Prototype Calorimeter Simulation with Silicon Photomultiplier as Photo–Detector for HCAL

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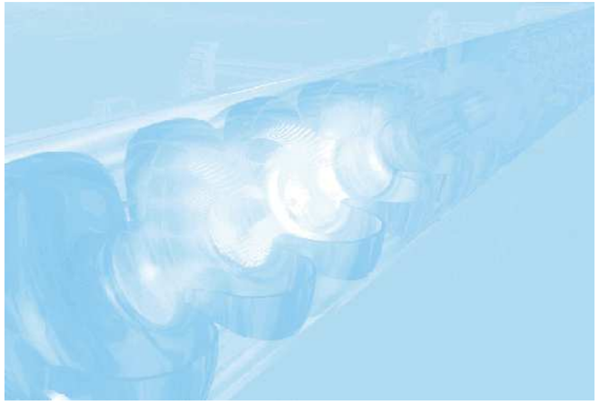
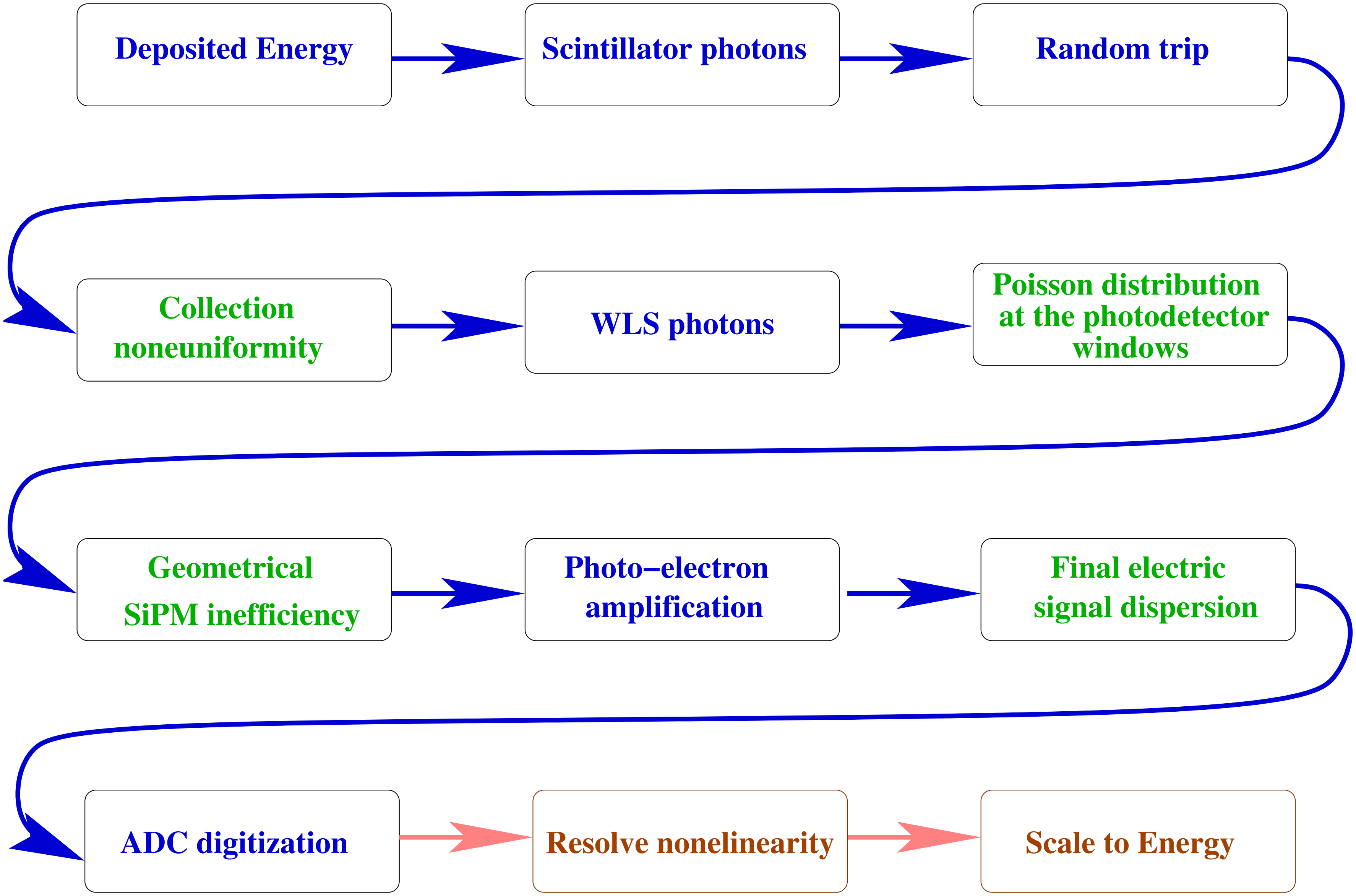
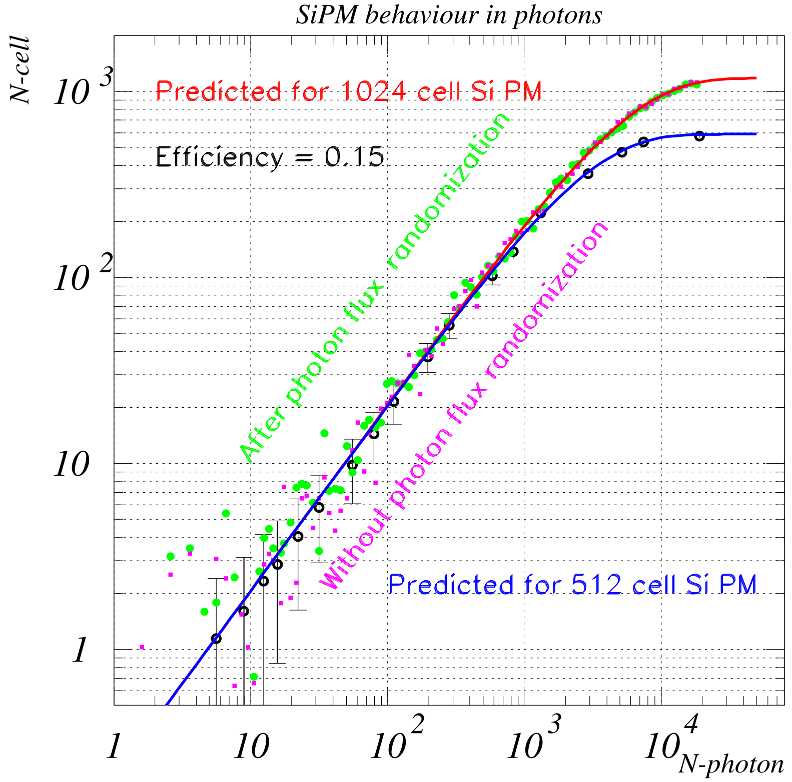


