PANDA X : Status and Prospects

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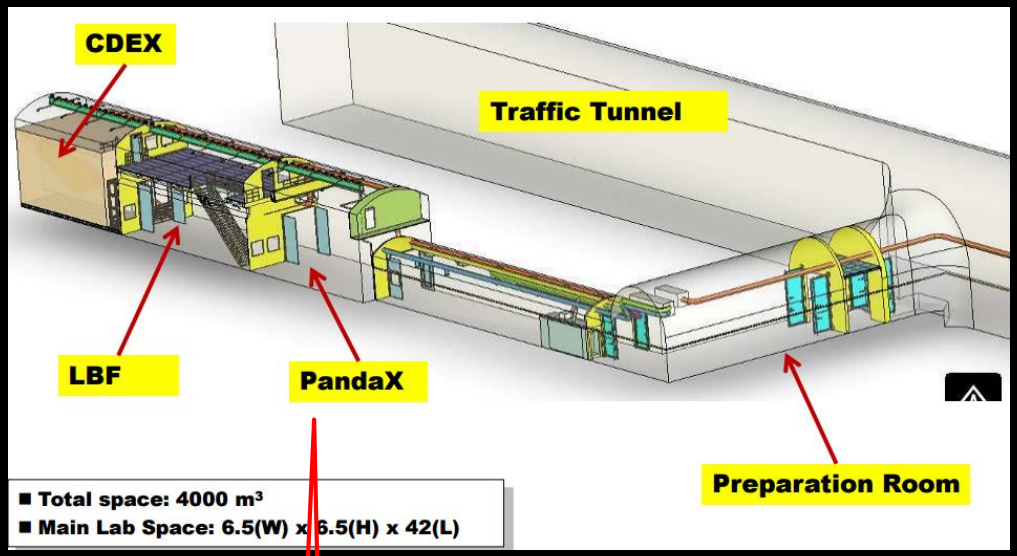
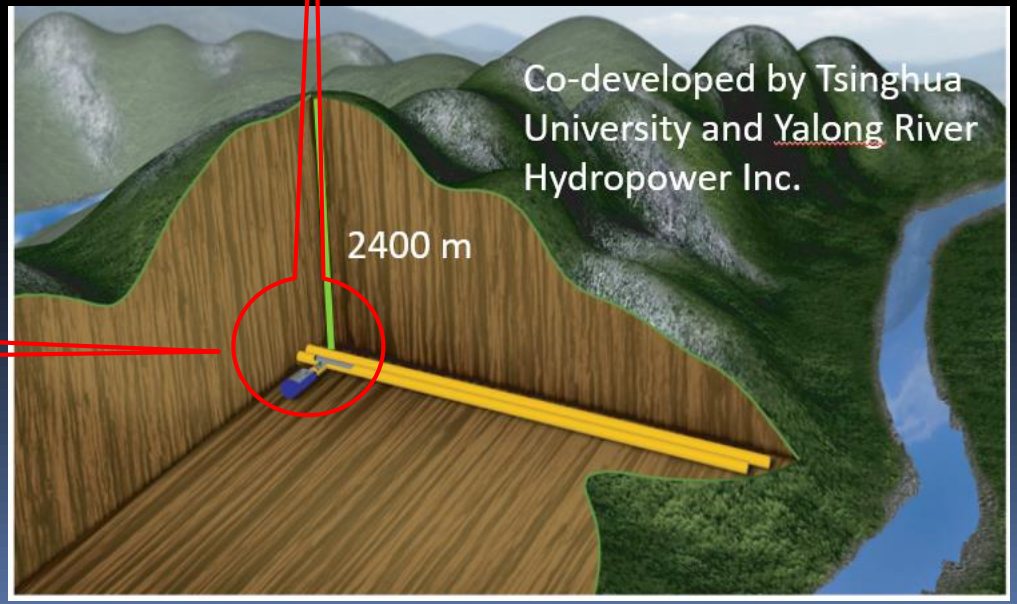
On behalf of PandaX Collaboration

China Jin-Ping Underground Lab (CJPL-I)

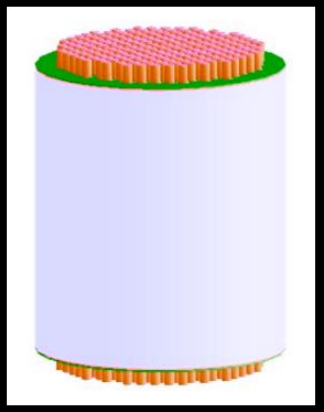




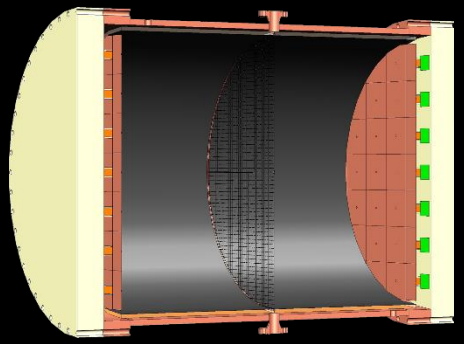
PandaX Experiments

PandaX-I: 120 kg DM experiment 2009-2014

PandaX-II: 580 kg DM experiment 2014-2018



PandaX-xT: multi-ton DM experiment Future



PandaX-III: 200 kg to 1 ton HP gas ^{136}Xe 0vDBD experiment Future

PANDA X = Particle and Astrophysical Xenon Experiments

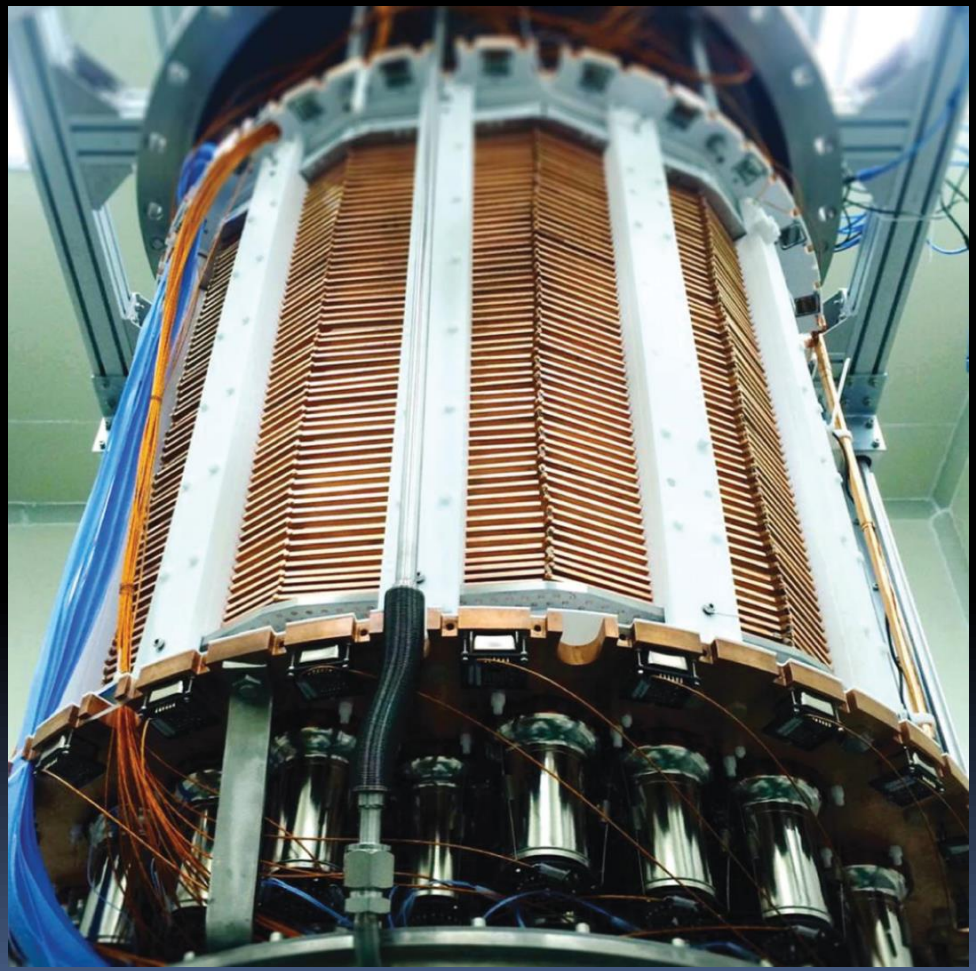
PandaX collaboration

Started in 2009, ~50 people

- Shanghai Jiao Tong University
- Peking University
- Shandong University
- Shanghai Institute of Applied Physics
- Yalong Hydropower Company
- University of Maryland
- University of Science & Technology of China
- China Institute of Atomic Energy
- Sun Yat-Sen University
- Lawrence Berkeley National Lab
- Alternative Energies & Atomic Energy Commission
- University of Zaragoza
- Suranaree University of Technology

