Preparatory experiments at LISOL to perform In Gas Laser Ionization and Spectroscopy (IGLIS) @ S³

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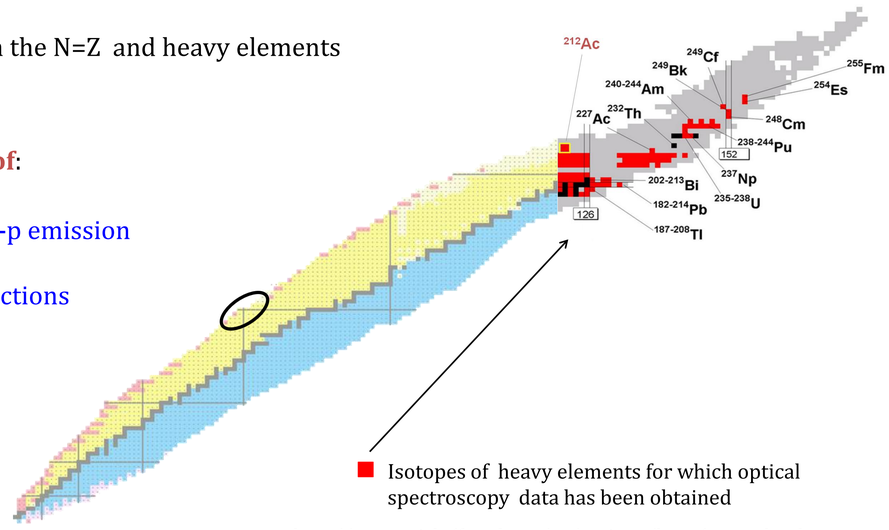
Motivation

Production of purified rare isotope beams in the N=Z and heavy elements region to study nuclear-structure effects

DAY 1 @ S3 → Laser spectroscopy of:

- ❑ **^{94}Ag**
  High-spin isomerism, b-delayed p, 1- and 2-p emission
- ❑ **^{80}Zr** (spk. person: B. Bastin)
  Single particle behavior and effective interactions
- ❑ **$^{107-101}$Sn**
  Test validity of shell-model predictions
- ❑ **VHE (Z ~ 89 - 102)**
  Validate nuclear and atomic theory



■ Isotopes of heavy elements for which optical spectroscopy data has been obtained

http://www.gsi.de/forschung/ap/projects/laser/survey.html

Introduction

- The SPIRAL2 project located at the GANIL facility (Caen, France) will deliver a wide vaiety of energetic rare isotope beam produced in fusion evaporation reactions to be used in nuclear physics, astrophysics and interdisciplinary research
- In laser spectroscopy experiments spectral linewidths are required to be as close as possible to the intrinsic natural linewidths of the atomic transitions of interest
- For **in-gas-cell** laser spectroscopy linewidths result from convoution of: Doppler broadening , pressure broadening , power broadening, and laser bandwidth. Typically **resolution mainly limited by pressure broadening.**
- For the successful study of atomic properties of elements with particularly small hyperfine splitting or high sensitivity to atomic collisions, a novel approach such as **in-gas-jet laser spectroscopy** would be the technique of choice
- To obtain optimum experimental conditions for the application of in-gas-jet laser spectroscopy the **temporal and** the **geometrical overlap** efficiency between the laser light and the atoms in the gas jet **must be maximized**

