The recent Fazia activity and its programmes

Gaspard Hyde Trace Workshop in Padua, 25/27 march 2015

Four-π A Z Identification Array

http://fazia.in2p3.fr

Symmetries

Summary

The Fazia collaboration
Detectors and Electronics
Very recent results
Programme
Cooperation perpsectives (simple hints)

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Fazia collaboration

Participating countries: Italy France and Poland
Manpower Total: abount 45 people (technologists and techinicians included)
Consumed funds: 2006-2014 (around 800ke)

A special and warm thank to Elio Rosato for the contribution he gave to FAZIA

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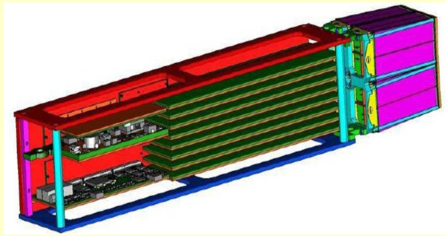
Fazia collaboration

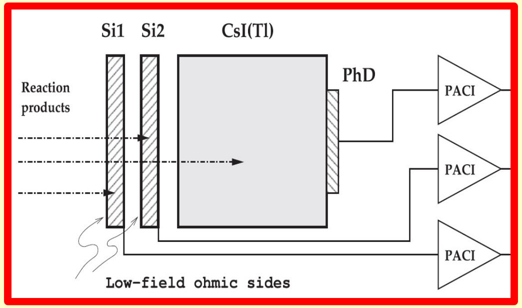
now

Az4pi 2003 | Nuclex 2006 | Spiral2pp | MoU 2011 | Demonstrator @ LNS 2014 2015 | Physics @ Ganil 2019

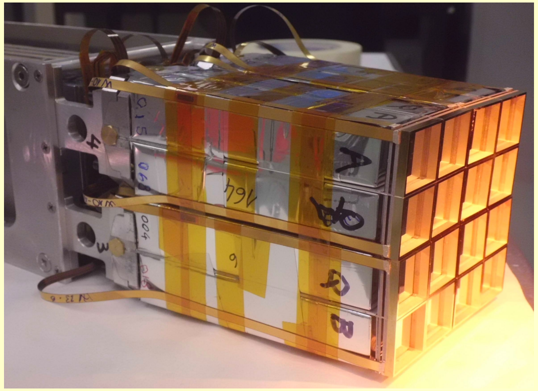
Phase0 STARTING: group assessment, Si-Si-CsI Telescope validation



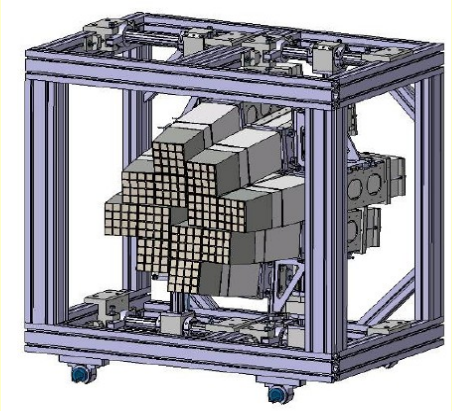
Phase1 R&D : Block design, FEE and DAQ prototyping



Phase2 CONSTRUCTION : from Teles to Blocks; commissioning



Phase3 DEMONSTRATOR (Faziatto) : experiments from LNS to GANIL with INDRA



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Why more powerful telescopes?

Some major PHYSICS themes

PHASE TRANSITIONS and EVENT CALORIMETRY
Reducing uncertainties from secondary to primary fragments

MULTIFRAGMENTATION
Better reconstruction of spinodal and freeze-out phases

SYMMETRY ENERGY and Nuclear EOS
A more complete view of isospin sensitive variables both in central (main hot source) and in semiperipheral events (QP and neck dynamics)

RARE DECAYS OF EXCITED EXOTIC SPECIES
Isospin effects and fragment formation at SPES energies (or higher)

➡ **Z and A identification with relatively <u>low thresholds</u>, with <u>wide dynamic range</u> and with <u>high acceptance</u>**

New solutions for telescopes and electronics

Four-π A Z Identification Array
http://fazia.in2p3.fr

Silicon recipe:

- nTD detectors for very high doping homogeneity (less than 3%)
- Random wafer cut to avoid channeling waveform fluctuations
- Reverse mounting to stress the signal shape variations for various ions
- Automatic continuous Silicon operating voltage follower

CsI(Tl) recipe:

- Contolled Tl doping with 'severe' constraints on the manufacturing
- Custom Photodiode sensors for maximum light collection
- New wrapping reflecting material to minimize fluorescence absorpion

Original performing Electronics :

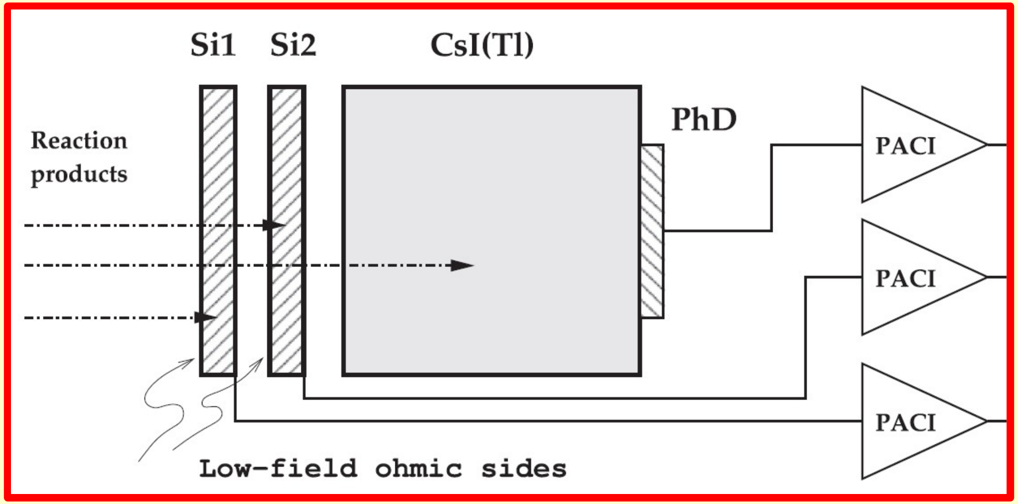
- Custom low noise preamp with charge and current output
- Fast Digital stages (100 and 250 MHz, 14 bit ADC)
- Embedded functions/regulations on the same multilayer board

Review article → R. Bougault et al. (FAZIA Coll.), Eur. Phys. J. A 50, 47 (2014)

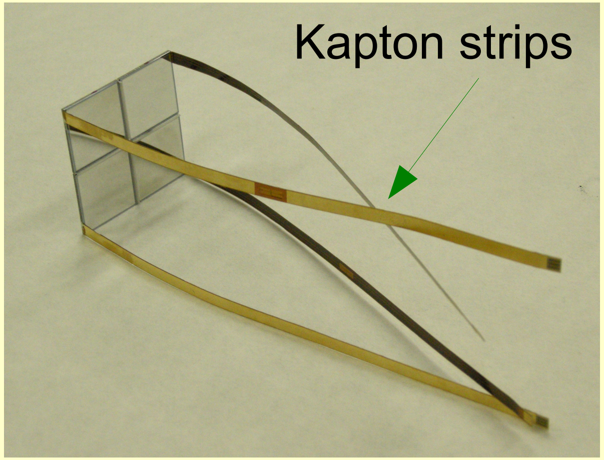
The basic Fazia detectors

Valuable work of
E.Scarlini on Slii-det
(Firenze)

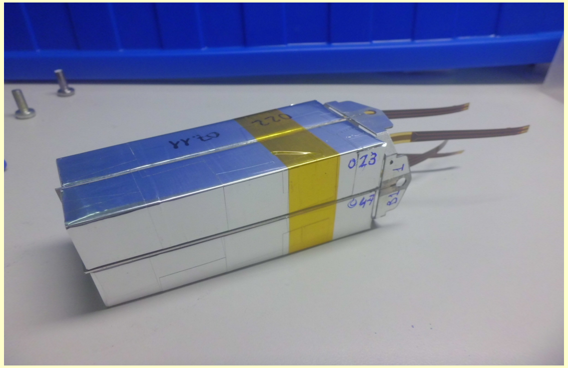
Silicons
20x20mm2
nTD type
ρ~3-4000 ohm*cm
300 and 500 μm
7deg cut off <100>



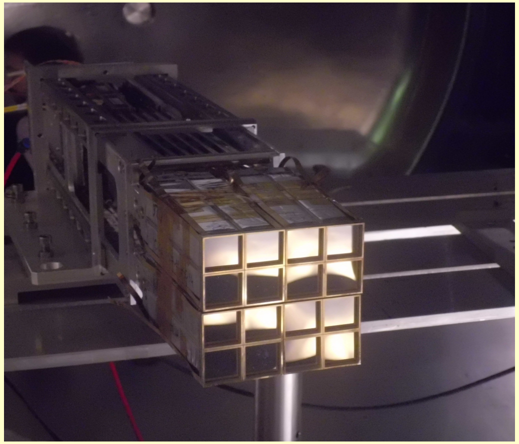
CsI(Tl)
20x20mm2 tapered
1500-2000ppm Tl-doping
Uniform doping
10 cm thick



Quartetto of Si mounted on Al (Ergal) support



Quartetto of CsI(Tl)

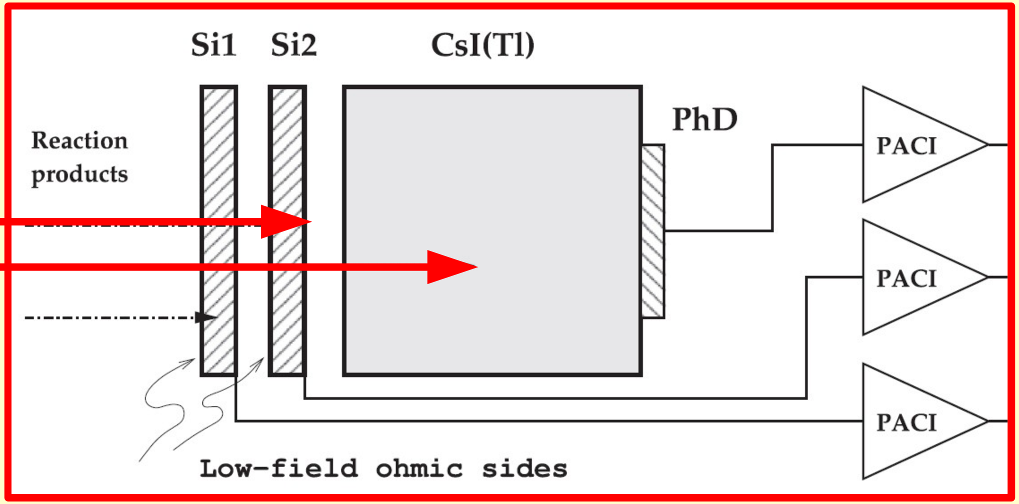


A BLOCK of 16 Telescopes
(brass collimators in front)

The detectors

Valuable work of
<u>E.Scarlini</u> on Slii-det
(Firenze)

Silicons
20x20mm2
nTD type
ρ~3-4000 ohm*cm
300 and 500 μm
7deg cut off <100>



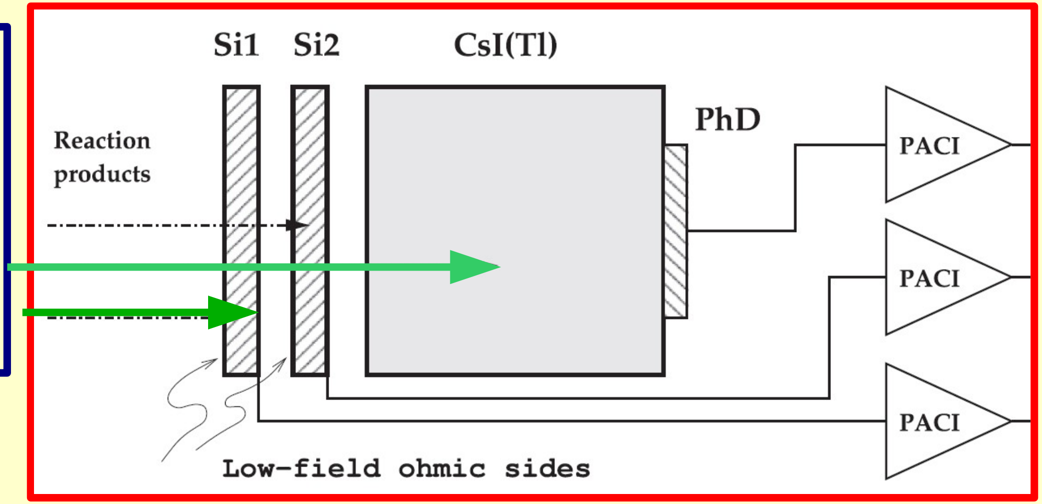
CsI(Tl)
20x20mm2 tapered
1500-2000ppm Tl-doping
Uniform doping
10 cm thick

