R&D in Bologna

A.Montanari
for Bologna IFR group

III SuperB Collaboration Meeting
Frascati, 21 March 2012

Outline

1)New results on tests of muon response of IFR scintillator bar readout with FBK photosensors

(G.Balbi, A.M., G.Torromeo, N.Tosi)

2)Highlights on simulation of scintillator bar with FLUKA

(T.Rovelli, S.Lo Meo)

Part 1: introduction

Measure SiPMs response on a IFR bar prototype

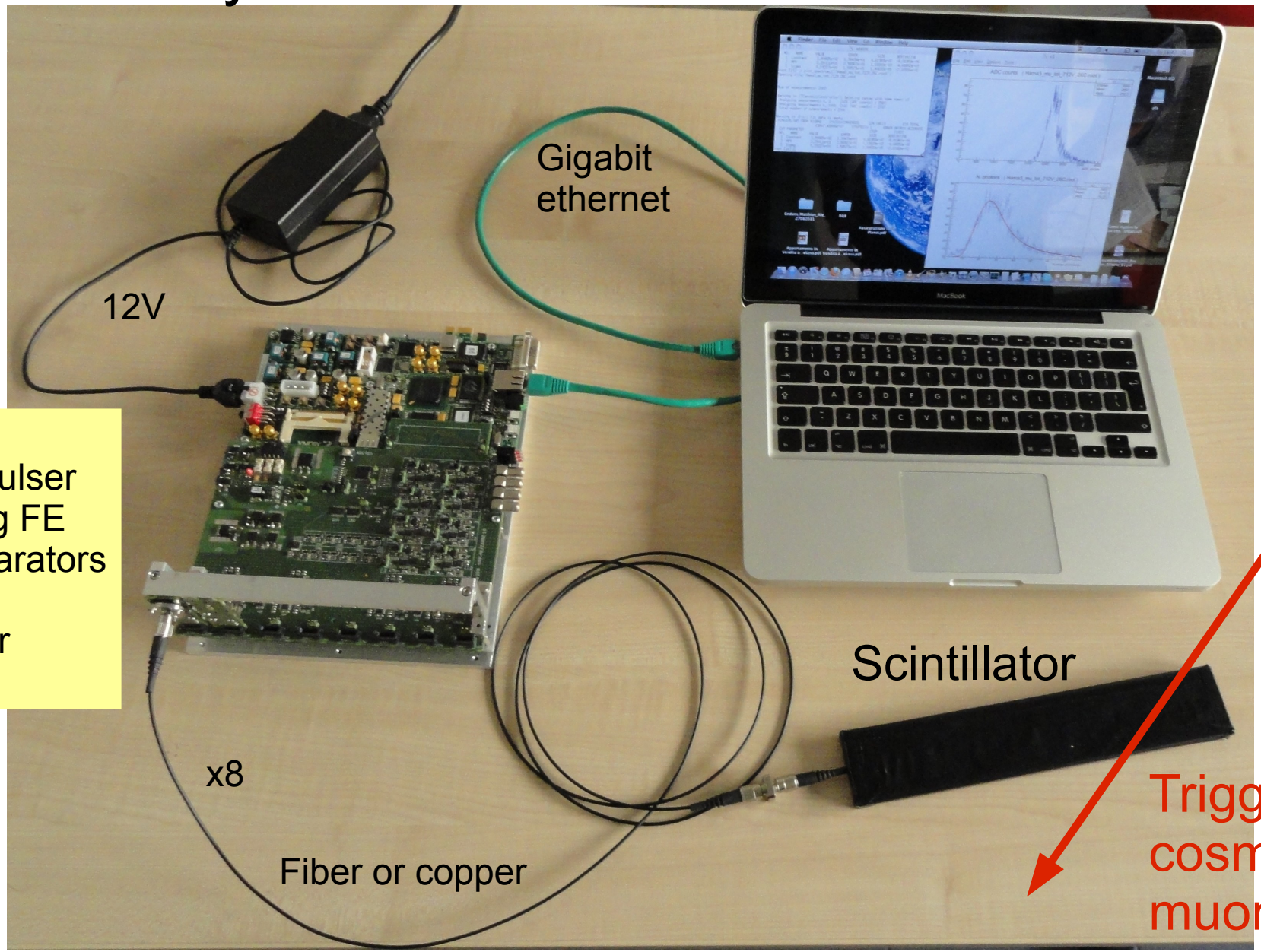
- light detection efficiency has implications on detector design (number of WLS fibers, geometry, SiPM signal collection..)

CAVEAT:

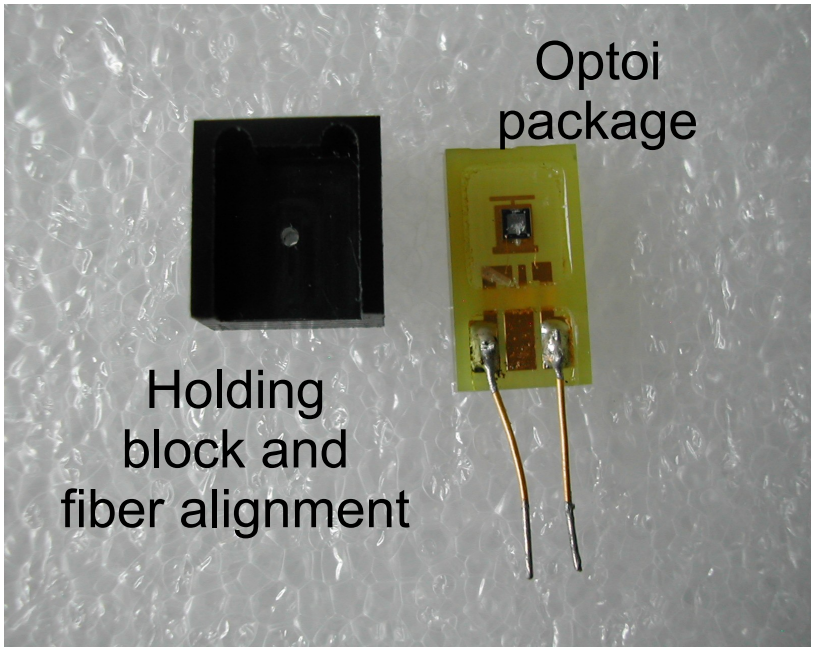
- better optical couplings with respect to previous measurements...but still critical
- still preliminary measurements !
- cosmic muon trigger not optimized

Custom readout and control system

- Versatile system for 8 channels:



SiPM from Bologna



FBK 1x1 mm^2

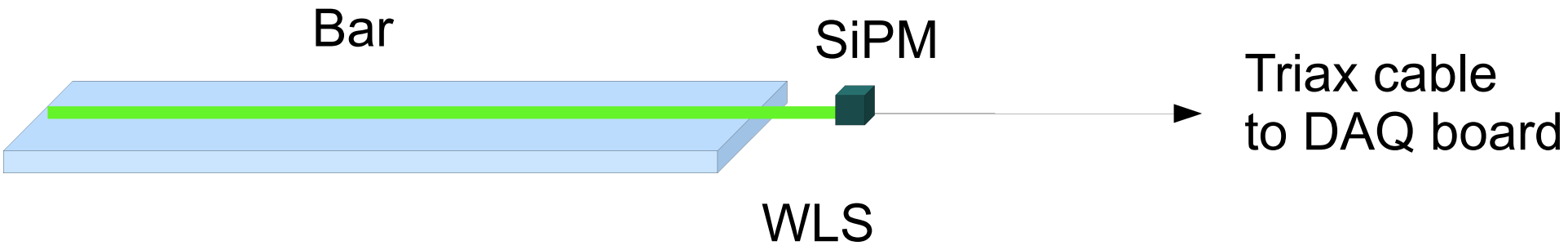
old 2008 sample, model C,

..not state of the art..

