

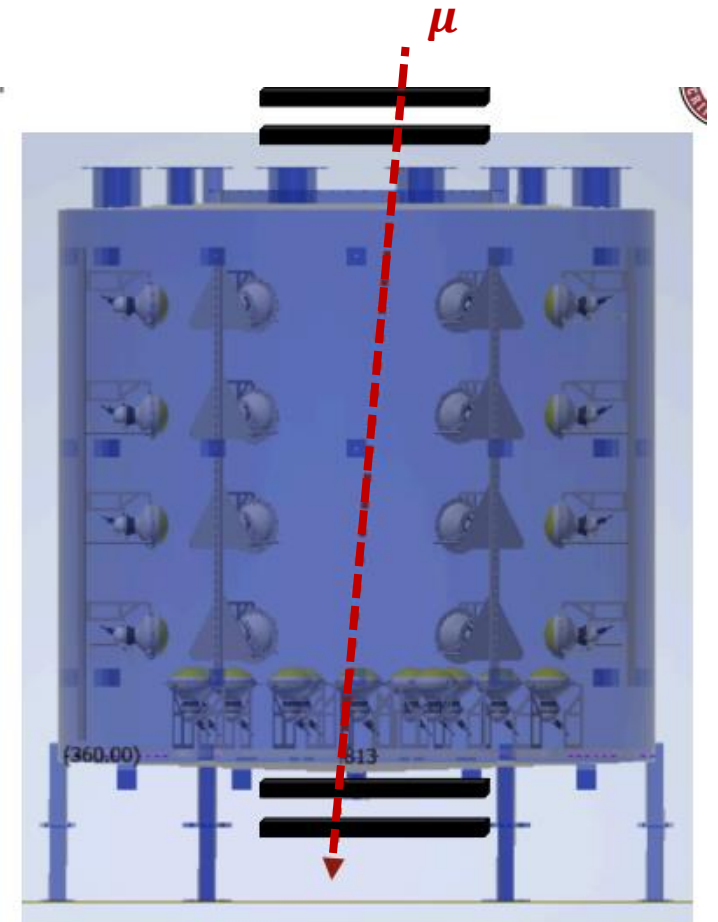
Introduction to the BNL 30-Ton Detector and OpticSiren Demonstration Plans

