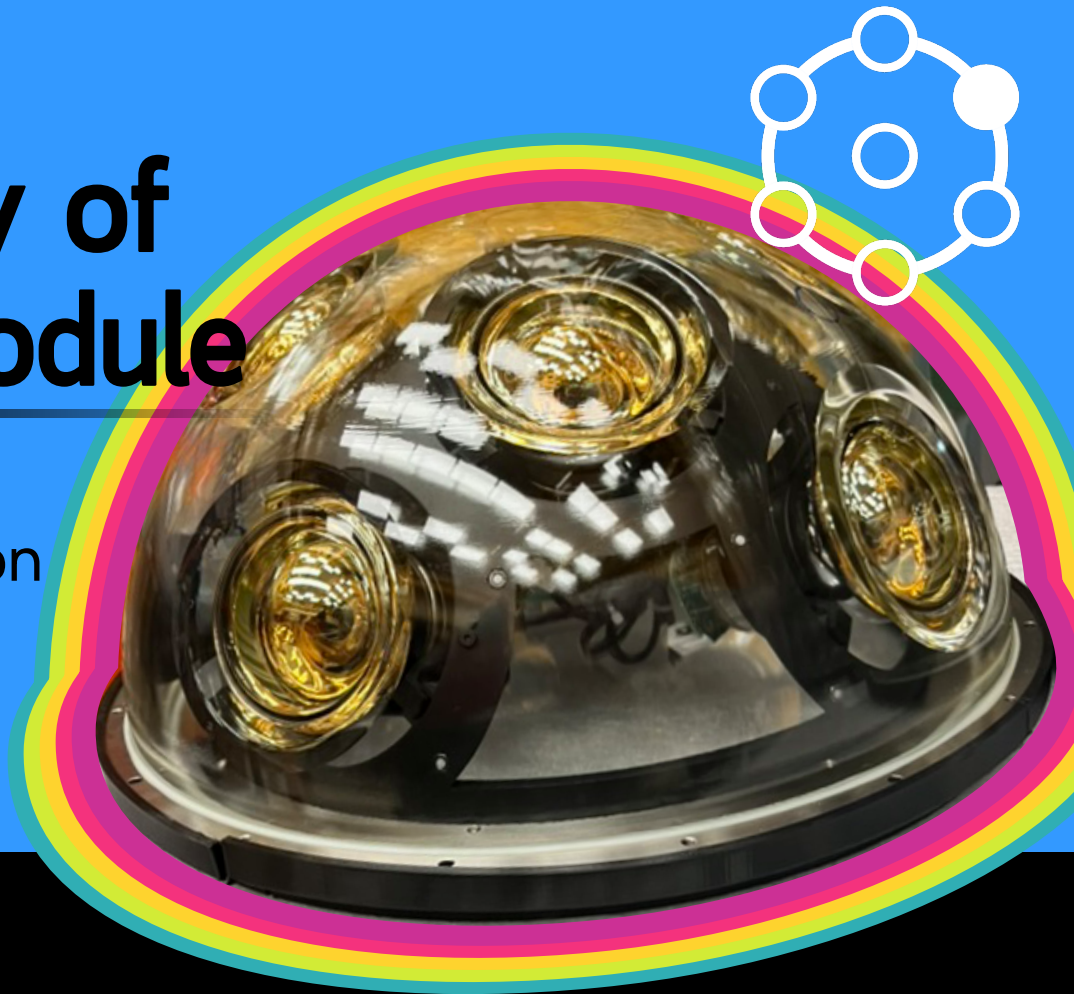


The Anatomy of an Optical Module

Alexia Alexander Wight
University College London

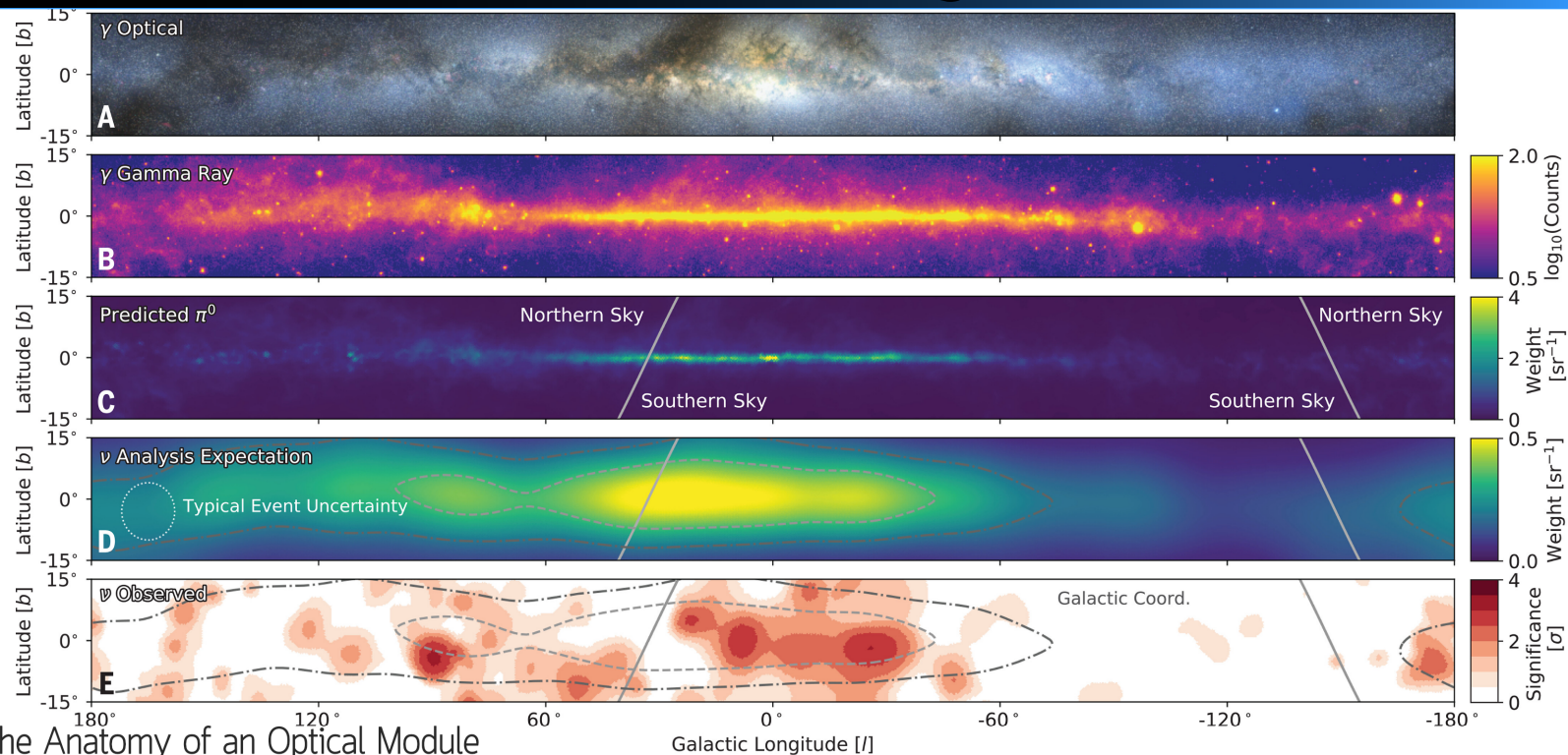


My first year

- **Autumn:** SM1, SM2, & Chicago collaboration meeting.
- **Spring:** Template pulse analysis.
- **Summer:** LTA in Vancouver & collaboration meeting.

