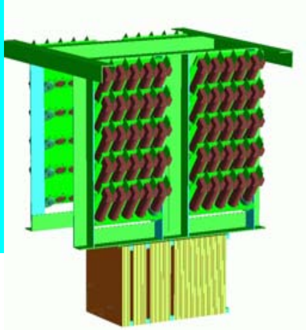
LCcal*



TALK SUMMARY

No many new inputs since last time…

- •Design principles
- •Prototype description
- •Construction (+SI pad) details
- •**Test Beam results**
- •**Conclusions**

*LCcal: Official INFN R&D project, official DESY R&D project PRC R&D 00/02
http://www.pd.infn.it/~checchia/lccal/Welcome.html ,
http://conference.ippp.dur.ac.uk/cdsagenda//fullAgenda.php?ida=a041 or in
LC-DET-2003-014, LC-DET-2003-101, Proceedings….

Contributors (Como, ITE-Warsaw, LNF, Padova, Trieste): M. Alemi, A.Anashkin, M. Anelli, M.Bettini, S.Bertolucci, E. Borsato, M. Caccia, P.C, C. Fanin, J.Marczewski, S. Miscetti, V. Morgunov, B.Nadalut, M. Nicoletto, M. Prest, R. Peghin, L. Ramina, F. Simonetto, E. Vallazza ….

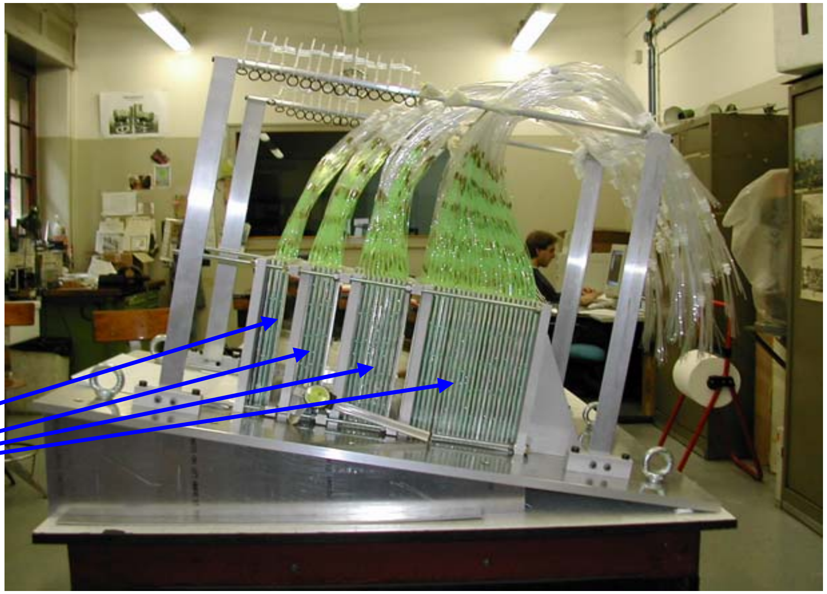
Prototype description

•45 layers

•$25 \times 25 \times 0.3\ cm^3$ Pb

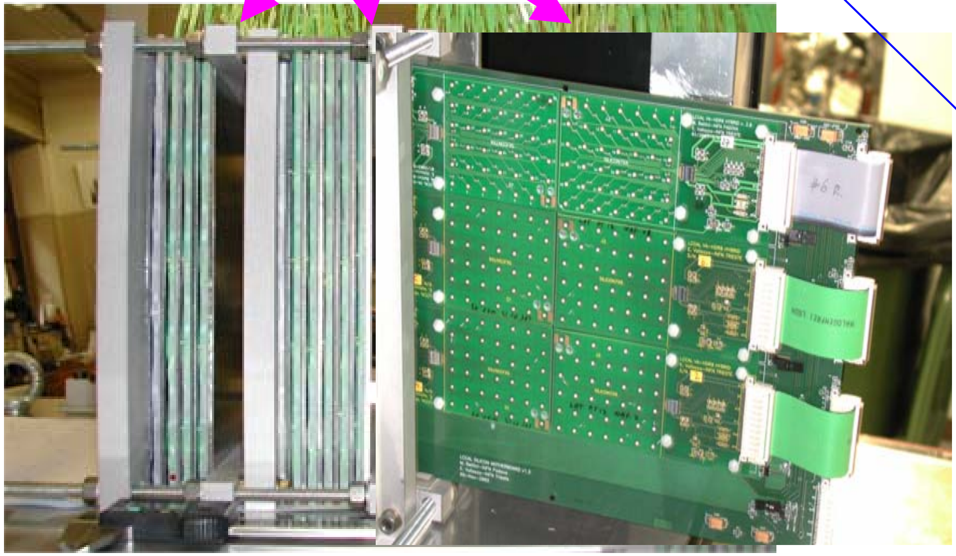
•$25 \times 25 \times 0.3\ cm^3$ Scint.: 25 cells $5 \times 5\ cm^2$

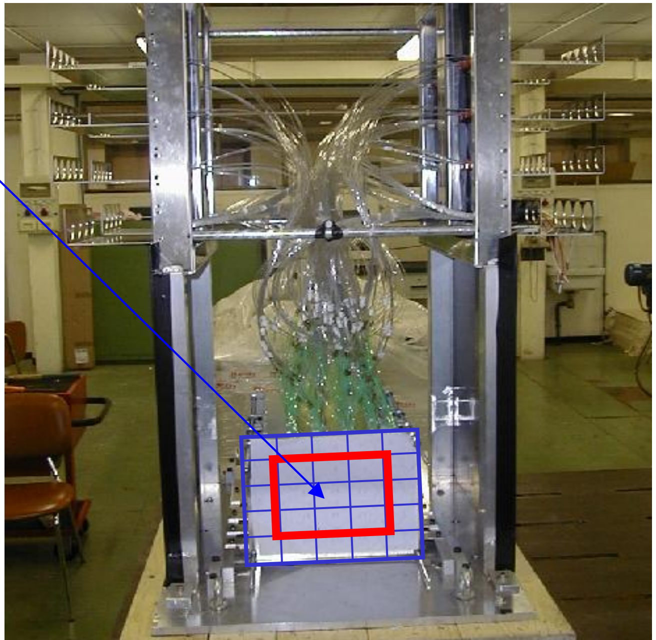
•3 planes: 252 $.9 \times .9\ cm^2$ Si Pads at: 2, 6, 12 X_0



Fibres grouped into 25x4 bundles making a 4-fold longitudinal segmentation in the 3x3 central cells

Slots for the insertion of the 3 Si pad planes (Motherboard).





