

# GEANT4 MC simulation of TOF at PANDA

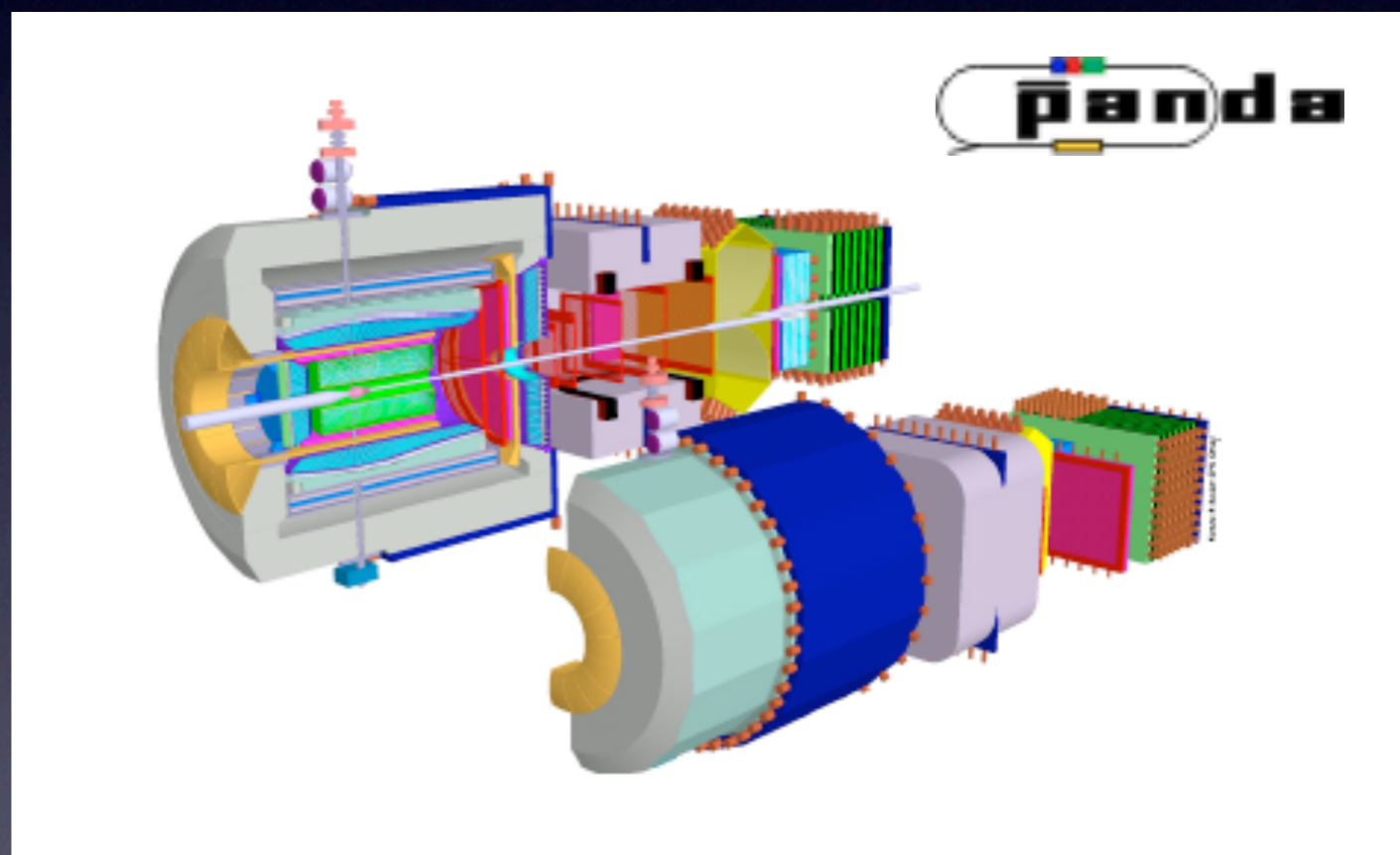
## Collaboration Meeting

10.12.2012 GSI

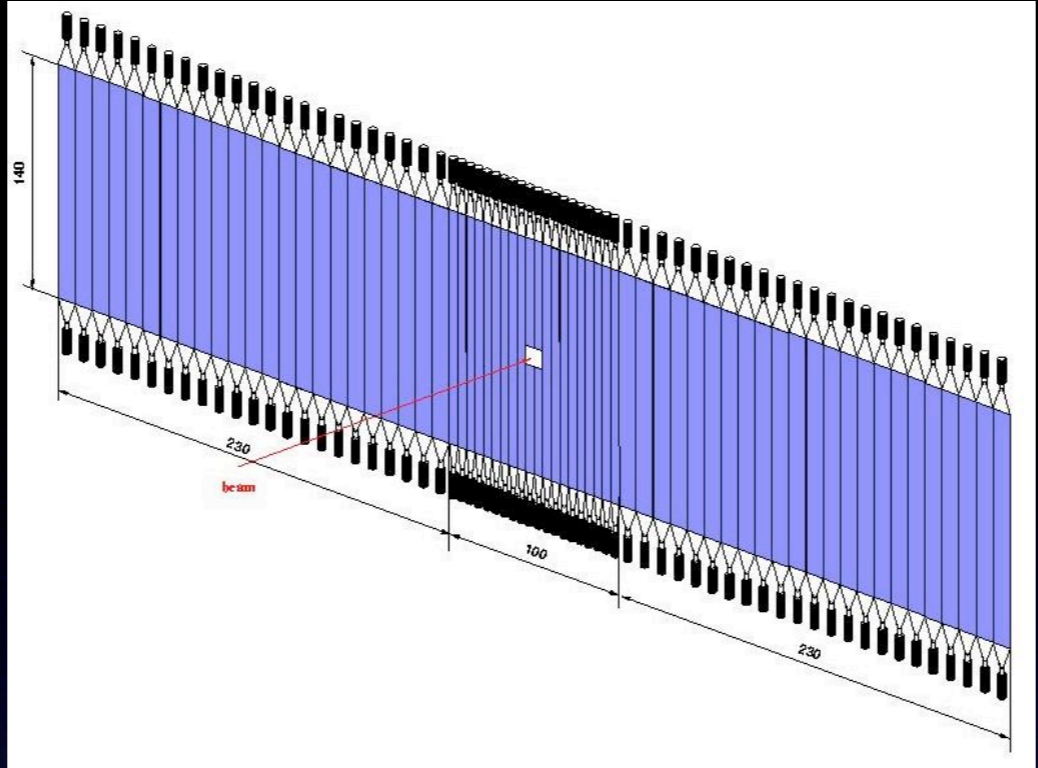
Polina Kravchenko

(PNPI)

- Introduction.
- Simulation of optical processes in GEANT4.
- MC studies. Time distributions.
- First estimations for time resolution.



# Geometry



# TOF WALL

BICRON 408

46 plates  $140 \times 10 \times 2.5 \text{ cm}^3$

20 plates  $140 \times 5 \times 2.5 \text{ cm}^3$

## PMT:

Hamamatsu R2083, R4998

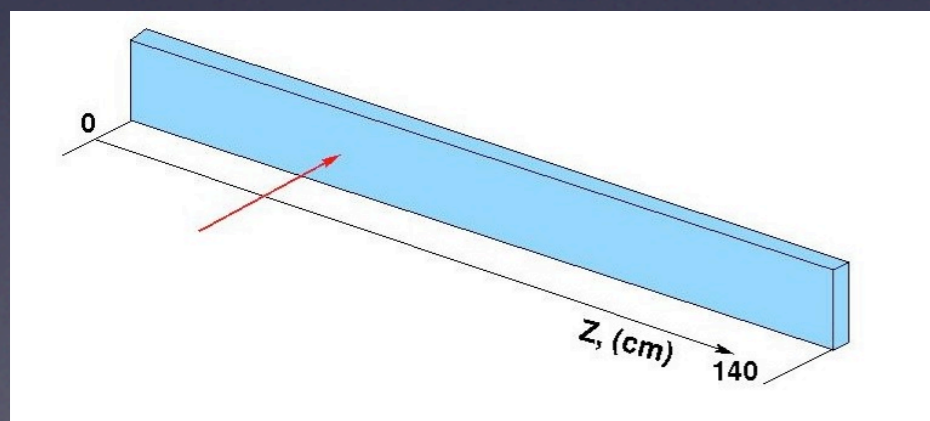
## TOF Side

14 plates  $100 \times 10 \times 2.5 \text{ cm}^3$

## SiPM

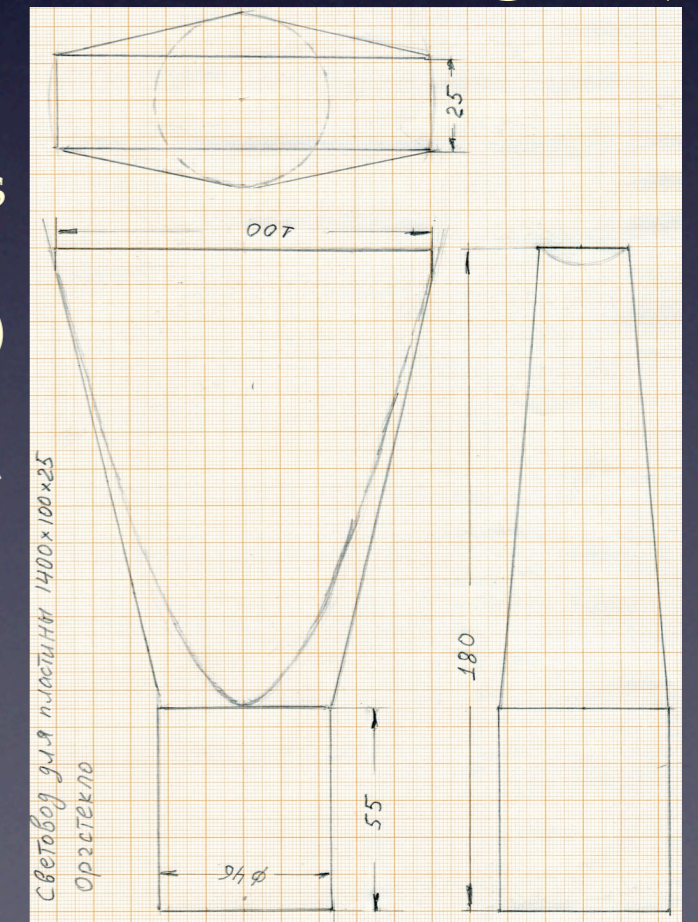
For simulation

## Scintillator BC 408



with light guides  
for 2" PMT (46 mm diameter)

