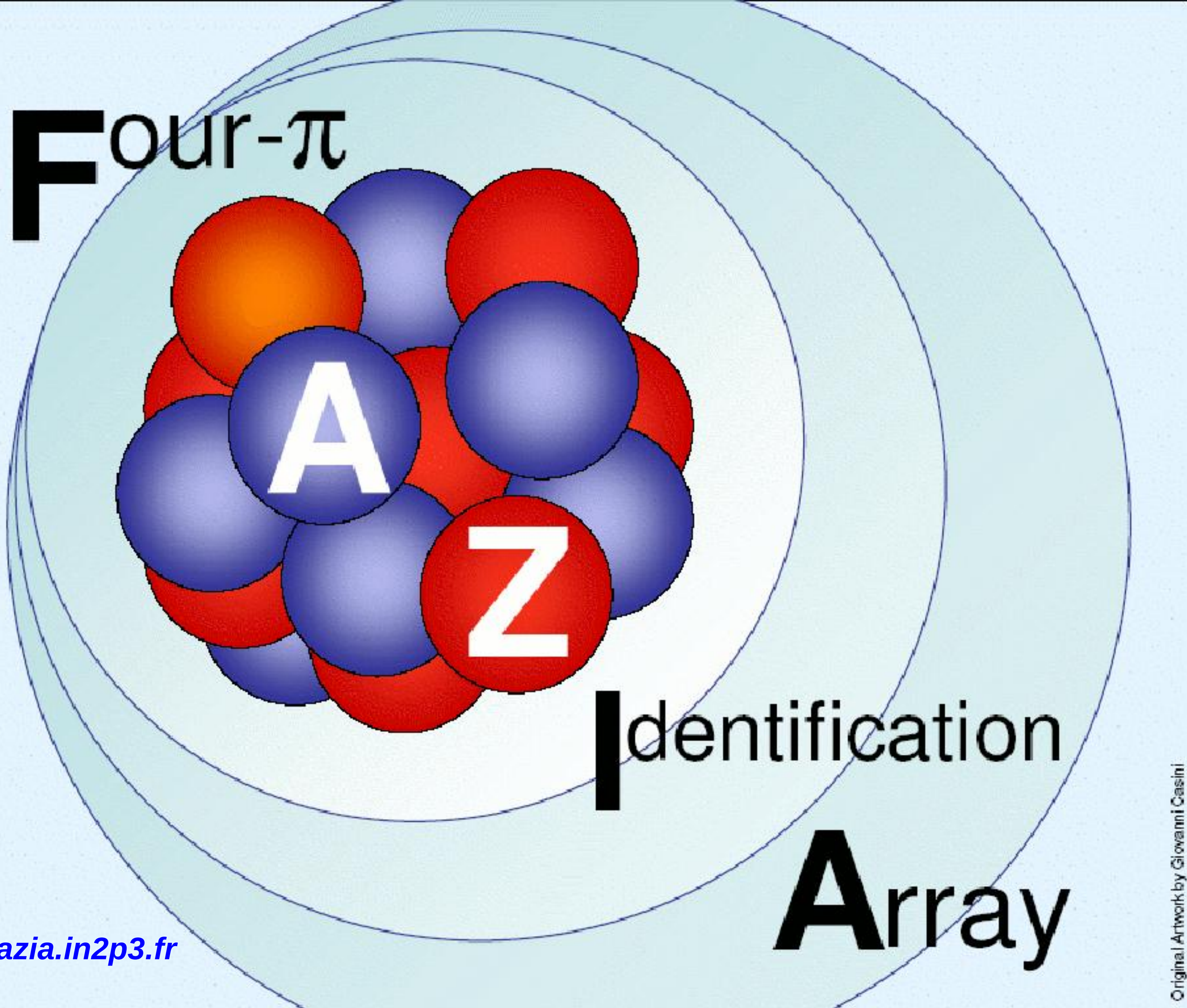


http://fazia.in2p3.fr

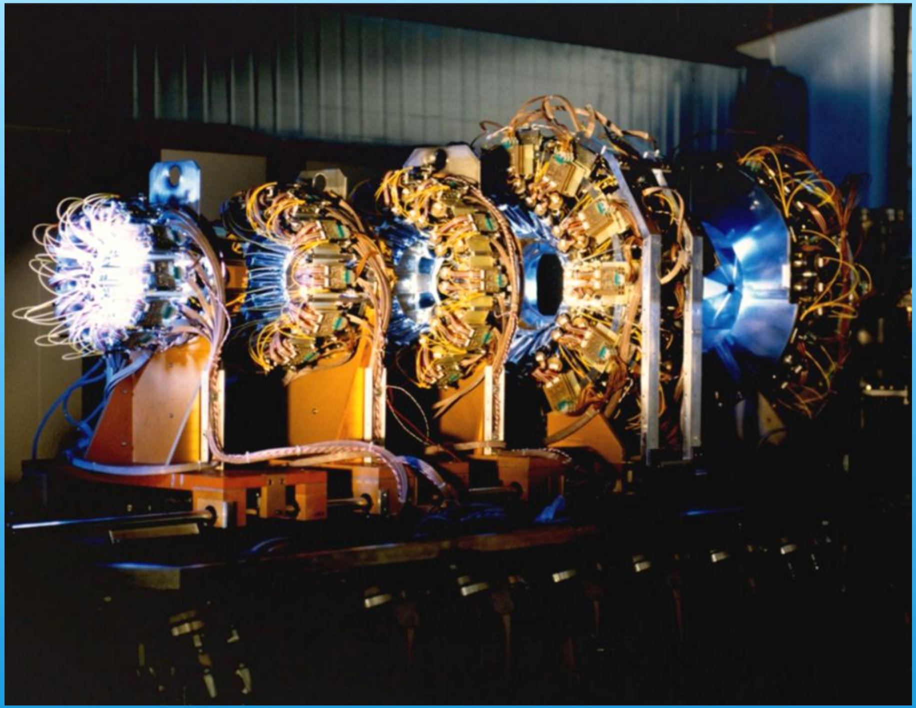
***The goal of the FAZIA Collaboration is to build a new detection array for European Radioactive Nuclear Beam facilities* (SPIRAL-2/GANIL, LNL/SPES, FAIR/NUSTAR and *EURISOL*).**

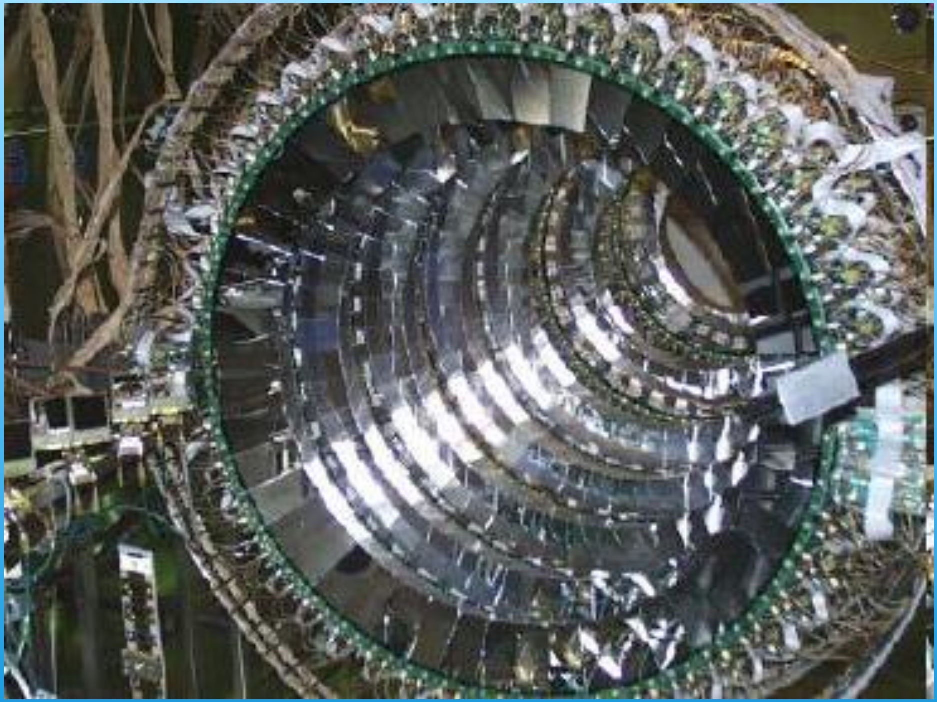
The detection array will be used to study Dynamics and Thermodynamics of nuclear collisions

The FAZIA organization

- Spoke-person: R. Bougault
- Deputy Spoke-person: G. Poggi
- Task Group1: Physics for PHASE II BIS, G. Casini (chairman),
  E. Vient (vice- chairman)
- Task Group2: Data analysis, N. Le Neindre (chairman)
- Task Group3: DAQ-FEE-Trigger, P. Edelbruck (chairman),
  A .Ordine (vice-chairman)
- Task Group4: Mechanics, M. Guerzoni (chairman), Y. Merrer (vice-chairman)
- Task Group5: Cesium Iodide crystals and Detectors B. Borderie (chairman),
  G. Poggi (vice-chairman)
- FPMB members: B. Borderie, R. Bougault, G. Casini, N. Le Neindre,
  P. Edelbruck, M. Guerzoni, J. Frankland, T. Kozik, G. Poggi,
  A. Raduta, E. Rosatto.

WHAT IS NEEDED FOR EXPERIMENTATION AT PRESENT AND FUTURE RNB FACILITIES?



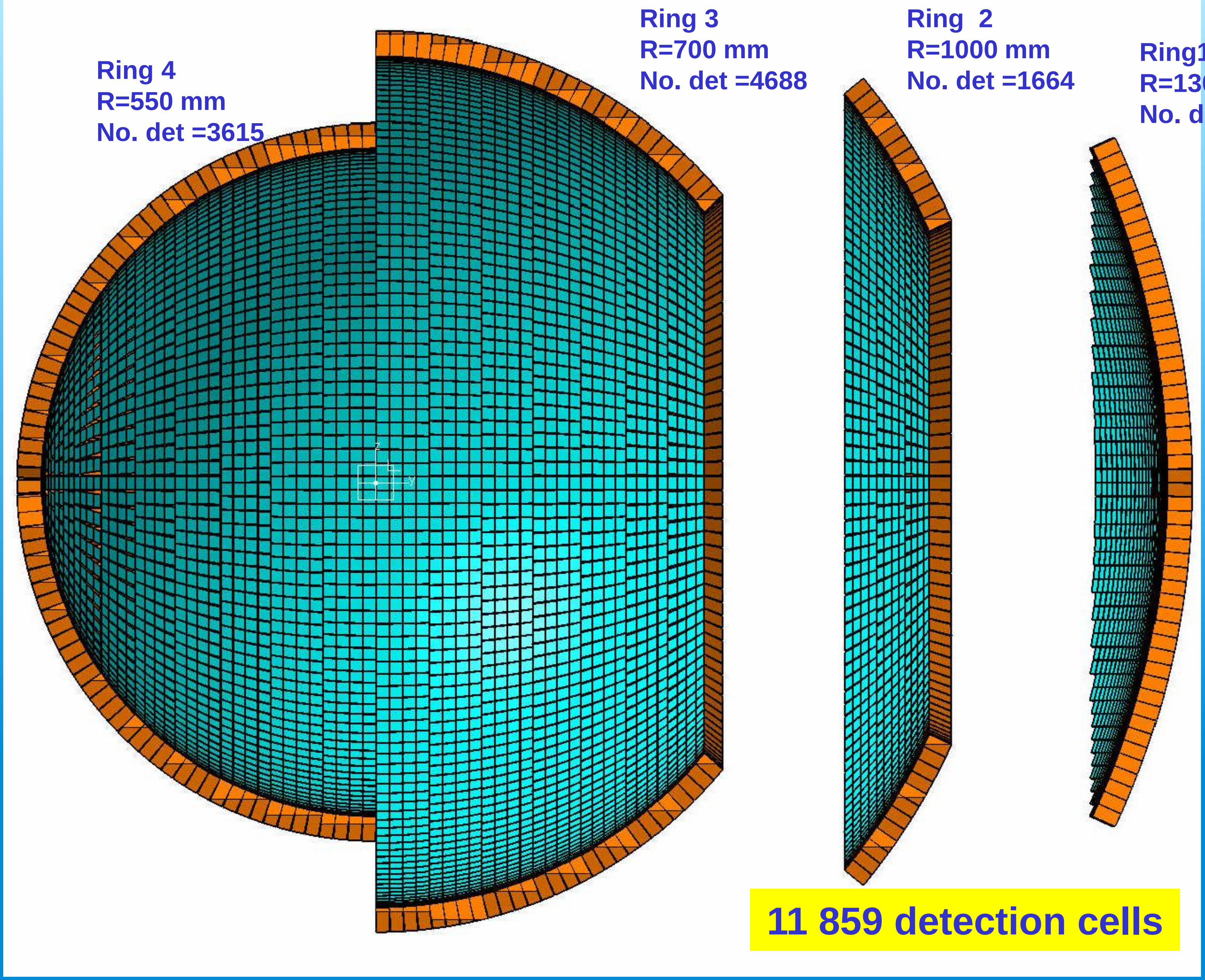


The general method to achieve the goal:

