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A compact RFQ cooler buncher 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]. Currently, radioactive ion beams are produced via proton impact with a suitable target at the ISOLDE (Ion separator On-line) facility at CERN. The resulting beam is then trapped, cooled, and bunched using the ISCOOL RFQ cooler buncher following mass separation. The ion bunches are then directed through a charge exchange cell for the purpose of neutralisation via interactions within an alkali vapour. The beam of atoms is then collinearly overlapped with multiple pulsed laser fields. This enables Doppler-free measurements of atomic hyperfine structure, leading to the determination of model-free nuclear properties. 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. We envisage significant improvements to the technique following the installation of an independent RFQ cooler buncher as an alternative to ISCOOL. 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 an exotic beam to a stable reference isotope from our independent offline ion source. Spatial limitations at CRIS require that the new RFQ cooler buncher is compact (<80 cm in length). SIMION calculations estimate that an early prototype device could achieve a trapping efficiency of ˜ 40% with a mean energy spread of ˜ 4 eV. Testing of the device is being conducted using an offline Ga ion source at the University of Manchester. Rapid prototyping has been enabled with the use of 3D printed parts, UHV compatibility of these parts is discussed.

[1]: T.E Cocolios et al: Nucl, Inst, Methods in Phys Res B 317 (2013)
[2]: K.T. Flanagan et al Phys rev lett 111, 212501 (2013)

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