STRAW-b bootcamp

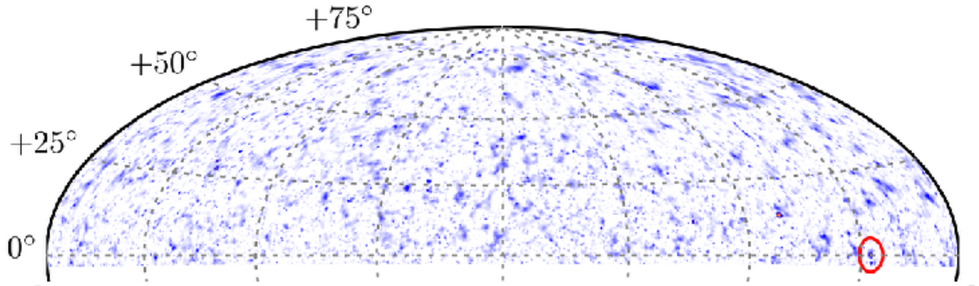
14.12.2021 - Kilian Holzapfel

Overview

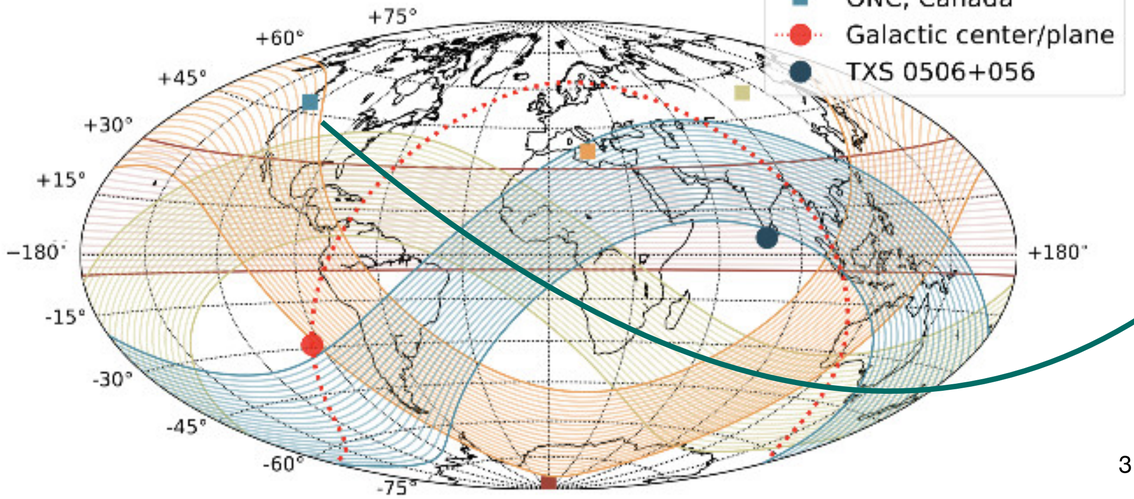
STRAW, STRAW-b, P-ONE

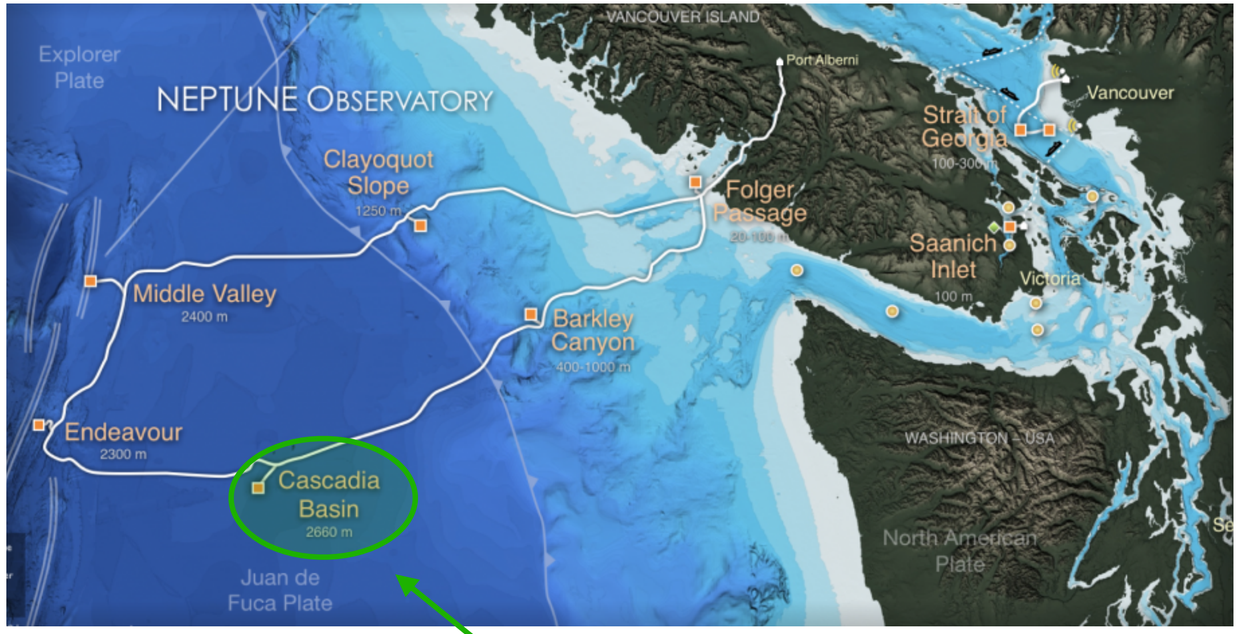
km³-scale Detectors for Astrophysical Neutrinos

Point-source search with astrophysical neutrinos



The directions with highest sensitivity for **astrophysical neutrinos** per detector





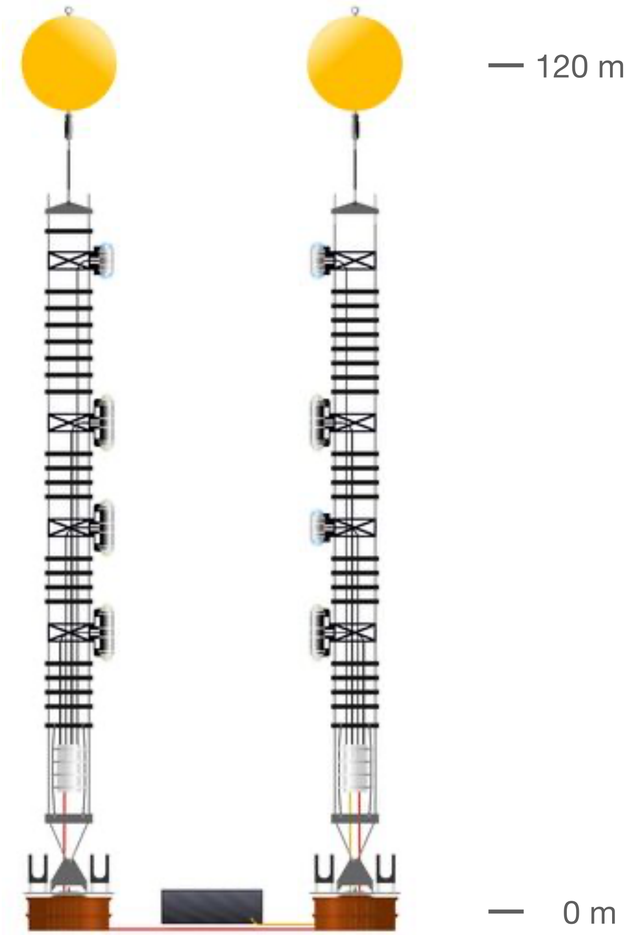
P-ONE

- 2660m deep
- Use of the existing deep sea infrastructure of ONC

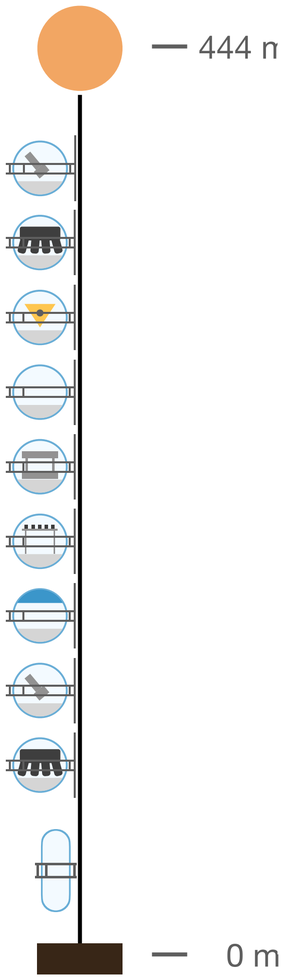
Our Path to a km³-scale Neutrino Detector

2018 — **STRAW**

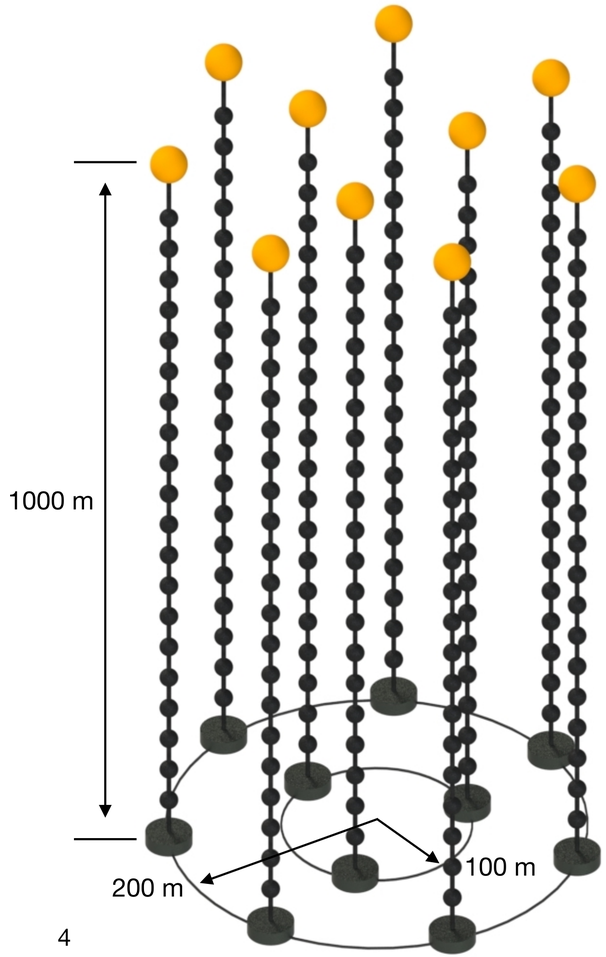
STRings for the **A**bsorption-length in **W**ater