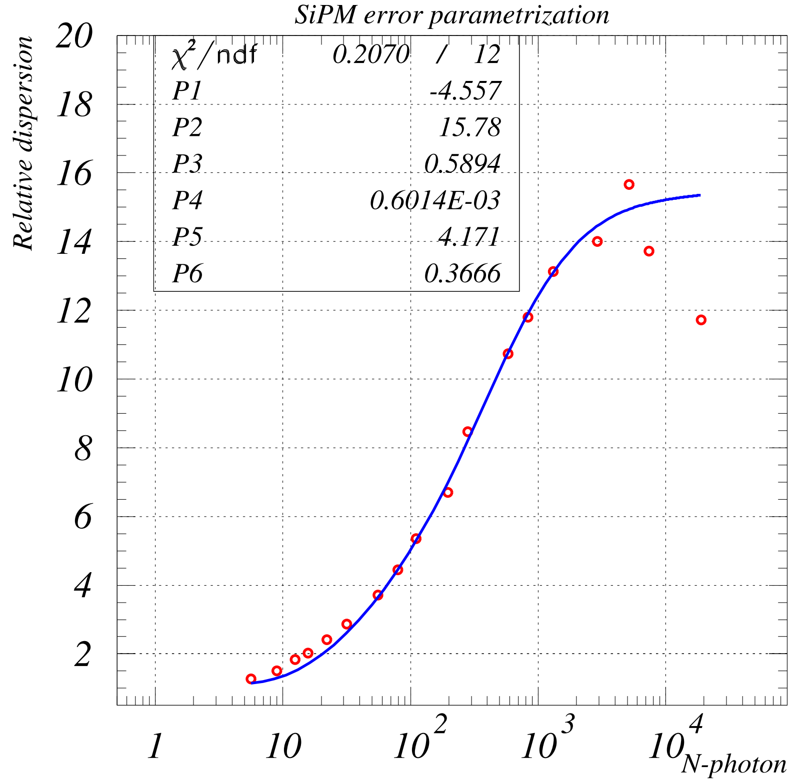
ECFA–DESY Workshop, 1–4 April 2003, Amsterdam

From Deposited Energy to ADC counters



SiPM Photo–Detector Properties Parameterization





Experimental response function parameterization.