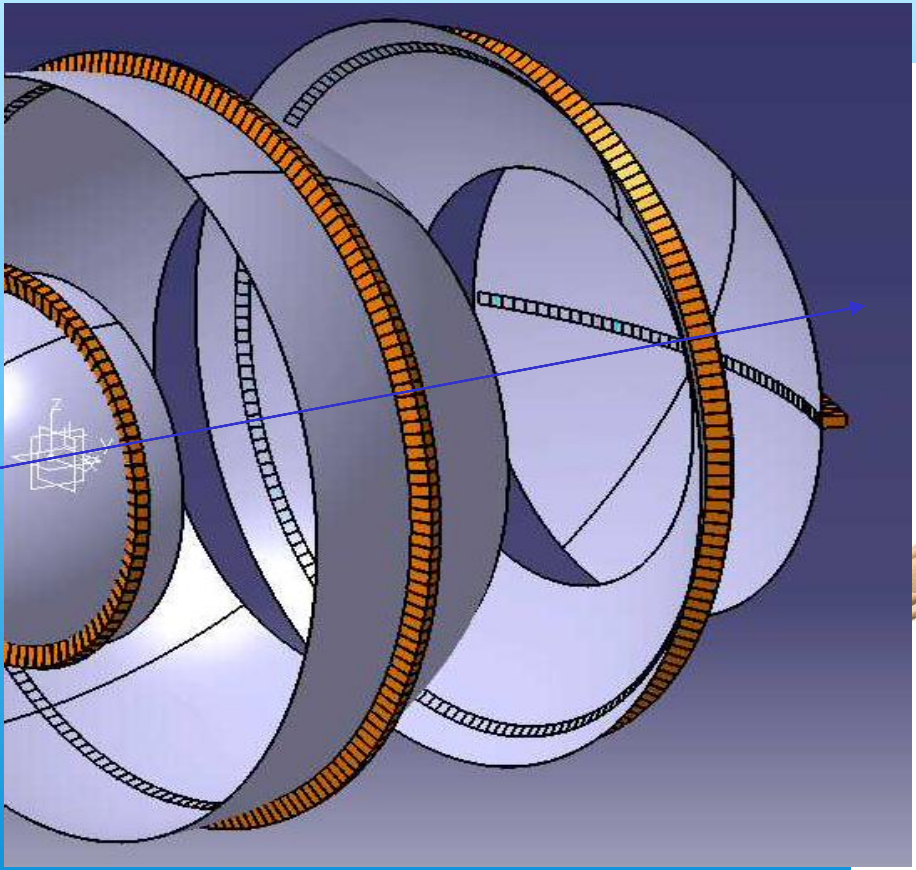
Fast digitalization of signals from detectors +

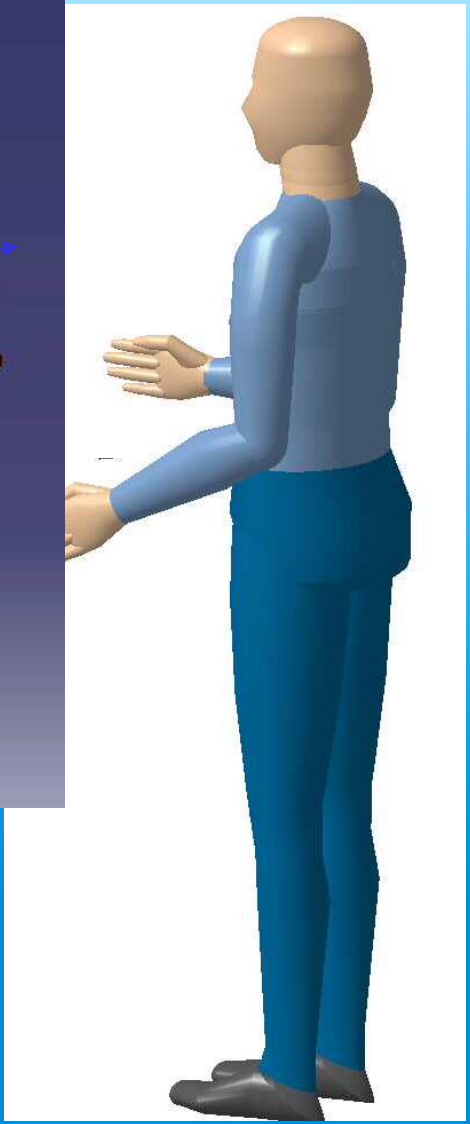
Pulse shape analysis (PSA)

FAZIA DETECTOR – DESTINATION



FAZIA detector - portability





Transportable array to various stable and radioactive beam facilities, e.g.:

GANIL/SPIRAL/SPIRAL2 Caen

GSI/FAIR/NUSTAR Darmstadt

LNL/ALPI/SPES Legnaro

LNS/EXCYT/FRIBS Catania

Time Schedule

Three programmed *FAZIA* Phases + final array

1. **Phase I: R&D on detection techniques, advanced solutions of digital electronics (2006-2008)**

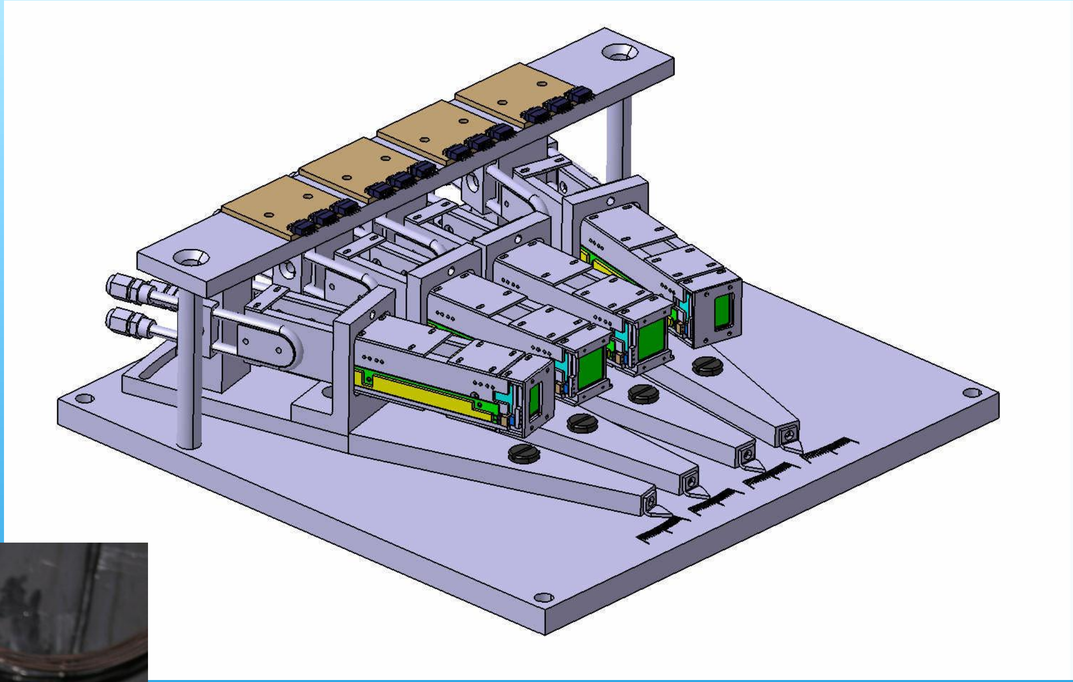
2. **Phase II: R&D and a prototype array with several modules, implementing the best identified solutions (2009-2012)**

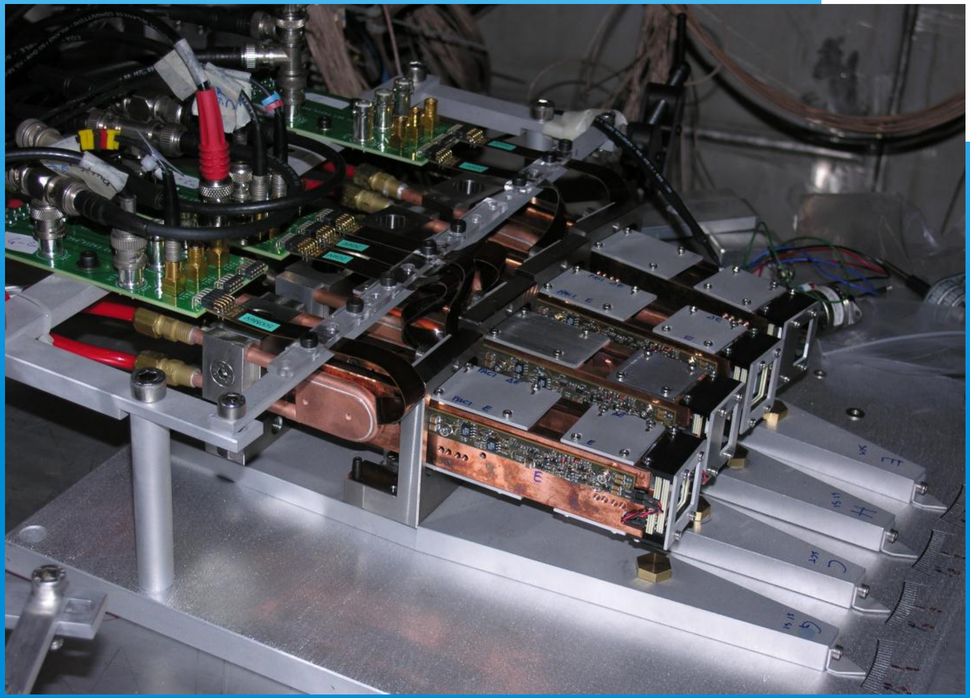
3. **Phase III: a Demonstrator array (2012-- ?) Tomorrow talk of Giovanni Casini**

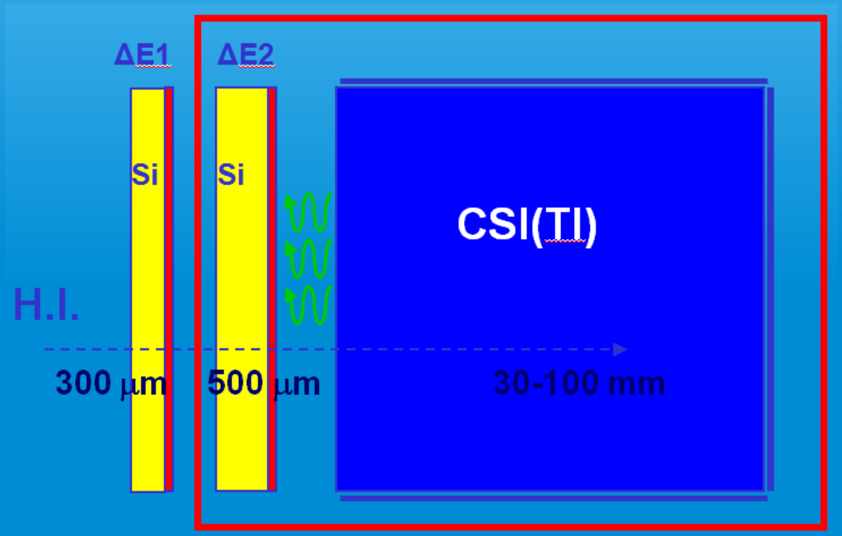
4. **Final goal: build the full array for lower (SPIRAL2 / LNL / SPES) and higher energy (GANIL / LNS / FAIR / EURISOL / RIA) studies with exotic and stable beams.**

prototype used in experiments

Series of experiments performed in LNL & LNS & GANIL within phases I, II, III testing prototype





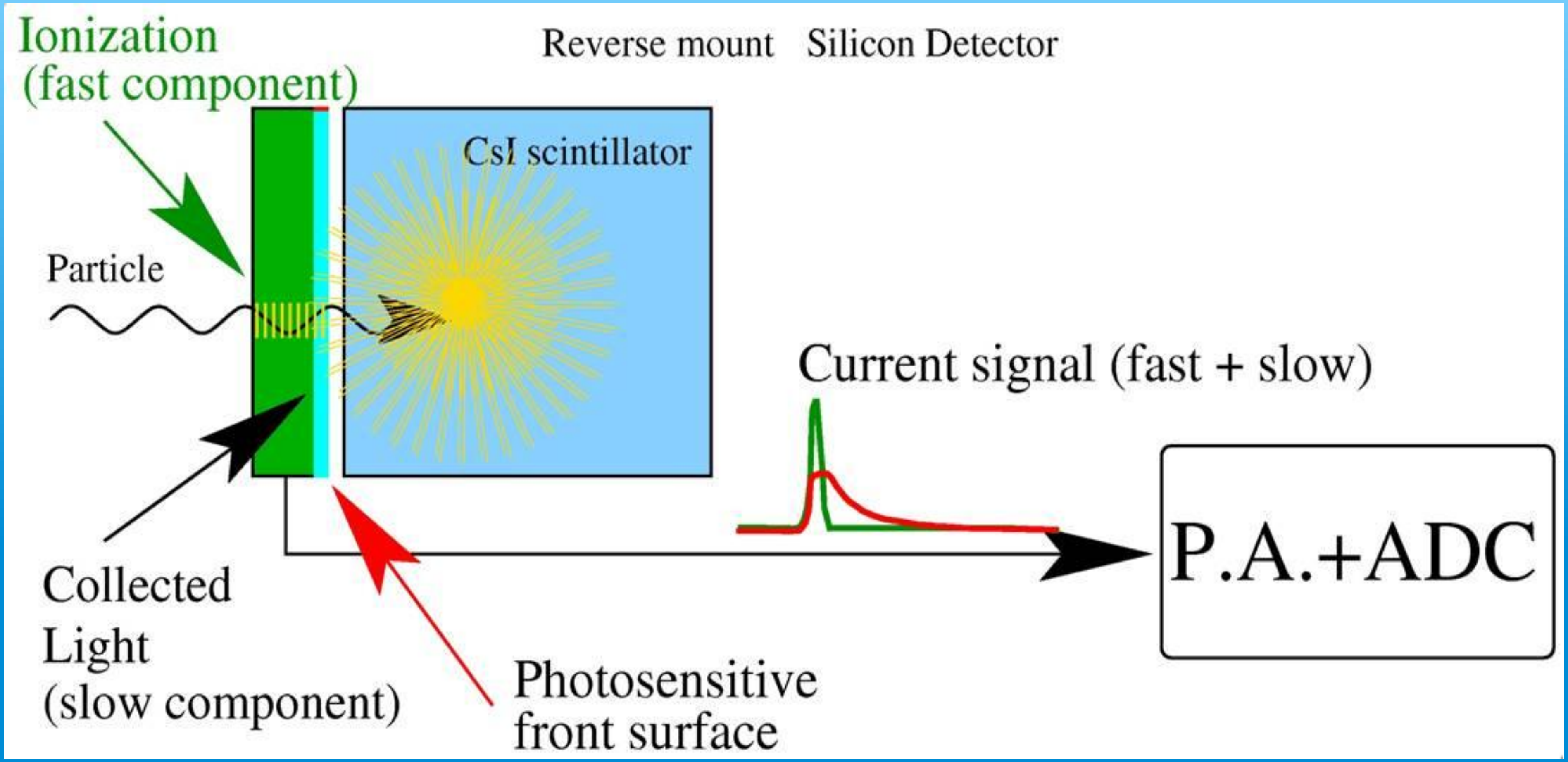


Basic issues solved

1. Single chip method – CsI readout by Si
2. Channeling/orientation effects in crystal lattice
3. Dopant homegenuity of semiconductor material
4. Planarity and paralelism of front and rear sides
5. Rear – front injection influence on the PSA
6. Design of dedicated preamplifiers
7. Constancy of the electric field as a function of time
8. Digital processing methods
9. Development of on line Pulse Shape Analysis methods
10. Theoretical description of plasma delay effects

