Femtoscope Array for Correlations and Spectroscopy

Exochim @ CT and LNS + INFN and Pol. Univ. @Milan
+ collaboration with GANIL and CEA-IRFU (France), Un. Of Huelva (Spain)

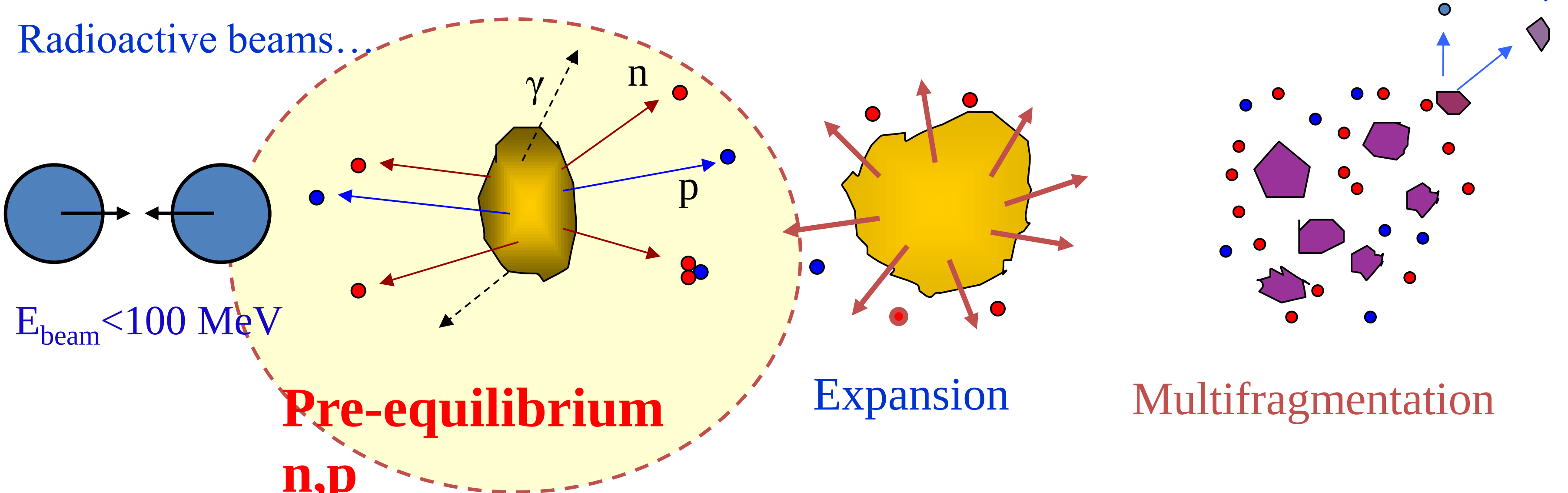
1. Heavy-ion collisions (stable and RI beams)
   - Dynamics (HBT, Femtoscopy)
     - Low & Intermediate energies
   - Multi-particle correlation spectroscopy (MPCS) → cluster states
2. Direct reactions with RIBs
   - Inverse and direct kinematics
     - Nuclei close to drip lines

Heavy-ion collisions – n/p observables

Study of N/Z effects in HIC → links to symmetry energy

^{124}Sn+^{124}Sn (N/Z=1.48), ^{48}Ca+^{48}Ca (N/Z=1.4), ^{197}Au+^{197}Au (N/Z=1.49)

Radioactive beams…

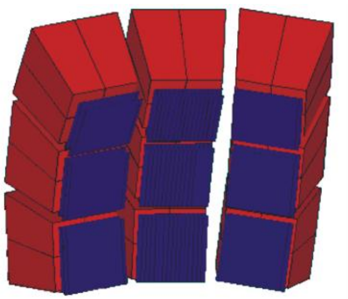


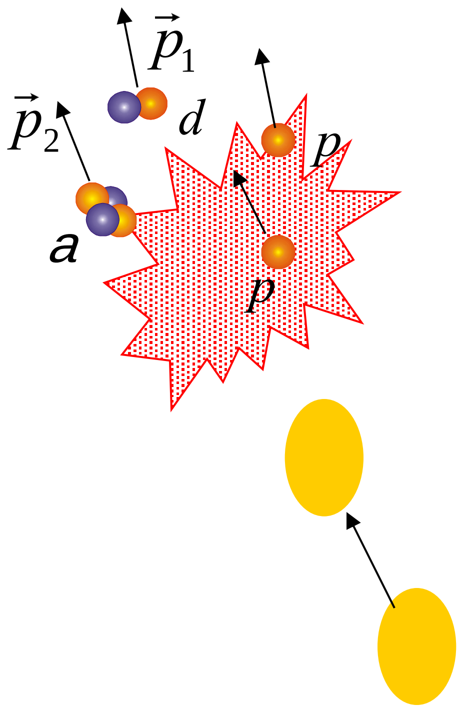
- **n/p energy spectra and angular distributions**
- **p-p, n-n and n-p correlation functions**

