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JUNO OSIRIS Calibration Systems

Flash talk

Tobias Sterr for the JUNO OSIRIS group

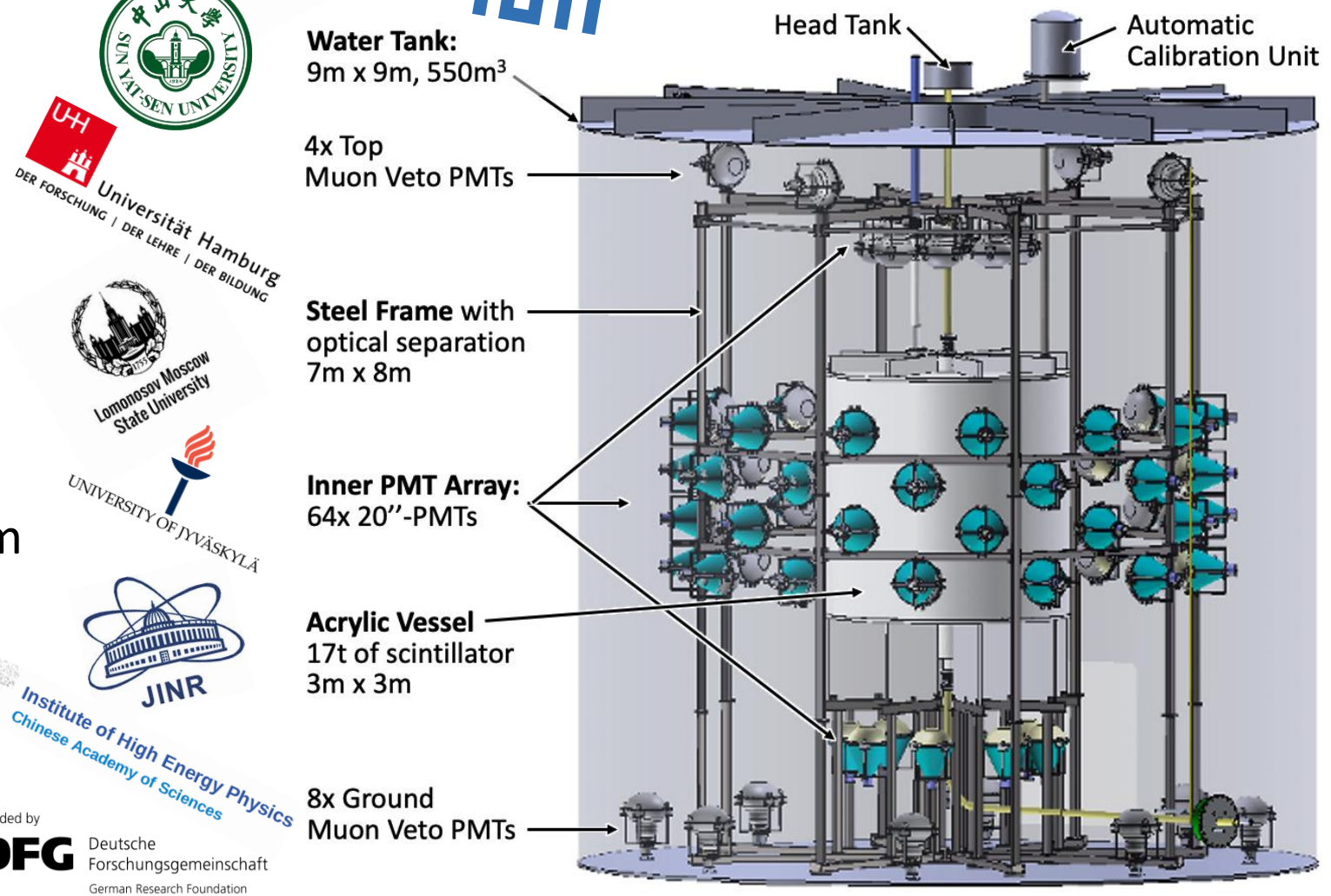
Neutel conference 2021 @ online

The OSIRIS Detector

- Due to the ambitious sensitivity goals of JUNO, a high purity level of the liquid scintillator (LS) is necessary
  - ➢ The Online Scintillator Internal Radioactivity Investigation System (OSIRIS) was introduced to monitor the purity of this LS
