Results from the XENON100 Dark Matter Search Experiment

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31st October 2012

1. Very Brief Intro to Dark Matter and Direct Detection
2. The LXeTPC & XENON100
3. Latest Results
4. The Next Generation

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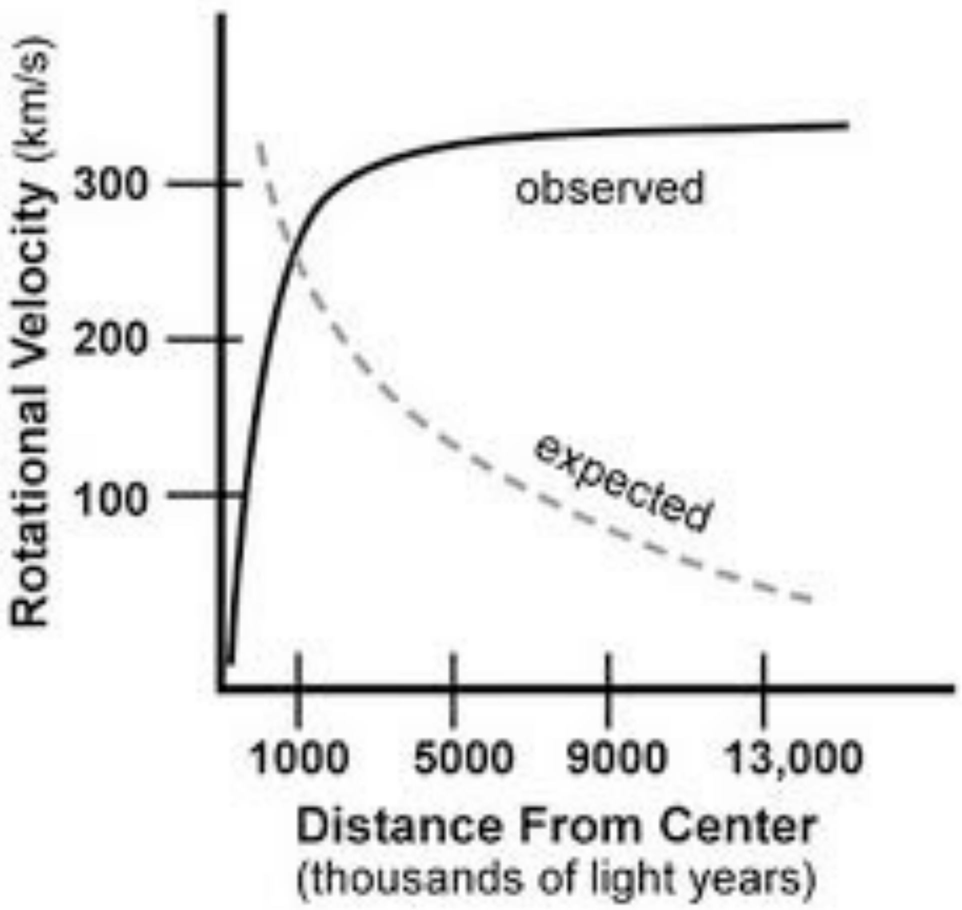
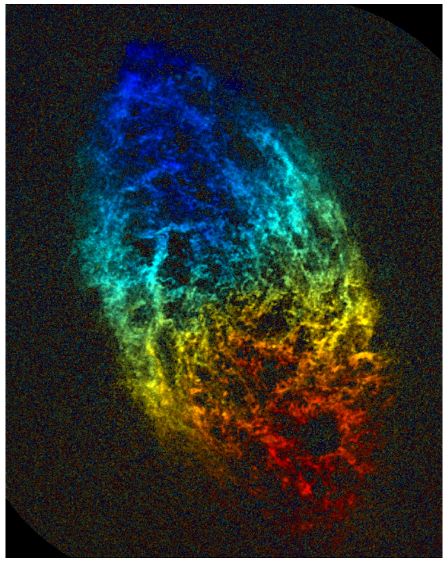
Early evidence for Dark Matter

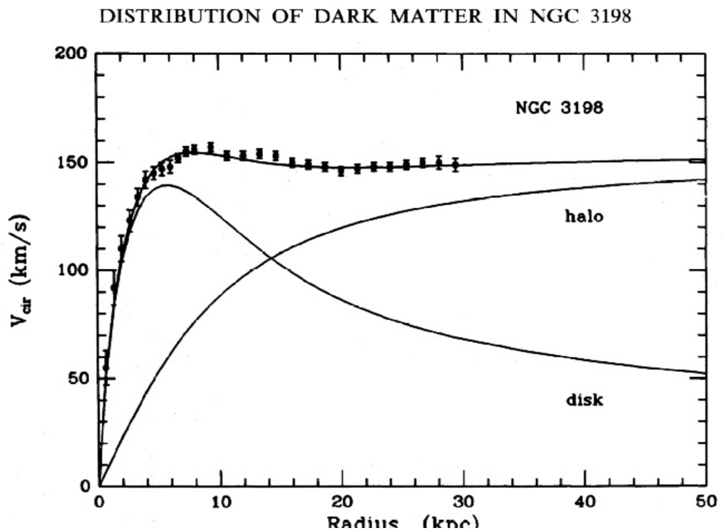
1930's - Fritz Zwicky
1970's - Vera Ruben
Measured rotational velocity of galaxies and observed flat curves rather than expected Keplerian fall-off with distance from galactic centre

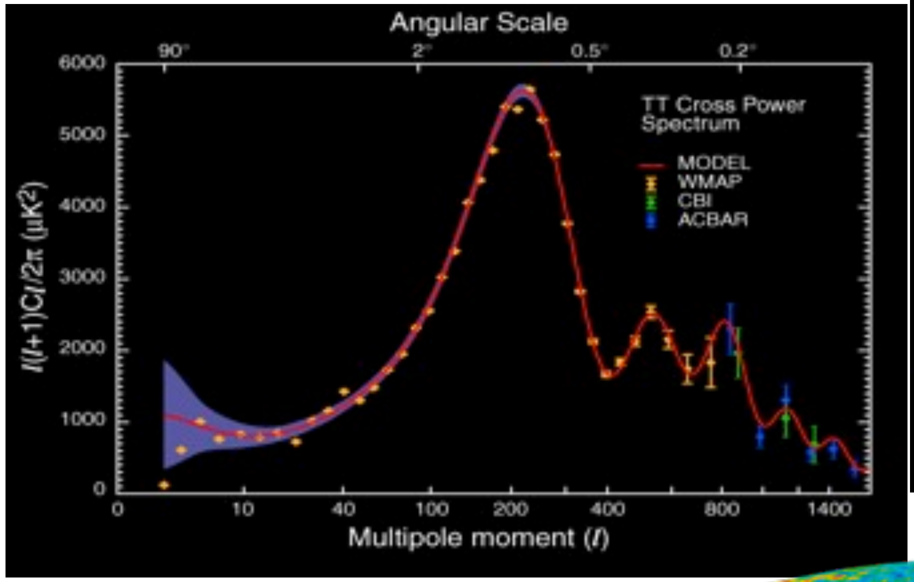
GALAXIES ARE ROTATING TOO FAST!

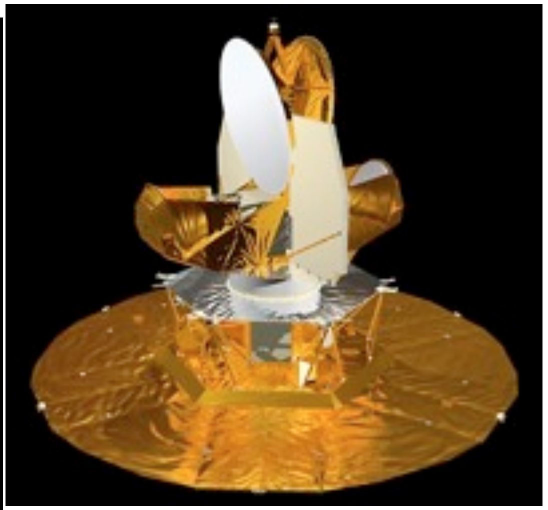


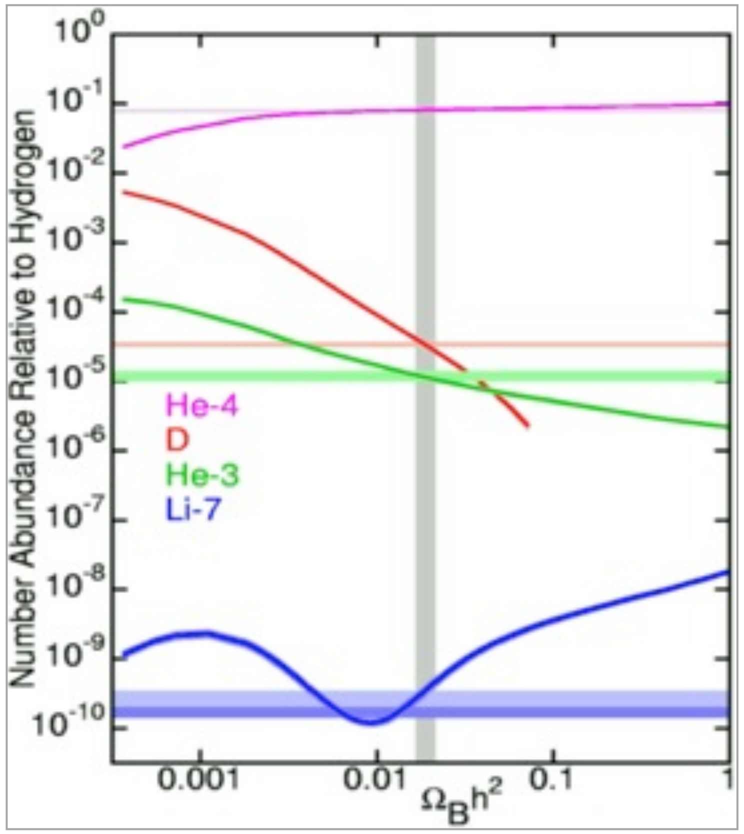
Lots more evidence since then - with little against...

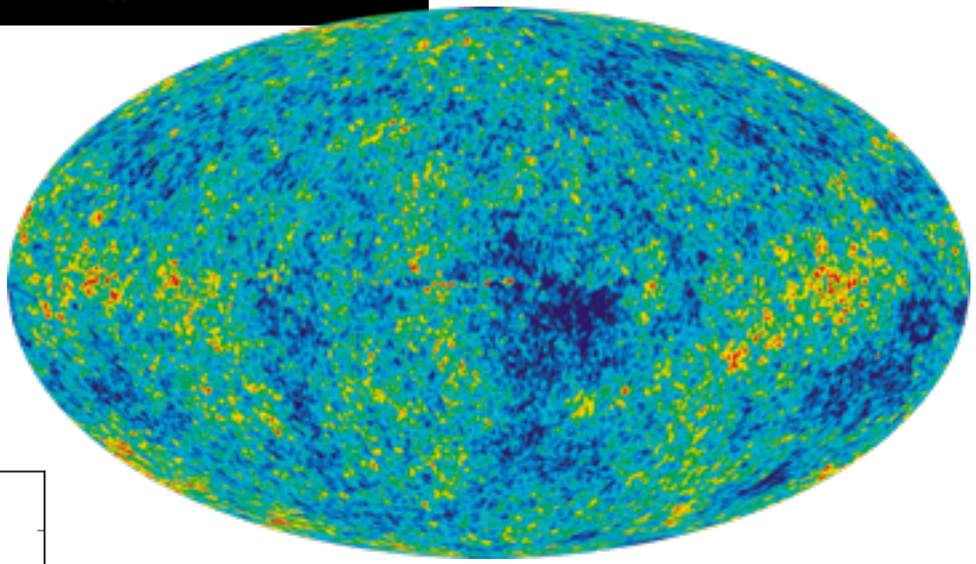


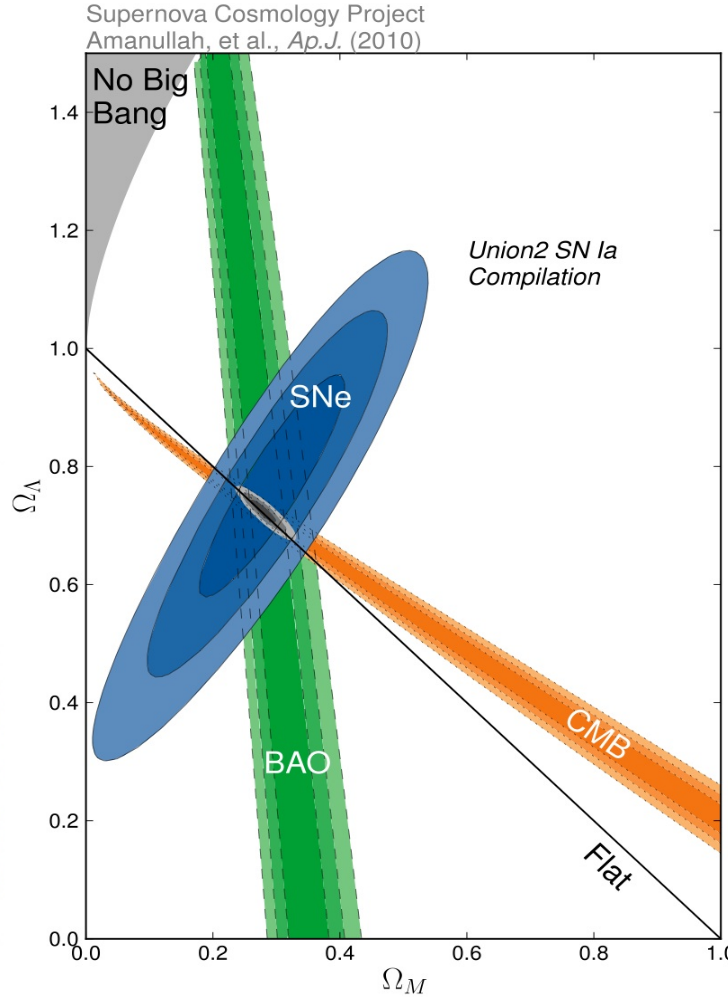

DISTRIBUTION OF DARK MATTER IN NGC 3198
NGC 3198
halo
disk
V_{cir} (km/s)
Radius (kpc)
0
50
100
150
200
0
10
20
30
40
50

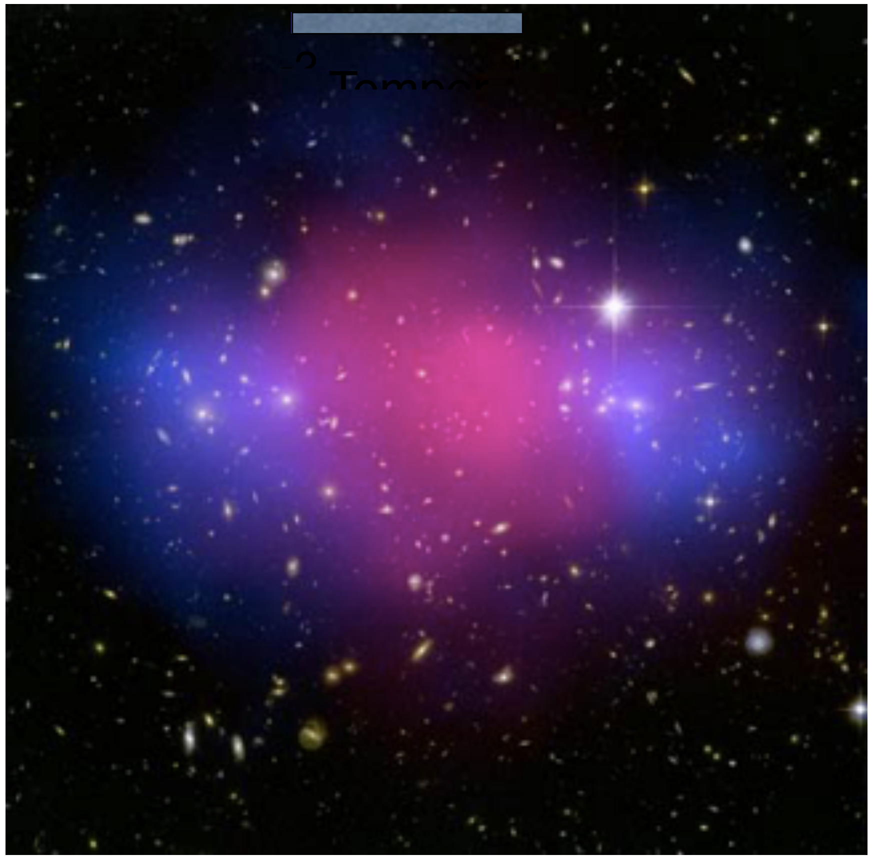

Angular Scale
90°
2°
0.5°
0.2°
TT Cross Power Spectrum
MODEL
WMAP
CBI
ACBAR
$l(l+1)C_l/2\pi$ (μK^2)
Multipole moment (l)
0
1000
2000
3000
4000
5000
6000
0
10
40
100
200
400
800
1400

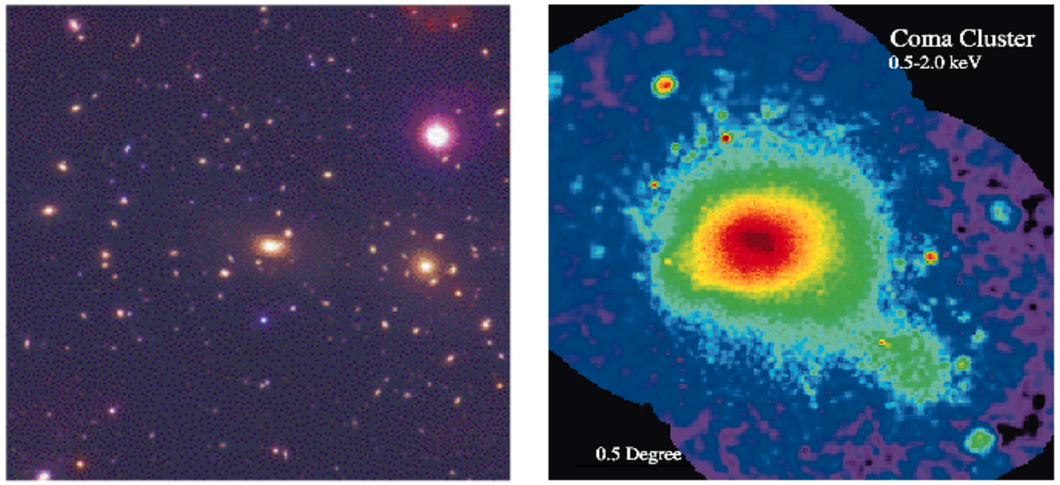



Number Abundance Relative to Hydrogen
He-4
D
He-3
Li-7
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
0.001
0.01
$\Omega_B h^2$
0.1
1

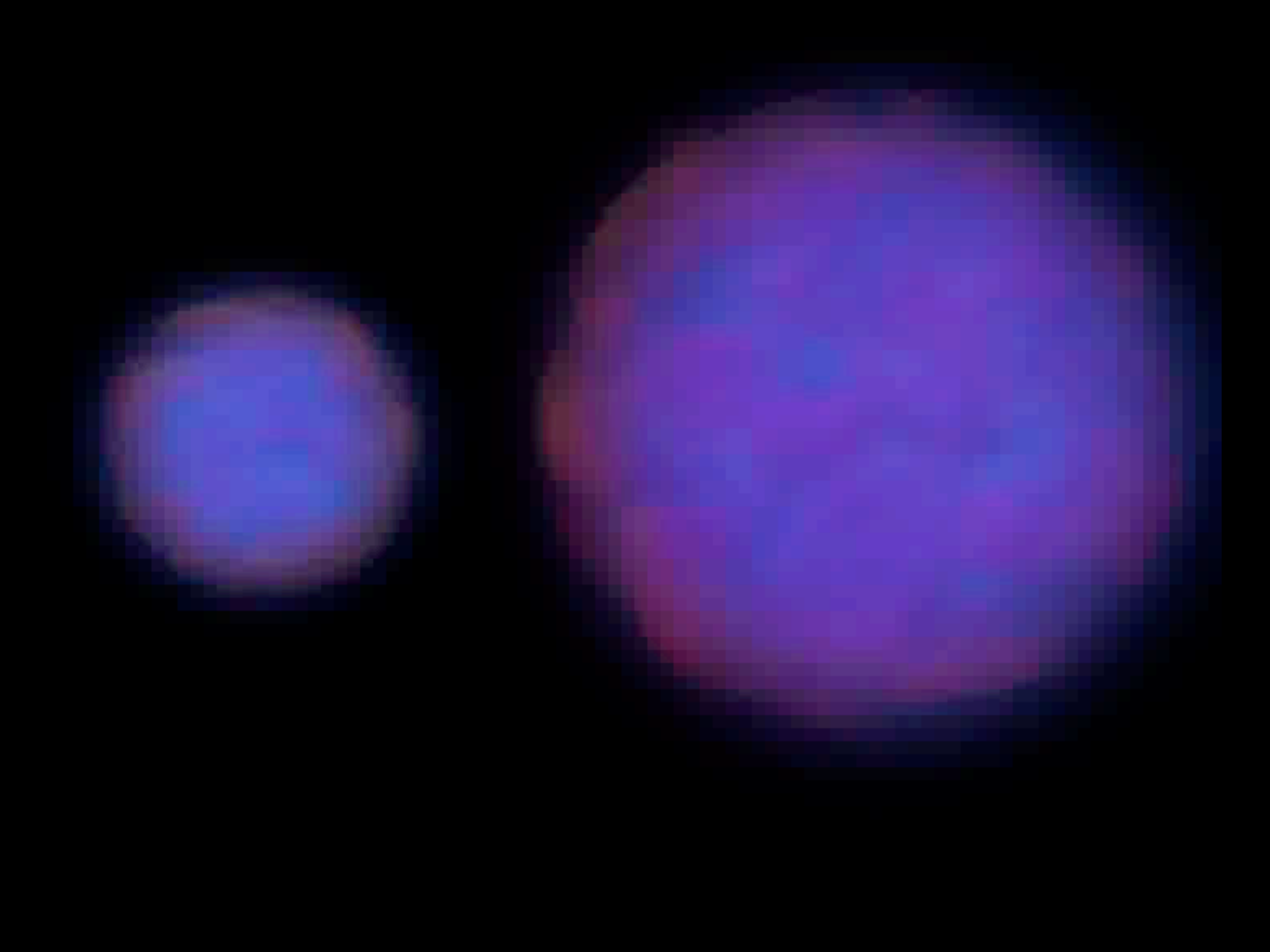


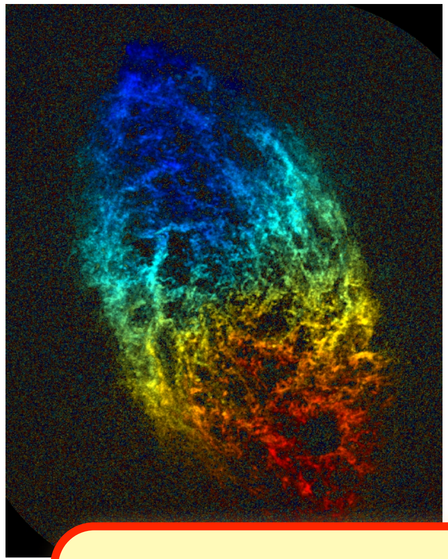

Supernova Cosmology Project
Amanullah, et al., *Ap.J.* (2010)
No Big Bang
Union2 SN Ia Compilation
SNe
BAO
CMB
Flat
Ω_Λ
Ω_M
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

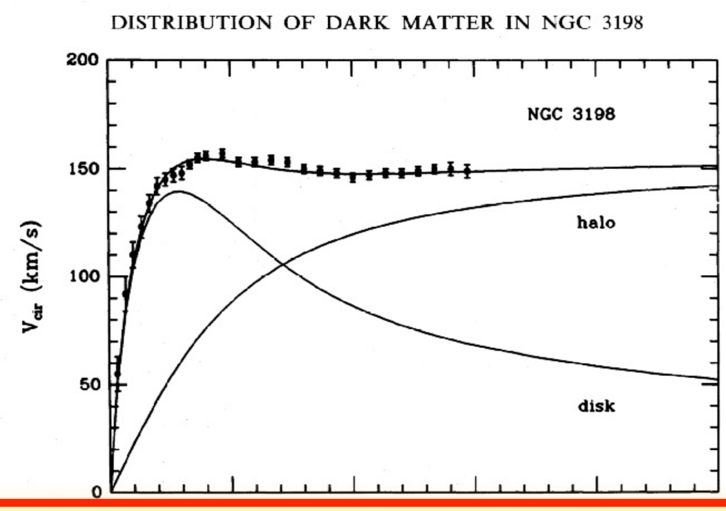


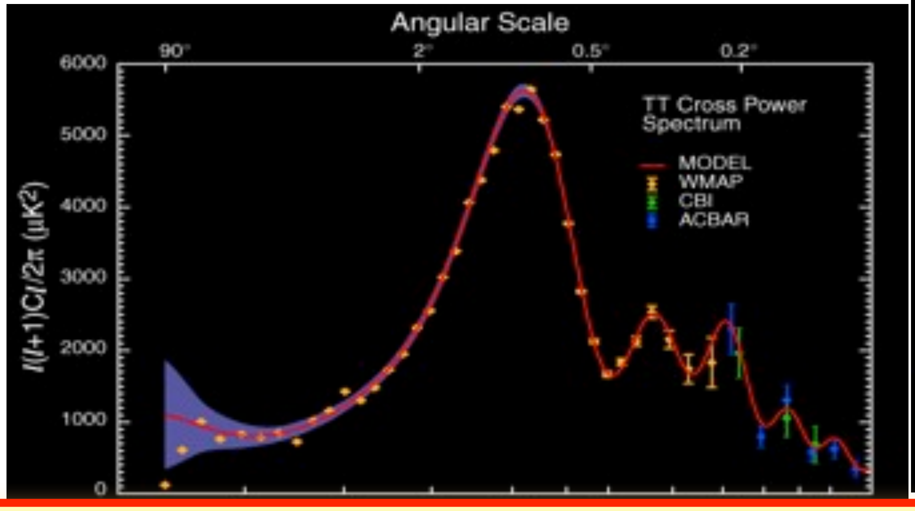

Coma Cluster
0.5-2.0 keV
0.5 Degree

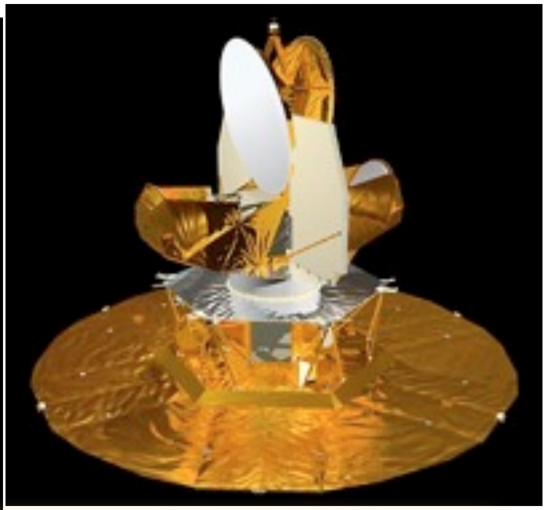
(a) (b)





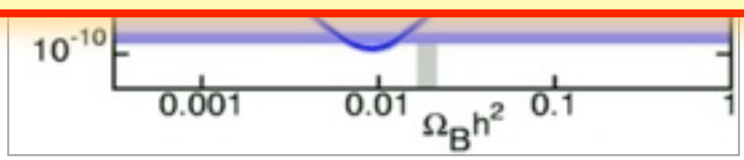


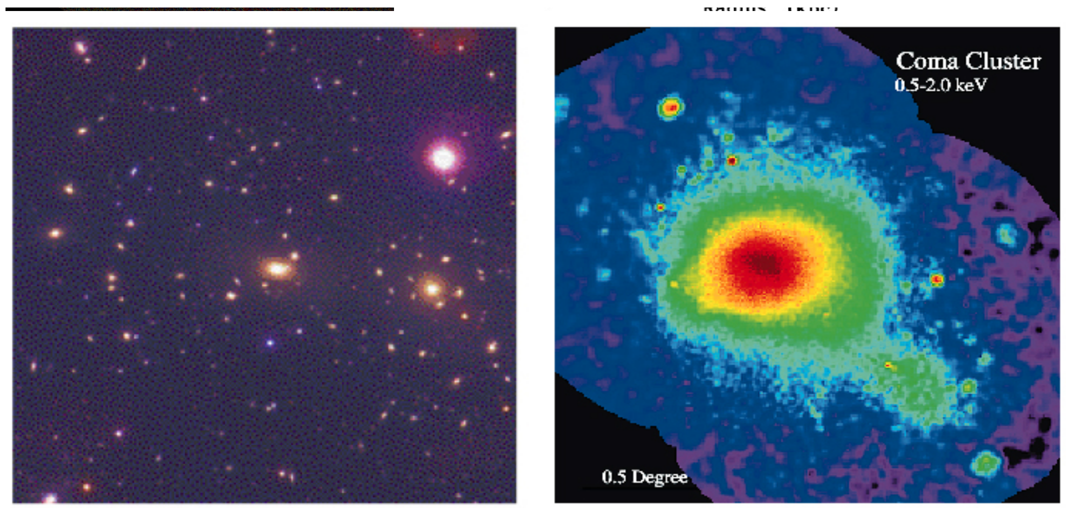




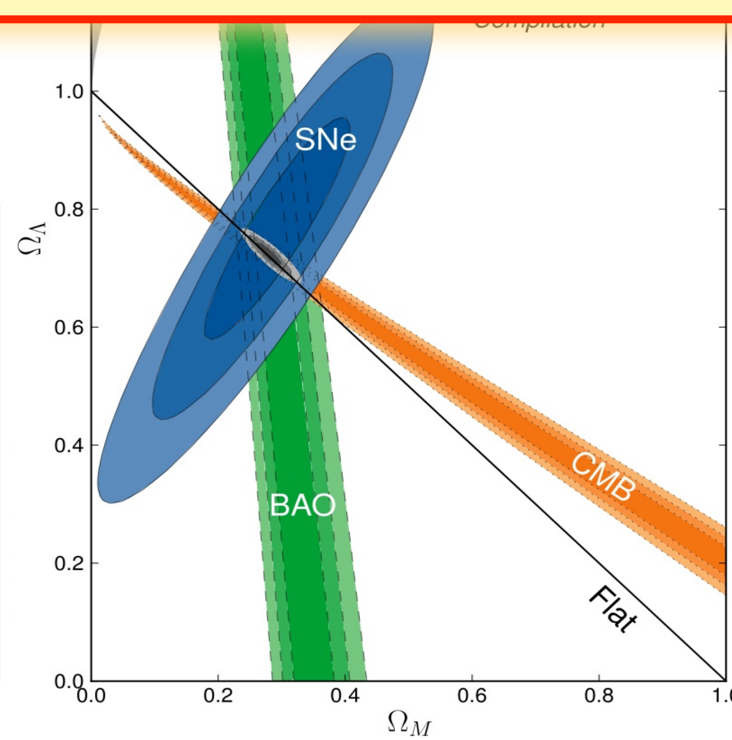
We have a ‘Missing Mass’ Problem!

