Longitudinally segmented shashlik calorimeters with SiPM readout: the SCENTT experiment

Claudia Brizzolari - 30 September 2016, Padova
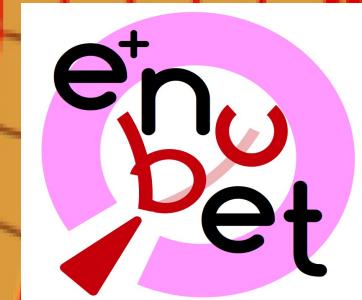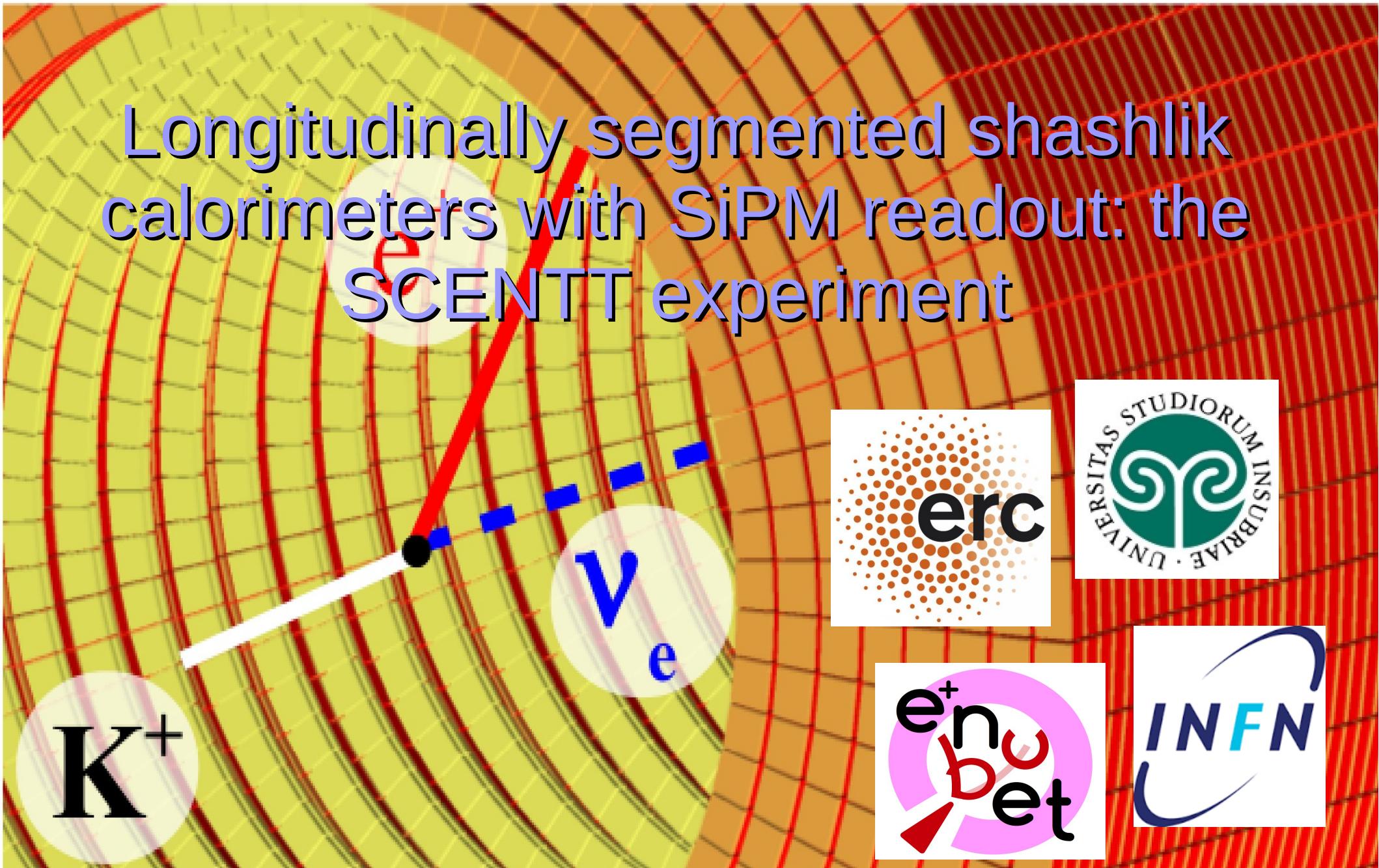
The SCENTT-ENUBET project

