JOHANNES GUTENBERG UNIVERSITÄT MAINZ

DISCO Experiment

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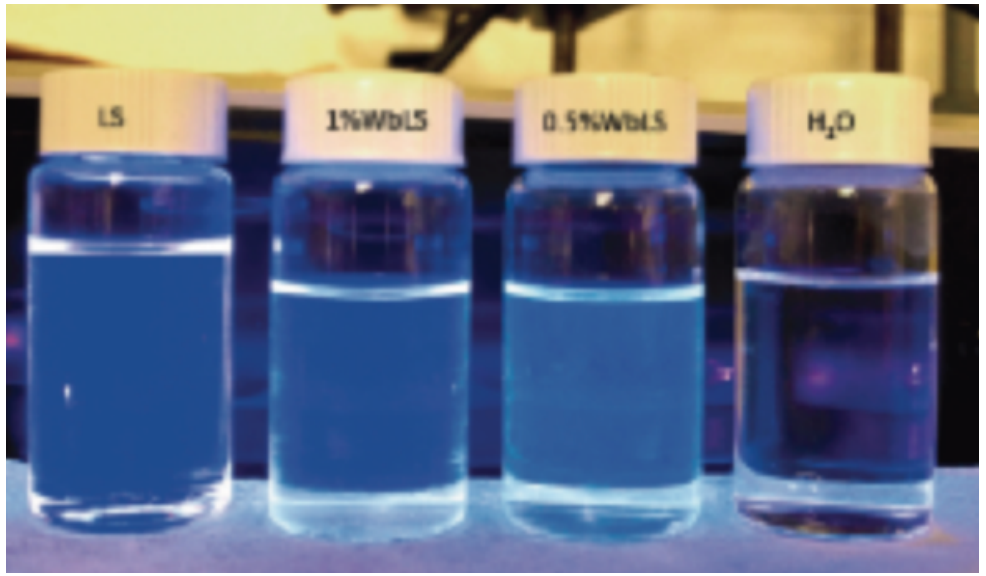
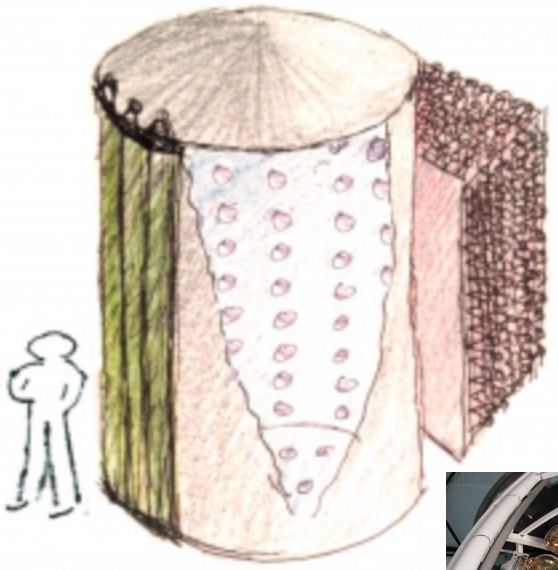
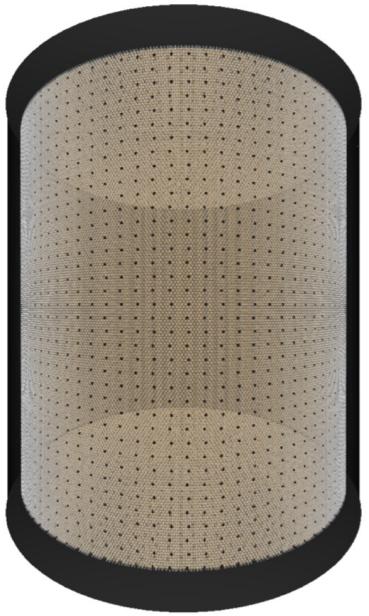
INTRODUCTION

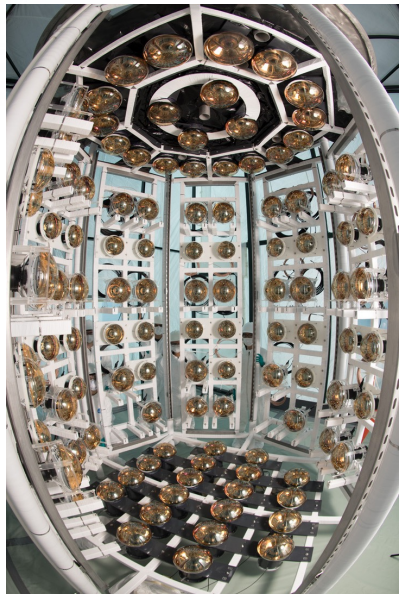
- Directionality In Scintillation Observer (DISCO) detector
  - Demonstrate the sepeartion of Cherenkov and Scintillation light
  - Charecterize Water Based Liquild Scintillators (WbLS)
- WbLS → water + scintillator
- Tunable light yield and timing profile
- Properties
  - Low energy threshold
  - High light yield
  - Directional information
  - Increased attenuation length



WATER BASED LIQUID SCINTILLATORS(WbLS)