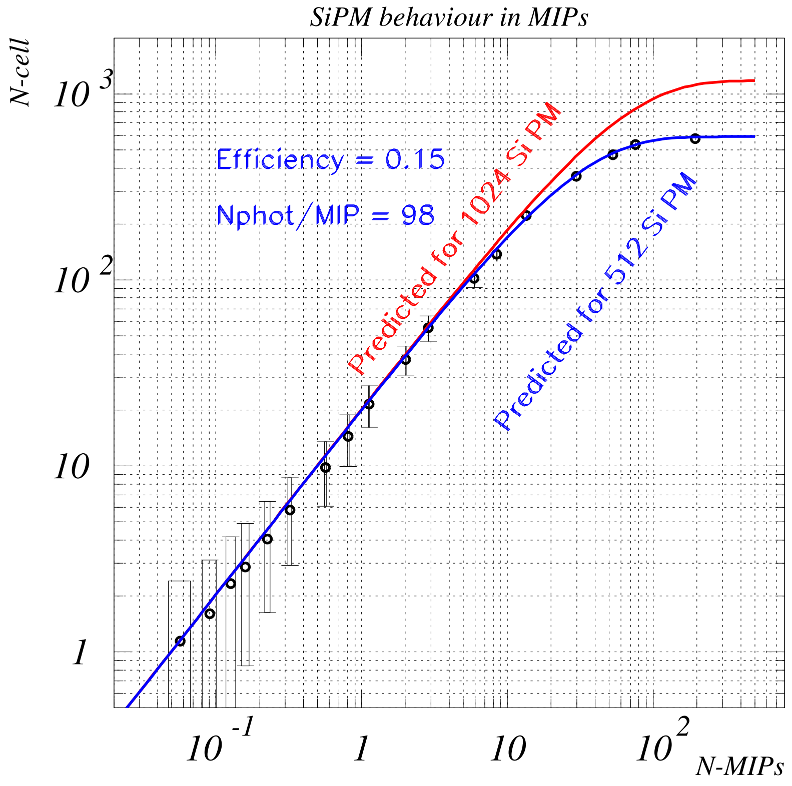
$$f_1(N_{ph}) = 1 - \exp\{-\epsilon_1 N_{ph}/N_{pt}\};$$
$$N_{cell} = N_{pt}(1+\epsilon_1) f_1 (1 + \epsilon_2(1 - f_1))$$

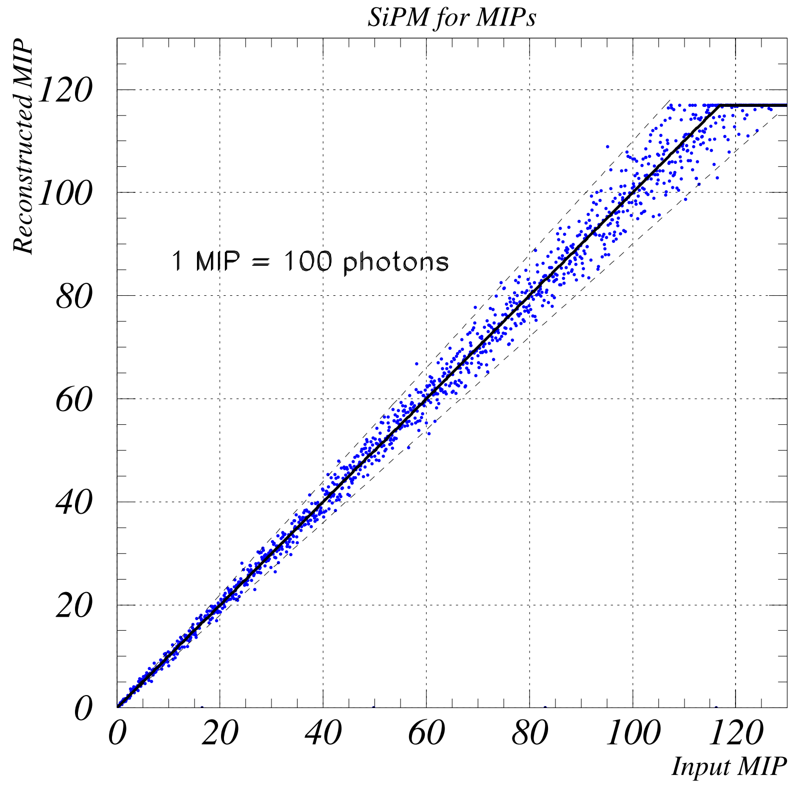
Experimental response dispersion parameterization.

$$Disp = A_1 \; (\ln N_{ph})^{A_3} \exp\{-A_4 \; (\ln N_{ph})^{A_5}\} + A_2(1 - \exp\{-A_6 \; \ln N_{ph}\})$$

Thanks E. Popova and A. Karakash for presented experimental results.

