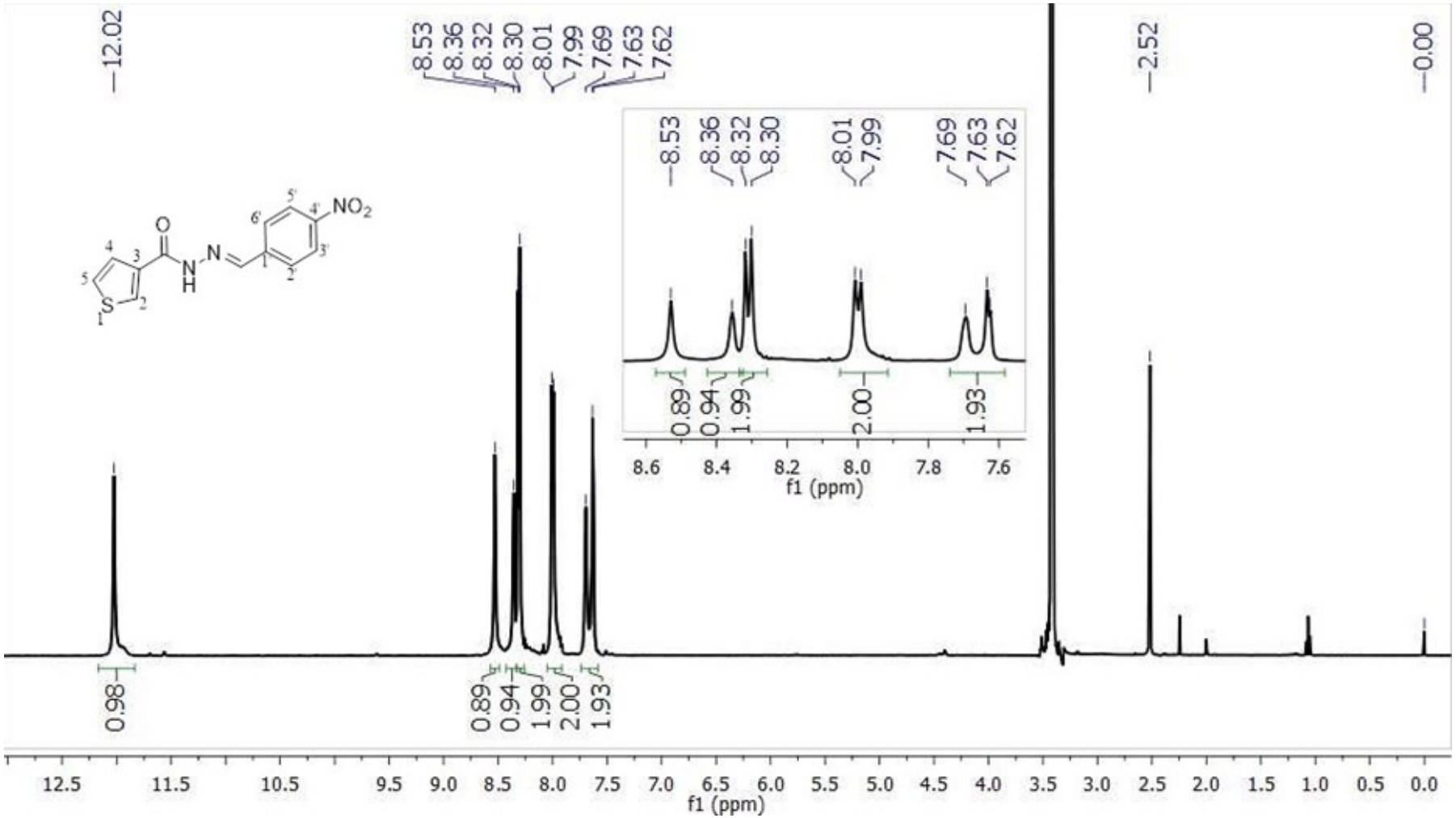
Spectrum 71 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **14** at 25ºC.



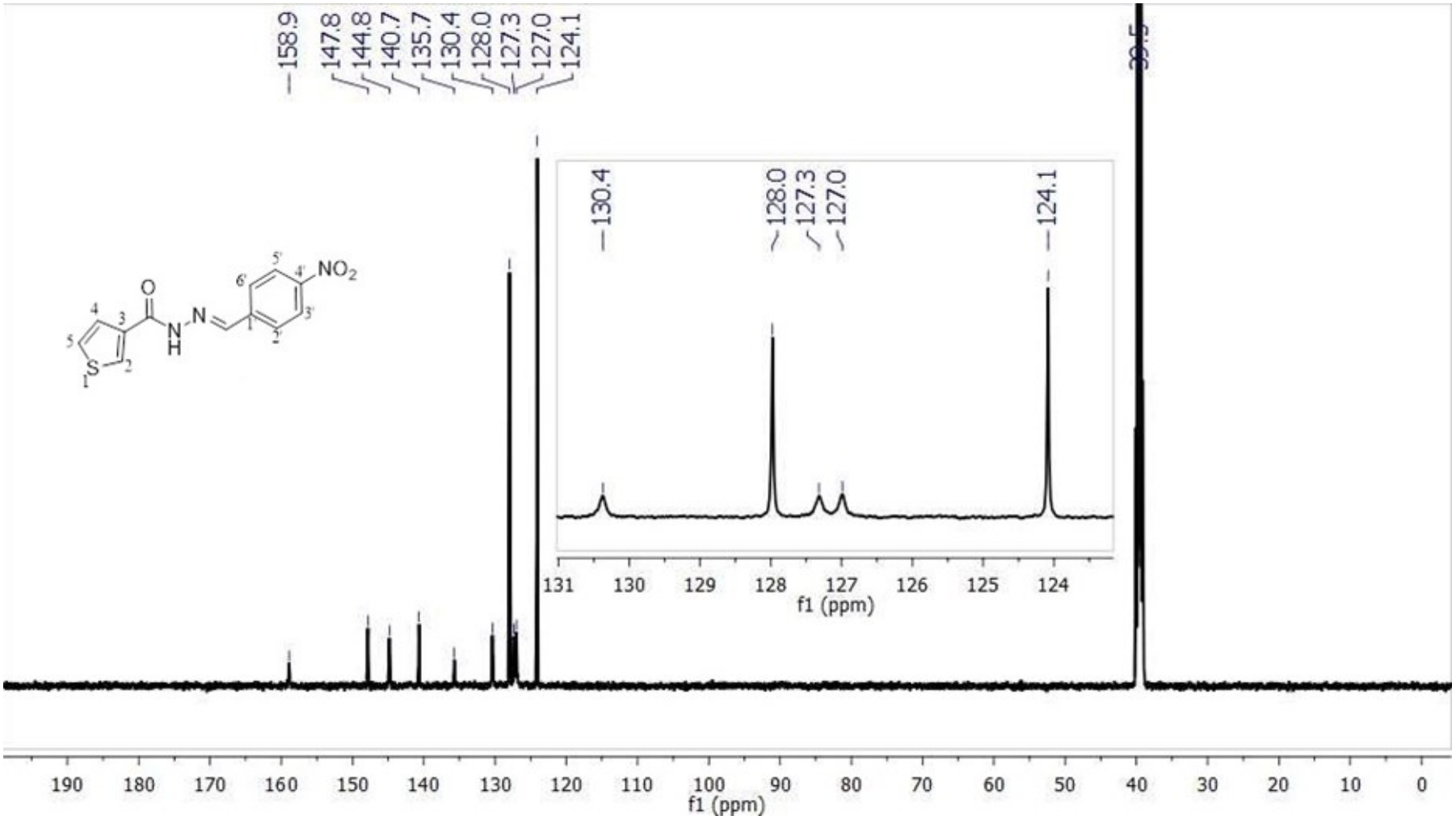
Spectrum 72 – Infrared spectrum (ATR) of compound **14**.



