STRONG-2020

Annual Meeting 2024

TA to GSI

Yvonne Leifels

Outline

01 Beam times @ GSI and recent developments

02 Experiments in 2024 and preliminary results from 2022

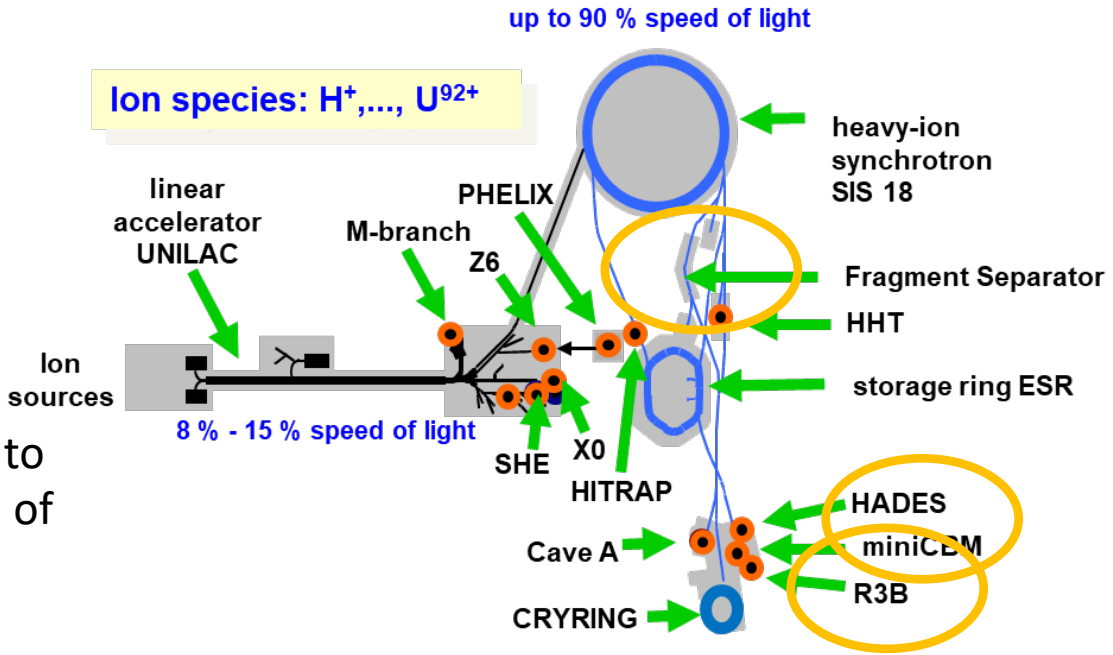
03 Overview on TA at GSI

FAIR Phase-0 at GSI

Science while realizing FAIR

Started in 2018

- Goal to provide beam time ~3 months/year during until FAIR is operational
- Using upgraded GSI facilities and exististing FAIR detector equipment to perform experiments in preparation of FAIR science
- No beam time in 2023
- Extended run planned for 2025



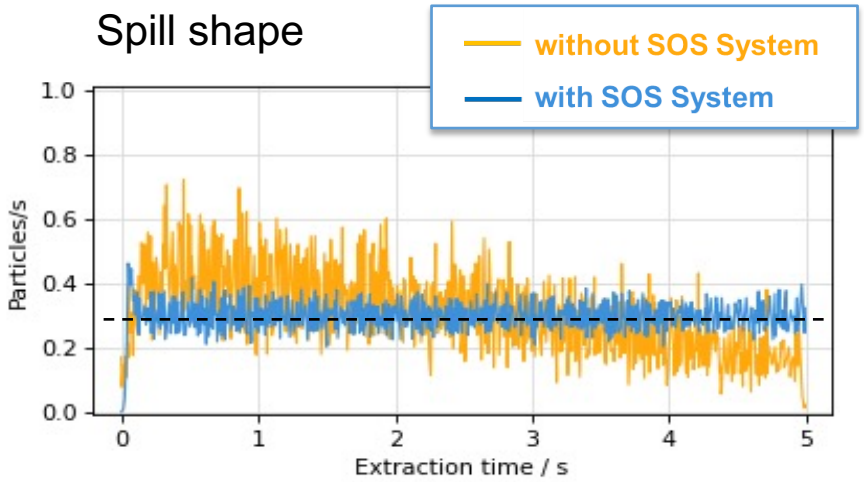
Accelerator developments

Major improvement of Ion Beam Quality

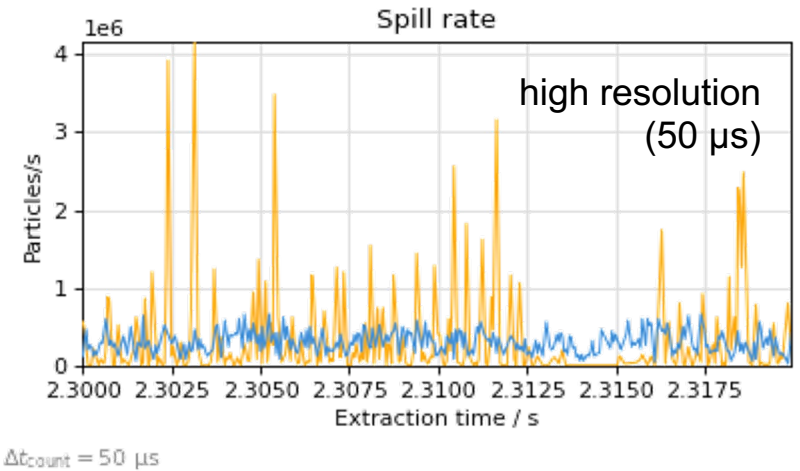
Digital Spill Optimization System (SOS)

Ph. Niedermayer et al.