Artificial MIPs in SiPM





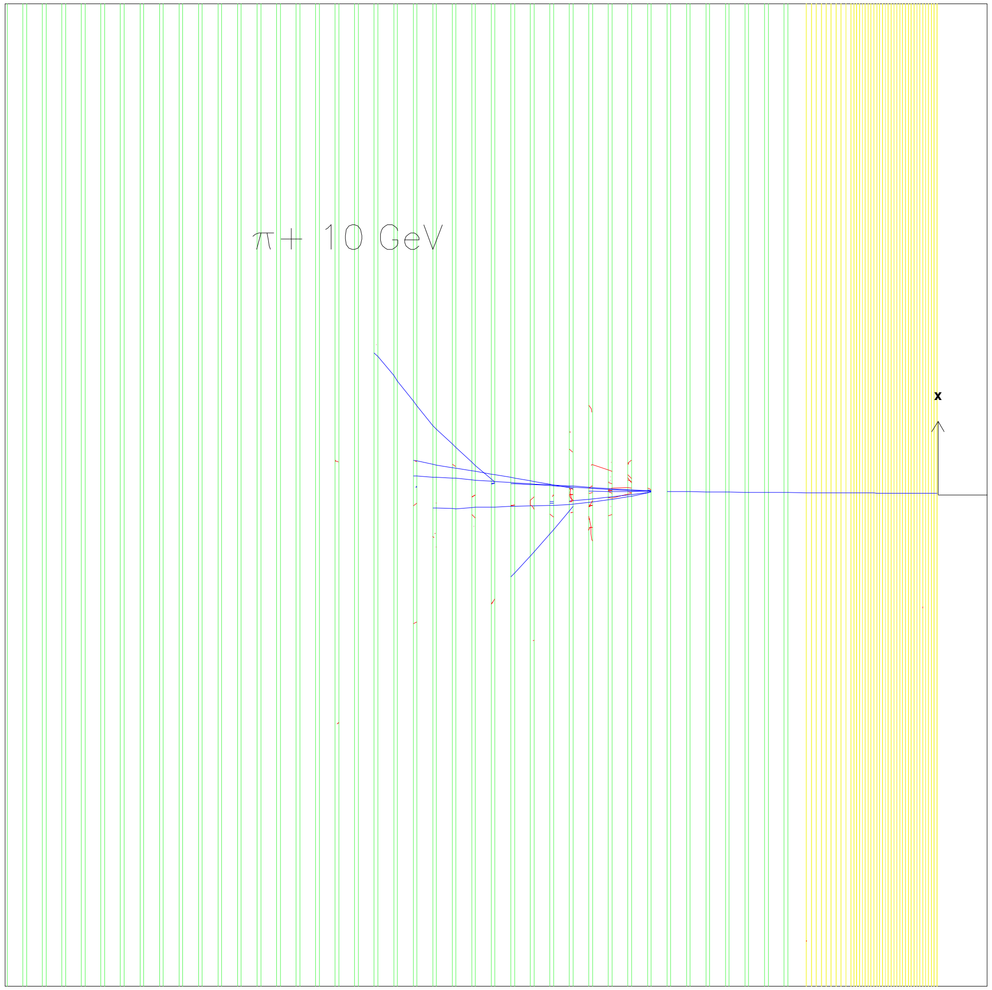
Simply rescaled number of photons to MIPs.

Here is a limit of about 120 MIPs for 1024 cells SiPM.

The backward solution for the SiPM response function was applied.

Big spread for large number of MIPs is due to the big SiPM photo–detector dispersion near by the saturation.