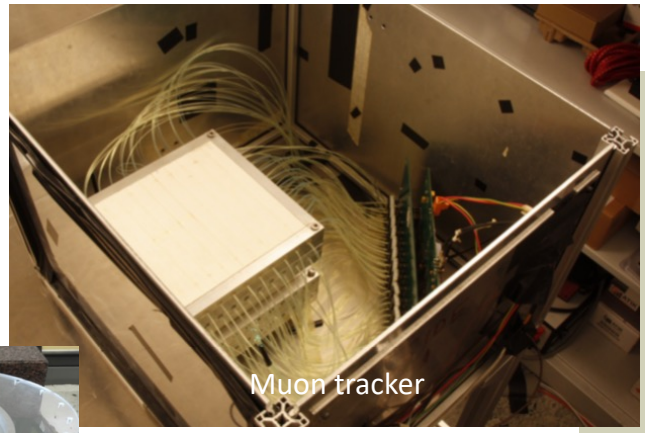


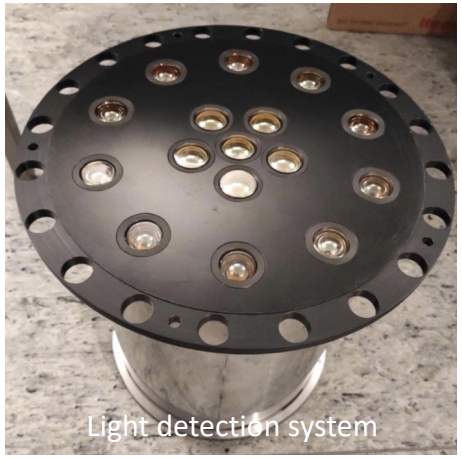


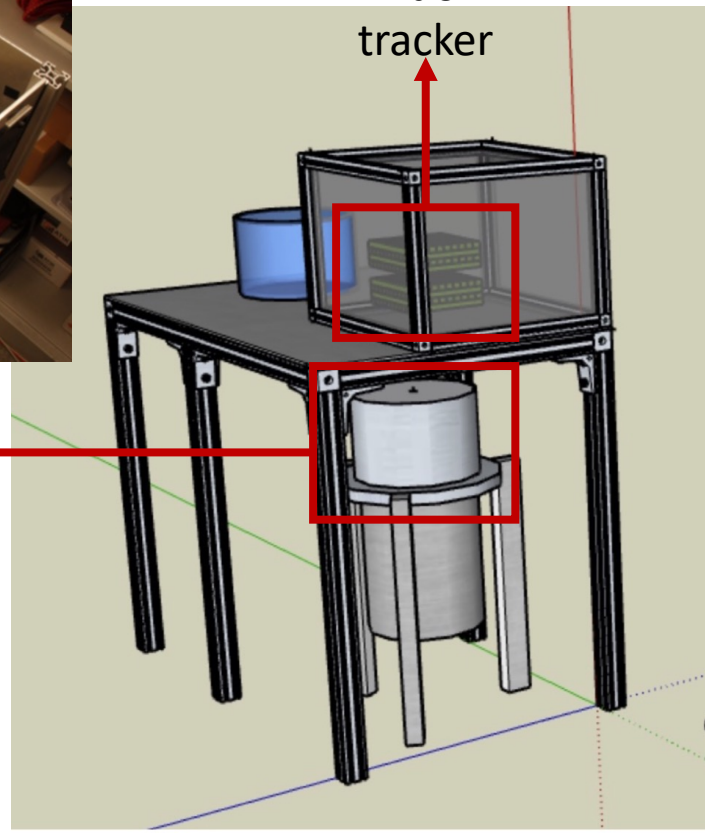
- Why use WbLS??
  - Enables detection of both Cerenkov and Scintillation light
  - Construct large detectors
  - Low energy threshold
  - Use in future experiments like THEIA, ANNIE, etc.

DISCO EXPERIMENT

- 3 main components:
  - Muon tracker
  - Test cell
  - Light detection system
- Test particles – muons

