

XMASS Results on WIMP Dark Matter

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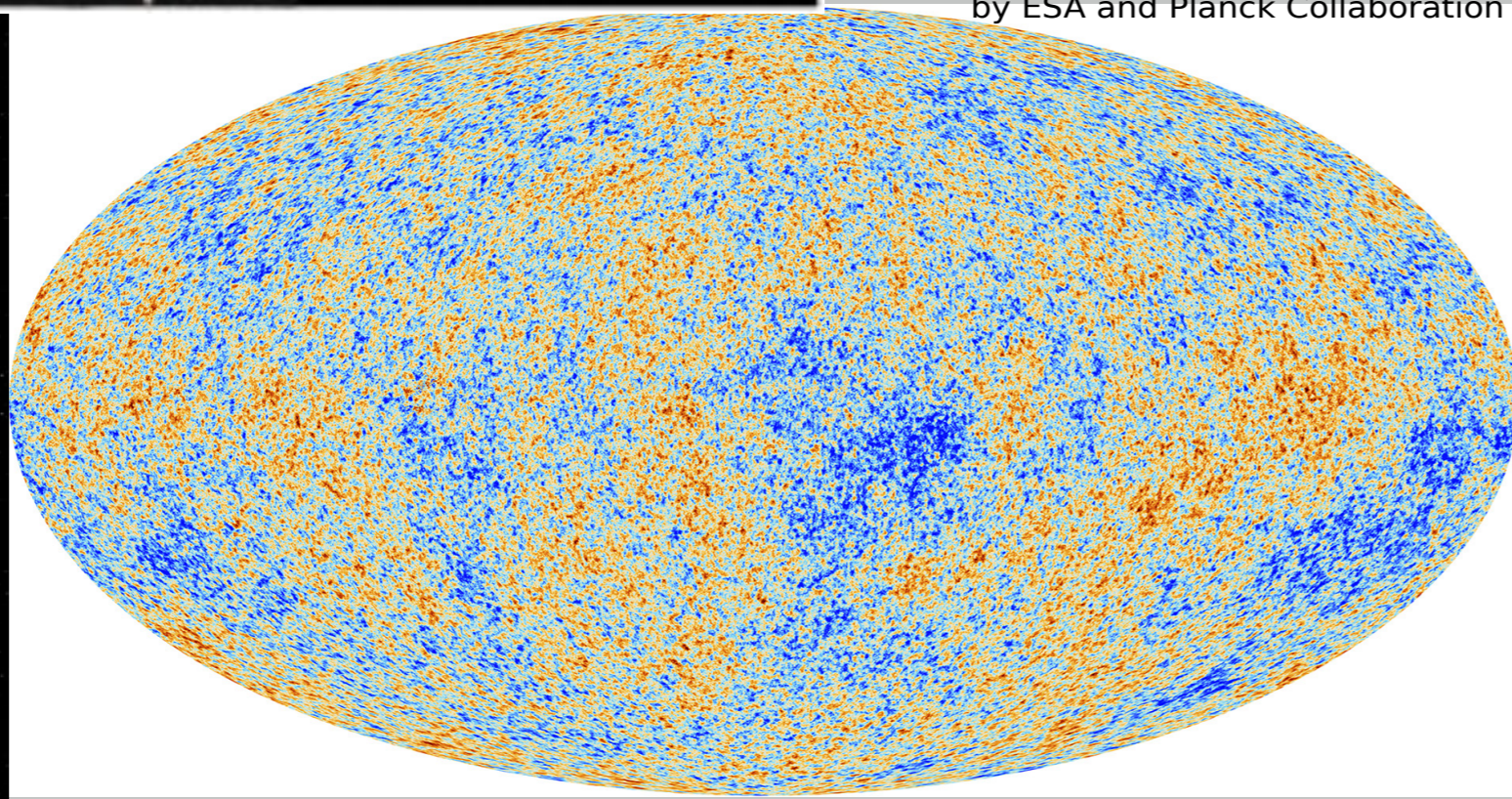
