

SNOWMASS 2021 Topical Group CF1

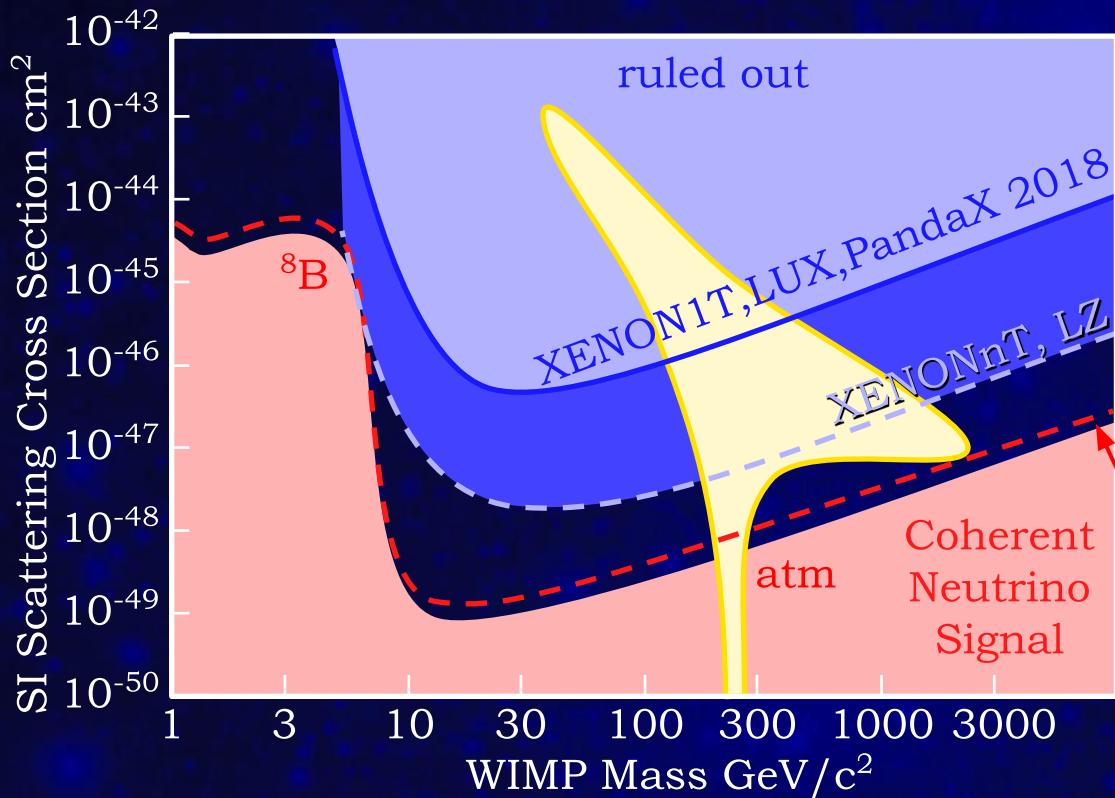
Liquid Xenon for a Generation-3 Detector

August 7, 2020

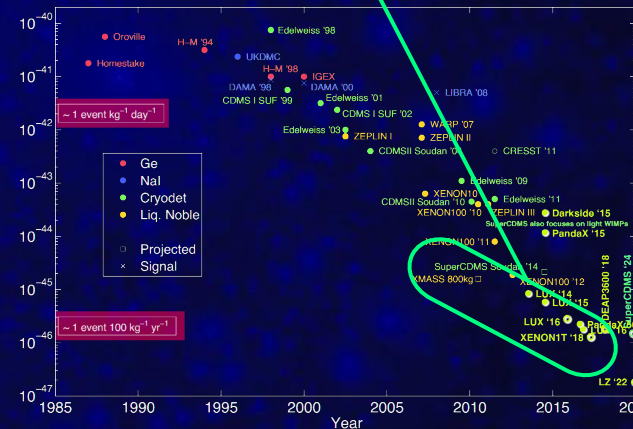
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Neutrino Floor is far, far away

