Water Cherenkov Test Experiment

Matej Pavin, on behalf of the TRIUMF Hyper-Kamiokande group

Water Cherenkov Detectors

Water Cherenkov detectors use Cherenkov light created by charged particles in water to measure or search for rare processes like neutrino interactions or proton decays. Future detectors such as Hyper-Kamiokande (Hyper-K) will allow us to enter a regime of precision measurements. However, increased data statistics require a significantly improved understanding of detector calibration and systematic uncertainties to a percent level.

Water Cherenkov Test Experiment

The neutrino group at TRIUMF is leading efforts to build the Water Cherenkov Test Experiment (WCTE) at CERN. The SPS Committee has recently approved the experiment with the possibility of becoming a permanent facility that will allow other users to test new water Cherenkov technologies.

The main goals of WCTE are:

- Measure detector response in well-defined particle beam (0.2-1.2 GeV/c)
- Test new detection technologies such as multi-PMT module
- Deploy and test new calibration techniques (photogrammetry for PMT position calibration)
- Measure physical processes (Cherenkov light production, pion interactions in water)
- Test new reconstruction and analysis techniques (machine learning)

The T9 Beamline

The T9 beamline in the newly renovated East Area at CERN was selected as the location of the experiment. The beamline provides secondary hadron and electron beams between 0.2 and 15 GeV/c. The TRIUMF group is currently participating in the beam test that will provide information on beam composition and intensity. In case data shows too low beam intensity and no pions at very low momenta, we will build a compact tertiary beamline that will use the 15 GeV/c secondary proton beam to generate low momentum pions and protons for WCTE.

Water Tank and multi-PMT sensors

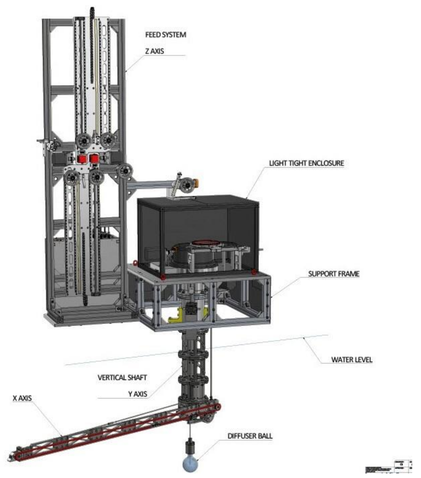
The main component of WCTE is the 3.4 m tall and 3.8 m wide water Cherenkov detector that is designed to contain 700 MeV/c muons fully. The detector consists of a stainless-steel water tank, inner support structure, hundred multi-PMT sensors, and various calibration systems.

The multi-PMT module is a light detector developed at TRIUMF that uses nineteen 8 cm PMTs enclosed in a cylindrical vessel. The module also provides high voltage generation for PMTs, signal readout, background rejection (scintillator plate) and LED calibration system. The WCTE will use multi-PMT modules developed for Hyper-K.

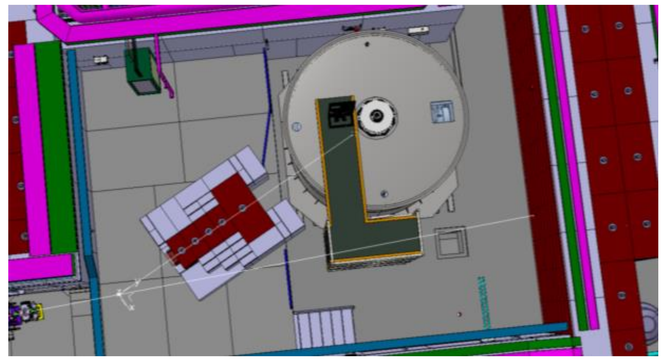
Calibration Systems

The WCTE will have several in-situ calibration systems:

- Manipulator arm for source deployment
- Camera modules for photogrammetry (multi-PMT position calibration)
- LED sources inside multi-PMT modules for timing calibration



The CAD design of the WCTE manipulator arm



The 3D design of the WCTE water tank and tertiary beamline in the T9 experimental area

The multi-PMT prototype designed and built at TRIUMF

The 3D model of the WCTE detector

CONCLUSIONS

The Water Cherenkov Test Experiment (WCTE) is a TRIUMF-lead and recently approved experiment at CERN. The main goal of WCTE is to measure the water Cherenkov detector response in a well-defined particle beam and reduce systematic uncertainties for upcoming water Cherenkov experiments such as Hyper-Kamiokande to a percent level.

Discovery, accelerated