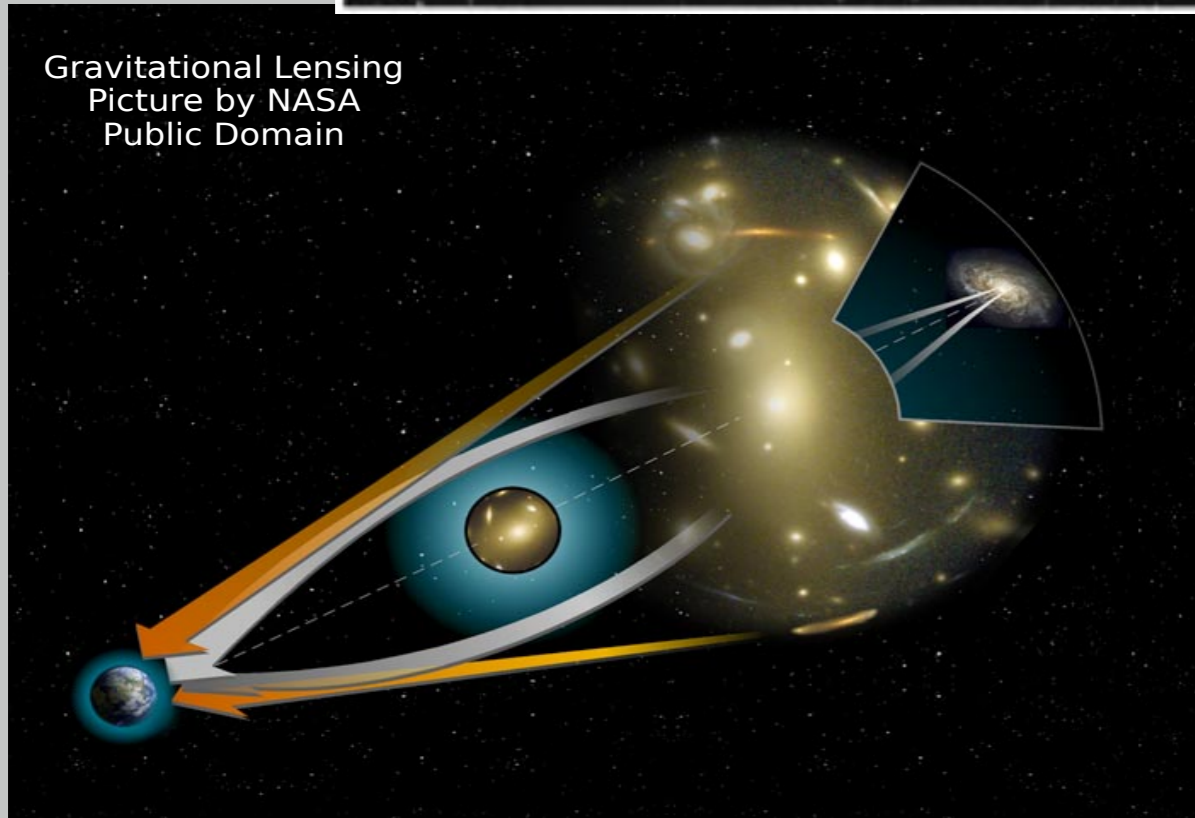
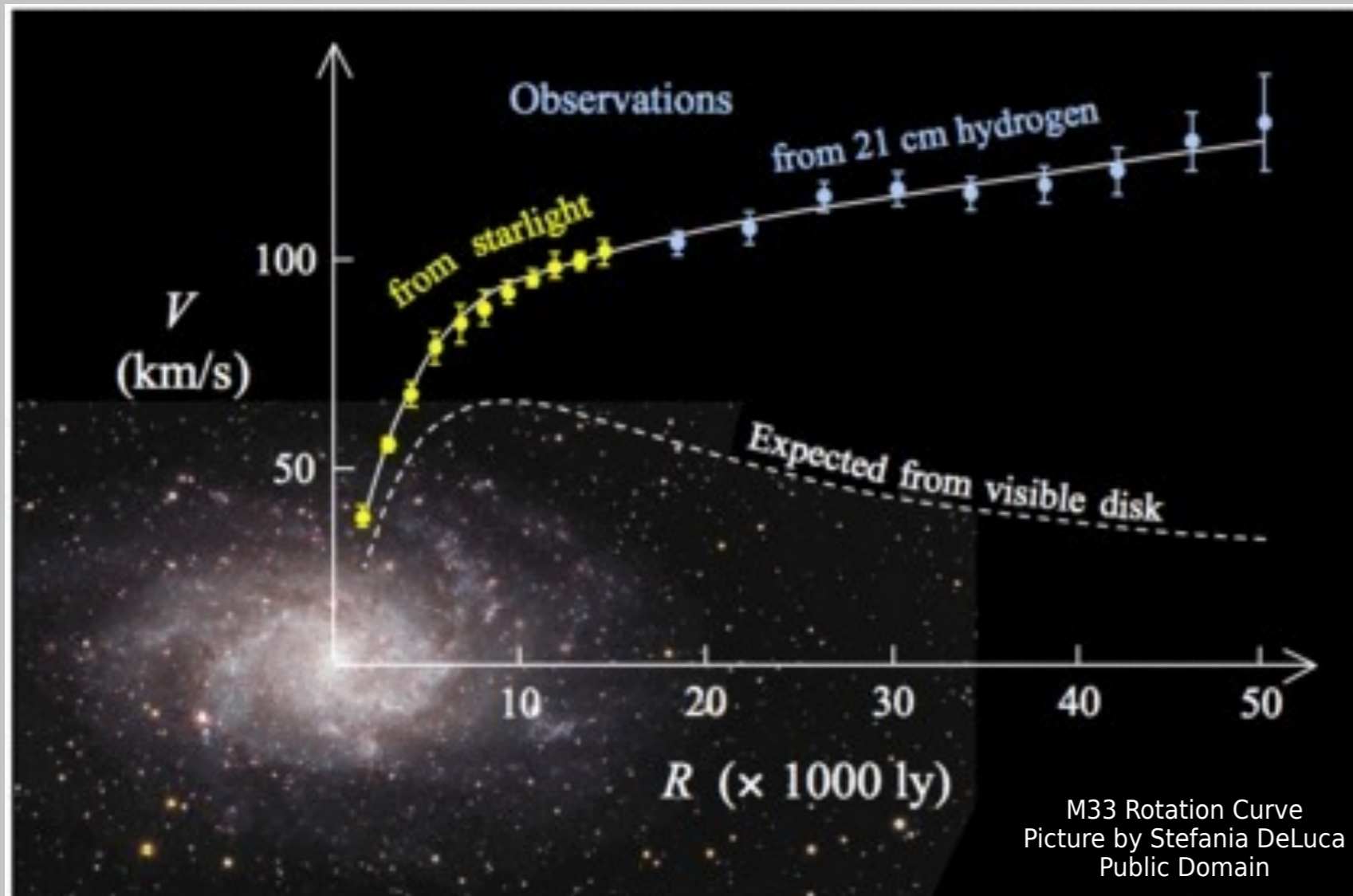
Kavli IPMU, UTIAS, the University of Tokyo, Japan



