CEνNS detection in XENONnT

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on behalf of the XENON Collaboration

PURDUE UNIVERSITY

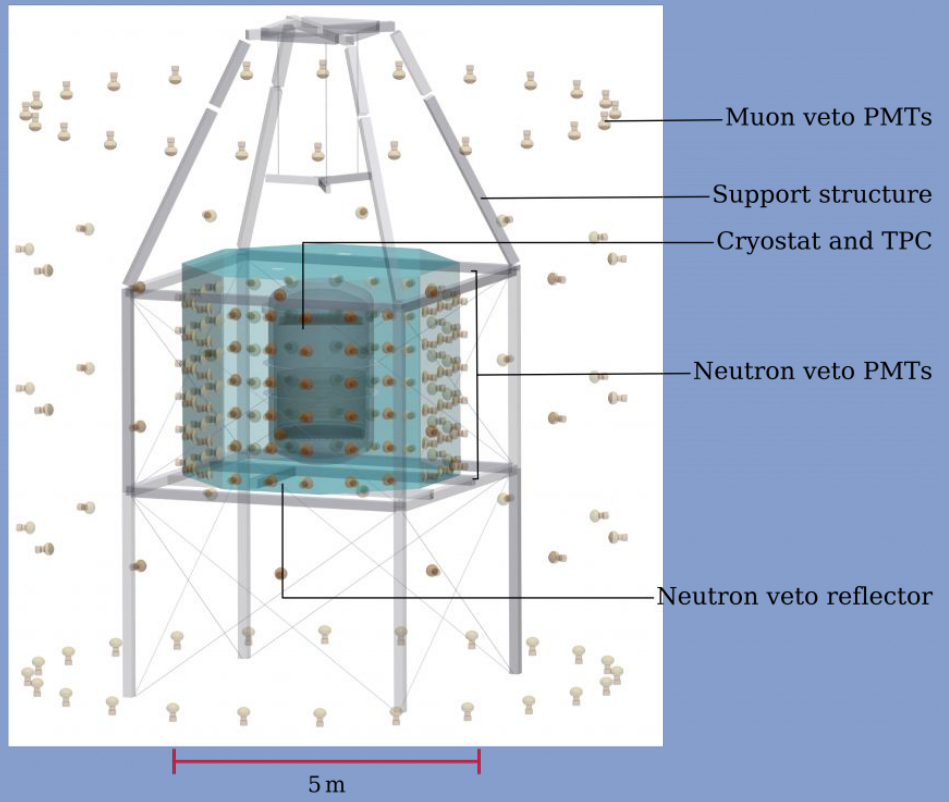
XENON

Columbia
KIT
Nikhef
Muenster
Stockholm
Mainz
MPIK, Heidelberg
Freiburg
Zurich
Chicago
Tsinghua
UCSD
Tokyo
Rice
Nagoya
Purdue
Kobe
Subatech
Coimbra
LPNHE
Torino
Bologna
L'Aquila
LNGS
Napoli
Weizmann
NYUAD

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)



