

Supporting Information

Practical Synthesis of Sultams via Sulfonamide Dianion Alkylation: Application in the synthesis of Chiral Sultams

Jaemoon Lee,* Yong-Li Zhong, Robert A. Reamer, and David Askin

Department of Process Research, Merck Research Laboratories, P.O. Box 2000, Rahway, New Jersey 07065

jaemoon_lee@merck.com

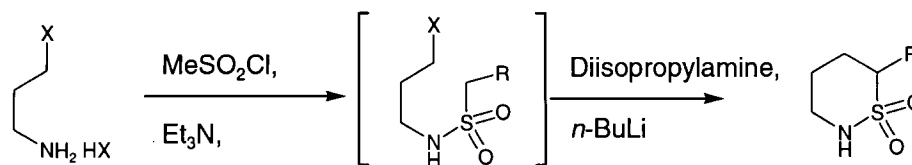
General Experimental Information

All reactions were carried out under nitrogen. Flash chromatography was carried out with EM science Silica gel 60 (neutral, 230-400 mesh). Thin-layer chromatography (TLC) was performed on EM science Silica gel (0.25mm, precoated on glass).

Visualization of compounds on TLC was accomplished by UV illumination or by staining with a solution prepared from 25g of ammonium molybdate and 1 g of ceric sulfate in 500 mL of 10% aq. sulfuric acid, followed by heating.

¹H NMR and ¹³C NMR spectra were recorded on a Bruker 400 MHz with chemical shifts reported in ppm relative to the residual deuterated solvent. Optical rotations were measured using a Perkin-Elmer 241 Polarimeter at 23 °C using sodium lamp (D line). HPLC analysis was performed on a Hewlett Packard 1100 MSD instrument.

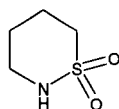
General procedures for the conversion of ω-halo alkylamine to sultam:



To a stirred slurry of haloalkylamine-HX salt (108 mmol) either in THF (X=Br, 300 mL) or acetonitrile (X=Cl) were added triethylamine (220mmol) and methanesulfonyl chloride (108 mmol) simultaneously via dropping funnels over 30 min (keeping the internal temp 5~10 °C). After 1 h at this temperature, the reaction was warmed to room temperature and stirred for an additional 1.5 h.

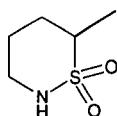
The triethylamine-HX salt was removed by filtration and the cake was washed with THF (40 mL). The THF solution of crude bromosulfonamide was used for next step without further purification.

The solution of halosulfonamide (106 mmol) in THF (340 mL) was placed in a 3-neck flask and cooled to -30°C. After addition of diisopropylamine (26.5 mmol) and 1,10-phenanthroline (30 mg), a solution *n*-BuLi in hexane (240 mmol, 1.6 M) was slowly added via a dropping funnel over period of 30 min maintaining the internal temperature range of -30 °C to -10 °C. During this time, a brown color appeared which indicated that 1.25 equiv of *n*-BuLi had been added. Then, the resulting solution was slowly warmed to 0 °C over 2 h. After 2h at 0 °C, the reaction was quenched by addition of 2N HCl (pH adjusted to ~5). After addition of 20% brine (75 mL), the phases were separated and the aq. layer was back-extracted with 100 mL of ethyl acetate. Concentration of the combined organic layers followed by crystallization gave the desired product.



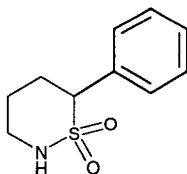
1,2-thiazinane 1,1-dioxide (1)

Conditions: 3-bromopropylamine-HBr (23.6g, 108 mmol), methanesulfonyl chloride (8.4 ml, 108 mmol), triethylamine (30.8 mL, 220 mmol) in THF (300mL); diisopropylamine (3.7 mL, 26.5 mmol), *n*-BuLi in hexane (163 mL, 240 mmol, 1.6 M). reaction temperature ;~ -30 °C to -10 °C ; then 0 °C for 2h. Crystallization (ethyl acetate-heptane , 1:1) of the crude reaction mixture afforded the desired product, **1** (9.4g, 72%) as a slightly yellow solid, mp 112~113 °C (lit.¹ 113 °C). ¹H NMR (CDCl₃, 400 MHz) δ 4.62 (br s, 1H), 3.41~3.37 (m, 1H), 3.10~3.07 (m, 2H), 2.22~2.16 (m, 2H), 1.64~1.58 (m, 2H); ; ¹³C NMR (CDCl₃, 100 MHz) δ 50.2, 45.4, 24.1, 23.7 ppm.



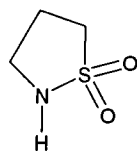
6-methyl-1,2-thiazinane 1,1-dioxide (6)

Conditions: 3-Chloropropylamine-HCl (6.3g, 49 mmol), ethanesulfonyl chloride (5.12 ml, 53.9 mmol), triethylamine (15.0 mL, 107 mmol) in acetonitrile (80 mL); diisopropylamine (1.55 mL, 11 mmol), *n*-BuLi in hexane (63 mL, 100.8 mmol, 1.6 M). THF (130 mL) reaction temperature ;~ -30 °C to -10 °C ; then 0 °C for 2h. Filtration of the crude reaction mixture over small plug of silica gel (ethyl acetate-hexane-methylene chloride , 3:6:1) afforded the desired product, **6** (5.4g, 72%) as a slightly yellow oil. ¹H NMR (CDCl₃, 400 MHz) δ 4.30 (br s, 1H), 3.40~3.33 (m, 2H), 3.08~3.02 (m, 2H), 2.08~2.14 (m, 1H), 1.88~1.98 (m, 1H), 1.72~1.77 (m, 1H), 1.57~1.60 (m, 1H), 1.39 (d, *J* = 6.75Hz, 3H); ¹³C NMR (CDCl₃, 100 MHz) δ 56.1, 45.4, 31.6, 25.2, 14.0 ppm.



6-phenyl-1,2-thiazinane 1,1-dioxide (8)

Conditions: 3-Bromopropylamine-HBr (6.1g, 27.8mmol), α-toluenesulfonyl chloride (5.5 g, 29 mmol), triethylamine (8.2 mL, 58.38 mmol) in THF (100 mL); diisopropylamine (0.97 mL, 6.9 mmol), *n*-BuLi in hexane (63 mL, 39.2 mmol, 1.6 M). THF (130 mL) reaction temperature ;~ -40 °C to -10 °C ; then 0 °C for 2h. Filtration of the crude reaction mixture over small plug of silica gel (ethyl acetate-hexane-methylene chloride, 3:6:1) afforded the desired product **8** as a yellow solid (4.4g, 75%). ¹H NMR (CDCl₃, 400 MHz) δ 7.45-7.35 (m, 5H), 4.36 (br s, 1H), 4.11 (dd, 1H, *J* = 12.8, 3.4Hz), 3.65~3.55 (m, 1H), 3.45~3.38 (m, 1H), 2.68~2.57 (m, 1H), 2.33~2.27 (m, 1H), 1.98~1.91 (m, 1H), 1.82~1.70; ¹³C NMR (CDCl₃, 100 MHz) δ 129.3, 128.9, 128.1, 67.1, 45.4, 30.5, 26.8 ppm

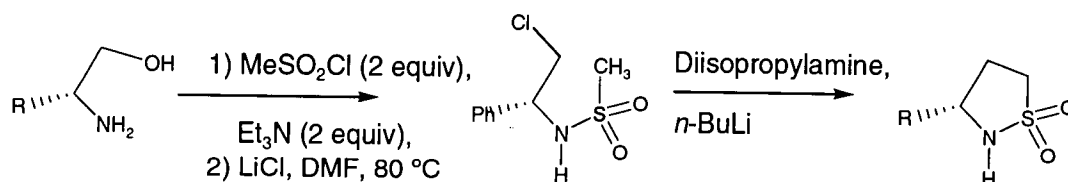


isothiazolidine 1,1-dioxide (11)

Conditions: 2-Chloroethylamine-HCl (12.2g, 106 mmol), methanesulfonyl chloride (8.6, 111 mmol), triethylamine (31.2 mL, 223 mmol) in acetonitrile (150 mL); diisopropylamine (3.5 mL, 25 mmol), *n*-BuLi in hexane (135 mL, 216 mmol, 1.6 M). THF (330 mL), reaction temperature; ~ -60 °C to -50 °C; then warmed to 0 °C over a period of 2h. Filtration of the crude reaction mixture over small plug of silica gel (ethyl acetate-hexane-methylene chloride, 3:6:1) afforded the desired product **11** (7.6g, 60%) as an oil.²

¹H NMR (CDCl₃, 400 MHz) δ 4.27 (br s, 1H), 3.43 (m, 2H), 3.09 (t, 2H, $J = 7.54$ Hz), 2.46 (m, 2H); ¹³C NMR (CDCl₃, 100 MHz) δ 46.5, 42.2, 23.9 ppm.

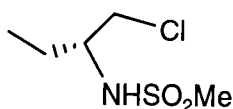
General procedures for the conversion of β -amino alcohol to 1,3-sultam:



Typical procedure; To a stirred solution of the amino alcohol (36.6 mmol) and triethylamine (75 mmol) in THF were added methanesulfonyl chloride (75 mmol) at 0°C. After aging for 4h at room temperature, 30 ml of MTBE was added. After filtration of the triethylamine-HCl salt, the filtrate was concentrated to afford bis-mesylate.

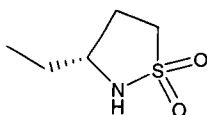
The resulting presumed bis-mesylate was treated with NaCl (55 mmol) in DMF (45 mL) and warmed to 80 °C. After aging for 16h at this temperature, the reaction was cooled to room temperature and diluted with water (30 mL) and EtOAc-hexanes (50 mL, 2:1). After phase separation, the organic layer was washed sequentially with 0.5N HCl and brine. The solution was dried over Na₂SO₄, filtered and concentrates under reduced pressure. The crude material was eluted through a small plug of silica gel (hex/EtOAc, 2:1) to afford the chloromethanesulfonate.

The solution of chlorosulfonamide (34 mmol) in THF (100 mL) was placed in 500 mL RBF and cooled to -60 °C under nitrogen atmosphere. After addition of diisopropylamine (8.3 mmol) and 1,10-phenanthroline (15 mg), a solution *n*-BuLi in hexane (73 mmol, 1.6 M) was slowly added via a dropping funnel maintaining the internal temperature below -50 °C over a period of 30 min. Then, the resulting solution was slowly warmed to 0 °C over 4 h. After 2h at 0 °C, the reaction was quenched by addition of 2N HCl (pH adjusted to ~ 5). After addition of 20% brine (30 mL), the phases were separated. The aq. layer was back-extracted with ethyl acetate (40 mL). Concentration of the combined organic layers followed by flash or filtering silica gel chromatography gave the desired product.



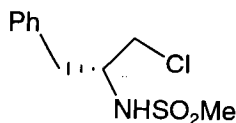
***N*-[(1*R*)-1-(chloromethyl)propyl]methanesulfonamide (16)**

$[\alpha]_D^{23} +16.8^\circ$ (c 0.037, EtOH); NMR (CDCl₃, 400 MHz) δ 4.50 (br s, 1H), 3.74 (dd, 1H, $J = 11.20, 4.04$), 3.66~3.58 (m, 2H), 3.04 (s, 3H), 1.68 (m, 2H), 1.01 (t, 3H, $J = 7.40$ Hz); ¹³C NMR (CDCl₃, 100 MHz) δ 56.1, 48.1, 42.1, 26.1, 10.3 ppm.



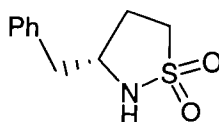
(3*R*)-3-ethylisothiazolidine 1,1-dioxide (17)

$[\alpha]_D^{23} +13.3^\circ$ (c 0.037, EtOH); ¹H NMR (CDCl₃, 400 MHz) δ 4.30 (br s, 1H), 3.54~3.50 (m, 1H), 3.24~3.14 (m, 1H), 3.04~3.04 (m, 1H), 2.54~2.46 (m, 1H), 2.12~2.02 (m, 1H), 1.70~1.57 (m, 2H), 0.99 (t, 3H, $J = 7.4$ Hz); ¹³C NMR (CDCl₃, 100 MHz) δ 56.6, 48.1, 29.4, 28.9, 10.4 ppm.



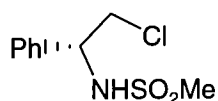
***N*-[(1*R*)-1-benzyl-2-chloroethyl]methanesulfonamide (19)**

$[\alpha]_D^{23} -33.9^\circ$ (c 0.038, EtOH); ¹H NMR (CDCl₃, 400 MHz) δ 7.37-7.25 (m, 5H), 4.84 (br d, $J = 8.8$ Hz, 1H), 3.88 (m, 1H), 3.70 (dd, $J = 11.8, 4.8$ Hz, 1H), 3.63 (dd, $J = 11.8, 4.8$ Hz, 1H), 3.02 (dd, $J = 13.8, 6.4$ Hz, 1H), 2.86 (dd, $J = 13.8, 6.4$ Hz, 1H), 2.58 (s, 3H); ¹³C NMR (CDCl₃, 100 MHz) δ 136.8, 129.6, 129.0, 127.4, 56.4, 48.1, 42.4, 39.2 ppm.

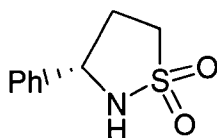


(3*R*)-3-benzylisothiazolidine 1,1-dioxide (20)

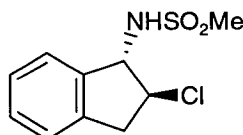
$[\alpha]_D^{23} -22.3^\circ$ (c 0.031, EtOH)³; ¹H NMR (CDCl₃, 400 MHz) δ 7.40-7.15 (m, 5H), 4.62 (br s, 1H), 3.90~3.80 (m, 1H), 3.26~3.20 (m, 1H), 3.16~3.06 (m, 1H), 3.00~2.84 (m, 2H), 2.53~2.45 (m, 1H), 2.21~2.15 (m, 1H); ¹³C NMR (CDCl₃, 100 MHz) δ 129.1, 128.9, 128.7, 127.2, 56.11, 47.9, 42.2, 28.9 ppm.

***N*-[(1*R*)-2-chloro-1-phenylethyl]methanesulfonamide (22)**

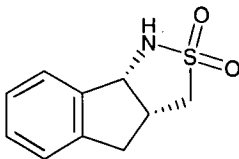
$[\alpha]_D^{23}$ -49.2° (c 0.031, EtOH); ^1H NMR (CDCl_3 , 400 MHz) δ 7.42-7.34 (m, 5H), 5.30 (br d, $J = 6.8\text{ Hz}$, 1H), 4.81 (m, 1H), 3.88 (dd, $J = 11.4, 7.2\text{ Hz}$, 1H), 3.77 (m, $J = 11.4, 7.2\text{ Hz}$, 1H), 2.79 (s, 3H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 137.8, 129.1, 128.8, 126.9, 58.7, 48.3, 42.0 ppm.

**(3*S*)-3-phenylisothiazolidine 1,1-dioxide (23)**

$[\alpha]_D^{23}$ -50.5° (c 0.033, EtOH)⁴; ^1H NMR (CDCl_3 , 400 MHz) δ 7.42-7.30 (m, 5H), 4.76~4.71 (m, 1H), 4.62 (br s, 1H), 3.40~3.33 (m, 1H), 3.26~3.18 (m, 1H), 2.82~2.79 (m, 1H), 2.46~2.36 (m, 1H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 140.2, 129.0, 128.5, 126.0, 58.2, 48.2, 32.2 ppm.

***N*-[(1*S*, 2*S*)-2-chloro-2,3-dihydro-1*H*-inden-1-yl]methanesulfonamide (25)**

$[\alpha]_D^{23}$ +91.3° (c 0.016, EtOH); ^1H NMR (CDCl_3 , 400 MHz) δ 7.43 (m, 1H), 7.32 (m, 2H), 7.31 (m, 1H), 5.03 (t, $J = 8.4\text{ Hz}$, 1H), 4.80 (br d, 1H), 4.29 (dd, $J = 15.5, 7.6\text{ Hz}$, 1H), 3.49 (dd, $J = 15.9, 7.6\text{ Hz}$, 1H), 3.20 (s, 3H), 3.14 (m, 1H); ^{13}C NMR (CDCl_3 , 100 MHz) δ 139.5, 138.7, 129.3, 128.1, 124.7, 124.3, 67.0, 63.2, 42.67, 40.1 ppm.