Plexiglass  
Mylar wrapping



# Simulation of optical processes in GEANT4

## Scintillation process only. (No Čerenkov photons)

### Material properties:

- atomic composition of the materials, density
- refractive index
- absorption length
- scintillation yield
- scintillation time constant (slow / fast)

### Known:

#### Scintillator BC408

density=1.032g / cc

n=1.58

AbsLength=210cm

scintillation yield=12800 / MeV

#### Plexiglass

density=1.18g / cc

n=1.49

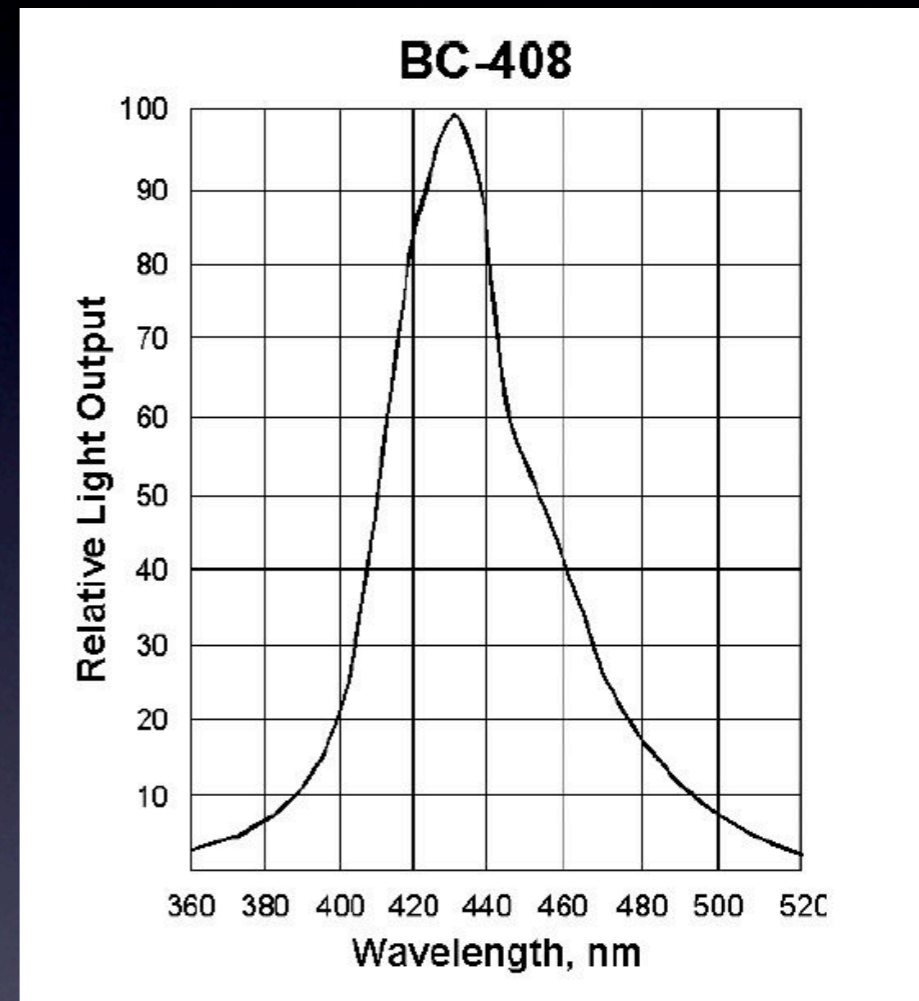
AbsLength=100m

#### Mylar

density=1.398g / cc

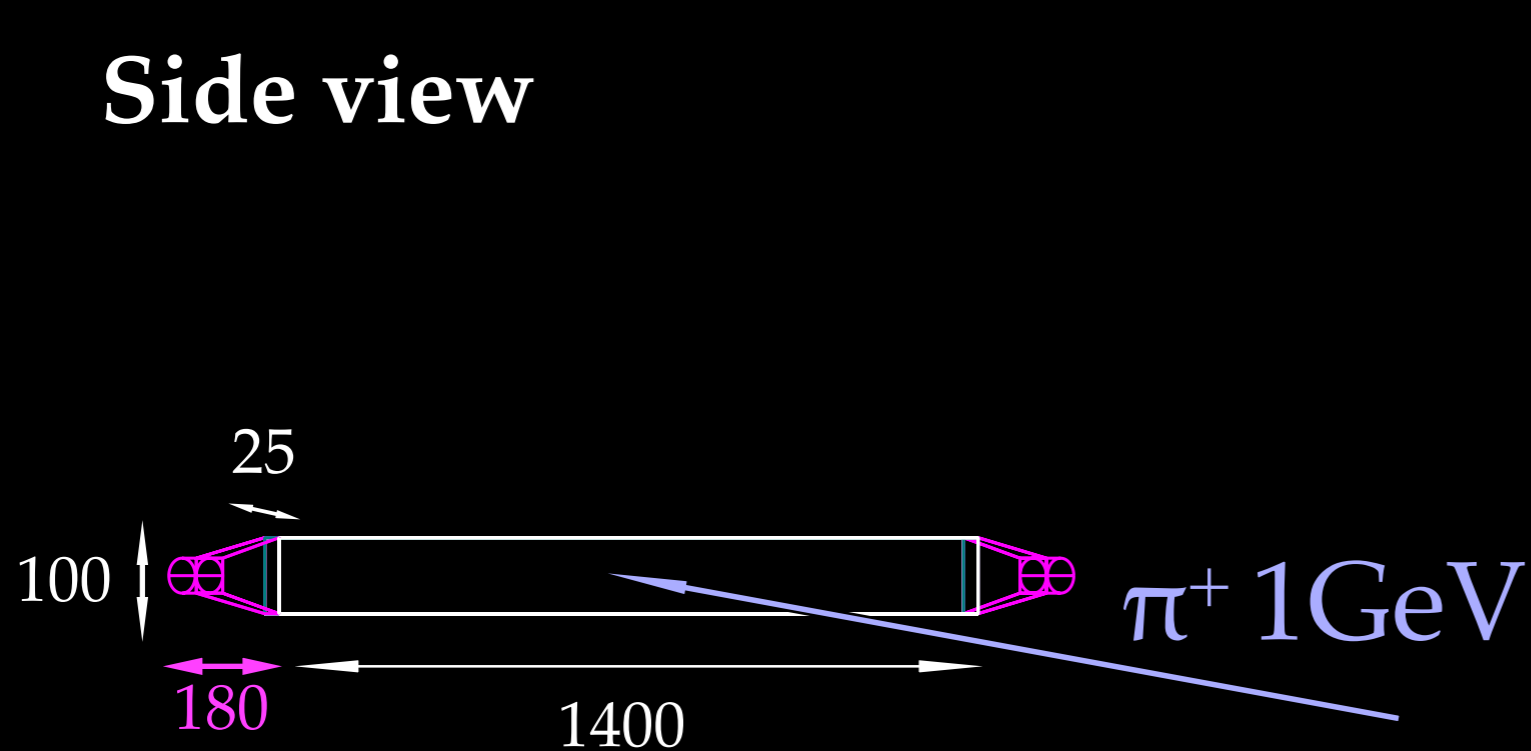
#### PMT glass

density=2.23g / cc

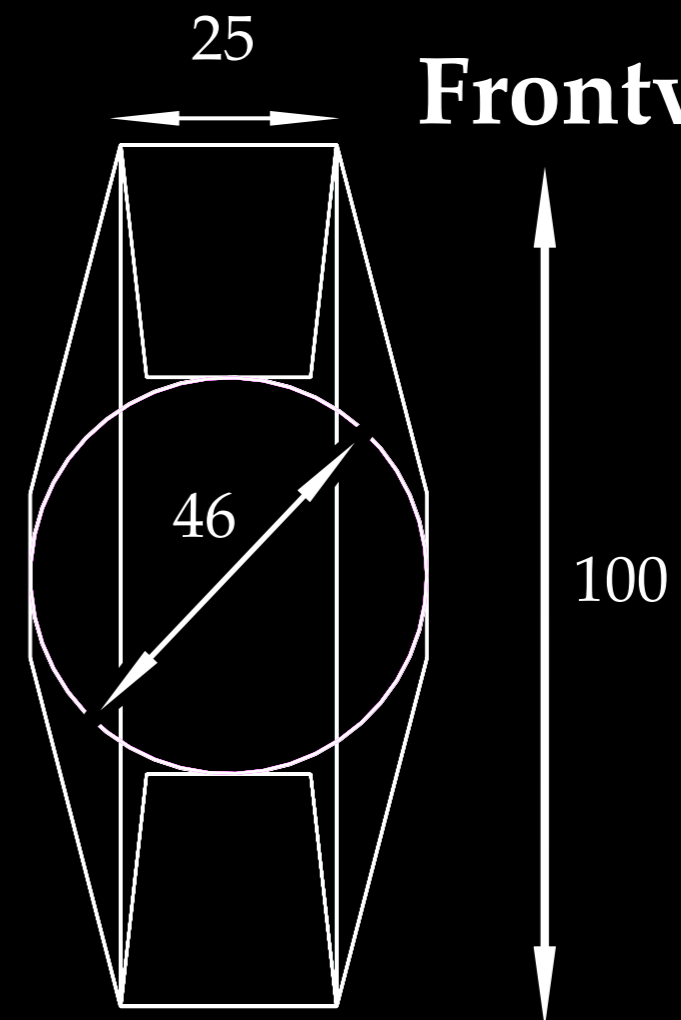


# Simulation of optical processes in GEANT4

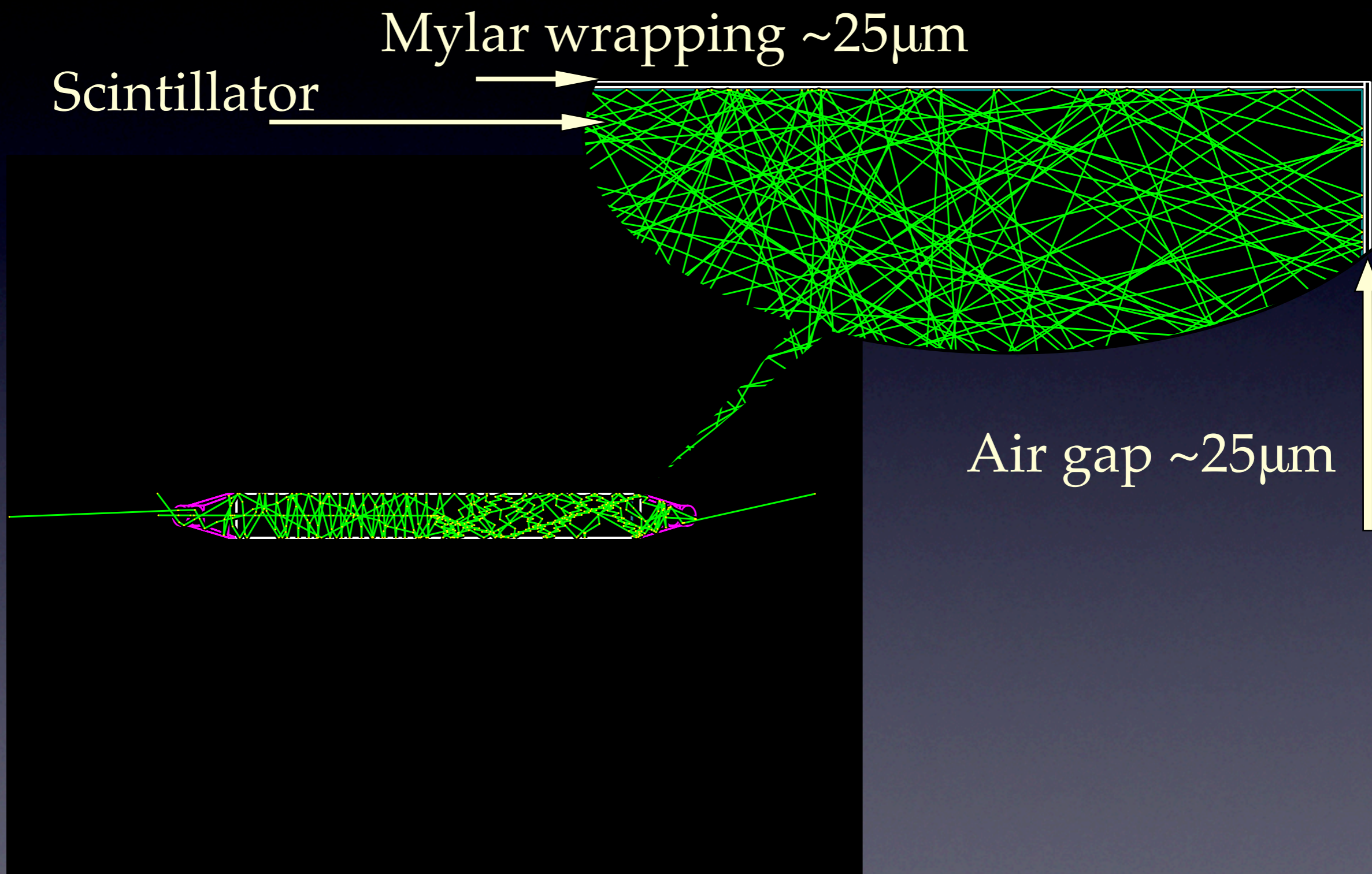
**Side view**



**Frontview**

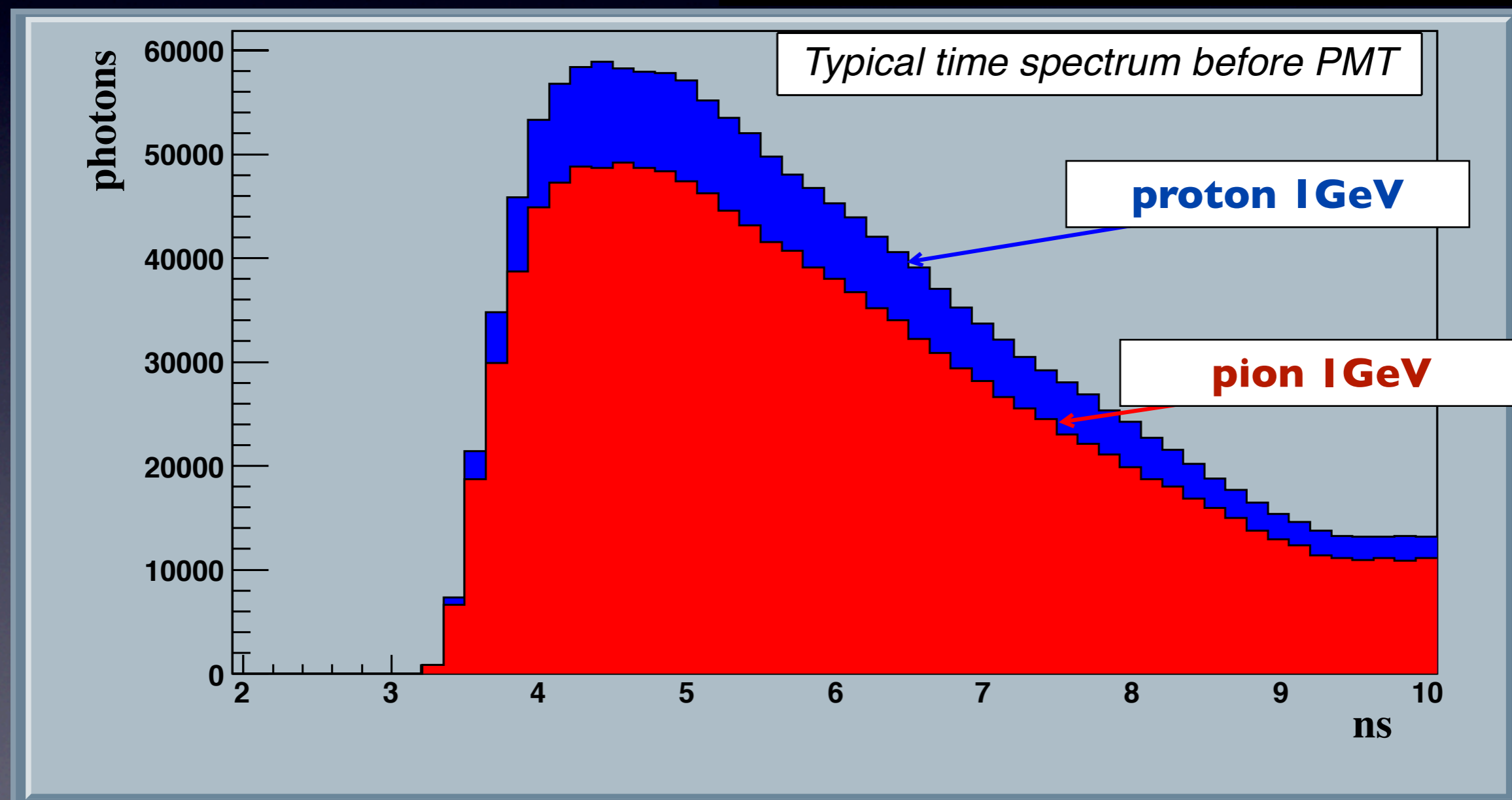
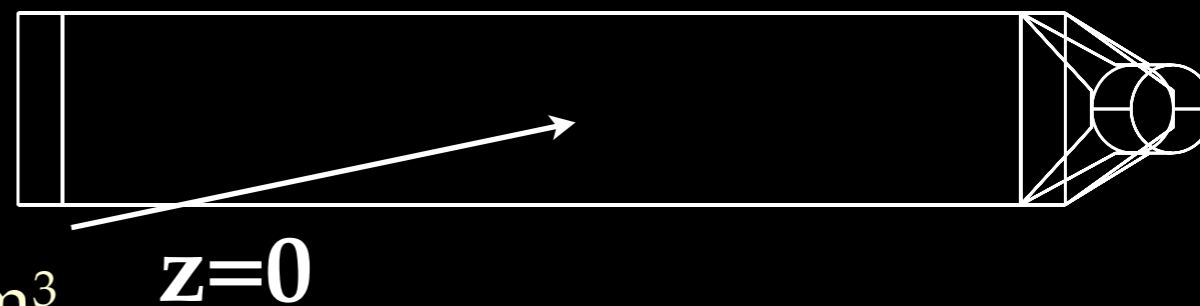


