

SHiP

*Search for Hidden Particles*

# SHiP calorimeter studies

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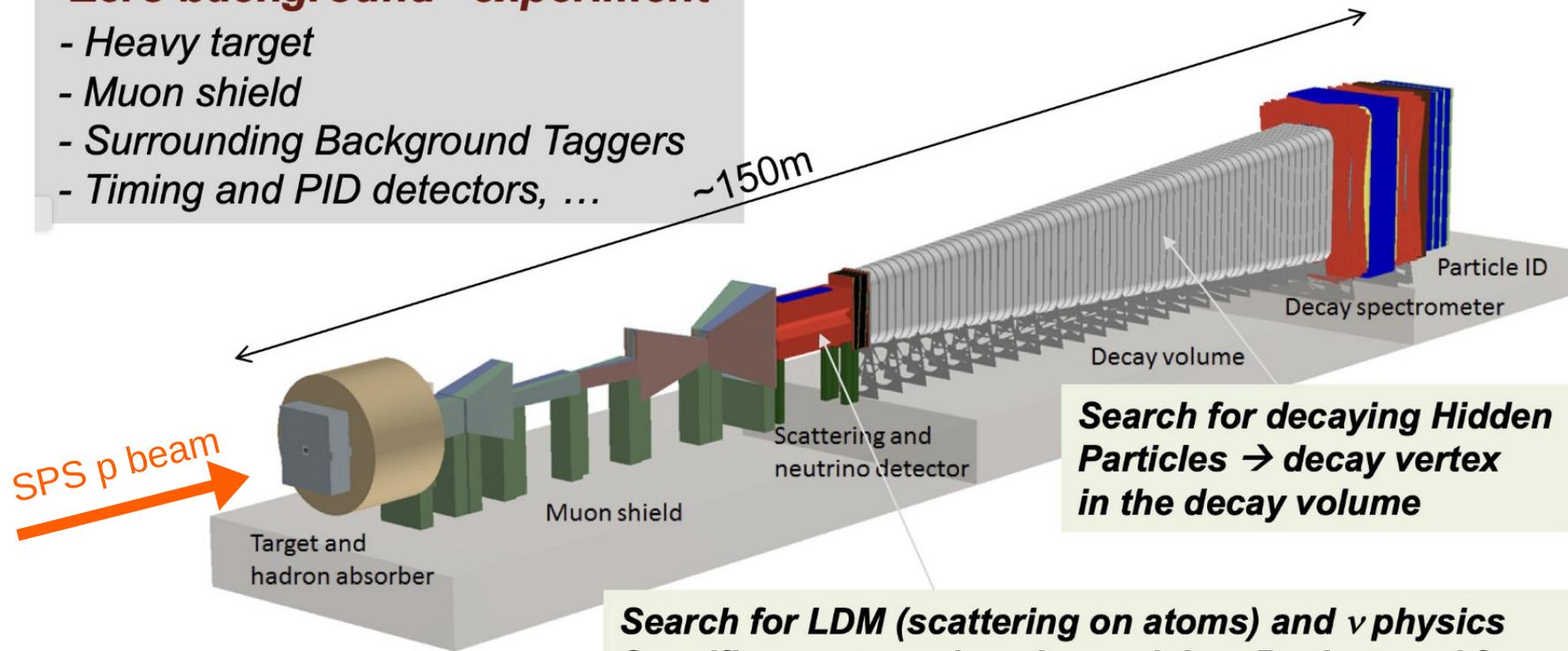


# Search for Hidden Particles – SHiP experiment



## “Zero background” experiment

- Heavy target
- Muon shield
- Surrounding Background Taggers
- Timing and PID detectors, ...

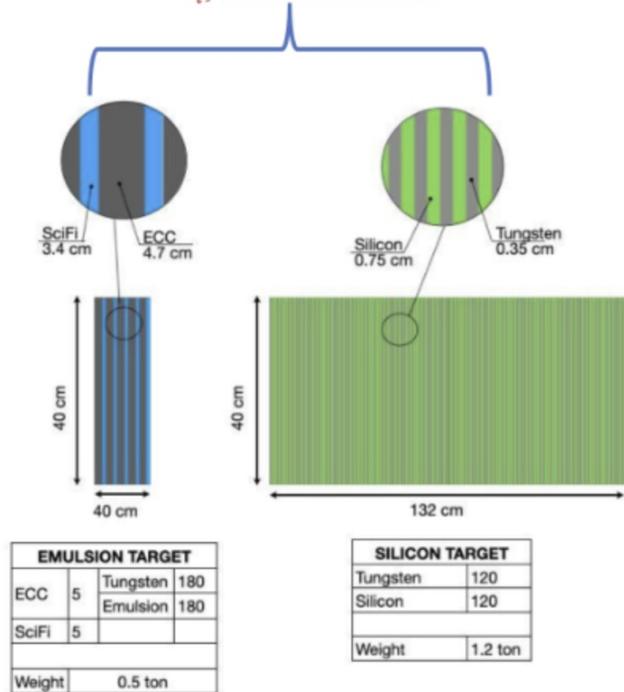


**Search for decaying Hidden Particles → decay vertex in the decay volume**

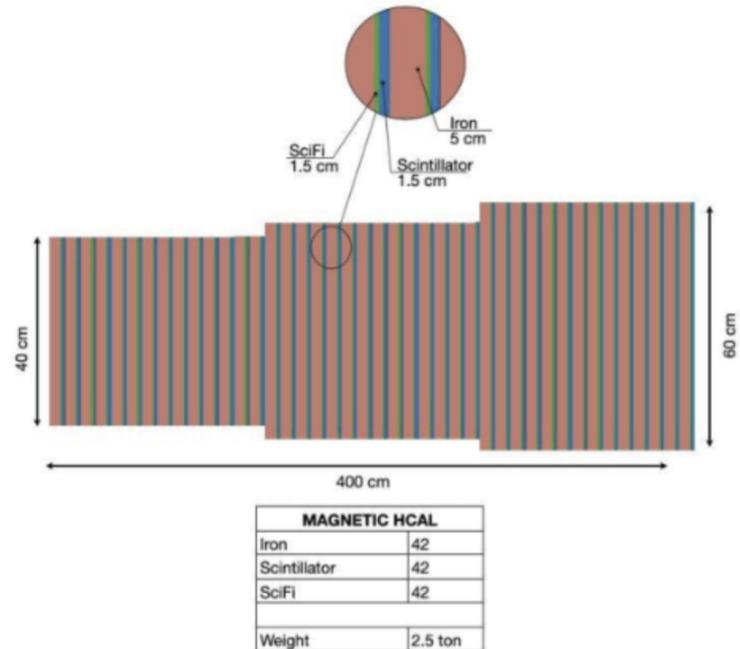
**Search for LDM (scattering on atoms) and  $\nu$  physics  
Specific event topology in emulsion. Background from neutrino interaction for LDM searches can be reduced to a manageable level**