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BNL30T demonstrator



Cylinder detector R: 1651mm H: 3057.5mm

36 Hamamatsu R16367-100-70PMTs (10-inch):
24 in the barrel (4*6)
12 in the bottom

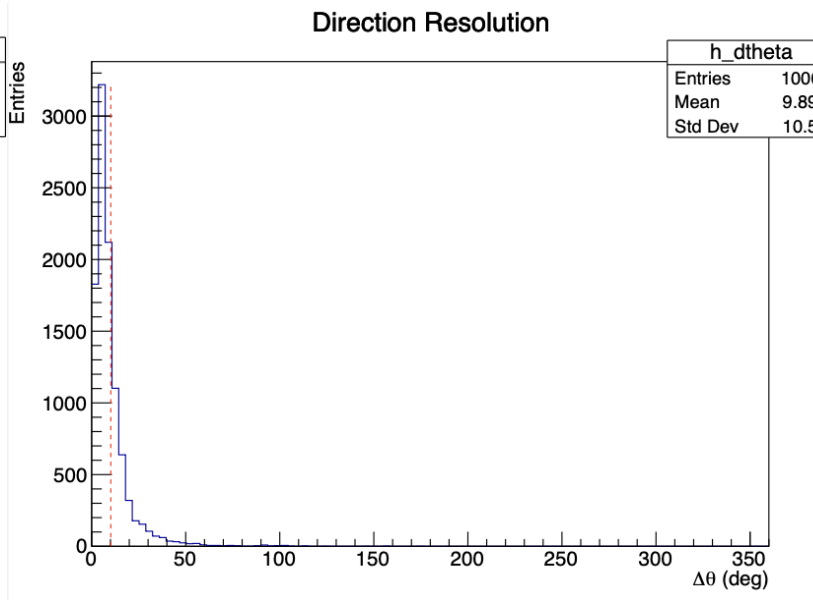
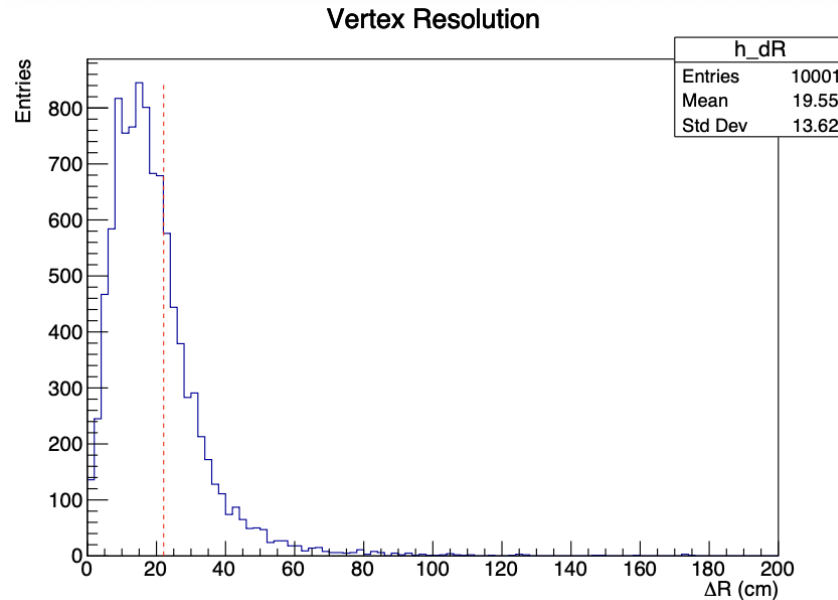
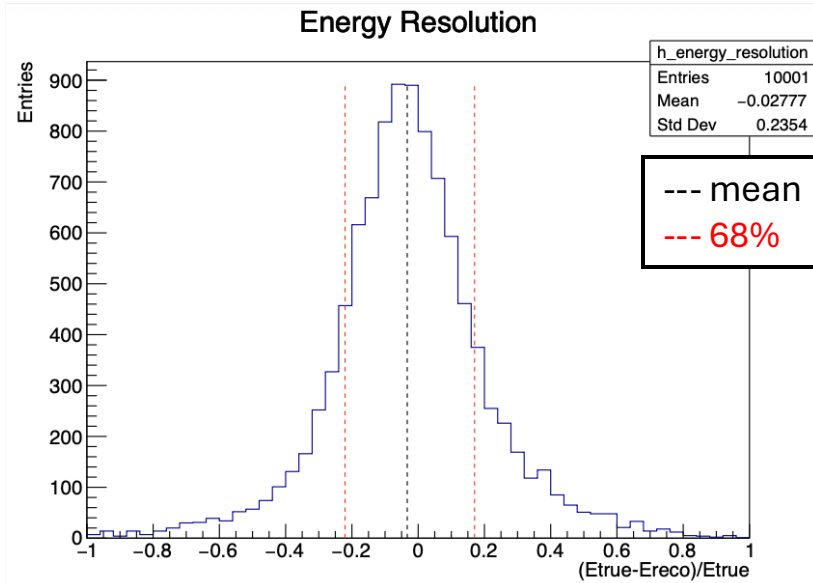
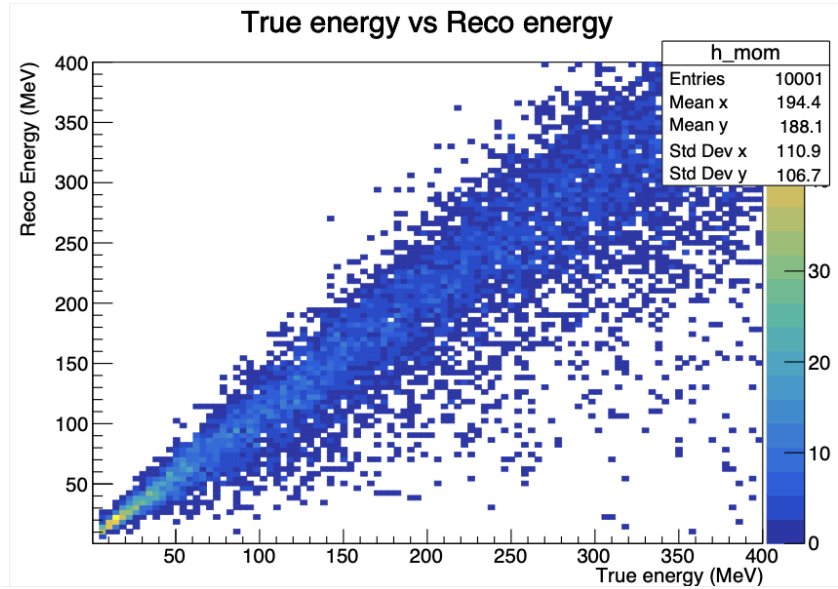
Pure-water & WbLS phases, Commissioning began in summer 2024.