Spill shape

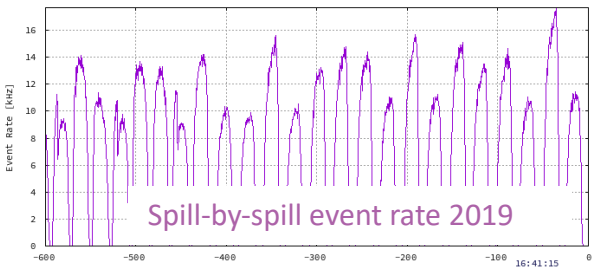


Spill quality

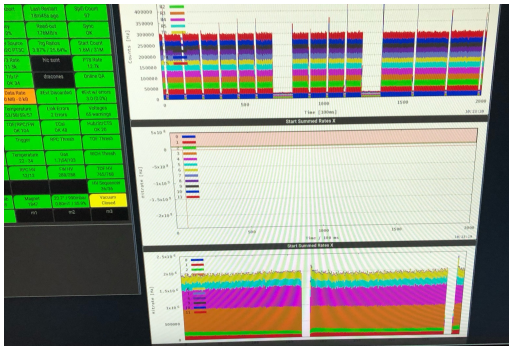


- Main focus of GSI's activities is on the construction of the FAIR facilities
- Extensive upgrade program of GSI accelerators for FAIR led to improved intensities and beam qualities

Accelerator improvements



- For the first time, HADES was running Au beam extracted with Knock-out (KO) extraction and the new feedback system
- HADES observed a duty factor with effectively ~90 % beam on target time
- KO extraction with feedback also improved substantially the micro spill time structure
- The slow extraction with KO system will enable data taking with about twice larger speed



HADES beam time

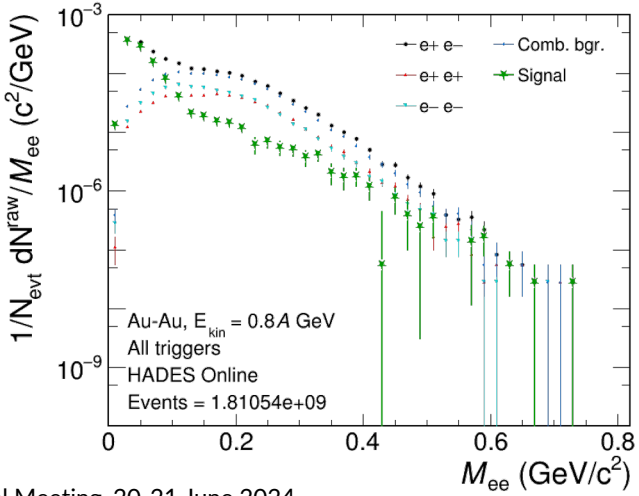
Au+Au/C+C collisions at 0,8 GeV/u (Feb./Mar. 2024

e+e- signal pairs at 0.8 AGeV

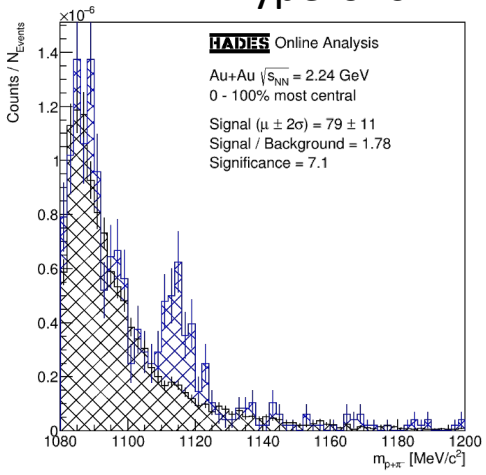
- Signal above π^0 mass - access to properties of a dense matter in the neutron star merger

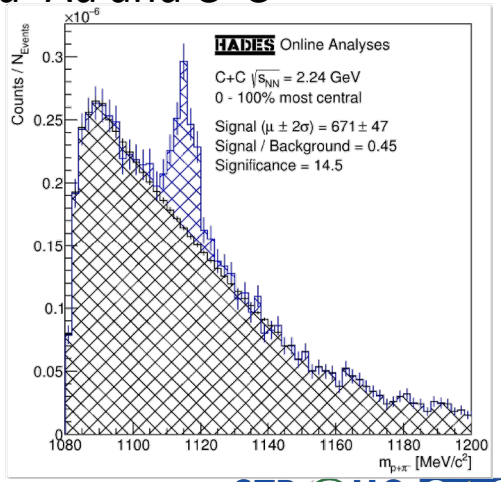
Deep sub-threshold strangeness production at 0.8 AGeV

