
# Status and Prospects

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On behalf of PandaX Collaboration

# Outline

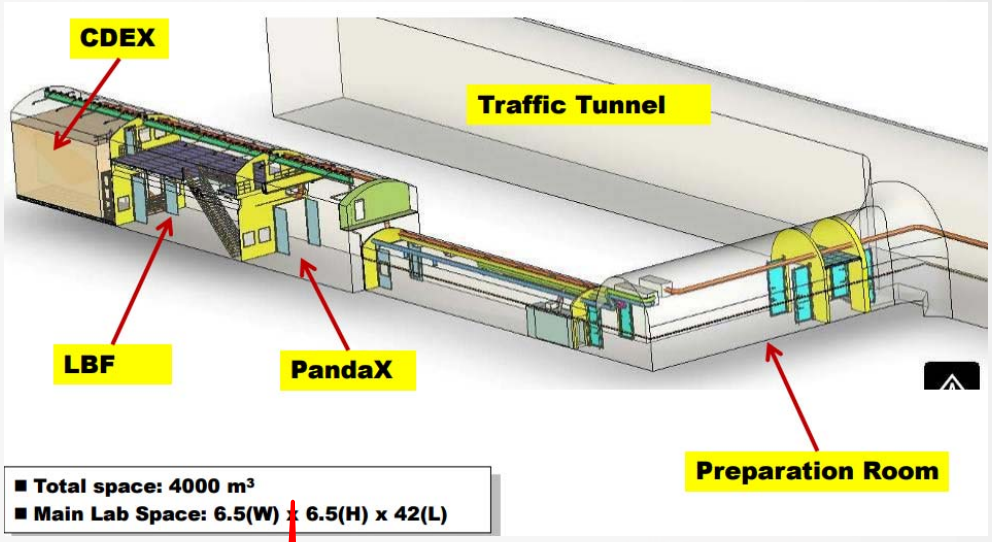
① Introduction to PandaX

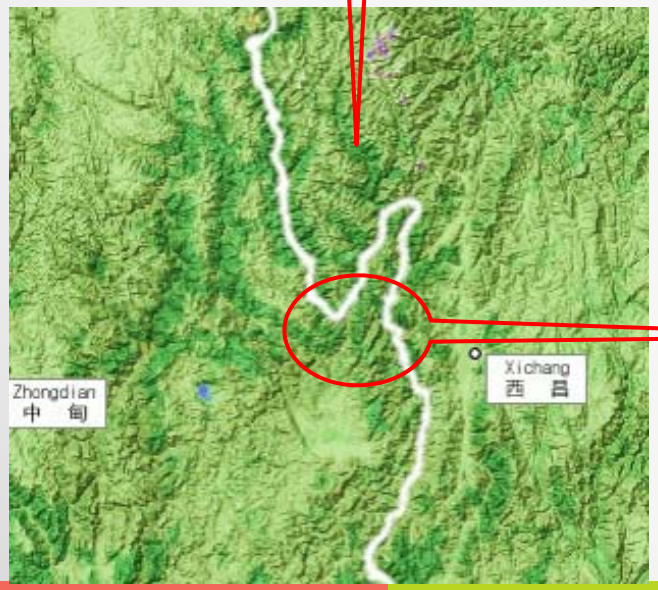
② Results from PandaX-II experiment

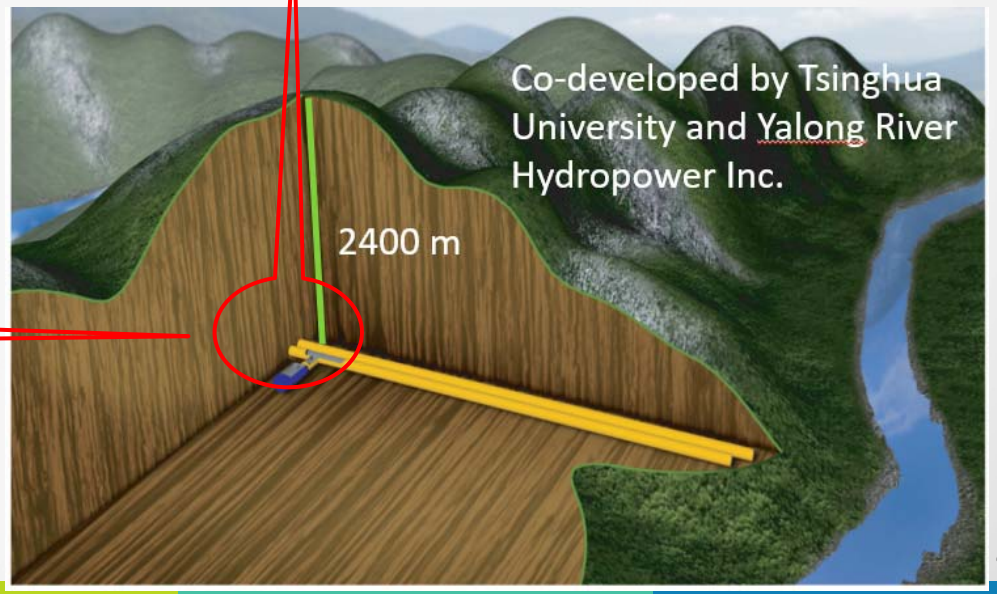
③ PandaX-xT

# ① Introduction to PandaX

# China Jin-Ping Underground Lab

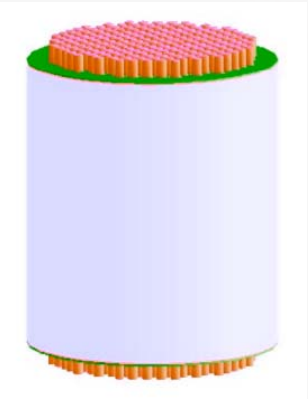



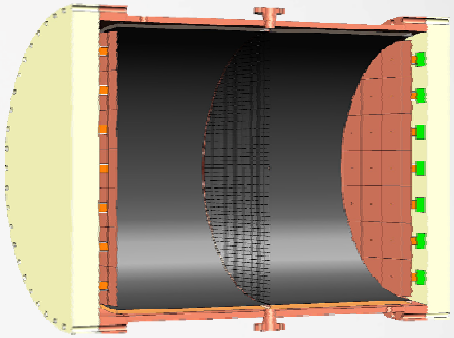
# PandaX Experiments

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

Particle and Astrophysical Xenon Experiments

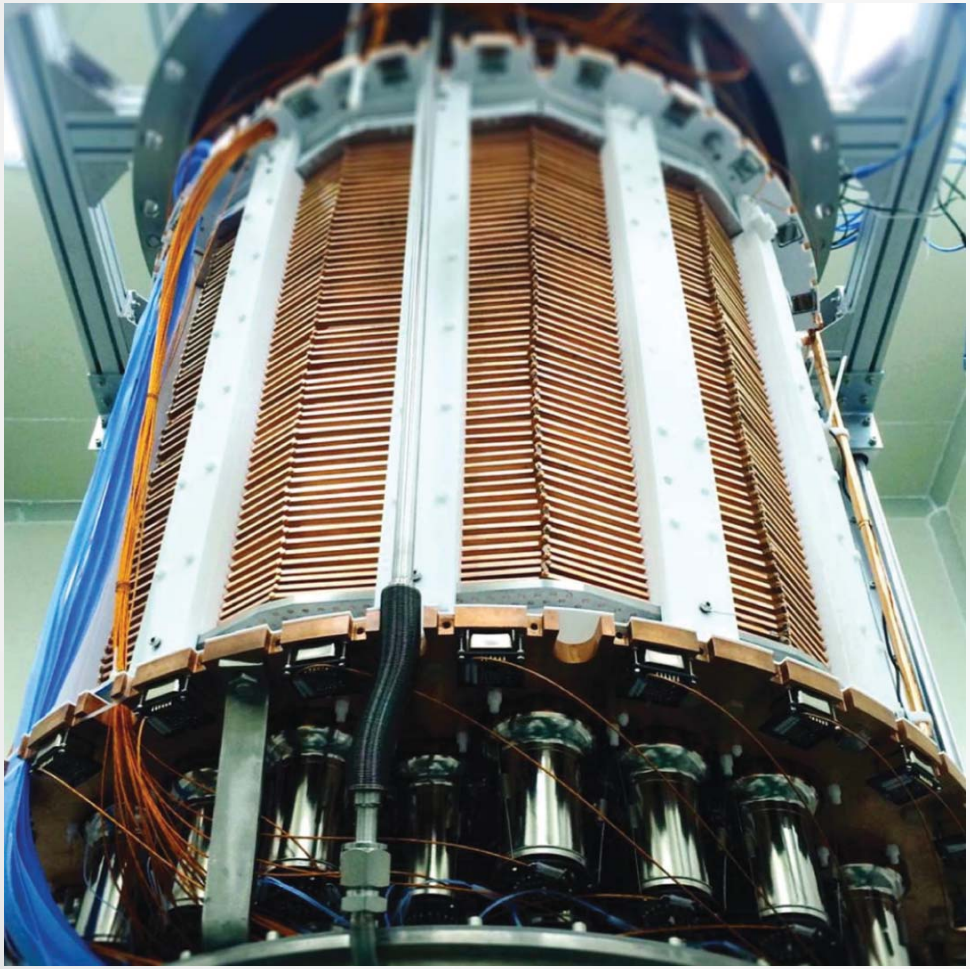
# PandaX Collaboration

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

