*Enrico De Filippo (INFN Catania) for the **NEWCHIM** collaboration*

Integration of the GET electronics for the CHIMERA + FARCOS devices

Physics cases: Working with Chimera + Farcos arrrays

Motivations of the new front-end electronic and DAQ upgrade

GET: generic electronics for TPC: a compact system going from front-end electronic to data readout designed by an international collaboration

Overview of a DAQ infrastructure in a complex system (GET digital DAQ for Farcos and CsI + Chimera Analog DAQ for Si detectors).

Results and comparisons using CS beams

New developments (pre-amplifiers, dual gain modules…)

Physical cases:

Upgrades: pulse shape, digital electronics, new generation detectors with improved isotopic identification
Coupling of 4π detectors with ancillary arrays (correlators)

Nuclear Equation of State and Symmetry energy of asymmetric nuclear matter: light particle correlations and space-time characterization of emitting sources. Symmetry energy parametrization.

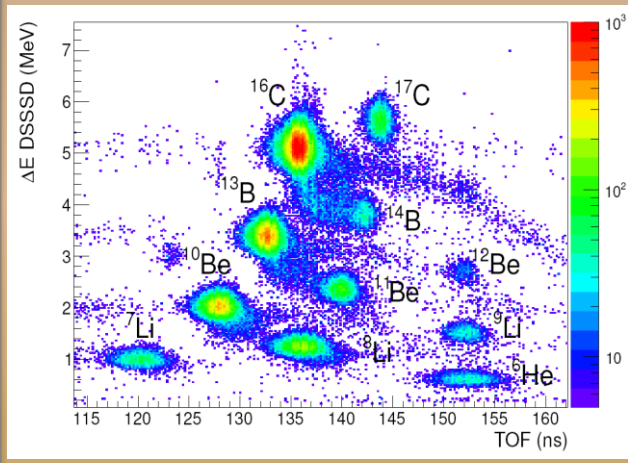
Dynamics and thermodynamics in heavy ion-reactions: time scale of particles and cluster emission, neck emission: fragment-fragment and particle correlations.

Multi-particle correlations. Alpha particle clustering (*see recent B. Borderie et al. (Chimera collaboration) PLB 755, 475 (2016)*).

Correlations of light particles from break-up reactions in neutron rich nuclei (UNSTABLE and CLIR experiments with FRIBs beams).

Perspectives at GSI energies (Asy-Eos at high densities). *see P. Russotto contribution in this workshop.*

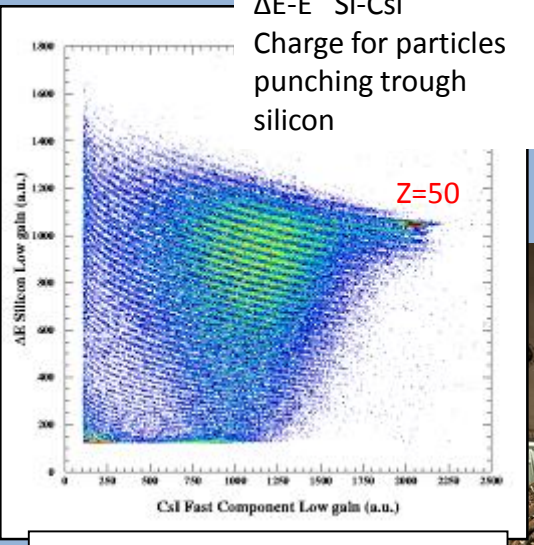
FRIBs cocktail beams from ^{18}O 55 A.MeV primary beam, as seen by the Chimera tagging system

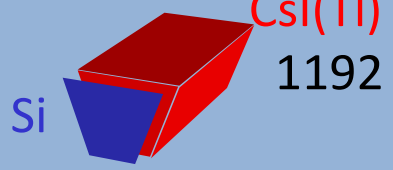


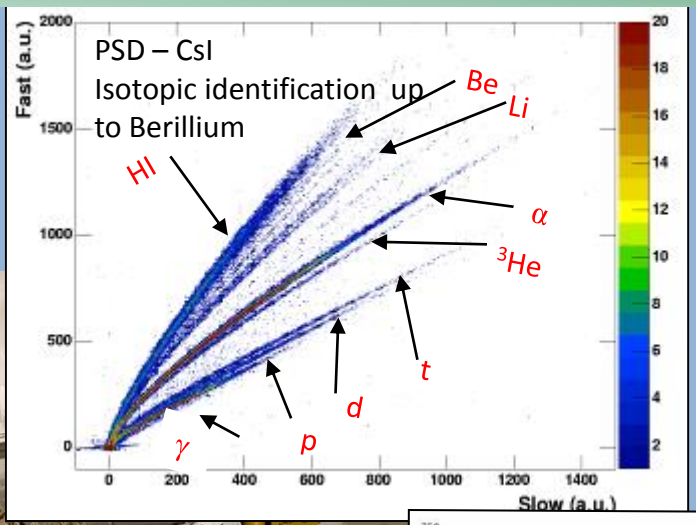
D. Dell'Aquila et al., Phys. Rev. **C93**, 024611 (2016).
L. Acosta et al. NIM A715, 56 (2013).

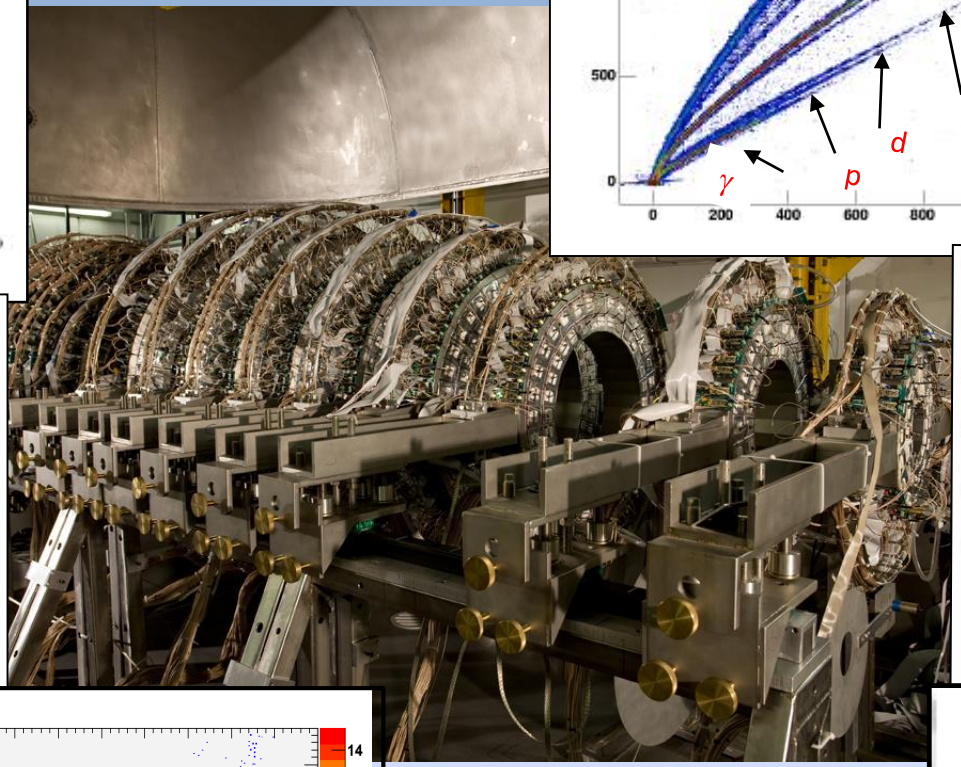
The CHIMERA detector : particle identification methods

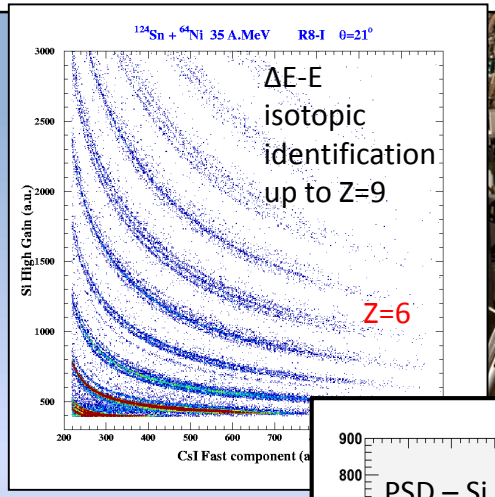
ΔE-E Si-Csi
Charge for particles punching trough silicon

