Proposal for Experiments of FTOF-Counter *(for SuperB)* at SLAC CRT-telescope

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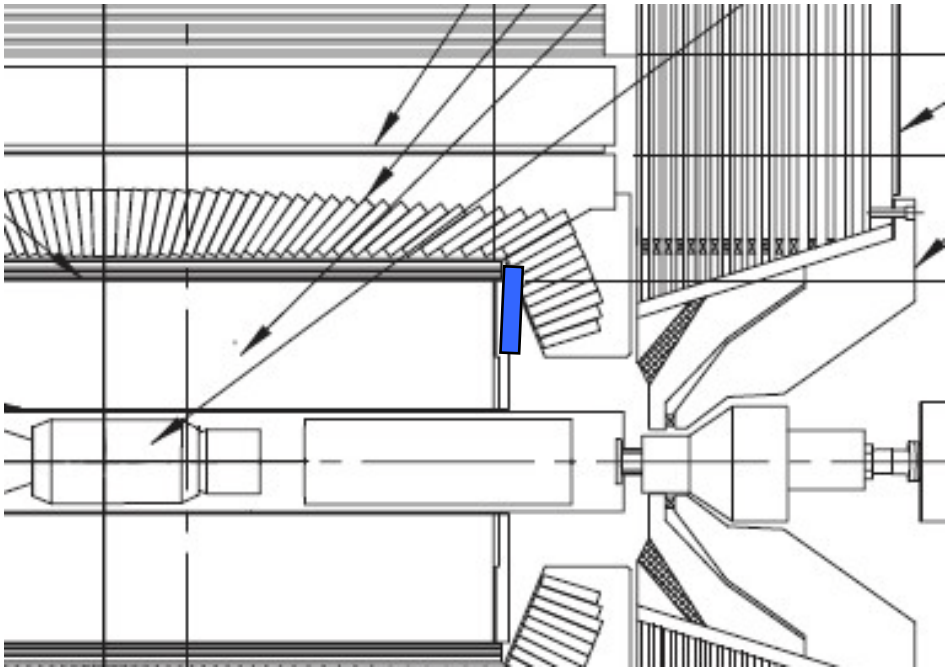
LAL and SLAC

FTOF-COUNTER
for SuperB

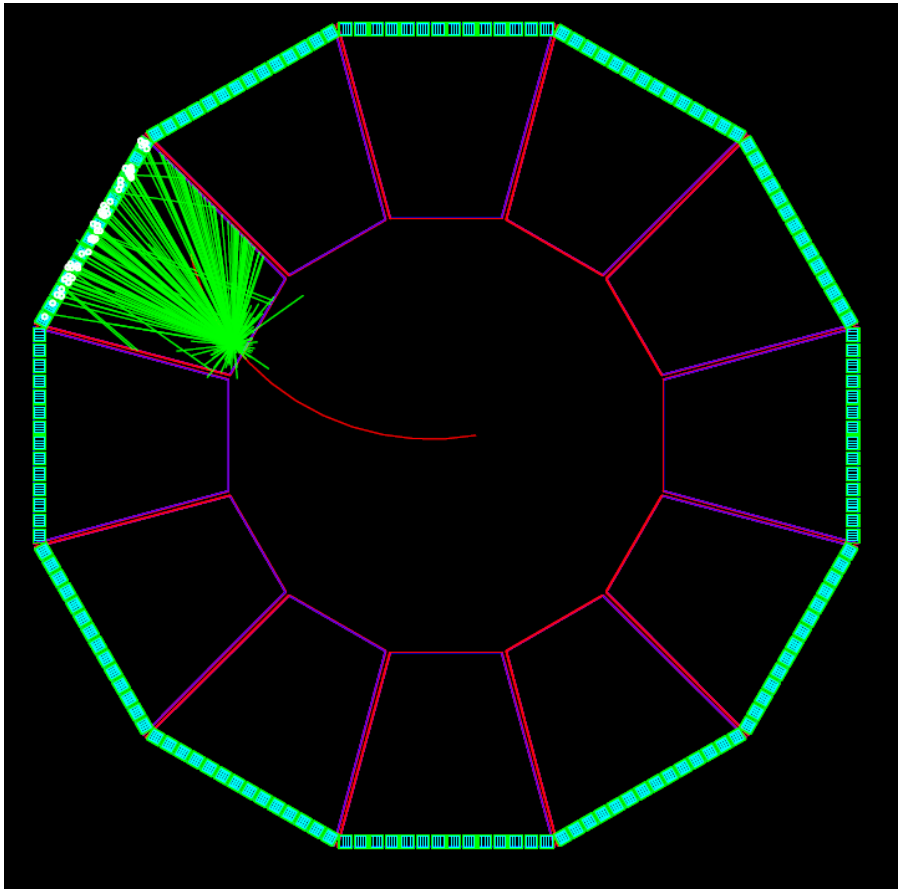
State-of-the-Art
(in between Annecy and Elba meetings)

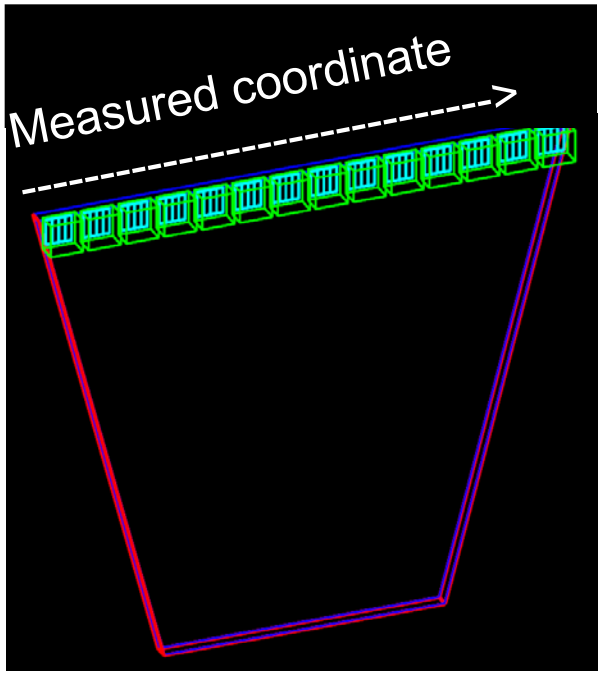
Forward PID in SuperB with a FTOF counter



It seems today that the best position for the FTOF counter
is to be as close as possible and parallel to the DCH wall
(preliminary studies show that the position of the FPID is not influent on the FEMC energy resolution)

Sofar the FTOF was placed near and parallel to the FEMC. The last simulation studies has shown that at that place the number of photoelectrons were not sufficiently high. See for more details http://agenda.infn.it/getFile.py/access?contribId=1&resId=0&materialId=slides&confId=2524



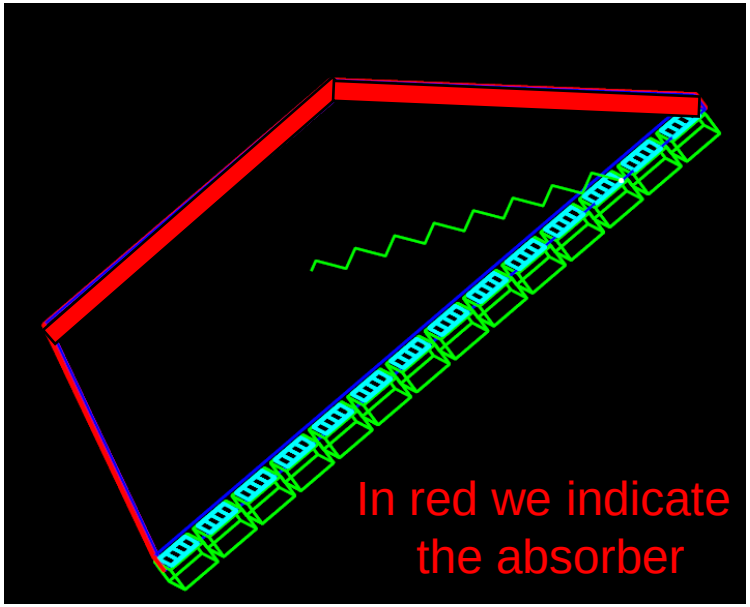


- The detector is made of quartz and 1.2cm thick, corresponding to **10% X_0**
- There are 12 sectors (30 degree in ϕ) covering **$15 < \theta < 25$** degrees
- The PMT's are placed in the outer radius (14 per sector)

Two possibilities are envisaged so far for the photon collections

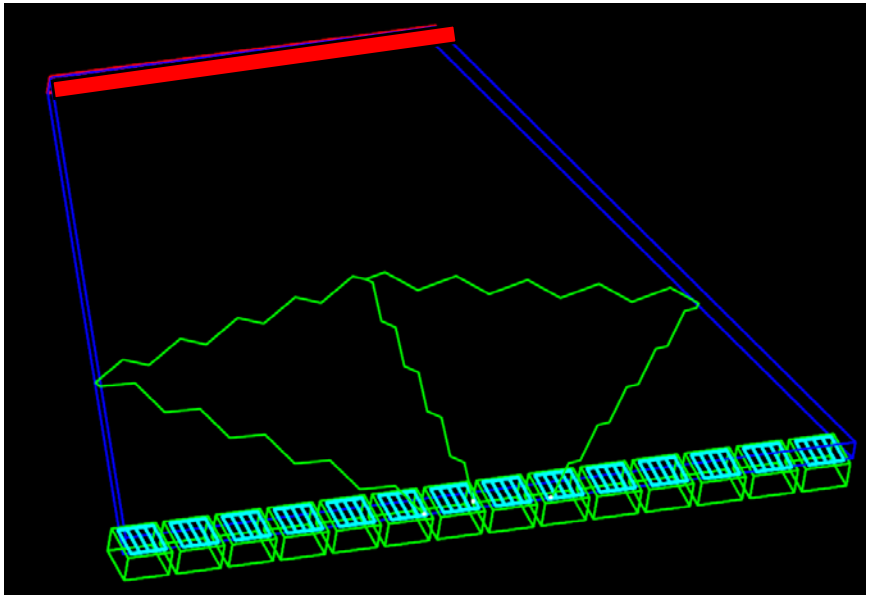
“simple geometry – with absorber”

(only direct photons are collected)

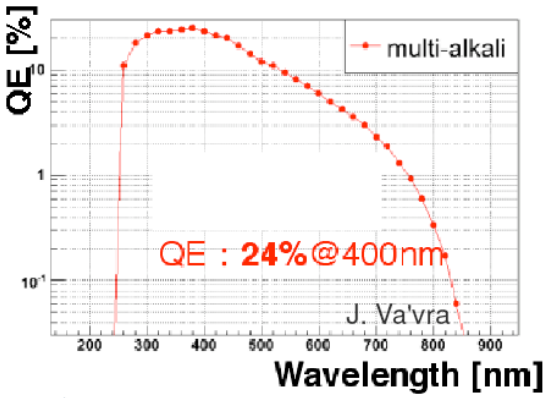


“without absorber”

(photons with different paths are collected)

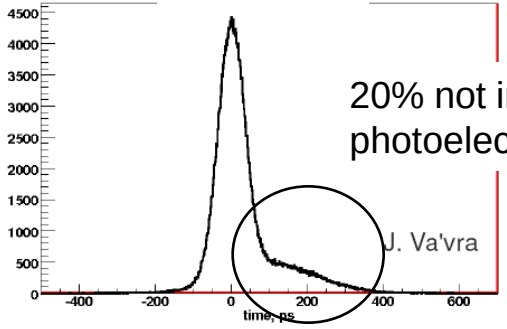


For these studies we have used SL10:



PDE = 0.24 (max.QE)
*0.65(phot. eff)
*0.82(pack. eff)
= ~0.13

TTS

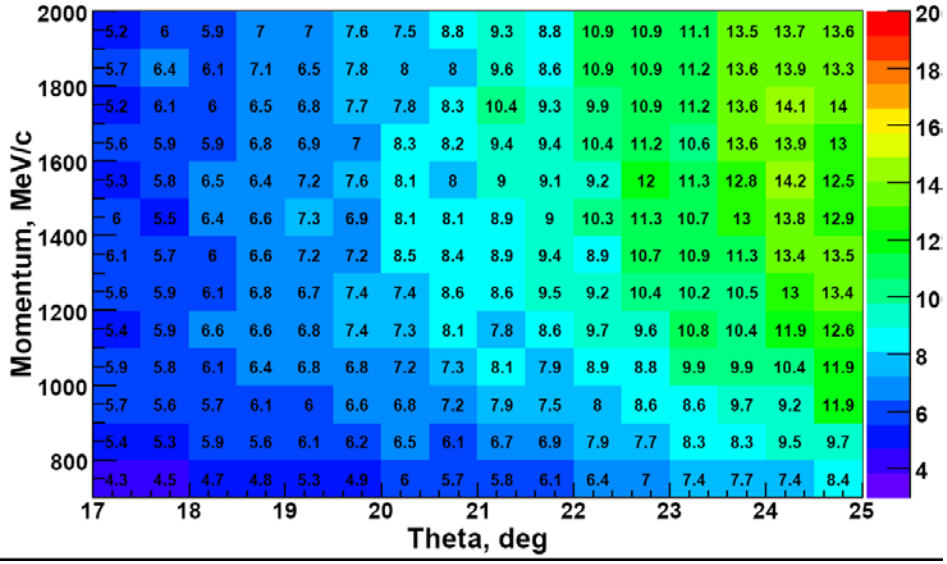


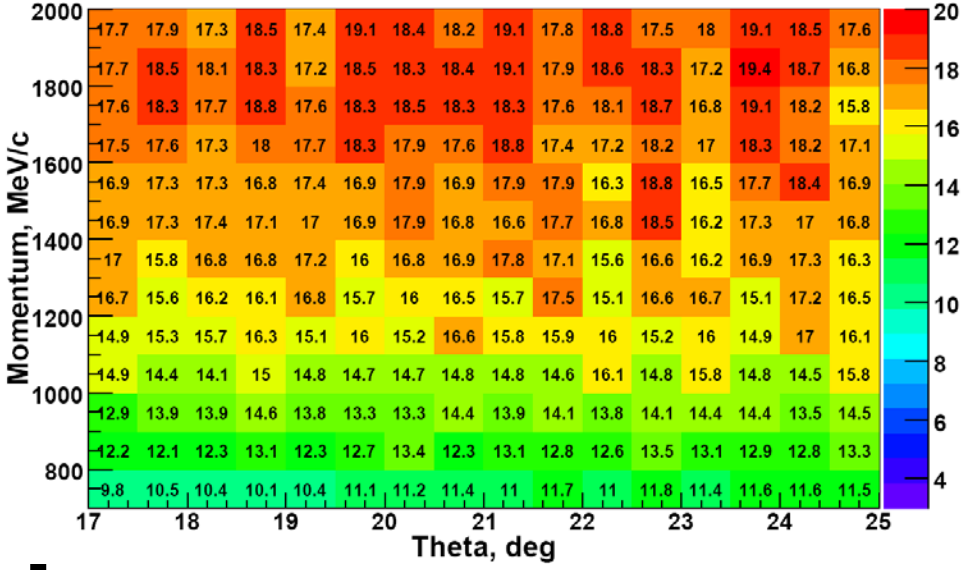
20% not in time photoelectron

“simple geometry – with absorber”

“without absorber”

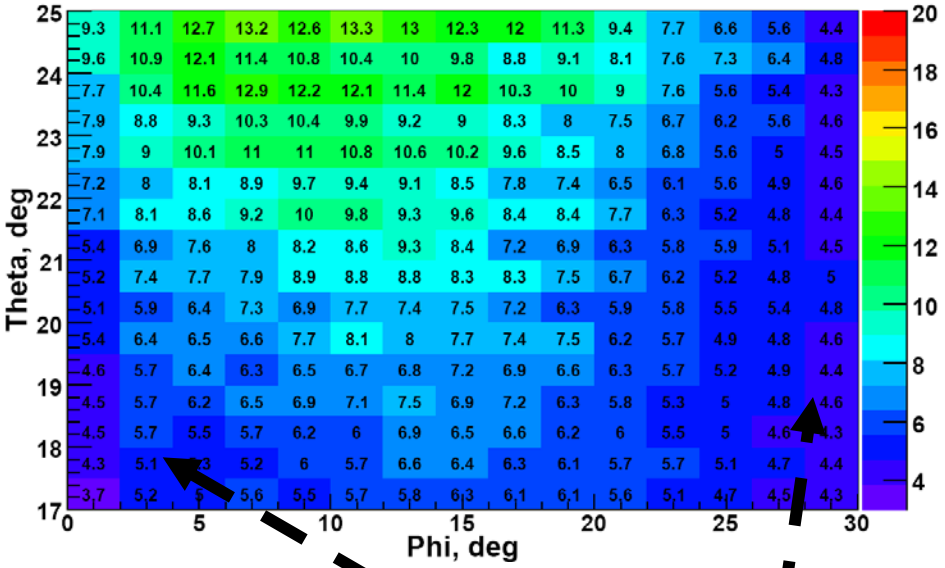
Average number of detected photelectron (phe.) momentum vs theta



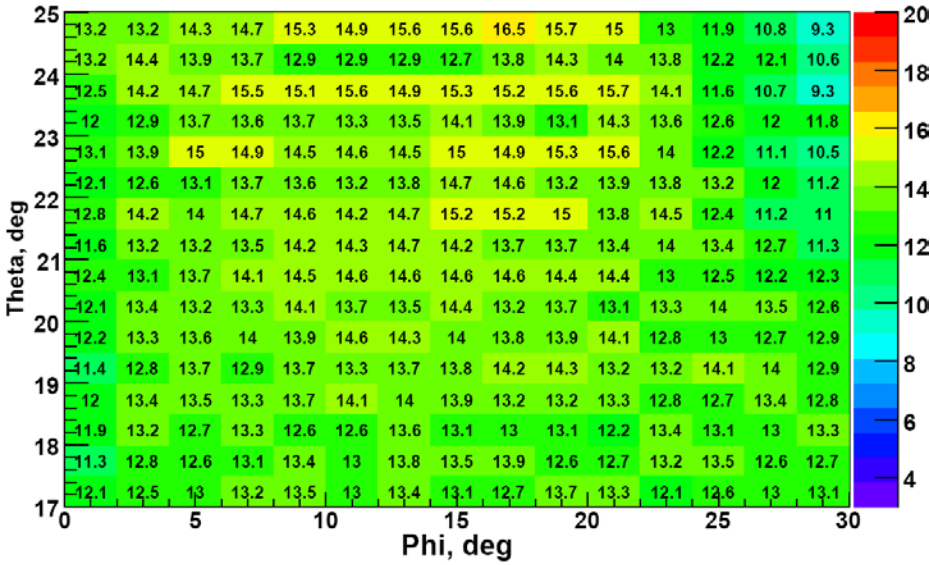


Taking a slide of the previous plot (ex. p = 900 MeV/c)

Theta vs phi for p=900Mev/c



Theta vs phi for p=900Mev/c

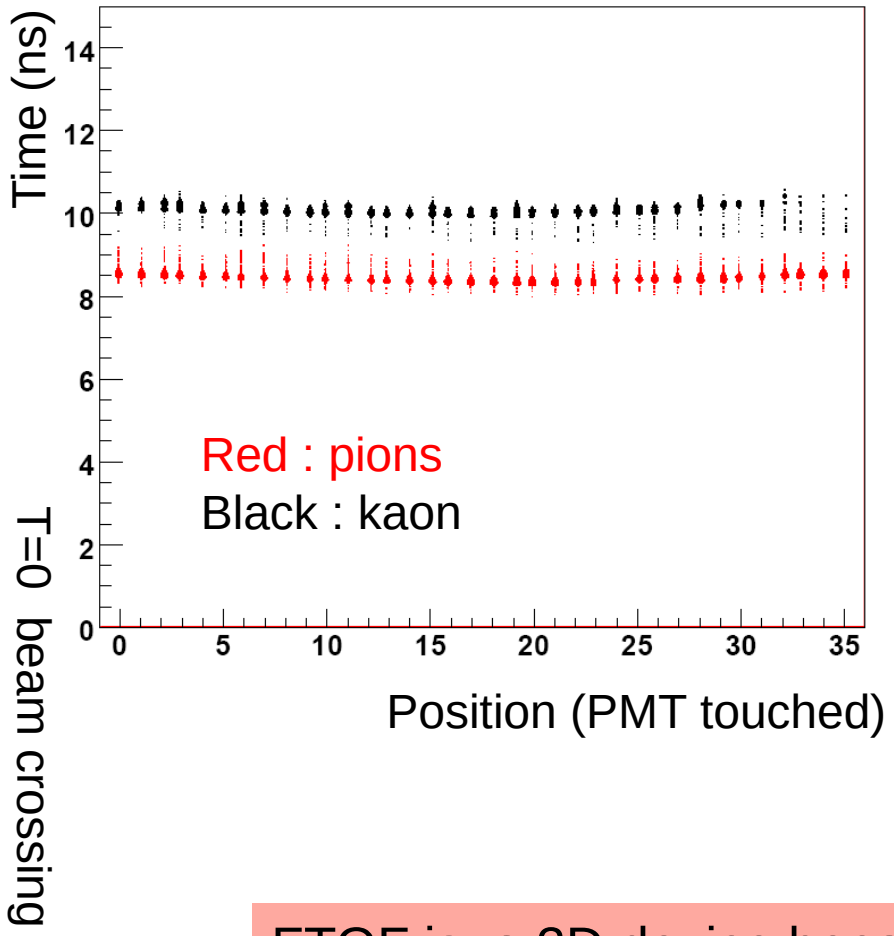


It can be noted the there is a lack of phe. in the phi-border of the detector
(for the geometry with absorber)

Overlap between sectors could help
(under study)

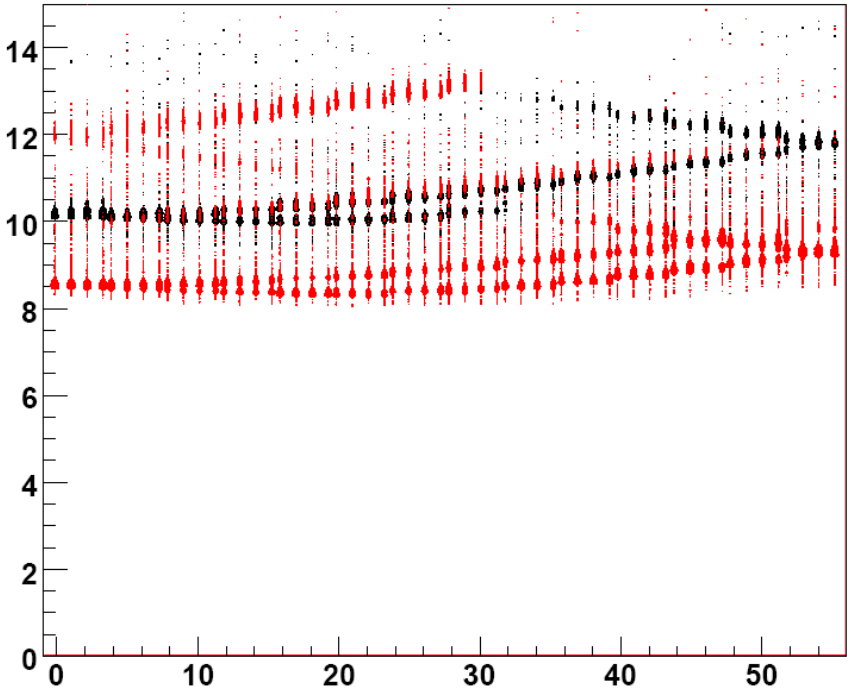
“simple geometry – with absorber”

P=700Mev , theta=17, phi=0



“without absorber”

