Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Pd-PEPPSI-IPent^{Cl}: A new highly efficient ligand-free and recyclable catalyst system for the synthesis of 2-substituted indoles via domino copper-free Sonogashira coupling/cyclization

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Supporting Information

I. General experimental details **S2-S4**

II. Characteristic data **S5-S9**

III. ^{1}H, ^{1}H-D_2O exchange, ^{13}C NMR, LC-MS, IR, and HRMS **S10-S70**

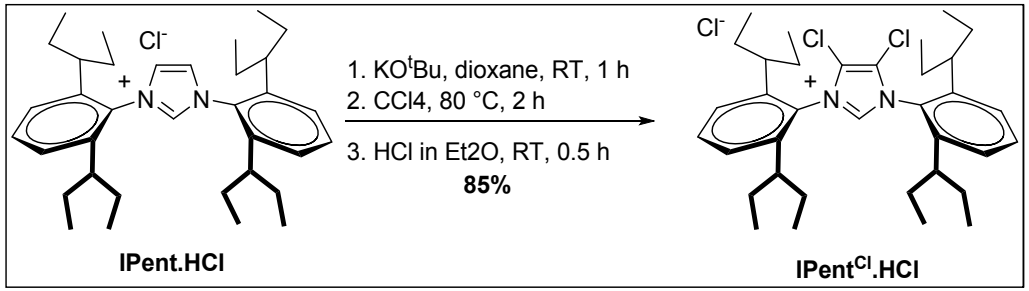
Experimental Section

General Experimental Details

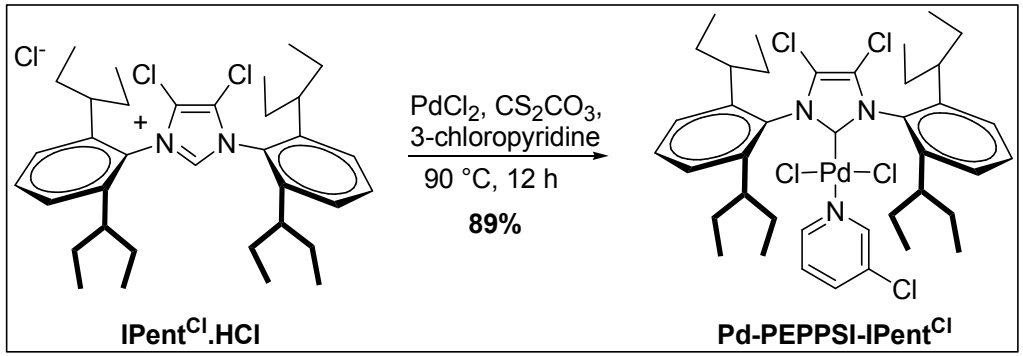
Most of the chemical reagents were purchased from Aldrich and all cases, were used without further purification. Thin layer chromatography (TLC) was performed using Merck 60 F_{254} precoated silica gel plate (0.2 mm thickness). Subsequent to elution, plates were visualized using UV radiation (254 NM). Further visualization was carried out by staining with an ethanolic solution of ninhydrin. Flash-column chromatography was performed using silica gel (100-200 mesh) with commercially available solvents. ^{1}H NMR, ^{13}C NMR, ^{31}P NMR spectra were recorded on Bruker avance III, 400 and 500 MHZ spectrophotometers using TMS as an internal standard. Chemical shifts for ^{1}H NMR spectra are reported as in units of parts per million (ppm) downfield from $SiMe_4$ (d 0.0) and relative to the signal of chloroform-d (7.2600, s). Multiplicities were given as: s (singlet); d (doublet); dd (doublet of doublet); t (triplet); q (quartet); or m (multiplet). Coupling constants are reported as a *J* value in hertz. Carbon nuclear magnetic resonance spectra (^{13}C NMR) are reported as in units of parts per million (ppm) downfield from $SiMe_4$ (d 0.0) and relative to the signal of chloroform-d (d 77.03, t). IR spectra were recorded on a SHIMADZU FTIR spectrometer. LCMS spectrums were recorded using the following apparatus, Description: Agilent 1290 series, Mass 6150 quadru pole LCMS, Software: Chemistation; and LCMS run method specifications are **Column:** Acquity UPLC BEH C18 (50 mmx2.1 mm, 1.7 um), **Mobile Phase**: B: 0.1% Formic acid in water, A: 0.1% formic acid in acetonitrile, **Gradient:** Time (min)/ %A: 0/2, 0.2/2, 1.5/98, 2.6/98, 2.61/2,3.2/2, **Column Temp**: 45 °C, Flow rate: 0.8 ml/min.

Experimental section

Procedure for the preparation of Pd-PEPPSI-IPent^{Cl}

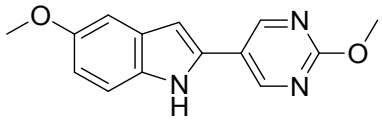


A stirred solution of IPent.HCl (500 mg, 0.99 mmol, 1.0 eq) in 1,4-dioxane (5 ml,) was added KO^{t}Bu (134 mg, 1.195 mmol, 1.2 eq) at RT, stirred at RT for 1 h. then added the CCl_4 (5 ml) and stirred at 80 °C for 2 h. The Reaction mixture was cooled to RT and added the 2.0 M HCl in diethyl ether (1 ml, 1.19 mmol, 1.2 eq) drop by drop at RT and stirred at RT for 30 min. the Rm was diluted with Dichloromethane (10 ml) and filtered through the celite bed. The filtrate was concentrated under reduced pressure to obtain the residue which is further washed with diethyl ether (20 ml) and dried under vacuum to afforded IPent^{Cl}.HCl (480 mg, 85%; white solid).TLC system: EtOAc - pet-ether; 1:1; R*f:* 0.12.



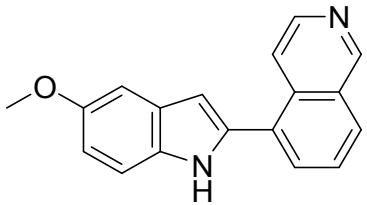
A stirred solution of IPent^{Cl}.HCl (300 mg, 0.526 mmol, 1.0 eq) in 3-chloro pyridine (4.5 ml,) were added Cs_2CO_3 (0.205 mg, 0.631 mmol, 1.2 eq) and $PdCl_2$ (110 mg, 0.631 mmol, 1.2 eq) at RT in the argon atmosphere and stirred at 90 °C for 12 h. The reaction mixture was concentrated under reduced pressure to remove the excess 3- chloro pyridine. The residue purified by flash column chromatography (Silica gel (100-200); EtOAc - pet ether; 50:50 → 60:40) to afforded Pd-PEPPSI-IPent^{Cl} (400 mg, 89%; white solid). TLC system: EtOAc - pet-ether; 1:1; R*f:* 0.12.

5-methoxy-2-(2-methoxypyrimidin-5-yl)-1H-indole (3a):



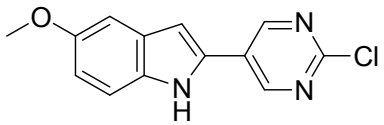
Pale Yellow colour solid, M.P.: 215.5-217.8 °C; ^{1}H NMR (500 MHz, DMSO-d_6): (ppm) 11.48 (s, 1H, Ar-NH-), 9.05 (s, 2H, Ar-H), 7.30 (d, *J* = 9 Hz, 1H, Ar-H), 7.04 (d, *J* = 2.5 Hz, 1H, Ar-H), 6.89 (d, *J* = 2.0 Hz, 1H, Ar-H), 6.77 (dd, *J* = 2.5 Hz, *J* = 8.5 Hz, 1H, Ar-H), 3.96 (s, 3H,-O-CH_3), 3.76 (s, 3H,-O-CH_3); ^{13}C NMR (125 MHz, DMSO-d_6, ppm): 164.04 (Ar-C), 155.64 (Ar-C), 153.73 (Ar-C), 132.26 (Ar-C), 132.11 (Ar-C), 128.82 (Ar-C), 120.85 (Ar-C),112.22 (Ar-C), 111.96 (Ar-C), 101.56 (Ar-C), 98.98 (Ar-C), 55.23 (-O-$\underline{C}H_3$), 54.72 (-O-CH_3); IR (KBr, cm^{-1}): 3190 (Ar-NH-), 2937 (Ar-C-H), 1614 (Ar-C=C-), 1560 (Ar-C=C-), 1535 (Ar-C=C-), 1472 (Ar-C=C-), 1330 (Ar-C-N-), 1223 (-C-O-); TLC system: Methanol- Dichloromethane; 0.5:9.5; R*f*: 0.43; HRMS (ESI$^+$); m/z calcd for $C_{14}H_{13}N_3O_2$ $[M+H]^+$ 255.10; found 256.1081.

5-(5-methoxy-1H-indol-2-yl)isoquinoline (3b):



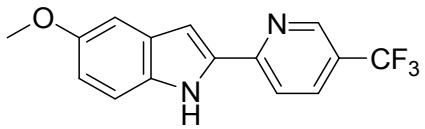
White colour solid, M.P.: 176-180 °C; ^{1}H NMR (400 MHz, DMSO-d_6): (ppm) 11.47 (s, 1H, Ar-NH-), 9.40 (s, 1H, Ar-H), 8.57 (d, *J* = 5.6 Hz, 1H, Ar-H), 8.17 (t, *J* = 9.2 Hz, 2H, Ar-H), 7.97 (dd, *J* = 1.2 Hz, *J* = 7.2 Hz, 1H, Ar-H), 7.80 (t, *J* = 8 Hz, 1H, Ar-H), 7.35 (d, *J* = 8.8 Hz, 1H, Ar-H), 7.13 (s, 1H, Ar-H), 6.81 (dd, *J* =2.4 Hz, *J*= 8.4 Hz, 1H, Ar-H), 6.74 (s, 1H, Ar-H), 3.79 (s, 3H,-O-CH_3); ^{13}C NMR (100 MHz, DMSO-d_6, ppm): 153.62 (Ar-C), 152.93 (Ar-C), 143.71 (Ar-C), 135.46 (Ar-C), 132.85 (Ar-C), 132.06 (Ar-C), 130.74 (Ar-C), 129.81 (Ar-C), 128.72 (Ar-C), 127.55 (Ar-C), 127.13 (Ar-C), 118.12 (Ar-C), 112.14 (Ar-C), 102.74 (Ar-C), 101.62 (Ar-C), 55.28 (-O-$\underline{C}H_3$); IR (KBr, cm^{-1}): 3321 (Ar-NH-), 3037 (Ar-C-H), 2983 (-C-H), 1616 (Ar-C=C-), 1579 (Ar-C=C-), 1487 (Ar-C=C-), 1448 (Ar-C=C-), 1371 (Ar-C-N-), 1220 (-C-O-); TLC system: EtOAc- Pet ether; 4:6; R*f*: 0.51; HRMS (ESI$^+$): m/z calcd for $C_{18}H_{14}N_2O$ $[M+H]^+$ 274.11; found 275.1171.

2-(2-chloropyrimidin-5-yl)-5-methoxy-1H-indole (3c):



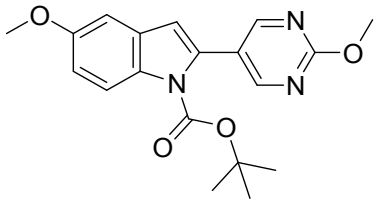
White colour solid, M.P.: 234-238 °C; ^{1}H NMR (400 MHz, DMSO-d_6): (ppm) 11.67 (s, 1H, Ar-NH-), 9.21 (s, 2H, Ar-H), 7.34 (d, *J* = 8.8 Hz, 1H, Ar-H), 7.11 (d, *J* = 1.2 Hz, 1H, Ar-H), 7.07 (d, *J* = 2.4 Hz, 1H, Ar-H), 6.83 (dd, *J* = 2.4 Hz, *J* = 8.8 Hz, 1H, Ar-H), 3.77 (s, 3H,-O-CH_3); ^{13}C NMR (100 MHz, DMSO-d_6, ppm): 157.60 (Ar-C), 155.79 (Ar-C), 153.91 (Ar-C), 132.79 (Ar-C), 130.31 (Ar-C), 128.58 (Ar-C), 125.65 (Ar-C), 113.59 (Ar-C), 112.34 (Ar-C), 101.66 (Ar-C), 101.50 (Ar-C), 55.24 (-O-$\underline{C}H_3$); IR (KBr, cm^{-1}): 3240 (Ar-NH-), 2933 (-C-H), 2897 (-C-H), 1620 (Ar-C=C-), 1523 (Ar-C=C-), 1394 (Ar-C-N-), 1219 (-C-O-); TLC system: Methanol- Dichloromethane; 0.5:9.5; R*f*: 0.54; HRMS (ESI^-); m/z calcd for $C_{13}H_{10}N_3OCl$ $[M+H]^+$ 259.05; found 260.0586.

5-methoxy-2-(4-(trifluoromethyl)pyridin-2-yl)-1H-indole (3d):



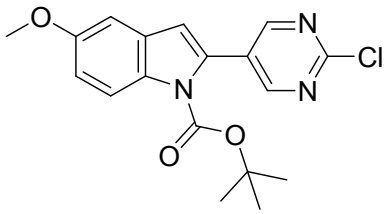
Pale Yellow colour solid, M.P.: 168-172 °C; ^{1}H NMR (400 MHz, DMSO-d_6): (ppm) 11.72 (s, 1H, Ar-NH-), 8.94 (s, 1H, Ar-H), 8.22 (dd, *J* = 2 Hz, *J* = 8.8 Hz, 1H, Ar-H), 8.14 (d, *J* = 8.4 Hz, 1H, Ar-H), 7.38 (d, *J* = 9.2 Hz, 1H, Ar-H), 7.24 (s, 1H, Ar-H), 7.08 (d, *J* = 2.4 Hz, Ar-H), 6.83 (dd, *J* = 2.4 Hz, *J* = 8.8 Hz, Ar-H), 3.77 (s, 3H,-O-CH_3); ^{13}C NMR (100 MHz, DMSO-d_6, ppm): 153.93 (Ar-C), 153.83(Ar-C), 146.04 (Ar-C), 146.00 (Ar-C), 135.85 (Ar-C), 134.31 (Ar-C), 132.99 (Ar-C), 128.46 (Ar-C), 125.29-122.10 (Ar-CF_3), 119.51 (Ar-C), 114.33 (Ar-C), 113.06 (Ar-C), 102.88 (Ar-C), 101.72 (Ar-C), 55.22 (-O-$\underline{C}H_3$); IR (KBr, cm^{-1}): 3398 (Ar-NH-), 1604 (Ar-C=C-), 1546 (Ar-C=C-), 1325 (Ar-C-N-), 1220 (-C-O-); TLC system: EtOAc- Pet ether; 5:5; R*f*: 0.41; HRMS (ESI^+); m/z calcd for $C_{15}H_{11}N_2OF_3$ $[M+H]^+$ 292.08; found 293.0916.

tert-butyl 5-methoxy-2-(2-methoxypyrimidin-5-yl)-1H-indole-1-carboxylate (3e):



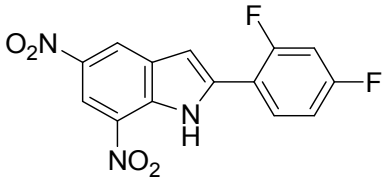
White colour solid, M.P.: 130.1-133.5 °C; ^{1}H NMR (400 MHz, DMSO-d_6): (ppm) 8.73 (s, 2H, Ar-H), 8.02 (d, *J* = 9.2 Hz,1H, Ar-H), 7.15 (d, *J* = 2.4 Hz, 1H, Ar-H), 6.97 (dd, *J* = 2.8 Hz, *J* = 9.2 Hz, 1H, Ar-H), 6.78 (d, *J* = 0.8 Hz, 1H, Ar-H), 3.97 (s, 3H,-O-CH_3), 3.80 (s, 3H,-O-CH_3), 1.37 (s, 9H,-tBu); ^{13}C NMR (100 MHz, DMSO-d_6, ppm): 164.24 (Ar-C), 158.64 (Ar-C), 155.66 (Ar-C), 149.19 (Ar-C), 133.80 (Ar-C), 131.27 (Ar-C), 129.49 (Ar-C),122.53 (Ar-C), 116.02 (Ar-C), 113.48 (Ar-C), 111.14 (Ar-C), 103.06 (Ar-C), 83.87 (-N-C=O), 55.31 (-O-CH_3), 54.76 (-O-CH_3), 27.32 (-C-(CH_3)$_3$); IR (KBr, cm^{-1}): 2978 (-C-H), 1735 (-C=O), 1546 (Ar-C=C-), 1465 (Ar-C=C-), 1303 (Ar-C-N-), 1222 (-C-O-); TLC system: EtOAc- Pet ether; 4:6; R*f*: 0.43; HRMS (ESI$^+$); m/z calcd for $C_{19}H_{21}N_3O_4$ $[M+H]^+$ 355.15; found 356.1602.

tert-butyl 2-(2-chloropyrimidin-5-yl)-5-methoxy-1H-indole-1-carboxylate (3f):



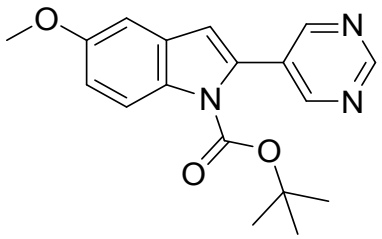
White colour solid, M.P.: 162.5-164.5 °C; ^{1}H NMR (400 MHz, DMSO-d_6): (ppm) 8.96 (s, 2H, Ar-H), 8.04 (d, *J* = 9.2 Hz,1H, Ar-H), 7.19 (s, 1H, Ar-H), 7.01 (dd, *J* = 2.8 Hz, *J* = 9.2 Hz, 1H, Ar-H), 6.92 (s, 1H, Ar-H), 3.80 (s, 3H,-O-CH_3), 1.38 (s, 9H,-C-(CH_3)$_3$); ^{13}C NMR (100 MHz, DMSO-d_6, ppm): 159.23 (Ar-C), 158.65 (Ar-C), 155.77 (Ar-C), 149.01 (Ar-C), 132.16 (Ar-C), 131.49 (Ar-C), 129.39 (Ar-C), 127.68 (Ar-C), 116.11 (Ar-C), 114.18 (Ar-C), 112.50 (Ar-C), 103.27 (Ar-C), 84.35 (-N-C=O), 55.34 (-O-CH_3), 27.29 (-C-(CH_3)$_3$); IR (KBr, cm^{-1}): 2980 (-C-H), 1730 (-C=O), 1535 (Ar-C=C-), 1458 (Ar-C=C-), 1301 (Ar-C-N-), 1224 (-C-O-); TLC system: EtOAc- Pet ether; 4:6; R*f*: 0.52; HRMS (ESI$^+$); m/z calcd for $C_{18}H_{18}N_3Cl$ $[M+H]^+$ 359.10; found 360.1129.

2-(2,4-difluorophenyl)-5,7-dinitro-1H-indole (3g):



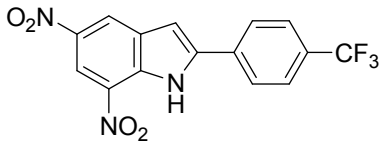
Yellow colour solid, M.P.: 202-206 °C; ^{1}H NMR (400 MHz, DMSO-d_6): (ppm) 12.51 (s, 1H, Ar-NH-), 9.06 (d, *J* = 2 Hz, 1H, Ar-H), 8.81 (d, *J* = 2 Hz, 1H, Ar-H), 8.00-8.06 (m, 1H, Ar-H), 7.49-7.55 (m, 1H, Ar-H), 7.33 (d, *J* = 2 Hz, 1H, Ar-H), 7.29-7.31 (m, 1H, Ar-H), 3.35 (s, 3H, -O-CH_3); ^{13}C NMR (125 MHz, DMSO-d_6, ppm): 161.62-163.70 (Ar-C-F), 158.61-160.72 (Ar-C-F), 139.79 (Ar-C), 137.60 (Ar-C), 131.96 (Ar-C), 131.71 (Ar-C), 131.27 (Ar-C), 123.22 (Ar-C), 115.14 (Ar-C), 113.93 (Ar-C), 112.05 (Ar-C), 111.86 (Ar-C), 106.20 (Ar-C), 104.75 (Ar-C); IR (KBr, cm^{-1}): 3388 (Ar-NH-), 1624 (Ar-C=C-), 1593 (Ar-C=C-), 1533 (Ar-C=C-), 1485 (Ar-C=C-), 1332 (Ar-C-N-); TLC system: EtOAc- Pet ether; 3:7; R*f*: 0.55; HRMS (ESI^+); m/z calcd for $C_{14}H_7N_3O_4F_2$ $[M+H]^+$ 319.04; found 320.0479.

tert-butyl 5-methoxy-2-(pyrimidin-5-yl)-1H-indole-1-carboxylate (3h):



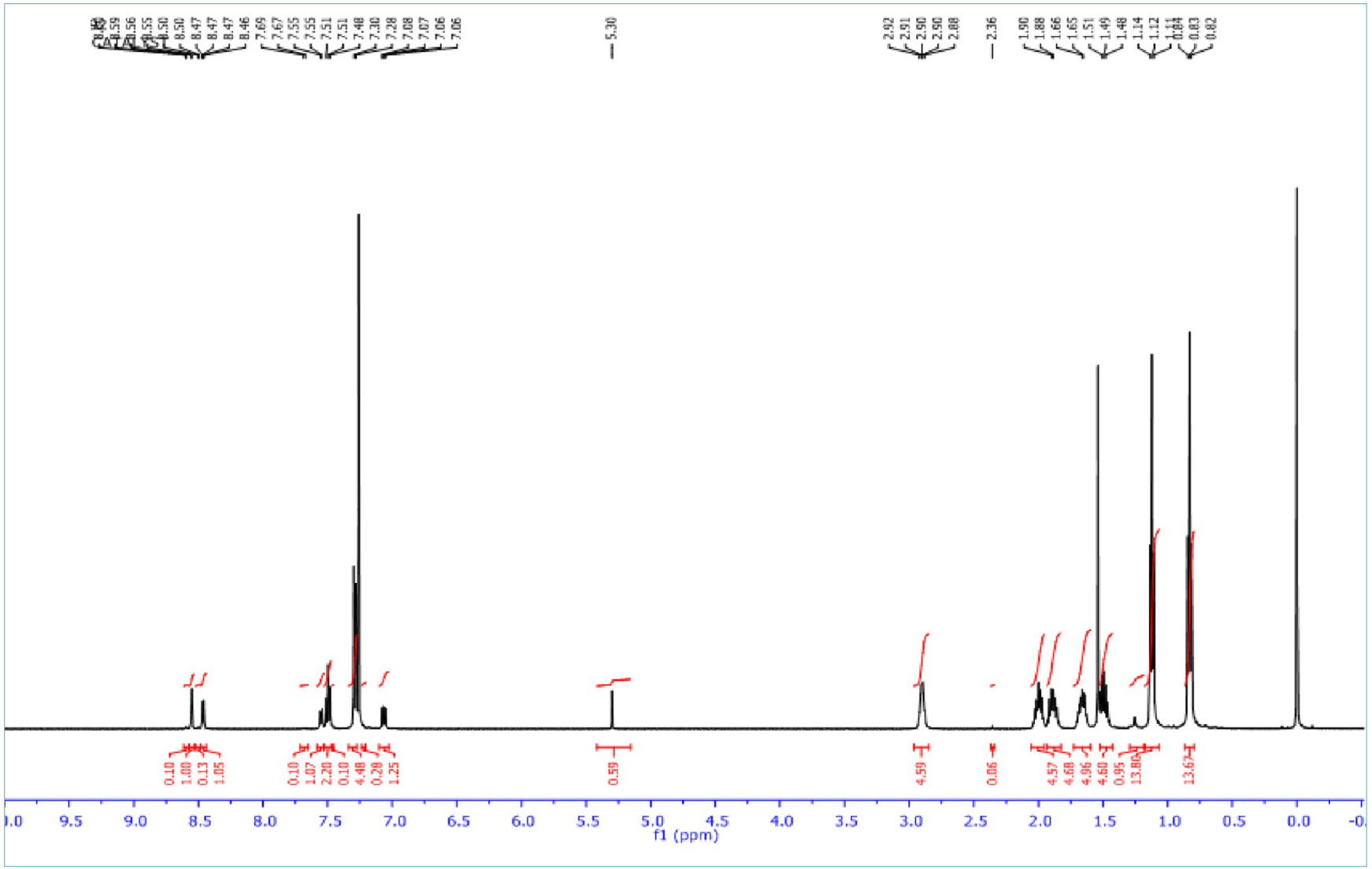
White colour solid, M.P.: 134-138 °C; ^{1}H NMR (500 MHz, DMSO-d_6): (ppm) 9.19 (s, 1H, Ar-H), 8.96 (s, 2H, Ar-H), 8.05 (d, *J* = 9 Hz, 1H, Ar-H), 7.18 (d, *J* = 2.5 Hz, 1H, Ar-H), 7.00 (dd, *J* = 2.5 Hz, *J* = 9 Hz, 1H, Ar-H), 6.88 (s, 1H,Ar-H), 3.81 (s, 3H,-O-CH_3), 1.33 (s, 9H,-tBu); ^{13}C NMR (125 MHz, DMSO-d_6, ppm): 157.03 (Ar-C), 155.96 (Ar-C), 155.74 (Ar-C), 149.06 (Ar-C), 133.56 (Ar-C), 131.49 (Ar-C), 129.45 (Ar-C), 128.67 (Ar-C), 116.02 (Ar-C), 113.95(Ar-C), 112.02 (Ar-C), 103.21 (Ar-C), 84.03 (-N-C=O), 55.33 (-O-CH_3), 27.25 (-C-(CH_3)$_3$); IR (KBr, cm^{-1}): 2970 (-C-H), 1735 (-C=O), 1608 (Ar-C=C-), 1548 (Ar-C=C-), 1300 (Ar-C-N-), 1224 (-C-O-); TLC system: EtOAc- Pet ether; 5:5; R*f*: 0.58; HRMS (ESI^+); m/z calcd for $C_{18}H_{19}N_3O_3$ $[M+H]^+$ 325.14; found 326.1509.

5,7-dinitro-2-(4-(trifluoromethyl)phenyl)-1H-indole (3i):

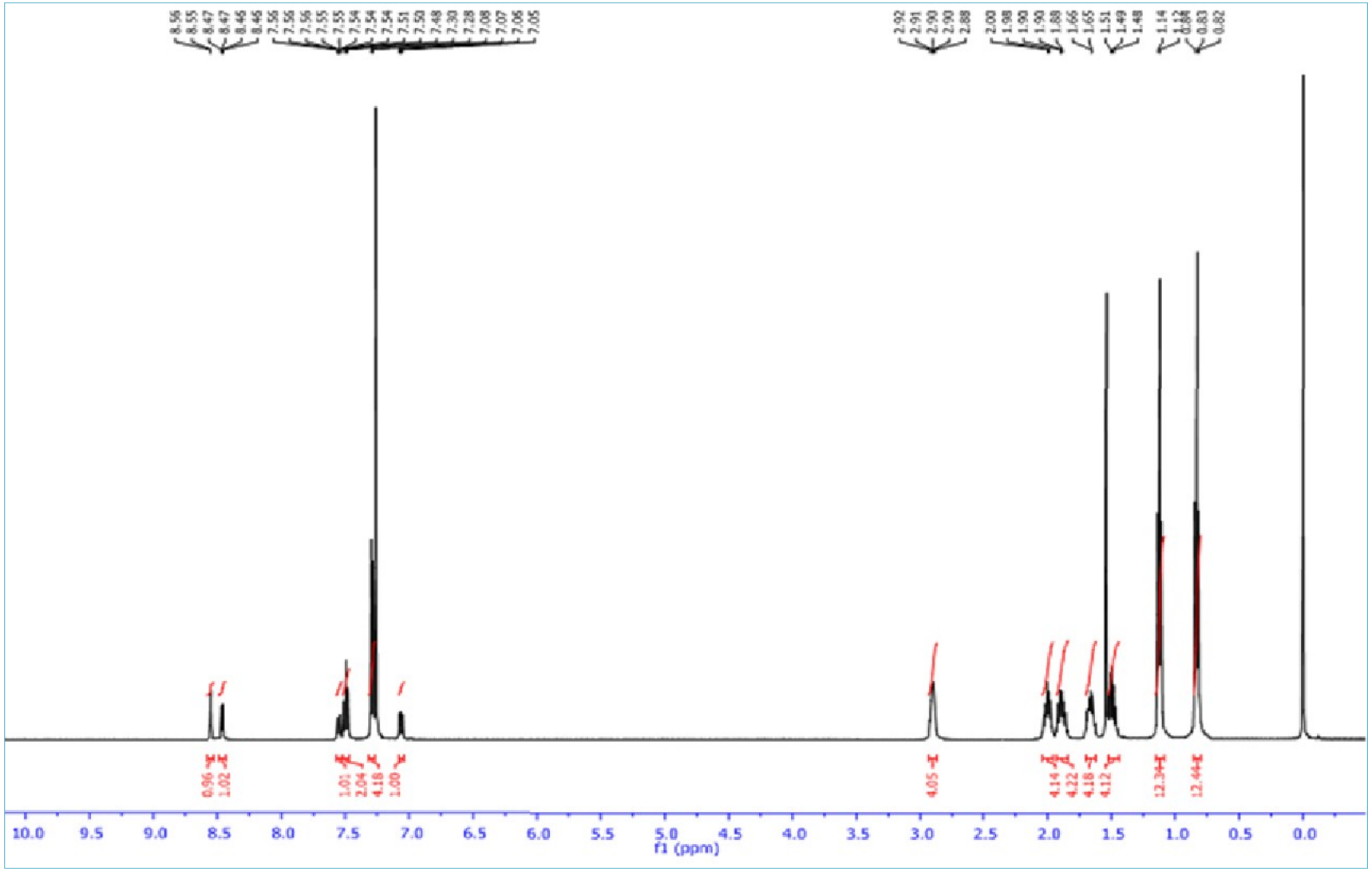


Yellow colour solid, M.P.: 192-196 °C; ^{1}H NMR (500 MHz, DMSO-d_6): (ppm) 12.46 (s, 1H, Ar-NH-), 8.99 (d, *J* = 2 Hz,1H, Ar-H), 8.79 (d, *J* = 2.5 Hz, 1H, Ar-H), 8.16 (d, *J* = 9 Hz 2H, Ar-H), 7.54 (d, *J* = 8 Hz, 1H, Ar-H), 7.45 (s, 1H, Ar-H); ^{13}C NMR (125 MHz, DMSO-d_6, ppm): 148.75 (Ar-C), 143.26 (Ar-C), 139.93 (Ar-C), 132.30 (Ar-C), 132.00 (Ar-C), 131.95 (Ar-C), 129.39 (Ar-C), 122.98 (Ar-C), 121.29 (Ar-C), 113.87 (Ar-C), 104.14 (Ar-C); IR (KBr, cm^{-1}): 3408 (Ar-NH-), 1537 (Ar-C=C-), 1332 (Ar-C-N-); TLC system: EtOAc- Pet ether; 3:7; R*f*: 0.55; LCMS $(ESI^{-})^{+}$; m/z calcd for $C_{15}H_8N_3O_4F_3$ $[M+H]^+$ 351; found 352.1253.

