HK 21: Instrumentierung V

Time: Tuesday 14:00–16:00 Location: HS2

Group Report HK 21.1 Tue 14:00 HS2

Challenges and Solutions for the Detection System of the R3B Experiment at FAIR — •Konstanze Boretzky for the R3B-Collaboration — GSI Darmstadt, Germany

The R3B (Reactions with Relativistic Radioactive Beams) experiment at the high-energy branch of the Super-FRS is designated for high-energy reaction studies in inverse kinematics. The experiment will allow for kinematically complete measurements of reactions with radioactive ions covering the full mass range up to uranium. For the heaviest nuclei this implies using beam energies of ≥ 1 GeV/u to ensure fully-stripped ions for proper separation and magnetic momentum analysis after the secondary target. The present contribution will review the progress achieved so far concerning the various components of the R3B setup. The large-acceptance super-conducting dipole GLAD, in conjunction with a high-resolution tracking system, will provide a momentum resolution of $\delta p/p \cong 10^{-3}$ even for the heaviest ions. A novel detection system NeuLAND for high-energy neutrons (0.2 to 1 GeV) with very good position and time resolution below 100 ps will allow invariant-mass spectroscopy with a resolution of 100 keV and a clean multi-neutron recognition even for the highest beam energies. An energy resolution of 20 keV at the threshold is envisaged e.g. for reactions of astrophysical interest. In order to cope with the huge Doppler effect at typical beam energies, the photon calorimeter CALIFA will consist of several thousands of crystals. The R3B setup will be subsequently installed, commissioned and used in experiments at the R3B-LAND hall at GSI before moving to the R3B experimental area at FAIR.

HK 21.2 Tue 14:30 HS2

Scintillator Concept of NeuLAND at R3B — Thomas Aumann[3], Konstanze Boretzky[2], Michael Heil[2], Alexander Ignatov[3], •Vassili Maroussov[1,2], Haik Simon[2], and Andreas Zilges[1] for the R3B-Collaboration — [1]Institut für Kernphysik, Universität zu Köln — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt — [3]Technische Universität Darmstadt

For the R3B experiment at FAIR a detection system for fast neutrons, NeuLAND (new **L**arge **A**rea **N**eutron **D**etector), is foreseen. Besides a time resolution of $\sigma_t \cong 100\,\mathrm{ps}$, spatial resolutions of $\sigma_{x,y,z} \cong 1\,\mathrm{cm}$, the detection efficiency of above 90% for neutrons of 0.2-1 GeV and a dedicated multi-neutron recognition capability are demanded. Using the FLUKA Monte Carlo code we studied a NeuLAND detector concept relying entirely on bars of a plastic scintillator (BC408). With a detector depth of 2 m the required efficiency is reached and the fraction of incident neutrons detected within resolution requirements varies from ~70% to 80% in the desired energy range. Simulations have verified that the introduction of an inactive converter like iron deteriorates the timing performance. Due to the low density of the scintillator secondary protons typically cross several modules, thus allowing the tracking of secondaries. The status of the multi-hit recognition algorithm using the tracking information will be presented along with the latest results for the scintillator prototypes for NeuLAND. Using the same framework a competing concept for NeuLAND based on MRPCs was studied as well and will be contrasted to the scintillator concept.

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HK 21.3 Tue 14:45 HS2

Teilchenidentifikation mit den CsI(Tl)-Kristallen für das CALIFA Kalorimeter* — •Michael Bendel, Tudi Le Bleis, Roman Gernhäuser, Reiner Krücken und Max Winkel für die R3B-Kollaboration — Technische Universität München, Physik-Dept. E12, 85748 Garching

Im R3B Experiment, das an der neuen Experimentiereinrichtung FAIR (Darmstadt) aufgebaut wird, soll die gesamte Targetregion von dem grossvolumigen Kalorimeter CALIFA eingeschlossen werden. Das Kalorimeter besteht aus ca. 5000 CsI-Kristallen, die mit Silizium-Avalanche-Photodioden ausgelesen werden. Die wesentlichen Anforderungen sind eine hohe Effizienz, eine gute Energieauflösung im Bereich von 5% bei 662keV γ-Strahlung und ein riesiger dynamischer Bereich, der es erlaubt gleichzeitig γ-Quanten mit wenigen 100keV, aber auch gestreute Teilchen mit mehreren 100MeV nachzuweisen. Dabei spielt die Identifikation der verschiedenen Teilchen aufgrund unterschiedlicher Lichtausbeute im Szintillator eine entscheidende Rolle. Wir stellen einen neu entwickelten Identifikations-Algorithmus vor und zeigen erste Ergebnisse eines Testexperiments am Tandembeschleuniger des Maier-Leibnitz-Laboratoriums (Garching b. München).

