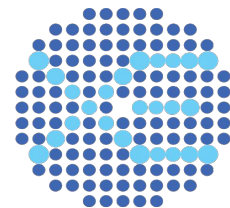




Stockholms
universitet



XENON

Novel limits on solar reflected dark matter with XENONnT

Light Dark World 2023, Karlsruhe
20 September 2023

Pueh Leng Tan
on behalf of the XENON collaboration

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XENON Collaboration

164 members, 27 institutes, 12 countries



Columbia



KIT



Nikhef



Muenster



Stockholm



Mainz



MPIK, Heidelberg



Freiburg



Zurich



Chicago



UCSD



Rice



Purdue



Subatech



Coimbra



LPNHE



Torino



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LNGS



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Tokyo



NAGOYA UNIVERSITY

Nagoya

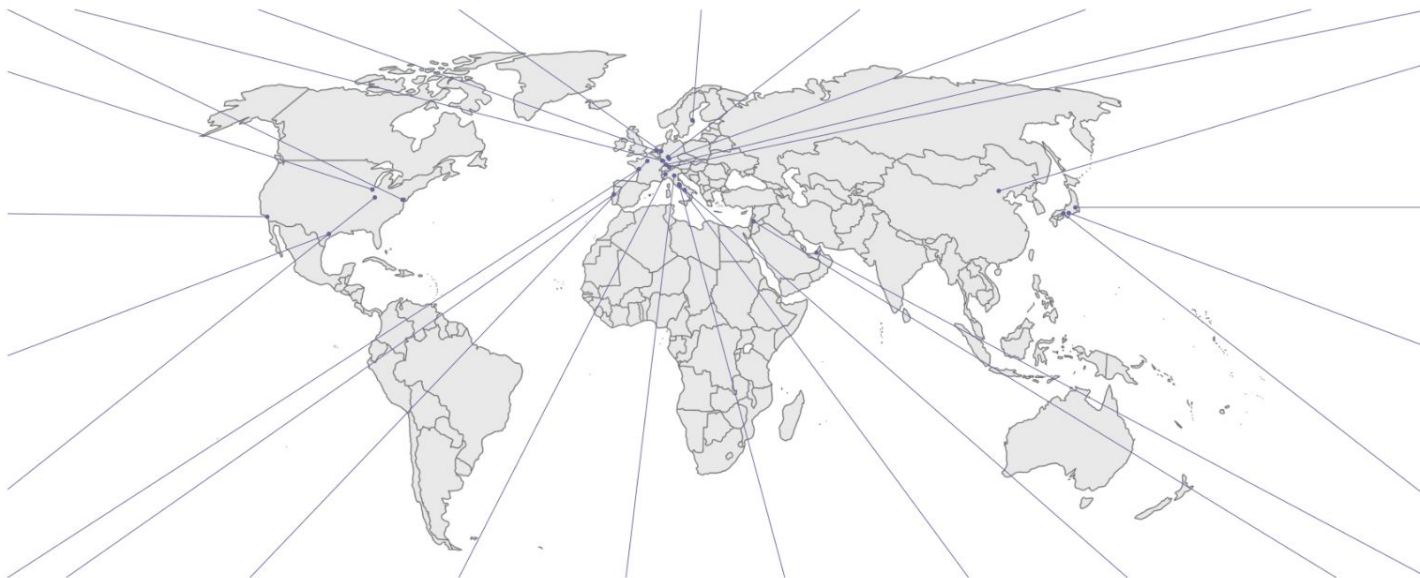


Kobe

جامعة نيويورك أبوظبي

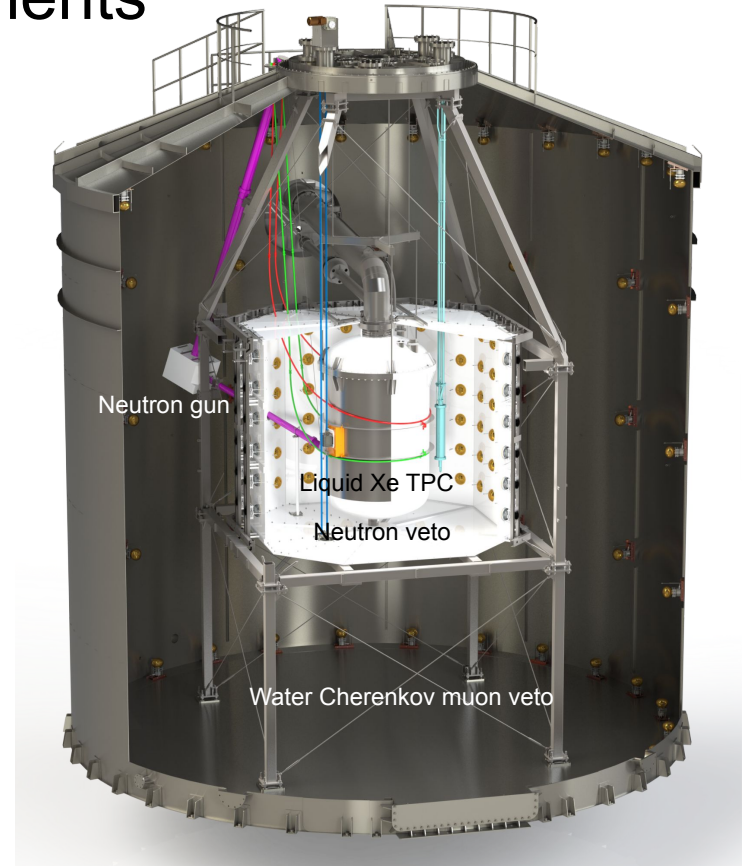


NYUAD

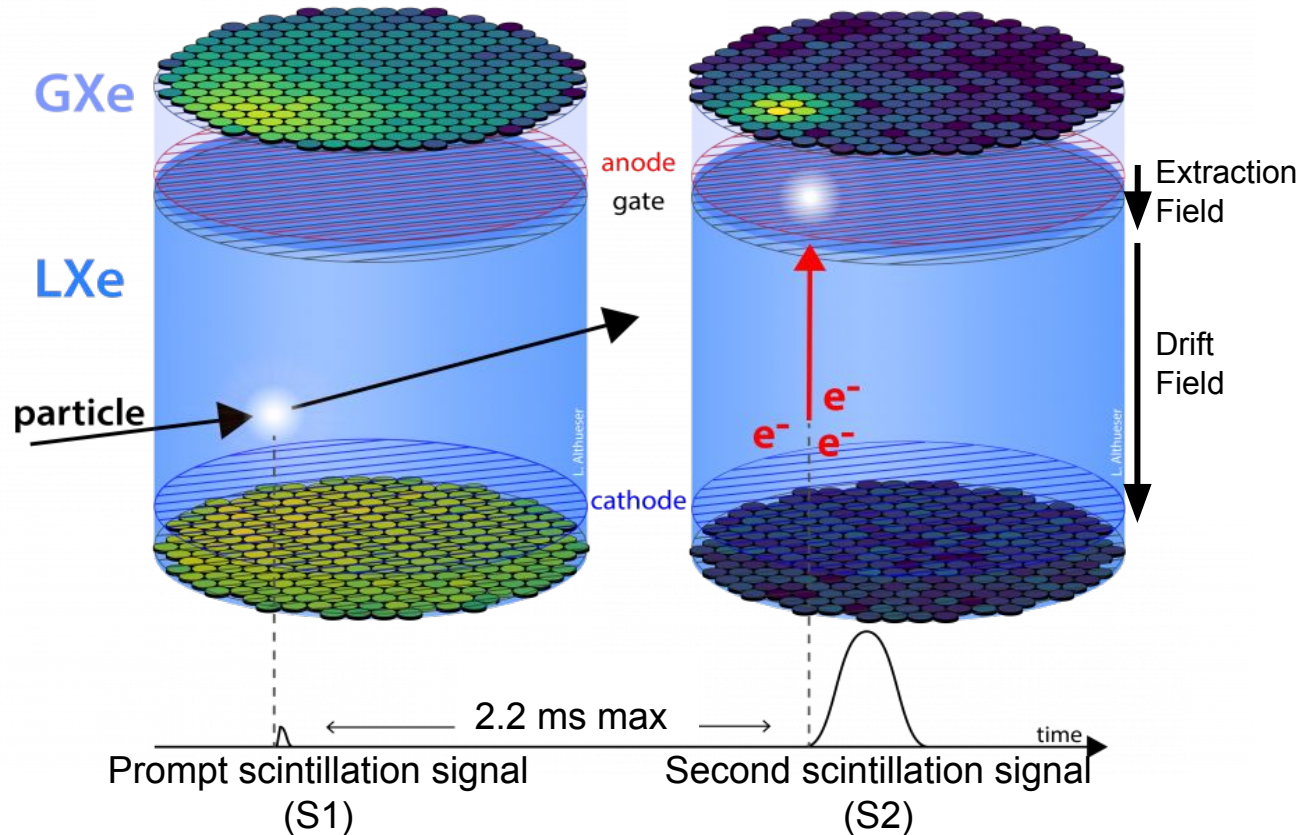


XENON1T → XENONnT improvements

- Larger Time Projection Chamber (TPC)
 - 2 tonnes→6 tonnes
- Improved cleanliness and radio purity
 - Liquid xenon purification system
 - Material screening
 - Radon distillation
- Water Cherenkov neutron veto
 - Will dope with Gd in future
 - Increase neutron tagging efficiency from 68% → 87%
- Triggerless Data Acquisition (DAQ)
 - Will not miss small signals
 - Single electron and S2-only analysis
 - Light dark matter searches



