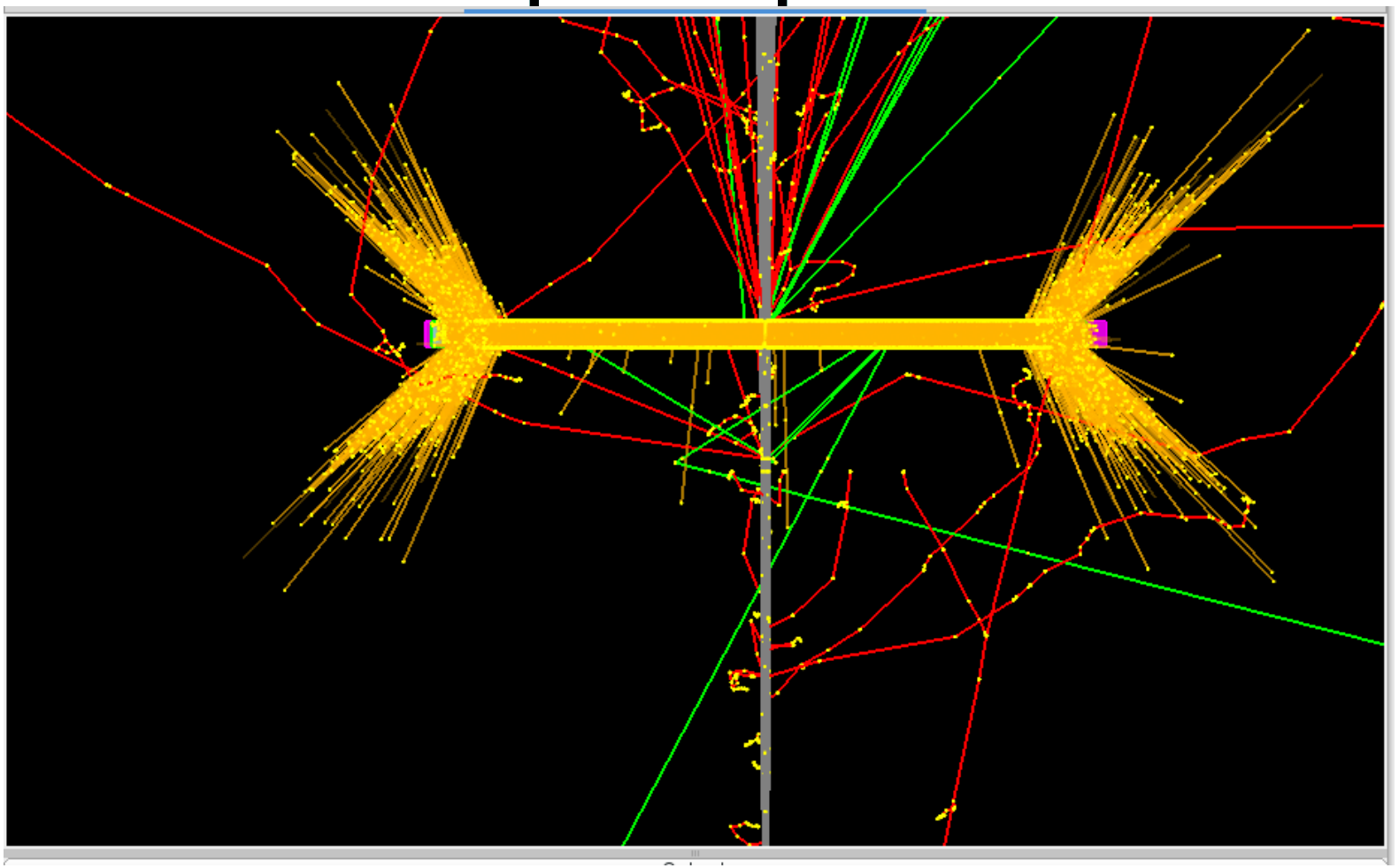
Variable Threshold Cherenkov Detector without gas using DIRC principle



A. Hayrapetyan for AG Düren , II Phys. Inst. JLU Giessen

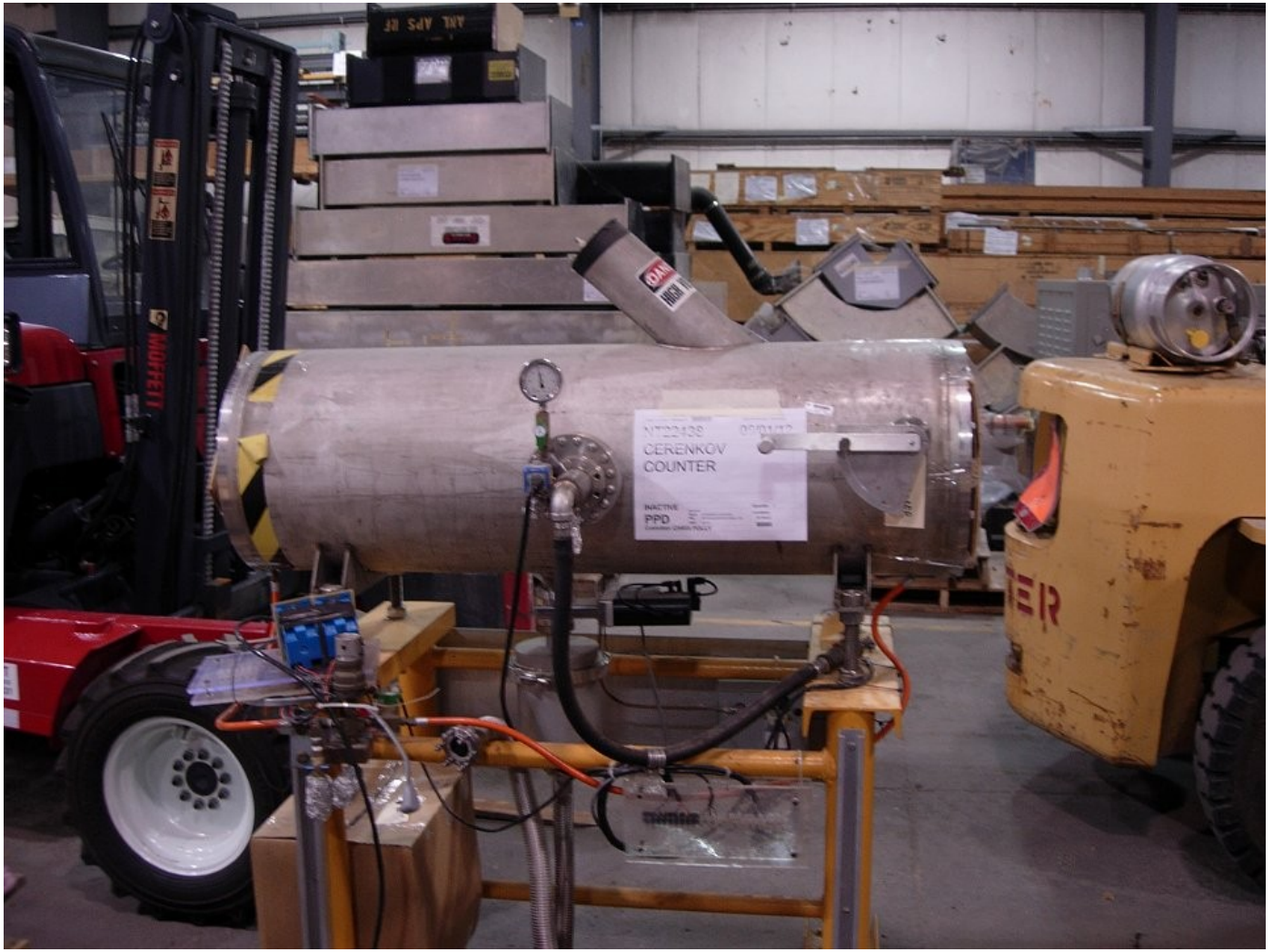
Outline

- Why we have looked for
- What alternatives could exist
- What type we suggest and how it works
- Where one can use it if built

Why we have looked for

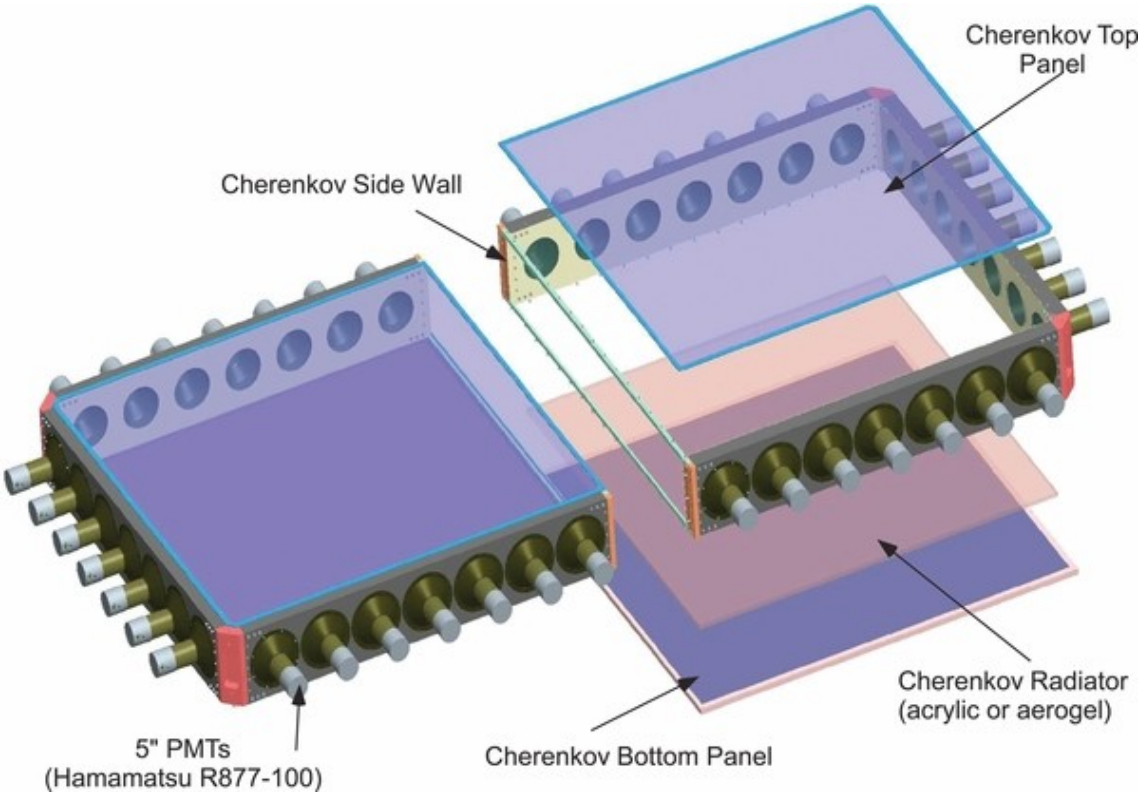
- To have cut cosmic muons below ~1 GeV/c
- The Muons Cherenkov photons emission angle in quartz above 1 GeV/c is ~ constant independent from their momentum
- This will make cosmic muons as a free test beam to test DIRC detectors at any location
- Sure we have also to define the muons trajectories
- All in all the task requires to reach <3 mrad resolution for trajectory and emission angle together to be compatible with test beams(CERN,DESY….)