50 μm pixel

Caveat:
not optimized
optical coupling

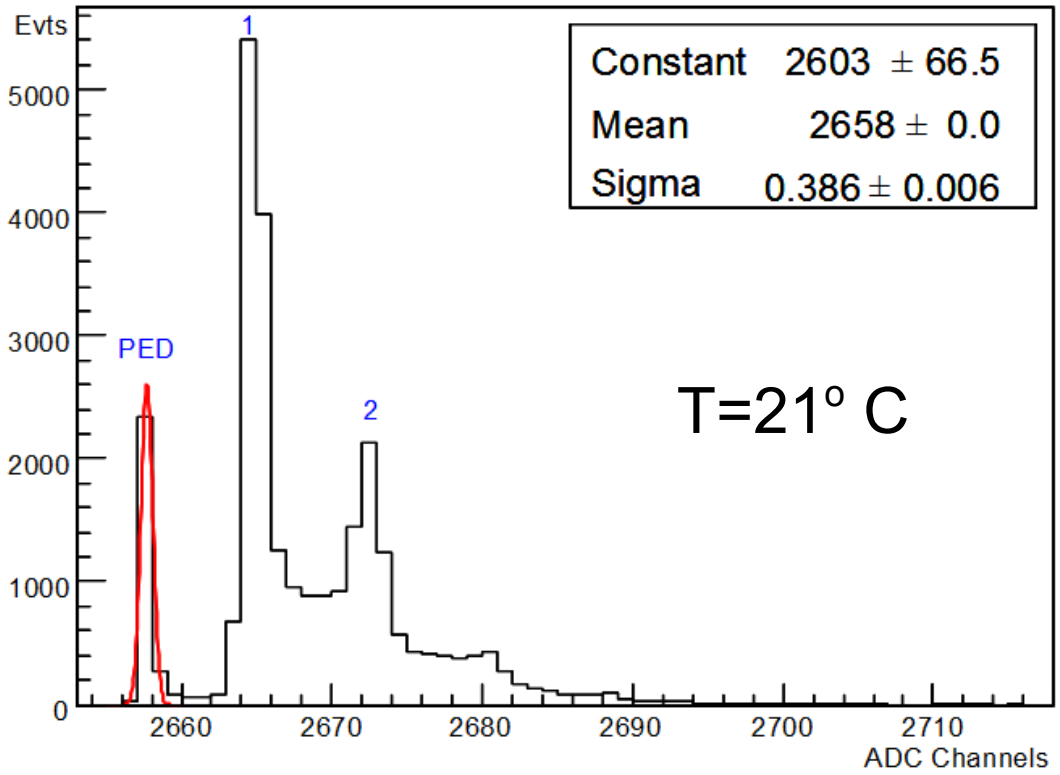
Test IFR scintillator bar



- Fermilab scintillator bar:
  - 250x40x10 mm^3
  - one straight groove on top
- WLS: Kuraray 1 mm diameter
  - glued inside the groove
  - not diamond cut
  - one end aluminized

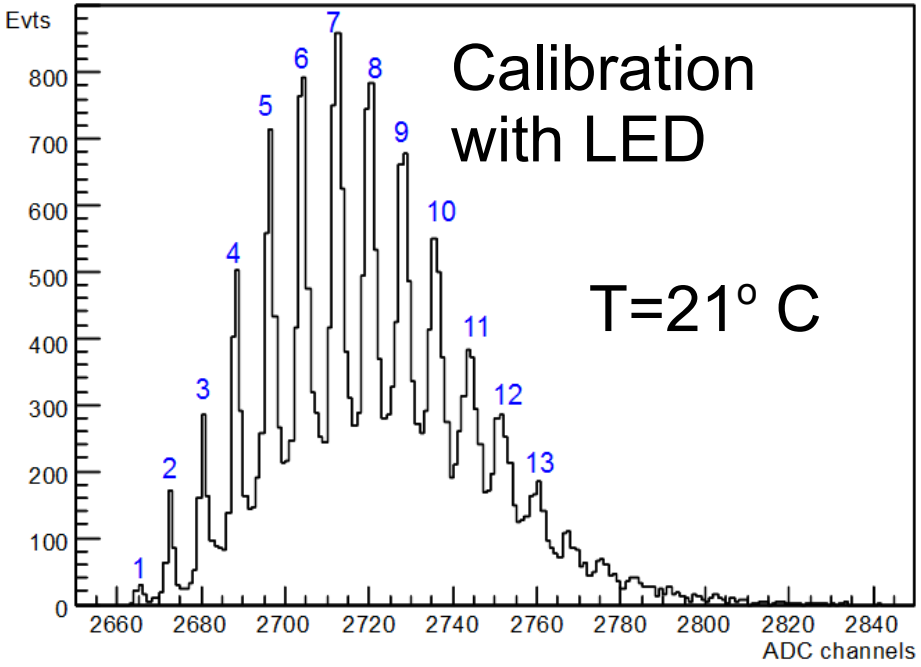
Caveat:
more attenuation is expected in longer bars !

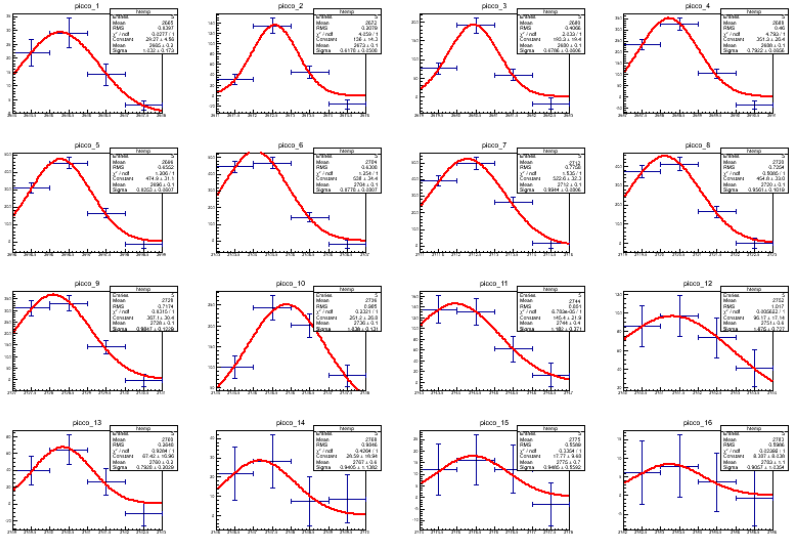
FBK-Bologna @ 32.5 V: dark noise



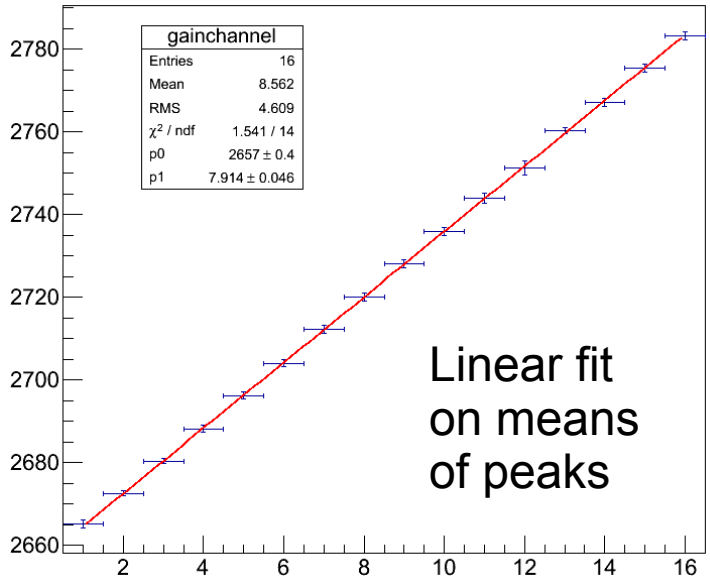
Pedestal = 2658 (ADC channels)