85% of the mass of the Universe is **DARK!**





(a) (b)

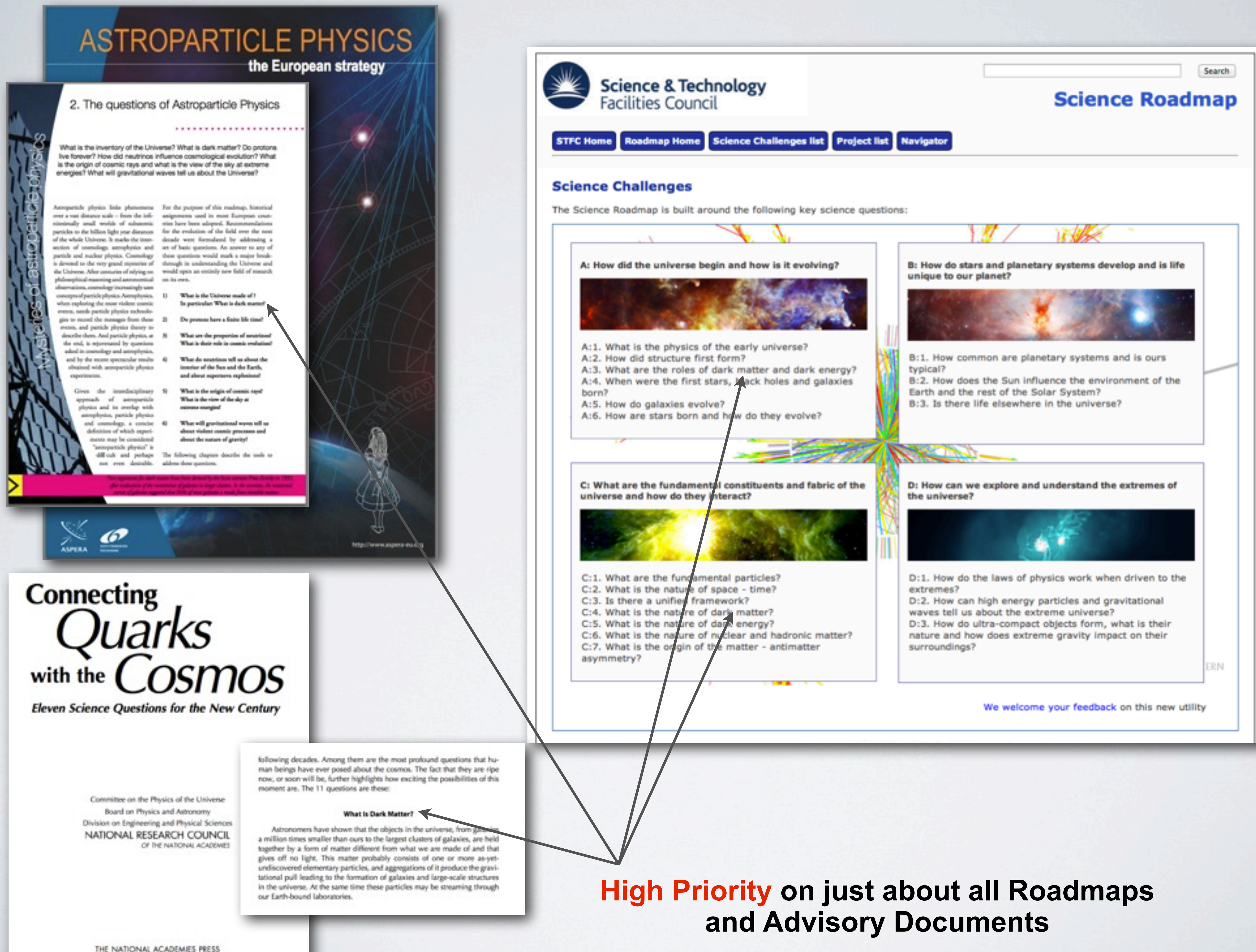


Dark Matter Detection

Favoured candidates are Weakly Interacting Massive Particles (WIMPs)

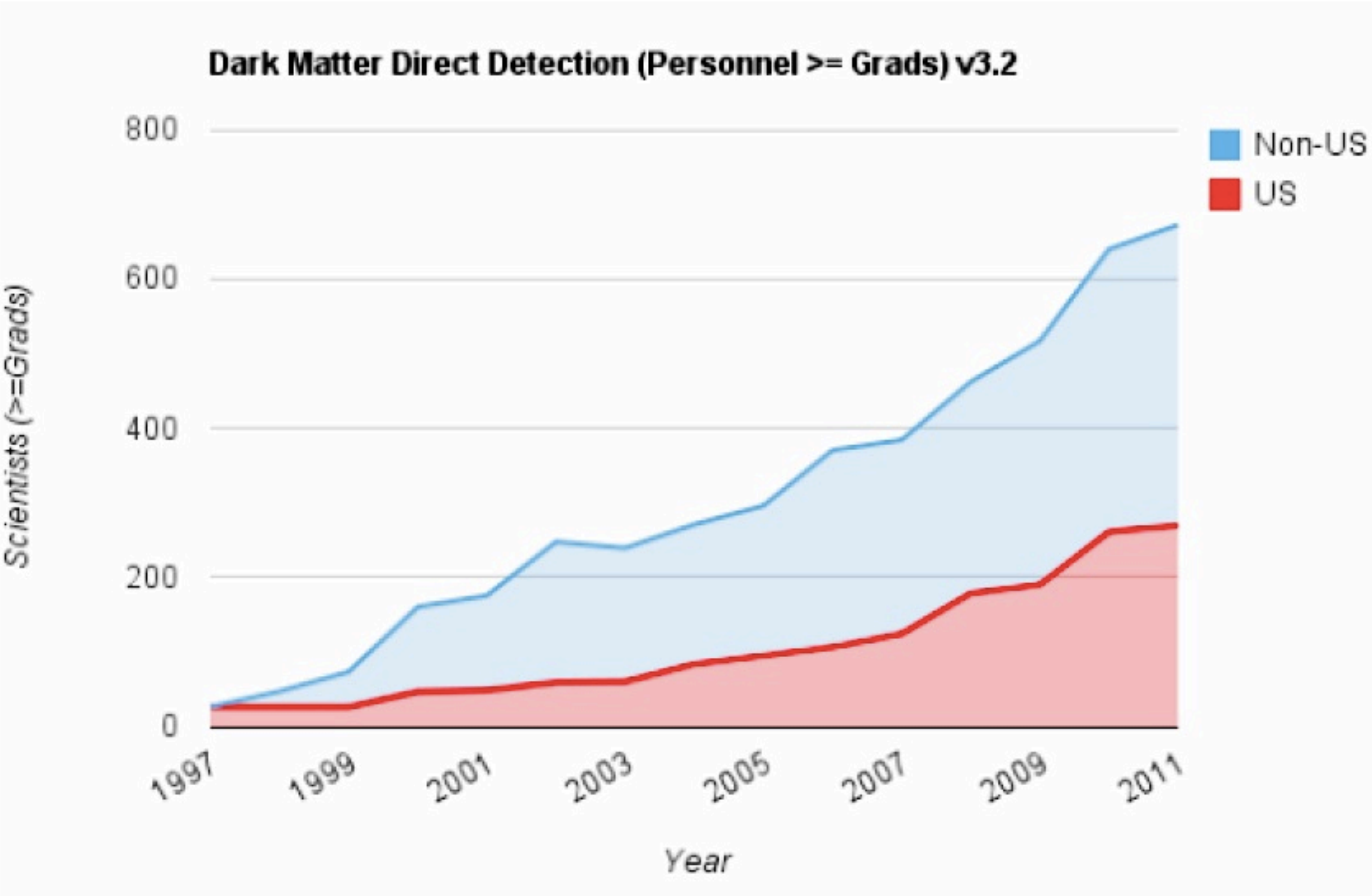
- Indirect - observe annihilation products
- Accelerator - produce WIMPs
- **Direct** - interact with galactic WIMPs (*our* Dark Matter!) in ultra-low background terrestrial detectors

Direct detection is internationally recognised as one of THE highest priorities in science!



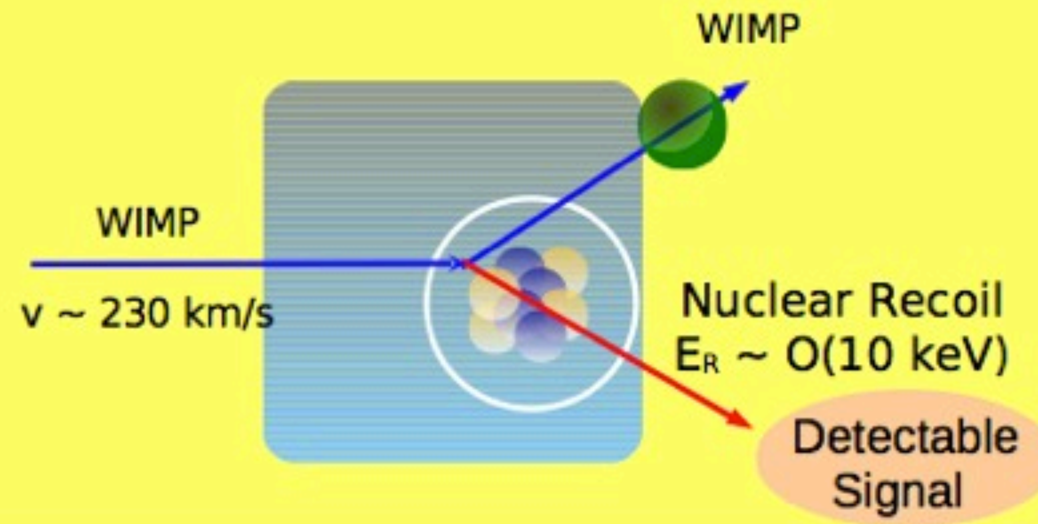
High Priority on just about all Roadmaps and Advisory Documents

A Growing Field



Direct WIMP Search

Elastic Scattering of WIMPs off target nuclei
→ nuclear recoil



Recoil Energy: $E_r \sim \mathcal{O}(10 \text{ keV})$

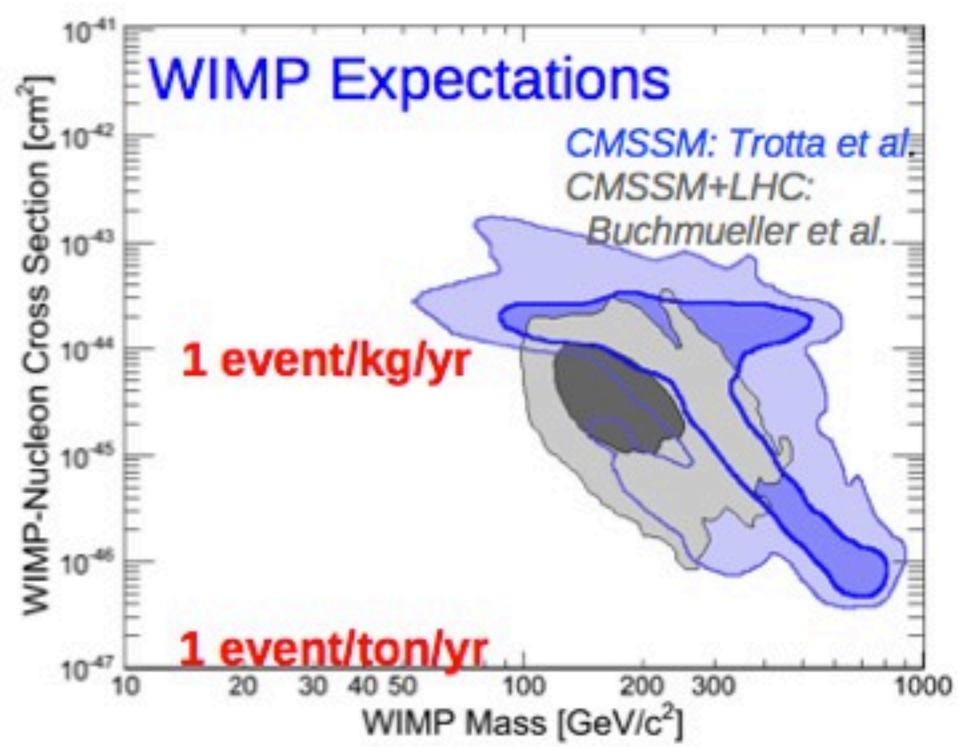
Event Rate: $R \propto N \frac{\rho_\chi}{m_\chi} \langle \sigma_{\chi-N} \rangle$

Detector

Local DM Density

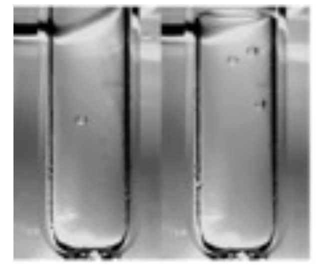
ρ_χ~0.3 GeV/c^2

Physics



WIMP Detection Techniques

Heat and ionisation bolometers:
CDMS
EDELWEISS



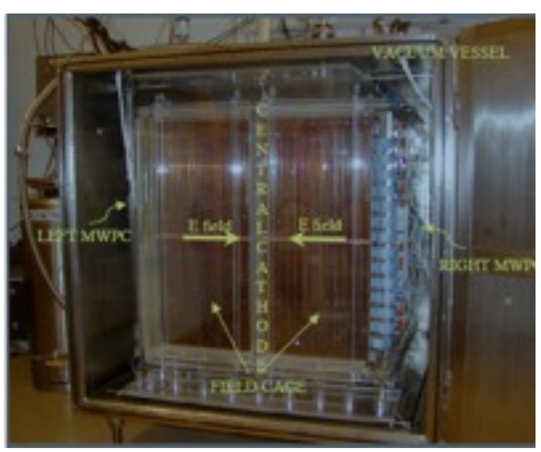
Bubbles and Droplets:
CUOPP
PICASSO

Light and heat Bolometers:
CRESST
ROSEBUD

Phonons

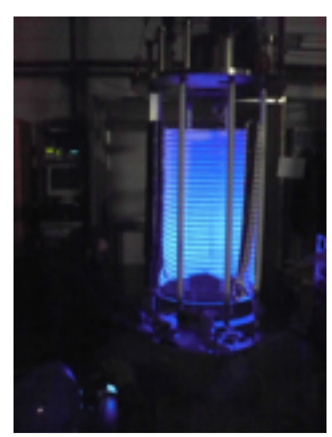
Charge

Light



Ionisation detectors:
DRIFT, DMTPC, GENIUS, NEWAGE,
HDMS, IGEX

Scintillation and ionisation charge detectors:
XENON
DarkSide
ZEPLIN
LUX



Scintillators:
DAMA
LIBRA
XMASS
CLEAN
DEAP
ANAIS
KIMS

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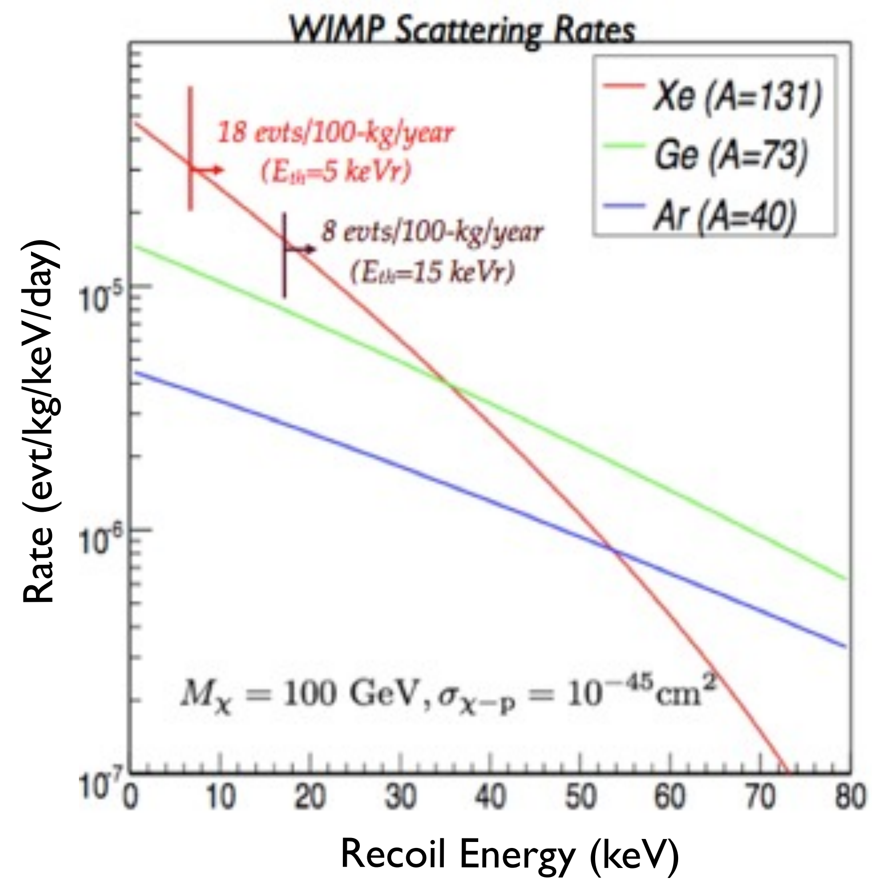
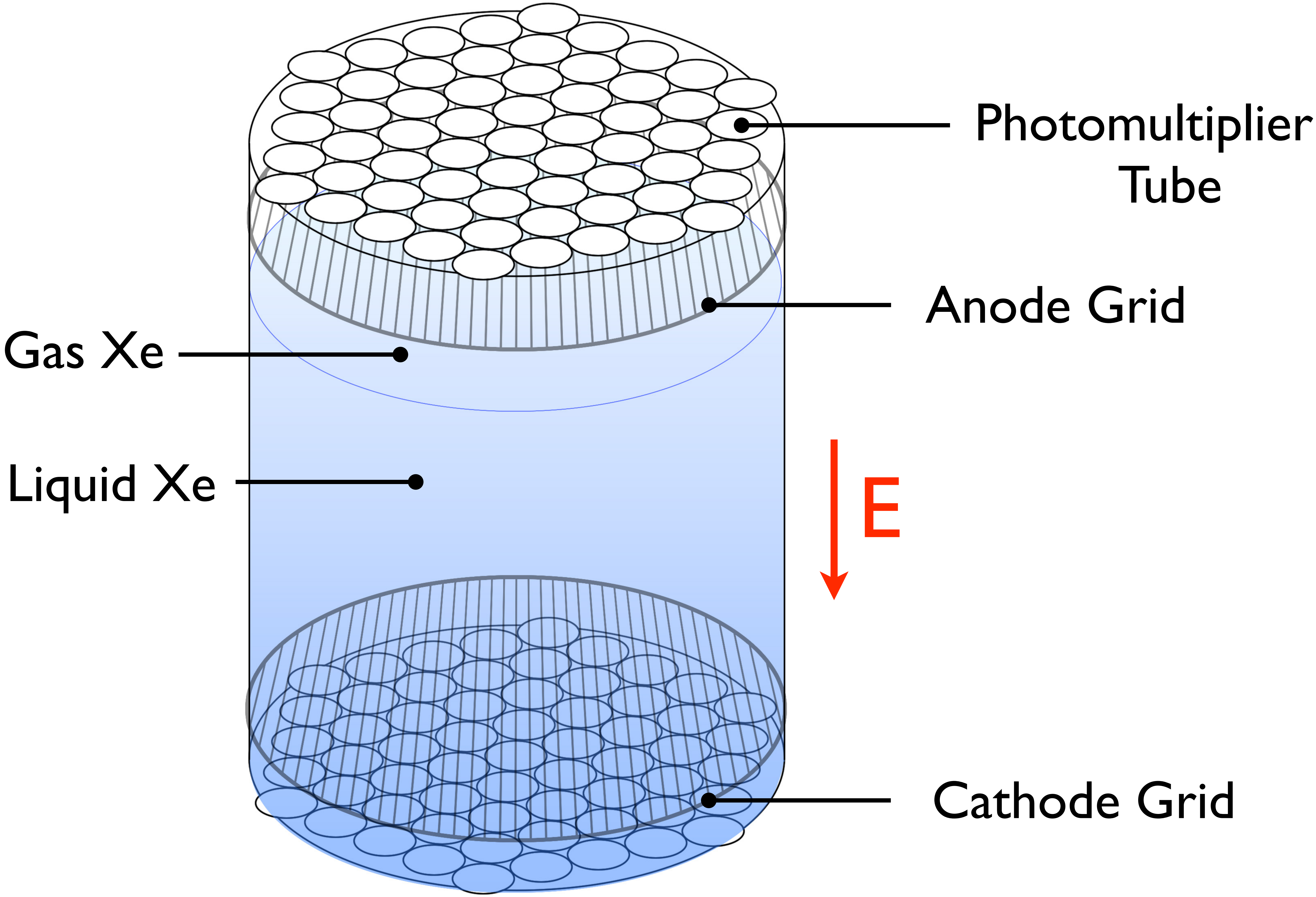
Liquid Xenon Time Projection Chambers

- **S1: LXe is an excellent scintillator**
  - Density: 3 g/cm^3
  - Light yield: >60 ph/keV (0 field)
  - Scintillation light: 178 nm (VUV)
  - **Nuclear recoil threshold ~5-8 keV**

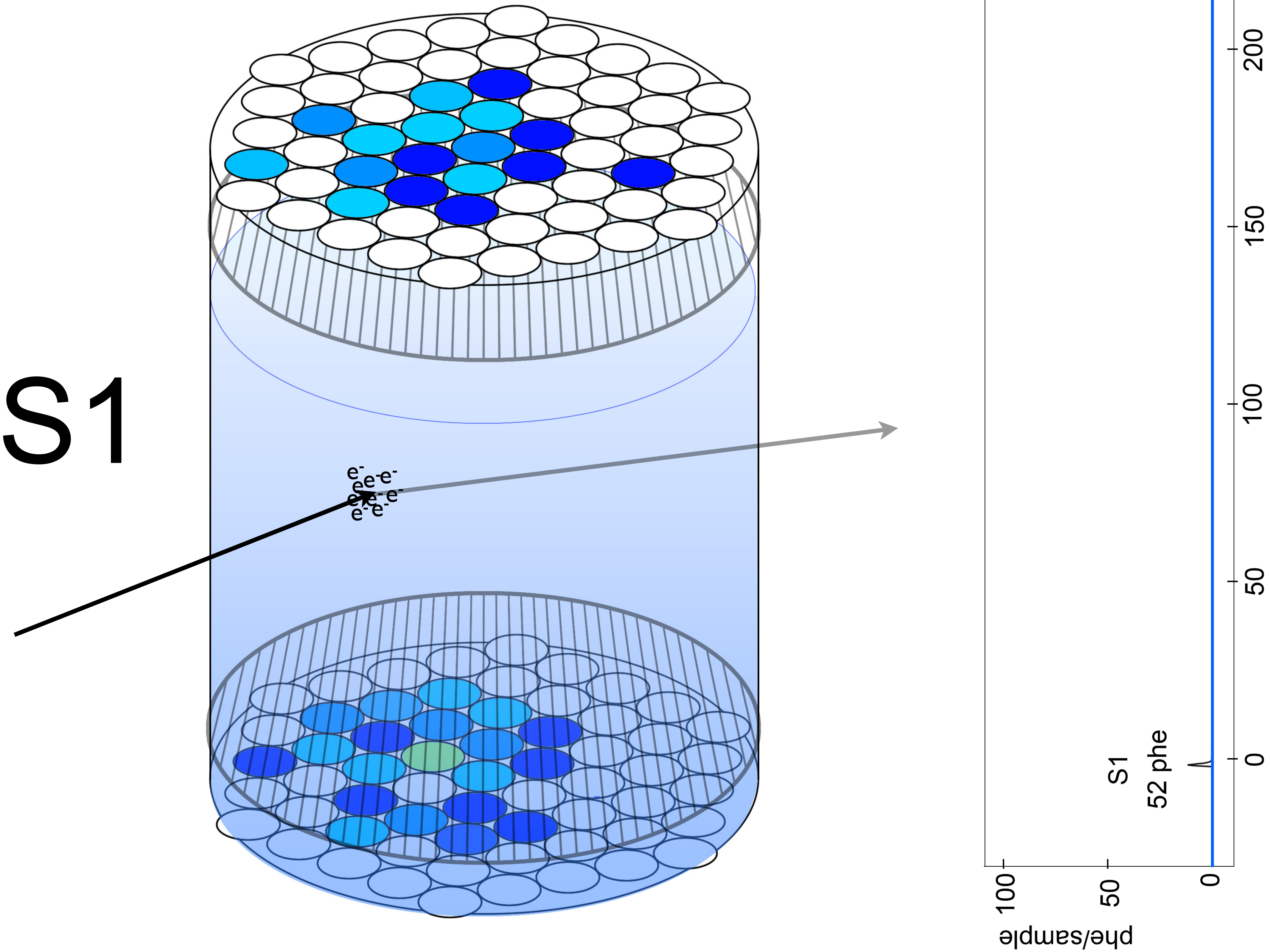


- **S2: Even better ionisation detector**
  - S1+S2 allows mm vertex reconstruction
  - Sensitive to single ionisation electrons
  - **Nuclear recoil threshold ~1 keV**

- **And a great WIMP target too**
  - Scalar WIMP-nucleon scattering rate dR/dE~A^2
  - Odd-neutron isotopes (^{129}Xe, ^{131}Xe) enable spin-dependent sensitivity
  - Excellent ionisation threshold: 'light WIMP' searches using S2 only
  - No intrinsic backgrounds (^{85}Kr can be removed, low rate from ^{136}Xe $2\nu\beta\beta$)
  - Easily scaled with no loss of performance (actually improves!)

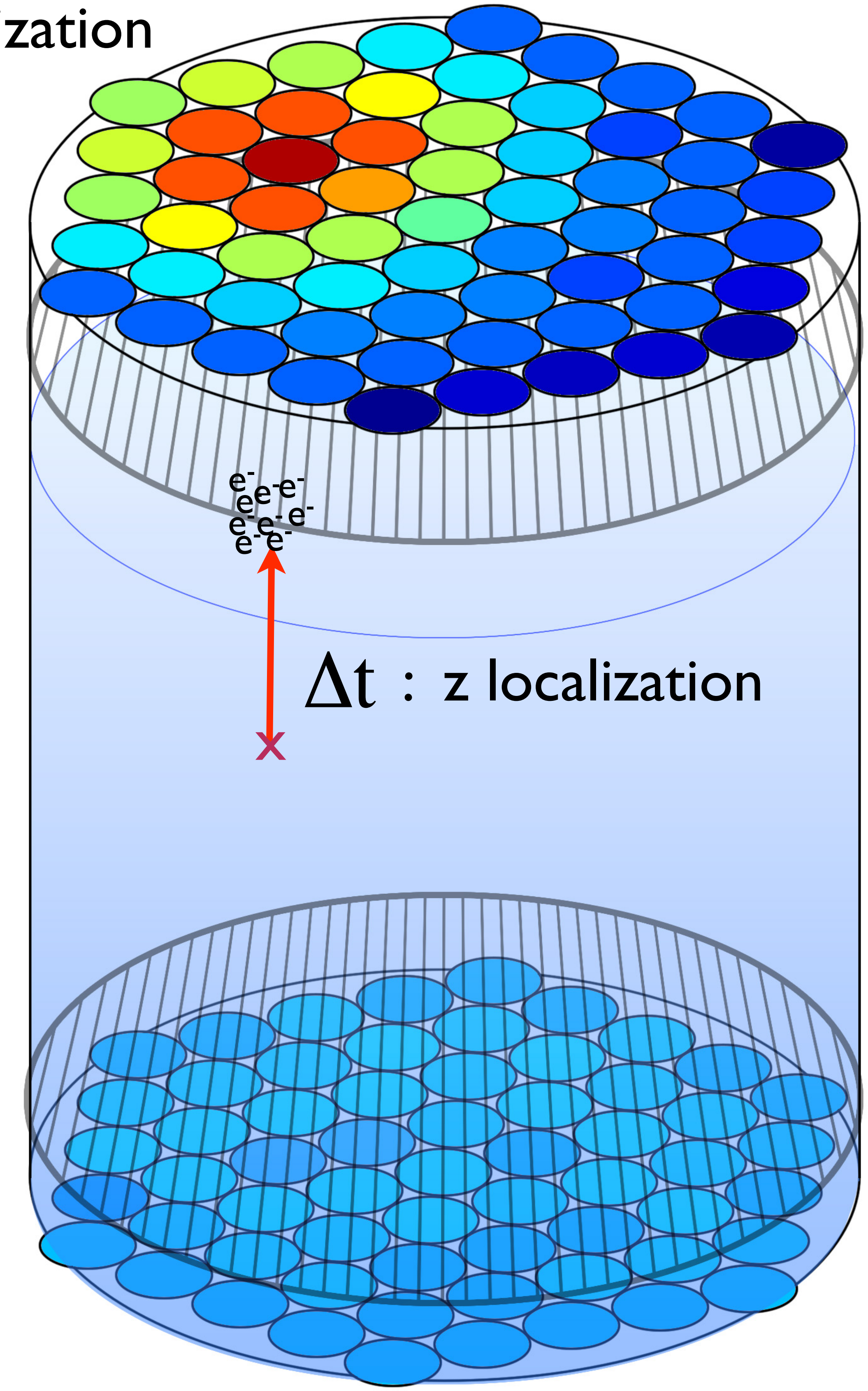

Photomultiplier
Tube
Anode Grid
Gas Xe
Liquid Xe
E
Cathode Grid

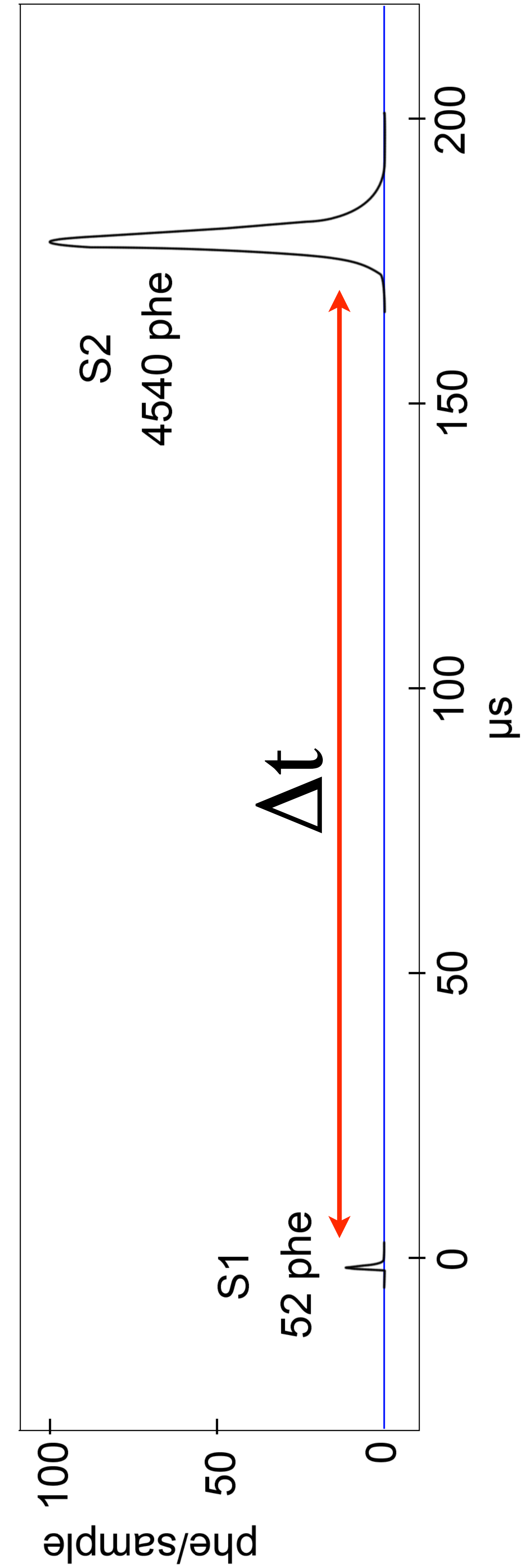
S1

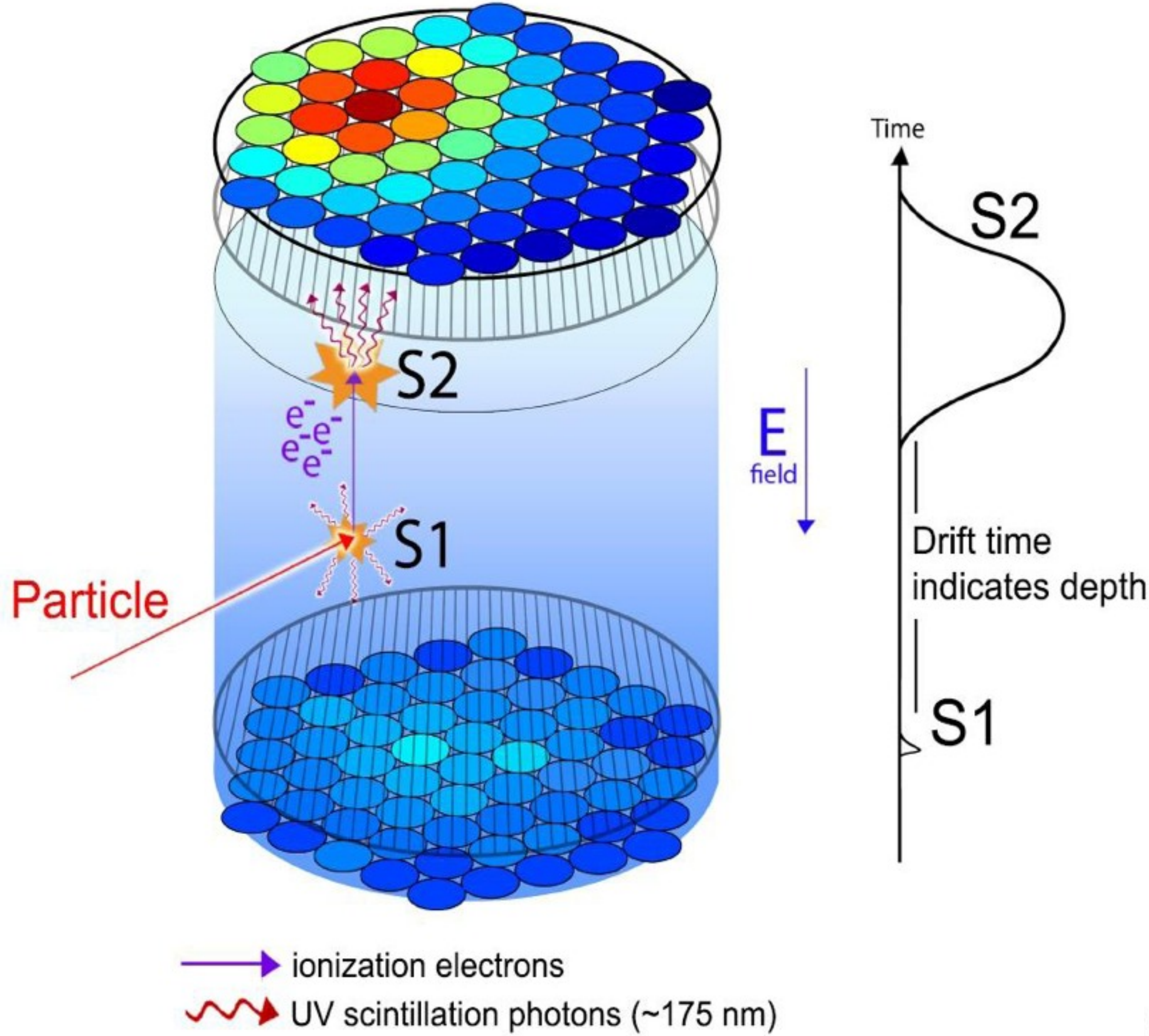


top hit pattern:
x-y localization

S2

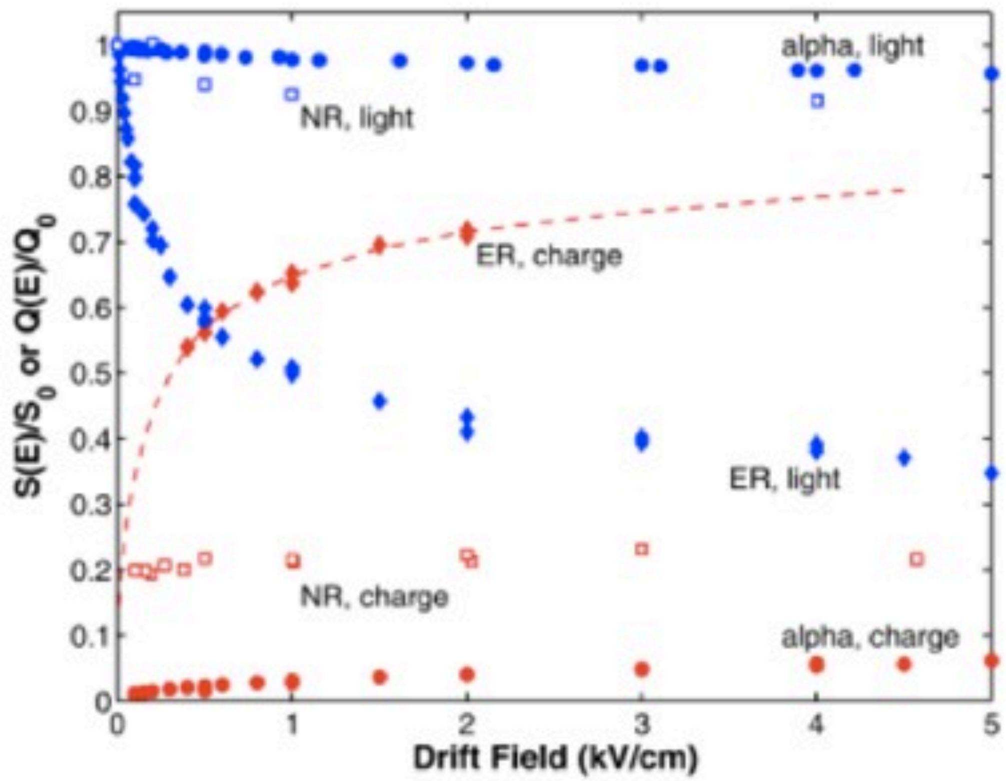


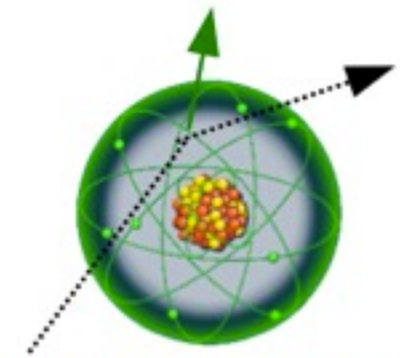



Time
S2
S2
e- e- e- e-
E
field
S1
Particle
Drift time
indicates depth
S1
ionization electrons
UV scintillation photons (~175 nm)

