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

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March 1982

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USDOE Office of Science (SC)

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AGS STUDIES REPORT

Date November 19 & 20, 1981 Time

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Reported by L. Ahrens

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OBSERVATIONS 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

Magnet Move	Date (1981)	Time	Magnets	Movement (mils) (+ = 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)

Measured Following Move #	Outside G13	Outside G17	Outside G20	At Exp. Trailer G20 Elevated	At Corner of EBE	Intensity Protons x 10^{12}
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

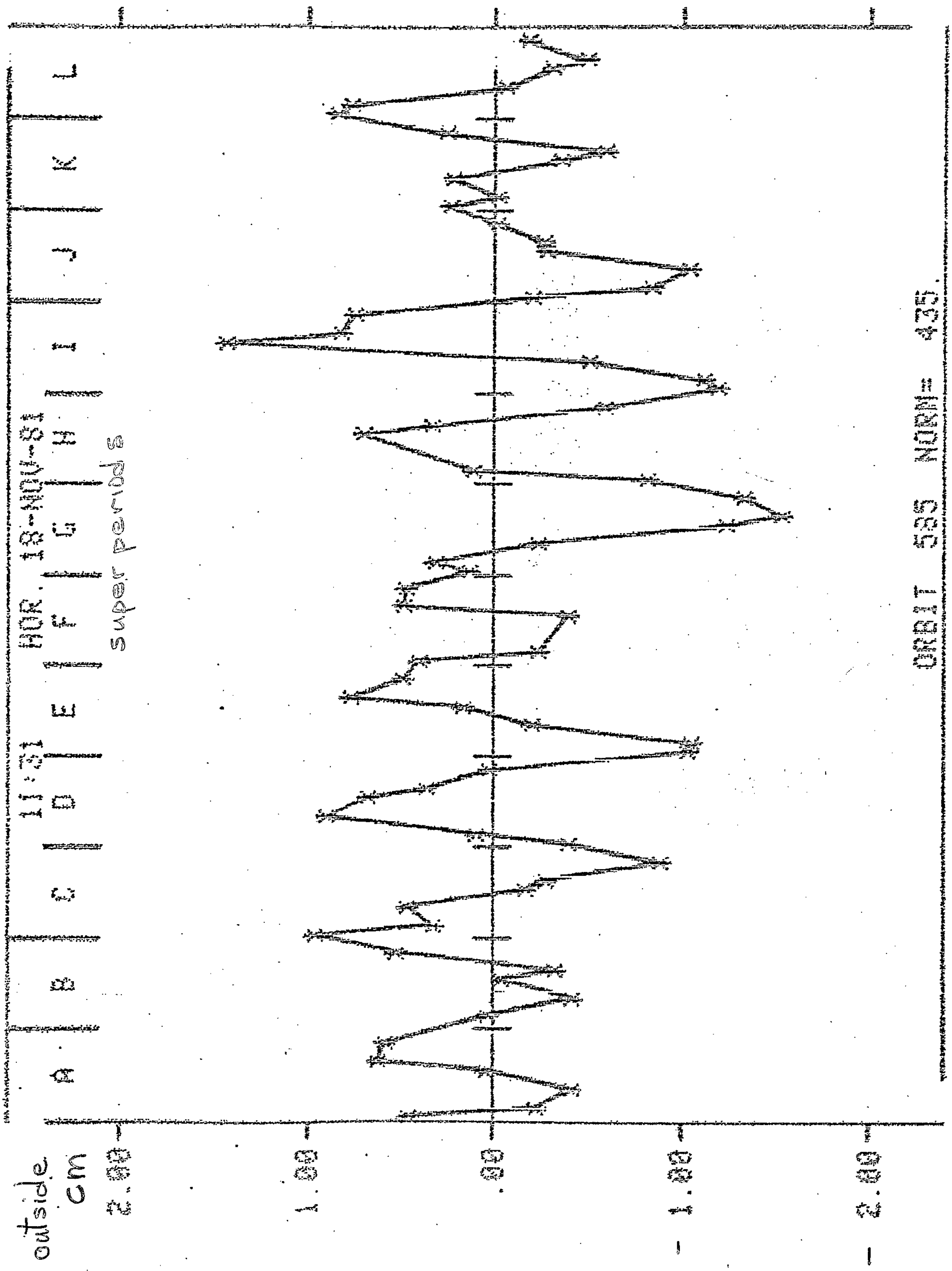

Figure 1. Apriori equilibrium horizontal orbit, high momentum

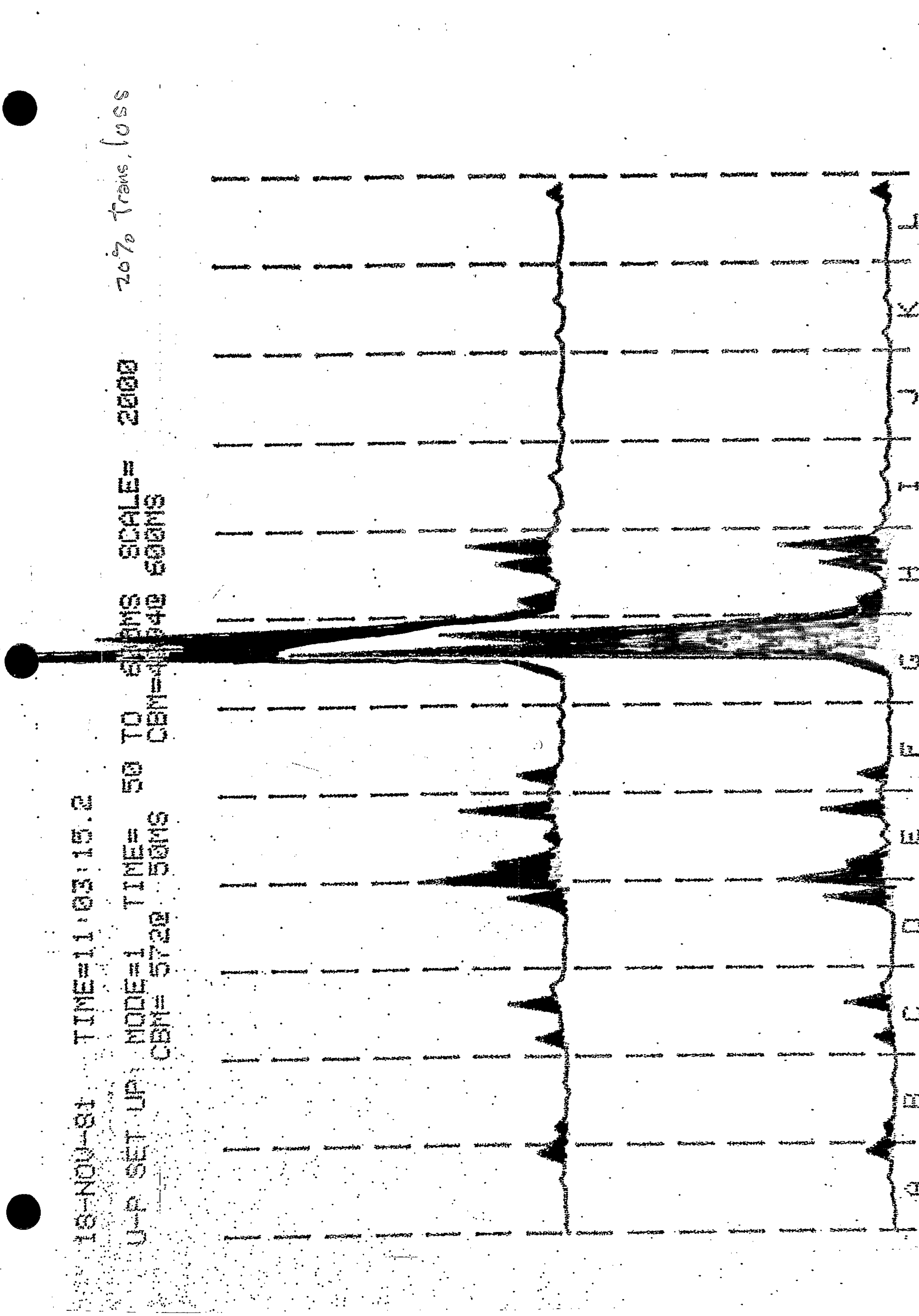

Figure 2 Apriori radiation loss around machine (R.F. off @500ms)