Traditional Threshold Detectors, Gas



One of many gas Cherenkov detectors in CERN moving to installation position

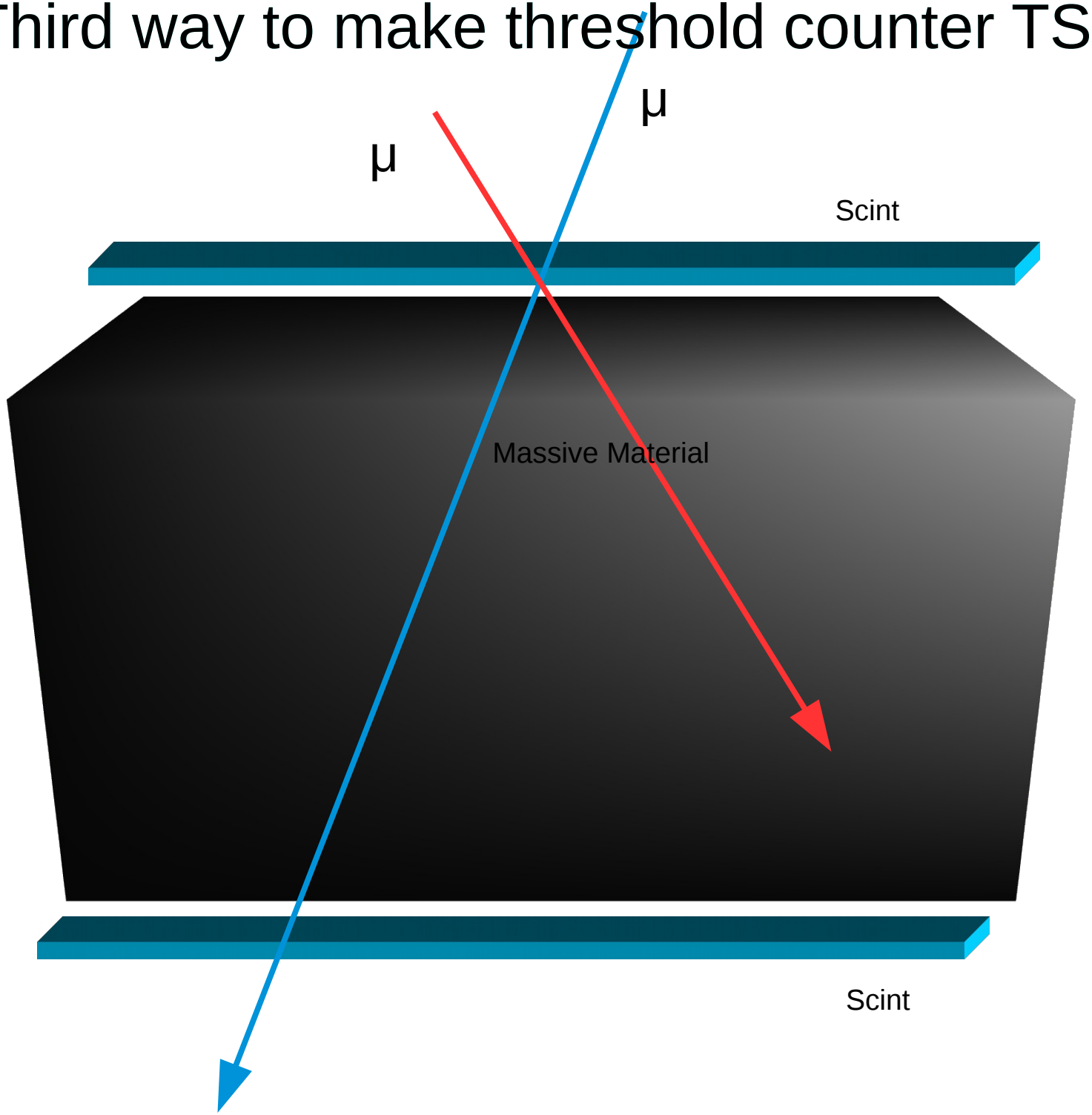
Traditional Threshold Detectors, Aerogel



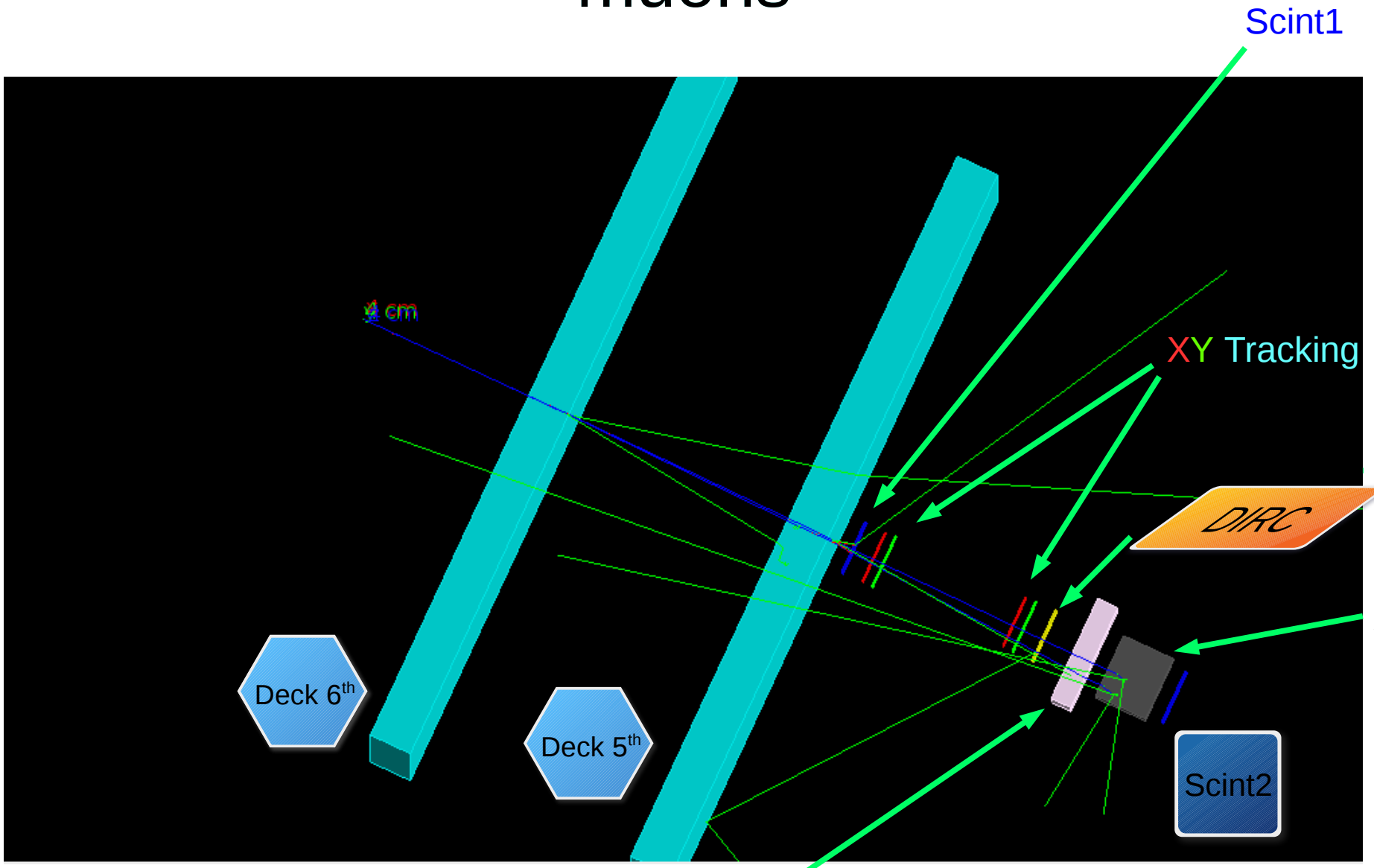
THE SUPERTIGER INSTRUMENT: MEASUREMENT OF ELEMENTAL ABUNDANCES OF ULTRA-HEAVY GALACTIC COSMIC RAYS

