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SIMULATING THE 200 MeV LINAC USING PARMILA AND PARTRACE

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Accelerator Division
Technical Note

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Introduction

The AGS was converted to H^- injection in 1983. One consequence was that the beam current that needs to be accelerated by the Linac was reduced by about a factor of three. Subsequently in 1988, the Cockcroft-Walton in Pit 1 was replaced with an RFQ, and the 750 keV LEBT line was redesigned. The Linac was never retuned after these changes in operating conditions since the task is a very formidable one. Because of the complexity of the optimization process, numerical simulations should be undertaken, first to understand the present performance of the injector, and second, to find ways to improve its performance.

The Codes

In the intervening years since the Linac was designed and built, personnel involved in the original work have dispersed, the evolution of computers has rendered obsolete the codes that were used in the design, and more sophisticated ones have been developed. We decided to use PARMILA[1] and PARTRACE[2] for these studies, and we have collected the information necessary to model the Linac with them.

PARMILA generates a drift tube Linac (DTL) and tracks bunched particles through it and its associated LEBT and HEBT lines, while keeping track of particles which are lost at apertures, or which fall out of an acceptable energy range.

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*This note is closely related to BNL AGSCD Tech. Note No. 119 on the Linac design.

PARTRACE uses PARMILA's input format and Linac generating capability, and the matrix transformation formalism of TRACE 3-D[3] to transport the beam through the Linac and transfer lines; consequently, it is much faster. However, it does not give information about particle losses, and it assumes a linear time dependence of the electric field in accelerating and bunching rf gaps, instead of a sinusoidal one. Thus, it should only be used for beams (bunches) of moderate longitudinal phase spread. PARTRACE does a linear treatment of beam space charge since the charge distribution in the bunches is assumed to be uniform.

At present, we use PARTRACE exclusively on the VAX, although the original copy obtained was meant for PCs. Graphical output was added as an option at BNL. We have been using a PC version of PARMILA, which does not generate quite the same Linac as does PARTRACE. Versions of PARMILA for VAXs exist, but none has been successfully implemented at BNL, mainly because of the problems with graphical post-processing.

The Input Data File*

The input data file is shown in Appendix A. The SFDATA tables of coefficients used to calculate transit time factors and other parameters, were prepared from the COFT tables in Benton's report on the original design calculations.[4] Other information was obtained from the "Blue Book", the definitive Linac report,[5] and from Linac operations personnel. The CHANGE cards are used to replace the quadrupole lengths and gradients produced by the linac generating subroutine, GENLIN2, with working values. The sequence of alternating quadrupole polarities was determined from information in the Blue Book.[6] It should be pointed out that the quadrupoles are still energized as they were for H^+, but because of the opposite ion charge, their focusing action is now reversed. For calculation purposes, it is best to consider the upstream half of the first quadrupole of Tank 1 as part of LEBT, and the downstream half of the last quadrupole of Tank 9 as the first element of HEBT - with the appropriate gradients and polarities. This is accomplished with appropriate entries in the TANK cards for these tanks.

Keeping in mind that the Linac was designed for a proton beam, but now accelerates H^- ions, we have tried to generate the tanks to have, in order of importance:

1. The same numbers of cells and lengths
2. The same output energy

*To keep down the bulk of the distributed version of this note, not all of the data and output are included. The complete document is in the AGS Department's files.

as in the original design. With only the electric field available as a parameter, we obviously could not meet all three goals simultaneously. Using either code, we can generate a Linac which has the same number of cells as the physical Linac, and is within 0.02% in length and 0.005% in output beam energy. These errors are acceptable for using this model to study the machine's behavior. When generating the Linac, we use a relative mass of 1 for the proton, but in the dynamical calculations, the relative mass is set to 1.001089 for H^-.

Linac Acceptance

The Twiss parameters for the acceptance of the Linac, defined at the midpoint of the first Linac quadrupole, were found using the Type 4 matching option of TRACE 3-D to match a beam of known emittance and current to a periodic structure - in this case, the first two cells of the first tank. In reality, the Linac is only quasi-periodic since there are gradual changes in cell properties and beam energy. The transverse emittances used in the match were obtained from measurements of emittance close to the first two bunchers in LEBT. For the longitudinal emittance, we used the calculated value out of the RFQ. Output from the matching calculation is shown in Fig. 1 FOR a 30 mA H^- beam. A beam matched to the Linac was then transported through the Linac using PARTRACE. (For the real beam, PARMILA must be used since the longitudinal phase space of the beam at the end of LEBT is expected to be highly distorted. There is a large longitudinal growth in the beam between the RFQ and the first buncher.) Beam profiles in the three phase planes are plotted tank-by-tank in Fig. 2. Each intertank drift space is treated as part of the preceding tank.

LEBT/HEBT

Input files for LEBT and HEBT lines have been prepared and will be reported in a subsequent note. Thus, in principle, it should be possible to follow the beam from the exit of the RFQ to injection into the AGS.

Results

Important properties of the Linac generated by PARMILA are tabulated in Appendix B and compared with the original design in Table 1; the agreement is very good. The behavior of the matched beam is shown, tank-by-tank, in Appendix C.

Conclusion

Using either of the codes PARMILA and PARTRACE, we can generate the BNL 200 MeV Linac, with excellent results. From our experience so far, PARMILA must be used for LEBT and at least, the first few tanks of the linac, when the longitudinal phase should have "settled down", whereas PARTRACE may be used for the remainder of the Linac and HEBT. Topics we can study include: Beam losses between the RFQ and the AGS and in the Linac, emittance growth in the Linac, the energy spectrum of the beam out of the Linac, the effects of random and systematic errors on beam transport. Some of these have already been done and will be reported later.

References

1. G.P. Boicourt, PARMILA - An Overview. AIP Conf. Proc. No. 177 (1988). A very recent review.

2. K.C. Crandall, Error Studies Using PARTRACE: A New Program that combines PARMILA and TRACE 3-D. Proc. Linear Acc. Conf. 1988. To be published.

3. K.C. Crandall, TRACE 3-D Documentation, LANL, LA-11054-MS (1987).

4. A. Benton, BNL AGSCD Tech. Note No. 119, 1970.

5. G.W. Wheeler, K. Batchelor et al., Particle Accelerators, Vol. 9 (1979) pp. 1-156.

6. Reference 5, p. 30. Table II.2.g.1.

TABLE 1

COMPARISON OF SOME PARAMETERS FOR THE ORIGINAL LINAC DESIGN AND THE PARMILA MODEL.

	CAVITY NUMBERS									
	1 IN	1 OUT	2 IN	2 OUT	3 IN	3 OUT	4 IN	4 OUT	5 IN	5 OUT
BEAM ENERGY (MeV)	.75 .750	10.42 10.422		37.54 37.536		66.18 66.180		92.55 92.555		116.54 116.545
BEAM VELOCITY, β	.04 .040	.148 .1478		.275 .2747		.357 .3570		.414 .4141		.457 .4569
ENERGY GAIN (MeV)	9.67 9.672		27.12 27.114		28.64 28.644		26.37 26.375		23.99 23.990	
CAVITY LENGTH (m)	7.44 7.446		19.02 19.018		16.53 16.527		16.68 16.684		15.58 15.586	
AVERAGE AXIAL FIELD (MV/m)	1.60 2.31 1.603 2.288		2.0 2.001		2.60 2.603		2.60 2.603		2.56 2.562	
ACCUMULATED LENGTH (m)	7.66 7.667		27.28 27.285		44.56 44.562		62.24 62.246		78.82 78.832	
AXIAL TRANSIT TIME FACTOR	.64 .81 .643 .806		.86 .81 .860 .808		.82 .75 .824 .750		.75 .69 .748 .687		.73 .69 .733 .686	

	6 IN	6 OUT	7 IN	7 OUT	8 IN	8 OUT	9 IN	9 OUT	TOTAL/ FINAL
BEAM ENERGY (MeV)		138.98 138.983		160.53 160.530		181.01 181.012		200.3 200.310	
BEAM VELOCITY, β		.491 .4913		.520 .5204		.545 .5452		.566 .5665	
ENERGY GAIN (MeV)	22.44 22.438		21.55 21.547		20.48 20.482		19.29 19.298		199.55 199.560
CAVITY LENGTH (m)	15.54 15.547		15.83 15.831		15.88 15.879		15.73 15.736		138.23 138.254
AVERAGE AXIAL FIELD (MV/m)	2.56 2.563		2.56 2.561		2.56 2.562		2.56 2.562		
ACCUMULATED LENGTH (m)	95.36 95.379		112.19 112.210		129.07 129.089		144.80 144.825		
AXIAL TRANSIT TIME FACTOR	.68 .65 .684 .645		.64 .61 .644 .610		.61 .58 .609 .579		.58 .55 .578 .552		

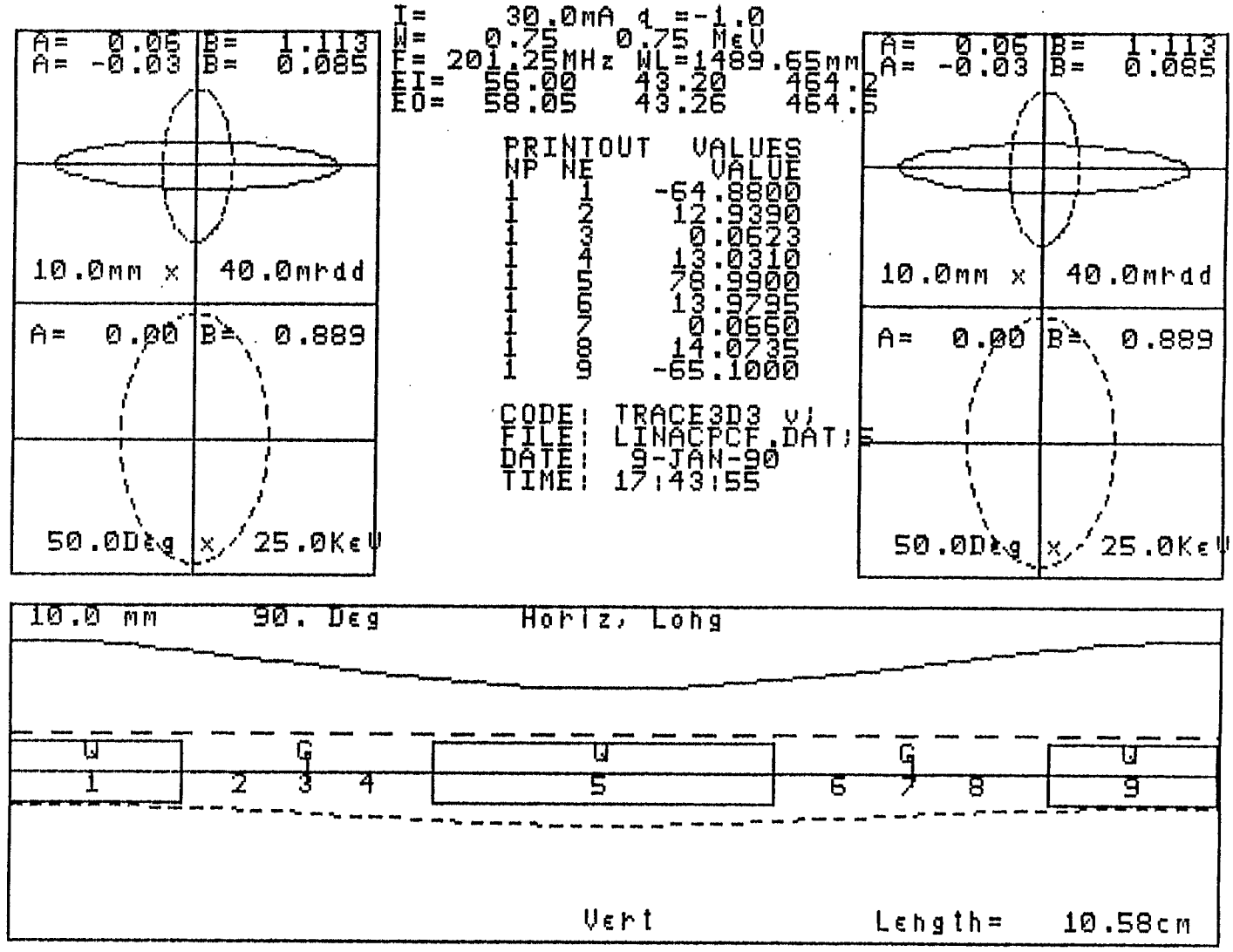


Figure 1: TRACE 3-D output for the Linac input matching Twiss parameters.

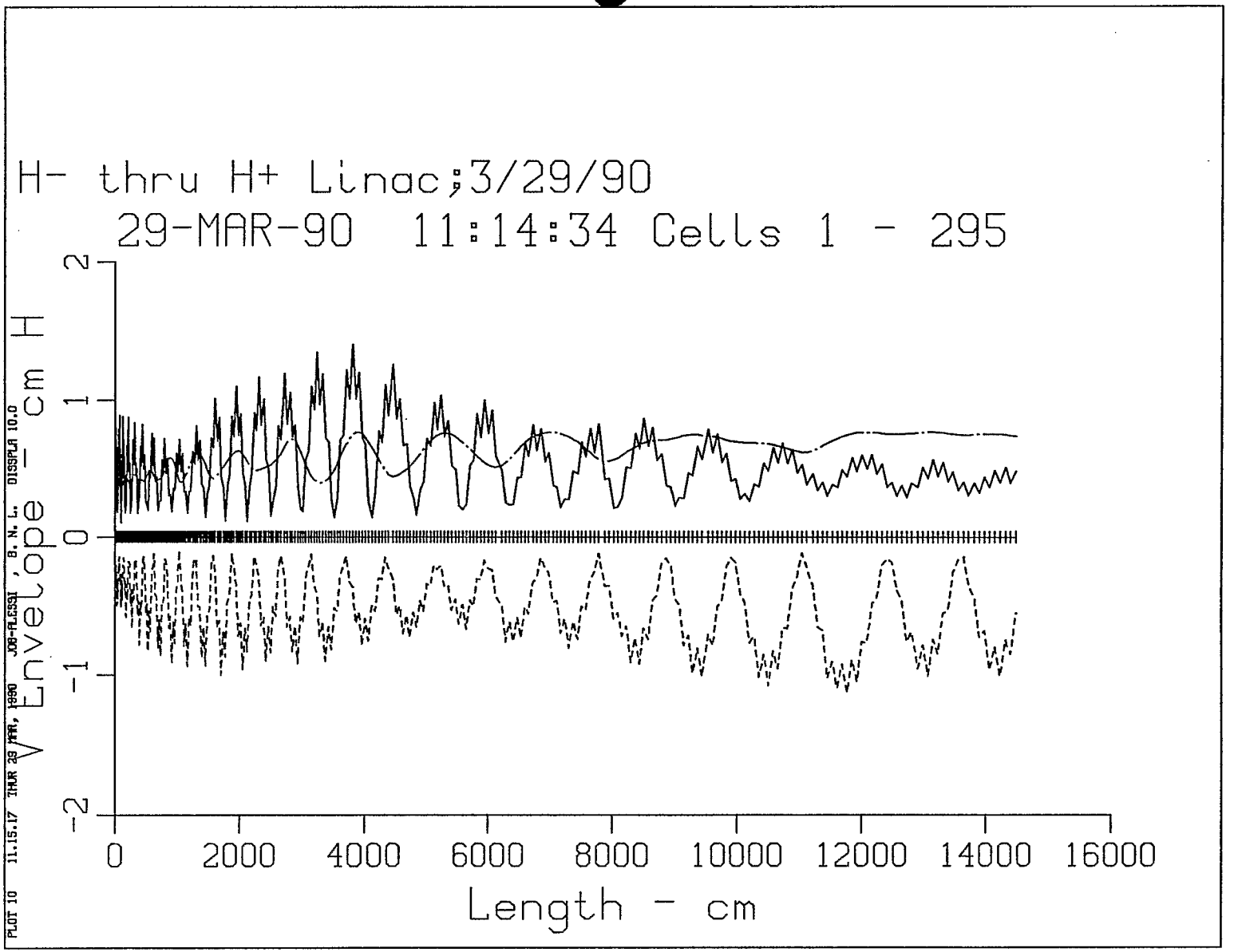


Figure 2: PARTRACE plots of beam envelopes in the Linac. Horizontal ———— ; Vertical– – – –; Longitudinal—·—·—·— .

a. All nine tanks and intertank drift spaces.

