

Towards a Kilotonne×Year Exposure in Liquid Xenon



Abigail Kopec
amk029@bucknell.edu

DPF-PHENO

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The Liquid Xenon Time Projection Chamber

Two signals:

S1 initial scintillation

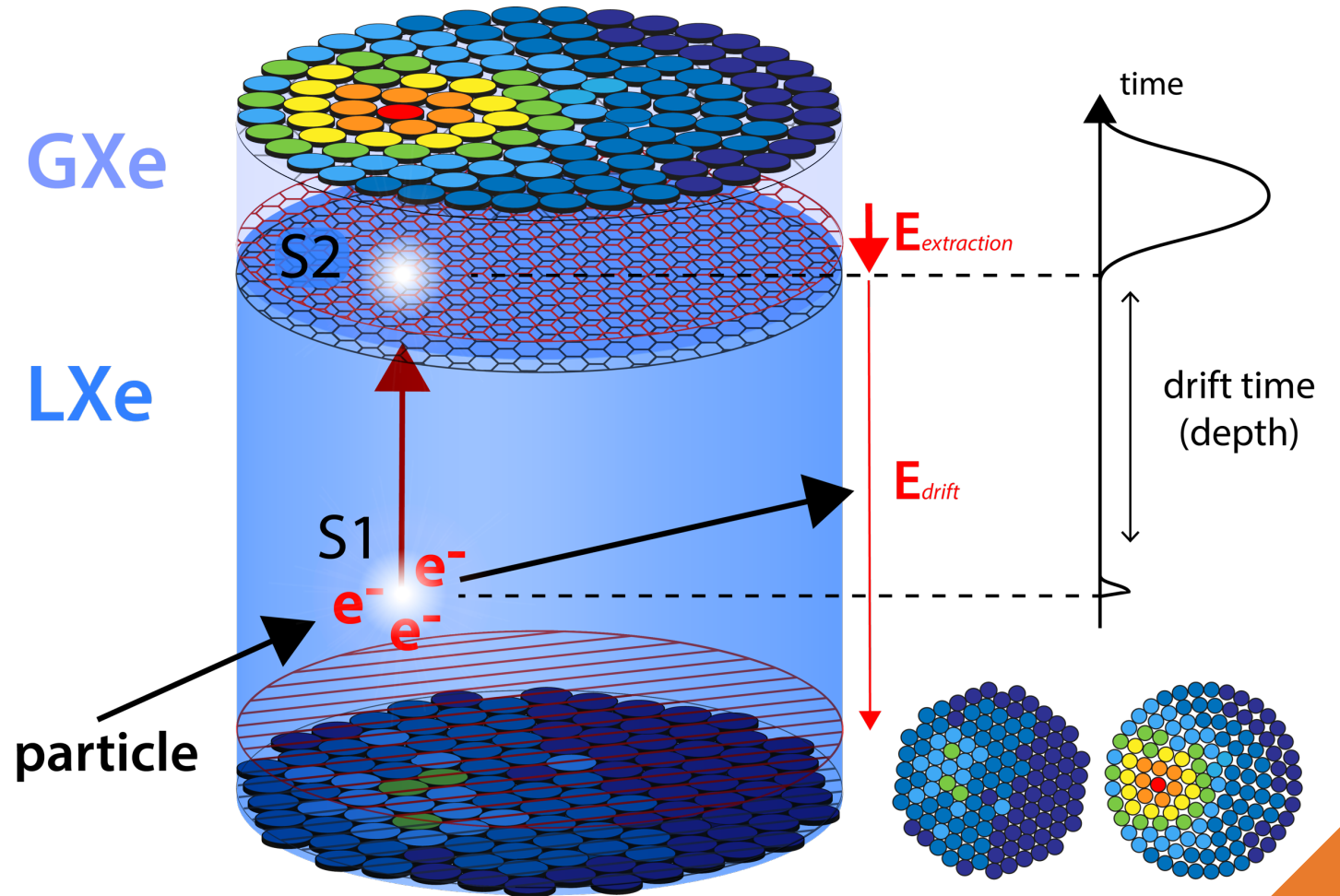
S2 electroluminescence

Give:

Energy

3D-Position

ER/NR discrimination



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S1 initial scintillation

S2 electroluminescence

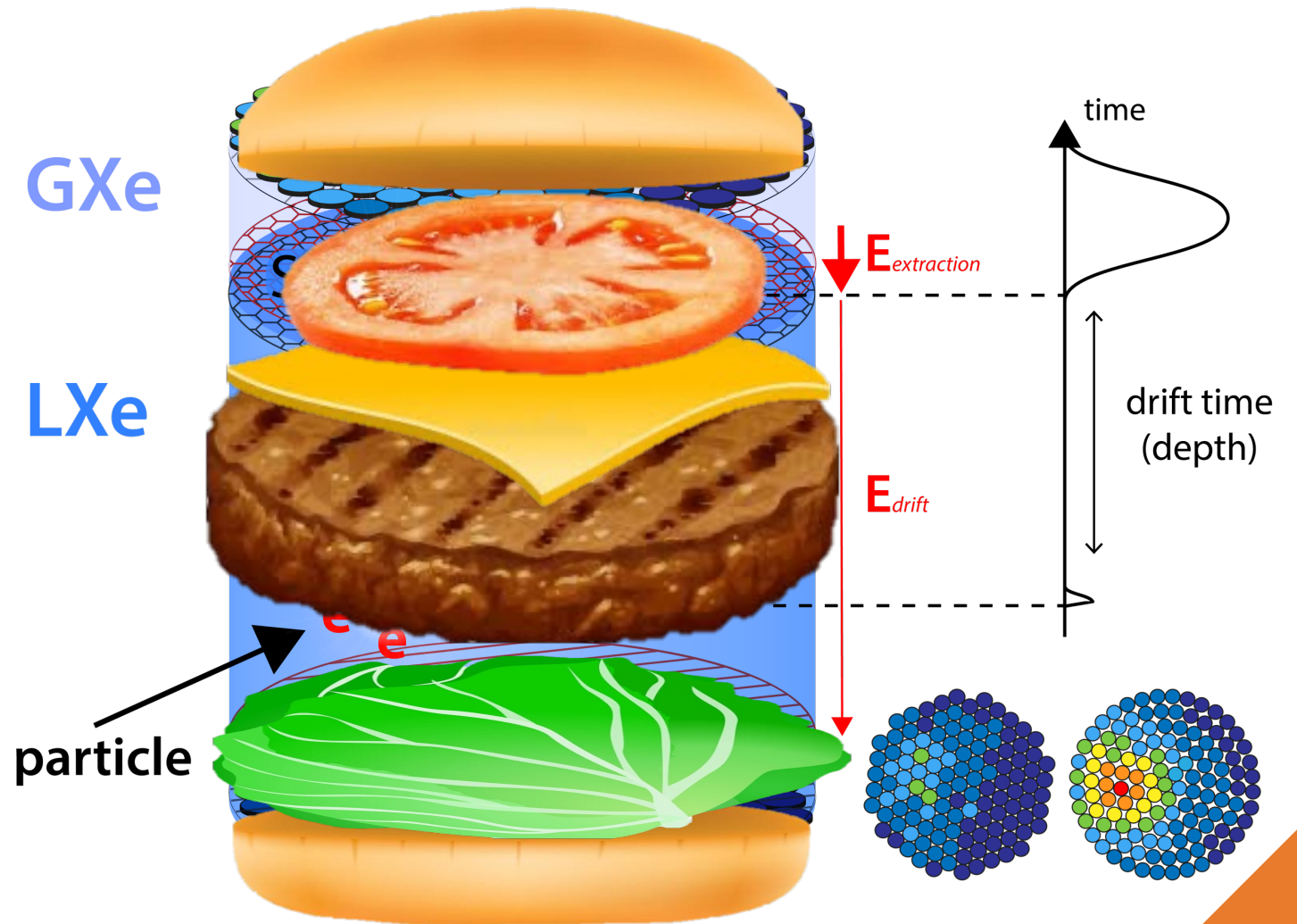
Give:

Energy

3D-Position

ER/NR discrimination

All parts of the sandwich must work together.

