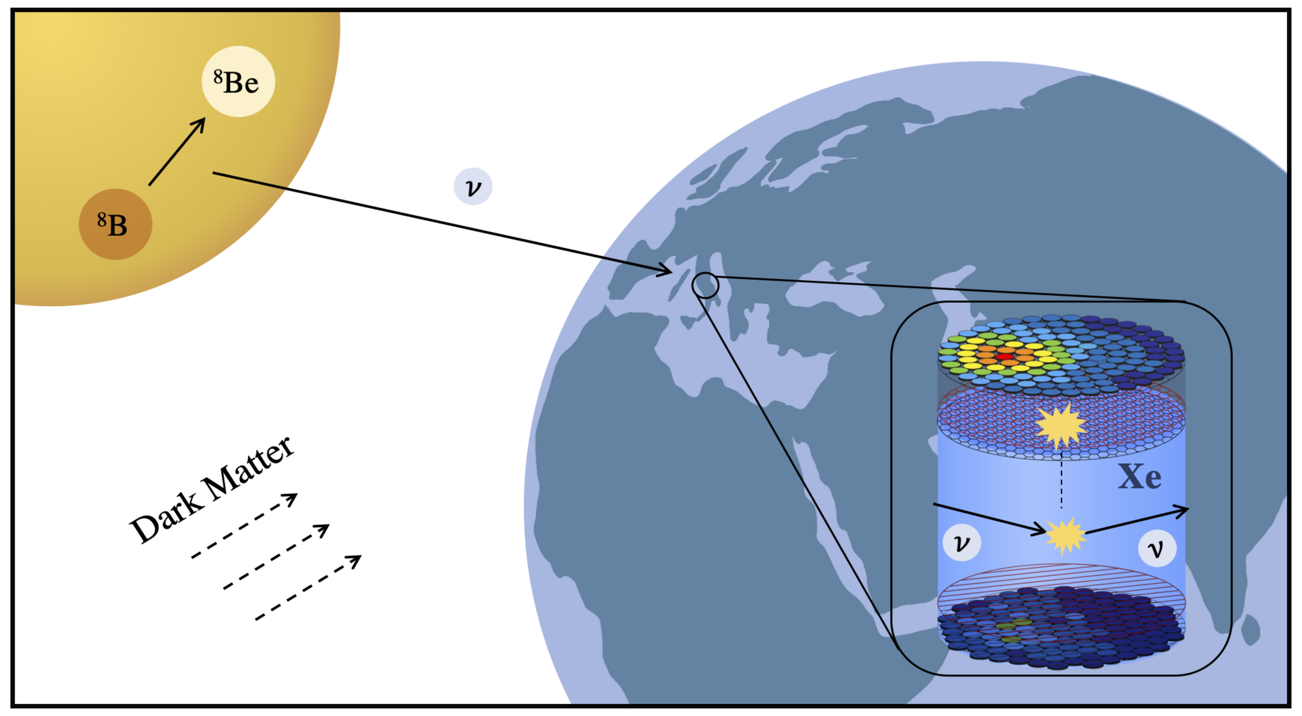
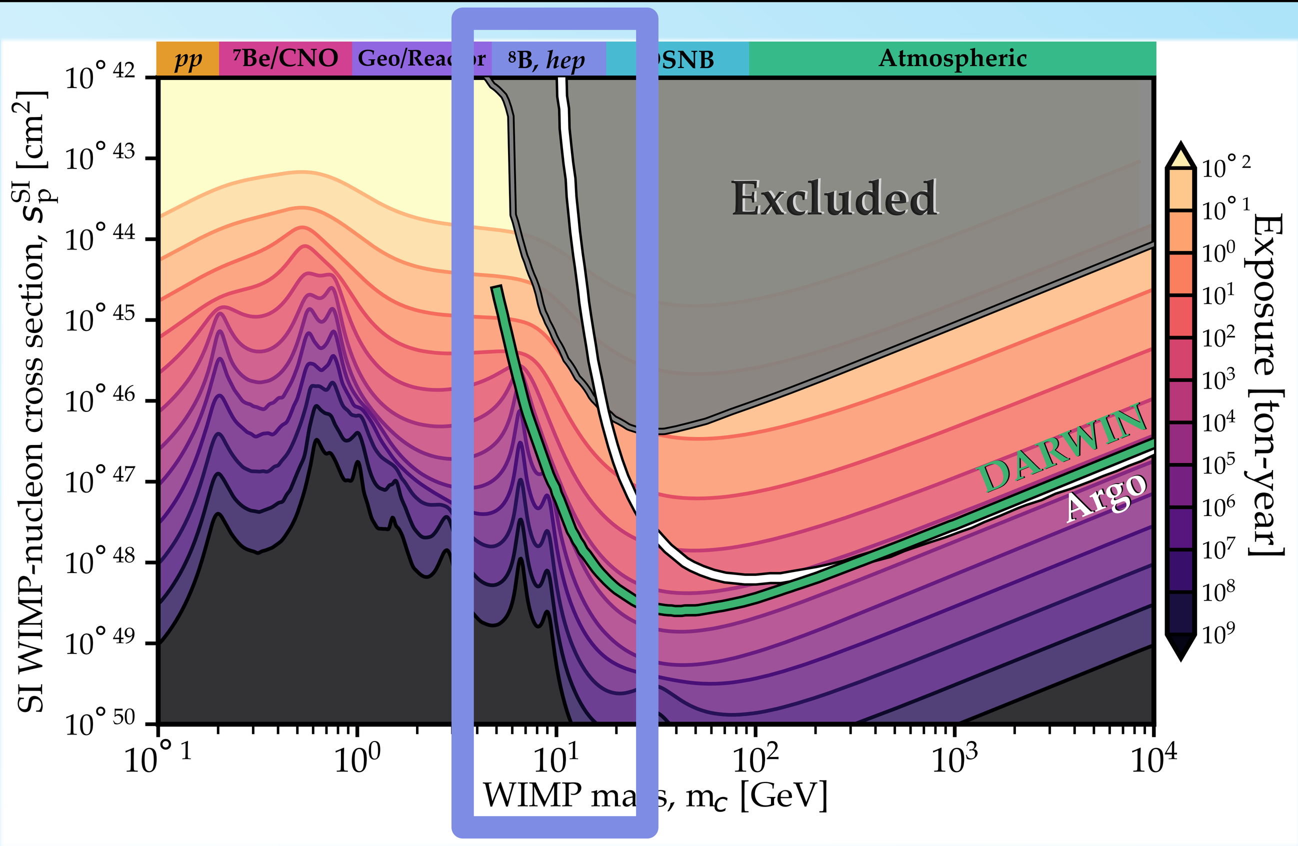