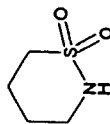
**(3*aR*, 8*bR*)-3,3*a*,4,8*b*-tetrahydro-1*H*-indeno[1,2-*c*]isothiazole 2,2-dioxide (26)**

$[\alpha]_D^{23}$ -101.2° (c 0.023, EtOH); ^1H NMR (CDCl_3 , 400 MHz) δ 7.36-7.27 (m, 4H), 5.05 (d, $J = 7.3\text{ Hz}$, 1H), 3.63~3.56 (m, 1H), 3.40~3.50 (m, 2H), 3.03 (dd, $J = 16.6, 4.0\text{ Hz}$, 1H), 2.89 (dd, 1H, $J = 12.7, 7.9\text{ Hz}$); ^{13}C NMR (CDCl_3 , 100 MHz) δ 141.3, 139.9, 129.5, 127.9, 125.4, 125.1, 63.0, 52.9, 39.8, 37.5 ppm.

References

1. White, E. H.; Lim, H. M. *J. Org. Chem.* **1987**, *52*, 2162.
2. Bliss, A. D.; Cline, W. K.; Hamilton, C. E.; Sweeting, O. *J. Org. Chem.* **1963**, *28*, 3537.
3. The antipode of sultam **20** has been reported in literature. However, no optical rotation value was given, see; Spaltenstein, A., Almond, M. R., Bock, W. J., Cleary, D. G., Furfine, E. S., Hazen, R. J., Kazmierski, W. M., Salituro, F. G., Tung, R. D., Wright, L. L. *Bioorganic. Med. Chem. Lett.* **2000**, *10*, 1159.
4. For the racemic *N*-methyl sultam **23** synthesis, see; Togo, H.; Harada, Y.; Yokoyama, M. *J. Org. Chem.* **2000**, *65*, 926.

nmr400a h-1



```

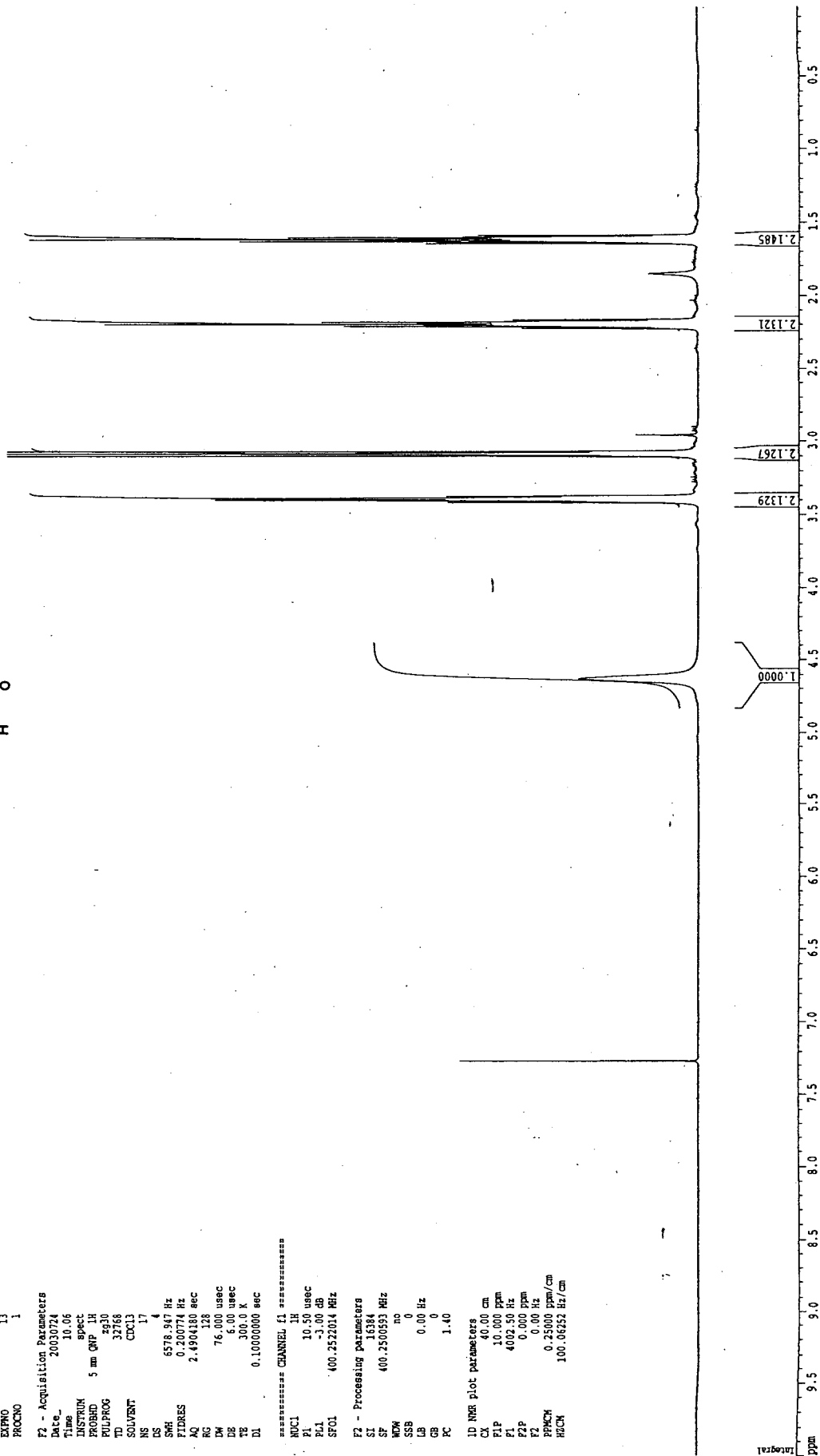
Current Data Parameters
NAME      66684-288
EXPNO     13
PROCNO    1

F2 - Acquisition Parameters
Date_     20030724
Time      10.06
INSTRUM   spect
PROBHD    5 mm QNP 1H
PULPROG   zg30
TD         32768
SOLVENT   CDCl3
NS         17
DS         4
SWH        6578.947 Hz
FIDRES     0.200774 Hz
AQ         2.4904180 sec
RG         128
DM         76.000 usec
DE         6.00 usec
TE         300.0 K
TE         300.0 K
D1         0.10000000 sec

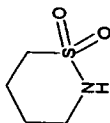
***** CHANNEL f1 *****
NUC1       1H
P1         10.50 usec
PL1        -3.00 dB
SFO1       400.2522014 MHz

F2 - Processing parameters
SI         16384
SF         400.2500553 MHz
WDW        no
SSB        0
LB         0.00 Hz
GB         0
PC         1.40

ID NMR plot parameters
CX         40.00 cm
F1P        10.000 ppm
F1         4002.50 Hz
F2P        0.000 ppm
F2         0.00 Hz
PPMCK     0.25000 ppm/cm
HECCK     100.06252 Hz/cm
    
```



nmr400a h-1 decoupled c-13



```

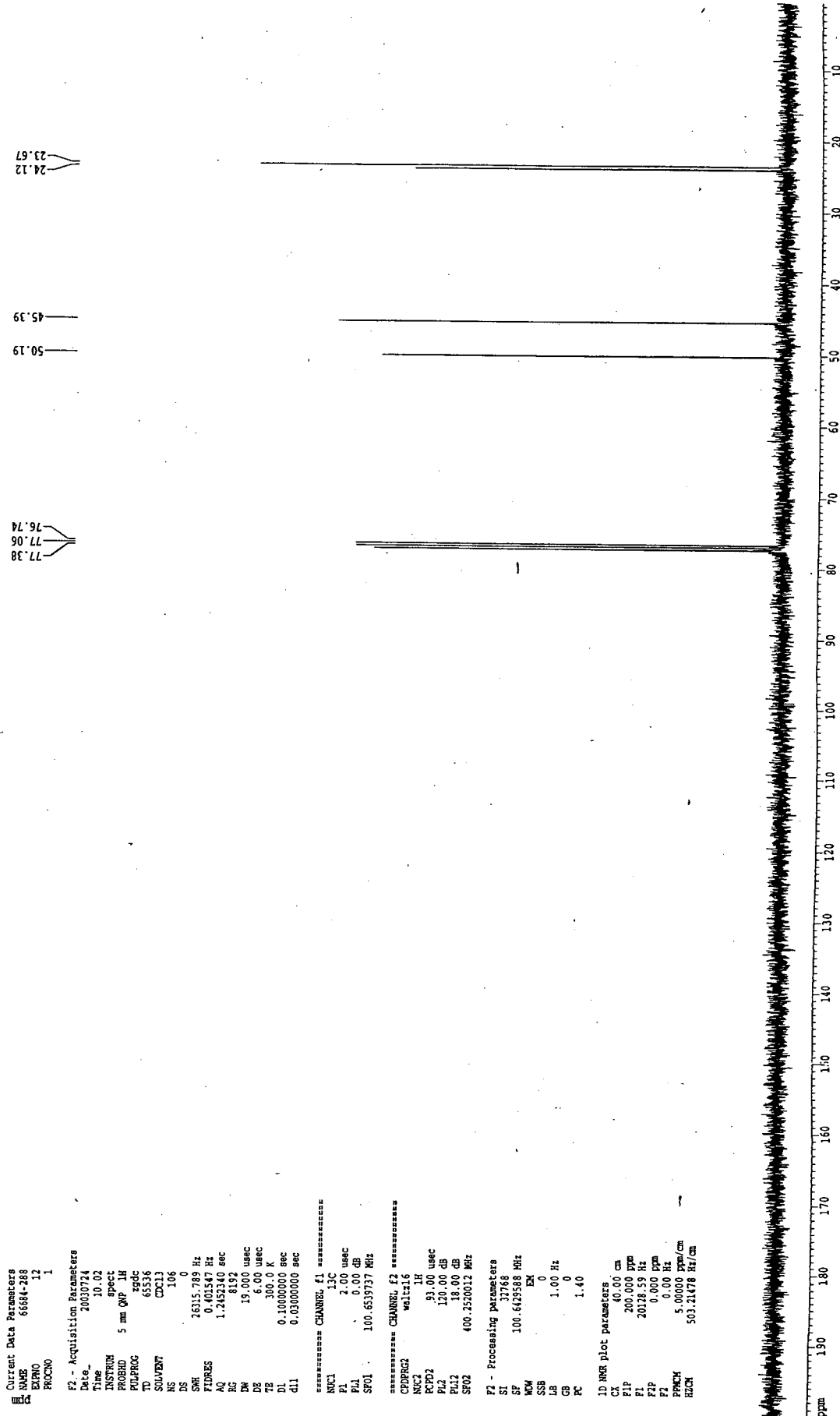
Current Data Parameters
=====
F1 - Acquisition Parameters
Date_      20030724
Time       10.02
INSTRUM    spect
PROBHD     5 mm QNP 1H
PULPROG    zgdc
TD         65536
SOLVENT    CDCl3
NS         106
DS         0
SWH        26315.789 Hz
FIDRES     0.401547 Hz
AQ         1.2452340 sec
RG         8152
DM         19.000 usec
DE         6.00 usec
TE         300.0 K
D1         0.10000000 sec
D11        0.03000000 sec

===== CHANNEL F1 =====
NUC1       13C
P1         2.00 usec
PL1        0.00 dB
SFO1       100.619737 MHz

===== CHANNEL F2 =====
CPDPRG3    waltz16
NUC2       1H
PCPD2      93.00 usec
PL2        170.00 dB
PL12       18.00 dB
SFO2       400.2500012 MHz

F2 - Processing parameters
SI         32768
SF         100.6429168 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

1D NMR Plot Parameters
CX         40.00 cm
F1P        200.000 ppm
F2P        20318.59 Hz
F2         0.000 ppm
F2         0.00 Hz
PPMCK     5.00000 ppm/cm
RGZM      503.21478 Hz/cm
    
```



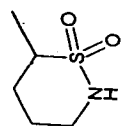
24.12
23.67

45.39
50.19

76.74
77.06
77.38

10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 ppm

nmr400b h-1



Current Data Parameters
 NAME 66684-272
 EXPNO 2
 PROCNO 1

F2 - Acquisition Parameters

Date 20030721
 Time 10.34
 INSTRUM spect
 PROBRD 5 mm QNP 1H
 PULPROG zg30
 TD 32768
 SOLVENT CDCl3
 NS 32
 DS 2
 SWH 6578.947 Hz
 FIDRES 0.200774 Hz
 AQ 2.4504180 sec
 RG 256
 DW 76.000 usec
 DE 6.00 usec
 TE 300.0 K
 DI 0.10000000 sec

***** CHANNEL f1 *****

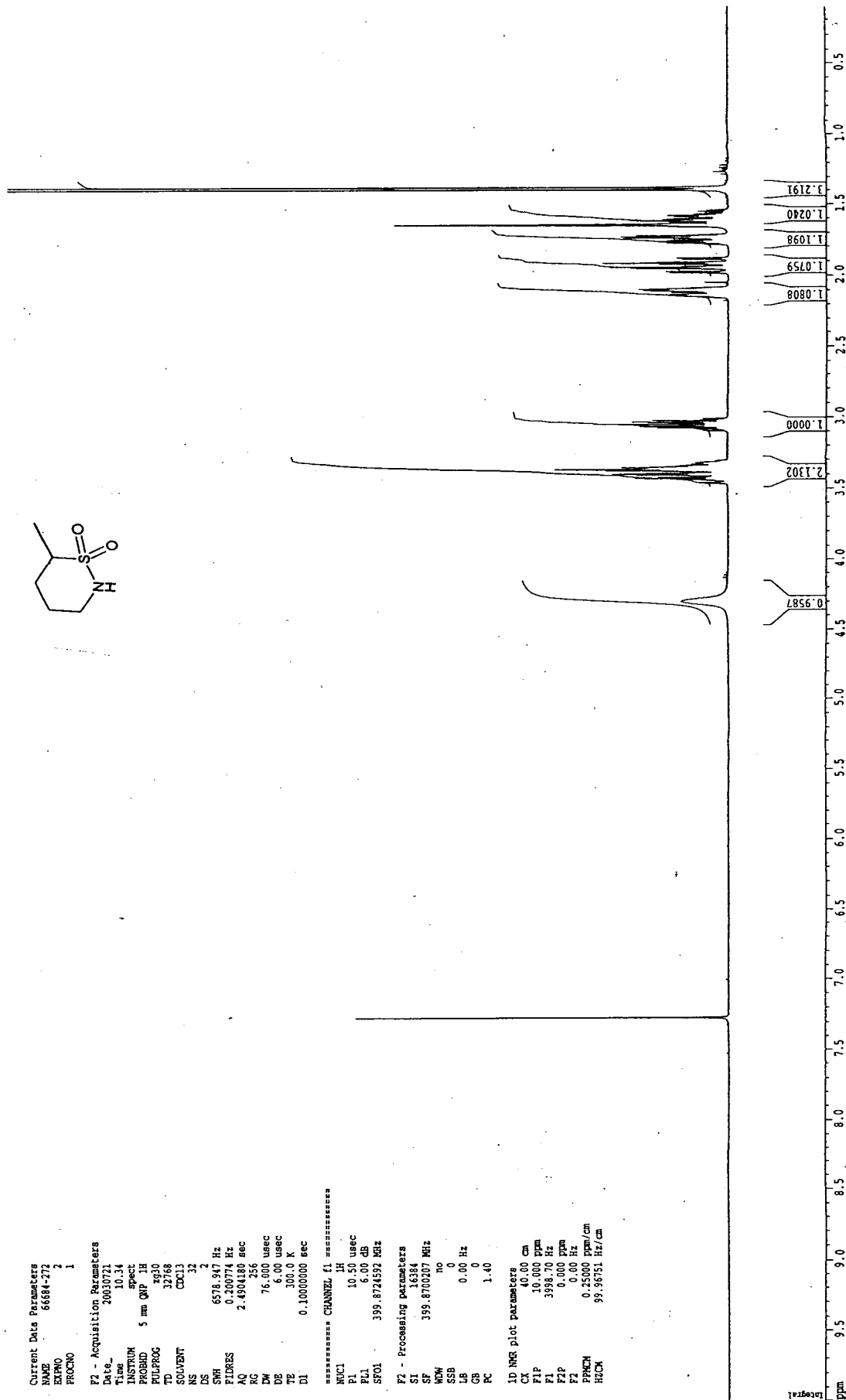
NUC1 1H
 P1 10.50 usec
 PL1 6.00 dB
 SFO1 399.8724592 MHz