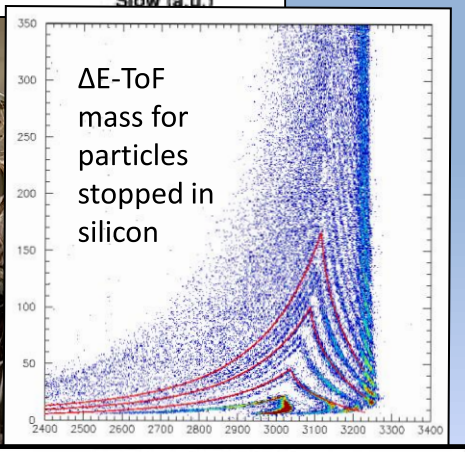


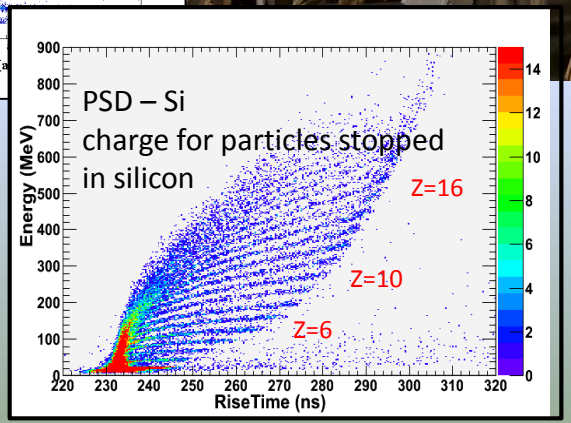




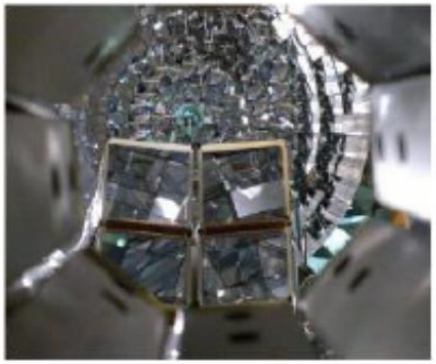




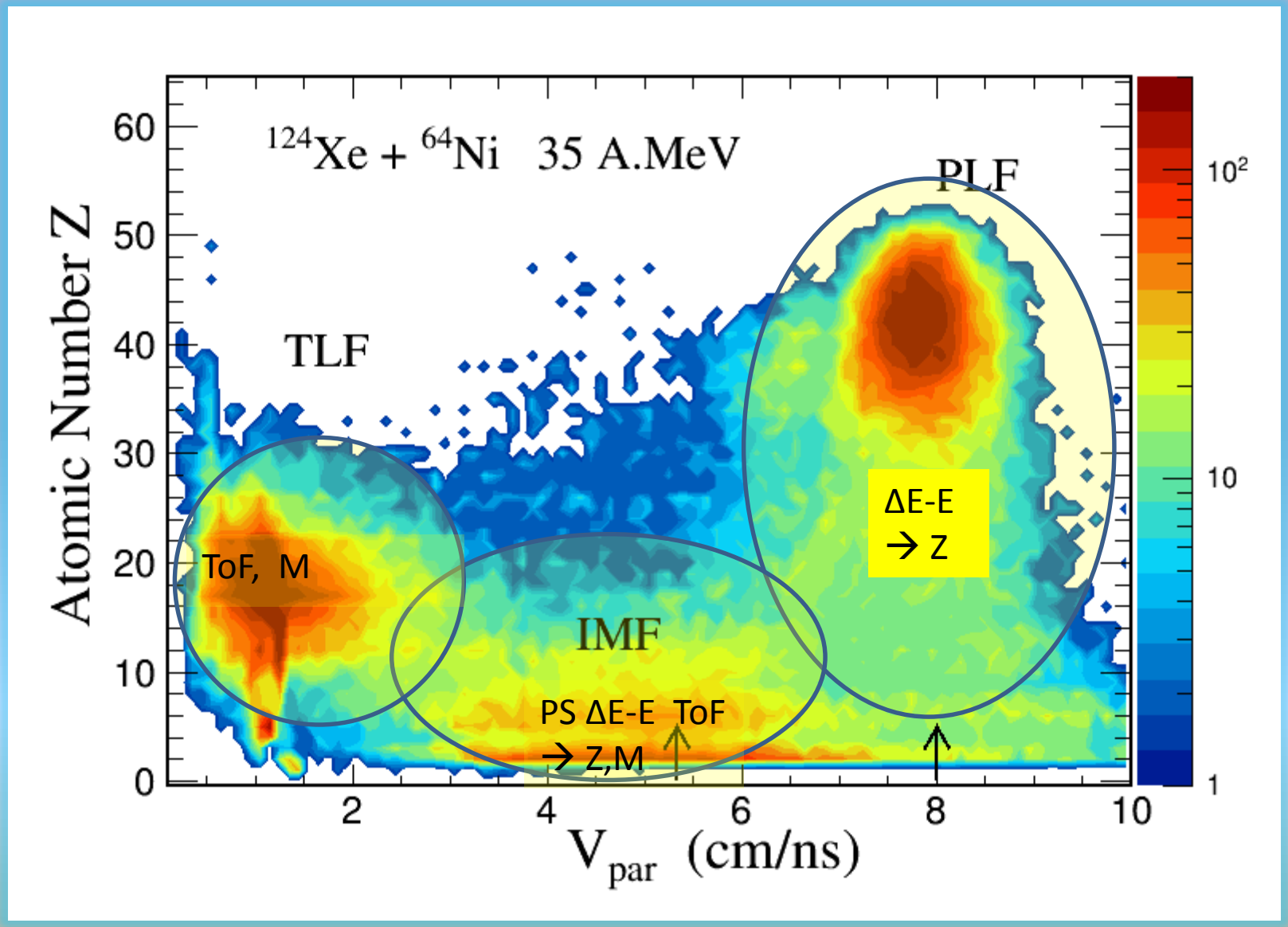




FARCOS : an array of triple telescopes DSSSD-CsI

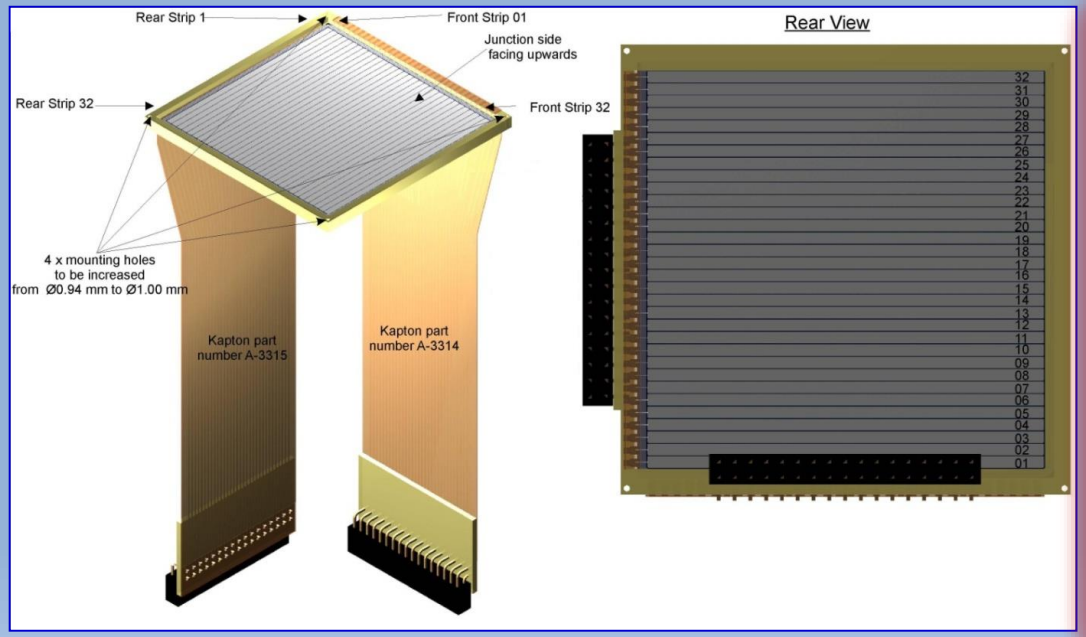


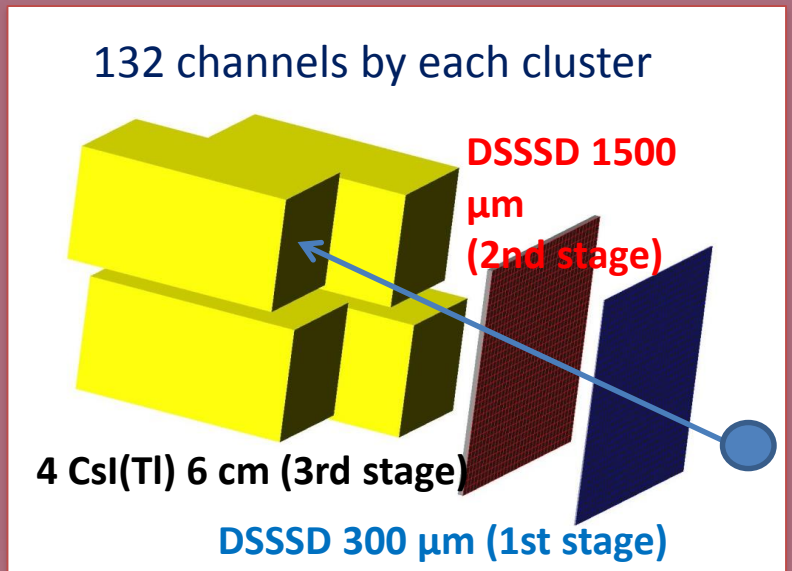
An example: Chimera three body analysis of fragments



FARCOS: Femtoscope Array for COrrelations and Spectroscopy

See Technical Design Report (TDR) for the Farcos project in the web…. for details