More photons collected, time algorithm more difficult. Under study

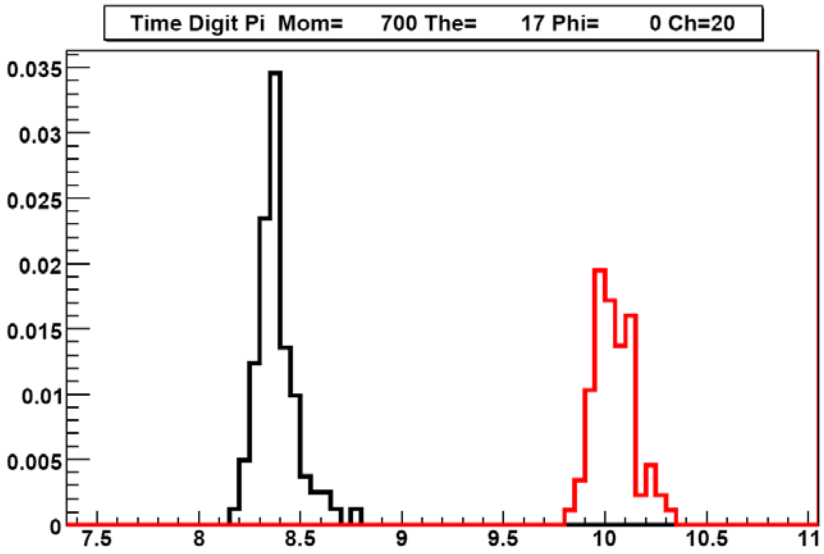


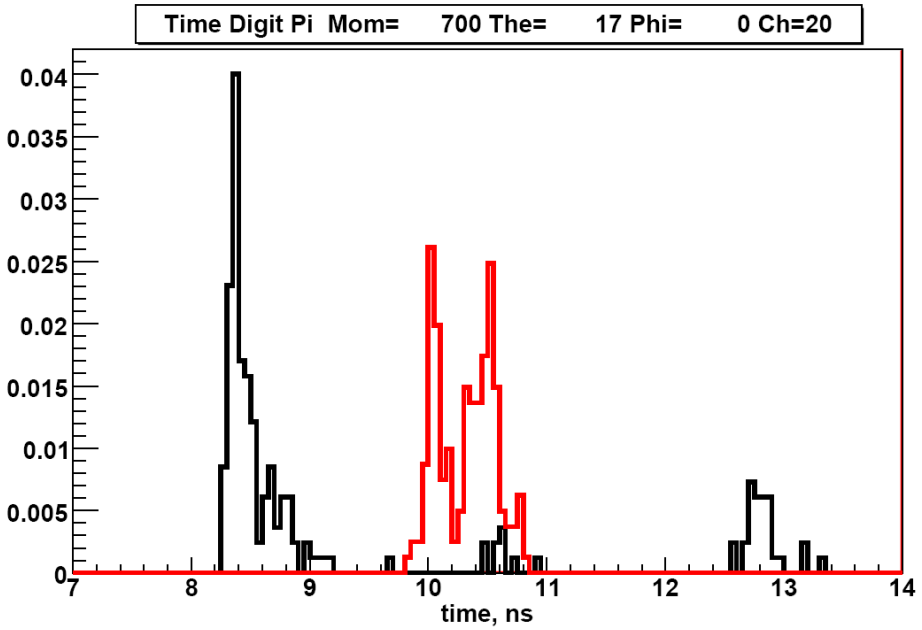
FTOF is a 2D device because it measures time vs position

“simple geometry – with absorber”

“without absorber”

In both cases we will use the algorithm T(expected)-T(measured).
Clearly in the simple geometry the algorithm is much simpler and with no ambiguities



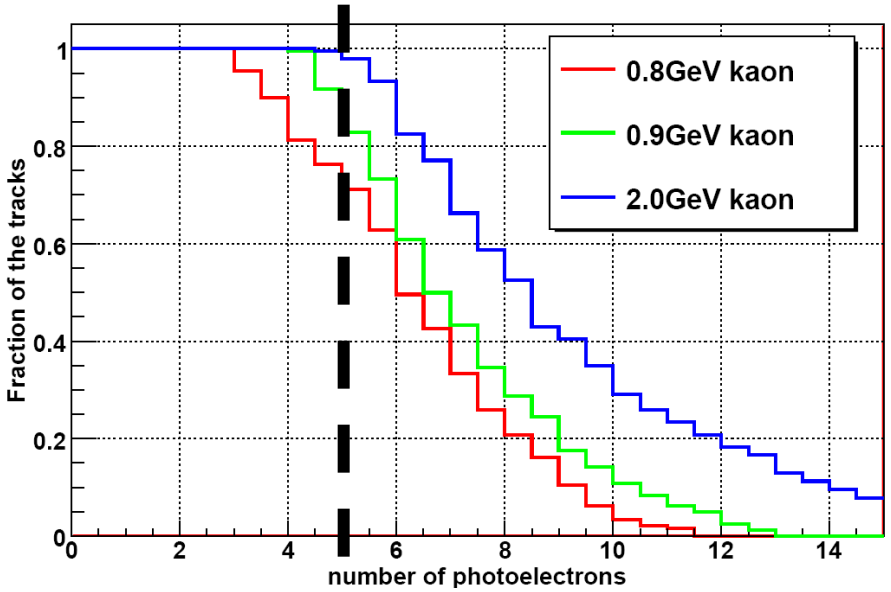


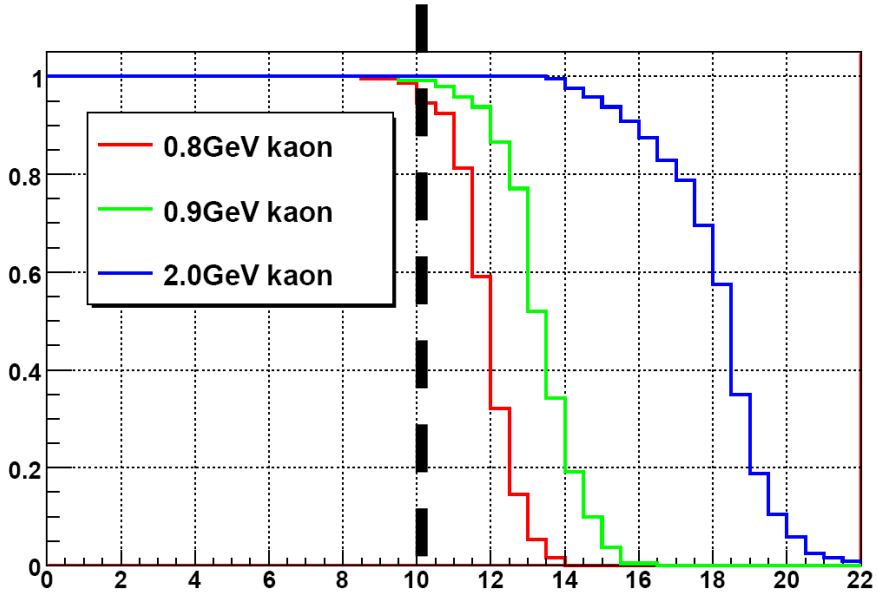
We are working on the algorithm

“simple geometry – with absorber”

“without absorber”

Fraction of tracks of a given momentum producing more than “x” number of photelectrons





more than 5 phe. for all theta
and momentum > 0.9 GeV/c

More 10 phe. for all theta
and momentum ? 0.9 GeV/c

Time vs position algorithm simple.

Time vs position algorithm more complicated

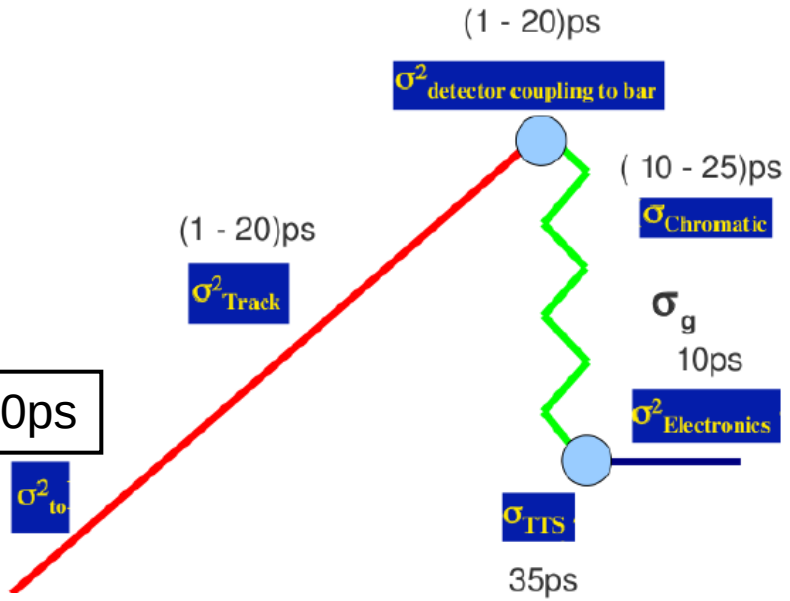
POSSIBLE IMPROVEMENTS :

- overlap between sectors
- Thicker detector (up to 15% X_0)

Time resolution

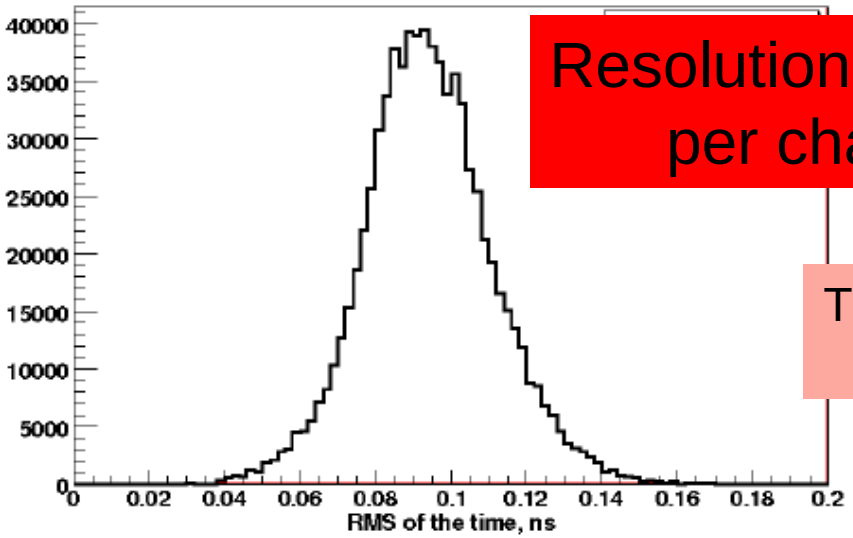
$$\sigma_{Total} \sim \sqrt{[\sigma^2_{Electronics} + (\sigma_{Chromatic}/\sqrt{(\varepsilon_{Geometrical_loss} * N_{pe})})^2 + (\sigma_{TTS}/\sqrt{N_{pe}})^2 + \sigma^2_{Track} + \sigma^2_{detector\ coupling\ to\ bar} + \sigma^2_{to}]}$$

J. Va'vra, Forward TOF update



σ^2_{to}	By hand
σ^2_{Track}	FastSim
$\sigma^2_{detector\ coupling\ to\ bar}$	FastSim
$\sigma_{Chromatic}$	Geant4
σ_g time spread due to geometry of the detector	Geant4
σ_{TTS}	By hand
$\sigma^2_{Electronics}$	By hand

