Imperial College London

Beam window simulation

Water Cherenkov Test Experiment collaboration meeting

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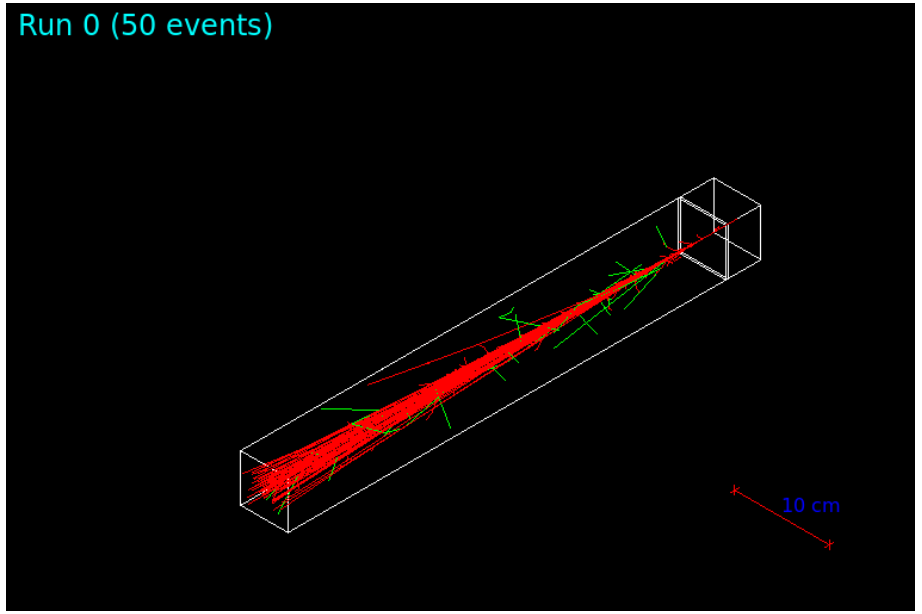
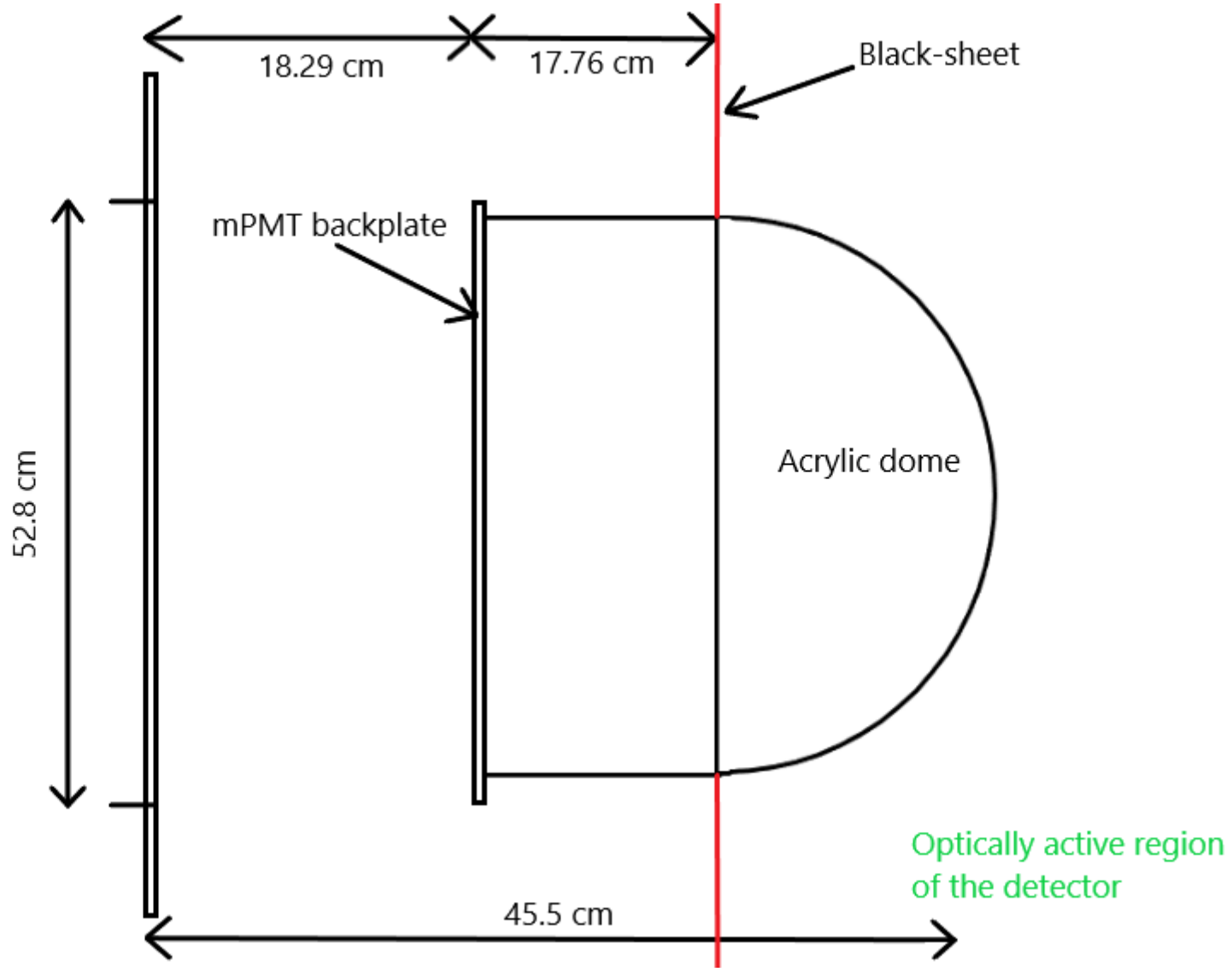
Simulation overview

