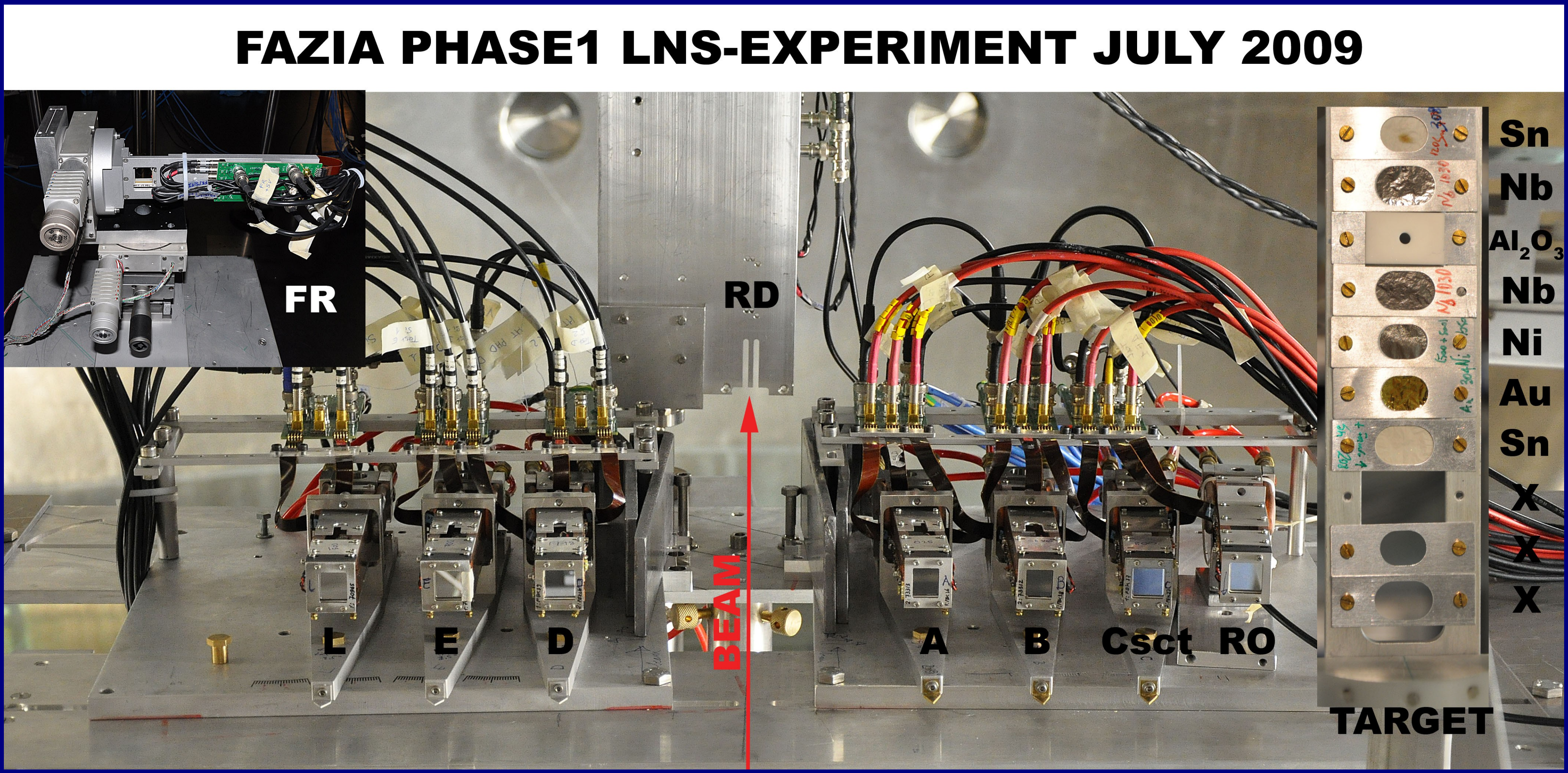
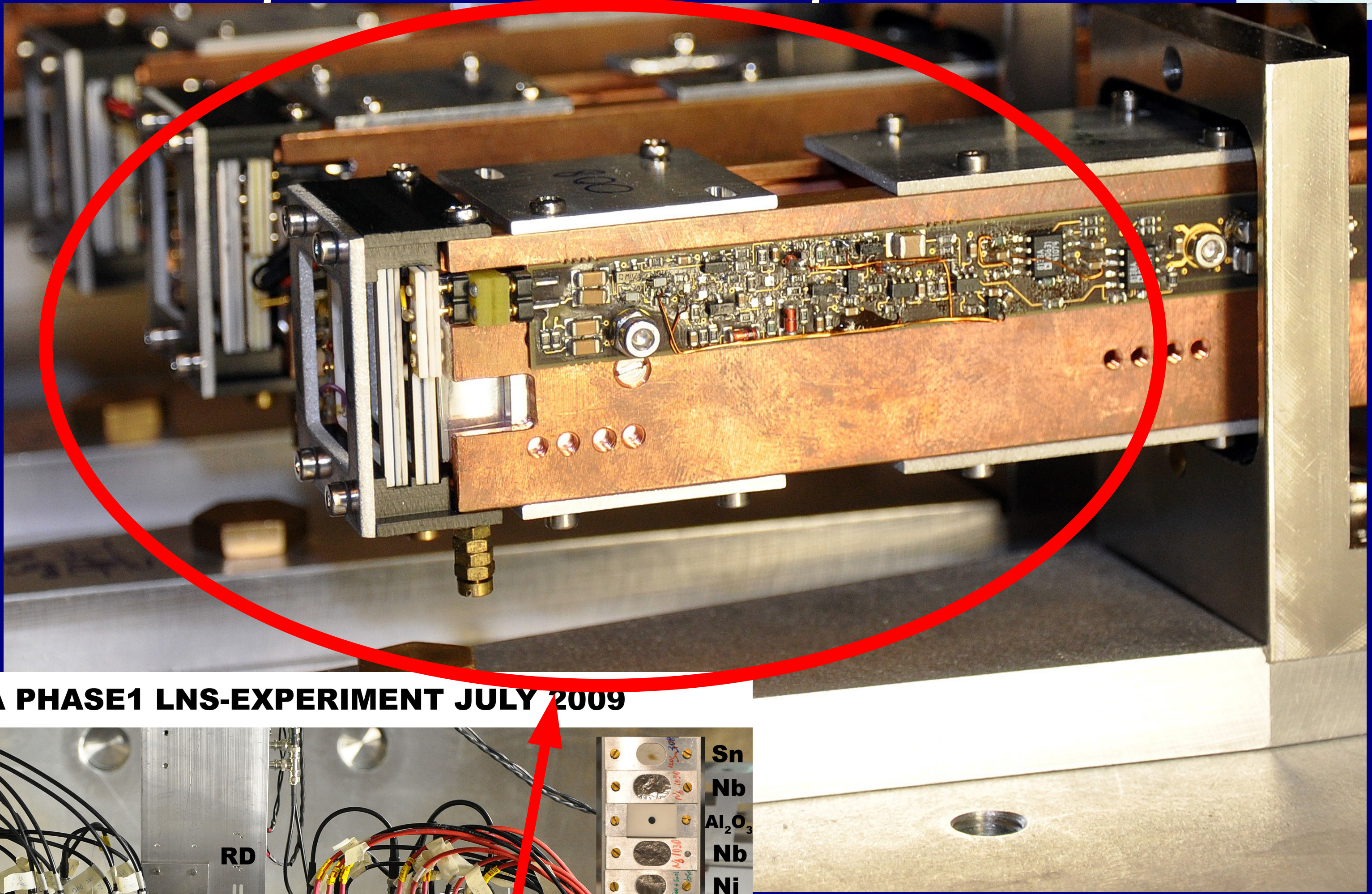
THE SINGLE CHIP TELESCOPE