- K^0/Λ signals from C+C and Au+Au
- First measured data at such low beam energy



Λ hyperons in Au+Au and C+C

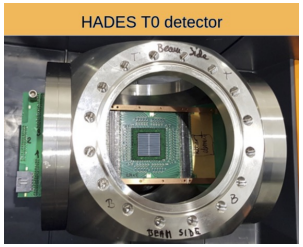


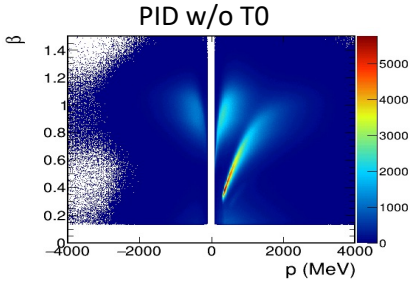


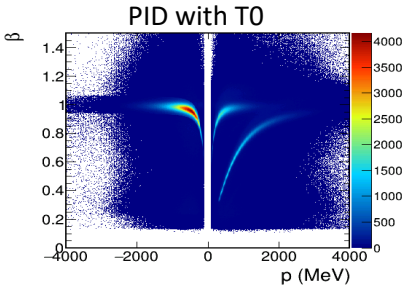
Hades developments

HADES T0 detector for p@4.5GeV beam:

- **LGAD Technology** – a dedicated sensor production at FBK
- Low power FEE, vacuum operation w/o cooling
- Low material budget, 200µm total thickness
- Particle rates about 10^8 protons/s/cm^2
- Time precision < 100ps
- Active area: 2cm x 2cm

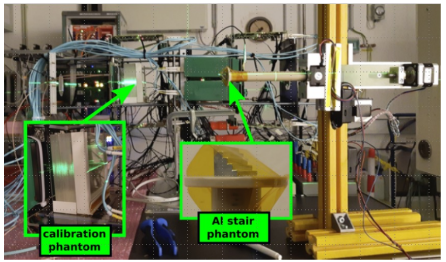


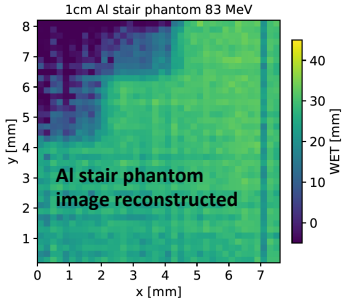




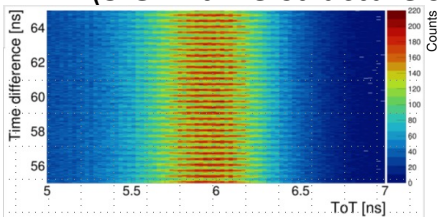
Spin-off projects:

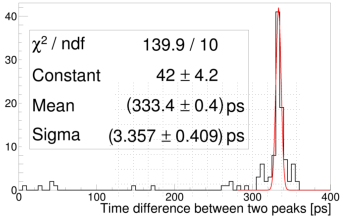
– LGAD-based ion imaging system





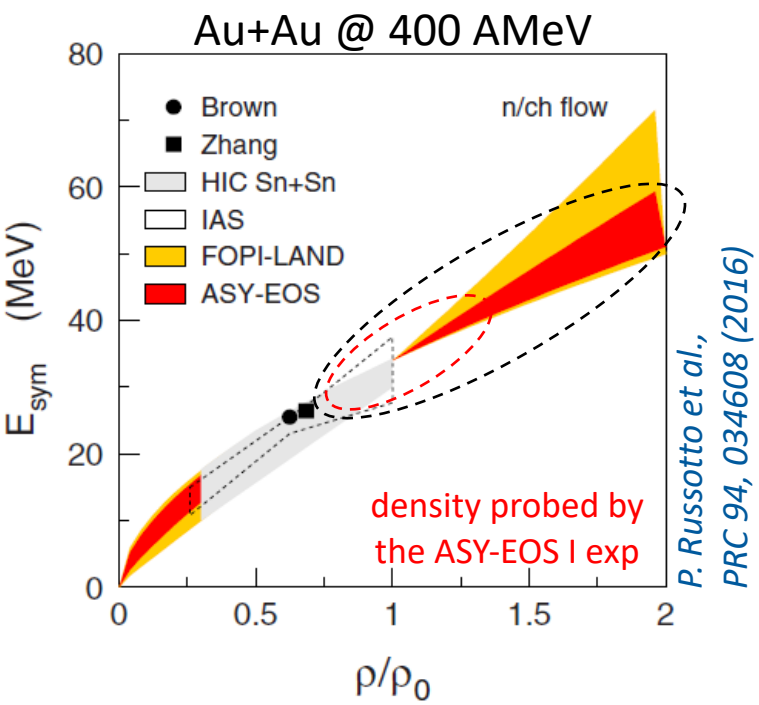
– Beam monitoring system for the S-DALINAC (3 GHz time-structure successfully resolved)





- Pietraszko, J et al. (2020), Eur. Phys. J. A 56.7.
- Kruger, W. et al. (2022), NIM A 1039, p. 167046.
- Ulrich-Pur, F. et al. (2022)., DOI: 10.1088/1361-6560/ac628b
- Kedych, V. et al. (2022), https://doi.org/10.18429/jacow-ibic2022-mop29
- Ulrich-Pur, F. et al. (2024), https://doi.org/10.1088/1361-6560/ad3326

