CEνNS detection and SNEWS implementation in XENONnT

Amanda (Depoian) Baxter
adepoian@purdue.edu

SNEWS Collaboration Meeting
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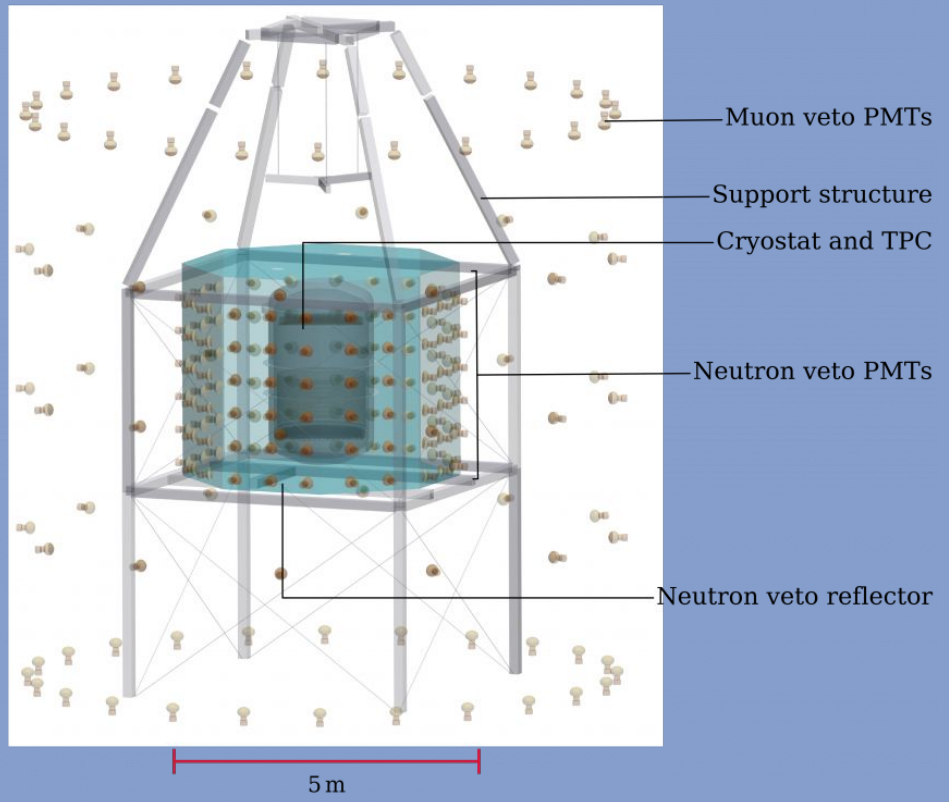
PURDUE UNIVERSITY