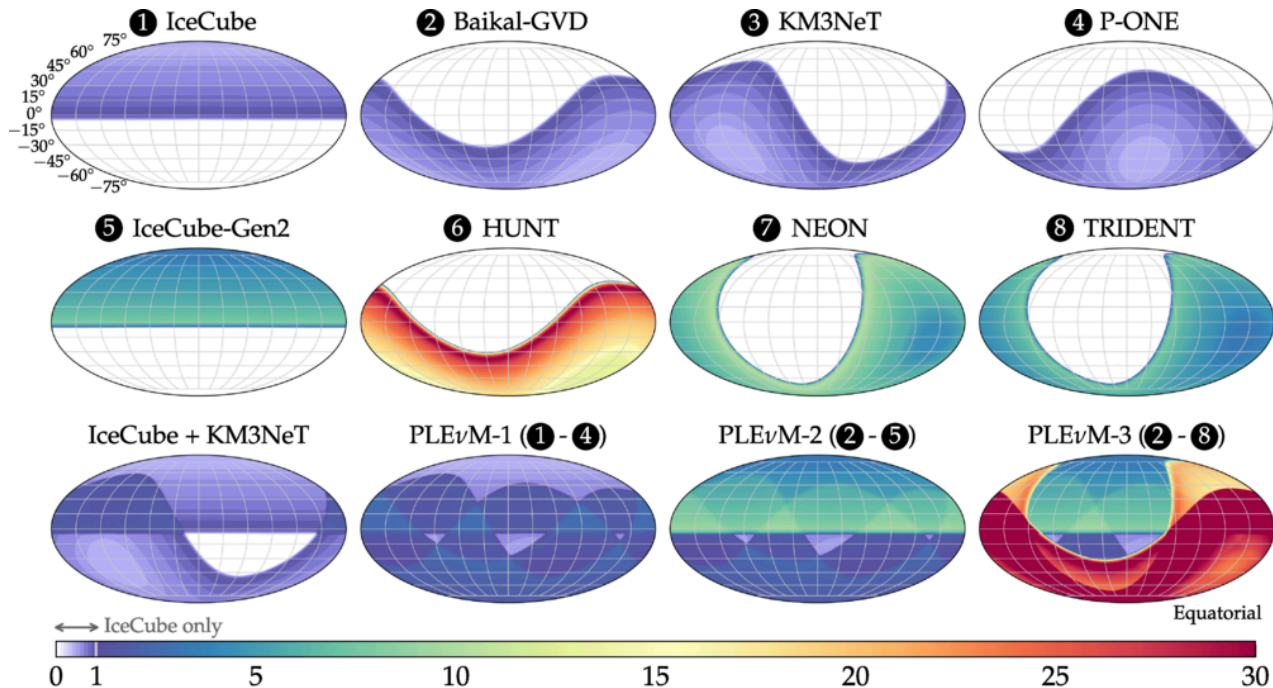


Neutrino Astronomy



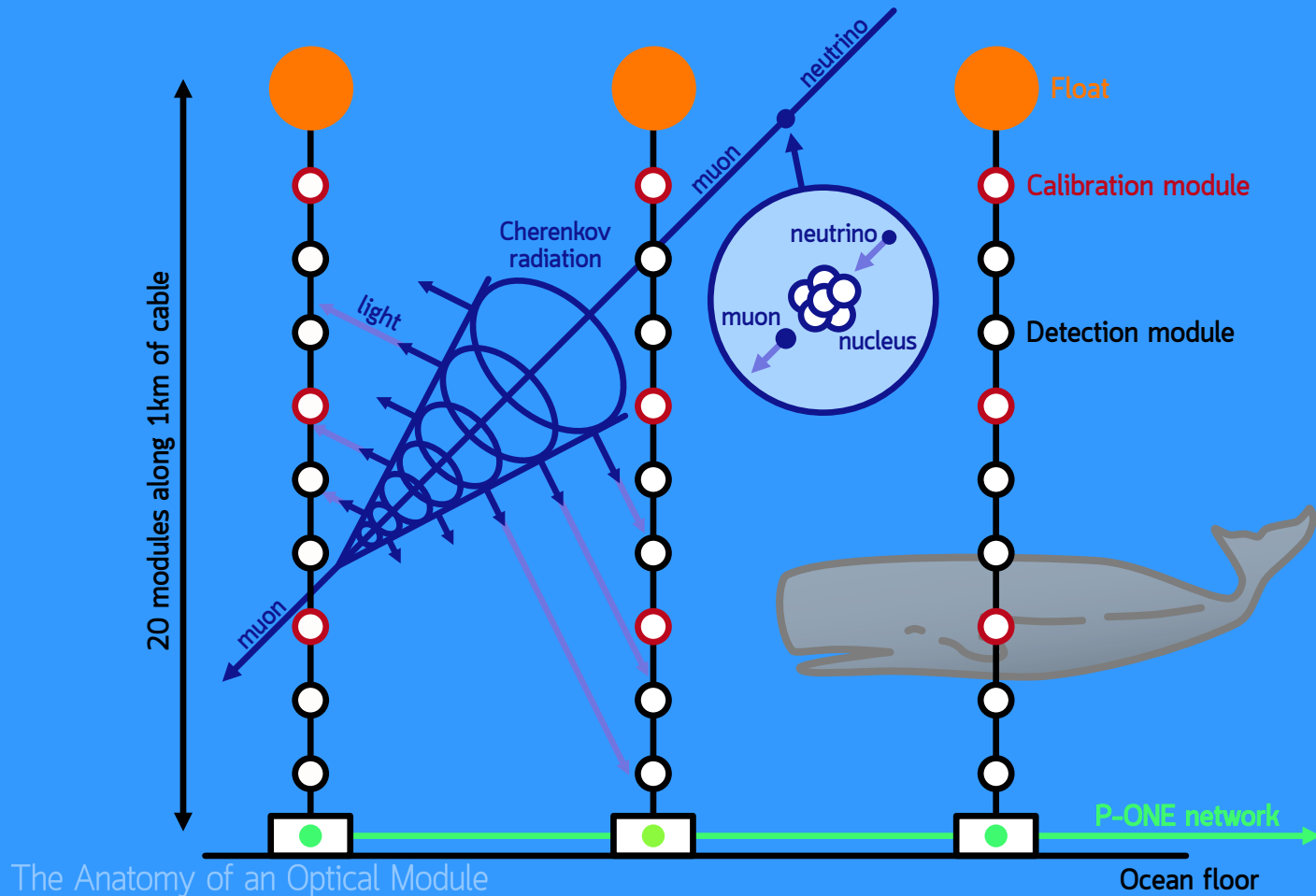
The Anatomy of an Optical Module

PLEvM



The Anatomy of an Optical Module

P-ONE



Anatomy

P-ONE

P-OM

Hemisphere

PMTs

Flashers

Axion flasher

Acoustic receiver

Muon in-situ tracker

Mainboards

Timing systems

Line

The Anatomy of an Optical Module



P-ONE-1

Purpose: Successful, stable data taking with a single string of optical modules.