Symmetry energy at high nuclear matter densities



P. Russotto et al., PRC 94, 034608 (2016)

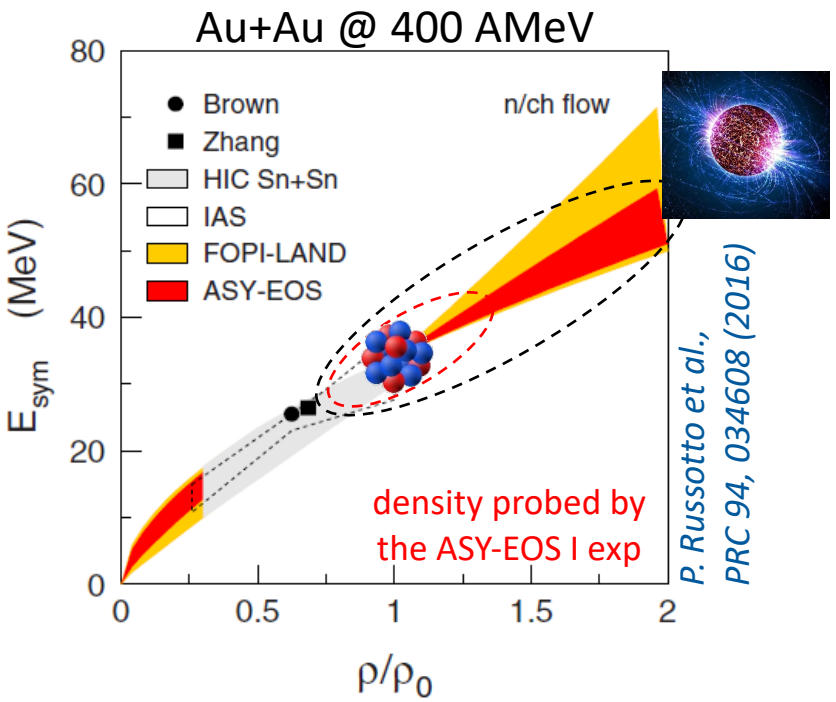
density to be probed in the ASY-EOS II exp, most relevant for neutron star physics

$$E_{sym}(\rho) = E_{sym,0} + \frac{L}{2}\left(\frac{\rho-\rho_0}{\rho_0}\right) + \frac{K_{sym}}{18}\left(\frac{\rho-\rho_0}{\rho_0}\right)^2$$

Constraints at low densities

- masses
  - Isobaric Analog States (IAS)
- neutron skins
  - scattering with electrons, anti-protons
  - excitation of nuclei: Pygmy resonances, dipole polarizability…
  - neutron removal cross section
- cluster formation at low densities
- fragmentation of nuclei
- isospin diffusion und isospin drift between nuclei of different N/Z

Symmetry energy at high nuclear matter densities



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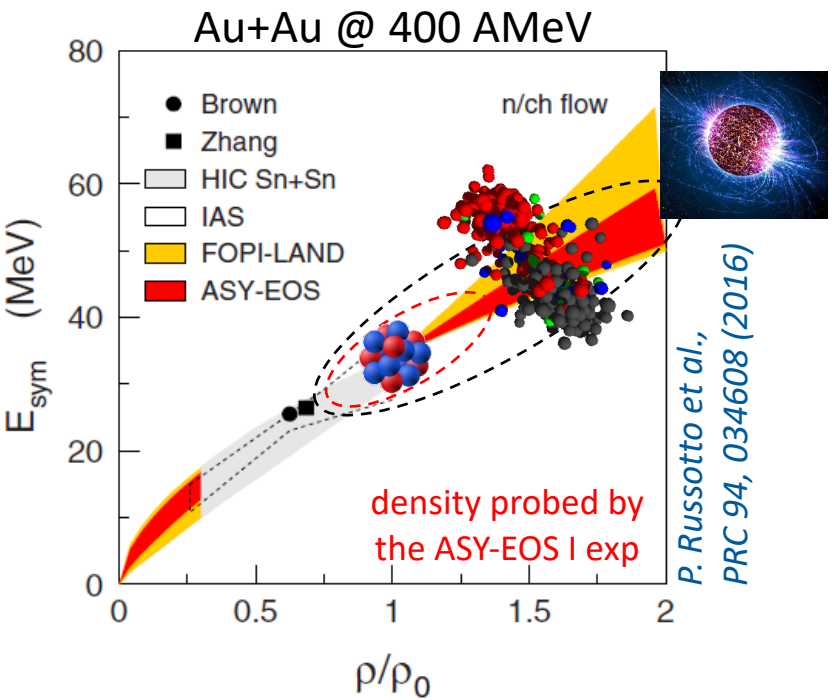
Constraints a very high densities

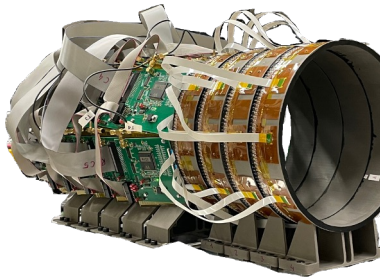
- masses and radii of neutron stars
- tidal deformability

