# Overview of the final Report

- CHERENKOV MEASURMENT USING UV TRANSMITANCE FILTER

- TIME FILTERING FOR CHERENKOV TO SCINTILLATION DISCRIMINATION

- SINGLE CUBE SIMULATIONS

- MAKING THE CRYSTAL VOLUME SENSITIVE AND MAKING A PRACTICAL WAY TO CONSTRUCT A MULTI CRYSTAL DETECTOR

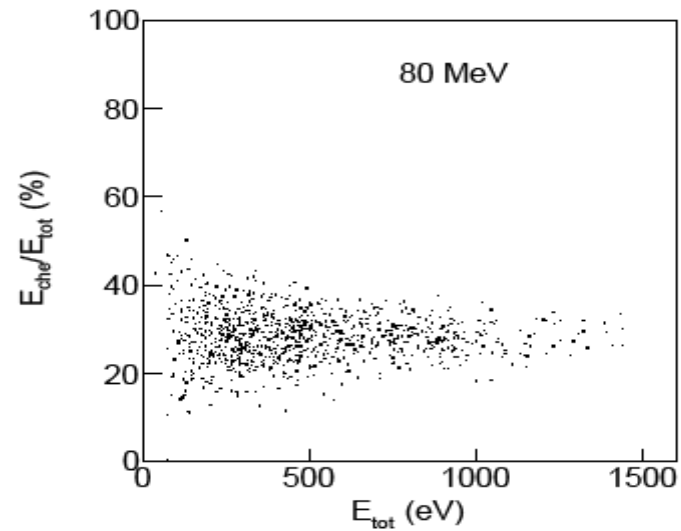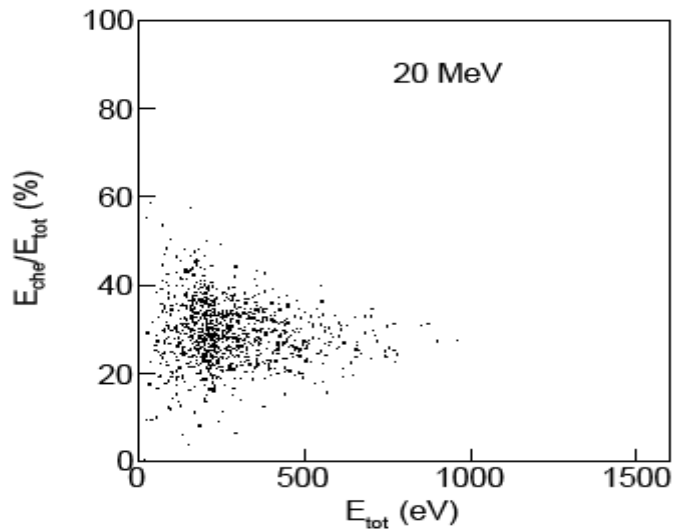- SPATIAL ANALYSIS FOR ACQUIRING THE SiPMS PHOTON STATISTICS

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Savvas Kyriacou

Makris Yiannis

# CHERENKOV MEASURMENT USING UV TRANSMITANCE FILTER
(thin plate simulation single electron beam)
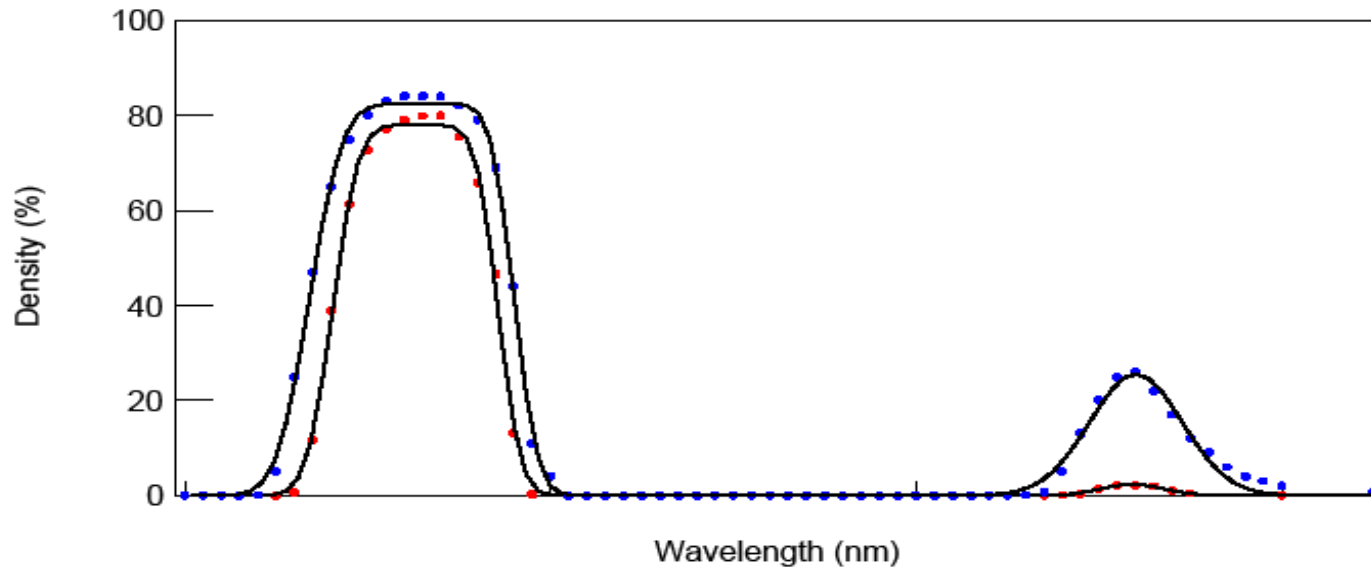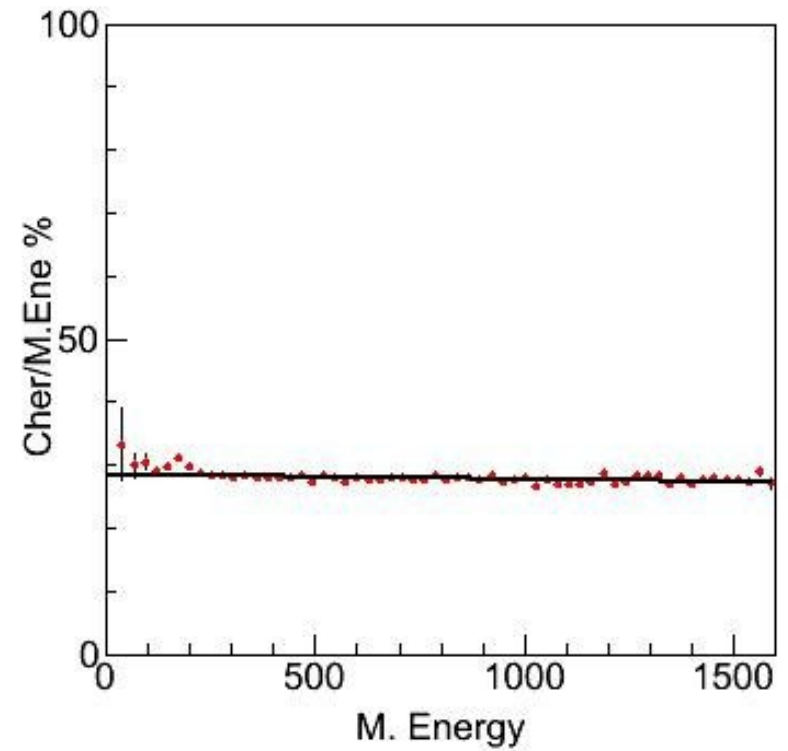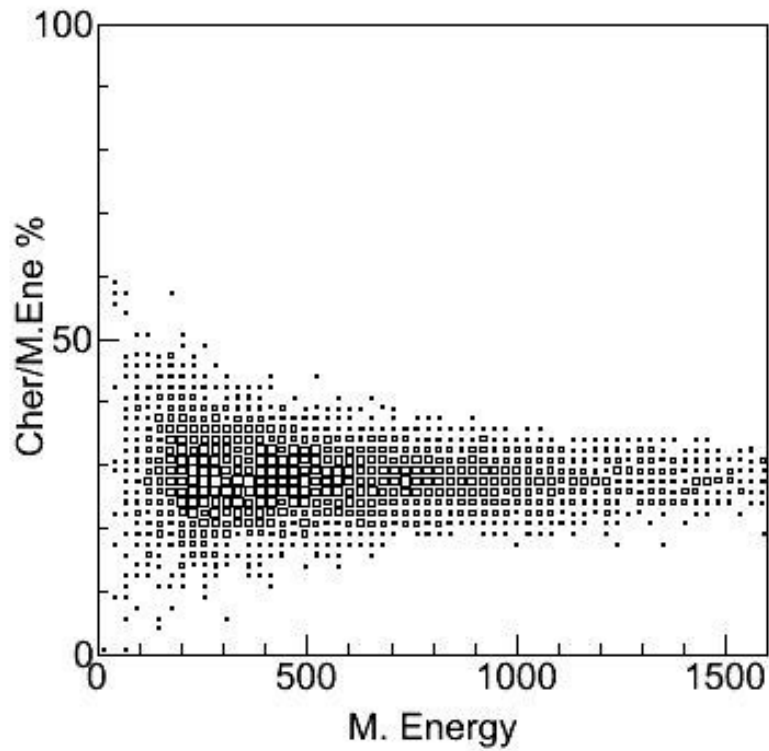