Single Chip Tlescope mode – CsI readout by Si

Digital techniques permitted to efficiently implement a "Single Chip Telescope" *(G.Pasquali et al: NIM A301 (1991) 101) and L.Bardelli et al: NP A746 (2004) 272)*



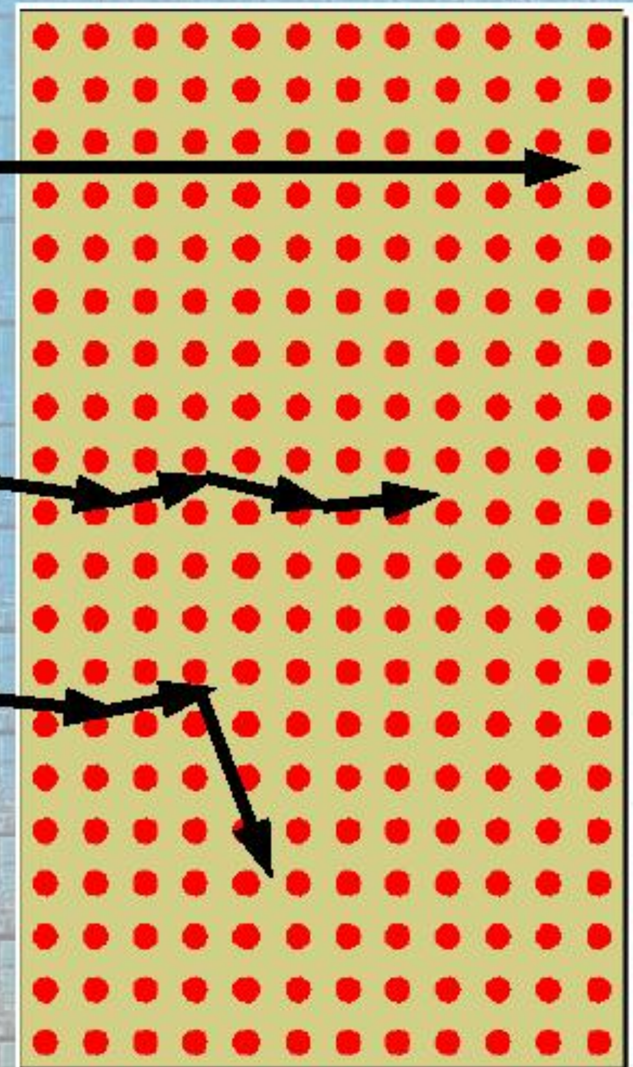
Channeling/orientation effects in crystal lattice

Energy loss in an crystal (aligned configuration):

"perfect" channeling
long range, low average dE/dx

shorter range, higher average dE/dx

channeling + de-channeling
even shorter range, higher average dE/dx

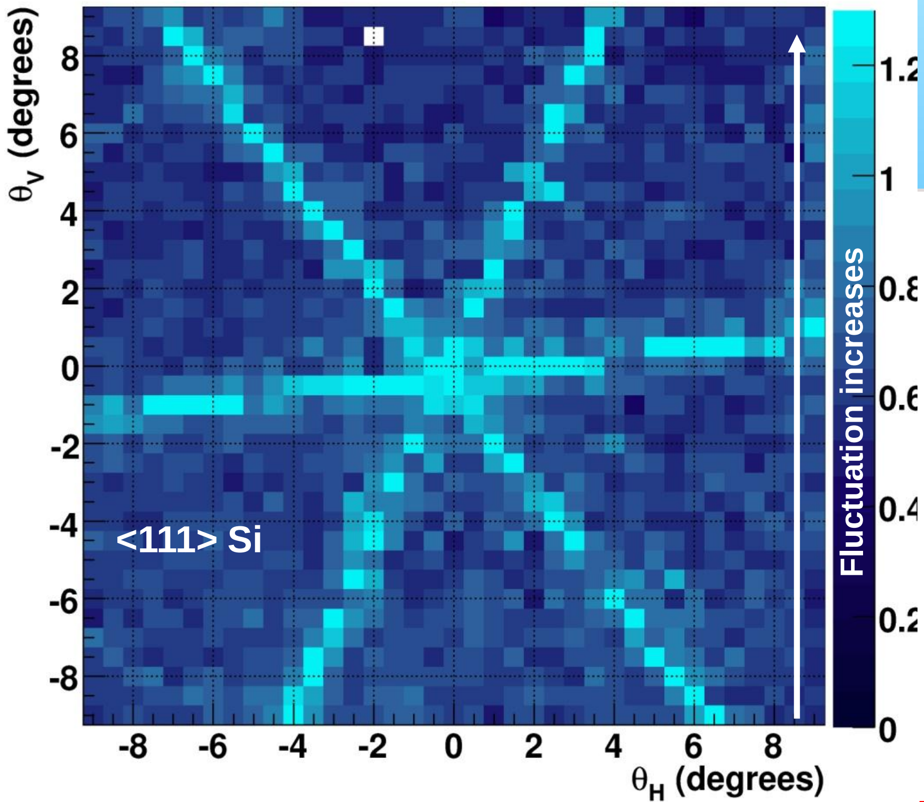


many possible trajectories leading to different ranges and/or average dE/dx

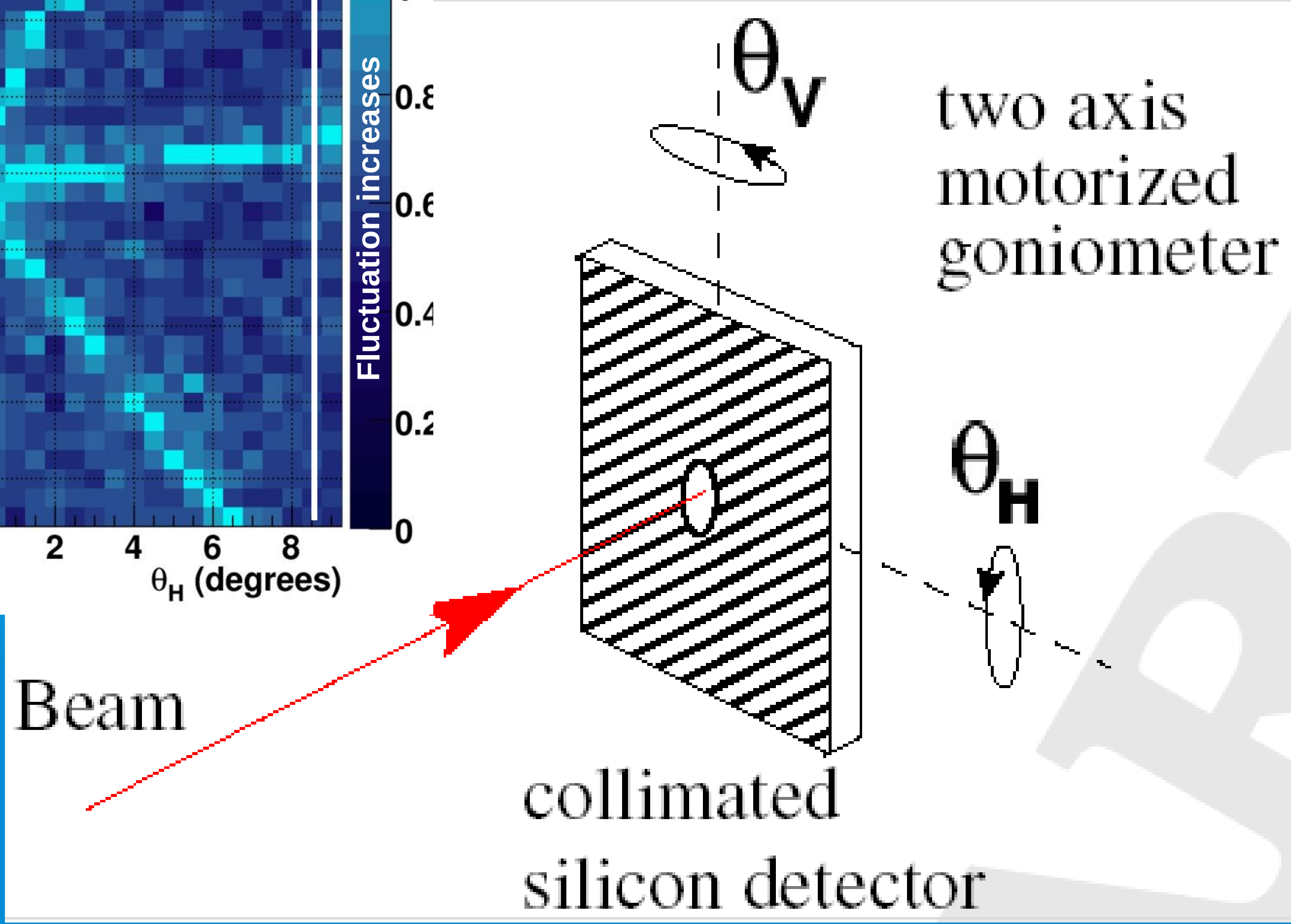
resolution loss!

