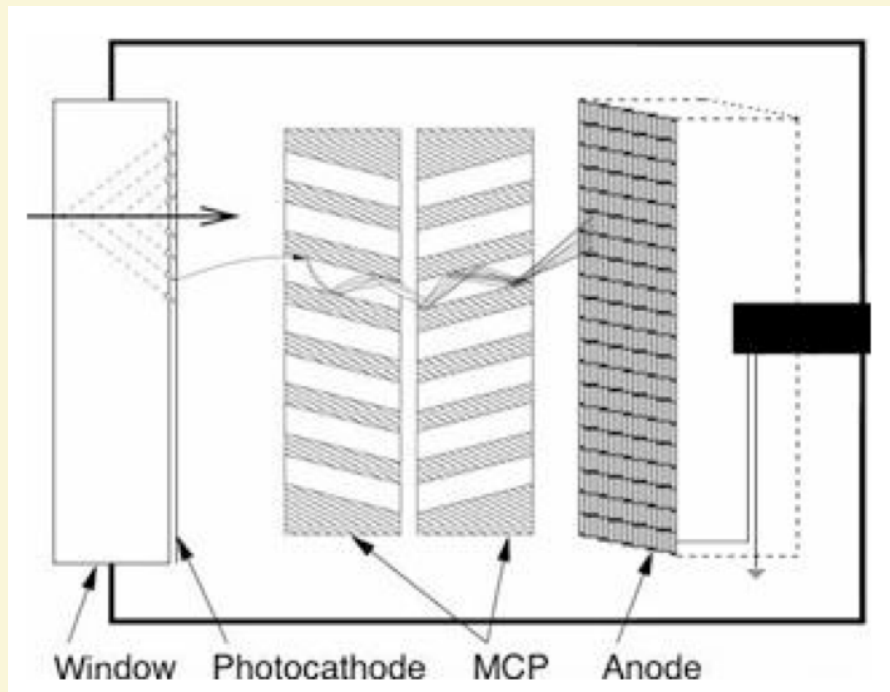# Geant4 simulation

A. Apresyan

Caltech

# Setup

- Trying to estimate how effective will the setup with Henry device be
  - Simulate muon passage through the glass window
  - Estimate total photon yield and energy spectrum from Cerenkov

- Simulation is ran through Geant4



Window    Photocathode    MCP    Anode

Schematic of the fast timing detector. A relativistic charged particle produces Cherenkov light in the window. This radiation is converted into electrons by a photocathode. The electrons produce a shower in the micro-channel plates (MCP), and the electrons are deposited on the segmented anode to be detected.

# Setup

- Implemented the detector volume as:
  - Borosilicate glass of 20x20x0.38mm thickness, as Andrey clarified
    - Refractive index of 1.538 and Absorption length 4.1-5.5cm (as a function of photon energy)
  - Glass is immersed in Air
    - Surface is also implemented to have the reflections and scattering
  - PMTs are simulated as circles of radius 2mm with Al photocathode and Glass tubes
    - At the moment the efficiency of PMT is set as 100%, can be easily changed

