Analysis progress and plans at University of Warsaw

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Outlook

MC analysis

- MC: leakage / linearity / resolution (by Kamil)

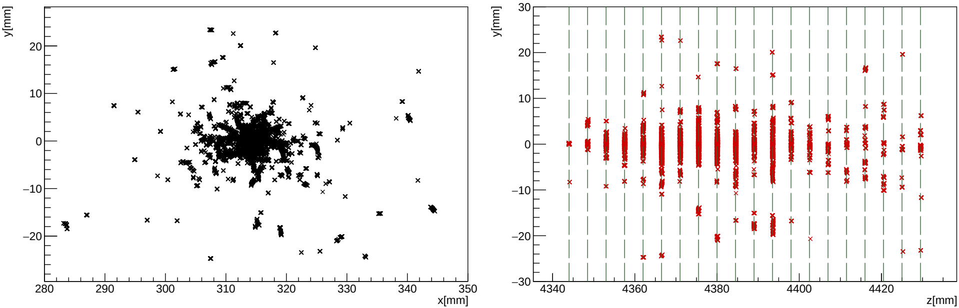
Telescope optimization

- EUDET experience (by Filip)

MC: further plans

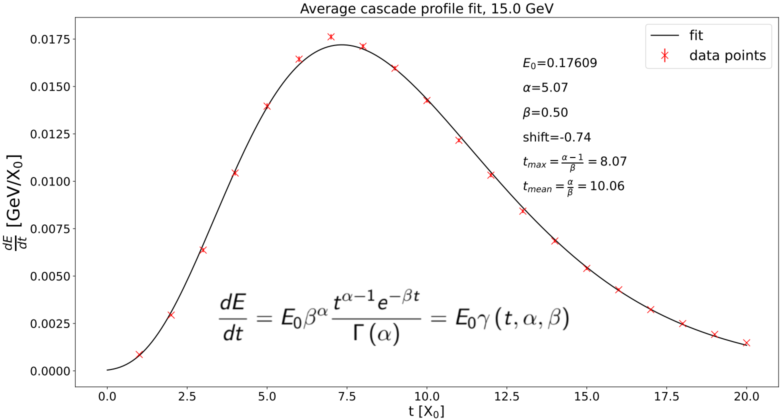
- Simulation of electronic response, pad/pixel structure ($dE/dx \rightarrow Q \rightarrow \#ADC$)

Positron Calorimeter: ECAL-P, MC cascade profiles



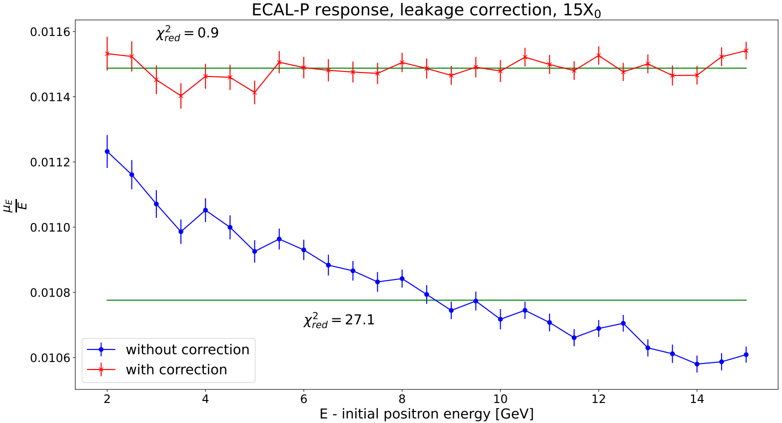
- Monte Carlo (Geant4) XY and YZ cascade profiles for 15 GeV e^+ beam
- Molire radius $\sim$ 10 mm, cascade length $\sim$ 100 mm

Positron Calorimeter: ECAL-P, cascade profile



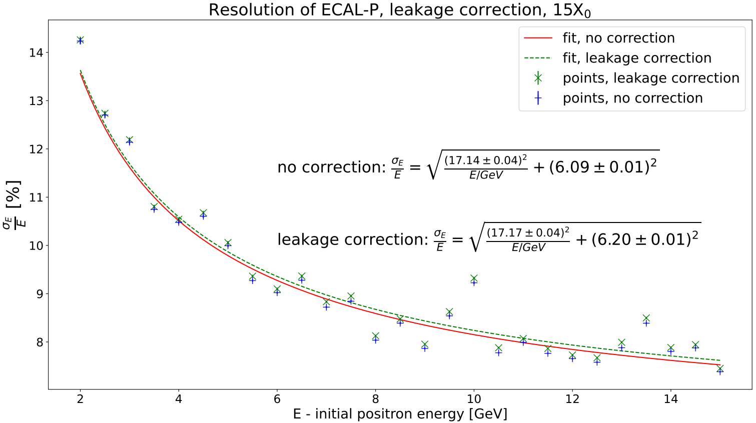
- **longitudinal cascade profile:** 15 GeV e^+ beam vs. t $[X_0]$
- parameterized by shifted gamma function: $t \to t - t_{shift}$

Positron Calorimeter: ECAL-P, linearity



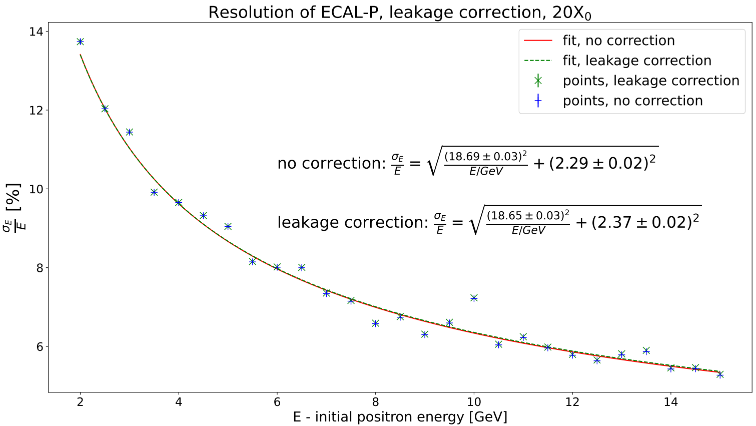
- correction for leakage: $15 \times 1X_0$ (15×3.5 mm tungsten layers)
- **restoring linearity** by adding the “leakage tail” ...