F2 - Processing parameters

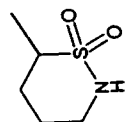
SI 16384
 SF 399.8700207 MHz
 WDW no
 SSB 0
 LB 0.00 Hz
 GB 0
 PC 1.40

1D NMR plot parameters

CX 40.00 cm
 FIP 10.000 ppm
 F1 3894.70 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 PPMCH 0.25000 ppm/cm
 HZCM 99.96751 Hz/cm



nmr400b h-1 decoupled c-13



```

Current Data Parameters
NAME      66684-272
EXPNO    1
PROCNO   1

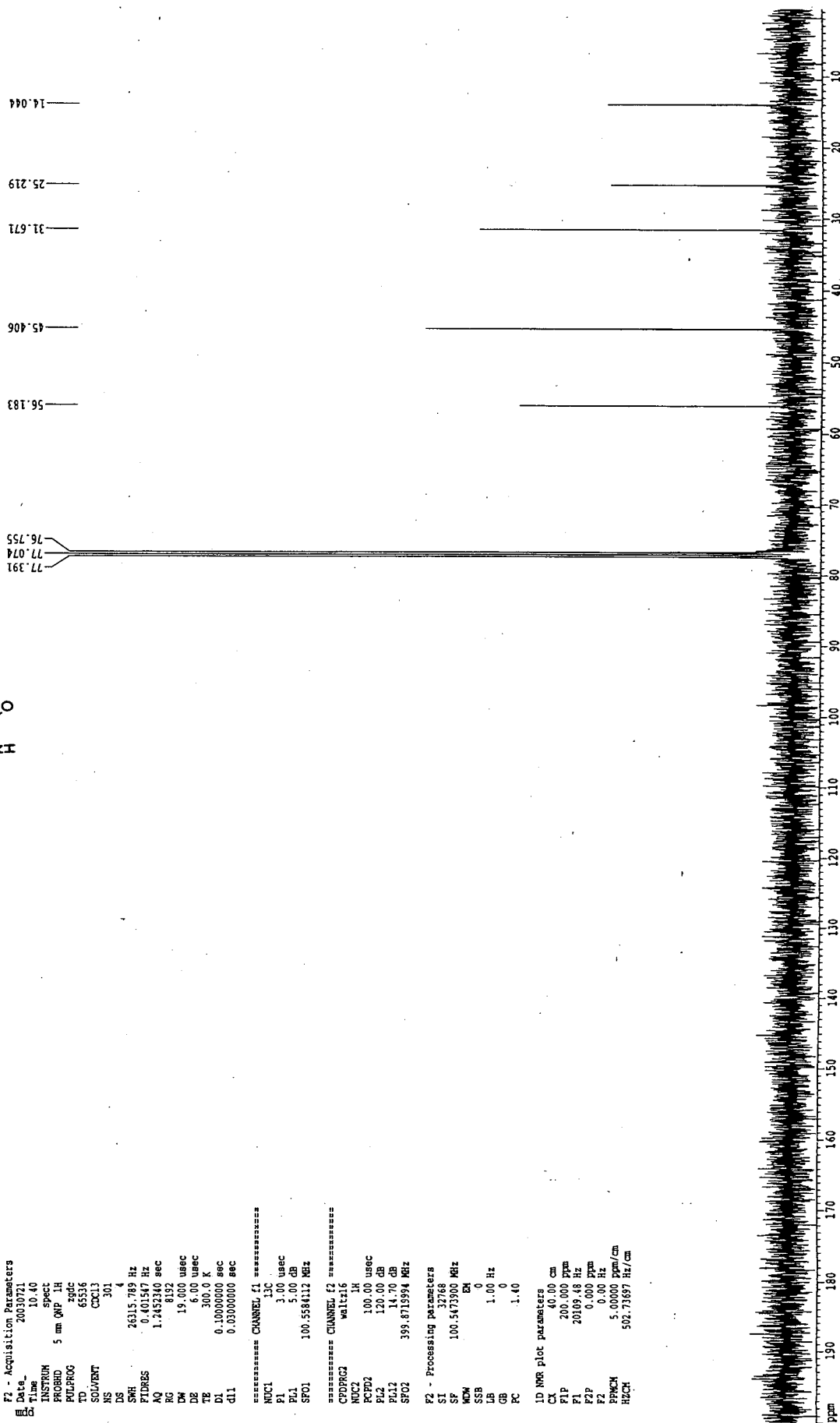
F2 - Acquisition Parameters
El Data_ 20030721
Time     10.40
INSTRUM spect
PROBHD   5 mm QNP 1H
PULPROG zgpg
TD       65536
SOLVENT  CDCl3
NS       301
DS       4
SWH      26315.789 Hz
FIDRES   0.401547 Hz
AQ       1.2457310 sec
RG       8192
DM       19.000 usec
DE       6.000 usec
TE       300.0 K
D1       0.10000000 sec
D11      0.03000000 sec

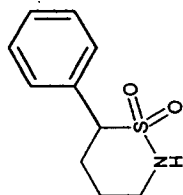
===== CHANNEL f1 =====
NUC1     13C
P1       3.00 usec
PL1     5.00 dB
SFO1    100.5584112 MHz

===== CHANNEL f2 =====
CPDPRG2 waltz16
NUC2     1H
PCPD2    100.00 usec
PL2     120.00 dB
PL12    14.70 dB
SFO2    399.8715994 MHz

F2 - Processing parameters
SI       32768
SF       100.5473900 MHz
WDW      EM
SSB      0
LB       1.00 Hz
GB       0
PC       1.40

1D NMR plot parameters
CX       40.00 cm
F1P      200.000 ppm
F1       20109.48 Hz
F2P      0.000 ppm
F2       0.00 Hz
PPMCH   5.00000 ppm/cm
HZCH    502.73687 Hz/cm
    
```





```

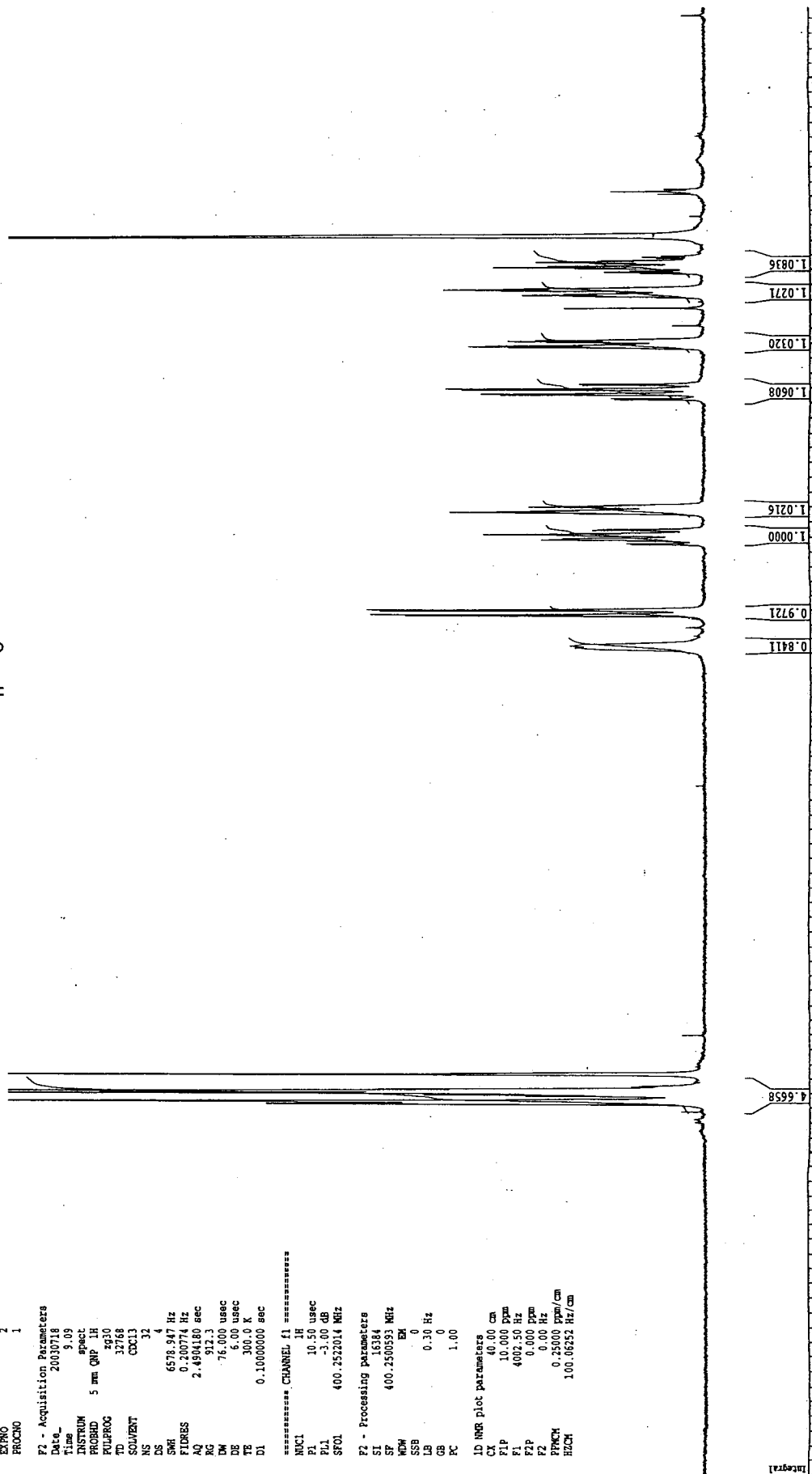
Current Data Parameters
NAME      66684-274
EXPNO    2
PROCNO   1

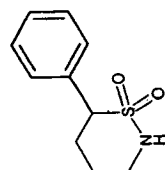
F2 - Acquisition Parameters
Date_    20030718
Time     9.09
INSTRUM spect
PROBHD   5 mm QNP 1H
PULPROG zg30
TD       32768
SOLVENT  CDCl3
NS       32
DS       4
SWH      6578.947 Hz
FIDRES   0.200774 Hz
AQ       2.4904180 sec
RG       912.3
DM       76.000 usec
DE       6.00 usec
TE       300.0 K
D1       0.10000000 sec

***** CHANNEL f1 *****
NUC1     1H
P1       16.50 usec
PL1      -1.00 dB
SFO1     400.2522014 MHz

F2 - Processing parameters
SI       16384
SF       400.2500593 MHz
WDW      EM
SSB      0
LB       0.30 Hz
GB       0
PC       1.00

ID MSF plot parameters
CX       40.00 cm
FLP      10.000 ppm
F1       4002.50 Hz
F2       0.000 ppm
F3       0.00 Hz
F4       0.00 Hz
F5       0.25000 ppm/cm
F6CH     100.00252 Hz/cm
    
```





nmr400a h-1 decoupled c-13

128.7
128.9
129.3

77.3
77.0
76.7

45.4

30.5

26.8

128.7
128.9
129.3

```

Current Data Parameters
NAME 66684-274
EXPNO 3
PROCNO 1

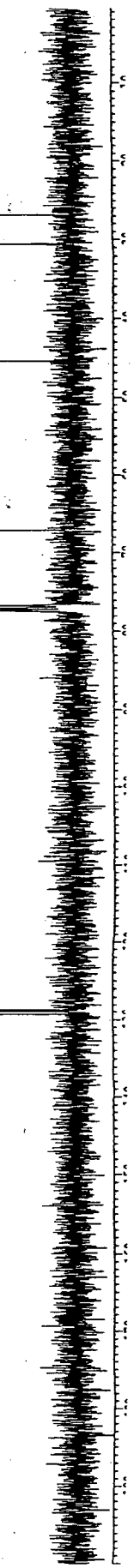
F2 - Acquisition Parameters
Date_ 20030718
Time 9:17
INSTRUM spect
PROBHD 5 mm QNP 1H
PULPROG zgpg
TD 65536
SOLVENT CDCl3
NS 380
DS 0
SWH 26315.789 Hz
FIDRES 0.401547 Hz
AQ 1.2452140 sec
RG 5180.6
RC 13.000 usec
DE 8.000 usec
TE 300.0 K
D1 0.1000000 sec
D11 0.0300000 sec
D12 0.0300000 sec

***** CHANNEL f1 *****
NUC1 13C
P1 2.00 usec
PL1 0.00 dB
SFO1 100.6251377 MHz

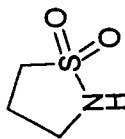
***** CHANNEL f2 *****
CPDPRG2 waltz16
NUC2 1H
P2 83.00 usec
PL2 130.00 dB
SFO2 400.2510012 MHz

F2 - Processing parameters
SI 32768
SF 100.6251377 MHz
WDW EM
SSB 0
GB 1.00 Hz
PC 1.40
SC 0

ID NMR plot parameters
SI 40.00 cm
F1 200.000 ppm
F2 2028.53 Hz
AQ 0.000 ppm
F2 34.000 ppm
WDW EM
SSB 0
GB 1.000 ppm/cm
PC 503.21478 Hz/cm
    
```



