

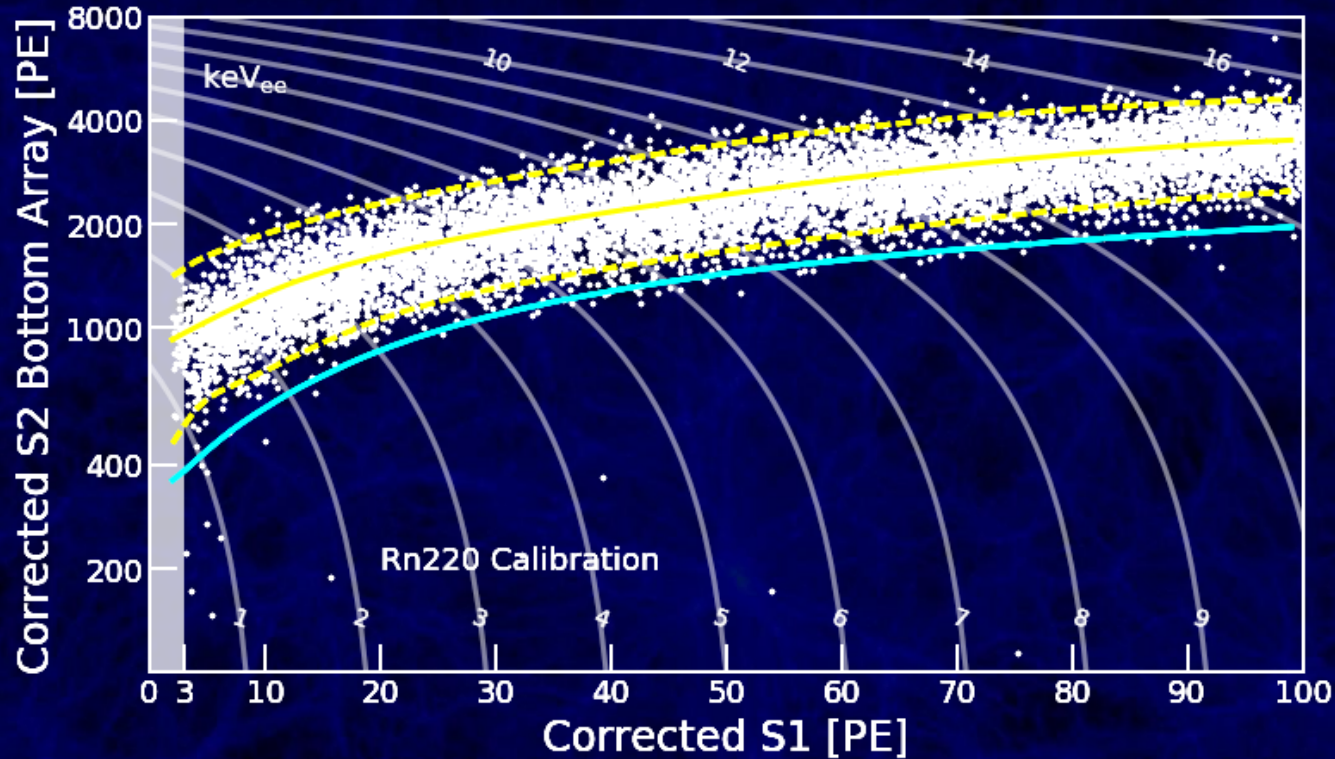
A photograph showing three scientists in a laboratory setting. They are focused on a complex piece of equipment, likely a detector component, which is densely packed with numerous orange cables. The scientists are wearing safety glasses and gloves. One scientist on the right is using purple gloves and tweezers to work on a small component. The overall scene is one of intense scientific collaboration and precision work.

LBECA: Pushing Xenon TPCs to Single Electrons

For the LBECA Collaboration: Rafael F. Lang,
Purdue University, rafael@purdue.edu