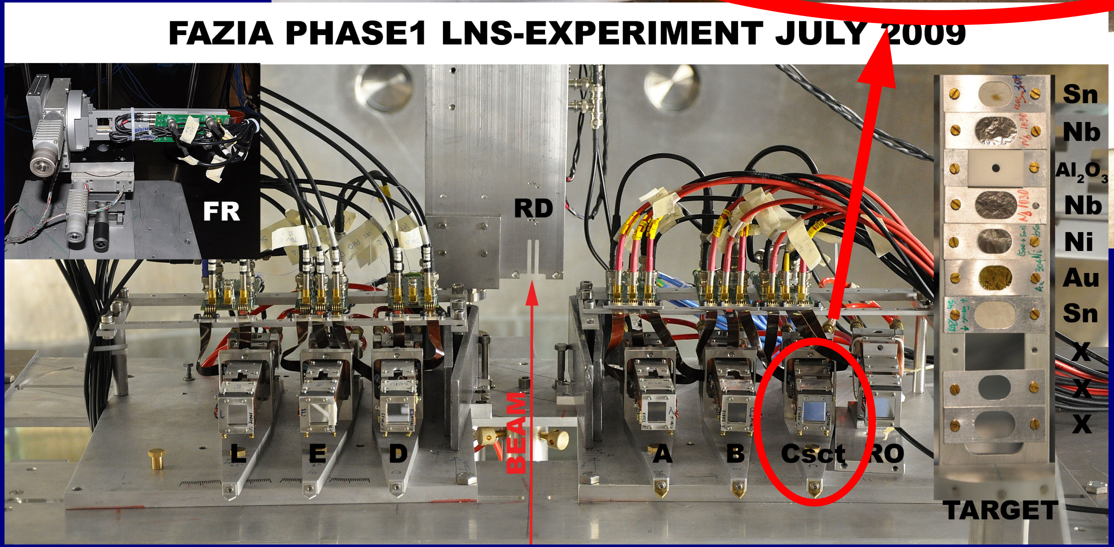
part of FAZIA R&D

Experimental Setup

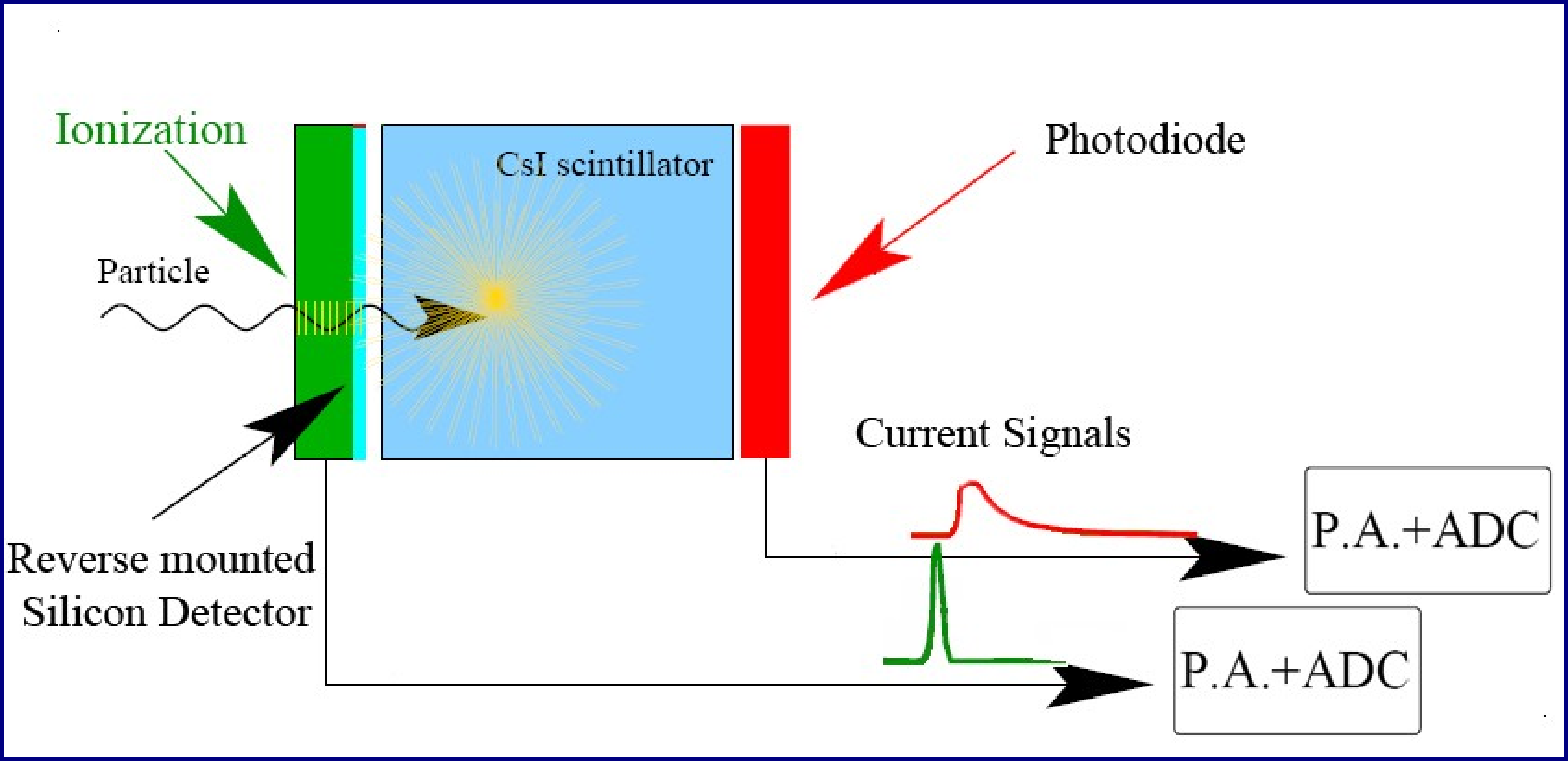


Experimental Setup

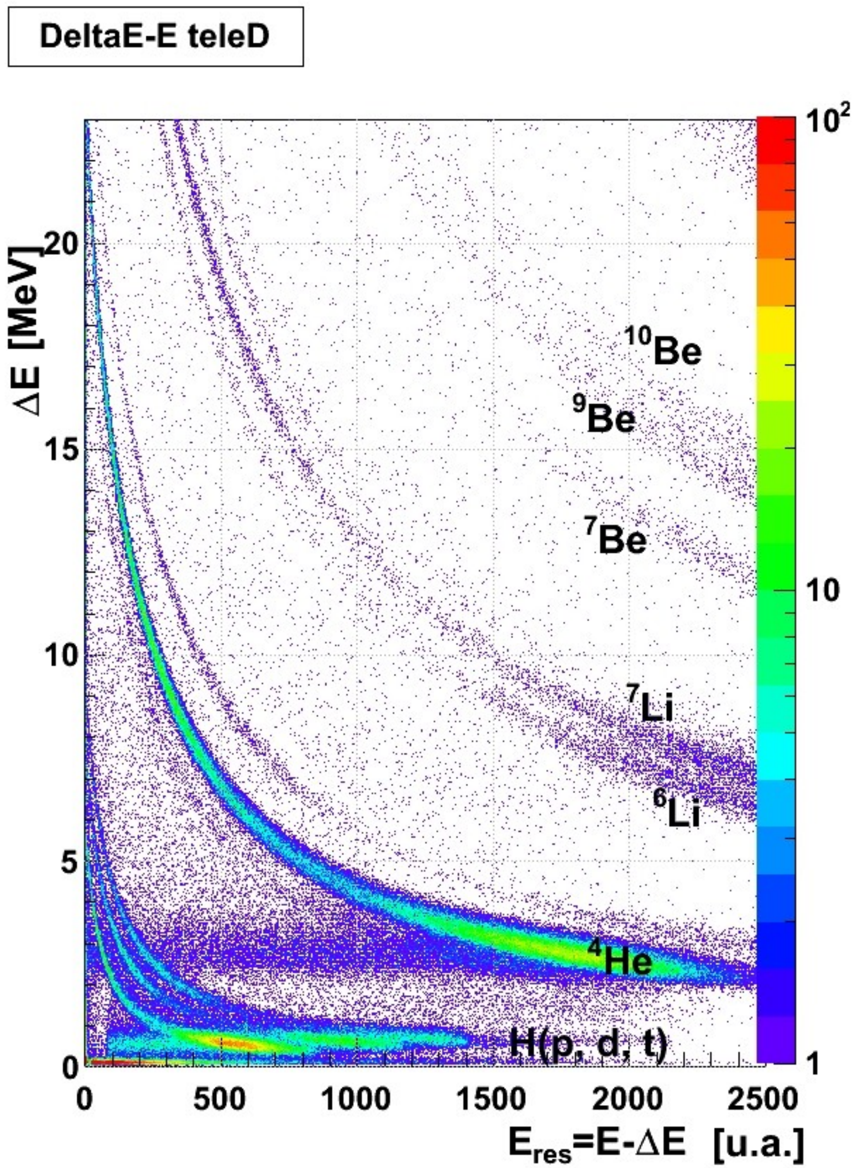


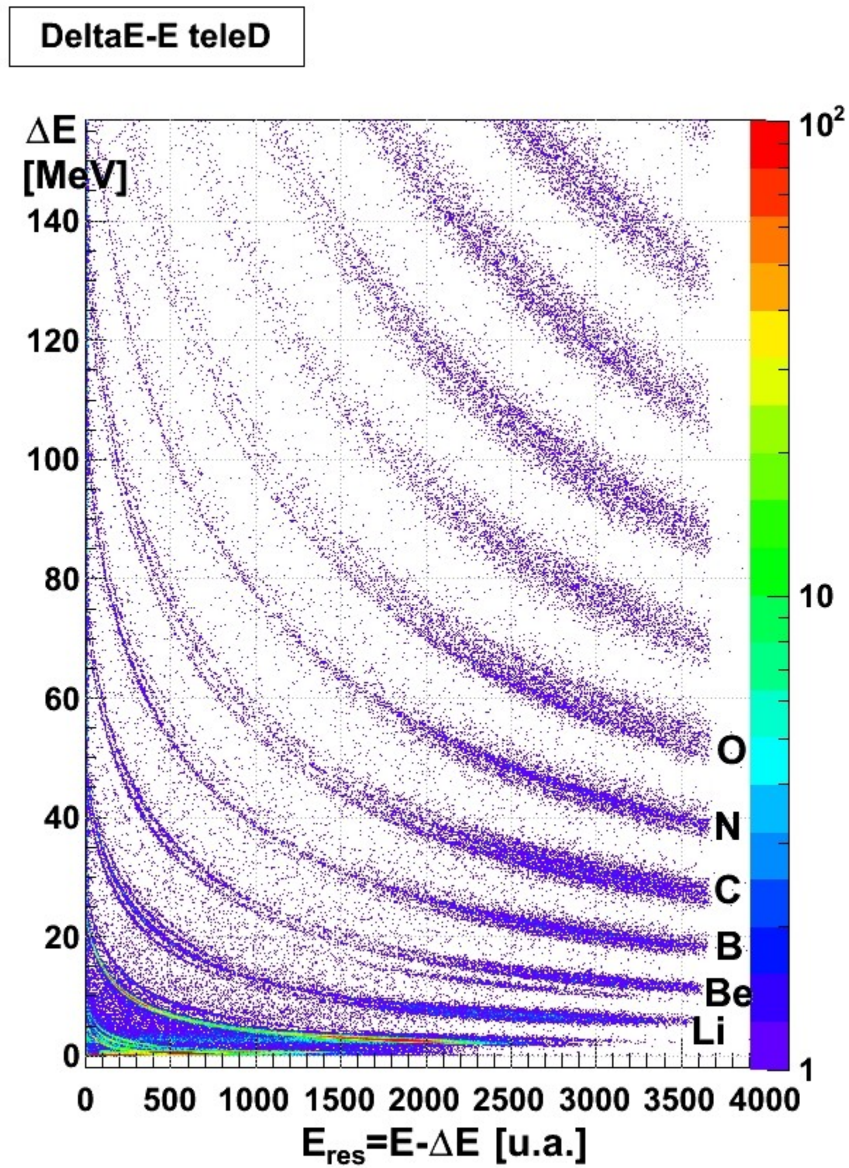


Standard ΔE-E *Telescope*

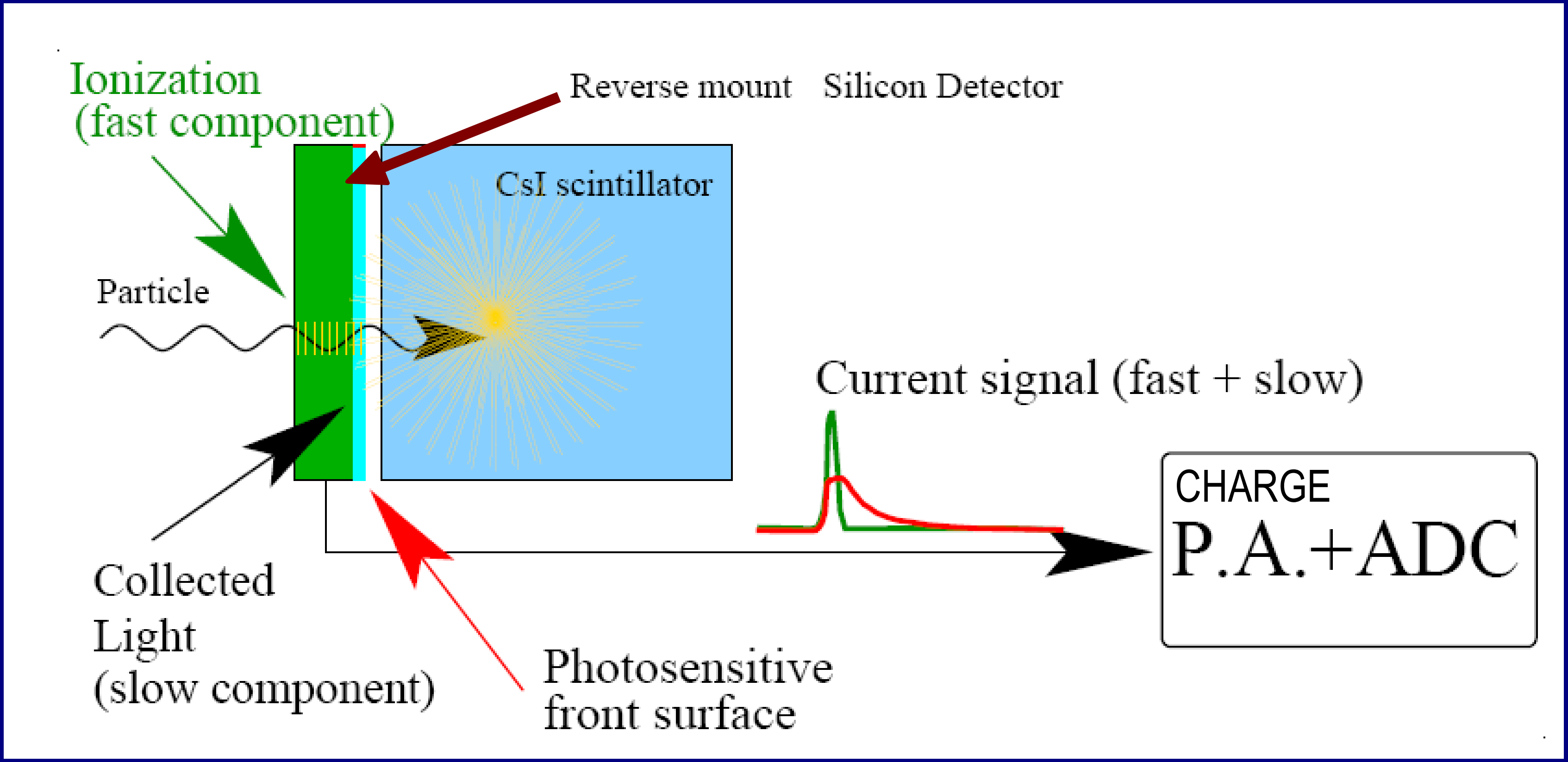


Standard ΔE-E *Telescope*





Single Chip Telescope



Picture: courtesy L.Bardelli

References:

G.Pasquali et al., NIM A301 (1991) 101

