



BNL-104014-2014-TECH

AGS.SN136;BNL-104014-2014-IR

Variation of the Location of the AGS Beam Loss Radiation by Modification of the High Field Equilibrium Orbit

L. Ahrens

March 1982

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

AGS STUDIES REPORTDate November 19 & 20, 1981 Time _____Experimenters L. Ahrens and J.W. GlennReported by L. AhrensSubject Variation of the Location of the AGS Beam Loss Radiation by Modification of the High Field Equilibrium OrbitOBSERVATIONS AND CONCLUSION

In November 1981 during the machine tune-up period in preparation for the FEB run, a series of movements of AGS main ring magnets were carried out with the objective of shifting the radial beam dump away from the G superperiod (and away from personnel working in the D line). The effects of these movements on ring radiation and equilibrium orbits were measured and are reported here.

The AGS main ring lattice is designed such that in each superperiod the radial beam envelope is largest near magnets 1, 5, 9, 13 and 17 and in these locations the smallest machine aperture occurs in the 5-ft. straights downstream of magnets 5, 13 and 17. Beam which is not successfully extracted from the AGS typically spirals in to the inside of the machine aperture and on to one of these limiting apertures. Which section and which superperiod actually act as the dump depends on the distortions in the beam equilibrium orbit relative to the magnet apertures. While this orbit is controllable at injection energies by a full set of correction dipoles, at high energies it is basically fixed by the main ring magnets. In particular, if one wishes to change the orbit, the most straight forward way is to move the AGS (combined function) magnets.

In November, 1981, it was desired to allow work to be performed near the G superperiod (in the D line) while the AGS was operating. The G-13 straight section was at this time the primary beam dump for particles lost from the AGS. Most of the beam was lost there if, for whatever reason, the beam was not extracted. The initial equilibrium orbit in the machine, at high momentum is shown in Figure 1. This plots data from the ring equilibrium orbit pick-up electrode (PUE) system, data points are joined by straight lines to encourage the eye. Indeed the orbit shows a large radial excursion to the inside near G-13. The distribution of radiation around the ring, when this entire beam is dumped by turning off the ring rf is shown in Figure 2. The two traces show

radiation on two machine cycles. This data is generated by the Ring Long Radiation Monitor (RLRM) system. Given our limited objective of reducing beam loss in G and having selected no "best" place for a new dump, we moved in reasonable steps to accomplish the first goal subject to the additional constraint that we reduce orbit excursions as reported by the PUE system. Moving each of a pair of magnets separated by a half-betatron wavelength by approximately 0.050 inches toward regions of lower field causes a "half lambda" orbit bump to the outside of amplitude approximately 2 mm. Given the fact that the magnet motion must be taken up by vacuum pipe bellows, this seemed a reasonable magnet motion and to get a reasonable amount of beam orbit motion, given the scale of orbit wiggle in Figure 1, two adjacent pairs were moved at each step. The actual motions performed were adjusted from the 50 mils to account for differences in beta function and magnet lengths at the moved magnets.

Following a move, the machine was started up again, orbits and radiation patterns were observed and the next step was formulated. In all three such bumps were placed around G-13 and one bump was placed around E2. The actual magnet moving was accomplished using hardware present on the magnets. Micrometers fastened to the support girders measured the displacements. Table 1 catalogues the motions. After two moves at G, it was clear that the new dump would be at E1 which is near an rf station and which was judged to be an unhappy choice. The bump at E avoided this and with the final G bump, the primary dumps ended in C13 and K13, with a relative loss of about 2 to 1 respectively. The overall perturbation to the equilibrium orbit is given in Figure 3. Figure 4 gives the final radiation pattern and Figure 5, the final orbit. For reference, the four partial bumps are shown in Figure 6. Again, for reference the radiation loss pattern before the final move at G is given in Figure 7. Table 2 shows how the radiation observed outside the ring in the D line construction area varied with the magnet shifts.

We appreciate the assistance of Frank Karl from the AGS Survey Group and the AGS Health Physics team in making these movements and measurements.

