LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

LIP Summer Internship 2023

Optimization of Water Cherenkov Detector for a next-generation gamma-ray observatory

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Introduction

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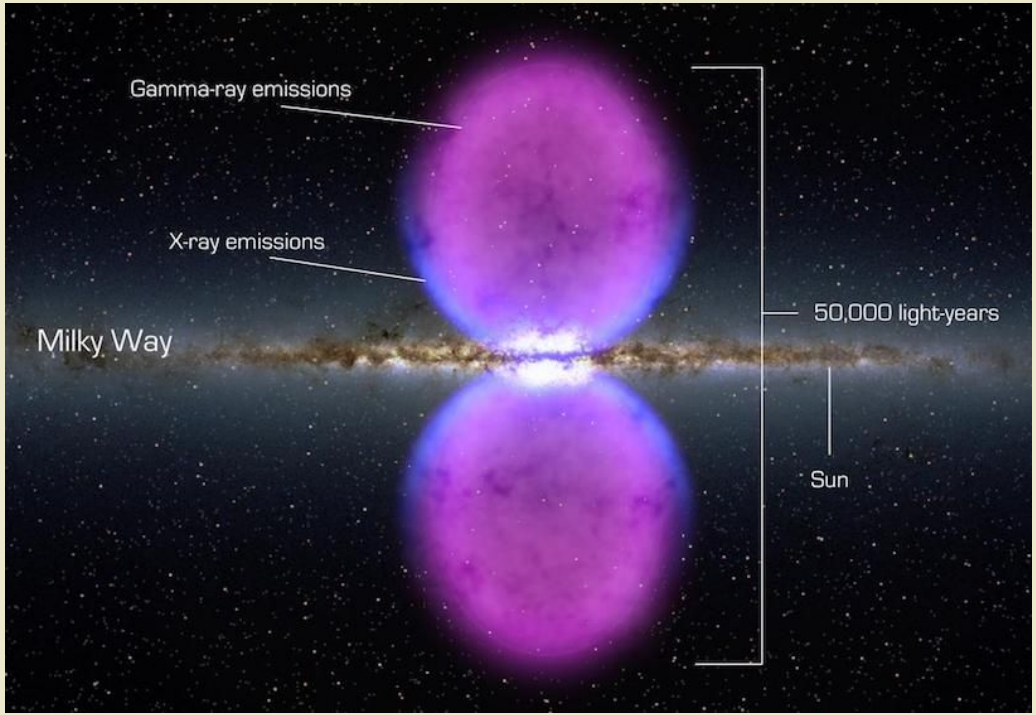


Fig 1- Fermi Bubbles

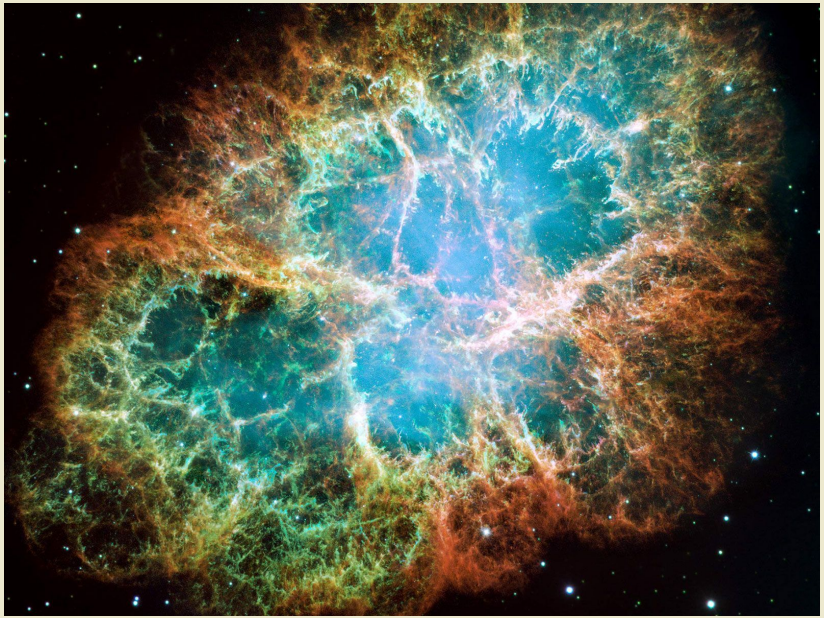


Fig 2- Supernova

Current Observatories and SWGO

LHAASO

China - Southeast Asia

Fig. 3:

Fig. 4:

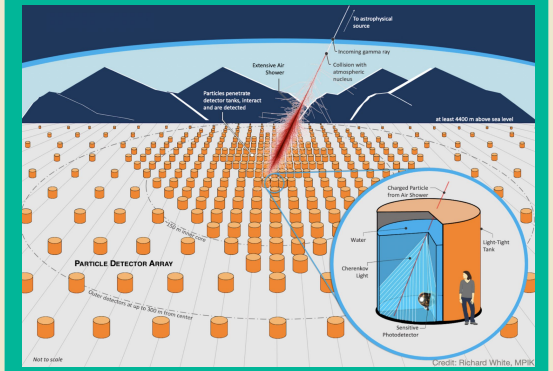
HAWC

Mexico- North America

SWGO

Location: TBD (South America)

Fig. 5:



WCD Principles

Cherenkov Radiation

electromagnetic radiation emitted when a charged particle travels through a dielectric medium at a speed greater than the phase velocity of light in that medium, creating a characteristic blue glow or cone of light.

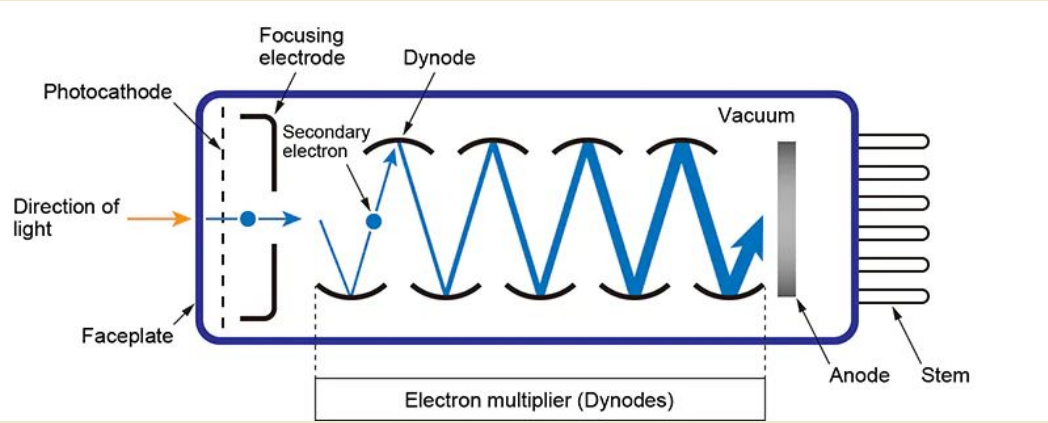


Fig. 6- Photomultiplier Tube (PMT)