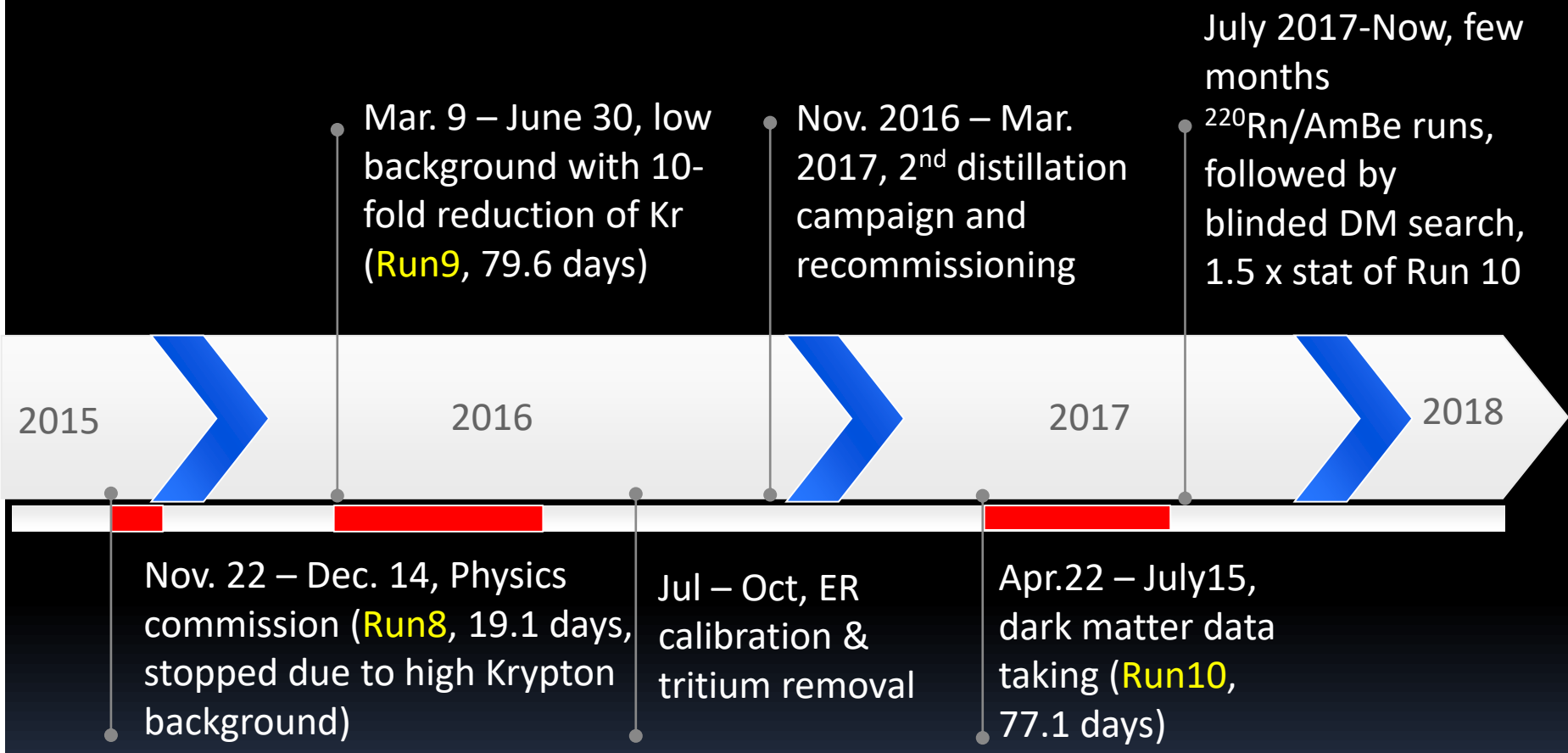
PandaX apparatus in CJPL-I

PandaX-II Detector



- 60 cm x 60 cm cylindrical TPC
- 580-kg of LXe in sensitive region, 1.2-ton LXe in total
- 55 top + 55 bottom R11410 3” target PMTs
- 24 top + 24 bottom R8520 1” VETO PMTs

PandaX-II data taking history

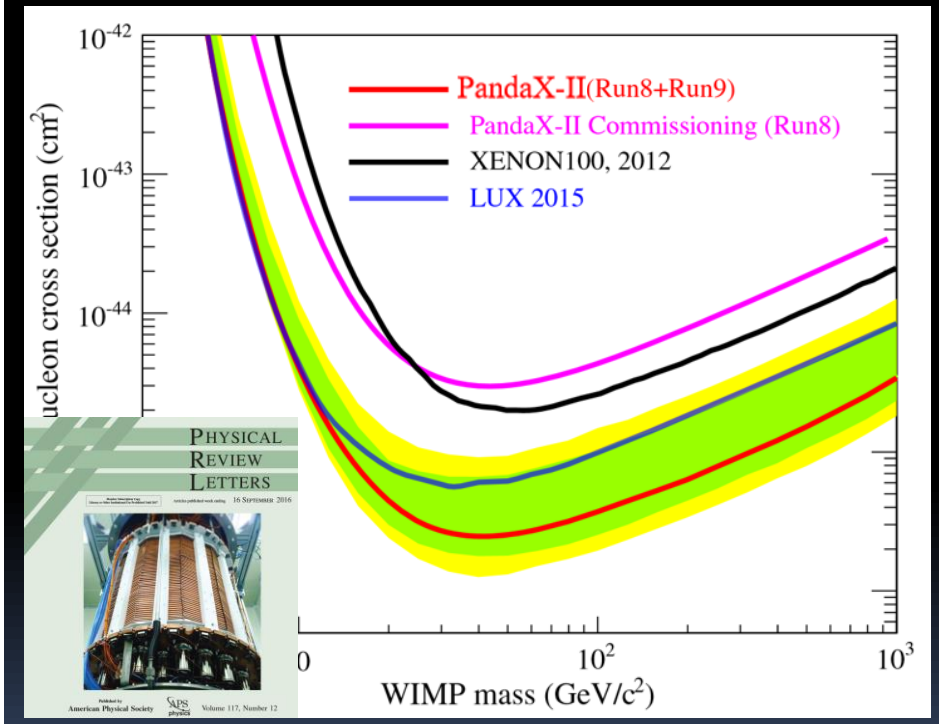


- Run9 =79.6 days, exposure: 26.2 ton-day
- Run10 =77.1 days, exposure: 27.9 ton-day
- Largest reported DM exposure to date

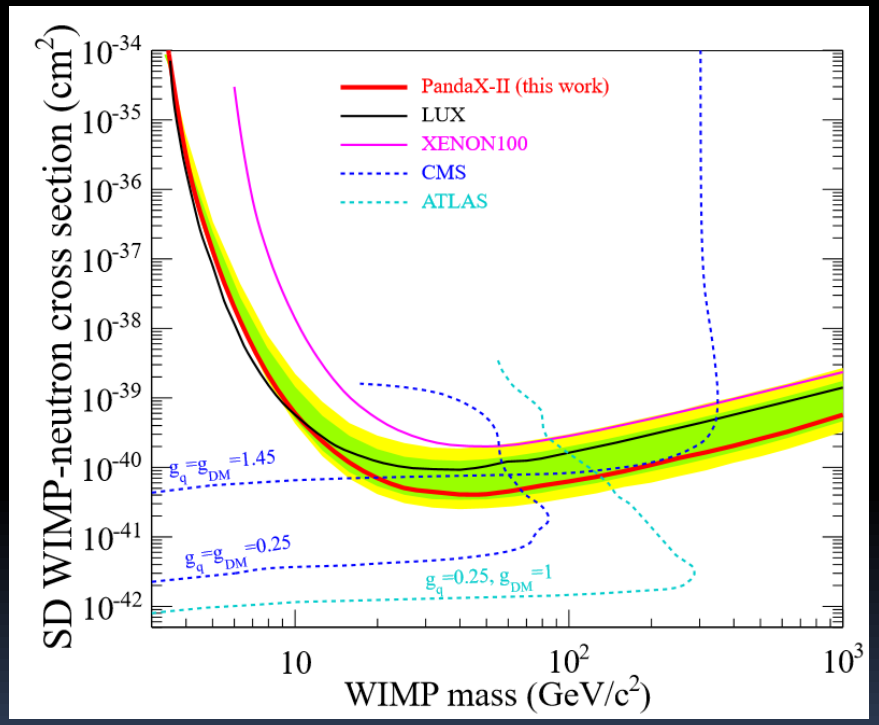
Run8+9 SI and SD results

33,000 kg-day exposure

PRL 117, 121303 (2016)



PRL 118, 071301 (2017)

