



IV Seminario Nazionale Rivelatori Innovativi

10-14 November 2014 - INFN - LNS

Acquisition of alpha and cosmic rays signals from CHIMERA CsI(Tl) with GET electronics

P. Russotto*

for EXOCHIM collaboration

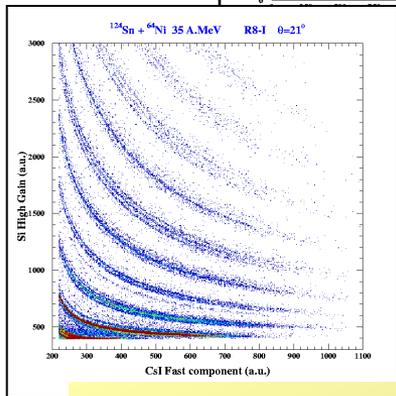
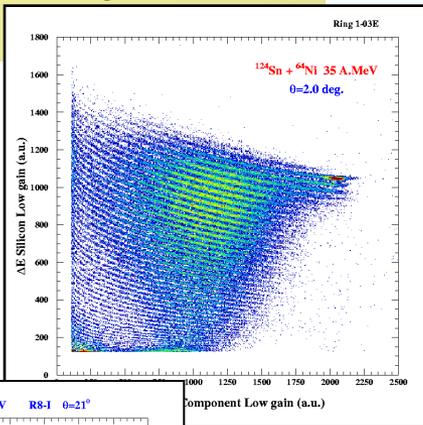


*INFN-Sez. di Catania, Italy

CHIMERA multi-detector

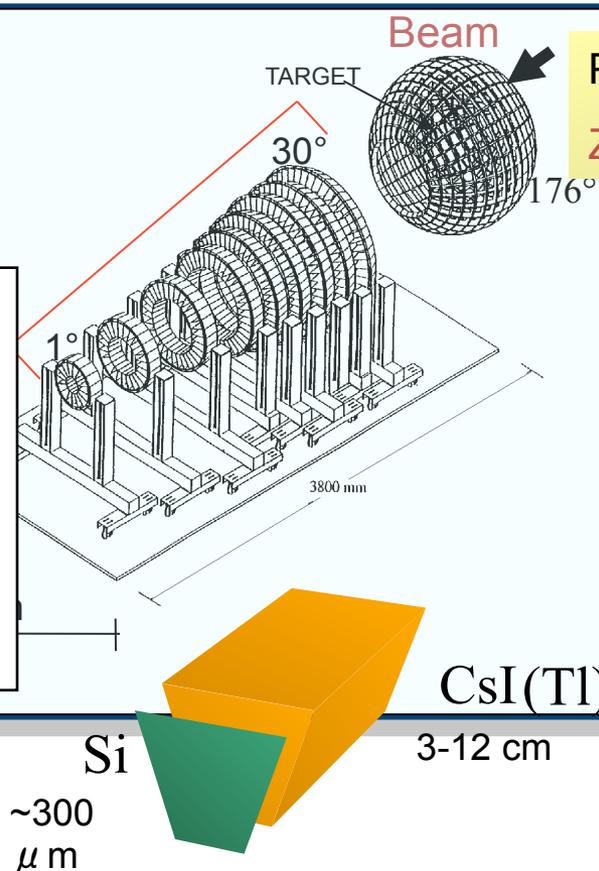
$\Delta E(\text{Si})-E(\text{CsI})$

Charge Z for particles punching through the Si detector



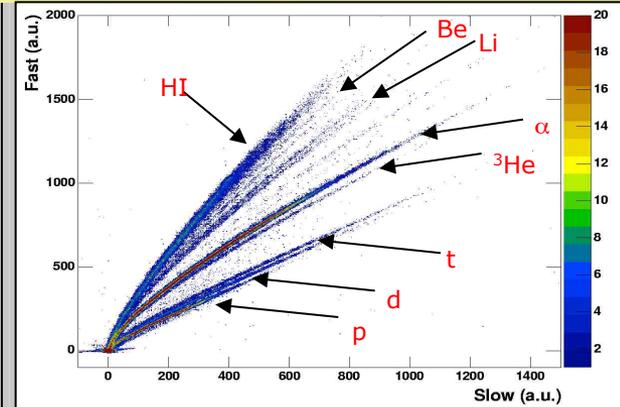
$\Delta E(\text{Si})-E(\text{CsI})$

Charge Z and A for light ions ($Z < 9$) punching through the Si detector



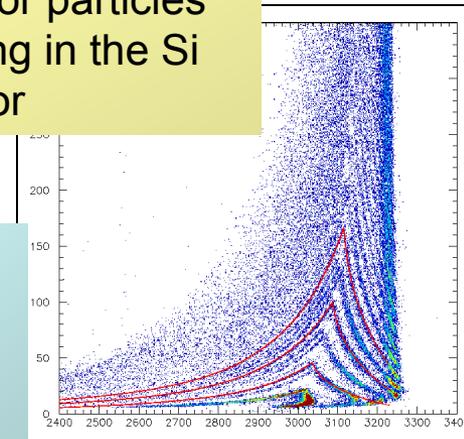
PSD in CsI(Tl)

Z and A for light charged particles



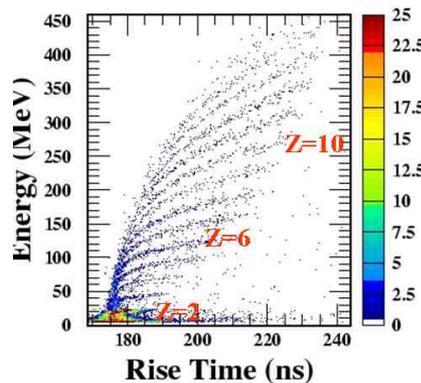
$\Delta E(\text{Si})-\text{ToF}$

Mass for particles stopping in the Si detector



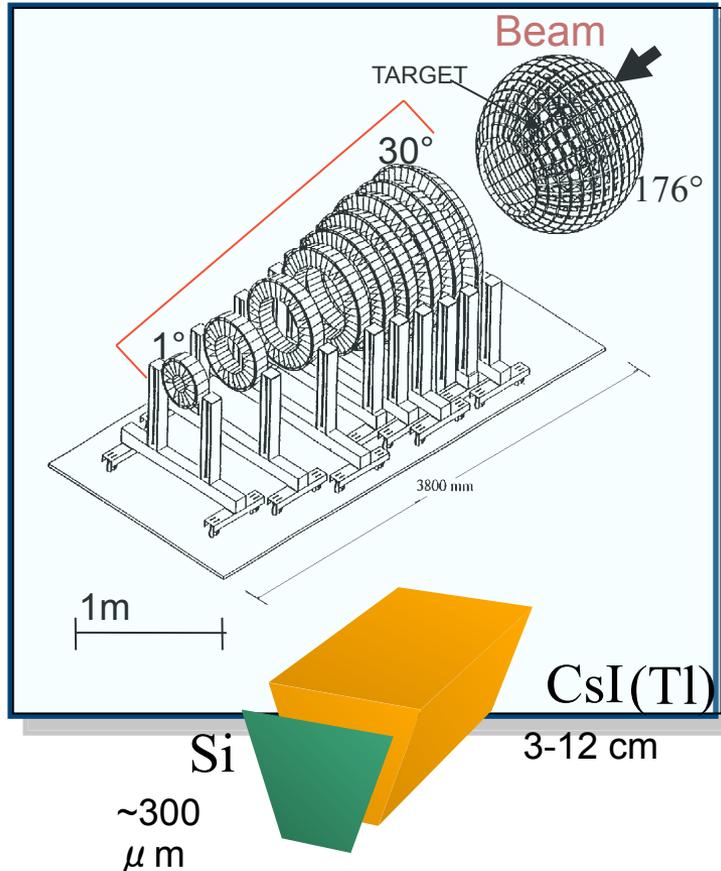
$E(\text{Si})-\text{Rise time}$

Charge Z for particle stopping in Si detectors



CHIMERA activity at LNS

Study of:



1192 telescopes

94 % of 4π

Several Id. technique

Low thresholds

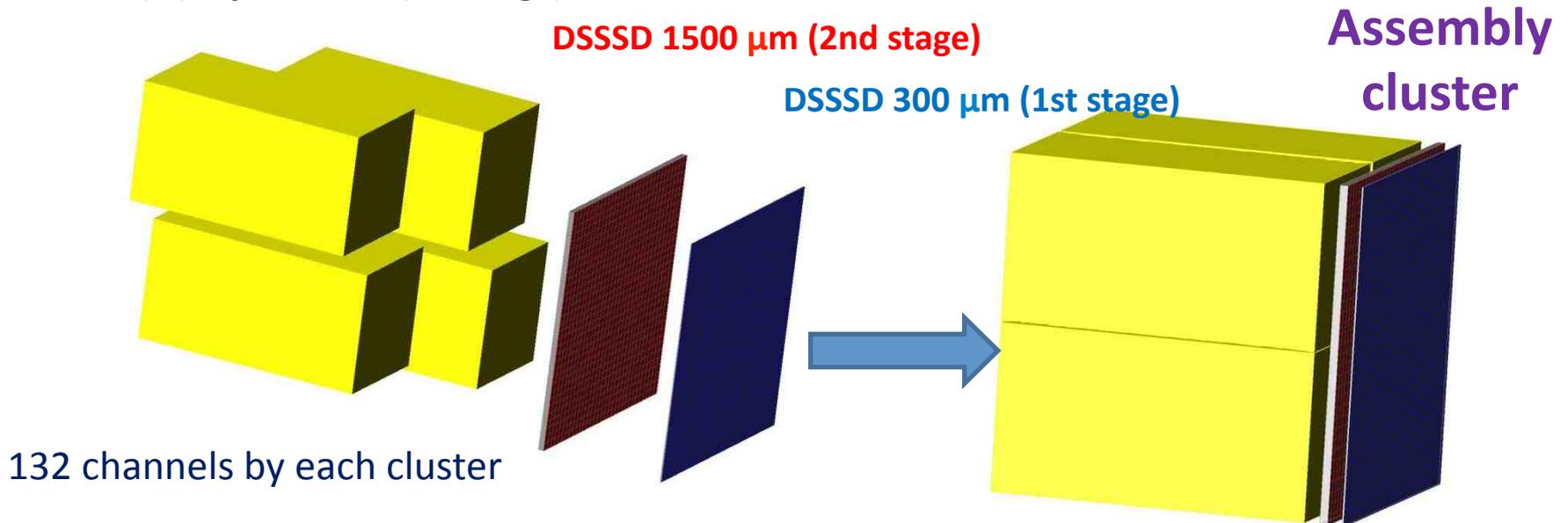
- Reaction mechanisms of Heavy-Ion collisions at Fermi energies
- Influence of Isospin on reaction mechanism
- Density dependence of Symmetry Energy at sub-saturation density
- New break-up mechanisms and exotic decaying in Au+Au from inelastic to central collisions
- In flight production and tagging of RIB
- Transfer reaction with light RIB
- Neutron and gamma detection
- Digital pulse sampling analysis
-and more

FARCOS

(Femtoscope ARray for COrrrelations and Spectroscopy)

- Based on (62x64x64 mm³) clusters
- 1 square (0.3x64x64 mm³) DSSSD 32+32 strips
- 1 square (1.5x64x64 mm³) DSSSD 32+32 strips
- 4 60x32x32 mm³ CsI(Tl) crystals

