Mass measurements of unstable nuclei with TITAN

Jens Dilling (TRIUMF/University of British Columbia) for the TITAN collaboration

Precision experiments and such as tests of symmetries in Nature as well as advancing fundament theories in physics rely on precise and accurate determination of atomic masses. At the forefront of this challenge are the measurements of on-line synthesizes nuclei with half-lives ranging from seconds to few milliseconds. The ideal tool for such mass measurements is a Penning trap, which can nowadays be coupled to accelerator facilities, which provide access to the nuclei. The TITAN (TRIUMF's Ion Trap for Atomic and Nuclei science) is such an experimental facility. It consists of three (soon four) ion trap. The short-lived ions are delivered first to a linear gas-filled Paul trap, used for cooling and bunching. The next stage is a powerful electron beam ion trap, where the originally singly charged ions can be charge bred to highly charged ions. From here, the ions are transferred to a Penning trap, where the mass is determined via a TOF measurement. In the near future, the cooler Penning trap is added, which will allow one to cool the highly charged ions with electrons or protons. TITAN has been used to determine the mass of singly and highly charged ions with half-lives as short as ~10ms.

The science motivation stems from tests of the unitarity of the quark mixing matrix, neutrino physics, tests of our understanding of the strong force, as well as nuclear astrophysics.