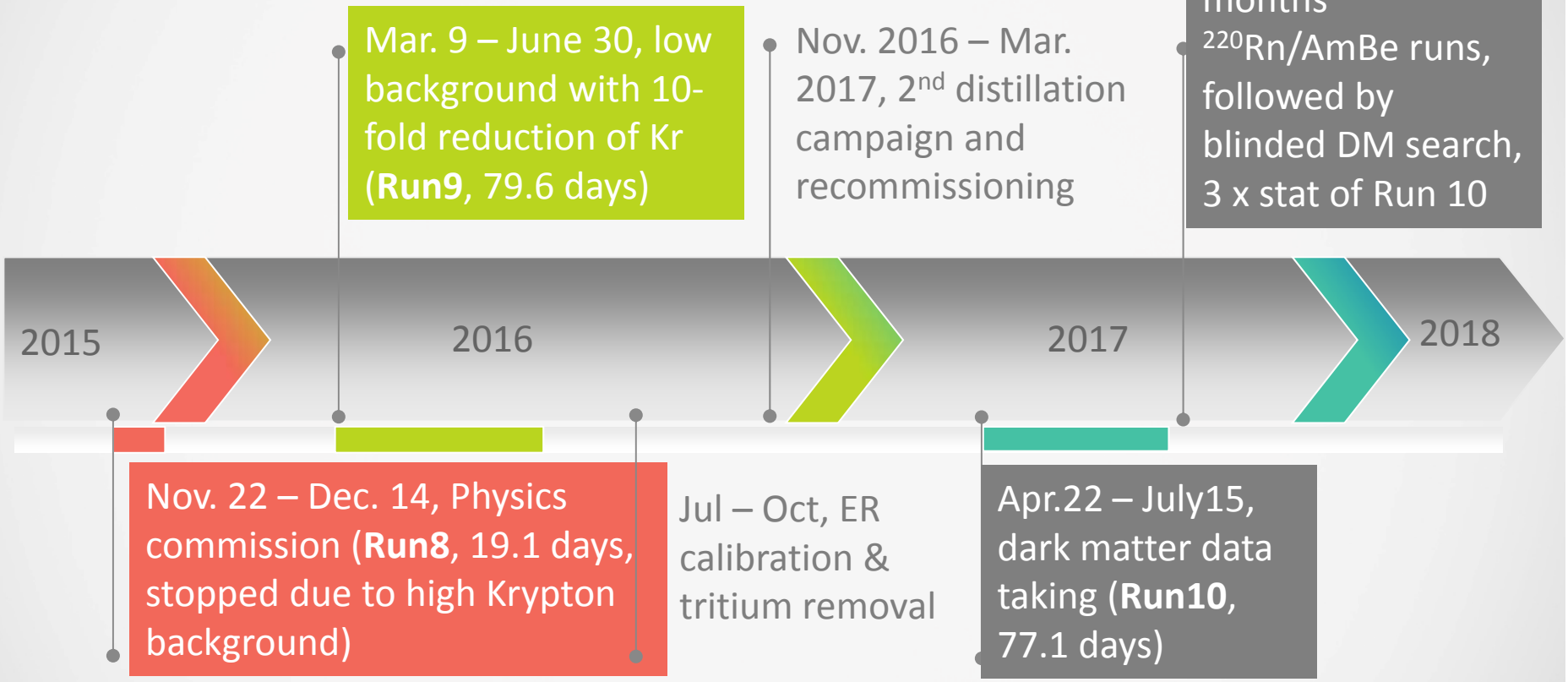
# PandaX-II Detector



- 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

# ② Results from PandaX-II experiments

# PandaX-II history

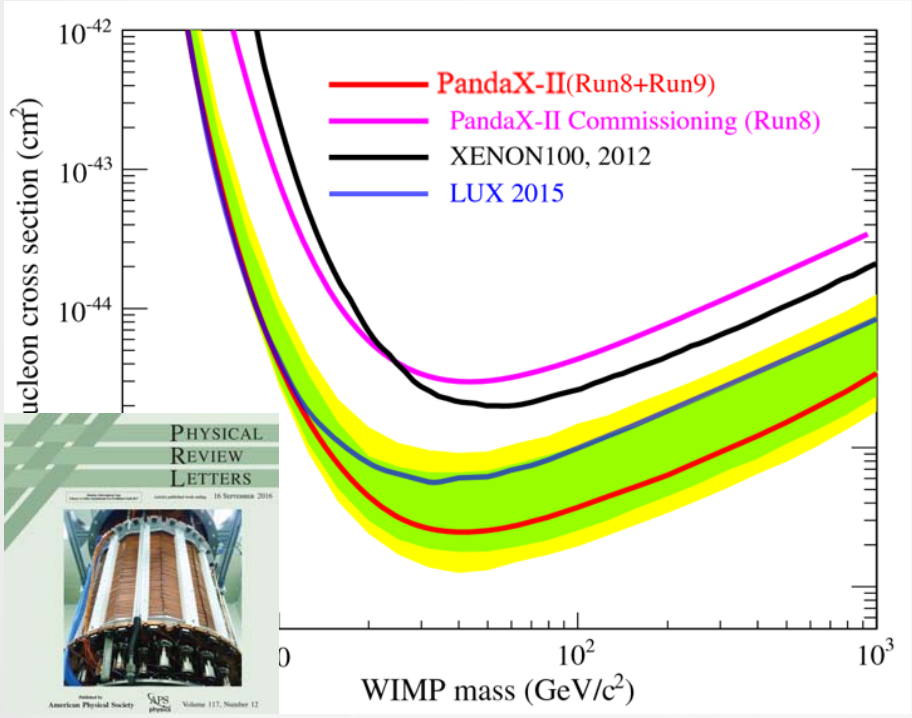



- Run9 =79.6 days, exposure: 26.2 ton-day
- Run10 =77.1 days, exposure: 27.9 ton-day

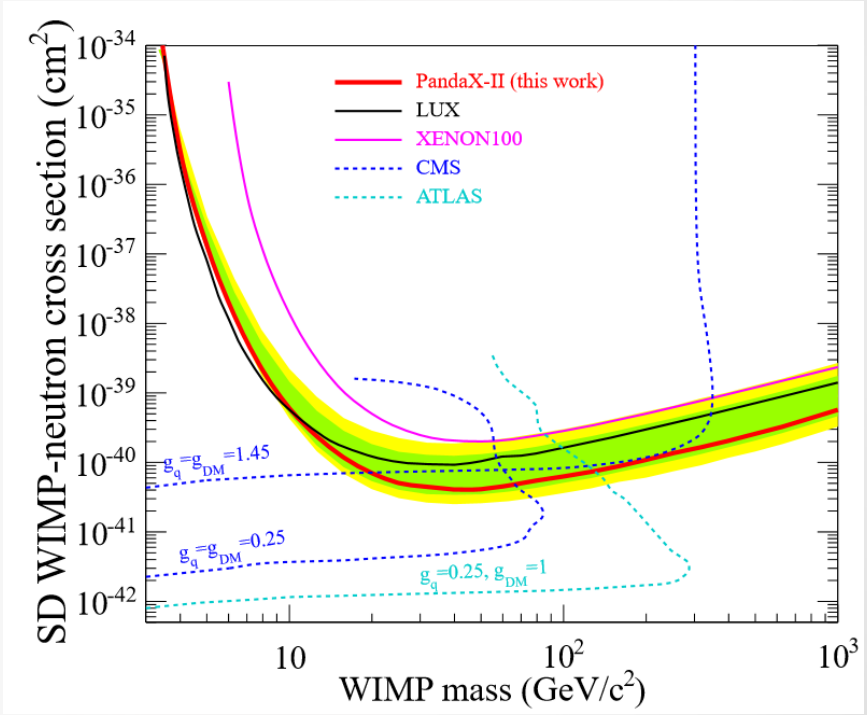
# Run8+9 SI and SD results

33,000 kg-day exposure

PRL 117, 121303 (2016)




PRL 118, 071301 (2017)




**Minimum elastic SI exclusion:**

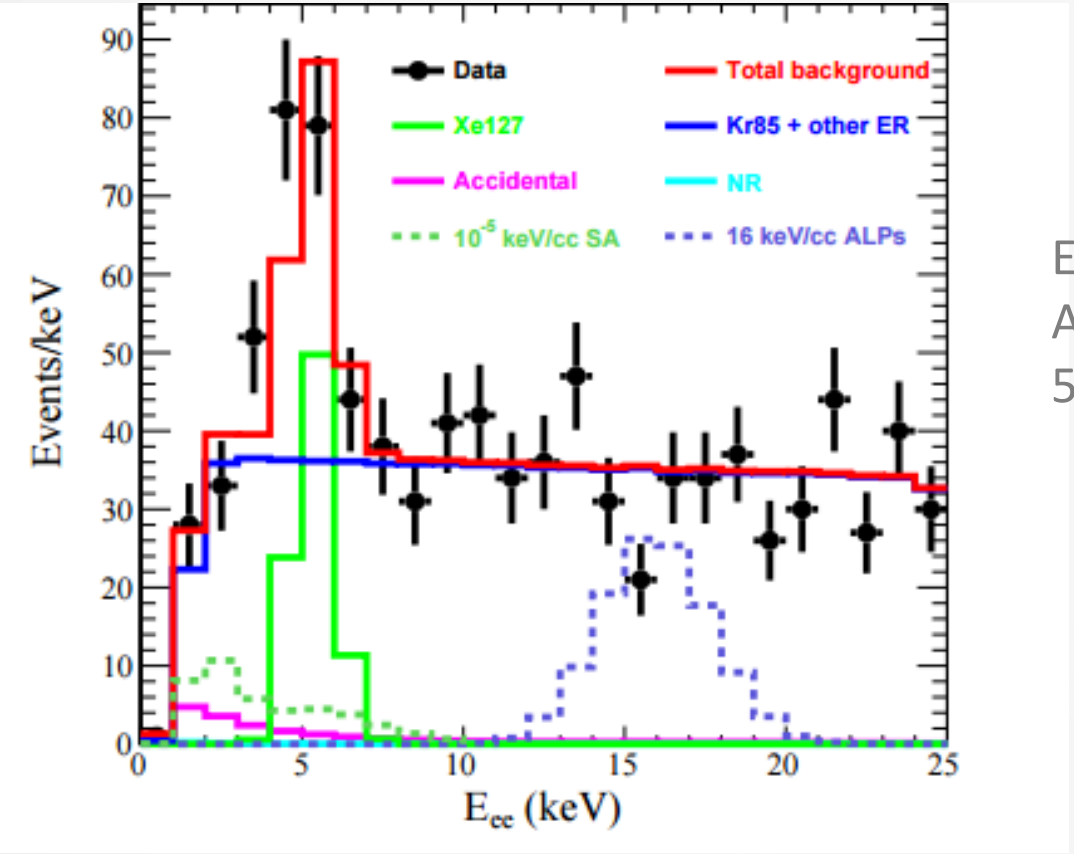
**$2.5\times10^{-46}$ cm² @ 40 GeV/c²**

**Minimum $\chi$-n SD cross section limit:**

**$4.1\times10^{-41}$ cm² at 40 GeV/c²**

# Run9 axion limits

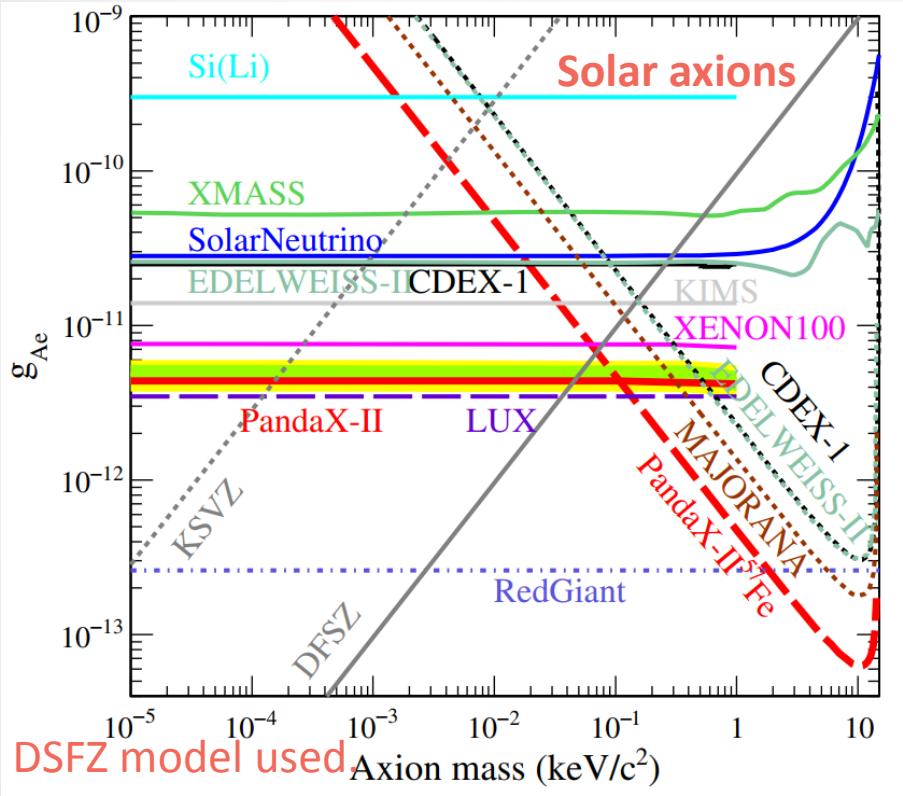
PRL 119, 181806 (2017)