Table 1

| <u>Magnet Move</u> | <u>Date (1981)</u> | <u>Time</u> | <u>Magnets</u> | <u>Movement (mils)</u> (+ = away from ring center) |
|--------------------|--------------------|-------------|---------------------|---|
| 1 | Nov. 19 | 1500 | G7, G8 H1, H2 | - 55 + 50 |
| 2 | Nov. 19 | 2300 | G9, G10 H3, H4 | + 55 - 50 |
| 3 | Nov. 19 | 2400 | D15, D16 E9, E10 | + 55 - 50 |
| 4 | Nov. 20 | 1400 | G5, G6 G19, G20 | + 35 - 55 |

Table 2

Radiation in Construction Area (mr/hr)

| <u>Measured Following Move #</u> | <u>Outside G13</u> | <u>Outside G17</u> | <u>Outside G20</u> | <u>At Exp. Trailer G20 Elevated</u> | <u>At Corner of EBE</u> | <u>Intensity Protons x 10¹²</u> |
|----------------------------------|--------------------|--------------------|--------------------|-------------------------------------|-------------------------|--|
| 0 | 100 | 200 | 80 | 150 | 300 | 5 |
| 1 | 20 | 40 | 20 | 25 | 60 | 6 |
| 3 | 20 | 30 | 20 | 10 | 50 | 5 |
| 4 | 7 | 5 | 7 | 3 | 20 | 4.5 |