- UG11 (Blue)
- U340 (Red)

The ratio $E_{che}/E_{tot}$ % over $E_{tot}$



Due to loss of energy by escaping electrons from the volume of the thin plate the distribution
For the 80MeV is much more shifted to the low energies than expected.

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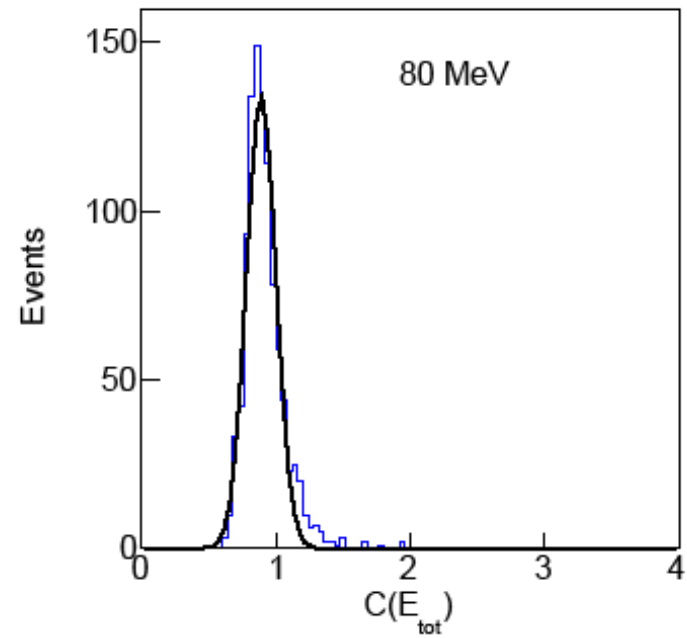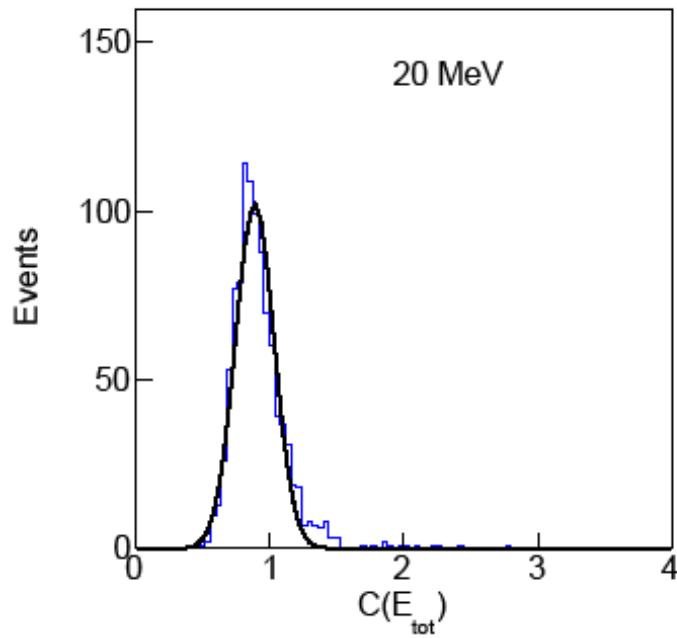The calculation function F(E_tot) (giving us the percentage of total energy that is in form of Cherenkov light)



Adding the distributions for all energies (10-80MeV, step:10MeV) and fitting them we determine the calculation function.

$$F(E_{tot}) = -0.00077E_{tot} + 28.52$$

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The compare function
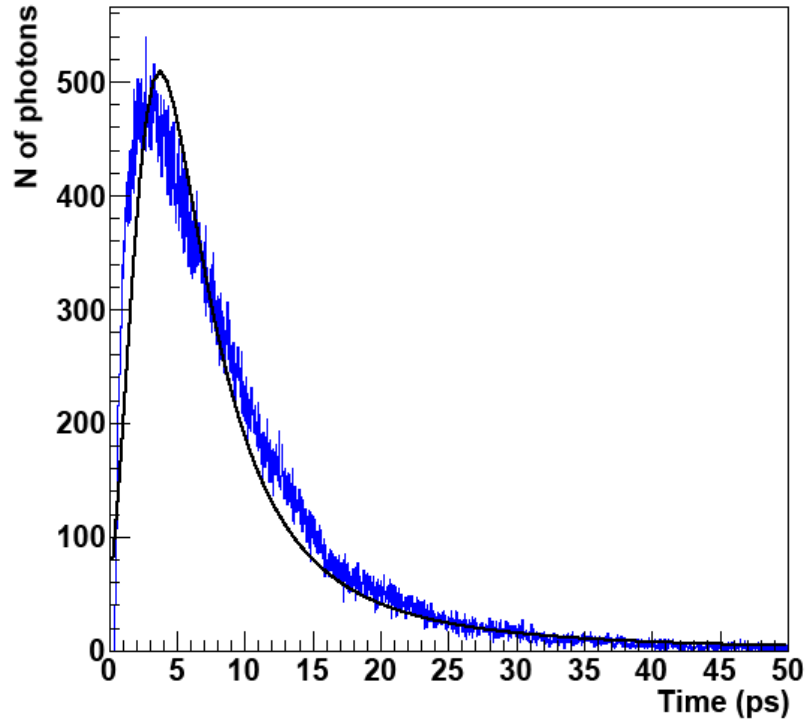$C(E_{tot}) = F(E_{tot}) \, E_{tot}/(100 E_{che})$.

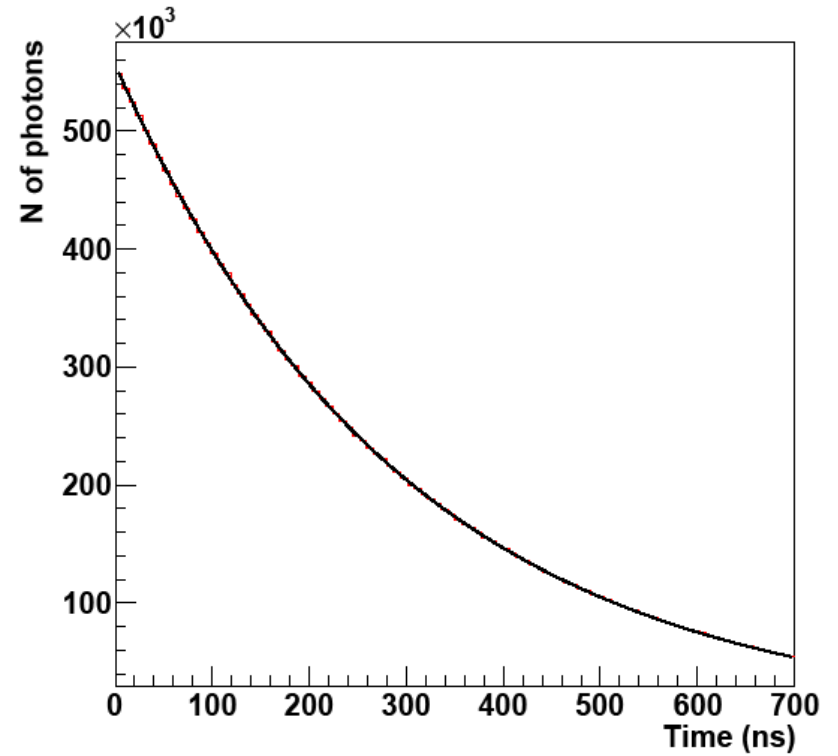Distributions as expected concentrated around 1