- Isospin diffusion, fractionation, isoscaling phenomena…

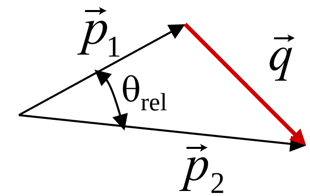
Correlation femtoscopy in HIC

Femtoscope

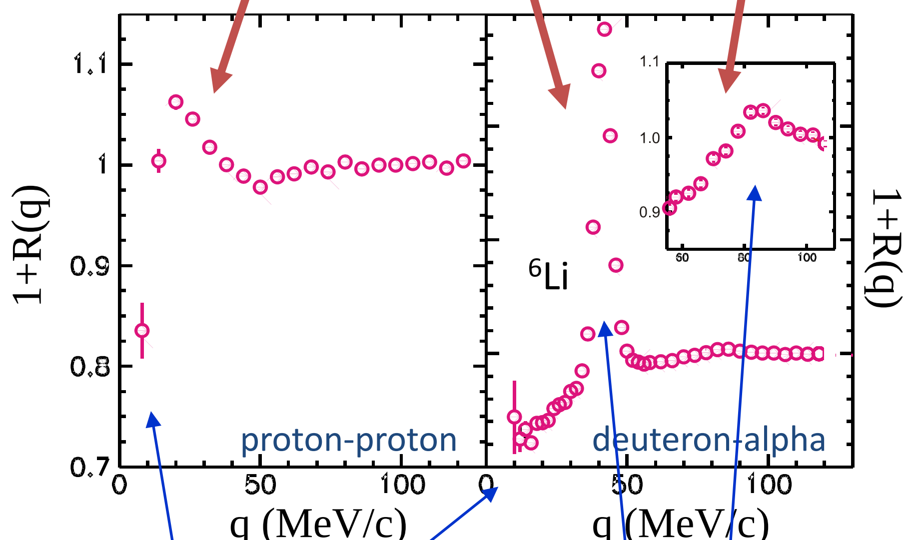




$$1+R(q)=k\times\frac{Y_{coin}\left(\vec{p}_1,\vec{p}_2\right)}{Y_{evt.mixing}\left(\vec{p}_1,\vec{p}_2\right)}$$



Sensitive to space-time properties

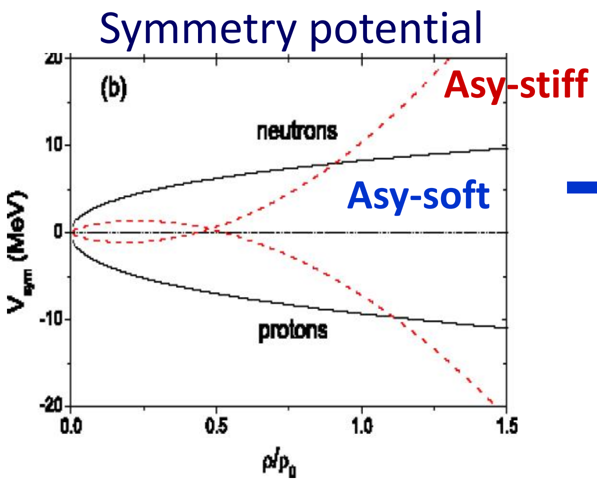


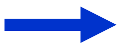
Low q (θ_{rel}) measurements

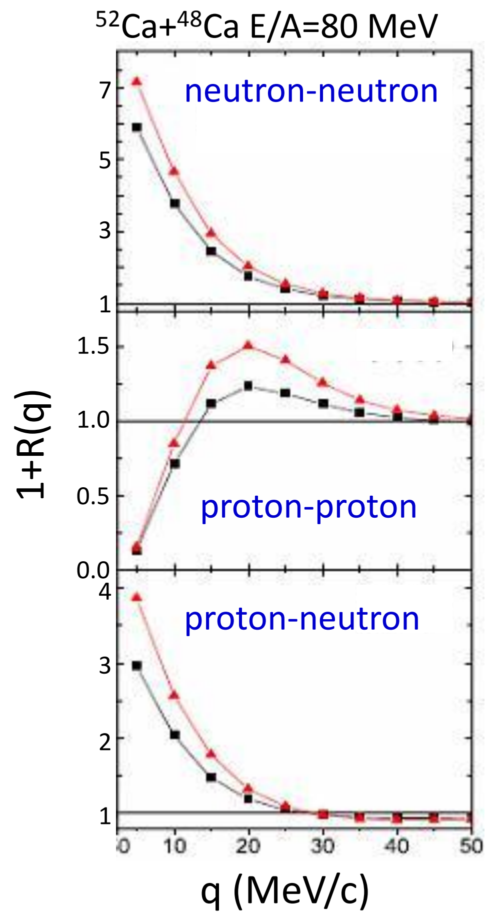
Resonances

High angular resolution required!

