

Outline

- core activities della linea di ricerca
- impatto scientifico in una prospettiva nazionale e internazionale
- contributo locale (stato attuale e prospettive)
- risorse disponibili e necessarie
 - ➔ punti di forza
 - ➔ punti di debolezza
 - ➔ possibili sinergie trasversali (scientifiche, tecnologiche, strumentali, umane)

darkside

two-phase argon TPC for Dark Matter Direct Detection



Member	Position	FTE (%)
S. Catalanotti	PA - Fis	100
V. Cataudella	PA - Fis	40
S. Caviuoti	RTDa - Fis	100
A.G. Cocco	RIC - INFN	40
G. Covone	RU - Fis	30
A. De Candia	RU - Fis	40
G. De Filippis	PA - Fis	40
M. Della Valle	DR - INAF - OAC	100
G. De Rosa	RU - Fis	30
G. Fiorillo	PA - Fis	70
G. Longo	PO - Fis	60
B. Rossi	RIC - INFN	70
P. Salatino	PO - Ing	100
M. Simeone	PA - Ing	100

Group composition
(provisional)

3 PO/DR

5 PA

5 RU/RIC

1 RTDa (+1 tba)

0 postdoc

0 PhD

Core activities

- DarkSide:

- G. Fiorillo Italian PI & Deputy Spokesperson;
- M. Simeone L1 manager URANIA;
- B. Rossi L3 manager photosensor characterisation

- ReD (Recoil Directionality):

- G. Fiorillo PI;
- international collaboration: Princeton, Temple, UCLA, UCDAvies, APC-IN2P3, INFN (Cagliari, Genova, LNGS, LNS, Napoli, Pisa, Roma1, TIFPA)

- TPC Detector development
- Photosensor characterisation
- Neutron and gamma beam calibrations
- Data analysis
- Science: Argon microphysics, Galactic DM, low energy neutrino astrophysics
- Plants: Argon extraction & purification

DarkSide laboratory @ Napoli

Laboratorio Criogenico di Ricerca della Materia Oscura



Broader Impact of CryoLab activities

Our detector provides an innovative technology for:

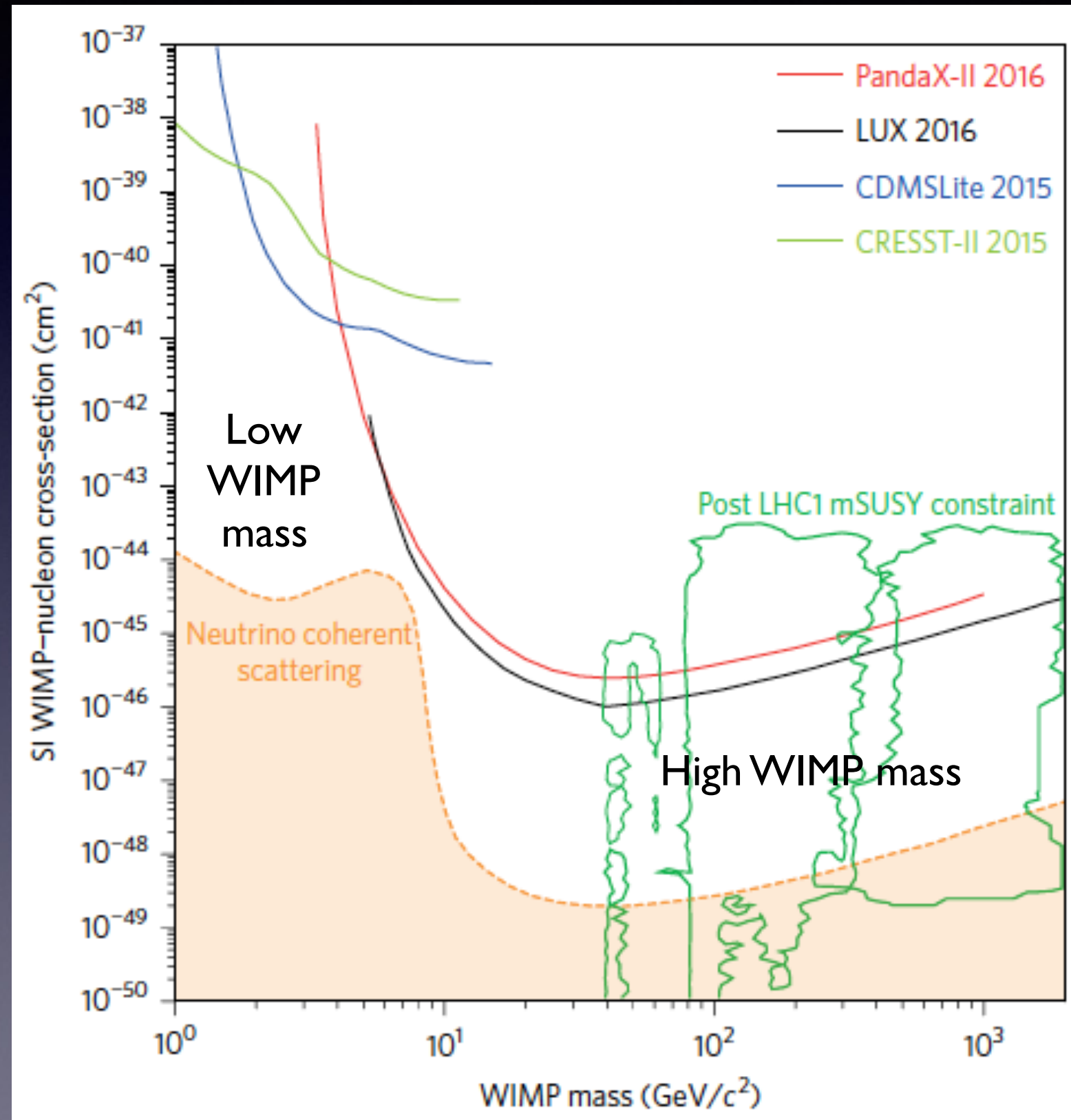
- Medical Imaging
 - Gamma-Camera, PET and TOF-PET development based on Liquid Argon scintillator and SiPM readout.
- Homeland security
 - Non-Intrusive Inspection systems to detect nuclear fission gammas and fast neutron emission from nuclear materials



