

INTERNAL REPORT SDL-90-05

DATA REDUCTION IN RUBY EMISSION EXPERIMENTS

X.A. SHEN

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Shock Dynamics Laboratory

Department of Physics

Washington State University

Pullman, WA 99164-2814

I. Introduction

The purpose of this report is to summarize the method used in the ruby emission experiments for determining the peak positions of the luminescence R lines. This method can also be applied to fluorescence, Raman scattering, as well as absorption studies, where an accurate measure of the spectral peaks is needed. The technique is based on fitting each R line to either a Gaussian or a Lorentzian curve, depending upon the spectra of interest, to obtain its peak position. In the ruby emission studies, the Lorentzian model provided a better fit to a room temperature spectrum while the Gaussian was more suitable for low temperature data.

The reduction of ruby emission data consists essentially of two steps: (a) calibrating the recording system to obtain wavelength as a function of channel number for every track, and (b) determining the peak position (in wavelength) of the ruby R lines in each track. In general, spectral calibrations are obtained by measuring the positions of emission lines from a known light source (e.g., a Hg lamp). Therefore, the entire data reduction process reduces to the determination of the peak positions of various emission lines, which can be achieved using the curve-fitting method discussed above.

II. Wavelength calibration and data reduction

Because of the high wavelength dispersion (18 Å/mm) provided by the ruby recording system, the overall spectral window was 200 Å wide. There is no standard calibration source available in such a narrow spectral range. The approach used here is to calibrate the recording system against ruby R-lines themselves because the wavelengths of the two R lines have been carefully measured at ambient pressure and are well documented in literature.¹

The calibration was performed as follows. The R line spectra were taken at 6 different settings of the spectrograph, separated by 20 Å. After it was completed, no further adjustment of the spectrograph was allowed. Thus, the last setting was also used for data recording. Since the wavelengths of the two R lines taken at the last setting were known and so was the difference between any two settings, we could assign a wavelength value to the location of each line using the following equation,

$$\lambda = \lambda_0 - (x_0 - x)$$

where λ_0 is the wavelength of either the R_1 or R_2 line, x_0 the last spectrograph setting, λ the wavelength corresponding to the location of either the R_1 or R_2 line in setting x . The relationship between wavelength and channel number could be obtained if the peak position of each line was known. Thus, the entire data reduction process boils down to the determination of the peak positions of various emission lines.

The CCD detector used in the ruby emission experiments for spectrum recording was divided into 400 pixels along the wavelength direction and 38 tracks along the time direction. Thus, each spectrum represented a 400x38 matrix. A SAS program (see below) was developed to read a MxN matrix and fit each track to either two Gaussian or two Lorentzian lines to determine their peak positions. Following are the steps used to analyze a ruby emission experiment.

- 1). All OMA data files, including calibration files and shock records, are first transferred onto the hp9000 system and subsequently converted to 400x38 matrices using a program called conv.c (`\users\xshen\bin\conv.c`).

- 2). The peak positions, peak heights, as well as background, of the two R lines in each track taken at different spectrograph settings for wavelength calibration, are roughly estimated using max.f (`\users\xshen\bin\max.f`), a Fortran program designed to provide starting values for a Gaussian/Lorentzian model used in curve fitting.
- 3). The estimated values from Step 2 for a given spectrograph setting and the R line spectrum taken at the same setting (PKXXXX.DATA and CMSXXXX.DATA, respectively, where XXXX is the setting of the spectrograph in wavelength) are used as input files for a SAS program, FIT.SAS, to obtain the peak position of each line (in channel number). The calculation in FIT.SAS uses a modified Gauss-Newton method² to produce least-squares estimates of the parameters of the Gaussian/Lorentzian model. The output of this calculation is a 8x38 matrix (File CMSXXXX.PST), in which the estimated peak position, height of each R line in each track are tabulated along with the value for the background. Step 3 is repeated until all six calibration spectra are analyzed.
- 4). Since each spectrum provides two data points (R_1 and R_2) and there are six of them, one obtains total 12 data points for each track. These 12 points are then fitted to a straight line, $w = a + b \cdot \text{channel}$, using a program called CALI.SAS and the results (a and b) are given in an output file named Fxxxx.DATA, where xxxxx is the shot number. In addition, CALI.SAS also creates a picture file, called CALI.PIC, which plots these 12 data points along

with the fit in each track for comparison. Steps 1-4 complete the wavelength calibration for each experiment.

- 5). Determination of the R line positions of a shocked spectrum is similar to Step 3 except that channel number is converted to wavelength prior to curve fitting using the parameters given in Fxxxxx.DATA. The output, Sxxxxx.RESULT provides the estimates of peak position, height, width of the R lines for each track. Similarly, a picture file, RUBY.PIC, is generated during the calculation to provide a comparison between the measured spectrum and the fit for each track.

Above five steps complete the entire data reduction process for a ruby emission experiment.

A program called REPLAY1.SAS was developed to convert the SAS picture files generated during the data reduction to files that can be plotted on hp9000. This program allows one to put up to six spectra on one page as shown in the examples below. Another program, LSHIFT.SAS, was designed to plot the shift of the R lines as a function of time using data in Sxxxxx.RESULT. The source codes for these two programs are also included in this report.

References

1. See for example, A. L. Schawlow, in *Advances in Quantum Electronics*, edited by T. R. Singer (Columbia University Press, New York, 1961), p.50.
2. SAS Institute Inc. SAS User's Guide: Statistics 1982 Edition, Cary, NC:SAS Institute Inc., 1982.

1.	296.0	3783.0	266.0	1388.0	265.0
2.	295.0	4172.0	266.0	1598.0	268.0
3.	295.0	4264.0	266.0	1735.0	266.0
4.	294.0	4167.0	266.0	1416.0	271.0
5.	295.0	4308.0	266.0	1762.0	268.0
6.	295.0	4345.0	266.0	1793.0	266.0
7.	295.0	4057.0	266.0	1541.0	265.0
8.	295.0	4217.0	264.0	1491.0	267.0
9.	295.0	4325.0	266.0	1555.0	264.0
10.	294.0	3807.0	266.0	1685.0	267.0
11.	294.0	3771.0	267.0	1596.0	263.0
12.	295.0	3300.0	264.0	1610.0	265.0
13.	295.0	3800.0	264.0	1373.0	265.0
14.	294.0	4510.0	264.0	1253.0	266.0
15.	294.0	4828.0	264.0	1510.0	261.0
16.	294.0	4122.0	266.0	1667.0	263.0
17.	294.0	4719.0	267.0	1830.0	263.0
18.	295.0	3988.0	266.0	1763.0	262.0
19.	294.0	4962.0	264.0	1826.0	265.0
20.	294.0	4323.0	266.0	1590.0	266.0
21.	295.0	4228.0	265.0	1625.0	262.0
22.	294.0	4573.0	266.0	1668.0	261.0
23.	294.0	4408.0	266.0	1628.0	263.0
24.	295.0	4789.0	266.0	1572.0	265.0
25.	294.0	5113.0	264.0	1617.0	263.0
26.	294.0	4503.0	266.0	1788.0	261.0
27.	295.0	3980.0	266.0	1331.0	262.0
28.	294.0	3842.0	266.0	1664.0	259.0
29.	294.0	4117.0	266.0	1548.0	264.0
30.	294.0	4101.0	266.0	1476.0	262.0
31.	294.0	4102.0	264.0	1786.0	263.0
32.	294.0	4517.0	266.0	1525.0	264.0
33.	295.0	4515.0	266.0	1578.0	260.0
34.	294.0	4859.0	267.0	1748.0	262.0
35.	295.0	4339.0	266.0	1428.0	263.0
36.	294.0	4115.0	266.0	1526.0	265.0
37.	295.0	4270.0	264.0	1475.0	263.0
38.	295.0	4031.0	266.0	1648.0	263.0

1.	253.0	3880.0	226.0	1461.0	270.0
2.	253.0	4108.0	225.0	1183.0	268.0
3.	253.0	3831.0	225.0	1500.0	269.0
4.	253.0	3734.0	226.0	1379.0	266.0
5.	255.0	3823.0	225.0	1504.0	263.0
6.	253.0	3779.0	226.0	1535.0	263.0
7.	253.0	3884.0	226.0	1588.0	266.0
8.	253.0	4117.0	226.0	1490.0	266.0
9.	253.0	4055.0	226.0	1571.0	266.0
10.	253.0	4365.0	225.0	1735.0	270.0
11.	254.0	4322.0	224.0	1782.0	261.0
12.	253.0	3950.0	225.0	1418.0	268.0
13.	253.0	3988.0	226.0	1331.0	268.0
14.	253.0	4627.0	224.0	1857.0	268.0
15.	253.0	4192.0	226.0	1671.0	267.0
16.	253.0	4615.0	224.0	1558.0	267.0
17.	253.0	4792.0	226.0	1539.0	267.0
18.	253.0	5026.0	226.0	1557.0	268.0
19.	253.0	5306.0	225.0	1780.0	271.0
20.	253.0	3660.0	225.0	1706.0	267.0
21.	253.0	4312.0	223.0	1326.0	265.0
22.	253.0	4126.0	223.0	1640.0	269.0
23.	253.0	4587.0	223.0	1675.0	267.0
24.	253.0	4130.0	225.0	1866.0	265.0
25.	253.0	4483.0	223.0	1418.0	265.0
26.	253.0	4529.0	225.0	1347.0	264.0
27.	252.0	4684.0	225.0	1416.0	267.0
28.	253.0	4811.0	225.0	1693.0	266.0
29.	253.0	4870.0	225.0	1859.0	264.0
30.	252.0	4780.0	225.0	1706.0	266.0
31.	252.0	4850.0	224.0	1824.0	265.0
32.	253.0	4667.0	224.0	1804.0	270.0
33.	253.0	4683.0	225.0	1560.0	266.0
34.	253.0	5039.0	225.0	1571.0	265.0
35.	253.0	4312.0	225.0	1898.0	268.0
36.	252.0	3733.0	225.0	1545.0	266.0
37.	253.0	4971.0	225.0	1873.0	265.0
38.	253.0	4600.0	225.0	1762.0	266.0

1.	213.0	3830.0	184.0	1437.0	271.0
2.	213.0	3601.0	183.0	1516.0	268.0
3.	212.0	3915.0	184.0	1356.0	267.0
4.	212.0	3749.0	184.0	1479.0	267.0
5.	211.0	3687.0	183.0	1300.0	271.0
6.	213.0	3780.0	183.0	1347.0	269.0
7.	213.0	4201.0	184.0	1761.0	267.0
8.	212.0	4739.0	184.0	1531.0	267.0
9.	212.0	4049.0	183.0	1431.0	267.0
10.	213.0	4107.0	183.0	1322.0	270.0
11.	213.0	4599.0	183.0	1517.0	268.0
12.	213.0	4427.0	185.0	1607.0	269.0
13.	213.0	4305.0	183.0	1519.0	263.0
14.	212.0	4680.0	184.0	1635.0	268.0
15.	211.0	4249.0	185.0	1448.0	268.0
16.	213.0	4747.0	184.0	1486.0	268.0
17.	213.0	4353.0	183.0	1535.0	266.0
18.	213.0	4309.0	184.0	1422.0	266.0
19.	213.0	5178.0	184.0	1790.0	268.0
20.	213.0	4026.0	184.0	1835.0	266.0
21.	213.0	4819.0	183.0	1633.0	267.0
22.	212.0	4986.0	184.0	1559.0	267.0
23.	213.0	5300.0	185.0	1685.0	265.0
24.	212.0	4559.0	183.0	1259.0	264.0
25.	213.0	4806.0	184.0	1466.0	264.0
26.	212.0	5047.0	185.0	1496.0	263.0
27.	211.0	4533.0	185.0	1660.0	266.0
28.	212.0	4333.0	184.0	1882.0	266.0
29.	213.0	4303.0	183.0	1503.0	266.0
30.	212.0	4051.0	183.0	1457.0	266.0
31.	211.0	4762.0	184.0	1699.0	264.0
32.	213.0	4327.0	184.0	1459.0	268.0
33.	212.0	5236.0	183.0	1831.0	262.0
34.	213.0	4683.0	182.0	1828.0	267.0
35.	213.0	4856.0	184.0	1676.0	268.0
36.	213.0	4227.0	182.0	1565.0	268.0
37.	213.0	4200.0	185.0	1541.0	265.0
38.	212.0	4315.0	184.0	1730.0	264.0

1.	172.0	3374.0	143.0	1161.0	278.0
2.	172.0	3620.0	143.0	1341.0	276.0
3.	172.0	3678.0	143.0	1531.0	276.0
4.	172.0	3672.0	143.0	1634.0	275.0
5.	172.0	3913.0	143.0	1611.0	276.0
6.	171.0	4285.0	143.0	1769.0	274.0
7.	171.0	3923.0	145.0	1672.0	276.0
8.	172.0	3828.0	142.0	1383.0	274.0
9.	172.0	3947.0	146.0	1263.0	278.0
10.	173.0	3937.0	142.0	1798.0	276.0
11.	172.0	4103.0	141.0	1619.0	277.0
12.	172.0	4518.0	142.0	2063.0	277.0
13.	172.0	3775.0	143.0	1686.0	277.0
14.	172.0	4289.0	143.0	1478.0	273.0
15.	172.0	4326.0	144.0	1969.0	278.0
16.	172.0	4177.0	142.0	1767.0	275.0
17.	171.0	4207.0	143.0	2036.0	273.0
18.	172.0	4273.0	143.0	1782.0	273.0
19.	172.0	4126.0	142.0	1800.0	275.0
20.	172.0	4504.0	142.0	1841.0	274.0
21.	172.0	4570.0	142.0	1980.0	276.0
22.	172.0	4906.0	145.0	1735.0	274.0
23.	170.0	4591.0	142.0	1670.0	275.0
24.	172.0	4181.0	142.0	1835.0	275.0
25.	172.0	4223.0	143.0	1876.0	274.0
26.	172.0	4217.0	143.0	1712.0	275.0
27.	172.0	3887.0	143.0	1655.0	275.0
28.	172.0	4680.0	140.0	1650.0	274.0
29.	172.0	3935.0	142.0	1715.0	275.0
30.	172.0	4332.0	144.0	1630.0	277.0
31.	171.0	4495.0	141.0	1679.0	278.0
32.	172.0	3476.0	143.0	1814.0	275.0
33.	171.0	4304.0	143.0	1756.0	275.0
34.	172.0	4003.0	142.0	1711.0	271.0
35.	172.0	4109.0	143.0	1892.0	276.0
36.	172.0	4331.0	143.0	1754.0	275.0
37.	172.0	4370.0	145.0	1582.0	279.0
38.	171.0	4013.0	144.0	1903.0	274.0

1.	131.0	3896.0	102.0	1585.0	271.0
2.	130.0	3639.0	102.0	1473.0	271.0
3.	130.0	3663.0	102.0	1523.0	268.0
4.	130.0	3736.0	102.0	1655.0	266.0
5.	131.0	4135.0	102.0	1645.0	271.0
6.	131.0	3694.0	102.0	1586.0	267.0
7.	131.0	3936.0	102.0	1860.0	268.0
8.	131.0	3611.0	102.0	1690.0	267.0
9.	130.0	3667.0	102.0	1571.0	270.0
10.	130.0	3723.0	103.0	1619.0	268.0
11.	132.0	3051.0	102.0	1682.0	261.0
12.	130.0	3561.0	104.0	1741.0	269.0
13.	130.0	3919.0	102.0	1660.0	267.0
14.	130.0	4031.0	103.0	2133.0	269.0
15.	130.0	3445.0	102.0	1567.0	269.0
16.	131.0	3872.0	103.0	1822.0	270.0
17.	130.0	4183.0	103.0	1701.0	268.0
18.	130.0	4415.0	102.0	1614.0	271.0
19.	130.0	3859.0	102.0	1857.0	270.0
20.	131.0	4004.0	100.0	1429.0	270.0
21.	130.0	3661.0	102.0	1870.0	269.0
22.	131.0	4561.0	102.0	1861.0	270.0
23.	130.0	3559.0	103.0	1566.0	265.0
24.	129.0	3573.0	103.0	1716.0	267.0
25.	130.0	4110.0	102.0	1725.0	271.0
26.	132.0	4181.0	103.0	1983.0	270.0
27.	131.0	4382.0	105.0	1539.0	264.0
28.	130.0	4459.0	102.0	2073.0	264.0
29.	131.0	4147.0	102.0	1656.0	267.0
30.	130.0	3914.0	102.0	1691.0	267.0
31.	130.0	3951.0	103.0	2148.0	269.0
32.	131.0	4136.0	103.0	1826.0	264.0
33.	131.0	3919.0	102.0	1802.0	266.0
34.	130.0	3592.0	102.0	1495.0	266.0
35.	130.0	3476.0	102.0	1560.0	269.0
36.	130.0	3925.0	103.0	1877.0	270.0
37.	130.0	3477.0	102.0	2055.0	265.0
38.	130.0	4060.0	103.0	1835.0	266.0

