national accelerator laboratory

EXP-28

January 16, 1973

ACCELERATOR EXPERIMENT--Booster Capture

Experimentalists: F.E. Mills (BNL) and M.F. Shea

Date Performed: 9 January 1973

Description of Experiment

A series of measurements was made to check the systematics of rf capture in the booster. Wide-band diagnostics were used with a divide by 84 scope trigger circuit to follow individual bunches through the capture processes and the subsequent losses which take place in the first millisecond after capture. Absolute monitoring of beam intensity was not attempted, so the trapping efficiency was not measured by this method. On the other hand, total current monitors show no appreciable loss through the 150-200 μsec trapping period so that we may surmise that the process is efficient, insofar as longitudinal phase space is concerned.

Conclusions

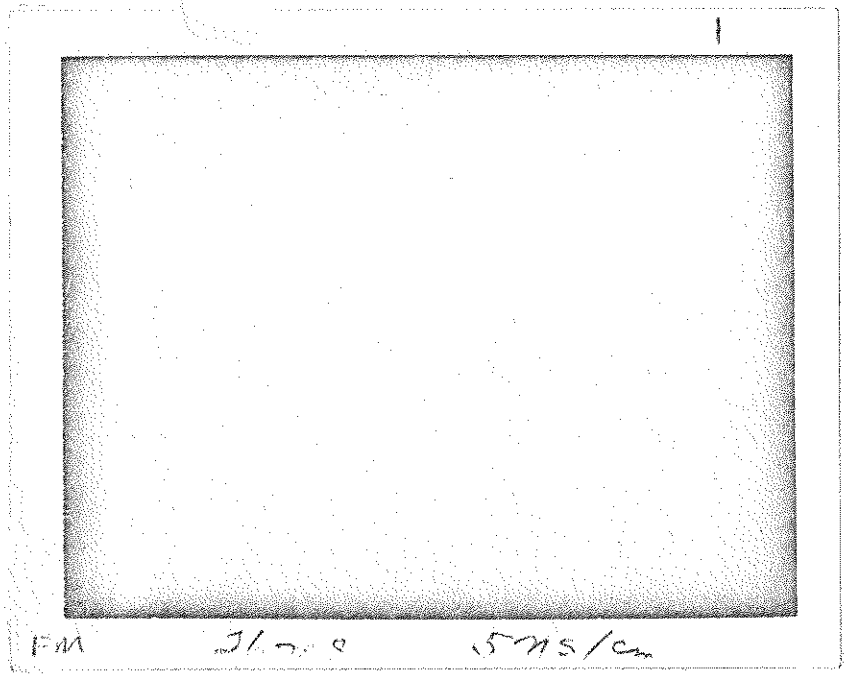
The main conclusions are:

1. At the end of the trapping period, the beam is trapped in bunches occupying approximately 3/4 of an rf cycle. This width is somewhat (50%) greater than the minimum expected on the basis of linac energy spread, rf voltage and perfect trapping.

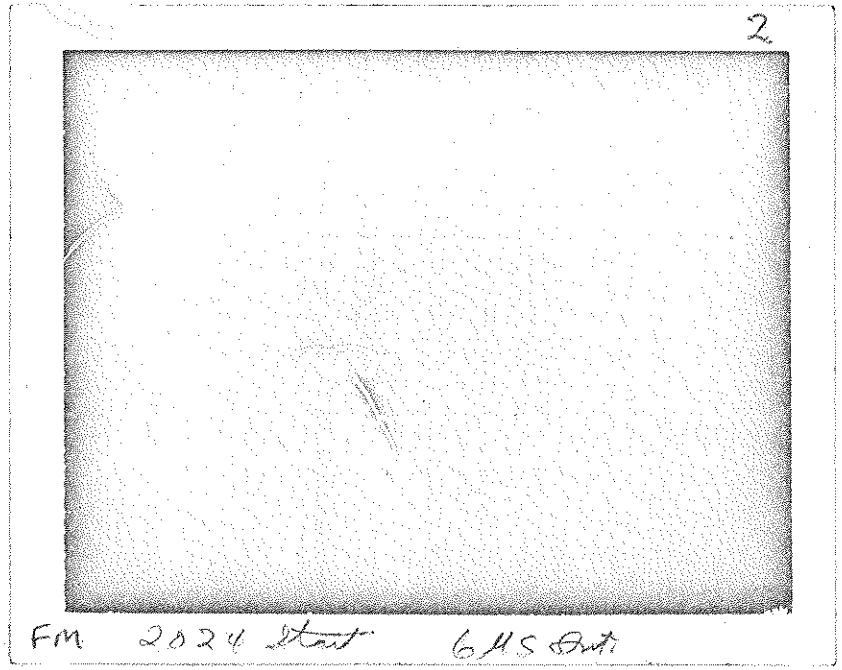
2. Losses which take place in the first millisecond take place primarily at large phase oscillation amplitude, i.e. the bunches get narrower with roughly the same peak current. There is no evidence of disruptive phase oscillation phenomena taking place in this period. One concludes the loss is due to effects on the transverse motion. The loss phenomena are enhanced by applying an 18-mm local orbit bump, a fact which is not well understood.