Symmetry energy and pp, nn and np correlations







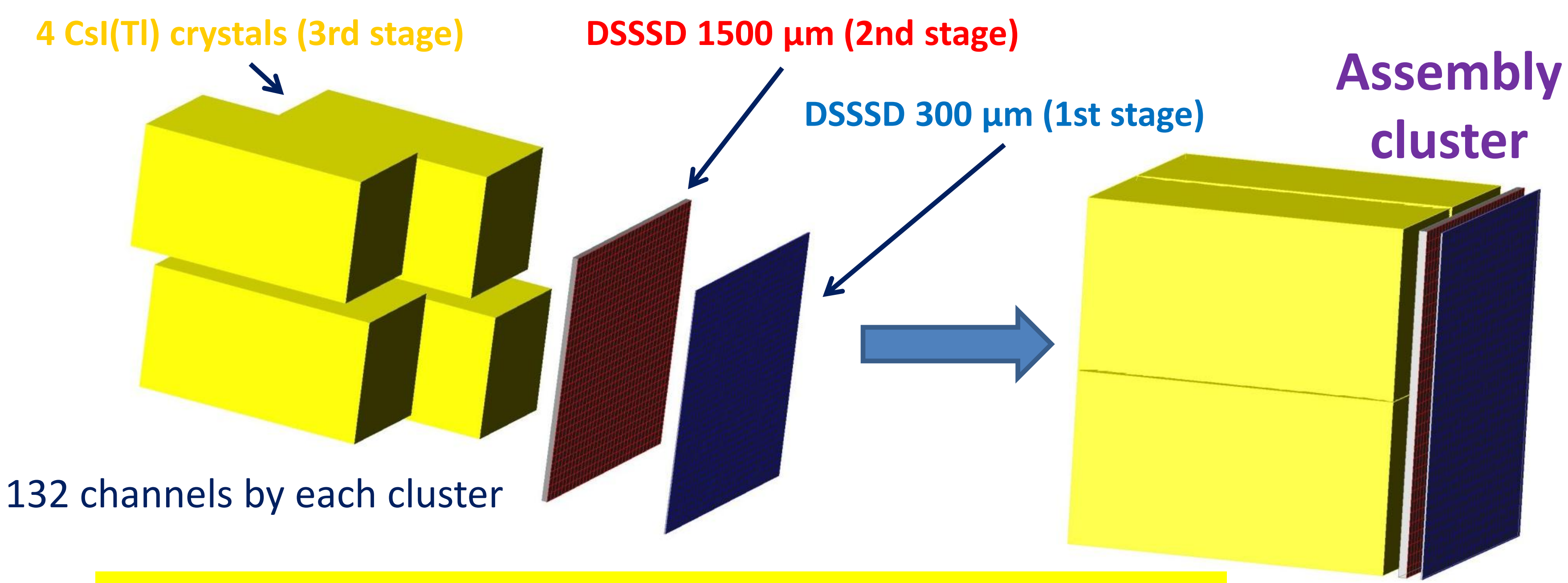
Important perspectives: pp, nn, np correlations

Within a 4pi detection system!

