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New trap technologies for in-trap recapture of HCI for mass measurements and in-trap decay spectroscopy for 2n2b decay

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TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) facility deploys three ion traps for Penning trap mass spectrometry of radionuclides and in-trap decay spectroscopy. The latter is performed in an electron beam ion trap (EBIT), which is radially surrounded by seven Si(Li) detectors. The magnetic field separates charged and neutral decay particles and hence eliminates 511 keV gamma rays from the annihilation of beta particles. The electron beam enhances the radial confinement of the magnetic field, thereby extending the observation period to minutes, enabling the observation of the evolution of the decay chains of the trapped isotopes. The setup has been commissioned with a branching-ratio and half-life measurement of 124Cs. More recently, ion stacking has been demonstrated: Hundreds of 116In ion bunches were collected in the EBIT, reaching close to its space-charge capacity of about 10**8 trapped ions. Stacking improves the statistical precision attainable with in-trap decay spectroscopy.

The other principle purpose of the EBIT is charge breeding for Penning-trap mass measurements, as the precision scales with the charge state of the ion. More generally, the use of highly charged ions (HCI) can reduce the beam-time requirements. In addition, TITAN has pioneered the use of HCI for beam purity, for example with threshold charge breeding. More recently, the EBIT has been used to enhance the beam availability at TITAN. The daughter of the beta-emitter 30Mg was recaptured in the EBIT and subsequently delivered to the Penning trap for a successful mass measurement. In-trap recapture circumvents difficulties in the production of certain nuclides via the ISOL technique employed at TRIUMF-ISAC, and it can ensure population of a particular nuclear state. Recent results and developments in ion manipulation will be presented.

Primary author: Dr KWIATKOWSKI, Anna A. (TRIUMF)

Co-authors: GALLANT, Aaron T. (TRIUMF and University of British Columbia); FINLAY, Andrew (TRIUMF and Simon Fraser University); LENNARZ, Annika (TRIUMF and University of Muenster); Dr BARQUEST, Brad (TRIUMF); KOOTTE, Brian A. (TRIUMF and University of Manitoba); Prof. ANDREOIU, Corina (Simon Fraser University); Dr LASCAR, Daniel (TRIUMF); SHORT, Devin A. (TRIUMF and Simon Fraser University); Prof. FREKERS, Dieter (University of Muenster); LEISTENSCHNEIDER, Erich (TRIUMF and University of British Columbia); Prof. GWINNER, Gerald (University of Manitoba); BALE, Jeff C. (TRIUMF and University of British Columbia); Prof. DILLING, Jens (TRIUMF and University of British Columbia); Dr LEACH, Kyle G. (TRIUMF and Simon Fraser University); ALANSARRI, Milad (University of Muenster); KLAWITTER, Renee (TRIUMF and University of Heidelberg); CHOWDHURY, Usman (TRIUMF and University of Manitoba)

Presenter: Dr KWIATKOWSKI, Anna A. (TRIUMF)

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