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X-Y SPACIAL DISTRIBUTION EXPERIMENTS WITH PARMELA
or, What I Did on my Summer Vacation*

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Abstract: Experiments using the Parmela simulation program predict that the potentially uneven spacial distributions in the electron beam generated by laser emission from the photo cathode gun has no appreciable effect on the beam outcome when compared to the more uniform thermionic gun.

The first step in making comparisons is to establish a proper reference. This required learning the Parmela system and becoming adept at running it using a variety of standard inputs. While I was learning the system, the actual magnetic fields of the optics following the photo cathode gun were measured. This gave me the opportunity to tune the parmela input to more closely approximate the working magnetic fields (see figure 1). Using Roger Miller's procedure, I created theoretical bucking coils to cancel stray fields which are in reality eliminated by steel mirrors. These bucking fields are located on either side of the Helmholtz coils in the position of the two lenses (see figure 2). These bucking fields are directly proportional to the Helmholtz coils and can be adjusted in proportion to the amount the coils are altered. A third, smaller bucking field is established across the second and third lenses to cancel stray fields from the sub-harmonic buncher. This coil collection is independent of the Helmholtz fields and so does not need to be altered unless the bunching fields are themselves changed.

Once I established appropriate lens currents to successfully run existing standard inputs, I created a reference run. All other runs would use the same parameters except for their spacial distributions. The reference run was a Parmela-generated gaussian random in X and Y but non-random in Z. It was later suggested that X and Y should be non-random as well, since a collection of 10exp11 particles is a very uniform gaussian while 999 particles makes for an irregular curve. After finishing the primary work, I found a way to generate distributions that are non-random in X, Y and Z. I have included such a run, called Second Standard, along with the reference for making comparisons to the other runs. As predicted, the random X and Y run was in no way discernably different from the equivalent non-random X and Y run in particle density or emmitance.

By contrast, the Parmela program seems to be highly sensitive to randomness in the longitudinal, Z distribution. A randomly formed gaussian in Z begins with high and low density areas which quickly become exaggerated by the effects of space-charge until the program crashes (see figure 3). Thus, all Z distributions are non-random gaussians. The Z distribution I used in the first reference is much taller and narrower than that created by Parmela (see figure 4) as they were generated differently. This difference expresses itself as a stronger space-charge spreading and probably accounts for some of the slight loss of particles and most of the change of emittance

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by the end of the run. By comparing the emittance of the reference run and the second standard run (see table 2) which vary primarily by the shape of the Z gaussian (that is sigma Z), it is easy to see just how sensitive Parmela is to Z distributions. Because the run called Second Standard uses the same Z distribution as the other runs (sigma Z = 15.6 cm with a curve width of two sigmas), I have decided to use it as my primary comparison.

Another quality to be considered when comparing runs to a standard is the timing. Often when the spacial distribution or the energy was changed, the relative timing would change, sometimes by considerable amounts. Timing has to be monitored whenever changing the input and usually adjusted to bring it close to the reference timing. This is done by making a run, determining the phase difference and estimating by trial and error (the effect is not generally linear) how much to change it by. The change is made on the "start" card of the parmela input in the first value (the clock starting phase).

Once longitudinal distribution and phase are properly accounted for, the user can vary the X-Y makeup. I did this in three ways. The first distribution I used was a random double gaussian across the X axis. This can be represented by a histogram lego plot in figure 5. I also created a double gaussian across the Y axis (that is, rotated by 90 degrees) for comparison. There was no essential difference between these except for the minor assymetry beyond the bend magnet. The next variation I tried was a symetric volcano shape with a peak in the center (see figure 6). The last run used a similiar volcano shape but with a rim that varied sinusoidally (see figure 7). This last distribution best represents the intensity distribution measured for the laser destined to be the photo cathode source (see figure 8). These three distributions, along with the reference can be compared in figure 9. A lego plot of the Second Standard is seen in figure 17.

The spacial distributions of the three variations at the end of their runs compare very favorably with that of the reference beam. The end of the run corresponds here to element #37, 420 cm from the cathode, past the first and second sub-harmonic and s-band bunchers. These results are illustrated in figures 10, 11 and 18. Apparently, the X and Y distribution and the Z bunching for each of the runs is virtually the same and the total number of particles that completed a given run varied by less than 2% for either standard (see table 1).

TABLE 1

RUN NAME	# OF GOOD PARTICLES	MAX # IN 20 BAND
REFERENCE	981	737
2ND STANDARD	977	758
DOUBLE X	973	740
VOLCANO	970	726
VOLCANO2	963	731

The greatest differences between these runs were the emittances. Tables of the X and Y emittances for the runs are found in figures 12 and 13, the Z emittances are found in figures 14 and 15 and the X, Y and Z emittances for the second standard are found in figure 16. Table 2 lists the emittances for each run after the last (37th) element and the percent difference from the second standard value:

TABLE 2

RUN NAME	RMS X	E MAX X,90%	E MAX X,100%	RMS Y	E MAX Y,90%	E MAX Y,100%	RMSZ X10	Z,90% X10	Z,100% X10
REFERENCE	6.79	36.2	180	7.61	39.2	205	114	560	7770
2ND STAND	8.05	40.3	184	8.54	43.9	234	114	562	7440
DOUBLE X	7.25	38.8	192	7.96	41.1	180	98.5	483	8810
% DIF	-11%	-3.1%	4.2%	-7.3%	-6.8%	-30%	-16%	-16%	18%
VOLCANO	8.02	39.0	221	8.30	39.1	254	121	568	8310
% DIF	-0.3%	-3.3%	23%	-2.9%	-12%	7.9%	5.8%	-1.1%	10%
VOLCANO2	8.79	44.2	251	8.25	41.7	320	109	505	8760
% DIF	8.4%	8.8%	36%	-3.5%	-5.3%	27%	-4.5%	-11%	17%

After running the preceding set of experiments, I repeated the runs with data sets that are all non-random in X and Y and use a more realistic non-random Z gaussian. This Z distribution used a sigma of 19.5 cm, formed across 1.60 sigmas. They have similiar shapes (see figure 19) as the previous runs and the names differ by an added "G" at the end. Table 3 represents the number of particles that completed the 410 cm run and the concentration in the largest 20 degree band (see figures 20-23):

TABLE 3

RUN NAME	# OF GOOD PARTICLES	MAX # IN 20 BAND
2ND STANDARD G	981	806
DOUBLE X G	977	801
VOLCANO G	976	709
VOLCANO2 G	982	800

Table 4 lists the emittances for each run after the last (37th) element and the percent difference from the Second Standard G value:

TABLE 4

RUN NAME	RMS X	E MAX X,90%	E MAX X,100%	RMS Y	E MAX Y,90%	E MAX Y,100%	RMSZ X10	Z,90% X10	Z,100% X10
2ND STND G	7.84	40.8	187	7.48	37.9	143	90.0	510	7320
DOUBLE X G	7.66	38.8	136	7.23	36.4	236	94.1	508	7440
% DIF	-2.3%	-5.2%	-38%	-3.5%	-4.1%	65%	4.4%	-0.4%	1.6%
VOLCANO G	8.16	39.3	167	8.97	43.0	227	89.4	495	7720
% DIF	3.9%	-3.8%	-12%	17%	12%	37%	-0.7%	-3.0%	5.2%
VOLCANO2 G	8.00	39.6	313	8.07	39.5	366	114	586	7970
% DIF	2.0%	-3.0%	67%	7.4%	4.1%	156%	21%	13%	7.2%

I conclude from this data, to the degree that Parmela is faithful to reality, irregular X-Y spacial distributions of particles will not run noticeably differently from true gaussian distributions. However, It should be noted that Parmela calculates the space-charge effects for each particle as though they were axially-symetric rings. This means the program automatically ignores X-Y spacial irregularities in the space-charge calculations. It is very possible that the high degree of precision in these results is due in large part to this programming simplification (where it was assumed that only regular spacial gaussians could be formed). The only ways to be certain are to run the same sets of inputs on a similar program that treats the particles as point charges or to wait for the photo cathode gun to come on line and compare the distribution patterns to the outcomes. All the same, I found this project very worthwhile and challenging.

Special Thanks to: Roger Miller, Ted Lavine, Barbara Woo, Tom Knight, Tor Raubenheimer, Bill Gabella, Mina Petradza and Margie Bangali.

DISCLAIMER

APPENDIX 1

The smallest spacial constrictions used in the Parmela simulation have radius of 1.40 cm and are found in elements 3, 4, 6 and 7. These elements correspond to, respectively: the start of the Helmholtz coil (40.7cm), the end of the Helmholtz (66.7cm), the second lens (93.7cm) and the end of the bend magnet (102.7cm). The following table shows the X or Y spacial limits of the beam in these four elements. It does not account for the radial limits off the X and Y axes, but it gives a good sense of the general beam size (all measurements in centimeters).

RUN NAME	ELEMENT 3	ELEMENT 4	ELEMENT 6	ELEMENT 7
REFERENCE	0.65	0.60	0.80	0.70
2ND STANDARD	0.70	0.70	0.80	0.85
DOUBLE-X	0.75	0.50	0.80	0.85
VOLCANO	0.75	0.55	0.80	1.00
VOLCANO2	0.80	0.55	0.85	1.00
2ND STAND G	0.70	0.70	0.75	0.80
DOUBLE-X G	0.70	0.55	0.80	0.75
VOLCANO G	0.75	0.50	0.75	0.75
VOLCANO2 G	0.70	0.50	0.75	0.80