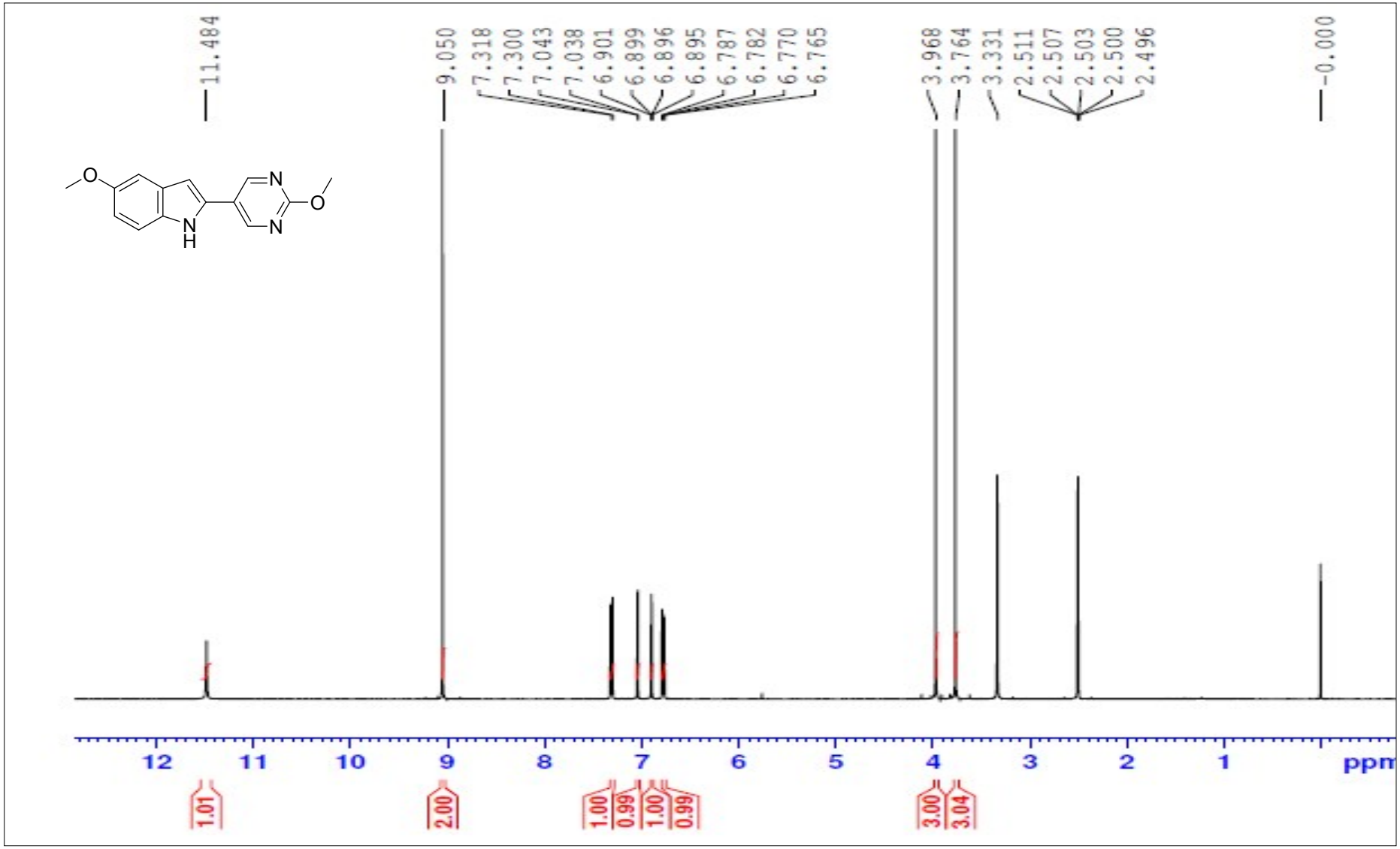
Pd-PEPPSI-IPent^{Cl} Catalyst ^{1}H NMR spectrum after recovery of three cycles



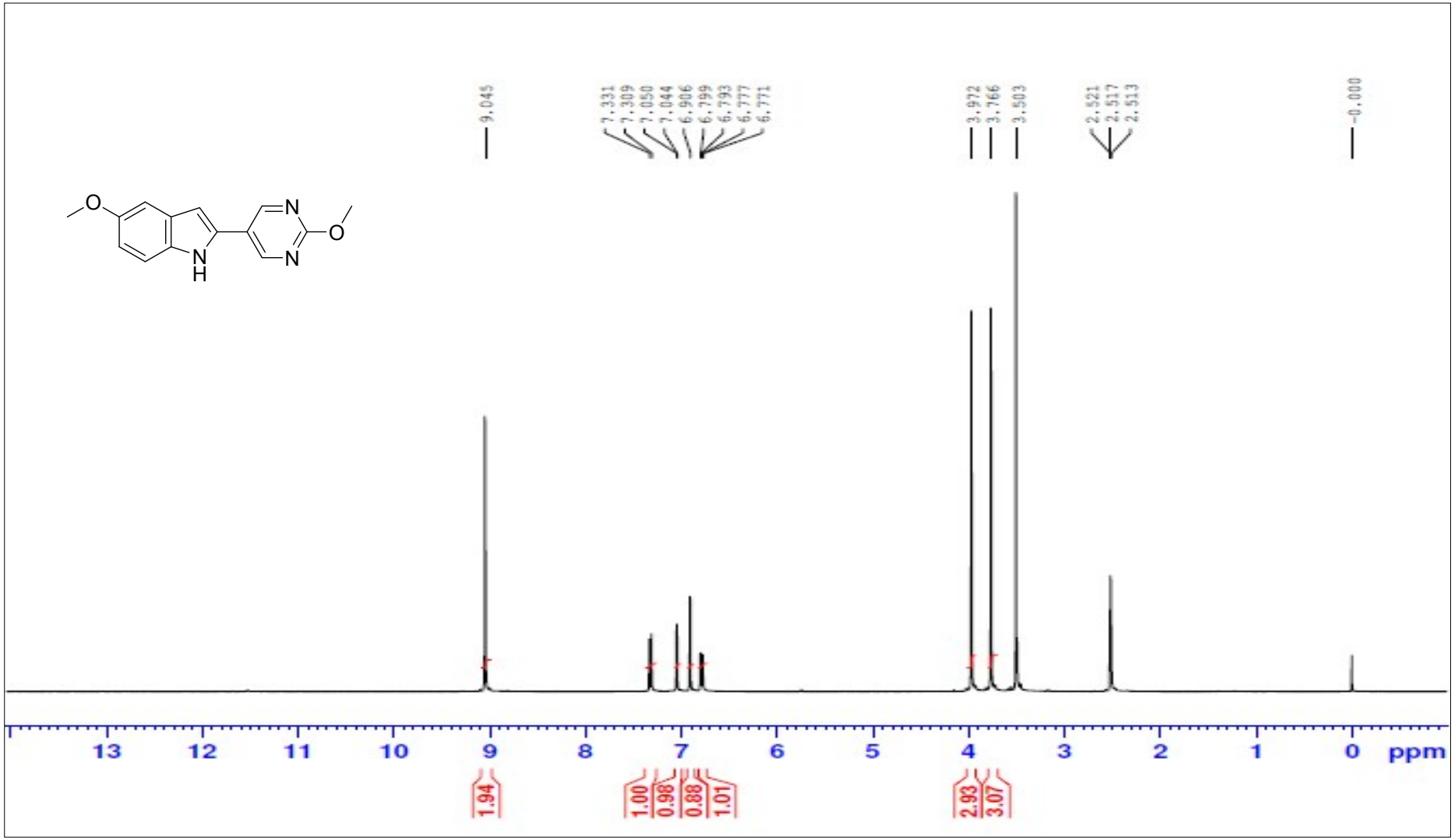
Pd-PEPPSI-IPent^{Cl} Catalyst ^{1}H NMR spectrum


f1 (ppm)

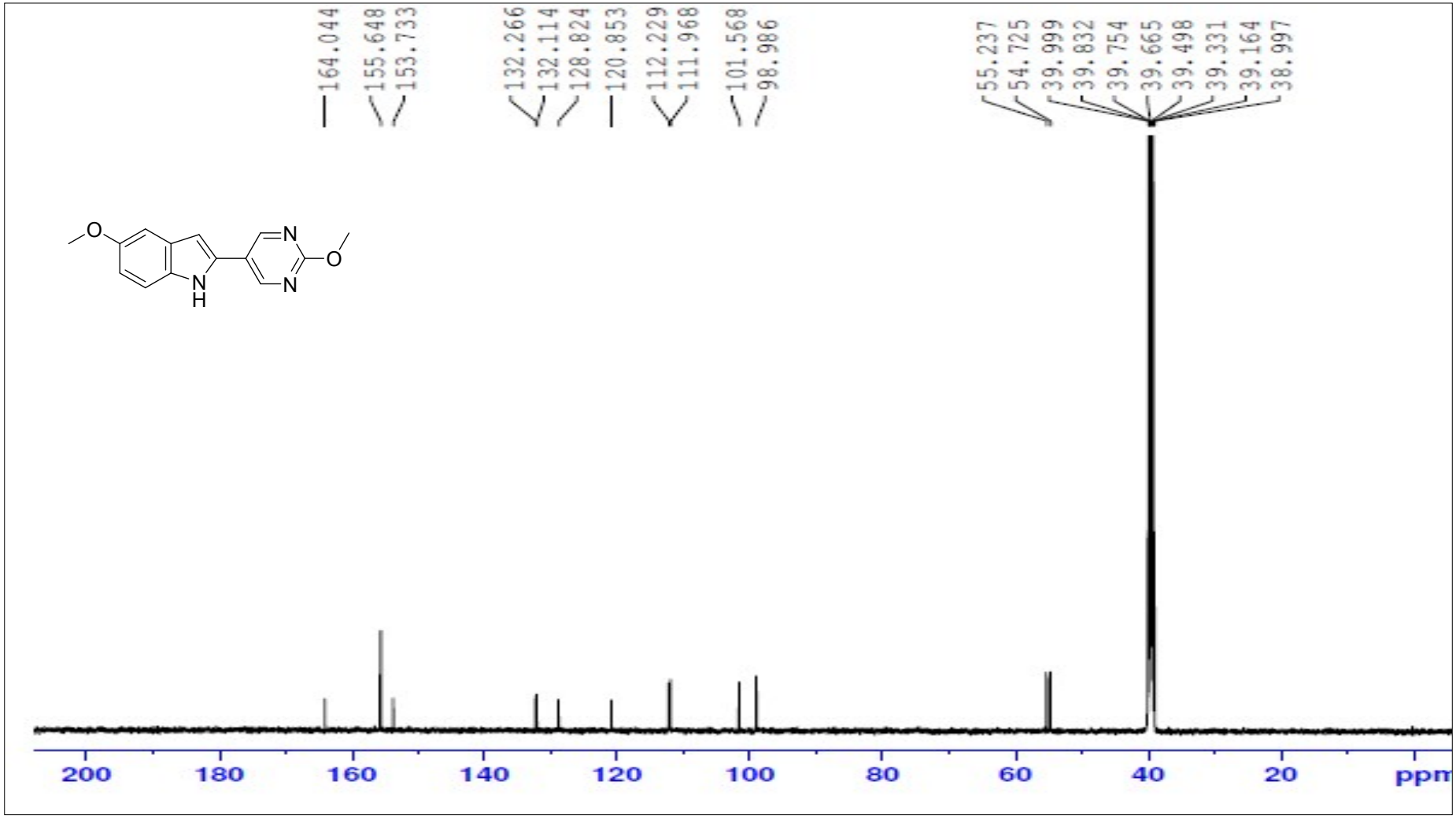
^{1}H NMR of compound 3a in DMSO-D_6 at 500 MHz



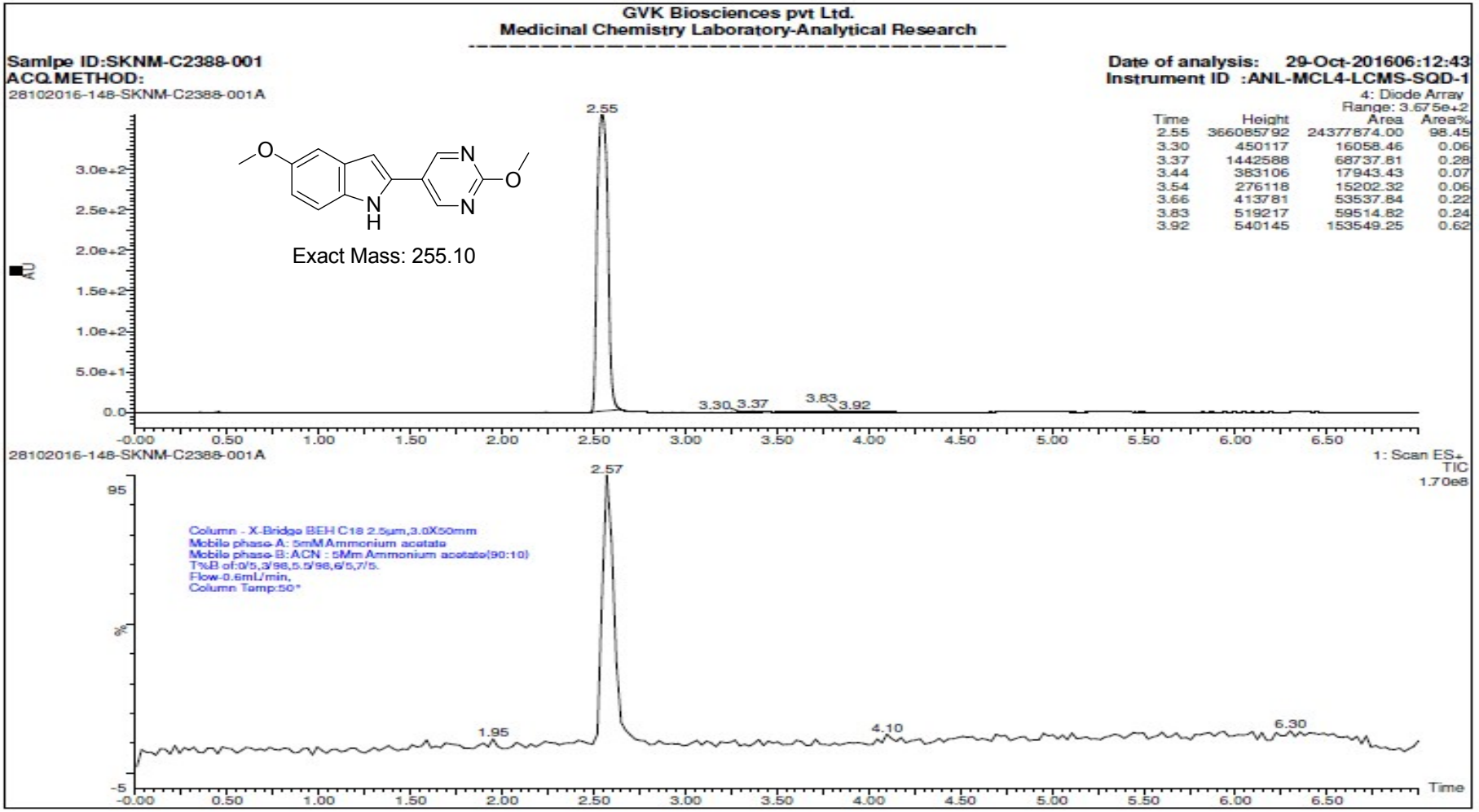
^{1}H NMR of compound 3a in DMSO-D_6 D_2O exchange at 400 MHz

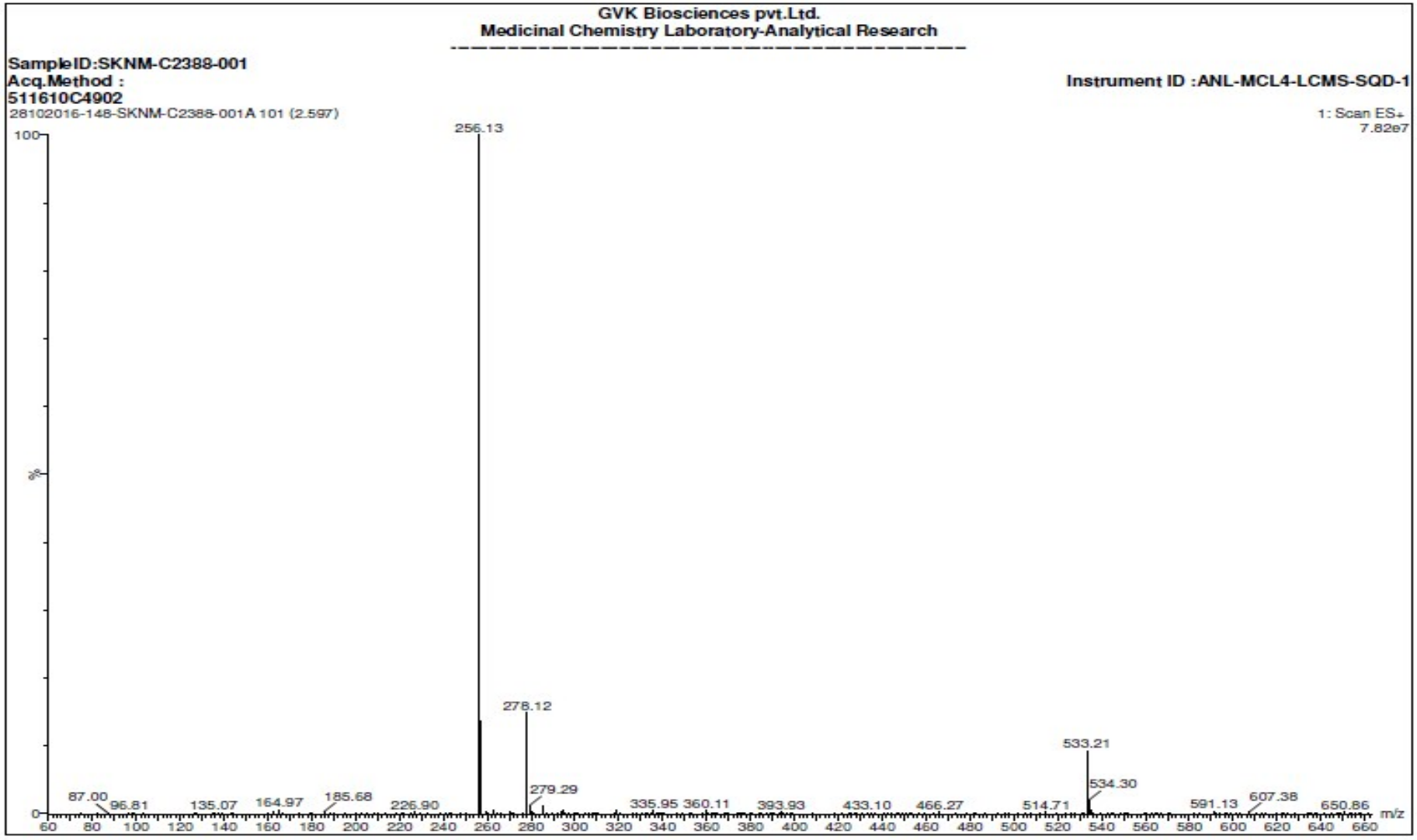


^{13}C NMR of compound 3a in DMSO-D_6 at 125 MHz



LCMS spectrum of Compound-3a




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C2388-001
Acq.Method :
511610C4902
Instrument ID :ANL-MCL4-LCMS-SQD-1
28102016-148-SKNM-C2388-001A 101 (2.597)
1: Scan ES+
7.82e7
100
%
0
256.13
278.12
533.21
534.30
279.29
87.00
96.81
135.07
164.97
185.68
226.90
335.95
360.11
393.93
433.10
466.27
514.71
591.13
607.38
650.86
m/z
60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660

HRMS spectrum of Compound-3a

Elemental Composition Report

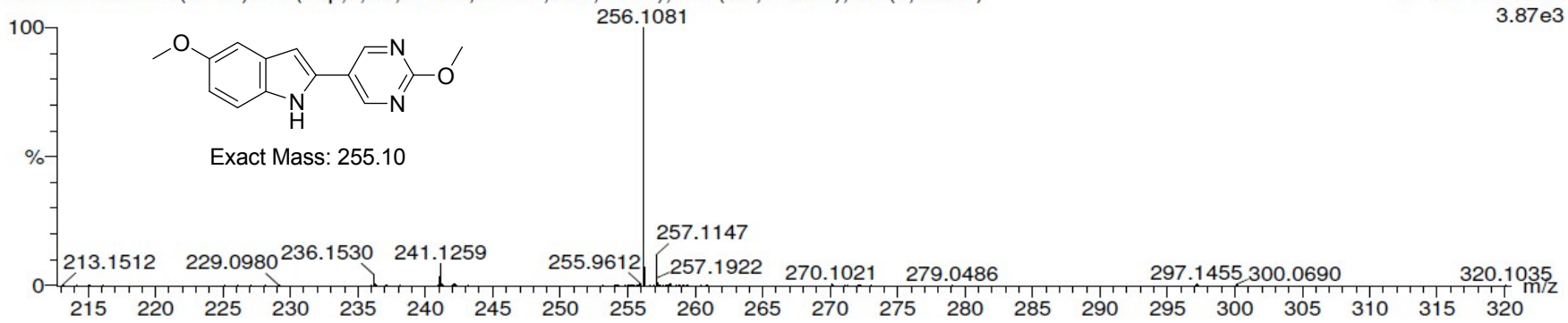
Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0
Selected filters: None

Monoisotopic Mass, Even Electron Ions
10 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-14 H: 0-14 N: 0-3 O: 0-2

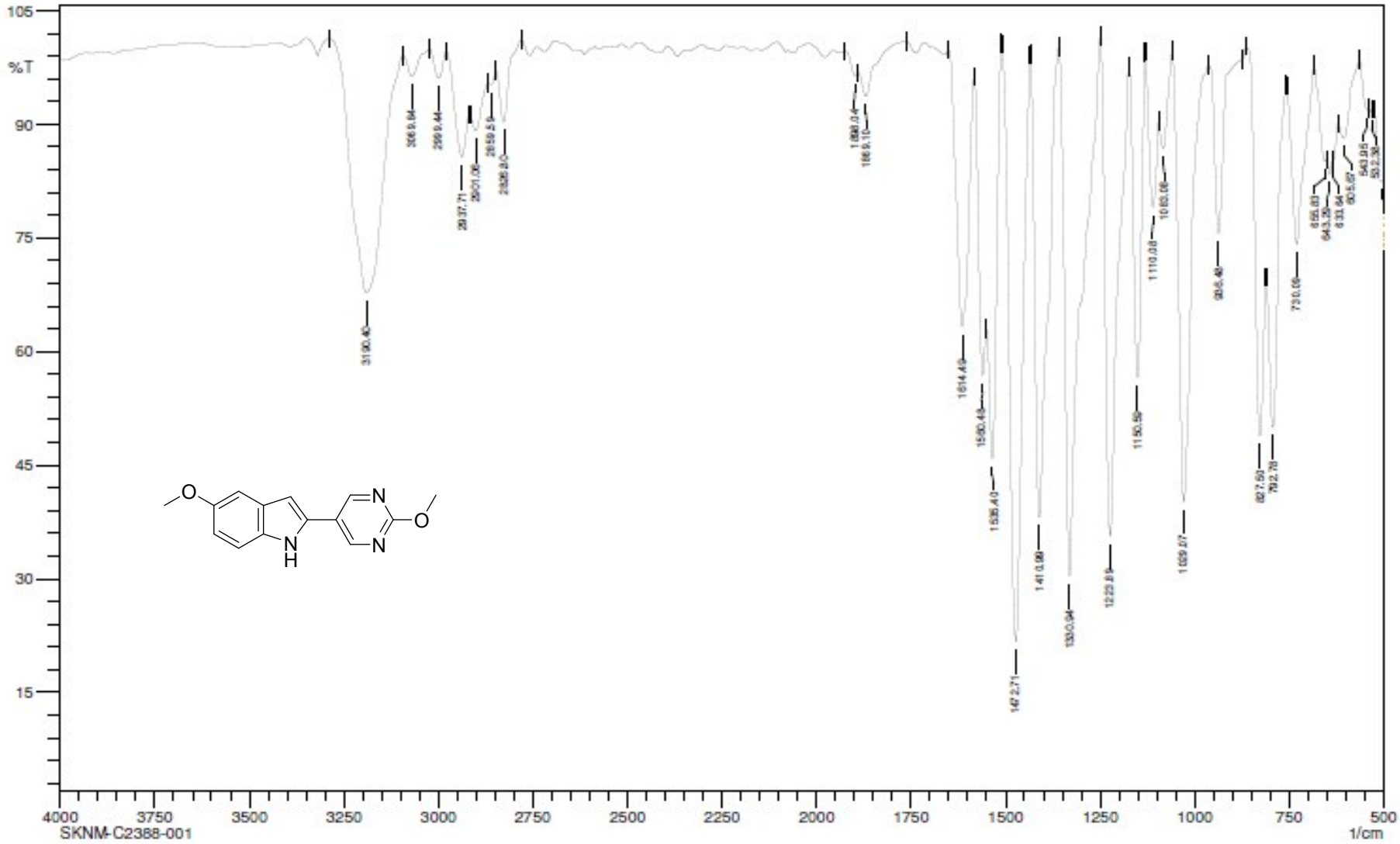
SKNM-C2388-001
511611B4903 21 (0.286) AM (Top,4, Ar,5000.0,195.12,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

1: TOF MS ES+
3.87e3

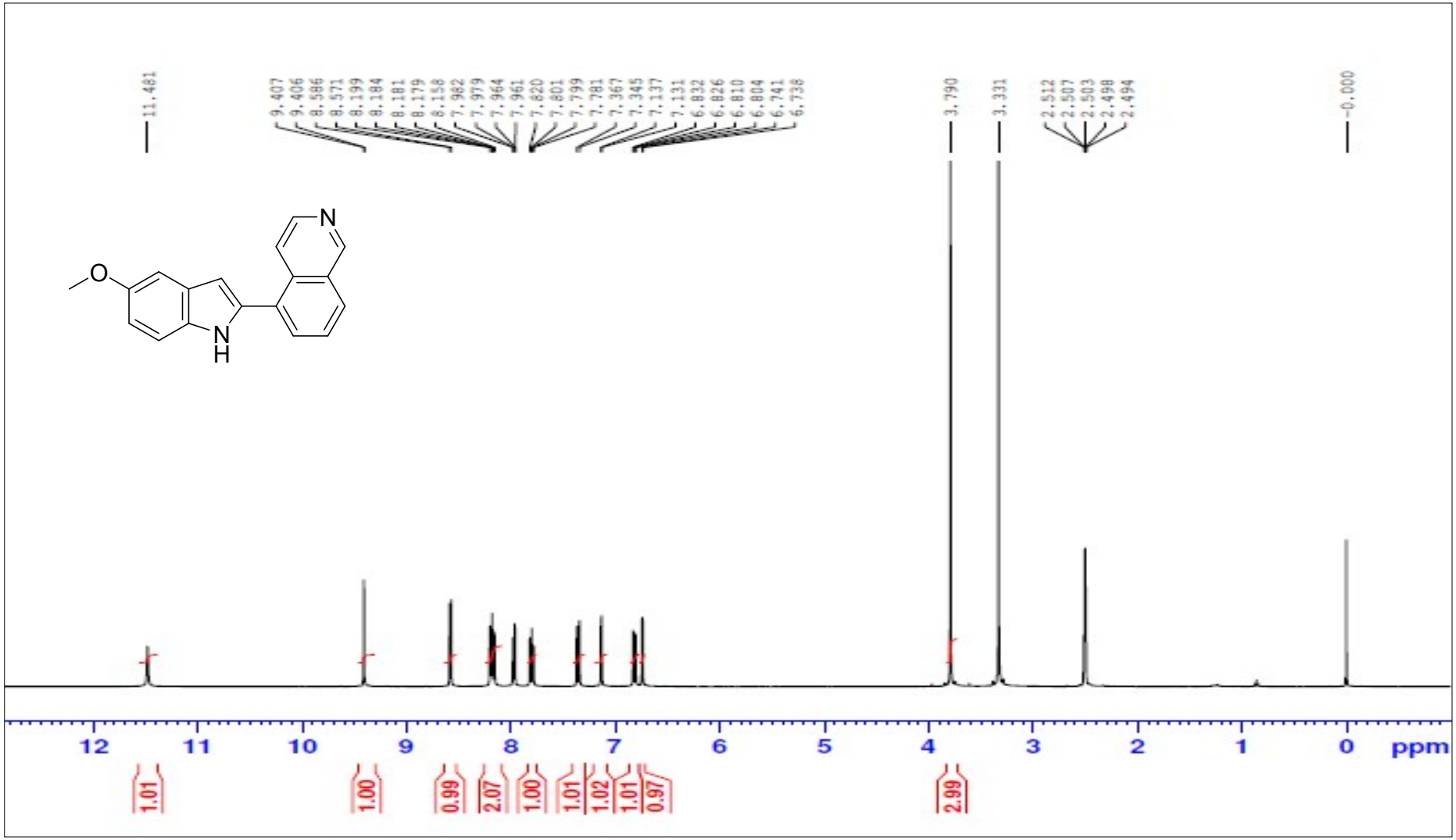


Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
256.1081	256.1086	-0.5	-2.0	9.5	827008.8	C14 H14 N3 O2