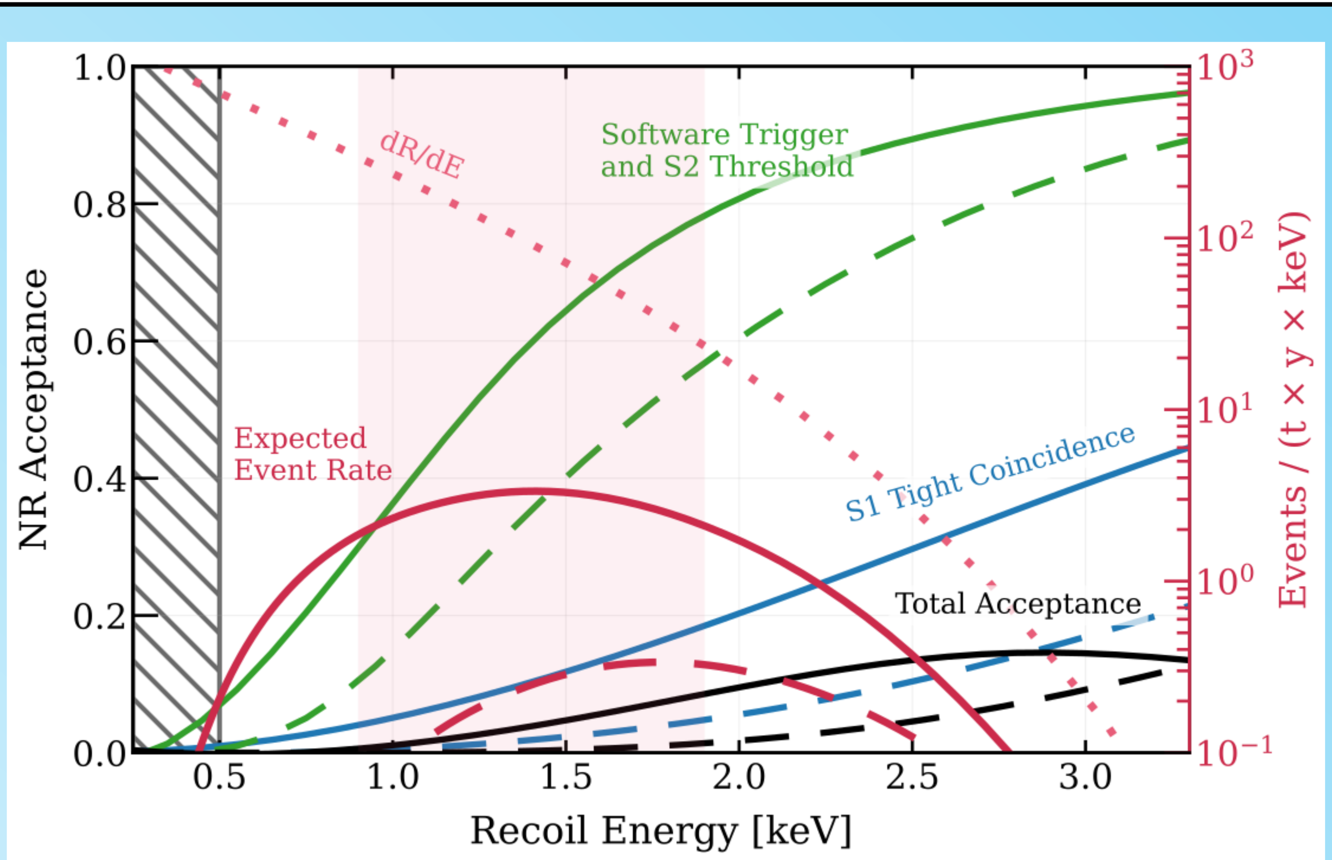