WIMP Signals in a Dual-Phase Xenon Detector

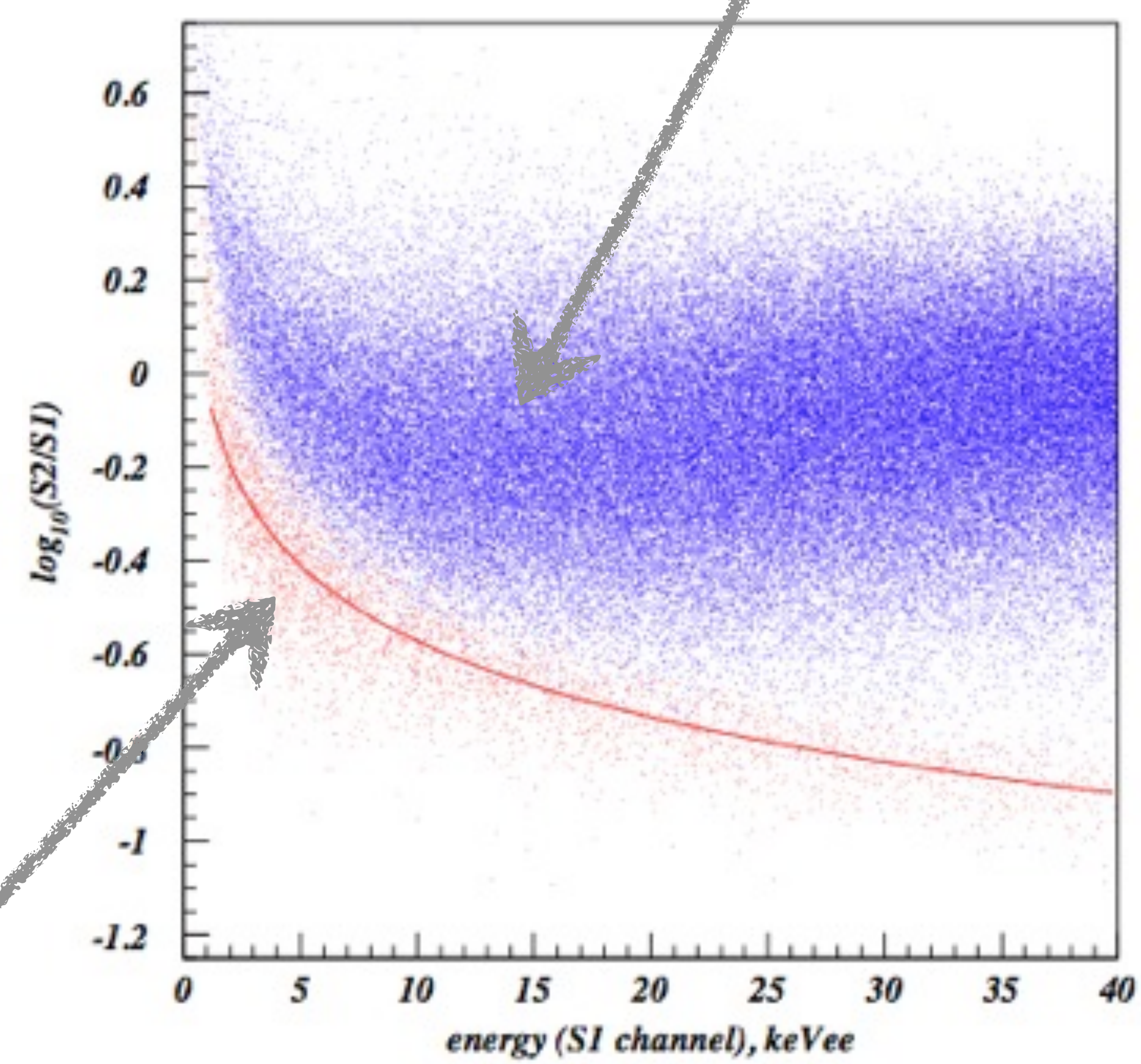
Particle Discrimination

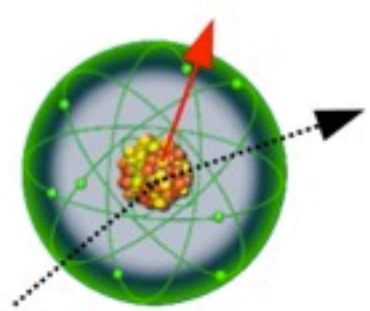




Electronic Recoils
(gamma, beta)

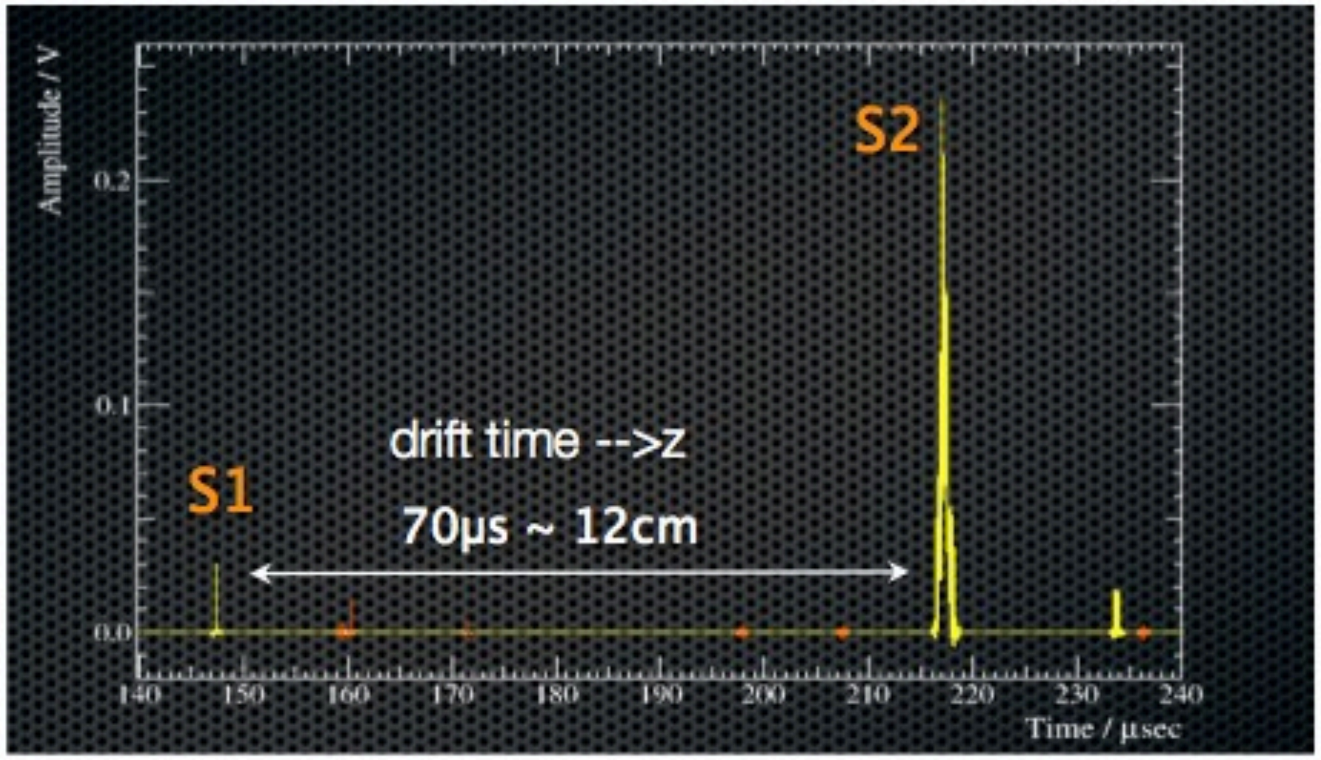
Light (S1) and charge (S2)
depend on recoil dE/dx

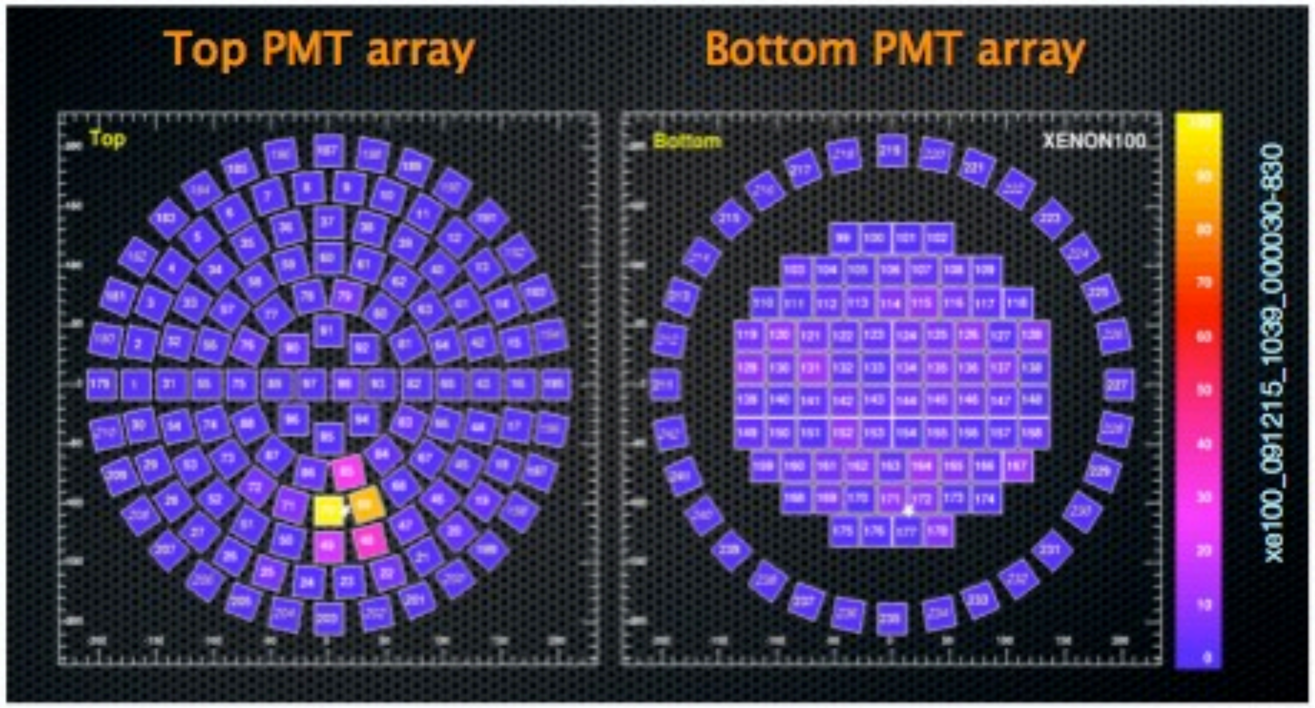




Nuclear Recoils
(neutron, WIMPs)

Event Position Reconstruction





Example of a low energy (9 keVnr)

4 photoelectrons detected from about 100 S1 photons

645 photoelectrons detected from 32 ionization electrons which generated about 3000 S2 photons

Event Z-position from measured drift time t(S2) - t(S1) and known e-velocity. dZ< 0.3 mm

event X-Y position from measured S2-hit-pattern. dR < 3mm

The XENON Roadmap

XENON10

2005-2007

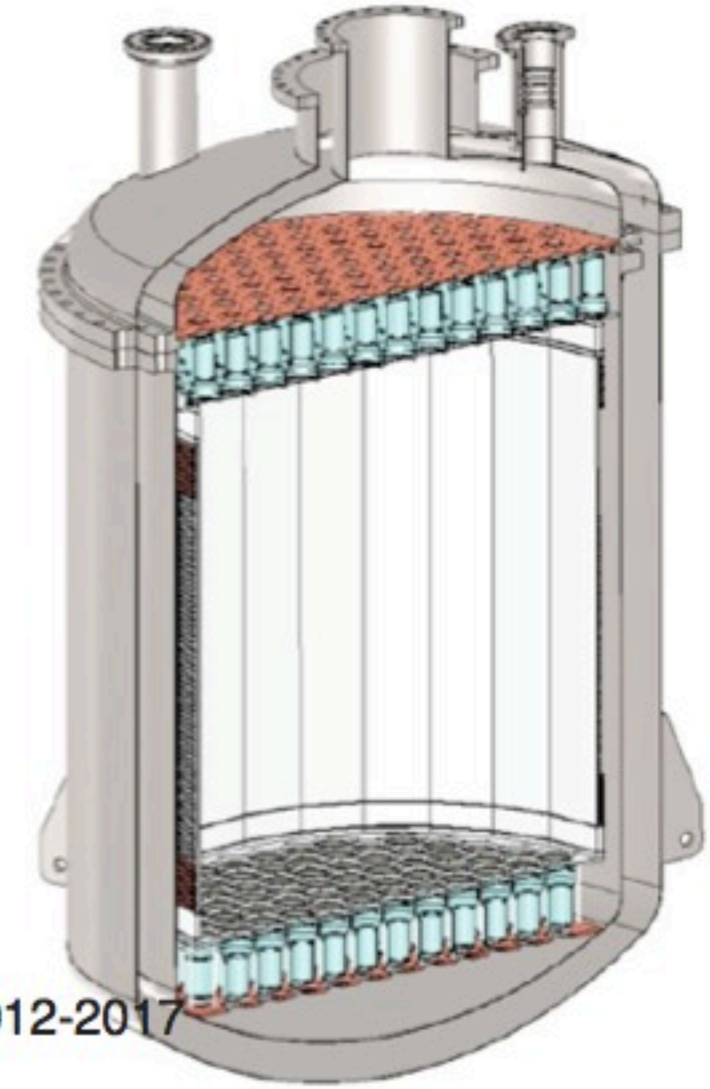
PRL100
PRL101
PRL 107
PRD 80
NIM A 601

XENON100

2007-2013

first results:
PRL105, PRL107, PRD84

XENON1T



2012-2017

approved at LNGS, Hall B
construction starts in fall 2012

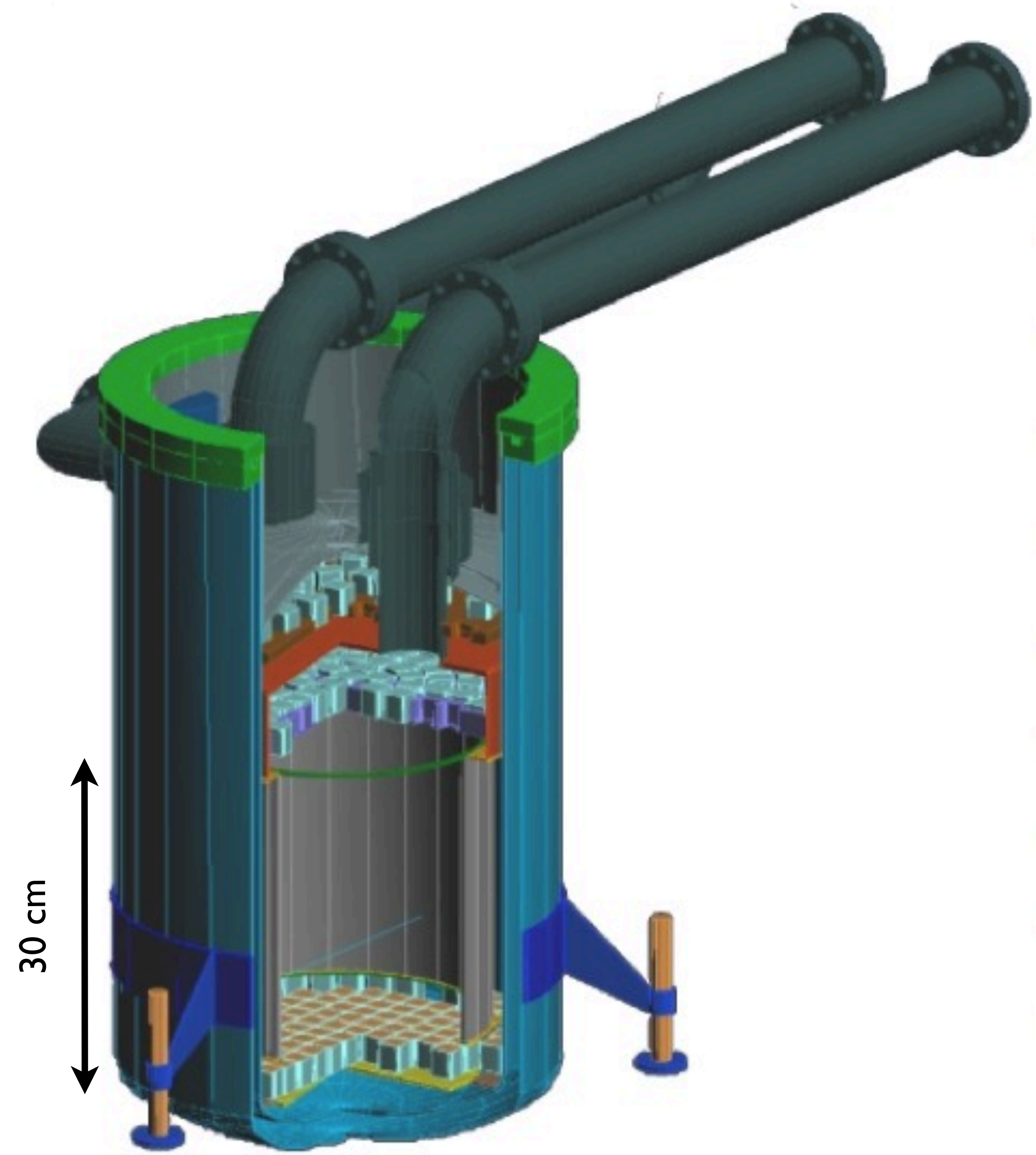
- Gradually increasing the WIMP target mass while decreasing the background level

The XENON Collaboration

Columbia Rice UCLA Zürich Coimbra LNGS SJTU

Mainz Bologna Subatech Münster Nikhef Heidelberg Weizman Purdue

The XENON100 detector overview

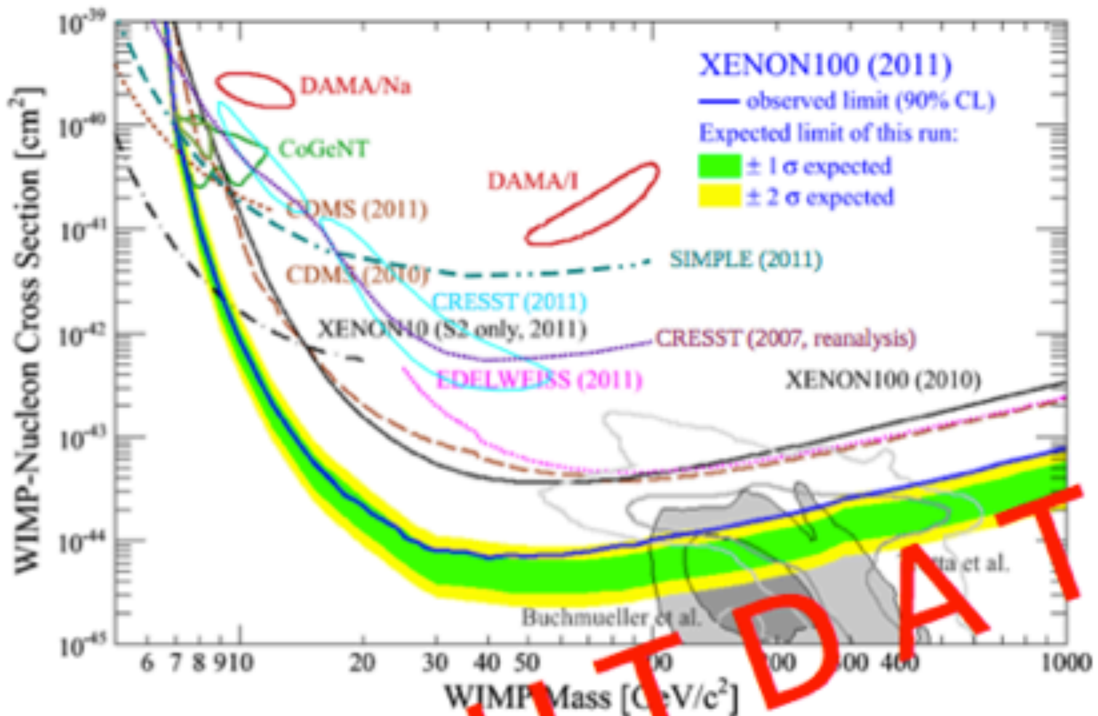


- 100 x less background than XENON10
- 10 x more fiducial mass than XENON10
- Cryocooler and FTs outside shield
- Materials screened for low radioactivity
- LXe scintillator active veto system
- Improved passive shield system
- Dedicated Kr distillation column
- TPC with 30 cm drift x 30 cm diameter
- 161 kg ultra pure LXe - 62 kg as target
- 1" square PMTs with ~1 mBq (U/Th)

XENON100 Location and Shield

- LNGS provides the shield against cosmic rays: 1.4 km of mountain
- Passive shield:
  - ➡ 5 cm (2 tons) of Cu, 20 cm (1.6 tons) of PE, 20 cm (33 tons) of Pb, plus 20 cm water shield
- Detector housing is continuously purged with boil-off N_2, to maintain a radon level < 0.5 Bq/m^3
- All materials screened with HPGe detectors at LNGS   see *Astroparticle Physics 35, 2011*

(spin-independent) WIMP Limit 2011

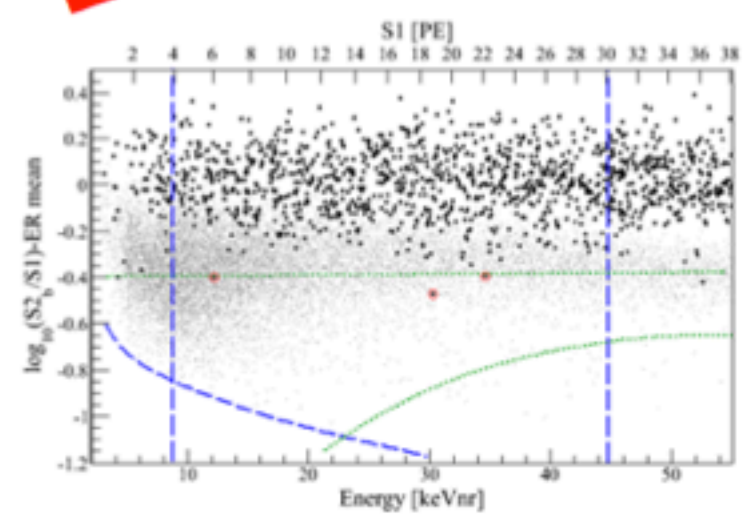


PRL 107, 131302 (2011)

already cited 362x

Limit derived with
Profile Likelihood method
PRD 84, 052003 (2011)

OUTDATED!!!



XENON100 sets the most sensitive limit over a large WIMP mass range

Challenges the CoGeNT, DAMA, CRESST-II signals as being due to light mass WIMPs

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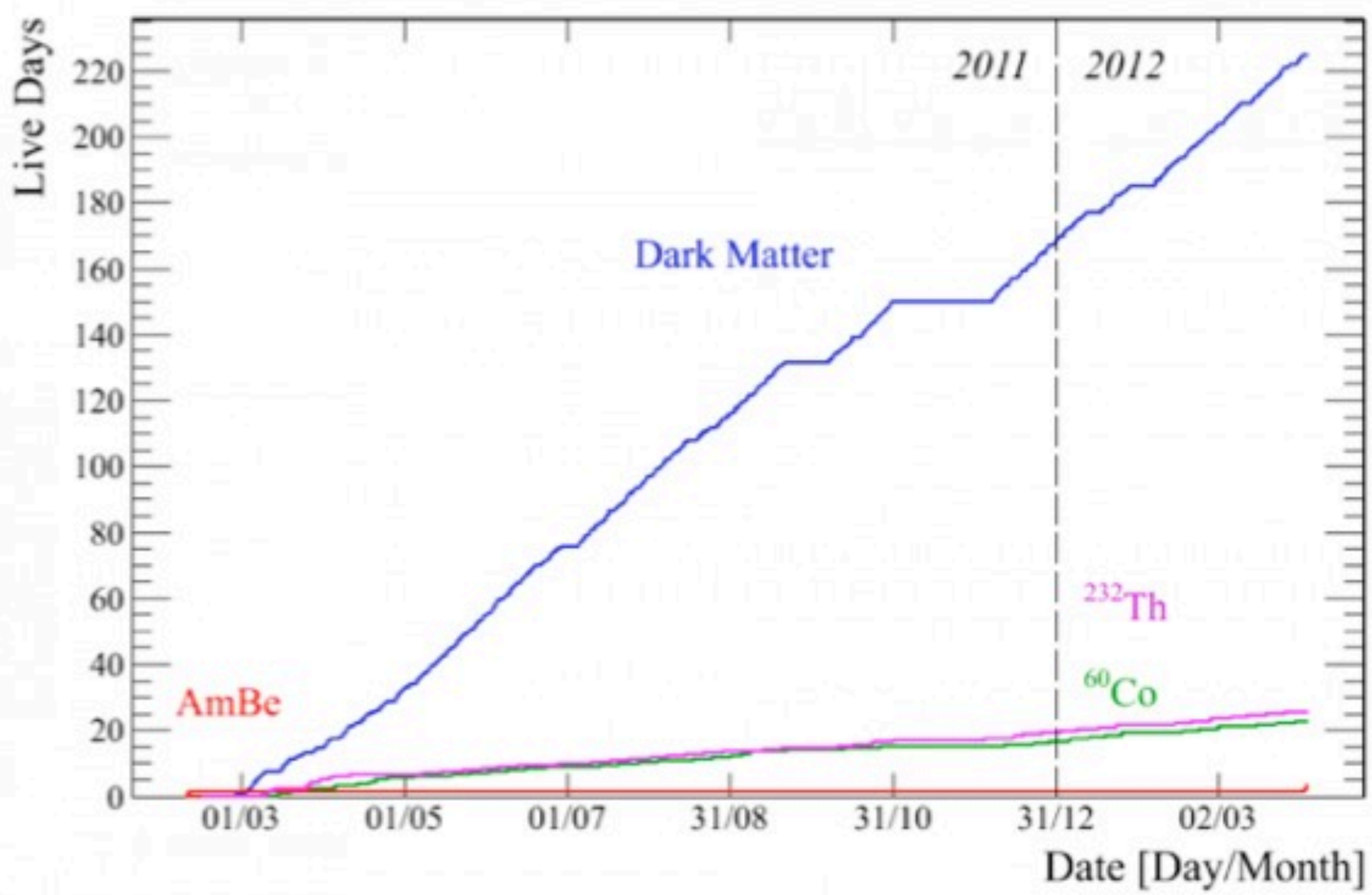
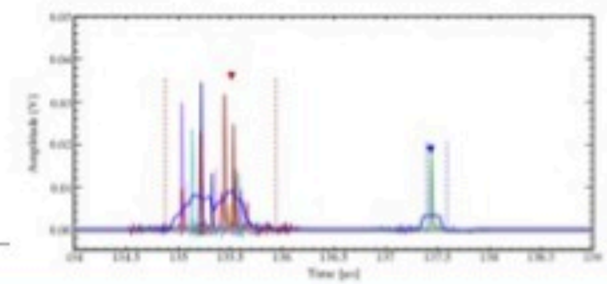
New XENON100 Dark Matter Search: Run10

- Data taking period: February 2011 - March 2012
- 224.56 live days of dark matter data
- 48 live days of ^{60}Co and ^{228}Th calibration data; 2 AmBe runs (beginning/end of science run)

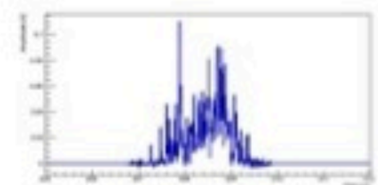


From raw waveforms to results



Majority trigger, efficiency > 99% for S2>150 pe

Data acquisition: sample PMT traces @ 100 MS/s in windows around signals > 0.35 pe



PMT waveforms →

Raw data processing, baseline and noise measurement; S1, S2 signal recognition; signal integration; position reconstruction; signal correction (gain, spatial)

↓ root trees

Event selection, remove bad events:
- noise
- S1/S2 not matching

Select single interaction events

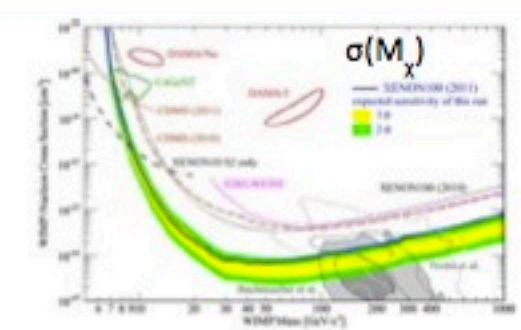
Acceptances!

