Fission Barrier Studies of Neutron-Rich Nuclei via the (p,2p) Reaction: Status of NP1306-SAMURAI-14 Experiment

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The aim of NP1306-SAMURAI-14 is to experimentally determine fission barrier heights in neutron-rich nuclei "north east" of doubly-magic ^{208}Pb using RIB's at RI Beam Factory (RIBF) at RIKEN. The results will drastically improve our experimental knowledge on fission barriers away from stability which is poor at present. Neutron-rich nuclei around $Z \approx 82$ and $N > 126$ are good subjects to be studied because the isospin dependence of fission barriers in those nuclei are quite controversial: The Rotating Liquid Drop Model predicts an increase of barrier heights with neutron number, while modern, more microscopic fission models make completely different and, depending on the model, quite varying behaviors (see e.g.[1]) and references therein). The behavior of fission barriers towards neutron-rich nuclei has a direct impact on the r-process[2]), which is believed to produce about half of the stable heavy elements in the universe.

The basic idea is to use the quasifree (p,2p) reaction in inverse kinematics to excite the nuclei of interest. Heavy neutron-rich nuclei provided at the RI Beam Factory bombard a hydrogen target and measurements of proton four-momenta tells us an excitation energy of the neutron-rich isotopes. In case that fission takes place, the two fission fragments are detected and analyzed with the large-acceptance SAMURAI spectrometer[3]). This allows to extract a threshold energy for the fission process.

For this experiment, heavy secondary beams must be produced from a primary ^{238}U beam and identified using BigRIPS. This is a difficult task as the secondary fragments after the production target have very similar A/Q ratios compared to the primary beam, which has to be stopped in the beam dump after the D1 magnet. A first test was performed from the BigRIPS team in autumn 2014 to produce neutron-rich Polonium (Z=84) nuclei (N. Inabe et al. in the present volume of this APR).

In April 2014, we performed a one day test at the SAMURAI setup using a stable ^{238}U beam. The experimental setup was basically identical to the one used for experiment NP1306-SAMURAI-17 (M. Sasano in the present volume of this APR). To keep the beam intensity below $5 \cdot 10^4$ pps in the SAMURAI area, the ^{238}U beam was produced as a secondary beam, using a 5 mm Be production target. The best setting was found by choosing the Q=87+ charge state after the target, followed by a Q=90+ charge state after a thin aluminum degrader. In this way, 40 kHz beam rate after BigRIPS was achieved using 0.75 pnA primary beam intensity. The beam purity was better then 98 %. The beam hit a 1 cm liquid hydrogen target. A multiplicity trigger of the WINDS array (see reports of the present volume of the APR) was used to trigger on possible (p,2p) events close to the target. These data are currently analyzed by S. Reichert. Indeed, based on time-of-flight and QDC information, coincident protons follow the expected kinematics of quasi-free scattering. However, in order to achieve the desired missing mass resolution, a new high-resolution proton-detection system is currently under development in collaboration of the TU Munich and RIKEN. The status of the development of this setup can be found in the report of S. Reichert et al. in the present volume of this APR.

The test experiment also gives first results about the response and performance of various detectors of the SAMURAI setup on high-Z beams. The mass and charge resolution for the identification of fission fragments is currently analyzed by M. Sako (see report in the present volume of this APR). Furthermore the data allow us to study the tracking efficiency of coincident fission fragments. A first analysis about the identification of fission fragments using the FDC1 detector was done by S. Reichert (see report in the present volume of this APR).

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