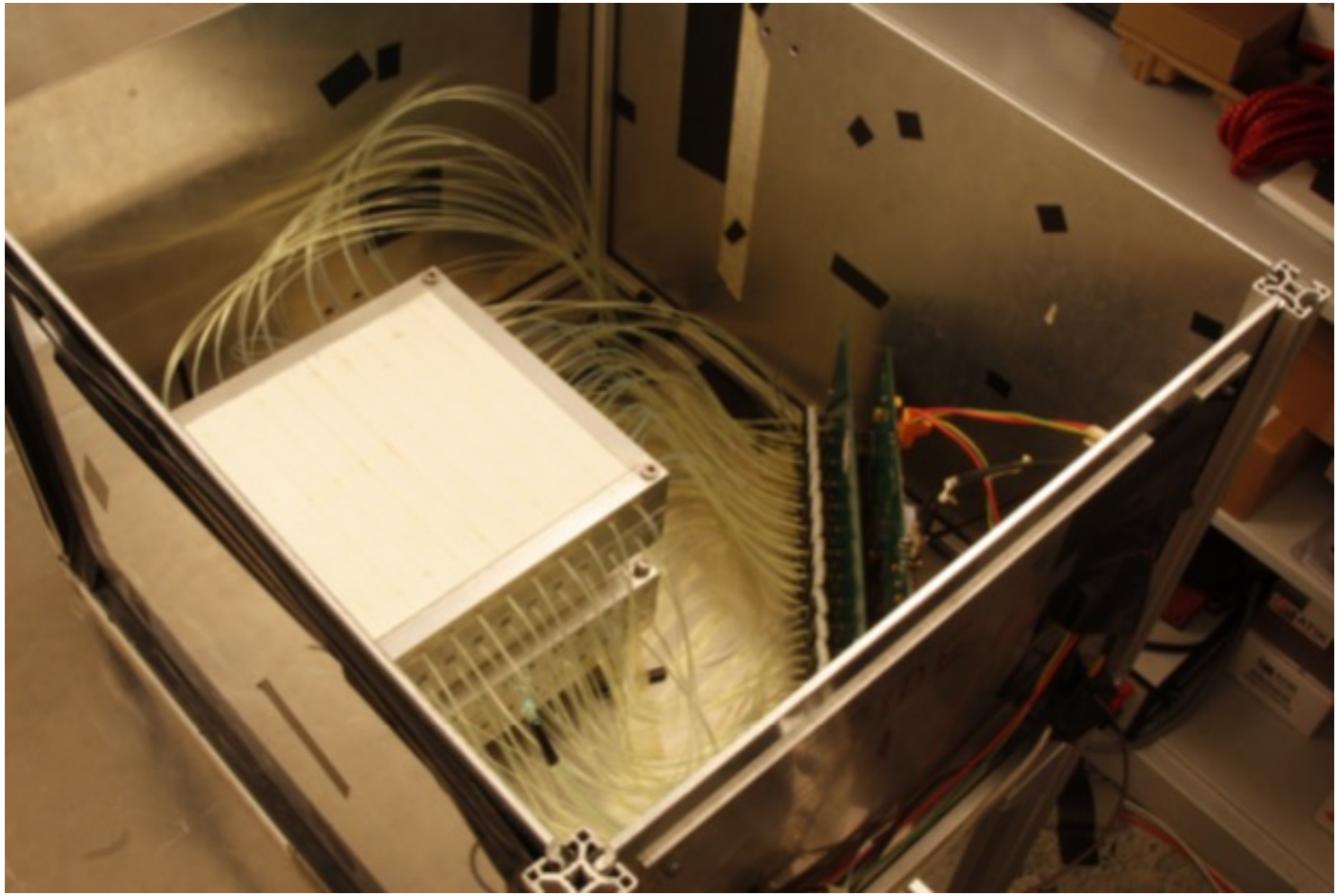






An illustation of the DISCO detector set-up.

DISCO EXPERIMENT: THE THREE COMPONENTS



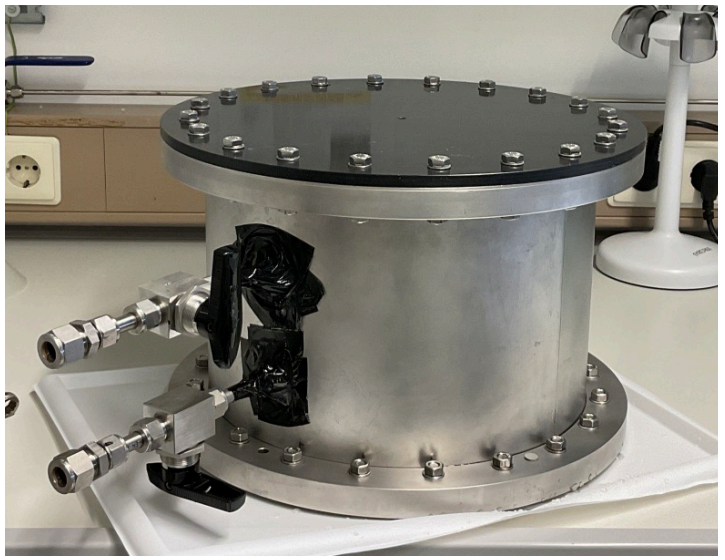
MUON TRACKER

- Eight planes, each plane consists of eight 19 cm long scintillating rods
- Read-out using SiPMs
- Provide external trigger signal
- Reconstruct muon tracks
- Placed above the test cell

DISCO EXPERIMENT: THE THREE COMPONENTS

TEST CELL

- Cylindrical steel tank enclosed with two plexiglass planes
- Detection volume ~ 14 L
- Height : 20 cm
- Diameter : 30 cm
- Can be filled with water, LS, WbLS
- Currently filled with water