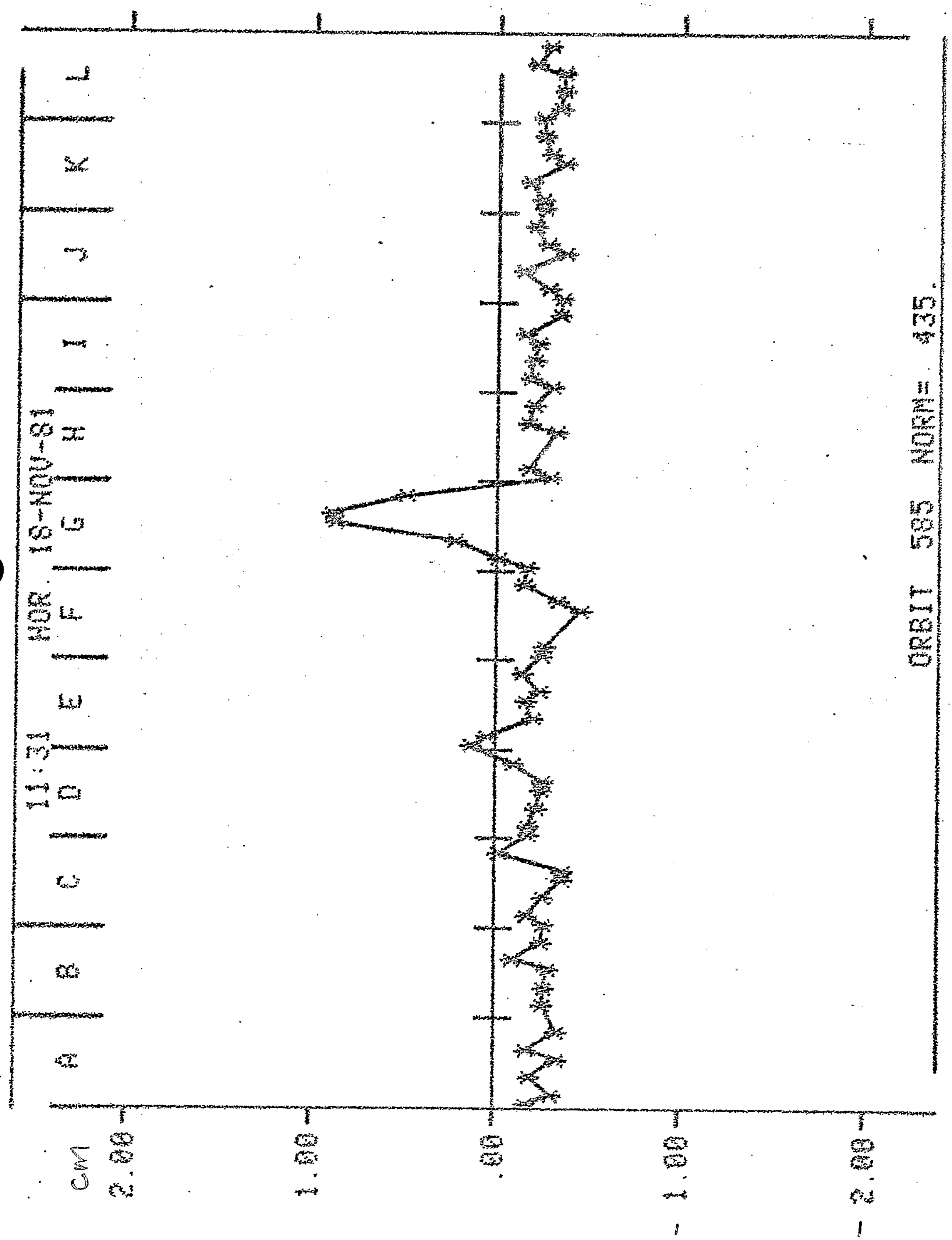

Figure 3 Change in equilibrium orbit (sum of 4 bumps)