Test beam results: Linearity and Energy Resolution

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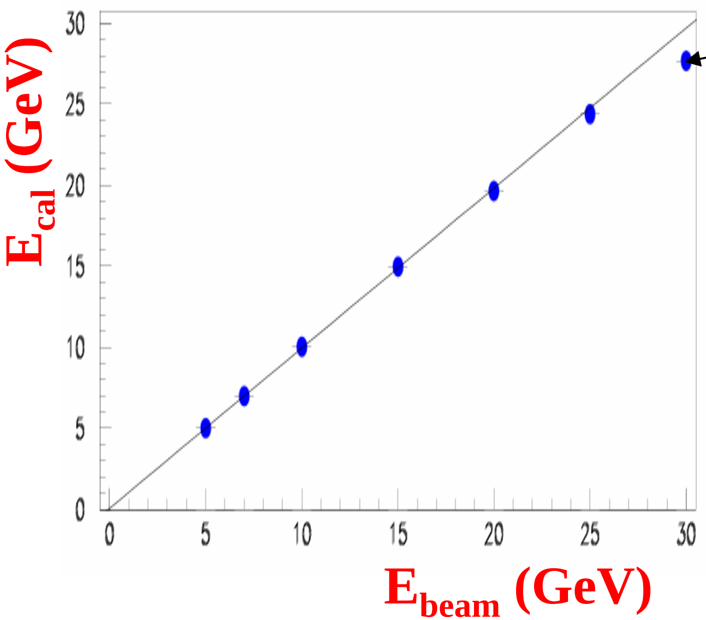
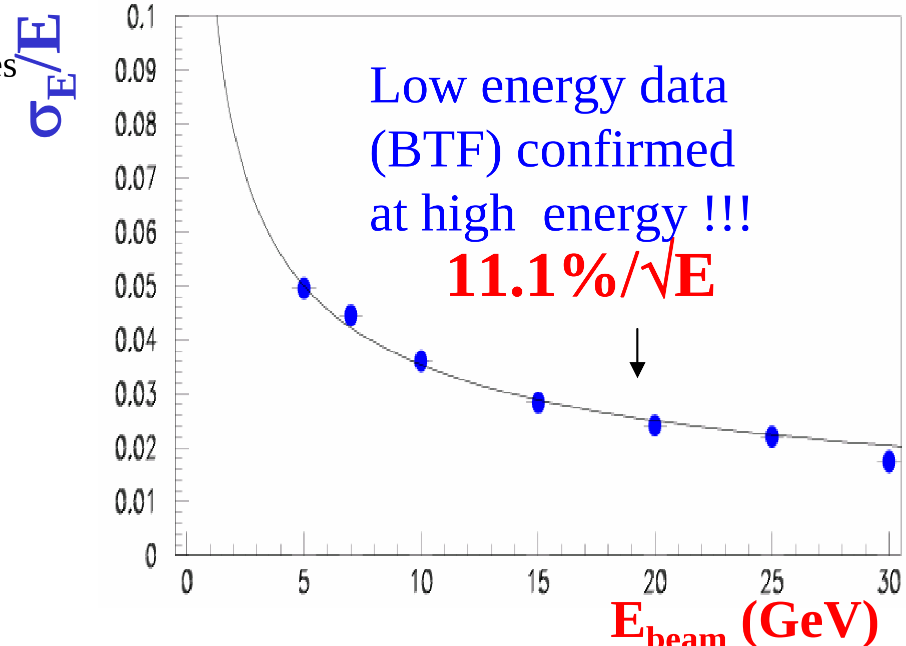
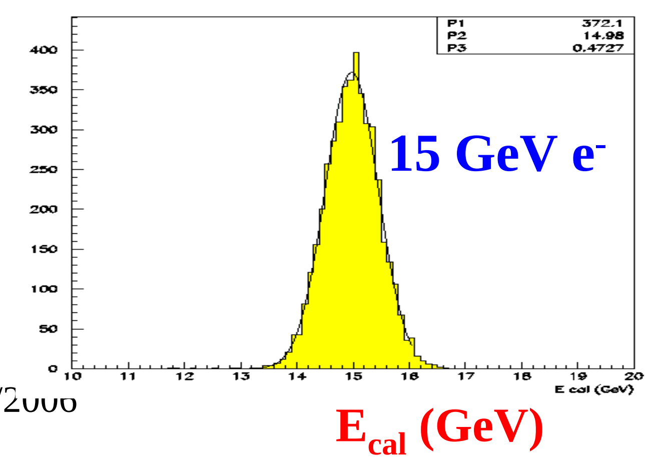


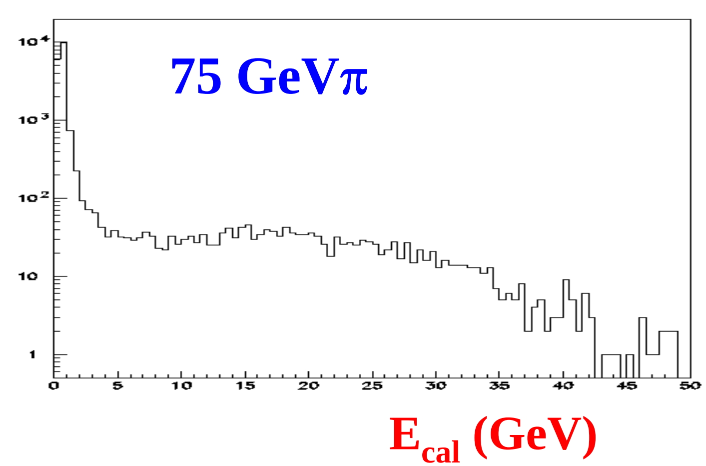
e^-



PM calibration from m.i.p. signal

Constant term compatible with beam Δp





Test beam results: Comparison with MC

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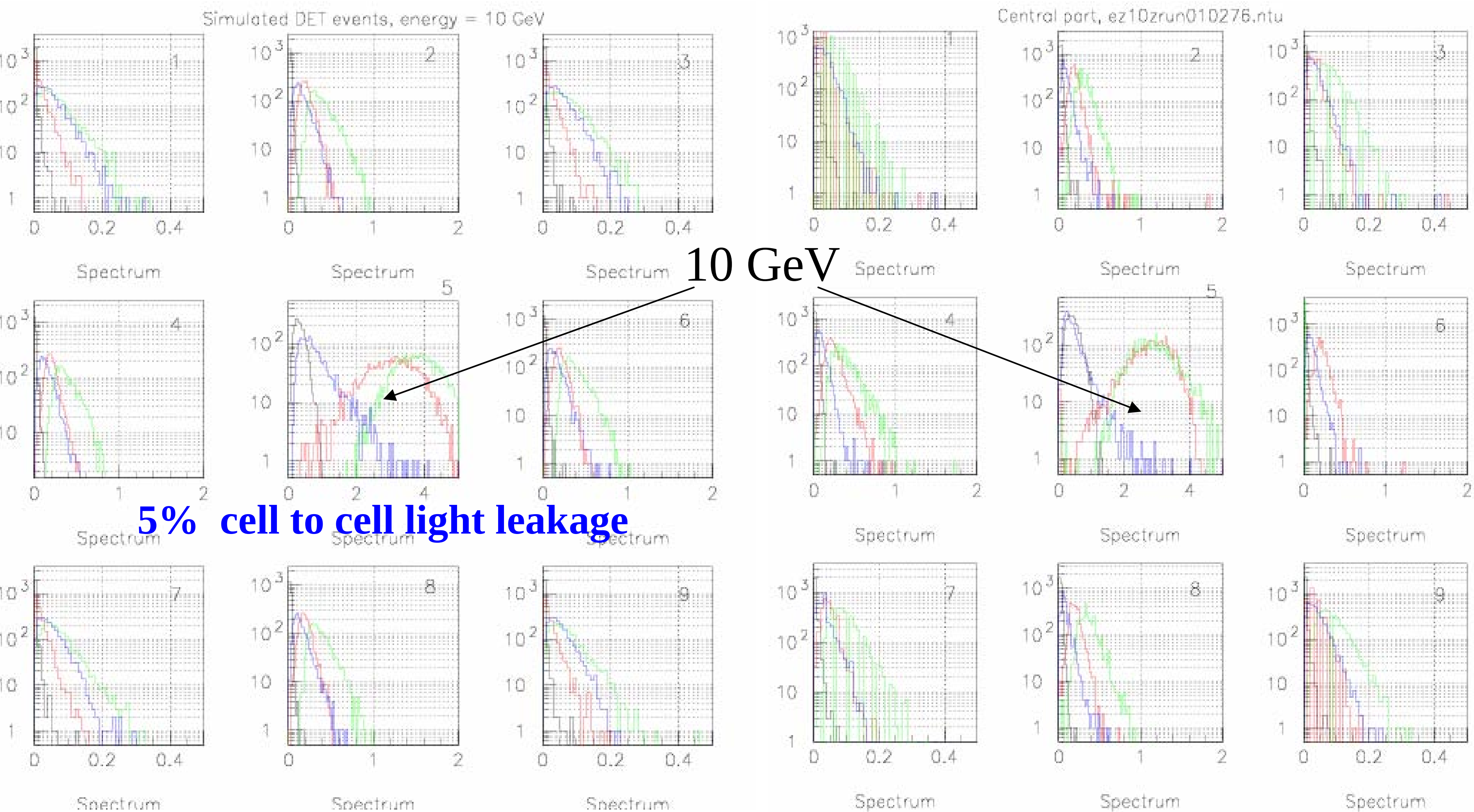
layer 1
2
3
4