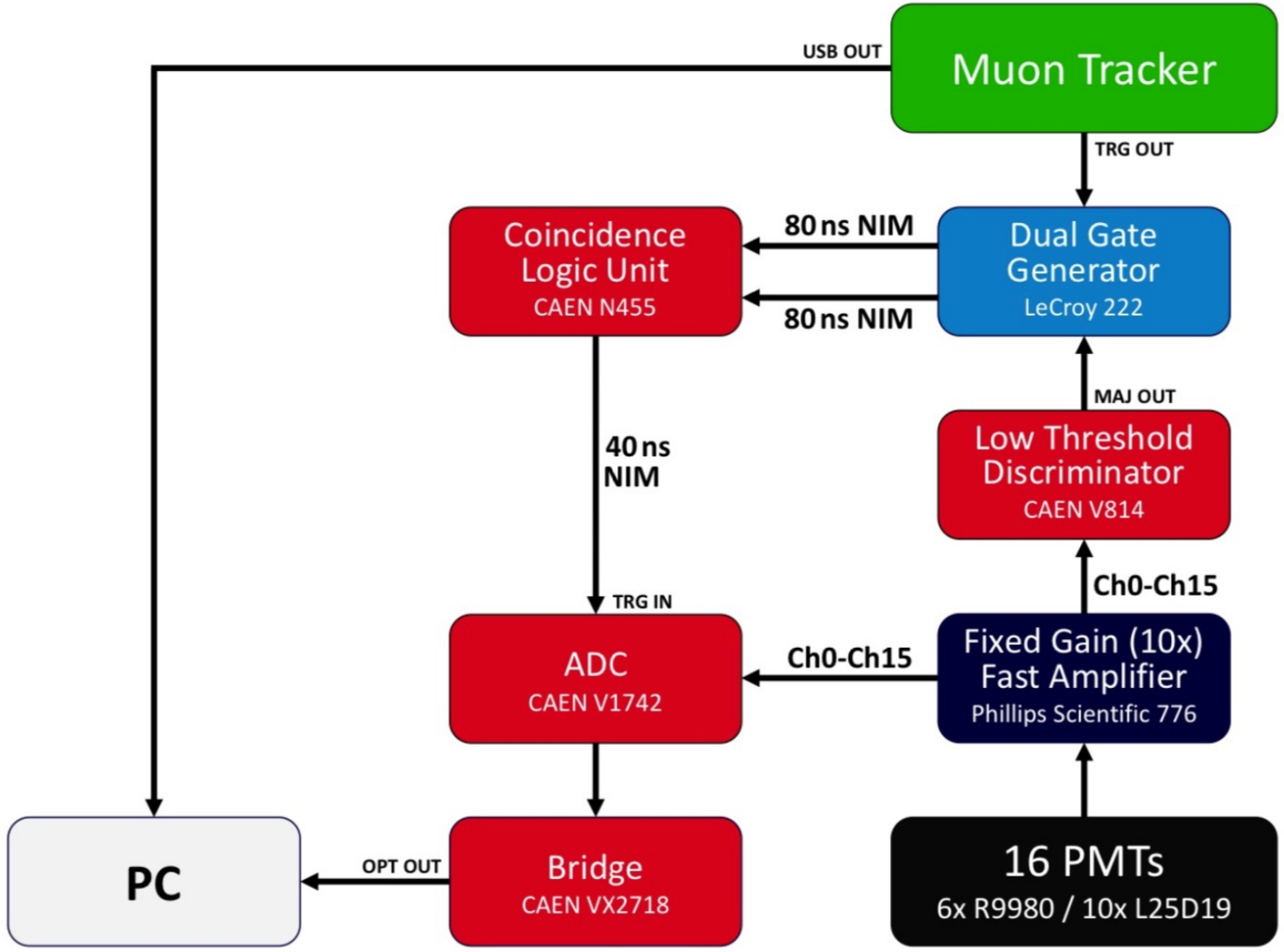
DISCO EXPERIMENT: THE THREE COMPONENTS

LIGHT DETECTION SYSTEM

- Cherenkov photons detected using sixteen 1” PMTs placed below the test cell.
- PMTs arranged in two concentric circles of radii 40 mm and 110 mm.
- PMTs are calibrated using laser of wavelength 405 nm

DATA ACQUISITION SYSTEM

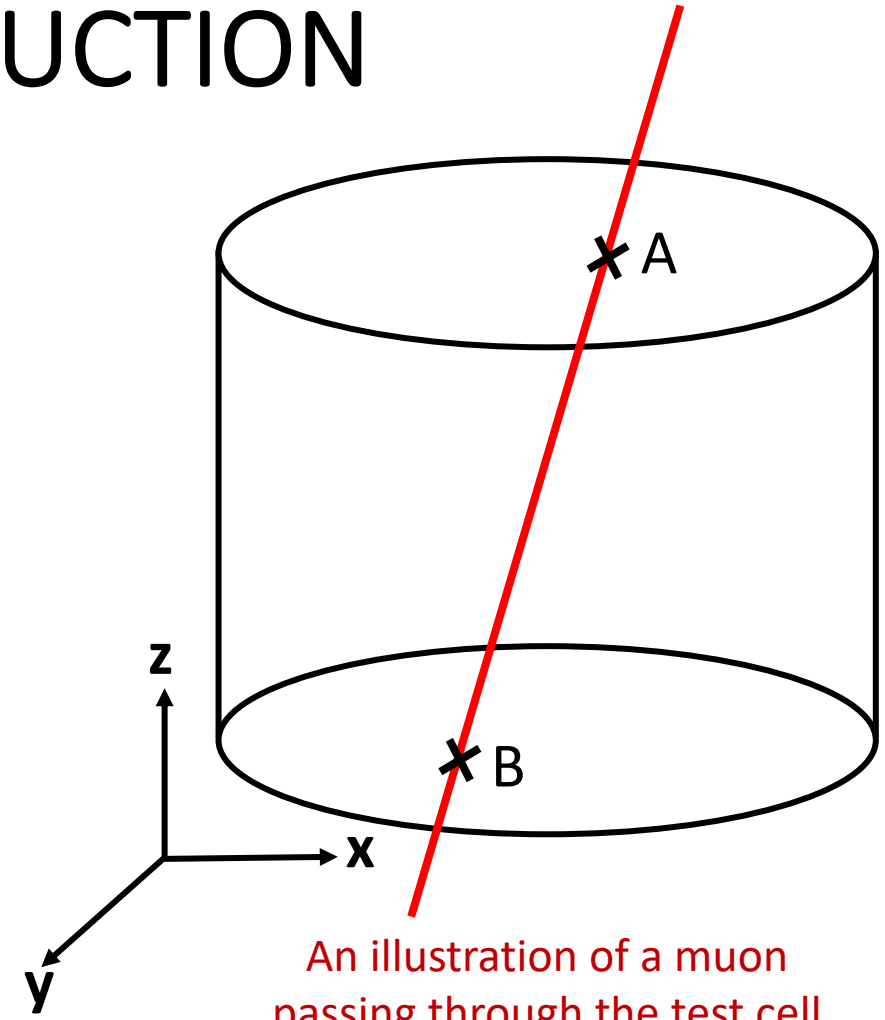
- PMT signal is amplified by a factor of 10
- External trigger:
  - Muon tracker + PMT signal
- PMT signals digitalized on receiving external trigger.
- Offline analysis → Extract hit time and charge