Mechanics:

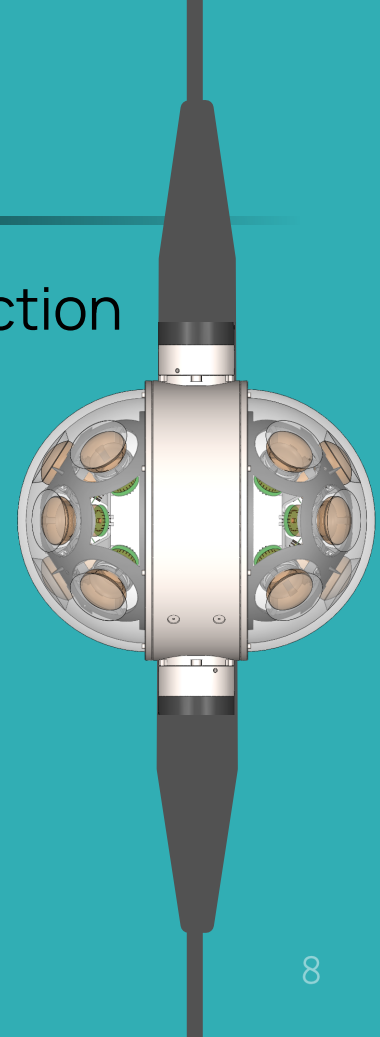
- Perform line time synchronization,
- Measure line position (with time),
- Characterize backgrounds (with time),
- Measure atmospheric muons,
- Measure optical water properties (with time),
- Perform module calibrations in-situ.



The P-OMs

Purpose: House all necessary hardware for detection and calibration.

Mechanics: Two glass hemispheres attached to a metal collar, which is then attached to the line.