4 CsI(Tl) crystals 6 cm(3rd stage)



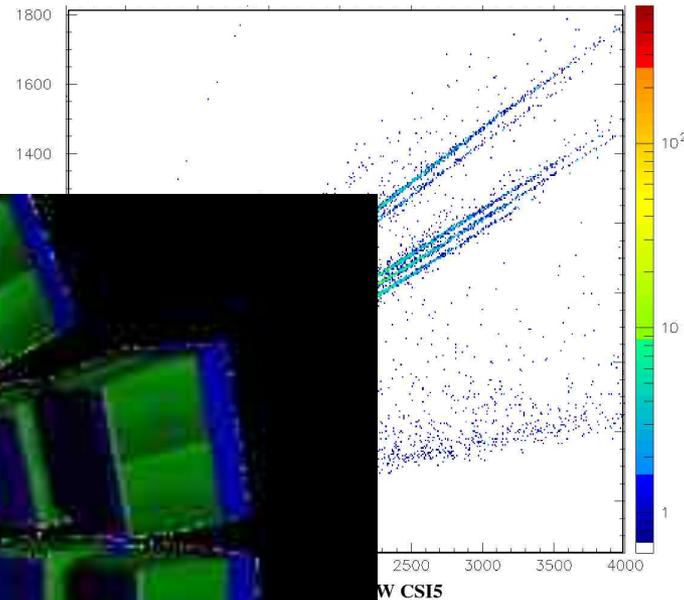
FARCOS Features

- High energy and angle resolution (θ, ϕ)
- Modularity, Flexibility, Portability
 - Geometry: coupling to 4π and Mag. Spectr.
 - Electronics: integrated, reconfigurable
- **Synergy with other highly segmented silicon detectors: shared technical efforts and physics cases with Must2, Trace, ...**
- Other features from new electronics:
 - Pulse-shape capabilities (Low identification thresholds)
 - Digitalization of detector signals
 - Wide dynamic range (correlation observables require light particle detection)

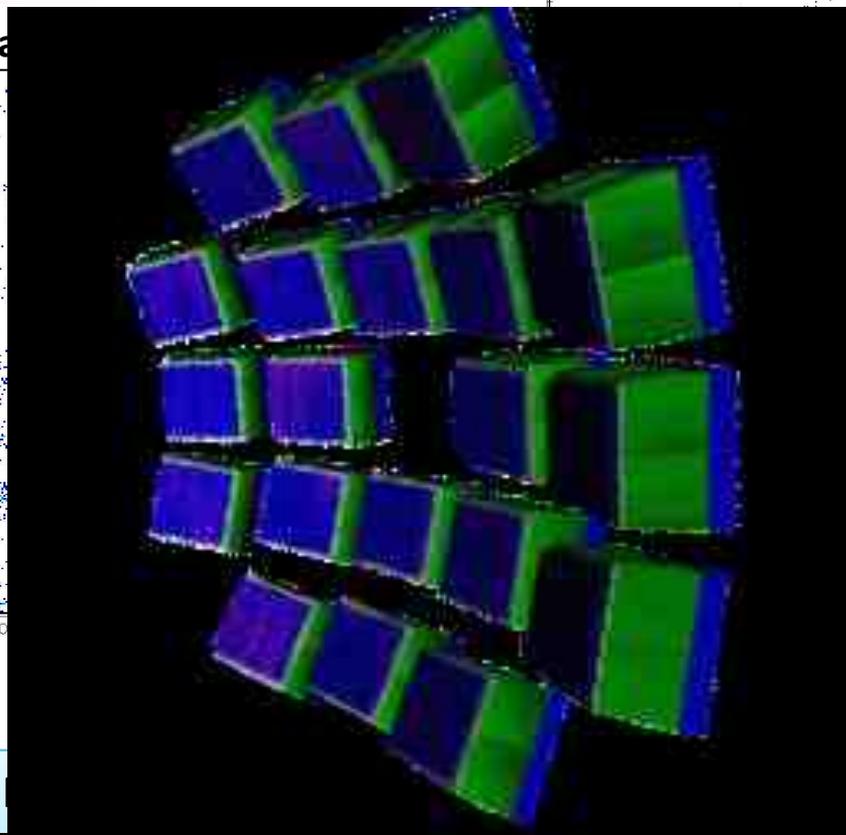
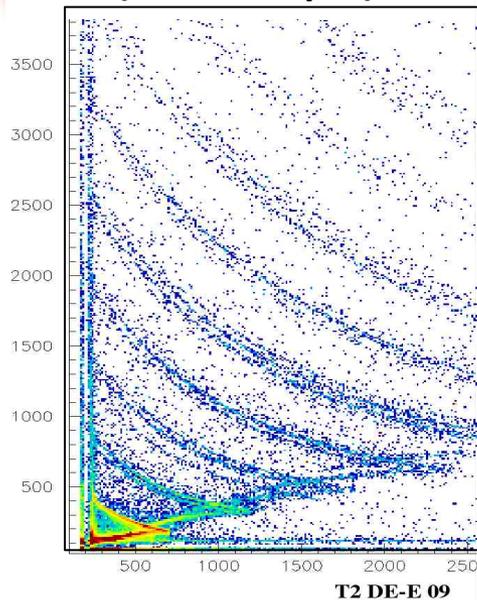
A new setup: the 4π CHIMERA + 4 modules of FARCOS prototype

Study of Mass vs Isospin effects with the $^{124}\text{Xe}+^{64}\text{Zn}$ and $^{124,112}\text{Sn}+^{64,58}\text{Ni}$ reactions at 35 AMeV

FAST-SLOW T4 Farcos

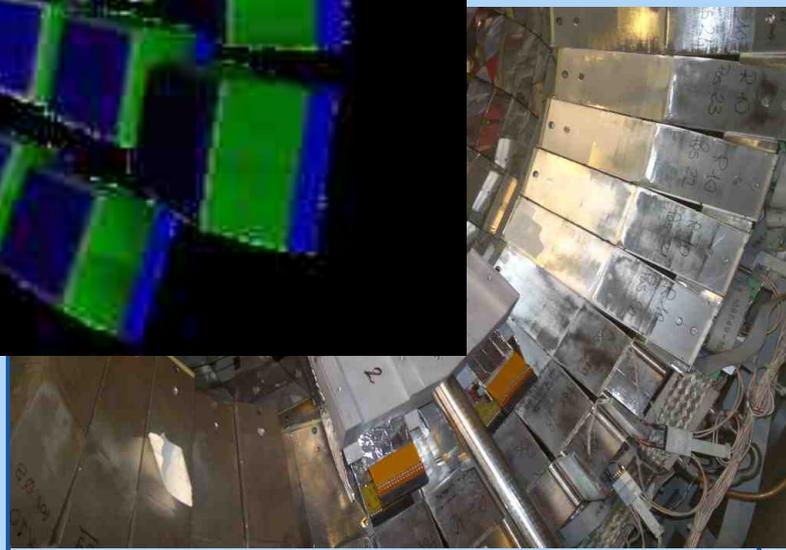


DE-E (300-1500 μm) T2 Farcos



LNS 2013 experiment:
inside the CHIMERA sphere

4 telescopes at 25 cm from the target
 $\theta_{\text{lab}} \sim 16^\circ - 44^\circ$ $\Delta\phi \sim 60^\circ$



General Electronics for TPCs (GET)

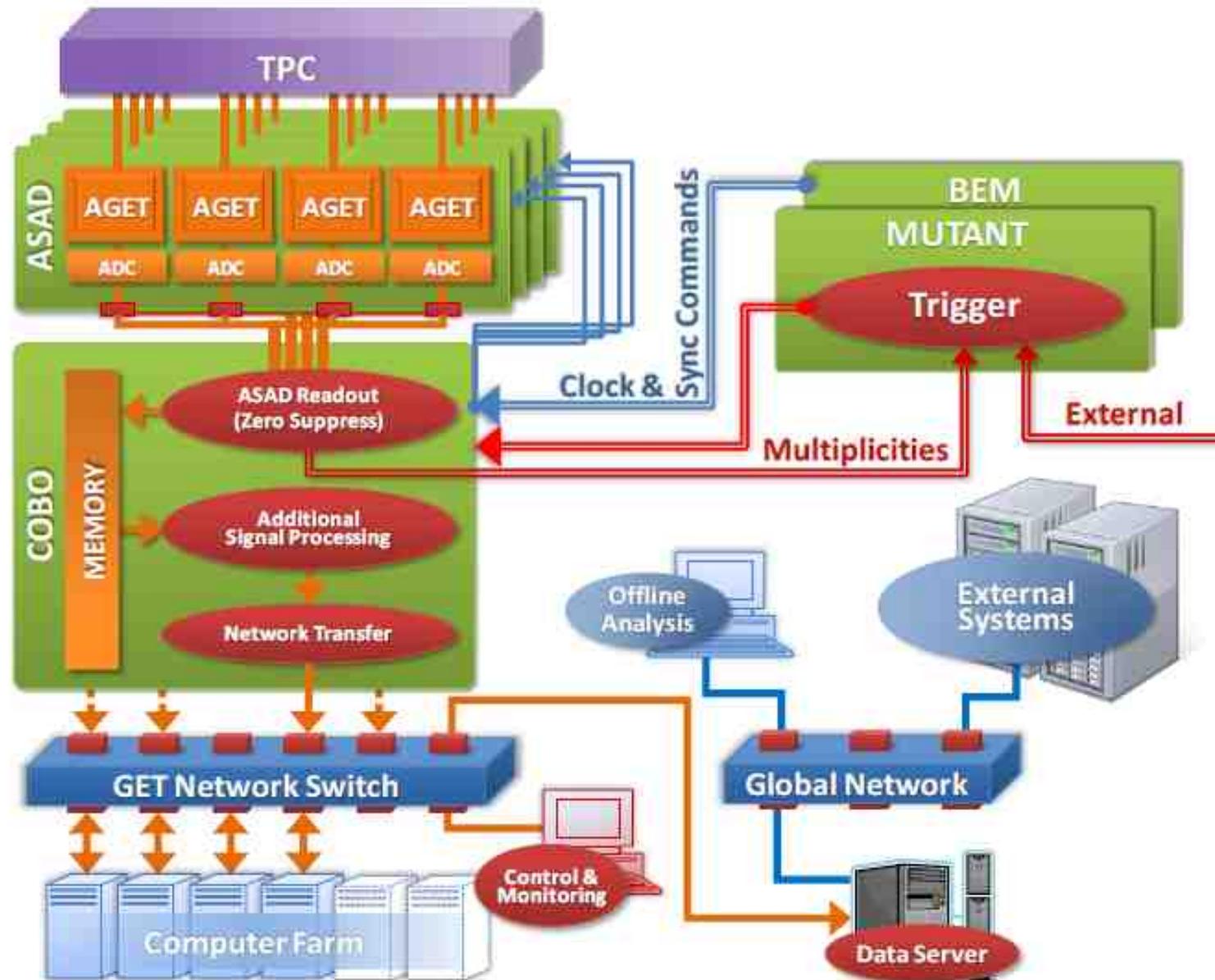
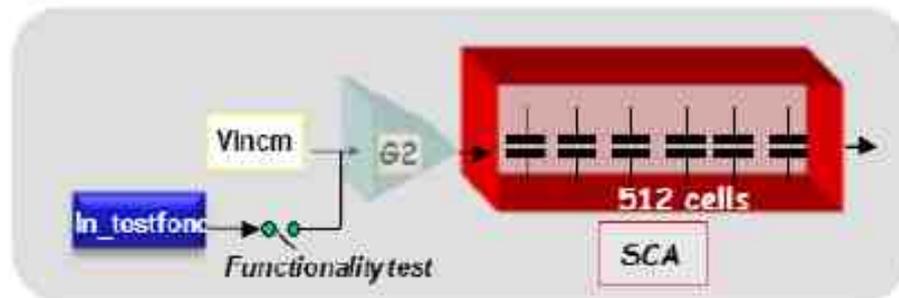


Fig. 1: Global view of the GET electronic.

2. Architecture of the front-end part of the channel



Structure of the fixed pattern noise channels from the AGET description document

Fig. 7: Schematic of a FPN channel.

