Contribution ID: **322** Type: **Oral (Student, In Competition) / Orale (Étudiant(e), inscrit à la compétition)**

Doppler shift lifetime measurements using the TIGRESS Integrated Plunger device

Tuesday 17 June 2014 14:15 (15 minutes)

Electromagnetic transition rate measurements serve as a fundamental probe of nuclear structure and provide a stringent test for theoretical models. Doppler shift lifetime measurements offer an opportunity to directly access information about electromagnetic transition rates and discriminate between model calculations. To take advantage of this opportunity, the TIGRESS Integrated Plunger device (TIP) has been constructed at Simon Fraser University. The current TIP infrastructure supports lifetime measurements via the Doppler Shift
Attenuation Method (DSAM) with charged particle identification provided by a modular silicon PIN diode wall and 24-element CsI(Tl) scintillator wall. One advantage of Doppler shift lifetime measurements is that lifetimes can be extracted independent of the reaction mechanism. TIP has been coupled to the TIGRESS segmented germanium array at TRIUMF as part of the experimental program at the ISAC-II facility at TRIUMF. The initial studies using TIP employ fusion-evaporation reactions. Here, reaction channel selectivity can greatly enhance the sensitivity of the measurement. To enable channel selection, the TIP CsI(Tl) wall has been coupled to TIP for evaporated light charged-particle identification. Reaction channel selectivity has been demonstrated using the TIP infrastructure following the successful identification of the ^{28}Mg two proton evaporation channel from the ^{18}O $+^{12}$C reaction at the ^{18}O beam energies of 56 and 48 MeV. DSAM lineshapes for the 1.2(1)ps $2^+ \rightarrow 0^+$ transition and 105(35)fs $4^+ \rightarrow 2^+$ transition in ^{28}Mg have been observed. Geant4-based analysis code for TIP and TIGRESS is being developed to extract lifetimes from these experimental spectra and aid in the optimization of future experiments using this setup. The device, experimental approach, analysis, and preliminary results will be presented and discussed.

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Session Classification: (T2-2) Nuclear Physics, Heavy Ions, Extreme Matter - DNP / Physique nucléaire, ions lourds et matière extrême - DPN

Track Classification: Nuclear Physics / Physique nucléaire (DNP-DPN)