Channeling/orientation effects in crystal lattice

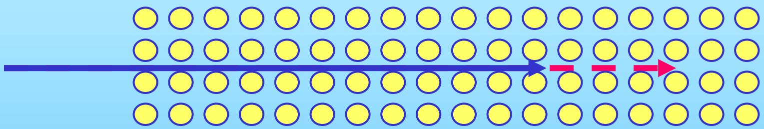
Risetime-fluctuations vs gonio-angles

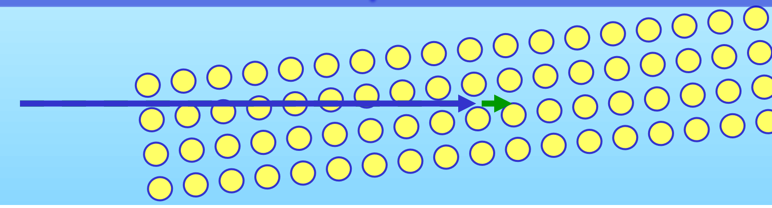


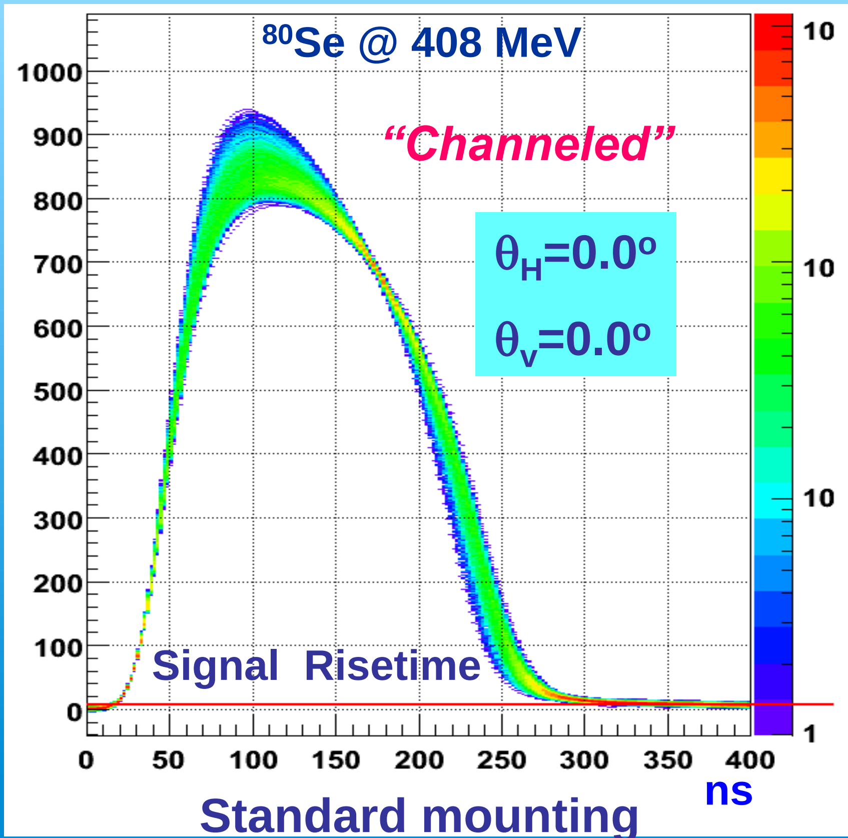
L. Bardelli et al. NIM A605 (2009) 353

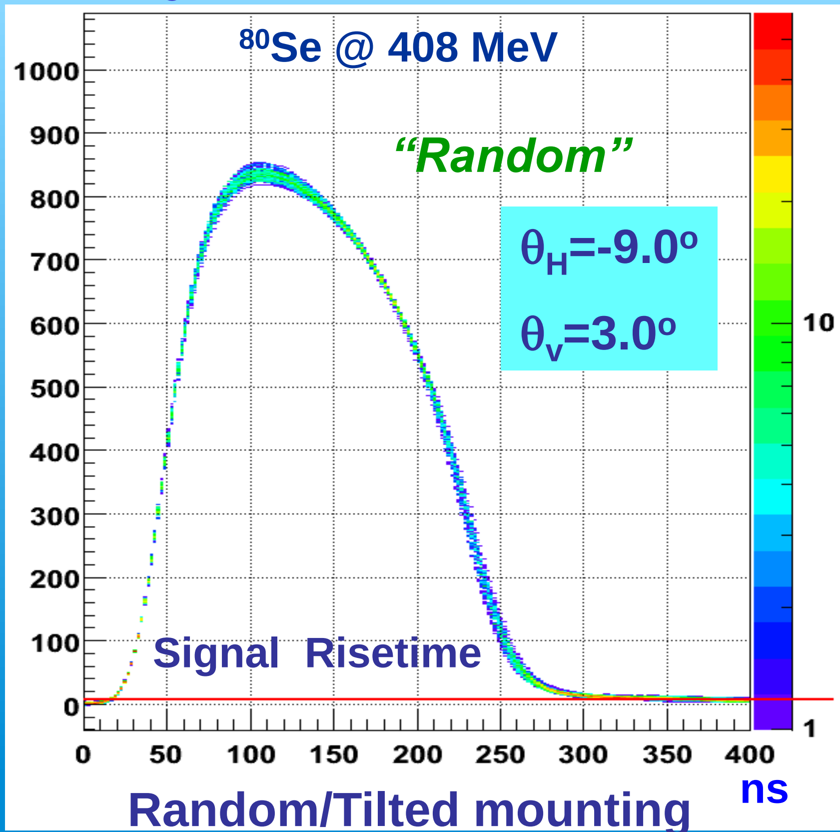


Channeling/orientation effects in crystal lattice





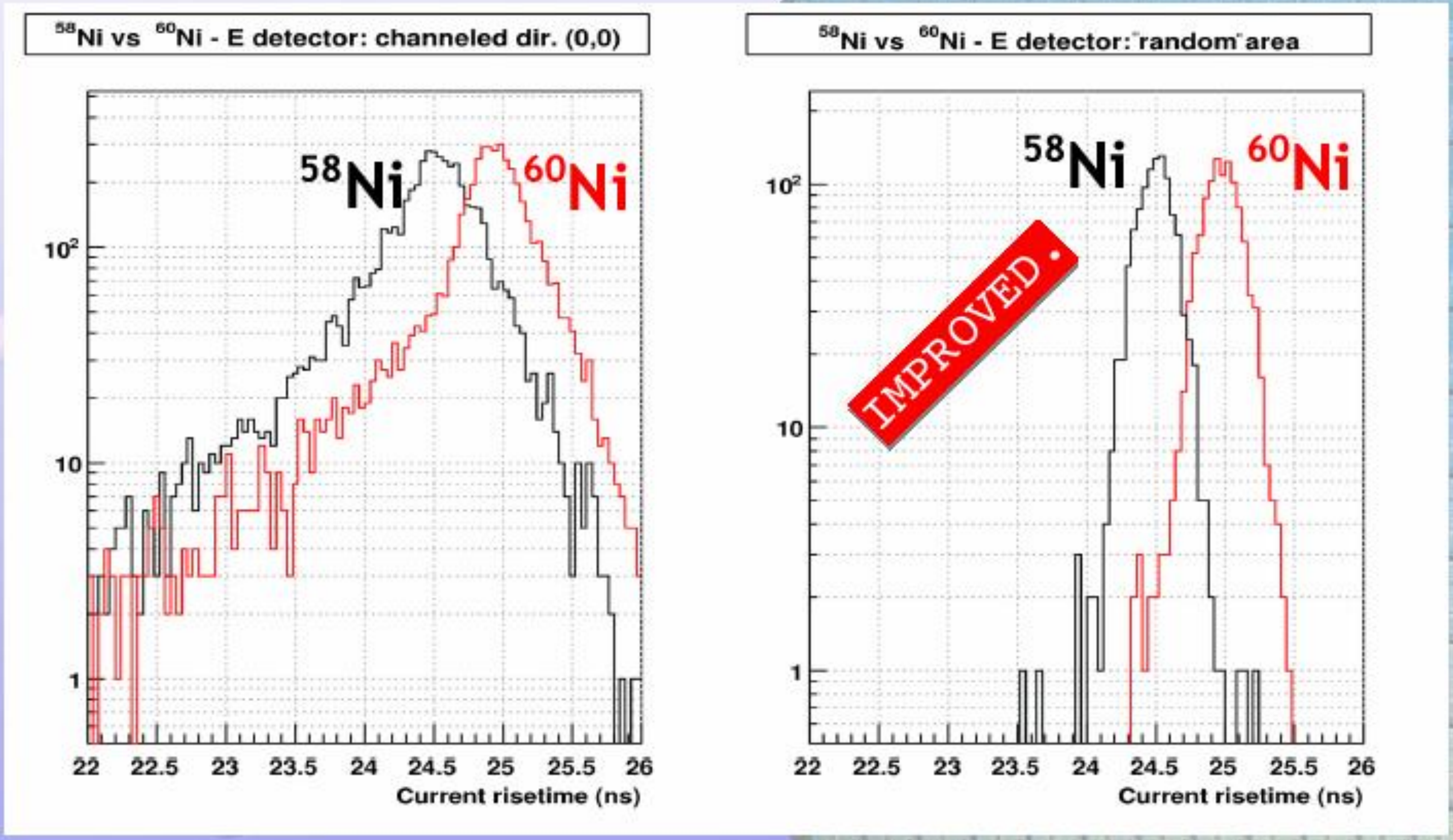




Detectors made of random-cut Silicon were not yet available. All detectors are cut 0° off <111>, axis parallel to the main crystallographic planes

Channeling/orientation effects in crystal lattice

An example of a Pulse Shape Analysis application:
isotopic discrimination (^{58}Ni vs ^{60}Ni, same energy, 703 MeV):



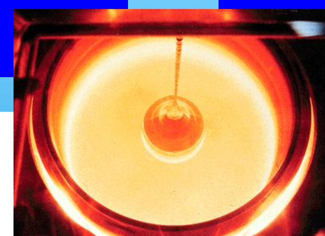
12 bit - 125 MS/s data (INFN-Fi card)

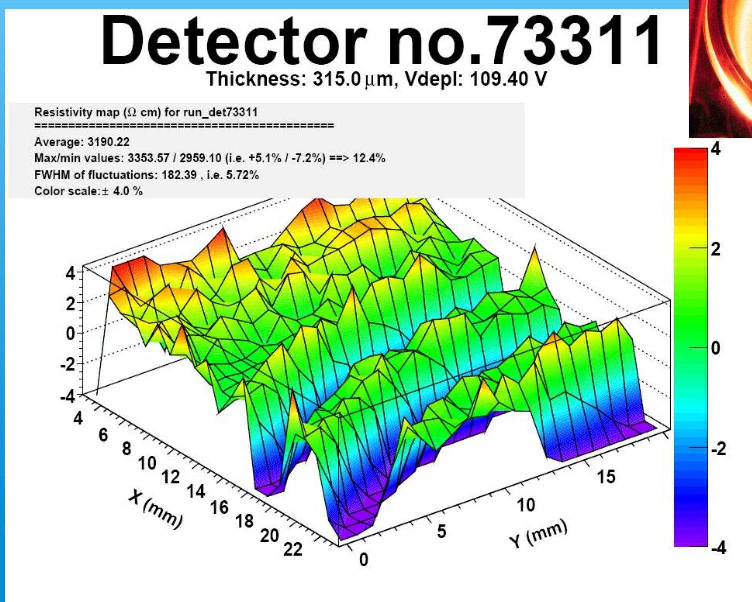
Homogeneity of Si - Uniformity of electric field

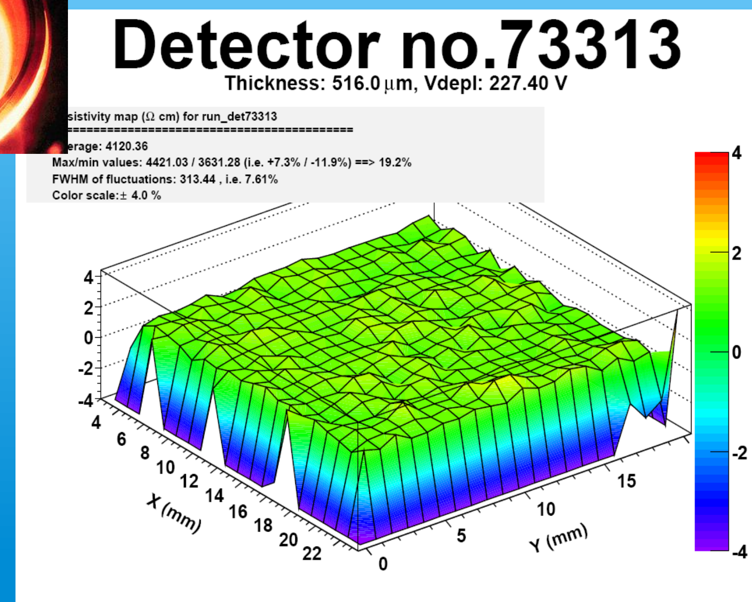
A newly developed procedure to map Silicon resistivity, based on Transient Current Technique has been systematically applied to our detectors

A typical detector: ~9% non-uniformity with striations (mm^{-1} spatial frequency)

A non typical, <u>very good</u> detector: ~1% non-uniformity with undetectable striations

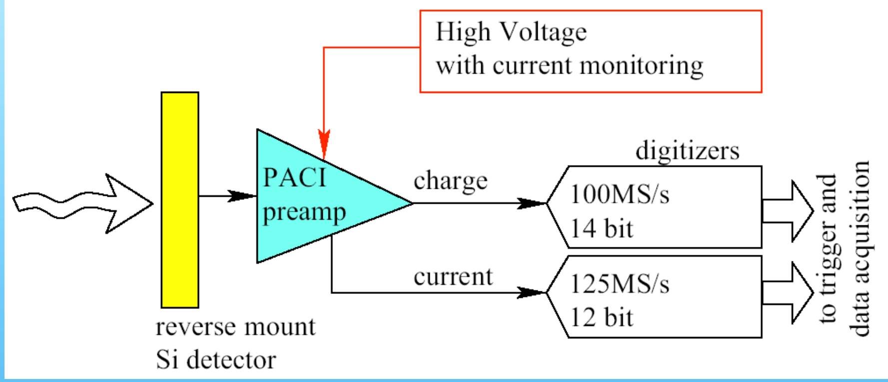




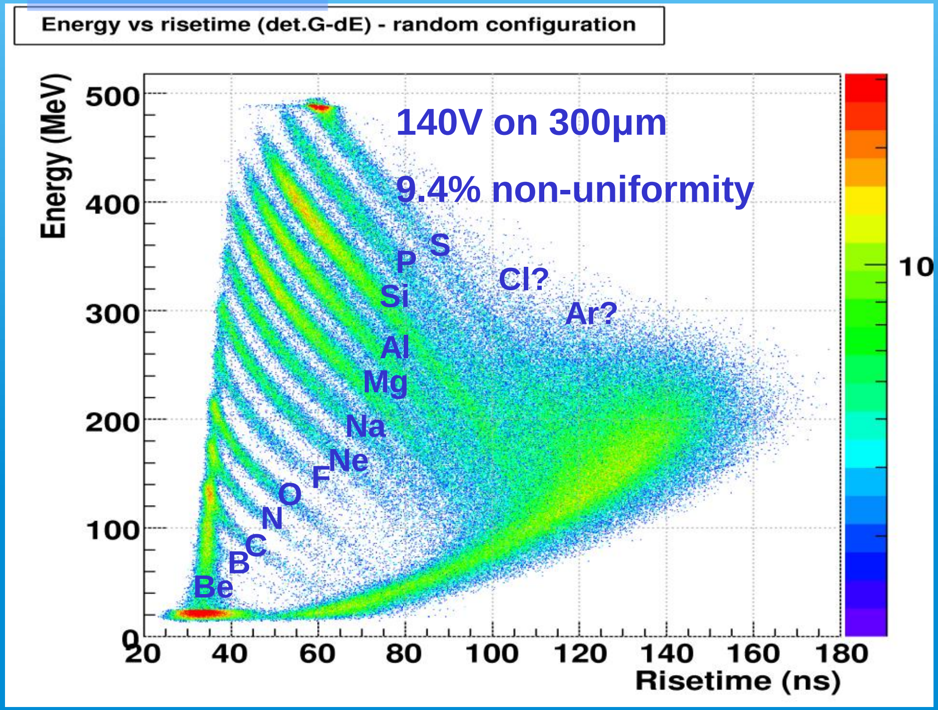


good resistivity uniformity → good uniformity of electric field → position independence of timing