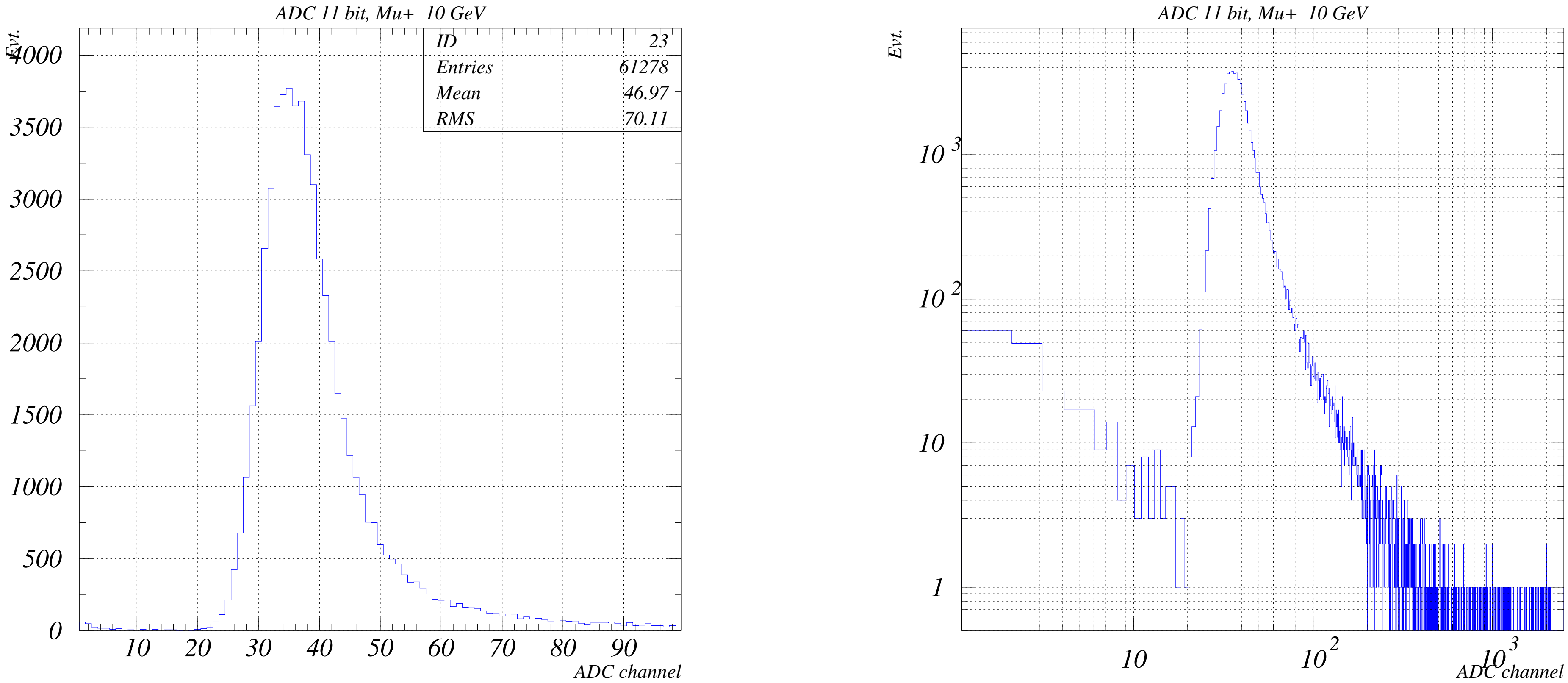
Calorimeter Prototype



Si–W ECAL with 1x1 cm cells,

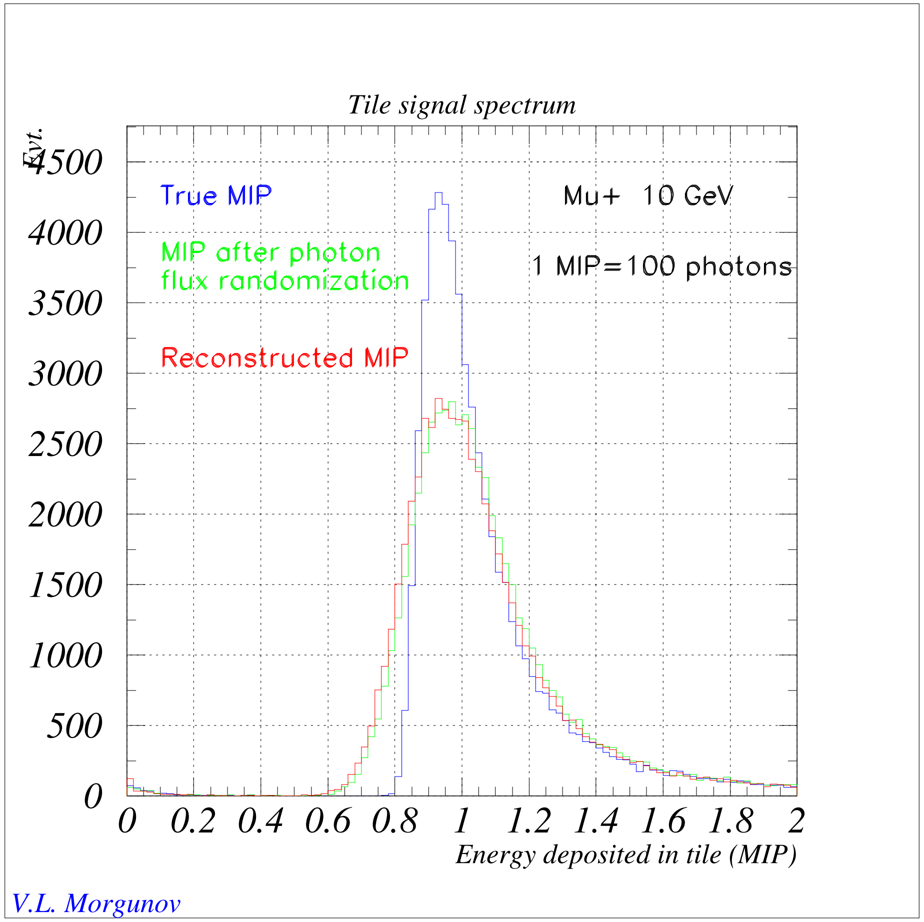
Fe–Scintillator HCAL with the same tile sizes 5x5 cm.