1.	91.0	3605.0	62.0	1436.0	277.0
2.	91.0	3271.0	62.0	1052.0	281.0
3.	91.0	3790.0	62.0	1119.0	276.0
4.	90.0	3540.0	64.0	1155.0	271.0
5.	91.0	3007.0	62.0	1446.0	277.0
6.	90.0	3862.0	63.0	1309.0	276.0
7.	90.0	3748.0	64.0	1356.0	274.0
8.	91.0	3320.0	62.0	1151.0	274.0
9.	91.0	4020.0	63.0	1334.0	271.0
10.	91.0	3570.0	63.0	1291.0	277.0
11.	91.0	3634.0	61.0	1368.0	273.0
12.	91.0	4275.0	64.0	1399.0	275.0
13.	91.0	3885.0	64.0	1357.0	277.0
14.	91.0	3994.0	60.0	1442.0	275.0
15.	91.0	3705.0	61.0	1599.0	271.0
16.	91.0	3903.0	64.0	1446.0	271.0
17.	90.0	4187.0	64.0	1617.0	274.0
18.	91.0	3887.0	62.0	1585.0	271.0
19.	90.0	3445.0	62.0	1447.0	274.0
20.	90.0	4038.0	64.0	1462.0	279.0
21.	91.0	3660.0	64.0	1291.0	270.0
22.	91.0	3639.0	62.0	1838.0	277.0
23.	91.0	4537.0	62.0	1499.0	275.0
24.	91.0	3967.0	62.0	1588.0	277.0
25.	91.0	3778.0	61.0	1502.0	270.0
26.	92.0	3737.0	62.0	1649.0	270.0
27.	91.0	4213.0	62.0	1685.0	275.0
28.	91.0	4045.0	64.0	1551.0	275.0
29.	91.0	3977.0	61.0	1366.0	277.0
30.	92.0	3979.0	62.0	1214.0	269.0
31.	91.0	3831.0	63.0	1620.0	274.0
32.	91.0	4519.0	62.0	1254.0	275.0
33.	91.0	3637.0	62.0	1691.0	274.0
34.	92.0	4031.0	62.0	1486.0	273.0
35.	91.0	3603.0	62.0	1782.0	271.0
36.	91.0	3863.0	62.0	1354.0	274.0
37.	91.0	3973.0	63.0	1418.0	273.0
38.	91.0	3698.0	60.0	1406.0	273.0

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CMS FILEDEF XAS DISK CMS6930 PST          (DISP MOD RECFM V;
CMS FILEDEF YOU DISK CMS6930 DATA A;
CMS FILEDEF ME  DISK PK6930 DATA A;
OPTIONS NOTEXT82 GPROTOCOL=GSAS7171;
*/HP7470 PLOTTER GOPTIONS AND FILEDEF/*;
GOPTION TEXT82  DEVICE=HP7470  SPEED=40 GPROTOCOL=GSAS7171
        NODISPLAY NOPROMPT
        HANDSHAKE=NONE
        PENMOUNTS=1
        SPEED=10
        COLORS=(BLACK)
        GSFNAME=HPOUT
        GSFMODE=REPLACE;
DATA ZERO;
  INFILE ME;
  INPUT DS C1 A1 C2 A2 BK;
DATA ONE;
  INFILE YOU  MISSEVER;
  DS = _N_;
  INPUT Y1-Y384;
DATA THREE;
  MERGE ZERO ONE; BY DS;
DATA ALL; SET THREE;
  ARRAY YY Y1-Y384;
  DO OVER YY;
    X = _I_;  W=X; Y = YY;  IF Y ^= . THEN OUTPUT;
  END;
  DROP Y1-Y384;
RUN;
PROC MEANS NOPRINT DATA = ALL;  BY DS;
  VAR Y; ID A1 A2 C1 C2 BK;
  OUTPUT OUT=SUMM N=NN MAX=YMAX;
DATA _NULL_; SET SUMM END=THEEND;
  LENGTH NCNT $3;
  RETAIN FIRSTOBS 1 OBS 0;
  OBS = OBS + NN;
  NCNT = LEFT(_N_);
  CALL SYMPUT('FIRST' || NCNT, FIRSTOBS);
  CALL SYMPUT('LAST'  || NCNT, OBS);
  CALL SYMPUT('AONE'  || NCNT, A1);
  CALL SYMPUT('ATWO'  || NCNT, A2);
  CALL SYMPUT('CONE'  || NCNT, C1);
  CALL SYMPUT('CTWO'  || NCNT, C2);
  CALL SYMPUT('BKGD'  || NCNT, BK);
  CALL SYMPUT('DS'    || NCNT, DS);
  FIRSTOBS = OBS + 1;
  IF THEEND THEN CALL SYMPUT('TOTAL',_N_);
RUN;
%MACRO STATE;
  %DO I=19 %TO 19;
    TITLE .F=DUPLEX TRACK &I ;
    PROC NLIN DATA = ALL (FIRSTOBS=&&FIRST&I OBS=&&LAST&I KEEP=W Y);
      PARM B=&&BKGD&I A1=&&AONE&I A2=&&ATWO&I C1=&&CONE&I C2=&&CTWO&I
      D1=5 D2=5;
    ** ***** LORENTZIAN MODEL *****;

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* MODEL Y= B + A1/(((W-C1)/D1)**2+1) + A2/(((W-C2)/D2)**2+1);
* DER.B=1;
* DER.A1=1/(((W-C1)/D1)**2+1);
* DER.A2=1/(((W-C2)/D2)**2+1);
* DER.C1=2*(W-C1)*A1/(D1*(((W-C1)/D1)**2+1)**2);
* DER.C2=2*(W-C2)*A2/(D2*(((W-C2)/D2)**2+1)**2);
* DER.D1=2*(W-C1)**2*A1/D1**3/(((W-C1)/D1)**2+1)**2);
* DER.D2=2*(W-C2)**2*A2/D2**3/(((W-C2)/D2)**2+1)**2);
***** GAUSSIAN MODEL *****;
MODEL Y= B + A1*EXP(-(W-C1)**2/D1**2))
        + A2*EXP(-(W-C2)**2/D2**2));
DER.B=1;
DER.A1=EXP(-(W-C1)**2/D1**2));
DER.A2=EXP(-(W-C2)**2/D2**2));
DER.C1=2*((W-C1)/D1**2)*A1*EXP(-(W-C1)**2/D1**2));
DER.C2=2*((W-C2)/D2**2)*A2*EXP(-(W-C2)**2/D2**2));
DER.D1=2*((W-C1)**2/D1**3)*A1*EXP(-(W-C1)**2/D1**2));
DER.D2=2*((W-C2)**2/D2**3)*A2*EXP(-(W-C2)**2/D2**2));
*****;
OUTPUT OUT=PLOT P=FIT PARMS=B A1 A2 C1 C2 D1 D2 ESS=DD;
PROC GPLOT DATA=PLOT GOUT=RUBY.PIC;
SYMBOL1 H=2.0 C=RED V=NONE I=SPLINE;
SYMBOL2 H=2.0 C=RED V=NONE I=SPLINE;
PLOT (Y FIT)*W/OVERLAY FRAME;
DATA ME;
SET PLOT (FIRSTOBS=1 OBS=1);
ERROR=(DD/(384-7))**0.5;
FILE XAS;
TRK=&I;
PUT TRK 2. +2 (C1 C2 D1 D2 A1 A2 B ERROR) (7.2,+2);
RUN;
%END;
%MEND STATE;
RUN;
%STATE;

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1	294.72	266.25	7.04	8.35	3276.88	951.72	304.03	81.82
2	294.13	266.15	7.48	7.51	3511.54	1189.06	303.57	101.68
3	294.49	266.45	6.68	5.80	3820.03	1313.04	311.21	66.16
4	294.32	266.54	6.28	6.73	3693.81	1022.00	308.49	69.77
5	294.57	266.18	7.35	6.07	3747.95	1317.95	308.54	76.86
6	294.35	265.94	6.55	5.63	3781.13	1388.63	304.38	80.37
7	294.53	266.06	6.85	6.05	3477.04	1168.77	305.49	81.50
8	294.65	266.25	6.55	10.22	3686.65	965.79	301.32	85.57
9	294.26	265.62	6.63	8.03	3951.82	1056.27	299.03	63.48
10	293.70	265.62	7.45	6.30	3384.75	1223.70	303.10	58.20
11	293.16	266.01	7.27	6.49	3157.82	1201.59	306.43	68.29
12	293.02	265.23	8.15	6.16	2907.63	1287.79	299.90	55.27
13	293.91	265.49	7.26	6.48	3372.13	1043.47	300.00	65.01
14	293.76	265.63	6.78	8.24	3975.18	848.59	306.95	80.19
15	293.73	265.07	6.31	7.11	4211.26	1102.32	307.45	68.94
16	293.69	265.61	6.63	5.95	3610.49	1252.23	310.51	67.06
17	294.11	266.22	6.53	6.35	4129.83	1393.60	313.16	95.89
18	293.67	265.81	6.81	5.72	3678.85	1340.29	307.21	65.75
19	294.02	264.76	6.56	5.99	4456.33	1336.91	311.21	71.17
20	294.03	265.61	6.91	7.84	3771.00	1171.82	306.17	89.57
21	294.51	264.99	7.02	7.38	3464.75	1208.63	308.56	90.69
22	293.89	265.26	6.43	6.88	3845.57	1268.97	310.37	89.32
23	293.84	265.96	6.43	7.81	3947.61	1121.04	310.28	81.20
24	293.90	265.68	6.50	8.72	4029.61	1117.18	308.19	101.71
25	293.70	265.45	6.45	8.41	4671.10	1145.56	304.77	83.34
26	293.95	265.13	6.79	8.87	3985.86	1239.00	300.85	73.95
27	294.14	265.76	6.68	9.90	3369.42	892.85	302.48	82.31
28	293.55	265.92	7.59	7.12	3343.13	1300.31	302.49	72.31
29	293.83	265.51	7.21	7.31	3516.64	1126.83	300.68	85.93
30	293.20	265.43	6.91	6.83	3567.19	1116.23	300.83	64.44
31	293.92	265.11	6.85	6.04	3607.17	1330.58	306.17	66.83
32	293.74	266.07	6.46	6.96	4107.08	1198.01	304.82	64.51
33	293.98	265.60	7.18	6.65	3997.01	1176.85	302.74	82.96
34	294.11	266.13	5.66	8.72	4349.94	1216.59	309.55	92.73
35	294.15	265.49	6.62	8.25	4038.35	1062.05	303.94	63.65
36	293.90	265.87	6.83	7.28	3714.02	1146.92	305.13	65.52
37	294.49	265.42	6.73	7.28	3728.63	1029.03	305.17	95.08
38	294.02	265.97	7.00	7.85	3519.72	1113.99	301.85	66.66

1	253.32	225.56	6.49	7.77	3362.10	1016.65	314.67	61.57
2	252.98	225.70	6.50	7.71	3598.98	808.33	308.99	53.73
3	253.16	225.59	5.88	7.81	3451.79	995.42	309.98	65.61
4	252.99	224.71	6.41	7.33	3326.44	1068.74	306.33	52.46
5	253.52	225.34	6.15	5.96	3443.21	1109.76	308.41	55.44
6	253.26	225.11	6.22	6.78	3430.46	1002.80	309.02	68.65
7	252.99	225.63	6.39	6.37	3390.59	1101.54	312.99	62.90
8	253.46	225.45	6.29	5.79	3649.36	1081.25	313.87	67.44
9	252.95	225.29	6.43	6.67	3523.98	1227.82	310.00	75.17
10	252.89	225.19	6.38	6.29	3660.62	1268.72	312.70	72.17
11	253.09	225.07	5.92	6.35	3955.55	1319.77	314.65	85.72
12	252.75	225.08	6.56	7.49	3582.95	1030.15	307.63	53.62
13	252.77	225.29	6.71	7.45	3555.30	971.30	305.73	60.06
14	252.82	224.44	6.05	5.63	4160.18	1451.19	310.31	59.70
15	252.57	225.07	6.38	6.31	3636.72	1257.87	317.74	67.64
16	252.62	224.51	6.29	6.43	4113.80	1200.57	317.89	70.31
17	252.83	225.54	6.12	6.19	4182.41	1131.21	309.54	68.24
18	252.76	225.33	6.27	6.39	4440.24	1154.18	312.28	73.73
19	253.08	224.80	6.16	6.28	4647.41	1349.75	318.01	66.38
20	252.42	225.36	7.55	5.27	3185.79	1238.45	312.19	70.13
21	252.77	224.48	6.54	6.34	4082.34	1006.11	314.14	58.05
22	252.83	223.22	5.81	6.81	3727.80	1193.03	317.72	64.75
23	252.68	224.50	6.35	6.77	4020.21	1300.14	314.08	71.31
24	252.70	224.85	6.92	5.56	3600.53	1470.98	311.11	66.91
25	252.65	224.05	6.24	6.42	3838.95	1074.71	315.33	77.42
26	252.77	224.44	5.81	7.19	3917.12	993.58	317.52	73.58
27	252.23	225.03	6.23	6.95	4184.76	1076.54	314.88	56.71
28	252.48	224.40	6.31	6.77	4268.07	1222.48	314.23	83.90
29	252.50	224.28	5.62	6.01	4189.03	1452.60	320.60	88.69
30	252.32	224.95	6.19	5.88	4174.54	1241.57	318.04	86.23
31	252.38	224.45	6.29	6.24	4372.58	1421.68	319.34	74.83
32	252.45	225.02	6.34	5.98	4123.15	1400.95	311.95	61.92
33	252.23	224.49	6.55	7.45	4055.20	1123.30	310.40	74.06
34	252.50	224.88	6.77	5.82	4334.25	1176.81	316.12	85.00
35	252.77	224.97	5.99	5.47	3789.23	1510.91	317.44	70.36
36	252.75	224.77	6.70	7.00	3299.82	1157.37	312.17	53.59
37	253.09	225.19	5.88	5.44	4357.45	1429.09	325.23	80.39
38	253.14	224.97	6.06	5.83	3980.34	1360.69	314.85	76.56

1	212.10	183.68	6.17	6.47	3363.92	1056.76	324.83	71.22
2	212.06	183.74	6.91	6.24	3200.56	1099.28	315.32	51.35
3	212.00	183.91	6.49	7.74	3563.81	945.87	311.61	53.04
4	211.81	183.78	6.80	7.70	3225.83	1021.59	317.31	78.03
5	211.54	183.04	6.98	6.71	3259.65	948.10	310.87	61.16
6	212.19	183.55	6.64	7.35	3398.71	982.30	310.51	56.05
7	211.87	183.80	6.74	6.69	3620.72	1357.44	314.67	71.70
8	212.11	183.66	5.66	6.59	4178.23	1144.54	317.22	69.81
9	211.99	183.42	6.23	8.17	3491.15	991.35	312.94	70.49
10	212.04	184.13	5.91	7.60	3667.03	937.19	318.83	59.45
11	212.13	183.62	5.67	7.43	4045.26	1103.23	321.22	80.42
12	211.86	184.28	6.01	8.71	3942.80	1187.75	318.73	77.66
13	211.64	183.83	6.21	10.04	3860.81	1000.99	311.35	74.05
14	211.73	183.80	5.97	6.72	4289.67	1256.92	315.30	61.74
15	211.81	184.67	6.25	7.96	3749.55	999.51	317.35	69.50
16	212.27	183.39	6.19	7.57	4203.25	1089.40	317.69	72.87
17	211.52	182.96	6.28	6.89	3860.01	1132.19	316.36	77.34
18	211.38	184.02	6.68	7.82	3902.85	996.13	320.75	69.75
19	212.14	183.61	5.53	6.72	4653.05	1376.11	324.37	76.39
20	211.78	183.83	6.49	6.92	3555.09	1378.37	316.87	74.03
21	211.90	184.11	5.92	6.74	4397.30	1258.09	319.49	71.29
22	211.68	184.15	5.76	7.54	4441.76	1135.06	313.67	75.97
23	211.85	184.48	5.81	6.64	4703.59	1301.70	317.06	85.41
24	211.92	184.53	5.98	9.23	4062.08	848.11	311.45	62.77
25	212.02	184.55	5.87	6.97	4290.15	1082.73	320.83	66.49
26	211.91	184.30	5.74	6.85	4598.16	1142.64	318.66	70.25
27	211.67	184.43	6.20	6.51	4069.39	1359.84	315.34	68.25
28	211.47	184.06	5.93	6.30	4025.23	1429.84	315.06	59.87
29	211.80	184.15	6.46	7.30	3956.97	1108.90	312.98	59.59
30	211.70	183.42	6.30	7.89	3768.28	983.63	306.71	46.17
31	211.45	183.20	6.15	6.02	4309.81	1250.86	317.50	62.24
32	211.90	183.75	6.44	8.33	3895.88	1011.74	310.91	66.54
33	212.02	182.81	5.51	6.52	4607.50	1479.78	320.43	89.14
34	212.07	183.13	5.81	6.74	4245.02	1387.86	313.19	87.25
35	212.39	184.25	5.75	6.55	4402.26	1246.71	319.21	85.70
36	212.02	183.84	6.57	6.62	3694.39	1271.10	313.41	81.95
37	212.13	183.76	6.28	8.55	3679.76	1132.83	315.13	84.45
38	211.76	183.41	5.99	7.17	3906.36	1233.98	314.77	59.63

1	171.48	143.47	6.64	7.72	2942.97	755.15	325.79	49.80
2	171.53	143.07	6.04	6.79	3167.15	1007.94	329.50	50.02
3	171.65	143.06	6.14	5.83	3221.31	1122.37	330.36	57.44
4	171.05	142.92	6.34	6.14	3205.41	1226.49	331.36	69.71
5	170.62	143.07	6.53	6.20	3499.85	1264.45	326.91	61.64
6	171.00	143.37	5.70	6.30	3920.02	1406.13	323.64	55.63
7	170.94	143.82	6.12	6.46	3569.44	1331.38	330.42	48.54
8	170.97	143.57	6.14	7.83	3449.16	1005.41	325.21	52.29
9	171.37	144.19	6.23	7.79	3557.39	903.96	326.13	63.95
10	171.37	143.22	6.35	6.81	3511.74	1411.94	326.29	73.38
11	171.43	142.50	6.60	7.14	3756.06	1166.54	325.93	62.00
12	171.46	143.11	6.06	5.55	4059.73	1711.74	331.17	68.07
13	171.03	143.54	5.92	6.93	3429.45	1298.91	335.54	58.06
14	171.21	143.29	6.19	6.37	3837.48	1029.53	340.11	61.08
15	171.12	143.38	6.22	5.70	3731.23	1481.73	333.88	70.95
16	171.26	142.48	6.48	5.88	3737.38	1315.47	330.35	72.78
17	170.88	143.08	6.46	5.22	3737.20	1677.46	328.17	59.10
18	170.88	143.11	6.58	6.66	3772.43	1413.96	332.57	60.69
19	171.64	143.05	5.60	7.10	3555.97	1303.03	339.37	83.45
20	171.35	142.72	5.99	6.43	3806.06	1425.94	334.98	87.39
21	171.23	142.97	6.12	5.74	3996.37	1616.55	332.07	66.61
22	171.03	143.14	6.19	6.13	4485.20	1368.80	322.86	60.16
23	170.82	142.98	5.86	6.49	4172.93	1345.56	327.66	66.83
24	171.18	142.75	6.67	6.62	3457.42	1477.86	335.29	79.25
25	171.38	142.87	6.34	5.15	3710.61	1466.90	332.49	61.61
26	171.18	142.63	6.66	6.07	3776.67	1298.94	329.62	61.69
27	171.22	142.68	6.20	6.67	3426.00	1196.25	324.70	53.21
28	171.10	142.09	5.78	6.99	4145.60	1282.83	331.93	65.48
29	170.80	142.49	6.02	6.85	3366.60	1203.46	336.62	71.63
30	170.81	143.17	6.38	6.67	3718.27	1287.17	323.93	66.54
31	170.86	142.82	6.28	6.55	3969.13	1329.71	328.31	60.47
32	170.84	143.16	6.59	5.68	3100.09	1398.23	331.54	63.34
33	171.18	143.24	6.09	5.32	3837.04	1311.23	333.65	73.79
34	171.32	142.51	6.33	7.10	3535.00	1287.29	329.86	72.01
35	171.39	142.45	5.91	6.63	3682.11	1477.81	324.97	57.32
36	171.55	143.45	5.70	6.52	3846.70	1236.68	333.07	60.68
37	171.27	143.29	6.24	7.91	3794.18	1193.40	329.75	78.55
38	171.22	143.08	6.04	6.89	3620.51	1487.36	327.58	79.14