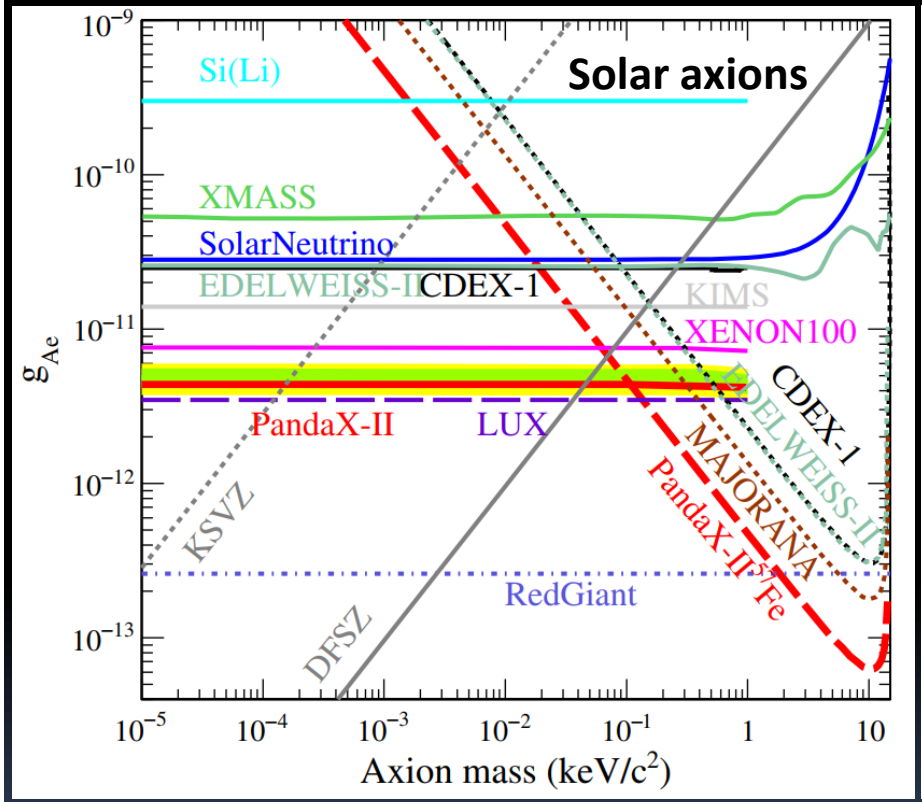


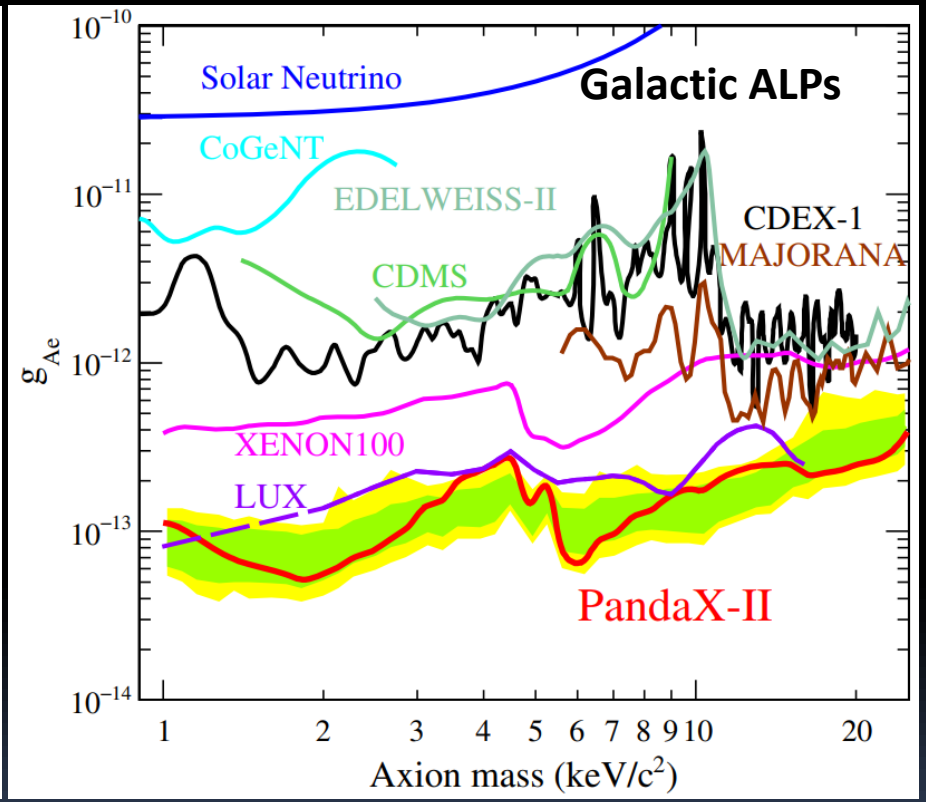
Minimum elastic SI exclusion:
2.5×10^{-46} cm² @ 40 GeV/c²

Minimum χ-n SD cross section limit:
4.1×10^{-41} cm² at 40 GeV/c²

Run9 axion limits **PRL 119, 181806 (2017)**

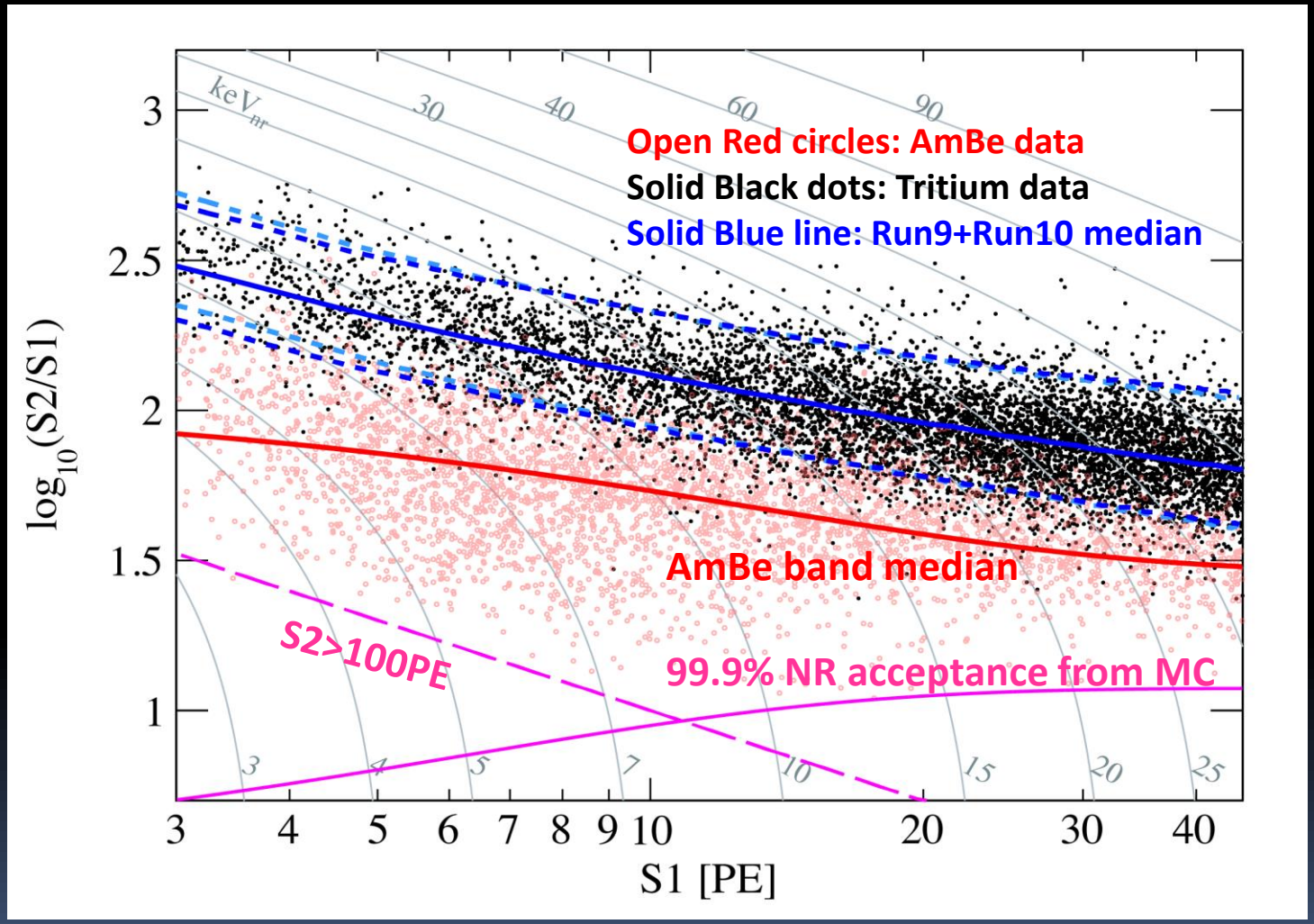
$$A + Xe \rightarrow Xe^{+} + e^{-}$$





- Among the leading axion search on axion-electron coupling using DD experiments

NR and ER calibration data



- ER events: tritium decay with >700 μs electron lifetime
- Fraction leaked below the NR median: 0.53(8)%

2nd distillation campaign

- After ER calibration, realized that the getter could not remove tritium background effectively
- Suspected tritium attached to wall, emanation rate balance with removal rate

⇒ 2nd distillation campaign (for Kr and tritium)

- Nov. – Mar 2017: **recuperate → distillation → refill,** flush (closed) detector with warm xenon

First beneficial occupancy of CJPL-II!

