

## Spectroscopy of $\eta'$ -mesic nuclei at FRS and Super-FRS\*

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A meson-nucleus system is a good tool to investigate the properties of mesons at finite density, which may be altered as a consequence of partial restoration of chiral symmetry. A series of pionic atom experiments at FRS has revealed partial restoration of chiral symmetry, by deducing the isovector parameter in the pion-nucleus potential. The ( $d, {}^3\text{He}$ ) reaction was used to produce deeply-bound pionic states in Sn or Pb atoms.

We will search for and investigate  $\eta'$ (958)-nucleus bound states by using the ( $p, d$ ) reaction on  ${}^{12}\text{C}$  target with the incident energy of 2.5 GeV [1]. The  $\eta'$  meson is expected to have a smaller mass at finite density, due to the suppression of the  $U_A(1)$  anomaly effect. We will make use of the FRS and later of the Super-FRS as a spectrometer for zero-degree deuterons.

### S437: First experiment at FRS

The first experiment (S437) will take place in July 2014. The detectors to be used in the experiment are almost ready. We will perform an integrity test for them by using the proton beam at the COSY synchrotron, Forschungszentrum Jülich, in January-February 2014 (Fig. 1).

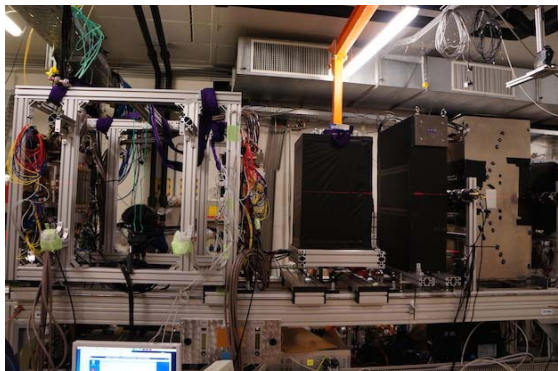


Figure 1: Experimental setup at the COSY-JESSICA site. Two sets of MWDC's, two types of high-refractive-index aerogel Čerenkov counters, and a total-internal-reflection Čerenkov counter are aligned along the beam axis.

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### Future plans at Super-FRS

The prolonged Super-FRS will enable us to carry out not only an inclusive measurement but also a semi-exclusive measurement. Each measurement has its own advantage, and we will improve the sensitivity of finding the signature of  $\eta'$ -mesic nuclei by the two different ways.

#### *inclusive measurement*

Since more intense beam from SIS-100 can be anticipated, we plan to upgrade the current VME-based DAQ system in order to cope with higher trigger rates. We will adopt an all-in-one readout board with Amplifier-Shaper-Discriminator (ASD) chips, Flash-ADC, and FPGA, based on the readout board for the Cylindrical Drift Chamber in the Belle-II experiment [2]. We will develop a new DAQ system for MWDC's with these readout boards.

#### *semi-exclusive measurement*

One promising idea for improving the signal-to-noise ratio, which is poor in an inclusive measurement, is to tag fast protons from the target.  $\eta'$  mesons in nuclei will be partly absorbed by two nucleons like  $\eta' NN \rightarrow NN$ , and the kinetic energy of the ejected nucleons will be around 500 MeV, larger than from any other process.

Monte Carlo simulations of a microscopic transport model, JAM [3], is under way to get a better understanding of background processes with proton emission as well as the signal, i.e. the production of  $\eta'$ -mesic nuclei.

### References

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