Stereo Calorimetry at JUNO

Controlling Systematics by Measuring Scintillation Light with two Redundant PMT Systems

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JUNO: an unprecedented Liquid Scintillator Detector

- 20 kt Liquid Scintillator
- 35.4 m Acrylic Sphere
- 17000 20” PMTs
- Water Buffer
- Water Cherenkov (µ veto)
- Top Tracker (µ veto)

Detect \( \nu_e \) from Nuclear Reactor

Goal: Determine Neutrino Mass Ordering by performing a precision measurement of the oscillated antineutrino energy spectrum at 53 km baseline

Stereo Calorimetry Concept: Calibration & Physics

To disentangle charge non-linearities from other response effects (e.g., non-linear LS light yield, non-uniform detector response) JUNO implements a system of 3” PMTs whose mean illumination is low enough for them to be always working in single-PE (photon counting) regime.

Cross-calibrate the response of the two systems to better control the systematic uncertainties associated to light detection and energy reconstruction.

Use both calibration sources and oscillation parameters as standard candles.

Charge Reconstruction and Energy Accuracy

Large Liquid Scintillator (LS) volume and large PMT surface (20” diameter) imply unprecedented PMT dynamic range making charge reconstruction challenging

Noise and overshoot can easily introduce charge non-linearities when many photoelectrons pile-up at the PMT anode

Stereo Calorimetry Implementation

Under Water Box x ~ 200

16 channels / ASIC
128 channels / readout board
Custom-designed underwater box hosting power & readout
Low voltage / data / clock via connection to surface

H2C Photonics (XP72B22)
Production rate: 2000/month
Gain (at JUNO): 3 10^6
QE x CE (at 420nm): 24%
SPE Resolution: 35%
Dark Rate at 1/4 PE: 1kHz
Transit Time Spread: 5 ns