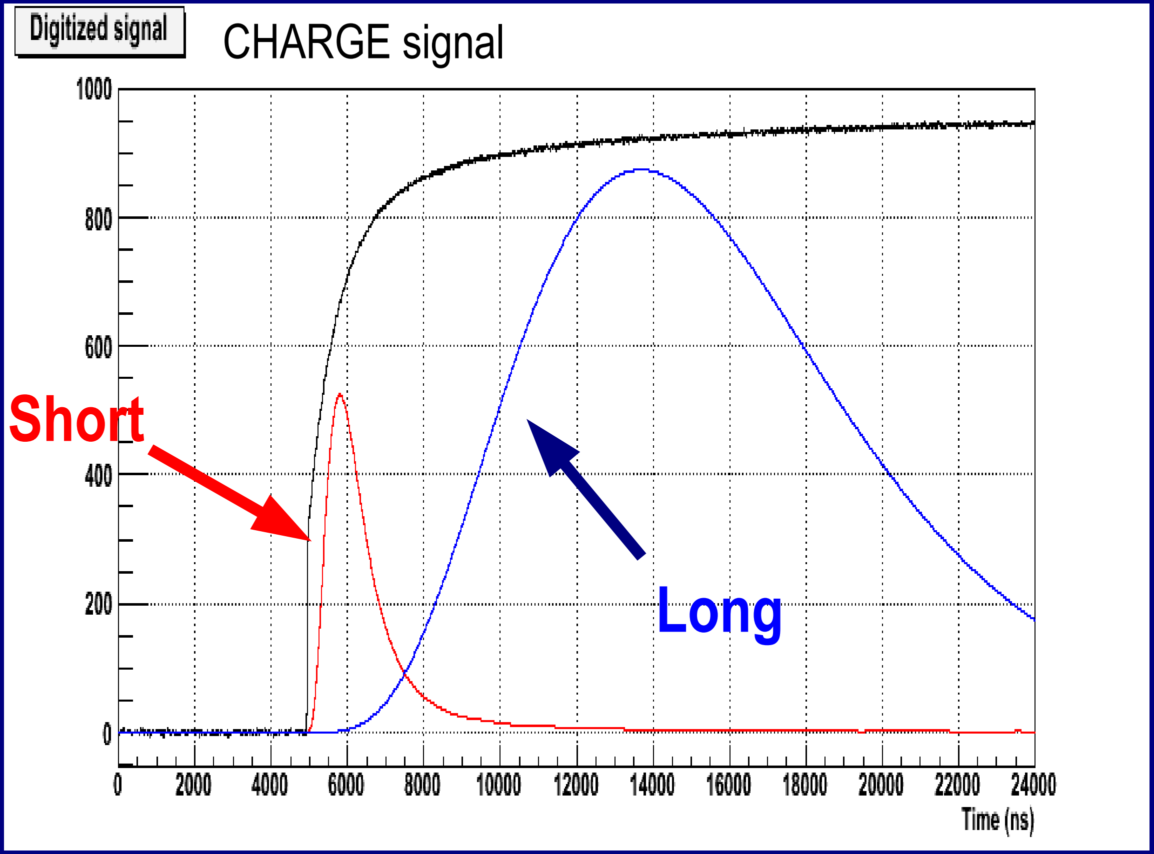
G.Prete et al., NIM A315 (1992) 109

“Easy” method to extract ΔE-E information from the single PA signal: two semigaussian shapers with different peaking times: “short” (0.7μs) and “long” (8μs).
[see original paper: NIM A 301(1991)101]

Let's call **A***short* and **A***long* the output amplitudes of the two shapers. It can be shown that the ΔE and residual E info can be calculated as follows:

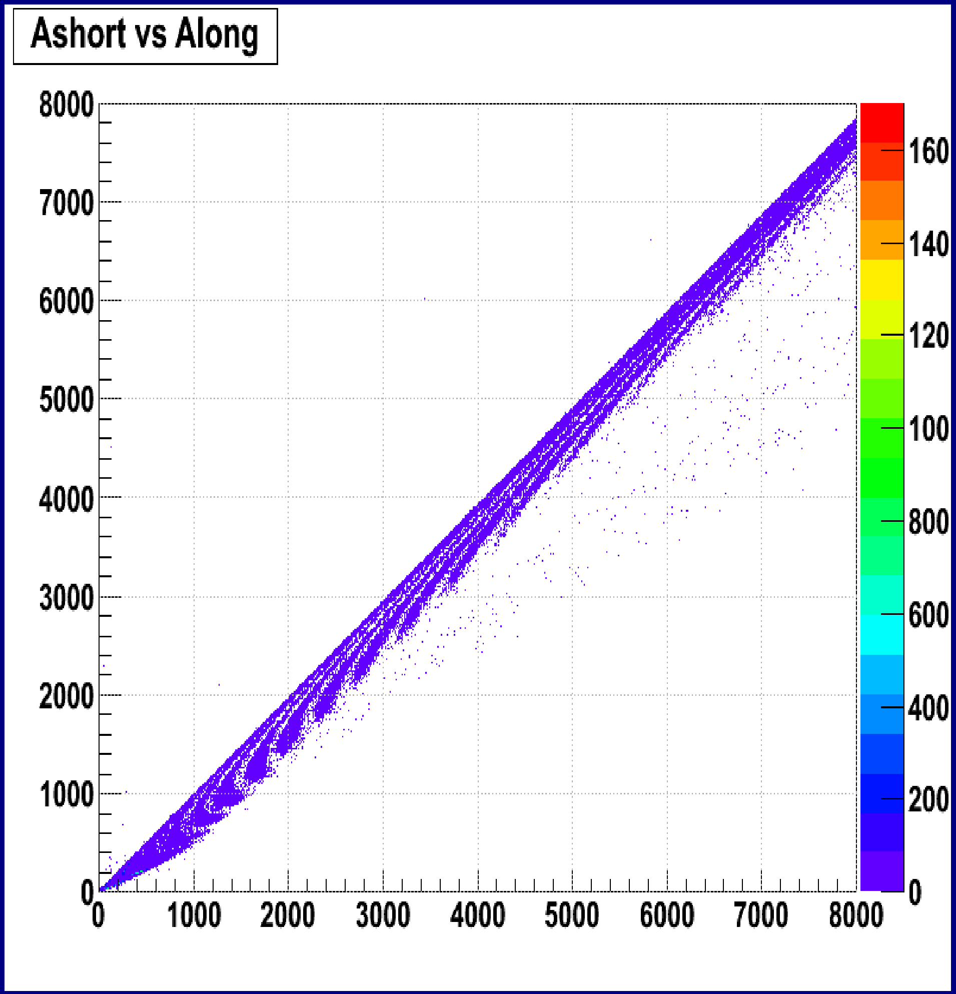
$$\Delta E = A_{Short} - 0.4 \cdot A_{Long}$$

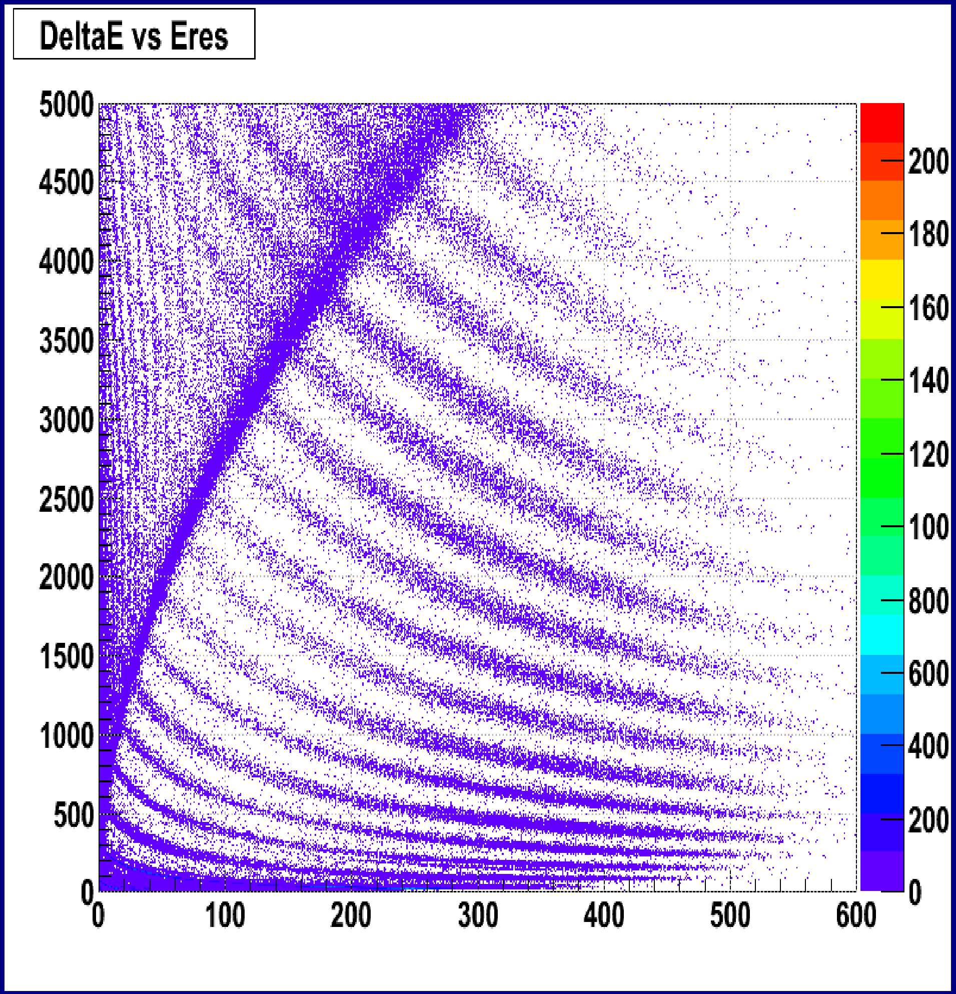
$$E = A_{Long} - 1.02 \cdot A_{Short}$$



where the constants 0.4 and 1.02 depend mainly on the shaping constants. They can be also easily determined by trials and errors just looking at the resulting ΔE-E correlation.

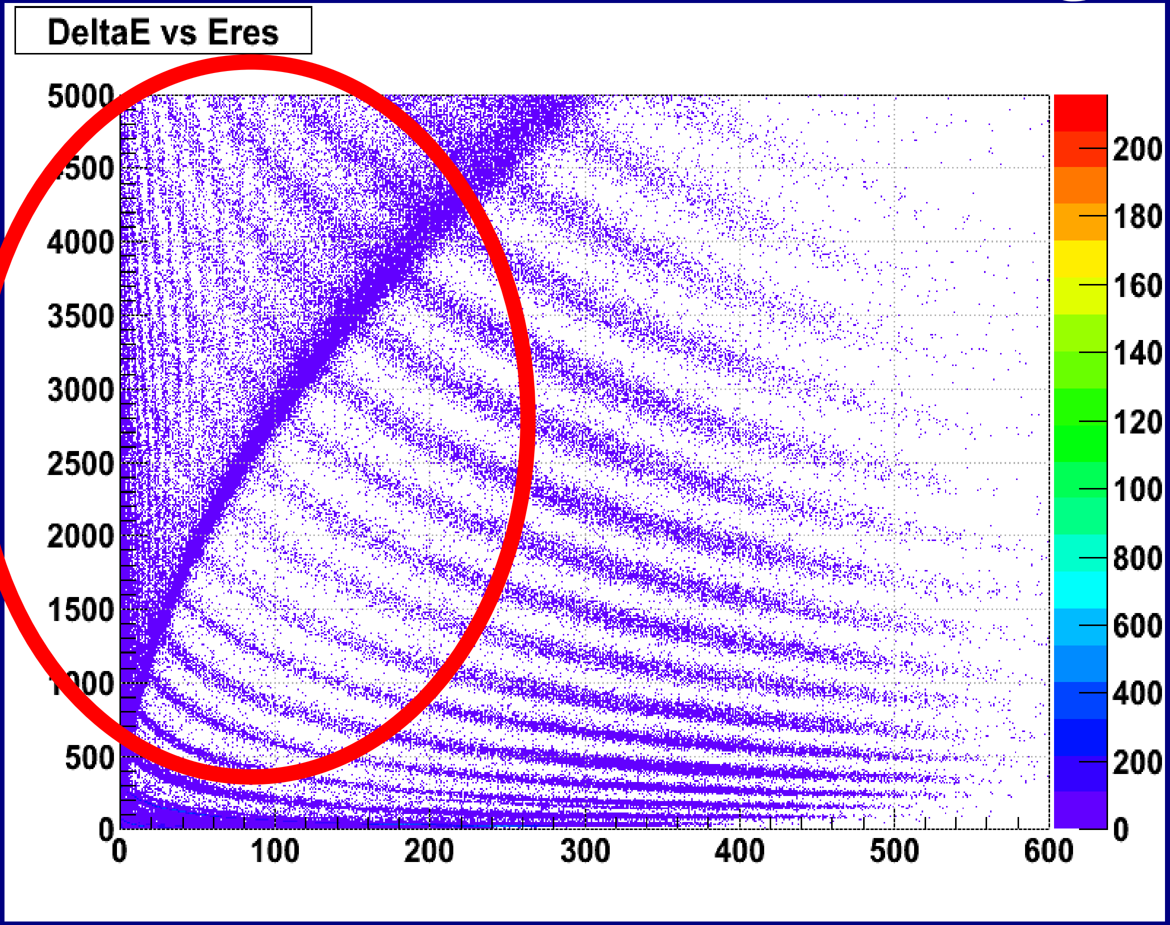
Correlations





Shown data collected in LNS July only (Si detector was changed for nov 2009 runs).
Data obtained from Q signals.