Shashlik Calorimeters for Electron Neutrino Tagging and Tracing, part of Enhanced NeUtrino BEams from kaon Tagging project - ERC-Consolidator Grant-2015, n° 681647 (PE2)
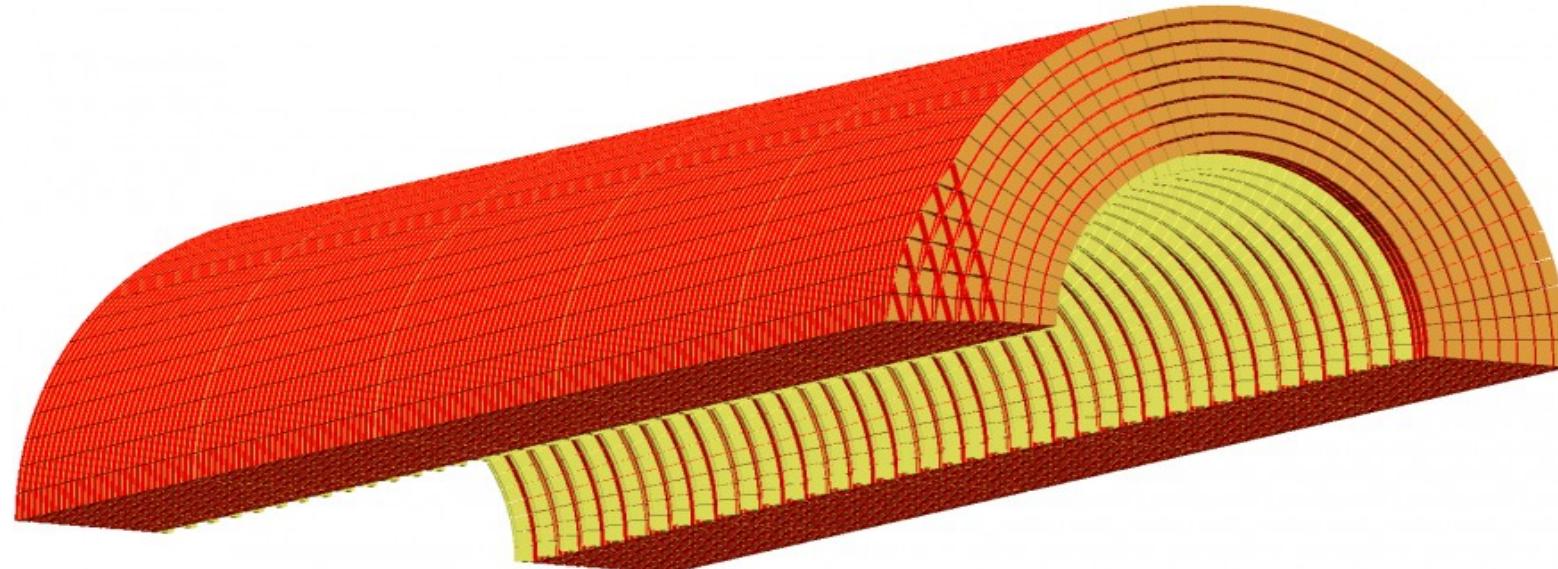
Goal: improve the current knowledge of the σ_ν at ~GeV to 1%

We want σ_ν at ~GeV at 1%

Right now is 10 - 20%

⬇

Initial flux of neutrinos unknown, inferred from hadro production data and beam simulation

⬇

Neutrino flux measured directly in the decay tunnel from

$$K^+ \rightarrow e^+ + \pi^0 + \nu_e \ (K_{e3})$$
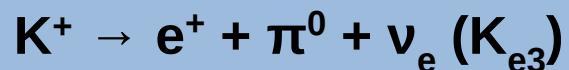
Tag e^+ associated with ν_e