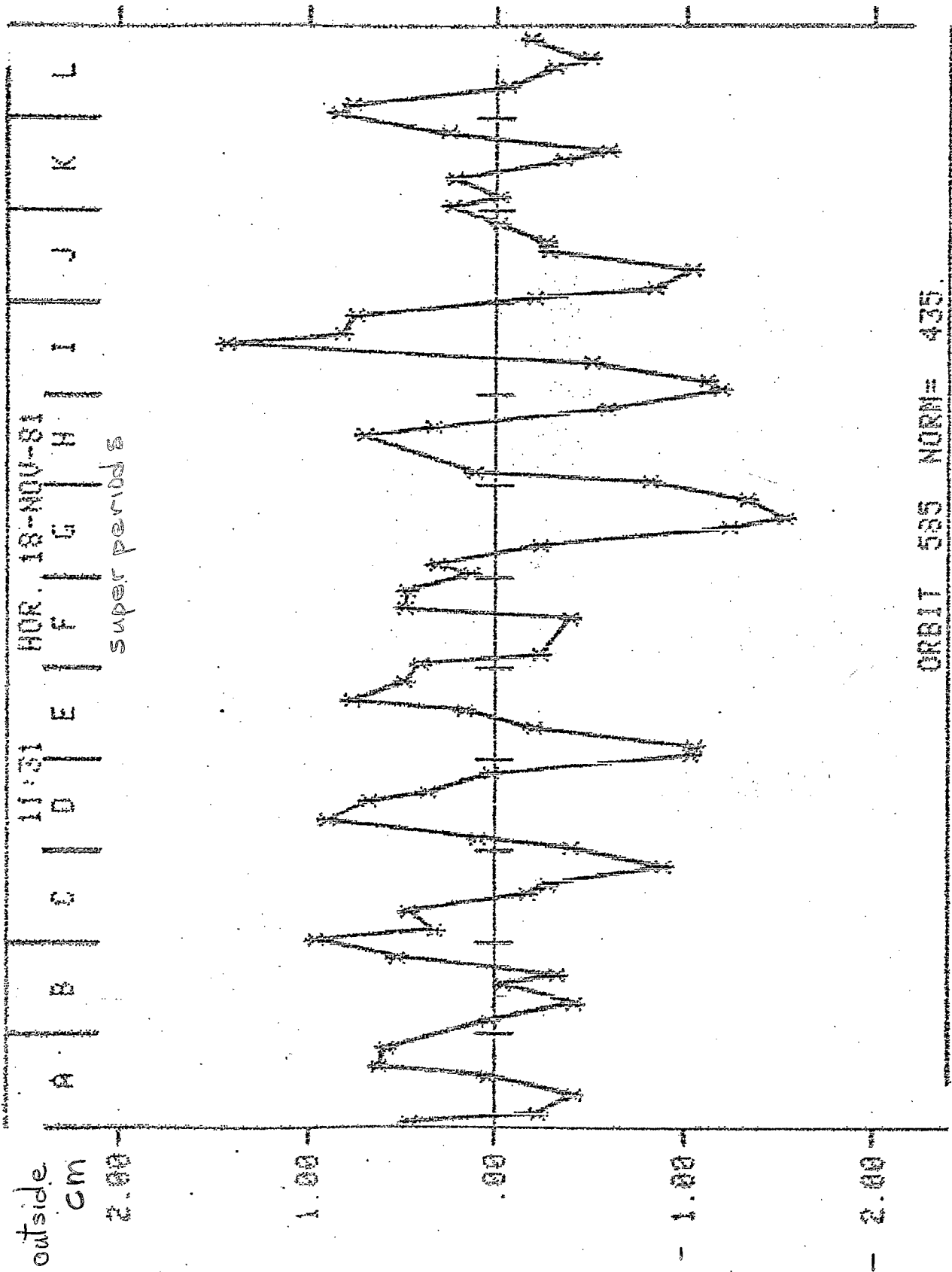


Figure 1. Aprion equilibrium horizontal orbit, high momentum

18-NOV-81 TIME=11:03:15.2

20% Trans. loss

SCALE= 2000

