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Ion transport simulations, recent hardware upgrade and current status of TITAN's cooler Penning trap

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Atomic mass measurements are vital to improve our understanding of the nuclear structure, astrophysical reaction paths, and test predictions of physics beyond Standard model. The measurement Penning trap at TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) facility is dedicated to performing high-precision mass measurements of short-lived radioactive isotopes. With the availability of highly charged ions produced in the TITAN electron beam ion trap, the sub-ppb mass measurement precision can be improved by an order of magnitude or more. The charge breeding, however, introduces an energy spread that can cause additional challenges to these mass measurements.

With TITAN's cooler Penning trap (CPET), we intend to further improve the precision by sympathetically cooling these highly charged ions with room temperature electron plasma in order to reduce the energy spread from a few 10 eV/q to 1 eV/q. Ion injection and extraction simulations were performed with the SIMION package to optimize the operational conditions of the off-line/development setup and for guiding the integration into the on-line setup. Transmission efficiency and the transversal and longitudinal emittance of the ion beam were found to be sensitive to the trap axial potential, extraction potential and the length of the ion beam. Upgrades motivated by the simulation results were performed to increase the efficiency of ion/electron transmission and trapping. Successful co-trapping of electrons and ions in the TITAN CPET was demonstrated for the first time including the verification of self-cooling of the electrons. We present the simulation results, current status of the trap and our approach towards achieving cooling of highly charged ions with electron plasma.

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