← reduced data

Physics analysis input: astrophysics, nuclear physics, DM data sidebands, NR and ER calibration => response, background estimate

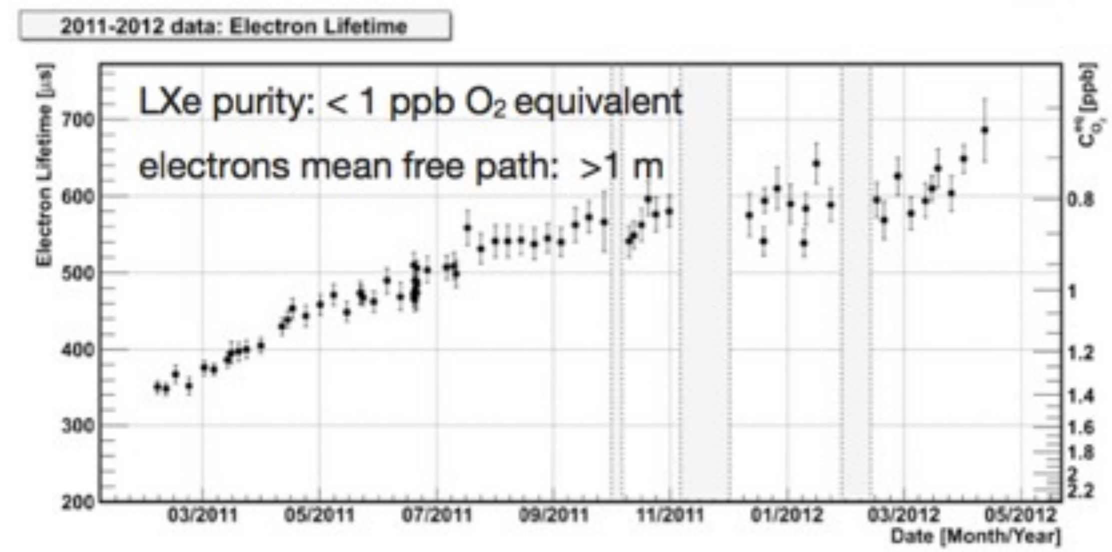
profile likelihood →

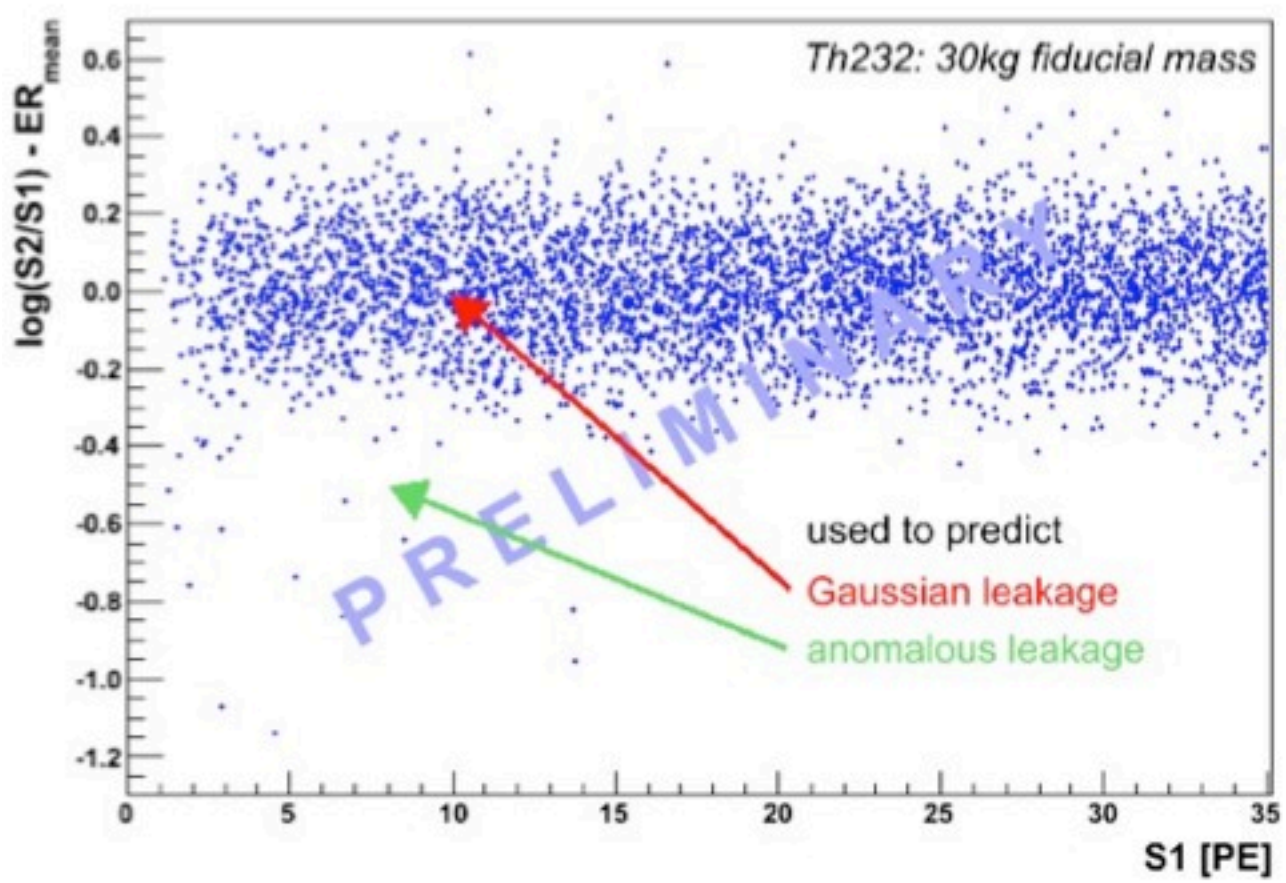
results →

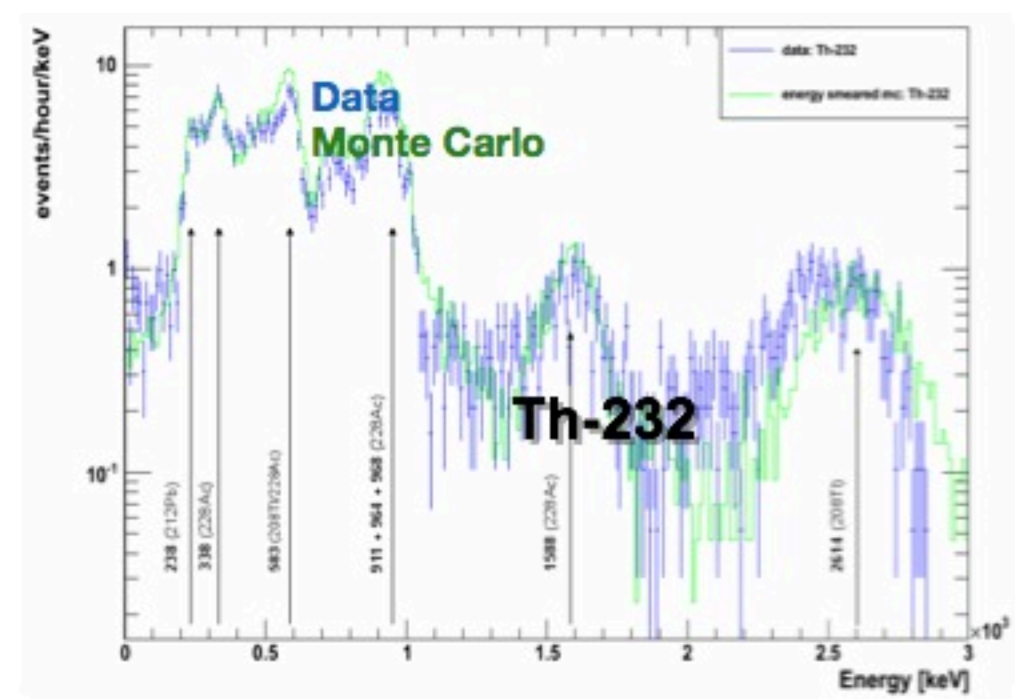


XENON100 gamma calibrations

- ^{137}Cs data to monitor the charge & light yields
- ^{60}Co and ^{232}Th data used to map the electron recoil band and predict EM background (irradiate at three points around TPC)
- ^{232}Th data also used to understand spectrum up to high energies

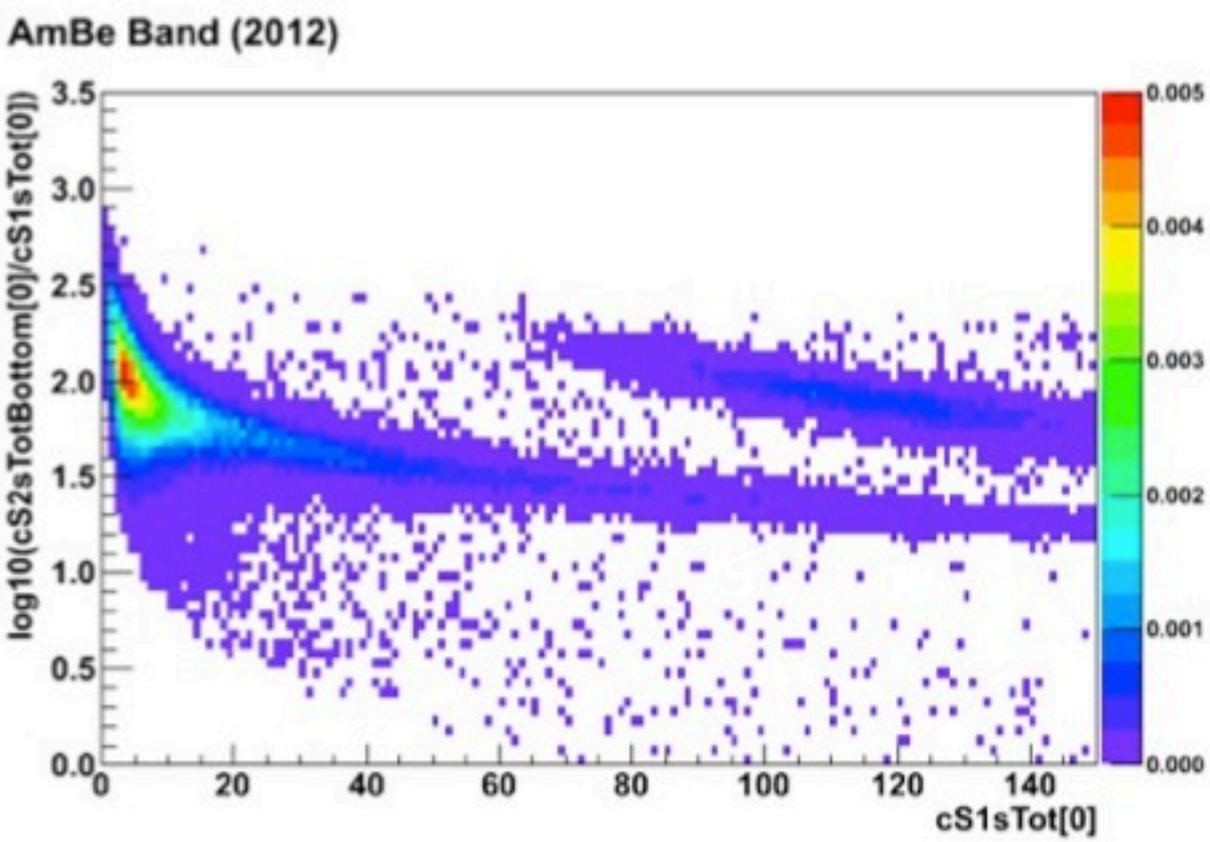


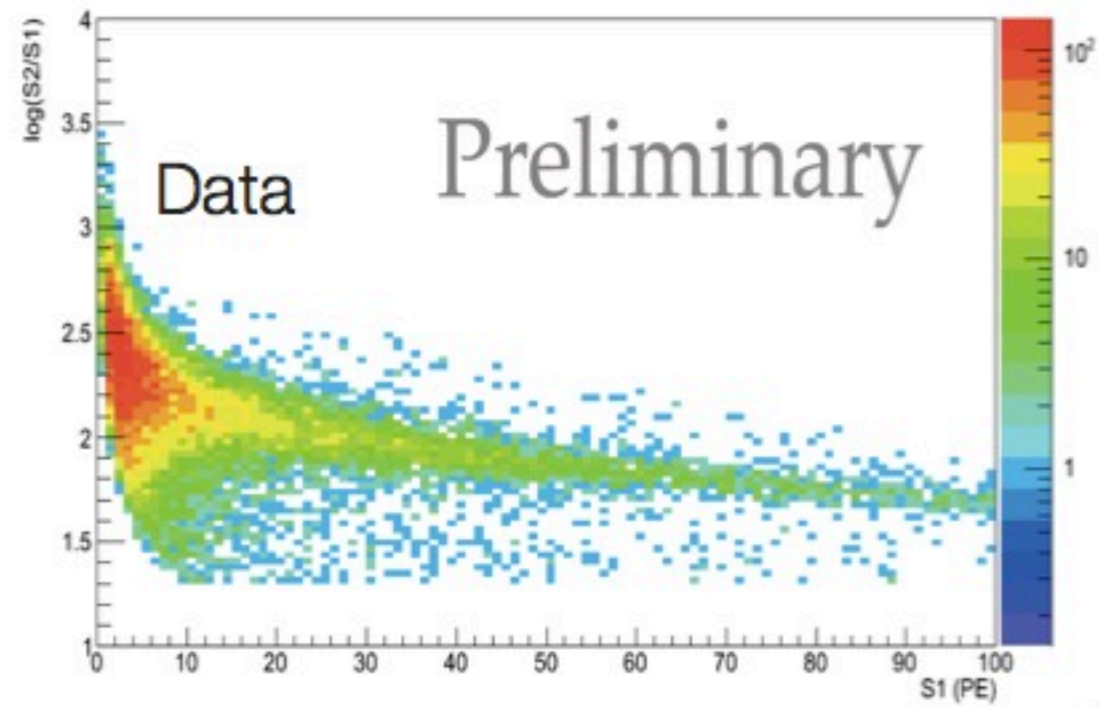


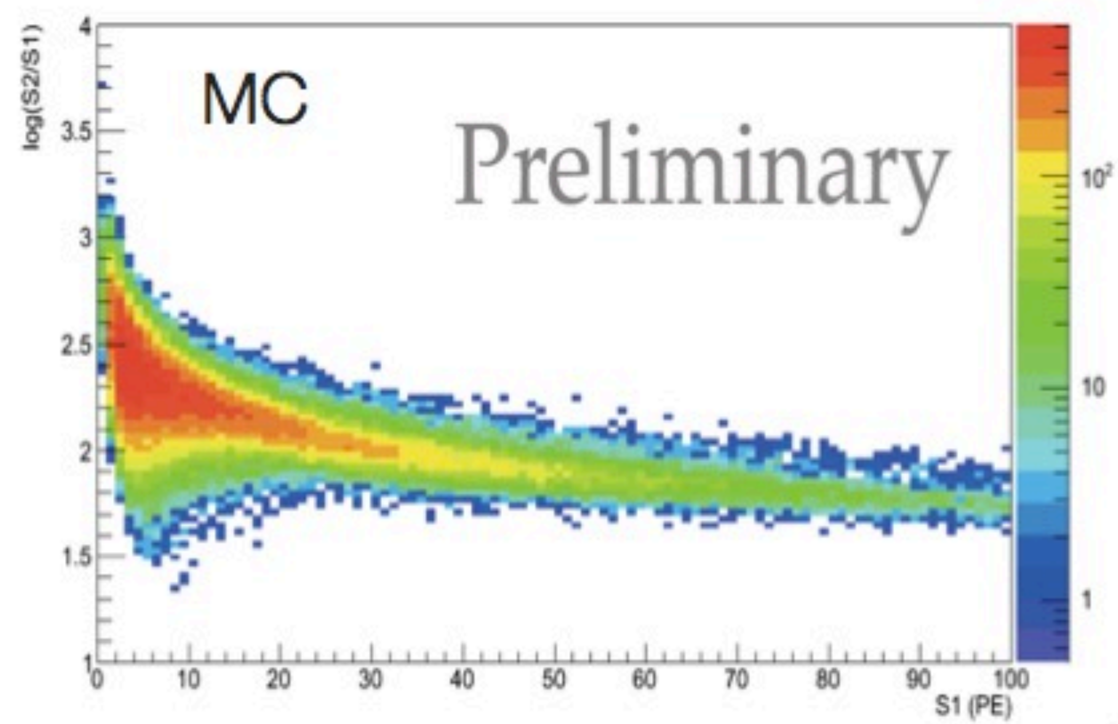


XENON100 neutron calibration

- Nuclear Recoil band calibration performed with a 220 n/s AmBe neutron source

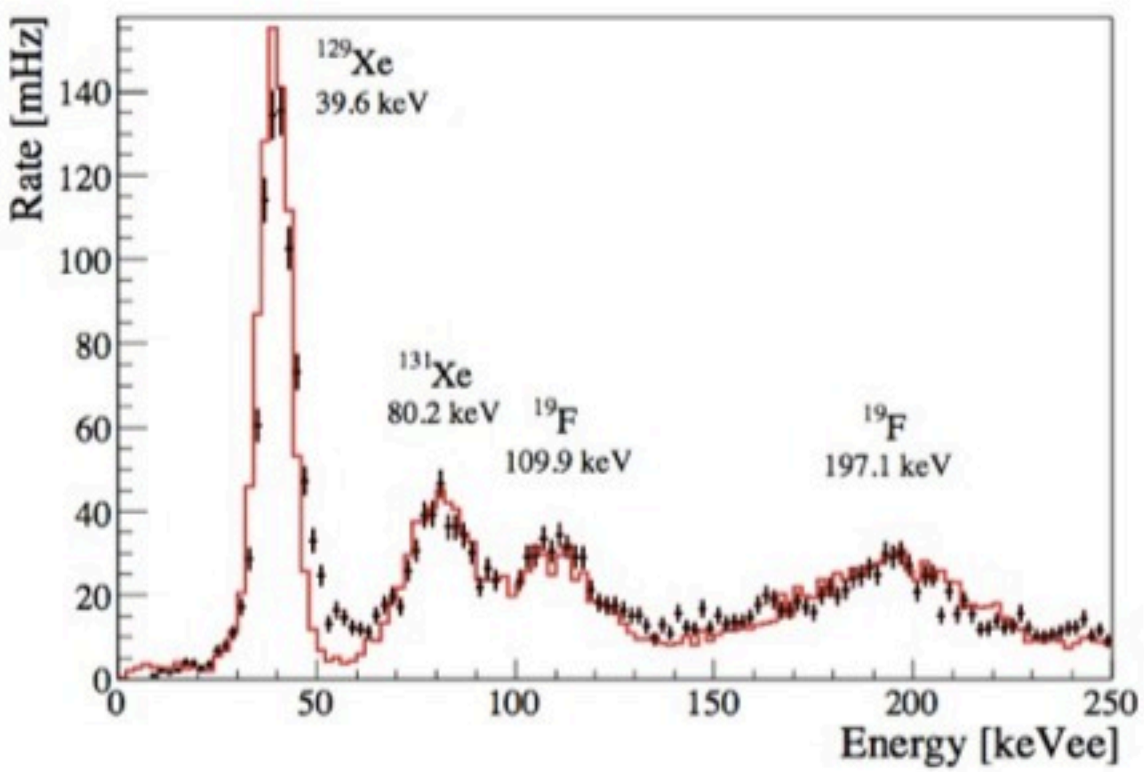


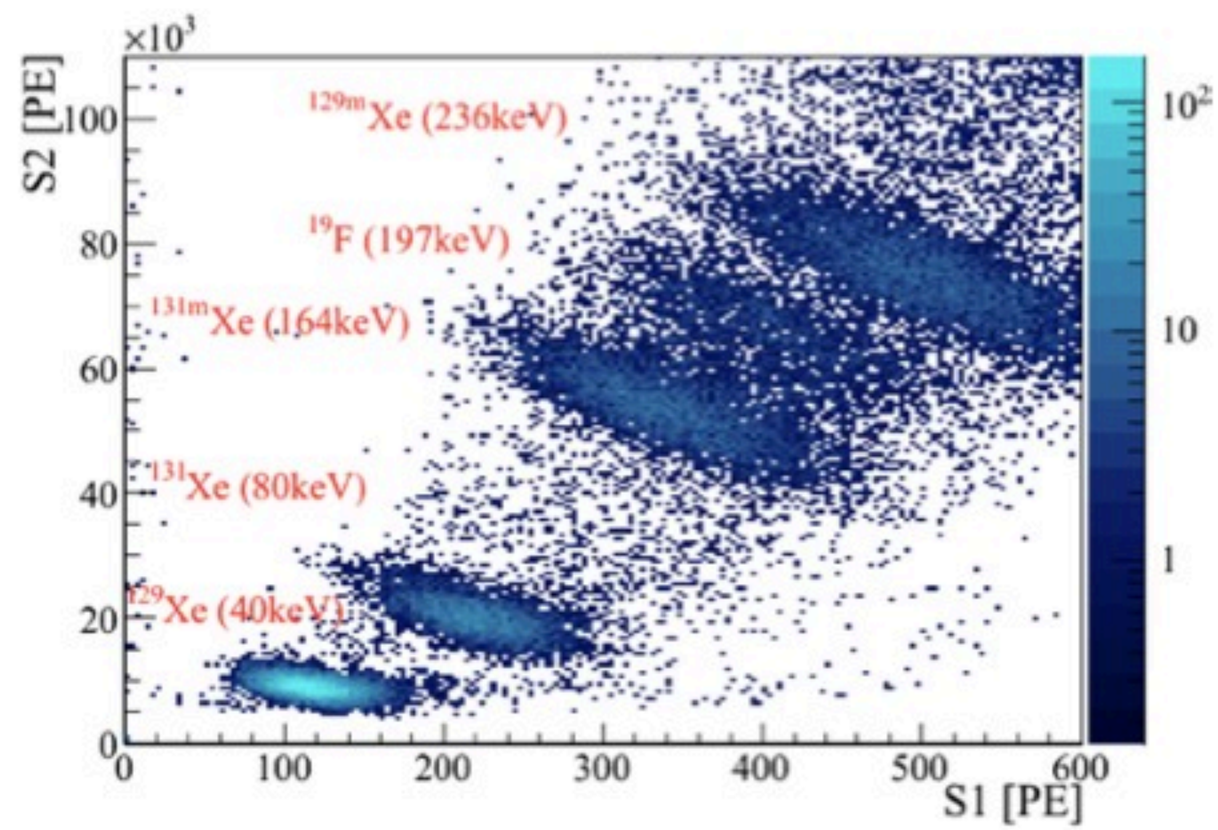




Gammas from neutron calibrations

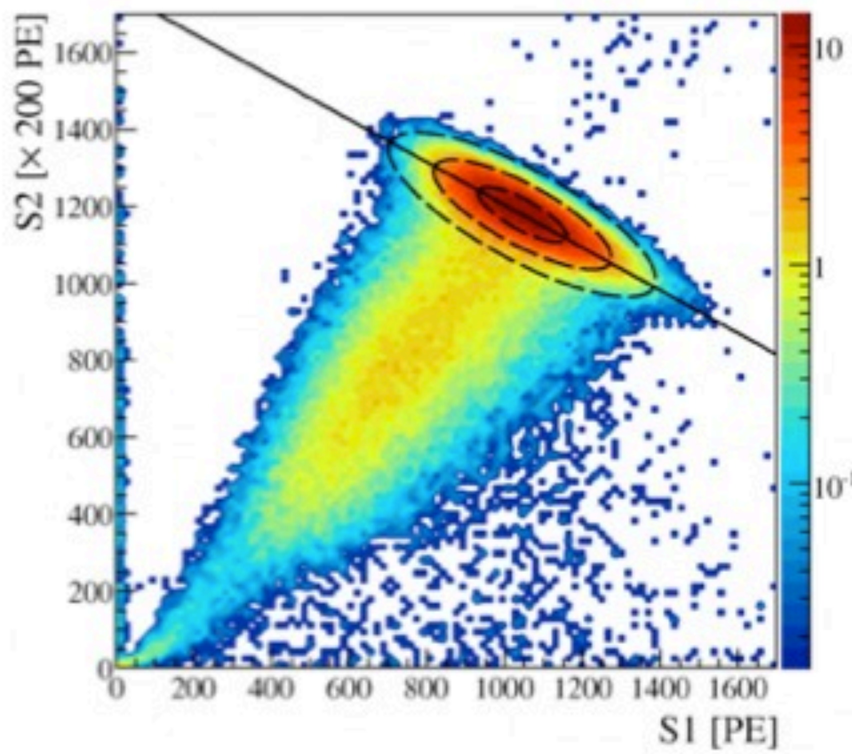
- AmBe (~ MeV neutrons) data to map the nuclear recoil band, 220 n/s
- Inelastic n-scattering on Xe: $^{129,131}Xe + n \rightarrow {}^{129,131}Xe + n + \gamma$ (40 keV, 80 keV)
- Inelastic n-scattering on F (in PTFE): $^{19}F + n \rightarrow {}^{19}F + n + \gamma$ (110 keV, 197 keV)
- Also Xe activation lines: ^{129m}Xe (236 keV) and ^{131m}Xe (164 keV)

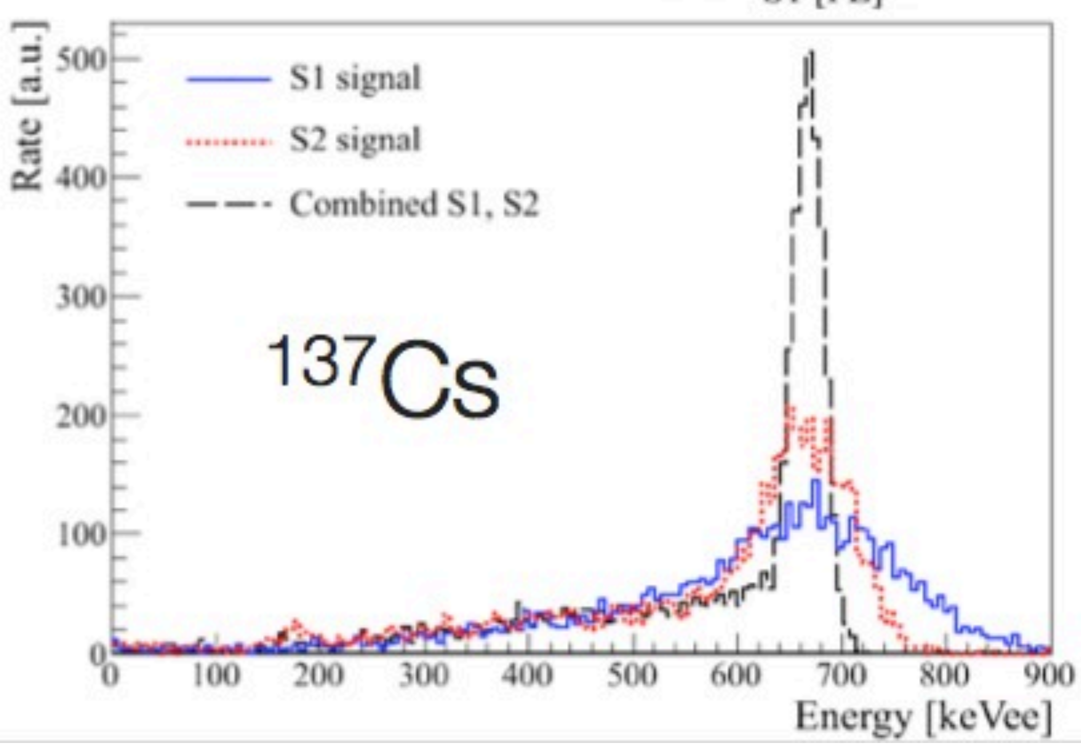


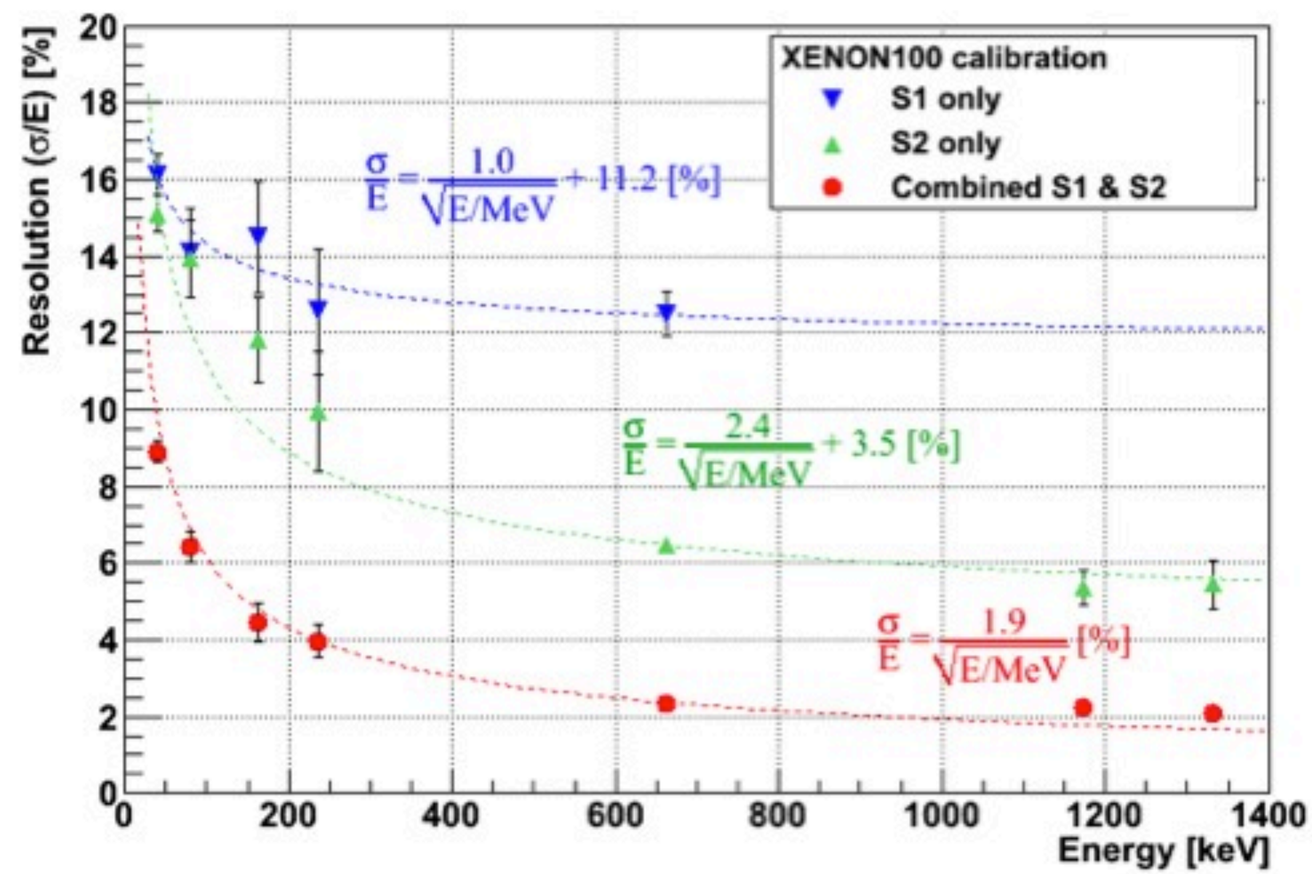


All gammas from the neutron irradiation of XENON100 are used to check/correct signal dependency with position and also to infer the LY at 122 keV

XENON100 energy resolution

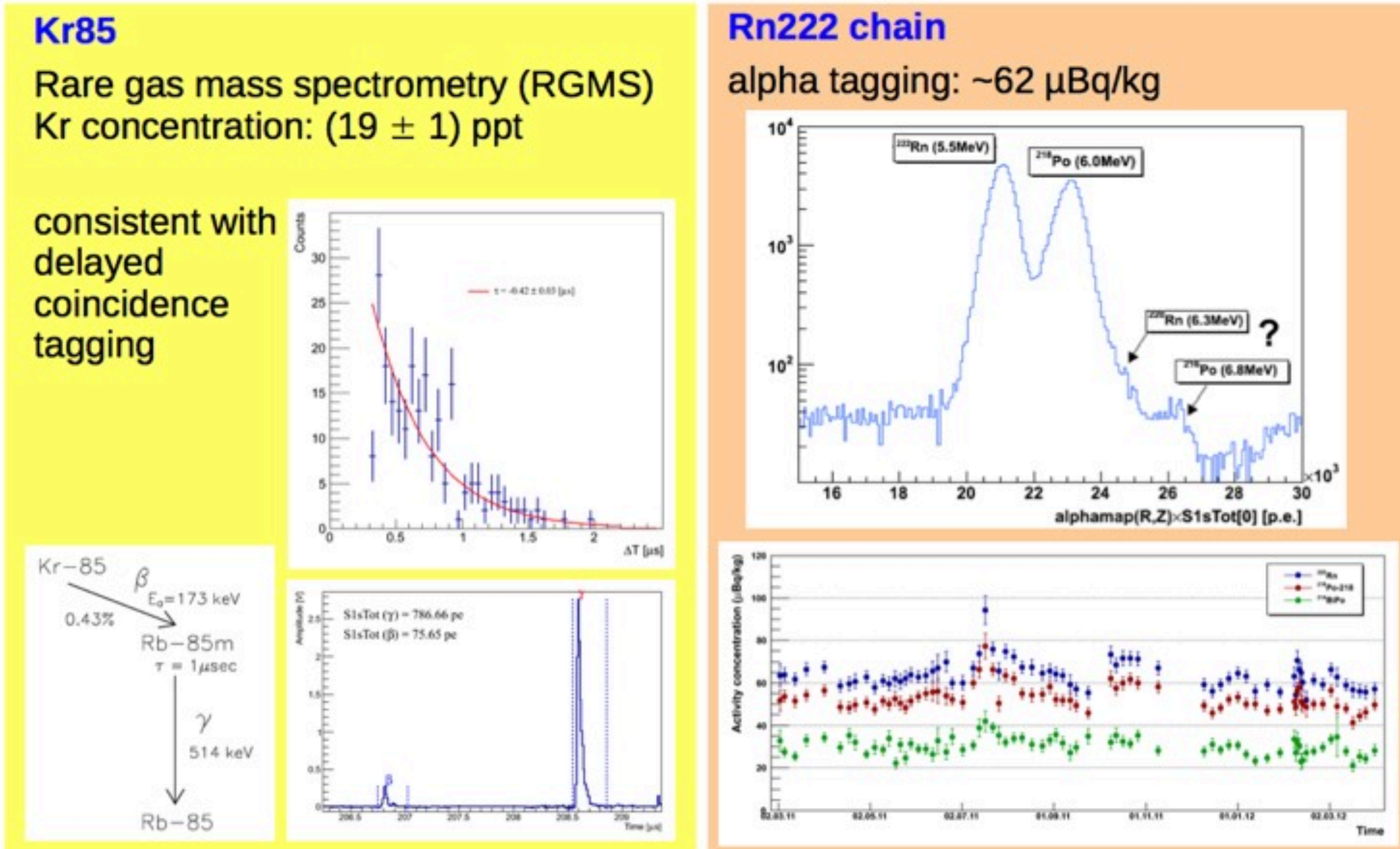






- Energy dependent energy resolution
- In S1, in S2 and in the “combined energy scale”
- Because of the anti-correlation of the S1 and S2 signals, the resolution is much improved when using both

