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Using the Linac Beam to Survey HEBT Quadrupole Magnets, Linac Position Monitors and SEM Units

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Observations and Conclusion

Since the redesign and conversion of the 200 MeV High Energy Beam Transport (HEBT) line from H^+ to H^- in 1981 there has been an uncertainty of the relative alignments of the quadrupole magnets, linac position monitors (LPM) and SEM units. Originally, the injection studies group had proposed possibly bleeding up the beam line to atmosphere and requesting an internal survey of the SEM units and correlating this with the quadrupole survey. This would however still leave the LPM's unsurveyed and require an extensive commitment of the survey and vacuum groups during the summer shutdown. An alternative procedure[1] was developed that would be performed using the beam and could be accomplished within 8-12 hours without breaking vacuum.

In two places in HEBT there are two sets of horizontal and vertical LPM's located between two quadrupoles (or a quadrupole and major horizontal dipole).

1. NX,Y31 and NX,Y35 are located between NQ29 and NQ42.

2. NX,Y221 and NX,Y246 are located between NQ218 and ND249.

The beam was first centered in both planes on the four LPM's indicated using a pair of horizontal and vertical dipoles between two upstream quadrupoles (ND9, ND16, NP9, NP16). The remaining steering elements from that point forward to ND249 were at zero current. Once the beam was centered in the four LPM's, upstream quadrupoles were varied by $\pm$10-20% while monitoring any movement on the LPM's. Most of the quadrupoles were adjusted during this procedure and with an oscilloscope display amplitude of 100 mV/division, essentially no movement could be seen, (baseline sensitivity of $\pm$5-10 mV was the accepted limit of the error in the measurement). This therefore implies that the quadrupoles and position monitors between tank #9 and ND249 have a common axis.

The calibration of the linac position monitor is as follows;

$$\frac{[\text{measured voltage (mV)}]}{[1.56\ \text{mV/mm}\cdot\text{mA}]\ [\text{beam current (mA)}]}$$

measured voltage limit = 10 mV
beam current = 30 mA

therefore, the possible error is 0.2 mm.

Previous measurements by Witkover indicate the LPM's in the HEBT/AGS matching section may not be properly calibrated. This area will be investigated in the fall.

An attempt was made to then determine if the linac HEBT SEM's also indicated they were/were not on the same common axis. However, the data rate was quite slow due to the AGS rep rate (1.6 seconds) and tank #9 was being pulsed only on the AGS pulse. The SEM's each take one point per pulse with 160 points per plane for 320 points (pulses) per SEM (H and V). Two SEM units may be used simultaneously and there are five SEM's. This would require 25 minutes minimum per complete data set and at least four sets were considered required. Therefore, this part of the study will be addressed in the fall when the linac (and tank #9) can be pulsed at 5 Hz.

Note

As an aside; quite by accident I noticed that movement on the HEBT LPM's can be seen, with no loss of beam, by adjusting the LEBT dipoles and even the 90° magnet in the dome. This implies that not only the linac but also the column is no longer a limiting aperture with H^- beam. This study was not in detail however but the general statement, I believe, is qualitatively correct.

[1] R.L. Witkover, private communication.
[2] R.L. Witkover, private communication.