The IGLIS Ion Source at the LISOL facility

- Dual Chamber Gas Cell enhances Efficiency and Selectivity

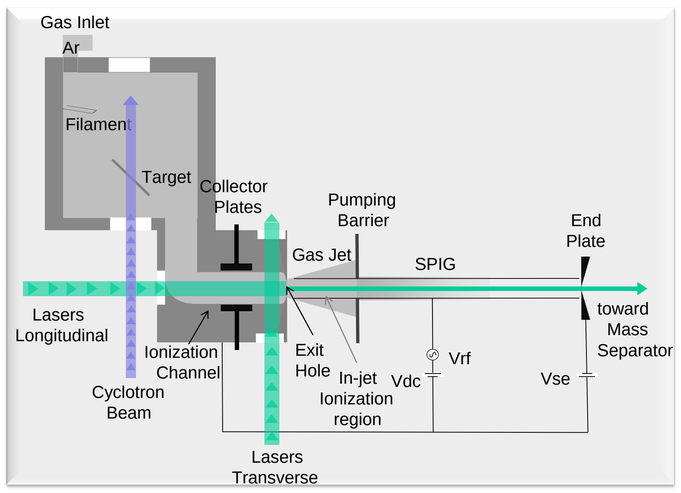
  Yu. Kudryavtev et al., NIM B 267 (2009) 2908

- First online In-gas-cell spectroscopy of neutron deficient Cu isotopes

  T. E. Cocolios et al., PRL 103, 102501 (2009)
  T. E. Cocolios et al., PRC 81, 014314 (2010)

- Demonstrated proof-of-principle for atomic laser spectroscopy in the gas jet

  T. Sonoda et al. NIM B267 (2009) 2918

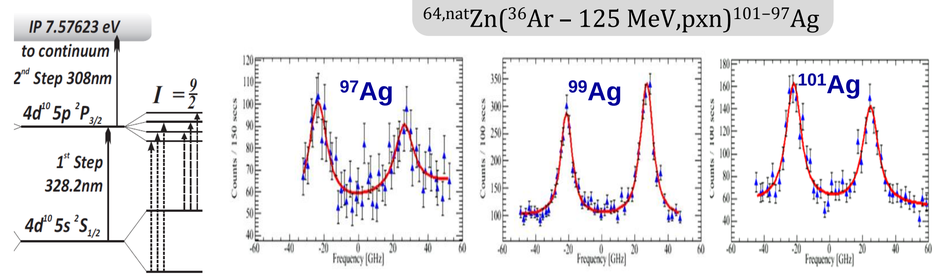


In Gas Cell Laser Spectroscopy of $^{101-97}$Ag

R. Ferrer et al. Phys. Lett. B, In preparation

^{92}Mo(^{14}N – 130 MeV,2pxn)$^{104-x}$Ag

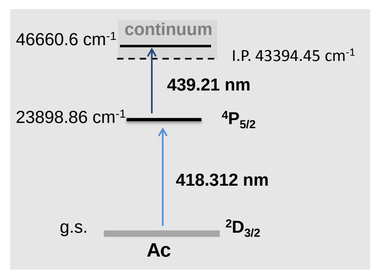
^{64,nat}Zn(^{36}Ar – 125 MeV,pxn)$^{101-97}$Ag