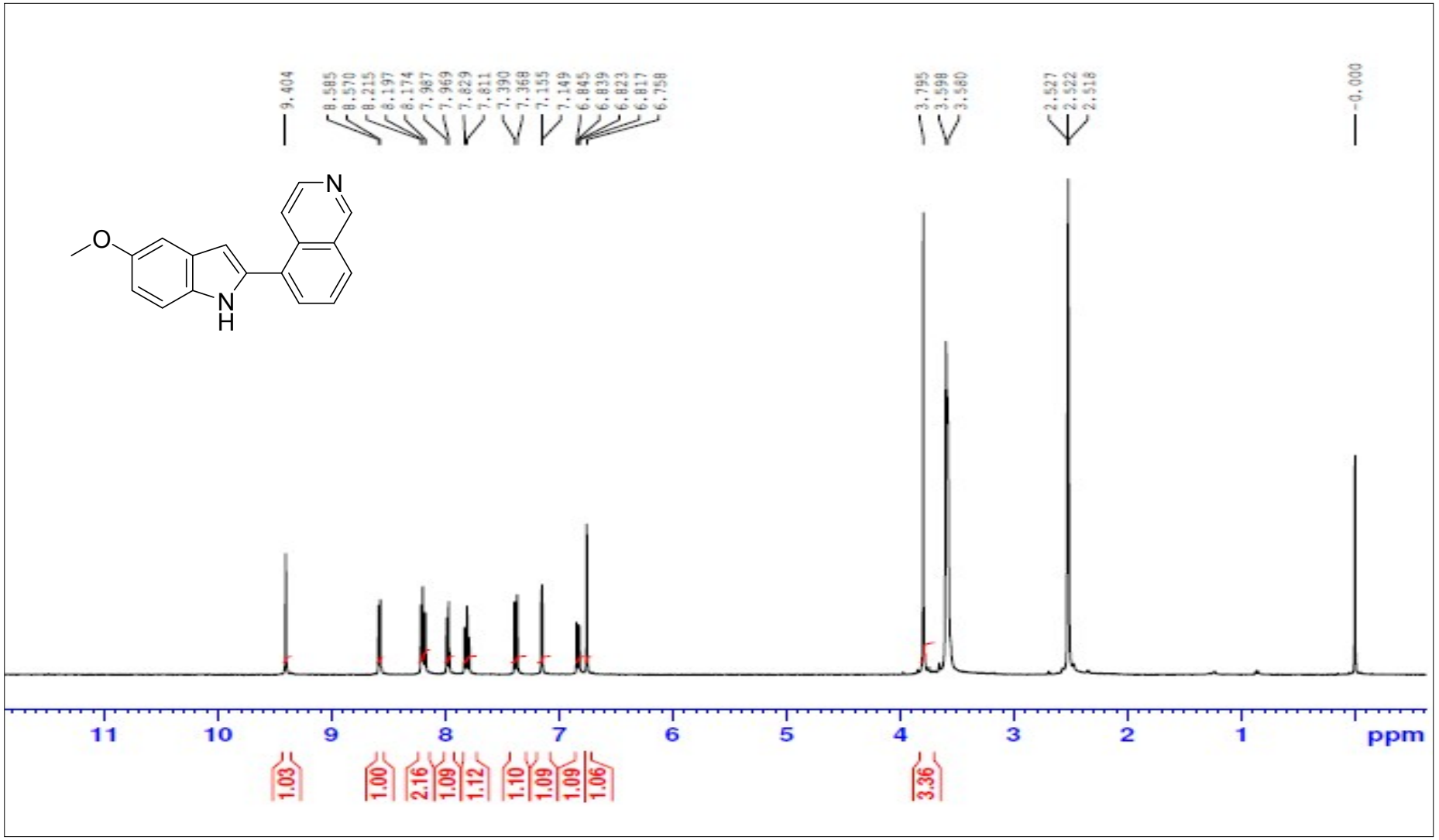
IR spectrum of Compound 3a



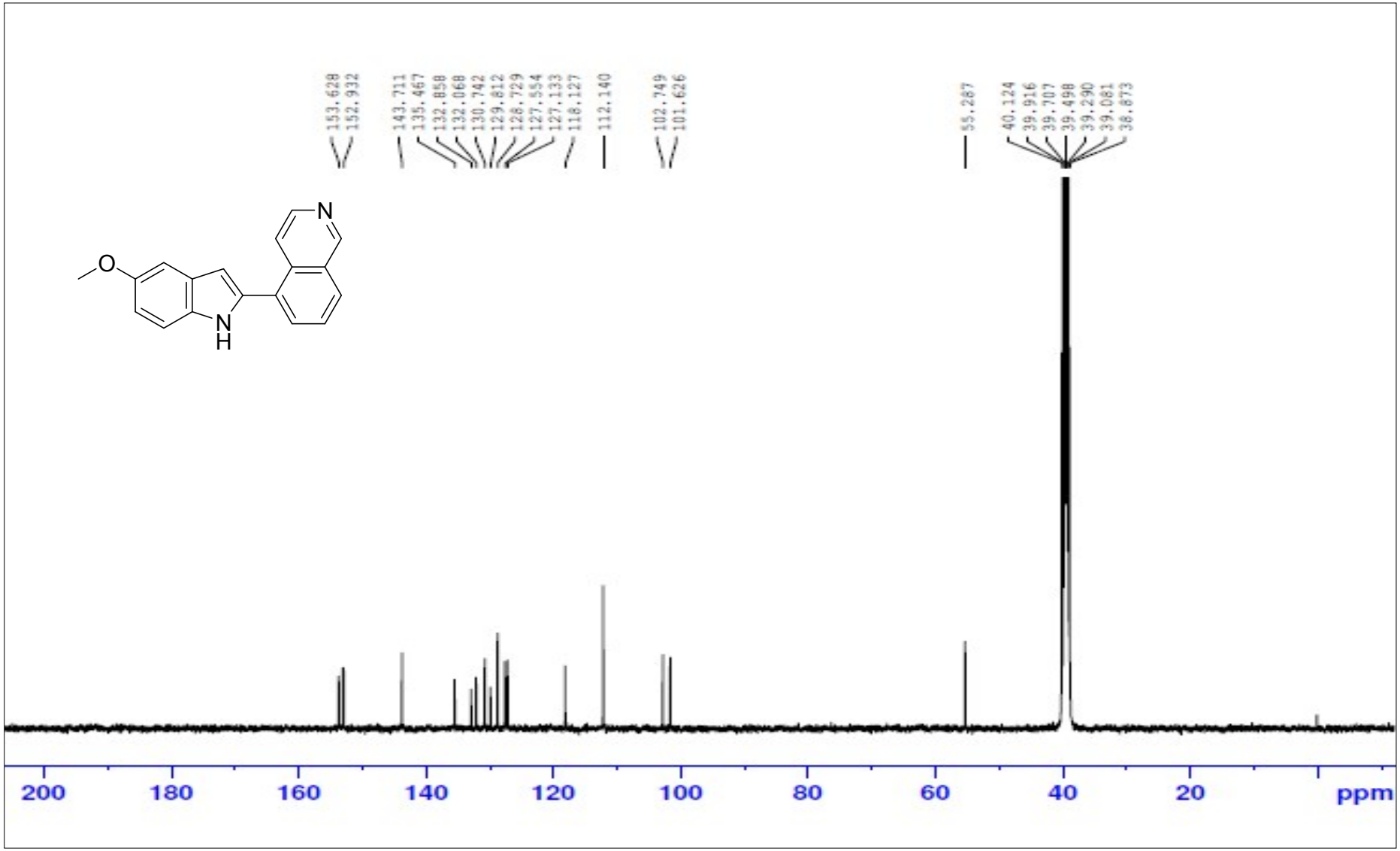
^{1}H NMR of compound 3b in DMSO-D_6 at 400 MHz



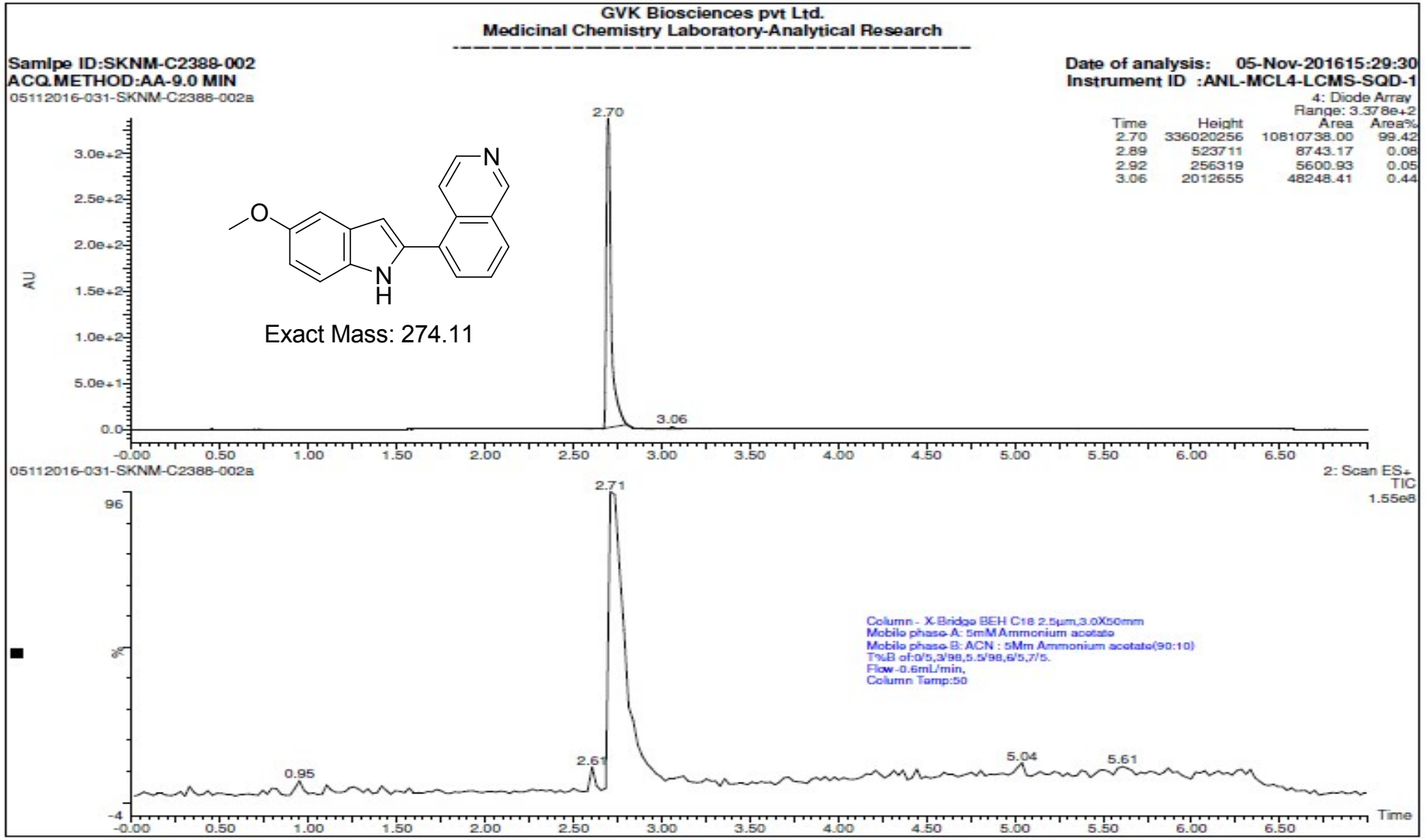
^{1}H NMR of compound 3b in DMSO-D_6 D_2O exchange at 400 MHz

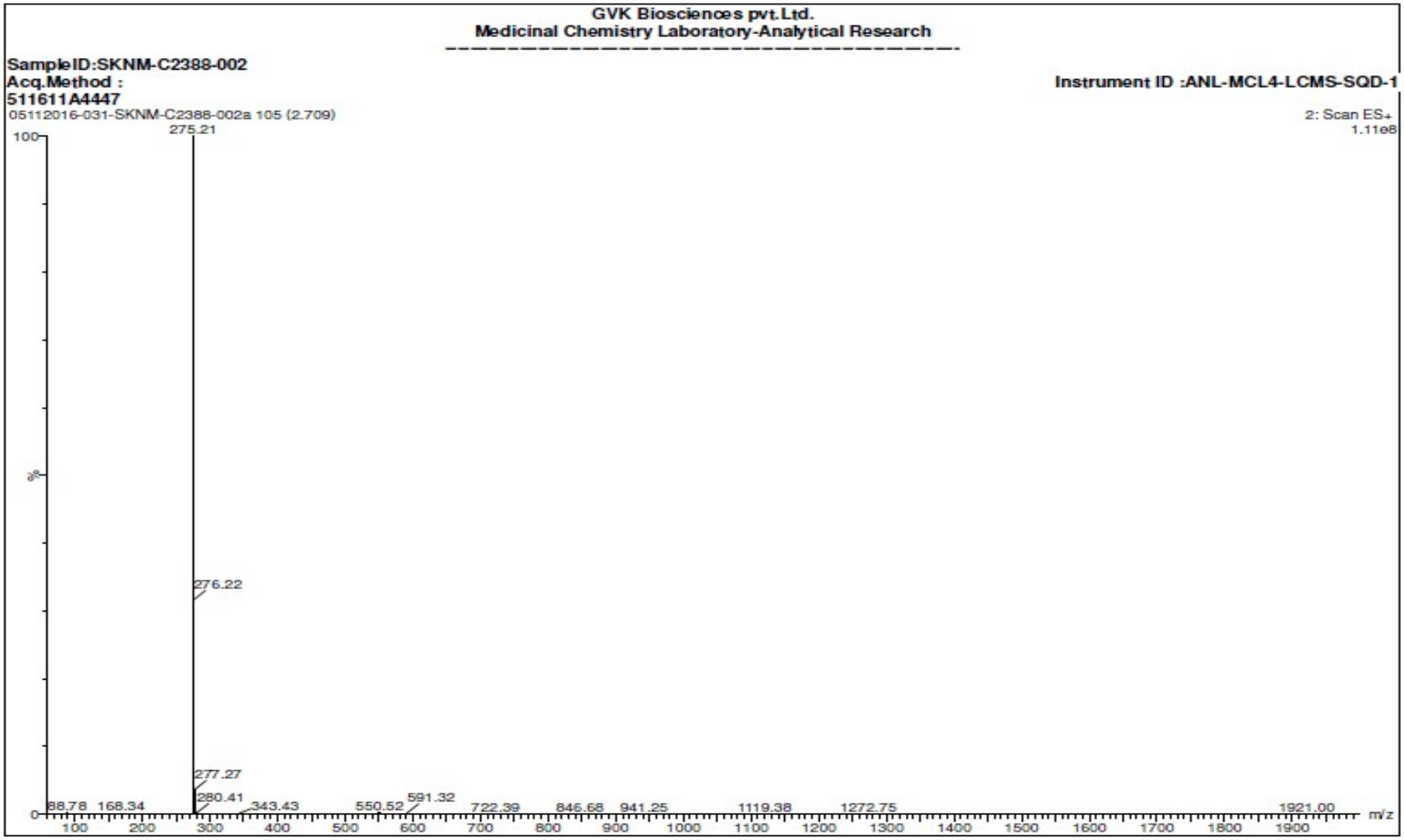


^{13}C NMR of compound 3b in DMSO-D_6 at 100 MHz



LCMS spectrum of Compound-3b




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C2388-002
Acq.Method :
511611A4447
Instrument ID :ANL-MCL4-LCMS-SQD-1
05112016-031-SKNM-C2388-002a 105 (2.709)
2: Scan ES+
1.11e8
100
%
0
275.21
276.22
277.27
280.41
88.78
168.34
343.43
550.52
591.32
722.39
846.68
941.25
1119.38
1272.75
1921.00
m/z
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

HRMS spectrum of Compound-3b

Elemental Composition Report

Page 1

Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0

Selected filters: None

Monoisotopic Mass, Even Electron Ions

2 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)

Elements Used:

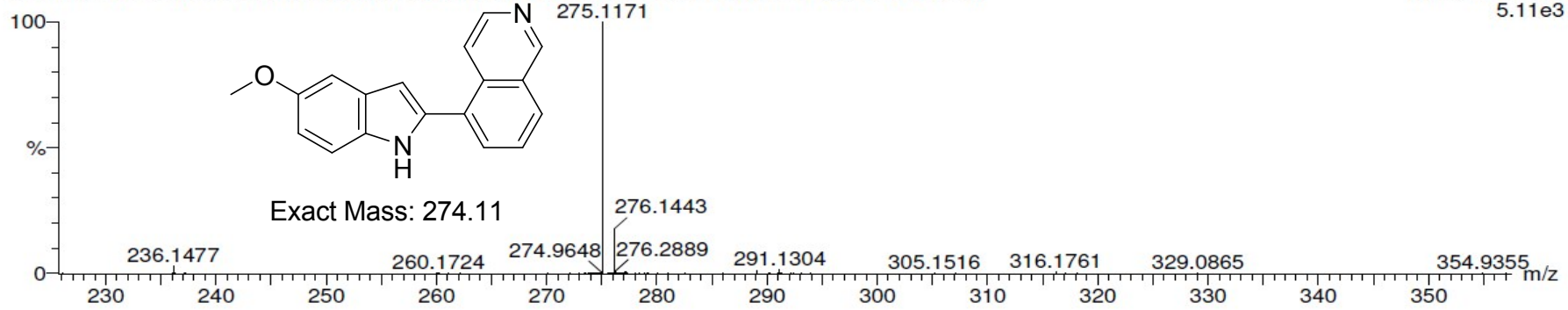
C: 0-18 H: 0-15 N: 0-2 O: 0-1

SKNM-C2388-002

511611B4445 22 (0.331) AM (Top,4, Ar,5000.0,195.13,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

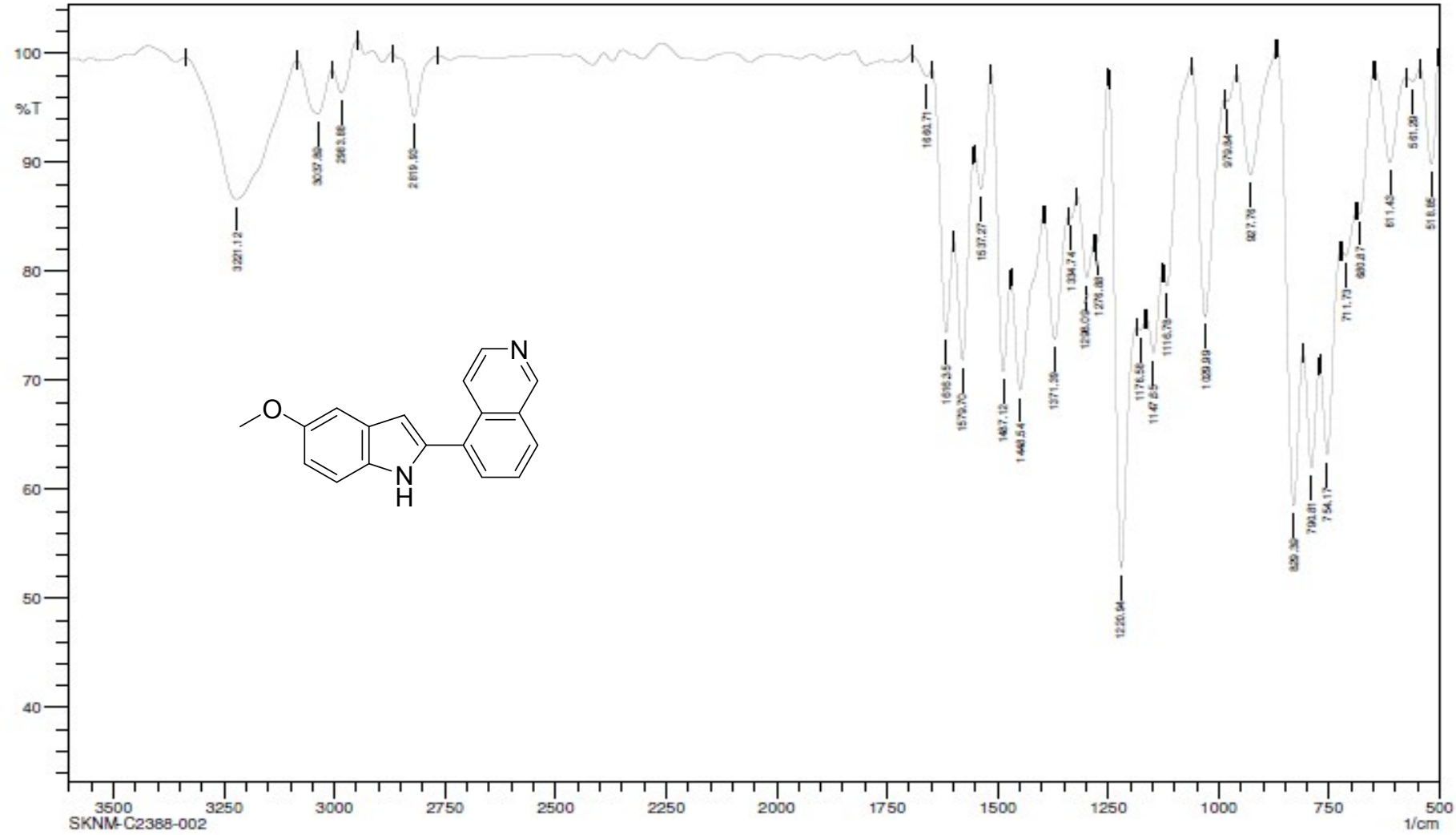
1: TOF MS ES+

5.11e3

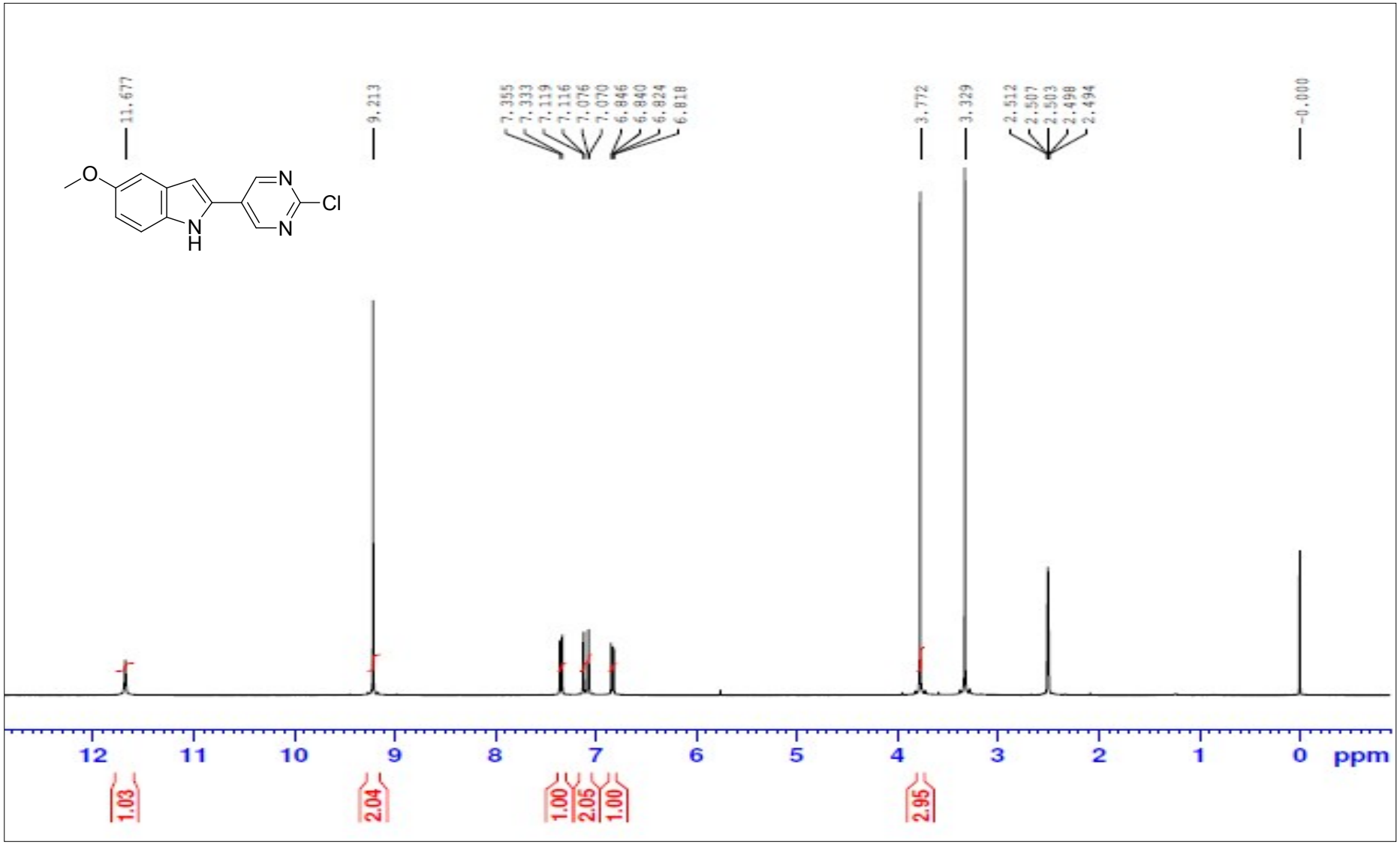


Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
275.1171	275.1184	-1.3	-4.7	12.5	947712.8	C18 H15 N2 O

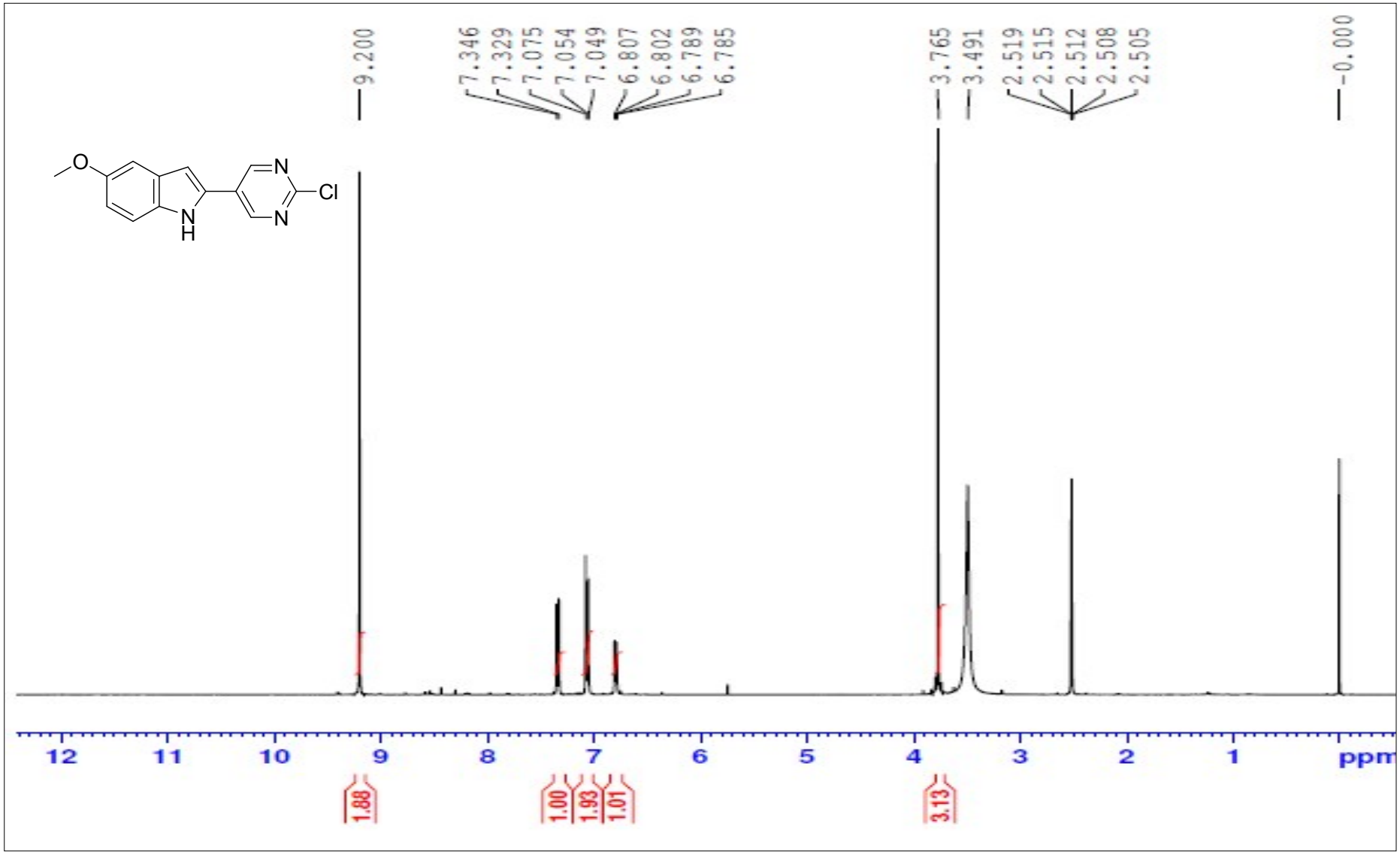
IR spectrum of Compound 3b



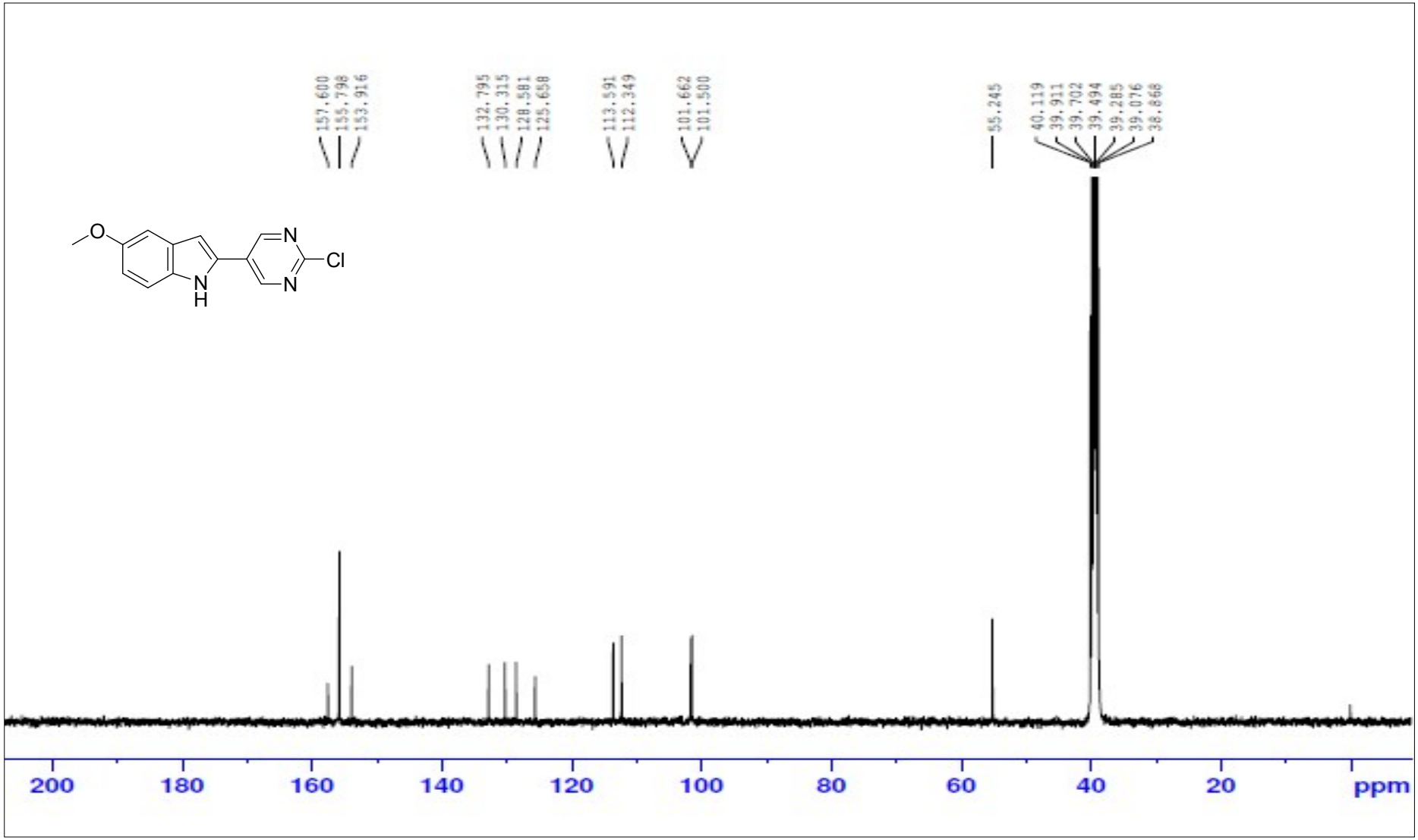
^{1}H NMR of compound 3c in DMSO-D_6 at 400 MHz