50 TO 600MS

MODE=1 TIME= 50 TO 600MS

CBM=41040 600MS

CBM=5720 50MS

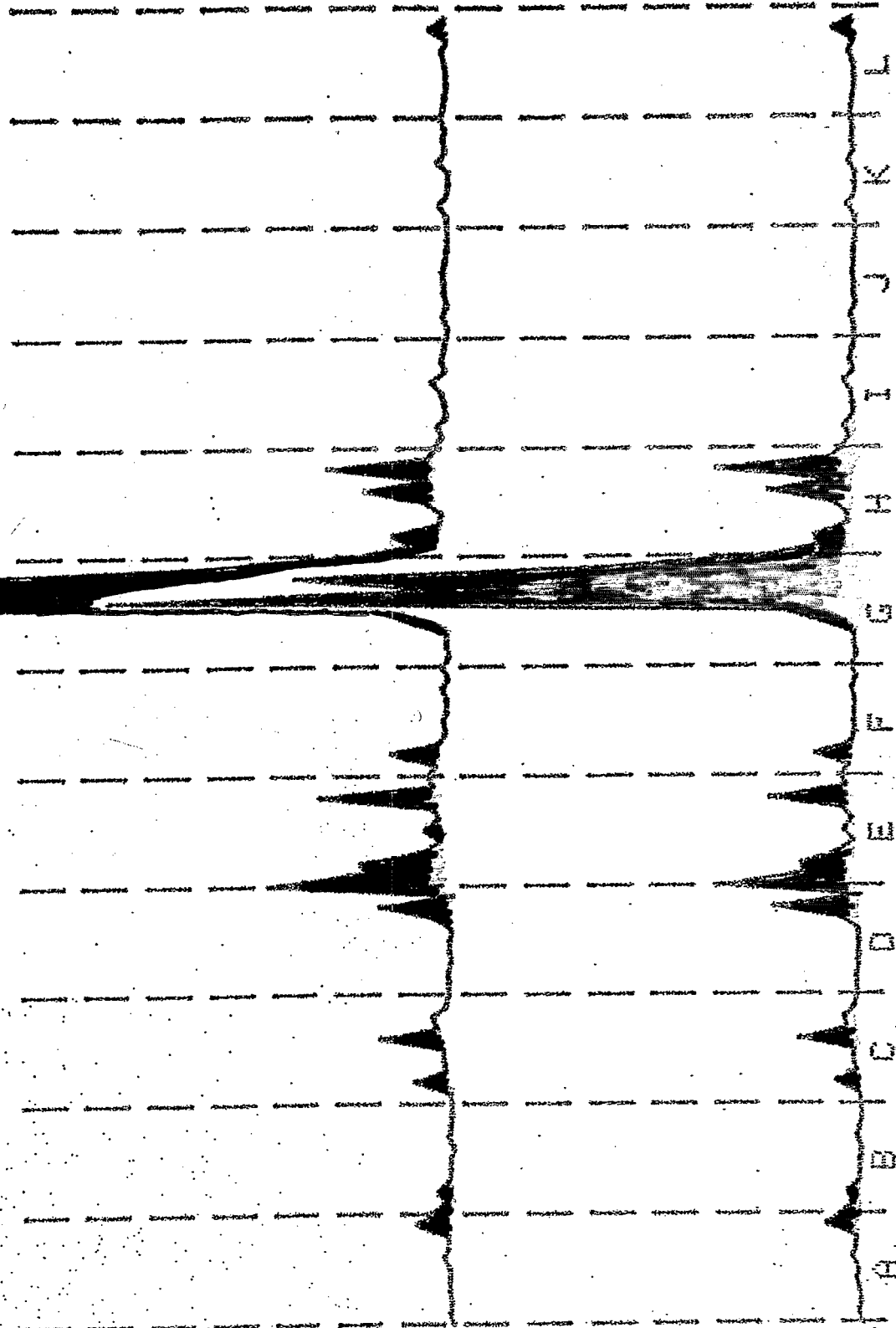
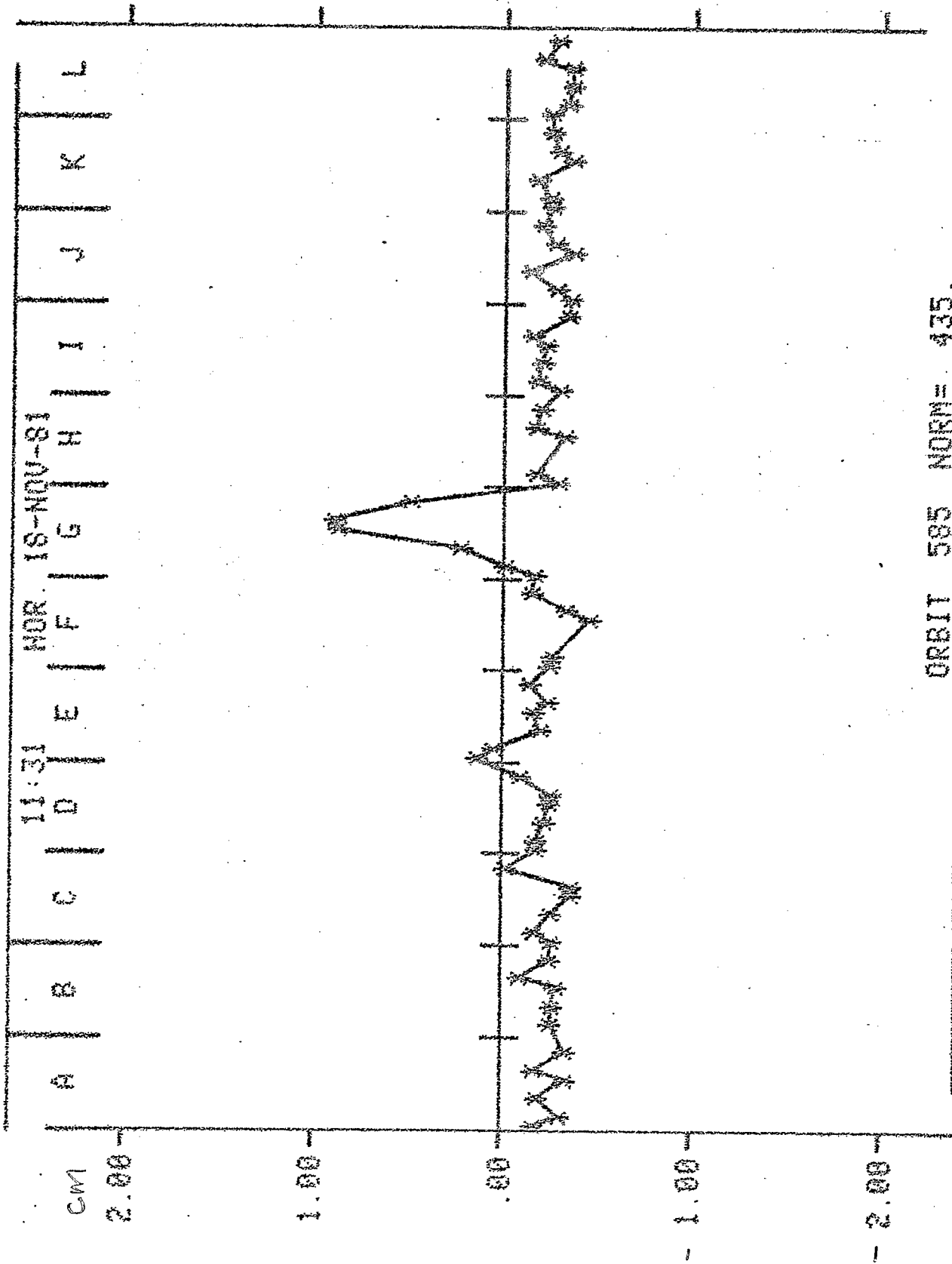