Evidence of Dark Matter

Dark matter is one of the most important open questions in modern physics, astronomy and cosmology. For 80 years, we do not know its nature, despite of compelling evidence of its existence on many scales:

1. the relative motion of galaxies in galaxy clusters,
2. galaxy rotation curves,
3. gravitational lensing,
4. structure formation in the universe and its imprint on the cosmic microwave background.

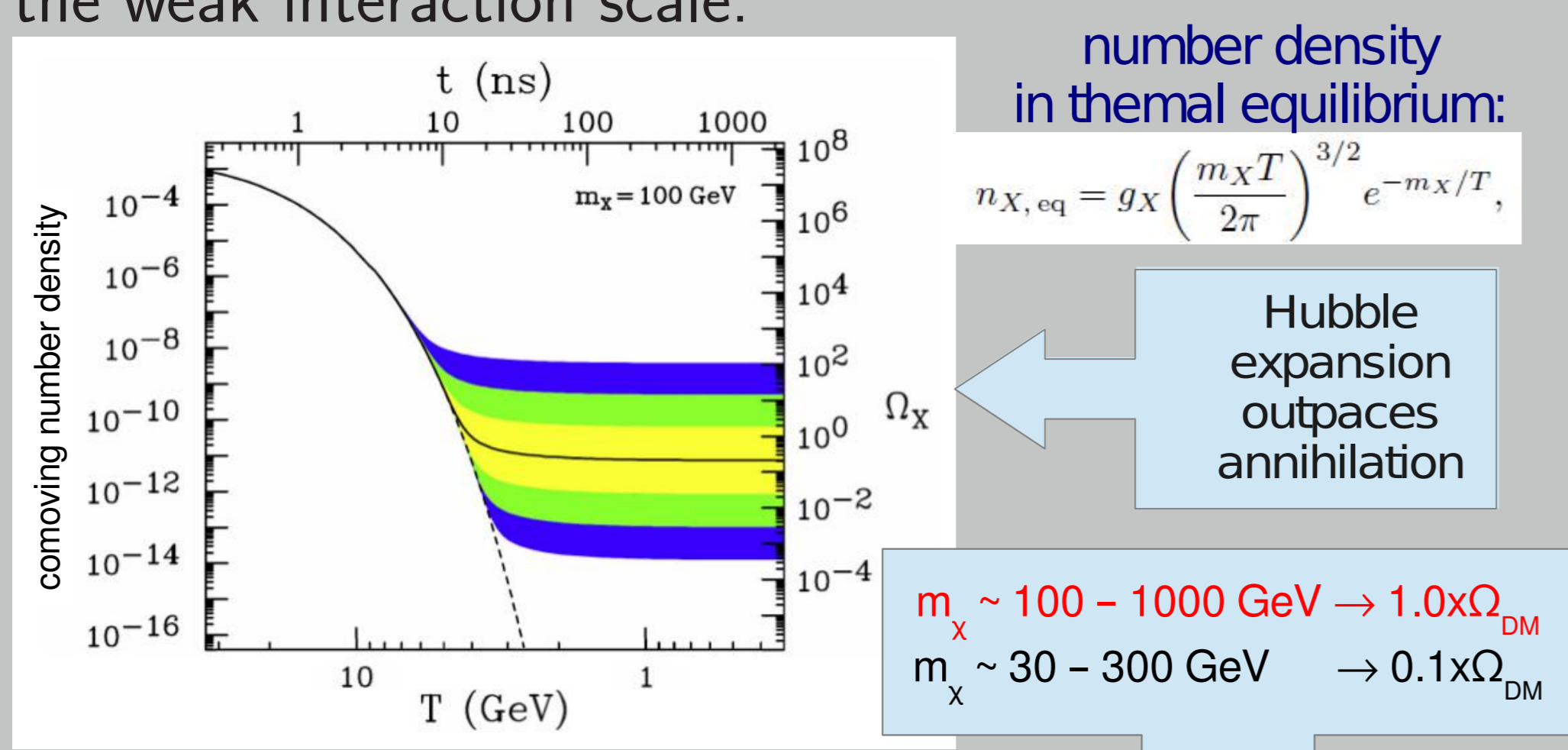


The "WIMP miracle"

"WIMP" (*weakly interacting massive particle*) is a non-baryonic hypothetical form of dark matter, as opposed to largely excluded normal matter solutions such as dwarf stars or even black holes.

