

Optical module characterization for P-ONE

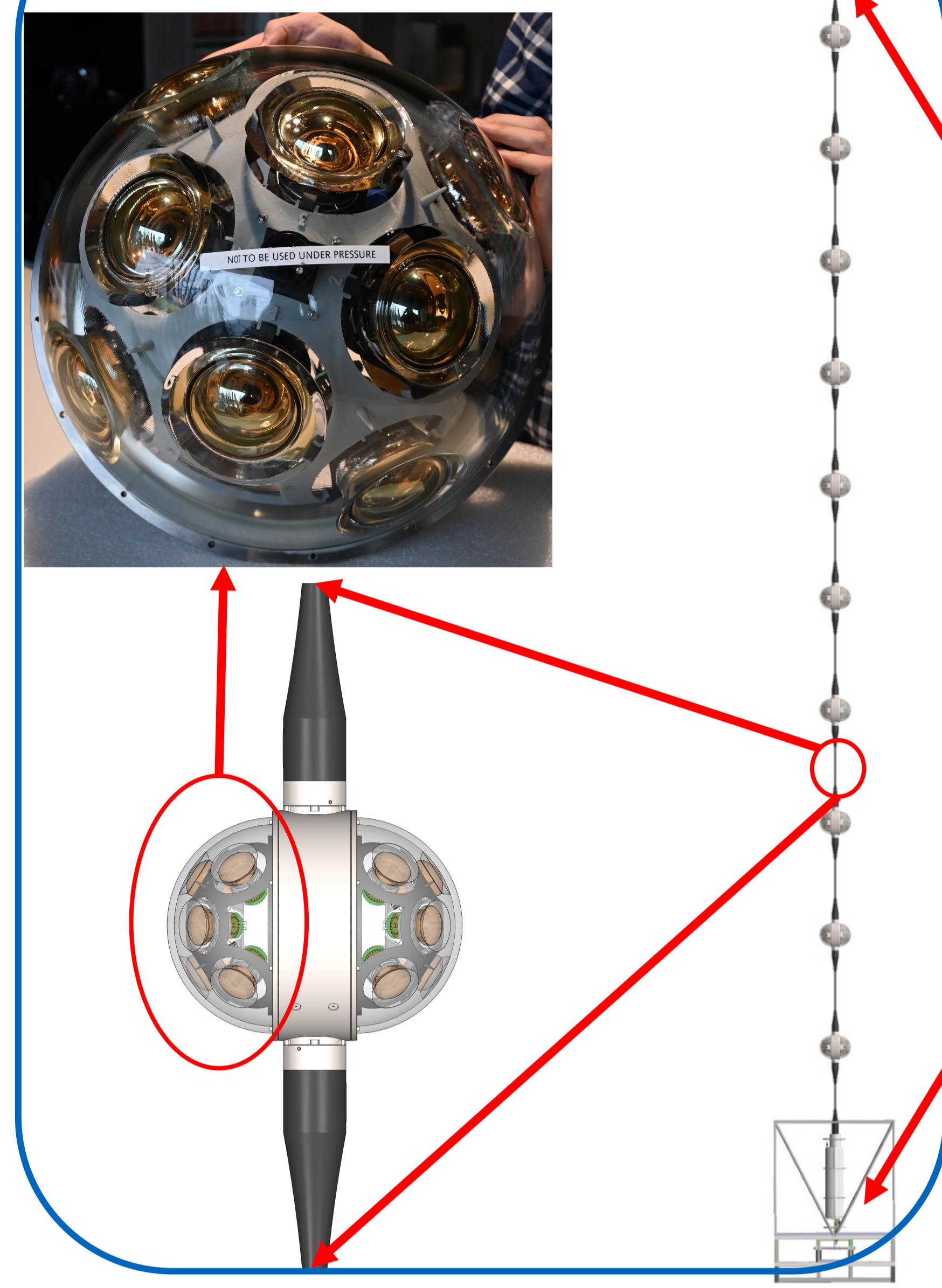
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for the P-ONE collaboration



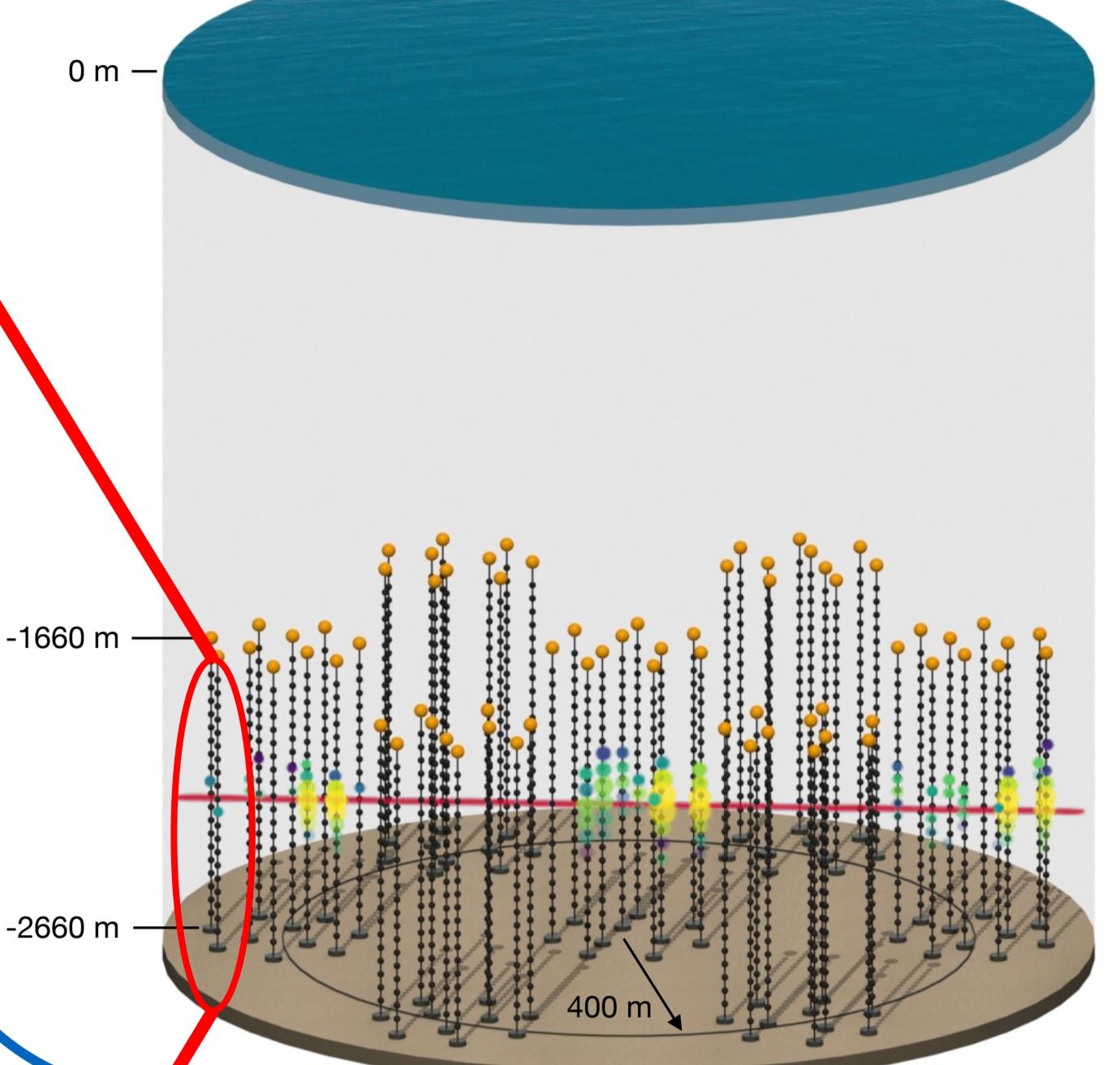
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P-ONE Optical Module (P-OM)