DE-E technique
Si1 vs. Si2 Deposited Energy
Si1+Si2 vs CsI Deposited Energy

The detectors

Valuable work of
<u>E.Scarlini</u> on Slii-det
(Firenze)

Silicons
20x20mm2
nTD type
ρ~3-4000 ohm*cm
300 and 500 μm
7deg cut off <100>



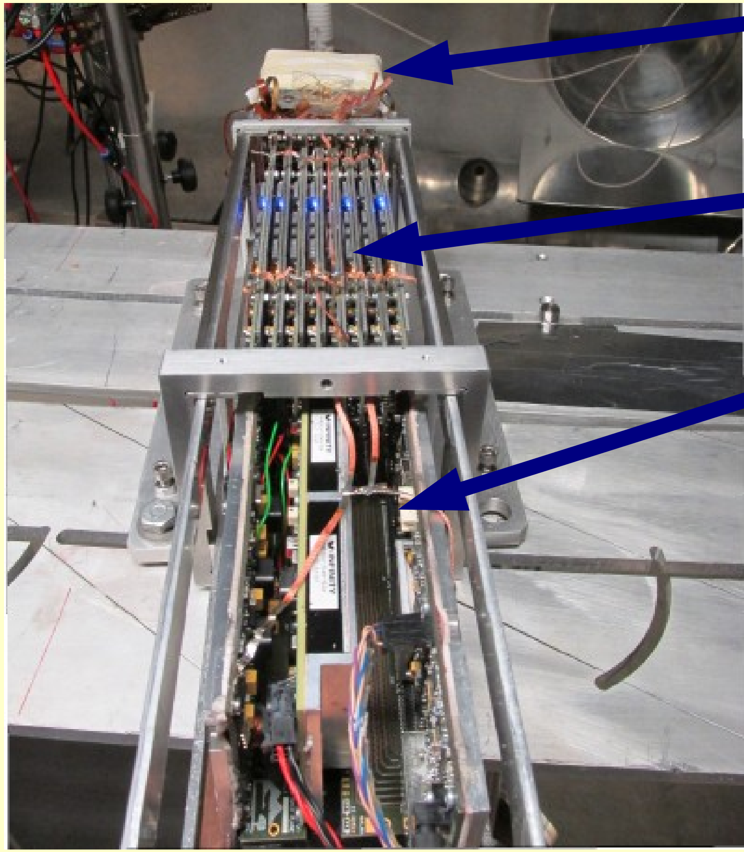
CsI(Tl)
20x20mm2 tapered
1500-2000ppm Tl-doping
Uniform doping
10 cm thick

DE-E technique
Si1 vs. Si2 Deposited Energy
Si1+Si2 vs CsI Deposited Energy

PSA
Si1 (and Si2) IMAX, Qrisetime
CsI fast-slow

The basic FAZIA Block

@ LNS



telescopes

FEE boards, 6x8 channels

HV stage, Block Card, electro-optical coupling

BLOCK: is the stand-alone FAZIA Module

- 16 Si-Si-Telescopes
- 8 FEE Cards wit 48 lines of preamplifiers, ADC and
- FPGA
- Power Generators and regulators. Pulser generation and control

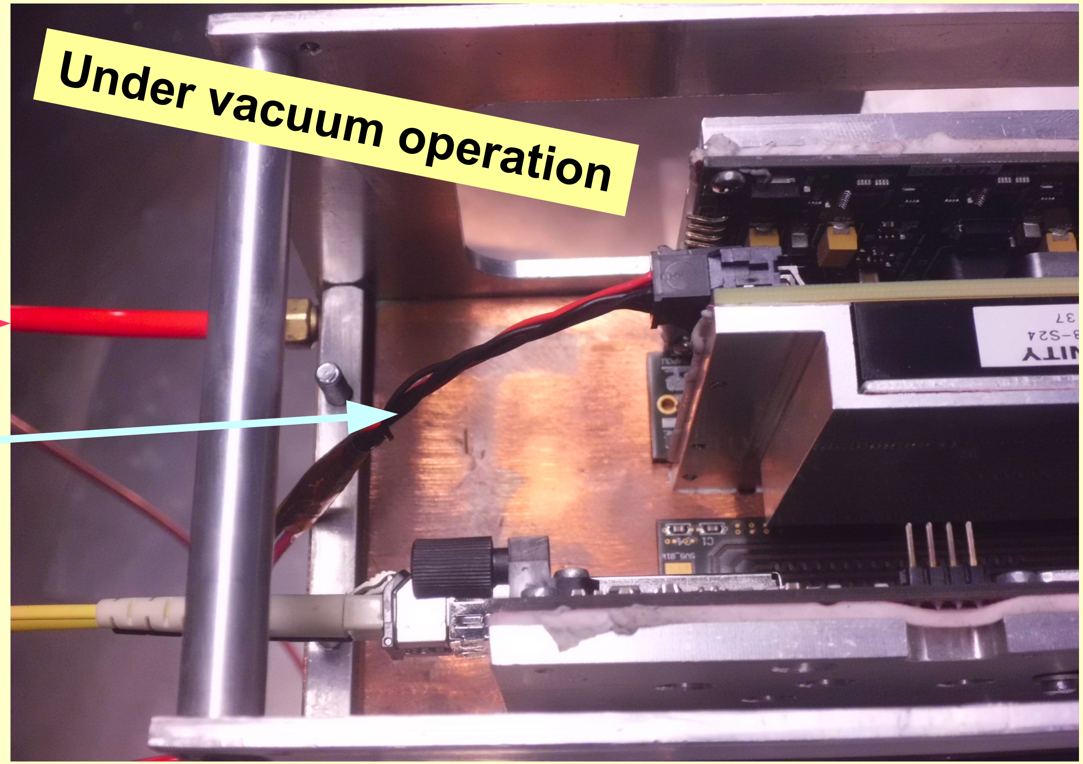
Powerful electronics

High Power, cooling, large data Bandwidth: all on a few cables !

COOLING — Water cooling pipe

POWER — 48V 'parent' Power supply

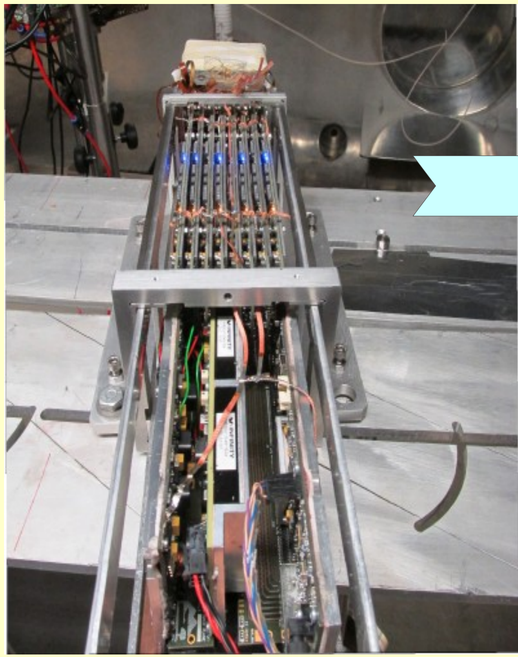
I/O DATA — 3GB/s optical fibers

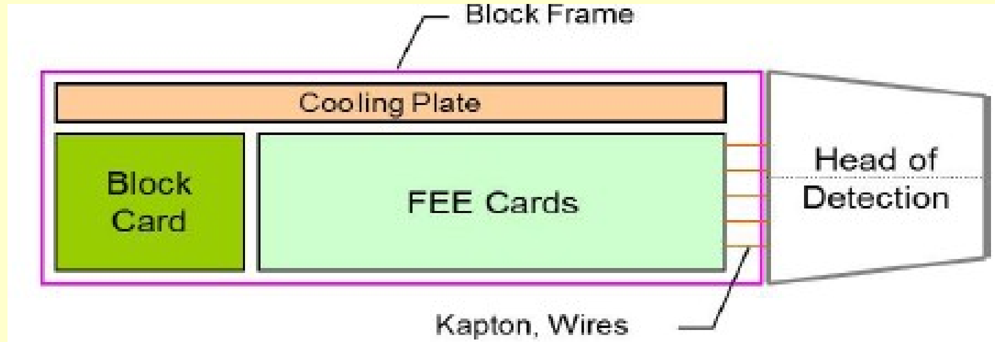


MAJOR CONTRIBUTIONS: **IPN (Orsay), INFN Naples and INFN Florence**

An original electronics

Charge and current l.n. Preamps; 48 channels on 8 FEE cards. Each FEE contains with 6 channels





Stage 1 (300 μm silicon detector):
- Charge: 250 Ms/s 14 bit (250MeV full scale)
- Charge: 100 Ms/s 14 bit (4 GeV full scale)
- Current: 250 Ms/s 14bit

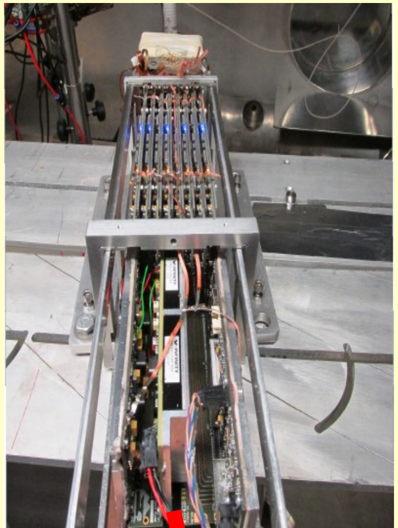
Stage 2 (500 μm silicon detector):
- Charge: 100 Ms/s 14 bit (4 GeV full scale)
- Current: 250 Ms/s 14bit

Stage 3 (10 cm CsI(Tl) + photo-diode):
- Charge: 100 Ms/s 14 bit (4 GeV silicon-equivalent full scale)

IPN (Orsay)

An original electronics

UP TO PRESENT

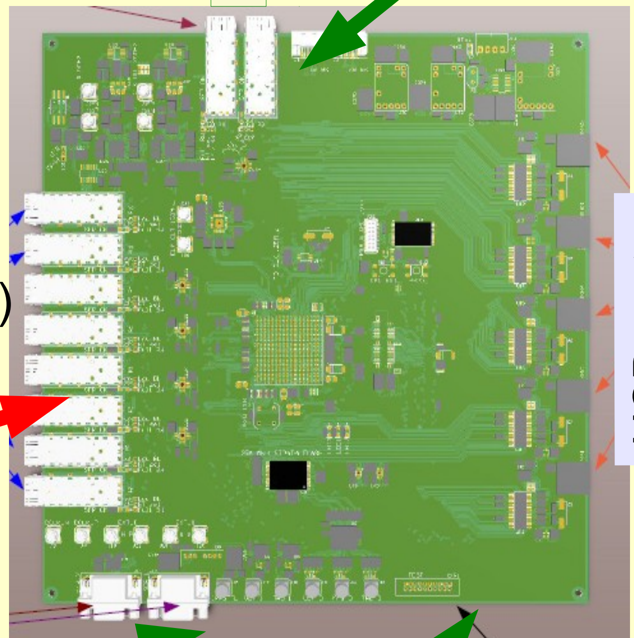


Fiber from BLOCK CARD

To PC

Ethernet 1000BaseSX (50MBps)

(8x)



USB ports

RS232 ports

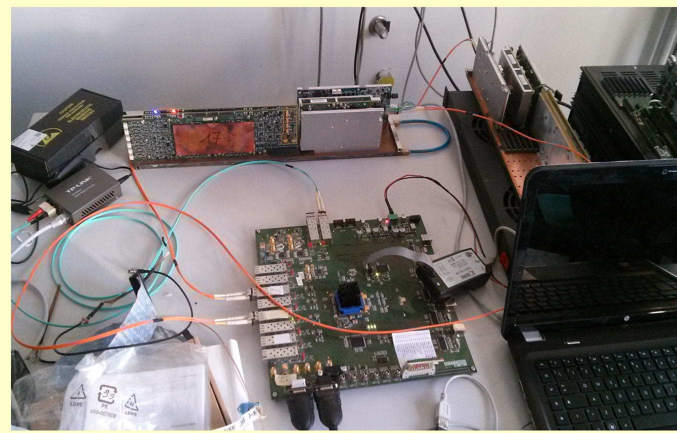
Zone for possible CENTRUM connector (GANIL DAQ dialogue)

TEST CARD PCB
A.Boiano
G.Tortone
A.Ordine
R. LaTorre (grant)

INFN Na

SW recent developments
M.Bini
S.Valdrè (PhD)