ER background budget table

	Run9	Run10
^{127}Xe	0.42	0.021
Tritium	0	0.27
^{85}Kr	1.19	0.20
^{222}Rn	0.13	0.12
^{220}Rn	0.01	0.02
Detector ER	0.20	0.20
Solar neutrino	0.01	0.01
^{136}Xe	0.0022	0.0022
Total	1.96	0.79

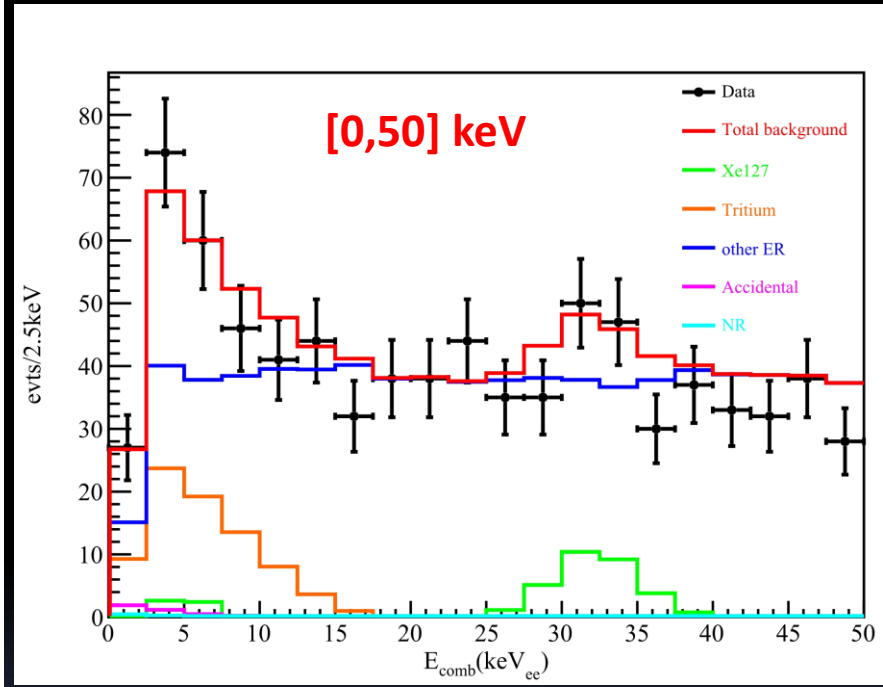
Original ^{127}Xe gone, additional introduced by a bottle of surface xenon during distillation

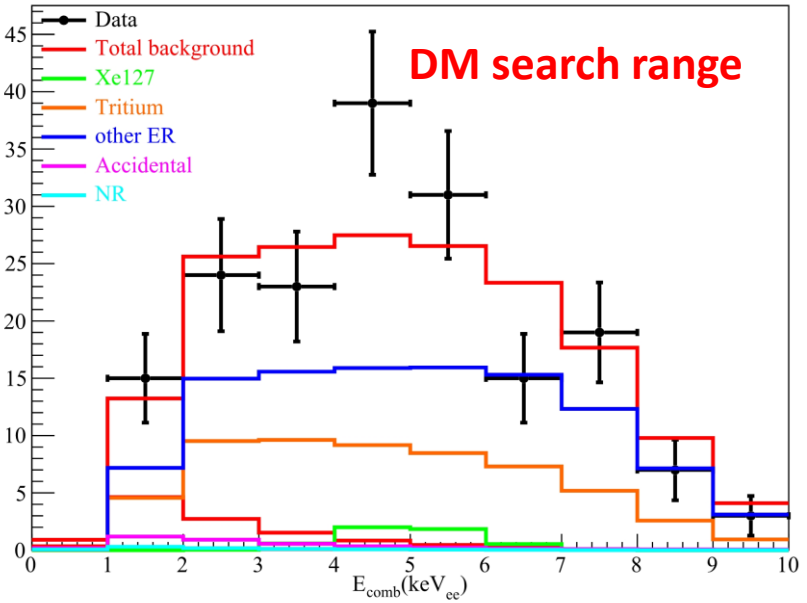
Based on best fit to data (later)

Rest are consistent between Run 9 and Run 10

Unit: mDRU = 10^{-3}/keV/day/kg
0.8 mDRU ~ 2 events a day!