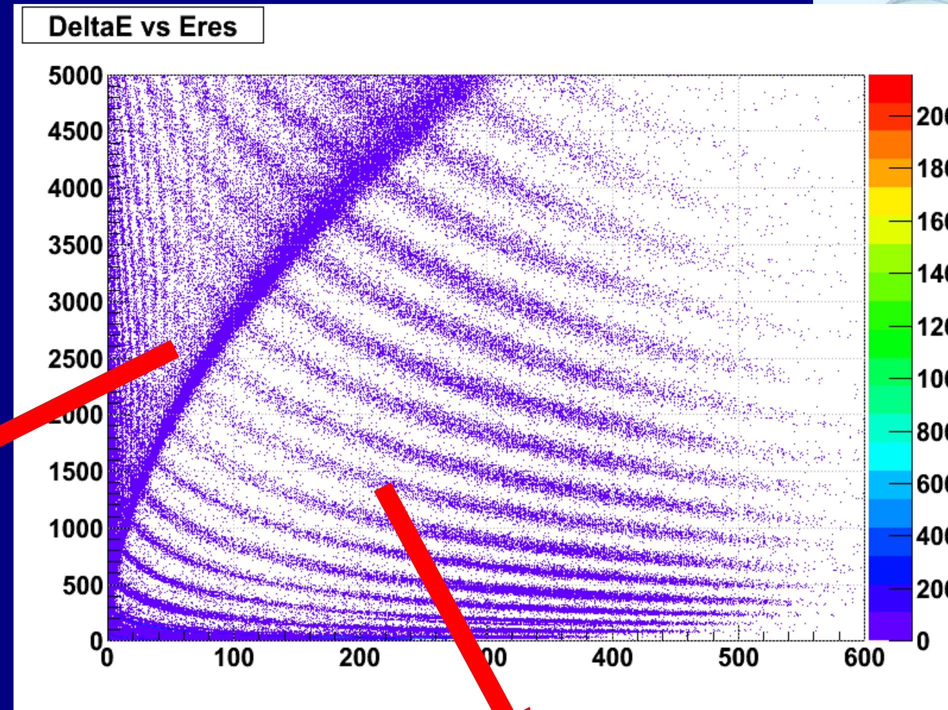
$^{129}Xe + ^{nat}Ni@35AMeV$

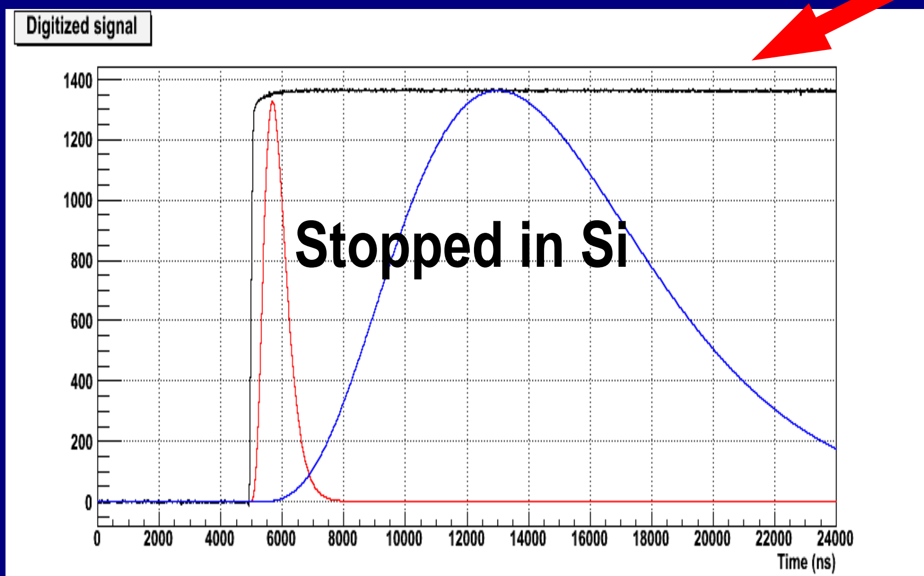


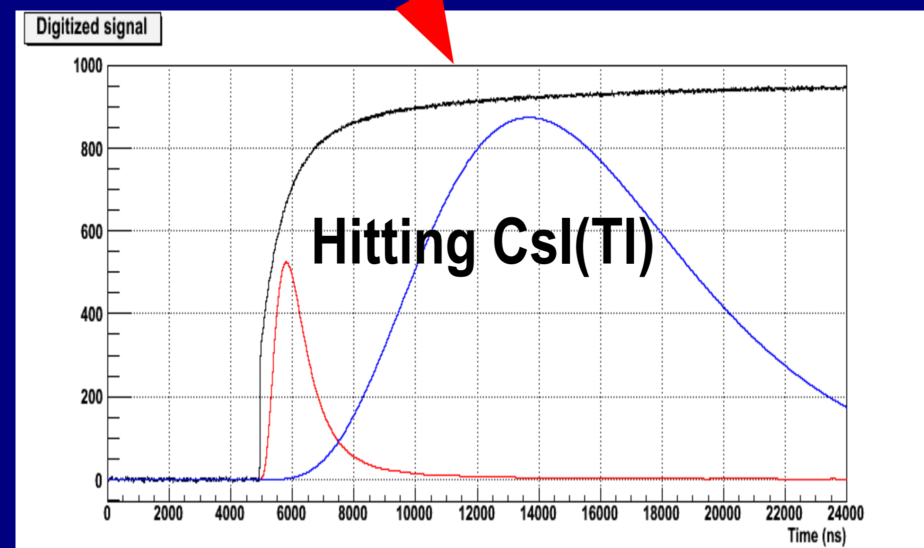
At first, we get a ΔE-E scatter plot where particles stopped in Si overlap with those punching through and getting to CsI.

Stopped particles appear separated in Z, due to PSA performed by the two semigaussian filters with different constants.

Looking at signals, stopped and punching through particles have quite different shapes (see leading edge).



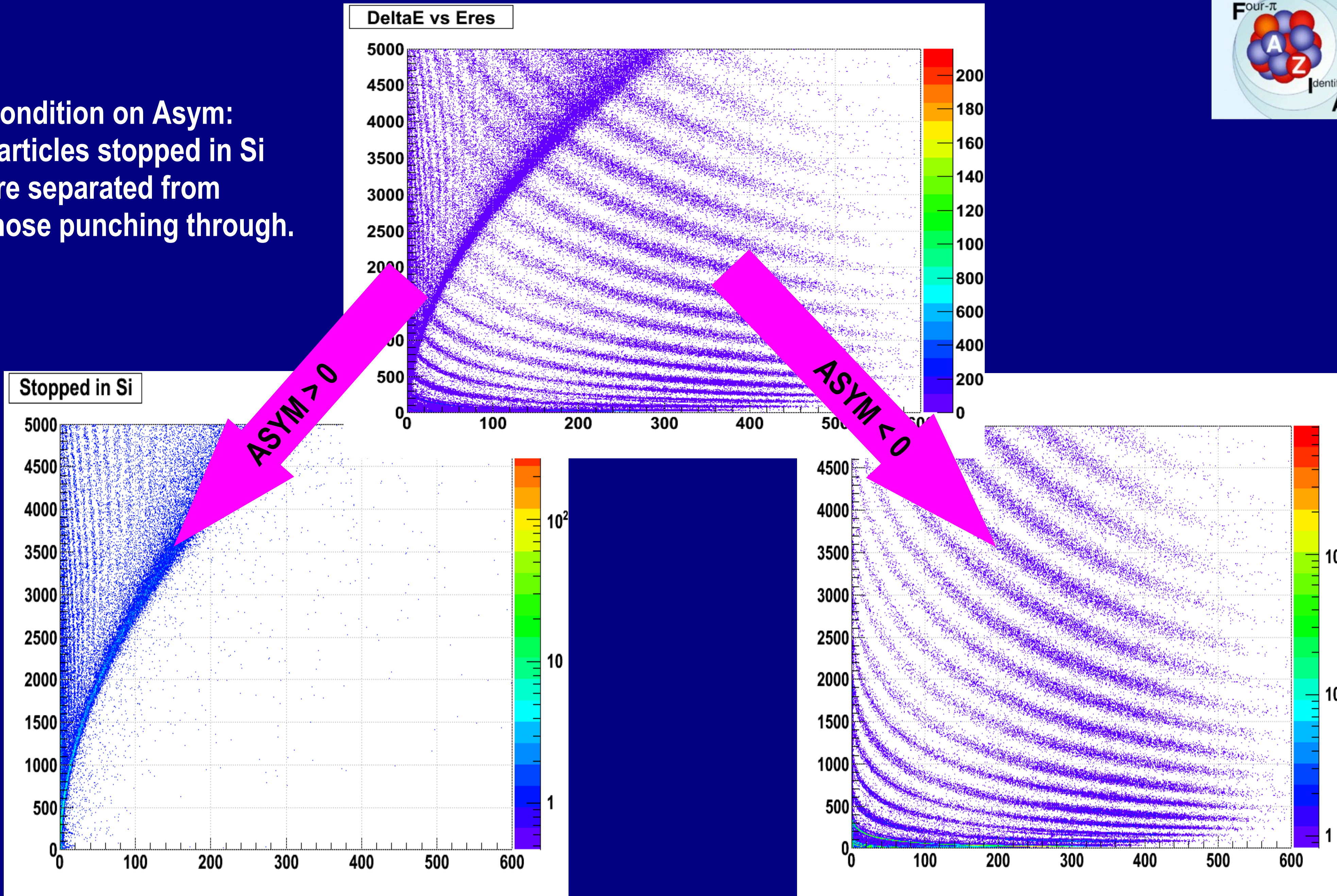




We define an asymmetry parameter based mainly on CFDs with different fractions:

$$ASYM = f(t_{50\%}, t_{80\%}, t_{90\%}, \Delta E)$$

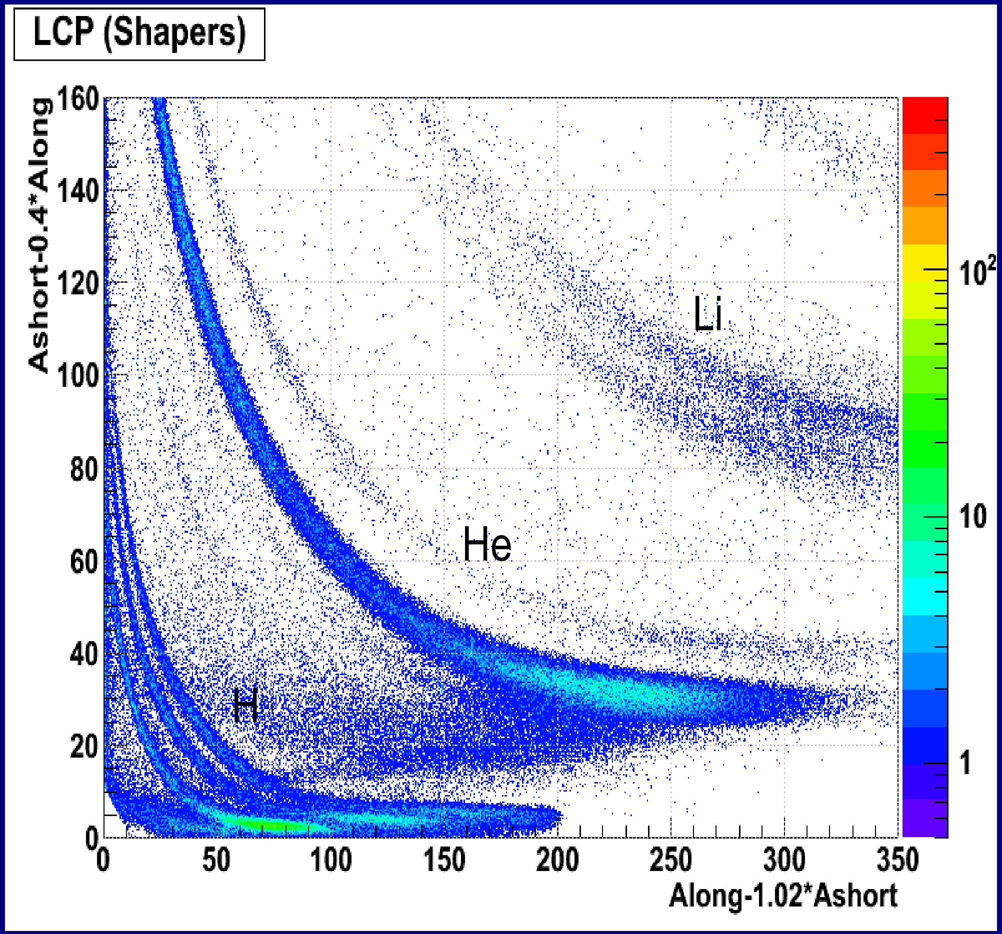
Condition on Asym: particles stopped in Si are separated from those punching through.

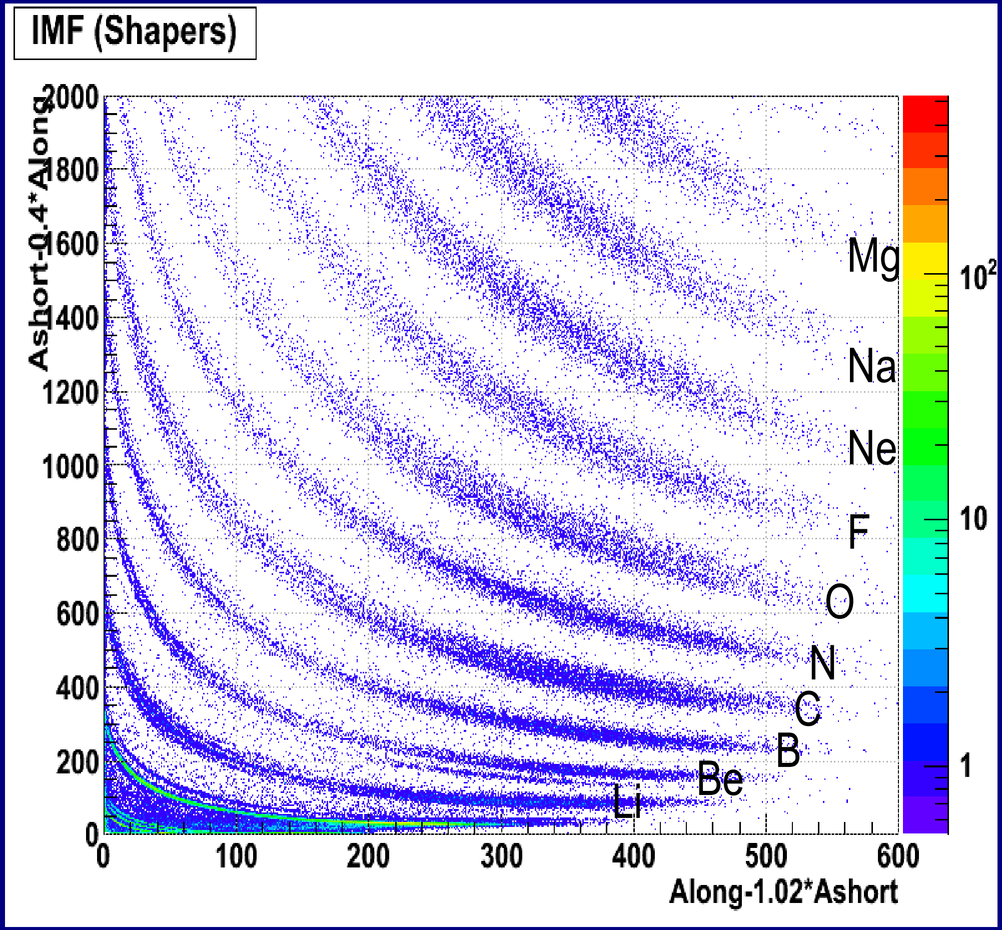


$$ASYM = f(t_{50\%}, t_{80\%}, t_{90\%}, \Delta E)$$

Particle identification using semigaussian shapers:

$$\Delta E = A_{Short} - 0.4 \cdot A_{Long}$$
$$E = A_{Long} - 1.02 \cdot A_{Short}$$





This is an example of transposing an analog technique to the digital domain. This could also be done with analog shapers.

Can we think something better, possibly exploiting the fully digitized waveforms?

First, most obvious, choice: fitting procedure on the waveforms.

Best avoid: iterative fitting procedures (e.g. MINUIT) not well suited to be applied in real time.

Let's assume, heuristically, constant “shapes” for Si and the two CsI components:

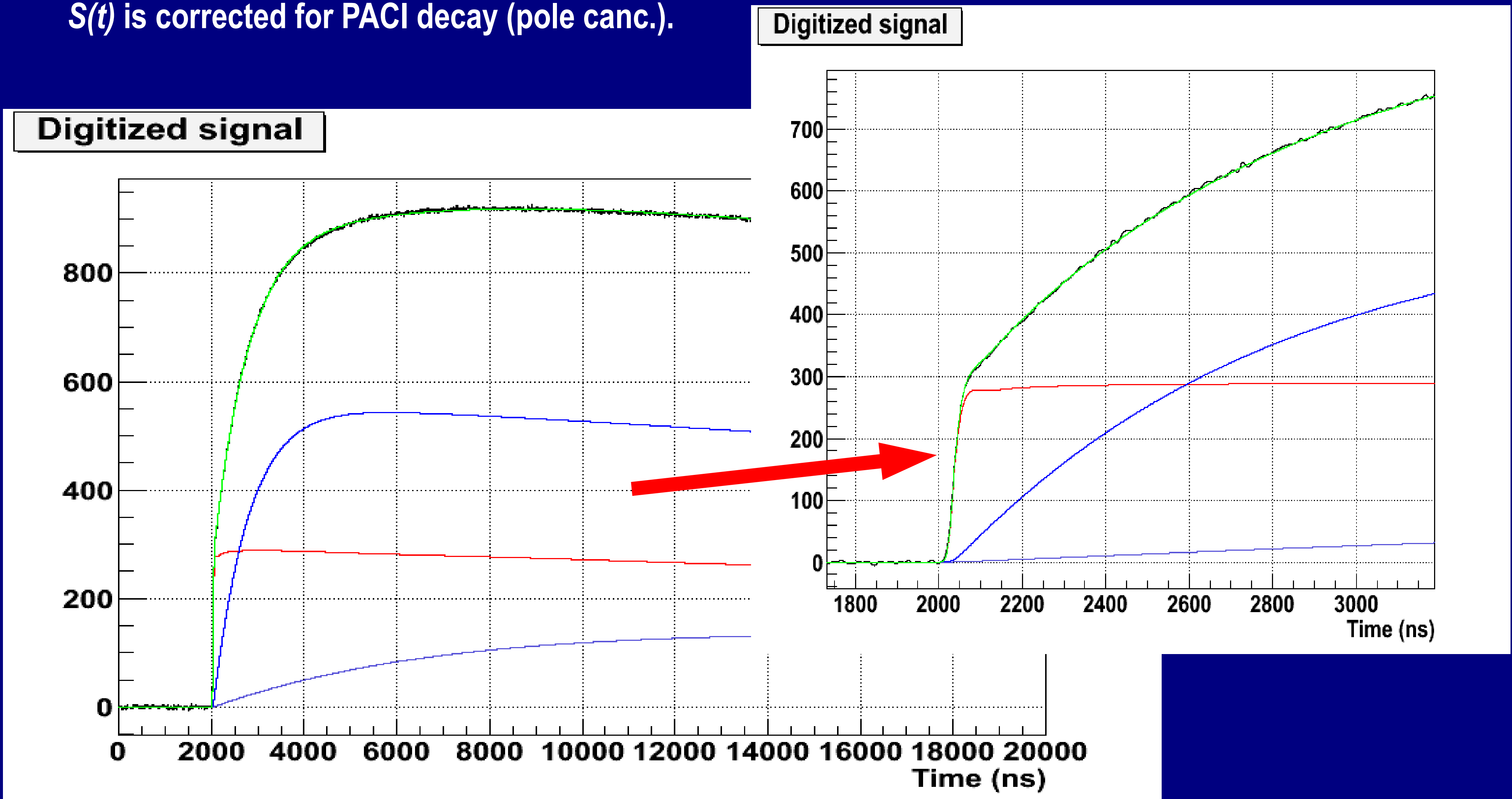
$$S(t) = A_{Si}\, S_{Si}(t) + A_{fast}\, S_{fast}(t) + A_{slow}\, S_{slow}(t)$$

Now we can <u>linearly</u> fit the preamplifier output (i.e. only amplitudes are fitted).