A schematic of the DAQ

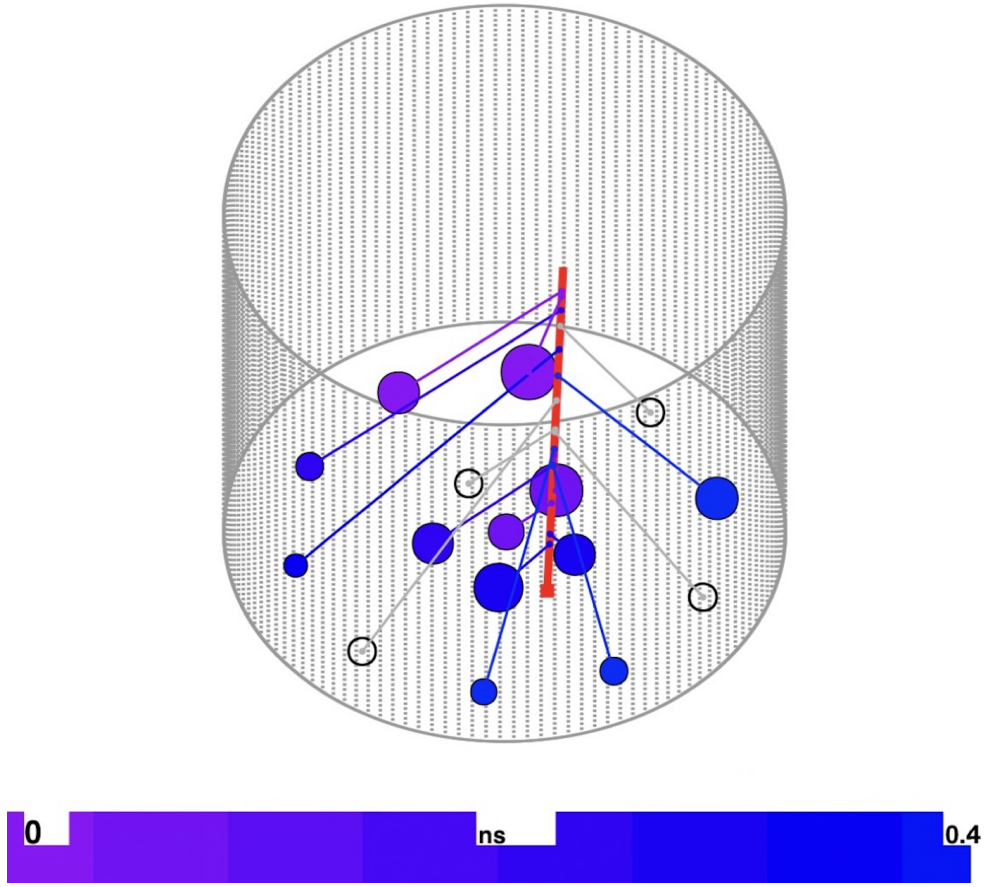
TRACK RECONSTRUCTION

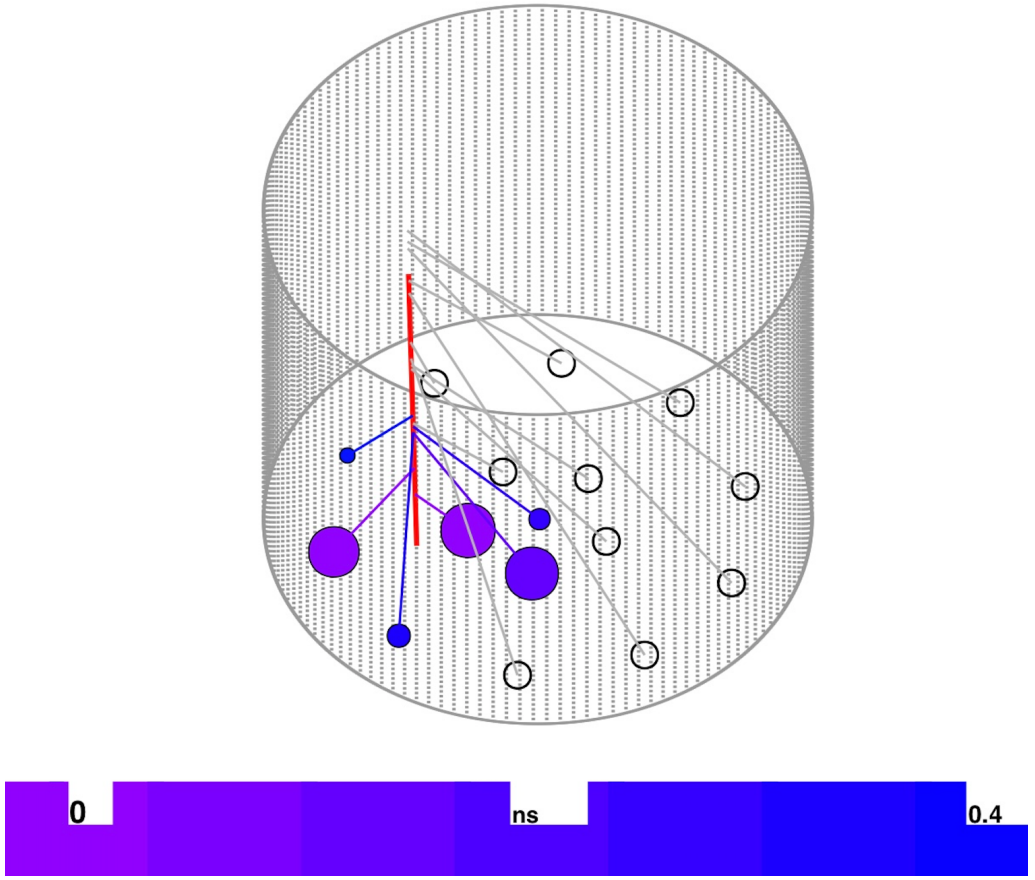
- Muon tracks described by:
  - Entry point (A) – (x_1, y_1, z_1)
  - Exit point (B) – (x_2, y_2, z_2)