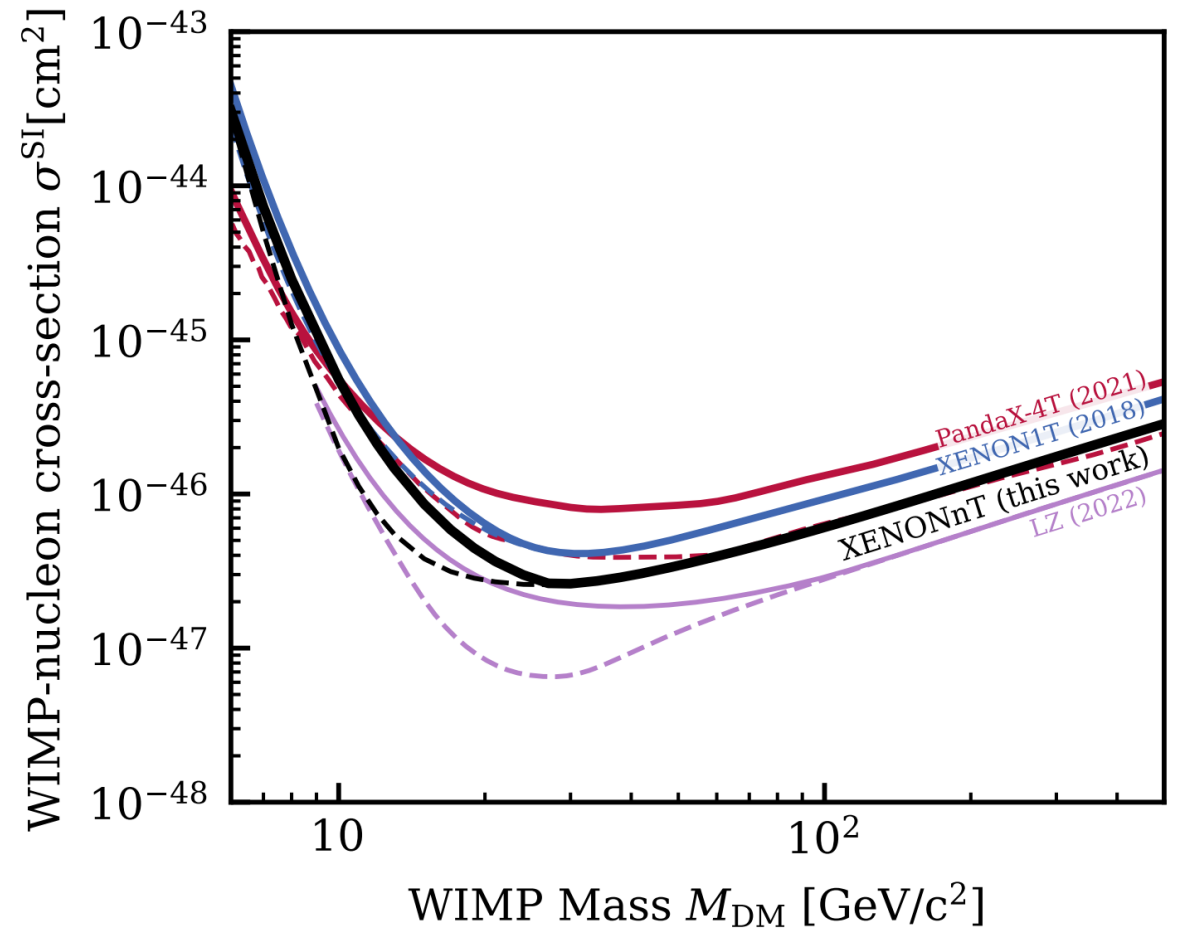


A World-Leading Technology

Liquid Xenon Time Projection Chambers have set the best limits on Spin-Independent Elastic Scattering Weakly Interacting Massive Particles.

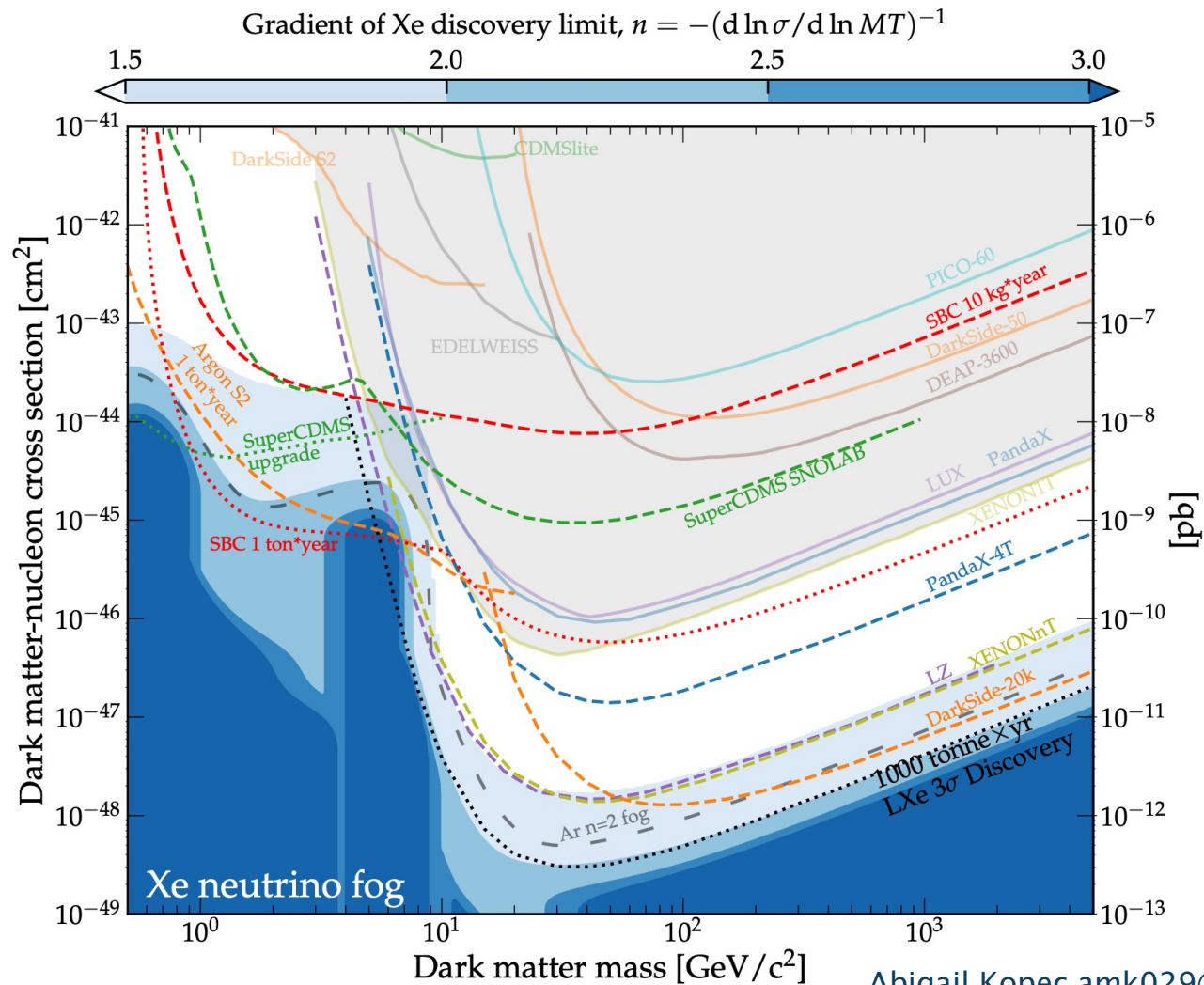
The State-of-the-Art:

- LUX-ZEPLIN
- PANDAX-4T
- XENONnT



Envisioning an Ultimate Detector

Snowmass 2021 Whitepaper arXiv: 2203.08084



There is a lot of parameter space left to look for WIMPs before reaching irreducible Neutrino backgrounds.