Intrinsic backgrounds

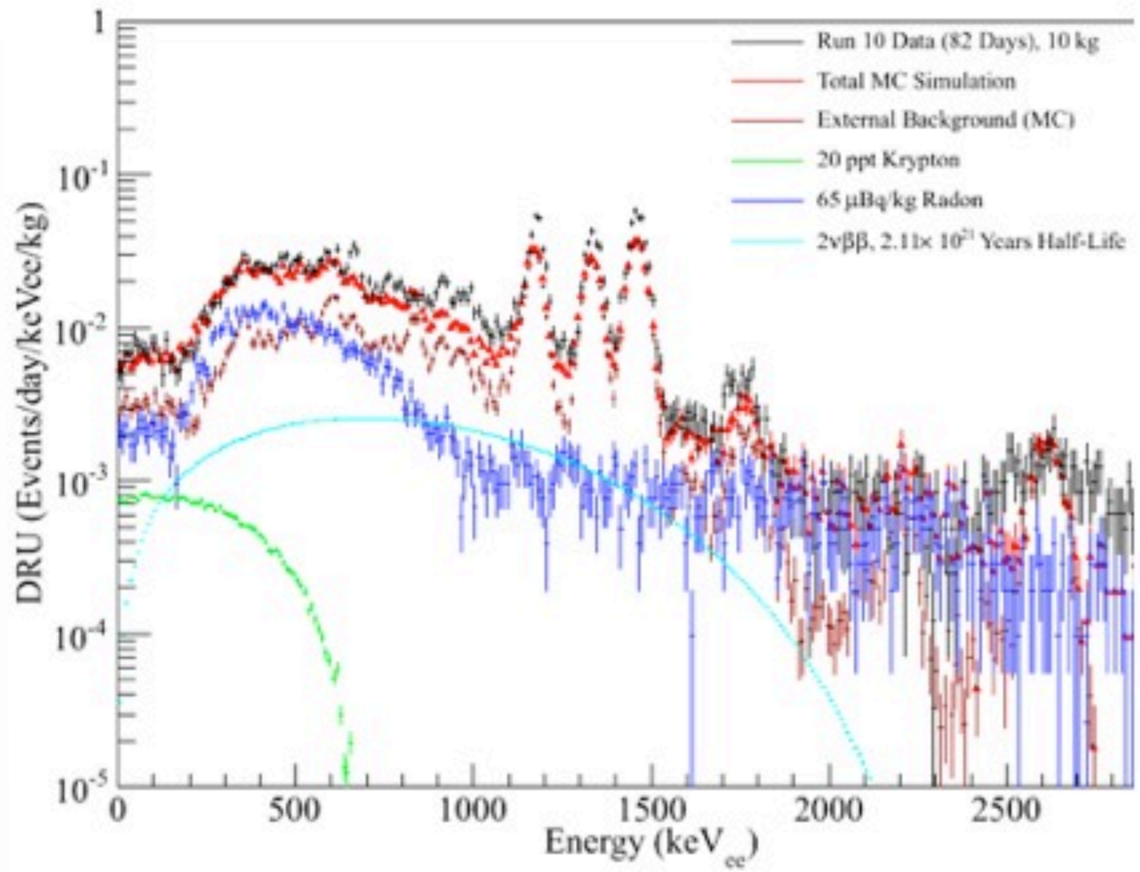


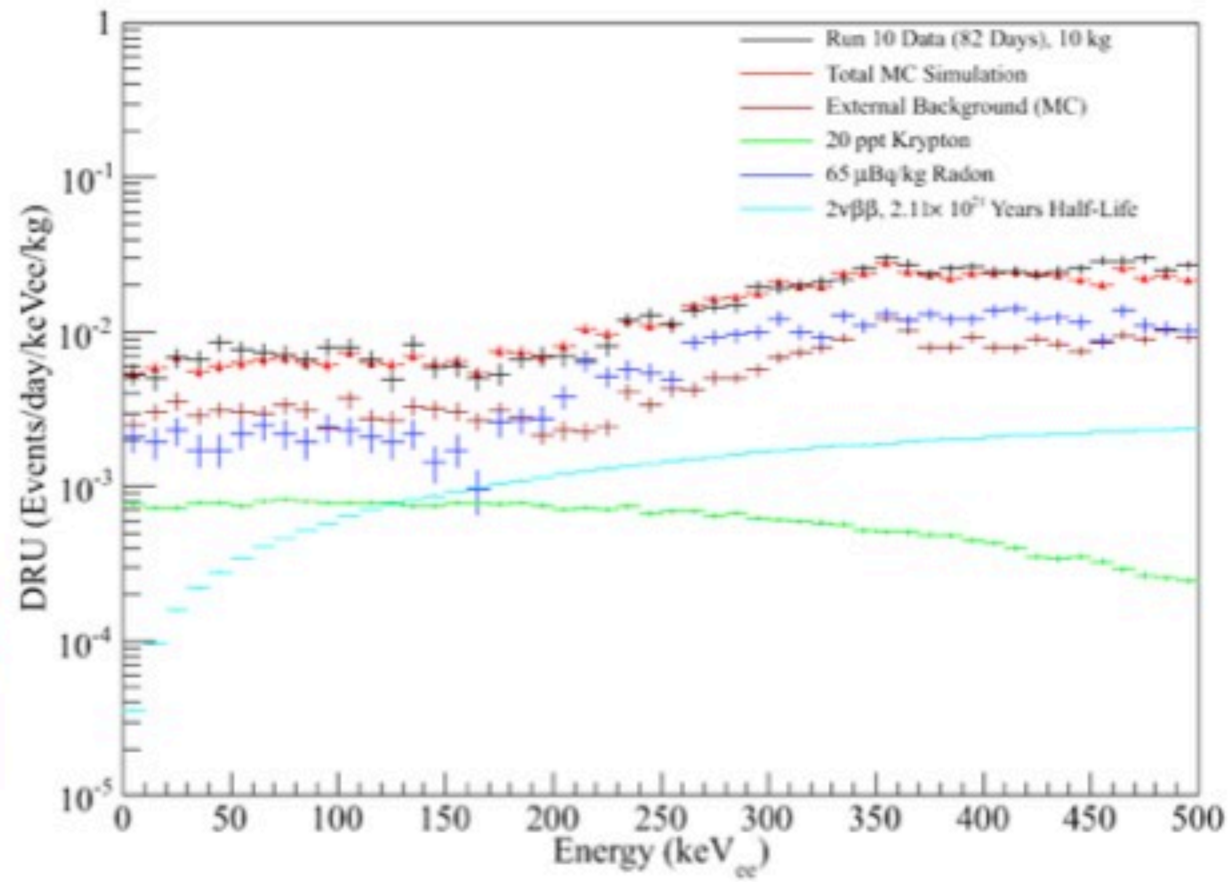
LXeTPCs easily identify surface backgrounds, alphas and delayed coincidences with 3D vertex and energy reconstruction

Measured Background Level in Run10

- Reached background level before S2/S1-discrimination: 5.3 x 10^{-3} events/(kg day keV)
- Same level as in 1st XENON100 results (E.Aprile *et al.*, Phys. Rev. Lett. **105,** 131302, 2010)
- **see also** PRD 83, 082001 (2011)

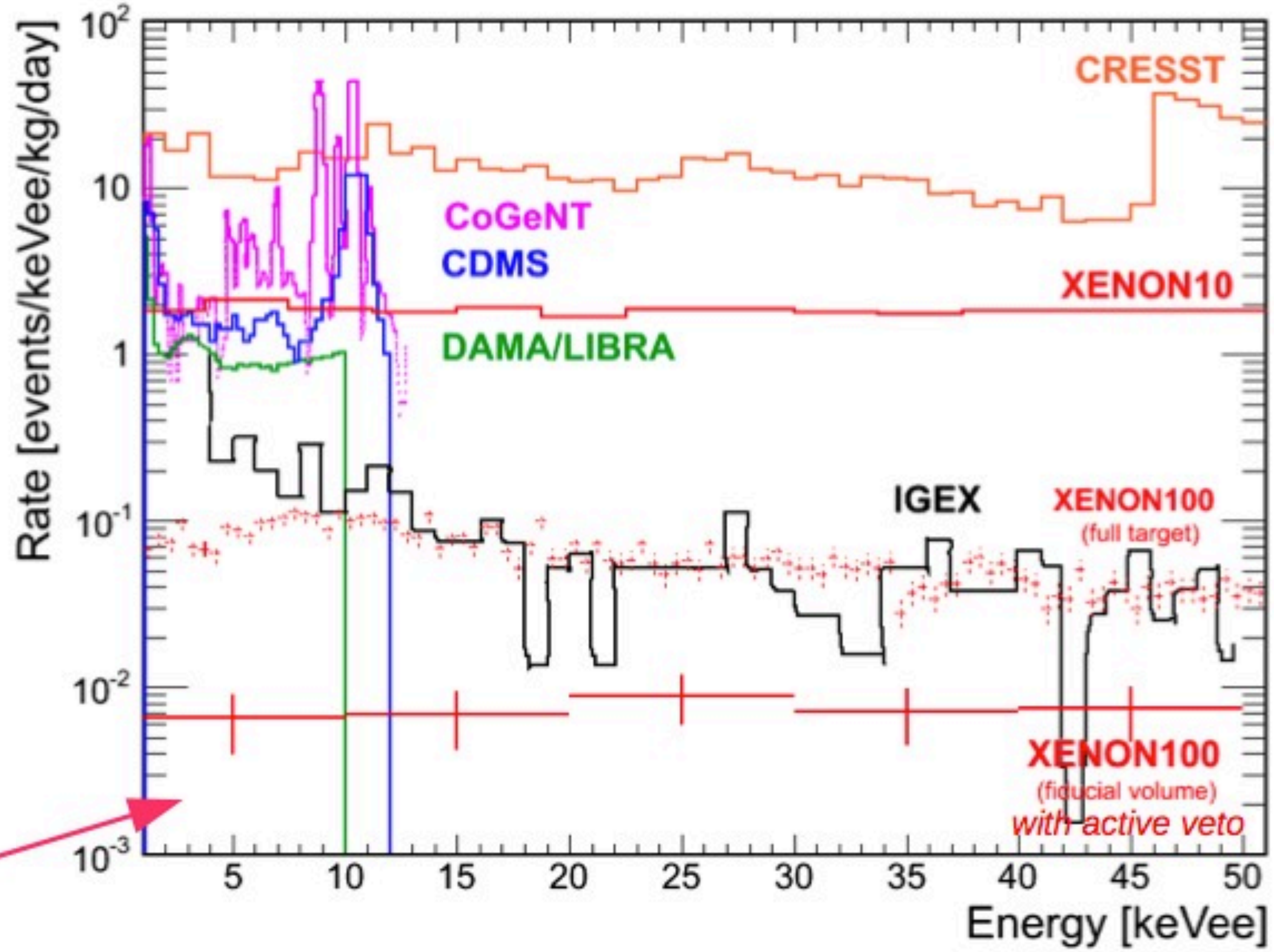
Before applying LXe veto cut





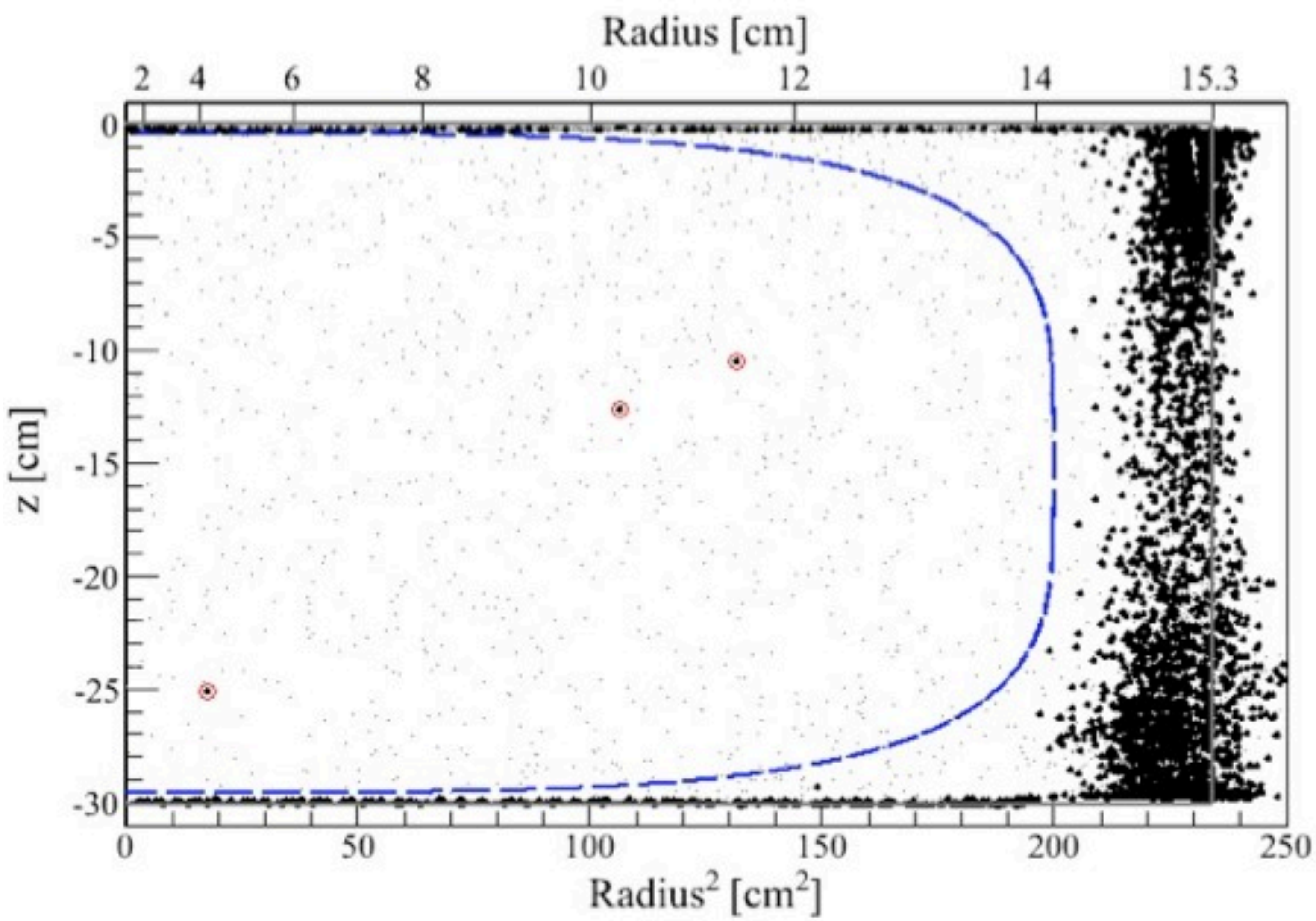
Measured Background in good agreement with MC prediction.

At low energies: Lowest background ever achieved in a Dark Matter Experiment!



Xenon keVee-Scale not precisely known below 9 keVee

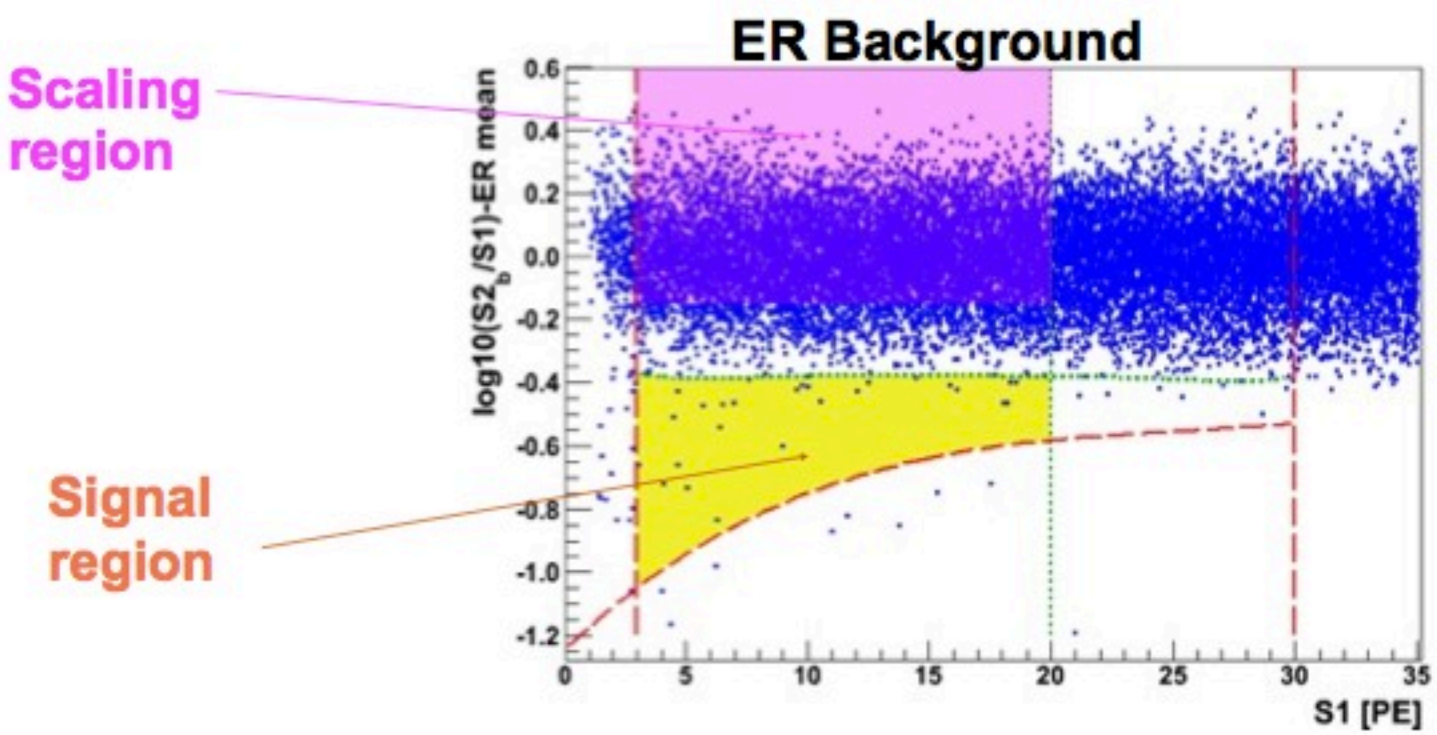
Volume Fiducialization: power of a TPC

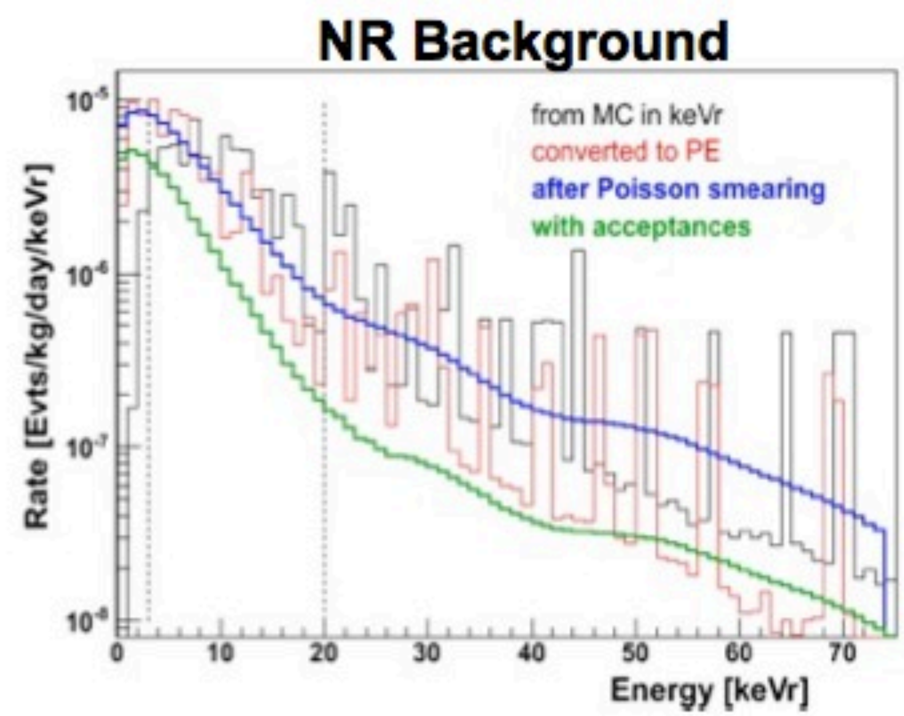


Background from published data (PRL 107)

- 3D event imaging allows to select only central volume with lowest background exploiting LXe self-shielding
- Gammas from detector components and external sources stopped at edges
- Remaining background in fiducialized volume dominated by internal sources like ^{85}Kr and ^{222}Rn in LXe

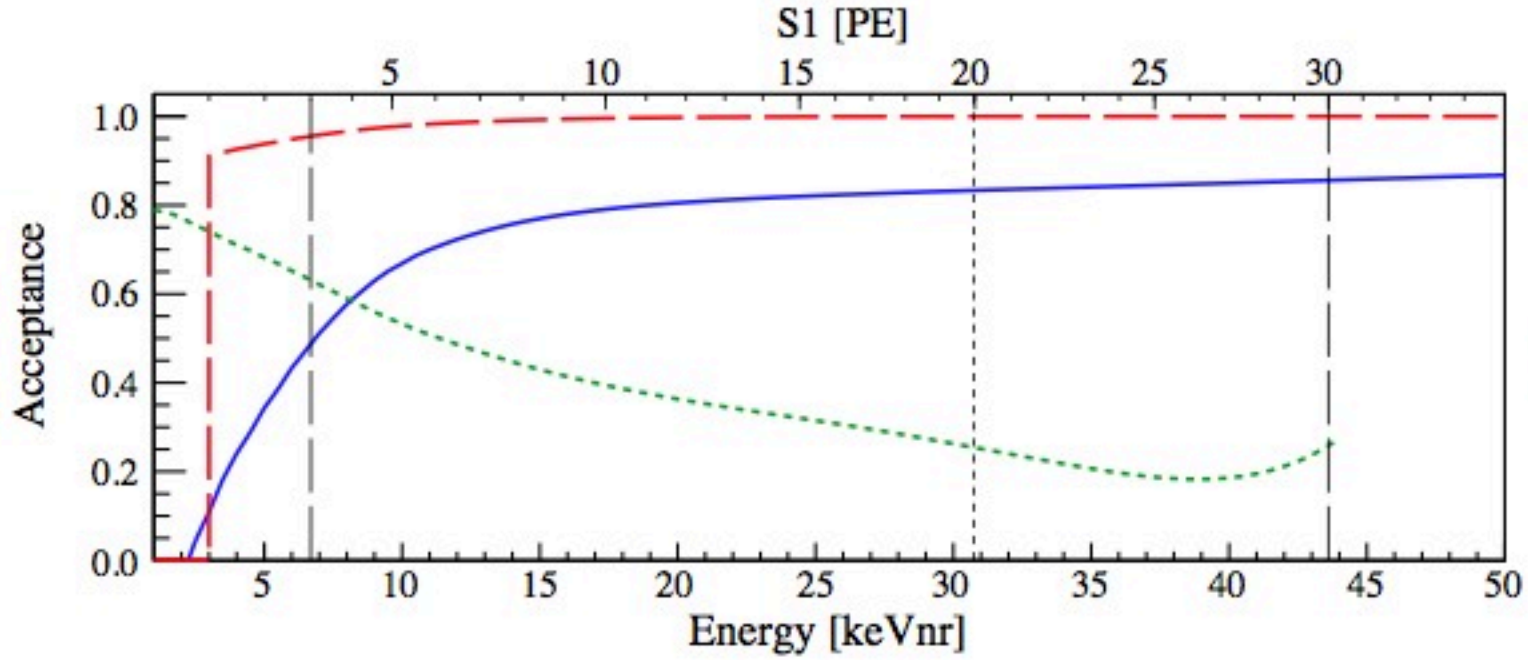
Background expectation





- The background expectation is computed from the calibration data
- The number of events in the signal region from ER calibration data is counted
- That number is scaled to the number of events in the non-blinded region
- An additional contribution from neutrons from the materials is added to the final number and scaled to the total exposure
- Background expectation: 1.0 ± 0.2 events (0.79± 0.16 from gammas, 0.17+0.12-0.07 from neutrons)

Cuts acceptance and L_{eff} parameterization

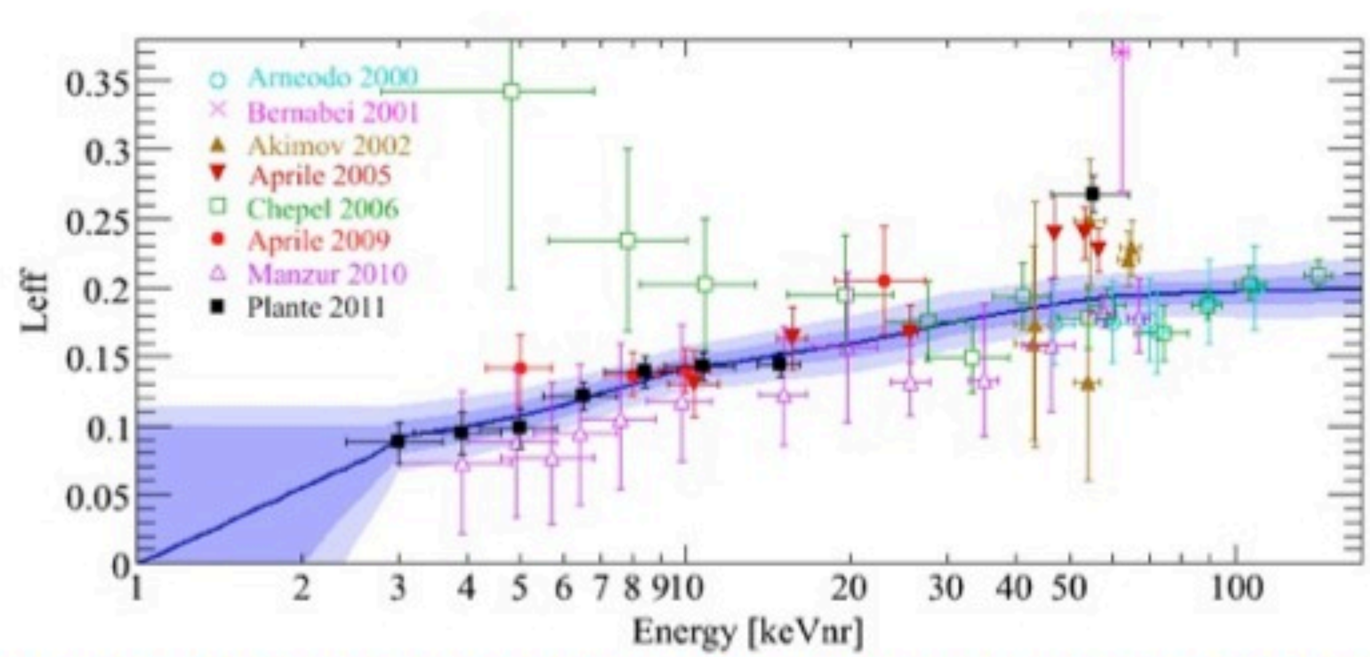


S2 threshold cut (S2 > 150 PE)

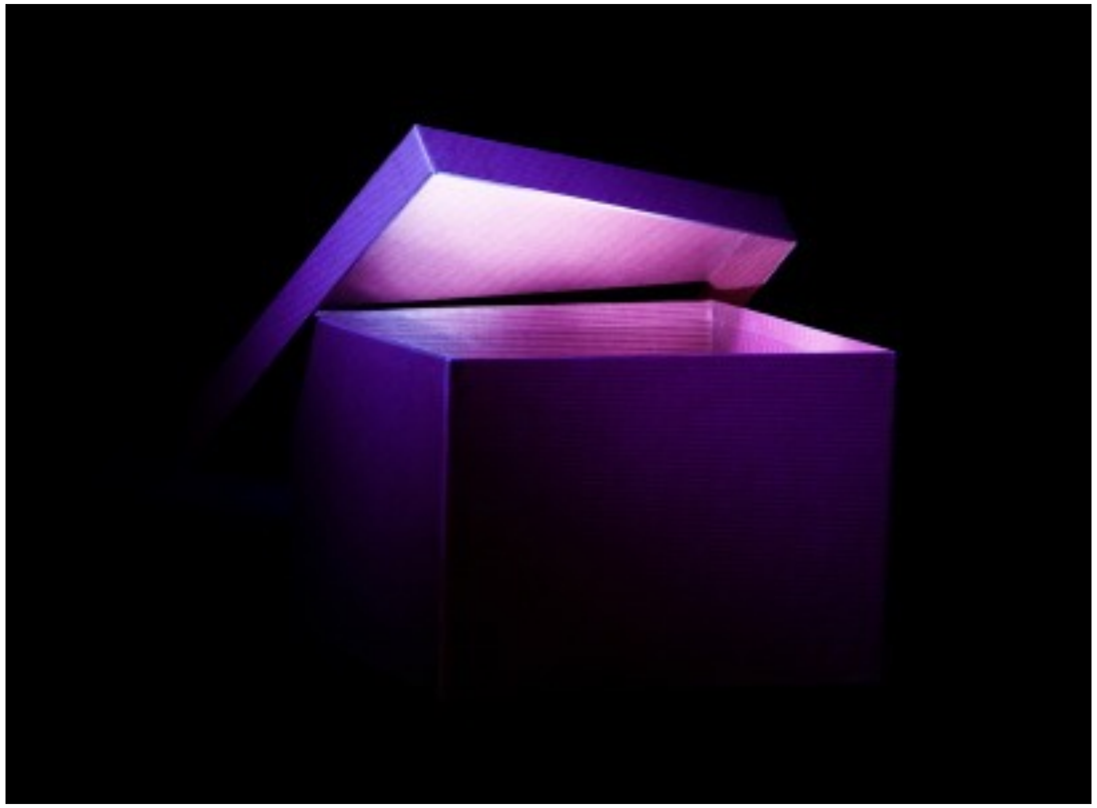
Combined acceptance

NR acceptance for a 99.75% ER rejection (Maximum Gap analysis only)

$$E_{nr} = \frac{S1}{L_{eff} \cdot L_y}$$



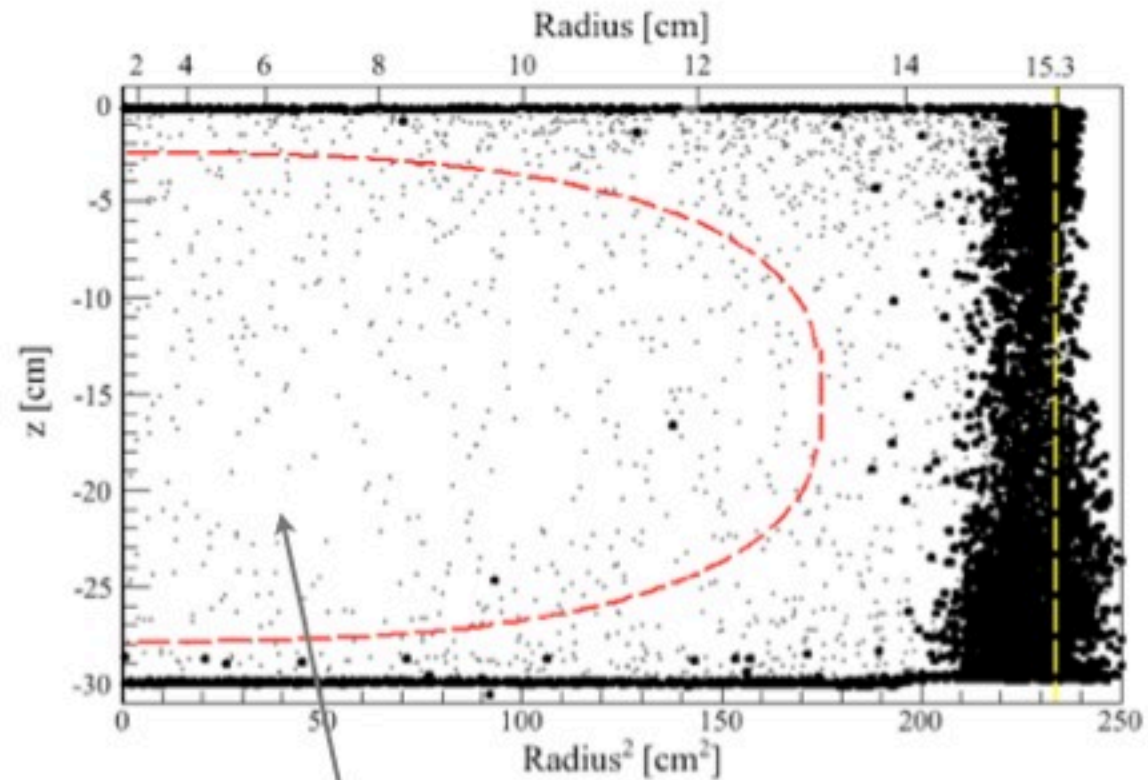
mean (solid) and 1- 2-sigma uncertainties (blue bands) of L_{eff} direct measurements

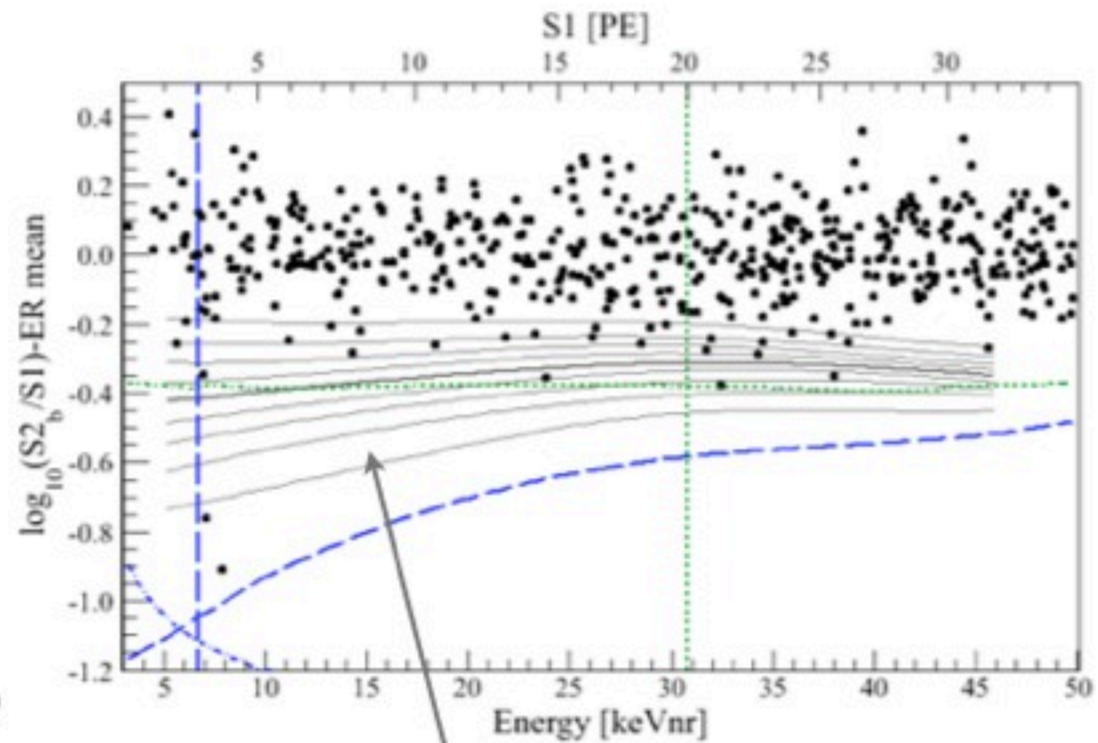


And the result.....