The Detector

~ 50 m at 8 GeV → K_{e3} only source of ν

➔ **limited cost**

➔ **good energy resolution**

➔ **geometrical adaptability**

The Detector

Shashlik calorimeter

+
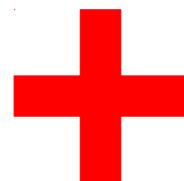
## Compact readout based on SiPM

- ✔ **Direct fibre-SiPM coupling**

- ✔ **Readout embedded in the calorimeter bulk → longitudinal segmentation**

- ✔ **Rate capability > 500 kHz/cm^2**

Hadronic module:
180 fibers, 24X0 sampling
Total dimension 20x70x9cm3

18 cm

15 cm

70 cm

7x4x2 EM Module matrix,
4X0 sampling

- **Fe + plastic scintillator**

- **EM + hadronic**
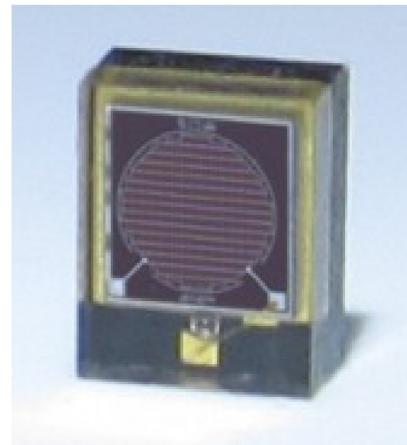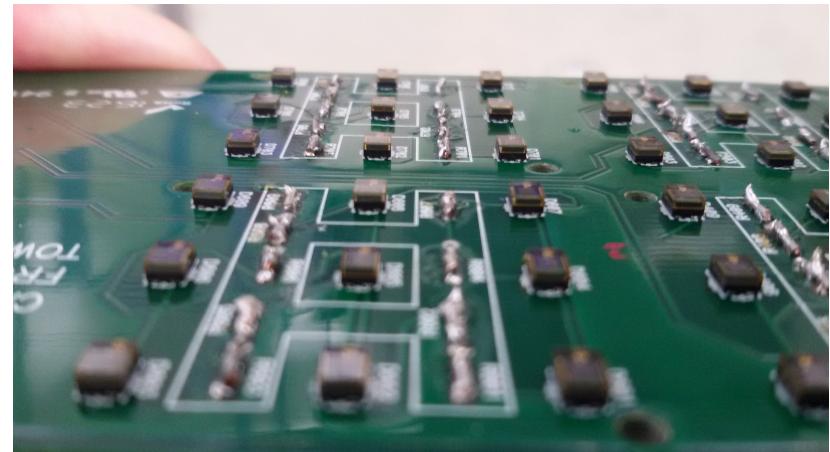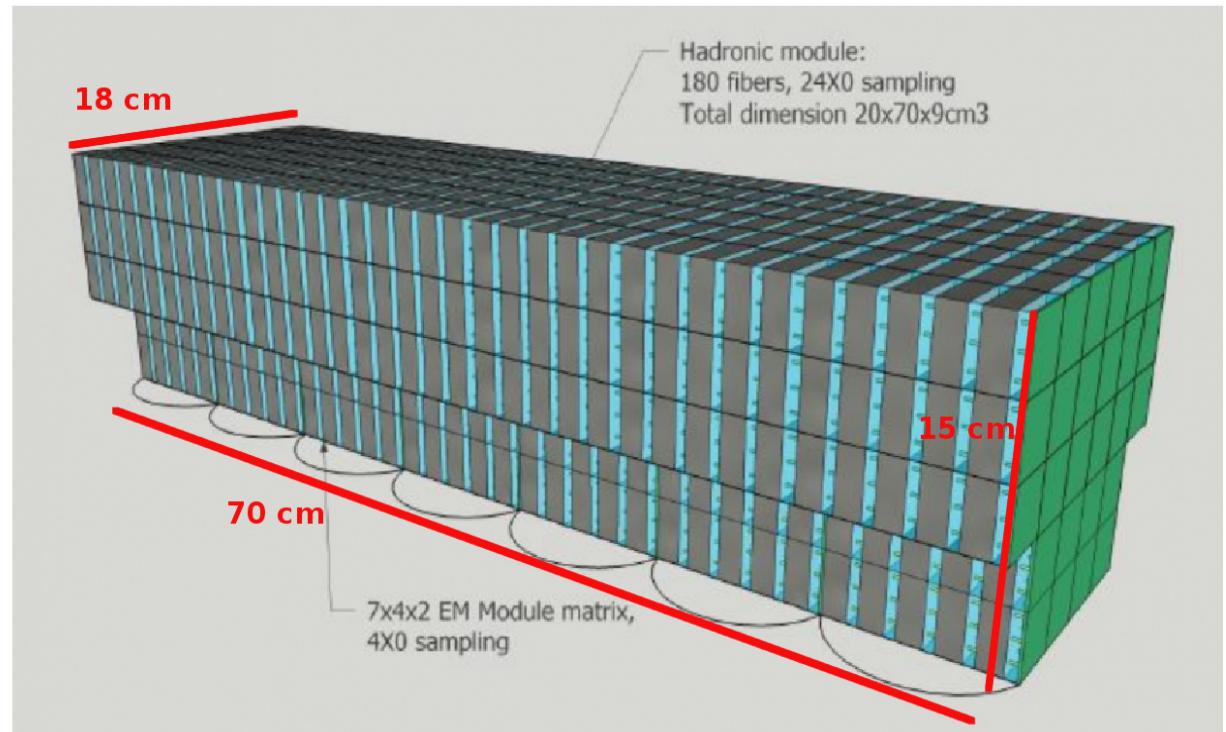
Sensitive area 1x1 mm^2
2500 20x20 μm^2 cells