nmr400a h-1



```

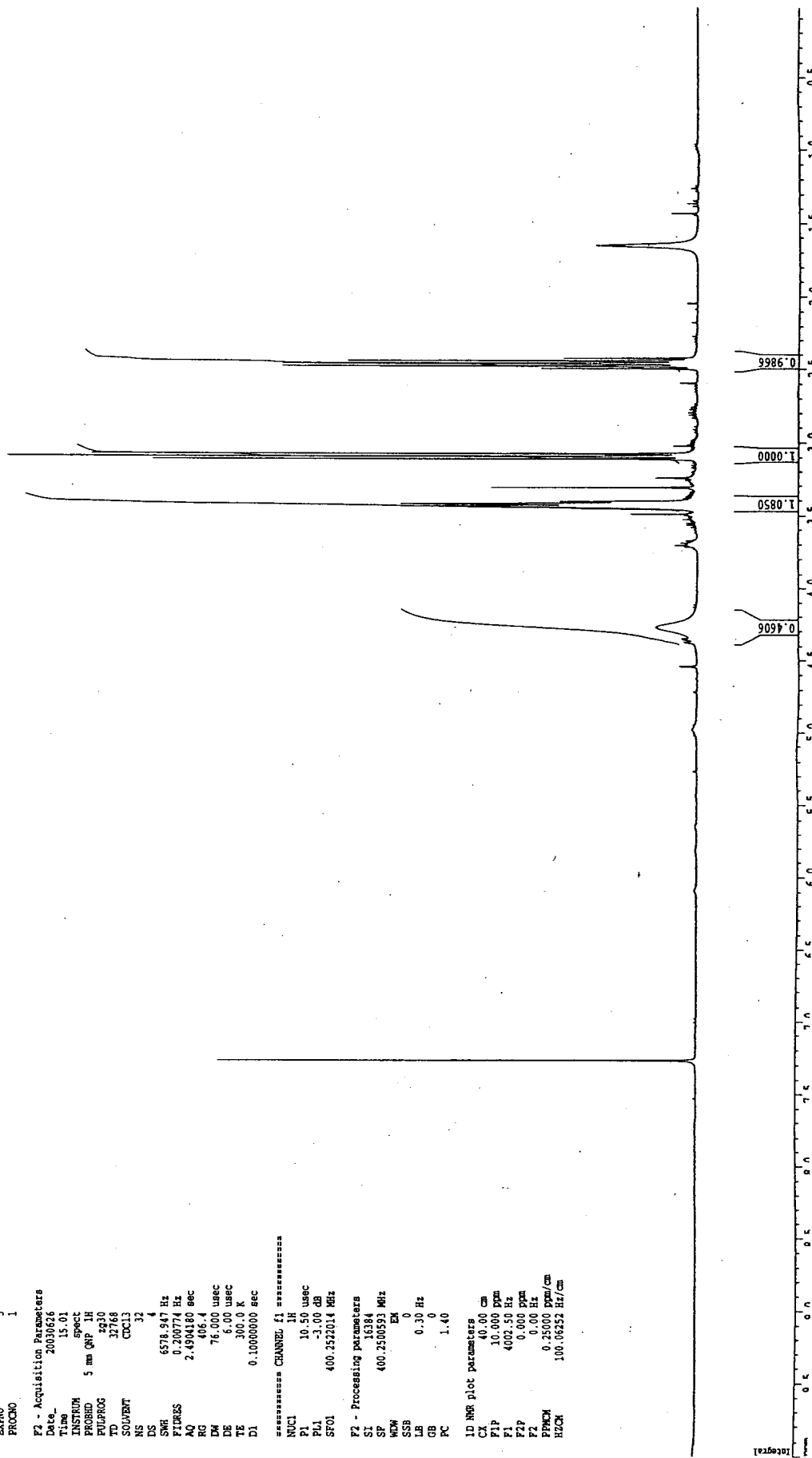
Current Data Parameters
NAME      66684-285
EXPNO    5
PROCNO   1

F2 - Acquisition Parameters
Date_    20030626
Time     15.01
INSTRUM  spect
PROBHD   5 mm QNP 1H
PULPROG  zg30
TD        32768
SOLVENT  CDCl3
NS        32
DS        4
SWH       6578.947 Hz
FIDRES    0.200774 Hz
AQ         2.490480 sec
RG         406.4
DM         76.000 usec
DE         6.00 usec
TE         300.0 K
D1         0.10000000 sec

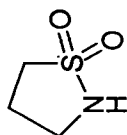
***** CHANNEL f1 *****
NUC1      1H
P1        10.50 usec
PL1       -3.00 dB
SFO1      400.2522014 MHz

F2 - Processing parameters
SI        16384
SP        400.2500593 MHz
SSB       0
WDM       EN
LB         0.30 Hz
GB         0
PC         1.40

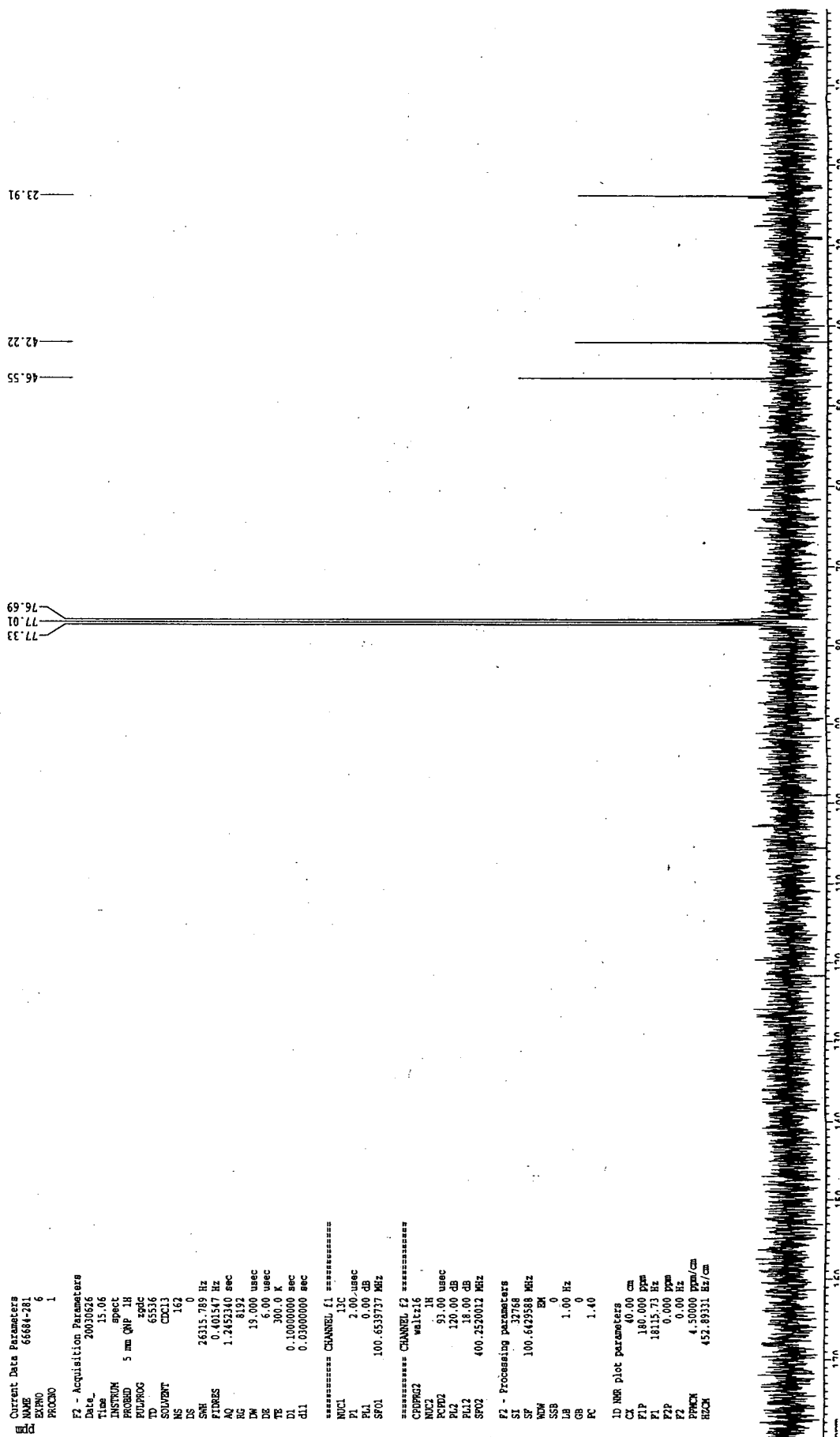
1D NMR plot parameters
CX         40.00 cm
F1P        10.000 ppm
F1         4002.50 Hz
F2P         0.000 ppm
F2          0.00 Hz
PPMCK      0.25000 ppm/cm
HZCK       100.06252 Hz/cm
    
```



Integral



nmr400a h-1 decoupled c-13



Current Data Parameters
 NAME 6688-281
 EXPNO 6
 PROCNO 1

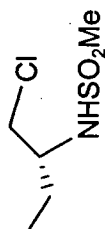
F1 - Acquisition Parameters
 File_ 20030626
 Time 15.86
 INSTRUM spect
 PROBHD 5 mm QNP 1H
 PULPROG zgpg30
 PROCNO 6596
 AQUIRE 1024
 COURSE 1024
 NS 162
 DS 4
 SW 26315.788 Hz
 F1RES 0.161547 Hz
 F2RES 1.2453740 sec
 PC 8192
 PM 19.000 usec
 PD 5.00 usec
 PE 300.0 Vsec
 PF 0.10000000 sec
 D1 0.03000000 sec
 d11 0.03000000 sec

***** CHANNEL F1 *****
 NUC1 13C
 P1 2.00 usec
 PL1 0.00 dB
 SF01 100.6539737 MHz

***** CHANNEL F2 *****
 CPDPRG2 waltz16
 NUC2 1H
 PCD2 93.00 usec
 PL2 120.00 dB
 PL12 18.00 dB
 SF02 400.2520012 MHz

F2 - Processing parameters
 SI 32768
 SF 100.6429588 MHz
 NQW 0
 SSB 0
 LA 1.00 Hz
 GB 0
 PC 1.40

1D NMR plot parameters
 CX 40.00 cm
 F1P 180.000 ppm
 F1 18115.73 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 FREQN 4.50000 ppm/cm
 HZCM 452.89331 Hz/cm



nmr400a h-1

```

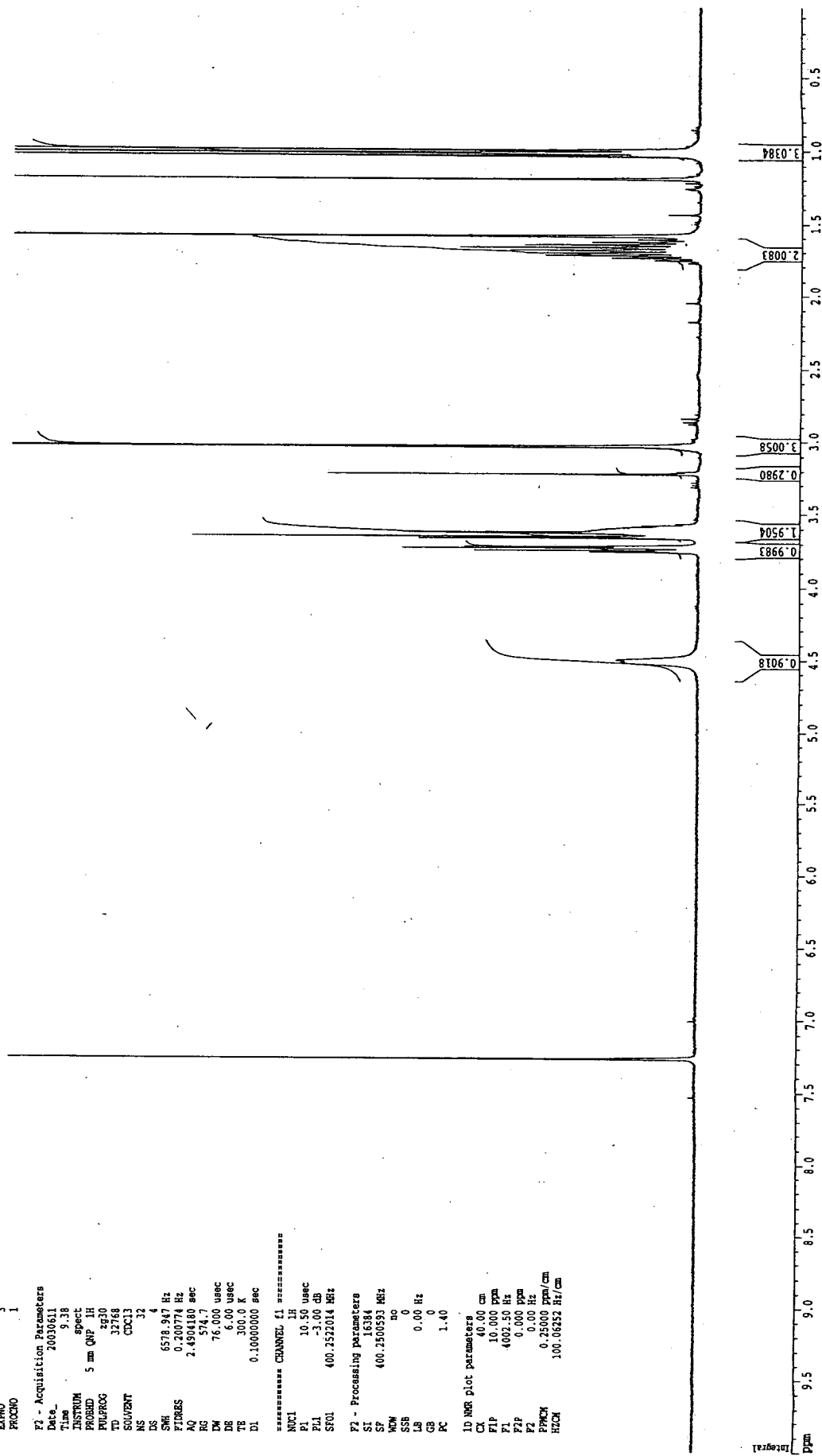
Current Data Parameters
NAME      66684-278
EXPNO     3
PROCNO    1

F2 - Acquisition Parameters
Date_     20010611
Time      9.38
INSTRUM   spect
PROBHD    5 mm QNP 1H
PULPROG   zg30
TD         32768
SOLVENT   CDCl3
NS         32
DS         4
SWH        6578.947 Hz
FIDRES     0.200774 Hz
AQ         2.4504180 sec
RG         574.7
DW         76.000 usec
DE         6.00 usec
TE         300.0 K
TR         1.0000000 sec
D1         0.10000000 sec

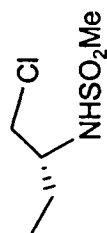
***** CHANNEL f1 *****
NUC1       1H
P1         10.50 usec
PL1        -3.00 dB
SFO1       400.2522014 MHz

F2 - Processing parameters
SI         16384
SF         400.2500593 MHz
WDW        do
SSB        0
LB         0.00 Hz
GB         0
PC         1.40

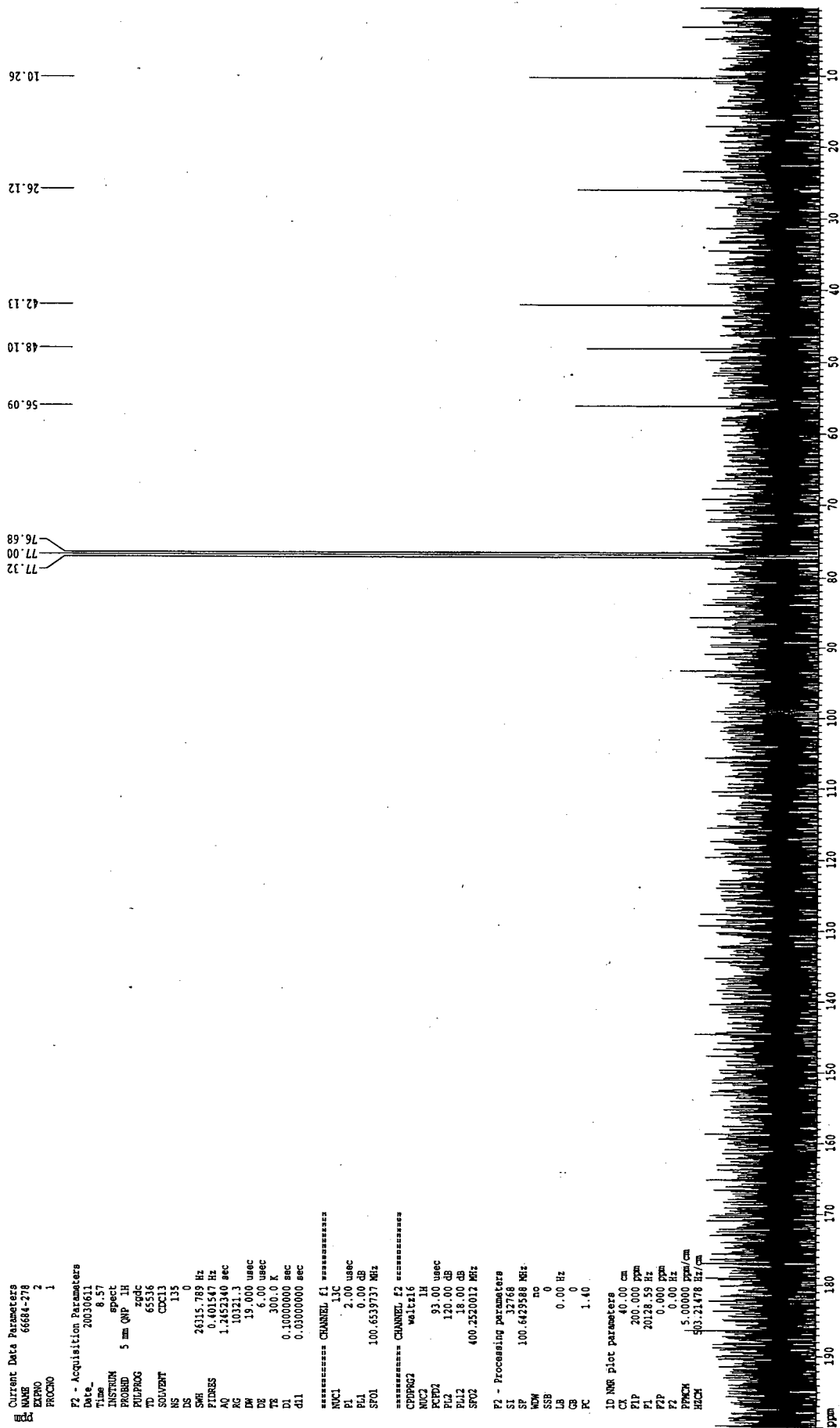
1D NMR plot parameters
CX         40.00 cm
FIP        10.000 ppm
F1         4002.50 Hz
F2P        0.000 ppm
F2         0.00 Hz
PPMCK      0.25000 ppm/cm
HZCK       100.06252 Hz/cm
    
```