XENON

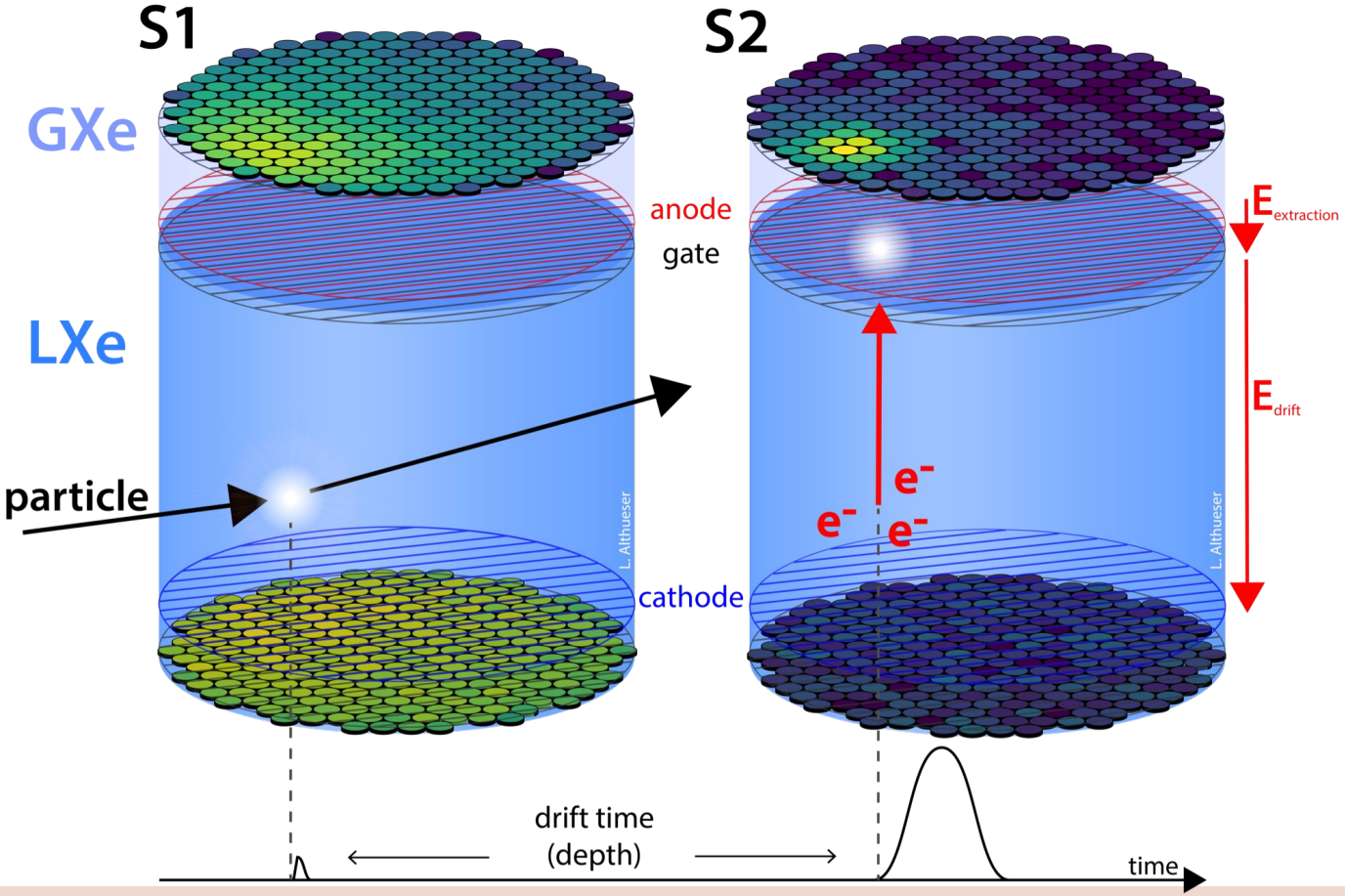
XENONnT

- Water Cherenkov Muon Veto
- Gd-Loaded Water Neutron Veto
- Time Projection Chamber
  - 5.9 tons of Xenon
  - 1.5 m tall x 1.3 m diameter
  - 494 PMTs

XENON Collaboration (arxiv: 2007.08796)



A. Baxter (adepoian@purdue.edu)


S1
S2
GXe
LXe
anode
gate
cathode
particle
e⁻
e⁻
e⁻
E extraction
E drift
drift time
(depth)
time
L. Althueser
L. Althueser

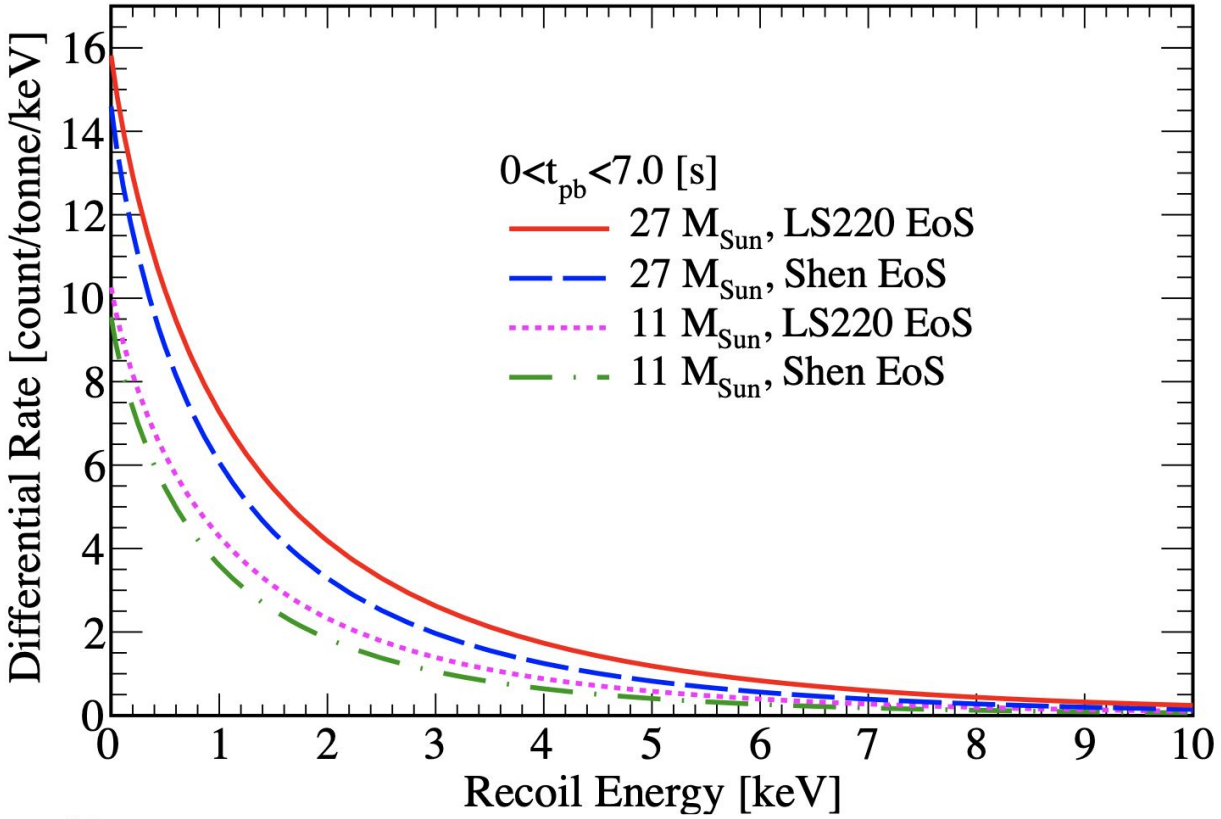
$$\frac{d\sigma}{dE_R} \propto A^2$$

$A = 131$ for xenon

This gives an enhancement in the scattering cross section for CEνNS interactions.