1	130.21	102.55	6.52	6.02	3378.17	1104.67	318.99	48.25
2	130.23	102.14	6.74	6.17	3078.93	1057.93	322.30	45.31
3	129.98	102.45	6.65	7.08	3237.63	1126.94	313.26	41.06
4	130.78	101.99	6.62	6.25	3239.88	1232.86	316.59	51.34
5	131.09	102.28	6.02	6.88	3705.32	1222.14	317.35	54.18
6	131.00	102.33	6.24	6.96	3369.76	1129.85	321.86	55.16
7	130.57	103.03	6.21	6.47	3445.11	1370.01	326.13	60.49
8	130.43	103.05	6.75	6.13	3238.26	1276.31	322.52	47.97
9	130.18	102.58	6.13	6.75	3317.23	1132.94	322.49	60.85
10	130.23	103.18	6.59	5.83	3243.96	1232.97	320.53	51.69
11	130.95	102.40	7.51	5.78	2636.90	1247.49	318.86	64.77
12	130.26	103.03	6.58	6.28	3170.41	1239.29	323.90	61.80
13	130.03	102.28	6.19	6.53	3279.29	1259.35	327.73	69.21
14	130.43	102.48	5.88	5.82	3563.72	1671.66	329.52	56.59
15	130.85	102.38	6.79	6.51	3183.74	1197.66	328.85	49.87
16	130.53	102.84	6.55	5.61	3484.77	1403.11	325.89	52.88
17	130.60	102.97	6.89	6.02	3652.22	1282.74	327.39	62.61
18	130.26	102.67	6.47	6.46	3924.39	1210.20	321.01	54.80
19	130.42	102.40	6.68	6.01	3279.37	1419.59	321.54	55.06
20	130.54	102.08	6.40	8.42	3568.64	1112.47	321.98	60.04
21	130.22	101.92	7.00	5.67	3205.95	1416.41	319.86	48.70
22	130.57	102.49	5.69	6.31	4040.89	1480.48	322.52	55.11
23	130.42	102.79	6.60	5.49	3236.16	1174.60	315.18	39.35
24	130.44	102.93	6.56	5.48	3149.57	1307.68	319.57	51.02
25	130.35	102.02	6.42	5.76	3635.41	1346.83	326.10	56.95
26	130.84	102.77	6.41	5.51	3665.46	1571.60	330.99	84.13
27	130.38	103.40	5.95	7.72	3917.02	1195.43	329.28	62.56
28	130.38	102.35	6.12	5.67	3840.02	1574.02	332.85	79.72
29	130.48	102.54	6.20	8.28	3680.17	1116.01	320.96	60.37
30	130.60	101.86	6.34	7.18	3388.07	1265.47	321.59	61.97
31	129.99	102.65	6.81	5.13	3395.27	1704.42	326.91	60.04
32	130.41	102.67	6.50	5.83	3618.37	1424.95	323.41	57.71
33	130.55	102.38	6.34	5.99	3300.51	1413.53	326.69	61.88
34	130.33	101.97	6.11	6.74	3324.40	1104.89	318.04	42.54
35	130.34	102.47	6.65	6.26	3000.01	1230.40	327.74	60.58
36	130.41	102.78	6.44	6.38	3400.94	1349.89	328.28	60.53
37	130.18	102.98	6.96	5.89	3159.34	1610.34	321.08	50.32
38	130.37	102.51	6.54	5.93	3529.02	1439.36	323.43	61.50

1	90.96	62.06	6.11	5.88	3262.54	1002.07	325.88	43.81
2	90.85	62.25	6.60	7.19	2790.10	701.89	326.54	42.08
3	90.49	62.26	5.78	6.83	3402.05	753.51	325.72	38.16
4	90.43	62.80	6.29	6.95	3113.03	817.35	318.72	39.60
5	90.24	62.62	6.52	6.45	2562.83	1061.14	328.22	42.07
6	90.50	62.69	5.50	5.80	3423.22	978.38	328.97	50.73
7	90.43	62.95	5.81	6.87	3269.47	982.27	330.80	50.09
8	91.03	62.70	6.68	8.46	2980.37	742.31	327.31	56.58
9	90.10	62.52	5.95	7.15	3521.50	922.39	329.47	59.27
10	90.73	61.39	6.16	7.57	3109.55	950.57	325.54	54.20
11	90.33	62.21	7.20	6.86	3028.96	1073.89	320.86	60.18
12	90.83	62.44	6.17	6.46	3657.27	1048.51	327.58	69.94
13	91.04	62.69	5.95	6.48	3466.17	927.24	331.06	50.28
14	90.65	61.82	6.22	6.33	3446.36	1064.63	336.64	61.43
15	90.59	61.80	6.33	5.47	3250.90	1247.93	333.22	55.19
16	90.92	62.62	6.07	6.38	3333.73	1077.97	330.16	72.35
17	90.24	62.61	5.99	5.86	3590.74	1260.69	329.64	56.41
18	90.96	62.43	6.32	6.07	3360.36	1210.06	324.06	77.23
19	90.38	62.33	6.96	6.44	3282.53	1036.94	331.37	54.02
20	90.51	63.10	6.63	5.84	3671.76	1036.16	330.67	51.28
21	90.45	63.41	6.08	7.81	3309.67	876.85	324.38	52.66
22	90.69	62.36	6.17	5.26	3110.87	1401.99	330.44	68.94
23	90.89	62.45	5.70	5.94	4047.30	1065.09	338.71	62.92
24	90.69	62.30	6.44	5.36	3462.07	1207.71	331.93	58.78
25	90.33	62.71	6.44	6.37	3291.64	1127.86	332.60	55.13
26	90.64	62.58	6.46	6.66	3228.98	1262.03	329.60	71.53
27	90.57	62.34	6.16	5.40	3820.74	1233.55	327.64	55.30
28	90.09	62.89	6.62	6.67	3696.46	1132.14	326.18	46.96
29	90.50	62.35	6.17	7.25	3399.15	1018.26	331.93	63.39
30	90.73	62.48	6.13	7.41	3494.99	896.19	324.42	64.50
31	90.78	62.47	6.68	6.41	3427.14	1160.28	324.96	56.05
32	90.83	62.66	6.02	7.17	4013.25	885.38	335.25	61.24
33	90.48	62.51	6.72	6.15	3097.85	1291.92	331.34	57.87
34	91.46	62.70	5.78	6.40	3561.47	1105.18	324.72	48.80
35	90.38	62.07	6.56	5.53	3098.26	1387.86	330.59	52.73
36	90.24	62.10	6.43	6.93	3367.10	996.35	326.19	47.98
37	90.66	63.21	6.74	6.35	3403.54	1064.84	325.03	55.04
38	90.18	61.90	7.26	6.87	3177.80	1104.56	327.06	51.07

```
CMS FILEDEF XAS DISK F90025 DATA A (DISP MOD RECFM V;
CMS FILEDEF MM1 DISK CMS6890 PST A;
CMS FILEDEF MM2 DISK CMS6910 PST A;
( ) FILEDEF MM3 DISK CMS6930 PST A;
CMS FILEDEF MM4 DISK CMS6950 PST A;
CMS FILEDEF MM5 DISK CMS6970 PST A;
CMS FILEDEF MM6 DISK CMS6990 PST A;
*GOPTIONS TEXT82 GPROTOCOL=GSAS7171;
*/HP7470 PLOTTER GOPTIONS AND FILEDEF/*;
CMS FILEDEF HPOUT DISK CALI PIC A;
GOPTION TEXT82 DEVICE=HP7470 SPEED=40 GPROTOCOL=GSAS7171
NODISPLAY NOPROMPT
HANDSHAKE=NONE
PENMOUNTS=1
SPEED=10
COLORS=(BLACK)
GSFNAME=HPOUT
GSFMODE=REPLACE;
```

```
DATA SETTING;
```

```
INFILE CARDS;
```

```
INPUT X0 LAMBDA0 XI;
```

```
CARDS;
```

```
6970 6935.3 6890
6970 6921.4 6890
6970 6935.3 6910
6970 6921.4 6910
6970 6935.3 6930
6970 6921.4 6930
6970 6935.3 6950
6970 6921.4 6950
( ) 6935.3 6970
6970 6921.4 6970
6970 6935.3 6990
6970 6921.4 6990
```

```
;
```

```
DATA ZERO;
```

```
SET SETTING;
```

```
LAMBDA=LAMBDA0-(XI-X0);
```

```
DATA ONE;
```

```
INFILE MM1 MISSEVER;
```

```
DS = _N_;
```

```
INPUT N1 Y1-Y2;
```

```
DATA TWO;
```

```
INFILE MM2 MISSEVER;
```

```
DS = _N_;
```

```
INPUT N2 Y3-Y4;
```

```
DATA THREE;
```

```
INFILE MM3 MISSEVER;
```

```
DS = _N_;
```

```
INPUT N3 Y5-Y6;
```

```
DATA FOUR;
```

```
INFILE MM4 MISSEVER;
```

```
DS = _N_;
```

```
INPUT N4 Y7-Y8;
```

```
DATA FIVE;
```

```

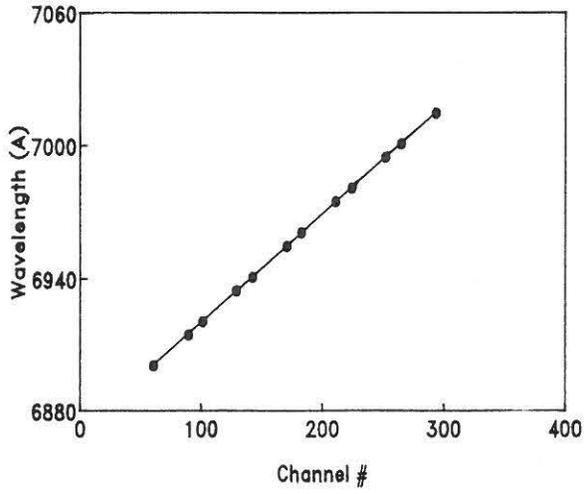
INFILE MM5 MISSEVER;
DS = _N_;
INPUT N5 Y9-Y10;
A SIX;
INFILE MM6 MISSEVER;
DS = _N_;
INPUT N6 Y11-Y12;
DATA ALL;
MERGE ONE TWO THREE FOUR FIVE SIX; BY DS;
ARRAY YY Y1-Y12;
DO OVER YY;
  X = _I_;  Y = YY;  IF Y ^= . THEN OUTPUT;
END;
DROP Y1-Y12;
RUN;
PROC MEANS NOPRINT DATA = ALL;  BY DS;
VAR Y;
OUTPUT OUT=SUMM N=NN MAX=YMAX;
DATA _NULL_; SET SUMM END=THEEND;
LENGTH NCNT $3;
RETAIN FIRSTOBS 1 OBS 0;
OBS = OBS + NN;
NCNT = LEFT(_N_);
CALL SYMPUT('FIRST' || NCNT, FIRSTOBS);
CALL SYMPUT('LAST' || NCNT, OBS);
CALL SYMPUT('DS' || NCNT, DS);
FIRSTOBS = OBS + 1;
IF THEEND THEN CALL SYMPUT('TOTAL', _N_);
RUN;
%MACRO GENNLIN;
%DO I=1 %TO 38;
DATA ALL1;
MERGE ZERO ALL (FIRSTOBS=&&FIRST&I OBS=&&LAST&I);
PROC NLIN DATA=ALL1;
MODEL LAMBDA=A+B*Y;
  PARM A=100 B=1;
  DER.A=1;
  DER.B=Y;
OUTPUT OUT=PLOT P=FIT PARMS=A1 B1;
DATA ME;
SET PLOT (FIRSTOBS=1 OBS=1 KEEP=A1 B1);
FILE XAS;
PUT A1 1-7 5 B1 10-17 5;
PROC SORT DATA=PLOT;
  BY Y;
PROC GPLOT DATA=PLOT GOUT=CALI.PIC;
  TITLE1 .F=DUPLEX TRACK &I;
  SYMBOL1 H=2.5 C=RED F=SPECIAL V=J I=NONE;
  SYMBOL2 C=RED V=NONE I=SPLINE;
  PLOT (LAMBDA fit)*Y /overlay FRAME  VAXIS=AXIS2 HAXIS=AXIS1;
  AXIS1 VALUE=(H=1.5 C=GREEN F=DUPLEX)
  ORDER=(0 TO 400 BY 100)
  MAJOR=(H=-1)
  MINOR=NONE
  LENGTH=7 IN

```

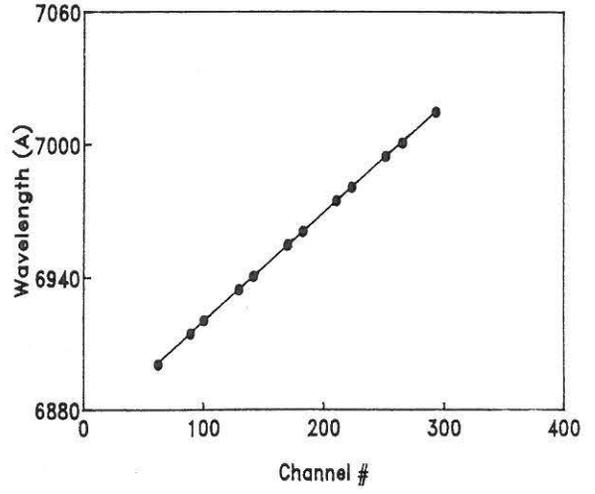
```
      OFFSET=(0,0)
      LABEL=(H=1.5 C=RED F=DUPLEX 'Channel #');
  AXIS2 VALUE=(H=1.5 C=GREEN F=DUPLEX)
      ORDER=(6880 TO 7060 BY 60)
      MAJOR=(H=-1)
      MINOR=NONE
      LENGTH=4.5 IN
      OFFSET=(0,0)
      LABEL=(H=1.5 C=RED F=DUPLEX A=90 'Wavelength (A)');
  RUN;
  %END;
%MEND GENNLIN;
RUN;
%GENNLIN;
```

6871.15	0.48980
6871.12	0.49033
6871.23	0.48957
6871.1	0.49058
6871.18	0.49015
6870.99	0.49094
6870.87	0.49129
6870.92	0.49085
6871	0.49107
6871.02	0.49113
6871.01	0.49137
6870.67	0.49318
6870.86	0.49207
6871.02	0.49151
6870.92	0.49184
6870.81	0.49253
6871.03	0.49115
6870.88	0.49202
6870.97	0.49167
6870.9	0.49188
6870.89	0.49203
6870.85	0.49264
6870.86	0.49203
6870.9	0.49177
6870.93	0.49201
6870.8	0.49250
6870.87	0.49197
6871	0.49193
6870.98	0.49195
6870.88	0.49263
6870.91	0.49259
6870.85	0.49214
6870.94	0.49212
6870.96	0.49160
6871.13	0.49064
6871	0.49125
6870.8	0.49193
6871.22	0.49032