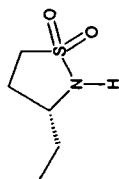


Integral



nmr400a h-1 decoupled c-13





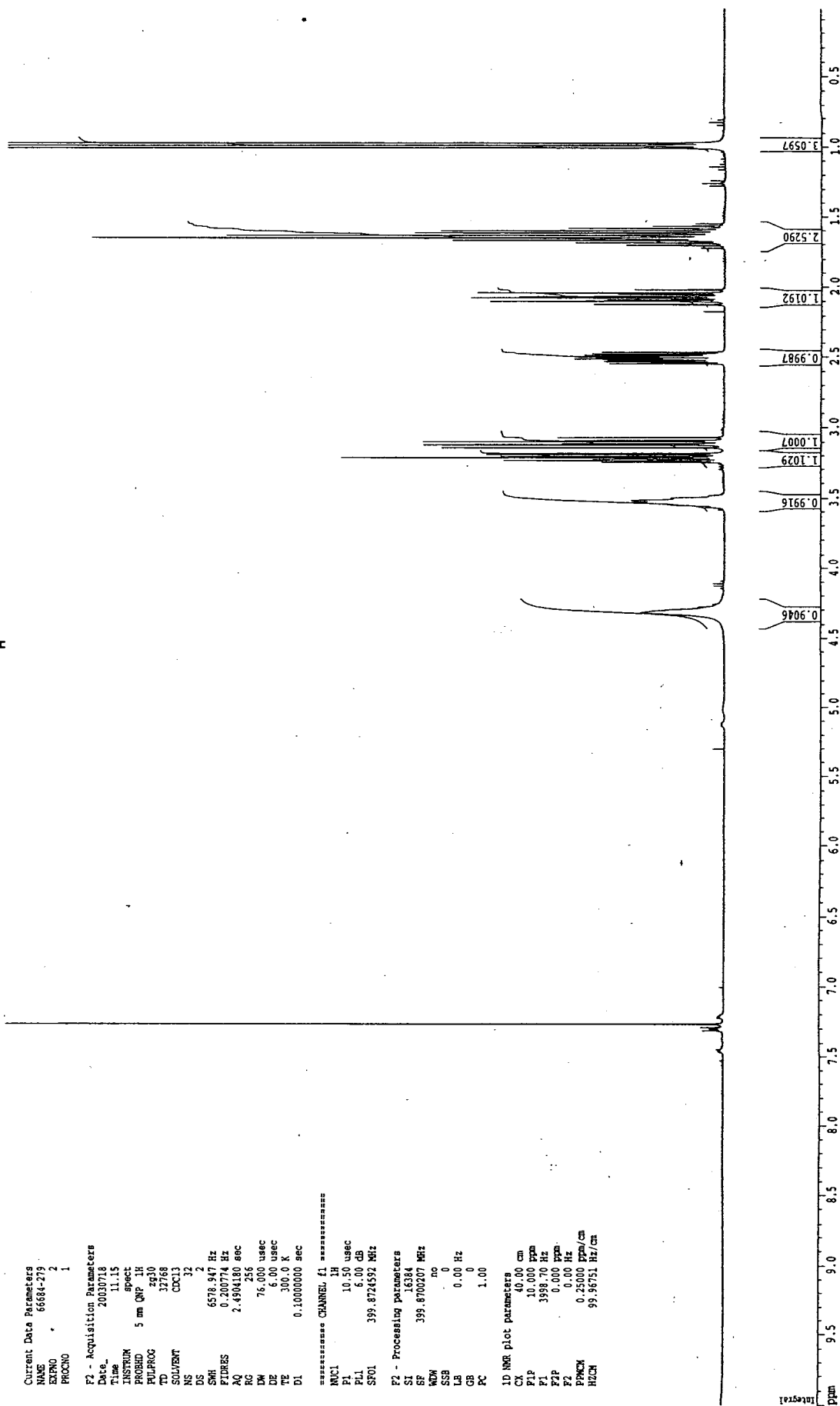
Current Data Parameters
 NAME 66684-279
 EXPNO 2
 PROCNO 1

F2 - Acquisition Parameters
 Date_ 20030718
 Time 11.15
 INSTRUM spect
 PROSD 5 mm QNP 1H
 PULPROG zg30
 TD 32768
 SOLVENT CDCl3
 NS 32
 DS 2
 SWH 6578.947 Hz
 FIDRES 0.200774 Hz
 AQ 2.4904180 sec
 RG 256
 DW 76.000 usec
 DE 6.00 usec
 TE 300.0 K
 D1 0.1000000 sec

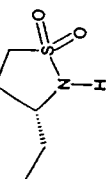
***** CHANNEL f1 *****
 NUC1 1H
 P1 10.50 usec
 PL1 6.00 dB
 SF01 399.8724592 MHz

F2 - Processing parameters
 SI 16384
 SF 399.8700207 MHz
 MDW no
 SSB 0
 LB 0.00 Hz
 GB 0
 PC 1.00

1D NMR plot parameters
 CX 40.00 cm
 P1P 10.000 ppm
 F1 3998.70 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 PPMCK 0.25000 ppm/cm
 HZCN 99.96751 Hz/cm



Integral



nmr400b h-1 decoupled c-13

```

Current Data Parameters
NAME      66684-279
EXPNO     3
PROCNO    1

F2 - Acquisition Parameters
Date_     20030718
Time      11.22
INSTRUM   spect
PROBHD    5 mm QNP 1H
PULPROG   zgpgc
TD         65536
SOLVENT   CDCl3
NS         111
DS         4
SWH        26315.789 Hz
FIDRES     0.401547 Hz
AQ         1.7452340 sec
RG         8192
DW         19.000 usec
DE         6.00 usec
TE         300.0 K
D1         0.10000000 sec
d11        0.03000000 sec

===== CHANNEL f1 =====
NUC1       13C
P1         3.00 usec
PL1        5.00 dB
SFO1       100.5584112 MHz

===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2       1H
PCPD2     100.00 usec
PL2       120.00 dB
PL12      14.70 dB
SFO2       399.8719994 MHz

F2 - Processing parameters
SI         32768
SF         100.5473900 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

ID NMR plot parameters
CX         40.00 cm
FIP        200.000 ppm
F1         20109.48 Hz
F2P        0.000 ppm
F2         0.00 Hz
PP4CH      5.00000 ppm/cm
HZCH       502.73697 Hz/cm
    
```

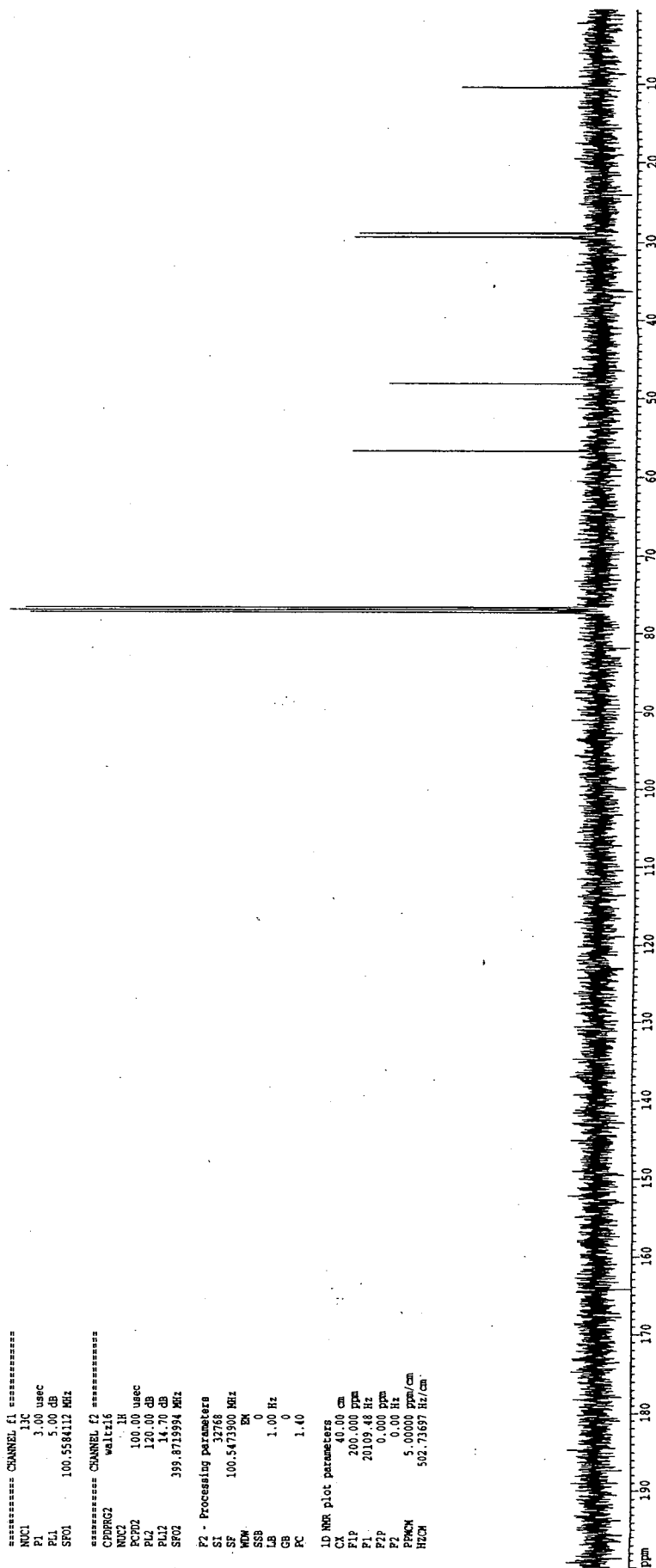
76.770
77.089
77.406

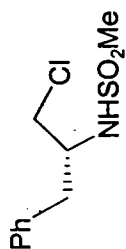
56.643

48.115

29.435
28.989

10.414





```

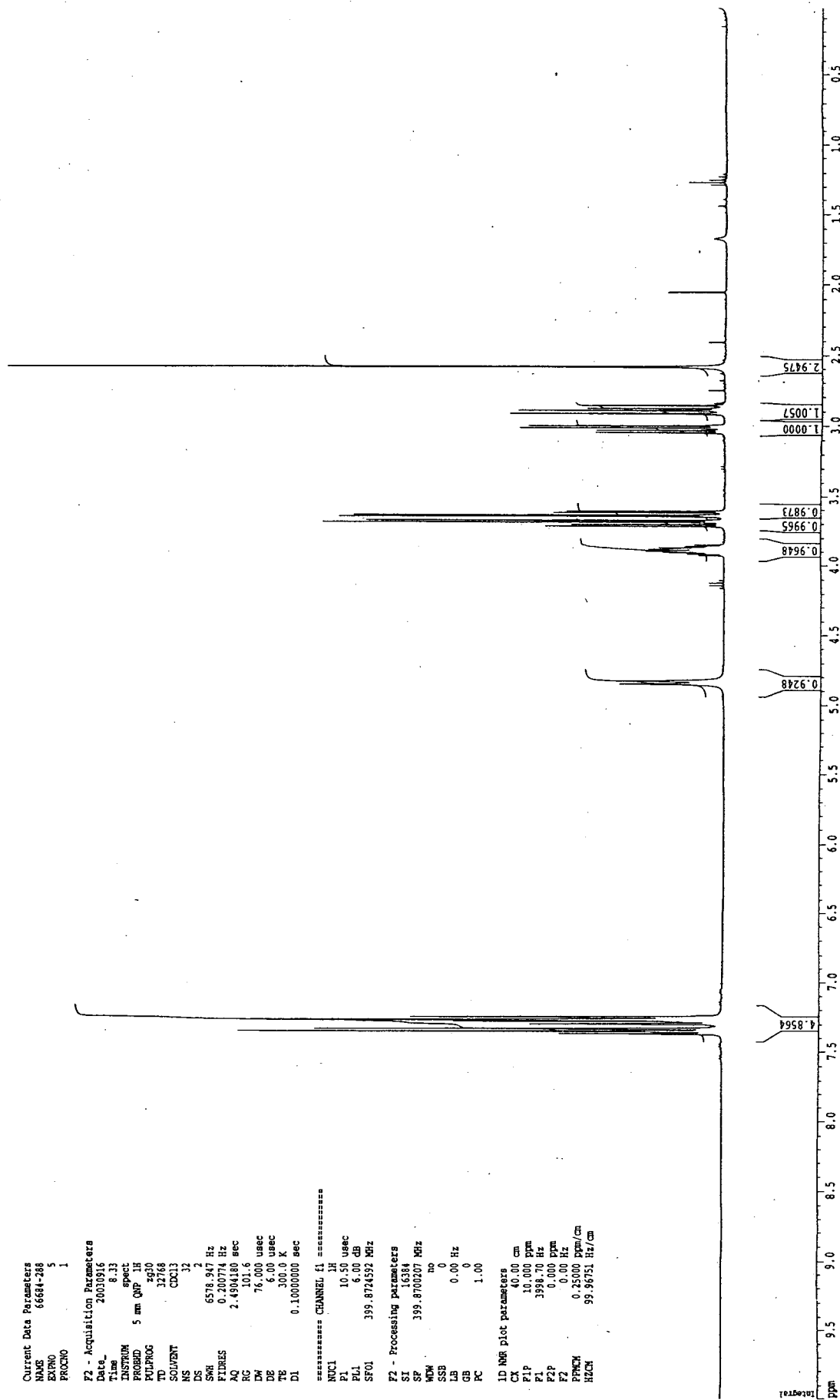
Current Data Parameters
NAME      66684-288
EXPNO     5
PROCNO    1

F2 - Acquisition Parameters
Date_     20030916
Time      8.33
INSTRUM   spect
PROBHD    5 mm QNP 1H
PULPROG   zg30
TD         32768
SOLVENT   CDCl3
NS         32
DS         2
SWH       6578.947 Hz
FIDRES    0.200774 Hz
AQ         2.4904180 sec
RG         101.6
RW         76.000 usec
DE         6.00 usec
TE         300.0 K
D1         0.10000000 sec

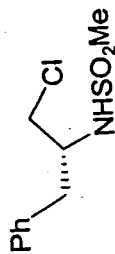
***** CHANNEL f1 *****
NUC1      1H
P1        10.50 usec
PL1       6.00 dB
SFO1      399.872452 MHz

F2 - Processing parameters
SI         16384
SF         399.870207 MHz
WDW        no
SSB        0
LB         0.00 Hz
GB         0
PC         1.00

ID NMR plot parameters
CX         40.00 cm
F1P        10.000 ppm
F2P        3998.70 Hz
F2         0.000 ppm
F2         0.00 Hz
PPMCK     0.25000 ppm/cm
HZCK      99.96751 Hz/cm
    
```