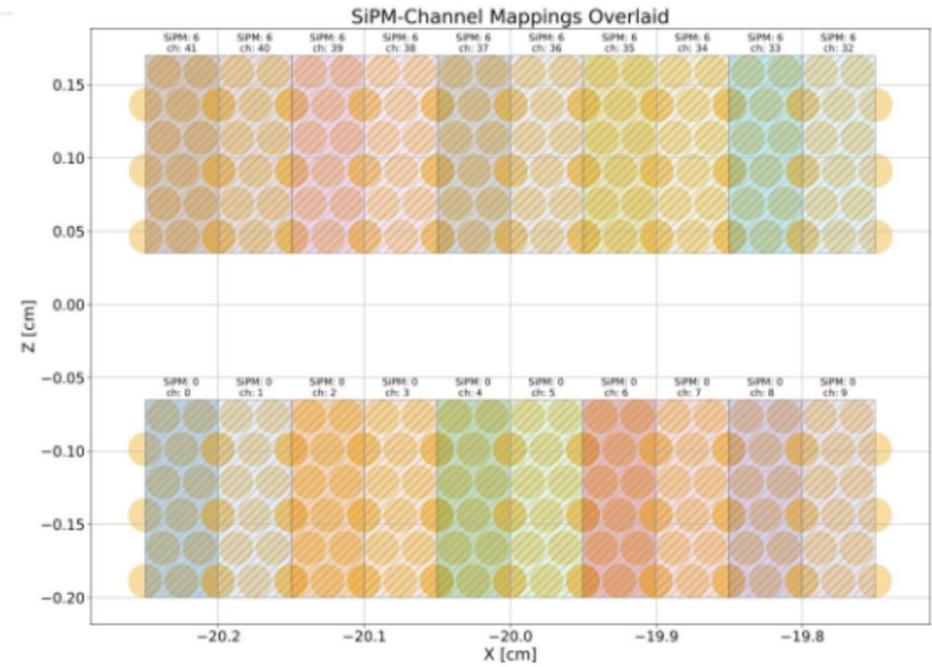
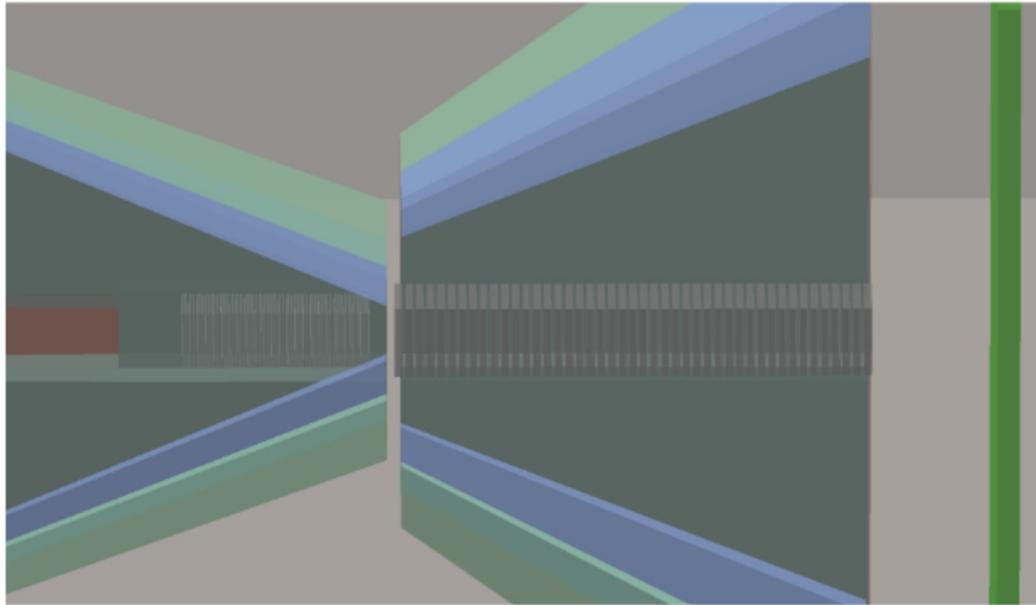
Andrei Golutvin  
ShiP Spokesperson

## High-precision VTX detector $\nu_\tau$ , charm and LDM



## Magnetised tracking calorimeter (MTC) $\nu_\tau$ , charm and LDM



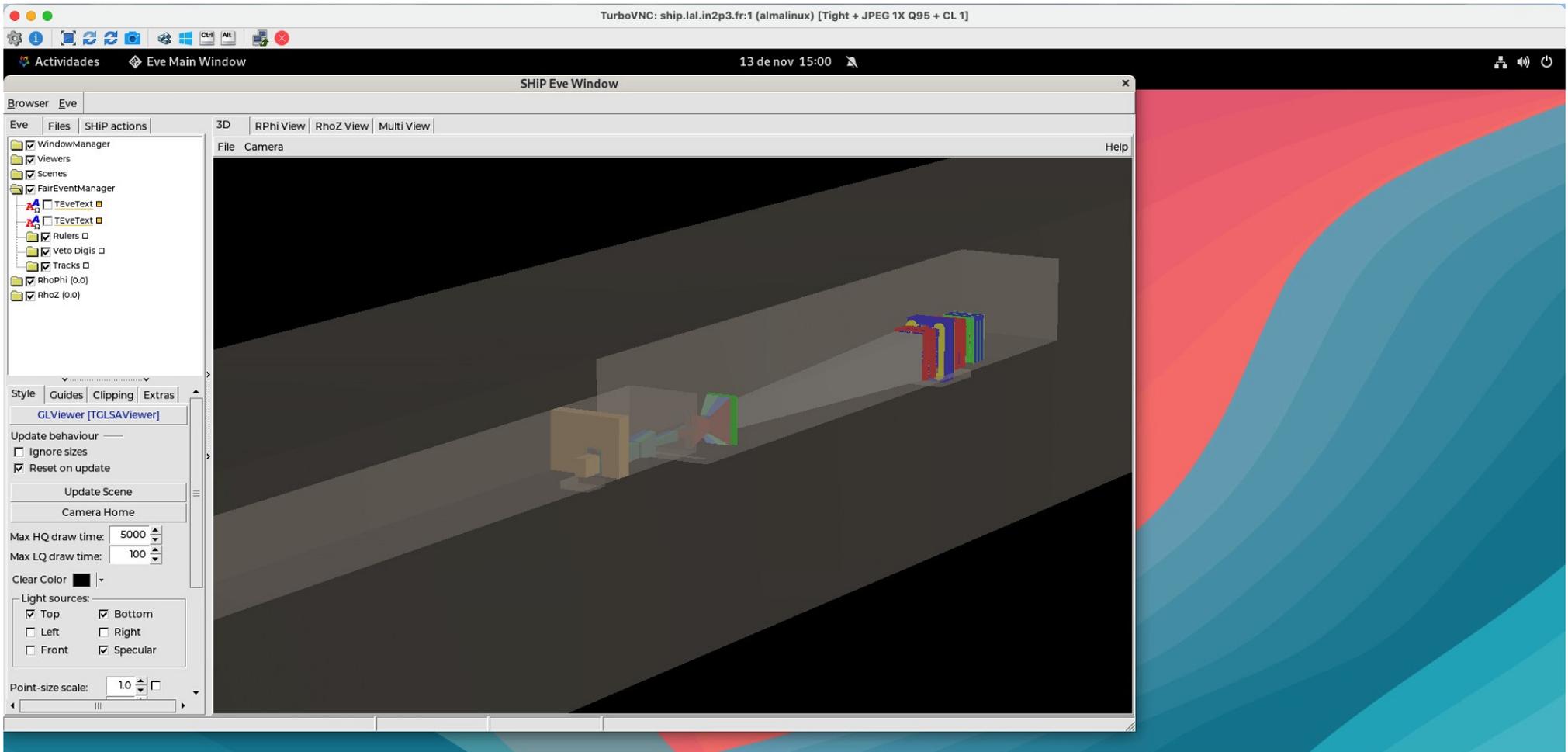


# Running geometry view / event display



- ▶ I built a VM in openstack to run 3D GUIs, also needed for dd4hep simulation viewers
  - ▷ There's a know terrible issue when X11 forwarding these GUIs into MAC so the only solution is either a linux (virtual) machine
- ▶ Ingredients for the VM:
  - ▷ Basic almalinux9 configuration
  - ▷ OpenBox for window management
  - ▷ TurboVNC for remote connection with visual display
  - ▷ All type of dependencies for running FairShip and other software
  - ▷ Cvmfs mounted
  - ▷ FairShip
- ▶ Link to instructions for building the VM in Openstacks:
  - ▷ [https://cernbox.cern.ch/files/spaces/eos/user/m/marquezh/VM\\_4\\_SHiP\\_tutorial.pdf](https://cernbox.cern.ch/files/spaces/eos/user/m/marquezh/VM_4_SHiP_tutorial.pdf)

# VM already prepared and running :)





# Material scan (WIP)

- ▶ It seems that material scan doesn't recognize sub-sub-divided volumes
  - ▷ The other SiW calorimeter appears as Tungsten-air layers unless you look deeper

0.35	0.95	0.03	tungstenalloySND	[ 0.00 0.00 2832.09]	[ 0.00 0.00 2832.44]	} 2 strips SiW layers + gap
0.75	0.00	0.00	air	[ 0.00 0.00 2832.44]	[ 0.00 0.00 2833.19]	
0.35	0.95	0.03	tungstenalloySND	[ 0.00 0.00 2833.19]	[ 0.00 0.00 2833.54]	} 2 of pixel SiW layers
3.72	0.00	0.00	air	[ 0.00 0.00 2833.54]	[ 0.00 0.00 2837.25]	
0.56	1.51	0.05	tungstenalloySND	[ 0.00 0.00 2837.25]	[ 0.00 0.00 2837.81]	}
0.07	0.00	0.00	air	[ 0.00 0.00 2837.81]	[ 0.00 0.00 2837.88]	
0.06	0.01	0.00	silicon	[ 0.00 0.00 2837.88]	[ 0.00 0.00 2837.94]	}
0.41	0.00	0.00	air	[ 0.00 0.00 2837.94]	[ 0.00 0.00 2838.35]	
0.56	1.51	0.05	tungstenalloySND	[ 0.00 0.00 2838.35]	[ 0.00 0.00 2838.91]	}
0.07	0.00	0.00	air	[ 0.00 0.00 2838.91]	[ 0.00 0.00 2838.98]	
0.06	0.01	0.00	silicon	[ 0.00 0.00 2838.98]	[ 0.00 0.00 2839.04]	}