3. It might be worthwhile to change the energy spread of the linac and observe the capture again, as well as the loss phenomenon. The loss should be enhanced for large phase oscillations; if a smaller linac energy spread indeed leads to smaller booster phase oscillations, then the loss mechanism should be of reduced importance.

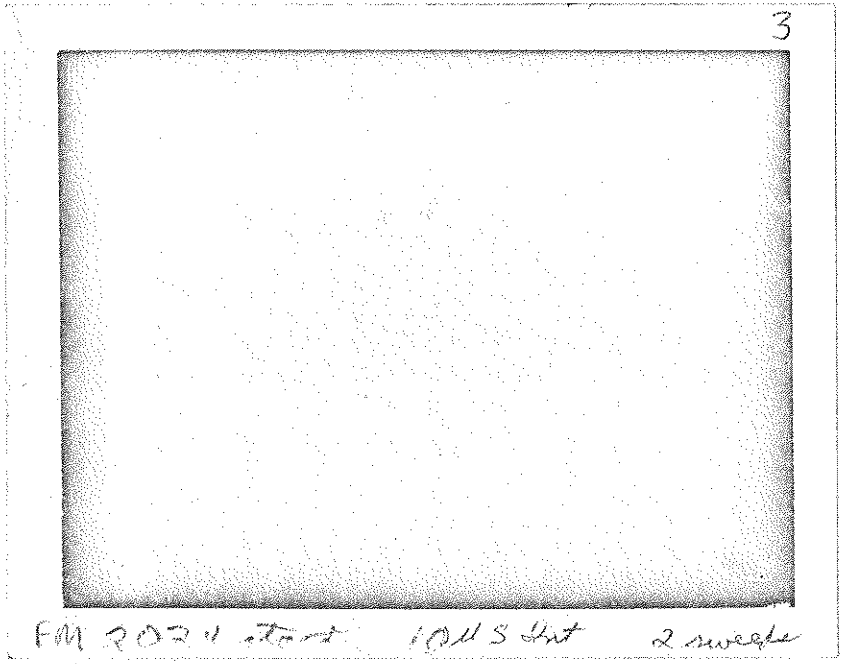
F. E. Mills



Fast toroid response late in cycle. This establishes the quality of the equipment.