$\sigma(z)/c = 600\mu m/c \sim 20ps$

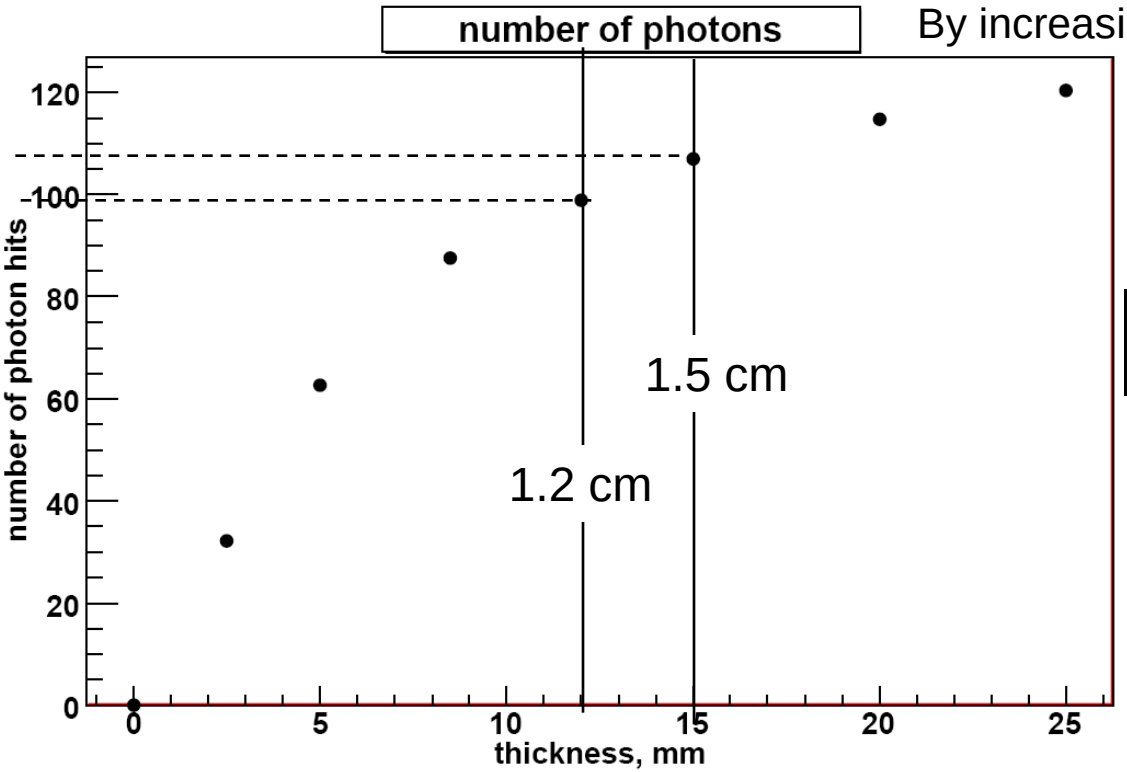


Resolution of ~90ps per channel

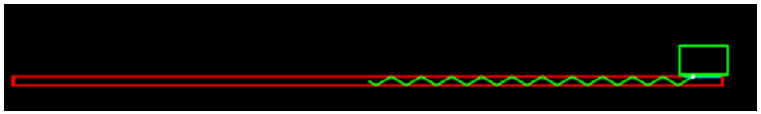
All these terms are "approximately" divided by **Sqrt (N-phe)**

The total time resolution will be between 30-40 ps (minimum 5 phe.)

Some further studies : Impact of the detector thickness (studies done for geometry “with absorber”)



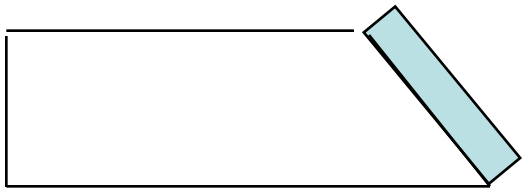
By increasing the thickness 1.2cm → 1.5cm (20%) We get 10% more photons.



The number of collected photon is not linearly growing with the thickness of the detector as understandable form the Figure

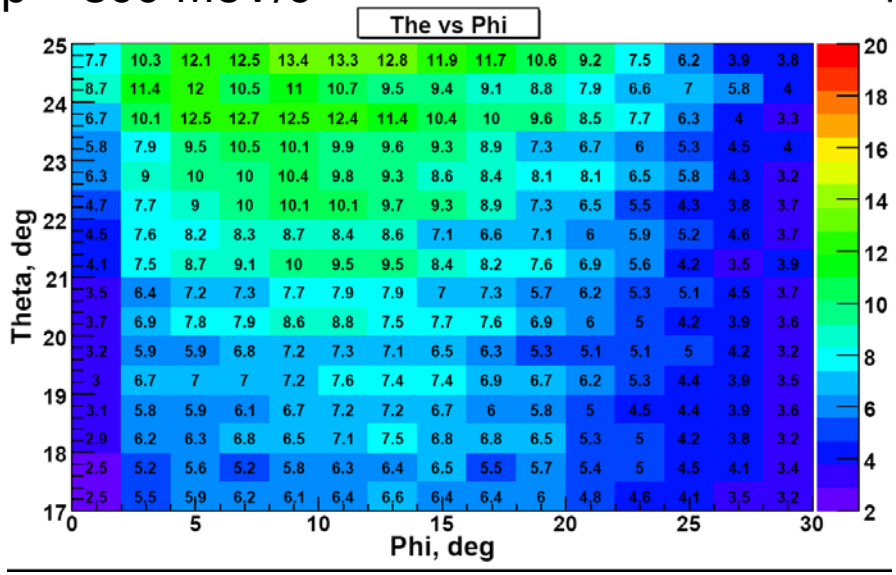
Possible solution could be to place PMT in a different way :

With reasonable PMT tilting angle for the magnetic field…

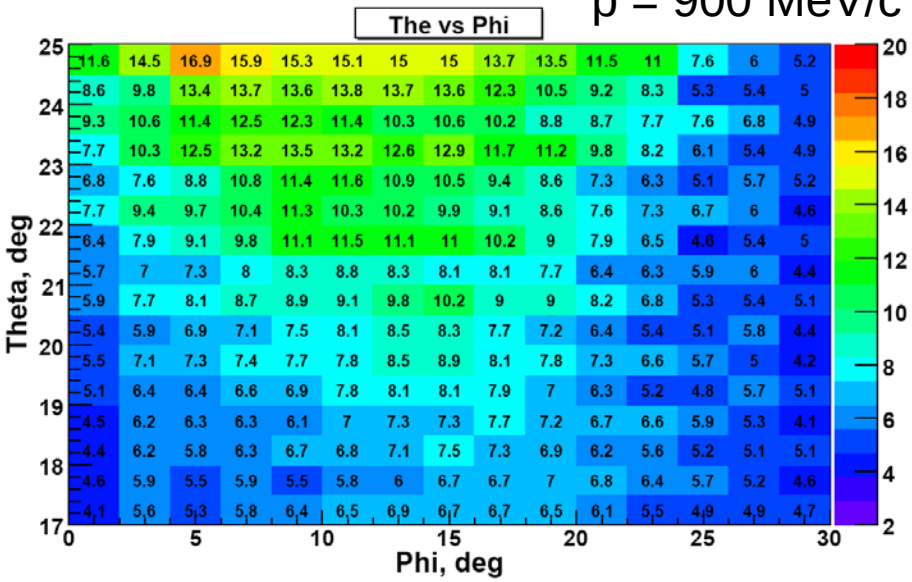


Number of photelectons collected

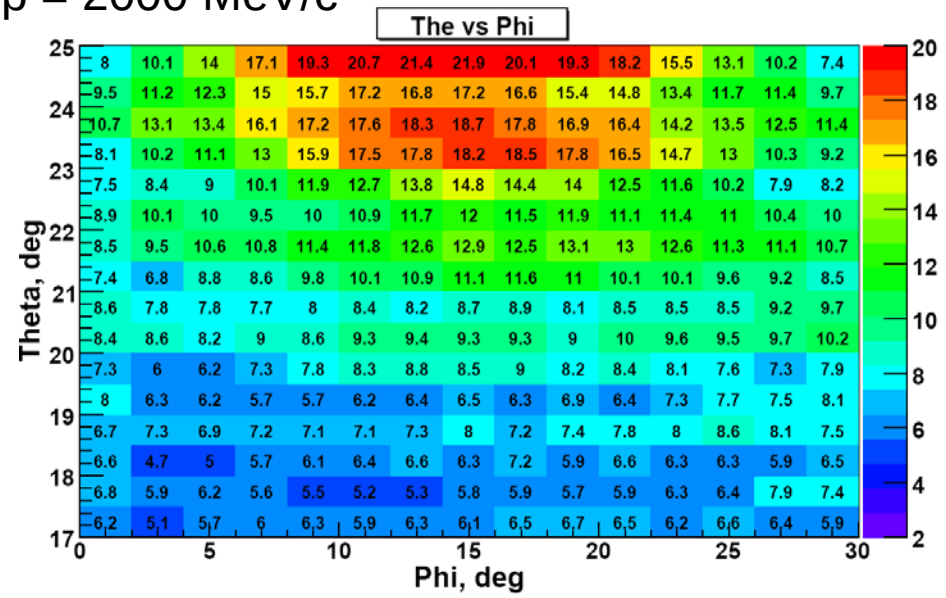
p = 800 MeV/c

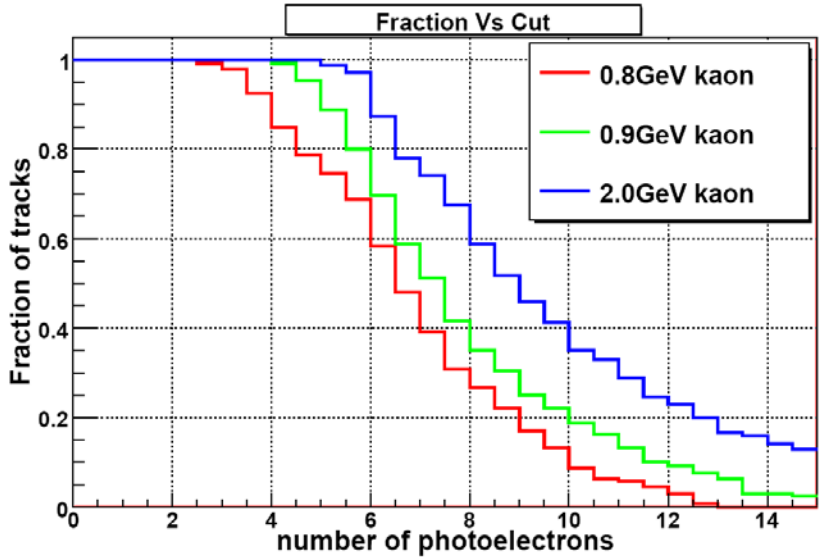


p = 900 MeV/c



p = 2000 MeV/c





Improved situation with respect to the geometry at 1.2cm thickness

Preliminary conclusions :

The FTOF device for PID in the forward region located near to the DCH seems to meet the requirements of the minimum number of collected photoelectrons.
Working without absorber (all faces reflecing photons) we can collect at least 10 photoelectrons
in all theta range and for p>0.9 GeV/c

The time resolution per photoelectron is of about 90 ps.