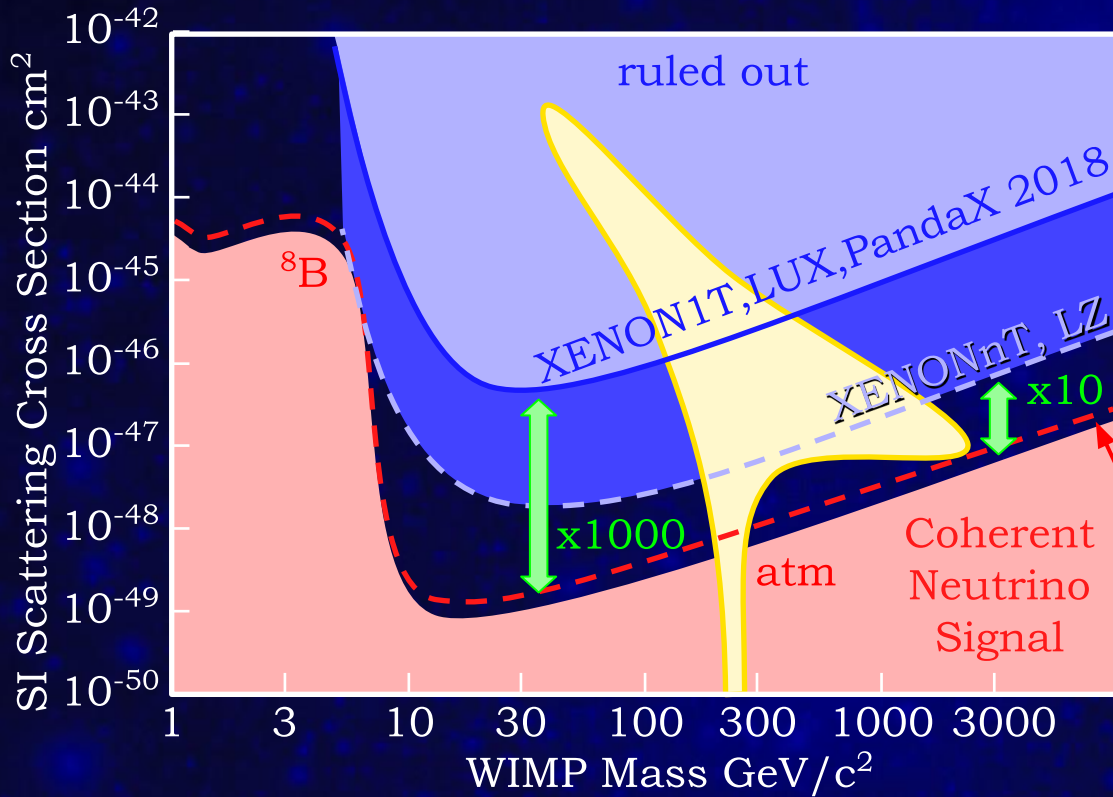


Leading SI limits all from LXe TPCs, for the past decade

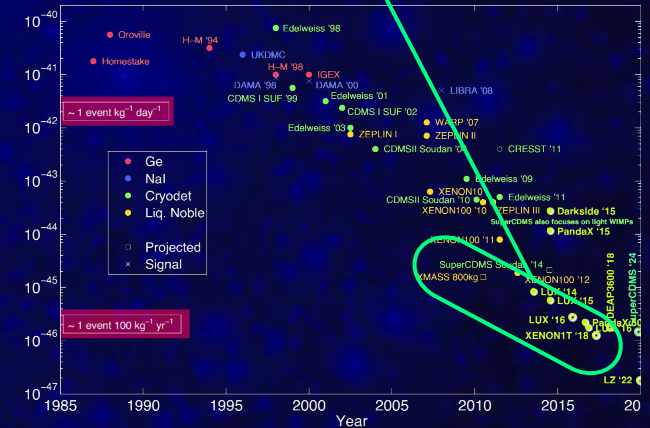


1 Neutrino Event

Neutrino Floor is far, far away

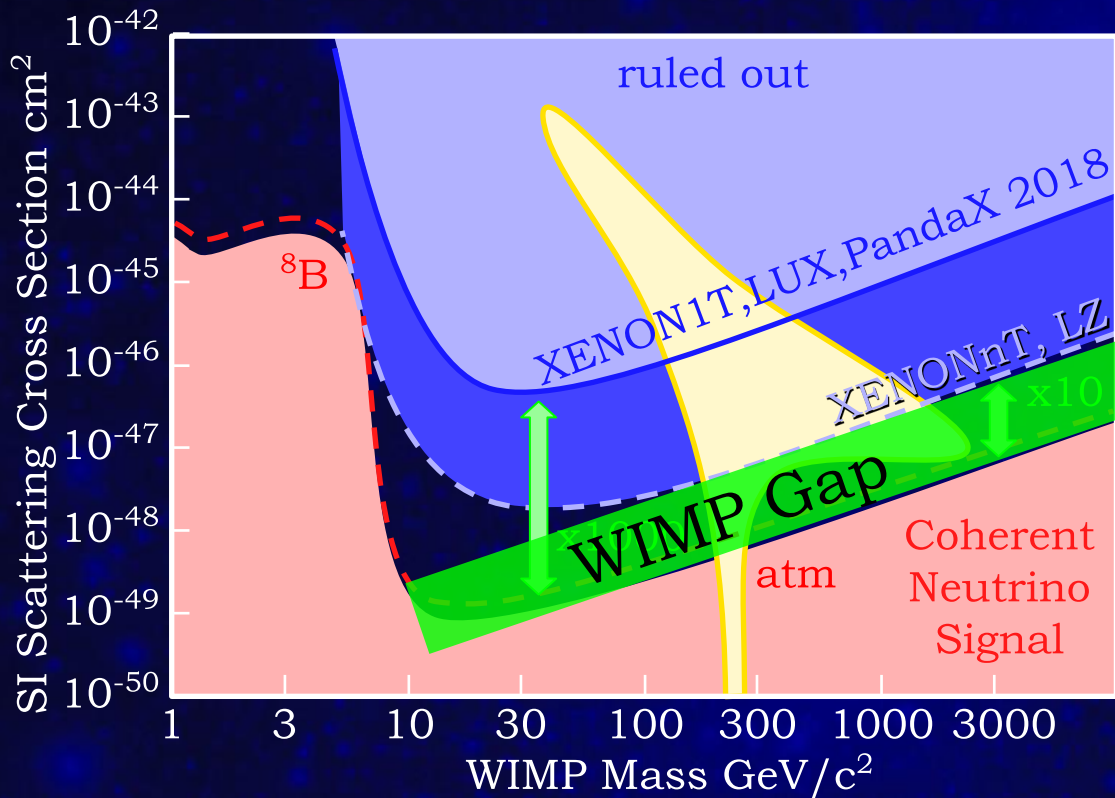


Leading SI limits all from LXe TPCs, for the past decade

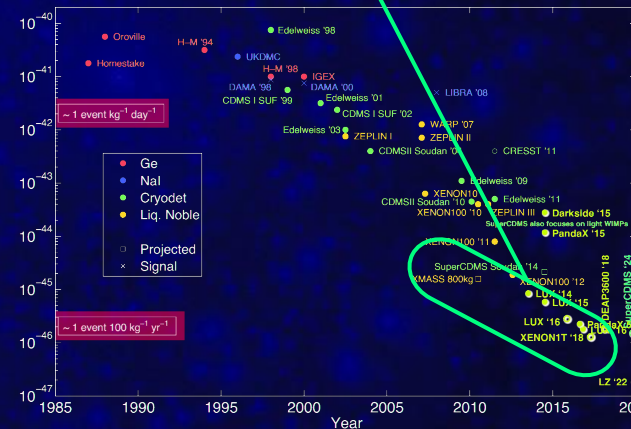


1 Neutrino Event

atm Neutrino Floor is far, far away