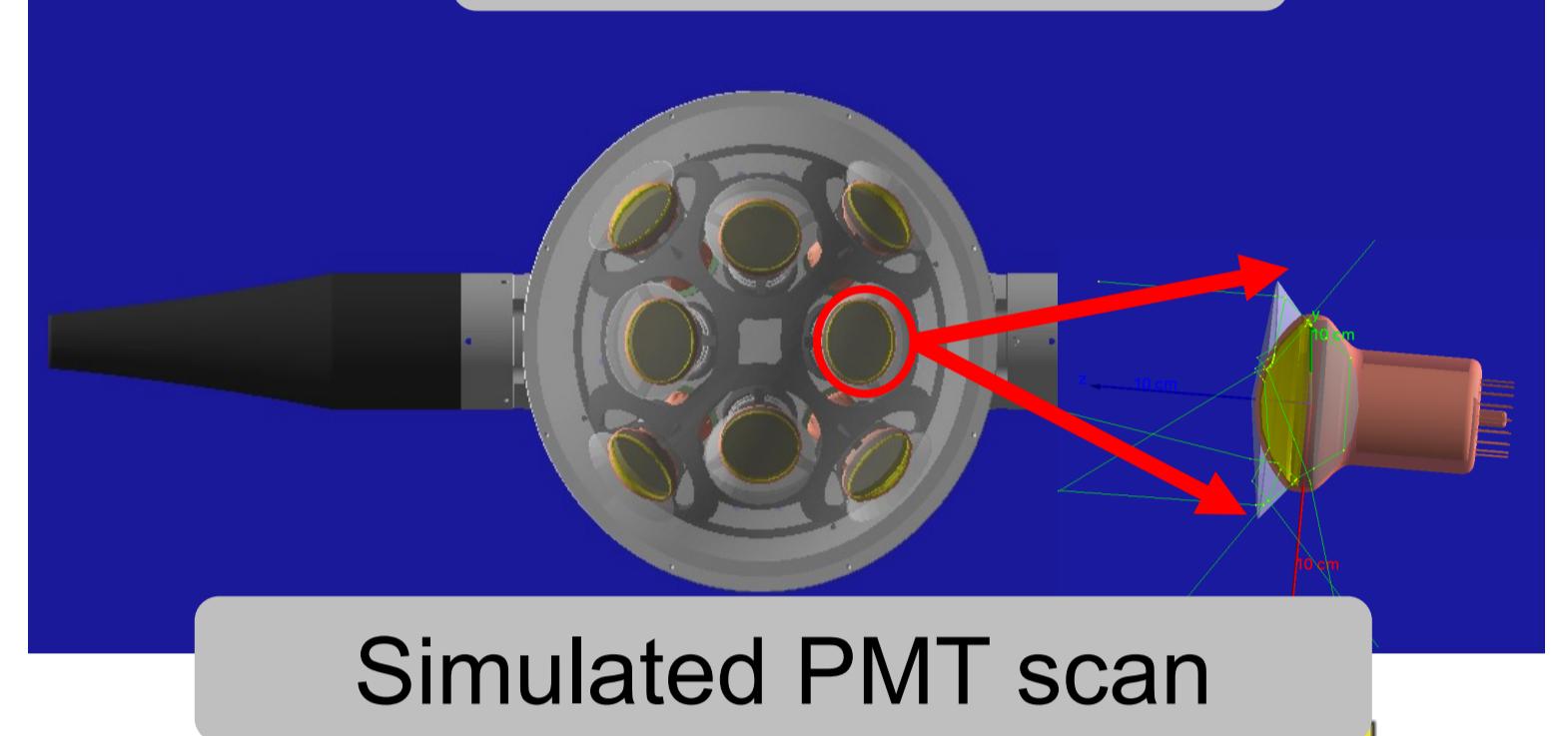


1-Pacific-Ocean-Neutrino Experiment [1]