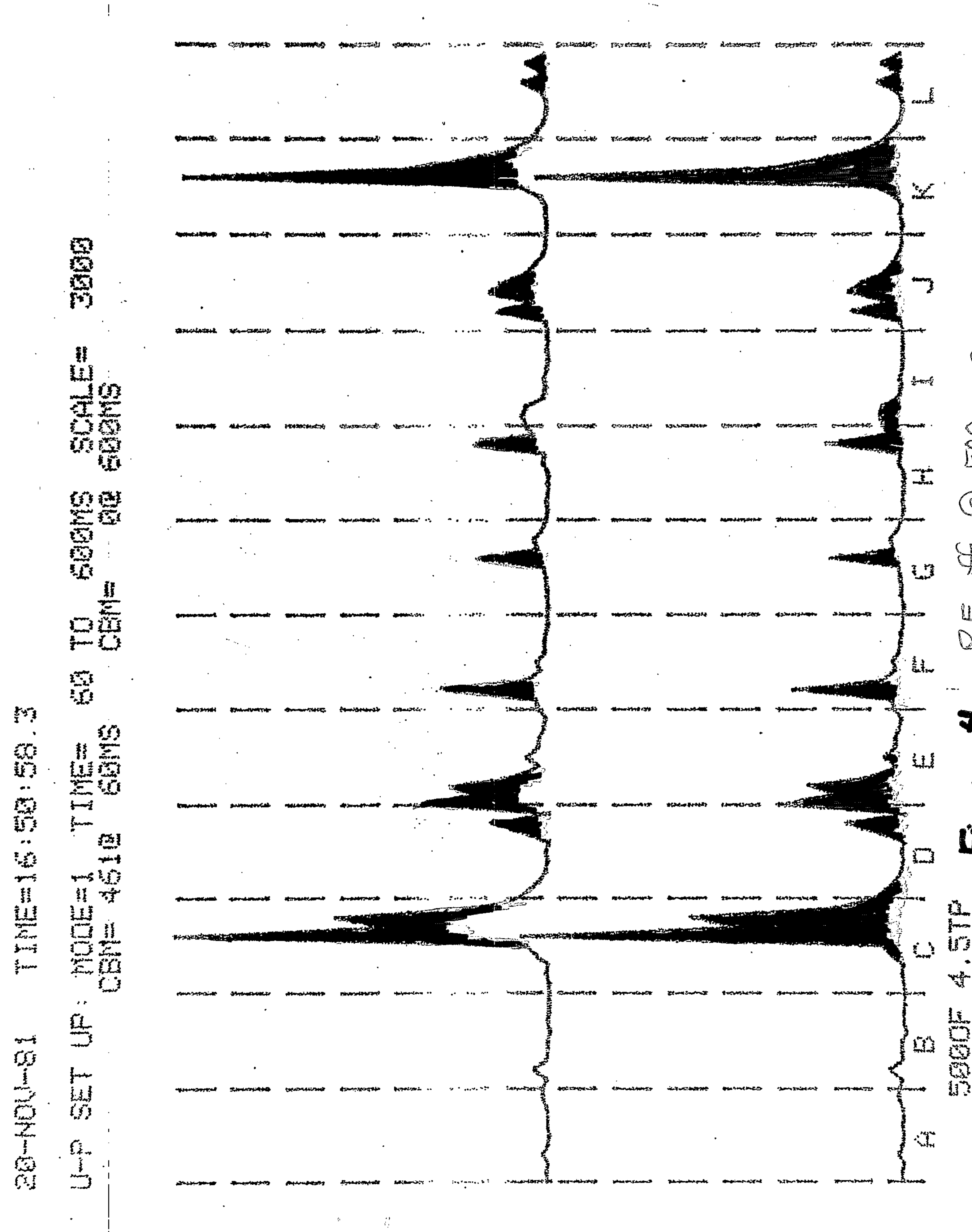

Figure 4 RF off @ 500 ms