FBK-Bologna @ 32.5 V: gain





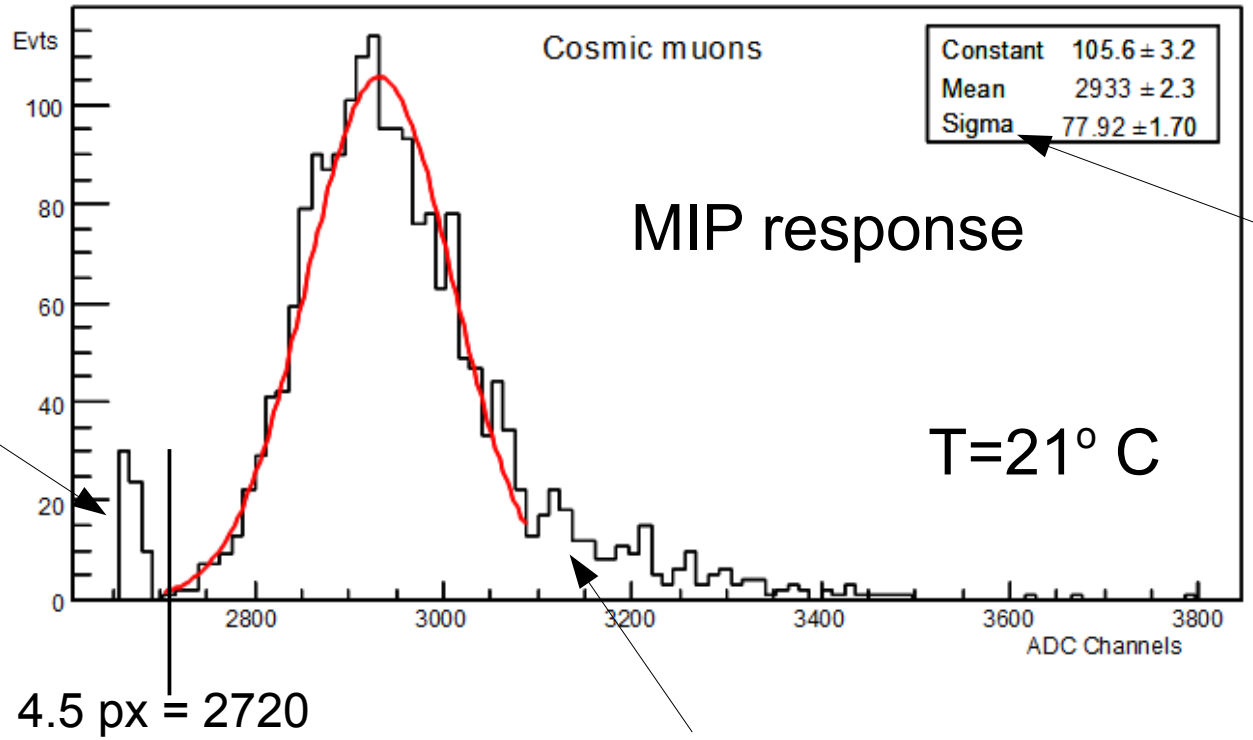
Gaussian fit on each peak

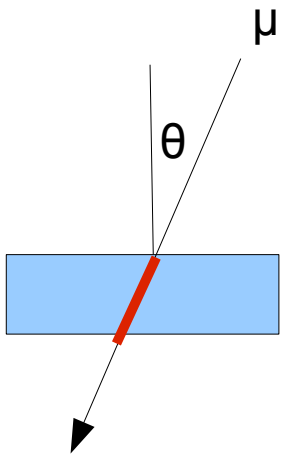


Gain = 7.9 (ADC channels)

FBK-Bologna @ 32.5 V: MIP response

Problem with trigger: muon not impinging on the bar



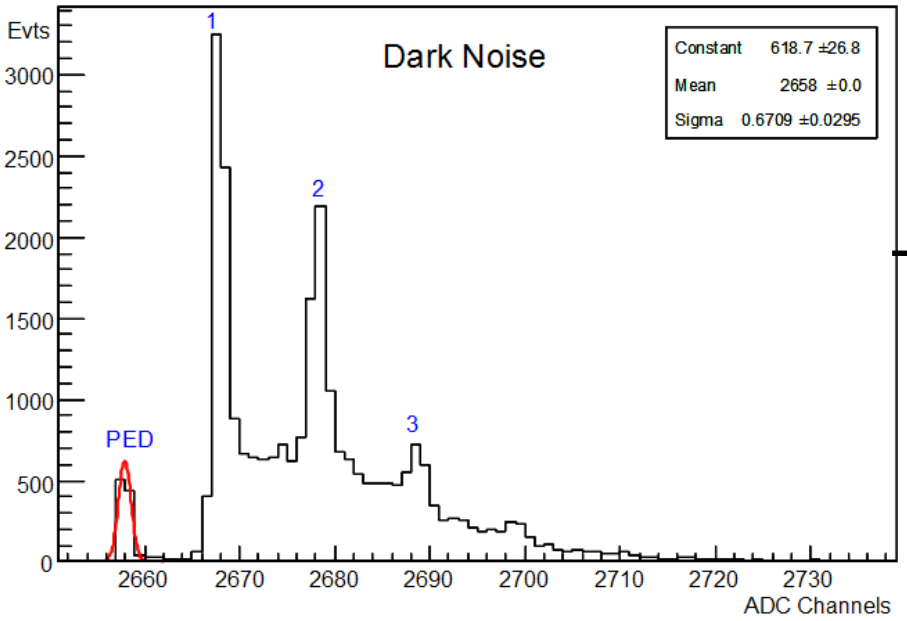


Path length depends on angle:broader distribution

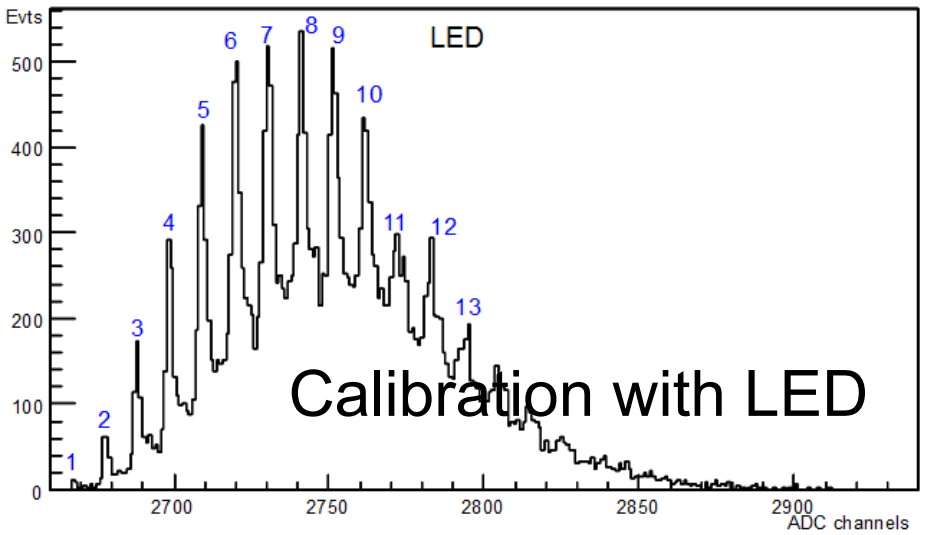
Fired pixels = detected photons + xtalk + afterpulses:

$$N_{px} = (2933-2658)/7.9 = 34.8$$

FBK-Bologna @ 33.5 V



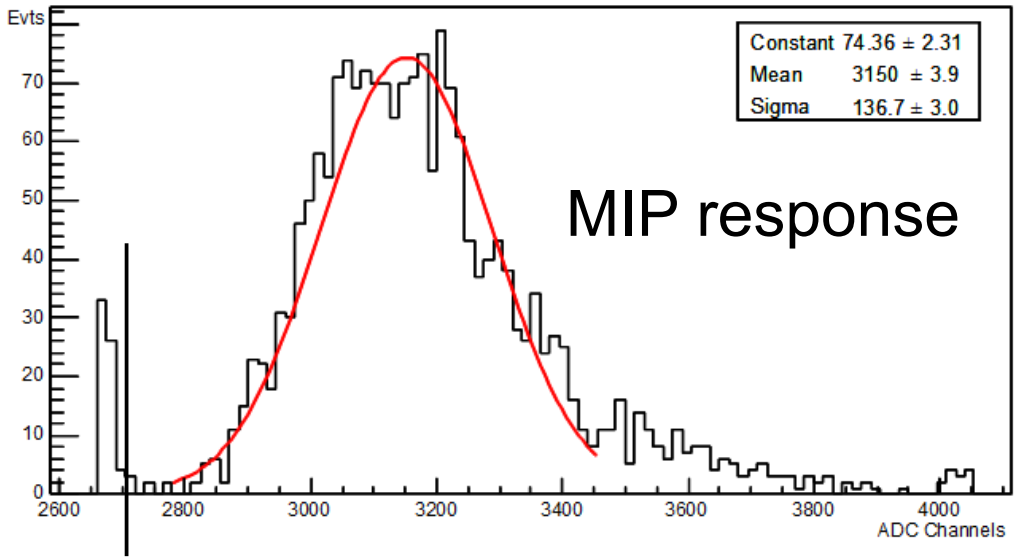
T=20° C



Calibration with LED

Fired pixels for a MIP:

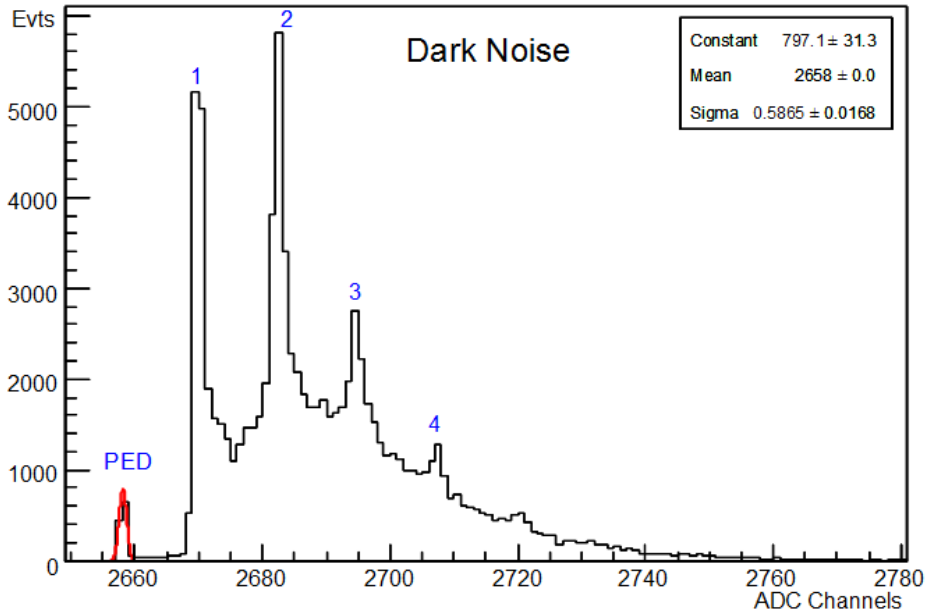
N_{px} =(3150-2658)/10.5 = 47



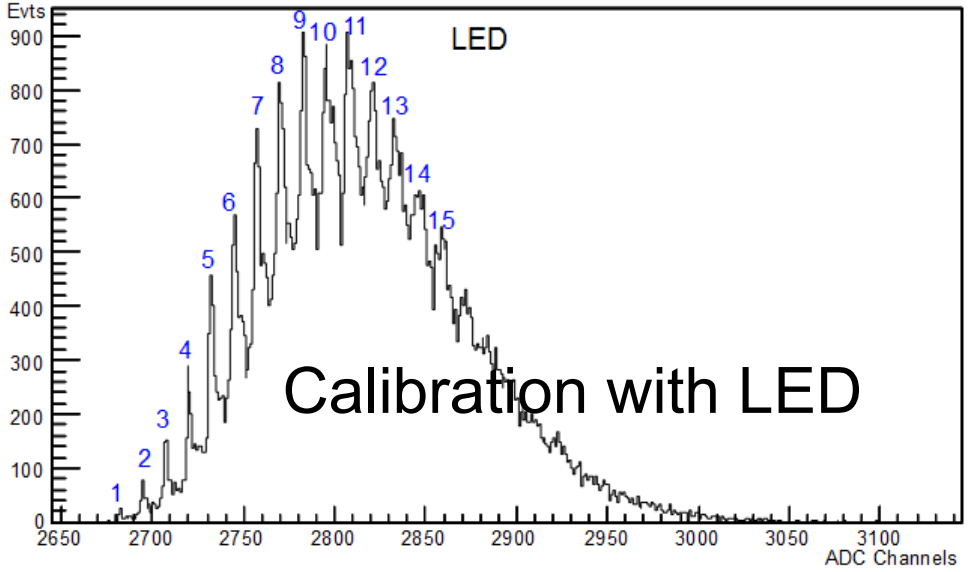
MIP response

4.5 px = 2705

FBK-Bologna @ 34.5 V

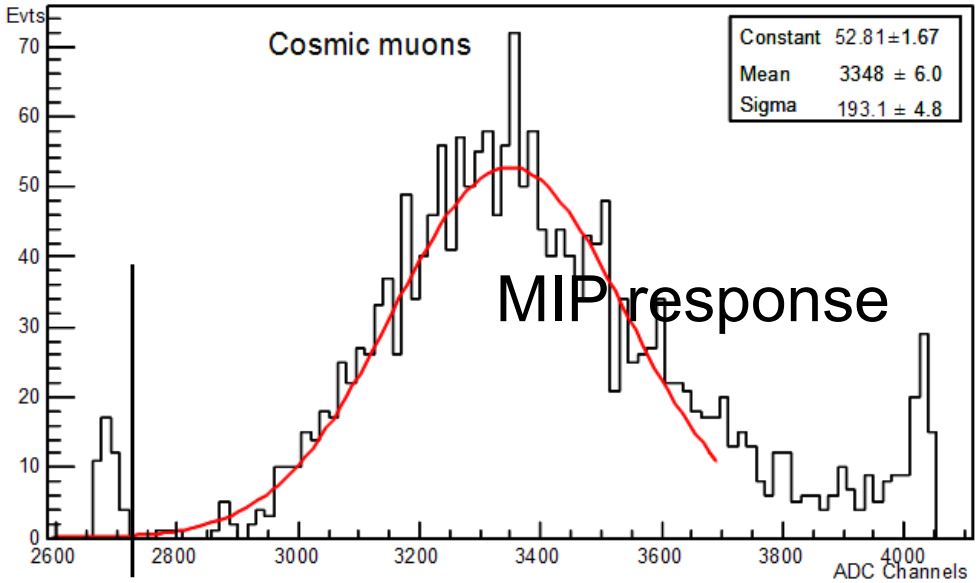


T=21° C



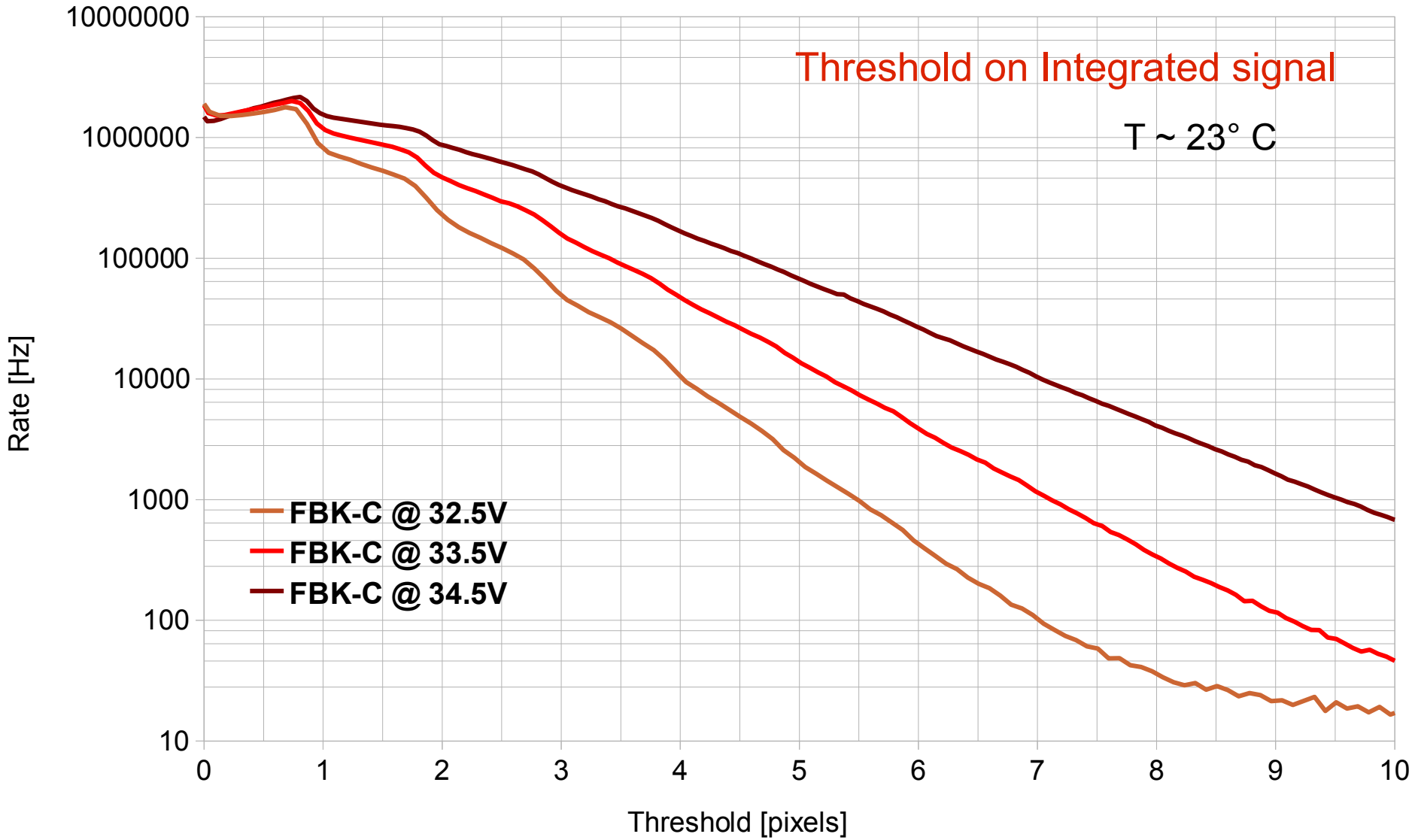
Fired pixels for a MIP:

N_{px} =(3348-2658)/12.7 = 54



4.5 px = 2705

Noise rate: FBK 2008



Summary

SiPM @ Bias	MIP response	Noise Rate (≥ 0.5 px)	Noise Rate (≥ 4.5 px)
FBK @ 32.5 V	35 px/μ	1.6 MHz	4.8 kHz
FBK @ 33.5 V	47 px/μ	1.7 MHz	25 kHz
FBK @ 34.5 V	54 px/μ	1.8 MHz	110 kHz

Notes:
- MIP response include contributions from cross talk and afterpulse
- Noise rates on integrated signal (70 ns)

Part 1: conclusion

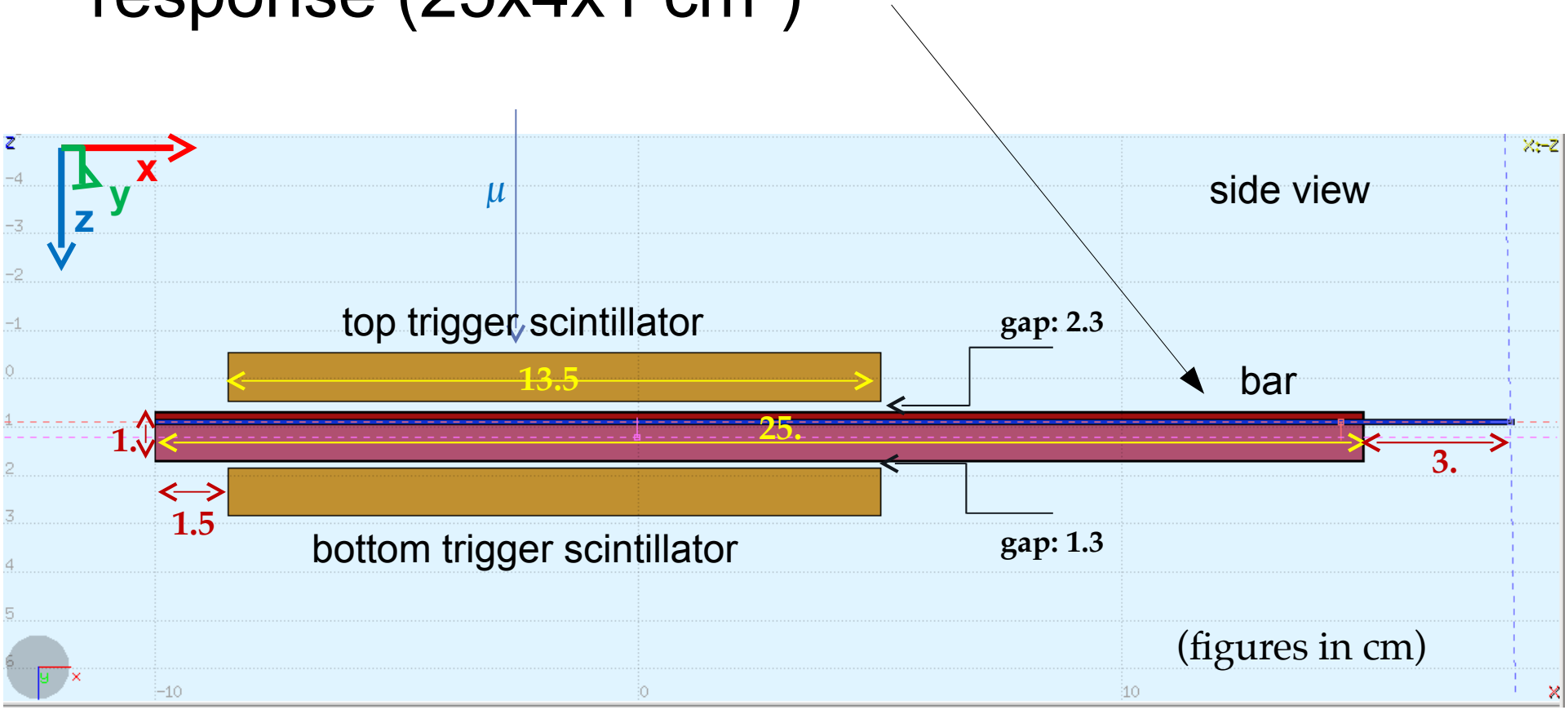
- Good performance of old (2008) FBK 50 μm
- On a short scintillator bar light detection is very satisfactory: but need to study on longer bars with full light collection chain !
- Dark count rate ~ 25 kHz at ≥ 4.5 pixels threshold (corresponding to a MIP efficiency ≥ 99 %)
- Need to study total irradiation dose effects on dark count rate
- Need to study long term stability of devices