- **Each SiPM coupled with one WLS fibre**

- **Custom PCBs**

Test Beam July @ CERN PS – T9 beamline: prototype
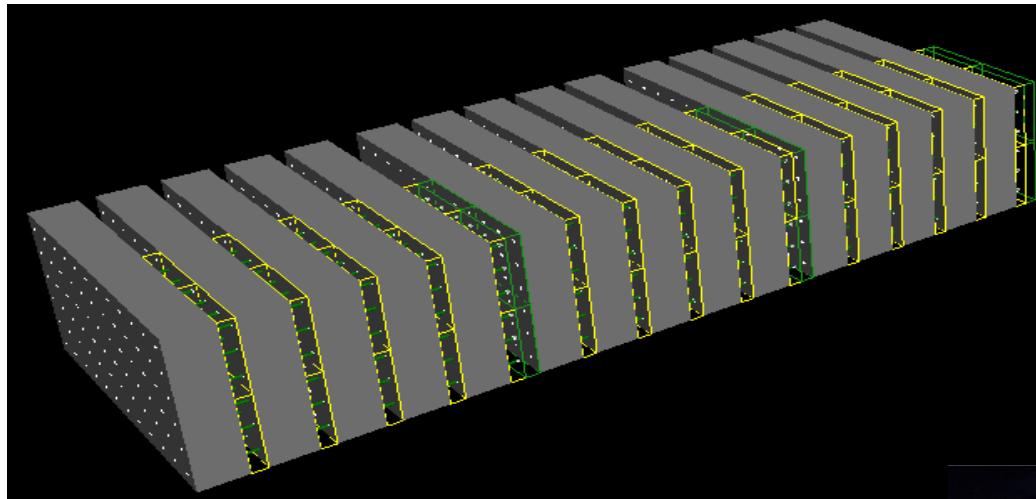
- EM calorimeter
- 30 cm, 3 modules
- 12 basic units
- Fe + SCIONIX EJ-200 or BC412

Plastic scintillator 0.5 cm

Fe 1.5 cm

PCB
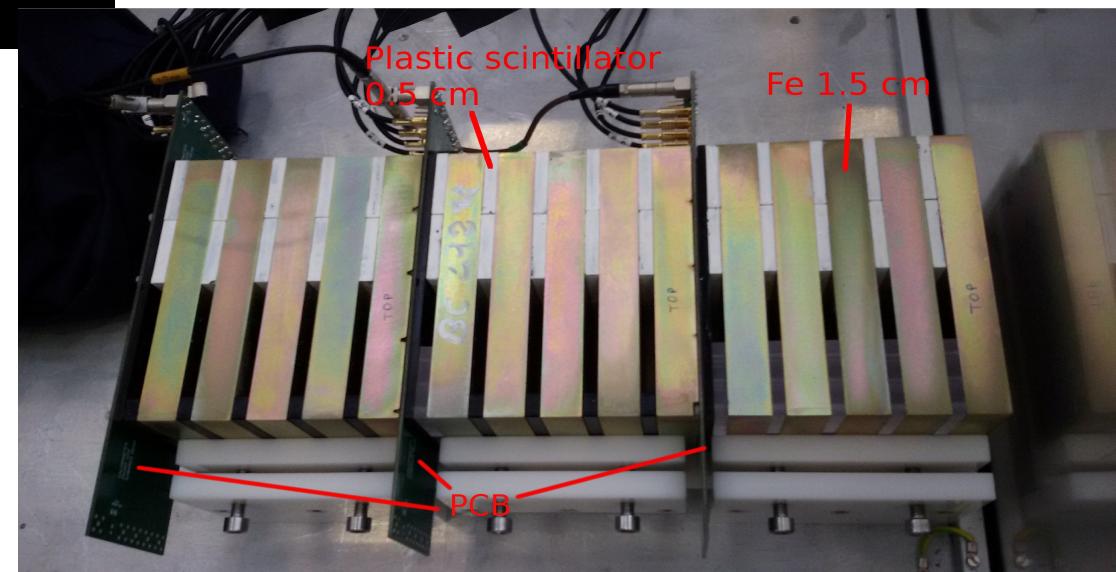
Test Beam July @ CERN PS – T9 beamline: tests performed