- Beam window simulation
  - Using Geant4 v4.10.01.p03
  - Using detector dimensions, material characteristics from WCSim
  - Physics lists:
    - FTFP_BERT, G4EmStandardPhysics, G4OpticalPhysics
  - Simulated and compared different beam window configurations
  - Using 200, 300, 2150 MeV/c electron, muon, pion and proton beam
  - 2500 events simulated
  - Looked at beam divergence and beam energy resolution at the black sheet position

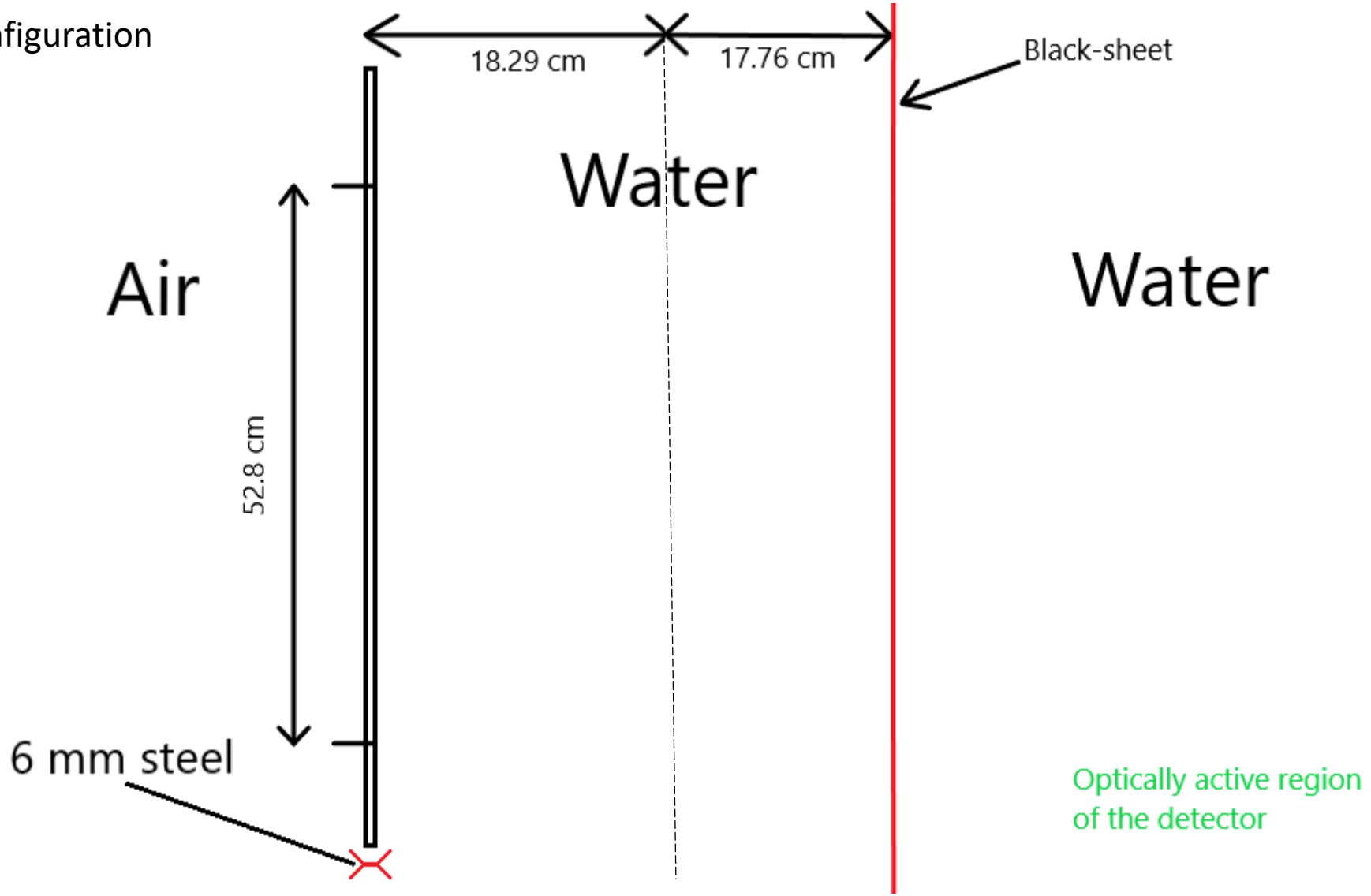


Simulation overview