Integrate



nmr400b h-1 decoupled c-13

Current Data Parameters
 NAME 66664-288
 EXPNO 6
 PROCNO 1

F2 - Acquisition Parameters
 Date_ 20030915
 Time 8.33
 spect

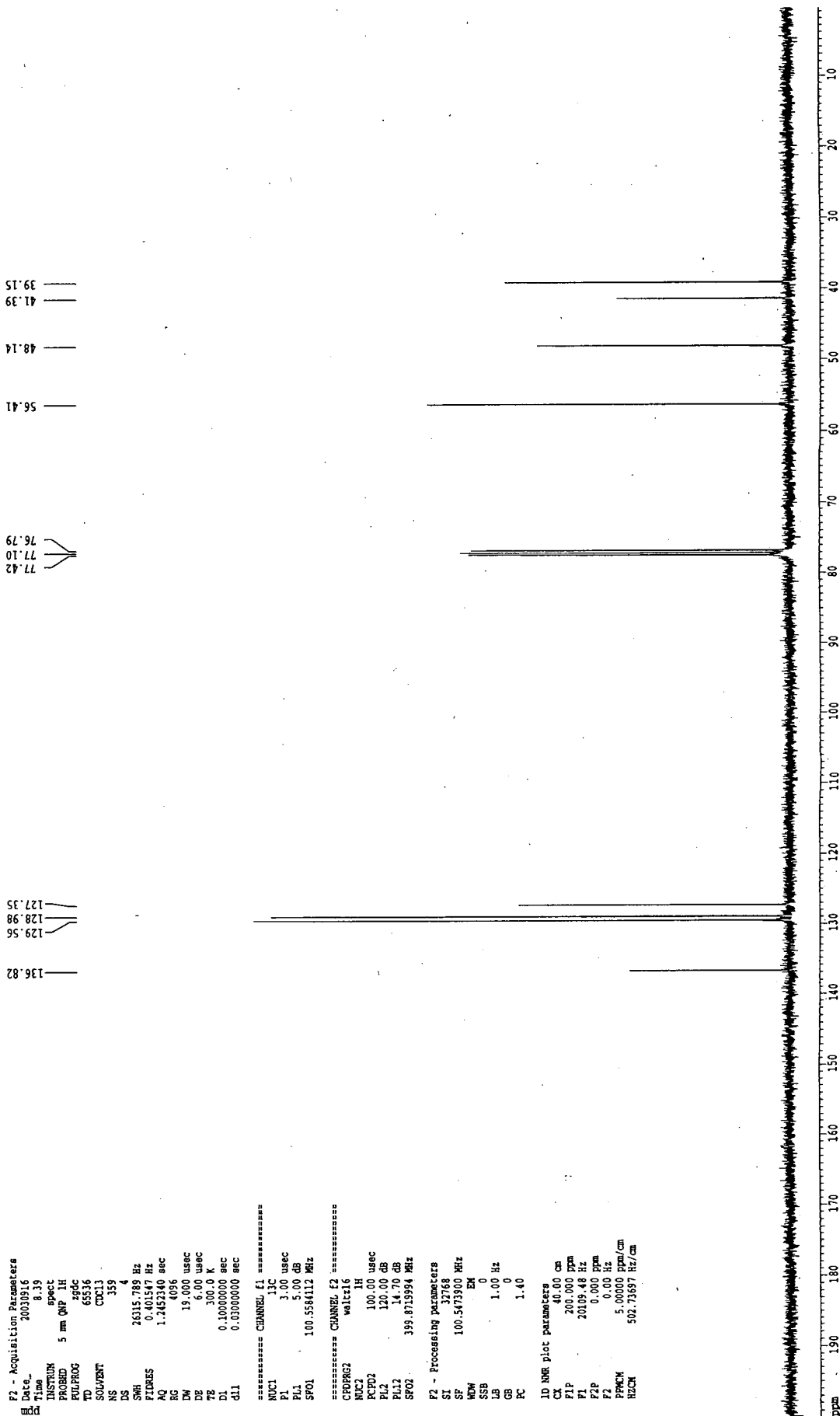
INSTRUM spect
 PROBHD 5 mm QNP 1H
 PULPROG zgpg30
 TO 65542
 SOLVENT CDCl₃
 NS 359
 DS 4
 SWH 26315.788 Hz
 FIDRES 0.1401547 Hz
 AQRES 1.2452340 sec
 PC 4096
 PD 19.000 usec
 PR 6.000 usec
 PW 300.0 K
 D1 0.10000000 sec
 D11 0.03000000 sec
 d11

===== CHANNEL F1 =====
 NUC1 13C
 P1 3.00 usec
 PL1 5.00 dB
 SFO1 100.5564112 MHz

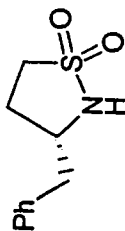
===== CHANNEL F2 =====
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 100.00 usec
 PL2 120.00 dB
 PL12 14.70 dB
 SFO2 399.8719994 MHz

F2 - Processing parameters
 SI 32768
 SF 100.5713900 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 CB 1.40

1D NMR plot parameters
 CX 40.00 cm
 F1P 200.000 ppm
 F1 200.9948 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 PPRCM 5.00000 ppm/cm
 HZCM 502.73587 Hz/cm



nmr400b h-1



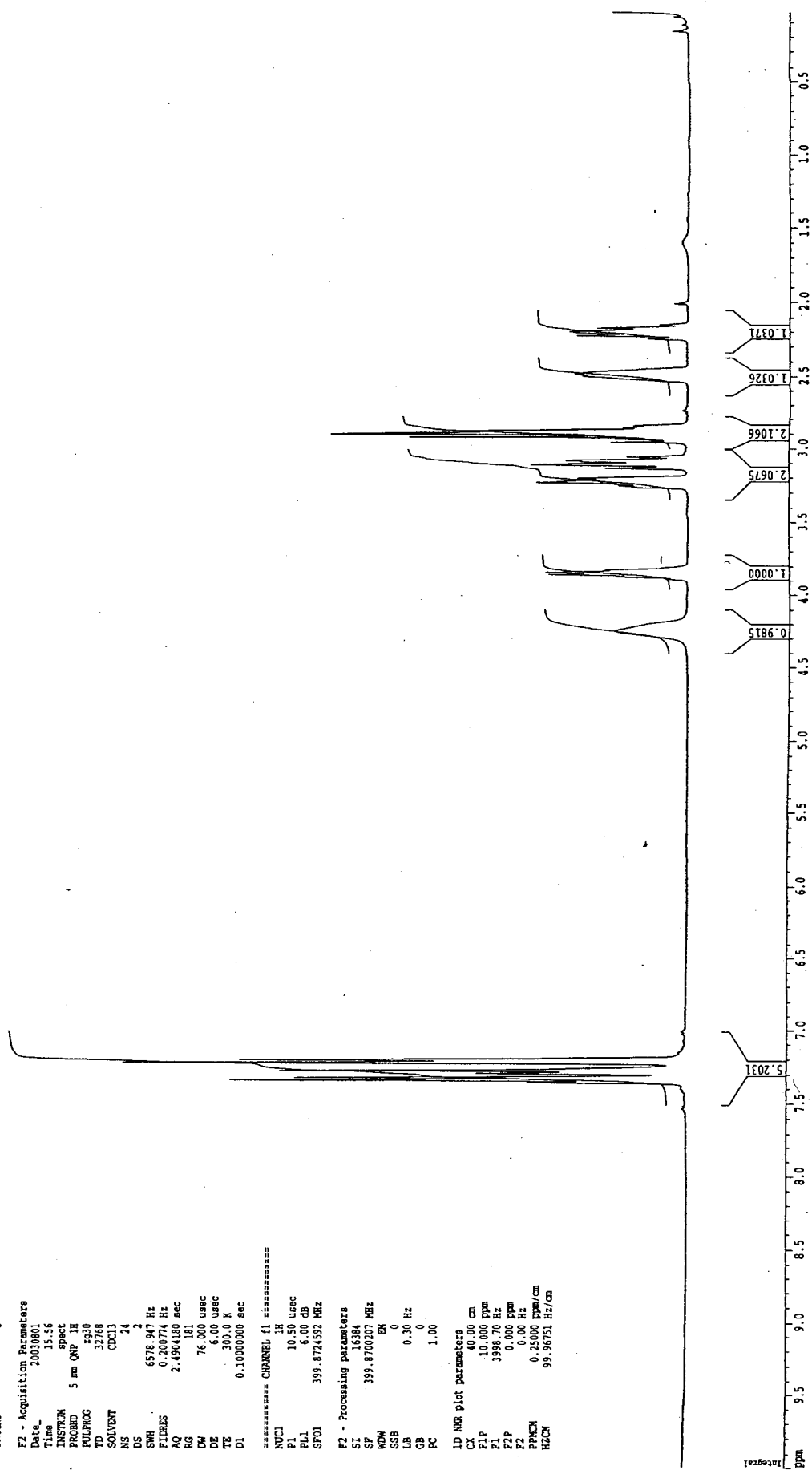
Current Data Parameters
 NAME 66684-288
 EXPRNO 4
 PROCNO 1

F2 - Acquisition Parameters
 Date_ 20030801
 Time 15.56
 INSTRUM spect
 PROBD 5 mm QNP 1H
 PULPROG zg30
 TD 32768
 SOLVENT CDCl3
 NS 24
 DS 2
 SWH 6578.947 Hz
 FIDRES 0.200774 Hz
 AQ 2.4904180 sec
 RG 181
 DW 76.000 usec
 DE 6.00 usec
 TE 300.0 K
 DI 0.10000000 sec

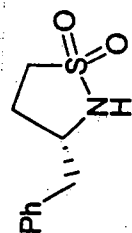
***** CHANNEL f1 *****
 NUC1 1H
 P1 10.50 usec
 PL1 6.00 dB
 SFO1 399.8724532 MHz

F2 - Processing parameters
 SI 16384
 SF 399.8700207 MHz
 WDW EN
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

1D NMR plot parameters
 CX 40.00 cm
 FIP -10.000 ppm
 F1 3998.70 Hz
 F2 0.000 ppm
 FZ 0.00 Hz
 PPMCK 0.25000 ppm/cm
 HZCK 99.96751 Hz/cm



Integral



nmr400b h-1 decoupled c-13

Current Data Parameters
 NAME 66684-288
 EXPNO 5
 PROCNO 1

F2 - Acquisition Parameters

El Date_ 20010801
 Time 16.01
 INSTRUM spect
 PROBNM 5 mm QNP 1H
 PULPROG zgpg30
 TD 65536
 SFO1 129.16
 SOLVENT CDCl3
 NS 120
 DS 4
 SWH 76315.789 Hz
 FIDRES 0.401541 Hz
 AQ 1.2482340 sec
 RG 4096
 DW 19.000 usec
 DE 6.00 usec
 TE 300.0 K
 D1 0.10000000 sec
 D11 0.03000000 sec

***** CHANNEL f1 *****
 NUC1 13C
 P1 3.00 usec
 PL1 5.00 dB
 SFO1 100.5584112 MHz

***** CHANNEL f2 *****
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 100.00 usec
 PL2 120.00 dB
 PL12 14.70 dB
 SFO2 399.8719994 MHz

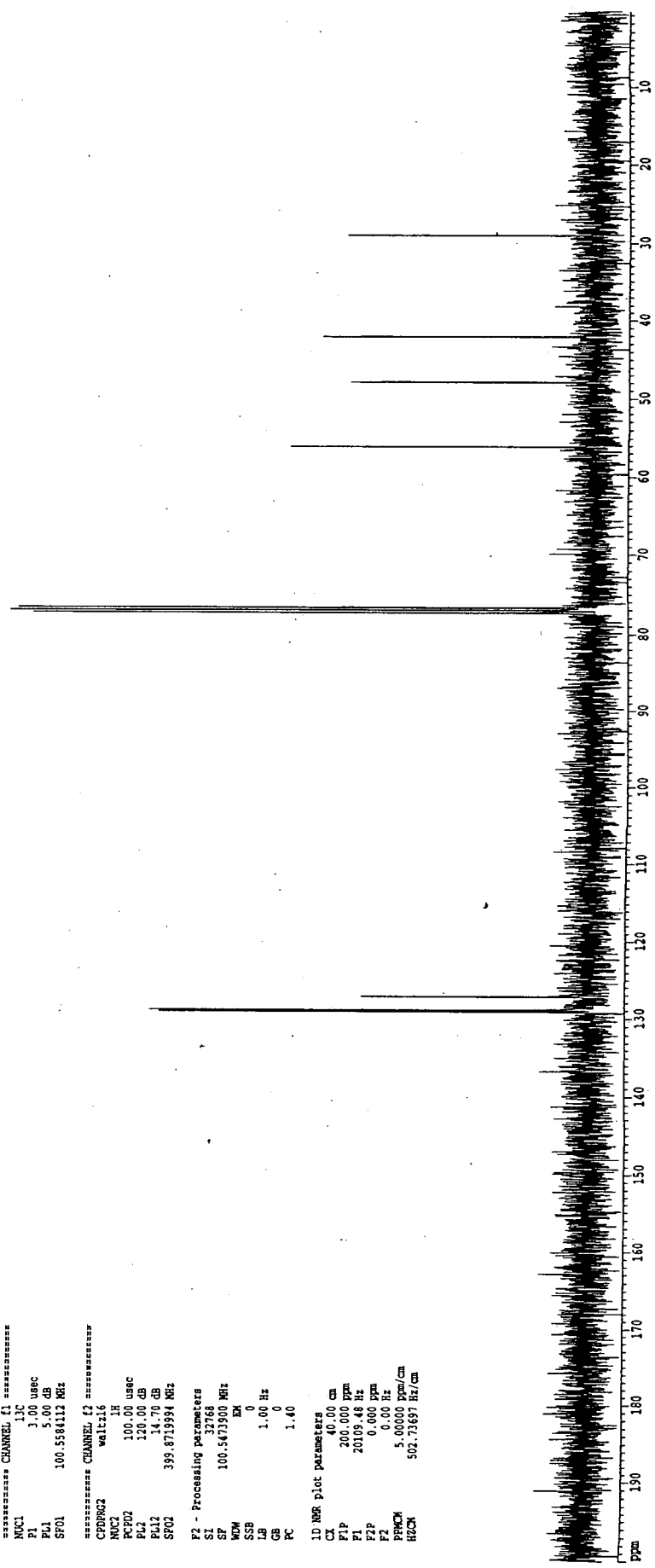
F2 - Processing parameters
 SI 32768
 SF 100.5473900 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

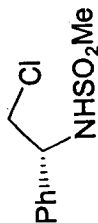
1D NMR plot parameters
 CX 40.00 cm
 F1P 200.000 ppm
 F1 20109.48 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 PPRCM 5.00000 ppm/cm
 HZCM 502.73697 Hz/cm

129.16
 128.95
 127.23

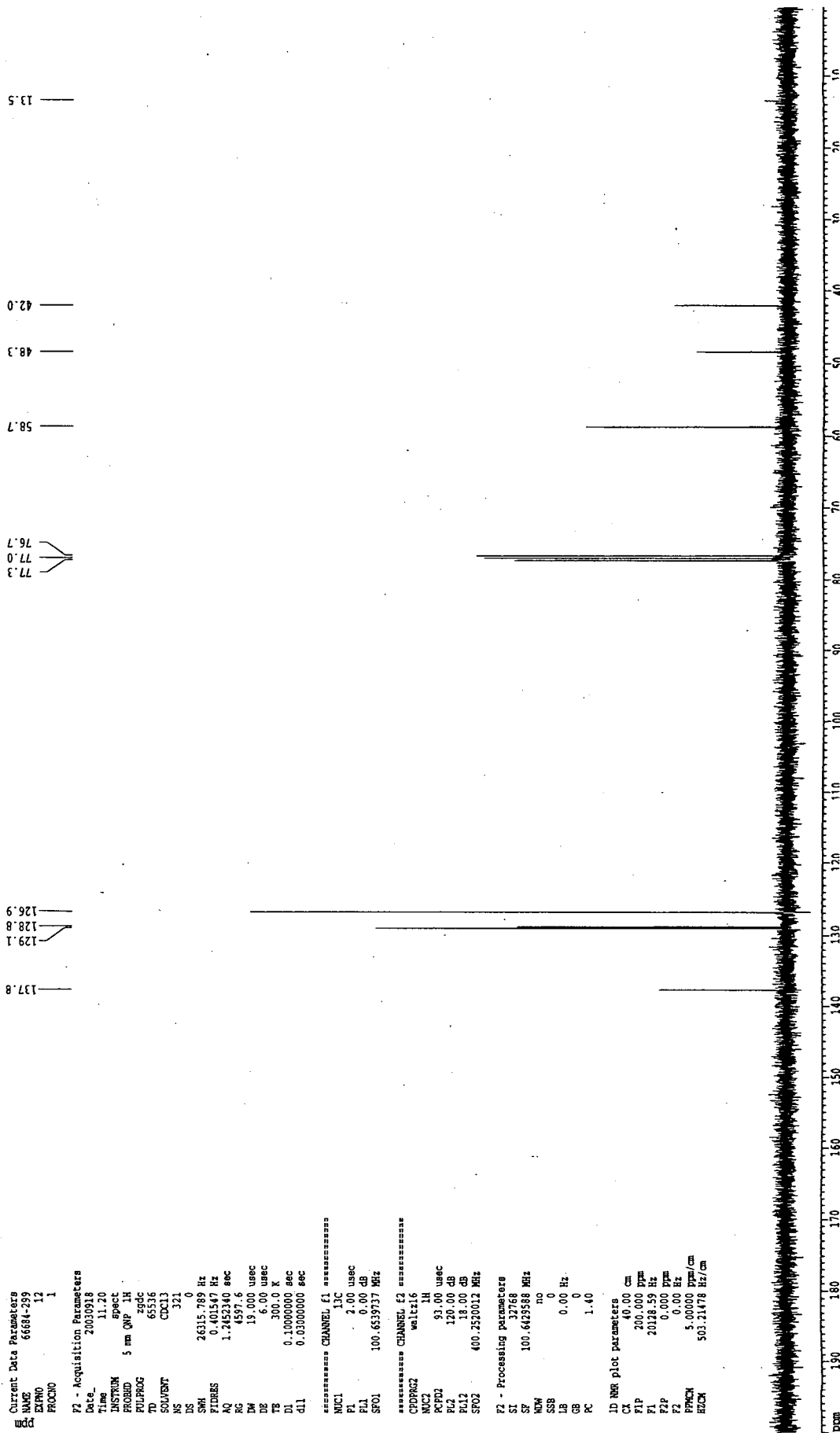
77.77
 77.77
 76.77

56.11
 47.94
 42.12
 29.01





nmr400a h-1 decoupled c-13



Current Data Parameters
 FI NAME 69884-289
 EXPNO 12
 PROCNO 1

F2 - Acquisition Parameters

Date_ 20030918
 Time 11.20
 INSTRUM spect
 PROBRD 5 mm QNP 1H
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 321
 DS 0
 SWH 26315.789 Hz
 FIDRES 0.401547 Hz
 AQ 1.2452340 sec
 RG 4597.6
 DW 19.000 usec
 DE 6.00 usec
 TE 300.0 K
 D1 0.10000000 sec
 D2 0.03000000 sec
 D3 0.03000000 sec