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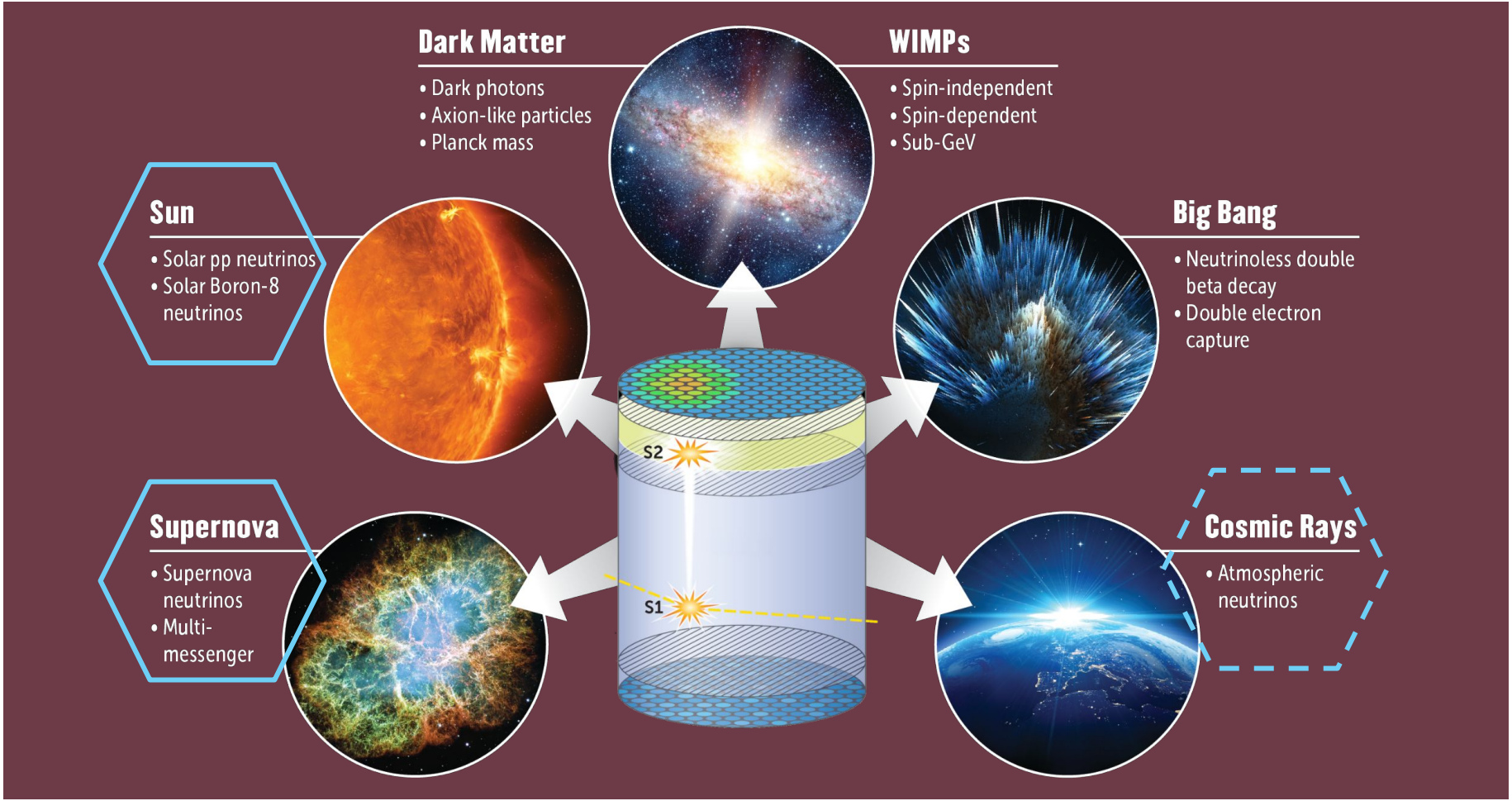
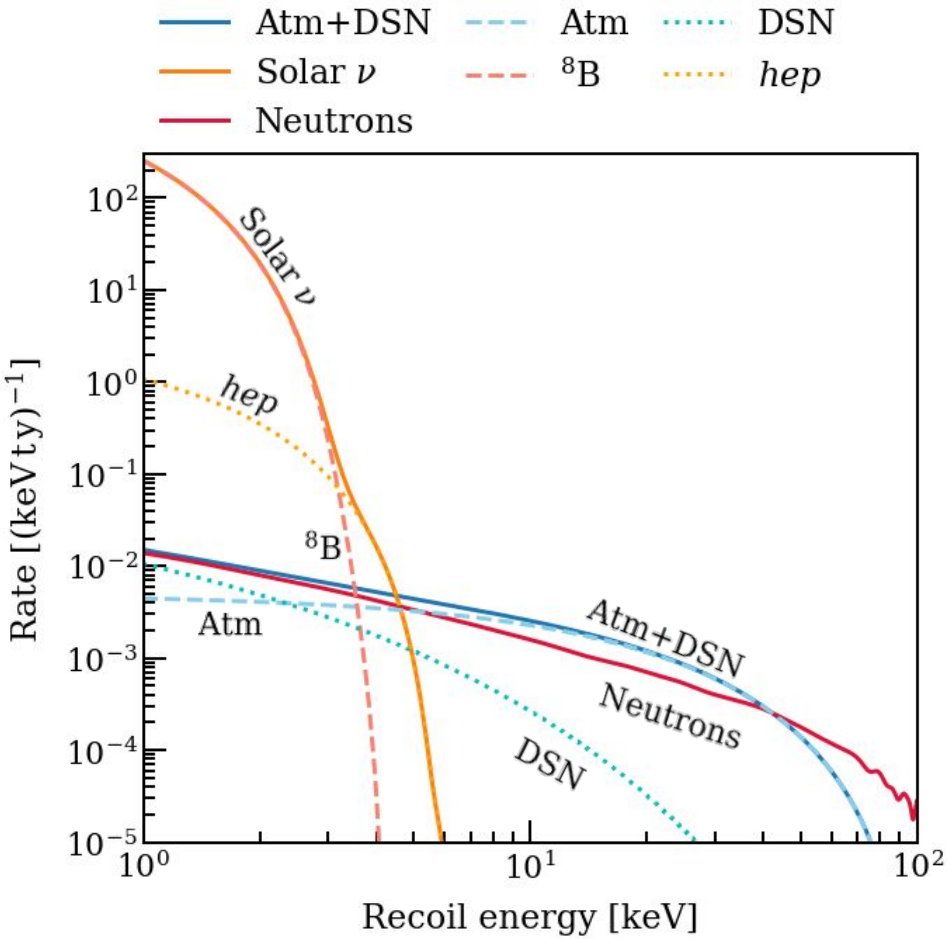

Dark Matter
• Dark photons
• Axion-like particles
• Planck mass
WIMPs
• Spin-independent
• Spin-dependent
• Sub-GeV
Sun
• Solar pp neutrinos
• Solar Boron-8 neutrinos
Big Bang
• Neutrinoless double beta decay
• Double electron capture
S2
S1
Supernova
• Supernova neutrinos
• Multi-messenger
Cosmic Rays
• Atmospheric neutrinos

Energy Spectra of NR in XENONnT



XENON Collaboration (arxiv: 2007.08796)