Top/Bottom Panels: Used to tag vertically crossing muons for stability monitoring.
Vertical Crossing Muons: Enable characterization of light production and propagation through the detector.

fiTQun Reconstruction in BNL30T

- The simulation is done by ratpac-two
- Adapted the fiTQun tuning in the BNL30T:
 - WCSim Cherenkov Profile, will be replaced with ratpac-two simulated Cherenkov Profile soon (No significant difference are observed)
 - Tuning of angular, charge PDF, attenuation, time PDF, scattering are generated with BNL30T geometry, ratpac-two simulation
- Reconstruction of the BNL30T is ongoing
- Has demonstrated the fiTQun reconstruction in BNL30T:
 - MC only
 - Water-phase only

fiTQun reconstruction performance in BNL30T



MC is generated by ratpac-two,

10,000 events

True information:

PID: Electron

Kinetic energy : 5 ~ 400MeV

Vertex (0,0,700) mm

Direction (0,0.5, -1)

Reconstruction:

Energy resolution

68% interval: -22.1% ~17.0%

Vertex resolution

68% interval: 22.1 cm.

Vertex (along track) resolution

68% interval: 10.2 cm.

Vertex (transverse) resolution

68% interval: 19.7 cm.

Direction resolution

68% interval: 10.1 deg.

fiTQun Reconstruction in BNL30T

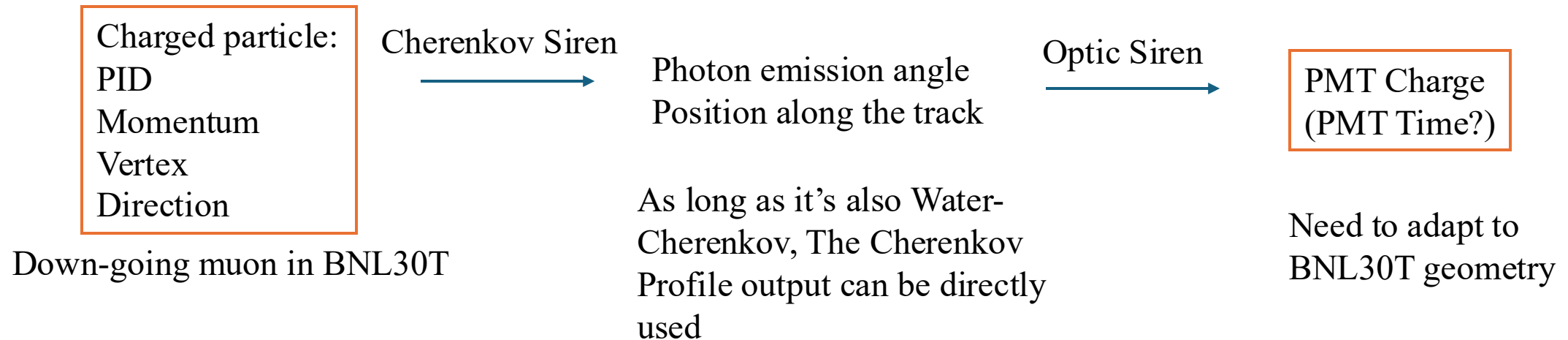
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 - Tuning of angular, charge PDF, attenuation, time PDF, scattering are generated with BNL30T geometry, ratpac-two simulation
- Reconstruction of the BNL30T is ongoing:
- Has demonstrated the fiTQun reconstruction in BNL30T:
 - MC-only,
 - water-phase only
 - The reconstruction works well for electrons, the muon reconstruction is ongoing
- The plan is to complete the water-phase for BNL30T -> adding the scintillation light -> extend the cylinder to box sharp

