BATATA: Buried Array Telescope AT Auger

An experimental characterization of the potential AMIGA muon signal contamination due to punch-through

+

AMIGA scintillators and electronics prototyping

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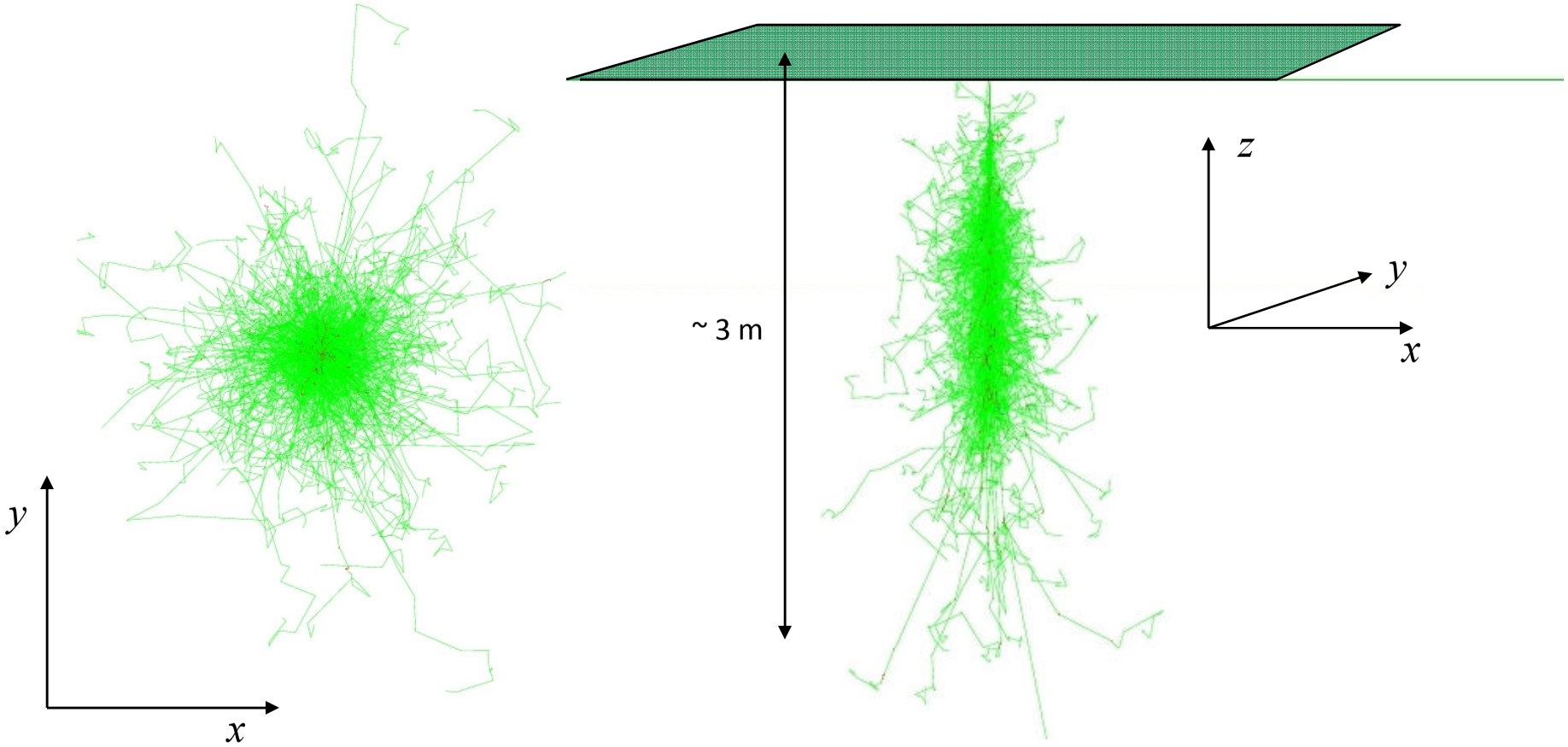
Humberto Salazar Ibargüen
Luis Manuel Villaseñor

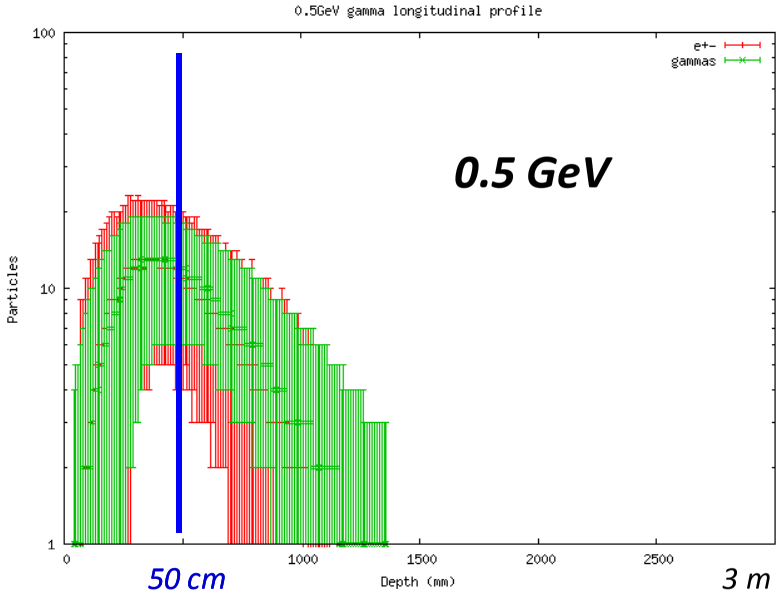
Geant4 – Parent: photon - $E_\gamma = 5$ GeV