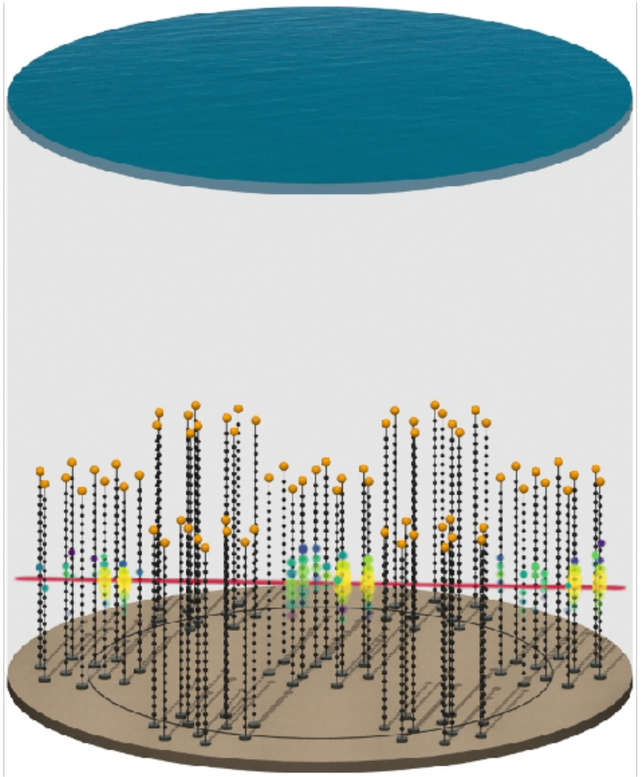
2020 — **STRAW-b**



202X — **P-ONE 10 String**



202X — **P-ONE**

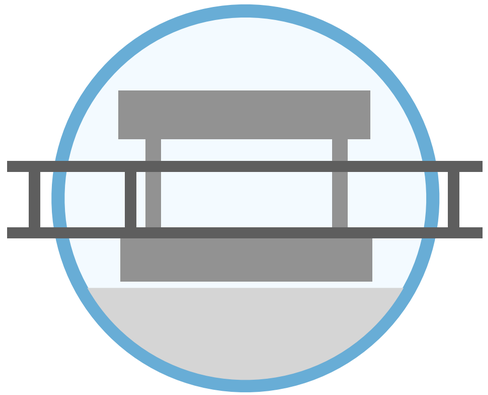


Motivation & Design

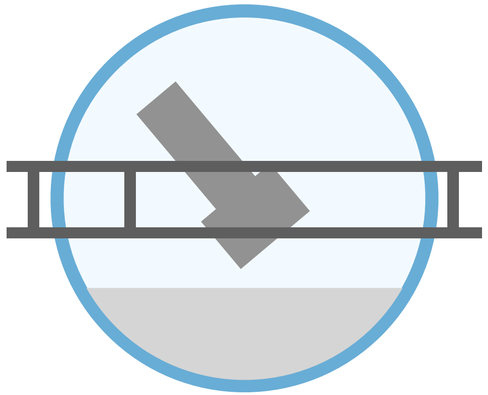
STRAWb

STRAW-b - Sensors

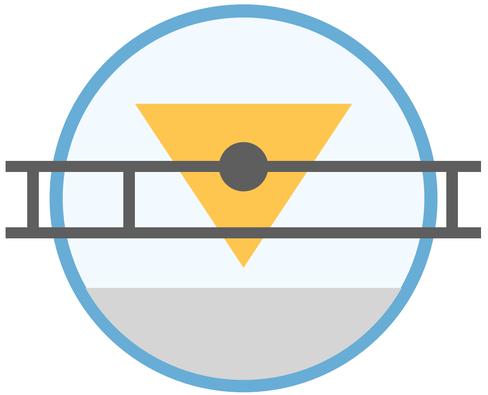
Muon-Tracker



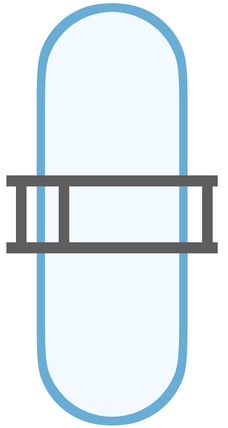
2x LiDAR



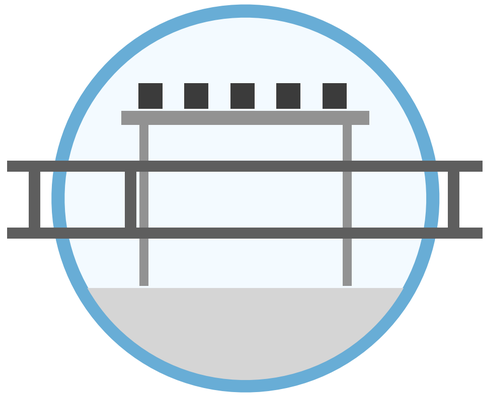
Standard + Art



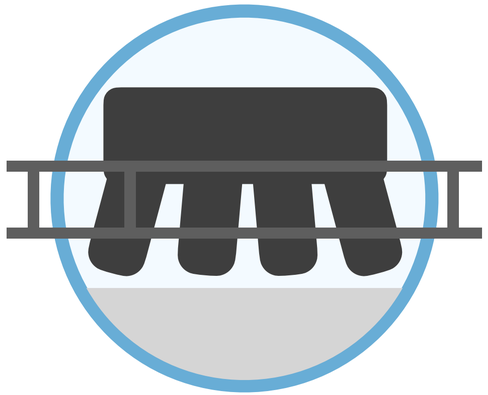
WOM



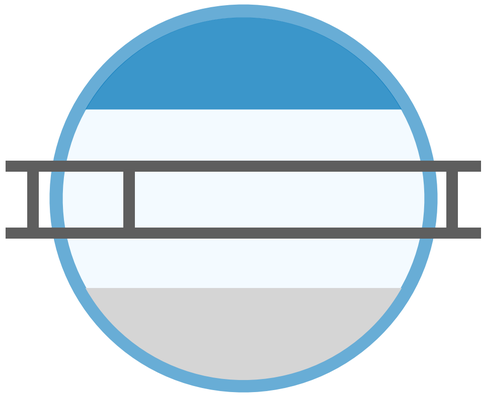
Mini-Spectrometer



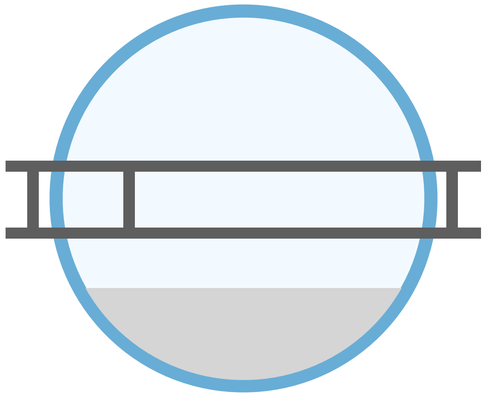
2x PMT-Spectrometer

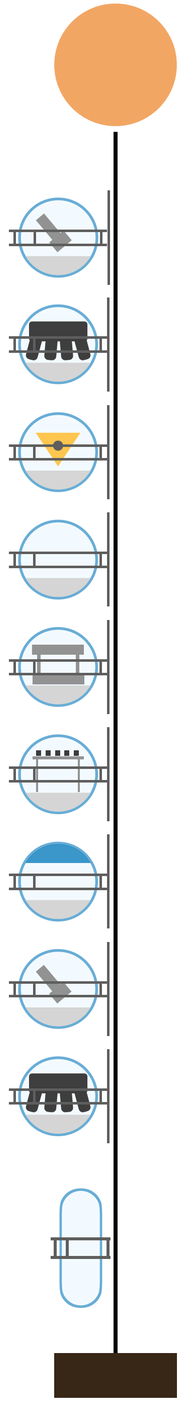


Standard + Art



Standard + Art

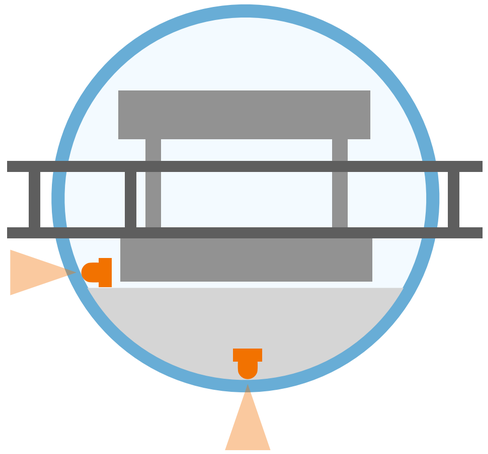




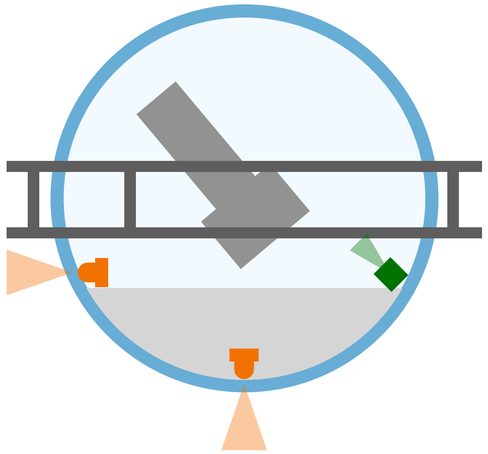
STRAW-b - Sensors

Minispectrometer Camera LED (Lucifer)