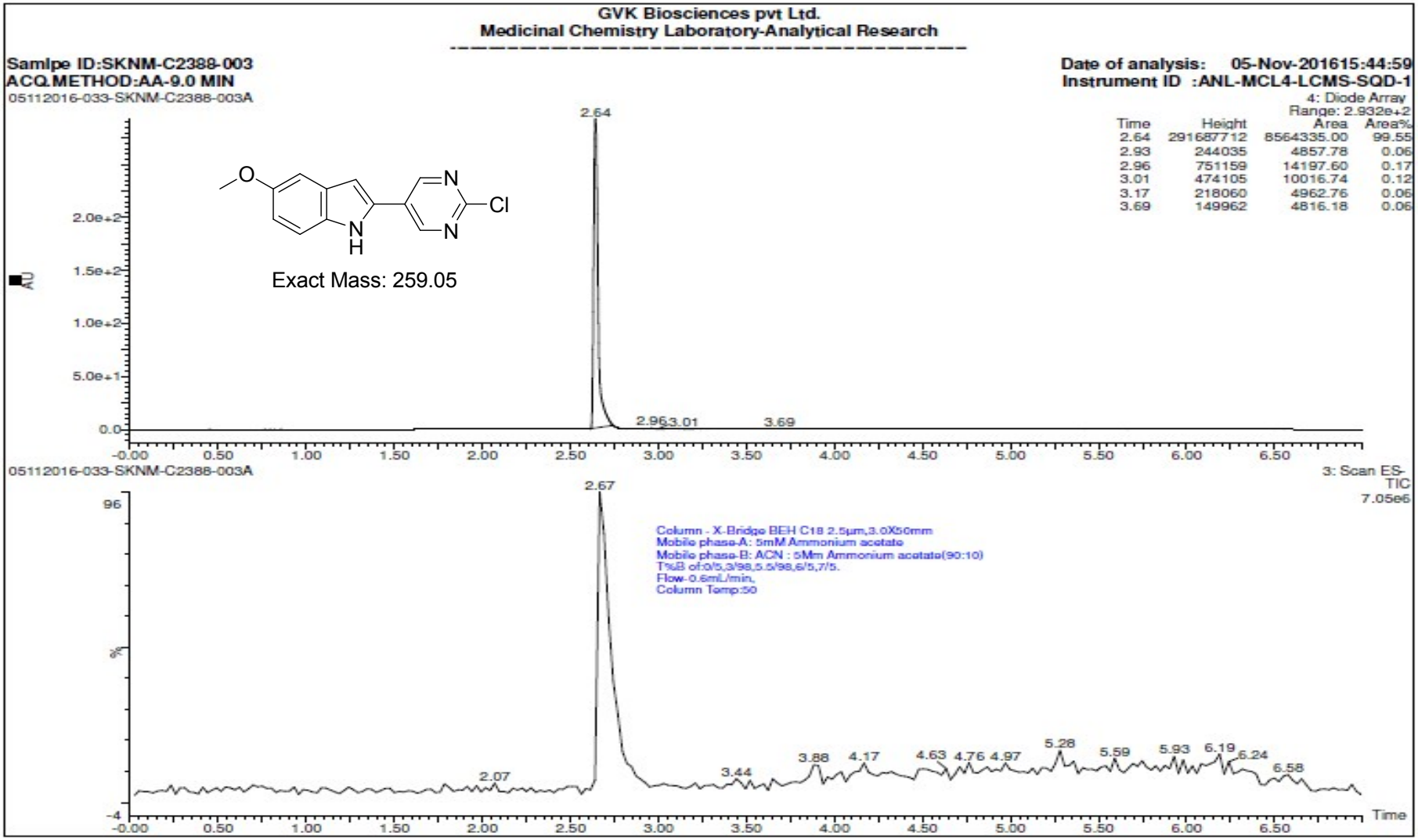
^{1}H NMR of compound 3c in DMSO-D_6 D_2O exchange at 500 MHz

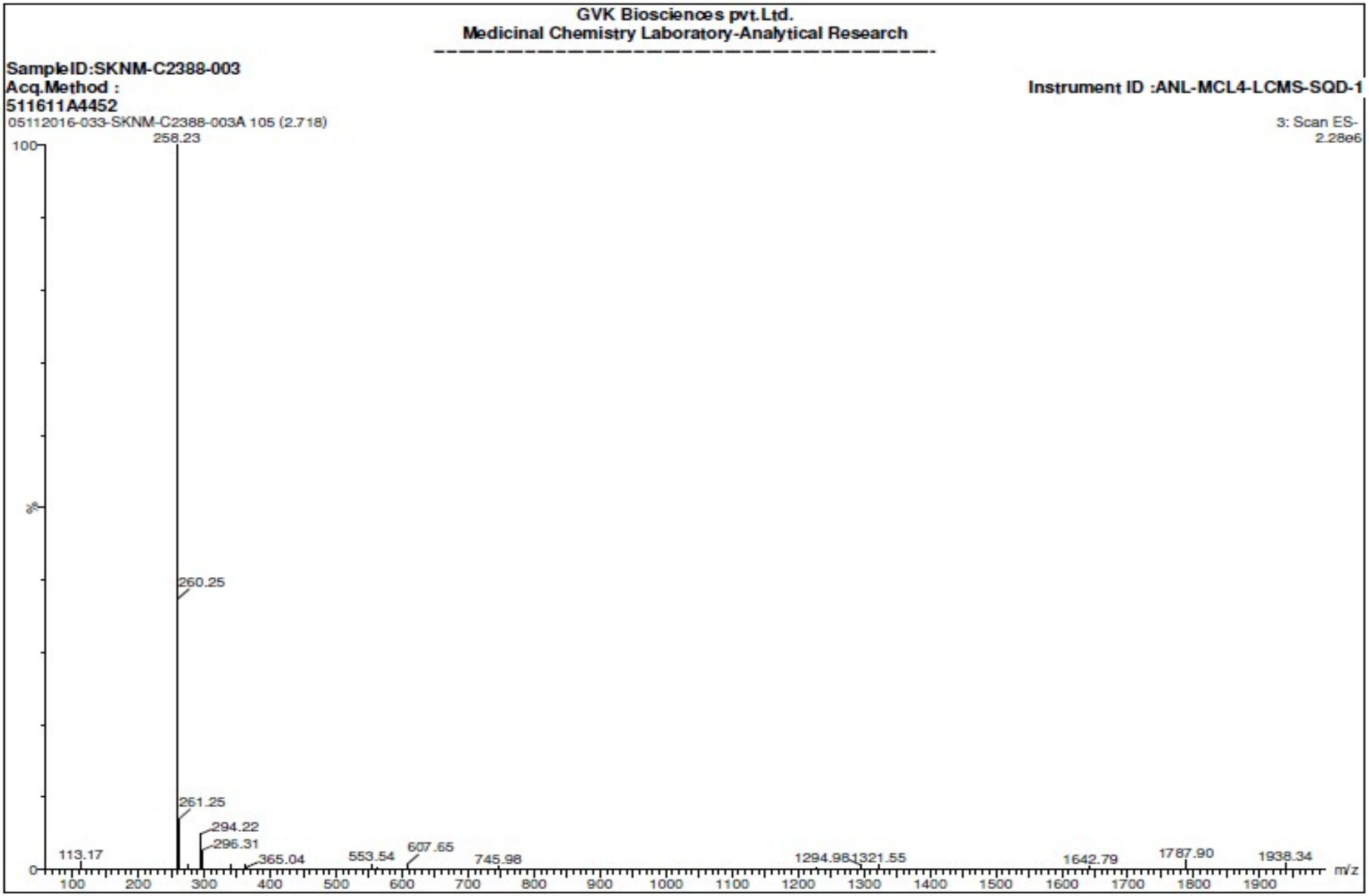


^{13}C NMR of compound 3c in DMSO-D_6 at 100 MHz



LCMS spectrum of Compound-3c




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C2388-003
Acq.Method :
511611A4452
Instrument ID :ANL-MCL4-LCMS-SQD-1
05112016-033-SKNM-C2388-003A 105 (2.718)
3: Scan ES-
2.28e6
100
%
0
258.23
260.25
261.25
294.22
296.31
113.17
365.04
553.54
607.65
745.98
1294.96
1321.55
1642.79
1787.90
1938.34
m/z
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

HRMS spectrum of Compound-3c

Elemental Composition Report

Page 1

Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0

Selected filters: None

Monoisotopic Mass, Even Electron Ions

14 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)

Elements Used:

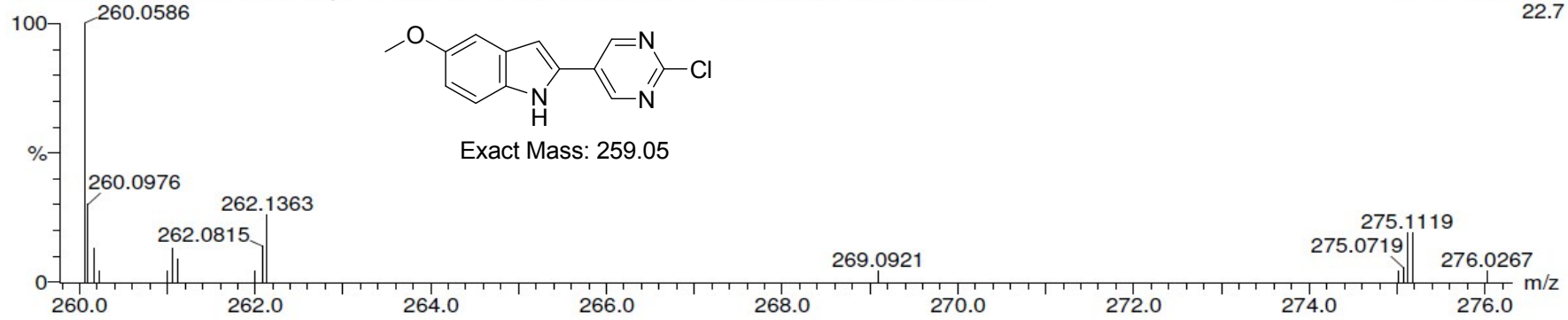
C: 0-13 H: 0-11 N: 0-3 O: 0-1 Cl: 0-1

SKNM-C2388-003

511611B4460 21 (0.287) AM (Top,4, Ar,5000.0,195.12,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

1: TOF MS ES+

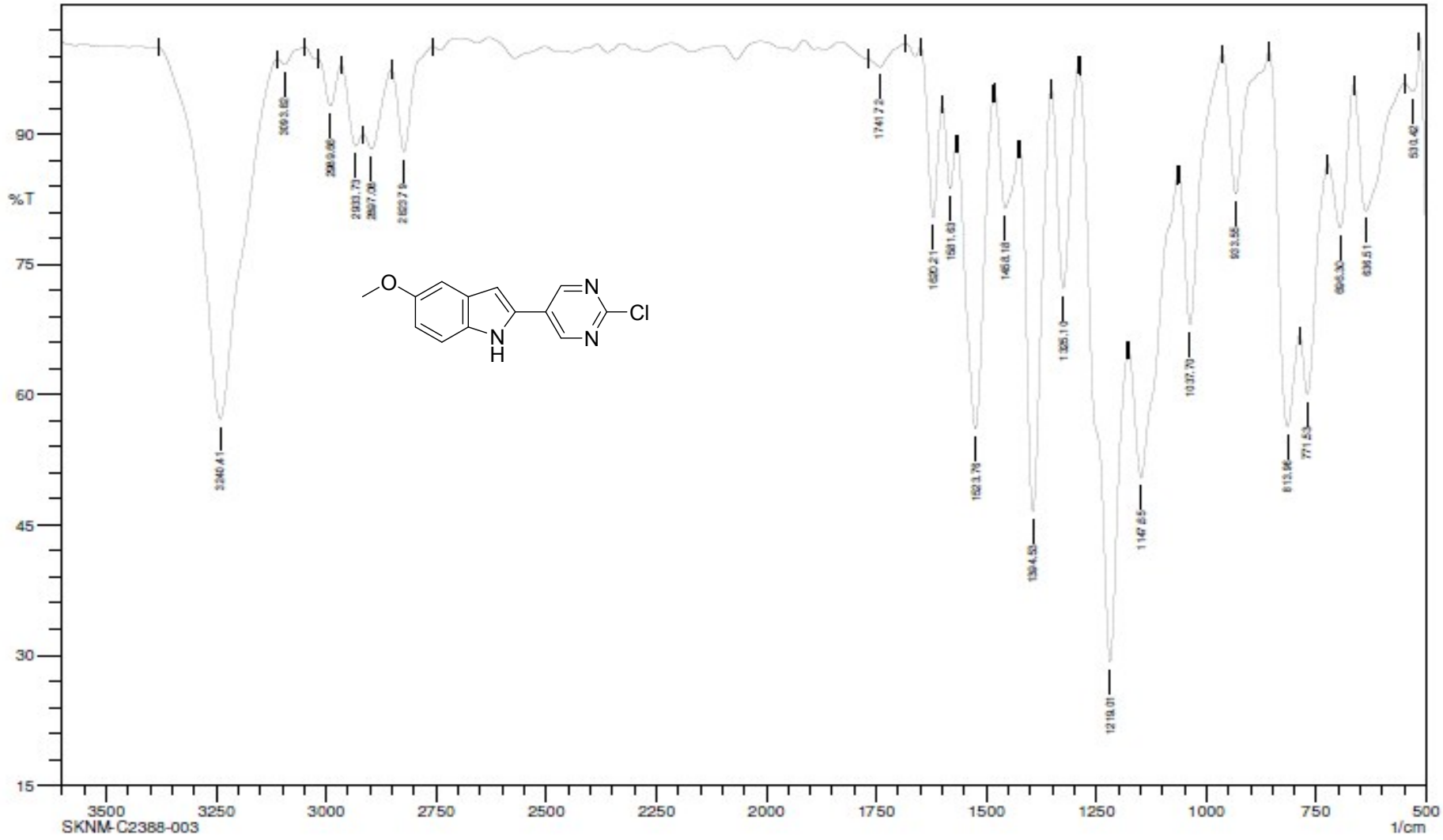
22.7



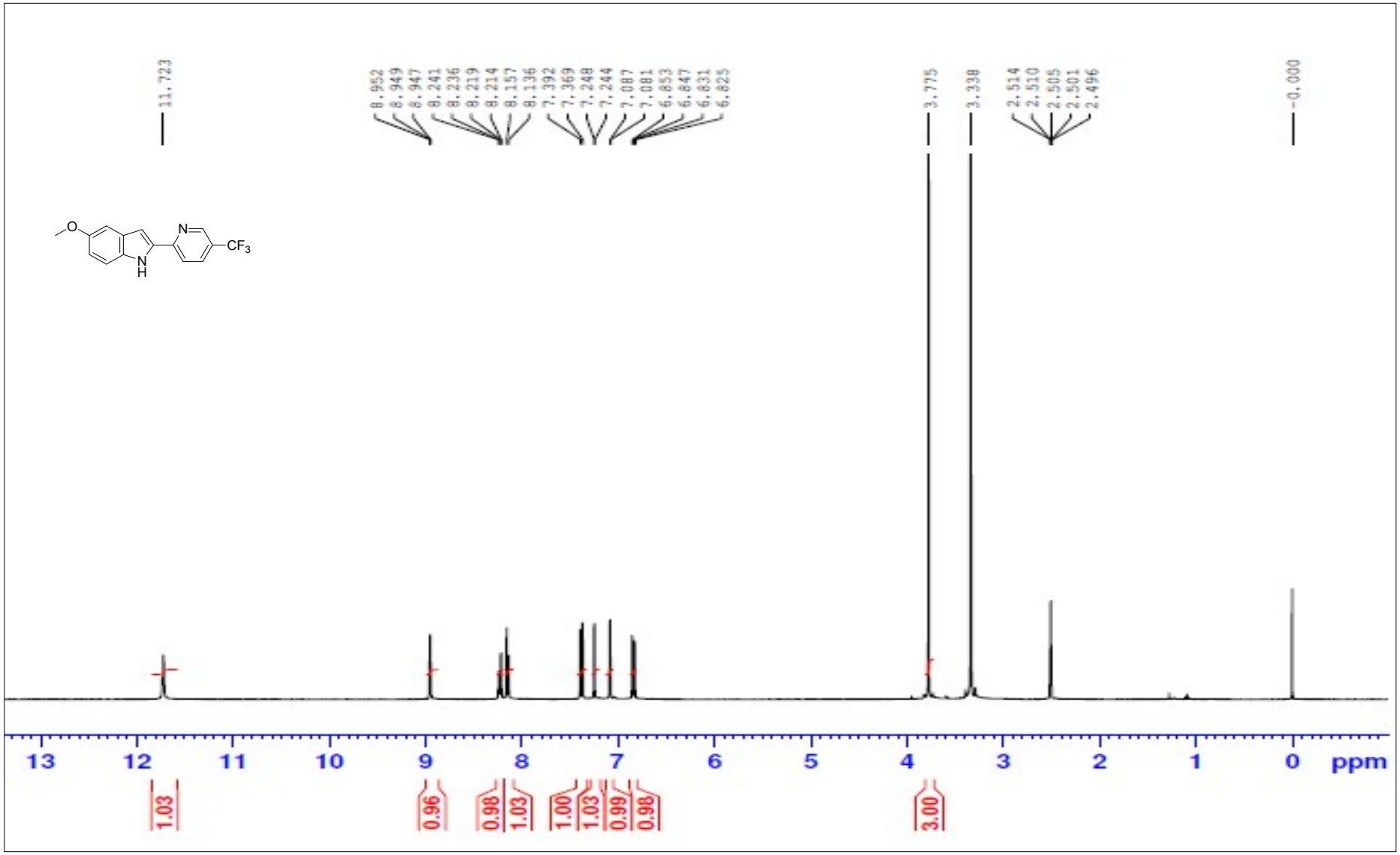
Exact Mass: 259.05

Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
260.0586	260.0591	-0.5	-1.9	9.5	4658.0	C13 H11 N3 O Cl

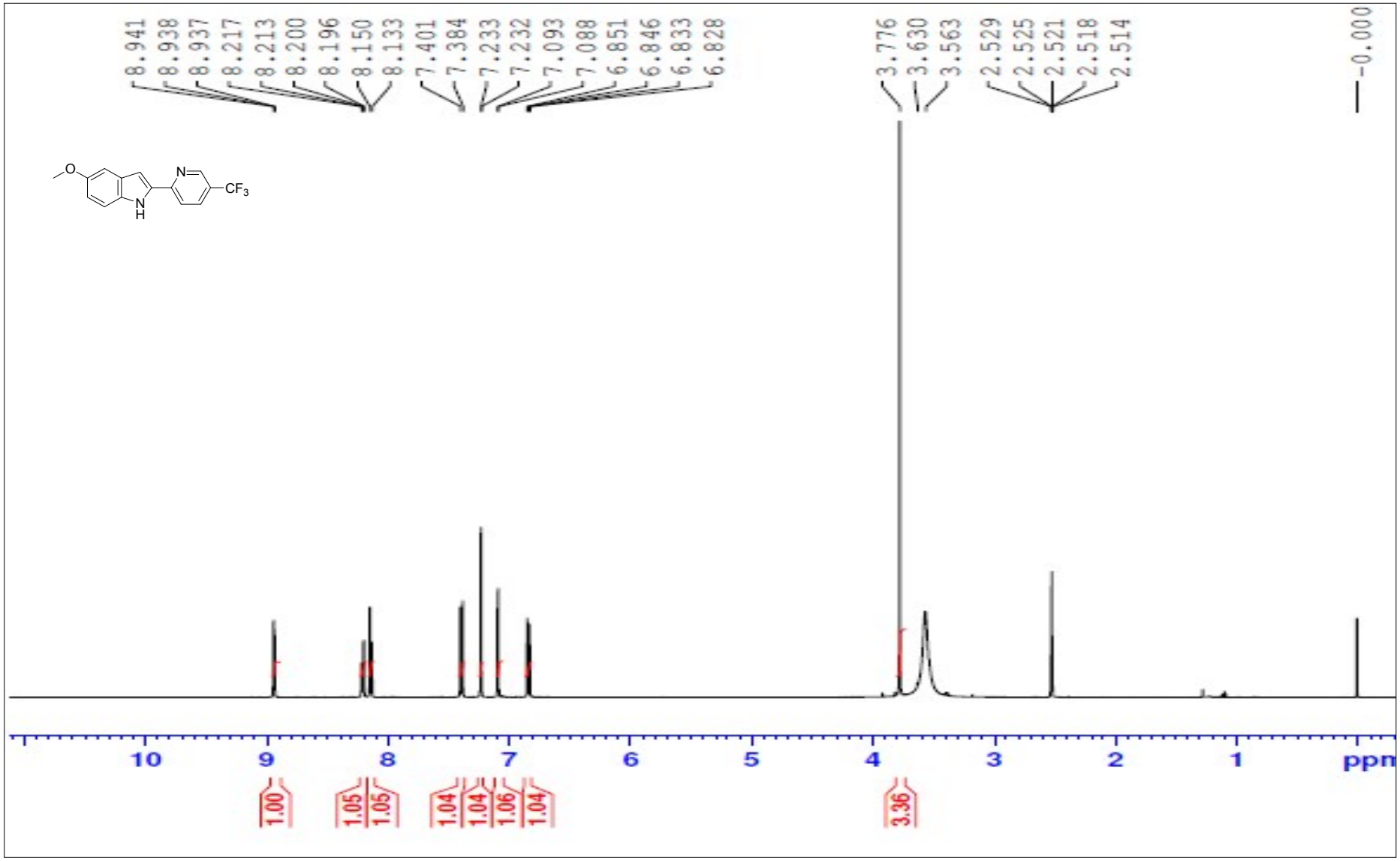
IR spectrum of Compound 3c



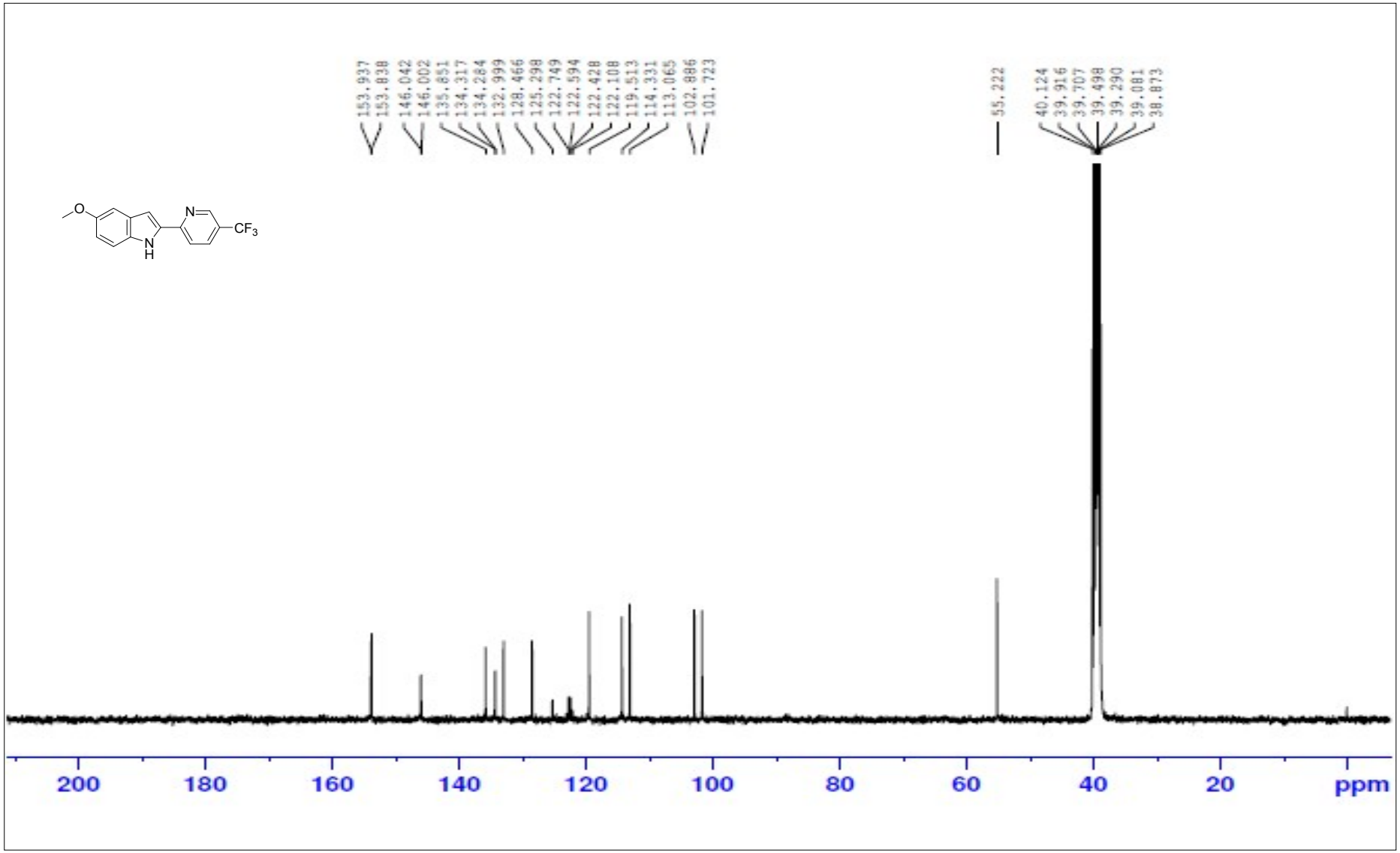
^{1}H NMR of compound 3d in DMSO-D_6 at 400 MHz



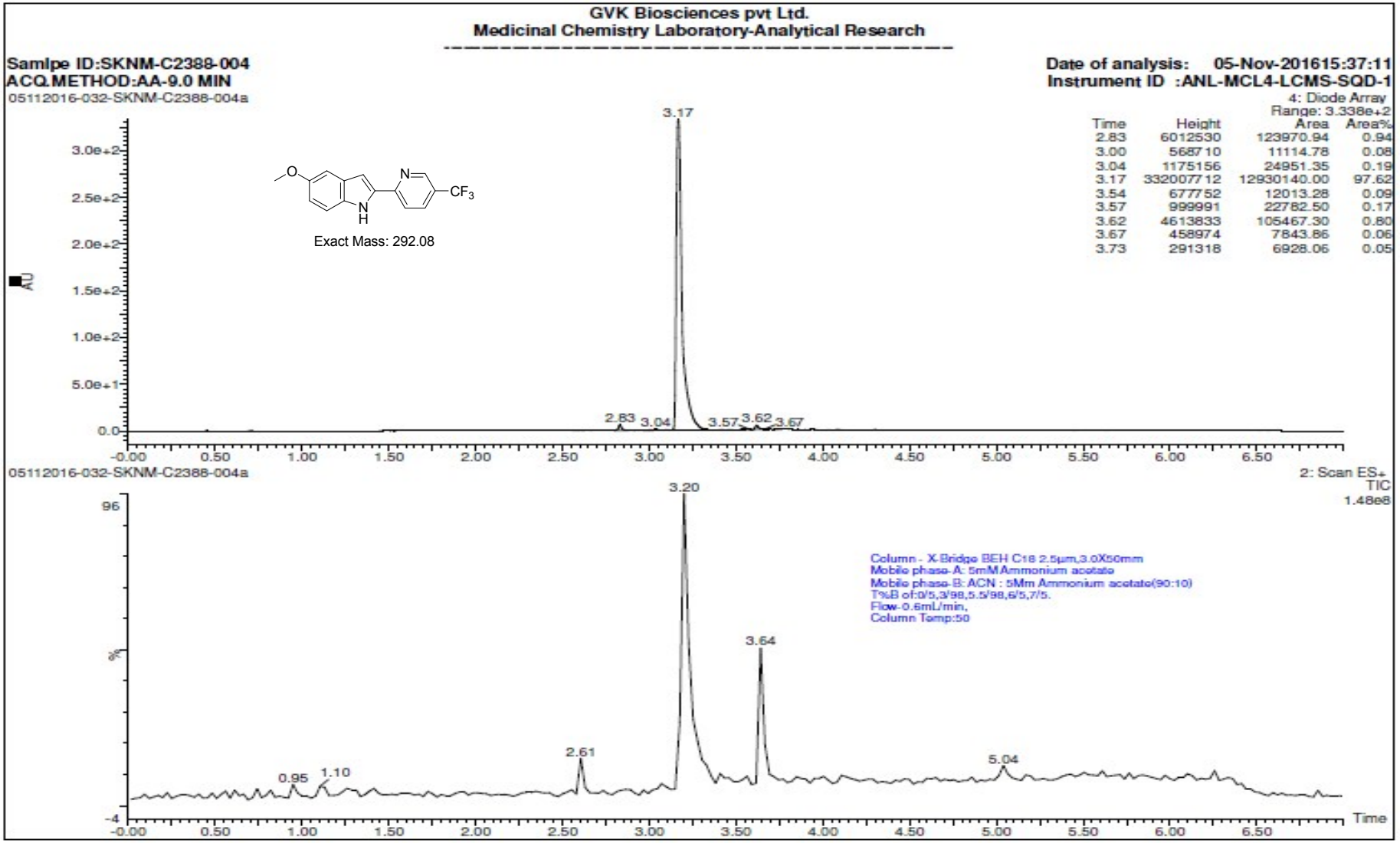
^{1}H NMR of compound 3d in DMSO-D_6 D_2O exchange at 500 MHz