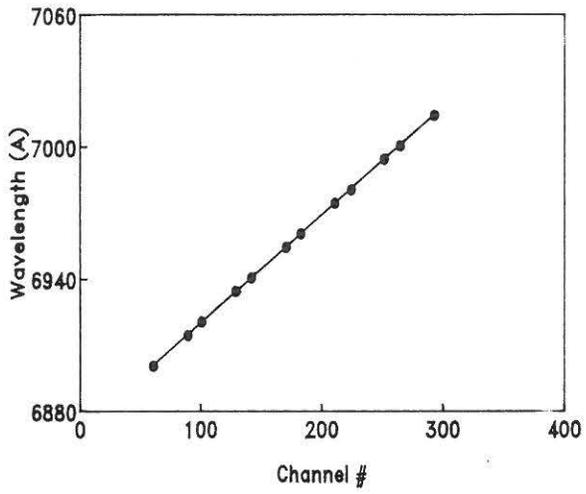
TRACK 1



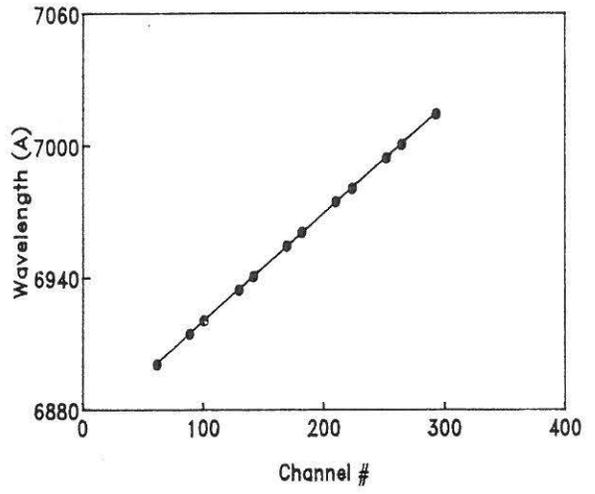
TRACK 4



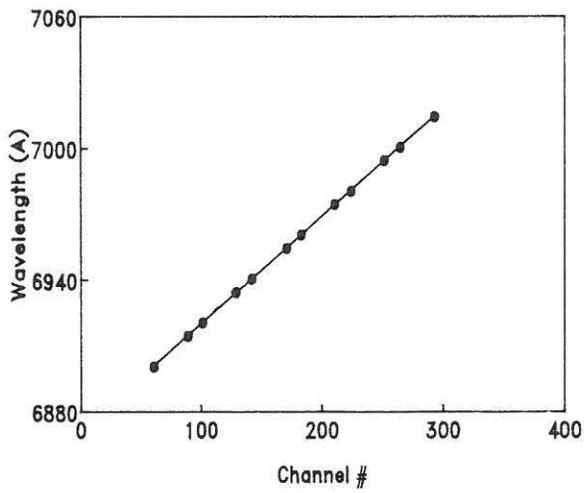
TRACK 2



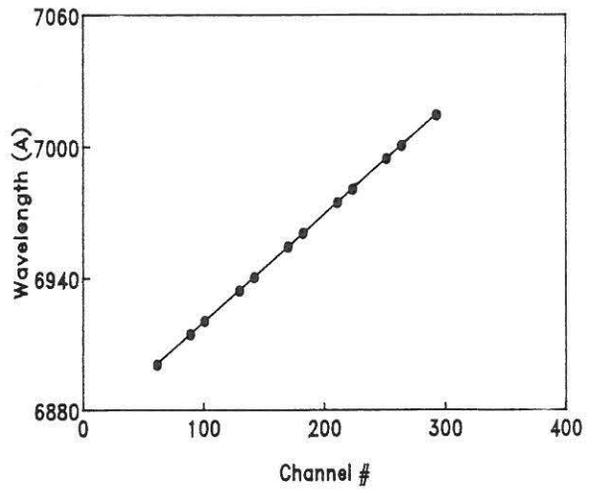
TRACK 5



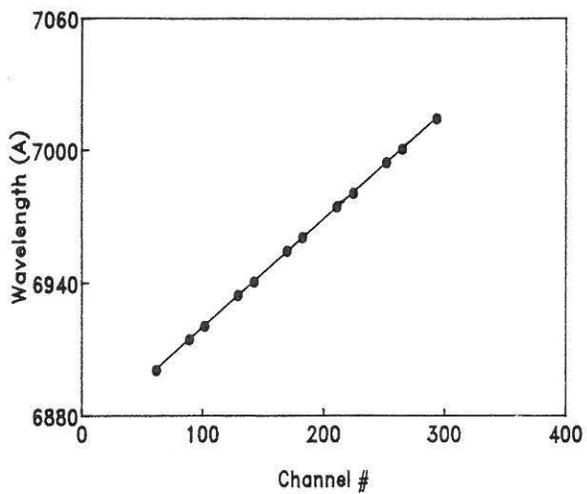
TRACK 3



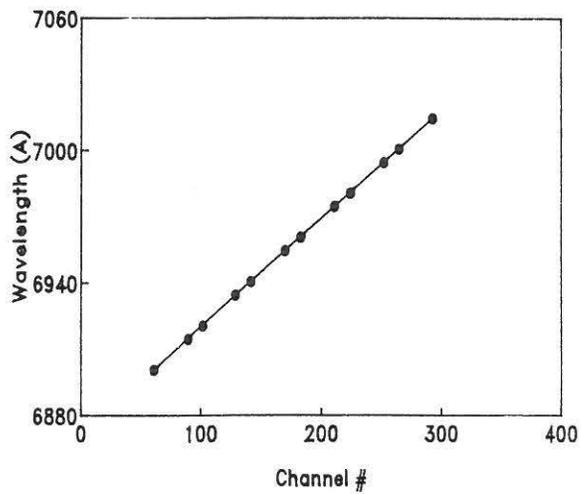
TRACK 6



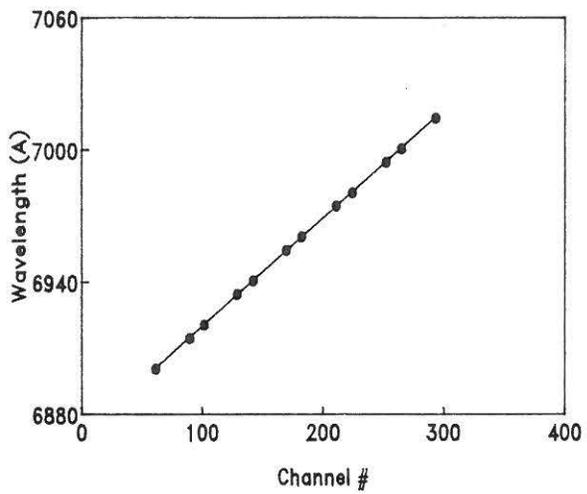
TRACK 7



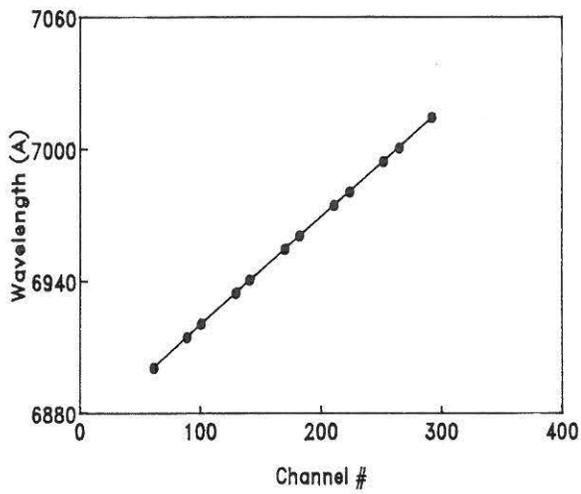
TRACK 10



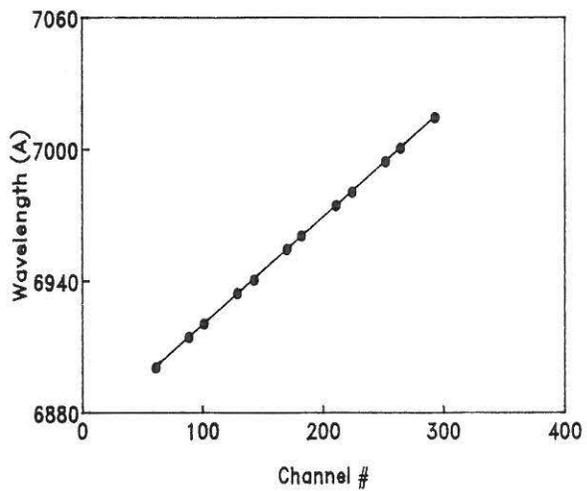
TRACK 8



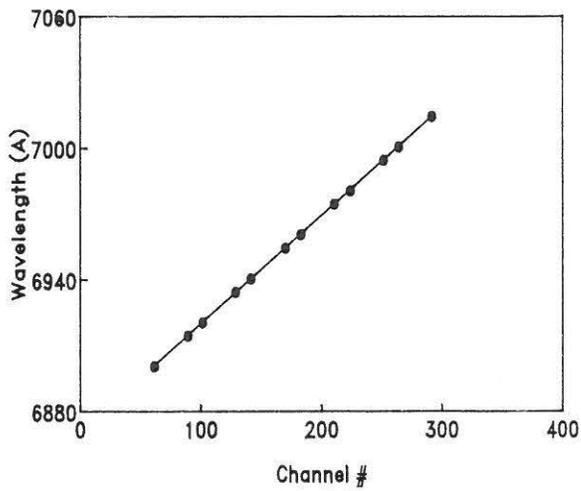
TRACK 11



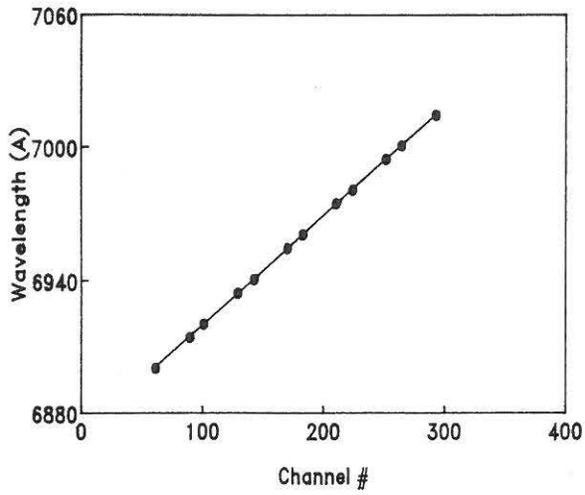
TRACK 9



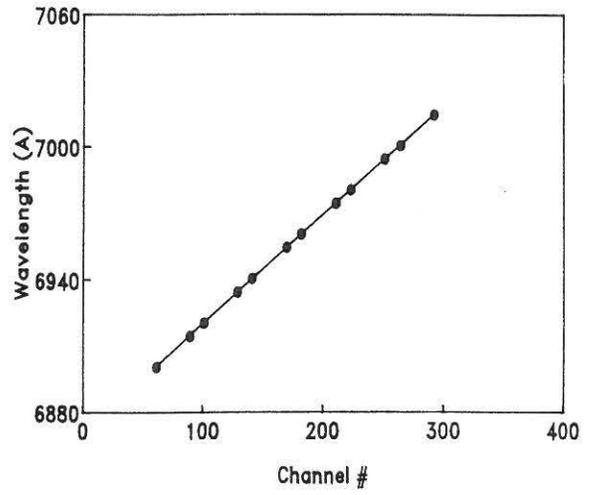
TRACK 12



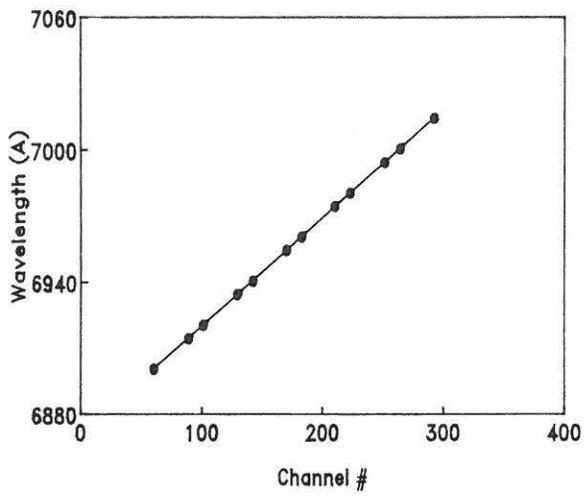
TRACK 13



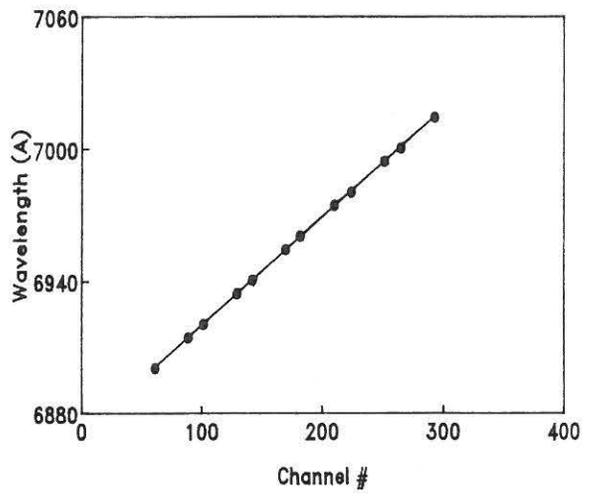
TRACK 16



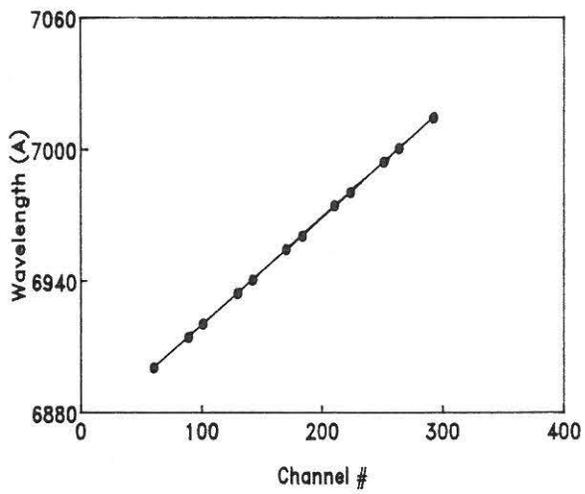
TRACK 14



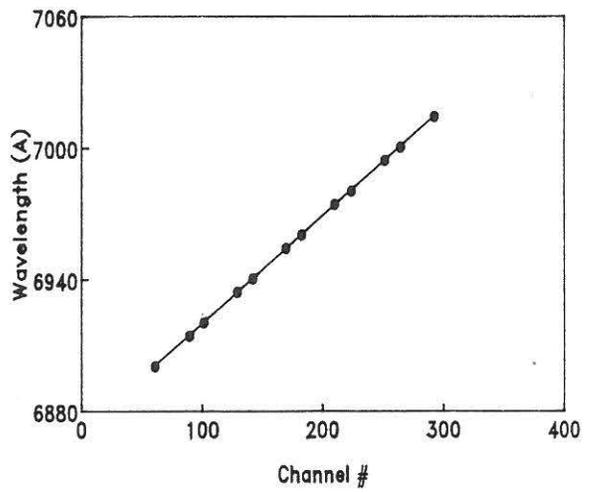
TRACK 17



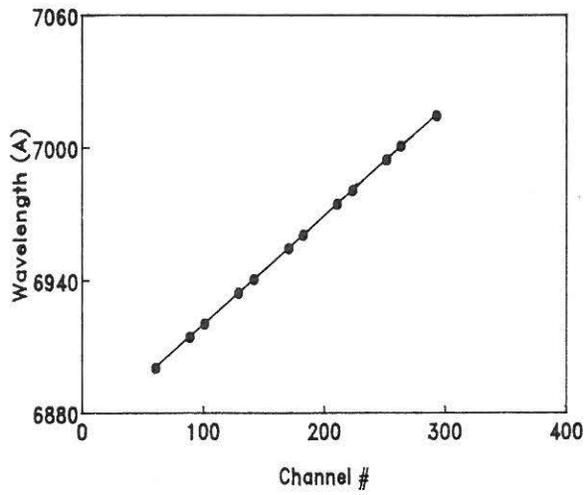
TRACK 15



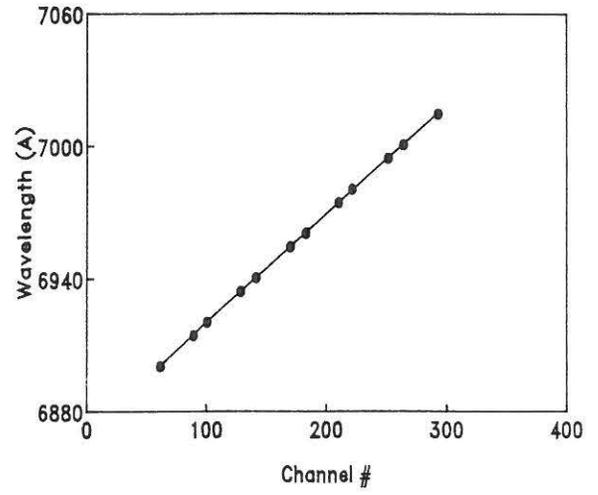
TRACK 18



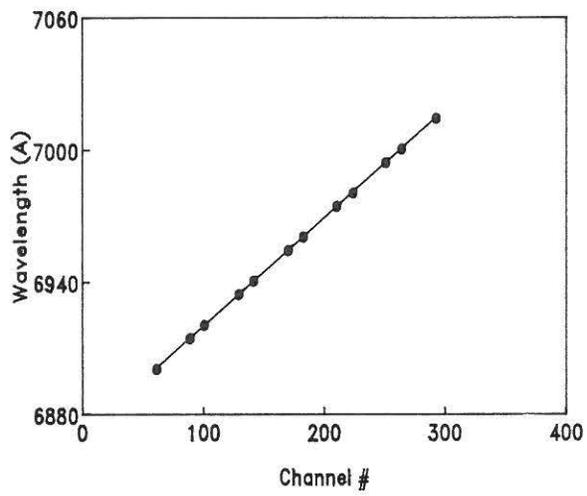
TRACK 19



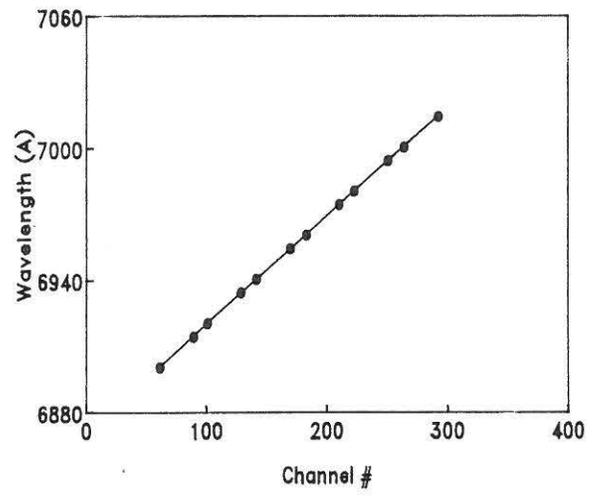
TRACK 22



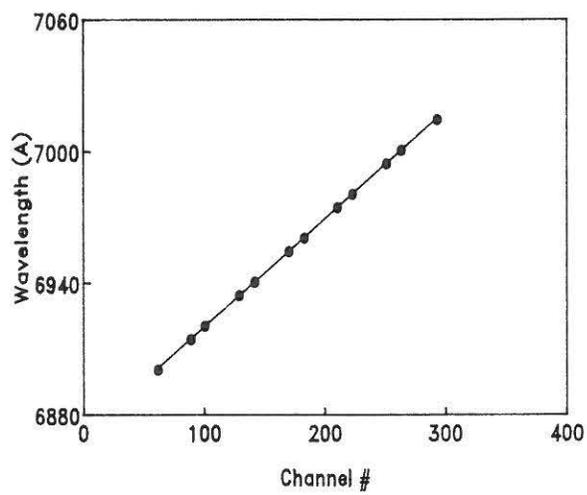
TRACK 20



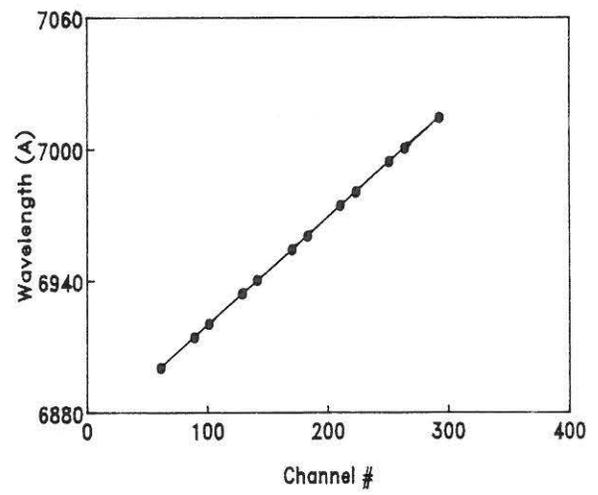
TRACK 23



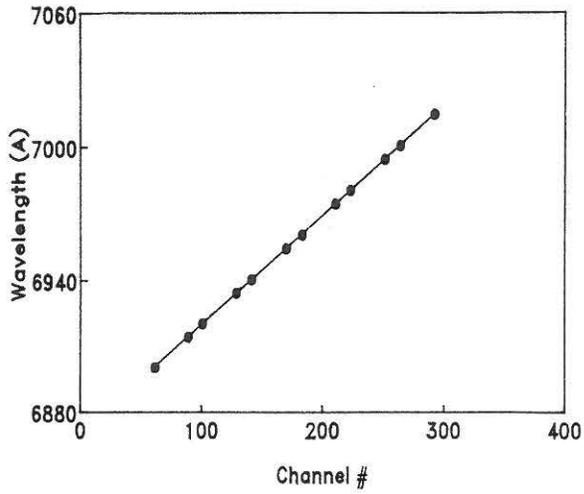
TRACK 21



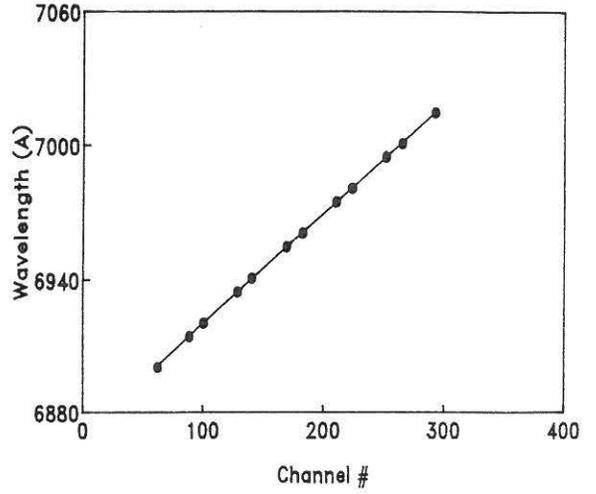
TRACK 24



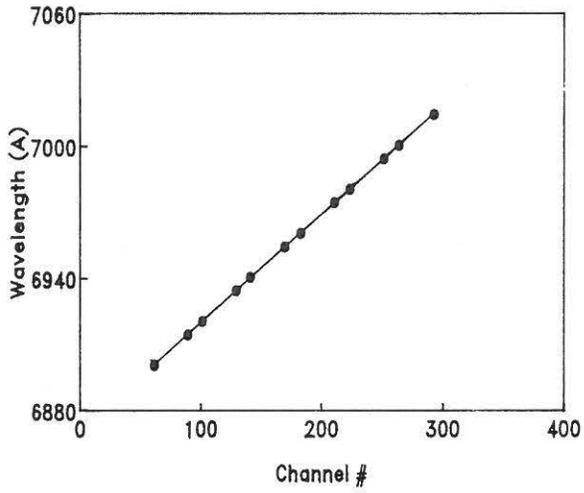
TRACK 25



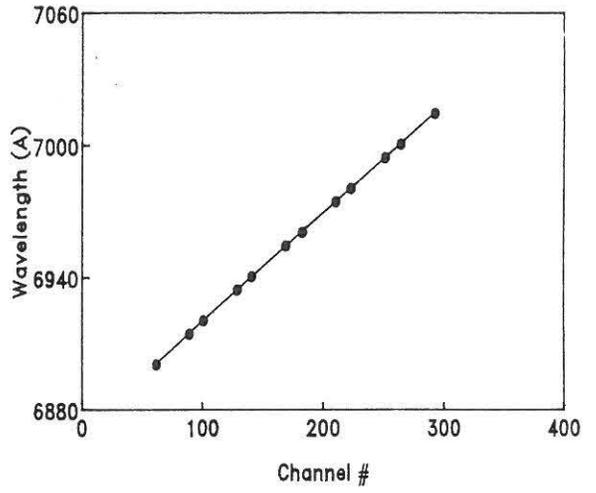
TRACK 28



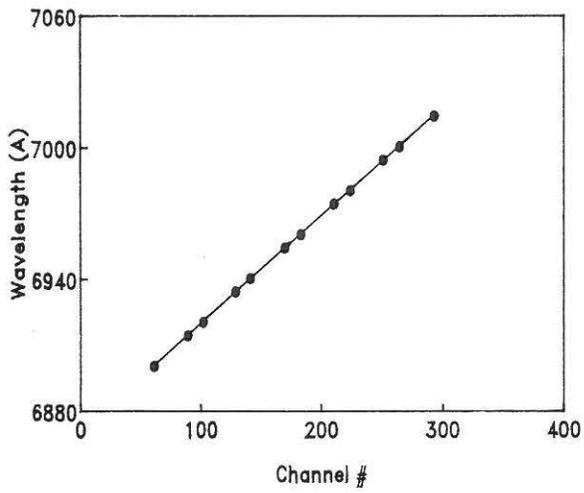
TRACK 26



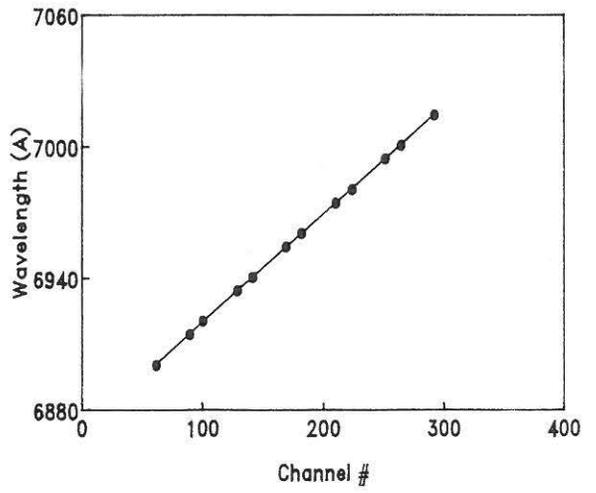
TRACK 29



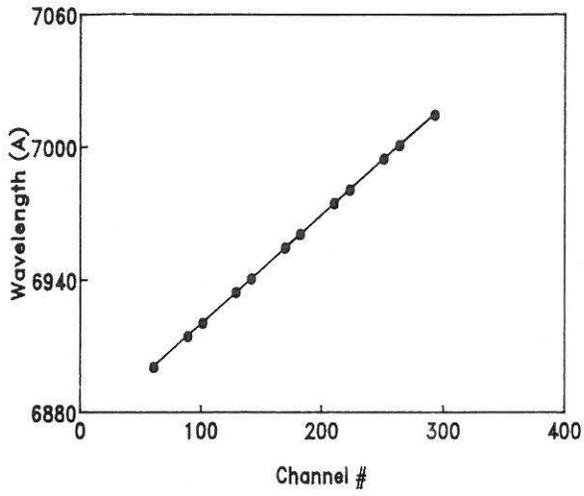
TRACK 27



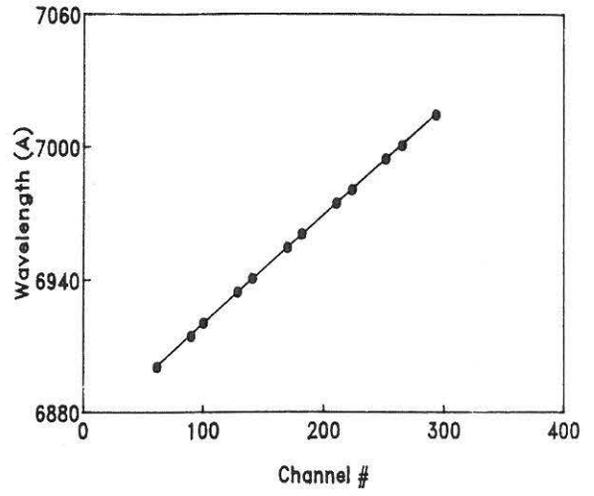
TRACK 30



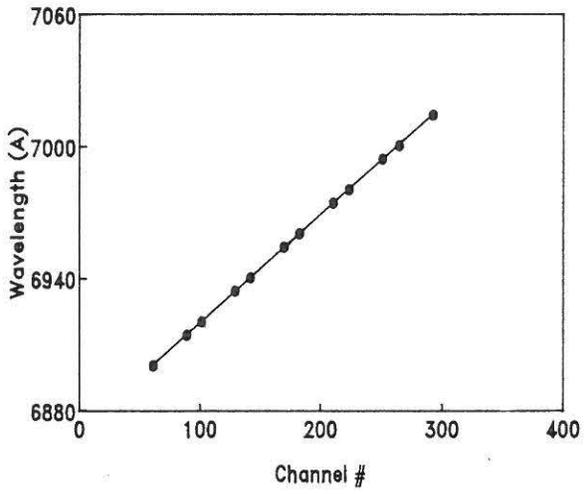
