Detector calibration in the sub-MeV range in JUNO

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Abstract

Newly developed intelligent event trigger system will enable to lower the JUNO energy threshold down to \(O(10)\) keV, and new calibration sources (such as \(^{226}\text{Ra}\) (186 keV \(\gamma\)-ray), \(^{241}\text{Am}\) (59.5 keV \(\gamma\)-ray)) are planned to be deployed to calibrate this low-energy region. The uncertainty in the energy scale calibration due to the source apparatus geometry and \(^14\text{C}\) contamination effects has been estimated to be less than 1% level, and this poster also presents the status of the radioactive source (\(^{226}\text{Ra}\) preparation).

Calibration in the sub-MeV Range

- New dedicated calibration sources:
  - \(^{241}\text{Am}\): After the \(\alpha\)-decay, 59.5 keV \(\gamma\)-ray is emitted.
  - \(^{241}\text{Am}\) is available from existing \(^{241}\text{Am}^{13}\text{C}\) neutron source.
  - \(^{226}\text{Ra}\): After the \(\alpha\)-decay, 186 keV \(\gamma\)-ray is emitted.
  - Daughter isotopes from \(^{226}\text{Ra}\), such as \(^{214}\text{Pb}\) (352, 295, 242, 53.2 keV), \(^{210}\text{Pb}\) (46.5 keV), also provide low-energy \(\gamma\)-rays.
  - \(^{226}\text{Ra}\) source has been newly produced.
  - Calibration feasibility has been studied using the JUNO simulation.

Estimated Uncertainty in Energy Scale Calibration

- Uncertainties due to the optical shadowing and energy losses in the source apparatus geometry, contaminations of \(^{14}\text{C}\) (\(\beta\)-decay, \(Q\) value \(~160\) keV, exp. rate \(~40\) kHz, \(10^{-17}\) g/g in LS) have been estimated to be less than 1%.
- \(^{14}\text{C}\) backgrounds are reduced by strict vertex position cut and subtracted by “source-off (\(^{14}\text{C}\) only)” samples.