Beam Physics Note
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Tuning the MEBT Rebuncher

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Abstract: This document contains a beam-based calibration of the MEBT rebuncher rf cavity and a brief procedure showing how to configure it to achieve a time focus at the centerpoint of the first IH structure in the ISAC-DTL.

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Beam-Based Calibration

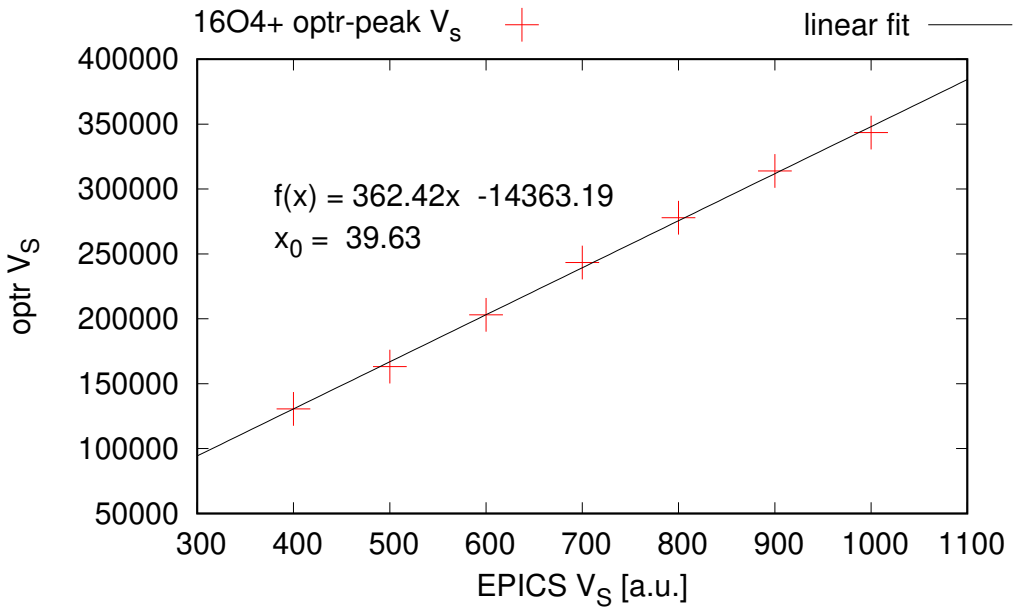

Figure 1: Calibration from 2017 dataset using $^{16}O^{4+}$, in which the rebuncher is set to achieve debunching at various amplitudes. The calibration offset is due to the nonlinear behavior of the amplifier at low amplitude settings. The x-intercept is labeled x_0.