# Simulation of optical processes in GEANT4



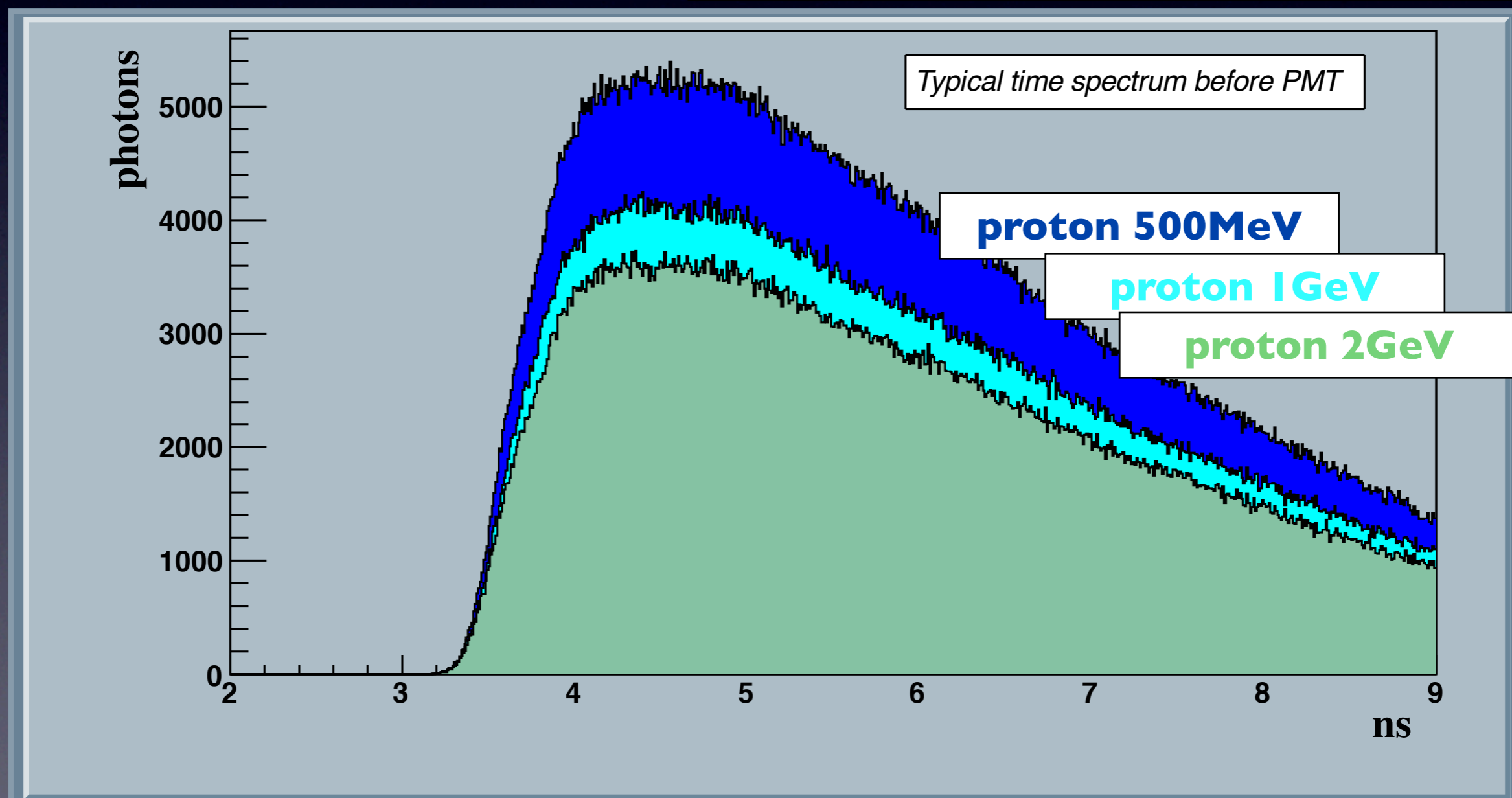
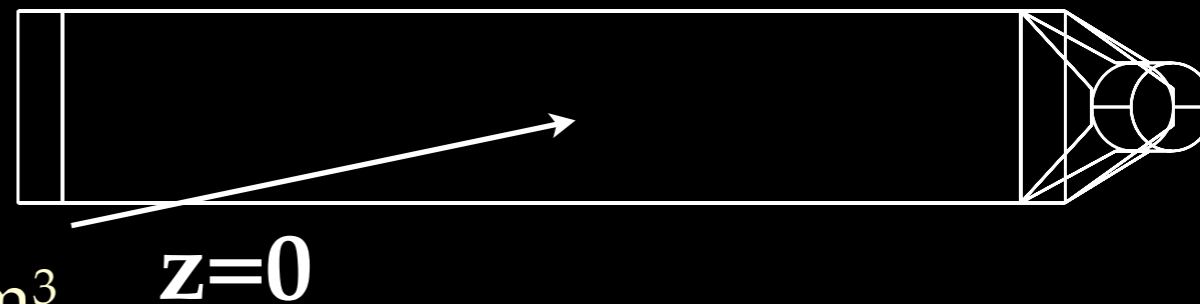
# Time distribution

BC408 plastic scintillator  $140 \times 10 \times 2.5 \text{ cm}^3$

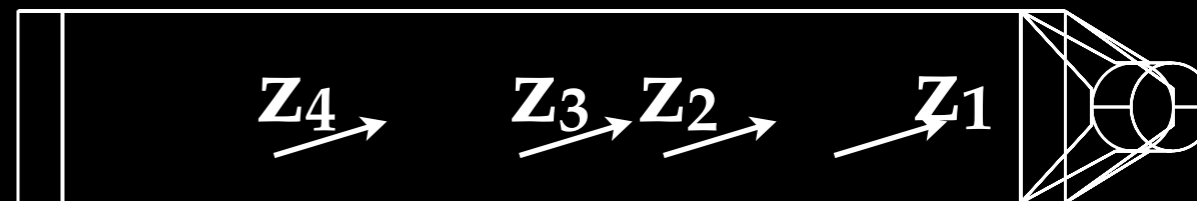


# Time distribution

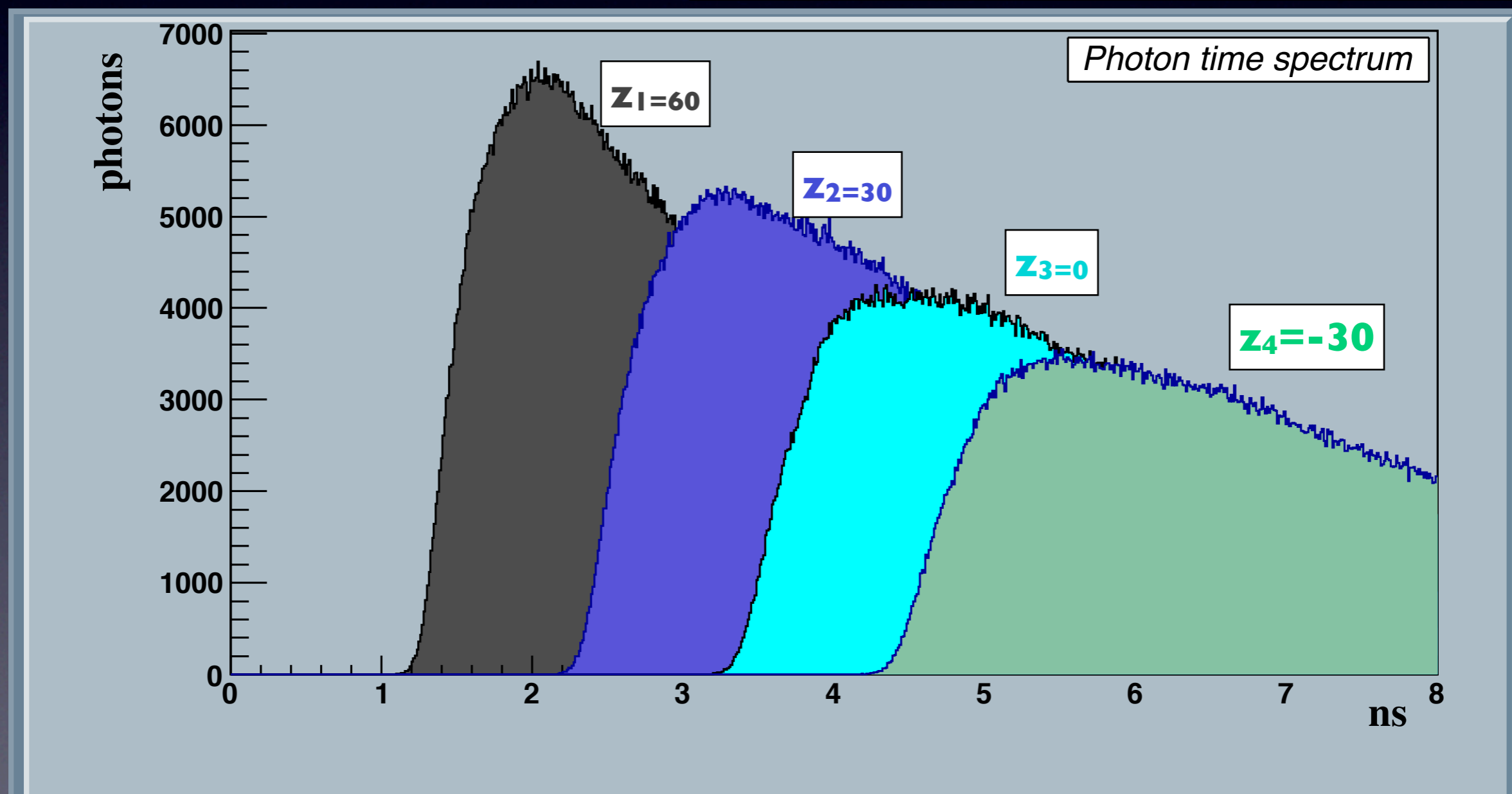
BC408 plastic scintillator  $140 \times 10 \times 2.5 \text{ cm}^3$