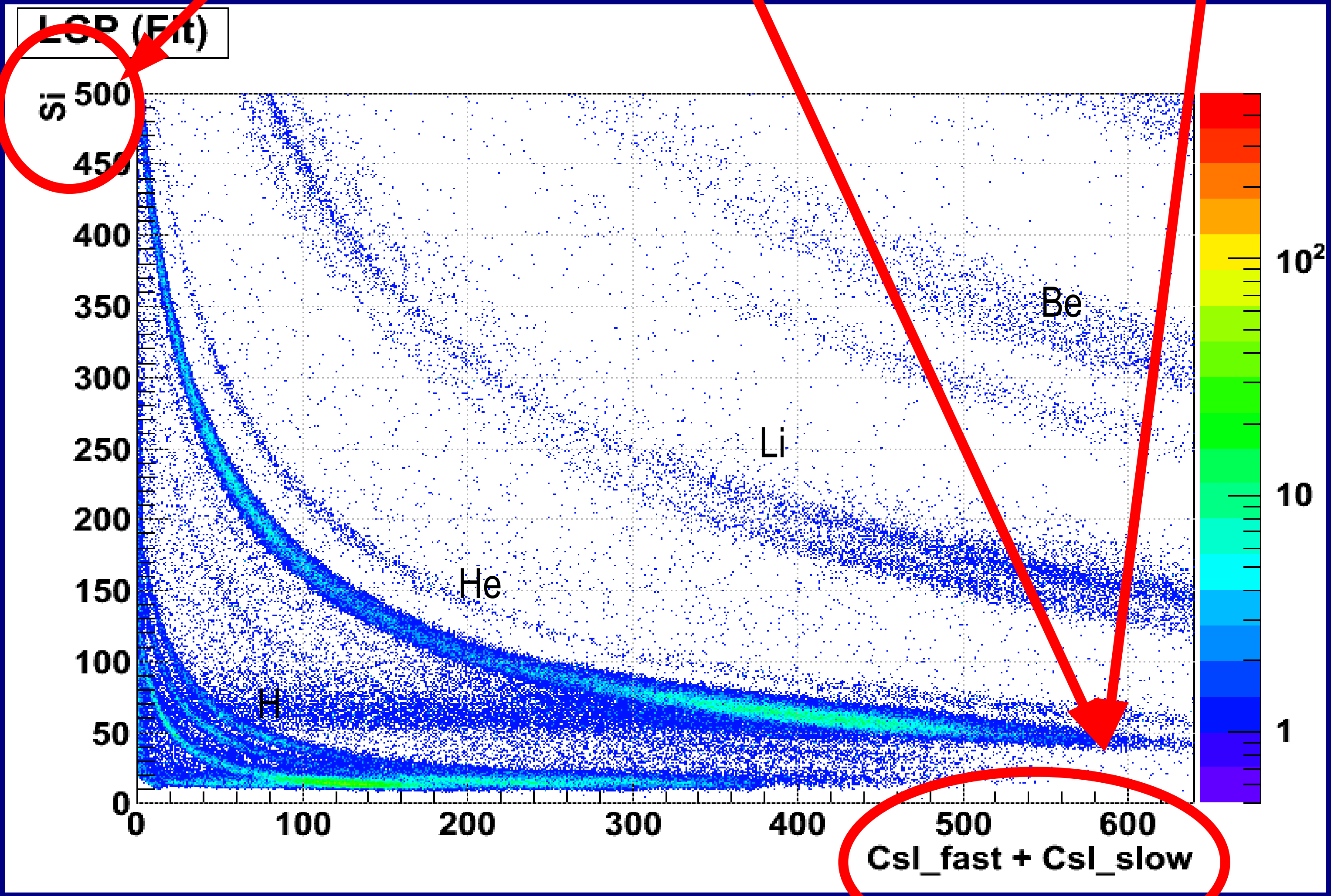
Three “shape” components (+baseline): Si + CsI “fast” (exp τ=750ns) + CsI slow (τ=5us).

$$S(t) = A_{bl} + A_{Si} S_{Si}(t) + A_{fast} S_{fast}(t) + A_{slow} S_{slow}(t)$$

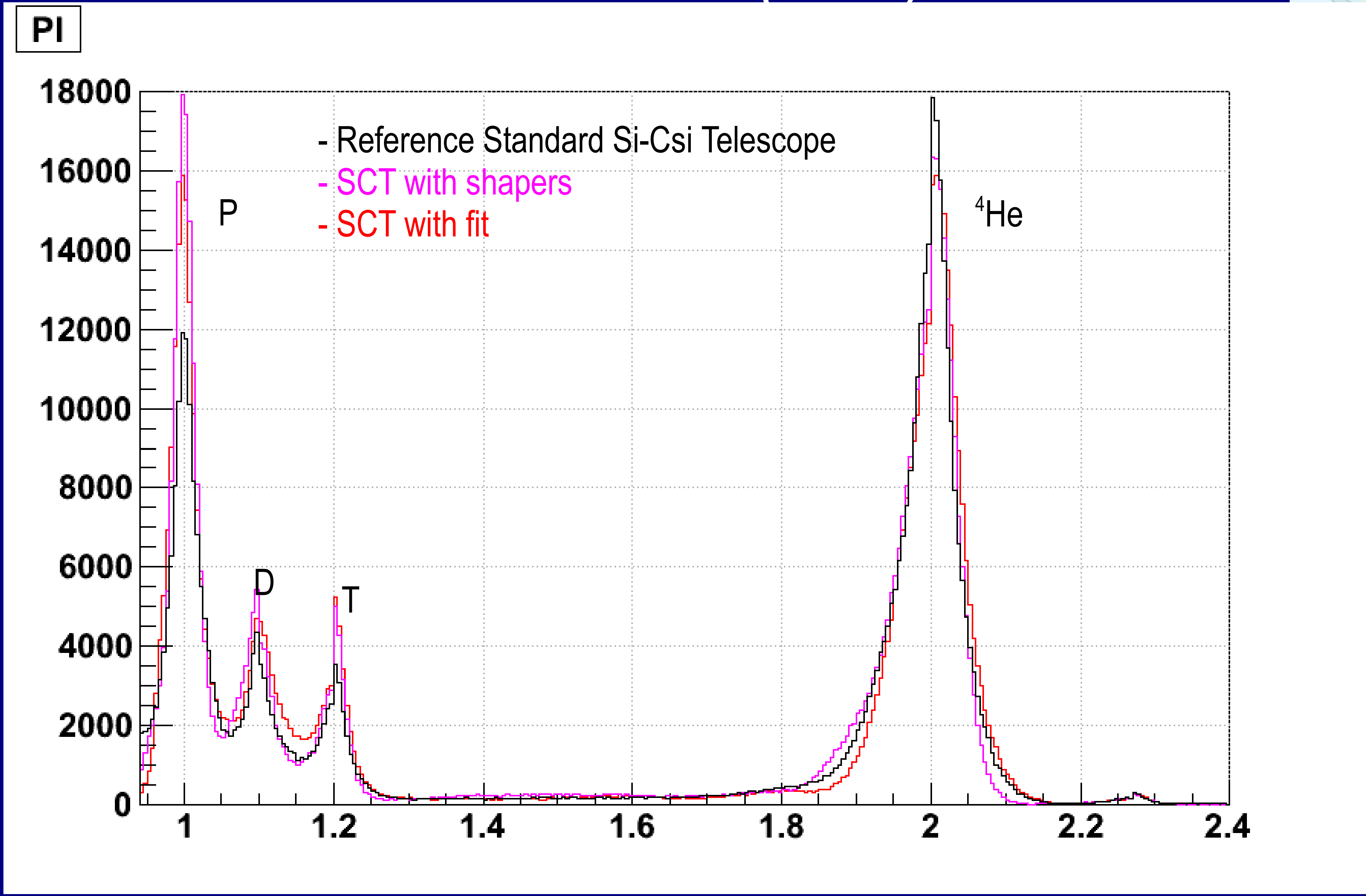
S(t) is corrected for PACI decay (pole canc.).