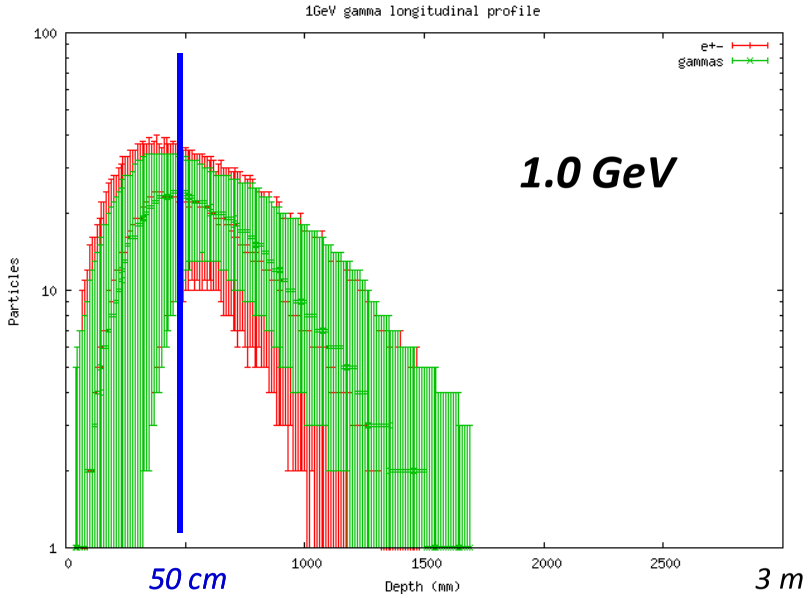
$\rho \sim 1.8$ g/cm³

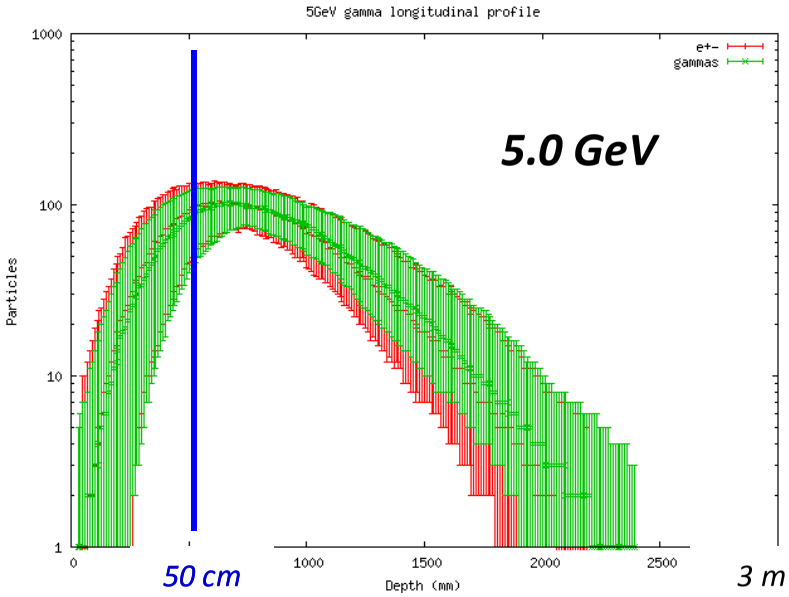


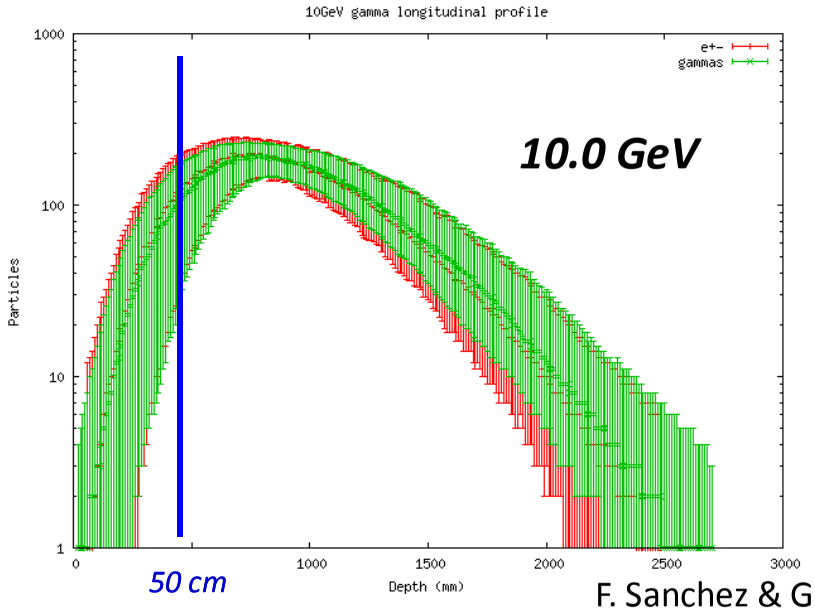
F. Sanchez & GMT

Geant4 – $\gamma/e^{+/-}$ Longitudinal profile





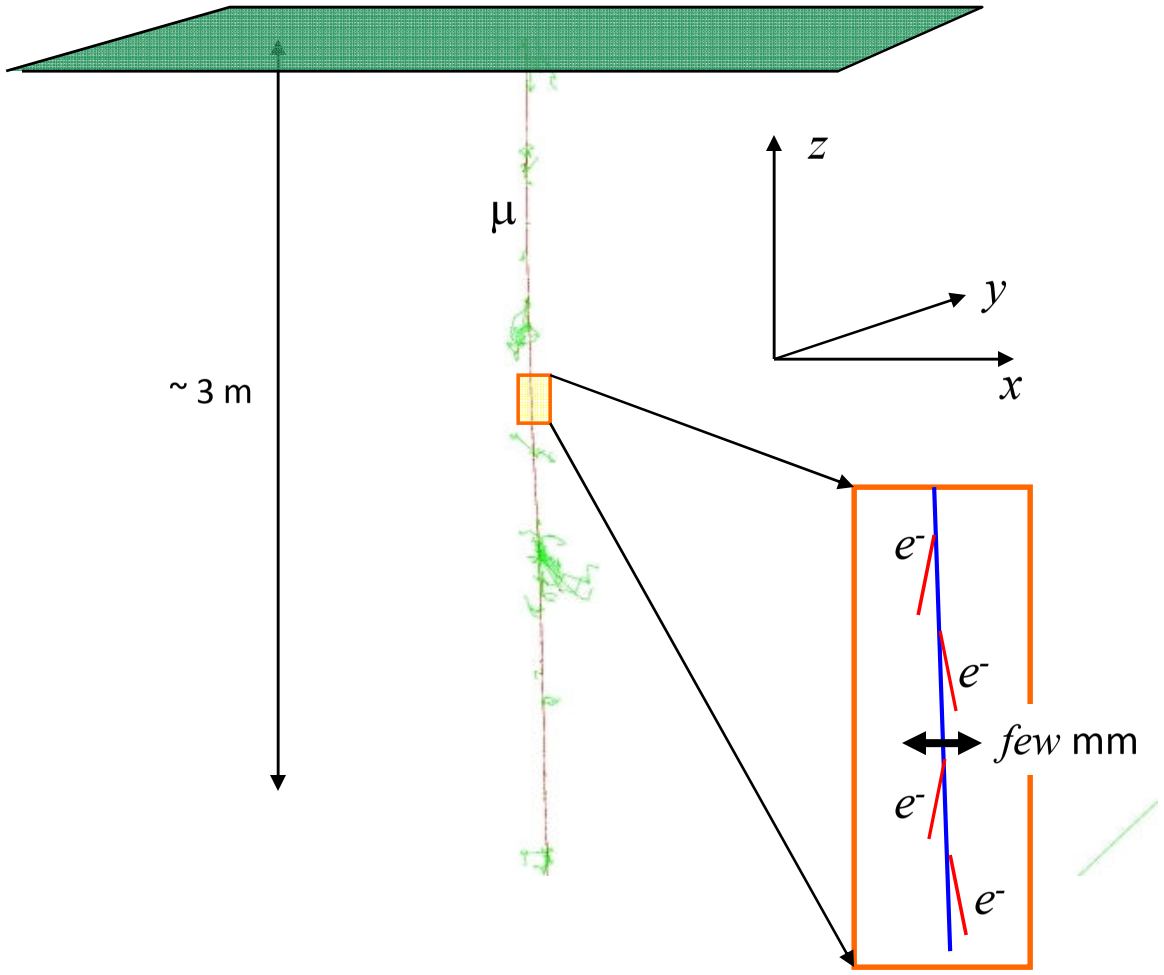




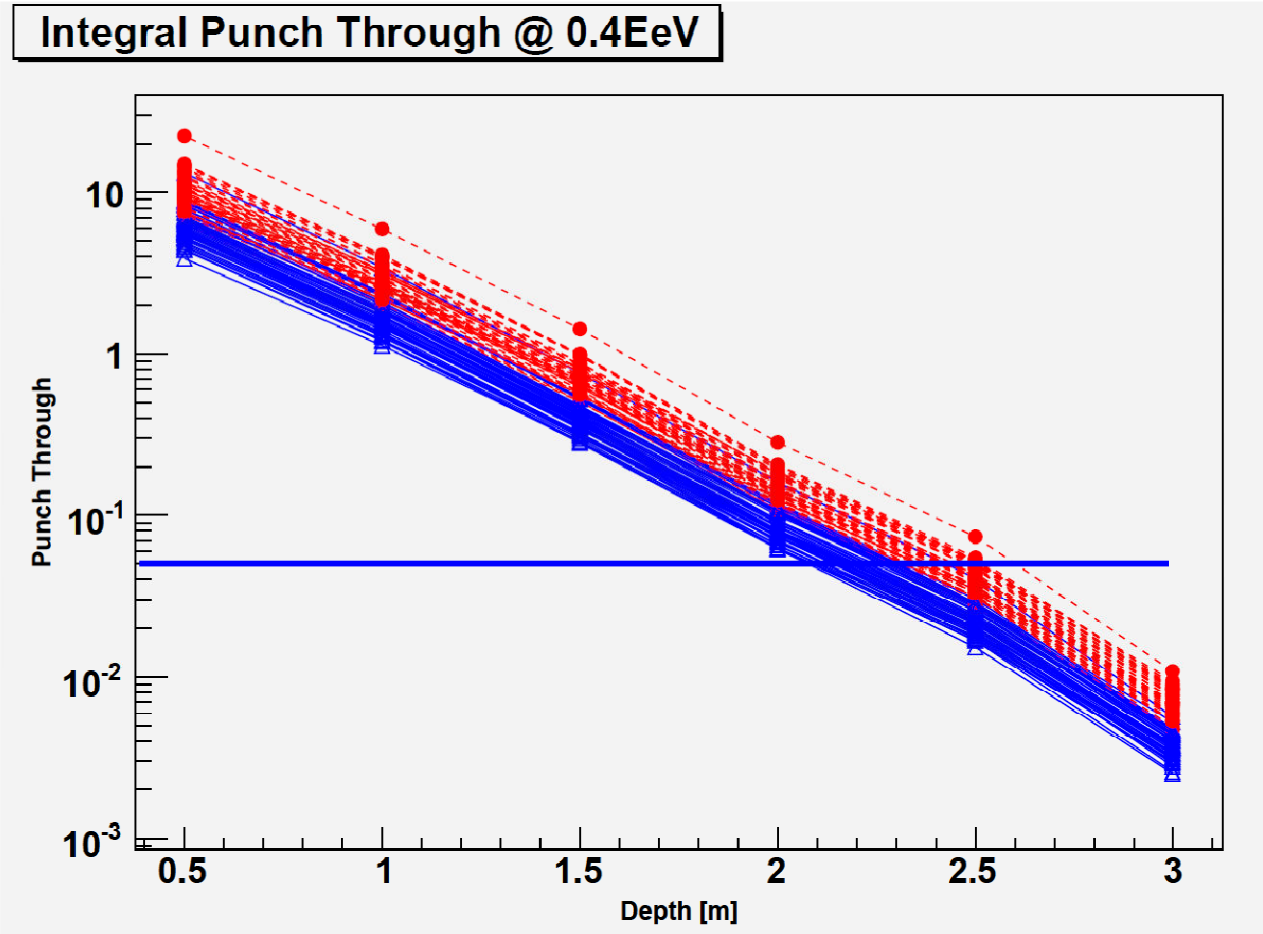
F. Sanchez & GMT

Geant4 – Parent: muon - $E_\mu = 5$ GeV

$\rho \sim 1.8$ g/cm³

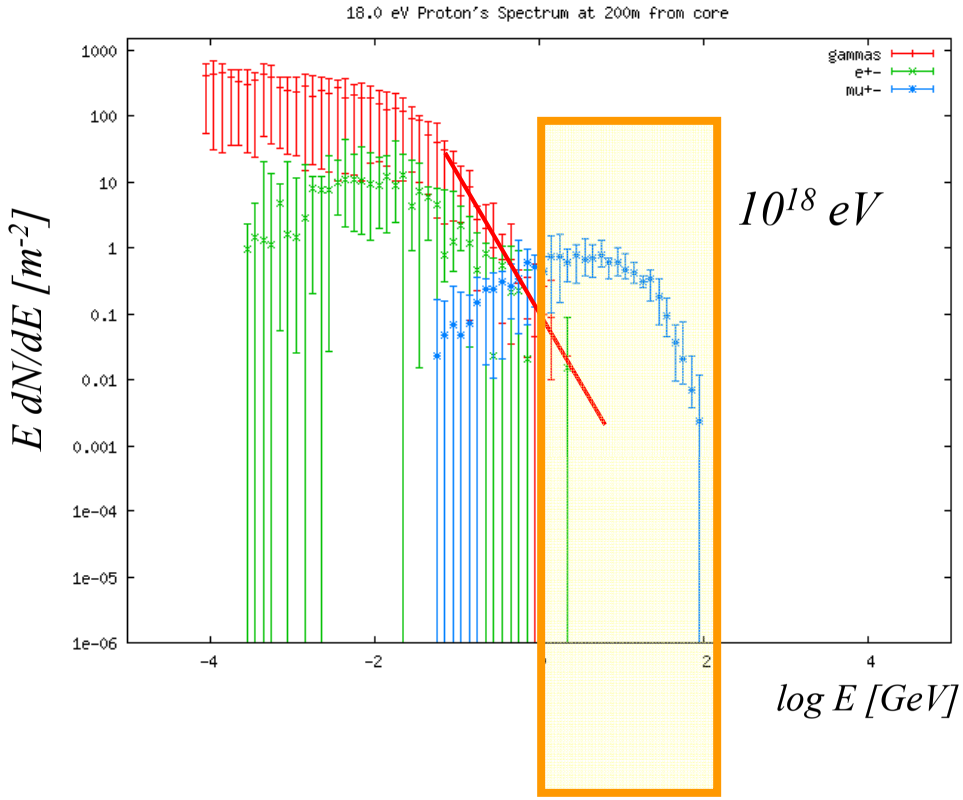


F. Sanchez & GMT



Punch through, *PT*(*D*), as a function of depth for showers of $10^{17:6}$ eV. The horizontal thick line indicates the limit of 5%. Each line correspond to a different air shower. The cases E_{min}^{dep} =0 keV (red, full circles joined by dashed lines) and E_{min}^{dep} =100 keV (blue, open triangles joined by solid lines) are shown.

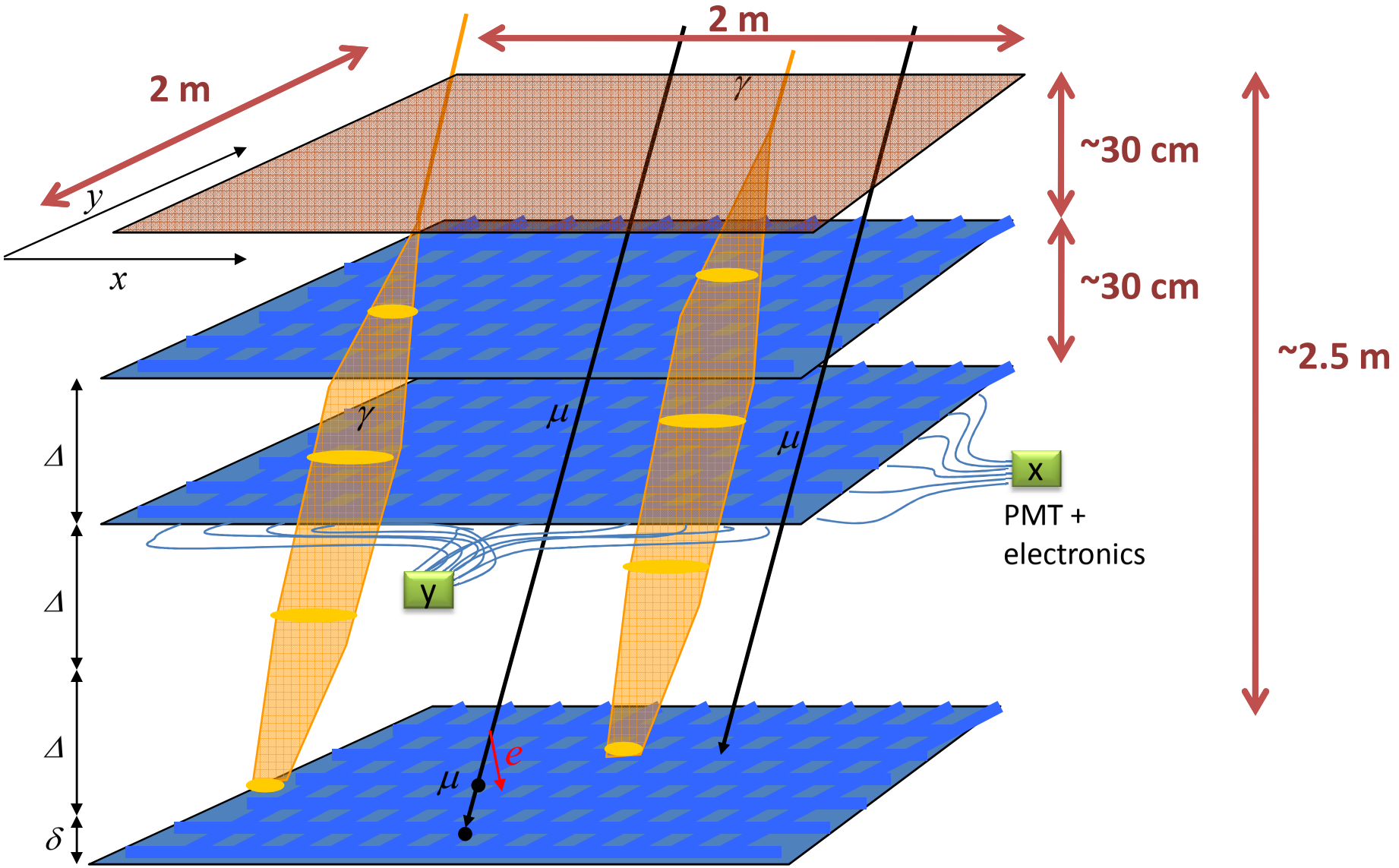
EeV protons: distribution functions @ 200 m from core



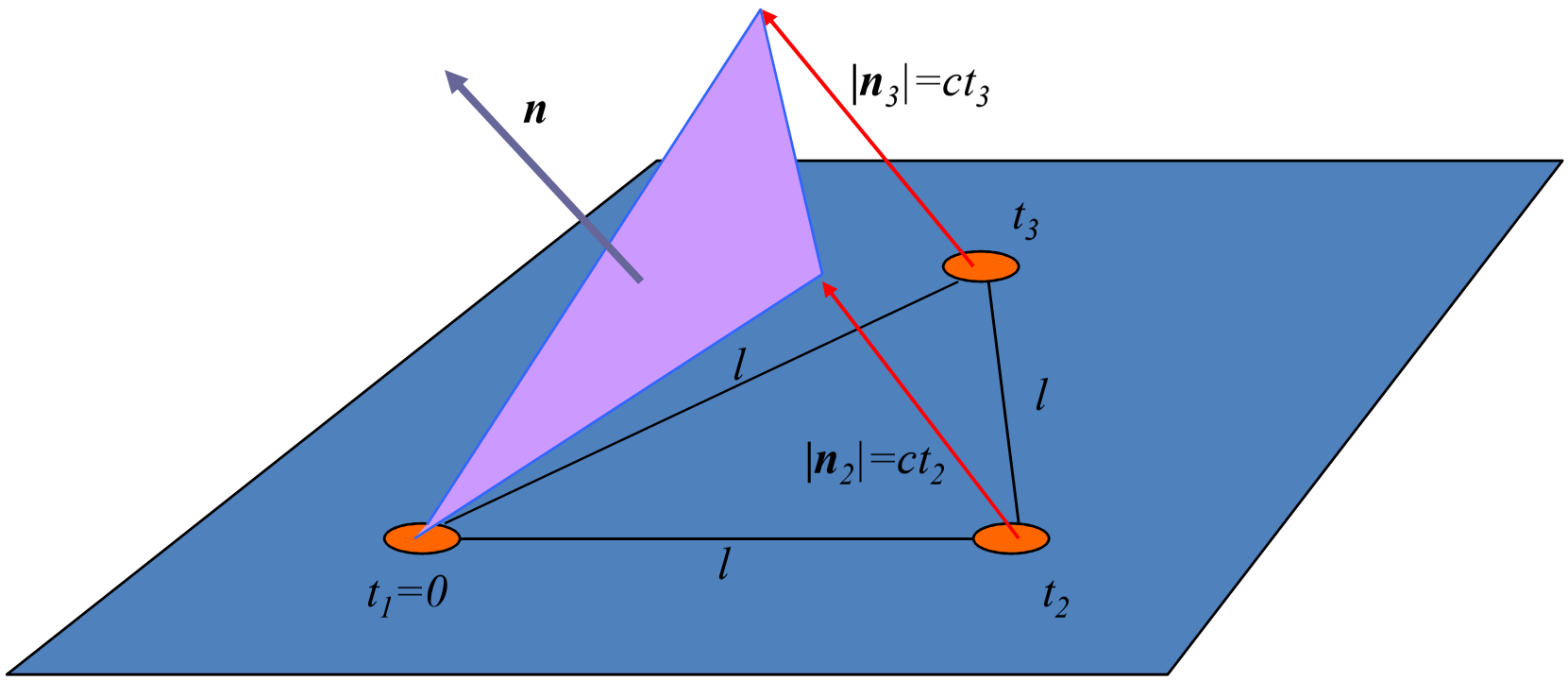
Region of interest for the shielded muon counters

Detector layout

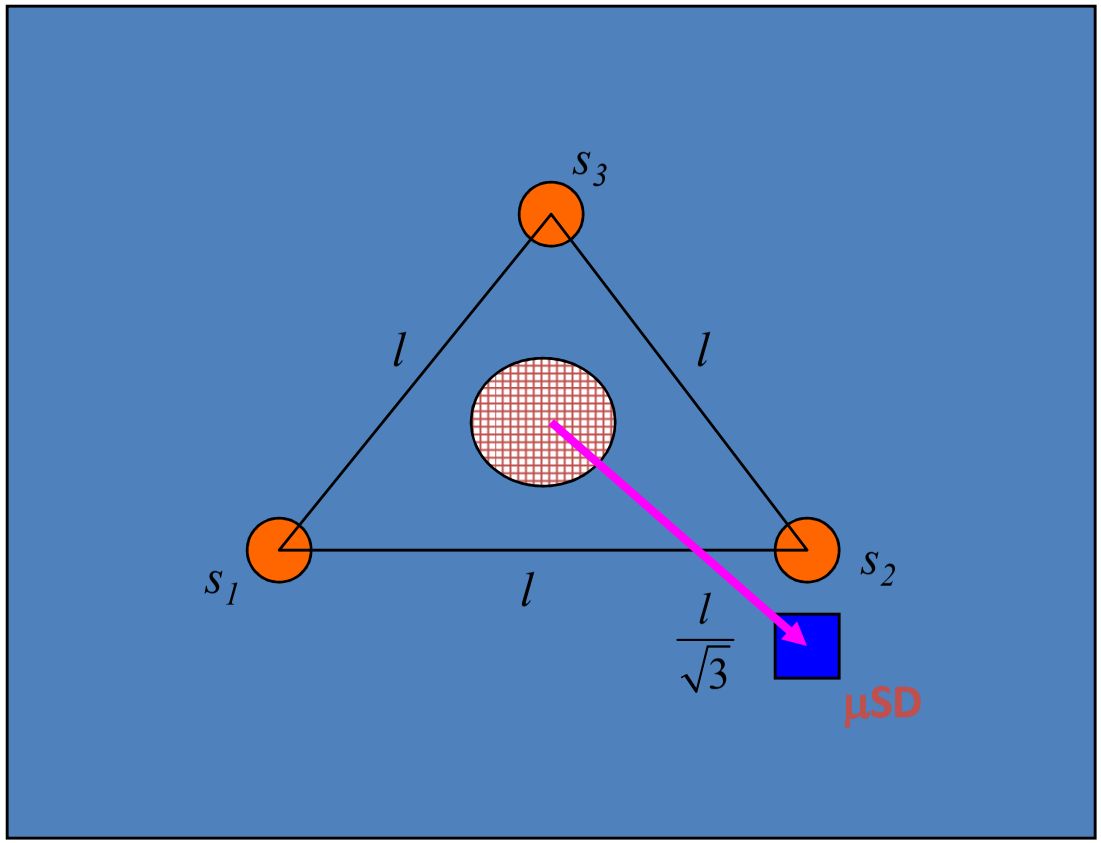
BATATA: PUNCH-THROUGH CHARACTERIZATION SYSTEM