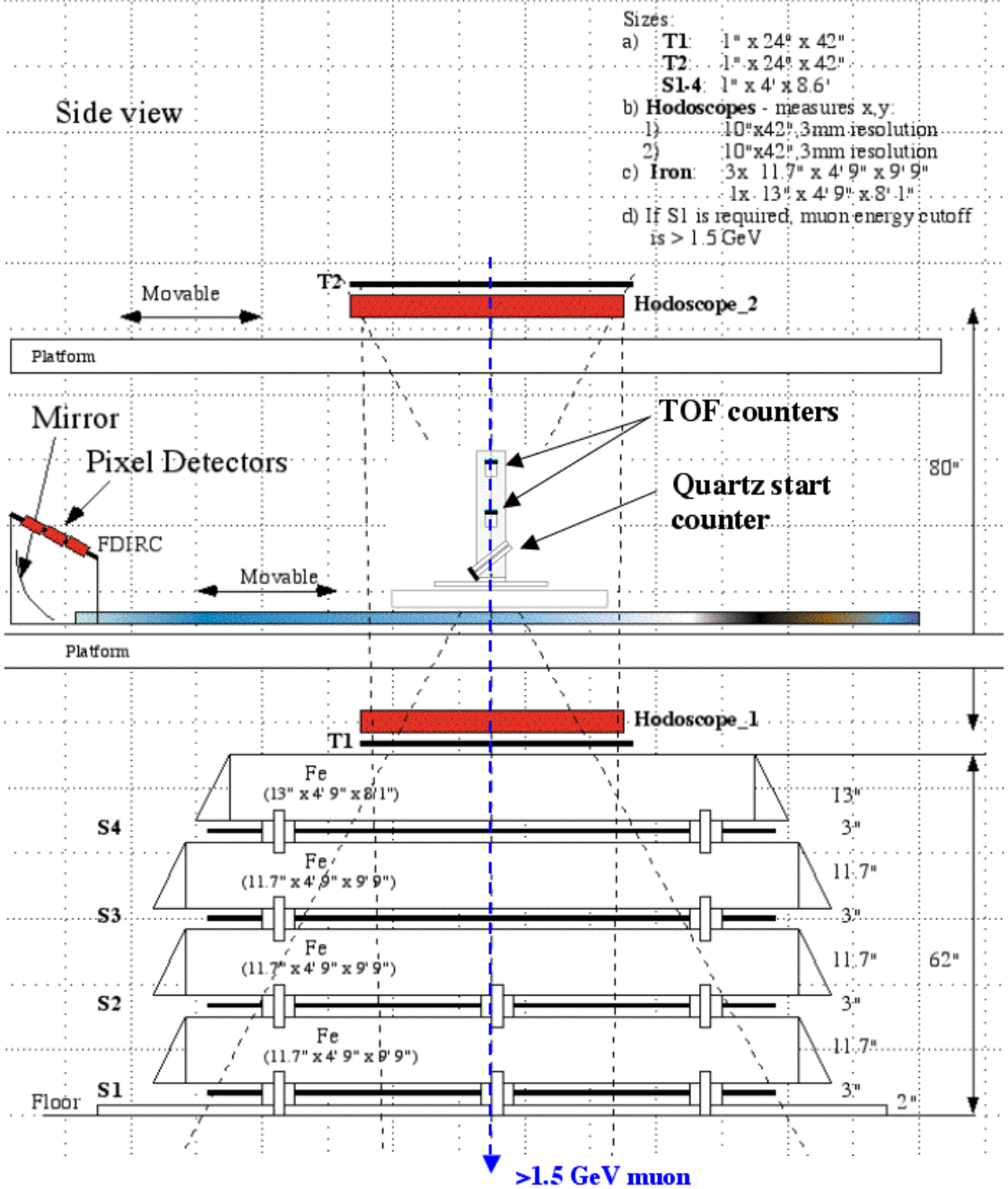
CAVEAT : Machine background has to be studied.

We propose to perform experiments of the FTOF counter at SLAC at the CRT telescope

AIMS

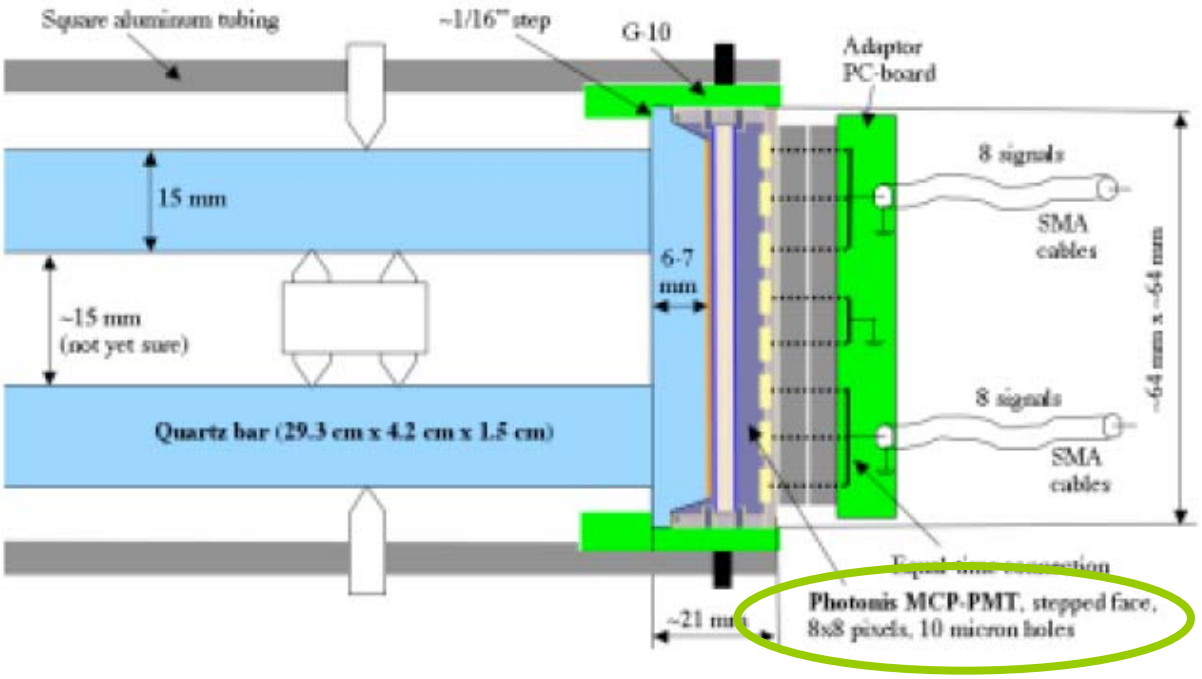
- To make detector + PMT + electronics working together
- To test and to prove on data the FTOF principle (for instance the algorithms for the geometry without absorber)

The SLAC Cosmic ray telescope



Experiment – PHASE I

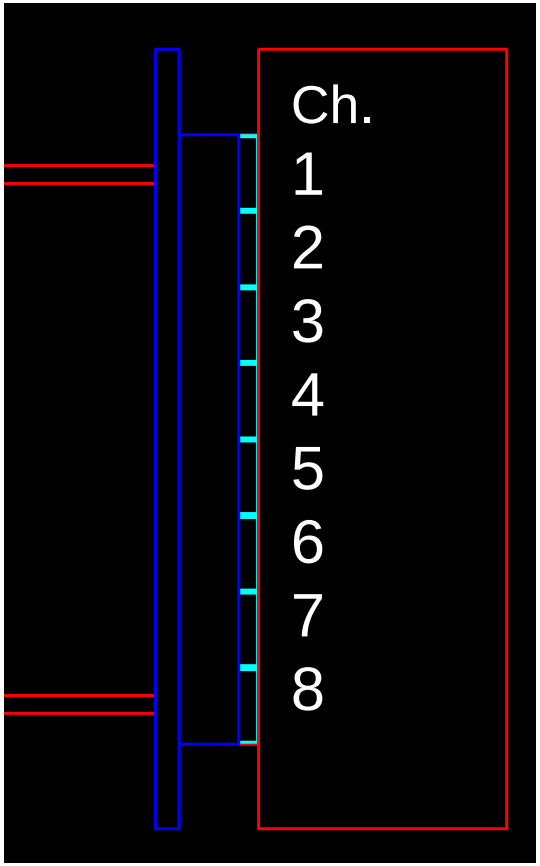
Quartz bars and the Photonis MCP-PMT (10 micron holes) are available at SLAC

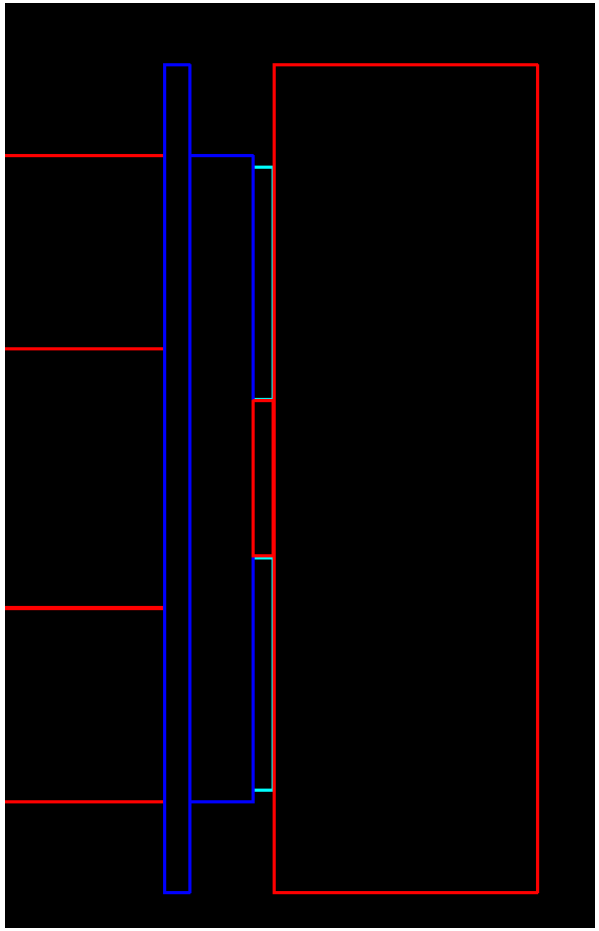


2 Quartz bar
From BaBar
29.3 X 4.1X1.5 cm

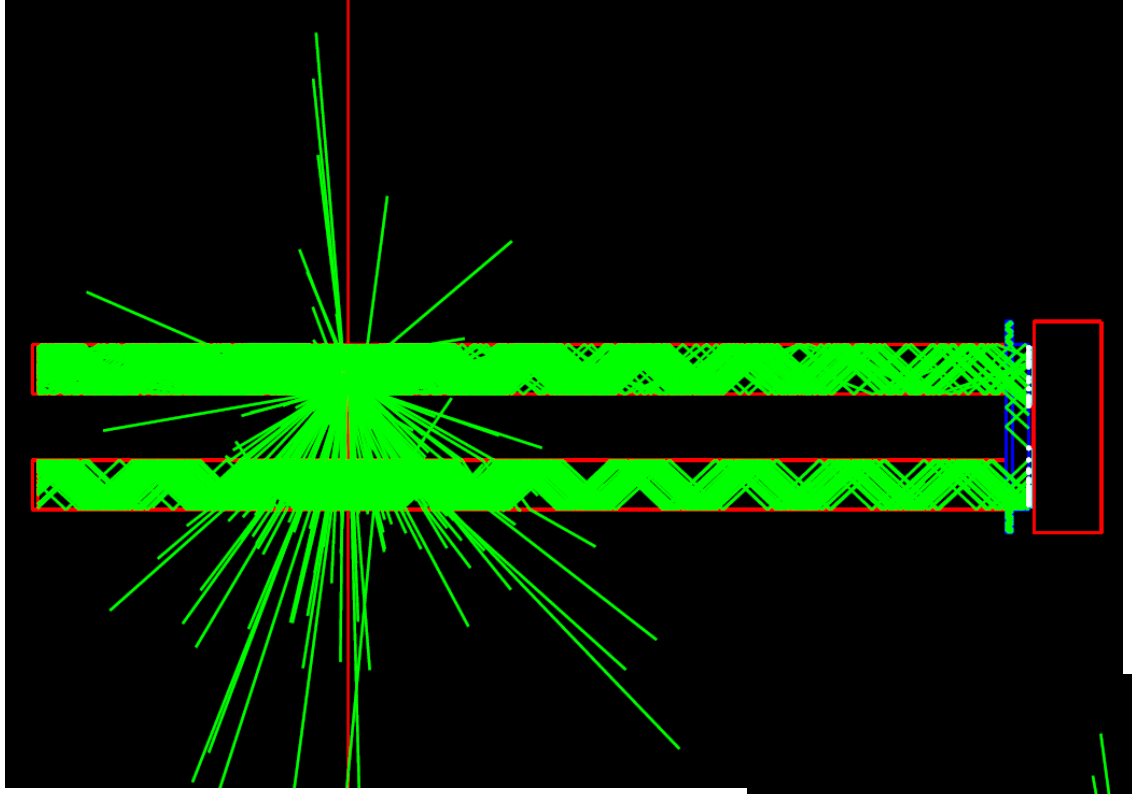
Photonis MCP-PMT
In this case PDE=0.2
- no packing efficiency
- no tails in TTS