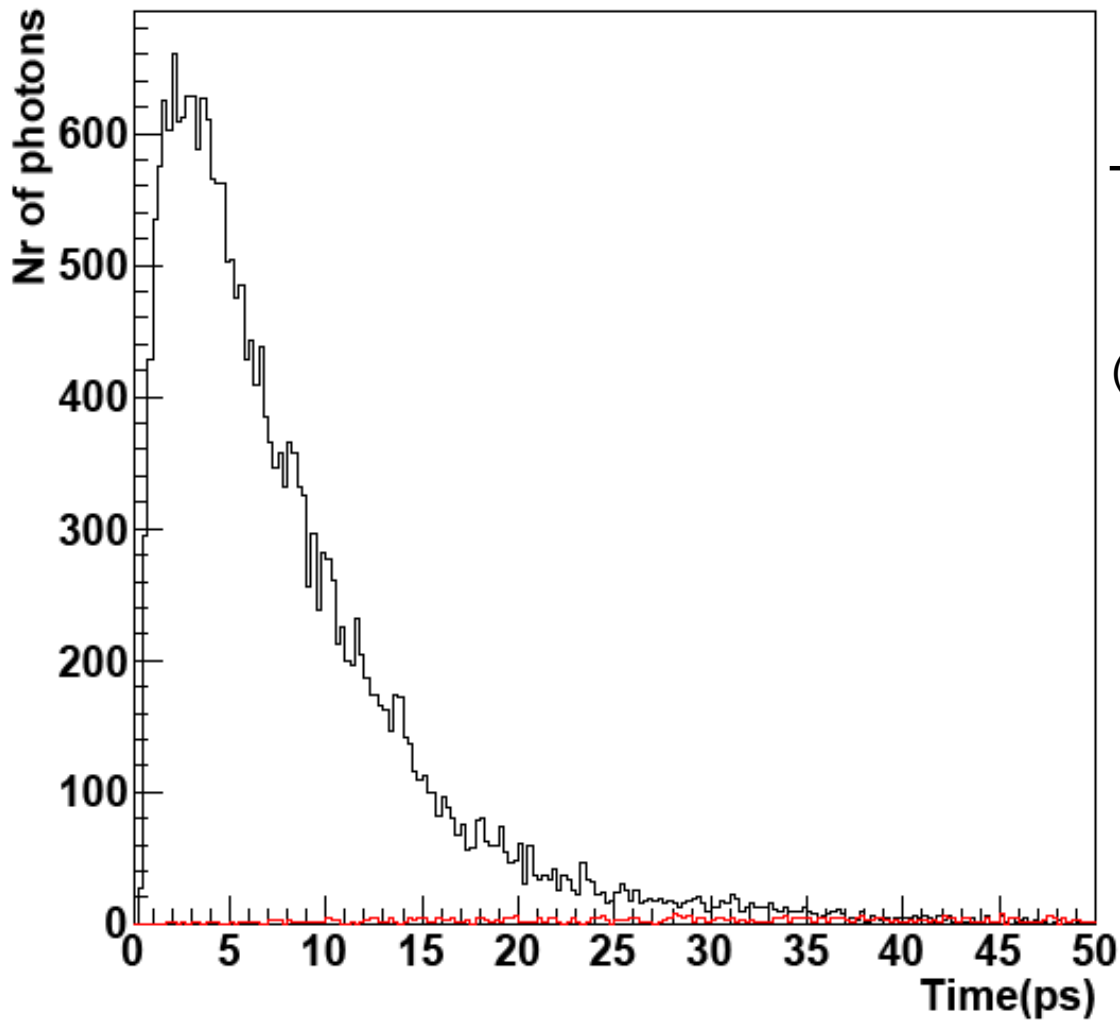# Time filtering for discriminating Cherenkov and Scintillation
(single electron beam simulation)



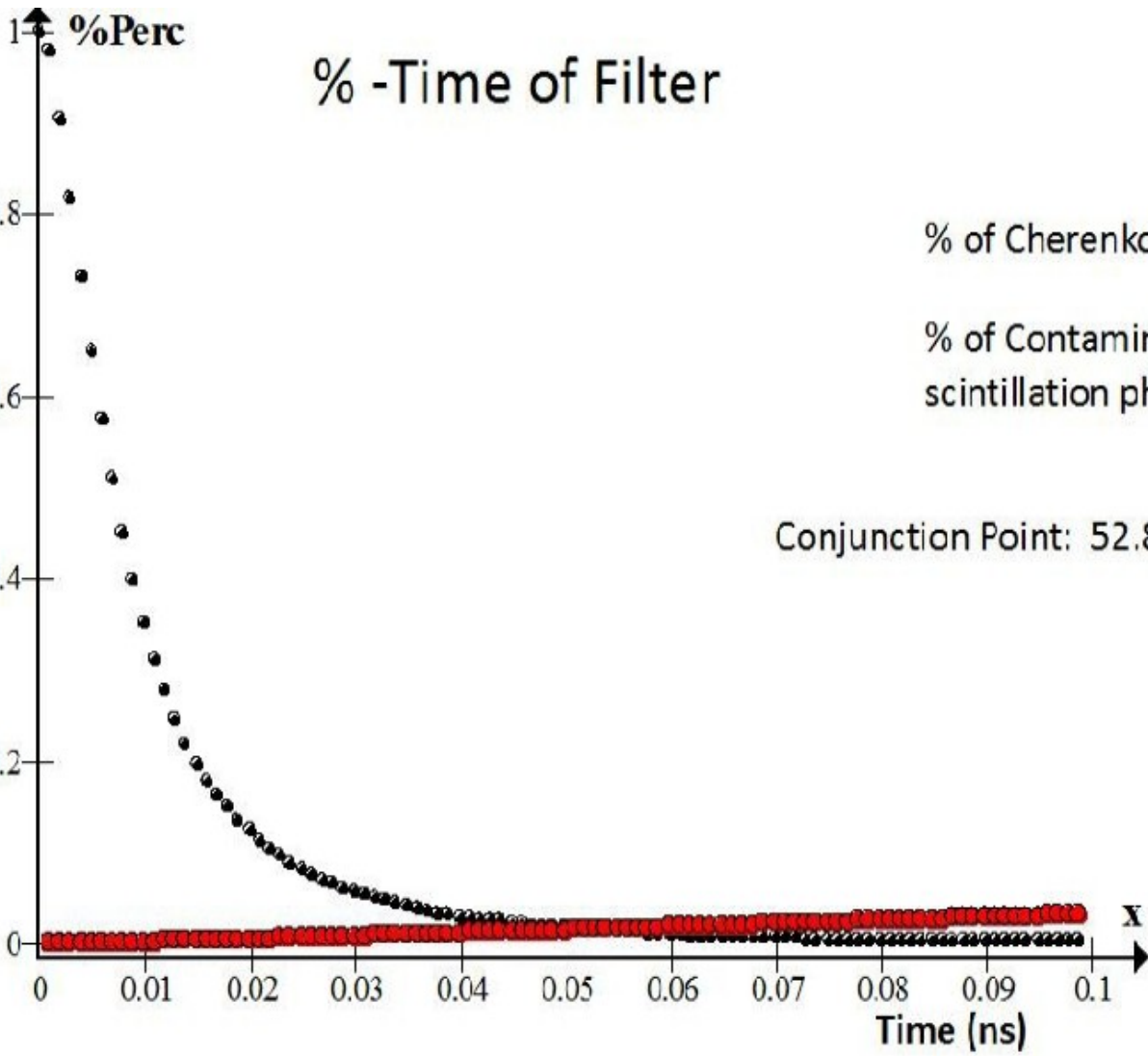Time distribution for Cherenkov light detection