Simulation (Geant 3*) **Test Data**



*detailed geometrical description by V. Morgunov

Test beam results: Comparison with MC

Cern TB 2003

layer 1
2
3
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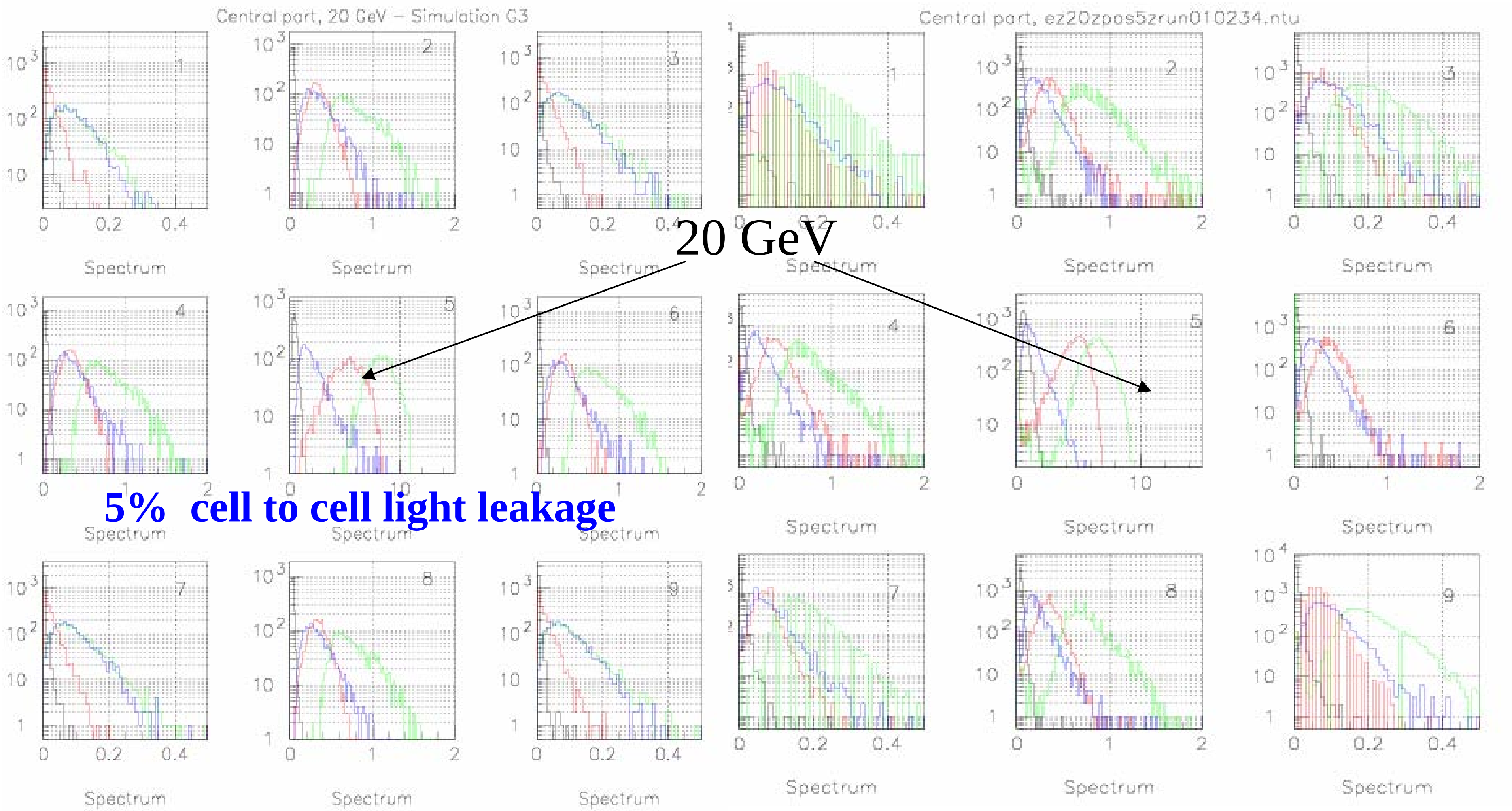
Simulation (Geant 3*) **Test Data**



*detailed geometrical description by V. Morgunov

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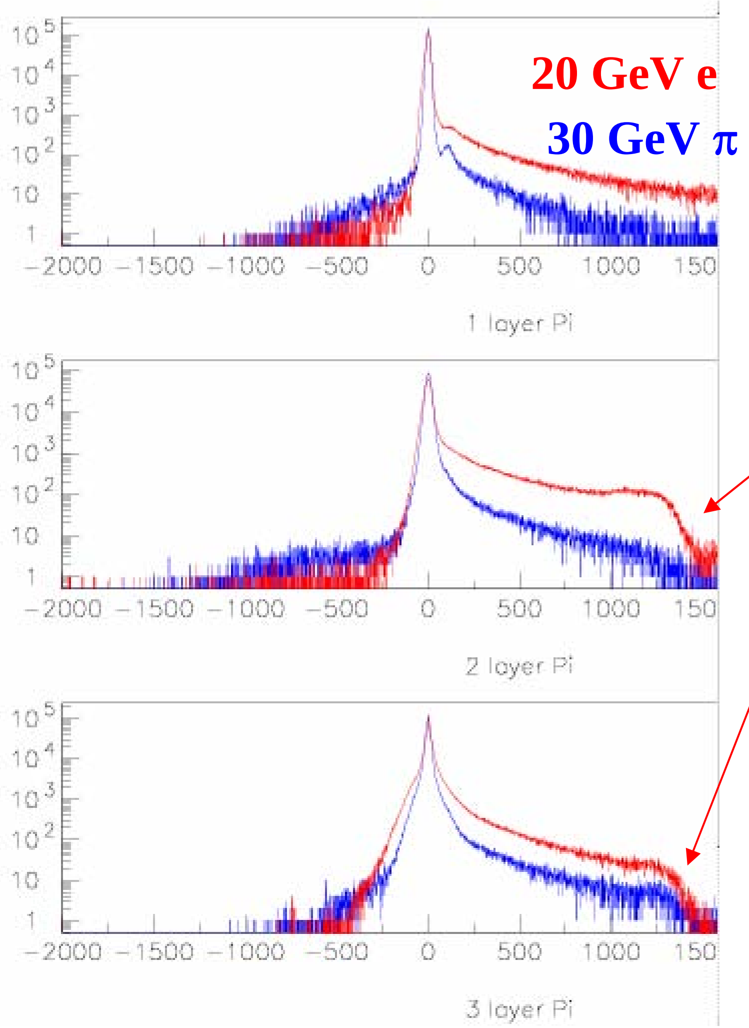
Test beam results: Si pad detector



saturation at ~15 m.i.p.

