



# Status of PandaX and the results from PandaX-I

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(On behalf of the PandaX Collaboration)

# PandaX collaboration, since 2009

PandaX: Particle AND Astrophysical Xenon experiment



## China:

Shanghai Jiao Tong University (2009 ~ )

Shanghai Institute of Applied Physics, CAS (2009~ )

Shandong University (2009 ~ )

Peking University (2009 ~ )

Yalong River Hydropower Development Co. (2009 ~ )

**University of Science and Technology of China (2015 ~ )**

**China Institute of Atomic Energy ( 2015 ~ )**

## USA:

University of Maryland(2009 ~ )

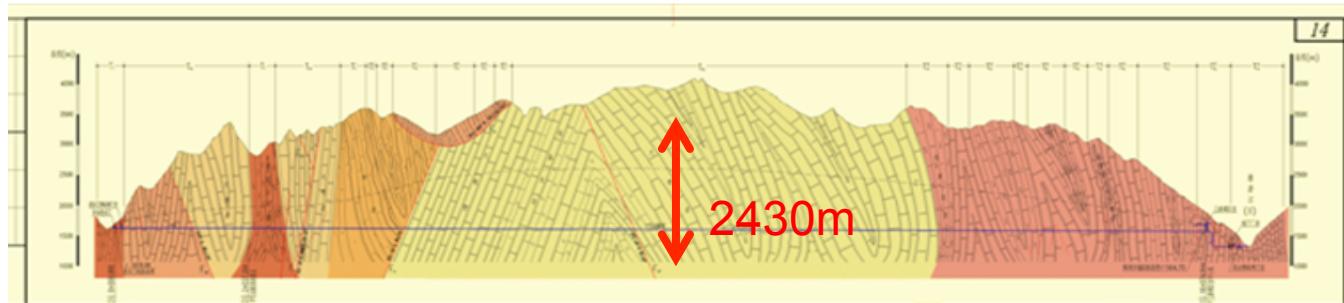
University of Michigan(2011~2015)

# China Jin-Ping underground Laboratory



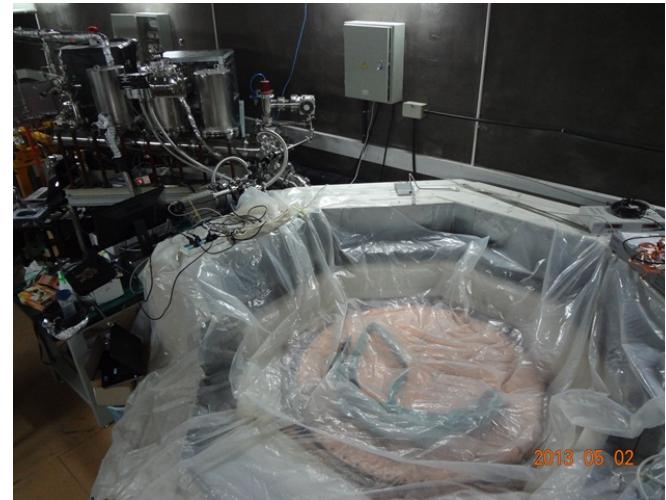
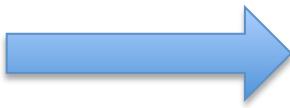
Depth	6800 mwe
Muon Flux	60 evn/m <sup>2</sup> /year
Rock	Marble
$^{238}\text{U}$	$1.8 \pm 0.2 \text{ Bq/kg}$
$^{232}\text{Th}$	<0.27 Bq/kg
$^{40}\text{K}$	<1.1 Bq/kg