INFN & Uni Fi

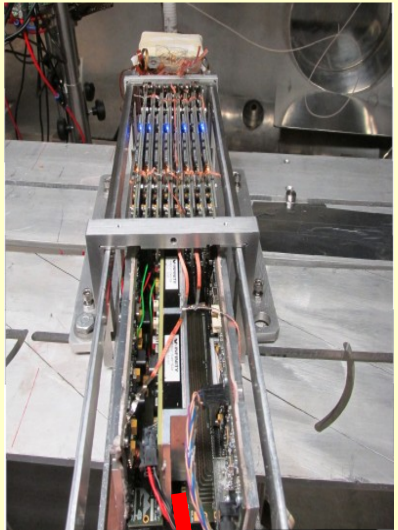


An original electronics

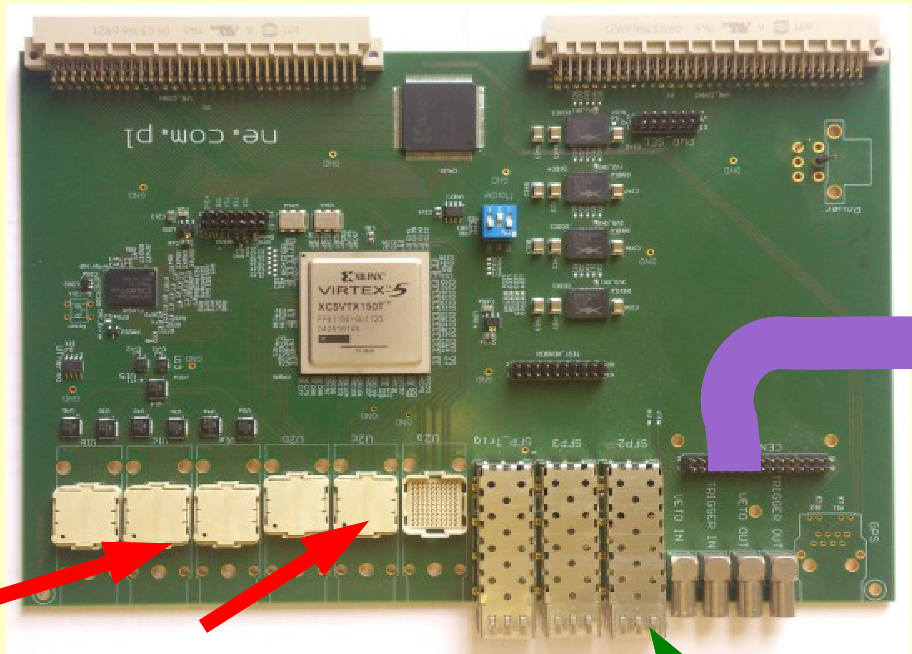
NEXT FUTURE

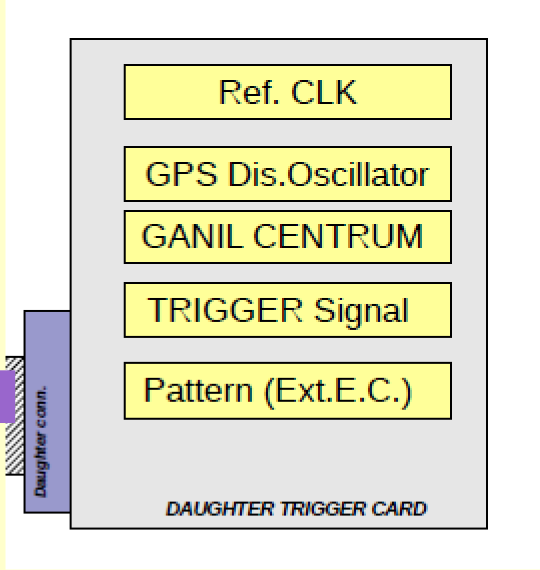
REGIONAL BOARD
M. Palka and
UNI Krakow
+ Na and Fi contributions

The Test Card is for 2015 experiments; then it will be replaced with this Regional Board



Fiber from BLOCK CARD





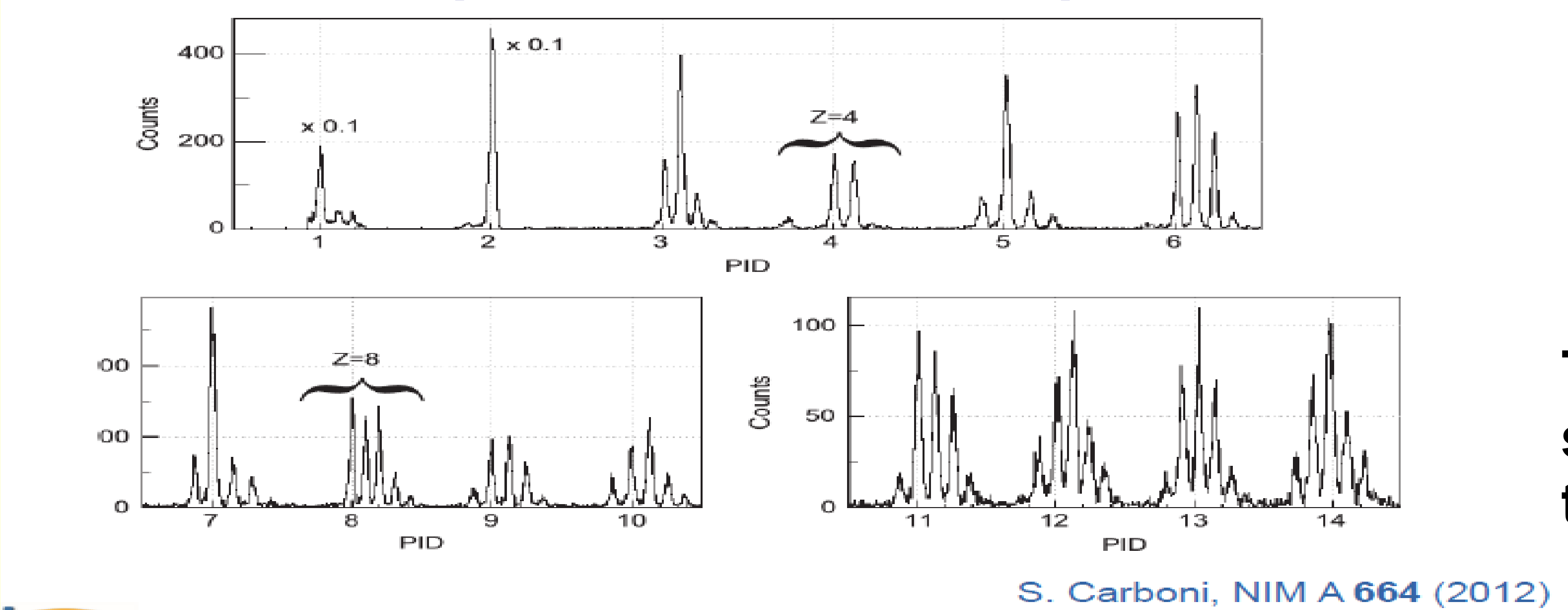
Snap12 Minipods
(trasmitters and receivers)

SFP 3Gbit

Capable of handling 36 blocks (3x12 sets)

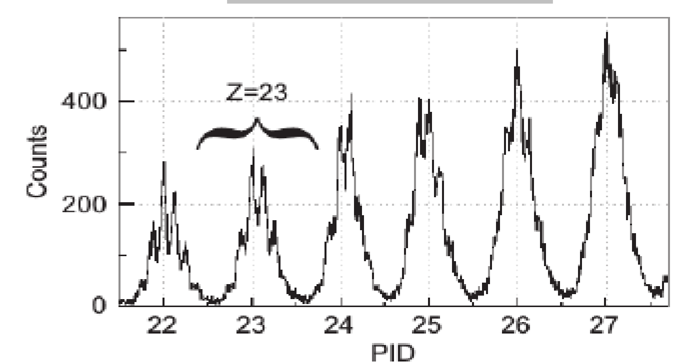
Results from Phase1

Improved ΔE-E technique

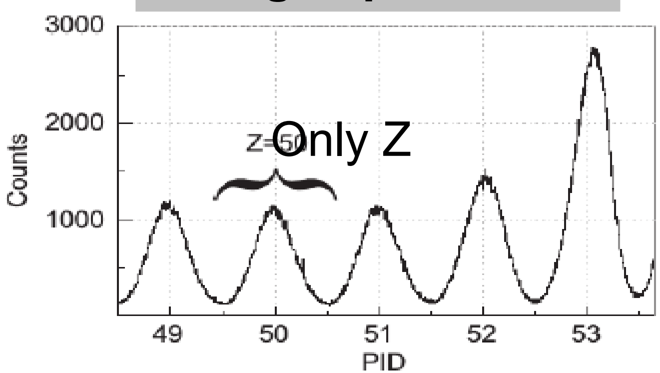


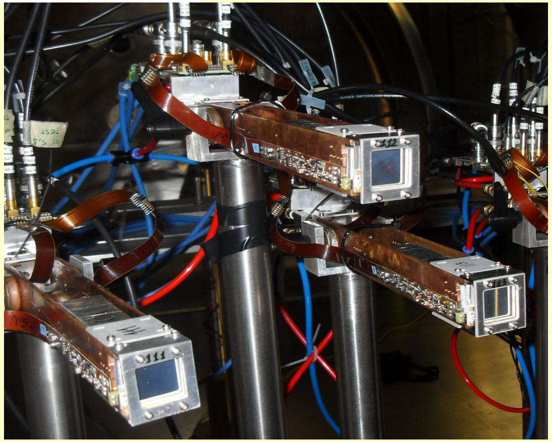
Test with single telescopes

A up to Z=24



Charge up to Z=54





asini - G.H.T. Workshop Pd 2015

Results from Phase1

Strong improvement of PSA

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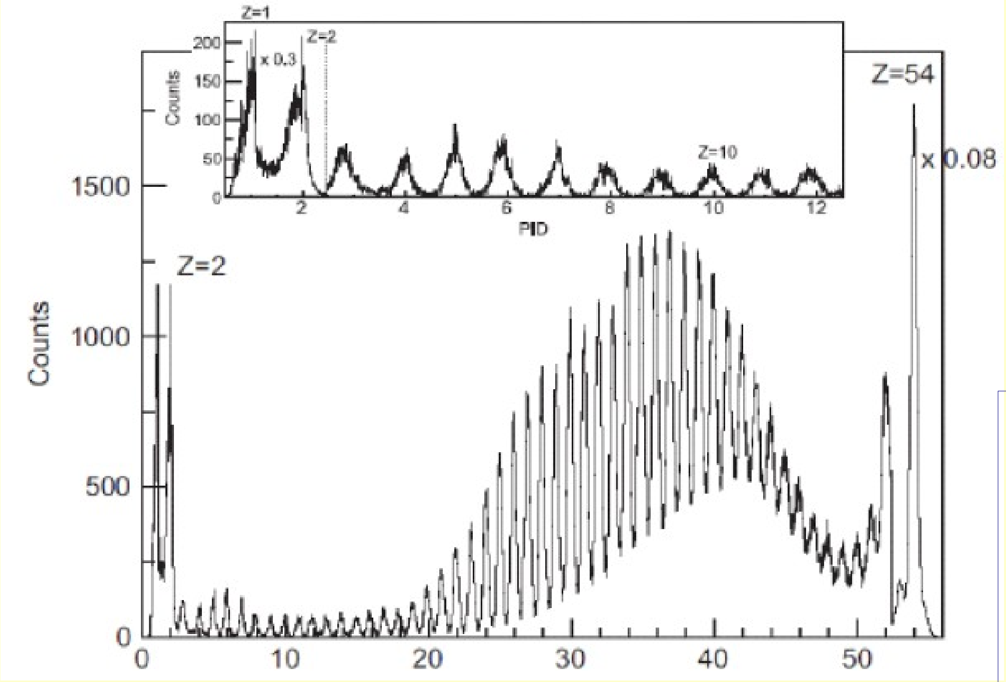
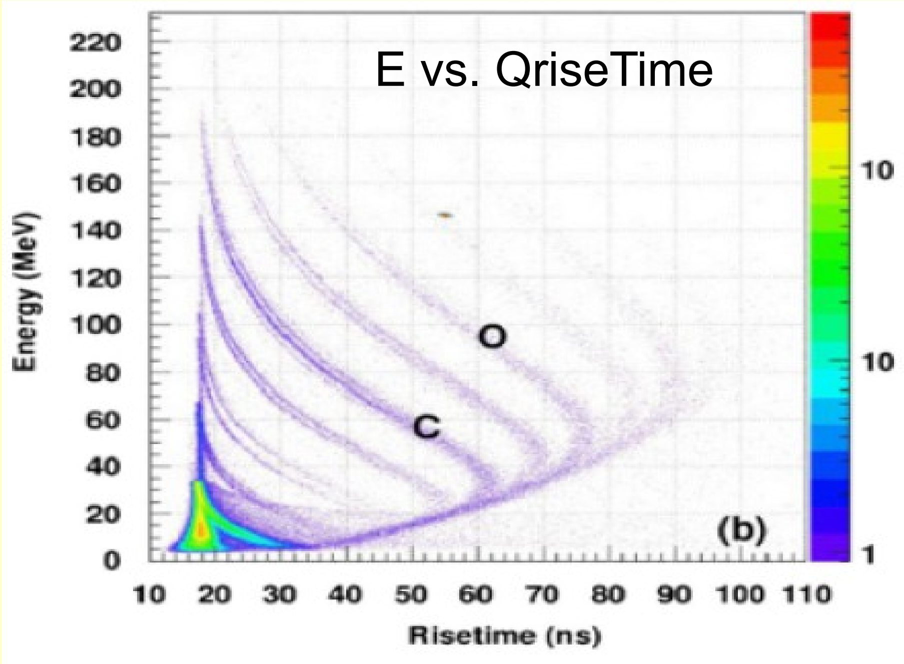
IONs STOPPED IN A
SINGLE LAYER



For path in the Silicon detector lower than 30 µm (for a C) to 100 µm (for a Xe), no discrimination is possible using PSA.