Part 2: introduction

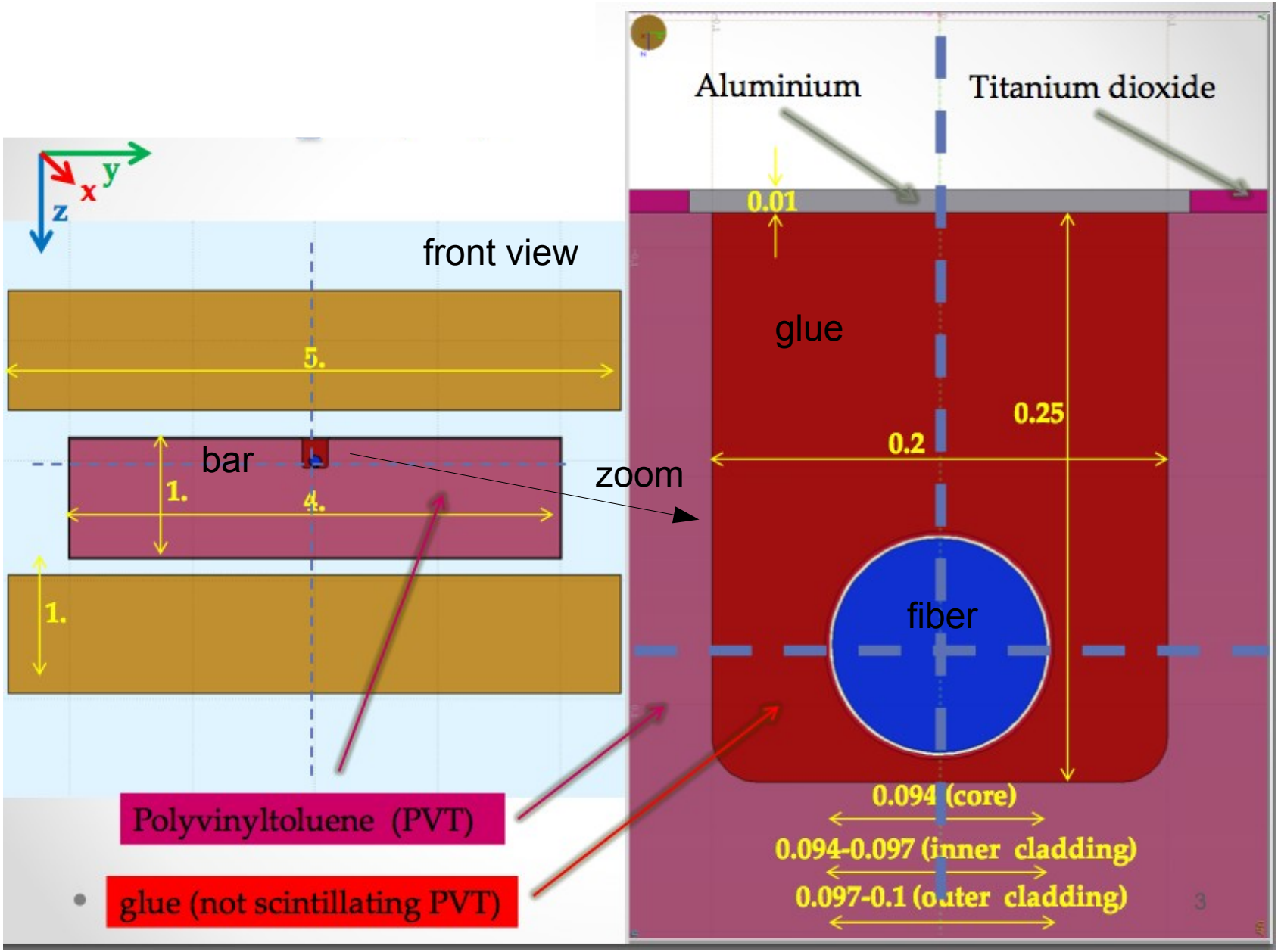
- setup a detailed simulation of light production, propagation and detection in a prototype of a scintillator bar (FLUKA)
- cross check expected results from simulation with data collected from a real prototype: tune simulation free/unknown parameters
- use simulation setup to study different geometries and optical couplings
- still preliminary results..

Prototype setup

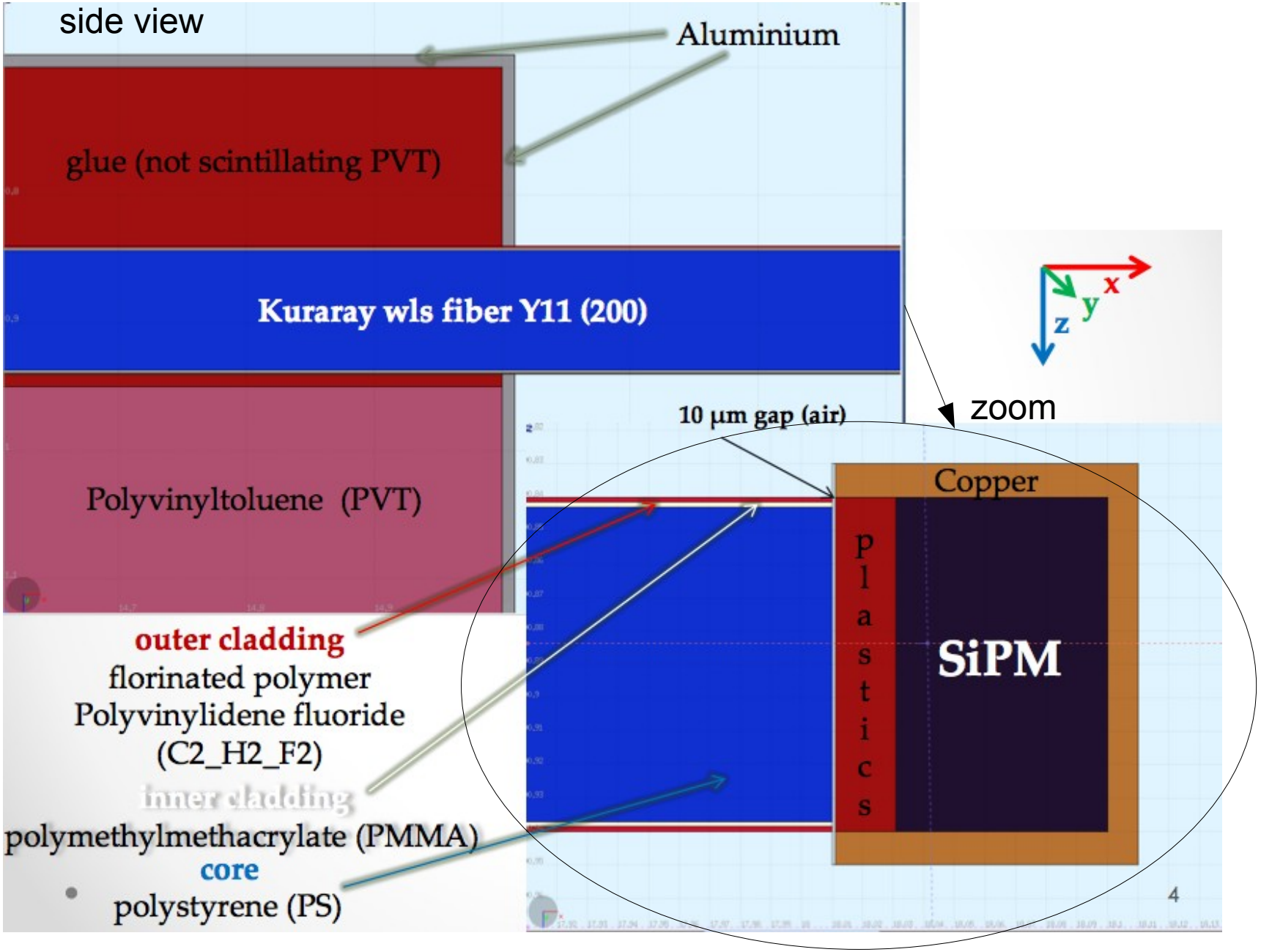
- use FLUKA (version 2011.2.10)
- simulation of bar prototype used to test MIP response (25x4x1 cm^3)