***** CHANNEL F1 *****

NUC1 13C
 P1 2.00 usec
 PL1 0.00 dB
 SFO1 100.6239737 MHz

***** CHANNEL F2 *****

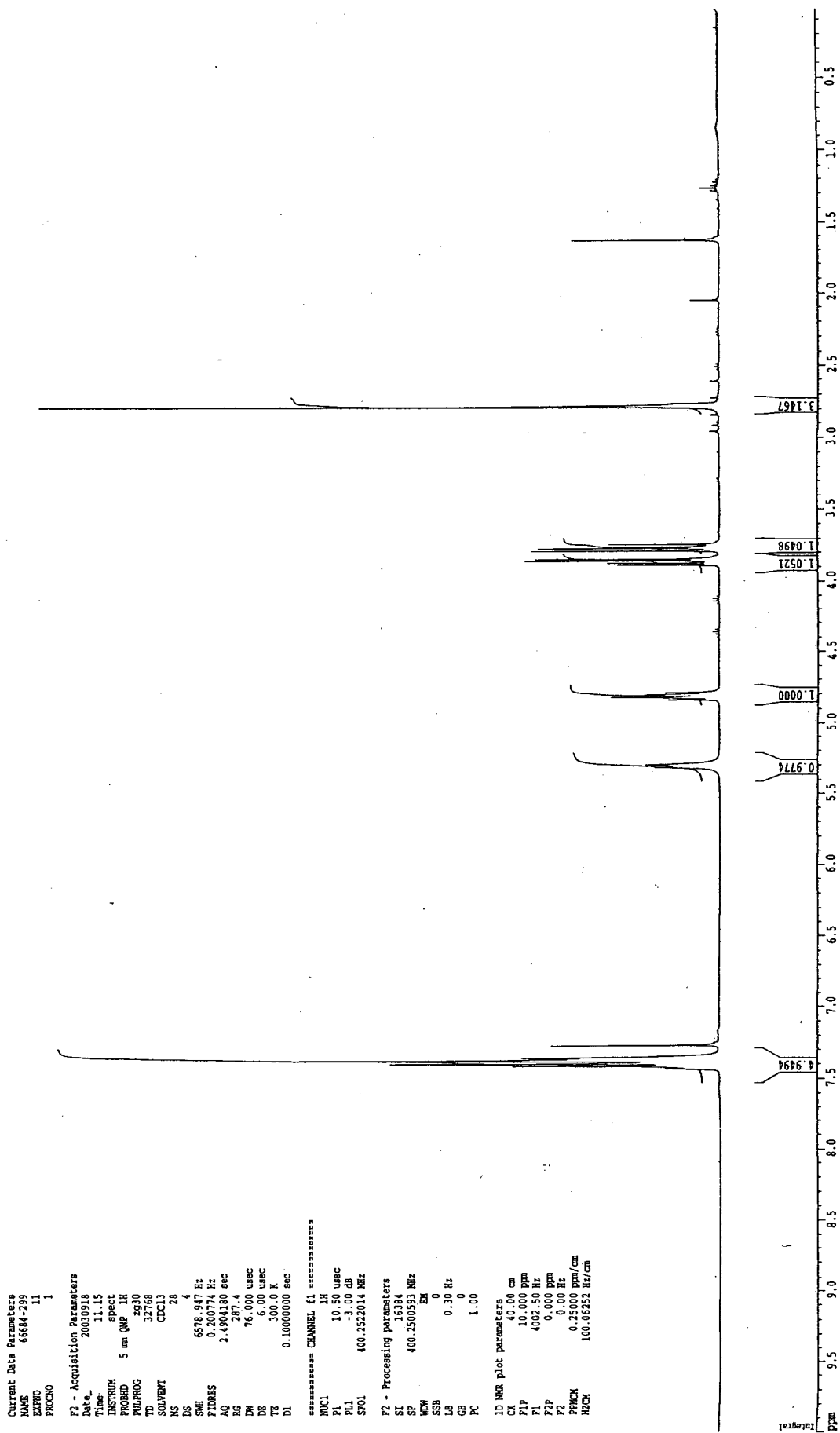
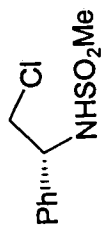
CPDPRG2 waltz16
 NUC2 1H
 PCPD2 93.00 usec
 PL2 120.00 dB
 PL12 18.00 dB
 SFO2 400.2520012 MHz

F2 - Processing parameters

SI 32768
 SF 100.6229588 MHz
 NS 0
 SSB 0
 LB 0.00 Hz
 GB 0
 PC 1.40

1D NMR plot parameters

CX 40.00 cm
 FIP 200.000 ppm
 F1 20128.59 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 PPMCN 5.000000 ppm/cm
 HZCN 503.21478 Hz/cm

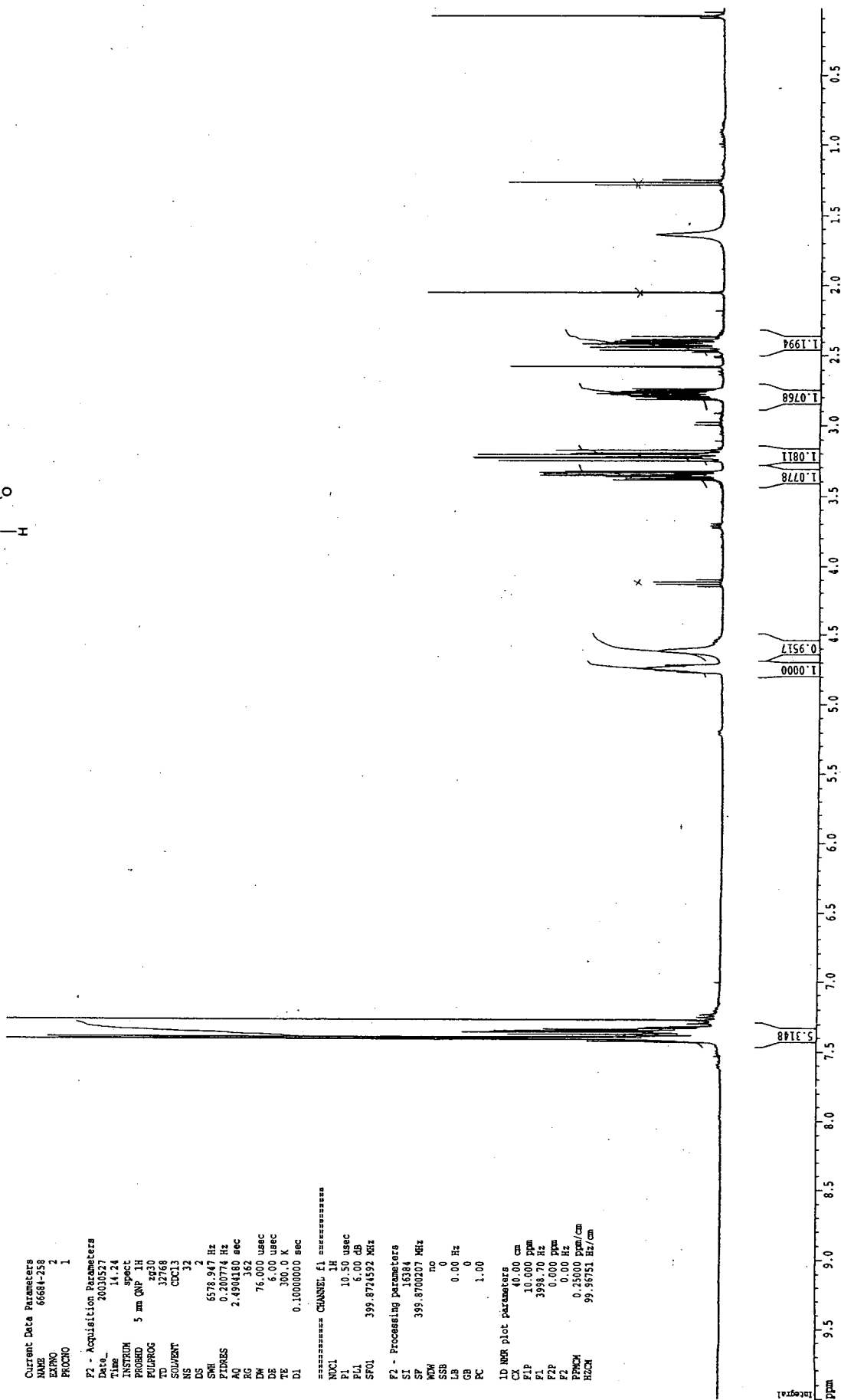
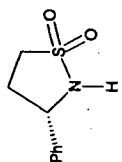


Current Data Parameters
 NAME 66684-299
 EXPNO 11
 PROCNO 1

F2 - Acquisition Parameters
 Date_ 20030918
 Time 11:15
 INSTRUM spect
 PROCNO 5
 PULPROG zgpg30
 TD 32768
 SOLVENT CDCl3
 NS 23
 DS 4
 SWH 6578.947 Hz
 FIDRES 0.200774 Hz
 AQ 2.4994180 sec
 RG 287.4
 TD 32768
 SFO1 400.2522014 MHz
 F2 - Processing parameters
 SI 16384
 SF 400.2500593 MHz
 EQ
 NS 0
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

1D NMR plot parameters
 CX 40.00 cm
 FL1 10.000 ppm
 F1 4002.50 Hz
 F2 0.000 ppm
 F2 0.00 Hz
 PPMCK 0.25000 ppm/cm
 HZCK 100.06253 Hz/cm

***** CHANNEL f1 *****
 NUCL 1H
 P1 10.50 usec
 PL1 -3.00 dB
 SFO1 400.2522014 MHz



Current Data Parameters
 NAME 66684-258
 EXPNO 2
 PROCNO 1

F2 - Acquisition Parameters

Date_ 20030527
 Time 14.24
 INSTRUM spect
 PROBHD 5 mm QNP 1H
 PULPROG zg30
 TD 32768
 SOLVENT CDCl3
 NS 32
 DS 2
 SWH 6578.347 Hz
 FIDRES 0.280774 Hz
 AQ 2.4904160 sec
 RG 362
 DW 76.000 usec
 DE 6.00 usec
 TE 300.0 K
 D1 0.10000000 sec

***** CHANNEL f1 *****

NUC1 1H
 P1 10.50 usec
 PL1 6.00 dB
 SFO1 399.874592 MHz

F2 - Processing parameters

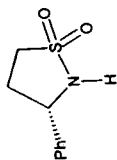
SI 16384
 SF 399.8700207 MHz
 MDW no
 SSB 0
 LB 0.00 Hz
 GB 0
 PC 1.00

1D NMR plot parameters

CX 40.00 cm
 F1P 10.000 ppm
 F1 3998.70 Hz
 F2P 0.000 ppm
 F2 0.00 Hz
 PPMCM 0.25000 ppm/cm
 HZCM 99.56751 Hz/cm

Integral

nmr400b h-1 decoupled c-13



```

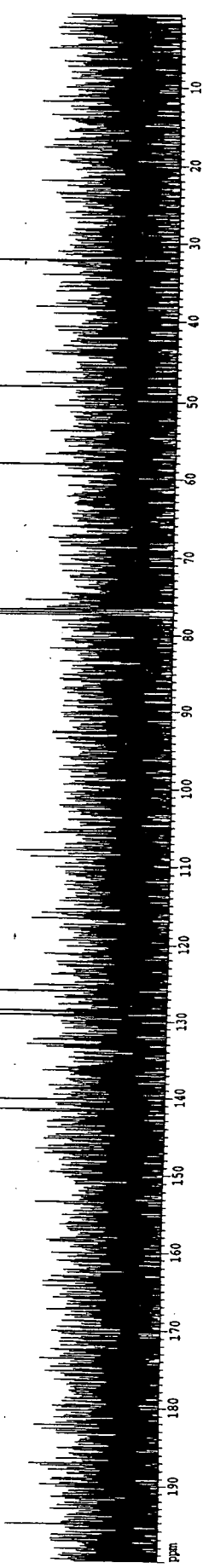
Current Data Parameters
NAME      66684-258
EXPNO     3
PROCNO    1

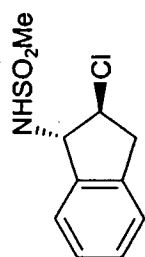
F2 - Acquisition Parameters
Date_     20030527
Time      14.30
INSTRUM   spect
PROBHD    5 mm QNP 1H
PULPROG   zgpg
TD         65536
SOLVENT   CDCl3
NS         4
DS         4
SWH        26315.789 Hz
FIDRES     0.401547 Hz
AQ         1.2452340 sec
RG         4096
AQ        19.400 usec
DE         6.00 usec
TE         300.0 K
T1         0.1000000 sec
T1R        0.0300000 sec
D1         0.0300000 sec
===== CHANNEL f1 =====
NUC1       13C
P1         3.00 usec
PL1        0.00 dB
SFO1       100.5584112 MHz

===== CHANNEL f2 =====
CPDPRG2   waltz16
NUC2       1H
P2         100.00 usec
PL2        120.00 dB
PCPD2     14.70 dB
SFO2       399.8715934 MHz

F2 - Processing parameters
SI         32768
SF         100.5473900 MHz
WDW        no
SSB        0.00 Hz
GB         0.00 Hz
PC         1.40
=====
ID NMR plot parameters
CX         40.00 cm
F1P        200.000 ppm
F1         20103.48 Hz
F2P        0.000 ppm
F2         0.000 Hz
PRACH      5.000 ppm/cm
HZCM       502.7567 Hz/cm
    
```