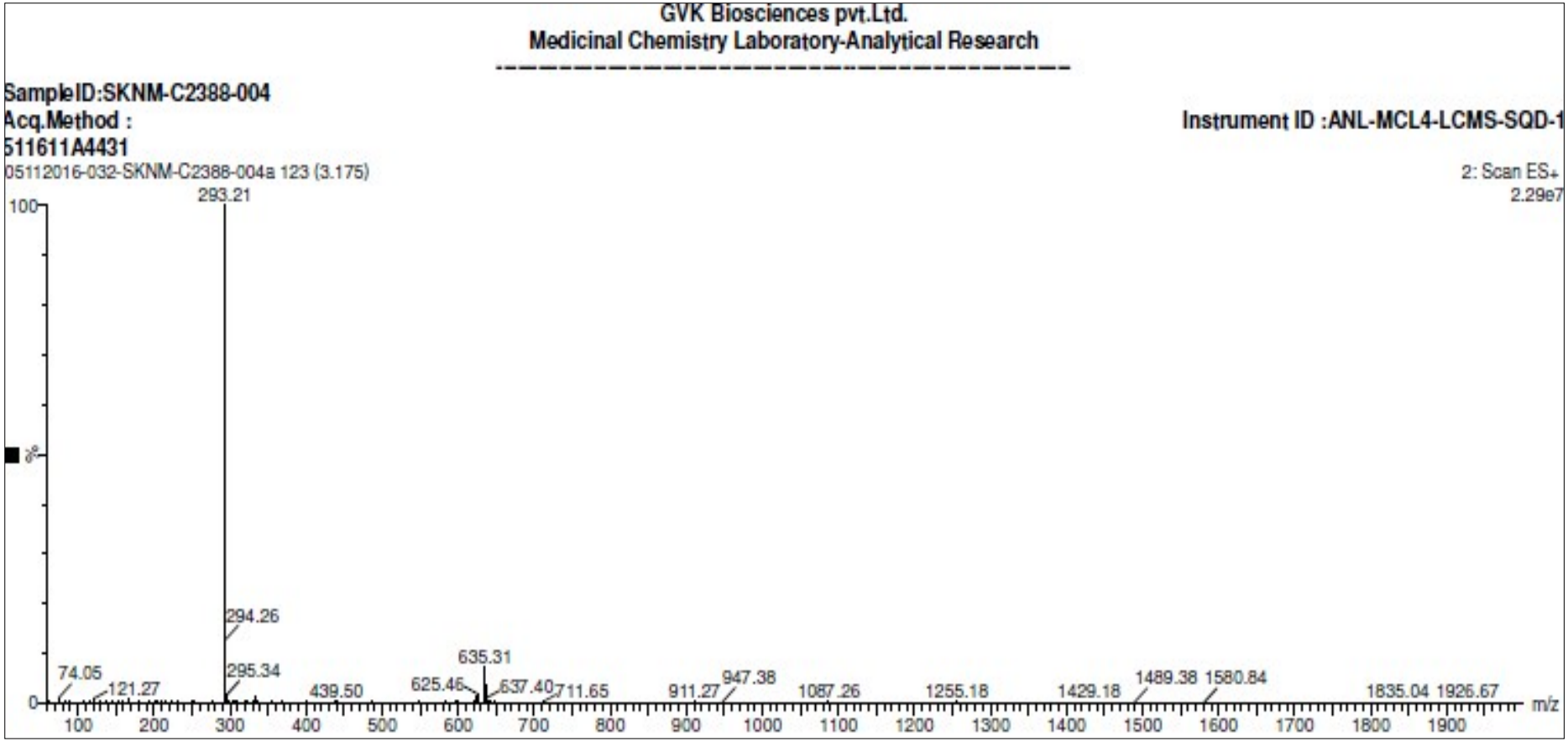


^{13}C NMR of compound 3d in DMSO-D_6 at 100 MHz



LCMS spectrum of Compound-3d




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C2388-004
Acq.Method :
511611A4431
Instrument ID :ANL-MCL4-LCMS-SQD-1
05112016-032-SKNM-C2388-004a 123 (3.175)
2: Scan ES+
2.29e7
100
%
0
293.21
294.26
295.34
74.05
121.27
439.50
625.46
635.31
637.40
711.65
911.27
947.38
1087.26
1255.18
1429.18
1489.38
1580.84
1835.04
1926.67
m/z
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

HRMS spectrum of Compound-3d

Elemental Composition Report

Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0

Selected filters: None

Monoisotopic Mass, Even Electron Ions

21 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)

Elements Used:

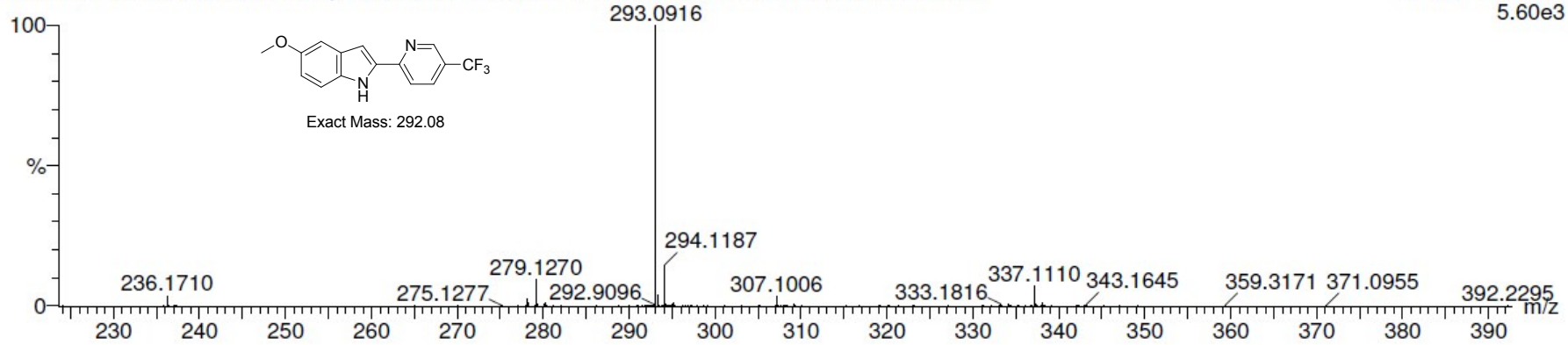
C: 0-15 H: 0-12 N: 0-2 O: 0-1 F: 0-3

SKNM-C2388-004

511611B4432 22 (0.331) AM (Top,4, Ar,5000.0,195.16,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

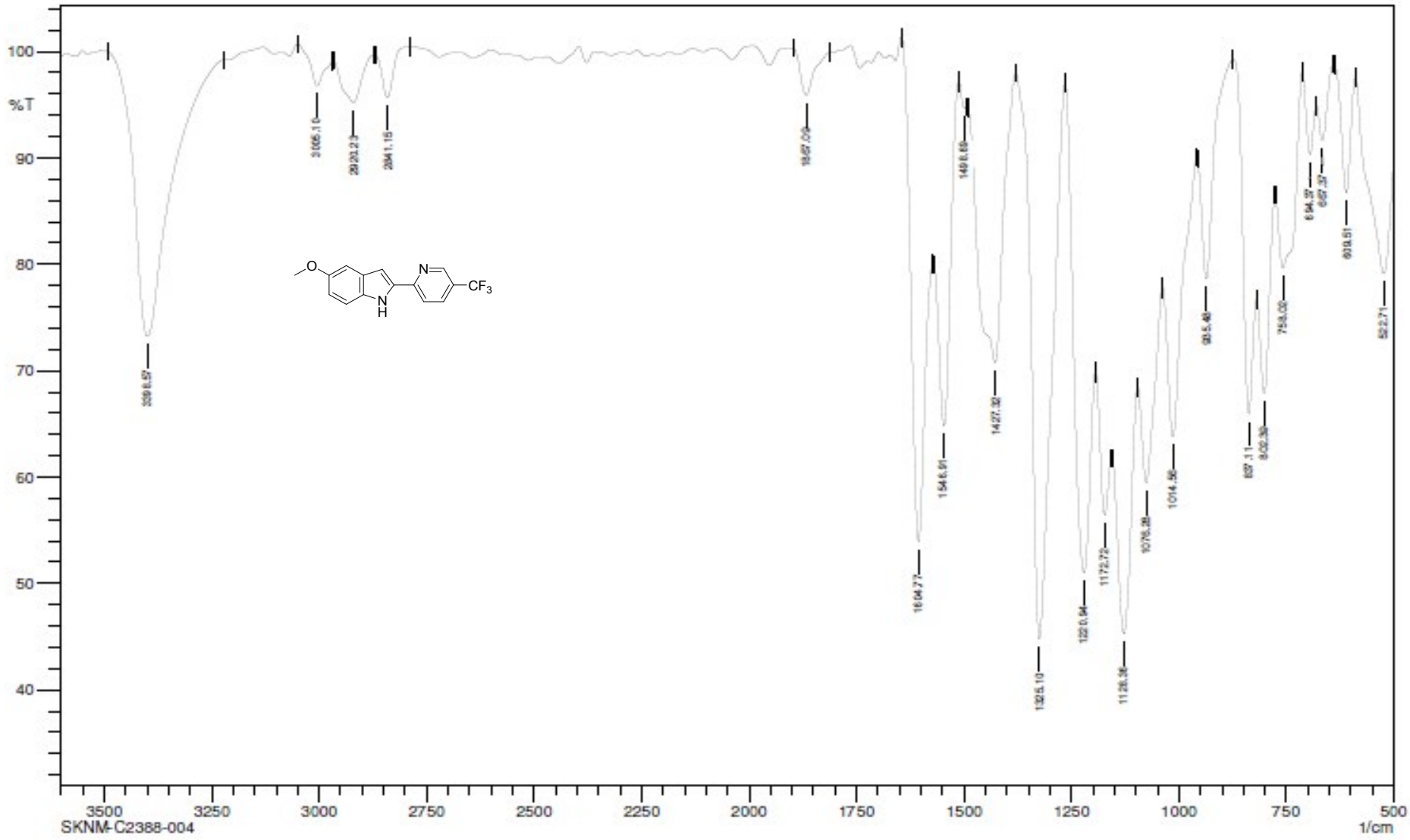
1: TOF MS ES+

5.60e3

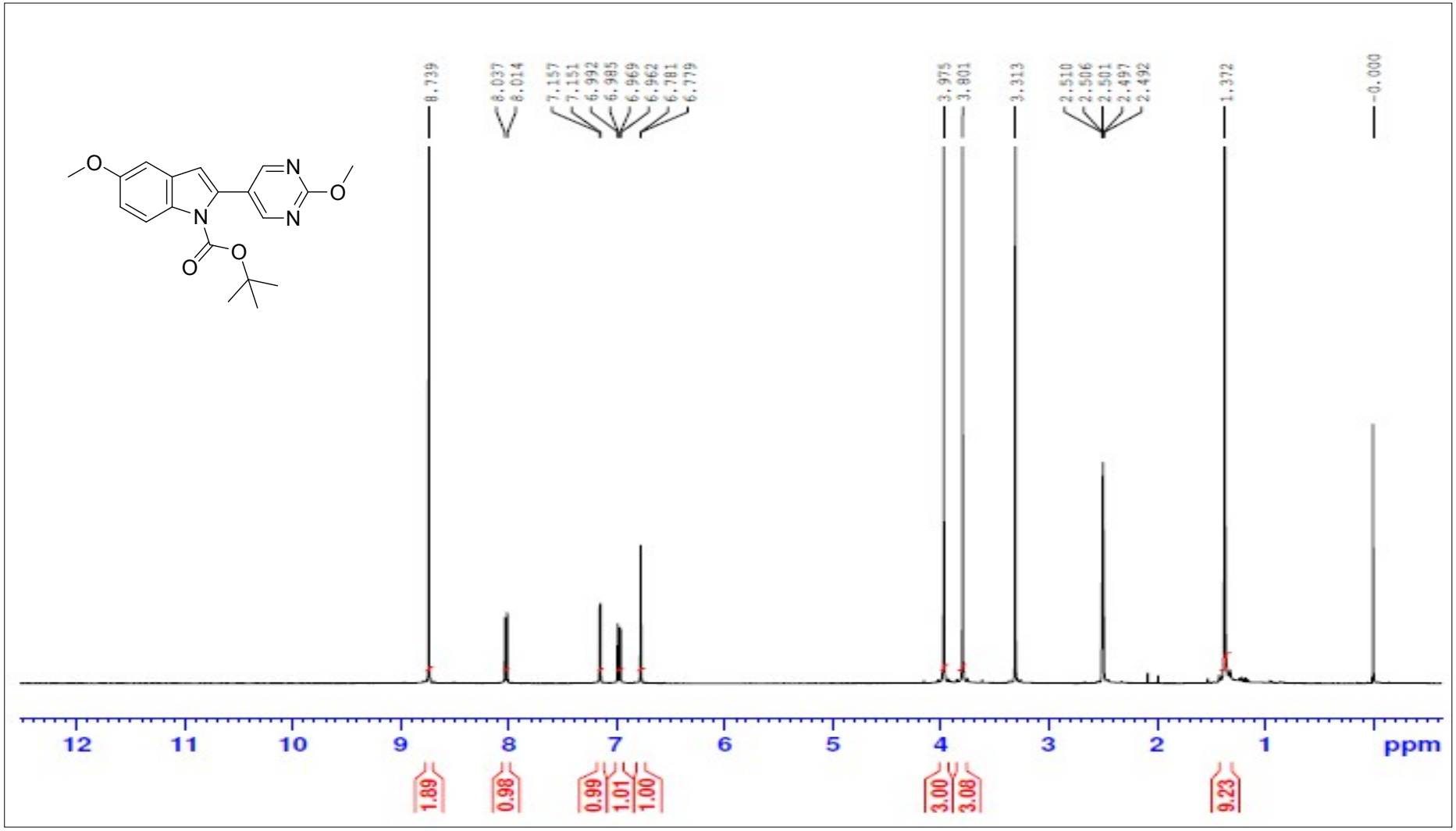


Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
293.0916	293.0902	1.4	4.8	9.5	912484.7	C15 H12 N2 O F3

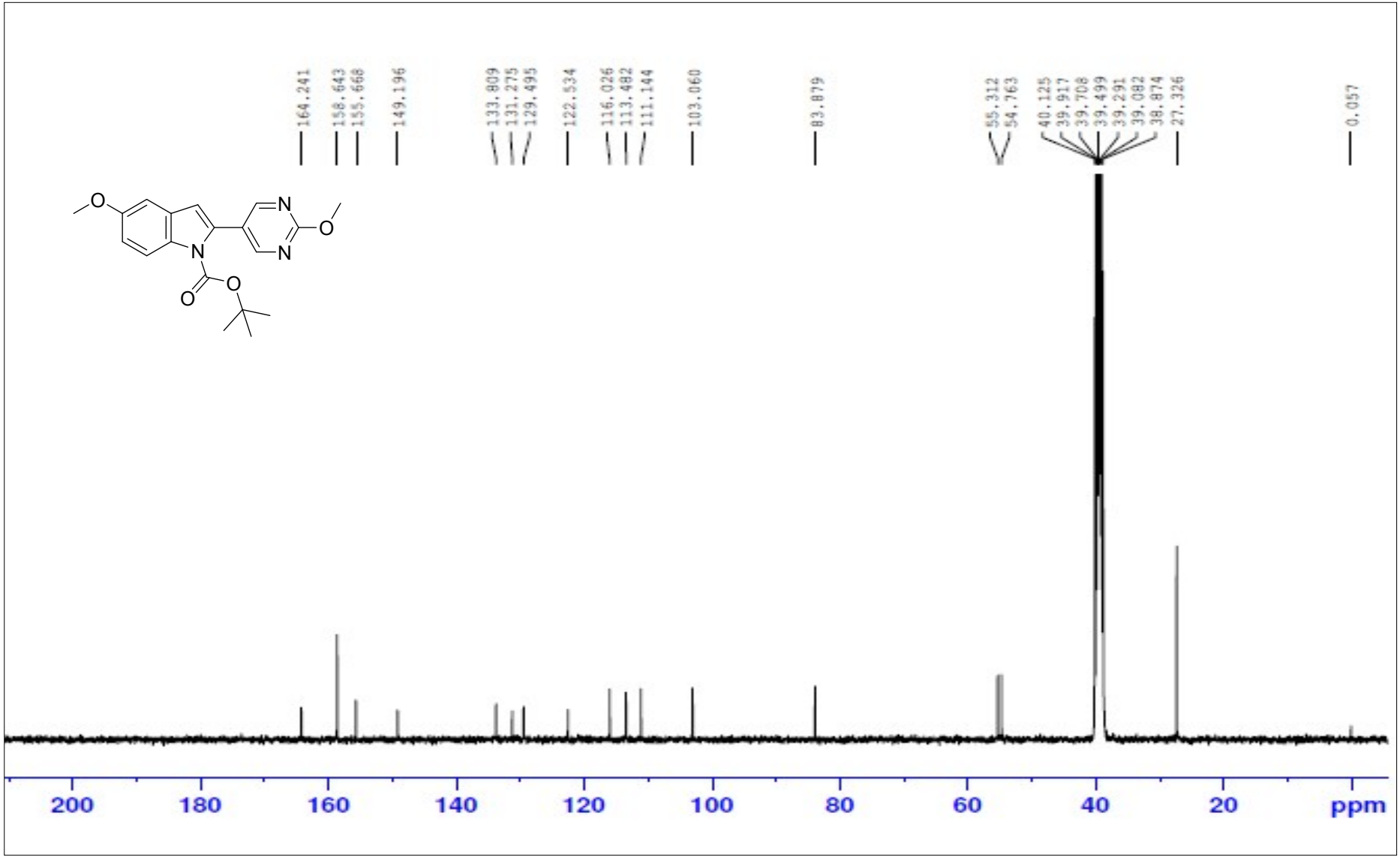
IR spectrum of Compound 3d



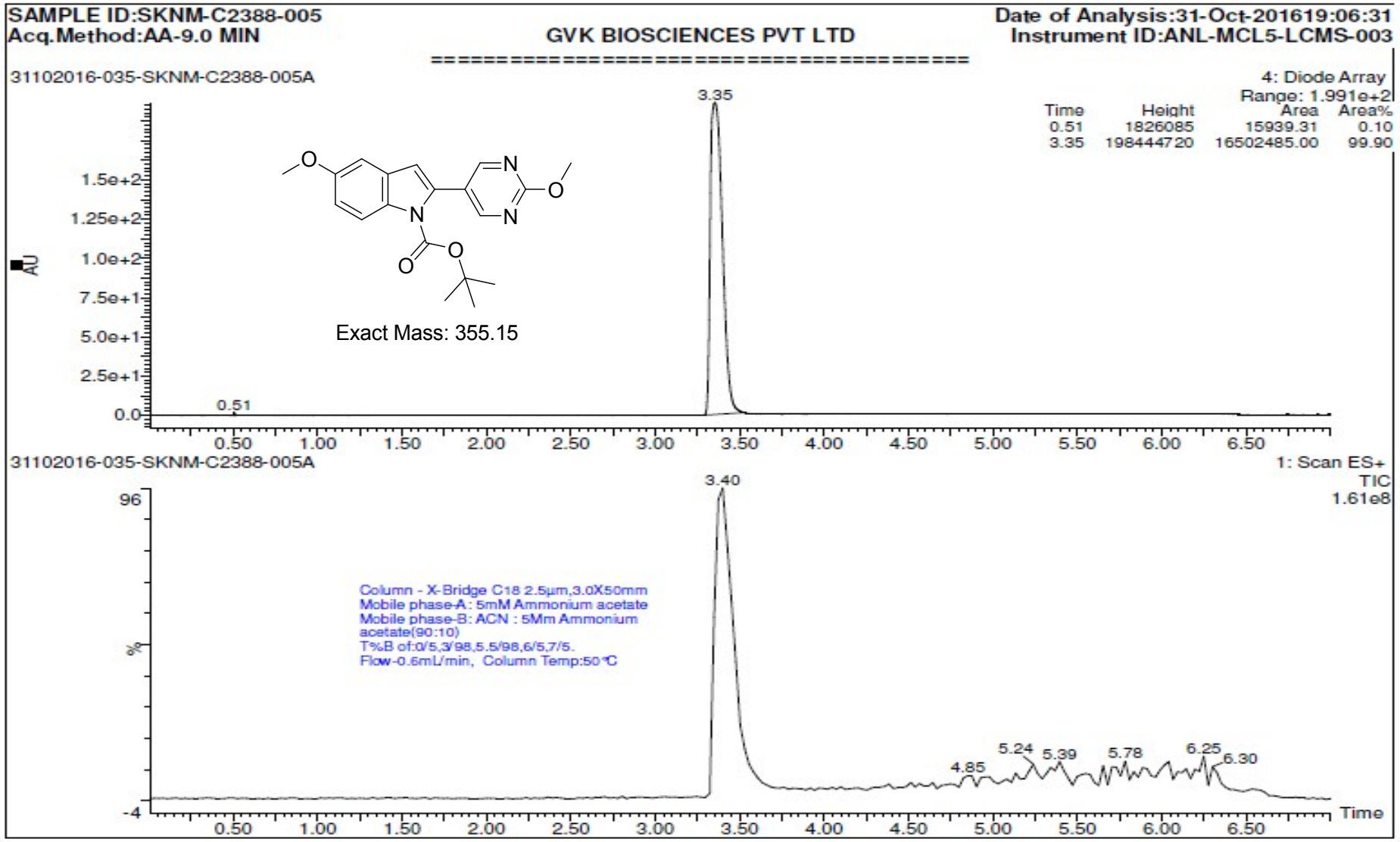
^{1}H NMR of compound 3e in DMSO-D_6 at 400 MHz

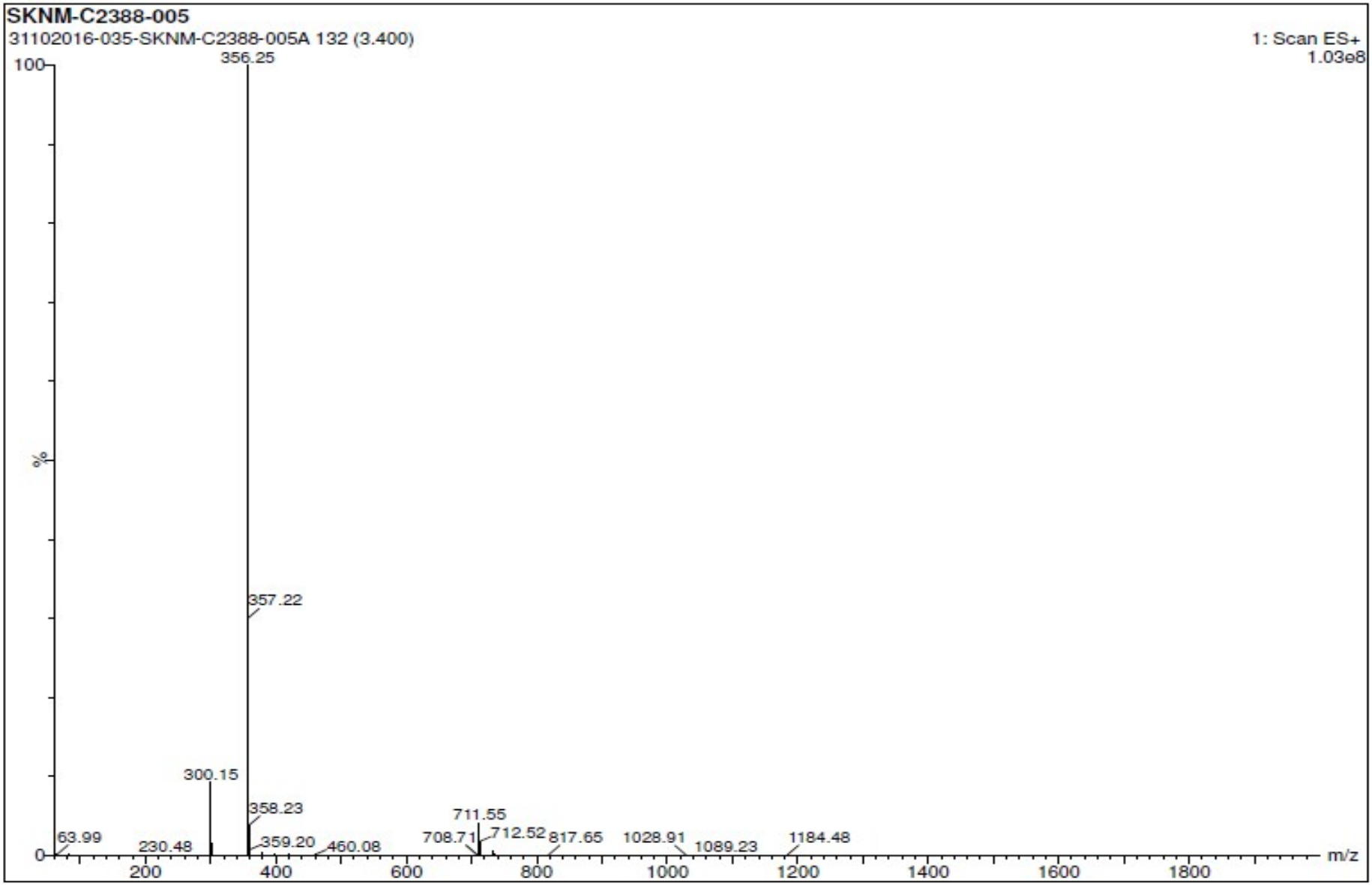


^{13}C NMR of compound 3e in DMSO-D_6 at 100 MHz



LCMS spectrum of Compound-3e




SKNM-C2388-005
31102016-035-SKNM-C2388-005A 132 (3.400)
1: Scan ES+
1.03e8
100
%
0
356.25
357.22
300.15
358.23
711.55
712.52
63.99
230.48
359.20
460.08
708.71
817.65
1028.91
1089.23
1184.48
200
400
600
800
1000
1200
1400
1600
1800
m/z

HRMS spectrum of Compound-3e

Elemental Composition Report

Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0

Selected filters: None

Monoisotopic Mass, Even Electron Ions

16 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)

Elements Used:

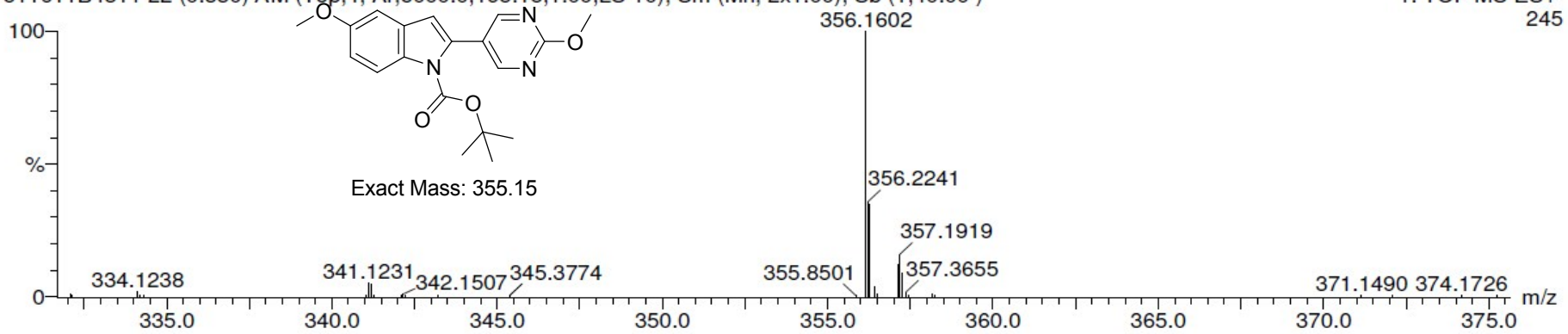
C: 0-19 H: 0-22 N: 0-3 O: 0-4

SKNM-C2388-005

511611B4311 22 (0.330) AM (Top,4, Ar,5000.0,195.15,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