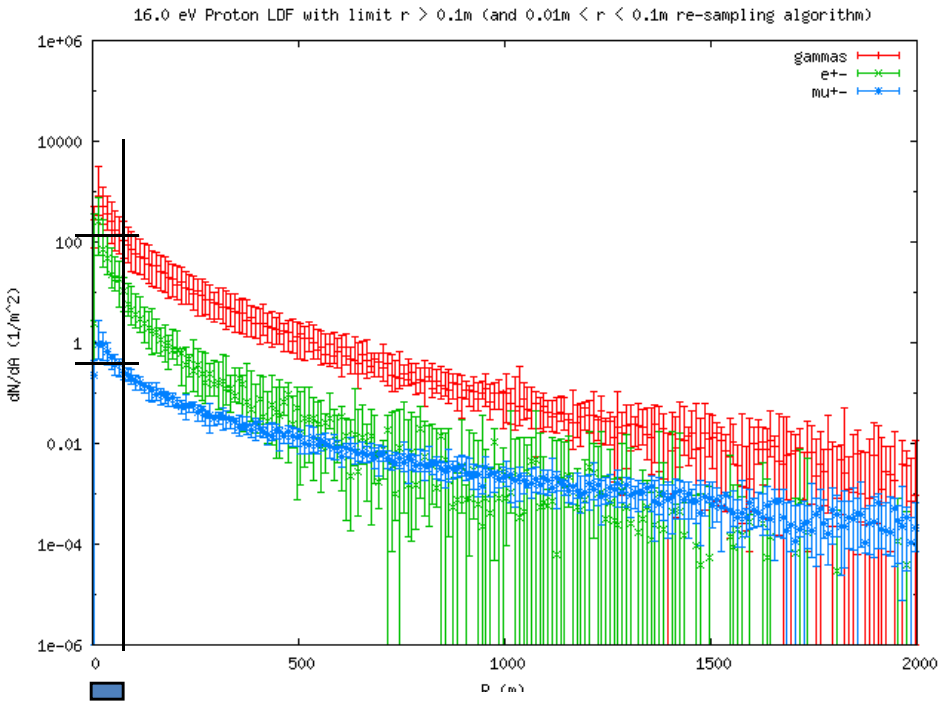
TRIGGER ARRAY

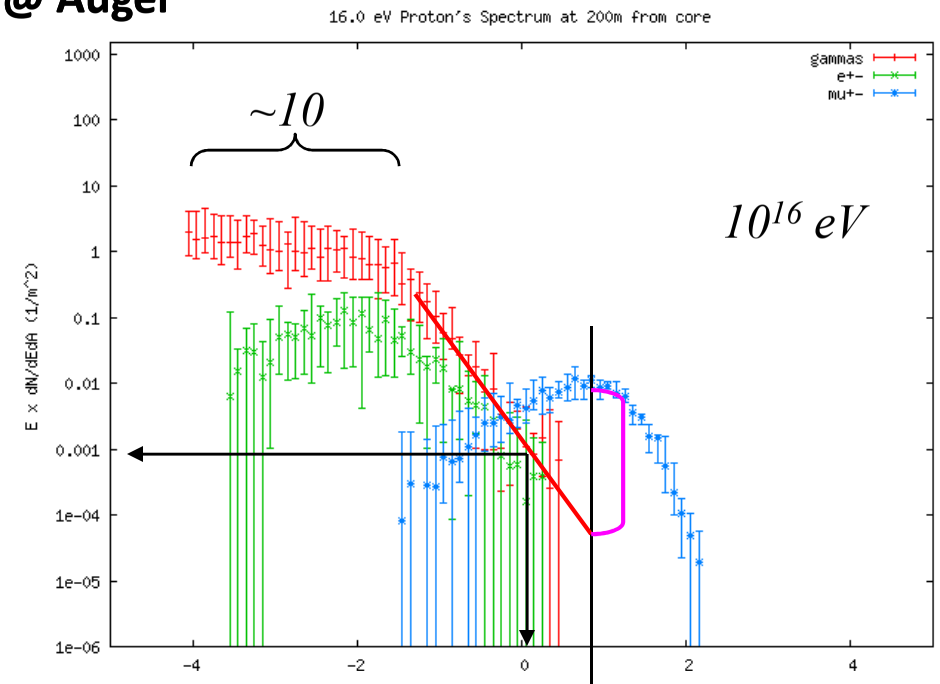


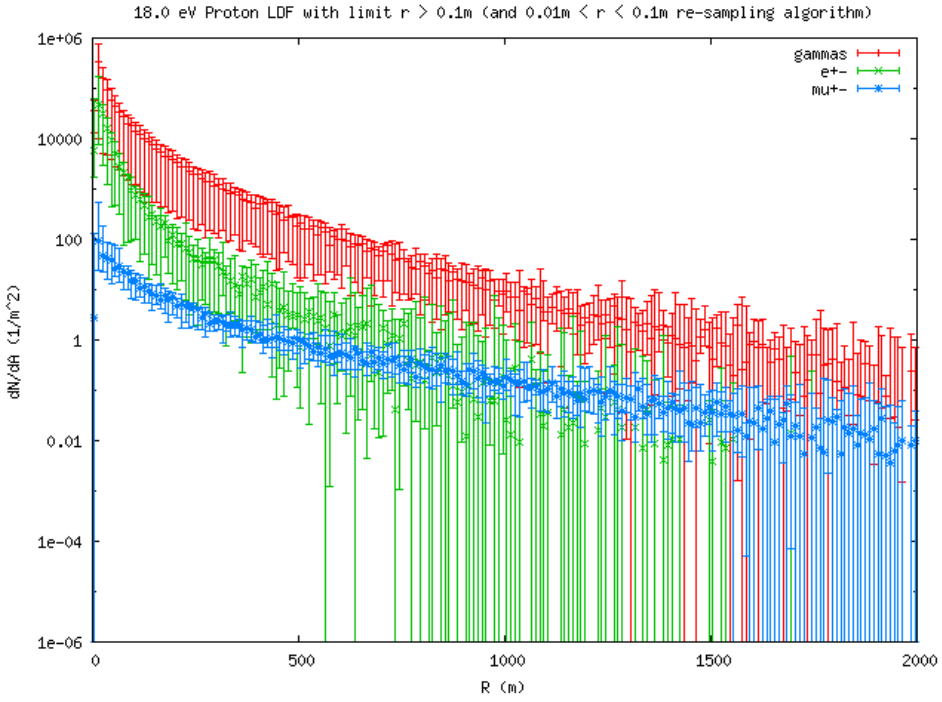
WHOLE BATATA ARRAY

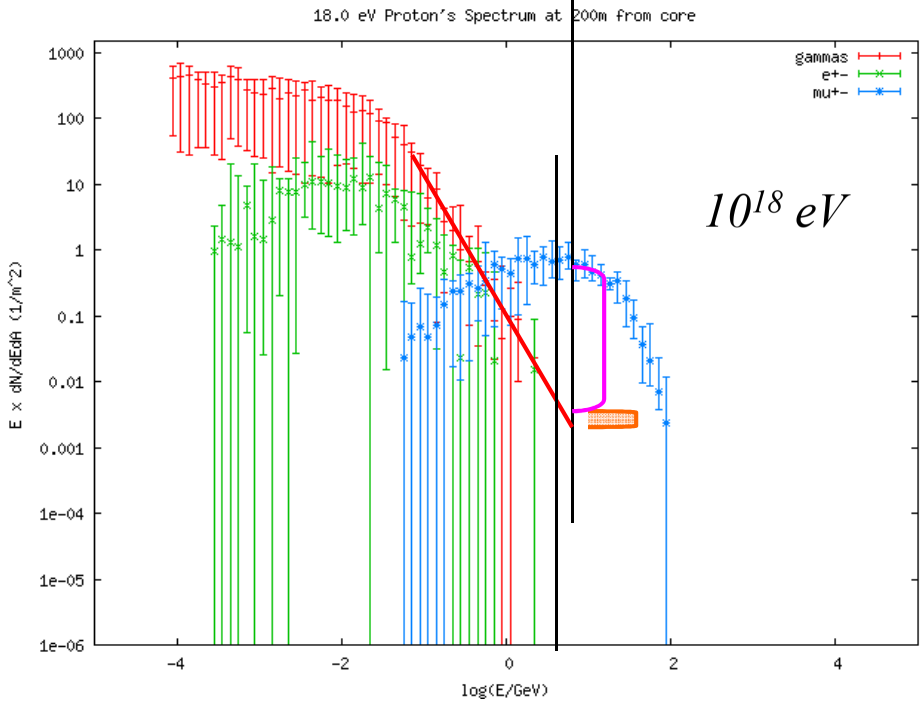


@ Auger


16.0 eV Proton LDF with limit r > 0.1m (and 0.01m < r < 0.1m re-sampling algorithm)
gammas
e+-
mu+-
dN/dA (1/m^2)
R (m)

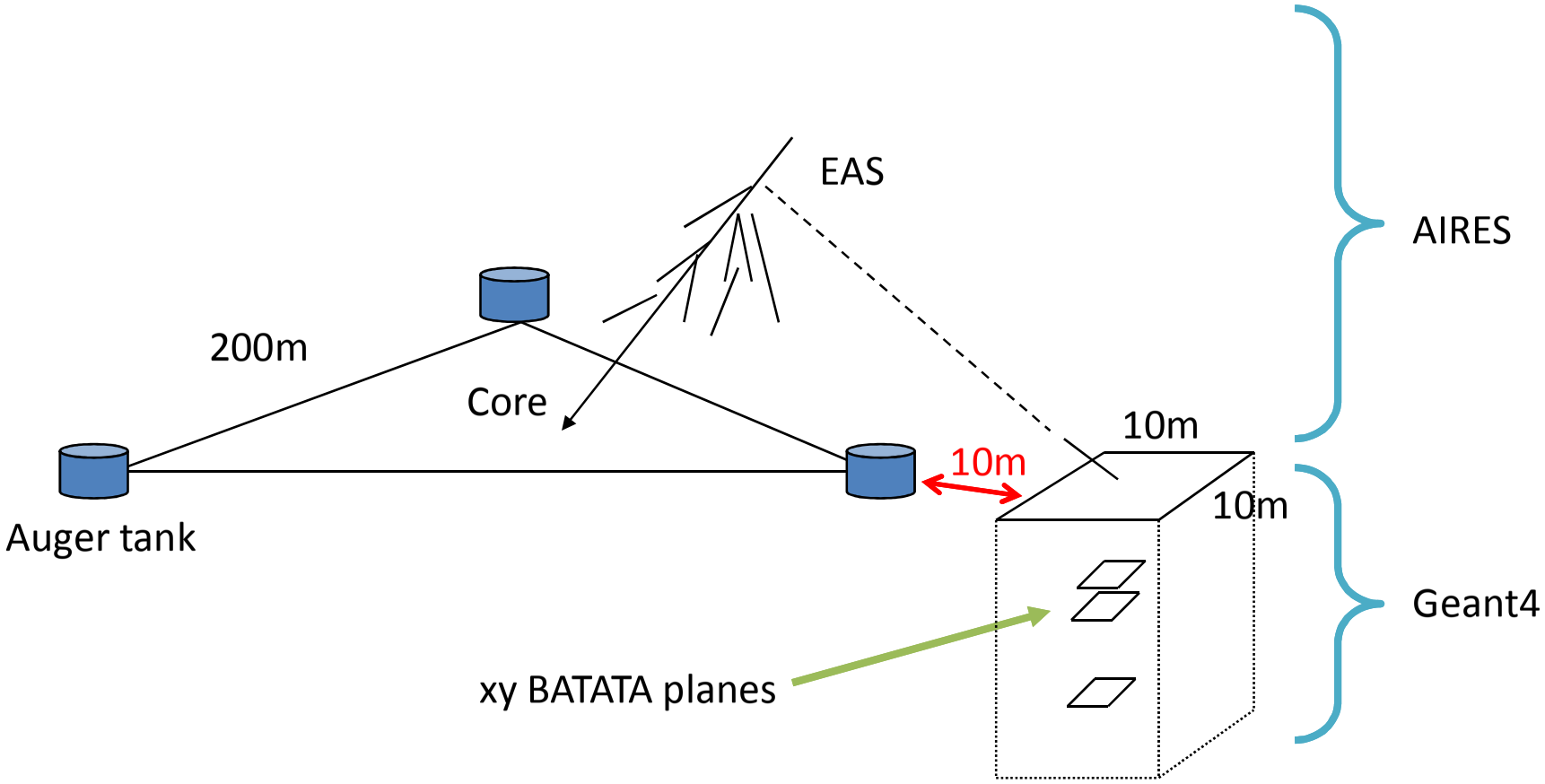

16.0 eV Proton's Spectrum at 200m from core
~10
10^{16} eV
gammas
e+-
mu+-
E x dN/dEdA (1/m^2)


18.0 eV Proton LDF with limit r > 0.1m (and 0.01m < r < 0.1m re-sampling algorithm)
gammas
e+-
mu+-
dN/dA (1/m^2)
R (m)

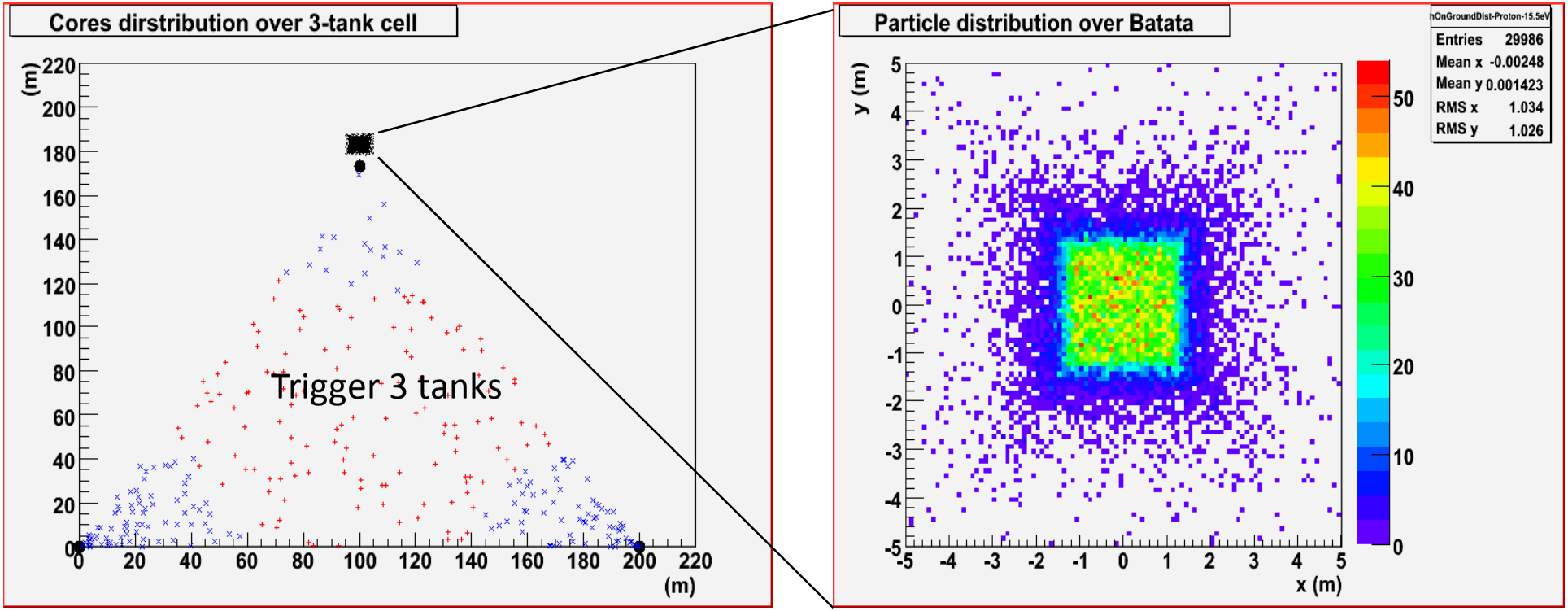

18.0 eV Proton's Spectrum at 200m from core
10^{18} eV
gammas
e+-
mu+-
E x dN/dEdA (1/m^2)
log(E/GeV)

End-to-end simulation

End-to-end BATATA simulations

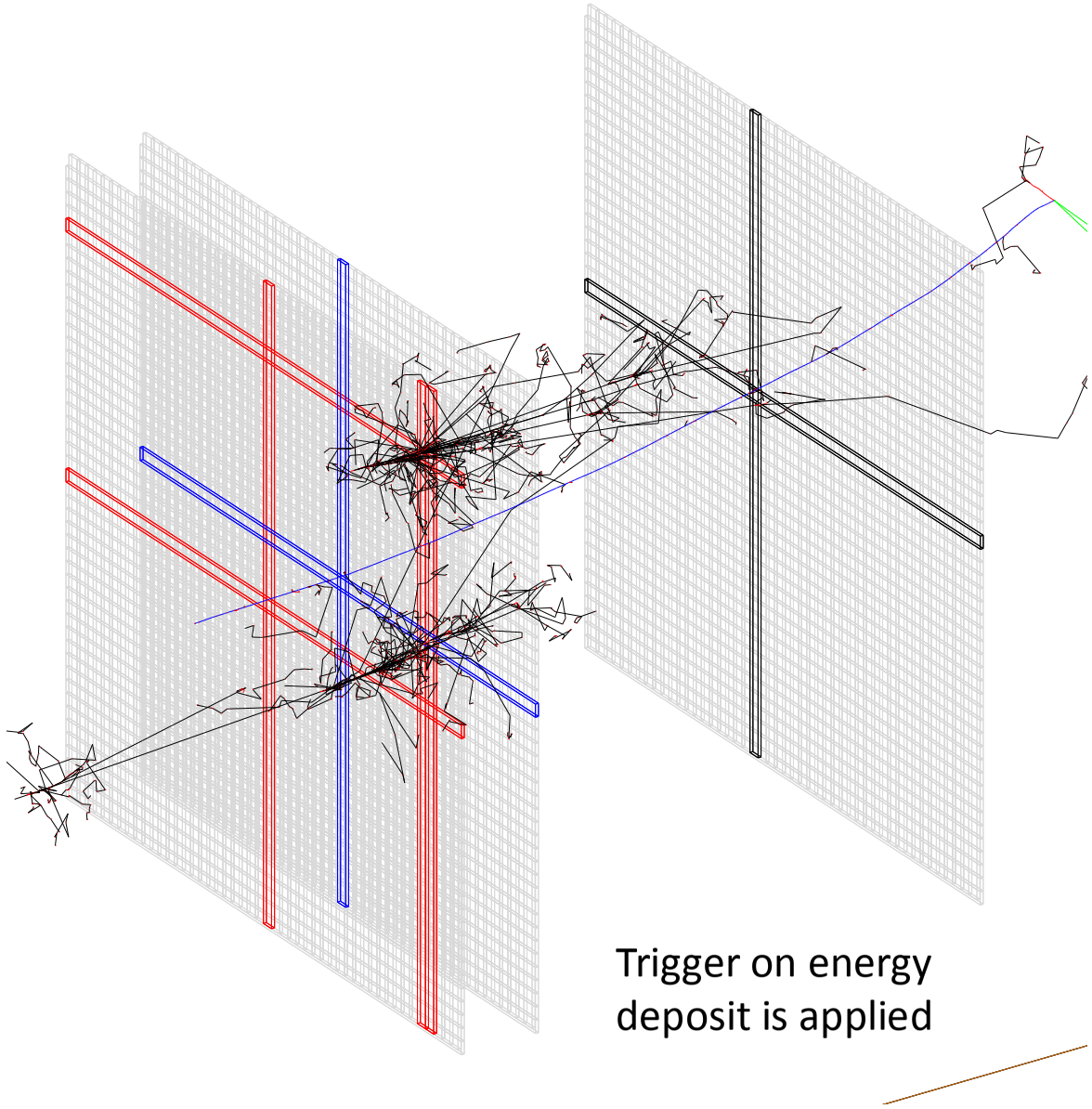


End-to-end BATATA simulations:



Temporal & spatial unthinnings are applied

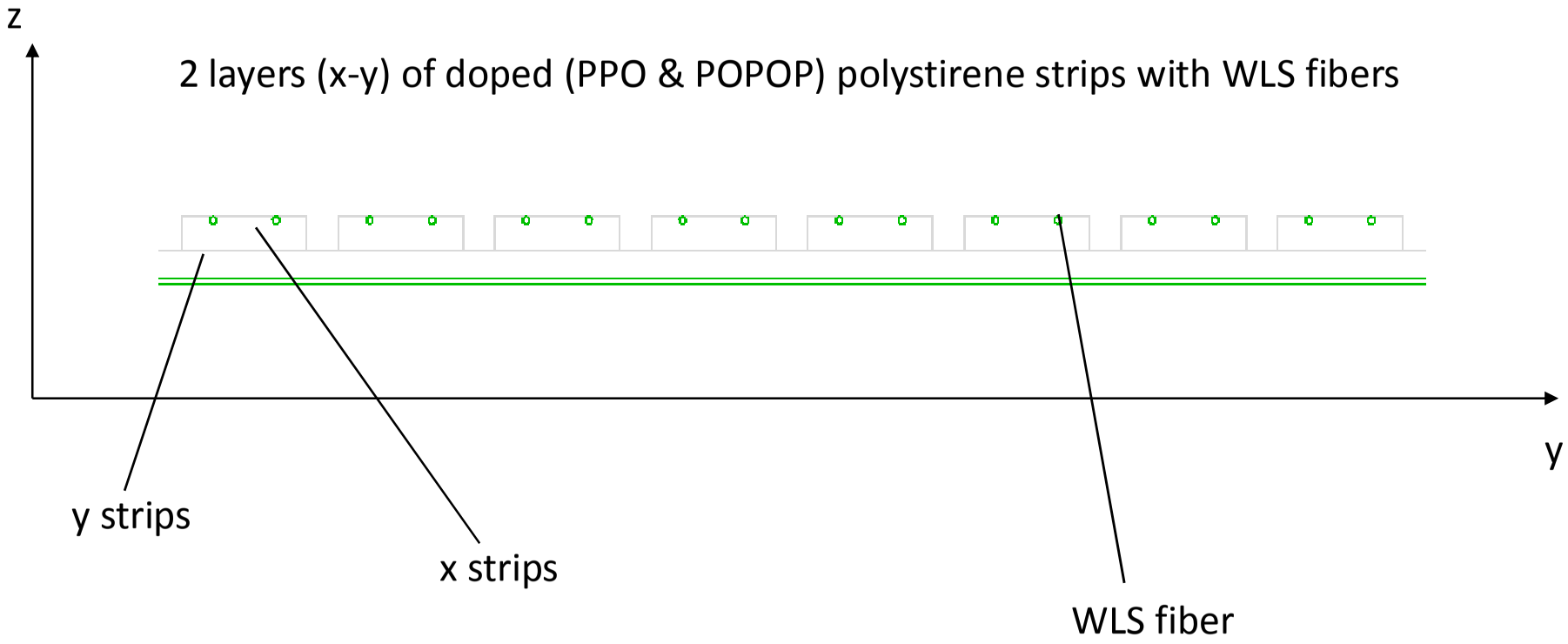
End-to-end BATATA simulations



Trigger on energy deposit is applied

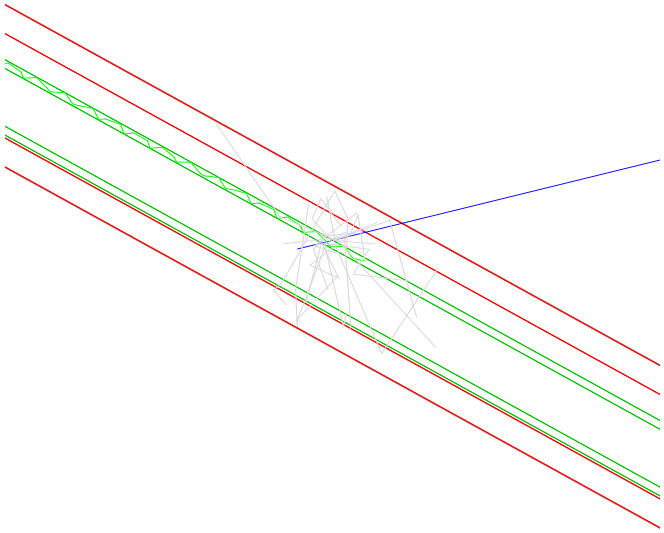
End-to-end BATATA simulations

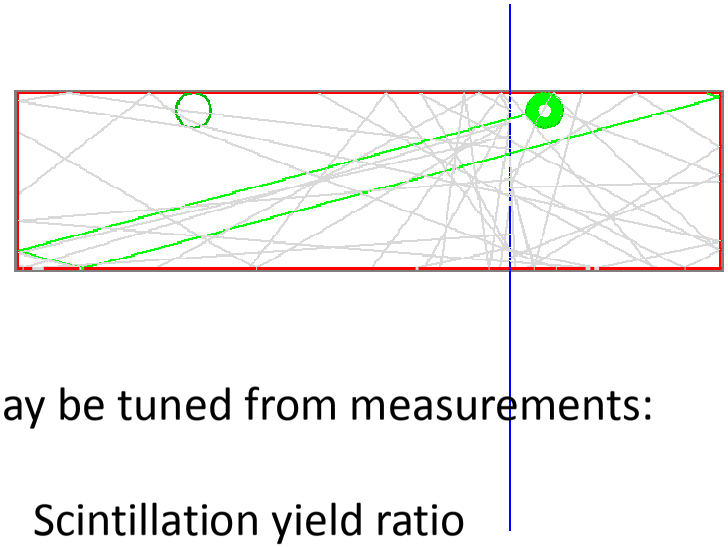
Scintillator strips simulation:



In order to implement a realistic trigger threshold in the BATATA simulations, we are calibrating at present energy deposit vs signal (mV) via simulated optical photons at the PMT window.

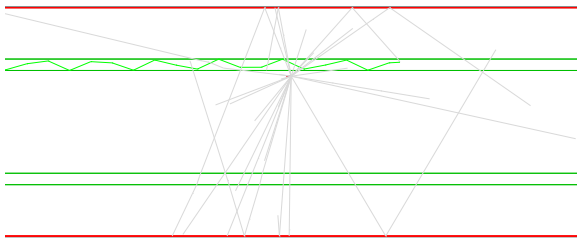
End-to-end BATATA simulations





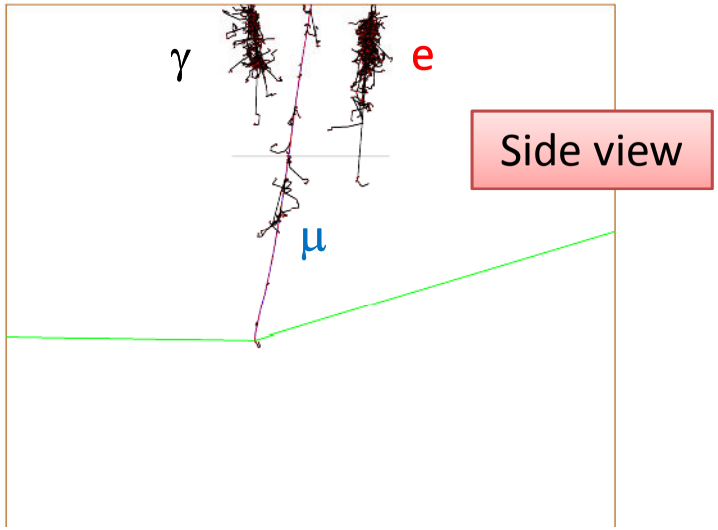
May be tuned from measurements:

1. Scintillation yield ratio
2. Absorption length
3. Reflection coefficient

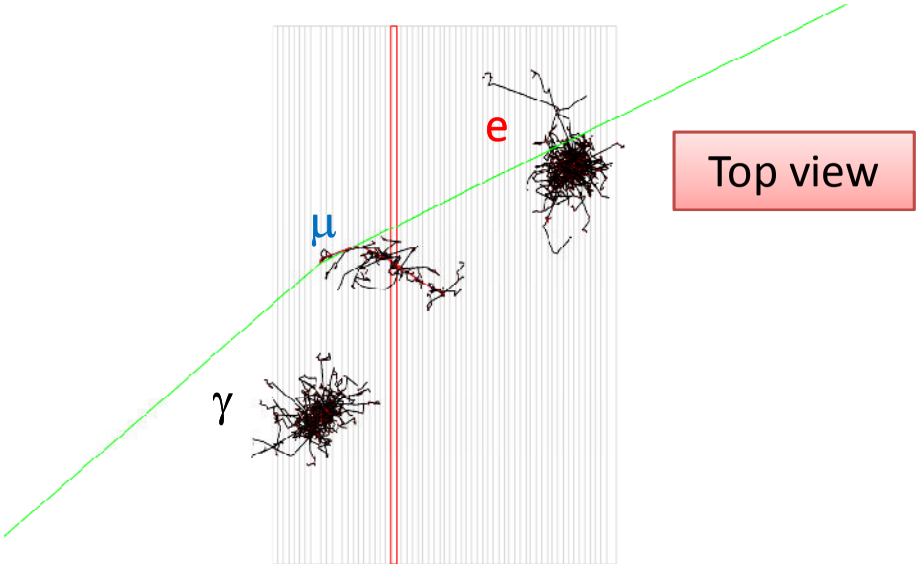


We can find the relation between
Energy deposit and trigger threshold

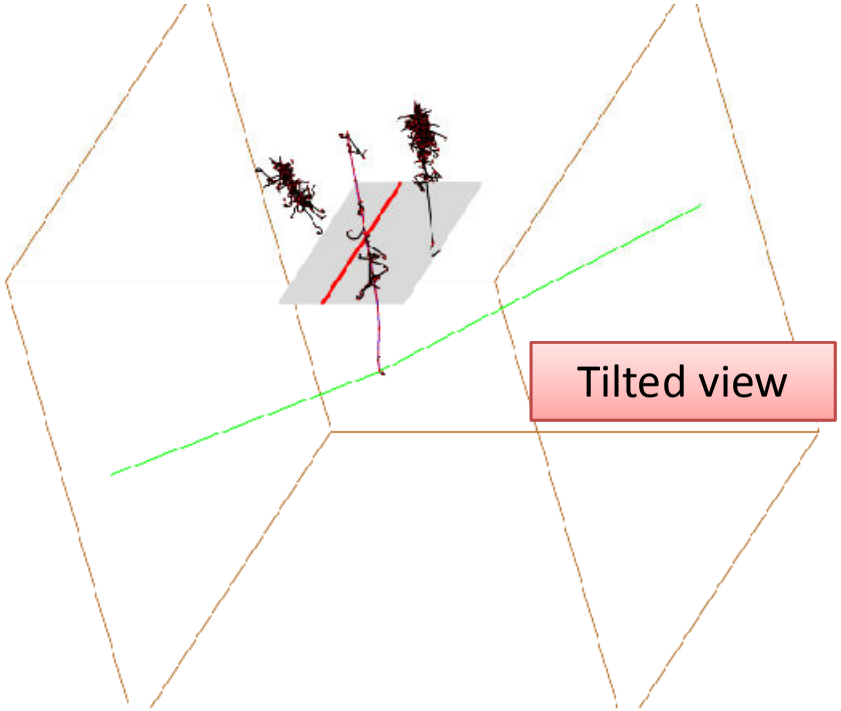
AMIGA application of BATATA simulation machine



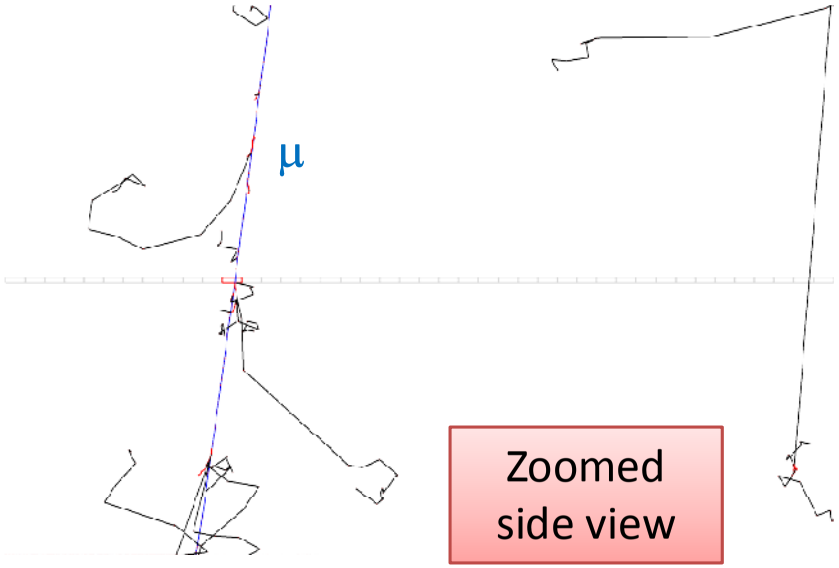
Side view



Top view

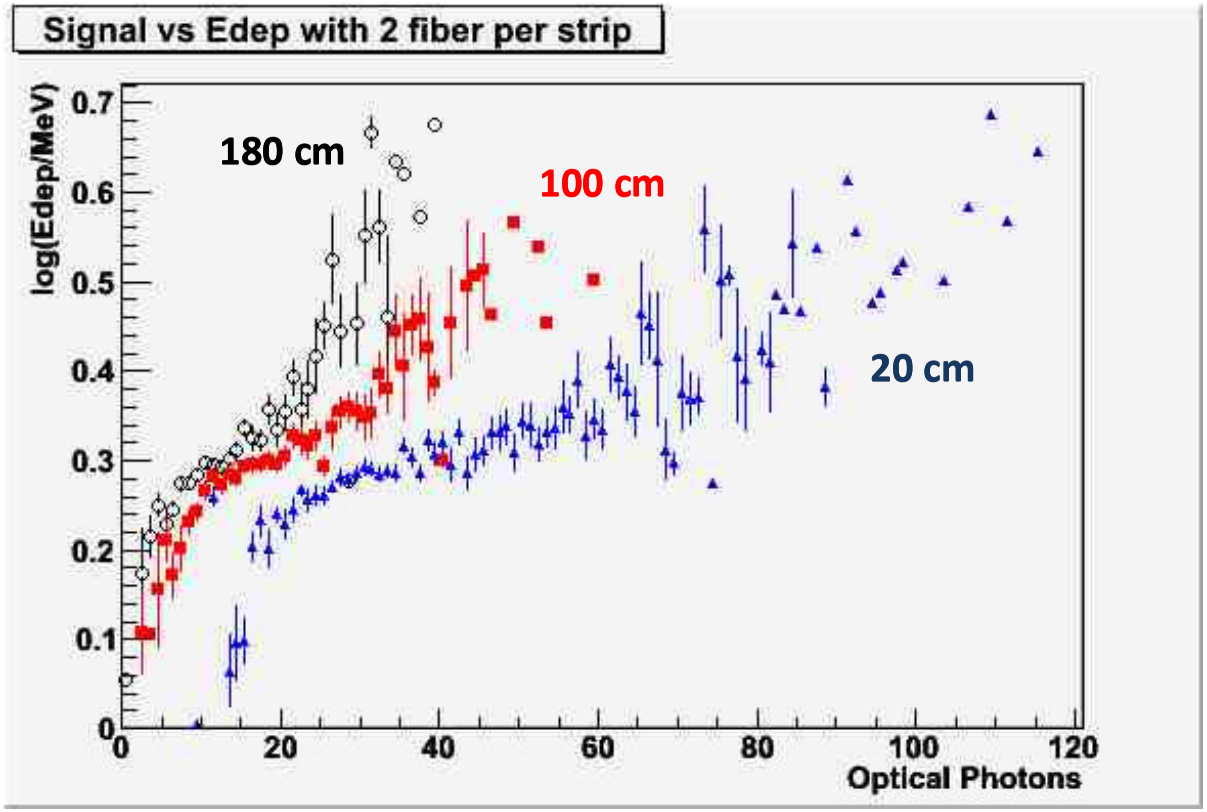


Tilted view

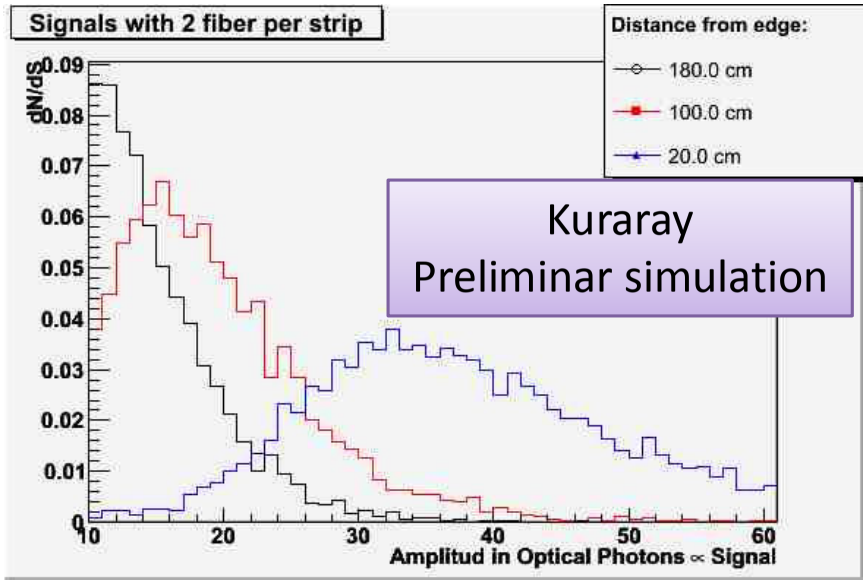


Zoomed side view

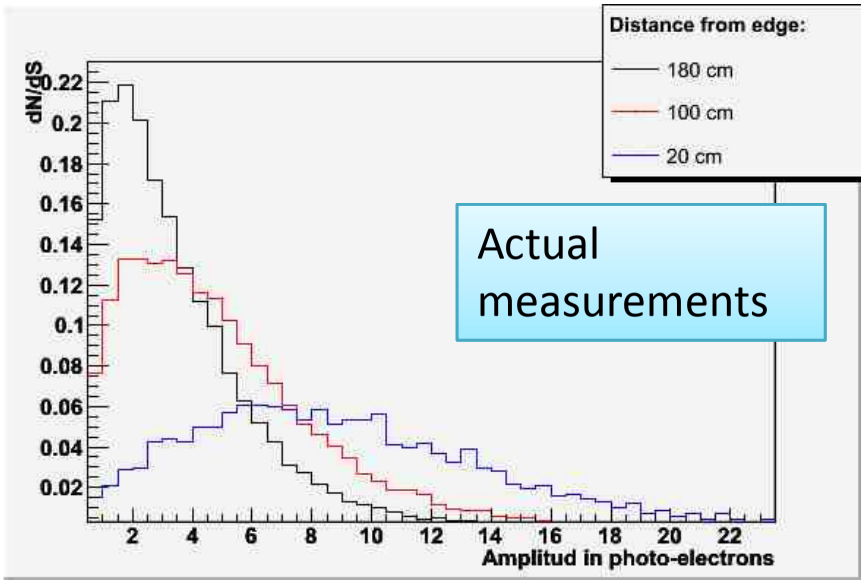
Strip + optical fibers characterization



End-to-end simulations
Scint.Strip + optical fiber
characterization & calibration