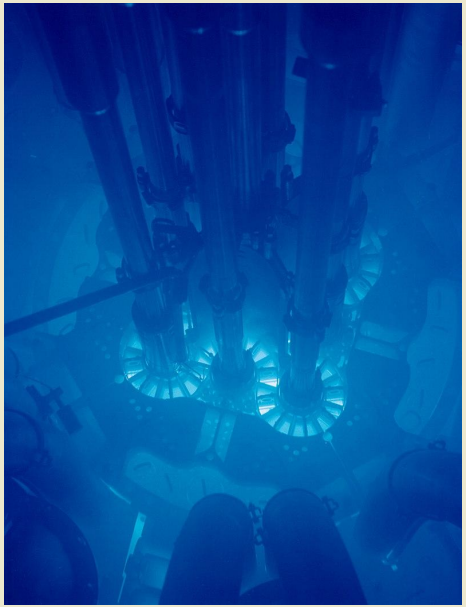


Fig. 7- Cherenkov radiation glowing in the core of a nuclear reactor

WCD Optimization

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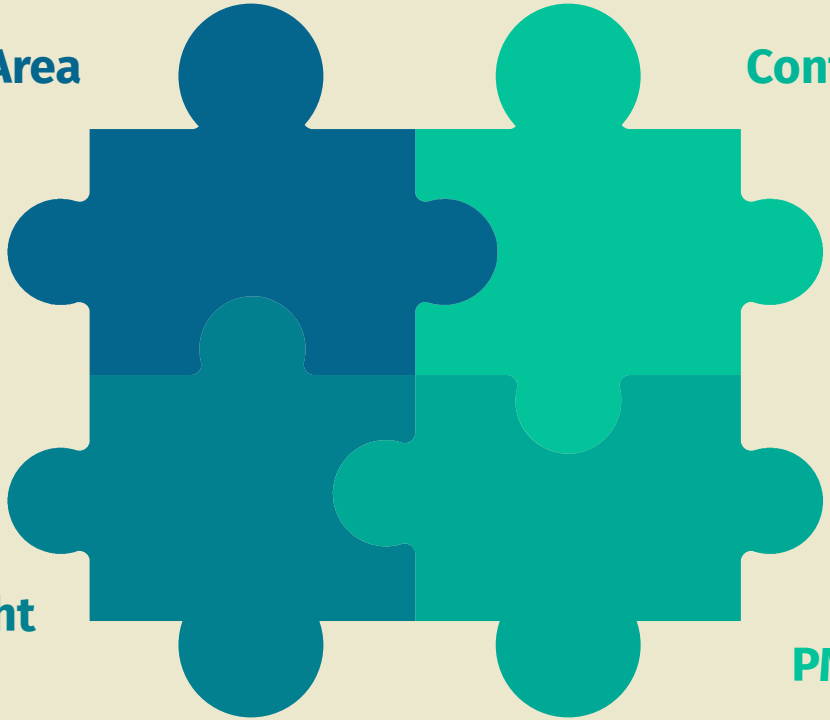
Surface Area

Container Walls Reflection



They are all part of the puzzle

These parameters significantly impact the WCD performance and cost.

Water Height

PMT type and Positioning

Work Timeline and Results

LATTESsim Intro

Simulation tool based on Geant4

Data Analysis

ROOT Cern was the main tool used

Initial Meetings

Particle Injection Simulations

- Multiple particle injection
- PMT collided with the tank walls
- Diameter dynamically adjusted

Discussion and Results

Particle injection Results

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Particles injected vertically with injection points uniformly distributed within a circular plane