Test beam results: Si pad detector (Position Meas.)

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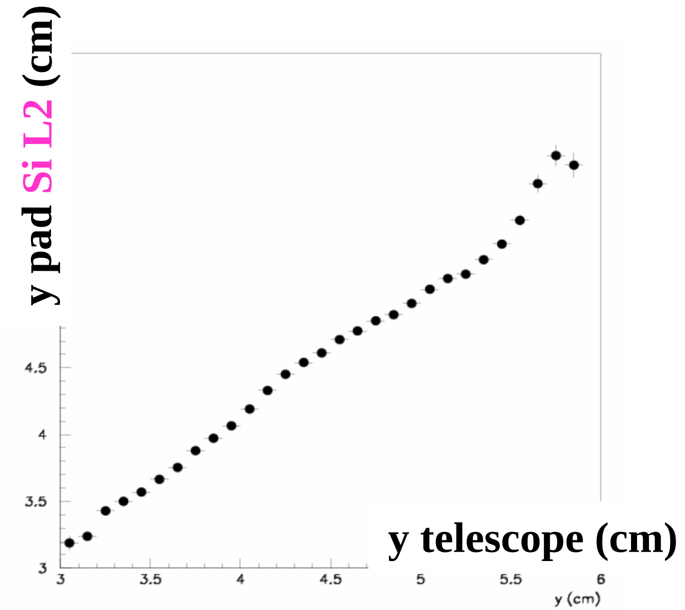
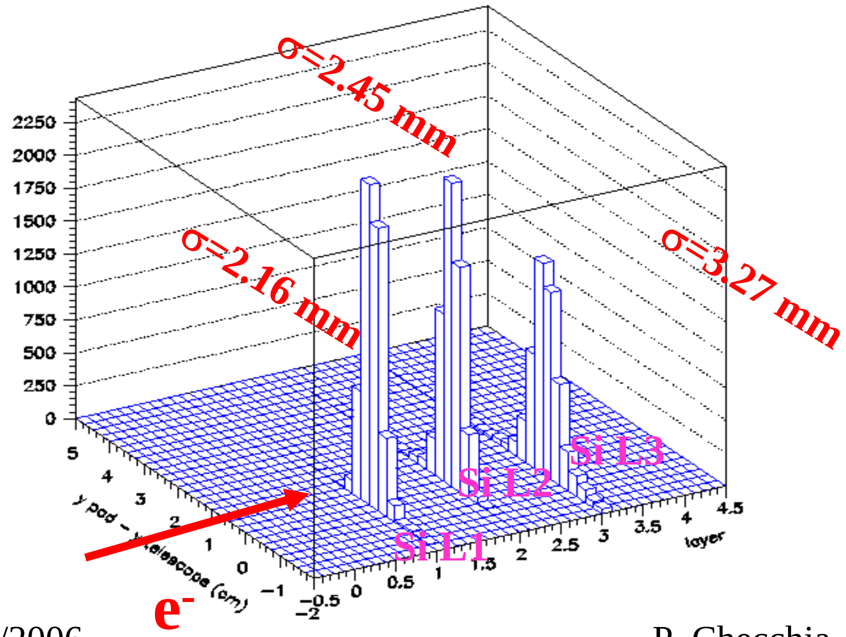
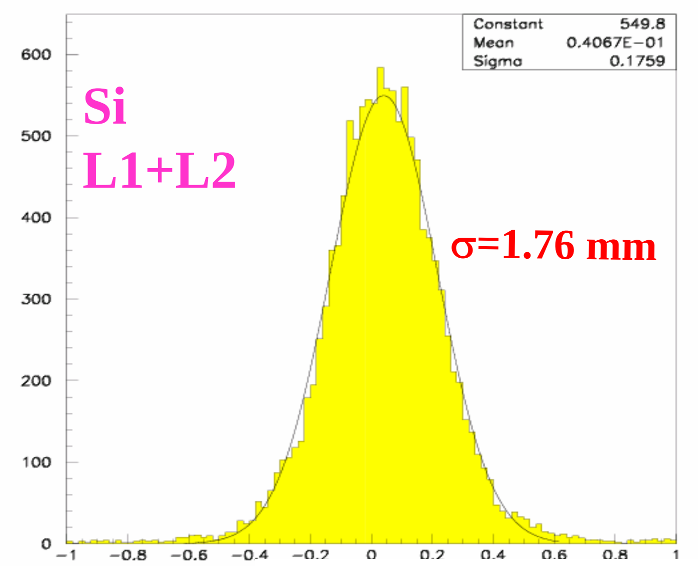
30 GeV electrons







Test beam results: Si pad detector (Position Meas.)

pad correlated noise not subtracted

effects of the Front-End saturation to be studied:

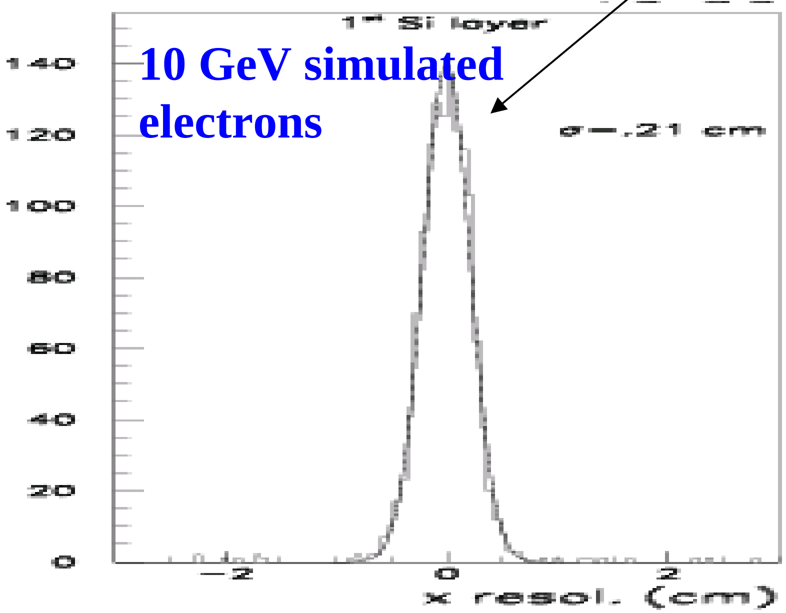
data new algorithm needed (head and tail) +

