PandaX-II 首批物理数据分析

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On Behalf of the PANDA X Collaboration

PandaX collaboration

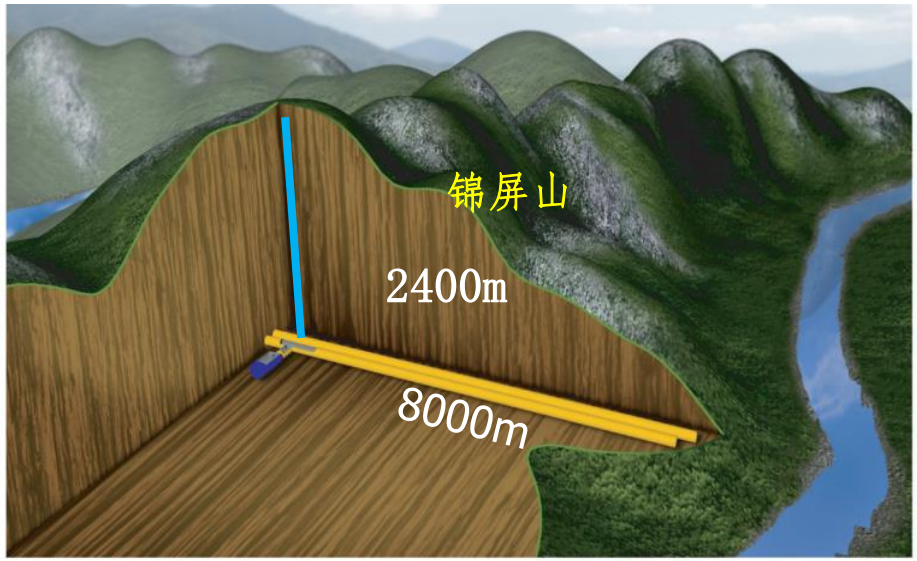
~50 people

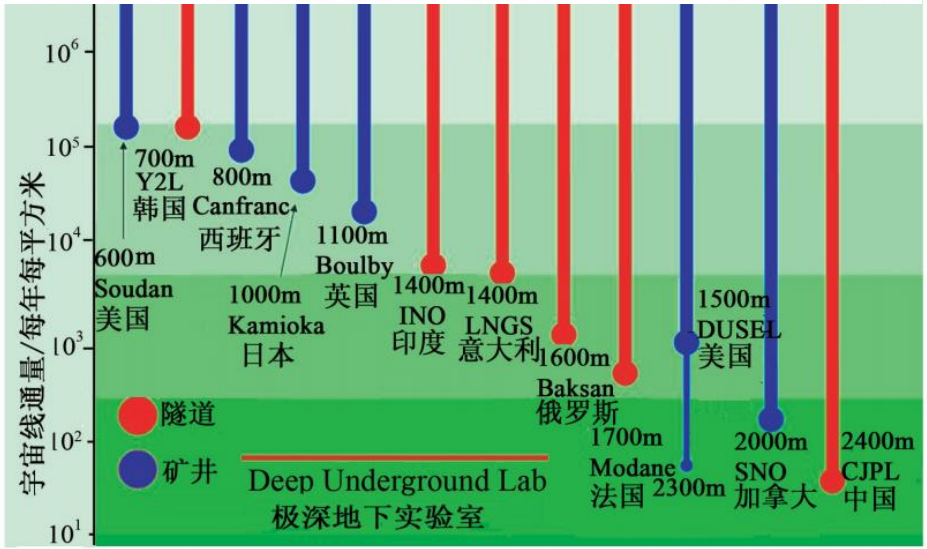
Started in 2009

- Shanghai Jiao Tong University (2009-)
- Peking University (2009-)
- Shandong University (2009-)
- Shanghai Institute of Applied Physics, CAS (2009-)
- University of Science & Technology of China (2015-)
- China Institute of Atomic Energy (2015-)
- Sun Yat-Sen University (2015-）
- Yalong Hydropower Company (2009-)
- University of Maryland (2009-)
- Alternative Energies & Atomic Energy Commission(2015-)
- University of Zaragoza(2015-)
- Suranaree University of Technology(2016-)

China Jinping Underground Laboratory

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



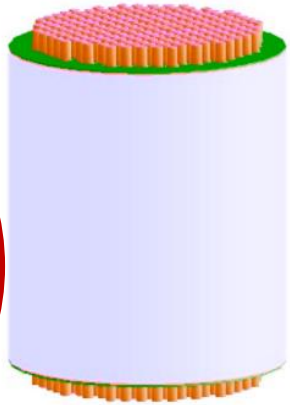


PandaX experiment

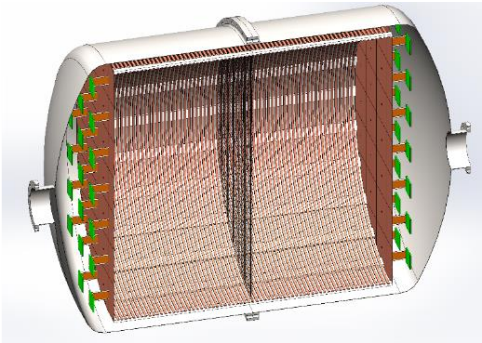
PandaX = Particle and Astrophysical Xenon Experiments