WIMPs are at present the most appealing candidate for dark matter, since

1. modified theories of gravity have difficulty in explaining recent observation of colliding galaxy clusters,
2. by the "WIMP miracle" it turns out that the right dark matter density can be achieved with WIMPs interacting with normal matter at roughly the weak interaction scale:



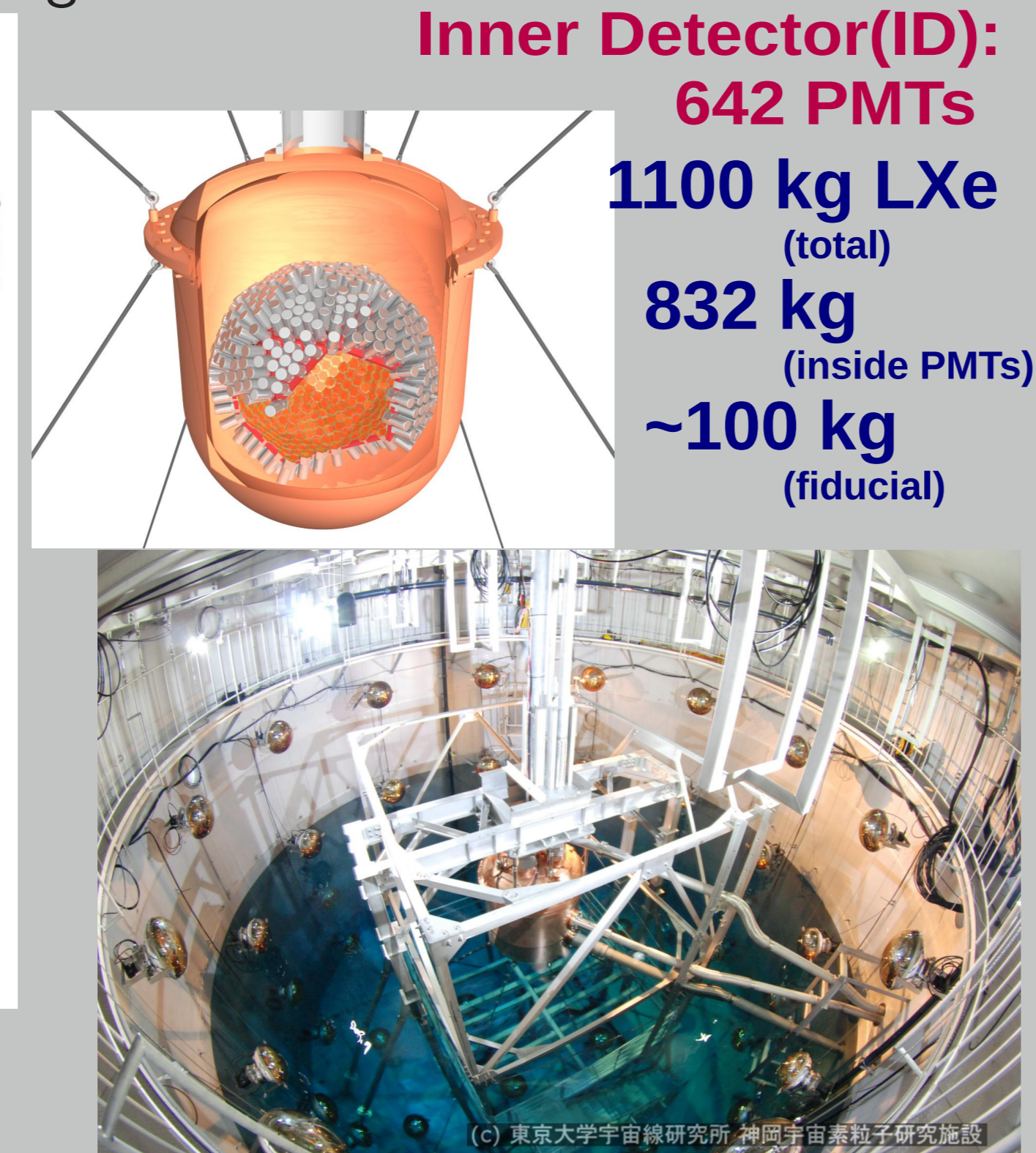
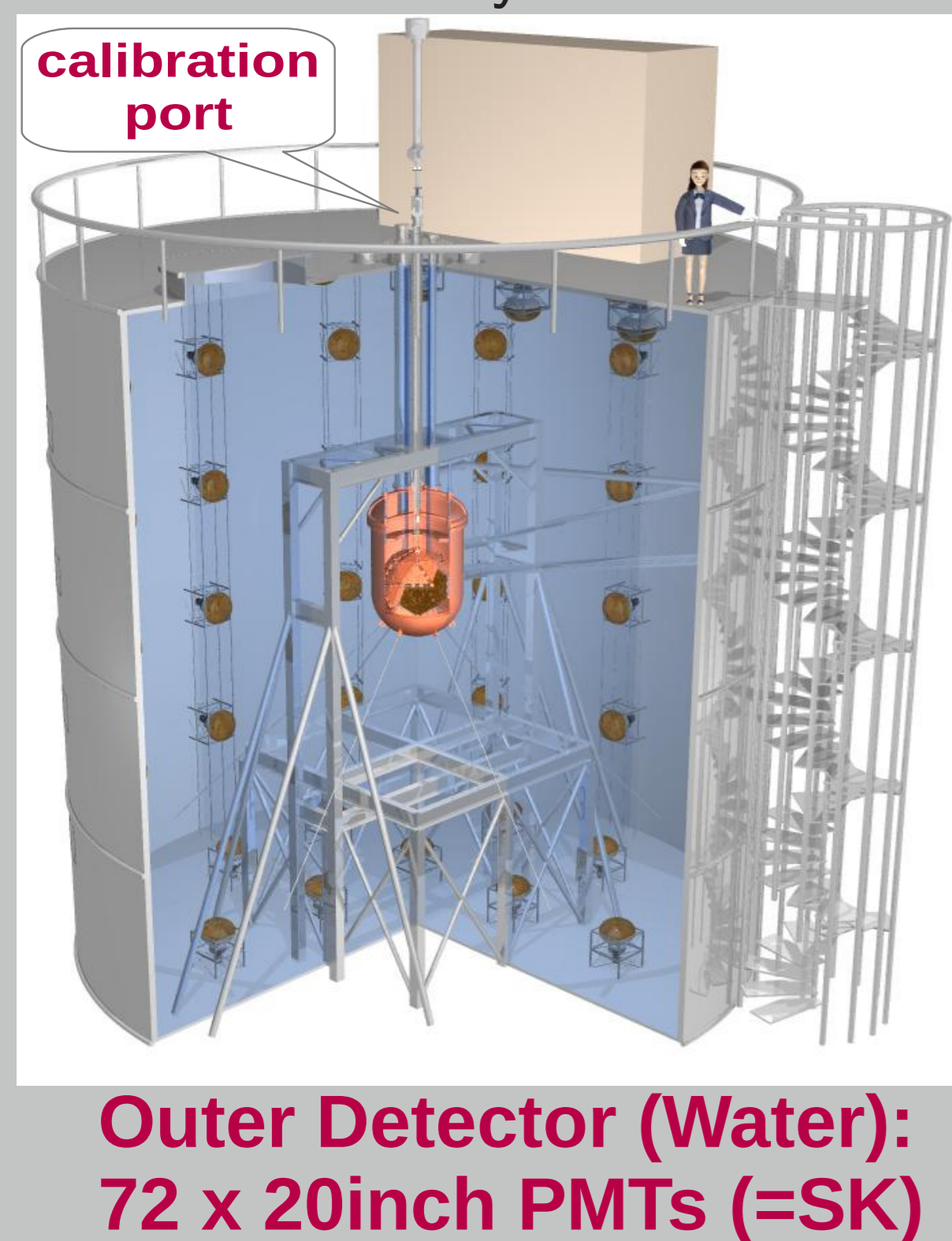
velocity averaged annihilation cross-section for GeV-TeV mass WIMPs: $\langle\sigma v\rangle = 3 \times 10^{-26} \text{ cm}^3/\text{s} \rightarrow$ correct DM density...