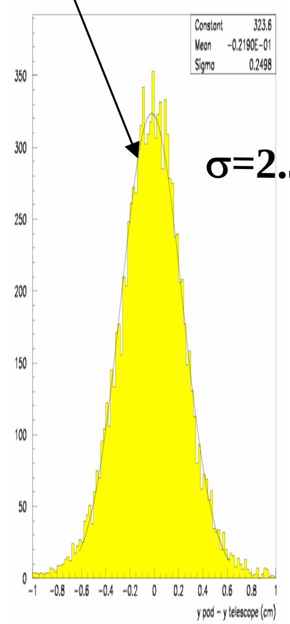
simulation of saturation effect

Position resolution ~ 2.5mm not far from Monte Carlo

10 GeV electrons

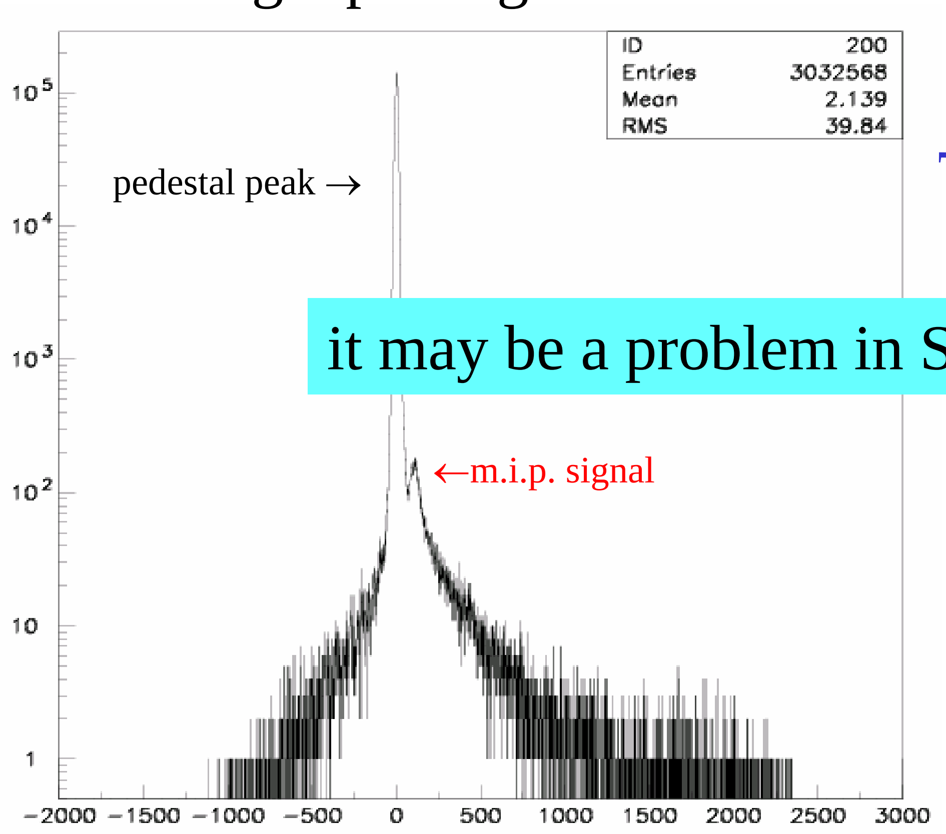
10 GeV simulated electrons



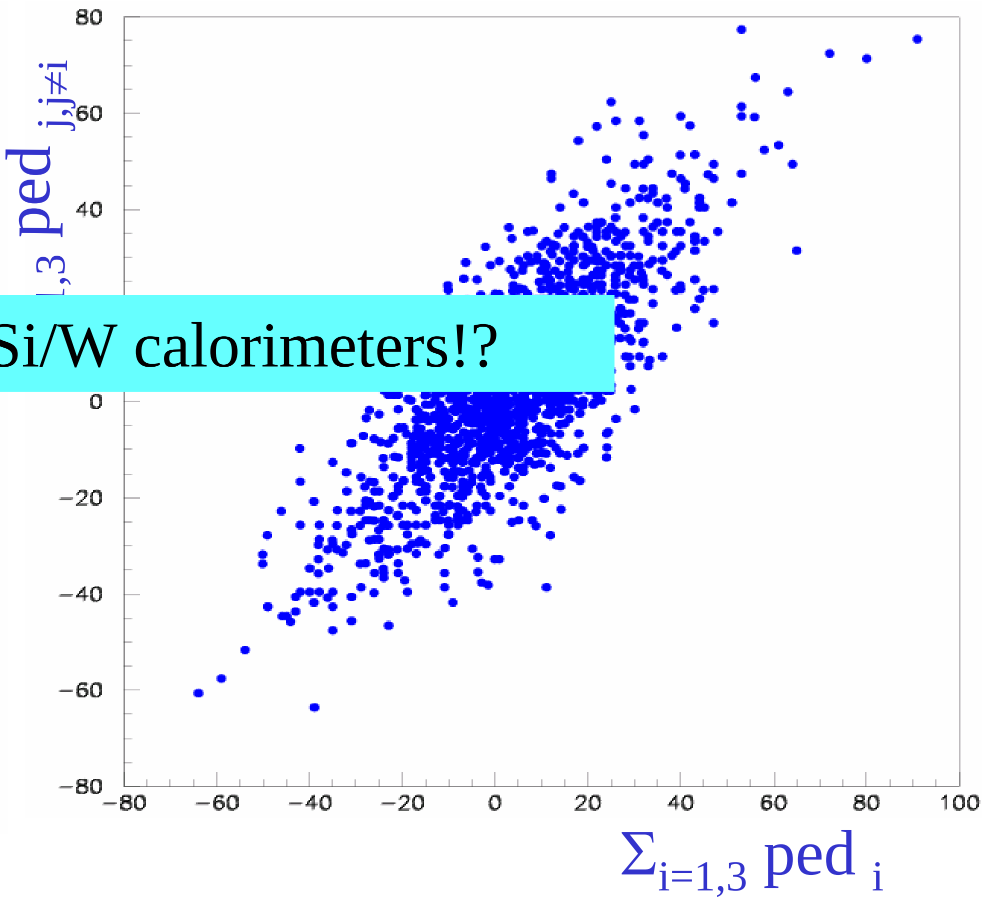


Test beam results: Si pad detector

single pad signal



correlated noise



it may be a problem in Si/W calorimeters!?

not so easy to subtract it in events with high occupancy in the same detector (6x7 pads) as it happens in e.m. showers