- ▶ In the meantime:
  - ▷ The script “getGeoInformation.py” allows for inspection in a different way

# Adding our calorimeter (2 models)



## ▶ In between SiW strip detector and MTC:

- ▶ 5 simplified layers (5.6mm W + 0.65mm Si)
- ▶ Pixel size of ~5.5mm
- ▶ 36x36 mm<sup>2</sup> layers

“SiWCalo”

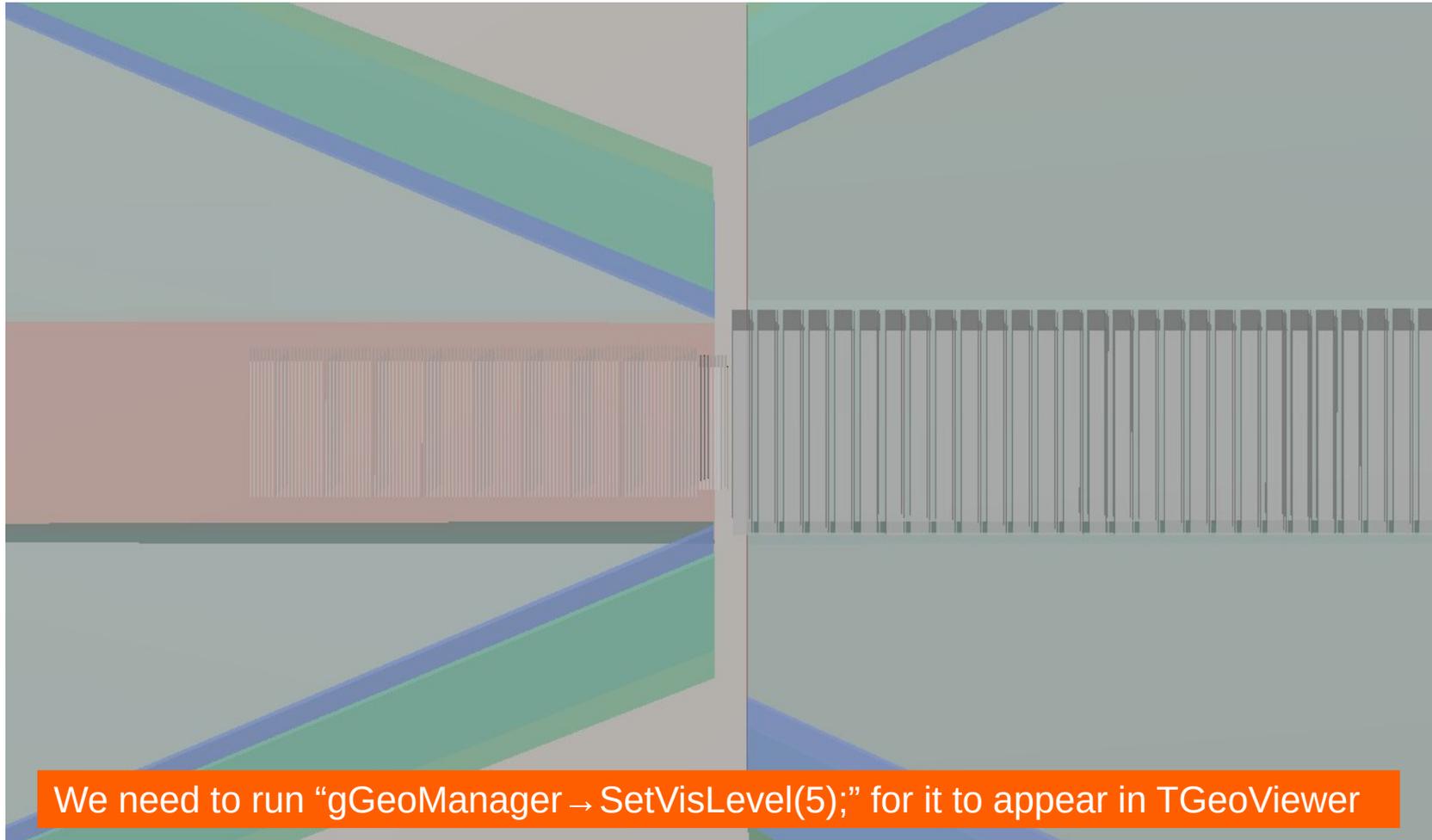
## ▶ After MTC:

- ▶ 12 simplified layers (50mm Fe + 0.65mm Si)
- ▶ Pixel size of ~5.5mm
- ▶ 54x54 mm<sup>2</sup> layers

“SiFeCalo”



- ▶ SiWCalo: PG simulations launching at  $z=2800$ , still inside the SiW strip calorimeter:
  - ▷ (300) 60 GeV  $\gamma$ : Expected big shower that leaks into our calo
  - ▷ (300) 60 GeV  $\mu$ : Just a MIP, one hit per layer
  - ▷ (300) 60 GeV  $\pi$ : Expected many hits in both calo, distributed shower
- ▶ SiFeCalo: PG simulations launching at  $z=3200$ , still inside the MTC strip calorimeter:
  - ▷ (300) 60 GeV  $\gamma$ : Expected an em shower (maybe leaks, not sure)
  - ▷ (300) 60 GeV  $\mu$ : Just a MIP, one hit per layer
  - ▷ (300) 60 GeV  $\pi$ : hadronic shower leaking into our calo
- ▶ I don't have any digitization implemented and no reconstructed analysis done yet
- ▶ I will only check the content on the ROOT containers filled by run\_simScript



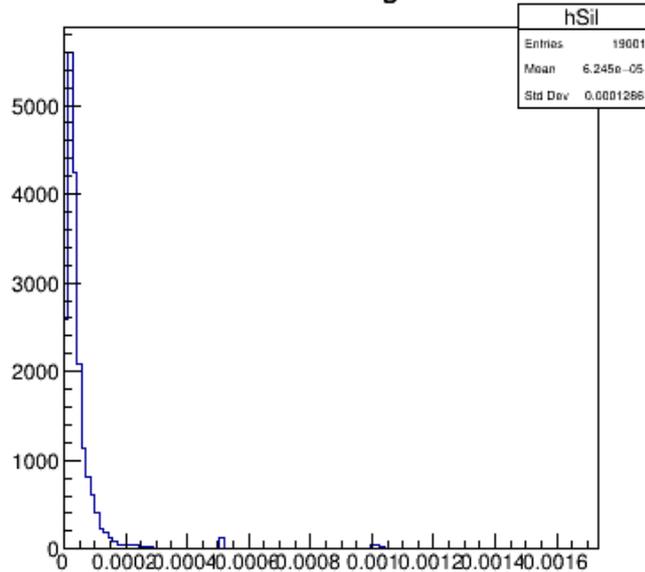
We need to run “gGeoManager → SetVisLevel(5);” for it to appear in TGeoViewer