http://iopscience.iop.org/article/10.1088/0004-637X/788/1/18/pdf

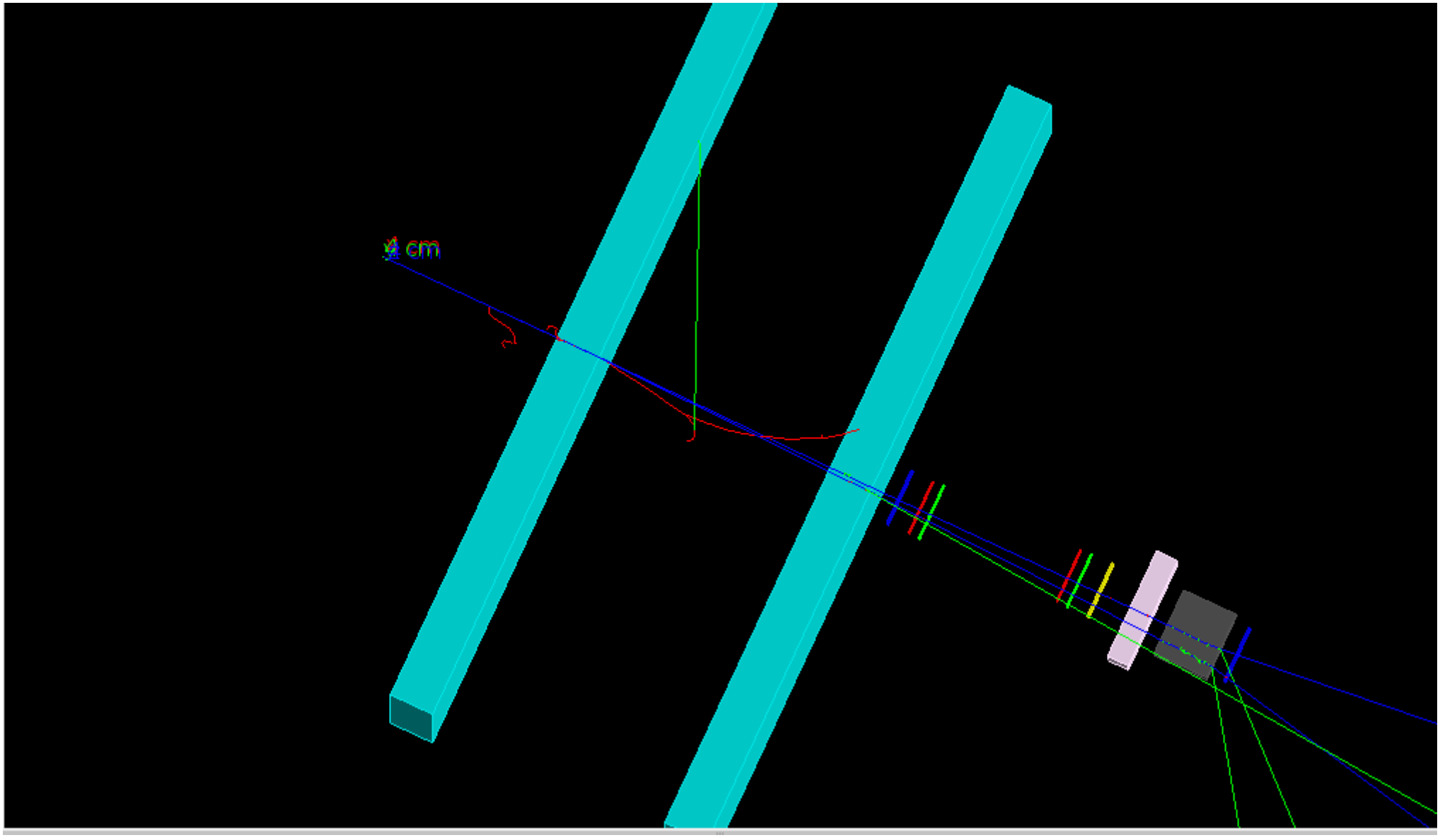
A Third way to make threshold counter TSC



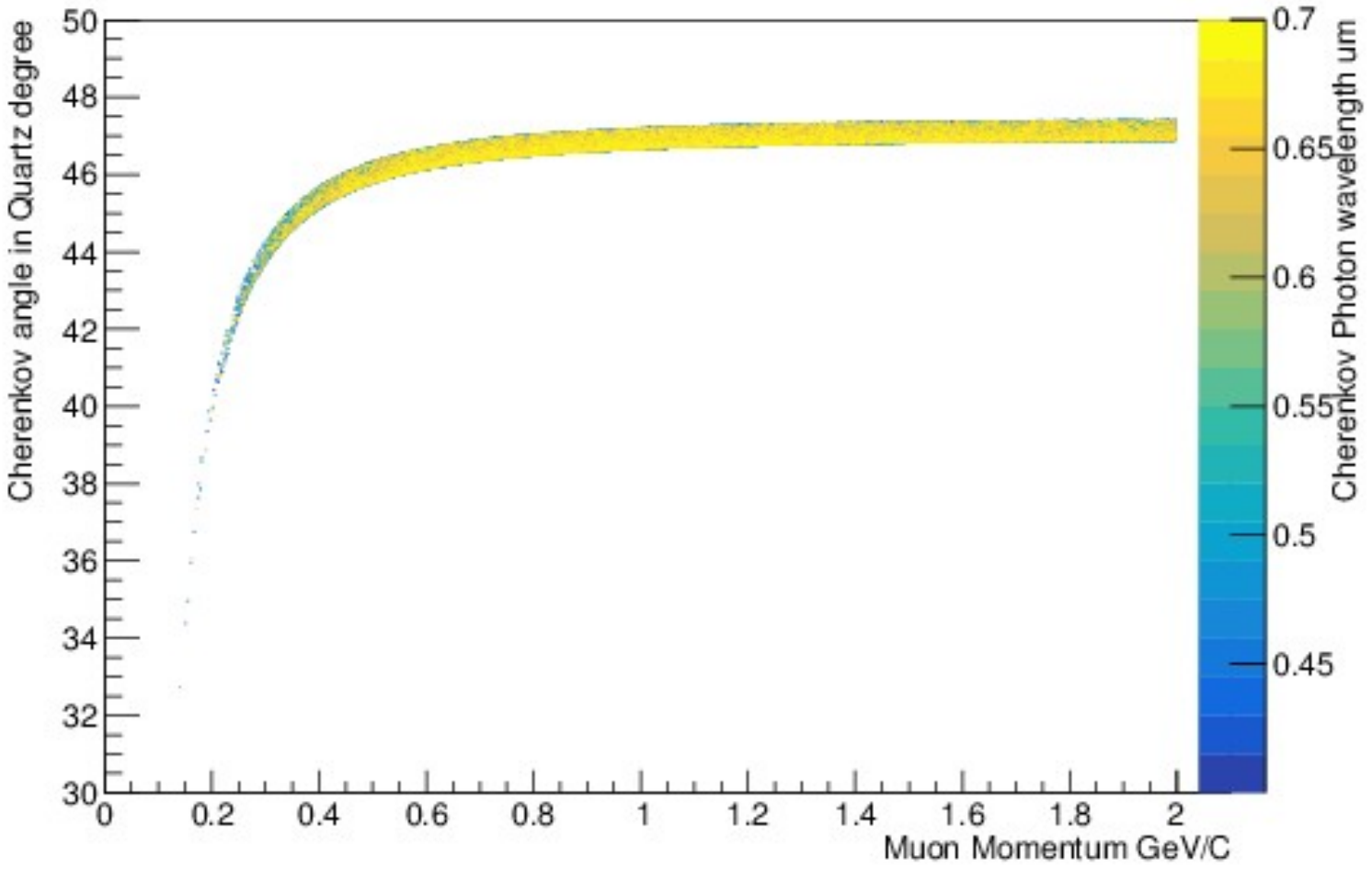
Geant4 view of Giessener Cosmic Station(GCS) with a few(blue) 700 MeV/C muons