Signal production in liquid xenon



- Particle interaction deposits energy in liquid xenon
- Generates scintillation photons (S1) and electrons
- Electrons drift to liquid surface and get extracted into gaseous xenon
- Electrons create more scintillation light in gaseous xenon (S2)

Solar Reflected Dark Matter (SRDM)

- Mean DM velocity ~ 350 km/s under the Standard Halo Model (SHM)
 - Sub-GeV DM too light to generate signals in liquid xenon TPCs
- Cheat SHM DM velocity by up-scattering halo DM off various objects
 - Cosmic Rays
 - Blazars
 - Diffuse Supernova Neutrino Background
 - **The Sun**
- Inference on sub-GeV DM properties
 - keV - MeV mass range
 - DM-electron cross section

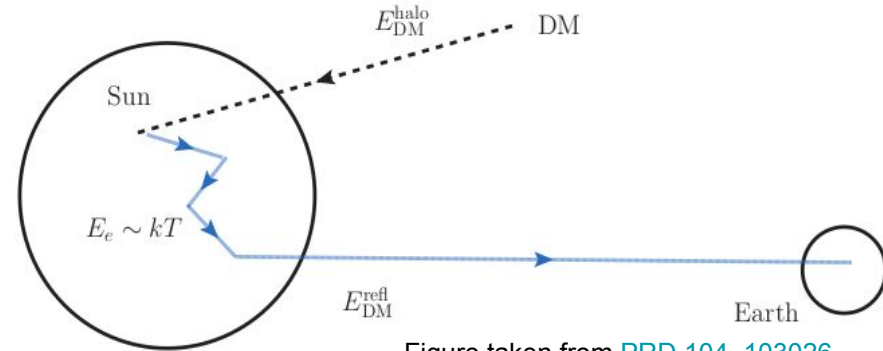
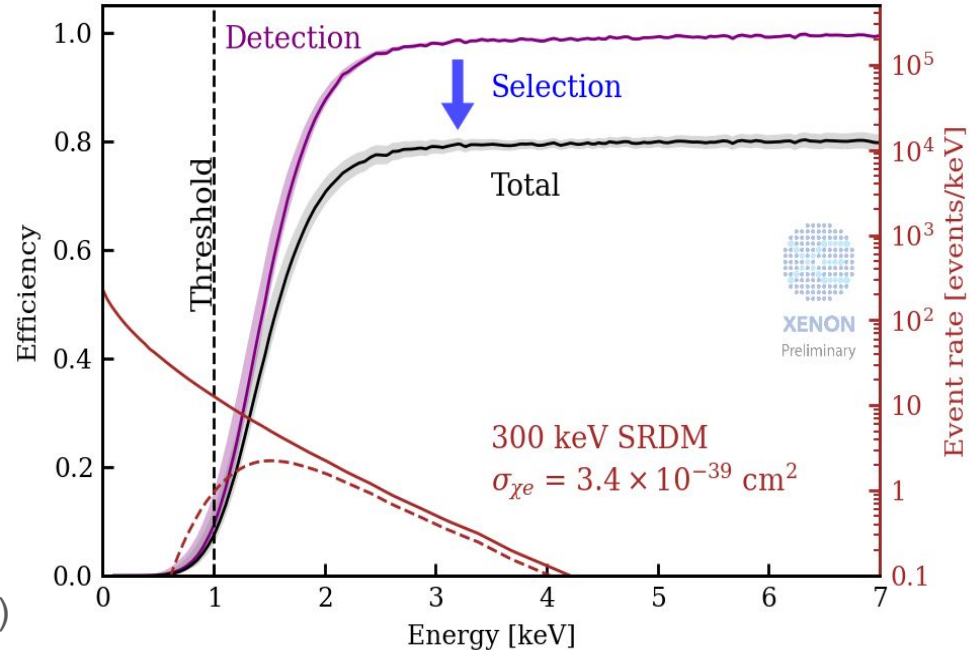


Figure taken from [PRD 104, 103026](#)