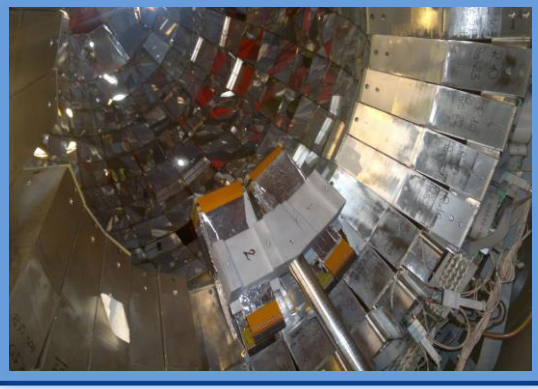
High angular and energy resolution

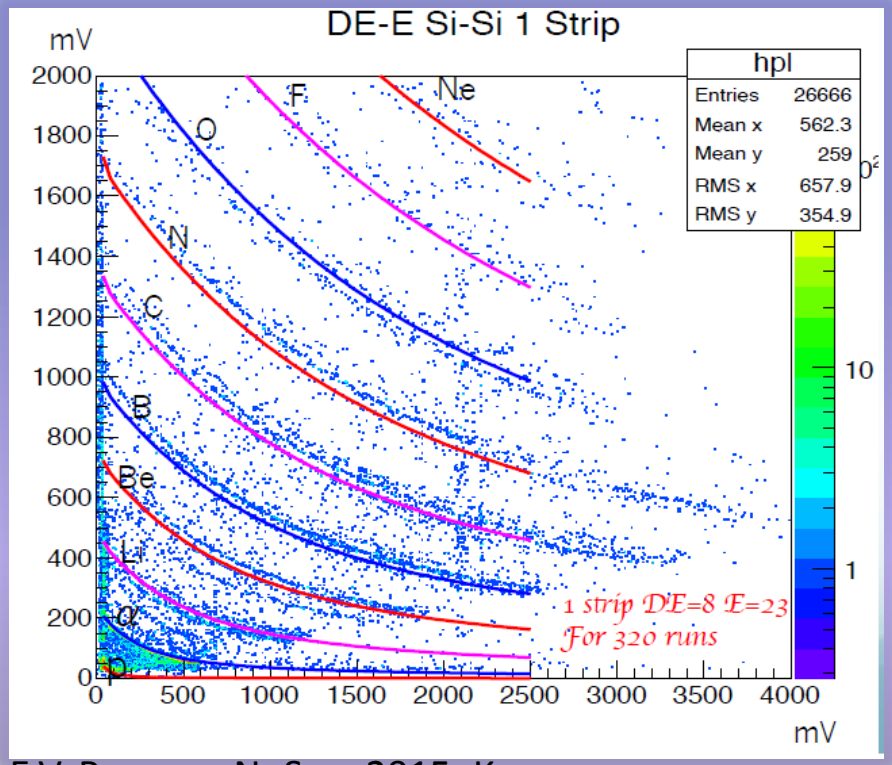
Double-Sided Silicon Strip Detectors
produced by Micron Semiconductor.
(300 and 1500 µm / C= 25pF and 5pF)
Capton cable 2x32pin connectors
Minimum PCB
frame-area thick, 4 mm,
frame-thick 6.5 mm
ΔE= 20KeV (α 5.48 MeV) **ΔE/E (elastic)=0.2-0.3%**
Rise time<20ns

Highly homogeneous CsI(Tl) crystals produced by SCIONIX.
Wrapped with 0.12 mm thick white reflector +50 µm aluminized mylar.
Aluminized mylar window 2 µm thick (0.29 gr/cm^2). Read by Photodiode Hamamatsu 300 µm
ΔE/E=2-3% (α 5.48 MeV)

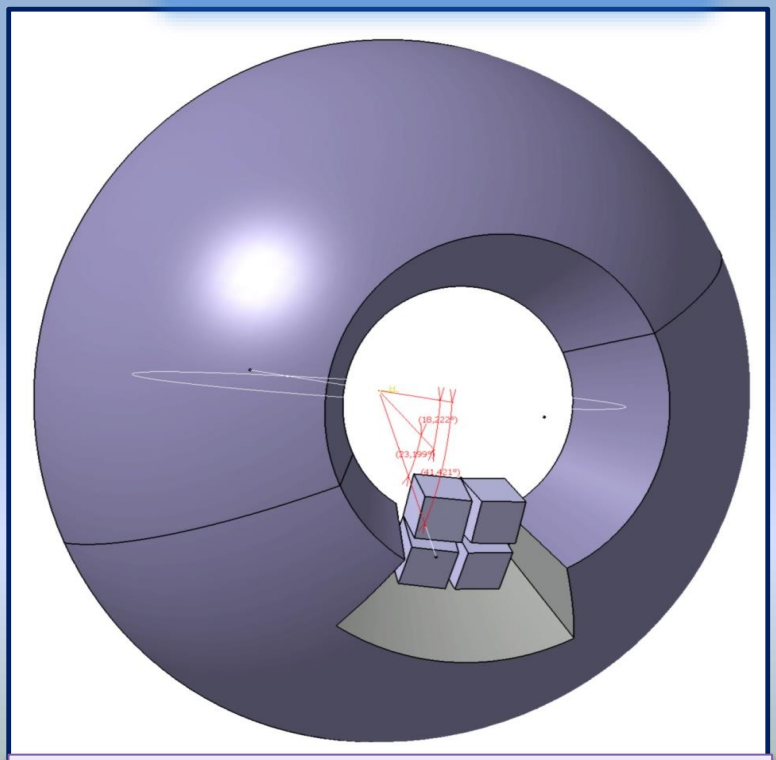
Setup: The 4π CHIMERA + a module of FARCOS prototype in the InKiIsSy (Inverse Kinematics Isobaric Systems) experiment: ^{124}Xe + ^{64}Zn,^{64}Ni@35 A.MeV

Physical case: competition between dynamical and statistica IMF emission.
Influence of the N/Z ratio of the entrance channel in the dynamical fission of th quasi-projectile





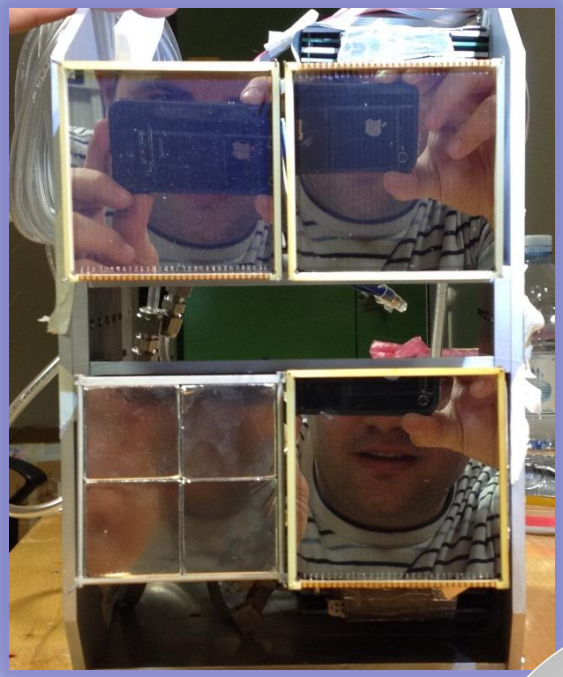
E.V. Pagano, NuSym 2015, Kracow



4 telescopes 25 cm from the target
θ_{lab} ~ 15-45 deg, $\Delta\phi$ ~ 75 deg

See P. Russotto et al., Phys. Rev C91, 014610 (2015) and E.d.F. et al. Proceedings NN2015 (to appear)

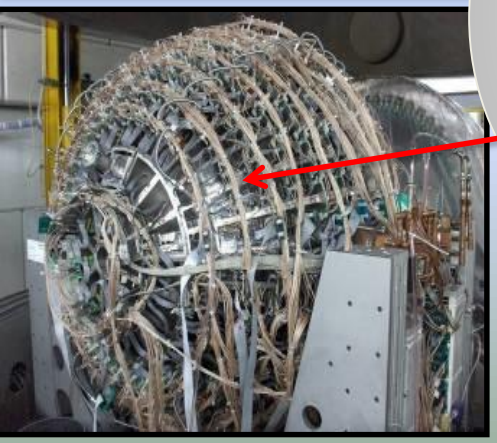
Setup: Detection system for the Pygmy experiment

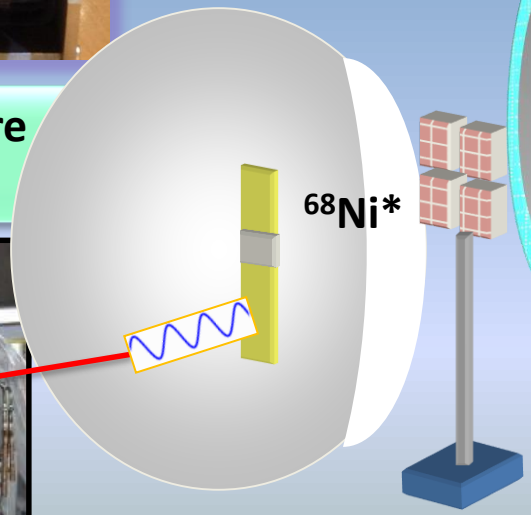


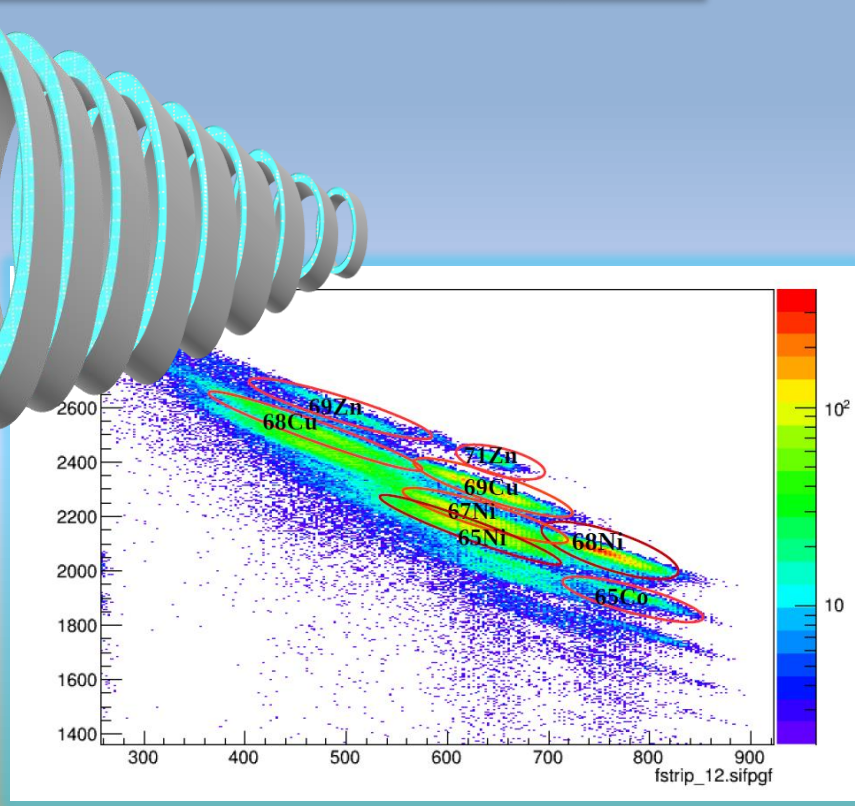
Search of the isoscalar excitation of the PYGMY resonance in ^{68}Ni using the LNS FRIB facility from a 40 A.MeV ^{70}Zn primary beam

FARCOS detects and identifies the ^{68}Ni (stopped in the two silicon stages of the telescopes)

The CsI(s) in the Sphere provide γ detection







Why a new front-end electronic ?