“S2 Only” Channel

XENON1T

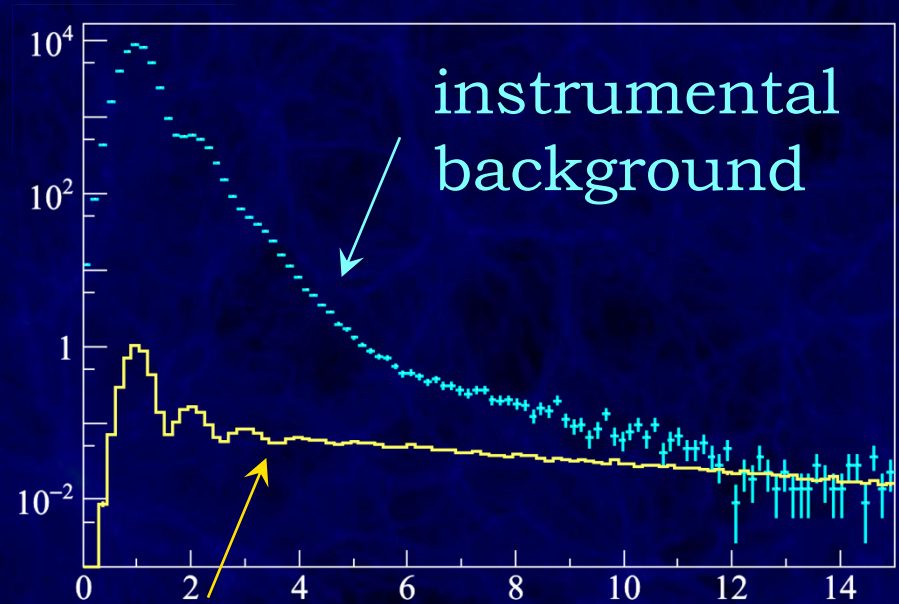
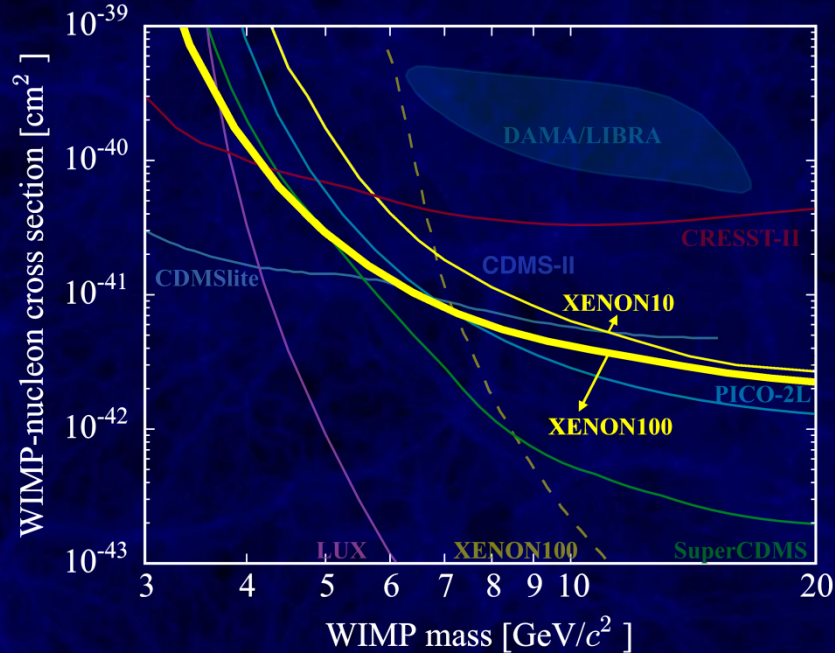


Exploit built-in amplification (proportional scintillation)

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Limited by Instrumental Background