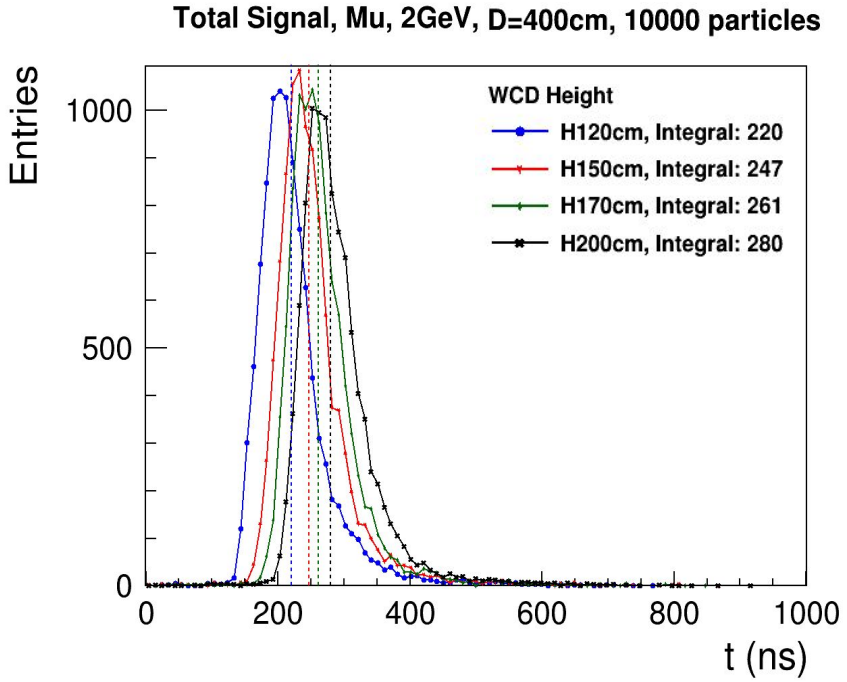

Fig. 8- Total Signal constant diameter 0º

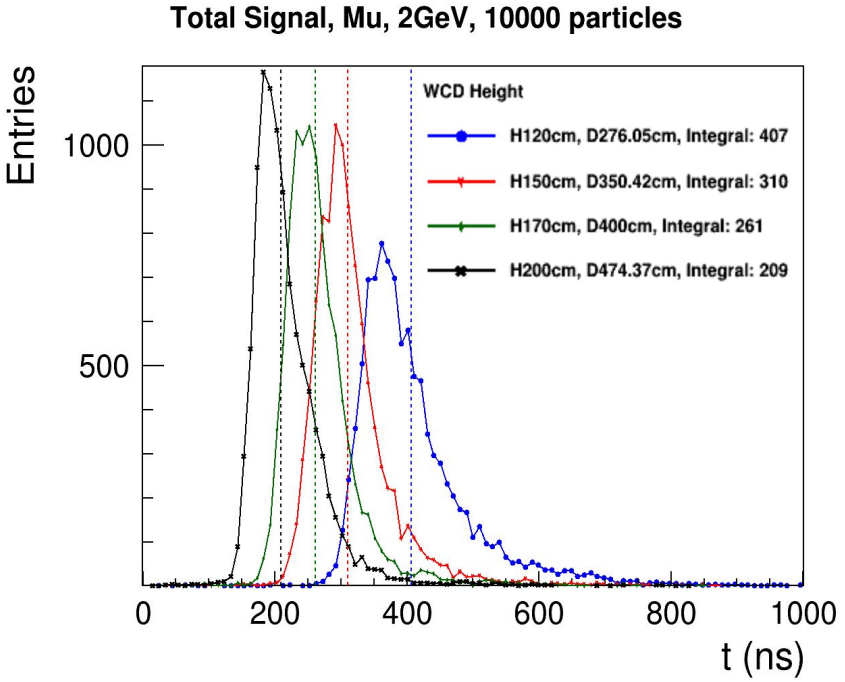

Fig. 9- Total Signal dynamic diameter 0º

Particle injection Results

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Particles injected at 45 degree with injection points uniformly distributed within a circular plane

