

Linac Emittance and Momentum Spread Variation with Current

R. Witkover

October 1977

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.EY-76-C-02-0016 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.

Date 10/20/77 Time 0030-0330 Experimenters R.L. Witkover, N. FewellSubject Linac Emittance and Momentum Spread Variation with CurrentOBSERVATIONS AND CONCLUSION

Objective: To vary linac beam current from 25-100 mA in a controlled manner and measure emittance and momentum spread.

Procedure: With the ion source magnet current fixed, adjust the anode pulser voltage for the desired current. Trim up bunchers, LEBT quads and rf compensation pulse for best transport (lowest radiation). Using the destructive emittance device at N300, measure the emittance in both planes. Using the slit at N202 and BM4, measure the momentum spread with the SEM at N302.

Results and Observations: Beam currents of 95 mA were obtained within 30 minutes. More detailed tuning could probably have gotten 100 mA, but it was felt wiser to work with this. Cursory adjustment of LEBT quads and bunchers did not improve the current. Only further source adjustment (arcing prevented this) and rf compensation seemed likely to help. Emittance was found to be:

$$\epsilon_H = 0.85 \text{ cm-mrad at } 80\%$$

$$\epsilon_V = 0.90 \text{ cm-mrad at } 80\%$$

The other data points were found to lie on a straight line. No data was taken below 50 mA.

The measurement at 50 mA was repeated for lower ion source magnet current and higher anode pulser voltage. The emittance was found to be 13% lower vertically and 25% lower horizontally.

Momentum spread was measured:

I_b (mA)	$\% \frac{\Delta p}{p}$ (at BM4) (90% FW)	$\% \frac{\Delta p}{p}$ (at T9) (90% FW)
95	0.415	0.34
80	0.4	0.335
50	0.365	0.317
25	0.27	0.235

A final test was made with both bunchers off. This yielded a value of 0.445% at BM4 for 40 mA. This should be compared to 0.33 with bunchers on.

Conclusion: Adjusting the linac current by means of the anode pulser for fixed ion source magnet current makes the linac behave as a constant brightness source. Lower effective emittance values can be obtained with proper settings. Whether this is due to improved source parameters or better matching of the source to the LEBT is not known. Measurements of emittance in LEBT are required to establish the cause and allow an estimate of emittance growth in LEBT and tank 1.

The momentum spread of the beam leaving the linac is nearly constant from 50-95 mA, dropping off below this value. The larger spread observed with bunchers off implies the bucket is not full even at 95 mA.