XENON100 1605.0626

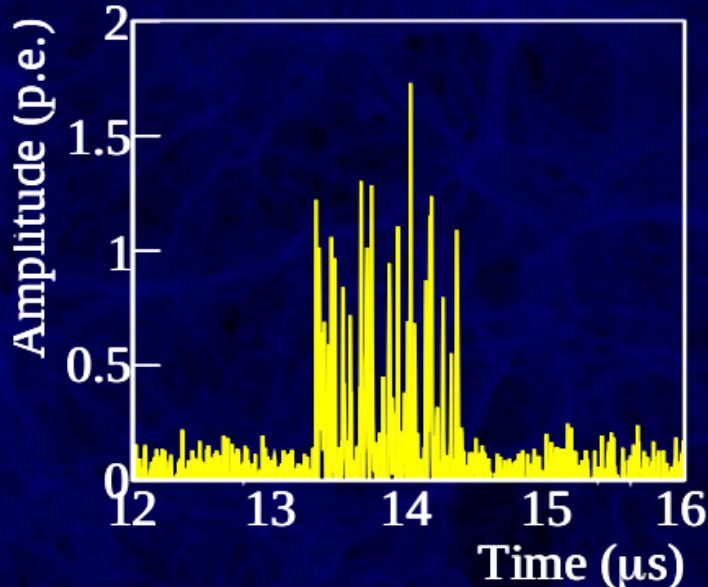


radioactive
background

J. Xu

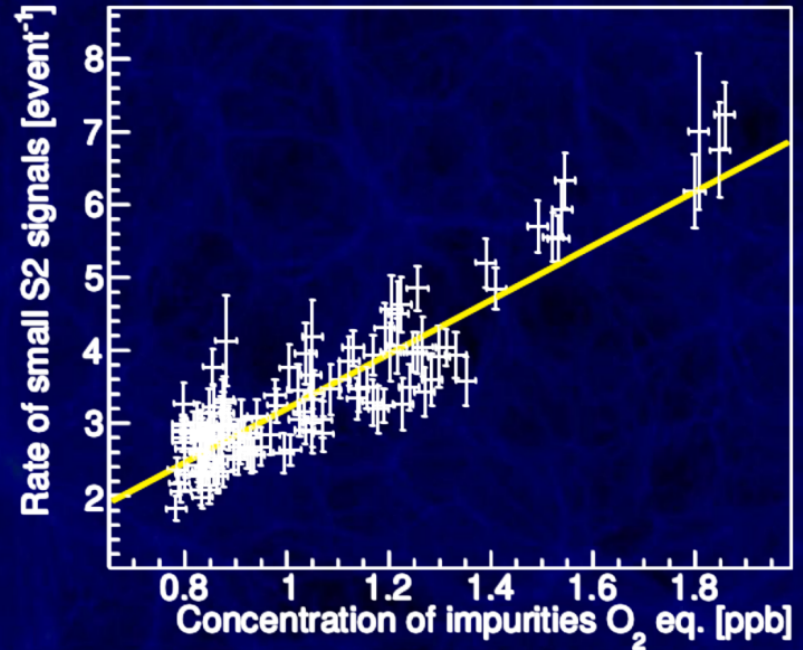
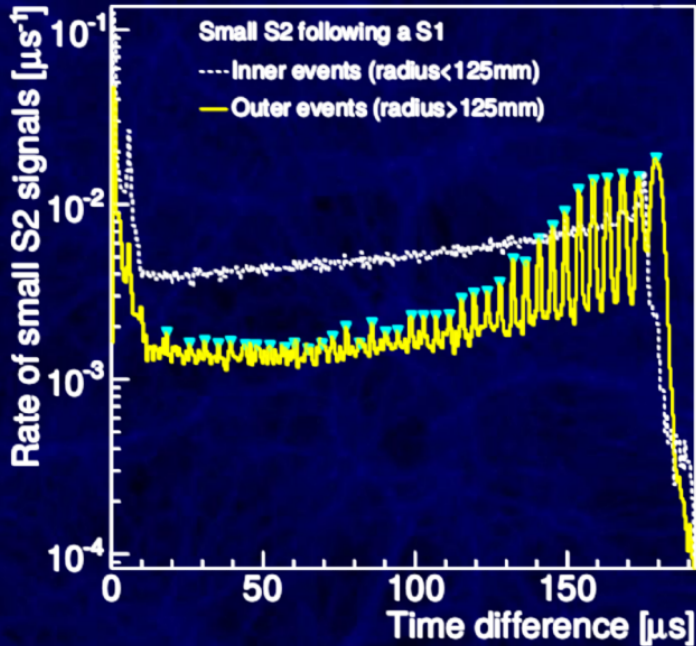
Why Push LXe to Single e^-

- Scalable to tons
- Whopping signal:
- Xenon is radio-clean
- Excellent self-shielding
- Ionization energy only ~ 9 eV \rightarrow Large χ - e^- scattering rate
- Easily ionize additional atoms (only ~ 14 eV_{ee})
 \rightarrow produce multiple e^-
 \rightarrow less background



