Technical Developments towards On-Line Spectroscopy at TRIGA-LASER

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Introduction: The TRIGA-LASER experiment within the TRIGA-SPEC collaboration aims for the study of neutron-rich fission products from the TRIGA Mainz research reactor [1]. The performance of the laser spectroscopy section has been studied and specified by various off-line studies. During the last year technical improvements of the existing setup and further development steps towards on-line coupling to the nuclear reactor were made. Furthermore first laser spectroscopic investigations towards nuclear ground state properties were started and partly completed at ISOLDE, CERN.

Technical Developments: Experimental studies have shown, that the environmental conditions in the reactor hall, e.g. a high noise level close to the beamline as well as variations in temperature, humidity and in particular in ambient pressure, do not enable stable operation of a laser which is frequency-locked to a cavity or a interferometer. Also frequency-doubling is strongly affected and hardly possible. Therefore the laser system has been transferred to the dedicated laser laboratory to be decoupled from these environmental conditions. This required the installation of a 180m long **fibre network** of single-mode infra-red and UV glass and silica fibres, respectively, throughout the institute of nuclear chemistry. In first transmission tests these fibres provided overall transport efficiencies of 30-60% from the laser laboratory to the beamline in the reactor hall.

Currently a combination of an ECR-plasma ion source with an aerosol-transport system [2] is applied for the ionization of fission fragments. Since this approach provided insufficient ion beam yields so far, a surface-ion source [3] has been developed and is ready to replace the ECR ion source. However this source is limited to a small number of elements, mainly to those with low ionization potential and sufficiently large vapor pressure. To access the variety of radioactive species produced in the neutron-induced fission close to the reactor core, a **hallow-cathode type plasma ion source** is currently being built.

In parallel to these on-line ion source developments, an **off-line surface-ion source** has been completed. This ion source is attached to the magnetic mass separator chamber and ions are injected along the emission axis of the separator. It will be used as test ion source for the development of a downstream installed radio-frequency quadrupole ion cooler and buncher.

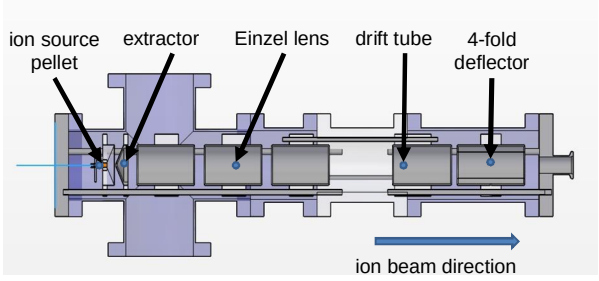

Figure 1: Schematic drawing of the off-line surface ion source utilizing a commercial heat wave labs© caesium pellet. On the left side relative to the insulator (white) everything is kept on an offset potential of 30 kV whereas the right side of the vacuum chamber is biased on ground potential.

For simultaneous measurements of different isotopes, as well as for isotopes with a wide hyperfine structure, a large scan range for the Doppler-tuning voltage is necessary. On the other hand, fast scans are less sensitive to slow drifts in laser power. Therefore, a **compact two stage high-voltage cage** has been developed, connecting a fast 500V, a slow 10kV and a 600W heating power supply in series. The system is computer-controlled via opto-couplers.

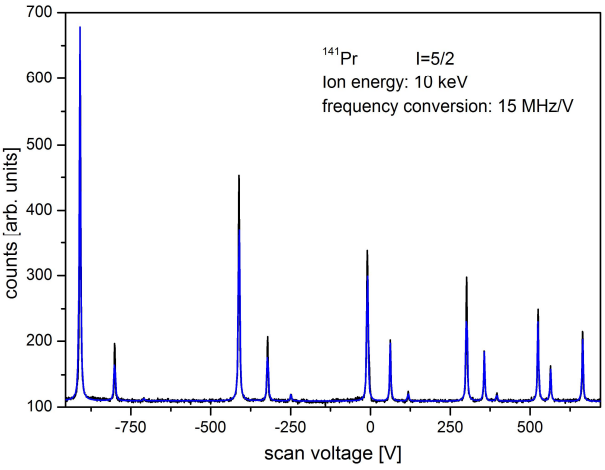

Figure 2: Hyperfine structure splitting of the stable isotope $^{141}Pr^{+}$ measured at the TRIGA-LASER experiment.

Spectroscopic studies: The **nuclear magnetic moment of ^{140}Pr** is of particular interest due to its importance for the explanation of the observed modulated electron capture decay of $^{140}Pr^{58+}$ in the ESR storage ring at GSI [4]. As a preparation for the determination of the magnetic moment of this isotope at the COLLAPS experiment at CERN, collinear laser spectroscopy of the stable isotope $^{141}Pr^{+}$ has been performed at the TRIGA-LASER experiment. A typical spectrum is shown in Fig. 2.

References

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Acknowledgement

Work supported by HGF under contract VH-NG-148 and 'Stiftung Rheinland-Pfalz für Innovation' under contract 961-386261/854. Andreas Krieger acknowledges support from the Carl Zeiss Stiftung (AZ:21-0563-2.8/197/1).