# Status of PandaX II


Karl Ludwig Giboni on behalf of the PandaX collaboration
Shanghai Jiao Tong University

**TPC Conference, Paris 5 -7 December, 2016**

# The PandaX Collaboration

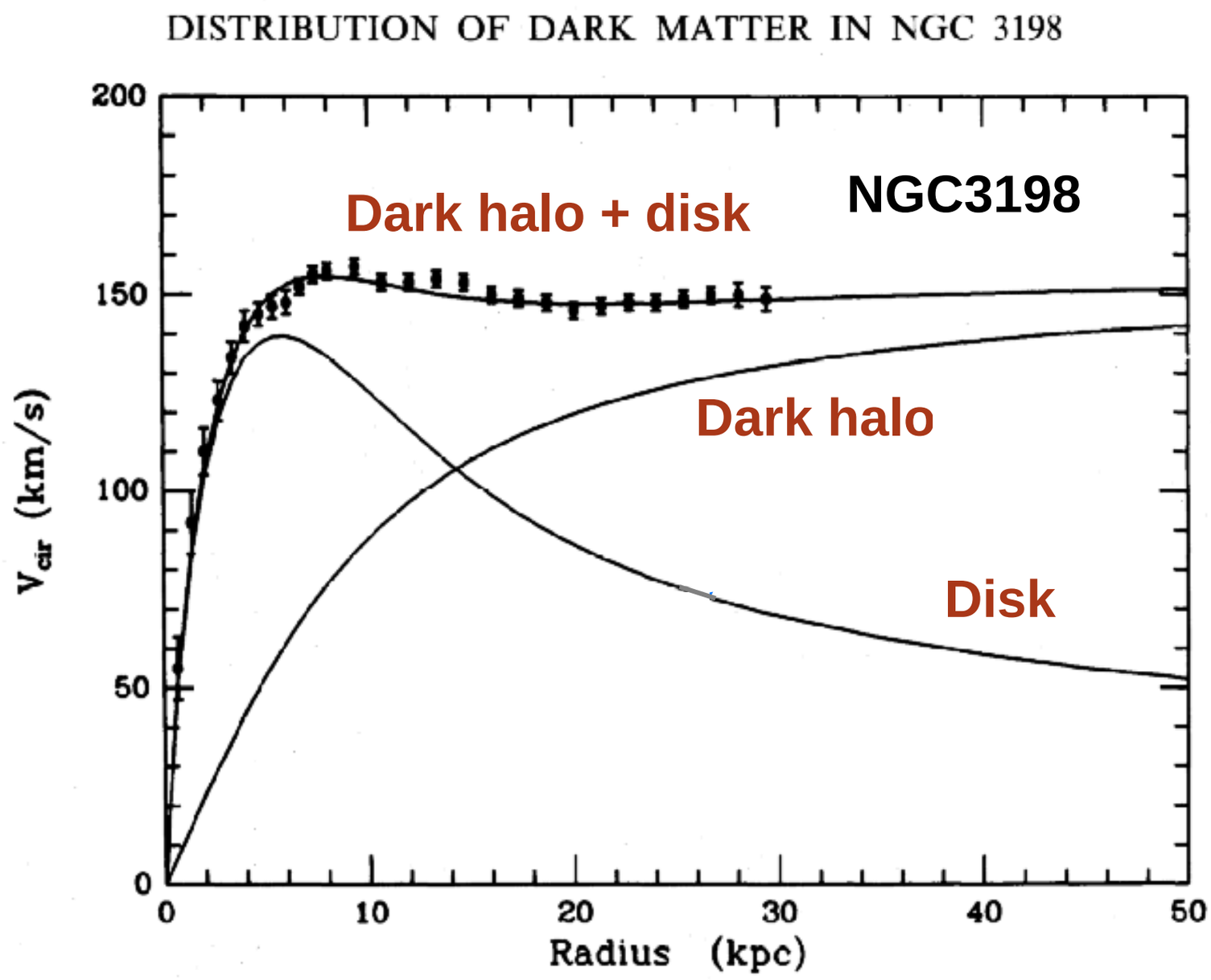
| | | |
|---|---|---|
| Shanghai Jiao Tong University, | SJTU | (2009~ ) |
| Shanghai Institute of Applied Physics, | CAS | (2009~ ) |
| Shandong University | SDU | (2009~ ) |
| Peking University | PKU | (2009~ ) |
| Yalong River Hydropower Company | | (2009~ ) |
| University of Science & Technology of China | USTC | (2015~ ) |
| China Institute of Atomic Energy | CIAE | (2015~ ) |
| University of Maryland | UMD | (2009~ ) |
| University of Michigan | UMICH | (2010~2015) |
| Lawrence Berkeley National Lab | LBNL | (2015~ ) |
| University of Zaragoza, Spain | | (2015~ ) |
| Saclay, France | IRFU | (2015~ ) |
| Suranaree University of Technology | SUT | (2016~ ) |

# Evidence for Dark Matter in Galaxies

## Observations of the movement of stars and Intergalactic Gas at large radii

The rotation curves are flat, as far out as one can measure

This requires:
10 times more matter as directly visible via radiation



# Dark Matter Candidates

There is ample proof of the existence of Dark Matter from Astronomical observation. Also the LHC is now getting into the range where a detection is possible. But, we still would like a direct detection.

To describe our world we normally use the **Standard Model,** but none of the SM particles is a good Dark Matter candidate!

The easiest candidate is the **WIMP** from **Super Symmetry**.
WIMP stands for Weakly Interacting Massive Particle.

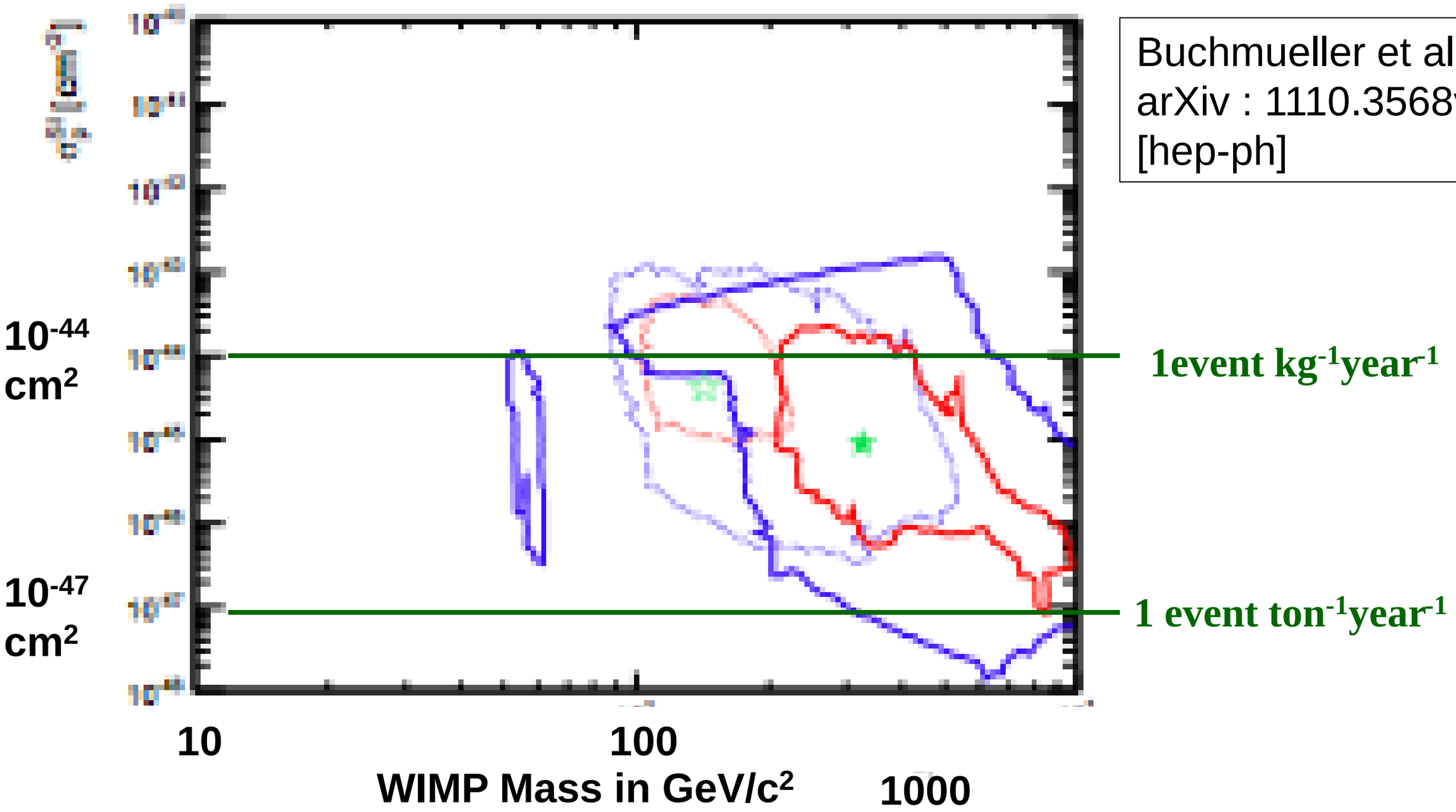
**But, Nature might have chosen differently!**

It sometimes does to make it more interesting!