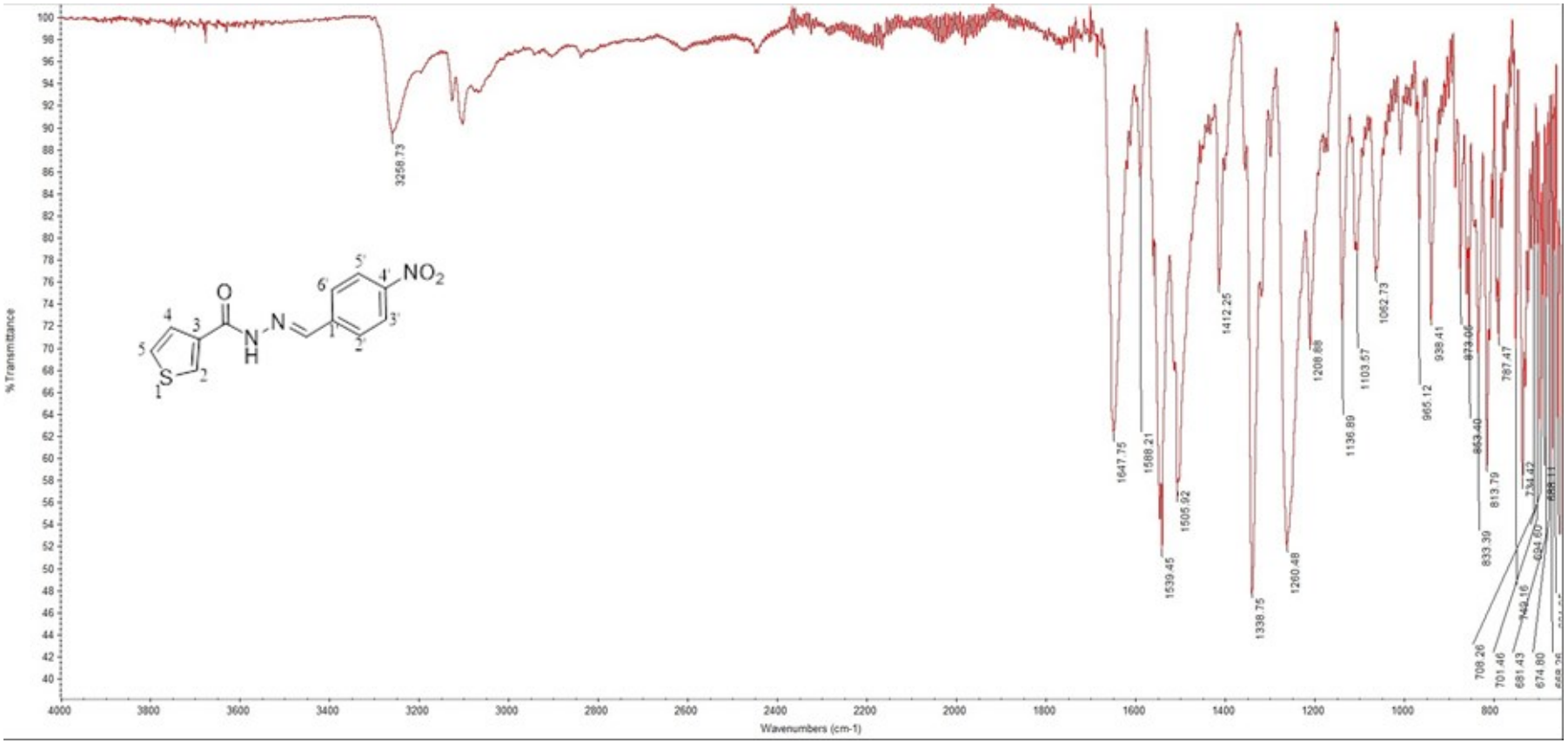
Spectrum 73 – High resolution mass spectrometry ($[M + H]^+$) of compound **14**.



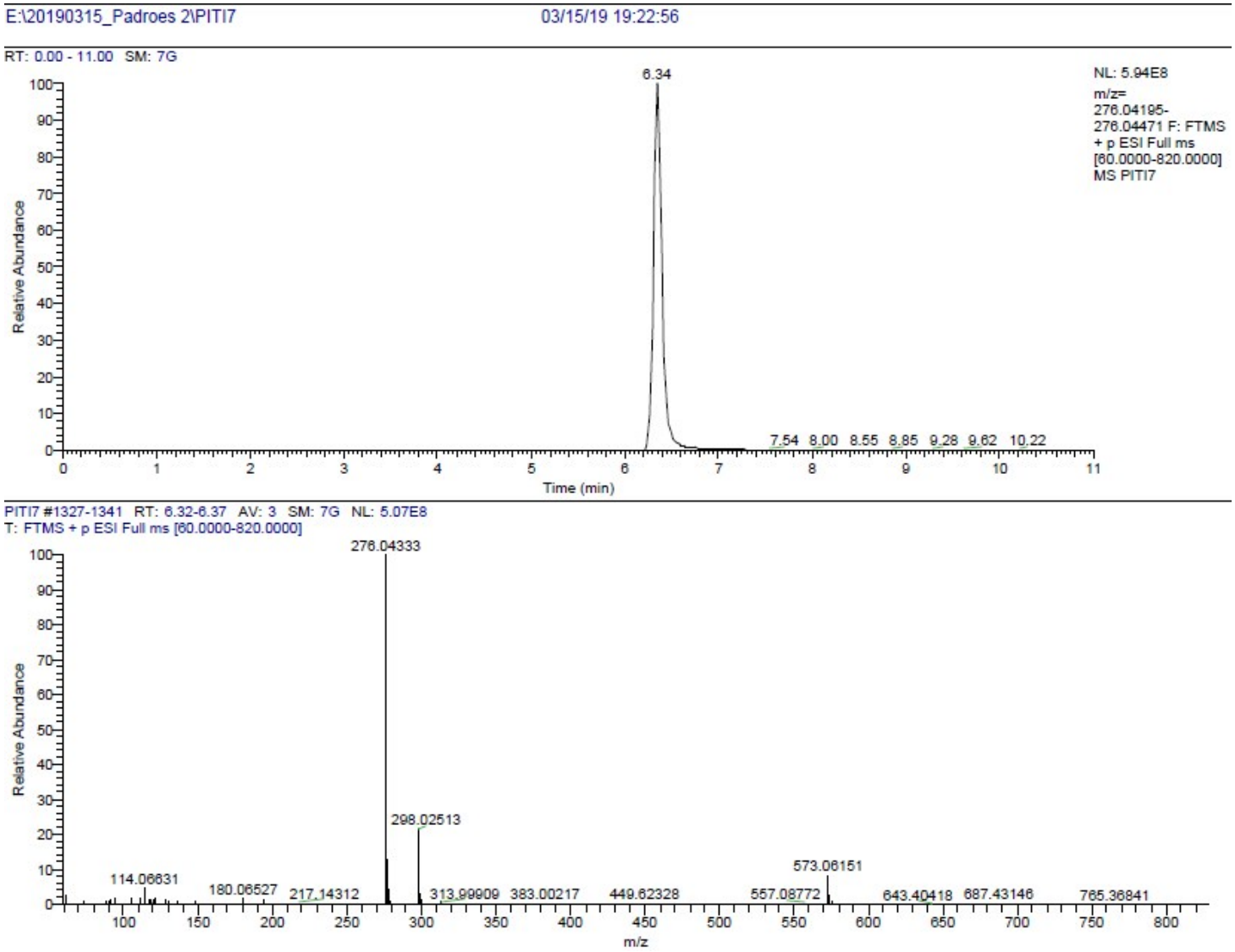
Spectrum 74 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **15** at 25ºC.