Unblinding: Distribution of events in the TPC

Exposure: 225 days x 34 kg fiducial mass





Fiducial mass region:
34 kg of liquid xenon
406 events in total

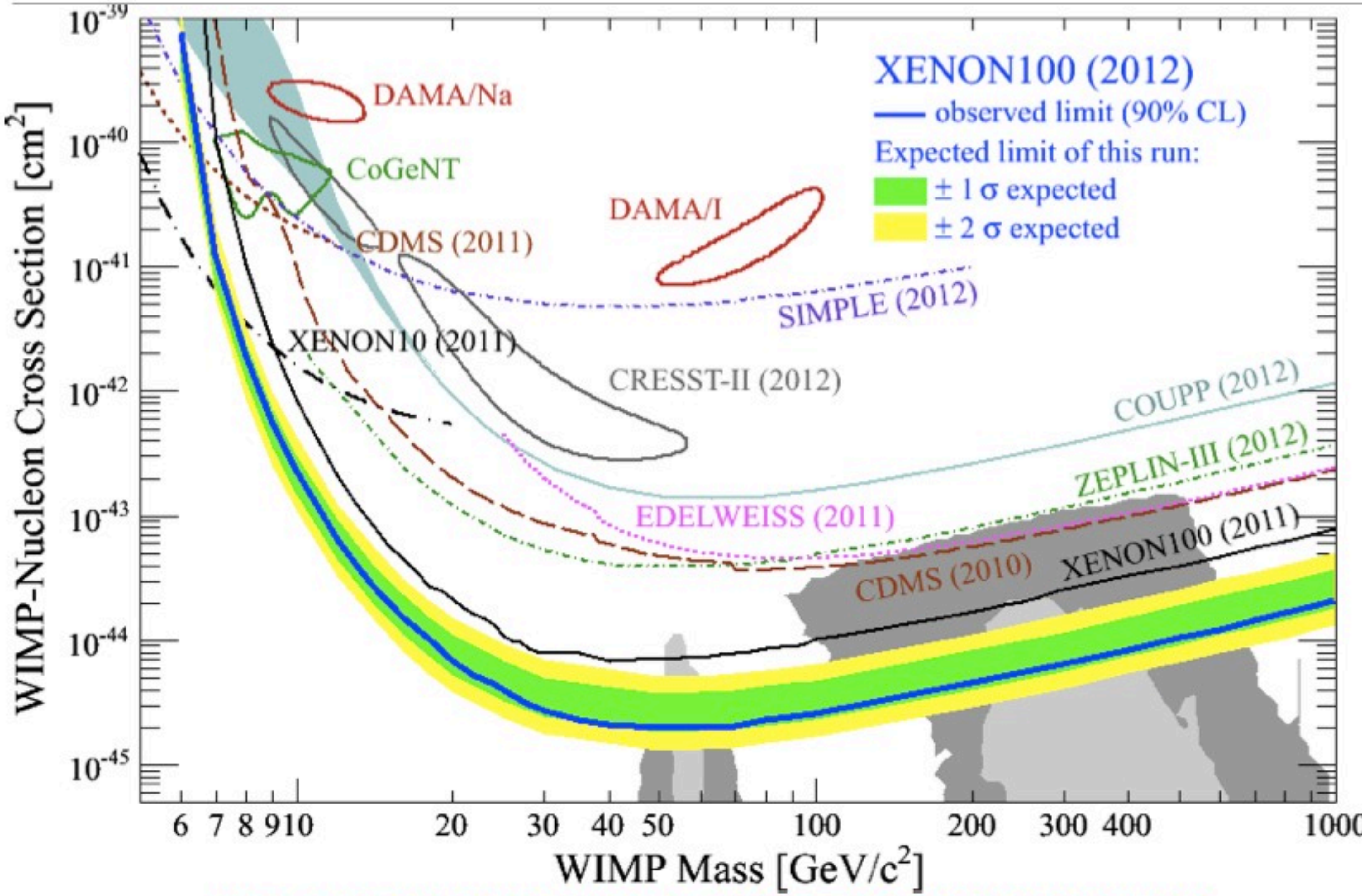
Signal region:
2 events are observed
0.79 ± 0.16 gamma leakage events expected
0.17 +0.12-0.7 neutron events expected

(1.0 ± 0.2) events expected
2 events observed

→ 26.4% probability that background fluctuated to 2 events
→ PL analysis cannot reject the background only hypothesis

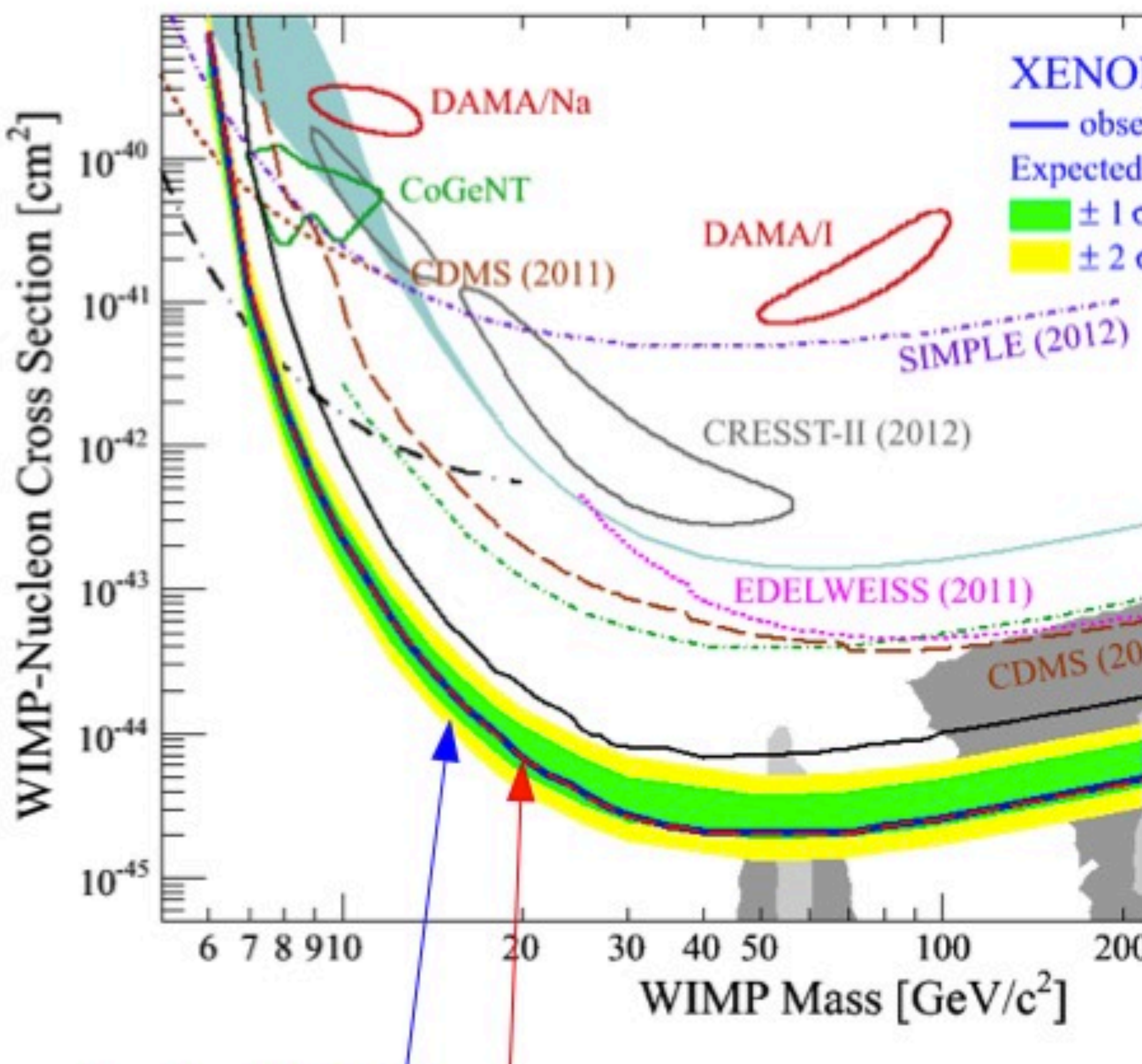
No significant excess due to a signal seen in XENON100 data.

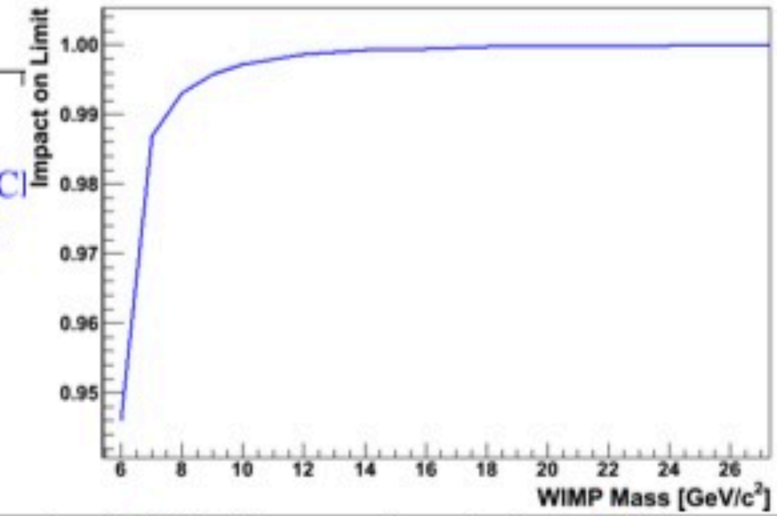
XENON100: New Spin-Independent Results

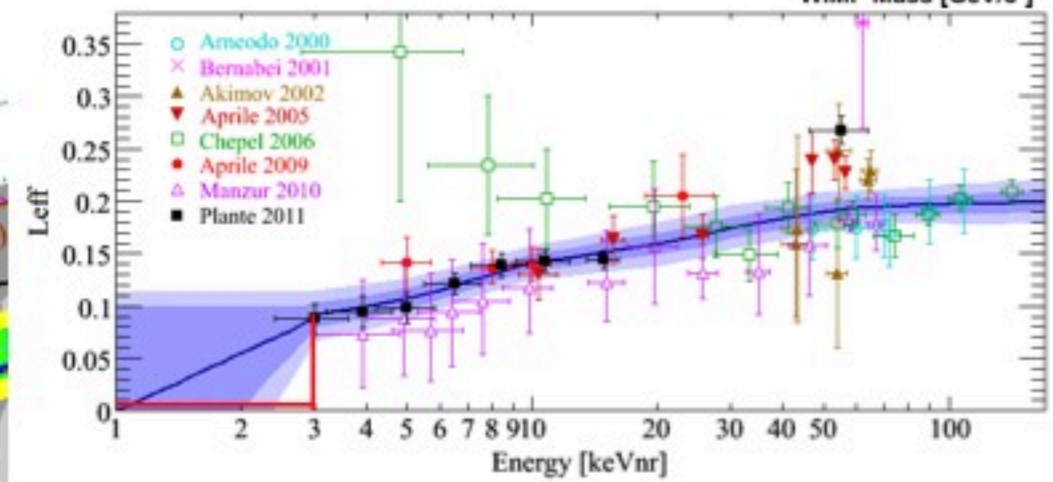


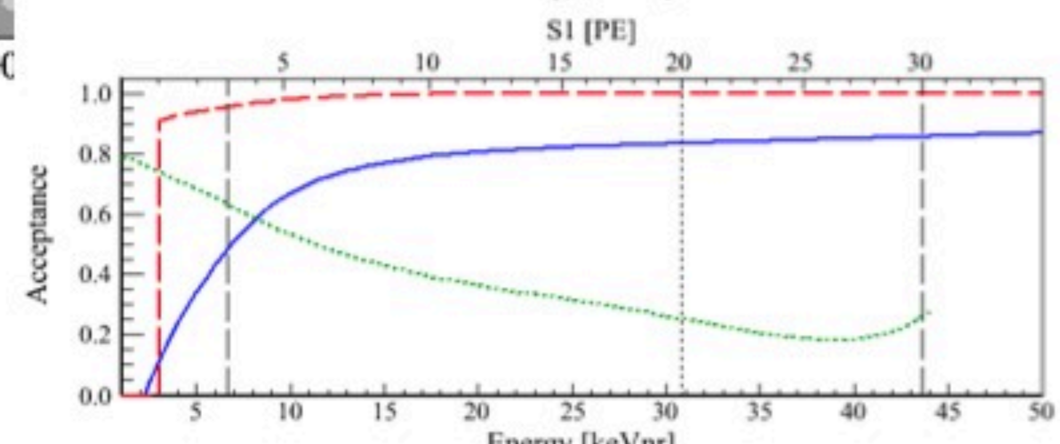
Upper Limit (90% C.L.) is 2×10^{-45} cm^2 for 55 GeV/c^2 WIMP

No Impact of Leff below 3 keVr





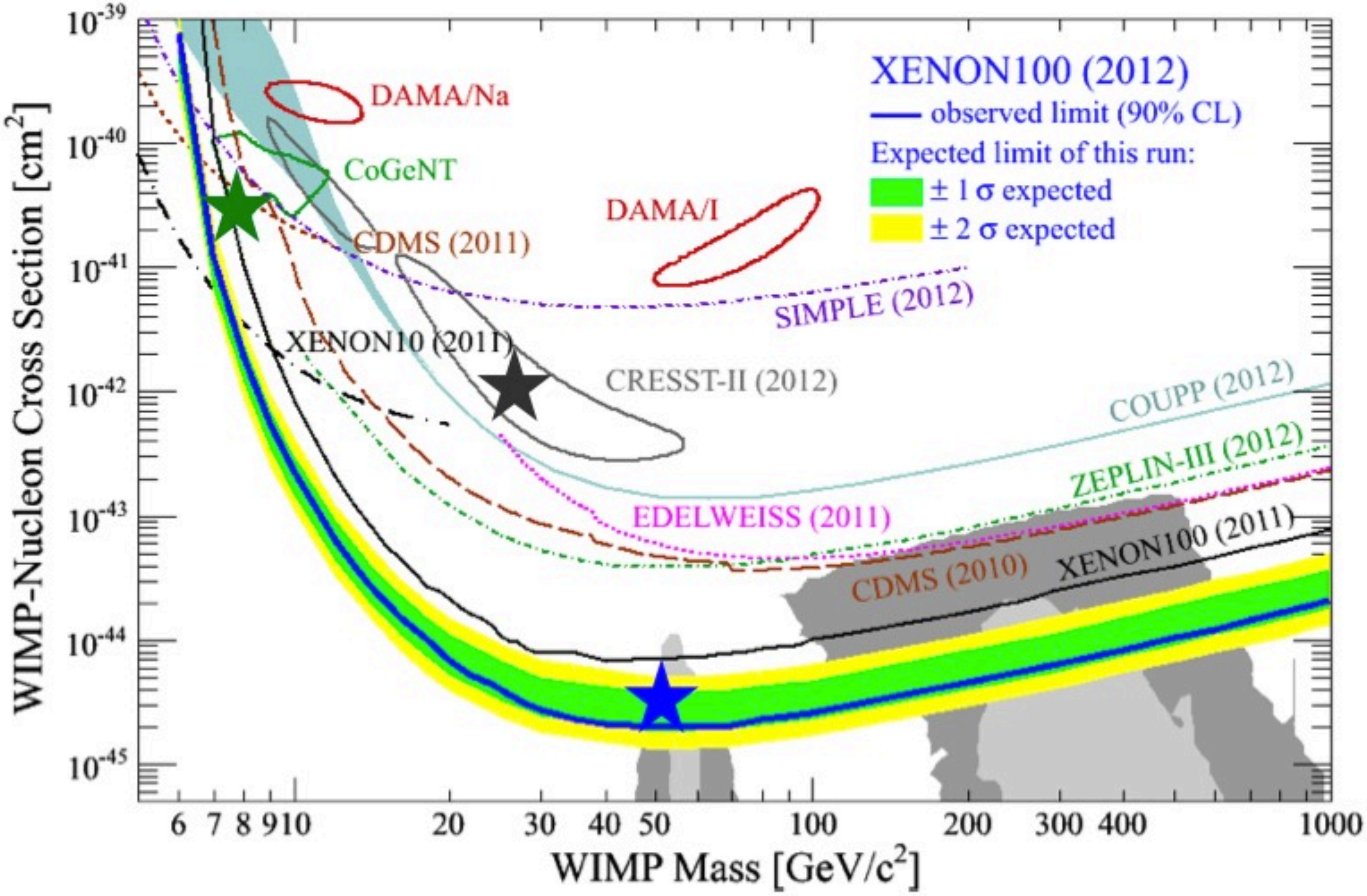




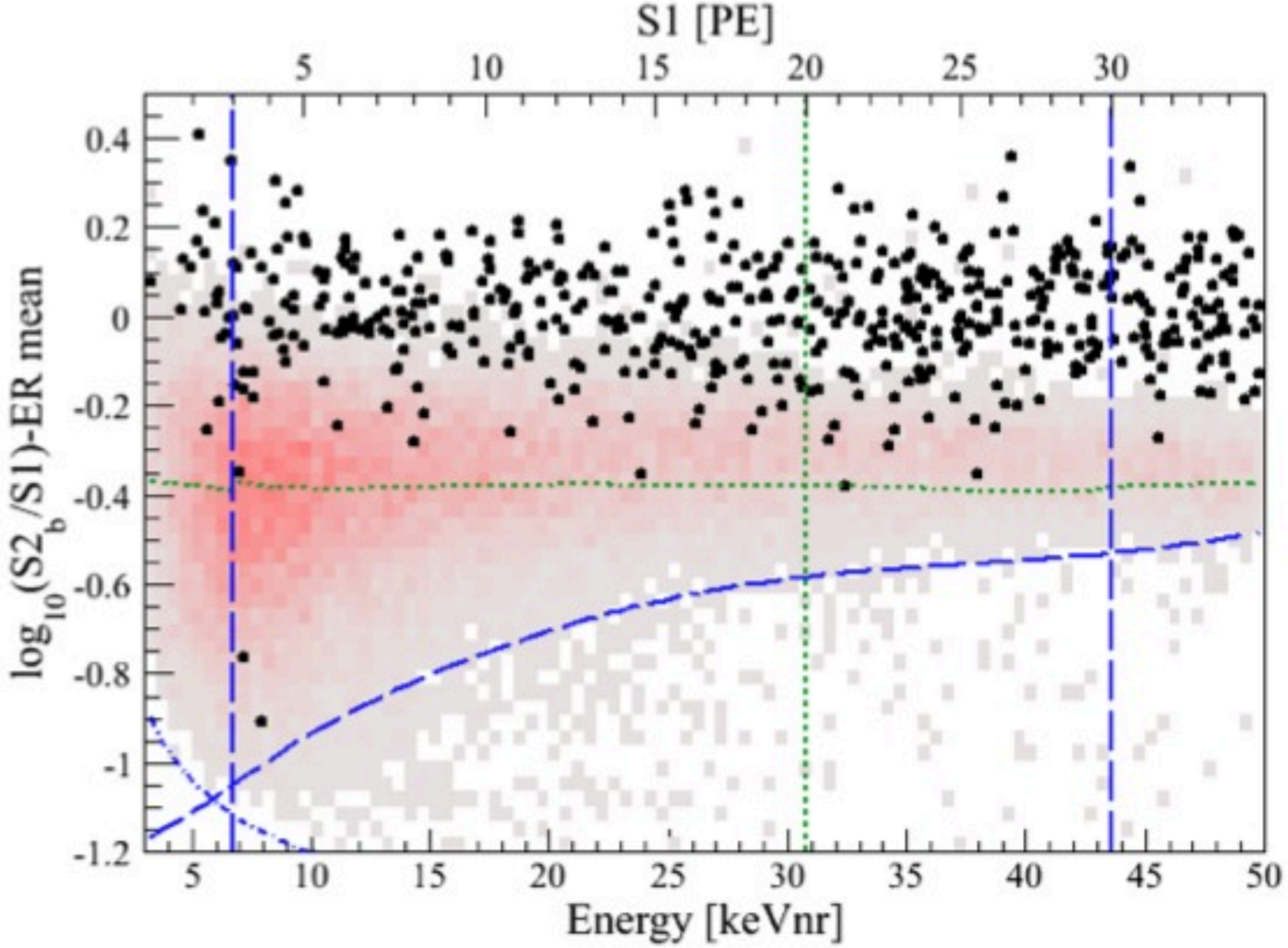
„standard“ Leff

Leff=0 below 3 keVnr

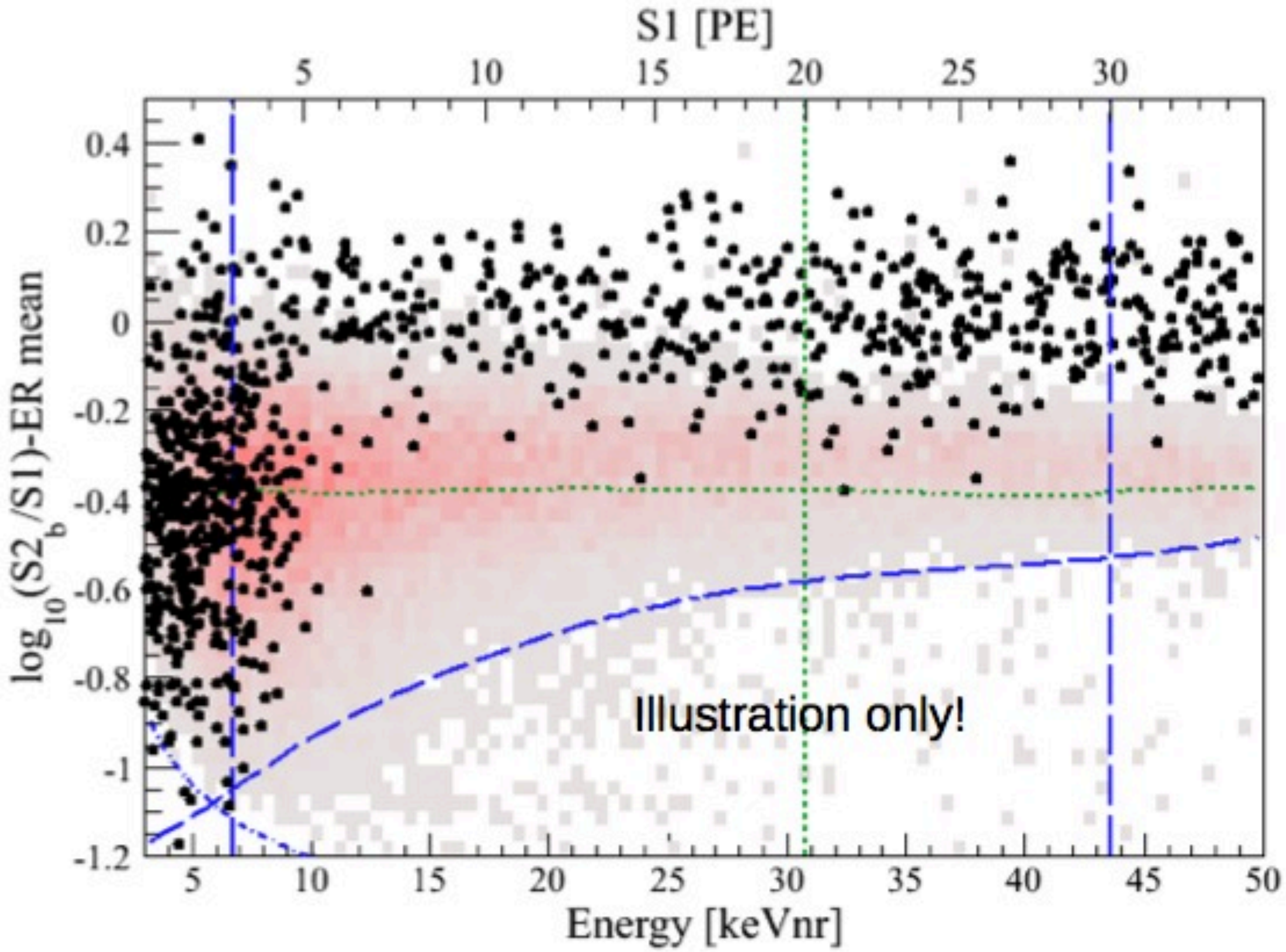
The new XENON100 Limit



What XENON100 sees...

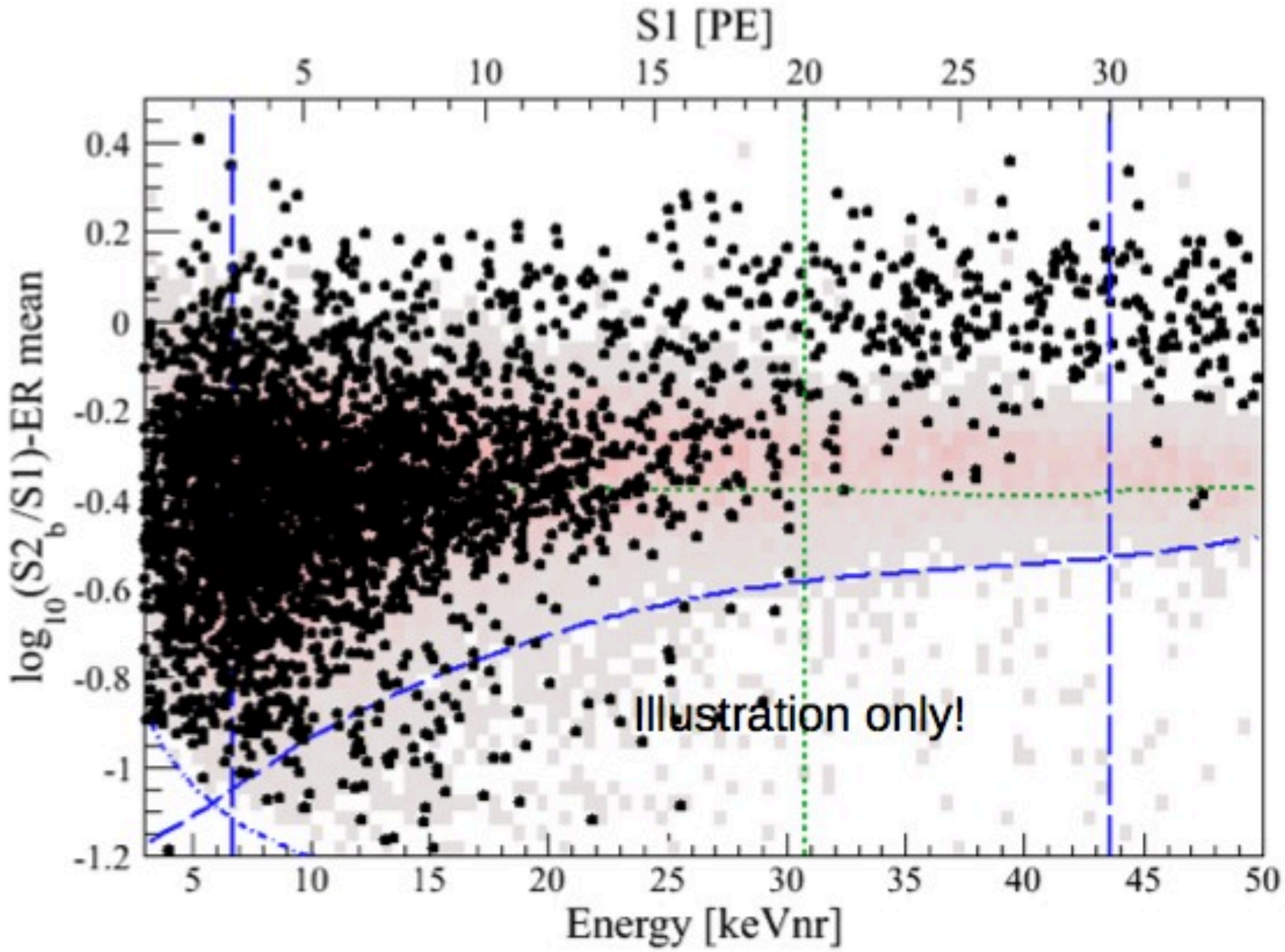


A light mass WIMP...



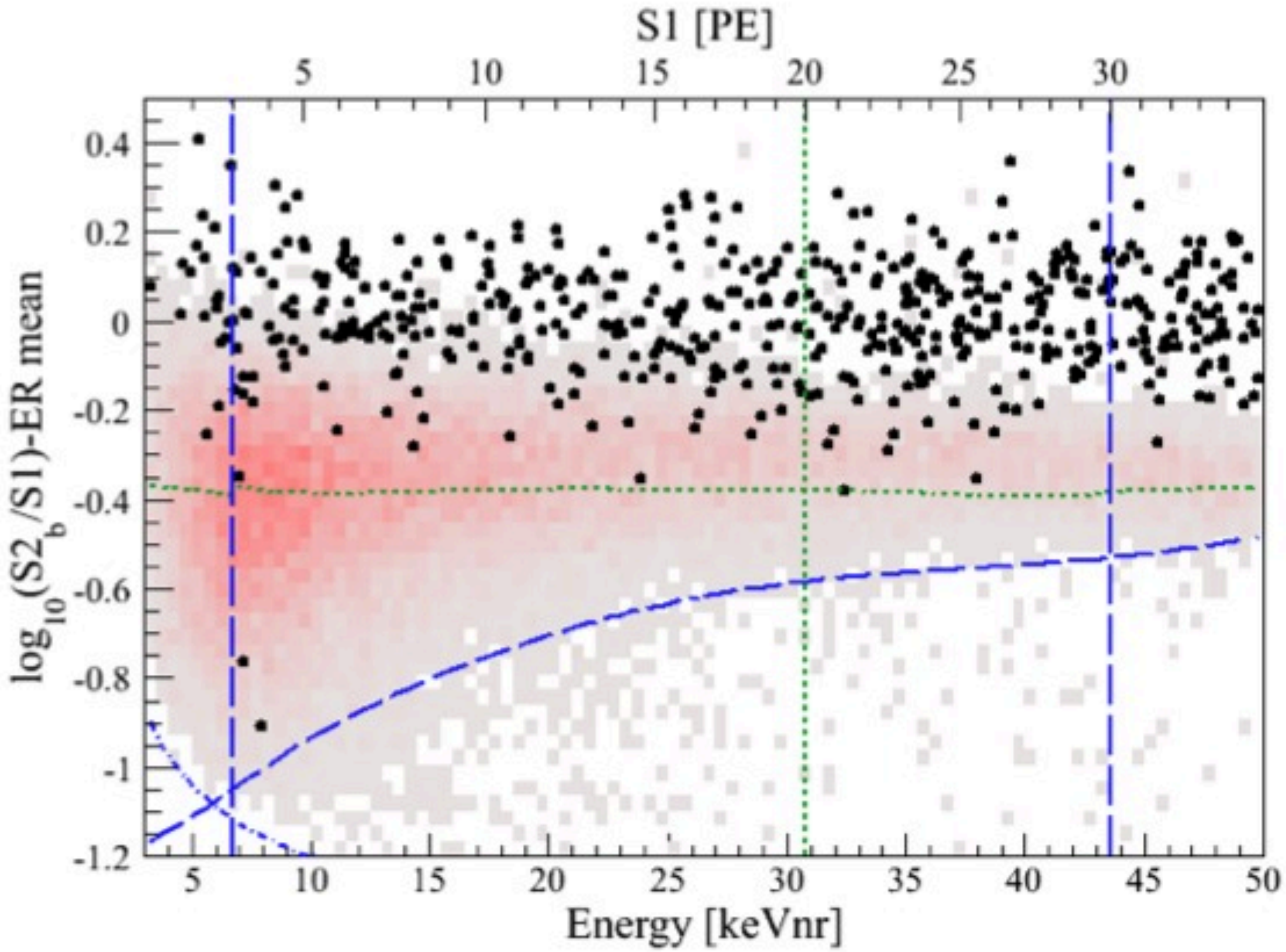
m_χ= 8 GeV/c² σ=1.0x10⁻⁴⁰cm²

A CRESST-like signal...

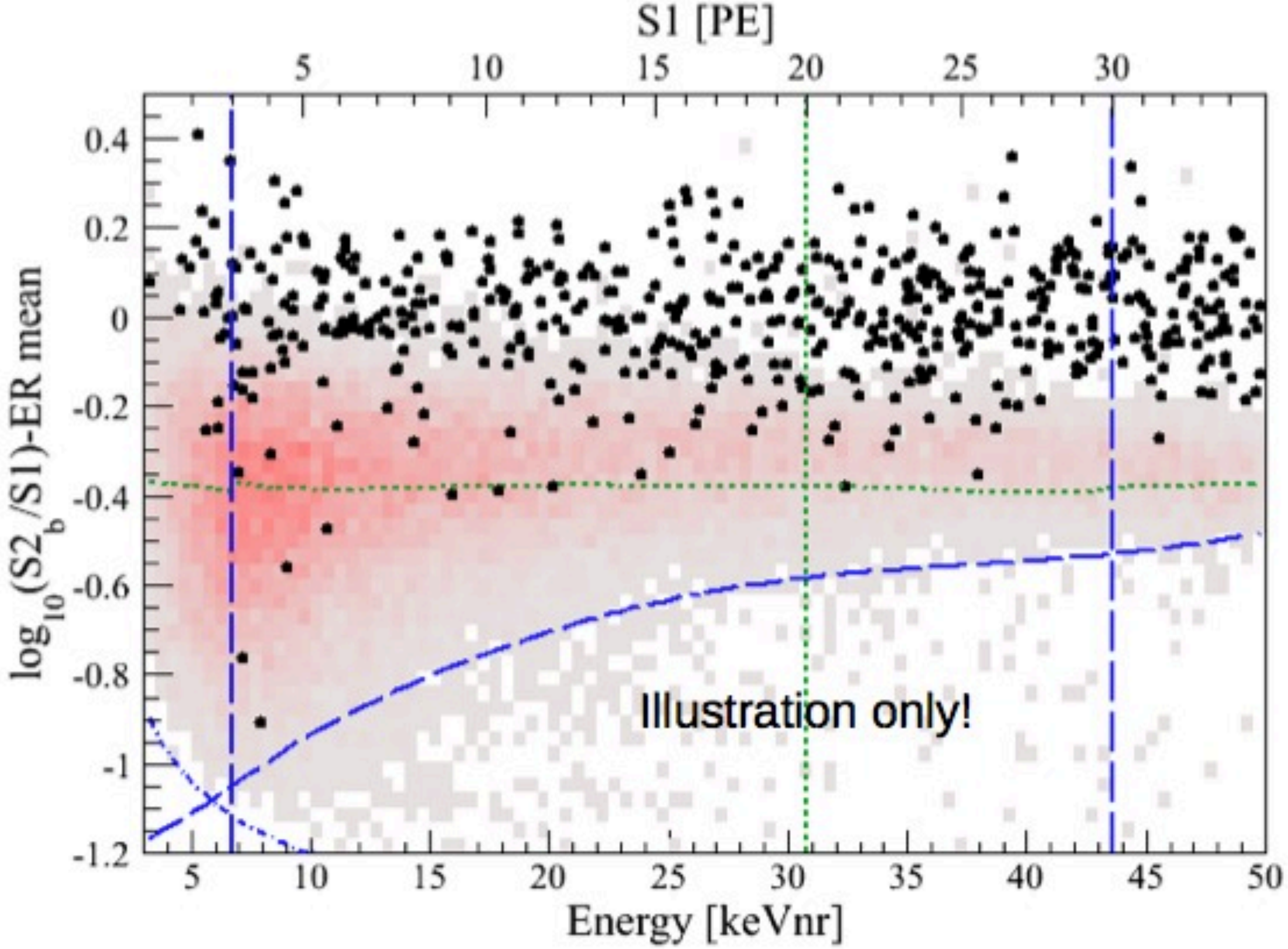


m_χ= 25 GeV/c² σ=1.6 x10^{-40} cm²

What XENON100 sees...