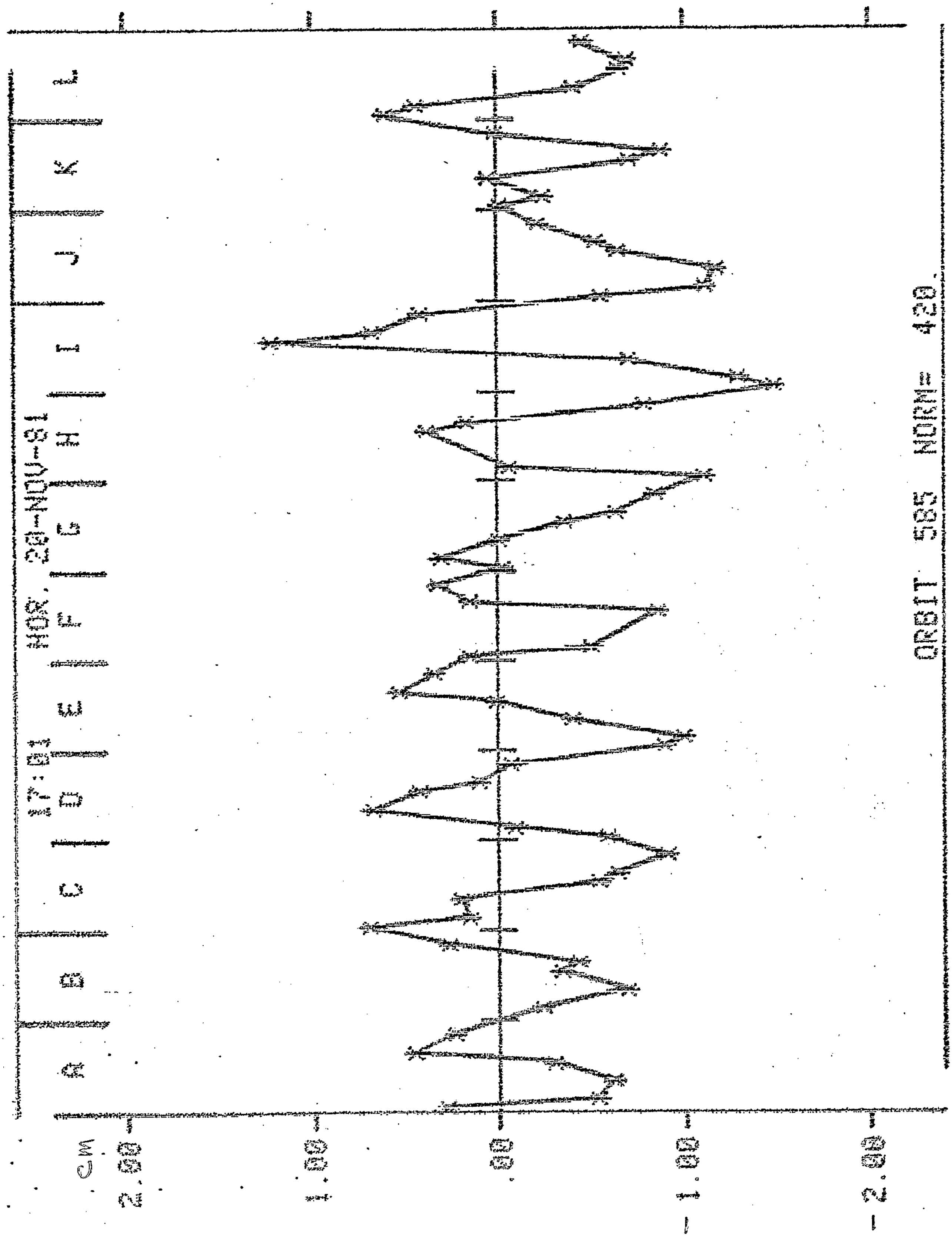

Figure 5 Final equilibrium orbit, high momentum