Background: Photoionization

Xenon light $175\text{nm}=7\text{eV}$ photoionizes metals & impurities



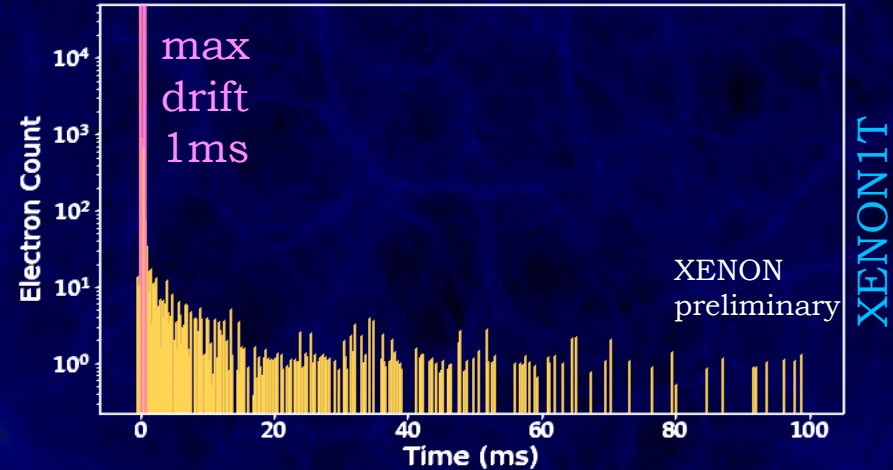
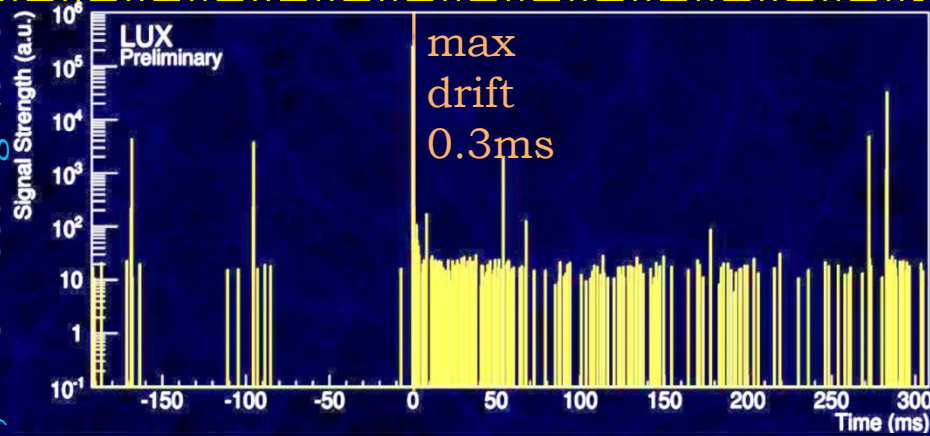
XENON100 1311.1088

Not a huge worry: simply veto away

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Background: Long Timescales

J.Xu/LUX, APS Meeting 2016



- Long-lived impurity states?
Sorensen&Kamdin 1711.07025
- Delayed extraction?
Sorensen 1702.04805
- Self-Organized Criticality?
Pereverzev in prep.

The LBECA Project



U.S. DEPARTMENT OF
ENERGY

Office of Science

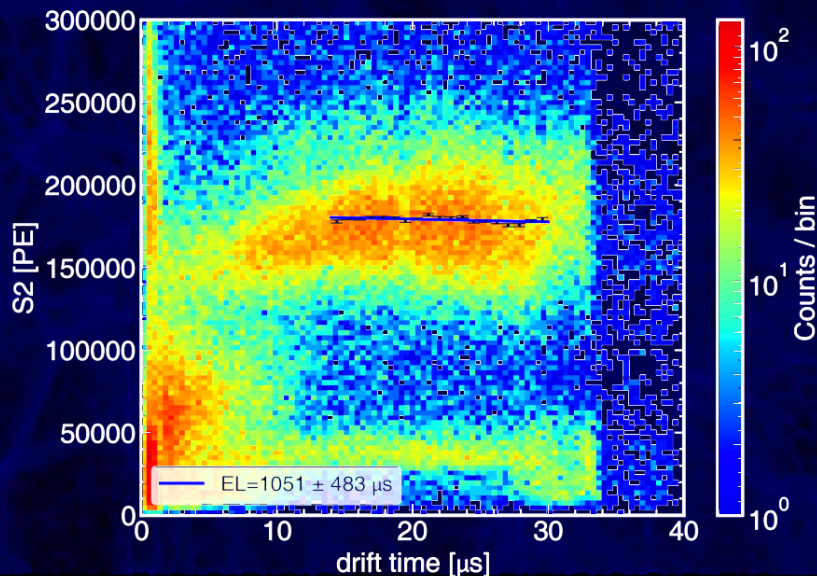
...in three easy steps:

- 1) Characterize backgrounds ongoing using R&D setups and XENON1T&LUX data
- 2) Mitigate backgrounds ongoing at Purdue, UCSD & LLNL (2019/2020)
- 3) Build a dedicated LXe TPC detector 2021/2022, design proposal submitted

LLNL: J.Xu, A.Bernstein, S.Pereverzev;
LBNL: P.Sorensen; UCSD: K.Ni; Stony
Brook: R.Essig, M.Fernandez-Serra;
Purdue: Rafael