Geant4 view of GCS with a few(blue) 1000 MeV/C muons

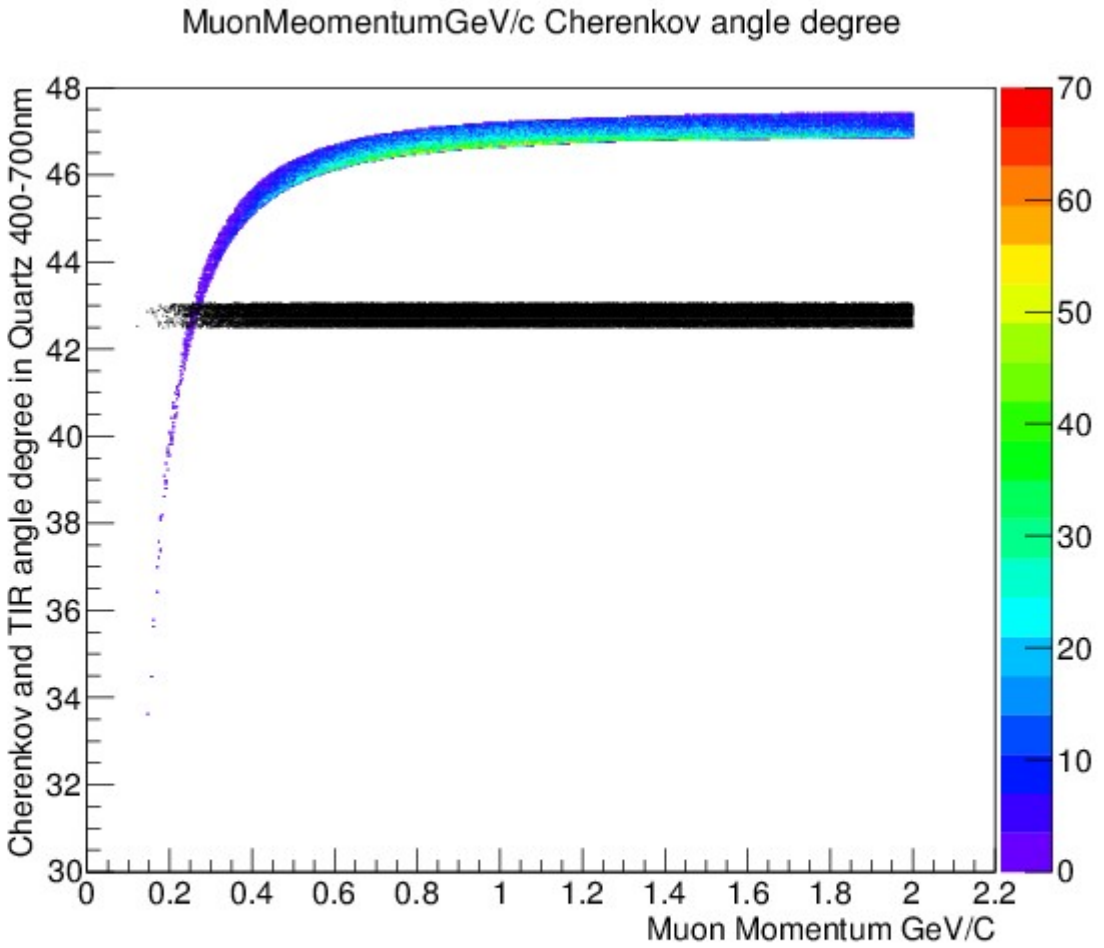


Classical Plot for RICH/DIRC



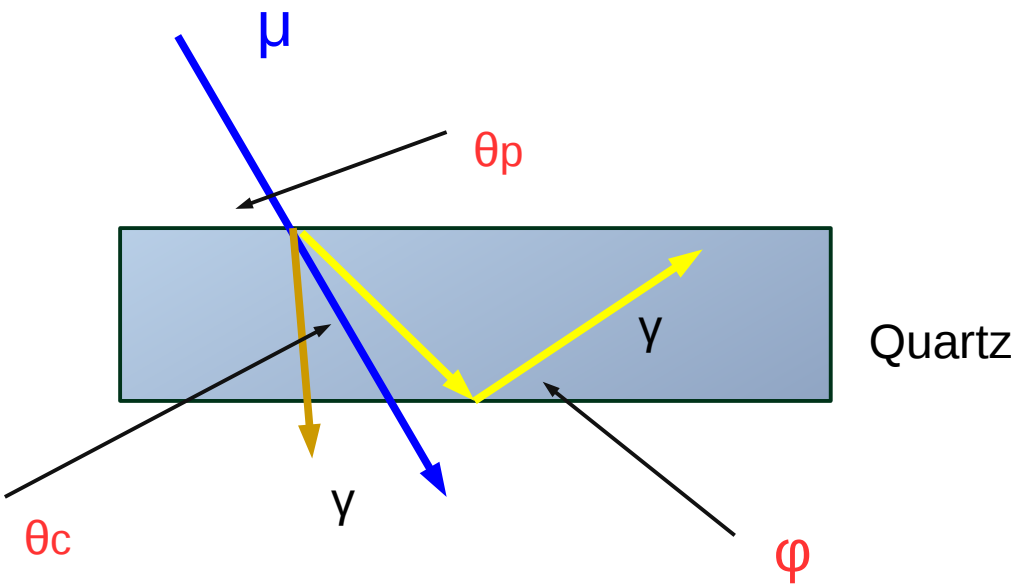
Cherenkov photons angle inside quartz against muon momenta

Similar Plot but now with TIR angle



Cherenkov photons angle inside quartz against muon momenta, below TIR angle practically all photons leave the medium

Whole DIRC things in 1 formula, a play with angles



$\cos(\theta c) = \sin(\theta p)\cos(\Phi)\cos(\varphi) + \cos(\theta p)\sin(\varphi)$

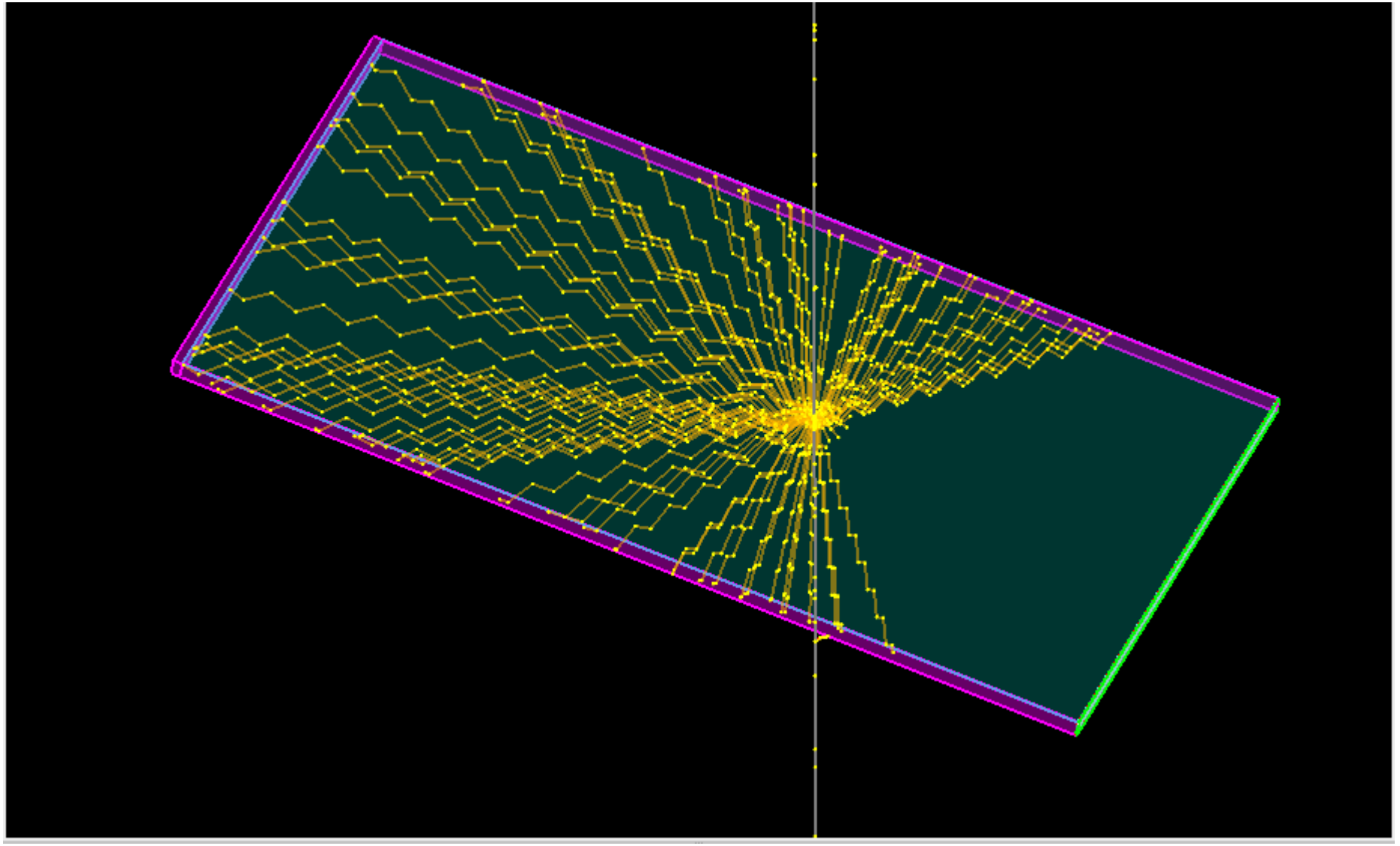
where the Φ is the angle of Cherenkov photons around particle(μ)

and

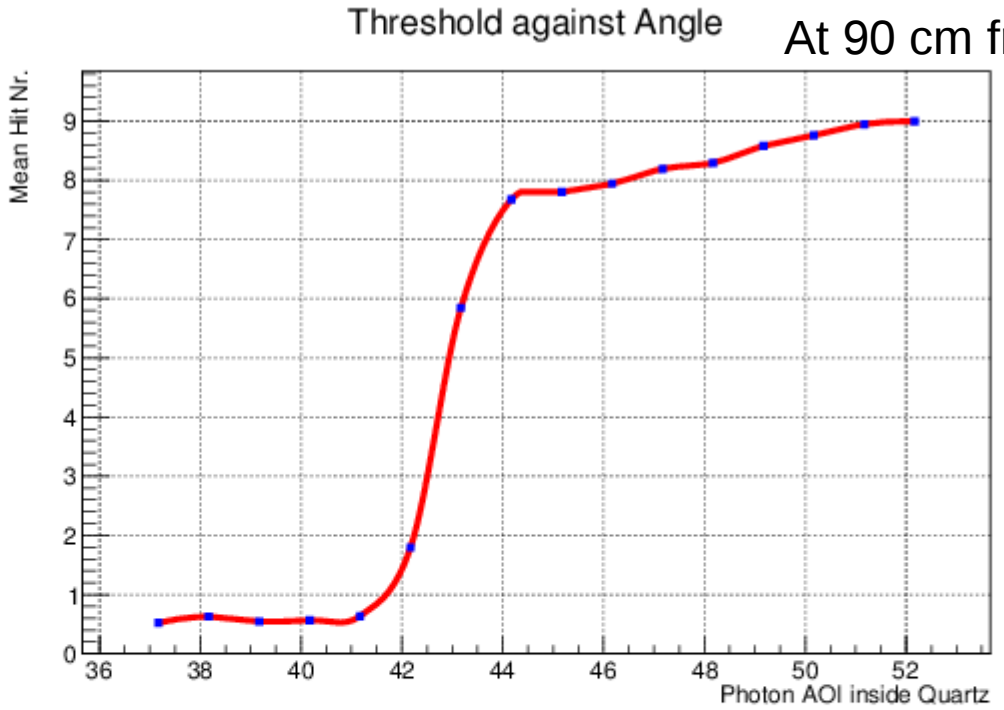
the condition for TIR

$\varphi > \arcsin(n2/n1)$ where $n1$ and $n2$ are refractive indexes of mediums

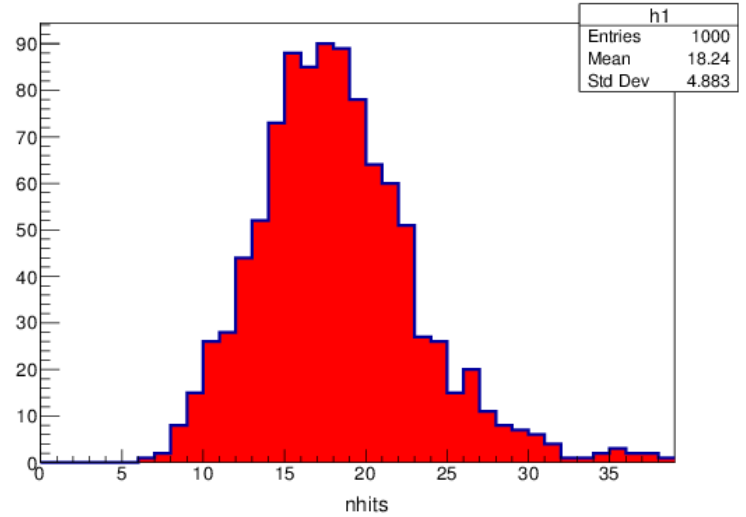
Threshold Cherenkov CounterTCC 3 sides blended 1 side open for photon detector