Calc vs Meas For L390, S390, S396, S400

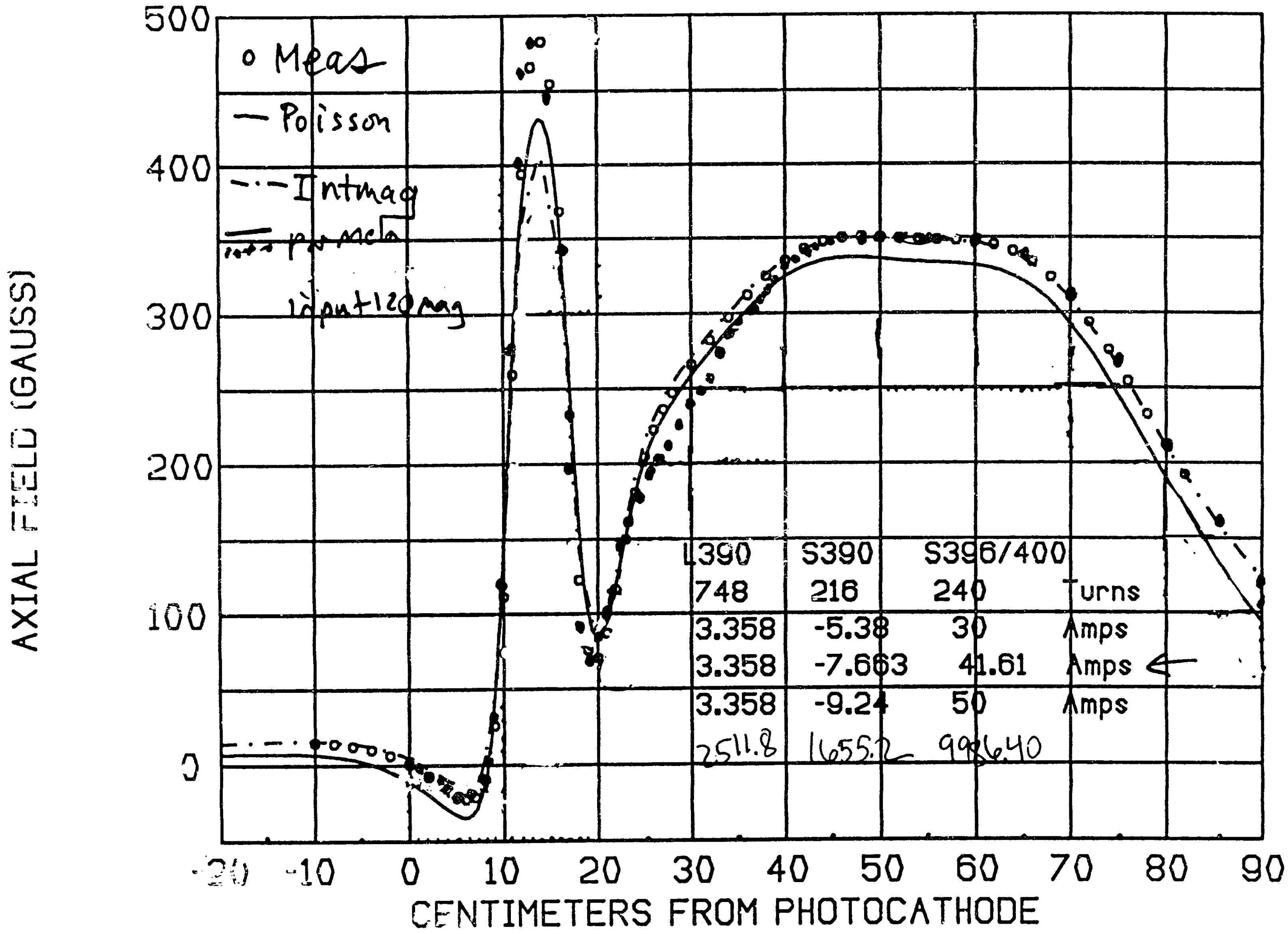


Figure 1

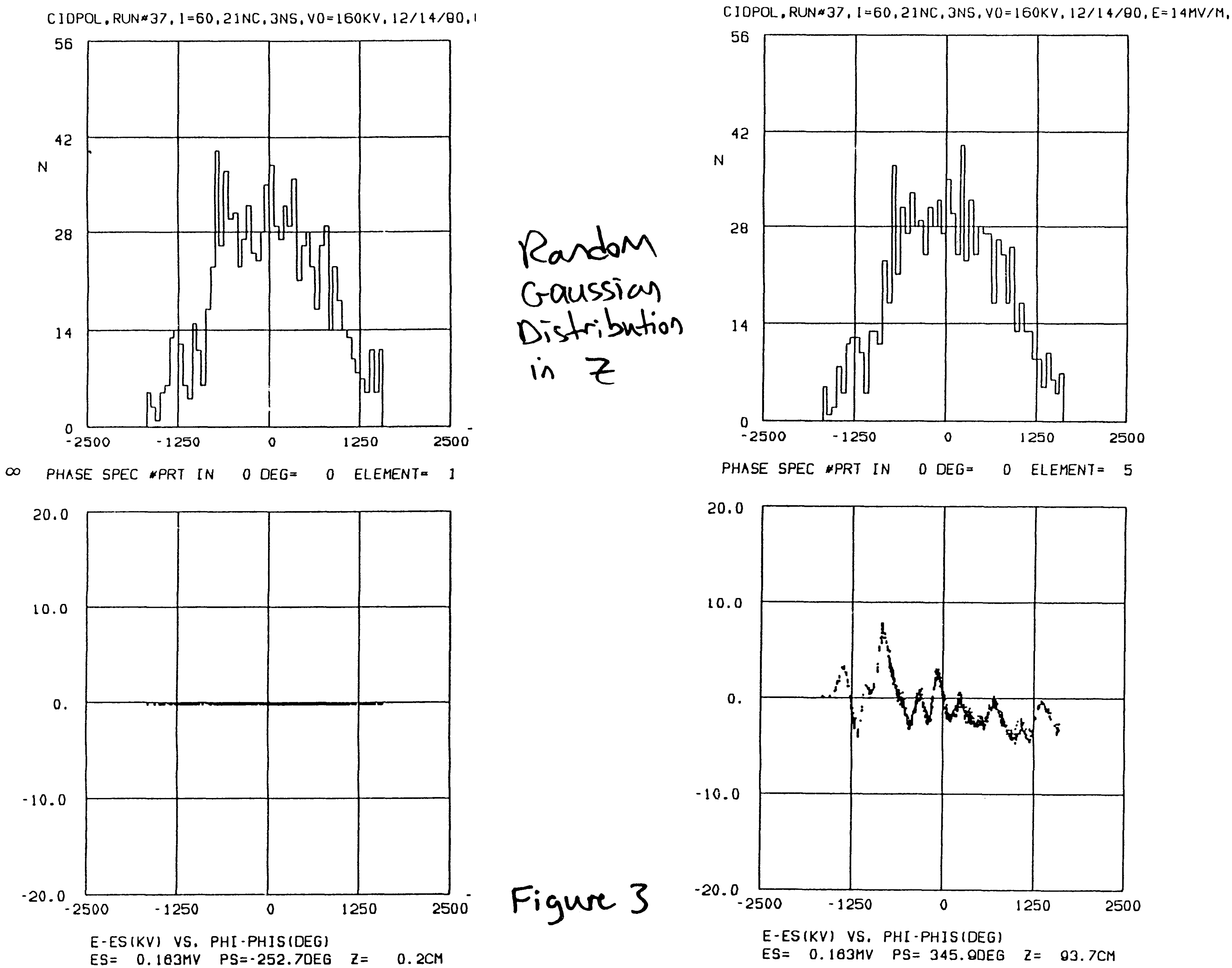
Parmela Input without lenses or bending magnets

```
coil  -7     4     -20    0 500
coil  -3     4     -75
coil   1     4     -110
coil   5     4     -280
coil   9     4     -245         bucking
coil  13     4     -230         coil
coil  17     4     -320
coil  19     4     -190
coil   9.9   2.54  0

PARMELA  INPUT    A1     Dated 07/15/91 12:20:17   From disk JRH192     Page  2

coil  11.1   2.54   0
coil  12.4   2.54   0
coil  13.7   2.54   0 ← 1st Lens
coil  15.0   2.54   0
coil  16.3   2.54   0
coil  17.5   2.54  0
coil  40.7   25.0   8000  } Helmholtz coils
coil  66.7   25.0   8000
coil  89.9   2.54  0
coil  91.1   2.54   0
coil  92.4   2.54   0
coil  93.7   2.54   0 ← 2nd lens
coil  95.0   2.54   0
coil  96.3   2.54   0
coil  97.5   2.54  0
coil  90     4     -320
coil  94     4     -290
coil  98     4     -195       Helmholtz
coil 102     4     -155       bucking
coil 106     4     -127
coil 110     4     -100
coil 114     4     -90
coil 118     4     -67
coil 122     4     -70
coil 126     4     -50
coil 119.9   2.54  0
coil 121.1   2.54   0
coil 122.4   2.54   0
coil 123.7   2.54   0 ← 3rd lens
coil 125.0   2.54   0
coil 126.3   2.54   0
coil 127.5   2.54  0
coil 88      4.4   -5
coil 92      4.4   -10       bunching coil
coil 96      4.4   -10       bucking
coil 100     4.4   -10
coil 104     4.4   -10
coil 108     4.4   -12
coil 112     4.4   -15
coil 116     4.4   -20
coil 120     4.4   -30
coil 124     4.4   -50
coil 128     4.4   -75
```

Figure 2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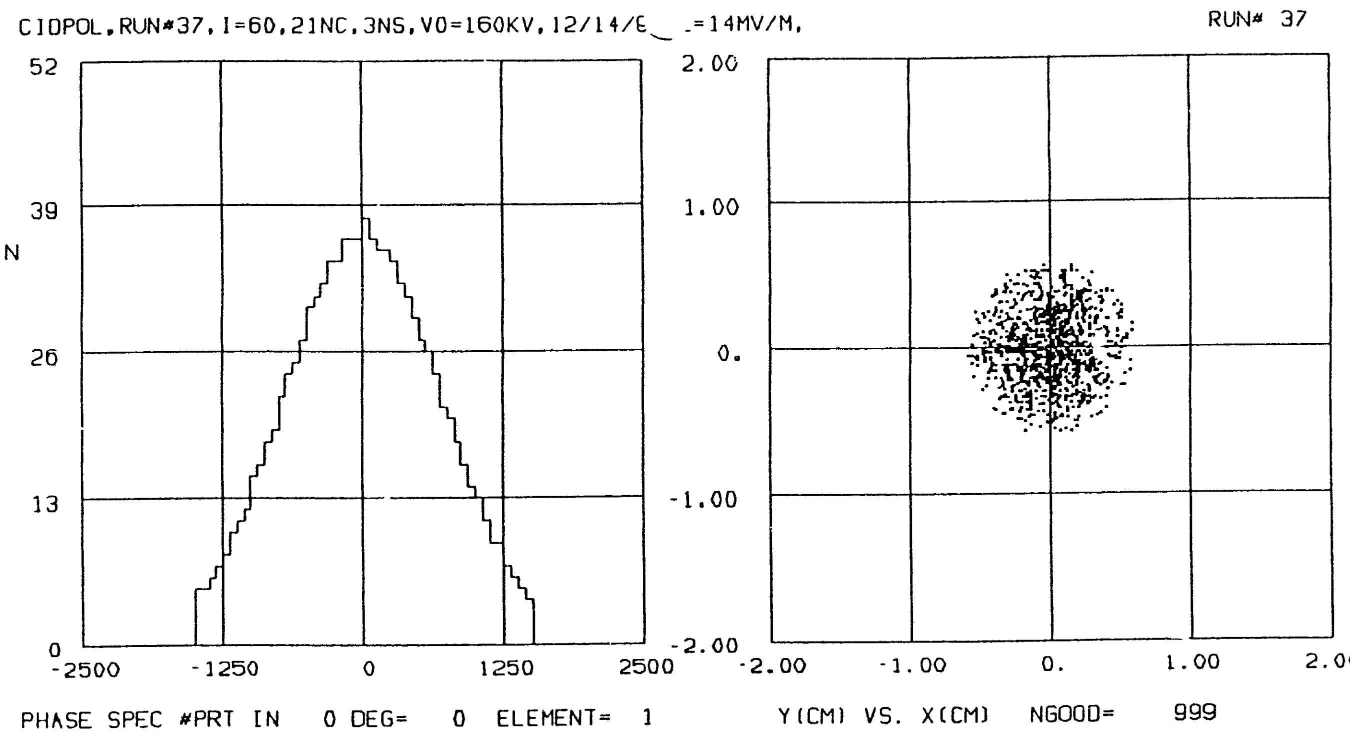
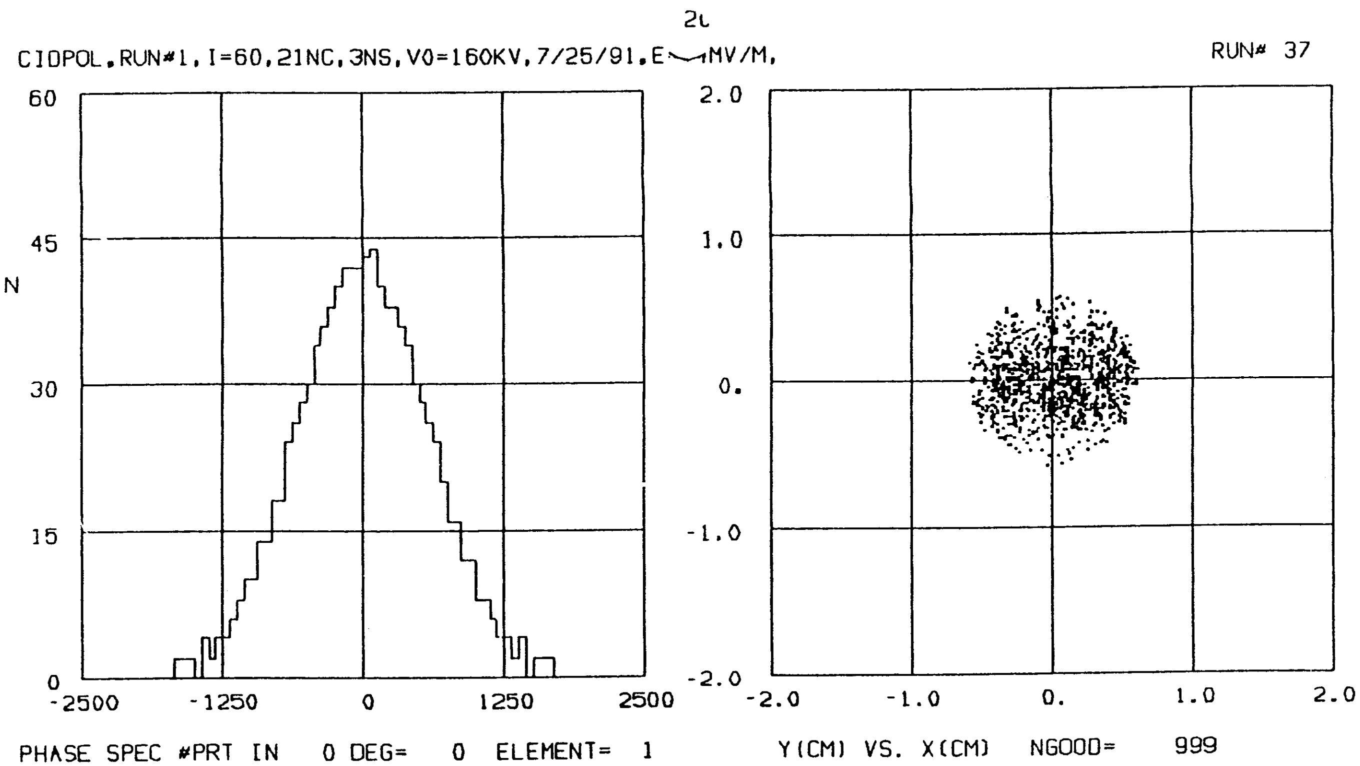
56
42
N
28
14
0
-2500
-1250
0
1250
2500
∞ PHASE SPEC #PRT IN 0 DEG= 0 ELEMENT= 1
20.0
10.0
0.
-10.0
-20.0
E-ES(KV) VS. PHI-PHIS(DEG)
ES= 0.183MV PS=-252.7DEG Z= 0.2CM
Random Gaussian Distribution in Z
CIDPOL,RUN#37,I=60,21NC,3NS,V0=160KV,12/14/80,E=14MV/M,
PHASE SPEC #PRT IN 0 DEG= 0 ELEMENT= 5
E-ES(KV) VS. PHI-PHIS(DEG)
ES= 0.183MV PS= 345.9DEG Z= 93.7CM