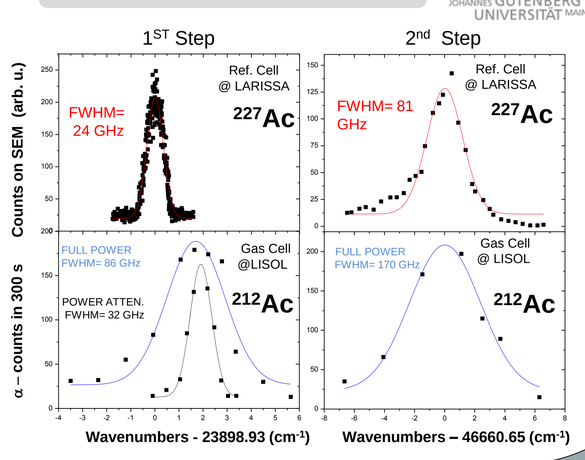
Broad Band Spectroscopy of ^{212,213}Ac

^{197}Au(^{20}Ne-145 MeV,4-n) ^{212,213}Ac

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

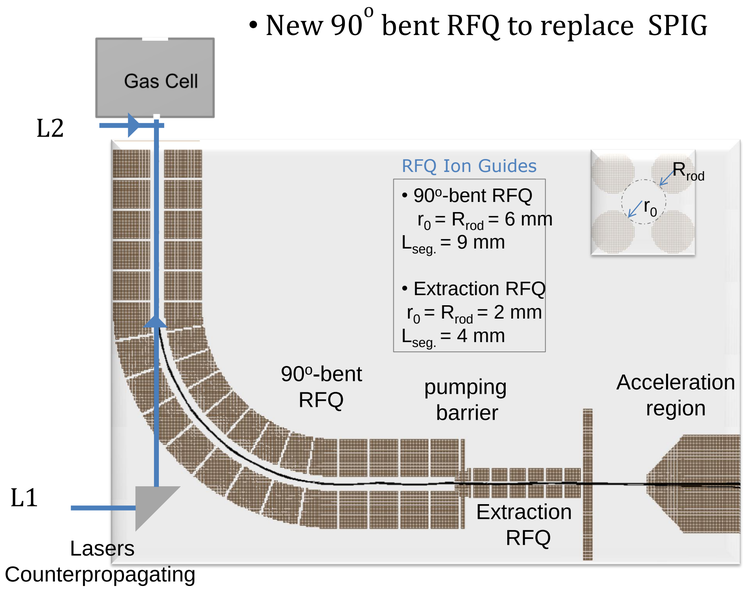


J. Rossnagel et al. Phys. Rev. A , 85 012525 (2012)

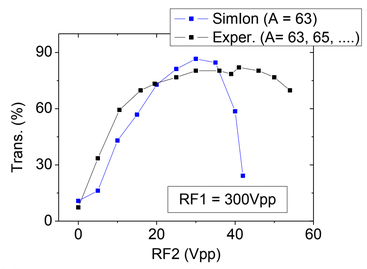


Improving Spatial Overlap

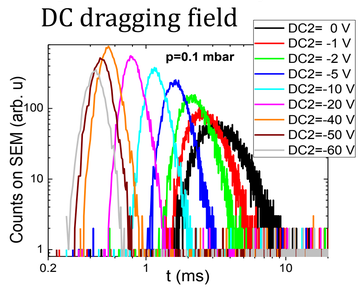
- New 90° bent RFQ to replace SPIG



Transmission through RFQ IG's



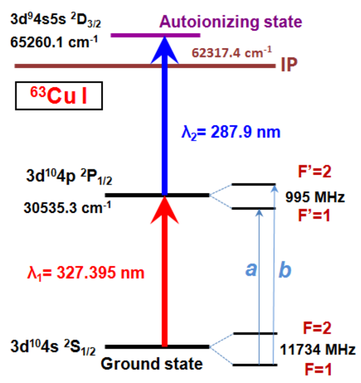
Manipulation of Ions by DC dragging field