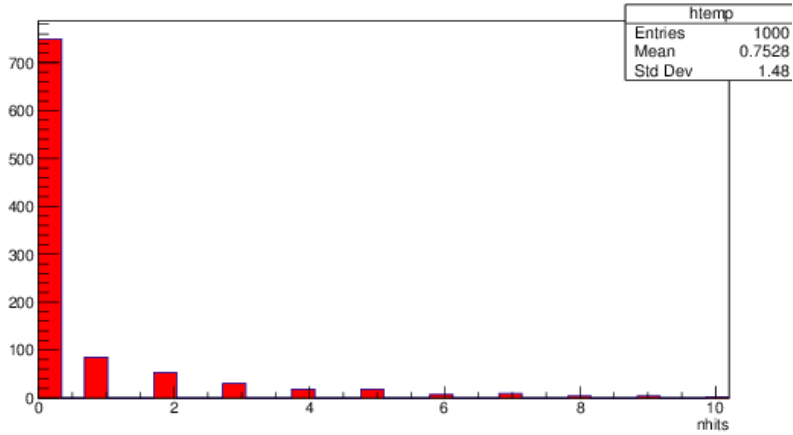


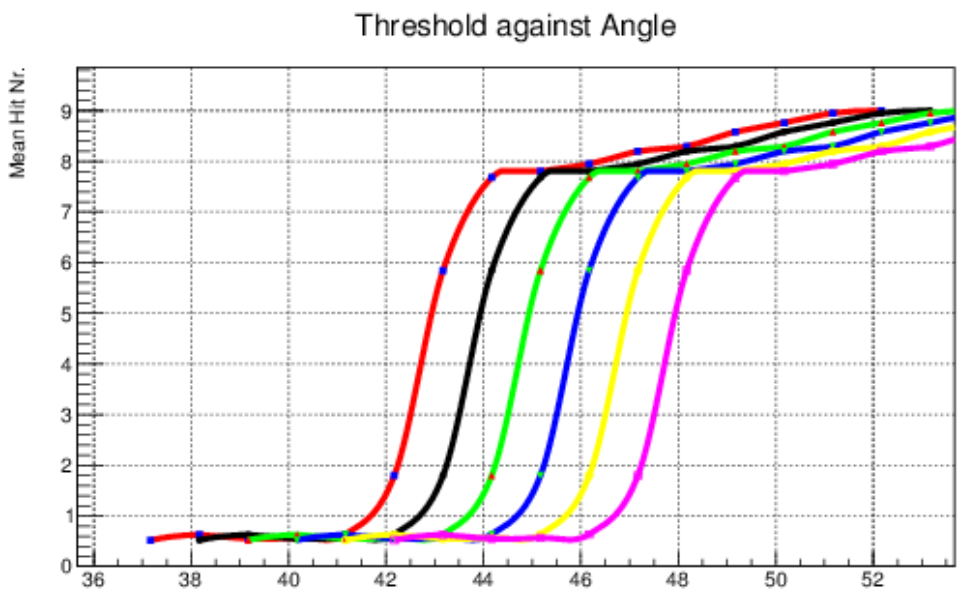
Tilting the TCC in Photondetector direction