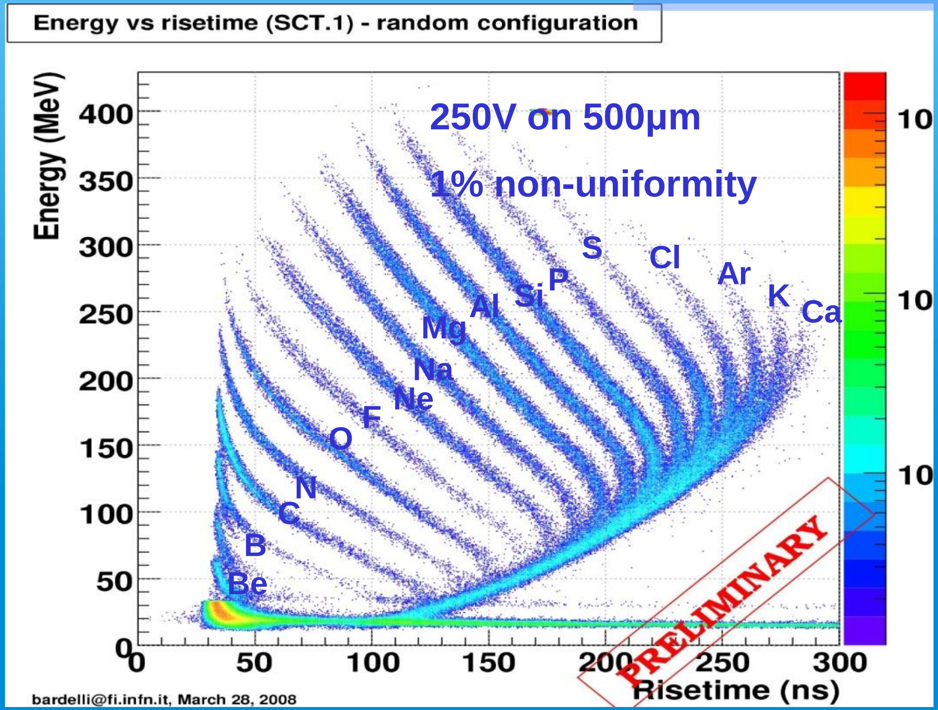
Homogeneity of Si - Uniformity of electric field



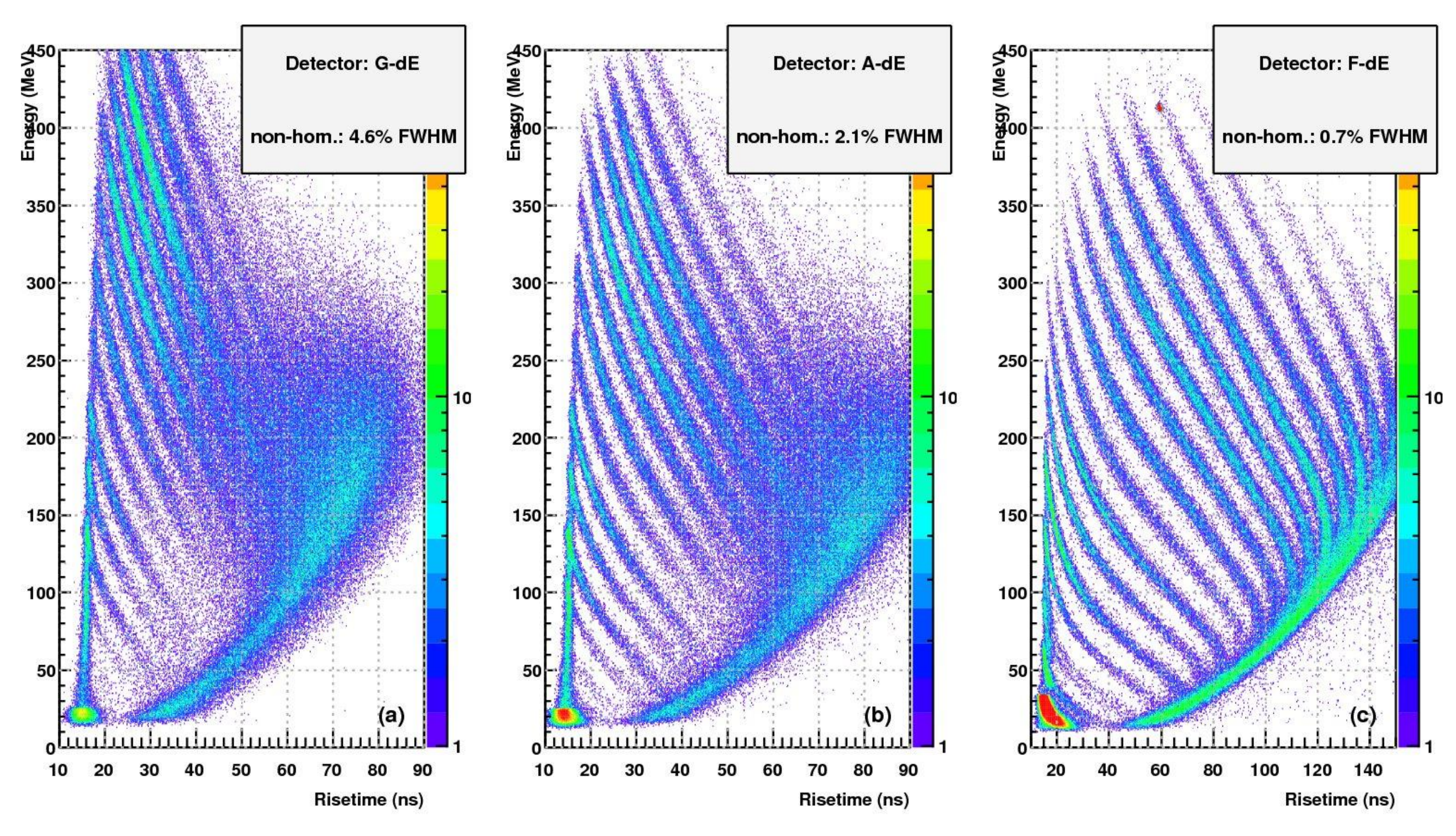
non-uniform



very uniform



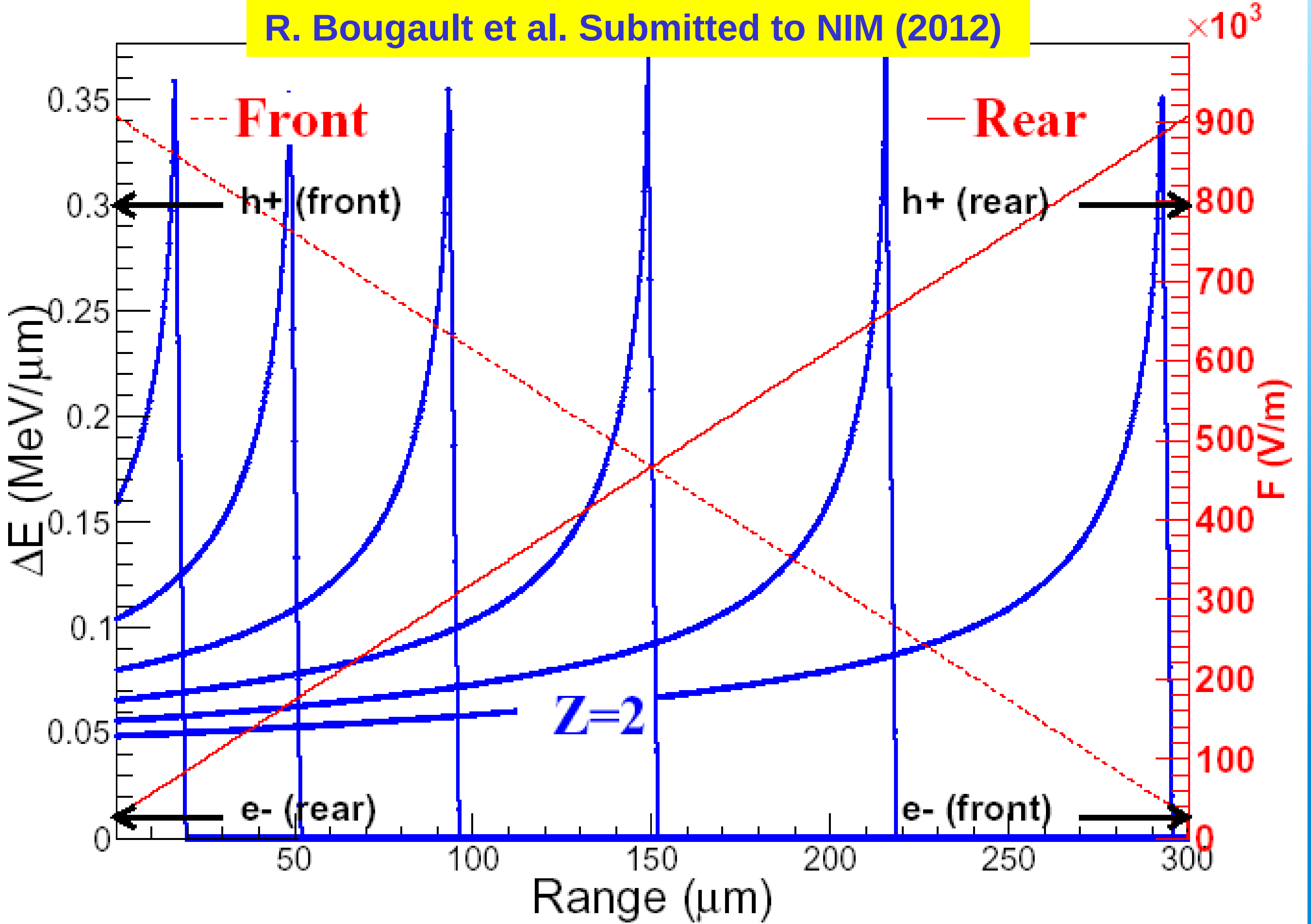
PSA plots – dependence on resistivity non-homogenuities



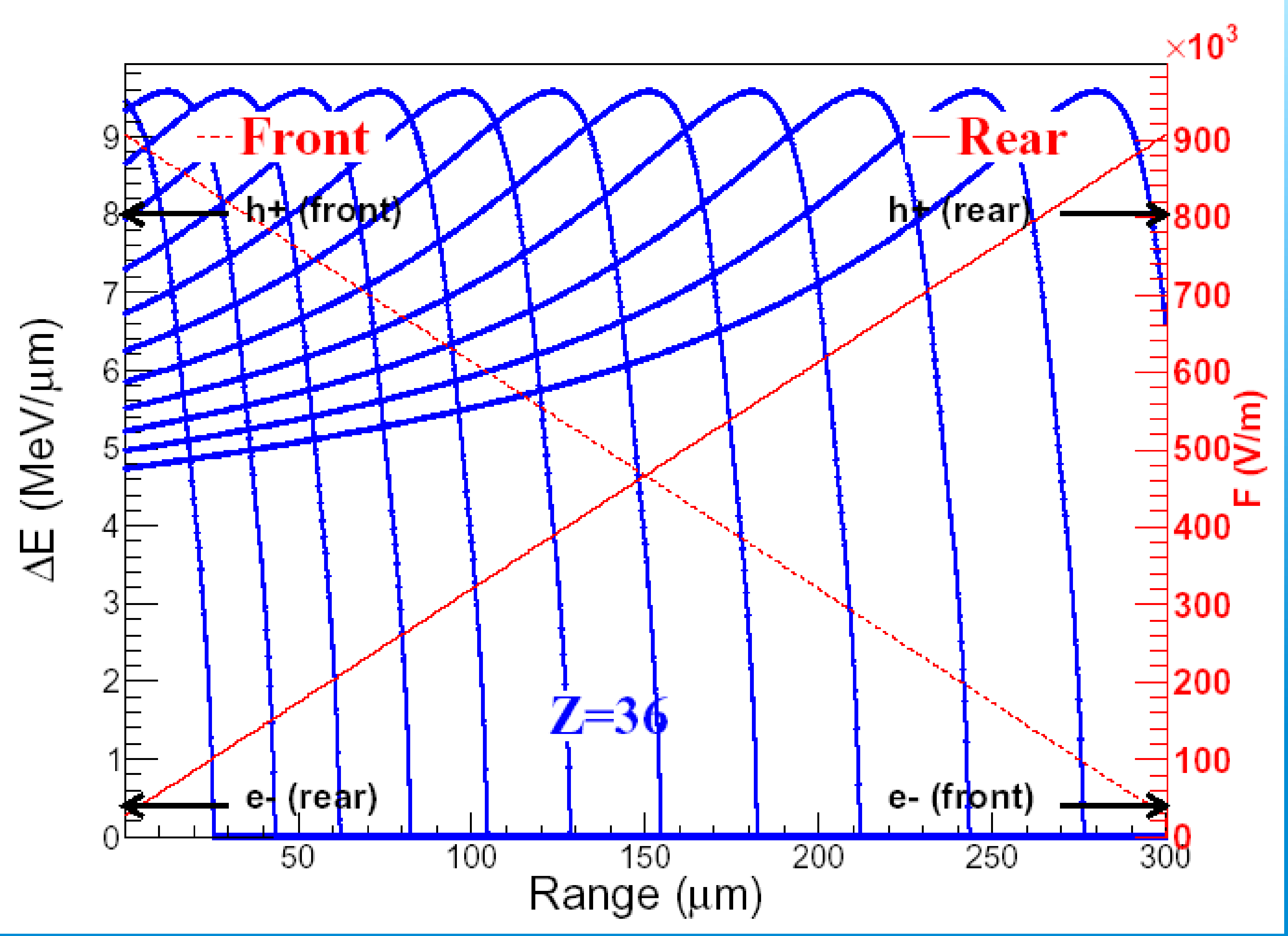
L. Bardelli et al. NIM A654 (2011) 272

Rear/front injection influence on the PSA

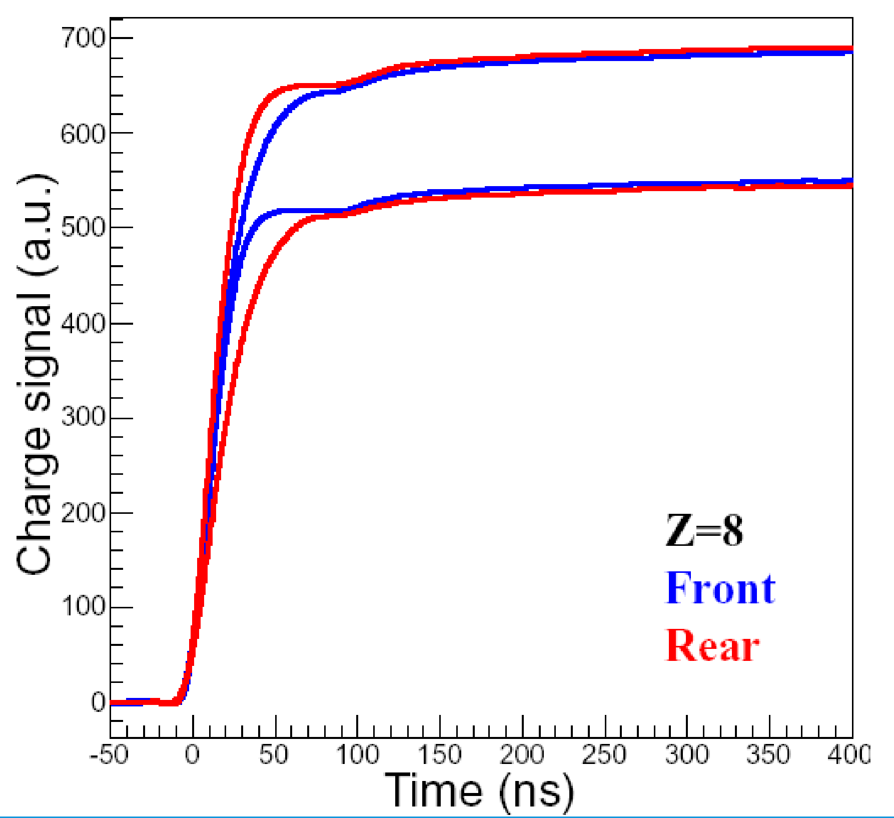
R. Bougault et al. Submitted to NIM (2012)