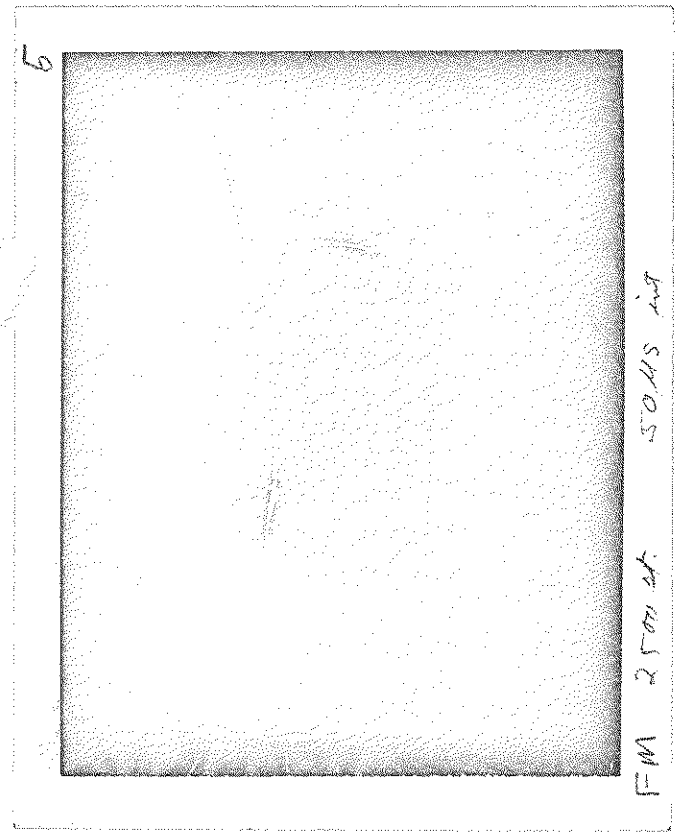
RF capture, early. 6 μsec intervals.



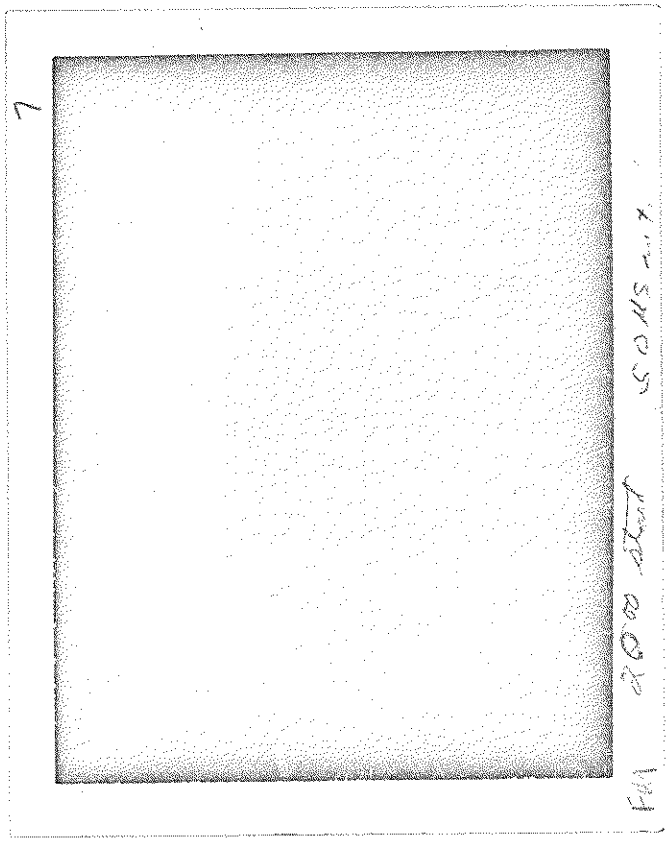
RF capture. 10 μsec intervals. Capture not complete by end of picture.

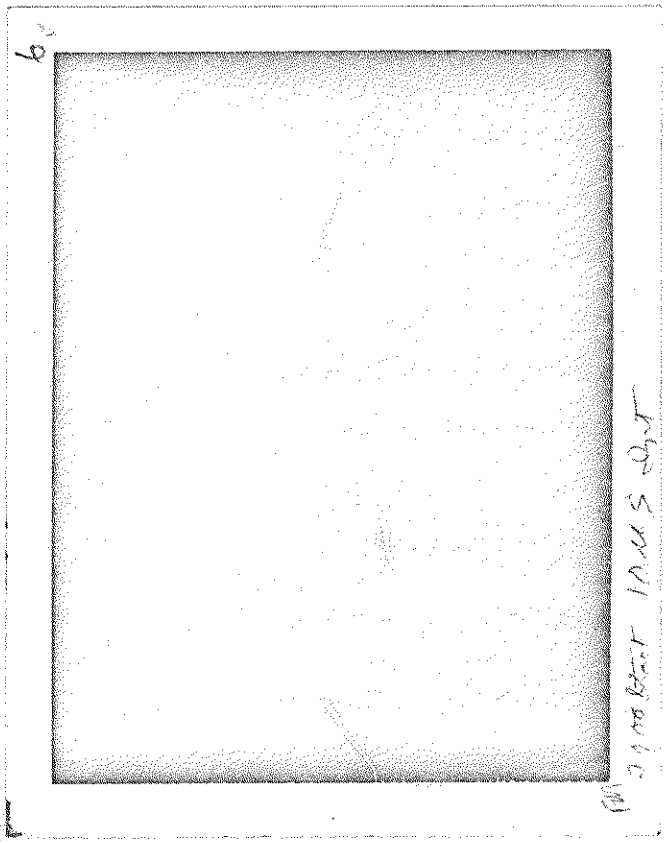
Photograph not available.