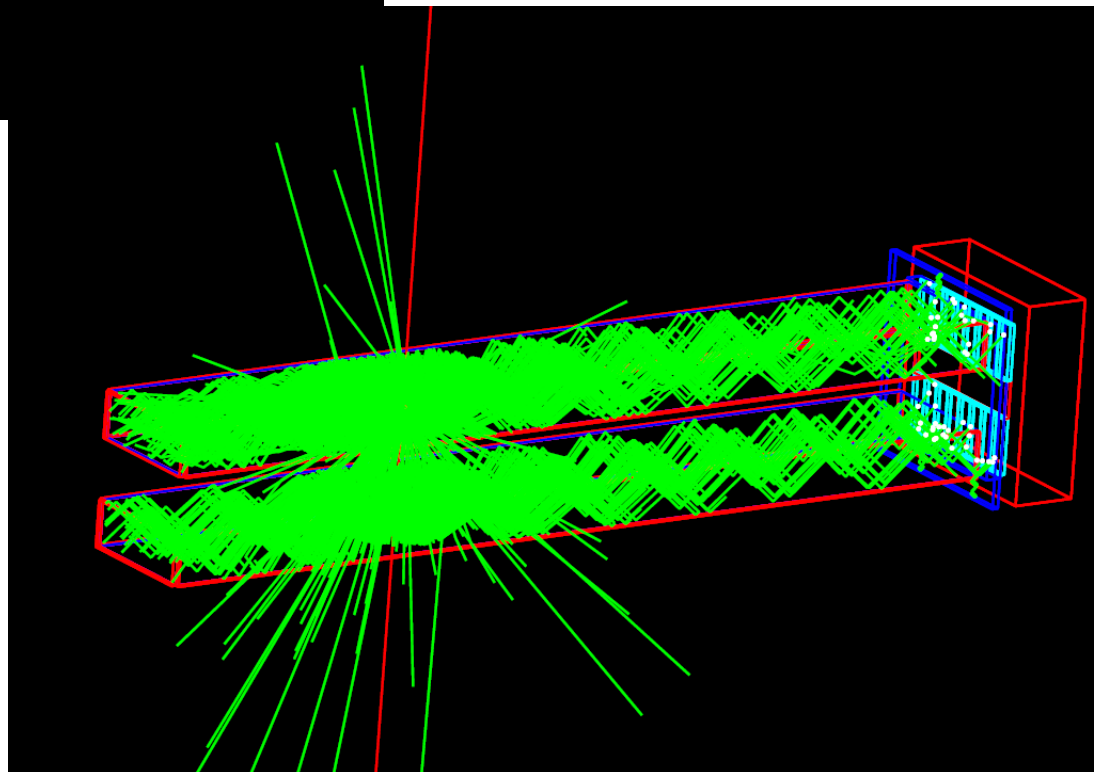
For this experiment we will need 8 wavecatcher electronic boards
(see at the end of cost evaluation)

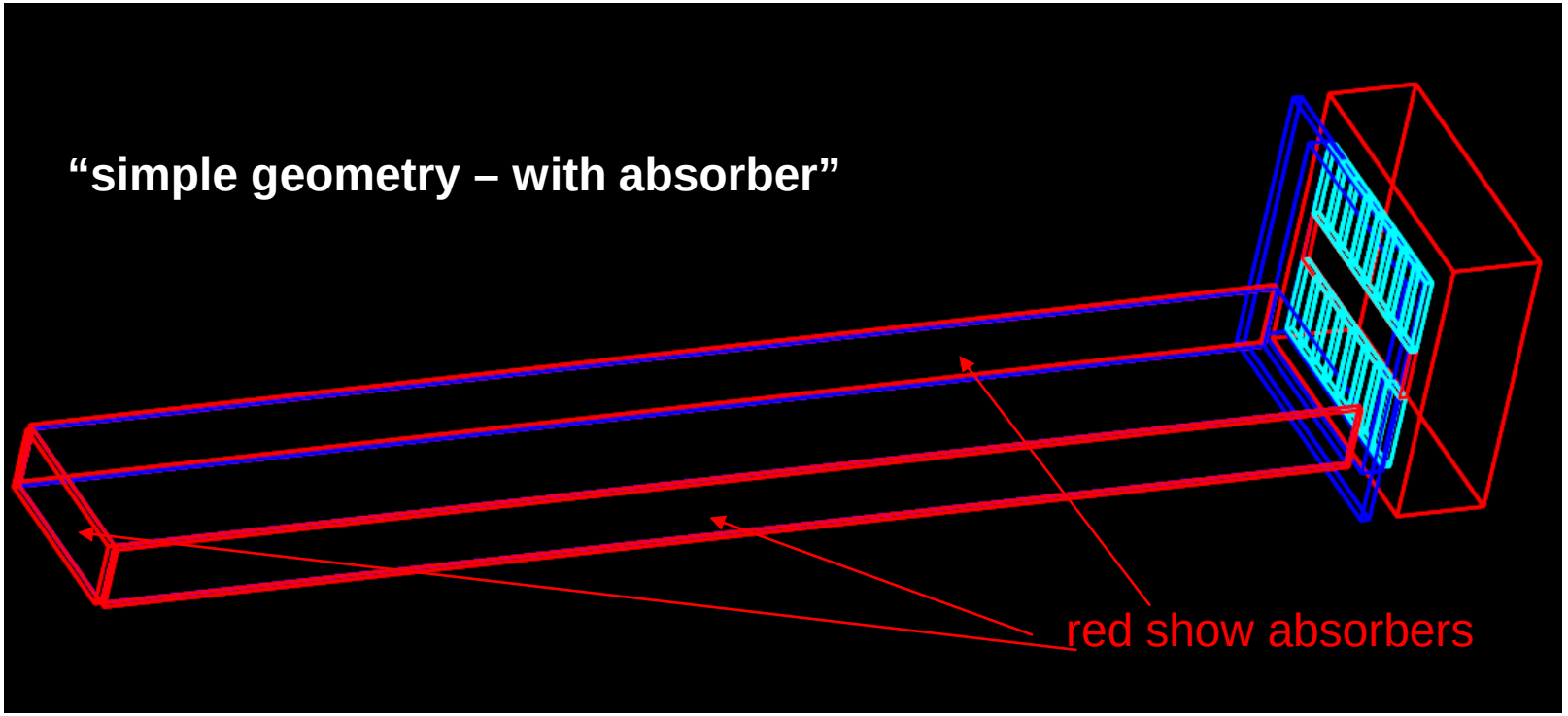

Ch.
1
2
3
4
5
6
7
8

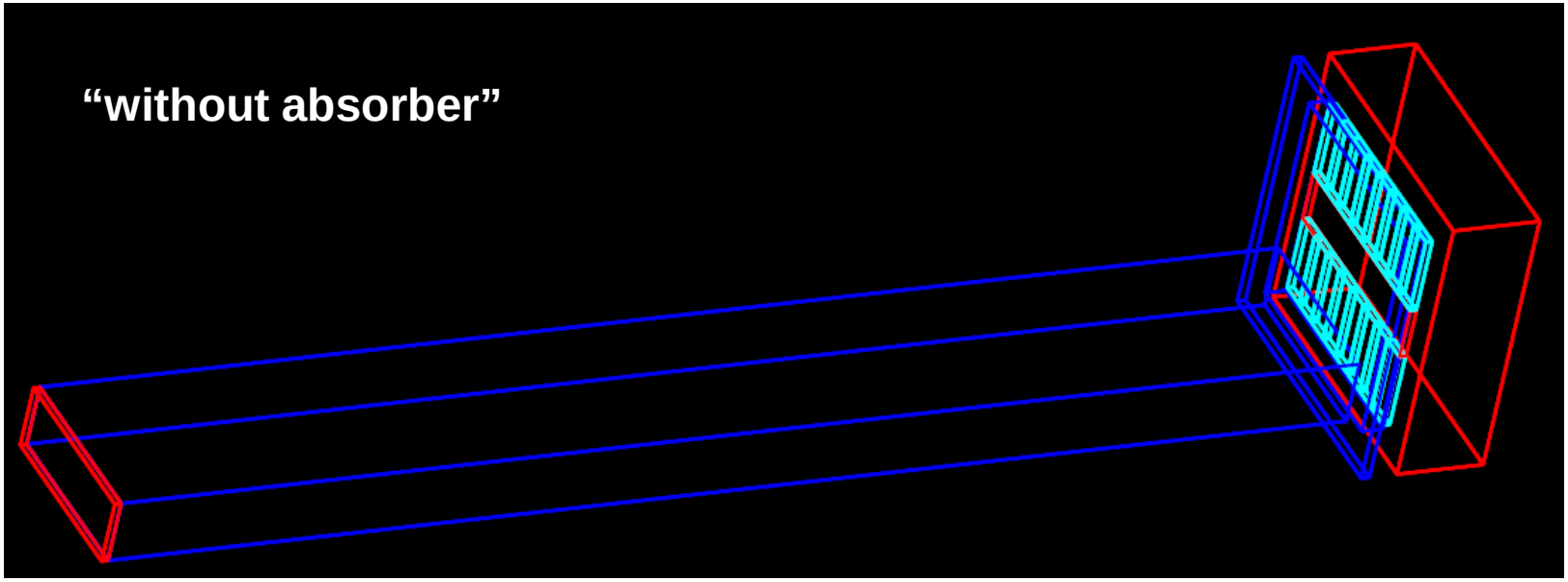


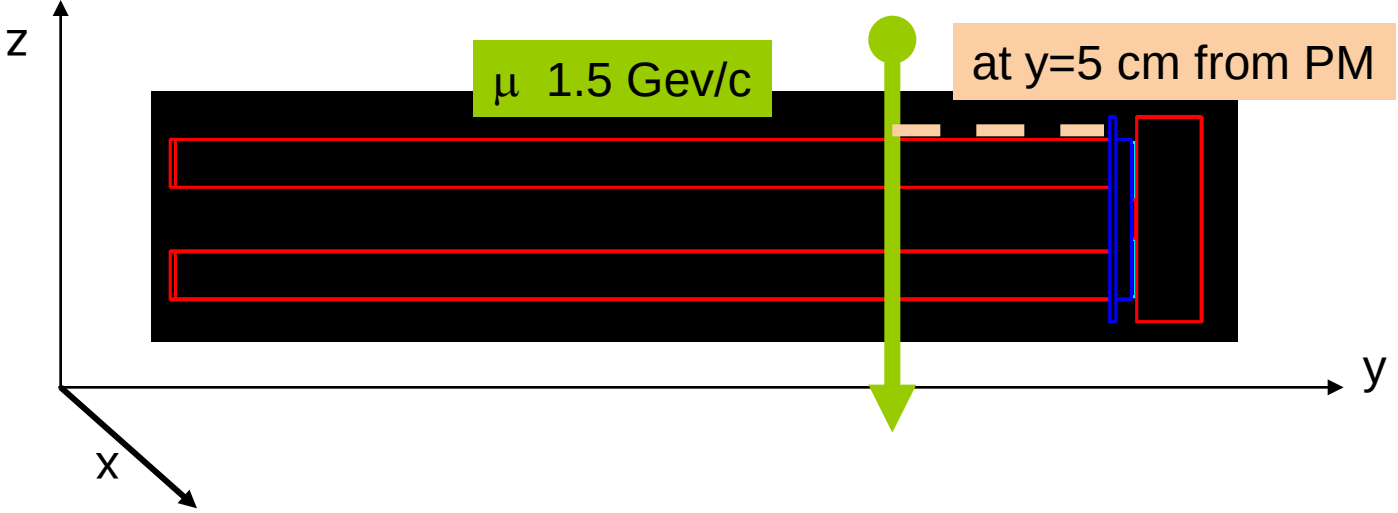
An event : muon at 1.5 GeV/c





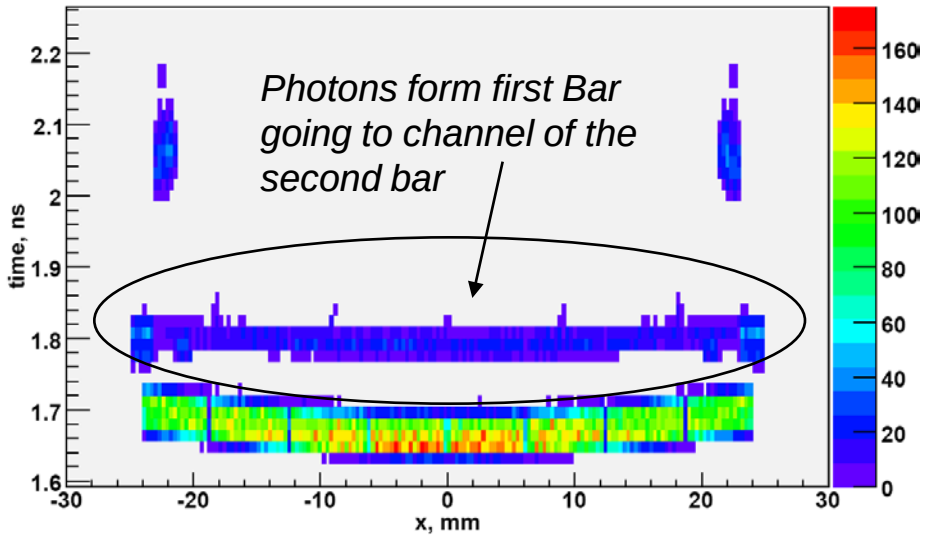

“simple geometry – with absorber”
red show absorbers


“without absorber”