Symmetry energy at high nuclear matter densities

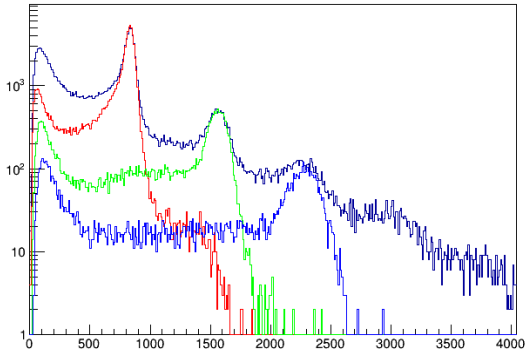


density to be probed in the ASY-EOS II exp, most relevant for neutron star physics

Measurement of neutron and p/d/t flow in Au+Au collisions



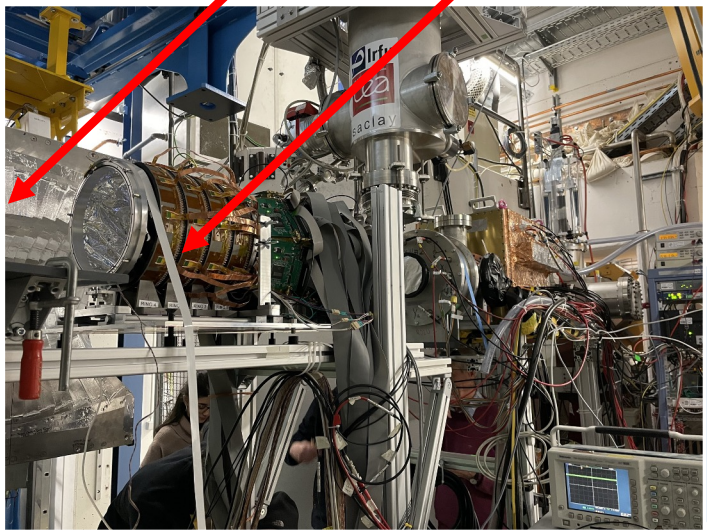
KRAB: new detector for reaction plane determination and on-beam centrality selection

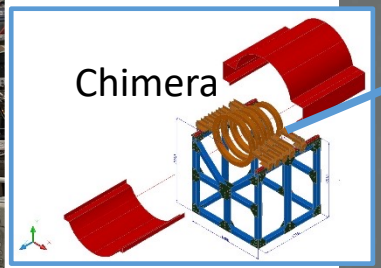


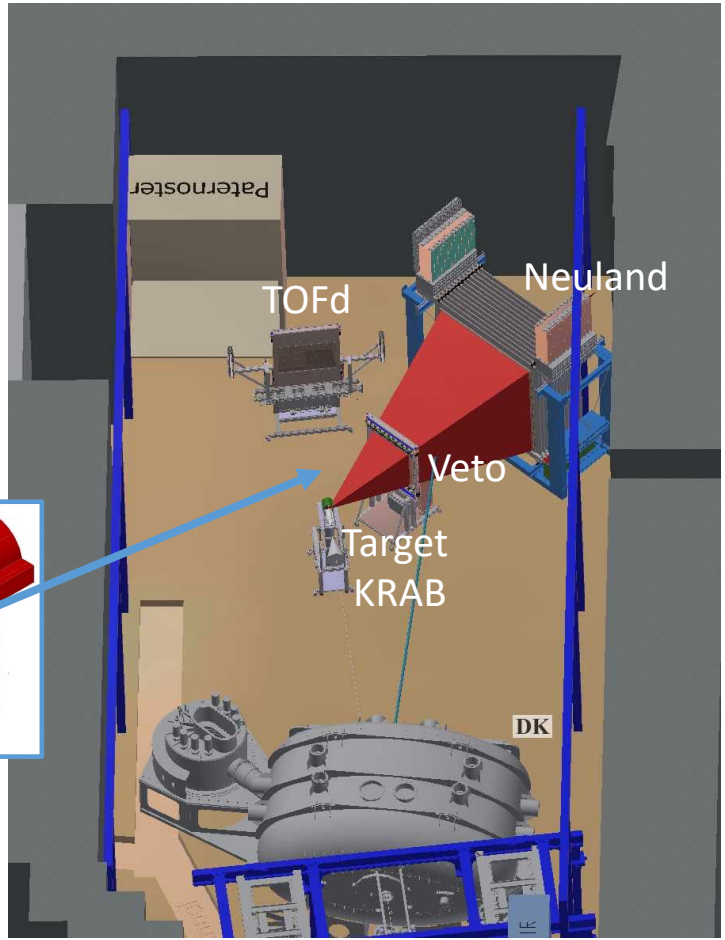
NeuLAND: capability to resolve **p**,**d**,**t**