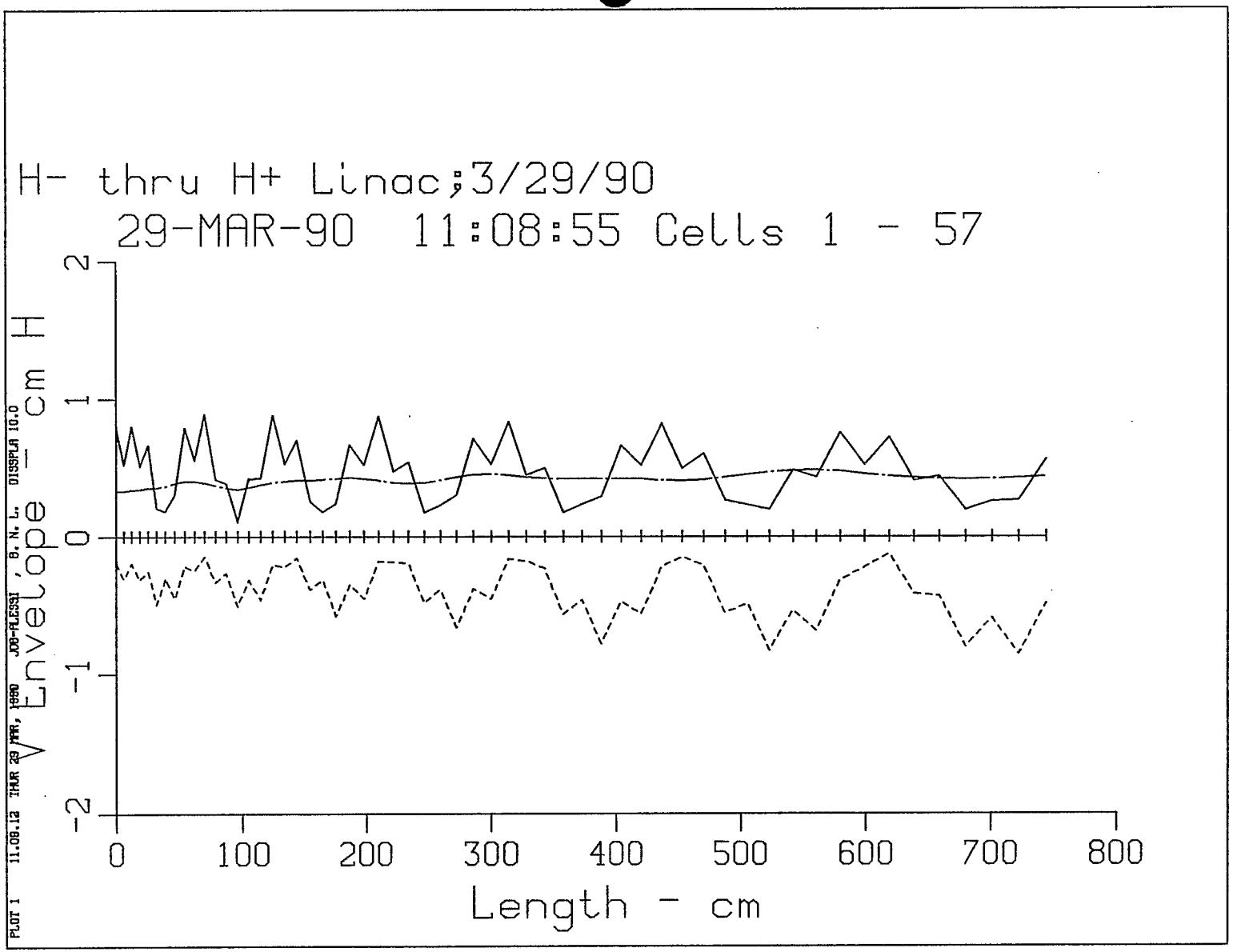


Figure 2b: Tank 1.

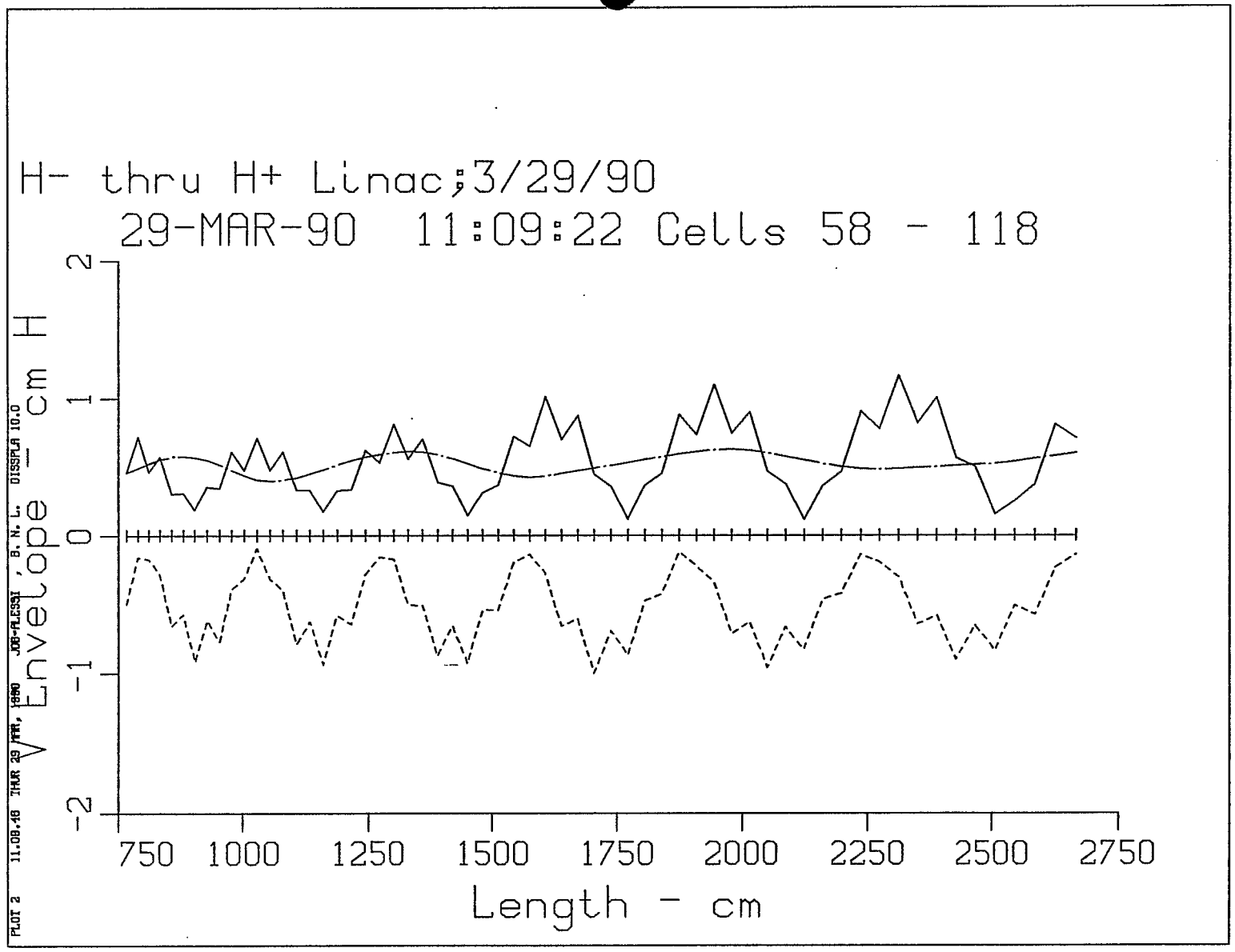


Figure 2c: Tank 2.

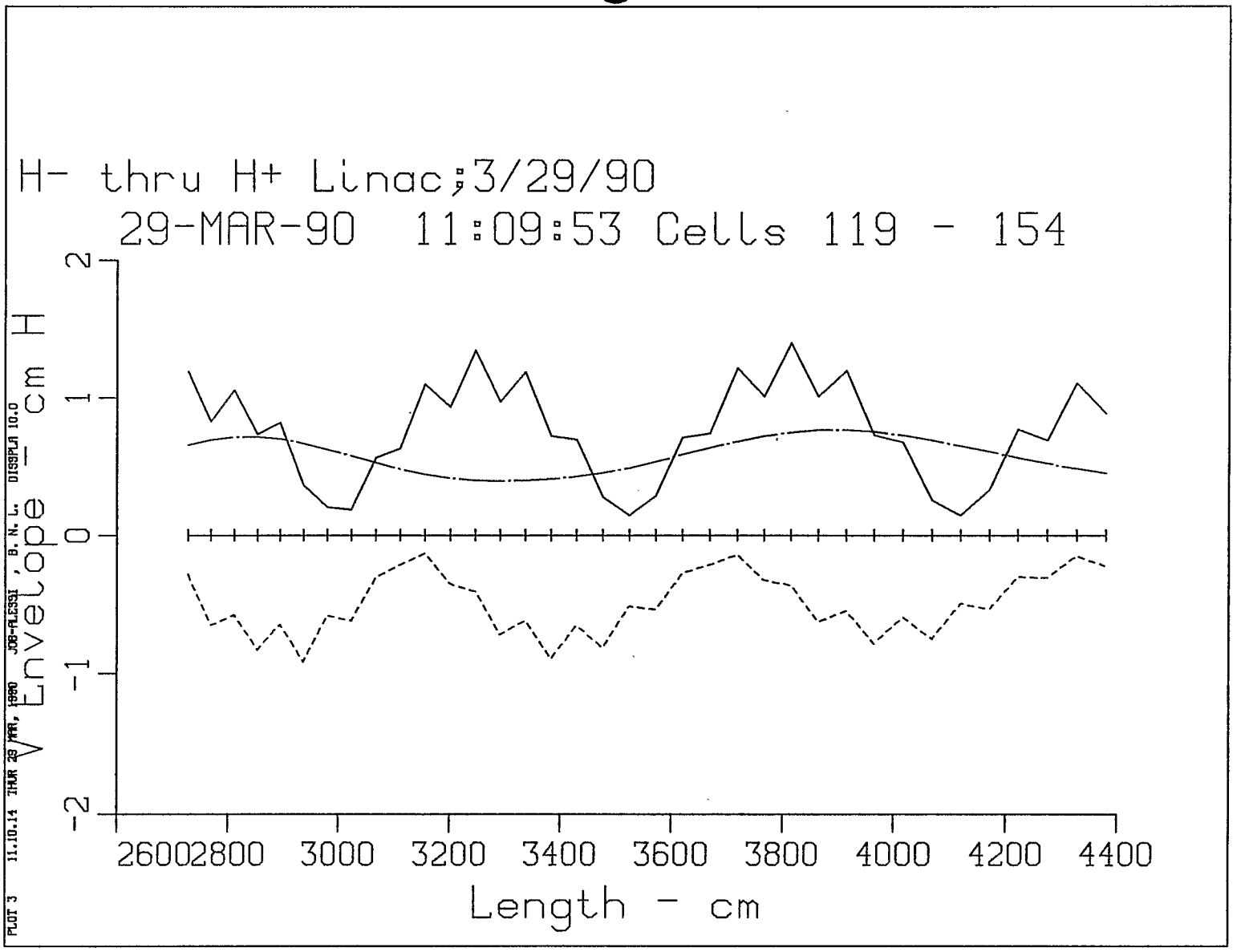
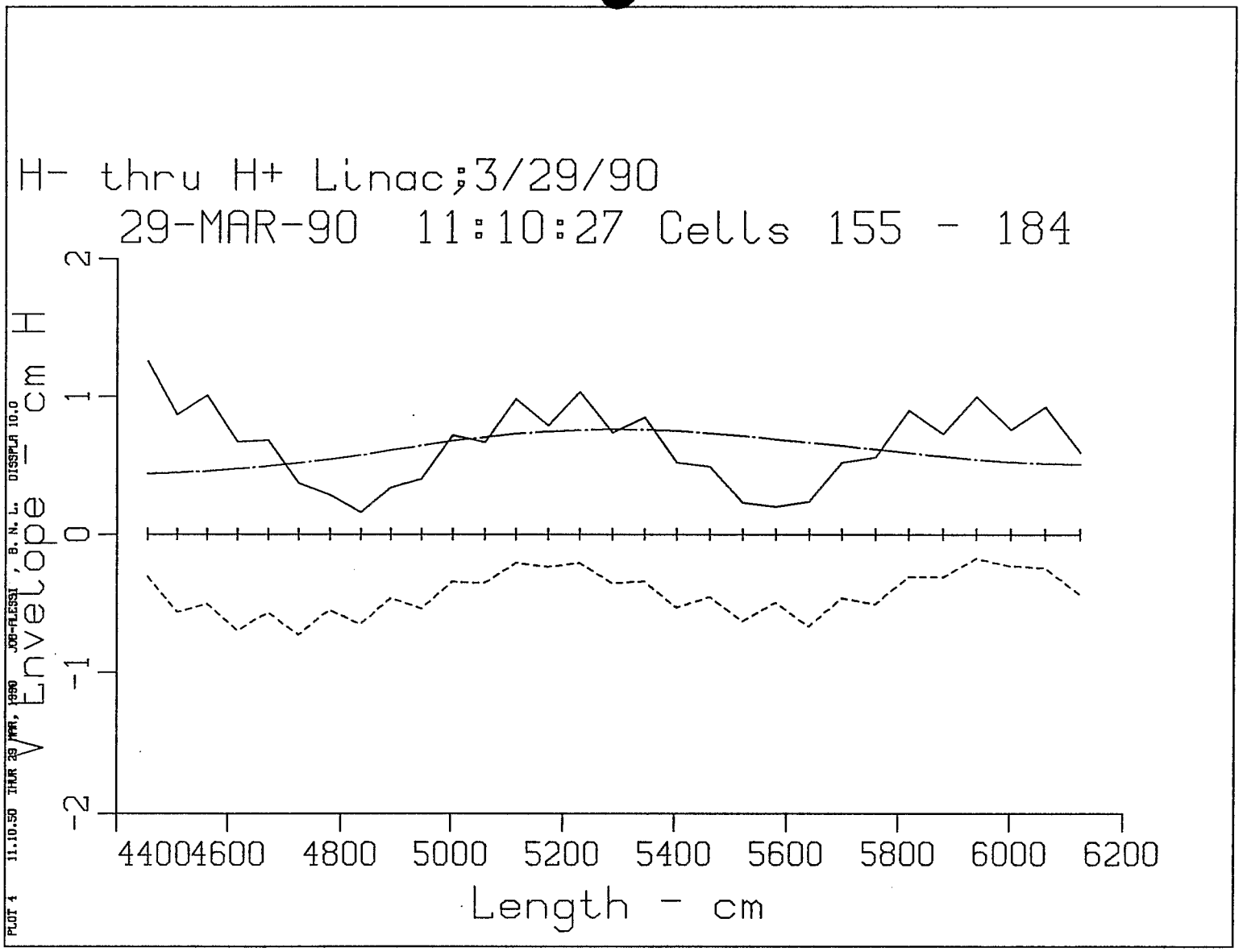


Figure 2d: Tank 3



Tank 2e: Tank 4.

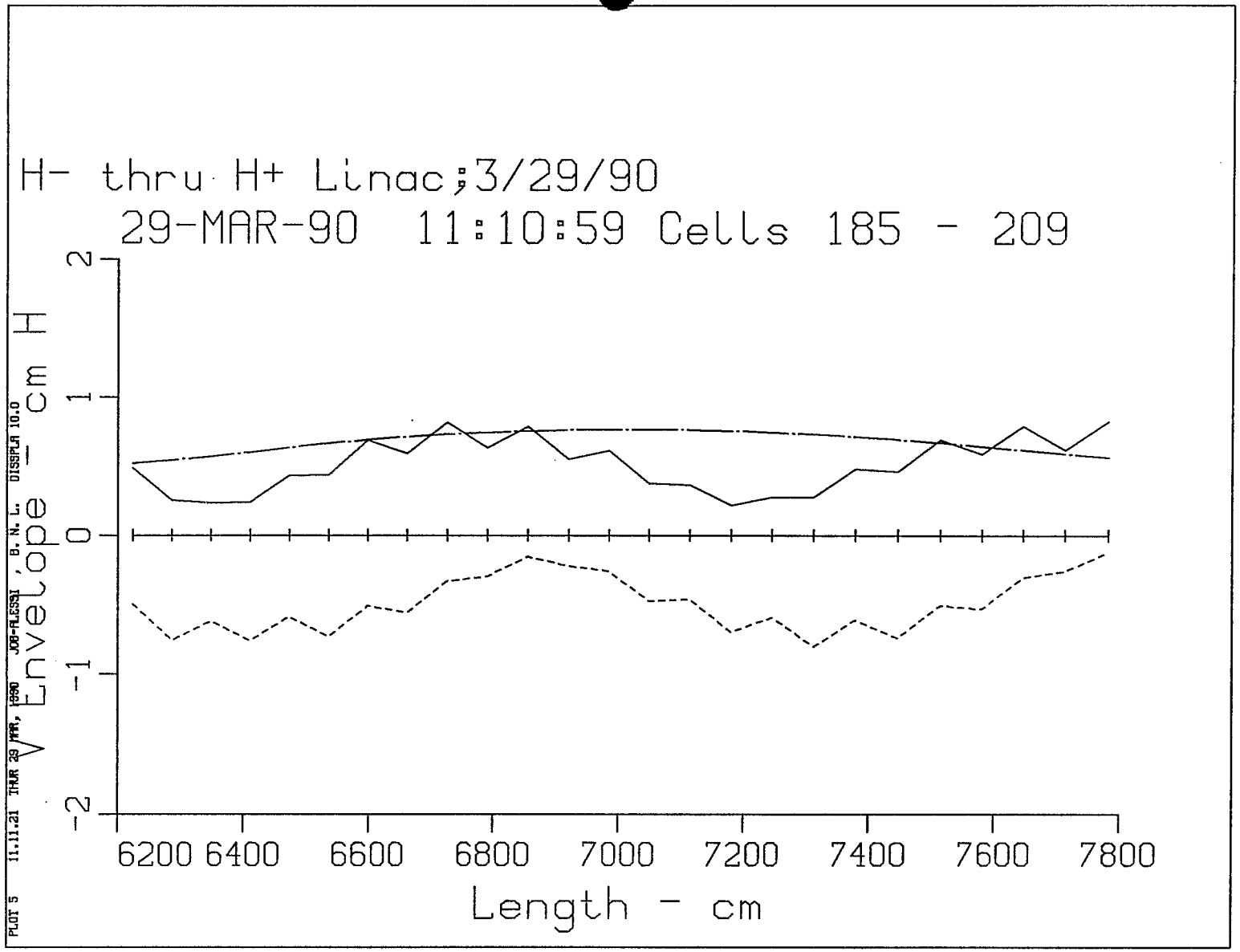


Figure 2f: Tank 5.