# Sanity checks (SiWCalo)

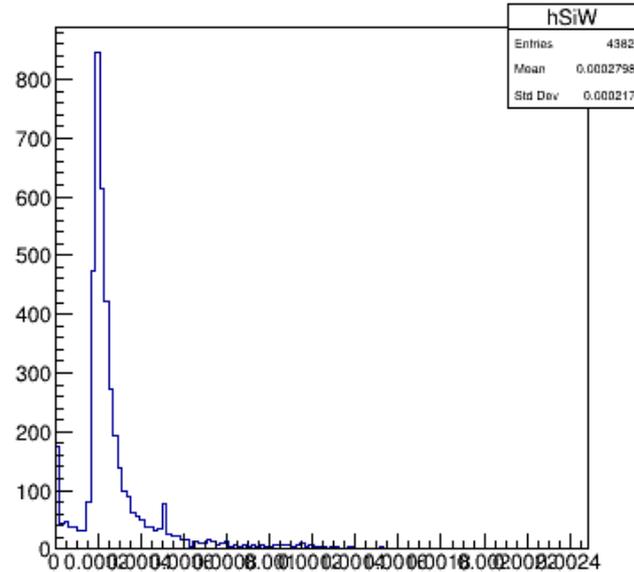


## ► Muons hit E.

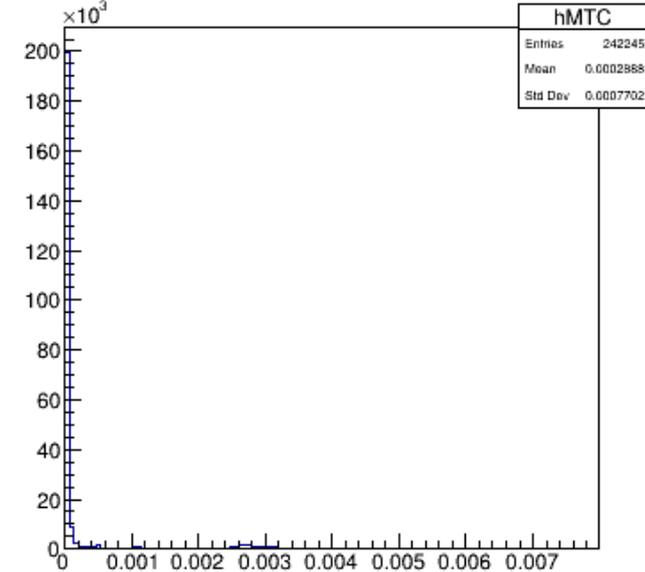
SiliconTarget



SiWCalo



MTCDet

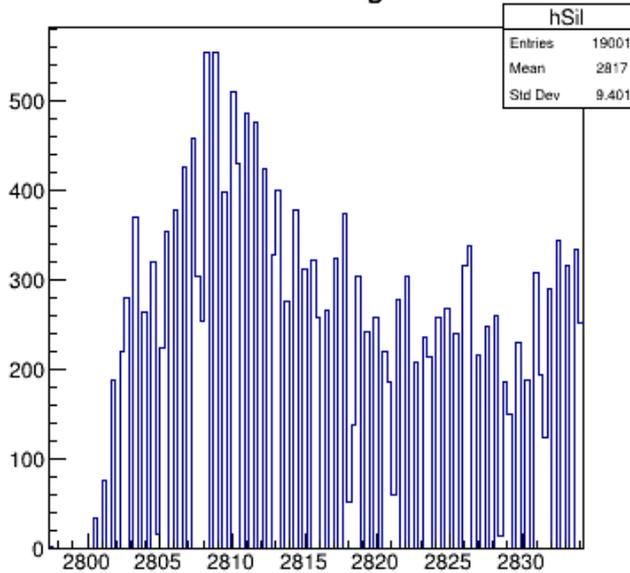


# Sanity checks (SiWCalo)

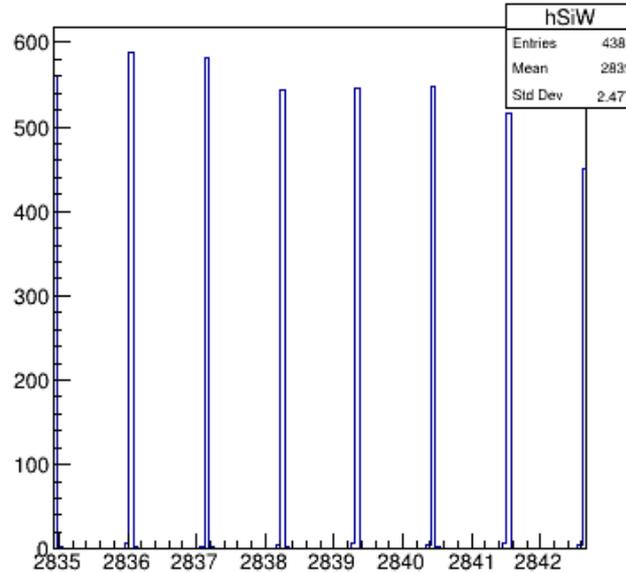


## ► Muons hit z

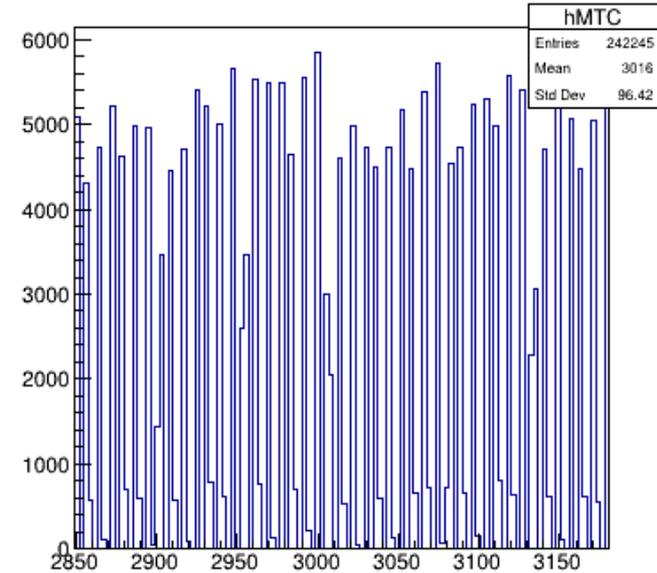
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SiWCalo



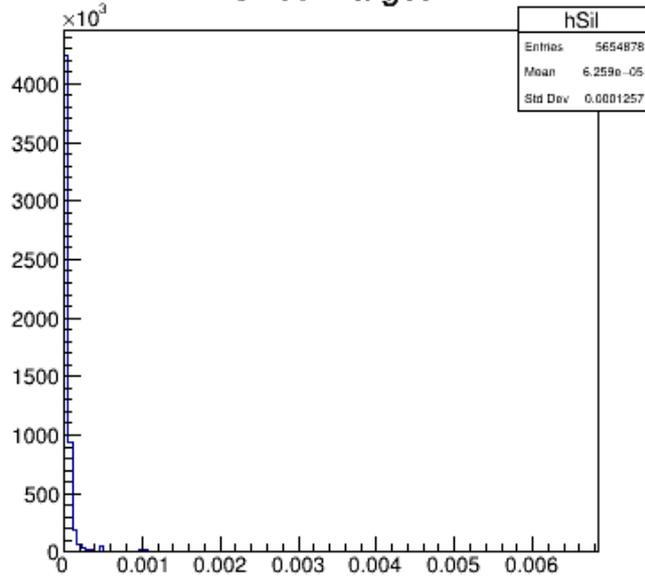
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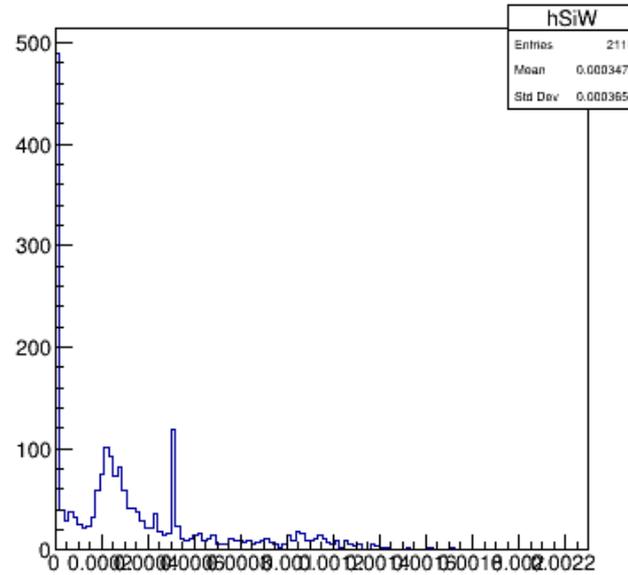
# Sanity checks (SiWCalo)

## ► Photons hit E.

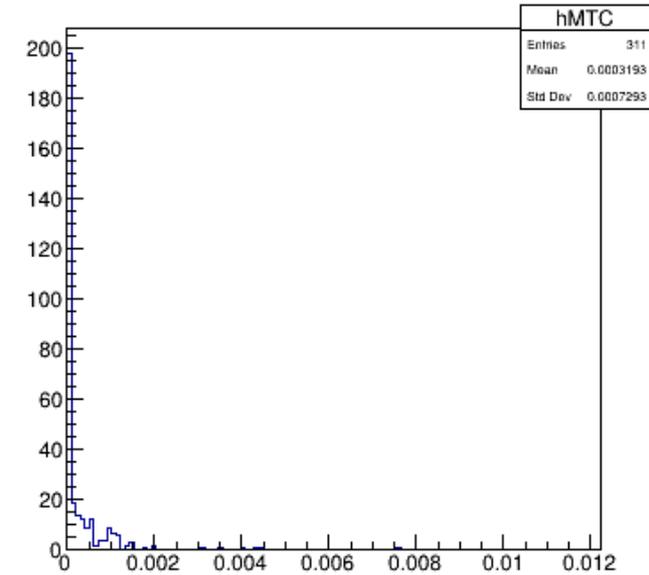
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SiWCalo