Chinese Phys. C. 37 (2013) 086001  
J Radioanal Nucl Chem. 301 (2014) 443–450



# PandaX-I Milestones

Aug. 16, 2012, apparatus arriving CJPL

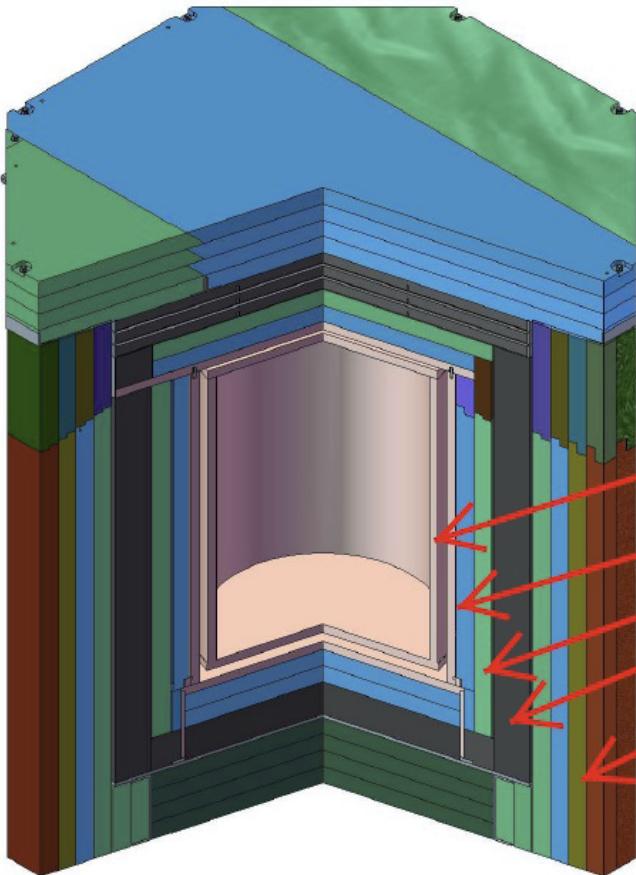


Mar. 2013: Commissioning



Mar. 2014: Physics data taking