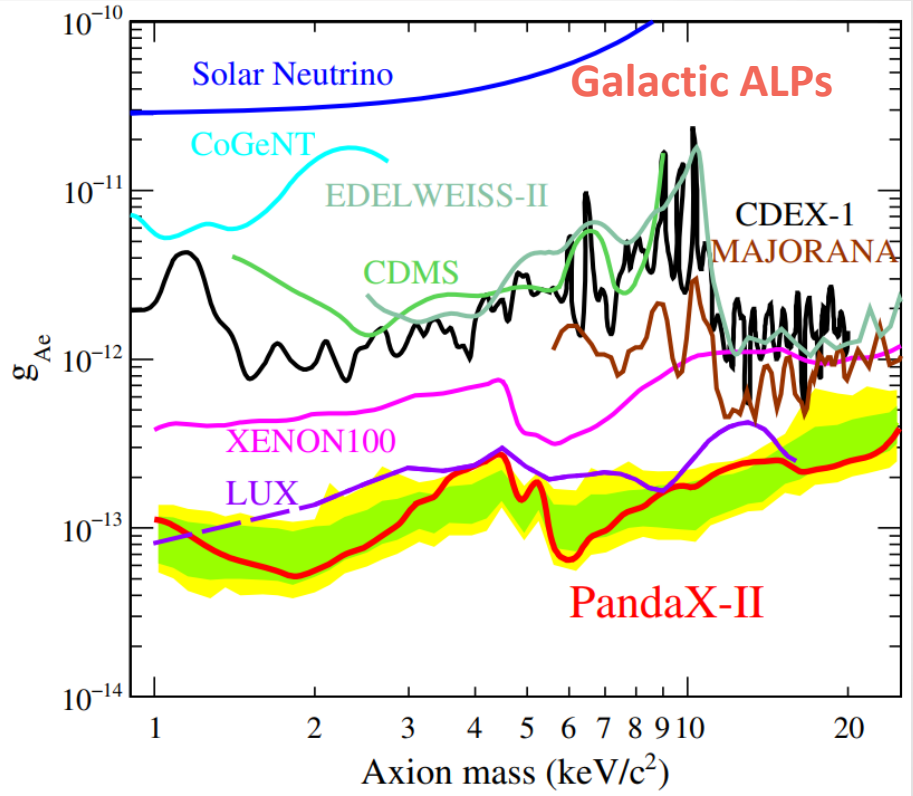



Electron recoil spectrum
Assuming coupling constant:
5e-12, 5e-13

# Run9 axion limits

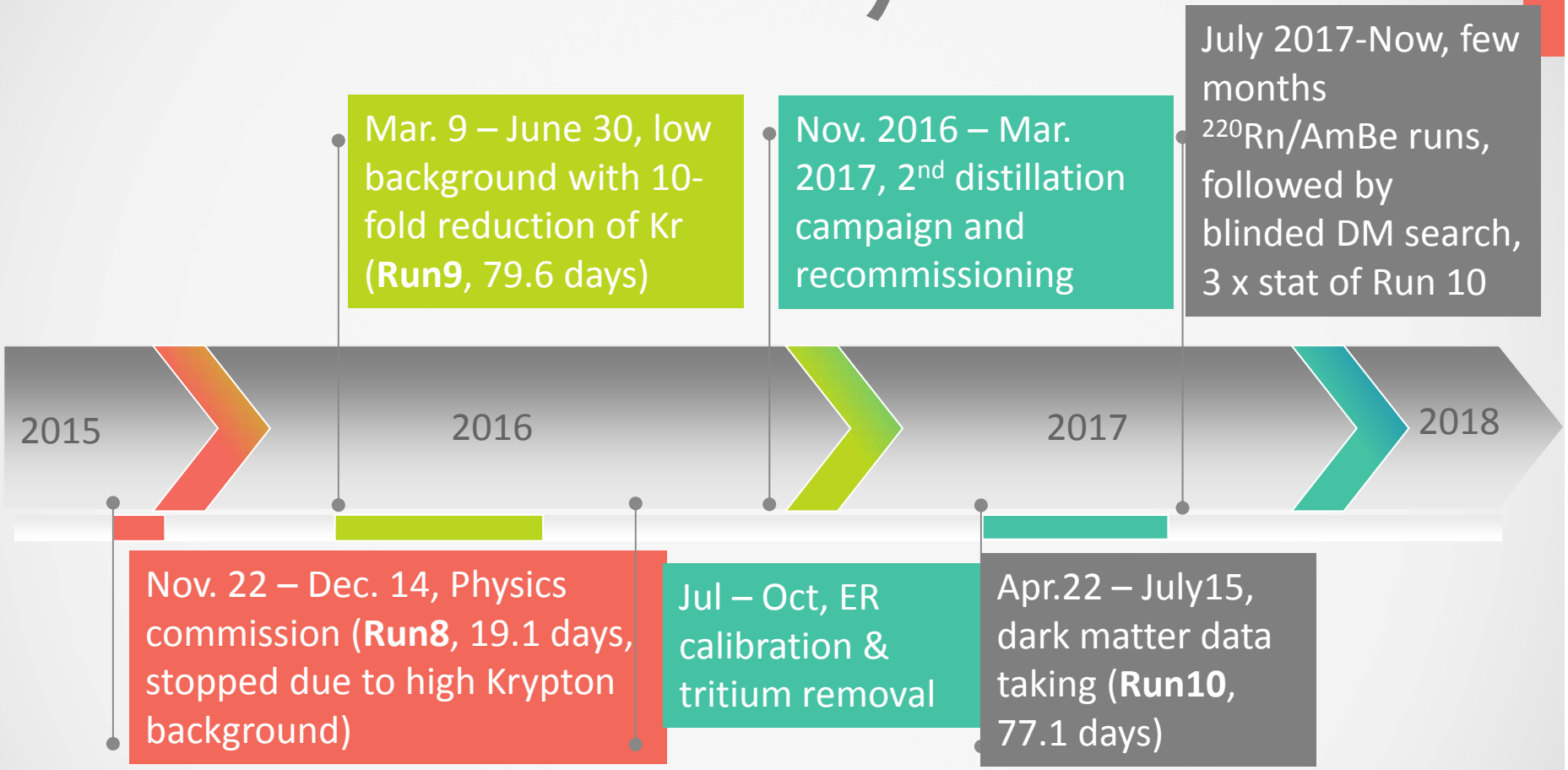
PRL 119, 181806 (2017)



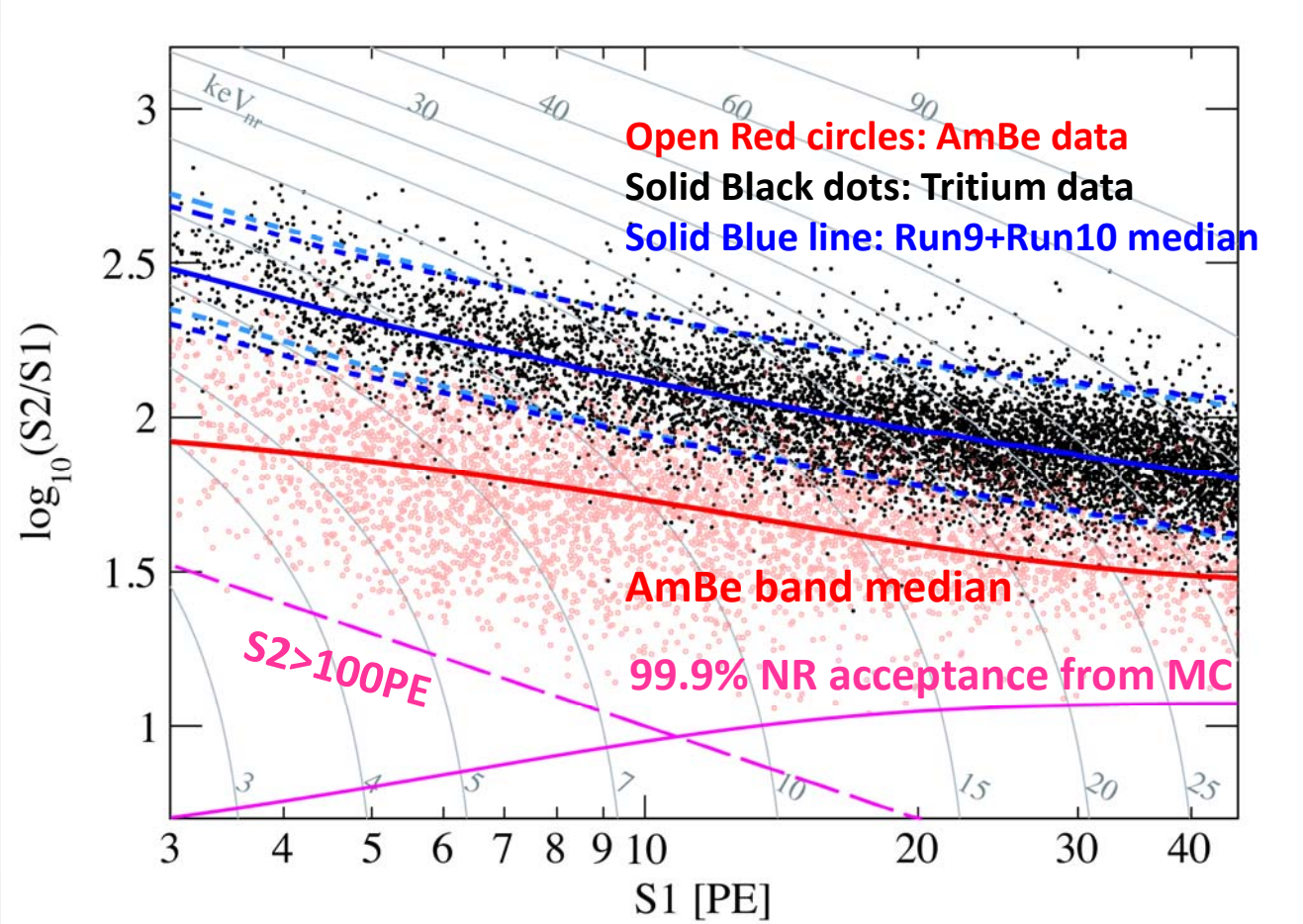

- Among the leading axion search on axion-electron coupling using DD experiments

# PandaX-II history




- Run9 =79.6 days, exposure: 26.2 ton-day
- Run10 =77.1 days, exposure: 27.9 ton-day