(WIMP means weak scale cross section...)

J.L. Feng(2010)

XMASS Liquid Xenon Scintillation Detector

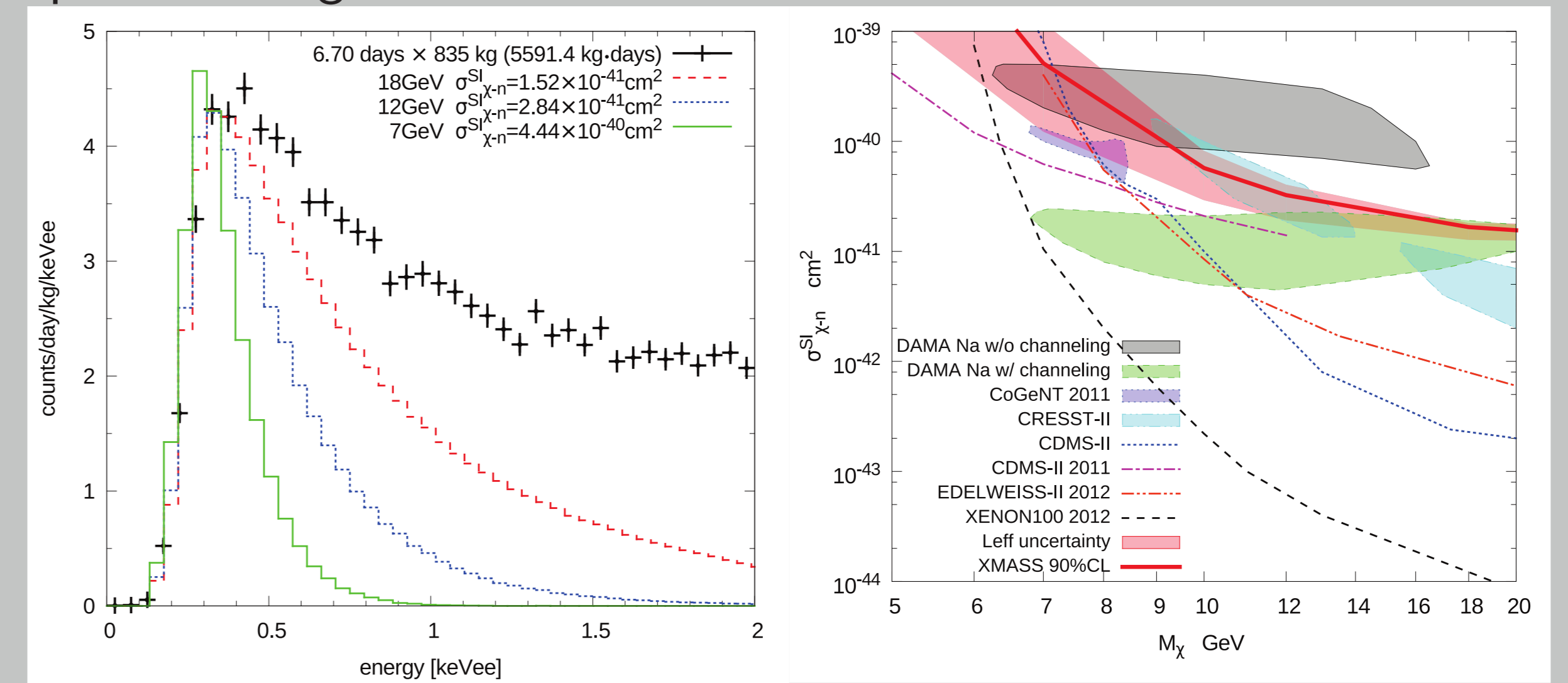
Located in the Hall C of the Kamioka Observatory in Japan, XMASS is a liquid xenon scintillation detector. It searches for signals from Xe nuclear recoils induced by WIMP scattering.