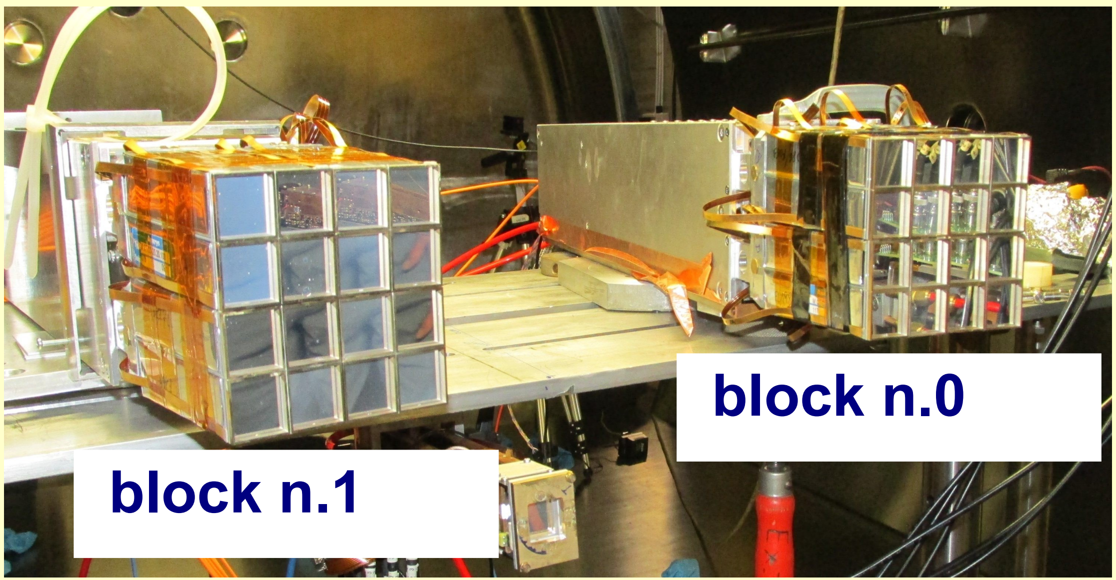
- Charge separation is obtained up to 54
- Mass separation is more critical; up to Z=14 in best detector-electronics conditions
- Reverse mounting needed
- IMAX is better that QriseTime as a shape parameter

LNS commissioning test

december 2014

OBJECTIVES:

- performance scalability, from single telescopes to telescope array (now 32 pieces)
- complete electronics chains
- data transport and DAQ
- triggering and coincidence issues
- Infrastructure equipments (cooling)



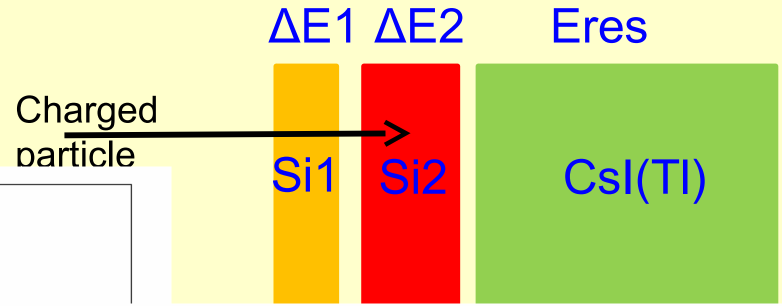
BEAM TEST with two blocks

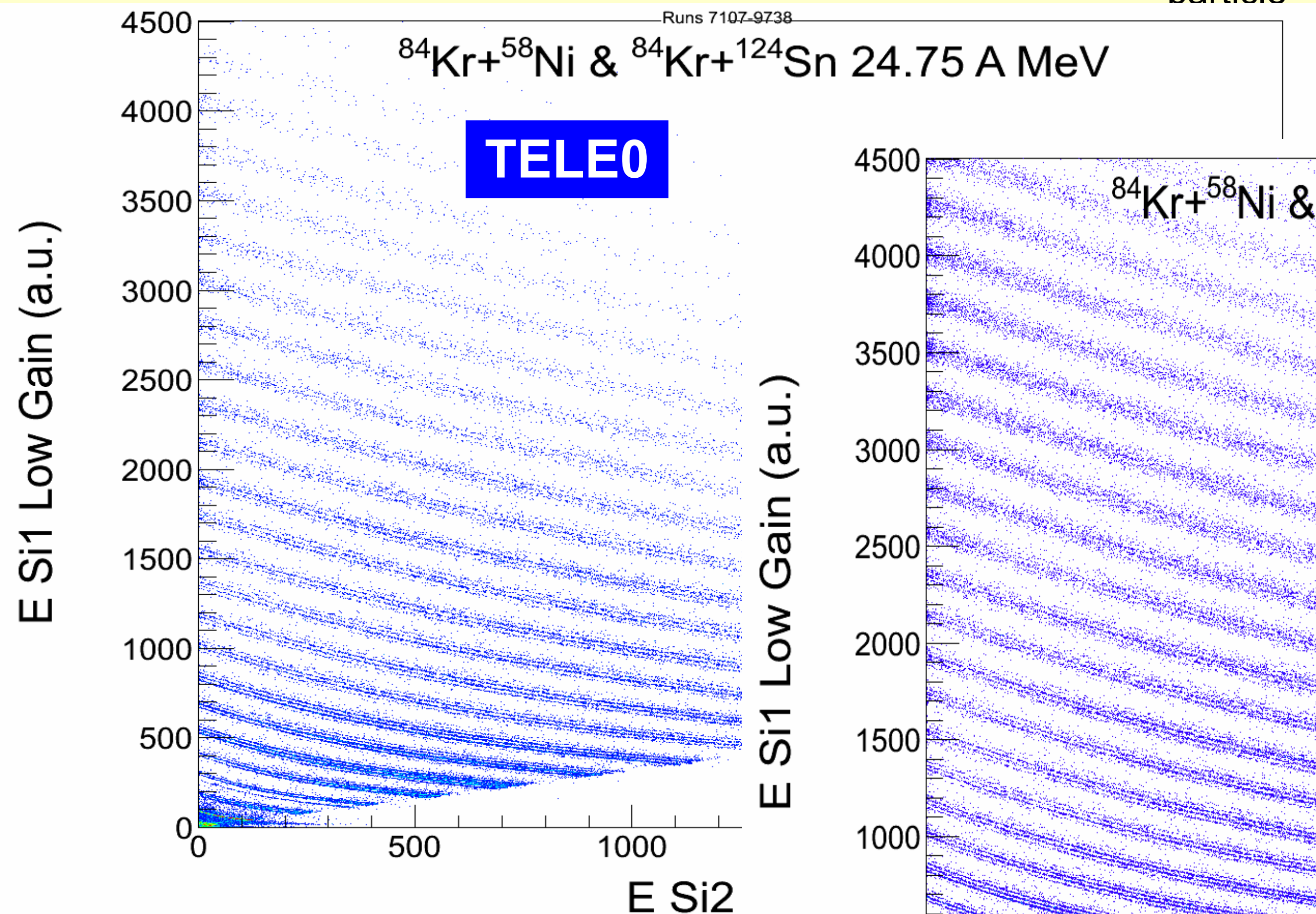
Ciclope Scattering chamber

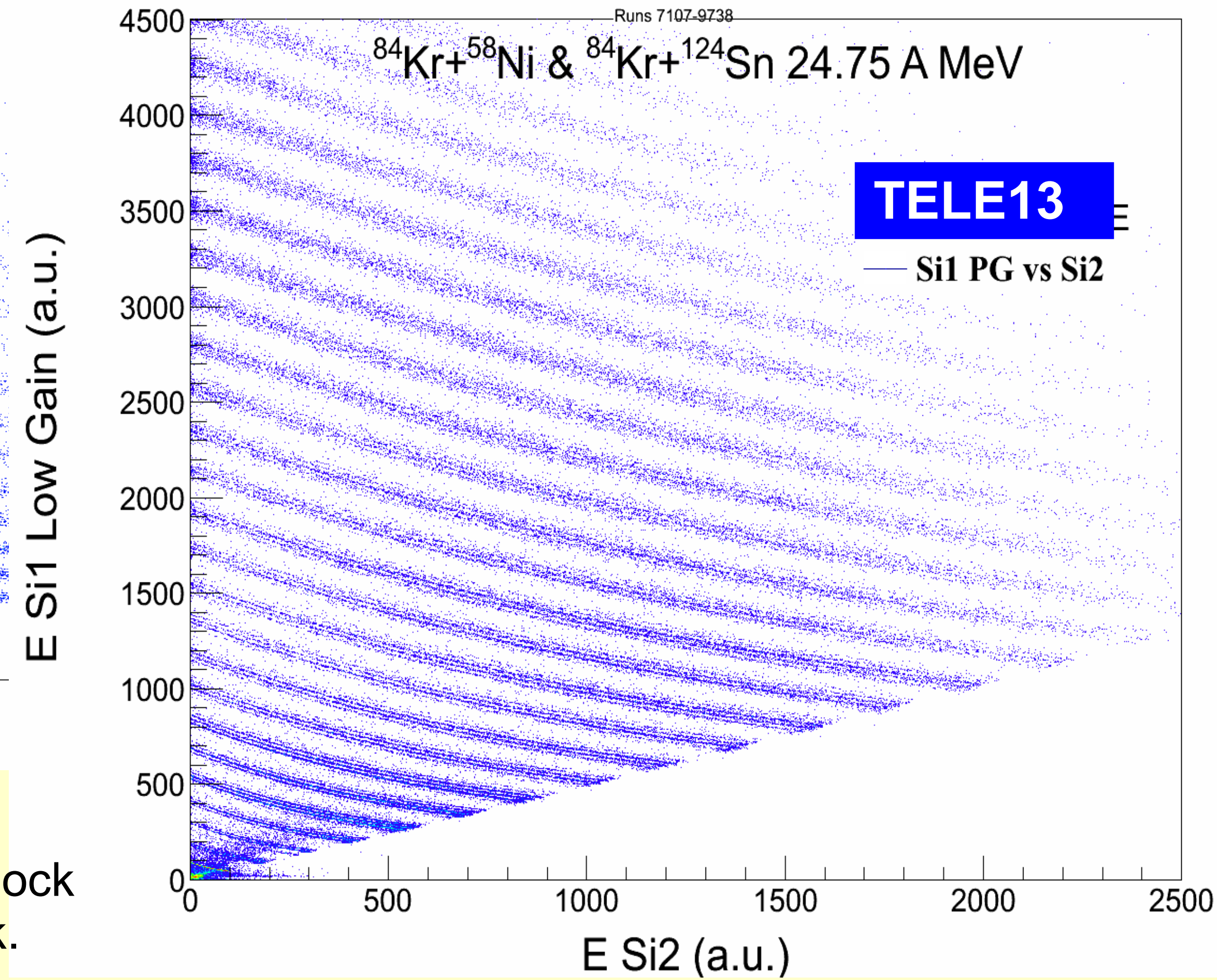
Valuable support from CICLOPE Staff LNS

Data Analysis mainly done by N.LeNeindre, O.Lopez, S.Barlini

LNS commissioning



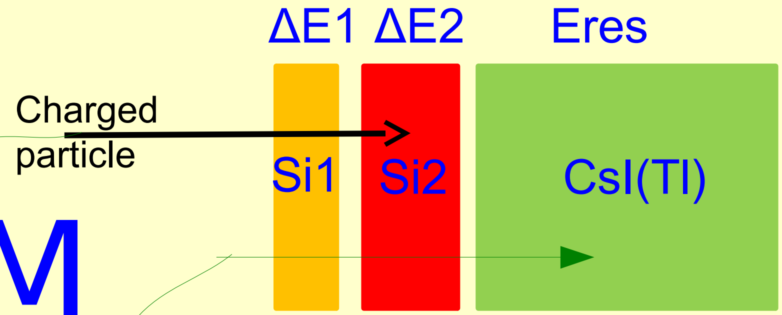




ONE BLOCK had an electrical shock maybe related to a vacuum break.