Test in R3B cave

CHIMERA Si and KRAB in Cave C

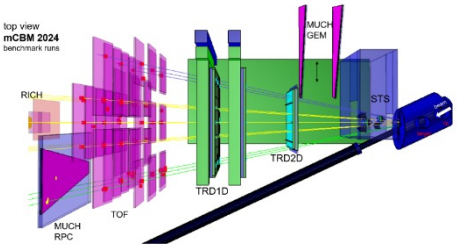


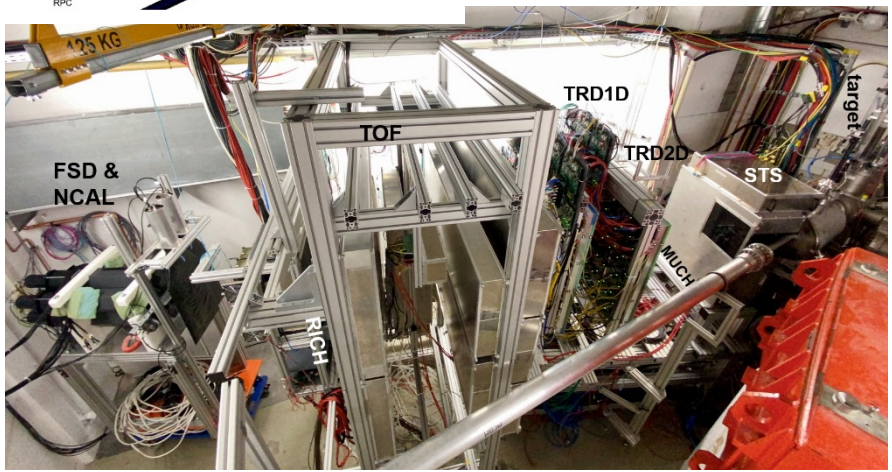




succesfully commissioned in realistic exp. conditions

mCBM





photograph of mCBM @ cave D (HTD), April 24th , 2024

2023 July - 2024 April
Synthetic runs (= real-time replay @ cluster)
for testing/optimizing the CBM online system prototype

2023, December
(High-rate) TOF tests
during machine engineering runs

2024, March
Commissioning with Au beam T = 1.2 AGeV,
1st test of online system prototype.

2024, May
Ni+Ni benchmark run, T = 1.93, 1.58, 1.23 AGeV,
Online reconstruction and selection
(events with Λ candidate)

2024, June
Rate scans with U beam, high-rate tests &
ageing studies, T = 1.06 AGeV

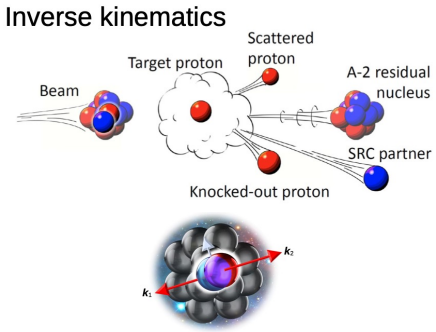
Groups on-site:
Warsaw, Bucharest, Prague, Kolkata, Münster,
Wuppertal, Bochum, Gießen, Heidelberg,
Frankfurt, Darmstadt

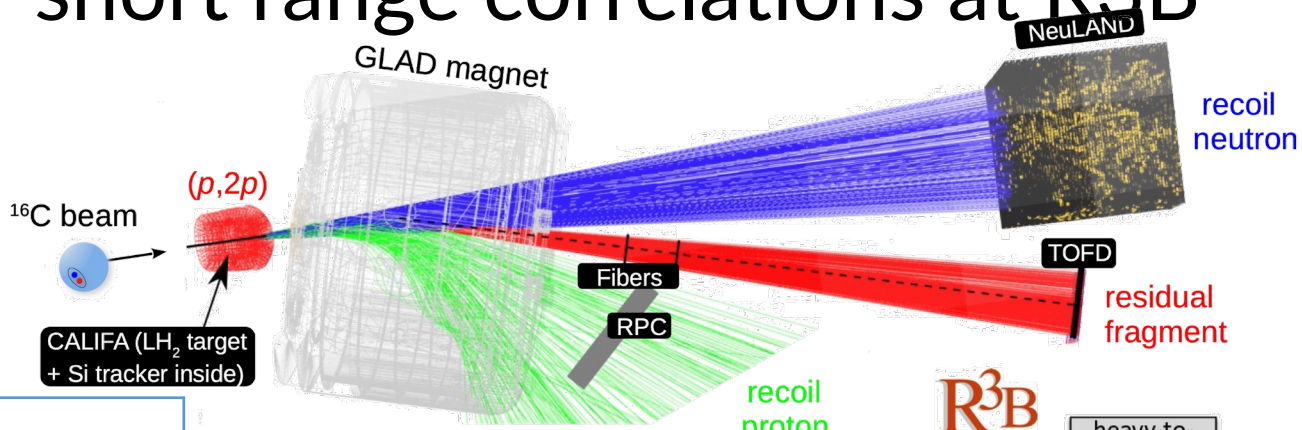
Previous experiments

Beam time 2022*

*WASA results will be reported in the talk of Josef Pochodzalla

Study of short range correlations at R3B





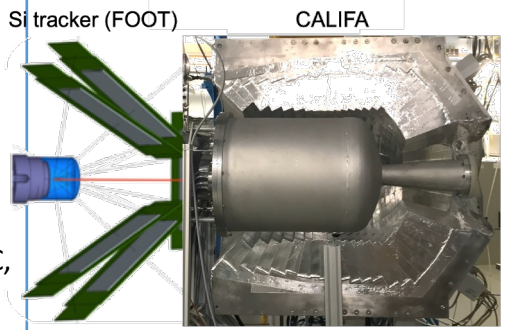
JLAB (e+A) conclusion: Protons more correlated in neutron-rich, stable nuclei