- Implemented a cosmic muon simulator CRY
  - http://nuclear.llnl.gov/simulation/main.html
  - data-based simulation of cosmic rays, standard package in many CR studies
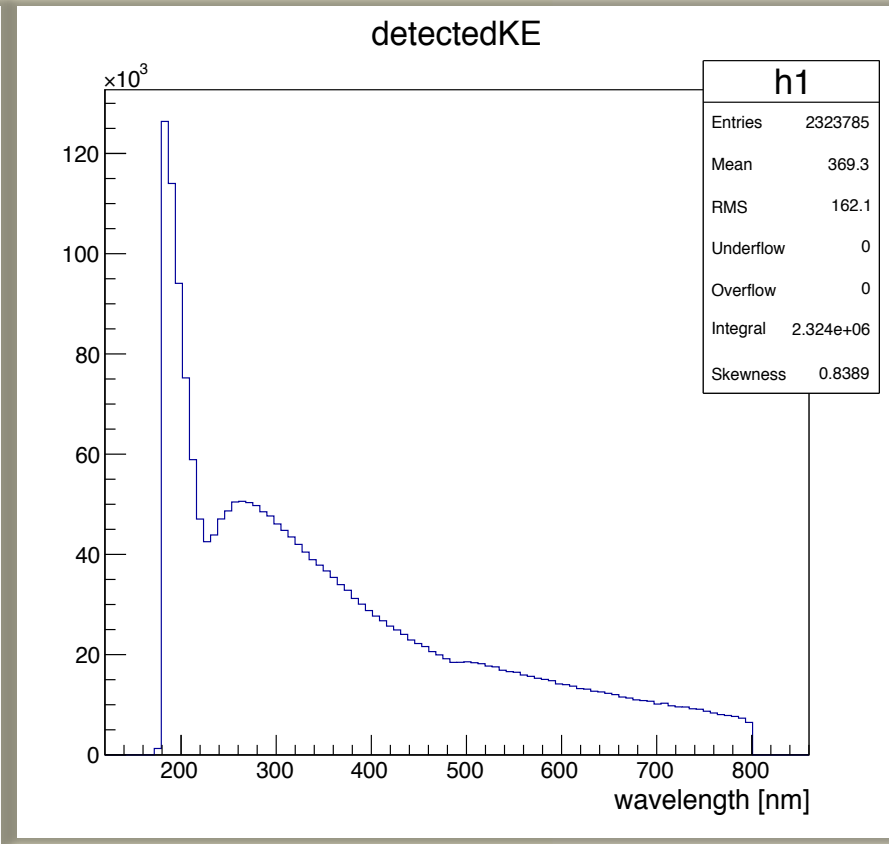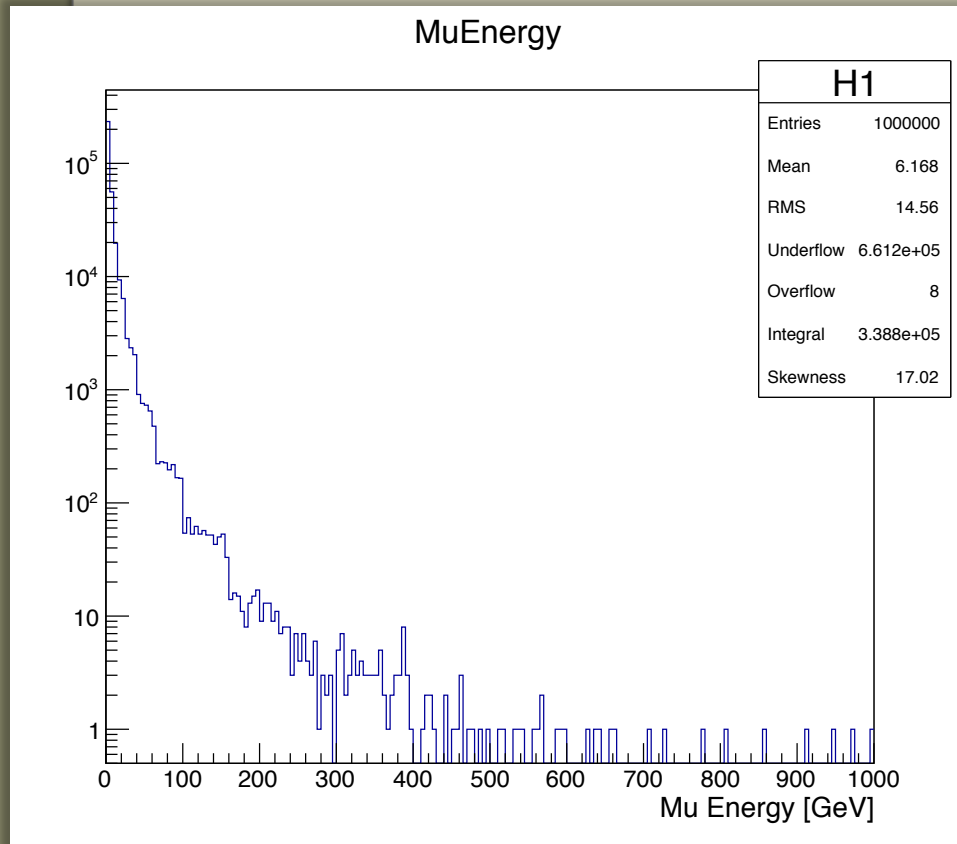
# Event displays