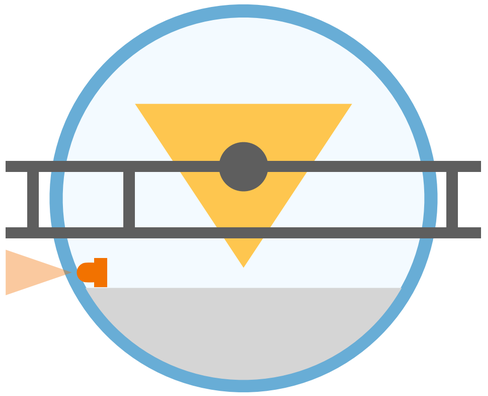
Muon-Tracker



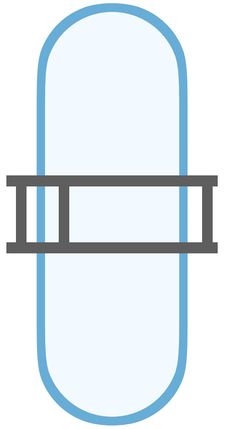
2x LiDAR



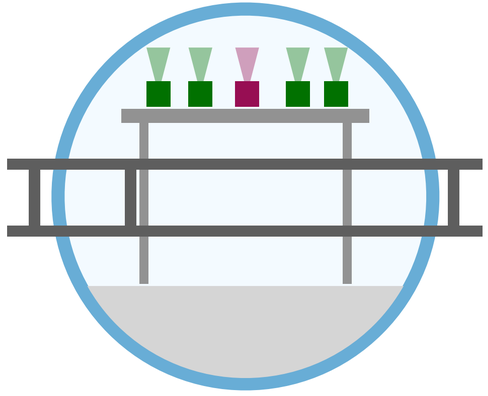
Standard + Art



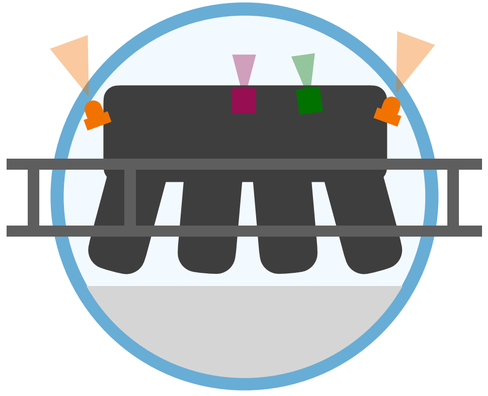
WOM



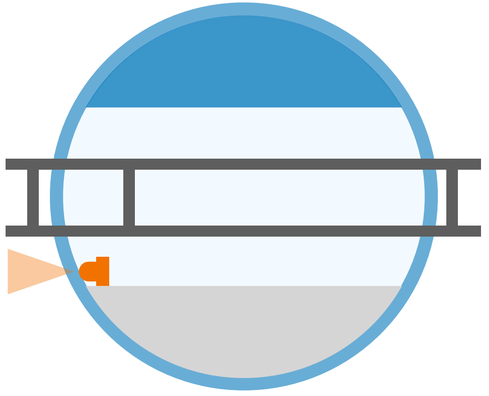
Mini-Spectrometer



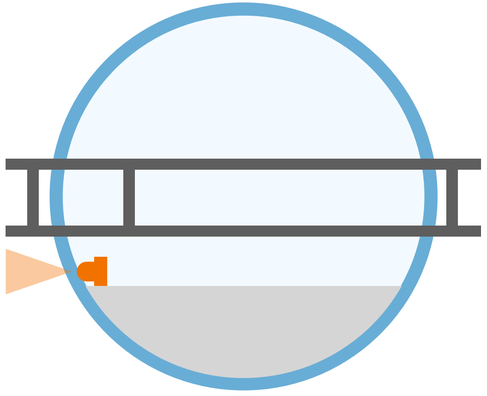
2x PMT-Spectrometer

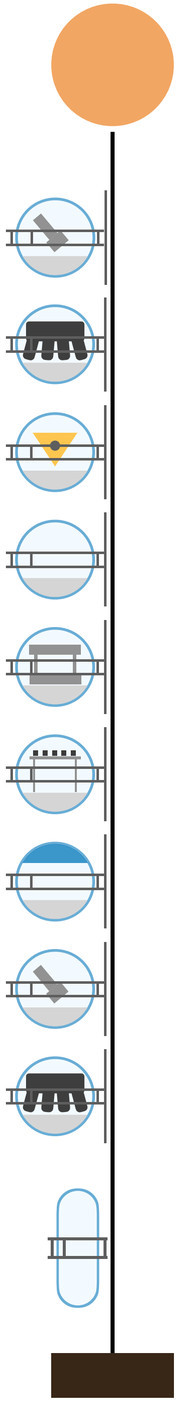


Standard + Art



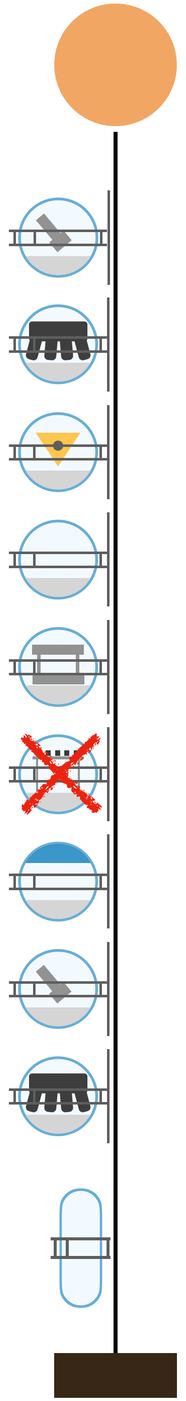
Standard + Art





Motivation for STRAWb

Module	Goal
Muon-Tracker	Measure Muons - reconstruct the direction & energy
PMT-Spectrometer	Bioluminescence/animal classification + spectra + image
PMT-Spectrometer + LiDAR	Wavelength dependent attenuation length of water
PMT-Spectrometer	Measure background characteristics for PONE (in addition to STRAW)
LiDAR	Attenuation length and scattering length of water
Mini/PMT-Spectrometer	Monitor sedimentation of module with camera
Logger	Analyse stress on construction during deployment
…	…

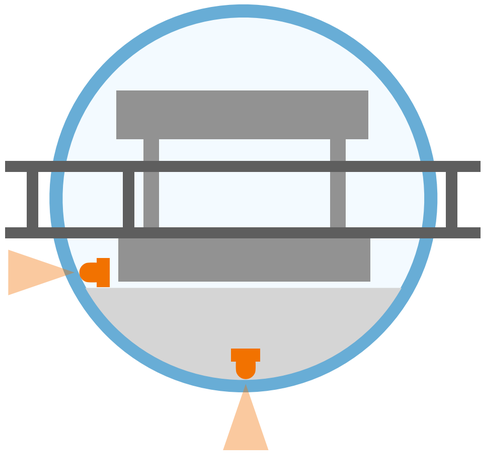


Status

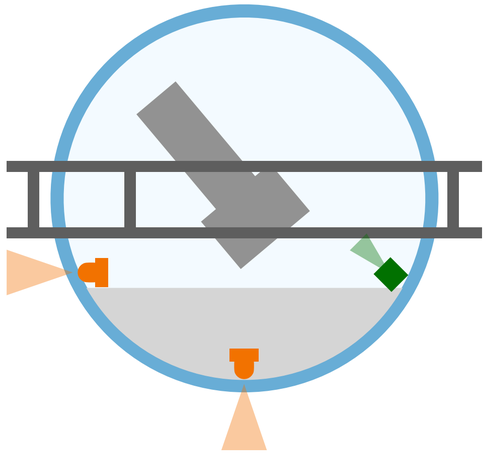
STRAWb

Status

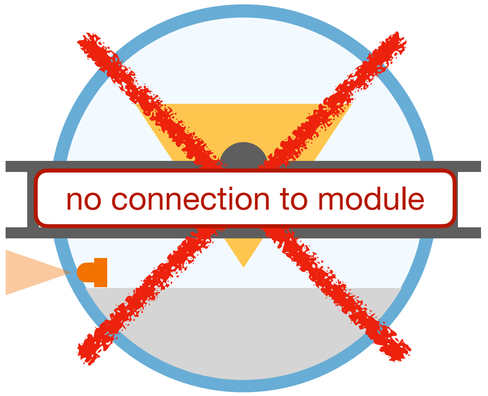
Muon-Tracker



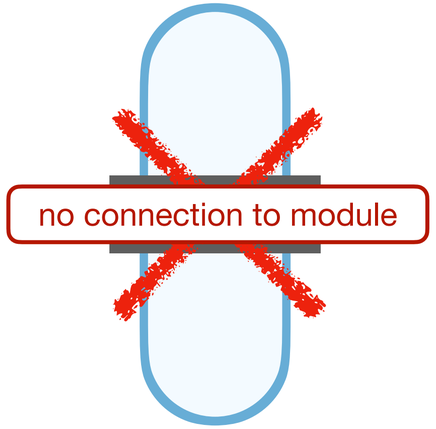
2x LiDAR



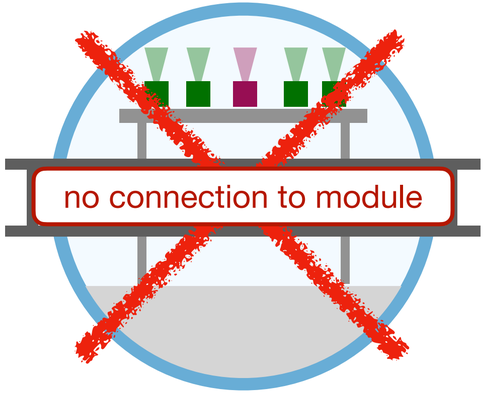
Standard + Art



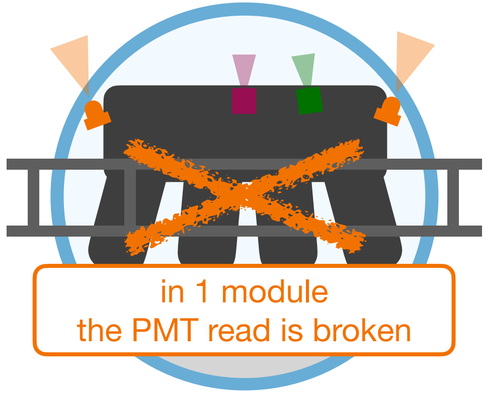
WOM



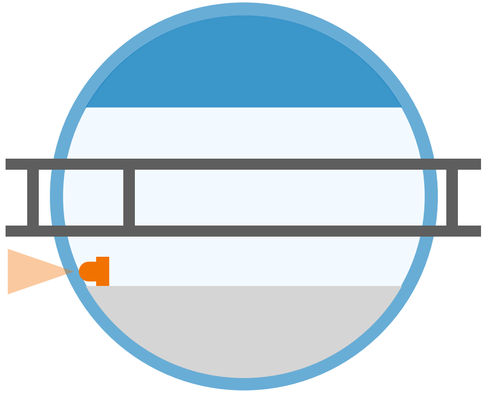
Mini-Spectrometer



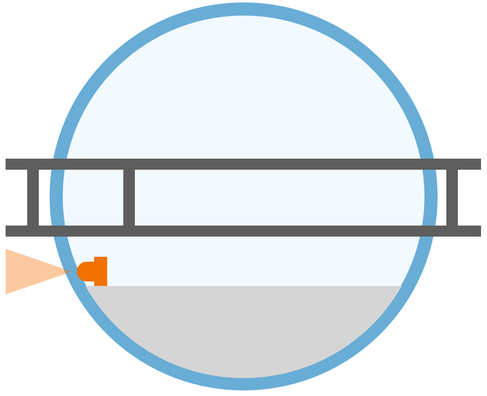
2x PMT-Spectrometer

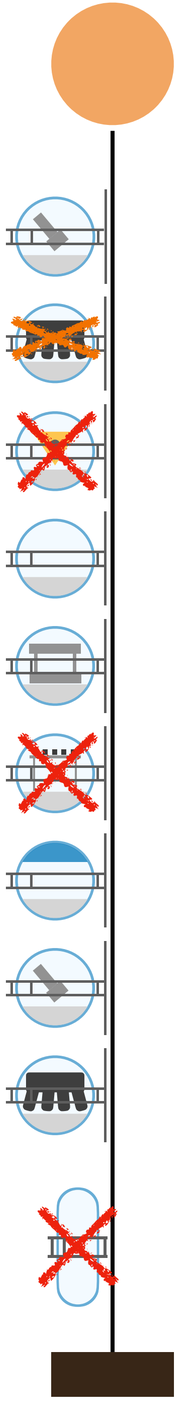


Standard + Art



Standard + Art



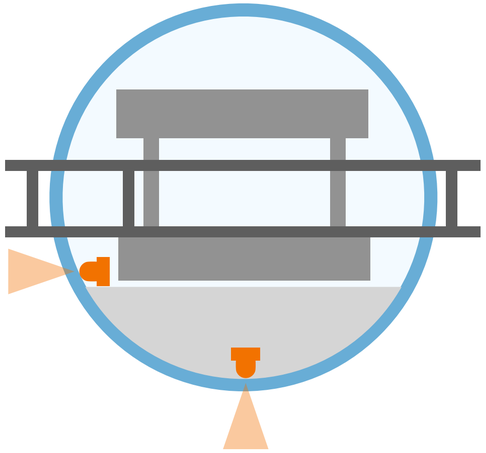


Status

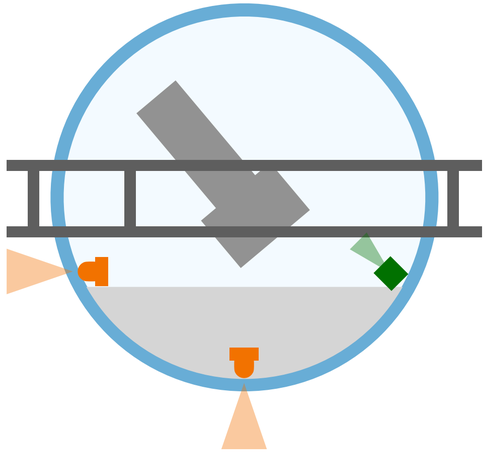
Minispectrometer Camera LED (Lucifer)

