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MIRACLS: A novel approach for Collinear Laser Spectroscopy

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Collinear laser spectroscopy (CLS) is a powerful tool to access nuclear ground state properties such as nuclear spins, electromagnetic moments and mean-square charge radii of short-lived radionuclides far from stability with high precision and accuracy [1,2]. Performing CLS with fast beams (>30 keV) provides an excellent spectral resolution approaching the natural linewidth [1]. However, depending on the specific case and spectroscopic transition, its fluorescence-light detection limits its successful application to nuclides with yields of several 100 to 10,000 ions/s [3].

Complementary to Collinear Resonance Ionization Spectroscopy (CRIS) [4], the novel MIRACLS project at ISOLDE/CERN, aims to combine the high resolution of conventional fluorescence based CLS with a high experimental sensitivity enhanced by a factor of 30 to 600. This will be achieved by extending the effective observation time, depending on the specific nuclides'mass and lifetime, by trapping ion bunches in an MR-ToF (Multi-Reflection Time of Flight) device [5-14] where they can be probed multiple times.

In order to demonstrate the functionality of this novel technique, a proof-of-principle experiment for MIRACLS was being set up around an existing MR-ToF device [15] operating at a beam energy of ~1.5 keV, which was modified for the purpose of CLS. CLS measurements in Mg ions were successfully carried out with up to 300 revolutions inside the MR-ToF device allowing the determination of the isotope shift of 24Mg+ vs 26Mg+. This contribution will present some preliminary results of the MIRACLS proof-of-principle experiment as well as the outlook towards further developments. These includes the design of a 30 keV MR-ToF device, a necessity for the high resolution of CLS.

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