- Main goal: monitoring of the U-Th chains via Bi-Po events ->
  - sensitivity of 10^{-16} g/g of U and Th for solar measurements
  - sensitivity of 10^{-15} g/g of U and Th for Inverse Beta Decay measurements in JUNO
- A contamination measurement of ^{14}C and ^{210}Po will be possible
- After its main purpose is fulfilled, OSIRIS offers a unique chance for low-budget high precision measurements of other topics like pp neutrinos, etc.

The OSIRIS Detector

- Light detection system of OSIRIS:
  - 76 newly developed iPMTs (PMTs with all readout and supply electronics included into base)
  - Two independent calibration systems: Automated calibration unit and Laser calibration system



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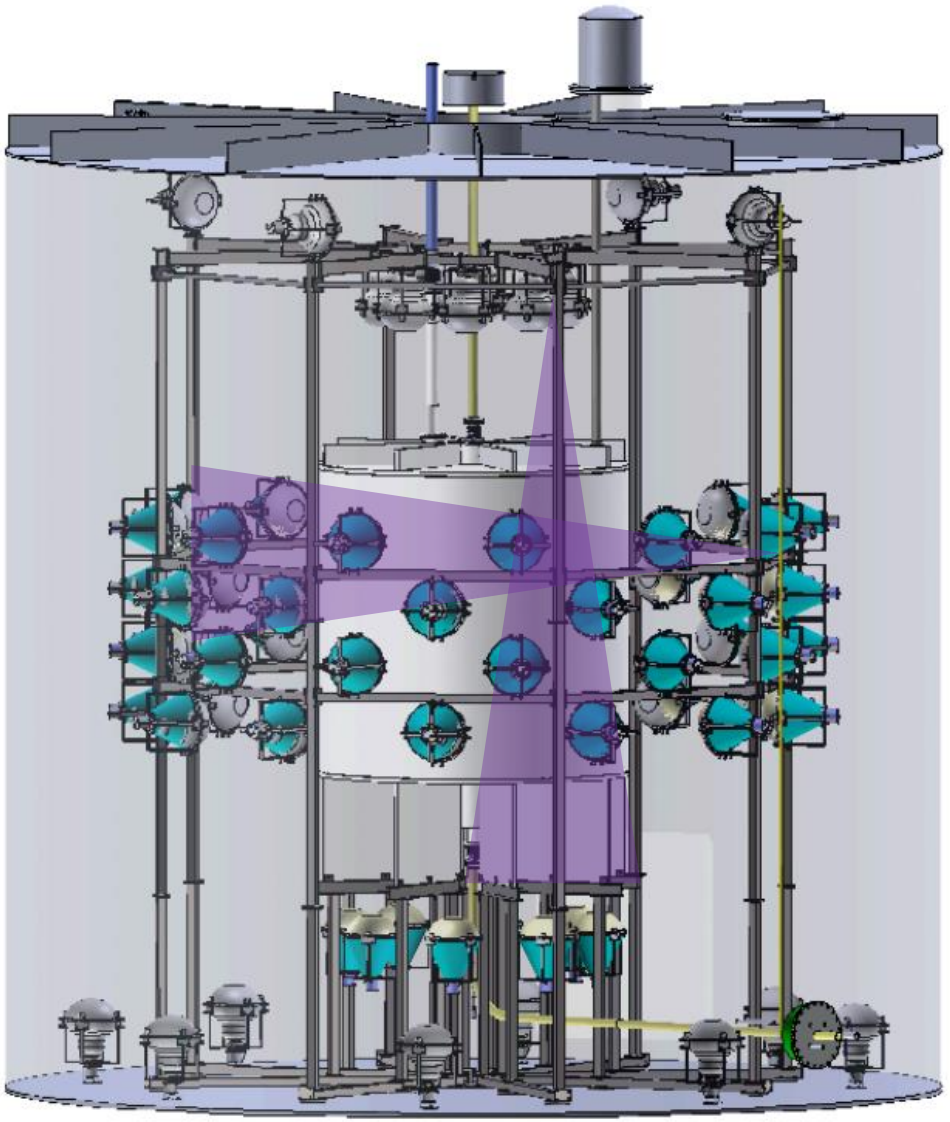
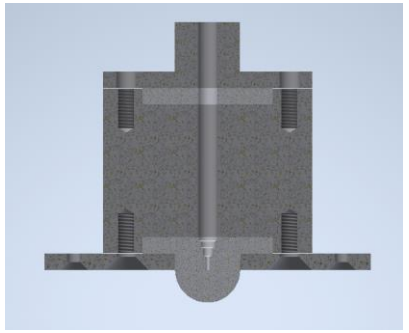
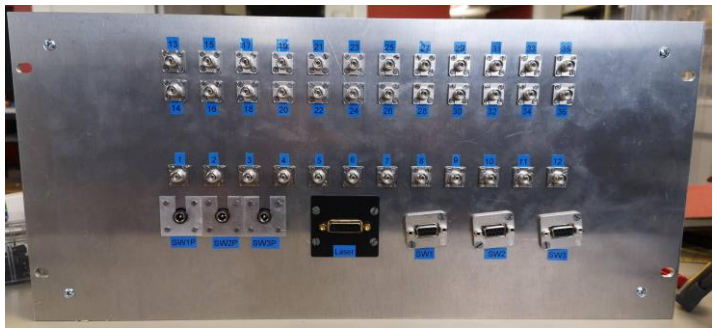
Laser Calibration System