- To validate the setup, increased the thickness to 3.8cm
- Z axis points up
    - The small circles at the bottom are the PMTs
    - PMTs above a threshold are displayed as RED circles
    - Exposure in this event display is 0.7 secs
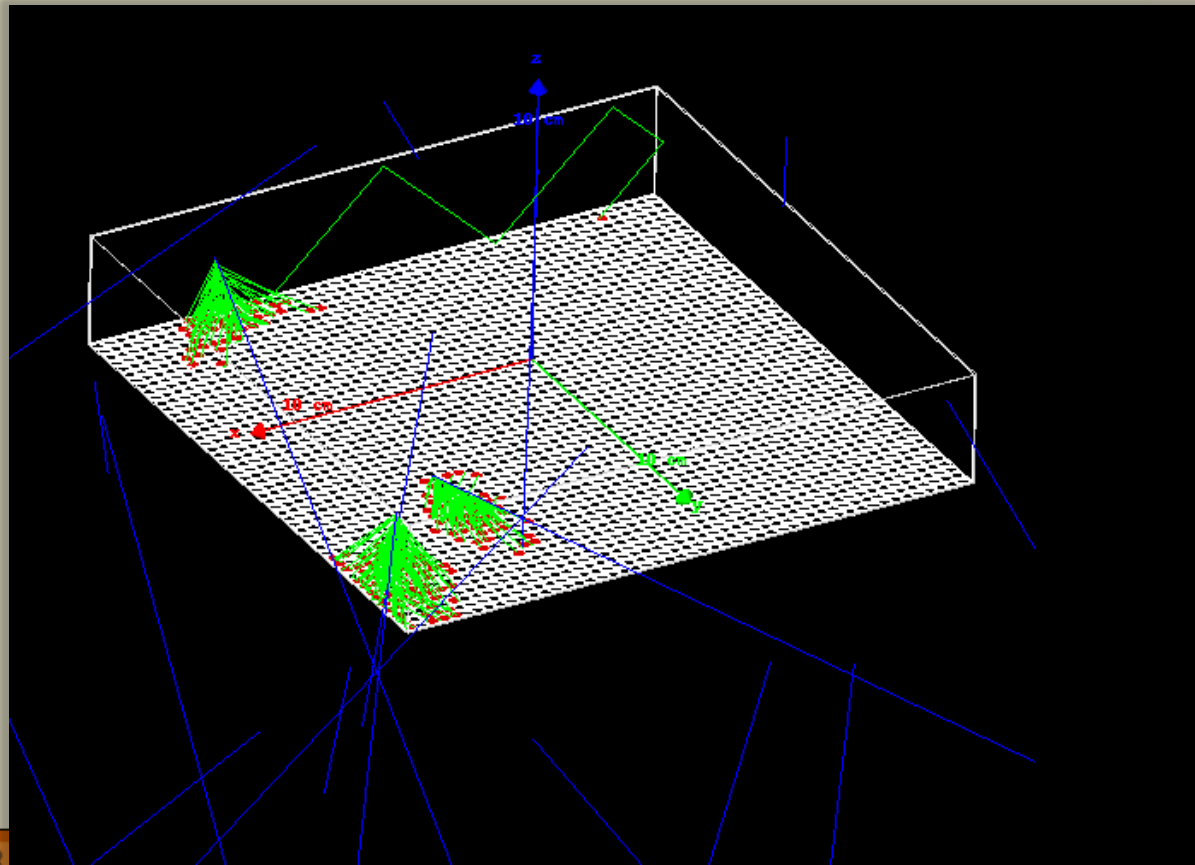
# Some plots