Improved Purity

Sealed acrylic TPC realized at UCSD

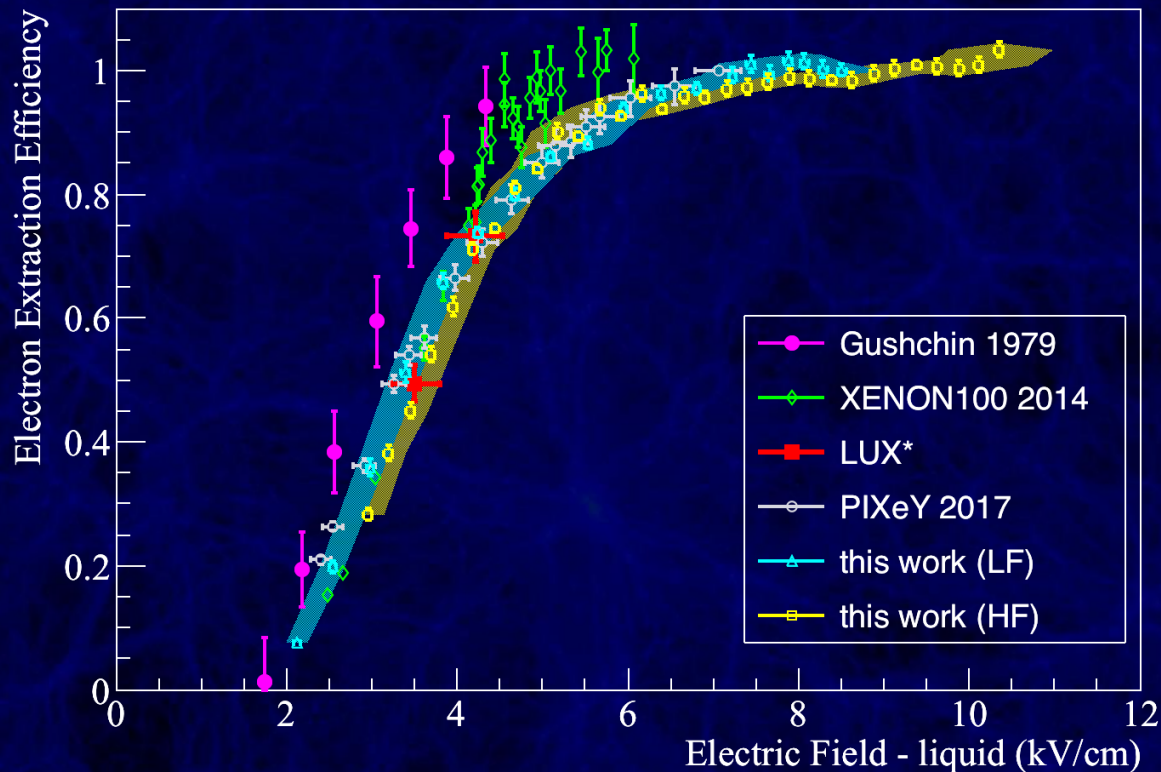


graphene-coated
fused silica electrode

Improved Extraction

Saturated extraction realized at LLNL

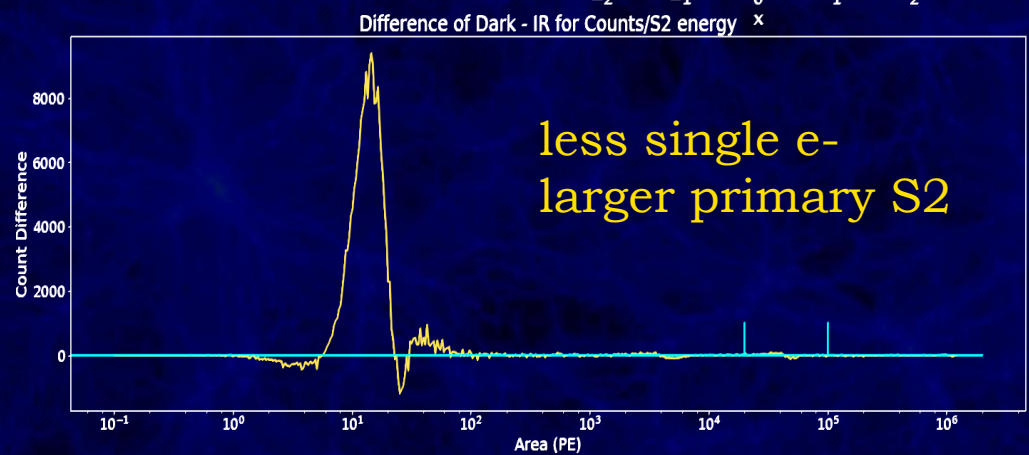
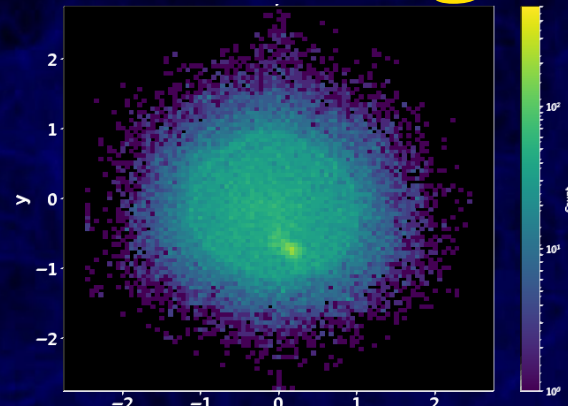
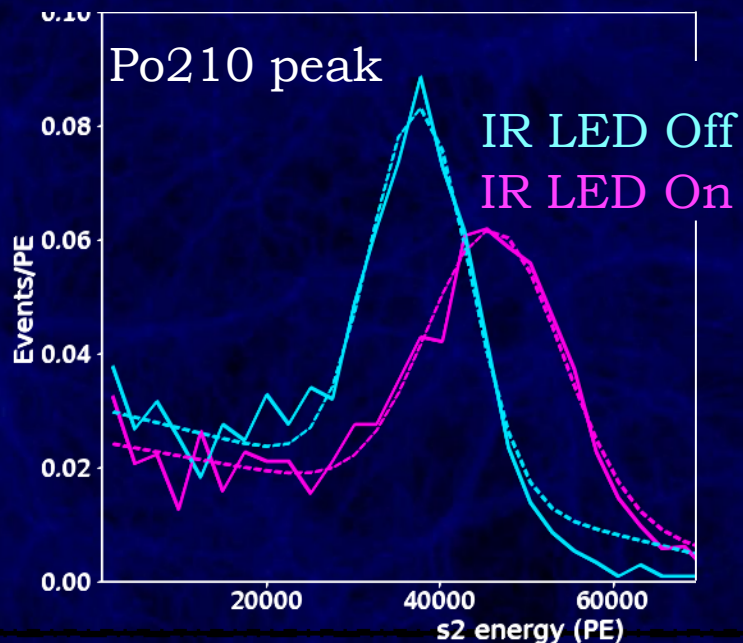
Xu+ 1904.02885