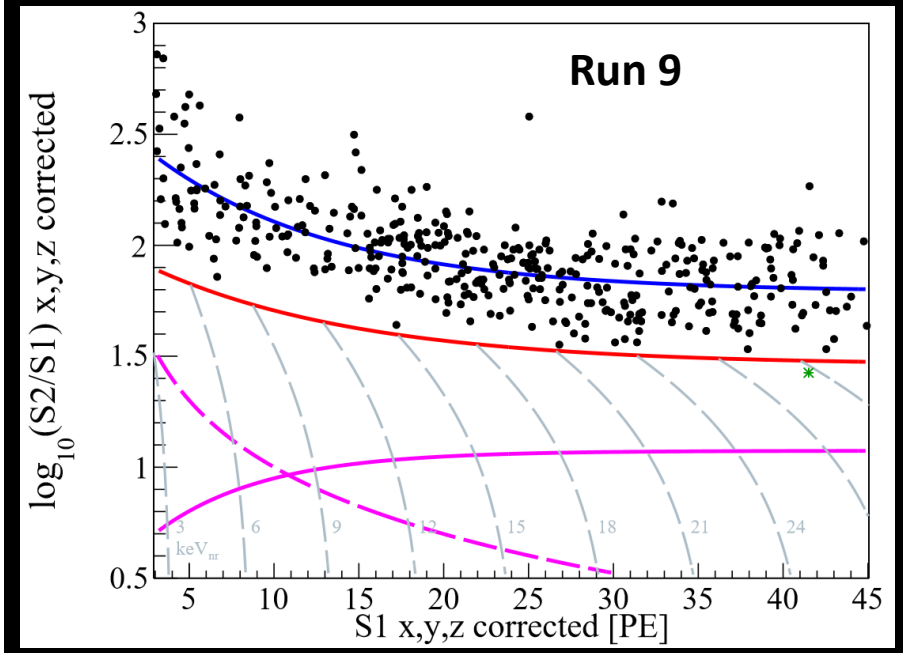
Energy spectrum in Run 10

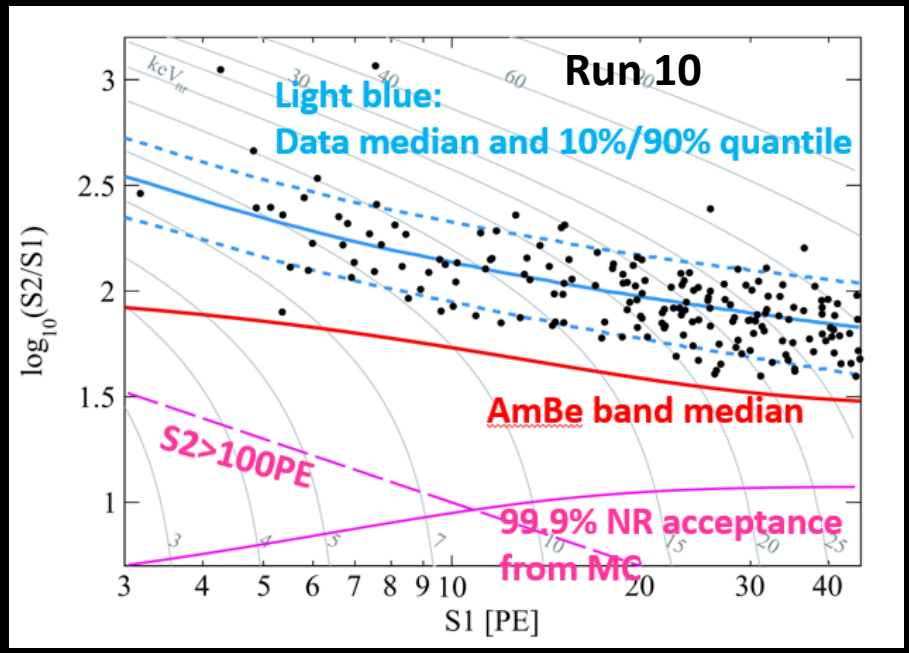




Data and expected background in good agreement

Distribution of events

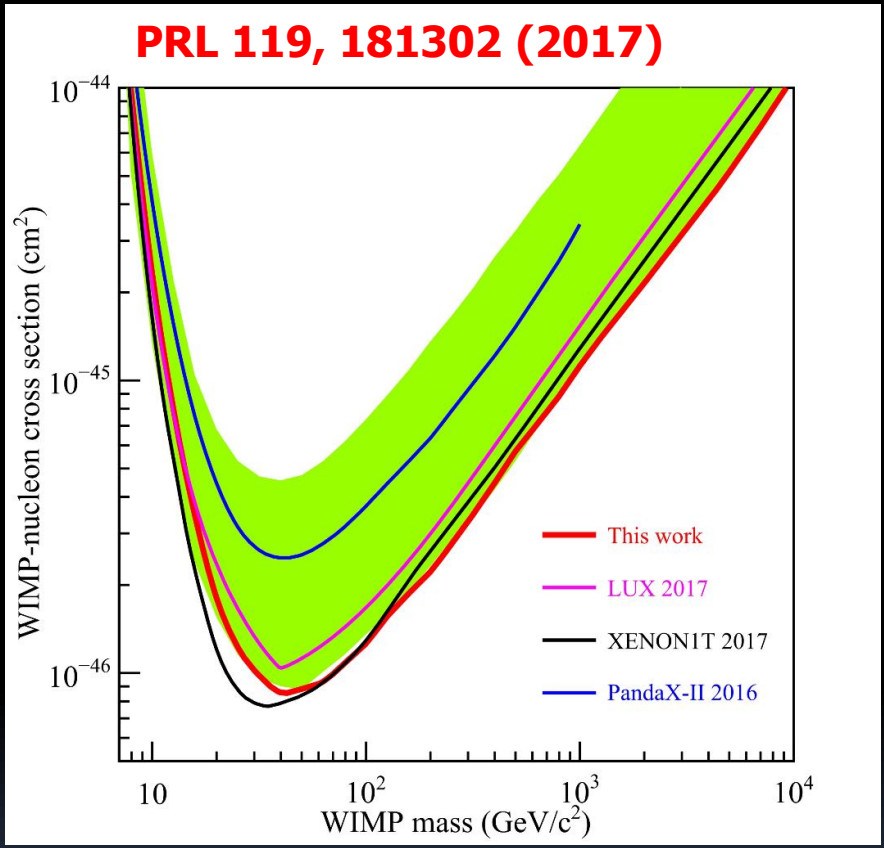


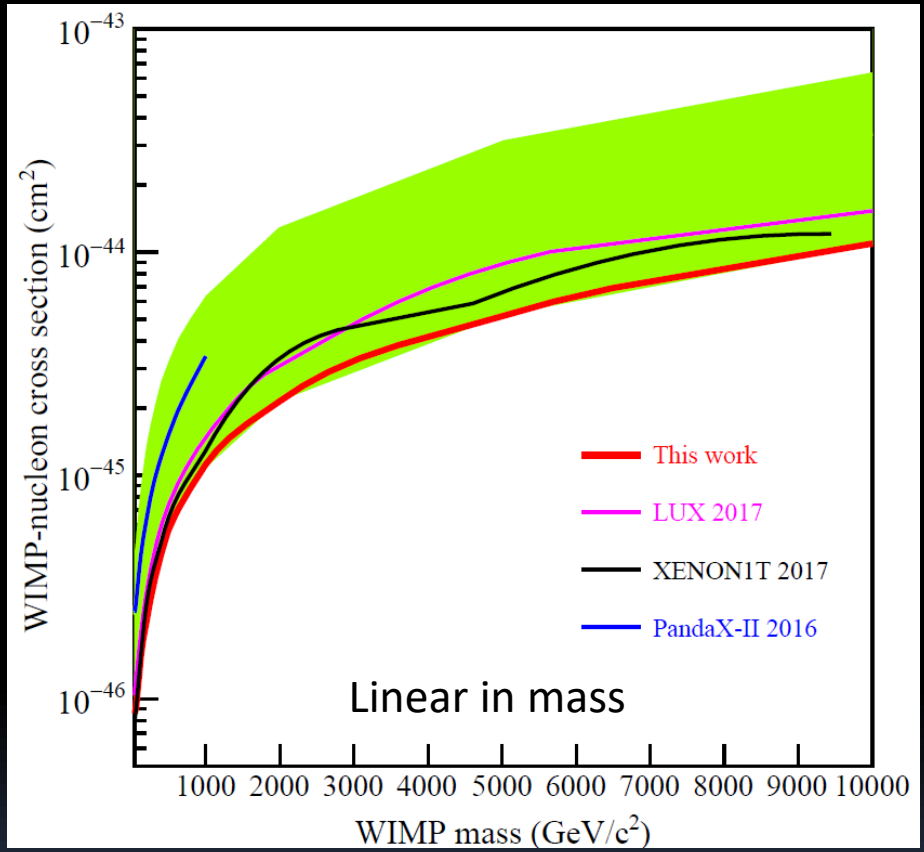


	ER	Accidental	Neutron	Total Fitted	Total Observed
Run 9	376.1	13.5	0.85	390 ± 50	389
Below NR median	2.0	0.9	0.35	3.2 ± 0.9	1
Run 10	172.2	3.9	0.83	177 ± 33	177
Below NR median	0.9	0.6	0.33	1.8 ± 0.5	0

Appears to have a downward fluctuation of background (p value 7% for Run 9+10)

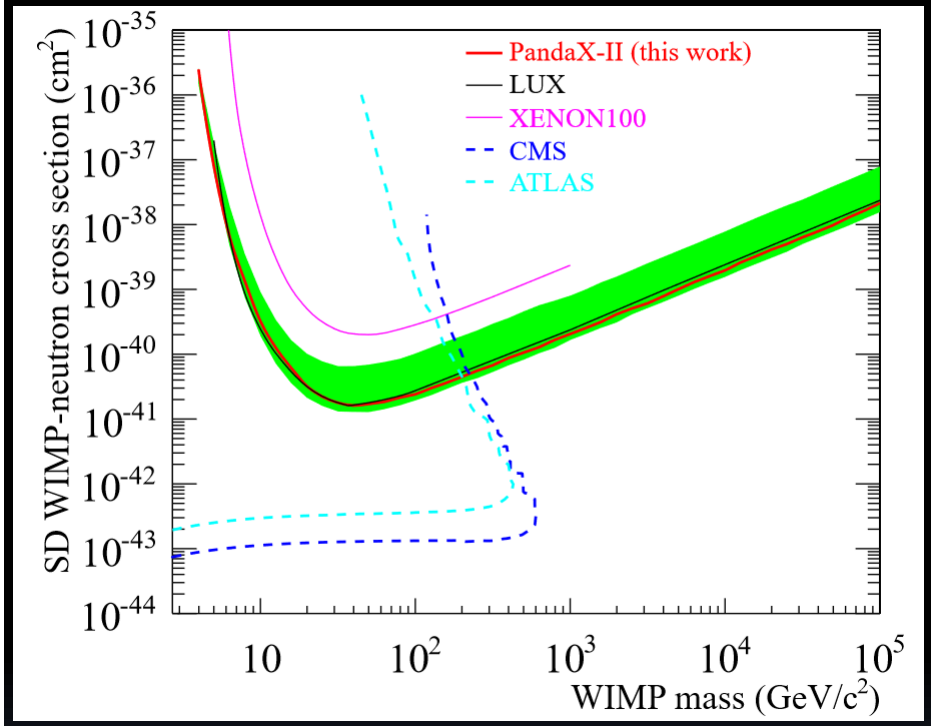
WIMP-nucleon SI results

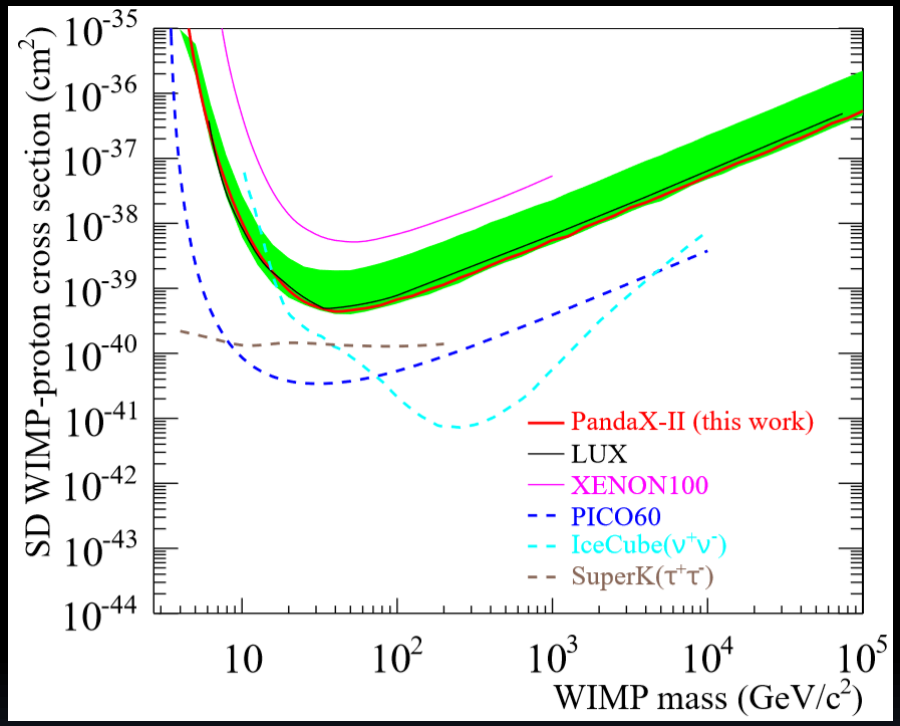




- Improved from PandaX-II 2016 limit about 2.5 time for >30GeV/c^2
- Lowest exclusion at 8.6×10^{-47}cm^2 at 40GeV/c^2
- Most stringent limit for WIMP-nucleon cross section for mass >100GeV/c^2 to date

WIMP-nucleon SD results (54 ton-day)





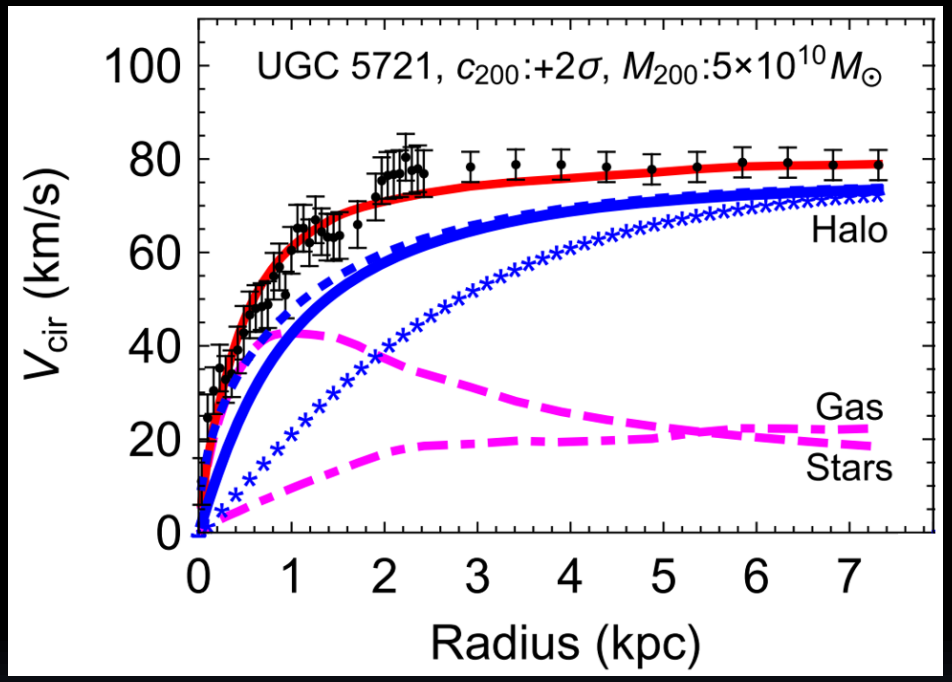
Minimum χ-n SD cross section limit:
1.6×10^{-41} cm^2 at 40 GeV/c^2