A Gamble In the Fog: Solar ^{8}B Neutrino Search in XENON1T

Joseph Howlett (Columbia University) on behalf of the XENON collaboration

CEvNS from solar ^{8}B neutrinos has yet to be observed, but will become a major background in upcoming DM searches. We decided to look for it in existing XENON1T data by lowering the energy threshold.





Events at the Threshold

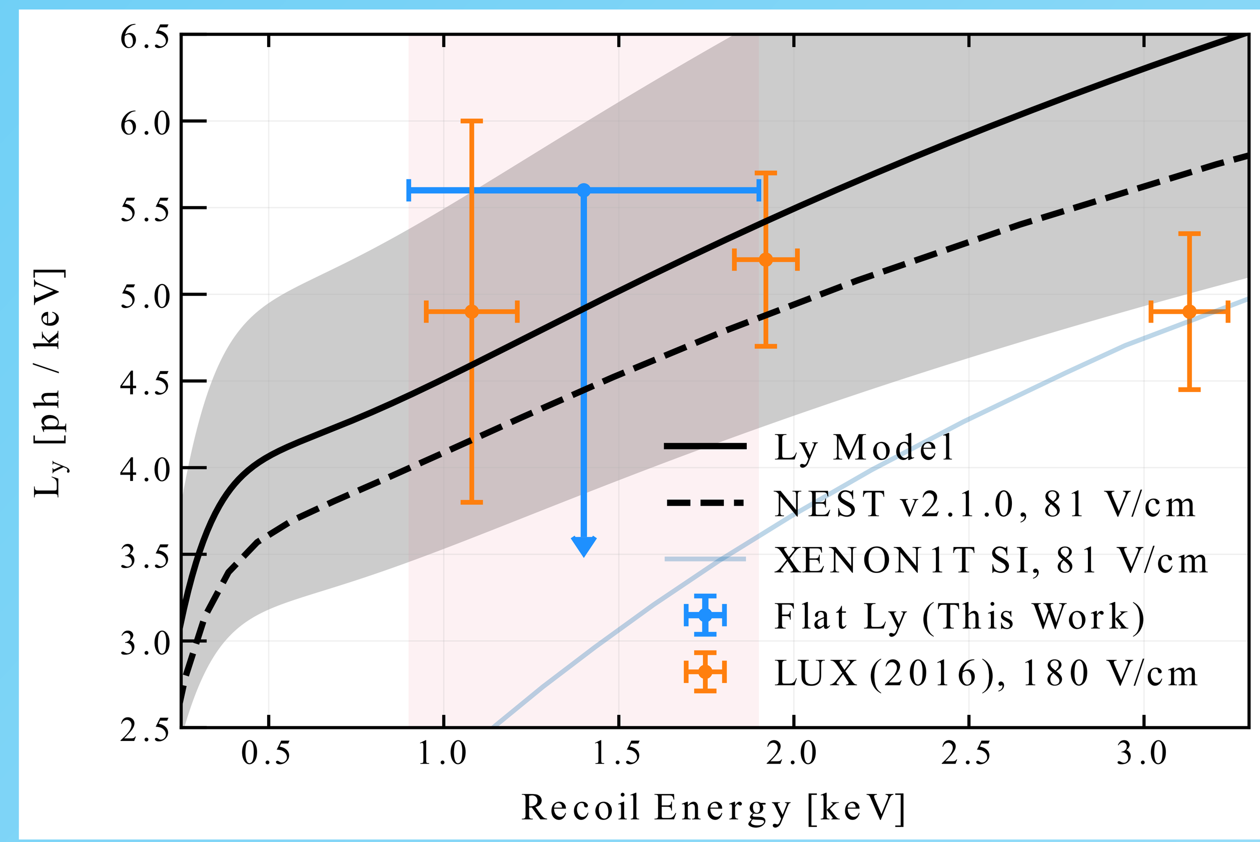
^{8}B neutrinos fall at the energy threshold of LXe TPCs, but exactly mimic low-mass WIMPs and will limit the sensitivy of future experiments, a phenomenon called the "neutrino fog".