… Farcos + Chimera @ LNS

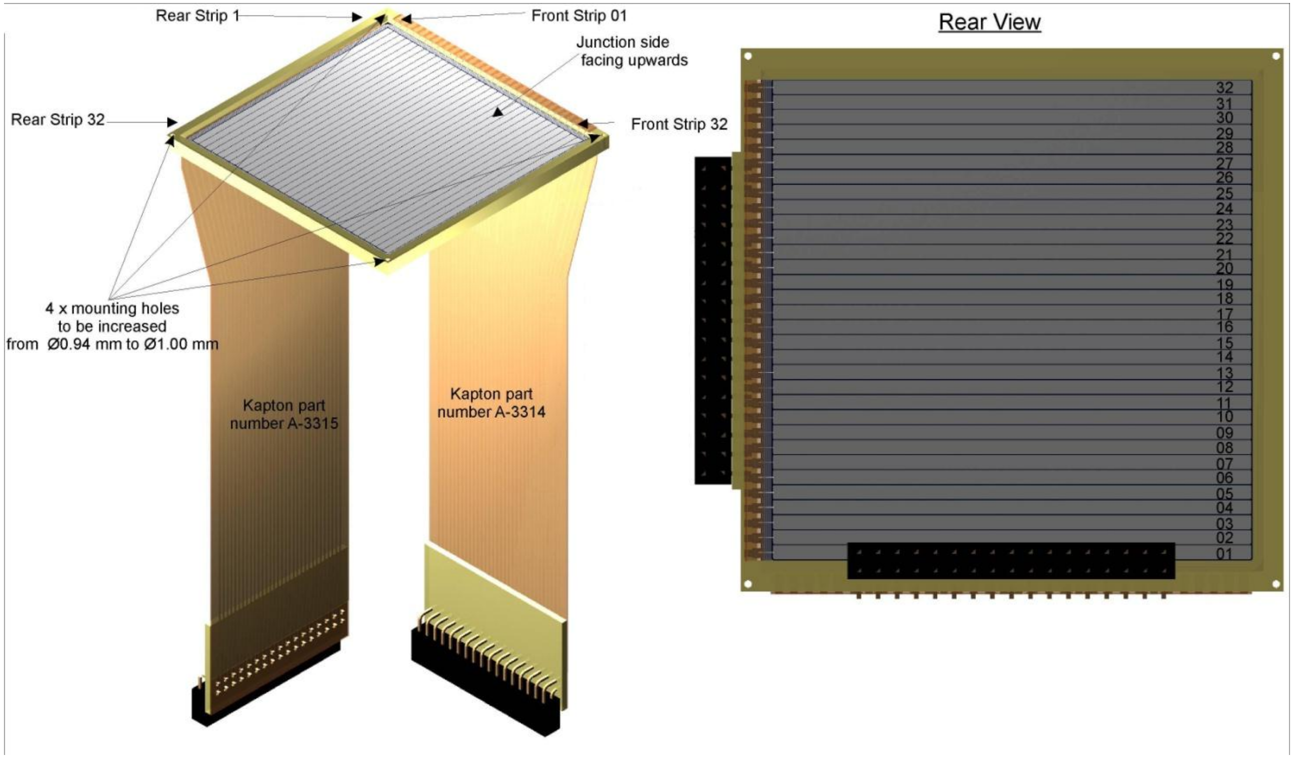
FARCOS TELESCOPE – phase 1

- Based on (62x64x64 mm^3) clusters
- 1 square (0.3x62x62 mm^3) DSSSD 32+32 strips
- 1 square (1.5x62x62 mm^3) DSSSD 32+32 strips
- 4 60x32x32 mm^3 CsI(Tl) crystals



Fully reconfigurable (more Si layers, neutron detection, …)

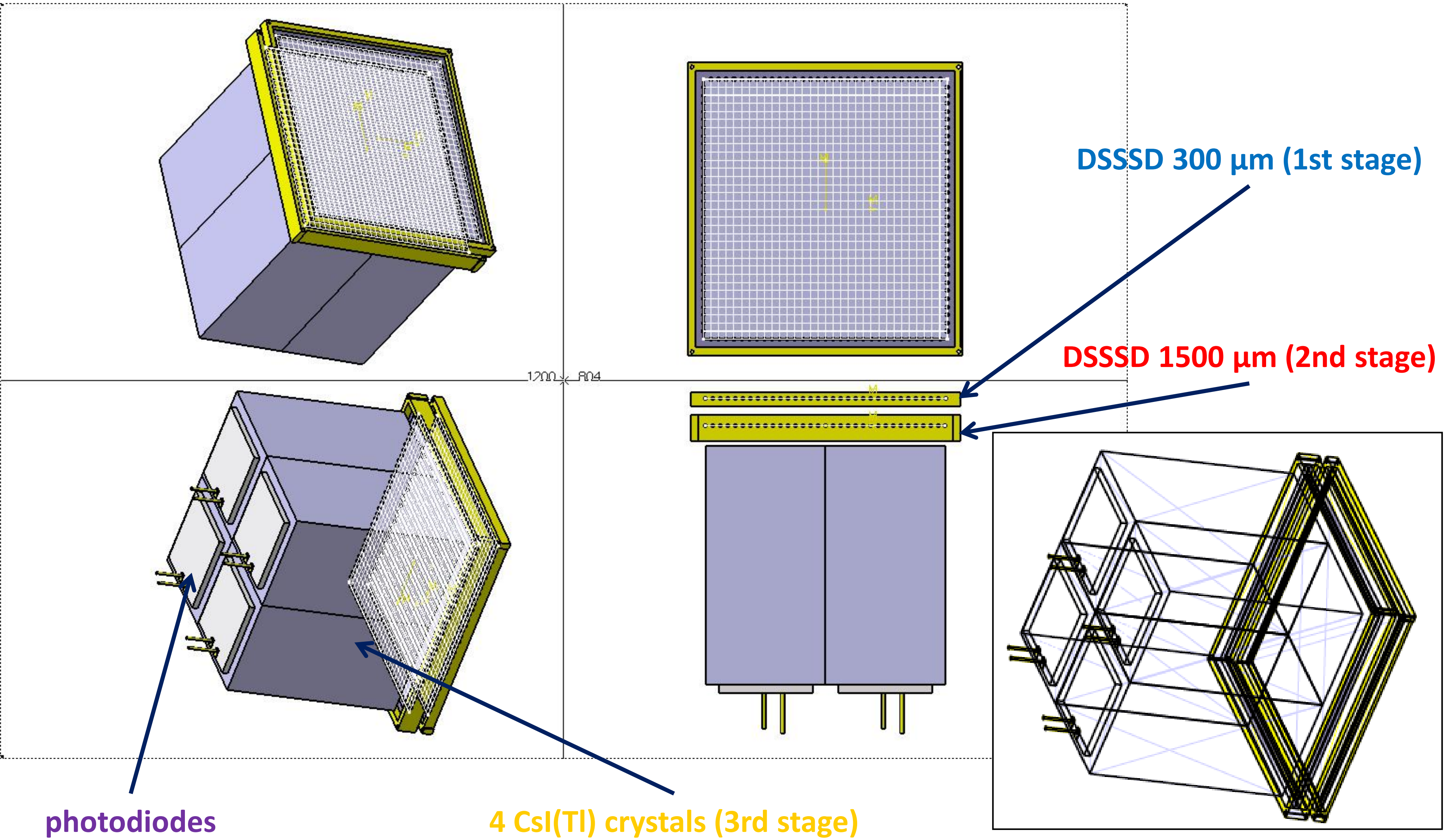
FARCOS detectors



- Double-Sided Silicon Strip Detectors
- 300 µm and 1500 µm
- Capton cable and 2x32pin connectors