LNS commissioning

4000MeV



ZOOM

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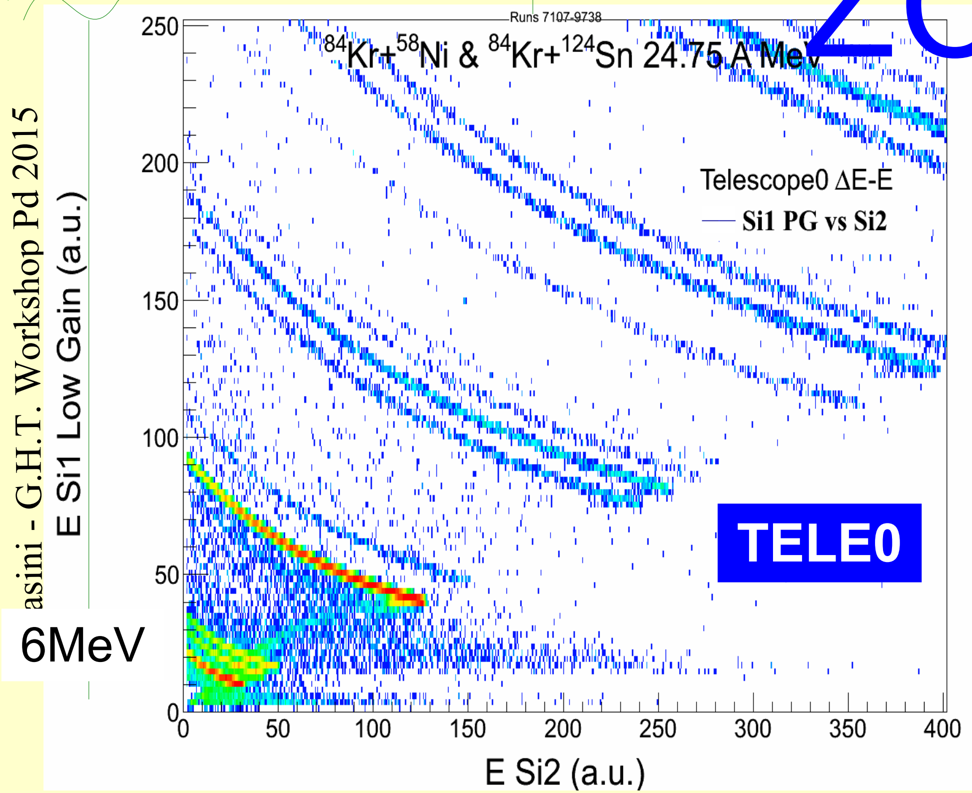
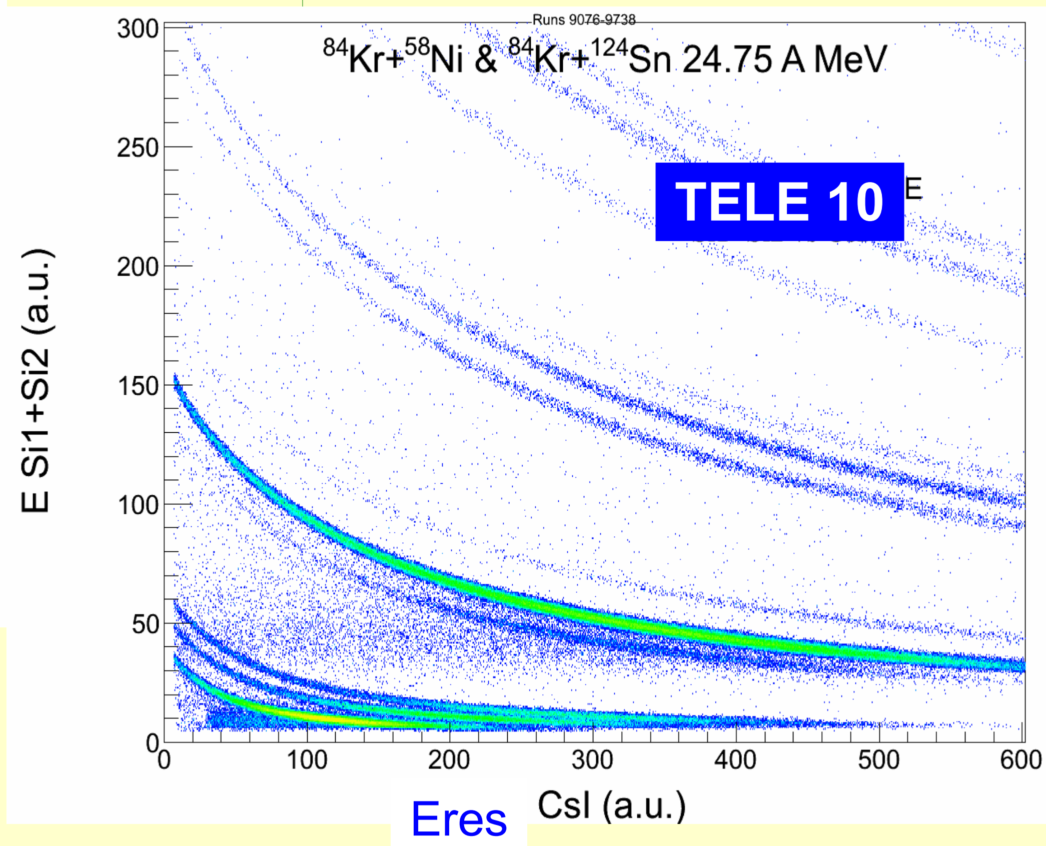
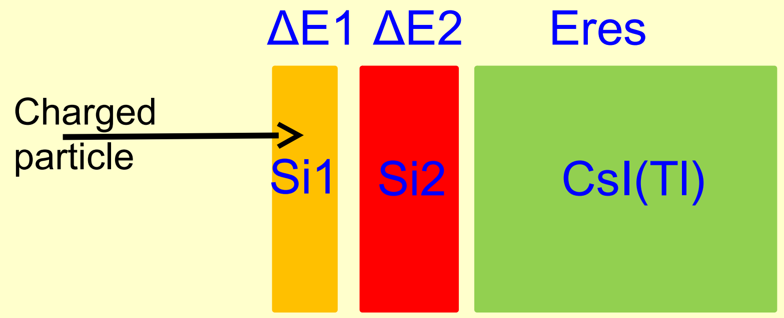
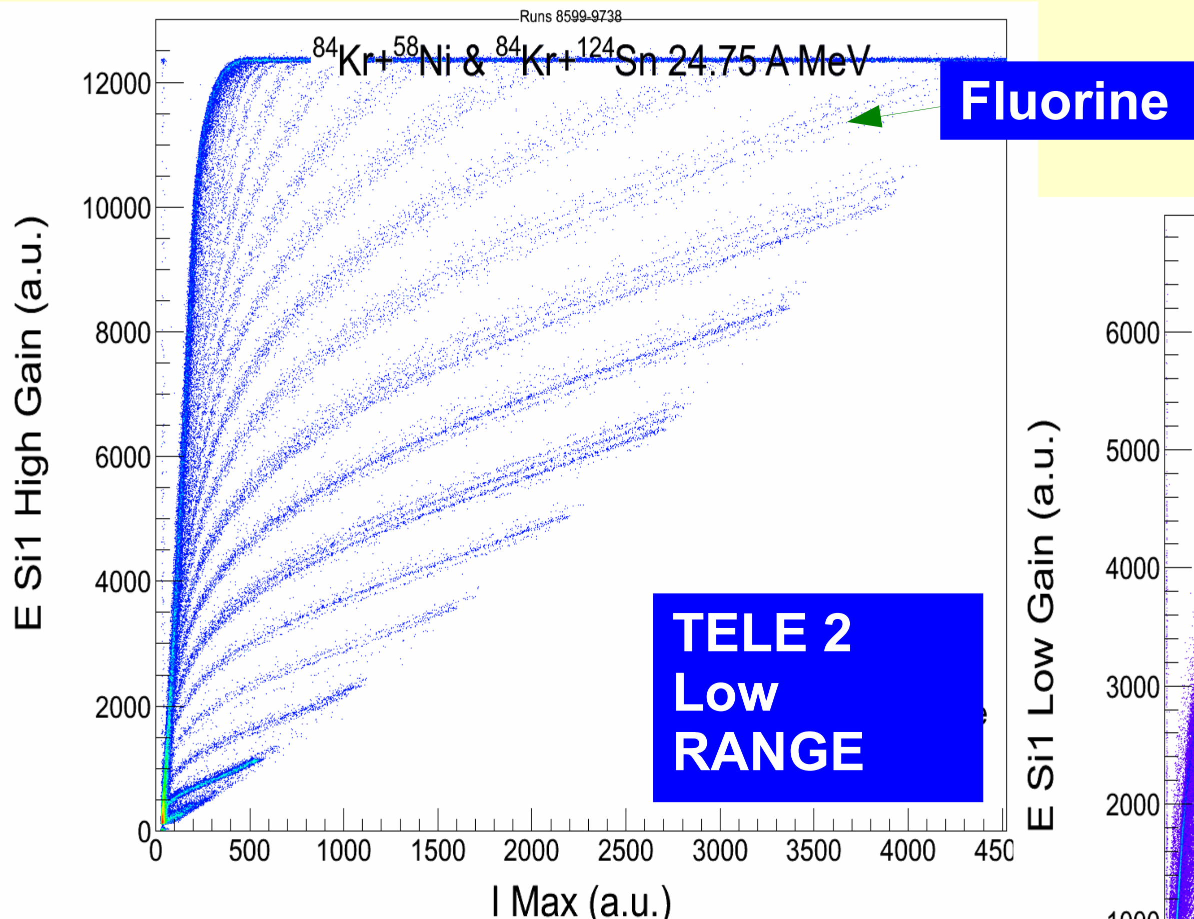


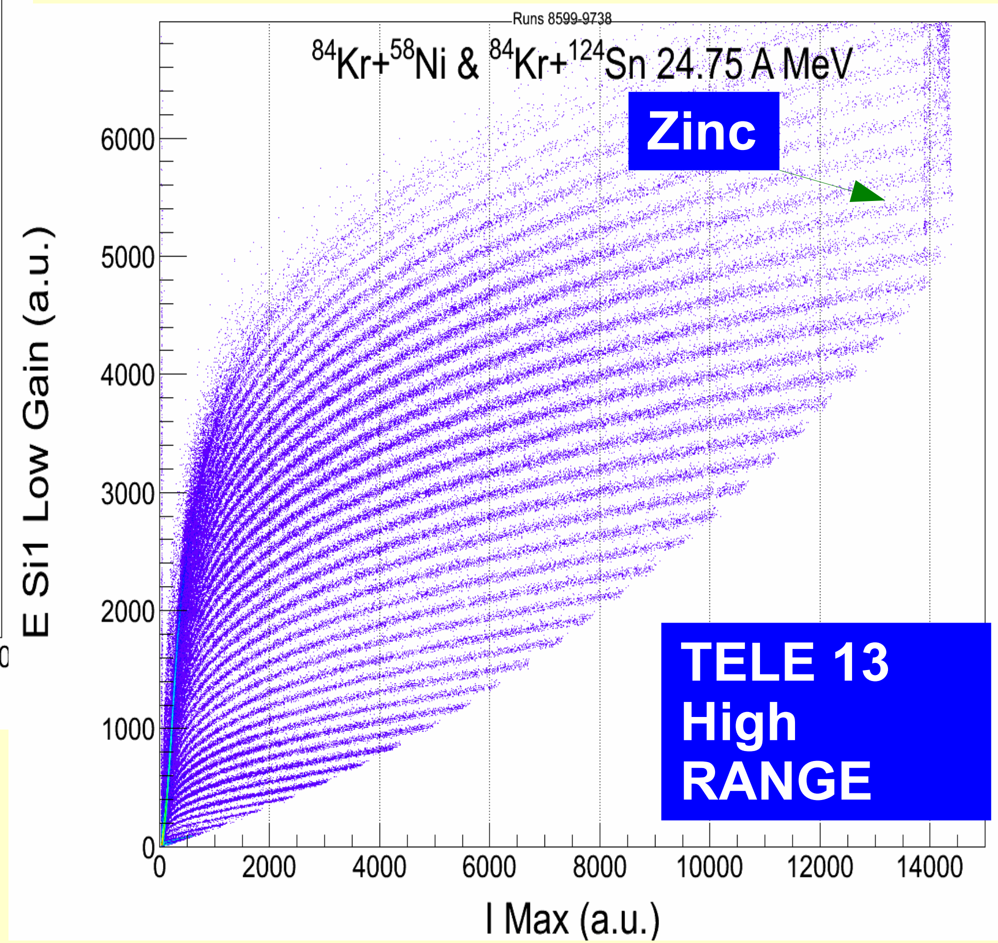


Very good isotopic separation also for light particles even with HighRange channel (ie. 4GeV dynamics!!)