MTCDet

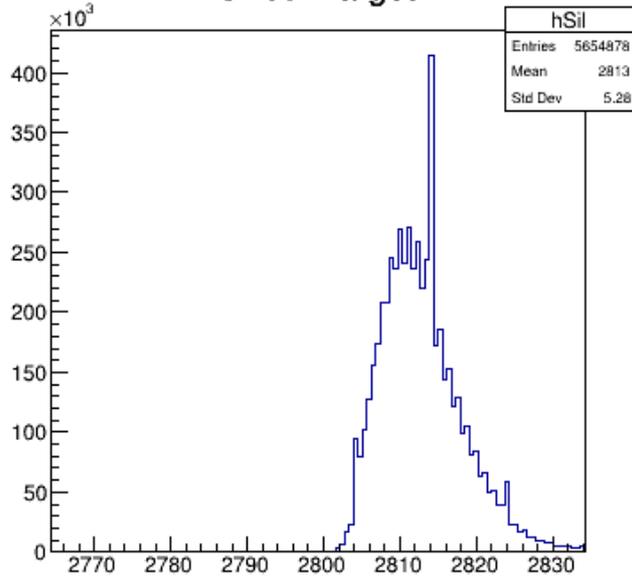


# Sanity checks (SiWCalo)

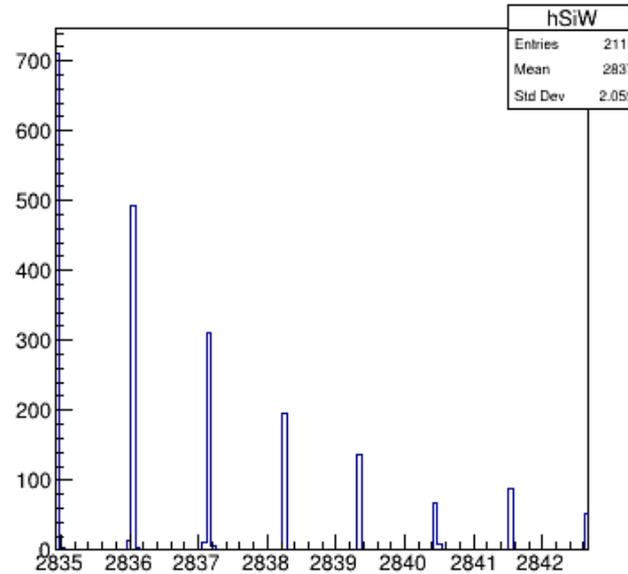


## ► Photons hit z

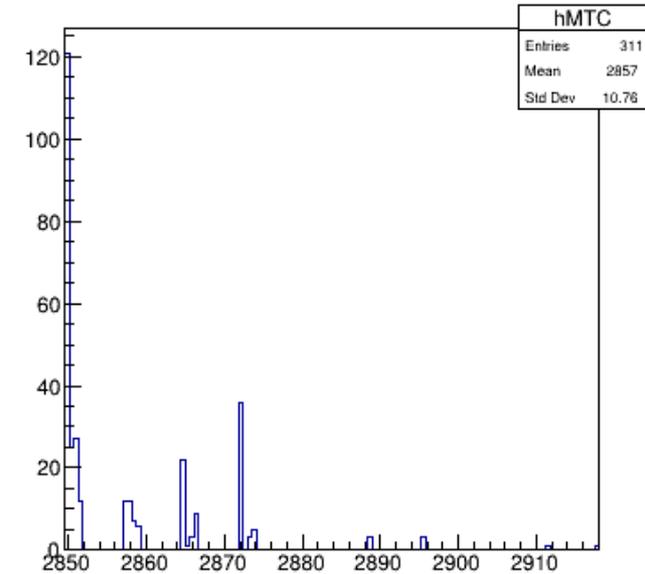
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SiWCalo



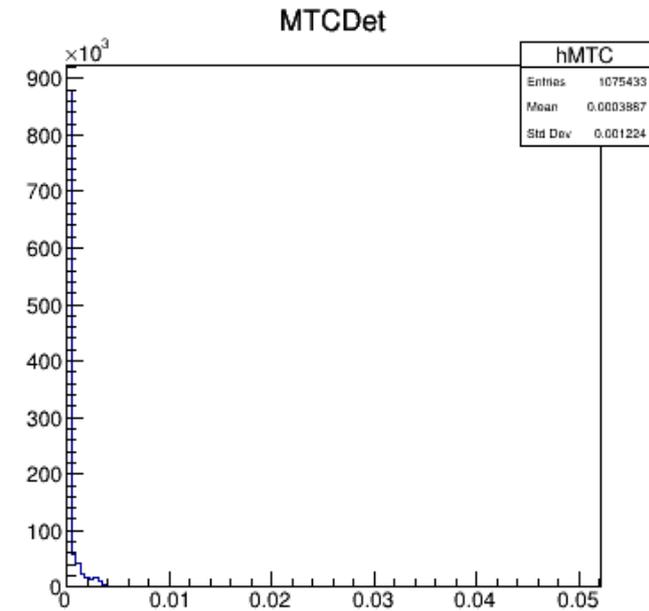
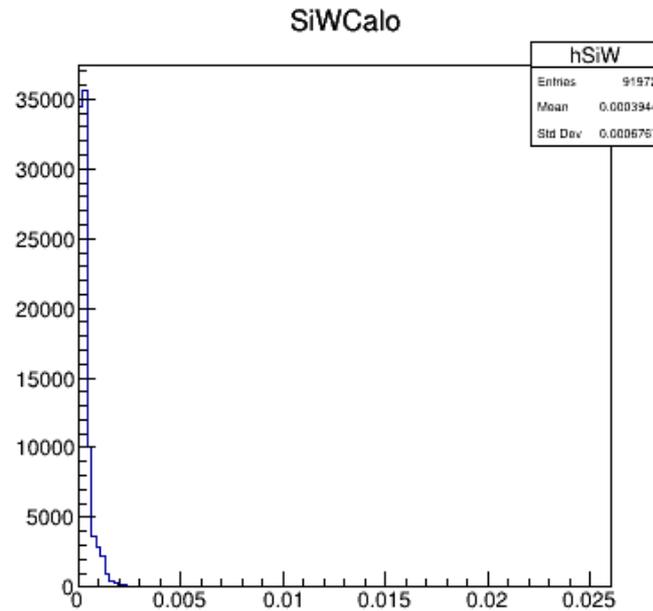
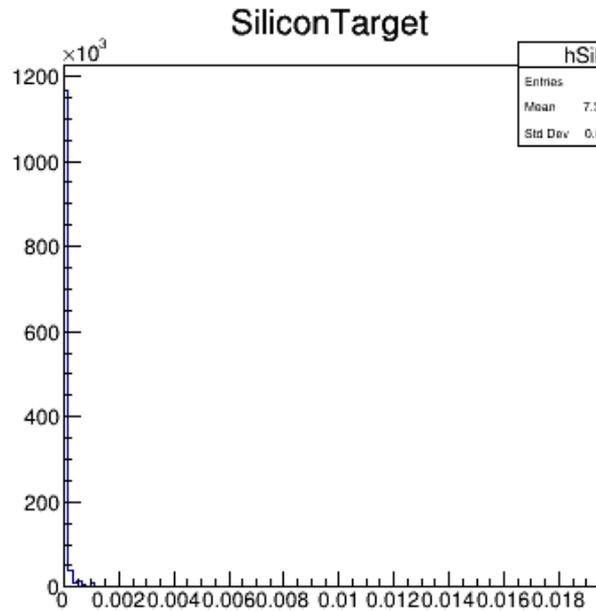
MTCDet