# Time distribution

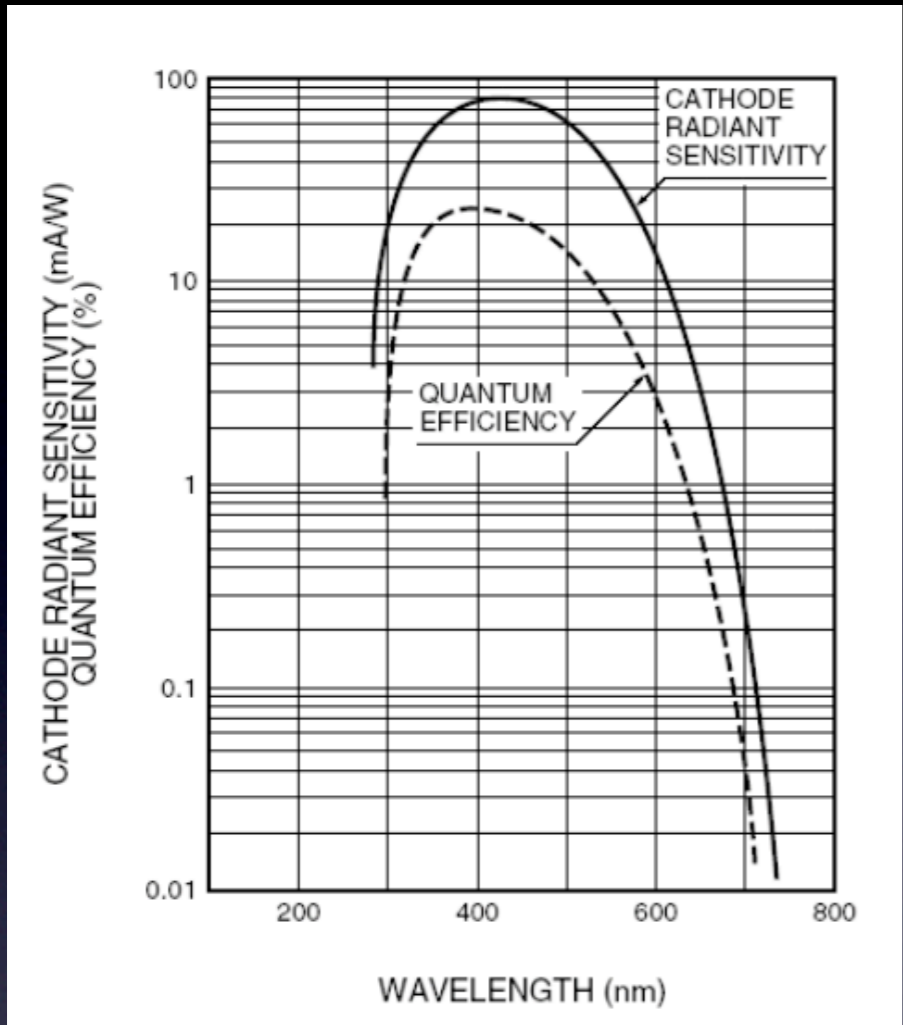


BC408 plastic scintillator  $140 \times 10 \times 2.5 \text{ cm}^3$

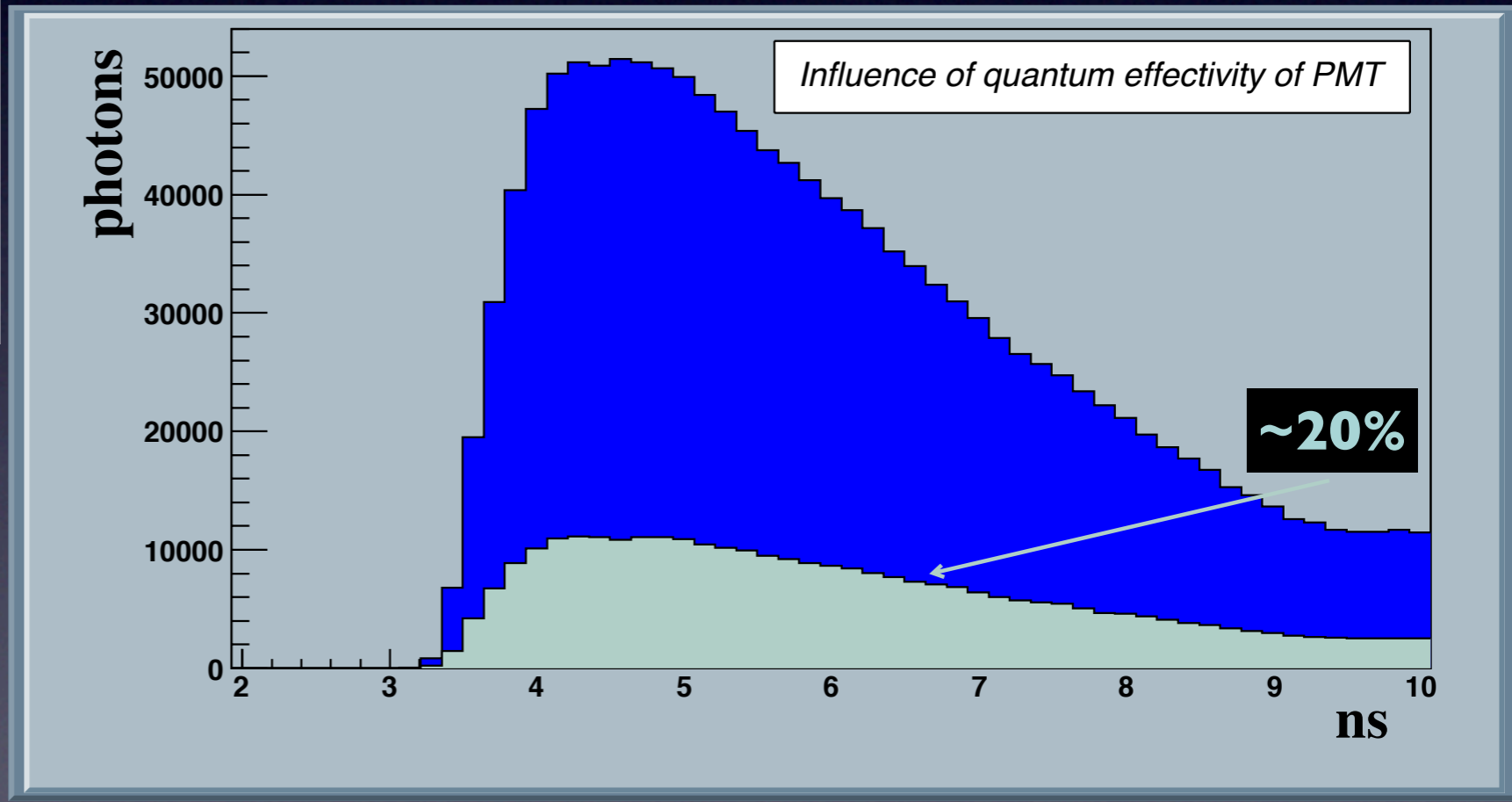




# PMT R2083 Hamamatsu