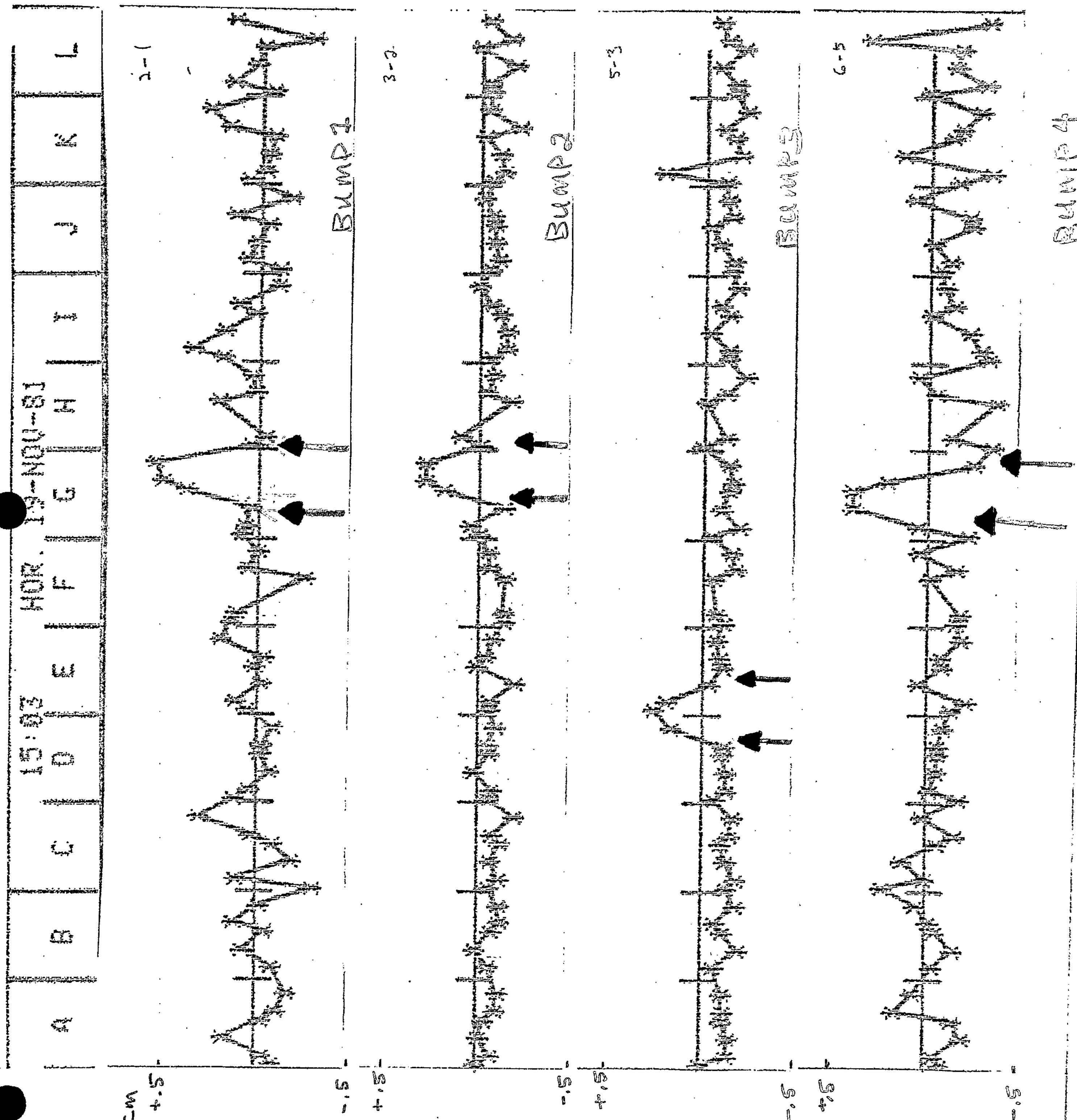

Figure 6 Difference Orbits