# 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

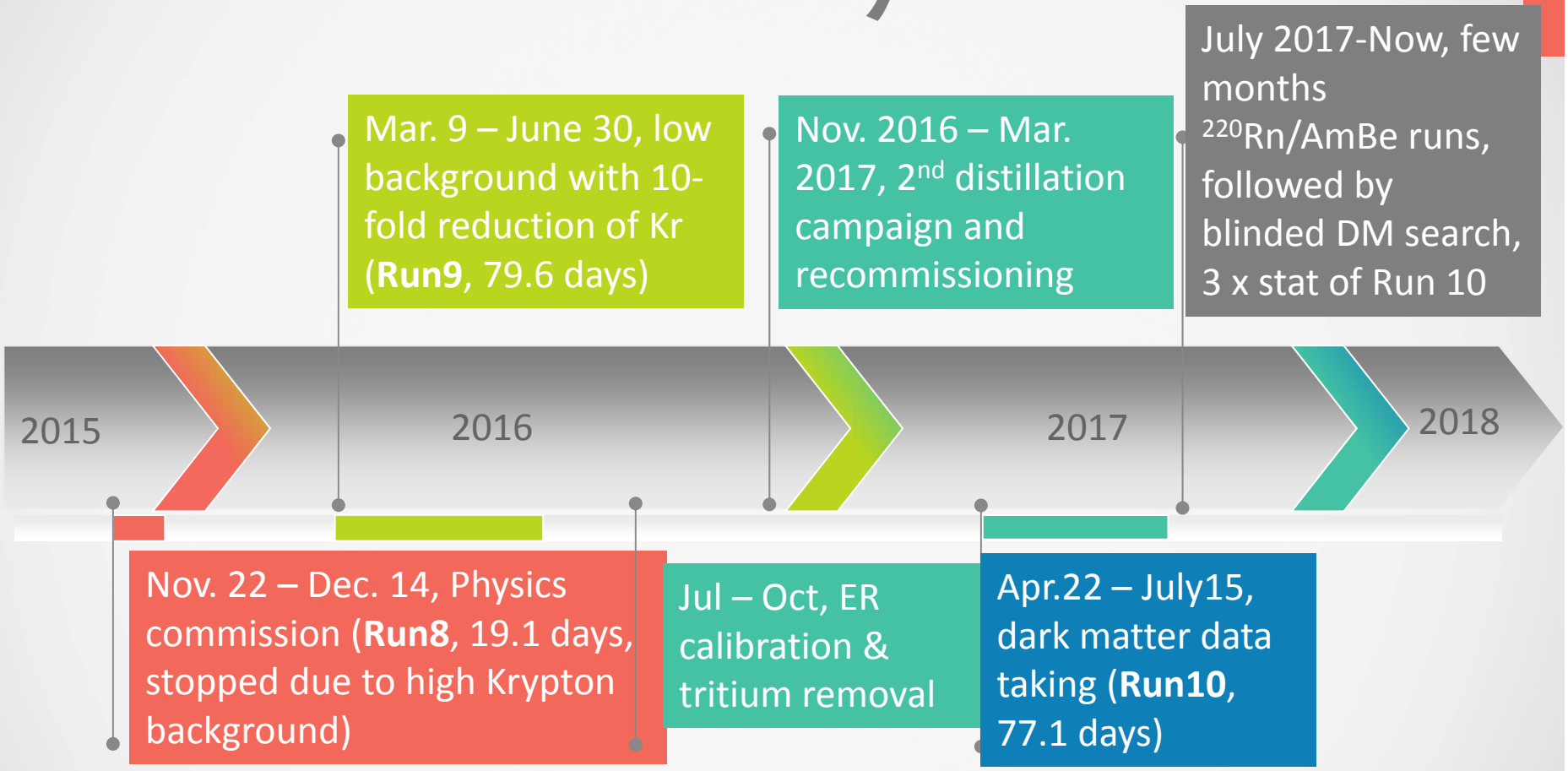
- After ER calibration, realized that the getter could not remove tritium background effectively
- Suspected tritium attached to wall, emanation rate balance with removal rate

⇒ 2nd distillation campaign (for Kr and tritium)

- Nov. 2016– Mar 2017: recuperate → distillation → refill, flush (closed) detector with warm xenon

First beneficial occupancy of CJPL-II!

# PandaX-II history




- Run9 =79.6 days, exposure: 26.2 ton-day
- Run10 =77.1 days, exposure: 27.9 ton-day

# ER budget

| | 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 |

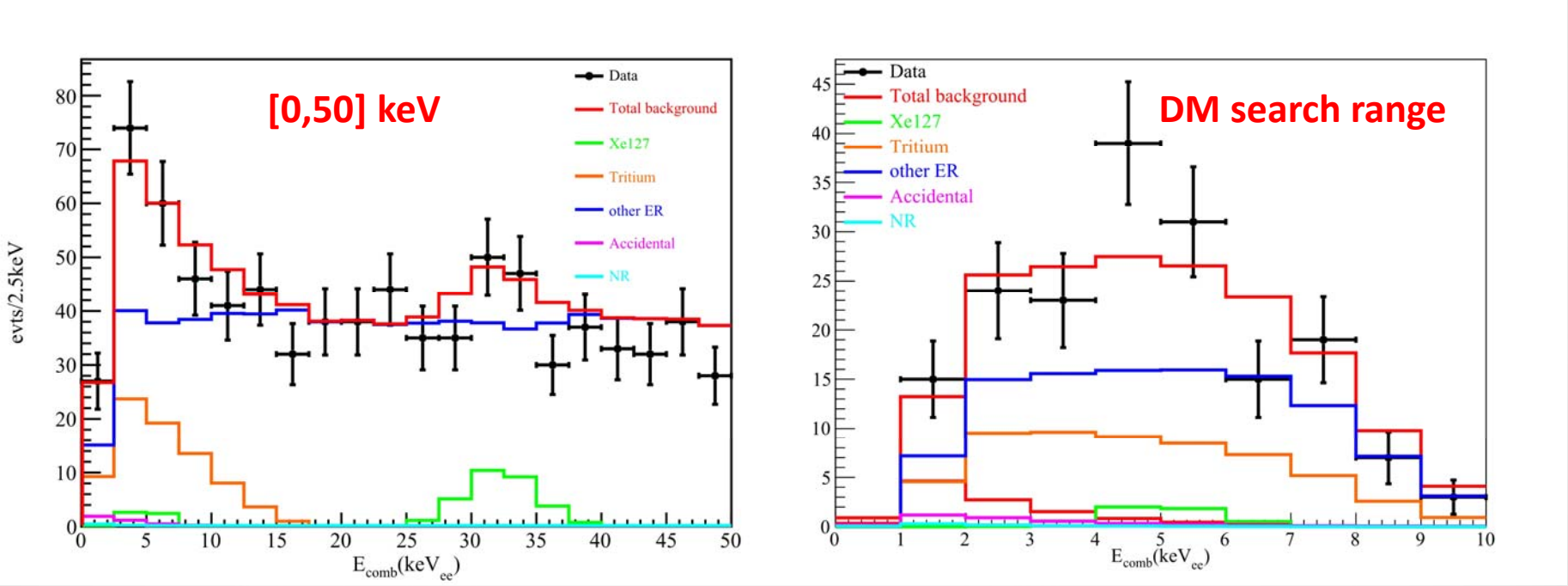
Original $^{127}$Xe gone, additional introduced by a bottle of surface xenon during distillation

Based on best fit to data (later)

Rest are consistent between Run 9 and Run 10

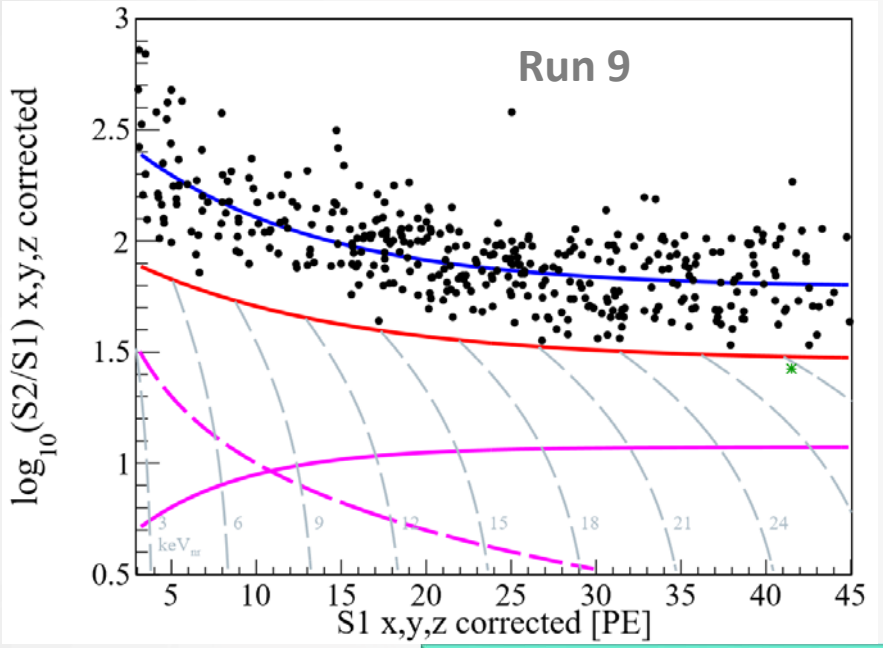
Unit: mDRU = $10^{-3}$/keV/day/kg
0.8 mDRU ~ 2 events a day!