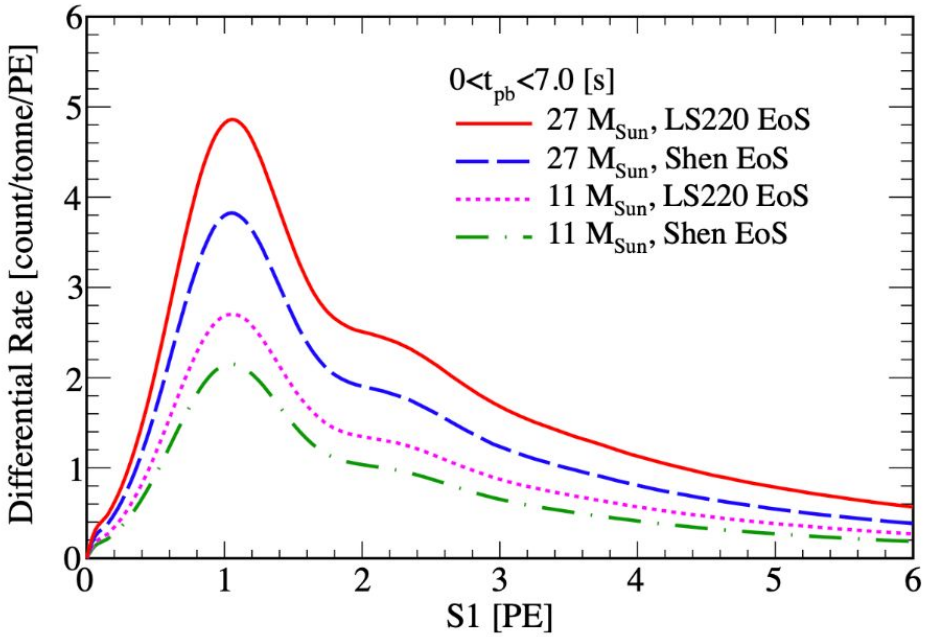
Analysis Channel	S1 Threshold	S2 Threshold	Detection Limitations
Standard WIMP	3 PE	200 PE	Energy threshold
2-fold analysis	2 PE	120 PE (4 e^-)	Energy threshold and backgrounds
S2-only analysis	0 PE	150 PE (5 e^-)	Backgrounds
		14 PE (1 e^-)	

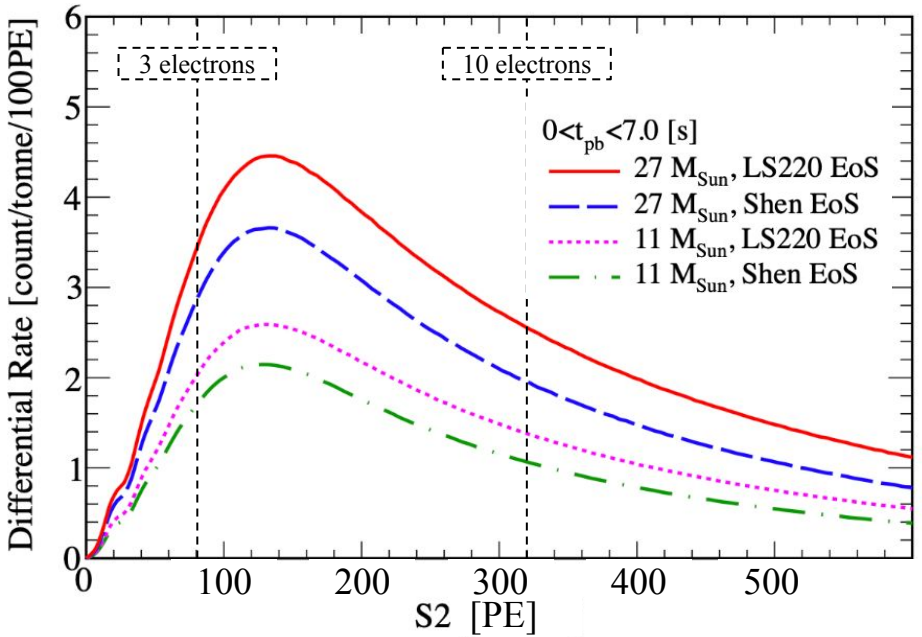
XENON Collaboration
(arxiv: 1805.12562, 2012.02846, 1907.11485, 2112.12116)



