COHERENT experiment: CsI detector

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on behalf of COHERENT
Outline

1. COHERENT detectors: location at SNS
2. CsI detector shielding and veto
3. Data taking and analysis strategy
4. Signal/background
5. Calibration and QF measurements
CsI [Na] detector location

Spallation Neutron Source

SNS basement, ~ 8 m.w.e. overburden

Looking for CEvNS – coherent elastic neutrino-nucleus scattering
Crystal parameters and shield design

The set up was developed at the University of Chicago

CsI[Na] cylindrical crystal manufactured by Amcrys-H, Ukraine:

- diameter: 11 cm,
- length: 34 cm,
- weight: 14.5 kg
- R877-100 PMT

Shielding design

<table>
<thead>
<tr>
<th>Layer</th>
<th>HDPE*</th>
<th>Low backg. lead</th>
<th>Lead</th>
<th>Muon veto</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>3”</td>
<td>2”</td>
<td>4”</td>
<td>2”</td>
<td>4”</td>
</tr>
<tr>
<td>Colour</td>
<td></td>
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* - high density polyethylene
Shield assembling
Data taking and analysis strategy

Recording of 70 μs waveforms with 500 MHz sampling of CsI and veto channels

\[ \text{ROI (After trigger)} - \text{ROI (Before trigger)} = \text{CEvNS} + \text{Beam correlated background} + \text{Fluctuations of the steady background} \]
- The steady state background at the SNS is by a factor of 5-10 smaller than the measurement performed at the University of Chicago laboratory (~6 m.w.e. overburden, almost similar shielding).

- The quenching factor has been remeasured indicating non-trivial increase in expected signal yield (TUNL and University of Chicago measurements).

- Expected neutrino induced neutron background rate is ~4% of the CEvNS signal due to HDPE.

$^{241}\text{Am}$ calibration and QF

$^{241}\text{Am}$ calibration, 59.54 keV

- photoelectrons $\rightarrow$ keVee
- the light yield shows $<\sim 2\%$ deviation along the length of a crystal

QF measurement at TUNL

D(D,n) neutron production, 12 backing detectors and the “zero-degree” beam monitor

- keVee $\rightarrow$ keVnr

two different datasets taken and two separate analyses performed by Chicago and Duke at TUNL
$^{133}$Ba calibration

A collimated pencil beam of $^{133}$Ba gammas is used to trigger on forward scattered gammas.

The maximum single scattering angle for a coincidence signal is $\theta \sim 12^\circ$.

Corresponding energy – up to 6.2 keV

Goal:

To have a dataset with few to few tens phe events to “train” cuts on a BrilLanCe crystal to trigger on forward scattered gammas.
Summary

Data and operation:

• $^{241}$Am and $^{133}$Ba calibrations of CsI[Na] detector were done
• QF measurements of CsI[Na] were performed
• CsI[Na] detector has been taking data for ~1 year at SNS (~400 CEvNS)

Analysis:

• $^{241}$Am analysis is mostly finished
• $^{133}$Ba is in process  We are starting to look at ROI!
• QF analysis is coming to its end

Plans:

• continue data taking at SNS
• perform in-situ neutron calibration with $^{252}$Cf
Backup: low energy event at SNS
Backup: QF measurements at TUNL

TUNL shielded source area (SSA)

- D(D,n) generator (3.8 MeV)
- Shield to attenuate off-axis neutrons
- Scatterer under investigation (not shown)
- Twelve backing detectors
- Zero-degree beam monitor