LNS commissioning



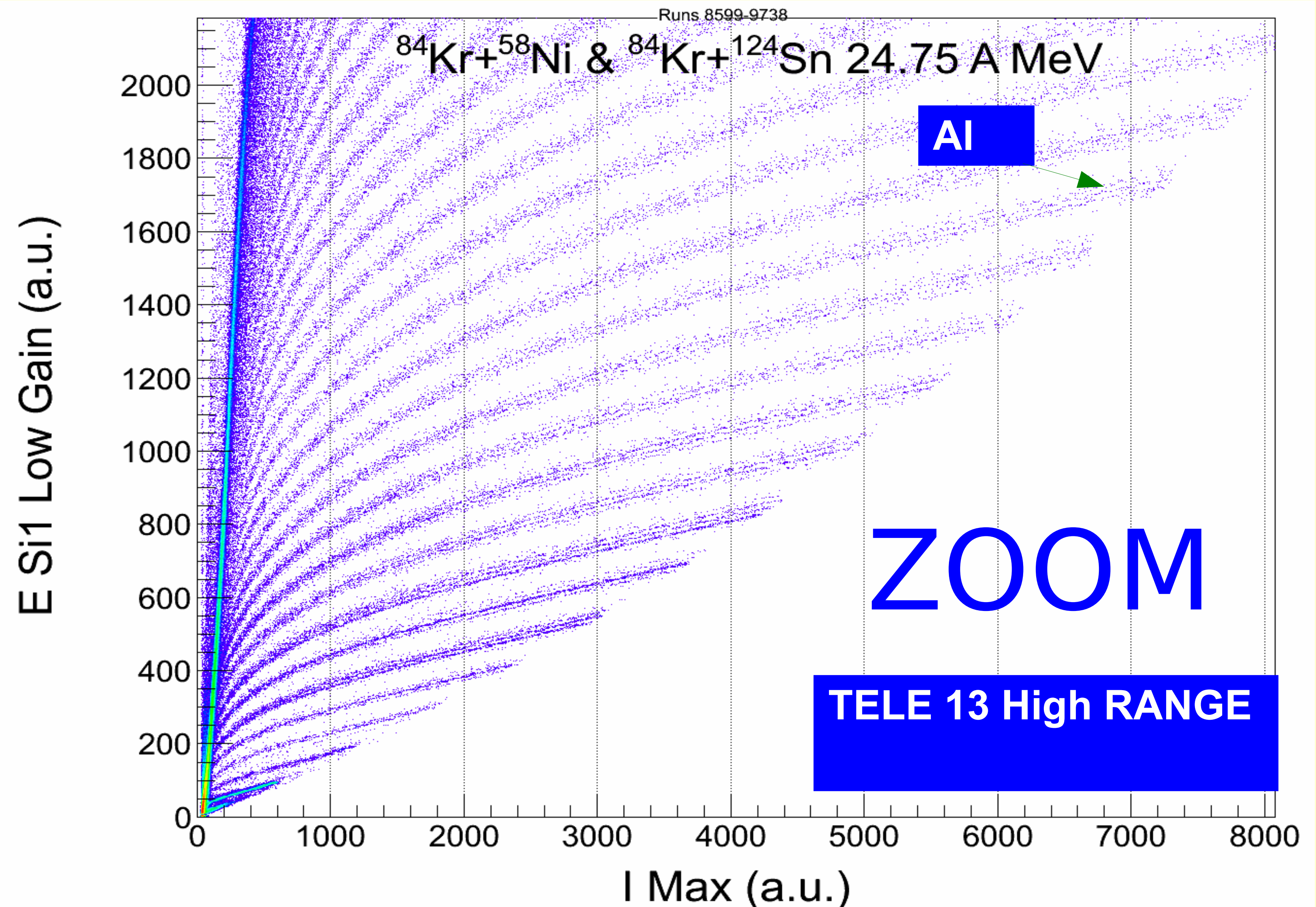




Isotopic separation from PSA up tp Z=9-13
Full Charge identification

LNS commissioning

Isotopes for Z at least 14 from PSA



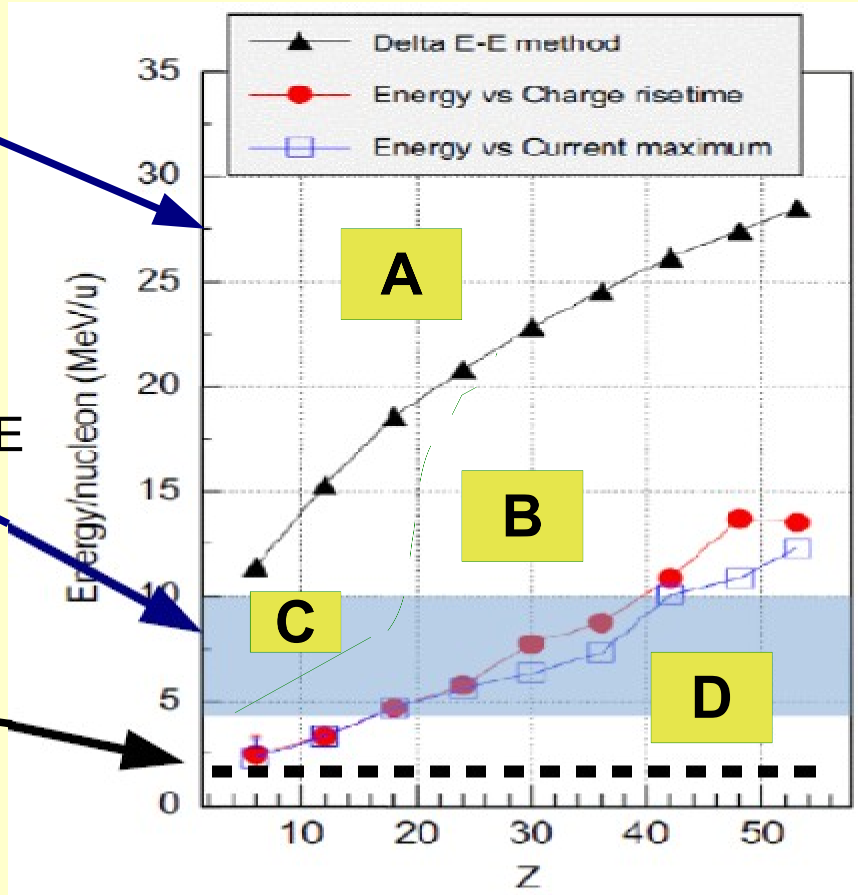
What thresholds needed?

Fazia telescopes are now well suited for Fermi energy regime

Fermi energy RANGE

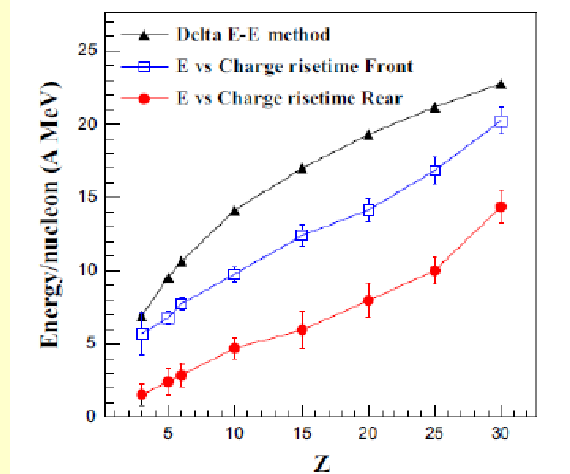
SPES beam energy RANGE

SPES lowest ER energies



A	Unlimited Z A up to Z=23-25
B	Unlimited Z
C	A up to Z=13-14
D	No identification

Reverse mounting mandatory



Further developments

Improve particle identification AND/OR reduce energy thresholds

Don't forget lower energy experiments with ISOL machines SPES and Spiral2

DE-E method: thinner stages

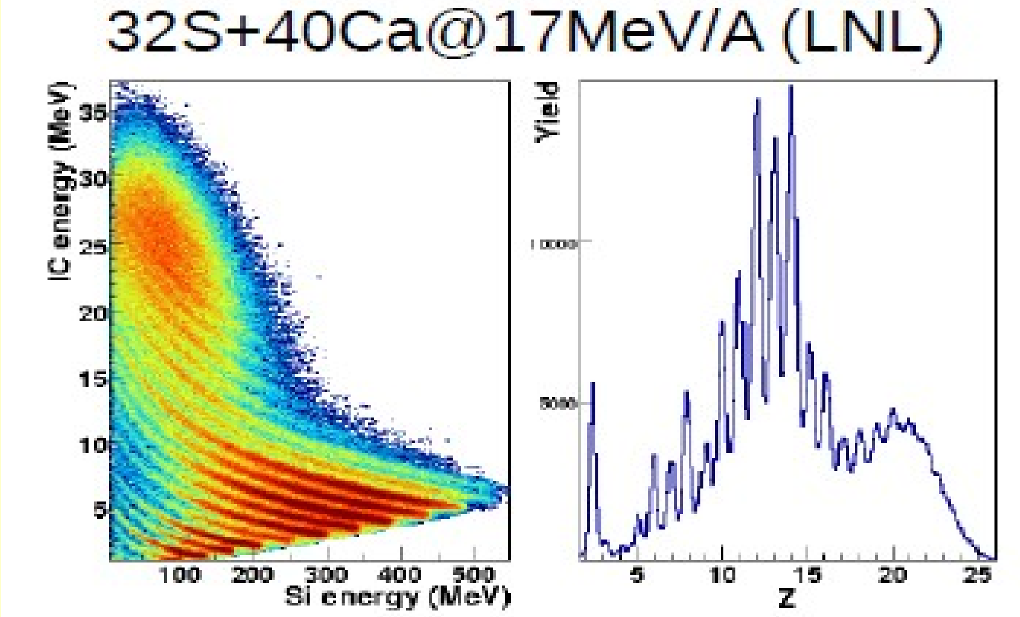
- GAS: lower thresholds, ok for Z (up to.....) but no isotopes
- Solid state: very thin Silicon, lower thresholds, ok for Z.... some mass resolution?

PSA

Exploring partially depleted Silicon diodes

To lower thresholds: gas

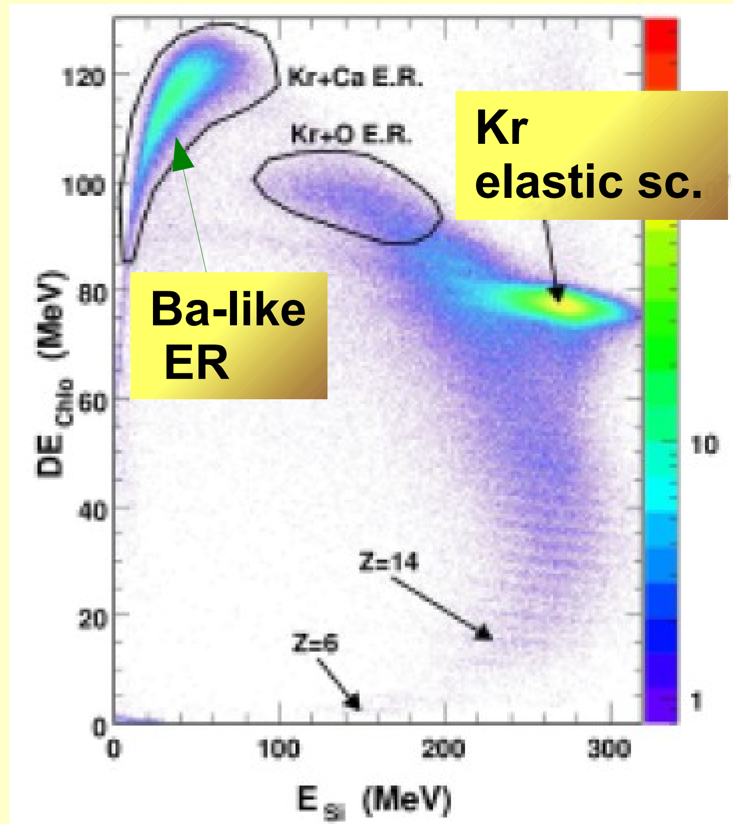
M.Bruno at al. EPJ A49,, 128   2013



GARFIELD

INDRA

G.Ademard PhD Thesis 2011
Kr+Ca 5.5MeV/u

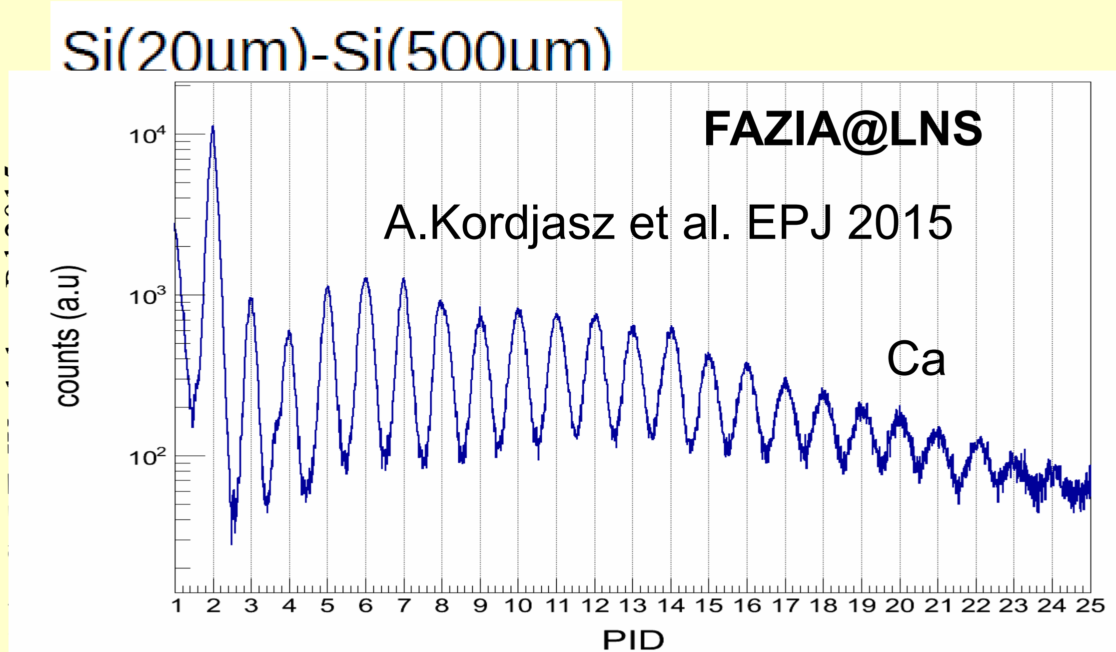


ADVANTAGE: Z identification is safe up to a certain limit; down to 1-2MeV/u for massive A>100 nuclei
DRAWBACKS: not-easy operation, no isotopes