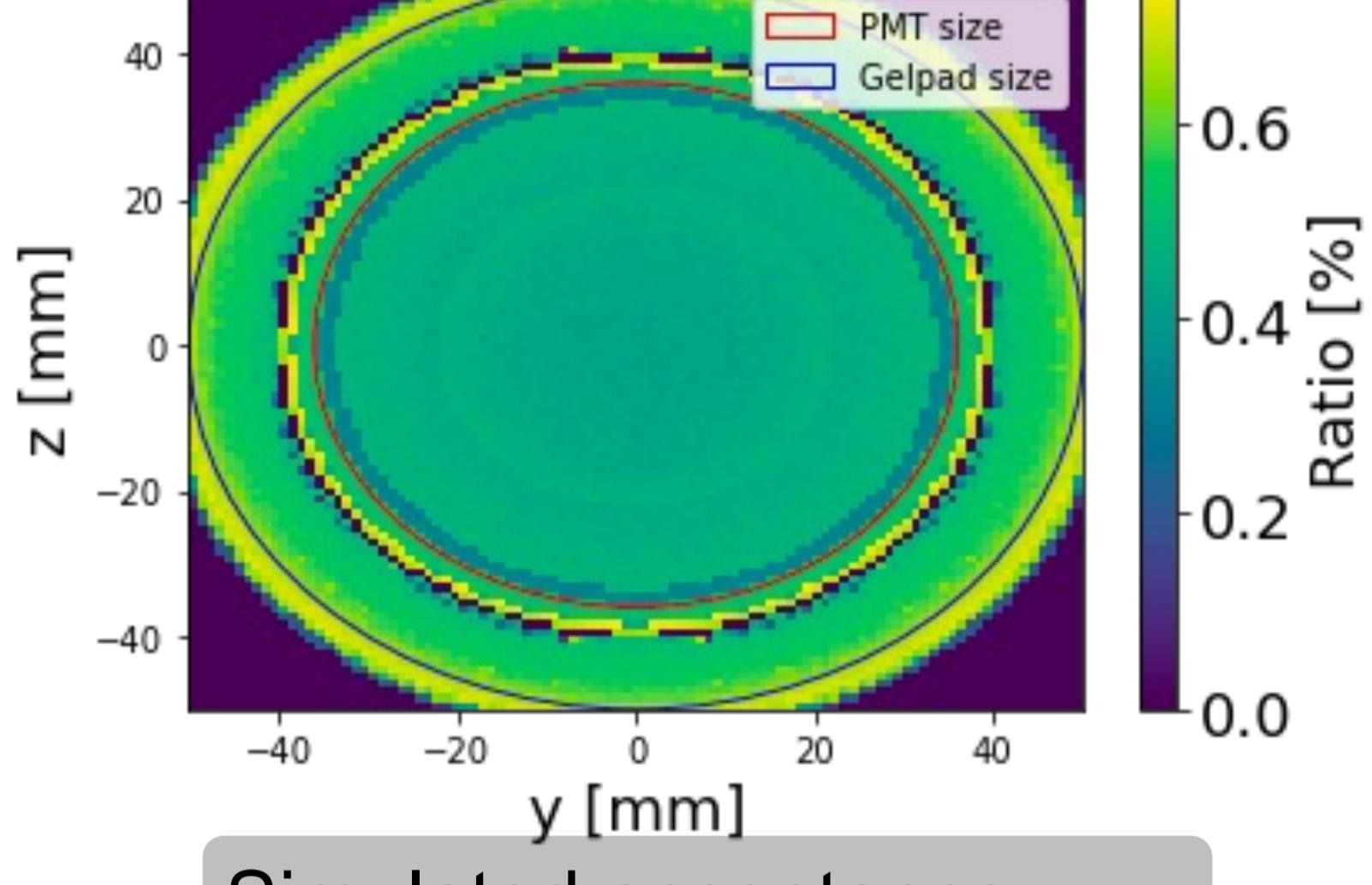


2-P-OM simulation

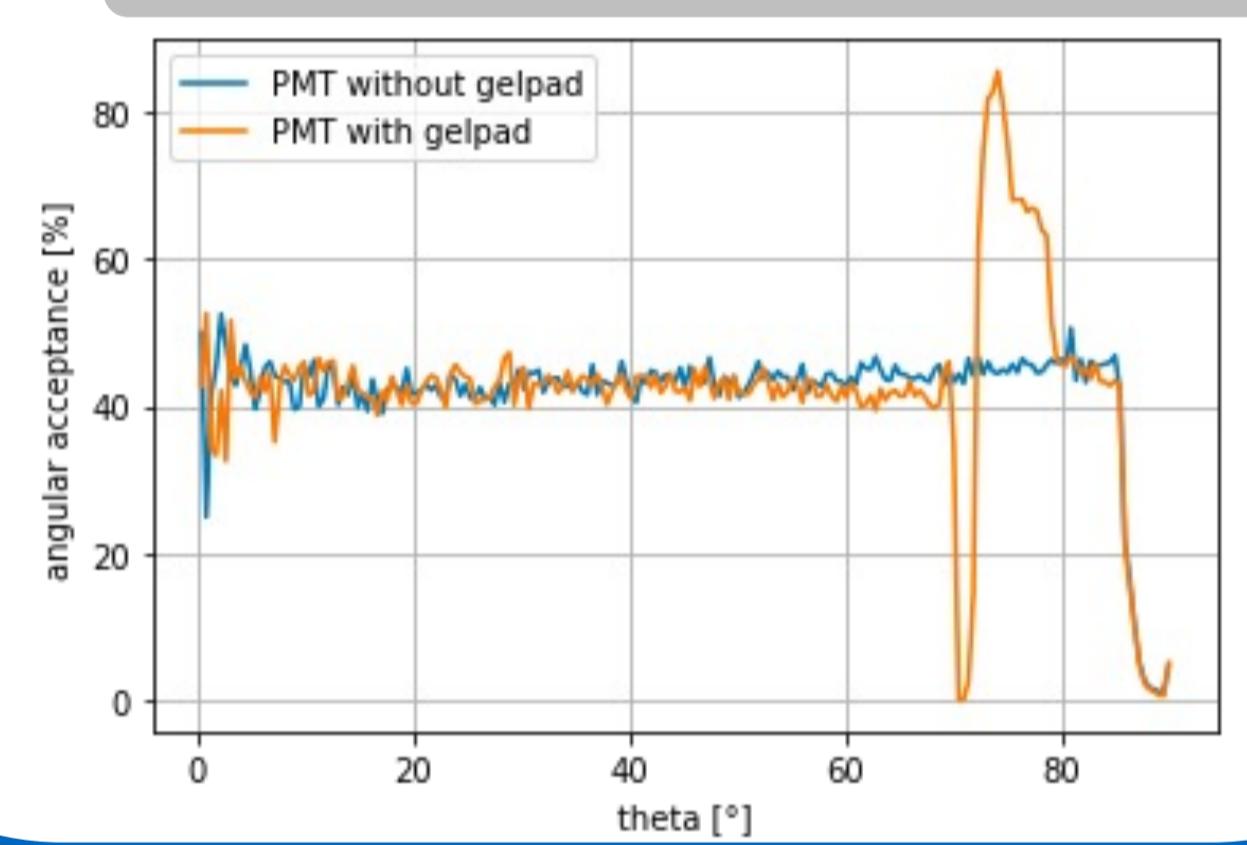
Geant4 model [5]



Simulated PMT scan



Simulated acceptance [5]



P-OM Monte-Carlo chain

- Knowing the most important calibration measurements needed before the deployment of P-ONE is challenging.
- A Monte-Carlo chain of the P-OM will be built to evaluate the importance of the available PMT measurements on the reconstruction of simulated event.
- Faster than full MC to allow quick adjustments

1-Muon event

2-Geant4 single P-OM module simulation

3-Input (PMT position, wavelength, intensity, voltage)