Positron Calorimeter: ECAL-P, energy resolution



- energy resolution, before and after leakage correction
- two scenarios: $15 \times 1X_0$ and $20 \times 1X_0$ layers ($\rightarrow$ next page)
- **... not spoiling the resolution**

Positron Calorimeter: ECAL-P, energy resolution



- energy resolution, before and after leakage correction
- two scenarios: $15 \times 1X_0$ and $20 \times 1X_0$ layers (this page)
- **Using longitudinal profile fit, leakage can be corrected for**

EUDET-Report-2007-01

EUDET Telescope Geometry and Resolution Studies

A.F.Żarnecki*, P.Nieżurawski*

February 12, 2007

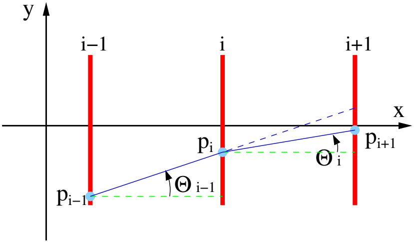
Track fitting

EUDET-Report-2007-01

We want to determine track positions in each plane (including DUT), i.e. N parameters $(p_i,\ i = 1 \ldots N)$, from $N-1$ measured positions in telescope planes $(y_i,\ i \neq i_{DUT})$.

However, we can use constraints on multiple scattering!

Contribution of plane i to χ^2 of the fit



position measurement — multiple scattering

$$\Delta\chi^2_i = \left(\frac{y_i - p_i}{\sigma_i}\right)^2 + \left(\frac{\Theta_i - \Theta_{i-1}}{\Delta\Theta_i}\right)^2$$

$$\text{where: } \Theta_i = \frac{p_{i+1} - p_i}{x_{i+1} - x_i}$$

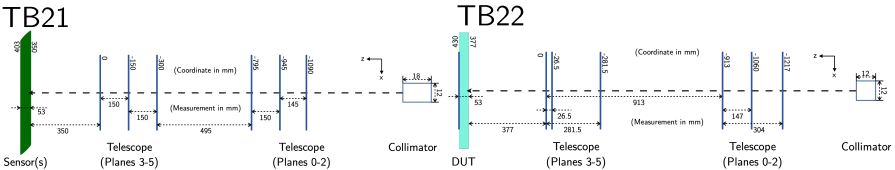
Both terms present for planes $i \neq 1, i_{DUT}, N$, first term missing for DUT, second for first and last plane

χ^2 minimum can be found by solving the matrix equation.

As a by-product we get also an **expected error** on the position reconstructed at DUT.

Implemented as a stand-alone program in C++ with simple text input file

Position precision at tested sensor plane (DUT)



Assuming ALPIDE sensors with 50 μm thickness and 8 μm resolution

Configuration		TB21	TB22
Vacuum	1 GeV	96.3 μm	129.3 μm
	3 GeV	39.5 μm	48.1 μm
	5 GeV	27.7 μm	31.0 μm
Air	1 GeV	119.9 μm	151.9 μm
	3 GeV	47.4 μm	56.5 μm
	5 GeV	32.9 μm	36.8 μm

Also predictions for the width of the residua distributions...

Analysis of GEANT4 simulation results

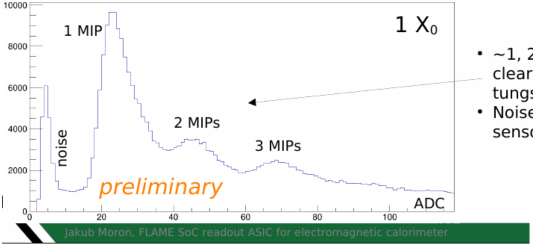
So far, all our results were based on GEANT hits (energy deposits) only.
Next step is to model detector structure and readout chain.

First (still simplified) concept assumes following processing steps:

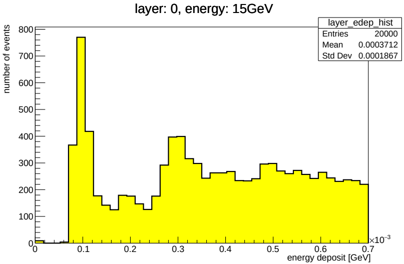
- converting energy deposit to primary charge distribution in sensor
- charge collection efficiency and charge sharing between pads
- possible effects related to charge readout (cross-talks?)
- impact of readout electronics (pedestal, gain, saturation effects) including possible variations between channels
- pedestal subtraction and application of calibration factors

We should be able to directly compare our results with test beam data...
($\rightarrow$ see next page for very initial plot)

DATA vs. MC energy loss distribution



- ~1, 2 and 3 MIPs peaks clearly seen after 1 X_0 tungsten absorber
- Noise peak seen (different sensor)



- DATA: single pixel readout after $1X_0$ tungsten plane
- MC: sum from first detector plane after $1X_0$ (15 GeV e^+ beam)
- MC: 3 MIPs ($e^+ + e^+e^-$) dominate over 2 MIPs peak