# WIMP Predictions

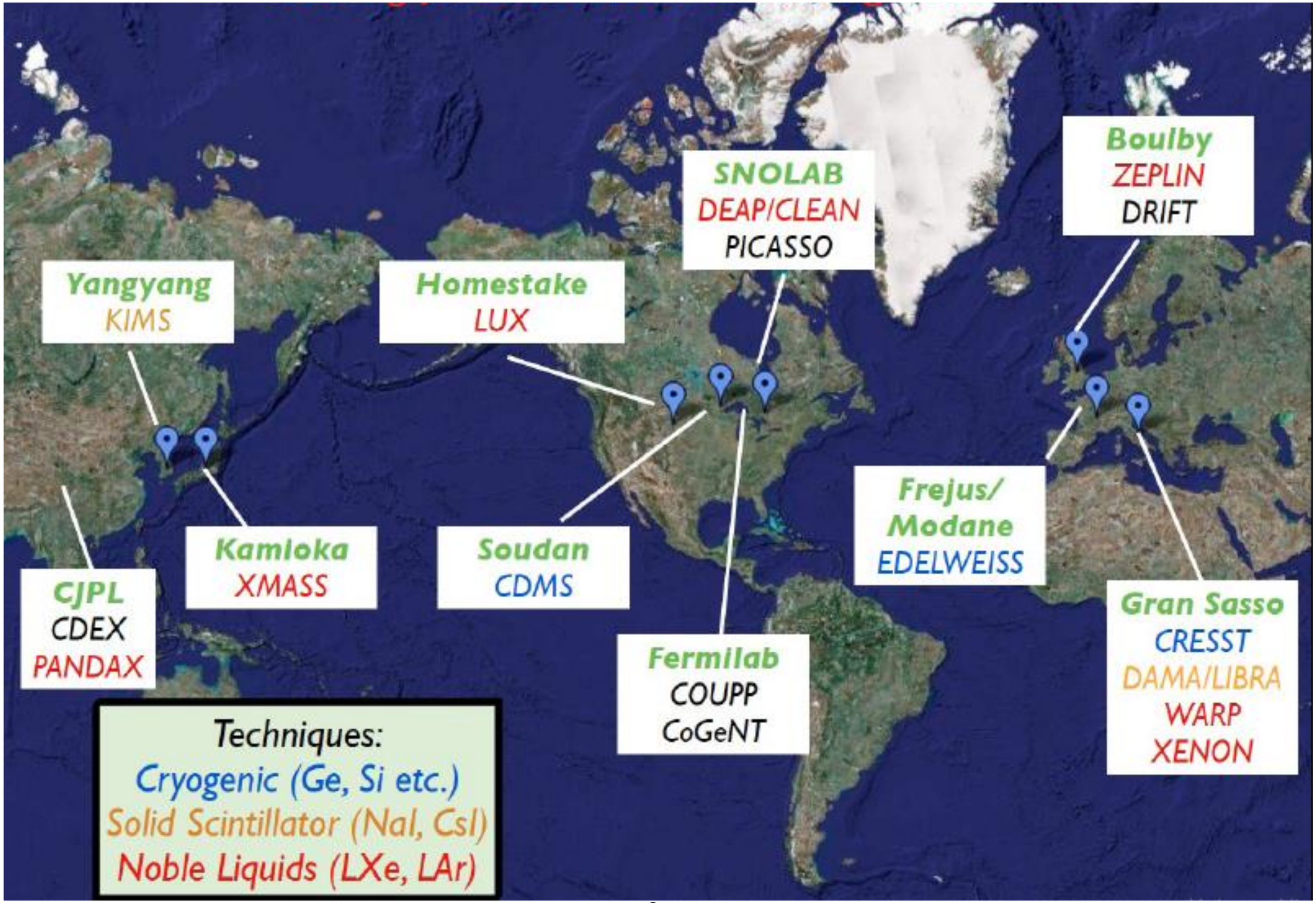
**WIMP Flux : $10^5$ cm$^{-2}$ sec$^{-1}$**

**WIMP Cross Section vs. WIMP Mass**



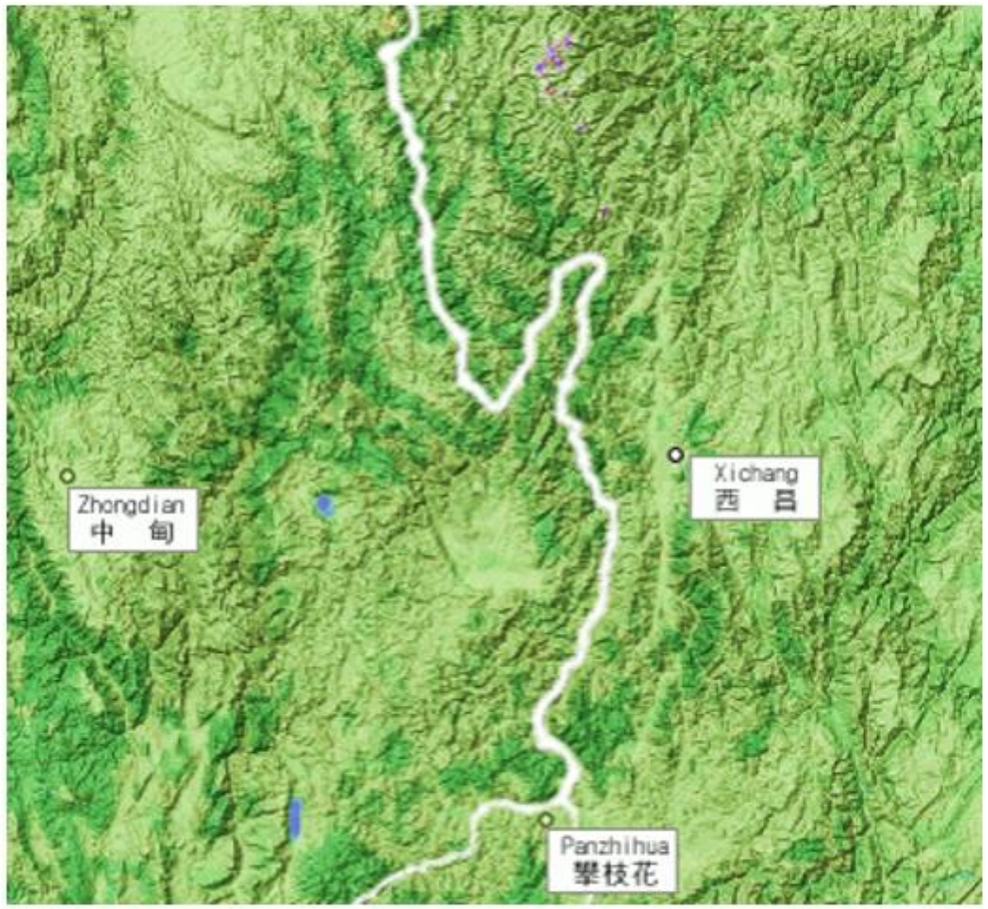

Buchmueller et al.
arXiv : 1110.3568v1
[hep-ph]