This analysis aims to detect the neutrinos as a signal in existing XENON1T data by lowering the energy threshold in two ways:

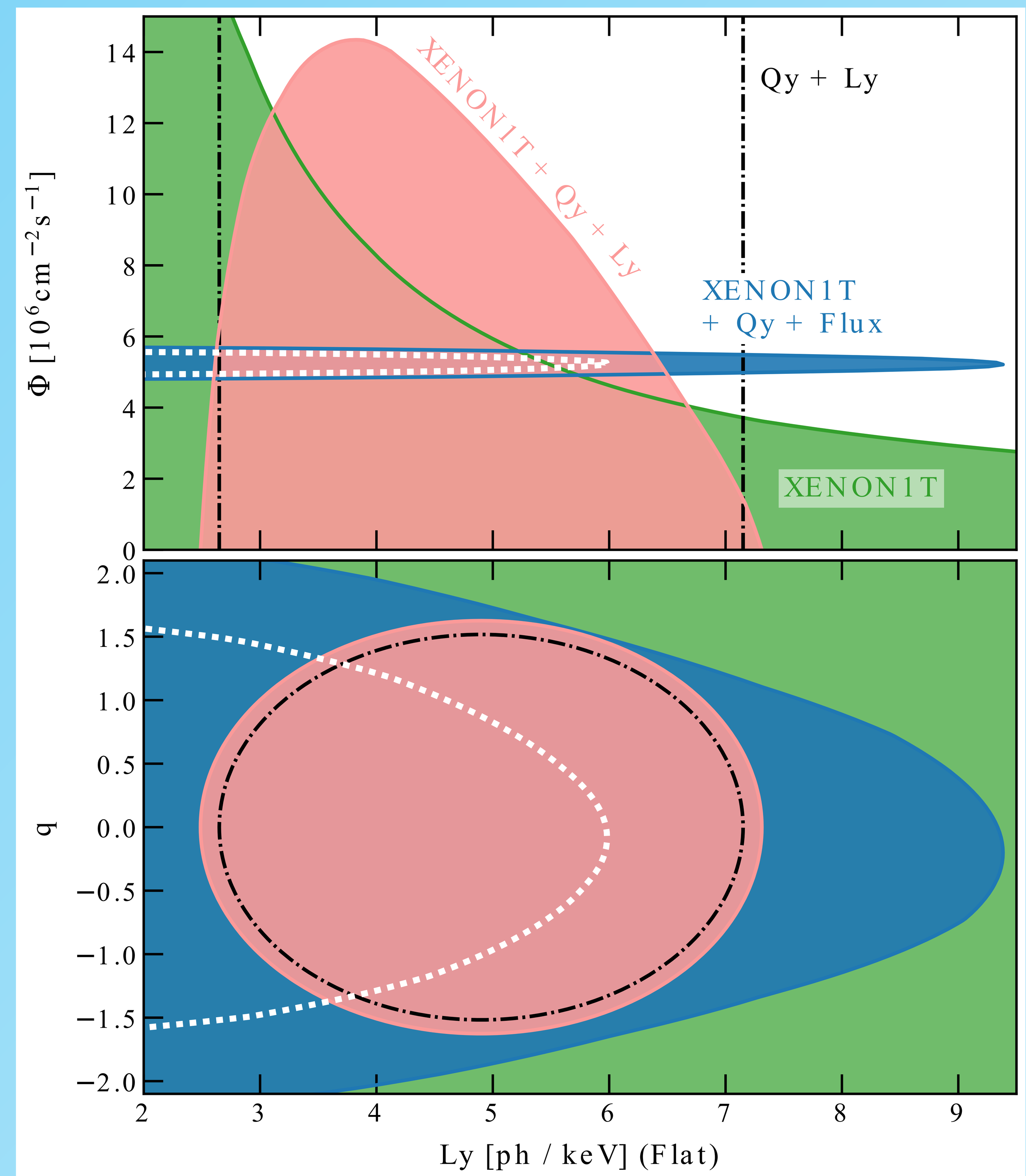
1. The requirement that primary scintillation light (S1) contain **three photons** detected within 50 ns is reduced to **two photons**.
2. The threshold on secondary scintillation light (S2) due to ionization is reduced from **200 PE to 120 PE.**