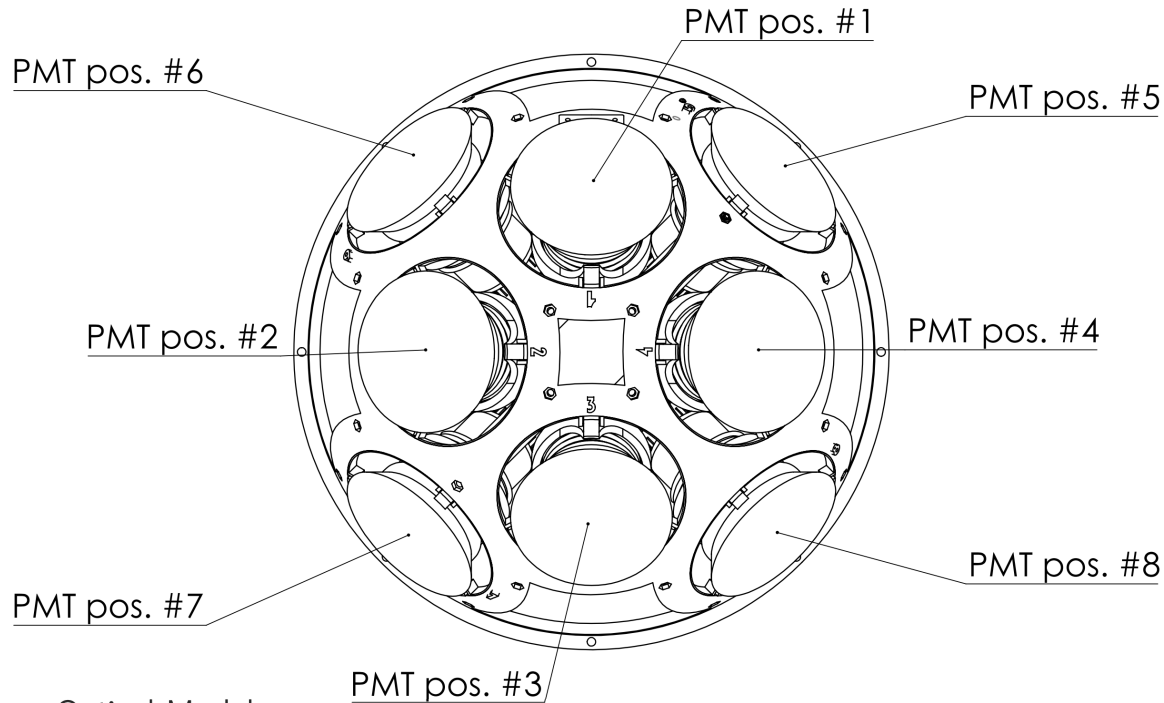
The hemisphere

Purpose: Detection of Cherenkov radiation and calibration of the detector.

Mechanics: Glass half sphere filled with all needed hardware for detection and calibration. Two types, A and B, with slightly different flasher set-up.



The hemisphere



The PMTs

Purpose: Detect light produced by Cherenkov radiation (and any light used for calibration).

Mechanics: 8 PMTs per hemisphere, with gel pads to optically couple them to the glass.



The PMTs

The PMTs will provide data point as to where Cherenkov light was produced, and allow us to build tracks showing the movement of charged particles in the ocean.

P-ONE-1 will be a single string so won't be able to build tracks, but can start taking more general data & calibrating.



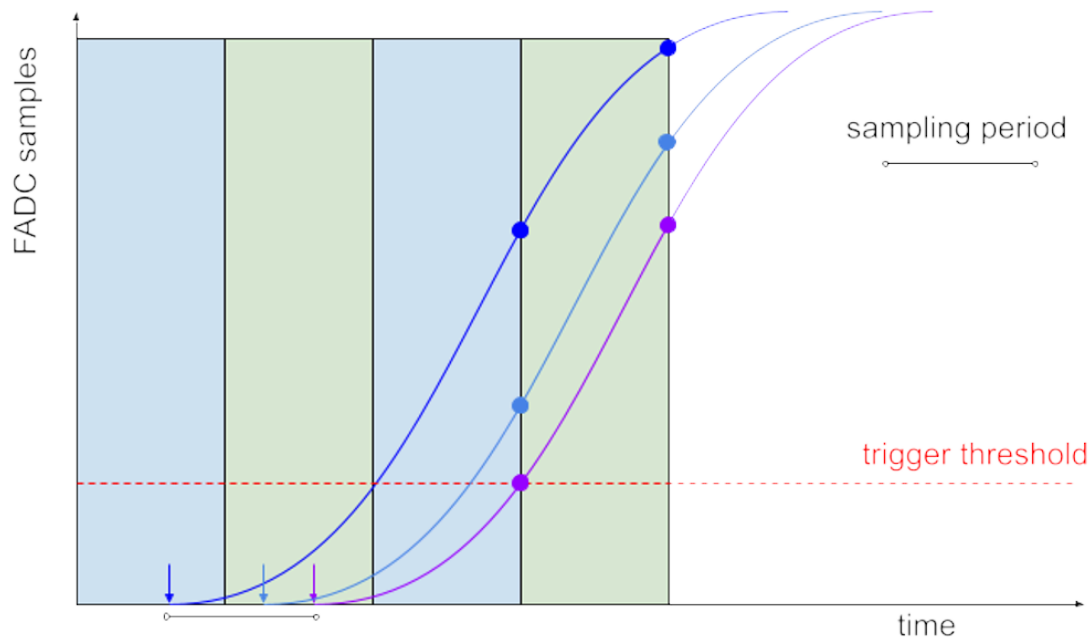
PMT template pulse

When we deploy P-ONE-1, we want to be able to characterise the PMT response whilst in situ.

To do this, we need to take a sample of waveforms, and combined them into an upsampled template waveform.

However, the waveforms will be out of phase due to the finite sampling period, so we first need to align them.

