Update on the TAMUTRAP facility

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The initial program of the TAMUTRAP facility is to search for scalar currents in the weak interaction via the measurement of $\beta - \nu$ angular correlation parameter, $a_{\beta\nu}$, for $T = 2, 0^+ \rightarrow 0^+$ superallowed beta-delayed proton emitters. The great advantage of beta-delayed proton emitters for such a study is that the proton energy distribution contains the information about the angle between β and $\nu, \theta_{\beta\nu}$. By observing the proton energy distribution the value of $a_{\beta\nu}$ will be deduced, which can then indicate the existence of a scalar current if it exists. Additional scientific goals for this system are mass measurements, and providing a low-energy radioactive ion beam (RIB) for various other applications.

After demonstrating the ability to perform high-precision mass measurements in a cylindrical Penning trap, we began the year by aligning Section 1 of the TAMUTRAP facility (see Fig. 1) to the T-

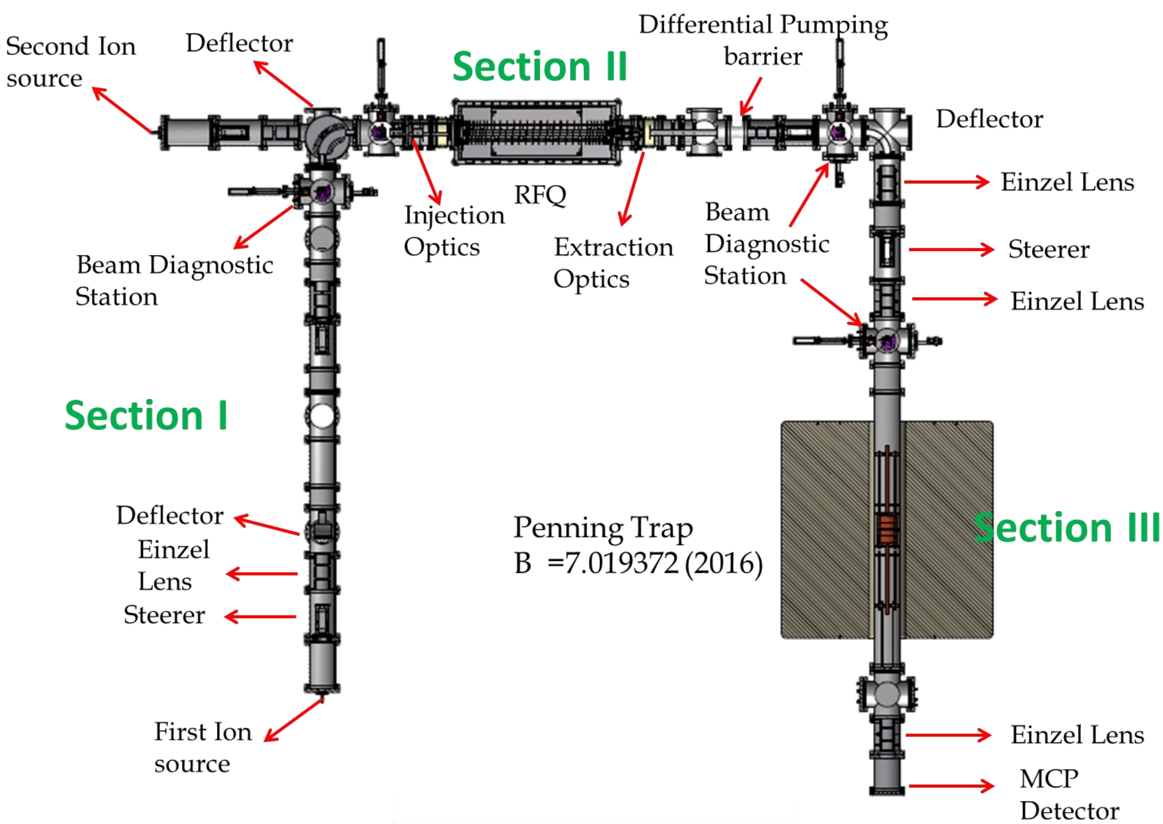

FIG. 1. Texas A&M University Penning Trap Facility (TAMUTRAP).