Prototype setup

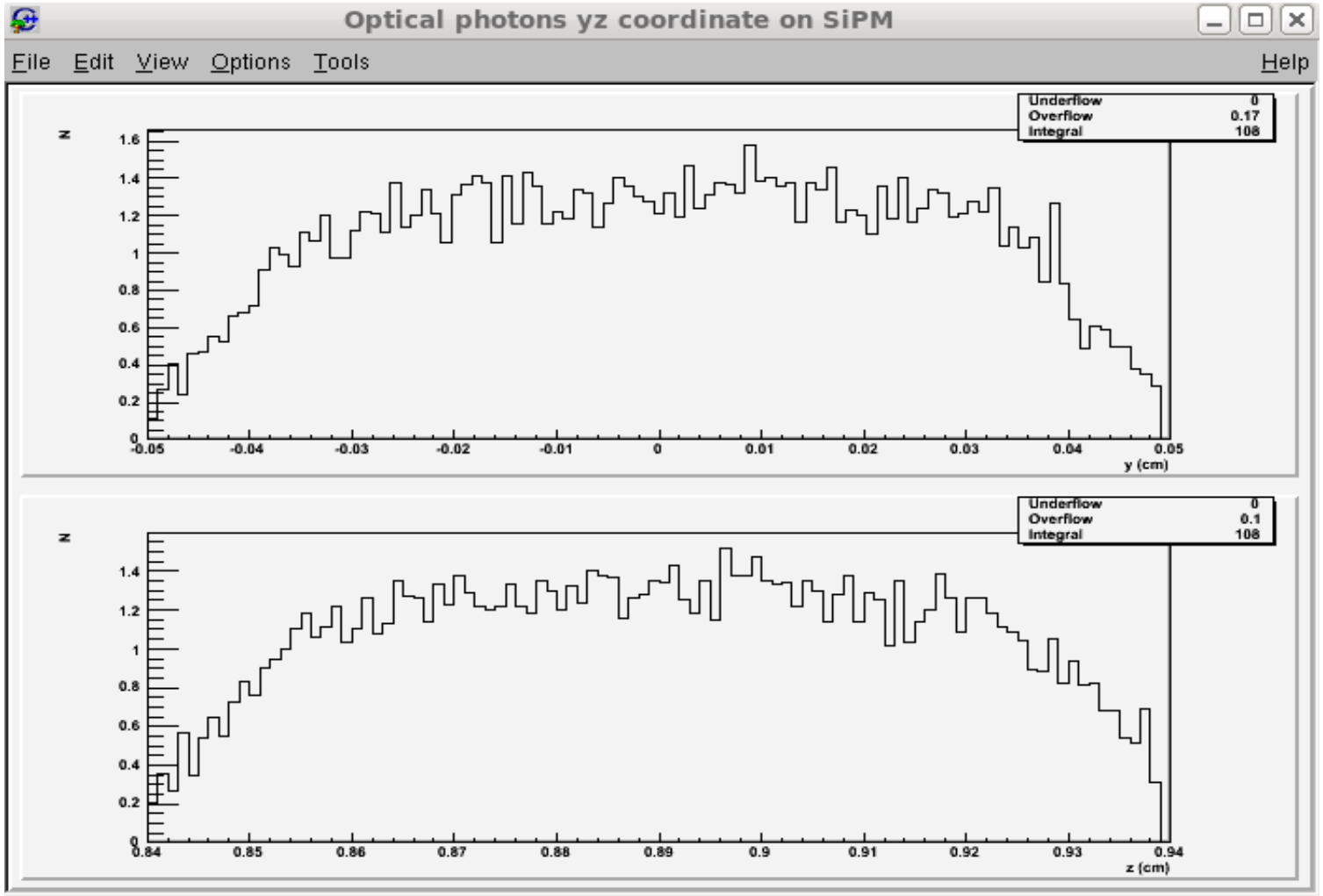


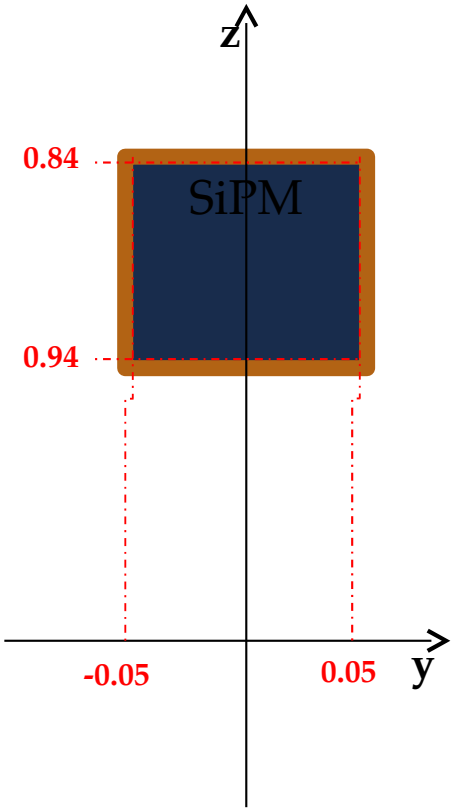
Prototype setup



Photons at fiber output

- More density in fiber core:
  - SiPM allignment less critical..