The final FARCOS array constituted by 5 modules (20 telescopes, in the final project) needs the readout of about **4k** channels.

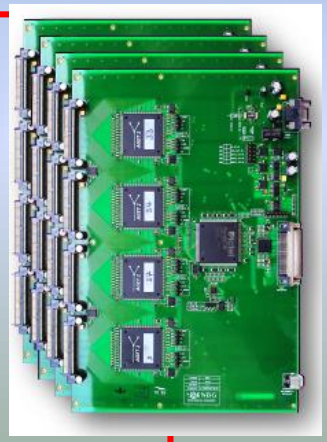
CHIMERA CsI(Tl) front-end (1192 detectors) is now obsolete, in particular the amplifiers and the **VME** QDCs for CsI fast-slow component integration (more than 15 years old technology).

Our choice was to develop a first stage front-end circuit for FARCOS (including new ASIC pre-amplifiers) and new dual-gain modules coupled to a compact hardware architecture covering digitalization and signal readout, syncronization and trigger functions . All these last aspects are covered by the GET project.

Consequences → digital DAQ for Farcos and CHIMERA (CsI) + Analog DAQ (Silicons)
Upgrade of the CHIMERA front-end for CsI(Tl) (in progress….)

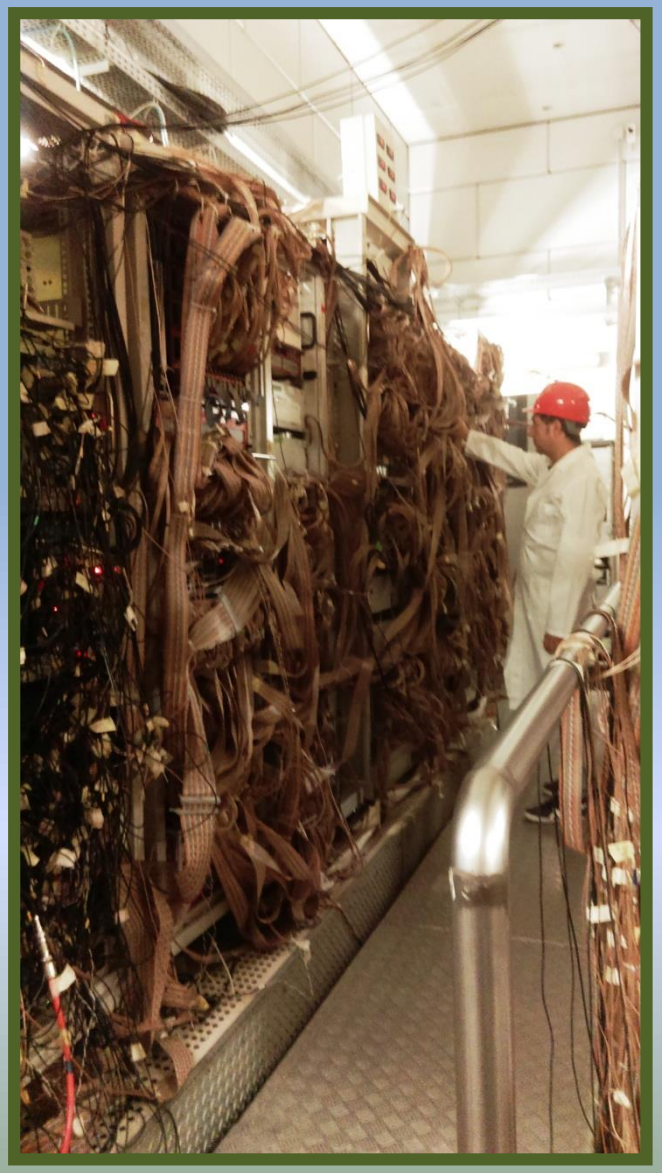
R&D Financed 75% (France)
25% (USA)

GET Project



More advantages

Standard CHIMERA



GET

COMPACT
1+1/2 crate all chimera+ farcos electronics

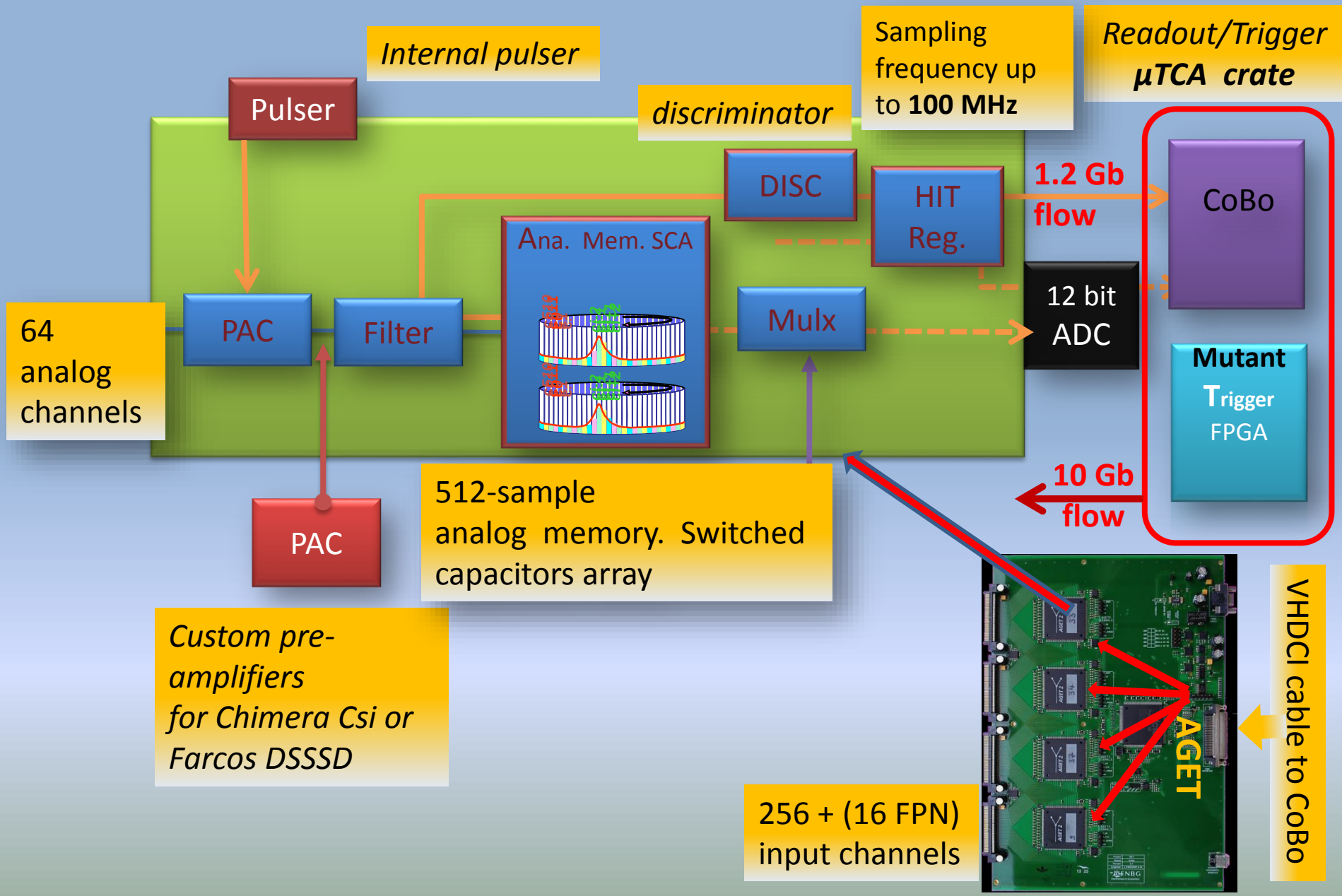
5W for 256 channels

With CHIMERA we need now about 60 kW power on 10 Racks

Who is using the GET project in the world ? (main source: E. Pollacco, 2015)

Project	N° channels	Lab	Agency
SπIRIT	10k	MSU, Riken… (USA,Japan)	DOE, Riken
ACTAR TPC	16k	GANIL,IRFU,IPNO… (France)	ERC,GANIL,IN2P3
LAMPS	2.5 -> 20k	IBS (Korea)	IBS
AT-TPC	10k	MSU… (USA)	NFS
N_TOF	2.5k	CERN,IRFU…..	IRFU
CNS-AT	2.5k	Univ. of Tokyo (Japan)	CNS
E-15	6k	J-ParC… (Japan)	J-PARC
ELI-TPC	1k	Univ. Warsaw (Poland)	ELI-NP
FARCOS/Chimera	5k	INFN Ct,LNS,Mi,Na (Italy)	INFN
TexAT-P	2-32k	Texas A&M (USA)	Texas A&M
ND-TPC	1k	Univ.ND (USA)	Univ. UND
Shanghai-TPC	1k	CAS (China)	CAS
NEXT	1->5k	Univ. Of Saragosa (Spain)	Univ. Of Saragosa
Lanzhou-TPC	2k	IMP (China)	IMP
S^3	4k	SPIRAL2 (France)	GANIL,IRFU
SpecMat	2.5k	KU Leuven (Belgium)	ERC
Focal-Plane	256	Orsay, IN2P3 (France)	IN2P3
SSD	1k	INFN-LNS (Italy)	INFN, ELI-NP
MINOS	6k	IRFU	ERC