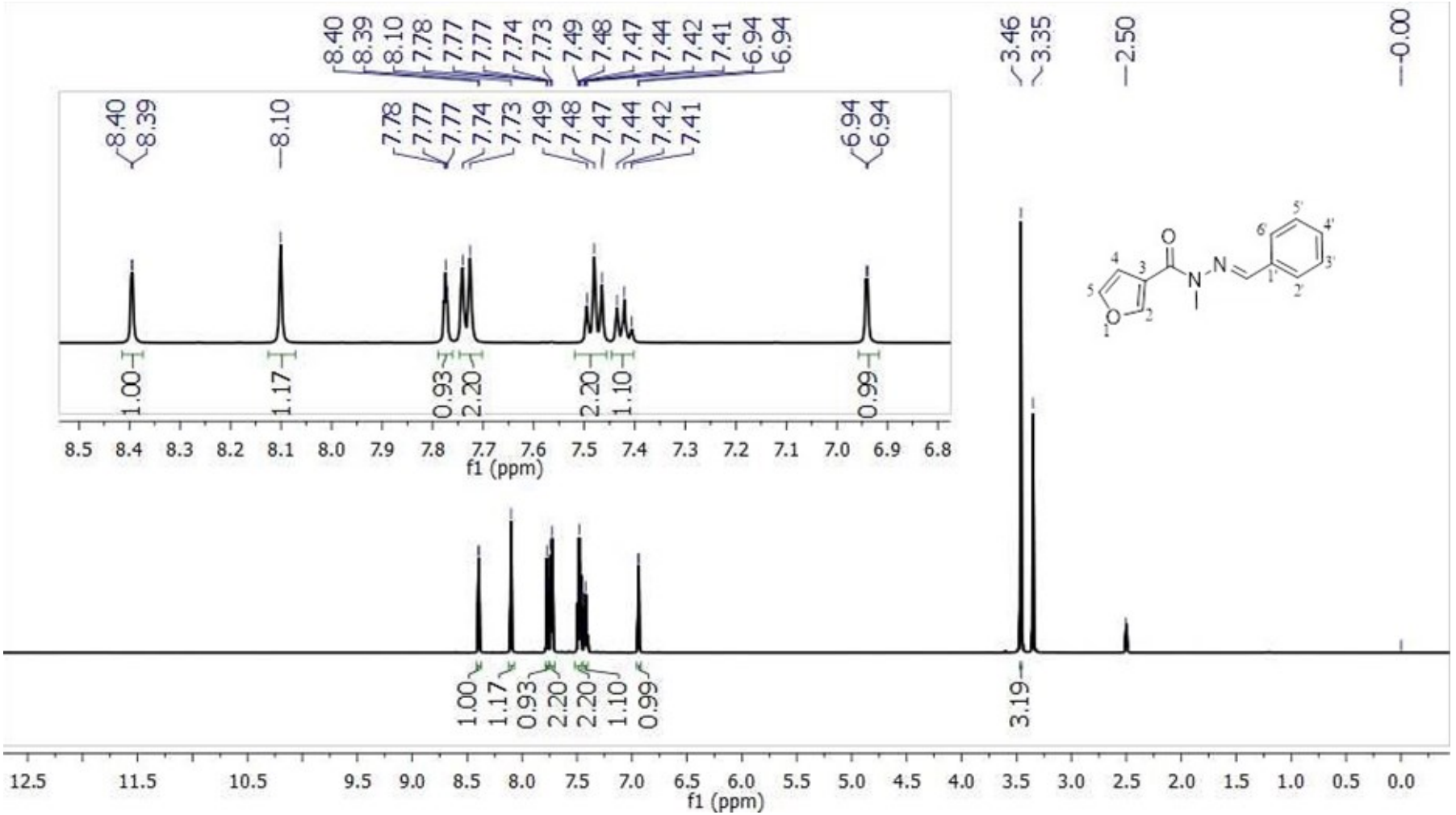
Spectrum 75 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **15** at 25ºC.



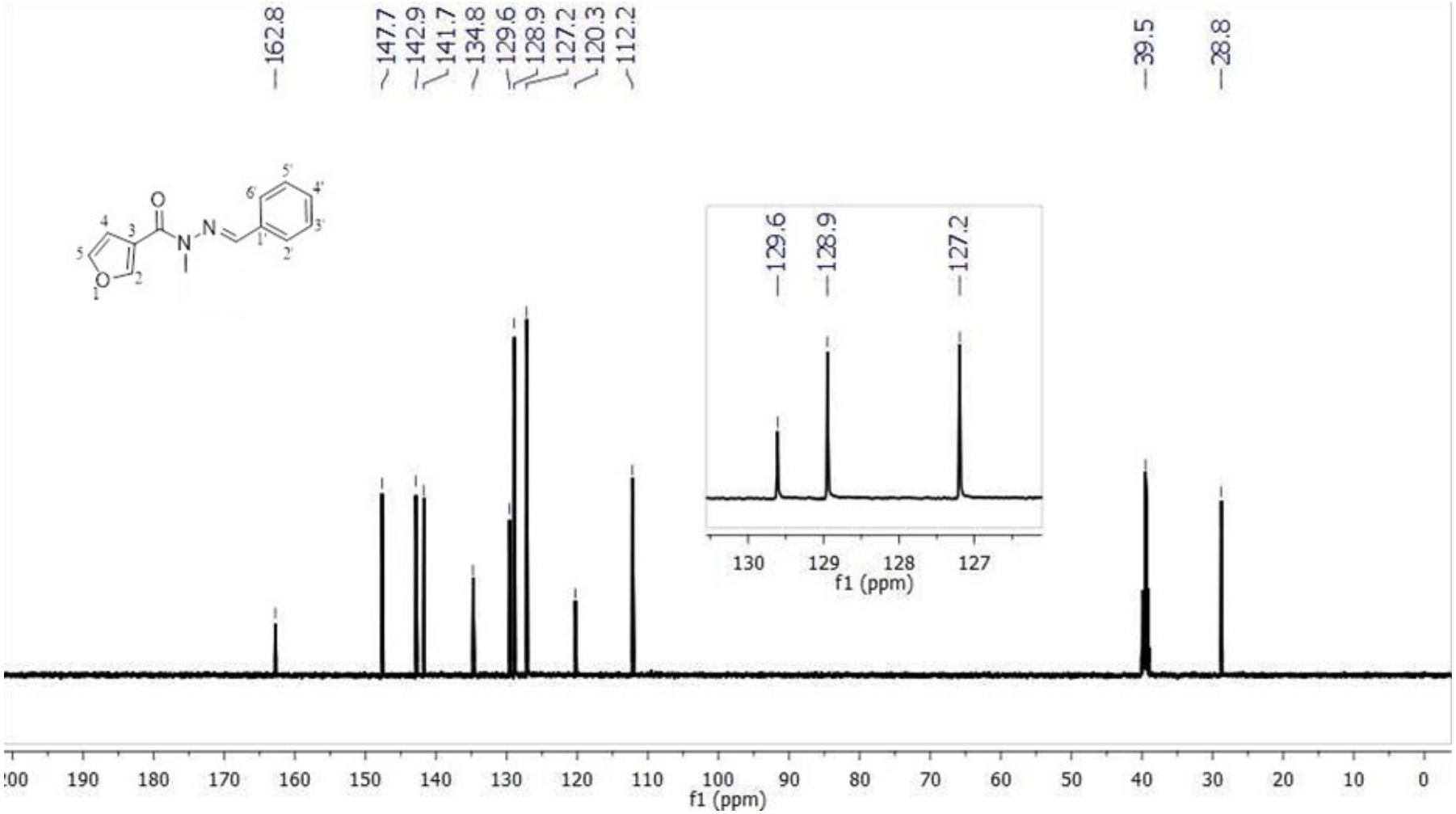
Spectrum 76 – Infrared spectrum (ATR) of compound **15**.