Science impact

Available parameter space for WIMPs

- **High mass**
 - no observations so far
- **Low mass**
 - a number of close contours and exclusion limits

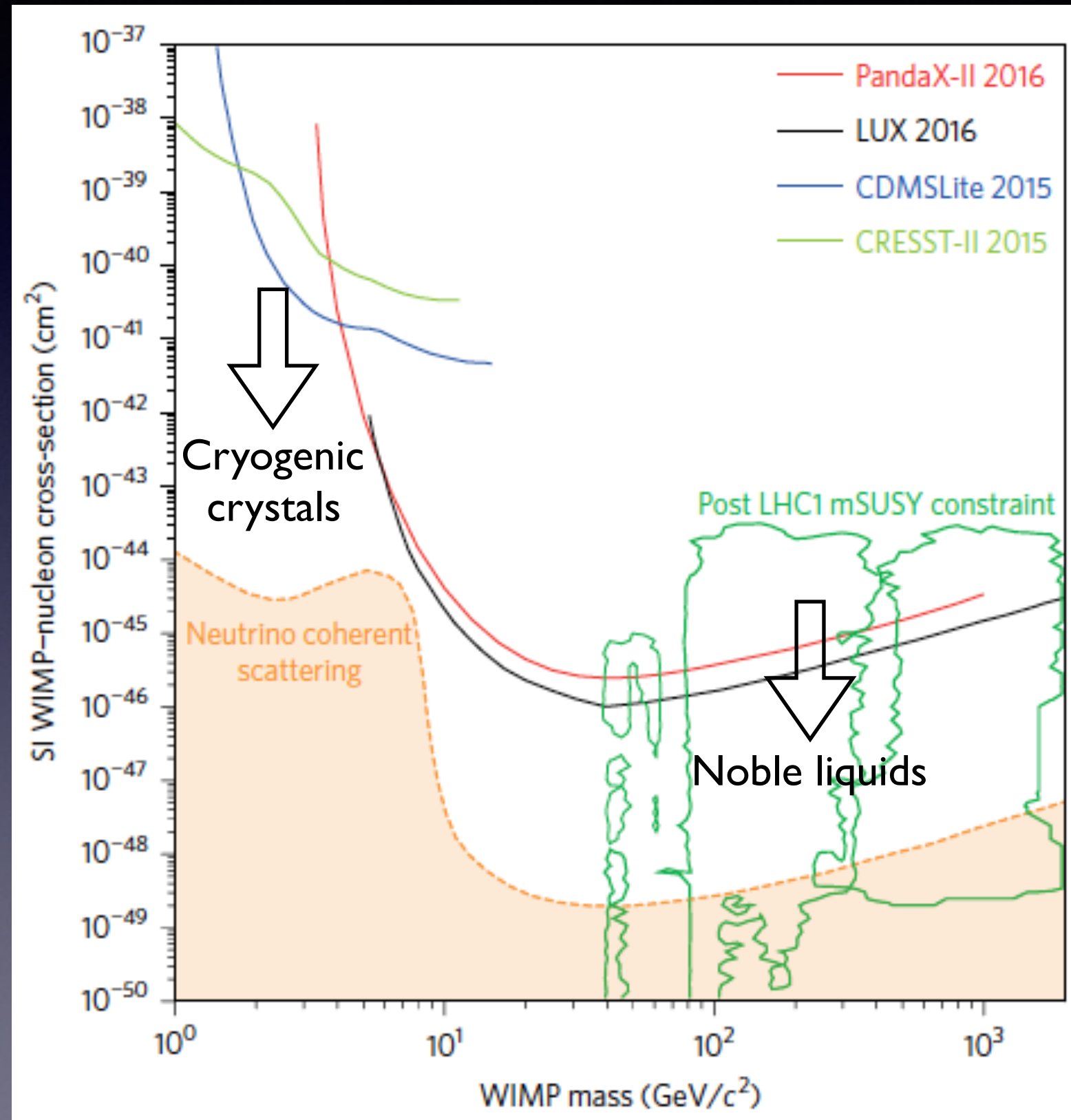


Science impact

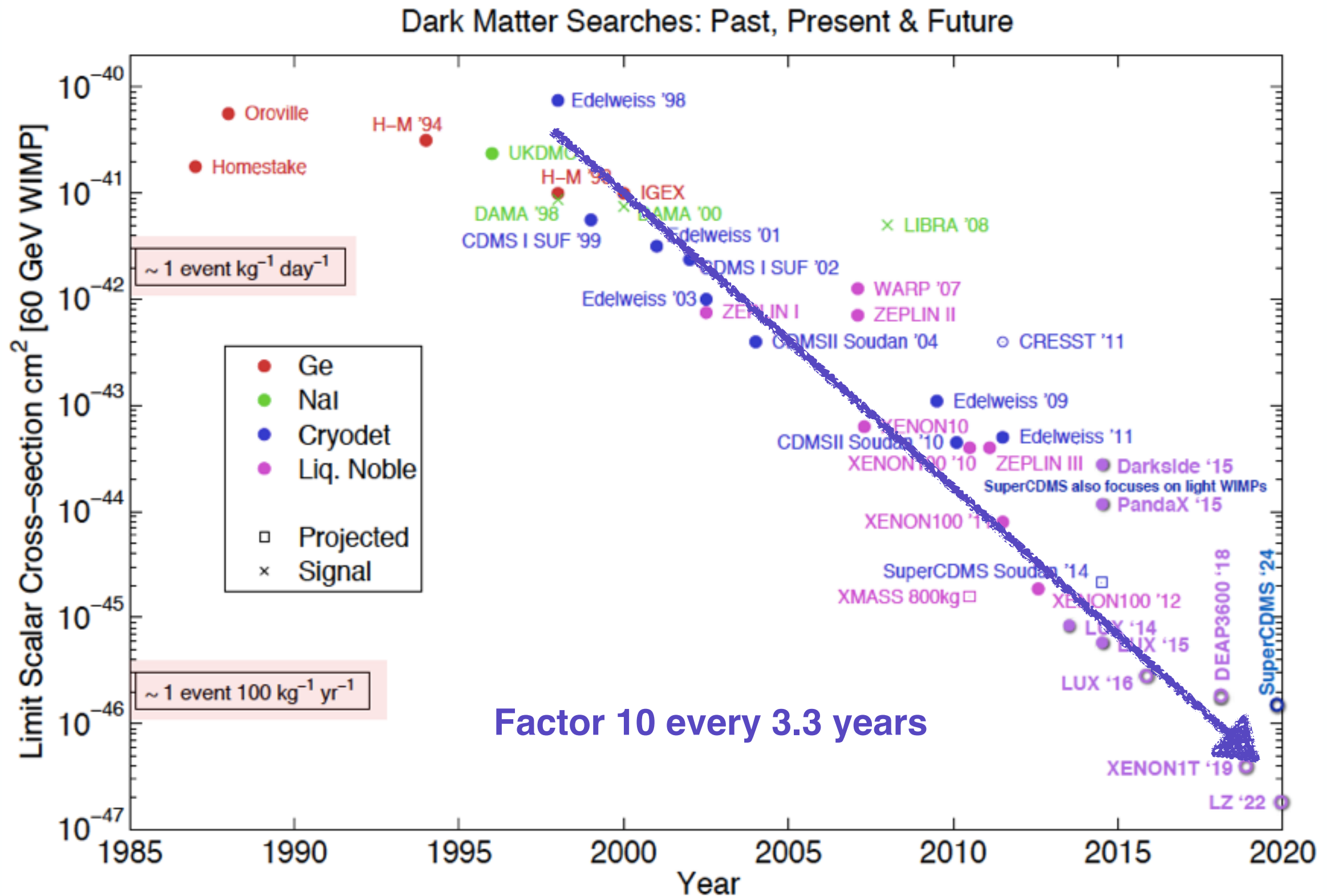
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NATURE PHYSICS DOI: 10.1038/NPHYS4039



WIMP search sensitivity improvement in both directions: high and low masses



High masses: noble liquid dual phase TPC

LUX @ SURF LXe

- 48cm×48cm, 250 kg target
- in-situ NR calibration studies
[arXiv:1608.05381](https://arxiv.org/abs/1608.05381)