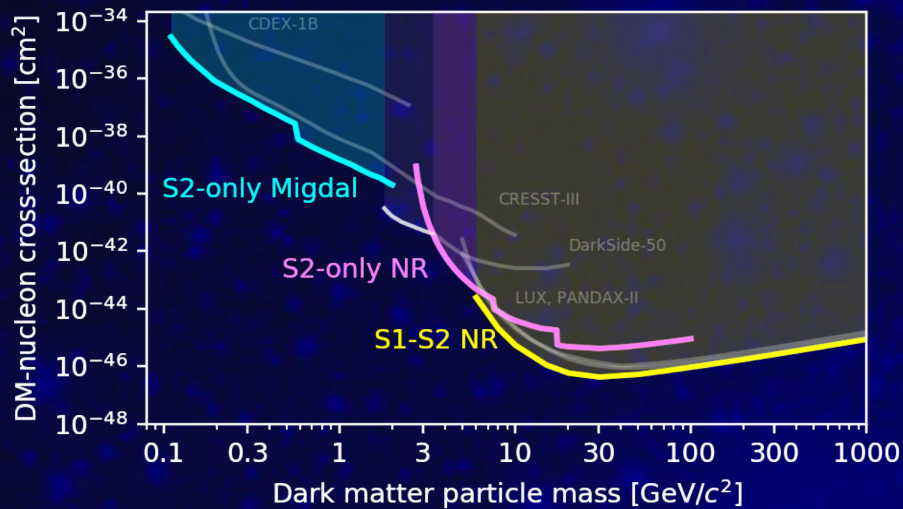
Leading SI limits all from LXe TPCs, for the past decade



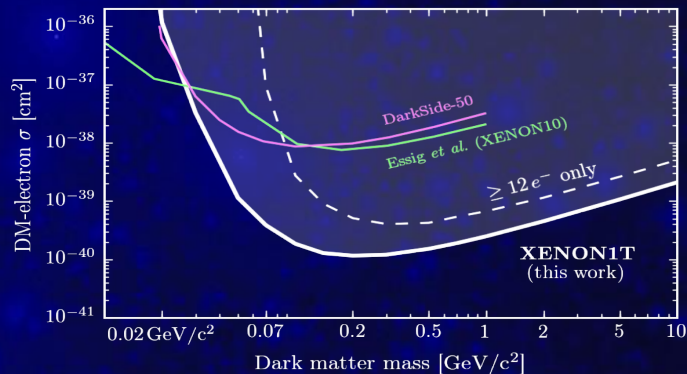
Current program leaves well-motivated WIMP Gap

Xenon: Sensitivity to Many Dark Matter Candidates

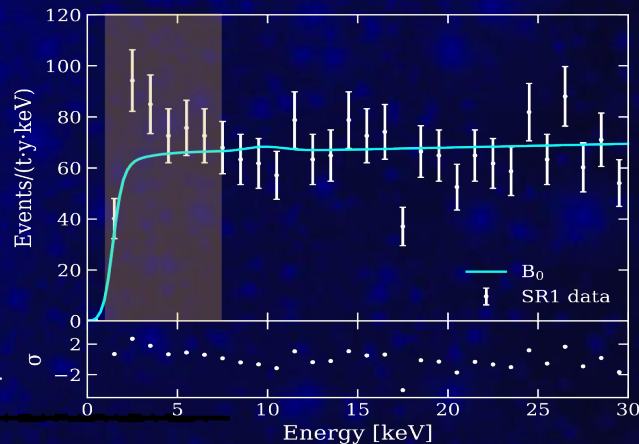
NR: also spin-dependent / EFT;
leading limits above 100MeV



ER: dark photons, axions, etc.