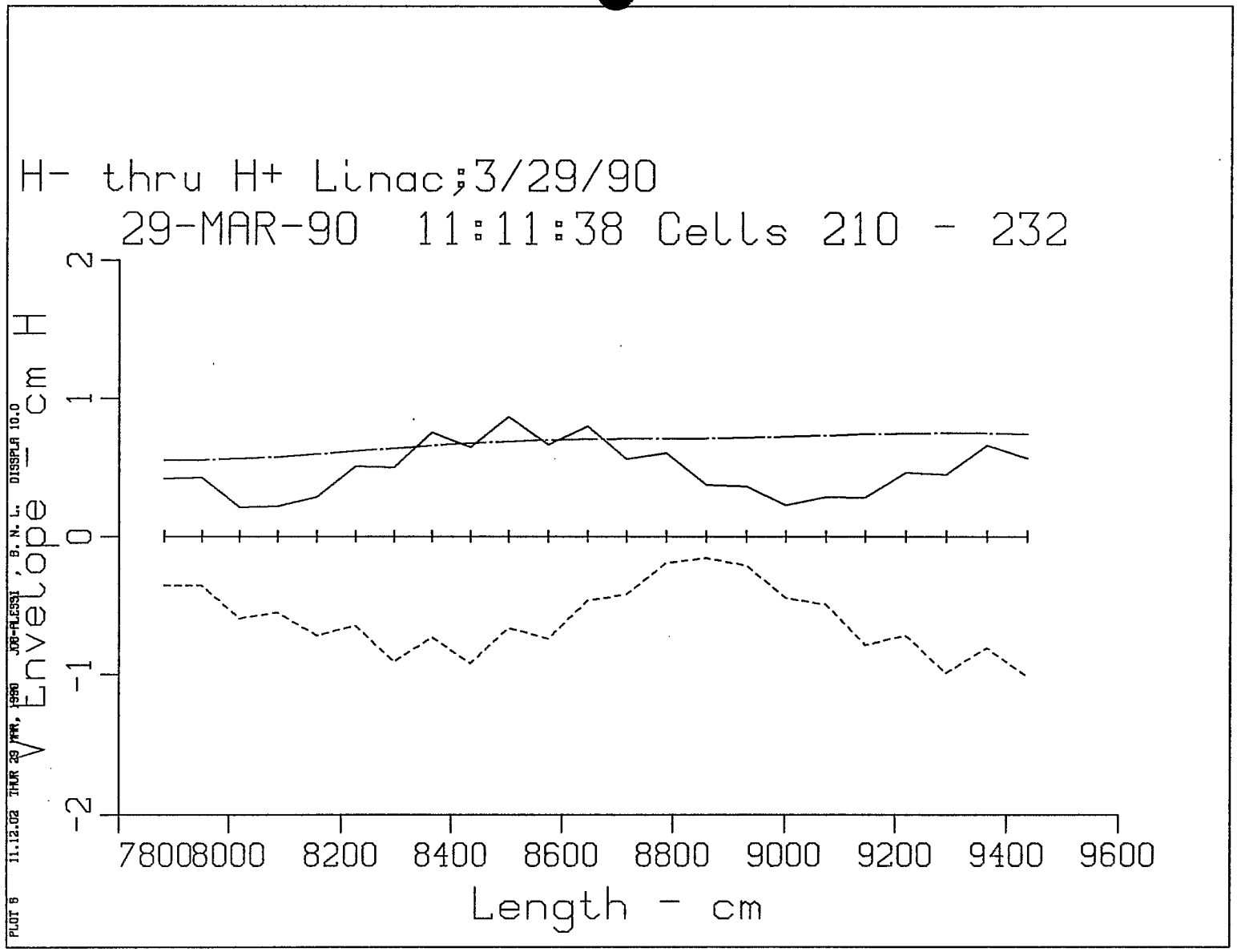


Figure 2g: Tank 6.

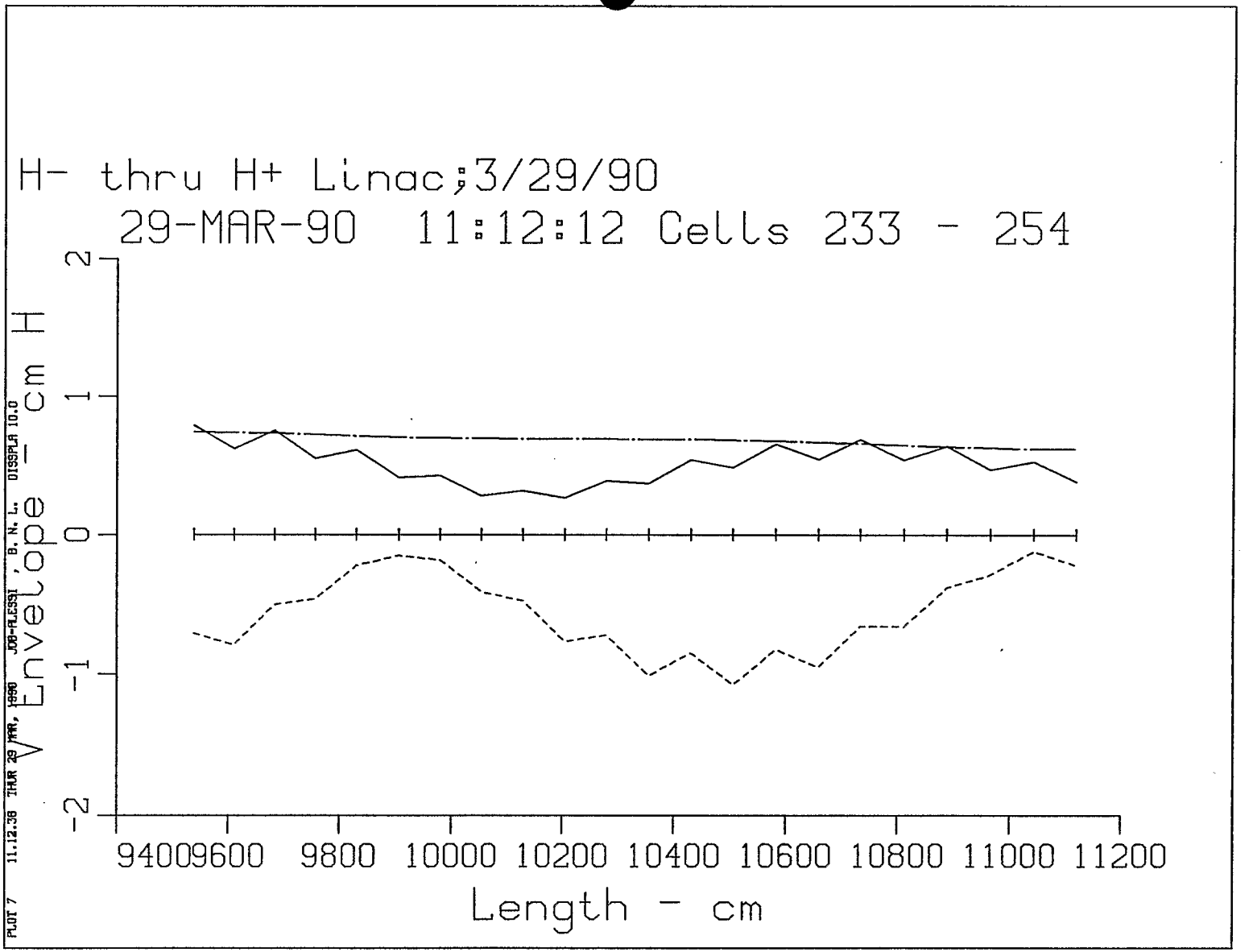
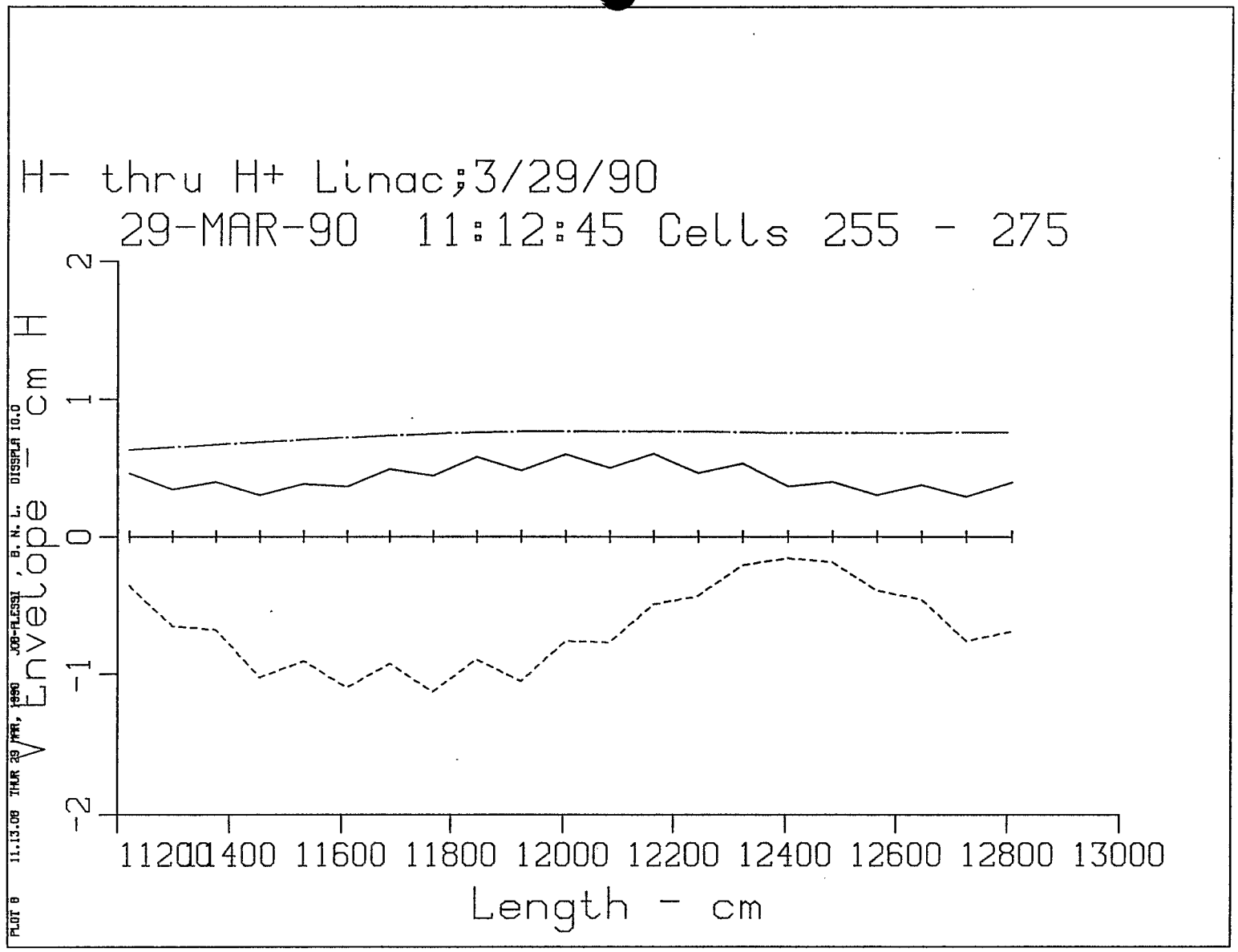


Figure 2h: Tank 7.


H- thru H+ Linac;3/29/90
29-MAR-90 11:12:45 Cells 255 - 275
Envelope - cm H
2
1
0
-1
-2
11200
11400
11600
11800
12000
12200
12400
12600
12800
13000
Length - cm
PLOT 8 11.13.09 THUR 29 MAR, 1990 JOB=FLESSI , B. N. L. DISSPLA 10.0

Tank 2 - Tank 8.