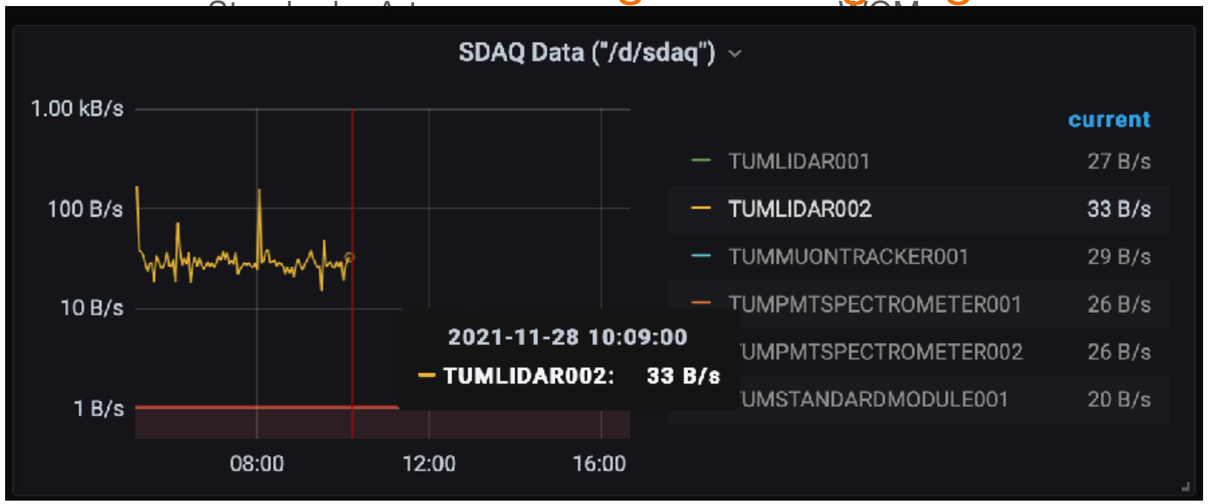
No connection since 28.11.2021
Investigation ongoing

Muon-Tracker

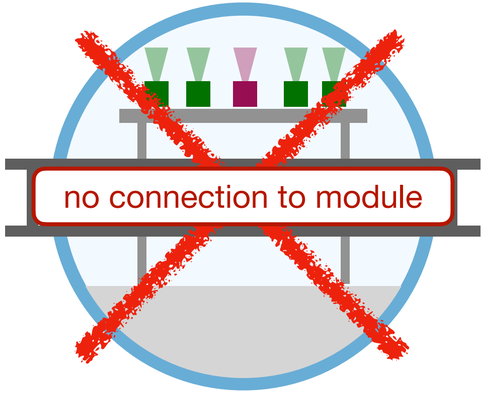


2x LiDAR

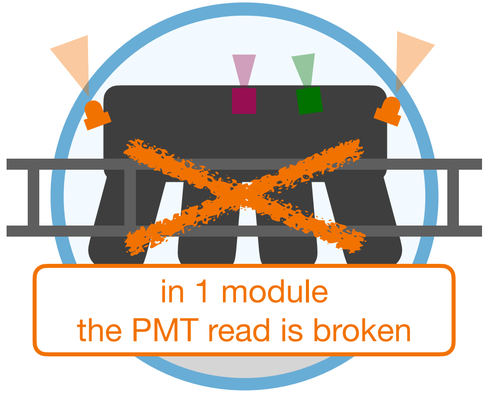




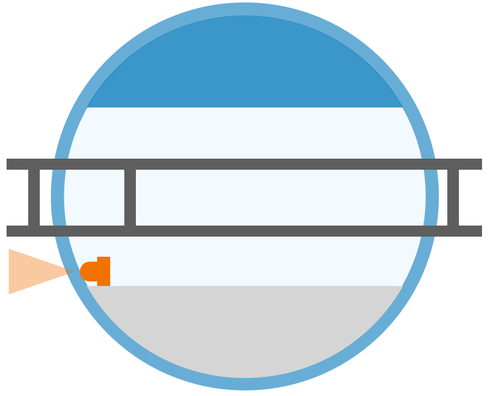
Mini-Spectrometer



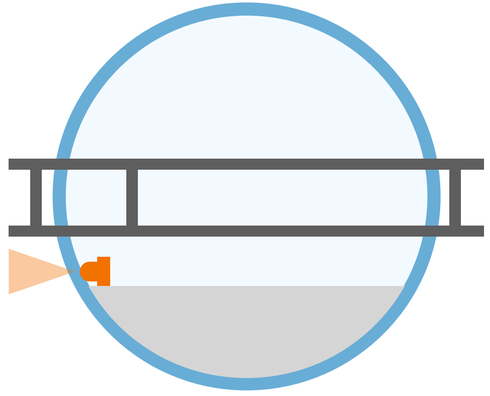
2x PMT-Spectrometer

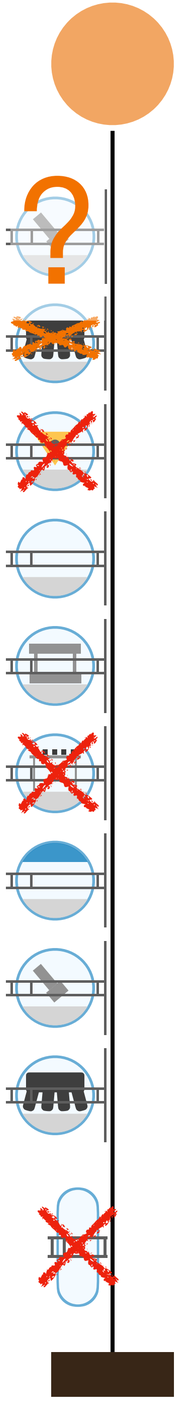


Standard + Art



Standard + Art

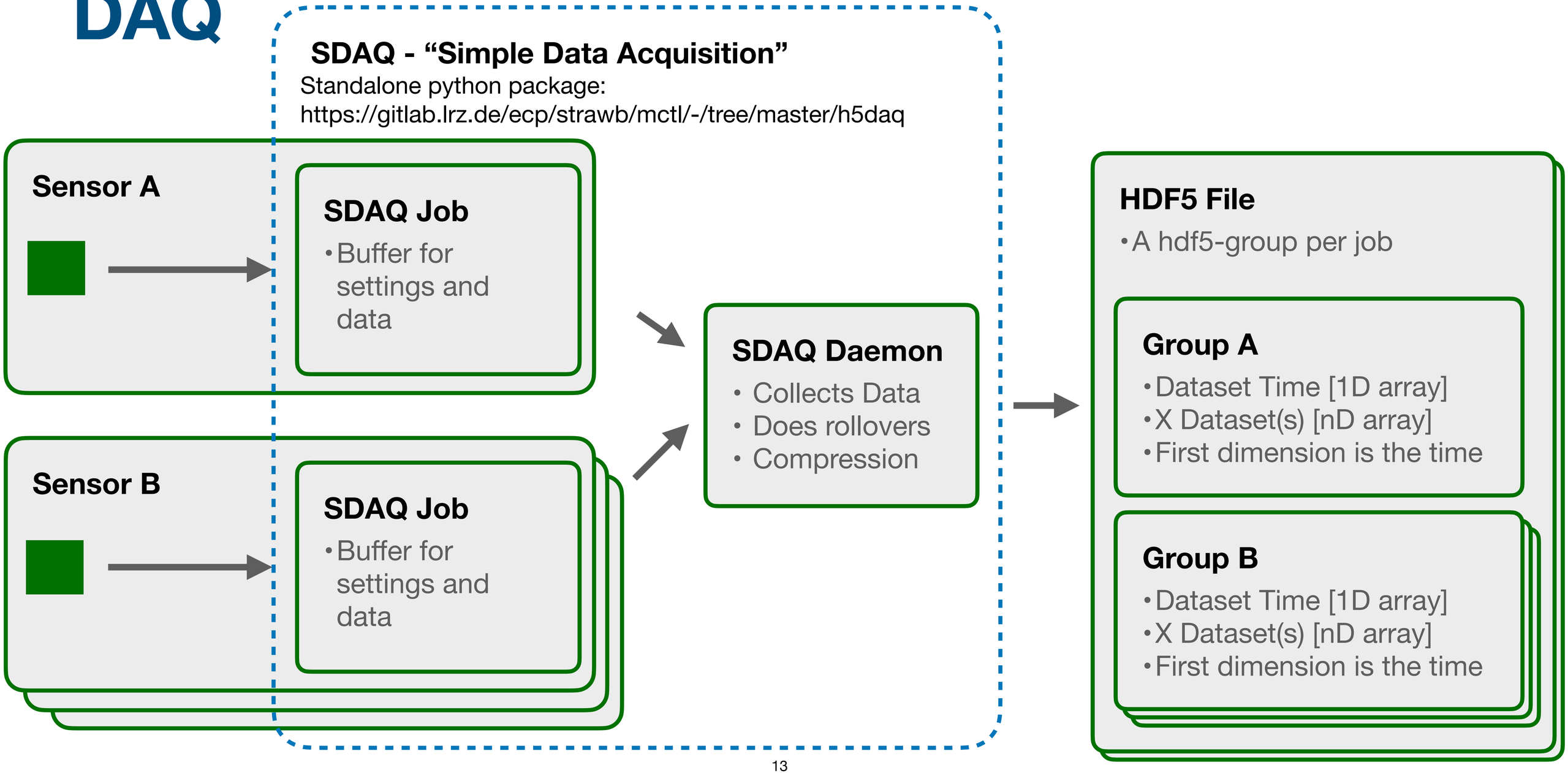




DAQ

STRAWb

DAQ


SDAQ - “Simple Data Acquisition”
Standalone python package:
https://gitlab.lrz.de/ecp/strawb/mctl/-/tree/master/h5daq
Sensor A
SDAQ Job
• Buffer for settings and data
Sensor B
SDAQ Job
• Buffer for settings and data
SDAQ Daemon
• Collects Data
• Does rollovers
• Compression
HDF5 File
• A hdf5-group per job
Group A
• Dataset Time [1D array]
• X Dataset(s) [nD array]
• First dimension is the time
Group B
• Dataset Time [1D array]
• X Dataset(s) [nD array]
• First dimension is the time

File Types

Module

.hdf5

- Voltage+Current readings per sensors
- Accel. Sensor
- Magnetic Sensor
- Temperature Sensors
- LED settings

Data-Logger

.hdf5

- Accel. Sensor
- Magnetic Sensor
- Temperature Sensors

- Connection works
- Accessing data fails

Camera

.hdf5

- Raw RGB-Intensity data
- Exposure time
- Gain settings
- Power settings

Standard Module

Specialised Module

Mini-Spectrometer

.hdf5

- Raw Wavelength/Intensity data
- Exposure time
- Senor temperature
- Power settings

LiDAR

.hdf5

- Gimbal parameters
- PMT settings
- Laser settings
- Power settings

.hld / .txt

- Raw TOT data (Time over Threshold)

PMT-Spectrometer

.hdf5

- PMT rates with 1 kHz readout
- HV settings
- Threshold settings
- Power settings
- Raw TOT data

.hld ~~/ .txt~~

- Raw TOT data (Time over Threshold)