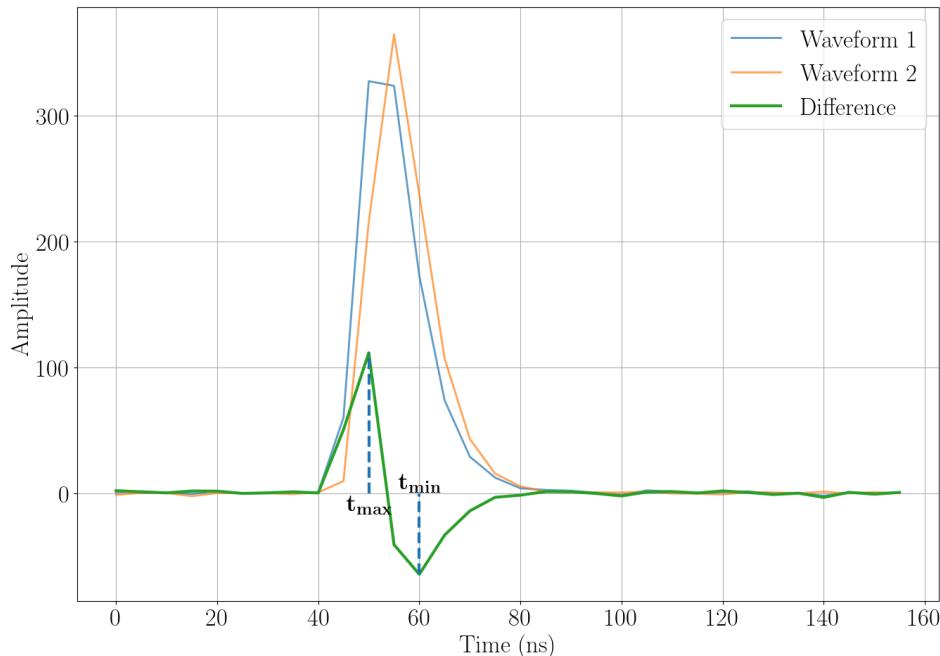
Sampling



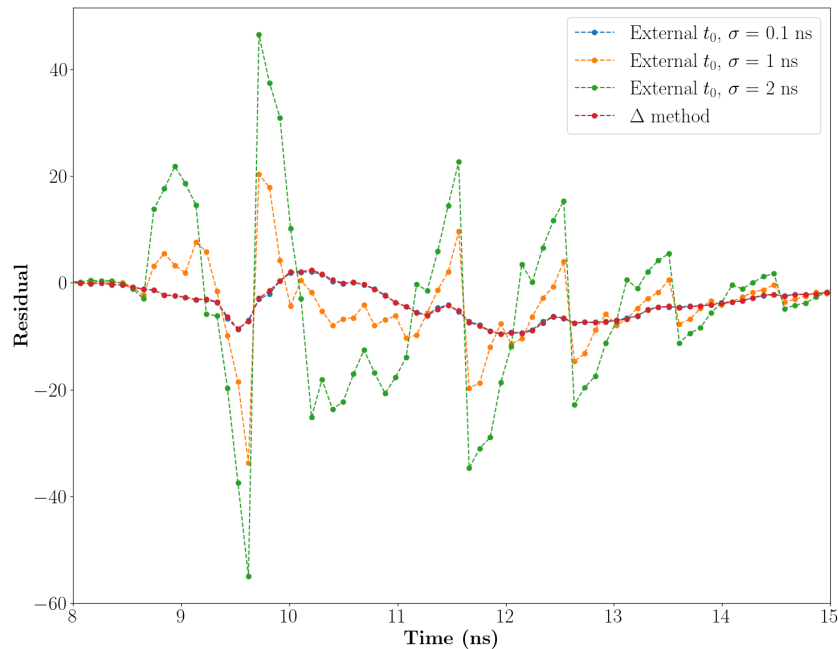
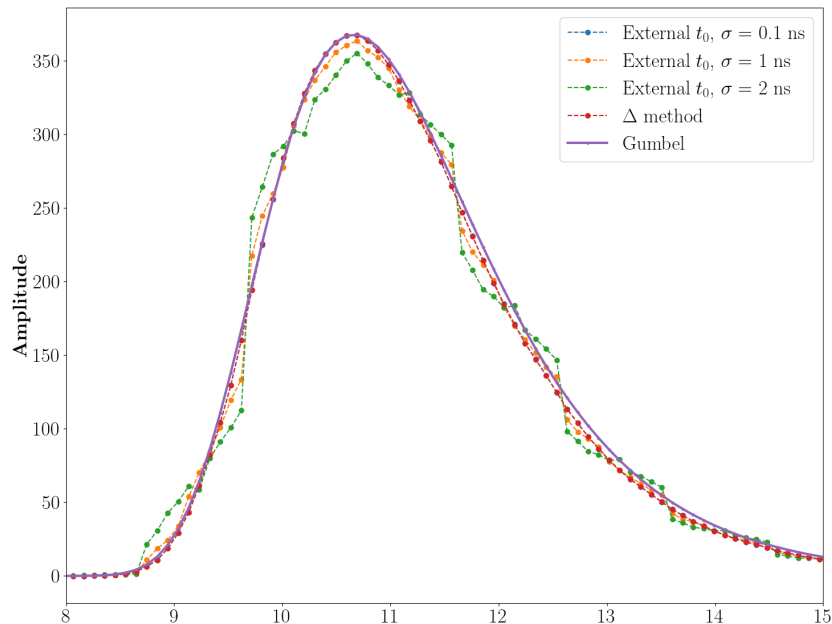
Ordering

We assign each waveform a figure of merit that allows us to reorder these waveforms in time.

This is traditionally done by using an external time stamp, but we have a novel method.



Waveform template



The flashers

Purpose: Measure the optical properties of water at different depths in order to properly construct tracks.

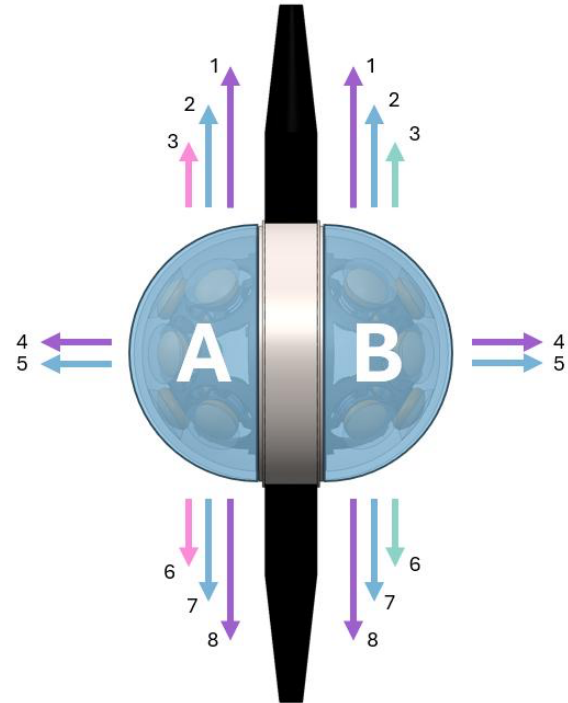
Mechanics: Eight flashes per hemisphere in three inserts, pointing up, down, & sideways.