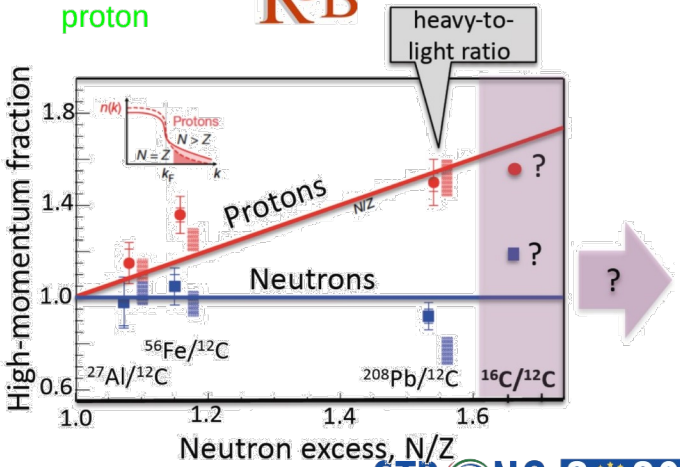
Open questions

- effect of mass ratio or asymmetry?
- development towards large N/Z

FAIR Phase-0 experiment at R3B

- changing N/Z at similar mass
- kinematically complete measurement using ^{12}C, ^{16}C beams
- A. Corsi et al.





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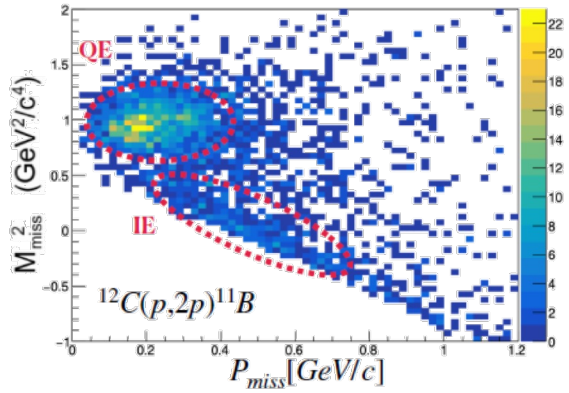
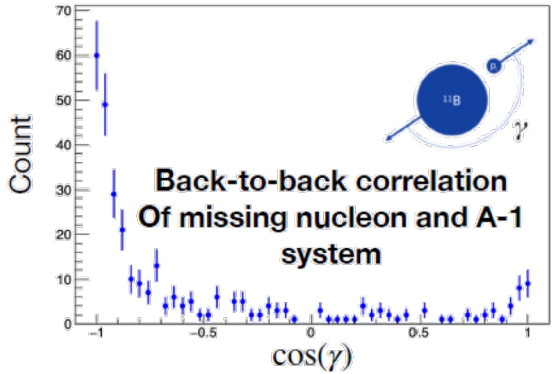
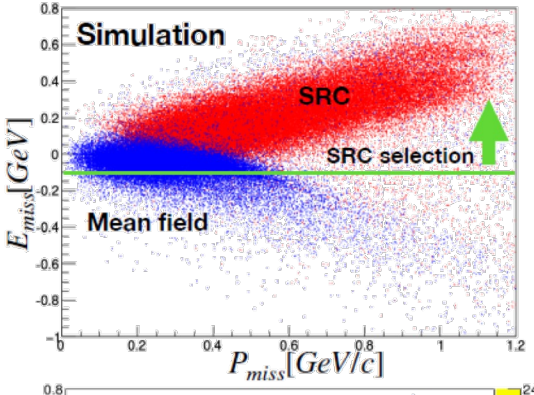
First results

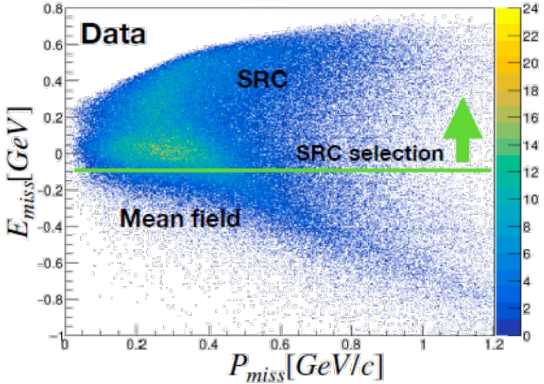
Quasi-free selection in $^{12}C(p,2p)^{11}B$ data