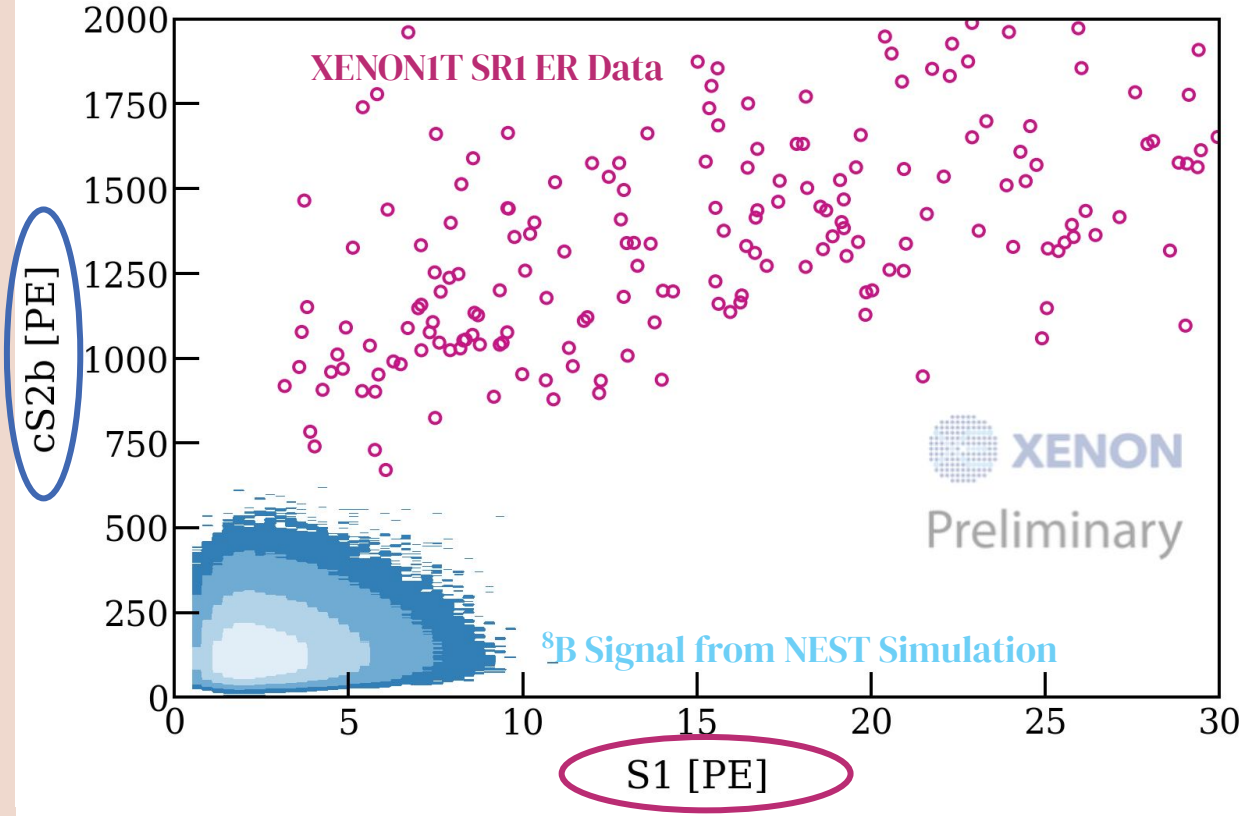
^{8}B CEνNS will be detectable with recoil energies < 4 keV

In XENON1T:

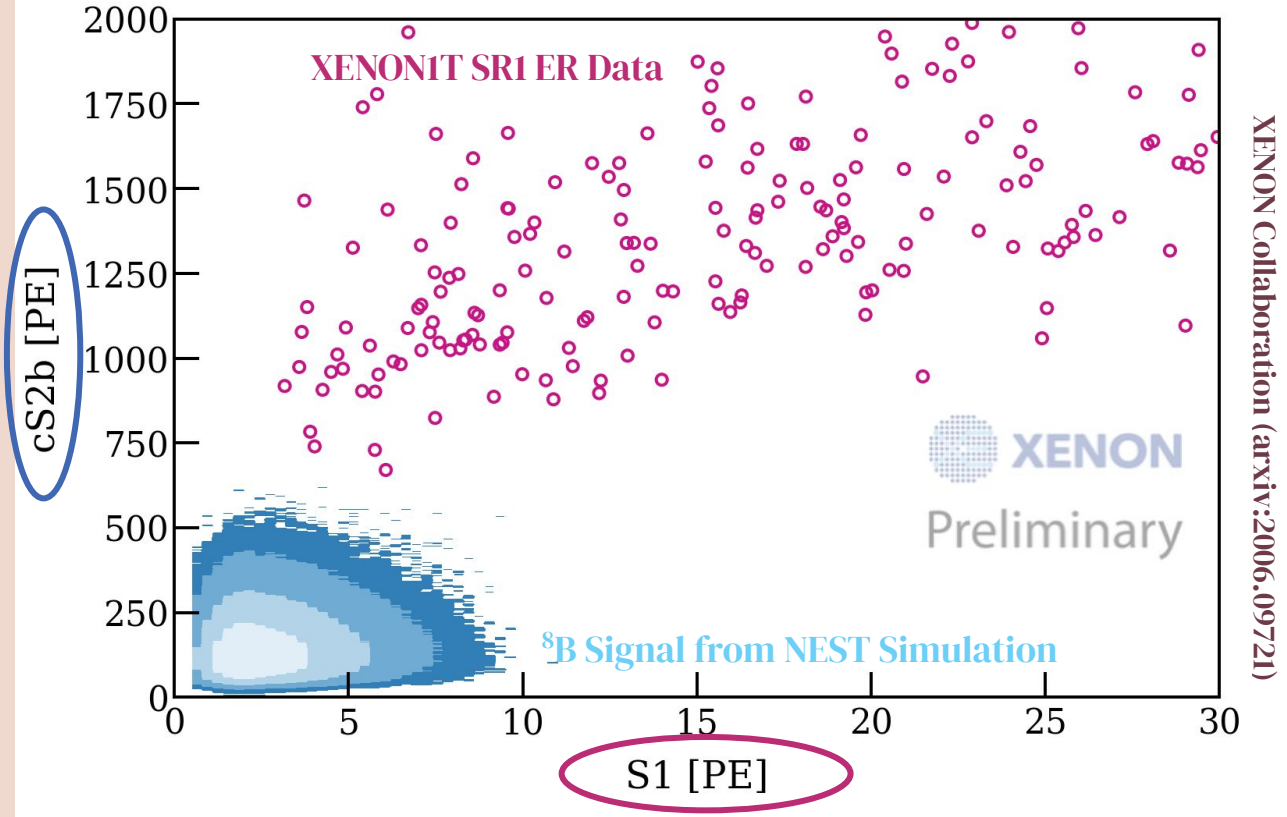
- **Energy threshold: 0.5 keV**
- **Exposure: 0.6 t×y**
- **Expected**
  - **2 ^{8}B CEνNS events**
  - **5 background events**
- **Observed 6 events**