- Mixed beam: electrons, muons, pions

- Energy scan 1 - 5 GeV

- Different overvoltages to check for SiPM saturation

- Two readouts: charge integrating ADC (V792, CAEN) and digitizer (V1730, CAEN)

Test Beam July @ CERN PS – T9 beamline: results
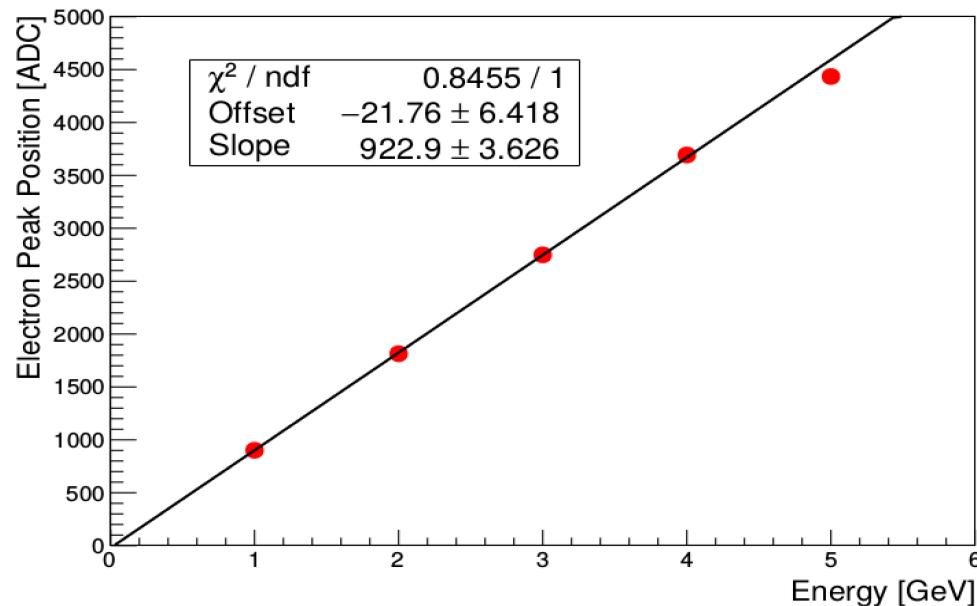
Deviation at 5GeV = -3.5%

V = 31(3) V
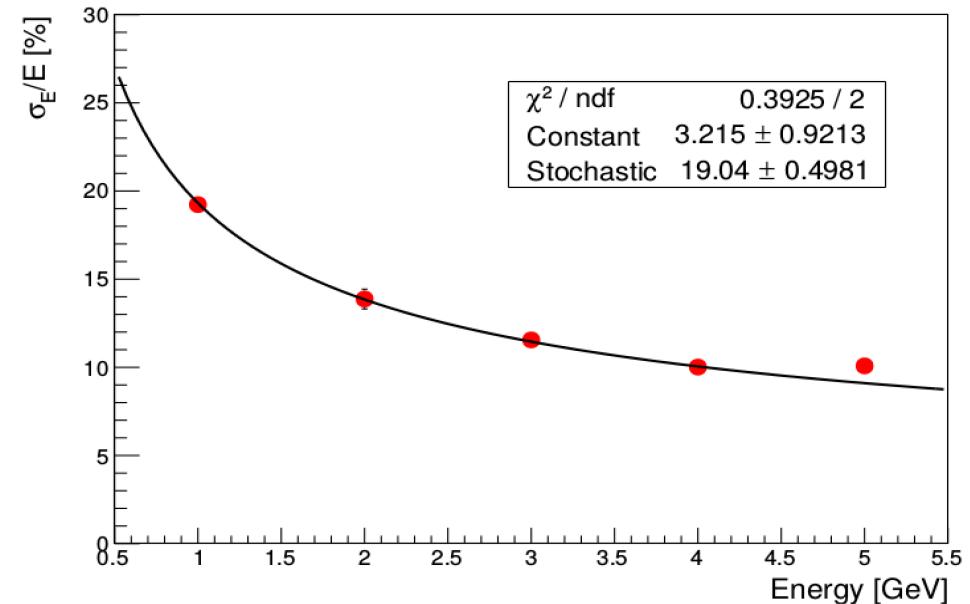
$$\frac{\sigma_E}{E} = \sqrt{\left(\frac{a}{\sqrt{E}}\right)^2 + b^2}$$