Flasher integration



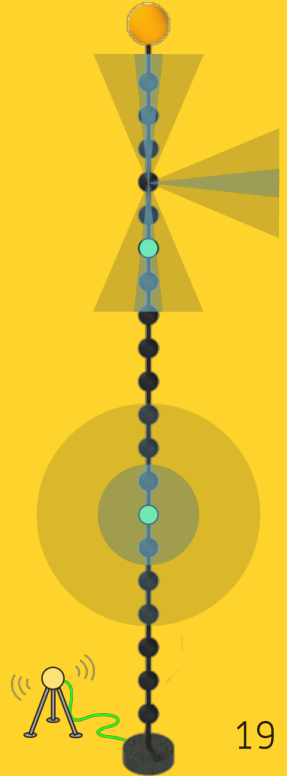
Worked on the integration of the flashers in ~30 hemispheres and finetuning the protocols.



The axicon flasher

Purpose: Monitoring of the string inclination and deflection, and determining optical properties of water.

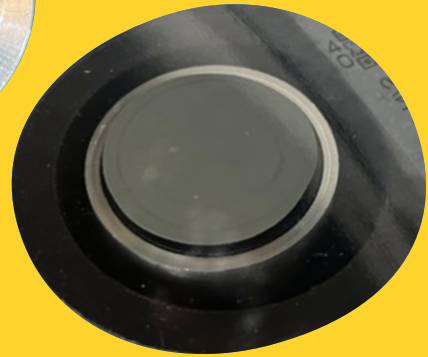
Mechanics: Laser cone emission with apex angle of 20 deg vertically (horizontal axicons have 59.8 degree cones).



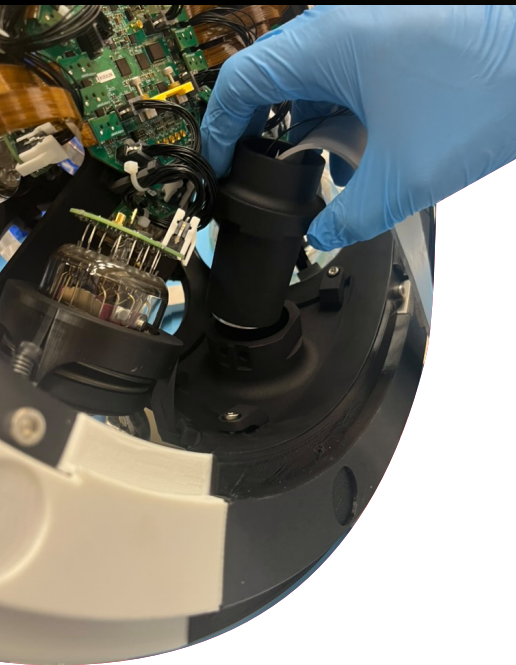
The acoustic receiver

Purpose: Locating the position of the optical modules and the string.

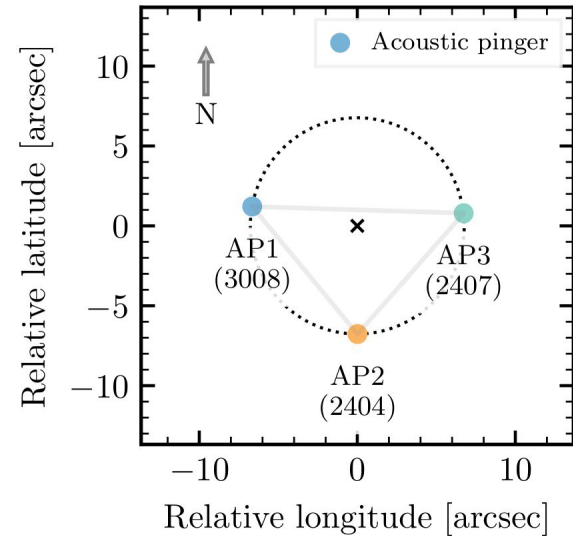
Mechanics: Acoustic transmitter on the ocean floor send pings to piezoelectric acoustic receivers in the hemisphere, which are acoustically coupled to the hemisphere with epoxy.