XENON Collaboration (arxiv: 2012.02846)

^{8}B CEνNS signal falls below previous science analysis threshold in both ionization and scintillation

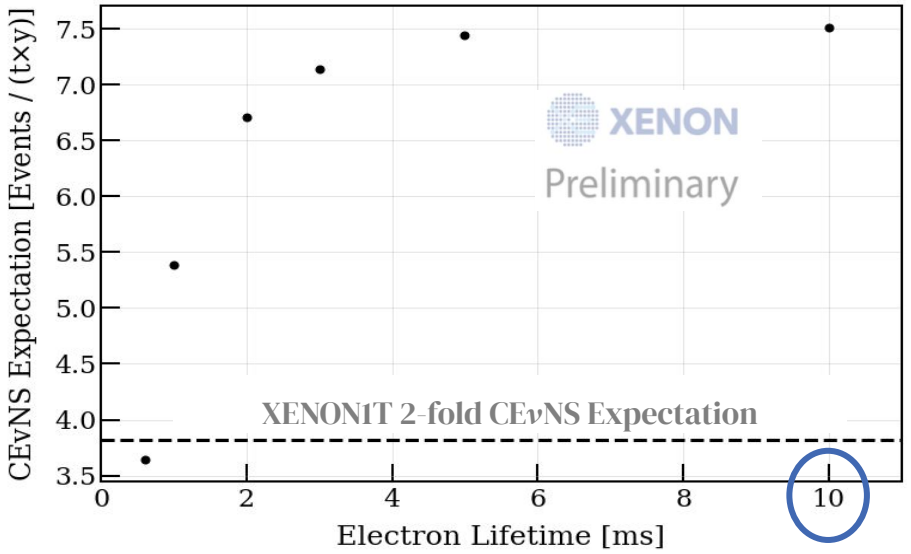


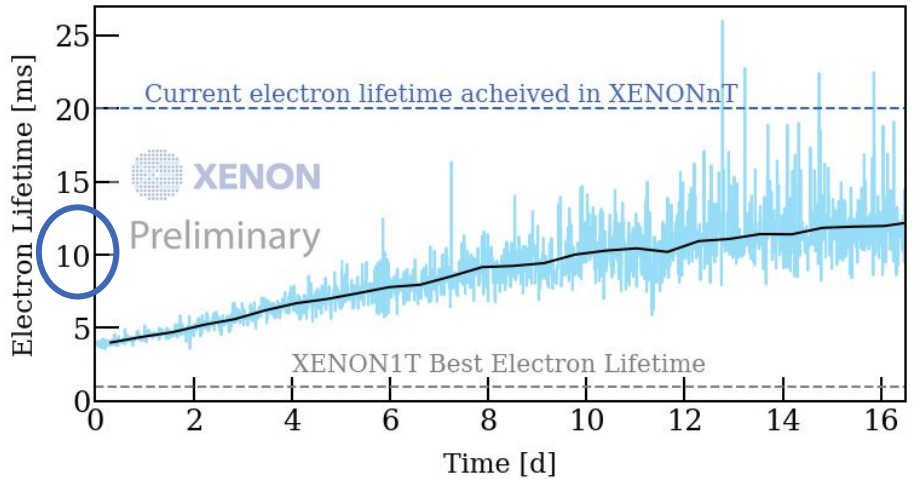
How can we improve our efficiency to detect CEνNS?



How can we improve our efficiency to detect CEνNS?