THE AGET ASIC in the ASAD board



Some definitions . . . (useful for for the following) and numbers

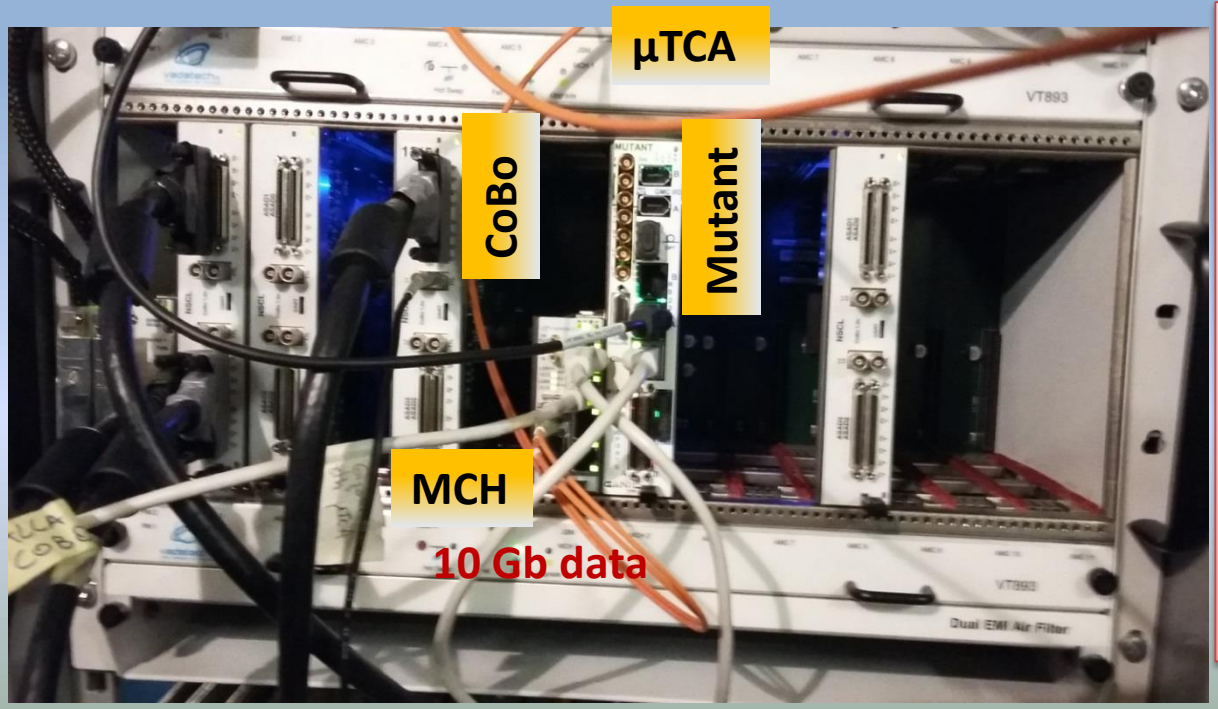
AGET: Asic for GET – 64 analog channels (+4 FPN) - 512 cells/channel

ASAD: AGET Support for Analog to Digital – 4 AGET

COBO: COllection BOard – 4 ASAD - 1024 digital channels

MUTANT: MUtiplicity, Trigger ANd Time (3 trigger levels)

MicroTCA: Micro Telecommunications Computing Architecture
MCH: Carrier Hub with 10 Gb and 1 Gb ethernet link



Chimera Test DAQ crate

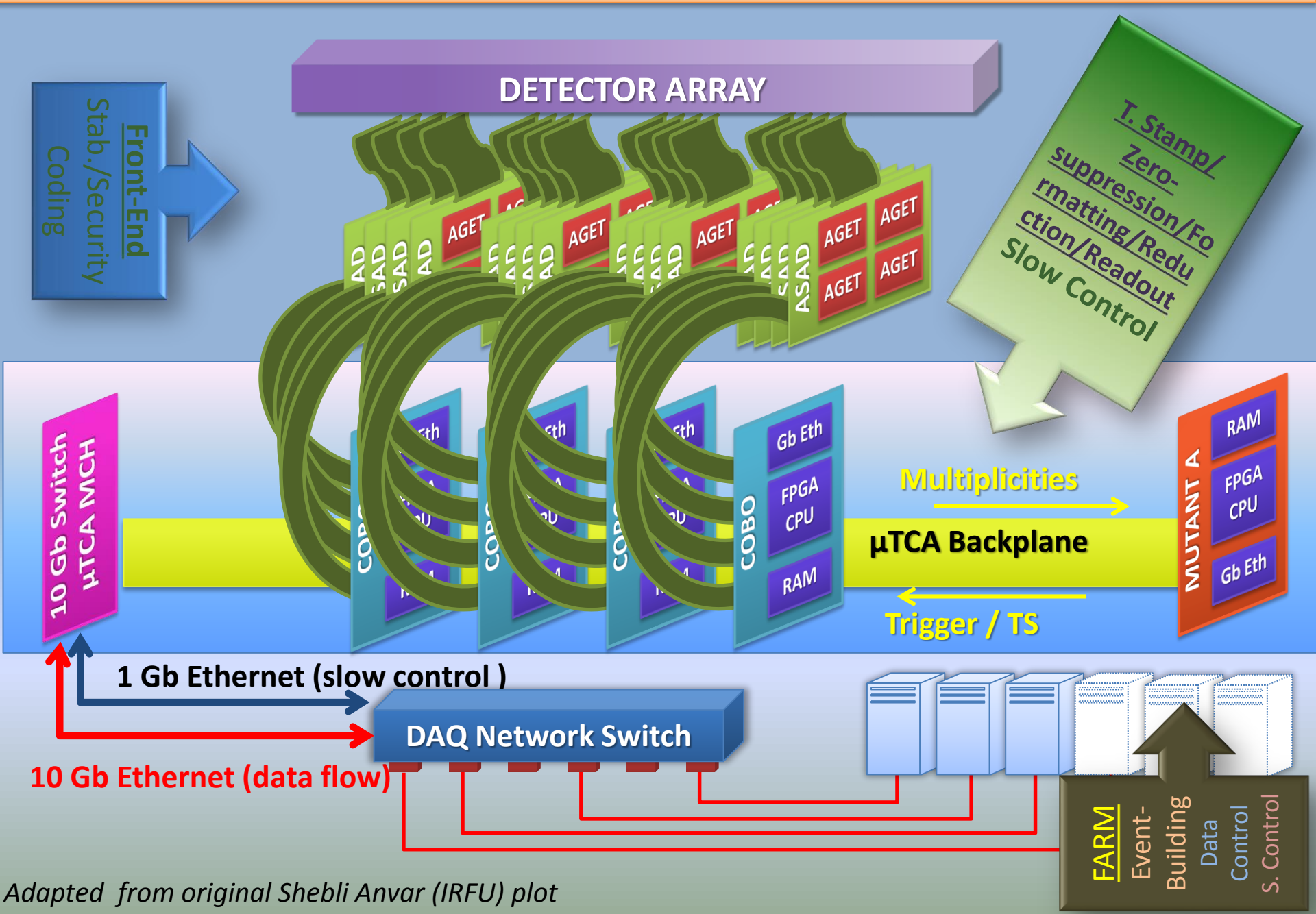
Chimera CsI:
8 ASAD → 2 CoBo (<2k signals)

Farcos (5 modules):
14 ASAD → 4 CoBo (<4k signals)

1 µTCA crate
1 Mutant (three levels trigger)

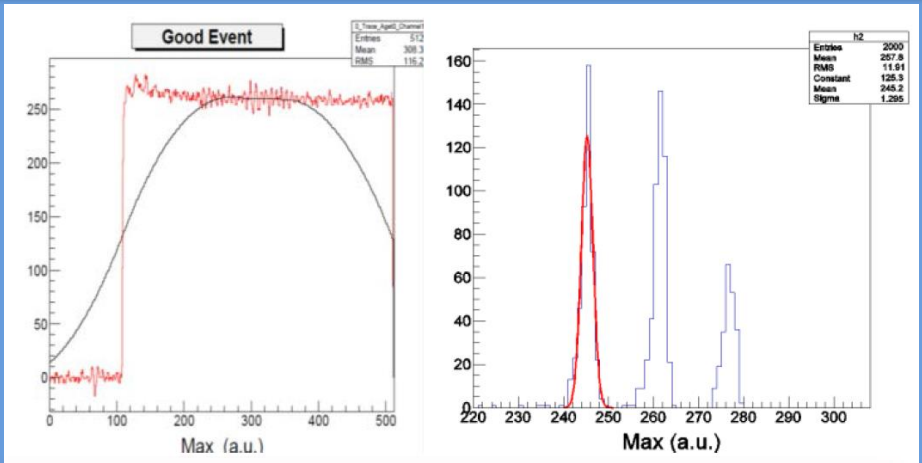
Computer farm + Storage (disk server) + 10Gb/1Gb switch

