# Harmonic kicker test concept

**(Short summary)**

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We propose an extension of the existing UITF to perform a beam test of the harmonic kicker envisioned as a potential injection device for the RCS at the EIC. The kicker is an RF device that exerts a change in transverse angle as a certain function of RF phase. The objective of the test is to verify that this function and the resulting impact on the emittance agree with simulations.

The existing components of the UITF relevant to this study are shown in Fig. 1. The RF base frequency of the kicker is $f_{\mathrm{HK}} = 86.6\,\mathrm{MHz}$; while the kicker is designed to work with a bunch frequency of $11 f_{\mathrm{HK}}$ and kick these bunches selectively, our test will avoid the complication of diagnosing the resulting separated beams and instead put every bunch on the same RF phase, effectively turning the kicker into a DC steerer. The lowest bunch frequency to accomplish this while also being a subharmonic of $f_0 = 1497\,\mathrm{MHz}$ is $f_0/121 = 12.4\,\mathrm{MHz}$. Because 121 is odd, this assumption relies on the availability of a 1497 MHz buncher cavity (case B in Fig. 1); the 750 MHz buncher currently installed will require halving the bunch frequency (case A).

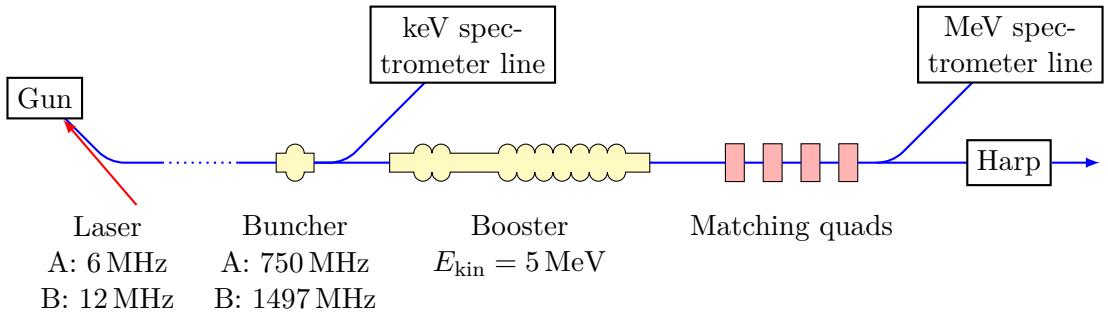


Figure 1: Existing UITF components relevant to this study.

The longitudinal phase space will be characterized using the existing MeV spectrometer line. The existing quads in the MeV section will allow us to match the optical functions to anything and, in conjunction with the existing harp, characterize the transverse phase space. From there, we will extend the straight-ahead line with a new setup as shown in Fig. 2. Two correctors will allow us to adjust both angle and displacement

going into the harmonic kicker. Two BPMs downstream of the kicker will measure the exit angle. Another two correctors can then be used to correct for the change in exit angle so as to always be able to obtain the same orbit through the downstream quads, which, together with another harp, will be used for emittance measurements.

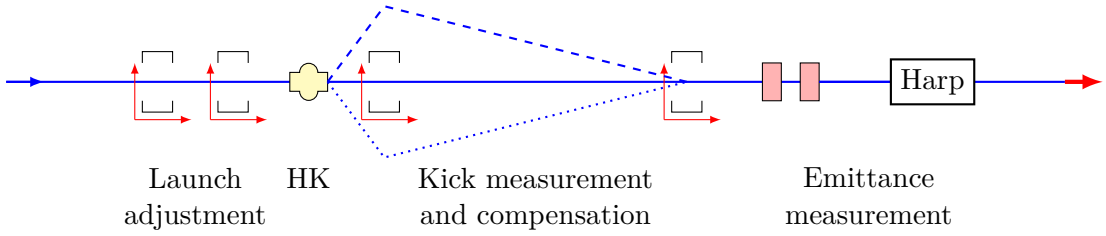


Figure 2: Conceptual sketch of a possible extension of the straight-ahead MeV line for the test of the harmonic kicker (HK). The dashed and dotted lines are exaggerated representations of the beam orbits with the kicker turned on and with its phase inverted, respectively.

At 5 MeV, the kicker is expected to deliver about 4 mrad of maximum kick angle, while the geometric emittance is reasonably low. With a suitably short drift length of $\sim 1$ m, this gives a comfortable compromise without the need for a special vacuum chamber to accommodate the kicked beams. The phase of the kicker can also be inverted to kick the beam in the opposite direction, effectively doubling the angular resolution of the measurement and exposing any potential geometric asymmetries. For the purposes of beam line and diagnostics commissioning, a corrector can conveniently be used in place of the kicker at first.

Turning this concept into a design will require the following input:

1. Desired / maximum permissible beam size and bunch length in order for the exit phase space to be comparable with the design; ideally a simulation study of the impact of these parameters.

2. Acquisition time / beam current to get the required signal-to-noise ratio from the available BPMs given the very low bunch frequency. Special detection circuitry may be needed for them to see any beam at all.

3. A way to make the low-frequency laser beam.