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Laser Spectroscopy with the Leuven gas cell-based Laser Ion Source

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The Leuven Isotope Separator Online (LISOL) facility, located at the Cyclotron Research Center (CRC), Louvain-la-Neuve, is a successful producer of purified rare ion beams using resonant laser ionization of reaction products thermalized in a buffer-gas cell. After almost two decades of operation high purity radioactive ion beams of more than 15 different elements have been obtained exploiting various production mechanism as light- and heavy-fusion evaporation reactions, proton-induced fission, and the spontaneous fission of 252Cf. Production and thermalization of radioactive species in a cell filled with ultra-pure buffer gas is used in combination with resonant laser radiation for selective ionization of the isotopes of interest by the Leuven gas cell-based laser ion source. These ions are extracted from the cell in a supersonic jet and transported by a radio frequency ion guide up to the mass separator, where they are segregated from non-isobaric contamination. Ion beams of high purity can then be sent to the detector station for the study of their characteristic decay radiation.

In addition to the routinely performed nuclear-decay-spectroscopy studies the recent implementation in the LISOL setup of a new concept gas cell [1] has allowed in-source laser spectroscopy studies of neutron-deficient 57–59Cu [2] and 97–102Ag [3] isotopes. These measurements have become feasible owing to the enhanced sensitivity of the apparatus, which has allowed spectroscopic studies on exotic species with count rates as low as 6 ions/s for 57Cu (T1=2 =200 ms) or 1 ion/s for 97Ag, both semimagic nuclei. Online experiments are currently being carried out to pursue similar results on actinium isotopes.

In spite of the good results obtained by in gas-cell laser spectroscopy the inherent pressure broadening makes this technique to be inapplicable to those elements with reduced hyperfine parameters and/or high sensitivity to atomic collisions, as observed in practice for instance, in the tin isotopes around A= 100. For the successful study of the atomic properties of these species, and in general, to achieve high resolution laser spectroscopy, a technique like in-jet laser spectroscopy would be the technique of choice. The proof of principle of in-jet laser spectroscopy has been demonstrated at LISOL [4] and the full benefits of it recently evaluated with a high-repetition laser system [5], making it the best candidate for future studies with the Leuven laser ion source. In this technique laser ionization takes place in the supersonic jet expanding out of the gas cell. Consequently, the isolated atomic beams are obtained by supersonic adiabatic expansion in vacuum, with a significant reduction of the Doppler broadening. In addition, the gas density in the ionization region is too low to contribute to the pressure broadening making the laser line width the main limitation for the final achievable resolution.

Two approaches to reduce the laser bandwidth of the LISOL laser system are currently under investigation. On the one hand, single longitudinal mode selection by a thick (14 mm air spaced) etalon placed inside the oscil-

lator of
the dye laser, and on the other hand, amplification of single mode cw diode laser light in a pulse dye amplifier. In my presentation I will report on the results obtained in the last online runs performed on the production of
Ac beams and in the different tests carried out to accomplish in-jet laser spectroscopy at LISOL in view of a full
implementation of this technique in the future low energy branch facility S3, at SPIRAL2.

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[5] R. Ferrer, V. T. Sonnenschein et al., In preparation

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