TRACK 31



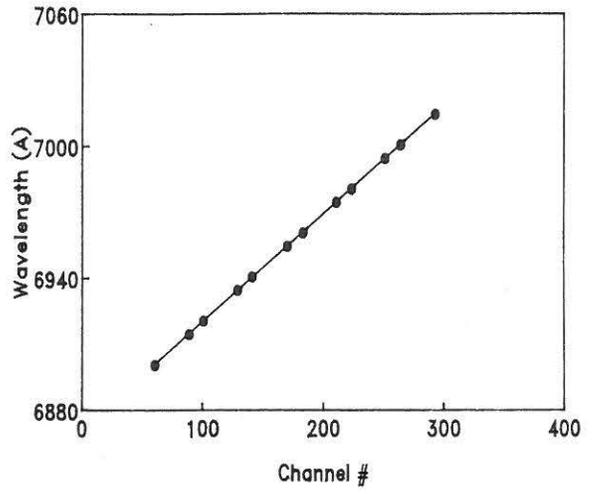
TRACK 34



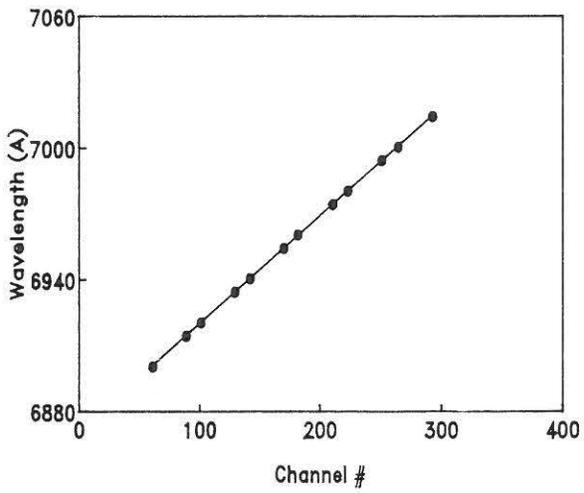
TRACK 32



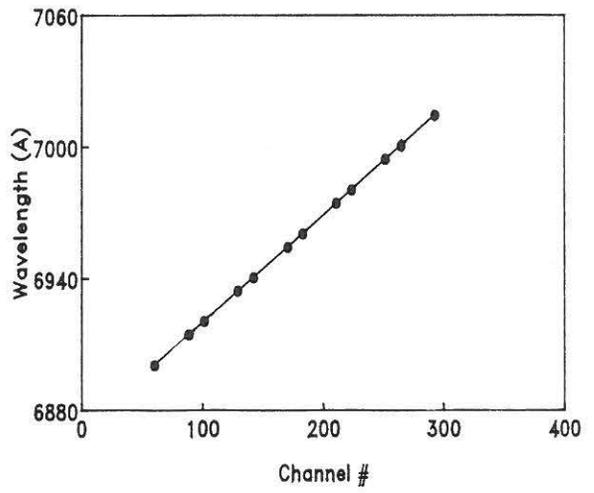
TRACK 35



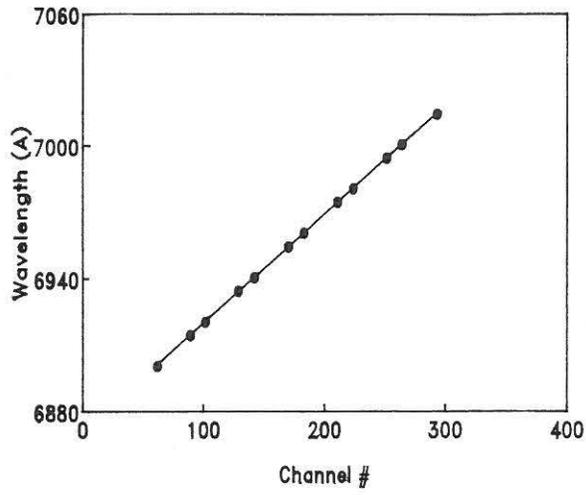
TRACK 33



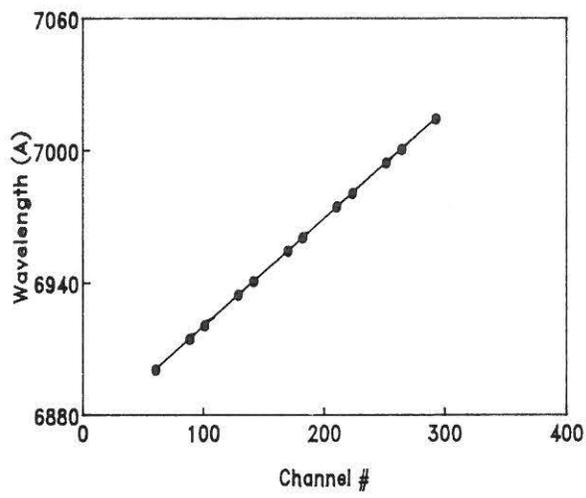
TRACK 36



TRACK 37



TRACK 38



```

CMS FILEDEF XAS DISK S90025 RESULT (DISP MOD RECFM V;
CMS FILEDEF YOU DISK CMS90025 DATA A;
CMS FILEDEF ME DISK PK90025 DATA A;
( ) FILEDEF SHE DISK F90025 DATA A;
*GOPTIONS NOTEXT82 GPROTOCOL=GSAS7171;
*/HP7470 PLOTTER GOPTIONS AND FILEDEF/*;
GOPTION TEXT82 DEVICE=HP7470 SPEED=40 GPROTOCOL=GSAS7171
NODISPLAY NOPROMPT
HANDSHAKE=NONE
PENMOUNTS=1
SPEED=10
COLORS=(BLACK)
GSFNAME=HPOUT
GSFMODE=REPLACE;

DATA ZERO;
INFILE ME;
INPUT DS C1 A1 C2 A2 BK;
BK=0;
DATA ONE;
INFILE YOU MISSEVER;
DS = _N_;
INPUT Y1-Y384;
DATA TWO;
INFILE SHE MISSEVER;
DS = _N_;
INPUT A B;
DATA THREE;
MERGE ZERO ONE TWO; BY DS;
C1=A+B*C1;
C2=A+B*C2;
DATA ALL; SET THREE;
ARRAY YY Y1-Y384;
DO OVER YY;
X = _I_; W=A+B*X; Y = YY; IF Y ^= . THEN OUTPUT;
END;
DROP Y1-Y384;
RUN;
PROC MEANS NOPRINT DATA = ALL; BY DS;
VAR Y; ID A1 A2 C1 C2 BK;
OUTPUT OUT=SUMM N=NN MAX=YMAX;
DATA _NULL_; SET SUMM END=THEEND;
LENGTH NCNT $3;
RETAIN FIRSTOBS 1 OBS 0;
OBS = OBS + NN;
NCNT = LEFT(_N_);
CALL SYMPUT('FIRST' || NCNT, FIRSTOBS);
CALL SYMPUT('LAST' || NCNT, OBS);
CALL SYMPUT('AONE' || NCNT, A1);
CALL SYMPUT('ATWO' || NCNT, A2);
CALL SYMPUT('CONE' || NCNT, C1);
CALL SYMPUT('CTWO' || NCNT, C2);
CALL SYMPUT('BKGD' || NCNT, BK);
CALL SYMPUT('DS' || NCNT, DS);
FIRSTOBS = OBS + 1;
IF THEEND THEN CALL SYMPUT('TOTAL',_N_);