# Sanity checks (SiWCalo)



## ► Pions hit E.

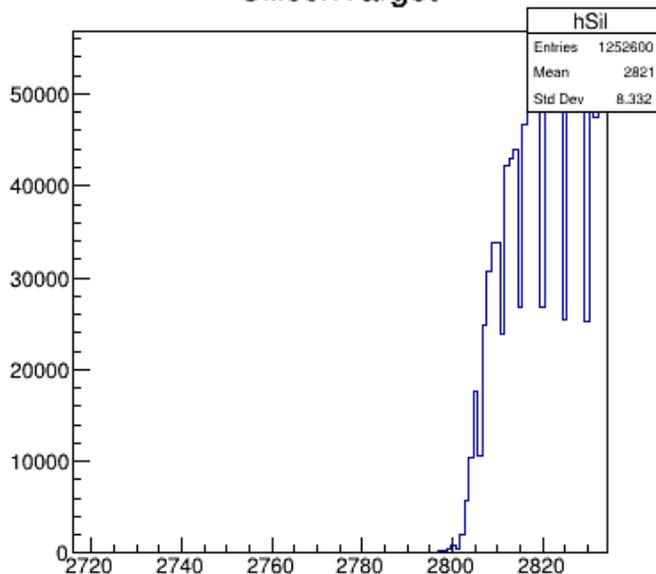


# Sanity checks (SiWCalo)

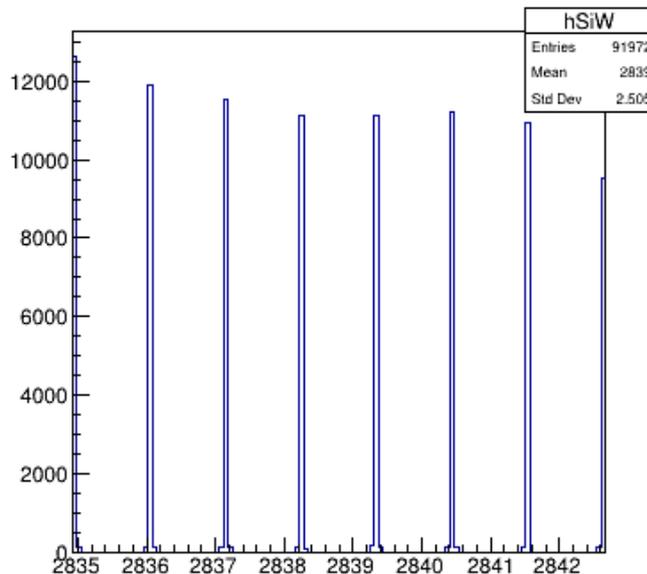


## ► Pions hit z

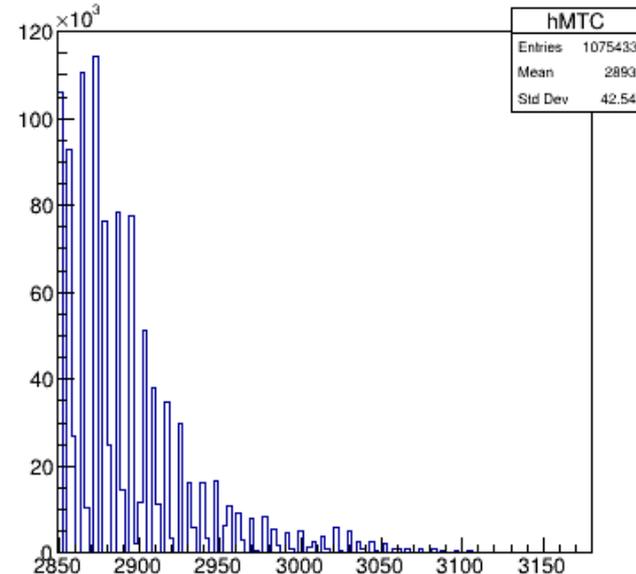
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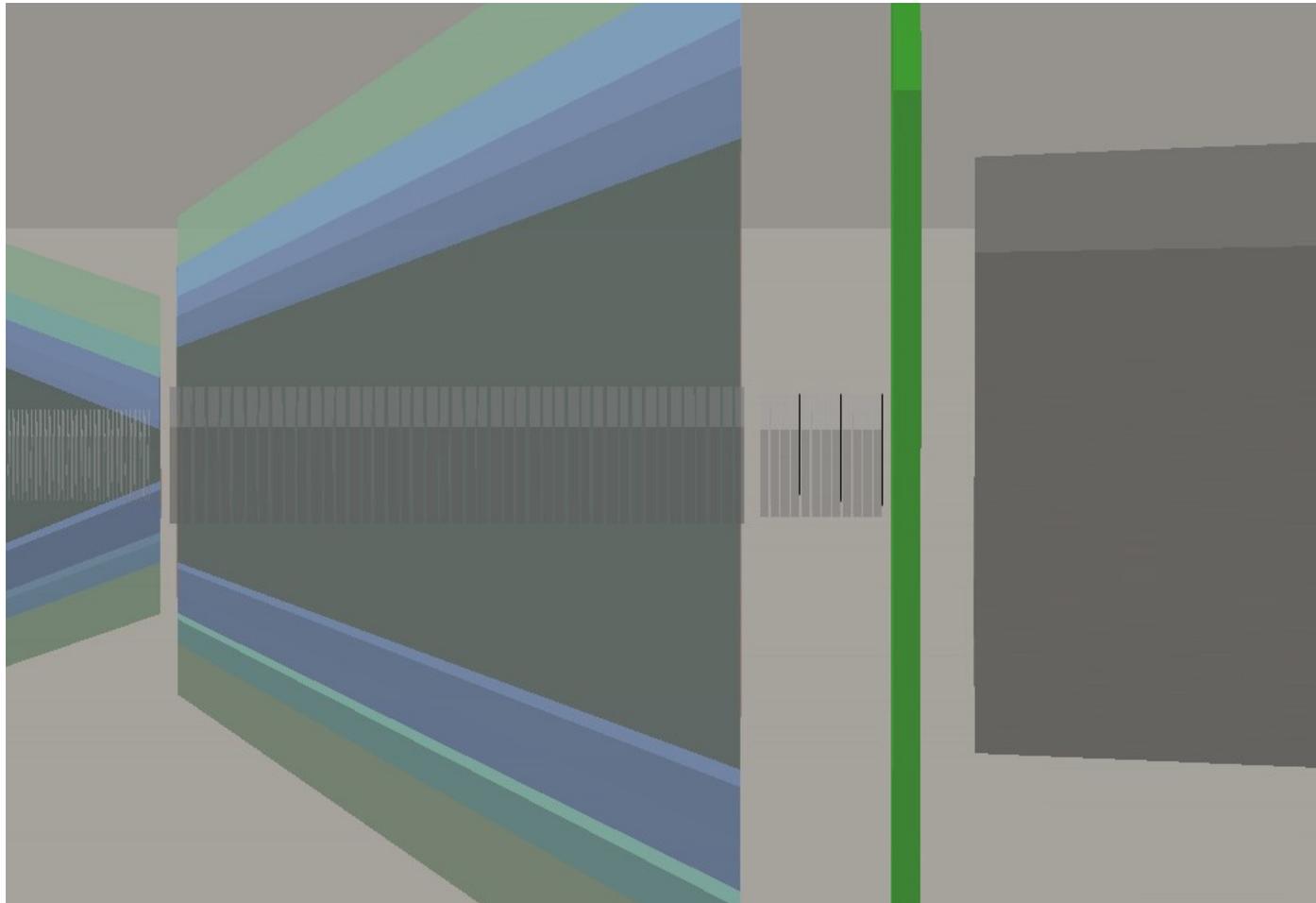