GET HARDWARE Design

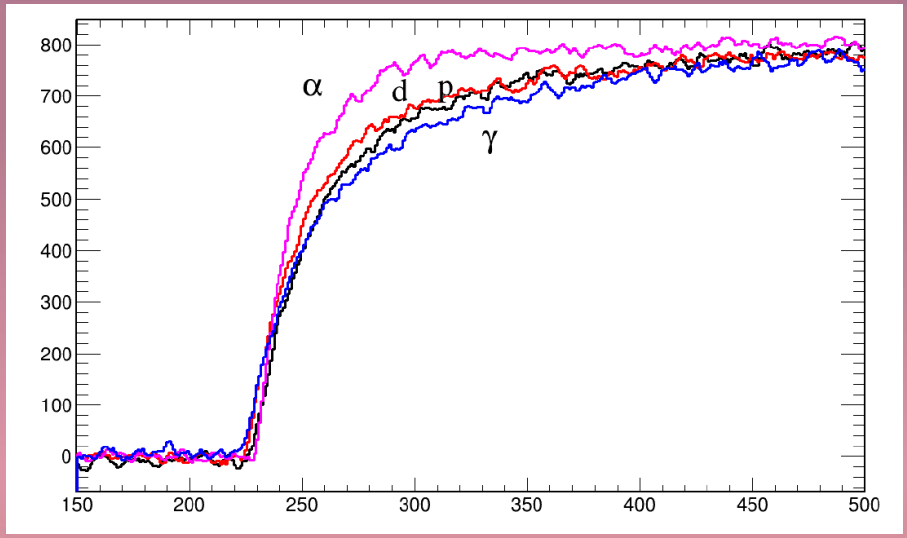


Adapted from original Shebli Anvar (IRFU) plot

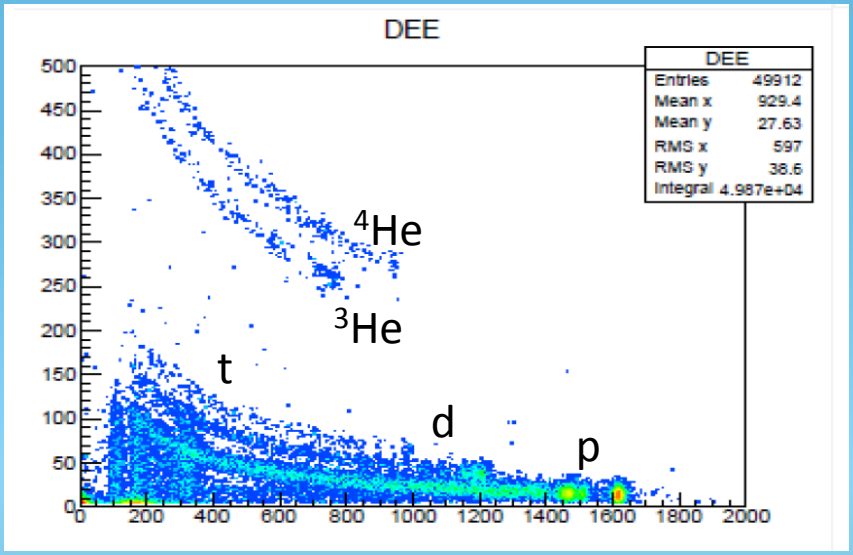
Tests performed on Farcos and CHIMERA



Digitized pre-amplifier (10 mV/MeV, 100 MeV dynamical range) signal after baseline restore and triangular filter and resulting three peaks alpha source (data obtained with R-Cobo readout) on a FARCOS strip



Collection of signals in CsI(Tl) for different particles releasing the same light and digitized at 25 MSamples (test with 62 MeV proton beam)

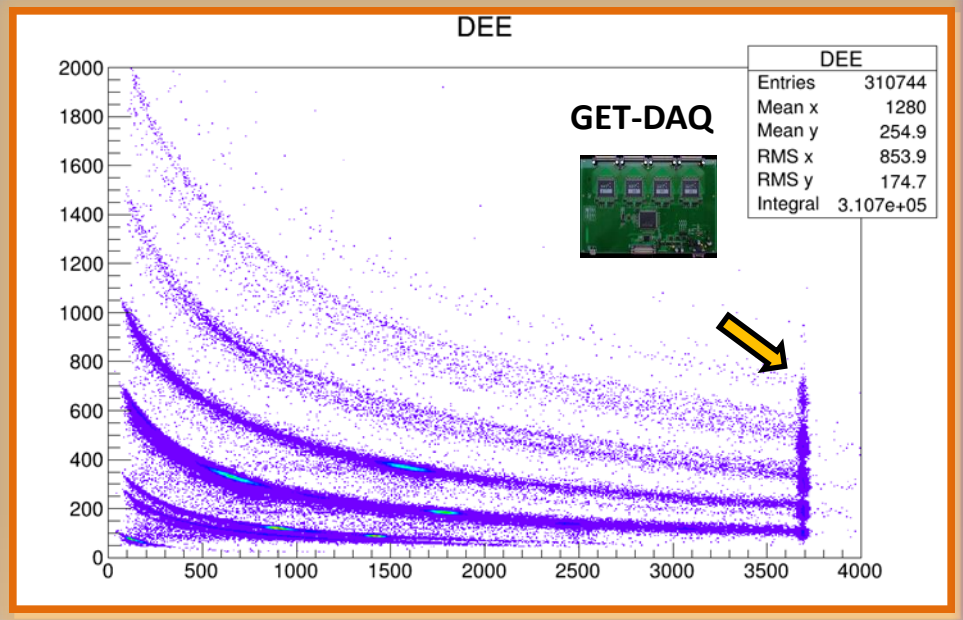


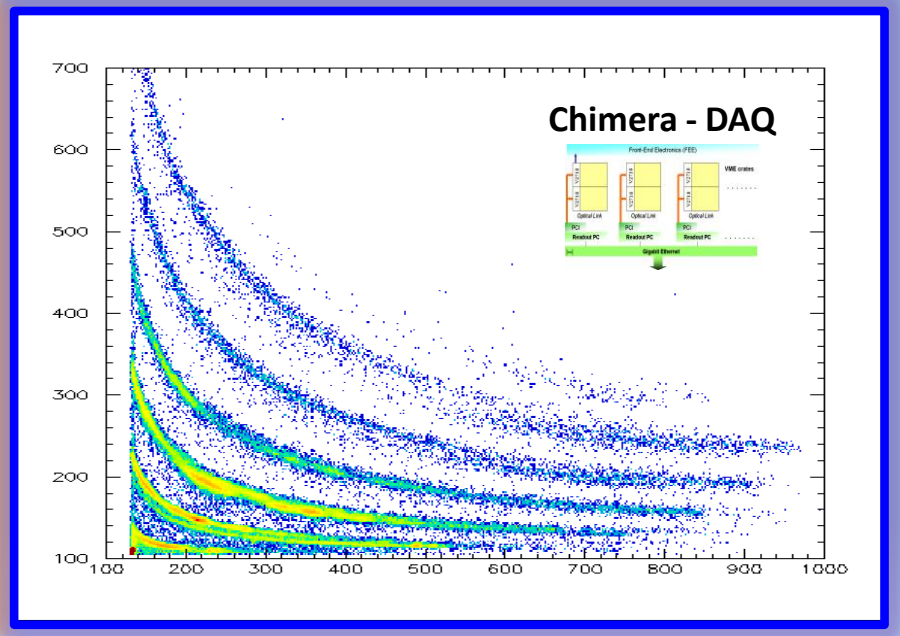
ΔE-E scatter plot in the same experiment p+deuterated plastic target at 62 MeV (Chimera).

Tests with fragmentation beams (≈ 50 A.MeV) on plastic target

Data from CLIR@LNS experiment

Fast component (CsI) vs. ΔE (Silicon

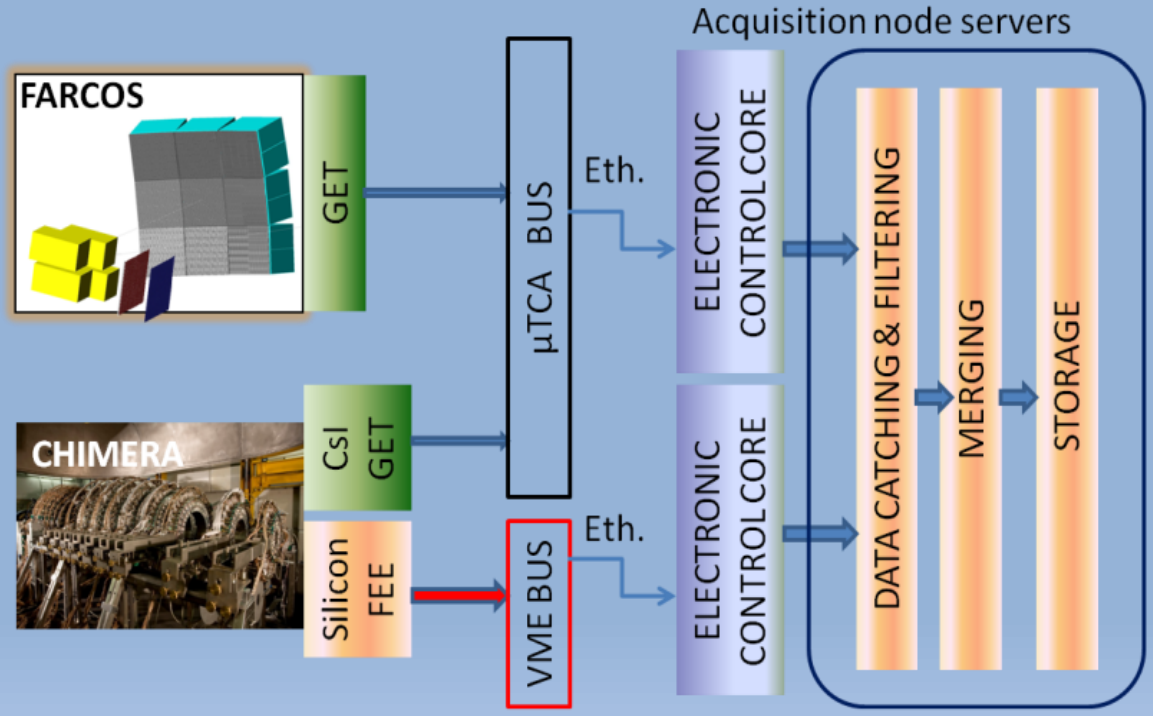




- Standard CHIMERA preamplifier used in the silicon stage (2 mV/MeV) [Chimera, ring 2E]
- The signals are digitized at a frequency of 50MHz
- Both signals Si/CsI are shaped with a 1µs shaping time in the SKF filter stage of AGET chips.