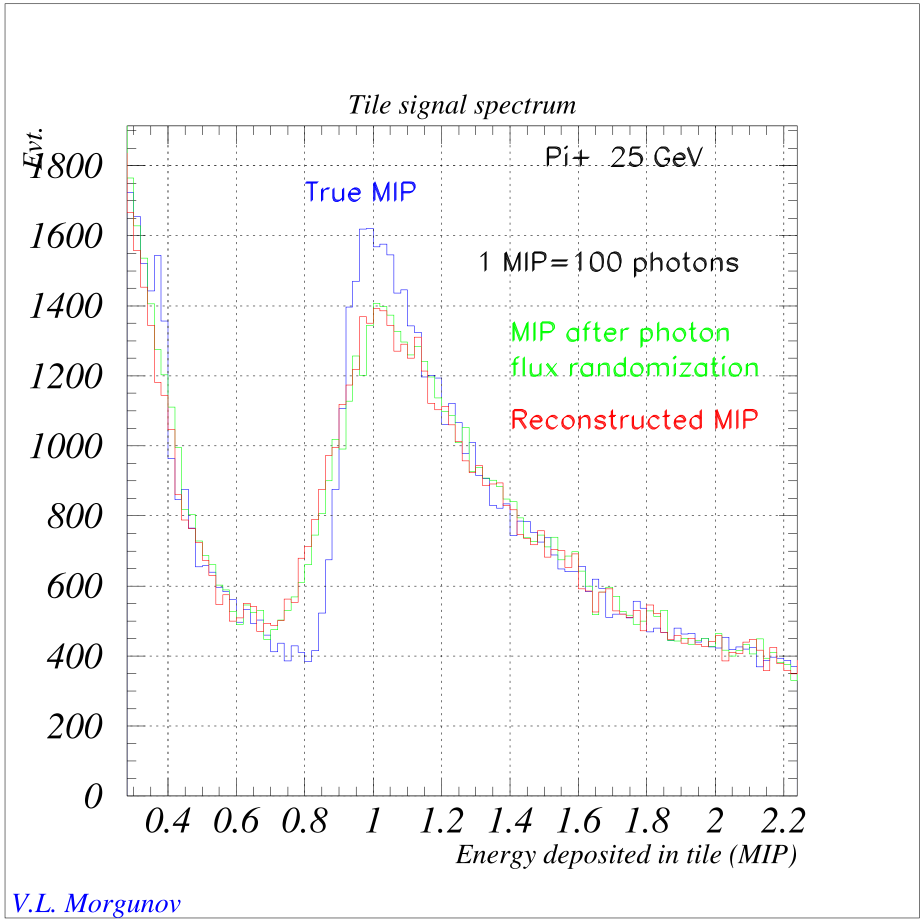
Calorimeter Signal Digitization



Digitized energy deposition spectrum for 10 GeV muon in scintillator tiles.