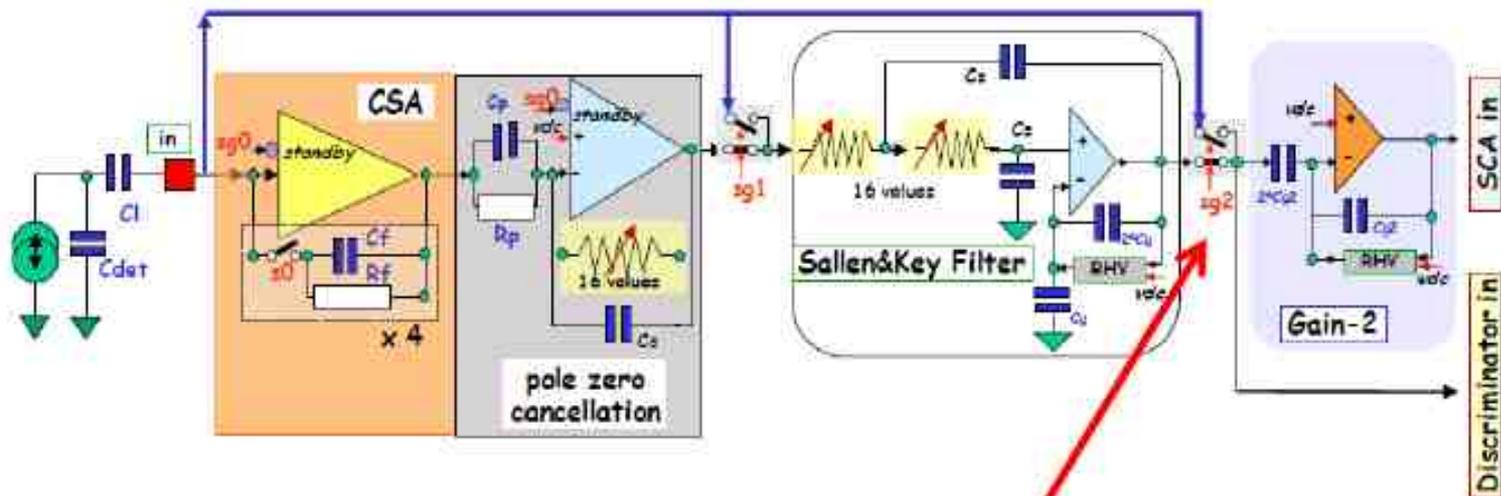


Fig. 5: Schematic of the front-end part of the analog channel.

The gain-2 input point used in the test

Parameter	Value
Polarity of detector signal	Negative or Positive
Number of channels	72
External Preamplifier	Yes; access to the filter or SCA input
Charge measurement	
Input dynamic range	120 fC; 1 pC; 10 pC
Gain	Adjustable/(channel)
Output dynamic range	2V p-p
I.N.L	< 2%
Resolution	< 850 e ⁻ (Charge range: 120fC; Peaking Time: 200ns; Cinchannel. < 30pF)
Sampling	
Peaking time value	50 ns to 1 μ s (16 values)
Number of SCA Time bins	511
Sampling Frequency	1 MHz to 100 MHz
Time resolution	
Jitter	60 ps rms
Skew	< 700 ps rms
Trigger	
Discriminator solution	LED
Trigger Output/Multiplicity	OR of the 72 hit channel registers; Width = 2xTSCAckread
Dynamic range	5% of input charge range
I.N.L	< 5%
Threshold value	4-bit DAC/channel + (3-bit + polarity bit) common DAC
Minimum threshold value	\geq noise
Readout	
Readout frequency	20 MHz to 25 MHz
Channel Readout mode	Hit channel; specific channels; all channels
SCA Readout mode	511 cells; 256 cells; 128 cells
Test	
calibration	1 channel / 72; external test capacitor
test	1 channel / 72; internal test capacitor (1/charge range)
functional	1, few or 76 channels; internal test capacitor/channel
Counting rate	< 1 kHz
Power consumption	< 10 mW / channel

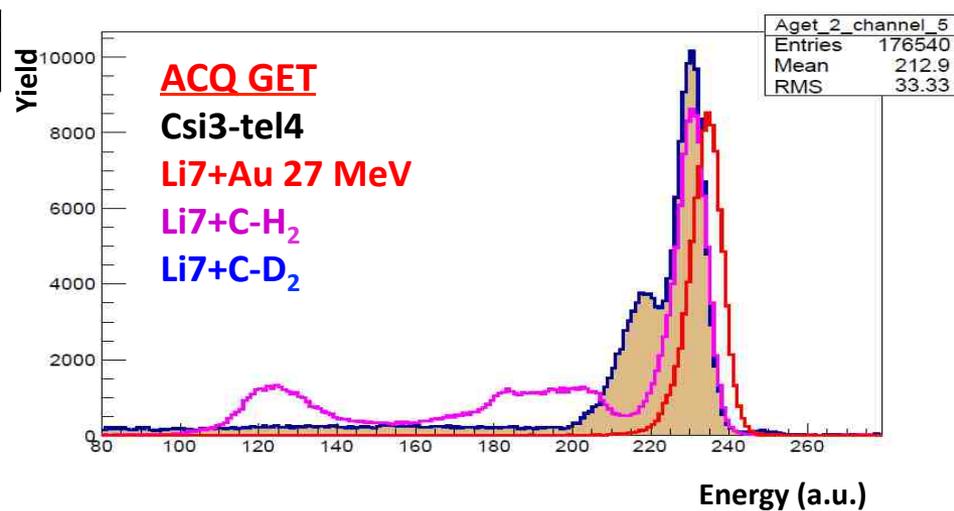
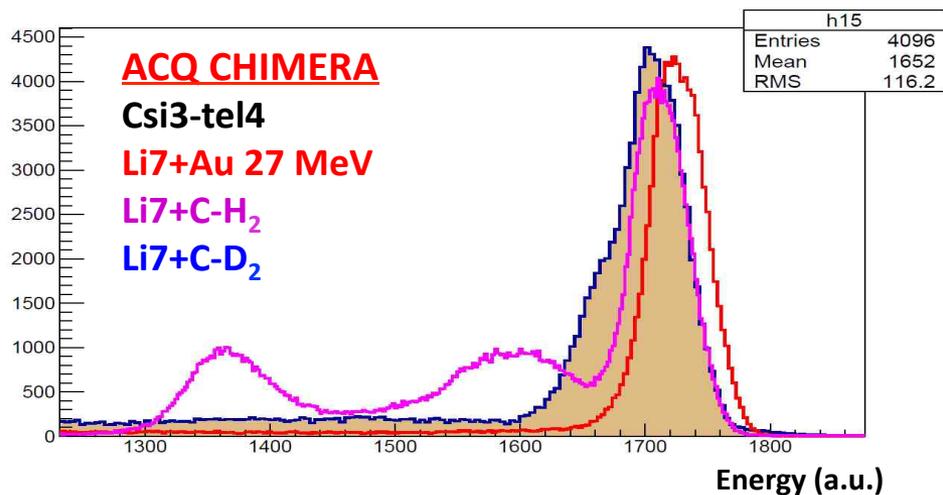
Table 1: The synthesis of the AGET requirements.

Test with GET Electronic: first results

Tandem beam ${}^7\text{Li}$ 27 MeV on various targets



Preliminary (March 2014)



Lab activity:

Acquisition of alpha and cosmic signals from CHIMERA CsI(Tl) with GET electronics

Cosa faremo:

CsI(Tl) di CHIMERA colpito da particelle alfa (da sorgente) e cosmici letto da fotodiode

Acquisizione di segnali dal PAC con elettronica GET

Campionamento del segnale CsI e dei Fixed Pattern Noise

Sottrazione del FPN dal segnale e ricostruzione della linea di Base

Filtraggio per ottenere il max (Energia)

Filtraggio per ottenere il RiseTime

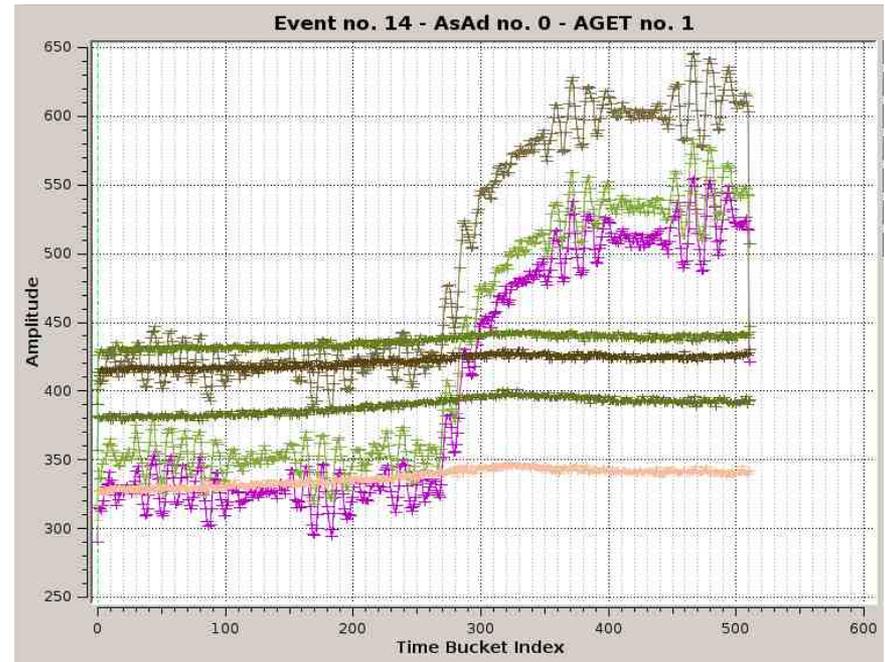
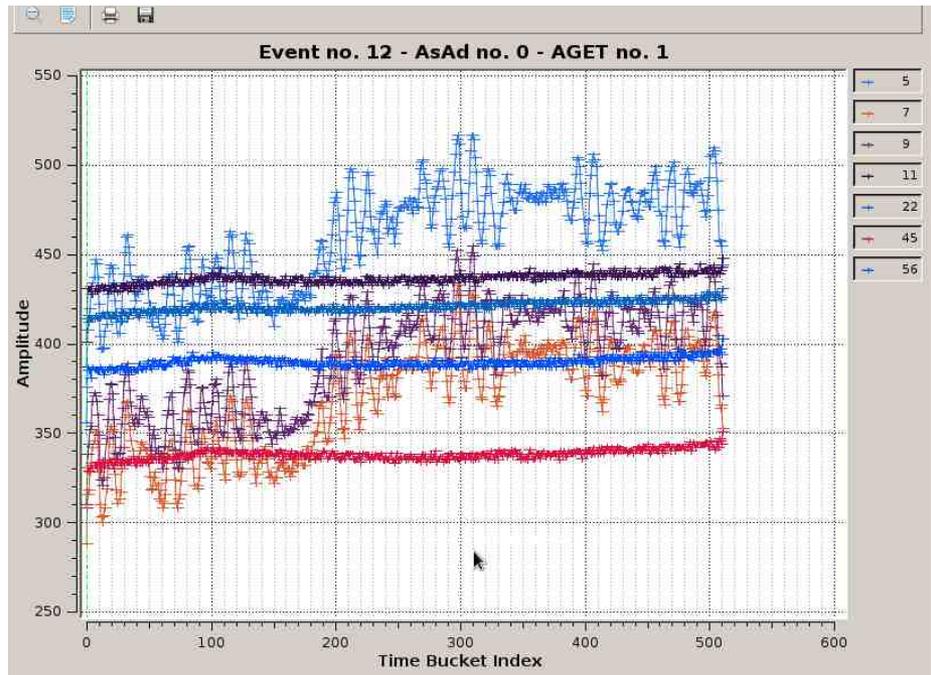
Costruzione della correlazione Energia-RiseTime per discriminare il tipo di particella

Lab activity:

CsI(Tl) di CHIMERA colpito da particelle alfa (da sorgente) e cosmici letto da fotodiodo

