Performance results of a high-granularity electromagnetic calorimeter

Chunhui Zhang, Ton Van Den Brink, Marco Van Leeuwen, Gert-Jan Nooren, Thomas Peitzmann, Hongkai Wang
Utrecht University/NIKHEF

Summary
- **Forward Calorimeter** (FoCal) under discussion for Alice Upgrade (possible installation in LS3 (~2024))
- A **high granularity** digital Si/W calorimeter **prototype** for FoCal has been built and tested.
- Very **small Molière radius** (11±0.5mm) has been measured.
- Unique **high resolution lateral shower profiles** have been obtained → two-shower separation.
- An additional **charge diffusion model** works well to improve the description in Geant 4 **simulations**.
- Sensor **sensitivities** and **dead area** have been **corrected** for.
- Performance of our prototype **agrees** reasonably well with the **simulation**.

Motivation
**Measurement of direct photons at large rapidity as a signal of gluon saturation.**

**Requirements** for the Focal detector
- Gamma/π^0 discrimination
- 3D shower shape analysis
- Particle flow
- Energy measurement by particle counting: requires high granularity due to high density of shower particles (10^3 mm^-2)

FoCal Prototype
- **Test beam setup**
- **Stack of W and Si layers**

A **unique** FoCal prototype:
- ~39 M pixels (pitch: 30µm)
- Small R_M ~ 11mm
Results

Lateral profile

Experimental data

Comparison to simulation

linearity

What was used in data analyses and simulation

Simulation

- A charge diffusion model was added to Geant 4 simulation

Experimental data

- Sensor sensitivity correction
- Dead area correction

Energy resolution

fit function:
\[ \frac{\sigma_E}{E} = 3.6\% \oplus 33.6/\sqrt{E(\text{GeV})} \]
\[ \frac{\sigma_E}{E} = 3.9\% \oplus 26.7/\sqrt{E(\text{GeV})} \]