Water Phase Energy Calibration in SNO+

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Outline

SNO+ Goals & Detector

Expected Signal

$^{16}\text{N}$ Source

Monte Carlo Simulations

Updating the Source Geometry

Conclusion
Physics Goals

Water Phase
  • Invisible Nucleon Decay
Pure Scintillator Phase
  • Solar Neutrinos
Tellurium Loaded Scintillator
  • Neutrinoless Double Beta Decay
All Phases
  • Supernova Neutrinos
  • Geo/Reactor Antineutrinos
SNO+ Detector

Acrylic Vessel
- 12m diameter

Phototube Support
- 9500 PMTs
- 54% coverage

Water Shielding
- 1700 tonnes inner
- 5300 tonnes outer

Phase I - Light Water
- 900 tonnes

Phase II - Scintillator
- 780 tonnes

Phase III - Te Loaded
- 3900 kilograms
Current Status

Rope net holds detector down in scintillator phase

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Invisible Nucleon Decay

Oxygen-16

\[ n \rightarrow \nu \nu \nu \nu \]

Oxygen-15

\[ \gamma = 6.18 \text{ MeV} \]

Nitrogen-15

\[ \gamma = 6.32 \text{ MeV} \]
Expected Signal - Monte Carlo Study

Understand Energy Scale with $^{16}$N Calibration Source

$^{[1]}$I. Coulter, SNO+ Collaboration
$^{16}\text{N} \text{ Source}$

Cleaned, measured and reassembled

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Run Plan

- Starting 25 May 2015 for Water Phase
- 104 unique positions
- Initially only scan in Z
- High stats central run
- Scans change in steps of 50cm
- 30 minute runs @500Hz
- External runs can be done for Scintillator Phase

Z Scan
- Z: -550.0cm ↔ 550.0cm

X scan
- X: -550.0cm ↔ 550.0cm

Y Scan
- Y: -550.0cm ↔ 550.0cm

3.0m ‘Corners’
2.3m ’Corners’
External Scan
- X: -586.11cm
- Y: -252.41cm
- Z: -500.0cm ↔ 500cm
First Look at $^{16}$N Data

Single Event from a Central Run from $^{16}$N Source

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Central $^{16}$N Monte Carlo

Energy from RSP fitter

<table>
<thead>
<tr>
<th>energyRSP</th>
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<tbody>
<tr>
<td>Entries</td>
</tr>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>RMS</td>
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Measured Cerenkov photons from Gamma produced electrons

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Central $^{16}$N Monte Carlo

Nhits versus RSP fitter

Correlation between number of PMTs hit versus Energy

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Monte Carlo - Full Z Scan

Change in Reconstructed Energy over Z-axis Scan

Need input from Calibration constants to improve fit
Updating the Source Geometry

SNO  Updated SNO  SNO+
Updating Source Geometry - Continued

Not a significant change and makes code run \approx 1.8\% quicker
Conclusion

$^{16}$N calibrations runs started 25 May 2017!!!

Energy Fitter needs $^{16}$N for efficiency model

Energy bias will improve with new timing calibrating runs

Correct geometry updated for Monte Carlo
Questions?
Backup Slides
# $^{16}$N Decay Scheme

$^{16}$N \( \rightarrow \) $^{16}$O$^\ast$ 7.13 s

\[ Q^+ \quad 10419.1 \text{ keV} \]

B$^-$: 100% $\rightarrow$ $^{16}$O$^\ast$

<table>
<thead>
<tr>
<th>J$^\pi$</th>
<th>En [keV]</th>
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<td>2+</td>
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<td>0+</td>
<td>6049.4</td>
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<tr>
<td>0+</td>
<td>0</td>
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$^{16}$O$^\ast$ STABLE

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