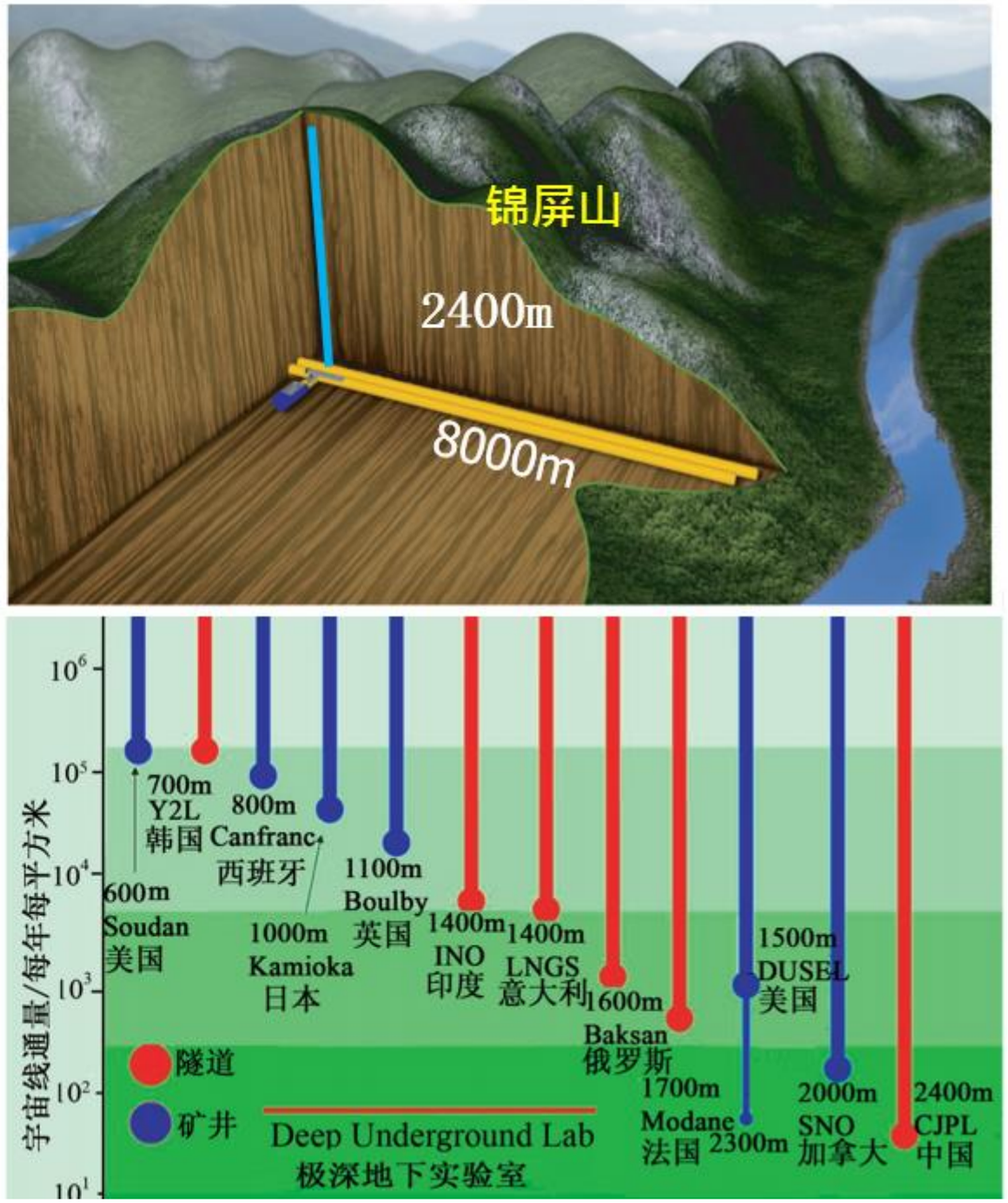
# The World Map for Dark Matter Search



# The JinPing Lab

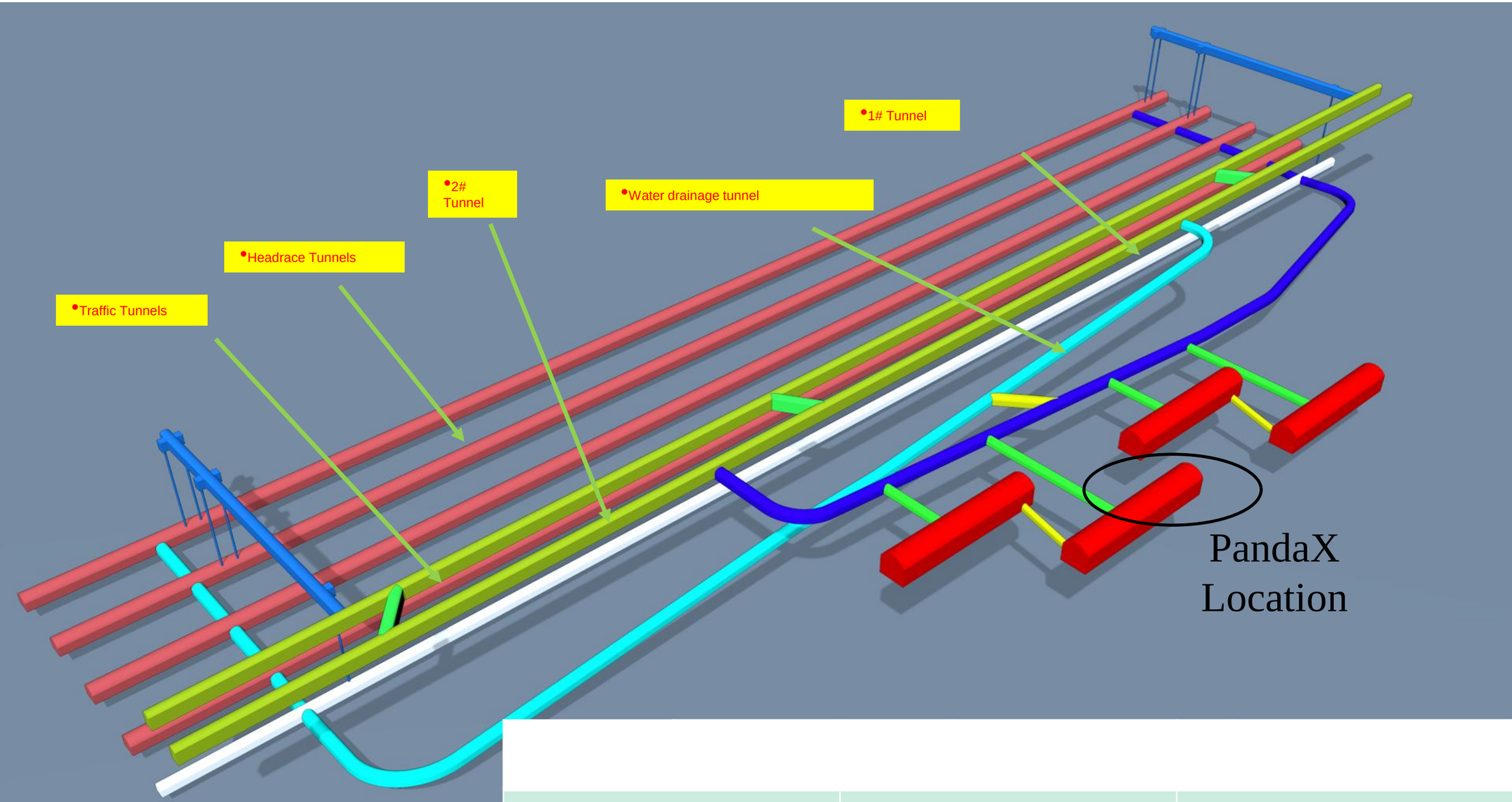
**Deepest in the world ( 1μ/week/m$^2$) and Horizontal access!**




Newly constructed deep underground lab in Sichuan Province.
At present CJPL is being extended to CJPL II.