MuonTracker

.hdf5

- SiPM rates with 10 Hz readout
- HV settings
- Threshold settings
- Power settings
- Raw TOT data

.hld ~~/ .txt~~

- Raw TOT data (Time over Threshold)

Digital infrastructure

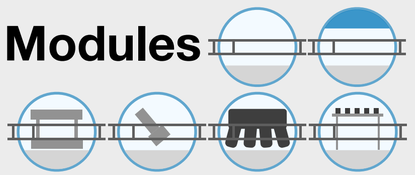
STRAWb

Digital Infrastructure for STRAWb

Module Monitoring
- Logs system states - server monitoring
- In case sends alert

Oceans2.0 DB (ONC)
- Downloads data from modules
- Holds a DB with all data

Modules



Server Backend (LRZ)

DSS Container
- Data Science Storage
- Backups

Computational Infrastructure
- LRZ VM hosting - Compute Cloud

Module Monitoring

Grafana
https://ycmb.spdns.org:3000
User: STRAWb
PW: 4734-4816-7213-2543

Integrate alert system → **Mail, Slack, SMS,....**

InfluxDB

Script(s)

Modules

LRZ Setup

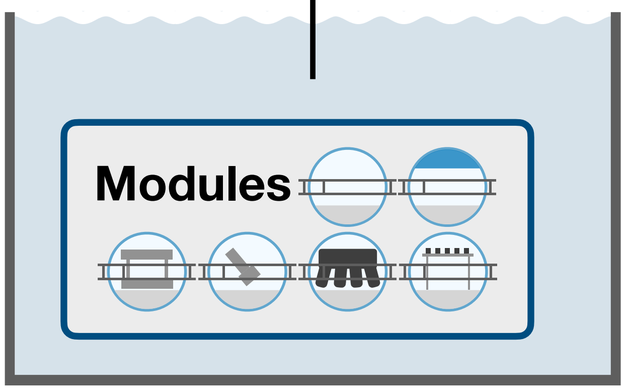
Oceans2.0 DB (ONC)
- Downloads data from modules
- Holds a DB with all data

Fork of the ONC Python API
- https://github.com/FlyingAndrew/api-python-client
- The VM runs the sync

Server Backend (LRZ)

DSS Container
- Data Science Storage
- Backups

Computational Infrastructure
- LRZ VM hosting - Compute Cloud
- Accessible via ssh

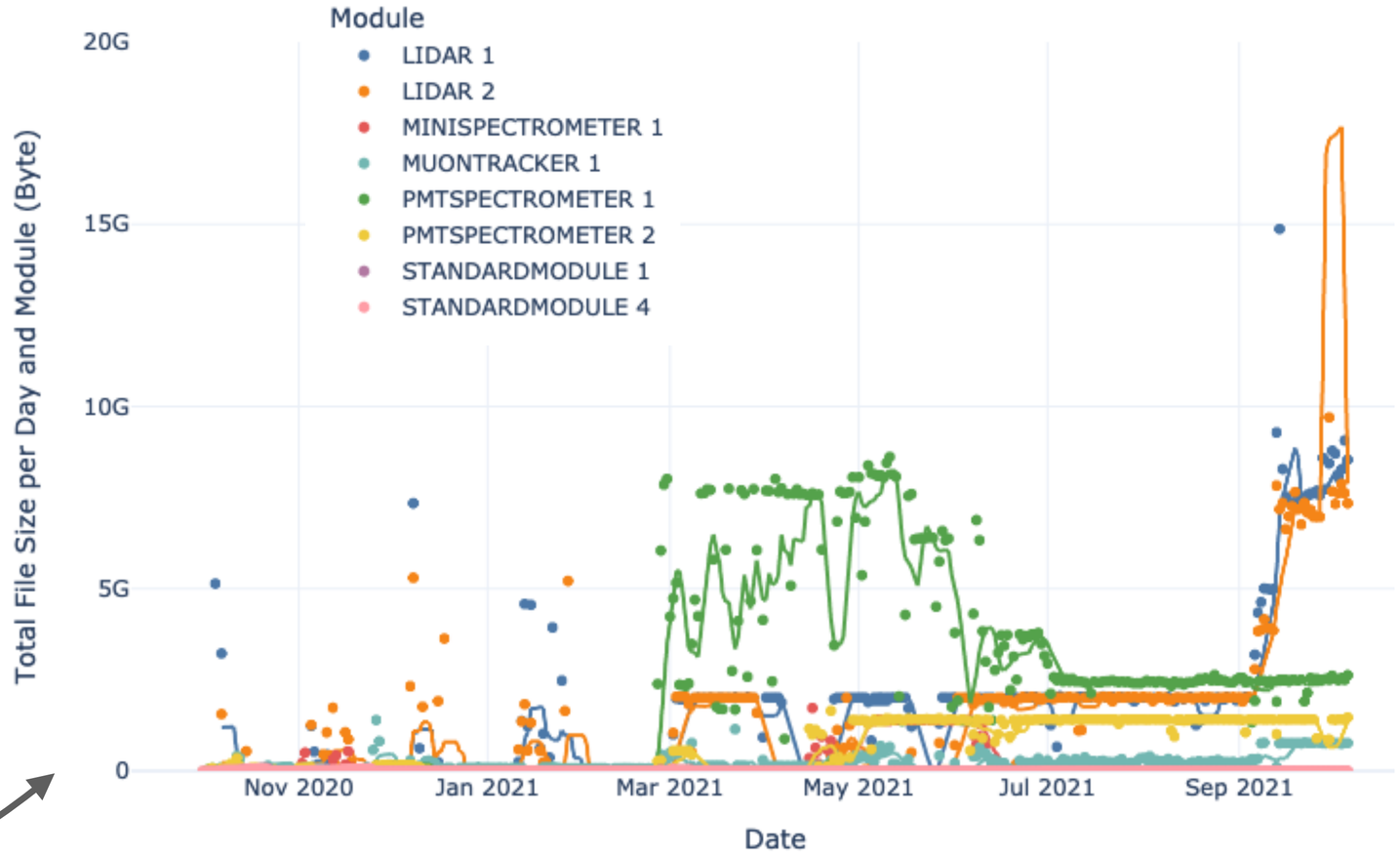


LRZ DSS Structure

DSS Container
- Mounted at the VM under: /dss/
- STRAW and STRAWb data

STRAWb Data
- All raw module data are located at: /dss/strawb/raw_module_data/
- Files are sorted with: <device_code>/<year-month>/ I.e.: tumlidar001/2021_10/…
- Includes a DB file: ../raw_module_data/pandas_file_sync_db.gz

A simple and reliable way to get the files.
No need to deal with path and filenames.



Example Notebook to generate the plot:
https://github.com/pone-software/strawb_package/blob/master/examples/pandas_file_sync_db_explorer.ipynb

Working with the Data

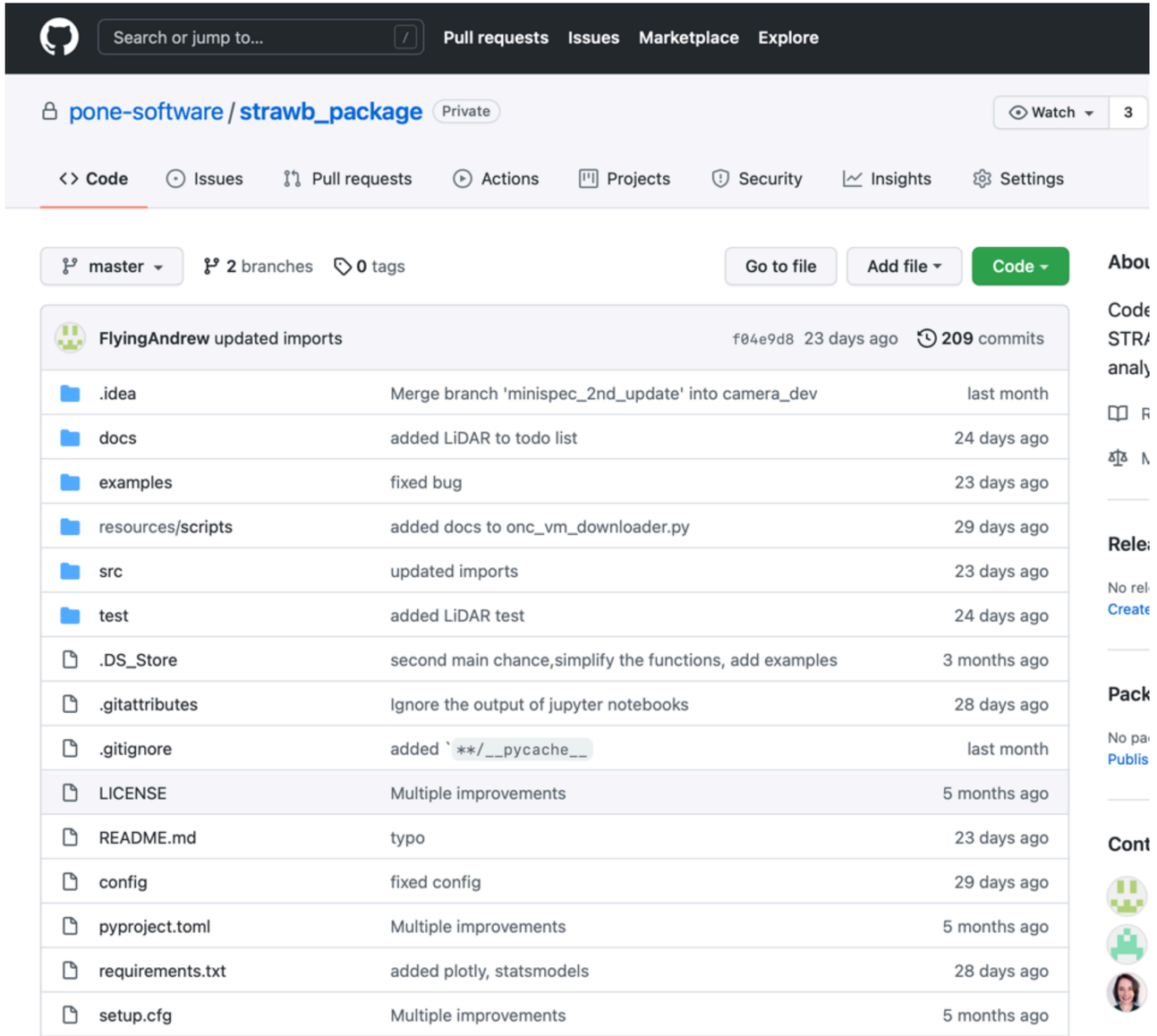
Python STRAWb package

Goal's

- Simplifies to access the data from the ONC server
- Simplifies reading of all STRAWb file types
- Collection of tools to process the data, including calibration
- Includes various examples for an easy start
- Features a DB for simple file access

Code

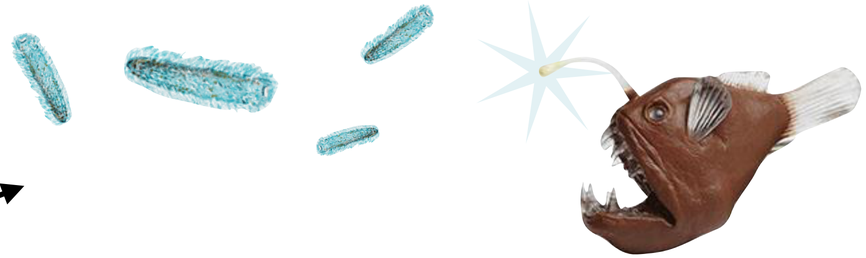
https://github.com/pone-software/strawb_package