Figure 3



Parmela-created z distribution

, 2cm



File-created z distribution

Figure 4

Start

X-Y DISTRIBUTION

ID=SCT1

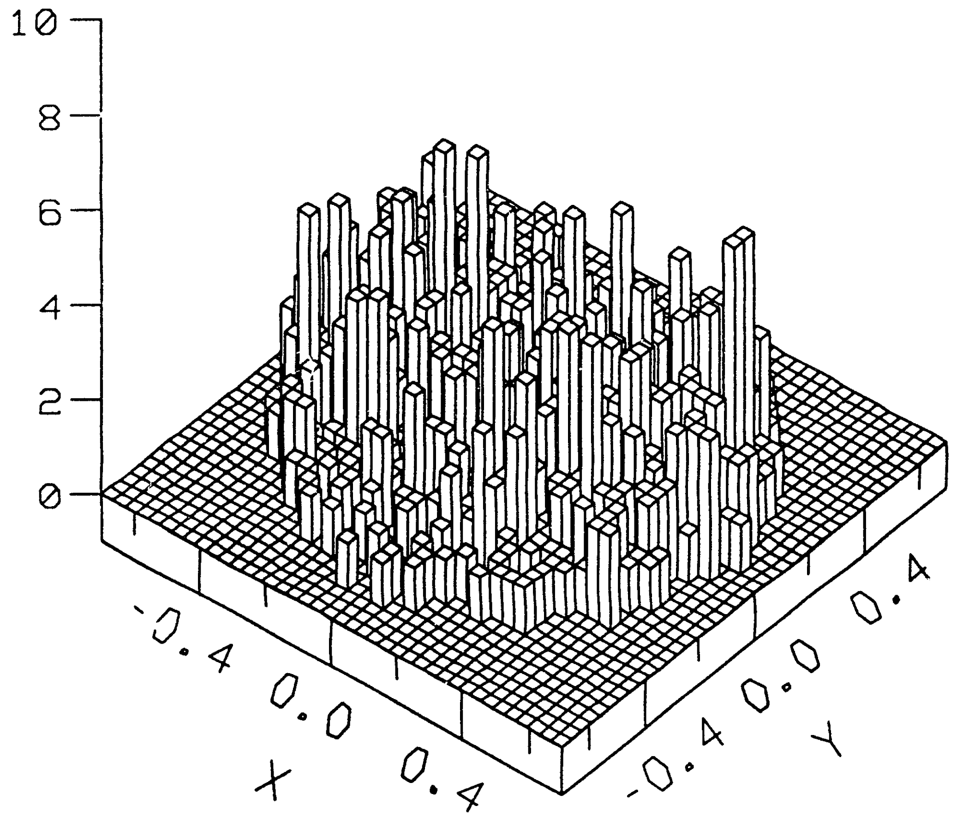


Figure 5

HANDYPAK JH014:36 2/

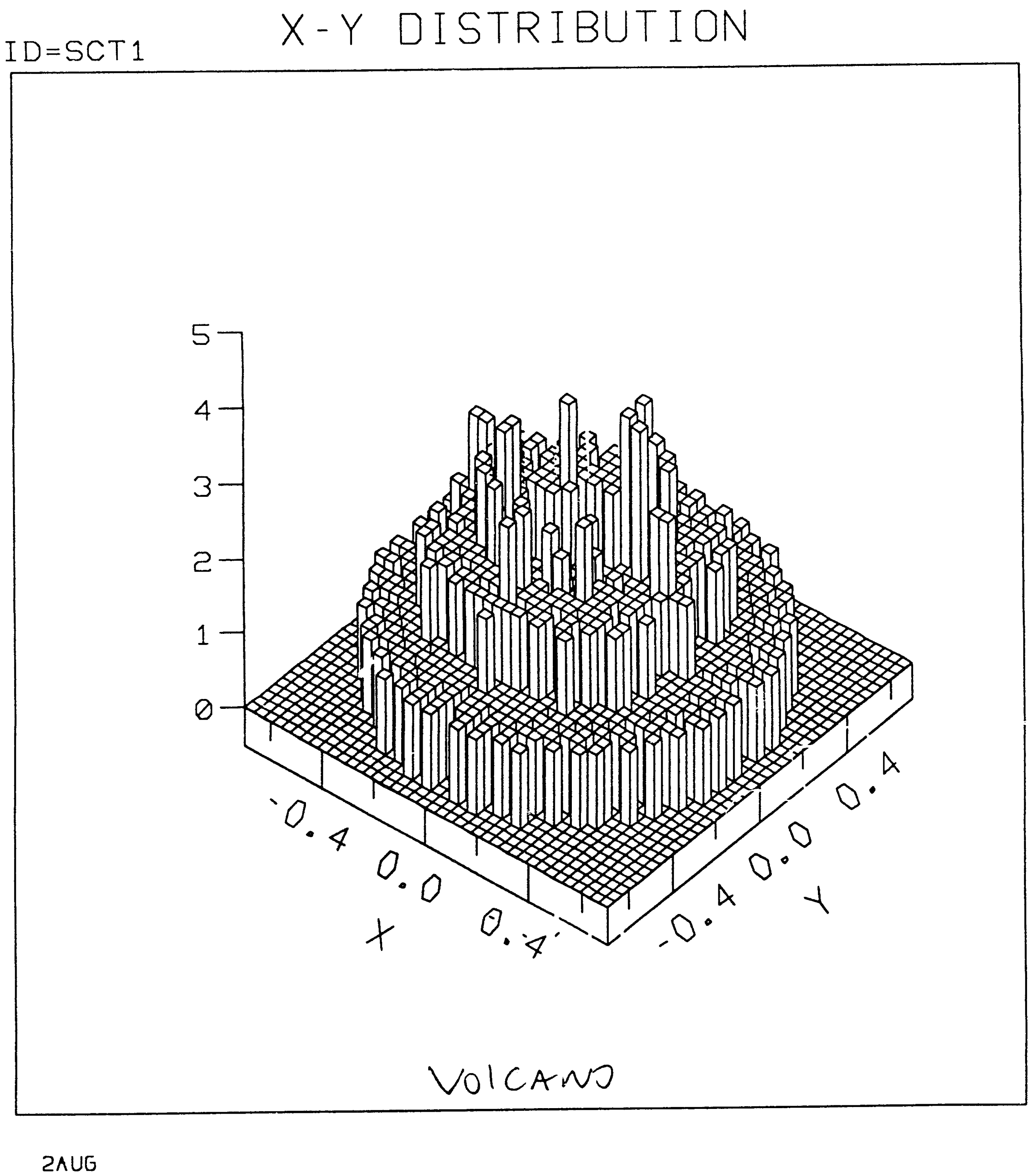

X-Y DISTRIBUTION
ID=SCT1
5
4
3
2
1
0
-0.4 0.0 0.4
X
-0.4 0.0 0.4
Y
VOLCANO
HANDYPAK JH013:08 2AUG

Figure 6

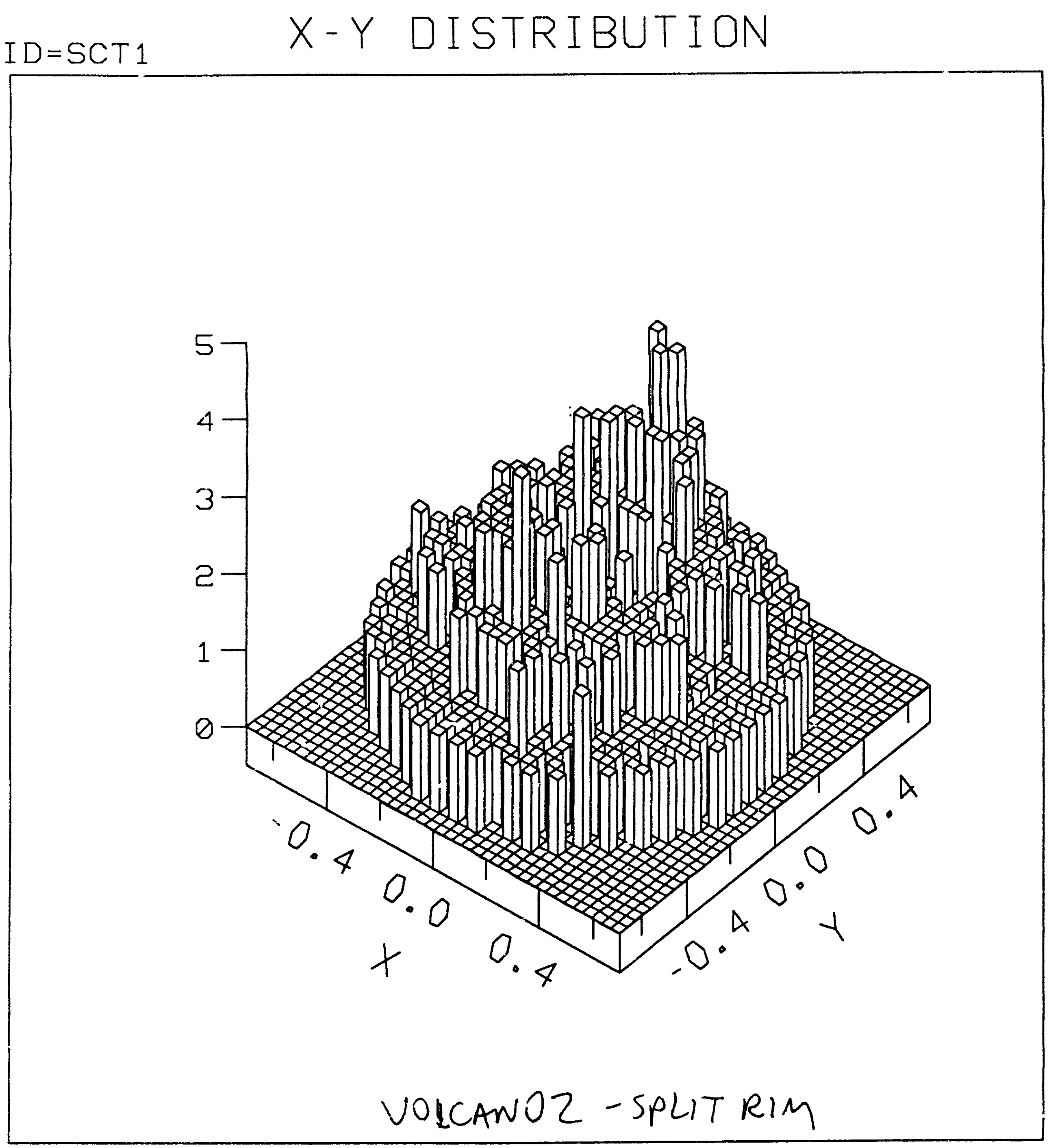


Figure 7

HANDYPAK JH013:33

Laser Intensity Plot

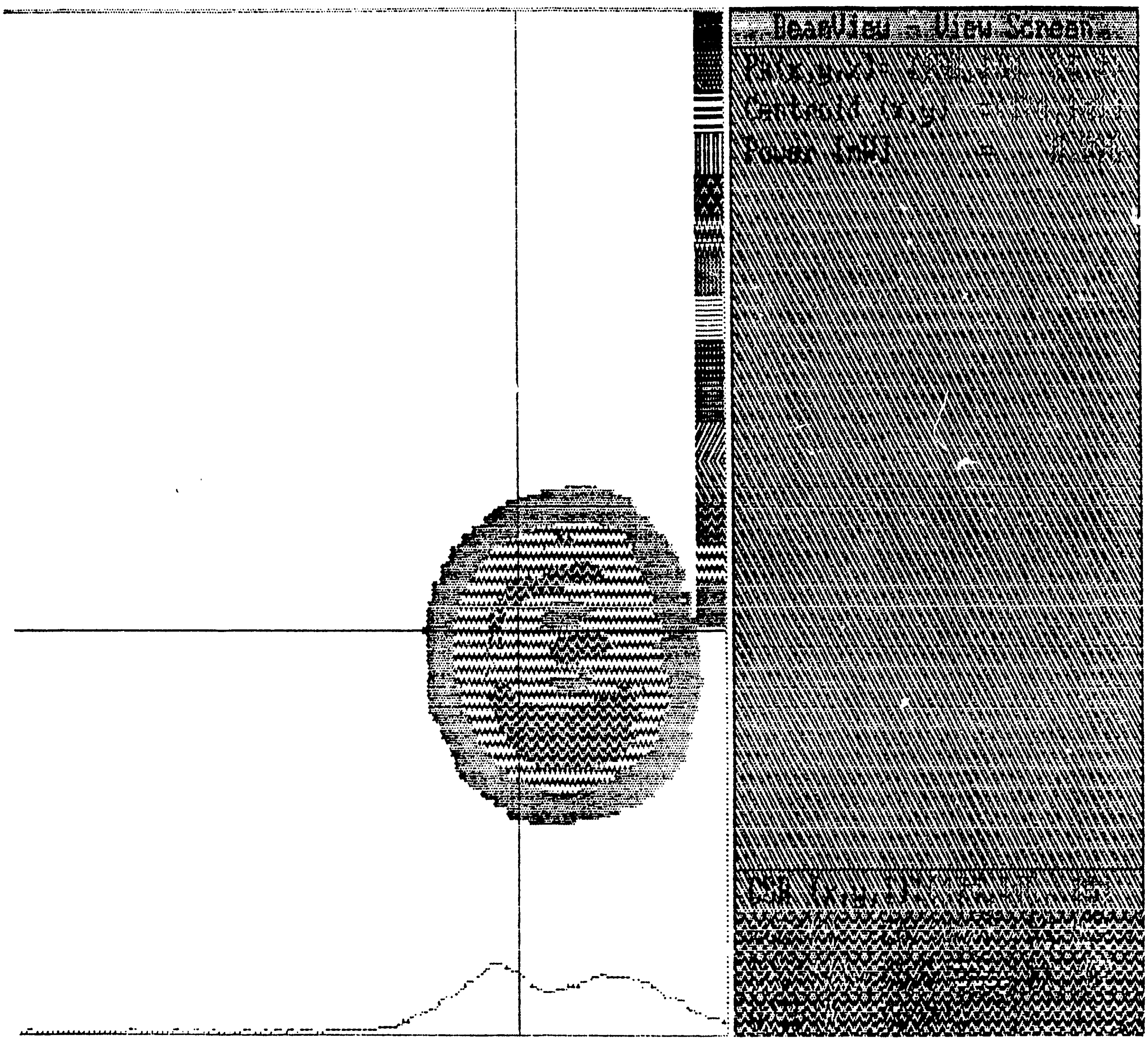


Figure 8

Initial X-Y distributions for the beam at 0.2 cm

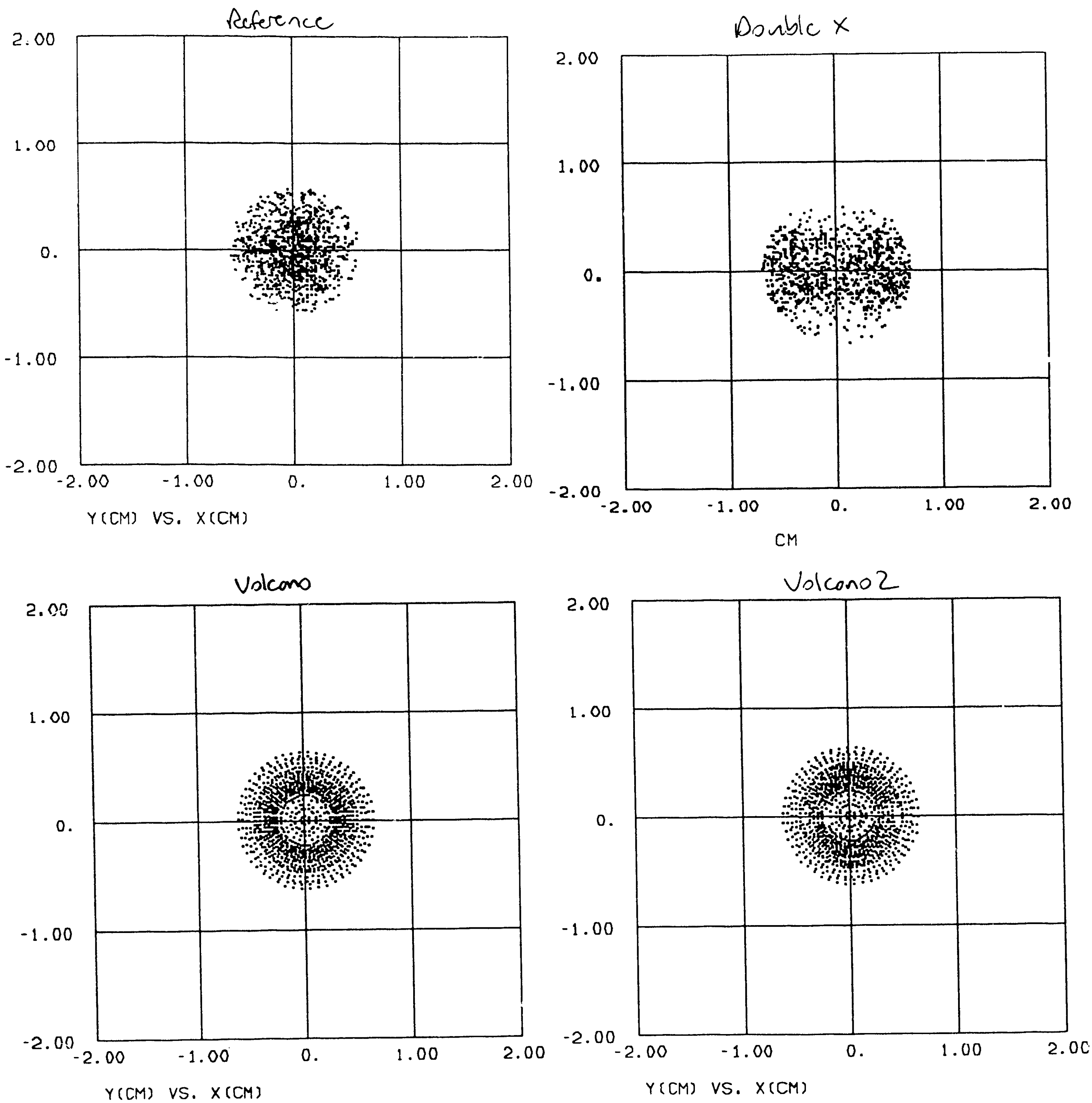
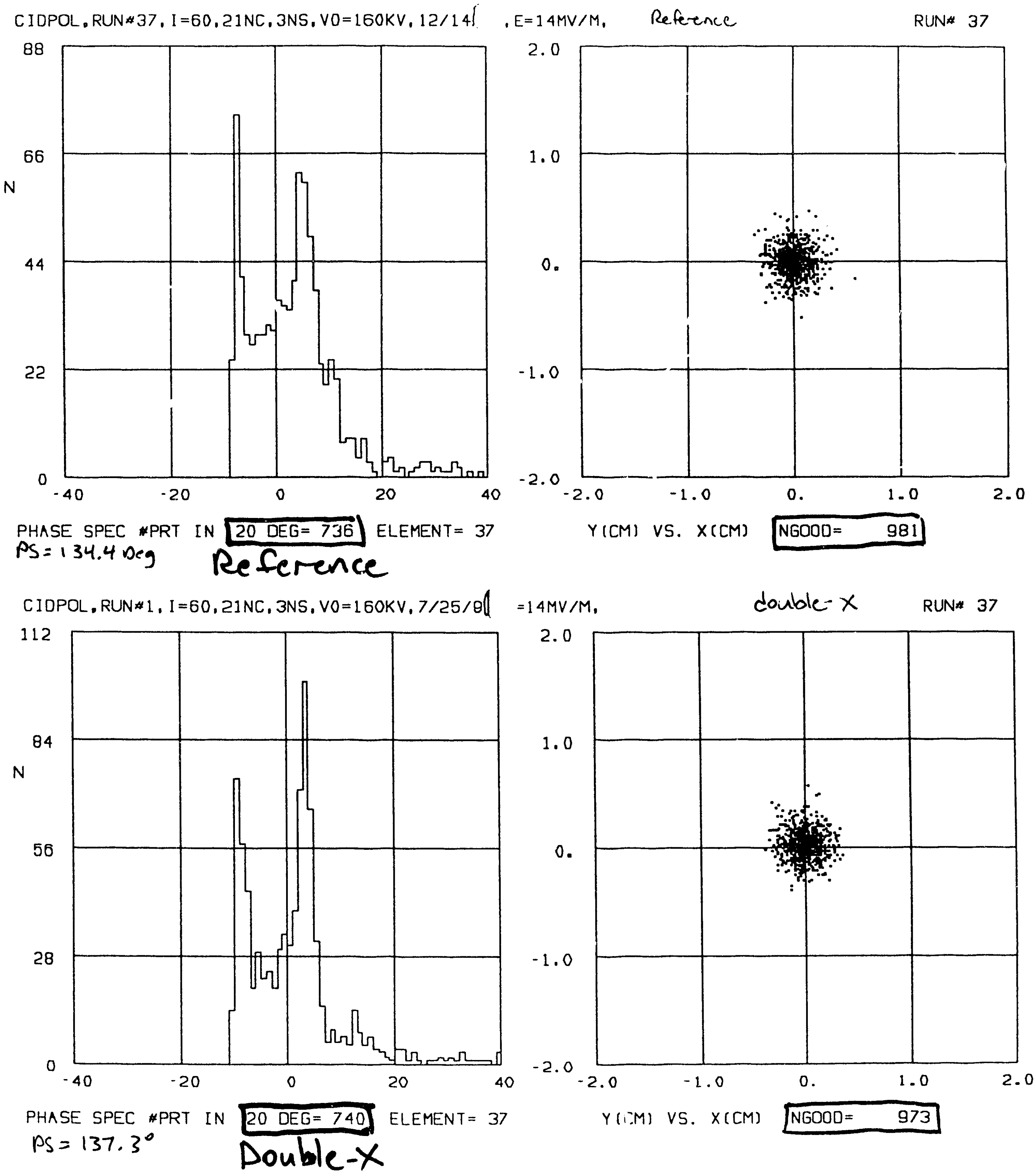


Figure 9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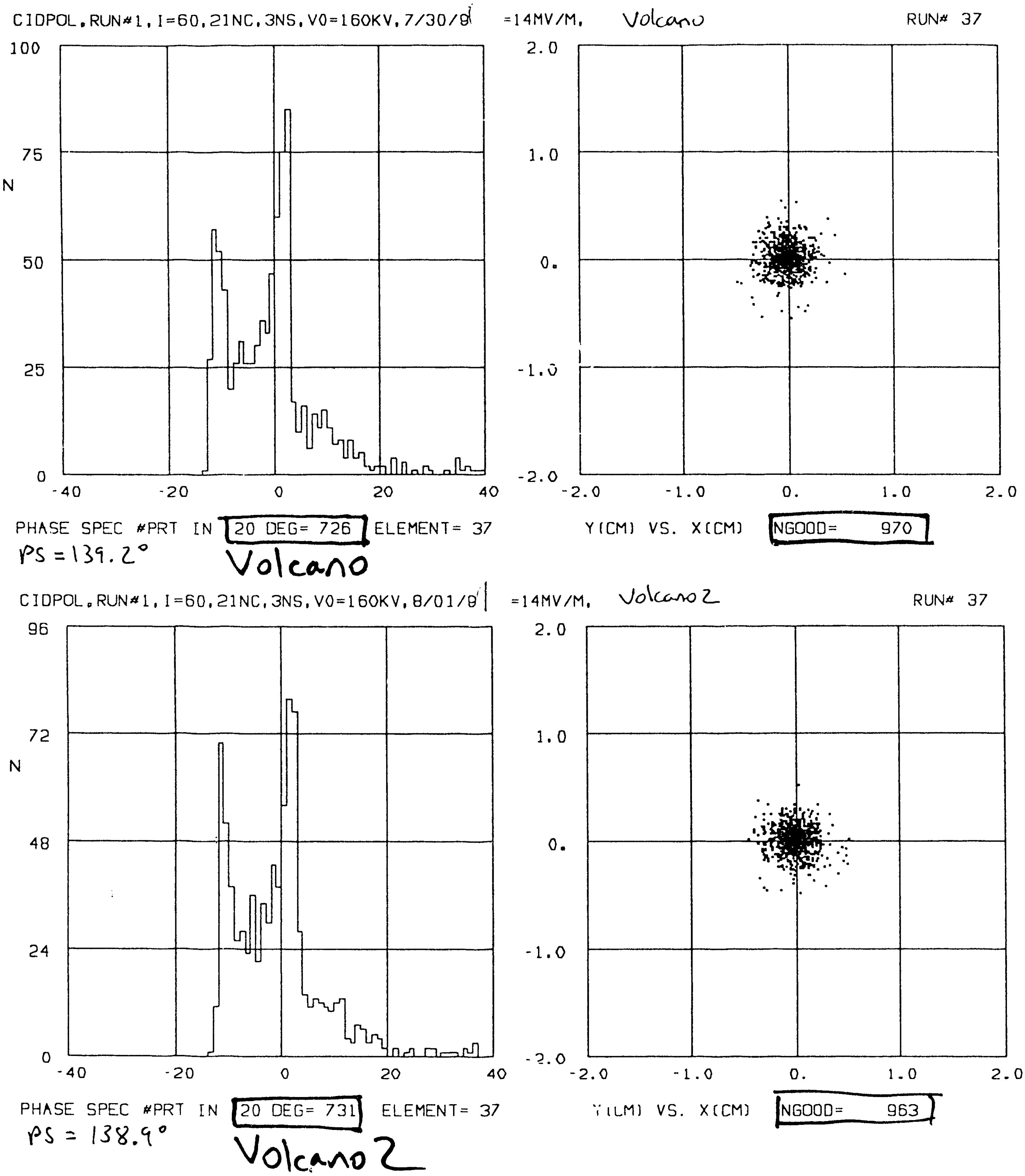
,E=14MV/M,
Reference
RUN# 37
N
PHASE SPEC #PRT IN 20 DEG= 736 ELEMENT= 37
PS= 134.4 Deg
Reference
Y(CM) VS. X(CM) NGOOD= 981
CIDPOL,RUN#1,I=60,21NC,3NS,V0=160KV,7/25/8
=14MV/M,
double-X
RUN# 37
N
PHASE SPEC #PRT IN 20 DEG= 740 ELEMENT= 37
PS= 137.3°
Double-X
Y(CM) VS. X(CM) NGOOD= 973

Figure 10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N
PHASE SPEC #PRT IN 20 DEG= 726 ELEMENT= 37
Y(CM) VS. X(CM) NGOOD= 970
PS = 139.2°
Volcano
CIDPOL, RUN#1, I=60, 21NC, 3NS, V0=160KV, 8/01/9 =14MV/M, Volcano 2 RUN# 37
N
PHASE SPEC #PRT IN 20 DEG= 731 ELEMENT= 37
Y(CM) VS. X(CM) NGOOD= 963
PS = 138.9°
Volcano 2

Figure 11

```
subnum 7
output 2 1  1  38
optcon 3 2.0 2  80 1 600 0 800 1
begin
```

Reference Emittance

CIDPOL,

NEL NO.	PART IN	PART OUT	RMS,N X CM_mr	EMAX,N X,90% CM_mr	EMAX,N X,100% CM_mr	RMS,N Y CM_mr	EMAX,N Y,90% CM_mr	EMAX,N Y,100% CM_mr	ALPHA X	BETA X CM	ALPHA Y	BETA Y CM
1	999	999	0.145	0.711	2.158	0.147	0.761	2.412	-0.9178	0.4063	-0.9152	0.4072
2	999	999	1.629	7.568	40.963	1.532	6.968	38.040	-0.3153	0.0826	-0.2796	0.0833
3	999	999	1.423	6.548	49.378	1.578	7.018	37.667	-0.2797	0.0407	-0.2886	0.0412
4	999	999	1.394	5.857	63.370	1.471	6.069	42.584	-0.0156	0.0240	0.0265	0.0230
4	999	4										
5	999	999	2.277	8.964	118.989	2.057	8.515	96.397	0.3116	0.0930	0.2211	0.0972
