CALIBRATION OF ANTINEUTRINO DETECTORS AT DAYA BAY

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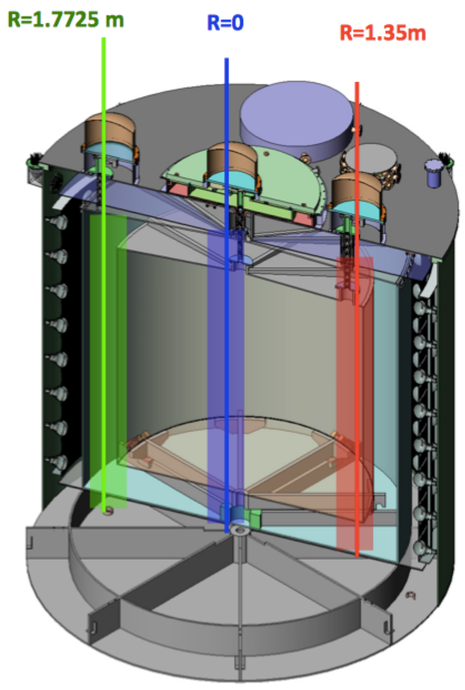
on behalf of the Daya Bay Collaboration

I. Automated Calibration Units (ACUs)

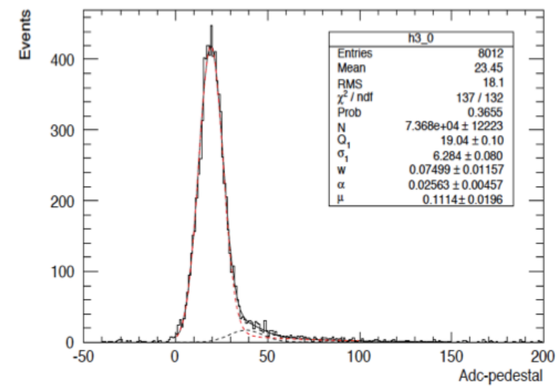
- deploys calibration sources along 3 vertical axes
- each unit has 3 switchable source holders
  - 10 Hz ^{68}Ge gamma source (2 x 0.511 MeV γ's)
  - 100 Hz ^{60}Co gamma source (1.173 + 1.332 MeV γ's) + 0.5 Hz ^{241}Am/^{13}C neutron source (3.5 MeV n without γ)
  - LED diffuser ball
- position accuracy is < 7 mm



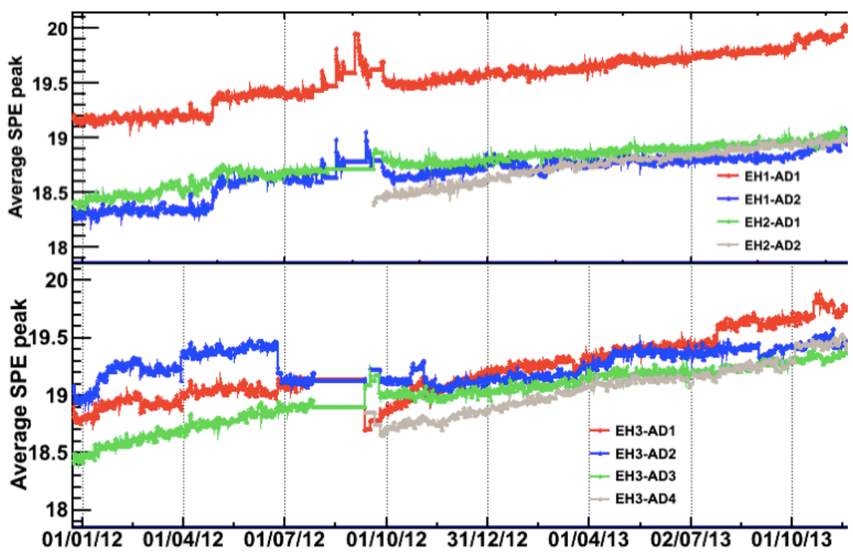
Automated Calibration Units (ACUs)

II. PMT Gain Calibration

- PMTs are operated at a gain of 10^7
- converts ADC value to photoelectron (p.e.) by fitting single photoelectron distribution
- calibrates regularly to compensate variations due to environment and electronics
  - low intensity LED (weekly)
  - PMT dark noise (rolling calibration, updated every ~6 hours)



Example fit of single photoelectron distribution



Time variations of average PMT gain

III. Energy Scale Calibration

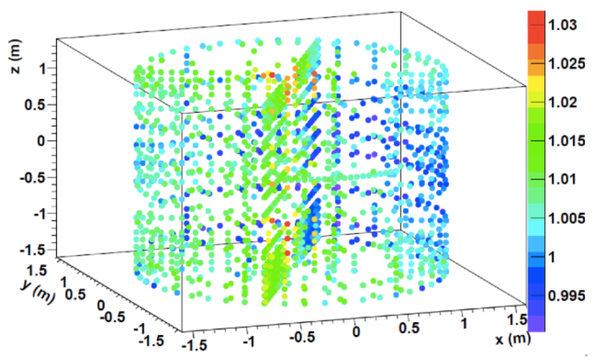
- converts total charge (p.e.) to detected energy (MeV)
- approximates with linear relation between light collection and detected energy
- sets a global energy scale for each detector

