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Simulations of Ion Trajectories inside the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy (MIRACLS)

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Due to its high precision, accuracy, and resolution, Collinear Laser Spectroscopy (CLS) is an important experimental technique to access nuclear spins, electromagnetic moments, and mean square charge radii of short-lived radionuclides and hence provides insight into the nuclear shell structure [1]. However, to experimentally probe the most exotic nuclides, which can only be produced with low production yields at today's radioactive ion beam facilities, new laser spectroscopy-techniques have to be envisioned.

This contribution will introduce the novel concept of the Multi Ion Reflection Apparatus for Collinear Laser Spectroscopy of radionuclides (MIRACLS). At MIRACLS, the goal is to increase the experimental sensitivity by a factor of 30-600 compared to traditional CLS by effectively extending the observation time. This can be achieved by trapping a bunched ion beam in a multi ion reflection time of flight (MR-ToF) device [2] in which the ion bunch and the laser can interact during each revolution.

A MIRACLS proof-of-principle experiment is currently carried out at ISOLDE/CERN to demonstrate the functionality of CLS inside an existing, low energy MR-ToF device [3], which has been modified for the purpose of CLS. Here, the experiment is performed with ion-beam energies of about 1.5 keV, whereas the future MIRACLS MR-ToF apparatus will operate at 30 keV in order to minimise the Doppler broadening.

The results of simulations of the ion trajectories inside the 1.5 keV MR-ToF device will be shown and their implications for CLS will be compared to the first experimental results. Moreover, the simulations of the ion trajectories inside the future 30 keV MR-ToF device will be presented.

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