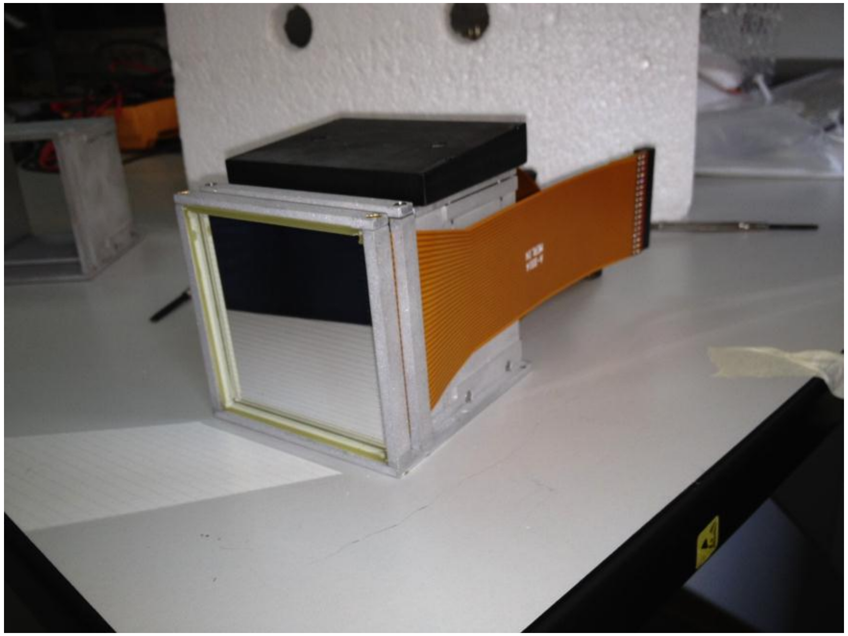
- Highly homogenous CsI(Tl) crystals
- Wrapping: 0.12mm thick white reflector +50µm aluminized Mylar.
- 2µm thick aluminized Mylar window at the entrance (0.29 g/cm^2)
- Read-out by photo-diodes (300µm)

Single cluster

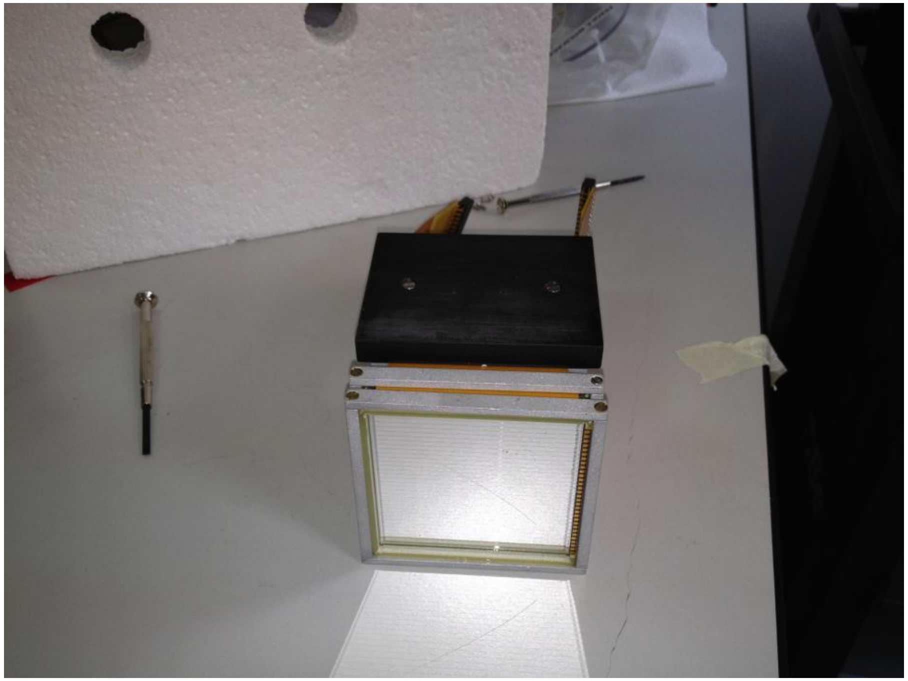


Mounting allows for addition of other detectors and neutron “transparency”

First prototype modules built



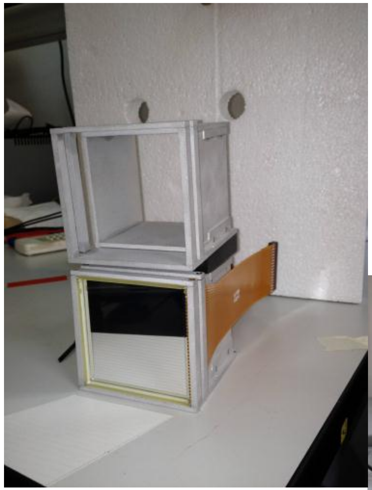
4 clusters expected to be ready
by the end of 2012



