Development and Characterization of Acrylic Target Vessels for the Daya Bay Antineutrino Detectors

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The Daya Bay Reactor $\bar{\nu}$ Experiment

- 8 ‘identical’ pair-constructed antineutrino detectors: near and far locations
- Near/far relative measurement 3o limit: $\sin^22\theta_{13} < 0.015$

Daya Bay Nuclear Power Plant

Acrylic Vessel (AV) Design

- Separates 3 detector volumes
- Transparent to scintillation light
- Low Background
- Accommodates filling
- Accommodates liquid overflow
- Accommodates calibration sources
- Compatible with AD liquids
- Can be nested post-fabrication
- Stable for 5+ years

Acrylic Type

Reynolds
PoSiang
Polycast

Optical Properties

- Measure attenuation of AV samples
- Measurement technique: UV/Vis Spectrometry
- Ensure stability by limiting UV exposure

Daya Bay $\bar{\nu}$ Detectors (ADs)

- 3-zone detectors: GdLS target, LS gamma catcher, mineral oil buffer
- Detect inverse beta decay scintillation light from target with PMTs in buffer

Acrylic Vessel Characterization

We need vessels and acrylic to meet optical, geometric, mechanical and radioactivity specifications of experiment

Acrylic Type

Reynolds
PoSiang
Polycast

Mechanical Stability

- Developed optical stress measurement system
- Established long, short-term stress limits for AVs
- Measured residual stresses on real AVs

Radioactivity

- Acrylic radioactivity is extremely low; only measured upper bound; more sensitive future measurements are planned

Acrylic Type

Reynolds
PoSiang
Polycast

Vessels for the Daya Bay Antineutrino Detectors

Development and Characterization of Acrylic Target

Vessels for the Daya Bay Antineutrino Detectors

- Shipped to Daya Bay in crates with acceleration, temperature, pressure monitors

AVs manufactured from separate acrylic sheets in Taiwan and Colorado

Acrylic provided by 3 different manufacturers: Reynolds (USA), Polycast (USA), PoSiang (China)

Fabrication and Transport

- AVs manufactured from separate acrylic sheets in Taiwan and Colorado
- Acrylic provided by 3 different manufacturers: Reynolds (USA), Polycast (USA), PoSiang (China)
- Shipped to Daya Bay in crates with acceleration, temperature, pressure monitors

Assembly

- Hand cleaned, rinsed, and dried AVs
- Removes radioactive contaminants, optical imperfections
- Leak-Check all AV connections
- Ensures proper knowledge of target mass
- Install AVs using cleanroom cranes

Acrylic Type

Reynolds
PoSiang
Polycast

Mechanical and Radioactivity Specifications of Experiment

We need vessels and acrylic to meet optical, geometric, mechanical, and radioactivity specifications of experiment. This includes:

- Dimensions measured at AV manufacturer
- Survey done during detector assembly
- Geometries for different ADs are acceptably identical

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Optical Properties

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Daya Bay Site Layout