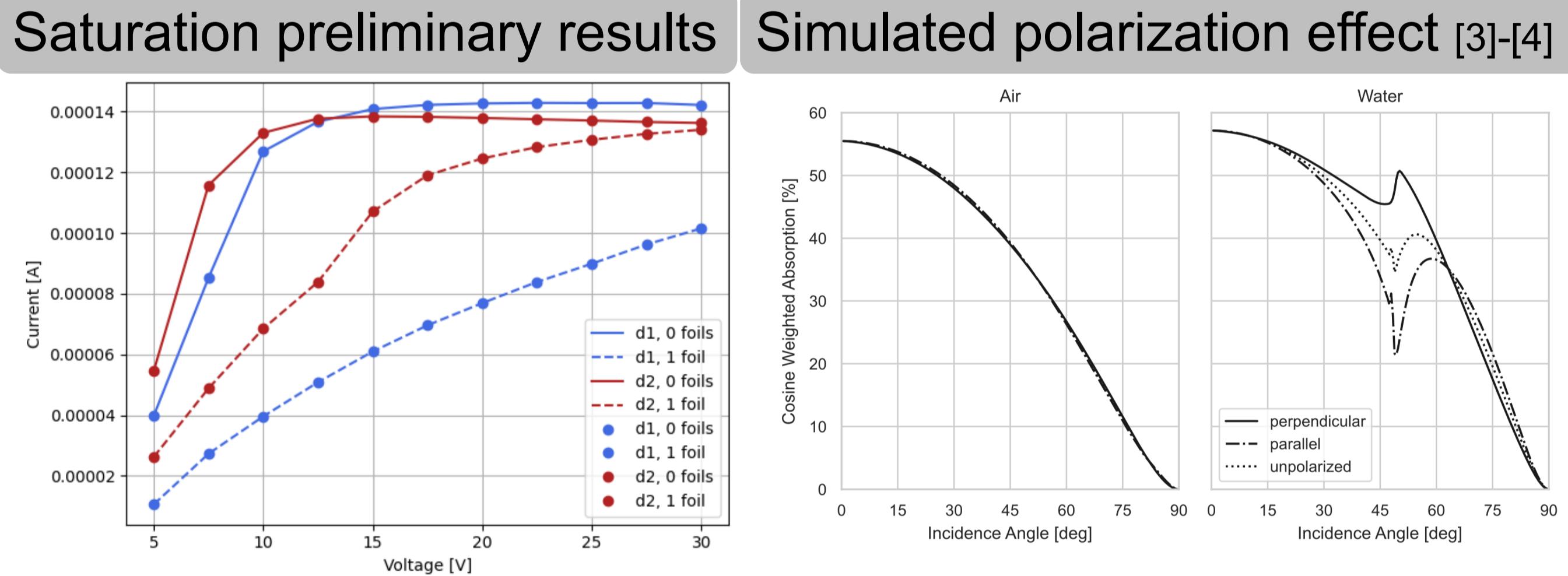
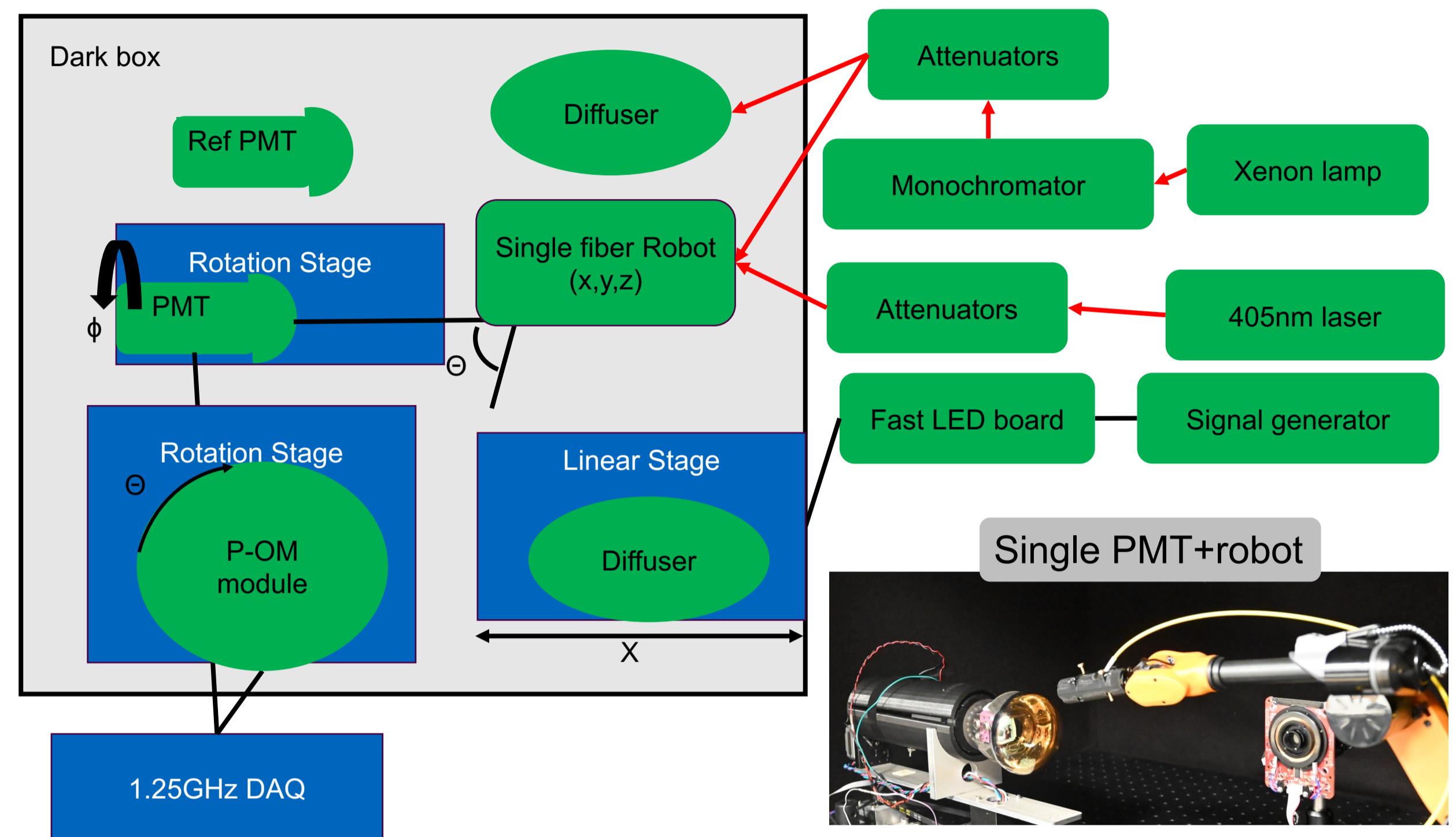
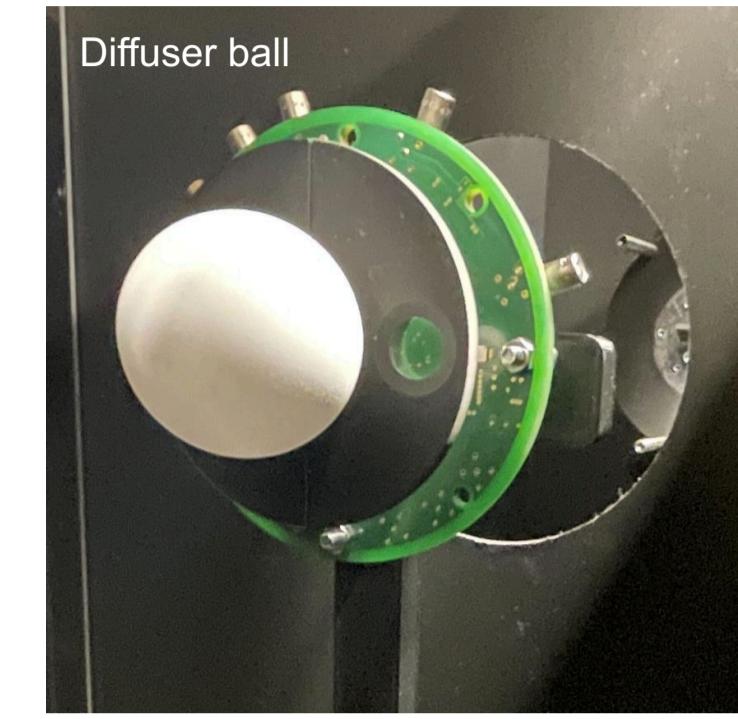
4-Output: General waveform