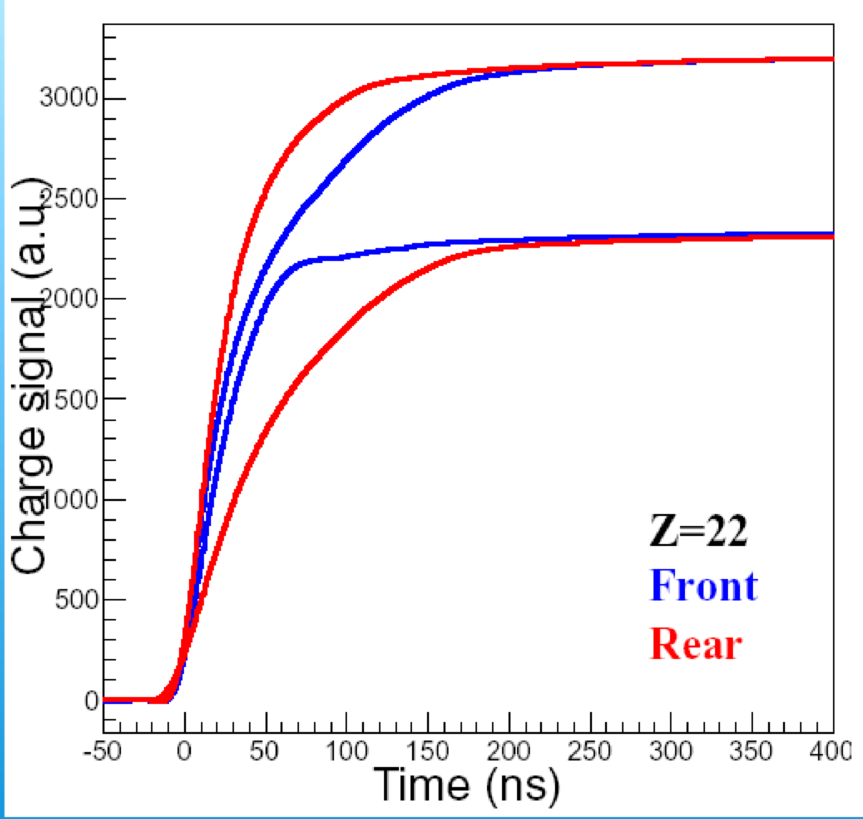


Rear/front injection impact on the PSA



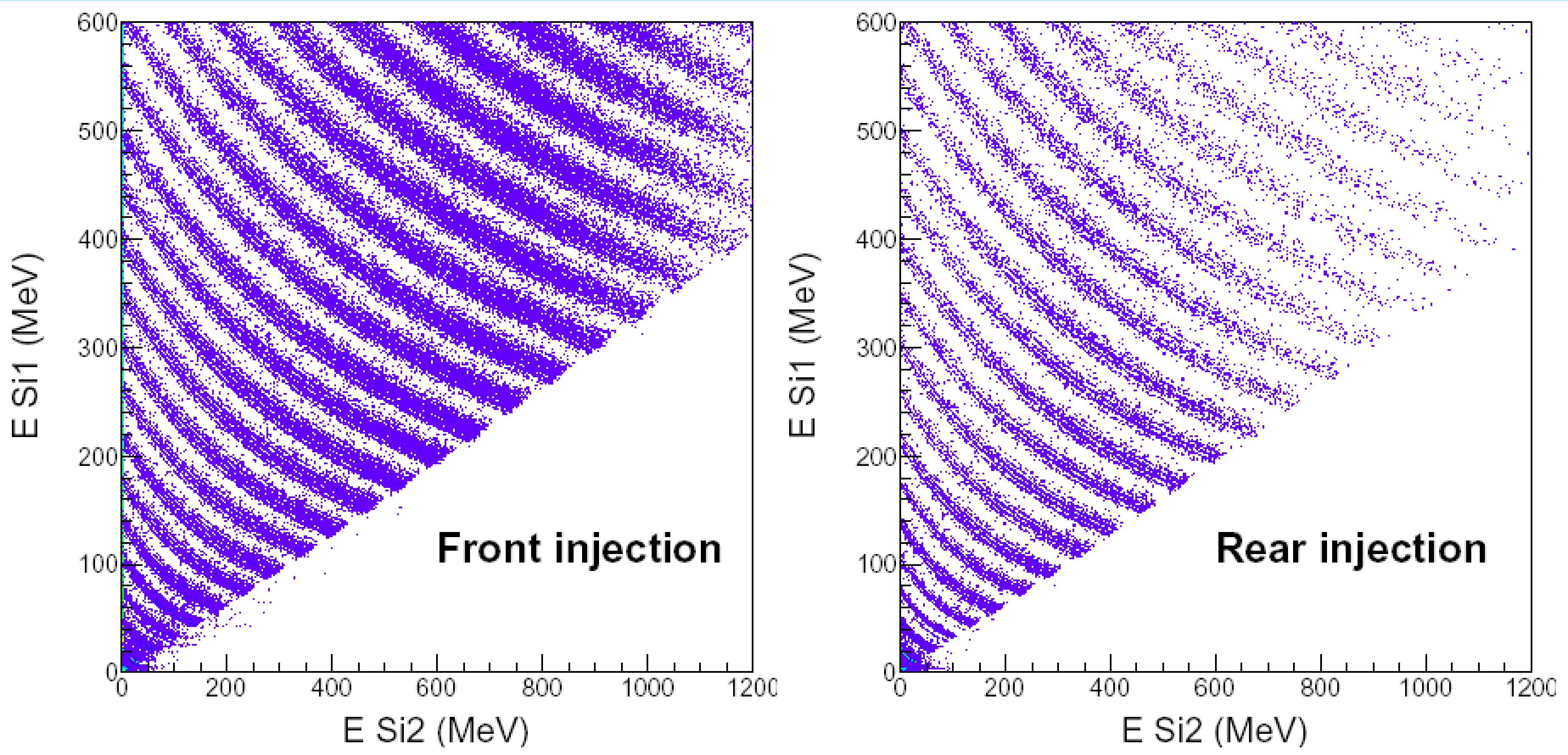
Rear/front injection impact on the PSA





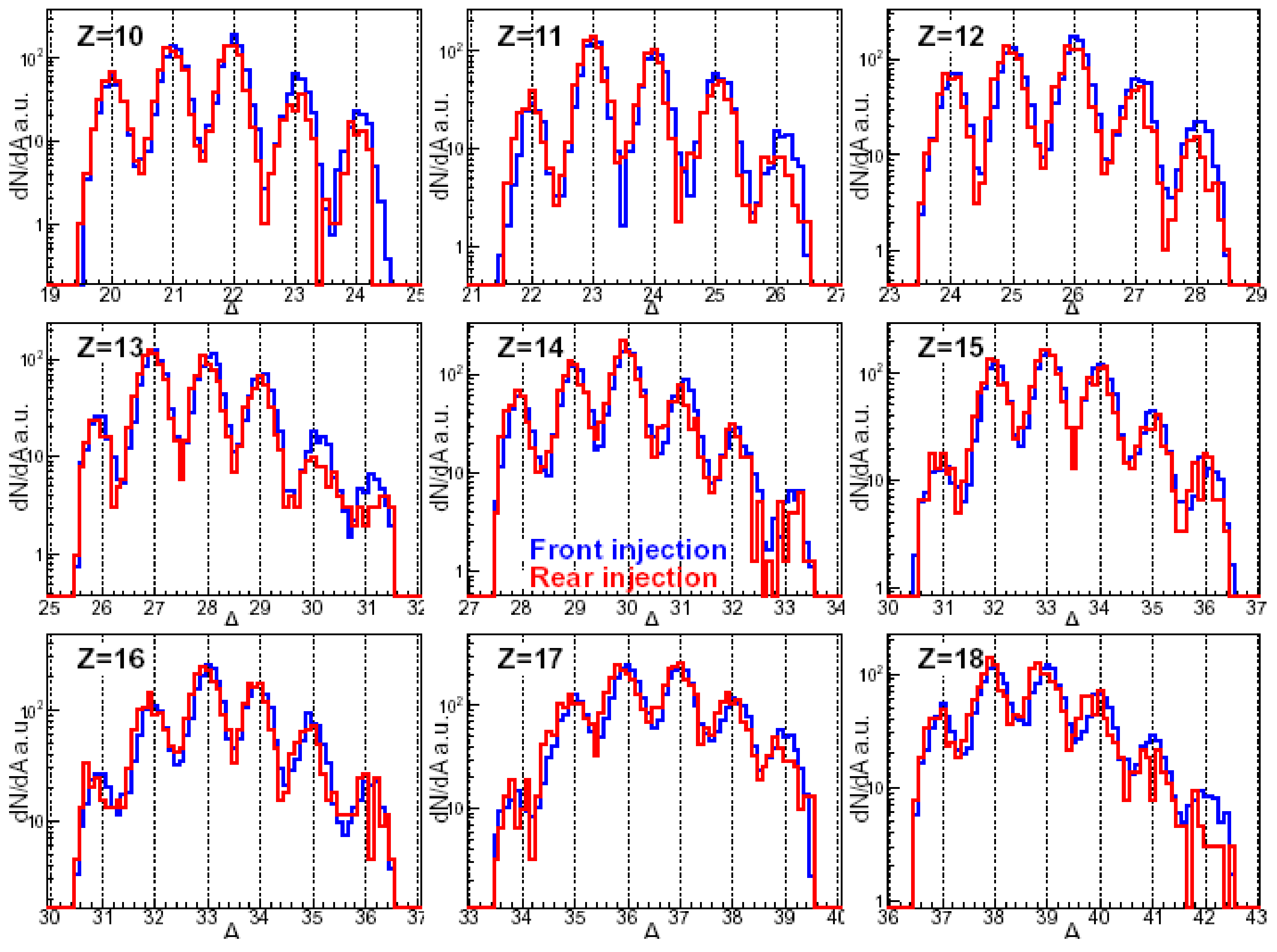
Comparison between mean charge signals in front and rear injection for various stopped particles of the same energy (range in the silicon) Z=8: 160 MeV (197µm) and 200 MeV (282µm), Z=22: 660 MeV (182µm) and 910 MeV (289µm), respectively. The signal shapes are for front injection (blue) and rear injection (red).

Rear/front injection impact on the PSA



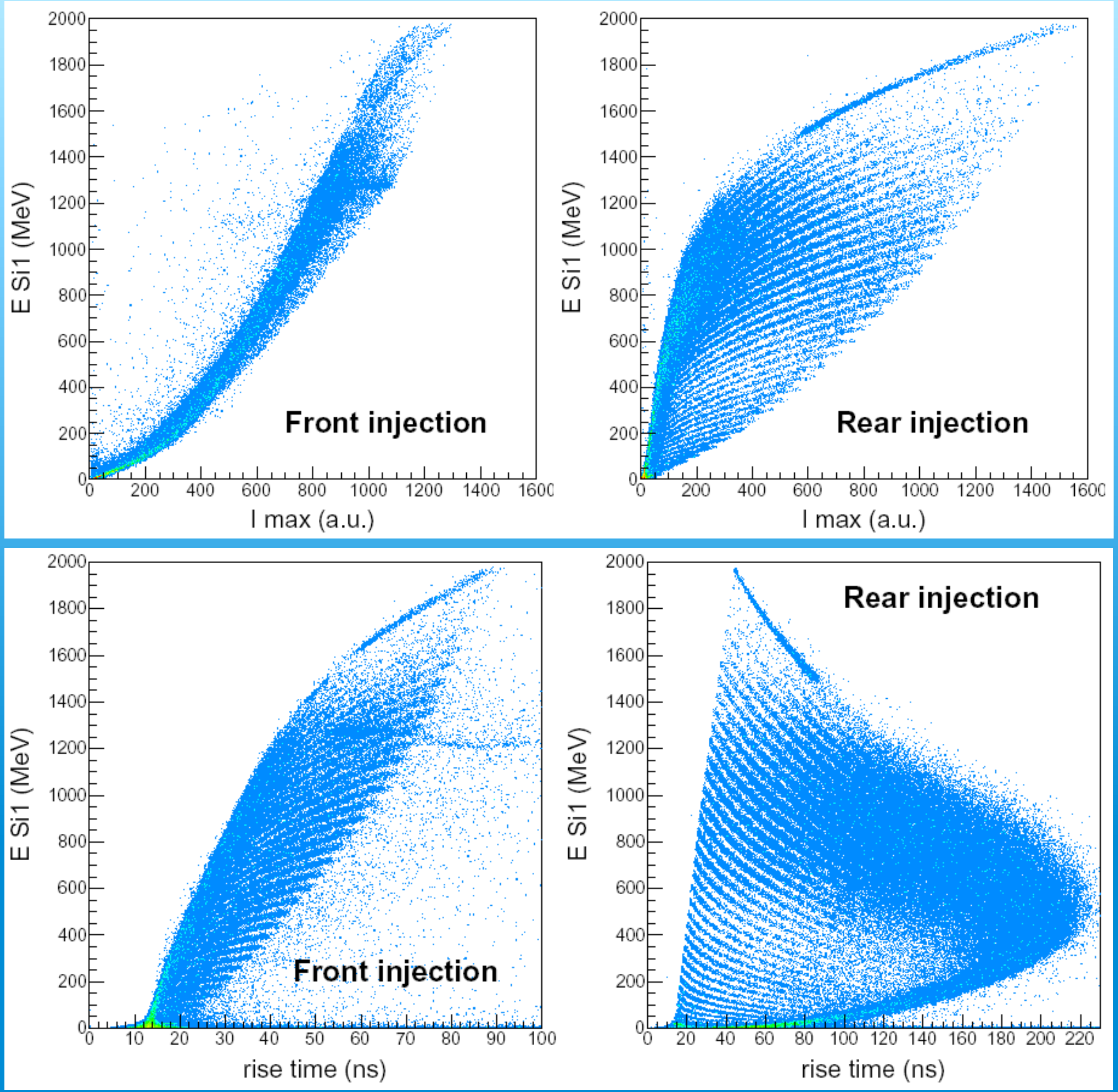
Same ΔE(Si1)-E(Si2) matrices as focusing on the low energy part. Punching through particles have been removed.