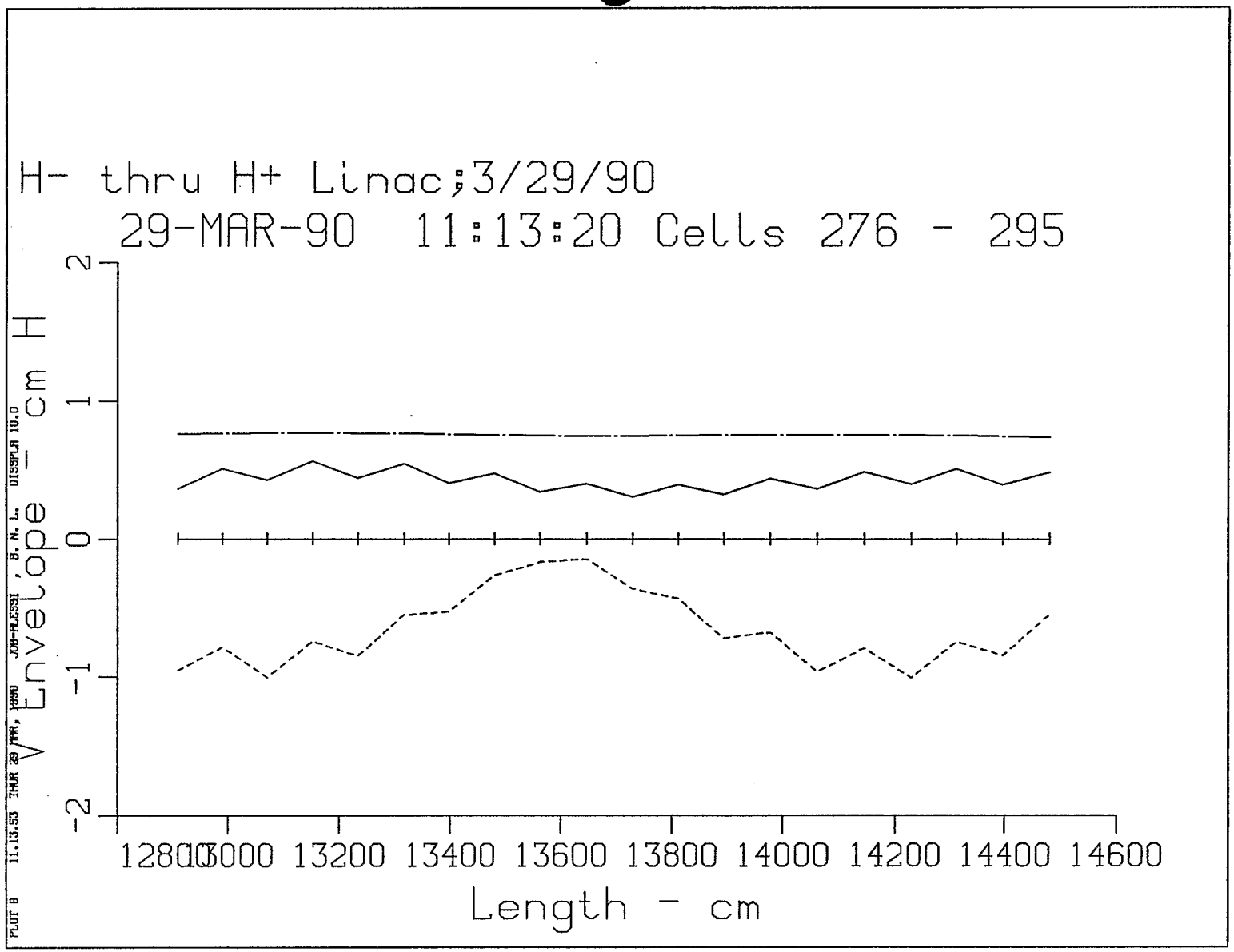


Figure 2j: Tank 9.

```
 RUN 1 0
LINAC 9 0.75 201.25  1.0
TITLE
 BLUE BOOK LINAC(FOR PROTONS)
TANK 1 10.42 -32.0 0.016 0.0005865  0.0231 22.0 0.0 3.0 -3.0
    -0.5 1 2 12  0.0 1.1 1.45 18  0.0
TANK 2 37.54 -32.0  0.02001 0.0 0.0  60.0 0.0 3.0 -3.0
    -0.5 1 1 22  0.0 1.7 0.0 0.0 0.0
TANK 3 66.18 -32.0  0.02603 0.0 0.0  75.0 0.0 3.0 -3.0
    -0.5 1 2 22  0.0 1.7 0.0 0.0 0.0
TANK 4 92.55 -32.0  0.02603 0.0 0.0 100.0 0.0 3.0 -3.0
    -0.5 1 2 22 0.0 1.7 0.0 0.0 0.0
TANK 5 116.54 -32.0 0.02562 0.0 0.0 100.0 0.0 3.0 -3.0
    -0.5 1 2 22 0.0 2.2 0.0 0.0 0.0
TANK 6 138.98 -32.0 0.02563 0.0 0.0 100.0 0.0 3.0 -3.0
    -0.5 1 1 22 0.0 2.2 0.0 0.0 0.0
TANK 7 160.53 -32.0 0.02561 0.0 0.0 100.0 0.0 3.0 -3.0
    -0.5 1 2 22 0.0 2.2 0.0 0.0 0.0
TANK 8 181.01 -32.0 0.02562 0.0 0.0 100.0 -18.6 3.0 -3.0
    -0.5 1 2 22 0.0 2.2 0.0 0.0 0.0
TANK 9 200.30 -32.0 0.02562 0.0 0.0   0.0 0.0 3.0 -3.0
    -0.5 1 1 21 0.0 2.2 0.0 0.0 0.0
CHARGE +1
SFDATA  0.0369   0.6070   0.0913   0.5635   0.0323   0.2105  23.6505
        0.0403   0.6406   0.0868   0.5511   0.0369   0.2138  26.7906
        0.0436   0.6697   0.0826   0.5396   0.0407   0.2170  29.6988
        0.0470   0.6946   0.0787   0.5289   0.0439   0.2203  32.3751
        0.0503   0.7157   0.0752   0.5190   0.0465   0.2236  34.8194
        0.0537   0.7336   0.0719   0.5100   0.0485   0.2268  37.0318
        0.0571   0.7485   0.0689   0.5019   0.0502   0.2301  39.0123
        0.0604   0.7610   0.0662   0.4945   0.0514   0.2334  40.7609
        0.0638   0.7714   0.0638   0.4881   0.0523   0.2367  42.2775
        0.0671   0.7802   0.0617   0.4825   0.0530   0.2399  43.5622
        0.0705   0.7877   0.0600   0.4777   0.0536   0.2432  44.6150  17
SFDATA  0.0671   0.7385   0.0696   0.5078   0.0494   0.2390  39.0716
        0.0738   0.7573   0.0663   0.4977   0.0512   0.2451  41.2223
        0.0806   0.7724   0.0636   0.4897   0.0528   0.2511  43.0295
        0.0873   0.7842   0.0613   0.4835   0.0540   0.2571  44.5192
        0.0940   0.7930   0.0595   0.4791   0.0549   0.2630  45.7175
        0.1074   0.8036   0.0571   0.4747   0.0563   0.2748  47.3437
        0.1141   0.8061   0.0564   0.4744   0.0568   0.2807  47.8238
        0.1208   0.8072   0.0561   0.4752   0.0572   0.2865  48.1164
        0.1275   0.8074   0.0561   0.4768   0.0576   0.2923  48.2478
        0.1343   0.8069   0.0563   0.4790   0.0580   0.2980  48.2438
        0.1410   0.8064   0.0567   0.4818   0.0585   0.3037  48.1305
        0.1477   0.8060   0.0573   0.4848   0.0591   0.3094  47.9340
        0.1544   0.8062   0.0581   0.4881   0.0599   0.3151  47.6802  -1
SFDATA  0.1410   0.8575   0.0417   0.4023   0.0518   0.1903  53.2567
        0.1477   0.8593   0.0416   0.4034   0.0522   0.1967  53.4898
        0.1611   0.8611   0.0415   0.4069   0.0531   0.2094  53.6289
        0.1745   0.8605   0.0419   0.4119   0.0539   0.2220  53.3780
        0.1880   0.8579   0.0427   0.4184   0.0548   0.2345  52.7921
        0.2014   0.8535   0.0439   0.4265   0.0558   0.2470  51.9261
        0.2148   0.8474   0.0455   0.4360   0.0567   0.2594  50.8350
        0.2282   0.8400   0.0476   0.4470   0.0578   0.2717  49.5739
        0.2417   0.8314   0.0500   0.4596   0.0589   0.2839  48.1978
        0.2551   0.8218   0.0529   0.4737   0.0600   0.2961  46.7617
        0.2685   0.8116   0.0561   0.4893   0.0611   0.3082  45.3206
        0.2752   0.8063   0.0579   0.4976   0.0617   0.3142  44.6155  -2
SFDATA  0.2752   0.8241   0.0525   0.4741   0.0604   0.2970  44.6626
```

```
          0.2887   0.8128   0.0557   0.4892   0.0615   0.3087   43.0898
          0.3021   0.8011   0.0591   0.5041   0.0625   0.3201   41.5170
          0.3155   0.7889   0.0625   0.5189   0.0633   0.3314   39.9443
          0.3289   0.7763   0.0660   0.5334   0.0639   0.3425   38.3715
          0.3424   0.7632   0.0696   0.5478   0.0645   0.3534   36.7987
          0.3558   0.7497   0.0733   0.5619   0.0649   0.3641   35.2259
          0.3692   0.7357   0.0770   0.5758   0.0651   0.3746   33.6532
          0.3826   0.7212   0.0809   0.5895   0.0653   0.3850   32.0804
          0.3961   0.7063   0.0849   0.6031   0.0653   0.3951   30.5076
          0.4095   0.6909   0.0889   0.6164   0.0651   0.4051   28.9349
          0.4162   0.6830   0.0910   0.6230   0.0650   0.4100   28.1485  -4
SFDATA    0.4095   0.7395   0.0425   0.5742   0.0657   0.3617   30.2808
          0.4162   0.7317   0.0435   0.5820   0.0658   0.3669   29.4431
          0.4229   0.7239   0.0445   0.5895   0.0658   0.3720   28.6336
          0.4296   0.7161   0.0455   0.5968   0.0659   0.3771   27.8503
          0.4363   0.7083   0.0464   0.6039   0.0659   0.3822   27.0916
          0.4431   0.7006   0.0472   0.6109   0.0658   0.3872   26.3557
          0.4498   0.6929   0.0481   0.6176   0.0657   0.3922   25.6410
          0.4632   0.6773   0.0496   0.6307   0.0654   0.4020   24.2677
          0.4699   0.6695   0.0504   0.6370   0.0652   0.4069   23.6058
          0.4766   0.6617   0.0511   0.6431   0.0650   0.4117   22.9579
          0.4833   0.6539   0.0518   0.6492   0.0647   0.4164   22.3224
          0.4900   0.6460   0.0525   0.6551   0.0644   0.4212   21.6975
          0.4968   0.6380   0.0532   0.6609   0.0640   0.4258   21.0815  -6
SFDATA    0.4900   0.6460   0.0525   0.6551   0.0644   0.4212   21.6975
          0.4968   0.6380   0.0532   0.6609   0.0640   0.4258   21.0815
          0.5035   0.6300   0.0538   0.6666   0.0636   0.4304   20.4727
          0.5102   0.6219   0.0545   0.6722   0.0632   0.4350   19.8692
          0.5169   0.6138   0.0551   0.6777   0.0627   0.4396   19.2694
          0.5236   0.6055   0.0557   0.6831   0.0622   0.4441   18.6715
          0.5303   0.5972   0.0564   0.6885   0.0616   0.4485   18.0737
          0.5370   0.5888   0.0570   0.6938   0.0610   0.4529   17.4744
          0.5438   0.5803   0.0576   0.6991   0.0603   0.4573   16.8717
          0.5505   0.5717   0.0582   0.7043   0.0597   0.4616   16.2640
          0.5572   0.5629   0.0588   0.7095   0.0589   0.4659   15.6495
          0.5639   0.5541   0.0594   0.7147   0.0582   0.4701   15.0264  -9
CHANGE 11 3.45   1   7   1
CHANGE 11 4.09   8  17
CHANGE 11 5.64  18  35
CHANGE 11 8.20  36  55
CHANGE 11 5.64  56  56
CHANGE 11 5.64  57  57  2
CHANGE 11 11.38 57 116
CHANGE 11 11.38 117 151 3
CHANGE 11 11.38 152 178 4
CHANGE 11 16.46 179 180
CHANGE 11 16.46 181 204 5
CHANGE 11 16.46 205 226 6
CHANGE 11 16.46 227 247 7
CHANGE 11 16.46 248 267 8
CHANGE 11 16.46 268 286 9
CHANGE 10 6488.   1   1   1
CHANGE 10 7899.   1   1
CHANGE 10 6510.   2   3
CHANGE 10 7888.   4   5
CHANGE 10 7758.   6   7
CHANGE 10 6629.   8   9
CHANGE 10 6477.  10  11
CHANGE 10 6412.  12  13
CHANGE 10 6315.  14  15
```

```
CHANGE 10 6239. 16 17
CHANGE 10 4678. 18 19
CHANGE 10 4582. 20 21
CHANGE 10 4497. 22 23
CHANGE 10 4396. 24 25
CHANGE 10 4311. 26 27
CHANGE 10 4221. 28 29
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CHANGE 10 4057. 32 33
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CHANGE 10 2897. 36 37
CHANGE 10 2824. 38 39
CHANGE 10 2751. 40 41
CHANGE 10 2717. 42 43
CHANGE 10 2644. 44 45
CHANGE 10 2604. 46 47
CHANGE 10 2537. 48 49
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CHANGE 10 2441. 52 53
CHANGE 10 2424. 54 55
CHANGE 10 3317. 56 56
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CHANGE 10 1821. 57 58
CHANGE 10 1790. 59 60
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CHANGE 10 1738. 63 64
CHANGE 10 1709. 65 66
CHANGE 10 1685. 67 68
CHANGE 10 1730. 69 70
CHANGE 10 1717. 71 72
CHANGE 10 1633. 73 74
CHANGE 10 1537. 75 76
CHANGE 10 1605. 77 78
CHANGE 10 1602. 79 80
CHANGE 10 1683. 81 82
CHANGE 10 1576. 83 84
CHANGE 10 1451. 85 86
CHANGE 10 1568. 87 88
CHANGE 10 1618. 89 90
CHANGE 10 1545. 91 92
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CHANGE 10 1498. 99 100
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CHANGE 10 1456. 107 108
CHANGE 10 1435. 109 110
CHANGE 10 1428. 111 112
CHANGE 10 1654. 113 114