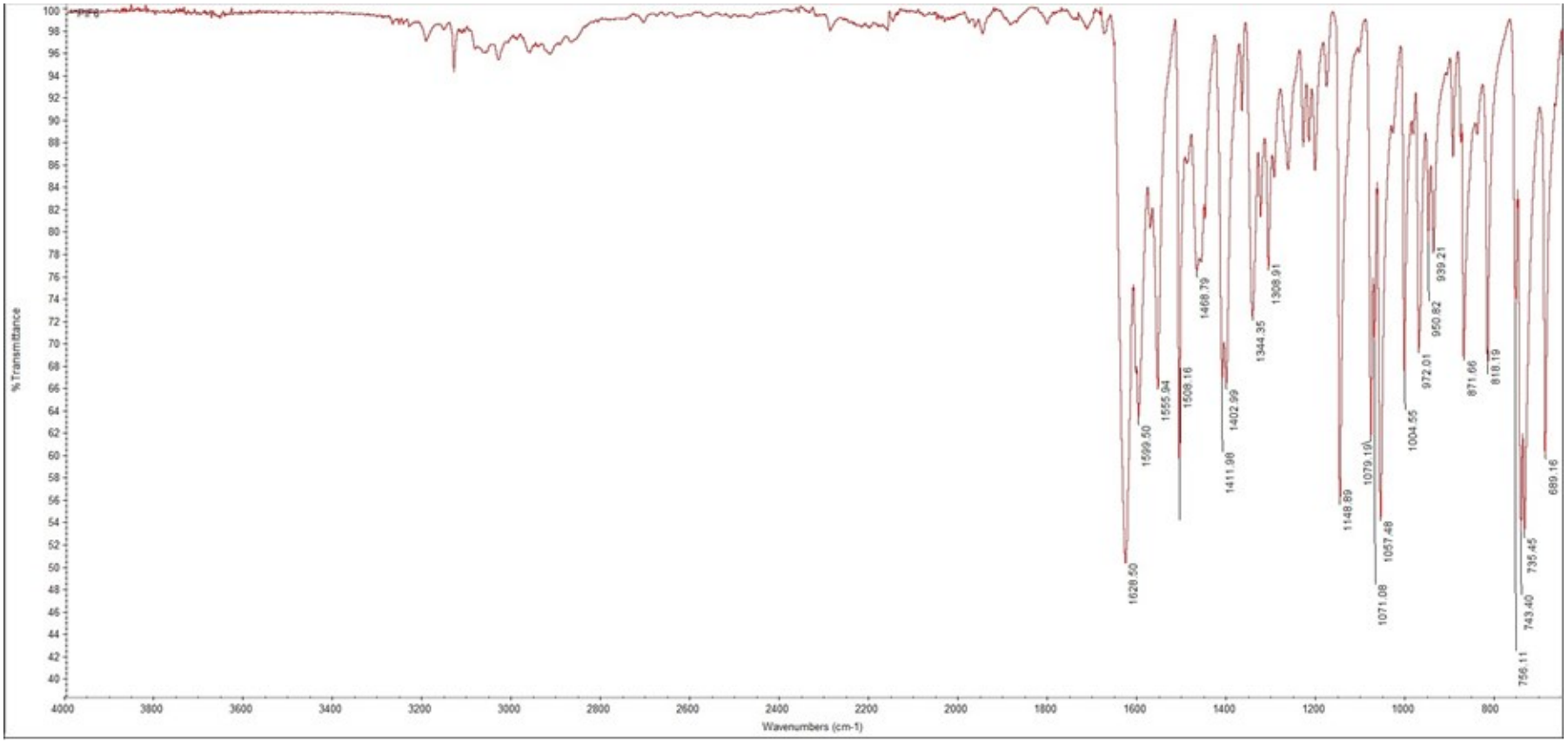
Spectrum 77 – High resolution mass spectrometry ($[M + H]^+$) of compound **15**.



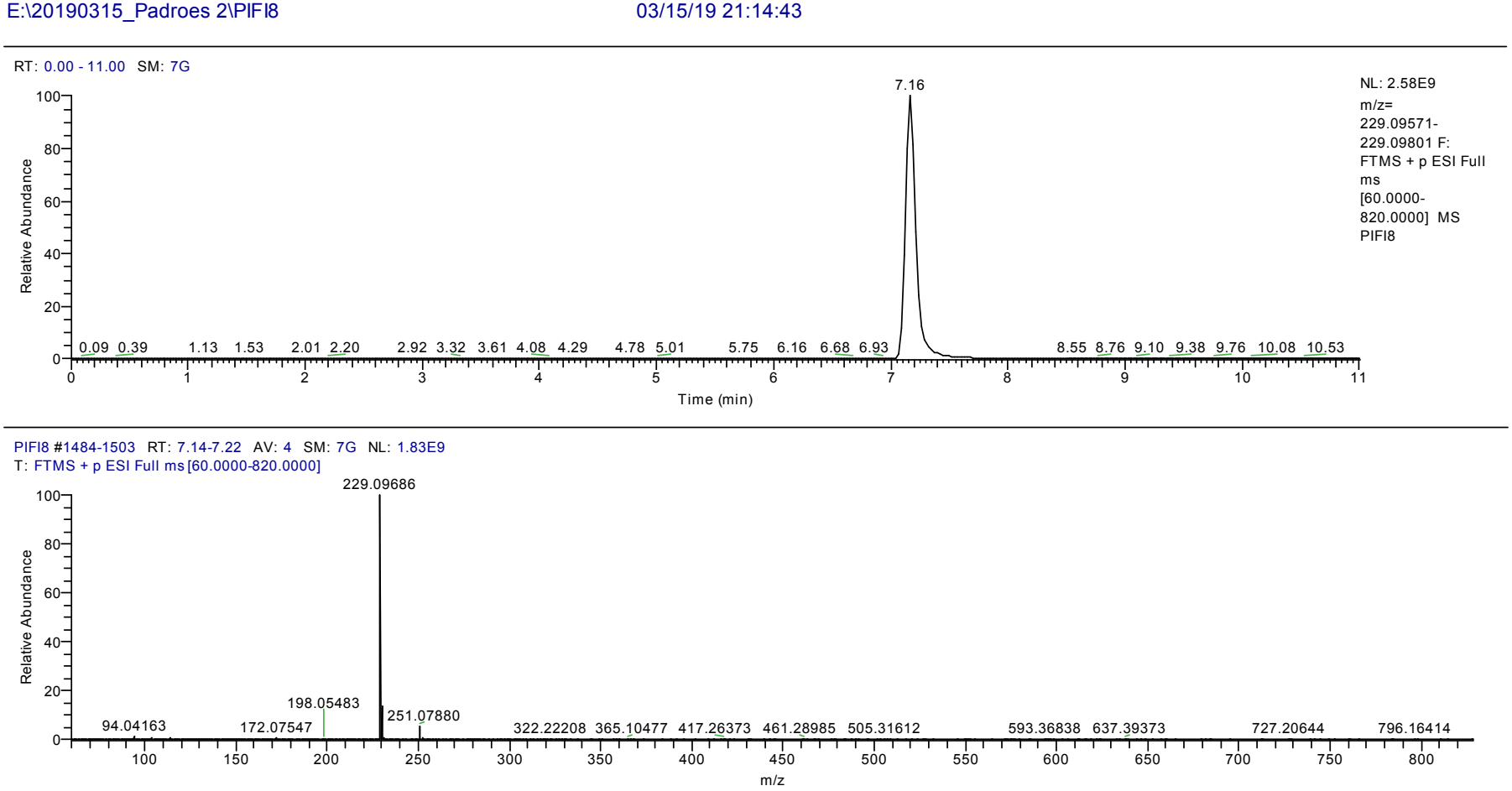
Spectrum 78 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **16** at 25ºC.