Stimulated Emission/Quenching

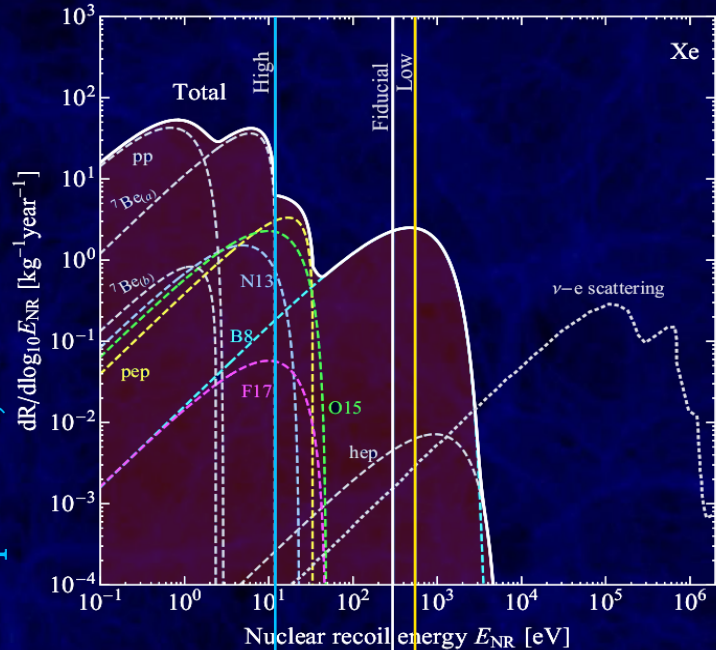
LXe IR setup at Purdue

This just in: IR light really helps

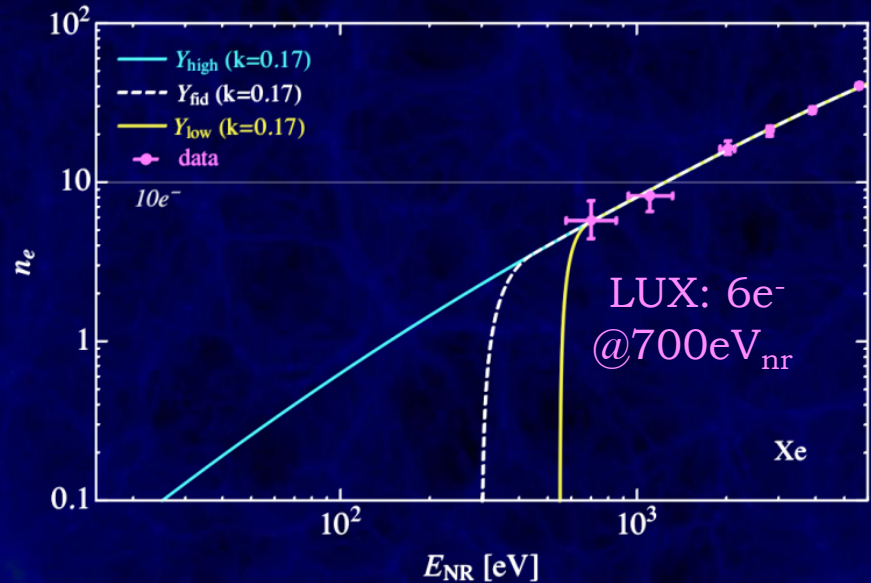


CE ν NS in liquid xenon