Phase I:
120 kg DM
2009-2014

Phase II:
500 kg DM
2014-2017

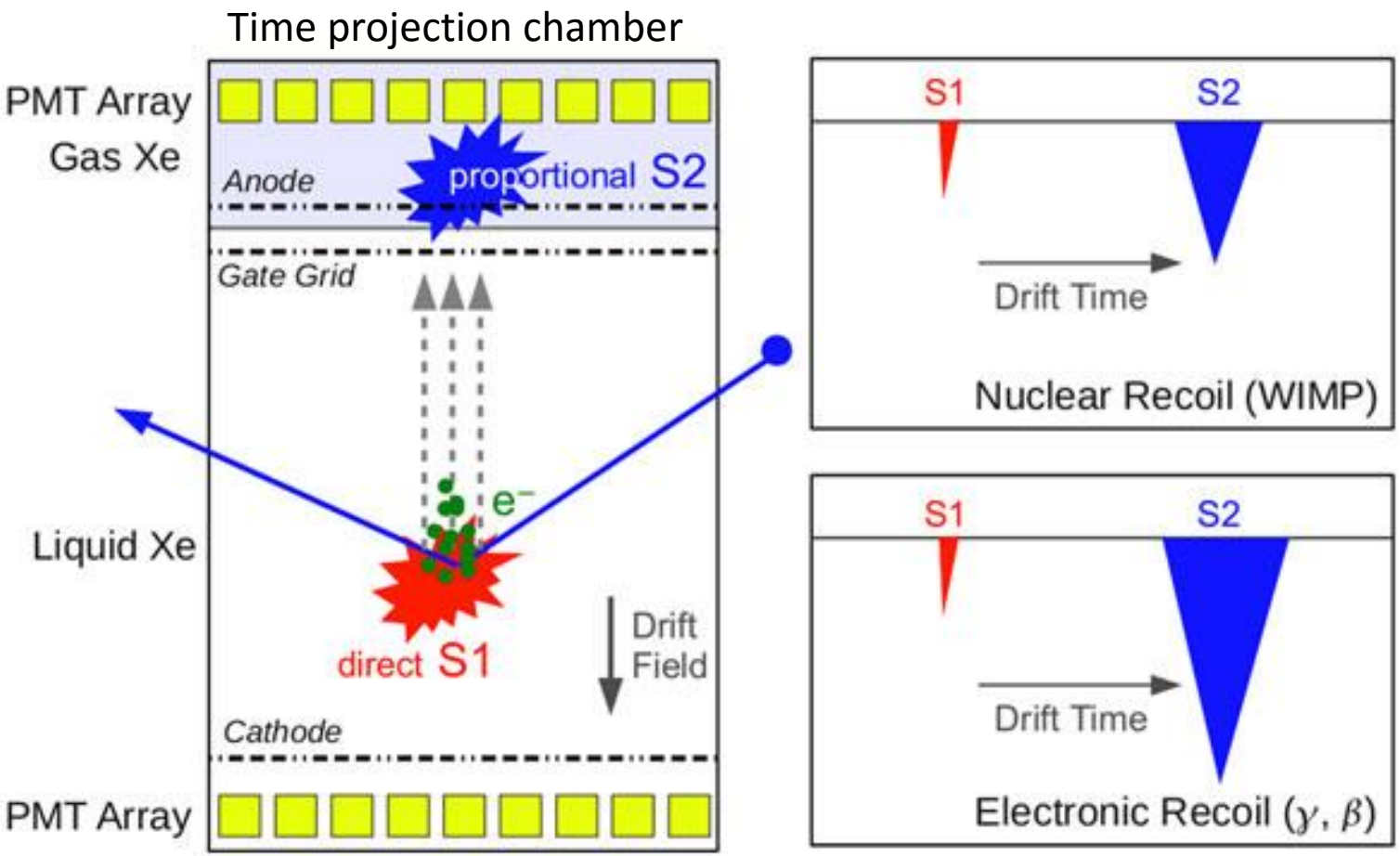


PandaX-xT:
multi-ton DM
2016-



PandaX-III:
200 kg to 1 ton
^{136}Xe 0vDBD
2016-

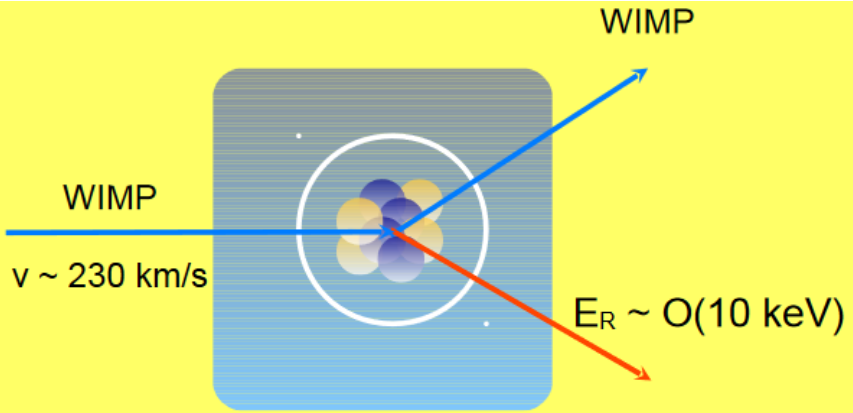
Dual-phase Xenon TPC principle

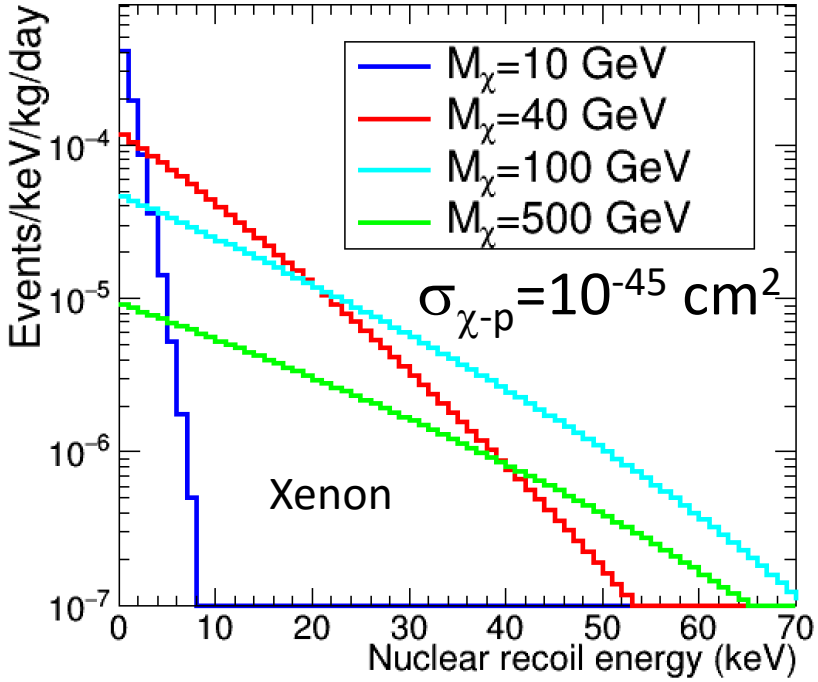


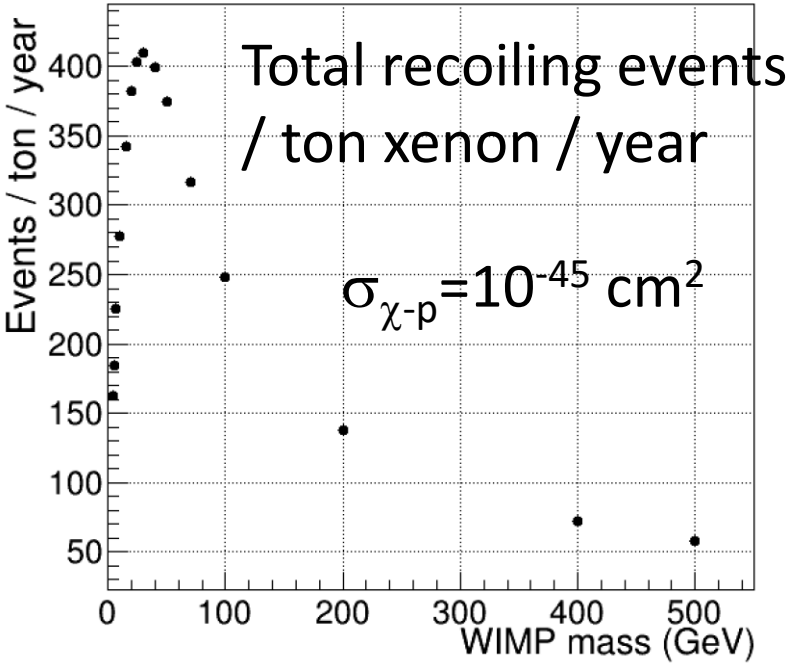
3D vertex, excellent background rejection, scalable target mass.

Nuclear Recoil Energy and Rate

Elastic Scattering of WIMPs off target nuclei
→ nuclear recoil







PandaX-II Run history

Series of Engineering runs

Distillation and re-started (Run9, 80 days)

Detector installation at CJPL

Nov 22 – Dec 14, Physics commission (Run8, 19 days, stopped due to high Krypton background)

Phys. Rev. D. 39, 122009 (2016)

Run8+Run9=98.7 days
