Solar Neutrinos From XENONnT and Single Photo Electron Calibration of ABALONE

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Section 1

Solar Neutrinos From XENONnT

Solar Neutrinos From XENONnT

Outline

- ➢ The XENON Experiment
- ➢ The ^{8}B Neutrino Signal
- ➢ Backgrounds
- ➢ Result
- ➢ Outlook

Component	Expectation	Best Fit
AC (SR0)	7.5 ± 0.7	7.4 ± 0.7
AC (SR1)	17.8 ± 1.0	17.9 ± 1.0
ER	0.7 ± 0.7	$0.5^{+0.7}_{-0.6}$
Neutron	$0.5^{+0.3}_{-0.2}$	0.5 ± 0.3
Total Background	$26.4^{+1.4}_{-1.3}$	26.3 ± 1.4
^{8}B	$11.9^{+4.5}_{-4.2}$	$10.7^{+3.7}_{-4.2}$
Observed	37	

With an expected 38.3 events we saw 37 events.

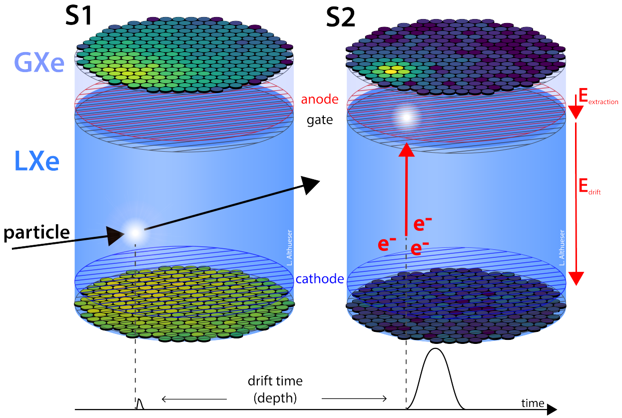
Reject BG only hypothesis at $\Rightarrow 2.73\sigma$

arXiv:2408.02877

The XENONnT Detector

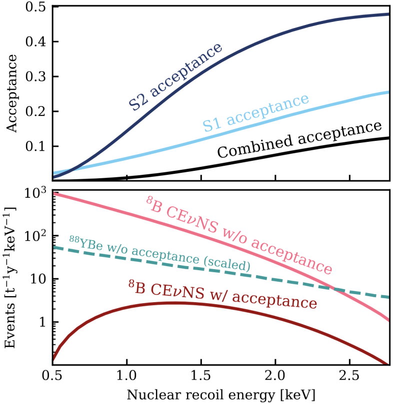
Our dual-phase TPC:

- ➢ DM interaction produces prompt scintillation light (S1) and electrons
- ➢ Electrons drift upwards and produce a second pulse in the gas phase (S2)



The Solar ^{8}B Neutrino Signal

- ^{8}B decay produces neutrinos in the sun
  $^8B \rightarrow {}^8Be + e^+ + \nu_e$
- Signal nearly identical to the WIMP signal
- Solar ^{8}B neutrino flux measured by the SNO experiment and the standard model Xe-CEνNS cross section give the expected spectrum on the right



Backgrounds

- Accidental coincidence (AC)
  - Spurious SPE and small S2 hits after high energy events
- Surface
  - Produced by ^{210}Pb on the TPC wall
- Neutron
  - Radioactivity from detector materials
- Electronic recoil (ER)
  - From nuclear decay and external gamma rays

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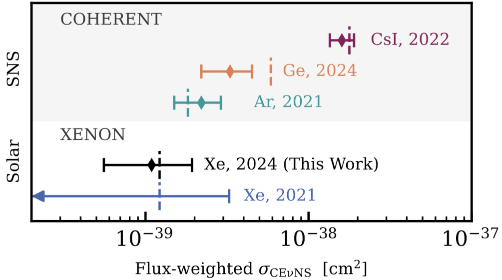
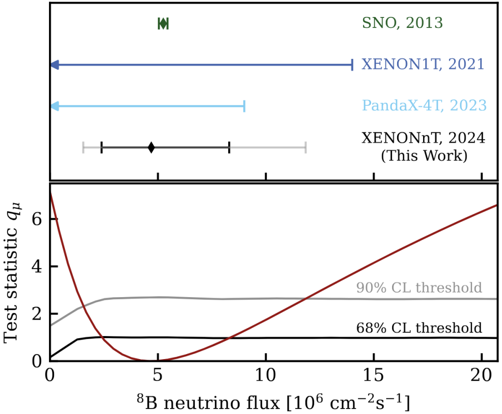
Result