CHANGE 10 1537. 115 115
CHANGE 10 1300. 116 116
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CHANGE 10 1537. 117 117
CHANGE 10 1209. 118 119
CHANGE 10 1495. 120 121
CHANGE 10 1362. 122 123
CHANGE 10 1342. 124 125
CHANGE 10 1331. 126 127
CHANGE 10 1321. 128 129
CHANGE 10 1310. 130 131
CHANGE 10 1303. 132 133
CHANGE 10 1289. 134 135
CHANGE 10 1282. 136 137
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CHANGE 10 1261. 140 141
CHANGE 10 1250. 142 143
CHANGE 10 1276. 144 145
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CHANGE 10 1540. 148 149
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CHANGE 10 1094. 155 156
CHANGE 10 1091. 157 158
CHANGE 10 1193. 159 160
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CHANGE 10 1188. 163 164
CHANGE 10 1185. 165 168
CHANGE 10 1177. 169 170
CHANGE 10 1329. 171 172
CHANGE 10 1164. 173 174
CHANGE 10 1303. 175 176
CHANGE 10 1175. 177 178
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CHANGE 10  829. 198 199
CHANGE 10  822. 200 201
CHANGE 10  817. 202 202
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CHANGE 10  574. 207 208
CHANGE 10  804. 209 210
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CHANGE 10  807. 213 214
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CHANGE 10  781. 219 220
CHANGE 10  785. 221 222
CHANGE 10  774. 223 224
CHANGE 10  787. 225 225
CHANGE 10  704. 226 226
CHANGE 10  704. 227 227 7
CHANGE 10  787. 227 227
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CHANGE 10  758. 230 231
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CHANGE 10  754. 234 237
CHANGE 10  748. 238 239
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CHANGE 10  738. 242 243
CHANGE 10  742. 244 245
CHANGE 10  719. 246 246
CHANGE 10  745. 247 247
CHANGE 10  745. 248 248 8
CHANGE 10  719. 248 248
CHANGE 10  768. 249 250
CHANGE 10  568. 251 252
CHANGE 10  660. 253 254
CHANGE 10  724. 255 256
CHANGE 10  654. 257 258
CHANGE 10  721. 259 260
CHANGE 10  825. 261 262
CHANGE 10  718. 263 264
CHANGE 10  852. 265 266
CHANGE 10  682. 267 267
CHANGE 10  682. 268 268 9
CHANGE 10  812. 268 285
CHANGE 10  631. 286 286
TITLE
H- ;+/-75 DEG INPUT;0 DEG AT T1;-18.6 DEG AT T9
LINAC 9 0.75 201.25 1.001089
CHARGE -1
INPUT 8 300 0.0603 111.32 0.0056 -0.0277 8.52 0.00432
      75.0 0.0232 0.0 0.0 0.0 0.0 0.0 0.0 0.0
SCHEFF 30.0 0.2 0.2 6 12 0 0 0 1 3
OUTPUT 3 1 0 0 0 0 1
OUTPUT 4 1 0 0 0 0 1 2 3 4 5 6 7 8 9
START -1
STOP  -9
BEGIN
END
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1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 1 TANK LENGTH 744.615 CENTIMETERS 56 CELLS POWER= 0.829 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	0.7500	0.0400						3.4500	-6.4880			0.000
1	0.8028	0.0413	6.0385	0.6427	0.0865	0.5503	0.0372	3.4500	7.8990	1.6028	-32.00	6.039
2	0.8586	0.0428	6.2467	0.6550	0.0847	0.5454	0.0388	3.4500	-6.5100	1.6086	-32.00	12.285
3	0.9176	0.0442	6.4596	0.6676	0.0829	0.5404	0.0404	3.4500	6.5100	1.6145	-32.00	18.745
4	0.9799	0.0457	6.6771	0.6787	0.0812	0.5358	0.0419	3.4500	-7.8880	1.6207	-32.00	25.422
5	1.0455	0.0472	6.8990	0.6896	0.0795	0.5311	0.0433	3.4500	7.8880	1.6270	-32.00	32.321
6	1.1146	0.0487	7.1252	0.6999	0.0778	0.5264	0.0446	3.4500	-7.7580	1.6336	-32.00	39.446
7	1.1873	0.0503	7.3556	0.7098	0.0762	0.5218	0.0458	3.4500	7.7580	1.6404	-32.00	46.802
8	1.2635	0.0518	7.5901	0.7191	0.0746	0.5173	0.0469	4.0900	-6.6290	1.6474	-32.00	54.392
9	1.3434	0.0535	7.8284	0.7276	0.0730	0.5130	0.0478	4.0900	6.6290	1.6547	-32.00	62.220
10	1.4271	0.0551	8.0705	0.7357	0.0715	0.5089	0.0487	4.0900	-6.4770	1.6621	-32.00	70.291
11	1.5146	0.0568	8.3163	0.7429	0.0700	0.5049	0.0496	4.0900	6.4770	1.6698	-32.00	78.607
12	1.6060	0.0584	8.5655	0.7500	0.0686	0.5010	0.0503	4.0900	-6.4120	1.6777	-32.00	87.172
13	1.7014	0.0601	8.8180	0.7564	0.0672	0.4972	0.0510	4.0900	6.4120	1.6859	-32.00	95.990
14	1.8008	0.0619	9.0739	0.7626	0.0658	0.4935	0.0515	4.0900	-6.3150	1.6943	-32.00	105.064
15	1.9043	0.0636	9.3329	0.7679	0.0646	0.4903	0.0520	4.0900	6.3150	1.7029	-32.00	114.397
16	2.0120	0.0654	9.5950	0.7730	0.0634	0.4871	0.0524	4.0900	-6.2390	1.7118	-32.00	123.992
17	2.1239	0.0672	9.8600	0.7778	0.0623	0.4840	0.0528	4.0900	6.2390	1.7209	-32.00	133.852
18	2.2399	0.0689	10.1191	0.7408	0.0692	0.5066	0.0496	5.6400	-4.6780	1.7303	-32.00	143.971
19	2.3481	0.0706	10.3757	0.7457	0.0683	0.5040	0.0501	5.6400	4.6780	1.7399	-32.00	154.347
20	2.4665	0.0724	10.6353	0.7505	0.0675	0.5013	0.0506	5.6400	-4.5820	1.7498	-32.00	164.982
21	2.5894	0.0741	10.8980	0.7555	0.0666	0.4987	0.0510	5.6400	4.5820	1.7599	-32.00	175.880
22	2.7167	0.0759	11.1637	0.7598	0.0658	0.4964	0.0515	5.6400	-4.4970	1.7702	-32.00	187.044
23	2.8486	0.0777	11.4324	0.7638	0.0651	0.4942	0.0519	5.6400	4.4970	1.7808	-32.00	198.477
24	2.9852	0.0796	11.7041	0.7679	0.0644	0.4921	0.0523	5.6400	-4.3960	1.7917	-32.00	210.181
25	3.1266	0.0814	11.9788	0.7720	0.0637	0.4899	0.0528	5.6400	4.3960	1.8028	-32.00	222.159
26	3.2728	0.0833	12.2563	0.7754	0.0630	0.4881	0.0531	5.6400	-4.3110	1.8142	-32.00	234.416
27	3.4239	0.0852	12.5368	0.7787	0.0624	0.4864	0.0534	5.6400	4.3110	1.8258	-32.00	246.953
28	3.5802	0.0871	12.8201	0.7820	0.0617	0.4846	0.0538	5.6400	-4.2210	1.8377	-32.00	259.773
29	3.7416	0.0890	13.1063	0.7851	0.0611	0.4831	0.0541	5.6400	4.2210	1.8499	-32.00	272.879
30	3.9082	0.0910	13.3953	0.7876	0.0606	0.4818	0.0544	5.6400	-4.1530	1.8623	-32.00	286.274
31	4.0802	0.0930	13.6871	0.7902	0.0601	0.4805	0.0546	5.6400	4.1530	1.8750	-32.00	299.961
32	4.2577	0.0949	13.9816	0.7928	0.0595	0.4792	0.0549	5.6400	-4.0570	1.8880	-32.00	313.943
33	4.4406	0.0969	14.2789	0.7945	0.0592	0.4785	0.0551	5.6400	4.0570	1.9012	-32.00	328.222
34	4.6290	0.0990	14.5786	0.7961	0.0588	0.4778	0.0553	5.6400	-3.9830	1.9148	-32.00	342.800
35	4.8232	0.1010	14.8810	0.7977	0.0584	0.4772	0.0555	5.6400	3.9830	1.9286	-32.00	357.681
36	5.0231	0.1031	15.1860	0.7993	0.0581	0.4765	0.0557	8.2000	-2.8970	1.9427	-32.00	372.867
37	5.2291	0.1051	15.4936	0.8009	0.0577	0.4758	0.0559	8.2000	2.8970	1.9571	-32.00	388.361
38	5.4412	0.1072	15.8040	0.8026	0.0573	0.4751	0.0562	8.2000	-2.8240	1.9718	-32.00	404.165
39	5.6595	0.1093	16.1171	0.8039	0.0570	0.4747	0.0564	8.2000	2.8240	1.9868	-32.00	420.282
40	5.8840	0.1115	16.4328	0.8047	0.0568	0.4746	0.0565	8.2000	-2.7510	2.0020	-32.00	436.715
41	6.1149	0.1136	16.7509	0.8055	0.0566	0.4745	0.0567	8.2000	2.7510	2.0176	-32.00	453.466
42	6.3522	0.1158	17.0717	0.8062	0.0564	0.4745	0.0568	8.2000	-2.7170	2.0335	-32.00	470.537
43	6.5961	0.1180	17.3949	0.8065	0.0563	0.4747	0.0570	8.2000	2.7170	2.0496	-32.00	487.932
44	6.8466	0.1201	17.7206	0.8069	0.0562	0.4750	0.0571	8.2000	-2.6440	2.0661	-32.00	505.653
45	7.1040	0.1224	18.0488	0.8072	0.0561	0.4753	0.0572	8.2000	2.6440	2.0829	-32.00	523.702
46	7.3682	0.1246	18.3795	0.8073	0.0561	0.4758	0.0574	8.2000	-2.6040	2.1000	-32.00	542.081
47	7.6395	0.1268	18.7127	0.8073	0.0561	0.4764	0.0575	8.2000	2.6040	2.1174	-32.00	560.794
48	7.9179	0.1291	19.0483	0.8074	0.0561	0.4769	0.0576	8.2000	-2.5370	2.1351	-32.00	579.842
49	8.2037	0.1314	19.3865	0.8072	0.0562	0.4777	0.0578	8.2000	2.5370	2.1532	-32.00	599.229
50	8.4969	0.1337	19.7271	0.8070	0.0562	0.4784	0.0579	8.2000	-2.4920	2.1715	-32.00	618.956
51	8.7977	0.1360	20.0703	0.8069	0.0563	0.4792	0.0580	8.2000	2.4920	2.1902	-32.00	639.026

52	9.1062	0.1383	20.4160	0.8067	0.0565	0.4801	0.0582	8.2000	-2.4410	2.2092	-32.00	659.442
53	9.4227	0.1407	20.7643	0.8065	0.0566	0.4811	0.0584	8.2000	2.4410	2.2285	-32.00	680.206
54	9.7473	0.1430	21.1152	0.8064	0.0568	0.4821	0.0586	8.2000	-2.4240	2.2481	-32.00	701.322
55	10.0802	0.1454	21.4688	0.8062	0.0570	0.4832	0.0588	8.2000	2.4240	2.2681	-32.00	722.790
56	10.4217	0.1478	21.8251	0.8061	0.0572	0.4843	0.0590	5.6400	-3.3170	2.2884	-32.00	744.615

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 2 TANK LENGTH 1901.808 CENTIMETERS 60 CELLS POWER= 1.993 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	10.4217	0.1478						5.6400	3.3170			766.615
57	10.7451	0.1501	22.1764	0.8595	0.0416	0.4037	0.0523	11.3800	-1.8210	2.0010	-32.00	788.792