# Design of CJPL-II




| | | |
|---|---|---|
| Rock Work | 4000 $m^3$ | 131000$m^3$ |
| Electric Power | 70 kVA | 1000 kVA |
| Fresh Air | 2400 $m^3/h$ | 40000 $m^3/h$ |

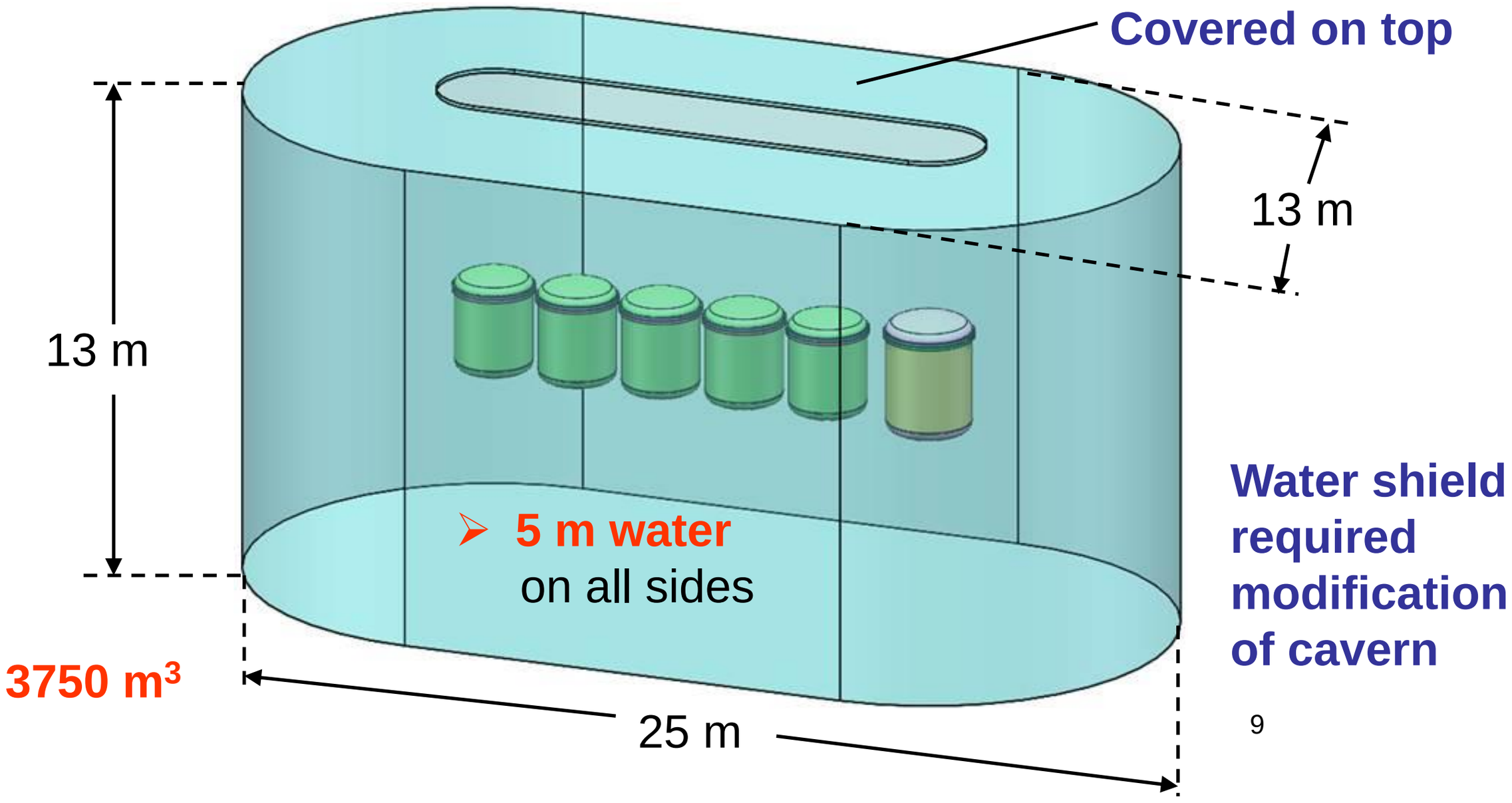
# New Laboratory CJPL II

Much larger Lab with world class Infrastructure

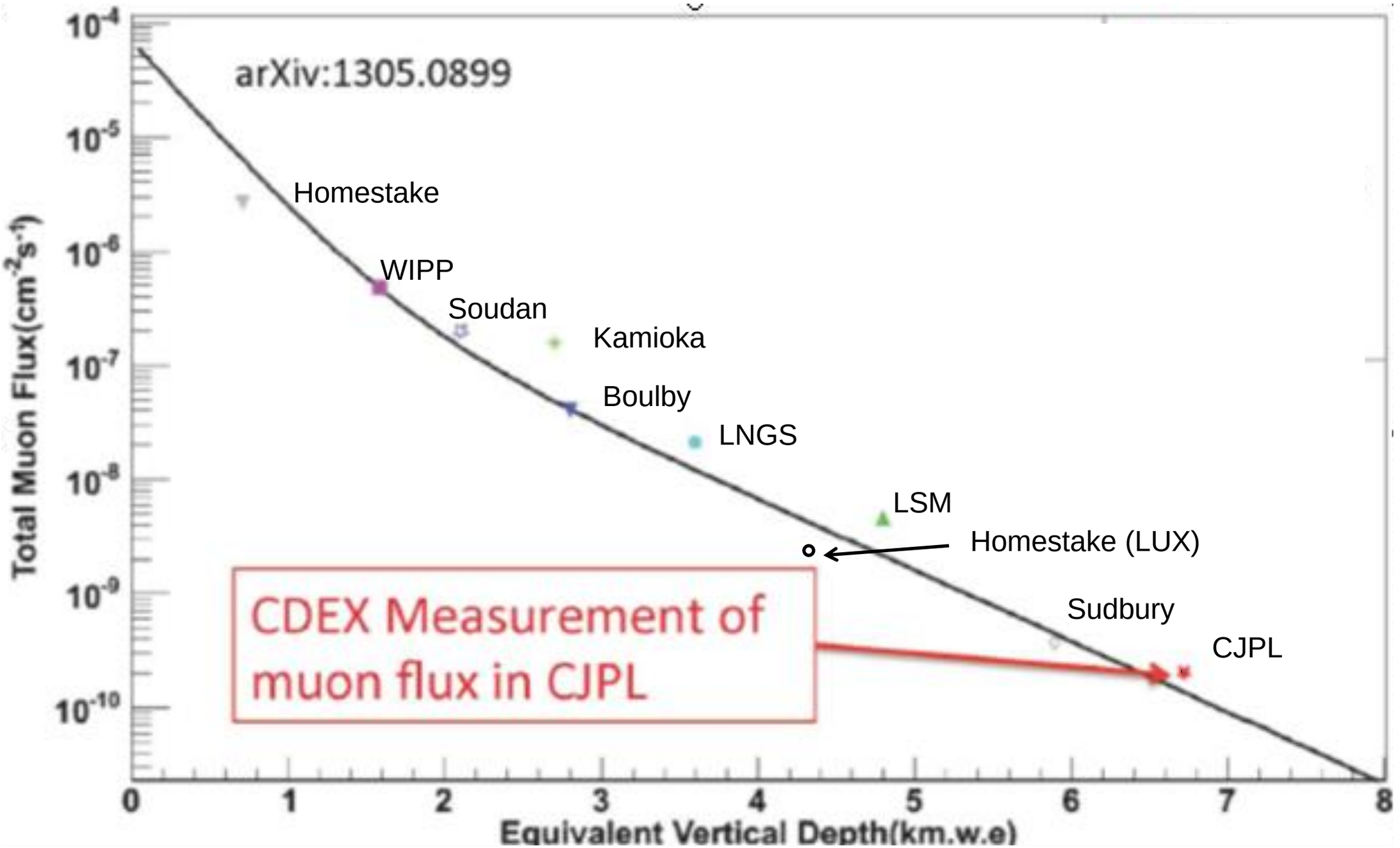
Sucess of PandaX I + II supported construction of new the laboratory