Stochastic term

Constant term

e⁻/π separation

Run @ 2GeV
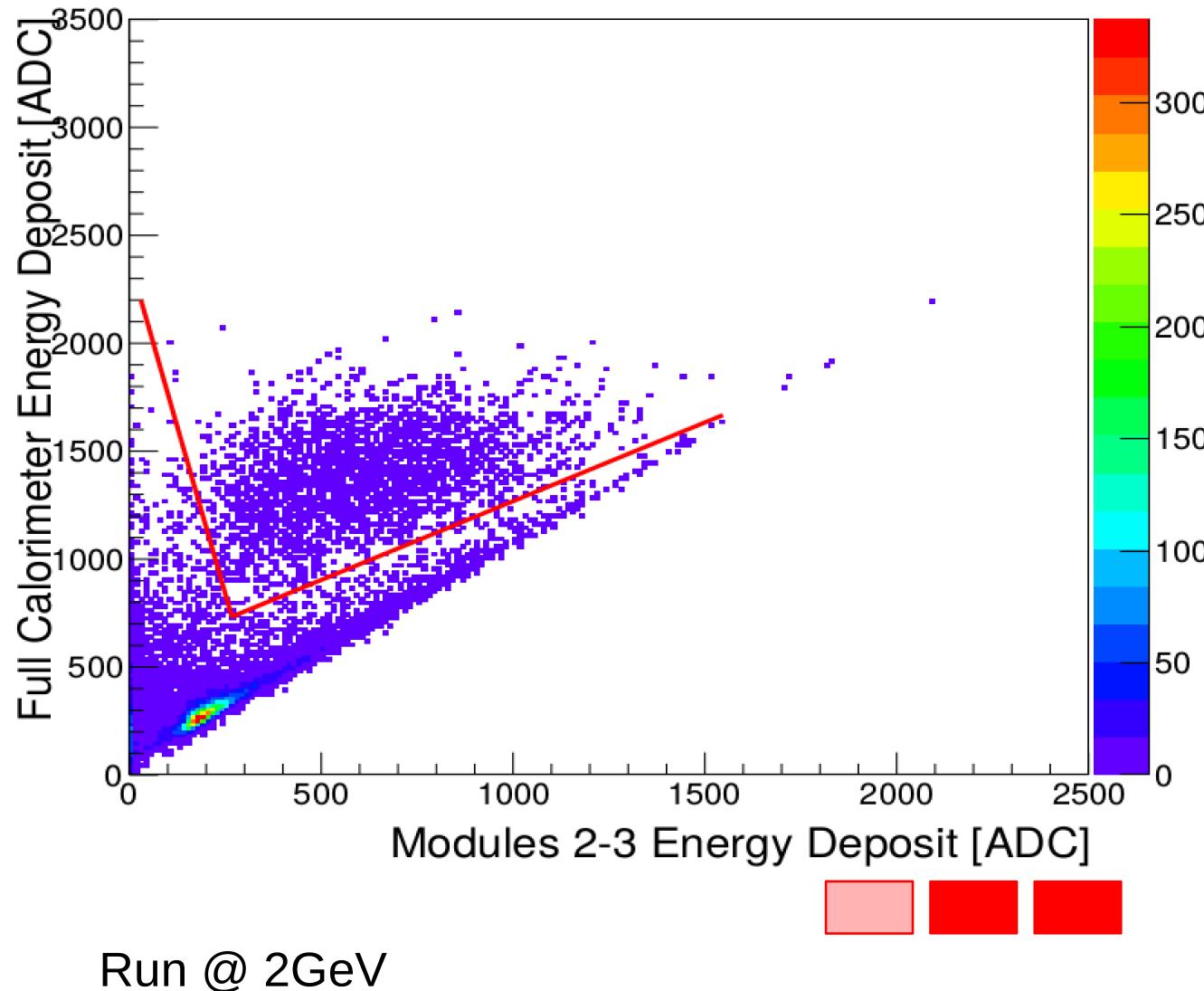
Nuclear counter effect (NCE)
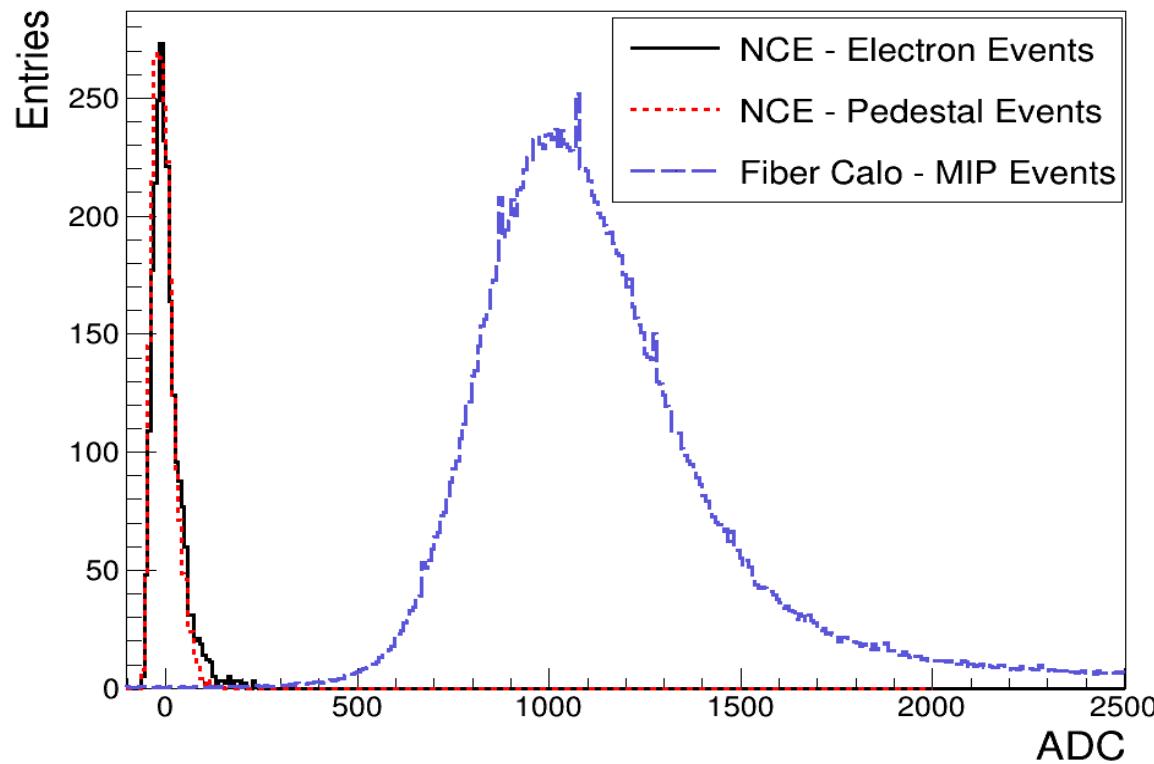
Nuclear counter effect studied in August 2015 on another prototype.
Red and black lines: run at 5 GeV without WLS fibres
Blue line: standard run at 5 GeV
[from: "A compact light readout system for longitudinally segmented shashlik calorimeters", published on Nuclear Instruments and Methods in Physics Research: Section A]

