# PXIE Low Energy Beam Transport Chopper
# Mechanical Design Specifications Constraints



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## Revision History

| Revision | Date | Section No. | Revision Description |
|---|---|---|---|
| 0 | 4/11/2014 | All | Initial Release. |
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## 1. Introduction:

The PXIE Low Energy Beam Transport (LEBT) chopper is the means of providing pulsed beam to the PXIE RFQ for commissioning and testing purposes. It will also act as a beam stop for machine protection. Finally, it may be used as a 'pre-chopping' device in order to lessen the MEBT absorber requirements.

## 2. Scope:

Functional specifications for the LEBT chopper have been written and published in Ref. [1]. The purpose of this document is to identify mechanical constraints for the realization of the chopper system consistent with the pre-conceptual design discussed in Ref. [2].

## 3. Assumptions:

The pre-conceptual design discussed in the 'Addendum' to Ref. [2] is shown schematically on Figures 1 & 2. It illustrates some of the constraints that have been identified. An important feature of the chopping system in Ref. [2] is that one of the kicker electrodes also acts as the absorber. The rationale for this choice is explained in some detail in Ref. [2].

## 4. Kicker/Absorber requirements

A pre-conceptual chopper design is shown on Figure 1. It consists of two parallel plates. The lower plate is biased negatively (pulse) to deflect the beam onto the upper plate (absorber). A DC potential may be applied to the upper plate, which can be used for ion clearing.
The chopper should be followed by an electrically isolated diaphragm (a.k.a. toroid protector) in order to protect the toroid insulator from charged particles.
Table 1 summarizes the requirements for the chopping system relevant for its mechanical design.

**Table 1. Chopper Requirements**

| | | |
|---|---|---|
| Dimensional constraints | | |
| | Kicker gap | 32 mm |
| | Minimum distance between kicker plates and flange surfaces (*Dimension A on Figure 1*) | 10 mm |
| | Plates length (*z*-direction) | 170 mm |
| | Plates width | 50 mm |
| Electrical | | |
| | Maximum applied voltage ($\Delta V_1$) to the lower plate with respect to ground | 10 kV |
| | Maximum applied voltage ($\Delta V_2$) on the upper plate with respect to ground (DC coupled) | 1 kV |
| | Maximum current to be measured from the upper plate | 10 mA |
| Power dissipation | | |
| | Total maximum beam power | 300 W |
| | Maximum angle of incidence on the absorber | 100 mrad |
| | Nominal/Minimum beam radius at the kicker exit, rms (Gaussian distribution) | 6/3 mm |
| | Maximum power density | 50 W/cm$^2$ |
| Vacuum | | |
| | Base pressure (with no beam) | $<10^{-7}$ Torr |
| | Effective pumping speed | 1000 l s$^{-1}$ |
| Toroid protector | | |
| | Inner diameter | 32 mm |
| | Maximum average power | 10 W |

Additional requirements:

- The vacuum chamber housing of the chopper should have provision for installing a view port to look at the absorber surface.
- The length of the chopper vacuum chamber should take into account the distance between the solenoids, 552 mm center-to-center (Figure 2).
- Design of the upper plate (absorber) should take into account blistering and sputtering.
- High voltage feed-through model to be used: MDC Vacuum P/N: SHV-20 Coaxial-Exposed-Weldable