PandaX III will occupy one of the 8 laboratory halls

Water shield for PandaX III + future DM detector



# Muon Flux at CJPL

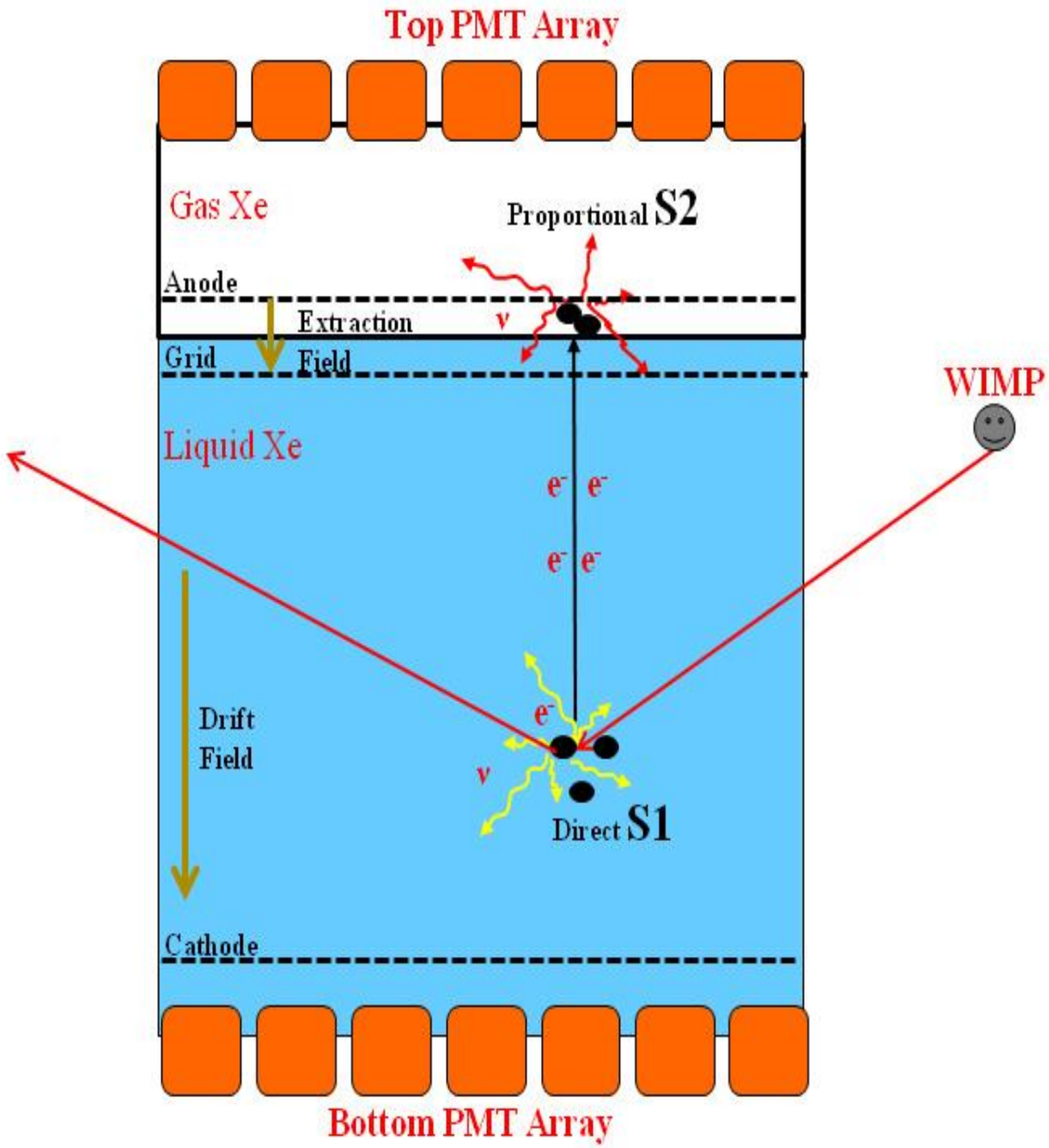


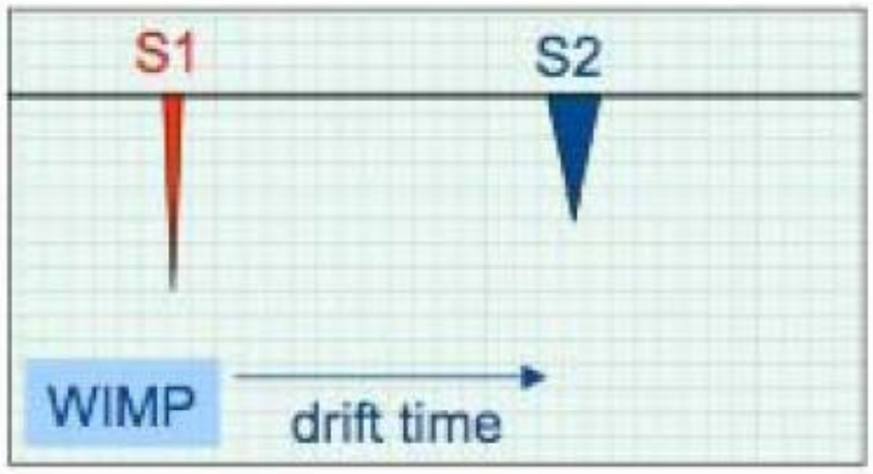


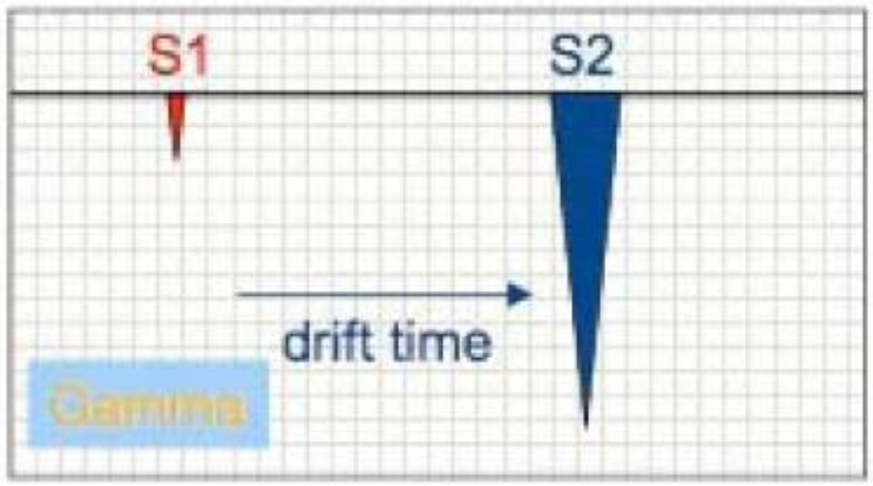

Muon Veto shield will not be necessary

# Operation Principle of Dual-Phase LXe TPC

PandaX II is a DM (WIMP) detector based on LXe.
Easily scalable to larger target masses for higher sensitivity
Measuring liberated charges and scintillation light
for better background rejection

