EMIS 2018

INTERNATIONAL CONFERENCE ON ELECTROMAGNETIC ISOTOPE SEPARATORS AND RELATED TOPICS

EMIS XVIII

CERN GENEVA / SWITZERLAND / 16 - 21 SEPTEMBER 2018

Contribution ID: **126** Type: **Poster**

Control Systems for improved Laser Ion Sources

Monday, 17 September 2018 18:04 (1 minute)

Over the past decades, laser ion sources have proven to be a selective and efficient ion source for high purity radioactive isotope and isomer beam research. Advanced control systems are a necessary tool for high resolution measurements and easy control of the laser ion source. In this framework, a new control and data acquisition system has been developed at KU Leuven. Furthermore, accurate control of the frequency selective elements in the laser are a requirement for a reproducible and reliable laser ion source.
The Heavy Elements Laser Ionization and Spectroscopy (HELIOS) project at KU Leuven has the goal of performing In-Gas Laser Ionization and Spectroscopy (IGLIS) measurements on the actinide and superheavy (transfermium) elements and around the ^{100}Sn region. These studies will allow to deduce atomic properties and nuclear properties with high precision owing to an improved spectral resolution down to 150 MHz (FWHM) for these elements. In these spectroscopic measurements, step-wise laser ionization of the involved isotopes takes place in the supersonic jet formed by a de Laval nozzle installed at the gas cell exit.[1,2,3] These include isomeric beams making use of the laser ionization mechanism.
A complete characterization of the in-gas-jet method can only be achieved when factors such as frequency and power instabilities of the lasers as well as the spectral linewidths are minimized and the timing for data acquisition of multiple systematic measurements can be synchronized. Therefore, a dedicated control system, IGLIS Control System, has been developed at KU Leuven. The program enables the stabilization of the laser wavelength, reducing the laser frequency fluctuations from 50 MHz down to 7 MHz, only limited by the precision of the employed wavelength meter. This reduction in frequency fluctuations is necessary to accurately perform spectroscopy on resonance peaks with a Full Width at Half Maximum (FWHM) in the order of tens of MHz. Furthermore, the control program synchronizes the full command to several types of data acquisitions e.g. Time-of-Flight measurements for isotope separation in an Atomic Beam Unit (ABU), image acquisitions for Planar Laser Induced Fluorescence (PLIF) spectroscopy of the seeded atoms in the supersonic jet and beam line diagnostics. This synchronization makes it possible to increase the signal-to-noise ratio and to study systematic effects by comparing the results of PLIF spectroscopy with those obtained in the ABU. Recently, the IGLIS Control Software allowed us to perform a first preliminary In-Gas Jet Laser Ionization Spectroscopic measurements on ^{63,65}Cu.
In the Laser Ion Source, the stability of the frequency selective elements, e.g. ethalons, in the laser will strongly influence their reliability. Therefore, a full characterization of different types of motorized mounts for these frequency selective elements is performed at RILIS $ˆ{4}, CERN, comparing a stepper motor, Galvanometer motor, an indirect piezo controlled mount and a closed-loop direct drive piezo mount. The presence of hysteresis in the movement of such mounts can result in non-reproducibility of the laser ion source. Therefore, it has been found that the closed-loop direct drive piezo mount ensures the most reliable and reproducible control of the frequency selective elements, contributing to a more stable and reliable laser ion source.
In this presentation we discuss the improvements in reliability and accuracy that were achieved with the IGLIS Control software for the In-Gas Jet Laser Ion Source. Furthermore, the characterization of the improved mounts for the frequency selective elements in lasers is discussed

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Session Classification: Poster Session 1

Track Classification: Isotope production, target and ion source techniques