RF capture, first 500 μsec. 50 μsec intervals. One can see the early development of a flat "valley" between the bunches.

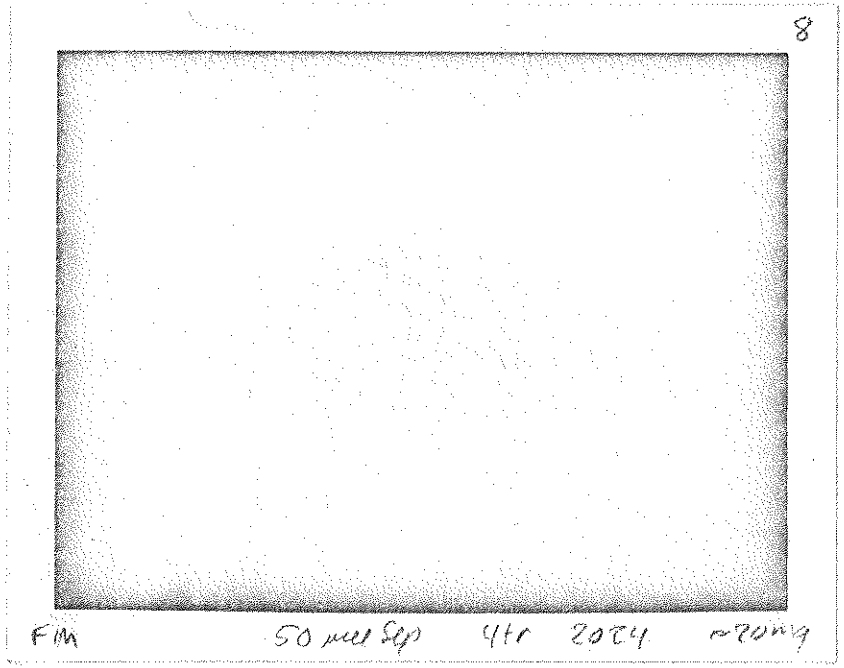


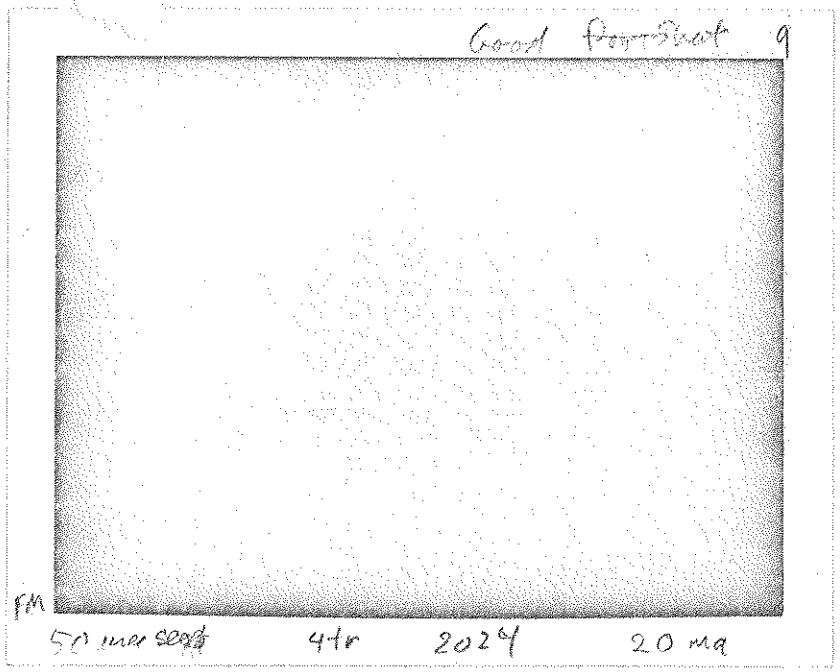
Second 500 μsec after capture



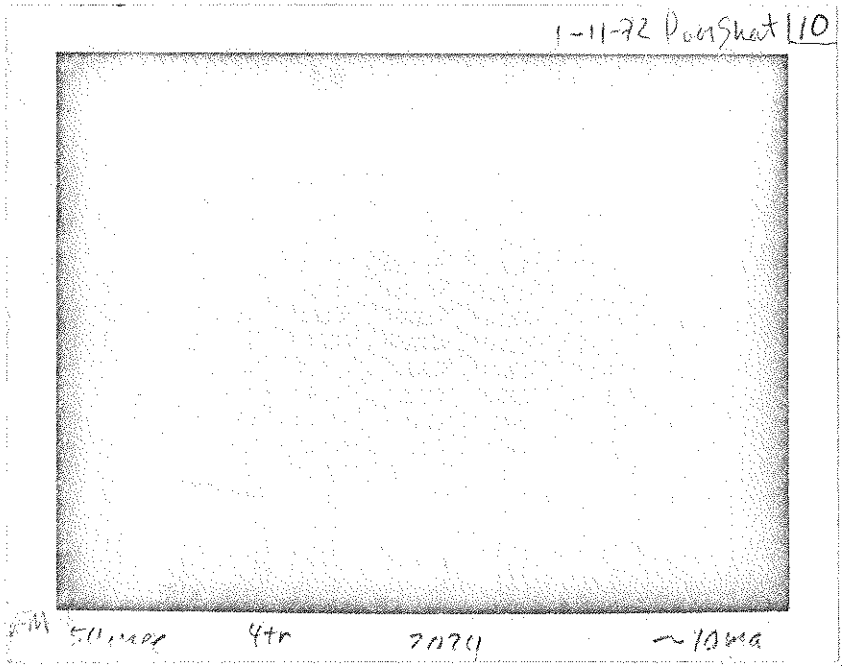


Injection with a notch. One can see beam leak from the sides into the notch during capture and then be "frozen" there at the end of capture. Bunch narrowing is apparent.

