Title: An in-situ ZnS(Ag) UCN detector: conceptual studies

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UCNTau, collaboration

Intended for: discussion with potential external collaborators
Web

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An in-situ ZnS (Ag) UCN detector

Z. Wang, C. L. Morris for the Lifetime Experiment

Los Alamos National Laboratory

Updated: Mar 21, 2014
Proposed measurement

- No material barriers in-between UCN’s and detector
- Real time
- UCN Spectroscopy (Adjustable in height)
Detection principle ($n \gg \alpha$, $^7\text{Li} \gg h\nu \gg e^-$)

$10^B + n \rightarrow ^7\text{Li} (0.84 \text{ MeV}) + \alpha (1.47 \text{ MeV}) + \gamma (0.48 \text{ MeV}), \quad (94\%)

$^7\text{Li} (1.02 \text{ MeV}) + \alpha (1.78 \text{ MeV}), \quad (6\%)$
Charge propagation

![Graph showing charge propagation in ZnS (Micron) vs. energy (keV), with distinct lines for different particles such as $^4\text{He}$ and $^{241}\text{Am}$]
ZnS (Ag) / Light yield

- Proven use for MeV charge particle detection
- Inorganic scintillator
- Eljen
  - 120 um thick substrate
  - 16 um average particle size
  - 4.09 g/cc
- Other suppliers
Component Testing
(for detector design)

- ZnS (Ag) Thickness
- Sensitivity to alpha’s w/different energies;
- Noise/background
- $h\nu \rightarrow e$ detector selection
Testing setup
α-response (on-contact)

/home/ucnbdaq/FADC/Data/Test/Processed/run235D.root

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![Graph showing α-response for Am-241, Gd-148, and background (bkg).]
PSD interpretation/Thin-Slab model

ZnS

Straggling $\rightarrow$ broadening (convolution function)
ZnS thickness scan (Thick slab)

1x = 3.25 mg/cm² (7.9 um)

(< 4 um thickness)
Alpha energy scan (II)

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300 s

0x, 2x, 4x, 6x, 8x, 10x, 12x, 14x thickness (1.473 mm)
PSD interpretation

ZnS

ZnS
Summary

• ZnS(Ag) substrates characterized through alpha-particle measurements
  – Am-241, Gd-148 sources;
  – 3” PMT
  – ZnS different thickness, manufacturers

• PSD can be explained by charge particle stopping + straggling

• Prototype fabrication underway
  – Detector design (3” diameter)
  – B-10 coating (~ 100 nm thick)