Two independent energy reconstruction algorithms are calibrated with different approaches:

- ^{60}Co gamma source
  - two gammas with total energy of 2.5 MeV
  - weekly ACU deployment at detector center
  - uniformity correction with off-center ^{60}Co ACU scans
- spallation neutrons
  - neutrons produced by comic rays, and captured by Gd with energy peak at ~8 MeV
  - in-situ data calibration with uniform distribution

IV. Summer 2012 Special Calibrations

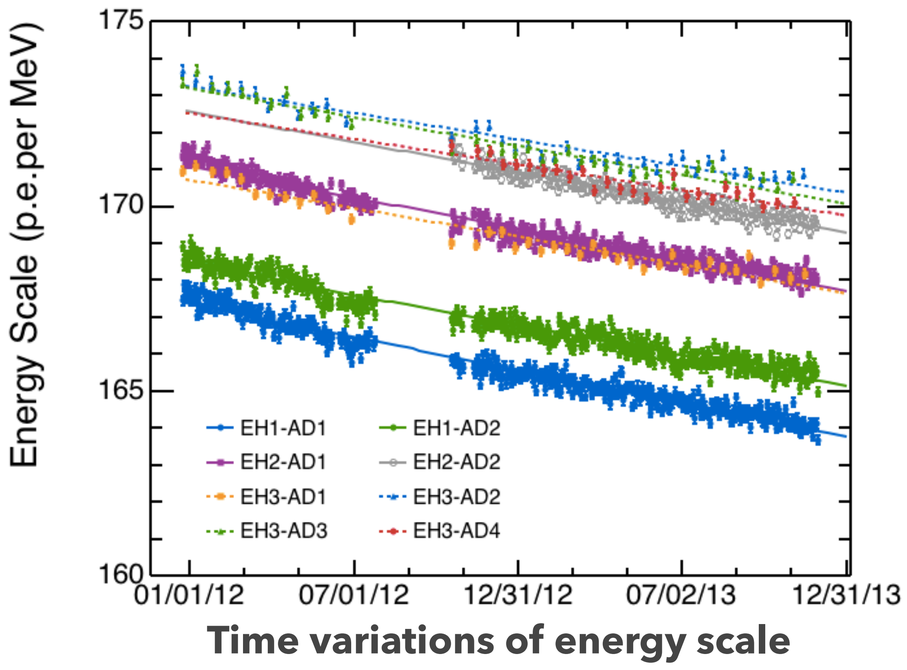
- Manual Calibration System (MCS)
  - deployed ^{60}Co + ^{239}Pu/^{13}C sources inside target volume
  - studied uniformity of the detector
- temporary sources in ACUs
  - ^{137}Cs, ^{54}Mn, ^{40}K, ^{241}Am/^{9}Be, ^{239}Pu/^{13}C
  - studied energy response at several energies
  - constrained spill-in / spill-out effect by neutron sources



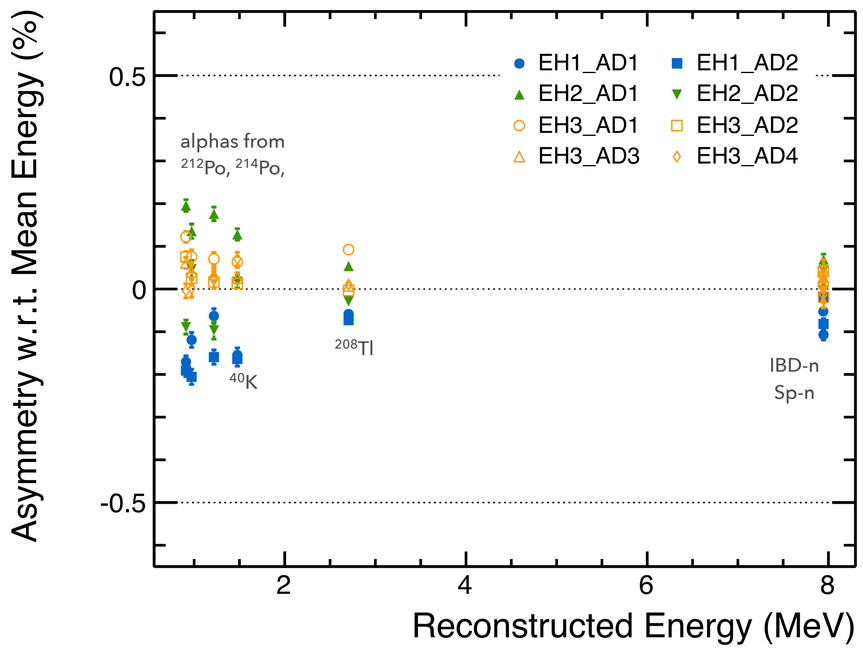
Variation of neutron capture peak (relative to 8MeV) at different source positrons

V. Summary

The Daya Bay experiment has achieved < 0.2% relative energy scale variation for all antineutrino detectors over the whole energy range.



Time variations of energy scale



Relative energy scale of Daya Bay antineutrino detectors

Please also checkout the poster "*Modeling the energy response of the Daya Bay antineutrino detectors*" by Sören Jetter.