Time distribution for scintillation light detection

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Time distribution for Cherenkov and scintillation light detection for t < 50 ps
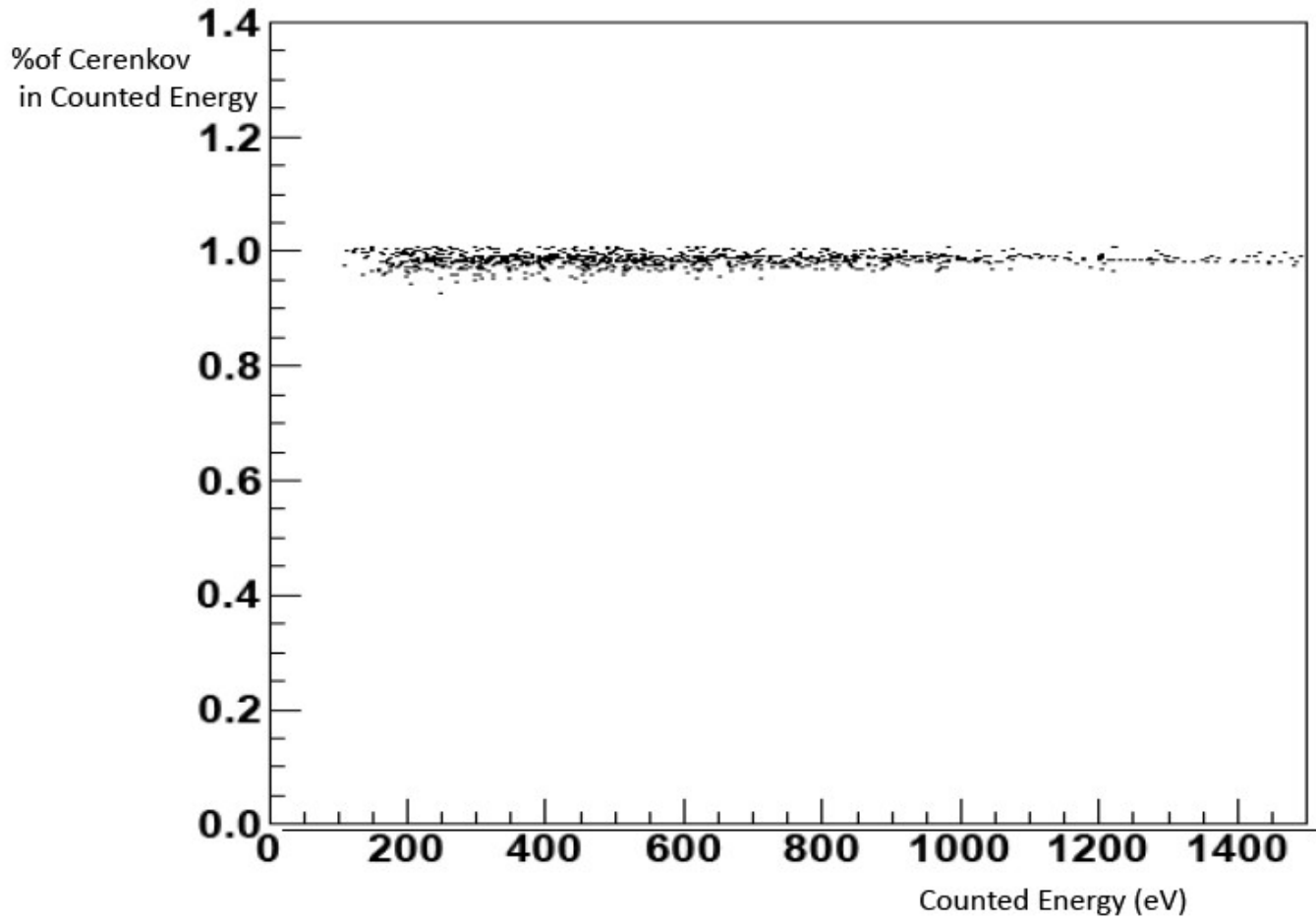(The scintillation photons red appear to be negligible)

% -Time of Filter

% of Cherenkov light loss ———

% of Contamination from ———
scintillation photons

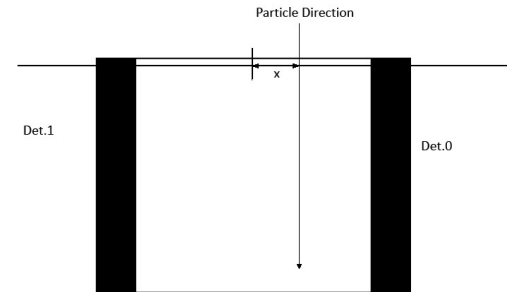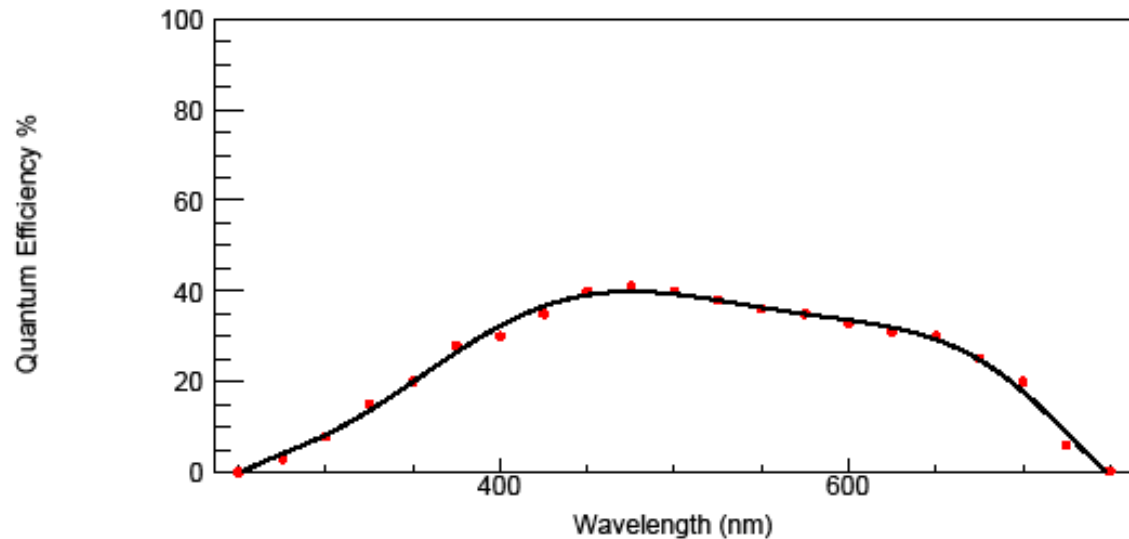Conjunction Point: 52.8 ps