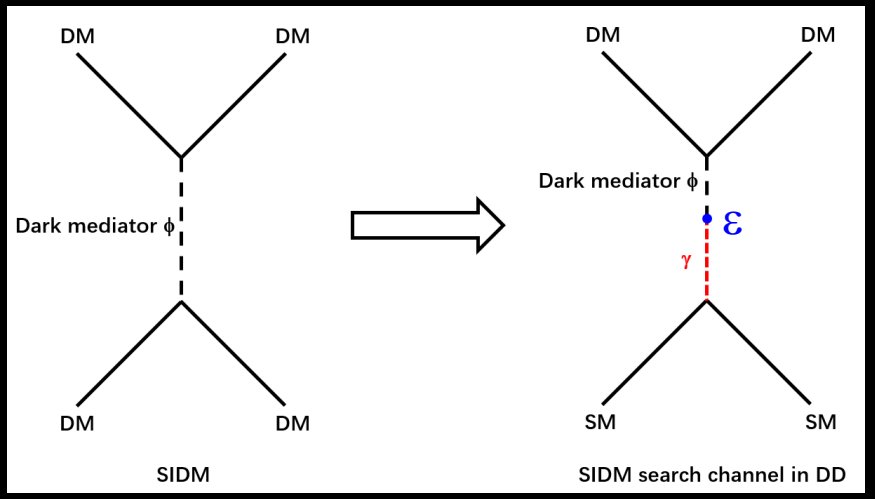
Minimum χ-p SD cross section limit:
4.4×10^{-40} cm^2 at 40 GeV/c^2

- More general EFT analysis completed
- Soon to be appeared on arXiv

Self-interacting DM search

PRL 119, 111102



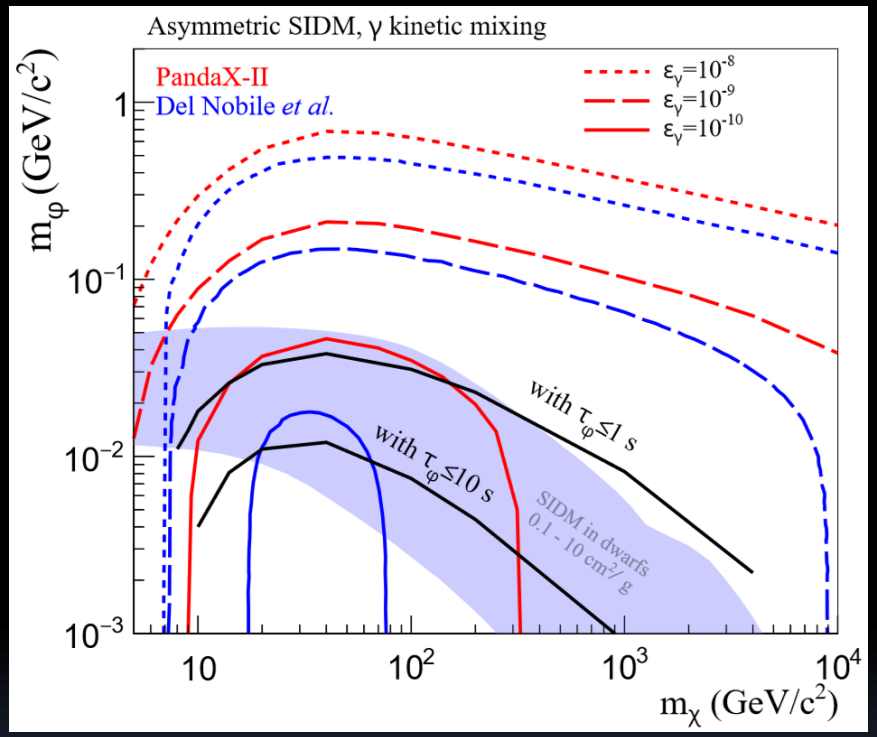


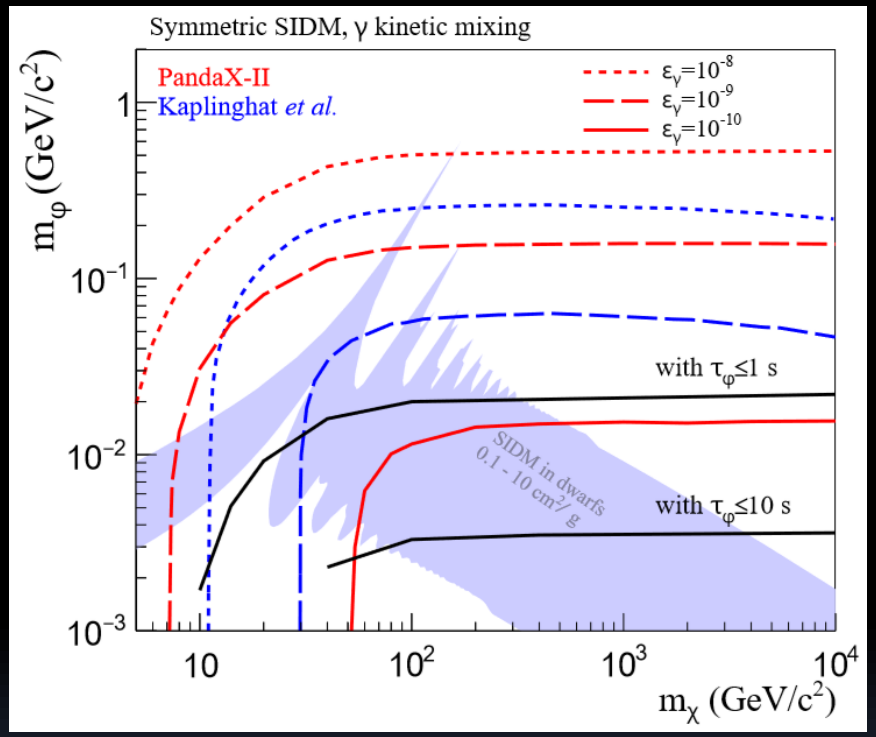
Astrophysical observations: SIDM could solve long standing "small-scale puzzle"

- DD constraint: **upper limit** of interaction strength of dark mediator with SM: $\sigma \sim \varepsilon^2/m_\phi^4$
- BBN constraint: **lower limit** of decay strength of dark mediator into SM: $\tau \sim (\varepsilon^2 m_\phi)^{-1}$

Self-interaction DM search (54-ton day)