New result August 2016

[Phys. Rev. Lett. 118, 021303 \(2017\)](https://arxiv.org/abs/1608.05381)

- $3.4 \cdot 10^4$ kg d = 0.1 t yr
- no signal excess
- $2.2 \cdot 10^{-46}$ cm² @ 50 GeV

PandaX-II @ CJPL LXe

- 60cm×60cm, 500 kg target
- 2nd largest running LXe TPC

New result July 2016

[Phys. Rev. Lett. 117, 121303 \(2016\)](https://arxiv.org/abs/1607.07626)

- $3.3 \cdot 10^4$ kg d = 0.1 t yr
- no signal excess
- best limit above ~4.5 GeV

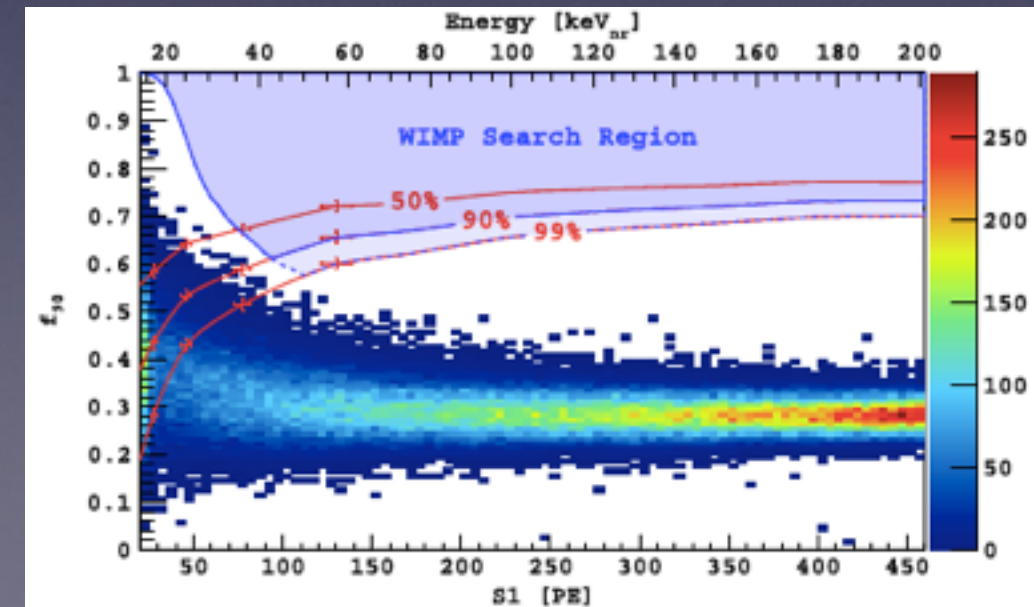
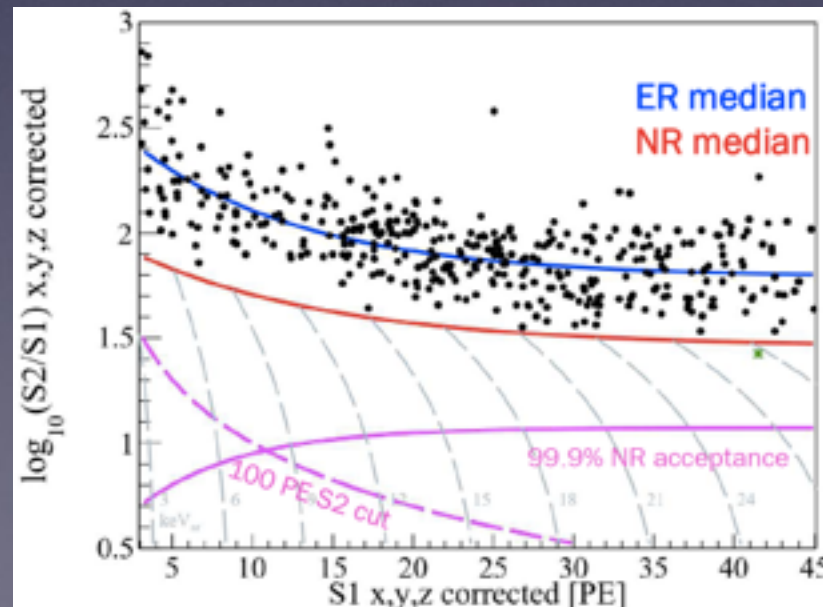
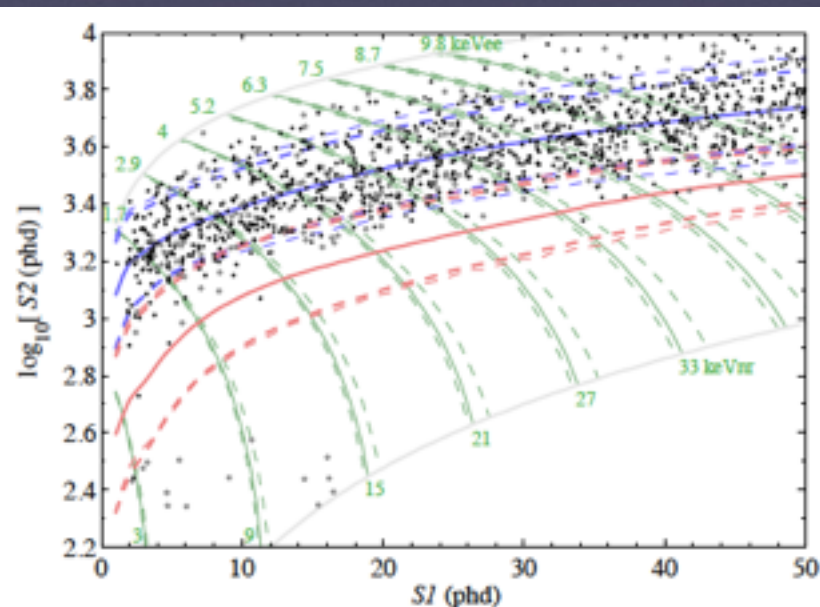
DarkSide-50 @ LNGS UAr