1: TOF MS ES+

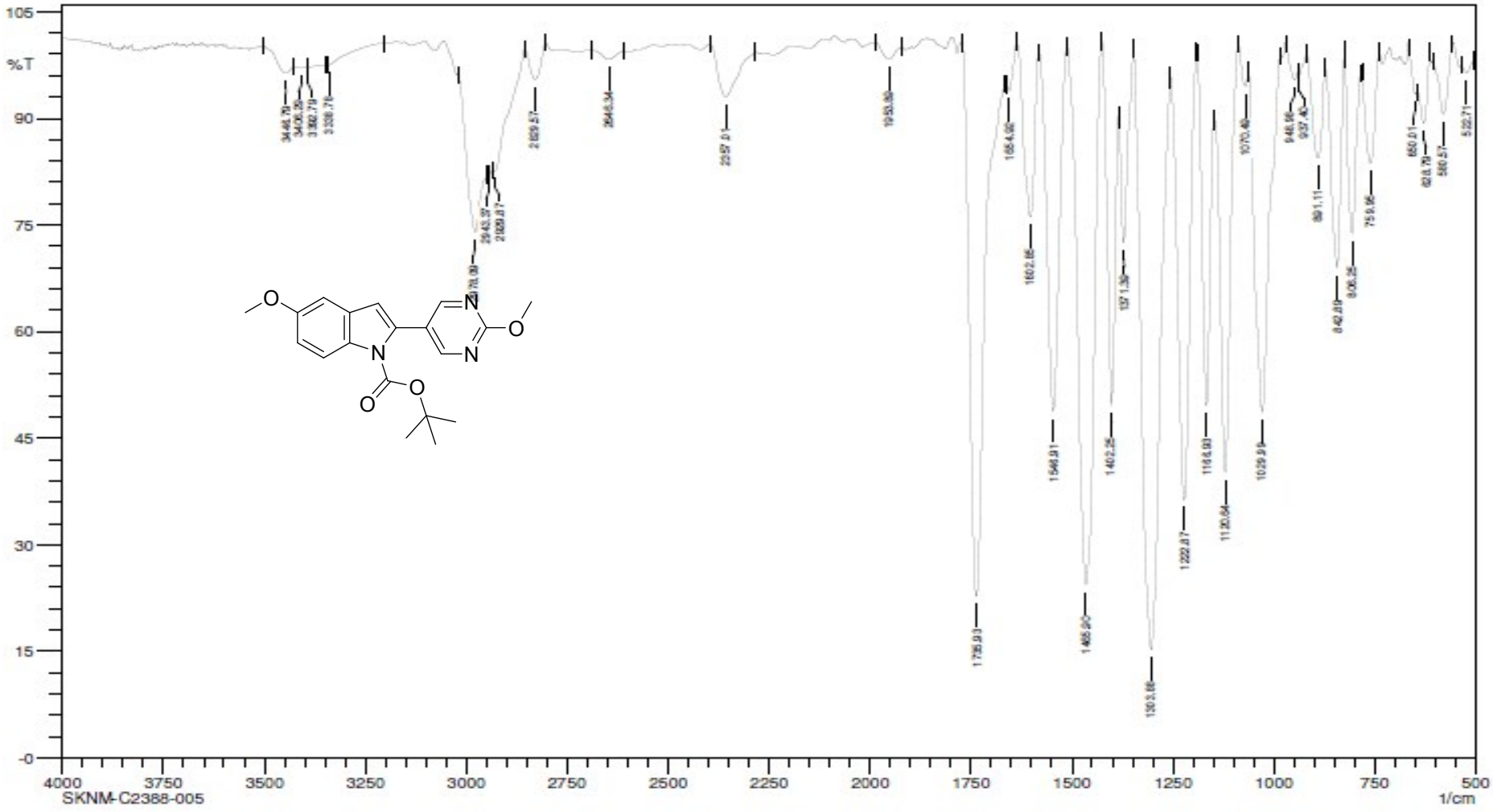
245



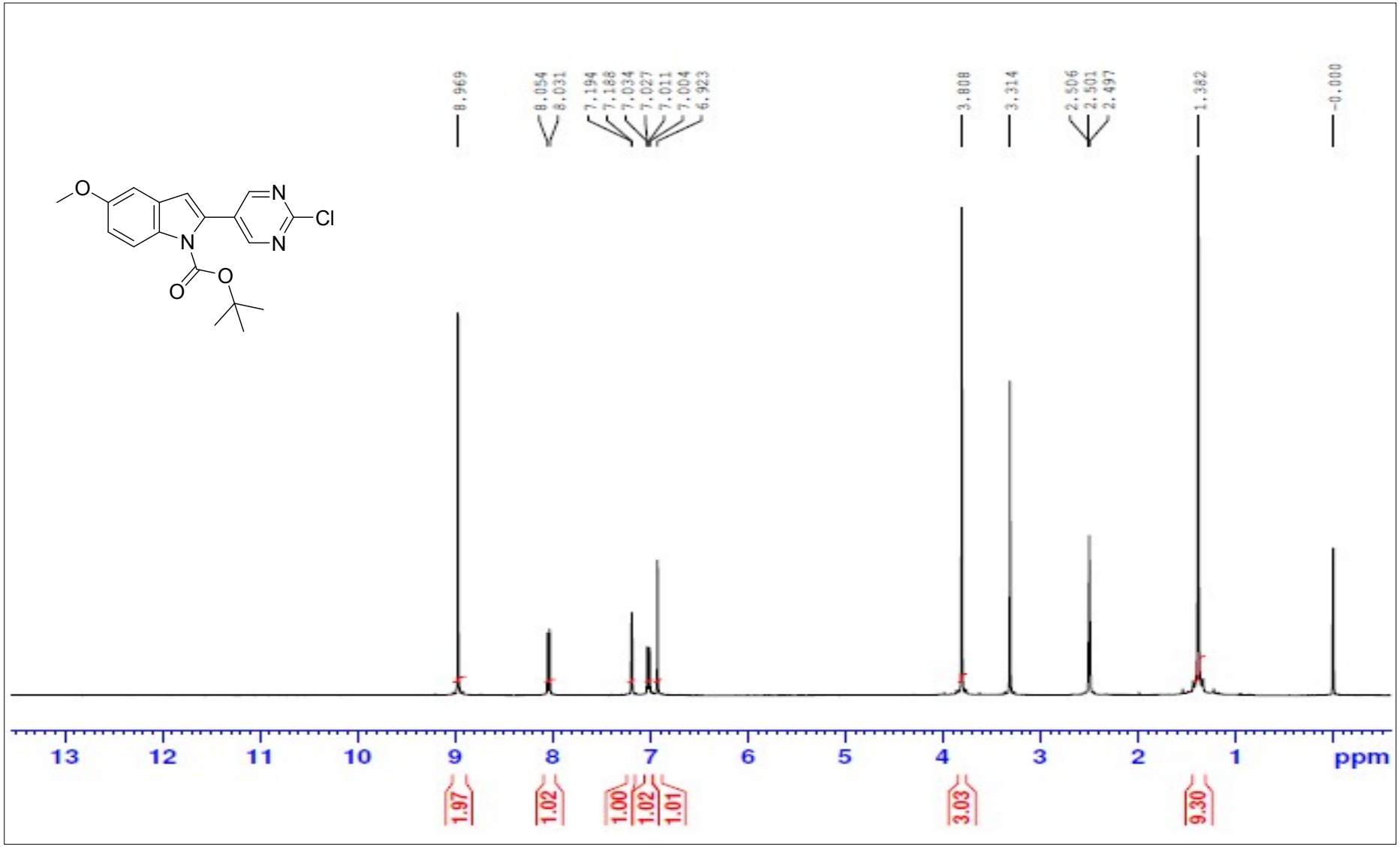
Exact Mass: 355.15

Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
356.1602	356.1610	-0.8	-2.2	10.5	27187.7	C19 H22 N3 O4

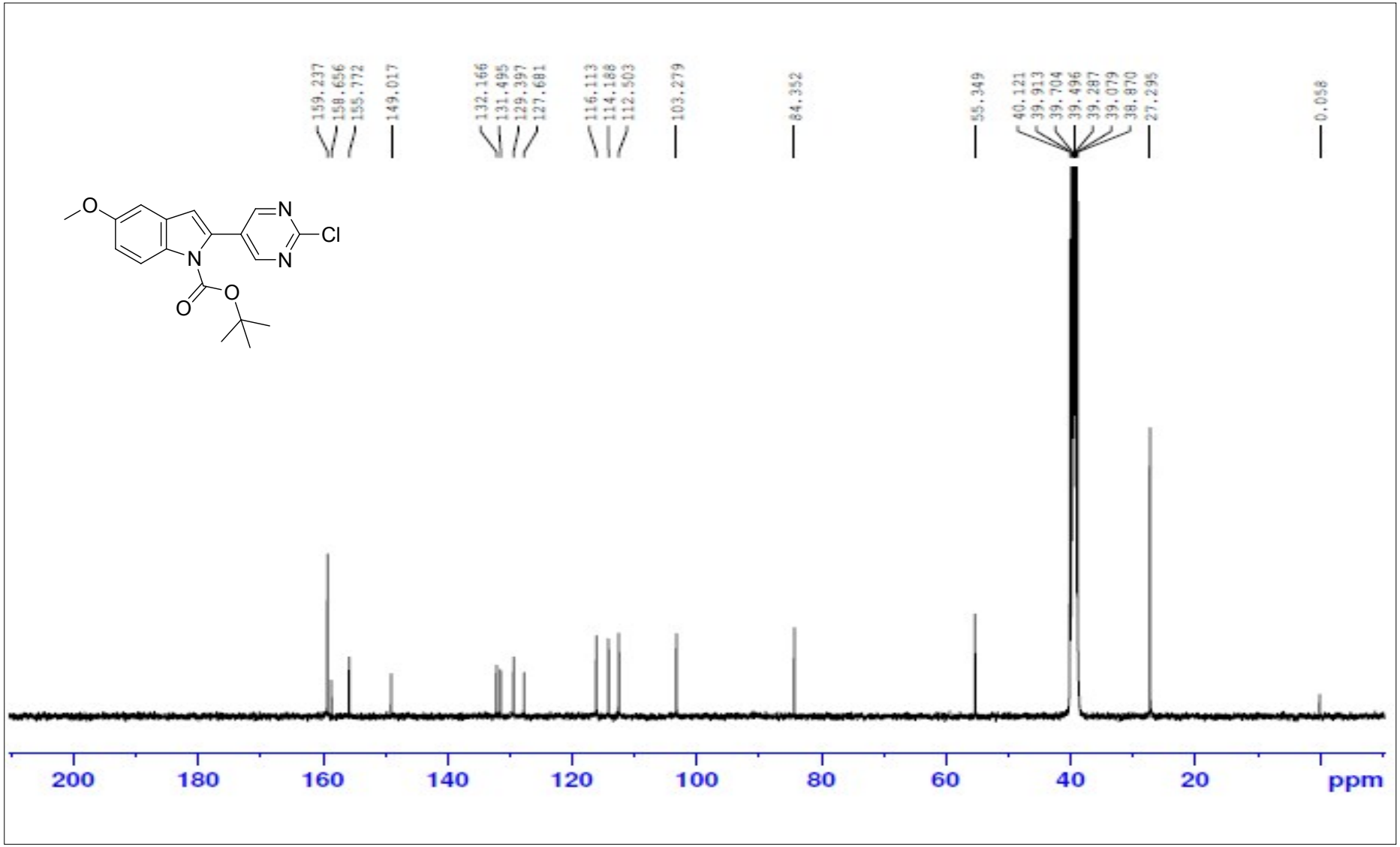
IR spectrum of Compound 3e



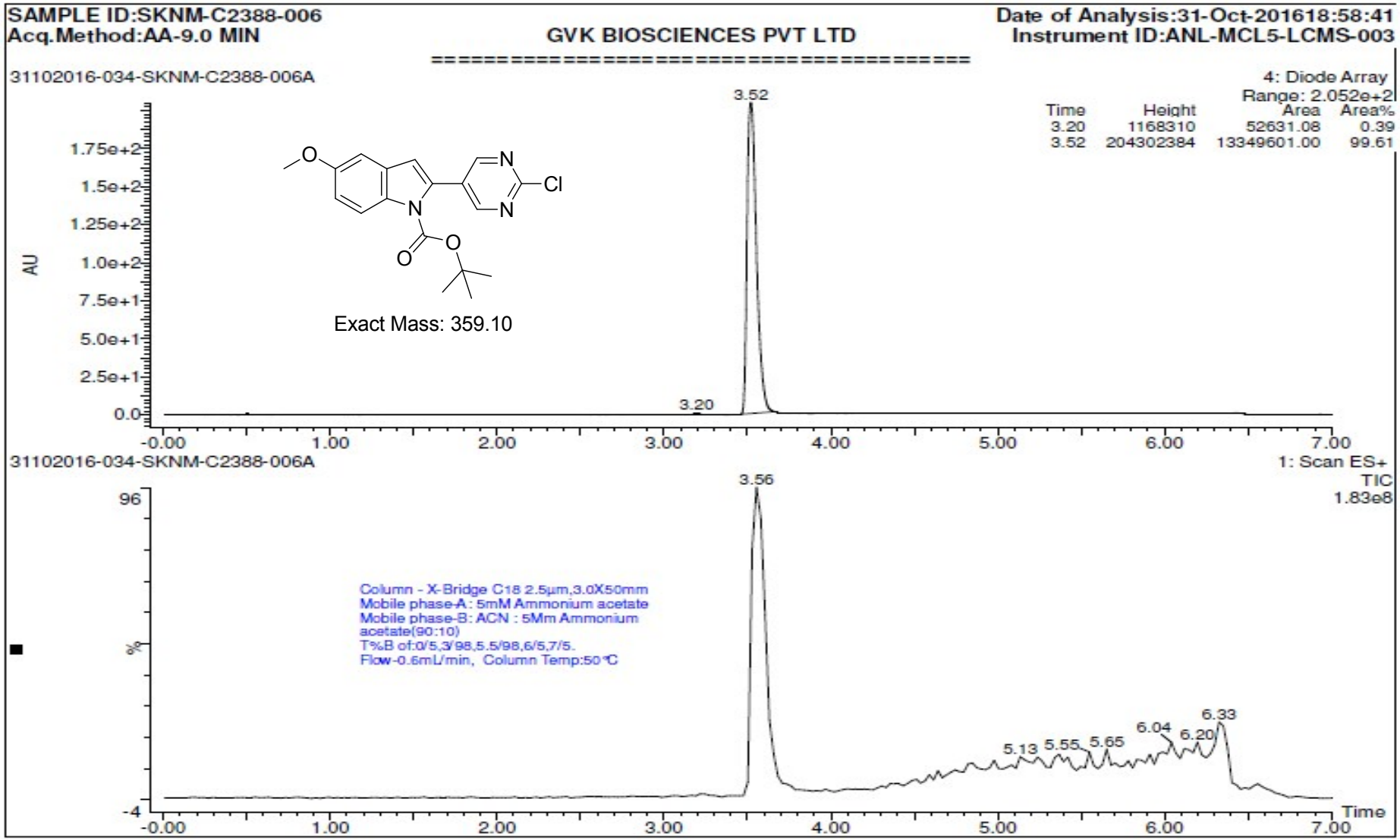
^{1}H NMR of compound 3f in DMSO-D_6 at 400 MHz

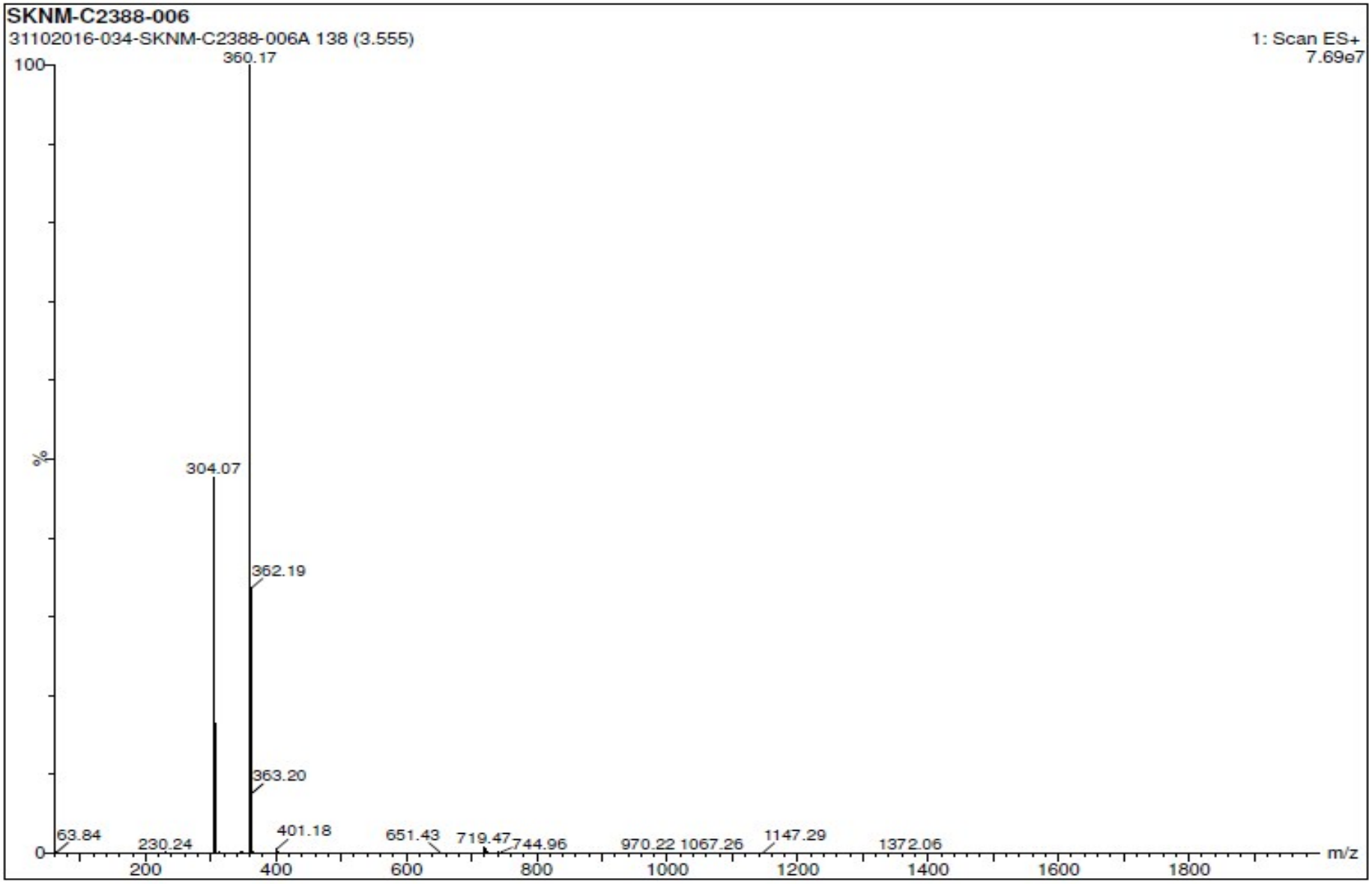


^{13}C NMR of compound 3f in DMSO-D_6 at 100 MHz



LCMS spectrum of Compound-3f




SKNM-C2388-006
31102016-034-SKNM-C2388-006A 138 (3.555)
1: Scan ES+
7.69e7
100
%
0
360.17
304.07
362.19
363.20
63.84
230.24
401.18
651.43
719.47
744.96
970.22
1067.26
1147.29
1372.06
m/z
200
400
600
800
1000
1200
1400
1600
1800

HRMS spectrum of Compound-3f

Elemental Composition Report

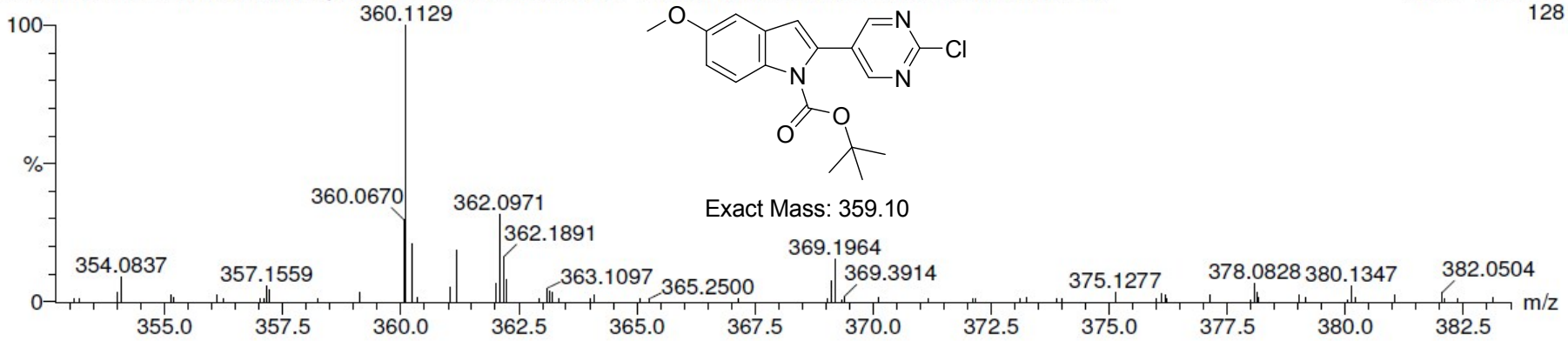
Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0
Selected filters: None

Monoisotopic Mass, Even Electron Ions
28 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-18 H: 0-19 N: 0-3 O: 0-3 Cl: 0-1

SKNM-C2388-006
511611B4328 22 (0.329) AM (Top,4, Ar,5000.0,195.14,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00); Cm (14:26)

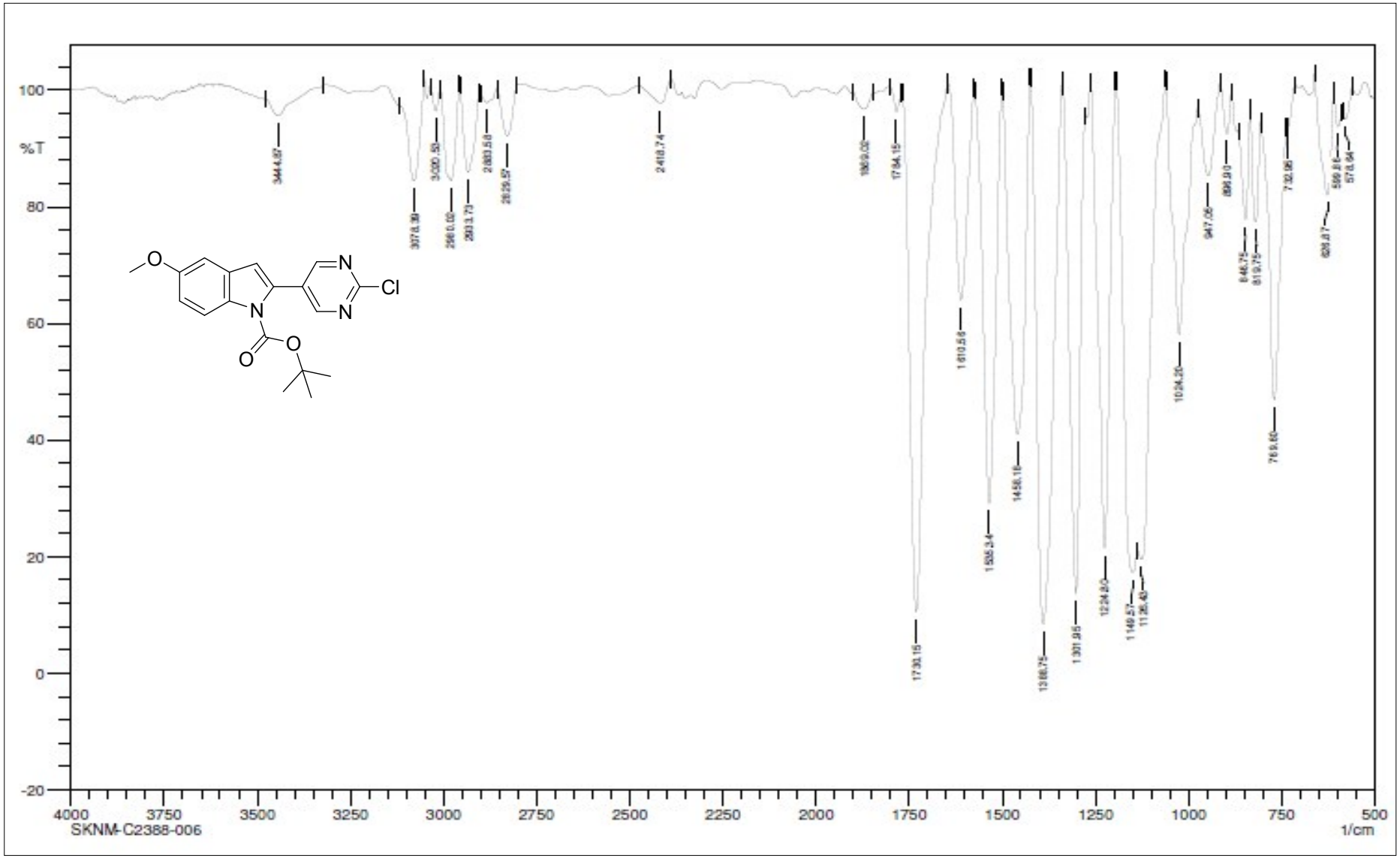
1: TOF MS ES+
128



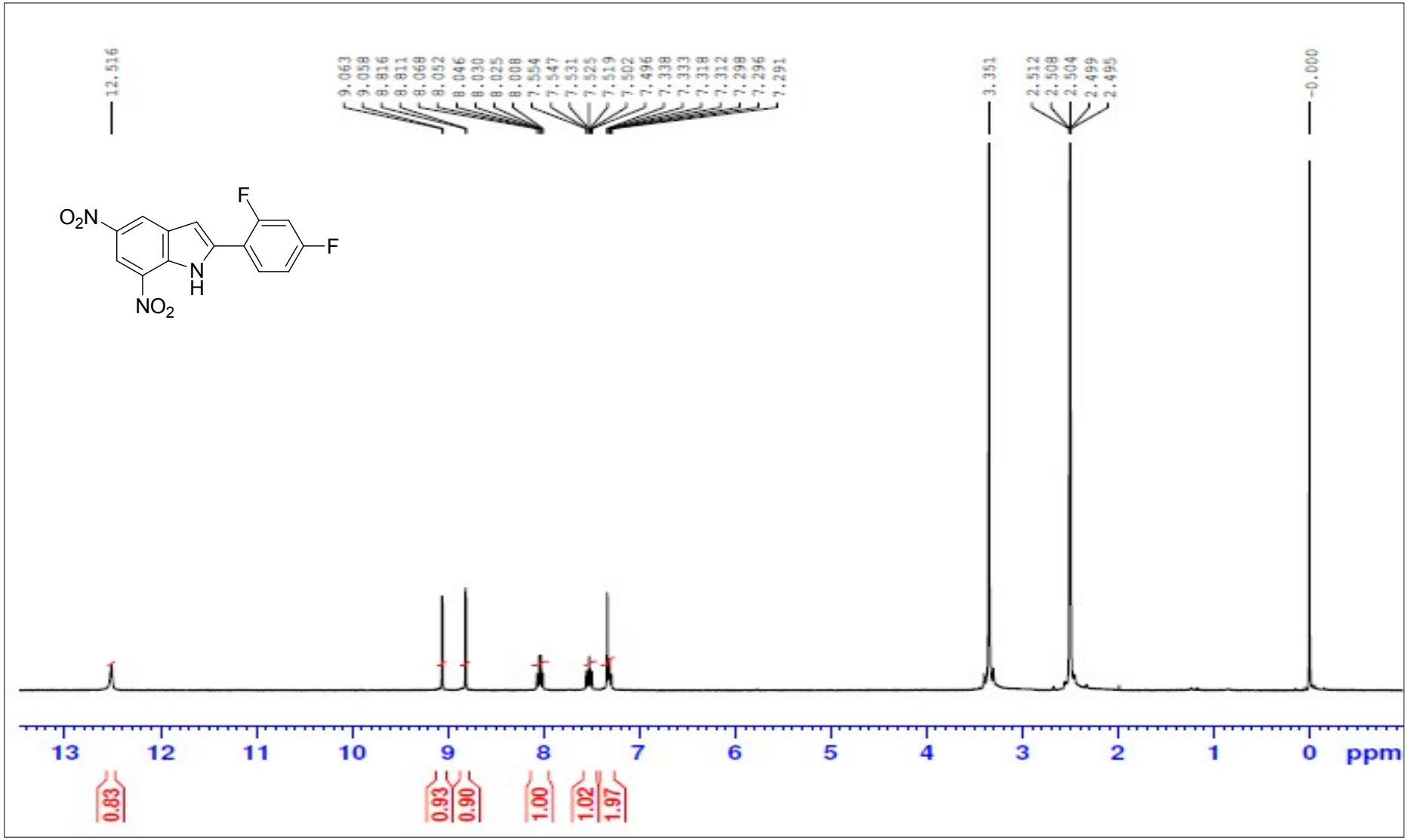
Exact Mass: 359.10

Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
360.1129	360.1115	1.4	3.9	10.5	13681.0	C18 H19 N3 O3 Cl