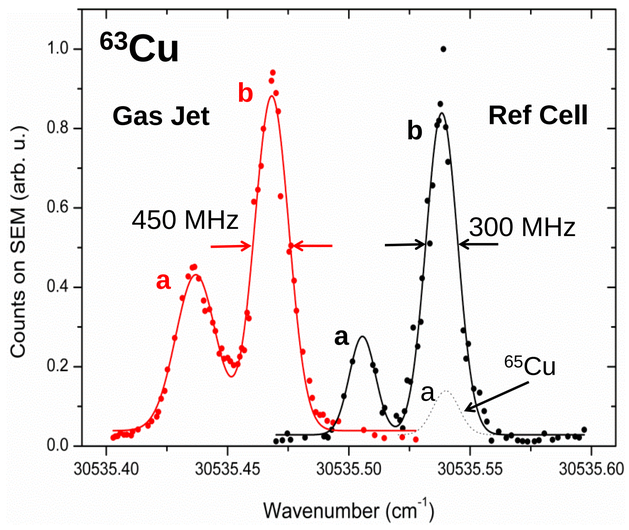


- Implementation of a de Laval nozzle at the gas cell exit orifice

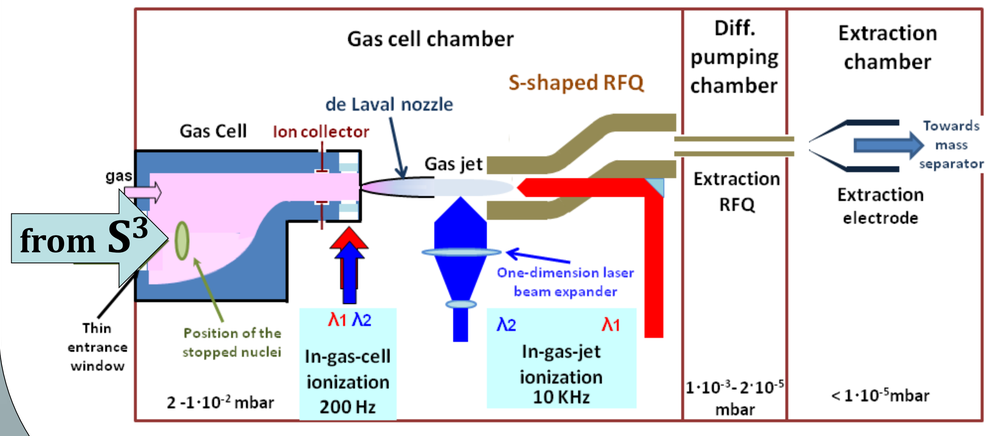
M. Reponen *et al.*, NIM A 635 (2011) 24

In Gas Jet Laser Spectroscopy using a crossed beam incidence on a free jet





- Generic IGLIS setup to be commissioned and tested at the HELIOS (Heavy Element Laser Ionization Spectroscopy) laboratory @ KU Leuven



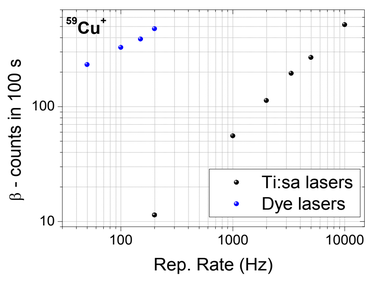
Yu. Kudryavtsev et al. NIM B, Submitted

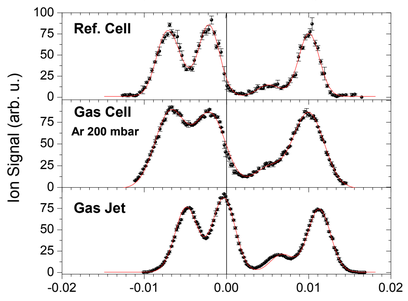
European Research Council
Established by the European Commission

After a test and optimization period the setup will be installed at the focal plane of S^3, where full operation in on-line conditions is intended

Improving Temporal Overlap

- Test of a high pulse repetition rate (10 kHz) Ti:sa laser system for ionization and spectroscopy experiments @LISOL (Uni. Mainz, GANIL, JYFL, IPN-Orsay, RIKEN)

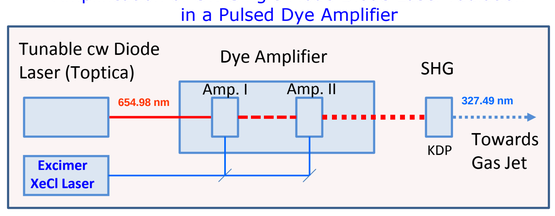


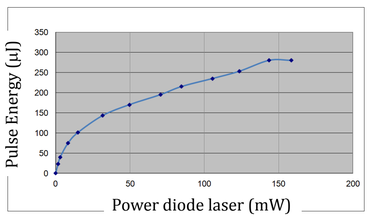


R. Ferrer, V. Sonnenschein et al. NIM B Accepted

Reduction of Laser Bandwidth

Amplification of CW Single Mode Diode Laser radiation in a Pulsed Dye Amplifier





Acknowledgments

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