58	11.0735	0.1523	22.5096	0.8598	0.0416	0.4043	0.0524	11.3800	1.8210	2.0010	-32.00	811.301
59	11.4069	0.1545	22.8427	0.8601	0.0416	0.4049	0.0526	11.3800	-1.7900	2.0010	-32.00	834.144
60	11.7452	0.1568	23.1755	0.8604	0.0415	0.4055	0.0527	11.3800	1.7900	2.0010	-32.00	857.320
61	12.0886	0.1590	23.5080	0.8607	0.0415	0.4060	0.0529	11.3800	-1.7610	2.0010	-32.00	880.828
62	12.4369	0.1612	23.8404	0.8610	0.0415	0.4066	0.0530	11.3800	1.7610	2.0010	-32.00	904.668
63	12.7901	0.1634	24.1724	0.8610	0.0415	0.4073	0.0532	11.3800	-1.7380	2.0010	-32.00	928.840
64	13.1481	0.1657	24.5041	0.8609	0.0416	0.4082	0.0533	11.3800	1.7380	2.0010	-32.00	953.344
65	13.5109	0.1679	24.8353	0.8608	0.0417	0.4090	0.0534	11.3800	-1.7090	2.0010	-32.00	978.180
66	13.8784	0.1701	25.1661	0.8607	0.0417	0.4098	0.0536	11.3800	1.7090	2.0010	-32.00	1003.346
67	14.2508	0.1723	25.4965	0.8606	0.0418	0.4107	0.0537	11.3800	-1.6850	2.0010	-32.00	1028.843
68	14.6280	0.1745	25.8265	0.8606	0.0419	0.4115	0.0538	11.3800	1.6850	2.0010	-32.00	1054.669
69	15.0098	0.1768	26.1560	0.8603	0.0420	0.4124	0.0540	11.3800	-1.7300	2.0010	-32.00	1080.825
70	15.3963	0.1790	26.4850	0.8599	0.0421	0.4135	0.0541	11.3800	1.7300	2.0010	-32.00	1107.310
71	15.7873	0.1812	26.8134	0.8594	0.0422	0.4145	0.0543	11.3800	-1.7170	2.0010	-32.00	1134.124
72	16.1830	0.1834	27.1413	0.8590	0.0424	0.4156	0.0544	11.3800	1.7170	2.0010	-32.00	1161.265
73	16.5832	0.1856	27.4686	0.8586	0.0425	0.4167	0.0546	11.3800	-1.6330	2.0010	-32.00	1188.733
74	16.9879	0.1878	27.7953	0.8582	0.0426	0.4177	0.0547	11.3800	1.6330	2.0010	-32.00	1216.529
75	17.3972	0.1899	28.1214	0.8576	0.0428	0.4189	0.0549	11.3800	-1.5370	2.0010	-32.00	1244.650
76	17.8109	0.1921	28.4469	0.8569	0.0430	0.4202	0.0550	11.3800	1.5370	2.0010	-32.00	1273.097
77	18.2289	0.1943	28.7717	0.8562	0.0432	0.4215	0.0552	11.3800	-1.6050	2.0010	-32.00	1301.869
78	18.6513	0.1965	29.0957	0.8555	0.0434	0.4228	0.0553	11.3800	1.6050	2.0010	-32.00	1330.964
79	19.0780	0.1986	29.4191	0.8548	0.0435	0.4241	0.0555	11.3800	-1.6020	2.0010	-32.00	1360.383
80	19.5091	0.2008	29.7418	0.8541	0.0437	0.4254	0.0557	11.3800	1.6020	2.0010	-32.00	1390.125
81	19.9444	0.2030	30.0637	0.8533	0.0439	0.4268	0.0558	11.3800	-1.6830	2.0010	-32.00	1420.189
82	20.3839	0.2051	30.3849	0.8523	0.0442	0.4283	0.0560	11.3800	1.6830	2.0010	-32.00	1450.574
83	20.8275	0.2073	30.7053	0.8513	0.0445	0.4298	0.0561	11.3800	-1.5760	2.0010	-32.00	1481.279
84	21.2752	0.2094	31.0248	0.8504	0.0447	0.4314	0.0563	11.3800	1.5760	2.0010	-32.00	1512.304
85	21.7270	0.2115	31.3436	0.8494	0.0450	0.4329	0.0564	11.3800	-1.4510	2.0010	-32.00	1543.648
86	22.1828	0.2137	31.6615	0.8484	0.0452	0.4344	0.0565	11.3800	1.4510	2.0010	-32.00	1575.309
87	22.6427	0.2158	31.9786	0.8475	0.0455	0.4359	0.0567	11.3800	-1.5680	2.0010	-32.00	1607.288
88	23.1065	0.2179	32.2949	0.8463	0.0458	0.4376	0.0569	11.3800	1.5680	2.0010	-32.00	1639.583
89	23.5742	0.2200	32.6102	0.8451	0.0461	0.4394	0.0570	11.3800	-1.6180	2.0010	-32.00	1672.193
90	24.0457	0.2221	32.9247	0.8440	0.0465	0.4411	0.0572	11.3800	1.6180	2.0010	-32.00	1705.118
91	24.5211	0.2243	33.2383	0.8428	0.0468	0.4428	0.0574	11.3800	-1.5450	2.0010	-32.00	1738.356
92	25.0002	0.2263	33.5509	0.8416	0.0471	0.4446	0.0576	11.3800	1.5450	2.0010	-32.00	1771.907
93	25.4832	0.2284	33.8627	0.8405	0.0475	0.4463	0.0577	11.3800	-1.5290	2.0010	-32.00	1805.769
94	25.9699	0.2305	34.1736	0.8392	0.0478	0.4481	0.0579	11.3800	1.5290	2.0010	-32.00	1839.943
95	26.4602	0.2326	34.4835	0.8379	0.0482	0.4501	0.0581	11.3800	-1.5210	2.0010	-32.00	1874.427
96	26.9541	0.2347	34.7924	0.8366	0.0486	0.4520	0.0582	11.3800	1.5210	2.0010	-32.00	1909.219
97	27.4516	0.2367	35.1004	0.8353	0.0489	0.4539	0.0584	11.3800	-1.5080	2.0010	-32.00	1944.319
98	27.9527	0.2388	35.4075	0.8340	0.0493	0.4559	0.0586	11.3800	1.5080	2.0010	-32.00	1979.727
99	28.4573	0.2408	35.7135	0.8326	0.0497	0.4578	0.0587	11.3800	-1.4980	2.0010	-32.00	2015.440
100	28.9655	0.2429	36.0187	0.8313	0.0500	0.4597	0.0589	11.3800	1.4980	2.0010	-32.00	2051.459
101	29.4770	0.2449	36.3228	0.8299	0.0505	0.4618	0.0591	11.3800	-1.4870	2.0010	-32.00	2087.782
102	29.9918	0.2470	36.6259	0.8284	0.0509	0.4640	0.0592	11.3800	1.4870	2.0010	-32.00	2124.408

103	30.5101	0.2490	36.9279	0.8270	0.0513	0.4661	0.0594	11.3800	-1.4770	2.0010	-32.00	2161.336
104	31.0316	0.2510	37.2290	0.8255	0.0518	0.4682	0.0596	11.3800	1.4770	2.0010	-32.00	2198.565
105	31.5564	0.2530	37.5291	0.8241	0.0522	0.4704	0.0597	11.3800	-1.4670	2.0010	-32.00	2236.094
106	32.0845	0.2550	37.8281	0.8226	0.0526	0.4725	0.0599	11.3800	1.4670	2.0010	-32.00	2273.922
107	32.6157	0.2570	38.1261	0.8212	0.0531	0.4747	0.0601	11.3800	-1.4560	2.0010	-32.00	2312.048
108	33.1502	0.2590	38.4231	0.8196	0.0536	0.4770	0.0602	11.3800	1.4560	2.0010	-32.00	2350.471
109	33.6877	0.2610	38.7191	0.8181	0.0541	0.4793	0.0604	11.3800	-1.4350	2.0010	-32.00	2389.190
110	34.2283	0.2630	39.0140	0.8166	0.0545	0.4816	0.0606	11.3800	1.4350	2.0010	-32.00	2428.204
111	34.7721	0.2649	39.3079	0.8151	0.0550	0.4839	0.0607	11.3800	-1.4280	2.0010	-32.00	2467.512
112	35.3188	0.2669	39.6008	0.8136	0.0555	0.4862	0.0609	11.3800	1.4280	2.0010	-32.00	2507.113
113	35.8686	0.2689	39.8926	0.8121	0.0559	0.4885	0.0610	11.3800	-1.6540	2.0010	-32.00	2547.005
114	36.4213	0.2708	40.1834	0.8106	0.0564	0.4908	0.0612	11.3800	1.6540	2.0010	-32.00	2587.189
115	36.9770	0.2728	40.4731	0.8091	0.0570	0.4933	0.0614	11.3800	-1.5370	2.0010	-32.00	2627.662
116	37.5356	0.2747	40.7618	0.8075	0.0575	0.4957	0.0616	11.3800	1.3000	2.0010	-32.00	2668.424

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 3 TANK LENGTH 1652.625 CENTIMETERS 35 CELLS POWER= 3.697 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	37.5356	0.2747						11.3800	-1.3000			2728.424
117	38.2827	0.2772	41.0944	0.8235	0.0527	0.4748	0.0605	11.3800	1.5370	2.6030	-32.00	2769.518
118	39.0347	0.2798	41.4750	0.8214	0.0533	0.4777	0.0607	11.3800	-1.2090	2.6030	-32.00	2810.993
119	39.7916	0.2823	41.8537	0.8193	0.0539	0.4805	0.0609	11.3800	1.2090	2.6030	-32.00	2852.847
120	40.5534	0.2849	42.2305	0.8172	0.0545	0.4834	0.0611	11.3800	-1.4950	2.6030	-32.00	2895.077
121	41.3200	0.2874	42.6056	0.8151	0.0551	0.4862	0.0613	11.3800	1.4950	2.6030	-32.00	2937.683
122	42.0913	0.2899	42.9787	0.8130	0.0557	0.4890	0.0615	11.3800	-1.3620	2.6030	-32.00	2980.662
123	42.8671	0.2924	43.3500	0.8108	0.0563	0.4918	0.0617	11.3800	1.3620	2.6030	-32.00	3024.012
124	43.6475	0.2948	43.7194	0.8086	0.0569	0.4945	0.0619	11.3800	-1.3420	2.6030	-32.00	3067.731
125	44.4324	0.2973	44.0870	0.8065	0.0575	0.4973	0.0620	11.3800	1.3420	2.6030	-32.00	3111.818
126	45.2216	0.2997	44.4527	0.8043	0.0582	0.5000	0.0622	11.3800	-1.3310	2.6030	-32.00	3156.271
127	46.0153	0.3022	44.8166	0.8022	0.0588	0.5027	0.0624	11.3800	1.3310	2.6030	-32.00	3201.087
128	46.8131	0.3046	45.1786	0.8000	0.0594	0.5054	0.0626	11.3800	-1.3210	2.6030	-32.00	3246.266
129	47.6151	0.3070	45.5387	0.7978	0.0600	0.5081	0.0627	11.3800	1.3210	2.6030	-32.00	3291.805
130	48.4212	0.3094	45.8970	0.7956	0.0606	0.5107	0.0629	11.3800	-1.3100	2.6030	-32.00	3337.702
131	49.2314	0.3118	46.2534	0.7935	0.0612	0.5134	0.0630	11.3800	1.3100	2.6030	-32.00	3383.955
132	50.0455	0.3142	46.6080	0.7913	0.0618	0.5160	0.0631	11.3800	-1.3030	2.6030	-32.00	3430.563
133	50.8636	0.3165	46.9608	0.7891	0.0624	0.5186	0.0633	11.3800	1.3030	2.6030	-32.00	3477.524
134	51.6854	0.3189	47.3117	0.7869	0.0630	0.5212	0.0634	11.3800	-1.2890	2.6030	-32.00	3524.835
135	52.5110	0.3212	47.6607	0.7847	0.0637	0.5237	0.0635	11.3800	1.2890	2.6030	-32.00	3572.496
136	53.3403	0.3236	48.0079	0.7825	0.0643	0.5262	0.0636	11.3800	-1.2820	2.6030	-32.00	3620.504
137	54.1732	0.3259	48.3533	0.7803	0.0649	0.5287	0.0637	11.3800	1.2820	2.6030	-32.00	3668.857
138	55.0098	0.3282	48.6968	0.7782	0.0655	0.5312	0.0638	11.3800	-1.2710	2.6030	-32.00	3717.554
139	55.8498	0.3305	49.0385	0.7760	0.0661	0.5337	0.0639	11.3800	1.2710	2.6030	-32.00	3766.593
140	56.6933	0.3327	49.3784	0.7738	0.0667	0.5361	0.0640	11.3800	-1.2610	2.6030	-32.00	3815.971
141	57.5401	0.3350	49.7165	0.7716	0.0673	0.5386	0.0641	11.3800	1.2610	2.6030	-32.00	3865.687