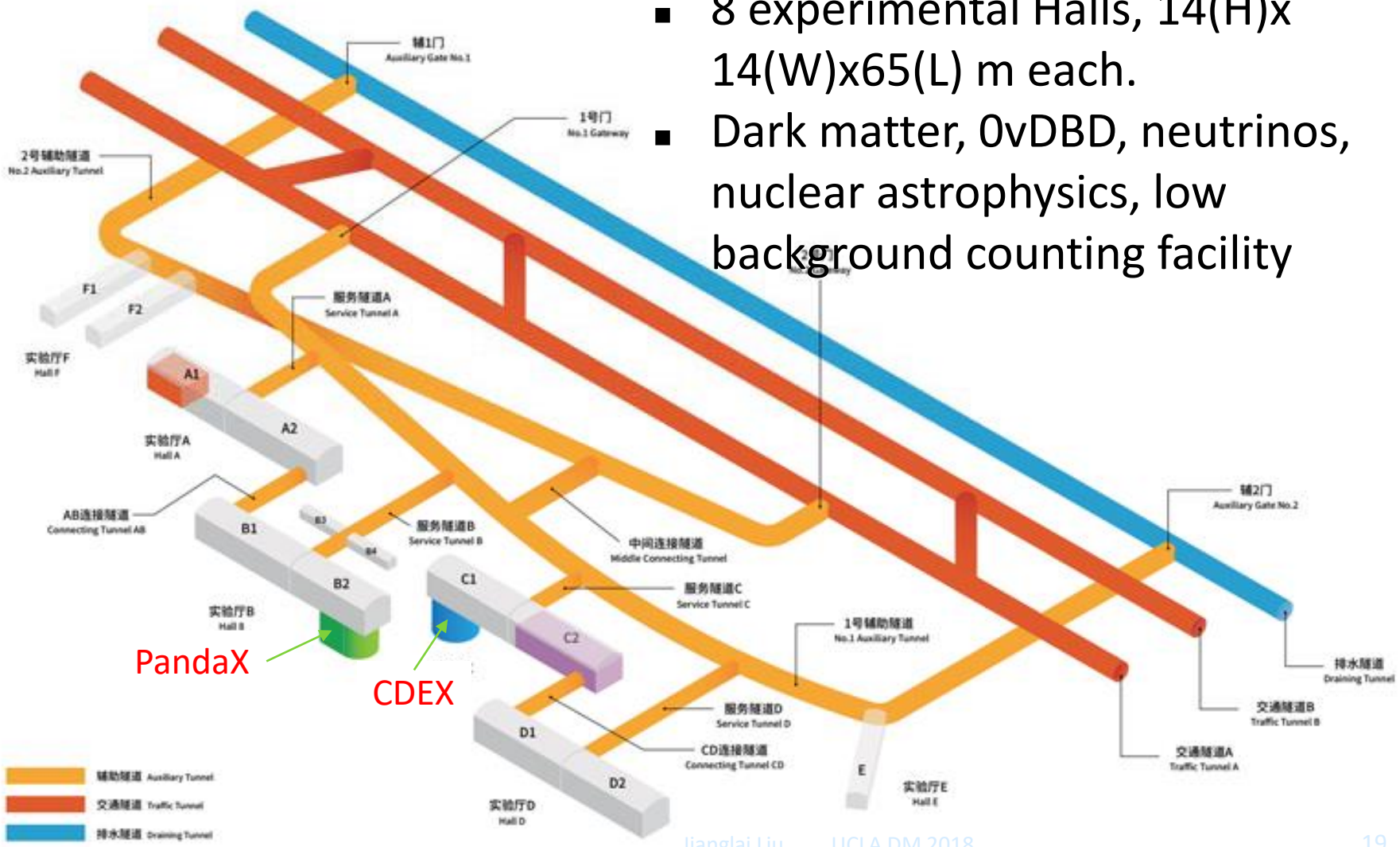
arXiv:1802.06912





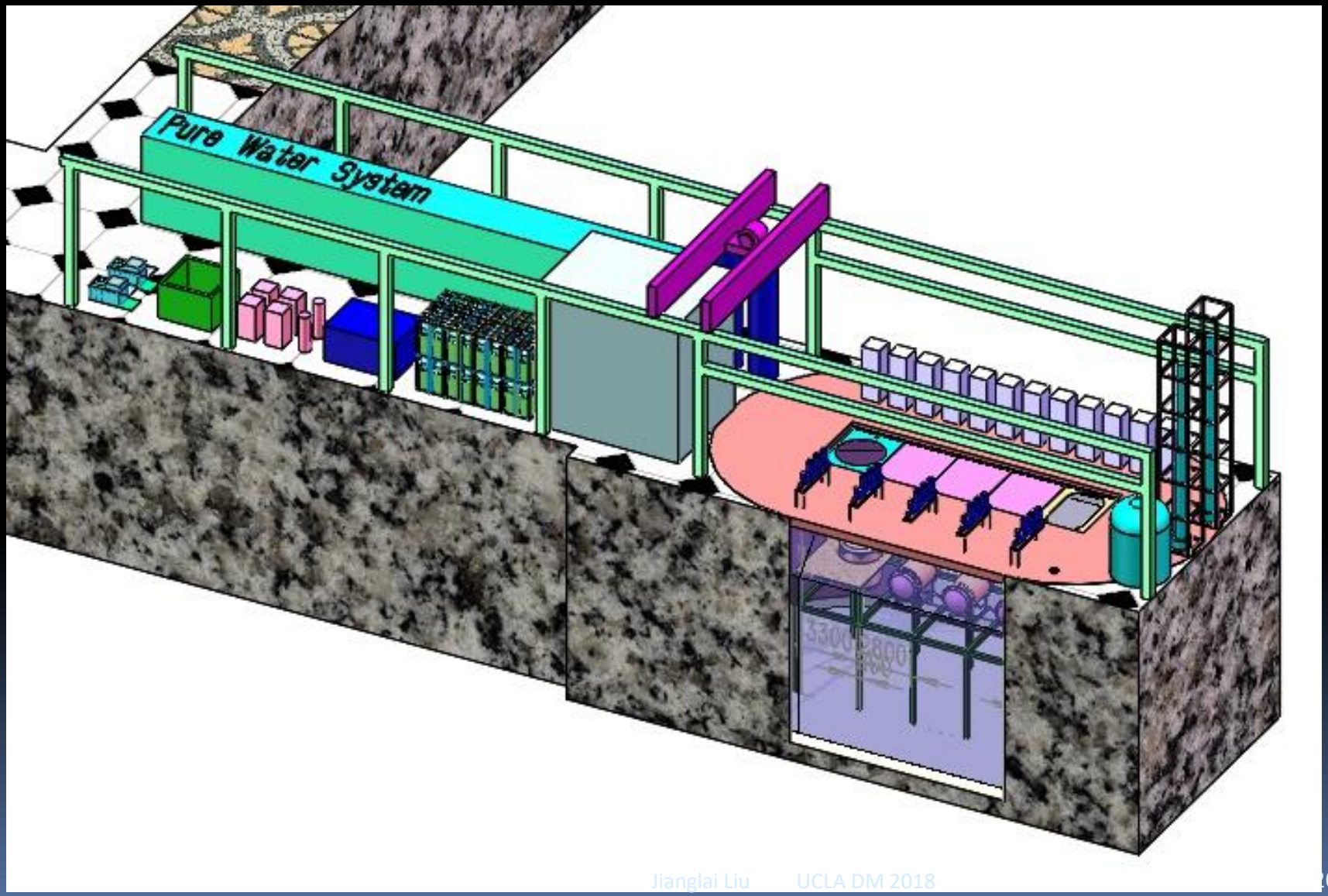
- Minimum mediator mass can be obtained "independent" of kinematic mixing when combining DD and BBN constraints
- Excluded big portion of parameter region favored by dwarf galaxies observations

Future: CJPL-II

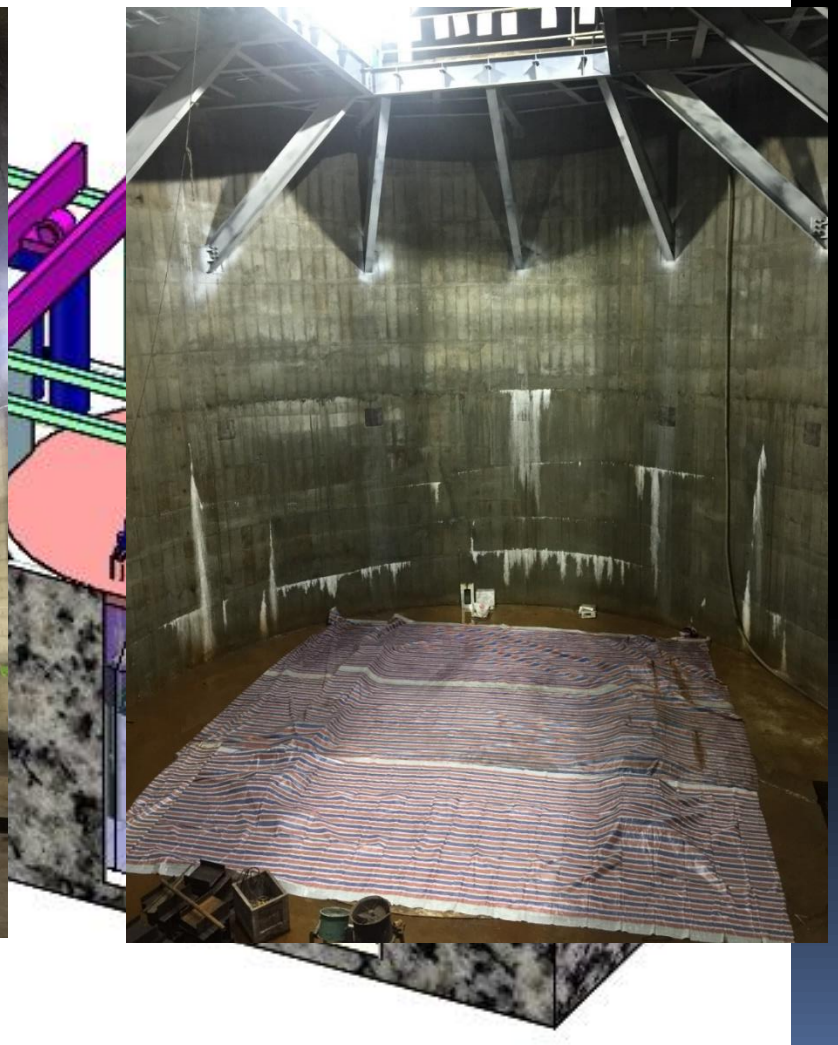


- 8 experimental Halls, 14(H)x 14(W)x65(L) m each.
- Dark matter, 0vDBD, neutrinos, nuclear astrophysics, low background counting facility