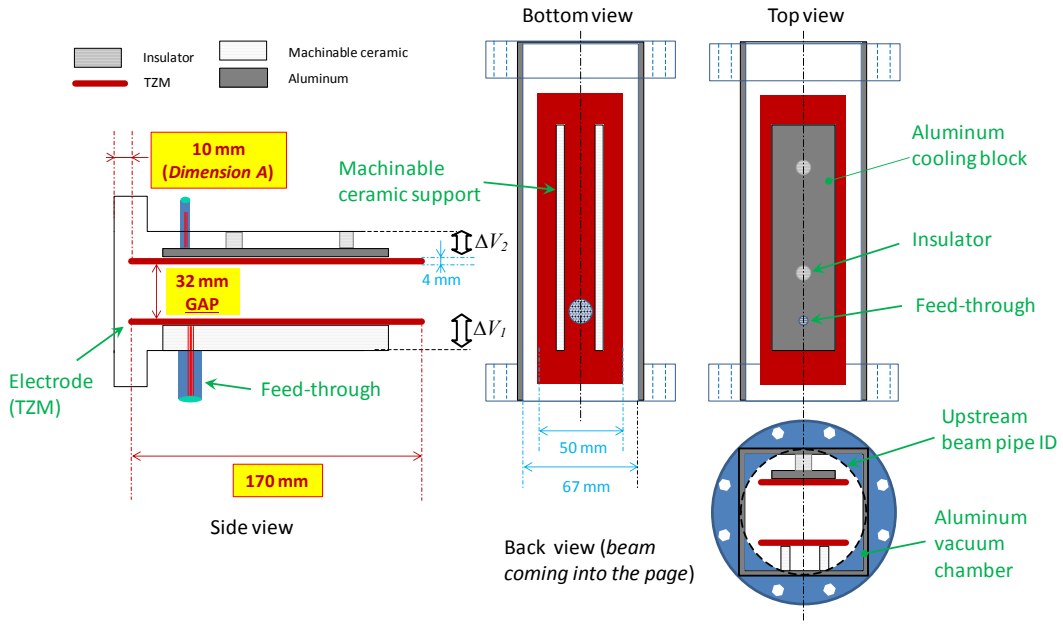


Figure 1: Schematic of a possible kicker geometry. Critical dimensions are indicated in red within yellow boxes. Indicated materials are initial suggestions.

Figure 2 shows a sketch of the beam line consistent with the optics lattice.

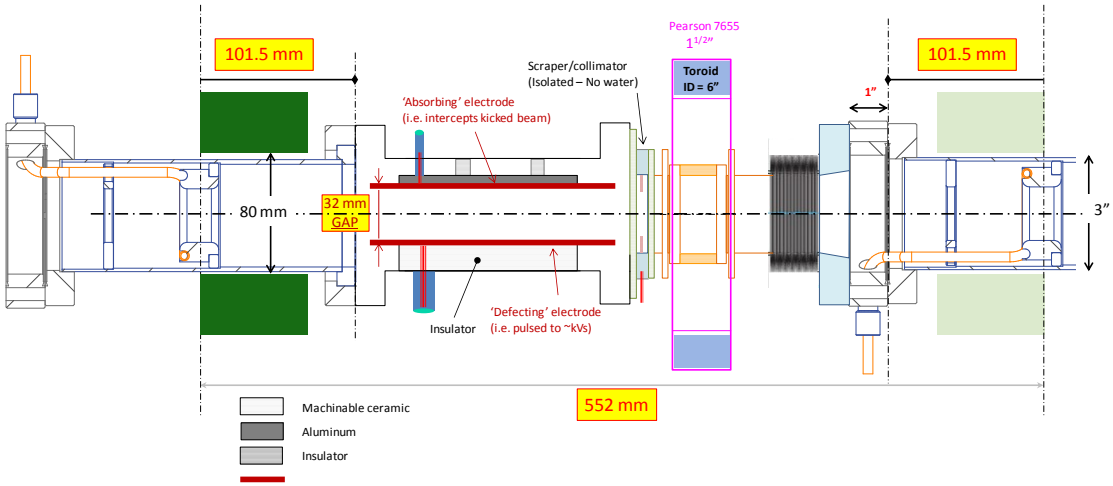


Figure 2: Preliminary beam line geometry. The design should assume the toroid to be a Pearson 7655.

## 5. References:

Documents with reference numbers listed are in the Project X DocDB: http://projectx-docdb.fnal.gov

[1] PXIE Low Energy Beam Transport Chopper Functional Requirements Specification
Document #: Project-X-doc-1163

[2] Considerations for the Design of the LEBT Chopper for PXIE,
Document #: Project-X-doc-1219