Test beam results: Si pad detector

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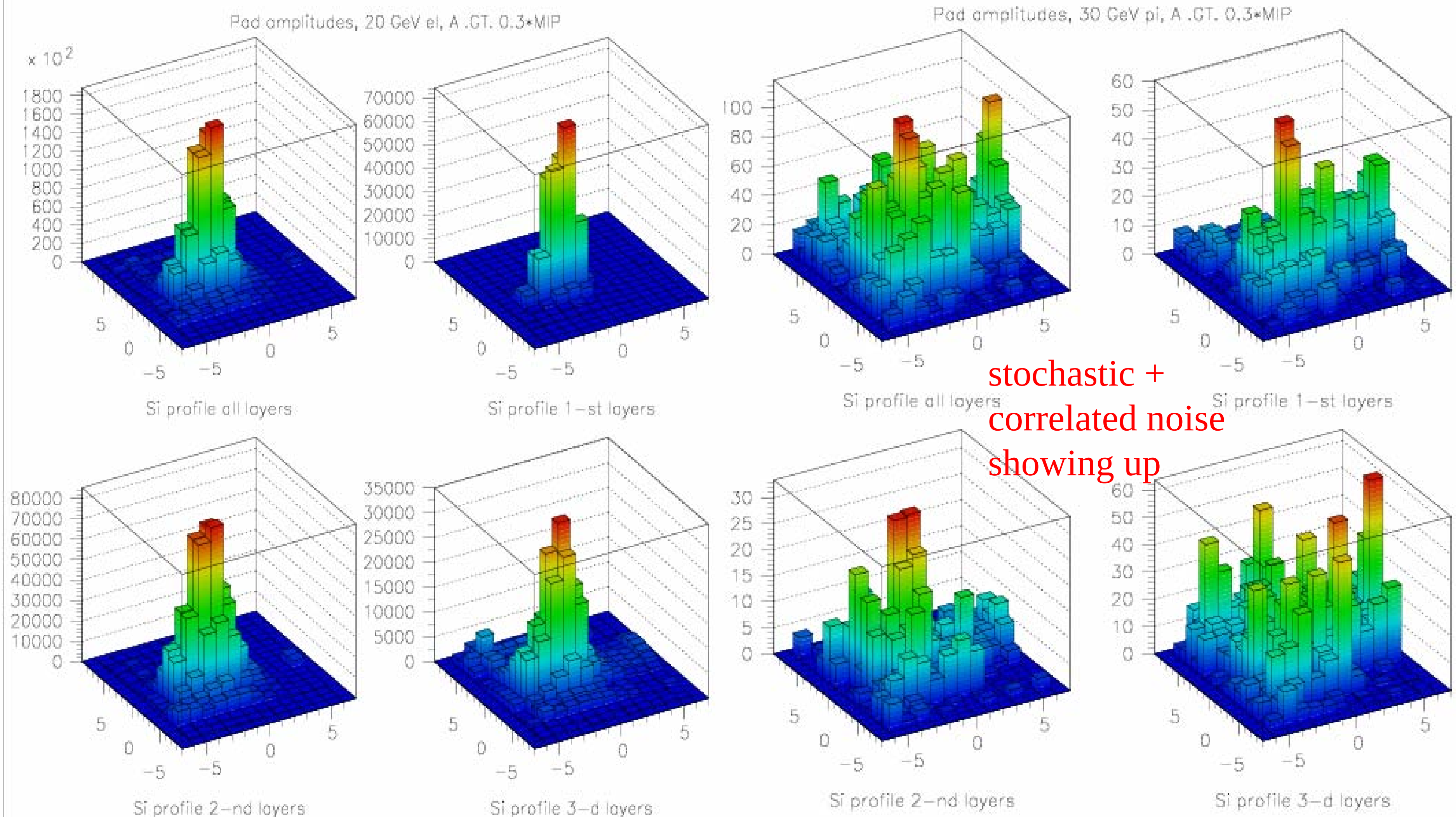
20 GeV e **30 GeV π**



stochastic + correlated noise showing up

Test beam results: uniformity in (light) Energy response

30 GeV e^-

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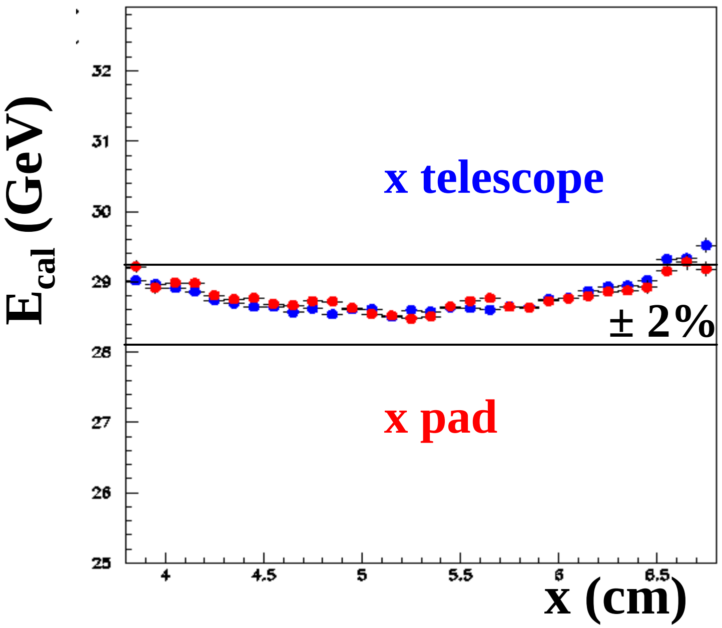
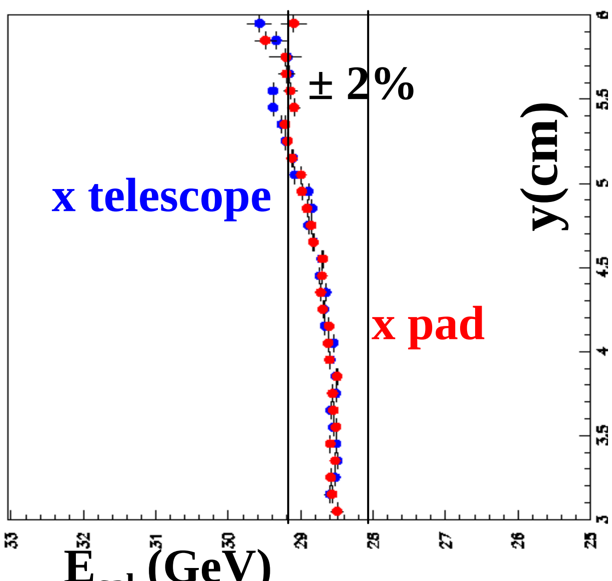
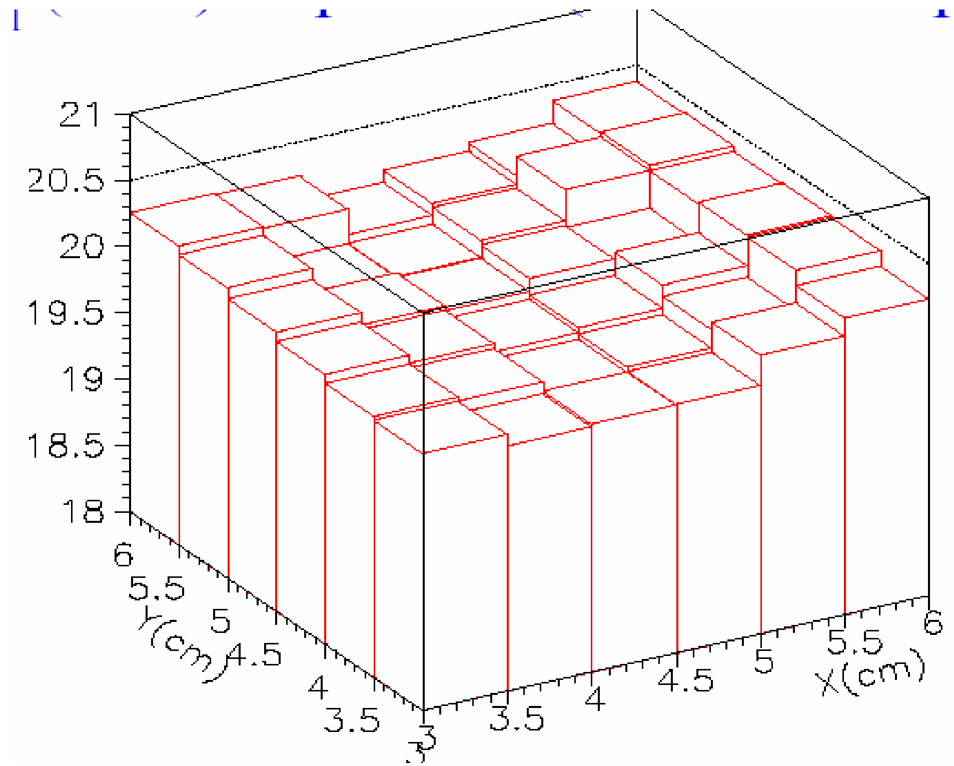




disuniformity < 2%

correction from pad reconstruction can be applied!



