An electron gun system for alignment of the Penning trap magnetic field

E. Bennett, B. Fenker, M. Mehlman, D. Melconian, J. Patti, and P.D. Shidling

One important aspect regarding the design of the TAMUTRAP experiment is beam alignment with the magnetic field and with the Penning trap itself. The 7 T field generated by the generally cylindrical superconducting magnet is – understandably – not perfect. There is both deviation within the field itself and alignment of the field lines with the entry and exit ports on either side of the cylindrical magnet. Additionally, it is important to align the small entry and exit ports of the Penning trap along the field lines and place the center of the Penning trap as close to the center of the cylindrical magnet as possible; otherwise, ions from the beam line feeding the trap will not be captured and reduce the efficiency of the system. Thus, to trap ions, it is necessary for there to be a high degree of accuracy in end-to-end alignment – on the order of about 0.2 mm.

To achieve this degree of accuracy, an alignment tool is required: an electron gun. A drawing of the electron gun designed specifically for the TAMUTRAP is shown in Fig. 1. The system spans the length of the beampipe resting within the 7 T cylindrical magnet so as to place an electron-generating tungsten filament at the center of the bore of the magnet. The beampipe itself can then be manipulated to place the electron-generating filament at or near the center of the magnet. Internal Faraday cups and collimators are provided both near the center and near the ends to assist in alignment (manipulation) of the beampipe with the field.

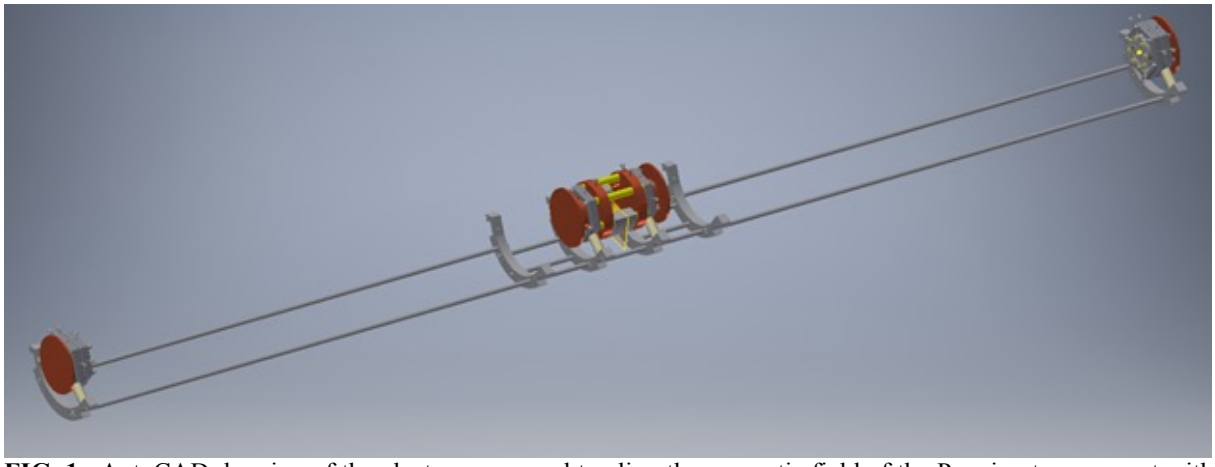

FIG. 1. AutoCAD drawing of the electron gun used to align the magnetic field of the Penning trap magnet with the beamline.

The collimators are paired with each of the Faraday cups and are identical to one another. The purpose is to generate a fine pencil beam of electrons across the entire length of the beampipe. These collimators are aligned using an optical transit outside of the vacuum to ensure a direct line of sight between each end and the filament. The collimators are also held in place by a hexagonal upper support having three alignment bolts – which adjust the center position of the ports in the collimators.

The electron gun has been built and we expect to have the field aligned with the beampipe in the summer of 2016. Once commissioned, a patent application will be forthcoming based on this design.