- Track parameters are obtained by minimizing the log likelihood function.
- Qualitative assesment of reconstruction procedure: look at the angular distribution of reconstructed tracks.



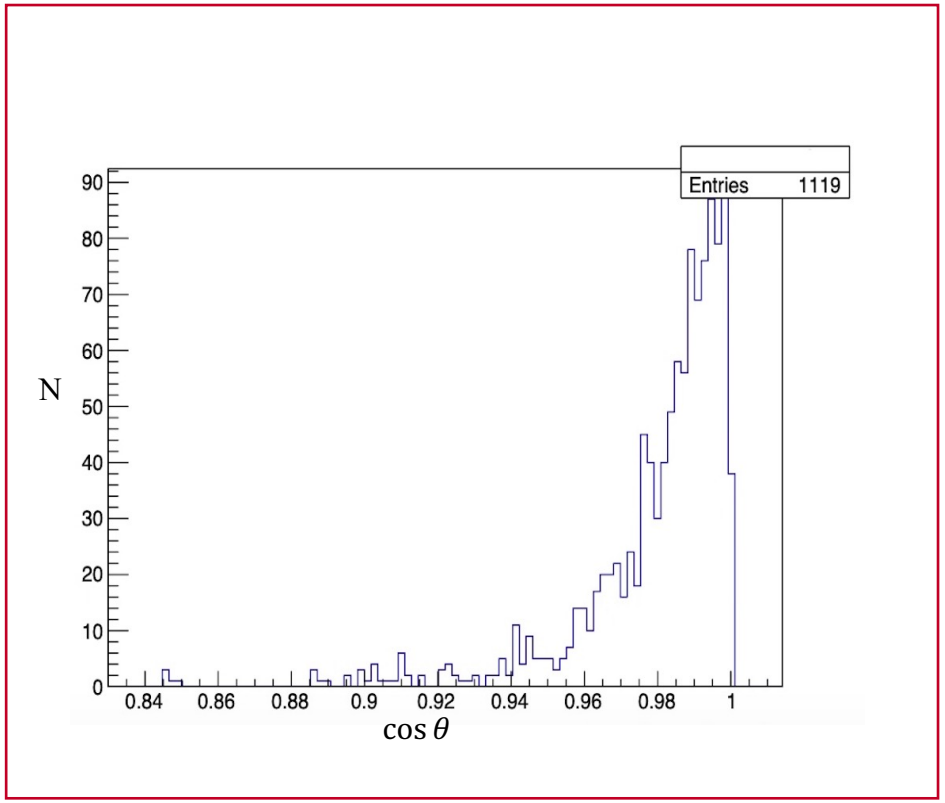
An illustration of a muon passing through the test cell