Signal Uncertainties

We need to make choices about the solar ^{8}B flux, and the scintillation and ionization yields of xenon at the relevant energies. We use a combination of external measurments.



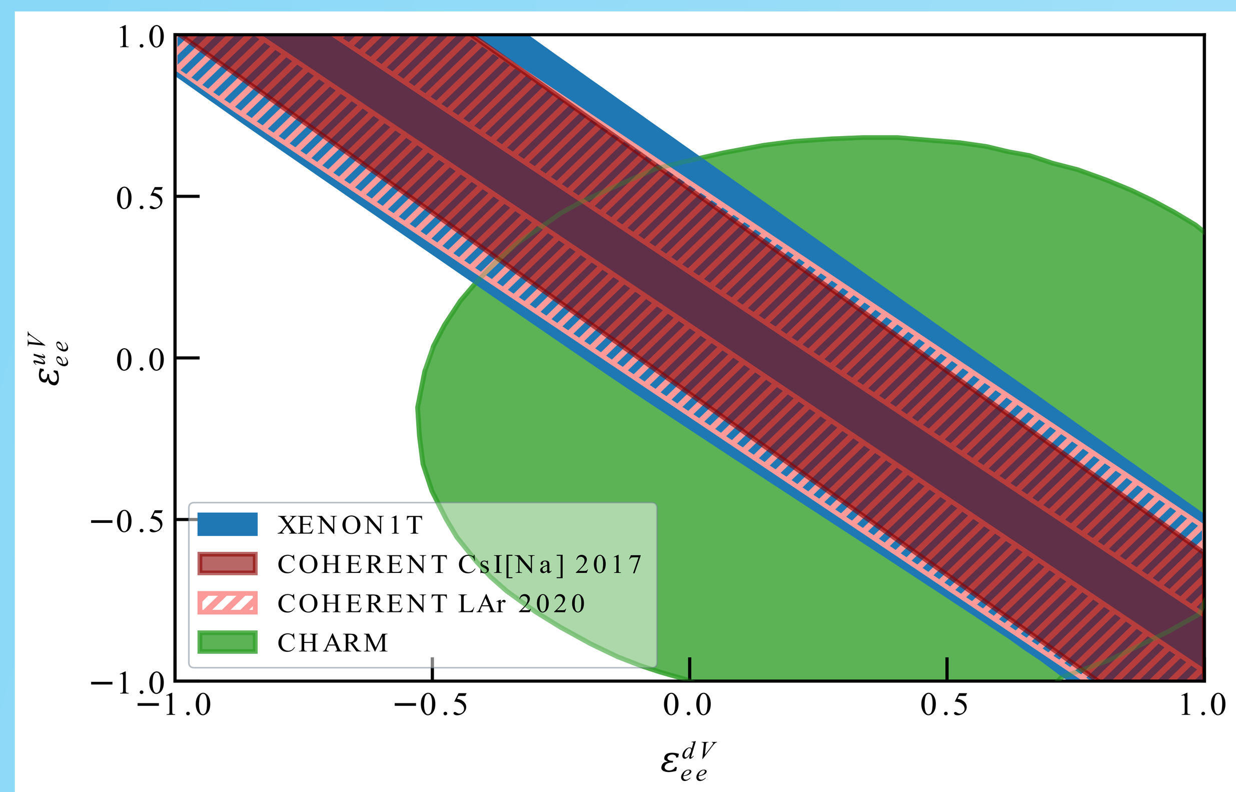
The most uncertain input is the scintillation yield (Ly) at ~ 1keV, where the extant calibration measurements have a 20% uncertainty. For the neutrino search, we treat this systematic (grey) with a profile likelihood approach. We additionally use the likelihood to set an upper limit on Ly over our sensitive energy range (light blue).