Conclusions and next plans

- no Nuclear Counter Effect, E resolution = 19% / E$^{1/2}$ → **OK!**

- investigate electron efficiency and purity in EM calorimeter

- testbeam scheduled for November 2016 @ CERN on EM + hadronic calorimeter → verify e$^+$/π
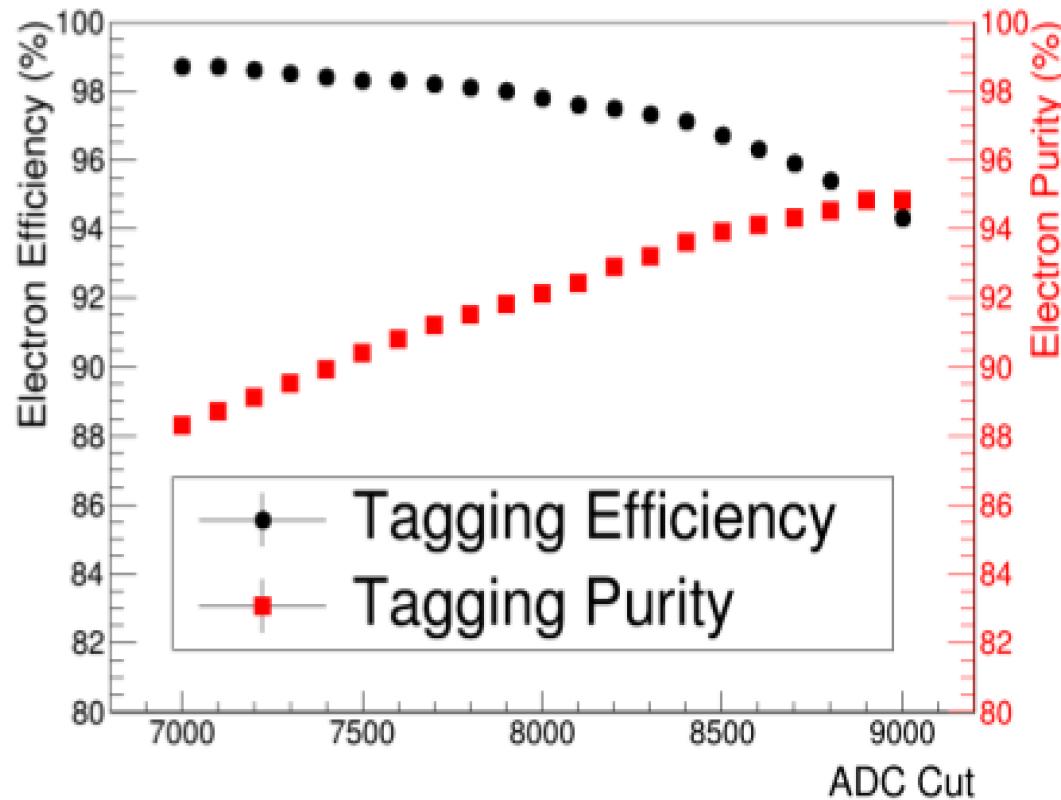
Appendix