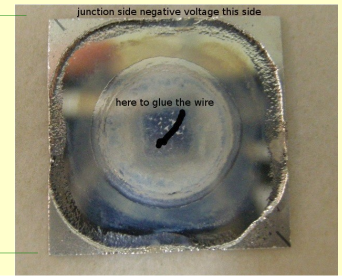
MUCH expertise within FAZIA collaboration

To lower thresholds: thin Si

Warsaw developments of thin 'large' silicon pads

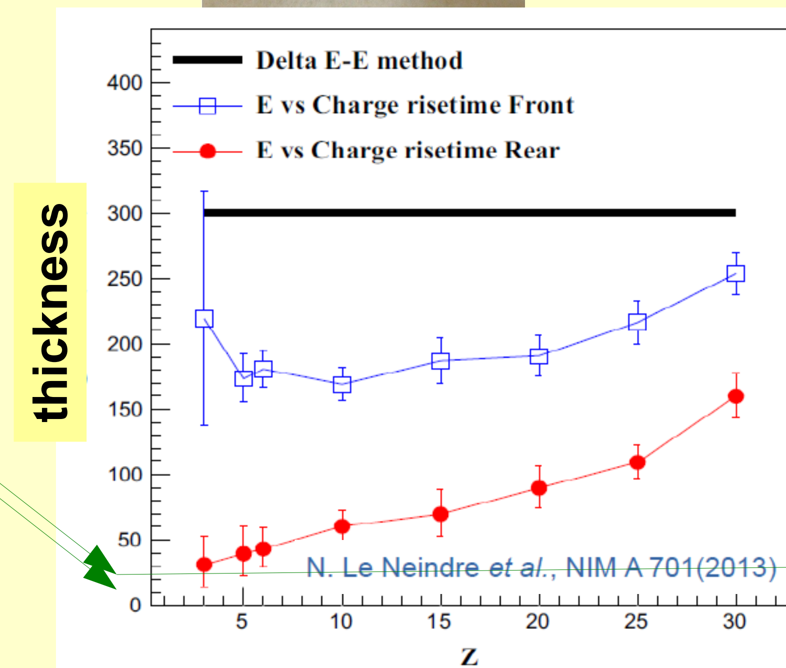


20mm



21µm thick

epitaxial



20x20 mm2 thin Silicon,
mounted on a FAZIA Telescope

Threshold
20micron

Promising results
Z-identification with thresholds as low as 1.1MeV for protons and 2MeV/u for Mn ions.

NO MASS SEPARATION, YET

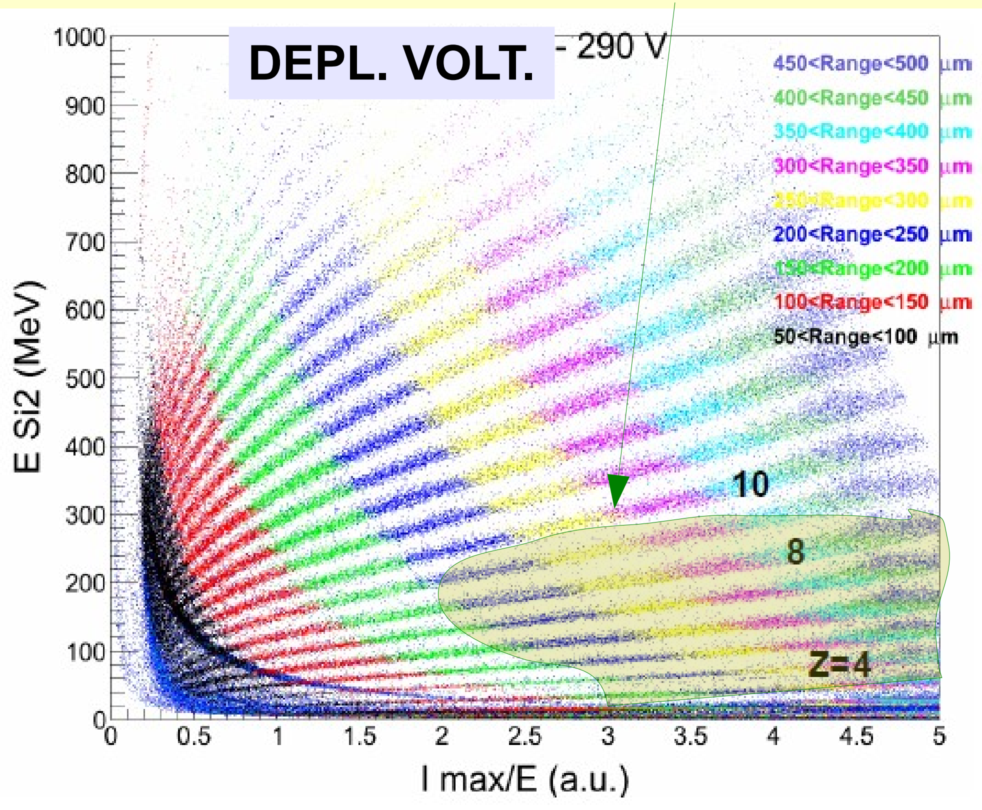
Underbiasing Si-detectors

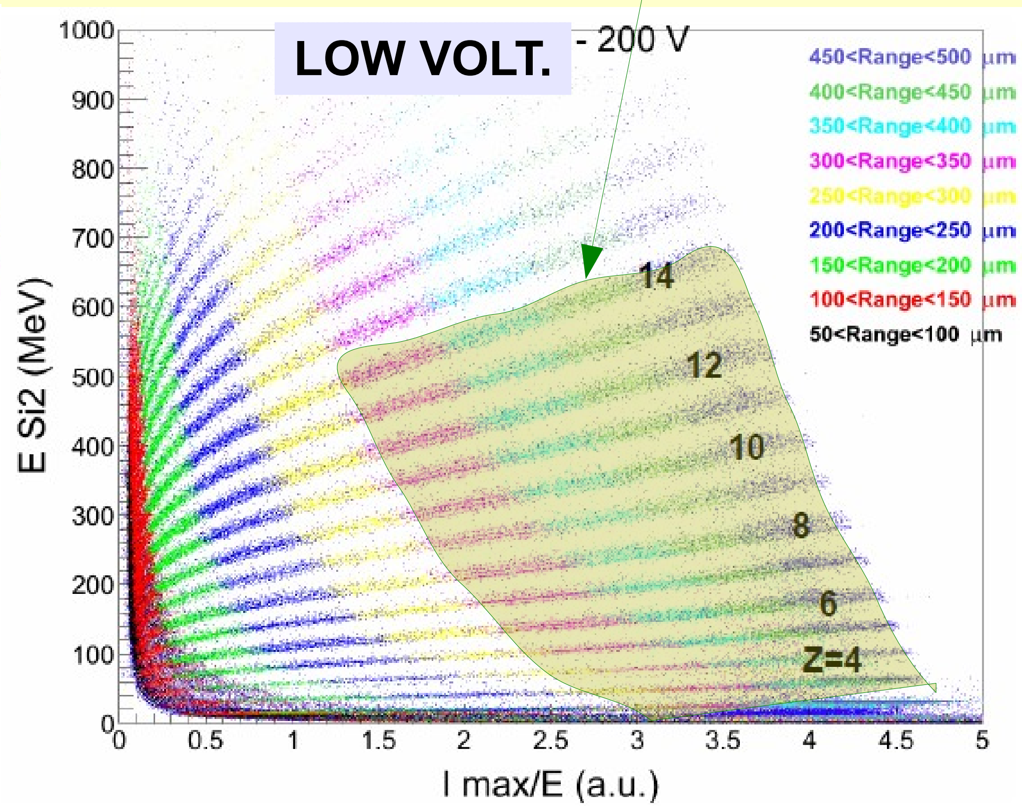
G.Pasquali et al
Eur. Phys. J. A (2014) **50**: 86

Test of a 500mm FAZIA Si, below depletion

Z OK; A for Z=3 to 9 R>200μm

Z OK; A for Z<14 R>350μm





ADVANTAGE: Improvement of the identification performance. Higher Resolution
DRAWBACK: loss of sensitivity, higher thresholds, long sampliing

Experimental programme

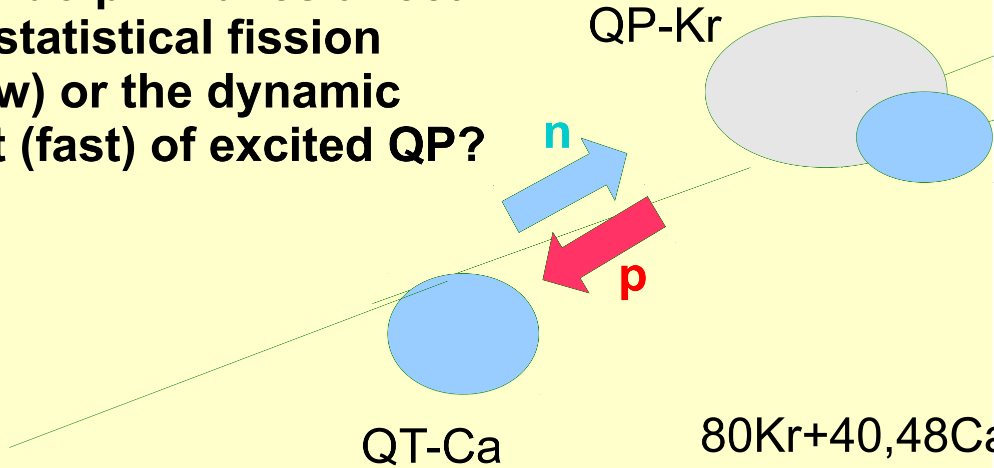
Two experiments planned in 2015 at INFN-LNS

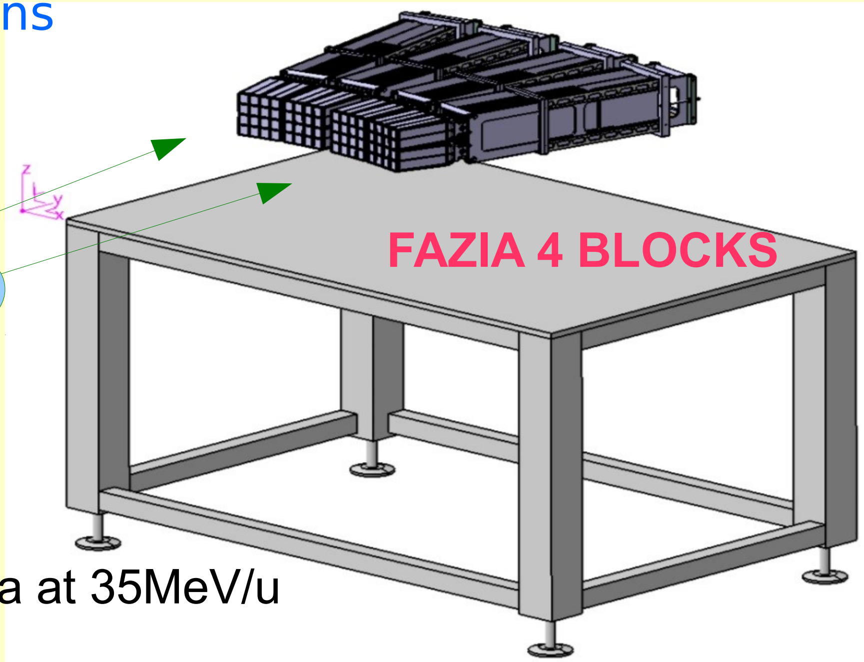
Spokep.
S.Piantelli INFN Fi

ISOFAZIA:
influence of n-p diffusion on the further decay of QP via fission (fast or statistical).

Isospin transport in semiperipheral collisions

How do p-n fluxes affect the statistical fission (slow) or the dynamic split (fast) of excited QP?