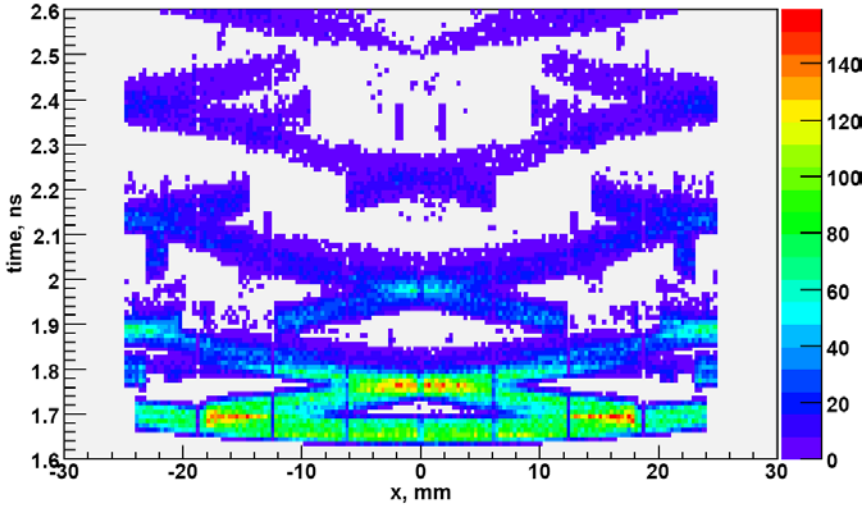


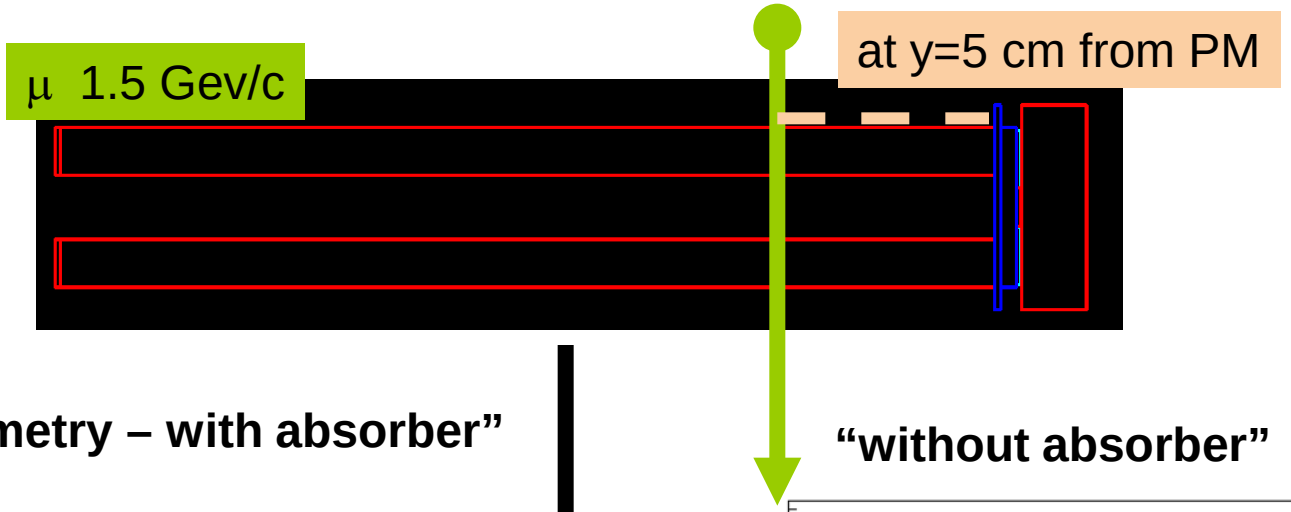
As in SuperB, we can define a simple geometry and a geometry with absorber

“simple geometry – with absorber”

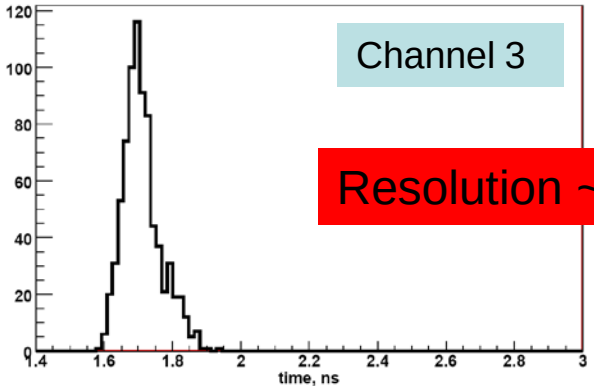


“without absorber”

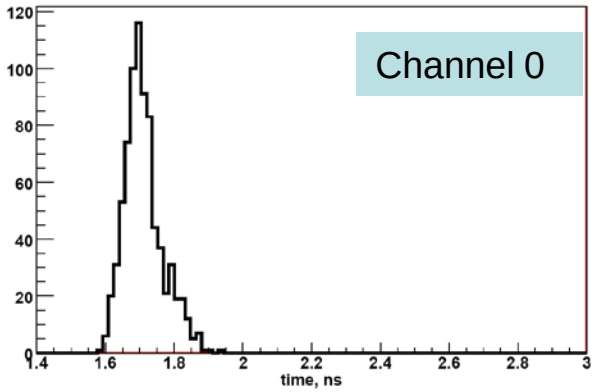




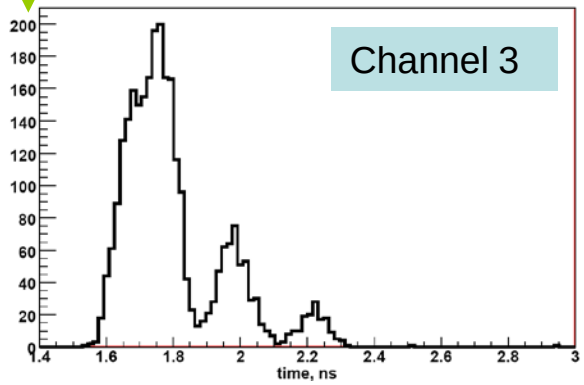
“simple geometry – with absorber”

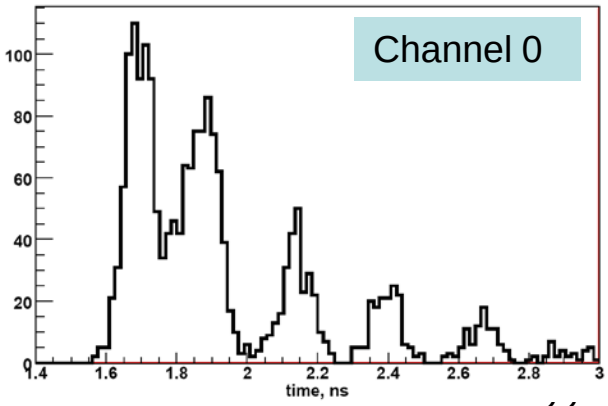


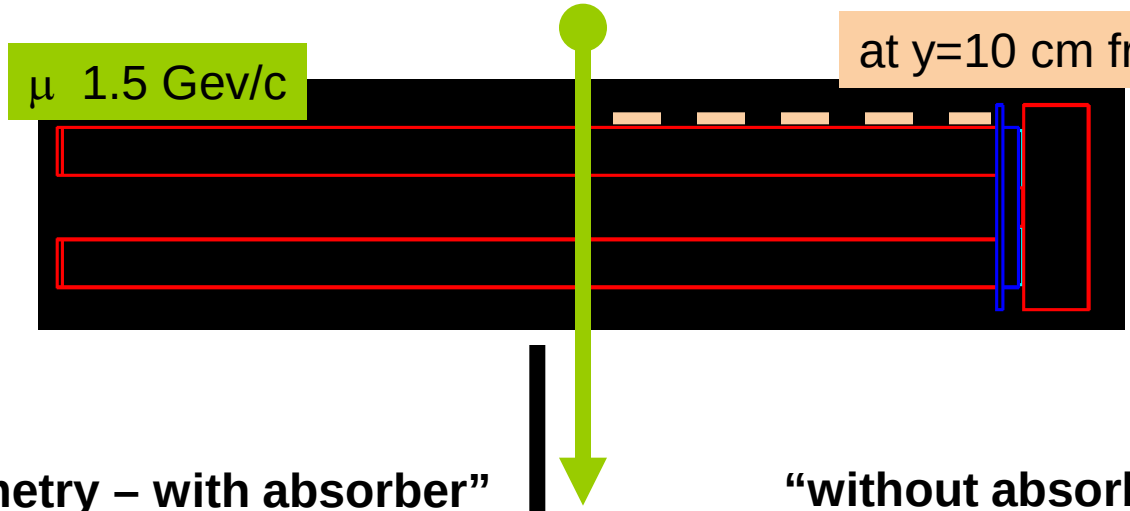
Resolution ~50ps



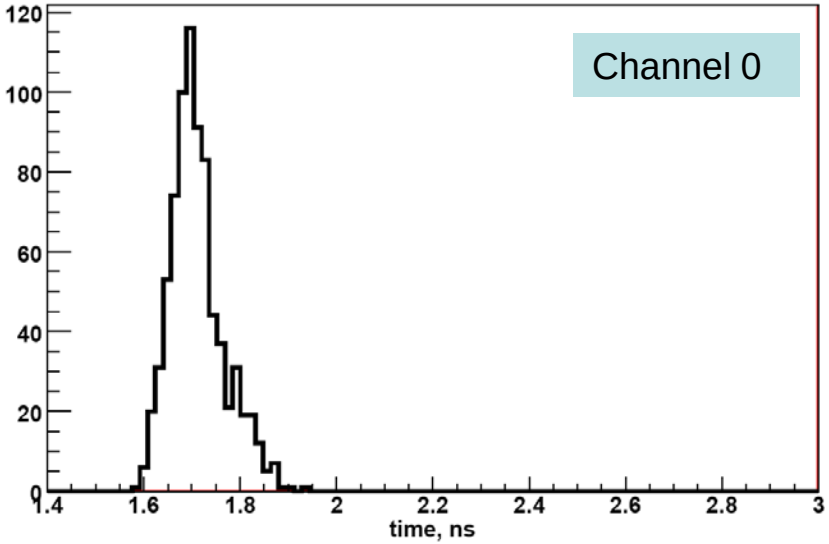
“without absorber”