142	58.3902	0.3373	50.0527	0.7694	0.0679	0.5410	0.0642	11.3800	-1.2500	2.6030	-32.00	3915.740
143	59.2436	0.3395	50.3871	0.7672	0.0685	0.5434	0.0643	11.3800	1.2500	2.6030	-32.00	3966.127
144	60.1001	0.3417	50.7198	0.7651	0.0691	0.5458	0.0644	11.3800	-1.2760	2.6030	-32.00	4016.847
145	60.9599	0.3439	51.0506	0.7629	0.0697	0.5481	0.0645	11.3800	1.2760	2.6030	-32.00	4067.898
146	61.8226	0.3461	51.3796	0.7607	0.0703	0.5504	0.0646	11.3800	-1.2350	2.6030	-32.00	4119.277
147	62.6883	0.3483	51.7069	0.7585	0.0709	0.5528	0.0646	11.3800	1.2350	2.6030	-32.00	4170.984
148	63.5570	0.3505	52.0323	0.7563	0.0715	0.5551	0.0647	11.3800	-1.5400	2.6030	-32.00	4223.017
149	64.4285	0.3527	52.3560	0.7541	0.0721	0.5573	0.0648	11.3800	1.5400	2.6030	-32.00	4275.373
150	65.3028	0.3548	52.6778	0.7519	0.0727	0.5596	0.0648	11.3800	-1.3080	2.6030	-32.00	4328.050
151	66.1799	0.3570	52.9979	0.7497	0.0733	0.5619	0.0649	11.3800	1.1490	2.6030	-32.00	4381.048

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 4 TANK LENGTH 1668.407 CENTIMETERS 29 CELLS POWER= 4.671 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	66.1799	0.3570						11.3800	-1.1490			4456.048
152	67.0597	0.3591	53.3163	0.7475	0.0739	0.5641	0.0649	11.3800	1.3080	2.6030	-32.00	4509.365
153	67.9420	0.3612	53.6328	0.7453	0.0745	0.5663	0.0650	11.3800	-1.0890	2.6030	-32.00	4562.998
154	68.8269	0.3633	53.9476	0.7431	0.0751	0.5685	0.0650	11.3800	1.0890	2.6030	-32.00	4616.945
155	69.7143	0.3654	54.2607	0.7409	0.0756	0.5707	0.0650	11.3800	-1.0940	2.6030	-32.00	4671.206
156	70.6042	0.3675	54.5719	0.7387	0.0762	0.5728	0.0651	11.3800	1.0940	2.6030	-32.00	4725.778
157	71.4965	0.3696	54.8815	0.7365	0.0768	0.5750	0.0651	11.3800	-1.0910	2.6030	-32.00	4780.659
158	72.3911	0.3716	55.1893	0.7343	0.0774	0.5771	0.0651	11.3800	1.0910	2.6030	-32.00	4835.849
159	73.2879	0.3737	55.4954	0.7321	0.0780	0.5792	0.0651	11.3800	-1.1930	2.6030	-32.00	4891.344
160	74.1870	0.3757	55.7997	0.7299	0.0786	0.5813	0.0652	11.3800	1.1930	2.6030	-32.00	4947.144
161	75.0882	0.3778	56.1023	0.7277	0.0792	0.5834	0.0652	11.3800	-1.1830	2.6030	-32.00	5003.247
162	75.9915	0.3798	56.4032	0.7255	0.0797	0.5854	0.0652	11.3800	1.1830	2.6030	-32.00	5059.650
163	76.8968	0.3818	56.7024	0.7233	0.0803	0.5875	0.0653	11.3800	-1.1880	2.6030	-32.00	5116.353
164	77.8042	0.3838	56.9999	0.7212	0.0809	0.5895	0.0653	11.3800	1.1880	2.6030	-32.00	5173.353
165	78.7136	0.3858	57.2957	0.7190	0.0815	0.5915	0.0653	11.3800	-1.1850	2.6030	-32.00	5230.648
166	79.6248	0.3877	57.5898	0.7168	0.0821	0.5935	0.0653	11.3800	1.1850	2.6030	-32.00	5288.238
167	80.5379	0.3897	57.8823	0.7146	0.0827	0.5955	0.0653	11.3800	-1.1850	2.6030	-32.00	5346.121
168	81.4528	0.3916	58.1731	0.7125	0.0832	0.5975	0.0653	11.3800	1.1850	2.6030	-32.00	5404.293
169	82.3695	0.3936	58.4622	0.7103	0.0838	0.5994	0.0653	11.3800	-1.1770	2.6030	-32.00	5462.756
170	83.2879	0.3955	58.7497	0.7082	0.0844	0.6014	0.0653	11.3800	1.1770	2.6030	-32.00	5521.505
171	84.2081	0.3974	59.0355	0.7061	0.0850	0.6033	0.0653	11.3800	-1.3290	2.6030	-32.00	5580.541
172	85.1298	0.3993	59.3197	0.7039	0.0855	0.6052	0.0653	11.3800	1.3290	2.6030	-32.00	5639.861
173	86.0530	0.4012	59.6023	0.7017	0.0861	0.6071	0.0652	11.3800	-1.1640	2.6030	-32.00	5699.463
174	86.9777	0.4031	59.8832	0.6995	0.0867	0.6090	0.0652	11.3800	1.1640	2.6030	-32.00	5759.347
175	87.9039	0.4049	60.1625	0.6974	0.0872	0.6108	0.0652	11.3800	-1.3030	2.6030	-32.00	5819.509
176	88.8314	0.4068	60.4402	0.6952	0.0878	0.6127	0.0652	11.3800	1.3030	2.6030	-32.00	5879.950
177	89.7604	0.4087	60.7163	0.6931	0.0883	0.6145	0.0651	11.3800	-1.1750	2.6030	-32.00	5940.666
178	90.6907	0.4105	60.9908	0.6910	0.0889	0.6163	0.0651	11.3800	1.1750	2.6030	-32.00	6001.657
179	91.6222	0.4123	61.2638	0.6888	0.0895	0.6181	0.0651	16.4600	-0.8780	2.6030	-32.00	6062.920
180	92.5550	0.4141	61.5351	0.6867	0.0900	0.6199	0.0650	16.4600	0.6570	2.6030	-32.00	6124.456

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 5 TANK LENGTH 1558.580 CENTIMETERS 24 CELLS POWER= 4.913 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	92.5550	0.4141						16.4600	-0.6570			6224.456
181	93.5397	0.4160	61.8239	0.7331	0.0433	0.5806	0.0658	16.4600	0.8780	2.5620	-32.00	6286.279
182	94.5259	0.4179	62.1066	0.7309	0.0436	0.5828	0.0658	16.4600	-0.7110	2.5620	-32.00	6348.386
183	95.5136	0.4198	62.3877	0.7287	0.0439	0.5849	0.0658	16.4600	0.7110	2.5620	-32.00	6410.773
184	96.5028	0.4217	62.6671	0.7265	0.0442	0.5870	0.0658	16.4600	-0.8450	2.5620	-32.00	6473.440
185	97.4933	0.4235	62.9449	0.7243	0.0444	0.5891	0.0658	16.4600	0.8450	2.5620	-32.00	6536.385
186	98.4853	0.4254	63.2211	0.7222	0.0447	0.5911	0.0658	16.4600	-0.8450	2.5620	-32.00	6599.606
187	99.4786	0.4272	63.4957	0.7200	0.0450	0.5931	0.0658	16.4600	0.8450	2.5620	-32.00	6663.102
188	100.4732	0.4291	63.7686	0.7179	0.0453	0.5951	0.0659	16.4600	-0.8390	2.5620	-32.00	6726.871
189	101.4691	0.4309	64.0400	0.7158	0.0455	0.5971	0.0659	16.4600	0.8390	2.5620	-32.00	6790.911
190	102.4662	0.4327	64.3098	0.7136	0.0458	0.5990	0.0659	16.4600	-0.8390	2.5620	-32.00	6855.220
191	103.4646	0.4345	64.5781	0.7115	0.0460	0.6009	0.0659	16.4600	0.8390	2.5620	-32.00	6919.798
192	104.4642	0.4363	64.8447	0.7095	0.0463	0.6028	0.0659	16.4600	-0.8390	2.5620	-32.00	6984.643
193	105.4649	0.4380	65.1099	0.7074	0.0465	0.6047	0.0659	16.4600	0.8390	2.5620	-32.00	7049.753
194	106.4668	0.4398	65.3735	0.7054	0.0467	0.6065	0.0659	16.4600	-0.8280	2.5620	-32.00	7115.126
195	107.4700	0.4416	65.6357	0.7034	0.0469	0.6083	0.0658	16.4600	0.8280	2.5620	-32.00	7180.762

196	108.4742	0.4433	65.8963	0.7014	0.0471	0.6101	0.0658	16.4600	-0.8340	2.5620	-32.00	7246.659
197	109.4796	0.4450	66.1555	0.6995	0.0473	0.6119	0.0658	16.4600	0.8340	2.5620	-32.00	7312.814
198	110.4860	0.4468	66.4132	0.6975	0.0476	0.6136	0.0658	16.4600	-0.8290	2.5620	-32.00	7379.227
199	111.4934	0.4485	66.6694	0.6955	0.0478	0.6153	0.0657	16.4600	0.8290	2.5620	-32.00	7445.896
200	112.5019	0.4502	66.9241	0.6935	0.0480	0.6171	0.0657	16.4600	-0.8220	2.5620	-32.00	7512.821
201	113.5112	0.4519	67.1774	0.6915	0.0482	0.6187	0.0657	16.4600	0.8220	2.5620	-32.00	7579.998
202	114.5215	0.4536	67.4293	0.6896	0.0484	0.6204	0.0656	16.4600	-0.8170	2.5620	-32.00	7647.427
203	115.5326	0.4552	67.6797	0.6876	0.0486	0.6220	0.0656	16.4600	0.9860	2.5620	-32.00	7715.107
204	116.5446	0.4569	67.9287	0.6857	0.0488	0.6237	0.0656	16.4600	-0.9710	2.5620	-32.00	7783.036

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 6 TANK LENGTH 1554.684 CENTIMETERS 22 CELLS POWER= 5.741 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	116.5446	0.4569						16.4600	0.9710			7883.036
205	117.5578	0.4586	68.1763	0.6837	0.0490	0.6253	0.0655	16.4600	-0.9860	2.5630	-32.00	7951.212
206	118.5718	0.4602	68.4226	0.6818	0.0492	0.6269	0.0655	16.4600	0.8170	2.5630	-32.00	8019.635
207	119.5866	0.4619	68.6675	0.6799	0.0493	0.6285	0.0655	16.4600	-0.5740	2.5630	-32.00	8088.302
208	120.6021	0.4635	68.9110	0.6780	0.0495	0.6301	0.0654	16.4600	0.5740	2.5630	-32.00	8157.213
209	121.6183	0.4651	69.1531	0.6761	0.0497	0.6317	0.0654	16.4600	-0.8040	2.5630	-32.00	8226.366
210	122.6353	0.4667	69.3938	0.6742	0.0499	0.6332	0.0653	16.4600	0.8040	2.5630	-32.00	8295.760
211	123.6529	0.4683	69.6332	0.6724	0.0501	0.6347	0.0653	16.4600	-0.8020	2.5630	-32.00	8365.393
212	124.6712	0.4699	69.8712	0.6705	0.0503	0.6362	0.0652	16.4600	0.8020	2.5630	-32.00	8435.264
213	125.6901	0.4715	70.1079	0.6686	0.0505	0.6377	0.0652	16.4600	-0.8070	2.5630	-32.00	8505.371
214	126.7096	0.4731	70.3433	0.6668	0.0506	0.6391	0.0651	16.4600	0.8070	2.5630	-32.00	8575.714
215	127.7297	0.4746	70.5773	0.6650	0.0508	0.6405	0.0651	16.4600	-0.7910	2.5630	-32.00	8646.291
216	128.7504	0.4762	70.8100	0.6632	0.0510	0.6420	0.0650	16.4600	0.7910	2.5630	-32.00	8717.101
217	129.7716	0.4777	71.0415	0.6614	0.0511	0.6434	0.0650	16.4600	-0.7920	2.5630	-32.00	8788.142
218	130.7933	0.4793	71.2716	0.6596	0.0513	0.6448	0.0649	16.4600	0.7920	2.5630	-32.00	8859.413
219	131.8155	0.4808	71.5005	0.6578	0.0515	0.6462	0.0648	16.4600	-0.7810	2.5630	-32.00	8930.913
220	132.8382	0.4823	71.7281	0.6560	0.0516	0.6476	0.0648	16.4600	0.7810	2.5630	-32.00	9002.642