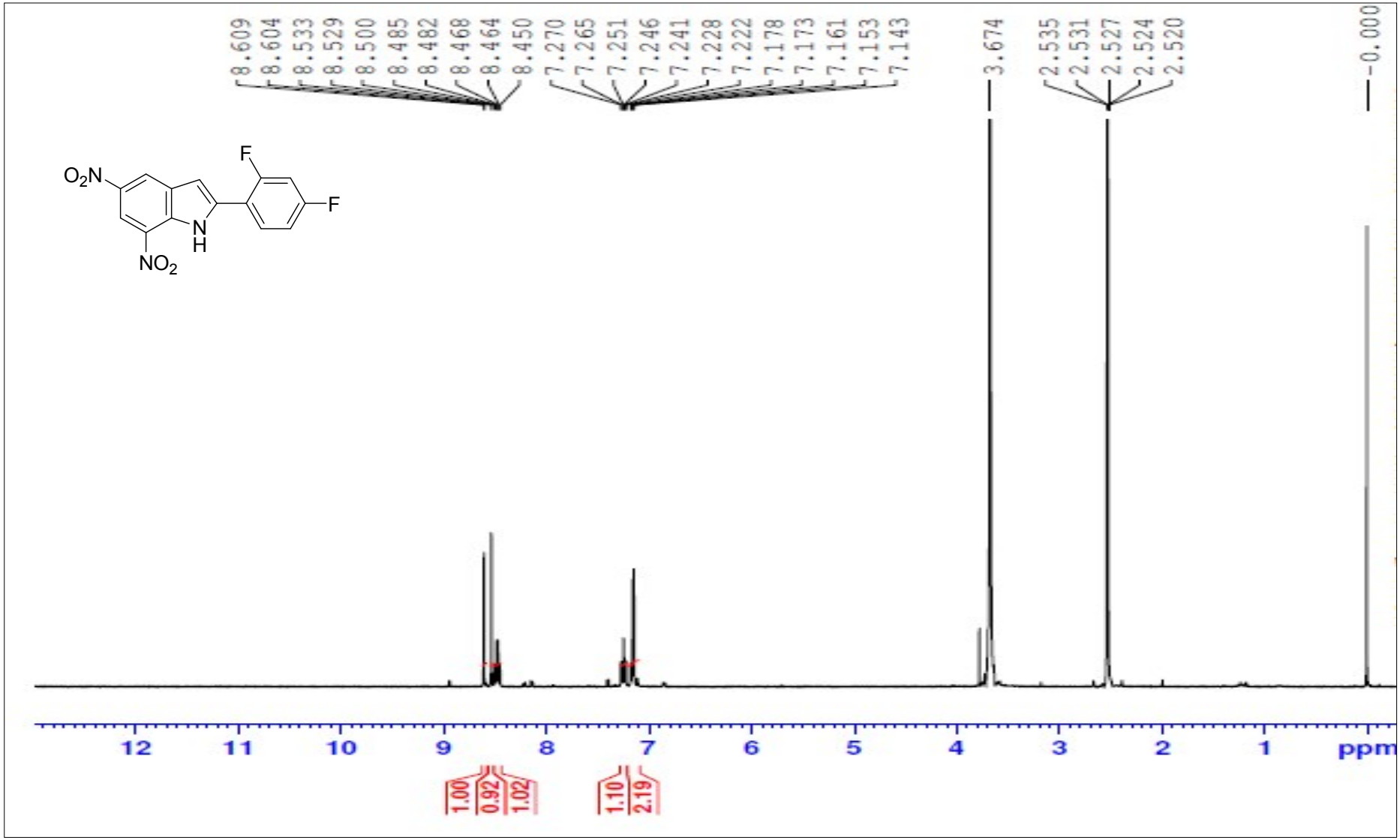
IR spectrum of Compound 3f



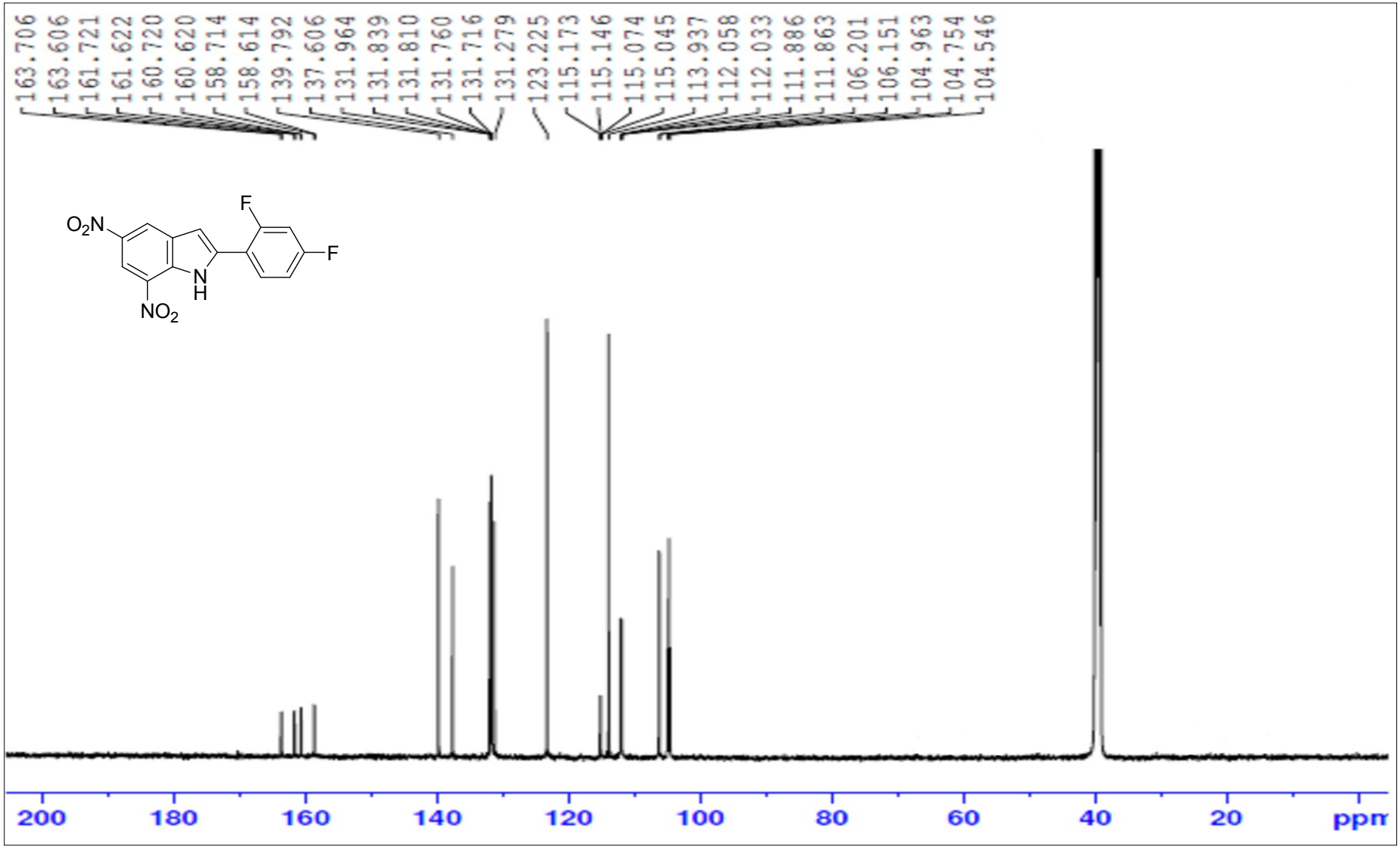
^{1}H NMR of compound 3g in DMSO-D_6 at 400 MHz



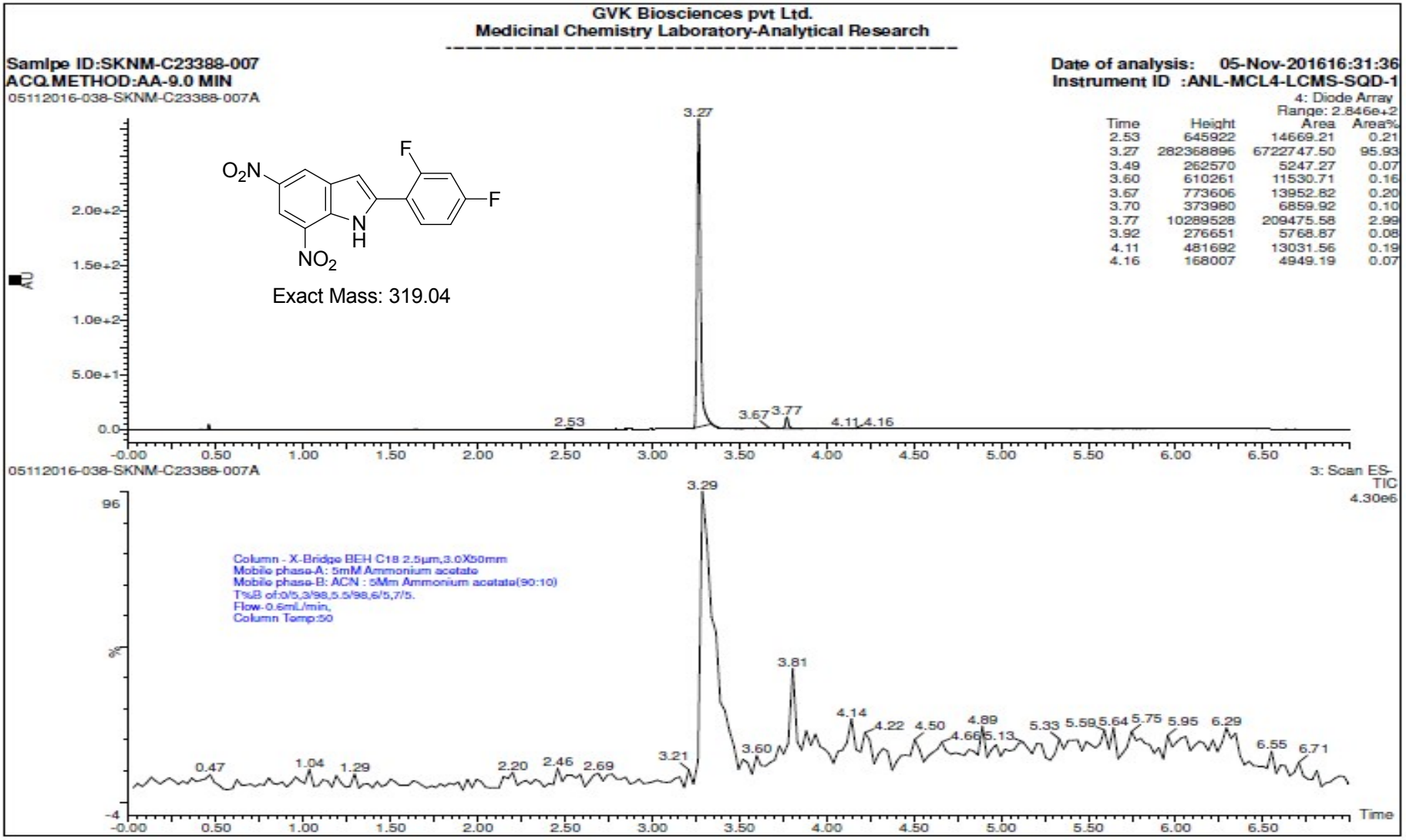
^{1}H NMR of compound 3g in DMSO-D_6 D_2O exchange at 500 MHz

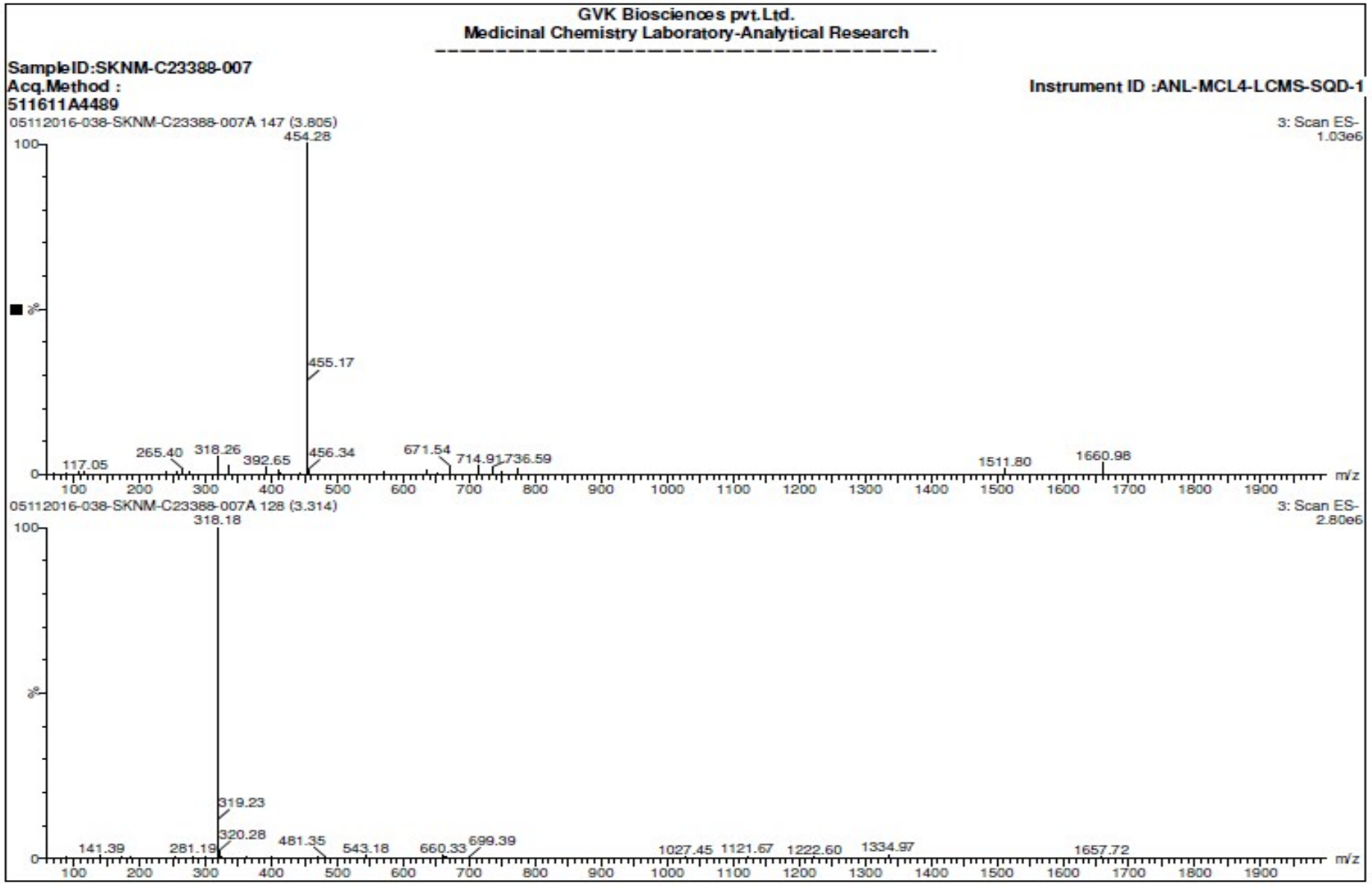


^{13}C NMR of compound 3g in DMSO-D_6 at 125 MHz



LCMS spectrum of Compound-3g




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C23388-007
Acq.Method :
511611A4489
Instrument ID :ANL-MCL4-LCMS-SQD-1
05112016-038-SKNM-C23388-007A 147 (3.805)
3: Scan ES-
1.03e6
454.28
455.17
117.05
265.40
318.26
392.65
456.34
671.54
714.91
736.59
1511.80
1660.98
05112016-038-SKNM-C23388-007A 128 (3.314)
3: Scan ES-
2.80e6
318.18
319.23
320.28
141.39
281.19
481.35
543.18
660.33
699.39
1027.45
1121.67
1222.60
1334.97
1657.72
m/z

HRMS spectrum of Compound-3g

Elemental Composition Report

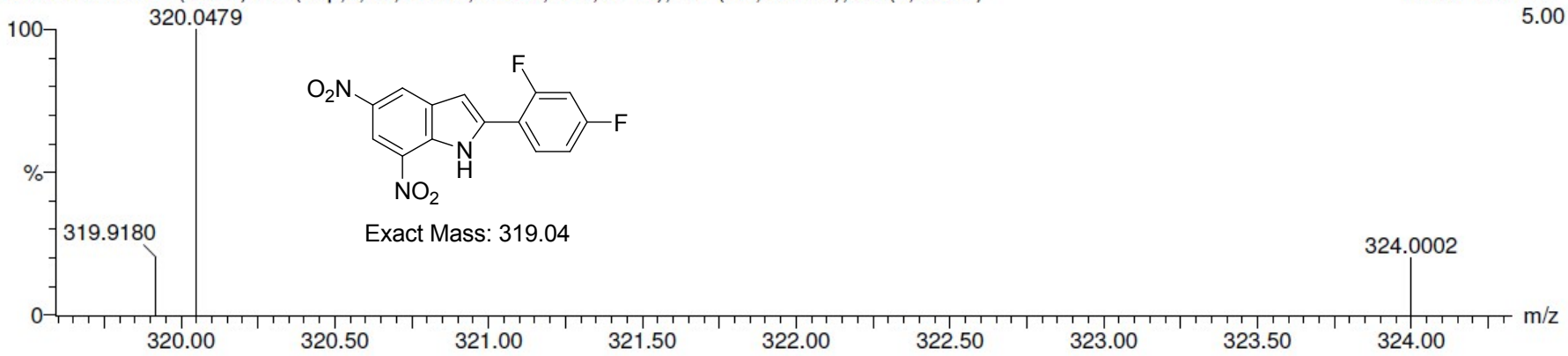
Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0
Selected filters: None

Monoisotopic Mass, Even Electron Ions
53 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-14 H: 0-8 N: 0-3 O: 0-4 F: 0-2

SKNM-C2388-007
511611B4491 21 (0.287) AM (Top,4, Ar,5000.0,195.68,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

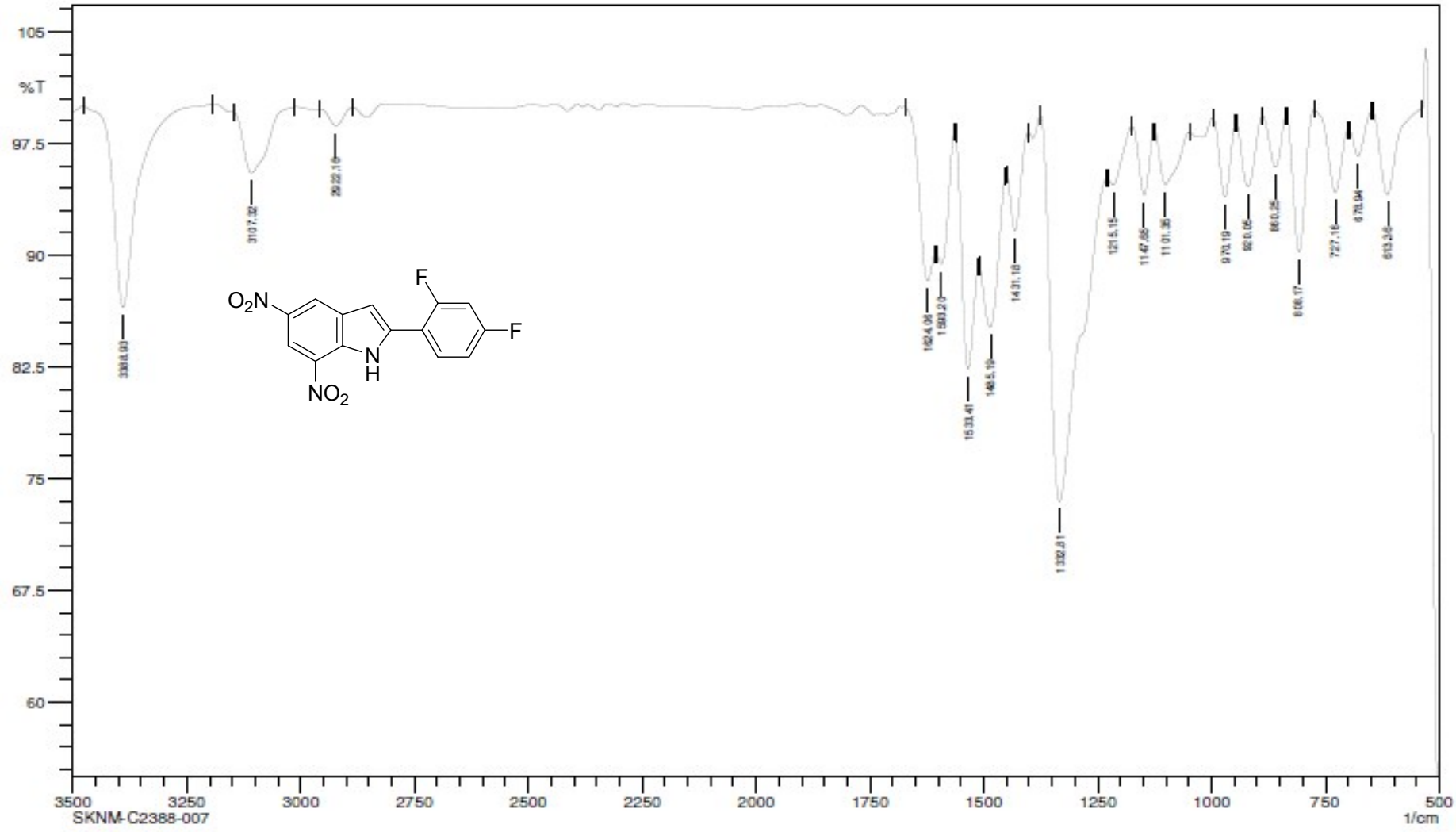
1: TOF MS ES+
5.00



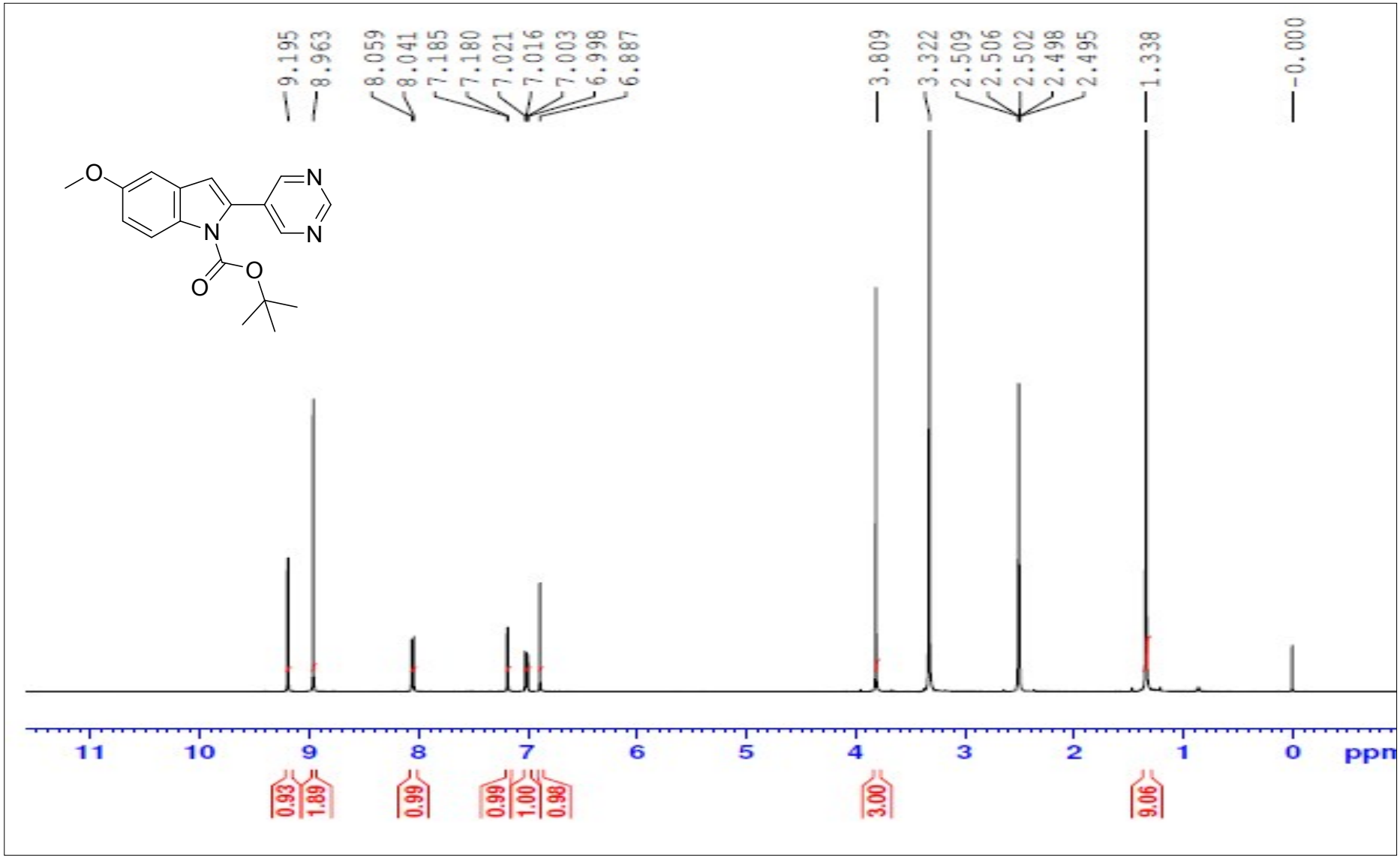
Exact Mass: 319.04

Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
320.0479	320.0483	-0.4	-1.2	11.5	684.9	C14 H8 N3 O4 F2

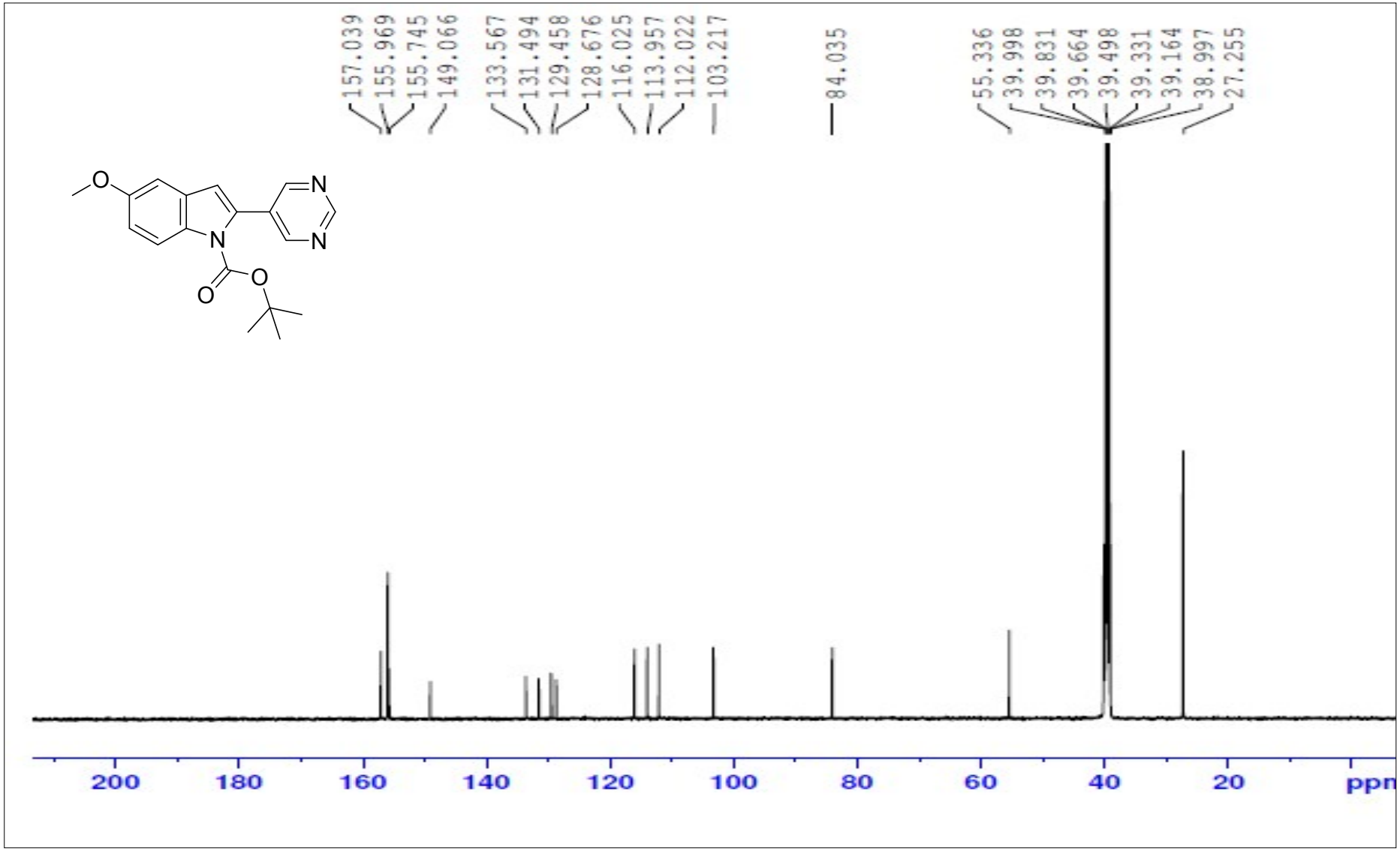
IR spectrum of Compound 3g



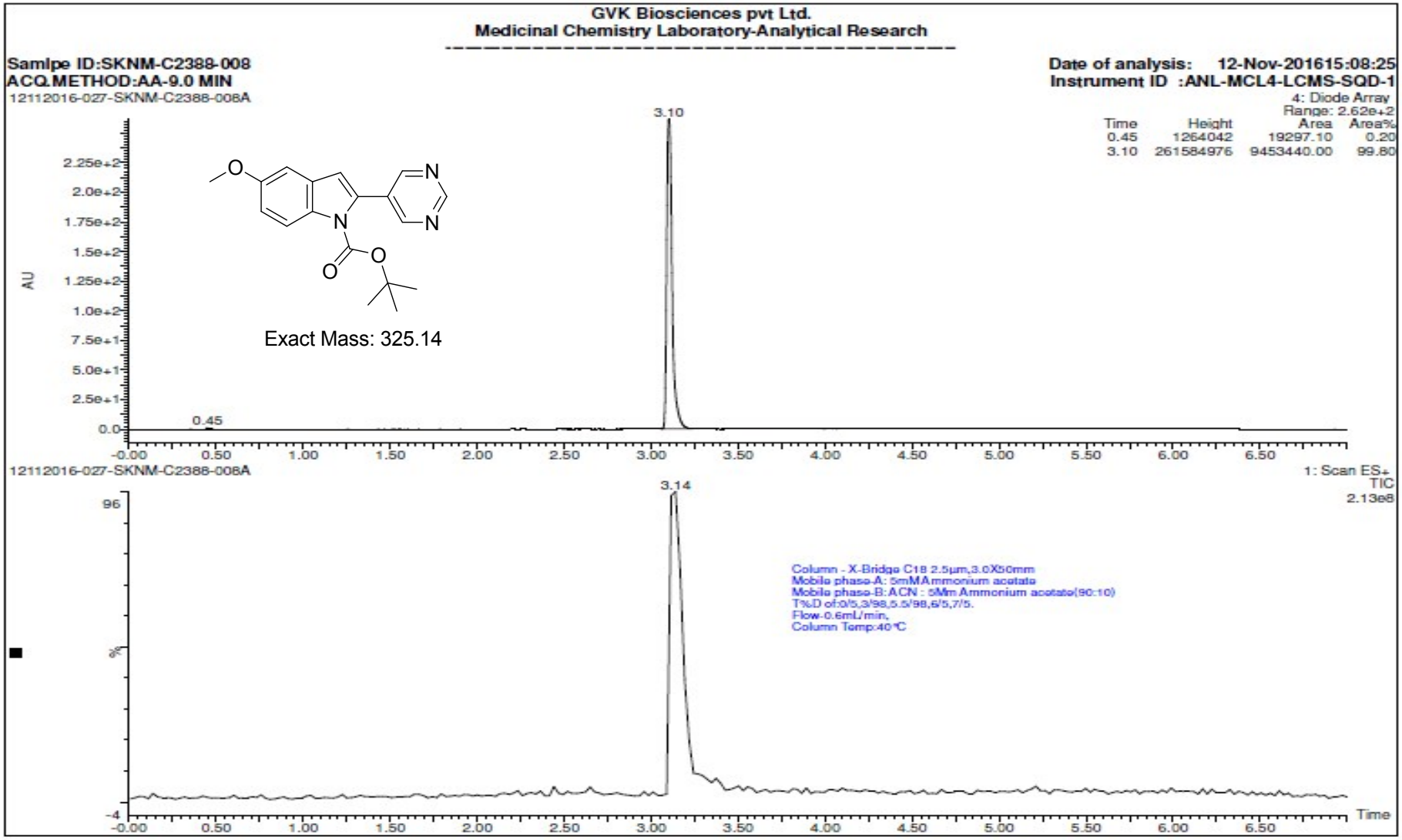
^{1}H NMR of compound 3h in DMSO-D_6 at 500 MHz