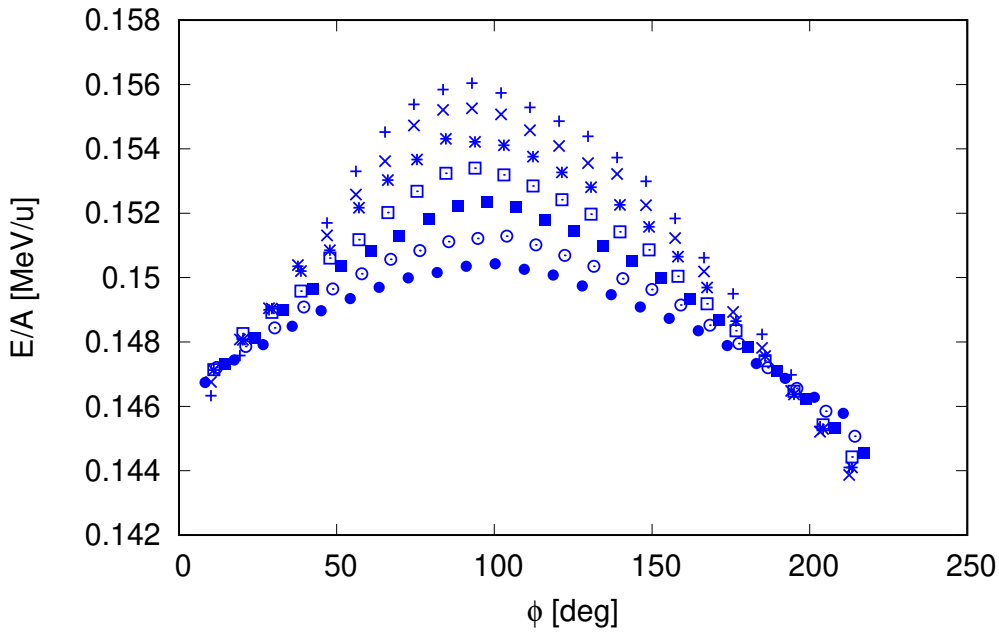

Figure 2: Measured MEBT rebuncher phase response, using an $^{16}O^{4+}$ beam and measured at the HEBT1 station. Each phase sweep (identical dots) is performed at constant rf amplitude.

Time Focus at Tank-1

1. Acquire drifting energy spectrum with rebuncher and all DTL rf unpowered at the HEBT1 magnet, record initial energy.
2. Power on rebuncher, leave at powerup amplitude and vary the rf phase to restore initial energy spectrum centroid at HEBT1, record rf settings.
3. Without changing the phase from Step 2, adjust rebuncher rf amplitude to minimize energy spectrum at HEBT1 and record this amplitude value.

With the beam debunched at HEBT1, the on-axis electric field intensity must be increased to achieve a time-focus at the mid-point of Tank-1, at unchanged rf phase. `TRANSOPTR` simulations indicate the increase in electric field scaling should be a factor of 2.85. The calibration shown in Figure 1 possesses a nontrivial (5%) offset to the y-scale. The `EPICS` rf amplitude A_T producing a time-focus mid Tank-1 is:

$$A_T = 2.85A_D - 113 \tag{1}$$

and A_D is the debunching rf ampltidue found in Step 3. Figure 3 shows this operation, with the design MEBT tune starting at the chopper slit and with the initial state z and z' envelopes shown as dotted lines, corresponding to Step 3.The corrected rf amplitude, per Eq. (1) is applied and is shown in the figure as solid z and z' envelopes, with beam focused at the centerpoint of the first IH structure. **Set the rebuncher amplitude to the value computed in Eq. (1).**

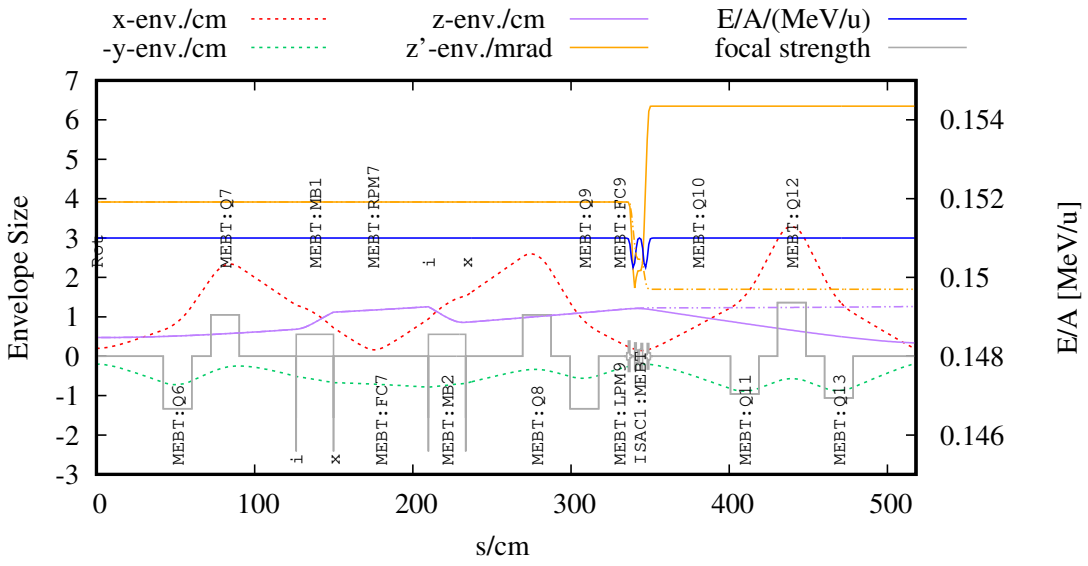

Figure 3: `TRANSOPTR` simulation showing the initial and final configuration of the longitudinal beam envelopes during MEBT rebuncher configuration.