Outer Detector (Water):
 72 x 20inch PMTs (=SK)

Full Volume Search: Light WIMP

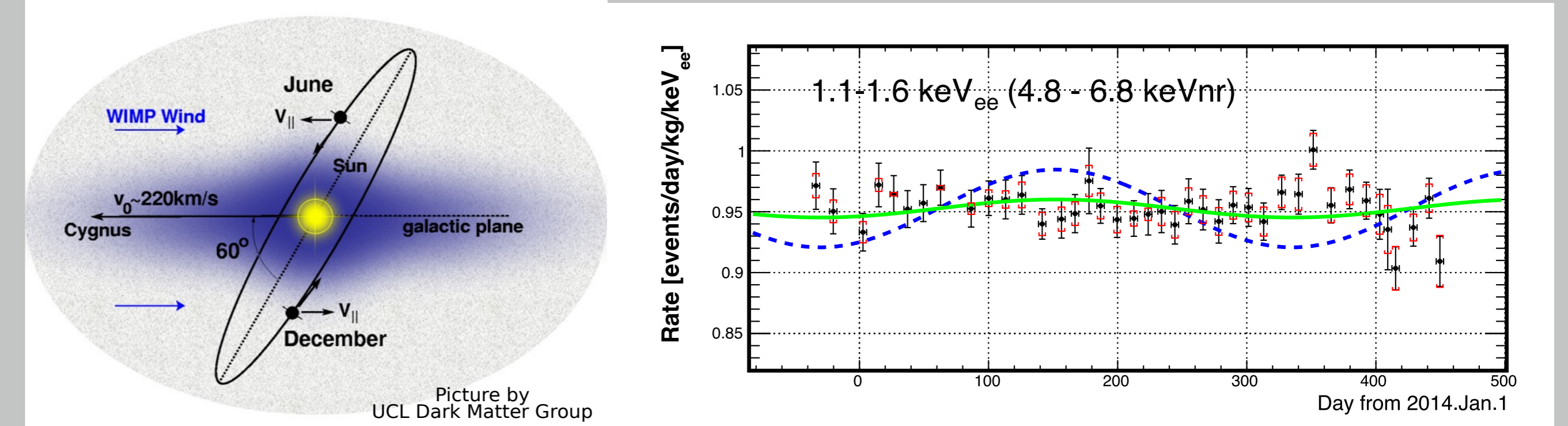
With an ultra-low radioactivity detector and a low energy threshold down to 0.3 keVee, we can take the event counts as-is, and without assuming specific background models, derive a limit on the WIMP cross section.



