

Mass measurements and collinear laser spectroscopy on neutron-rich and heavy nuclides at the research reactor TRIGA Mainz*

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The TRIGA-SPEC project comprises a Penning trap setup for high-precision mass measurements as well as a beamline for collinear laser spectroscopy on neutron-rich and heavy nuclides at the research reactor TRIGA Mainz. These techniques have been employed for decades at on-line facilities, but to reach regions further away from stability and to improve accuracy, e.g., for fundamental tests of the standard model, a continuous effort towards the development of more efficient and more accurate techniques is required. TRIGA-SPEC is devoted as a test bench particularly for the planned MATS [1] and LASPEC [2] facility at FAIR. However, due to the infrastructure at Mainz and the coupling to the research reactor, it provides also the opportunity to perform measurements on heavy trans-actinides as well as short-lived fission products far away from the valley of stability. The data provided will be of high interest for nuclear structure studies. The proposed experimental setup is shown in Fig. 1. Thermal neutron induced fission nuclei will be produced in a target chamber placed near the reactor core and transported towards an ion source via a gas-jet transport system [3].

For first off-line measurements on heavy actinide el-

ements between ²³⁵U and ²⁴⁹Cf, a laser desorption ion source has been developed. Ions of heavy elements as well as carbon clusters for mass calibration are produced with a pulsed frequency-doubled Nd:YAG laser with a wavelength of 532 nm and a pulse length of 3-5 ns. The ion-optical transport from the source to the Penning traps was optimized using SIMION 8.0 simulations and the transport efficiency for shooting ions through the traps is estimated to be 80%. For the cylindrical purification trap and the hyperbolical precision trap [4], a 7 T superconducting magnet similar to the one at SHIPTRAP [5] was installed and commissioned. For the very first time the Fourier-Transform Ion Cyclotron Resonance (FTICR) detection method, which was improved to reach single ion sensitivity, will be applied for mass measurements on heavy nuclei. For mass separation of the fission products a 90° dipole mass separator will be used, which reaches a mass energy product of 15 MeVamu. To guide the ions either to the Penning trap or to the collinear laser spectroscopy beamline a 45° electrostatic switchyard was designed and optimized with SIMION 8.0 simulations. For the collinear beamline an alkaline vapour charge exchange cell and an ion deflector with optical viewports to overlap the ion or atom beam with the laser were designed and are currently being manufactured. Collinear spectroscopy needs an accurate determination of the acceleration voltage [6]. Thus, we are going to test a high precision voltage divider with an accuracy of 10⁻⁵ for voltages up to 60 kV. Additionally, the applicability of a frequency comb for absolute measurements of the transition frequencies will be investigated.

References

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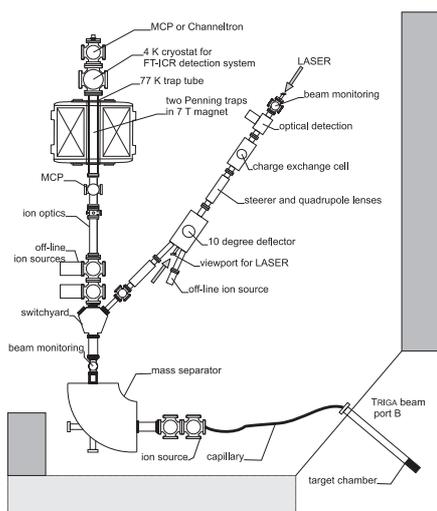


Figure 1: Experimental setup with the mass spectrometry beamline to the left and the laser spectroscopy beamline to the right. Fission products will be transported by a carrier gas to the ion source and subsequently mass separated.

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