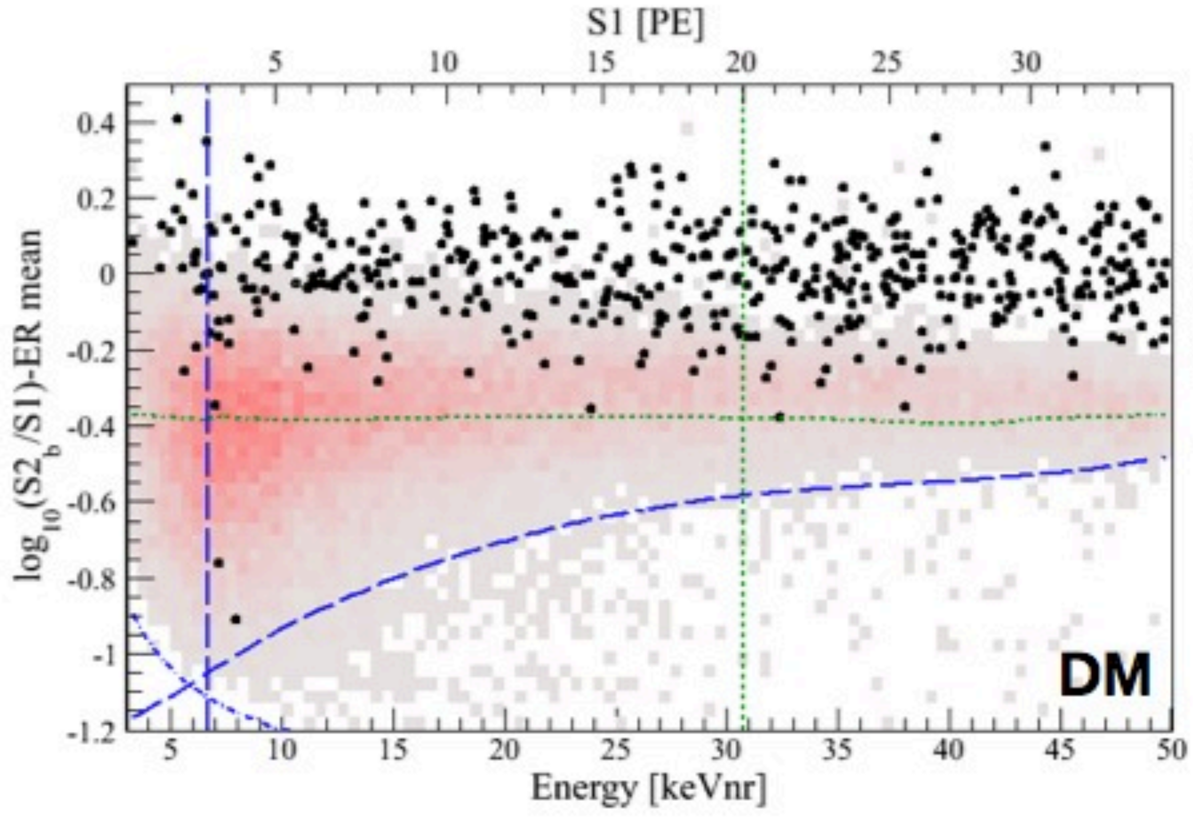


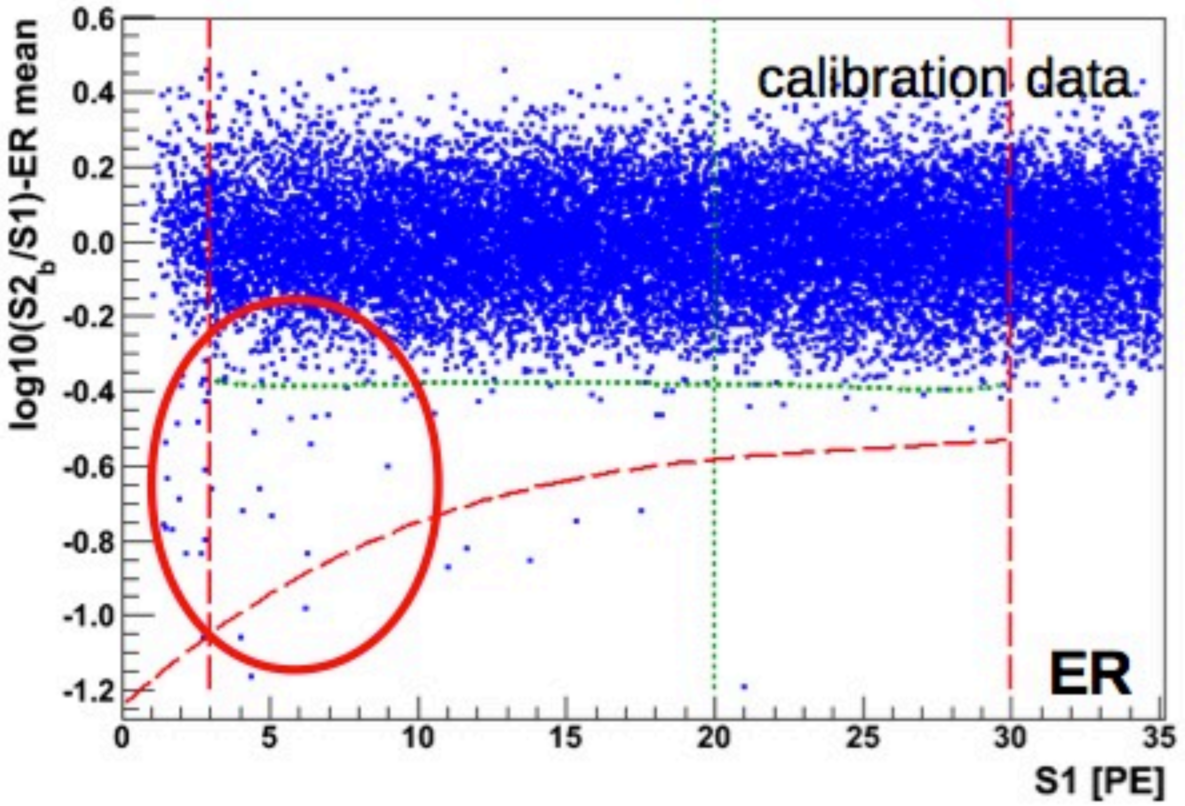
What XENON100 excludes...



m_χ= 50 GeV/c² σ=3.0 x10^{-45} cm²

What could the Events be?

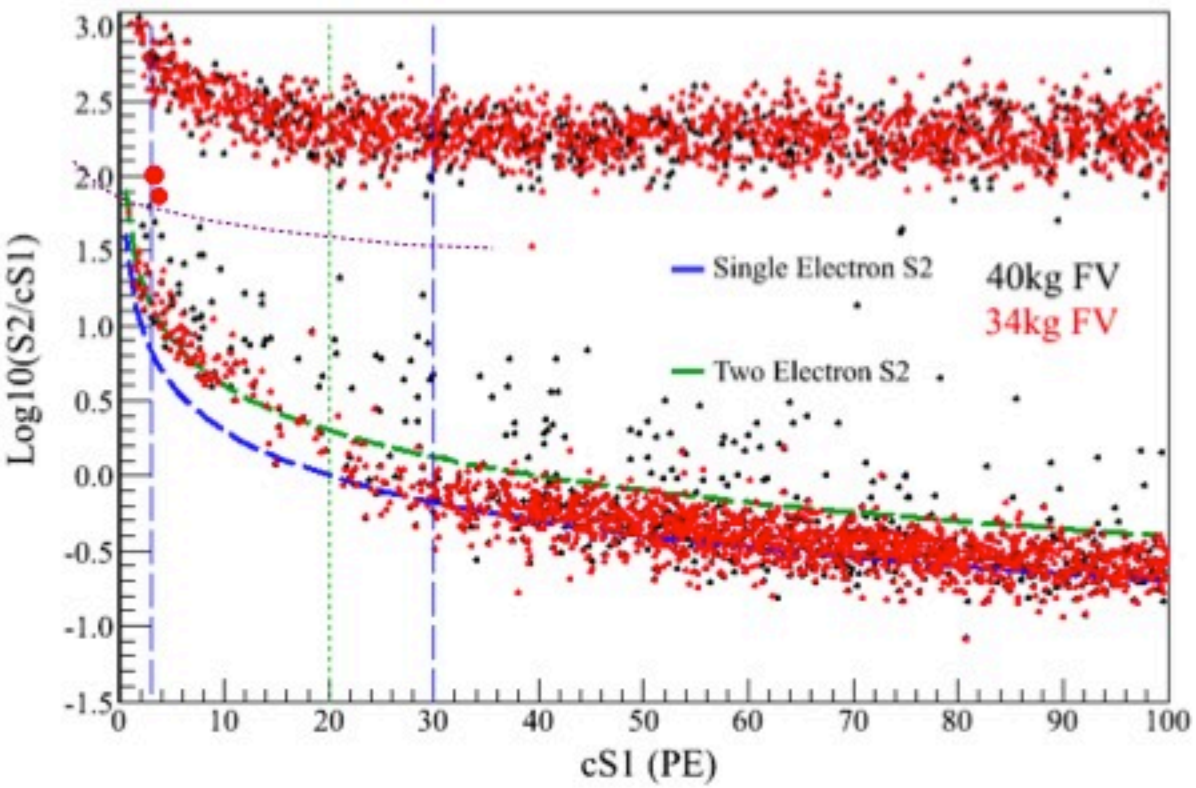


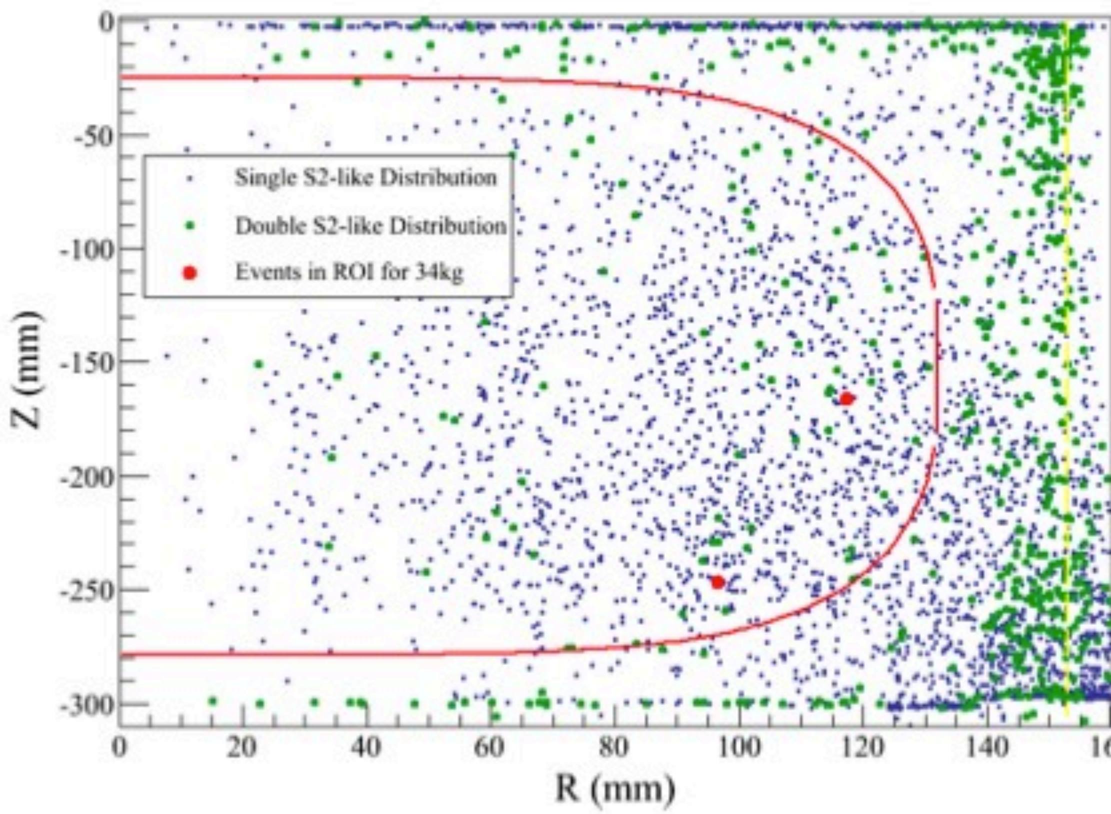


Reminder:
Background is modeled using ER calibration data from Co60 and Th232
This data shows an increased probability for anomalous leakage below ~8 PE

Background prediction depends on the information which is put into the model

Sensitivity to single electrons



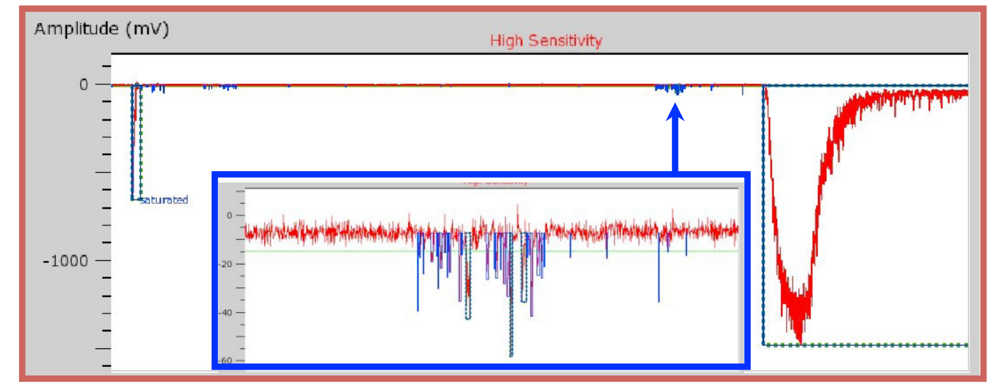


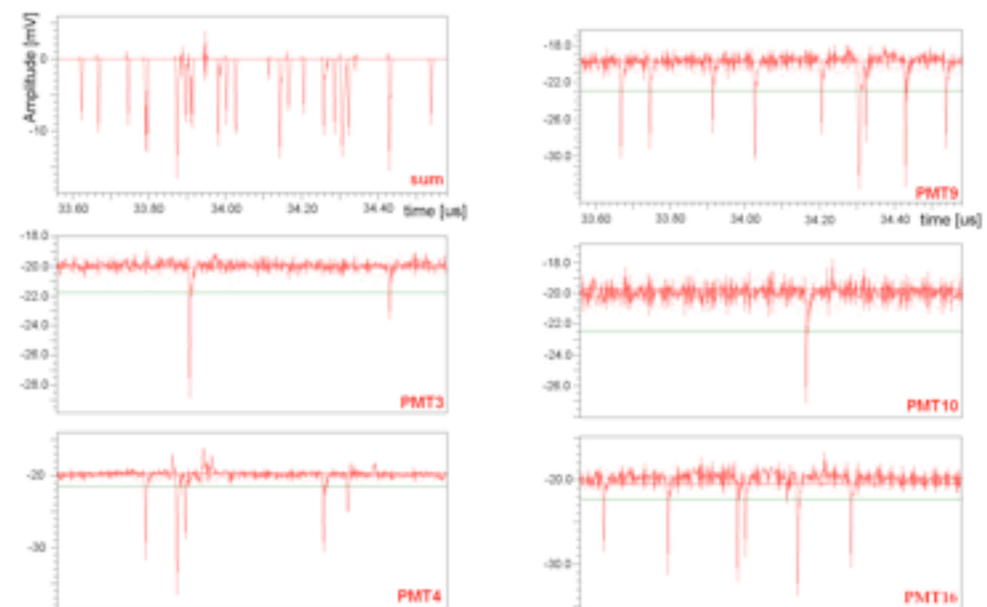
Relaxing the S2 threshold condition (S2>150 PE)
leads to a band of events at very low S2/S1(below signal range)

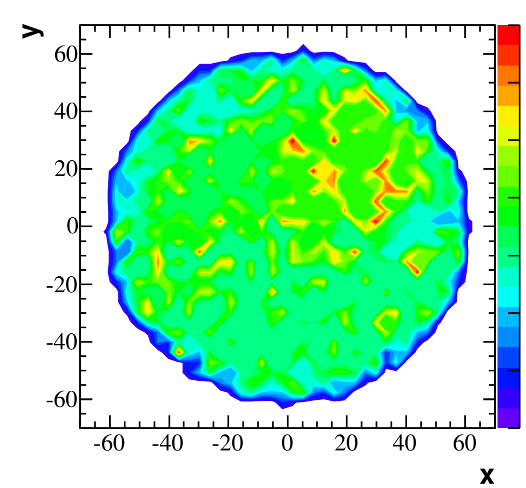
→ can the 2 events be in the tail of this band???
→ further studies are required
→ aim: quantify and put into background model for the next run

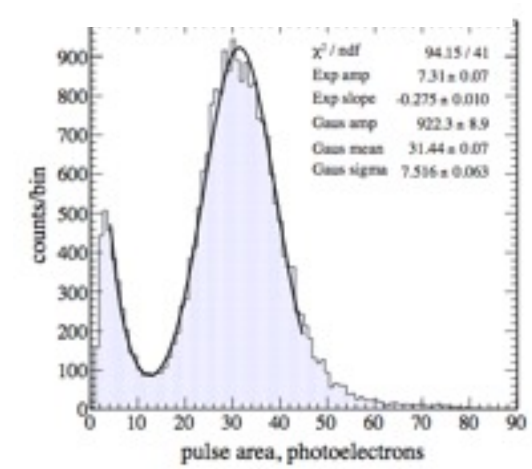
(Further) Exploiting the Ionisation Channel

- Resolution of primary scintillation is dominated by photon generation and photoelectron collection statistics
- Single electron detection demonstrated in LXe TPCs
- In ZEPLIN-III, single electrons detected within 36 μs timeline and with dedicated runs
- Origin:
  - ✤ Photon-induced (post S1): photoionisation and emission from cathode
  - ✤ Spontaneous emission: background related
- Application:
  - ★ Electron lifetime measurement (extremely useful for ton and greater scale detectors)
  - ★ Lower thresholds (~1 keV) and superior resolution
  - ★ **Low mass WIMP searches**
  - ★ **Neutrino physics**

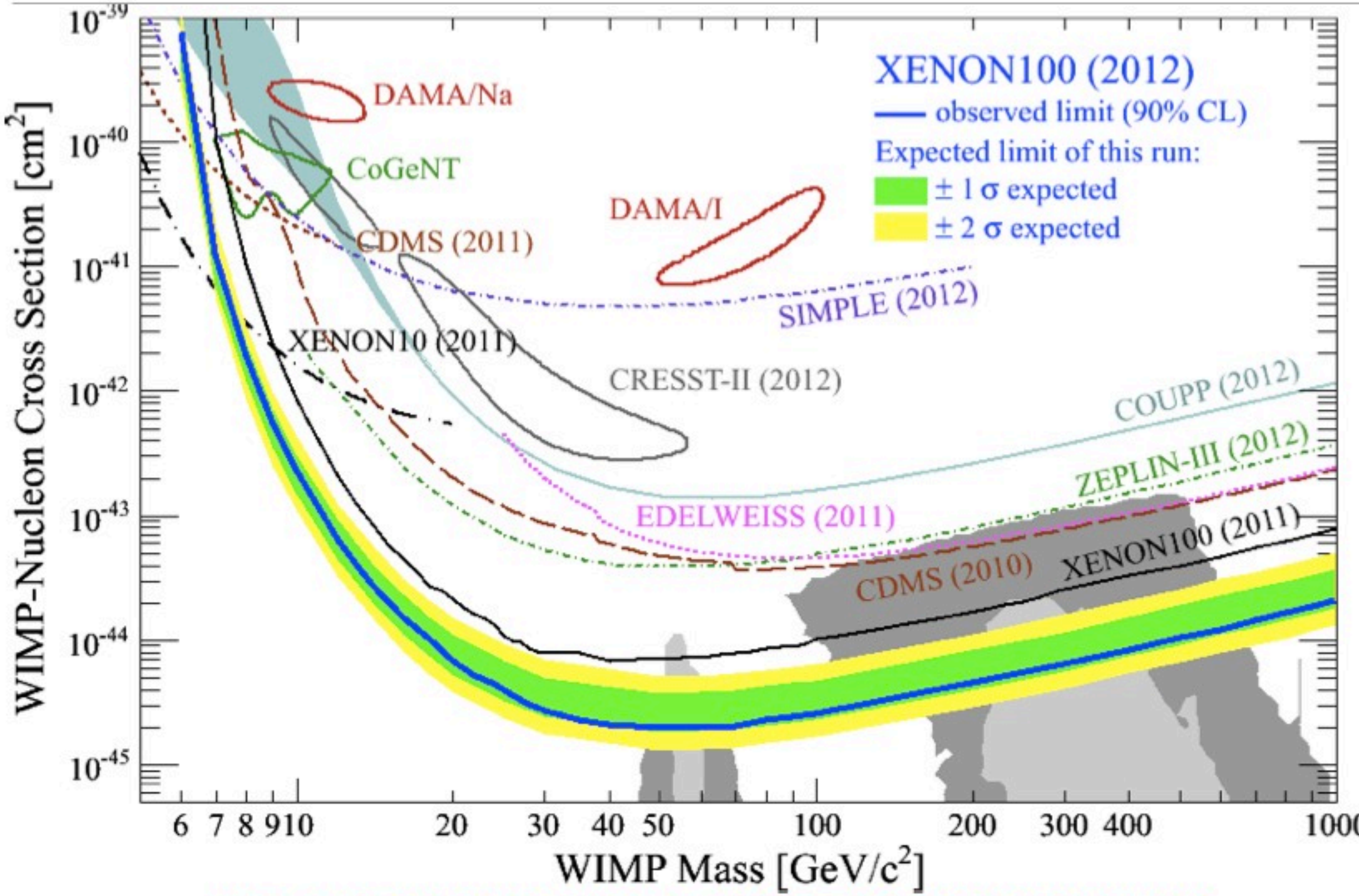




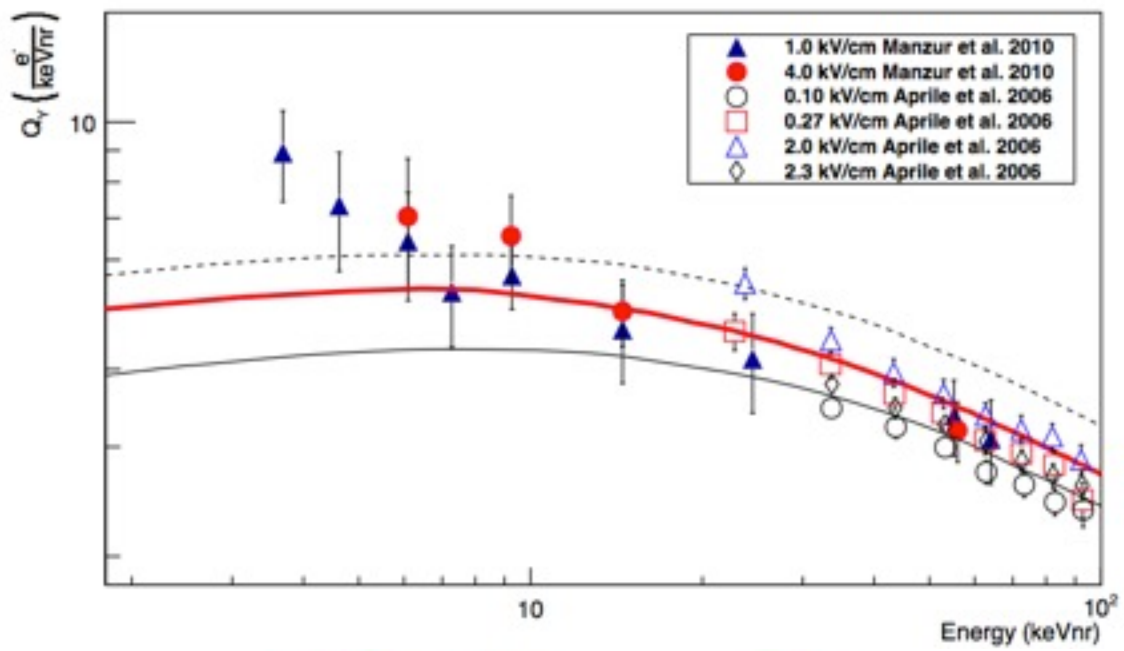


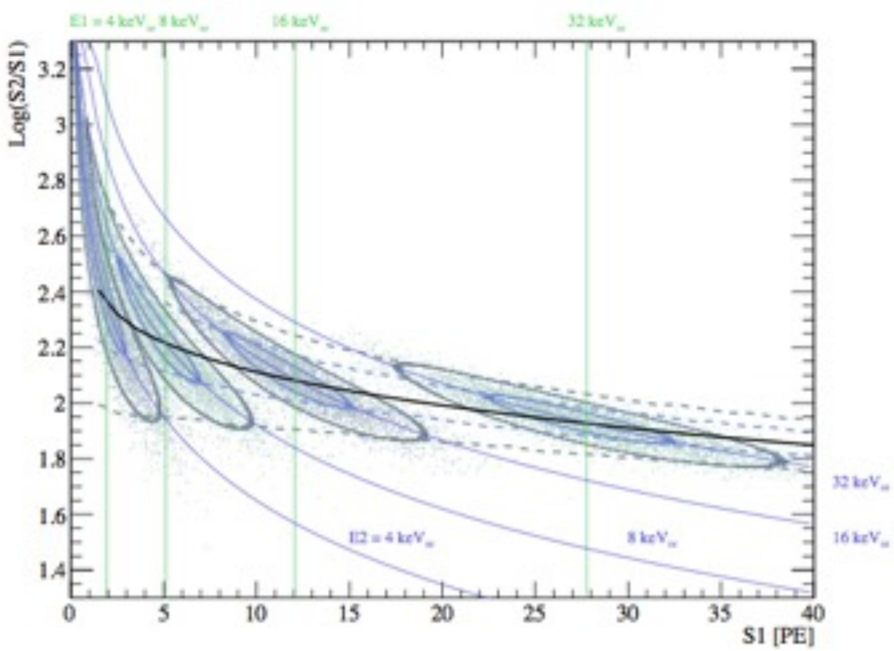


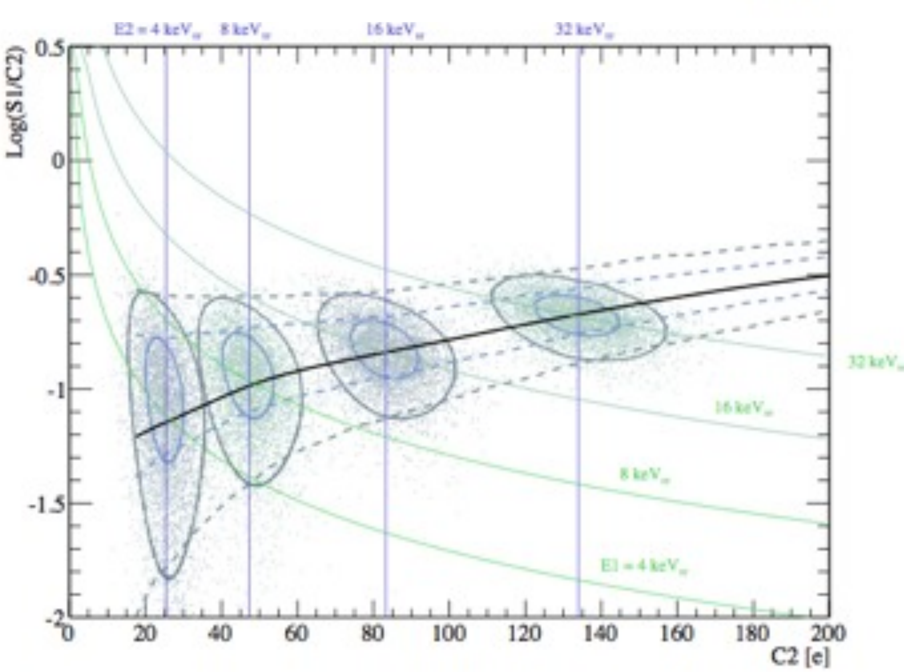
XENON100: New Spin-Independent Results



Upper Limit (90% C.L.) is 2×10^{-45} cm² for 55 GeV/c² WIMP







WIMPs

CNNS

Single electron emission in two-phase xenon with application to the detection of coherent neutrino-nucleus scattering

ZEPLIN–III Collaboration

E. Santos,[1,2] B. Edwards,[3] V. Chepel,[1] H.M. Araújo,[2] D.Yu. Akimov,[4] E.J. Barnes,[5] V.A. Belov,[4] A.A. Burenkov,[4] A. Currie,[2] L. DeViveiros,[1] C. Ghag,[5] A. Hollingsworth,[5] M. Horn,[2] G.E. Kalmus,[3] A.S. Kobyakin,[4] A.G. Kovalenko,[4] V.N. Lebedenko,[2] A. Lindote,[1,3] M.I. Lopes,[1] R. Lüscher,[3] P. Majewski,[3] A.St J. Murphy,[5] F. Neves,[1,2] S.M. Paling,[3] J. Pinto da Cunha,[1] R. Preece,[3] J.J. Quenby,[2] L. Reichhart,[5] P.R. Scovell,[5] C. Silva,[1] V.N. Solovov,[1] N.J.T. Smith,[3] P.F. Smith,[3] V.N. Stekhanov,[4] T.J. Sumner,[2] C. Thorne[2] & R.J. Walker[2]

Journal of High Energy Physics 12 (2011) 115

AXIONS

Expected Sensitivity to Galactic/Solar Axions and Bosonic Super-WIMPs based on the Axio-electric Effect in Liquid Xenon Dark Matter Detectors

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Department of Physics and Astronomy, University of California, Los Angeles, 475 Portola Plaza, Los Angeles, CA 90095, USA

Abstract

We present systematic case studies to investigate the sensitivity of axion searches by liquid xenon detectors, using the axio-electric effect (analogue of the photoelectric effect) on xenon atoms. Liquid xenon is widely considered to be one of the best target media for detection of WIMPs (Weakly Interacting Massive Particles which may form the galactic dark matter) using nuclear recoils. Since these detectors also provide an extremely low radioactivity environment for electron recoils, very weakly-interacting low-mass particles (< 100 keV/c^2), such as the hypothetical axion, could be detected as well – in this case using the axio-electric effect. Future ton-scale liquid Xe detectors will be limited in sensitivity only by irreducible neutrino background (pp-chain solar neutrino and the double beta decay of ^{136}Xe) in the mass range between 1 and 100 keV/c^2. Assuming one ton-year of exposure, galactic axions (as non-relativistic dark matter) could be detected if the axio-electric coupling g_{Ae} is greater than 10^{-14} at 1 keV/c^2 (or 10^{-13} at 100 keV/c^2). Below a few keV/c^2, and independent of the mass, a solar axion search would be sensitive to a coupling $g_{Ae} \sim 10^{-12}$. This limit will set a stringent upper bound on axion mass for the DFSV and KSVZ models for the mass ranges $m_A < 0.1$ eV/c^2 and < 10 eV/c^2, respectively. Vector-boson dark matter could also be detected for a coupling constant $\alpha'/\alpha > 10^{-33}$ (for mass 1 keV/c^2) or $> 10^{-27}$ (for mass 100 keV/c^2).

http://arxiv.org/pdf/1209.3810.pdf

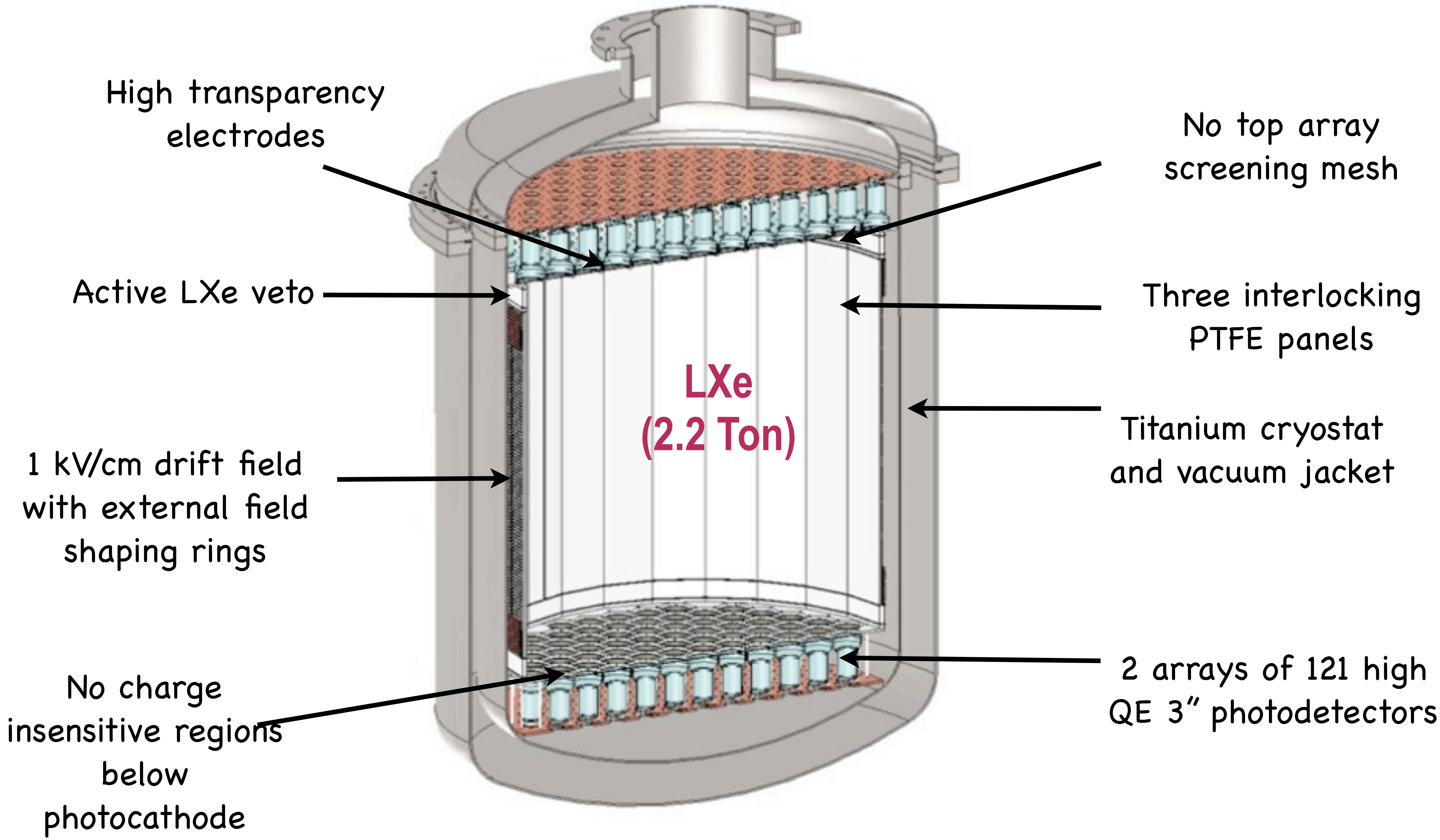
1. Very Brief Intro to Dark Matter and Direct Detection