Percentages for
different time cuts

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Percentage of Cherenkov energy related to the total counted energy in the time < 52.8 ps
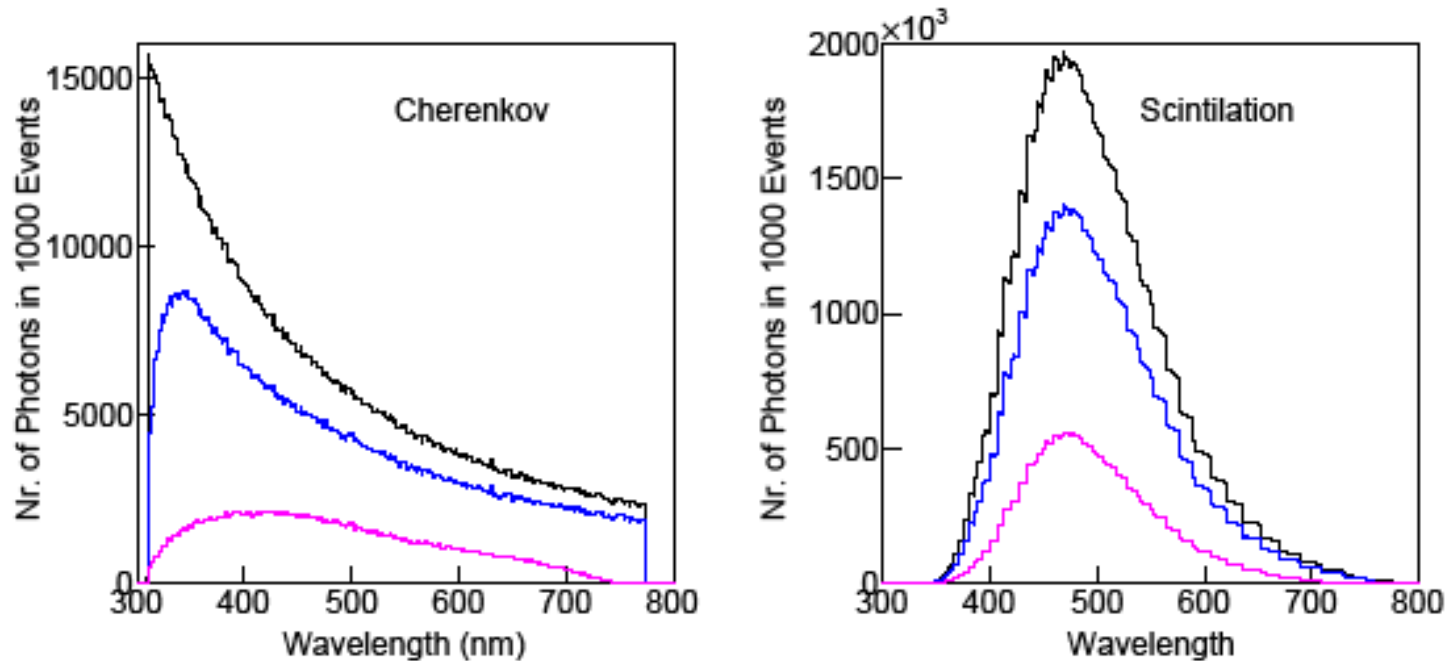
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## SINGLE CUBE SIMULATIONS

Cube: 2x2x2 cm$^3$
2 Sens. Det. (x=-1,x=1)
Crystal: BGO
Surface: chemically etched surface, with tyvek
Particles: μ$^-$
Events: 1000
Energy: 10GeV



**The Quantum Efficiency:** 1.215435E − 15 **λ⁷** − 4.2251872E − 12 **λ⁶** +6.1263248E −09 **λ⁵** − 4.7909616E −06 **λ⁴** +0.0021767518 **λ³** −0.57372701 **λ²** +81.409558 **λ**−4817.2722



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Wavelength distributions



(black) The amount of photons produced in the crystal
(blue) The amount of photons arriving ate the detectors
