HK 45: Instrumentierung

Zeit: Donnerstag 14:00–15:45 Raum: HZ 10

Gruppenbericht HK 45.1 Do 14:00 HZ 10

Status and Perspective of the FRS Ion Catcher Experiment — •Jens Ebert — Justus-Liebig-Universität Gießen

Exotic nuclei are produced in stellar processes like the p- and r-process and are essential for our understanding of nucleosynthesis beyond iron. They have in common that they are on the chart of nuclides far away from the valley of stability, which corresponds to an unusual ratio of neutrons to protons and short half-lives. Possible ways of producing exotic nuclei in the laboratory are for example projectile fragmentation and fission. Nuclei produced this way have high energies and must be slowed down for high-accuracy low-energy experiments like MATS and LaSpec. At the FRS Ion Catcher experiment this has been done in July and August 2012 for an Uranium beam with 1GeV/u fragmented on a Beryllium target. The projectile fragments have been separated in-flight, range-bunched, slowed-down in the Fragment Separator (FRS) at GSI and subsequently thermalized in a cryogenic stopping cell (CSC). With the ions extracted from the CSC and transported to a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS), mass measurements were performed for isotopes with A=211 and A=213. Essential for the measurements were a fast and efficient extraction from the CSC and a quick mass measurement, because of the low detection rate and short half-lives for the nuclides of interest. In this presentation the results of our experiment in July and August 2012 and goals for the next beam time in 2014 will be presented.

HK 45.2 Do 14:30 HZ 10

Cluster-jet targets for laser induced ion acceleration — •S. Grieser[1], D. Bonaventura[1], M. Büscher[2], I. Engin[3], A.-K. Hergemöller[1], E. Köhler[1], F. Schlüter[2], A. Täschner[1], and A. Khoukaz[1] — [1]Institut für Kernphysik, Westfälische Wilhelms-Universität Münster — [2]Peter Grünberg Institut (PGI), FZ Jülich — [3]Institut für Kernphysik, (IKP), FZ Jülich

The directed ion acceleration induced by high-energy laser pulses is a strongly increasing research field. In such experiments ultra-short laser pulses focussed on a target create a plasma, in which strong secondary electric fields can accelerate protons and ions to multi-MeV energies. A major drawback of the commonly used targets, like gas-jets or foils, is their low density or the need to be replaced after each laser pulse. An innovative perspective for high-flux and high-repetition-rate experiments is the application of a cluster-jet source, which continuously produces a flux of cryogenic solid clusters by the expansion of pre-cooled gases within fine Laval nozzles. Therefore, a cluster-jet target was built up and set successfully into operation at the University of Münster and will be used for experiments on laser and plasma physics at the University of Düsseldorf. Systematic measurements were done to determine the target beam thickness, possible beam structures, the stability, and the position within the scattering chamber to ensure the ideal requirements for the experiments. For this purpose, the cluster beam was illuminated by a diode laser 33 cm behind the Laval nozzle and observed by a CCD camera. The results on the cluster beam properties will be presented and discussed.

HK 45.3 Do 14:45 HZ 10

Laval Nozzles for Cluster-Jet Targets — •Ann-Katrin Hergemöller, Daniel Bonaventura, Silke Grieser, Esperanza Köhler, Alexander Täschner, and Alfons Khoukaz — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

Cluster-jet targets are highly suited as internal targets for storage ring experiments. Here the target beam itself is produced by the expansion of pre-cooled gases within fine Laval nozzles. With such targets high and constant target beam thicknesses can be achieved and adjusted continuously during operation. At the prototype cluster-jet target for the PANDA experiment, which was built up and set successfully into operation at the University of Münster, density structures within the cluster beam directly behind the nozzle have been observed. Therefore, a tilting system was installed, allowing for an adjustment of the nozzle system relative to the experimental setup. With this installation target densities of more than 2×10^{15} atoms/cm^2 at a distance of 2.1 m behind the nozzle were achieved. To study the impact of the Laval nozzle geometry on the beam structures and the achievable densitiy, an improved nozzle production method was established. With this technique it is possible to produce with high efficiency fine micrometer-sized nozzles with variable geometries, e.g. different opening angles, opening diameters or lengths of the exit trumpet. The method for the production of Laval nozzles will be presented and new perspectives will be discussed. Supported by EU (FP7), BMBF, and GSI F+E.