Rear/front injection impact on the PSA

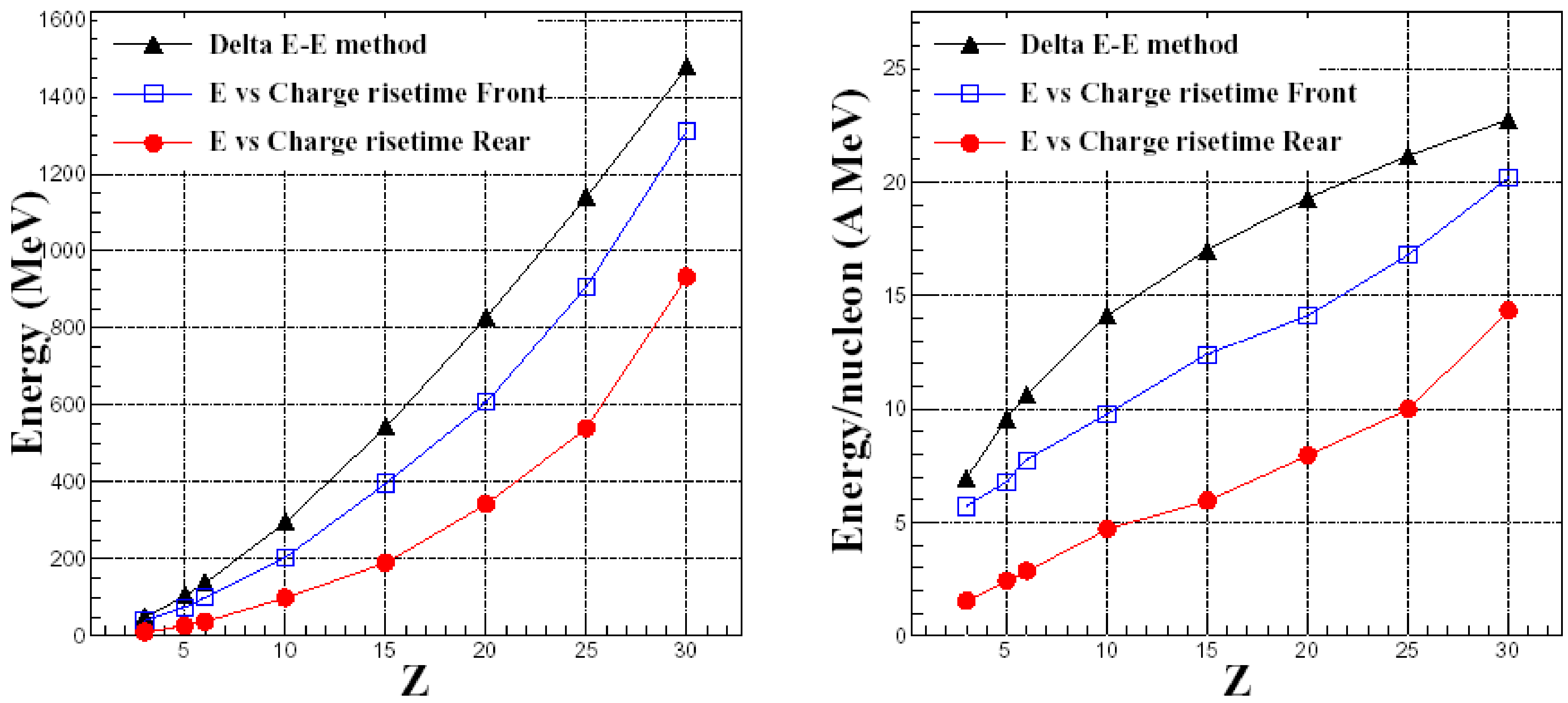


Linearization of the previous ΔE(Si1)-E(Si2) matrices, front (blue line) and rear (red line) injection. For each atomic number Z, isotopic spectra have been normalized on the yields obtained for 21Ne, 23Na, 25Mg, 27Al, 29Si, 32P, 32S, 35Cl and 38Ar respectively

Rear/front injection impact on the PSA

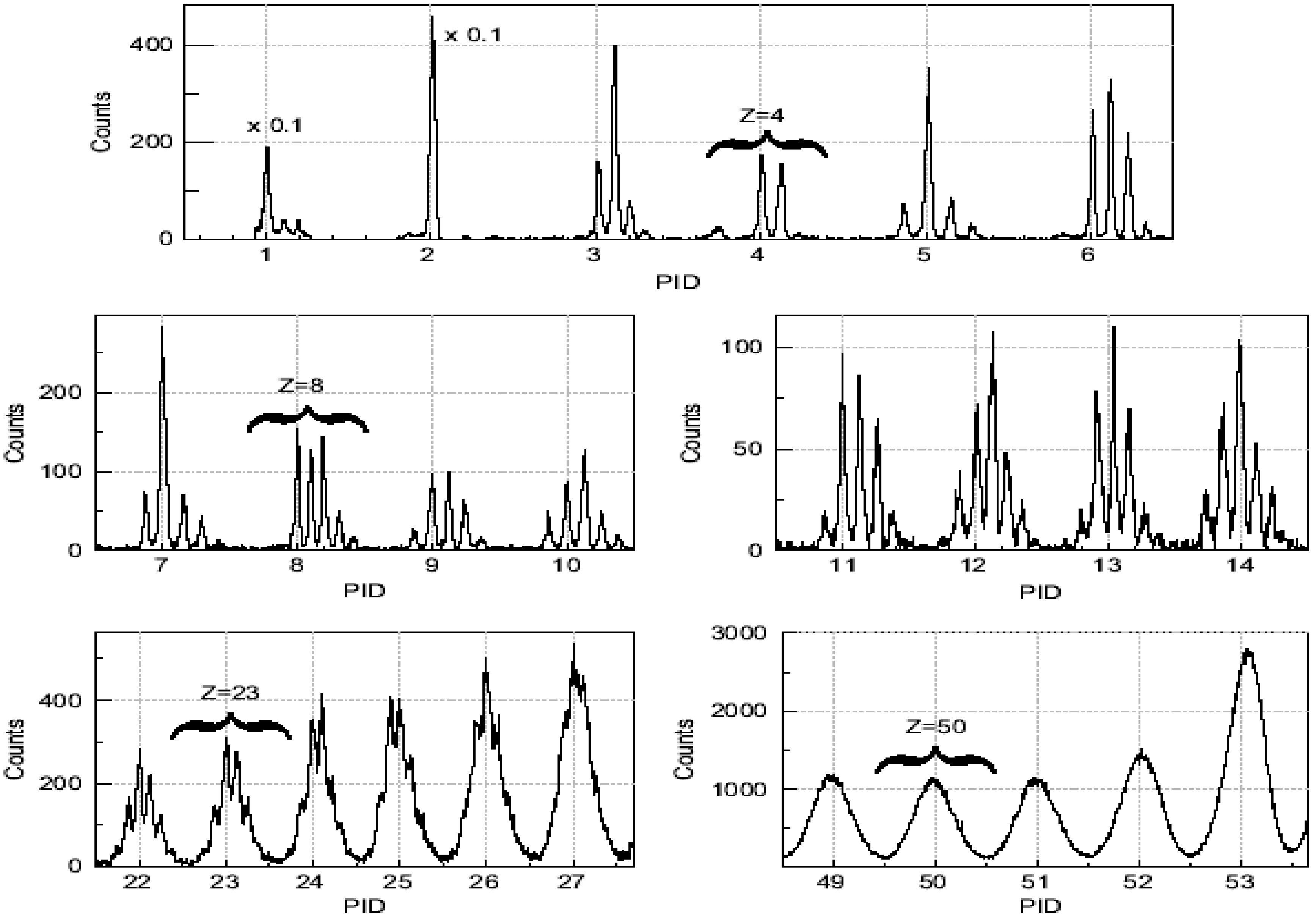


Rear/front injection influence on the PSA

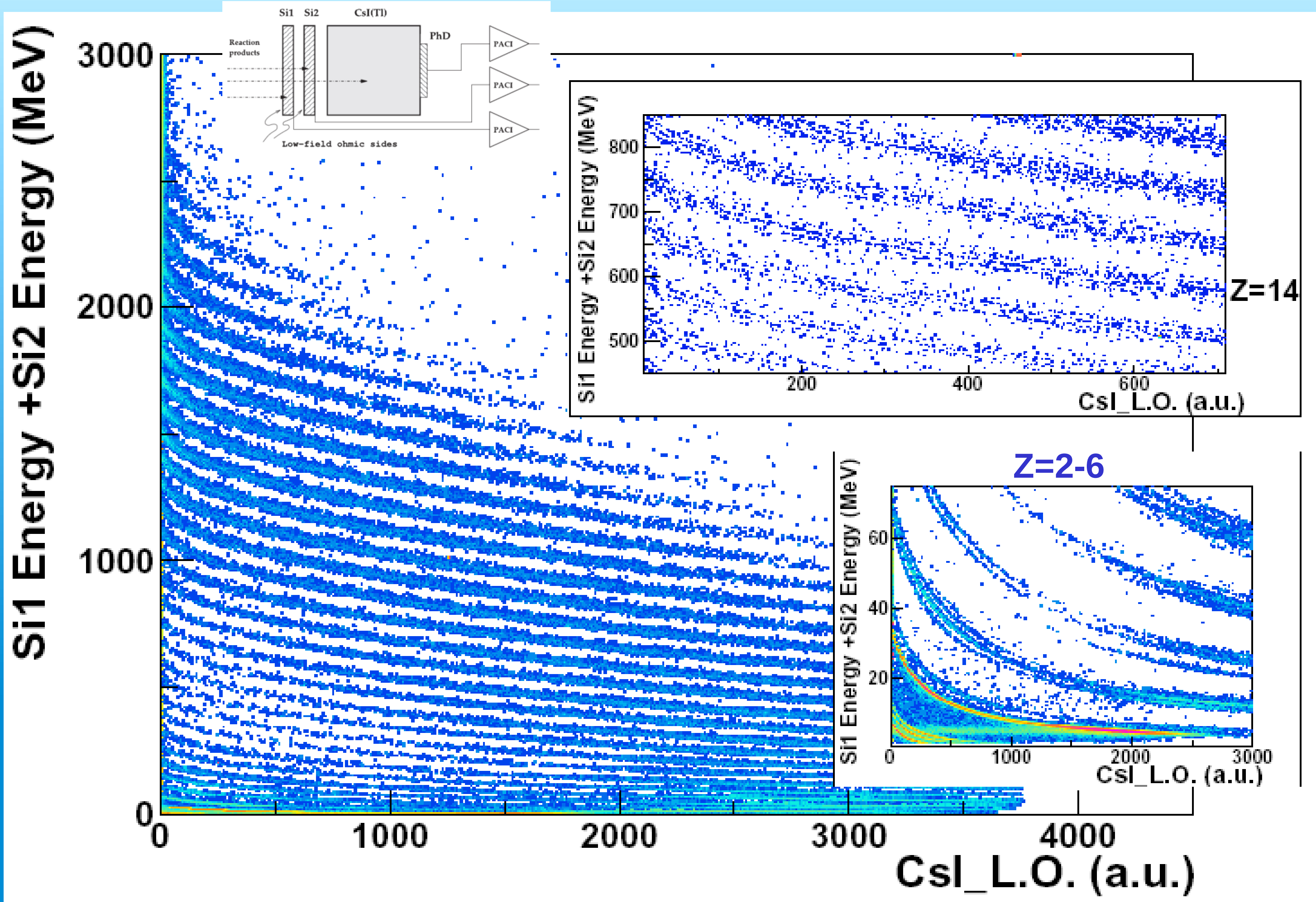


Energy thresholds for Z identification with $\Delta E(300\mu m)$-E technique (black triangles) and with PSA technique (energy vs charge risetime: red points "rear injection" and blue squares "front injection") as a function of atomic number Z. The thresholds values are presented in terms of total energy (left) and energy per nucleon (right).