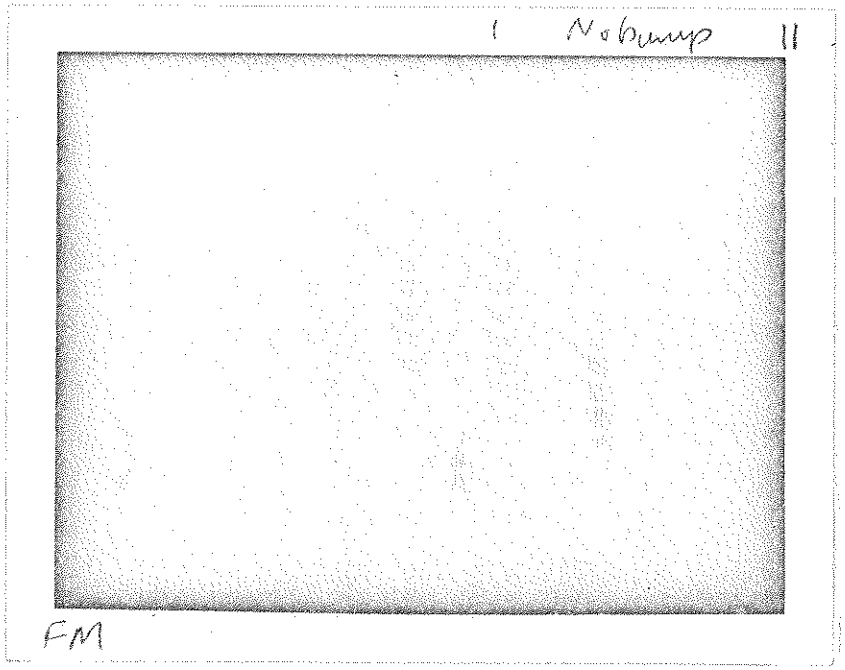




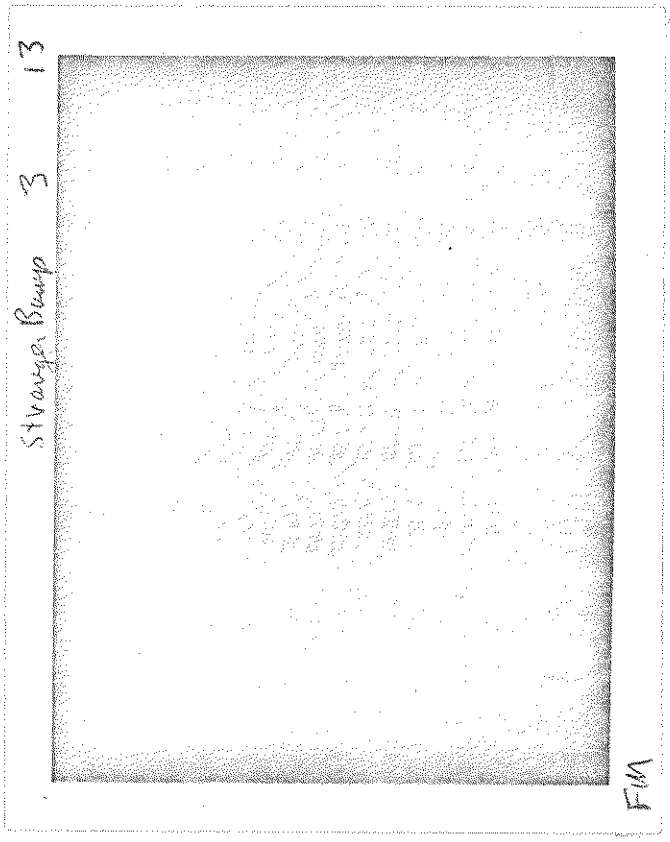
Closer look at bunches for first 800 μsec. Narrowing is apparent. Good booster pulses.



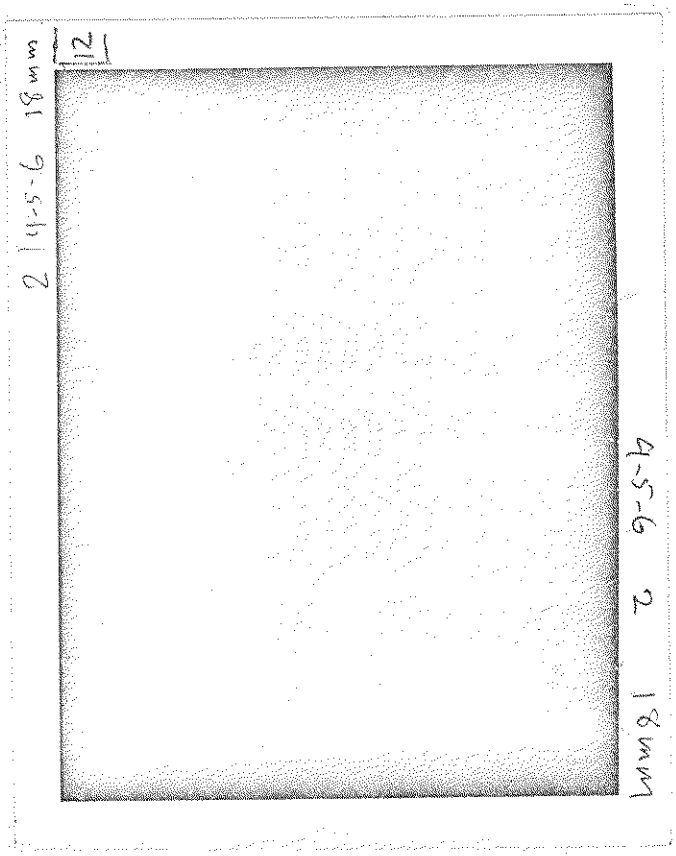
A "poor" booster shot. Bunches are quite narrow.



This series shows the effect of a local bump. First picture is normal.



Stronger bump, narrower bunches.



18-mm bump. Enhanced loss of large phase oscillations.