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Doppler shift lifetime measurements using the TIGRESS Integrated Plunger

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Along the $N = Z$ line, shell gaps open simultaneously for prolate and oblate deformations; the stability of these prolate and oblate configurations is enhanced by the coherent behaviour of protons and neutrons in $N = Z$ nuclei. Additionally, amplification of proton-neutron interactions along the $N = Z$ line may yield information on the isoscalar pairing interactions which have been predicted in many nuclear models but not yet experimentally observed. Electromagnetic transition rates measured via Doppler shift lifetime techniques are recognized as a sensitive probe of collective behavior and shape deformation and can be used to discriminate between model calculations. To take advantage of this opportunity, the TIGRESS Integrated Plunger (TIP) has been constructed at Simon Fraser University. The current TIP infrastructure [1] supports lifetime measurements via the Doppler Shift Attenuation Method (DSAM). 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 HPGe array at TRIUMF as part of the experimental program at ISAC-II. 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 24-element TIP CsI wall was used for evaporated light charged-particle identification. Reaction channel selectivity has been demonstrated using the TIP infrastructure following the successful production of the $N = Z$ nucleus ^{68}Se via the ^{36}Ar + ^{40}Ca fusion-evaporation reaction. A Geant4-based code for TIP is being developed as a tool to aid the analysis and for the optimization of future experiments. The device, experimental approach, analysis, and preliminary results will be presented and discussed. [1] P. Voss et al., Nucl. Inst. and Meth. A746, (2014) 87.

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