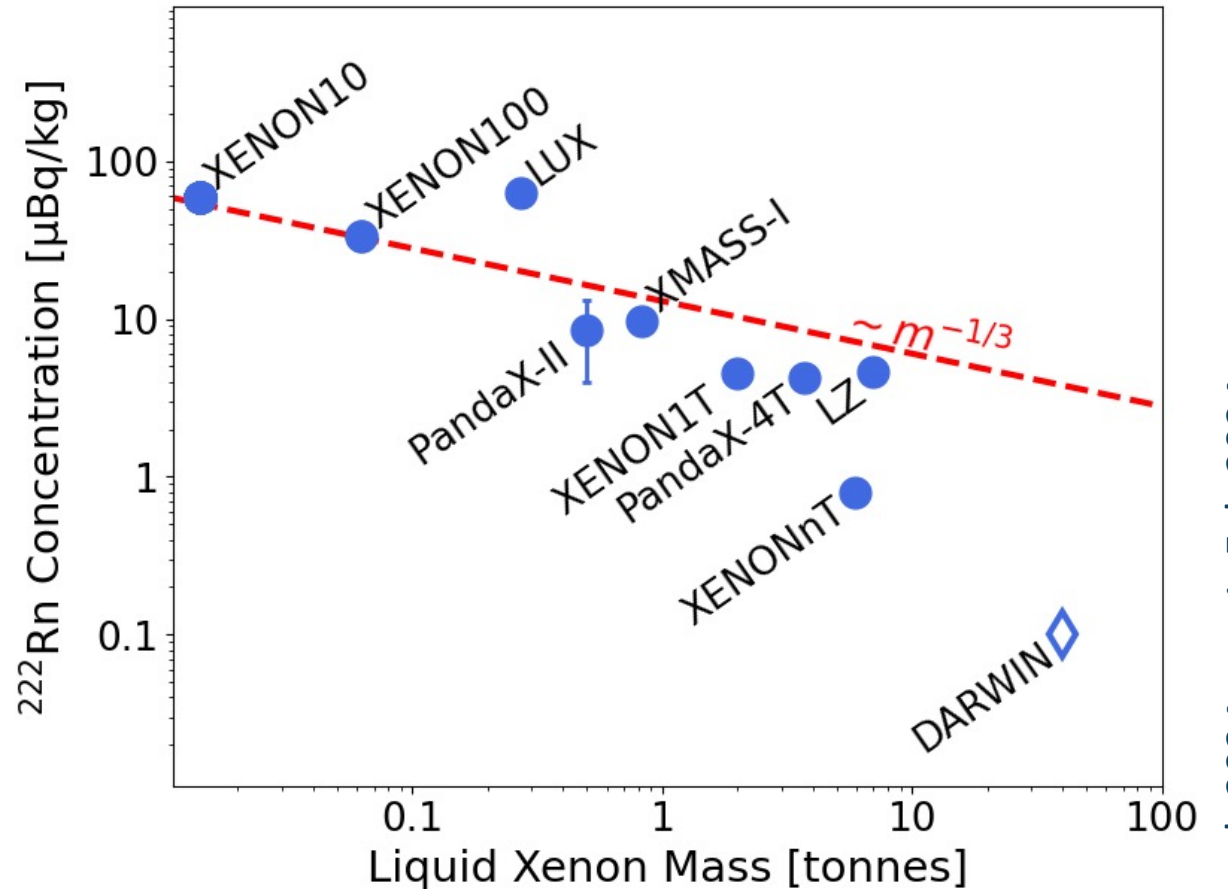
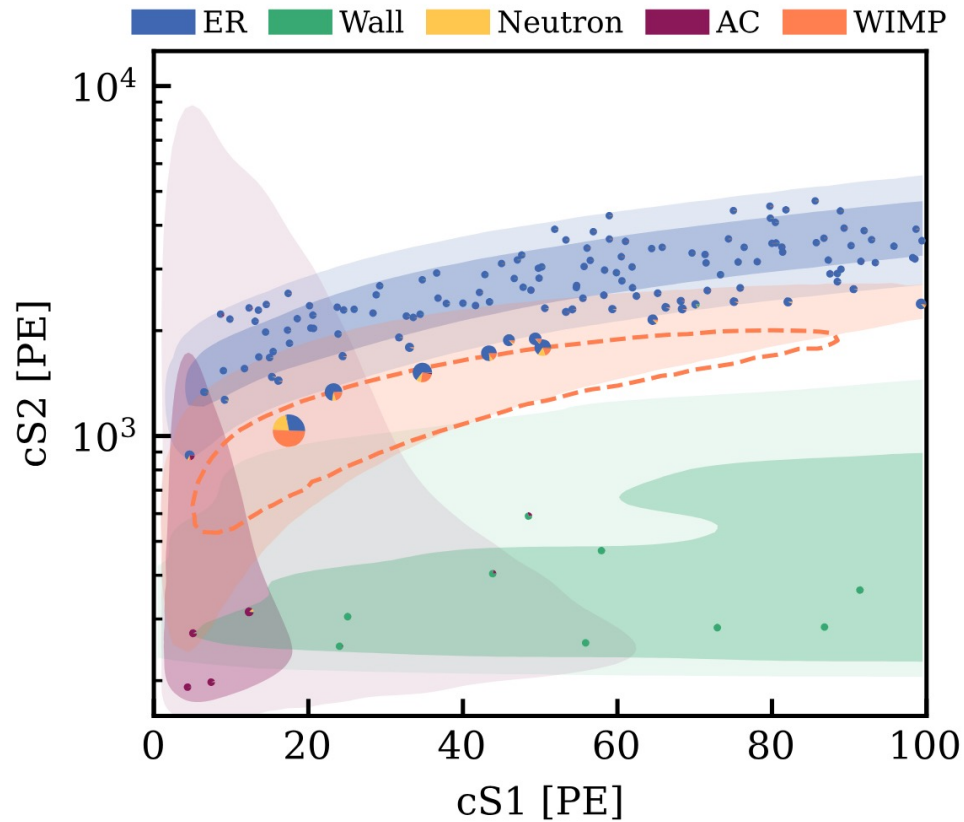
We need a kilotonne \times year exposure.