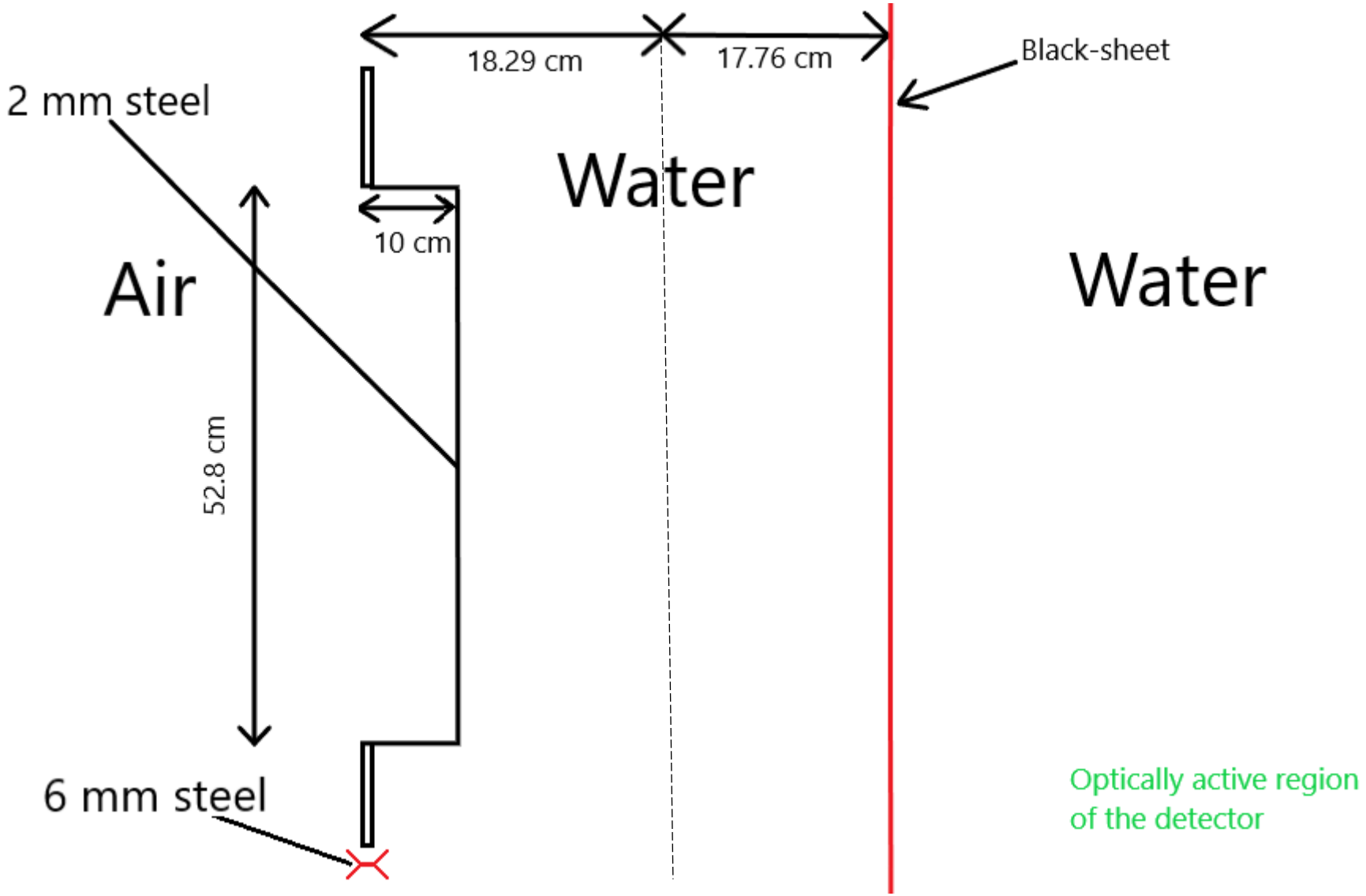


Simulation overview

Nominal configuration

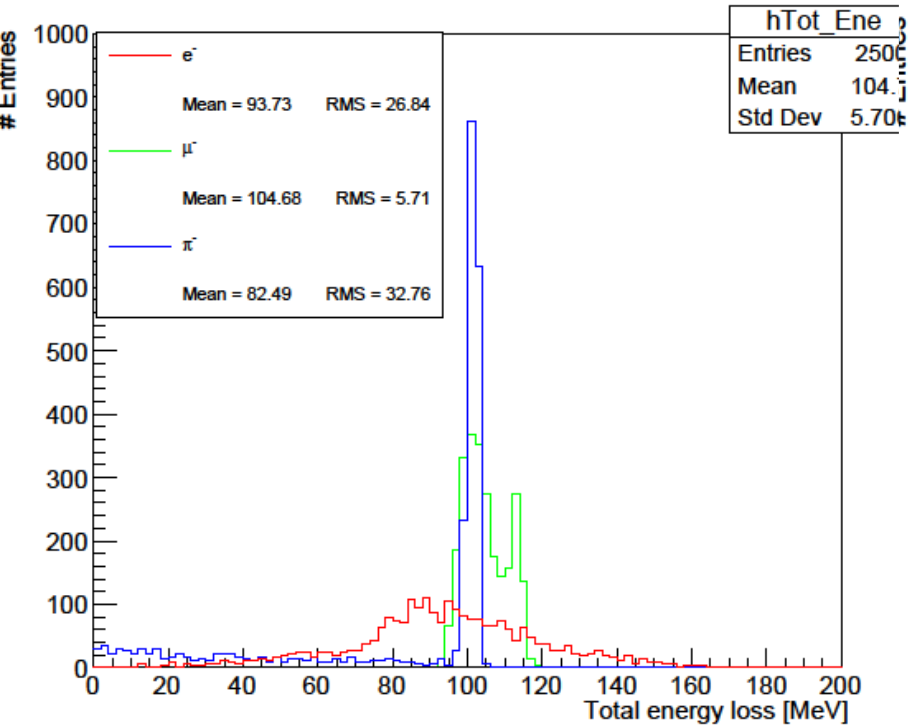


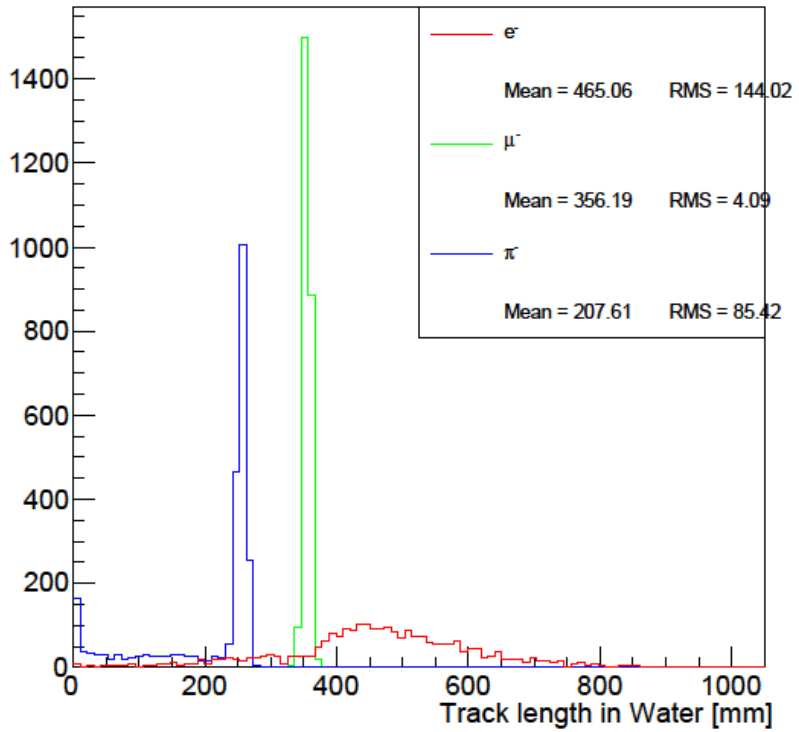
Simulation overview

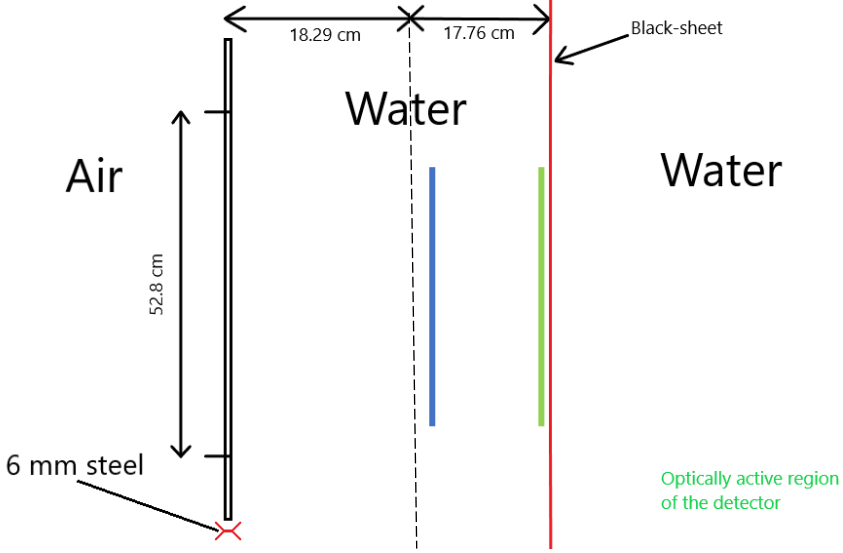


6 mm steel @ 200 MeV/c

Nominal configuration



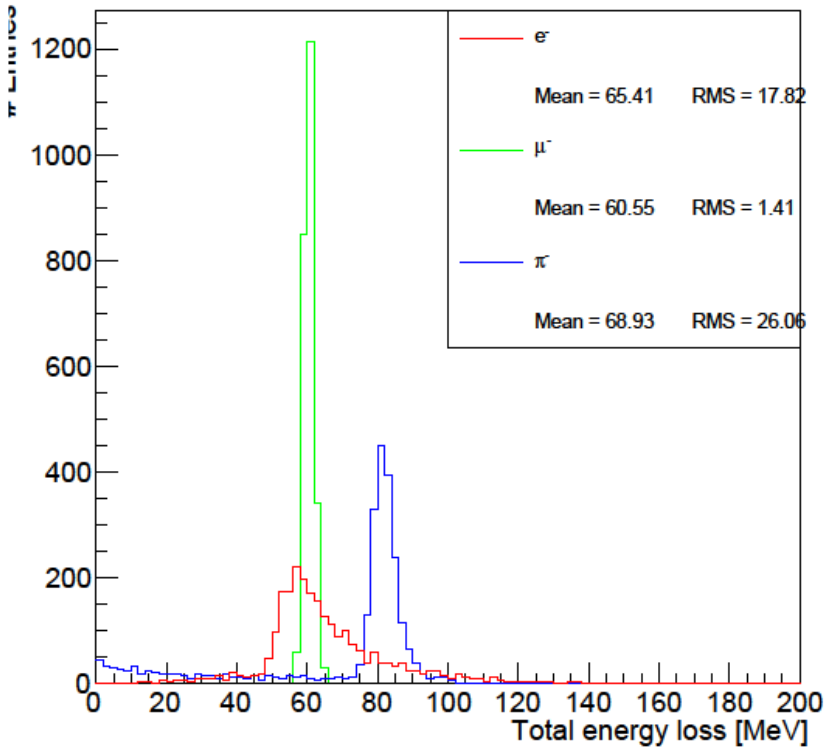


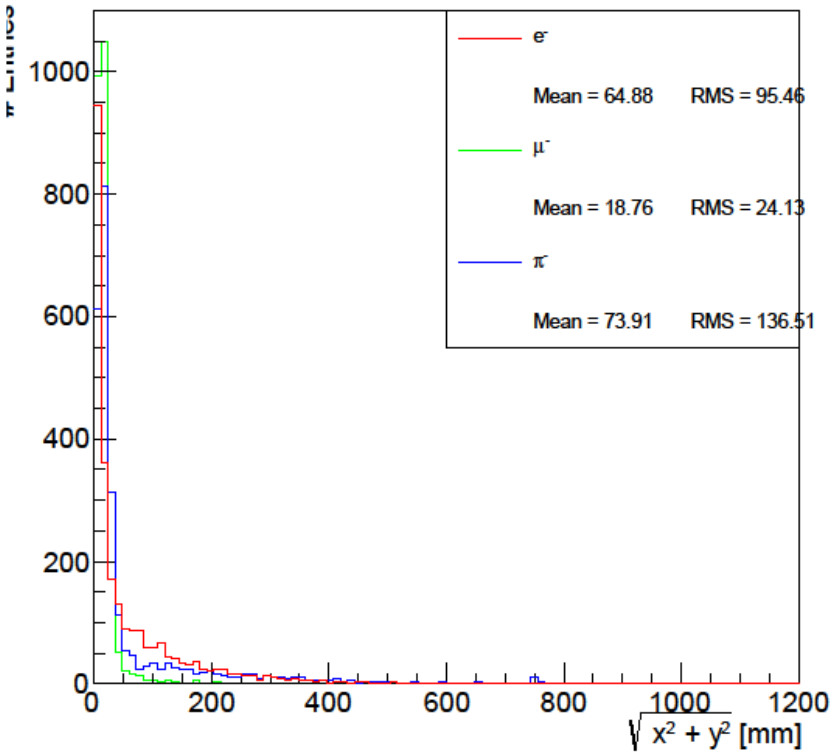


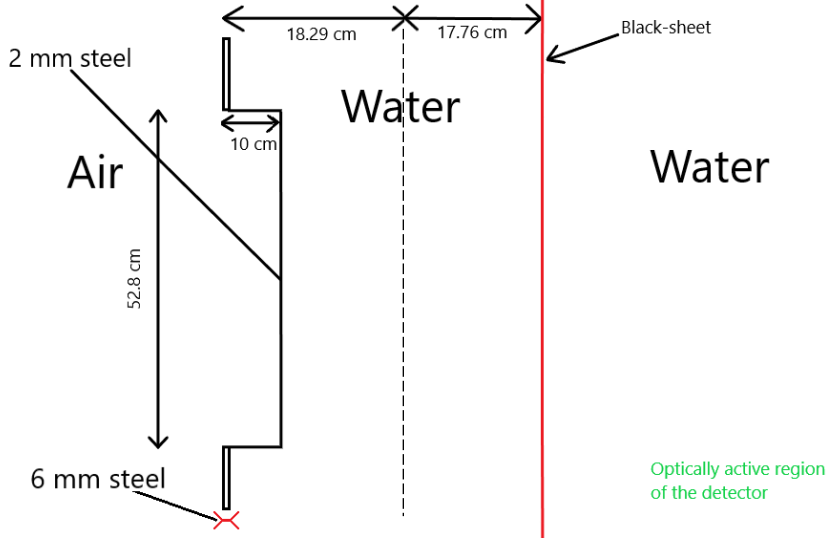
- Nominal configuration (no beam window), simulated muon, pion and electron beams with 200 MeV/c momentum
