The new EXL strategy at the GSI and FAIR storage rings



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Scattering experiments with radioactive beams at FAIR (CDR)







Experiments at storage rings (CDR)



- Reactions with
 internal targets
 - Elastic p scatt.
 - (p,p') (α , α ')
 - charge-exchange
 - transfer
- Electron scattering
 - elastic scattering
 - inelastic
- Antiproton-A collider





Light-ion scattering in the storage ring (EXL)



Scattering in inverse kinematics

Low-momentum transfer region often most important, e.g.,

- giant monopole excitation
- elastic scattering

Experimental difficulty

- low recoil energies
- thin targets (low luminosity)

EXL solution:

in-ring scattering at internal gas-jet targets

gaining back luminosity due to circulation frequency of $\sim 10^6$







We have investigated the isoscalar

M. Harakeh, Giant Resonances, Oxford Sc. P., 2001



The EXL experiment CDR)



EXotic Nuclei Studied in Light-Ion Induced Reactions at the NESR Storage Ring









New opportunities using storage rings







Short-range correlations



First pioneering experiments at Brookhaven and JLAB Dominance of n-p correlated pairs \rightarrow neutrons **Probing Cold Dense Nuclear Matter** 0.9 0.32 fm⁻³ Subedi et al. 13 JUNE 2008 VOL 320 **SCIENCE** protons 0.8 $\rho = 0.16^{-1} \text{fm}^{-3}$ 80% 0.7 T. Frick et al.. Phys. Rev. C 71 (2005) 014313 Electron-induced 0.6 <u></u>0 18% 0.2 0.4 0.6 0.8 knockout (JLab) α 1% Probing strong interaction at shorter distances Single nucleons Sensitive to higher densities n-p n-n Dependence on neutron-proton asymmetry p-p → Importance for nuclei and nuclear matter and EoS



Short-range correlations



First experiments with radioactive beams at HESR (3-5 GeV/nucleon)









EXL at FAIR MSV and moderate extensions







Dedicated Detection Systems





Eierlegende Wollmilchsau

HESR:

- Si ring (70-90 degree)
- Forward scintillator walls
- Gamma detection
- Target and heavy-ion detection in collaboration with APPA

ESR:

- Si ring (30-60 degree)
- Forward scintillator walls (shared)
- Target and heavy-ion detection in collaboration with APPA

CRYRING:

- o dE/E detection system for transfer
- Target and heavy-ion detection in collaboration with APPA



EXL phases



FAIR Phase 0 (<2025)

- R&D and experiments to be carried out at GSI / ESR / CRYRING
- Conceptual Design Report for EXL at FAIR MSV (distributed and dedicated detection systems)
- Technical Design Reports
- Stepwise upgrades and construction of detection systems

Phase 1 (>2025)

- Core detectors completed
- First measurements with FAIR/Super-FRS beams
- Elastic scattering at HESR
- Short-range correlations program at HESR
- Experiments at ESR/CRYRING with FRS

Phase 2

- Moderate upgrades (return line), optimization of ESR
- Essentially the full EXL program can be performed