Acquisizione di segnali dal PAC con elettronica GET

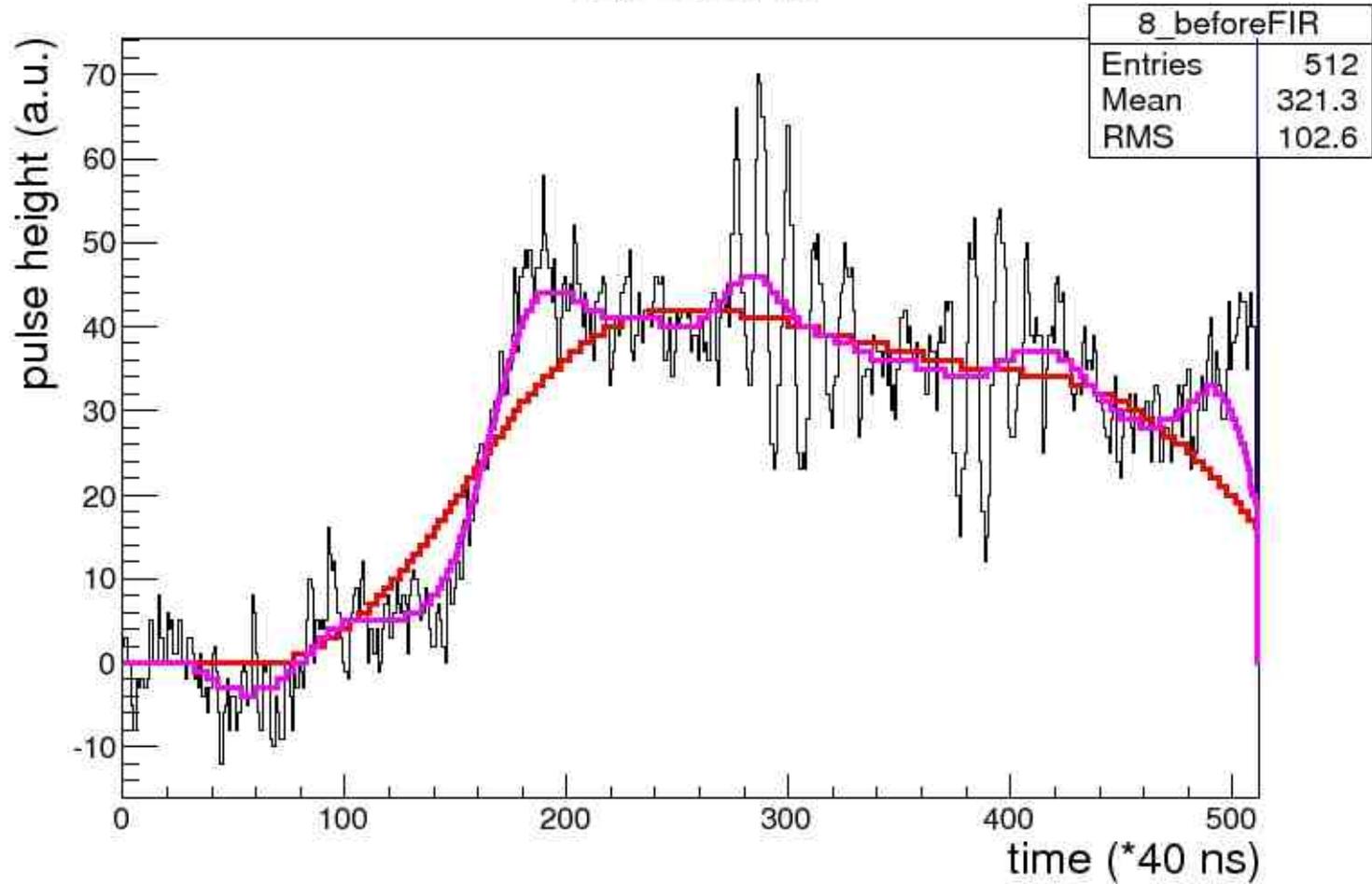
Campionamento del segnale CsI e dei Fixed Pattern Noise



Lab activity:

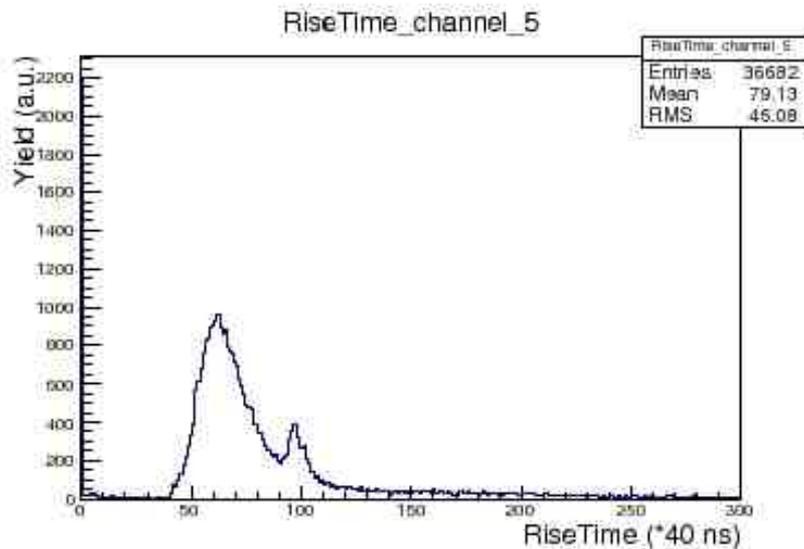
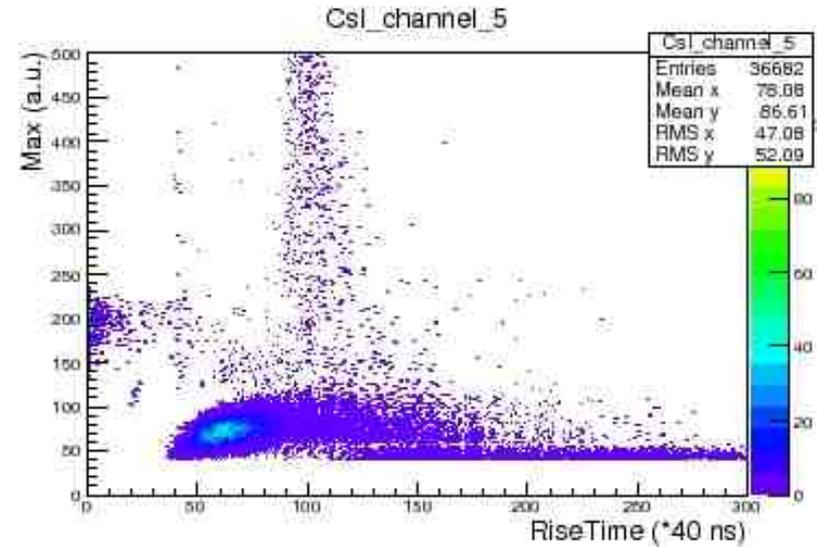
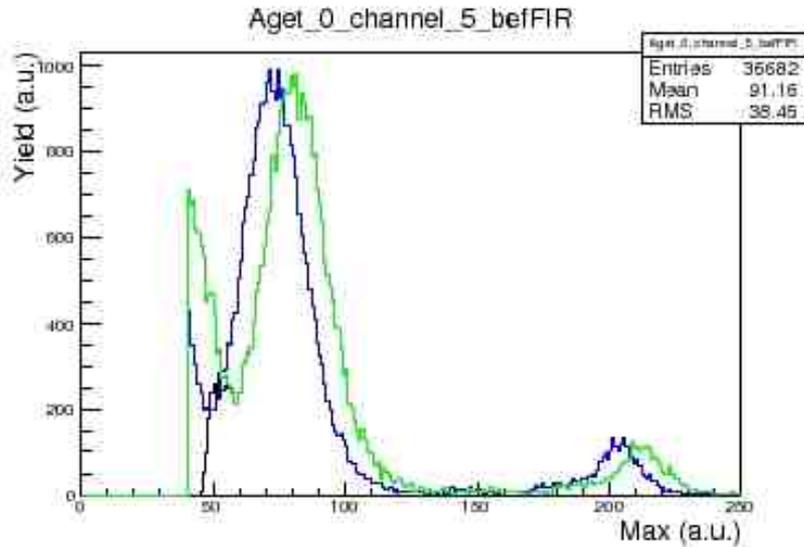
Sottrazione del FPN dal segnale e ricostruzione della linea di base

8_beforeFIR



Lab activity:

Costruzione della correlazione Energia-RiseTime per discriminare il tipo di particella



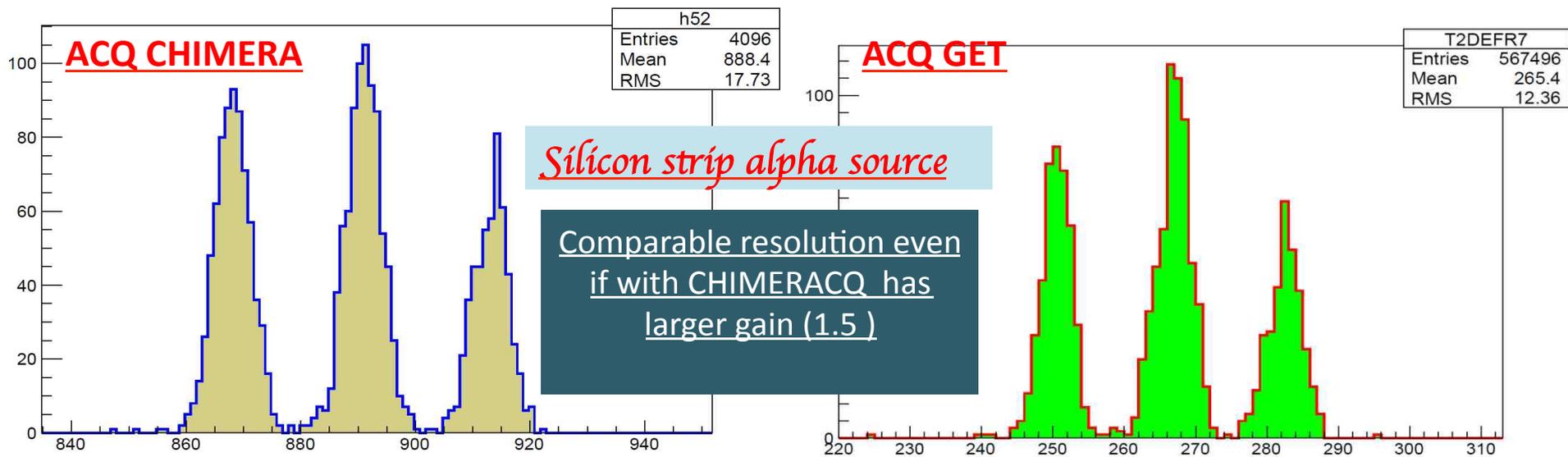
See you there!