6	999	999	2.804	11.303	144.102	2.302	9.515	93.688	1.3051	0.0373	1.4189	0.0399
7	999	999	2.520	8.892	125.193	2.043	8.041	83.769	-0.0729	0.0230	-1.0247	0.0372
8	999	999	2.453	9.649	93.136	2.363	9.561	87.366	-0.1566	0.0442	-0.5083	0.0595
9	999	999	2.681	10.269	145.960	2.402	9.139	120.684	-1.5321	0.0601	-1.1303	0.0378
10	999	996	2.991	12.337	96.756	3.343	11.839	115.301	1.1364	0.0321	1.5793	0.0393
11	999	996	3.907	15.159	219.538	3.370	14.024	172.568	0.4553	0.0374	0.2349	0.0289
12	999	996	4.115	17.341	159.997	4.311	19.836	183.999	0.4813	0.0290	0.2101	0.0236
13	999	996	3.273	12.778	165.391	2.983	13.145	119.581	-0.3973	0.0206	-0.4114	0.0197
14	999	996	4.255	15.737	219.623	4.821	18.379	234.448	0.3710	0.0274	0.3569	0.0251
15	999	999	3.513	12.421	215.286	3.833	13.320	216.714	-0.3466	0.0212	-0.3248	0.0109
15	999	12										
16	999	999	4.278	16.729	184.751	3.874	14.005	166.808	0.2416	0.0172	0.4184	0.0181
16	999	5										
17	999	996	3.478	12.648	132.319	4.015	14.412	143.632	0.1427	0.0176	0.0692	0.0149
18	999	996	3.860	14.317	228.860	4.435	17.250	251.091	-0.3274	0.0160	-0.3542	0.0173
19	999	996	4.599	19.002	201.546	5.189	20.536	195.594	0.4215	0.0163	0.3611	0.0142
21	999	999	5.351	23.594	190.961	5.518	22.535	261.298	-0.0122	0.0041	0.1175	0.0037
20	999	996	4.770	18.432	179.163	4.782	19.667	144.275	0.0877	0.0044	0.1827	0.0039
21	999	15										
22	999	996	6.095	28.565	206.849	6.121	30.777	242.071	-0.1413	0.0034	-0.1017	0.0033
26	999	999	5.949	26.865	175.532	5.911	29.846	211.797	0.1646	0.0024	0.1431	0.0025
26	999	4										
27	999	999	6.260	31.248	193.000	6.171	28.873	312.846	-0.1230	0.0028	-0.1993	0.0029
26	999	1										
28	999	998	6.610	30.762	194.896	6.298	28.597	229.578	-0.1806	0.0029	-0.1460	0.0029
33	999	985	7.984	40.034	407.560	7.740	35.841	993.640	0.2007	0.0025	0.1841	0.0026
37	999	981	6.794	36.181	179.755	7.614	39.279	205.045	0.0305	0.0019	-0.0429	0.0019

```
subnum 7
output 2 1  1  38
optcon 3 2.0 2  80 1 600 0 800 1
begin
```