5-Electronic effects

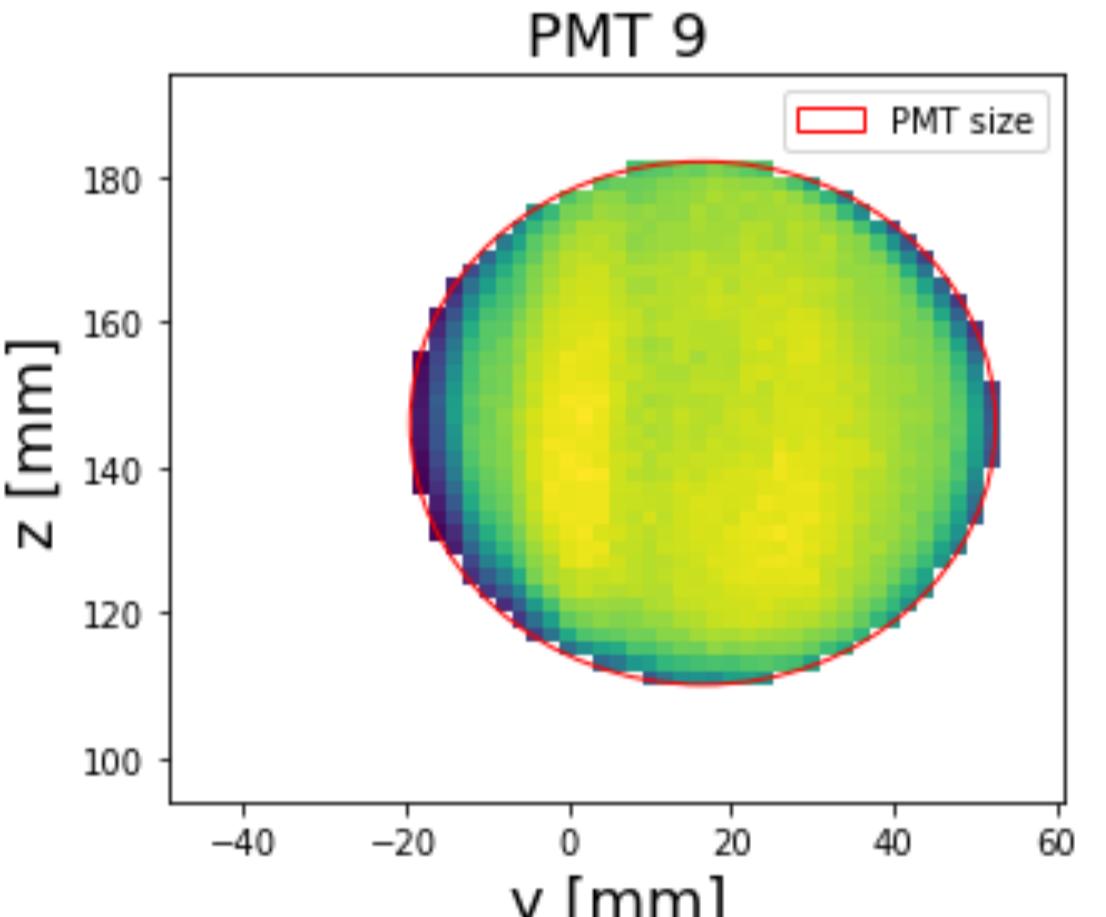
6-Reconstruction (GraphNeT^[2])

3-Optical Module Calibration Unit (OMCU)

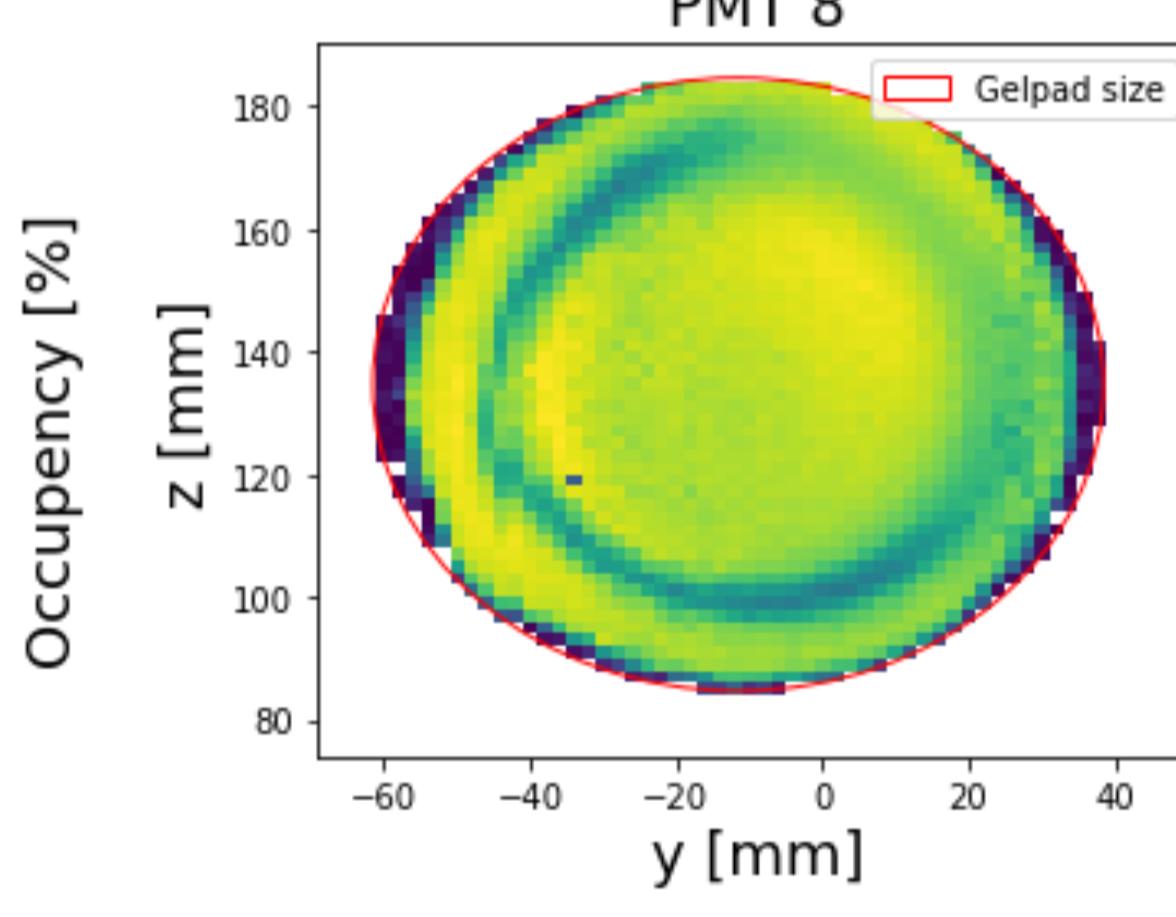
- 405 nm single photon laser (diffuse and steady point)
- Angular acceptance (moving and steady light source)
- Single PMT or P-OM module
- In development :
 - Quantum efficiency measurement
 - Saturation measurement
 - Polarization measurement