Plans for Demonstrating OpticSiren in the BNL30T

Start with the water phase, down-going muon

Plans for the workshop

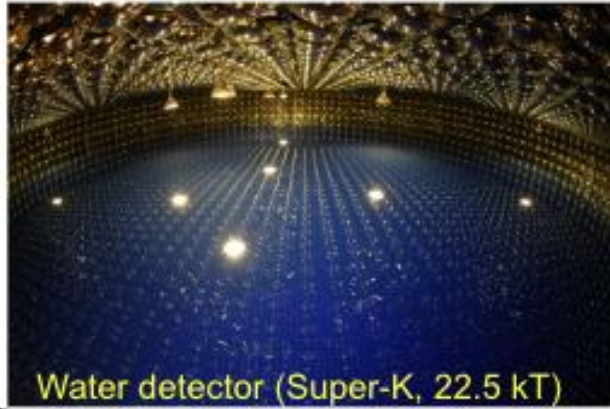
- OpticSiren: PMT charge (& time) w/ BNL30T geometry
 - Can prepare before & work at workshop
- Go through the full reconstruction pipeline
 - Review the pipelines we did at last workshop (before the workshop)
 - Work on the full-reconstruction at the workshop



backup

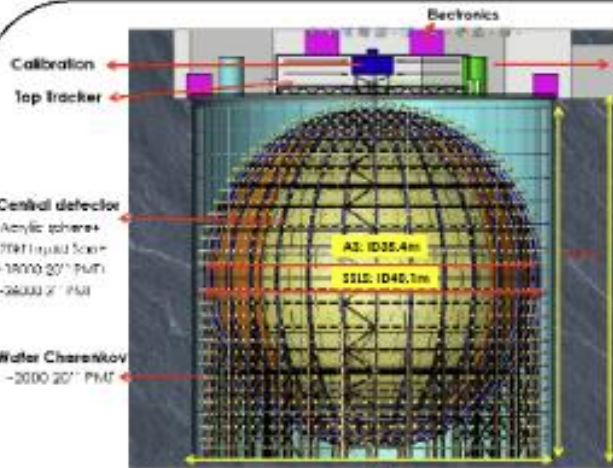
A DUNE Phase II Detector: Water-based Liquid Scintillator (WbLS)

- A different nuclear target based on a combination of two mature technologies.



Water detector (Super-K, 22.5 kT)

- Excellent Transparency
- Directionality
- Particle ID
- Cheap
- Potential for large Isotopic Loading
- No access to physics below the Cherenkov threshold
- Low light yield



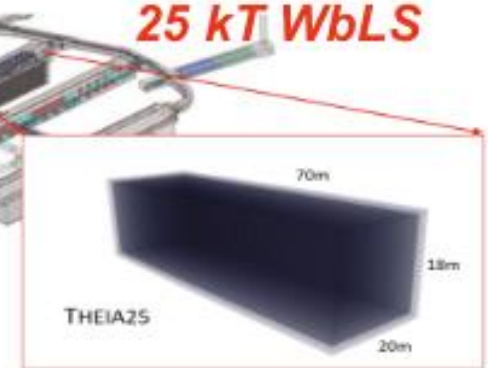
Liquid Scintillator detector (JUNO, 22.5 kT)