Exposure:3.3x10^4 kg-day

Analysis chains overview

RAW data:
(PMT pulse)

→

Reconstruction:
S1, S2 and
Vertex, Energy

Xiaopeng's talk in this session

→

Calibration:
Electron recoil
Nuclear recoil

→

Selections:
Trigger
Fiducial volume
S1&S2

→

Results:
Background and
signal estimate,
Limit

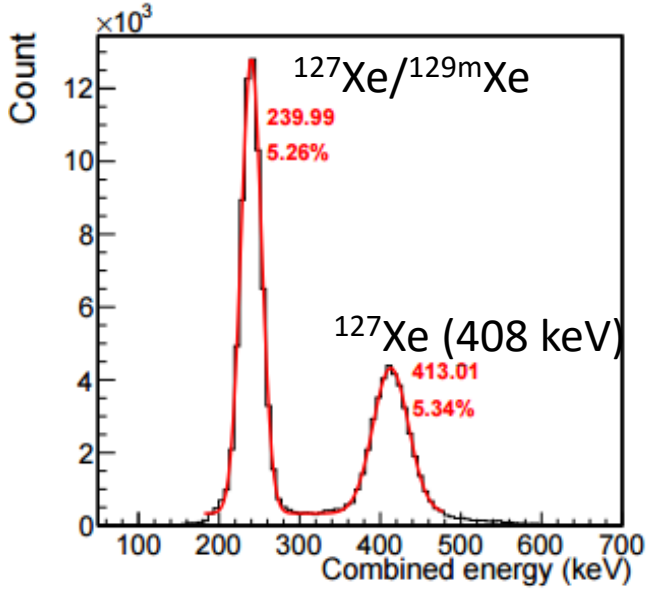
Event Selections Summary

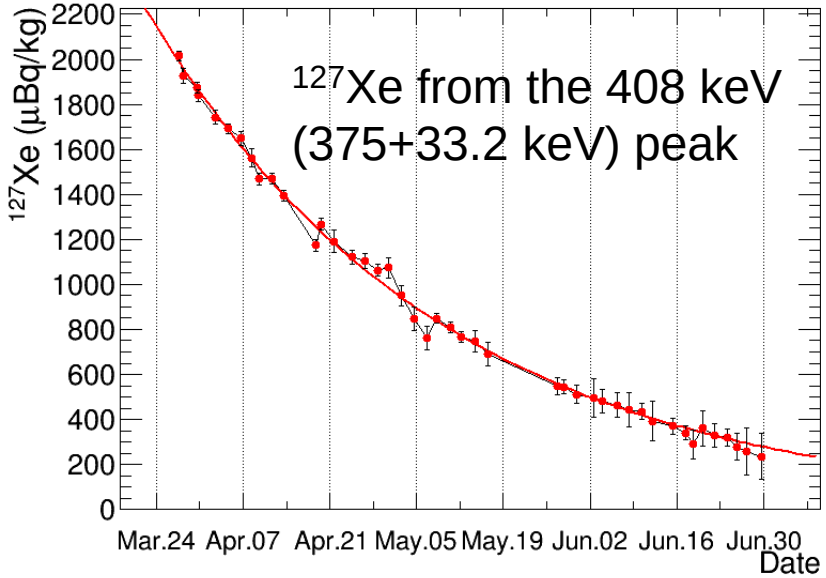
Event Selections	Notes
Trigger	Mostly triggering on s2 signal, threshold about 80 PE
Data quality	S1, S2 Identification, bad files removal, etc
Skin Veto	Suppress ambient gamma background
Single S2	Remove double-scattering events
Fiducial volume	Suppress ER&NR background
BDT cut	Suppress accidental background
3<S1<45 PE, S2(raw)>100 && S2<10000 PE	Low energy selection