- 36cm×436cm, 46 kg active target
- inside a LSci 30 t neutron veto and a 1 kt Water Cherenkov muon veto

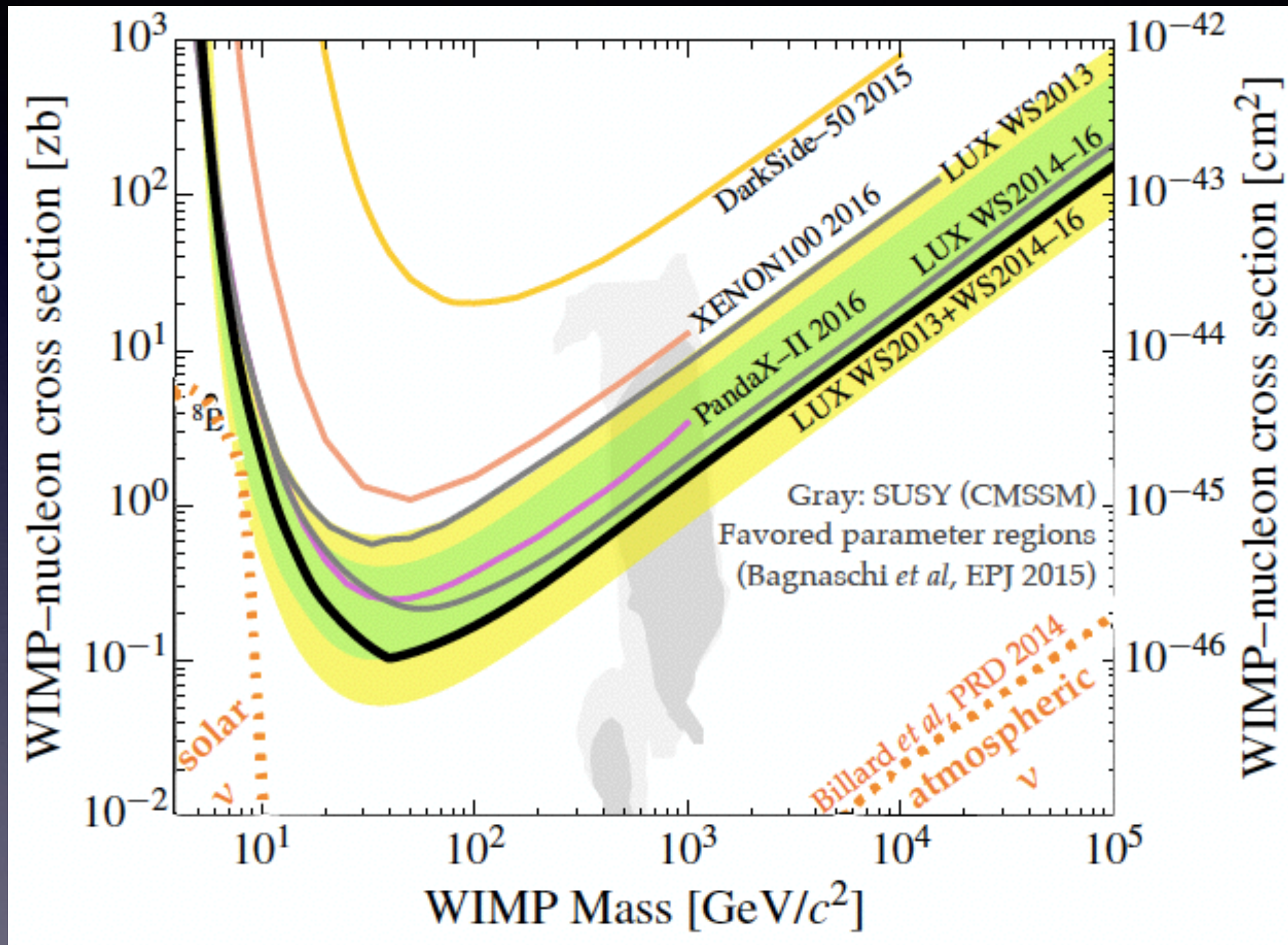
Latest result October 2015

[Phys. Rev. D 93, 081101\(R\)](https://arxiv.org/abs/1510.07734)