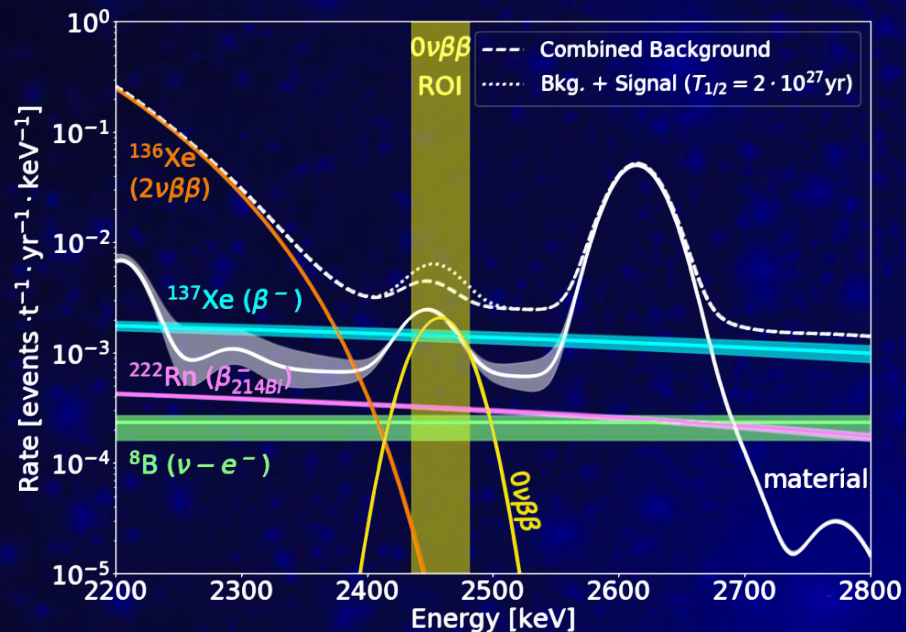
XENON1T “Excess”:
~100 citations in 1 month



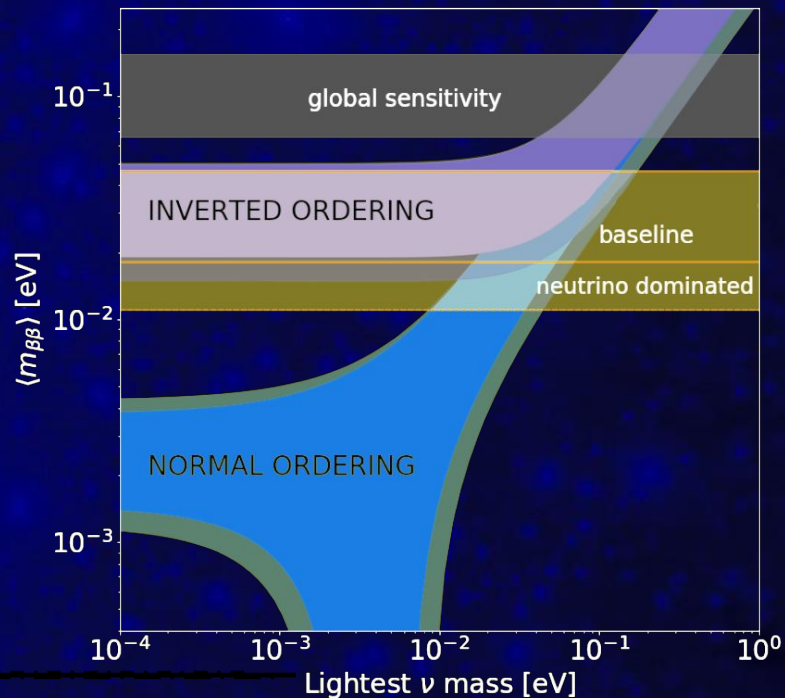


^{136}Xe $0\nu 2\beta$ with $^{\text{nat}}\text{Xe}$ Target

Abundance 8.9%: No (expensive) enrichment



potentially probe entire inverted hierarchy



plus additional $\beta\beta$ channels

Generation-3 Liquid Xenon Experiment

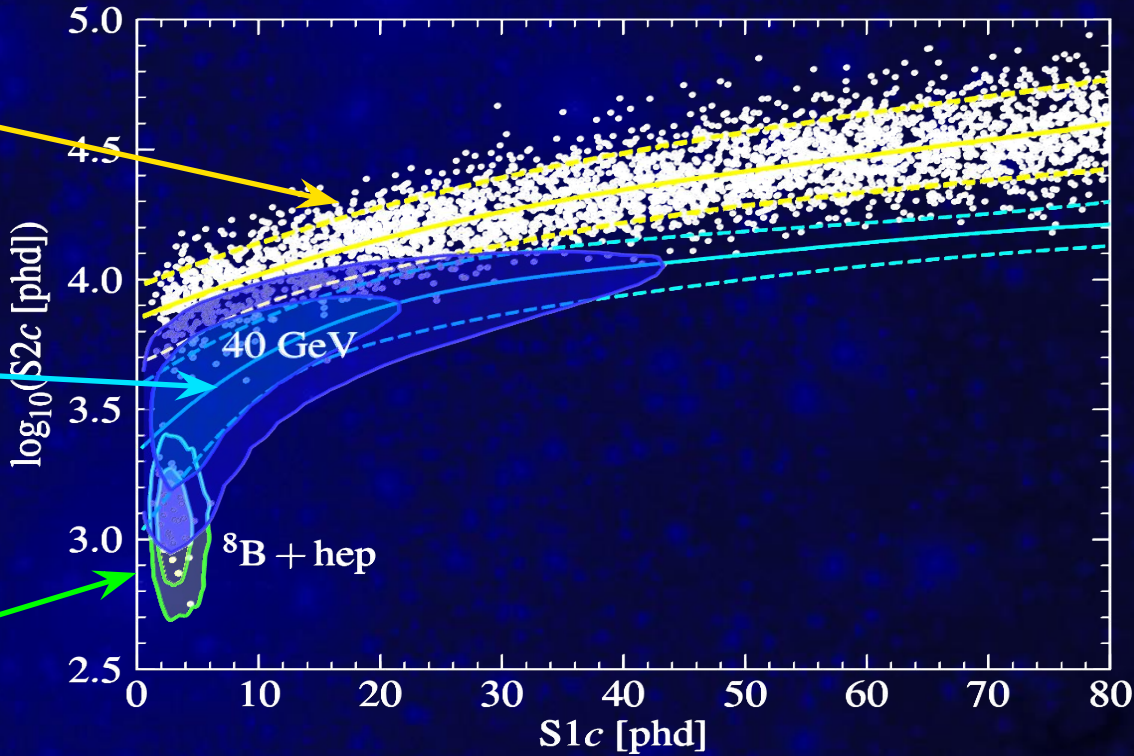
Solar ^8B CE ν NS ~2025: Guaranteed Science

