HK 57: Nuclear Astrophysics V

Zeit: Donnerstag 16:30–18:15 Raum: S1/01 A04

Gruppenbericht HK 57.1 Do 16:30 S1/01 A04

A 5 MV Pelletron accelerator providing $^{1}H^{+}$, $^{4}He^{+}$, and $^{12}C^{+}$ beams for underground nuclear astrophysics — •Stefan Reinicke[1,2], Daniel Bemmerer[1], Thomas E. Cowan[1,2], Marcel Grieger[1,2], Arnd R. Junghans[1], Felix Ludwig[1,2], Stefan E. Müller[1], Ferdinand Rath[1,2], Tobias P. Reinhardt[2], Bernd Rimarzig[1], Marko Röder[1,2], Ronald Schwengner[1], Tamás Szücs[1], Marcell P. Takács[1,2], Andreas Wagner[1], Louis Wagner[1,2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]Technische Universität Dresden

Accelerator-based experiments at the 0.4 MV LUNA underground accelerator at Gran Sasso have enabled great progress for studies of Big Bang and solar fusion reactions. However, to complete the picture of solar fusion reactions and open up helium and carbon burning reactions to study, higher beam energies are required. A 5 MV Pelletron accelerator will be installed in the Felsenkeller underground laboratory in Dresden. It will allow both, tandem mode operations for $^{12}C^{+}$ beams and the use of a radio frequency ion source on the high voltage terminal for $^{1}H^{+}$ and $^{4}He^{+}$ beams. The beam from the RF ion source is fed in with a remotely controlled electrostatic deflector. In addition, a large, ultra-sensitive high-purity germanium detector for offline measurements will be installed at Felsenkeller. The final timeline of the project will be shown, as well as the science case for in-house research and the capabilities available to external scientific users. – Supported by NAVI (HGF VH-VI-417) and by DFG (TU Dresden Institutional Strategy, "support the best").

HK 57.2 Do 17:00 S1/01 A04

Measurement of the natural neutron background underground with moderated ^{3}He counters in the Dresden Felsenkeller — •Marcel Grieger[1,2], Daniel Bemmerer[1], Stefan E. Müller[1], Tamás Szücs[1], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

A new underground ion accelerator with 5 MV acceleration potential will soon be installed in the Dresden Felsenkeller. The site consists of altogether nine mutually connected tunnels. It is shielded from cosmic radiation by a 45 m thick rock overburden, enabling uniquely sensitive experiments. Here, a measurement of the neutron flux in Felsenkeller tunnel IV is reported. The flux has been measured in three differently shielded laboratories with a set of seven moderated ^{3}He tubes provided by the BELEN collaboration. FLUKA simulations have been used to calculate the detector responses. The observed neutron count rates were unfolded with the MAXED and GRAVEL algorithms, and an energy spectrum has been derived. — Supported by NAVI (HGF VH-VI-417).

HK 57.3 Do 17:15 S1/01 A04

Charged-particle-induced reactions for astrophysics with storage rings — •Zuzana Slavkovská[1,2], Jan Glorius[1,2], Christoph Langer[1,2], and René Reifarth[1,2] — [1]Goethe-University Frankfurt — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

The astrophysical p-process involves reactions on unstable proton-rich isotopes with small cross sections in the astrophysically relevant energy range. As such, no suitable targets can be produced. The use of ion storage rings with beam cooling offers unique experimental conditions for experiments on such isotopes using inverse kinematics. The radioactive beams, especially short-lived, can be stored efficiently. Using a gas-jet hydrogen target, sufficiently high luminosities can be reached allowing investigation of charged-particle-induced reactions.

A pilot experiment using the Experimental Storage Ring (ESR) at GSI in Darmstadt allowed first measurements of (p,γ) reactions using stored ^{96}Ru ions at the energy of a few AMeV close to the Gamow window and proofed the applicability of this method.

This talk describes general advantages of using ion storage rings over traditional methods and improvements of the ESR experimental setup towards measurements directly inside the Gamow window. Future plans of possible measurements at the ESR and the new low-energy storage ring CRYRING will be presented.