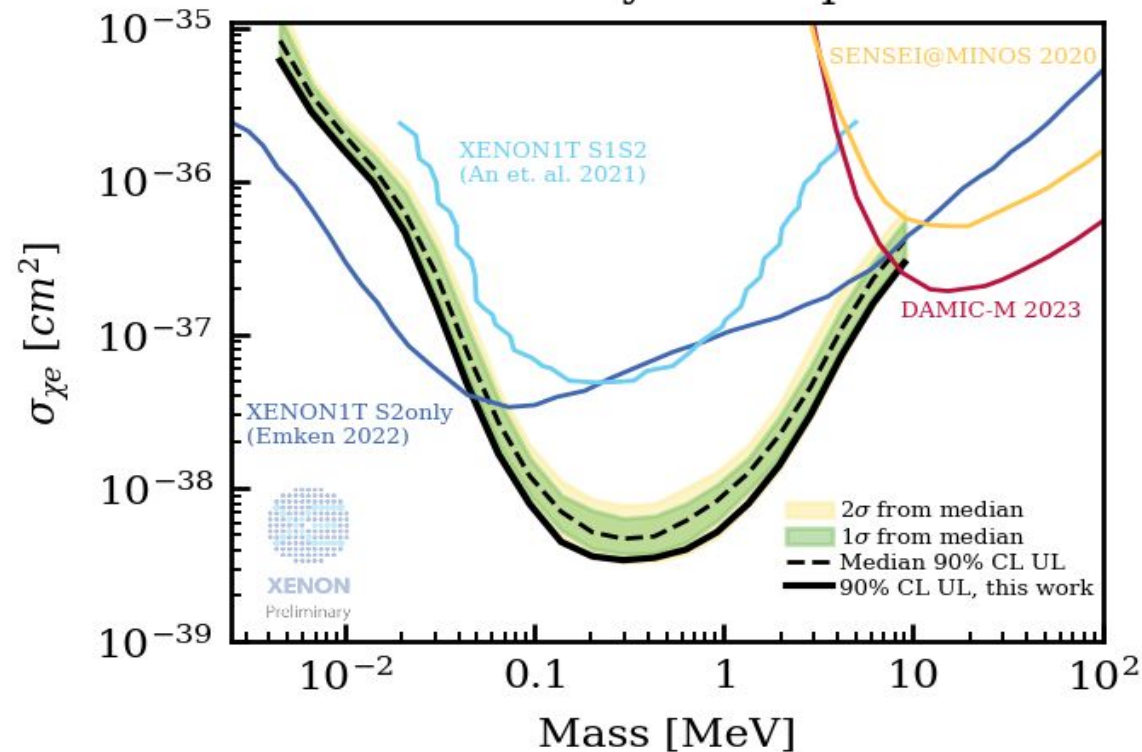
Recoil spectrum with detector effects

- True recoil spectrum computed using Monte Carlo simulations
 - No analytic solution for multiple DM-electron scatterings in sun
 - [DaMaSCUS-SUN](#)
- Finite energy resolution
 - Convolution with skewed Gaussian obtained from fitting monoenergetic calibration sources
- Detection efficiency
 - 3-fold coincidence for S1
- Event selection removes
 - Multiple-scatter events
 - Events far away from electronic recoil (ER) region
 - Events coincident with neutron veto events



Results

nT SR0 lowER SRDM search
1.16 tonne years exposure



- Unbinned loglikelihood analysis
 - Electronic Recoil (ER) data
 - 1-140 keV
 - Full background model
- Order of magnitude more stringent UL than existing limits
- Improvements from XENONnT
 - ~2 times the exposure
 - ~5 times lower ER background
 - Refer to [PRL 129, 161805 \(2022\)](#) for details
- Probes different DM mass range
 - Liquid xenon: 4.6 keV - 9 MeV
 - Solid-state detectors: 0.5 MeV - 1 GeV

Summary

- Probe sub-GeV mass range with liquid xenon TPCs
 - 4.6 keV - 9 MeV
- Novel limits on DM-electron cross section with XENONnT SR0 lowER data
 - $3.4 \times 10^{-39} \text{ cm}^2$ for 300 keV DM
- Main improvements from XENONnT
 - ~2 times the exposure
 - ~5 times lower ER background
- Future plan
 - Include SRDM as signal model into XENONnT S2only analysis



Questions

Thank you!



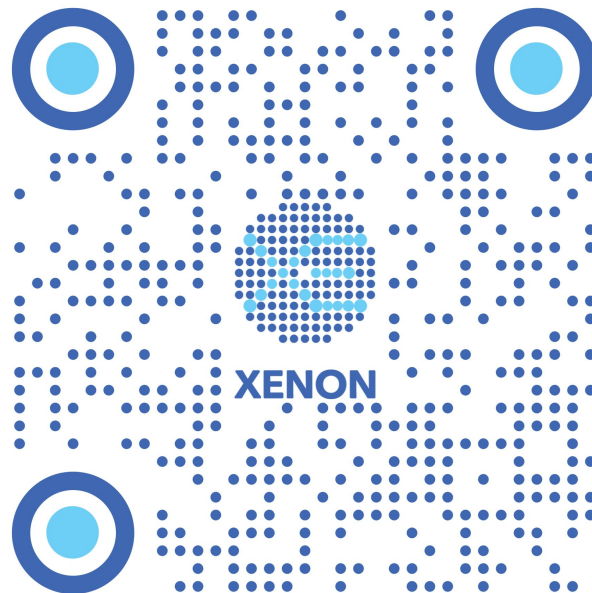
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