March-April 2012

Preamplifier box – Phase 1

32 channels Hybrid charge preamplifiers in a volume of about 8cm x 10cm x 2mmm



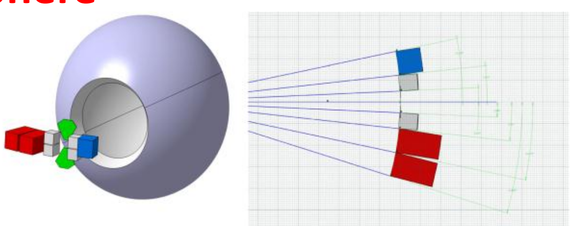
- **Low power consumption:** ~750 mW pwe 32 channels (simplify cooling operations)
- **Rise-Time (pulser):** ~ 3-7 nsec for C_{input}=0-100pF
- **Energy resolution (pulser)**~ 4.3 KeV for C_{input}=0-100pF
- Available with several sensitivities (5, 10, 45, 100 mV/MeV…)

INFN, Milano – C. Boiano, R. Bassini

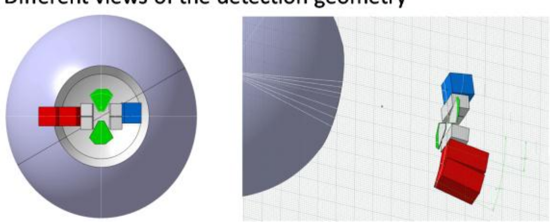
First test with beams – July 2012

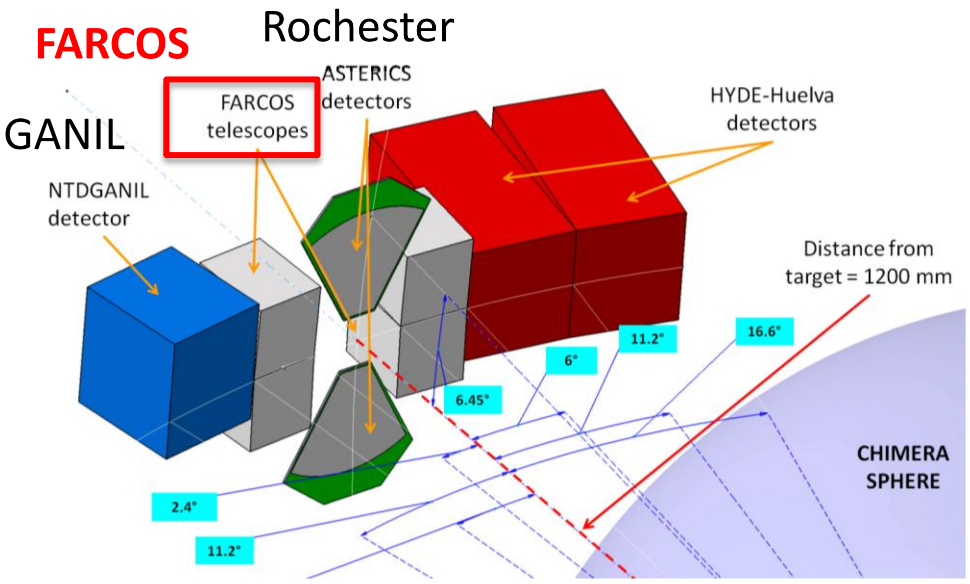
Tests of CsI(Tl) uniformity with scattered beams and particles