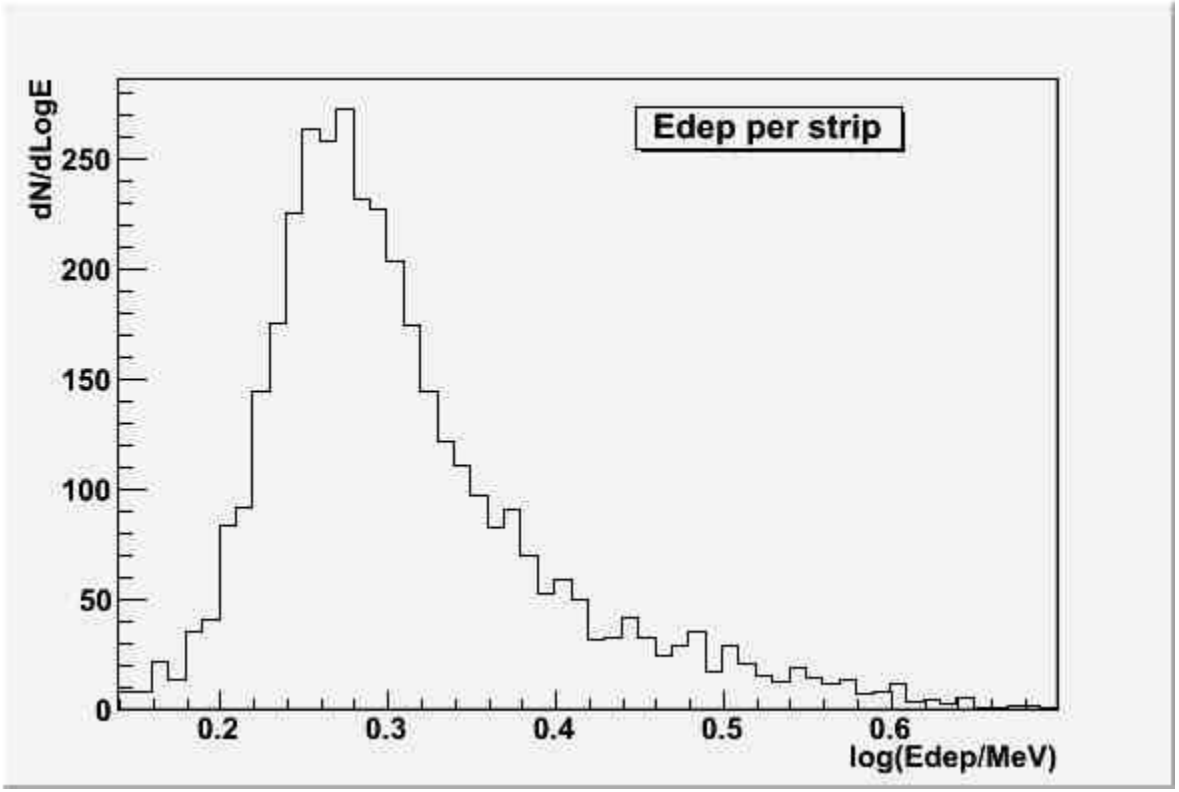


Kuraray
Preliminar simulation



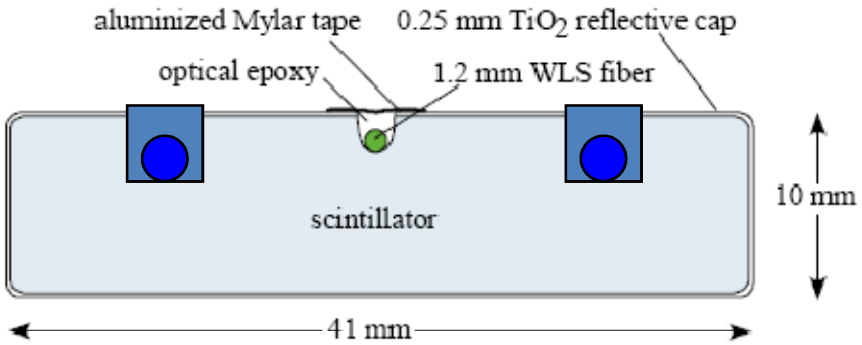
Actual
measurements

Muon energy deposit while traversing 1 cm of scintillator



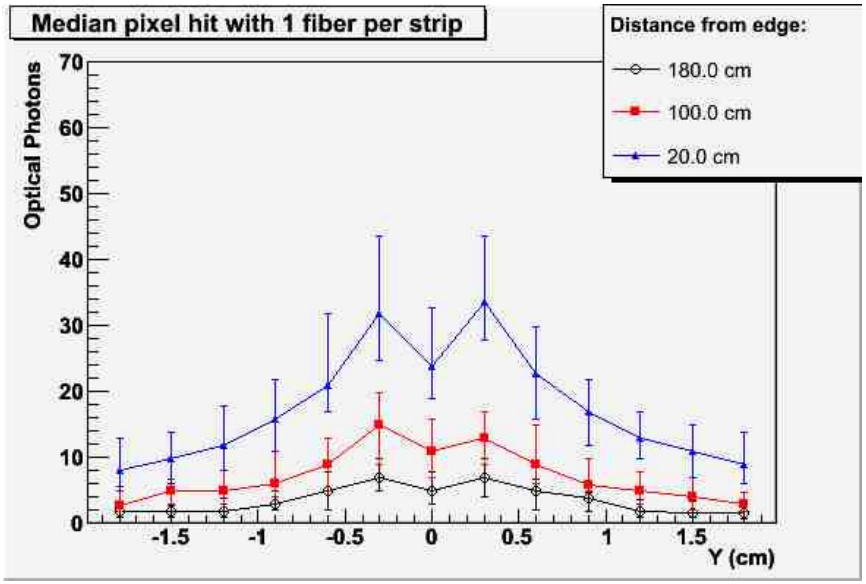
Two fiber setup

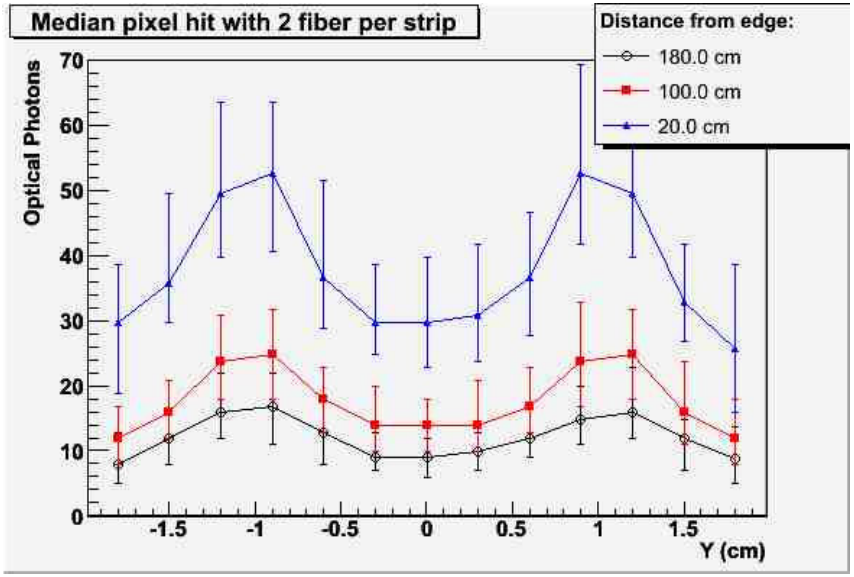
- Test with two lateral fibres bicron BC9929AMC

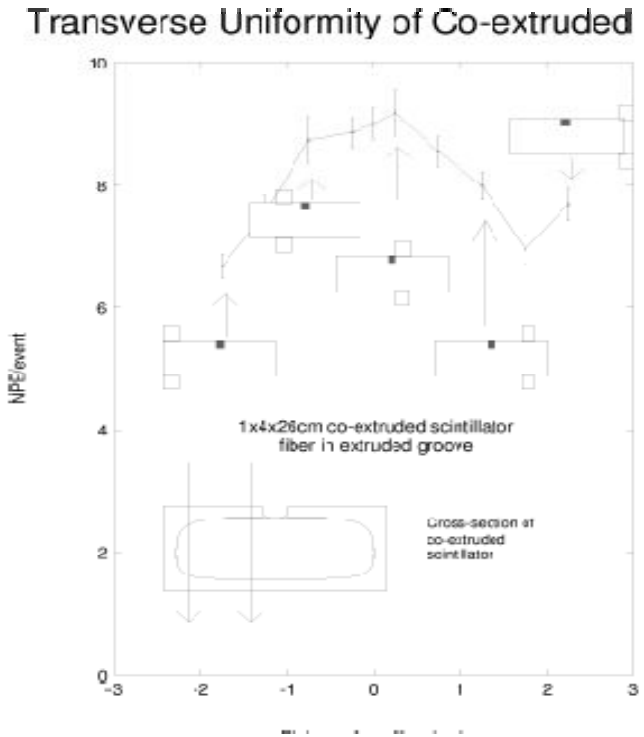


Paic & Patiño

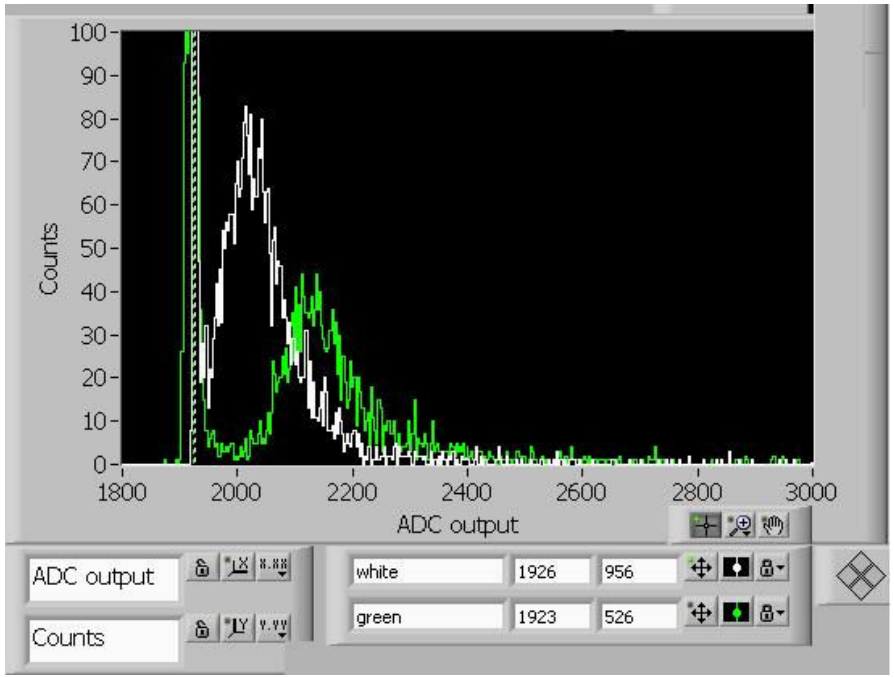
Transversal strip efficiency for 1 and 2 fibers (simulations)



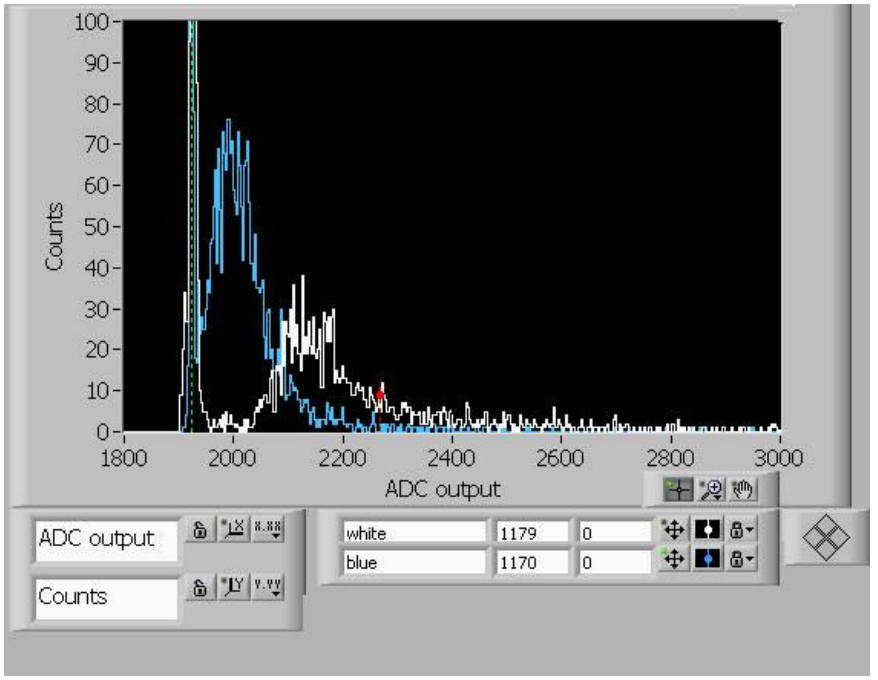




Comparison 1 fiber and 2 fibers position of PMT at 10cm

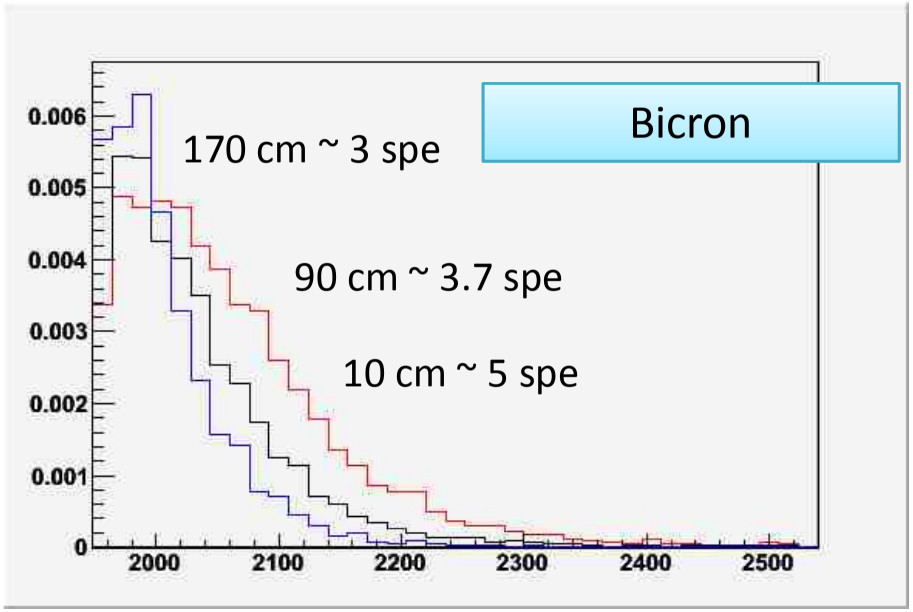


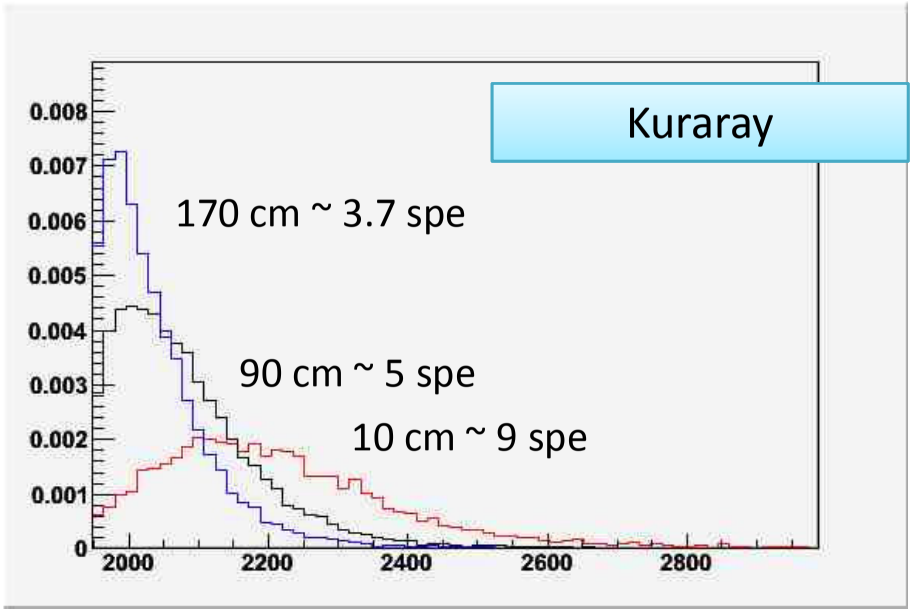
Comparison 1 fiber and 2 fibers position of PMT at 100cm