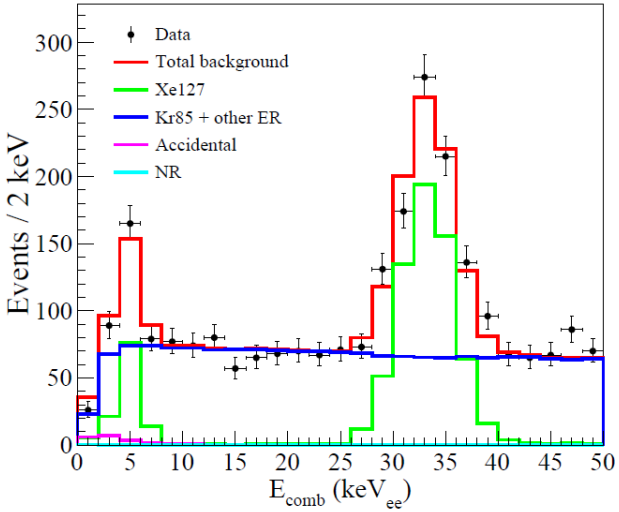
Background Overview

Background	Run8	Run9	Estimate Method
Electron Recoil	Mostly Kr-85	Mostly Kr-85, Xe-127	Normalization from data, distribution from MC&Data (eff. applied)
Accidental	Single S1 and single S2 random coincidence		From Data
Nuclear Recoil	Neutrons in detector materials		Neutron spectra calculated with SOURCES4A package, distri. from MC (eff. applied)

ER background

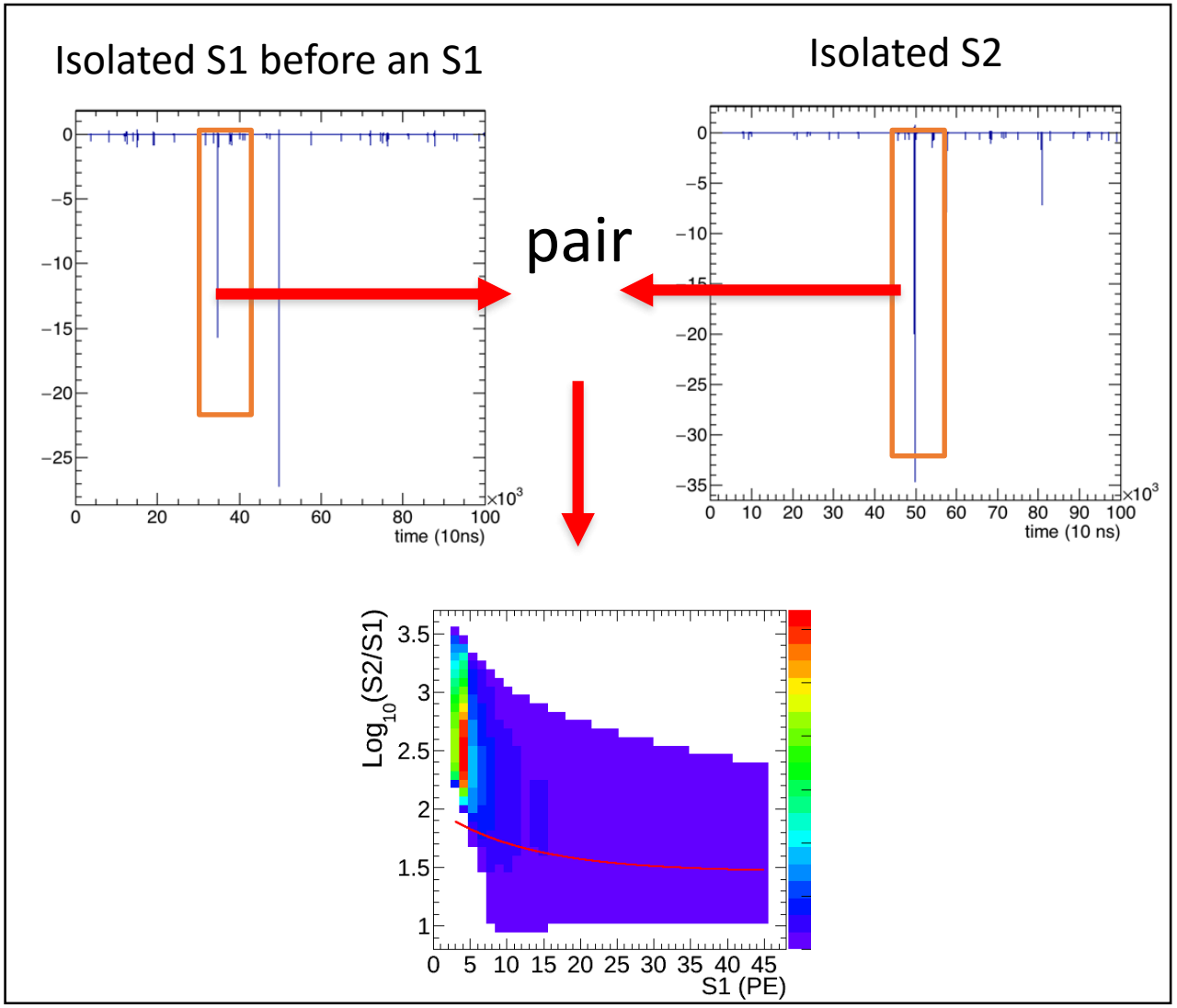






- Normalization of Xe127&Kr-85 extracted from data
- ~0.4 mDRU(10^{-3}/keV/kg/day) for <10 KeV_{ee}