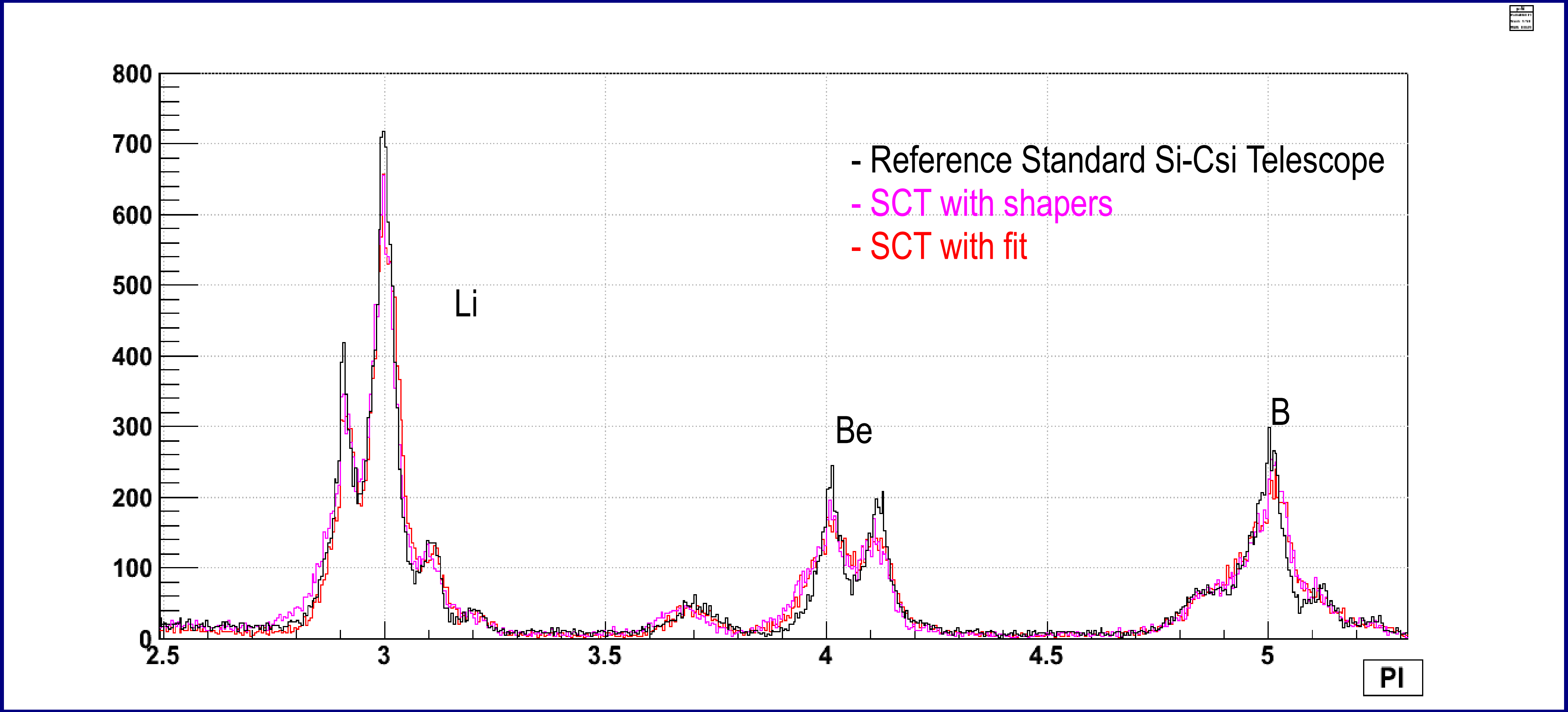
$$S(t) = A_{bl} + A_{Si} S_{Si}(t) + A_{fast} S_{fast}(t) + A_{slow} S_{slow}(t)$$



Particle Id (LCP)



Particle Id (IMF)



Both fit and shapers work equally good until Z=5.
Standard Telescope seems better at higher Z.

Summary

- Single Chip Telescope uses only 1 electronic chain to carry both the ionization and scintillation information.
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- A prototype has been tested at LNS in 2009 with Kr and Xe beams
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- Isotopic resolution until Z=5 comparable to standard telescope
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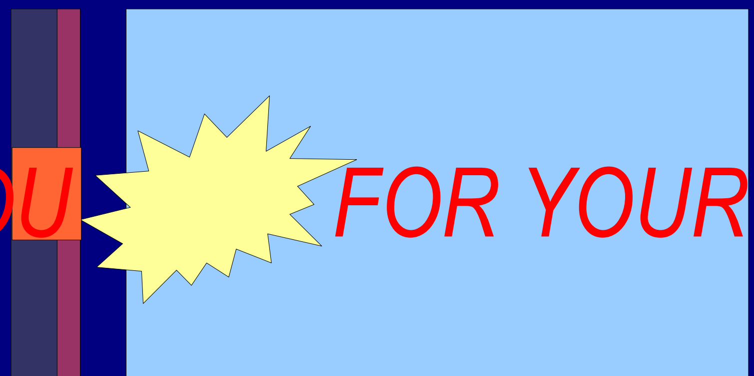
- Work is in progress to better understand the factors limiting performance and find out possible improvements
-



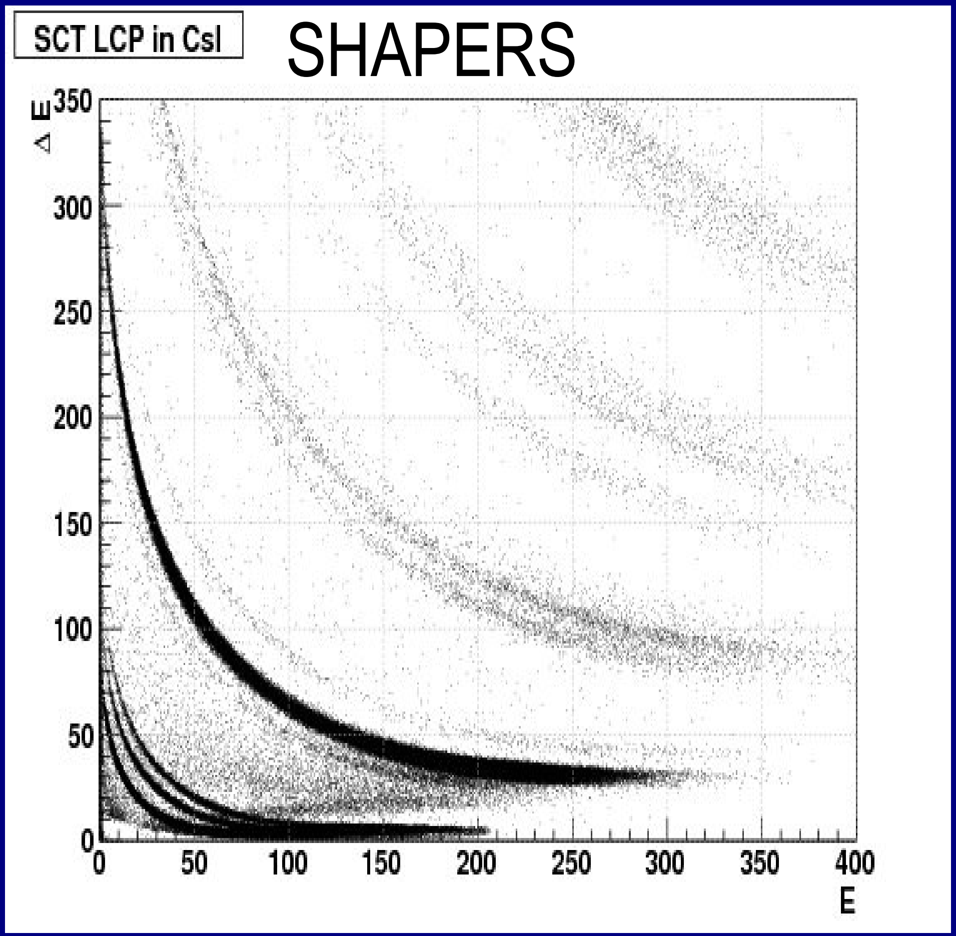
THANK YOU FOR YOUR ATTENTION!

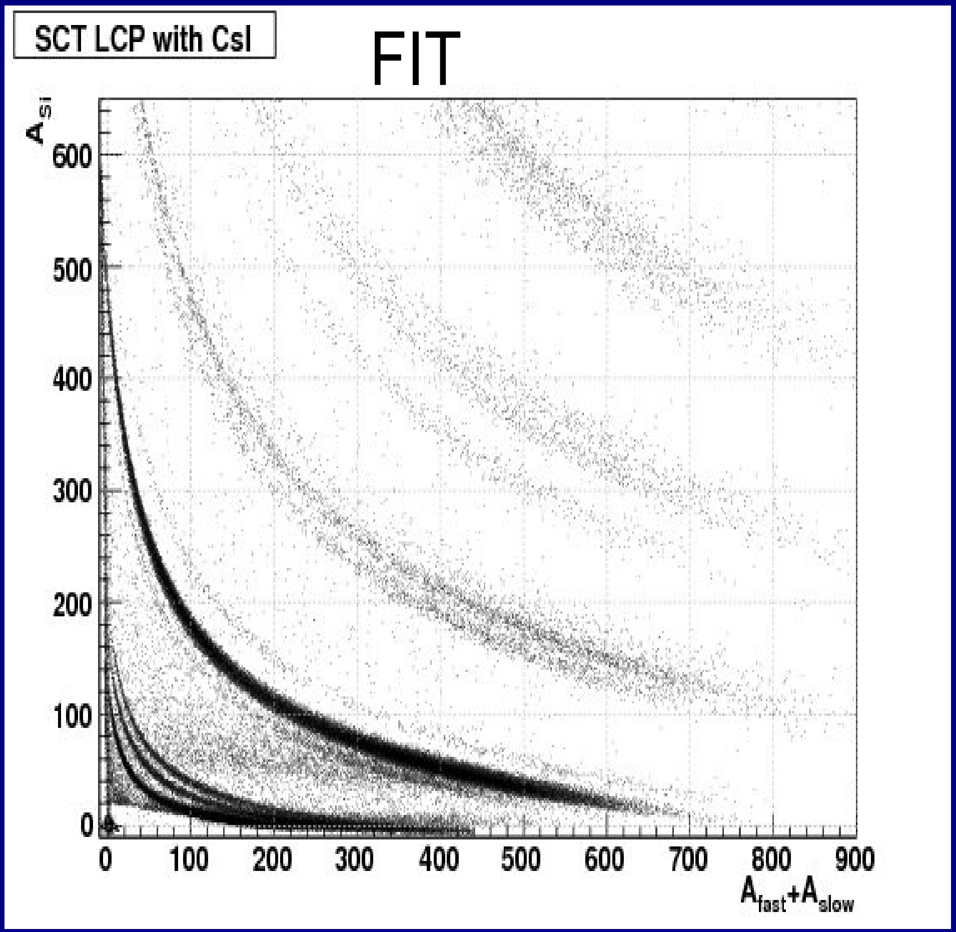
ASYM parameter

$$ASYM = (t_{90\%} - t_{80\%}) - (t_{80\%} - t_{50\%})$$

Present state of the (fit) art:
Mass separation is still slightly better using shapers (please note: same data sample, different methods).

Work in progress: refine the fitting procedure (e.g. taking into account the cable and FEE response).





Nice trick: with the fit method, we can exploit the fast-slow PSA in CsI to enhance LCPs mass identification (look at d-t separation).