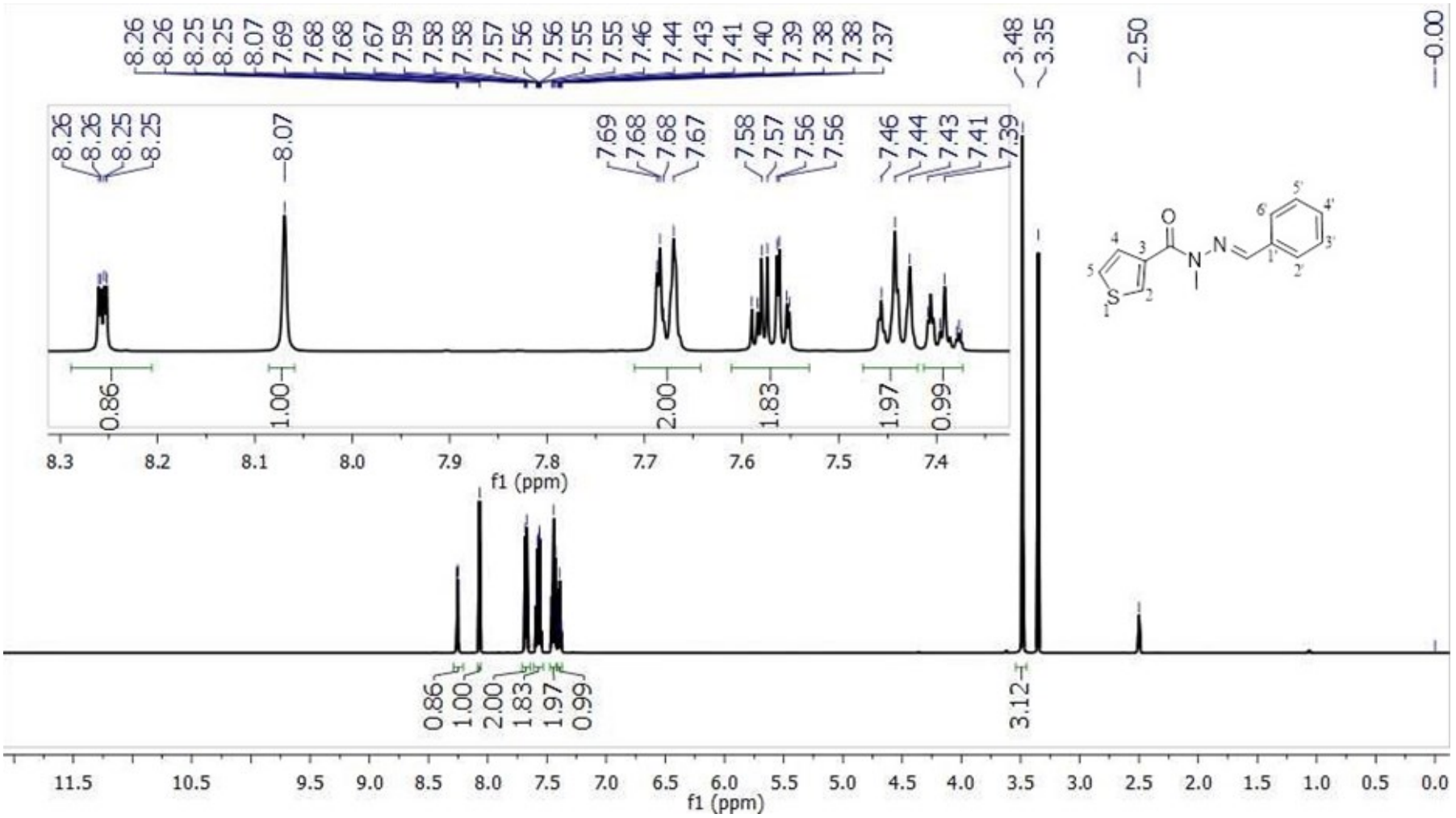
Spectrum 79 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **16** at 25ºC.



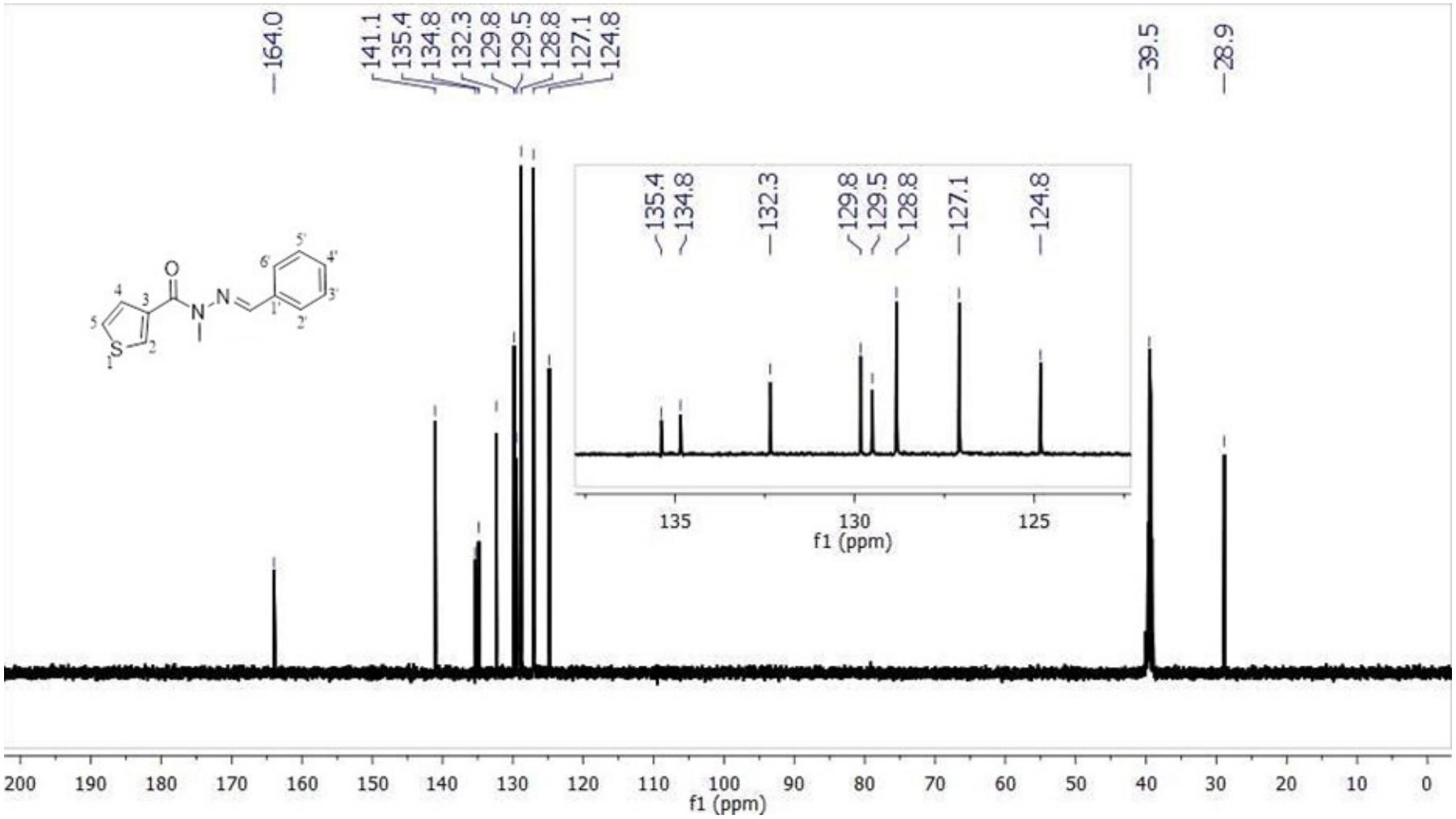
Spectrum 80 – Infrared spectrum (ATR) of compound **16**.



