INFN-FRIB collaboration for EoS/E_{sym}

G. Verde, S. Valdrè – INFN
K. Brown, Z. Chajecki – FRIB (MSU, WMU)

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Letter of Intent

INFN-NUSDAF (INFN - Nuclear Structure, Dynamics and Astrophysics at FRIB)

Giuseppe Verde[1], C. Agodi[2], M. Battaglieri[9], M. Bondì[1], M. Cavallaro[2], M. Colonna[2], D. Gambacurta[2], A. Gottardo[3], L. Lamia[4,2], S. Leoni[5,6], S. Pirrone[1], G. Pizzone[2,4], P. Russotto[2], S. Valdrè[7], J.J. Valiente[3], M. Viviani[8]

on behalf of the ASFIN, CHIRONE, EPIC, GAMMA, JLAB12, NUCL-EX, NUMEN, MONSTRE and NUCSYS groups of INFN (see Appendix 3 for detailed list of institutes)

Kyle Brown[10], Giordano Cerizza[10], Zbigniew Chajecki[11], Alexandra Gade[10], Dean Lee[10], Artemis Spyrou[10], Remco Zeger[10]

Local points of contact who agreed to collaborate and support these programs

[1]INFN Catania, [2]INFN Laboratorio Nazionali del Sud, [3]INFN Laboratori Nazionali di Legnaro, [4]University of Catania, [5]University of Milan, [6]INFN Milan, [7]INFN Florence, [8]INFN Pisa, [9]INFN Genova
[10]FRIB, Michigan State University, [11]Western Michigan University

Six Scientific Initiatives

1. **SYMEOS** – EoS and Esym with HIC
2. **GASPEC** - γ spectroscopy and Collective excitations
3. **RIBDCE** – RIB-induced Double Charge Exchange
4. **NUSYC** – NUcleoSYnthesis and Clustering
5. **THEOF** – THEOretical physics @ FRIB
6. **SYSTERSE** - SYnergic Stategy for future ElectRonics and Streaming rEadout solutions

Phase I @ FRIB

Coupling existing FRIB detectors to incoming equipment to extend the physics reach → EoS, Esym, clustering, in-medium structure, invariant mass spectroscopy, …

Phase II @ FRIB400

"The age of FRIB-TPCs" + ancillary detectors → extend the number of observables (pion emissions, n-p femtoscopy, etc.)

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Observables and transport model ingredients

Observables	Spectra	(Double-) ratios	Femtoscopy	Flow	Isospin diffusion
Transport model ingredients					
Symmetry energy		✔	✔	✔	✔
Effective mass		✔		?	?
Cross section	✔	✔	✔	✔	✔
Cluster production	✔	✔	✔	✔	✔

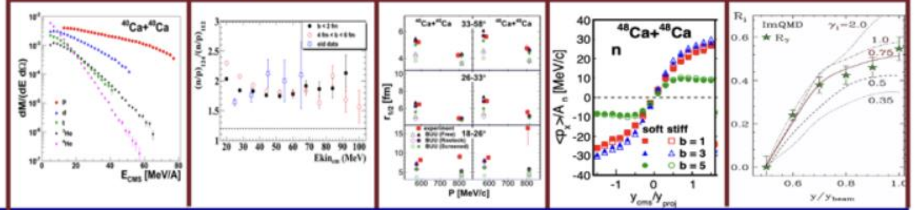
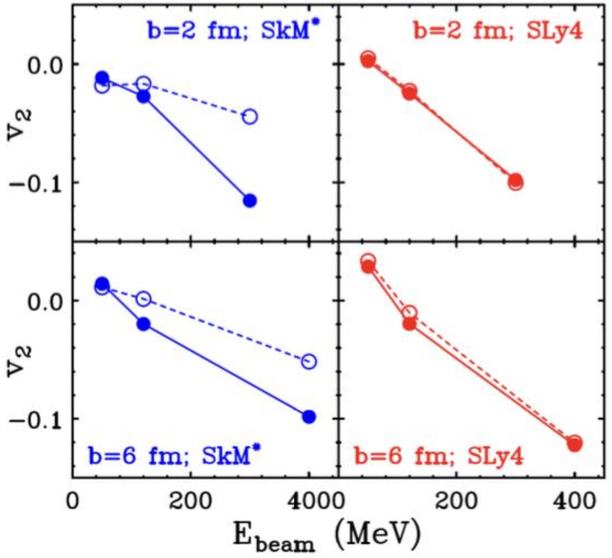
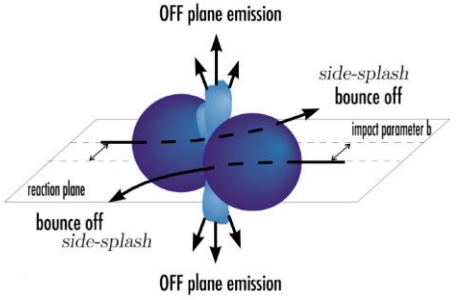


Figure 2.2. Links of transport properties to heavy-ion collision observables.