Essig, Sholapurkar, Yu 1801.10159



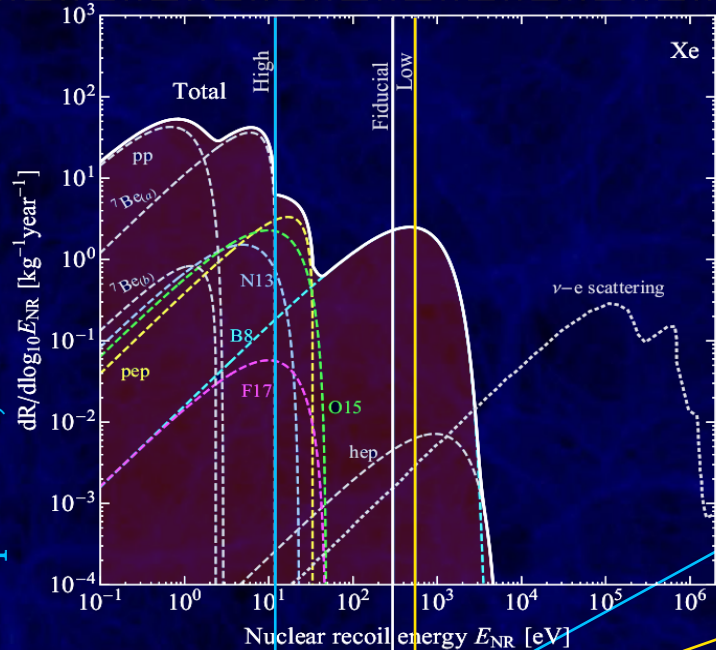
high/fid/low



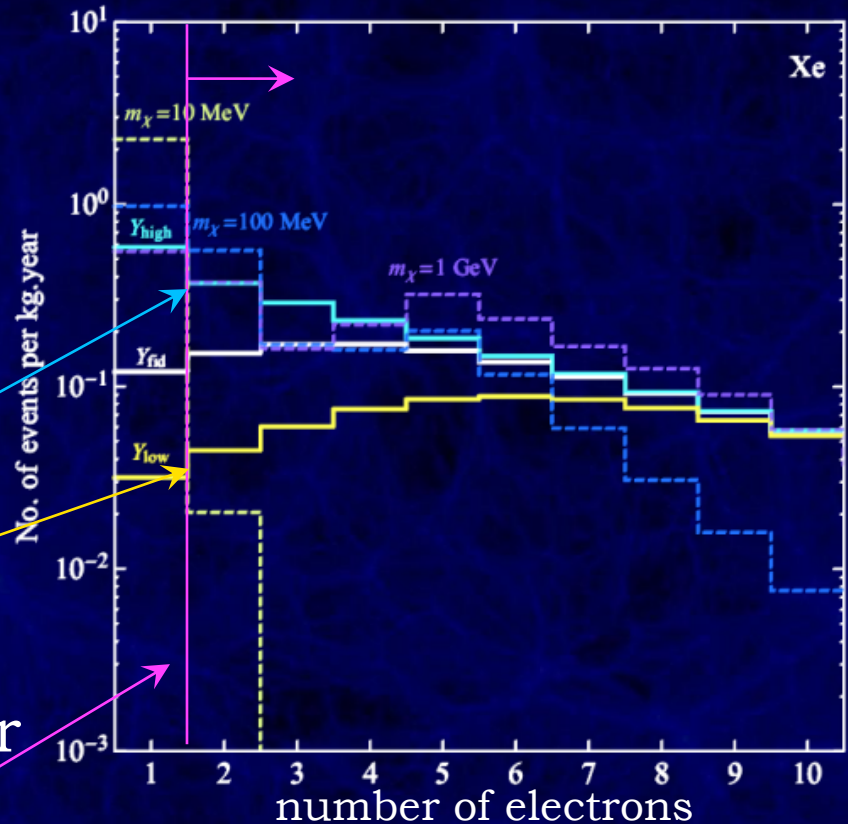
Expected rate uncertain:
need dedicated calibration
(already in progress)

