Large Liquid Scintillation Detector for Neutron Measurement

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Neutron Background Measurements

Two categories

- ✓ radioactivity in rock (a, n), fission decay
- ✓ Muon induced spallation neutrons

Fatal background

- behave the same way as signals dark matter
- Neutron caused nuclear activation



LARGE LIQUID SCINTILLATION NEUTRON DETECTOR



Detector Design

- 1m long LS neutron detector filled with 12 liters LS EJ301.
- Internally covered with diffusive paint EJ520.
- 2 Hamamtsu 5" PMTs(R4144) attached to the detector through Pyrex glass windows.



Detector Response



- Working High Voltage: Ch0 2000V, Ch1 2000V, attenuator 23dB applied for Both.
- Time coincidence within 30ns(peak time) are required for two PMTs. Detector response to the room background signal are shown above(Ch0 left, Ch1 right).
- Muon minimum ionization peak and the response to 22Na source along with the Tube are marked in the left figure. We can use these curves for energy reconstruction.





Na22: 1.0µCi. Placed at each 2.5 cm along with the tube. AmBe: 3.33MBq. Placed at the fixed position above the detector.

Response to 22Na source



- Actual position VS charge ratio response to 22Na source(Left).
- Total charge (Ch0) VS charge ratio response to 22Na source(Right)

Energy – Position independent?



$$L_{left} = 0.5L_{tot}e^{-x/l}$$
$$L_{right} = 0.5L_{tot}e^{-(D-x)/l}$$
$$\sqrt{L_{left}L_{right}} = 0.5L_{tot}e^{-D/l} \sim E_{tot}$$

Lright

Energy - Position Independence



Three calibration source energy: Na22(1.27MeV), AmBe (4.4MeV) and muon minimum ionization peak(~20MeV)

n/g Discrimination at Surface



• AmBe source at surface about 68 hours data.

Detector deployment @ Soudan Mine



AmBe Calibration at Soudan Mine



- In order to remove the effect of gamma ray contamination, two layer of lead bricks(4" total) is place right above the tube and the AmBe source located on the top of it.
- We took about two days Ambe data and three days background data w/wo the source.



Detection Efficiency



The detection efficiency curve is determined by simulation.

Surface Data



Surface run with live time about 19 days.

Surface Data



Different from NY surface data measured at the roof, our data are taken in first floor of a three-story building(about 1 m.w.e).

Neutrons at Soudan Mine



Soudan run about 75 days data.

Current Status for Neutron Detection

- The neutron detector has been calibrated with AmBe source both at surface and underground. Simulation results match the data between 4~10 MeV pretty well.
- About 20 days neutron surface data and 6 months Soudan underground data have been taken and analyzed. The fast neutron energy spectrum have been reconstructed.
- The whole setup will be deployed to Homestake Mine 4850ft level this fall.

Thanks for your attention Questions?

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Backup I: Quenching factor(KamLand)