HK 45.4 Do 15:00 HZ 10

Optimization of the target system for the hypernuclear experiment at $\overline{\text{P}}$ANDA — •Sebastian Bleser[1], Felice Iazzi[2], Josef Pochodzalla[3], Kai Rittgen[3], Cihan Sahin[3], Alicia Sanchez Lorente[1], and Marcell Steinen[1] — [1]Helmholtz-Institut Mainz — [2]Politecnico di Torino and INFN, Sez. di Torino, Italy — [3]Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz

Gamma spectroscopy of double Λ hypernuclei will be one of the main topics addressed by the $\bar{\text{P}}$ANDA experiment at the planned FAIR-facility at Darmstadt, Germany. For this project a dedicated hypernuclear detector setup will be installed. In addition to the general purpose of the $\bar{\text{P}}$ANDA detector it consists of a primary nuclear target for the production of $\Xi^- + \bar{\Xi}$ pairs, a secondary active target for the formation of hypernuclei and the identification of associated decay products as well as a germanium detector array to perform γ spectroscopy.
Results of the current hardware development will be presented in the talk: For the positioning of the primary filament target in the beam halo the functionality of piezo motors is investigated in vacuum. Stability tests of the primary target chamber are performed with various thin materials. For the secondary target the readout of silicon microstrip detectors with ultra-thin flexible cables is checked to fan out the readout electronics. Furthermore, design studies of support structures for the whole detector setup are considered.
On the simulation side a compromise between the stopping probability of Ξ^- hyperons and the reconstruction accuracy of weak decay pions will be discussed.

HK 45.5 Do 15:15 HZ 10

Performance of the Cryogenic Stopping Cell for the LEB at the FRS Ion Catcher — •Moritz Pascal Reiter for the FRS Ion Catcher-Collaboration — II.Physikalsiche Institut JLU Giessen

At the FRS Ion Catcher, projectile and fission fragments are produced at relativistic energies, separated in-flight, range-focused, slowed-down and thermalized in a cryogenic stopping cell (CSC) to kinetic energies to a few eV. A multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) is used to perform direct mass measurements and to remove isobaric contaminants. The isobarically clean beam may be delivered to further experiments, for example mass-selected decay spectroscopy. The FRS Ion Catcher serves as a test bench for the Low-Energy-Branch of the Super-FRS at FAIR, where the CSC and the MR-TOF-MS will be key devices for experiments with stopped projectile and fission fragments. The CSC has been commissioned with ^{238}U projectile fragments produced at 1000 MeV/u. The spatial isotopic separation in-flight was performed with the FRS applying a monoenergetic degrader. For the first time, a stopping cell was operated with exotic nuclei at cryogenic temperatures (70 to 100 K). An overall efficiency of up to 15 %, a combined ion survival and extraction efficiency of about 50 %, and short extraction times of 24 ms were achieved for heavy α-decaying uranium fragments. Mass spectrometry with a multiple-refection time-of-fight mass spectrometer has demonstrated the excellent cleanliness of the CSC. In this presentation advantages of the cryogenic operation for the cleanliness as well as the behavior of the CSC during the online experiments will be discussed.

HK 45.6 Do 15:30 HZ 10

A laser ablation carbon cluster ion source for MR-TOF-MS — •Christine Hornung[1], Timo Dickel[1,2], Jens Ebert[1], Hans Geissel[1,2], Wolfgang R. Plass[1,2], Ann-Kathrin Rink[1], and Christoph Scheidenberger[1,2] — [1]II. Physikalisches Institut, Justus-Liebig-Universität Giessen, Giessen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The FRS Ion Catcher at GSI is the test facility for the future Low-Energy Branch (LEB) of the Super-FRS at FAIR. It consists of the FRS, a cryogenic stopping cell and a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). At the LEB high precision mass measurements of exotic nuclei will be possible at the MATS experiment. The MR-TOF-MS is an indispensable diagnostic device for operation of the cryogenic stopping cell.

For calibration and systematic studies of the MR-TOF-MS at the FRS Ion Catcher calibrants over a broad mass range are essential. For this purpose a laser ablation carbon cluster ion source has been designed, commissioned and tested. The system can be operated at order of magnitude higher repetition rates (100Hz) than existing system and is thus ideally suited for the needs of the MR-TOF-MS (repetition rates ∼100Hz). Several measures (small laser spot size, special ion optics, x-y-movable targettable) have been taken to ensure long term stable operation (∼weeks) at highest repetition rate. Results of the commissioning and first tests with different targets will be presented.