Journal of Physics: Conference Series **488** (2014) 142003 doi:10.1088/1742-6596/488/14/142003

STRONG-FIELD PHYSICS USING LASERS AND RELATIVISTIC HEAVY IONS AT THE HIGH-ENERGY STORAGE RING HESR AT FAIR

T. Kuehl*, [1,2,3] V. Bagnoud, [1, 3], T. Stoehlker, [1,3,6,7], Y. Litvinov, [1] D.F.A. Winters, [1] B. Zielbauer,[1,3] H. Backe,[2] Ch. Spielmann,[3,6] J. Seres,[3,6] A. Tünnermann,[3,6] P.Neumayer,[4,5] B. Aurand, [7] S. Namba,[8] H.Y. Zhao [9]

[1] GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany
[2] Johannes-Gutenberg-Universität, Mainz, Germany
[3] Helmholtz Institut Jena, Germany
[4] Extreme Matter Institute (EMMI), Darmstadt, Germany
[5] Goethe-Universität Frankfurt am Main, Germany
[6] Friedrich-Schiller-Universität Jena, Germany
[7] Lund University, Sweden
[8] Hiroshima University, Japan
[9] IMP-CAS Lanzhou, China

Synopsis The HESR high-energy ion storage ring at FAIR will provide unprecedented possibilities for strong-field physics using novel laser sources on relativistic heavy ions. An overview on the planning will be given.

In the current FAIR planning, the High-Energy Storage Ring (HESR) will be available for storing ionic species accelerated by the SIS [1].This opens the way for a far reaching expansion of present laser experiments using stored heavy-ion beams [2].The large SPARC community, mainly centering on Atomic Physics and bound state QED has gathered a strong physics case for experiments with these stored, cooled particles.

As a novel and unique possibility for research in ultra-high field science the HESR will provide brilliant intense stored ion pulses at relativistic velocities of (γ = 6). For the interaction with laser pulses, the interaction frame will see a Doppler shift of the laser frequency by more than one order of magnitude. In addition, the relativistic Doppler effect will shorten a counter-propagating laser pulse, in total boosting the power density by more than 2 orders of magnitude. Changes in the ionic charge can be detected on a single particle level. Interaction with lasers and x-ray laser sources will be possible in the straight sections, or just before the 180° arcs. Novel laser sources given by e.g. the PHELIX laser [3], and laser driven x-ray sources [4] can be used in this context. Additional developments for increasing the accessible parameter range are in progress.

For the application of these sources an experimental station has to be created, where laser and ion beams can be merged in counter - propagating direction. This is possible at several locations within the HESR. Exploiting the large Doppler shift and the excellent beam quality, novel spectroscopy approaches for studies not only in the ionic states, but also in nuclear excitations and pair-creation processes are accessible.
An overview on the planning will be given.

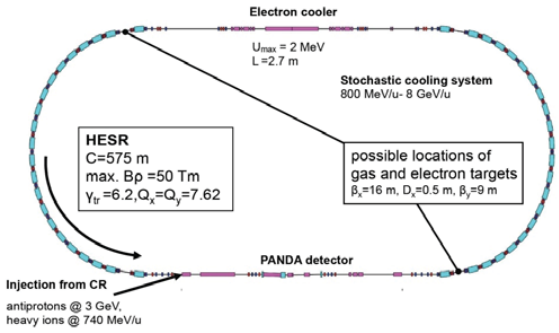

Figure 1. Layout of the HESR at FAIR The ions are injected from the bottom-left and circulate the ring in an anti-clockwise direction.

References

[1] M Steck *et al.* **2012**, *Proceedings of IPAC2012*
[2] S Reinhard *et al.* **2010**, *Proc. Laser Spectroscopy 2010*, 10.1142/9789814282345_0027, 297
[3] V Bagnoud *et al.* **2010**, *Appl. Phys.* **B100**(1), 137
[4] B Ecker *et al.* **2012**, *Opt. Express* **20**(23), 25391

E-mail: t.kuehl@gsi.de