- For time and charge calibration: distributed fiber system, driven by pico-second Laser (pulse length ≈ 80ps)
- 24 diffusor capsules distributed in inner volume and muon Veto
- Laser system for time and charge calibration:
  - ➢Timing alignment ≈ 25ps (1σ)
  - ➢Charge calibration accuracy ≈ 7 x 10^{-3} p.e.

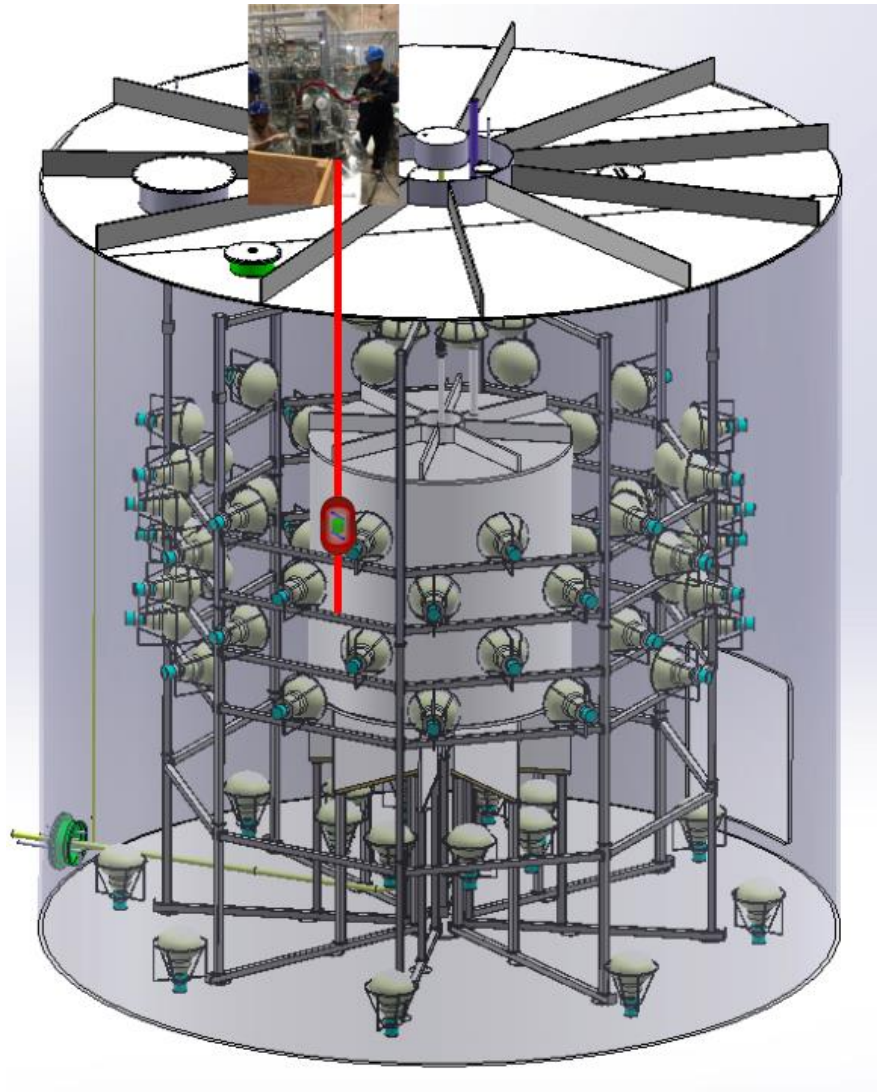






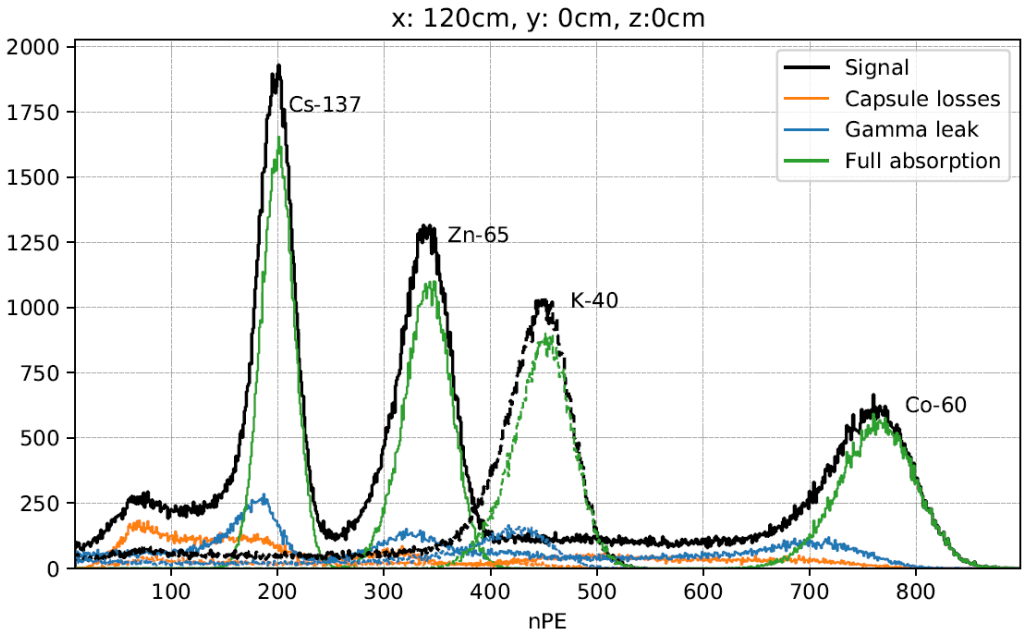
Automated Calibration Unit (ACU)