80Kr+40,48Ca at 35MeV/u

*Barlini et al., Physical Review C **87**, 054607 (2013)*
Piantelli et al., Physical Review C 88, 064607 (2013)
DeFilippo et al EXOCHIM at AsyEOS Workshop 2015
Russotto et al Phys Rev C 91 2015

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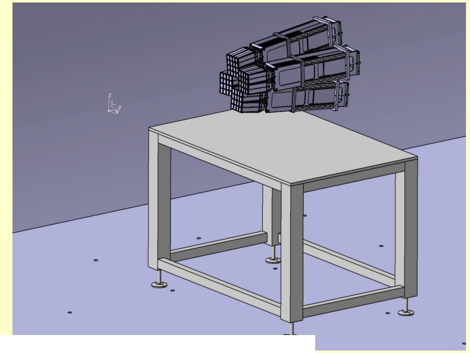
Experimental programme

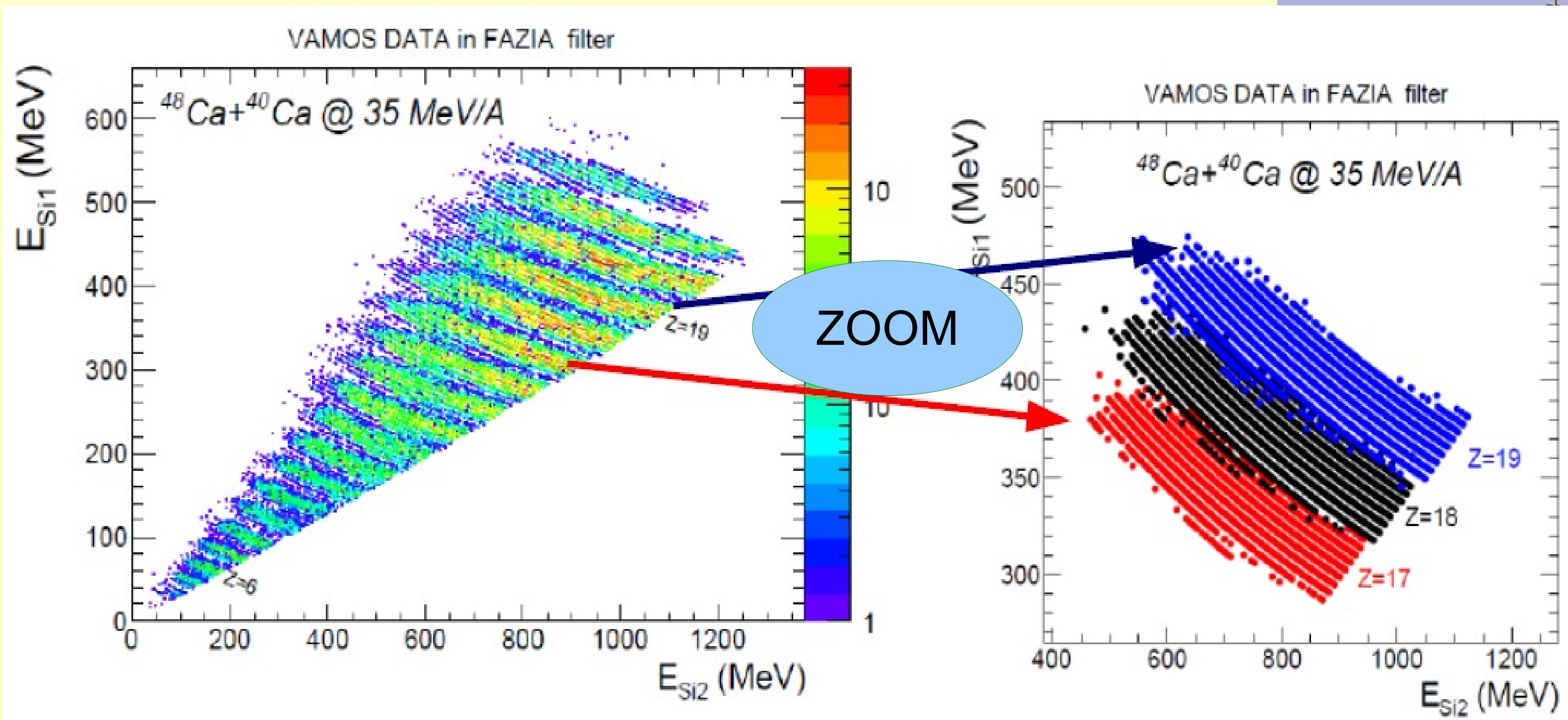
40,48Ca+40,48Ca at 35MeV/U

Spokep.
E.Bonnet GANIL



FAZIASYM:

Complete the INDRA-VAMOS campaign
Verify the wide isotopic distributions for n-rich system
Measure absolute cross sections



Data set measured with VAMOS filtered through the FAZIA apparatus

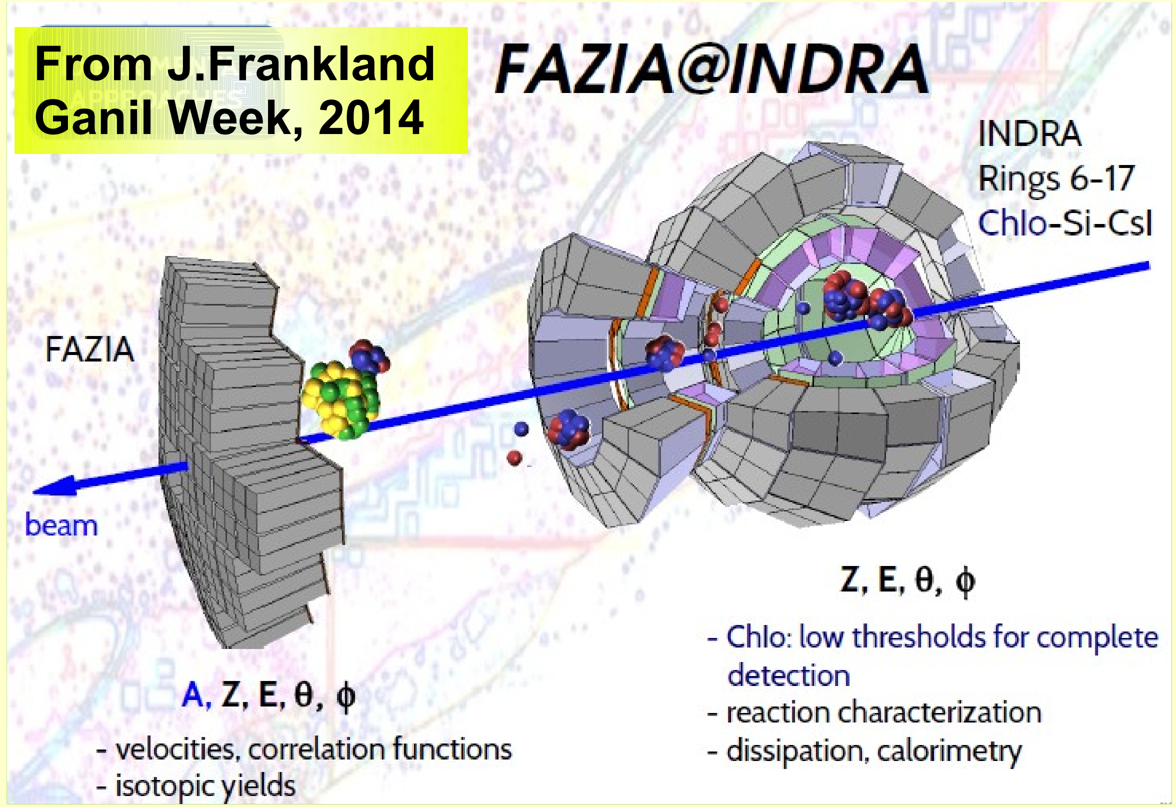
Experimental programme

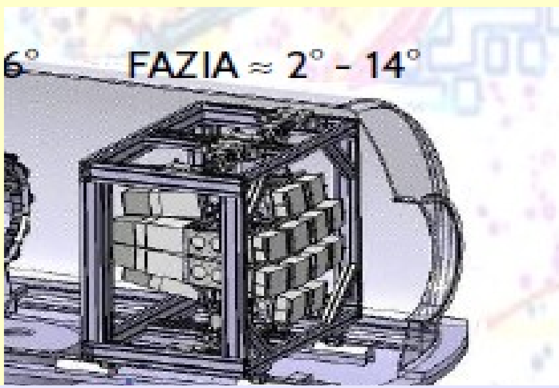
from 2017 : GANIL experimental phase

CSS2 will return to operation; stable beams between Ca and Xe (E=40-80MeV/u)

FAZIA A,Z for Z<25 at forward angles (<14deg); Z for all others

INDRA gives high acceptance to get reliable event reconstruction





FAZIA on its support in the INDRA chamber (D5)

Hints for cooperation

On a physical ground

- **Mutiparticle correlations at high-energies: FAZIA vs. Strip detectors for momentum resolution**
- **Collective excitation in nuclei. From Temperature evolution of GDR to shape transition at high spin values to DDR as an isospin equilibration mode**

On a detector ground:

- **Optimizing Silicon production and operation (doping, thickness unif., channeling)**
- **Strip detectors**
- **Timing with Silicon detectors**

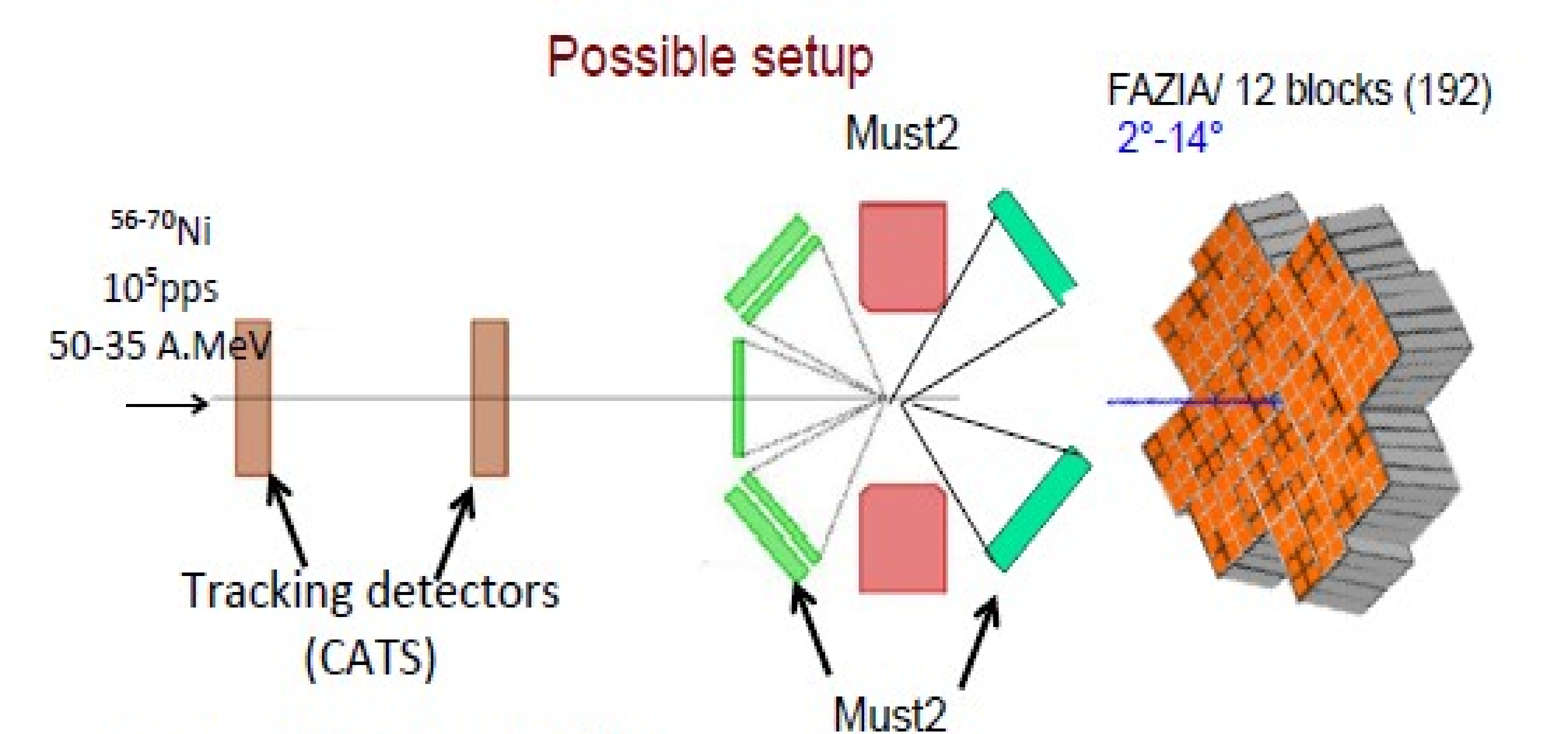
On an electronics ground:

- **Test our FEE boards coupled with specific 'non-Fazia' detectors**
- **R&D: towards a more integrated electronics, ASIC**

If manpower and money will permit....

Hints for cooperation

Possible experiment with the LISE exotic bems (after 2018)



$\delta = (N-Z)/A = 0.2$, for ^{70}Ni

$\delta = 0.0$ for ^{56}Ni