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Linac Emittance and Momentum Spread Variation with Current

R. Witkover

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Collider Accelerator Department

Brookhaven National Laboratory

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OBSERVATIONS 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.