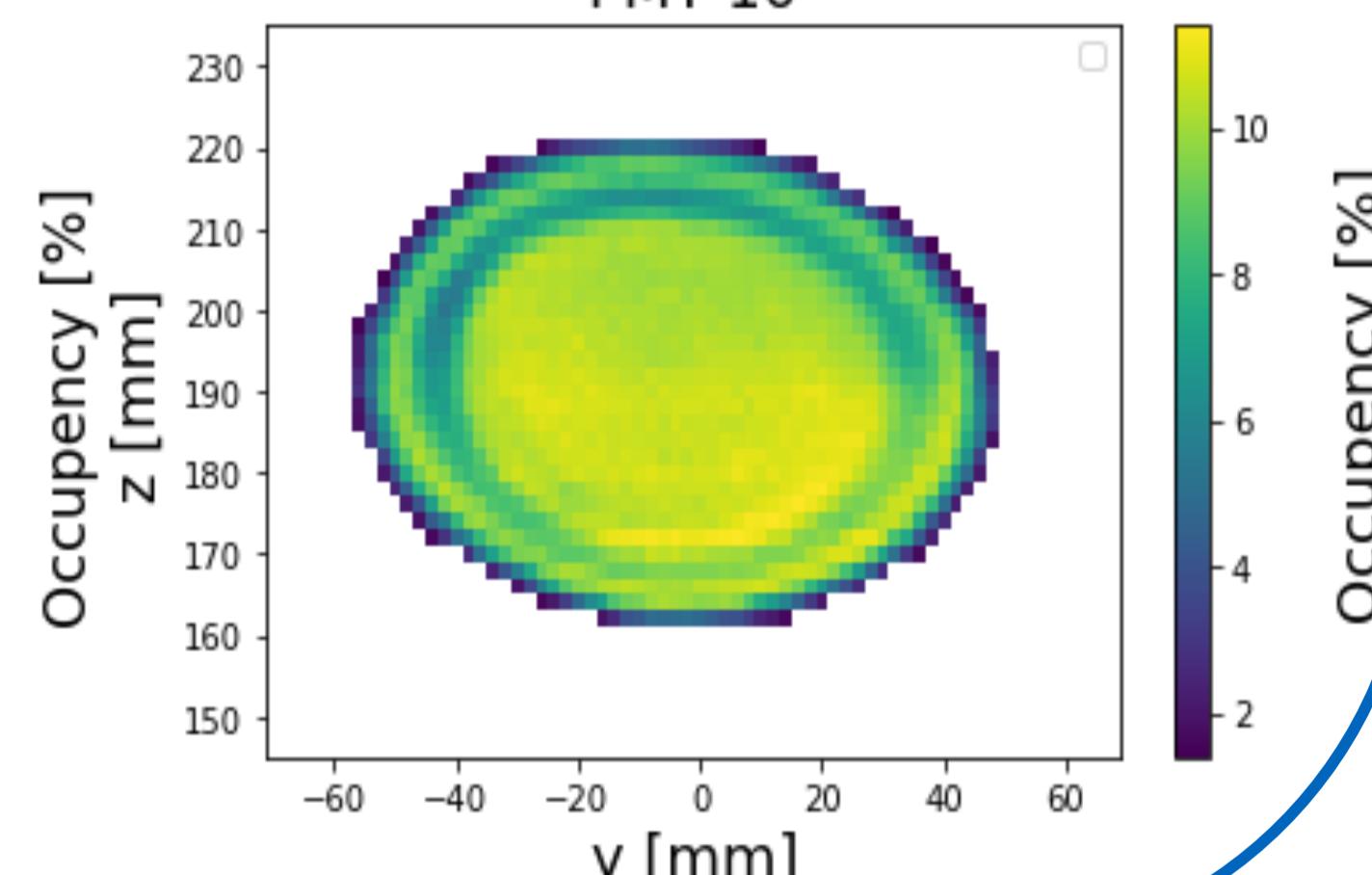
Single PMT



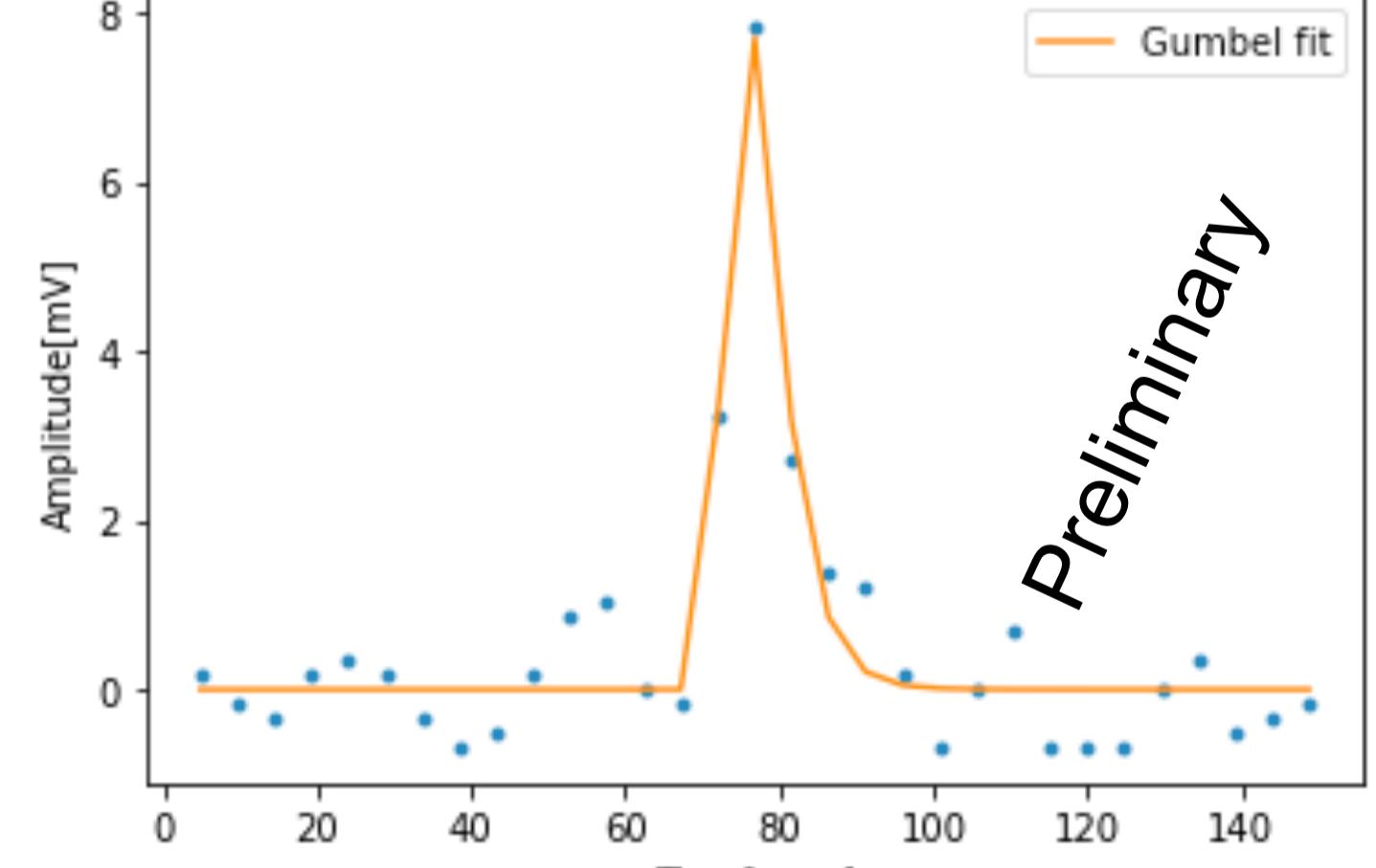
PMT + Gel pad



Integrated PMT



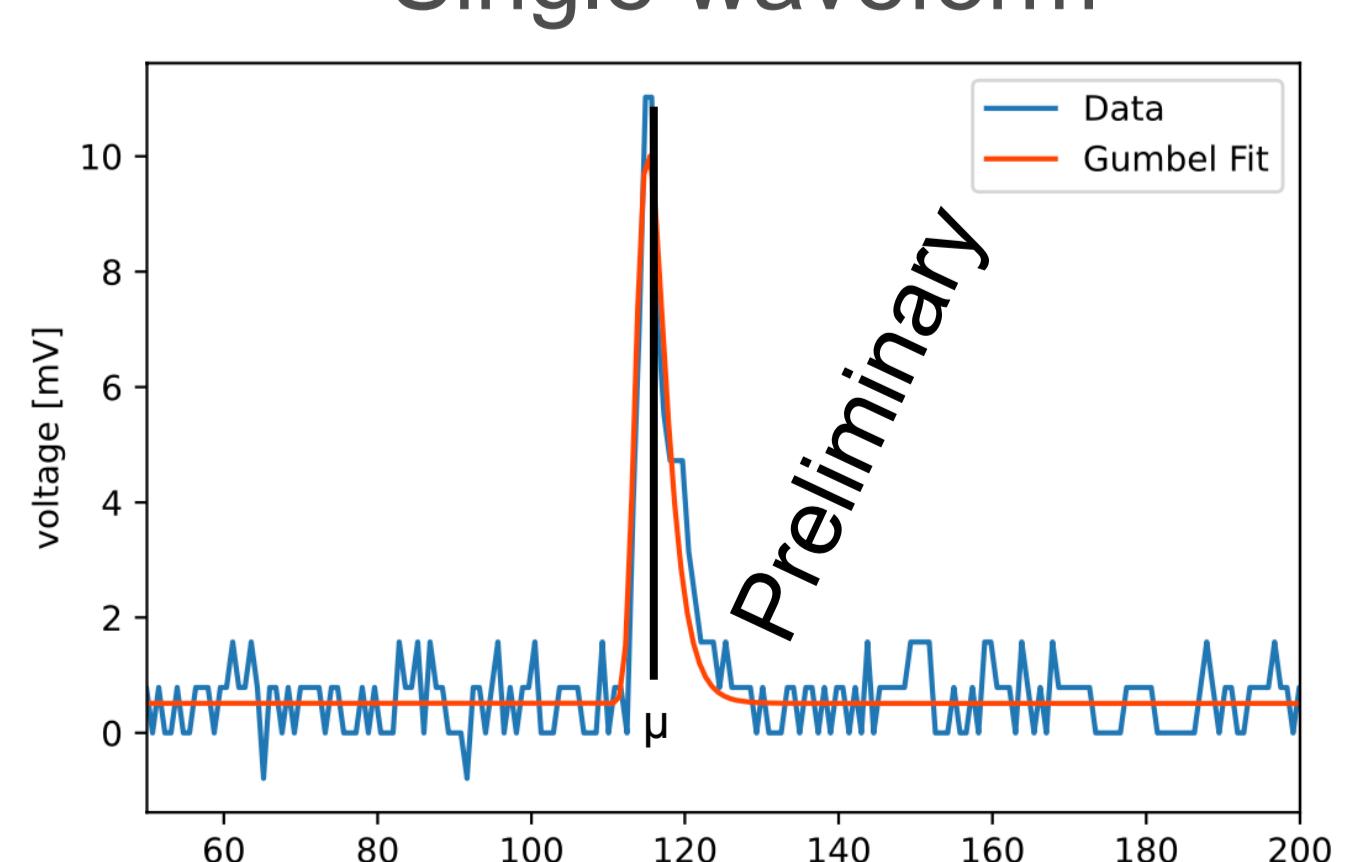
5-Mainboard PMT readout



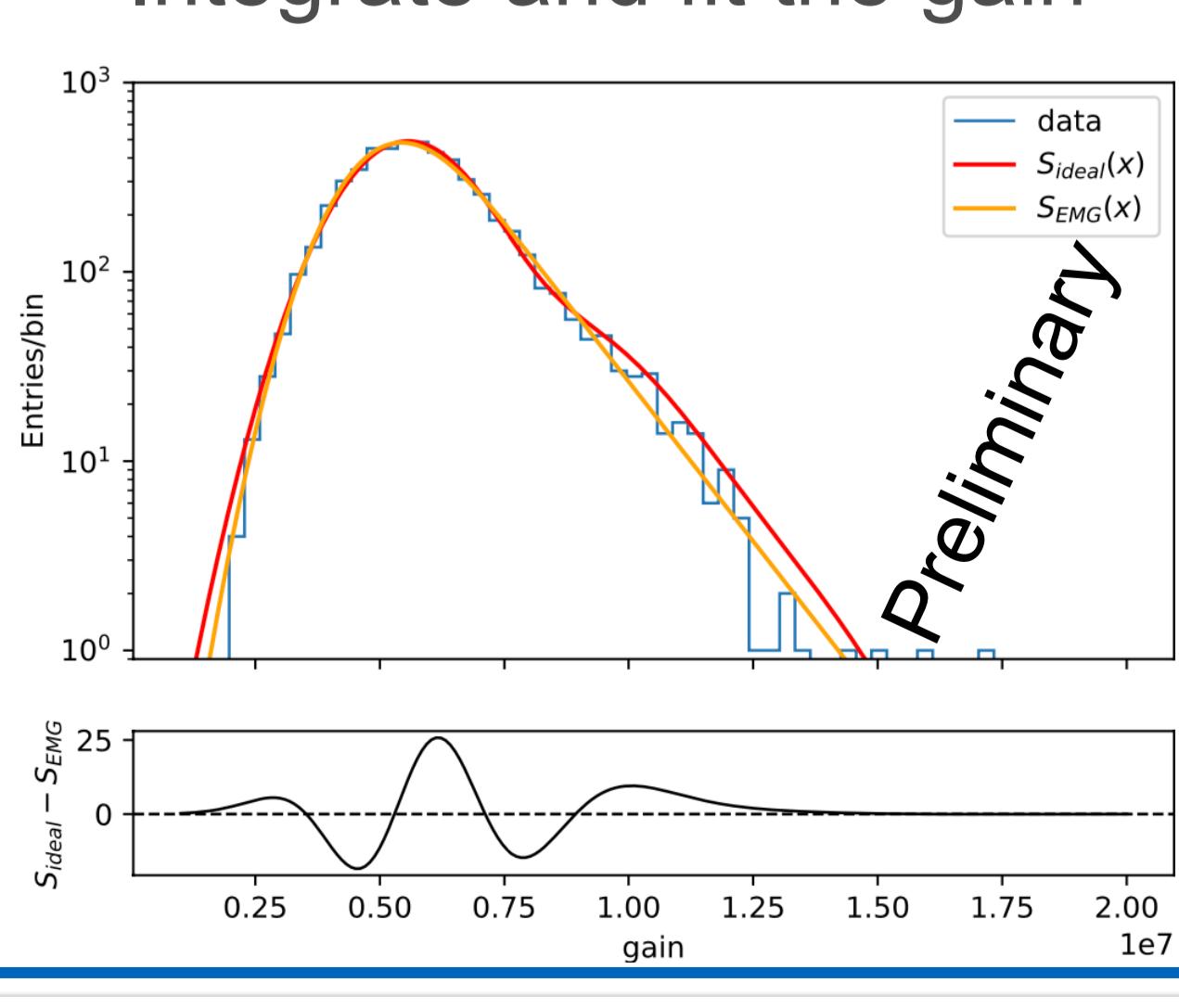
4-Parameters distribution fit

$$I(t) = A \cdot \exp\left(-\left(\frac{t-\mu}{\sigma} + e^{-\frac{t-\mu}{\sigma}}\right)\right) \cdot \frac{1}{\sigma}$$