```

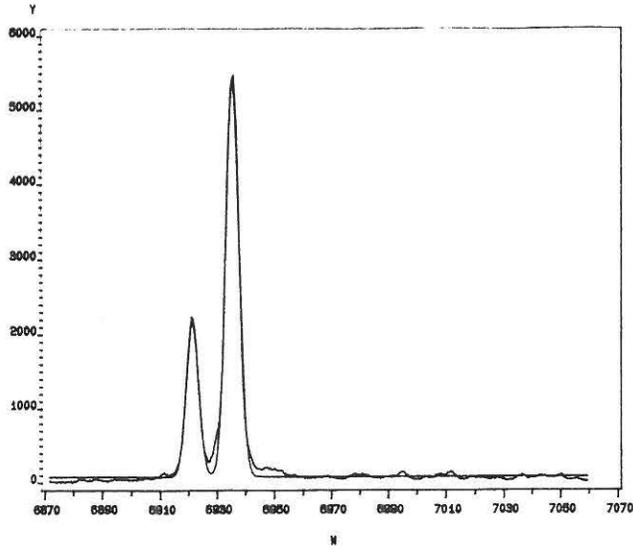
```

RUN;
%MACRO STATE;
  %DO I=1 %TO 3 ;
    TITLE .F=DUPLEX TRACK &I ;
    PROC NLIN DATA = ALL (FIRSTOBS=&&FIRST&I OBS=&&LAST&I KEEP=W Y);
    PARM B=&&BKGD&I A1=&&AONE&I A2=&&ATWO&I C1=&&CONE&I C2=&&CTWO&I
    D1=5 D2=5;
** ***** LORENTZIAN MODEL *****;
* MODEL Y= B + A1/(((W-C1)/D1)**2+1) + A2/(((W-C2)/D2)**2+1);
* DER.B=1;
* DER.A1=1/(((W-C1)/D1)**2+1);
* DER.A2=1/(((W-C2)/D2)**2+1);
* DER.C1=2*(W-C1)*A1/(D1*(((W-C1)/D1)**2+1)**2);
* DER.C2=2*(W-C2)*A2/(D2*(((W-C2)/D2)**2+1)**2);
* DER.D1=2*(W-C1)**2*A1/D1**3/(((W-C1)/D1)**2+1)**2;
* DER.D2=2*(W-C2)**2*A2/D2**3/(((W-C2)/D2)**2+1)**2;
** ***** GAUSSIAN MODEL *****;
  MODEL Y= B + A1*EXP(-(W-C1)**2/D1**2)
    + A2*EXP(-(W-C2)**2/D2**2);
  DER.B=1;
  DER.A1=EXP(-(W-C1)**2/D1**2);
  DER.A2=EXP(-(W-C2)**2/D2**2);
  DER.C1=2*((W-C1)/D1**2)*A1*EXP(-(W-C1)**2/D1**2);
  DER.C2=2*((W-C2)/D2**2)*A2*EXP(-(W-C2)**2/D2**2);
  DER.D1=2*((W-C1)**2/D1**3)*A1*EXP(-(W-C1)**2/D1**2);
  DER.D2=2*((W-C2)**2/D2**3)*A2*EXP(-(W-C2)**2/D2**2);
** *****;
  OUTPUT OUT=PLOT P=FIT PARMS=B A1 A2 C1 C2 D1 D2 ESS=DD;
  PROC GPLOT DATA=PLOT GOUT=RUBY.PIC;
  SYMBOL1 H=2.0 C=RED V=NONE I=SPLINE;
  MBOL2 H=2.0 C=RED V=NONE I=SPLINE;
  PLOT (Y FIT)*W/OVERLAY FRAME;
DATA ME;
  SET PLOT (FIRSTOBS=1 OBS=1);
  ERROR=(DD/(384-7))**0.5;
  FILE XAS;
  TRK=&I;
  PUT TRK 2. +2 (C1 C2 D1 D2 A1 A2 B ERROR) (7.2,+2);
  RUN;
  %END;
%MEND STATE;
RUN;
%STATE;

```

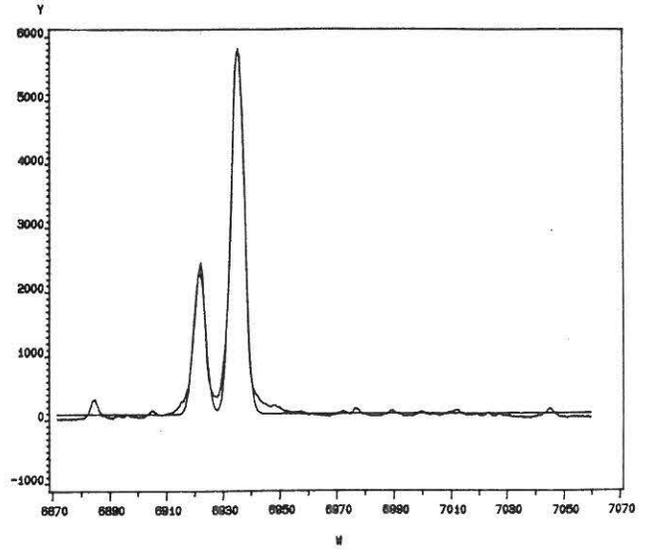
1	6935.46	6921.39	3.21	3.05	5341.39	2074.67	80.54	63.34
2	6935.44	6921.73	3.01	3.41	5517.99	2056.21	79.35	76.30
3	6935.28	6921.44	3.10	3.22	6069.97	1908.32	82.82	77.56
4	6935.29	6921.75	3.25	2.95	5738.14	2231.63	88.91	79.67
5	6935.47	6921.52	3.08	3.01	6493.56	2301.83	92.01	82.87
6	6935.16	6921.64	3.37	2.97	5614.38	2448.30	83.24	86.90
7	6935.18	6921.41	3.23	3.35	6456.46	2162.63	84.18	83.01
8	6935.41	6921.70	3.04	3.47	6479.76	2042.81	93.08	99.28
9	6935.33	6921.63	3.03	3.32	6597.95	2091.18	99.14	90.81
10	6935.35	6921.39	2.94	3.07	6793.54	2198.28	95.74	96.39
11	6935.34	6921.73	3.13	3.40	6757.58	2295.16	105.99	84.65
12	6935.09	6921.15	3.05	3.52	6265.78	2187.50	116.01	96.77
13	6935.34	6921.42	3.17	3.52	6406.63	2302.57	170.55	126.99
14	6935.53	6921.94	3.36	3.12	6303.85	2755.34	861.13	353.90
15	6967.97	6956.94	3.18	4.63	3341.11	973.26	963.44	422.52
16	6968.06	6957.97	3.01	3.69	4884.57	1813.61	229.46	92.79
17	6967.99	6957.79	2.97	3.80	5793.78	1666.14	111.83	84.12
18	6968.20	6957.55	2.92	3.84	6213.58	1792.01	85.91	88.51
19	6968.16	6957.23	3.29	3.63	4914.78	1851.99	78.49	74.82
20	6968.20	6957.98	3.26	5.00	4264.60	1428.19	77.71	91.01
21	6968.59	6957.81	3.45	3.51	4500.04	1966.80	74.36	81.30
22	6968.68	6958.55	3.57	3.68	4390.55	1895.92	66.76	65.31
23	6969.09	6958.55	3.89	3.51	3897.64	1846.58	61.37	51.65
24	6969.42	6958.71	3.62	3.42	3914.58	1765.46	76.91	91.69
25	6969.84	6959.32	3.46	3.93	4781.97	1512.90	73.70	80.04
26	6969.92	6959.26	3.38	4.39	4093.32	1421.96	67.75	70.68
27	6970.01	6959.55	3.26	4.59	4353.93	1475.30	72.00	80.08
28	6970.29	6959.28	3.87	3.99	3529.76	1750.77	59.93	53.59
29	6970.32	6959.42	3.45	3.58	3847.79	1806.51	78.06	83.63
30	6970.48	6959.70	3.45	3.69	3531.19	1784.06	92.11	94.17
31	6970.15	6959.89	3.70	3.54	3077.31	1979.48	108.29	103.19
32	6939.87	6926.50	4.45	4.28	2755.19	924.82	190.46	232.34
33	6939.53	6925.90	3.21	3.86	5725.14	2145.94	129.07	116.85
34	6939.49	6925.59	3.40	3.86	5616.32	2208.72	115.80	111.03
35	6939.36	6925.33	3.33	3.92	5766.52	2110.74	108.23	122.54
36	6939.62	6925.50	3.56	3.78	5656.61	2340.51	105.80	116.26
37	6939.86	6926.02	3.42	4.17	5232.85	2136.89	104.79	109.91
38	6940.14	6926.40	3.48	3.91	5471.84	2135.66	96.50	102.30

2

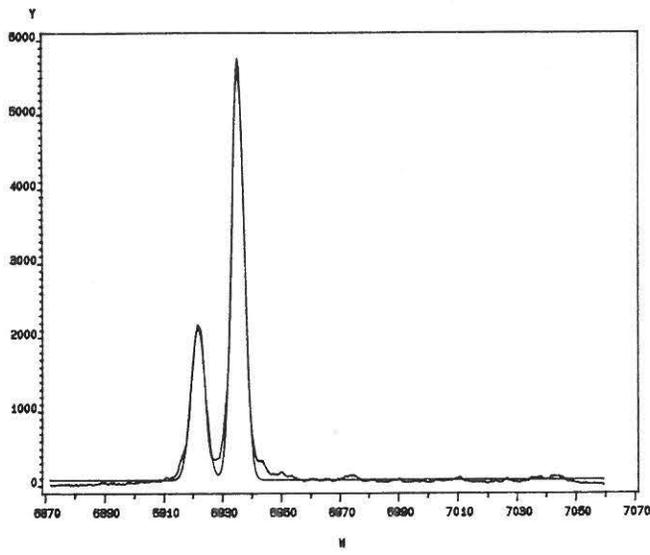


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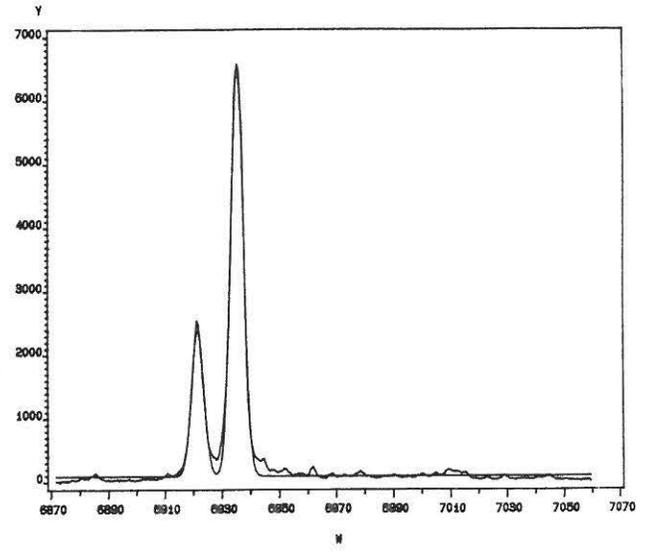
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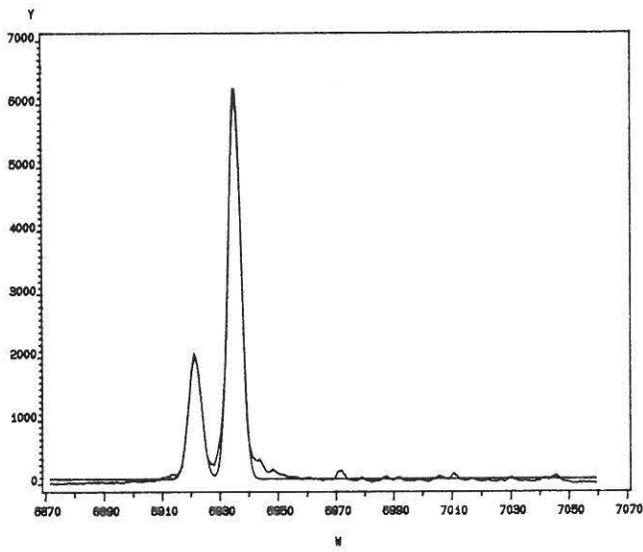
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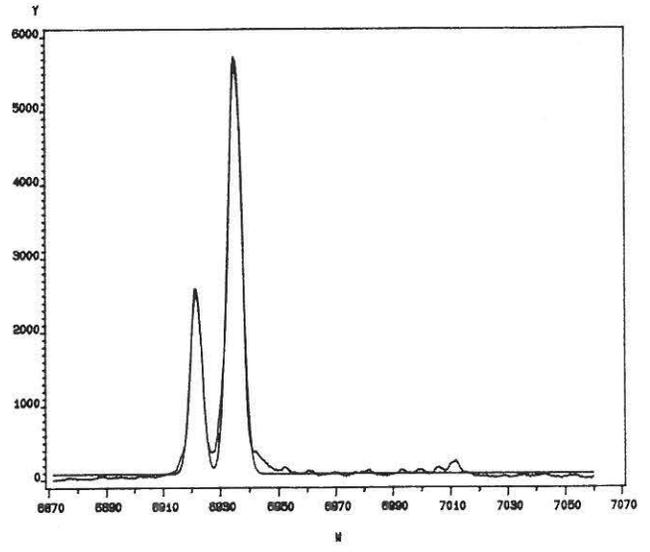
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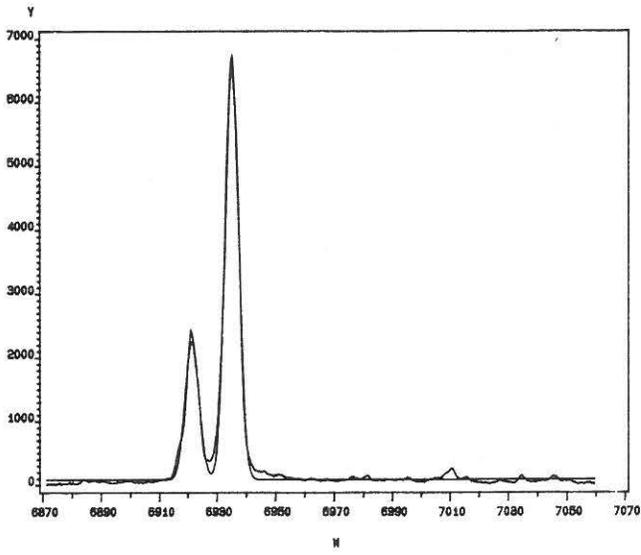


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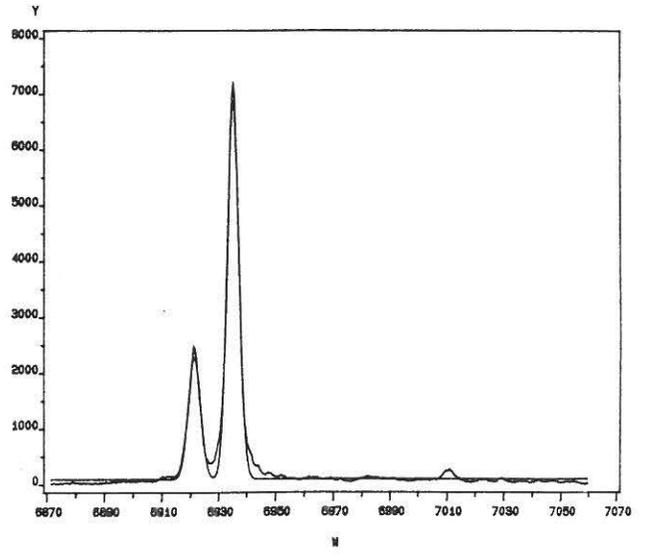