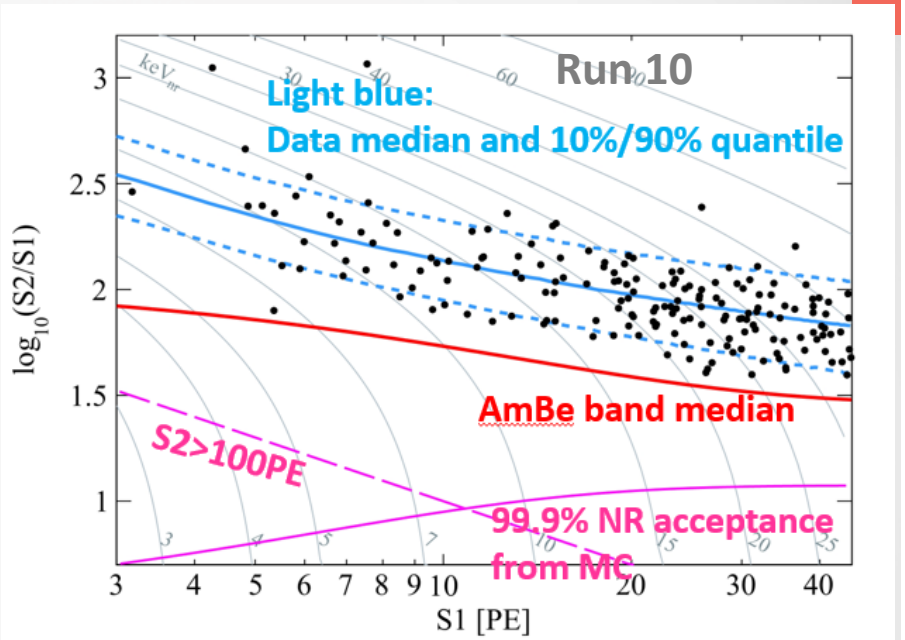
# Energy spectrum in Run 10




Data and expected background in good agreement

# Distribution of events

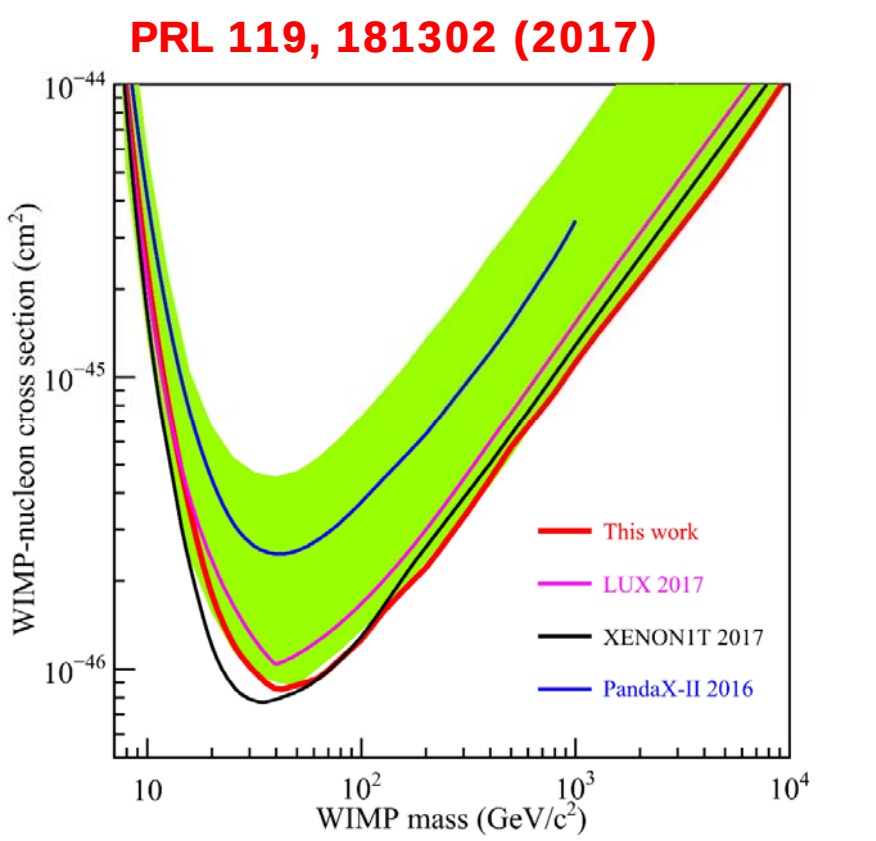


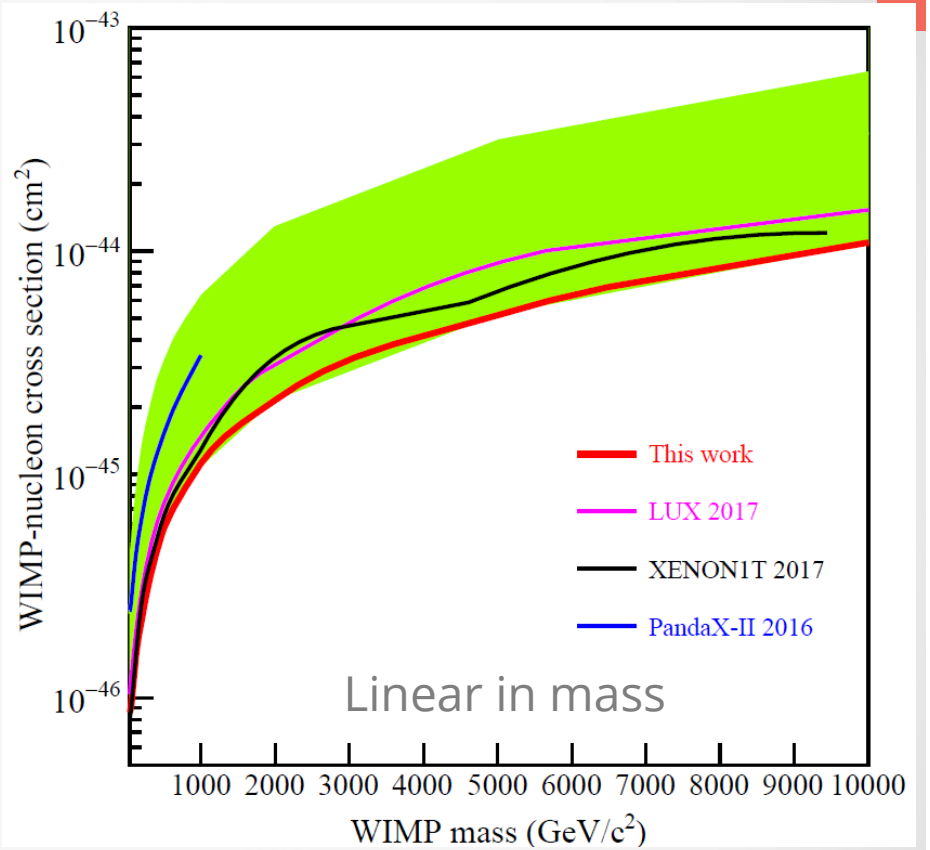




| | ER | Accidental | Neutron | Total Fitted | Total Observed |
|---|---|---|---|---|---|
| Run 9 | 376.1 | 13.5 | 0.85 | $390 \pm 50$ | 389 |
| Below NR median | 2.0 | 0.9 | 0.35 | $3.2 \pm 0.9$ | 1 |
| Run 10 | 172.2 | 3.9 | 0.83 | $177 \pm 33$ | 177 |
| Below NR median | 0.9 | 0.6 | 0.33 | $1.8 \pm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

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

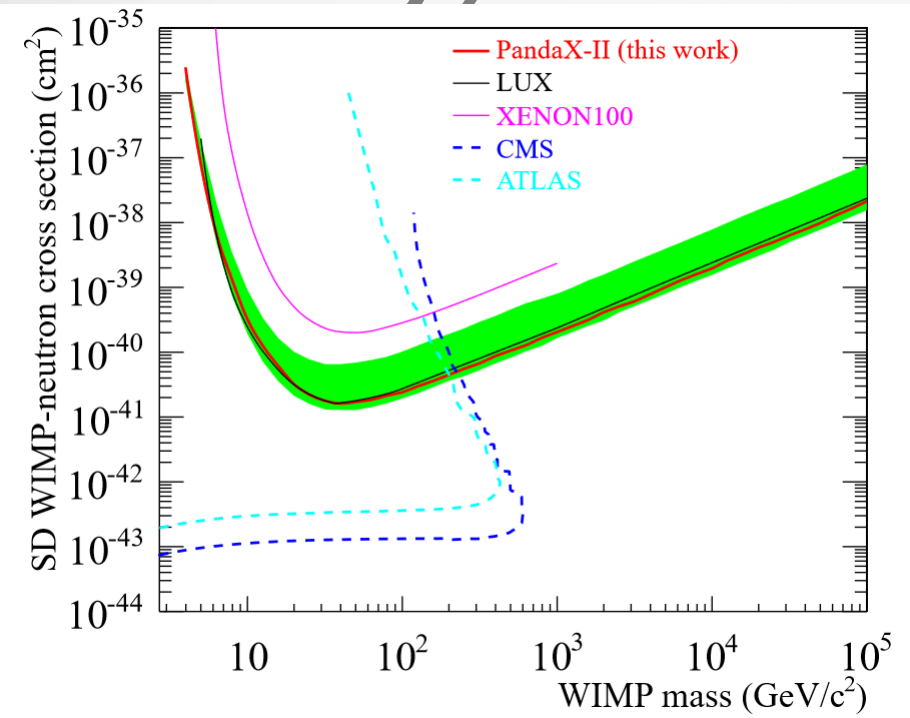
# WIMP-nucleon SI results

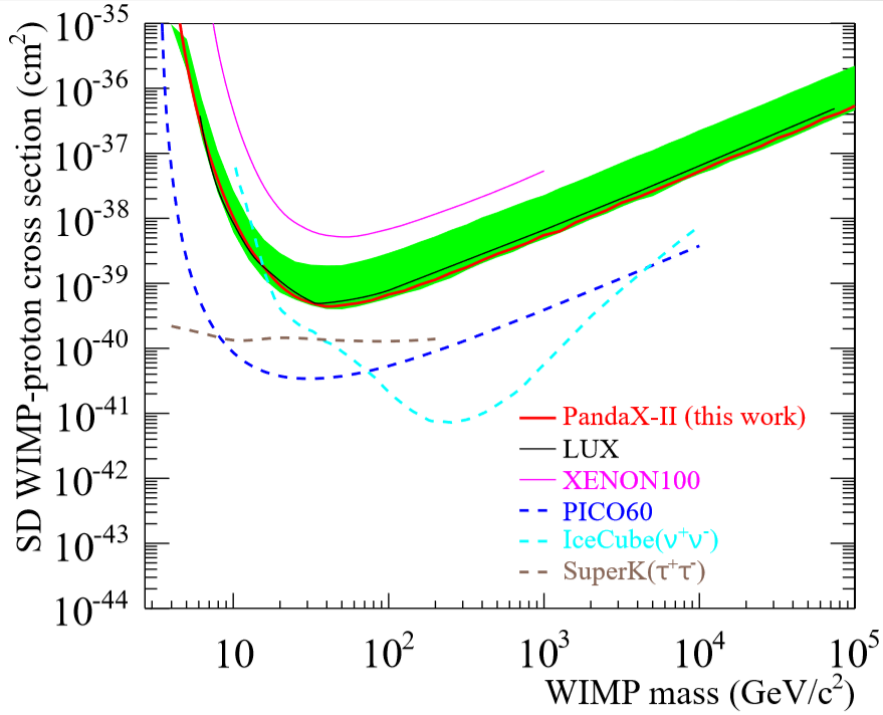



- Improved from PandaX-II 2016 limit about 2.5 time for >30GeV/c$^2$
- Lowest exclusion at $8.6\times10^{-47}$cm$^2$ at 40GeV/c$^2$