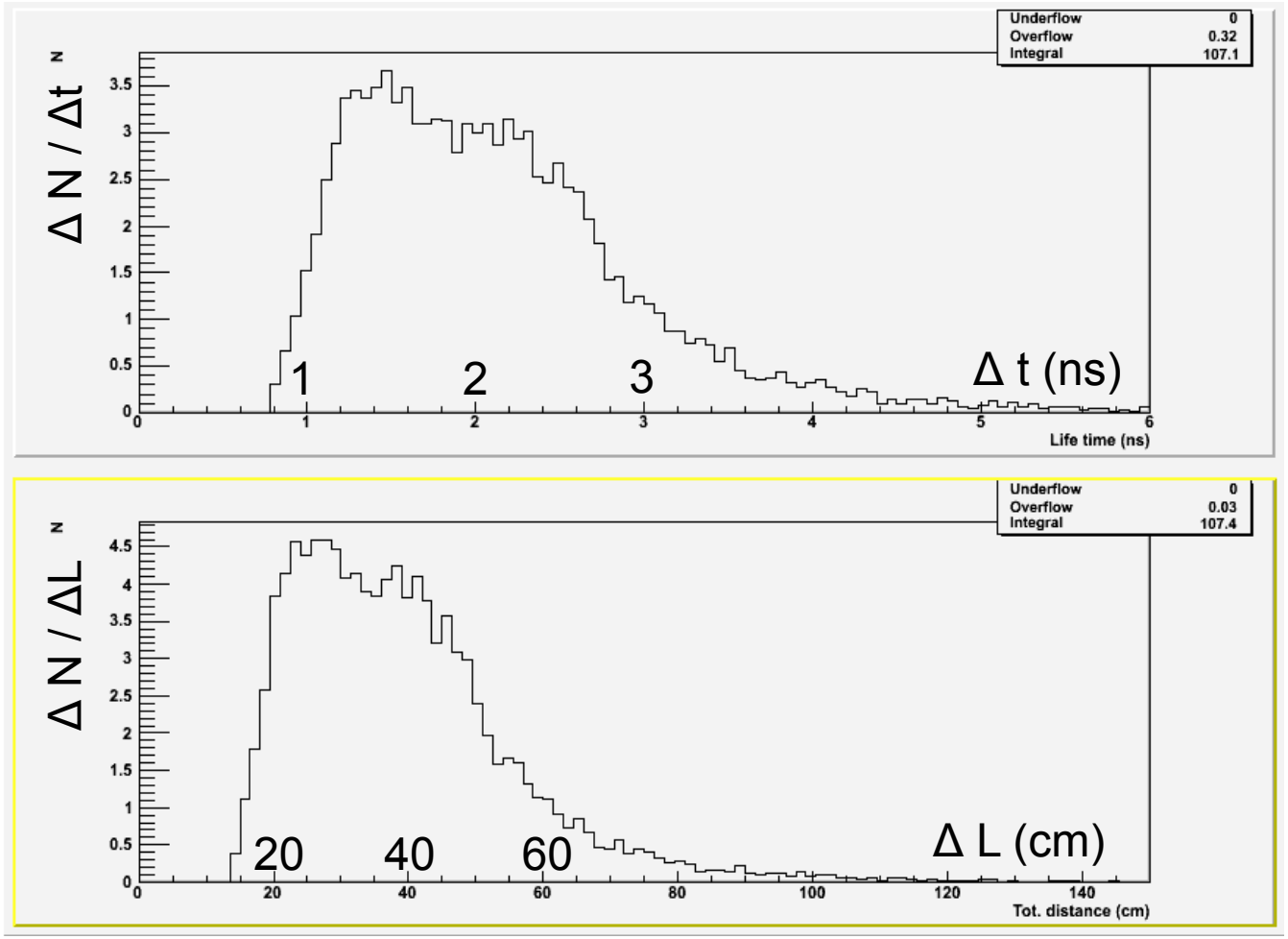




19

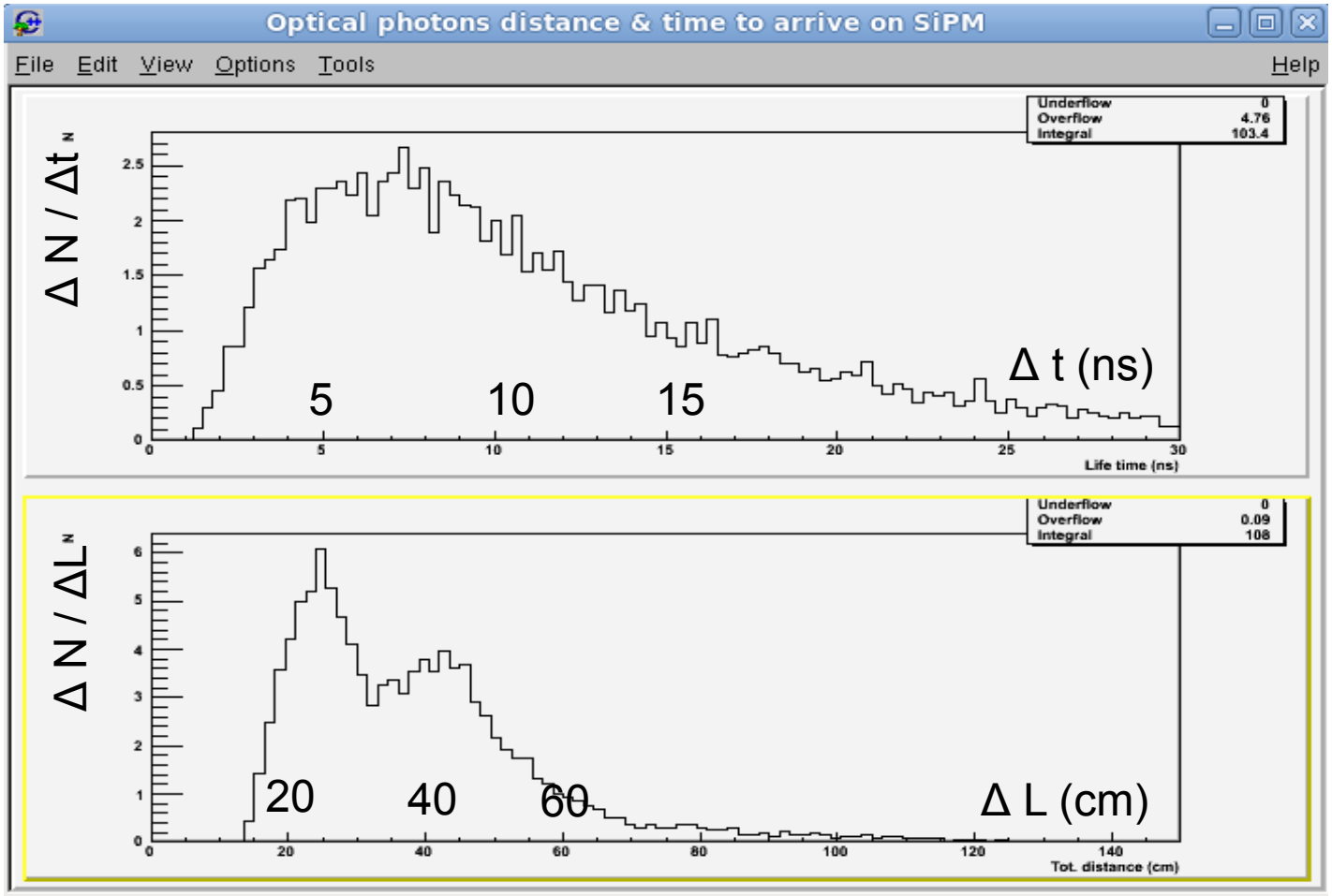
Photons arrival times

- If scintillator and WLS fiber decay times are NOT simulated:



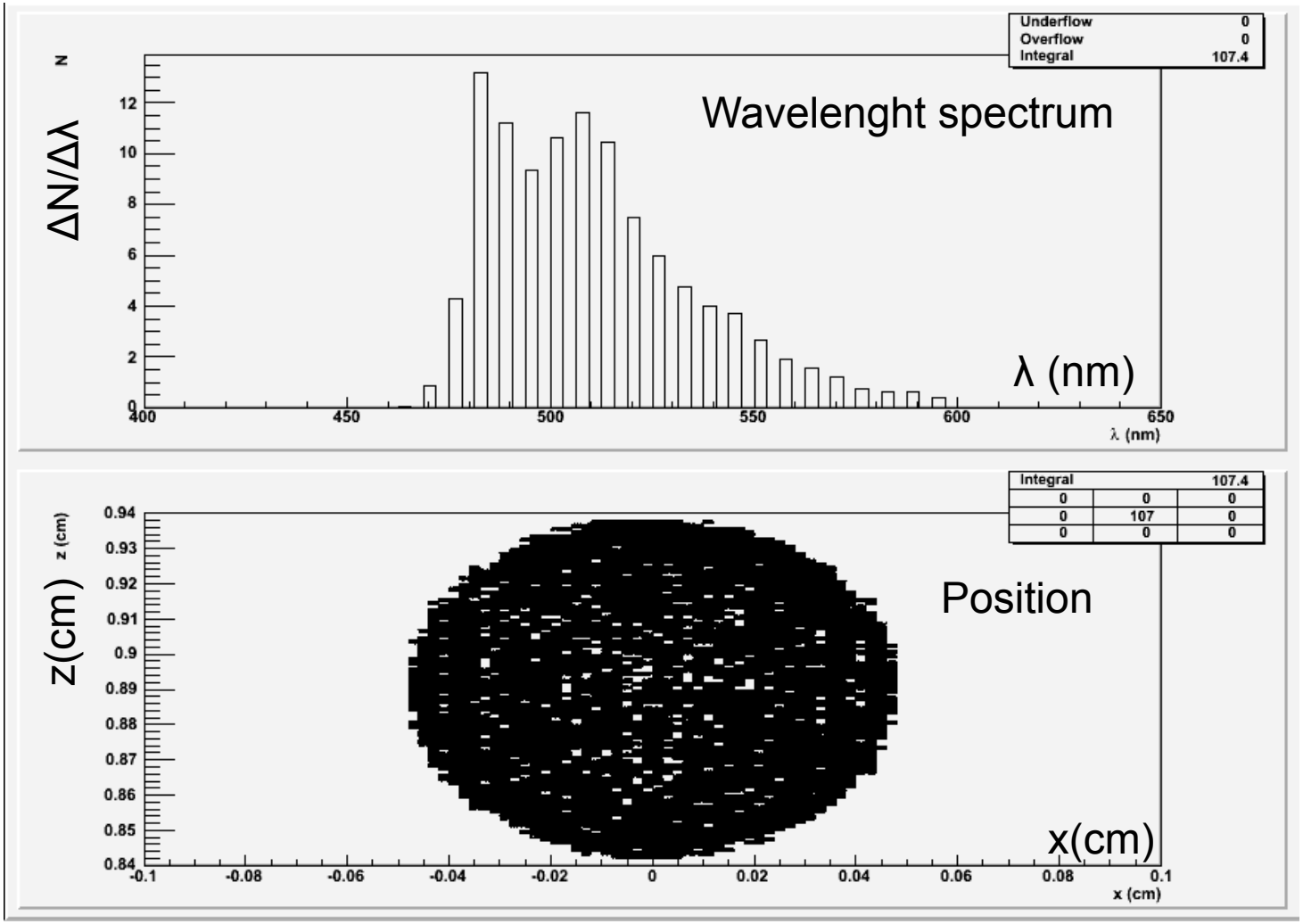
Photons arrival times

- Adding decay times simulation:
  - scintillator: τ = 2 ns
  - WLS fiber: τ = 7.5 ns



Photons detected by SiPM

- About 100 detected photons/MIP
  - simulation not yet tuned



Part 2: conclusion

- First version of simulation was setup
- Not yet tuned through cross check with data
- O(100) detected photons:
  - not too far from real data...promising !