Neutron-Proton Elliptic flow



FRIB → FRIB400

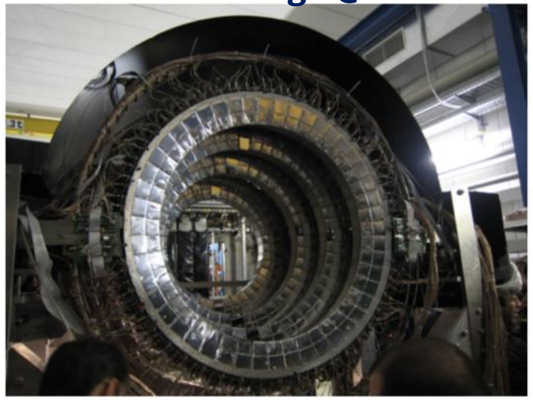


Investment on multi-purpose experimental equipment

Measure several EoS and Esym sensitive observables under the same experimental conditions and on an event-by-event basis → improve constraints on transport models and Bayesian statistical analyses

Short-term plans (coupling of existing detectors: FRIB + INFN)

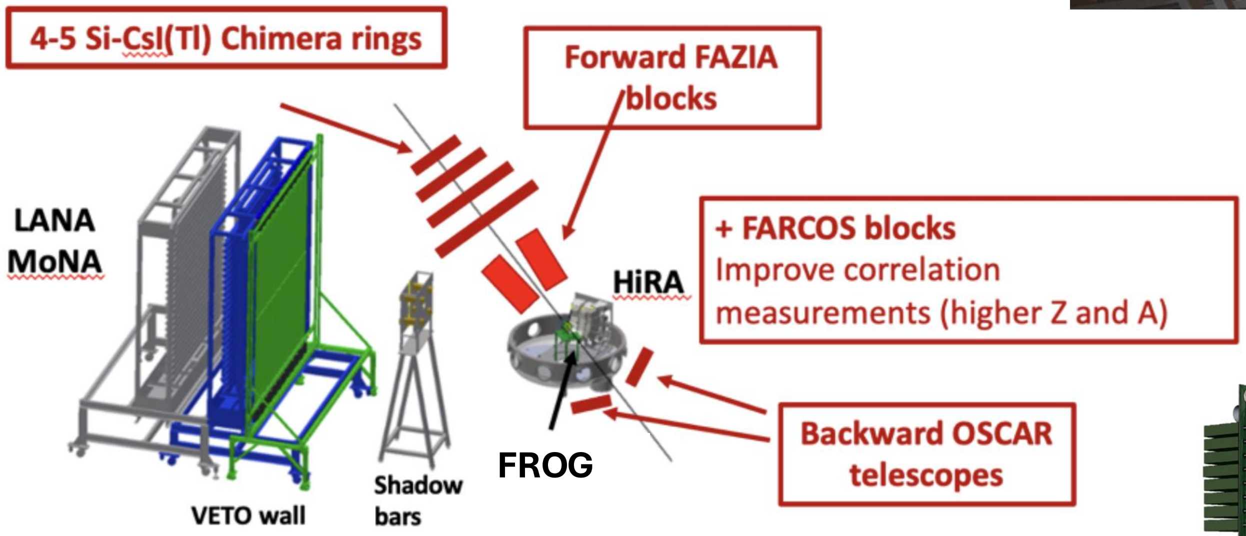
CHIMERA rings @ GSI



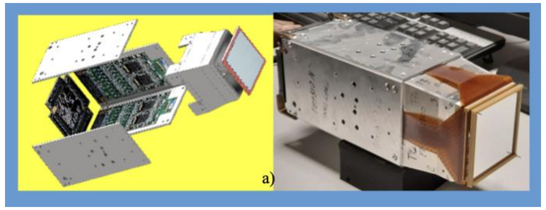
≈350 Si-CsI(Tl) telescopes
+ FROG
→ reaction plane, b, …

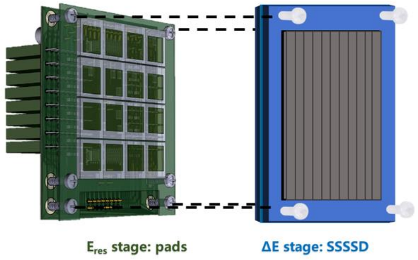
FAZIA @ GANIL

12 blocks * 16 units each
→ 192 Si-Si-CsI(Tl) telescopes
→ Isotopic identification and low thresholds up to Z=25
→ Isospin diffusion/transparency, isotopic distributions from participants and spectators



LANA and MoNA
Neutron detectors (flows, femtoscopy, invariant mass spectroscopy)