# WIMP-nucleon SD results (54 ton-day)



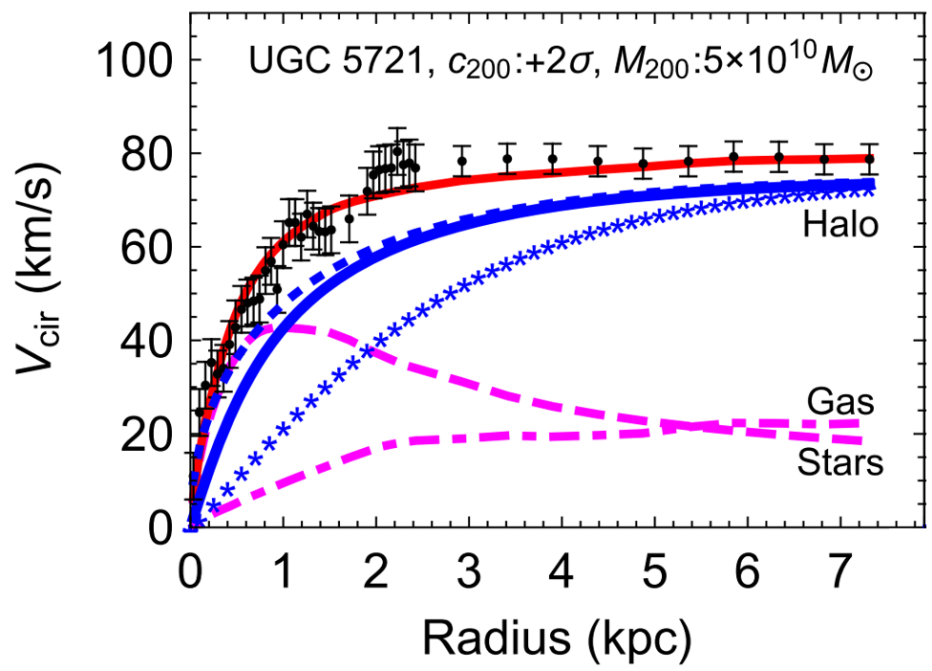

**Minimum χ-n SD cross section limit:**
**$1.6\times10^{-41}$ cm² at 40 GeV/c²**

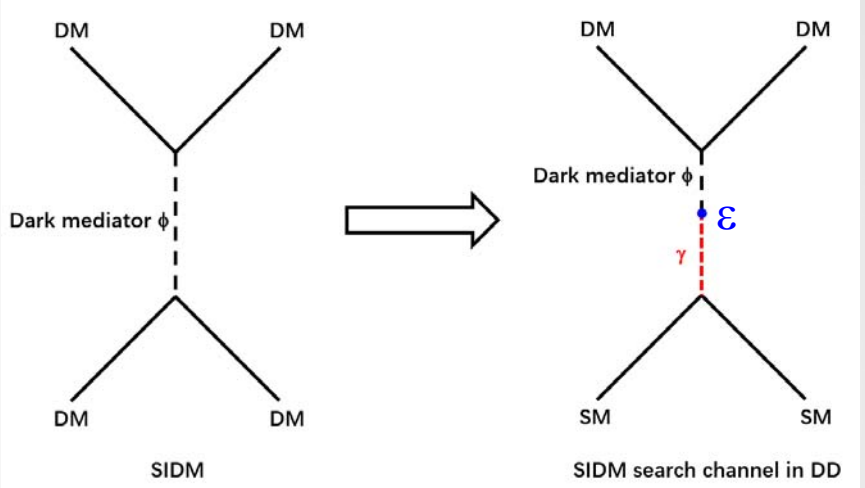
**Minimum χ-p SD cross section limit:**
**$4.4\times10^{-40}$ cm² at 40 GeV/c²**

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

# Self-interacting DM search

PRL 119, 111102

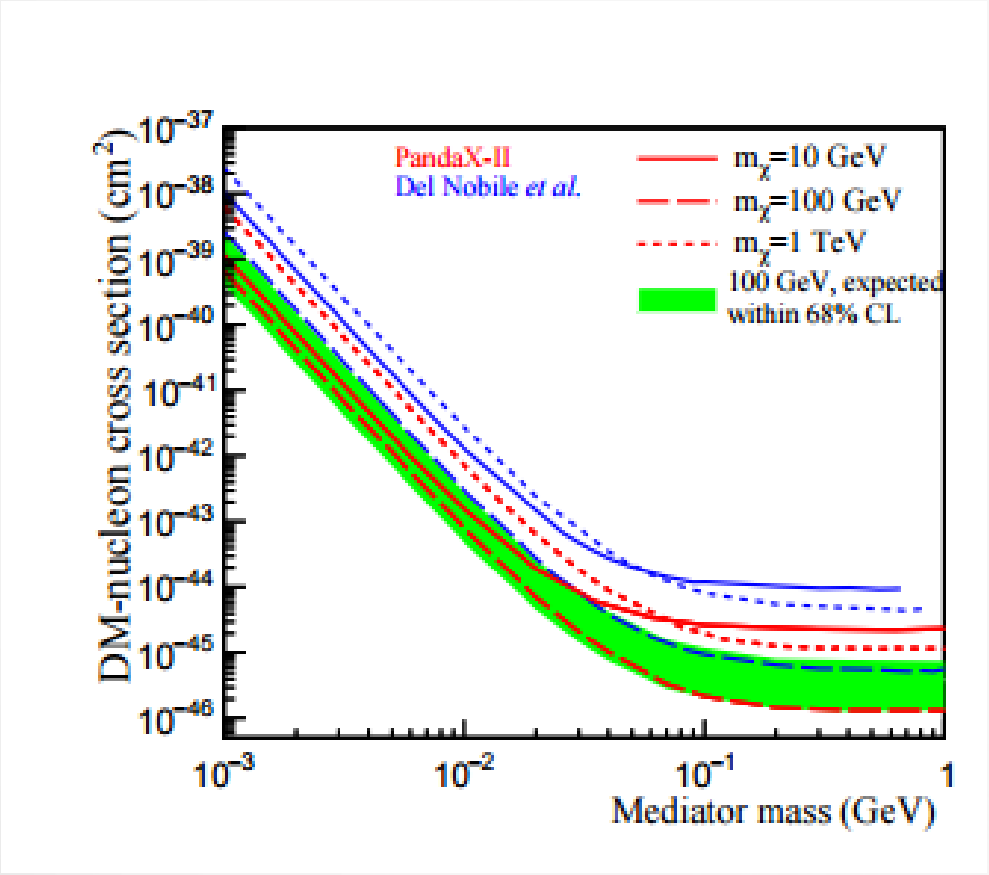



- DD constraint: **upper limit** of interaction strength of dark mediator with SM: $\sigma \sim \varepsilon^2/m_\phi^4$
- BBN constraint: **lower limit** of decay strength of dark mediator into SM: $\tau \sim (\varepsilon^2 m_\phi)^{-1}$

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

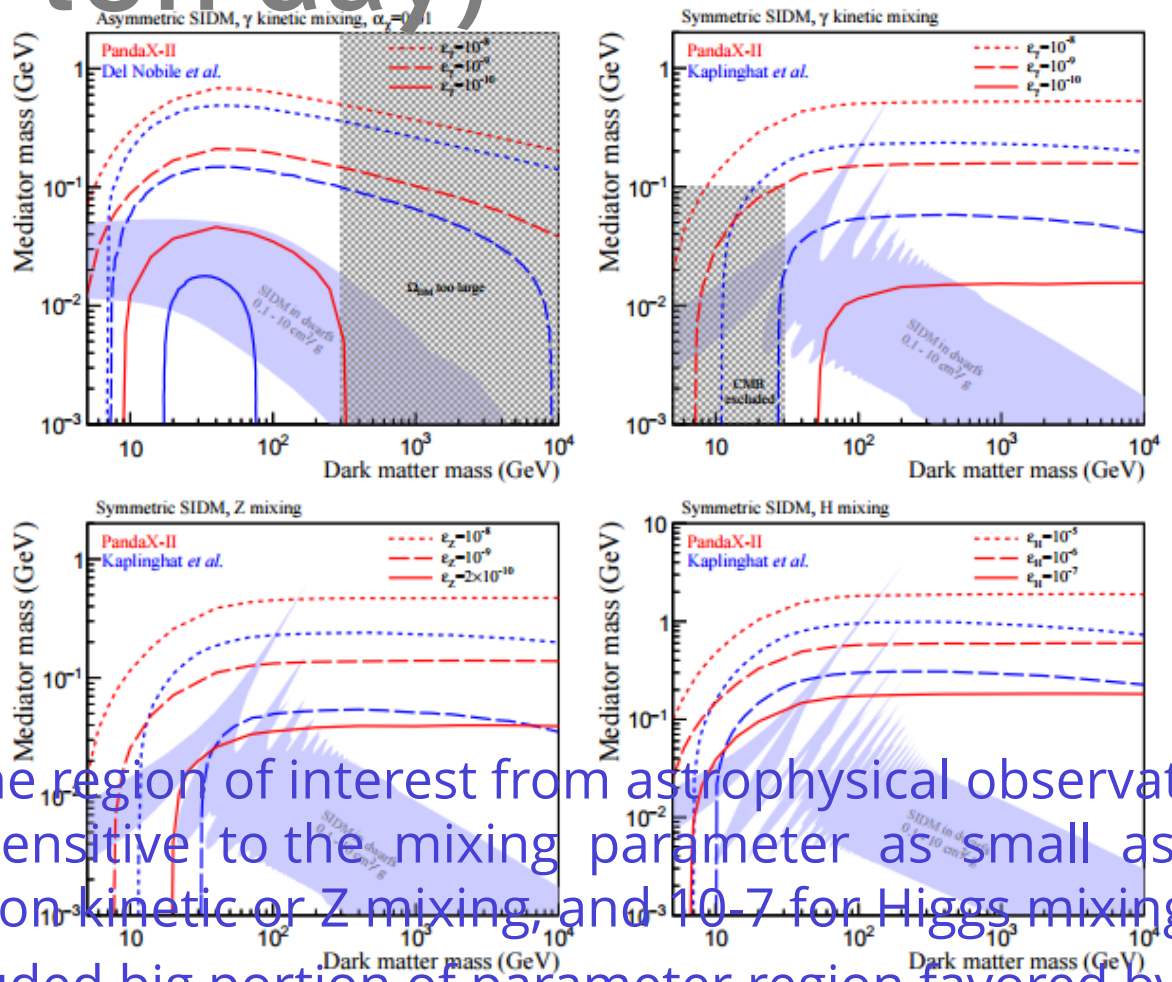
# Self-interacting DM search




the detection sensitivy can be worsen by orders of magnitude
if mediator mass goes from GeV to MeV.