Here: simulation of 1000 days LZ

electronic recoils
mostly pp solar ν

dark matter
nuclear recoils

^8B solar neutrino
nuclear recoils

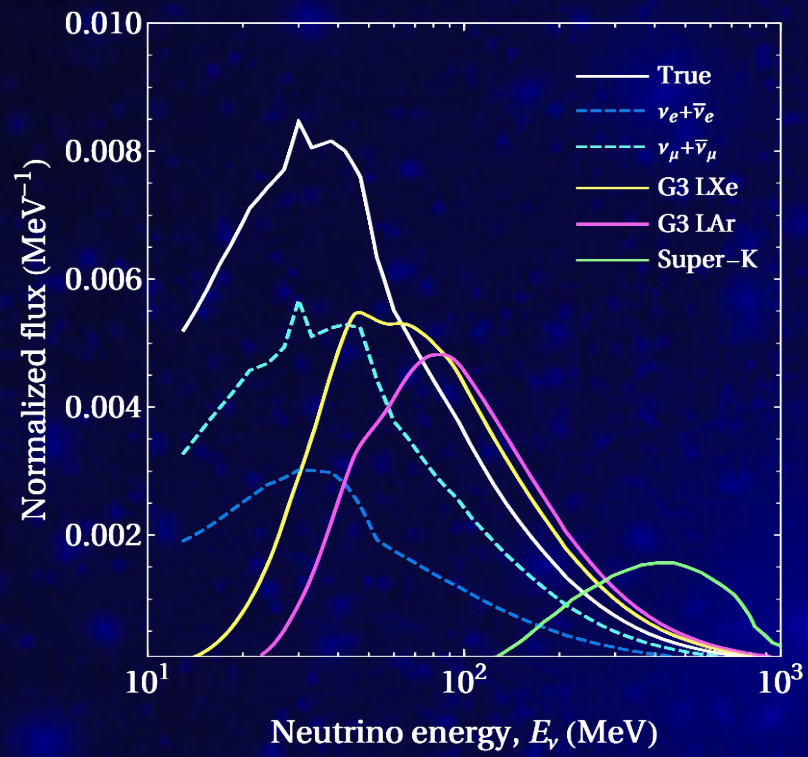


LZ 1802.06039

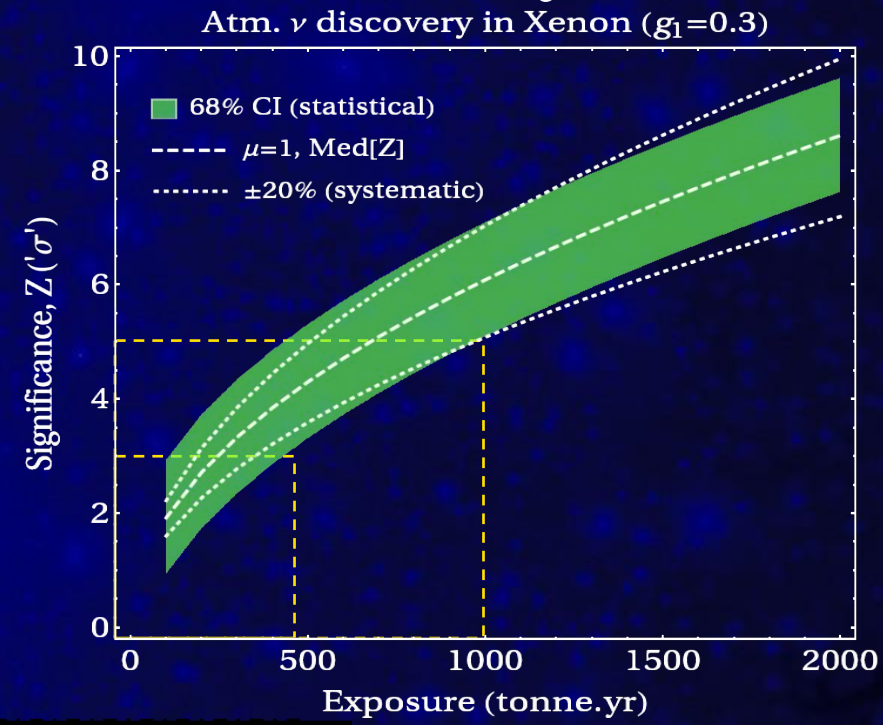
$$\nu_{\mu,e} + N \rightarrow \nu_{\mu,e} + N$$

<100MeV Atmospheric Neutrino CEvNS

measure low energies:

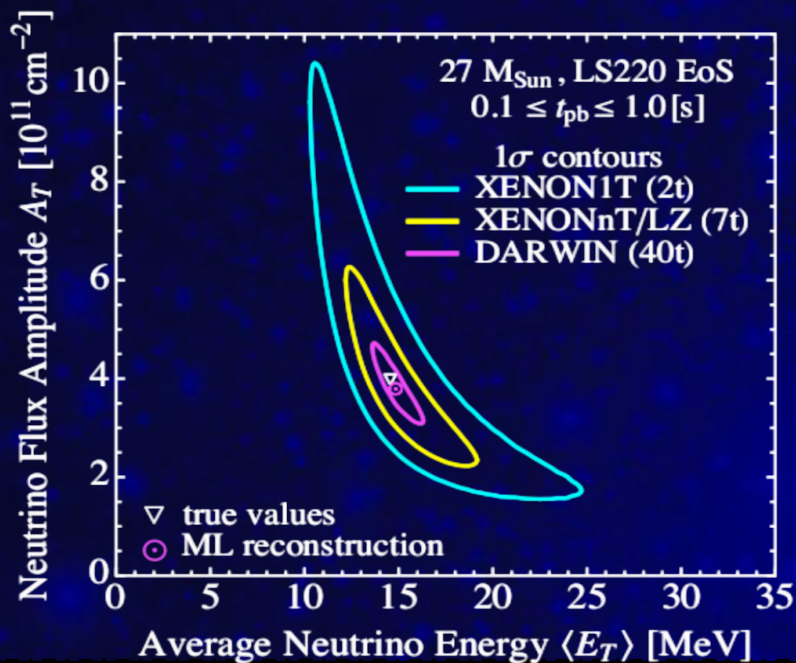
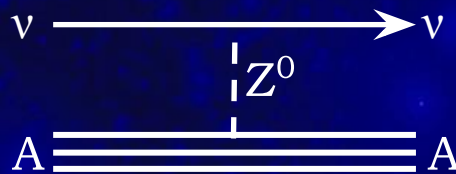


need >500 t years:

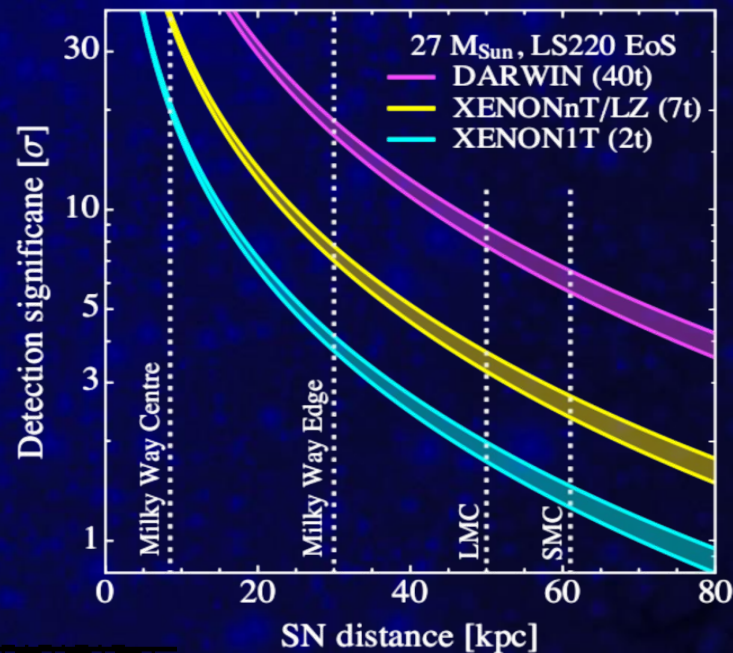


Supernova Neutrino CEvNS

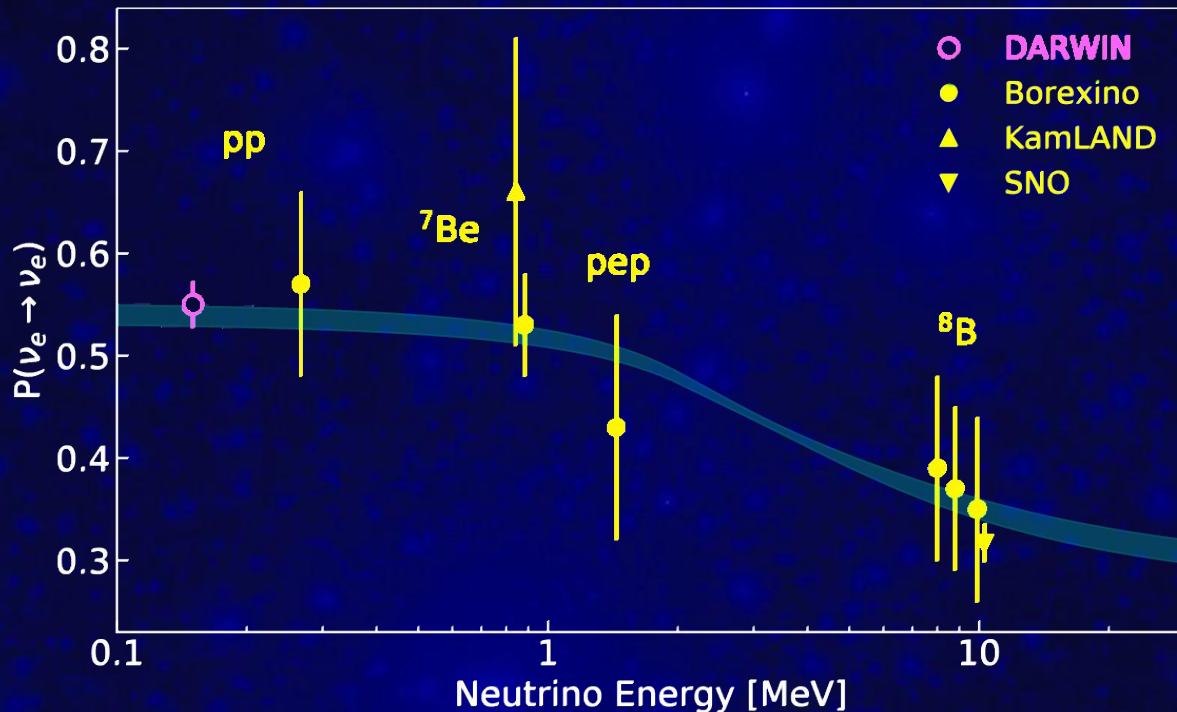
flavor-independent:
complementary
measurement



sensitivity:



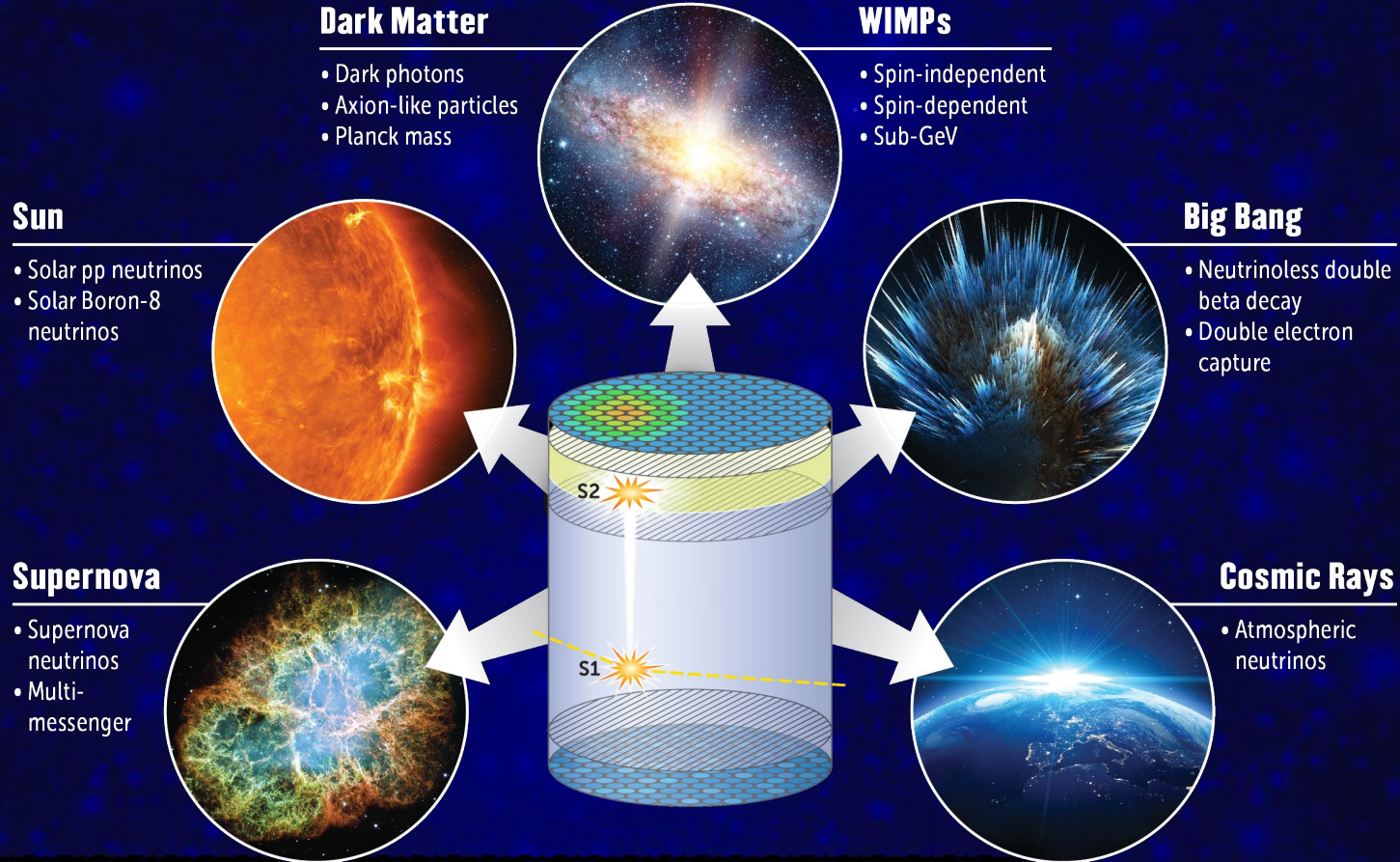
Elastic pp Solar Neutrino Scattering



Also measure $\sin^2 \theta_W$ to a few percent

Cerdeno+ 1604.01025

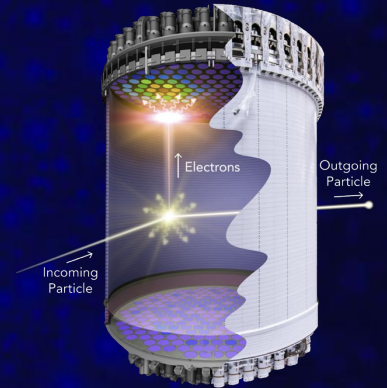
Diverse Program with Xenon



The Next Steps for the US Dark Matter Program

Exploit demonstrated & scalable Xe detector designs

- Scale-up existing TPCs by $\sim \times 10$
- Manageable run times: 5 -10 years
- Controlled and mitigated backgrounds
- Capitalize on investments and leadership
 - Exploit existing experiments & upgrades
 - Expand R&D efforts