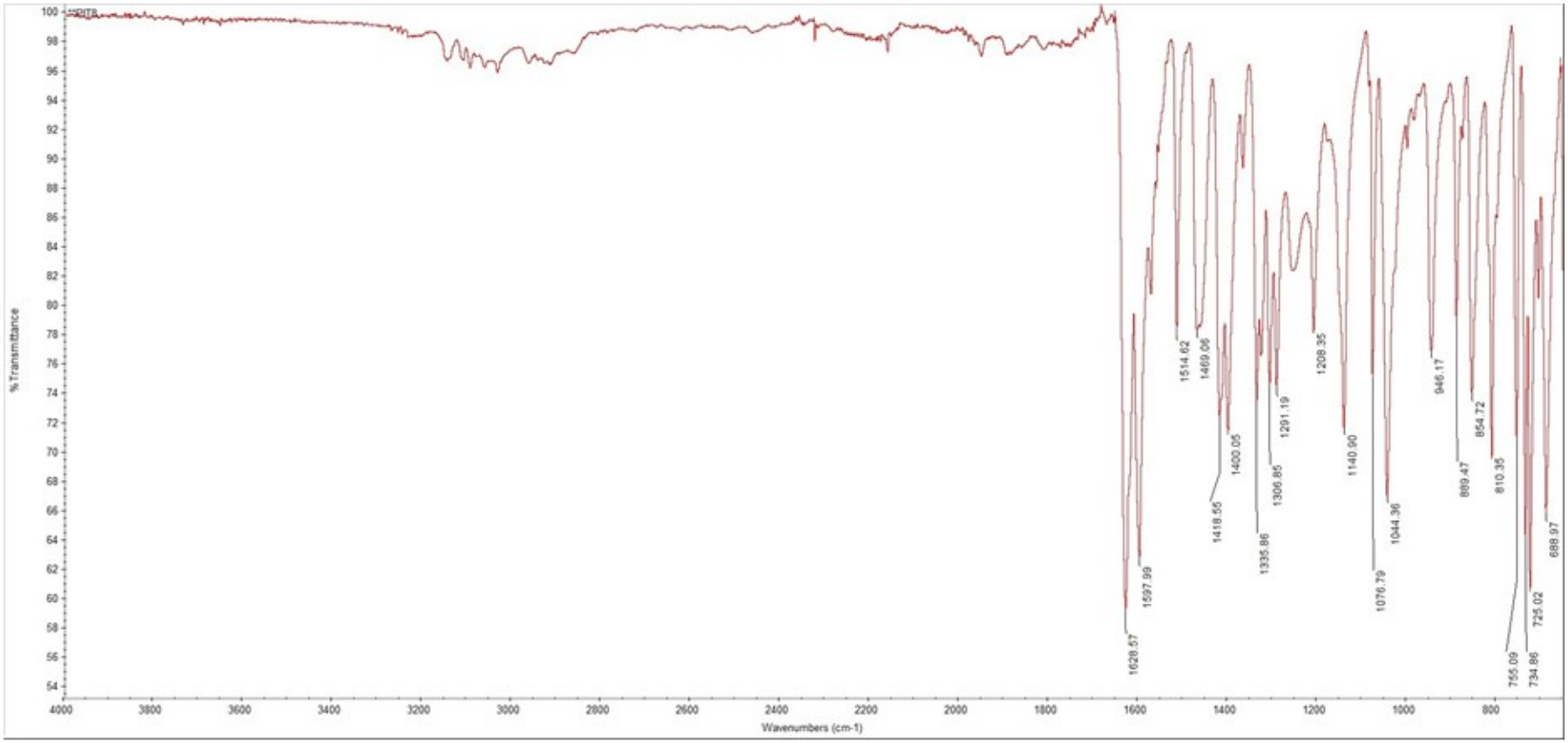
Spectrum 81 – High resolution mass spectrometry ($[M + H]^+$) of compound **16**.



