First EXL Experiment with Radioactive Beam: Proton Scattering on ^{56}Ni*

M. von Schmid[1], *S. Bagchi*[2], *S. Bönig*[1], *M. Csatlós*[3], *I. Dillmann*[4], *C. Dimopoulou*[4], *P. Egelhof*[4], *V. Eremin*[5], *H. Geissel*[4], *R. Gernhäuser*[6], *M.N. Harakeh*[2], *A.-L. Hartig*[1], *S. Ilieva*[1], *N. Kalantar-Nayestanaki*[2], *O. Kiselev*[4], *H. Kollmus*[4], *C. Kozhuharov*[4], *A. Krasznahorkay*[3], *T. Kröll*[1], *M. Kuilman*[2], *S. Litvinov*[4], *Yu.A. Litvinov*[4], *M. Mahjour-Shafiei*[2], *M. Mutterer*[4], *D. Nagae*[8], *M.A. Najafi*[2], *C. Nociforo*[4], *F. Nolden*[4], *U. Popp*[4], *C. Rigollet*[2], *S. Roy*[2], *C. Scheidenberger*[4], *M. Steck*[4], *B. Streicher*[2,4], *L. Stuhl*[3], *M. Takechi*[4], *M. Thürauf*[1], *T. Uesaka*[9], *H. Weick*[4], *J.S. Winfield*[4], *D. Winters*[4], *P.J. Woods*[10], *T. Yamaguchi*[11], *K. Yue*[4,7], *J.C. Zamora*[1], *and J. Zenihiro*[9]

[1]IKP, TU Darmstadt; [2]KVI, Groningen; [3]Atomki, Debrecen; [4]GSI, Darmstadt; [5]PTI, St. Petersburg; [6]TU München; [7]IMP, Lanzhou; [8]University of Tsukuba; [9]RIKEN, Tokio; [10]University of Edinburgh; [11]Saitama University

EXL (**EX**otic nuclei studied in **L**ight-ion induced reactions at the NESR storage ring) is a project within NUSTAR at FAIR. The nuclear structure will be probed with direct reactions in inverse kinematics. One of the key interests of EXL is the investigation of reactions at very low momentum transfer where, for example, the nuclear matter distribution, giant monopole resonances or Gamow-Teller transitions can be studied [1].

The existing storage ring ESR at GSI, together with its internal gas-jet target, provides a unique opportunity to perform this kind of experiments on a smaller scale already. In autumn of 2012, we successfully performed an experiment (E105) with stable ^{58}Ni as well as radioactive ^{56}Ni beams interacting with H_2 and ^{4}He targets. The main goal was the investigation of the reaction ^{56}Ni(p,p)^{56}Ni at 400 MeV/u in order to measure the differential cross section for elastic proton scattering and deduce the nuclear matter distribution of ^{56}Ni. The experiment was the first of its kind and represents an essential milestone towards the realization of the EXL project.

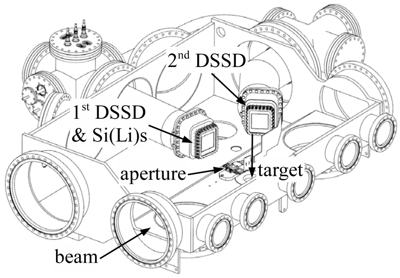

Figure 1: Schematic drawing of the EXL setup at the ESR.

In the last years we have developed a UHV compatible detector setup mainly based on DSSDs (**D**ouble-sided **S**ilicon-**S**trip **D**etector) for the target-like recoils [2]. Here, the DSSDs act as active windows separating the UHV from an auxiliary vacuum where non-bakeable components can be placed. In this way, additional dead layers are avoided and a low energy-threshold is maintained. Figure 1 shows a schematic drawing of the setup around the gas-jet target of the ESR. The two DSSDs have an active area of (6×6) cm^2 each and are divided into 128×64 strips. The first detector close to 90° is set up as a telescope of one DSSD and two 6.5 mm thick Si(Li) detectors placed in the auxiliary vacuum. During bake-out of the ESR and during the experiment the Si(Li)s were actively cooled. To reach the necessary angular resolution a remotely moveable aperture with two motors operated inside the UHV was placed in front of the extended target. Not shown is a detection system for the projectile-like heavy ions further downstream of the target. It features an array of six silicon PIN-diodes directly facing the UHV. Furthermore, a SSD was used in a vacuum pocket for the same purpose. To investigate the conditions for the detection of neutrons and gammas we utilized ELENS (**E**uropean **L**ow **E**nergy **N**eutron **S**pectrometer) and a CsI detector placed outside the vacuum chamber.

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Figure 2 shows a preliminary 2-dimensional plot of the reconstructed energy of the recoiling protons as function of laboratory scattering angle measured by the detector telescope close to 90°. The kinematical lines for both elastic and inelastic scattering are nicely separated and clearly visible. The data analysis is currently in progress.

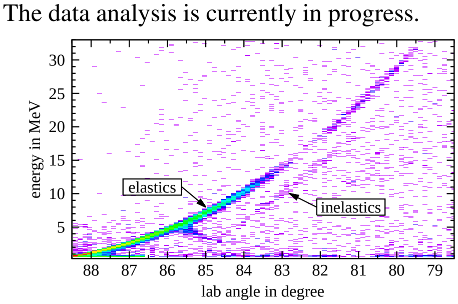

Figure 2: Reconstructed energy vs. angle of recoil protons for ^{56}Ni(p,p)^{56}Ni and ^{56}Ni(p,p')^{56}Ni* reactions.

After this successful experiment, an upgraded detector setup covering a substantially larger solid angle is envisioned to be implemented for further reaction experiments at the ESR.

References

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