Engage the Strong International Community

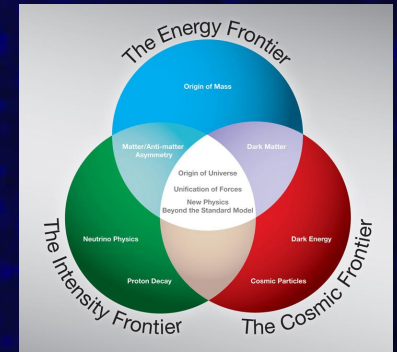
- Large community of (> 500) interested scientists with LXe expertise: LZ, XENON, XMASS, PandaX, ...
- Initial R&D funding in place in Europe
- Excellent opportunities and platforms in the US for essential G3 R&D

Xe: Essential Part of the Global Program in Dark Matter

We recognize the value of pursuing multiple technologies and targets with physics topics of this importance: Dark Matter, $0\nu\beta\beta$, & Neutrinos

Look forward to quantifying the complementarity of different technologies at Snowmass as detector mass, backgrounds, and operational parameters are better understood.

The Xe G3 program builds directly on the Snowmass 2014 Report & P5 Recommendations



Snowmass and 2014 P5 Report

“The results of G2 direct detection experiments and other contemporaneous dark matter searches will guide the technology and design of third-generation experiments. As the scale of these experiments grows to increase sensitivity, the experimental challenge of direct detection will still require complementary experimental techniques, and international cooperation will be warranted. The U.S. should host at least one of the third-generation experiments in this complementary global suite.”

Recommendation 20: Support one or more third-generation (G3) direct detection experiments, guided by the results of the preceding searches. Seek a globally complementary program and increased international partnership in G3 experiments.”

Conclusions for the Xe G3 Program

Excellent Scientific Reach & Discovery Potential

- Variety of Well-motivated Dark Matter Candidates
- Neutrinoless Double-beta Decay
- Astrophysical Neutrinos

Proven Record Delivering Sensitivity Goals & Performance

- 3 multi-tonne detectors being commissioned

Strong Scientific Expertise and Leadership in the US

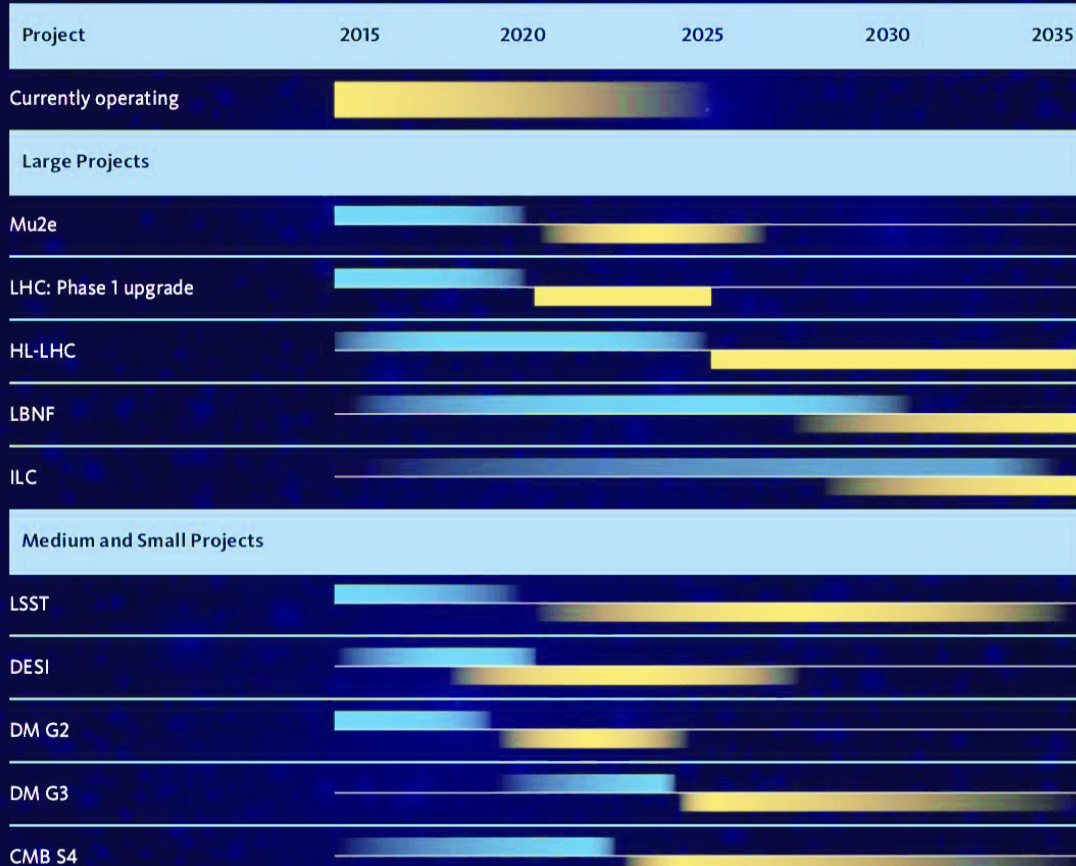
- Exploit Operating Expts and Upgrades to Inform G3

Well-aligned with Existing US and International Plans

- Complementary Technologies and Targets

Extras

Challenge for Snowmass 2021



Multi-Target Approach to Identify Signals