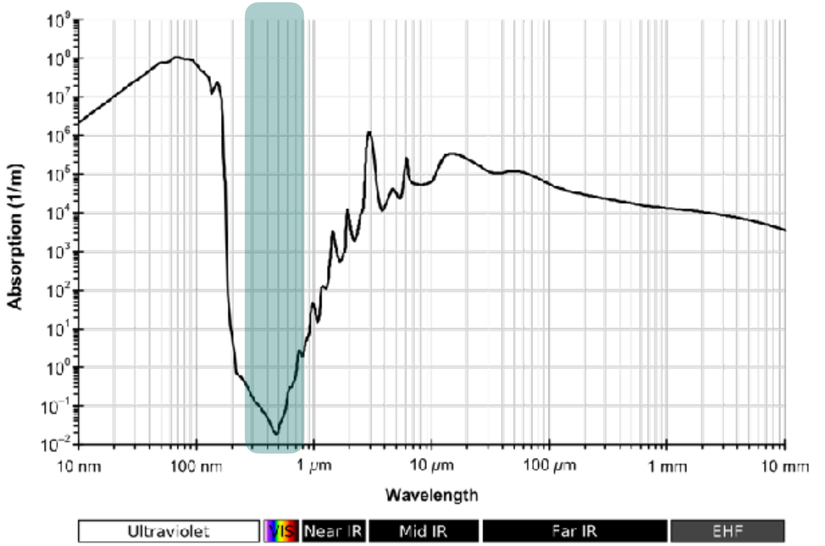


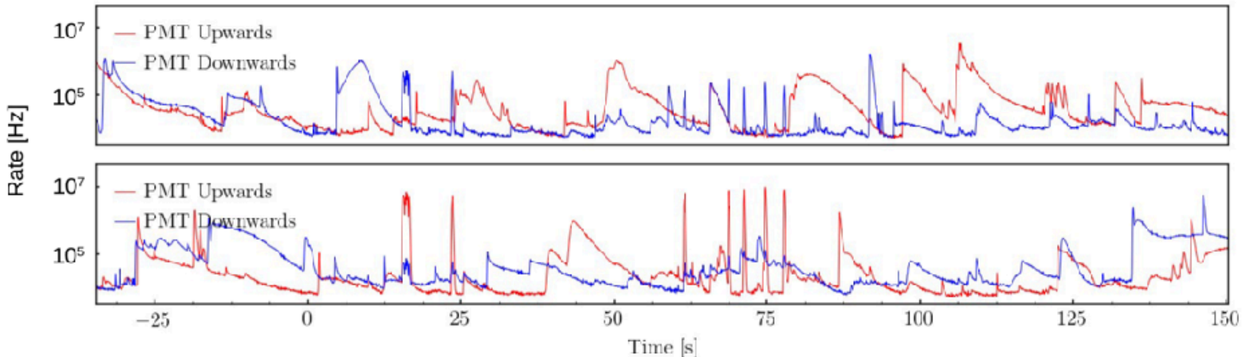
PMT-Spectrometer

Motivation - Goals

Module	Goal
Muon-Tracker	Measure Muons - reconstruct the direction & energy
PMT-Spectrometer	Bioluminescence/animal classification + spectra + image
PMT-Spectrometer + LiDAR	Wavelength dependent attenuation length of water
PMT-Spectrometer	Measure background characteristics for PONE (in addition to STRAW)
LiDAR	Attenuation length and scattering length of water
Mini/PMT-Spectrometer	Monitor sedimentation of module with camera
Logger	Analyse stress on construction during deployment



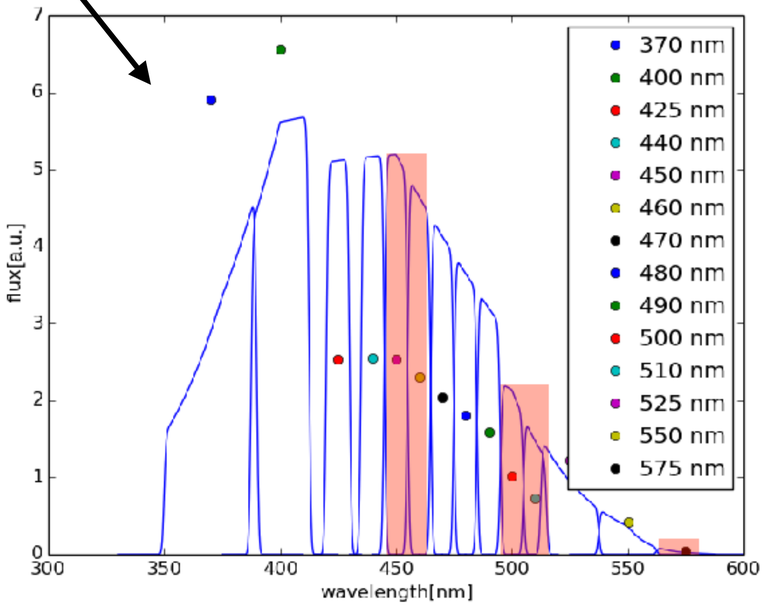


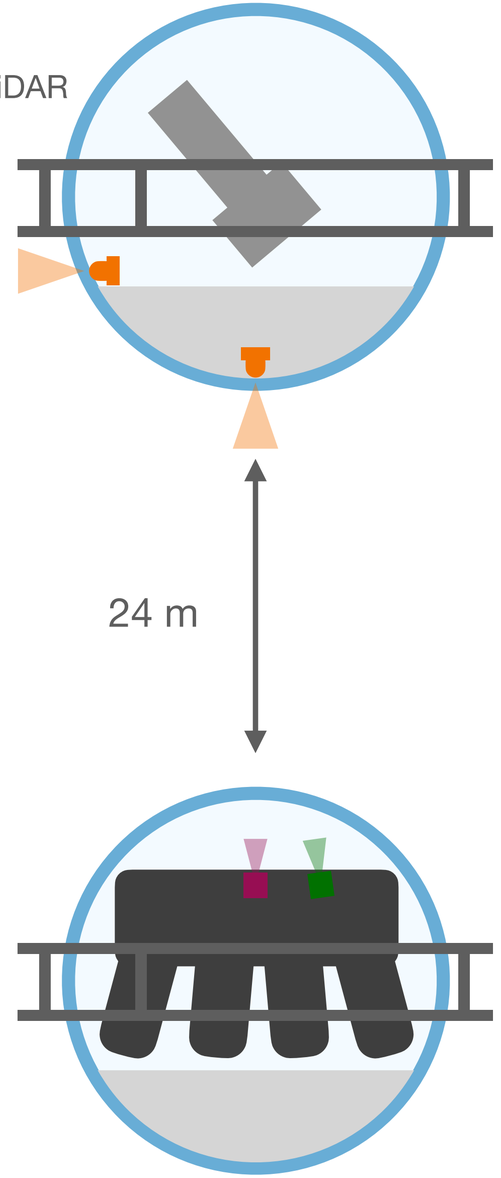


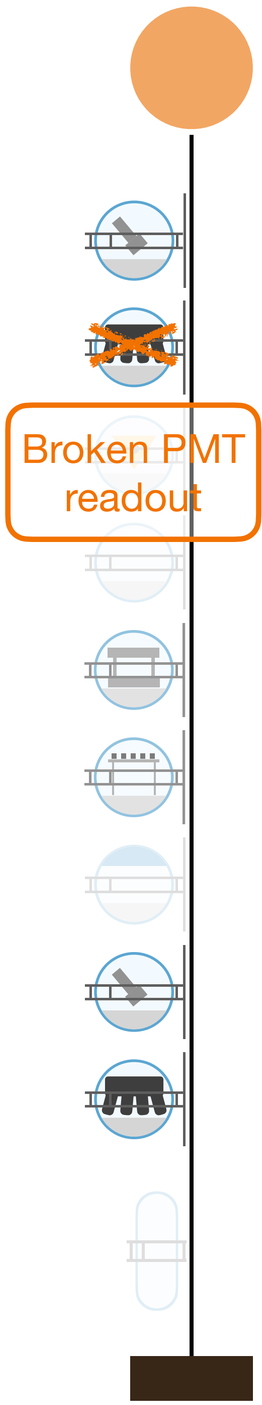
Wavelength dependent attenuation

Measurement principle

- LED on the side and bottom of the LiDAR emit light
- Light propagates 24 m through water
- Measure the spectra with the PMTs, Mini-Spectrometer and Camera
- + calibration lab measurements, e.g.:







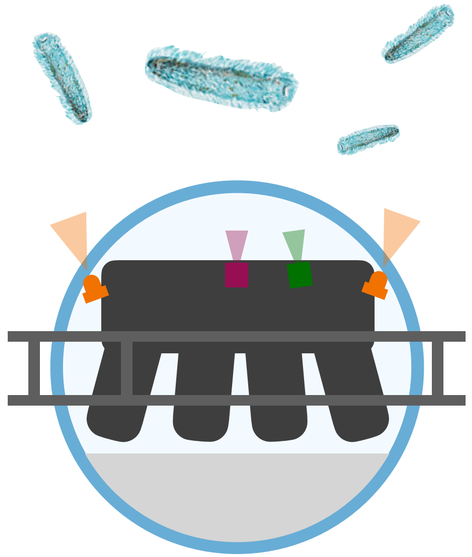
Not 100% clear if it works as only one distance is available
But it can be use as an in-situ calibration of the PMT spectra

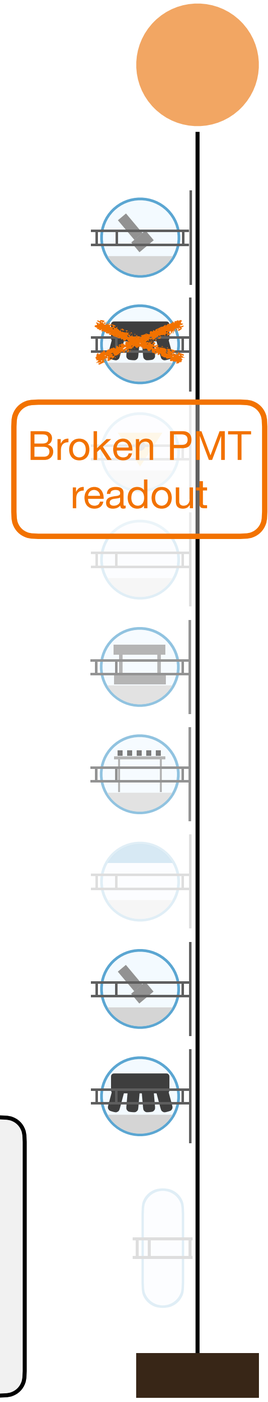
Minispectrometer Camera LED (Lucifer)

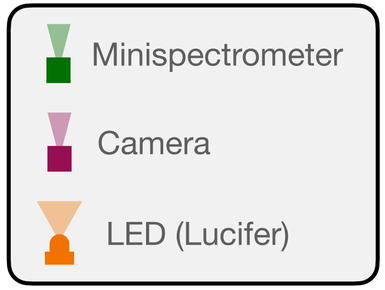
Bioluminescence spectra and image

Measurement principle
- Animals emit light
- Detect the position of the animal with the camera
- Measure the spectra with the PMTs (and Camera?)