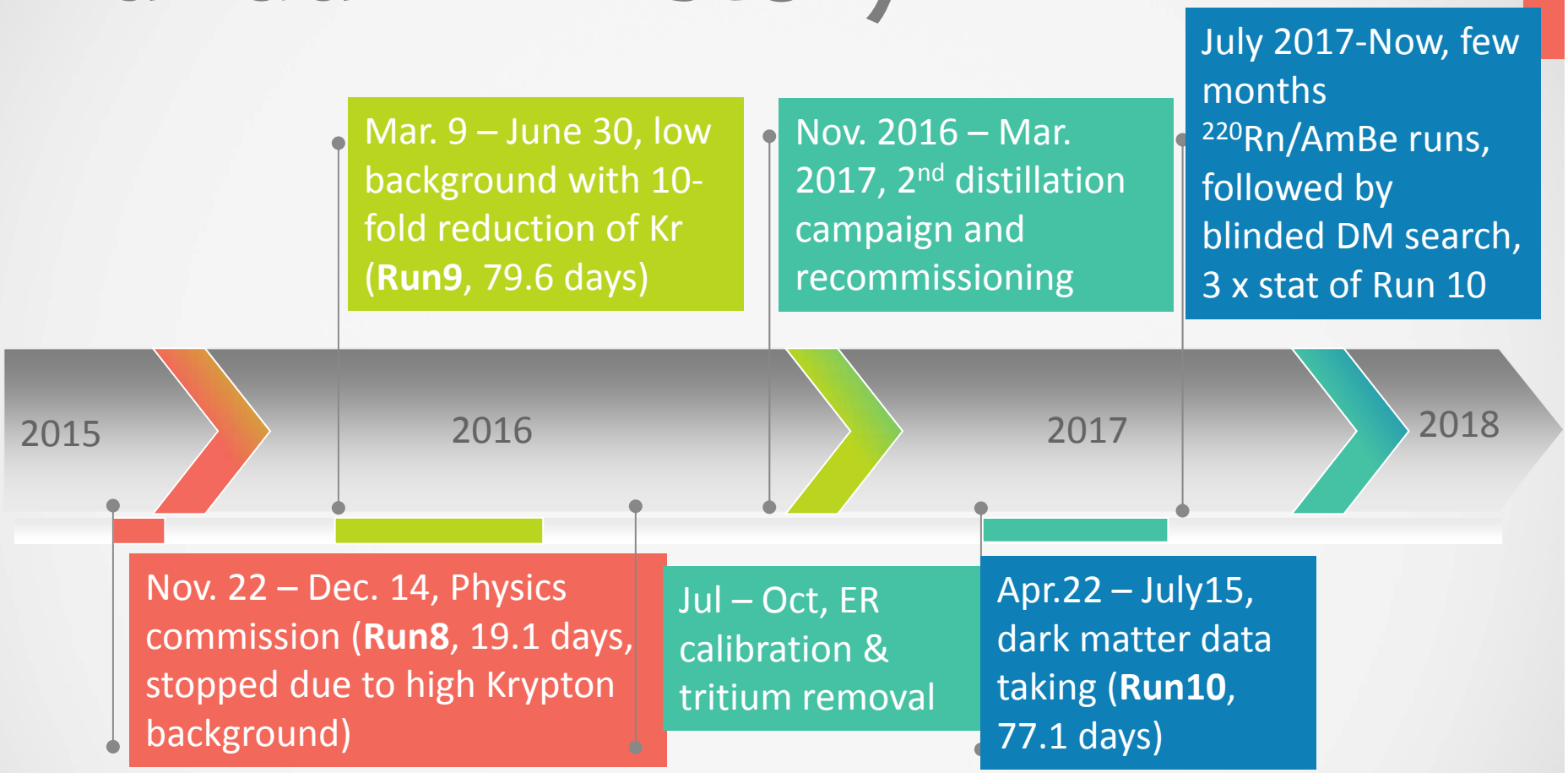
# Self-interacting DM search (54-ton day)

arXiv:1802.06912




- in the region of interest from astrophysical observation, our results are sensitive to the mixing parameter as small as 1E-10, for photon kinetic or Z mixing, and 10-7 for Higgs mixing.
- Excluded big portion of parameter region favored by dwarf galaxies observations

# PandaX-II history




- Run9 =79.6 days, exposure: 26.2 ton-day
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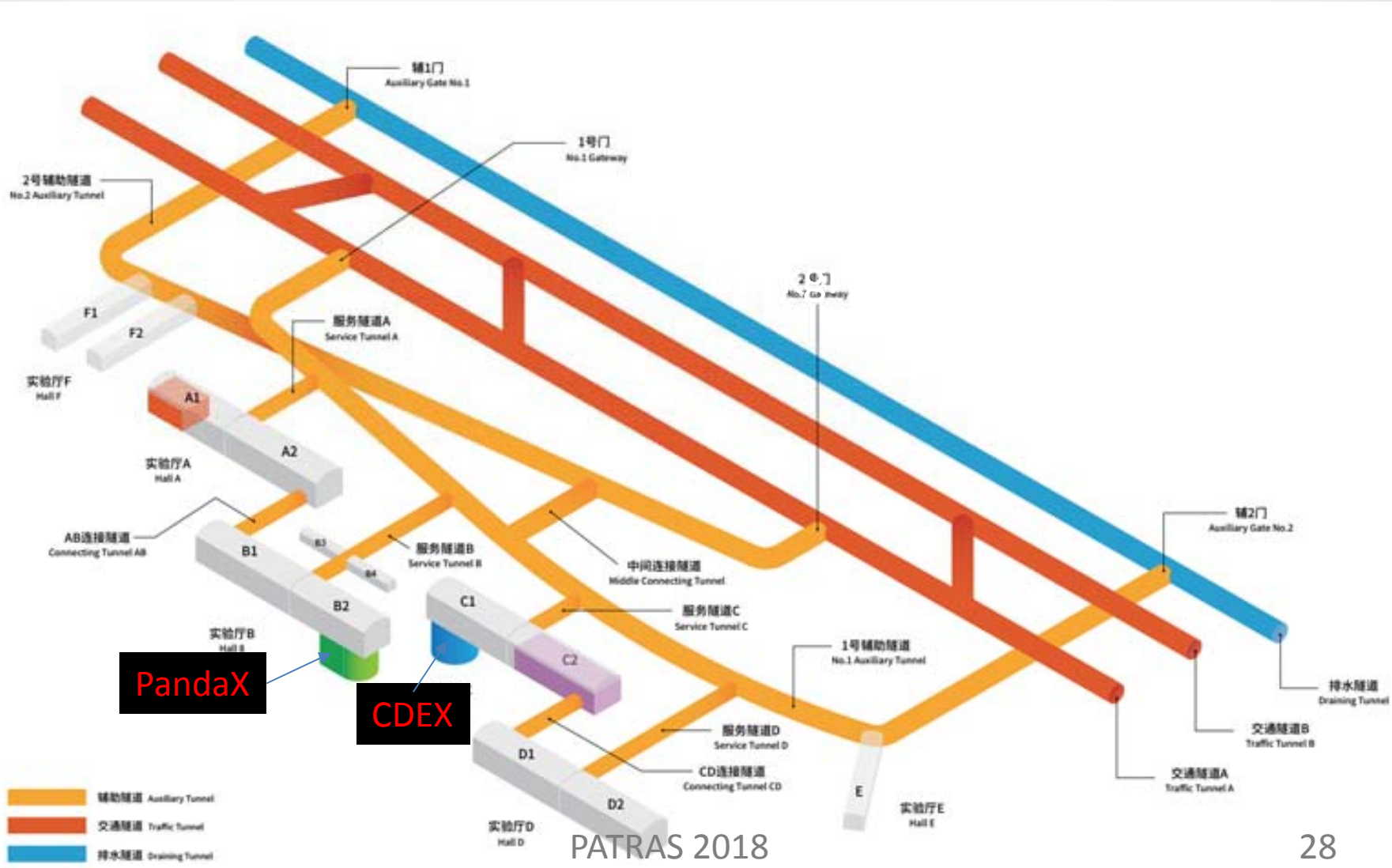
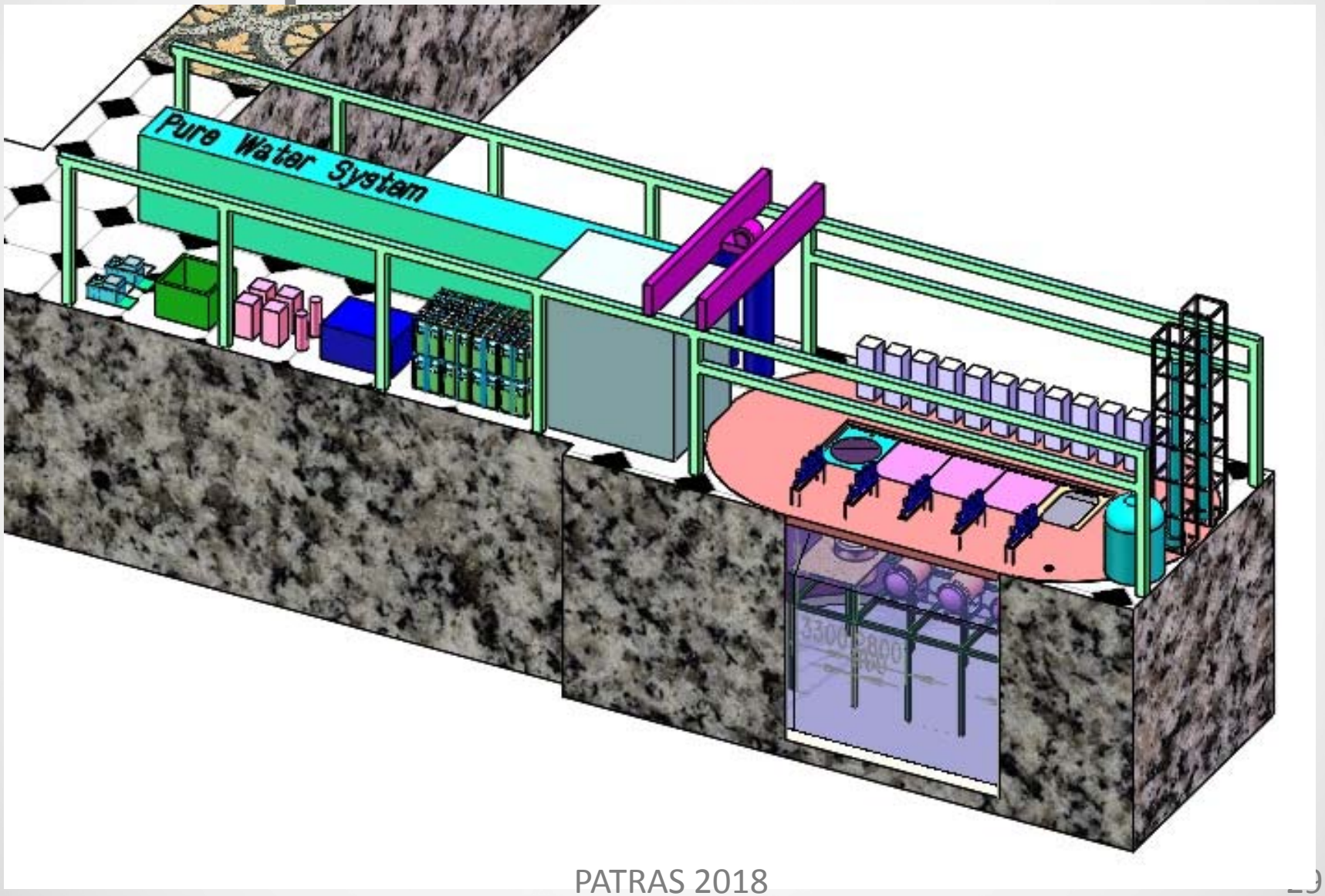
# ③ PandaX-xT