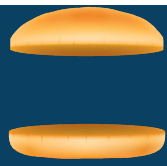


Xenon Quality: Radon Backgrounds

Major Radioactive impurities are mitigated.

XENON Collaboration,
Phys. Rev. Lett. 131, 041003 (2023)

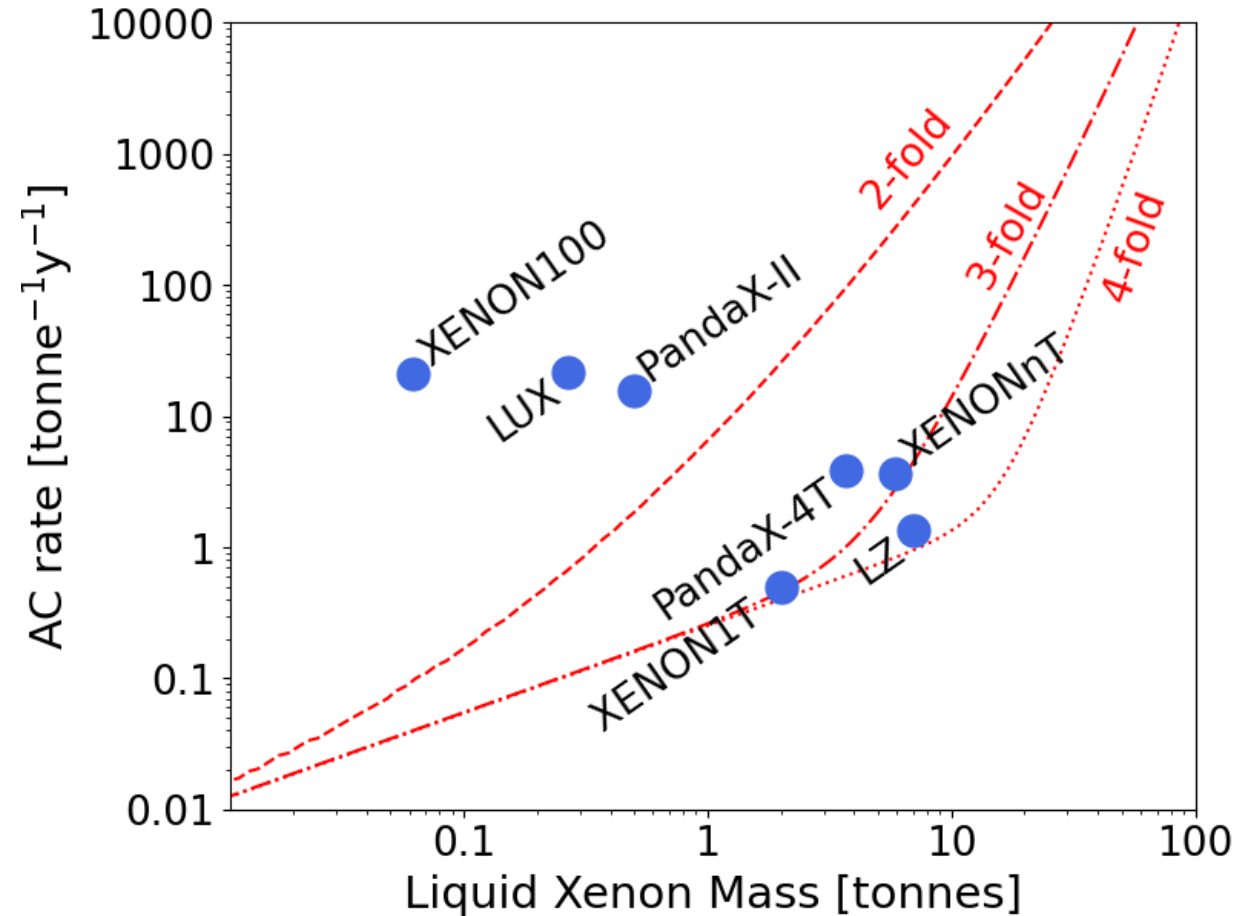
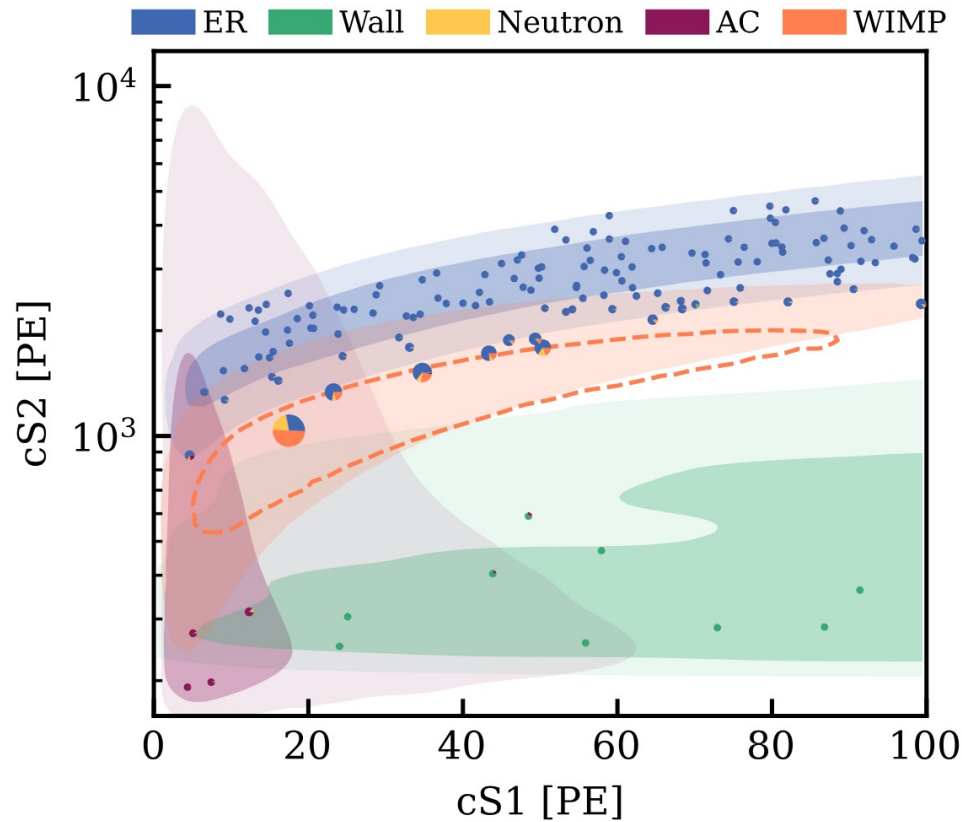