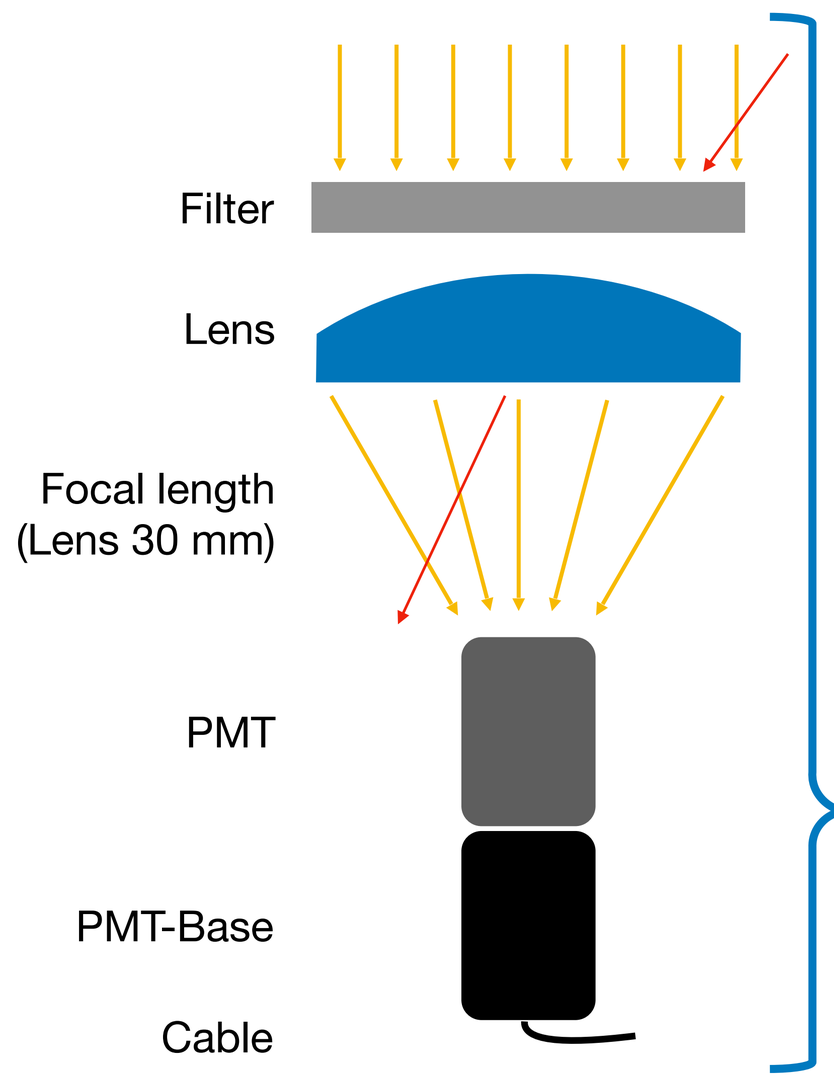
Classification of bioluminescence
- Based on the previous detected criteria
- Camera provide: position, track length, RGB-color and emission shape
- PMTs provide: emission timing and spectra







PMT-Spectrometer - Design



2 LEDs (not shown)

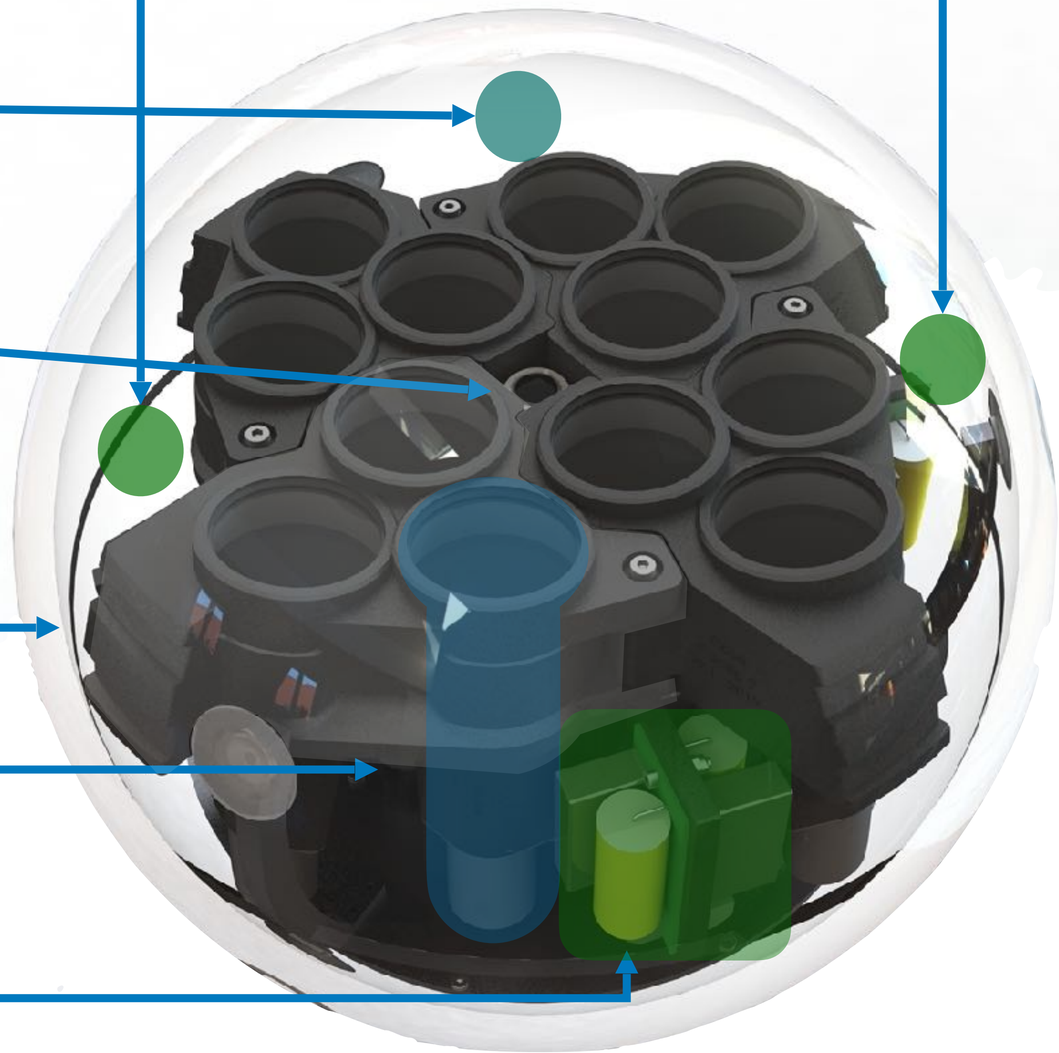
Mini-Spectrometer
(not shown)

Camera

4x PMT holding
structure

12x Lens + Filter + PMT

8x PMT HV-Supply



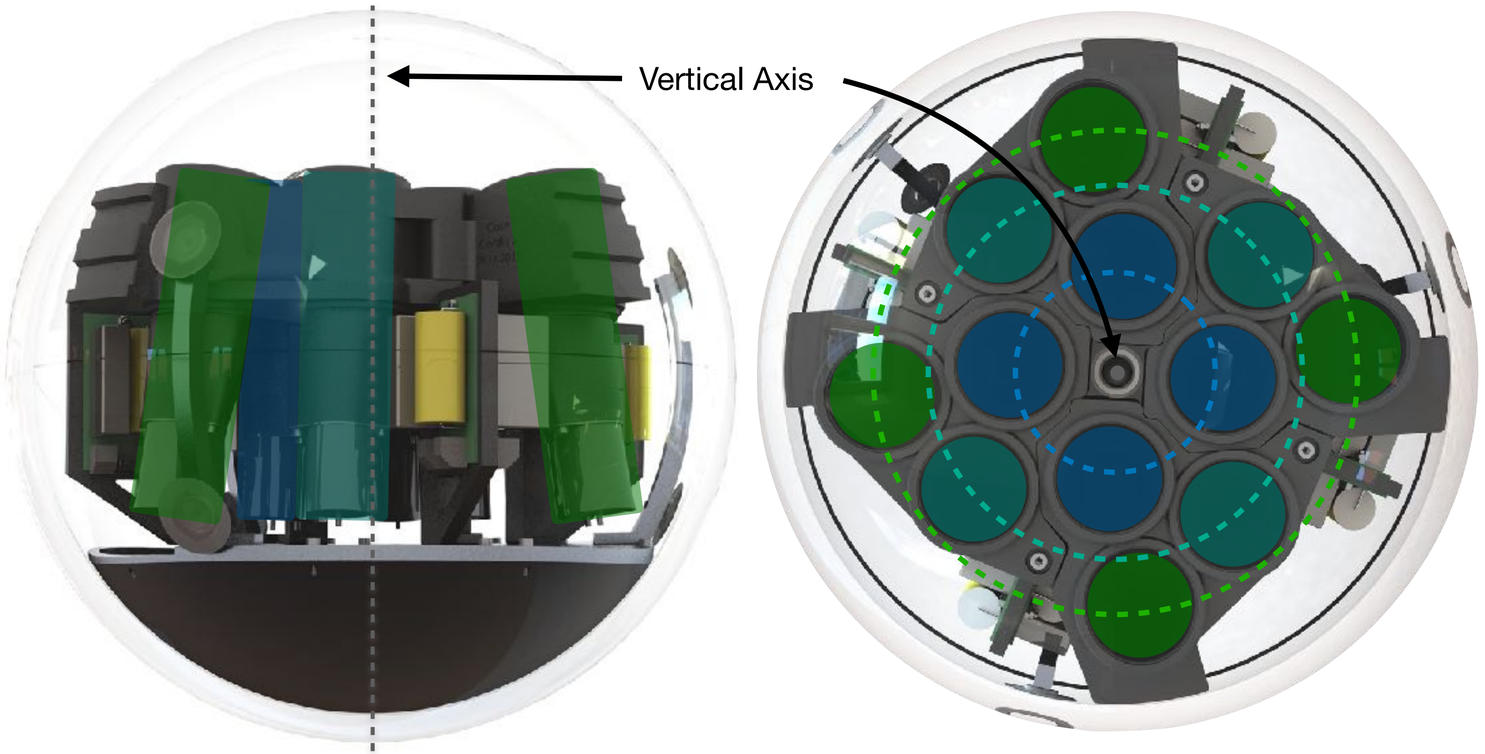
PMT-Spectrometer - Optics

Optics are optimised for

- all 12 PMTs have the same field of view
- have the same acceptance in the field of view
- correct the optical effect of the spherical glass