CE ν NS in liquid xenon

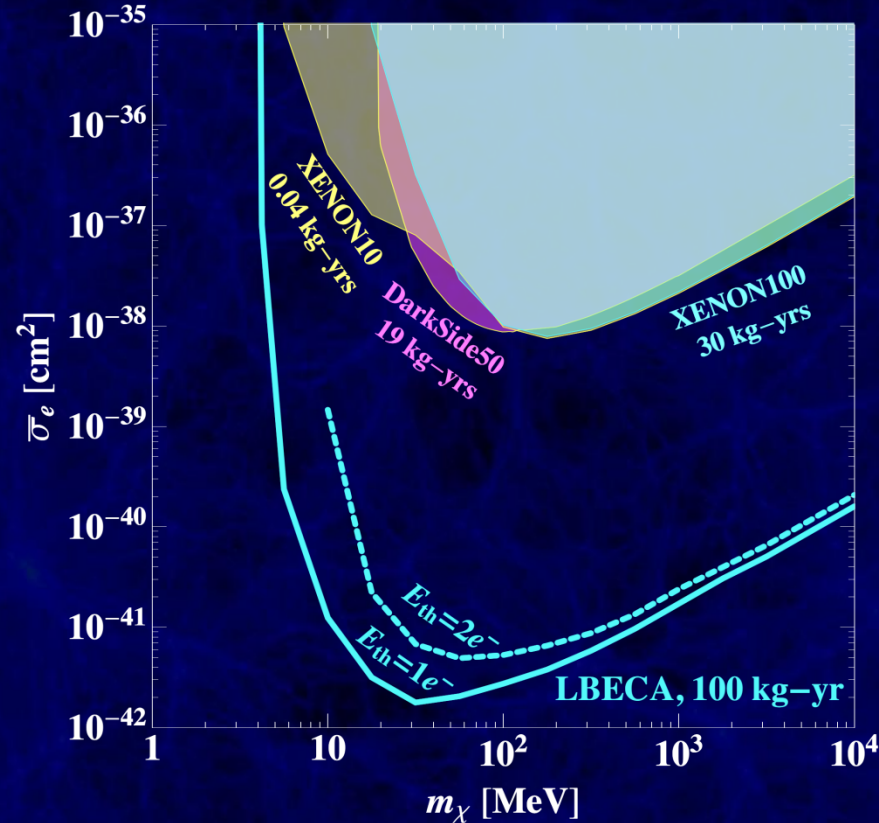
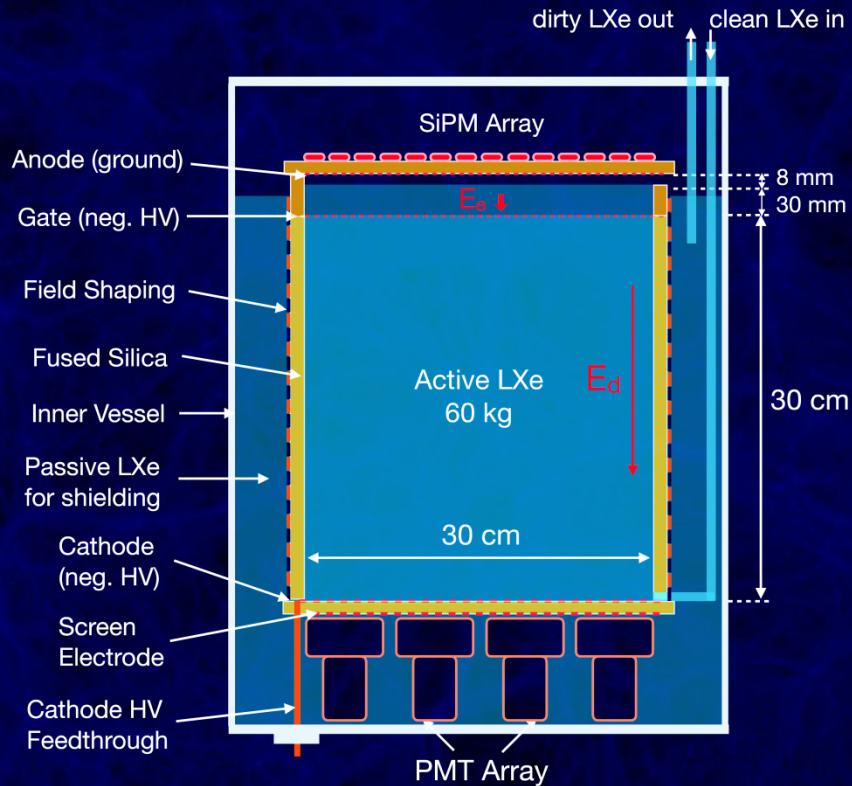
Essig, Sholapurkar, Yu 1801.10159



14 – 6 events/kg/year
with $2e^-$ threshold



LBECA Draft Design & Reach



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