- Better isotopic resolution obtained with GET.
- ⟹ Note the fast component signal saturation → dual gain (DG) module needed

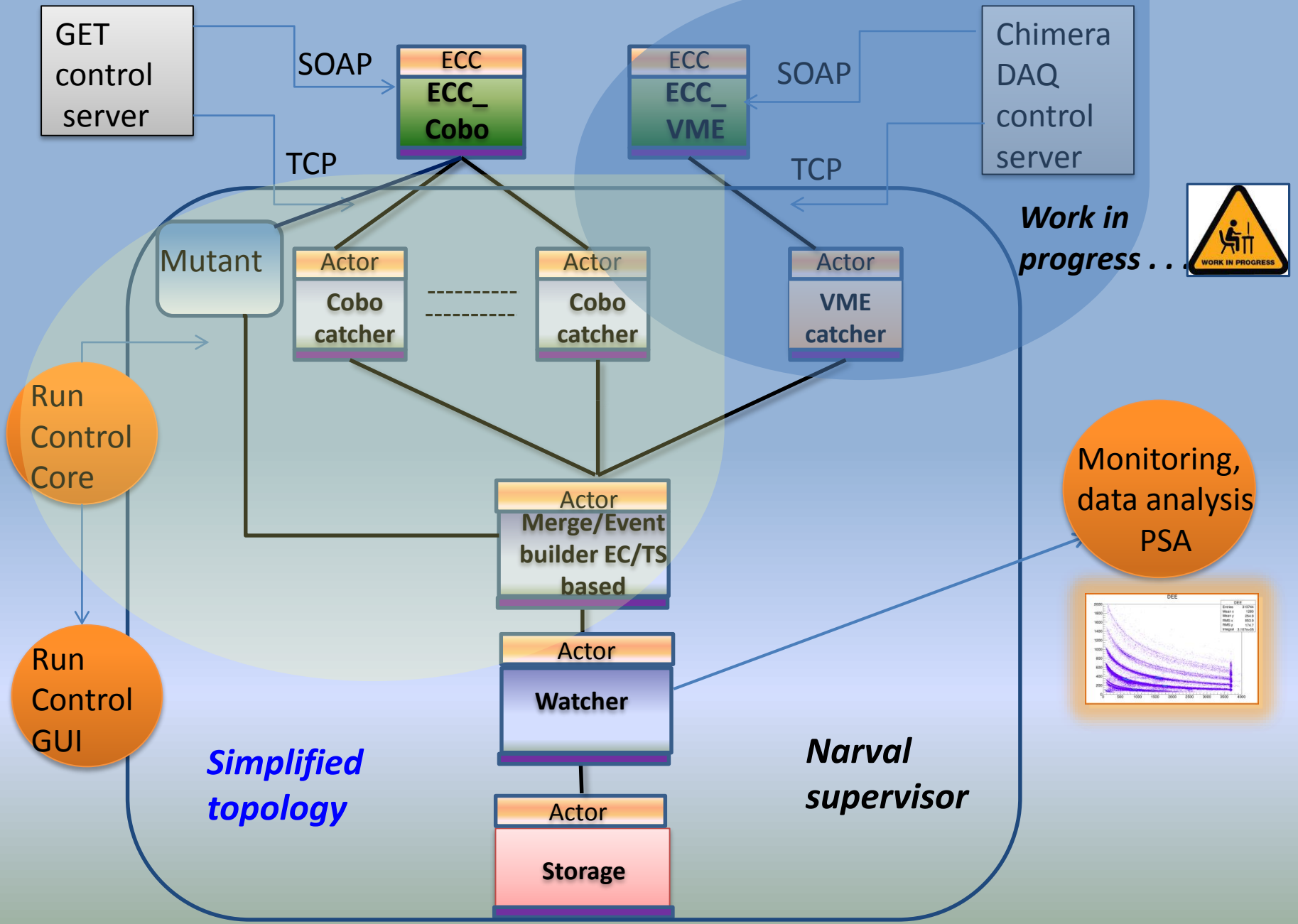
GET + CHIMERA DAQ COUPLING (a brief overview)



We use «**NARVAL**» as supervisor for both CHIMERA and GET data acquisitions

- developed at IPN-Orsay by X. Grave
- based on the concept of generic **Actors**
- written in OO language ADA with C++ interface
- Data flow: TCP/IP
- Run Control Core and GUI interface based on Java (GANIL)

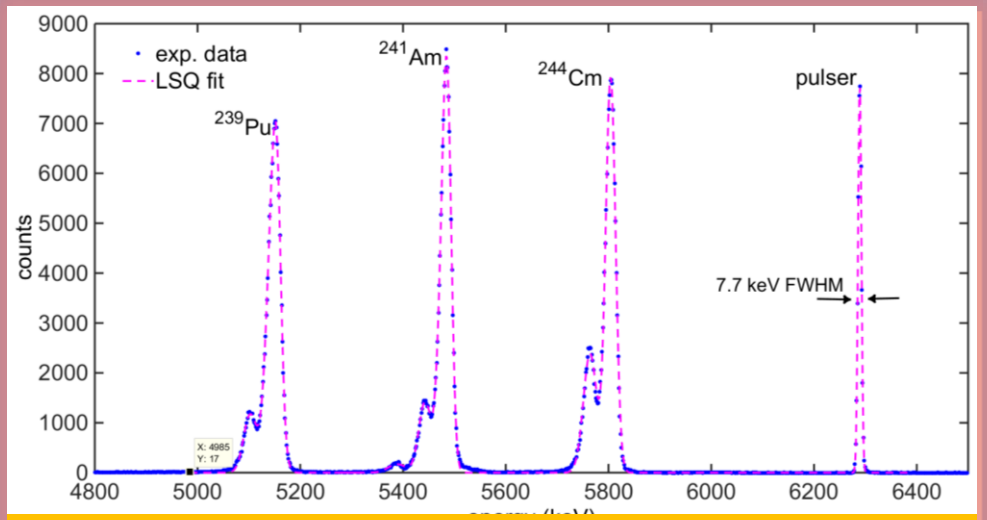
GET + CHIMERA DAQ COUPLING (a brief overview)



Selectable-Gain CMOS Charge Preamplifier for Pulse Shape Analysis in Double Sided Silicon Microstrip Detectors for FARCOS

Specs

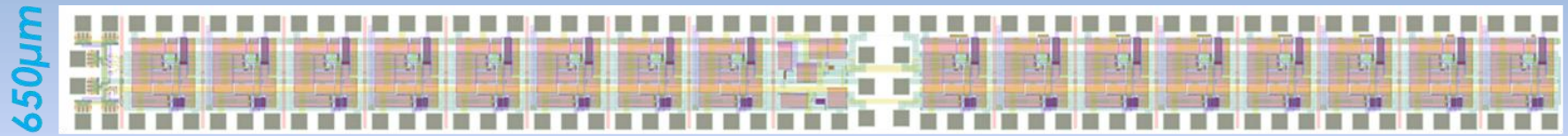
- ✓ single design for both thicknesses and of both polarities
- ✓ strip capacitance about 65 pF (300 µm) and 35 pF (1500 µm)
- ✓ strip leakage current ~5 nA (300 µm) and ~25 nA (1500 µm) @RT in vac
- ✓ target dynamic ranges: 90 MeV, 200 MeV, 350 MeV and 500 MeV.
- ✓ static power consumption ~10 mW/channel
- ✓ Selectable gain



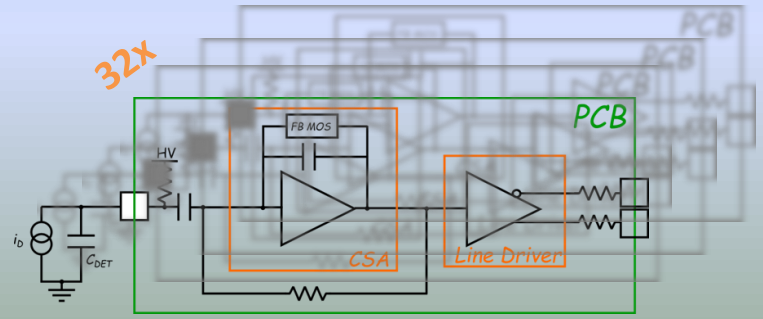
Alpha source with FARCOS DSSSD, 300 mm thick

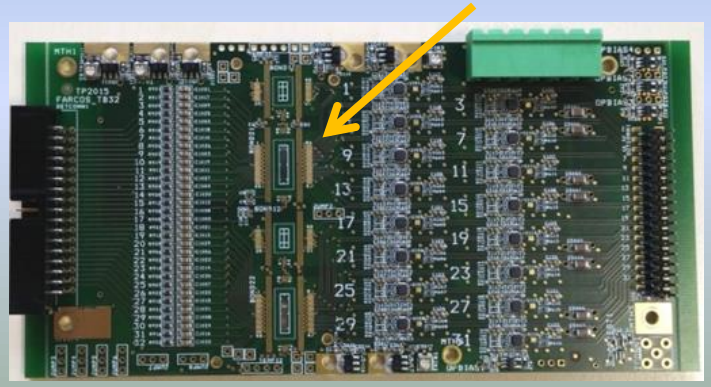
16-ch ASIC layout

0.35 µm C35B4C3 AMS tech



32-ch motherboard with differential line drivers





A. Castoldi, C. Guazzoni, T. Parsani: Politecnico di Milano and INFN sezione di Milano

Selectable-Gain CMOS Charge Preamplifier for Pulse Shape Analysis in Double Sided Silicon Microstrip Detectors for FARCOS

