**Background Radiation Studies for Future, Above-Ground Antineutrino Detectors**

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**Abstract**

This poster will describe an assembly of detectors that quantifies the background radiation present at potential above ground antineutrino detector sites. Antineutrino detectors show great promise for safeguard applications in directly detecting the total fission rate as well as the change in fissile content of nuclear power reactors. One of the major technical challenges that this safeguard application must overcome is the ability to distinguish signals from antineutrinos originating in the reactor core from noise due to background radiation created by terrestrial and cosmogenic sources. To date, antineutrino experiments have increased the signal to noise in their detectors by this system. For antineutrino monitoring to be a widely deployable solution, we must understand the backgrounds found above ground at nuclear power plants that can mimic the antineutrino signal so that these backgrounds can be easily identified, separated, and subtracted rather than shielded. The design, construction, calibration, and results from the deployment of these detectors at a variety of sites will be presented.

**Antineutrino Safeguards and Monitoring**

- **Cooperative Monitoring**
  - Agencies such as the I.A.E.A. track the flow of fissile material through the civilian nuclear fuel cycle
  - Current reactor safeguards involve:
    - Checking declarations
    - Containment and surveillance
    - Event accounting
- **Flawed**
  - Require expensive detailed inspections
  - Do not directly measure the Pu created in the reactor

- **Antineutrino Monitoring**
  - Determine operational status (On vs. Off)
  - 99% confidence within 5 hours
  - Directly measure the thermal power of the reactor
  - 8.3% error for daily measurements
  - 3% error for weekly measurements
  - Directly track fissile content of the reactor core
- **Detector** is low maintenance, remotely deployable, and gives real-time estimates of the fissile content.

**Background Monitor-Deployment and Results**

- **Detector Assembly**
  - NaI
- **Gamma spectrum with 10% energy resolution at 662 keV**
- **Energy range- 600 keV to 4 MeV**
- **Liquid Scintillator**
  - 2” cell with Eljen 301 scintillator
  - Gamma/Neutron pulse shape discrimination
- **Energy range 600 keV to 4 MeV**
- **Neutron**
- **Muons**
- **Paddle**
- Allows for correlations between muons and gamma/neutrons
- **He**
- **Thermal neutron rate**

**Deployment**
- 01/2008 Above-ground Sandia, California
- 02/2008 6 meters water equivalent (m.w.e.), University of Chicago
- 03/2008 2nd floor above-ground, University of Chicago
- Summer 2008 Above-ground at a nuclear power plant (planned)

**Detector Calibration**

- **Pulse Shape discrimination**
- **Comparison of detector rates at 241Am/Be source 1 meter from liquid scintillator cell**
- **Two-dimensional cut on energy and pulse timing**
- **Muon Paddle**
- **2nd story office in LASR at UC**

**Detector Results**

- **Comparison of detector rates at 6 mwe at UC**

**Summary**

- **Two particles from unrelated events** deposit energy in the detector
  - Gamma, muons, etc.
- **Random time intervals between events**
- **Require correlated timing**
- **Done in analysis**
- **Adding radiopure materials**
- **Adding gamma and neutron shielding**
- **Arbitrary size to the footprint**

**Conclusion and Ongoing work**

- **Portable background radiation monitor with multiple detector sites** is important when moving antineutrino detectors above ground.
- **Both correlated and uncorrelated antineutrino backgrounds** will increase one to two orders of magnitude above ground.
- **Next:**
  - **Measure absolute radiation rates at a variety of above-ground sites**
  - **Measure timing correlations between muons and other radiation particles**
  - **Compare rates to the underground tendon gallery**
  - **Adapt to future needs**