Three degenerate nuisance parameters determing the CEvNS expectation: the scintillation yield (Ly), the ionization yield (via "interpolation parameter" q), and the solar ^{8}B flux Φ. Our data can be combined with various external measurements tomutually or individually constrain these nuisance parameters.

Unblinding and Results

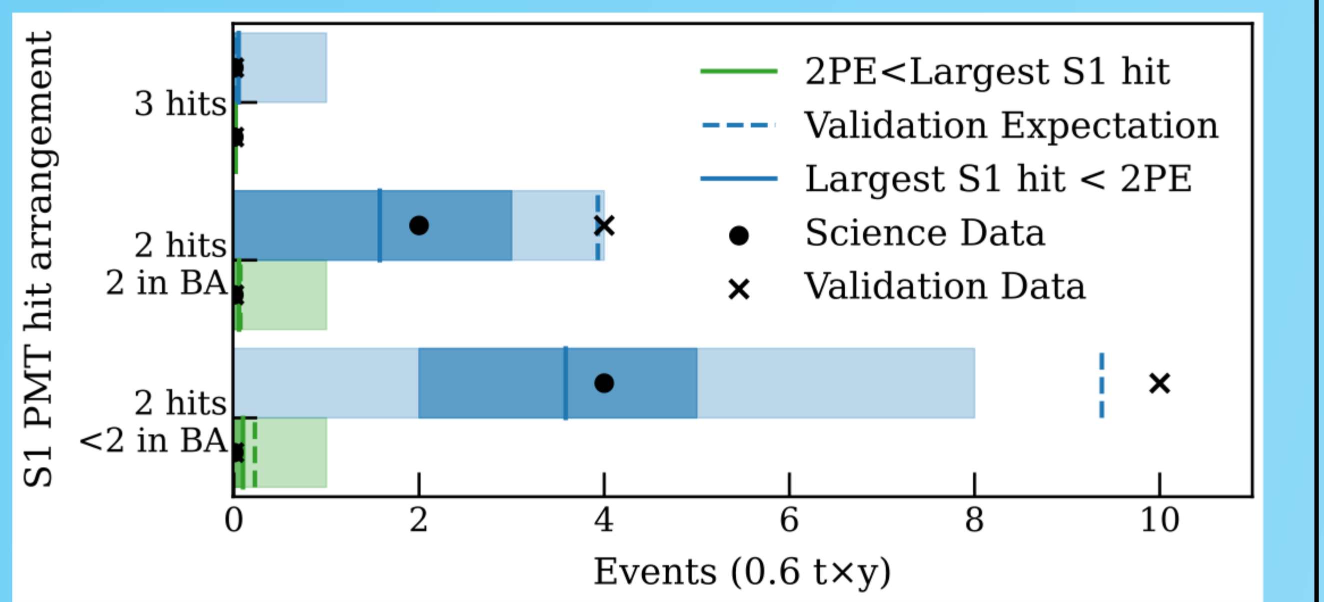
In addition to a straightforward search for an excess of neutrino events, we are able to consider new physics scenarios including low-mass dark matter and non-standard interactions between neutrinos xenon nuclei.



NSI cases would enhance or reduce the CEvNS cross-section, leading to a higher or lower signal expectation. Our non-detection of neutrinos places an upper limit on this cross-section, which is translated into a constraint on the neutrino-quark coupling enhancement parameters shown here.

Validation and Discovery Analysis

The data was split into six bins to discriminate signal and background. These reflect the number and positions of PMTs detecting S1 light, since background events tend to be smaller and occur less frequently on the bottom array (BA) of PMTs than signal events.



Data in a "validation region" with zero signal expected was unblinded first and showed excellent agreement with the prediction. Then, the 0.6 ton-year science exposure was unblinded, and was found to be consistent with the background expectation.

Thus, **no excess of CEvNS events was observed**.

By considering solar neutrinos as a background, we can improve existing XENON1T dark matter limits using our new, lower energy threshold. The new limits are world-leading in the 3-10 GeV mass range.