double X Emittance

CIDPOL,

NEL NO.	PART IN	PART OUT	RMS,N X CM_mr	EMAX,N X,90% CM_mr	EMAX,N X,100% CM_mr	RMS,N Y CM_mr	EMAX,N Y,90% CM_mr	EMAX,N Y,100% CM_mr	ALPHA X	BETA X CM	ALPHA Y	BETA Y CM
1	999	999	0.187	0.852	3.157	0.142	0.680	2.182	-0.9611	0.4967	-0.8659	0.3367
2	999	999	1.993	8.401	51.587	1.846	8.401	45.555	-0.1015	0.0910	-0.3337	0.0666
3	999	999	1.671	7.439	37.162	1.541	7.275	44.885	-0.5531	0.0492	-0.2455	0.0402
4	999	999	1.658	5.991	75.340	1.877	7.995	45.870	0.0545	0.0270	-0.0855	0.0170
5	999	999	2.893	12.558	122.424	2.818	9.775	136.162	0.1919	0.0743	0.3391	0.0912
6	999	999	2.924	12.102	135.171	3.719	13.656	132.258	1.0367	0.0324	1.2915	0.0347
7	999	999	2.639	10.653	101.633	3.018	10.536	103.362	-0.3040	0.0244	-0.9250	0.0349
8	999	999	2.098	8.271	113.053	3.024	13.126	114.679	-0.0803	0.0578	-0.3417	0.0655
9	999	999	3.469	12.483	212.783	3.166	13.437	135.848	-1.0378	0.0416	-0.9108	0.0324
10	999	990	2.692	11.746	98.130	3.625	13.841	170.963	1.7428	0.0482	1.5564	0.0419
11	999	990	3.348	12.967	236.193	4.021	16.138	263.999	0.1411	0.0398	0.1509	0.0310
12	999	990	3.889	15.072	271.249	4.689	19.898	243.777	0.2064	0.0319	0.1782	0.0266
13	999	990	2.946	12.434	104.947	2.684	10.470	83.628	-0.2568	0.0190	-0.1869	0.0212
14	999	990	5.106	18.848	320.696	3.869	13.314	351.854	0.2622	0.0281	0.2725	0.0351
15	999	990	3.385	12.501	253.190	3.591	12.359	223.956	-0.3646	0.0189	-0.3023	0.0192
16	999	990	4.003	16.404	155.636	4.205	14.453	168.841	0.4675	0.0185	0.4322	0.0193
17	999	990	3.620	12.500	158.129	3.282	11.938	180.383	0.2433	0.0164	0.2487	0.0170
18	999	998	4.180	13.806	277.161	3.920	13.145	262.678	-0.2519	0.0151	-0.2589	0.0152
19	999	990	4.828	18.109	326.014	4.778	19.023	320.215	0.4122	0.0156	0.3861	0.0154
20	999	990	5.128	20.850	201.616	4.684	21.333	154.415	0.2601	0.0034	0.2884	0.0037
21	999	999	5.741	25.146	423.260	6.038	25.639	285.490	-0.2961	0.0042	-0.1536	0.0040
22	999	990	7.241	31.875	329.990	6.945	30.464	354.863	-0.2787	0.0041	-0.2743	0.0040
26	999	994	6.607	32.606	204.990	6.497	30.475	188.089	-0.0418	0.0025	0.0407	0.0023
27	999	991	7.491	36.790	333.559	18.274	55.220	15407.645	-0.0572	0.0029	-0.1100	0.0013
28	999	993	7.275	36.196	317.743	7.389	41.585	281.114	-0.0708	0.0029	0.1075	0.0030
33	999	979	8.412	42.366	288.585	7.823	39.379	221.146	0.2074	0.0028	0.2774	0.0032
37	999	973	7.252	38.818	191.839	7.959	41.111	179.529	0.1084	0.0017	0.0499	0.0017

Figure 12

```
subnum 7
output 2 1  1  38
optcon 3 2.0 2  80 1 600 0 800 1
begin
```

Volcano Emittance

CIDPOL,

NEL NO.	PART IN	PART OUT	RMS,N X CM_mr	EMAX,N X,90% CM_mr	EMAX,N X,100% CM_mr	RMS,N Y CM_mr	EMAX,N Y,90% CM_mr	EMAX,N Y,100% CM_mr	ALPHA X	BETA X CM	ALPHA Y	BETA Y CM
1	999	999	0.177	0.797	2.953	0.173	0.779	2.671	-0.8552	0.4685	-0.8618	0.4799
2	999	999	1.976	9.149	53.231	1.884	8.837	52.366	0.1653	0.0809	0.1475	0.0855
3	999	999	1.484	7.115	46.128	1.578	7.369	39.684	-0.7471	0.0444	-0.7156	0.0434
4	999	999	2.039	7.729	60.915	2.106	7.988	63.669	0.2444	0.0217	0.1368	0.0199
5	999	999	3.330	13.603	147.166	2.968	12.256	169.991	0.0892	0.0646	0.0020	0.0761
6	999	999	4.035	16.130	154.674	3.618	14.770	147.748	0.7807	0.0292	0.8754	0.0314
7	999	999	3.873	14.616	139.308	2.977	11.285	140.567	-0.2793	0.0232	-1.1902	0.0399
8	999	998	2.987	12.004	84.251	2.757	10.835	83.460	0.1173	0.0533	-0.1818	0.0787
9	999	998	3.705	14.961	117.005	3.369	13.983	124.290	-0.8778	0.0377	-0.5627	0.0214
10	999	995	3.473	14.666	90.038	4.190	17.860	98.291	1.2610	0.0397	1.7265	0.0505
11	999	995	3.988	16.039	206.575	3.939	17.481	216.715	0.1364	0.0382	-0.0940	0.0349
12	999	995	4.485	19.948	179.439	4.979	23.528	270.641	0.2409	0.0321	0.0783	0.0287
13	999	995	3.505	15.535	129.339	3.248	13.729	79.272	-0.3250	0.0158	-0.1854	0.0162
14	999	995	5.027	19.747	208.247	4.671	20.198	334.990	0.4285	0.0309	0.4254	0.0313
15	999	995	3.873	15.440	250.488	3.901	14.924	208.046	-0.3807	0.0205	-0.6048	0.0224
16	999	995	4.959	21.907	135.355	4.611	19.194	191.357	0.2084	0.0163	0.2880	0.0155
17	999	995	3.904	15.763	140.843	4.590	18.682	122.669	0.1065	0.0168	-0.0397	0.0152
18	999	999	4.086	16.540	316.114	4.890	19.917	258.316	-0.4571	0.0184	-0.3035	0.0169
18	999	5										
19	999	999	5.699	21.741	260.059	5.291	21.129	206.850	0.2273	0.0136	0.2526	0.0138
19	999	4										
20	999	999	5.082	21.061	176.252	5.668	24.613	216.971	0.0905	0.0034	0.2600	0.0036
21	999	999	6.457	30.304	230.112	6.479	32.040	294.435	-0.2180	0.0041	-0.1682	0.0040
22	999	999	7.274	35.255	330.776	7.534	32.897	250.566	-0.0982	0.0039	-0.1538	0.0040
20	999	7										
21	999	12										
22	999	5										
27	999	999	7.414	34.356	228.130	7.307	33.540	291.891	-0.0331	0.0029	-0.0260	0.0029
26	999	996	6.487	30.513	190.501	7.328	32.411	189.052	0.0509	0.0027	0.1072	0.0026
27	999	6										
28	999	995	7.904	39.305	273.685	6.886	32.923	224.053	-0.0139	0.0028	-0.0157	0.0028
33	999	973	8.323	39.583	285.594	8.631	38.258	221.609	0.2164	0.0025	0.2424	0.0026
37	999	970	8.015	39.025	220.631	8.304	39.143	254.314	-0.0591	0.0017	-0.0572	0.0019

```
subnum 7
output 2 1  1  38
optcon 3 2.0 2  80 1 600 0 800 1
begin
```

Volcano2 Emittance

CIDPOL,

NEL NO.	PART IN	PART OUT	RMS,N X CM_mr	EMAX,N X,90% CM_mr	EMAX,N X,100% CM_mr	RMS,N Y CM_mr	EMAX,N Y,90% CM_mr	EMAX,N Y,100% CM_mr	ALPHA X	BETA X CM	ALPHA Y	BETA Y CM
1	999	999	0.171	0.804	2.990	0.184	0.792	2.569	-0.8335	0.4471	-0.8805	0.4898
2	999	999	1.938	9.299	50.672	1.933	8.818	50.194	0.1390	0.0789	0.1740	0.0873
3	999	999	1.481	7.033	45.912	1.599	7.430	41.391	-0.7166	0.0427	-0.7746	0.0447
4	999	999	2.106	7.971	60.818	2.013	7.561	67.296	0.2132	0.0205	0.1948	0.0203
5	999	999	3.220	13.239	139.927	3.141	12.835	170.504	0.1169	0.0650	-0.0523	0.0768
6	999	999	4.100	15.843	152.559	3.518	14.349	164.914	0.8371	0.0296	0.8947	0.0325
7	999	999	3.875	14.485	136.493	2.918	10.931	138.267	-0.2278	0.0227	-1.1929	0.0404
8	999	998	3.213	12.769	82.602	2.568	9.807	85.681	0.1436	0.0502	-0.2508	0.0803
9	999	998	3.833	14.532	97.304	3.257	13.786	119.873	-0.9094	0.0386	-0.6090	0.0216
10	999	996	3.740	15.656	97.481	3.985	16.713	103.888	1.1665	0.0369	1.8249	0.0512
11	999	996	4.469	19.233	205.351	3.755	17.098	187.413	0.2410	0.0350	-0.0520	0.0356
12	999	996	4.998	24.209	199.961	4.994	23.871	197.828	0.2937	0.0293	0.1165	0.0269
13	999	996	3.815	17.911	98.027	3.548	17.346	74.072	-0.4188	0.0179	-0.2915	0.0158
14	999	996	4.752	19.075	182.470	5.361	22.982	289.697	0.4457	0.0294	0.4965	0.0274
15	999	996	4.014	15.852	280.688	4.397	19.220	188.600	-0.4397	0.0215	-0.5128	0.0239
16	999	996	5.081	22.025	134.562	4.838	20.650	119.094	0.1226	0.0155	0.1151	0.0140
17	999	996	3.817	15.365	158.068	5.172	24.319	137.897	0.0345	0.0170	-0.2061	0.0160
18	999	996	4.585	18.457	340.281	5.634	27.394	252.251	-0.4252	0.0180	-0.3563	0.0175
19	999	996	5.458	20.623	227.948	5.868	22.797	199.262	0.1034	0.0138	0.1773	0.0122
21	999	999	6.514	26.430	237.255	7.321	37.768	215.631	-0.1360	0.0039	-0.1286	0.0042
22	999	999	7.911	35.403	291.778	7.746	35.158	246.072	-0.1269	0.0037	-0.1327	0.0039
20	999	996	5.823	25.003	164.473	5.372	21.704	204.024	0.0235	0.0032	0.1596	0.0036
21	999	22										
22	999	5										
28	999	999	7.824	40.399	212.861	8.406	39.175	735.842	-0.0070	0.0027	0.0533	0.0027
26	999	996	7.503	33.203	207.905	7.183	31.725	171.776	-0.0364	0.0023	-0.0049	0.0025
28	999	3										
27	999	988	8.099	44.035	220.236	8.340	43.673	303.349	-0.0578	0.0030	-0.0522	0.0028
33	999	980	9.073	43.763	340.146	8.690	41.536	273.338	0.2003	0.0027	0.1731	0.0027
37	999	963	8.792	44.219	250.645	8.251	41.730	320.493	0.0311	0.0018	-0.0295	0.0017

Figure 13

PARGRAF OUTGRAF A1 Dated 08/07/91 10:44:19 From disk SPC200 Page

Reference Z Emittance

PARMELA 10:41:59: 0 AM THURSDAY AUGUST 7, 1991 RUN NO.

subnum 7
output 2 1 1 11
optcon 1 2.0 1 80 1 2500 0 20 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
1	999	999	4.6	23.7	52.6	-0.8	0.0	1.0	88357.1
2	999	999	114.9	430.5	1344.5	-0.4	0.1	1.3	3555.8
3	999	999	224.9	923.5	2404.4	0.5	0.0	2.0	1824.1
4	999	999	326.6	1241.9	3856.4	-10.0	-0.1	2.3	1260.5
4	999	4							
5	999	999	482.7	1873.1	6429.8	2.0	0.2	2.2	868.2
6	999	999	467.3	1717.7	6475.1	2.5	0.1	2.4	901.5
7	999	999	505.1	1840.6	7235.9	1.4	0.0	2.5	842.2
8	999	999	566.4	2148.5	7631.7	1.7	-0.1	2.4	755.7
9	999	999	636.0	2471.7	9065.8	2.4	-0.3	2.5	682.9
10	999	996	662.3	2509.6	11582.0	3.8	-0.1	2.9	682.4
11	999	996	805.7	3154.0	14485.7	5.7	0.0	3.0	585.0

subnum 7
output 2 1 12 18
optcon 1 2.0 1 80 1 2500 0 120 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
12	999	996	2810.7	9396.2	120558.1	5.7	2.8	-6.5	165.9
13	999	996	2684.6	9007.5	121142.7	10.0	2.3	-5.9	138.5
14	999	996	2478.9	8261.2	117442.1	13.7	2.3	-5.5	114.3
15	999	999	2199.[illegible]	7327.4	115369.0	5.0	2.5	-4.9	89.9
15	999	12							
16	999	999	1965.8	6864.4	108051.9	12.0	3.2	-4.4	72.6
16	999	5							
17	999	996	1955.7	6822.9	104979.7	16.7	3.8	-4.3	69.4
18	999	996	2821.0	10854.8	181000.5	17.7	6.7	-5.4	43.6

subnum 7
output 2 1 19 38
optcon 1 2.0 1 80 1 800 0 200 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
19	999	996	1566.3	5603.9	140946.1	35.1	7.2	-5.7	29.4
21	999	999	3618.9	9818.5	97734.6	24.0	9.1	-1.2	2.5
20	999	996	1869.9	8821.8	38241.7	34.4	9.9	-2.0	8.3
21	999	15							
22	999	996	6327.1	22966.0	212831.7	44.0	-20.8	-0.4	1.4
26	999	999	13213.6	90392.2	450544.2	78.7	-80.7	0.9	1.3
26	999	4							
27	999	999	16063.7	93071.9	513455.[illegible]	90.7	17.0	0.2	1.5
26	999	1							
28	999	998	28652.4	147966.4	1414198.0	92.8	137.8	0.1	1.0
33	999	985	81502.5	393710.9	5626899.0	67.3	396.4	0.2	0.4
37	999	981	114267.6	560467.0	7774995.0	65.0	359.5	0.4	0.3