- ACU features three calibration sources:
  - High activity source (CS-137, Zn-65, Co-60) ∑≈1kBq
    - ➢ Used for vertex reconstruction
  - Low activity source (K-40), ≈ 0.2-1Bq
    - ➢ Remains in the detector as continuing reference
  - Pulsed LED with diffusor ball encapsuled in acrylics
    - ➢ Redundant to Laser system
- Of axis calibration due to large variation of detector response along central axis
- Simulation to extrapolate remaining detector
- The ACU is a spare part from the Daya Bay collaboration, modified to the needs of OSIRIS

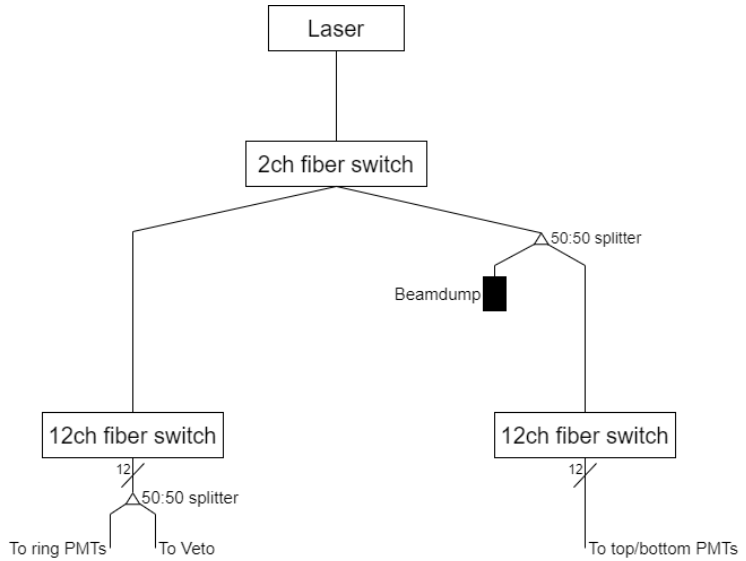


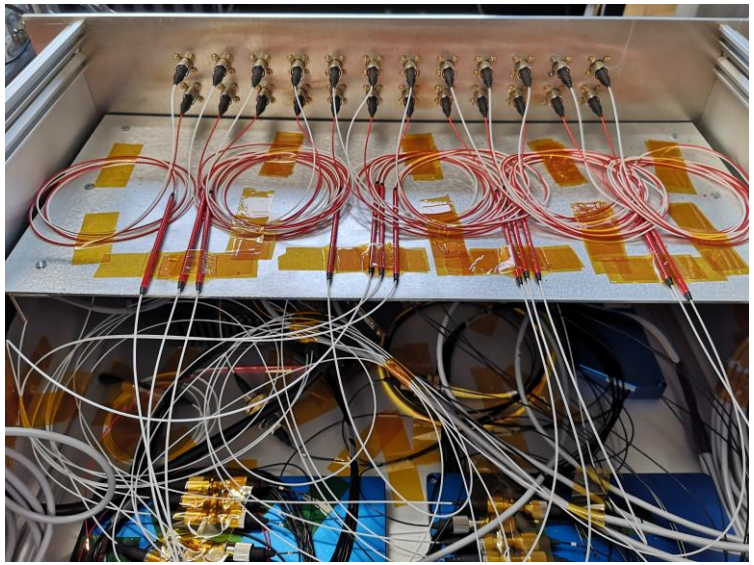
Expected Calibration Performance

- ACU source calibration:
  - Relative source position accuracy: 0.5 cm
  - Relative precision of energy scale: uncertainty of 0.2% - 0.5% @ 1MeV
- ACU LED calibration:
  - Timing alignment <= 1ns
  - Charge calibration accuracy ≈ 0.01 p.e.



Typical measured calibration spectra of the ACU (simulated). Fits of this plot are used for the estimation of the energy calibration uncertainty.





Thank you.

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