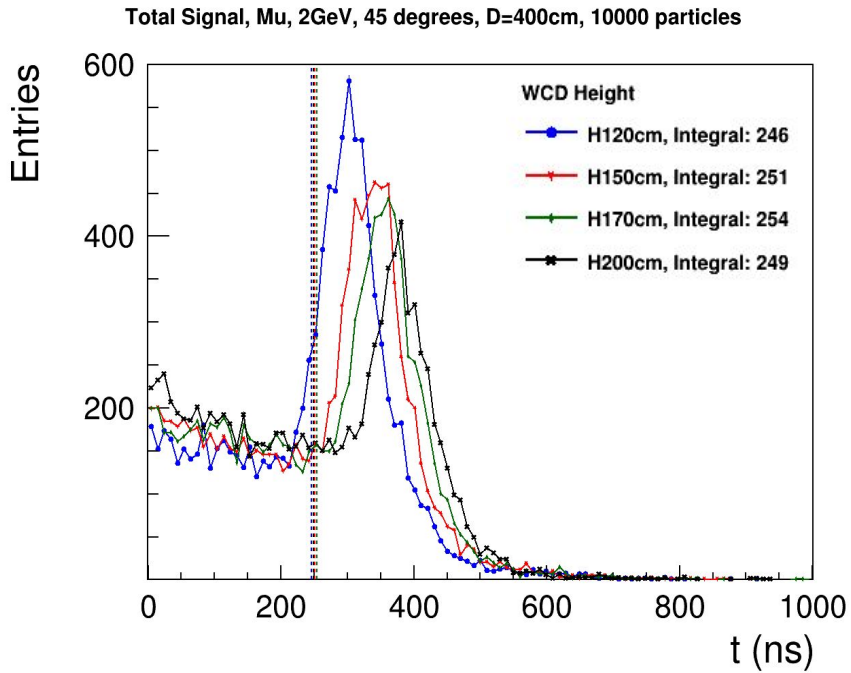

Fig. 10- Total Signal constant diameter 45º

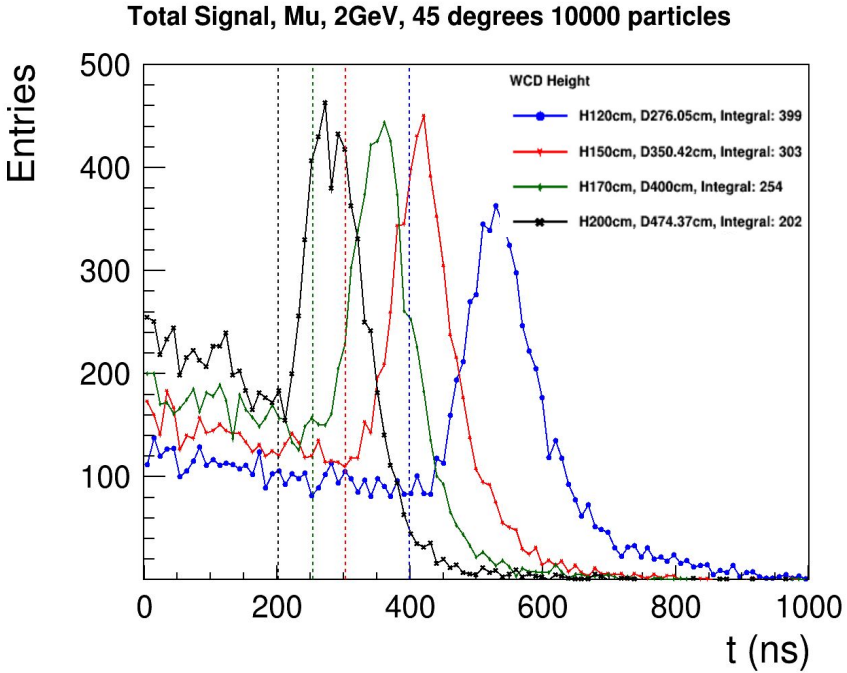

Fig. 11- Total Signal dynamic diameter 45º

Particle injection Results

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TProfile of 0 degrees particle injections