# Detector: External shielding



Vacuum Vessel

inner diameter 1240mm

inner height 1750mm

50mm Cu Vessel

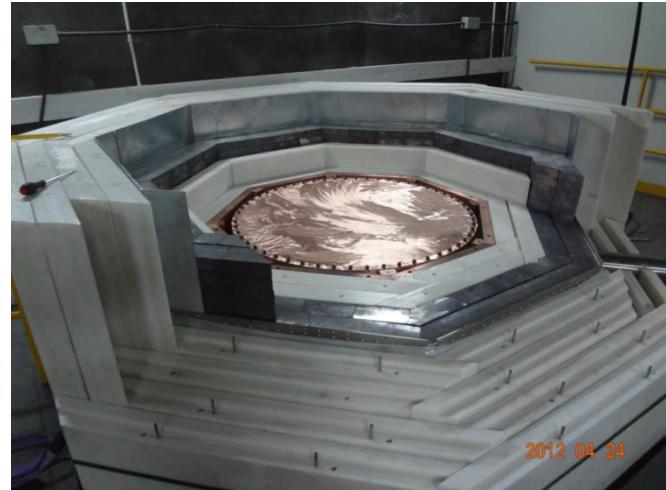
50mm Cu

200mm inner PE

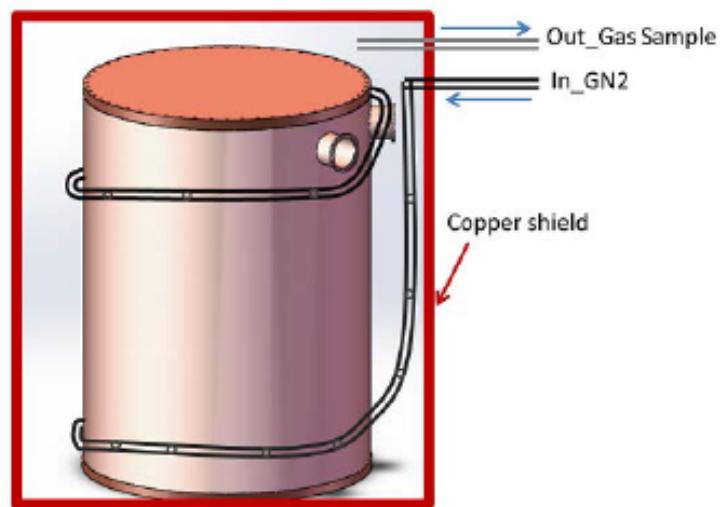
200mm Pb

400mm outer PE