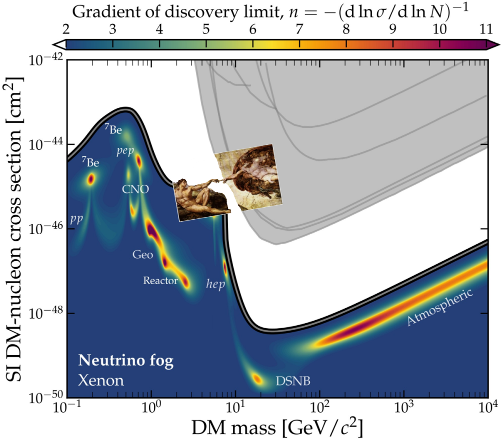
- 3.5 ty of exposure gathered in total
- Expected: 26.4 BG + 11.9 ^{8}B events
- 37 events measured $\rightarrow$ 2.73σ





Outlook

- ➢ First measurement of CEνNS with Xe nuclei from a blind search
- ➢ Neutrino flux and CEνNS cross section consistent with SNO measurement and SM prediction
- ➢ First step into the neutrino fog
- ➢ More data is being taken $\rightarrow$ more precise measurements to come



courtesy Ciaran A. J. O'Hare and Dominik Fuchs

Section 2

Model Independent Single Photon Calibration for ABALONE

Outline

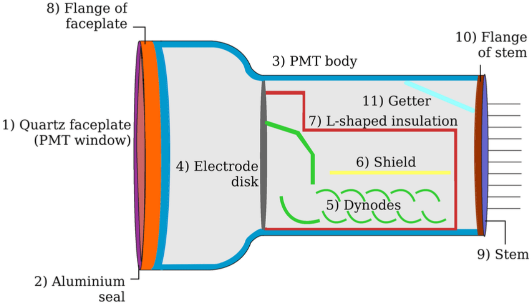
- ➢ The ABALONE Photosensor
- ➢ SPE Calibration Methods
- ➢ Results
- ➢ Outlook

arXiv:2111.02924

The ABALONE Photosensor

PMT:

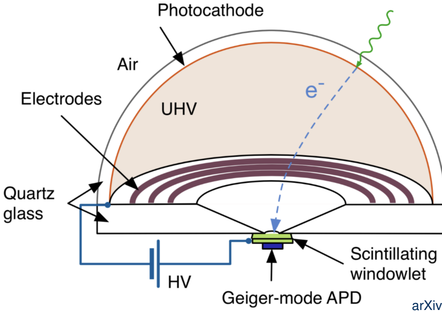
- complex, manual construction, many radioactive materials



arXiv:1503.07698

ABALONE:

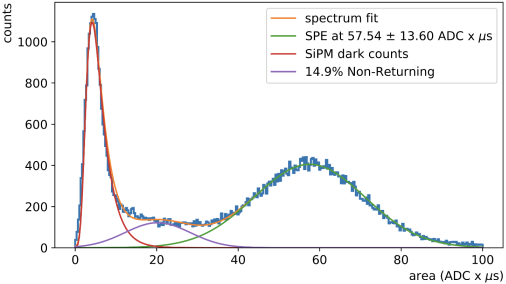
- 2 main glass components, very radiopure



arXiv:2111.02924

The Fitting SPE Calibration Method

- ➢ Use LED at very low voltage as single photon source
- ➢ Find peaks using threshold
- ➢ Fit the distribution with a model



arXiv:2111.02924

The Model Independent Method I

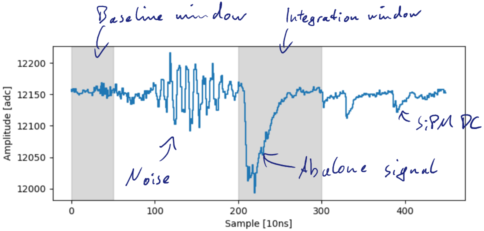
arXiv:1602.03150

Let $E[S]$ and $E[B]$ denote the means of the singal and the background (noise + SiPM DC) distribution.

$$E[S] = E[S + B] - E[B]$$

Similar we can calculate the second moments of the distributions.
Take an LED and a noise dataset and integrate a fixed window around the LED peak.