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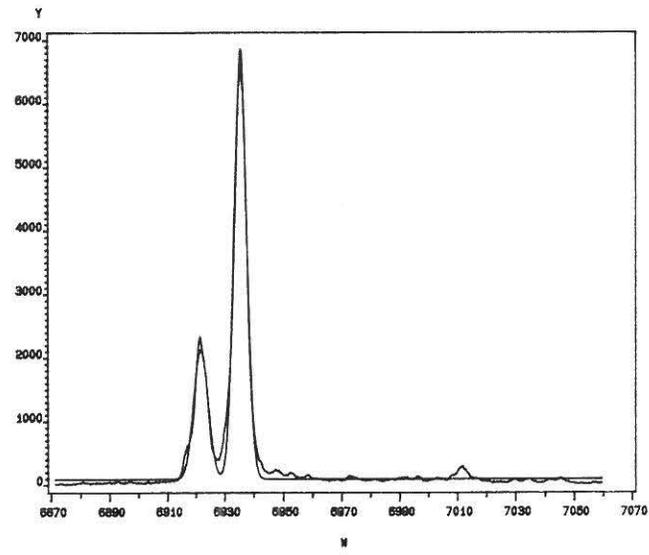
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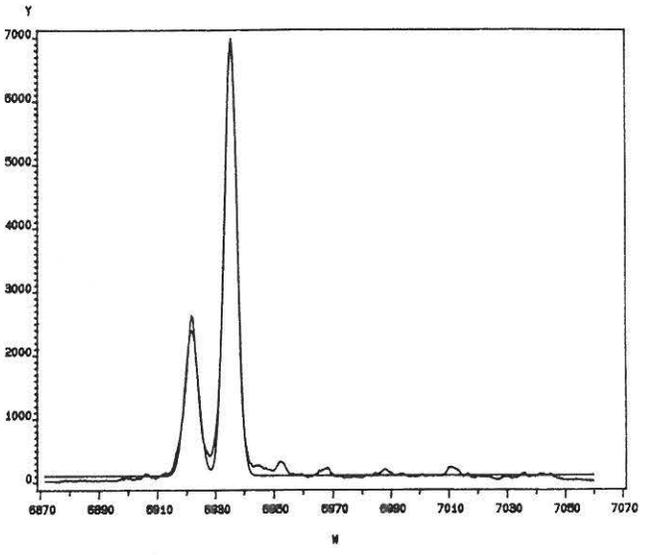
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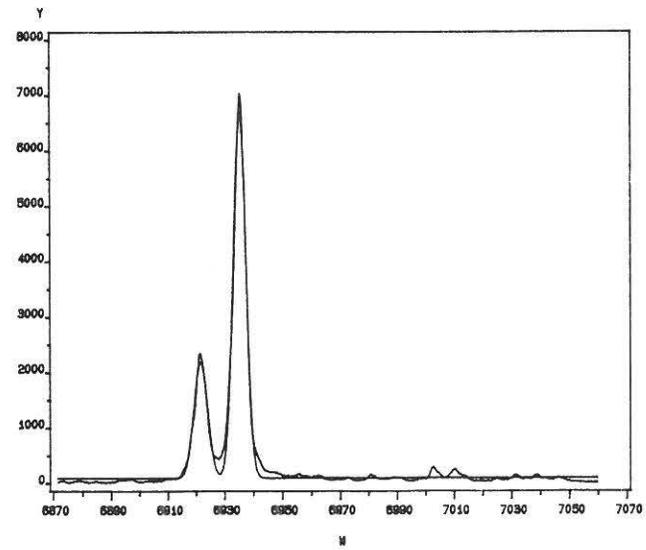
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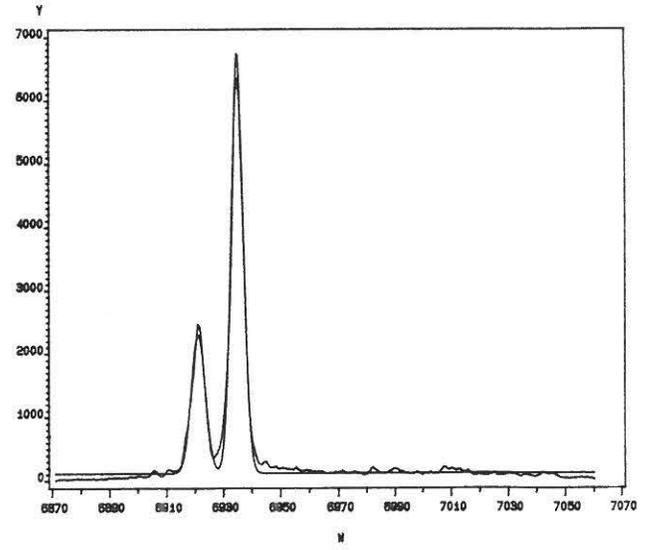
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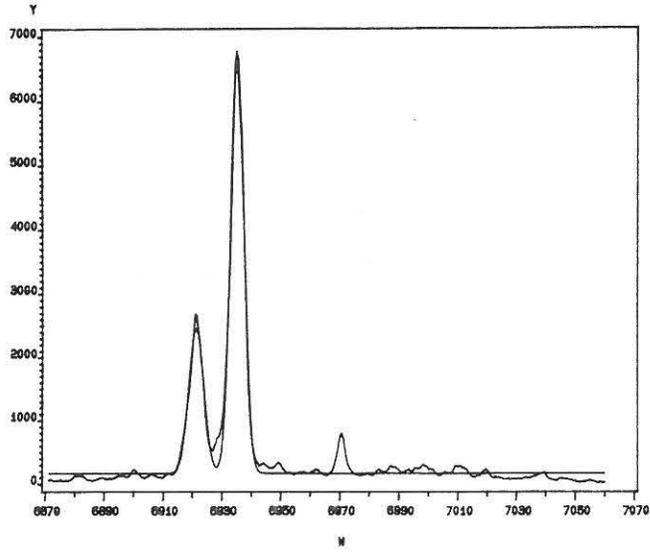
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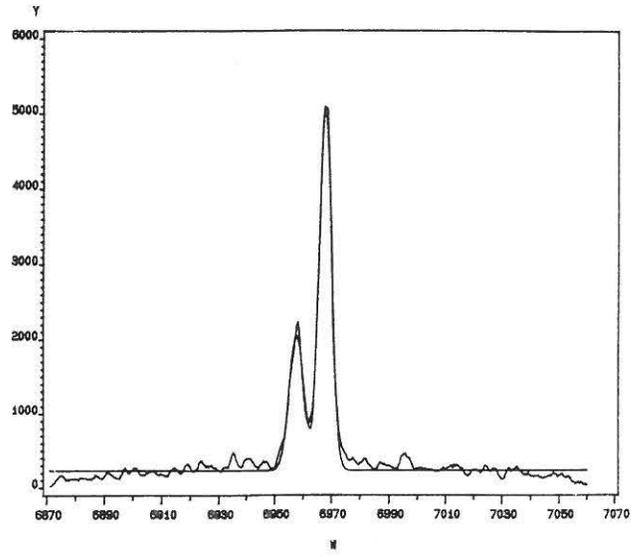
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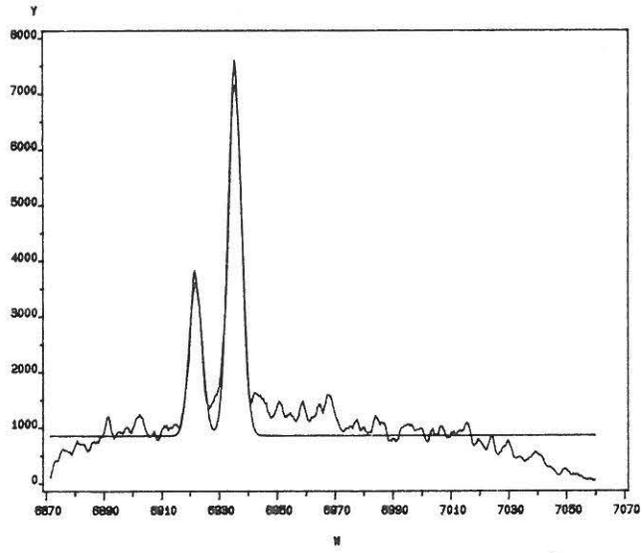
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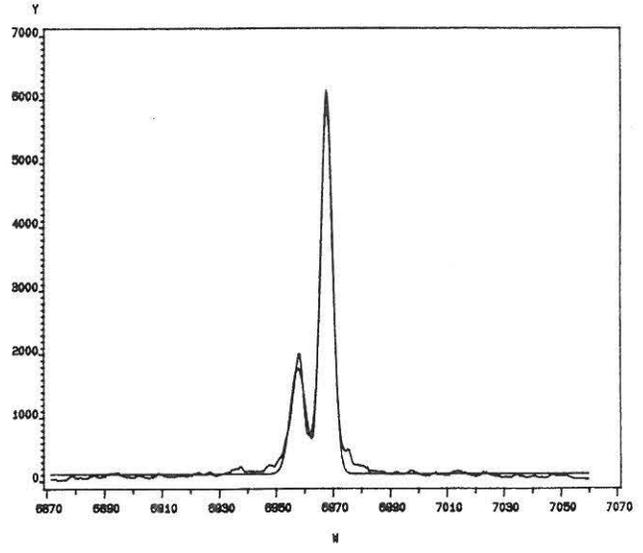
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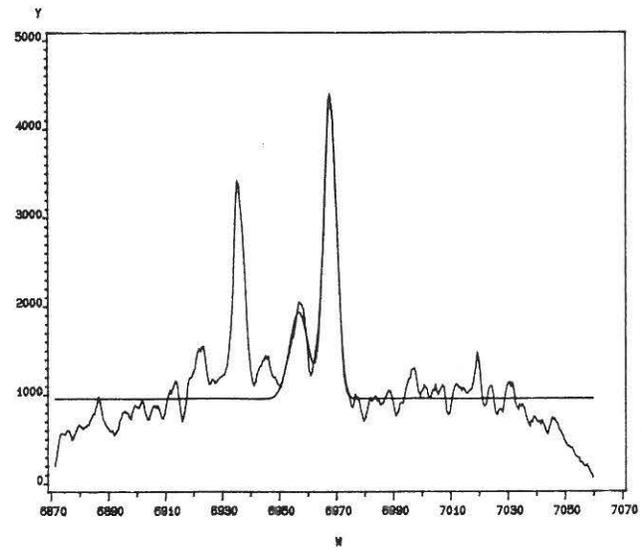
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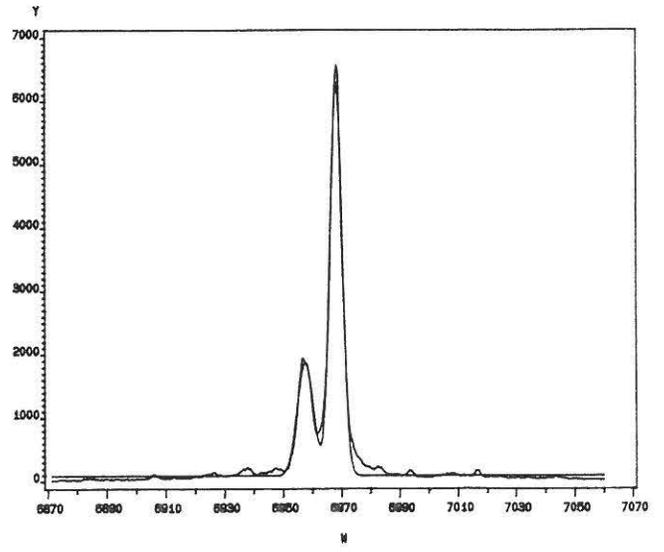
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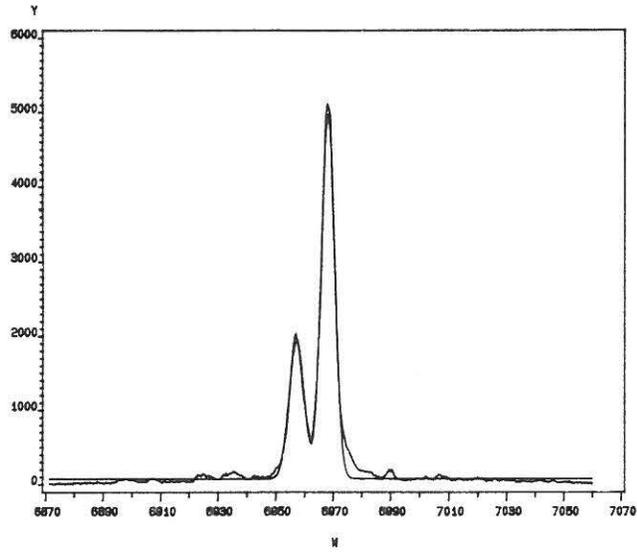
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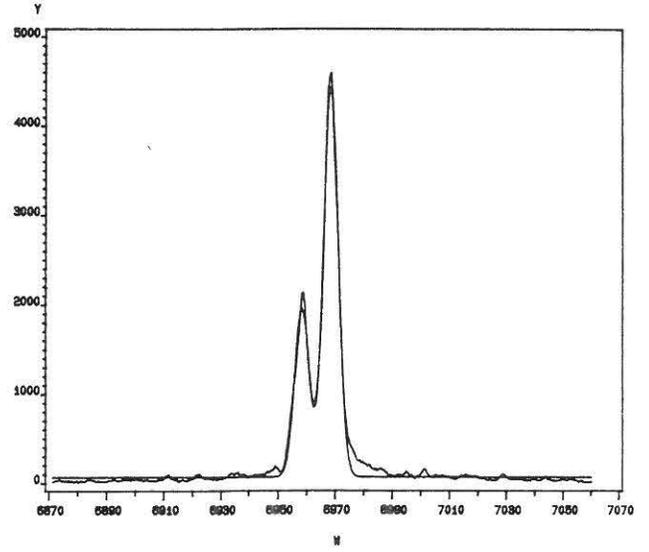
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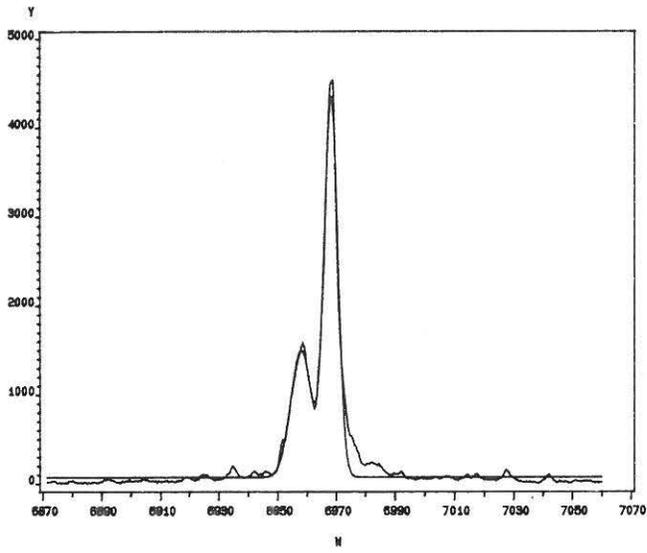
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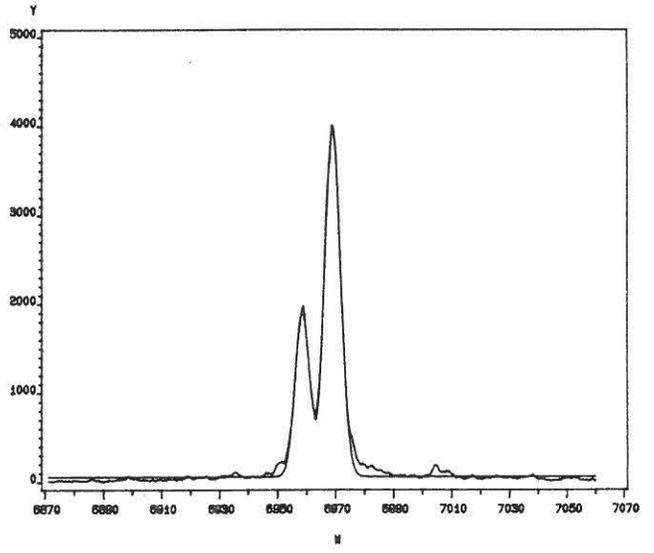
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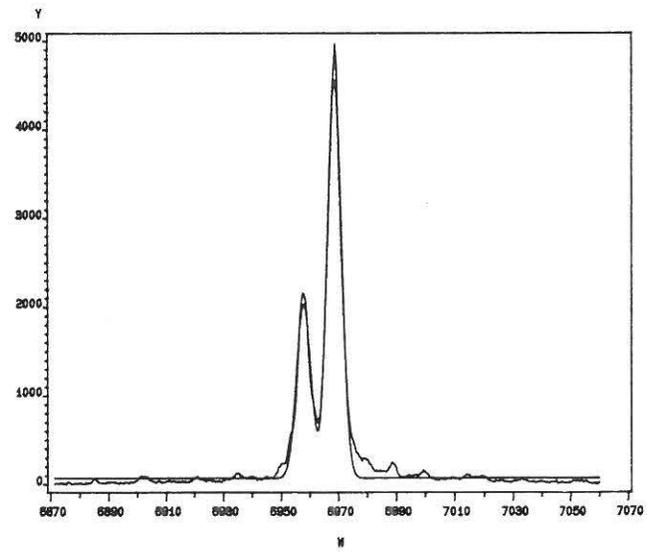
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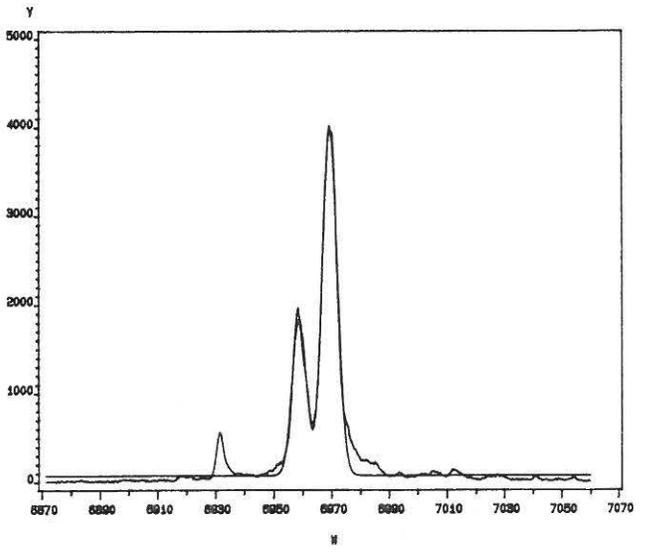
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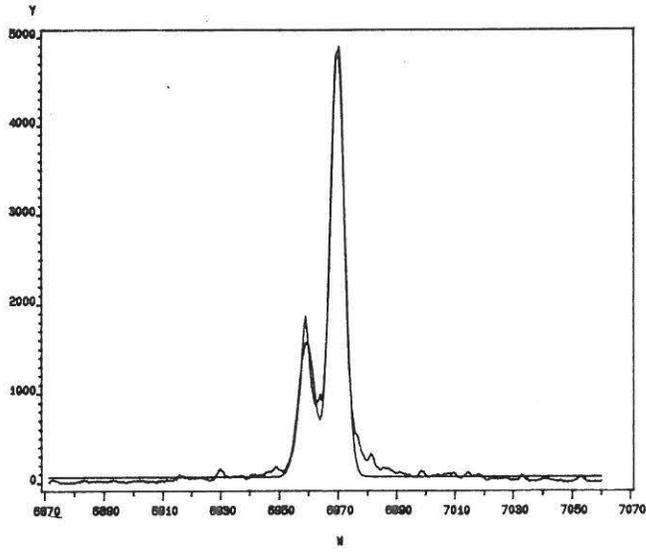
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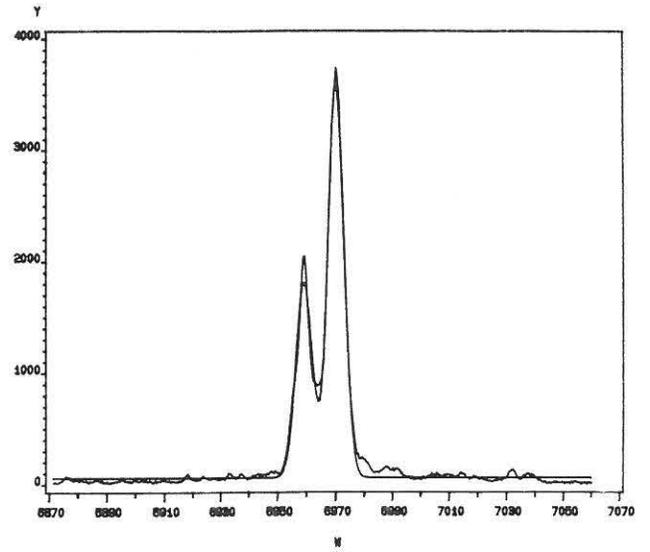
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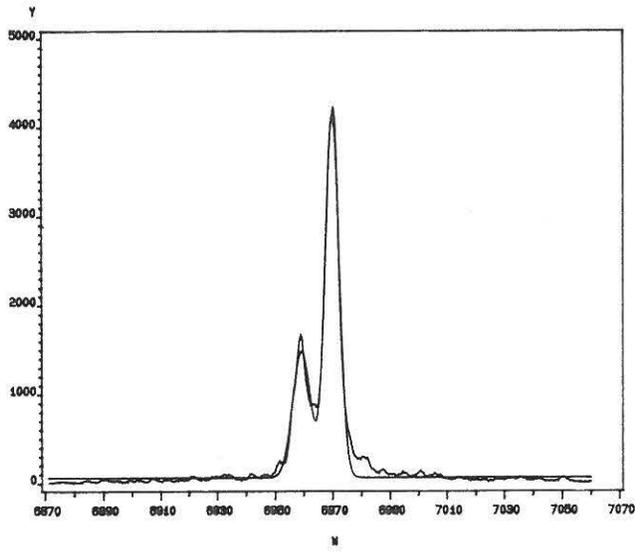
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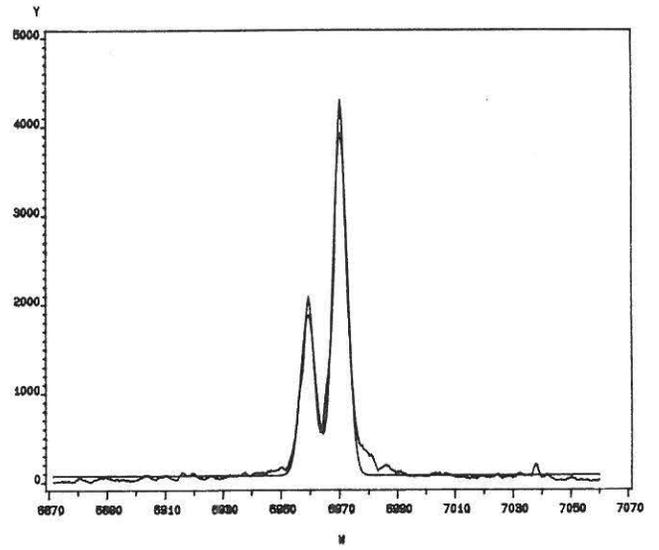
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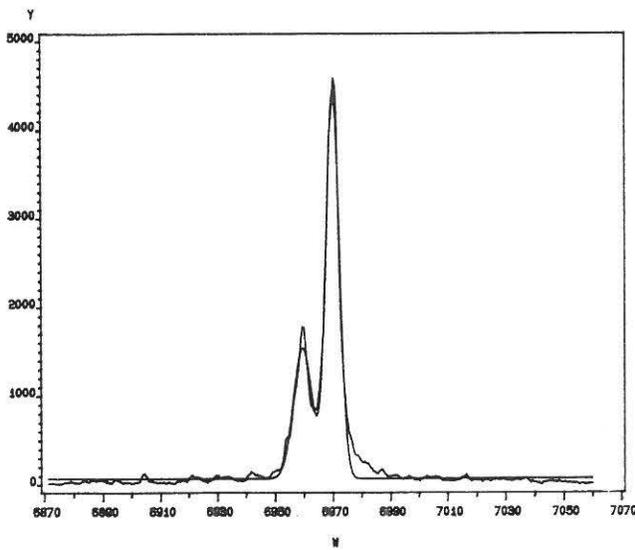
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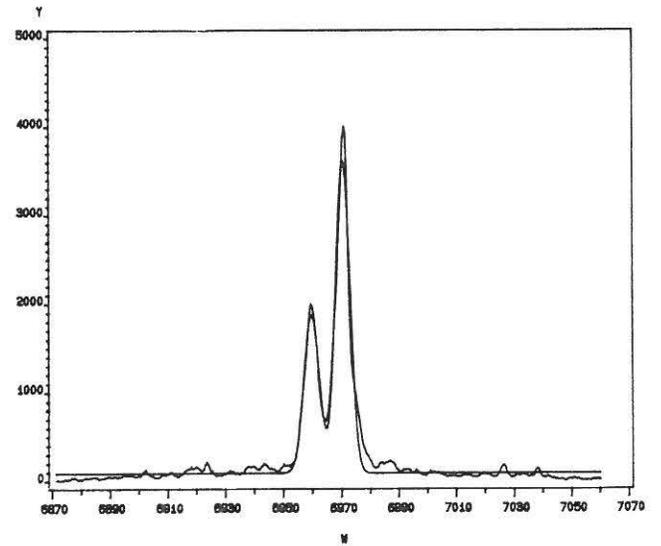
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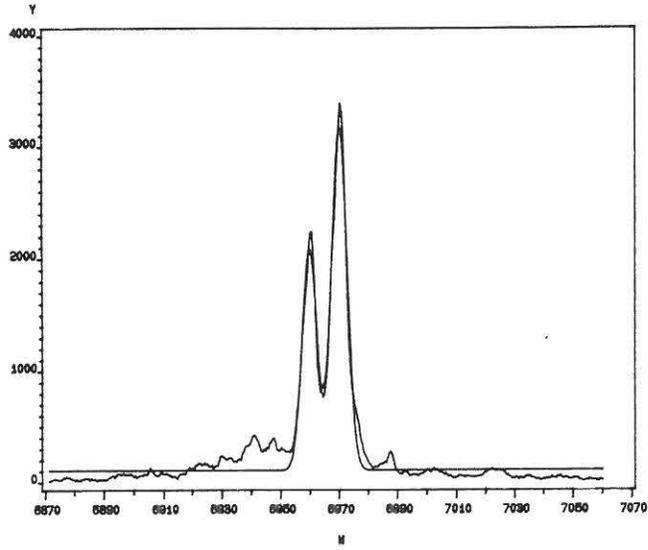
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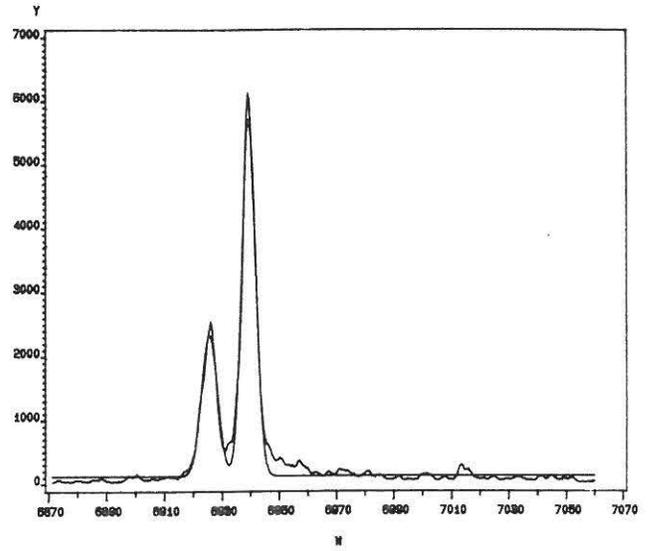
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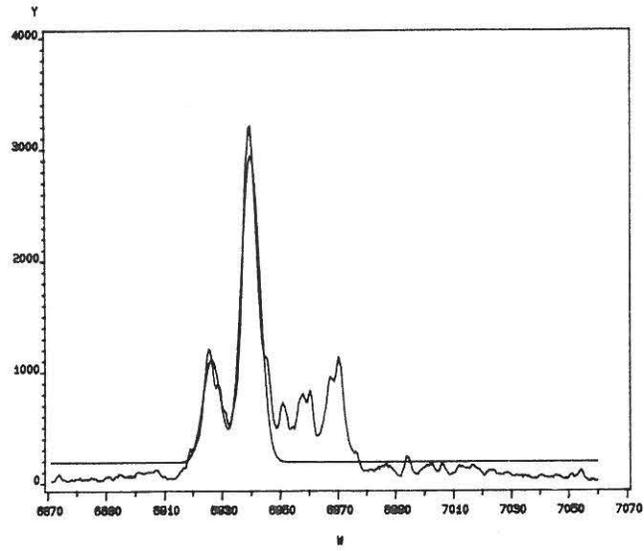
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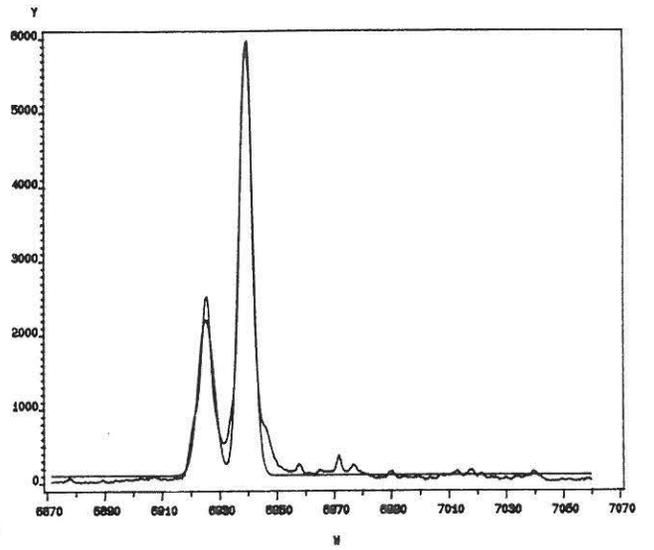
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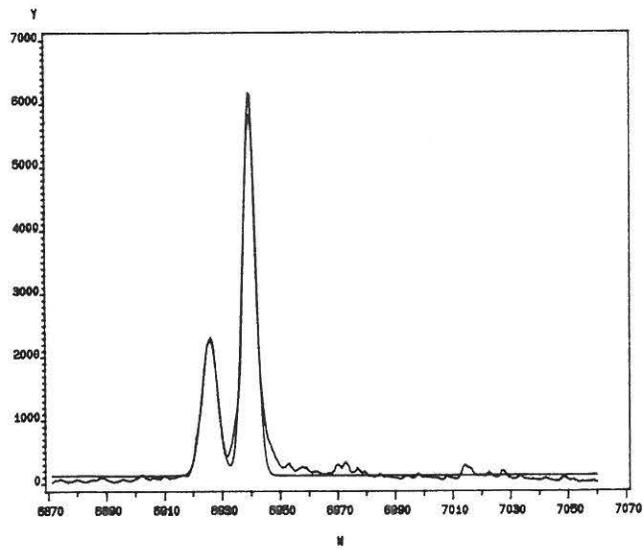
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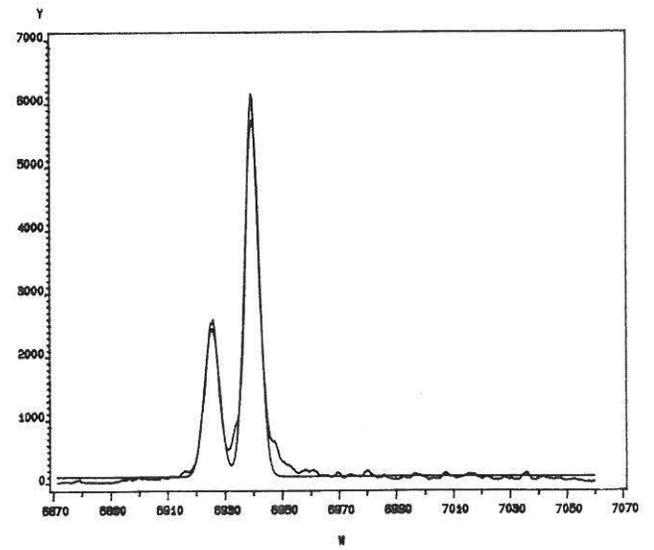
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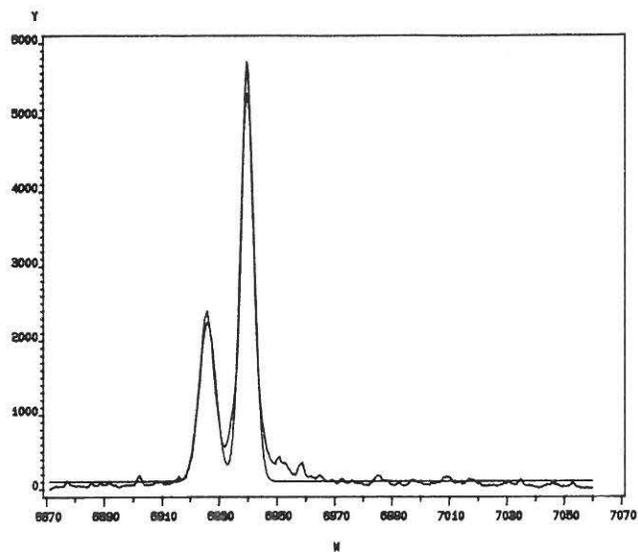
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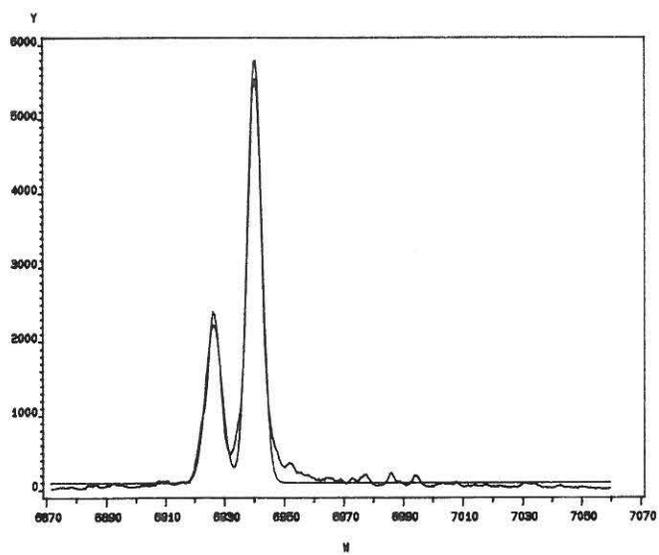
SAS