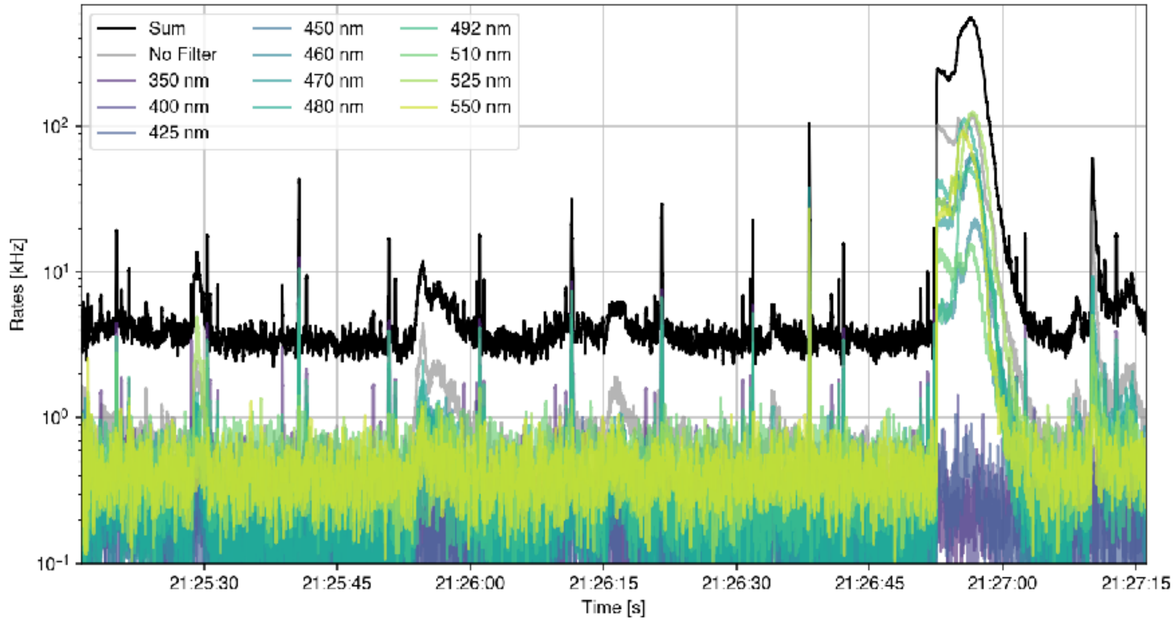
The 12 PMT Detection Unit

- A PMT Detection Unit is the PMT, lens and filter
- The PMT detection units are symmetrical placed around the vertical axis in 3 groups
- Within each group the Detection Units have the same radius and the same declination angle to the vertical axis



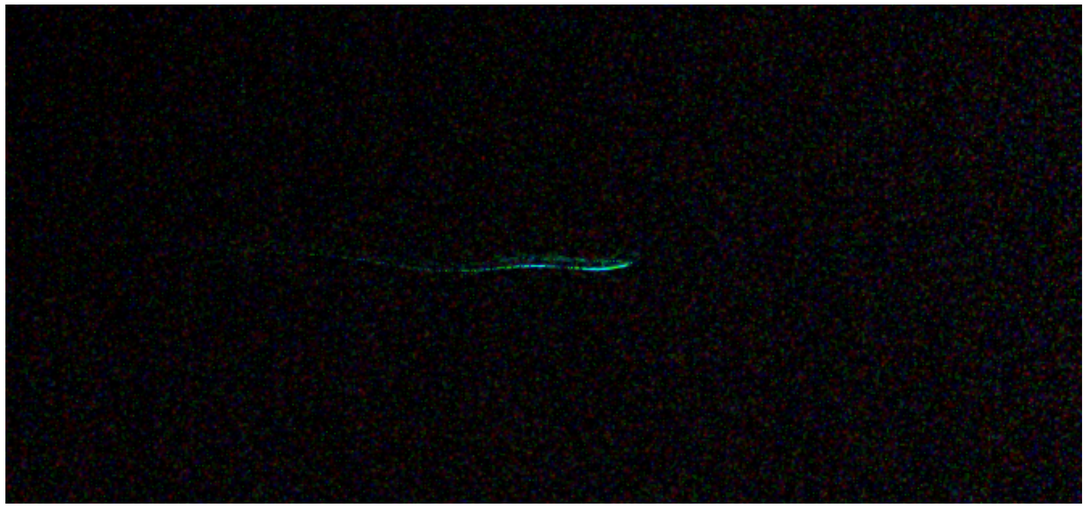
Sensors

PMTs
- 12 channels: 11 color + 1 integrated (no filter)
- **Measurement:** 1kHz * 12 channels, 24/7
- Geant4 simulation -> e.g. FOV ~10 deg
- Calibration data

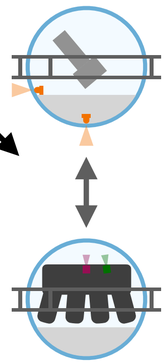


Camera
- ~1300x900 pixel in RGGB
- Covers more FOV as PMTs
- Shares upper sensitivity range of PMTs
- **Measurement:** every 93s 1 image (63s exposure time + 30s readout)
- Calibration data -> Korean group?

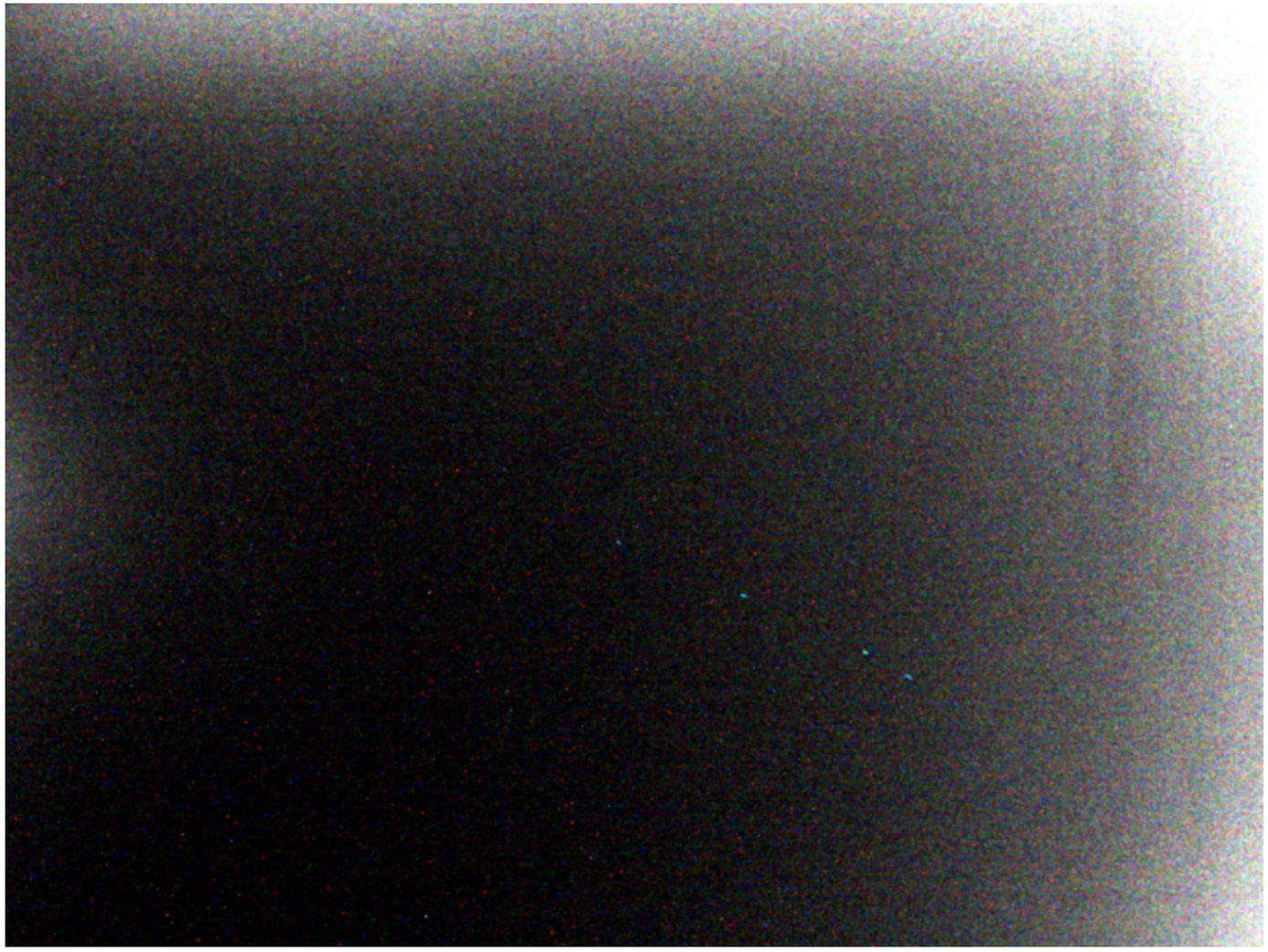
Minispec
- **Measurement:** every 93s 1 image (93s exposure time)
- 288 pixel eq. Different wavelength

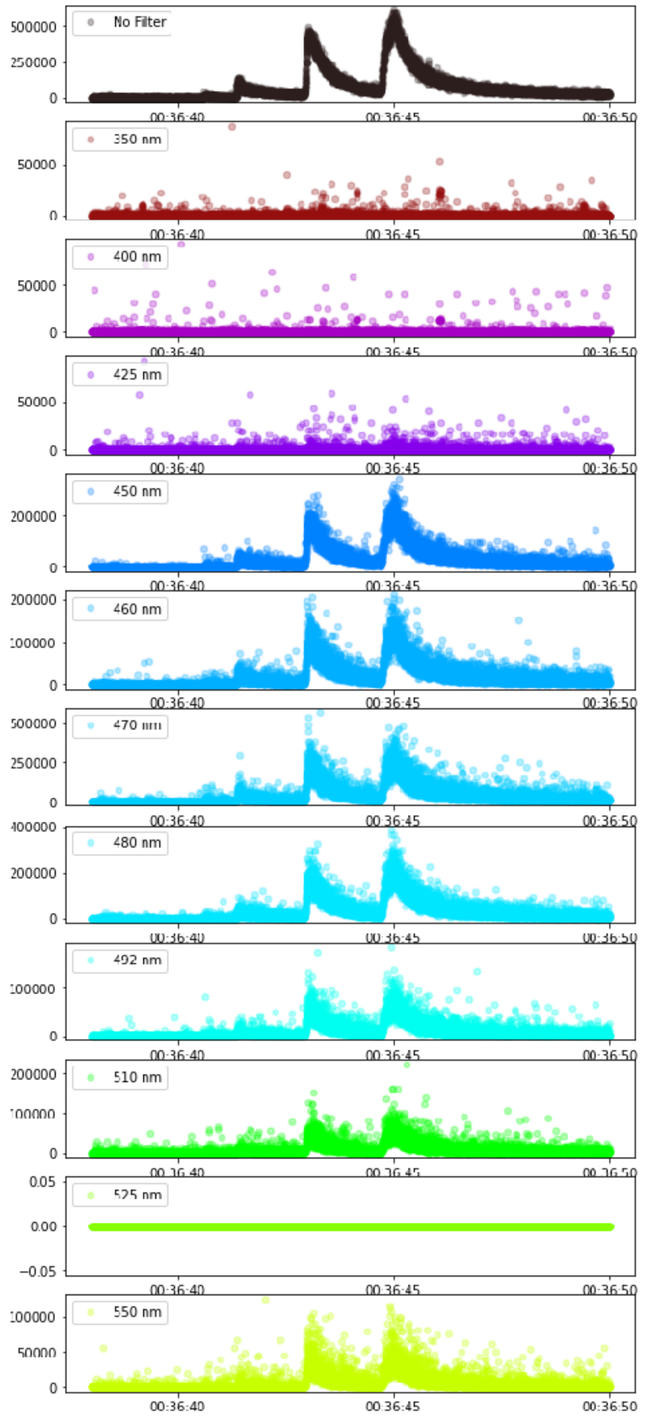


+ 2 LEDs (blue, green) in LiDAR above
- Calibration of PMTs and camera
- Missing: no calibration of LEDs exists: spectra, intensity, angle



Another event





Detected and plotted by Lisa Schumacher