Test beam results: (e/π rejection)

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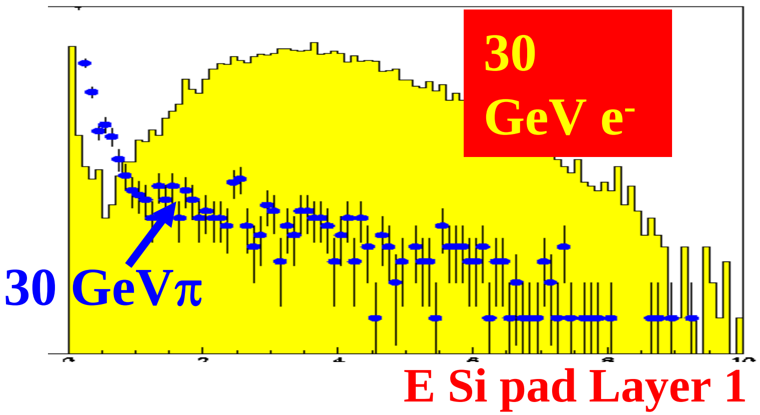
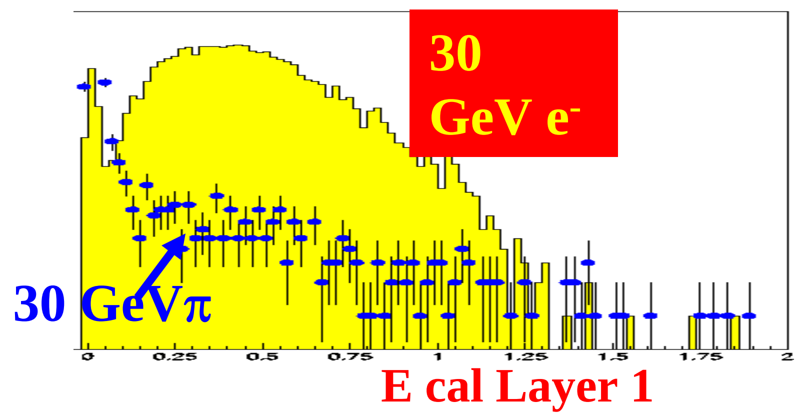
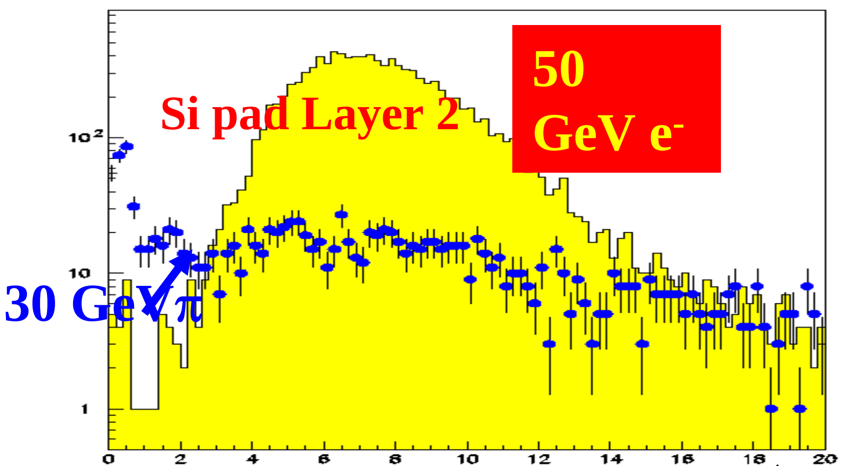
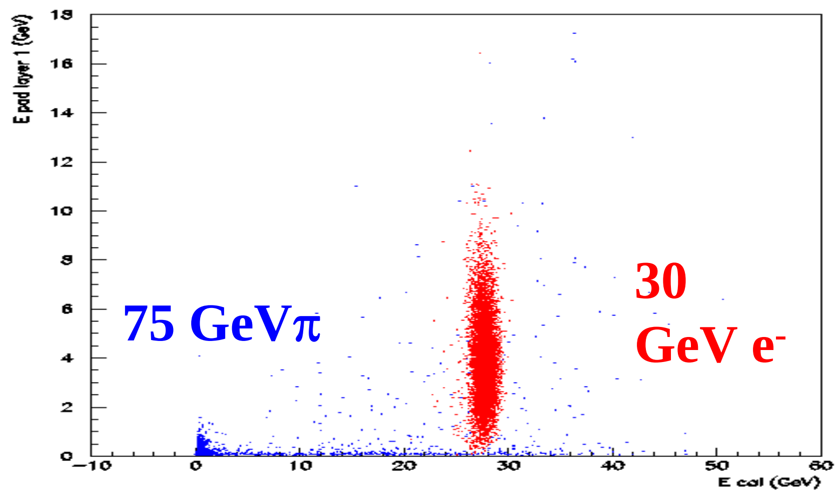
the redundancy of the information on the linear/lateral shower development makes the rejection very easy (difficult to quantify below 10^{-3} due to beam contamination)