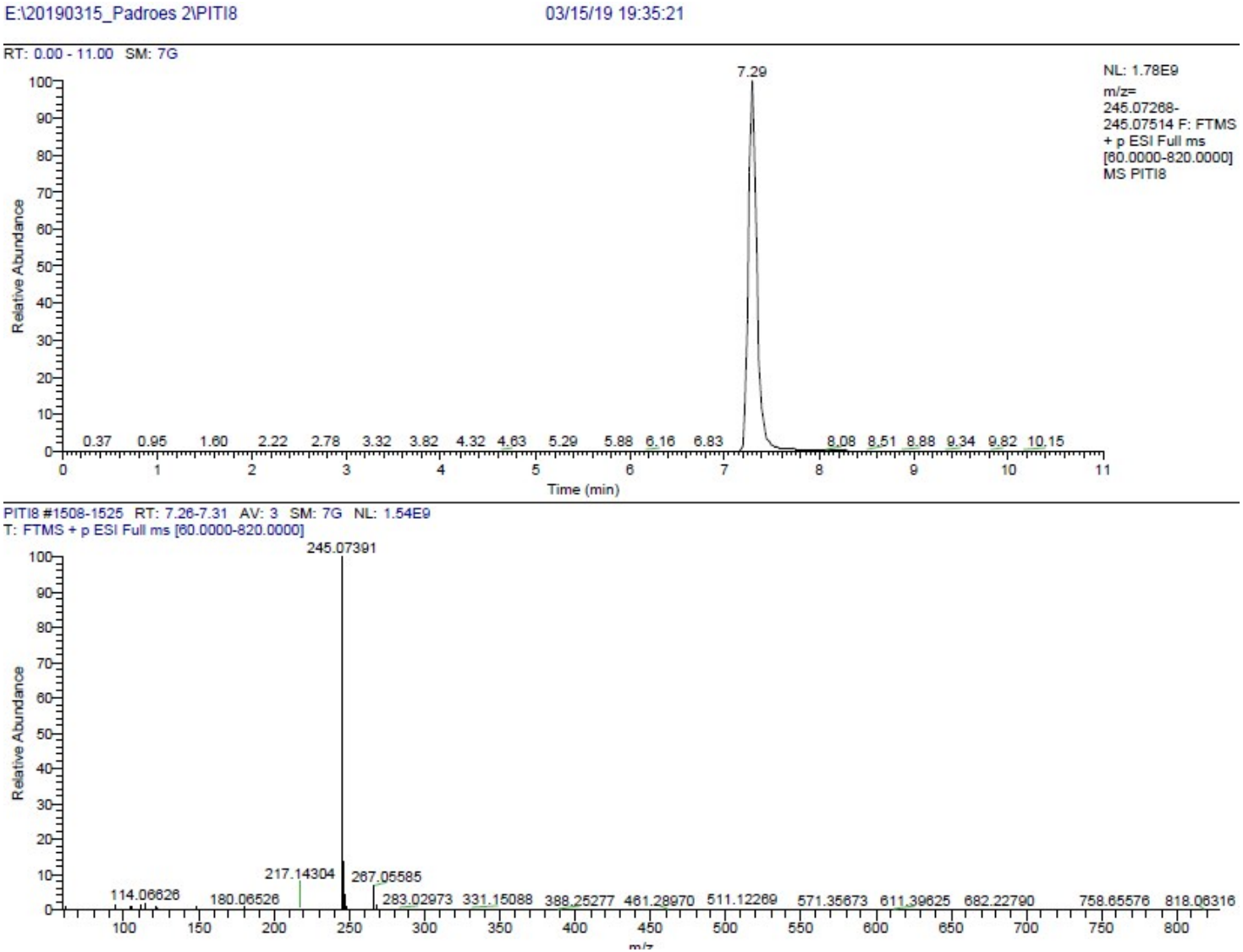
Spectrum 82 – ^{1}H NMR (500 MHz, DMSO-d_6) of compound **17** at 25ºC.



Spectrum 83 – ^{13}C NMR (125 MHz, DMSO-d_6) of compound **17** at 25ºC.



Spectrum 84 – Infrared spectrum (ATR) of compound **17**.



Spectrum 85 – High resolution mass spectrometry ($[M + H]^+$) of compound **17**.

CRYSTALLOGRAPHIC DATA

Procedure for obtaining the crystals

The both crystals were obtained by dissolving 5 mg of the pure solid compounds **2** and **9** in 20 mL of methanol which were left to stand at room temperature for slow evaporation.

Table S1. Crystal data and structure refinement for compounds **2** and **9**.

Identification code	**(2)**	**(9)**
Empirical formula	$C_{12}H_{10}N_2O_2$	$C_{12}H_{12}N_2O_2S$
Formula weight/g mol^{-1}	214.22	248.30
Temperature/K	293.0	293(2)
Crystal system	monoclinic	N/A
Space group	$P2_1/n$	$P2_1/n$
a/Å	11.3370(10)	4.8356(8)
b/Å	4.9540(4)	19.976(4)
c/Å	19.4646(16)	12.518(3)
α/°	90	90
β/°	104.141(5)	95.013(5)
γ/°	90	90
Volume/Å^3	1060.07(16)	1204.6(4)
Z	4	4
ρ_{calc}g/cm^3	1.342	1.369
μ/mm^{-1}	0.094	0.260
F(000)	448.0	520.0
Crystal size/mm^3	0.434 × 0.393 × 0.174	0.544 × 0.089 × 0.068
Radiation	MoKα (λ = 0.71073)	MoKα (λ = 0.71073)
2Θ range for data collection/°	4.316 to 50.71	5.226 to 50.014
Index ranges	-13 ≤ h ≤ 13, -5 ≤ k ≤ 5, -23 ≤ l ≤ 23	-5 ≤ h ≤ 5, -23 ≤ k ≤ 23, -14 ≤ l ≤ 14
Reflections collected	23399	16061
Independent reflections	1928 [R_{int} = 0.1634, R_{sigma} = 0.0542]	2119 [R_{int} = 0.2339, R_{sigma} = 0.1089]
Data/restraints/parameters	1928/0/146	2119/75/177
Goodness-of-fit on F^2	1.060	1.068
Final R indexes [I ≥ 2σ (I)]	R_1 = 0.0524, wR_2 = 0.1139	R_1 = 0.0649, wR_2 = 0.0955

Final R indexes [all data]	R_1 = 0.1009, wR_2 = 0.1337	R_1 = 0.1680, wR_2 = 0.1225
Largest diff. peak/hole/e Å^{-3}	0.16/-0.16	0.24/-0.20

Table S2. Bond Lengths for compounds **2** and **9**.

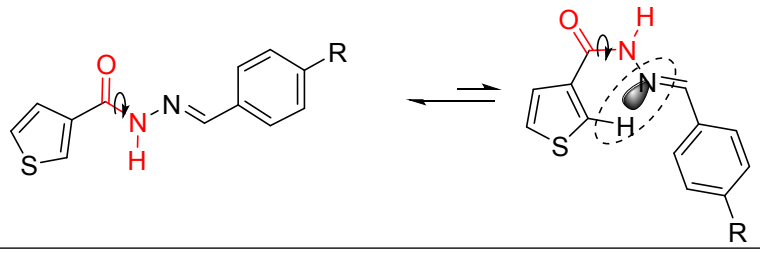
(2)			**(9)**		
Atom	**Atom**	**Length/Å**	**Atom**	**Atom**	**Length/Å**
O2	C8	1.241(3)	C12	C11A	1.326(11)
N1	N2	1.370(2)	C12	C9	1.397(5)
N1	C8	1.345(3)	C12	S1B	1.668(5)
N2	C7	1.277(3)	C9	C10	1.372(5)
O1	C11	1.354(3)	C9	C8	1.482(5)
O1	C12	1.354(3)	C10	C11B	1.326(11)
C1	C7	1.460(3)	C10	S1A	1.669(5)
C1	C6	1.383(3)	C11A	S1A	1.722(11)
C1	C2	1.380(3)	S1B	C11B	1.722(11)
C9	C8	1.470(3)	O1	C8	1.234(4)
C9	C10	1.426(3)	N2	C8	1.339(4)
C9	C12	1.337(3)	N2	N1	1.382(3)
C6	C5	1.380(3)	N1	C7	1.276(4)
C10	C11	1.322(4)	C1	C2	1.379(5)
C5	C4	1.365(4)	C1	C6	1.387(5)
C2	C3	1.375(4)	C1	C7	1.456(5)
C4	C3	1.384(4)	C2	C3	1.388(5)
			C6	C5	1.382(5)
			C3	C4	1.362(5)
			C5	C4	1.363(5)

Table S3. Bond Angles for compounds **2** and **9**.