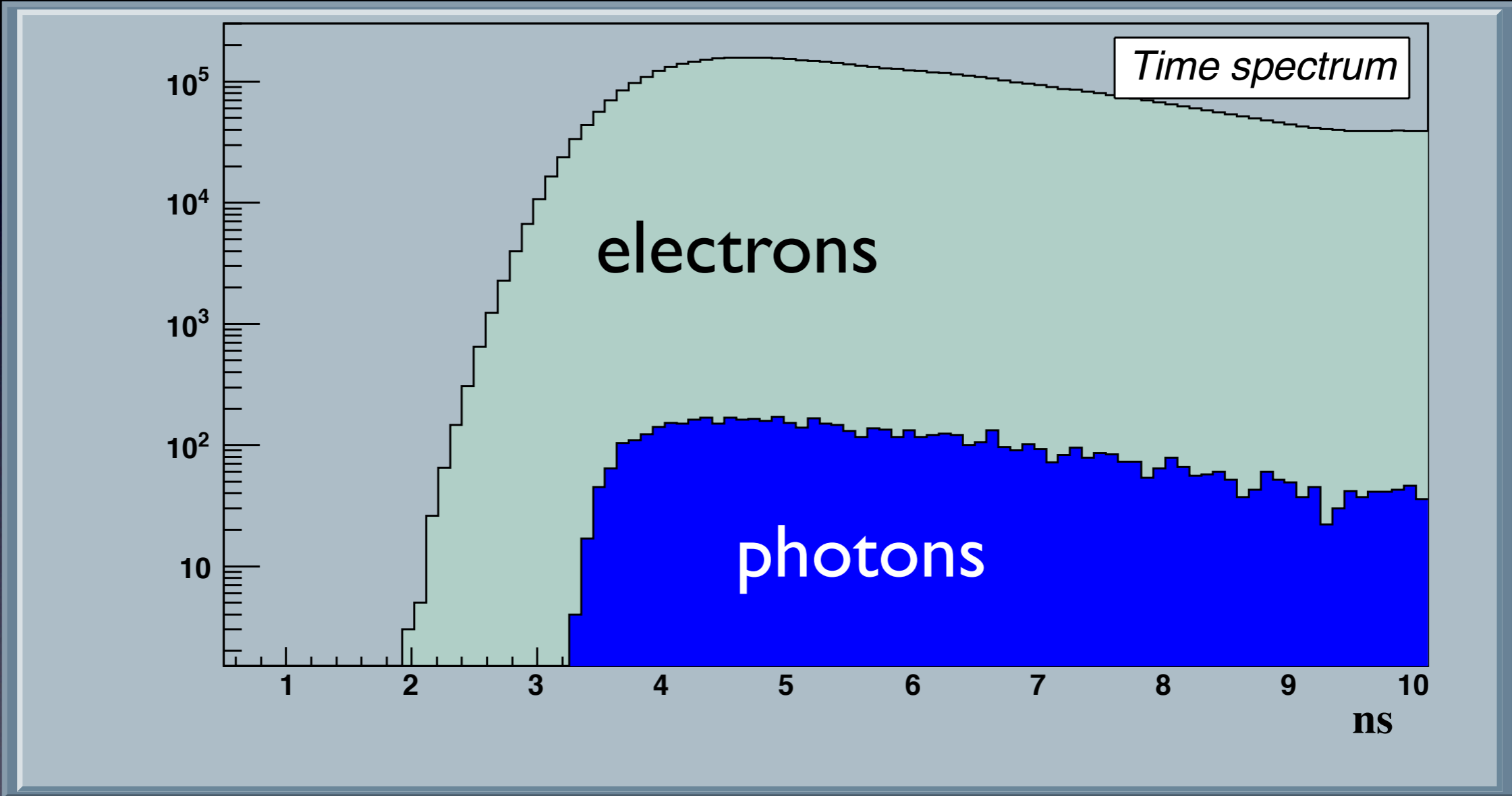


## Quantum Efficiency

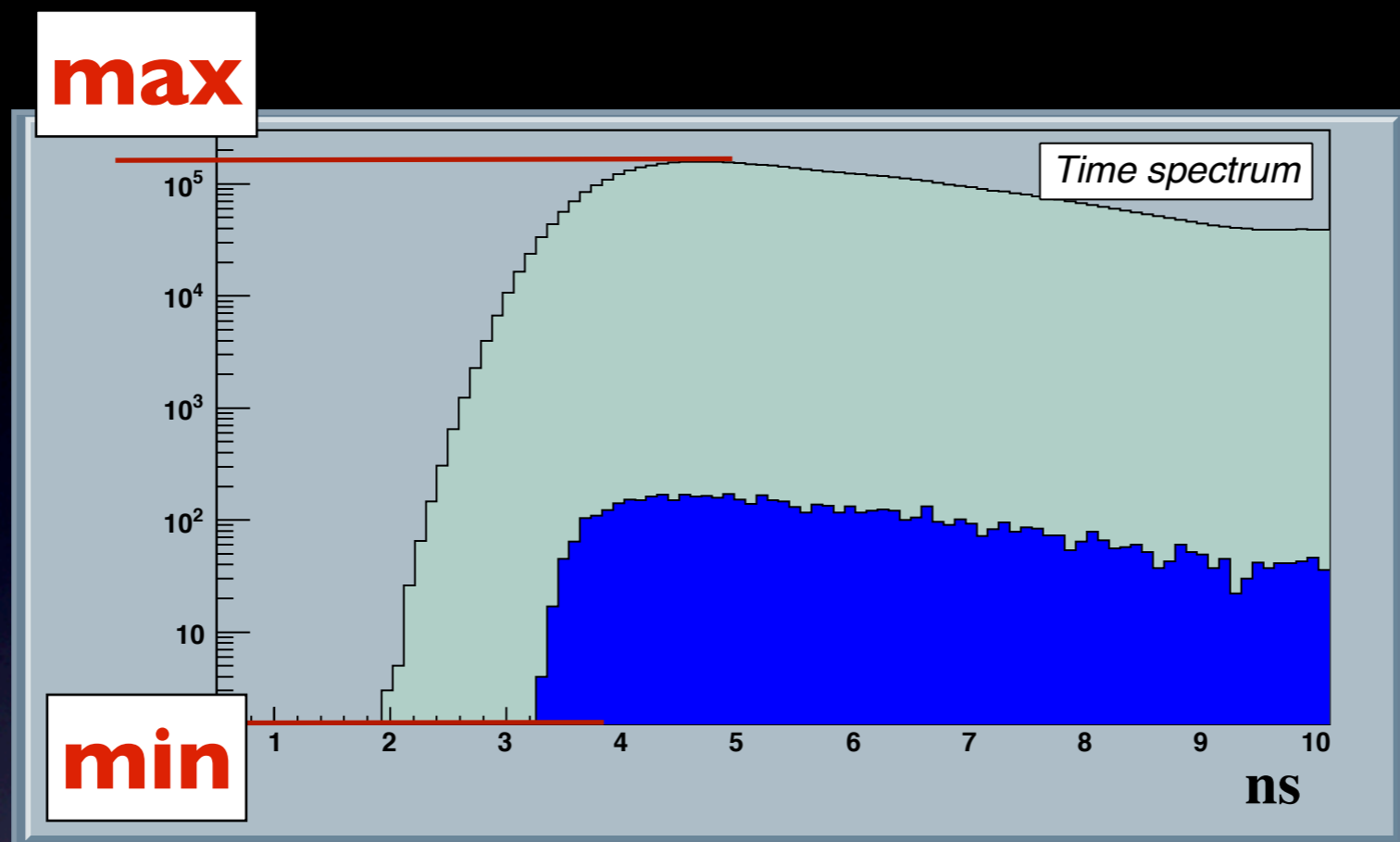


# PMT R2083 Hamamatsu

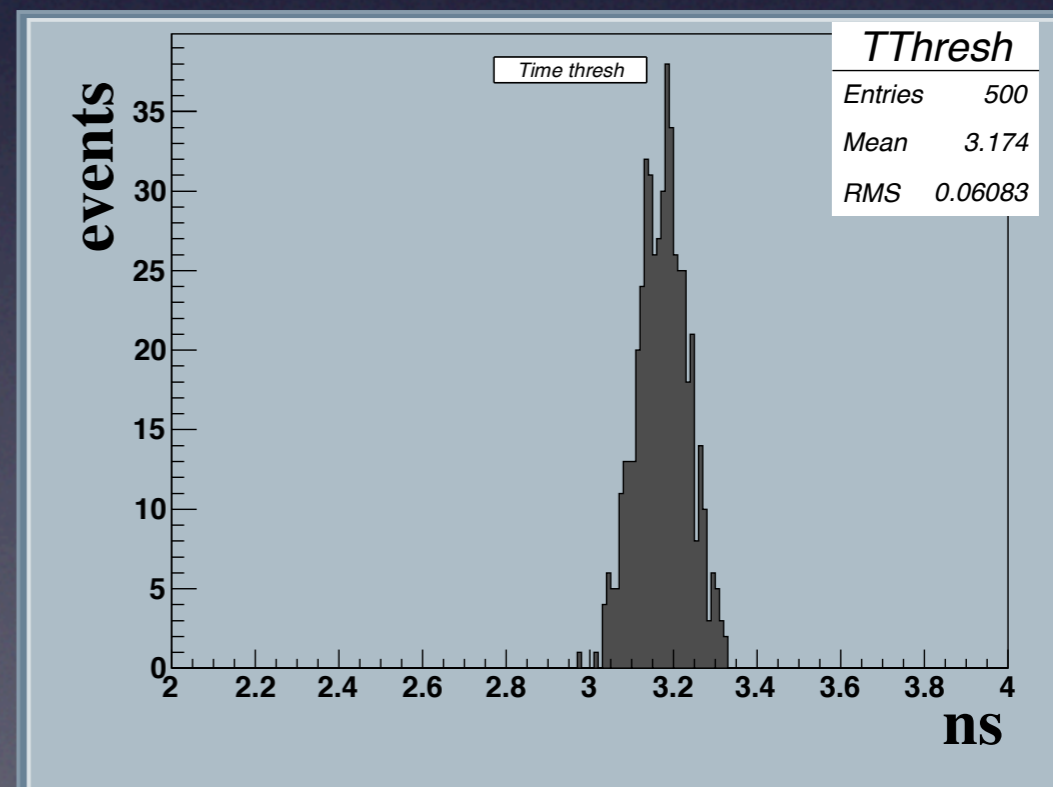
$10^6 e^-$  with  $\sigma \sim 370 \text{ps}$