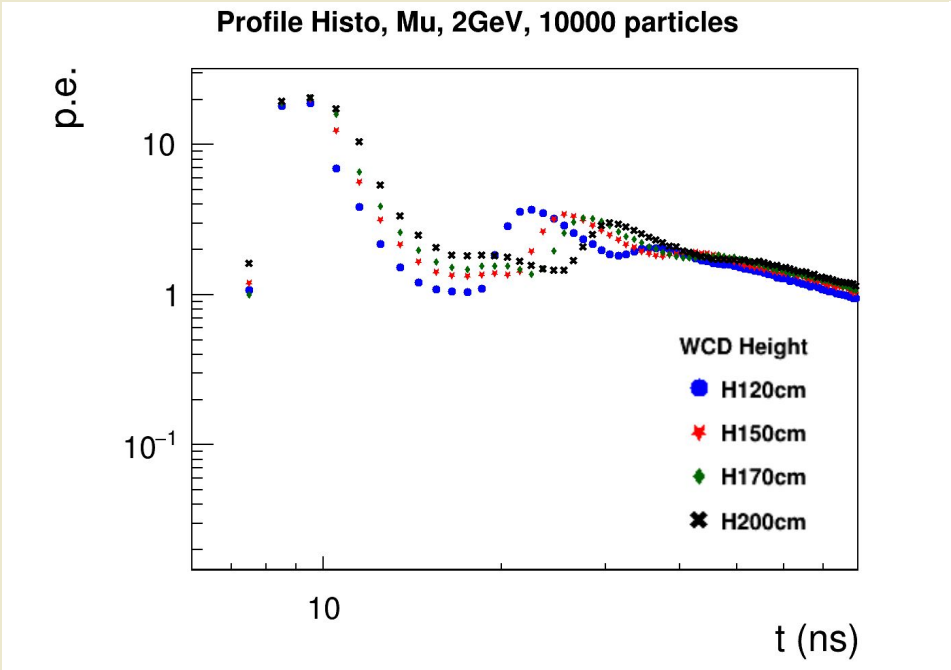

Fig. 12- TProfile constant diameter 0º

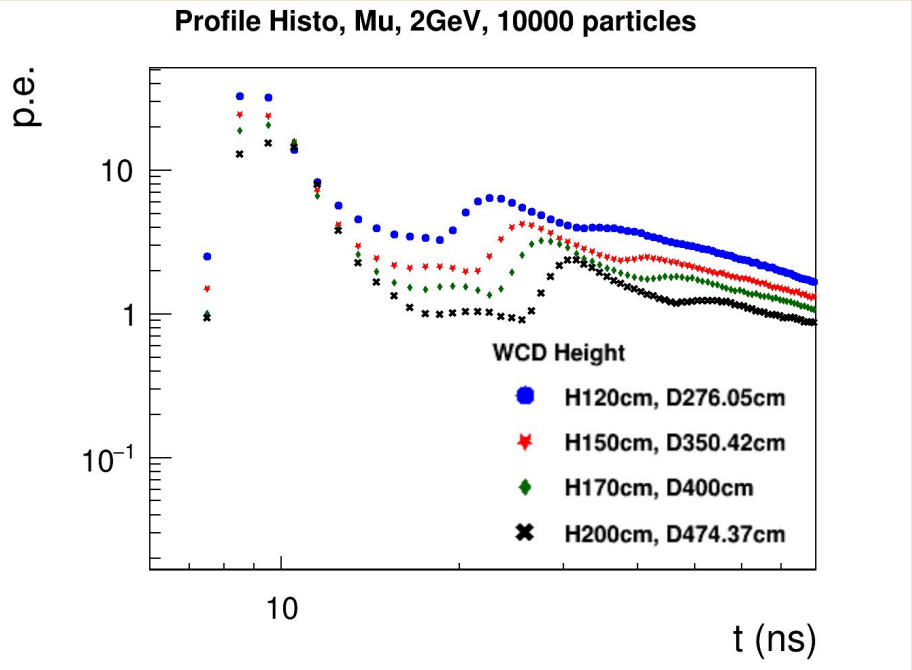

Fig. 13- TProfile dynamic diameter 0º

Particle injection Results

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TProfile of 45 degrees particle injections