- 2616 kg d exposure
- no signal excess
- $2.0 \cdot 10^{-44}$ cm² @ 100 GeV



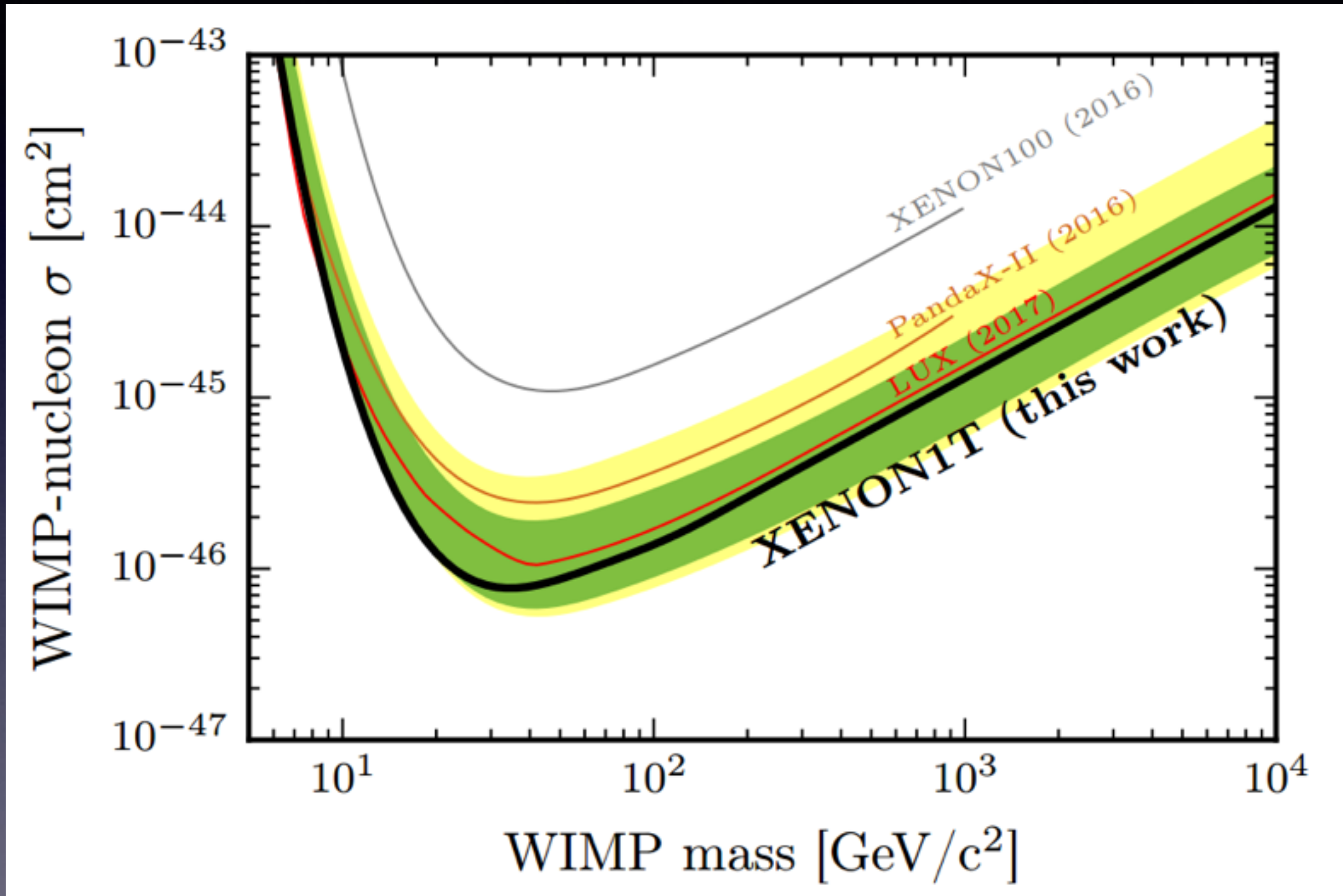
Noble liquid dual phase TPC



E. Pease, Berkeley December 2016

LUX results combined $1.1 \cdot 10^{-46} \text{ cm}^2$ at 50 GeV

Ton scale noble liquid dual phase TPC

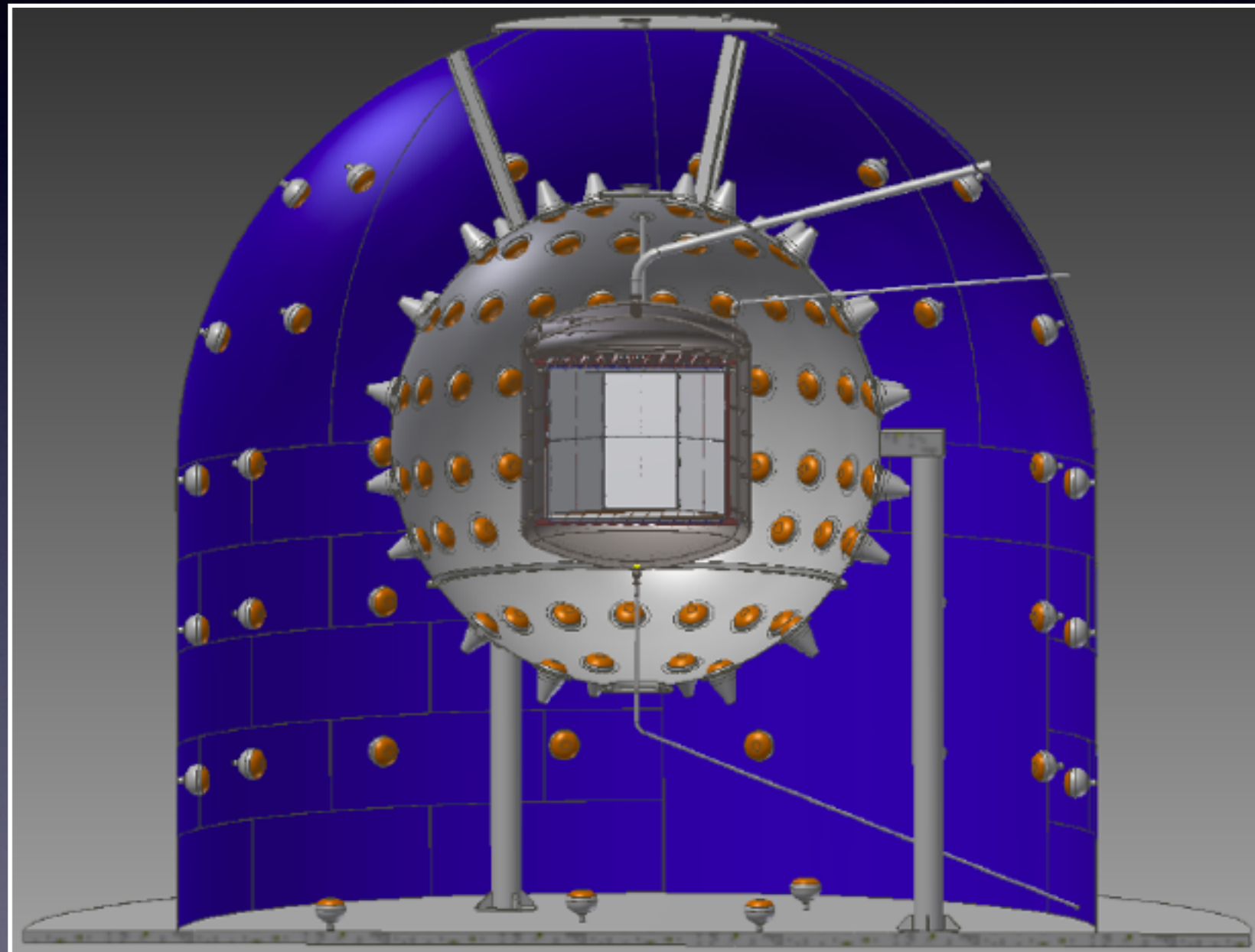


arXiv:1705.06655v1

XENONIT results released on May 18, 2017

DarkSide-20k @ LNGS

- 30 ton total, 20 ton fiducial, argon from underground wells, depleted in radioactive ^{39}Ar
- inside a 8m diameter SS sphere filled with boron-loaded liquid scintillator, serving as active neutron veto
- inside a 15m diameter 16m tall water tank, as active muon veto
- radiopure construction
- 15m^2 SiPM sensors (low radioactivity, increased LY)
- Scalable design for application to larger scale detector