# Time resolution

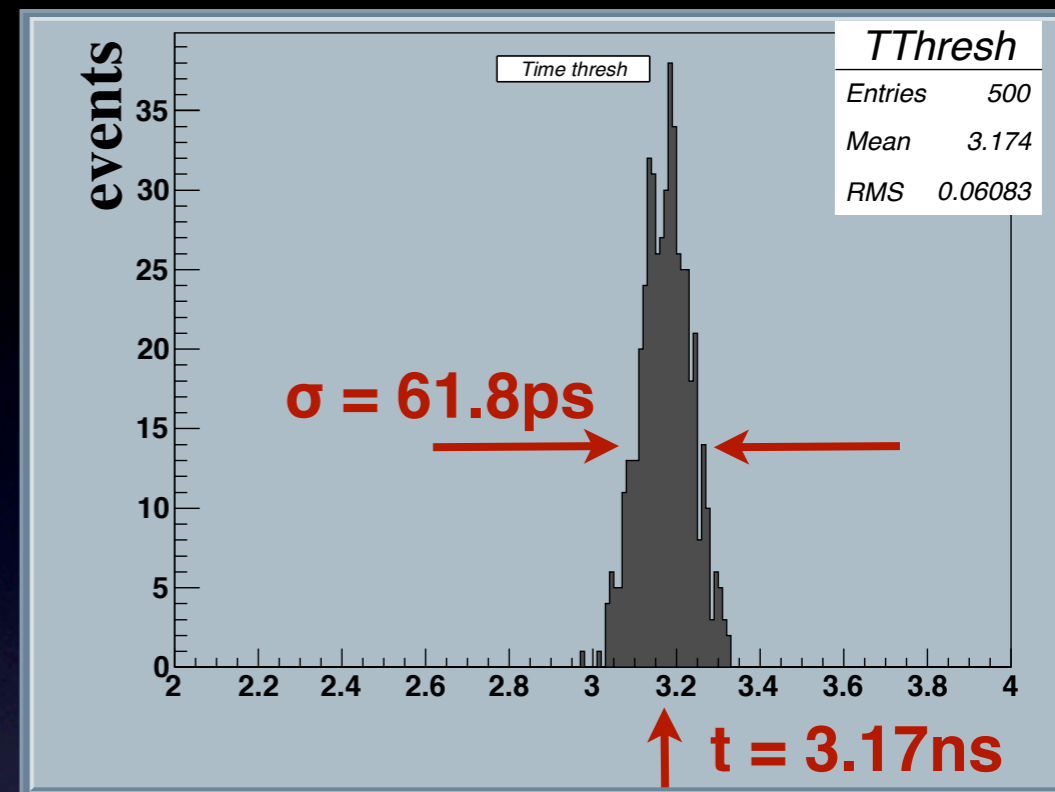


Threshold=10% of  $\langle \text{max} \rangle$



# Time resolution

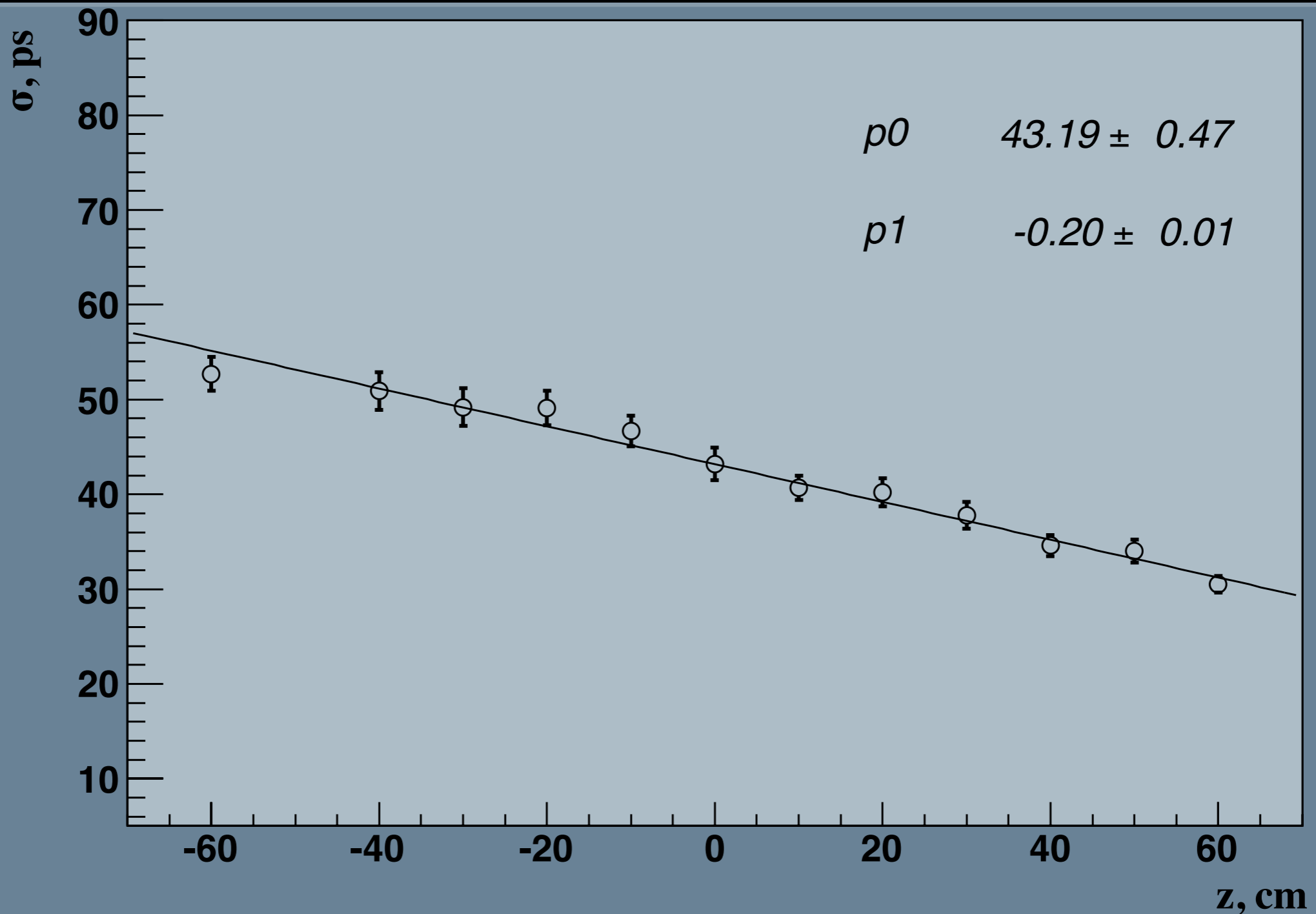
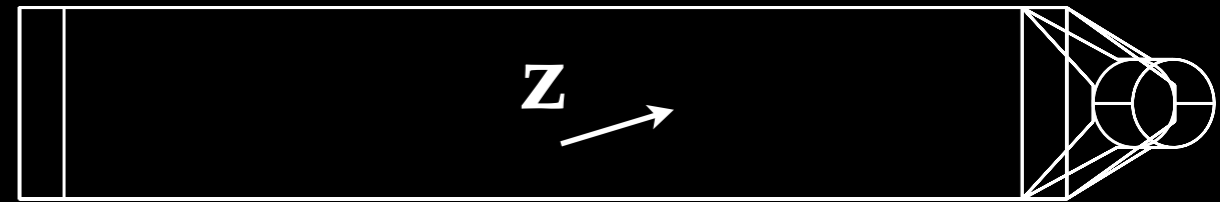
Threshold=10% of  $\langle \max \rangle$



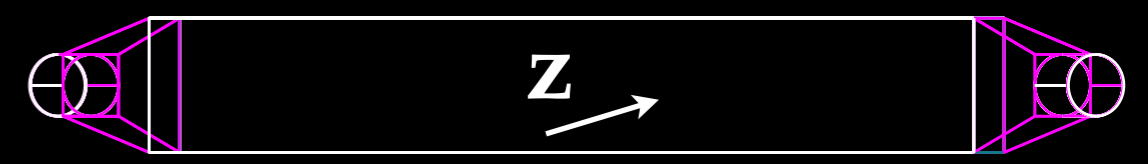
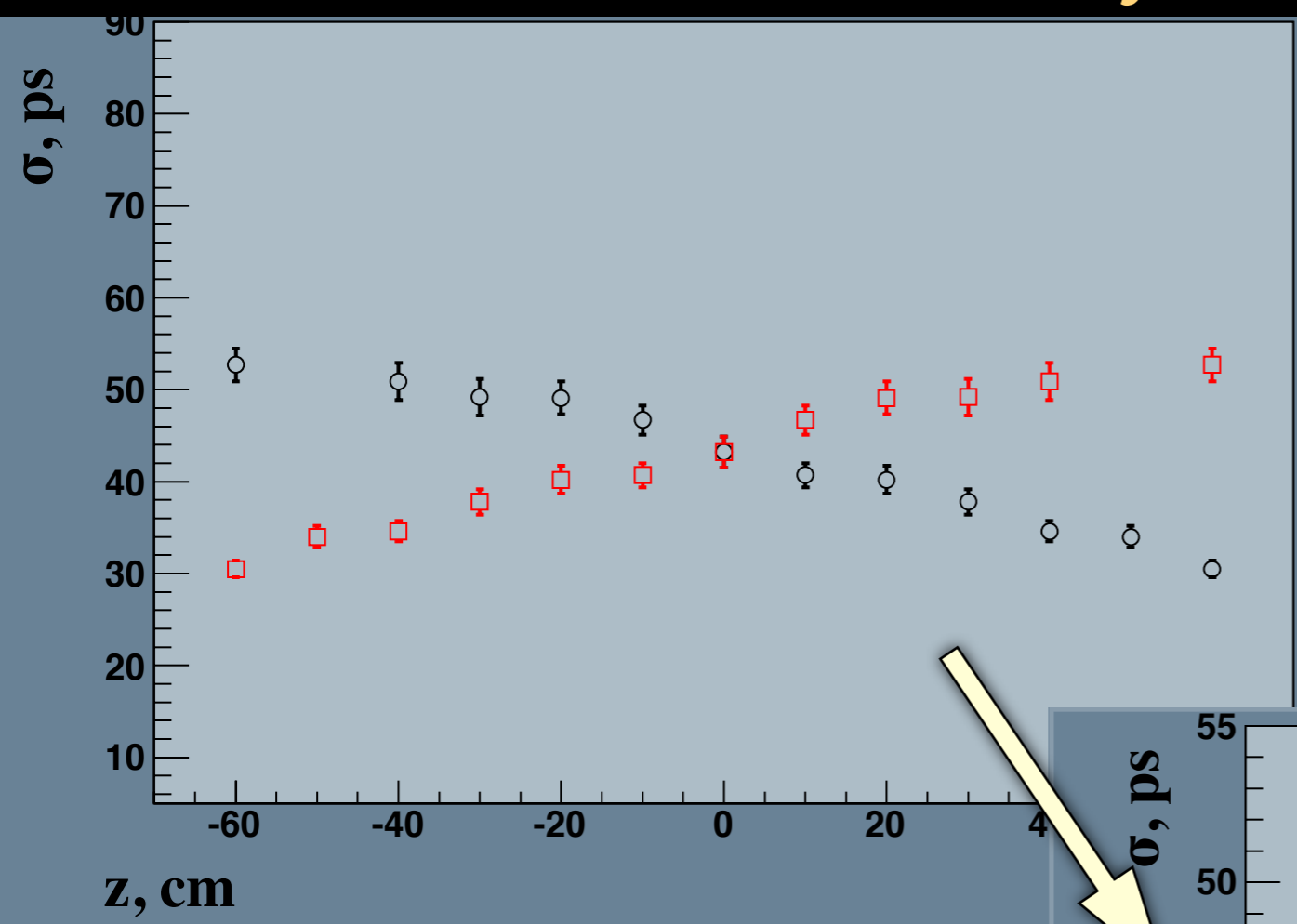
Time(ns)	sigma*10 <sup>-2</sup> (ns)	Hadron	E(GeV)	z(cm)
3.17	6.18+/-0.26	pi+	1	0.0
2.82	5.29+/-0.19	pi+	1	10.0
3.15	4.81+/-0.20	proton	1	0
3.17	5.23+/-0.19	proton	2	0.0