SiWCalo



MTCDet

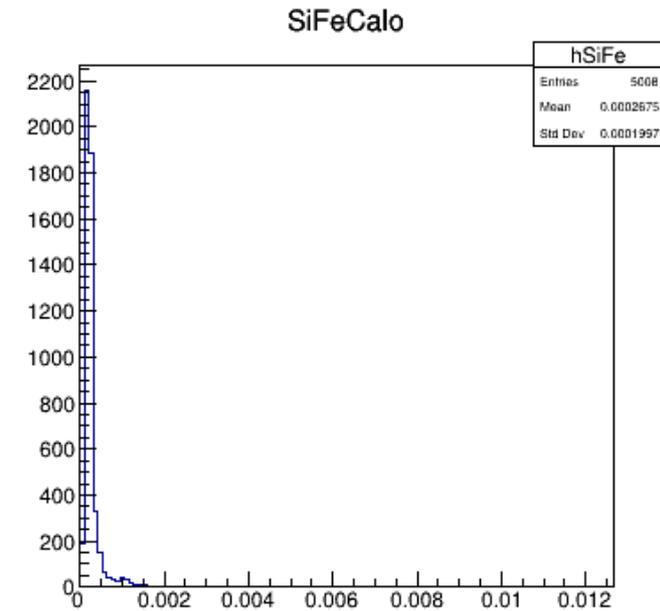
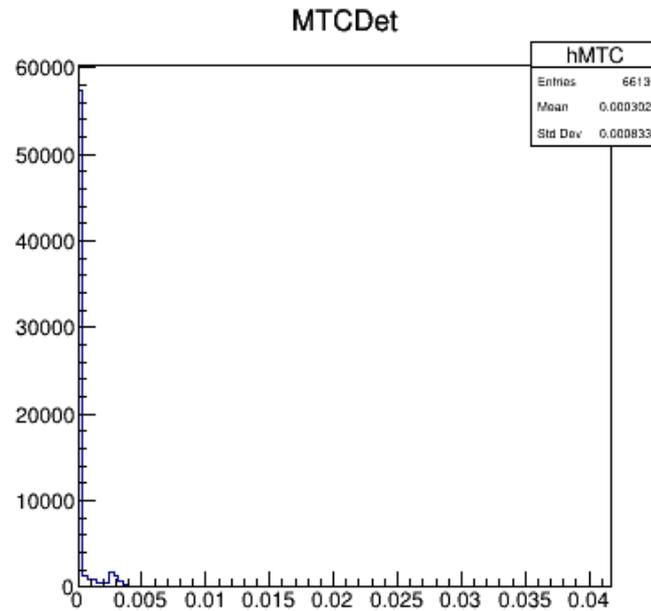




# Sanity checks (SiFeCalo)



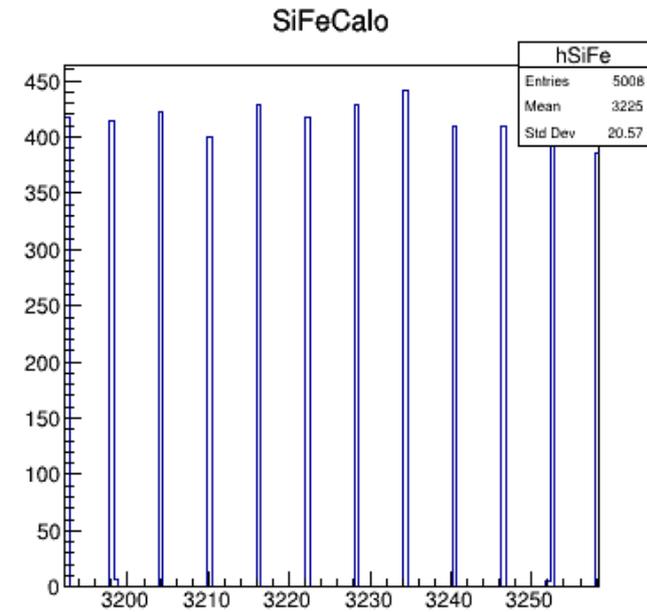
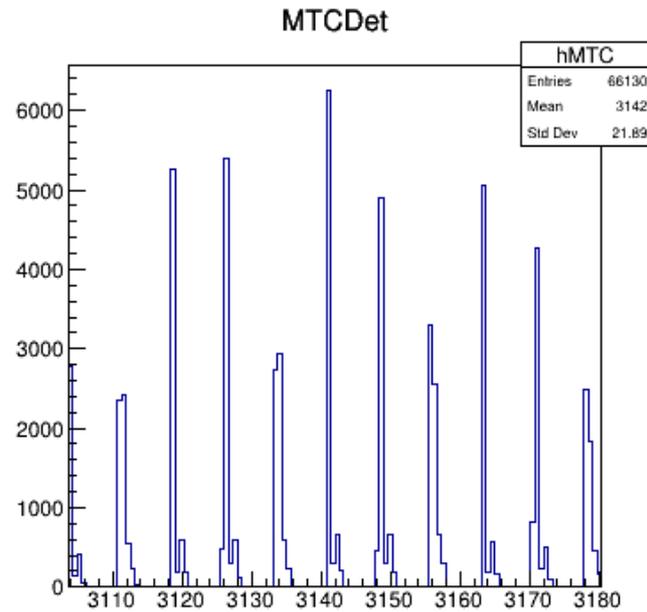
## ► Muons hit E.



# Sanity checks (SiFeCalo)

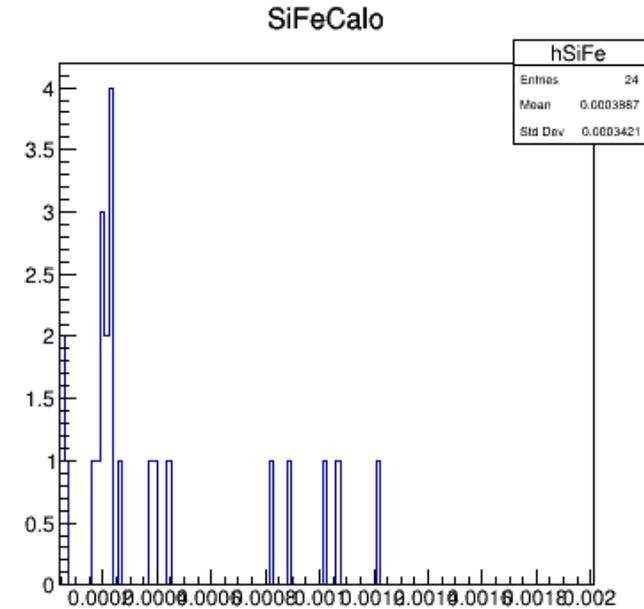
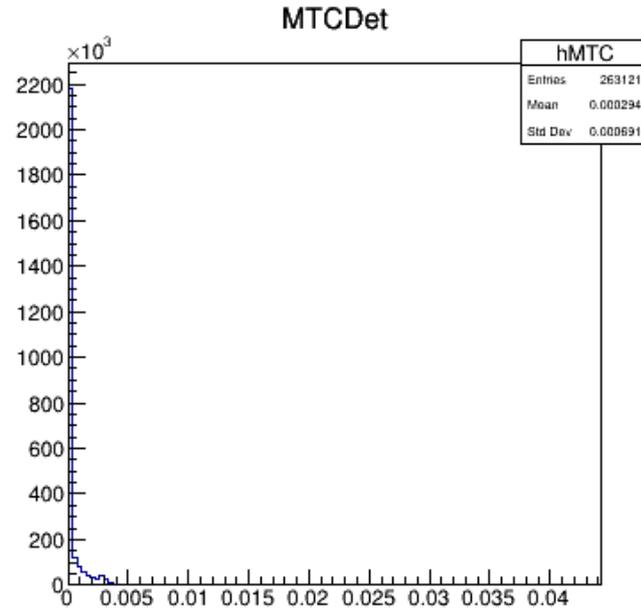


## ► Muons hit z



# Sanity checks (SiFeCalo)

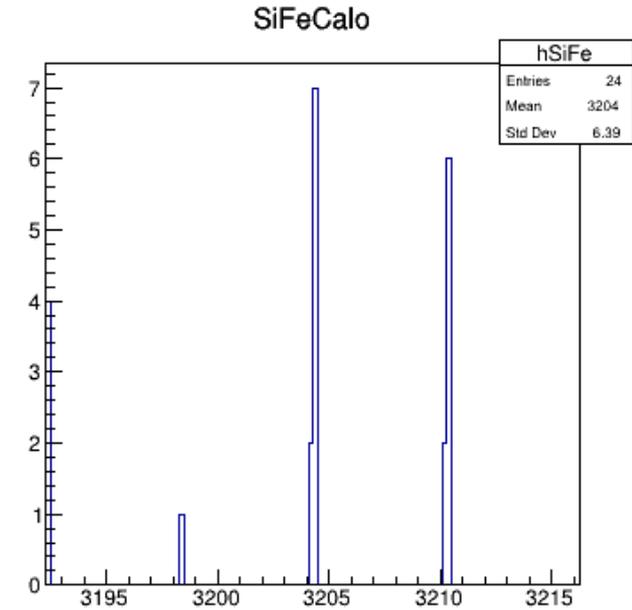
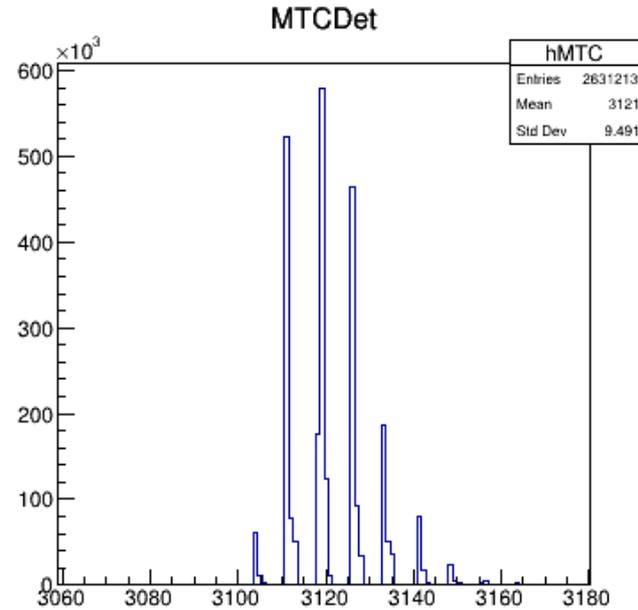
## ► Photons hit E.