- All the following are with 20x20x0.38cm glass with 50 mins exposure



Cosmic muon energy spectrum from CRY I correctly reproduce the expected flux of ~100muons/cm/sec for $E_\mu$>1GeV
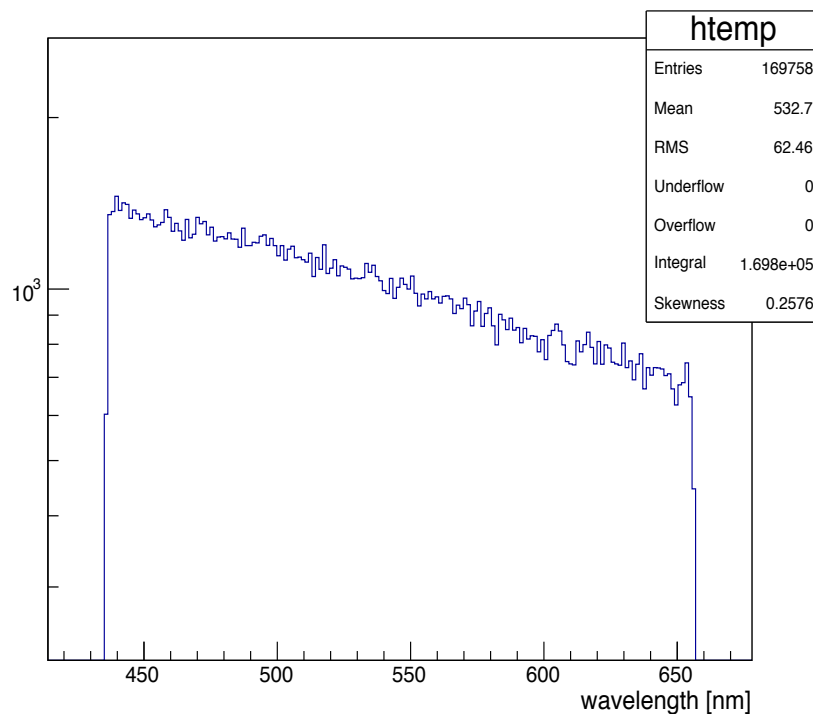
Spectrum of photons that reach PMTs. For the moment the PMT efficiency is set to constant 100%.
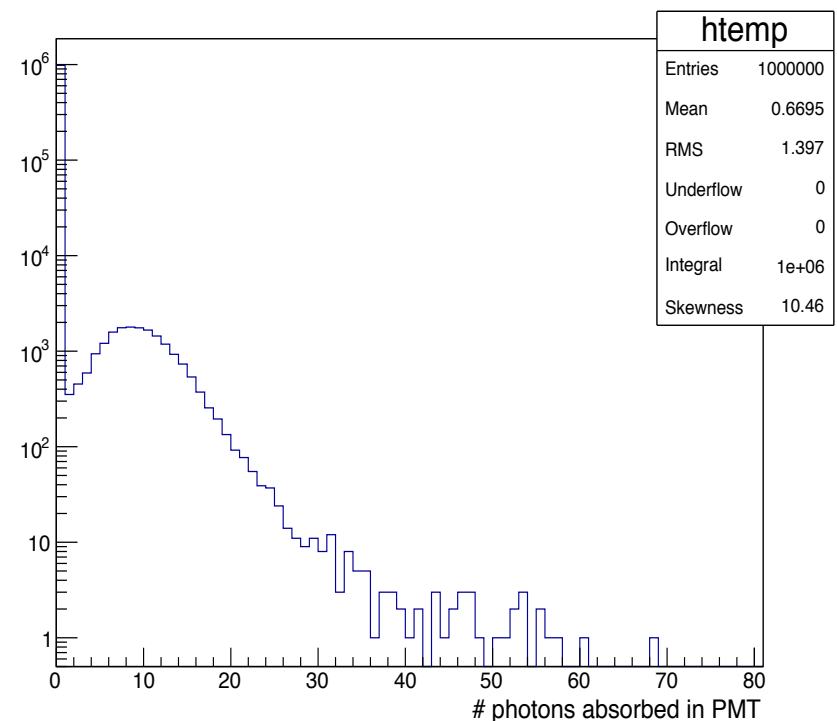
# Some plots