(magenta) curves are the amounts of photons detected after the Q.E. appliance

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Nr of photons per event distribution for Scintillation light at each Detector for different incidence point of the particle
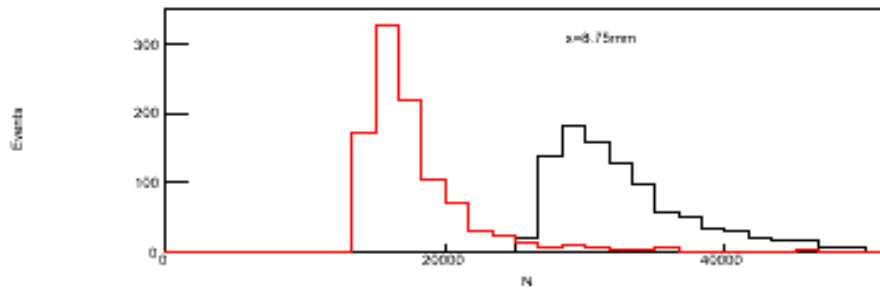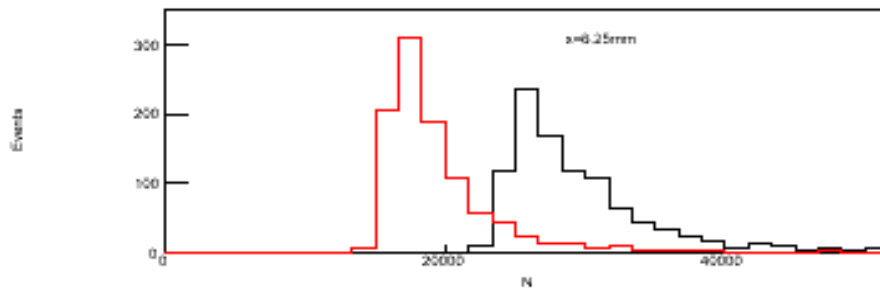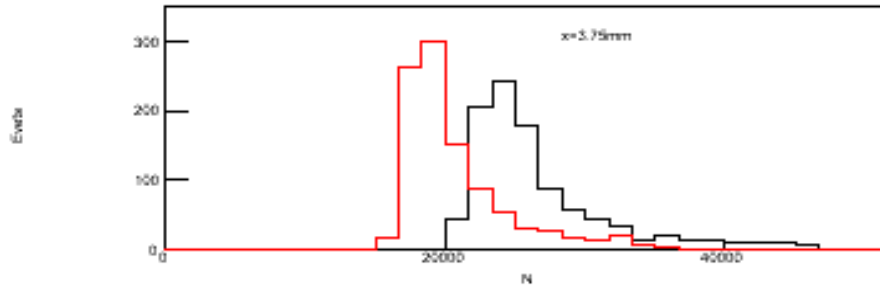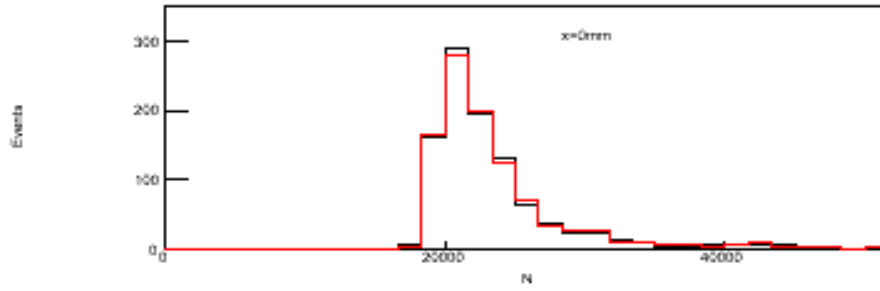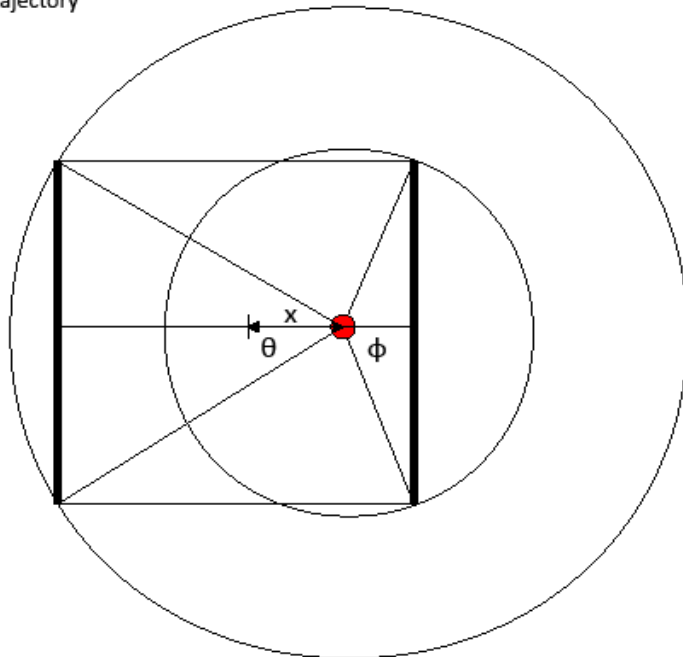
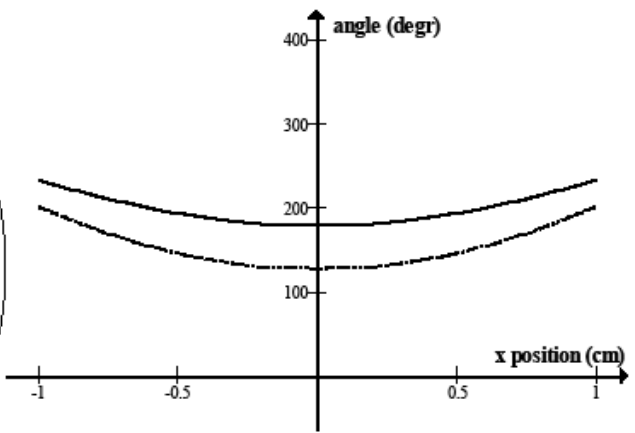Nr of photons per event distribution for Cherenkov light at each Detector
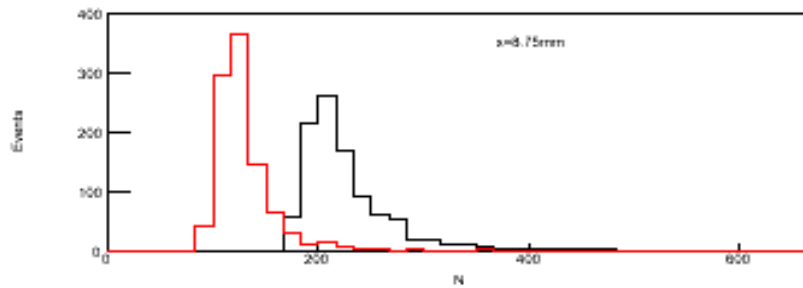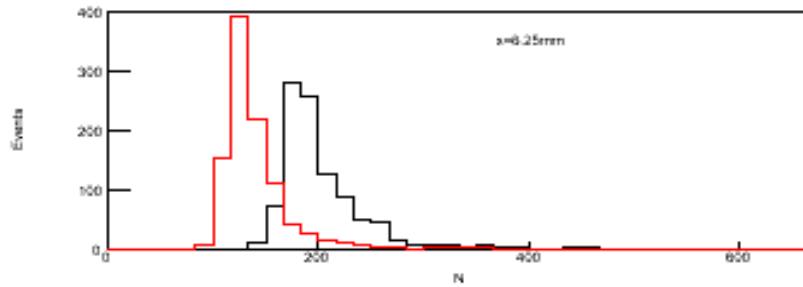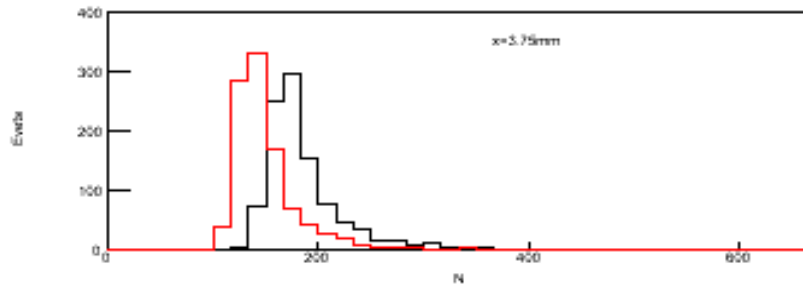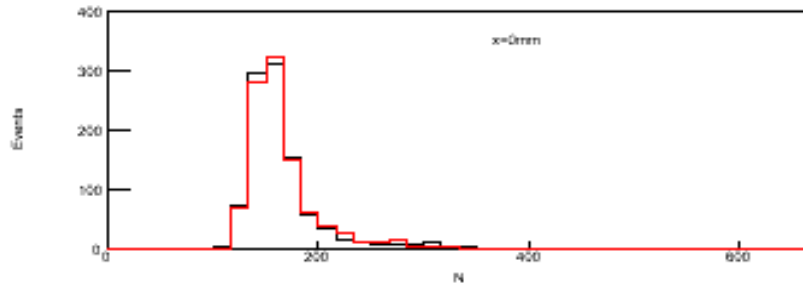
Expected function form for
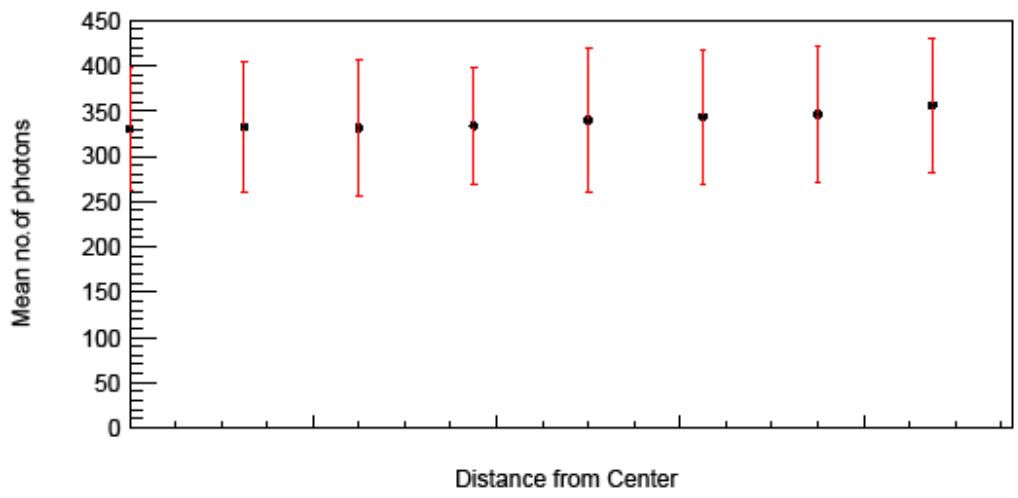Cherenkov light yield by both crystal from geometrical analysis