REX upgrade project and by installing gate valves at two different locations of the beamline. The third cylindrical deflector (Section 3 in Fig. 1) was replaced by spherical deflector to improve the bending efficiency without changing the longitudinal and transverse emittance of the beam. The vacuum in the Section III has been improved by factor of two by installing a differential pumping barrier at the exit of the He-gas-filled RFQ (see Fig. 1). The differential pumping barrier is a 5”-long tube with an inner diameter of 1.5”. The factor of two improvement in the vacuum in Section III of Figure 1 allowed us to perform mass measurements for longer excitation times.

Mass measurements with an excitation time, $T_{RF} = 200$ ms, were performed for several stable isotopes, ^{23}Na, ^{85,87}Rb and ^{133}Cs with ^{39}K as reference mass. The measured masses of ^{23}Na, ^{85,87}Rb and ^{133}Cs agrees with the literature value within a precision of 1.2×10^{-8} with a measurement precision at the 10^{-8} level. In the case of rubidium (^{85,87}Rb) isotopes, a new excitation scheme was implemented for selecting and centering the chosen rubidium isotope in the Penning trap. This technique allows us to operate the Penning trap in a dual mode (purification & measurement trap) and does not rely on the application of buffer gas for selecting and centering the ions. In this method, all trapped ions are first excited with a dipolar field to a large magnetron radius. The ions of interest are then excited resonantly with a quadrupolar field at the sum of the magnetron and the reduced cyclotron frequency. After coupling the radial motions, ions are cooled for 100 ms. During the cooling process, ions of interest are brought back to the trap axis whereas all others move even further out to larger magnetron radii. Once the ions of interest are on the trap axis, the ions are then excited resonantly with a quadrupolar field to measure the cyclotron frequency by time-of-flight resonance technique [2].

The performance of RFQ in bunched mode was improved by rewiring the RFQ electronics and changing the resistors value of last segment which is used to bunch the beam. The change in resistor value of the last segment improved the switching of the last segment during ejection and gave a satisfactory results.

The current prototype Penning trap has an inner diameter of 90 mm and is presently the world’s largest Penning trap [1]. However, in order to perform the planned measurement the diameter of the Penning trap needs to be twice the dimension of prototype Penning trap. The assmebly of the TAMU-Penning trap (180 mm diameter) is completed and will be installed in the bore magnet by end of June, 2019. The TAMU-Penning trap system consists of 40 cm long drift tube in the injection side and three drift tube of 15 inch long on the extraction side. The purpose of the three short drift tubes is to guide the ion bunch out of the Penning trap, through the magnetic field to the micro channel plate (MCP) detector located at 1 m distance away from the exit of magnet with higher efficiency. The three short drift tubes will be floated at different voltages to increase the time of flight separation between ions that have gained radial energy during quadrupolar excitation (on-resonance frequency) and the base line (off-resonance frequencies). More details about the 180 mm diameter Penning trap has been described in Ref. [3].

GEANT4 Monte Carlo simulations for the TAMUTRAP Penning trap setup is a work in progress and more detail can be found in Ref. [4]. We also made significant progress in automating the frequency scan for performing mass measurements and have also updated the timing card for TAMUTRAP beamline. Details on automation scan and timing card has been described in Ref. [5].

The immediate outlook for the TAMUTRAP facility involves installing 180 mm inner diameter TAMU-Penning trap system and demonstrate the ability to perform high precision mass measurements. We expect to complete the simulation and finalize the dimensions of the detectors by fall 2019.

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[2] V.S. Kolhinen *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2017- 2018), p. IV-39.

[3] V.S. Kolhinen *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p. IV-45.

[4] B. Schroeder *et al*., *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p.IV-50.

[5] M. Nasser *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2018-2019), p. IV-43.