140.21
129.09
128.53
126.07
77.39
77.07
76.76
58.22
48.20
32.22





nmr400b h-1

```

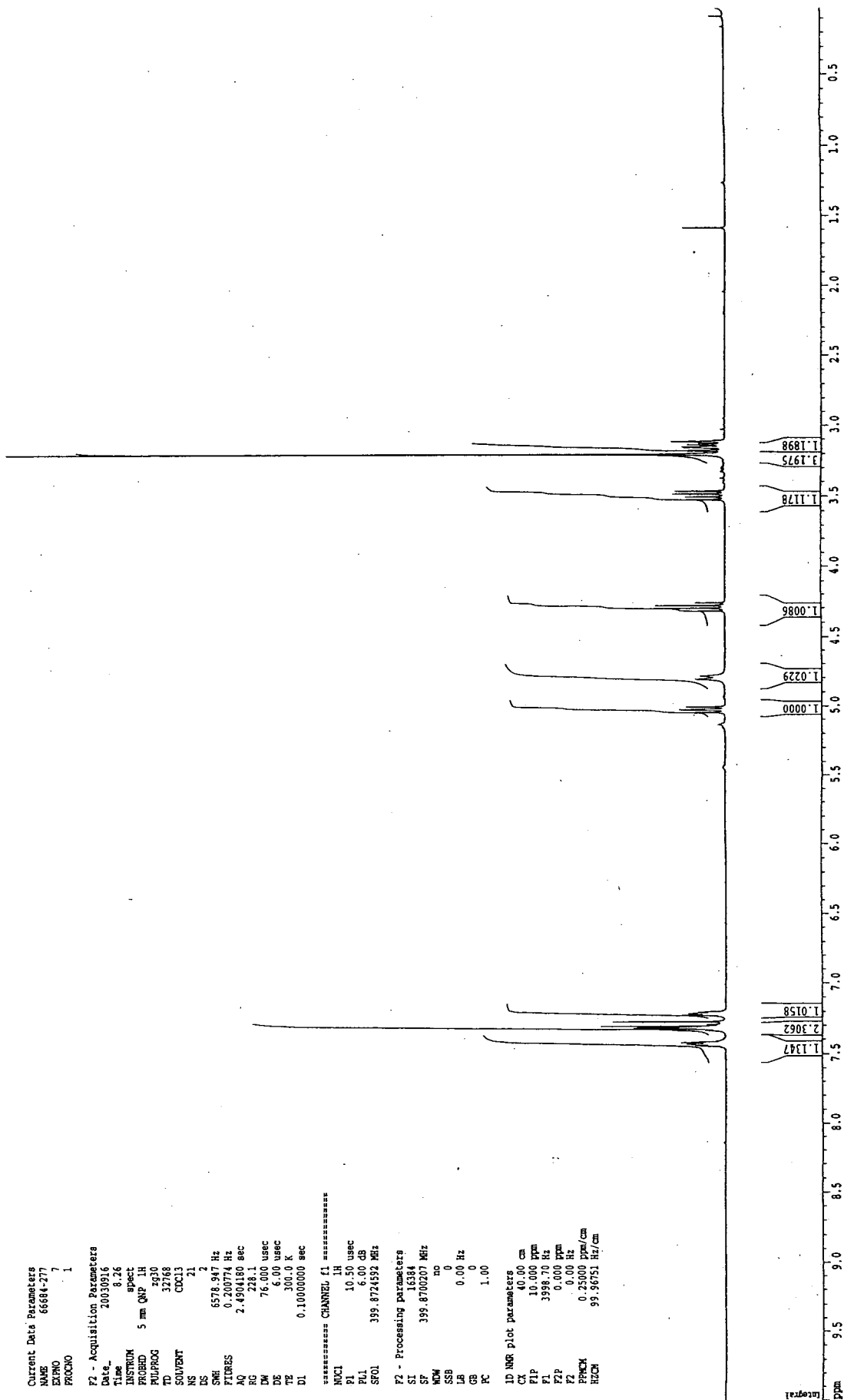
Current Data Parameters
NAME      66684-277
EXPNO     7
PROCNO    1

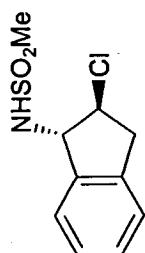
F2 - Acquisition Parameters
Date_     20030916
Time      8.26
INSTRUM   spect
PROBHD    5 mm QNP 1H
PULPROG   zg30
TD         32768
SOLVENT   CDCl3
NS         21
DS         2
SWH        6578.947 Hz
FIDRES     0.200774 Hz
AQ         2.4904180 sec
RG         228.1
DM         76.000 usec
DE         6.00 usec
TE         300.0 K
TE        0.10000000 sec

***** CHANNEL f1 *****
NUC1       1H
P1         10.50 usec
PL1        6.00 dB
SFO1       199.8724532 MHz

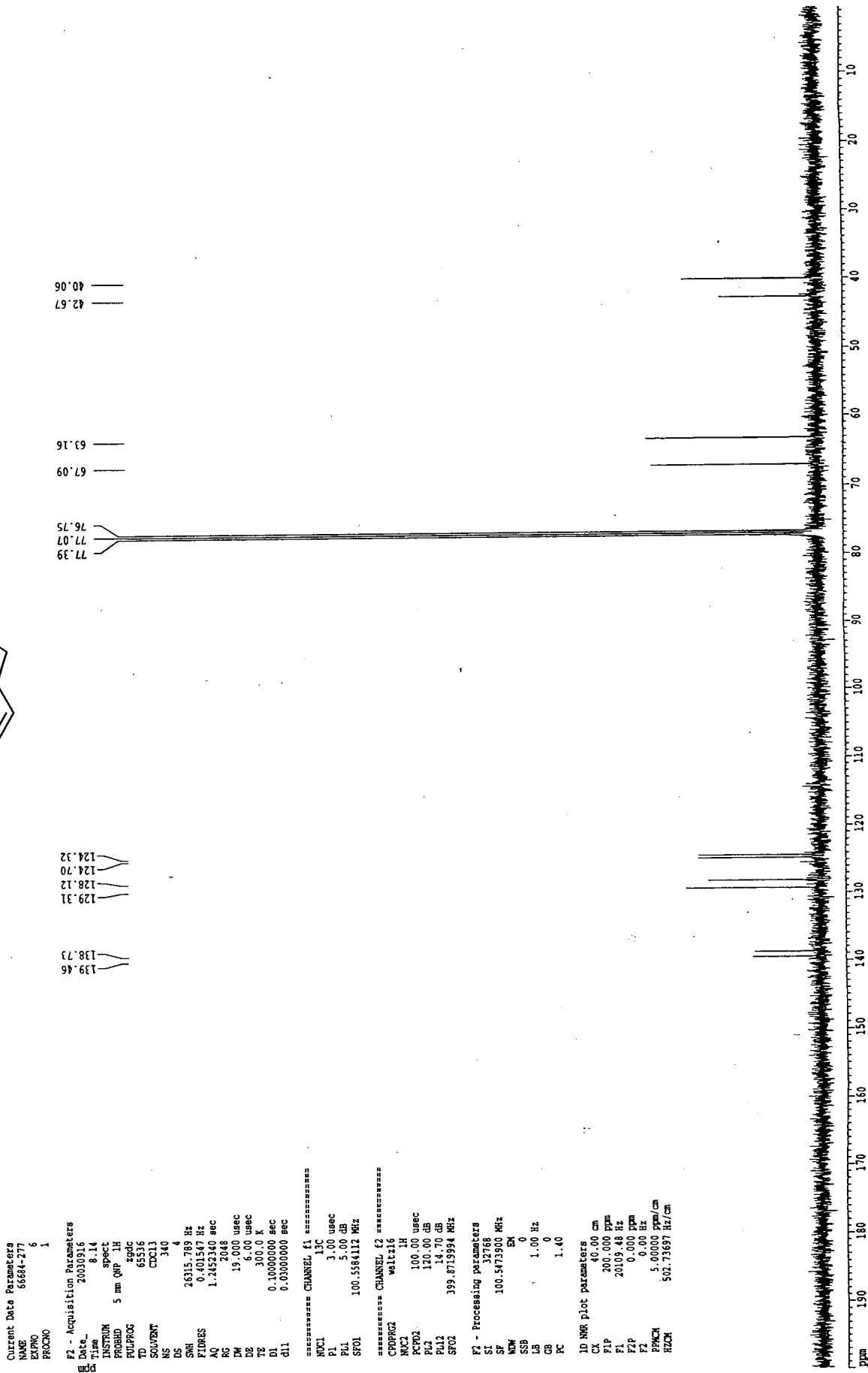
F2 - Processing parameters
SI         16384
SF         199.8700207 MHz
WDW        no
SSB        0
LA         0.00 Hz
GB         0
PC         1.00

ID NMR plot parameters
CX         40.00 cm
F1P        10.000 ppm
F1         3998.70 Hz
F2P        0.000 ppm
F2         0.00 Hz
PPMCK     0.25000 ppm/cm
HZCK      99.96751 Hz/cm
    
```





nmr400b h-1 decoupled c-13



Current Data Parameters
 NAME 66684-277
 EXPNO 6
 PROCNO 1

F2 - Acquisition Parameters
 Date_ 20030916
 Time 8.14

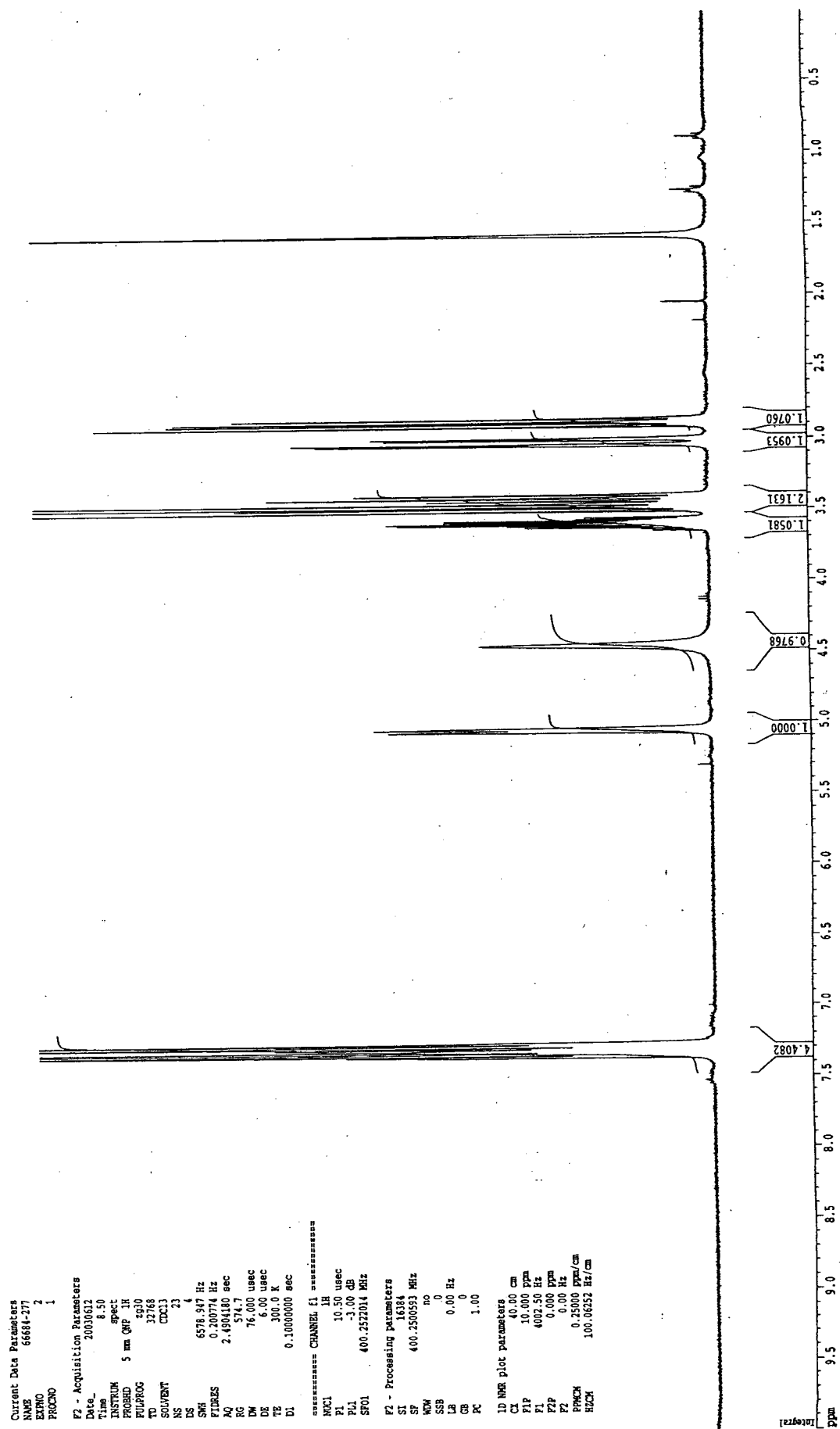
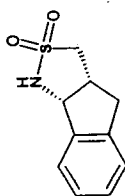
INSTRUM spect
 PROBHD 5 mm QNP 1H
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 340
 DS 4
 SWH 26315.789 Hz
 FIDRES 0.401547 Hz
 AQ 1.2452340 sec
 RG 2048
 DW 19.000 usec
 DE 6.00 usec
 TE 300.0 K
 D1 0.1000000 sec
 d11 0.0300000 sec

***** CHANNEL f1 *****
 NUC1 13C
 P1 3.00 usec
 PL1 5.00 dB
 SFO1 100.5584112 MHz

***** CHANNEL f2 *****
 CPDPRG2 waltz16
 NUC2 1H
 PCPD2 100.00 usec
 PL2 120.00 dB
 PUL2 14.70 dB
 SFO2 399.8719894 MHz

F2 - Processing parameters
 SI 32768
 SF 100.5473500 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

ID NMR plot parameters
 CX 40.00 cm
 FIP 200.000 ppm
 F1 20109.48 Hz
 F2 0.000 ppm
 FZ 0.00 Hz
 PPMCH 5.00000 ppm/cm
 HZCH 502.73697 Hz/cm



```

Current Data Parameters
NAME      66684-277
EXPNO    2
PROCNO   1

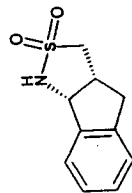
F2 - Acquisition Parameters
Date_    20010612
Time     8.50
INSTRUM  spect
PROBHD   5 mm QNP 1H
PULPROG  zg30
TD       32768
SOLVENT  CDCl3
NS       23
DS       4
SWH      6578.947 Hz
FIDRES   0.200774 Hz
AQ       2.4804180 sec
RG       574.7
BW       76.000 usec
DE       6.00 usec
TE       300.0 K
TE2      0.1000000 sec
D1       0.1000000 sec

***** CHANNEL f1 *****
NUC1      1H
P1       10.50 usec
PL       -3.00 dB
SFO1     400.2522014 MHz

F2 - Processing parameters
SI       16384
SF       400.2500593 MHz
WDW      no
SSB      0
LB       0.00 Hz
GB       0
PC       1.00

1D NMR plot parameters
CH      40.00 cm
F1F2    10.000 ppm
F1      4002.50 Hz
F2      0.000 ppm
NUC2     0.00 Hz
PRACH   0.25000 ppm/cm
HZCN    100.06252 Hz/cm
    
```

nmr400a h-1 decoupled c-13



77.3
77.0
76.7
63.0
52.9
39.8
37.5

141.3
139.9
129.5
127.9
125.4
125.1

Current Data Parameters
 NAME 66984-277
 EXNO 1
 PROCNO 1

P2 - Acquisition Parameters
 Date_ 20030612
 Time 8:54
 INSTRUM spect
 PROBRD 5 mm QNP 1H
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 143
 DS 0
 SWH 76315.789 Hz
 FWHZ 0.481547 Hz
 XTURNS 1.2463240 sec
 AQ 182
 RG 19.000 usec
 DW 5.000 usec
 DE 300.0 usec
 DI 0.10000000 sec
 D1 0.03000000 sec
 D11

***** CHANNEL f1 *****
 NUC1 13C
 P1 2.00 usec
 PL1 0.00 dB
 SFO1 100.6263737 MHz

***** CHANNEL f2 *****
 CPDPRG2 waltz16
 NUC2 1H
 PCDP2 93.00 usec
 PL2 120.00 dB
 PL12 18.00 dB
 SFO2 400.2530012 MHz

P2 - Processing parameters
 SI 32768
 SF 100.6263688 MHz
 MDW no
 SSB 0
 LB 0.00 Hz
 GB 0
 PC 1.40

ID NMR plot parameters
 CX 40.00 cm
 F1P 200.000 ppm
 F1 2028.58 Hz
 P1P 0.000 ppm
 P2 0.00 Hz
 P2P 0.00 Hz
 RFPCN 5.000000 ppm/cm
 RFZCN 503.21478 Hz/cm

ef