- Better LXe Purity

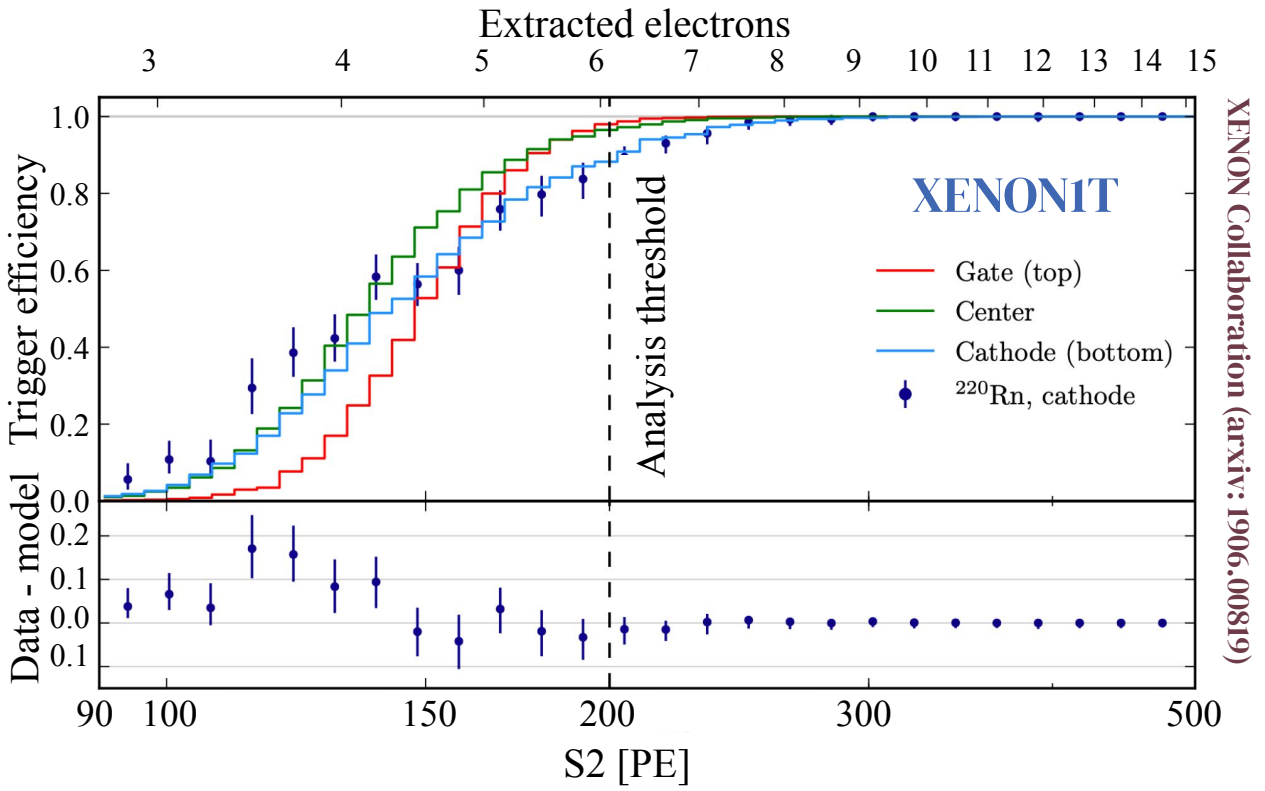




XENON Collaboration (arxiv: 2012.02846)

How can we improve our efficiency to detect CEνNS?

- Better LXe Purity
- Remove Software Trigger



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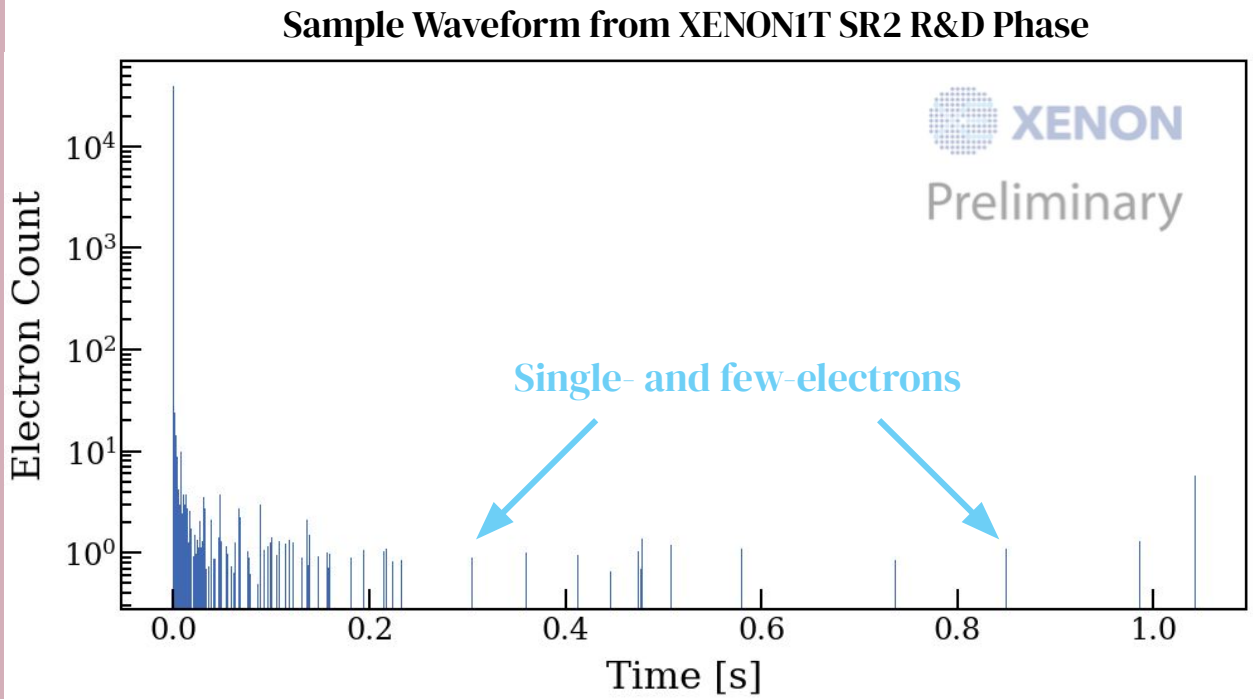

XENONnT has a Triggerless DAQ

We permanently record all signals in detector!

How can we improve our efficiency to detect CEνNS?

- Better LXe Purity
- Remove Software Trigger
- Lower Energy Threshold

XENON1T Analysis Channels

	Standard analysis	2-fold analysis	S2-only analysis
S1 threshold	3 PE	2 PE	0 PE
S2 threshold	200 PE	120 PE (4 electrons)	150 PE (5 electrons)
Detection Limitations	Threshold Energy	Exposure	Background

XENON Collaboration
arxiv: 1805.12562, 2012.02846, 1907.11485

How can we improve our efficiency to detect CEνNS?