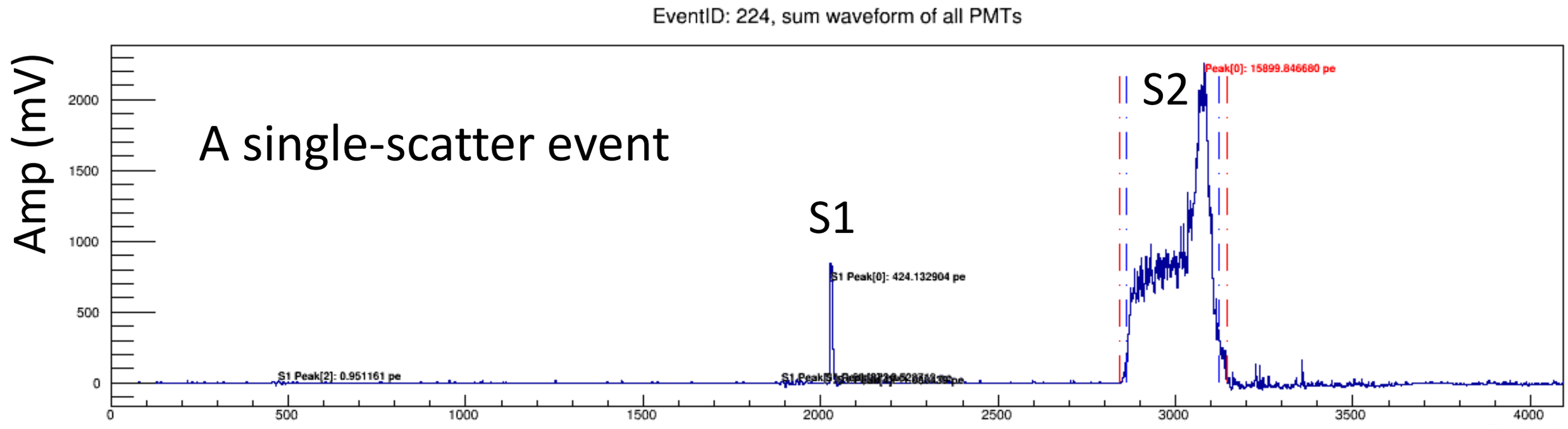


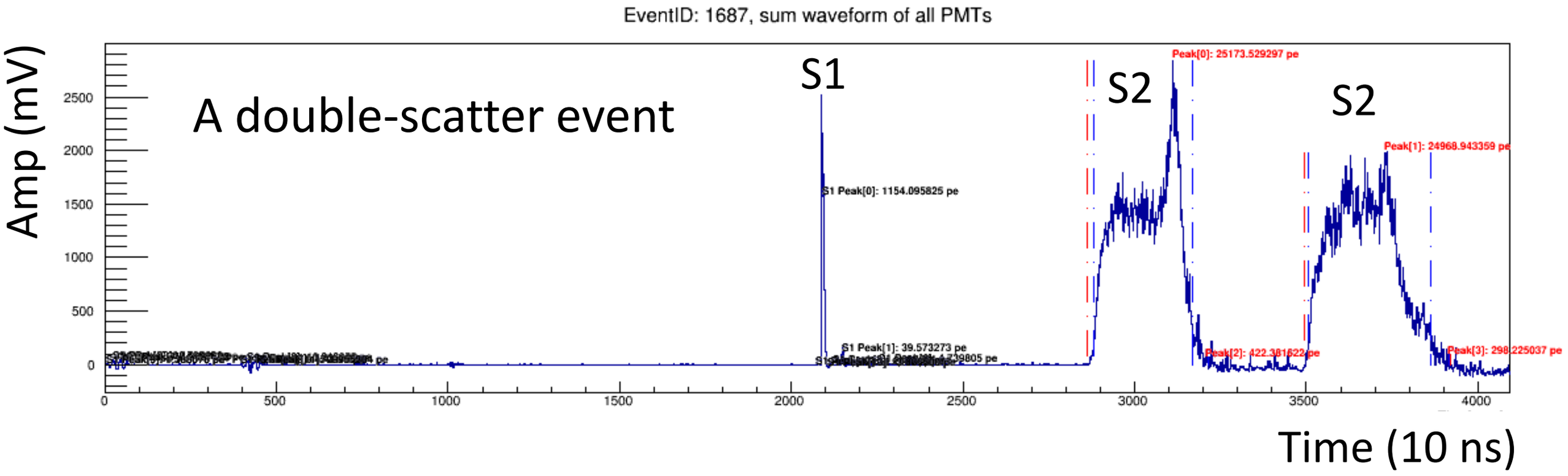



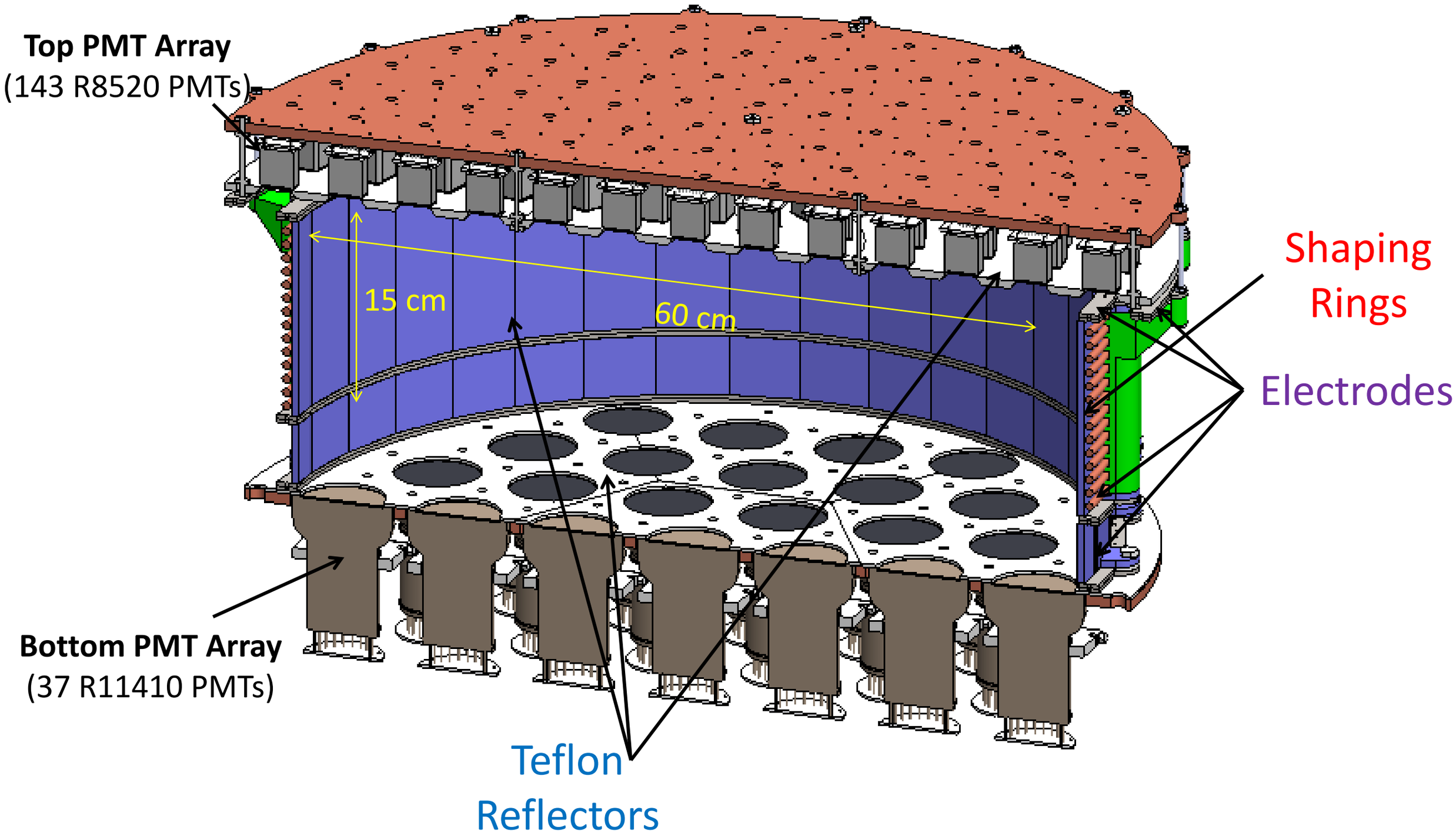

$(S2/S1)_{wimp} << (S2/S1)_{gamma}$

# Dual Phase Signals

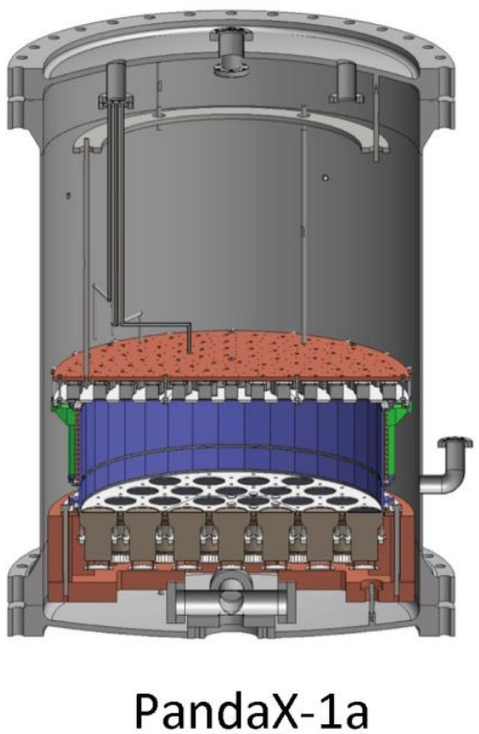


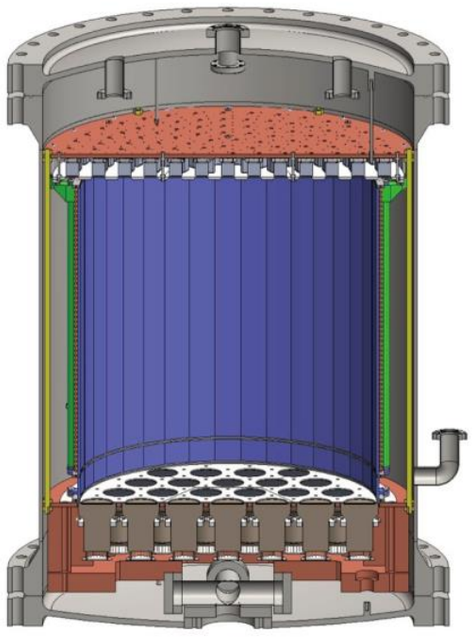
# Panda X I TPC


Top PMT Array
(143 R8520 PMTs)
15 cm
60 cm
Shaping
Rings
Electrodes
Bottom PMT Array
(37 R11410 PMTs)
Teflon
Reflectors

# From PandaX I to PandaX II (Baseline Design)



PandaX-1a



PandaX-1b

All systems of Panda-X are designed for >500 kg active mass

Easy transition from 125 kg to 500 kg:

- Lengthen PTFE panels (and shaping rings)
- Adjust overflow point
- Increase HV
- Fill more LXe

Everything else stays the same.