particle perpendicular
trajectory

x

θ          φ

Approximation on photon yield to x by angle
calculation

angle (degr)

400

300

200

100

x position (cm)

-1          -0.5          0.5          1

Total amount of Cher. photons detected to x

Mean no. of photons

450
400
350
300
250
200
150
100
50
0

Distance from Center

Ratio of the photons reaching Det1 over photons on Det2 as
a function of Distance x from the Center



| $\chi^2$ / ndf | 0.2 / 6 |
| --- | --- |
| Constant | 0.00446 ± 0.05226 |
| Slope | -0.07576 ± 0.01014 |

Distance from Center (mm)
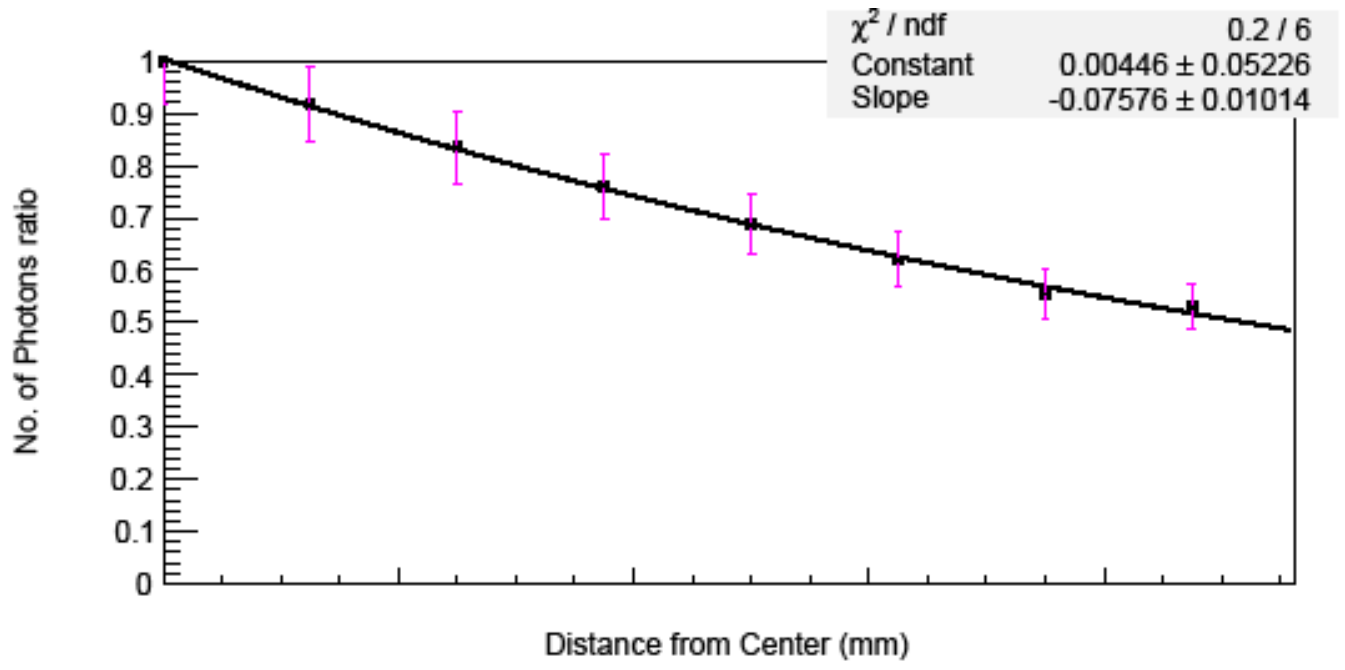
Experimental data fitted with an exponential function.
This function could be used to determine the position of impact
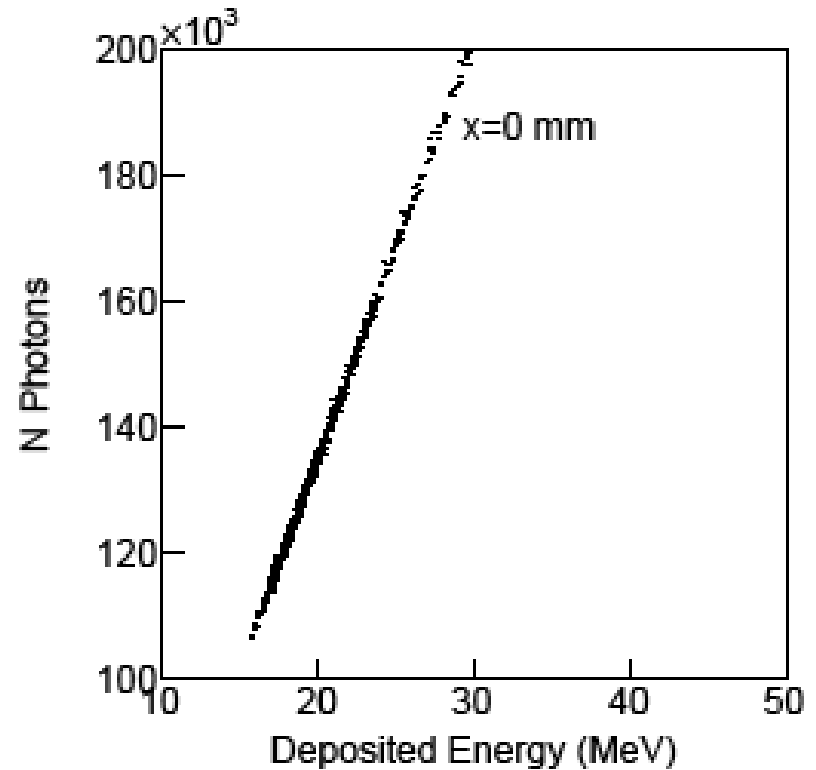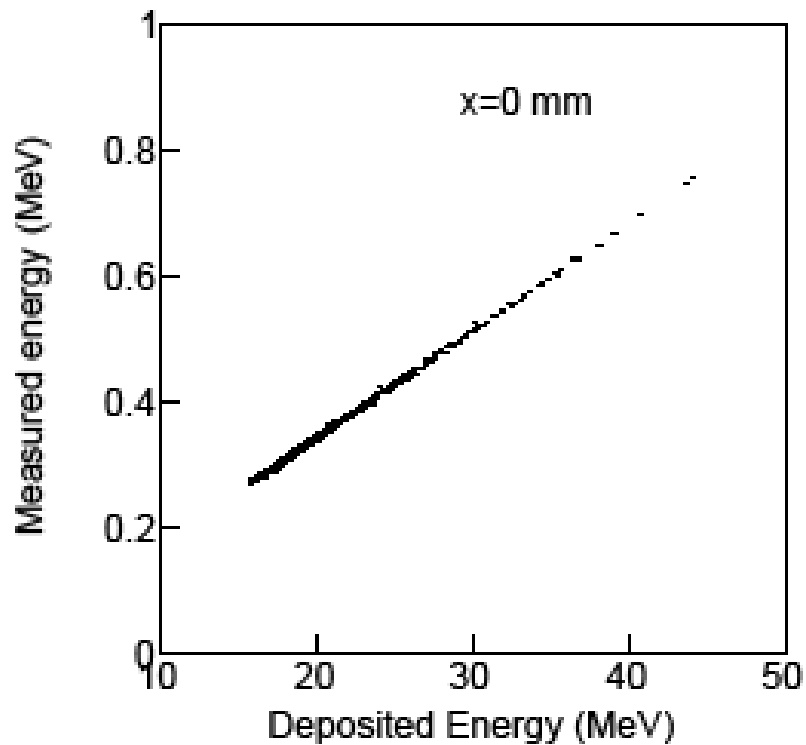
# The 5 Detectors Simulation Setup
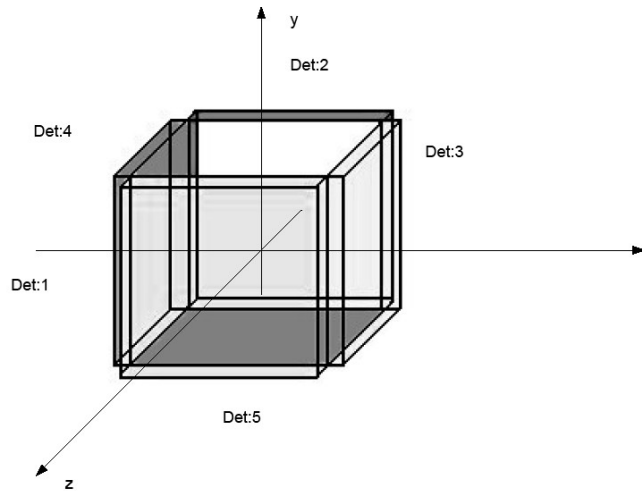


Cube: 2x2x2 cm$^3$
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Crystal: BGO
Surface: chemically etched surface, with tyvek
Particles: μ$^-$
Events: 1000
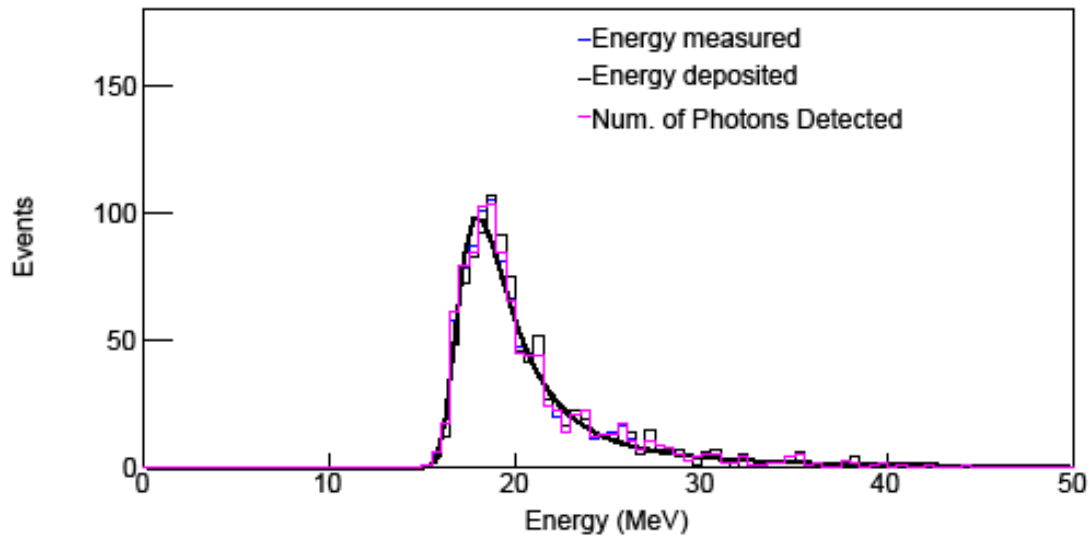Energy: 10GeV

Nr of photons per Event on
Each Detector.