- We can see from the track length in water that muon and pion tracks are stopped before entering the optically active region of the detector
- This can also be verified when looking at the total energy loss, both muons and pions tracks lose all their kinetic energy in the simulated volume
- From this study we can see that we need an “inward going” beam window

2 mm steel @ 200 MeV/c

Inward going configuration







- Inward going configuration, simulated muon, pion and electron beams with 200 MeV/c momentum
- In this configuration, all tracks enter the fiducial volume of WCTE
- From the energy loss plot we can see that pions and muons would enter the optically active region of the detector very close to Cherenkov threshold
- This beam window configuration improves the energy deviation and the beam divergence compared to the nominal configuration

6 mm steel @ 200 MeV/c

Nominal configuration

	Total energy loss [MeV]	Energy deviation [MeV]	Radius [mm]
Electron	93.73	26.84	94.32
Muon	104.68	5.71	26.30
Pion	82.49	32.76	75.05

2 mm steel @ 200 MeV/c

Inward going configuration

	Total energy loss [MeV]	Energy deviation [MeV]	Radius [mm]
Electron	65.41	17.82	64.88
Muon	60.55	1.41	18.76
Pion	68.93	26.06	73.91

Summary

- Beam window simulation show that the addition of a beam window could influence our measurements
- The thickness of steel has less impact on the beam resolution in energy and vertex position compared to the path length in water
- From a physics point a view, it would be beneficial to minimize the length of water the beam travels before getting to the optically active region of the detector
- If possible, a beam window extending to the mPMT backplate position or event further could be beneficial regarding the fact that at low momentum pions would enter the fiducial volume of WCTE near or below Cherenkov threshold
- The effect of the beam window on the beam resolution are lower for higher energy beams