Figure 2 Apriori radiation loss around machine (R.F. off @500ms)

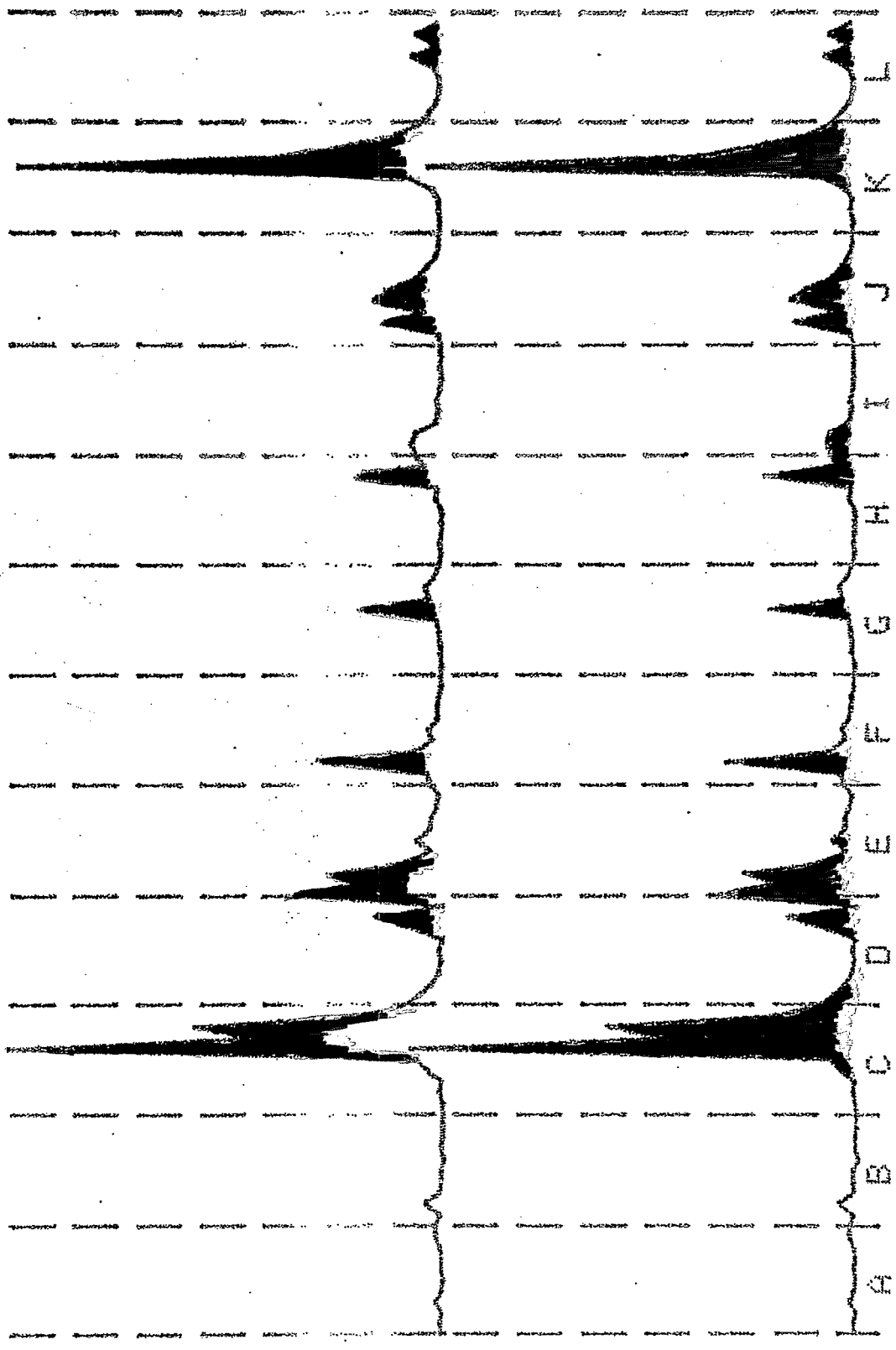


ORBIT 585 NORN= 435.