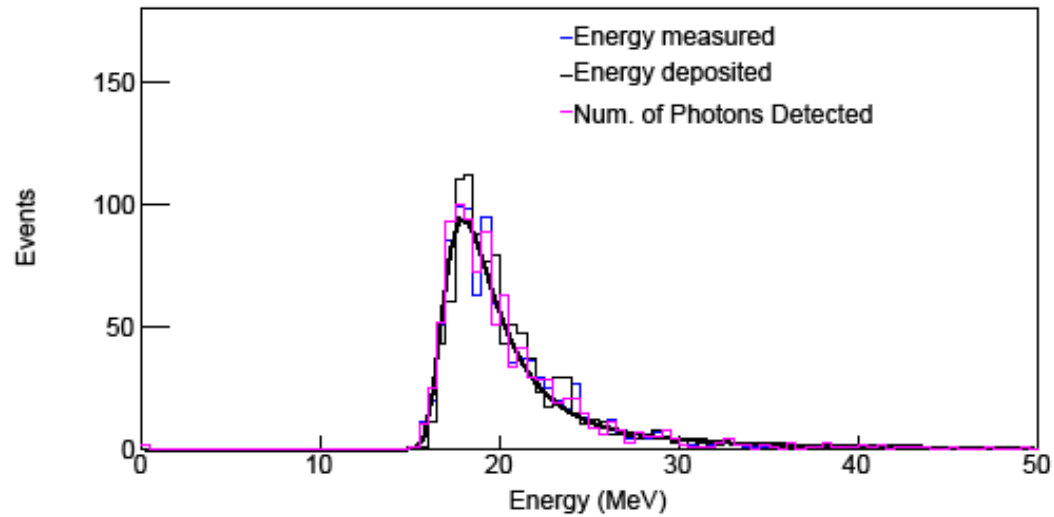16
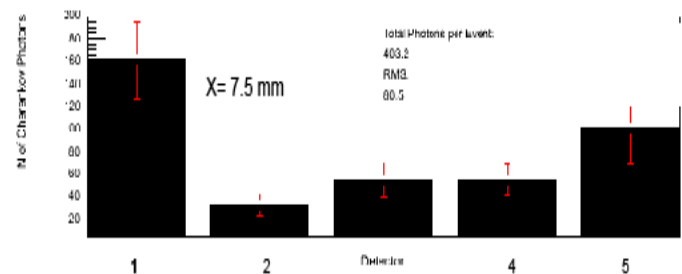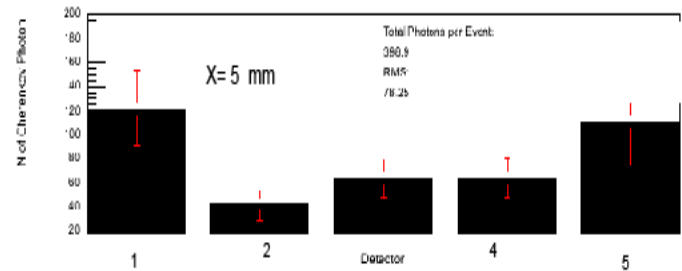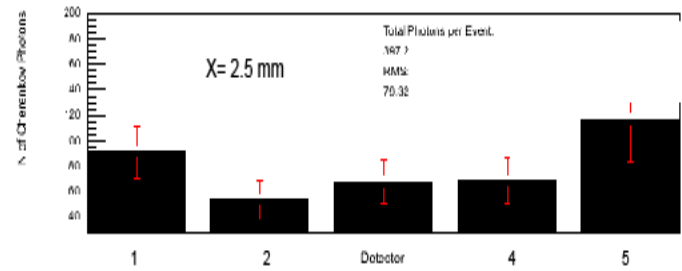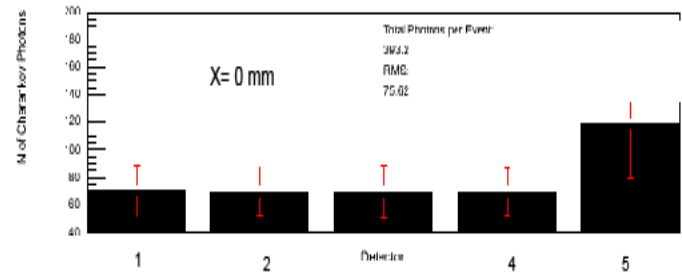
# MAKING THE CRYSTAL VOLUME SENSITIVE



The energy measured is linear depended to the deposited
energy in the crystal bar.
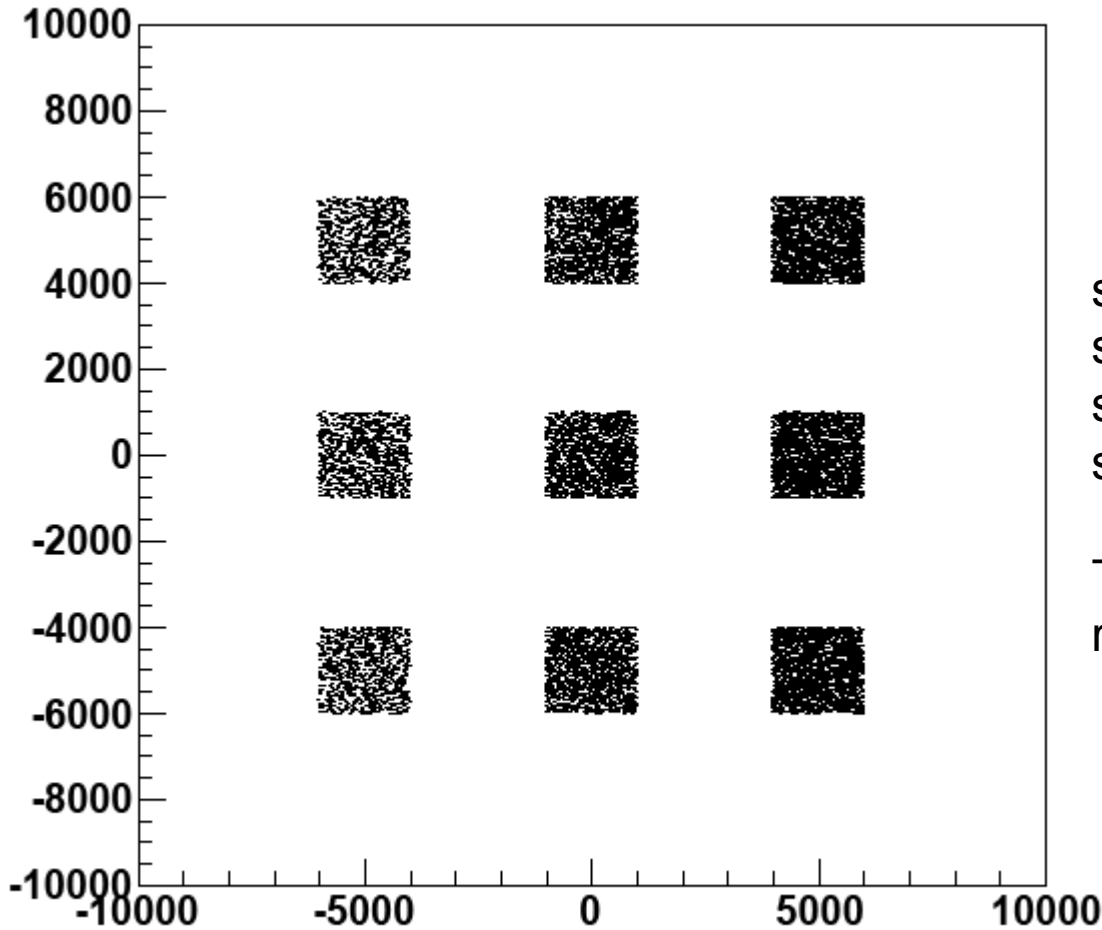This is expected as this is assumed by Geant-4.

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Energy distributions for x=0 mm



Energy distributions for GPS

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# SPATIAL ANALYSIS FOR ACQUIRING THE DETECTORS PHOTON STATISTICS



|        | Total perc. |        | Cherenkov perc. |
|--------|-------------|--------|-----------------|
| side1  | 9.1%        | side1  | 8.9%            |
| side2  | 8.9%        | side2  | 8.8%            |
| side1qe| 9.0%        | side1qe| 8.9%            |
| side2qe| 9.0%        | side2qe| 8.9%            |

This ratios correspond to the ratios of the sensitive area to the total area of the detector which is 9%