→ The mean area of the LED signal



The Model Independent Method II

arXiv:1602.03150

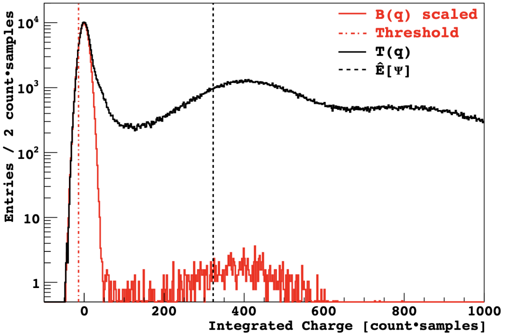
The we can get the mean number of photons in the LED signal (occupancy) using the poisson statistics of the LED photon emission:

$$L(p) = \frac{\lambda^p e^{-\lambda}}{p!}$$

$$\lambda = E[L]$$

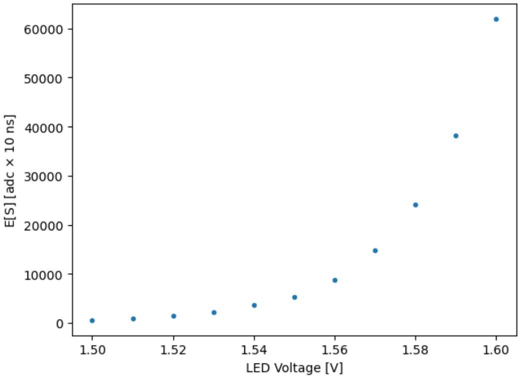
$$\lambda = -\ln(L(0))$$

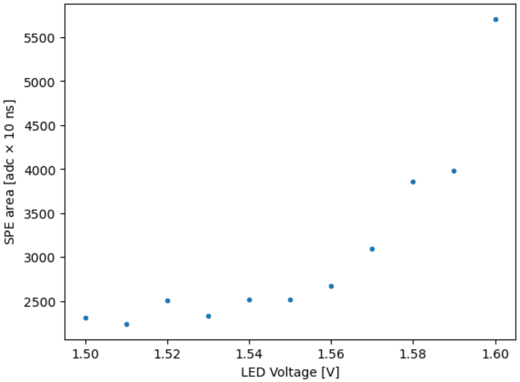
Make a cut on the signal distribution, such that there are no signal events left. Use the shape of the background distribution to correct for empty events above the cut.



arXiv:1602.03150

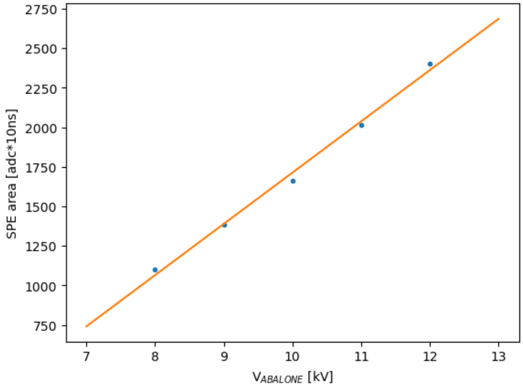
SPE Area vs LED Voltage



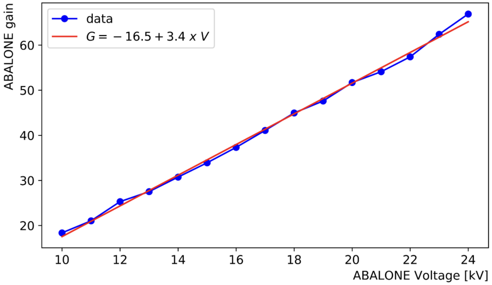


SPE Area vs ABALONE Voltage

Model independent method



Fitting method



arXiv:2111.02924

Outlook

This is preliminary, more verification needed. Cautiously optimistic, that the model independent method will also work for ABALONE

- ➢ No reliance on model
- ➢ Inclusion of underamplified PE
- ➢ More robust to noise
- ➢ Computationally less expensive

Thank you for your attention!