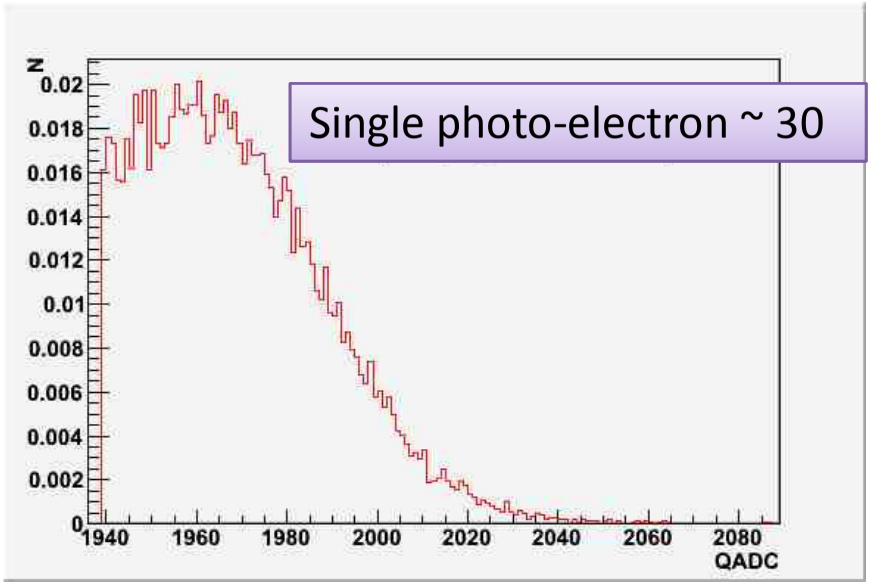


Paic & Patiño

QADC distribution function - 2 fibers per strip @ 10, 90 & 170 cm



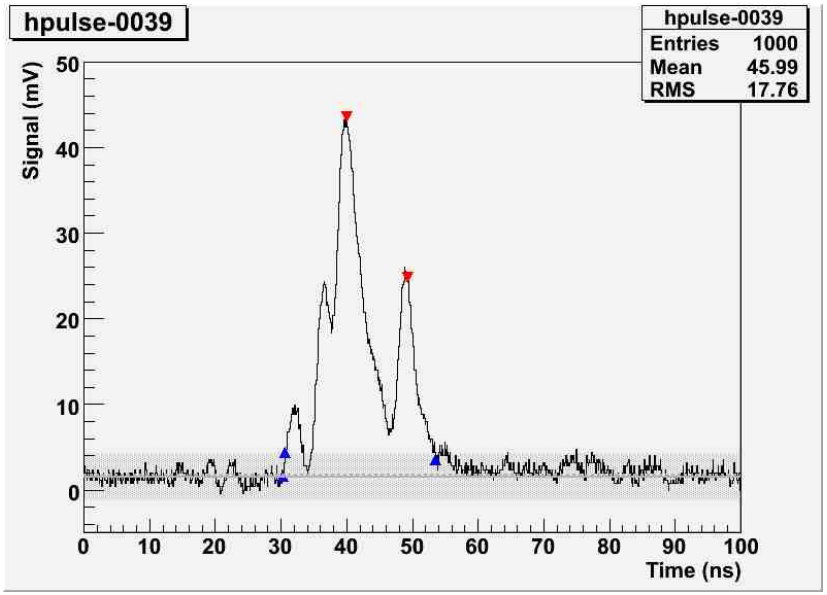


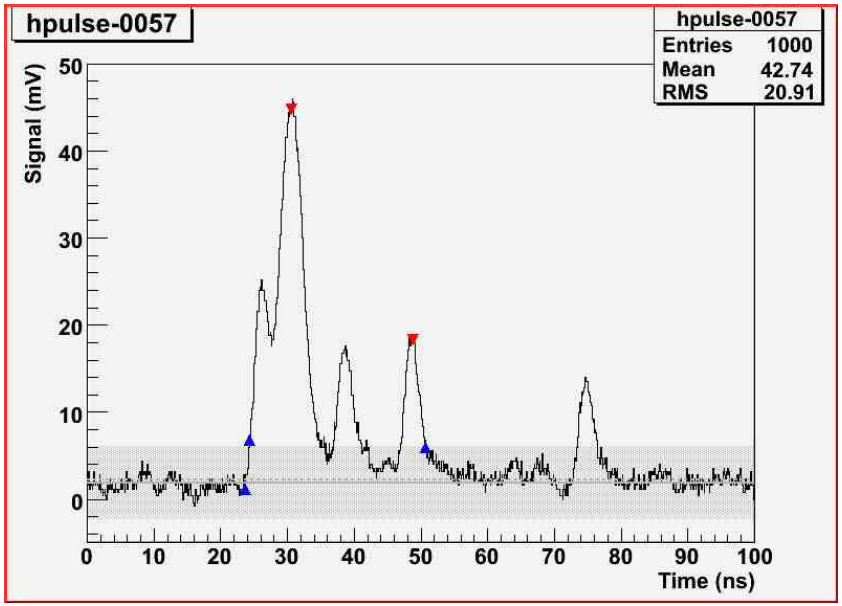


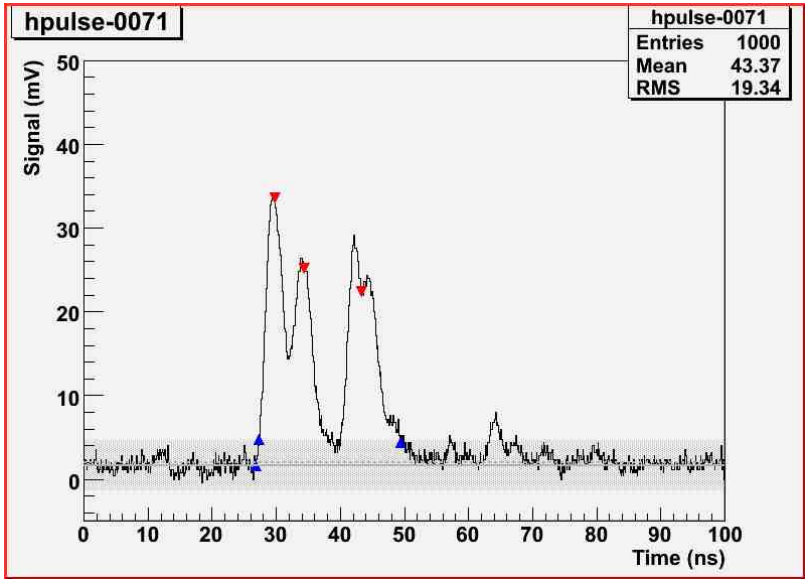
SPE ~ 5 mV

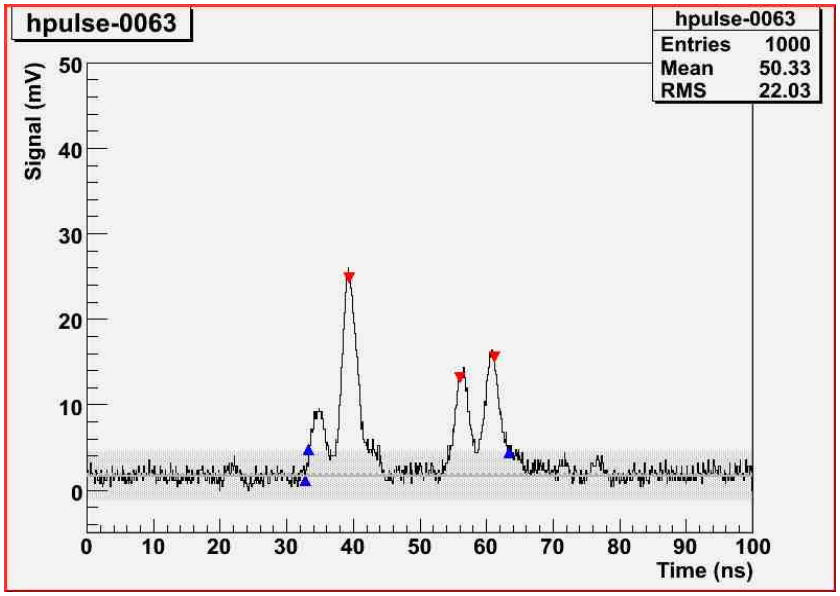
Paic & Patiño

Kuraray - pulse shape - 2 fibers per strip @ 10 cm

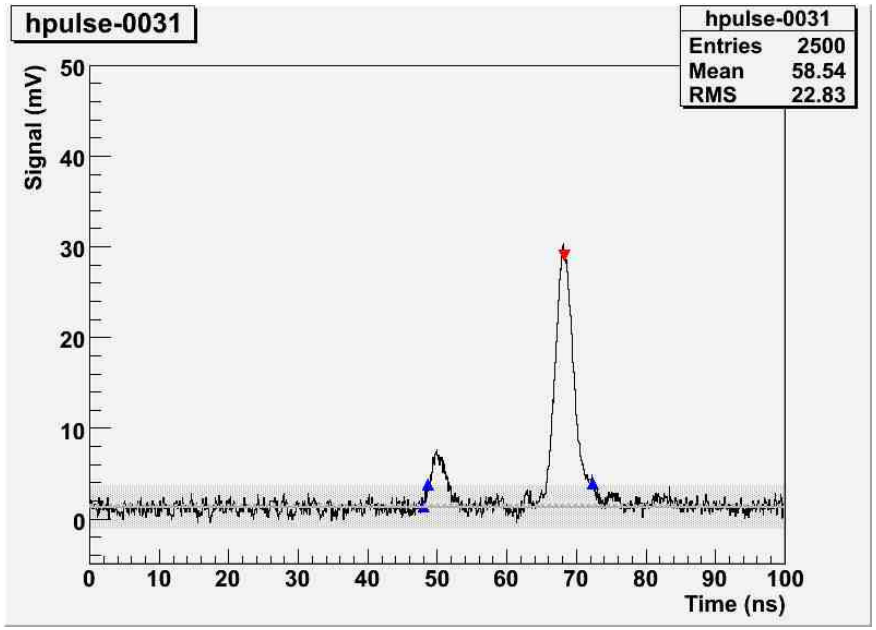


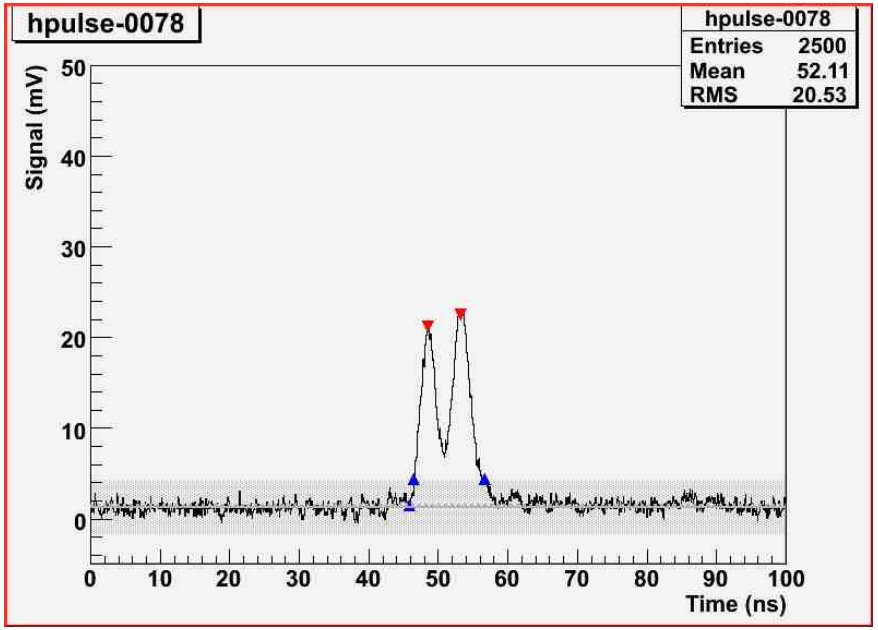


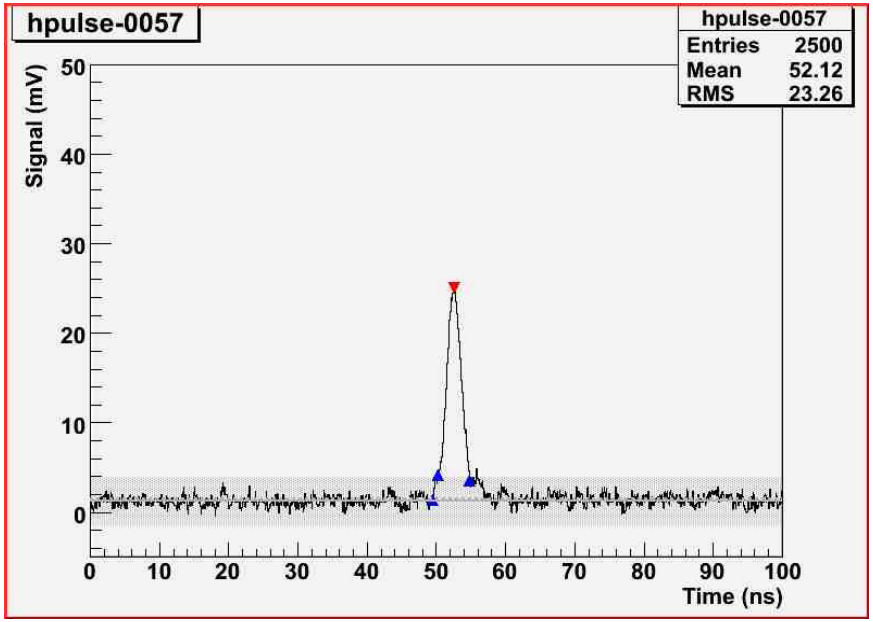


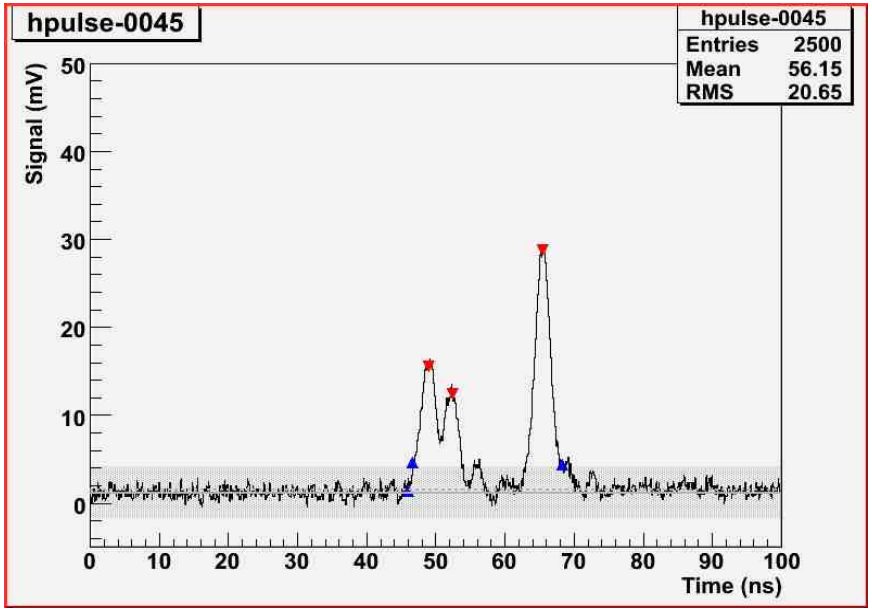


Bicron - pulse shape - 2 fibers per strip @ 10 cm

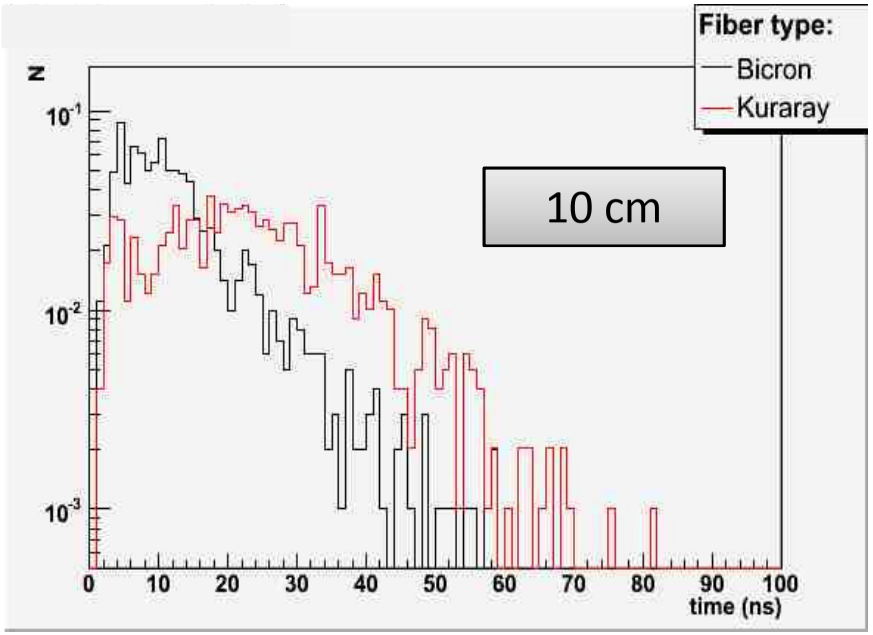