FARCOS Physics case

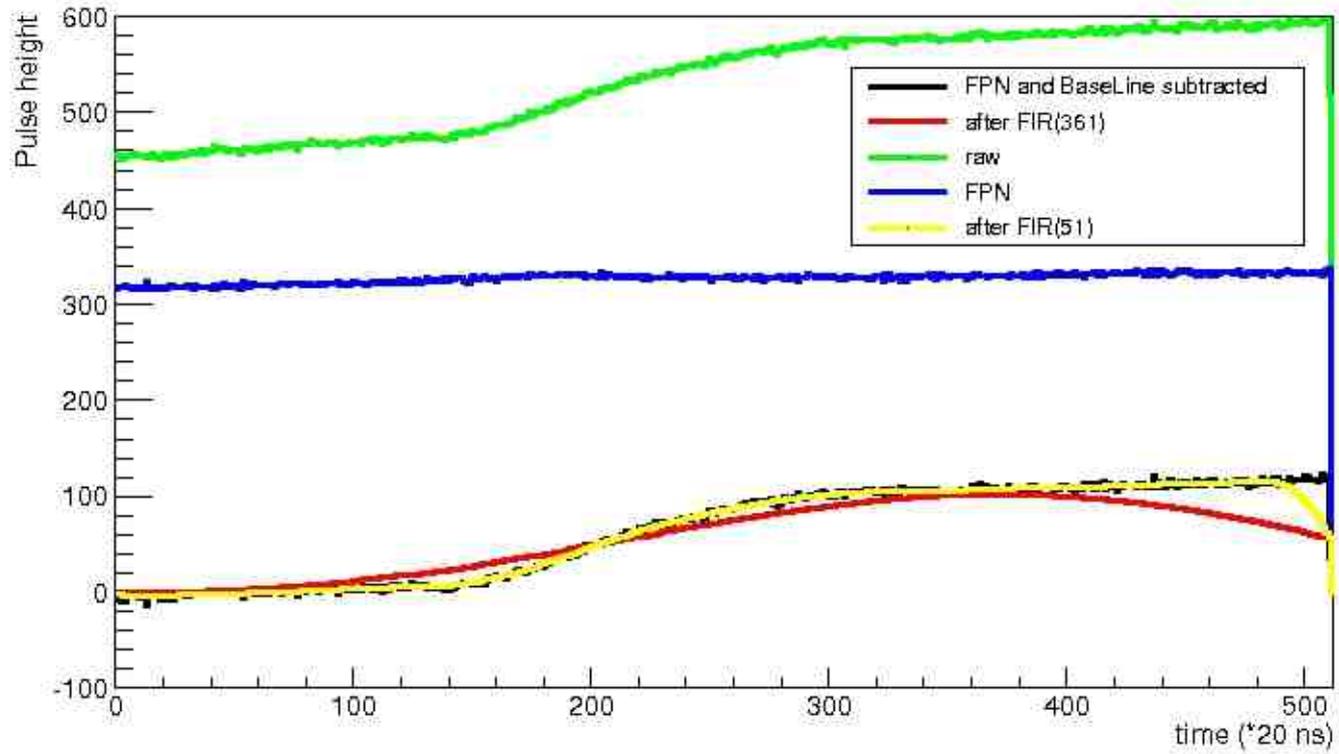
1. Dynamics in heavy-ion collision (low and intermediate energies, stable beams and RIB)
 - Femtoscopy: space-time probes of light particle emitting sources
2. Invariant mass spectroscopy (with stable and exotic fragmentation beams)
 - Multi-particle decay correlations
 - Cluster states (alpha-conjugate, boson condensates)
 - Direct reactions



Test with GET Electronic: first results

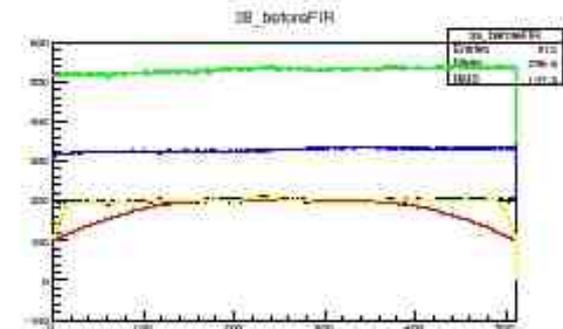
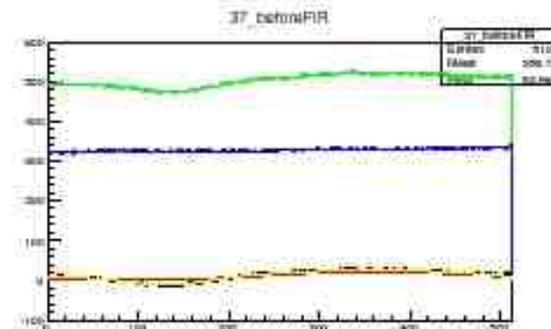
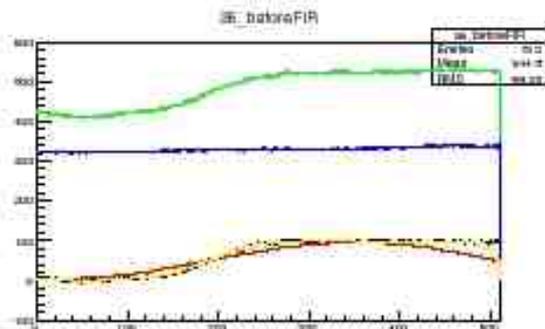
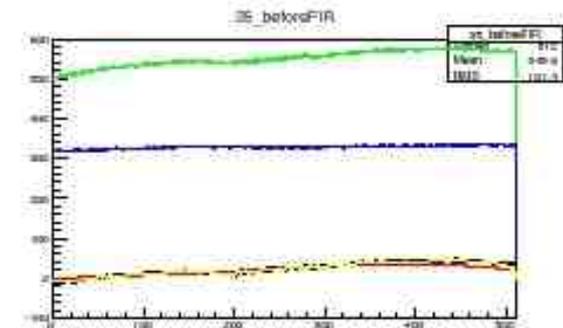
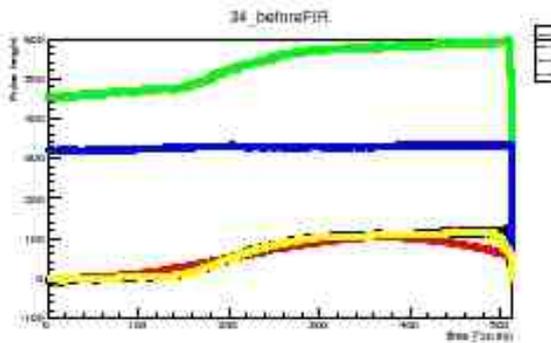
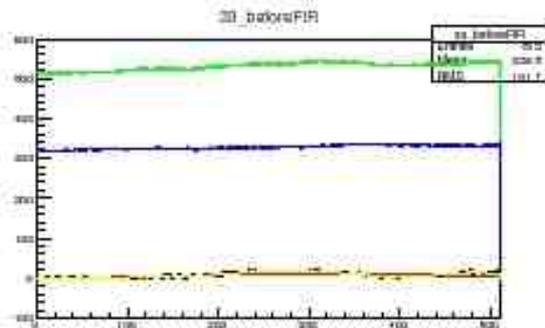
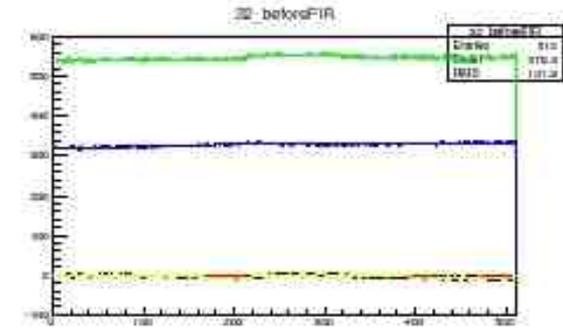
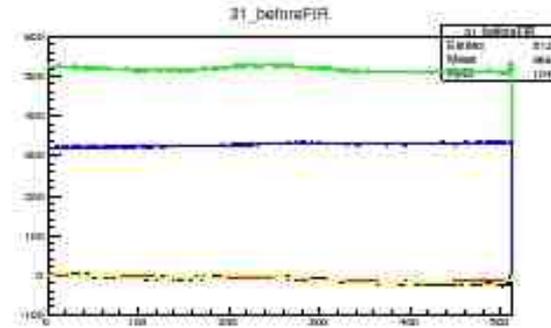
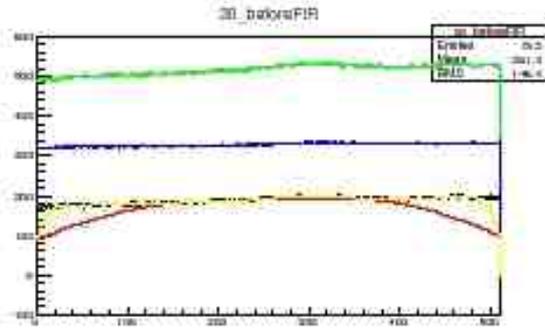


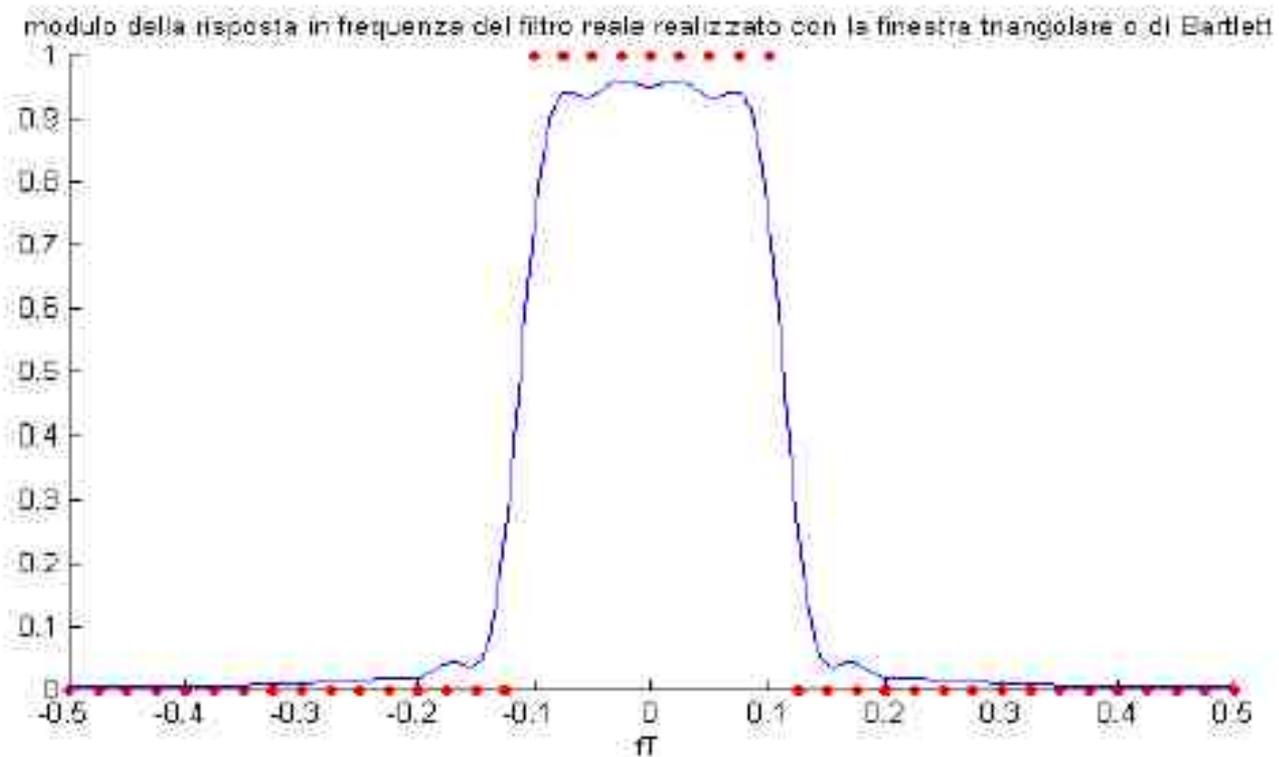
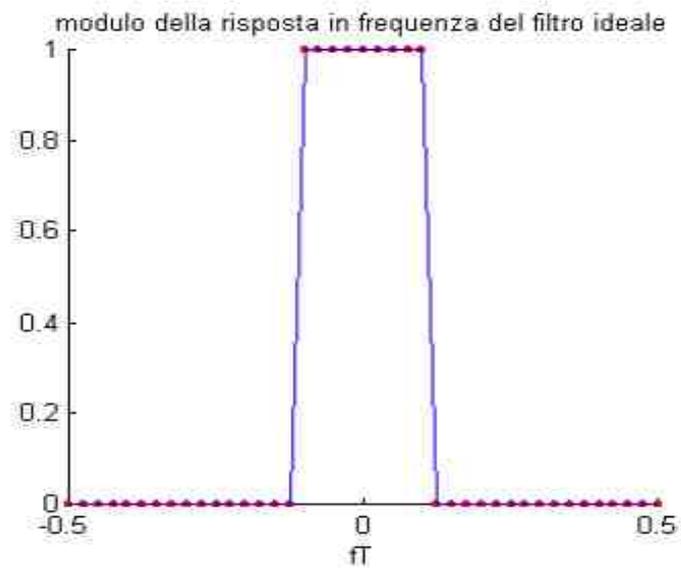
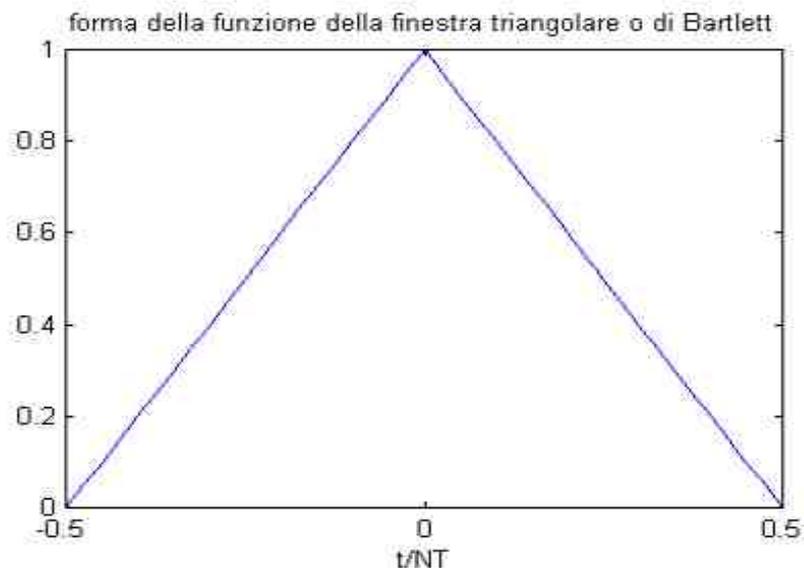
34_beforeFIR