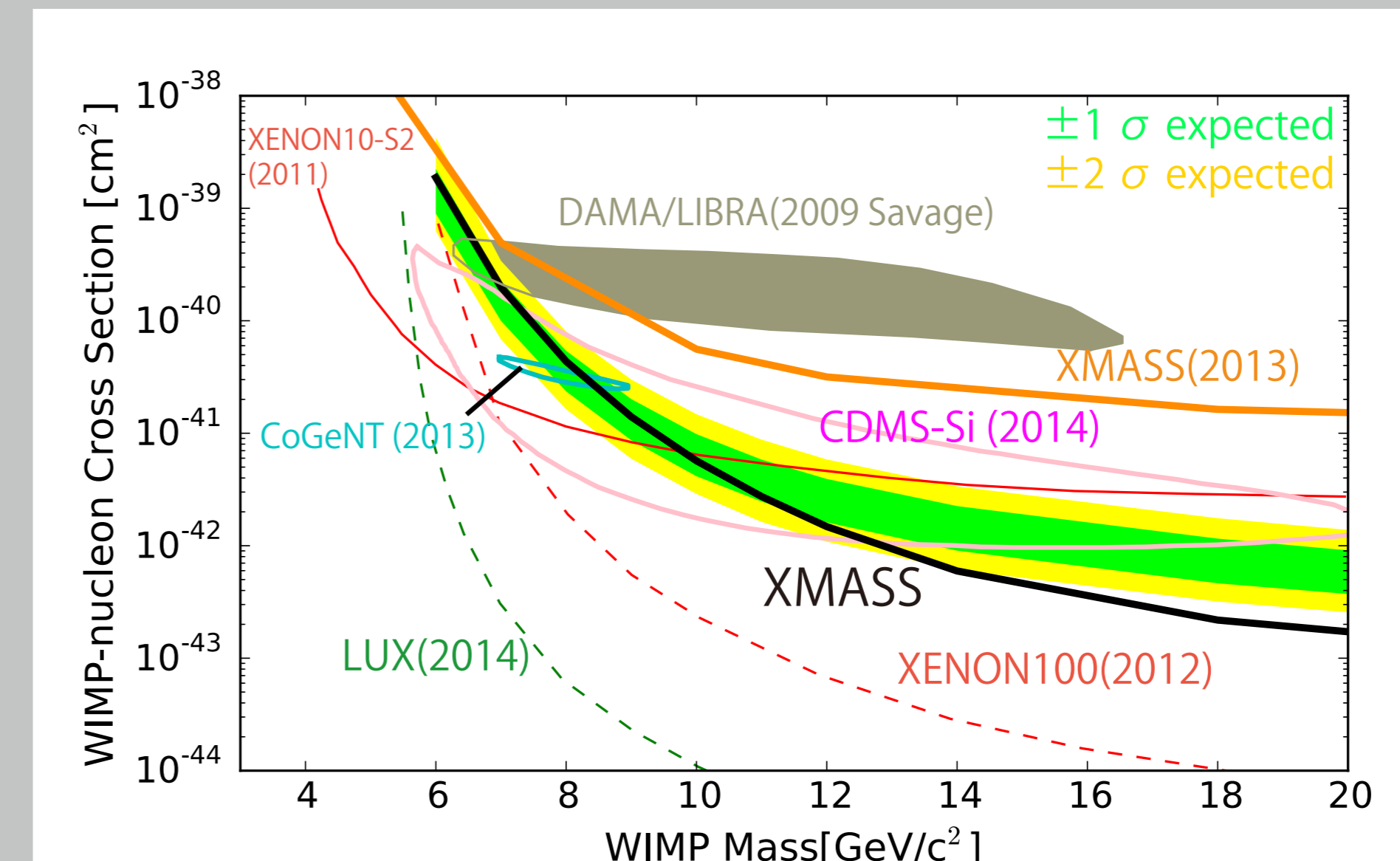
Phys. Lett. B 719 (2013) 78

Full Volume Search: Annual Modulation

The WIMP flux is modulated by the Earth velocity relative to the galactic frame. WIMPs are the gravitational seeds of galaxy formation, and do not move relative to the galaxy.



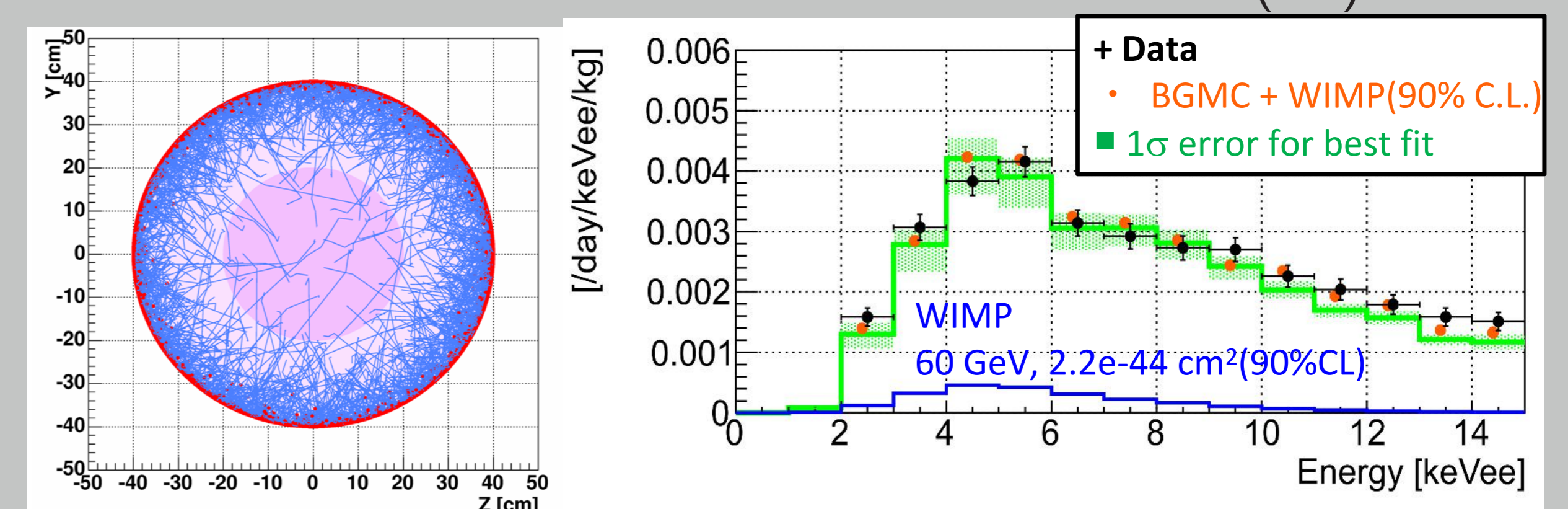
The expected resulting annual modulation provides a means to distinguish a WIMP signature from radioactive background in the detector.