Chimera sphere



Different views of the detection geometry



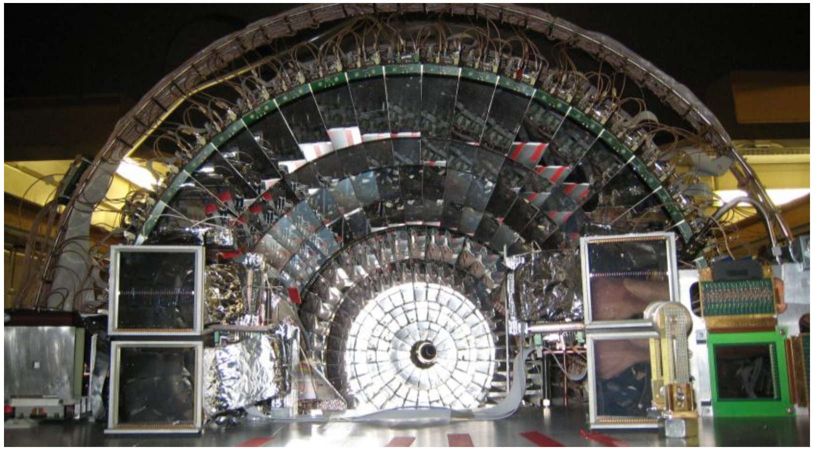


p,α + p, d, C E/A=40, 80 MeV Transfer reactions

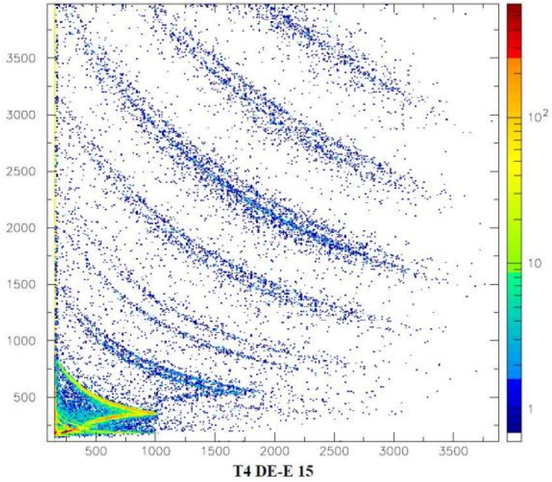
Silicon resolution
Integrating DAQ into Chimera system

proto-Farcos preliminary results

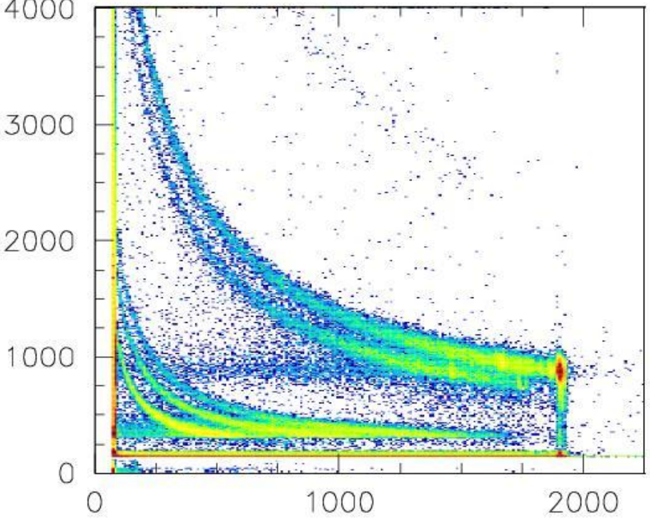
Calibration beams at 60 MeV/u
Farcos @ Chimera (July 2012)