(2)				(9)			
Atom	**Atom**	**Atom**	**Angle/°**	**Atom**	**Atom**	**Atom**	**Angle/°**
C8	N1	N2	122.4(2)	C11A	C12	C9	111.5(7)
C7	N2	N1	115.5(2)	C9	C12	S1B	115.8(5)
C12	O1	C11	106.1(2)	C10	C9	C12	111.2(4)
C6	C1	C7	119.5(2)	C10	C9	C8	120.8(4)
C2	C1	C7	121.9(2)	C12	C9	C8	128.0(3)
C2	C1	C6	118.6(2)	C11B	C10	C9	108.7(11)
C10	C9	C8	123.0(2)	C9	C10	S1A	114.0(3)
C12	C9	C8	131.9(2)	C12	C11A	S1A	114.0(9)
C12	C9	C10	105.0(2)	C10	S1A	C11A	89.2(5)
N2	C7	C1	121.8(2)	C12	S1B	C11B	85.6(9)
O2	C8	N1	119.1(2)	C10	C11B	S1B	118.7(15)
O2	C8	C9	119.8(2)	C8	N2	N1	118.6(3)
N1	C8	C9	121.1(2)	C7	N1	N2	115.2(3)
C5	C6	C1	120.6(2)	O1	C8	N2	122.7(3)
C11	C10	C9	107.2(2)	O1	C8	C9	120.7(3)
C4	C5	C6	120.6(3)	N2	C8	C9	116.6(3)
C3	C2	C1	120.6(3)	C2	C1	C6	118.6(3)
C10	C11	O1	110.5(2)	C2	C1	C7	119.3(3)
C9	C12	O1	111.2(2)	C6	C1	C7	122.0(3)
C5	C4	C3	119.2(3)	N1	C7	C1	121.5(3)
C2	C3	C4	120.5(3)	C1	C2	C3	121.1(4)
				C5	C6	C1	119.9(4)
				C4	C3	C2	119.1(4)
				C4	C5	C6	120.3(4)
				C3	C4	C5	120.9(4)

MOLECULAR MODELING

Table S4. Potential energy surface scans for the derivatives (**9** – **15**), using the CAM-B3LYP/631(d) methodology with the C-PCM solvation model for polar organic solvent option available in the Spartan'18 software.



Amide bond Dihedral Angle (O=C-N-H)	R, energy in kcal/mol						
	$-N(CH_3)_2$ (**12**)	$-OCH_3$ (**11**)	$-CH_3$ (**10**)	-H (**9**)	-Cl (**13**)	$-CF_3$ (**14**)	$-NO_2$ (**15**)
180°	0.00	0.00	0.00	0.00	0.00	0.00	0.00
165°	0.03	0.03	0.01	0.05	0.03	0.01	0.04
150°	0.87	0.84	0.82	0.87	0.85	0.83	0.86
135°	2.60	2.55	2.55	2.57	2.57	2.52	2.56
120°	5.17	5.10	5.07	5.08	5.05	5.02	5.03
105°	8.29	8.19	8.13	8.13	8.06	8.04	8.02
90°	11.52	11.40	11.32	11.29	11.24	11.15	11.12
75°	14.28	14.08	14.00	13.95	13.87	13.78	13.67
60°	15.67	15.41	15.24	15.19	15.08	14.92	14.72
45°	5.37	5.35	5.32	5.34	5.36	5.33	5.36
30°	2.75	2.81	2.78	2.83	2.84	2.82	2.89
15°	1.16	1.25	1.20	1.31	1.31	1.28	1.35
0°	0.63	0.71	0.72	0.74	0.80	0.78	0.86

FIGURES

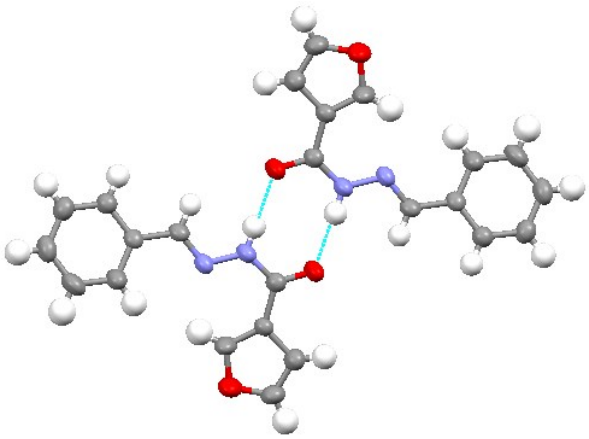


Figure S1. Dimeric structure stabilized by the ring formed by two symmetry related structures of the compound **2**.

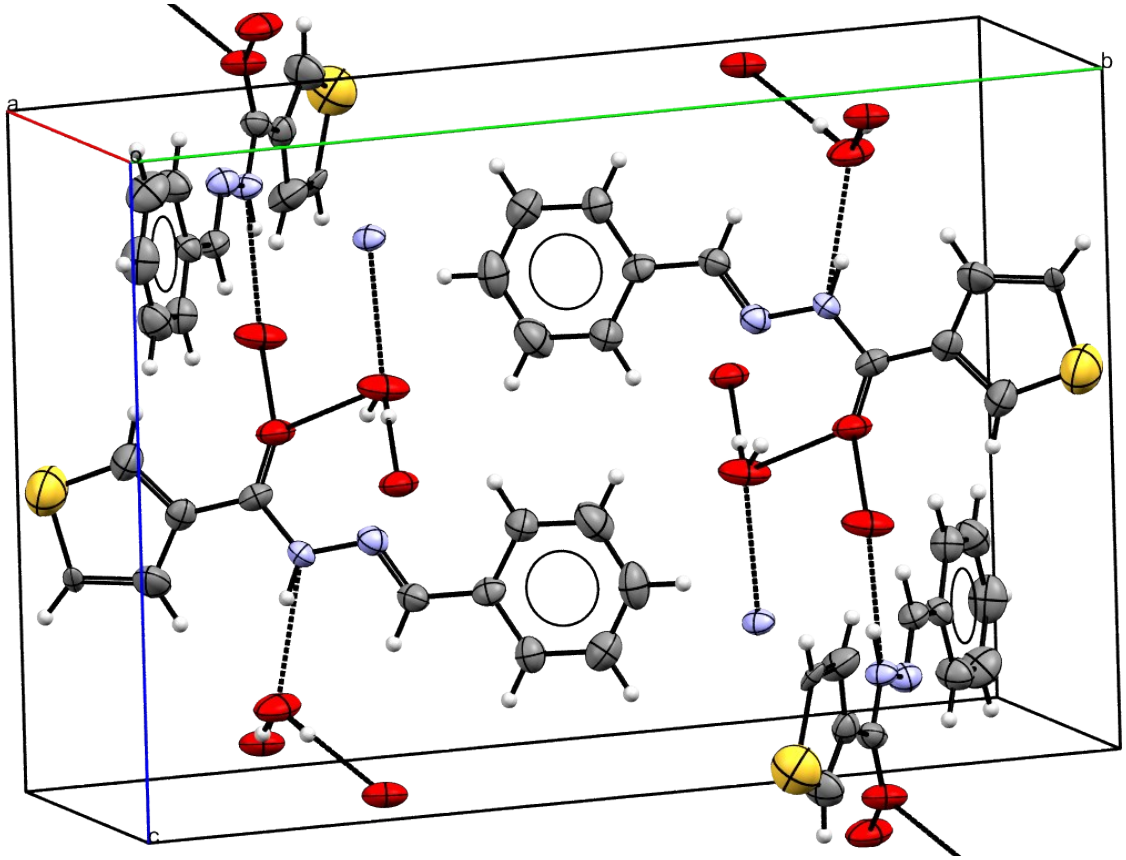


Figure S2. Packing and hydrogen bond interactions of compound 9.