- In the following I set the optical properties to those in the Henry device, as pointed by Andrey Elagin

| Wavelength λ (nm) | 435.8 | 479.9 | 546.1 | 589.3 | 643.8 | 656.3 |
|---|---|---|---|---|---|---|
| Index of Refraction n | 1.48015 | 1.47676 ($n_{F'}$) | 1.47311 ($n_e$) | 1.47133 | 1.46953 ($n_{C'}$) | 1.46916 |

detectedKE.detectedKE

| htemp | |
|---|---|
| Entries | 169758 |
| Mean | 532.7 |
| RMS | 62.46 |
| Underflow | 0 |
| Overflow | 0 |
| Integral | 1.698e+05 |
| Skewness | 0.2576 |

NPhotonsPMT

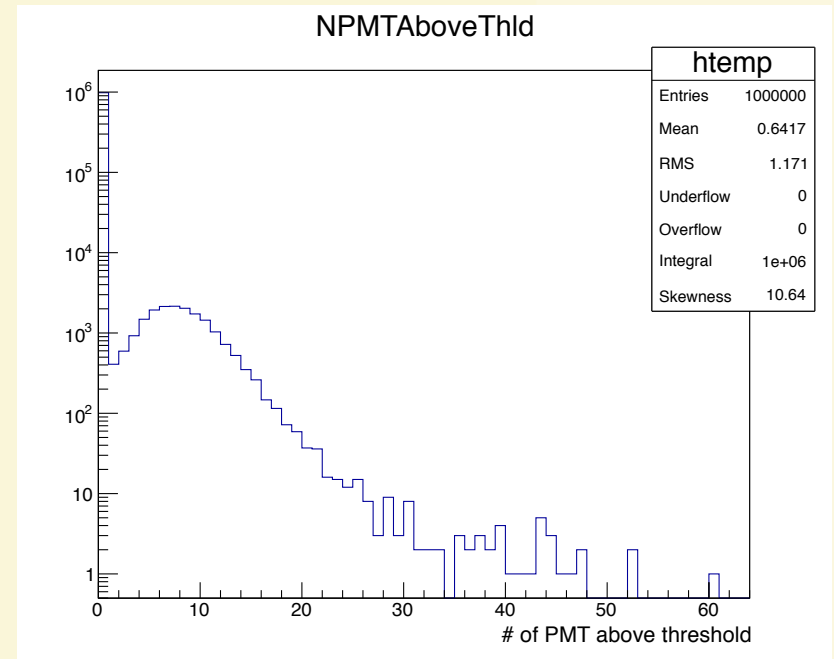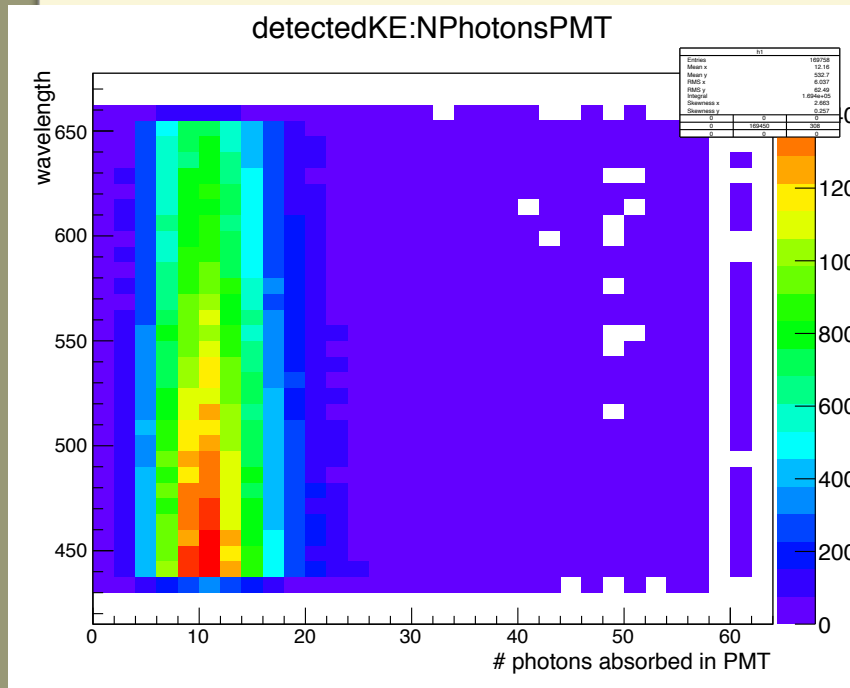| htemp | |
|---|---|
| Entries | 1000000 |
| Mean | 0.6695 |
| RMS | 1.397 |
| Underflow | 0 |
| Overflow | 0 |
| Integral | 1e+06 |
| Skewness | 10.46 |