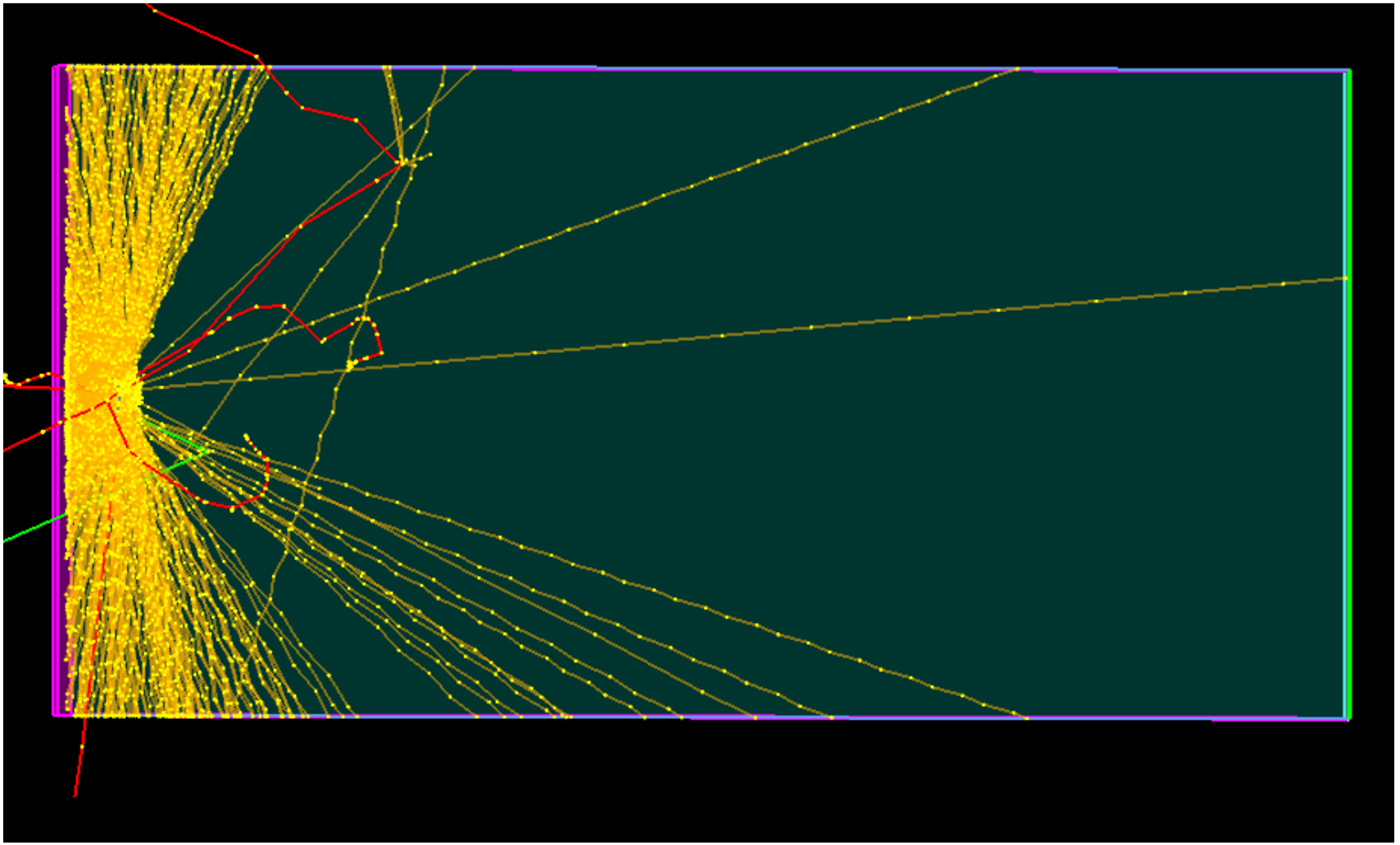


At 90 cm from Detectors

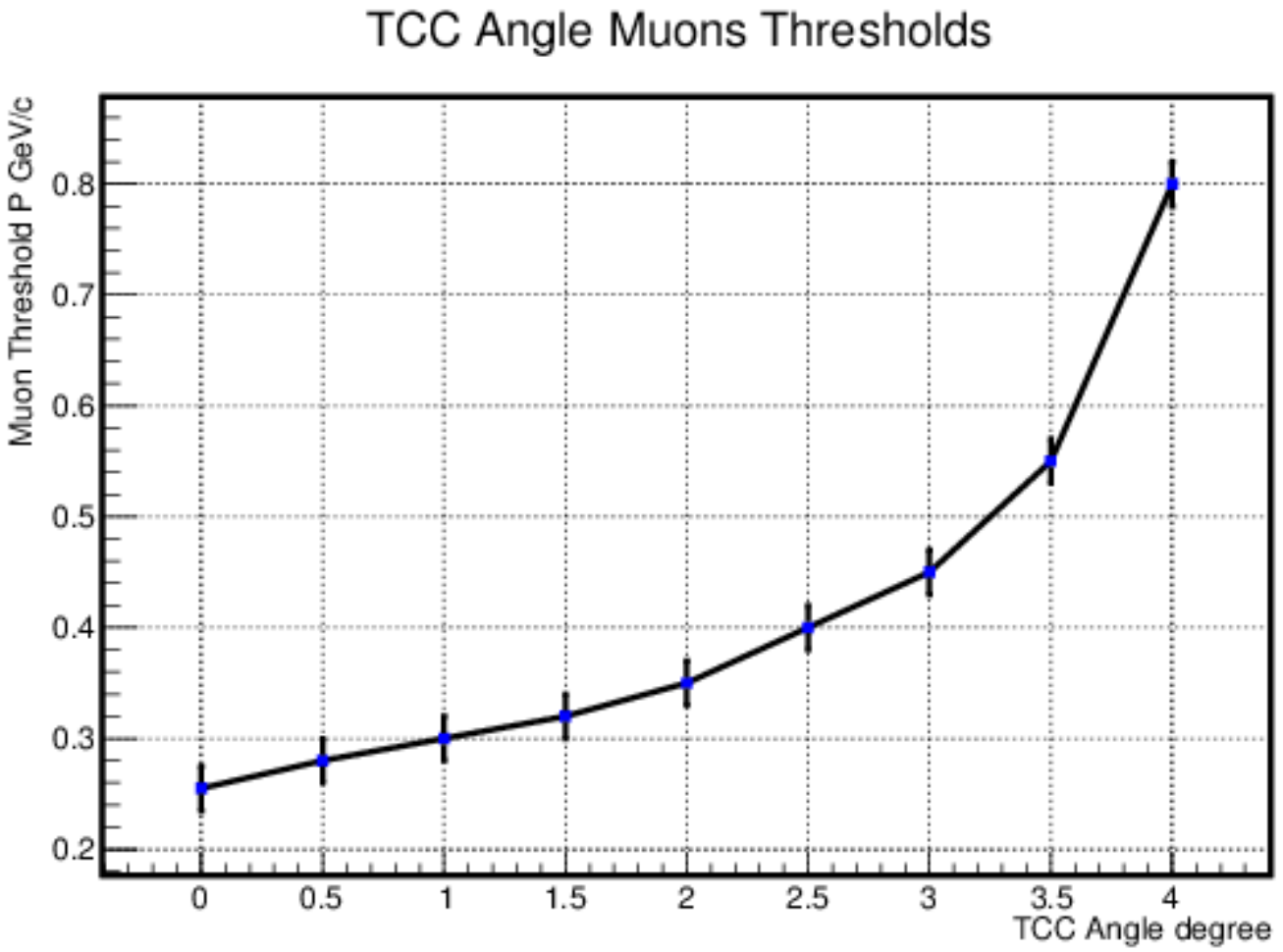






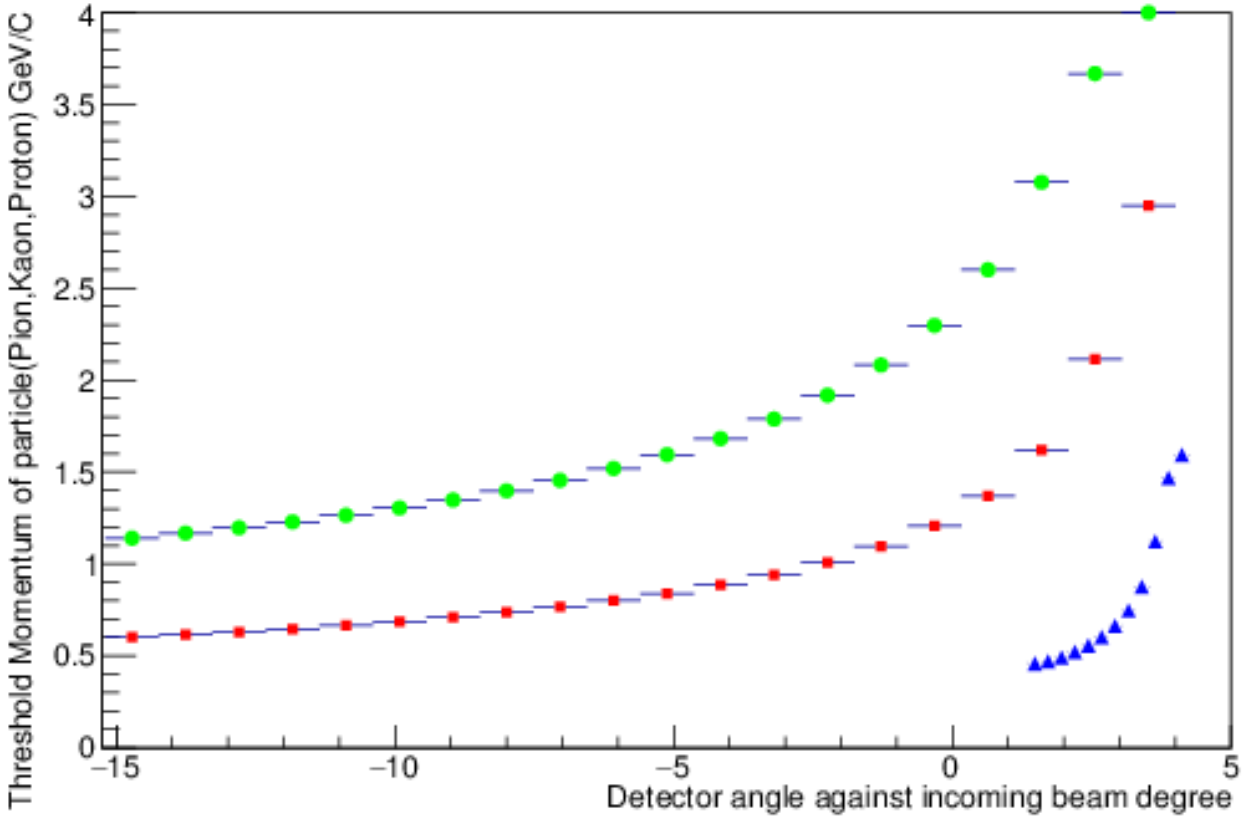


Effect of the tilt on muons that yield photons on detector side



One sees that by simply tilting the TCC angle one can cut muons below certain momentum

Thresholds for Proton Kaon Pion



In principle we could use such a TCC detector at CERN T9 to select Pions above 3 GeV/C

Comparison of TCC's

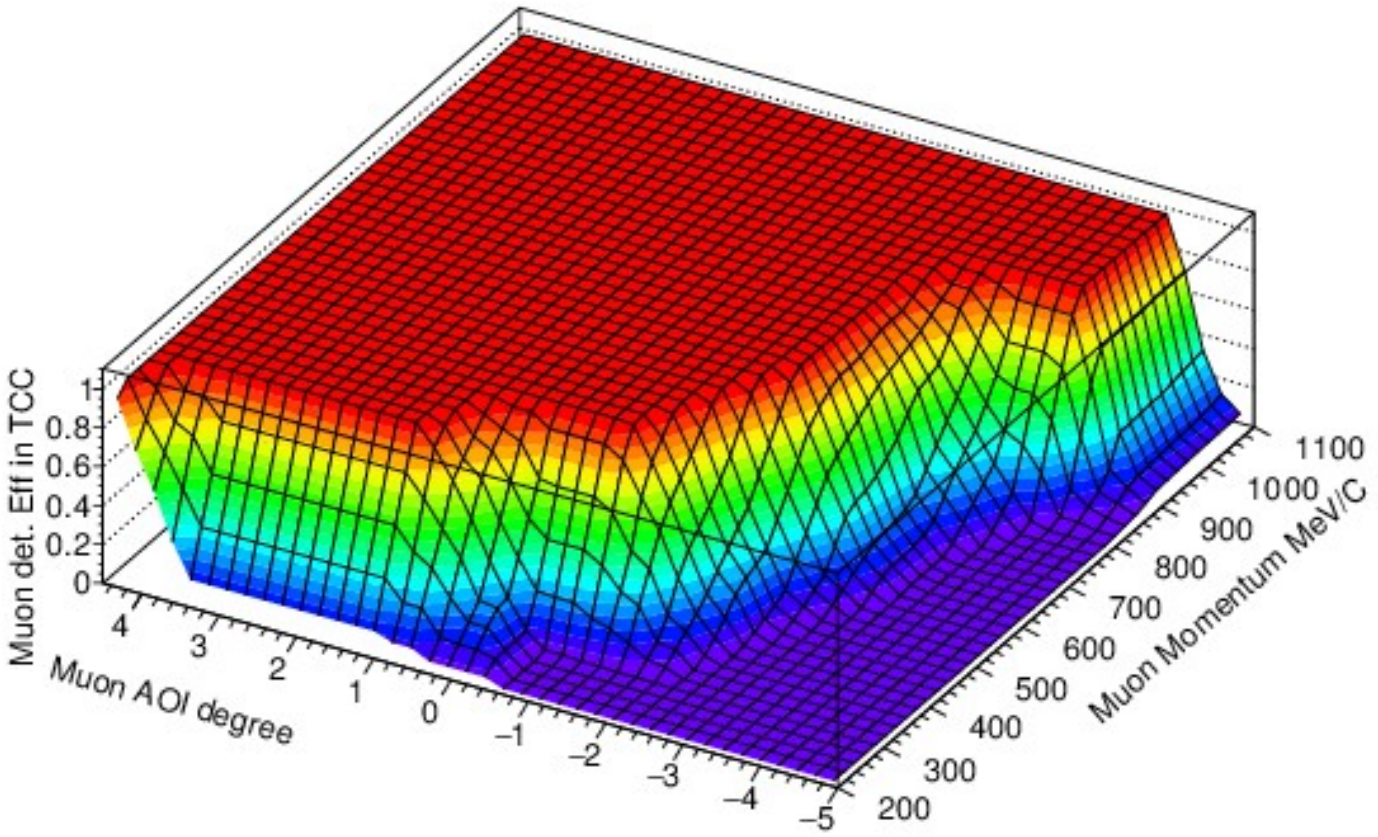
	Operation	Variation of Threshold	Detection Efficiency	Dependence from AOI
Gas TCC				
Aerogel TCC				
TSC based on Absorber				
TCC based on DIRC				