- High light yield
- Low energy threshold
- Good energy and position resolutions
- Can be radiologically very clean
- Costly
- High absorption
- Limited directionality

WbLS produced at BNL

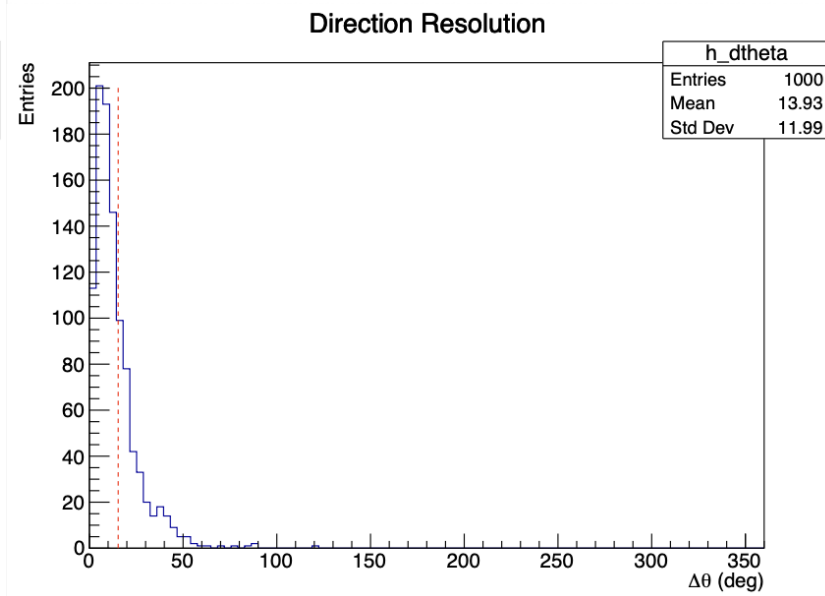
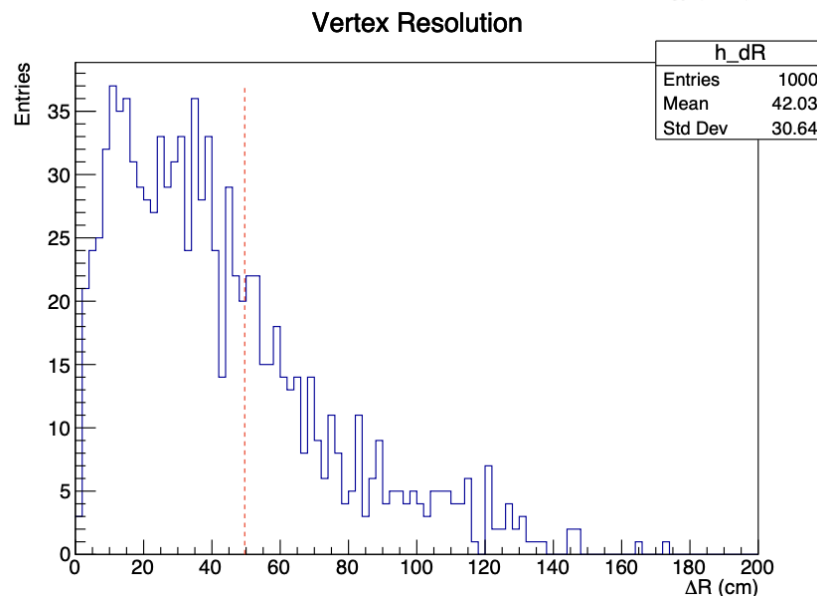
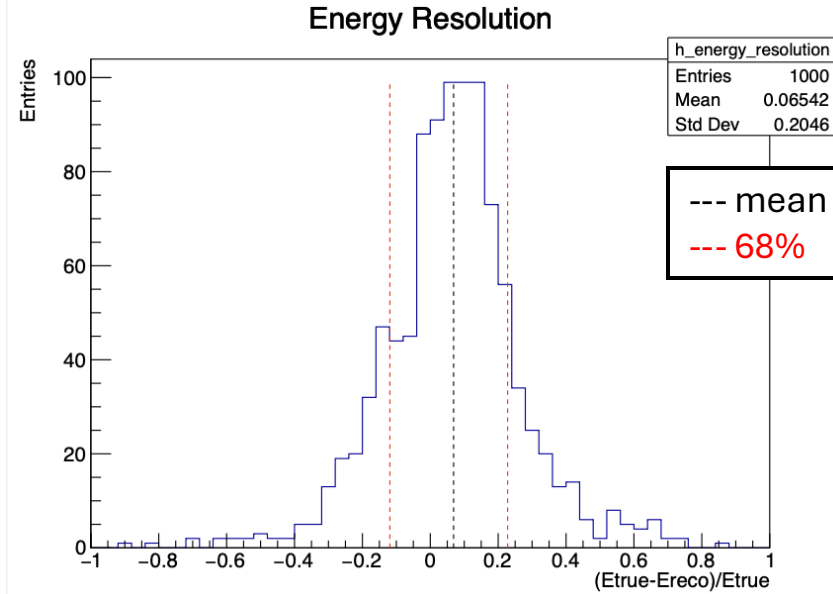
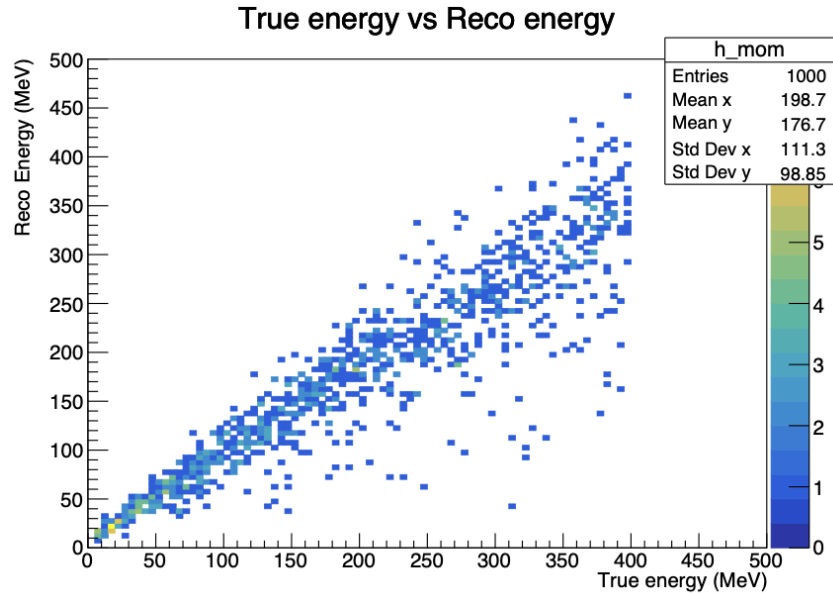


25 kT WbLS



- **Good timing:** sub-ns timing enables Cherenkov/Scintillation light separation
- **High LY:** > 500 photons per MeV with 5% concentration enables access to the low-energy neutrinos with low background
- **Supernova pointing:** 10° angular resolution and electron antineutrino detection
- **Low-energy beam neutrino detection:** enables the use of multiple oscillation maxima
- **All physics capabilities:** EPJC vol.80, 416 (2020)

fiTQun reconstruction performance in BNL30T



MC is generated by ratpac-two,
1,000 events, **direct light only**

True information:

PID: Electron

Kinetic energy : 5 ~ 400MeV

Vertex (0,0,700) mm

Direction (0,0.5, -1)

Reconstruction:

Energy resolution

68% interval: -11.9% ~ 22.8%.

Bias: 6.9%

Vertex resolution

68% interval: 49.6 cm.

Vertex (along track) resolution

68% interval: 13.9 cm.

Vertex (transverse) resolution

68% interval: 25.8 cm.

Direction resolution

68% interval: 15.4 deg.