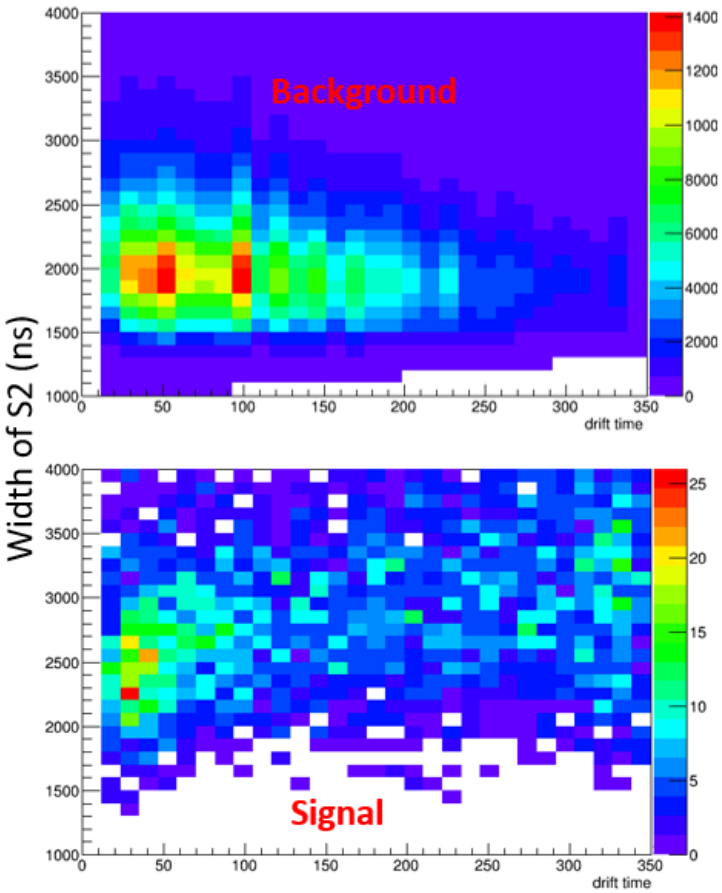
Accidental background



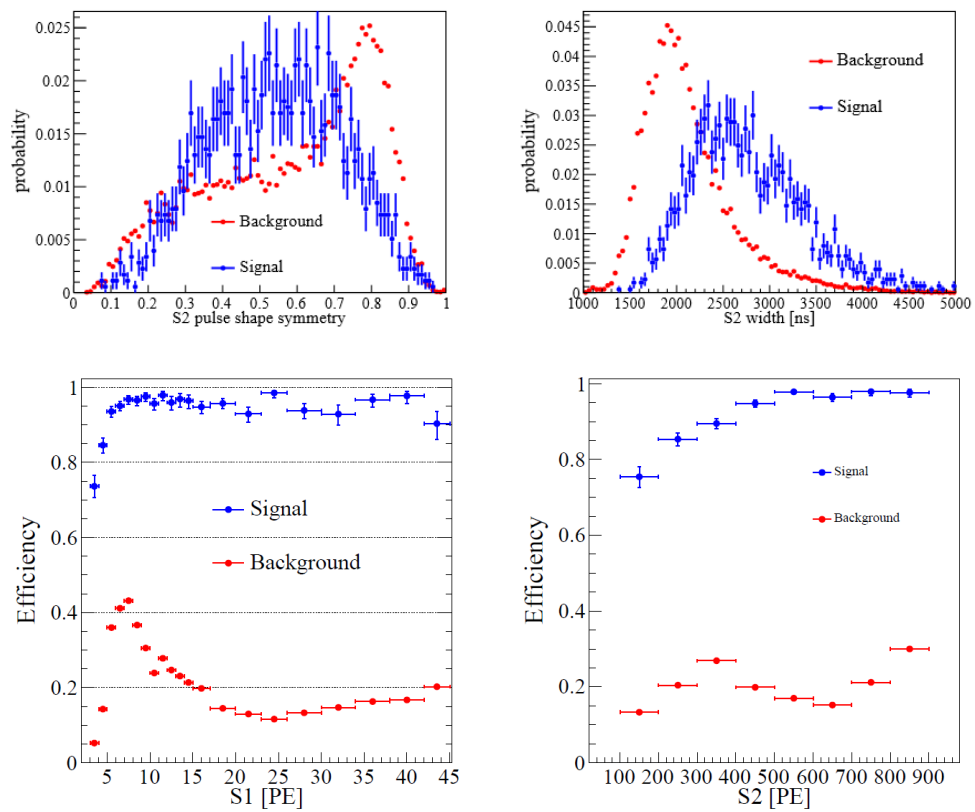
- Isolated S1 and S2 were selected and randomly paired to simulate accidental events
- Significantly reduced using a multivariate technique (BDT).
  - x3 rejection for background
  - 90% efficiency for signals