Figure 3 Change in equilibrium orbit (sum of 4 bumps)

20-NOV-81 TIME=16:58:58.3

U-P SET UP: NODE=1 TIME= 60 TO 600MS SCALE= 3000
CBM= 4610 60MS CBM= 00 600MS



5000F 4.5TP Figure 4 RF off @ 500 ms

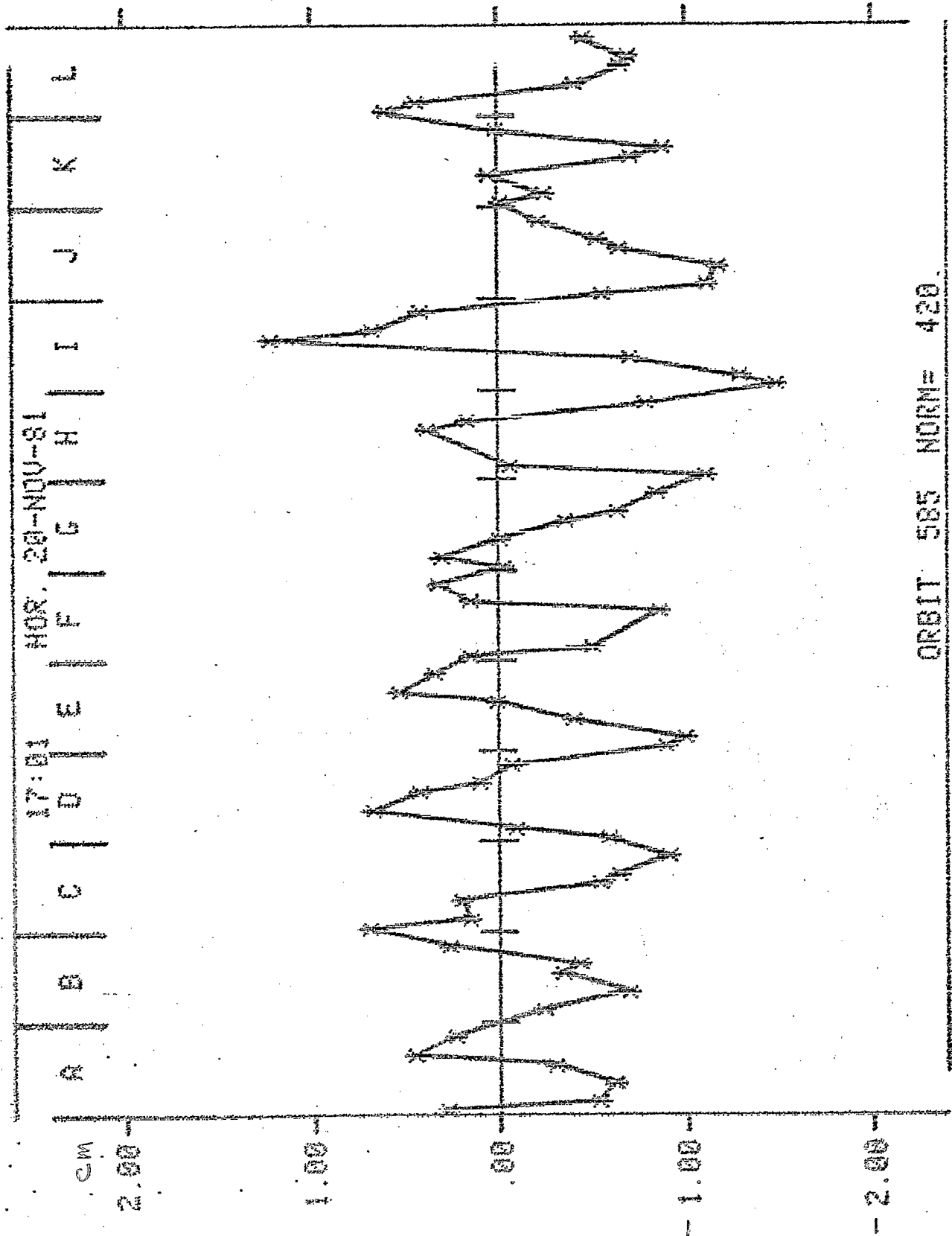


Figure 5 Final equilibrium orbit, high momentum

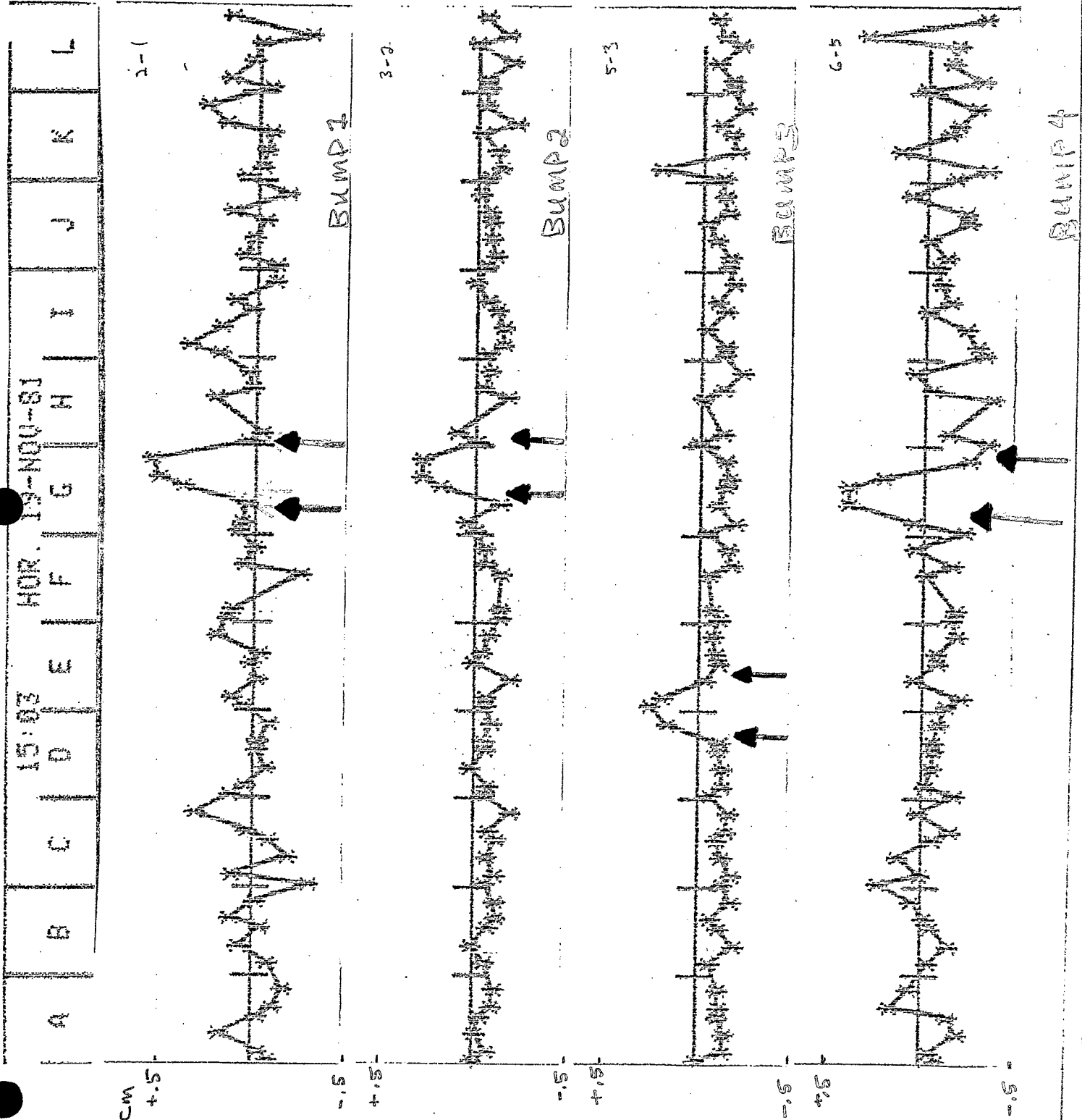
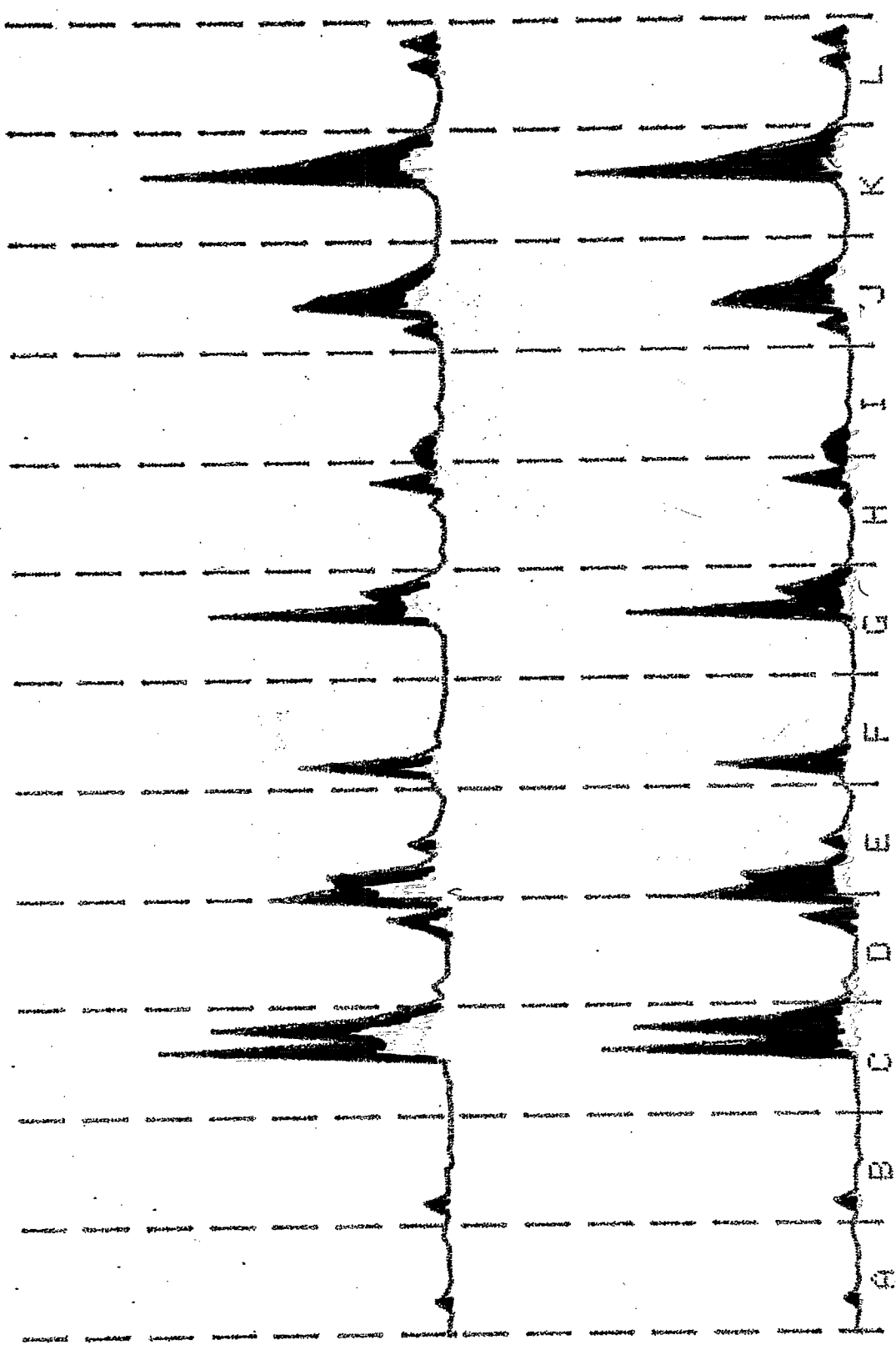


Figure 6 Difference Orbits

20-NOV-81 TIME=12:10:53.6
 U-P SET UP: MODE=1 TIME= 60 TO 600MS SCALE= 3000
 CEN= 5500 SONS CEN= 502 600MS



580 OF Figure 7 R.F. off @ 580 ms