wavelength [nm]

# photons absorbed in PMT

# Some plots

- PMT threshold is now set at 1photon, can be changed
- "number of photons absorbed in PMT" means they were deposited in PMT sensitive volume, i.e. are detected

- Number of optical photons produced is larger than those that get to PMT, since some are absorbed.
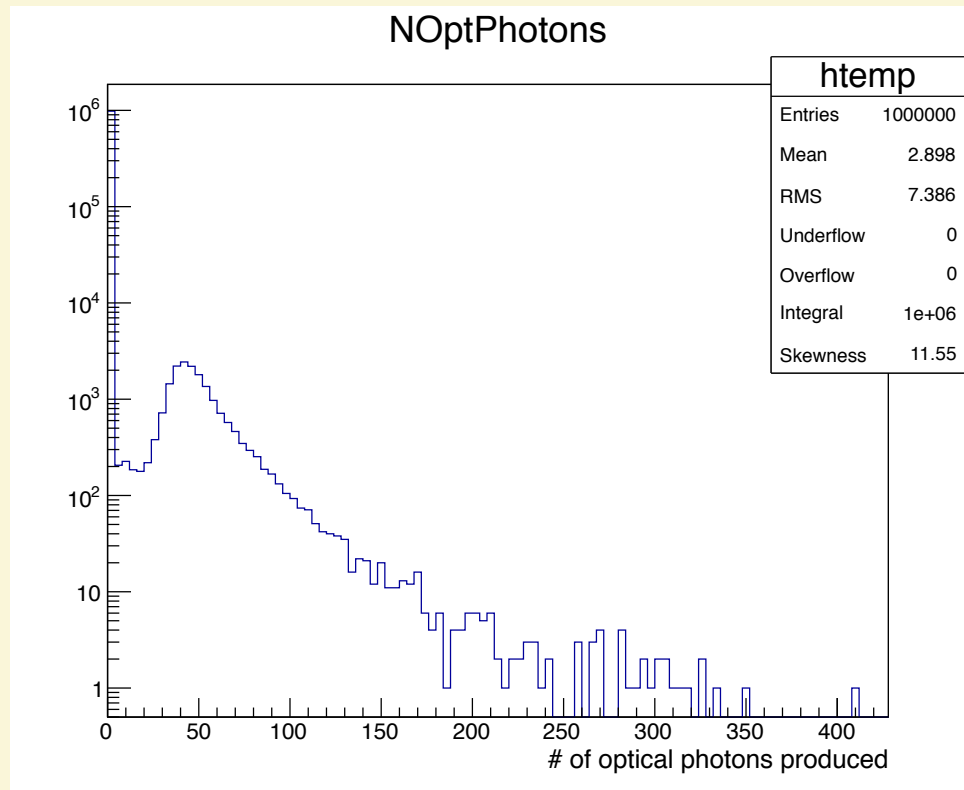
# PMT with 20% efficiency

- Now I change PMT to 20% efficiency