BDT discrimination power

- Accidental S1 and S2 lack intrinsic correlations

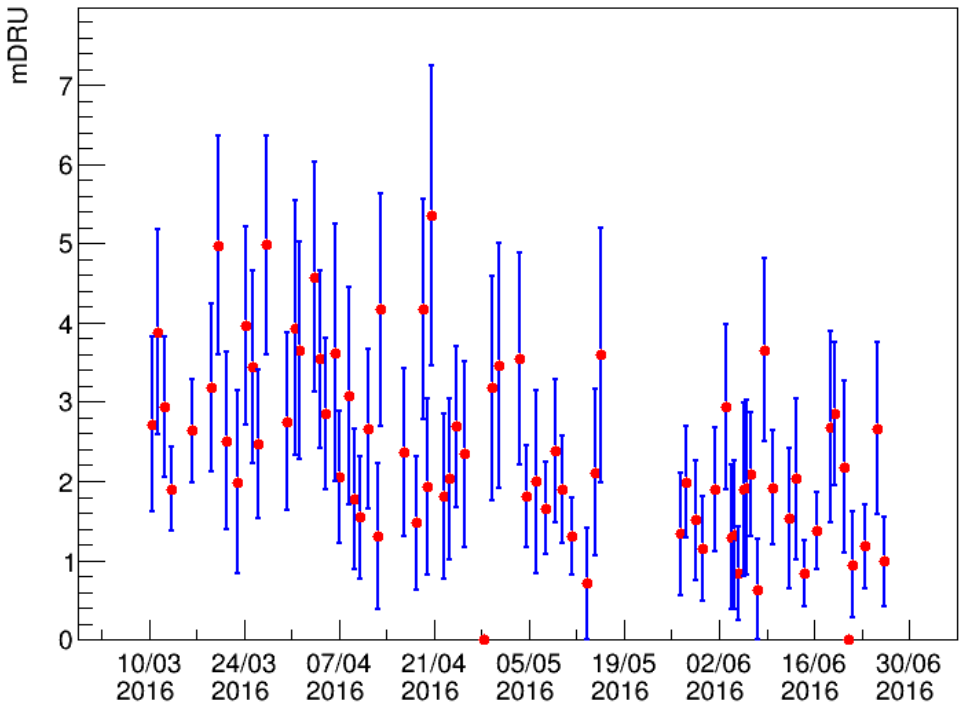


- Single S2 likely originated from the gate grid (small width, large asymmetry)



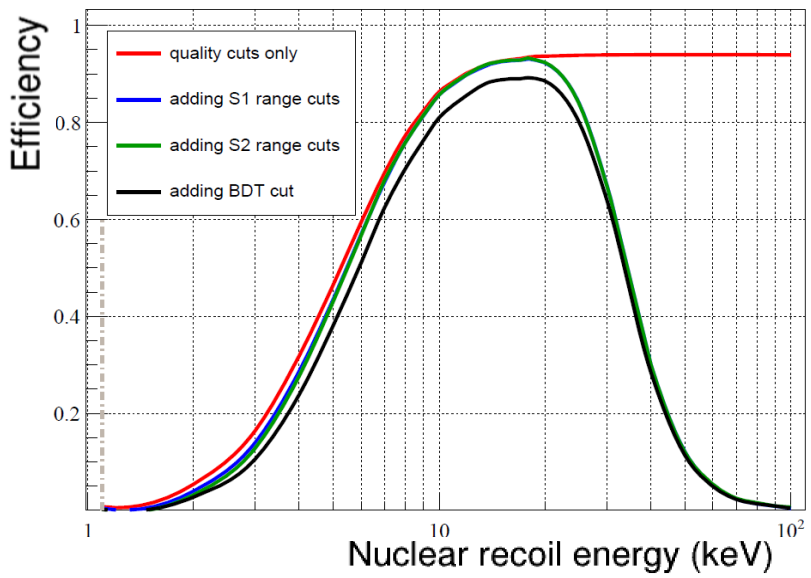
Overall background rate in run9

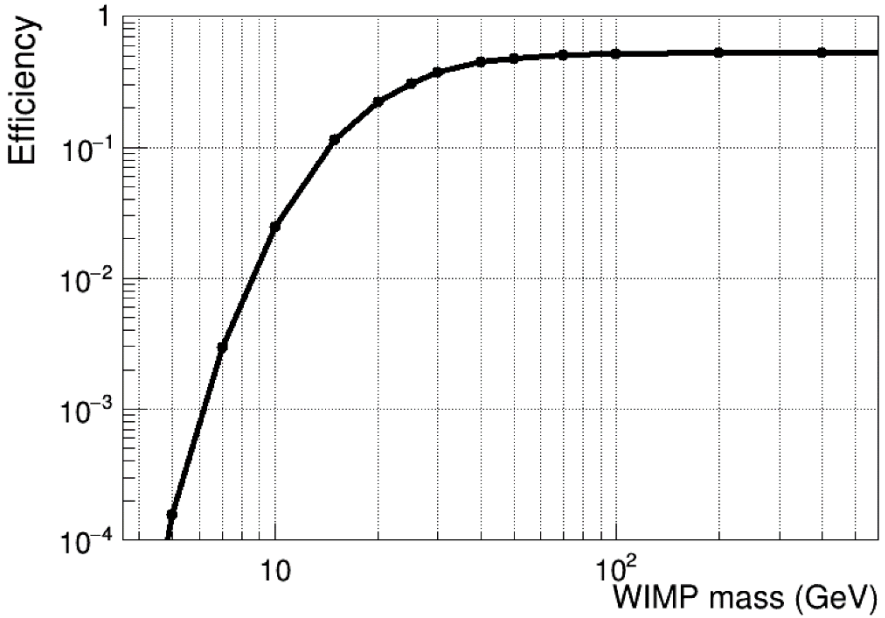
Item	Run 8 (mDRU)	Run 9 (mDRU)
^{85}Kr	11.7	1.19
^{127}Xe	0	0.42
^{222}Rn	0.06	0.13
^{220}Rn	0.02	0.01
Detector material ER	0.20	0.20
Total	12.0	1.95



- Events selected with energy <10 keV
- ~2 mDRU on average (15.3 mDRU in Run 8)
- Decrease over time due to ^{127}Xe decay