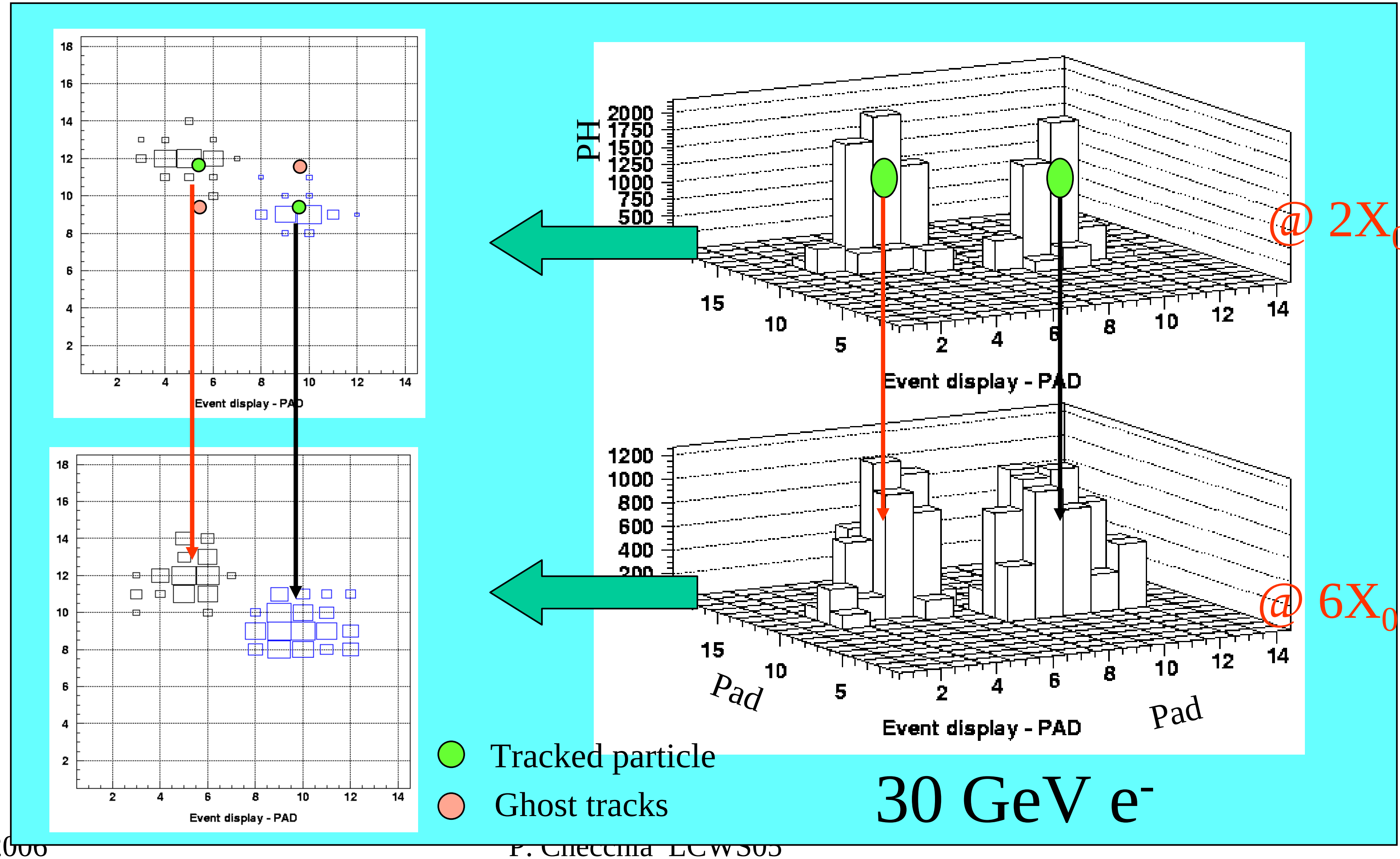






shower variance: $\sum_i r_i^2 E_i \Big/ \sum_i E_i$

Test beam results: Si Pad two particle separation



Conclusions

After the achieved results:

- **The LCcal prototype has been built and fully tested.**
- **Energy and position resolution as expected:**
  $\sigma_E/E \sim 11.\text{-}11.5\% /\sqrt{E}$, $\sigma_{pos} \sim 2$ mm (@ 30 GeV)
- **Light uniformity acceptable.**
- **e/π rejection very good ($<10^{-3}$)**

Manpower problems to continue

- **Study of Detector response during test beam (preliminary to the particle separation).**
- **Simulation:** study geometrical-construction optimisation (MC) . Include a calorimeter made following this technique into the general LC simulation and Pattern recognition. ….
- **Combined test with Hcal**

backup

Si Production details

MIP Signal to Noise ratio

Theory:

$$\begin{cases} \mathrm{ENC} = A + \dfrac{B}{pF} \\ \mathrm{ENC} = \dfrac{e}{q}\sqrt{\dfrac{qI_l T_p}{4}} \\ \mathrm{ENC} = \dfrac{e}{q}\sqrt{\dfrac{T_p k_B T}{2R}} \end{cases}$$

Front-end

$\approx 1000e^- +$

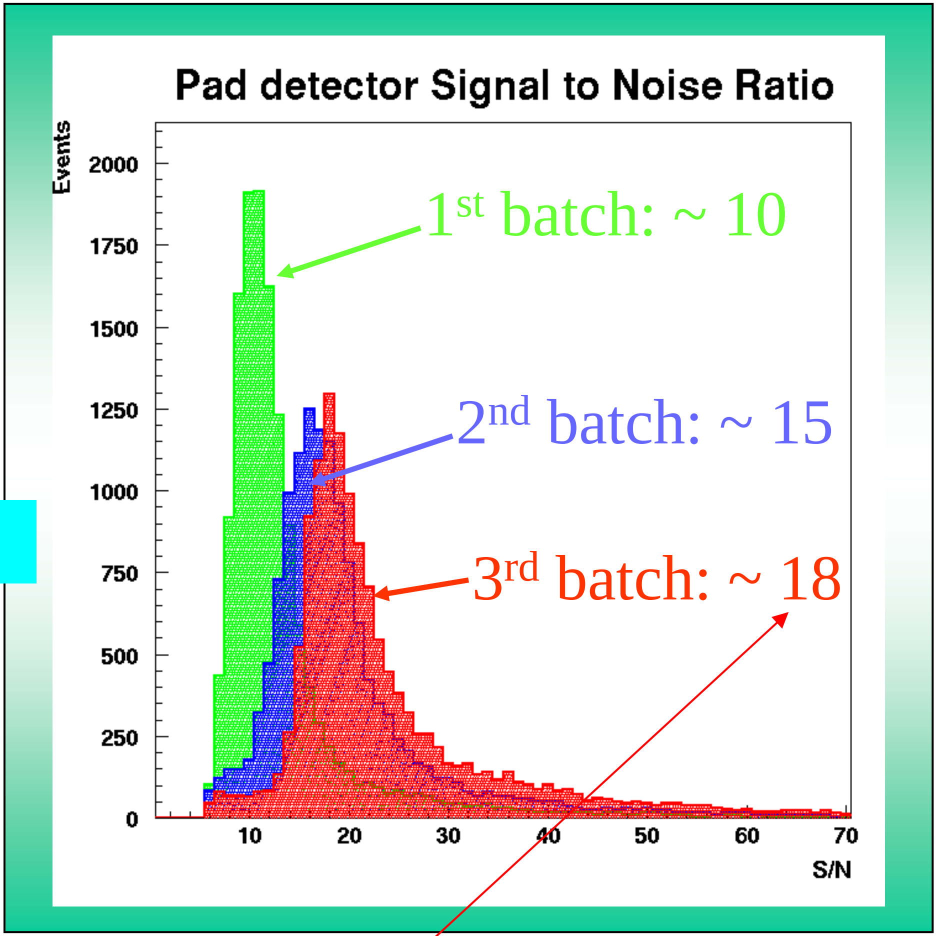
Leakage

$\approx 30e^- \quad +$

Bias Resistance

$\approx 230e^- \quad =$

$\approx 1030e^-$



MIP ~ 23000 e^-

SNR ~ 22

Value close to what achieved for the 3rd batch detectors

Test beam results CALORIMETER (2.1 X_0)

4 layers

m.i.p.→check light output and uniformity in Light collection:

Ratio signal/sigma →lower limit for photoelectrons

N_{phe}>5.1 /layer

→ cal(45layers):>220 phe/m.i.p.

good uniformity:

Simulated Light collection disuniformity(20%)