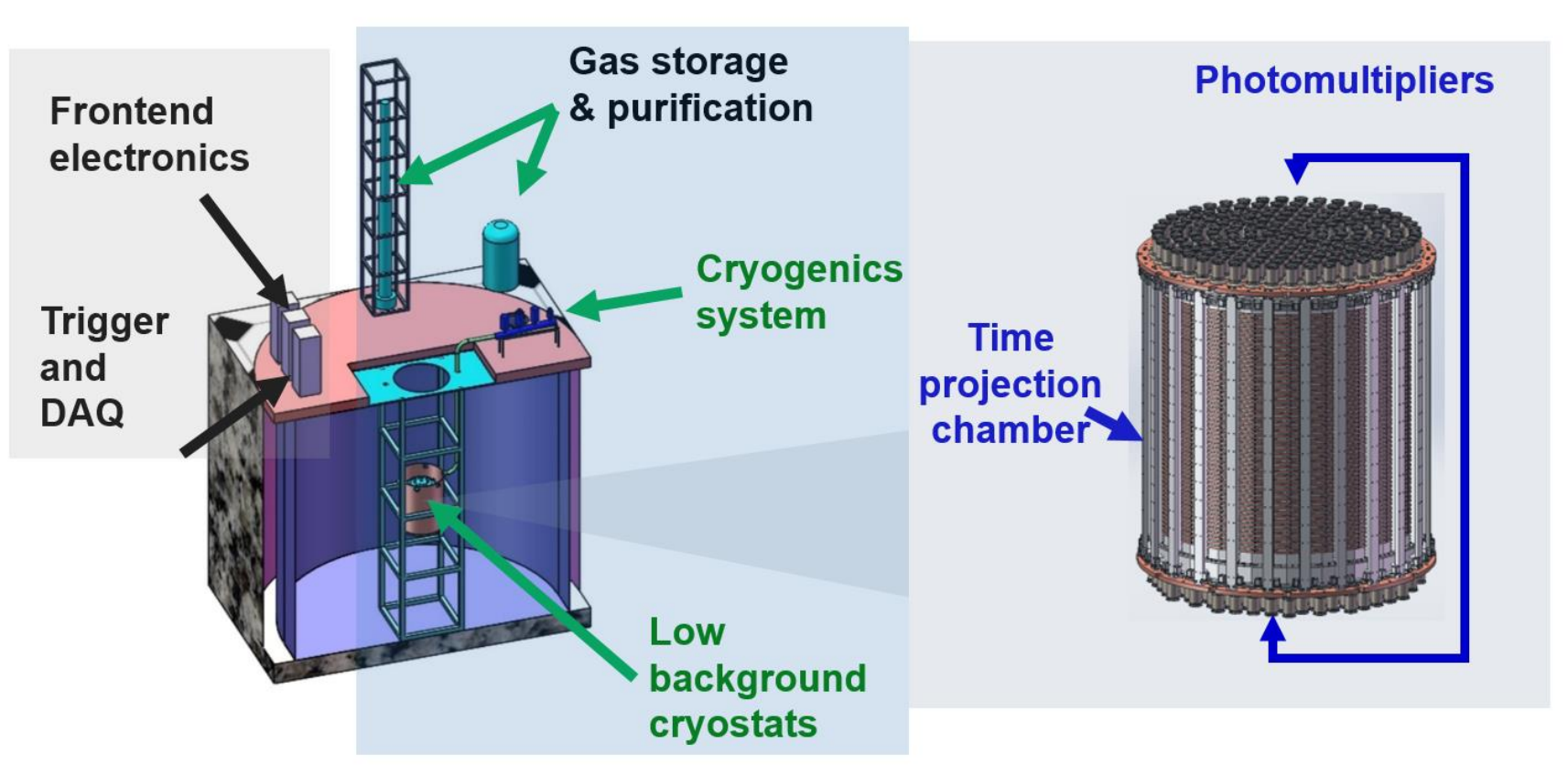
B2 experimental hall



B2 experimental hall

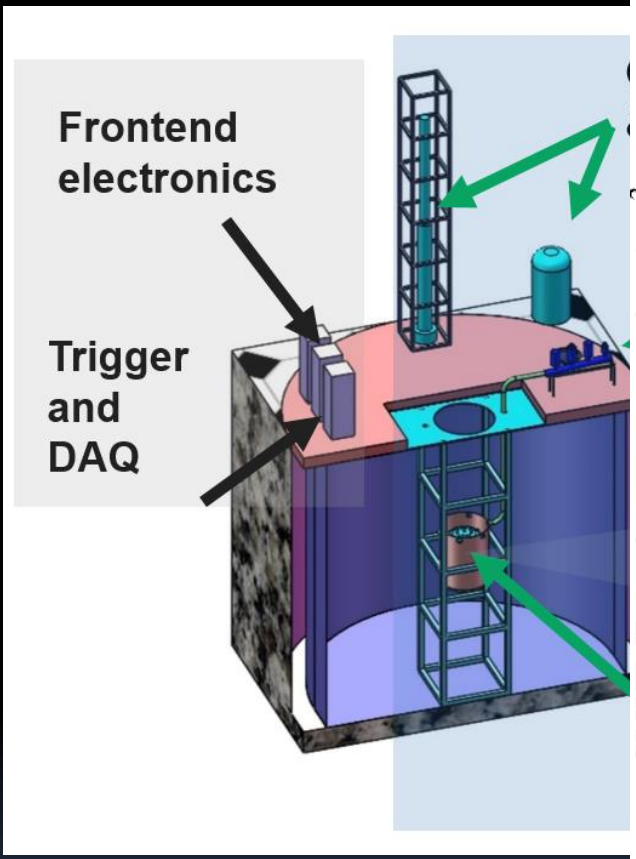


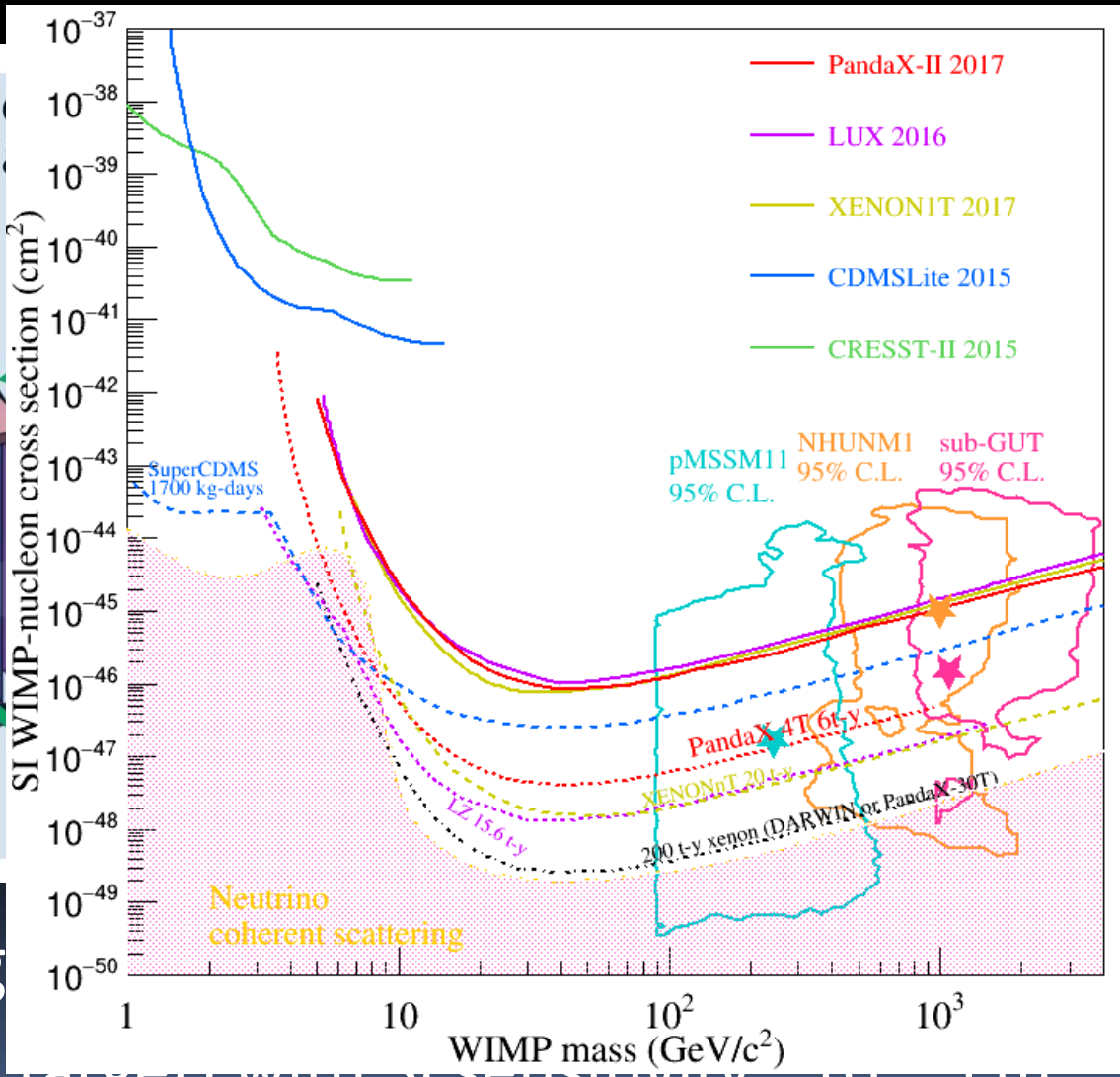
PandaX-xT



- Intermediate stage:
  - **PandaX-4T** (4-ton target) with SI sensitivity ~10^{-47} cm^2
  - On-site assembly and commissioning: 2019-2020

PandaX-xT





- Intermediate stag
  - **PandaX-4T** (4-ton target) with SI sensitivity ~10 cm
  - On-site assembly and commissioning: 2019-2020

Summary and outlook

- PandaX-II continues to probe the forefront of the dark matter particle models
- 2018 expected completion of PandaX-II
- Exciting upgrade plans and future opportunities at CJPL-II for PandaX