# Sanity checks (SiFeCalo)



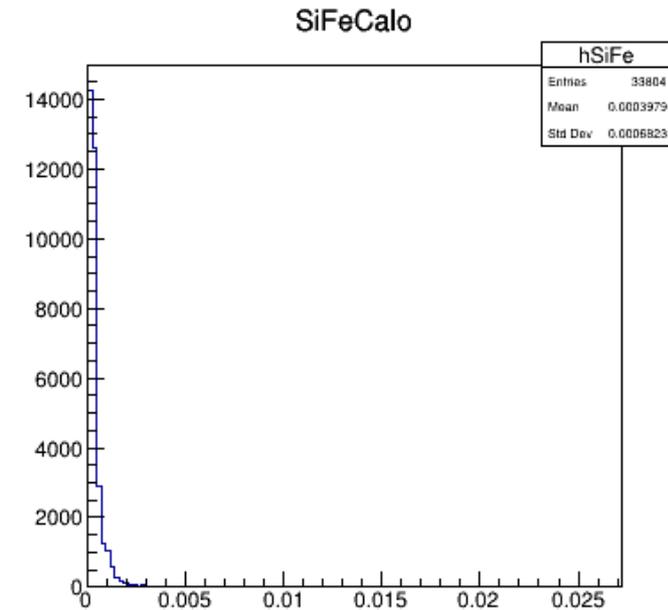
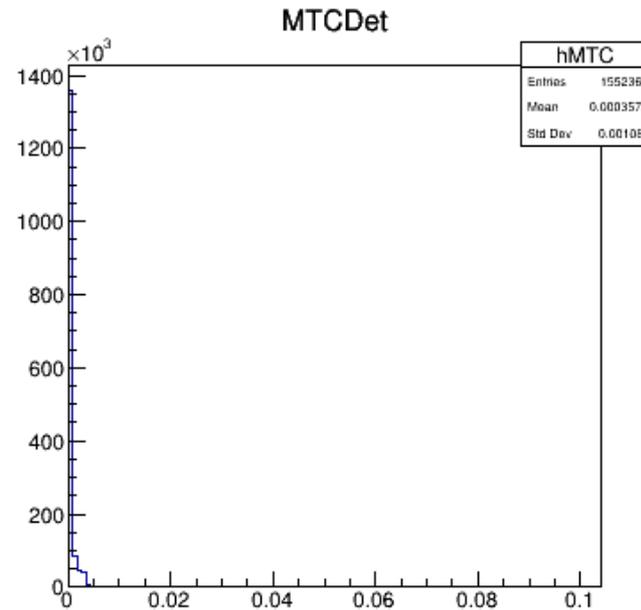
## ► Photons hit z



# Sanity checks (SiFeCalo)



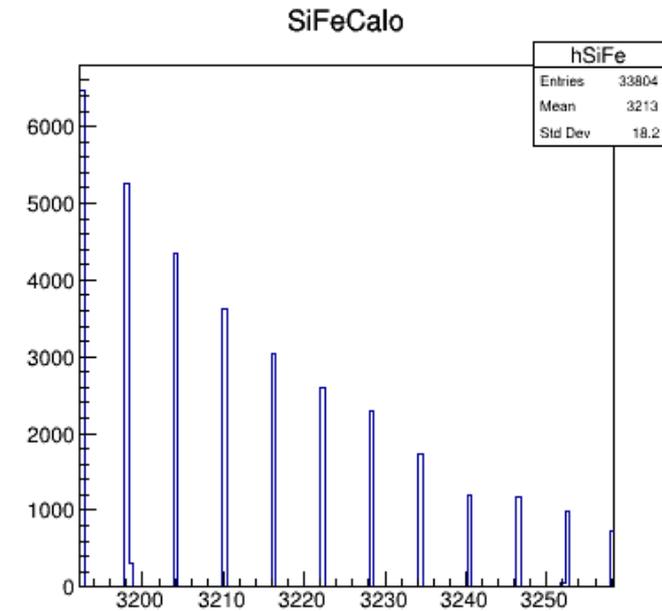
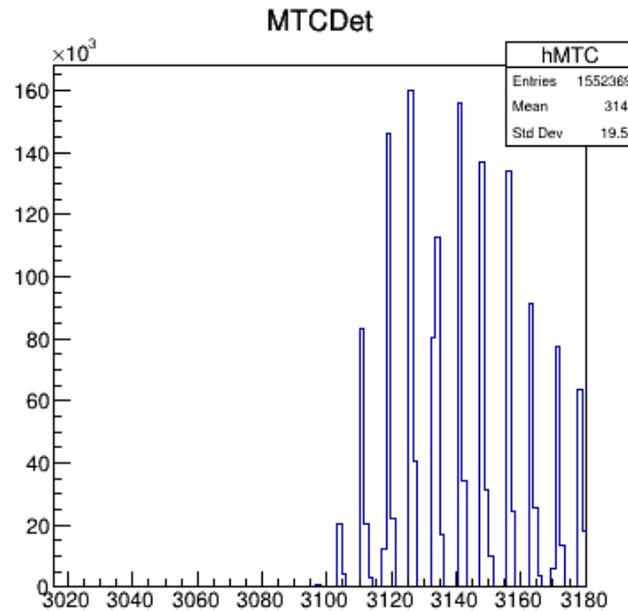
## ► Pions hit E.



# Sanity checks (SiFeCalo)

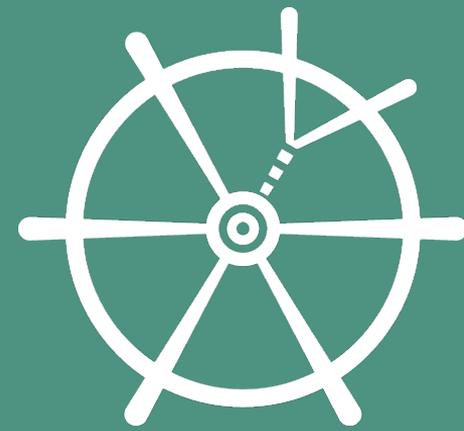


## ► Pions hit z





- ▶ Implementing basic digitization
  - ▷ At least a  $\text{GeV}^2\text{MIP}$  calibration factor and cutting  $E_{\text{hit}} > 0.5 \text{ MIP}$ 
    - The conversion factor I could get it from my previous simulations
  
- ▶ Neutrino events :
  - ▷ I want to have a look, they're done separately
  
- ▶ At reco level:
  - ▷ Joining the SiWCALO and SiFeCALO into the reco software
  - ▷ Conversion to ACTS format for a combined tracking of all calorimeters
  
- ▶ More future talk:
  - ▷ After first tests here... should I try to implement a dd4hep box-like simulation?



SHiP

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BACK-UP



# Adding our SiWCalo or SiFeCalo



- ▶ Procedure (example with SiW):
  - ▷ Changes in “CmakeList.txt”, /python/shipDet\_conf.py, shipdata/ShipDetectorList.h
  - ▷ New file ”geometry/SiWCalo\_config.yaml”
  - ▷ New folder SND/SiWCalo
    - Similar structure than the other SiW calorimeter
  - ▷ Simplified layers: 5.6mm W + 0.65mm Si
  - ▷ Segmentation of  $(18/32 \times 18/32) \text{ cm}^2 \sim 5.5\text{mm} \times 5.5\text{mm}$  (but idealized w/o margins)