Commissioning of *TRIGA-LASER* - tests and developments of the LaSpec beamline

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Introduction: The major parts of the TRIGA-LASER experiment for collinear laser spectroscopy on exotic fission products from the TRIGA research reactor [1] are now installed and are currently being commissioned. Besides the exploration of unknown ground in the nuclear chart with respect to spins, moments and charge radii, the experiment is the prototype of the the LaSpec experiment [2] at FAIR, GSI and will serve as a development platform until the final installation at FAIR.

Experimental: For commissioning, laser spectroscopy experiments were carried out with stable Rb ions from an offline ion source. The charge exchange cell (CEC) and the optical detection system were installed at the beamline and tested. Charge exchange of the rubidium ions was accomplished with potassium vapor produced in the cell at temperatures of $100 - 200°$ C. A charge exchange efficiency of 99% can be reached. However, laser spectroscopy experiments will be performed with efficiencies of $20 - 40\%$ at about 140° C to avoid artificial broadening of the resonance lines. To change the velocity of the neutralized beam for Doppler tuning, the CEC can be floated to a potential of up to 10 kV. Voltage scans can either be performed with a Heinzinger PNChp10000 high-precision high-voltage power supply programmed via GPIB or with a Kepco HV amplifier controlled by the voltage of a 16 Bit DAC. The fluorescence detector after the CEC is a combination of a light collecting elliptical mirror with a light guide and a photomultiplier. The Hamamatsu R1017 multiplier exhibits 5% quantum efficiency at the Rb transition wavelength of 780 nm.

Results: The first laser spectroscopy experiments were performed with Rb atoms after charge exchange with an acceleration voltage of 10 kV and a maximum Doppler tuning voltage of ± 1 kV. This range is equivalent to approximately 9.5 GHz and sufficient to record the full Rb hyperfine structure of both naturally abundant isotopes ^{85}Rb and ^{87}Rb simultaneously. This is shown in Fig. 1, which shows the complete hyperfine structure as a function of the scanning voltage. The inset shows the strongest peak and demonstrates the resolution. The linewidth of 25 MHz is close to the natural linewidth of 6 MHz. The detection efficiency was optimized and a value of $\epsilon \approx 1$ photon / 360 atoms was achieved. The background caused by scattered laser light is about 150 kHz at 0.6 mW and therefore still too high. However, a signal-to-noise ratio of ≈ 2 in a 6 h integration time, assuming a resonance scan with 20 points, can be achieved with an atom beam intensity of 1×10^4 atoms/s. Currently, a

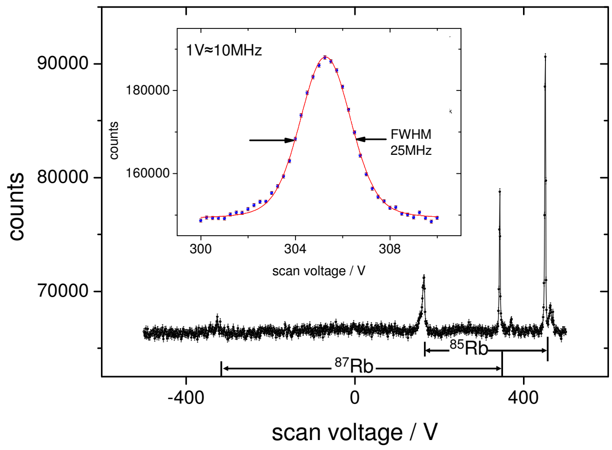

Figure 1: Full hyperfine spectrum of ^{85}Rb and ^{87}Rb and enlarged scan of the strongest peak. Spectra are the sum of 10 and 50 scans for the overall spectrum and the single peak, respectively ($P_{\text{Laser}} = 0.54$ mW, $I = 3 \times 10^7$ atoms/s).

particle detection system for low count rates is being tested which will allow to perform particle-photon coincidence measurements to increase the sensitivity [3]. Lower straylight background and higher detection efficiency of fluorescence light are the objectives of a new light collection module which is currently being designed and simulated. Coupling to the reactor and first online experiments are expected for the end of 2010.

References

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Acknowledgment

Work supported by HGF under contract VH-NG-148 and 'Stiftung Rheinland-Pfalz für Innovation' under contract 961-386261/854.