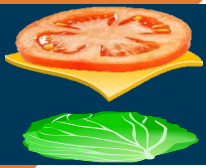


Photosensors: Accidental Coincidence

With more photosensors and volume, random signal pile-up is a new challenge.

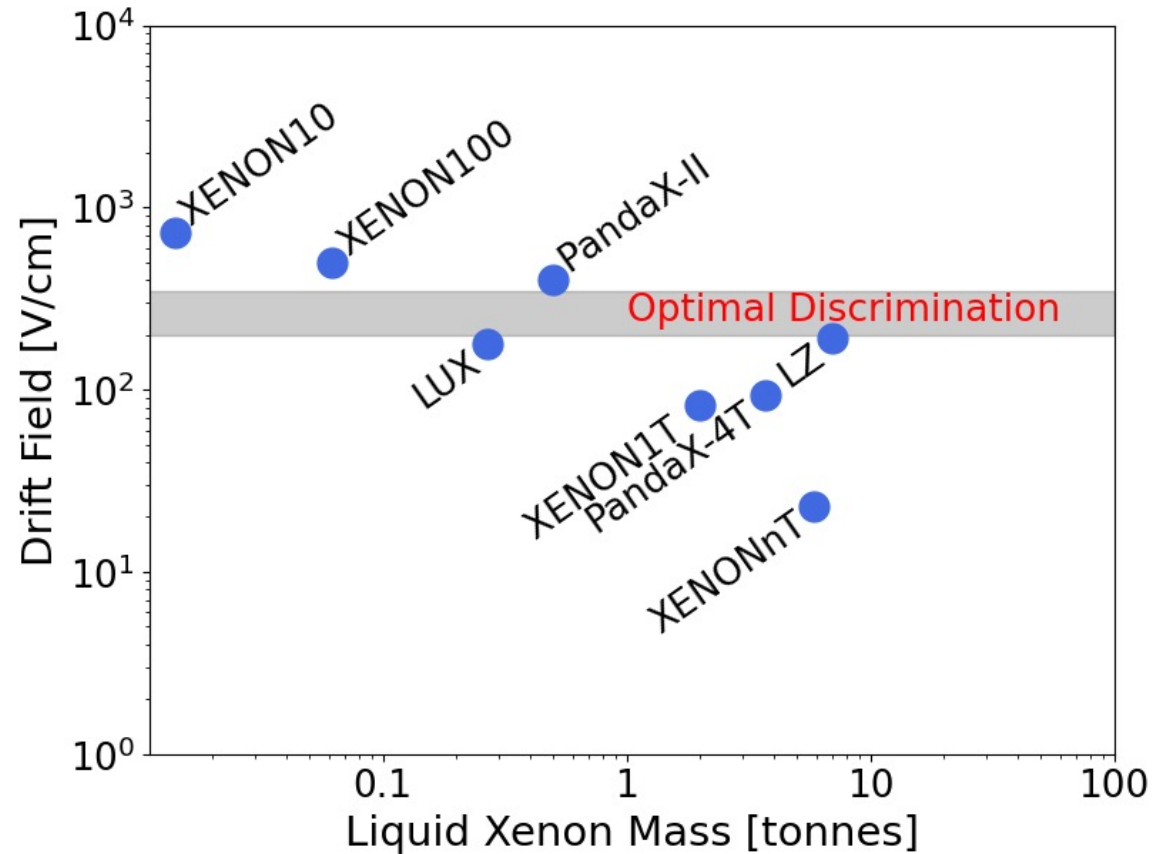
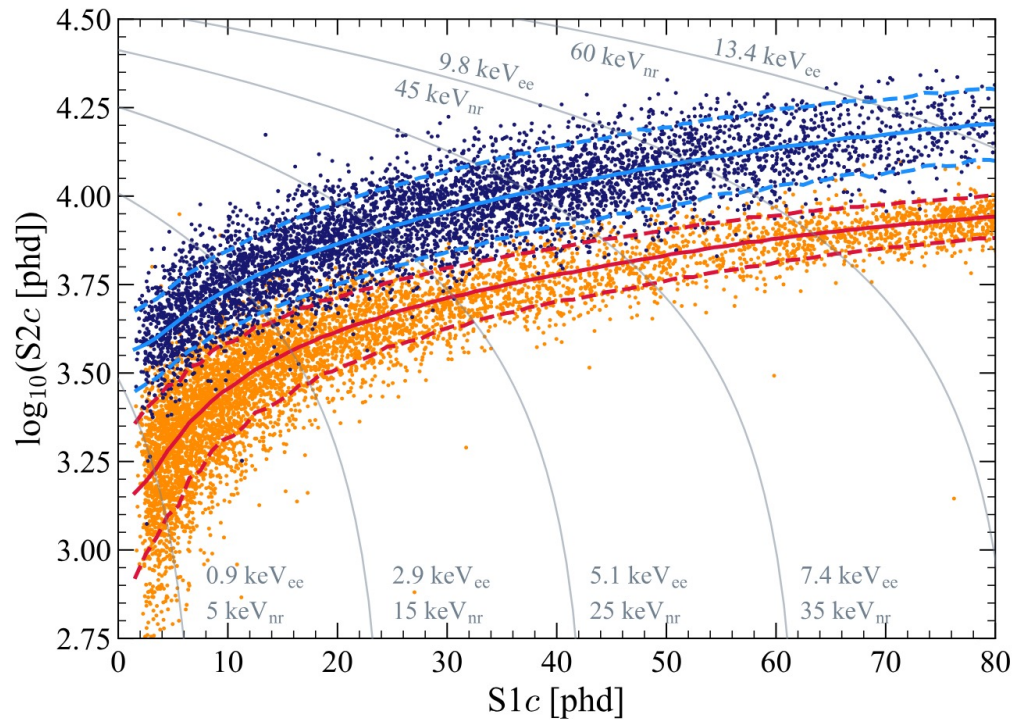
XENON Collaboration,
Phys. Rev. Lett. 131, 041003 (2023)





Electrodes: ER/NR Discrimination

Maintaining high fields on optically transparent meter-scale diameter electrodes may be a challenge.



