

## Mechanical Design of Water Cherenkov Test Experiment at CERN

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## Introduction

The Water Cherenkov Test Experiment (WCTE) is a test experiment proposed at CERN in year 2023 to measure the response of a Water Cherenkov Detector to charged particles such as  $\pi \pm$ , p+, e $\pm$ , etc. The data obtained from WCTE will be used in future neutrino experiments such as Hyper-K.

The WCTE require a Support structure to arrange multi-PMT photosensors (mPMT) for detection of Cherenkov light required to be stable under static and dynamic loads during

- Experiment
- Lifting and Transportation
- Seismic activities



Fig 1. CAD image of fully Assembled Water Cherenkov Test Experiment Detector with Calibration System and roller system.

## WCTE Support Structure Components and mountings

The WCTE consists of **130** mPMT modules, Camera & Lights setup for Photogrammetry, Calibration System and Beam windows.

There are two beam windows at an angle of 450 mrad for Tertiary and Secondary Beam configuration:

- Secondary Beam Window –
- ✓ **Diameter:** 100 mm and can extend radially inside the tank
- Tertiary Beam Window
  - **Diameter:** 500 mm and stationary on  $\checkmark$ the wall of WCTE.

The support structure is designed in standard SS304 beams **120 mm x 60 mm x 5mm** hollow cross-section which makes it economical, strong and compatible with Ultra pure water.

The Simulation studies of the support structure for static case shows the maximum equivalent stress is 65 MPa.

Lifting lugs are designed for lifting the whole structure to place it in and out of the tank. **Roller systems**<sup>#</sup> will be used to move the detector between secondary and Tertiary beam.

Photogrammetry will be used to map the exact positions of the mPMTs which will lead to accurate reconstruction of the Cherenkov light cone.

Calibration System<sup>#</sup> consist of the Calibration Arm which moves the diffuser ball and other calibration source inside the Detector.

The assembly of the support structure is enclosed inside the SS304 Tank of dimension ~4.0 m in diameter and ~4.0 m in height. The tank can hold 50 tons of ultrapure water with a water circulation systems to avoid the formation of Bacteria and Algae.









Fig 3. (Top row)Position of various components (ports for water circulation, cover gas circulation, Cables and other accessories) on the lid of WCTE Detector

Fig 2. (Top row) WCTE, mPMT, Camera Housing & Calibration Arm, Lifting lug & its zoomed image and details of Beam windows. (Middle row) Transportation between Beam Window and Beam windows on Tank cross section. (Bottom row) Roller system for the motion of the tank, zoom view of the rollers & image of actual roller and Stress Analysis result of Static case in air (MPa).

- A SS304 support structure for 130 mPMTs, compatible with ultrapure water, is designed The Static simulation of WCTE shows the structure is safe.
- Dynamic analysis of the structure for lifting operations is underway.
- Design of roller system for shifting of the WCTE setup with water from secondary to tertiary beam is being done.
- Static and dynamic simulations of WCTE setup with water will be carried out.



## Summary