Conclusion, Thanks , Desire

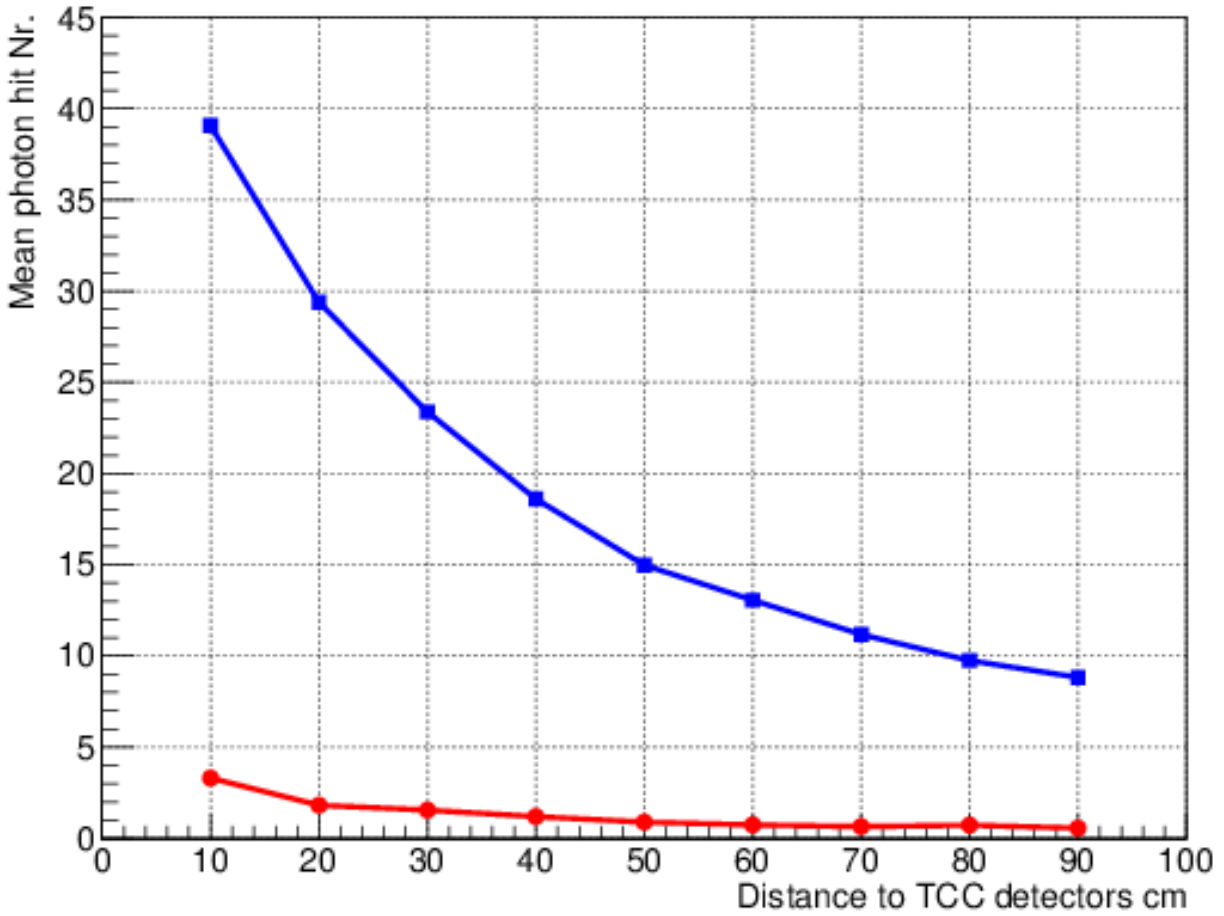
- In MC one can “build” a TCC which can cut
- Protons in range 1.2–4.0 GeV/c
- Kaons 0.6 – 2.8 GeV/c
- Pions 0.3 – 1.3 GeV/c
- Muons 0.2 – 1.0 GeV/c
- So such a detector could fulfill GCS requirement for example, it is intriguing if one can build/test
- Special Thanks goes to Roman making “PRTDIRC”(not only) project open source project