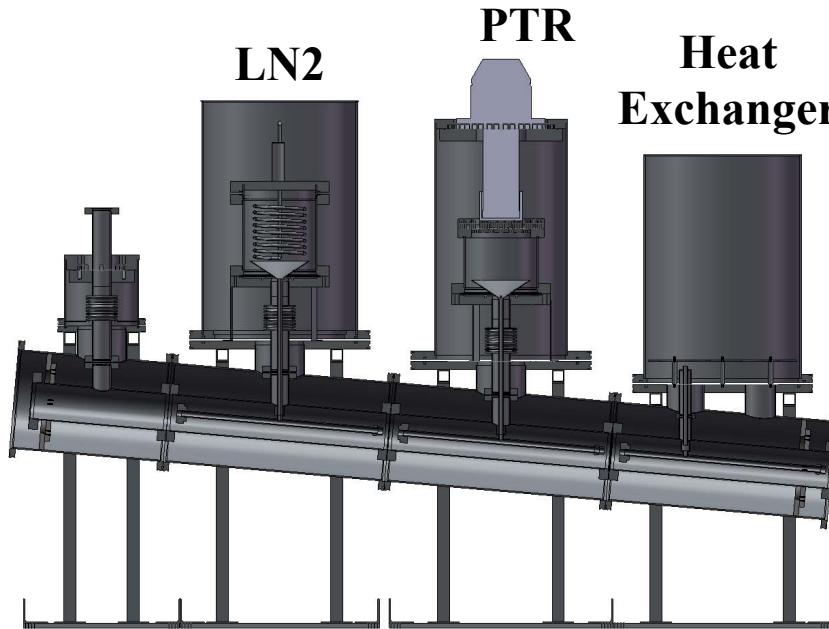
Rn Level < 5 Bq/m<sup>3</sup>



Rn purge with N<sub>2</sub> gas

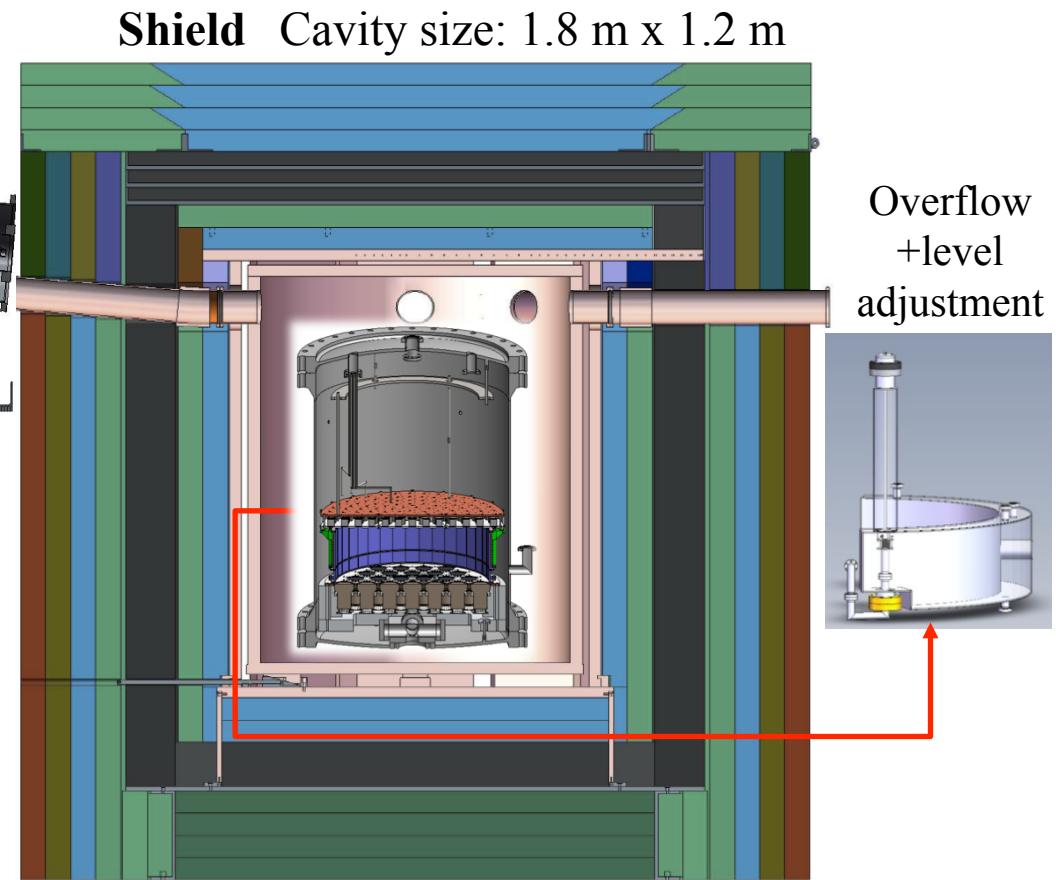


# Detector: Cryogenic system



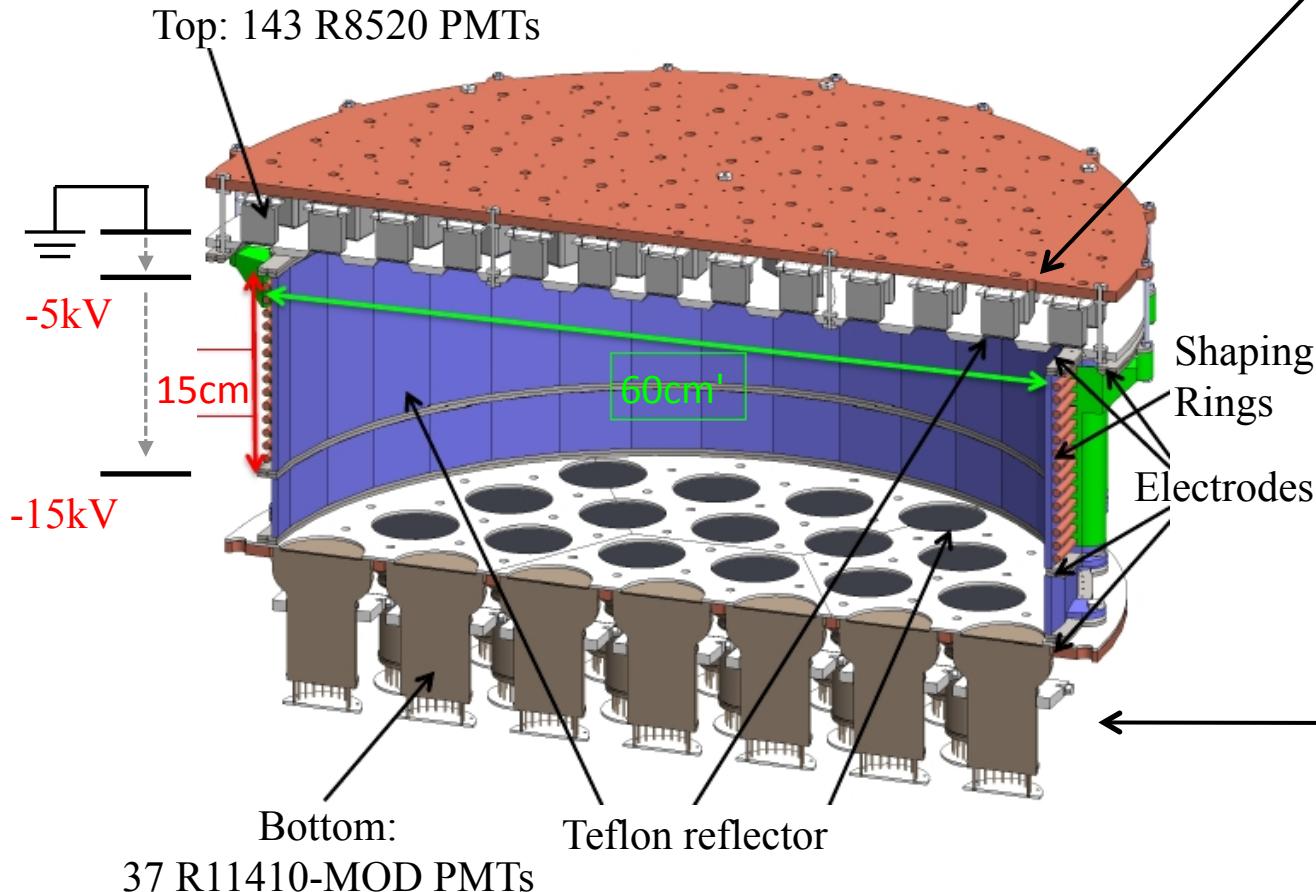
Cryogenic System

[2013 JINST 8 P01002](#)