EVENT DISPLAYS

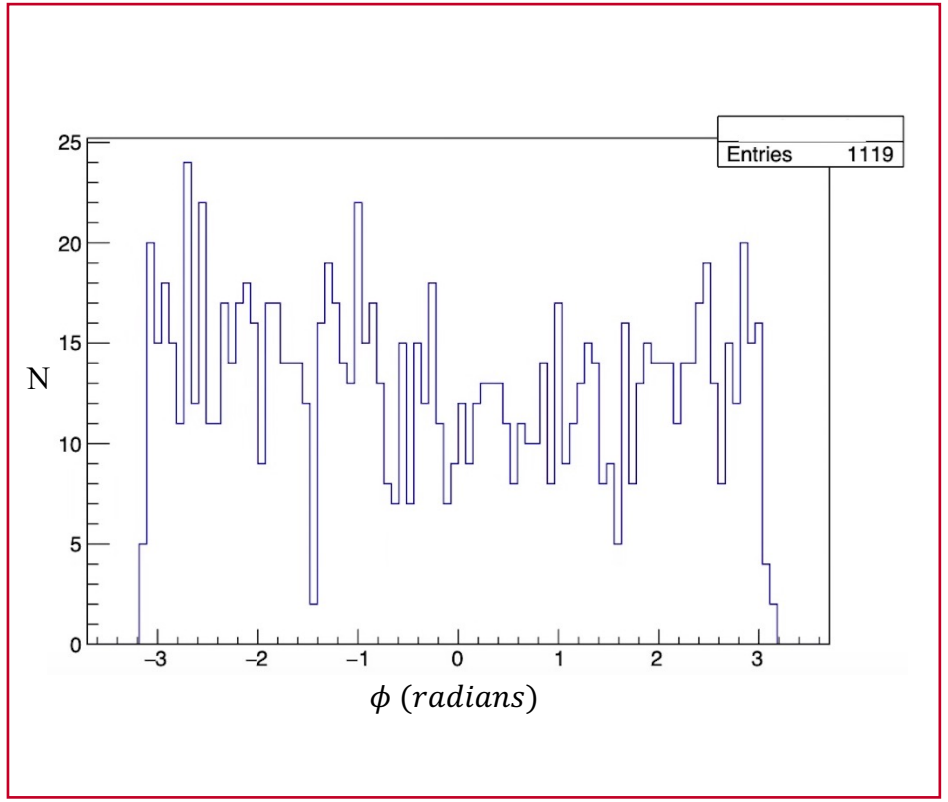




ANGULAR DISTRIBUTIONS OF RECONSTRUCTED TRACKS



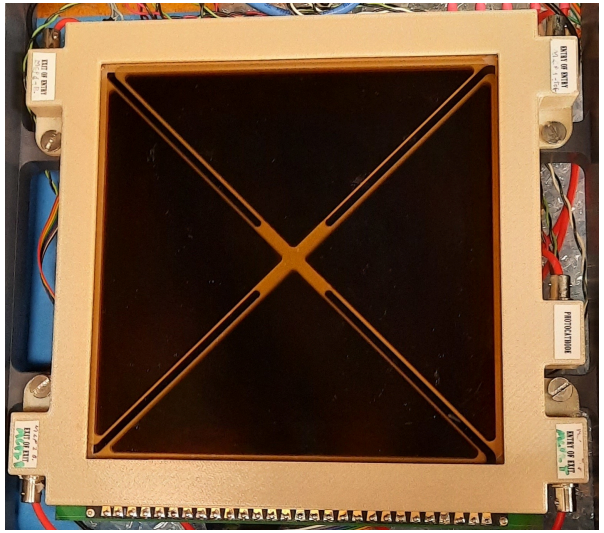
Distribution of muons as a function of zenith angle



Distribution of muons as a function of azimuthal angle

SUMMARY AND NEXT STEPS

- DISCO: lab scale experiment to charecterize WbLS
- Tested DISCO with water
- Muon tracks were reconstructed by combining the PMT hit-time (χ_t^2) and charge information (log likelihood)
- Next Steps:
  - Replace water with WbLS in test cell and take data
  - Replace PMTs at the bottom with LAPPD → enables precise track reconstruction