- Low-energy recoils
- Few events per tonne per keV
- 6 tonne FV in XENONnT

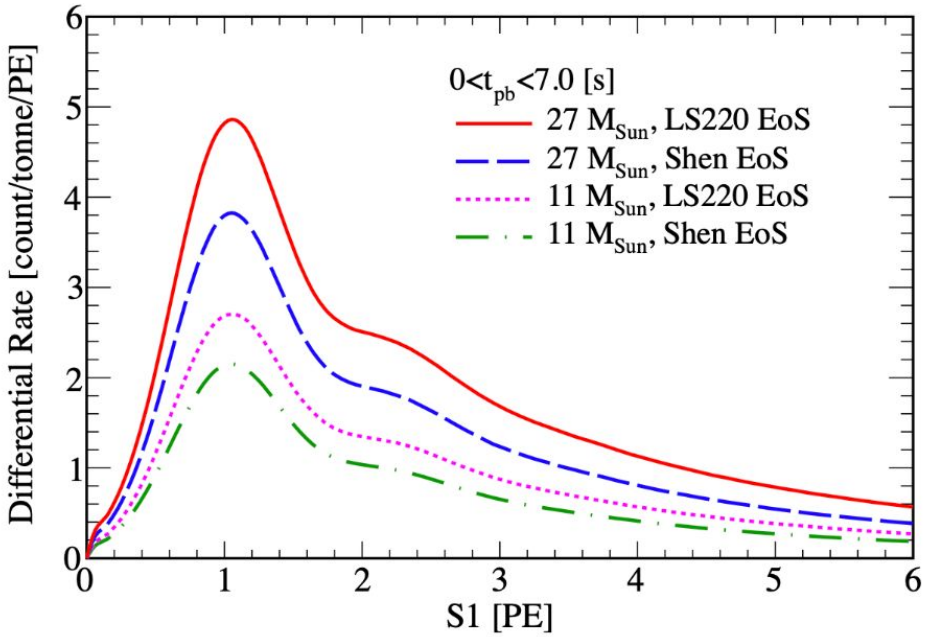
Lang et al. (arxiv: 1606.09243)

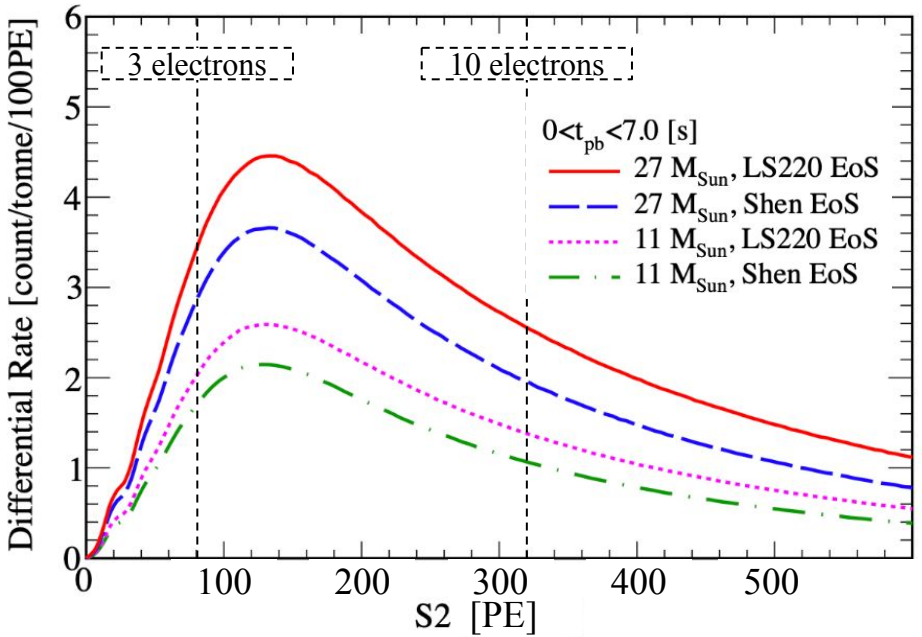




Optimal analysis channel is the S2-only analysis.

Lang et al. (arxiv: 1606.09243)