34_beforeFIR
File No: 001
File No: 1001
File No: 0110

Lab activity II

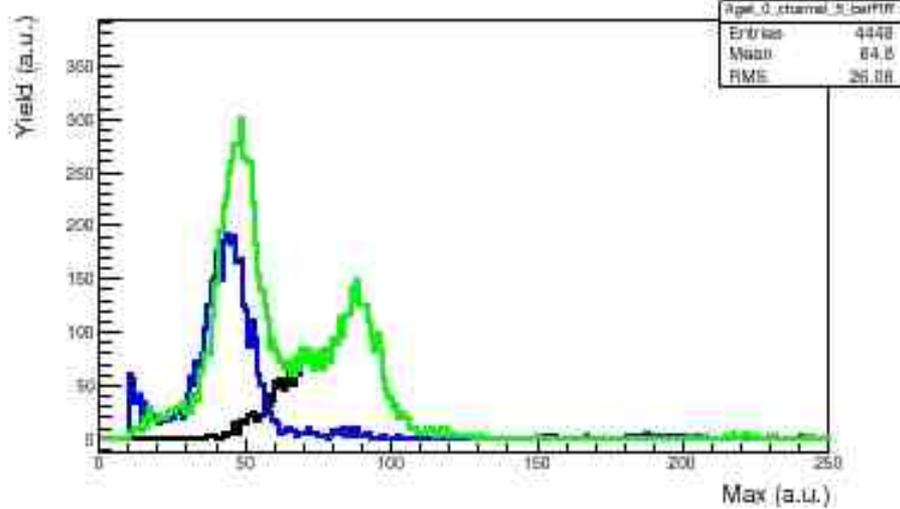




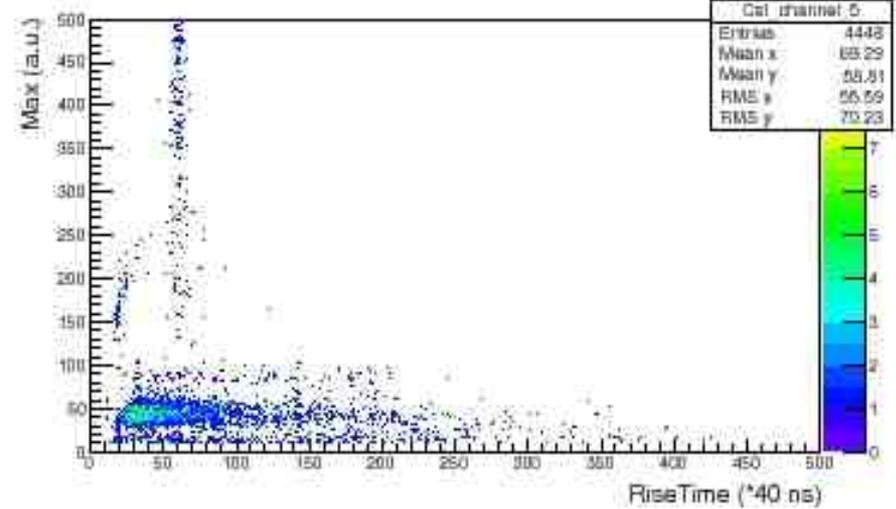
Lab activity:

Costruzione della correlazione Energia-RiseTime per discriminare il tipo di particella

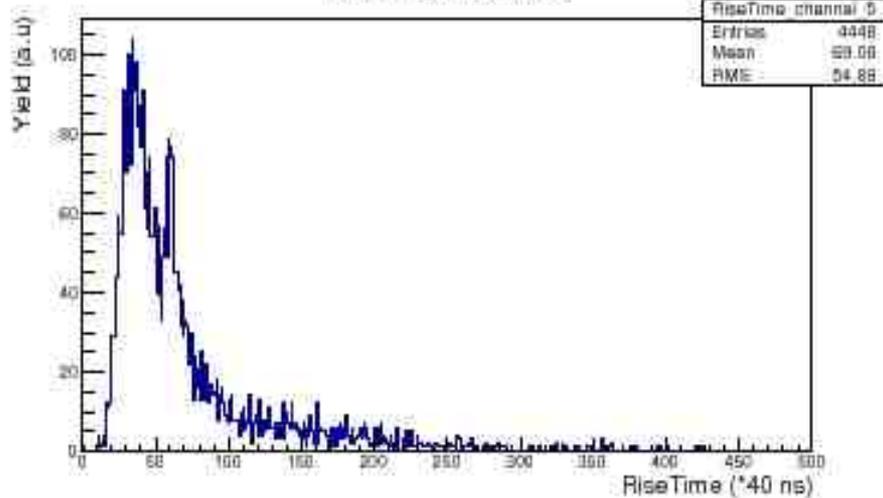
Aget_0_channel_5_befFIR



Csl_channel_5

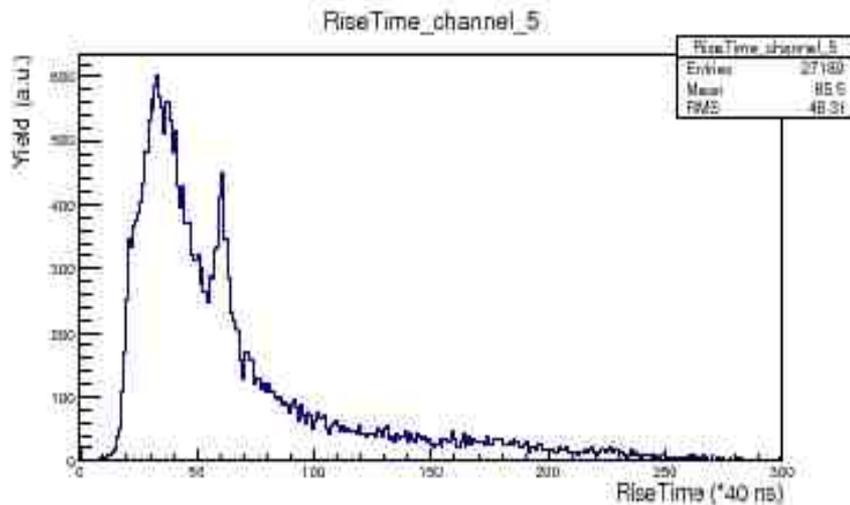
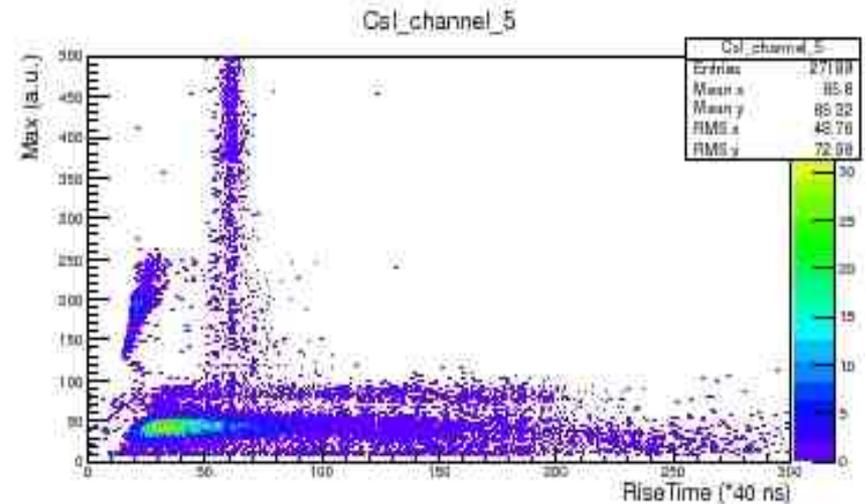
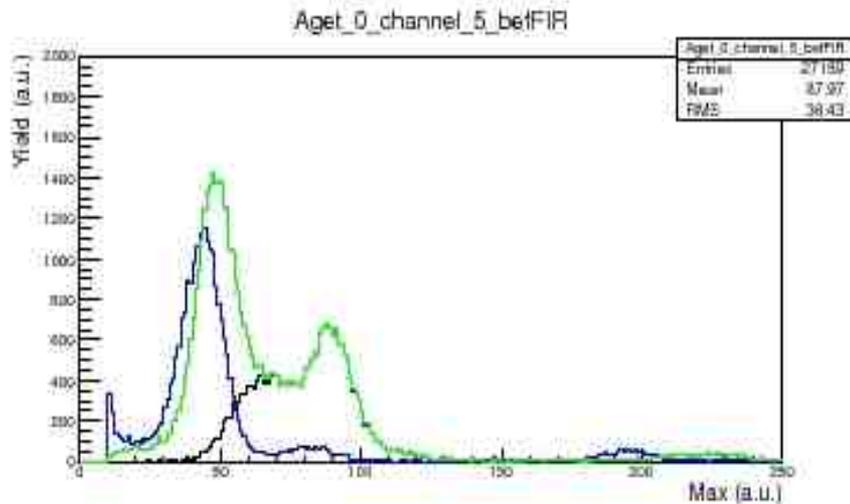