221	133.8614	0.4839	71.9544	0.6542	0.0518	0.6490	0.0647	16.4600	-0.7850	2.5630	-32.00	9074.596
222	134.8850	0.4854	72.1795	0.6524	0.0519	0.6503	0.0646	16.4600	0.7850	2.5630	-32.00	9146.775
223	135.9090	0.4869	72.4033	0.6507	0.0521	0.6516	0.0646	16.4600	-0.7740	2.5630	-32.00	9219.179
224	136.9333	0.4884	72.6258	0.6489	0.0522	0.6529	0.0645	16.4600	0.7740	2.5630	-32.00	9291.805
225	137.9580	0.4898	72.8472	0.6472	0.0524	0.6542	0.0644	16.4600	-0.7870	2.5630	-32.00	9364.652
226	138.9830	0.4913	73.0673	0.6454	0.0526	0.6555	0.0644	16.4600	0.7040	2.5630	-32.00	9437.720

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 7 TANK LENGTH 1583.138 CENTIMETERS 21 CELLS POWER= 6.681 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	138.9830	0.4913						16.4600	-0.7040			9537.720
227	140.0076	0.4928	73.2861	0.6437	0.0527	0.6568	0.0643	16.4600	0.7870	2.5610	-32.00	9611.006
228	141.0324	0.4942	73.5036	0.6420	0.0529	0.6580	0.0642	16.4600	-0.7680	2.5610	-32.00	9684.510
229	142.0575	0.4957	73.7199	0.6403	0.0530	0.6593	0.0641	16.4600	0.7680	2.5610	-32.00	9758.229
230	143.0829	0.4971	73.9351	0.6386	0.0532	0.6605	0.0640	16.4600	-0.7580	2.5610	-32.00	9832.165
231	144.1085	0.4986	74.1490	0.6369	0.0533	0.6617	0.0639	16.4600	0.7580	2.5610	-32.00	9906.314
232	145.1342	0.5000	74.3618	0.6351	0.0534	0.6629	0.0639	16.4600	-0.7590	2.5610	-32.00	9980.676
233	146.1602	0.5014	74.5734	0.6335	0.0535	0.6641	0.0638	16.4600	0.7590	2.5610	-32.00	10055.249
234	147.1863	0.5028	74.7838	0.6318	0.0537	0.6653	0.0637	16.4600	-0.7540	2.5610	-32.00	10130.033
235	148.2126	0.5042	74.9931	0.6301	0.0538	0.6665	0.0636	16.4600	0.7540	2.5610	-32.00	10205.026
236	149.2389	0.5056	75.2013	0.6284	0.0539	0.6677	0.0635	16.4600	-0.7540	2.5610	-32.00	10280.228
237	150.2653	0.5070	75.4082	0.6267	0.0541	0.6689	0.0634	16.4600	0.7540	2.5610	-32.00	10355.636

238	151.2918	0.5084	75.6141	0.6250	0.0542	0.6700	0.0634	16.4600	-0.7480	2.5610	-32.00	10431.250
239	152.3183	0.5097	75.8188	0.6234	0.0544	0.6712	0.0633	16.4600	0.7480	2.5610	-32.00	10507.068
240	153.3448	0.5111	76.0224	0.6217	0.0545	0.6723	0.0632	16.4600	-0.7490	2.5610	-32.00	10583.091
241	154.3714	0.5124	76.2249	0.6201	0.0546	0.6734	0.0631	16.4600	0.7490	2.5610	-32.00	10659.315
242	155.3979	0.5138	76.4263	0.6185	0.0548	0.6745	0.0630	16.4600	-0.7380	2.5610	-32.00	10735.742
243	156.4245	0.5151	76.6266	0.6168	0.0549	0.6756	0.0629	16.4600	0.7380	2.5610	-32.00	10812.369
244	157.4510	0.5165	76.8259	0.6152	0.0550	0.6767	0.0628	16.4600	-0.7420	2.5610	-32.00	10889.195
245	158.4775	0.5178	77.0240	0.6136	0.0551	0.6778	0.0627	16.4600	0.7420	2.5610	-32.00	10966.220
246	159.5038	0.5191	77.2211	0.6120	0.0552	0.6789	0.0626	16.4600	-0.7190	2.5610	-32.00	11043.440
247	160.5300	0.5204	77.4170	0.6103	0.0554	0.6800	0.0625	16.4600	0.7450	2.5610	-32.00	11120.857

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

TANK NO. 8 TANK LENGTH 1587.921 CENTIMETERS 20 CELLS POWER= 7.611 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	160.5300	0.5204						16.4600	-0.7450			11220.857
248	161.5565	0.5217	77.6120	0.6087	0.0555	0.6810	0.0624	16.4600	0.7190	2.5620	-32.00	11298.470
249	162.5827	0.5230	77.8059	0.6071	0.0556	0.6821	0.0623	16.4600	-0.7680	2.5620	-32.00	11376.275
250	163.6089	0.5243	77.9988	0.6055	0.0557	0.6831	0.0622	16.4600	0.7680	2.5620	-32.00	11454.274
251	164.6348	0.5256	78.1906	0.6039	0.0558	0.6841	0.0621	16.4600	-0.5680	2.5620	-32.00	11532.465
252	165.6606	0.5269	78.3814	0.6023	0.0560	0.6852	0.0620	16.4600	0.5680	2.5620	-32.00	11610.847
253	166.6861	0.5282	78.5712	0.6007	0.0561	0.6862	0.0619	16.4600	-0.6600	2.5620	-32.00	11689.418
254	167.7114	0.5294	78.7599	0.5992	0.0562	0.6872	0.0617	16.4600	0.6600	2.5620	-32.00	11768.178
255	168.7365	0.5307	78.9476	0.5976	0.0564	0.6882	0.0616	16.4600	-0.7240	2.5620	-32.00	11847.125
256	169.7612	0.5319	79.1343	0.5960	0.0565	0.6892	0.0615	16.4600	0.7240	2.5620	-32.00	11926.260
257	170.7858	0.5332	79.3200	0.5945	0.0566	0.6902	0.0614	16.4600	-0.6540	2.5620	-32.00	12005.580
258	171.8100	0.5344	79.5048	0.5929	0.0567	0.6912	0.0613	16.4600	0.6540	2.5620	-32.00	12085.085
259	172.8339	0.5356	79.6885	0.5914	0.0568	0.6922	0.0612	16.4600	-0.7210	2.5620	-32.00	12164.773
260	173.8574	0.5369	79.8712	0.5898	0.0569	0.6931	0.0611	16.4600	0.7210	2.5620	-32.00	12244.645
261	174.8807	0.5381	80.0530	0.5883	0.0570	0.6941	0.0610	16.4600	-0.8250	2.5620	-32.00	12324.697
262	175.9036	0.5393	80.2337	0.5868	0.0571	0.6951	0.0608	16.4600	0.8250	2.5620	-32.00	12404.931
263	176.9262	0.5405	80.4136	0.5853	0.0572	0.6960	0.0607	16.4600	-0.7180	2.5620	-32.00	12485.345
264	177.9484	0.5417	80.5925	0.5838	0.0574	0.6969	0.0606	16.4600	0.7180	2.5620	-32.00	12565.937
265	178.9702	0.5429	80.7704	0.5823	0.0575	0.6979	0.0605	16.4600	-0.8520	2.5620	-32.00	12646.708
266	179.9917	0.5441	80.9474	0.5808	0.0576	0.6988	0.0603	16.4600	0.8520	2.5620	-32.00	12727.655
267	181.0128	0.5452	81.1234	0.5793	0.0577	0.6997	0.0602	16.4600	-0.6820	2.5620	-32.00	12808.778

1 LINOUT SUBROUTINE NO. 1 DYNAMICAL PARAMETERS

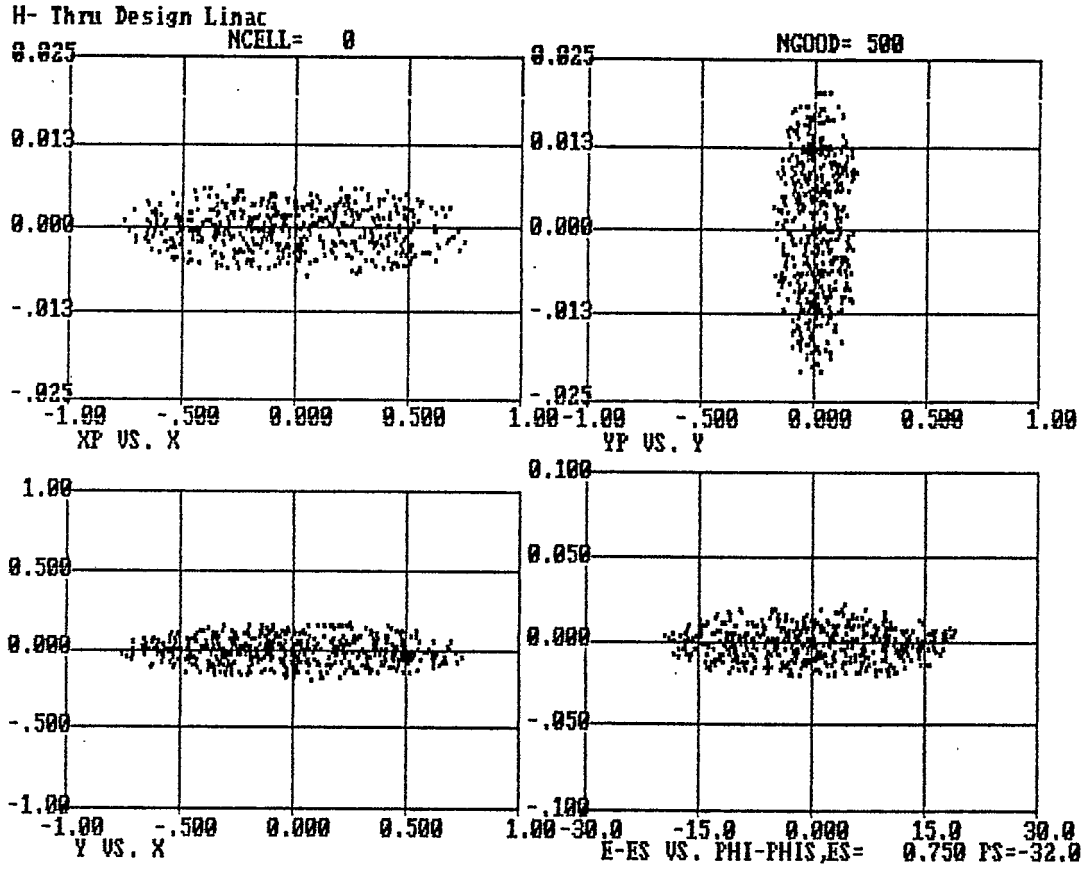
TANK NO. 9 TANK LENGTH 1573.579 CENTIMETERS 19 CELLS POWER= 8.535 MW FREQUENCY= 201. MHZ

CELL NUMBER	KINETIC ENERGY	BETA	LENGTH	T	TP	S	SP	QUAD LENGTH	QUAD GRADIENT	EZERO MV/M	PHIS	TOTAL LENGTH
0INITIAL	181.0128	0.5452						16.4600	0.6820			12908.778
268	182.0334	0.5464	81.2985	0.5778	0.0578	0.7006	0.0601	16.4600	-0.8120	2.5620	-32.00	12990.077
269	183.0535	0.5476	81.4727	0.5763	0.0579	0.7015	0.0600	16.4600	0.8120	2.5620	-32.00	13071.550
270	184.0732	0.5487	81.6459	0.5748	0.0580	0.7024	0.0599	16.4600	-0.8120	2.5620	-32.00	13153.195
271	185.0923	0.5499	81.8183	0.5733	0.0581	0.7033	0.0598	16.4600	0.8120	2.5620	-32.00	13235.014
272	186.1110	0.5510	81.9897	0.5718	0.0582	0.7042	0.0597	16.4600	-0.8120	2.5620	-32.00	13317.003
273	187.1291	0.5522	82.1602	0.5703	0.0583	0.7051	0.0596	16.4600	0.8120	2.5620	-32.00	13399.163
274	188.1466	0.5533	82.3298	0.5688	0.0584	0.7060	0.0594	16.4600	-0.8120	2.5620	-32.00	13481.493
275	189.1636	0.5544	82.4985	0.5674	0.0585	0.7069	0.0593	16.4600	0.8120	2.5620	-32.00	13563.991
276	190.1799	0.5556	82.6663	0.5659	0.0586	0.7077	0.0592	16.4600	-0.8120	2.5620	-32.00	13646.657
277	191.1957	0.5567	82.8332	0.5644	0.0587	0.7086	0.0590	16.4600	0.8120	2.5620	-32.00	13729.490
278	192.2108	0.5578	82.9993	0.5629	0.0588	0.7095	0.0589	16.4600	-0.8120	2.5620	-32.00	13812.489
279	193.2254	0.5589	83.1644	0.5615	0.0589	0.7103	0.0588	16.4600	0.8120	2.5620	-32.00	13895.653

280	194.2393	0.5600	83.3287	0.5600	0.0590	0.7112	0.0587	16.4600	-0.8120	2.5620	-32.00 13978.982
281	195.2526	0.5611	83.4921	0.5586	0.0591	0.7120	0.0586	16.4600	0.8120	2.5620	-32.00 14062.475
282	196.2653	0.5622	83.6547	0.5572	0.0592	0.7129	0.0584	16.4600	-0.8120	2.5620	-32.00 14146.129
283	197.2773	0.5633	83.8164	0.5557	0.0593	0.7137	0.0583	16.4600	0.8120	2.5620	-32.00 14229.945
284	198.2887	0.5643	83.9773	0.5543	0.0594	0.7146	0.0582	16.4600	-0.8120	2.5620	-32.00 14313.923
285	199.2995	0.5654	84.1374	0.5529	0.0595	0.7154	0.0581	16.4600	0.8120	2.5620	-32.00 14398.061
286	200.3095	0.5665	84.2966	0.5515	0.0596	0.7162	0.0580	16.4600	-0.6310	2.5620	-32.00 14482.357

1

Tank 1 In



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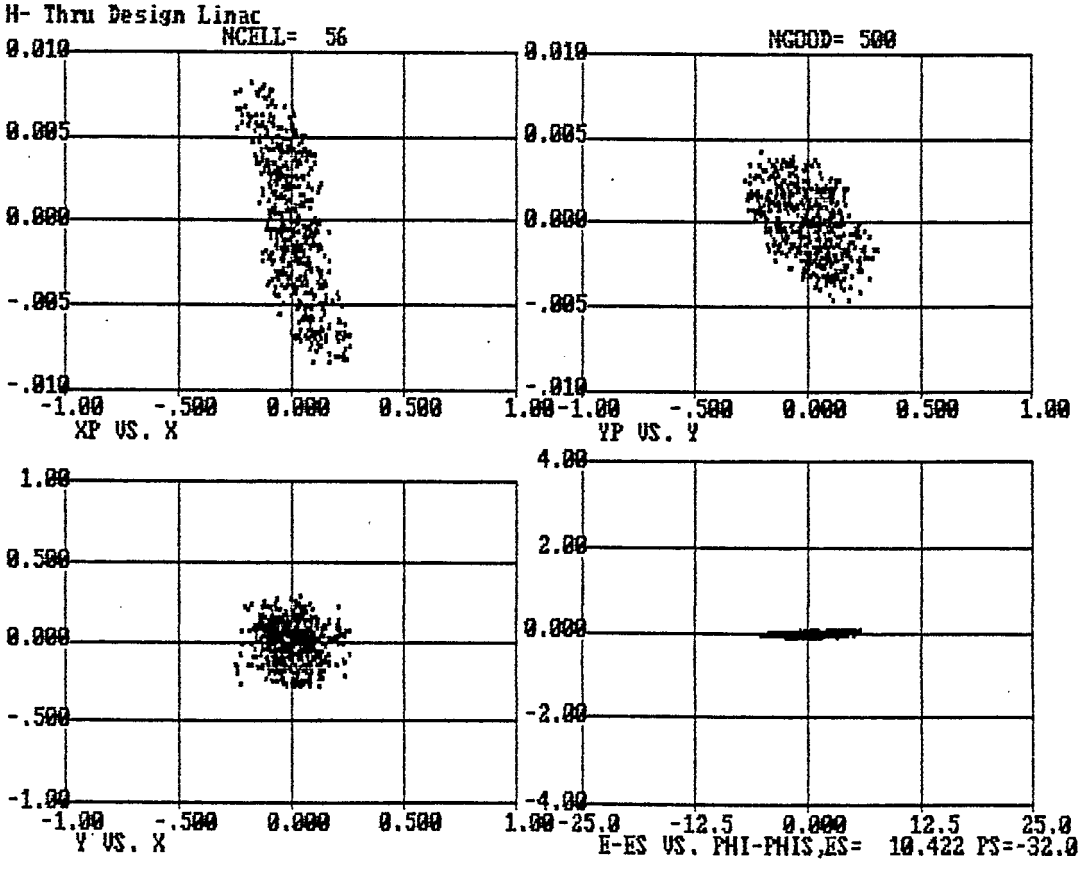

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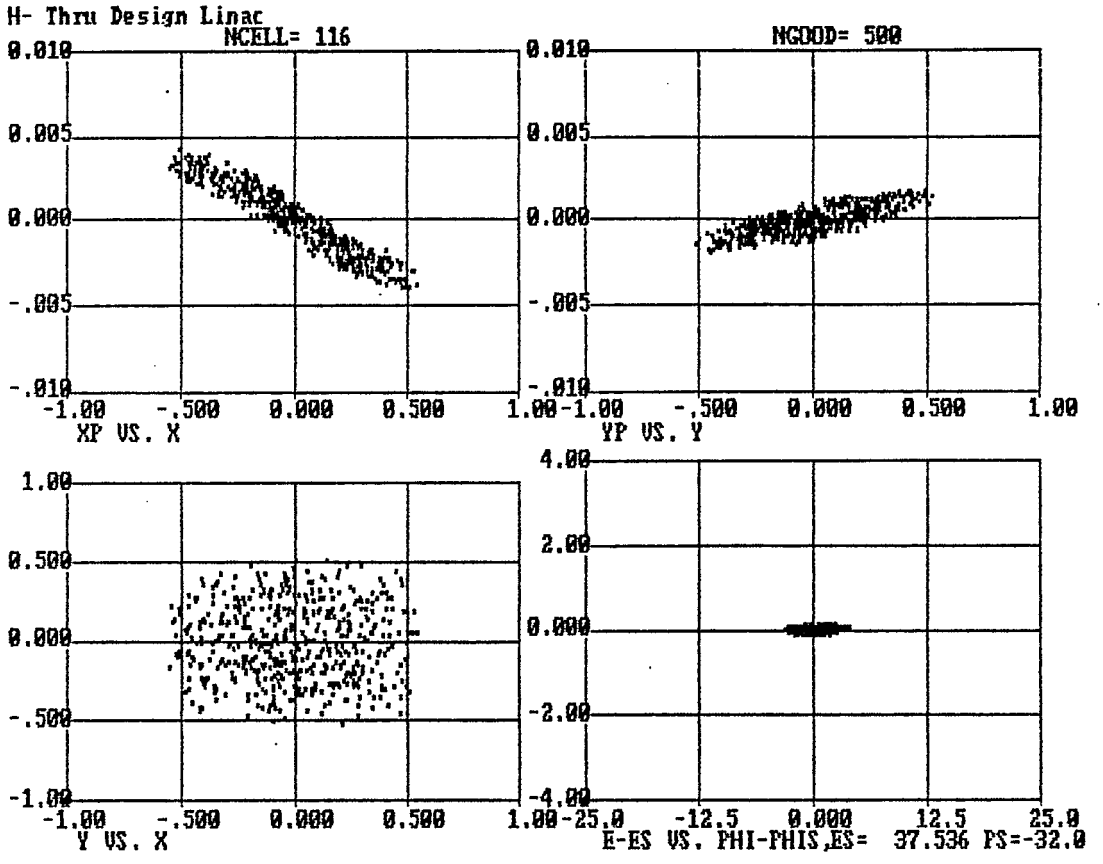

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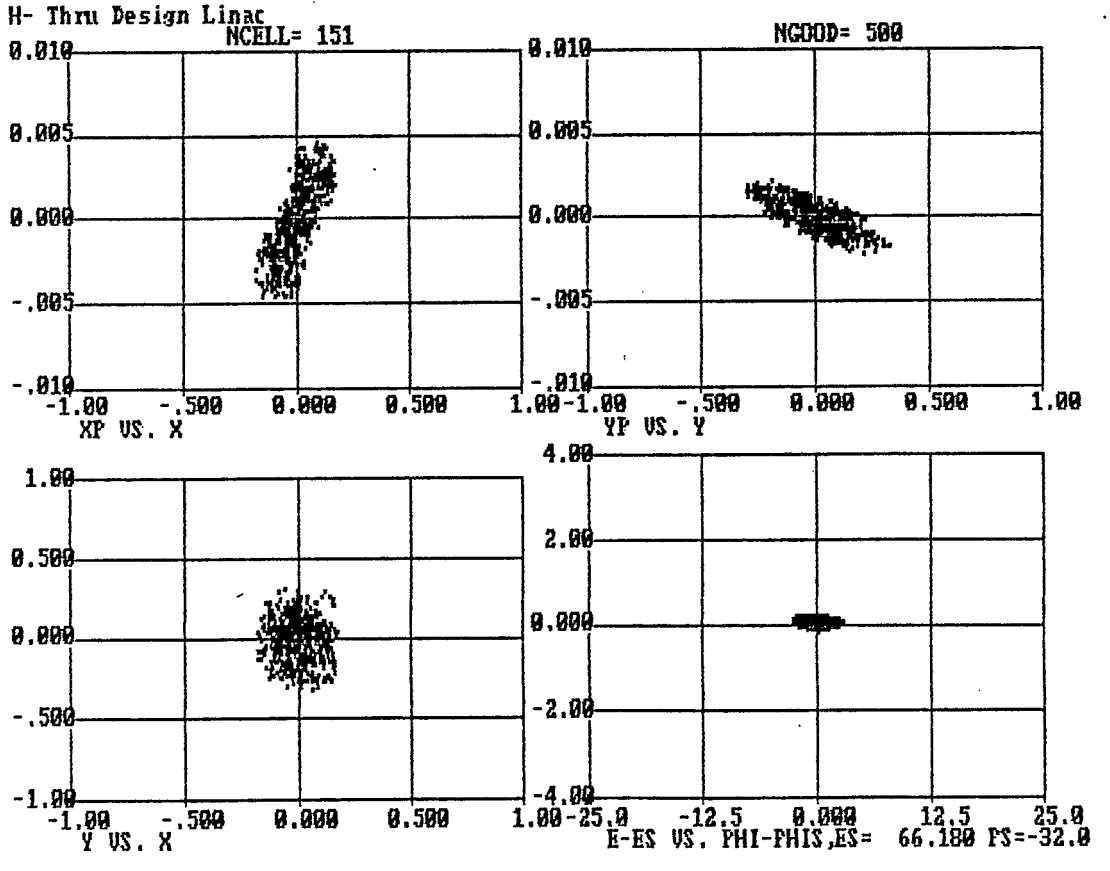

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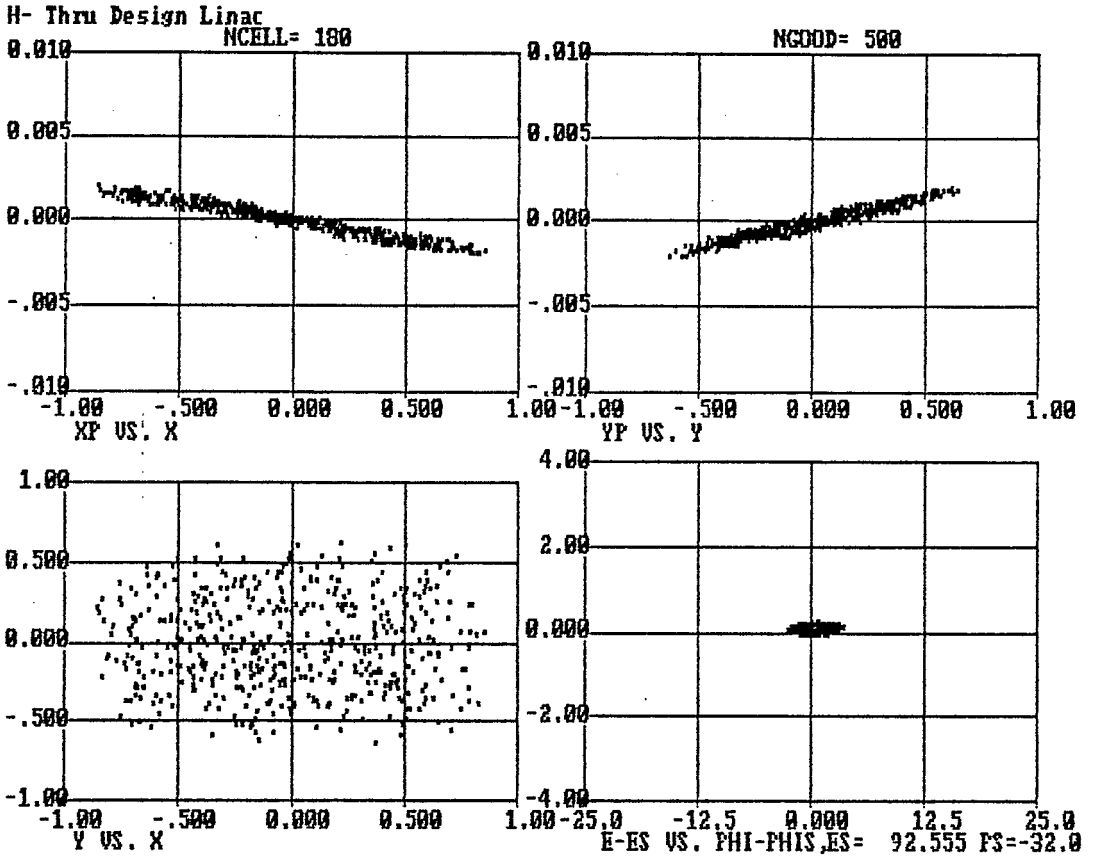

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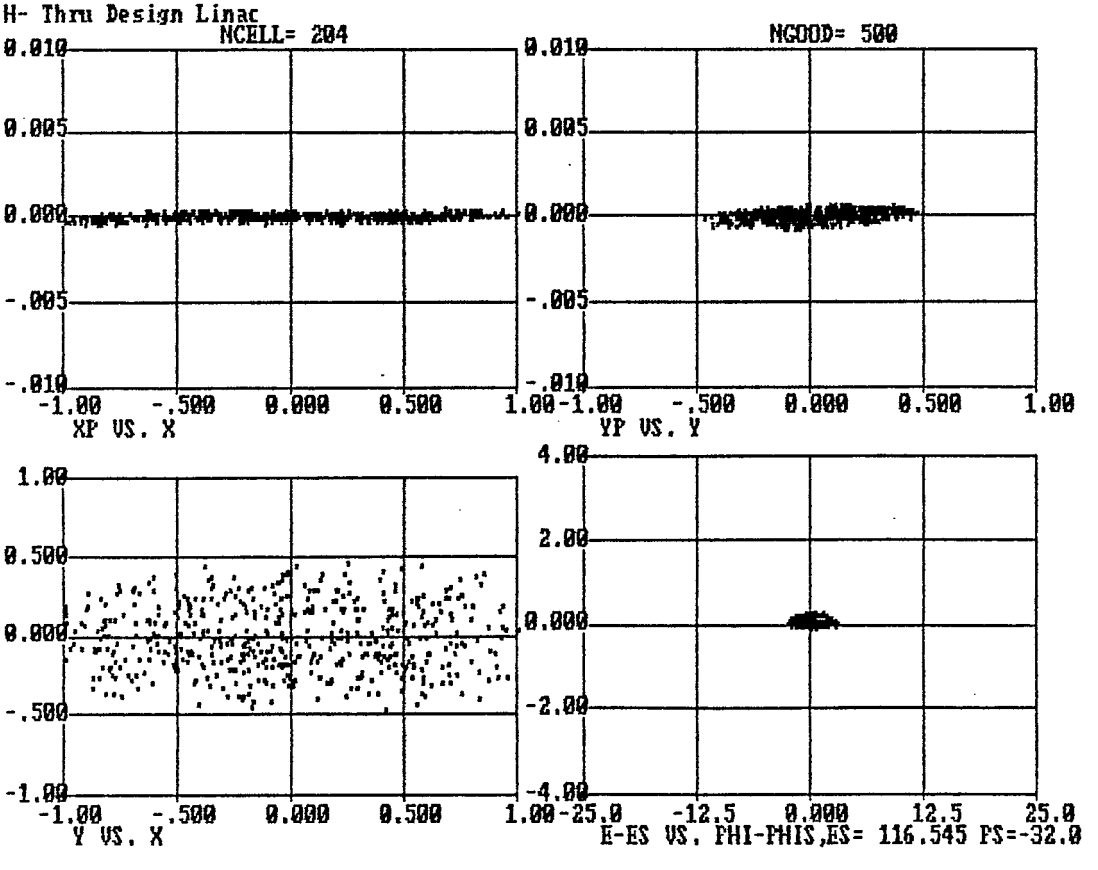

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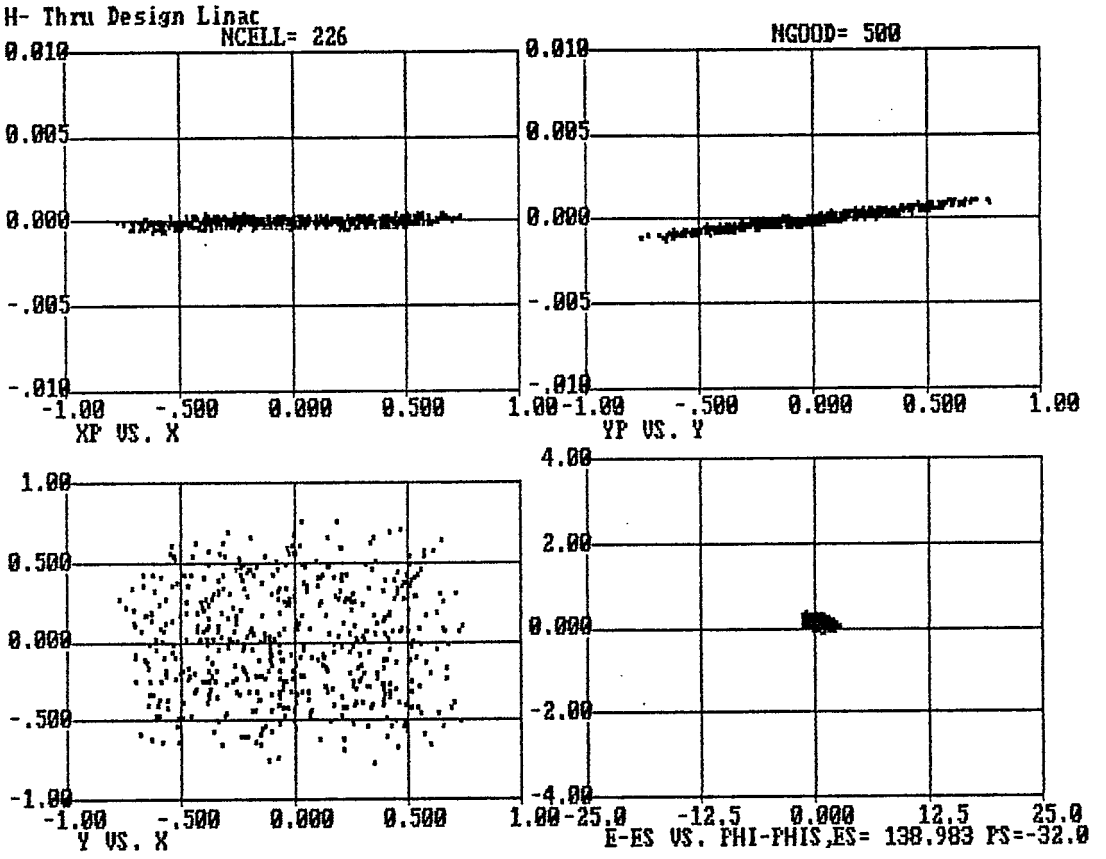

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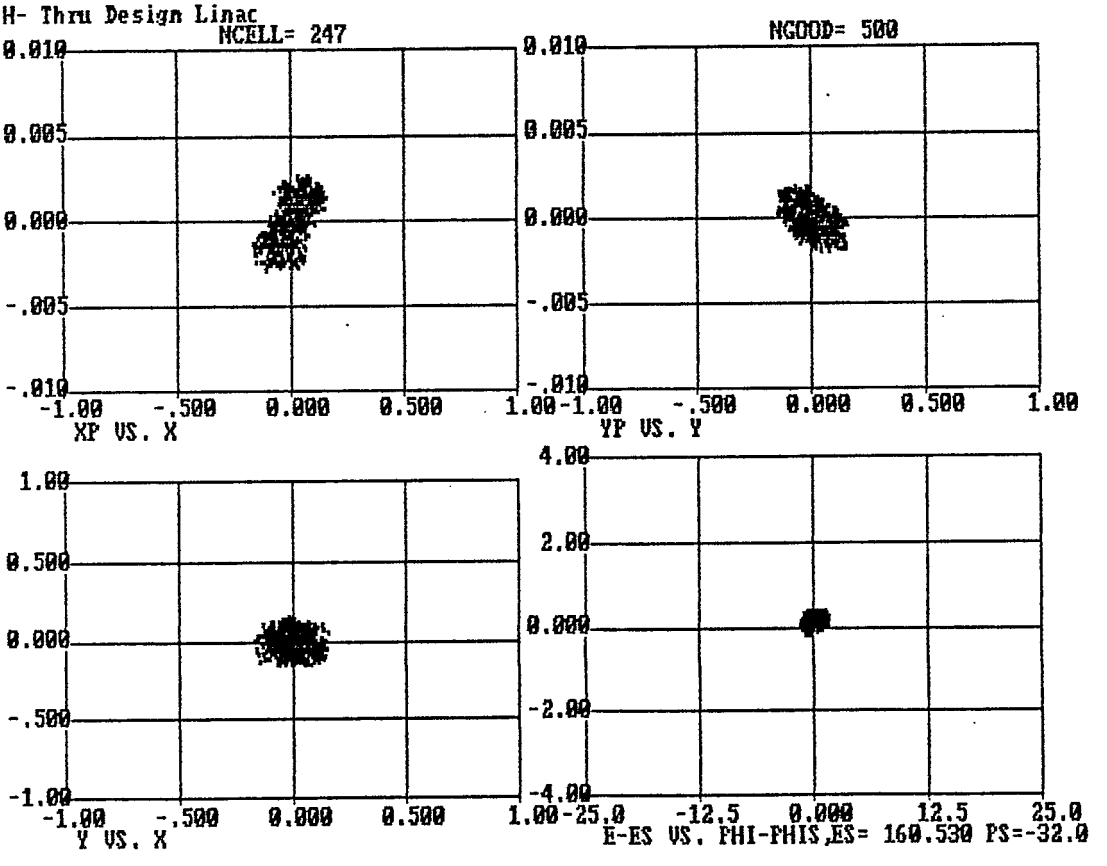

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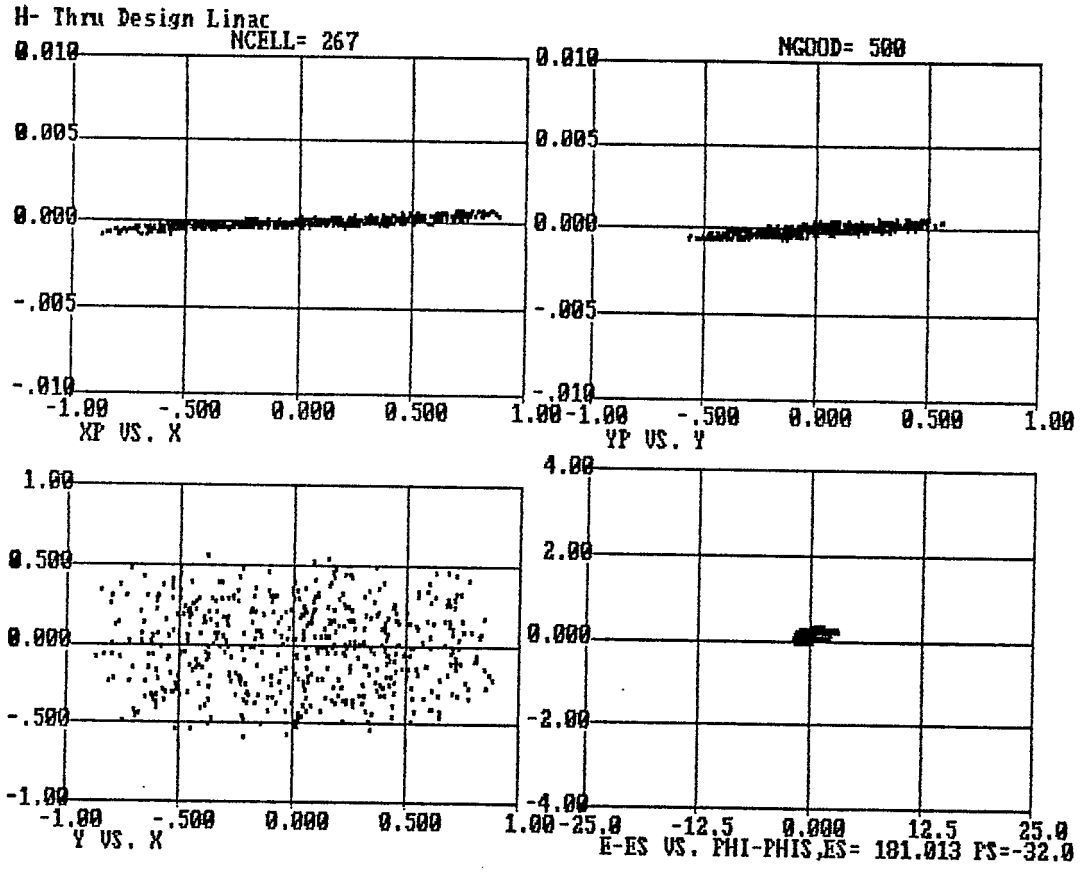

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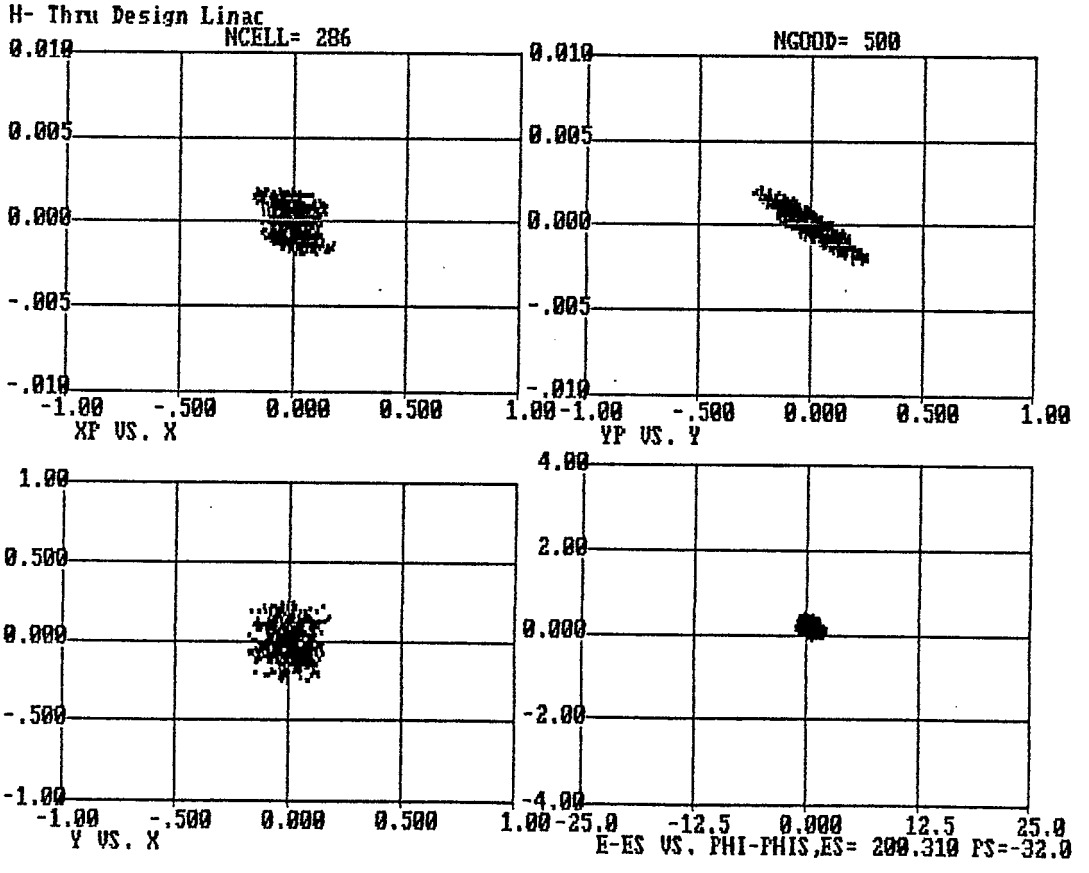

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