This project is supported by BMBF-CRYRING, HGS-HIRe and HIC for FAIR.

HK 57.4 Do 17:30 S1/01 A04

Silicon photomultiplier readout of a monolithic 270×5×5 cm^{3} plastic scintillator bar for time of flight applications — •Marko Röder[1], Daniel Bemmerer[1], Thomas E. Cowan[1,2], Stefan Gohl[1,2], Klaus Heidel[1], Tobias P. Reinhardt[2], Stefan Reinicke[1,2], Daniel Stach[1], Andreas Wagner[1], David Weinberger[1], and Kai Zuber[2] for the R3B-Collaboration — [1]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden — [2]TU Dresden

The detection of 200-1000 MeV neutrons requires large amounts of detector material because of the long nuclear interaction length of these particles. In the example of the NeuLAND neutron time-of-flight detector at FAIR, this is accomplished by using 3000 scintillator bars of 270×5×5 cm^{3} size made of the fast plastic polyvinyltoluene. In the present work, we investigated whether silicon photomultiplier (SiPM) photosensors can replace fast timing photomultiplier tubes. The response of the system consisting of scintillator, SiPM, and preamplifier was studied using 30 MeV single electrons provided by the ELBE superconducting electron linac. The results were interpreted by a simple Monte Carlo simulation, and the time resolution was found to obey an inverse-square-root scaling law with the number of fired pixels. In the electron beam tests, a time resolution of $\sigma_t = 136$ ps was reached with a pure SiPM readout, well within the design parameters for NeuLAND. — Supported by NupNET NEDENSAA (BMBF 05 P 09 CRFN5), GSI F&E (DR-ZUBE), Helmholtz DTS, and the EU (MUSE, contract no. 690835).

HK 57.5 Do 17:45 S1/01 A04

Recent results from the Penning-trap mass spectrometer ISOLTRAP — •Dinko Atanasov for the ISOLTRAP-Collaboration — Max-Planck Institute for Nuclear Physics

Precision mass measurements of the nuclides $^{129-131}Cd$ have been performed by using the mass spectrometer ISOLTRAP at ISOLDE/CERN. Deviation of about 400 keV is found in the case of ^{130}Cd compared to the previous nuclear studies in the same region. These new findings confirm and quantify the previous indications for the decrease of the shell closure below doubly magic ^{132}Sn. Furthermore, ^{130}Cd in a nuclear astrophysical context is a key nuclide, i.e. a classical waiting-point nuclide for the production of heavy nuclei through the rapid neutron-capture process. The results of the measurement campaign were used to theoretically study the nucleosynthesis by two different astrophysical scenarios, the neutrino driven wind of type-II supernovae and the compact object binary mergers, respectively. The astrophysical simulations result in direct and consistent impact on the Solar System abundance around $A = 128 - 132$ peak. In this contribution all measured masses will be presented and their influence on the nucleosynthesis discussed.

HK 57.6 Do 18:00 S1/01 A04

High Precision Mass Measurements of Thermalized Relativistic Uranium Projectile and Fission Fragments with a Multiple-Reflection Time-of-Flight Mass Spectrometer — •Samuel Ayet San Andrés for the FRS Ion Catcher-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — Justus Liebig Universität, Gießen, Germany

At the FRS Ion Catcher at GSI, a relativistic beam of ^{238}U at 1GeV/u was used to produce fission and projectile fragments on a beryllium target. The ions were separated in-flight at the FRS, thermalized in a cryogenic stopping cell and transferred to a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) where high precision mass measurements were performed.

The masses of several fission and projectile fragments were measured (including short-lived nuclei with half-lives down to 18 ms) and the possibility of tailoring an isomerically clean beam for other experiments was demonstrated. With the demonstrated performance of the MR-TOF-MS and the expected production rates of exotic nuclei far from stability at the next-generation facilities such as FAIR, novel mass measurements of nuclei close to the neutron drip line will be possible and key information for understanding the r-process will be available.

The results from the last experiment and an outlook of possible future mass measurements close to the neutron drip line at FAIR with the MR-TOF-MS will be presented.