Calorimeter MIPs in SiPM

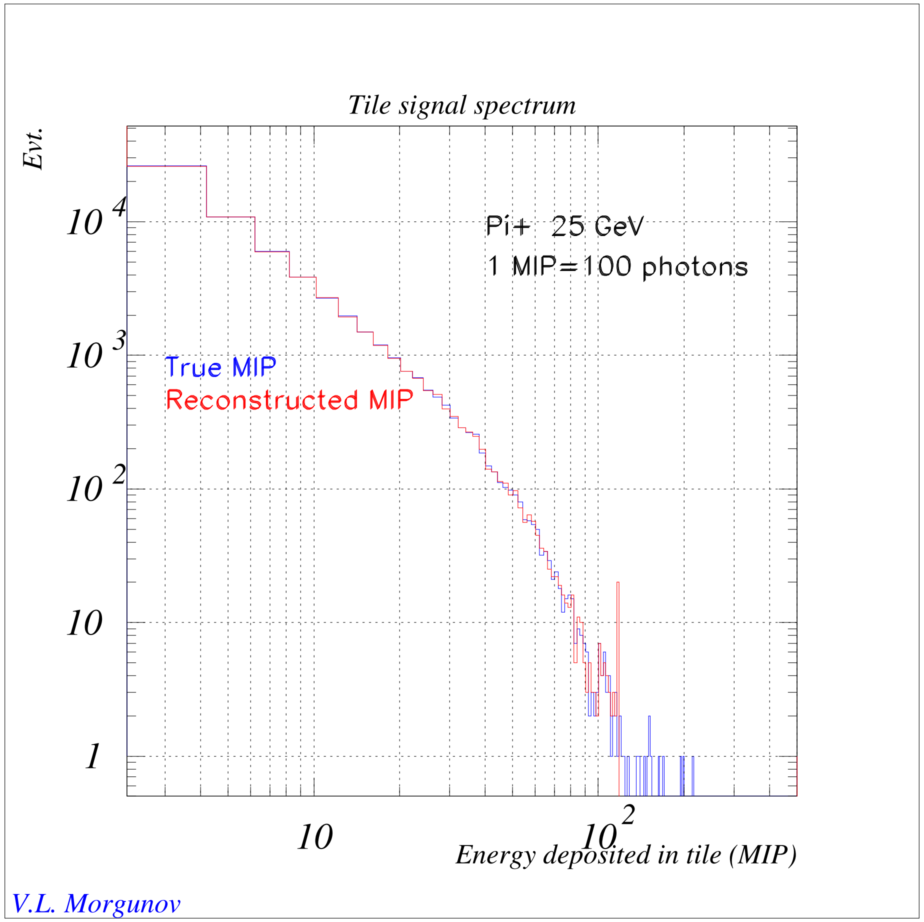


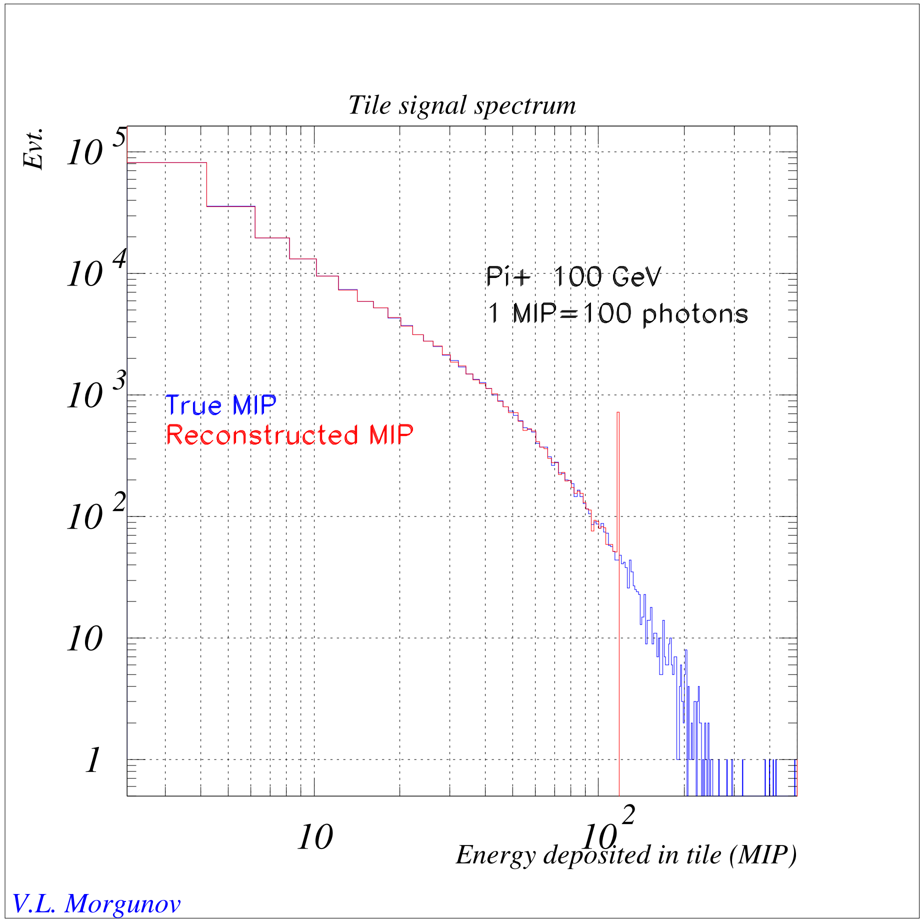


Fluctuation of scintillator photon number increases MIP width.

There is not visible influence of SiPM photo–detector here.

Look to the tail



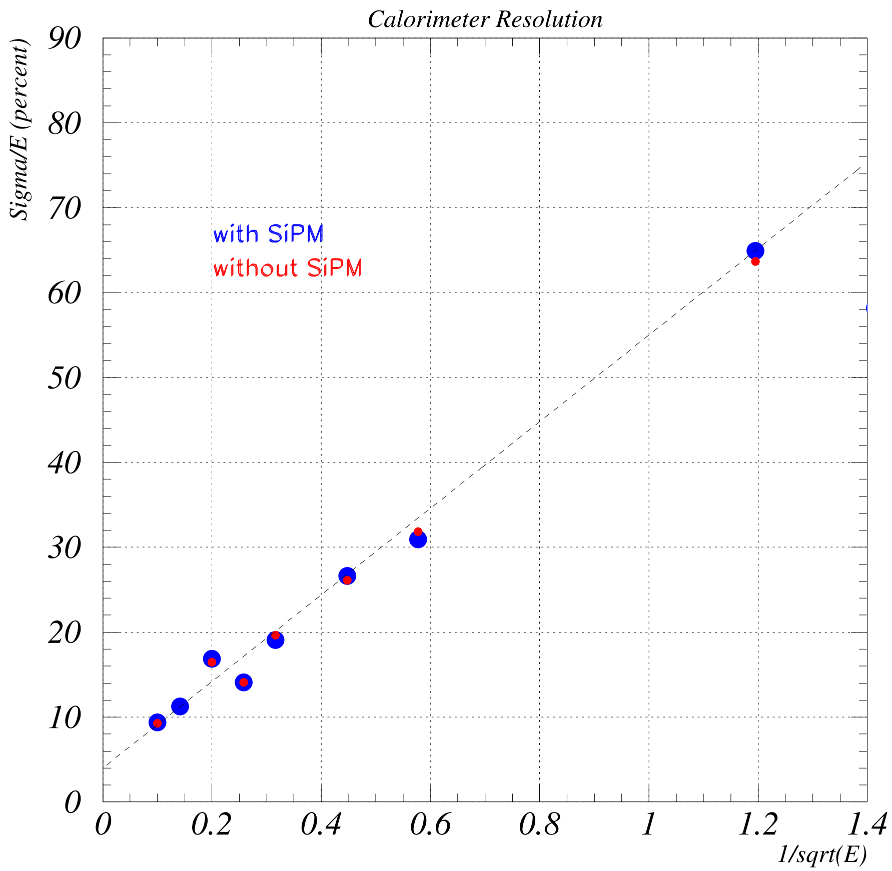


Red spike at about 120 MIPs is the cut–off due to the SiPM saturation.

Whole statistics at the right histogram is 732.753

Number of spikes is about 700 $\Rightarrow$ 0.1% of hits are out of range.

Calorimeter Resolution



There is no any sensible difference with using SiPM for the prototype calorimeter resolution.

Pro and Contra

Silicon Photomultipliers, installing at every tile, might be proposed as the photodetector for the TESLA scintillator tile hadron calorimeter.

All tile sizes at this case should be the same and close to 5x5 centimeters.

Such a solution leads to the factor 8–10 increasing of number of channels in the calorimeter!

- No clear fibers,
  (-cost)
- Shorter WLS fibers,
  (-cost)
- Easy assembling,
  (-cost)
- Number of electronic channels,
  (better for reconstruction)
- Every sampling layer will be read,
  (better for reconstruction)

- Number of electronic channels,
  (+cost)
- Noise frequency,
  (DAQ rate, if there is no trigger)
  (cooling, gating)