PARGRAF OUTGRAF A1 Dated 08/07/91 10:46:51 From disk SPC200 Page 1

Double X Emittance

PARMELA 10:45:11: 0 AM THURSDAY AUGUST 7, 1991 RUN NO. 0

subnum 7
output 2 1 1 11
optcon 1 2.0 1 80 1 2500 0 20 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
1	999	999	7.3	30.5	2598.0	-0.7	-0.2	0.7	45944.2
2	999	999	147.4	515.6	3335.7	-0.1	-0.1	1.1	2287.9
3	999	999	324.9	1110.2	7688.1	1.6	-0.3	1.5	1044.0
4	999	999	533.4	1575.6	13650.3	3.3	-0.4	1.6	642.8
5	999	999	744.2	2325.3	19676.9	5.3	-0.2	1.6	468.8
6	999	999	769.7	2300.0	20448.4	6.2	-0.3	1.6	456.2
7	999	999	836.2	2419.6	22037.4	5.8	-0.3	1.7	424.0
8	999	999	902.8	2639.3	24054.8	6.5	-0.2	1.7	395.9
9	999	999	1043.9	3060.7	27653.0	7.9	-0.5	1.7	349.0
10	999	990	1155.5	3531.4	34033.4	12.9	-0.7	1.9	333.6
11	999	990	1378.1	4171.3	41402.0	17.0	-1.4	2.0	295.3

subnum 7
output 2 1 12 18
optcon 1 2.0 1 80 1 2500 0 120 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
12	999	990	1923.7	7047.0	156490.2	17.1	1.7	-8.0	209.5
13	999	990	1819.5	6784.2	151831.1	20.0	2.4	-7.4	177.6
14	999	990	1547.6	5581.4	145341.3	22.3	2.9	-7.4	160.3
15	999	990	1398.3	5475.5	134006.9	23.3	3.1	-6.8	132.3
16	999	990	1172.1	4860.1	120320.2	22.7	3.3	-6.6	114.0
17	999	990	1156.2	4919.9	113751.1	22.2	3.3	-6.3	106.4
18	999	998	2318.5	8778.5	175532.8	14.7	5.5	-6.1	51.3

subnum 7
output 2 1 19 38
optcon 1 2.0 1 80 1 800 0 200 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
19	999	990	900.9	3597.1	144473.2	34.0	6.4	-9.0	49.1
20	999	990	1286.8	5331.8	65300.2	33.8	9.6	-3.1	11.9
21	999	999	4633.1	14134.1	232903.6	31.5	18.2	-1.1	2.4
22	999	990	6373.1	20845.8	272970.9	45.8	-11.5	-0.2	1.3
26	999	994	12966.9	86678.7	469781.7	84.5	-66.2	1.0	1.6
27	999	991	13712.0	80789.4	478194.0	88.5	36.5	0.1	1.7
28	999	993	25189.1	140008.8	1436733.0	87.9	158.0	0.0	1.1
33	999	979	68159.9	382448.2	4453922.0	57.8	376.8	0.0	0.4
37	999	973	98521.1	482712.7	8813949.0	59.1	312.8	0.2	0.3

Figure 14

PARGRAF OUTGRAF A1 Dated 08/07/91 10:18:29 From disk SPC200 Page 1

Volcano Z Emittance

PARMELA 10: 9:46: 0 AM THURSDAY AUGUST 7, 1991 RUN NO. 0

subnum 7
output 2 1 1 11
optcon 1 2.0 1 80 1 2500 0 20 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
1	999	999	7.3	30.2	2659.9	-0.7	-0.2	0.7	46127.2
2	999	999	137.8	484.1	3112.4	0.0	-0.1	1.1	2448.9
3	999	999	324.6	1164.2	7837.1	1.7	-0.3	1.5	1045.5
4	999	999	536.3	1745.8	13563.5	3.5	-0.4	1.5	639.6
5	999	999	764.2	2496.4	18759.8	5.7	-0.2	1.5	456.6
6	999	999	789.1	2387.7	19644.2	6.6	-0.2	1.6	445.1
7	999	999	855.2	2638.1	21687.8	8.7	-0.2	1.6	415.7
8	999	998	914.3	2851.7	23793.1	7.9	-0.1	1.6	390.1
9	999	998	1046.0	3018.9	26886.1	9.1	-0.2	1.7	347.5
10	999	995	1136.8	3334.4	34413.2	11.6	0.1	1.9	331.9
11	999	995	1357.7	3909.3	41883.3	14.0	-0.1	2.0	293.6

subnum 7
output 2 1 12 18
optcon 1 2.0 1 80 1 2500 0 120 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
12	999	995	1872.0	7037.8	151734.1	14.1	2.7	-8.1	210.9
13	999	995	1753.8	6654.1	147298.6	16.9	2.5	-7.6	180.2
14	999	995	1495.7	5661.7	138759.6	19.4	2.8	-7.6	161.9
15	999	995	1343.9	5165.7	125442.6	20.8	3.0	-7.0	134.1
16	999	995	1174.9	4811.7	108017.7	21.0	3.1	-6.4	110.5
17	999	995	1151.9	4652.1	100795.6	20.9	3.1	-6.1	103.6
18	999	999	1793.4	7283.2	194301.5	17.5	5.3	-7.0	57.7
18	999	5							

subnum 7
output 2 1 19 38
optcon 1 2.0 1 80 1 800 0 200 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
19	999	999	916.9	3842.6	111499.6	32.4	5.5	-8.1	43.7
19	999	4							
20	999	999	1475.9	6825.1	53312.1	34.6	6.0	-2.2	8.5
21	999	999	3799.2	11579.4	90707.1	30.3	21.2	-1.1	2.2
22	999	999	5685.7	18885.2	149873.4	45.2	-6.3	-0.3	1.1
20	999	7							
21	999	12							
22	999	5							
27	999	999	13522.9	78754.1	333509.0	89.2	52.0	0.2	1.6
26	999	996	14434.7	86479.1	1868009.0	87.8	-57.9	1.1	1.6
27	999	6							
28	999	995	26924.9	138475.9	2126665.0	90.0	169.0	0.1	1.1
33	999	973	80771.1	393876.4	5581255.0	59.8	342.0	0.2	0.4
37	999	970	120965.7	568141.1	8310048.0	61.4	280.2	0.5	0.3

PARGRAF OUTGRAF A1 Dated 08/07/91 10:49:03 From disk SPC200 Page 1

Volcano Z Z Emittance

PARMELA 10:47:57: 0 AM THURSDAY AUGUST 7, 1991 RUN NO. 0

subnum 7
output 2 1 1 11
optcon 1 2.0 1 80 1 2500 0 20 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
1	999	999	7.3	30.2	2641.3	-0.7	-0.2	0.7	45911.3
2	999	999	138.3	486.0	3122.9	0.0	-0.1	1.1	2440.7
3	999	999	324.9	1145.1	7825.0	1.7	-0.3	1.5	1044.6
4	999	999	534.7	1735.5	13629.4	3.6	-0.4	1.5	641.6
5	999	999	761.0	2466.8	18721.5	5.7	-0.2	1.5	458.5
6	999	999	787.1	2395.8	19595.3	6.7	-0.3	1.6	446.3
7	999	999	855.0	2606.6	21610.5	8.4	-0.2	1.6	416.1
8	999	998	914.3	2756.8	23730.2	7.7	-0.2	1.6	390.3
9	999	998	1039.8	3016.2	26809.2	8.9	-0.3	1.7	349.9
10	999	996	1133.9	3252.8	34221.6	10.8	0.0	1.9	332.7
11	999	996	1354.5	3852.1	41515.1	12.9	-0.3	2.0	294.3

subnum 7
output 2 1 12 18
optcon 1 2.0 1 80 1 2500 0 120 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
12	999	996	1886.6	7244.4	151259.8	12.9	2.5	-8.0	209.3
13	999	996	1760.0	6870.0	147314.8	15.3	2.1	-7.6	179.6
14	999	996	1508.1	5802.7	138576.0	17.5	2.3	-7.5	160.6
15	999	996	1354.2	5553.4	125360.6	18.4	2.9	-6.9	133.1
16	999	996	1187.6	4895.4	107494.7	18.1	2.9	-6.3	109.3
17	999	996	1155.9	4911.6	100764.6	17.7	2.5	-6.1	103.3
18	999	996	1843.3	7663.6	197295.0	18.3	5.0	-7.2	59.0

subnum 7
output 2 1 19 38
optcon 1 2.0 1 80 1 800 0 200 1
begin

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
19	999	996	967.9	3901.2	107814.8	31.5	6.6	-8.1	43.9
21	999	999	3549.0	10518.9	98428.2	24.1	13.1	-1.2	2.1
22	999	999	5634.8	18311.2	150400.4	44.2	-17.4	-0.3	1.1
20	999	996	1392.5	6378.0	63545.6	33.5	8.0	-2.7	10.4
21	999	22							
22	999	5							
28	999	999	27424.2	148150.6	690543.0	92.7	155.2	0.2	1.1
26	999	996	13537.2	92138.4	620226.9	85.1	-61.2	1.1	1.5
28	999	3							
27	999	988	14001.7	78224.5	805072.6	89.4	49.0	0.3	1.8
33	999	980	76744.7	344784.7	6061485.0	55.4	346.4	0.1	0.4
37	999	963	108553.9	505137.9	8761921.0	55.8	305.4	0.3	0.3

Figure 15

Second Standard Emittances

PARMELA 4:10:19: 0 PM SATURDAY AUGUST 9, 1991 RUN NO.

```
subnum 7
output 2 1 1 11
optcon 1 2.0 1  80 1 2500 0  20 1
begin
```

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
1	999	999	7.7	31.6	2544.5	-0.7	-0.2	0.7	43916.1
2	999	999	160.8	585.6	3593.8	-0.1	-0.1	1.0	2098.8
3	999	999	320.7	1078.3	8029.3	1.4	-0.1	1.5	1058.3
4	999	999	528.5	1562.0	13108.1	2.7	-0.3	1.6	649.2
5	999	999	733.3	2276.0	19605.1	[illegible]	0.0	1.6	475.9
6	999	999	742.3	2185.0	20375.1	5.5	-0.1	1.7	473.3
7	999	999	817.3	2386.0	21521.8	5.9	-0.2	1.7	434.1
8	999	999	900.7	2691.9	23842.7	6.5	-0.2	1.7	397.1
9	999	999	1019.5	3007.5	27753.7	7.6	-0.4	1.7	357.6
10	999	994	1103.1	3170.0	32969.7	12.2	-0.3	1.9	347.8
11	999	994	1322.9	3697.7	40742.4	16.1	-1.2	2.0	306.0

```
subnum 7
output 2 1 12 18
optcon 1 2.0 1  80 1 2500 0 120 1
begin
```

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
12	999	994	2048.9	7406.7	157803.0	16.2	2.1	-7.5	195.7
13	999	994	1930.6	6943.6	152536.9	18.7	2.4	-7.0	166.5
14	999	999	1680.4	6244.1	145617.7	15.9	2.4	-6.7	144.3
14	999	2							
15	999	994	1523.7	5953.7	134217.2	22.3	2.8	-6.2	120.8
16	999	999	1289.7	5259.7	119468.1	20.0	3.0	-5.8	99.8
16	999	3							
17	999	994	1299.1	5431.4	113346.8	22.3	3.0	-5.5	94.2
18	999	994	2087.0	8728.6	222340.3	23.0	5.7	-6.4	53.4

```
subnum 7
output 2 1 19 38
optcon 1 2.0 1  80 1 800 0 200 1
begin
```

NEL	PART IN	PART OUT	Z-EMITTANCE (DEG-KEV) RMS	90%	100%	DPB	DWB	ALPHA	BETA
19	999	994	998.7	3747.4	167789.4	36.2	6.0	-8.0	43.6
21	999	999	3934.0	11748.2	100154.6	34.4	21.4	-1.1	2.1
22	999	999	5170.3	14830.0	118277.0	43.5	-10.0	-0.2	1.1
20	999	999	1128.3	4886.0	37137.4	38.9	7.8	-3.3	12.4
26	999	999	11514.4	73582.0	443572.9	74.5	-38.7	1.0	1.4
27	999	999	13676.9	91915.8	307479.2	84.4	57.2	0.2	1.6
28	999	999	26319.2	149613.4	729422.1	87.6	156.1	0.2	1.1
33	999	982	87833.6	401401.6	[illegible]	61.8	337.7	0.3	0.5
37	999	977	113621.5	562200.5	7442646.0	56.6	254.1	0.4	0.3

```
subnum 8
output 2 1 1  38
optcon 1 3 0. 400. 18 0 2.0  1 2500 0
begin
subnum 7
output 2 1  1  38
optcon 3 2.0 2  80 1 600 0 800 1
begin
```

CIDPOL,

NEL NO.	PART IN	PART OUT	RMS,N X CM_mr	EMAX,N X,90% CM_mr	EMAX,N X,100% CM_mr	RMS,N Y CM_mr	EMAX,N Y,90% CM_mr	EMAX,N Y,100% CM_mr	ALPHA X	BETA X CM	ALPHA Y	BETA Y CM
1	999	999	0.155	0.772	2.532	0.162	0.846	2.572	-0.9150	0.3444	-0.9239	0.3222
2	999	999	1.877	8.147	50.134	1.878	8.208	57.794	-0.7418	0.0764	-0.7738	0.0720
3	999	999	1.704	7.202	56.743	1.837	7.760	67.467	0.1579	0.0488	0.2037	0.0443
4	999	999	1.557	5.965	51.109	1.541	6.334	47.398	-0.5260	0.0241	-0.5366	0.0235
5	999	999	2.708	11.039	72.650	2.824	11.208	118.667	0.7485	0.0923	0.7555	0.0946
6	999	999	2.921	12.051	84.787	3.132	12.593	117.644	1.6164	0.0336	1.6608	0.0341
7	999	999	2.648	10.057	74.209	2.540	8.979	83.590	-0.2433	0.0171	-0.8557	0.0277
8	999	999	2.469	10.588	77.960	2.791	11.605	71.916	-0.6080	0.0455	-0.9078	0.0541
9	999	999	3.769	13.652	279.610	2.967	11.875	115.921	-1.5624	0.0585	-1.2875	0.0473
10	999	994	3.161	13.760	111.742	3.887	14.530	173.170	1.1660	0.0268	1.3208	0.0284
11	999	994	4.794	18.904	238.266	4.396	18.166	219.754	0.7153	0.0332	0.4985	0.0264
12	999	994	5.015	20.123	213.324	5.072	23.276	232.958	0.5832	0.0242	0.3928	0.0212
13	999	994	4.176	19.547	215.517	3.605	14.015	150.358	-0.4618	0.0220	-0.4381	0.0249
14	999	999	5.885	22.704	212.899	5.721	24.485	216.062	0.2568	0.0215	0.2699	0.0210
14	999	2										
15	999	994	4.725	18.301	203.685	5.014	20.912	193.296	-0.1083	0.0176	-0.1723	0.0182
16	999	999	4.931	20.496	198.483	5.010	18.332	198.938	0.2697	0.0178	0.3109	0.0177
16	999	3										
17	999	994	4.321	19.330	152.818	4.442	14.361	165.591	0.2683	0.0162	0.1601	0.0155
18	999	994	5.009	19.001	179.666	4.825	17.420	182.529	-0.2246	0.0145	-0.1546	0.0152
19	999	994	6.092	25.642	283.354	5.739	25.732	202.875	0.3383	0.0130	0.2635	0.0144
21	999	999	7.131	33.426	284.441	6.626	30.759	273.521	-0.2482	0.0034	-0.1858	0.0035
22	999	999	7.628	36.275	251.871	8.112	40.552	349.367	-0.2786	0.0037	-0.2488	0.0038
20	999	999	5.419	22.743	218.651	5.652	24.393	270.887	0.2885	0.0036	0.3274	0.0039
20	999	2										
21	999	11										
22	999	11										
26	999	999	7.219	35.729	182.451	7.639	37.643	200.271	0.0046	0.0024	0.1074	0.0024
27	999	999	7.737	38.220	198.503	8.070	42.877	225.477	-0.1040	0.0028	-0.1013	0.0030
28	999	999	8.255	47.139	240.284	7.062	35.913	200.131	-0.1139	0.0028	-0.0271	0.0030
26	999	11										
27	999	4										
28	999	2										
33	999	982	8.730	40.015	283.898	8.495	41.627	262.821	0.2322	0.0027	0.1924	0.0027
37	999	977	8.049	40.281	183.720	8.539	43.871	234.247	0.0054	0.0018	-0.0472	0.0018