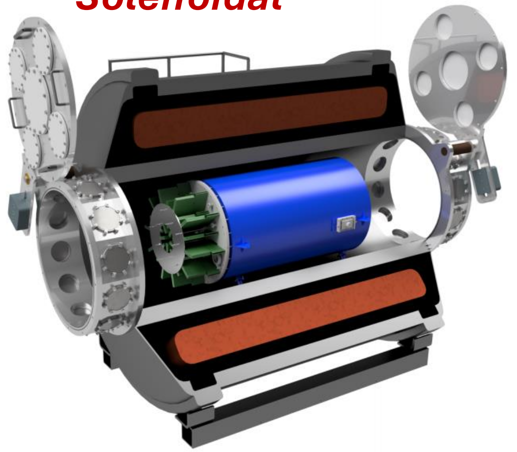




HiRA + FARCOS + OSCAR DSSSD: Femtoscopy and Invariant Mass Spectroscopy

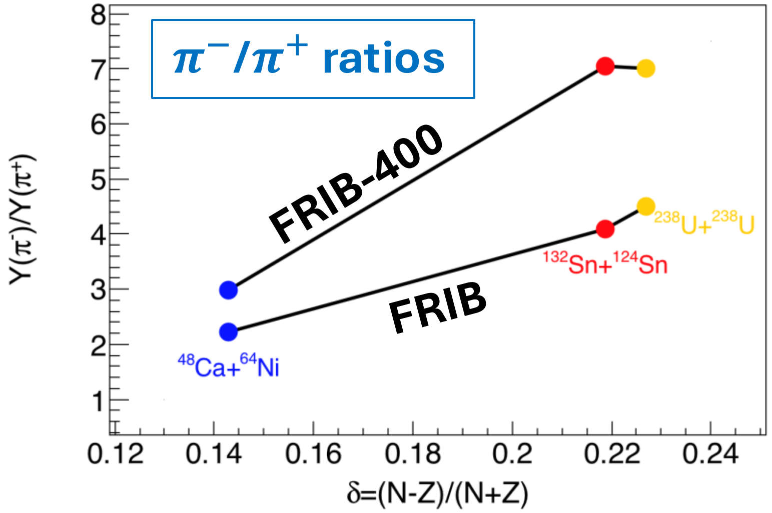
Long-term solution: TPC + Ancillary detectors

Phase 1 – AT-TPC like
Solenoidal

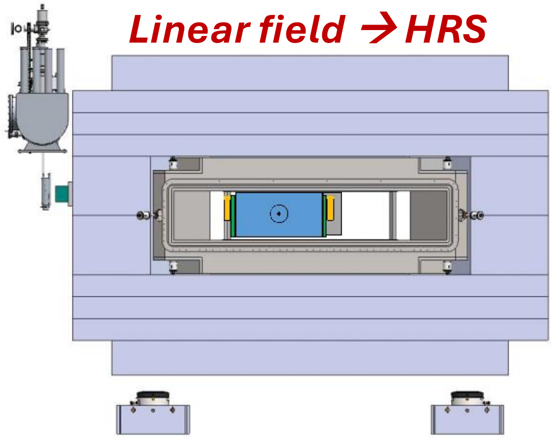


Extend E_{sym}-sensitive observables

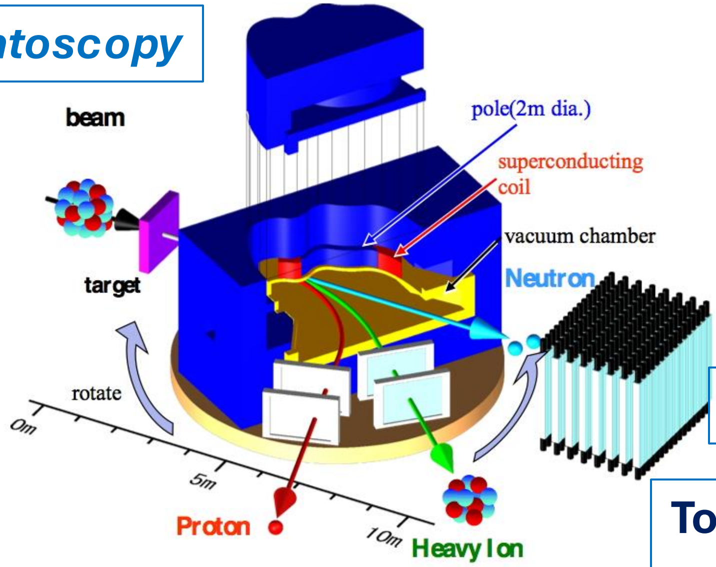
- π^-/π^+ ratios and flow
- neutron-proton femtoscopy
- ...others



Phase 2 – Sπrit-like
Linear field → HRS



n-p Femtoscopy



MoNA

FAZIA/FARCOS-like hodoscopes

K. Brown and S. Hudan, P.I.s

Towards a common DAQ protocol:

- Streaming readout
- Sinergy between FRIB and EIC experiments (i.e. EPIC)