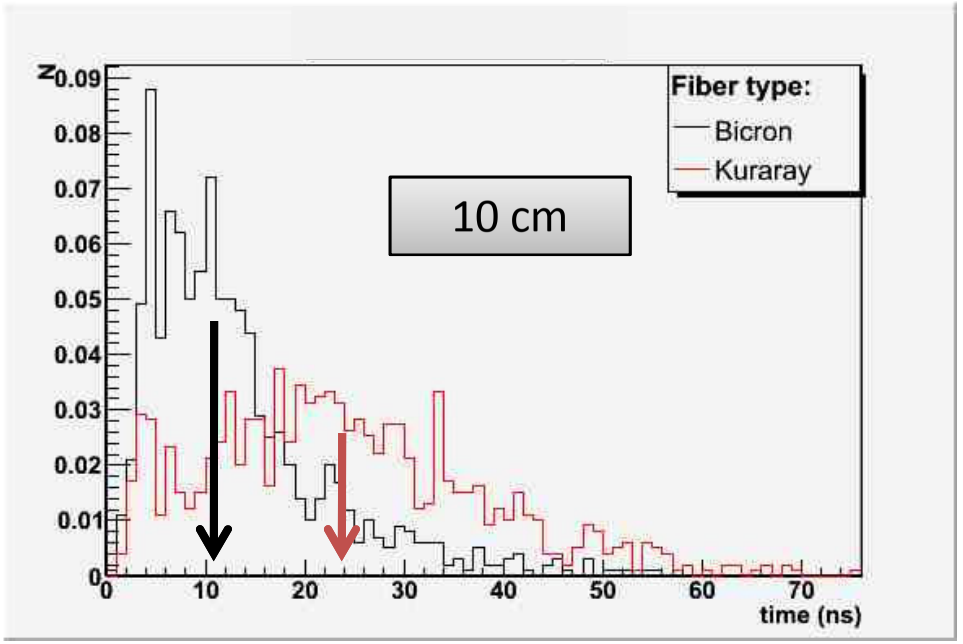


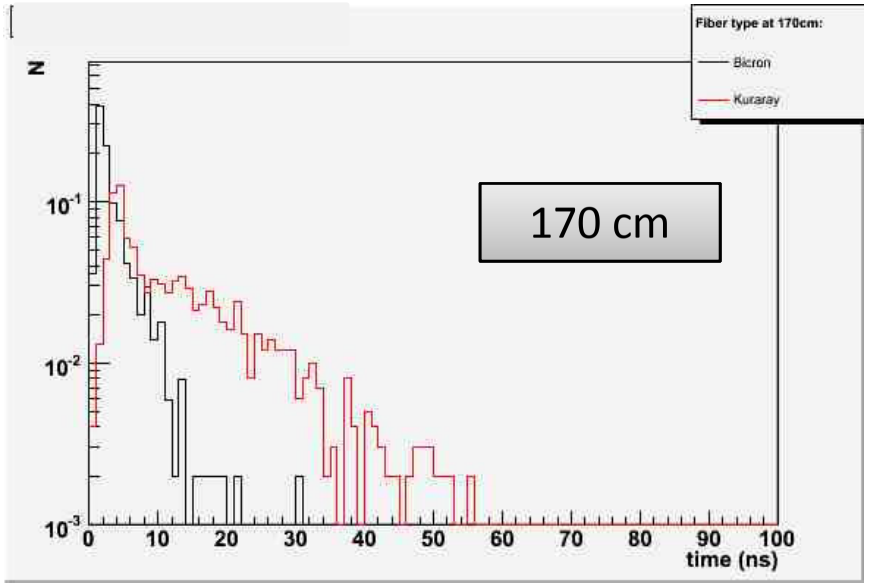




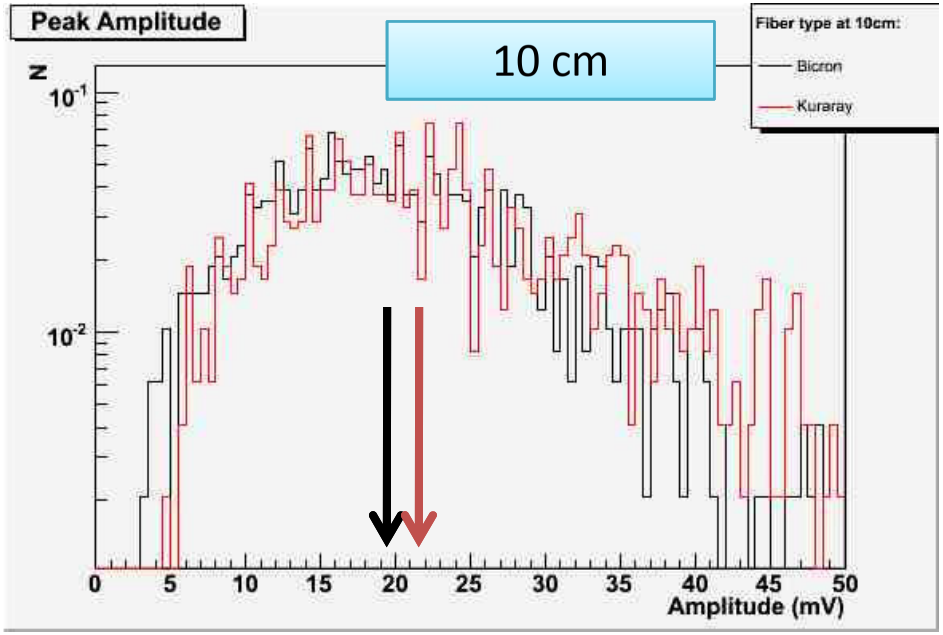
Signal time-length as a function of optical fiber

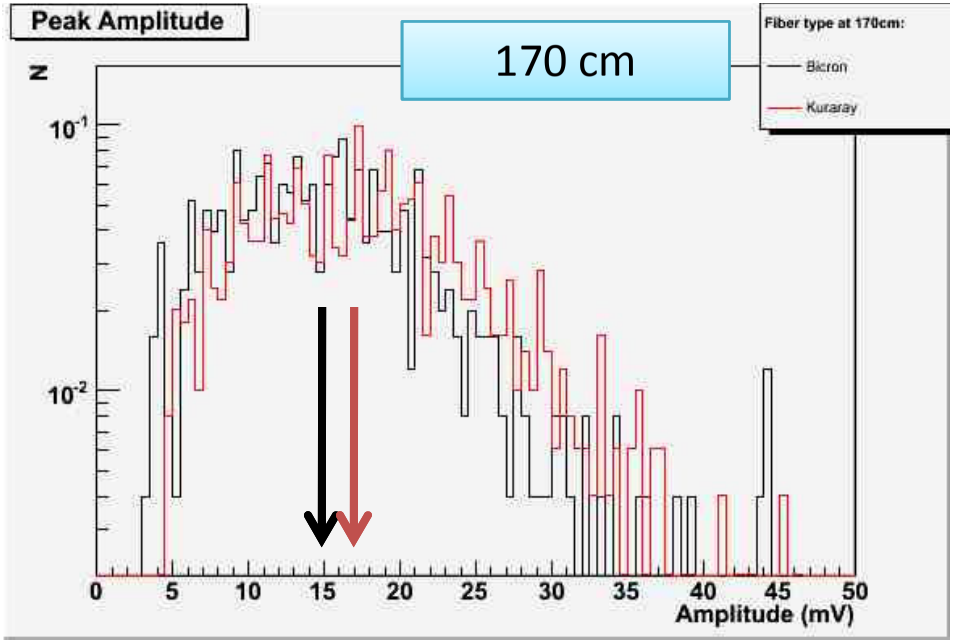




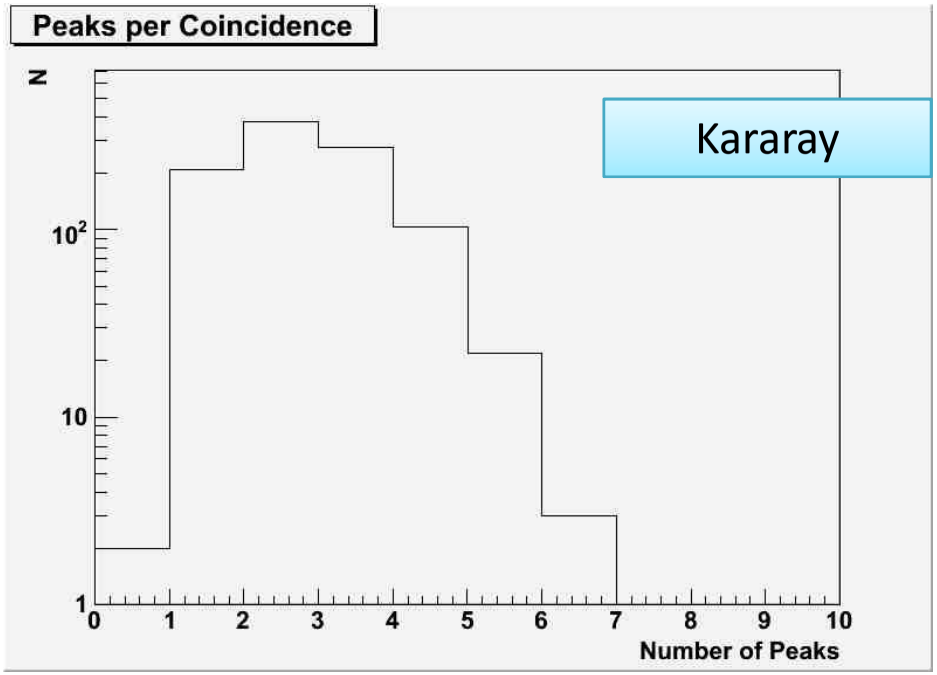


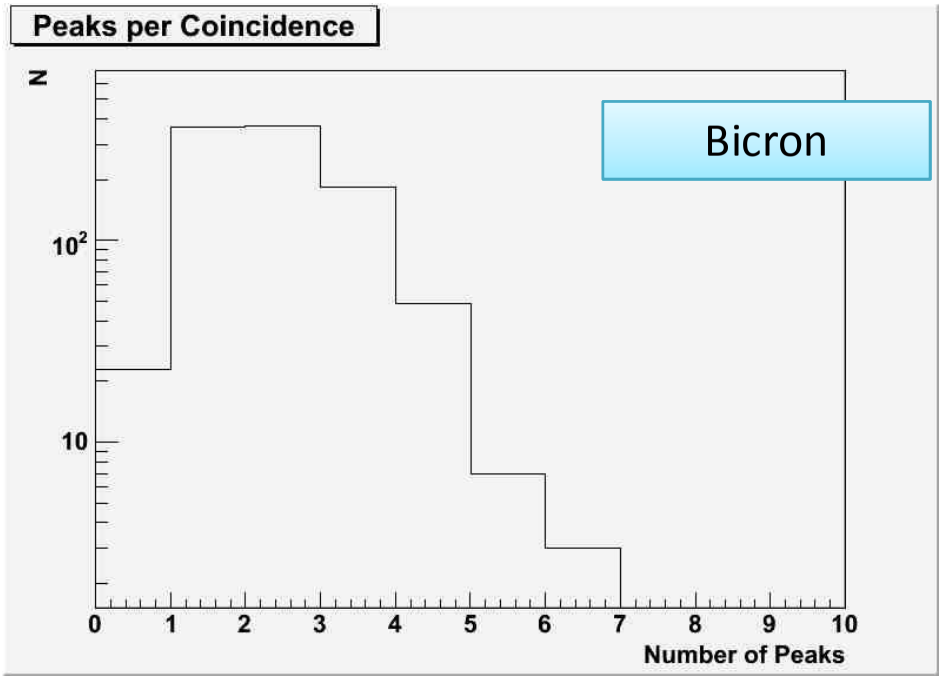
1st peak amplitude as a function of optical fiber (@ 10 & 170 cm)



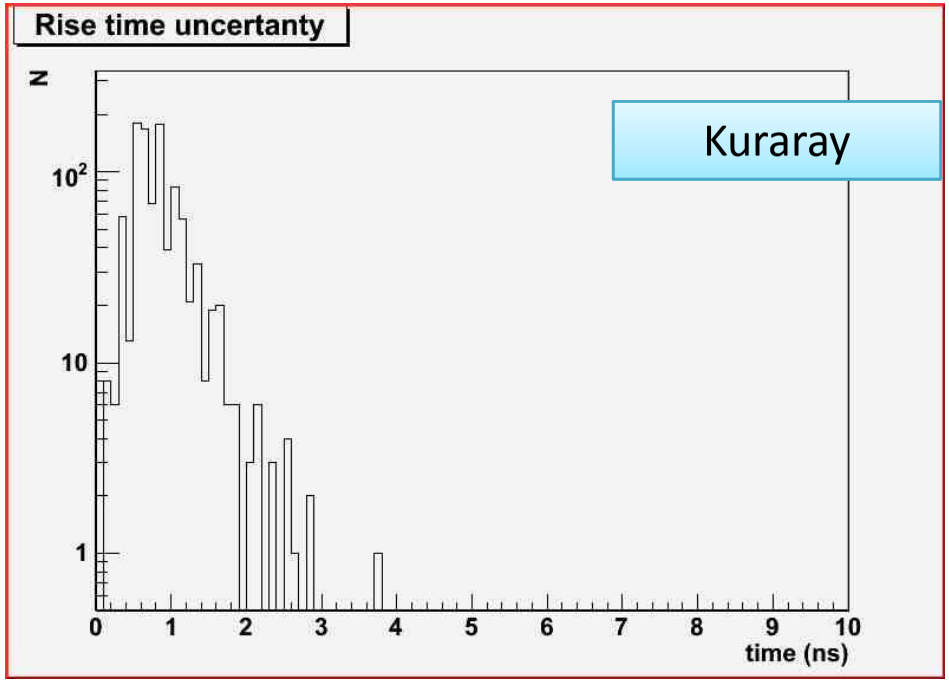


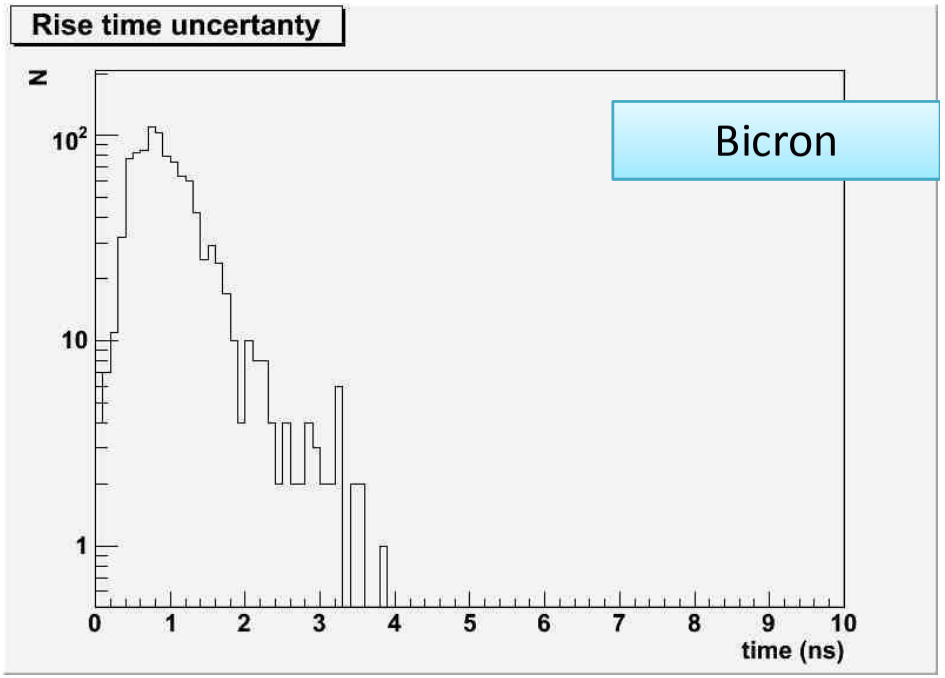
No. of peaks per pulse as a function of optical fiber (@ 10 cm)





Rise time (1σ-10σ) 1st peak as a function of optical fiber (@ 10 cm)