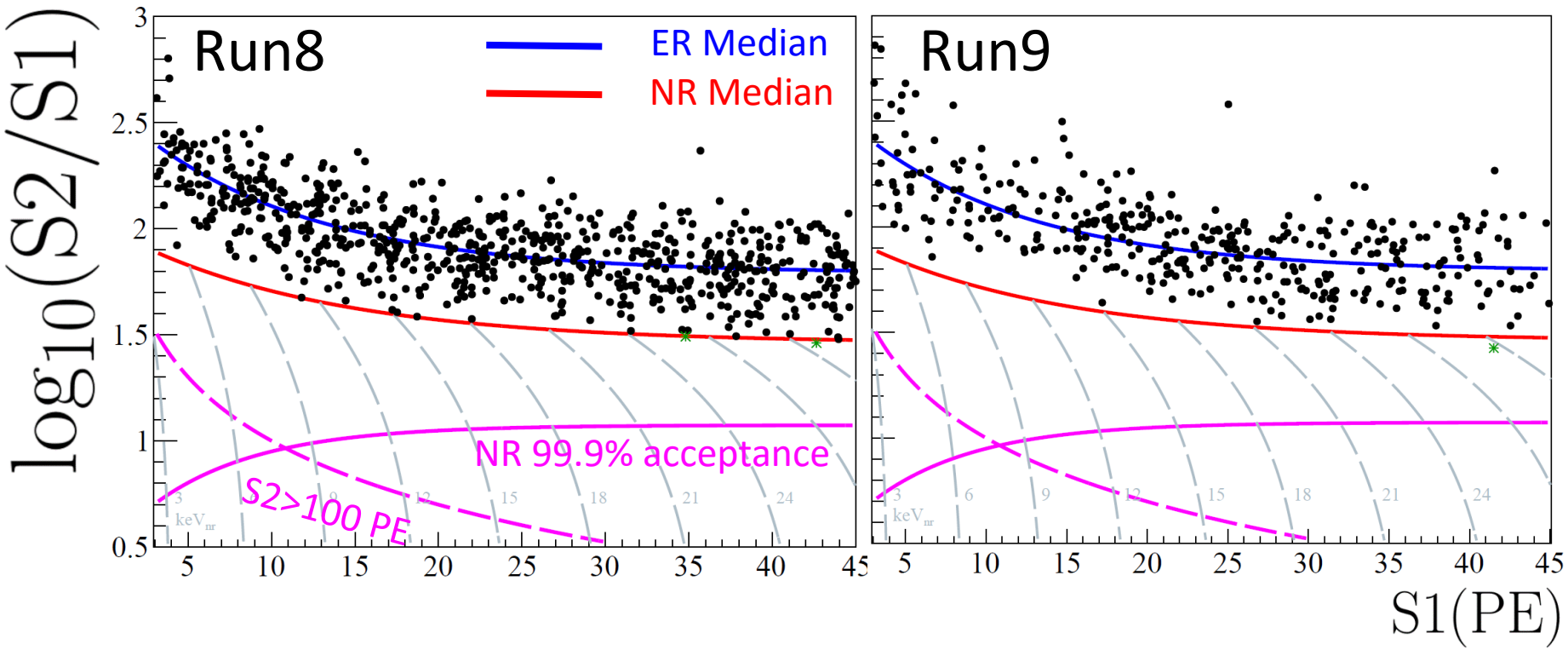
WIMP signal efficiency





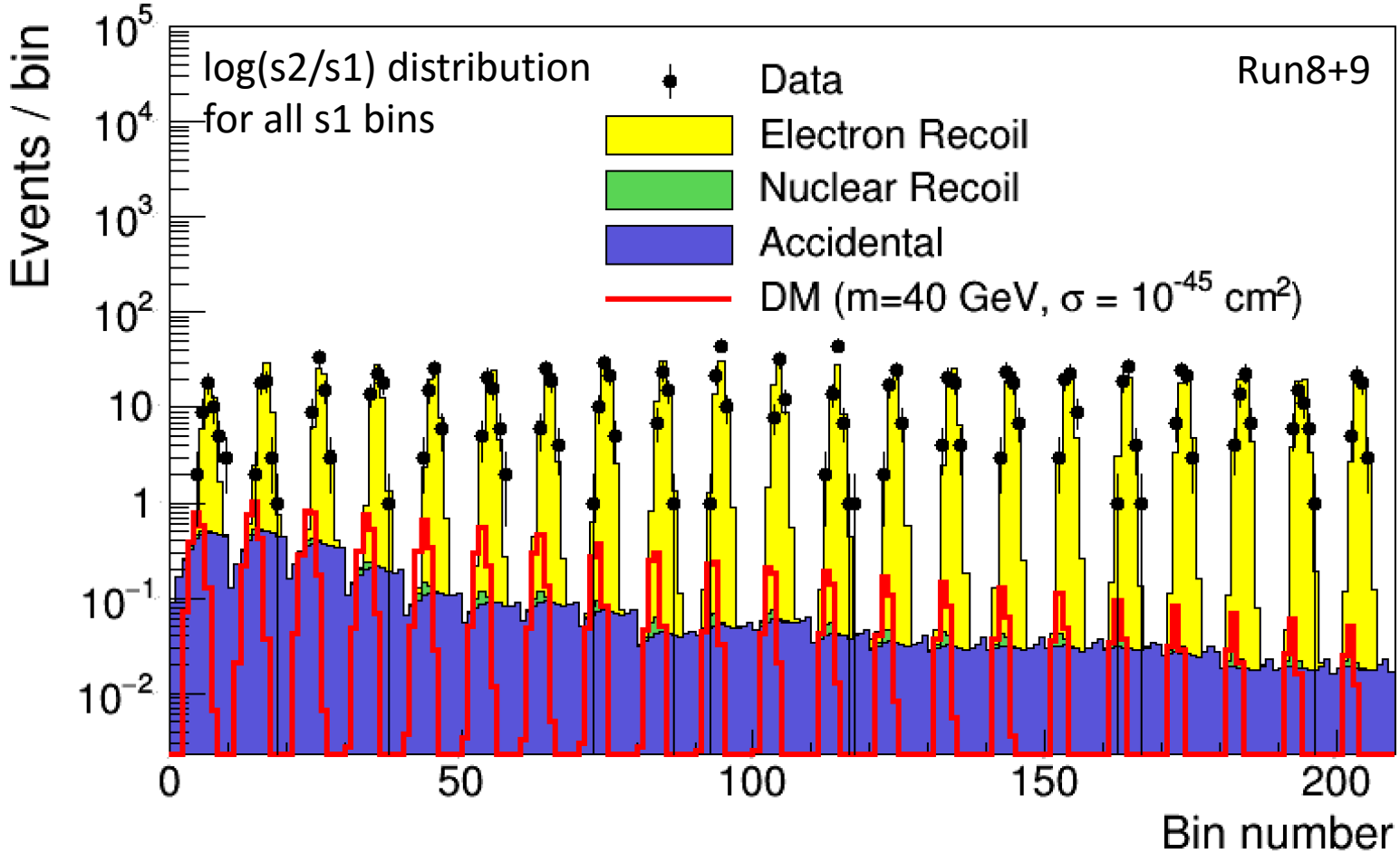
- > 80% efficiency for recoil energy 10-20 keV
- DM detection efficiency
  - 2.5% @ 10 GeV, 52% @ 100 GeV