# Vessel Design

**Significant background reduction with custom steel from China Iron & Steel Research Institute**
**Replace inner vessel material**

| Unit (mBq/kg) | Ra226(U238) | Th228(Th232) | Co60 | K40 | Cs137 |
|---|---|---|---|---|---|
| Requirement | <2.1 | <1.7 | <1.1 | <14 | <7.9 |
| Best Domestic Sample | 36-64 | 7-20 | 6—75 | <7-53 | <0.4-1.8 |
| Best Foreign sample | <0.35-3.9 | <0.27-5.2 | 1.4-45 | <0.8-4.7 | <0.1-0.77 |
| Sample of the Special Steel | <1.3-1.5 | <1.3-2.2 | <0.4-0.6 | <9-13 | 0.5-2.7 |

中国钢研科技集团有限公司
CHINA IRON & STEEL RESEARCH INSTITUTE GROUP



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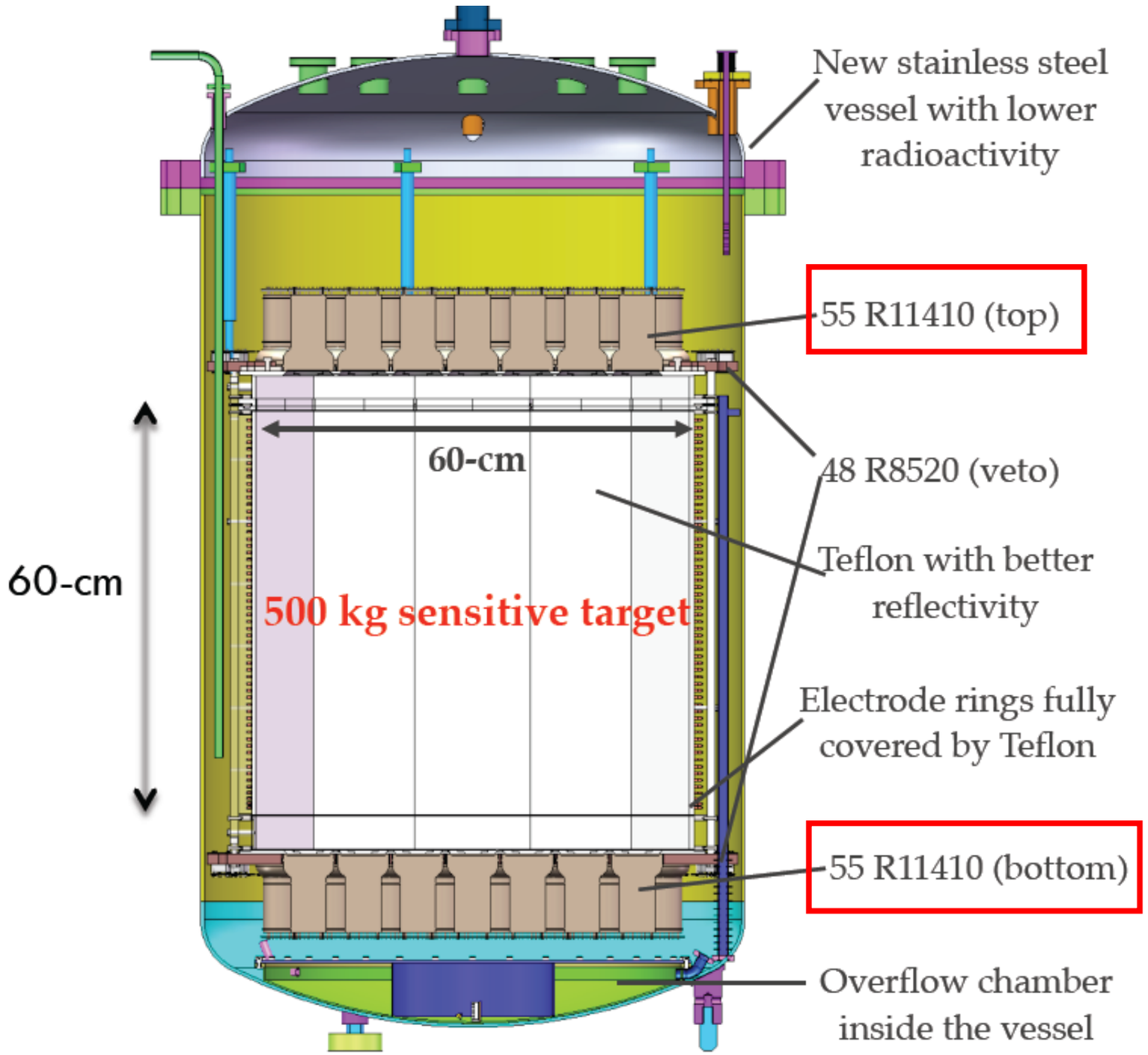
# PandaX-II




- New inner vessel with clean SS
- New and taller TPC with better PTFE and electrodes
- More 3” PMTs and improved base design
- New separate skin veto region
- New overflow chamber