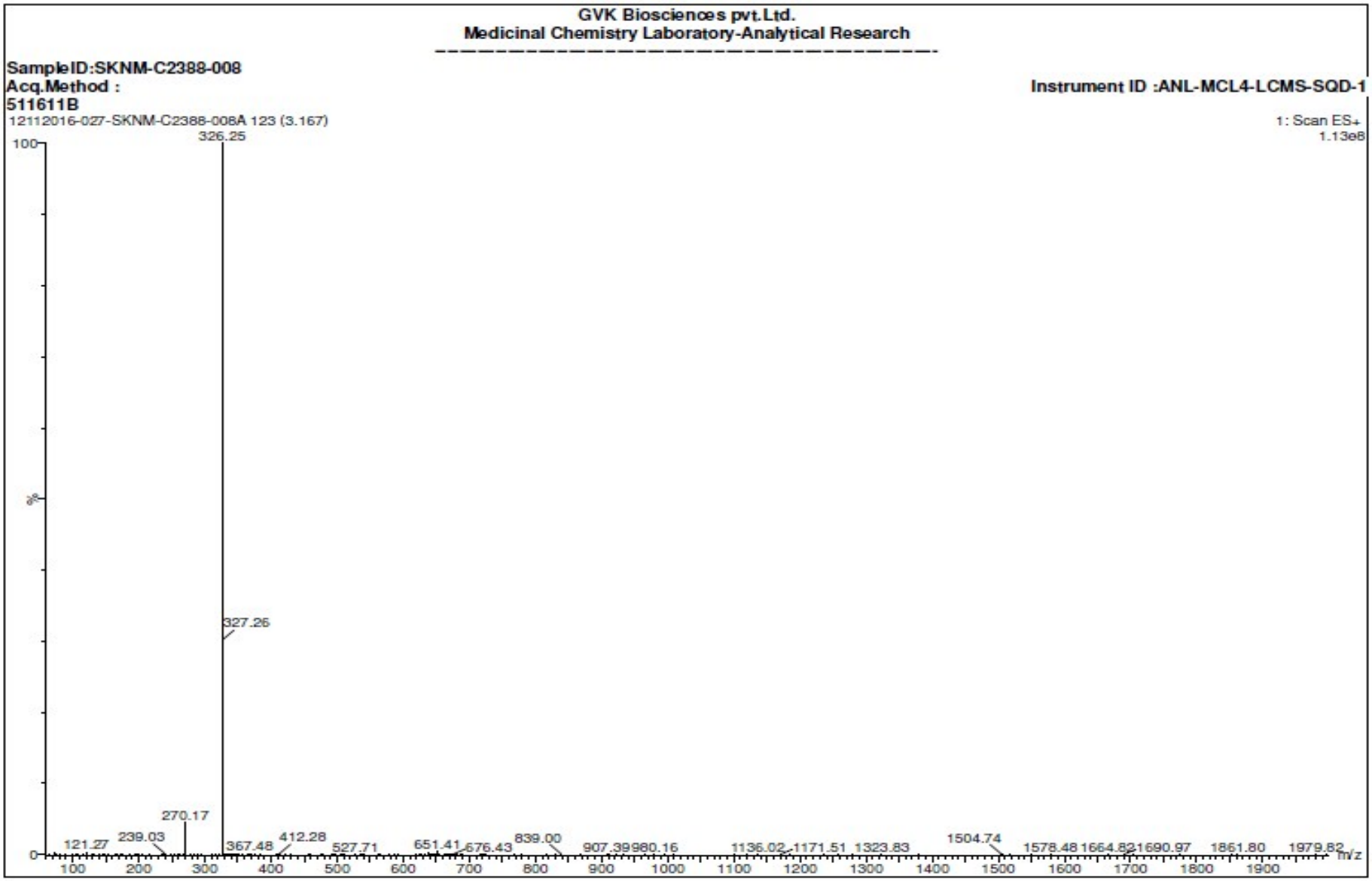


^{13}C NMR of compound 3h in DMSO-D_6 at 125 MHz



LCMS spectrum of Compound-3h




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C2388-008
Acq.Method :
511611B
Instrument ID :ANL-MCL4-LCMS-SQD-1
12112016-027-SKNM-C2388-008A 123 (3.167)
1: Scan ES+
1.13e8
100
%
0
326.25
327.25
270.17
121.27
239.03
367.48
412.28
527.71
651.41
676.43
839.00
907.39
980.16
1136.02
1171.51
1323.83
1504.74
1578.48
1664.82
1690.97
1861.80
1979.82
m/z
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

HRMS spectrum of Compound-3h

Elemental Composition Report

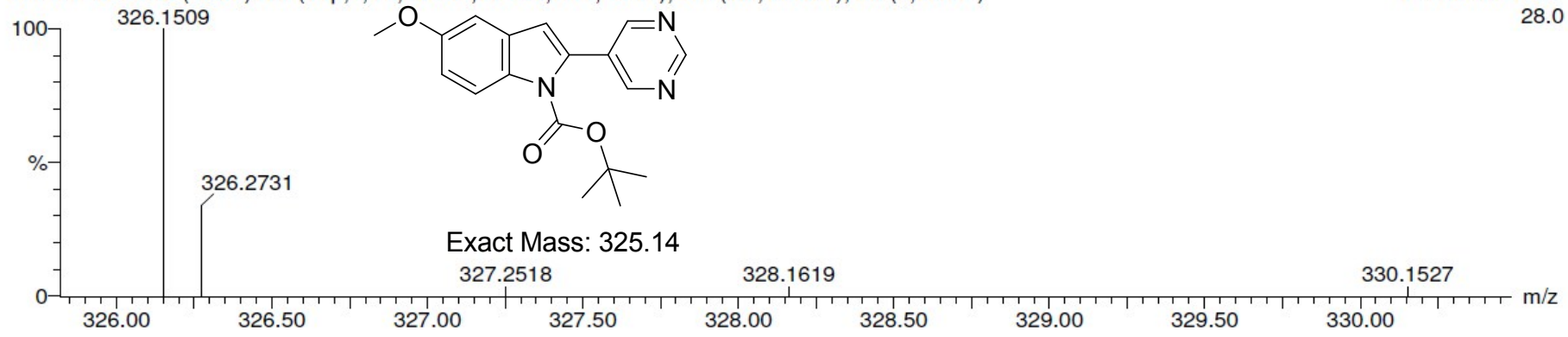
Single Mass Analysis

Tolerance = 10000.0 PPM / DBE: min = -1.5, max = 50.0
Selected filters: None

Monoisotopic Mass, Even Electron Ions
12 formula(e) evaluated with 1 results within limits (up to 1 closest results for each mass)
Elements Used:
C: 0-18 H: 0-20 N: 0-3 O: 0-3

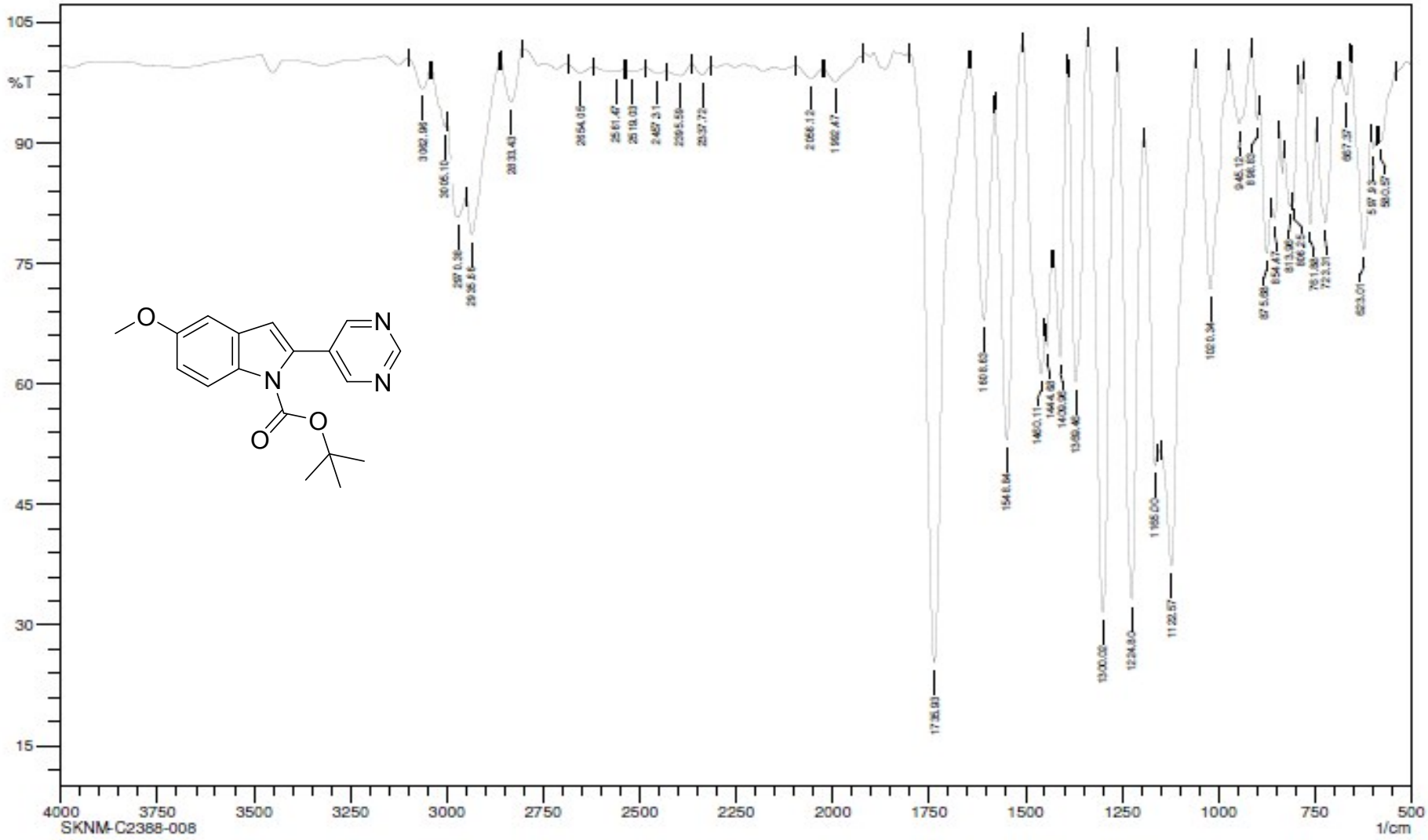
SKNM-C2388-008
511611B3768 16 (0.237) AM (Top,4, Ar,5000.0,195.16,1.00,LS 10); Sm (Mn, 2x1.00); Sb (1,40.00)

1: TOF MS ES+
28.0

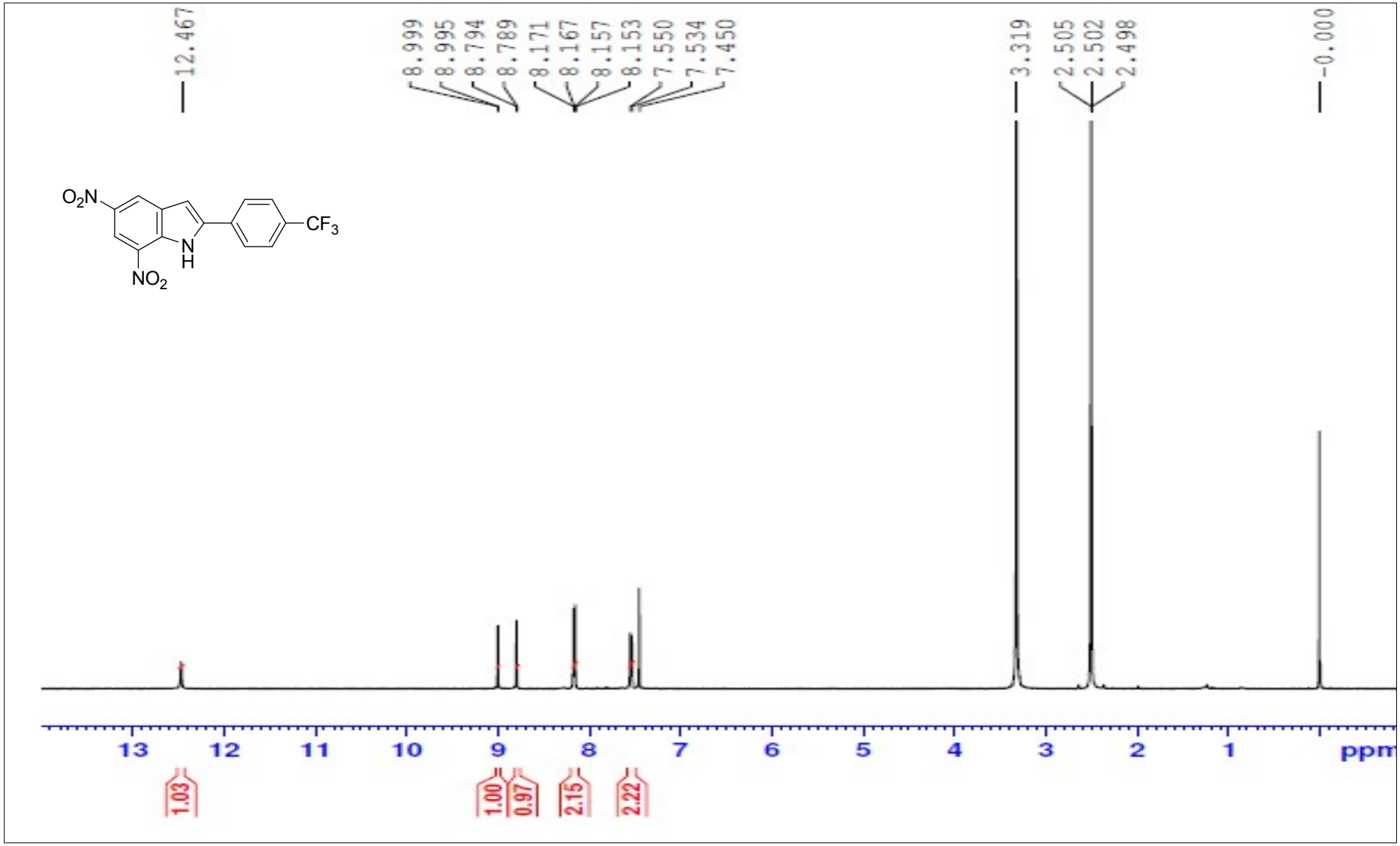


Minimum:				-1.5		
Maximum:		5.0	10000.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
326.1509	326.1505	0.4	1.2	10.5	3690.1	C18 H20 N3 O3

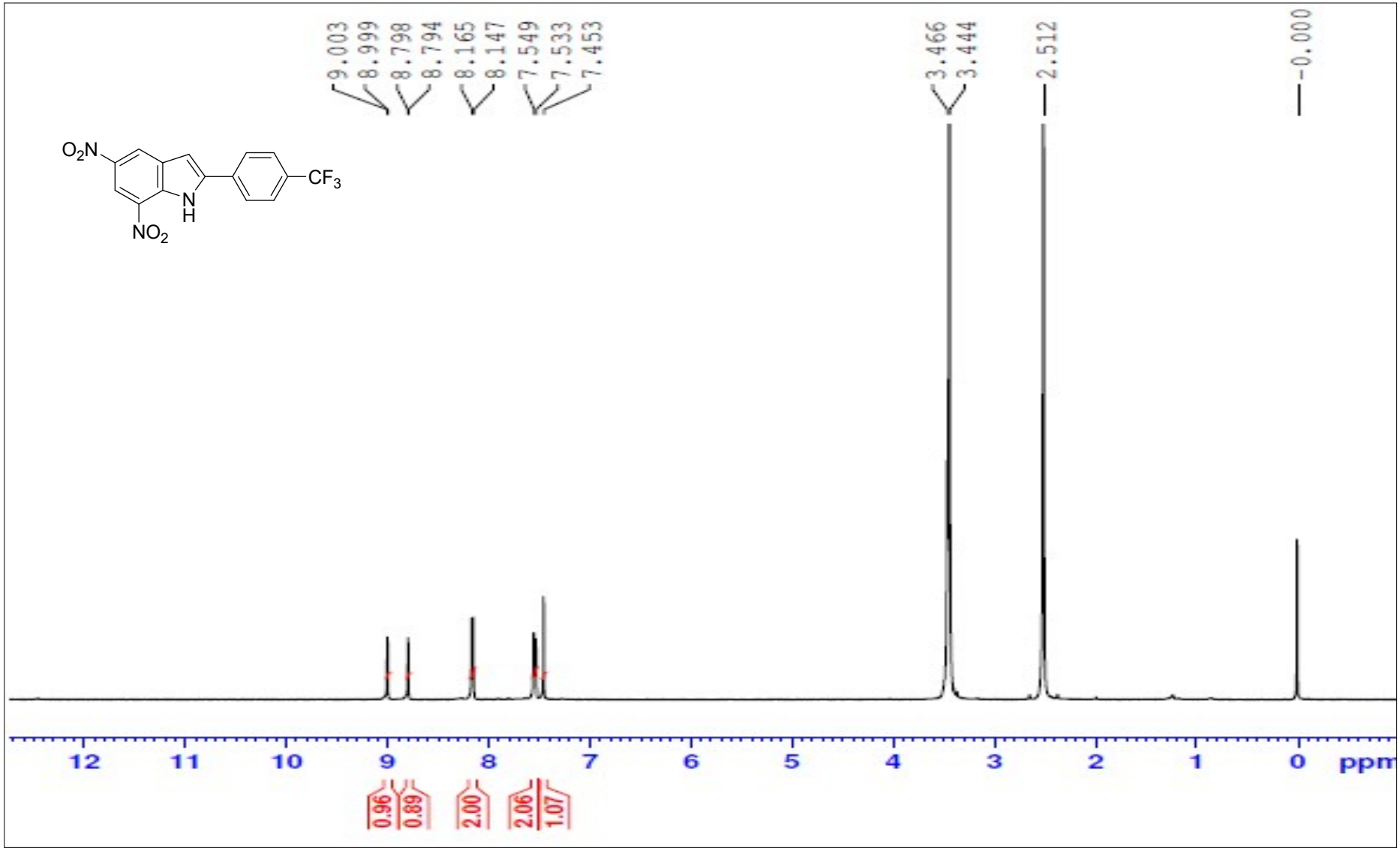
IR spectrum of Compound 3h



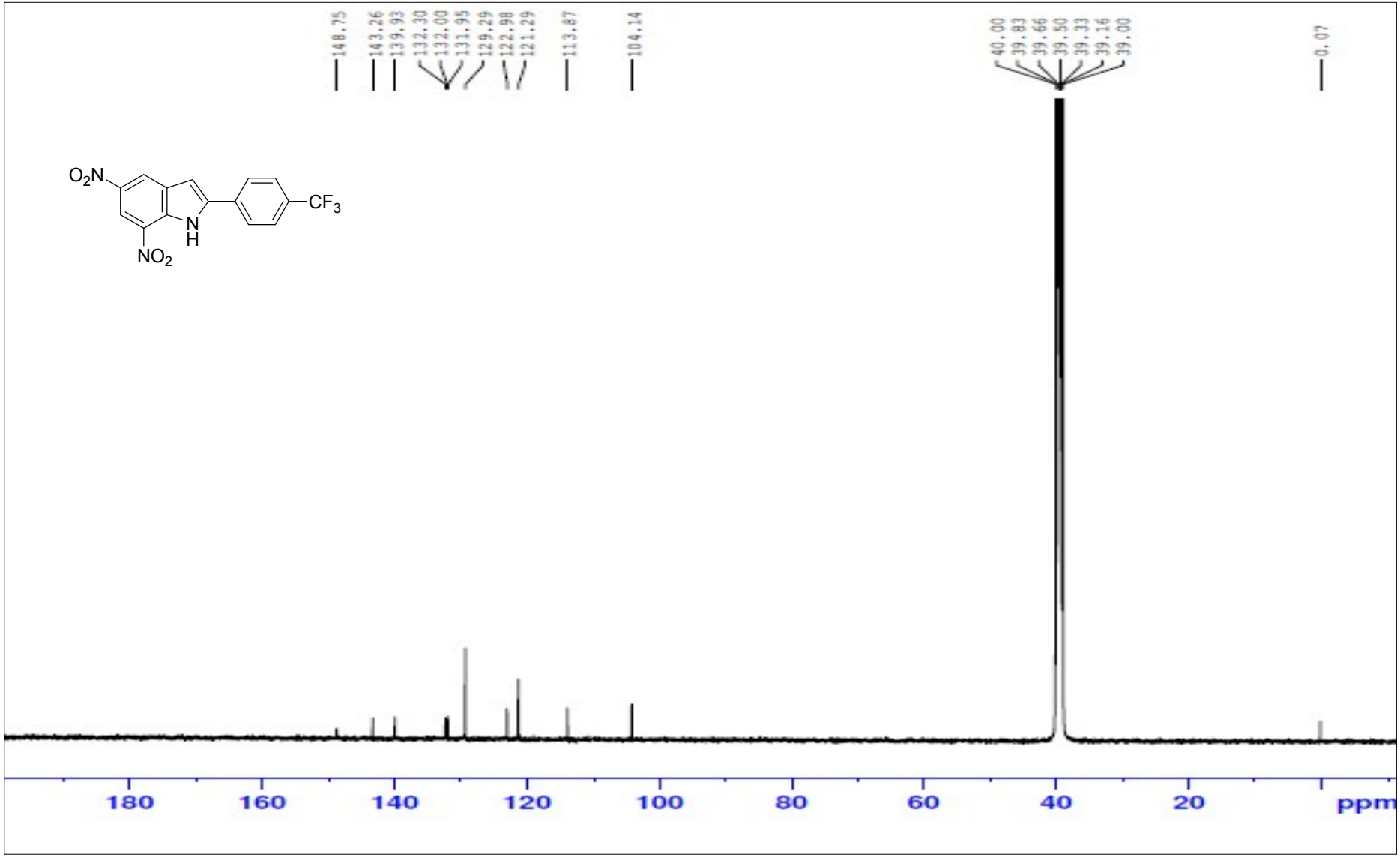
^{1}H NMR of compound 3i in DMSO-D_6 at 500 MHz



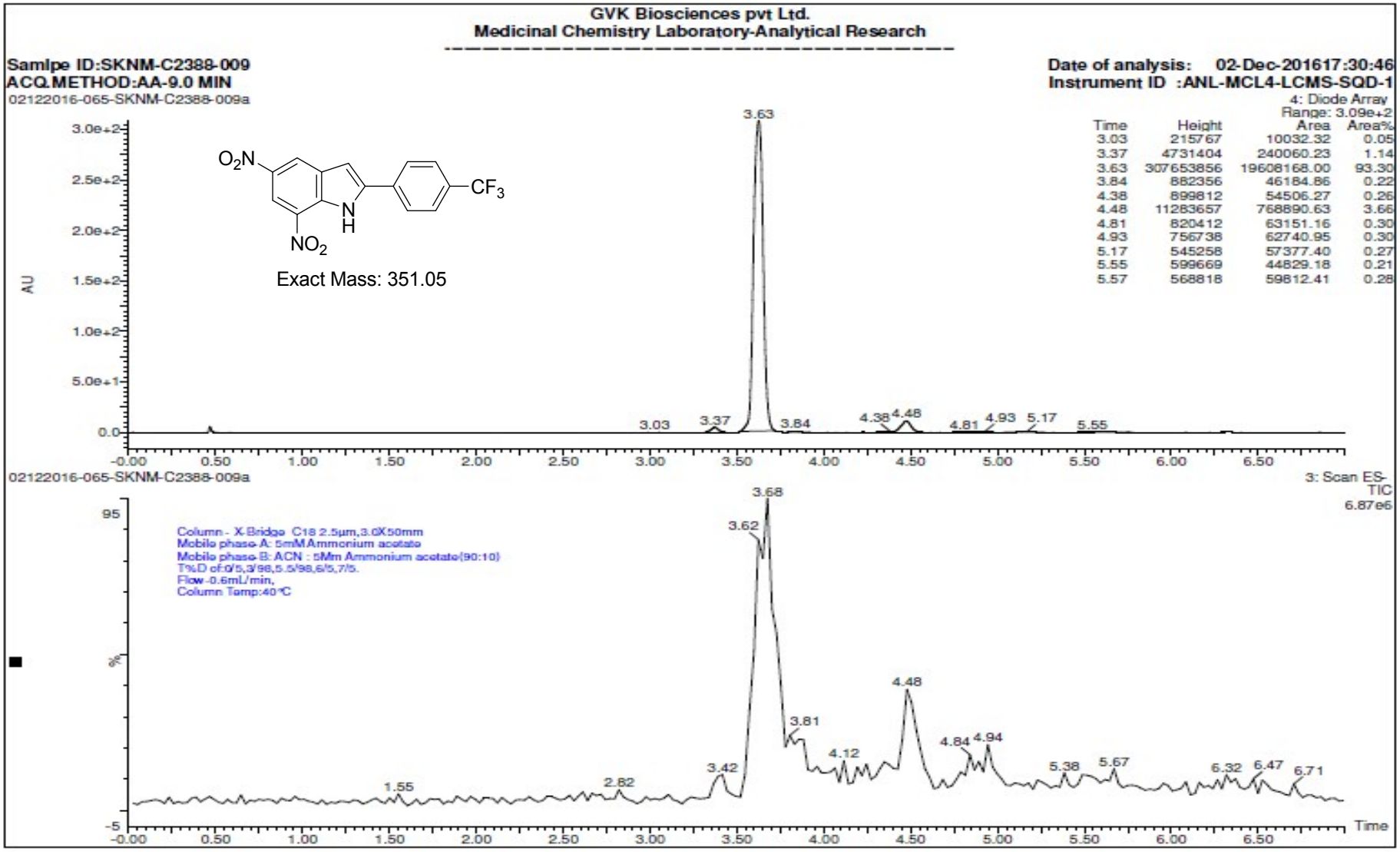
^{1}H NMR of compound 3i in DMSO-D_6 (D_2O exchange) at 500 MHz

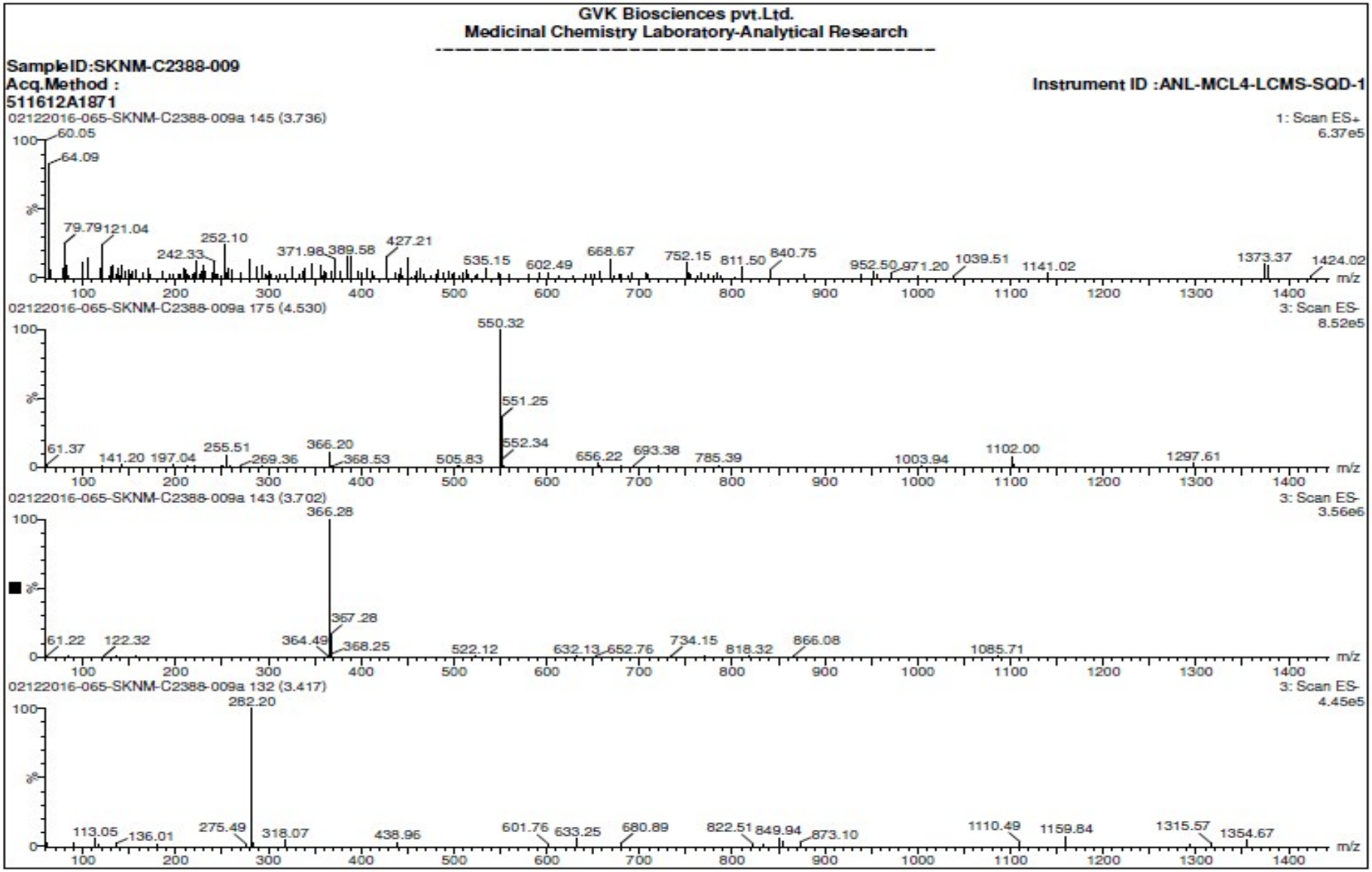


^{13}C NMR of compound 3i in DMSO-D_6 at 125 MHz



LCMS spectrum of Compound-3i




GVK Biosciences pvt.Ltd.
Medicinal Chemistry Laboratory-Analytical Research
SampleID:SKNM-C2388-009
Acq.Method :
511612A1871
Instrument ID :ANL-MCL4-LCMS-SQD-1
02122016-065-SKNM-C2388-009a 145 (3.736)
1: Scan ES+
6.37e5
60.05
64.09
79.79
121.04
242.33
252.10
371.98
389.58
427.21
535.15
602.49
668.67
752.15
811.50
840.75
952.50
971.20
1039.51
1141.02
1373.37
1424.02
02122016-065-SKNM-C2388-009a 175 (4.530)
3: Scan ES-
8.52e5
550.32
551.25
552.34
61.37
141.20
197.04
255.51
269.36
366.20
368.53
505.83
656.22
693.38
785.39
1003.94
1102.00
1297.61
02122016-065-SKNM-C2388-009a 143 (3.702)
3: Scan ES-
3.56e6
366.28
367.28
61.22
122.32
364.49
368.25
522.12
632.13
652.76
734.15
818.32
866.08
1085.71
02122016-065-SKNM-C2388-009a 132 (3.417)
3: Scan ES-
4.45e5
282.20
113.05
136.01
275.49
318.07
438.96
601.76
633.25
680.89
822.51
849.94
873.10
1110.49
1159.84
1315.57
1354.67
%
m/z
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400

IR spectrum of Compound-3i