

PXIE MEBT kicker specifications

The kicker is a part of the PXIE MEBT chopping system, which will prepare a pre-specified bunch structure of the 2.1 MeV H- beam. For at least 80% of the time, bunches are directed to the absorber, and the remaining part (1 mA) of initially 5 mA, 162.5 MHz CW beam is sent to the linac.

The PXIE MEBT beam optics scheme assumes 2 travelling-wave kicker assemblies with a physical length of 650 mm (flange to flange) and an effective electromagnetic length of ~500 mm each, working in sync. Each assembly consists from two 25-cm kickers. The kicker electric field is generated by applying equal and opposite polarity voltage to the two opposing electrodes of each kicker assembly.

The difference in the angular beam deflection for bunches assigned for removal or passing is 7.4 mrad per the kicker assembly of two 25 cm kickers. Below this requirement is translated into electrode voltages.

Bunch dimensions (6-sigma) at kicker locations are: ~12 mm vertical (Y), ~16mm horizontal (X) , and ~1.3 ns in time.

Two drive schemes are being considered:

Drive Scheme A: A unipolar drive scheme. The voltage is applied to kicker electrodes to kick the beam out. Zero electric field is generated for bunches intended to pass through.

Drive Scheme B: A bipolar drive scheme. The voltage is applied to kick the beam out, and the opposite polarity is applied to kick beam in and allow it to pass through. The magnitude of the voltage applied to each kicker side is half that of Scheme A.

1. Any bunch of the 162.5 MHz CW train can either pass or be removed.
2. Flattop voltage to kick the beam is defined by two parameters being met simultaneously:
 - a. A minimum voltage to kick the bunch by a specified amount.
 - b. A minimum length of time of ± 0.65 ns with respect to the bunch center.
3. Minimum flattop voltage for kicking the beam out (for the kicker gap of 16 mm):
 - a. Drive scheme A: 500 V on each plate.
 - b. Drive scheme B: 250 V on each plate.
4. Voltage tolerance for bunches passing through:
 - a. Drive scheme A: 0 V ± 25 V on each electrode.
 - b. Drive scheme B: flattop voltage ± 25 V on each electrode for the duration of the flattop.
5. The voltages specified above are for the ideal case of two long parallel plates. Any reduction of the integral kicker strength caused by gaps between the kicker plates is to be compensated by increasing the applied voltage by the corresponding amount.
6. Any difference between kicker phase velocity and beam velocity is to be corrected by widening the flattop width by a corresponding amount. For the 25 cm structure, the correction is 0.13 ns per 1% of the velocity error.

7. Uniformity of the kicker electric field in the horizontal direction shall be adequate
 - a. Drive scheme A: to kick beam out as specified above. Any reduction of the integral kicker strength due to field non-linearities at the periphery of the horizontal beam size $\Delta X = \pm 8$ mm is to be compensated for by increasing the applied voltage by the corresponding amount.
 - b. Drive scheme B: the kick applied to the particles within 6 sigma of the bunch, i.e. over the horizontal beam size $\Delta X = \pm 8$ mm, should not differ by more than 5%.
8. If necessary, additional limitations can be applied:
 - a. Beam removal for longer than 200 ns is made by LEBT kicker
 - b. During 1 μ s element of periodicity, the total number of alterations (pass->remove) or (remove->pass) is not more than $(2 \cdot 162.5 / 5) = 65$, i.e. the maximum average frequency of switching cycles is 33 MHz.

Other requirements

1. The gap between kicker plates is 16 mm.
2. The kicker electrodes should withstand a steady-state heat load from the beam of 20W and an accidental loss of 10 J per one 25-cm electrode.
3. The kicker structure should not deteriorate from a steady-state radiation by 10 μ A tails of the H- beam per 25-cm electrode.
4. The kick is in the vertical direction.
5. The kicker assembly should incorporate two pairs of electrically isolated plates for protecting the kicker from accidental beam scraping. The plates should be mounted within the assembly physical length of 650 mm (flange to flange).
6. Vacuum in the kicker section without the beam should be <100 nTorr.