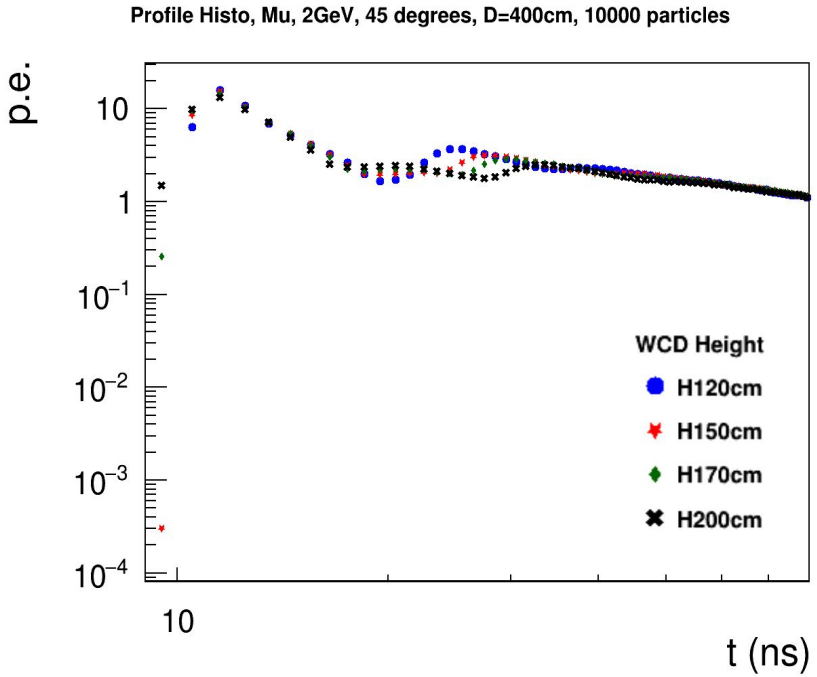

Fig. 14- TProfile constant diameter 45º

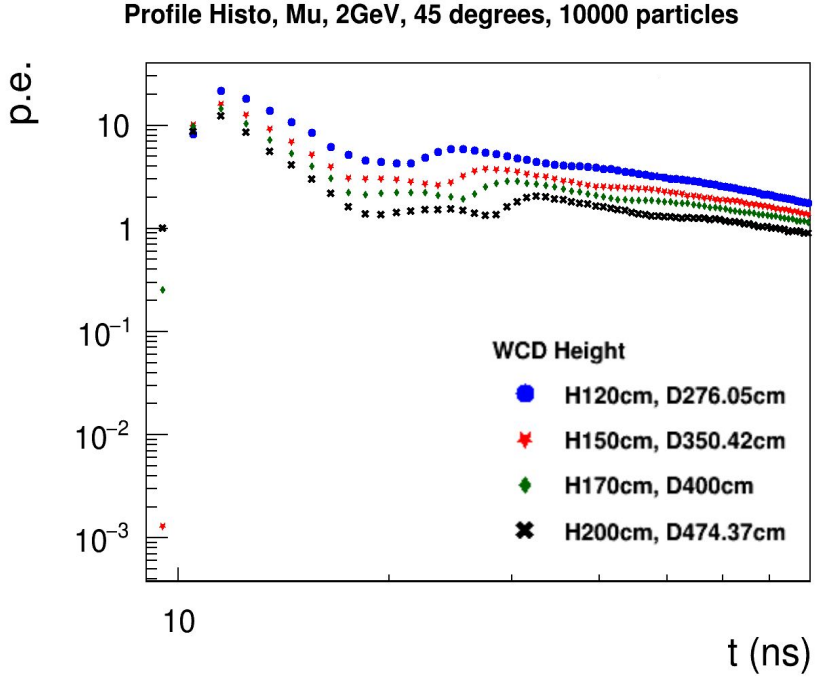

Fig. 15- TProfile dynamic diameter 45º

Future work

Why are smaller tanks displaying higher total signal?

- Possibility of investigating the physical mechanisms for the smaller tanks showing an increased total signal

PMT Angle Optimization

- Continue research on the angles of PMTs
- Experiment with different PMT angles within the Mercedes configuration
- Determine the most efficient setup for maximizing signal detection and minimizing noise.

Thank you for your attention!