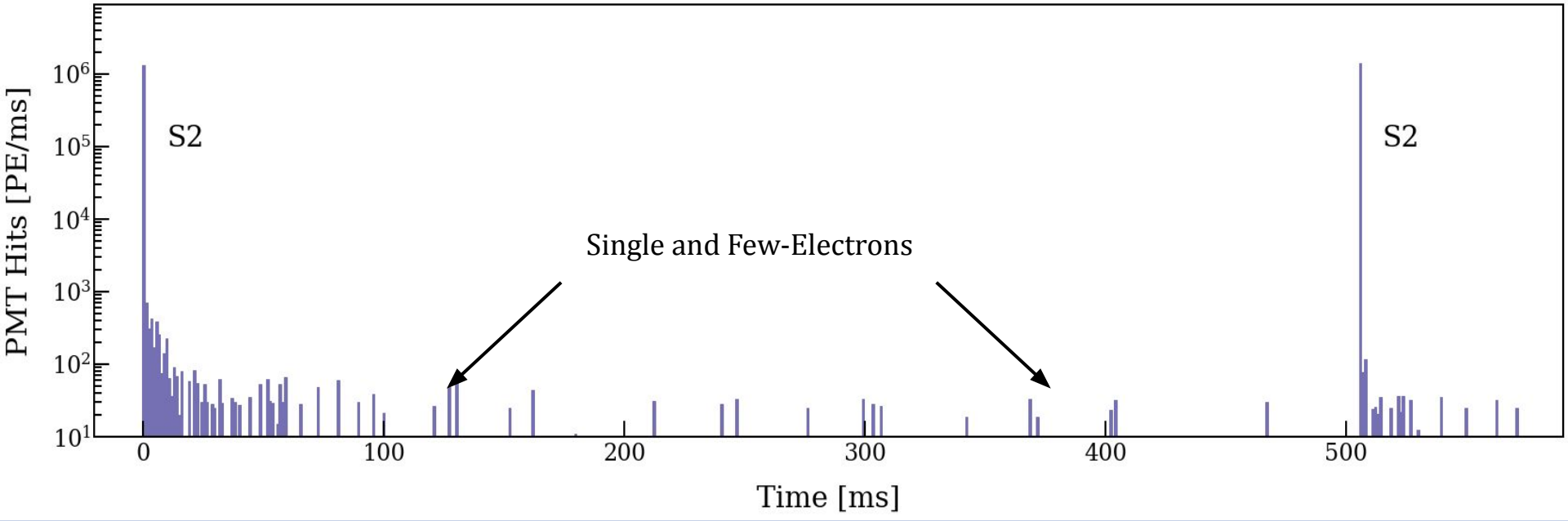




Optimal analysis channel is the S2-only analysis.

But this channel is plagued with few-electron backgrounds.

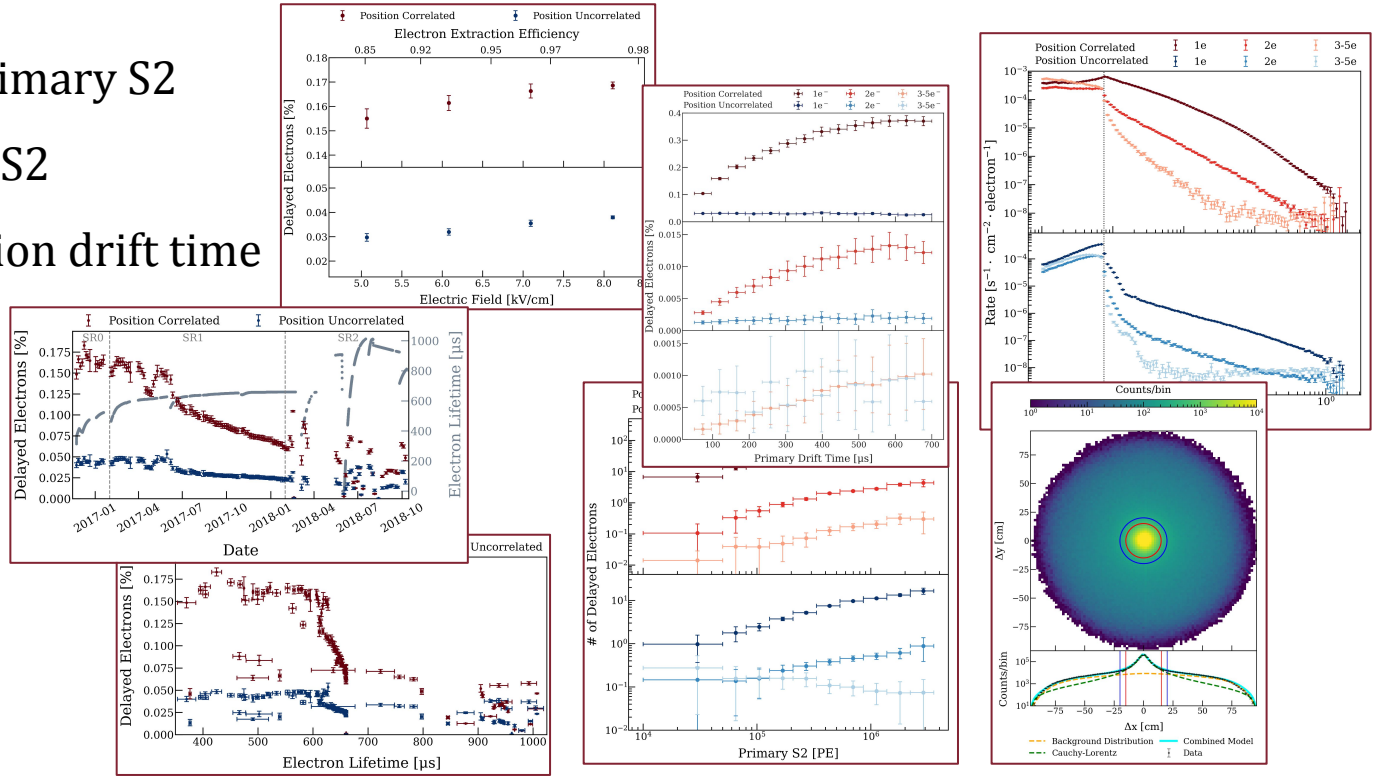
Lang et al. (arxiv: 1606.09243)