Silicon 300µm vs Silicon 1500µm

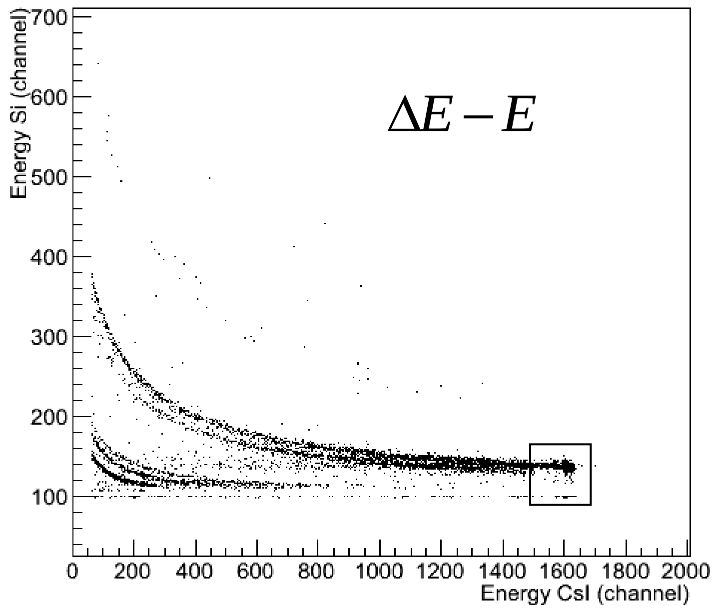


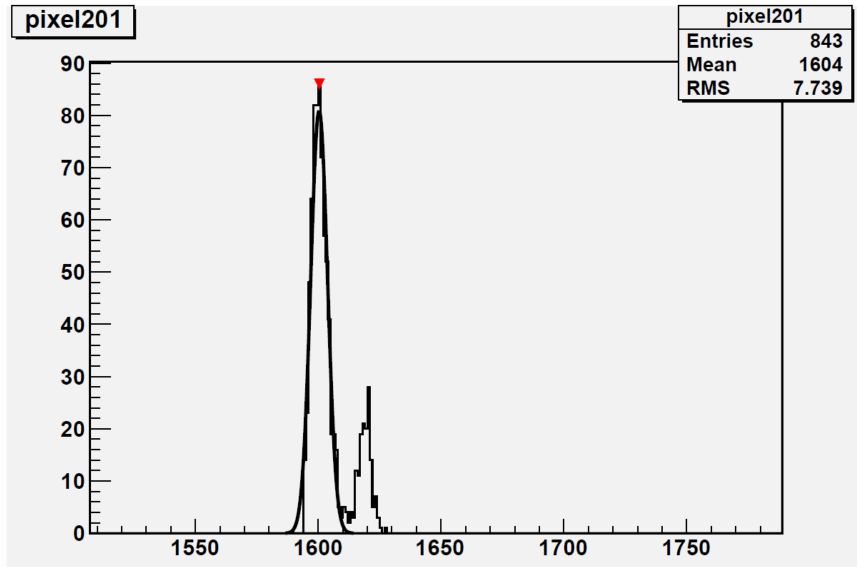
Silicon 1500µm vs CsI(Tl) 6cm



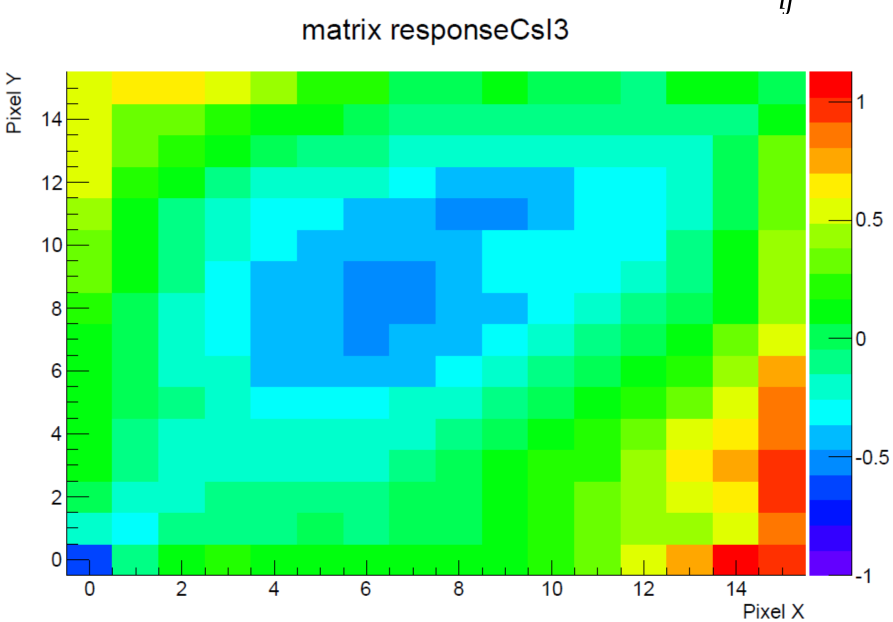
CsI 3

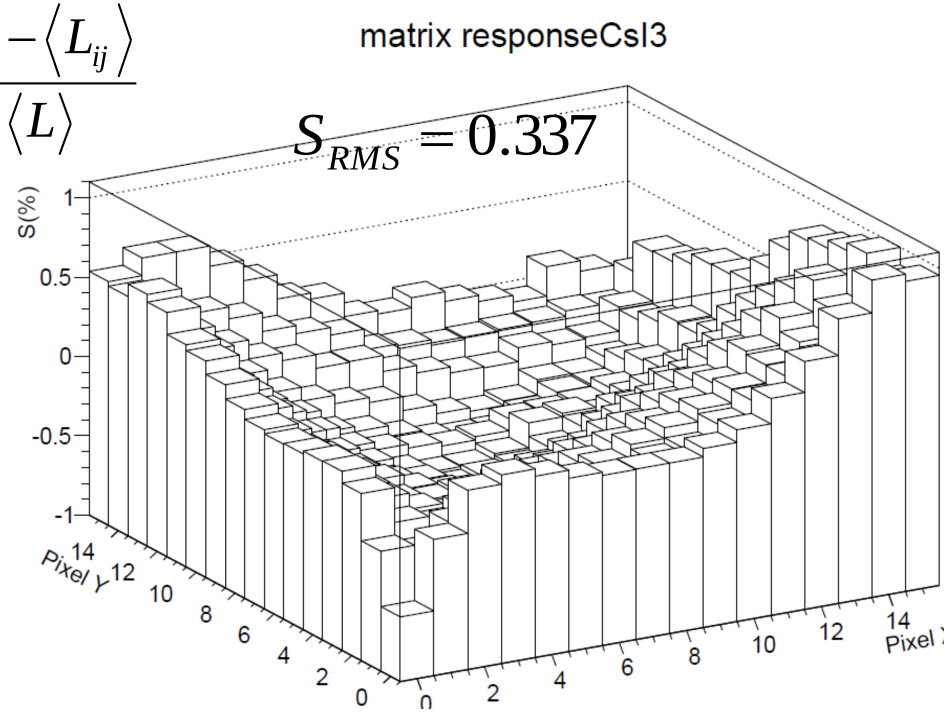
L. Quattrocchi, L. Acosta





$$S_{ij} = \frac{L_{ij} - \langle L_{ij} \rangle}{\langle L \rangle}$$





Plans for phase 2

- From compact to integrated electronics:
  - Reduce form factor of preamplifiers (maintain performances!... cross-talk to be studied…) → Towards ASIC solution
  - Tests of GET system with silicon strip detectors
- Pulse-shape capabilities: profit from Chimera experience and performances
- Digitalization of detector signals
- Update possibilities
  - Increase solid angle
  - **Neutron detection… stay tuned on Angelo's presentation**