2. The LXeTPC & XENON100

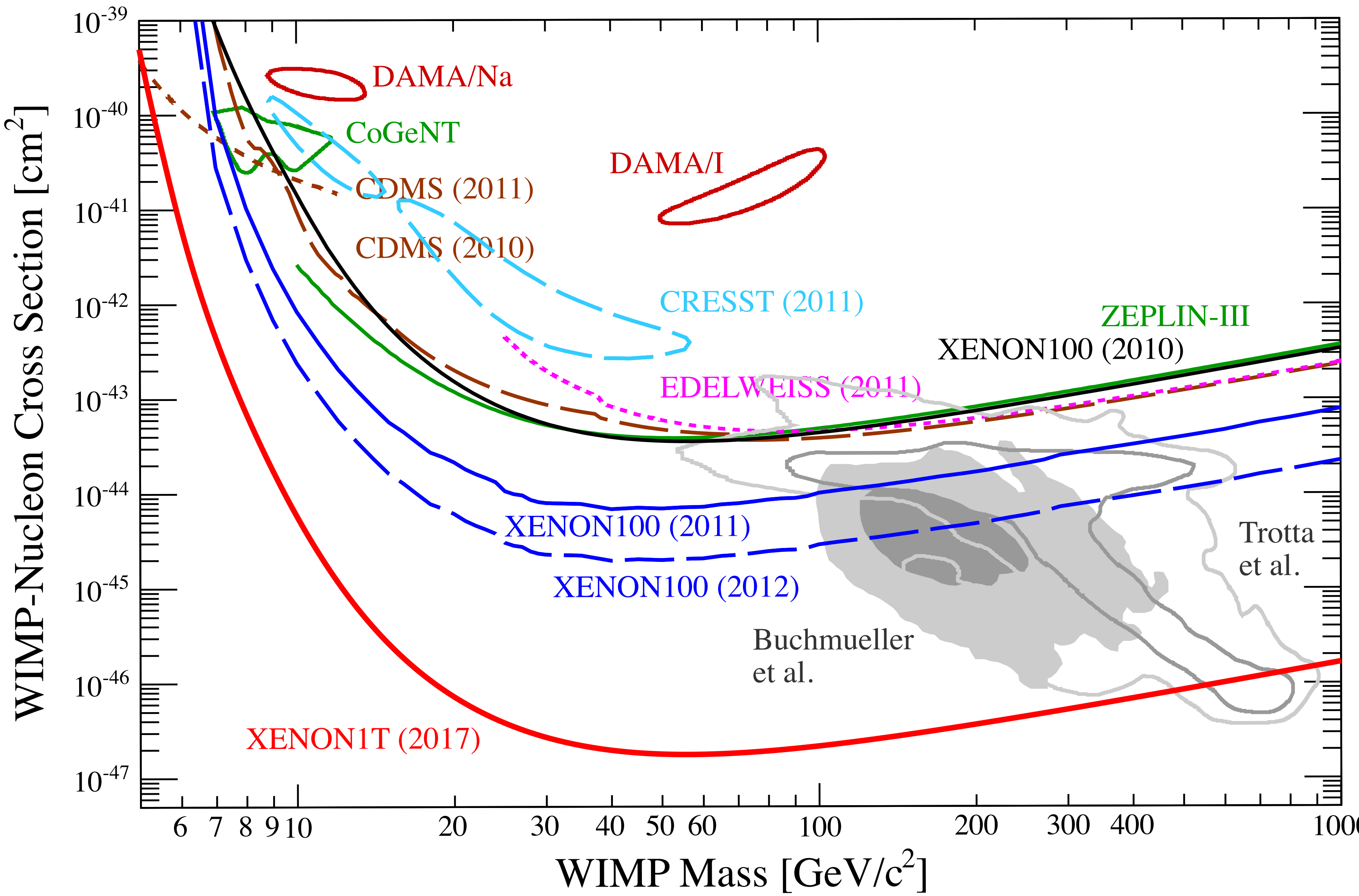
3. Latest Results

4. The Next Generation

The Next Step: XENON1T



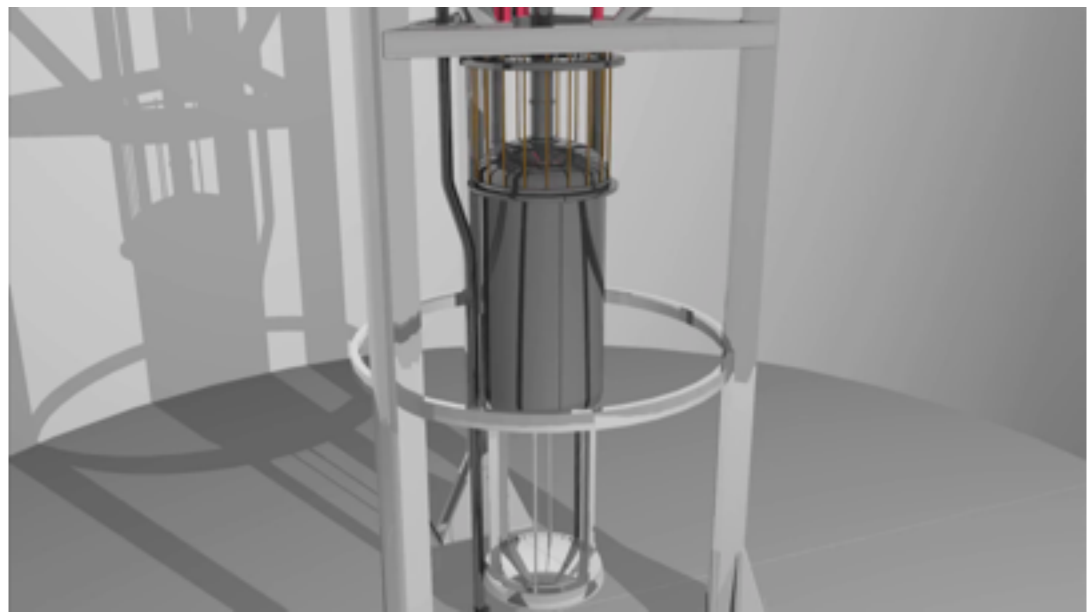
Scaleability has been demonstrated repeatedly - gets easier (no performance loss) as we get bigger!



1 Tonne Fiducial Mass
2 Year Exposure (~2017)

Homestake mine
South Dakota

Davis Cavern (5th May 2011)
4850 ft depth



Dec 2011

World leader in 2013

Sept 5th 2012
Water Shield and lab ready for LUX!

The LUX Collaboration

Brown

Richard Gaitskell	PI, Professor
Simon Fiorucci	Research Associate
Monica Pangilinan	Postdoc
Jeremy Chapman	Graduate Student
Carlos Hernandez Faham	Graduate Student
David Malling	Graduate Student
James Verbus	Graduate Student

Case Western

Thomas Shutt	PI, Professor
Dan Akerib	PI, Professor
Mike Dragowsky	Research Associate Professor
Tom Coffey	Research Associate
Carmen Carmona	Postdoc
Karen Gibson	Postdoc
Adam Bradley	Graduate Student
Patrick Phelps	Graduate Student
Chang Lee	Graduate Student
Kati Pech	Graduate Student
Tim Ivancic	Graduate Student

University of Rochester

Frank Wolfs	PI, Professor
Wojtek Skutski	Senior Scientist
Eryk Druszkiewicz	Graduate Student
Mongkol Moongweluwan	Graduate Student

Lawrence Livermore

Adam Bernstein	PI, Leader of Adv. Detectors Group
Dennis Carr	Mechanical Technician
Kareem Kazkaz	Staff Physicist
Peter Sorensen	Staff Physicist
John Bower	Engineer

SD School of Mines

Xinhua Bai	PI, Professor

University of South Dakota

Dongming Mei	PI, Professor
Chao Zhang	Postdoc
Dana Byram	Graduate Student
Chris Chiller	Graduate Student
Angela Chiller	Graduate Student

University of Maryland

Carter Hall	PI, Professor
Attila Dobi	Graduate Student
Richard Knoche	Graduate Student

Texas A&M

James White	PI, Professor
Robert Webb	Professor
Rachel Mannino	Graduate Student
Clement Sofka	Graduate Student

UC Davis

Mani Tripathi	PI, Professor
Robert Svoboda	Professor
Richard Lander	Professor
Britt Hollbrook	Senior Engineer
John Thomson	Senior Machinist
Matthew Szydagis	Postdoc
Richard Ott	Postdoc
Jeremy Mock	Graduate Student
James Morad	Graduate Student
Nick Walsh	Graduate Student
Michael Woods	Graduate Student
Sergey Uvarov	Graduate Student

Lawrence Berkeley + UC Berkeley

Bob Jacobsen	PI, Professor
David Taylor	Engineer
Mia ihm	Graduate Student

Yale

Daniel McKinsey	PI, Professor
Peter Parker	Professor
James Nikkel	Research Scientist
Sidney Cahn	Lecturer/Research Scientist
Alexey Lyashenko	Postdoc
Ethan Bernard	Postdoc
Markus Horn	Postdoc
Blair Edwards	Postdoc
Nicole Larsen	Graduate Student
Evan Pease	Graduate Student
Brian Tennyson	Graduate Student

UC Santa Barbara

Harry Nelson	PI, Professor
Mike Witherell	Professor
Dean White	Engineer
Susanne Kyre	Engineer

Imperial College London

Henrique Araujo	PI, Senior Lecturer
Tim Sumner	Professor
Alastair Currie	Postdoc

University of Edinburgh

Alex Murphy	PI, Reader
Lea Reichhart	Graduate student

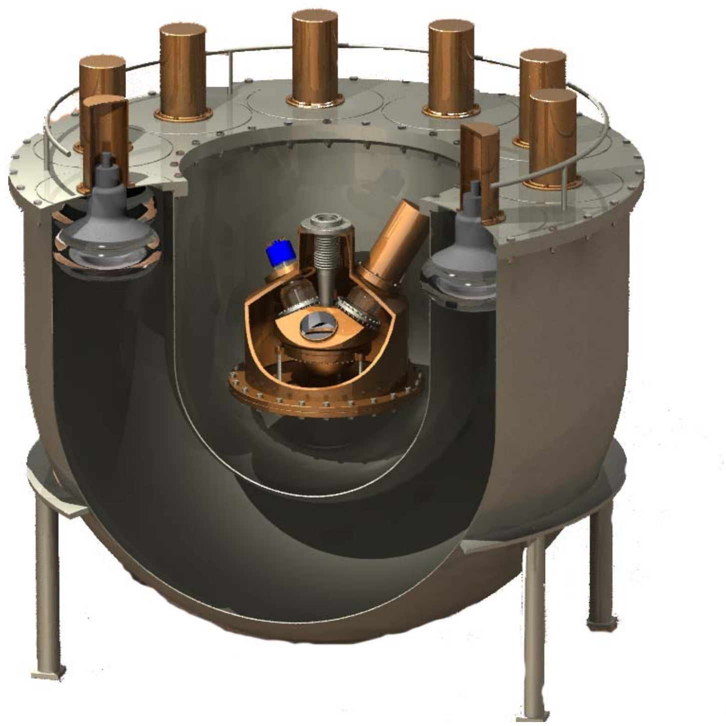
University College London

Chamkaur Ghag	PI, Lecturer

LIP Coimbra

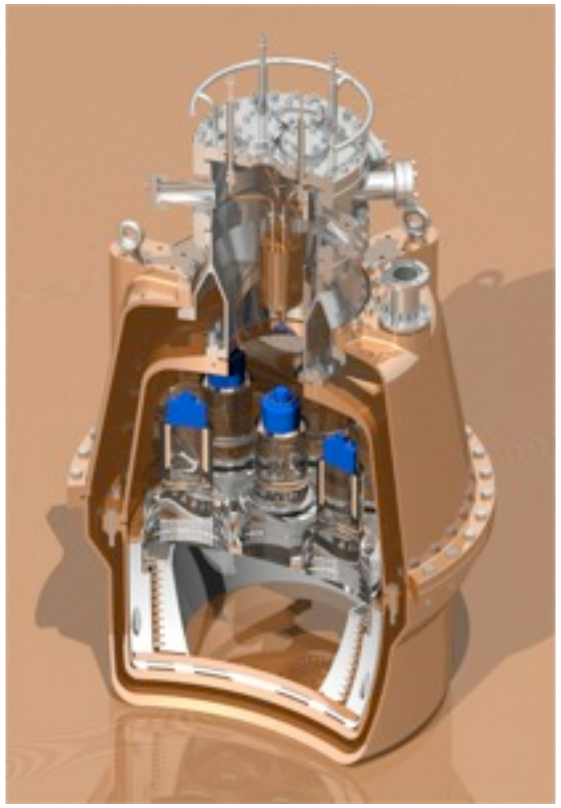
Isabel Lopes	PI, Professor
Jose Pinto da Cunha	Assistant Professor
Vladimir Solovov	Senior Researcher
Luiz de Viveiros	Postdoc
Alexander Lindote	Postdoc
Francisco Neves	Postdoc
Claudio Silva	Postdoc

The ZEPLIN Programme at Boulby



ZEPLIN I
Single phase, 3 PMTs, 5/3.1 kg
Run 2001-04
Limit: $1.1*10^{-6}$ pb

Single-phase



ZEPLIN II
Double phase, 7 PMTs,
moderate E field, 31/7.2 kg
Run 2005-06
Limit: $6.6*10^{-7}$ pb

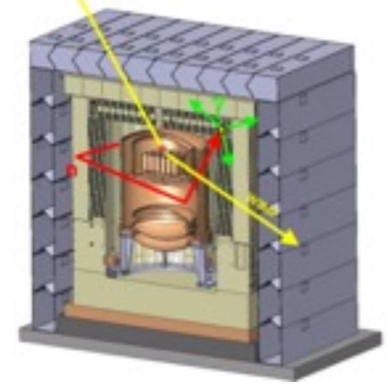
The first 2-phase LXe Dark Matter detector!

ZEPLIN III
Double phase, 31 PMTs,
high E field, 10/6.4 kg
Run 2009-11
Limit: $3.9*10^{-8}$ pb

Europe's most sensitive SI
World's best WIMP-neutron SD

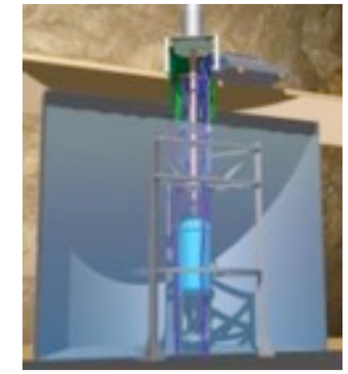
LUX-ZEPLIN (LZ)

ZEPLIN-III



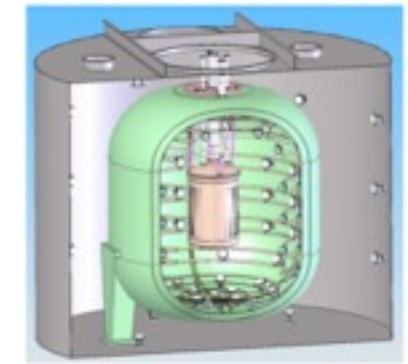
6 kg LXe (fid)

LUX350



100 kg

LZ



5,000 kg

Next-generation LXe experiment building on LUX and ZEPLIN programmes

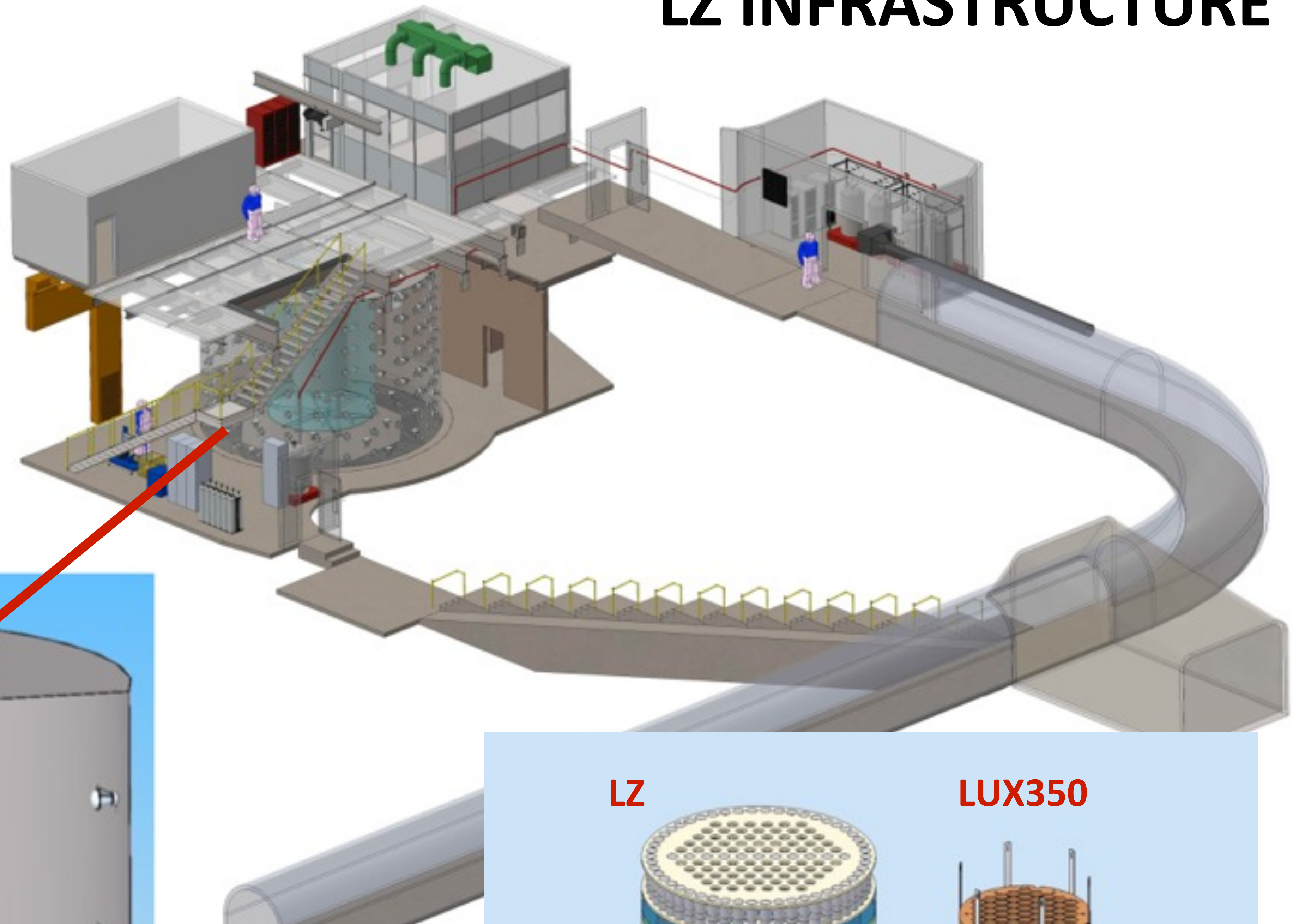
- **Route to detection & study: a <u>progressive</u> programme**
  - UK-led **ZEPLIN** programme pioneered liquid xenon for WIMP searches
  - **LUX** (now with UK) about to turn on – expect leading sensitivity in 2013
  - **LZ** could discover at 10^{-11} pb or exclude at 10^{-12} pb with 3 year run
- **Experimental approach: a <u>low risk</u> and <u>aggressive</u> programme**
  - Background free strategy (self-shielding, modest discrimination assumed)
  - Two-phase Xe technology: high readiness level (ZEPLIN, XENON, LUX)
  - Teams with huge track record in DM searches
  - Much infrastructure inherited from LUX350
- **LXe provides exciting physics for light & heavy WIMPs (GeV-TeV)**
  - Since we do not yet know what BSM physics looks like!

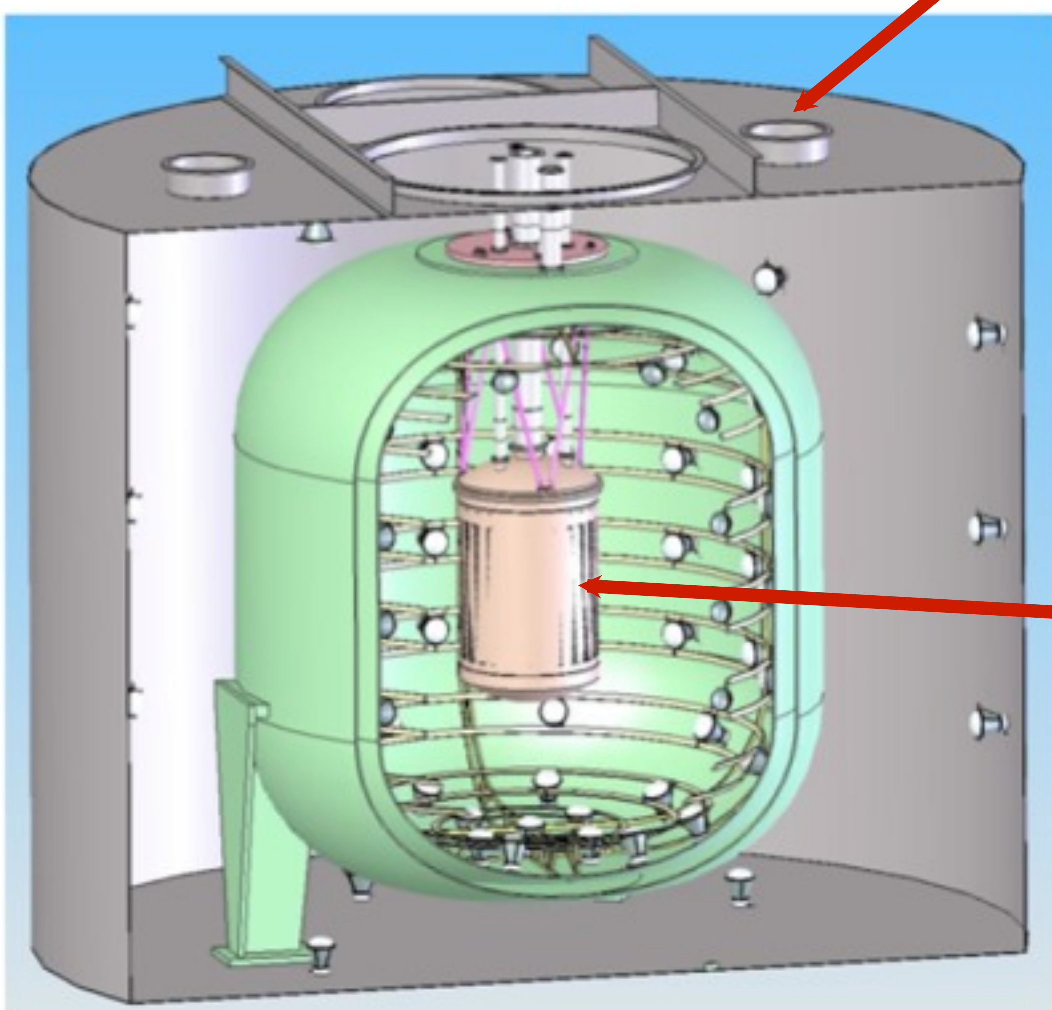
SANFORD LAB, DAVIS COMPLEX (4850-ft)
LZ INFRASTRUCTURE

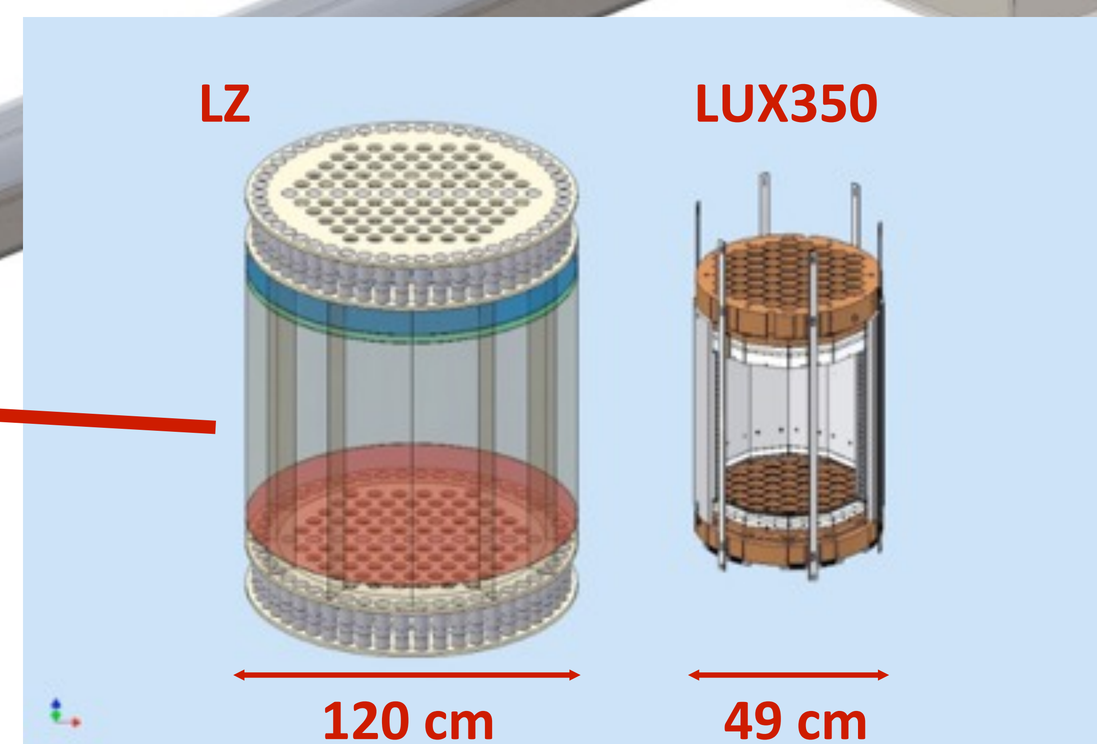
7 tonne LXe TPC
to fit LUX water tank

Modest increase in linear
scale factor from LUX (low risk)

But huge increase in sensitivity







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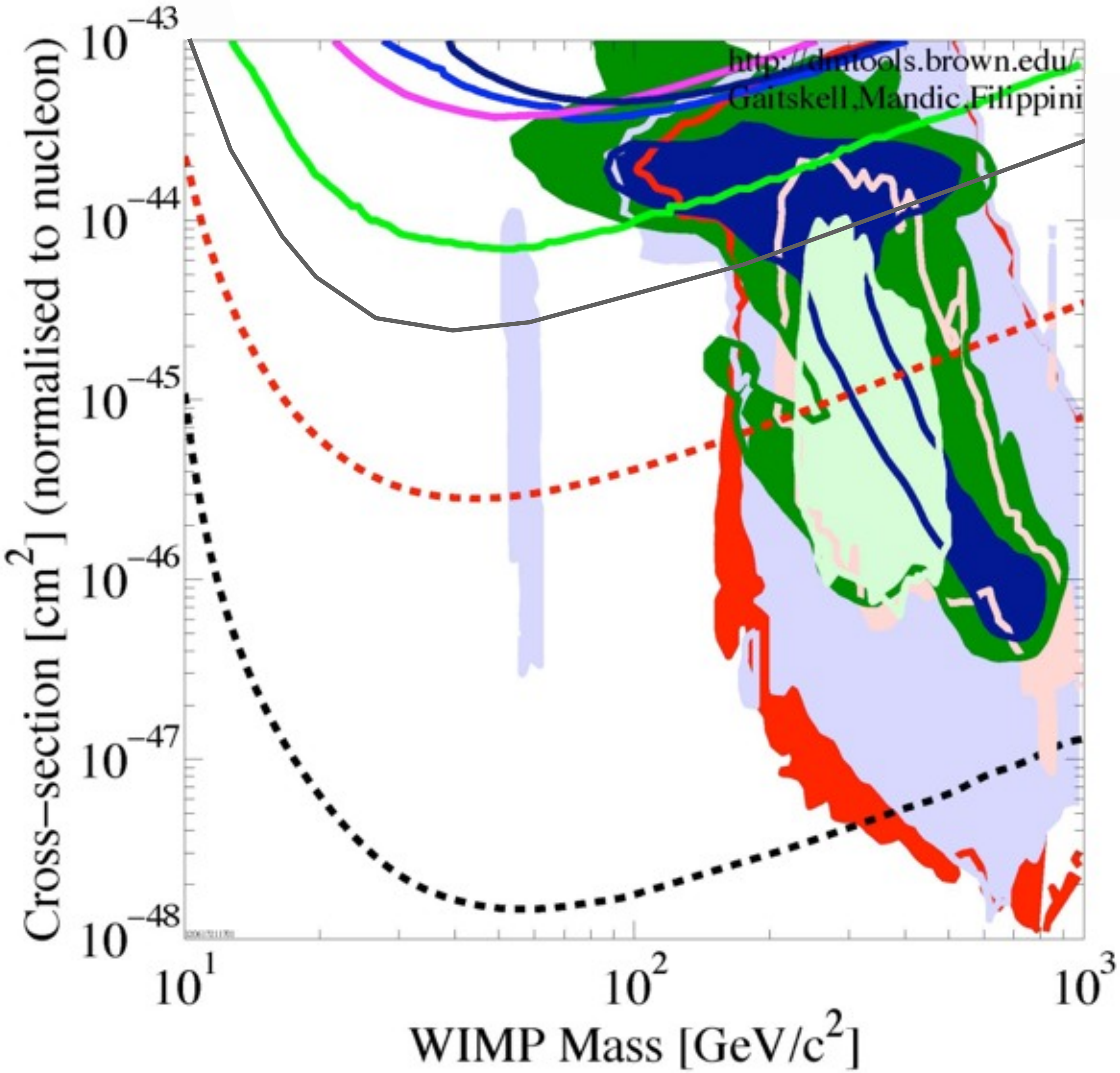


Elastic scattering SI cross-section

Results

ZEPLIN-III 2011 (magenta)

XENON100 2011 (green)

XENON100 2012 (grey)

EDELWEISS II 2011 (dark blue)

CDMS-II 2010 (blue)

Projections

LUX (red dash)

100 kg fiducial x 300 live days

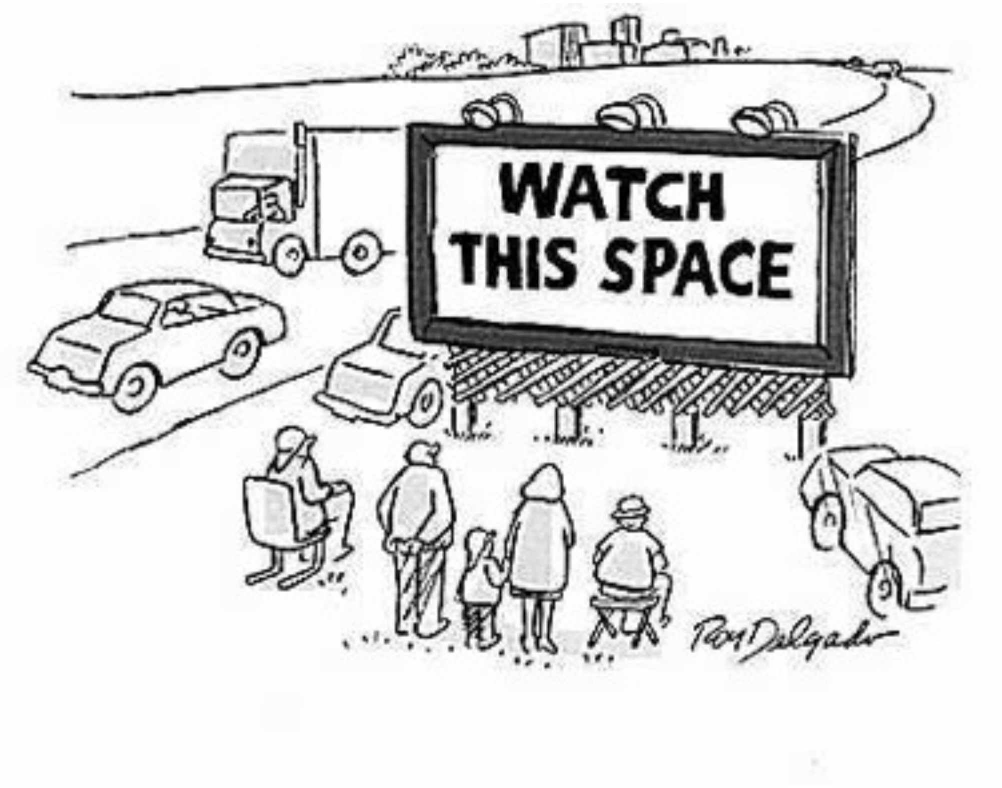
LUX-ZEPLIN (black dash)

5-tonne fiducial x 1,000 live days

LZ Collaboration (UK/ZEPLIN)

- **Imperial College London (ZEPLIN-III, LUX, LZ)**
  - H. Araujo (A), T. Sumner (A), A. Currie (PDRA)
- **Rutherford Appleton Laboratory (ZEPLIN-III, LZ)**
  - P. Majewski
- **Edinburgh University (ZEPLIN-III, LUX, LZ)**
  - A. Murphy (A), J. Dobson (PDRA), L. Reichhart (PG)
- **University College London (LUX, LZ)**
  - C. Ghag (A), J. Dobson (PDRA)
- **Daresbury Laboratory (LZ)**
  - J. Simpson (A)
- **LIP-Coimbra (ZEPLIN-III, LUX, LZ)**
  - M.I. Lopes (A), J. Pinto da Cunha (A), V. Solovov (RF), L. de Viveiros (RA), A. Lindote (RA), F. Neves (RA), C. Silva (RA)
- **ITEP-Moscow (ZEPLIN-III, RED-100, LZ)**
  - D. Akimov (A), V. Belov, A. Burenkov, A. Kobyakin, A. Kovalenko, V. Stekhanov

Exciting times ahead....



Thank you all for listening!