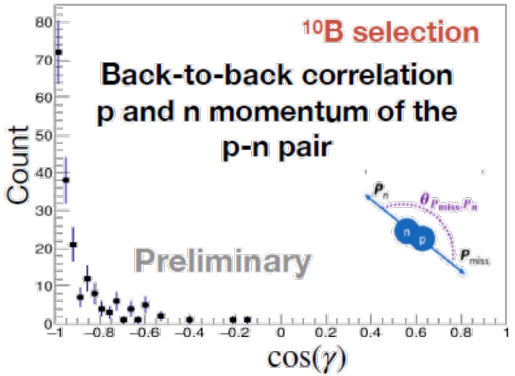


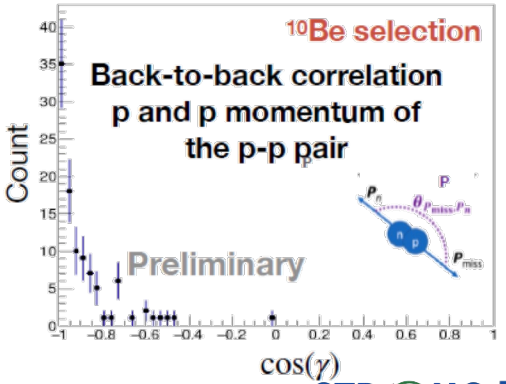
Mean-field/SRC separation



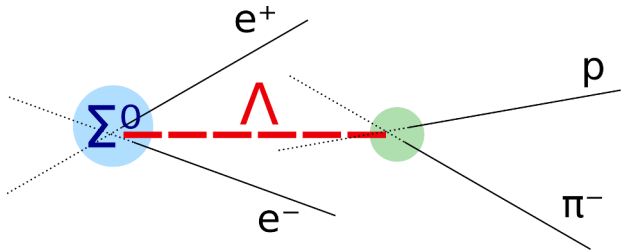


$^{12}C(p,2p)(^{10}Bn)/(^{10}Bep)$ SRC selection





Hyperon Dalitz Decays at HADES



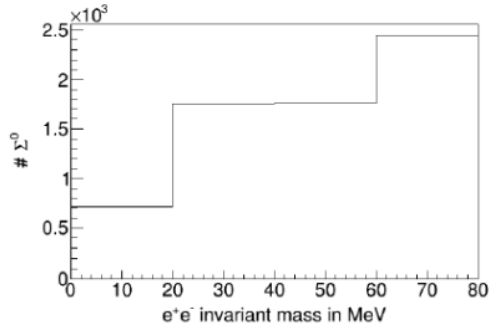
Study of $\Sigma^0 \rightarrow \Lambda e^+ e^-$ Dalitz decay in pp-> $pK^+\Sigma^0$ reaction

Reconstruction of Λ (-> p π^-) and e^+e^- pair:

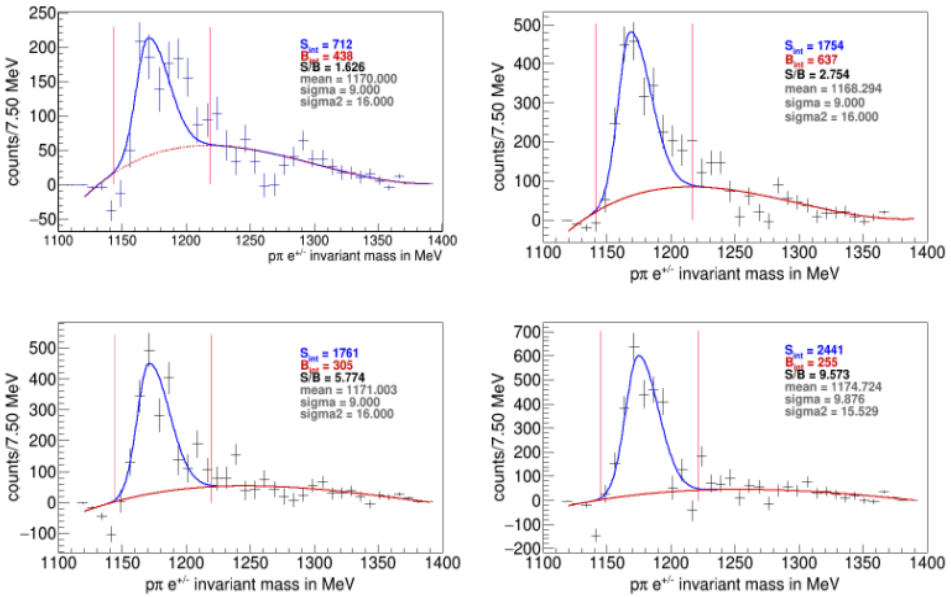
Missing mass of (p π^- e^+e^-) > m(K p)-20MeV

Side band subtraction

Towards $\Sigma^0 \rightarrow \Lambda$ electromagnetic transition form factor…



Invariant mass of e^+e^- in Σ peak (not efficiency corrected)



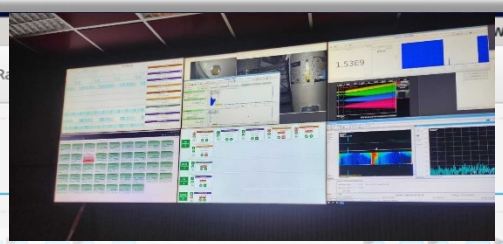
Invariant mass of Λ e+e-

Overview on TA to GSI

	Promised	Report 1	Report 2	Report 3 1.6.2022 – preliminary	Total
T&S	204.800 €	0	55.562 €	95.000 €	150.000 * €
Days	1760	0	502	1358	1860
Travels	160	0	41	136	177
Users	80	0	28	72	83
Hours delivered	1450	0	860	969	1829

*large backlog from beam time ~ 39 travels not yet recorded

Summary



- Analyses of beam time data in 2022 ongoing
- Beam time 2024 started in February
  - major failure during last weekend, repairs ongoing
- Using spill smoothing feedback system the first time: HADES reported 90 % duty factor
  - unfortunately cooling system of HADES magnet failed and beam time was interrupted
- Successfull runs of mCBM and ASY-EOS
- TA support was very well received

Machine status display during beam time 2024

Outlook

Outlook