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HK 21.4 Tue 15:00 HS2

First application of a multi-reflection time-of-flight mass separator to radioactive beams — •M. Rosenbusch for the ISOLTRAP-Collaboration — EMAU Greifswald

In most cases, radioactive ion beams are delivered only as a mixture of several isobaric species. This constitutes a major limitation for precision mass spectrometry of short-lived isotopes by use of Penning traps, since the presence of contaminant ions leads to frequency shifts. The state-of-the-art procedure to remove unwanted ions, mass-dependent ion centering by resonant excitation while applying buffer-gas cooling, takes several 100ms and works only for small ratios of "unwanted" to "wanted" ions. Thus, there is need for a cleaning method which not only conserves a high ion-of-interest throughput in the case of contamination, but also works on short time scales. An auxiliary device for isobaric purification of rare-isotope ensembles, in the form of a multi-reflection time-of-flight mass separator (MR-ToF MS), has recently been integrated into the Penning-trap mass spectrometer ISOLTRAP at the on-line isotope separator ISOLDE/CERN. An outline will be given of the MR-ToF-MS and the modifications of ISOLTRAP components that were required for the implementation. In addition, the performance of the combined setup both in off-line tests as well as in the context of the first applications during on-line beamtimes will be described.

HK 21.5 Tue 15:15 HS2

Offline commissioning of a cryogenic stopping cell for the (Super-) FRS at GSI — •Sivaji Purushothaman[1], Peter Dendooven[2], Marcel Diwisch[3], Hans Geissel[1,3], Wolfgang Plass[1,3], Manisha Ranjan[2], Daniel Schaefer[3], Christoph Scheidenberger[1,3], and Timo Dickel[3] — [1]GSI, Darmstadt, Germany — [2]KVI, University of Groningen, Netherlands — [3]Justus-Liebig-Universität, Gießen, Germany

The low-energy branch of the Super Fragment Recoil Separator (Super-FRS) at FAIR in Darmstadt, Germany, will allow studies of radioactive isotopes using laser techniques and ion traps. For this purpose, we are developing an ion catcher that will stop high-energy ions from the Super-FRS in helium gas and extract them as a low-energy beam using DC and RF electric fields. The high purity of the helium gas will be ensured by operation at low temperature. We have constructed a gas cell with a stopping volume of length 1 m and diameter 0.25 m. To ensure fast and efficient extraction of the ions stopped throughout the volume of the cell we have opted for a DC field throughout the length of the cell and an RF carpet with DC field superimposed at the exit side to guide the ions towards the exit-hole without hitting the wall. We will present the results from the successful offline commissioning of the cryogenic stopping cell. Plans for online commissioning and use at the FRS will be discussed.

HK 21.6 Tue 15:30 HS2

A multiple-reflection time-of-flight isobar separator for TITAN at TRIUMF and other ISOL-facilities — •Christian Jesch[1], Timo Dickel[1,2], Wolfgang Plass[1,2], Jens Ebert[1], Hans Geissel[1,2], Johannes Lang[1], Moritz Pascal Reiter[1], Christoph Scheidenberger[1,2], and Mikhail I. Yavor[3] — [1]Justus-Liebig-Universität Gießen — [2]GSI, Darmstadt — [3]Inst. for Analytical Instrum., Russian Academy of Sci., St. Petersburg

The production of radioactive ion beams via the ISOL method has the advantage of a high yield of the desired radioisotope. The usually even higher production yields of contaminants is a drawback for ISOL and calls for efficient separation methods. The commonly used magnetic separators with mass resolving power of a few 10^3 allow the separation of contaminants with a mass difference ≥ 1 amu but no preparation of an isobarically clean beam.

TRIUMF's Ion Trap for Atomic and Nuclear science is a facility for mass measurements, laser spectroscopy and nuclear branching ratio measurements in Vancouver, Canada. TITAN's performance strongly benefits from isobarically clean beams by means of unambiguity and higher efficiency.

In order to significantly extend TITAN's capabilities, a specialized multiple-reflection time-of-flight mass spectrometer has been developed in order to provide an efficient, fast ($\approx$ ms), high mass resolving power ($\approx 10^5$) and high capacity ($> 10^6 s^{-1}$) separation of the radioactive nuclei. The separator concept, a novel RFQ-type switch yard concept and preliminary results will be presented.

HK 21.7 Tue 15:45 HS2

A new resonant Schottky pickup for nuclear physics measurements of highly charged ions in storage rings — •M. Shahab Sanjari[1,2], Peter Hülsmann[1,2], Fritz Nolden[2], Alwin Schempp[1], Dinko Atanasov[3], Klaus Blaum[3], Fritz Bosch[2], Violetta Ivanova[2], Christophor Kozhuharov[2], Yuri A. Litvinov[2,3], Peter Moritz[2], Claudius Peschke[2], Peter Petri[2], Daria Shubina[3], Markus Steck[2], Helmut Weick[2], Nicolas Winckler[3], Junxia Wu[4], Yongdong Zang[4], and Tiecheng Zhao[4] — [1]Goethe-Universität, Frankfurt am Main — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [3]Max-Planck-Institut für Kernphysik, Heidelberg — [4]Institute of Modern Physics, Lanzhou, China

An RF cavity was designed and used as a sensitive resonant pickup for Schottky noise of single or few particle beams in the ESR at GSI. The particle-induced energy builds up inside the resonator and is extracted with a matched loop antenna. A dedicated signal analysis system is then used for further processing. To allow high current experiments, the resonator can be disabled by taking apart its air-filled parts and shorting its gap. The design allows remote detuning of the resonance frequency. The resonator complements the existing capacitive Schottky noise pickup at the ESR. Nuclear experiments with highly charged ions such as time-resolved Schottky mass spectrometry and life time measurements were performed with much higher sensitivity. A similar cavity is currently being installed in the CSRe at IMP, Lanzhou. We will discuss the principles and recent results of these detectors.