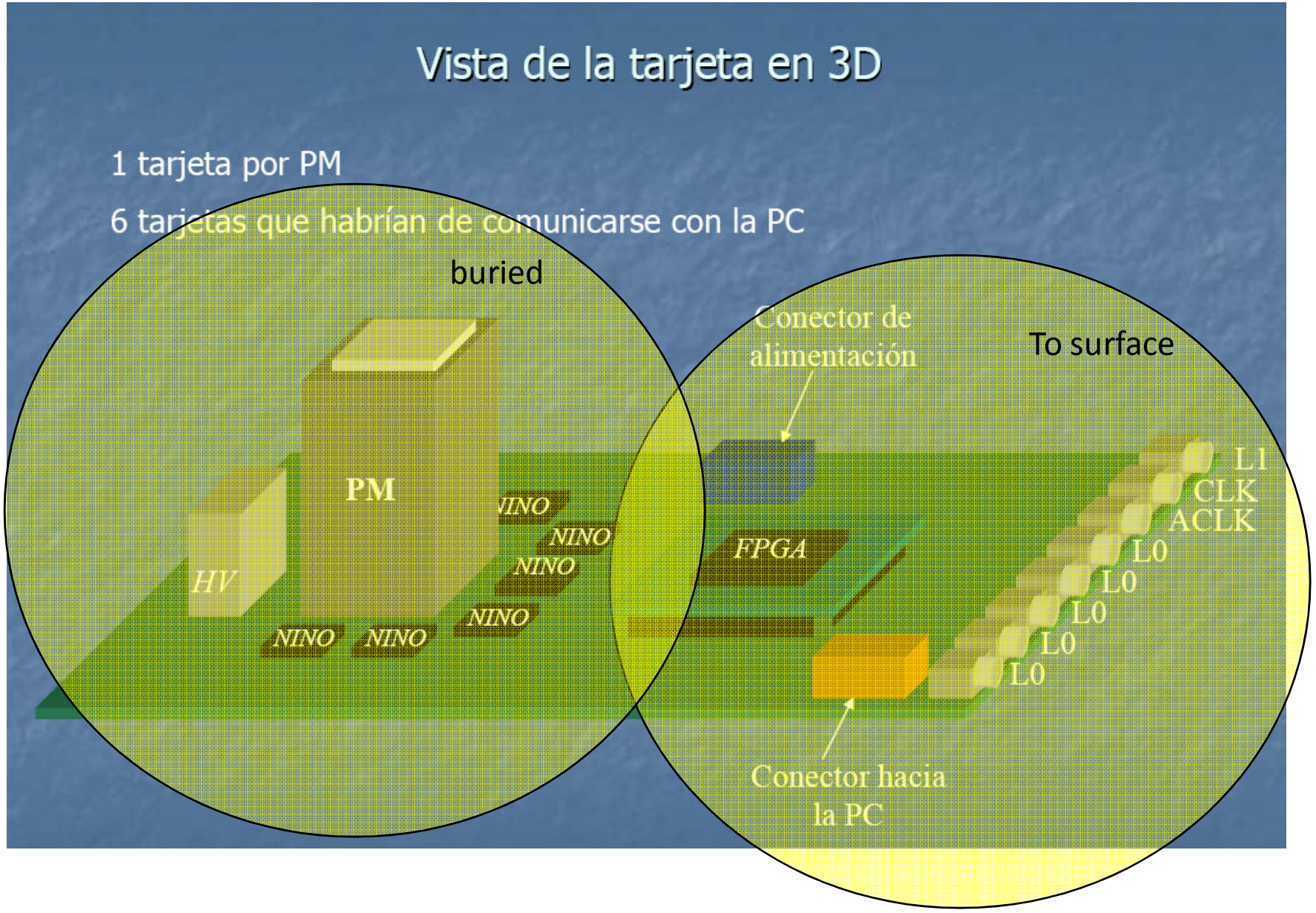


electronics

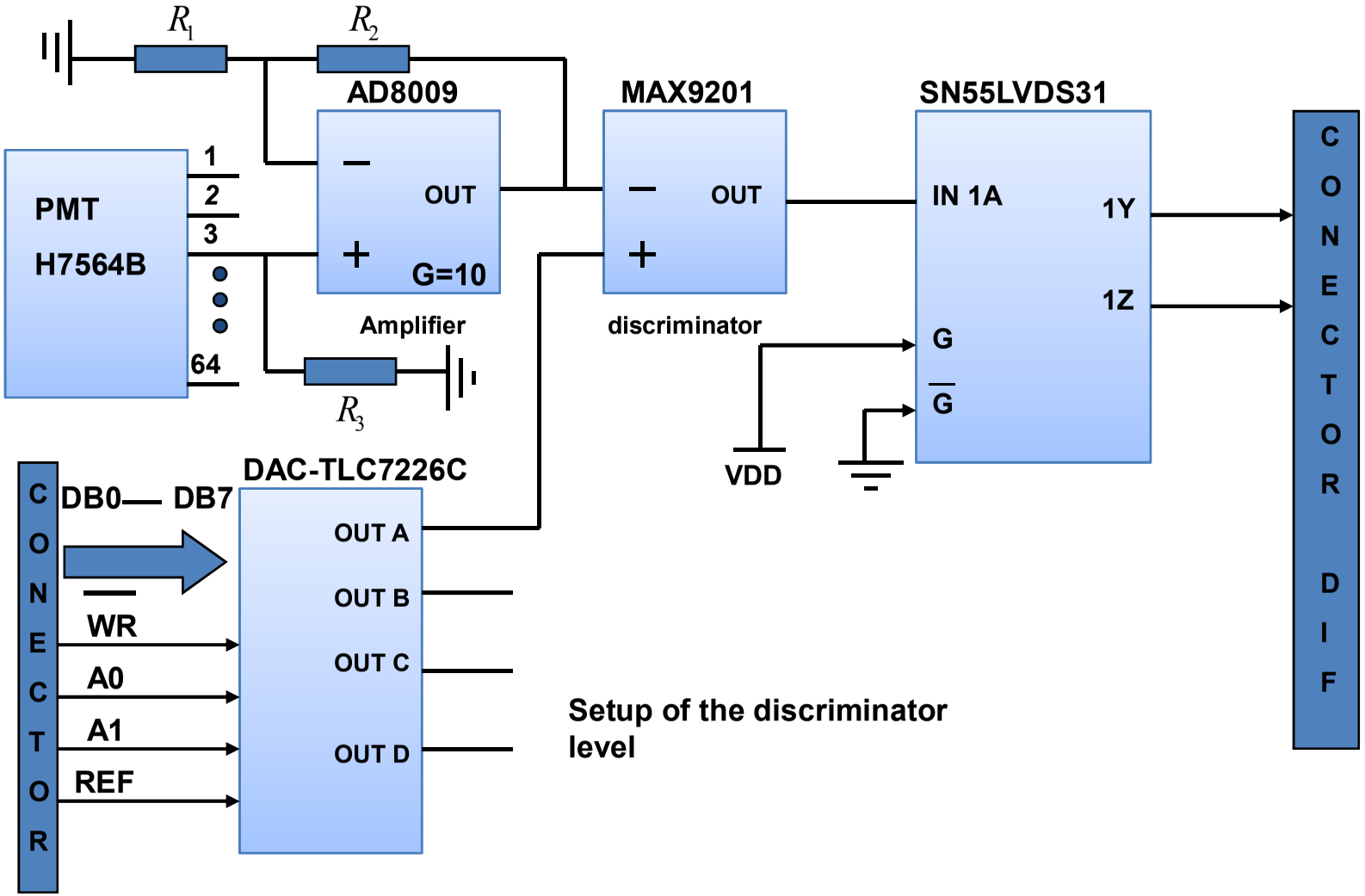
Vista de la tarjeta en 3D

1 tarjeta por PM

6 tarjetas que habrían de comunicarse con la PC

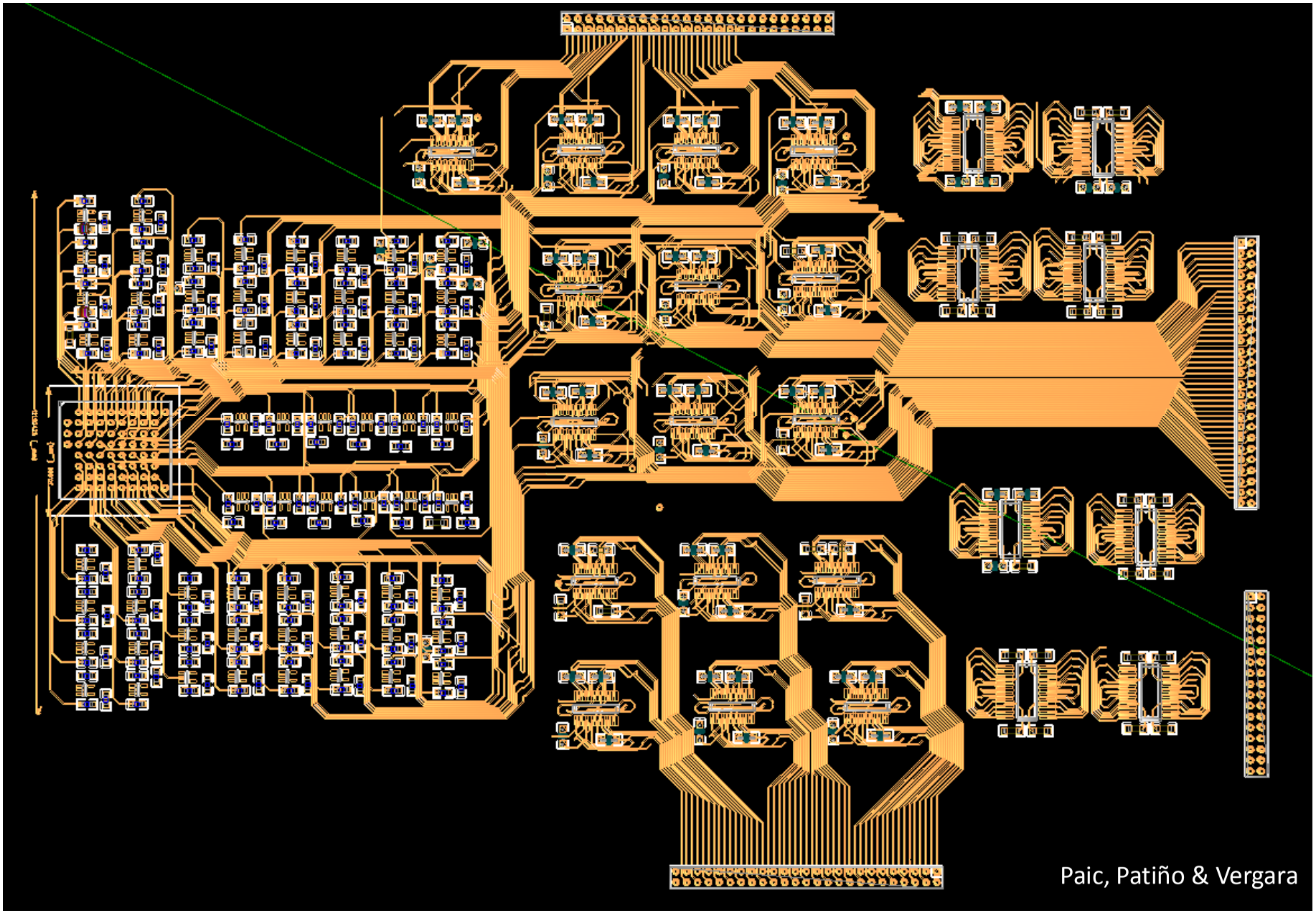


Front end electronics for one channel with a differential output LVDS

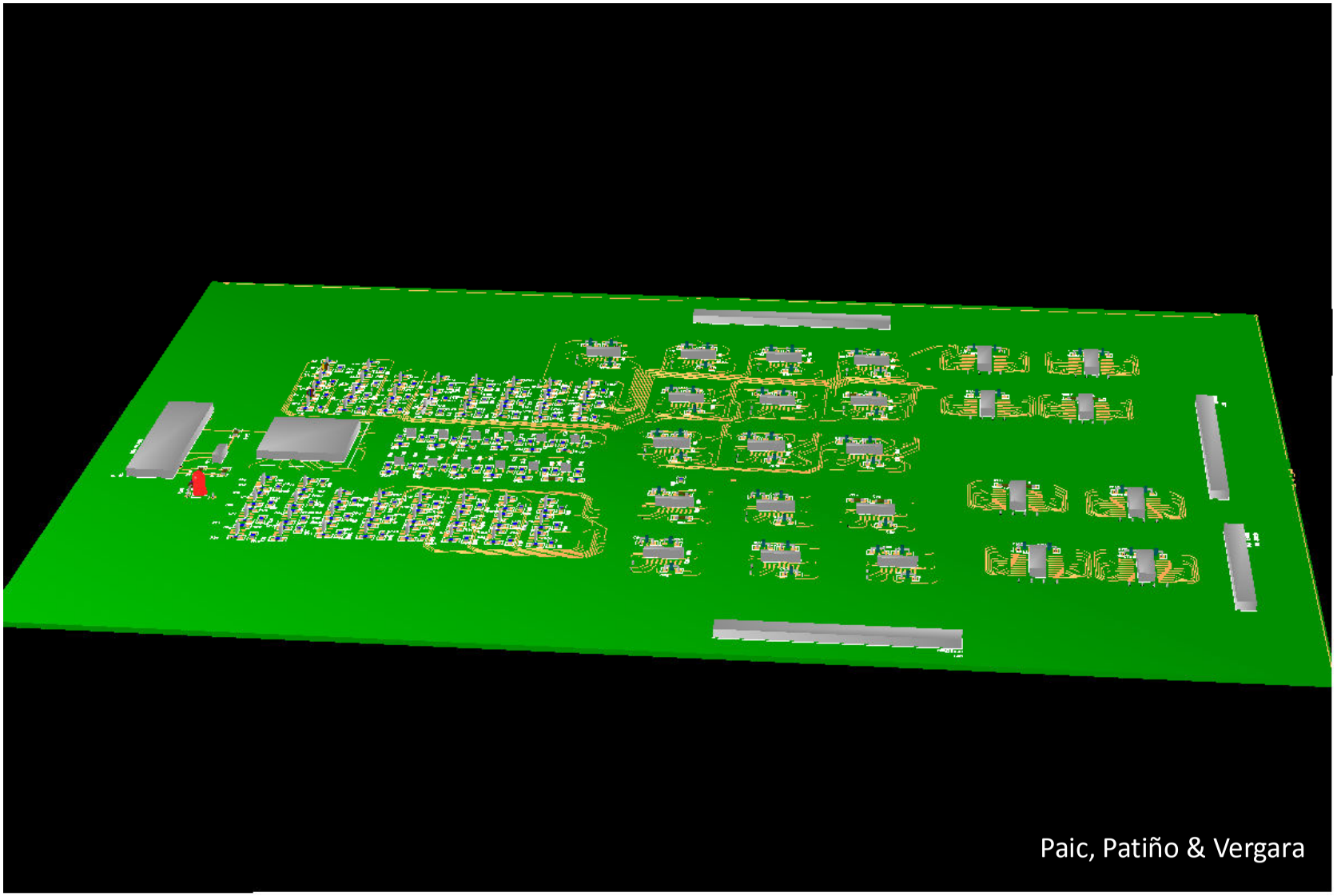


Paic, Patiño & Vergara

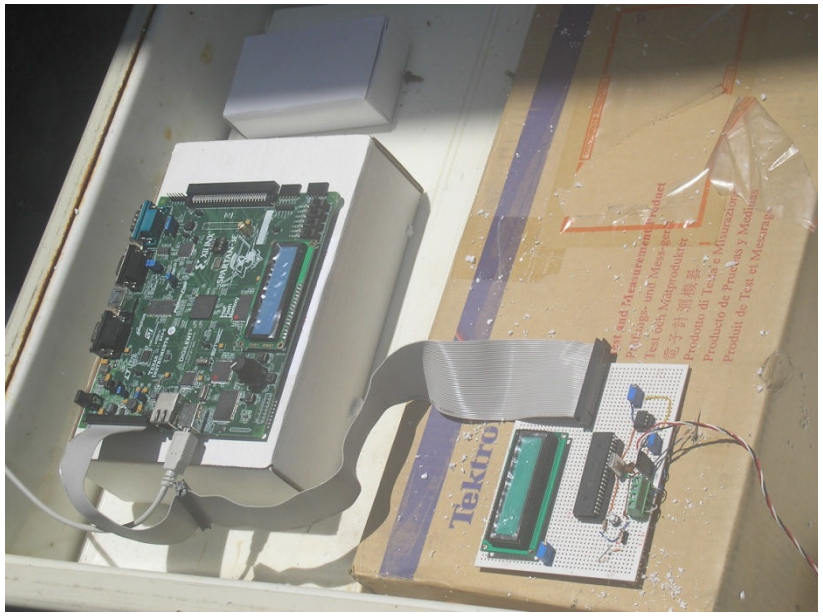
BATATA electronics



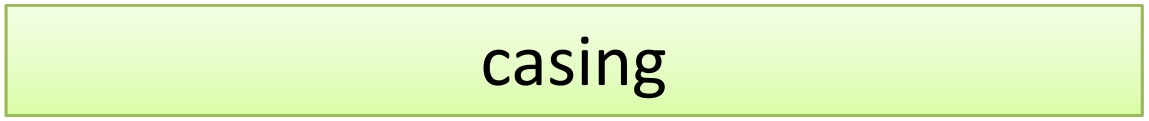
BATATA electronics



Electronics equilibrium temperature

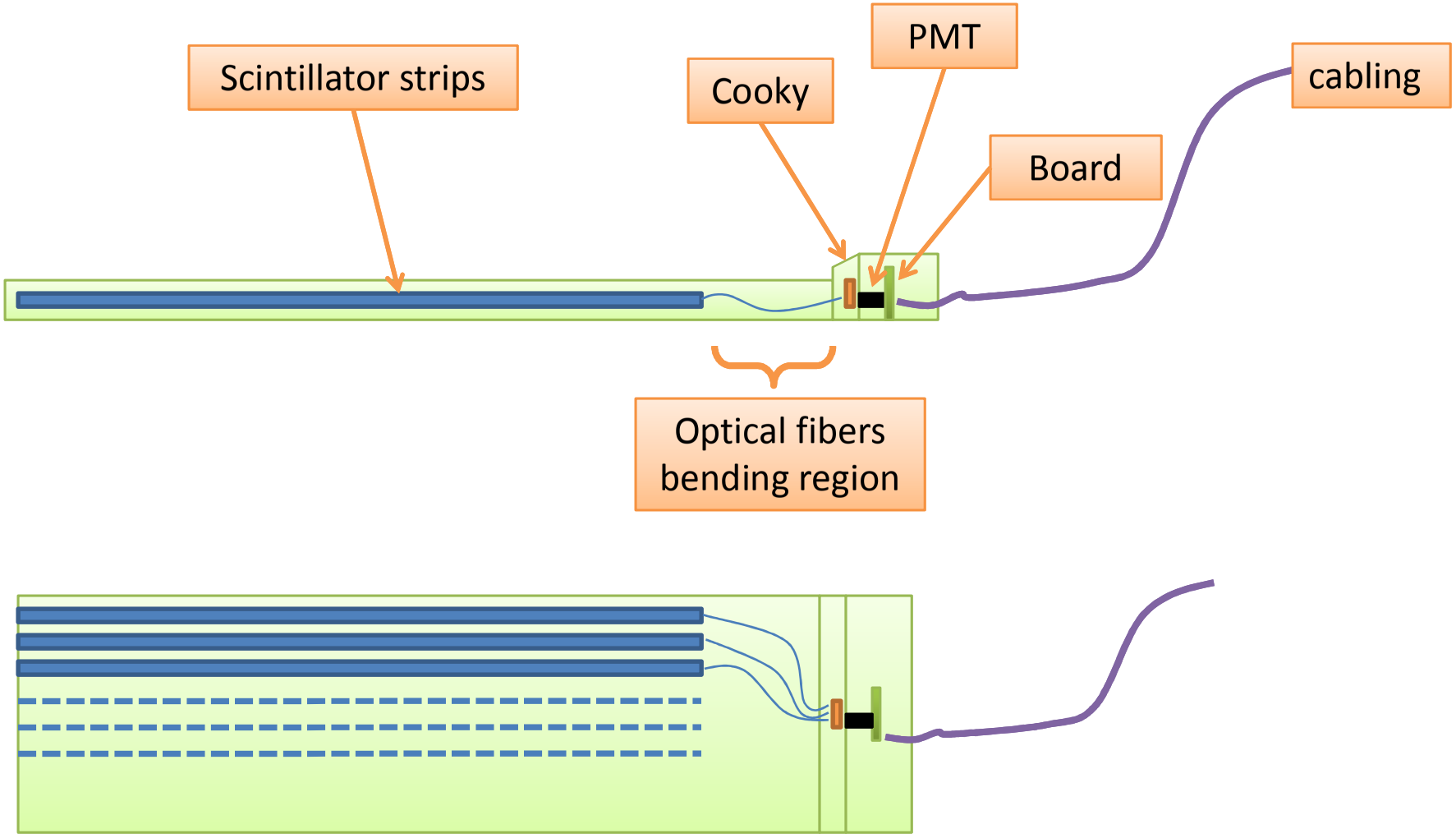


Soil temperature = 16 – 18 °C
Board temperature = 31 – 33 °C


casing

Casing – general idea

Two independent cases for each x-y plane



BATATA: current status & cronogram

Design	-	General design: FROZEN (except exact depths planes 1 & 2)
	-	Operating strategy: FROZEN
End-to-end simulations: 90%	-	Ongoing: calibration w/measurements
Electronics: 50%	-	Ongoing: printing/assembling & FPGA
Scintillator	-	buying 32m^2 from Fermilab
optical fiber } 80%	-	Kuraray vs. Bicron characterization
PMT	-	have 1 PMT 64 pix -- buying 6 more
Data analysis software: 30%	-	2 startegies: multiparam. analysis & N-Networks
Casing (embrionic)	-	Colab. UNAM / Utah
SD array: 0%	-	Colab. Balceiro (Bariloche)

Chronogram

Assembly:	October 2007
Delivery:	November 2007
Installation:	January 2008 (?)
Operation starts:	February 2008 (?)
Stable operation:	April 2008 (?)