Figure 16

2nd Standard

2nd Standard

ID=XY@@

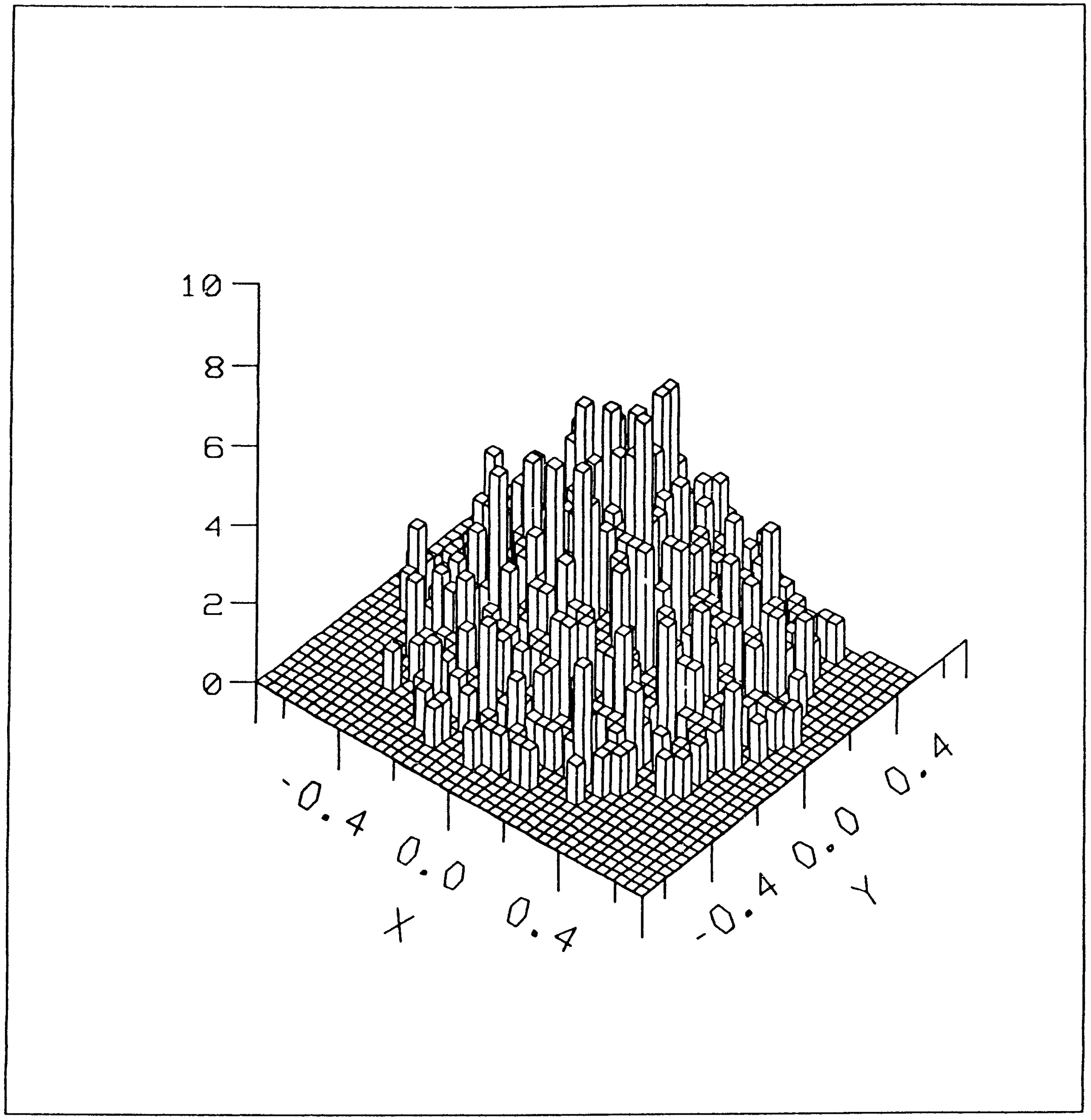


Figure 17

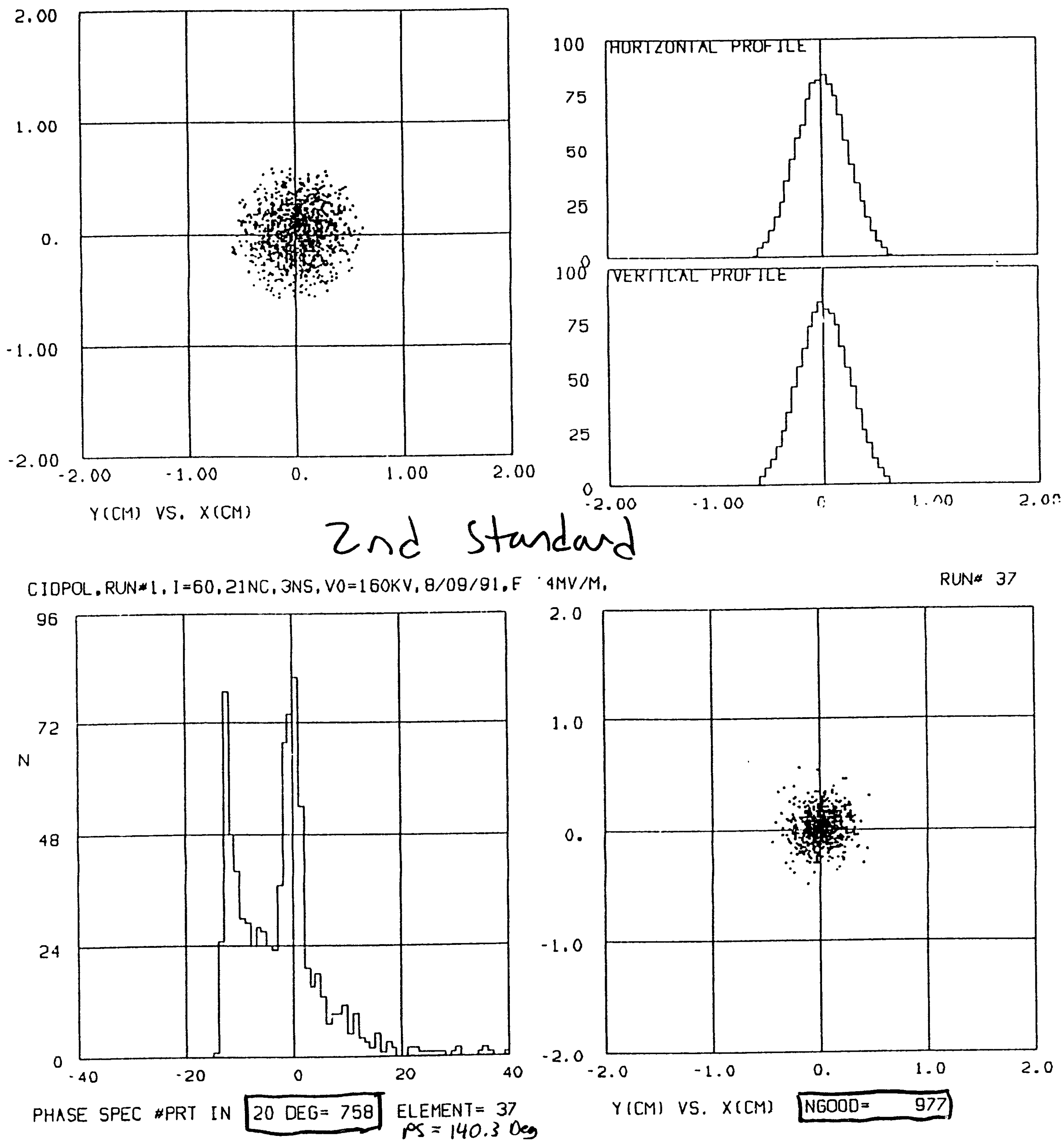

HORIZONTAL PROFILE
VERTICAL PROFILE
Y(CM) VS. X(CM)
2nd Standard
CIDPOL,RUN#1,I=60,21NC,3NS,V0=160KV,8/09/91,F 4MV/M,
RUN# 37
N
PHASE SPEC #PRT IN 20 DEG= 758
ELEMENT= 37
PS = 140.3 Deg
Y(CM) VS. X(CM)
NGOOD= 977