Backup

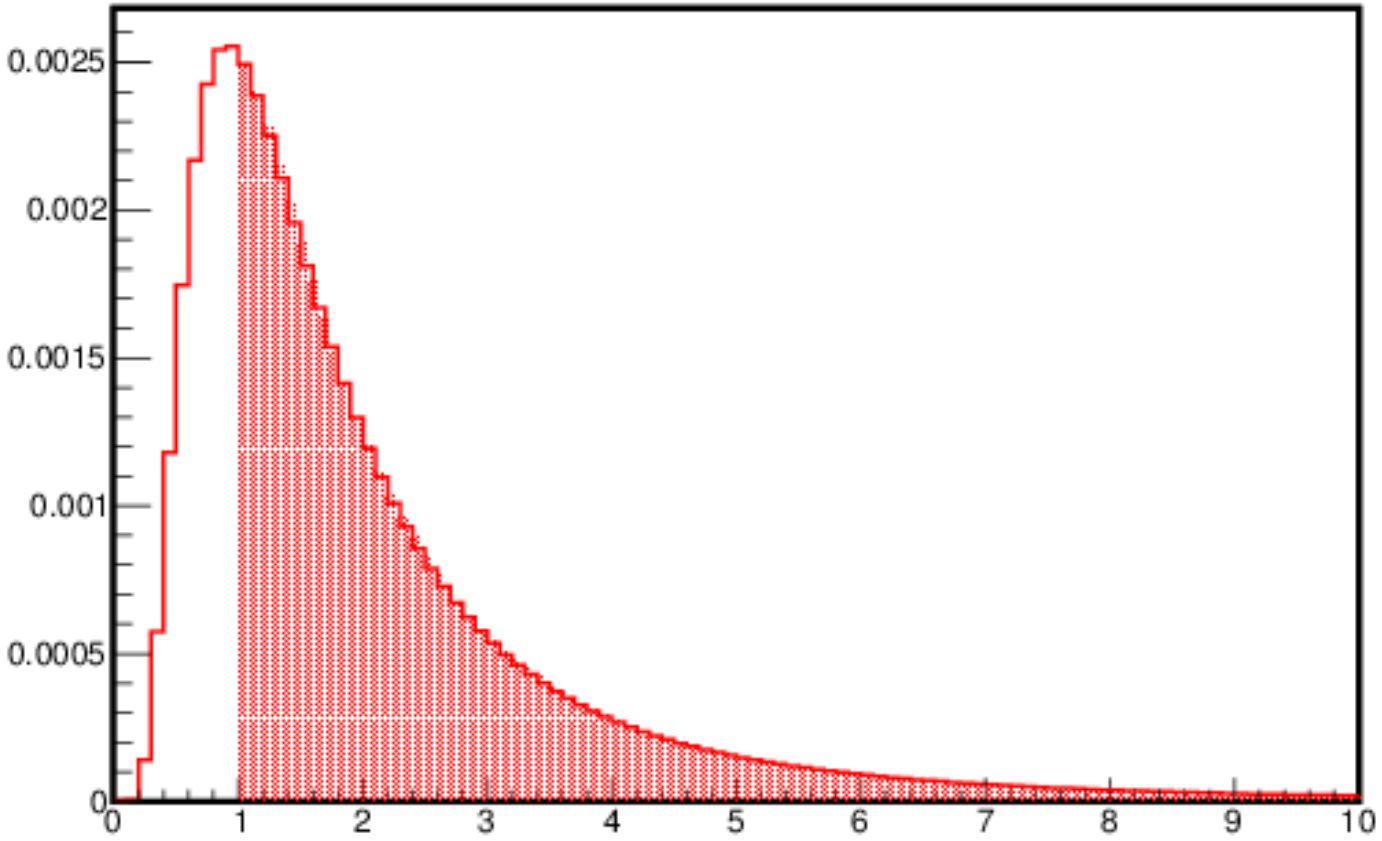
TCC Efficiency



TCC distance dependence for signal 1 and 0

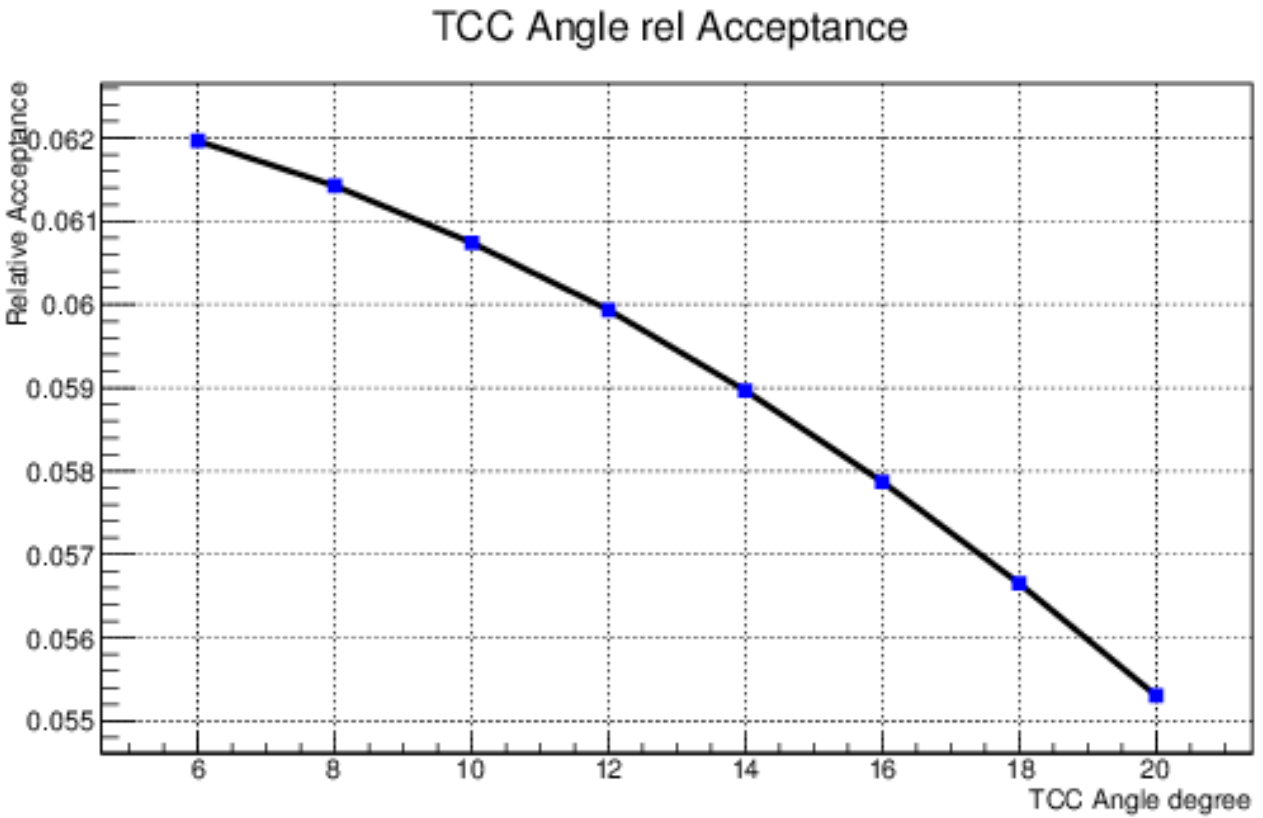


Moun Momentum and our desired range

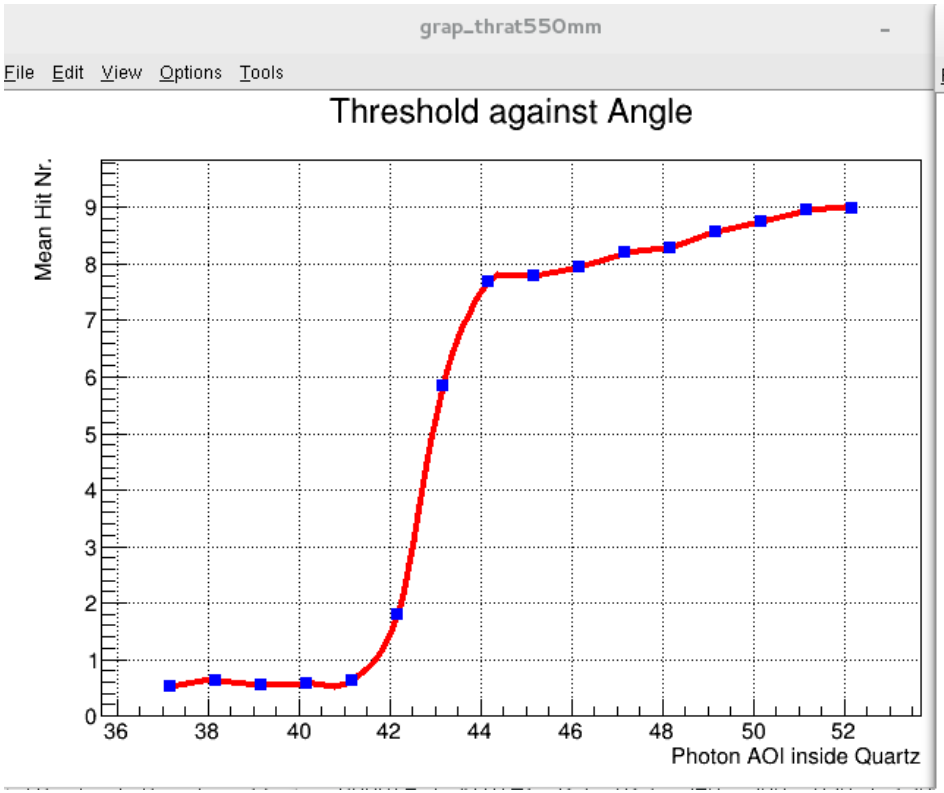


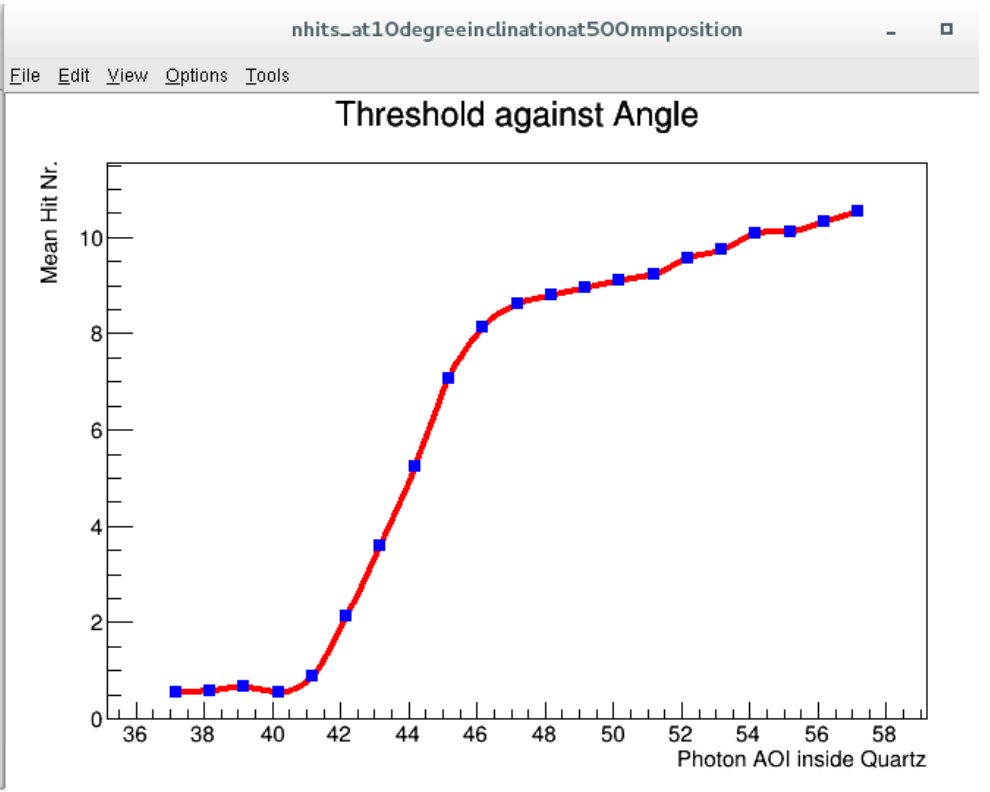
As one can see from Muon momenta spectra
We will able to accept more than 73% of Muons
According to momenta model, b'cos above 1GeV/C then the Cherenkov angle is constant in quartz

The TCC relative acceptance in GCS

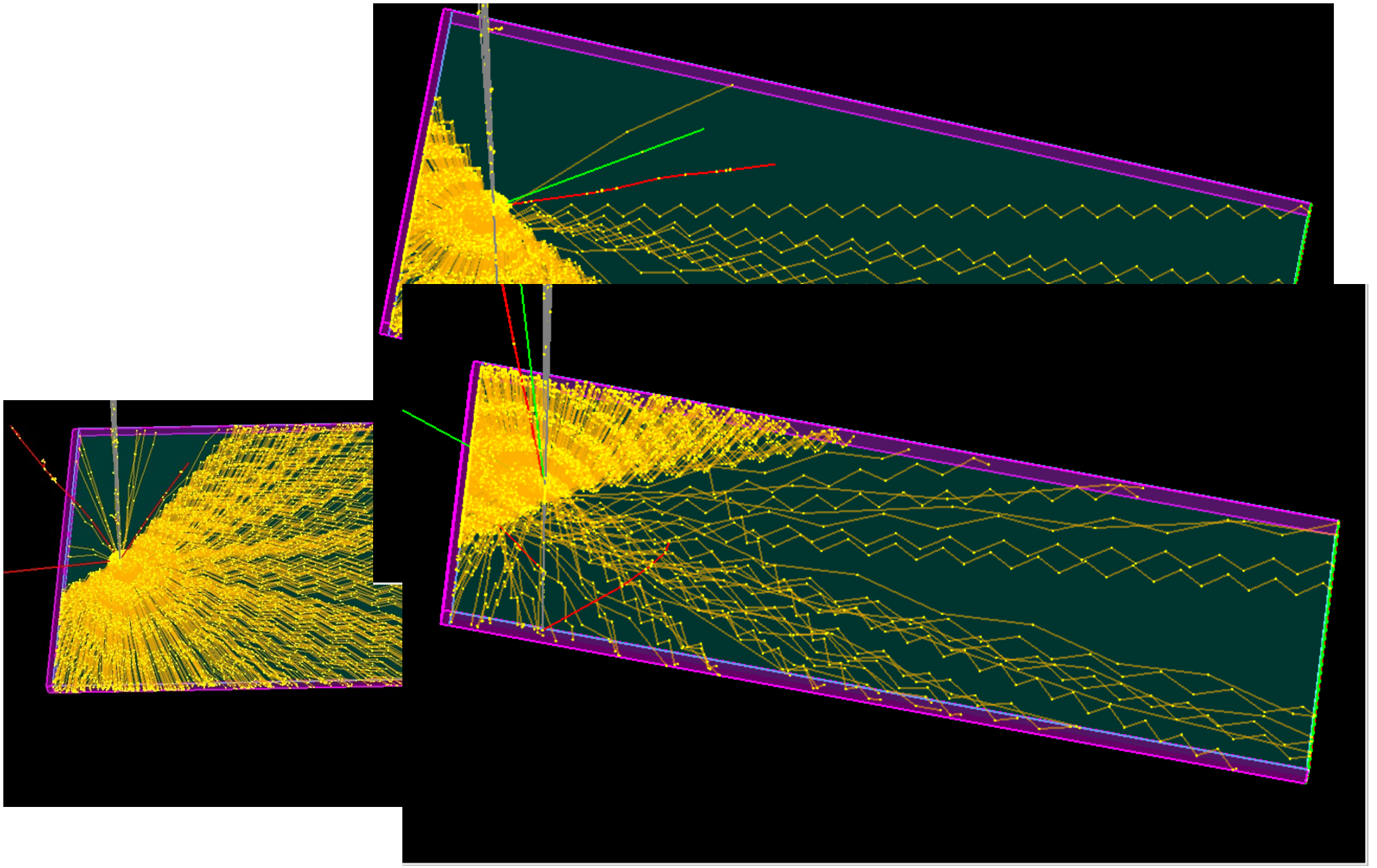


Efect of beam inclination in one direction 10 degree





Effect of +-10 degree beam inclination in GEANT



JLAB SHMS with full flavour of Threshold Cherenkov usage