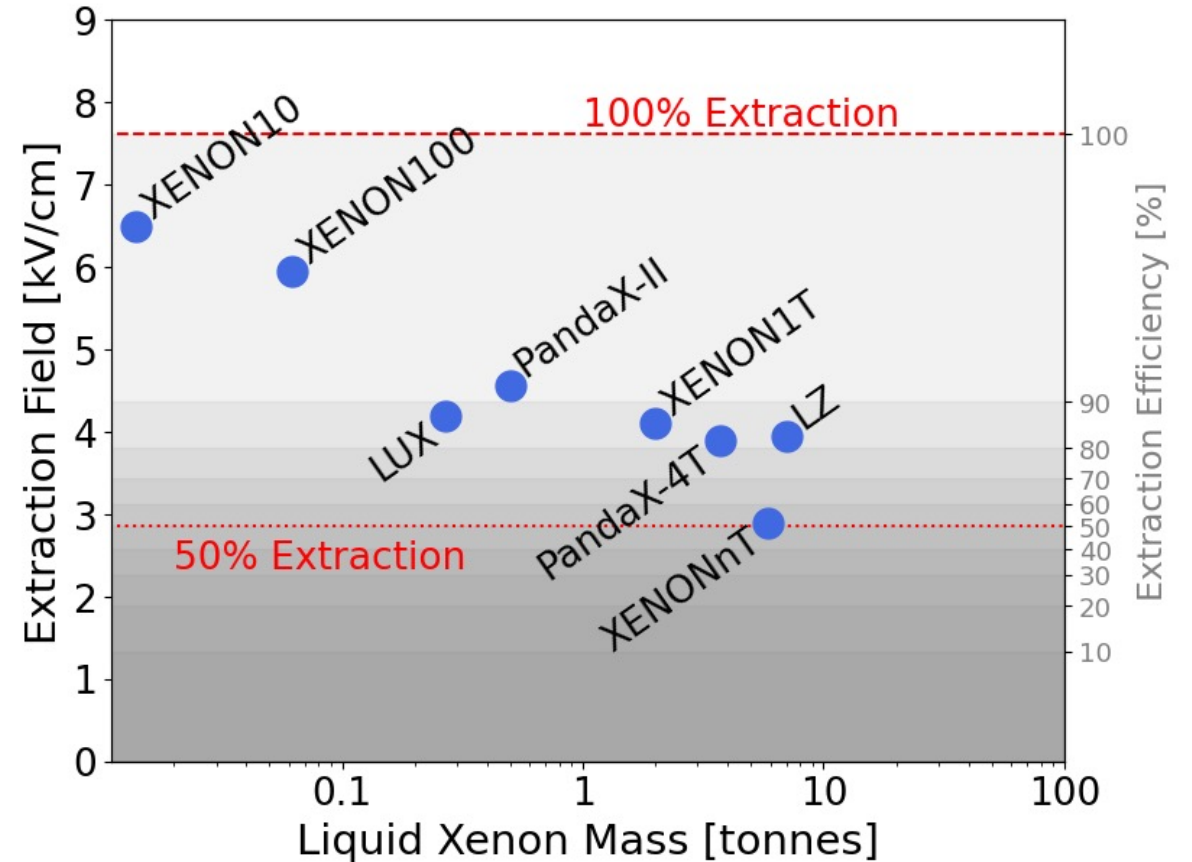
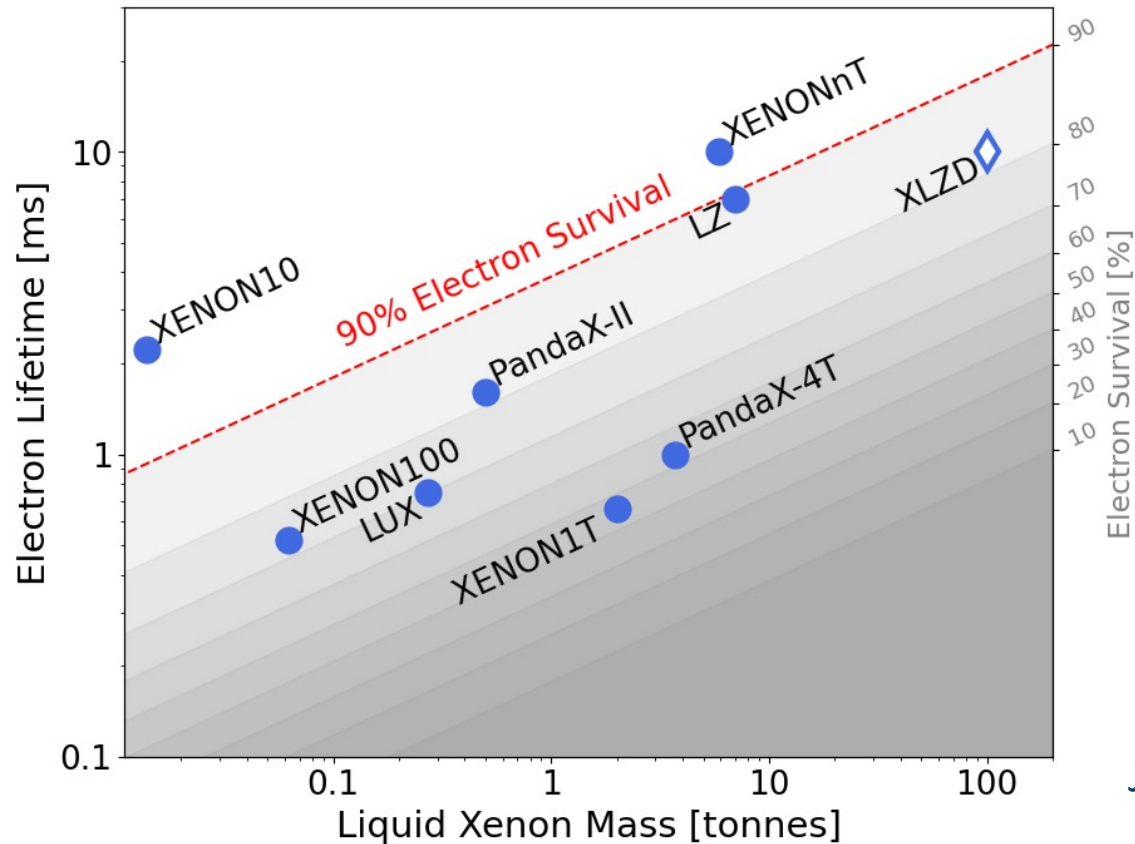
LUX-ZEPLIN Collaboration,
Phys. Rev. Lett. 131, 041002 (2023)



Performance: S₂ Detection

Minimize electronegative impurities.

Maximize extraction field.



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Summary

60+ tonnes with a science program for decades

Quality ingredients for the detector are possible to produce.

Mitigating Accidental Coincidence backgrounds is a recipe for success.