Specs

- ✓ single design for both thicknesses and of both polarities
- ✓ strip capacitance about 65 pF (300 µm) and 35 pF (1500 µm)
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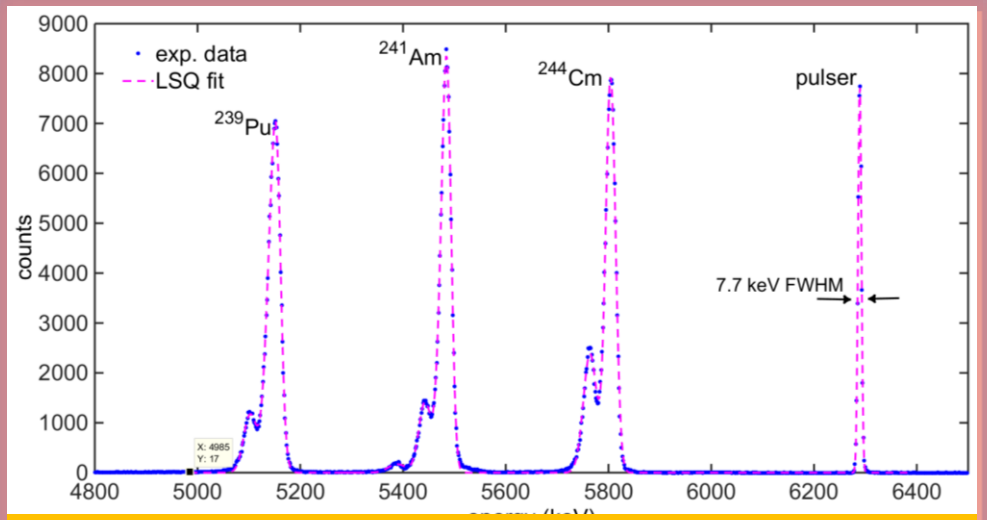
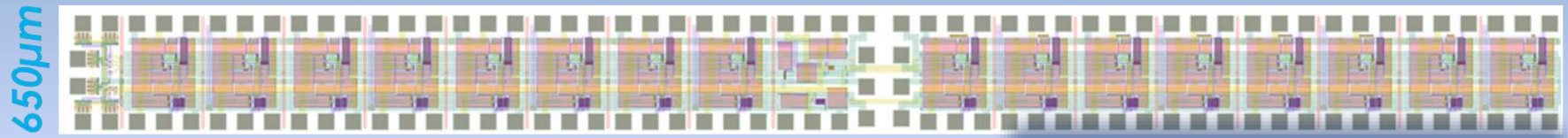


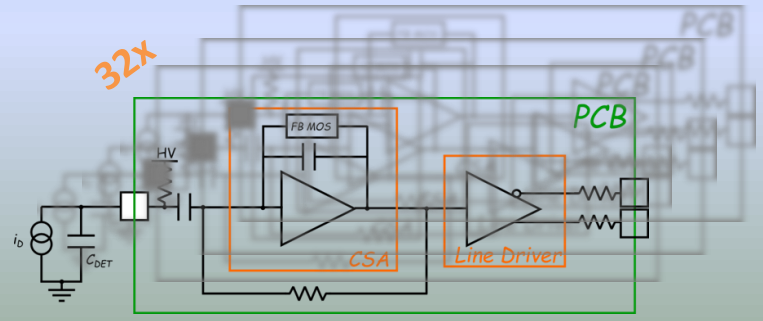
Alpha source with FARCOS DSSSD, 300 mm thick

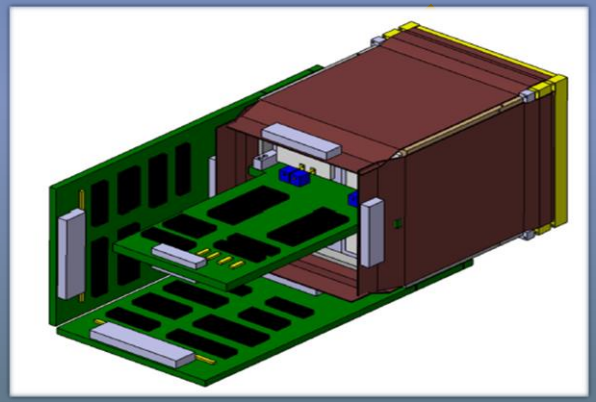
16-ch ASIC layout

0.35 µm C35B4C3 AMS tech



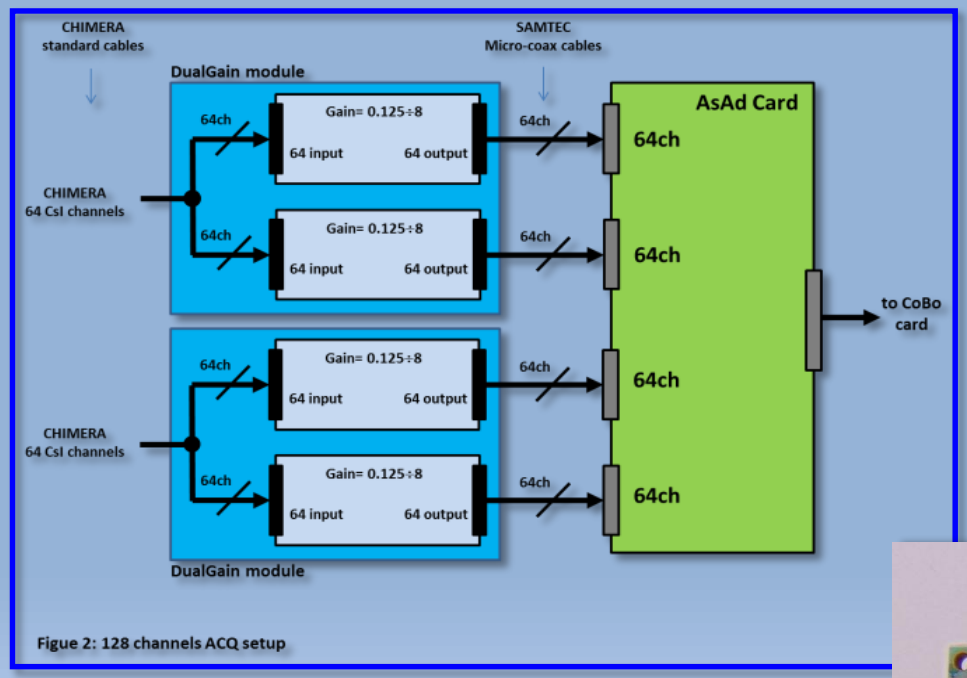
32-ch motherboard with differential line drivers





A. Castoldi, C. Guazzoni, T. Parsani: Politecnico di Milano and INFN sezione di Milano

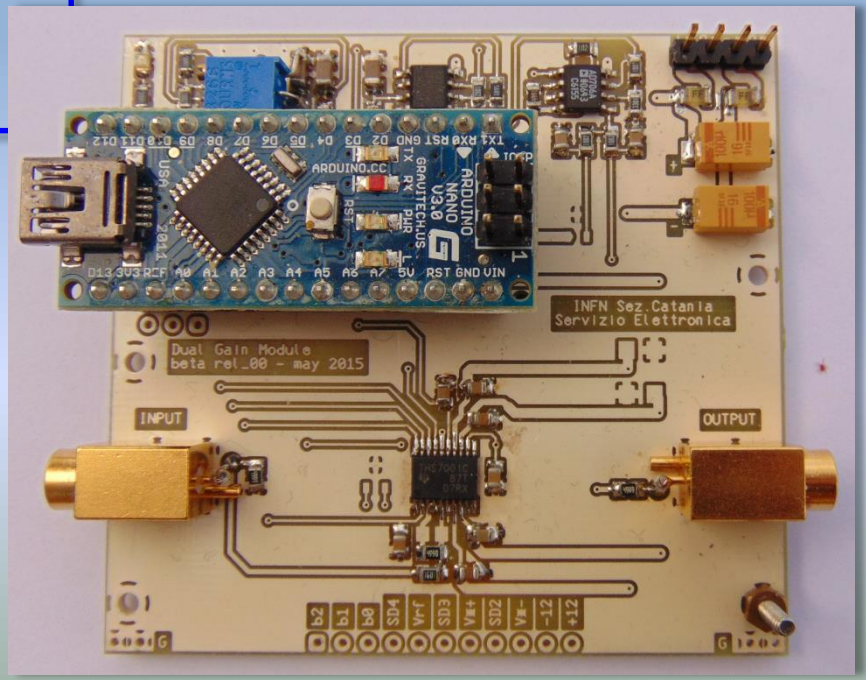
The FARCOS dual gain module (DG) project (INFN - Catania)



Figue 2: 128 channels ACQ setup

Te FARCOS dual-gain module splits each FARCOS channel and adapts the signals level to the ASAD requirements.

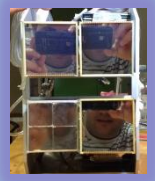
The user can set the gain in the range from 0.032 V/V_{in} to 4 V/V_{in}



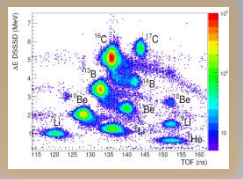
Development beta card at INFN sez. Catania. The microcontroller allows the data setup, firmware development and user communications.

Test with CS beam: May 2016, LNS

Summary



Following the building of a first Farcos module demonstrator and the approval for the construction of 5 Farcos modules we have adopted a compact electronic front end based on the design of new ASIC preamplifiers for silicon strips and the GET electronics for digitalization and data readout.



This ancillary detector, with its high and angular resolution, enhances the physics that can be studied with the CHIMERA array (including two and multi-particles correlations) both with stable and radiactive beams, in the field of dynamics of heavy ion collisions and spectroscopy of light nuclei at border of drip lines.

Indeed it wiil be coupled with other devices in national and international laboratories (SPES,GANIL,GSI) following the physics cases

Chimera front-end for CsI(Tl) detector s will be upgraded by using GET electronic as well.

Collaboration for Farcos project and Chimera upgrade

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