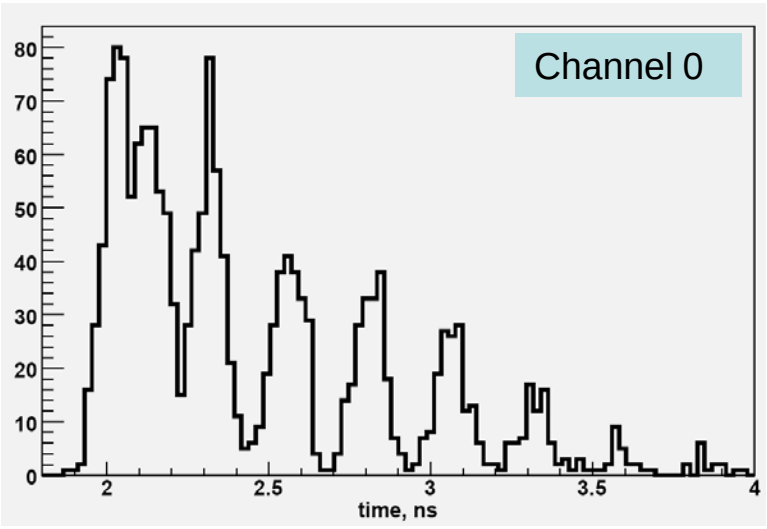


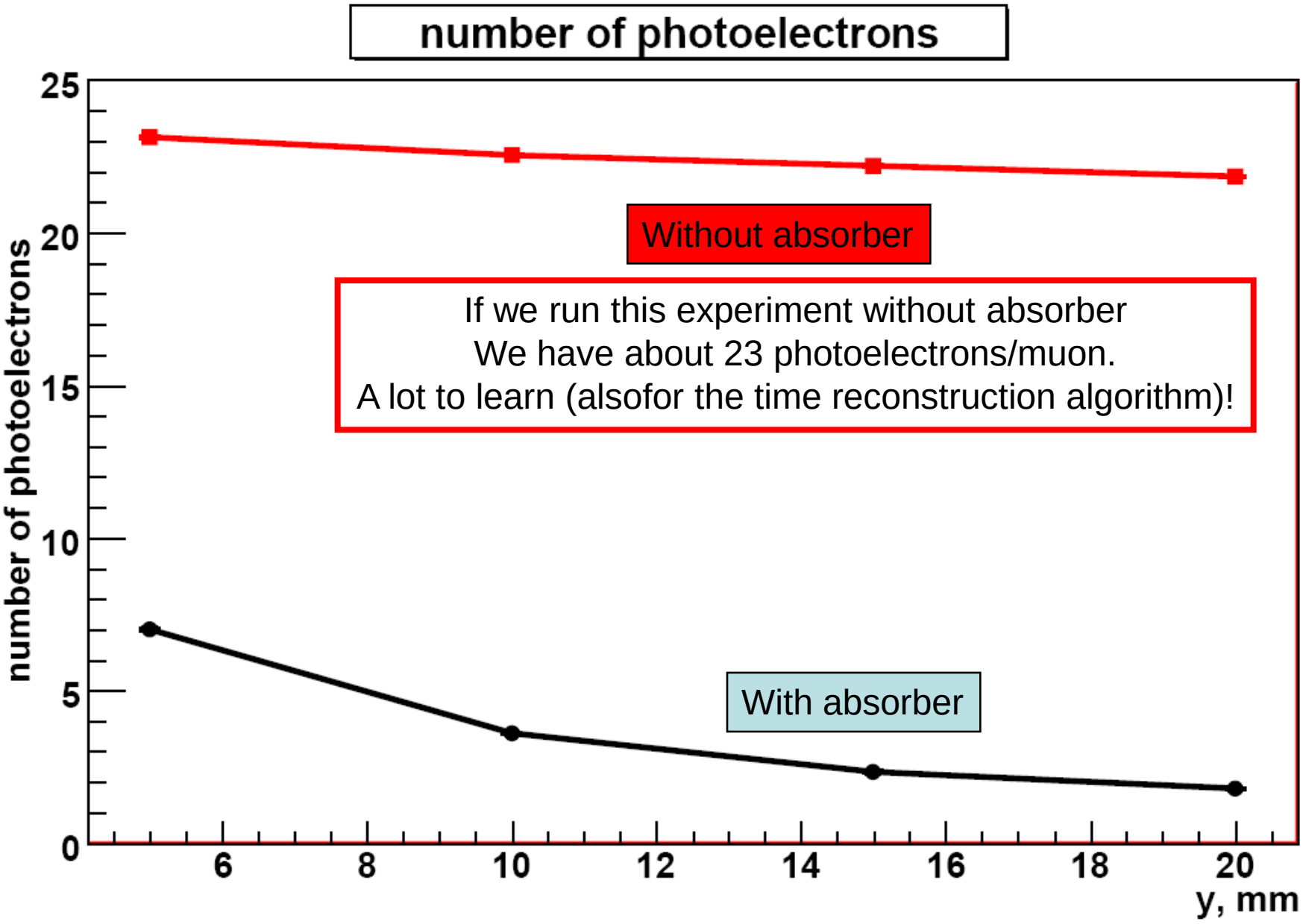


“simple geometry – with absorber”

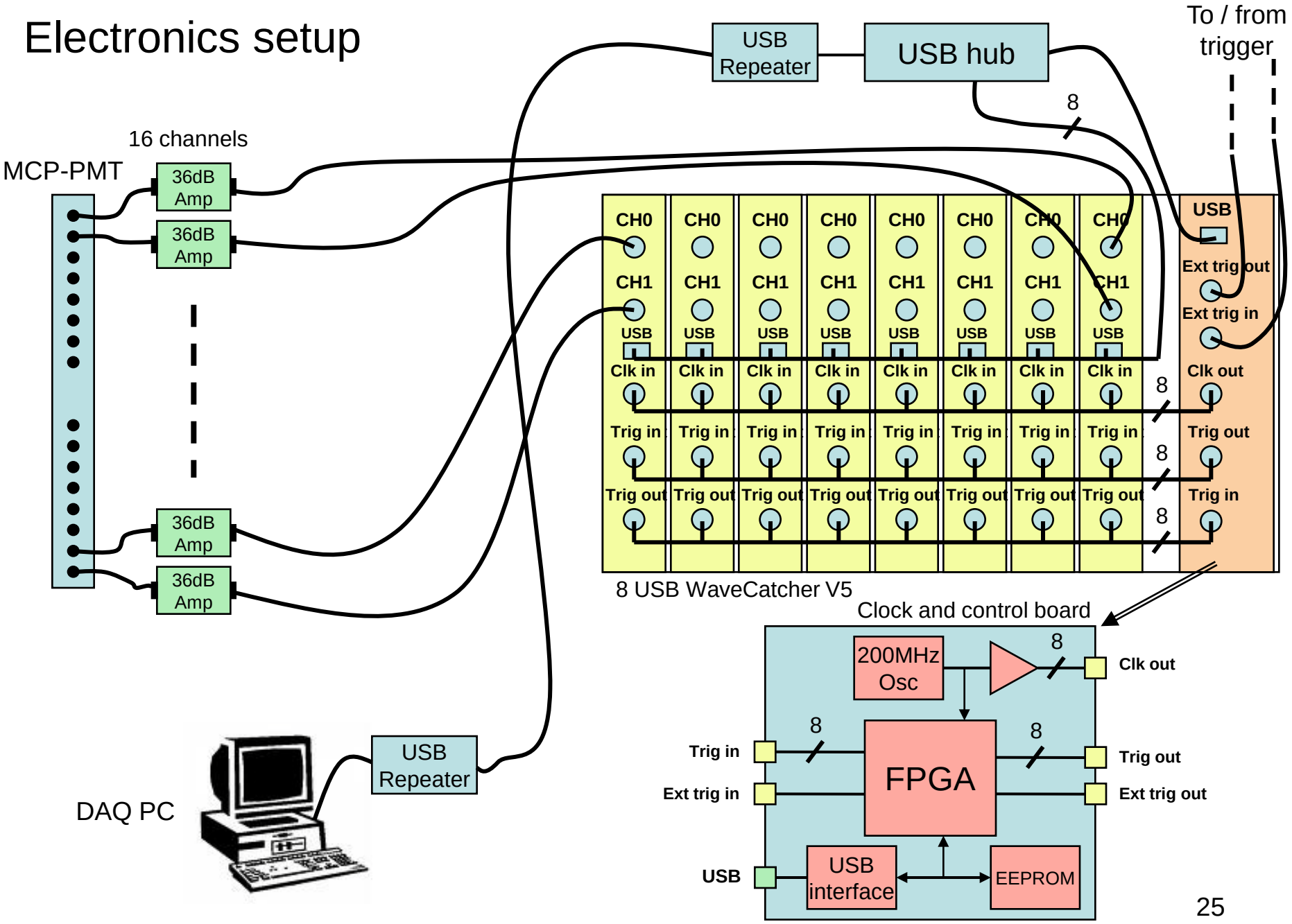


“without absorber”



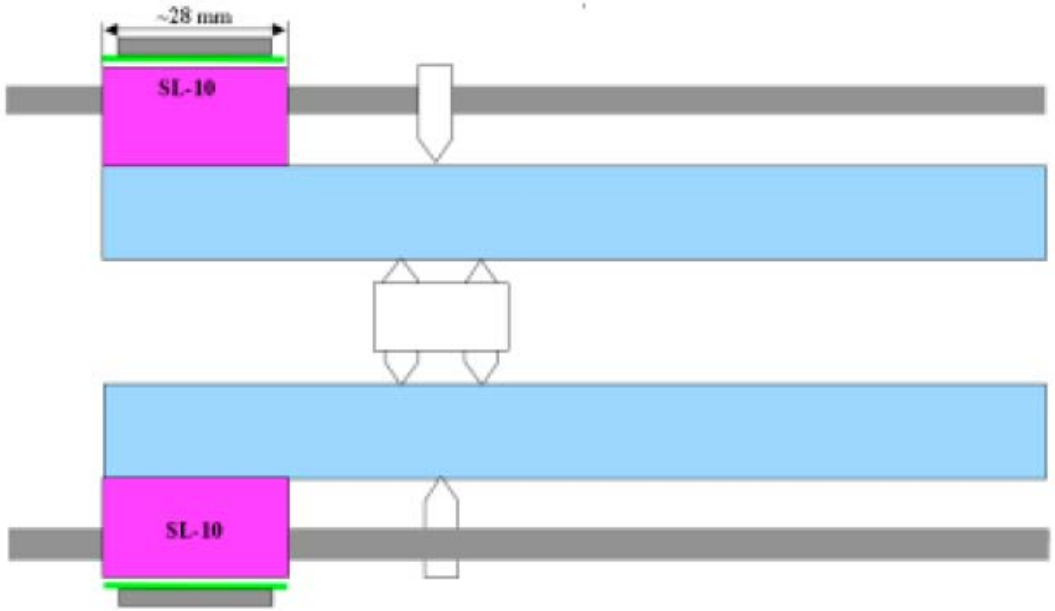

number of photoelectrons
number of photoelectrons
25
20
15
10
5
0
6
8
10
12
14
16
18
20
y, mm
Without absorber
If we run this experiment without absorber
We have about 23 photoelectrons/muon.
A lot to learn (alsofor the time reconstruction algorithm)!
With absorber

Electronics setup



Experiment – PHASE II

We foresee another experiment with two SL-10 PMT in the position indicated on the Figure.



This experiment will be very useful to :

- make detector + PM + electronics working together
- test and to prove on data the FTOF principle
  [for instance the algorithms for detector without absorber]

Estimated cost

Experiment – PHASE I

Electronics cards :

- 1 PM base board (to design) => 500 Euros
- 16 amplifiers MITEQ AM-1610-1000 => 375 Euros each
- 8 USB Wave Catchers (bare board) => 600 Euros each
- 1 Clock and Control board (to design) => 1500 Euros
- 80 cables with SMA plugs => 1500 Euros
- USB repeater and cables => 300 Euros

TOTAL 14,6K Euros

Experiment – PHASE II

2 SL-10 PMT ➔ 11KEuros each.
Double the electronics (if yes) ➔ 14,6K Euros

TOTAL 36,6K Euros

Preliminary calendar	May 1st-15th	May 15th-end	Jun 1st-15th	Jun 15th-end	Jul 1st-15th	Jul 15st-end	Aug 1st-15th	Aug 15th-end	Sep 1st-15th	Sep 15th-end	Oct 1st-15t	Oct 15th-end	Nov 1st-15th	Nov 15th-end
Mechanics														
Electronics Cards Design														
Electronics Card tests														
Acquisition Software devel.														
First Test on CRT														
Installation On CRT														
Running (1 month)														
Ordering SL-10														
Test SL-10														
Running (1 month)														