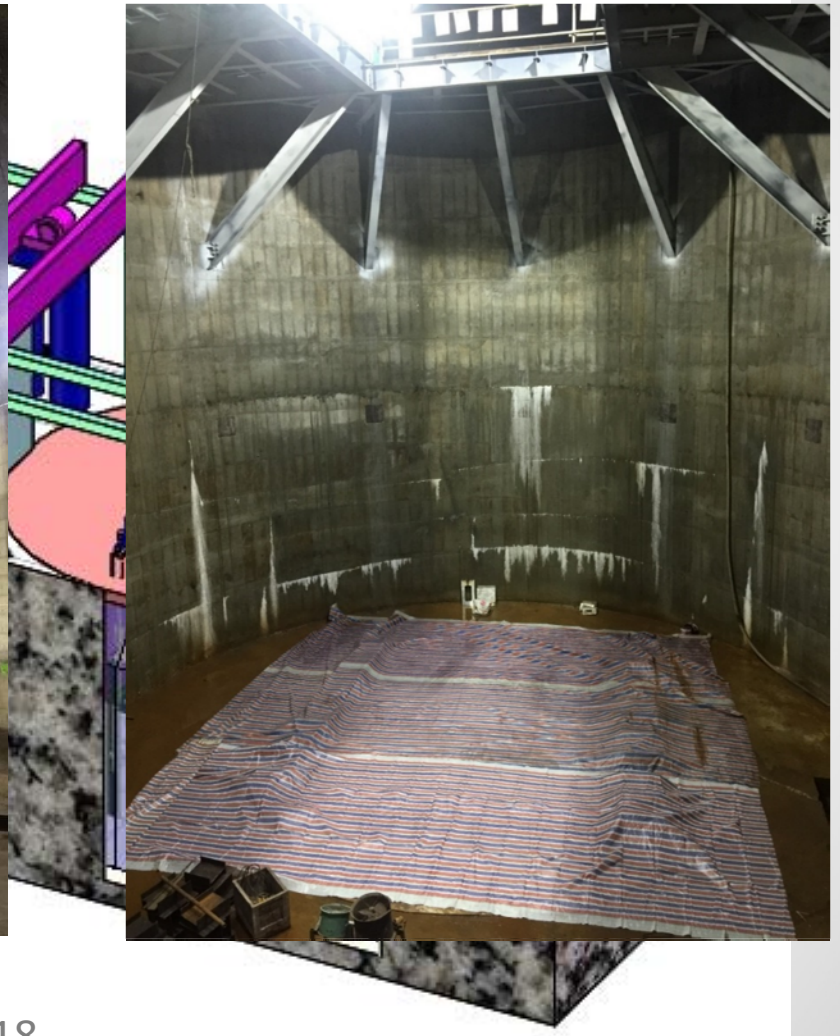
# Future: CJPL-II



# B2 experimental hall

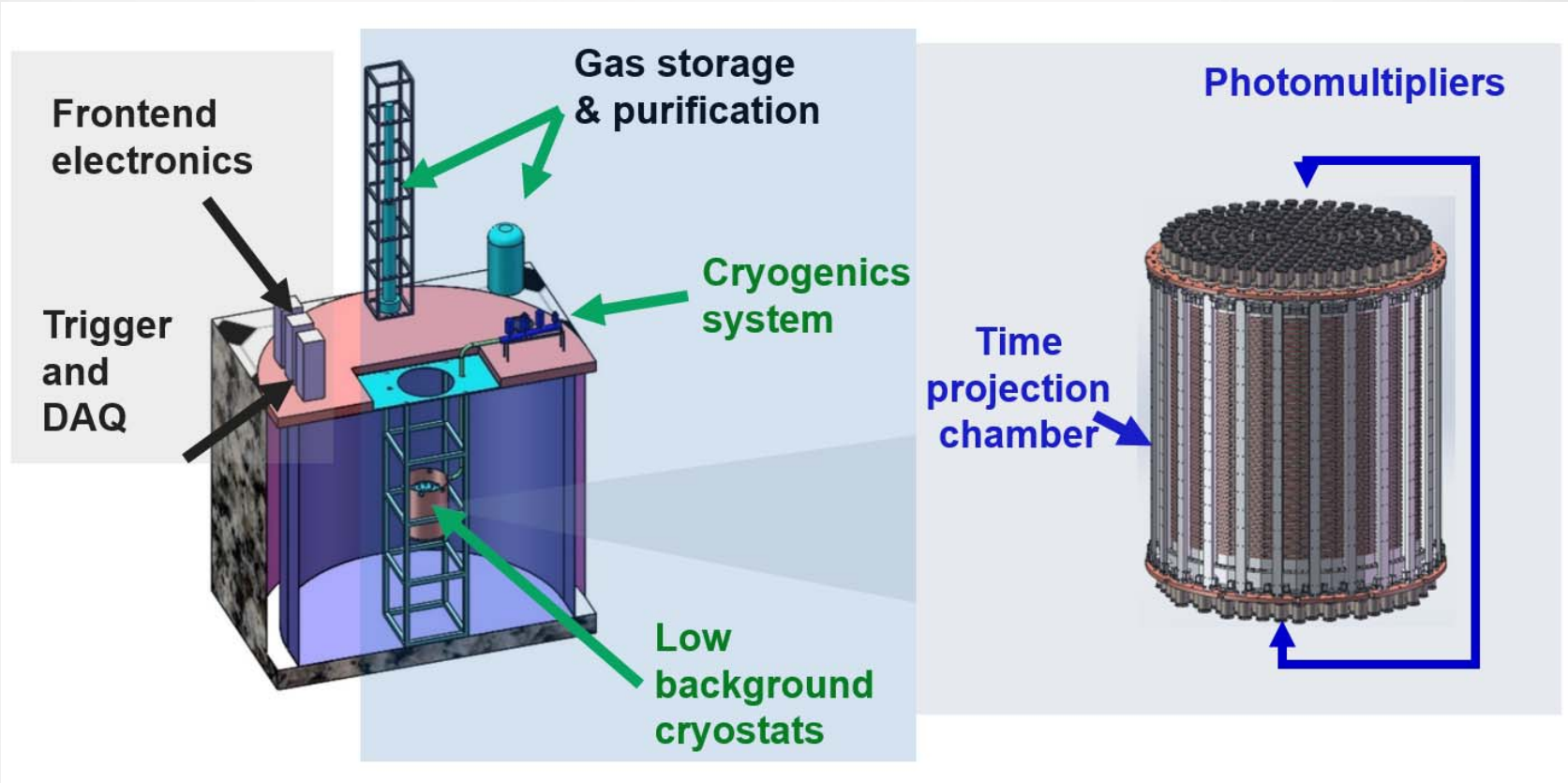


# B2 experimental hall



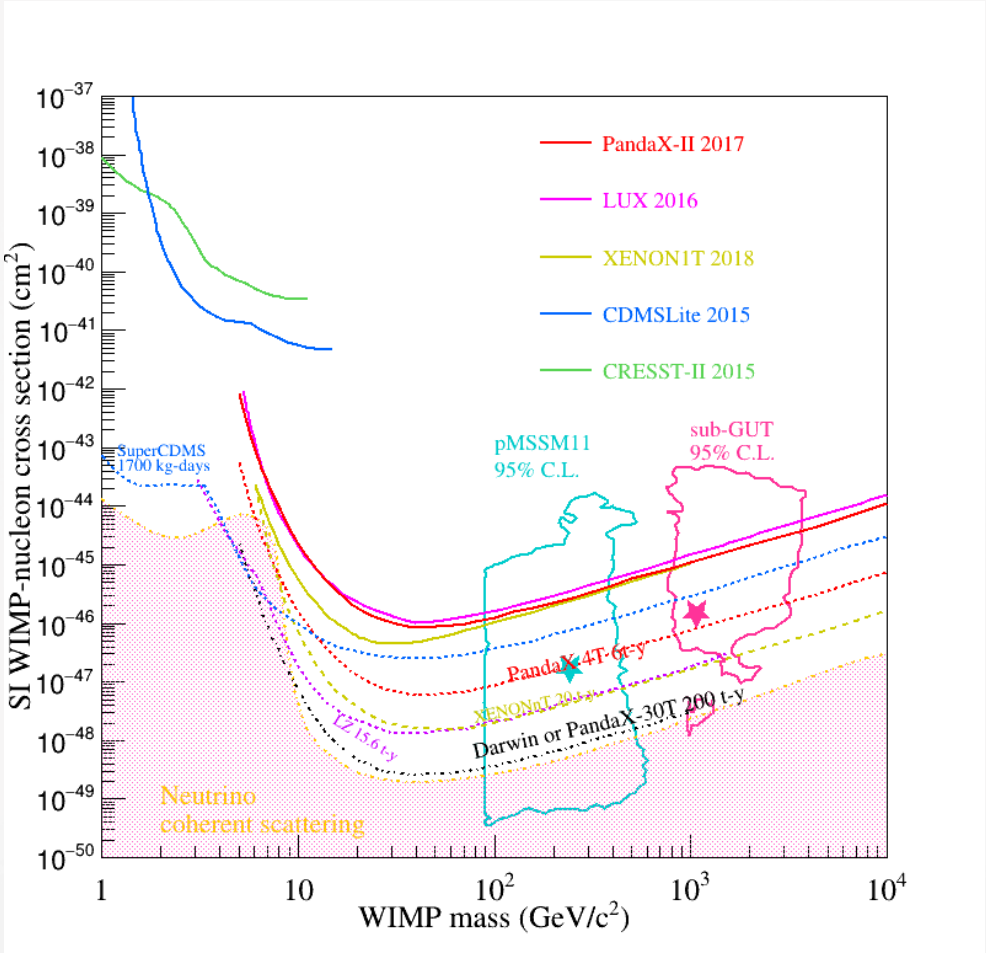
# PandaX-xT

arXiv:1806.02229




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

# PandaX-xT sensitivity



# 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

# Thank you!