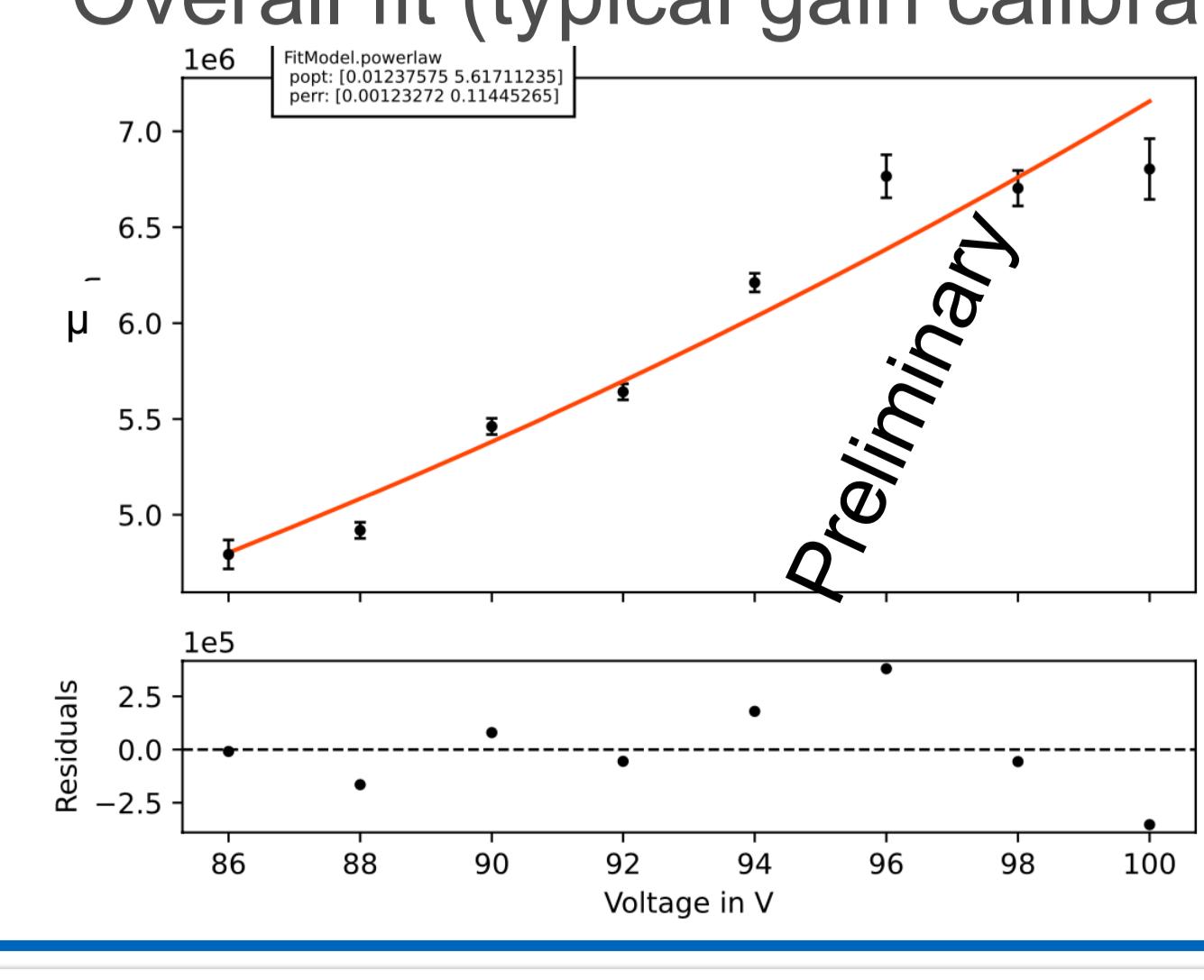
Single waveform



Integrate and fit the gain



Overall fit (typical gain calibration)



References

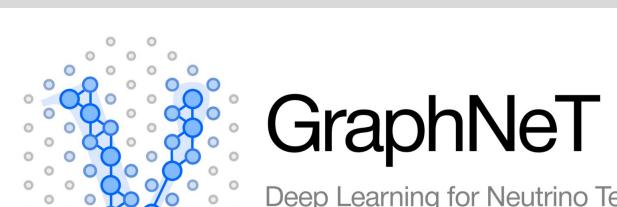
[1] P-ONE experiment <https://pos.sissa.it/44/1219/pdf>

[2] GraphNet <https://github.com/graphnet-team/graphnet>

[3] T.Kershner, The Simulation of Polarized Light Propagating in Ocean Water, TUM, Master's thesis, 2024

[4] M. Moorhead, 'Reflectors in Cherenkov Detectors'. PhD thesis, University of Oxford, 1992

[5] N. Retza, The Pacific Ocean Neutrino Experiment: Advancements in the Optical Module Development for the First Detector Line of P-ONE, TUM, Master's thesis, 2023



Deep Learning for Neutrino Telescopes



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