XENON Collaboration (arxiv: 2112.12116)

Backgrounds plaguing low recoil energy regions

- XY-Position to Primary S2
- Time to Primary S2
- Primary interaction drift time
- Primary S2 size
- Extraction Field
- Xenon Purity
- Long-time scales

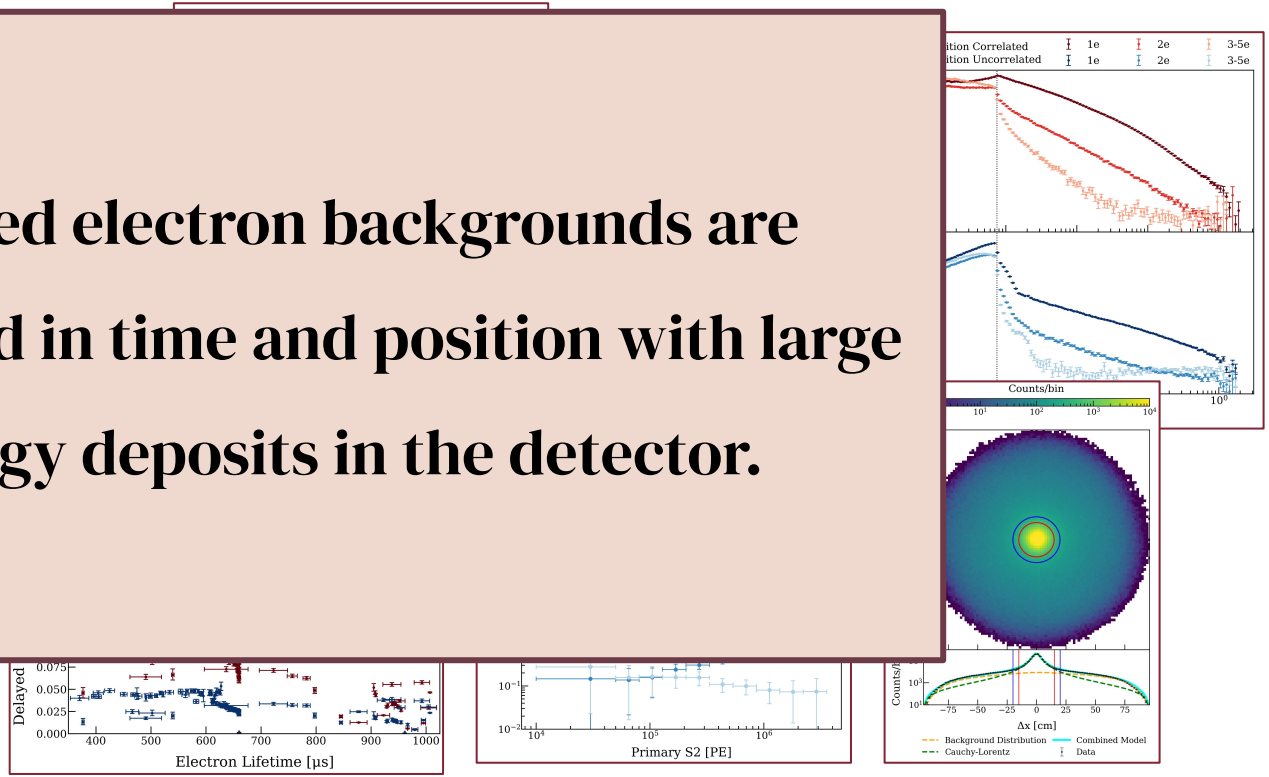


XENON Collaboration (arxiv: 2112.12116)

Backgrounds plaguing low recoil energy regions

- XY-Pos
- Time t
- Primar
- Primar
- Extract
- Xenon
- Long-t

Delayed electron backgrounds are correlated in time and position with large energy deposits in the detector.



