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A compact gas filled linear Paul trap for CRIS experiments.

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The CRIS technique (Collinear Resonance Ionisation Spectroscopy) has been shown to be an efficient method for accessing fundamental nuclear properties of exotic isotopes [1]. The technique can be applied to stable ion beams produced via laser ablation [2] which are pulsed due to the method of production. However, with radioactive cases produced at the ISOLDE (Isotope separator On-line) facility at CERN, a gas filled linear Paul trap is required for creating ion bunches. Currently, radioactive ion beams are produced via proton impact with a suitable target at ISOLDE. The resulting beam is then trapped, cooled, and bunched using the ISCOOL device following mass separation. The ion bunches are then directed to the CRIS setup where they are prepared for laser spectroscopy experiments. The technique has been shown to reveal properties such as nuclear spins, magnetic and electric quadrupole moments, and isotopic variations in the nuclear mean square charge radii. Measurement of these properties is made possible with ion beams that have been bunched with reduced emittance. The CRIS method has so far measured fundamental nuclear properties of neutron deficient Francium [3], and neutron rich radium [4] isotopes, among others. We envisage significant improvements to the CRIS technique following the installation of an independent gas filled linear Paul trap at ISOLDE as an alternative to the ISCOOL device. This would reduce set up times prior to time constrained experiments at the ISOLDE facility. It would enable constant optimisation of beam transport and quality. It would also trivialise switching from a radioactive beam to a stable reference isotope from our independent offline ion source. We provide an overview of the work completed since the first prototype was constructed and installed at the University of Manchester [5], where tests utilising a Ga ion source are ongoing. These tests include ion transport and gas attenuation within the device. Spatial limitations require that the new device is compact (<80 cm in length). SIMION calculations estimate that a prototype device with a 20 cm rod length could achieve a trapping efficiency of up to ~ 40% with a mean energy spread of ~ 4 eV.

[1]: T.E Cocolios et al. Nucl, Inst, Methods in Phys Res B, 317 (2013) [2]: R.F. Garcia Ruiz et al. Phys. Rev. X 8, 041005 (2018) [3]: K.T. Flanagan et al. Phys rev lett 111, 212501 (2013) [4]: K. M. Lynch et al. Phys. Rev. C 97, 024309 (2018) [5]: B. S. Cooper et al. Hyperfine Interact, 240:52 (2019)

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