BACK-UP

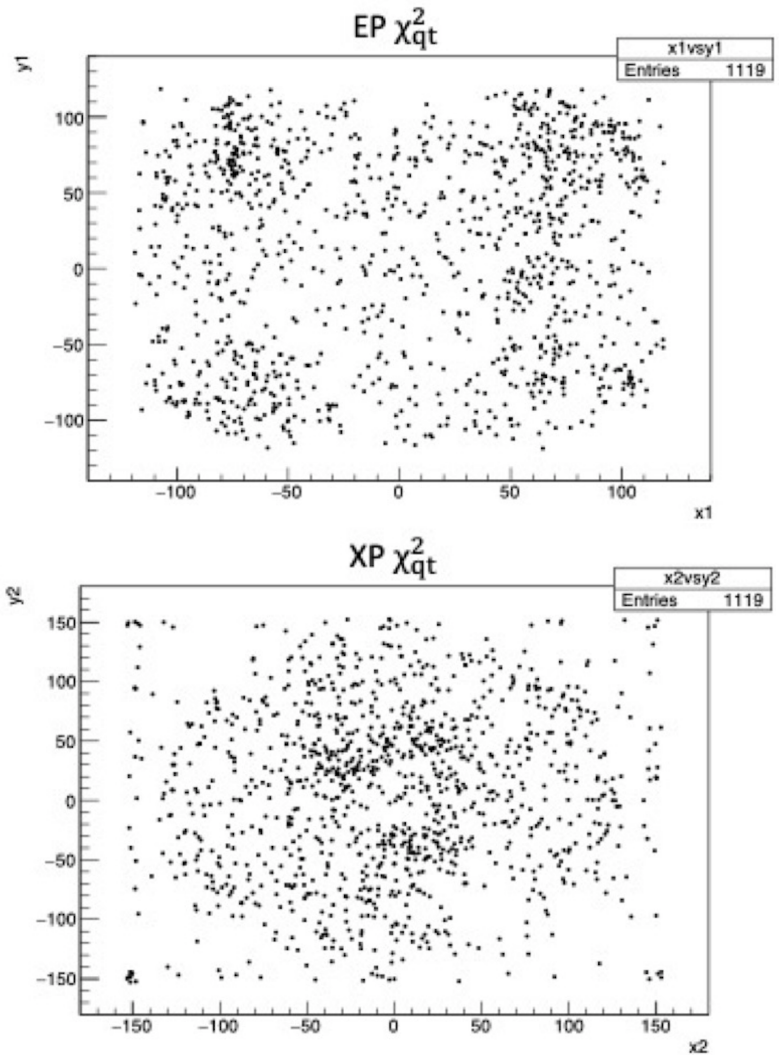
PMT SPECIFICATIONS

- Inner ring : 6 Hamamatsu R9980 PMTs
  - Mainly for the detection of scintillation light
  - Bias Voltage : 1300 V
- Outer ring : 10 ADIT L25D19 B546 PMTs
  - Mainly for the detection of Cherenkov light
  - Bias Voltage : 1250 V

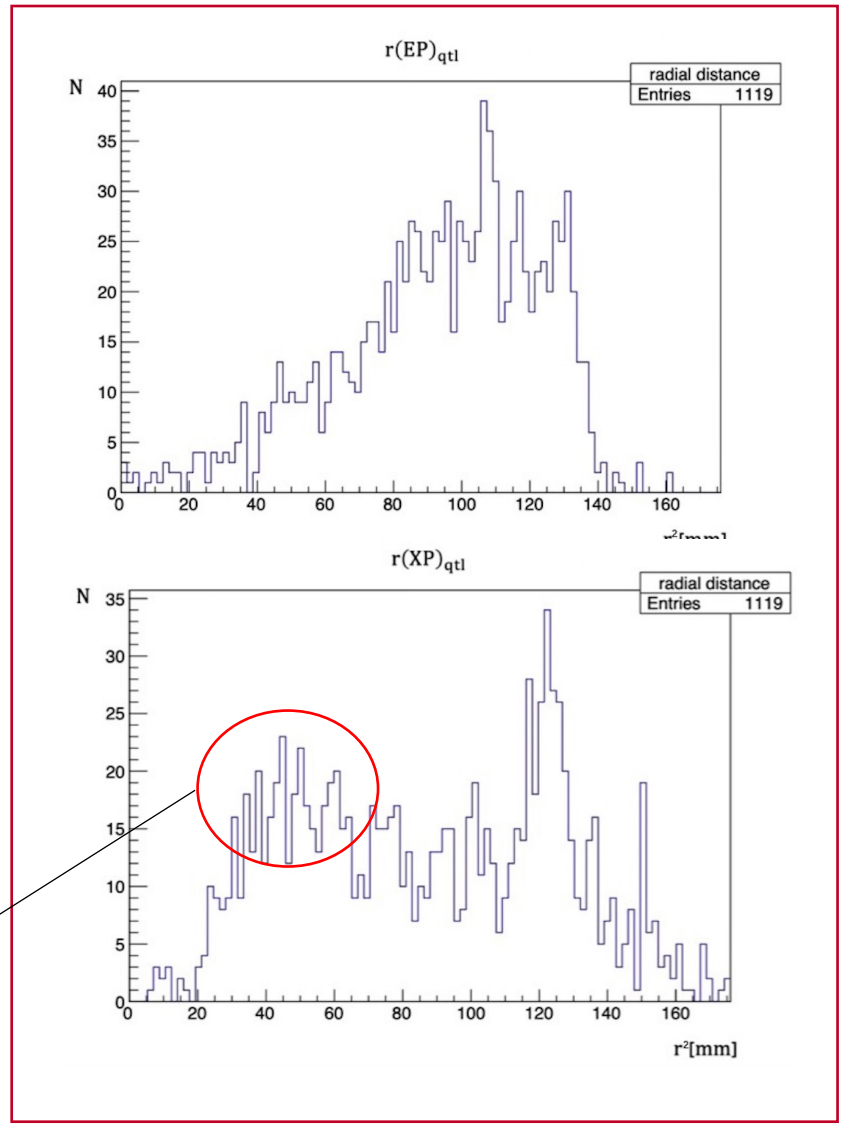
MEASURES OF GOODNESS OF RECONSTRUCTION PROCEDURE

- Quantitative assessment: Compare reconstructed tracks with tracks obtained from muon tracker
- Perform qualitative assesment of track reconstruction algorithm using the distributions:
  - Entry Points
  - Exit Points
  - Radial distances of entry and exit points
  - Angular distributions – Zenith and Azimuthal angle

DISTRIBUTION OF ENTRY AND EXIT POINTS



- Number of muons detected on a surface of radius r $\propto \pi r^2$
- Mostly uniform distribution
- Slight clustering of events towards the inner PMTs



Clustering near inner PMTS

ADDITIONAL IMPROVEMENTS

- Inserted black shields inside the test cell to minimize internal reflections