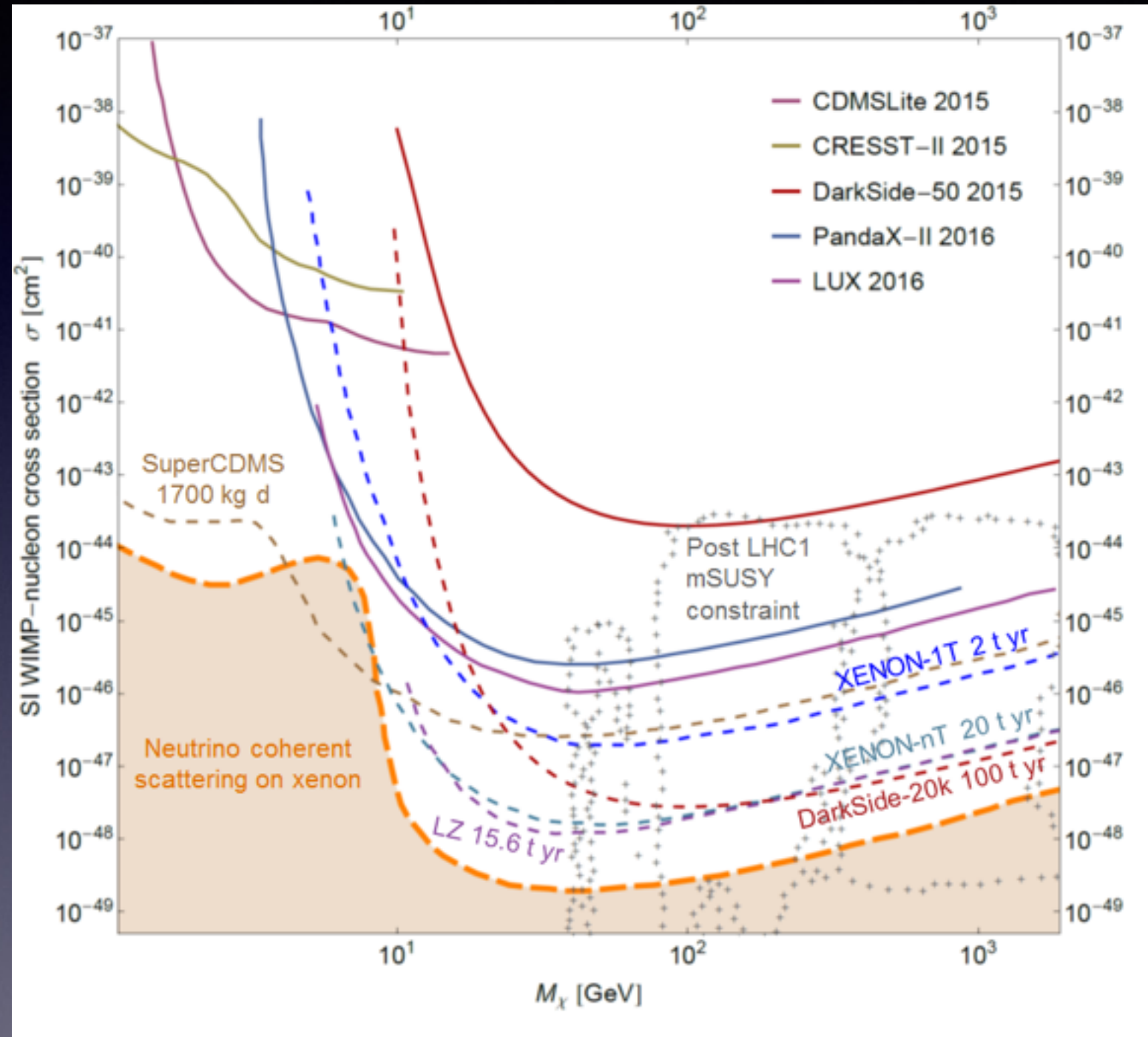


Start of operation in 2021

Future perspective

by M. Cadeddu (adapted from **NATURE PHYSICS** DOI: 10.1038/NPHYS4039)

- DS-20K competitive with LZ
–start operation 2021
- 1000-tonne years (future detector) reaches down to neutrino floor
- Complimentary to xenon – only other target allowing such large exposure
- b/ γ discrimination: solar pp neutrino ES background not a concern – in XIT, LZ expected dominant bkg at 0.5 event per tonne-year after recoil discrimination
- Through the neutrino floor
 - **directional measurements?**



ReD experiment to sense recoil directionality in LAr

A global Argon collaboration

Researchers from

- DarkSide
- DEAP
- ArDM
- MiniCLEAN

DS-20K → multi-100-T

>350 researchers

planning to collaborate on future program:

- Completion of current science and R&D programs by each collaboration (DS-50, DEAP-3600, MiniCLEAN, ArDM)
- Joint collaboration on DS-20K at LNGS, including Low Radioactivity Argon (operation starting 2021) and SiPM photodetectors

Joint collaboration on future multi-hundred-tonne LAr detector, site TBD (mid-2020's)

DarkSide

- > 350 researchers, 70 Institutions, 12 Countries
- INFN flagship program for the discovery of dark matter in the next decade
- DS-Napoli:
 - National & International leadership
 - LAr technology development
 - ➔ Synergies with the Neutrino Program at accelerators
- Science: particle physics & astrophysics, atomic physics