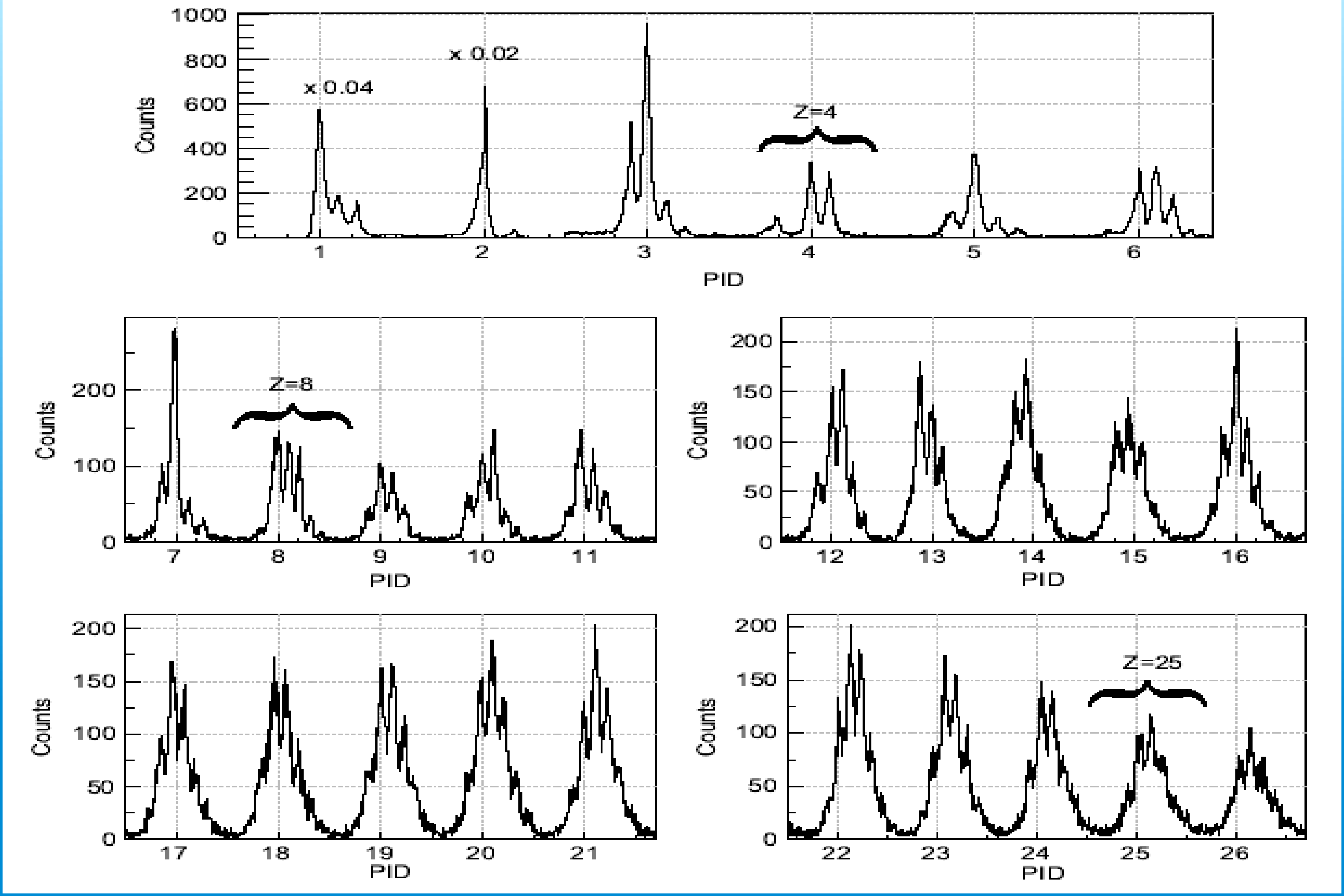
Particle Identification (PID) by ΔE(Si1) – E(Si2) correlation



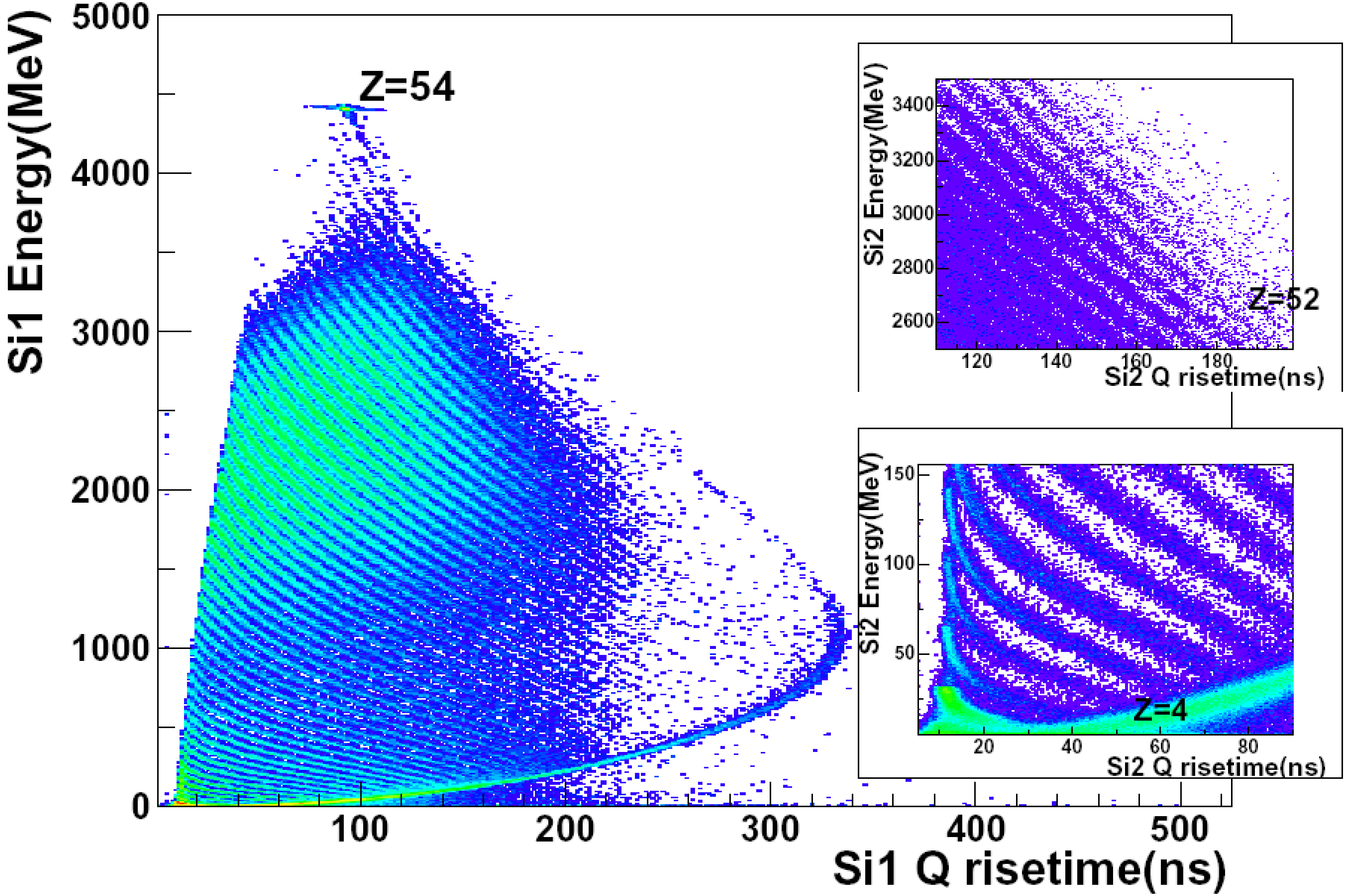
PID 3 detectors ΔE(Si1) + E(Si2) vs light output of rear CsI



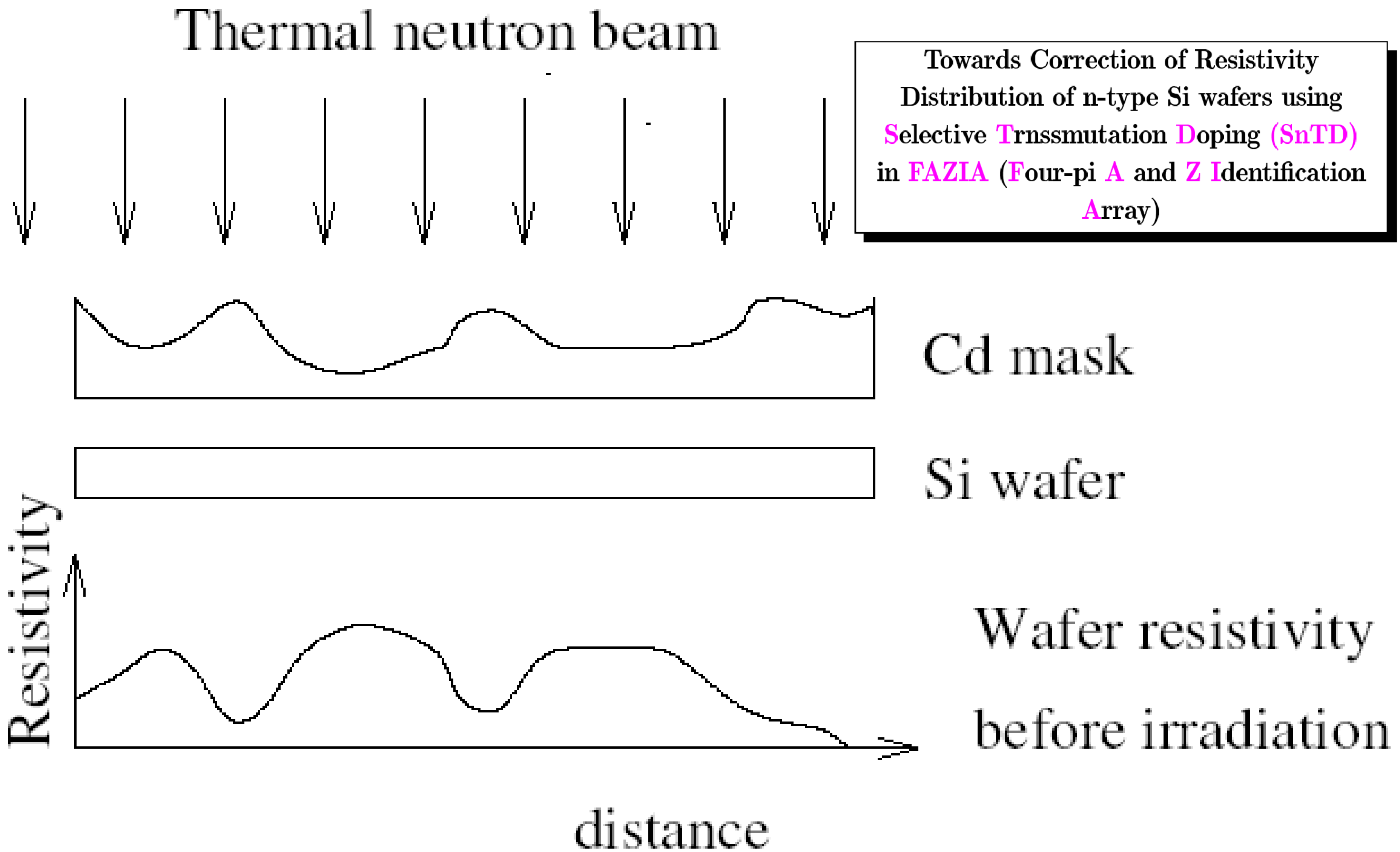
PID 3 detectors ΔE(Si1) + E(Si2) – CsI method



PSA Single 500 μm detector Charge identyfication

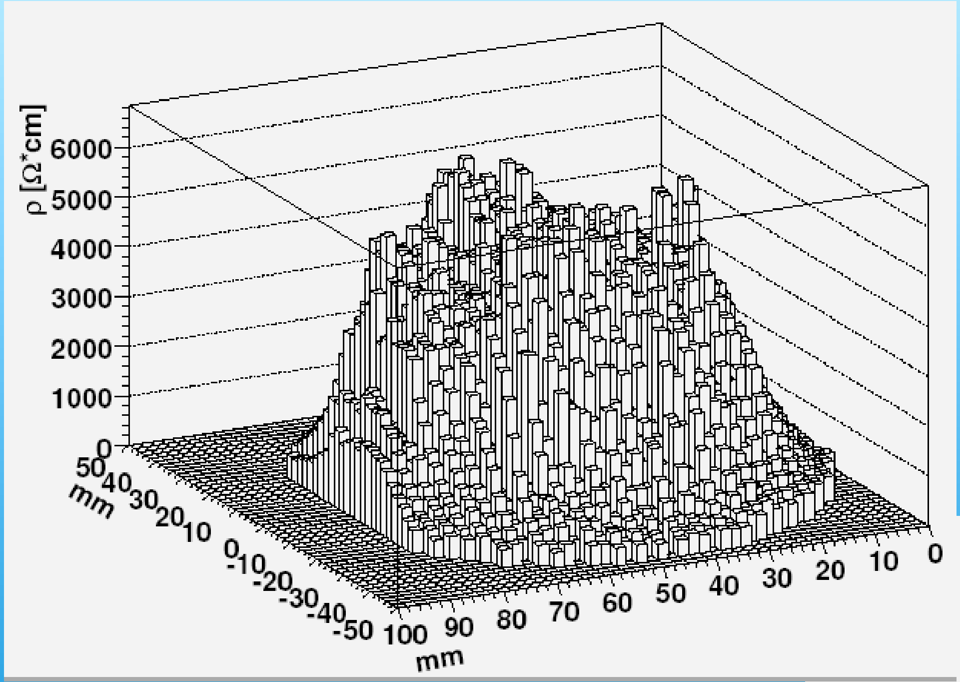


Correction of non-uniformity – Andrew Kordyasz



Towards Correction of Resistivity Distribution of n-type Si wafers using Selective Trnssmutation Doping (SnTD) in FAZIA (Four-pi A and Z Identification Array)

Correction of non-uniformity - Andrew Kordyasz



Towards Correction of Resistivity Distribution of n-type Si wafers using **S**elective **T**rnssmutation **D**oping **(SnTD)** in **FAZIA** (**F**our-pi **A** and **Z** **I**dentification **A**rray)