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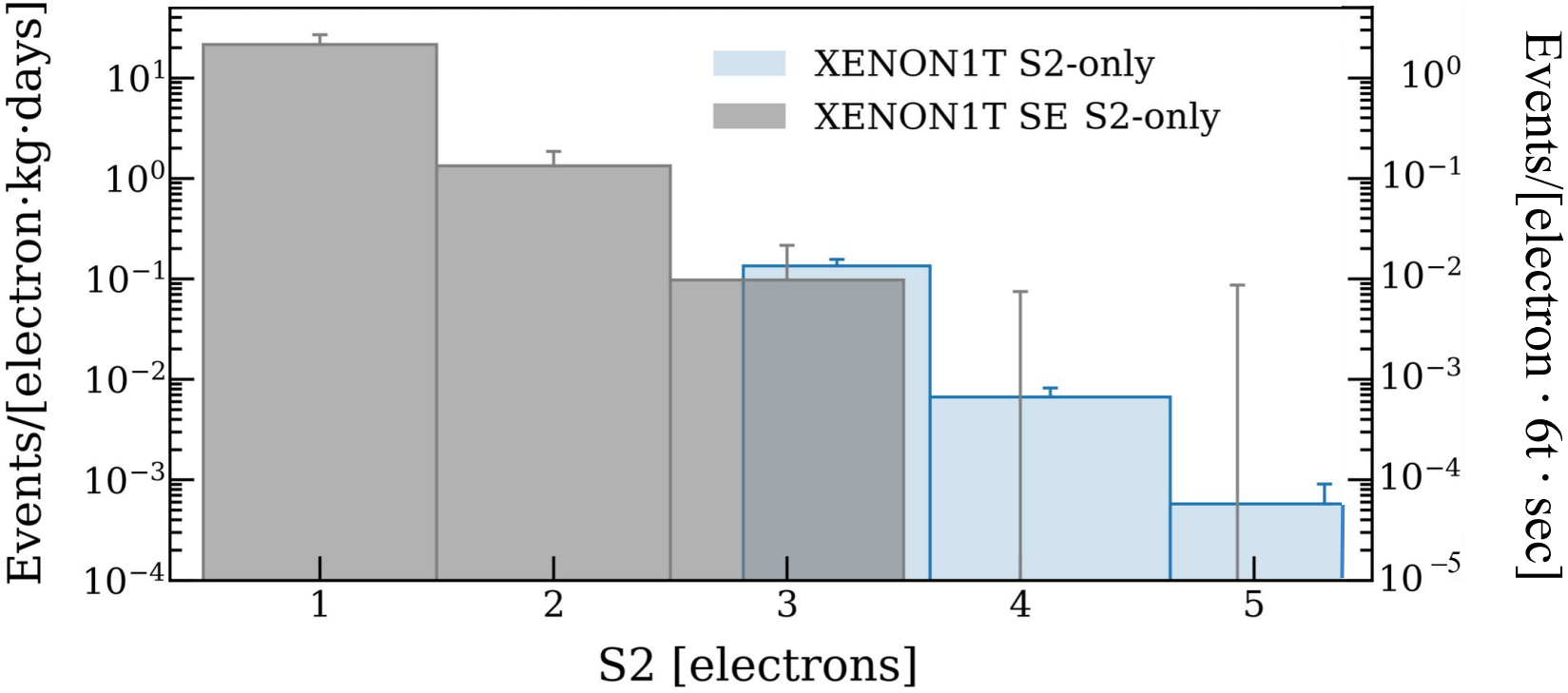
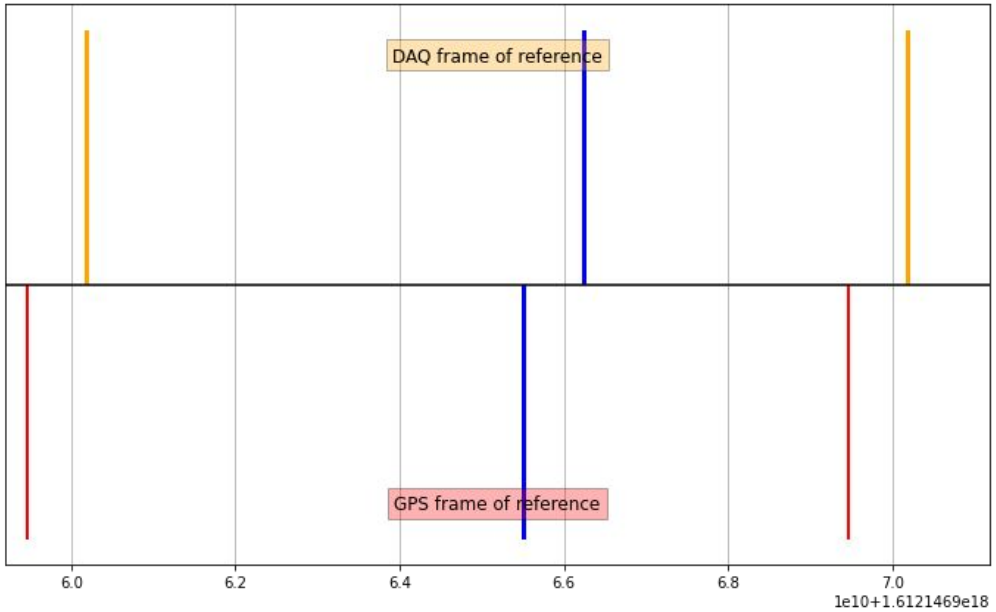