Acoustic receiver integration



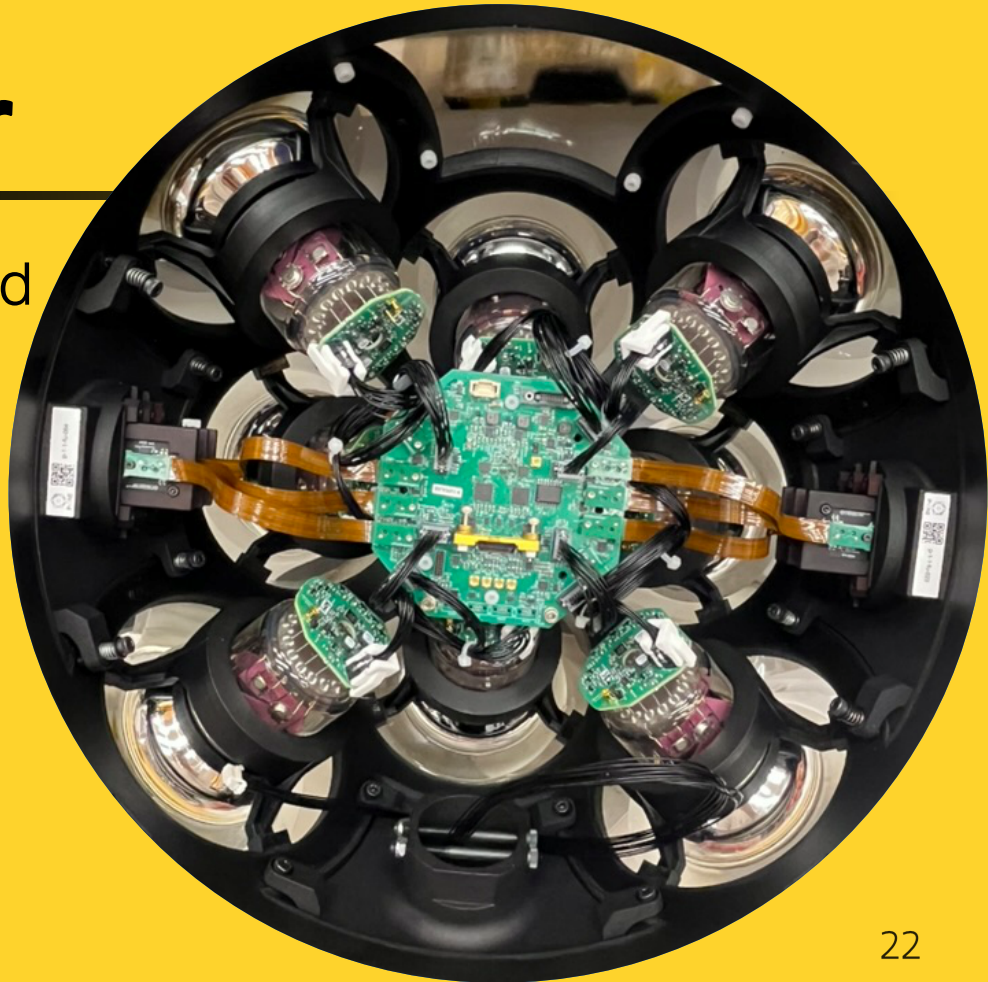
Worked on the integration of the acoustic receivers in ~30 hemispheres and finetuning the protocols.



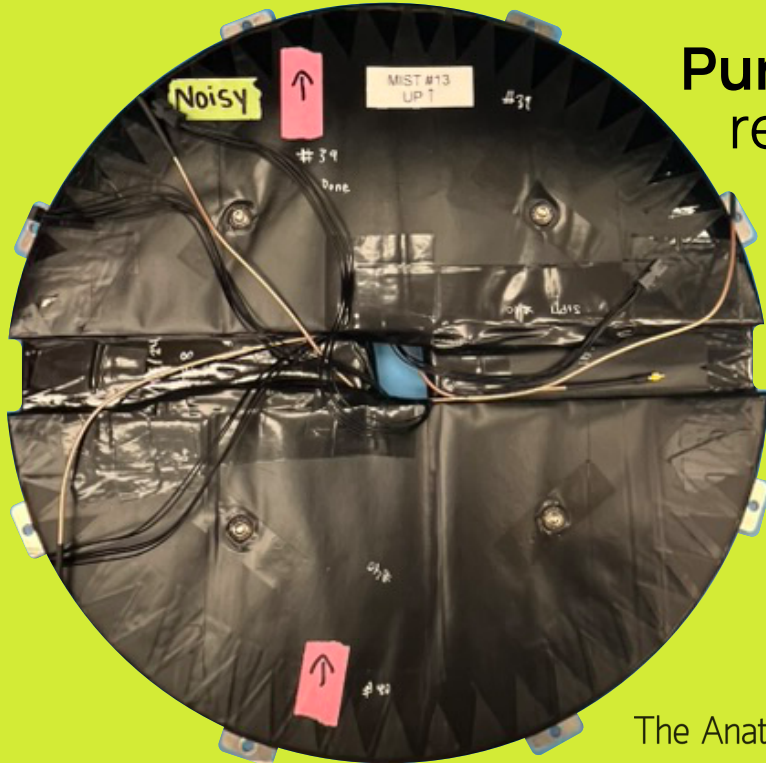
The interposer

Purpose: Route signals and power from the mainboard to the other components in the hemisphere.

Mechanics: PCB connected to mainboard and all hemisphere components.