RiseTime_channel_5

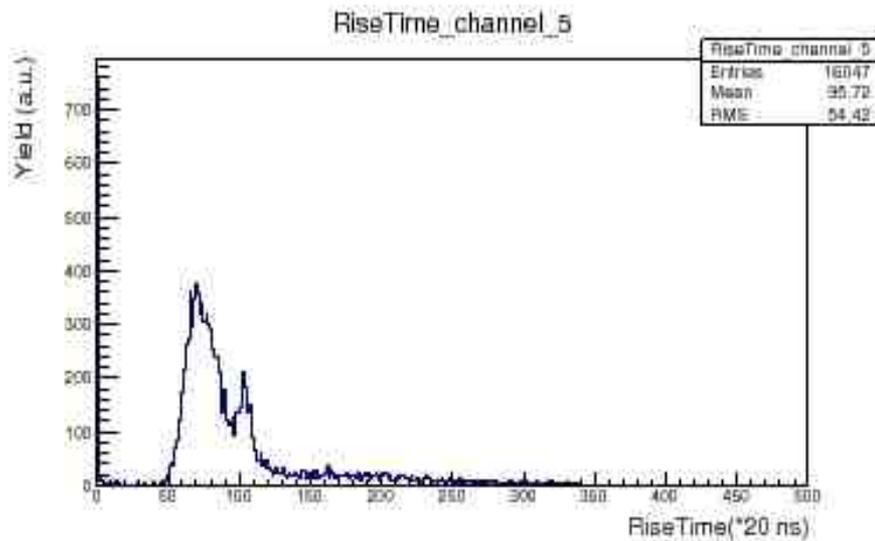
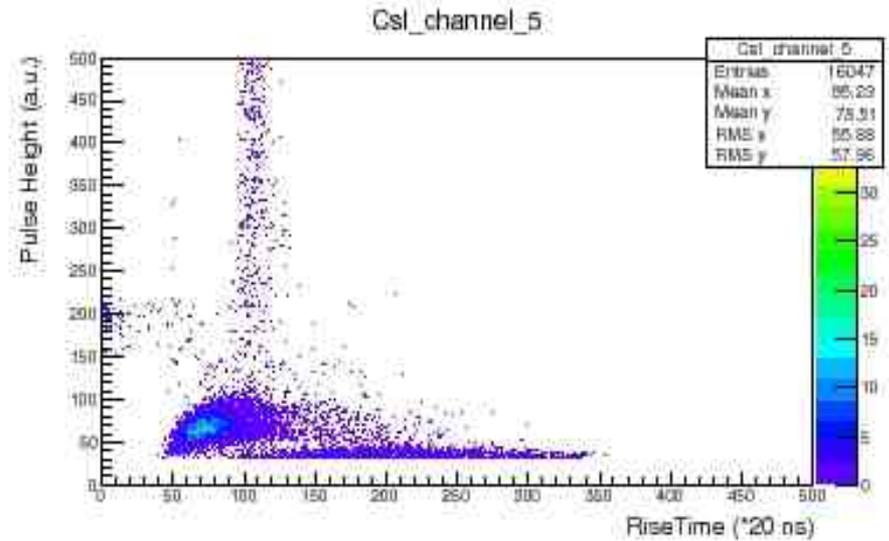
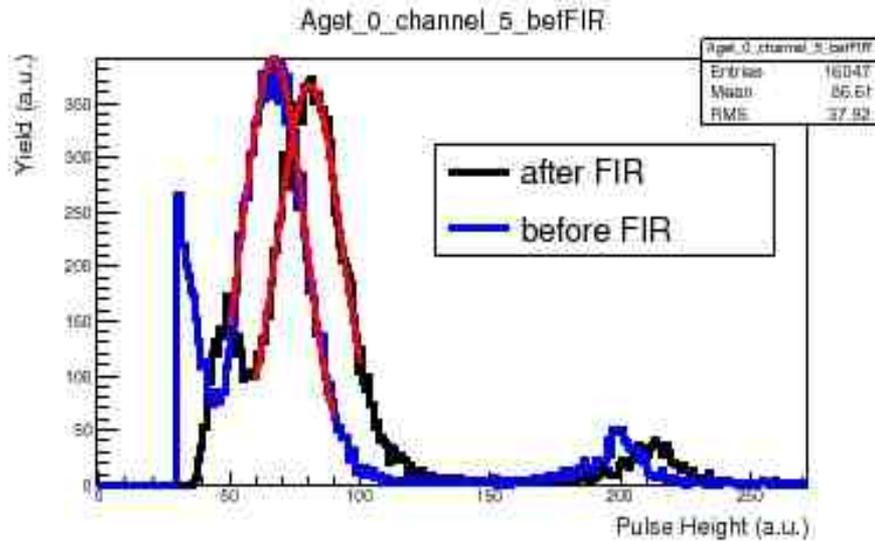


Lab activity:

Costruzione della correlazione Energia-RiseTime per discriminare il tipo di particella



Lab activity

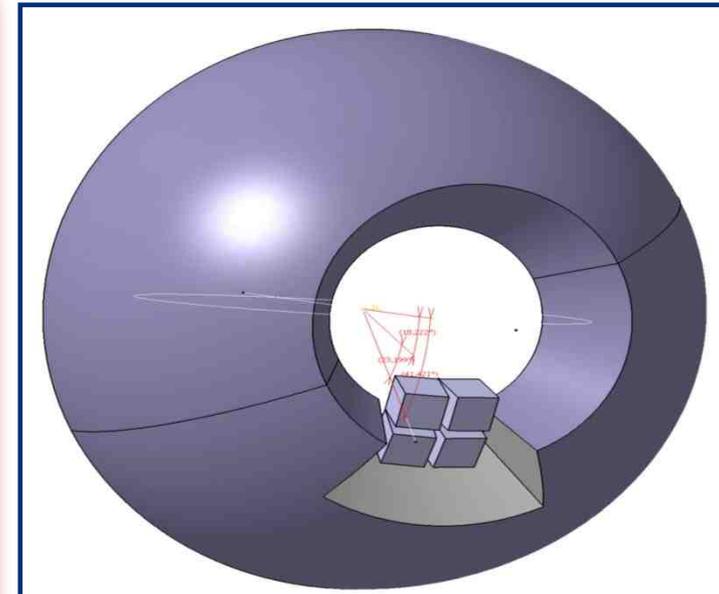
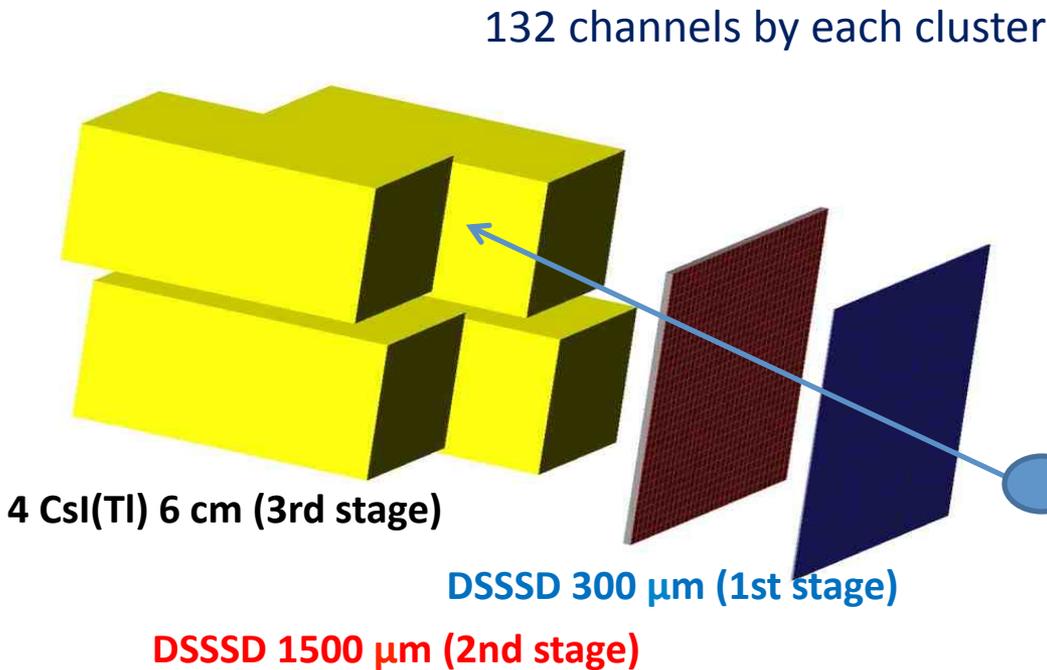


The InKiIsSy (INverse KInematics ISobaric SYSTEMS) April 2013

The idea is to use a projectile/target combination having the same mass of the neutron rich $^{124}\text{Sn}+^{64}\text{Ni}$ system and a N/Z similar to the neutron poor $^{112}\text{Sn}+^{58}\text{Ni}$ one, that is $^{124}\text{Xe}+^{64}\text{Zn}$, at the same bombarding energy of **35 AMeV** using the 4π detector CHIMERA and 4 modules of FARCOS prototype.

System	N/Z Projectile	N/Z target	N/Z compound
$^{124}\text{Sn}+^{64}\text{Ni}$	1.48	1.29	1.41
$^{124}\text{Xe}+^{64}\text{Zn}$	1.30	1.13	1.24
$^{112}\text{Sn}+^{58}\text{Ni}$	1.24	1.07	1.18

A new setup: the 4π CHIMERA + 4 modules of FARCOS prototype



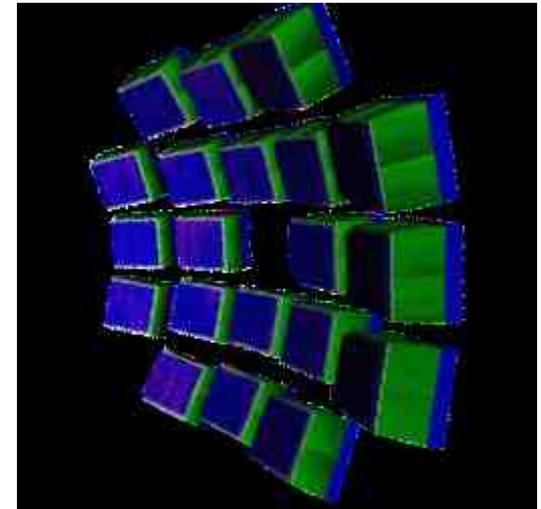
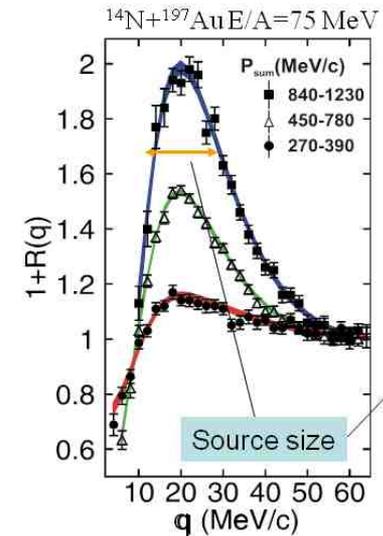
4 telescopes at 25 cm from the target
 $\theta_{\text{lab}} \sim 16\text{-}44$ deg, $\Delta\phi \sim 45$ deg

Conseguenze sperimentali

I rivelatori vanno posti ad almeno 50 cm per avere con fasci CS (dimensioni fascio dell'ordine di 5 mm) risoluzione angolare effettiva dell'ordine di $.5^\circ$

Le misure inkiissy hanno mostrato che si riesce ad ottenere una discreta statistica ma dobbiamo ancora verificare se sarà sufficiente dopo i tagli di centralità degli eventi

Per coprire lo stesso angolo solido della configurazione INKIISSY serviranno almeno il quadruplo di telescopi visto che sarà necessario raddoppiare la distanza di posizionamento.



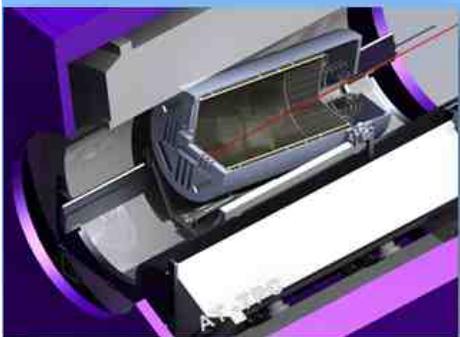
Quale elettronica per FARCOS?

Nell'esperimento INKISSY è stato utilizzato per la prima volta il prototipo del rivelatore FARCOS quali scelte per l'elettronica di questo rivelatore?