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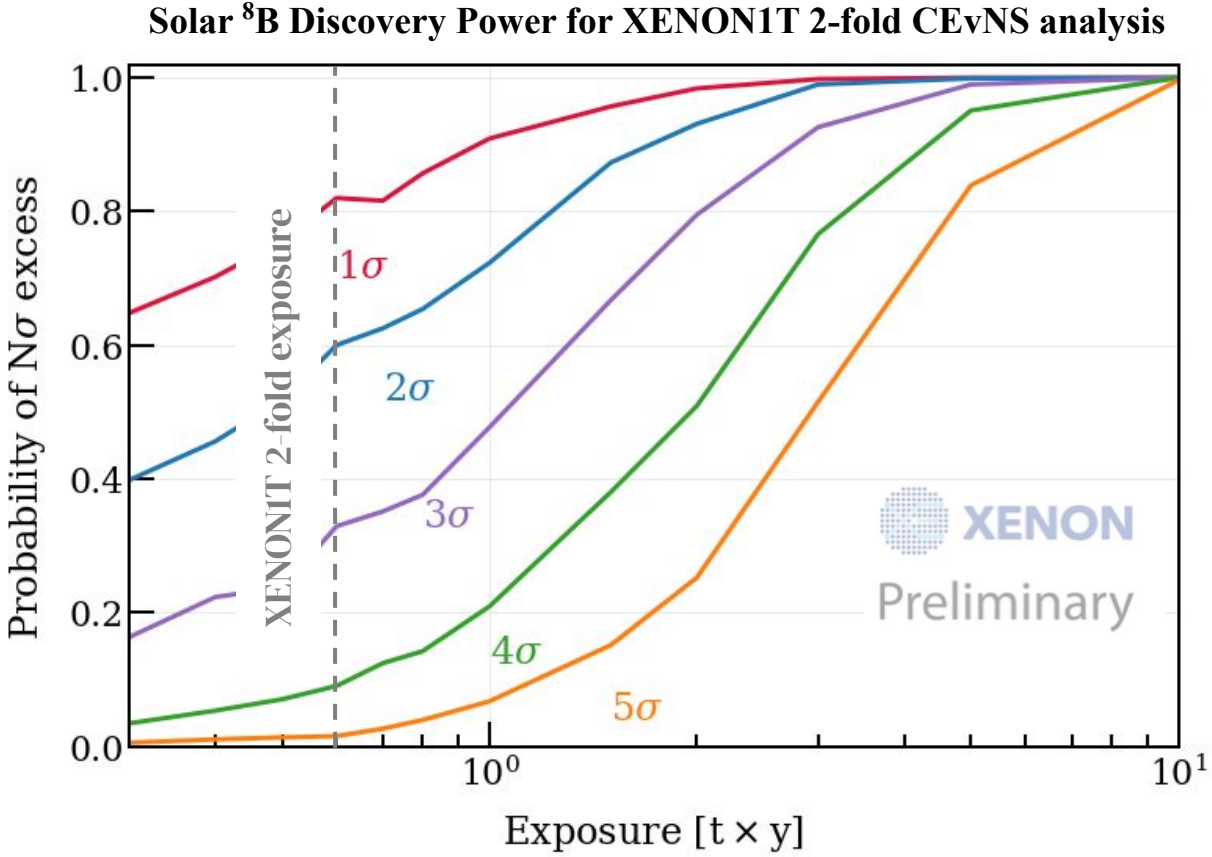
XENON1T Analysis Channels

	Standard analysis	2-fold analysis	S2-only analysis
S1 threshold	3 PE	2 PE	0 PE
S2 threshold	200 PE	120 PE (4 electrons)	1 electron
Detection Limitations	Threshold Energy	Exposure	Background

XENON Collaboration
arxiv: 1805.12562, 2012.02846, 1907.11485

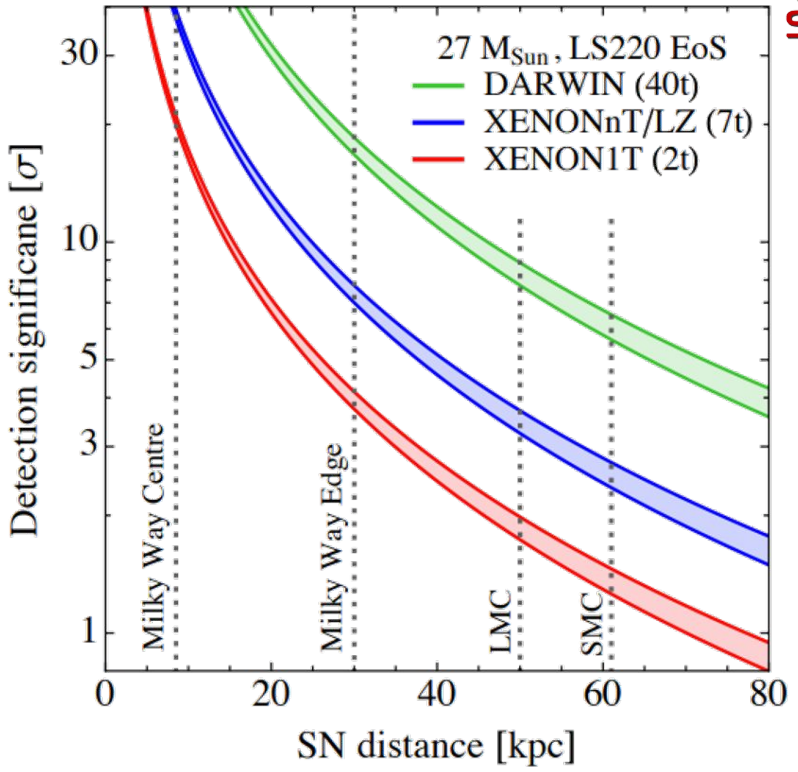
How can we improve our efficiency to detect CEνNS?

- Better LXe Purity
- Remove Software Trigger
- Lower Energy Threshold
- Larger Exposure



Baxter et al. (arxiv: 2101.07779)

XENONnT will be an active participant in the SuperNova Early Warning System (SNEWS 2.0)



Lang et al. (arxiv: 1606.09243)

Summary

XENONnT features:

- Larger exposure
- Better purity
- Triggerless DAQ
- Lower energy threshold

This will allow XENONnT to:

- Detect ^{8}B solar neutrinos via CEνNS
- Be an active participant in SNEWS

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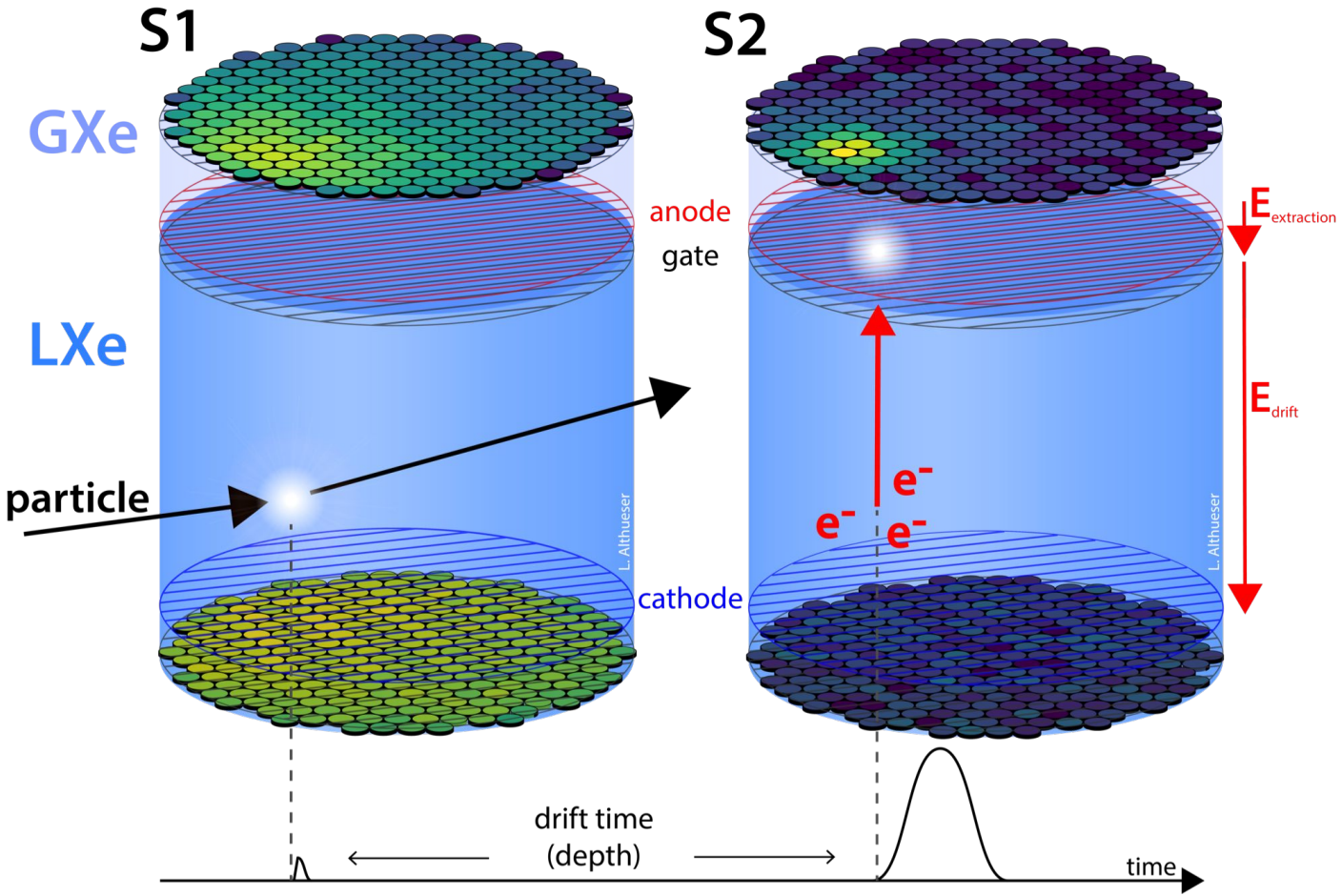
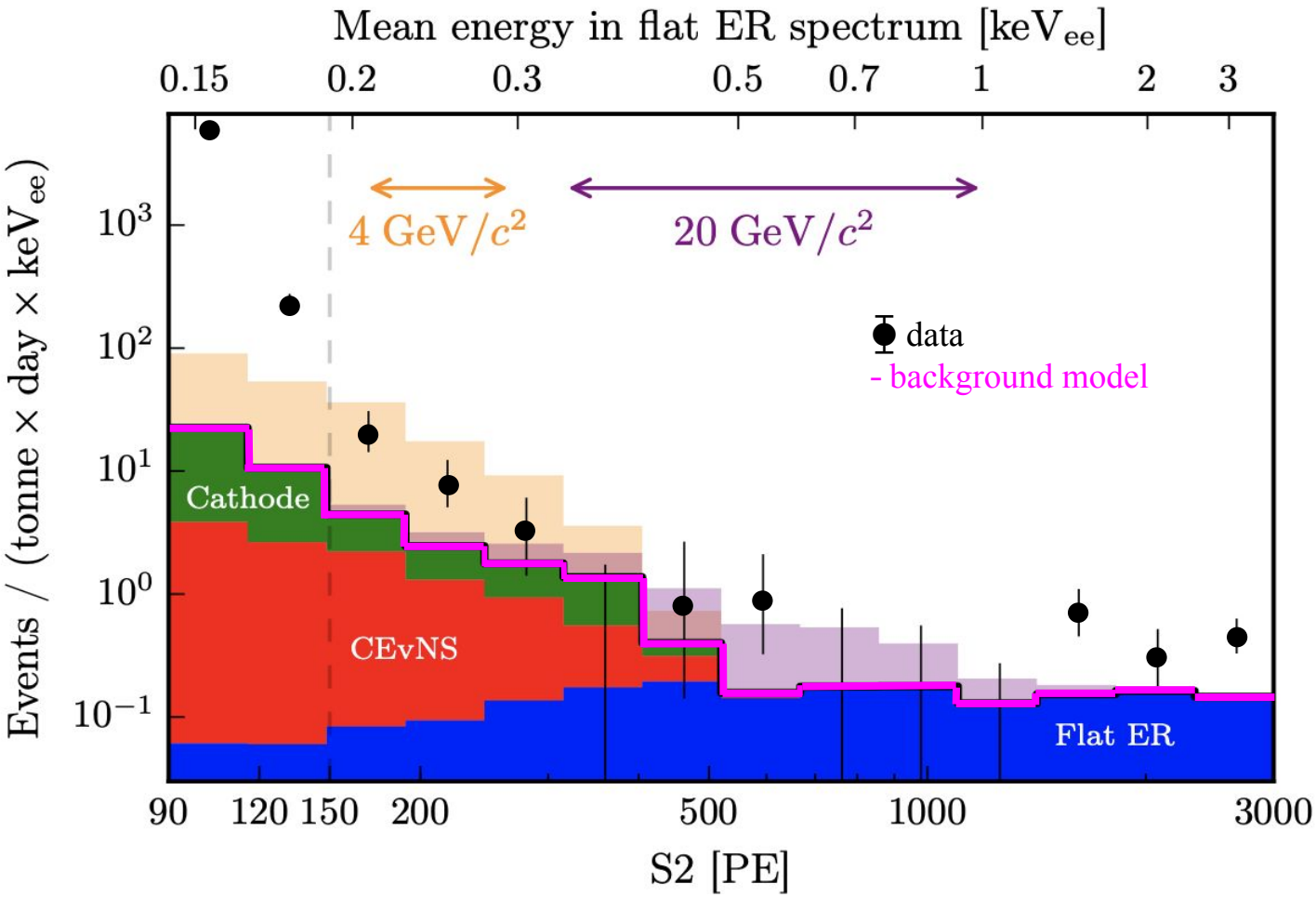
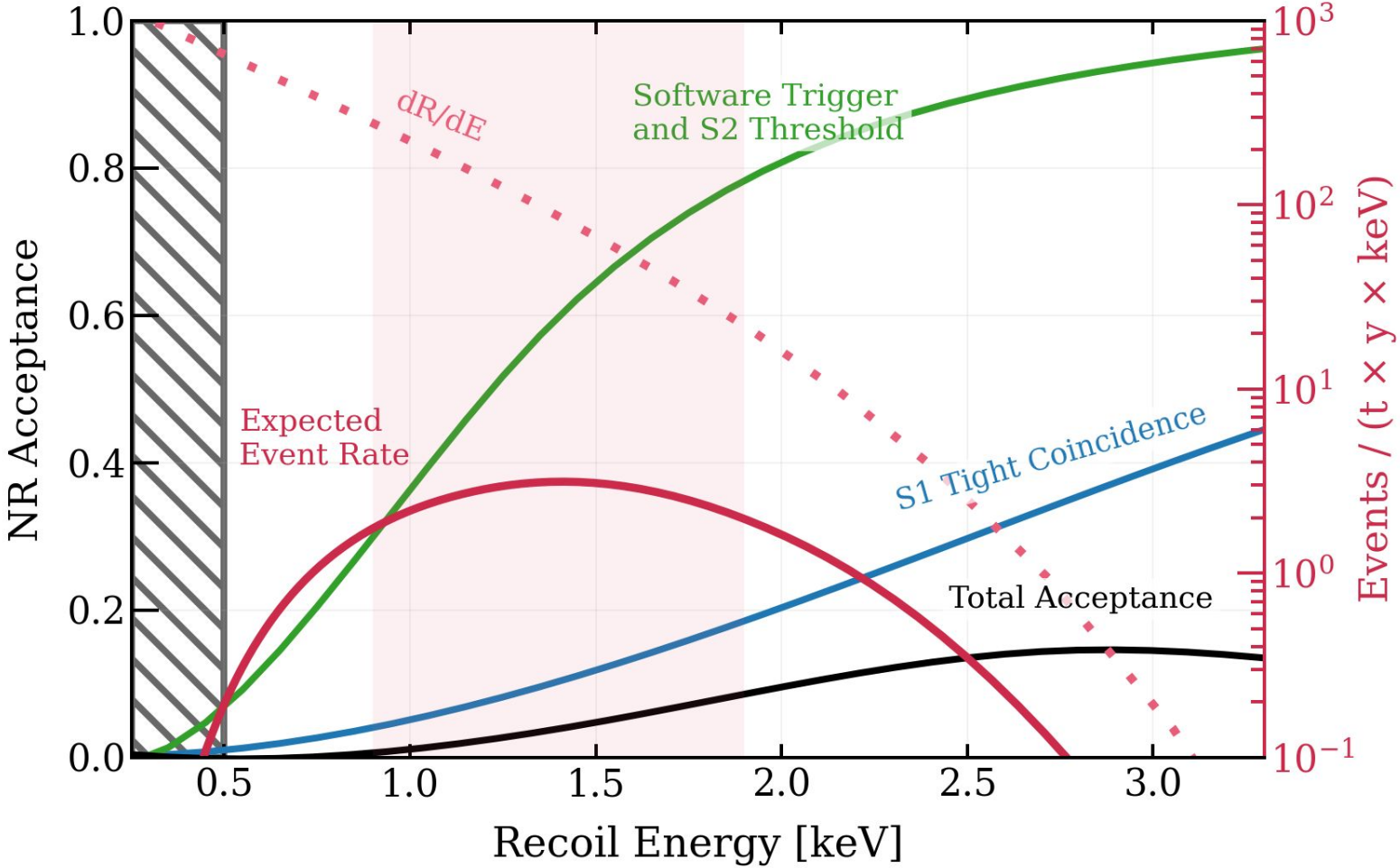
Backup Slides


S1
S2
GXe
LXe
anode
gate
cathode
particle
$E_{extraction}$
E_{drift}
e⁻
e⁻
e⁻
L. Althueser
L. Althueser
drift time
(depth)
time



XENON Collaboration (arxiv: 1907.11485)



XENON Collaboration (arxiv:2006.09721)