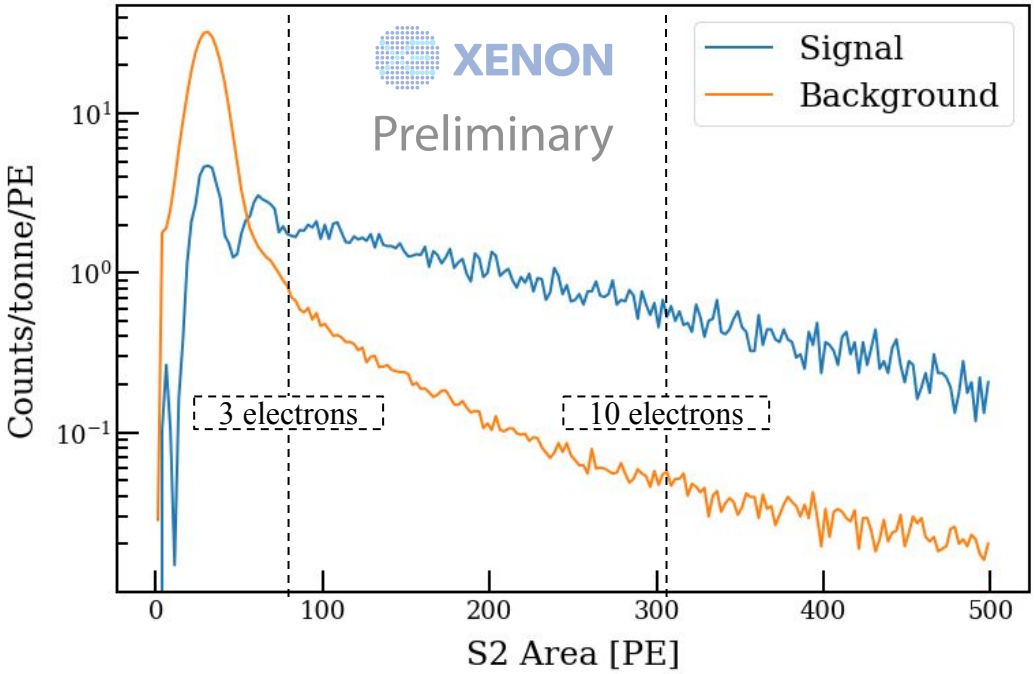
SNEWS Implementation - Done

- We have GPS timestamps implemented and available.
- XENONnT is able to communicate with SNEWS via HOPSKOTCH and participated in the 1st fire-drill.
- Integrated all SNEWPY models into xenon waveform simulator.



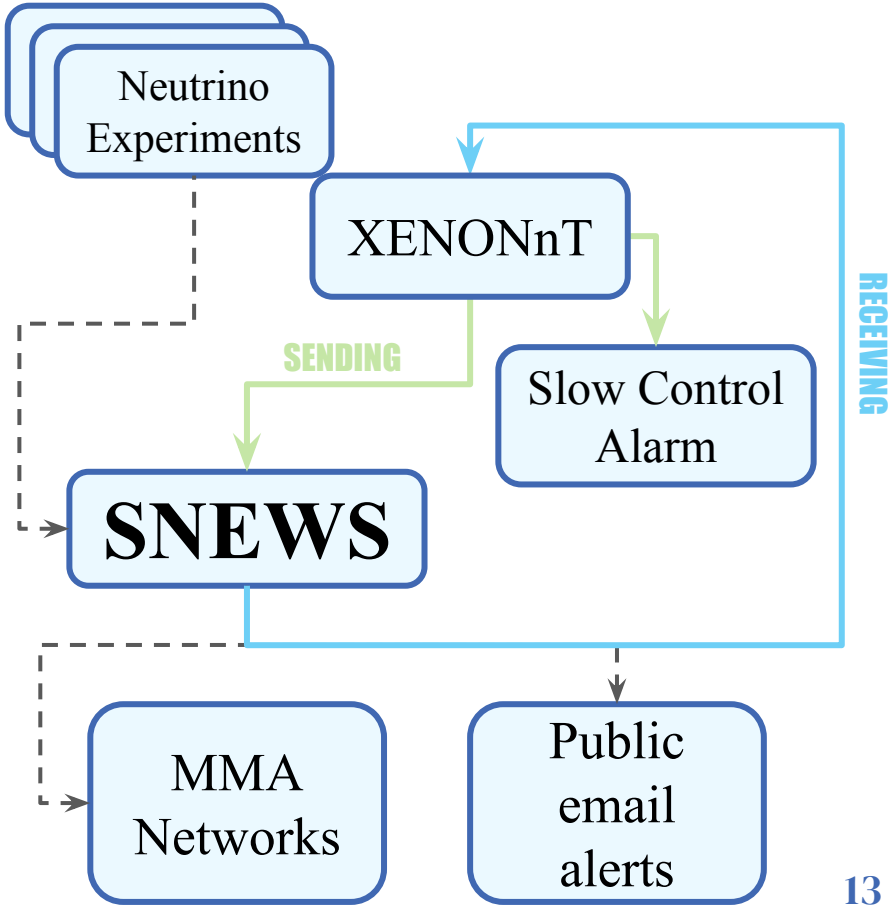
SNEWS Implementation - In Progress

- Understanding the expected signal is under way.
- Writing script to continuously pull new data (every 21 s) and monitor for SNν.
- Optimizing cuts to reduce background.
- Defining threshold above background to trigger alarms.



SNEWS Implementation - To Be Completed

- Set up slow control alarms for internal alarms.
- Run script to continuously pull new data and monitor for SNν.
- Include veto detectors in trigger (charge-current interactions).
- Finalize alert procedure (do nothing!) for on-site shifters and experts.



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Summary

- XENONnT will detect supernova neutrinos via CEνNS.
- Delayed electron backgrounds plague our S2-only analysis, but we have characterized these backgrounds to remove them.
- XENONnT will be listening and sending heartbeats soon (hopefully by the end of this week)!

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