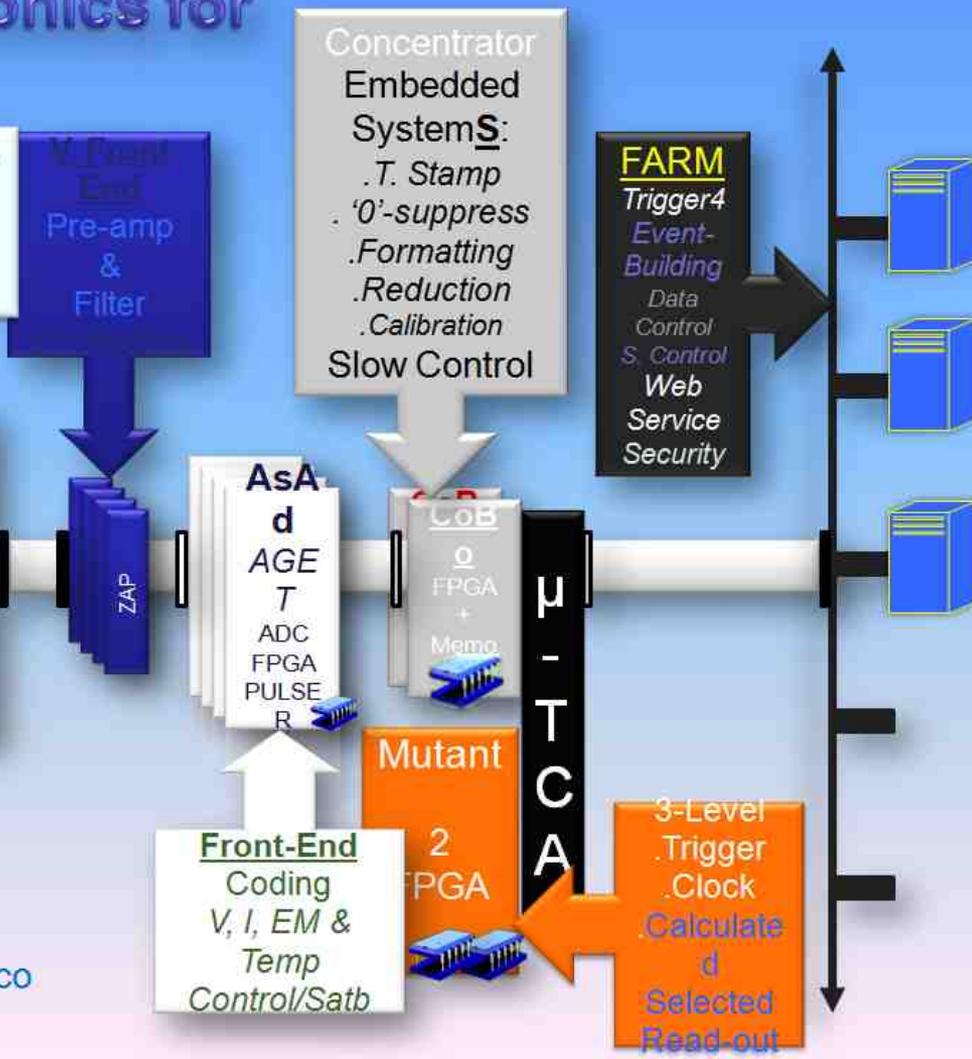
General Electronics for TPC

Generic Structure (H&S)

2¹² Final Dyn Range
10Gbit B.width
4 Level Digital Trigger



L. Pollacco

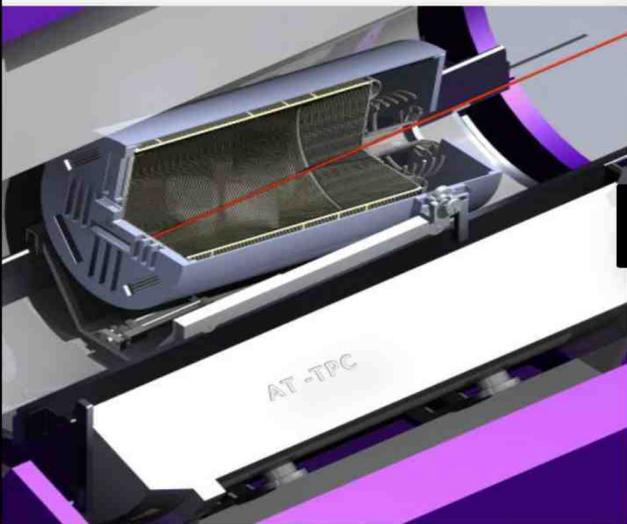


GET Electronics

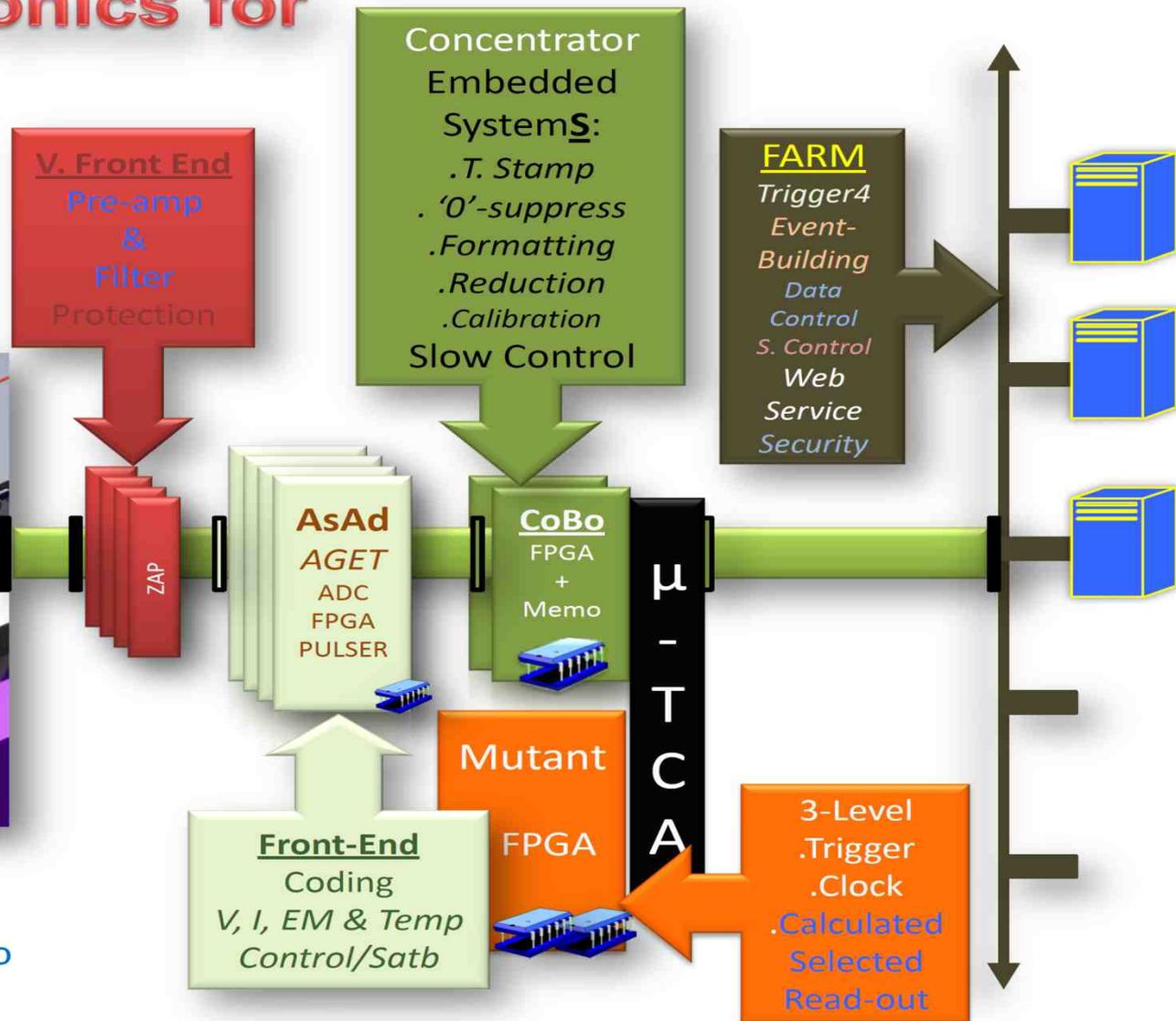
General Electronics for TPC

Generic Structure (H&S)

2¹² Final Dyn Rnge
10Gbit B.width
4 Level Digital Trigger



L. Pollacco



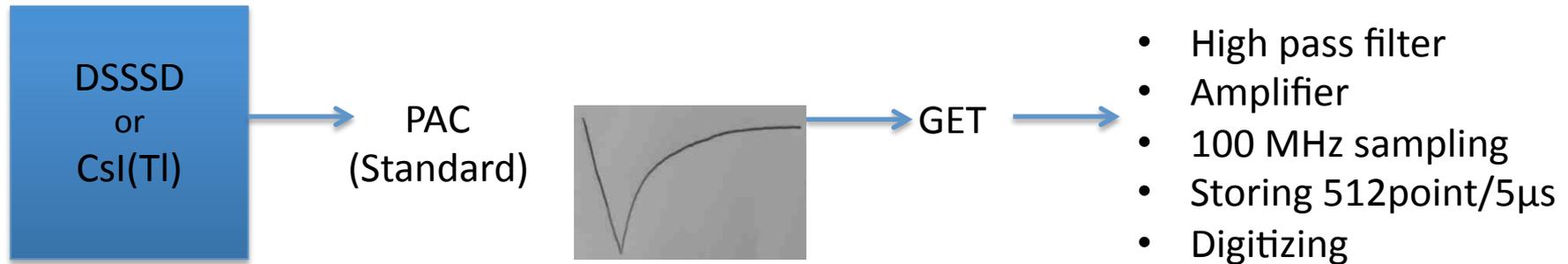
Catania, Italy
7 May, 2014



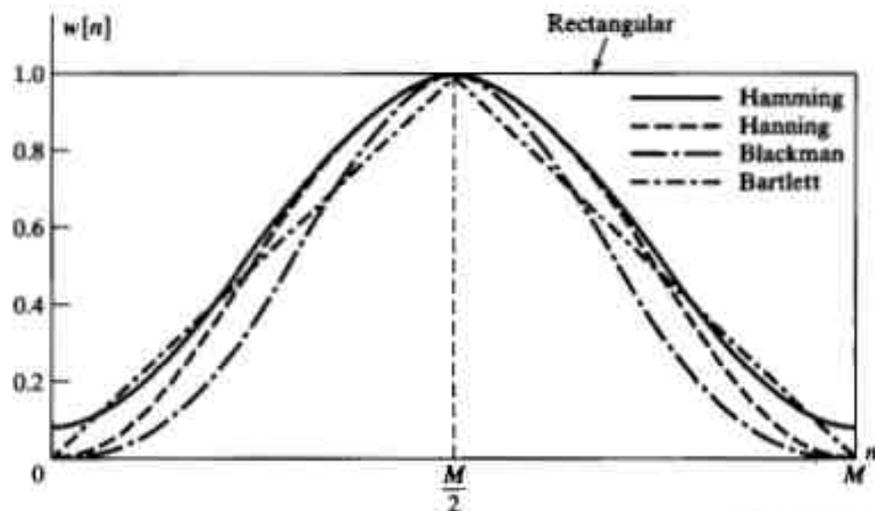
F. V. Pagano
Univ. of Catania & LNS-INFN

Test with GET Electronic

GET (General Electronics for TPC)



G.Cardella , T.Minniti, E. De Filippo et al.



Bartlett (triangular)

$$w[n] = \begin{cases} 2n/M, & 0 \leq n \leq M/2, \\ 2 - 2n/M, & M/2 < n \leq M, \\ 0, & \text{otherwise} \end{cases}$$

Hamming

Figure 7.21 Commonly used windows.