# Time resolution viewed by 1 PMT. 2 GeV proton

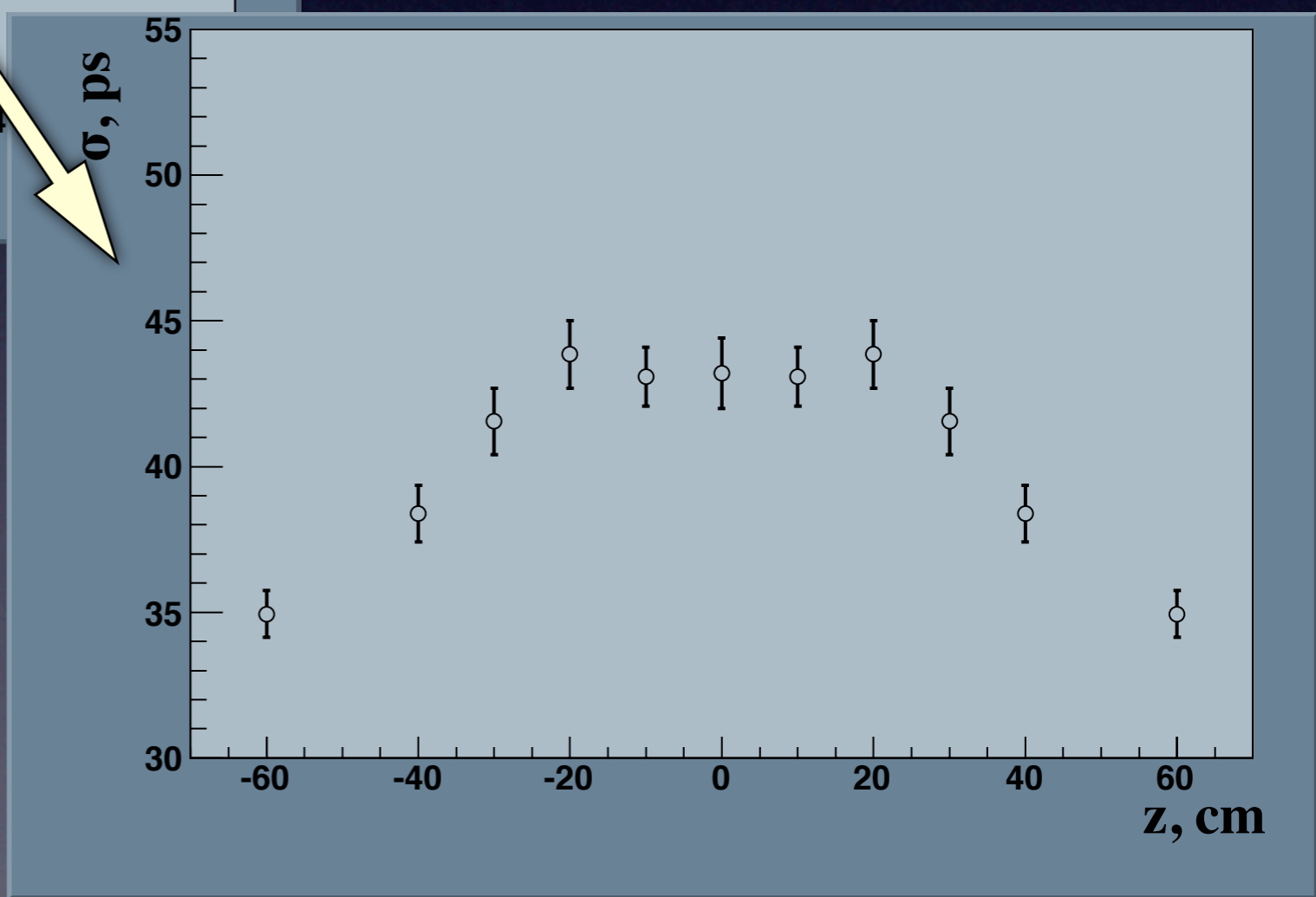
BC408 plastic scintillator  $140 \times 10 \times 2.5 \text{ cm}^3$



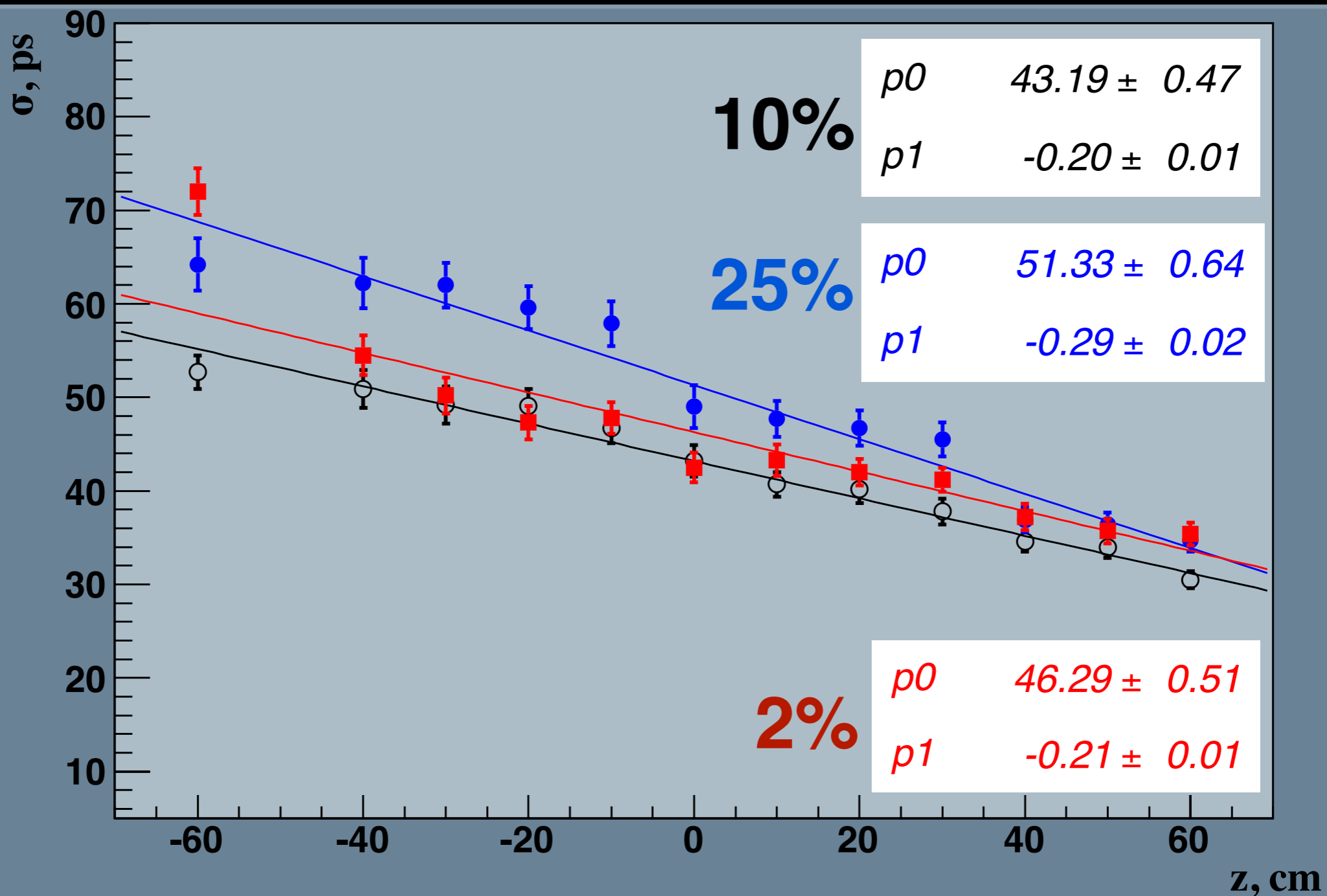
# Time resolution viewed by 2 PMTs. 2 GeV proton



$$\frac{1}{\sigma_k^2} = \sum_{i=1}^n \frac{1}{\sigma_i^2}$$



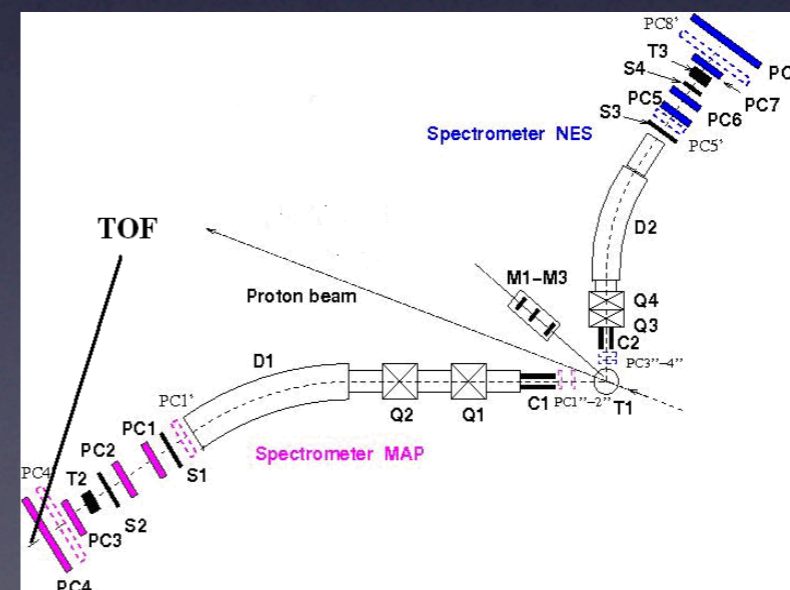
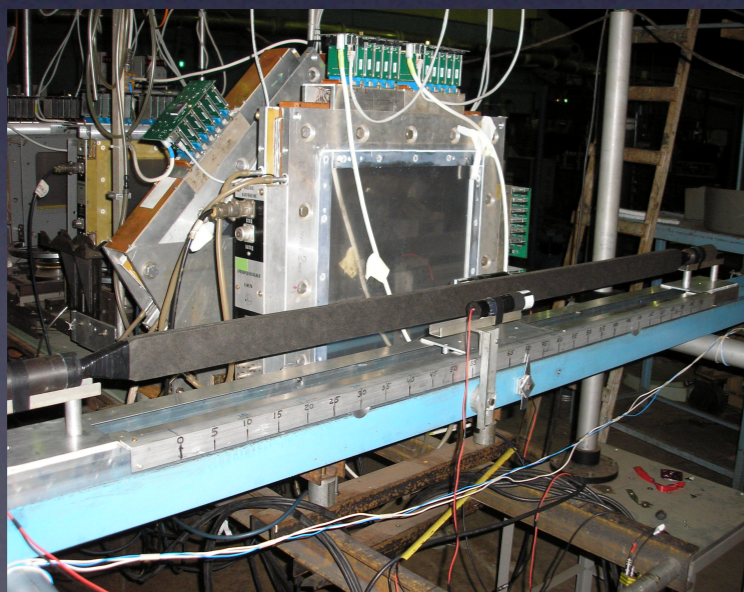
# Time resolution. Influence of threshold.



# Time resolution. Influence of thickness.

thickness(cm)	p0 (ps)	p1
1.5	55.26+/-1.35	-0.25+/-0.03
2.5	43.19+/-0.47	-0.20+/-0.01
5.0	38.02+/-0.78	-0.10+/-0.02

TOF prototype test @ 1 GeV proton beam (PNPI, Gatchina)





# Conclusion

- Timing characteristics of 140cm long scintillation counter with  $10 \times 2.5 \text{ cm}^2$  cross section have been studied using GEANT4 based MC simulation.
- The time resolution for counter varies from 45 ps at the bar center to 35 ps at the ends for 2GeV proton beam.
- Influence of thickness of scintillator and influence of threshold value have been presented.

# Outlook

The prototype with BC408 plastic  $140 \times 10 \times 2.5 \text{ cm}^3$  is ready for testing:

Gatchina 28.11-05.12.2012

Jülich 10.12-20.12.2012