Comparison between the efficiency (in black) and the purity (in red) obtained varying the energy cut *[Alessandro Berra]*

Appendix

Spectra of K_{e3} e^+
and π^+ from $K^+ \rightarrow \pi^+\pi^0$

e^+

π^+
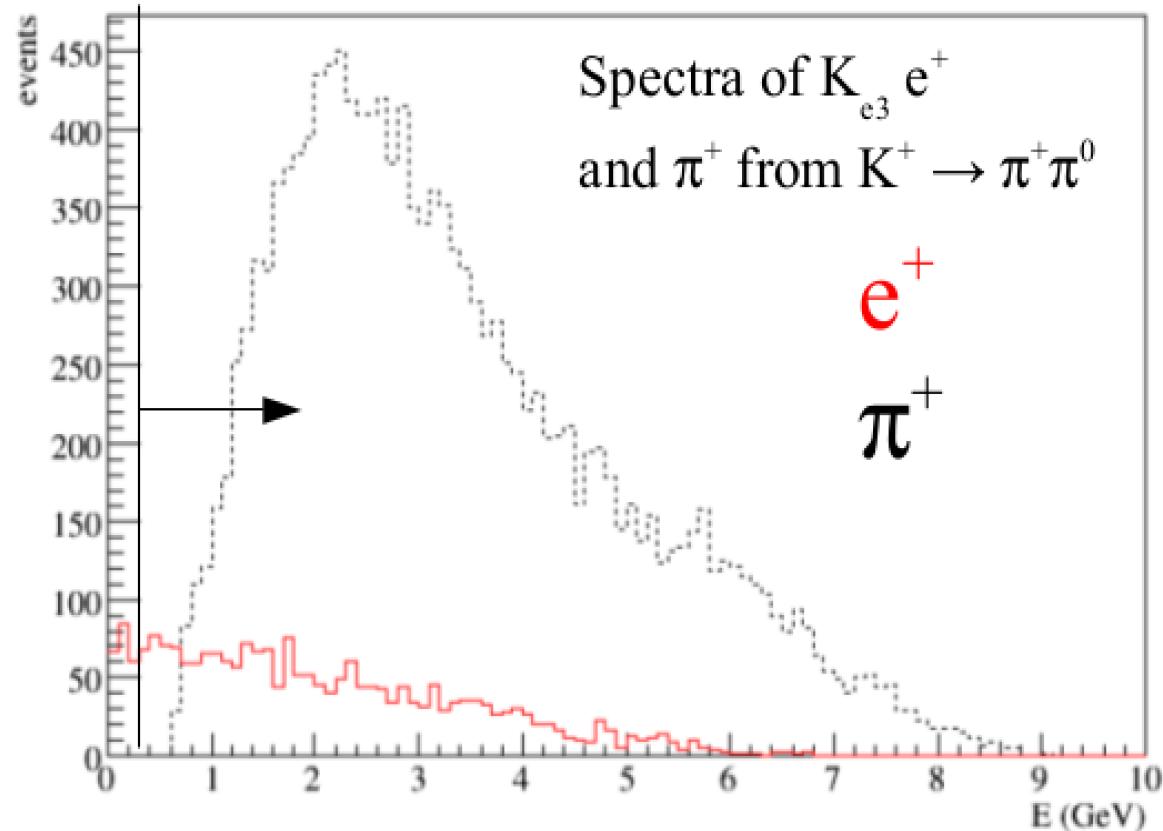
[Andrea Longhin]

Appendix

at 2 GeV