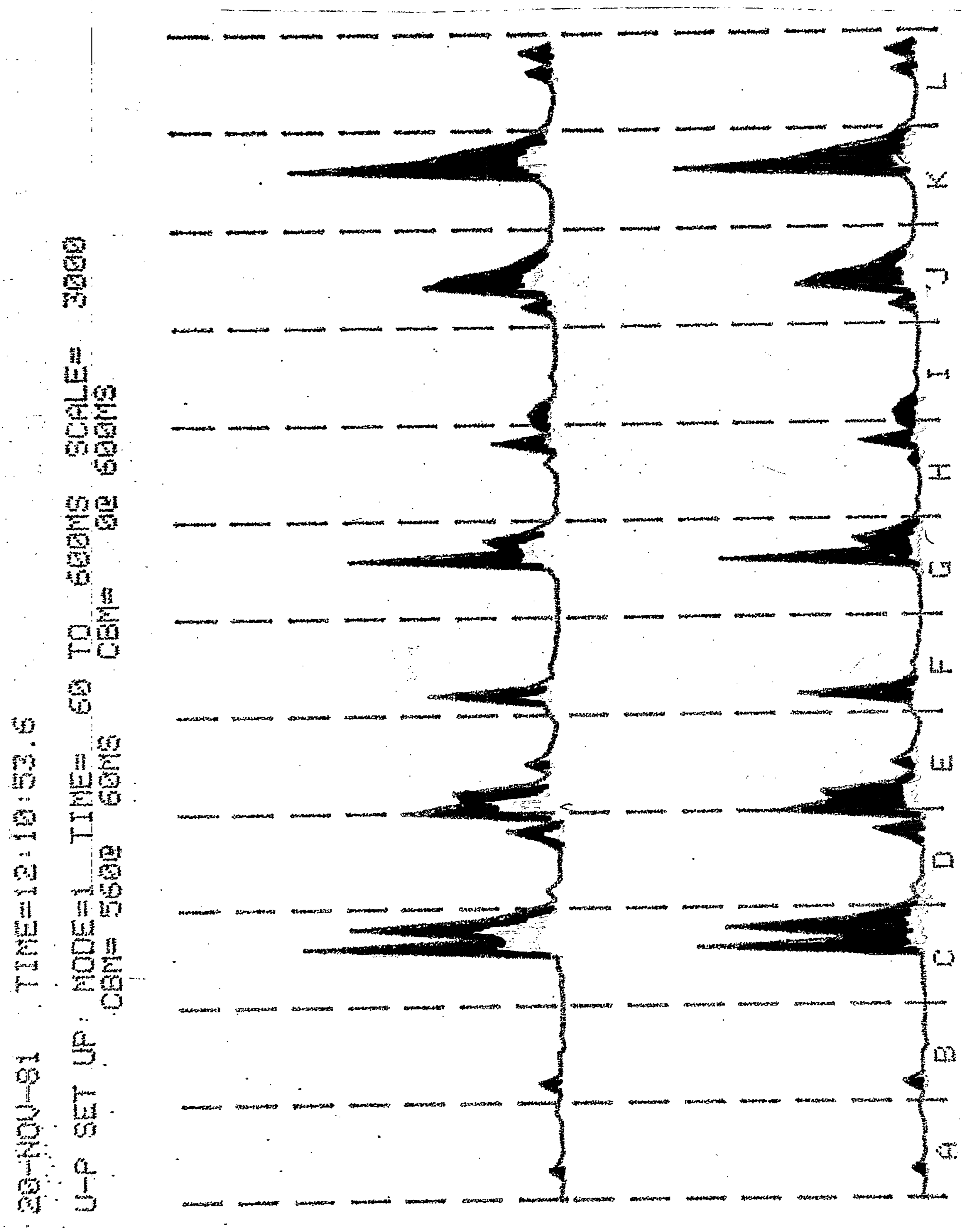

Figure 7 R.F. off @ 550 mS