The muon in-situ tracker



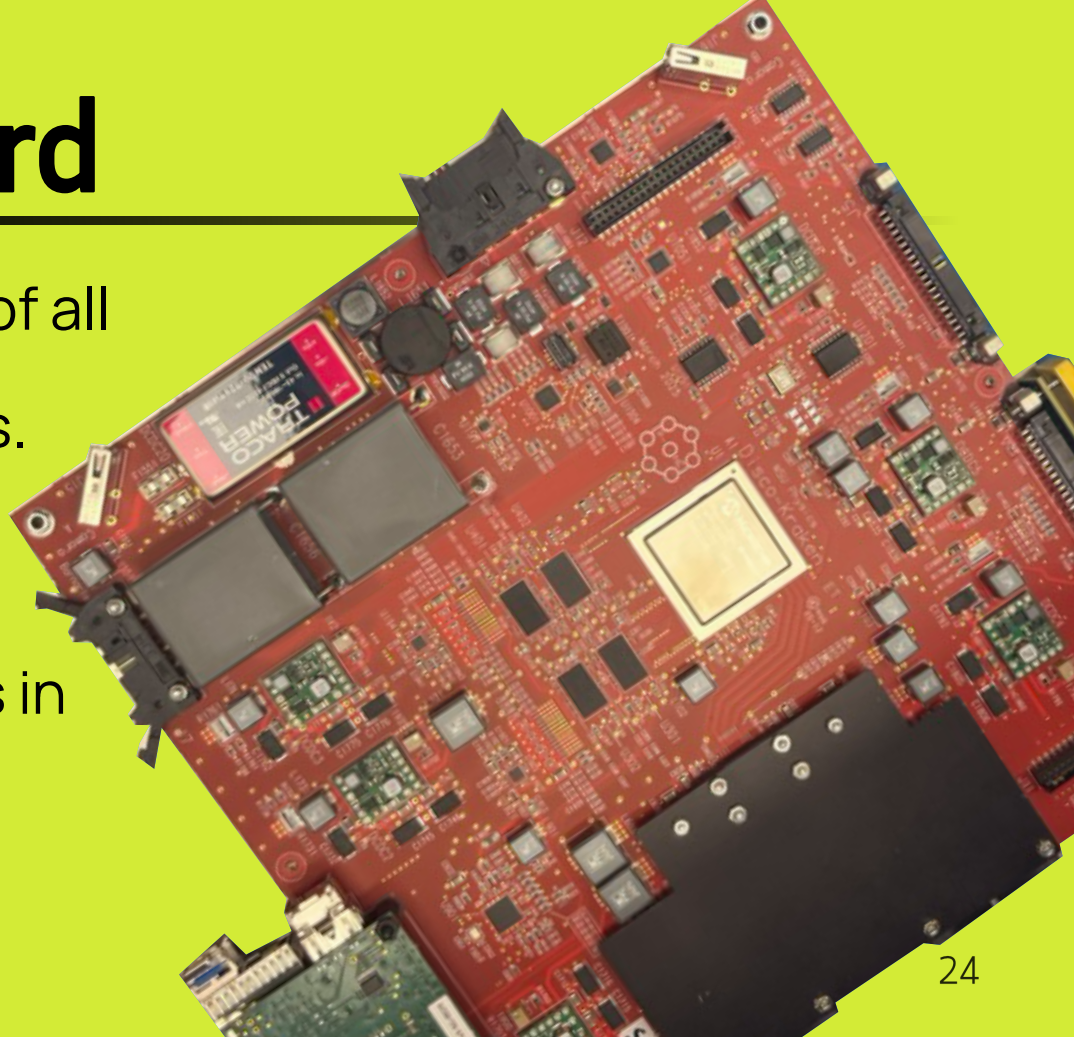
Purpose: Calibration of pointing resolution of P-ONE that is independent of light observed by PMTs.

Mechanics: 4 stacked scintillator plates, with SiPMs that detect light produced by crossing muons.

The mainboard

Purpose: Management of all signals, data, and power, including timing systems.

Mechanics: Large PCB that the interposers and MIST plug into. Two separate timing systems in parallel.



The P-OMs

P-OM

Hemisphere

PMTs

Flashers

Axion flasher

Acoustic receiver

Coatings & polishing

Muon in-situ tracker

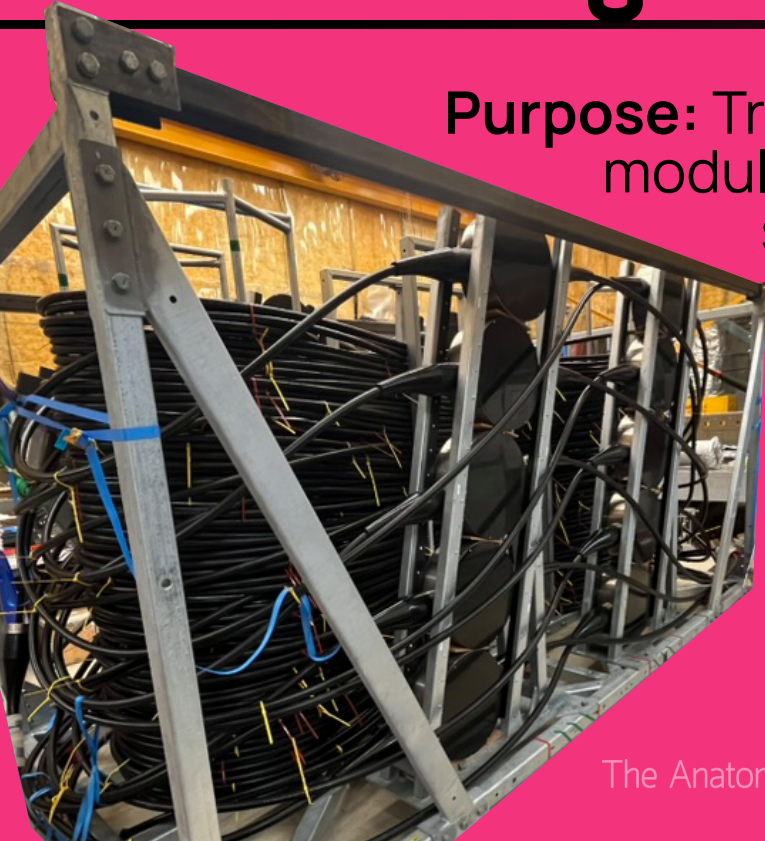
Mainboards

Timing systems

The Anatomy of an Optical Module



The string



Purpose: Transfers power to optical modules and builds the grid structure of the P-ONE detector.

Mechanics: Heavy duty cable that attaches all modules together, with titanium junction box at the base.



The string



The Anatomy of an Optical Module

The work so far



Future focus



- Finishing template pulse analysis.
- Using my knowledge of both software & hardware to contribute to the commissioning phase.
- Building simulations to analyse the physics case for P-ONE.

Any questions?

Thank you to Matteo and also the team at SFU for their support whilst I was in Vancouver.

Thank you for listening!