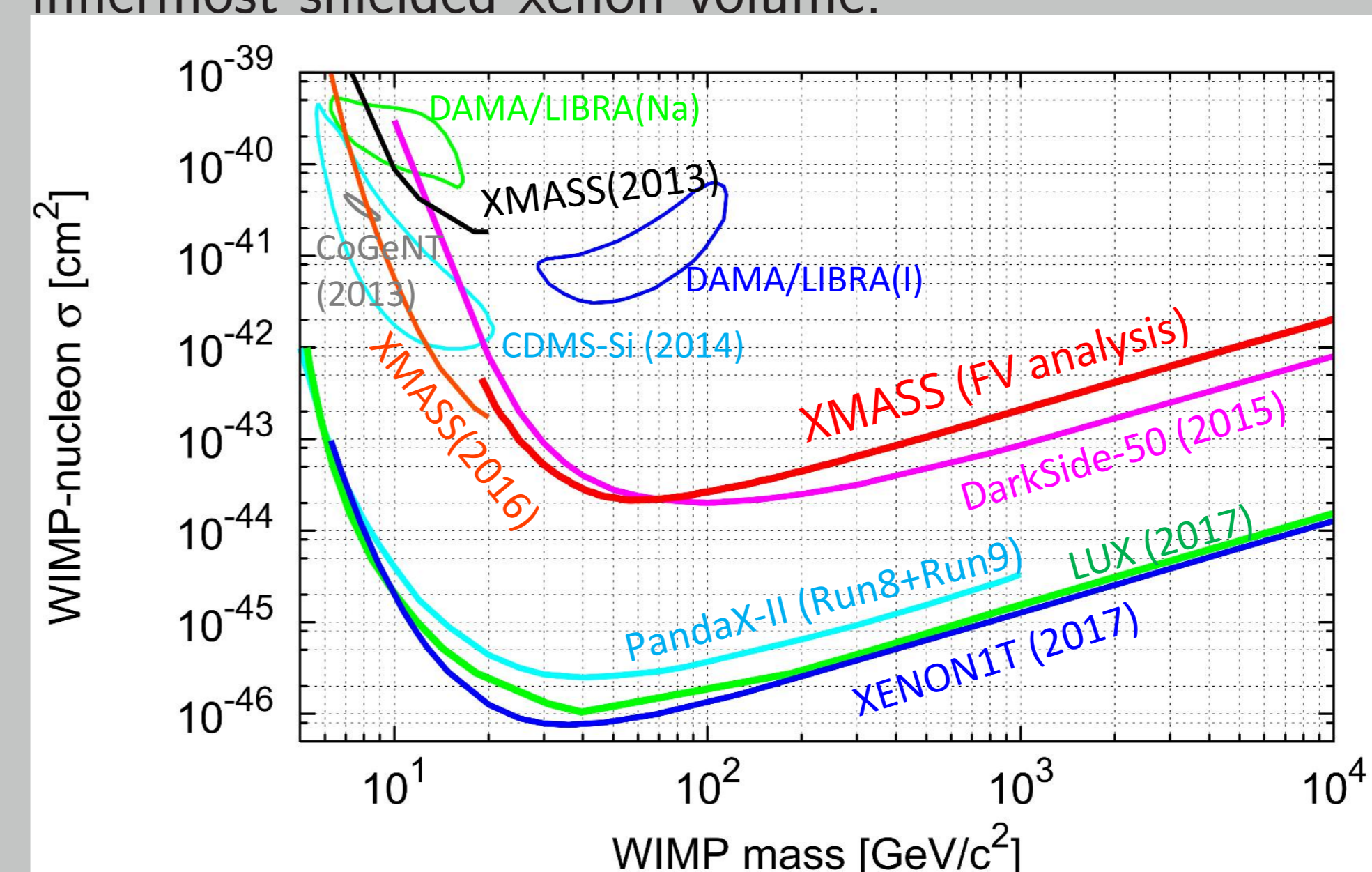
Phys. Lett. B 759 (2016) 272 (update including new data in preparation)

Fiducial Volume Search: Self Shielding of Liquid Xenon

The PMTs and supporting Cu are not as clean as the xenon itself. An outer layer of xenon serves as a high density active shield to the innermost xenon. γ rays from e.g. the PMTs rarely penetrate 20 cm of xenon. The volume inside of this 20cm shield is called the fiducial volume (FV).



An event's position and energy are reconstructed based on charge and timing responses of the PMTs. The candidate events are selected from the innermost shielded xenon volume.



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