Figure 18

X, Y Spacial Distributions at Start

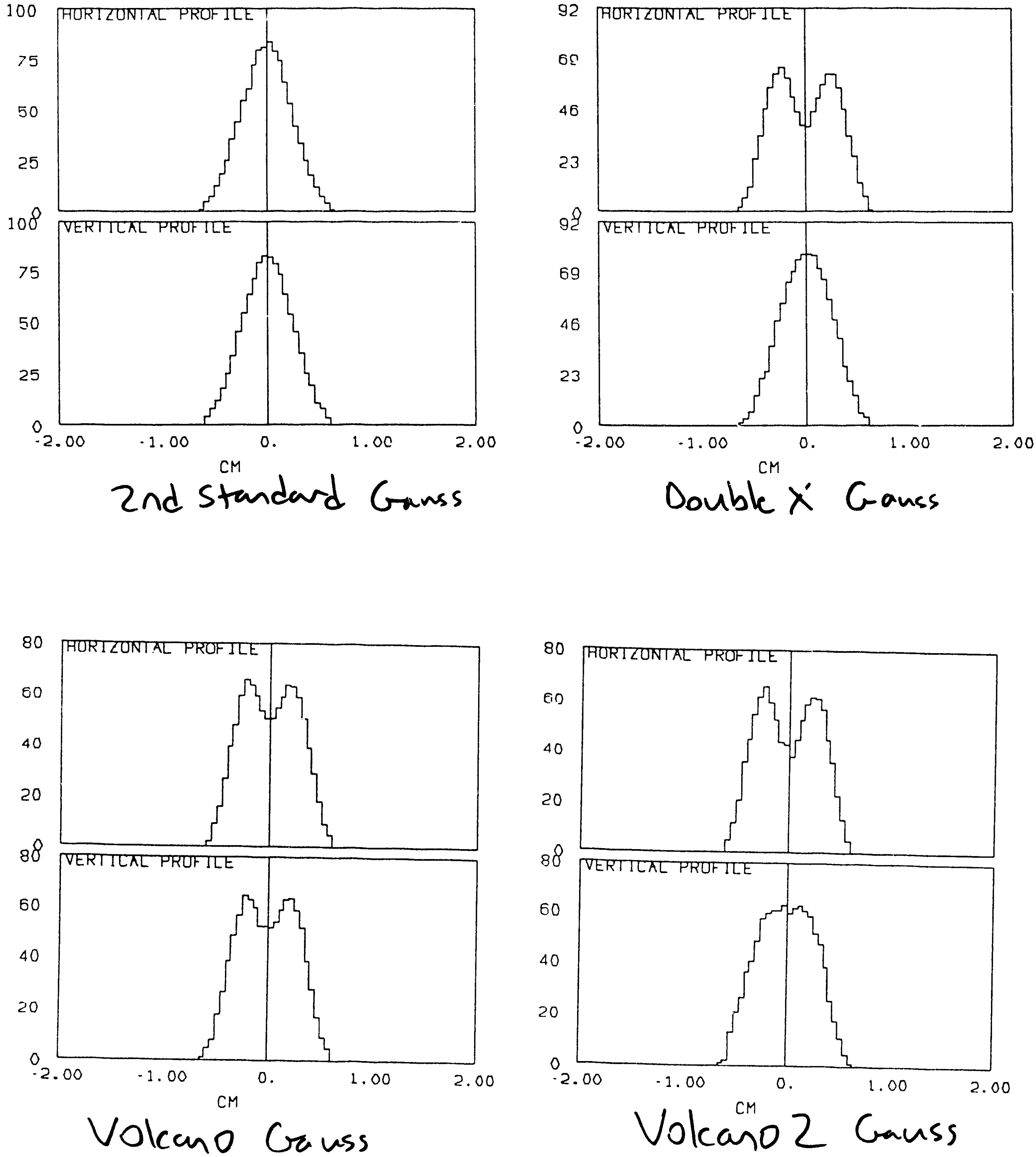
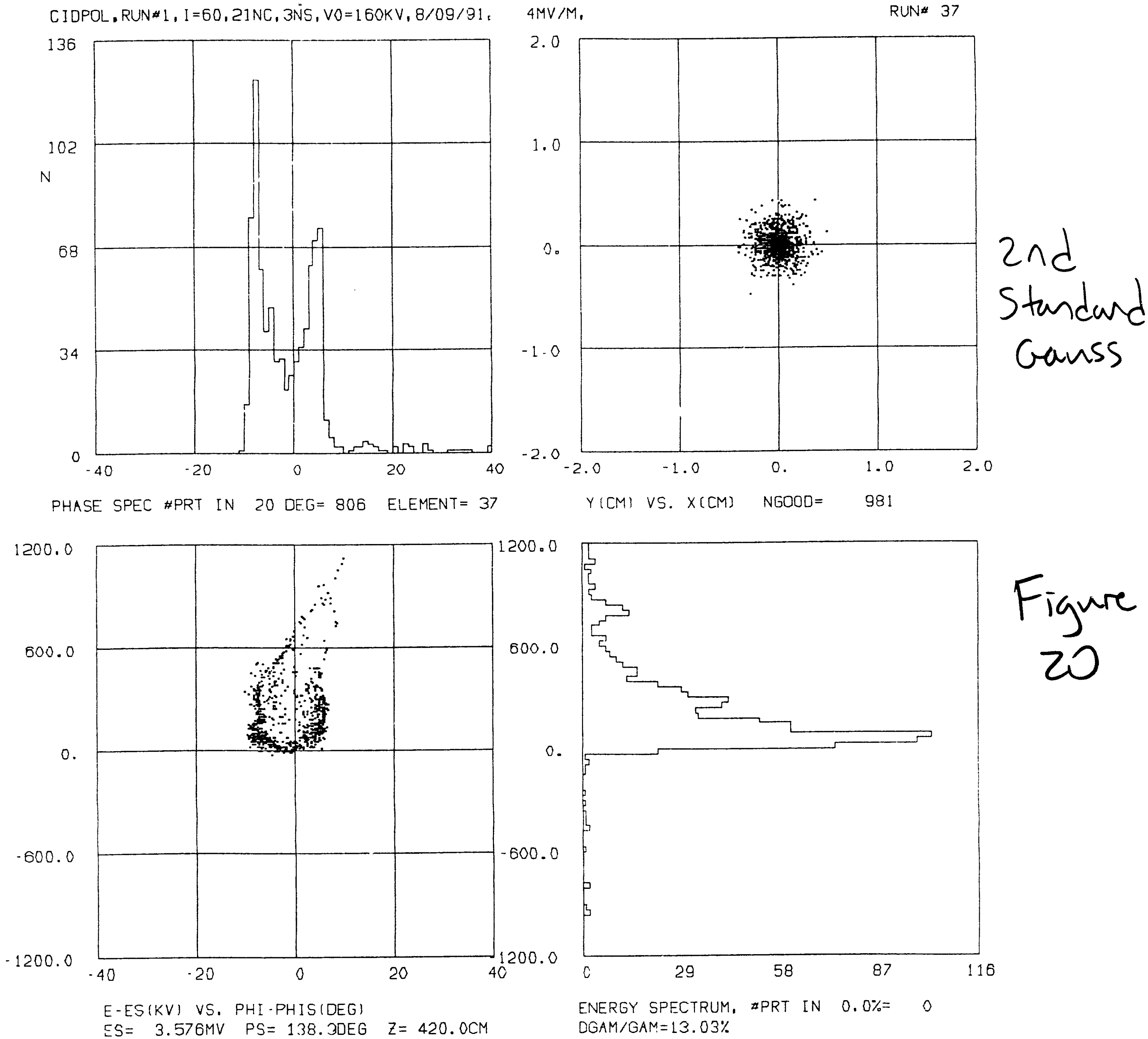
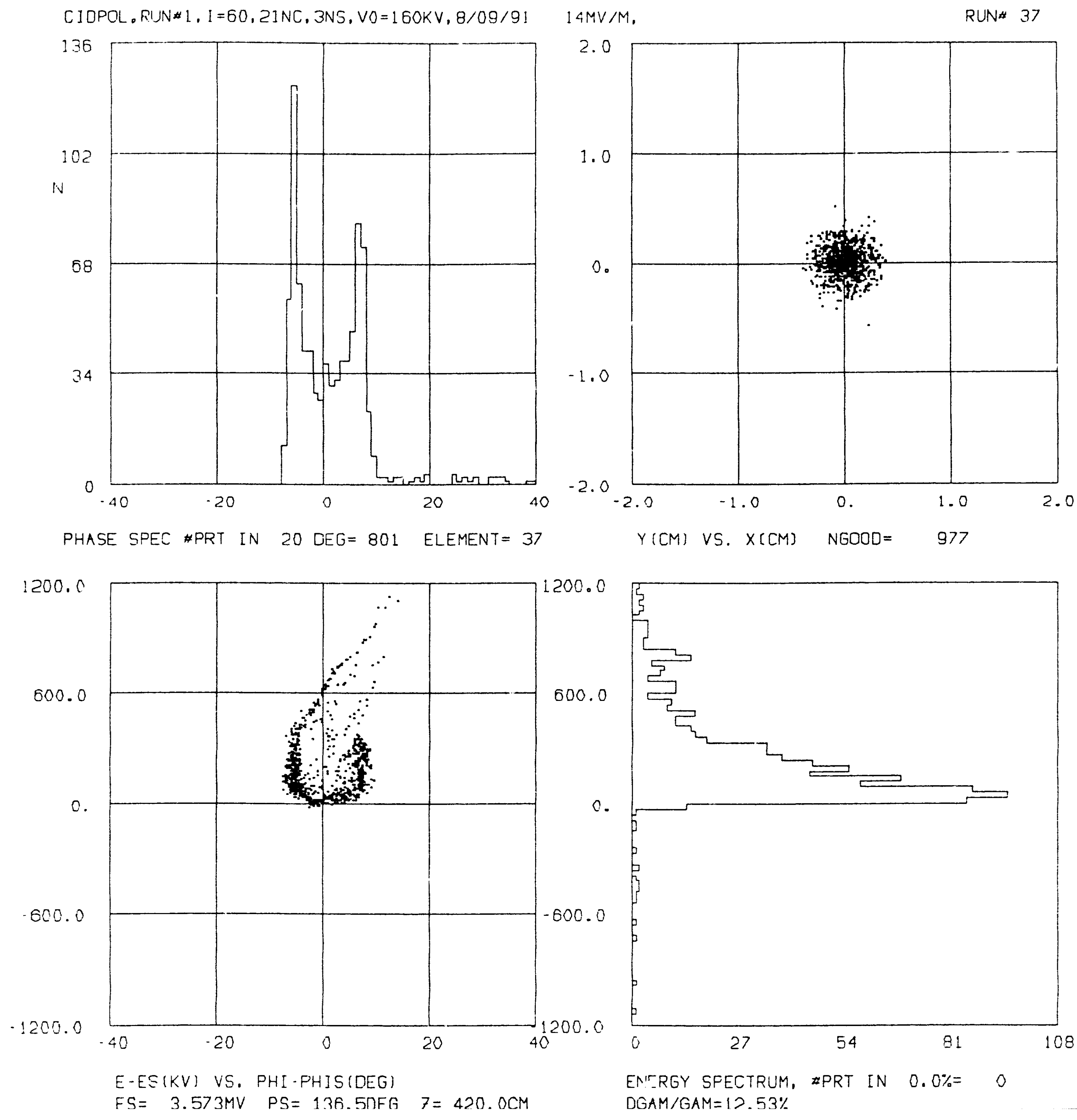


Figure 19



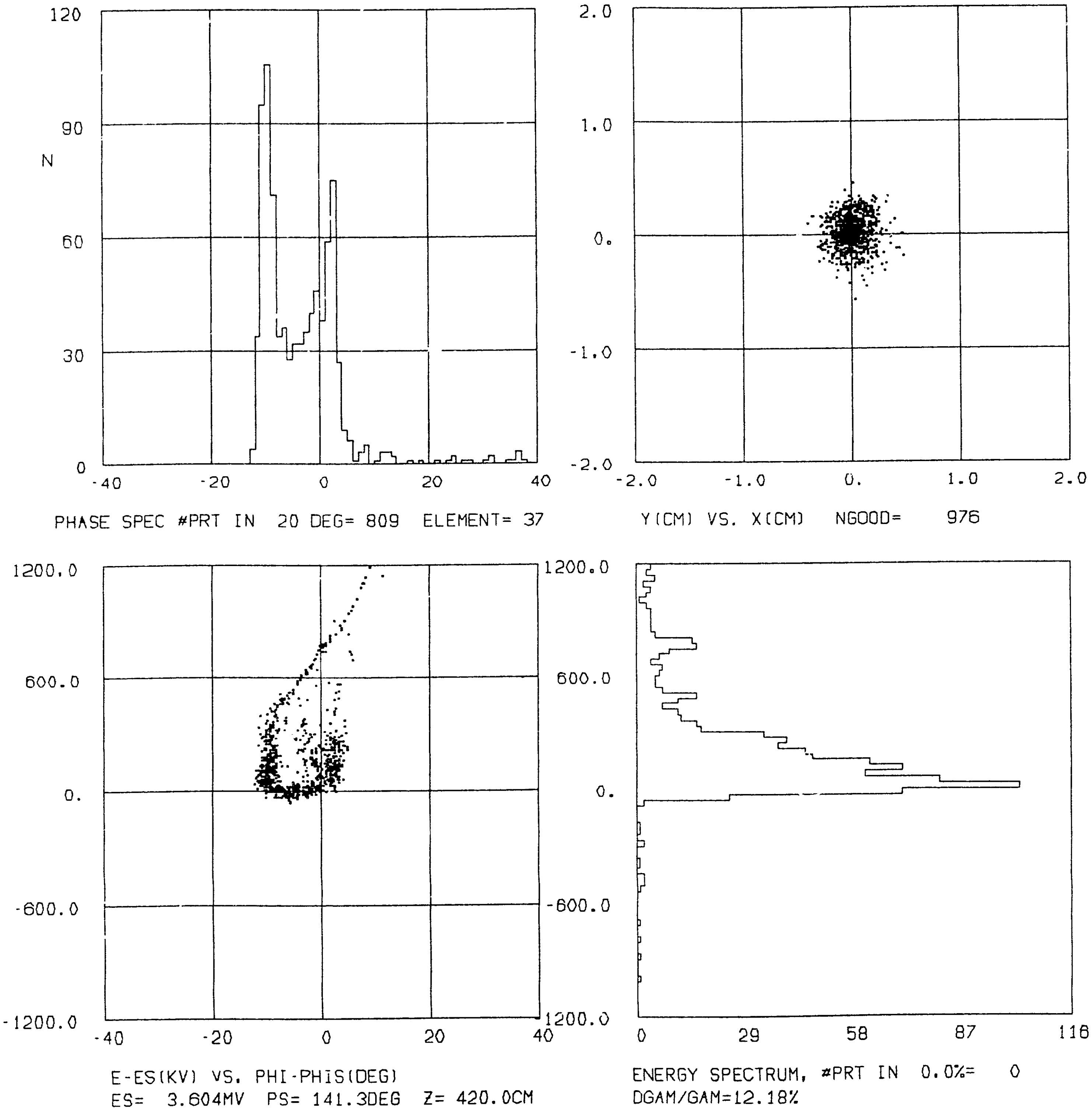
CIDPOL,RUN#1,I=60,21NC,3NS,V0=160KV,8/09/91, 4MV/M,
RUN# 37
136
102
N
68
34
0
-40
-20
0
20
40
PHASE SPEC #PRT IN 20 DEG= 806 ELEMENT= 37
2.0
1.0
0.
-1.0
-2.0
-2.0
-1.0
0.
1.0
2.0
Y(CM) VS. X(CM) NGOOD= 981
2nd Standard Gauss
1200.0
600.0
0.
-600.0
-1200.0
-40
-20
0
20
40
E-ES(KV) VS. PHI-PHIS(DEG)
ES= 3.576MV PS= 138.3DEG Z= 420.0CM
1200.0
600.0
0.
-600.0
1200.0
0
29
58
87
116
ENERGY SPECTRUM, #PRT IN 0.0%= 0
DGAM/GAM=13.03%

Figure 20



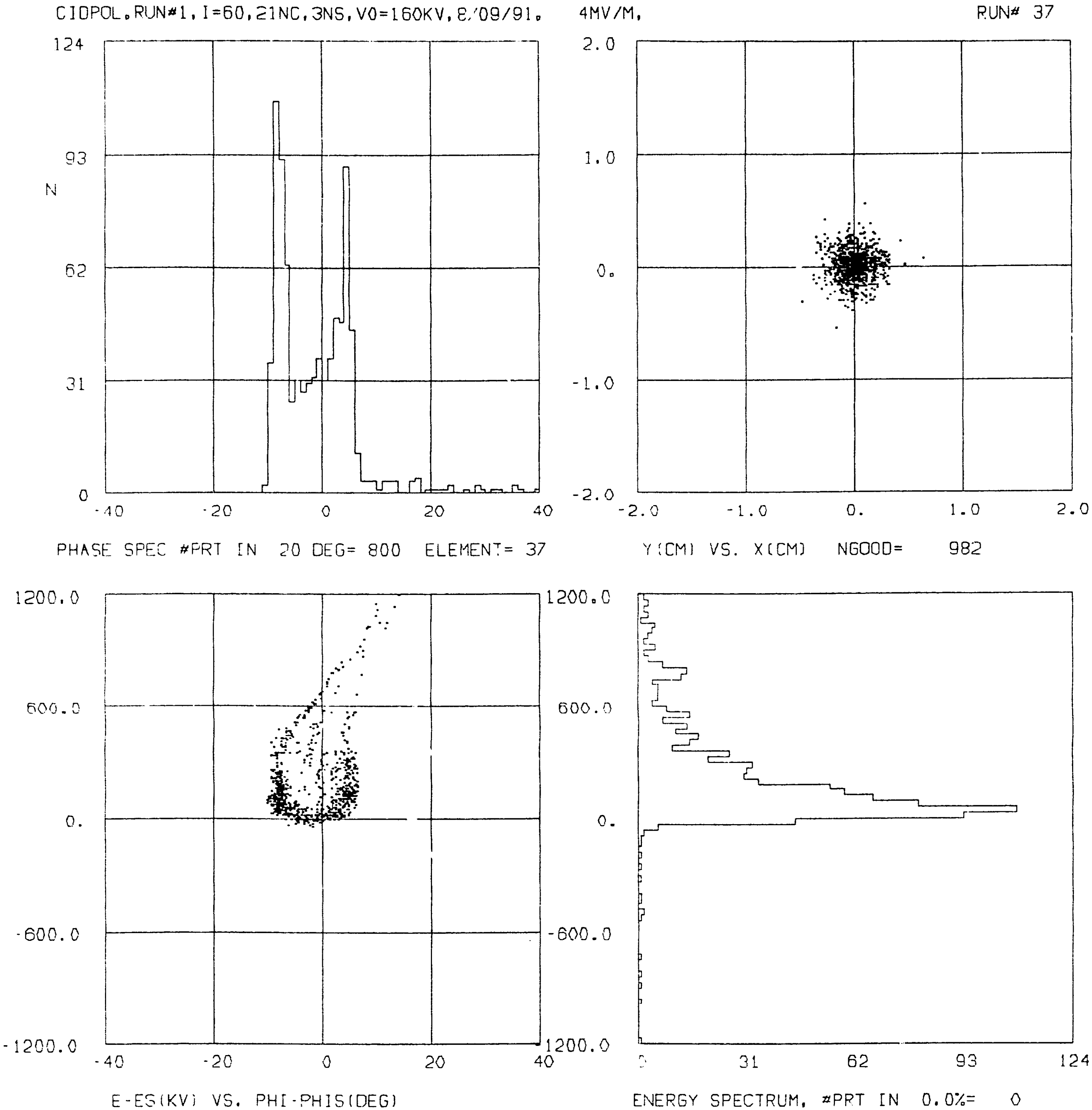
Double-X Gauss

Figure 21



Volcano Gauss

Figure 22



Volcano2
Gauss

Figure
23

END

DATE FILMED

11/12/91