SAS



SAS



```
CMS COPY 6PIC LOOK A 6PIC INPUT A;
CMS FILEDEF HPOUT DISK OUTPUT PIC A (DISP MOD;
GOPTIONS NOTEXT82 DEVICE=HP7550 SPEED=10 GPROTOCOL=GSAS7171
NODISPLAY NOPROMPT NOBORDER HANDSHAKE=NONE
PENMOUNTS=1 SPEED=10 COLORS=(BLACK) GSFNAME=HPOUT
GSFMODE=APPEND ROTATE;
```

```
%MACRO PIC;
```

```
%DO I=1 %TO 5;
```

```
PROC GREPLAY NOFS;
```

```
IGOUT=INPUT.PIC;
```

```
DEVICE=HP7550A;
```

```
TC=SASTMP.MYTMP;
```

```
*****;
```

```
TEMPLATE=L3R3;
```

```
TREPLAY 1:1 2:2 3:3 4:4 5:5 6:6;
```

```
DELETE 1 2 3 4 5 6;
```

```
*TREPLAY 1:1 2:2 3:3 4:10 5:11 6:12;
```

```
*TREPLAY 1:10 2:11 3:12 4:1 5:2 6:3 ;
```

```
*DELETE 1 2 3;
```

```
*****;
```

```
*TEMPLATE=T1B1;
```

```
*TREPLAY 1:1 2:2;
```

```
*DELETE 1 2;
```

```
%END;
```

```
%MEND PIC;
```

```
%PIC;
```

```
CMS ERASE 6PIC INPUT A;
```

```

CMS FILEDEF YOU DISK S90031 RESULT A;
*GOPTIONS NOTEXT82 GPROTOCOL=GSAS7171; *DEVICE=TEK4010;
*/HP7550 PLOTTER GOPTIONS AND FILEDEF/*;
S FILEDEF HPOUT DISK LSHIFT PIC A;
GOPTION NOTEXT82 DEVICE=HP7470 SPEED=40 GPROTOCOL=GSAS7171
NODISPLAY NOPROMPT
HANDSHAKE=NONE
PENMOUNTS=1
SPEED=10
COLORS=(BLACK)
GSFNAME=HPOUT
GSFMODE=REPLACE;

```

```

DATA NOTES;
LENGTH FUNCTION $ 8 TEXT $ 20 POSITION $ 1;
FUNCTION='LABEL';
XSYS='2'; YSYS='2';
X=100; Y=6990.0;
SIZE=1.3;
POSITION='6';
TEXT='a-axis';
OUTPUT;
X=100; Y=6985.0;
SIZE=1.3;
POSITION='6';
TEXT='168 kbar';
OUTPUT;

```

```

DATA ALL;
INFILE YOU MISSEVER;
* INPUT X R1 R2 W1 W2 H1 H2;
* T= X*20;
INPUT X R1 A1 D1 D2 B ERR;
T= X*50-100;
* DR1=R1-6938.16;
* DR2=R2-6924.40;
* MEAN=(R1+R2)/2;
PROC SORT;
BY T;
PROC GPLOT DATA = ALL GOUT=SHIFT.PIC;
SYMBOL1 H=2.0 C=RED F=SPECIAL V=J I=NONE;
SYMBOL2 H=2.0 C=RED F=SPECIAL V=K I=NONE;
SYMBOL3 H=1.5 C=RED V=PLUS I=NONE;
TITLE1 F=DUPLEX ' ';
PLOT R1*T / OVERLAY FRAME
ANNOTATE=NOTES VAXIS=AXIS2 HAXIS=AXIS1;
* PLOT R*T / OVERLAY FRAME;
AXIS1 VALUE=(H=1.8 C=GREEN F=DUPLEX)
ORDER=( 0 TO 1200 BY 400)
MAJOR=(H=-1)
MINOR=NONE
LENGTH=7 IN
LABEL=(A=0 H=1.8 F=DUPLEX 'TIME (ns)');
* LABEL=NONE;
AXIS2 VALUE=(H=1.8 C=GREEN F=DUPLEX)
ORDER=(5520 TO 5600 BY 20)
MAJOR=(H=-1)

```

```
MINOR=NONE
LENGTH=4.5 IN
LABEL=(A=90 H=1.8 F=DUPLEX 'WAVELENGTH (A)');
LABEL=NONE;
NOTE M=(4.2,0.1)
IN A=0 H=2.0 F=DUPLEX 'TIME (ns)';
* NOTE M=(0.4,3.1) IN A=90 H=2.0
F=DUPLEX 'R' H=1.5 M=(+1,-0) '1' H=2.0 M=(-1,+0) '(A)';
```