Results



Below NR med.	ER	Accidental	NR	Total bkg.	Data
Run8	2.0	0.33	0.09	2.4 ±0.8	2
Run9	1.2	0.84	0.35	2.4 ±0.7	1

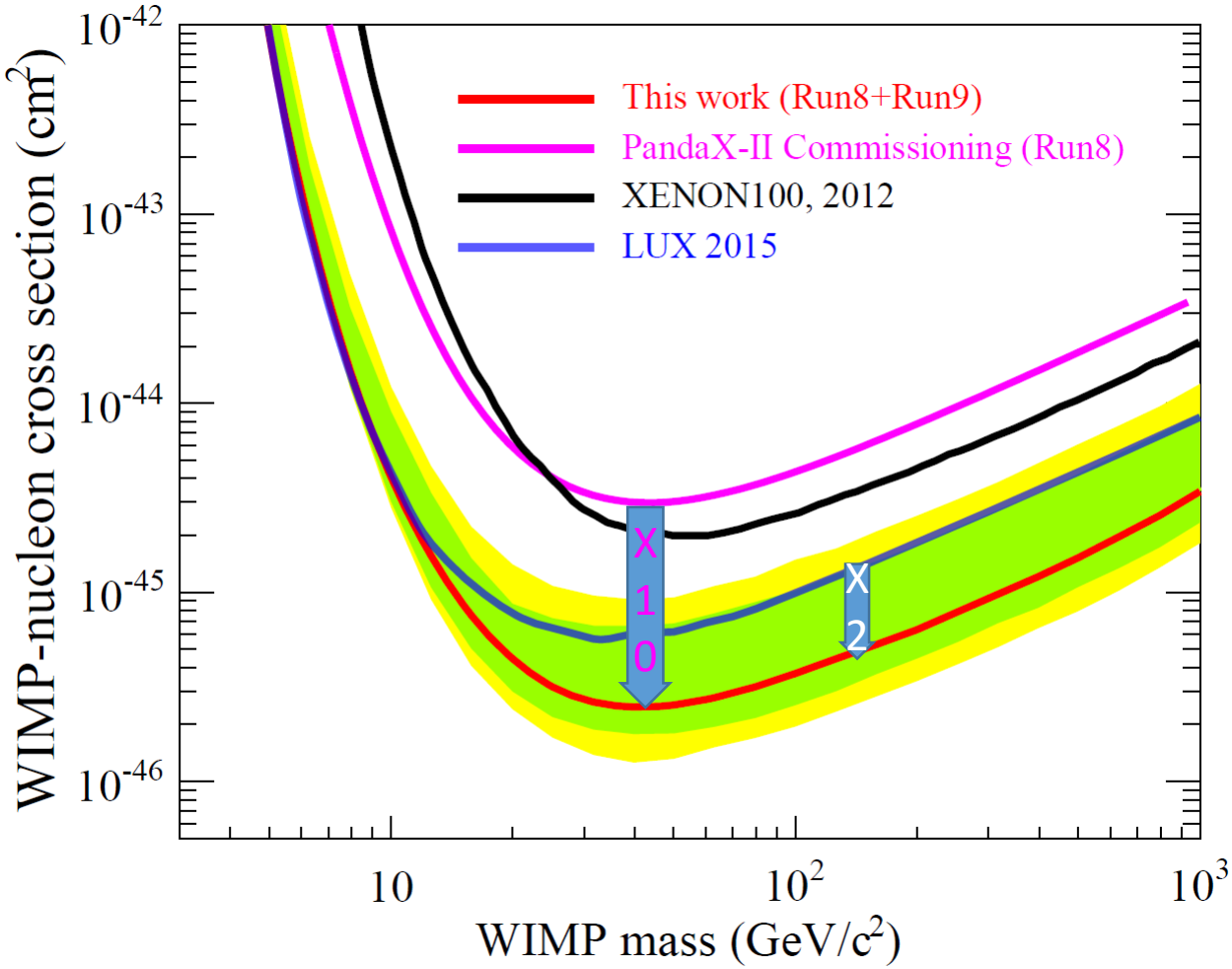
Selected Data/Bkg in 1-D comparison



Good agreement between data and background prediction

WIMP-nucleon SI upper limits

90% CL Spin-independent limits calculated with CLs method



Summary and outlook

PandaX-II has reached the forefront of the DM search!

- 79.6 live-day of dark matter data with much suppressed background (15⇒2 mDRU)
- In combination with commissioning run (19.1 day), ~33,000 kg-day exposure in total. No DM signals are observed
- The WIMP-nucleon elastic scattering cross sections are constrained to 2.5×10^{-46} cm^2 at 40 GeV DM mass.
- Continue PandaX-II data taking till end of 2017. In preparation for PandaX-xT!