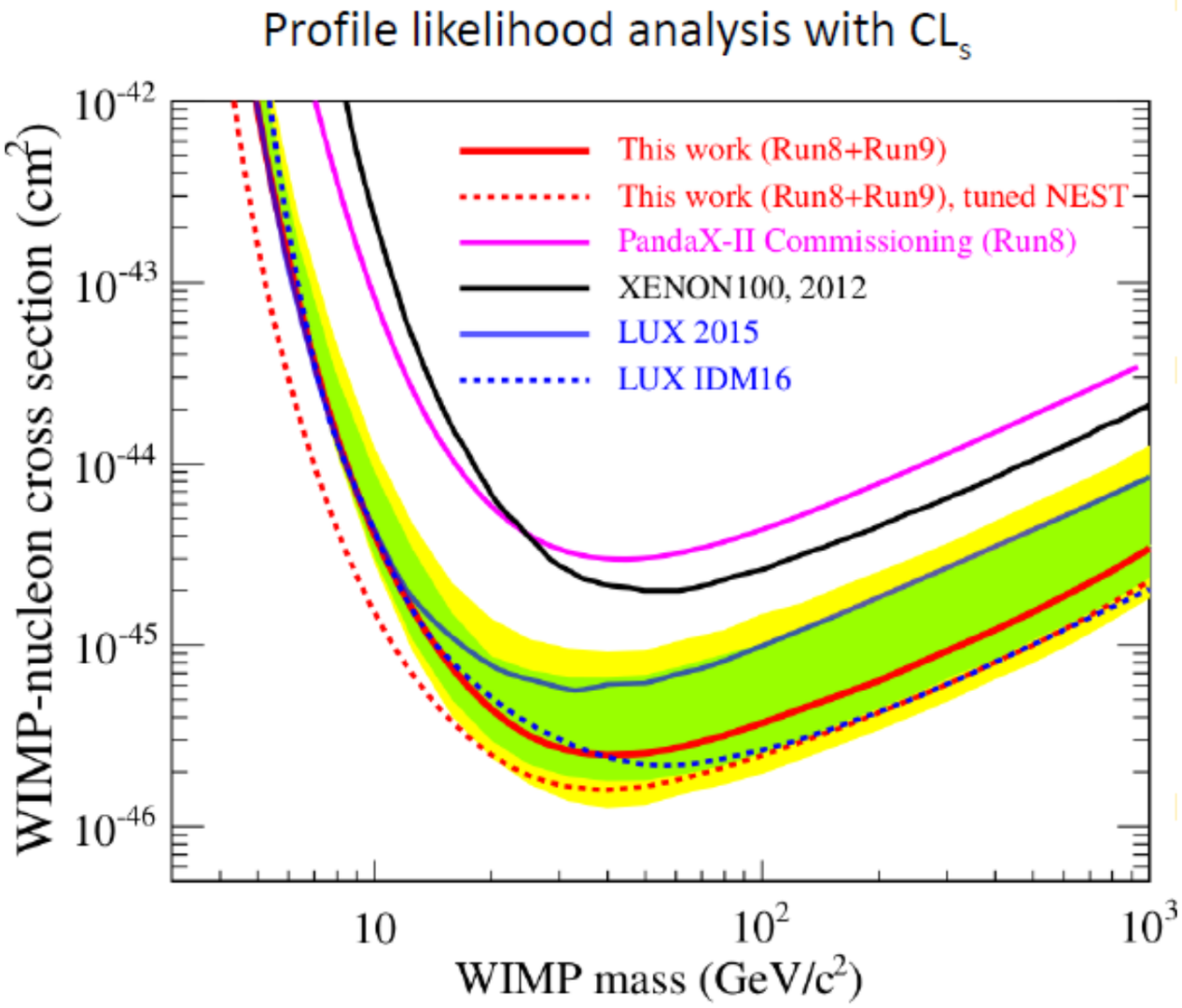
# The History of the PandaX Dark Matter Program

| | |
|---|---|
| 2010 | Start of the program. No prior legacy. |
| | Set up infrastructure. |
| 2011 | Detector Design |
| | Subsystem R&D |
| 2012 | Move to Underground Lab (CJPL) |
| 2013 | Installation of PandaX I |
| | PandaX I commissioning |
| 2014 | PandaX I first results |
| 2015 | PandaX I final results |
| | Convert to PandaX II |
| 2016 | Commissioning of PandaX II |
| | Data from Enineering Run |
| | First results of PandaX II |

PandaX II is presently the ~~largest~~ Liquid Xenon TPC for Dark Matter search

**We lost this claim since the XENON 1T is taking DM Data**

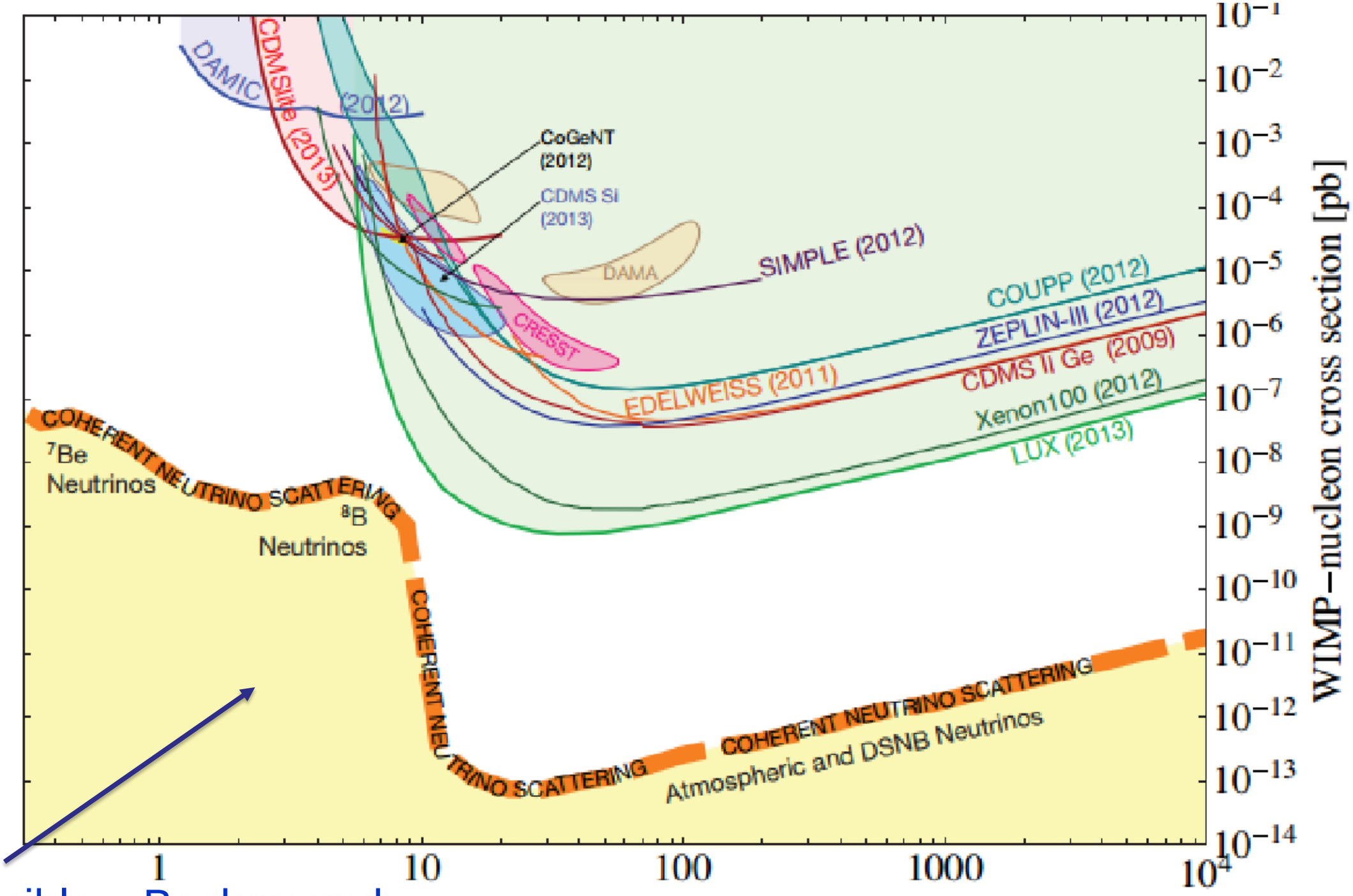
# Results so far




arXiv:1607.07400, accepted by PRL at Aug. 16

- Minimum upper limit for isoscalar SI elastic cross section at $2.5 \times 10^{-46}$ cm$^2$ @ 40 GeV/$c^2$, improved x10 from Run 8, >x2 from LUX 2015
- A more constraining result if a tuned NR model is used (agreeing better with our own calibration data), but we chose to use a conservative NR energy model to report official results
- LUX presented their 332-day results at IDM 2016 (arxiv:1608.07648) with very similar exposure and cross section limit (slightly more constraining than PandaX towards high mass)

# Long Range Projection




Irreducible ν Background. Physics might be very interesting

# Summary an Outlook

**With PandaX we II have reached the forefront of DM Search !**

79.6 live day of DM data with much reduced background

Combined with Engineering Run  33,000 kg day exposure

No DM significant signal observed

Limit for WIMP –Nucleon elastic cross section < 2.5 x $10^{-46}$ $cm^2$

More results to come, e.g. spin dependent cross section (SD)

Continue Data taking up to 2 years life time

Use PandaX II as test bed for new technologies

Prepare for larger DM (PandaX IV) detector in CJPL II