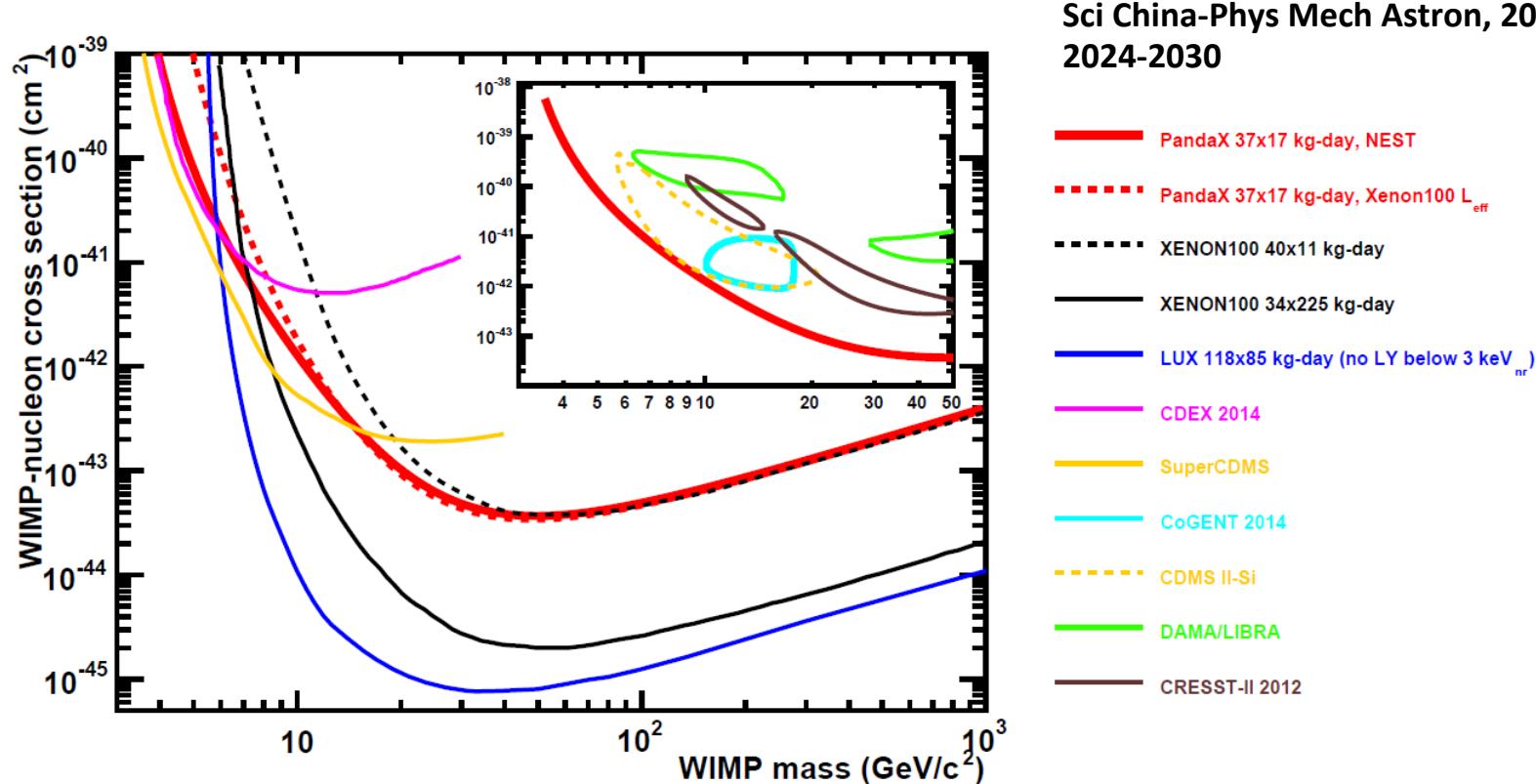
# Detector: TPC

- Total Xe mass: ~450 kg
- Target Xe mass: ~120 kg
- Fiducial volume Xe mass: ~54 kg



**Key design goal: high light collection efficiency**

# PandaX-I first results



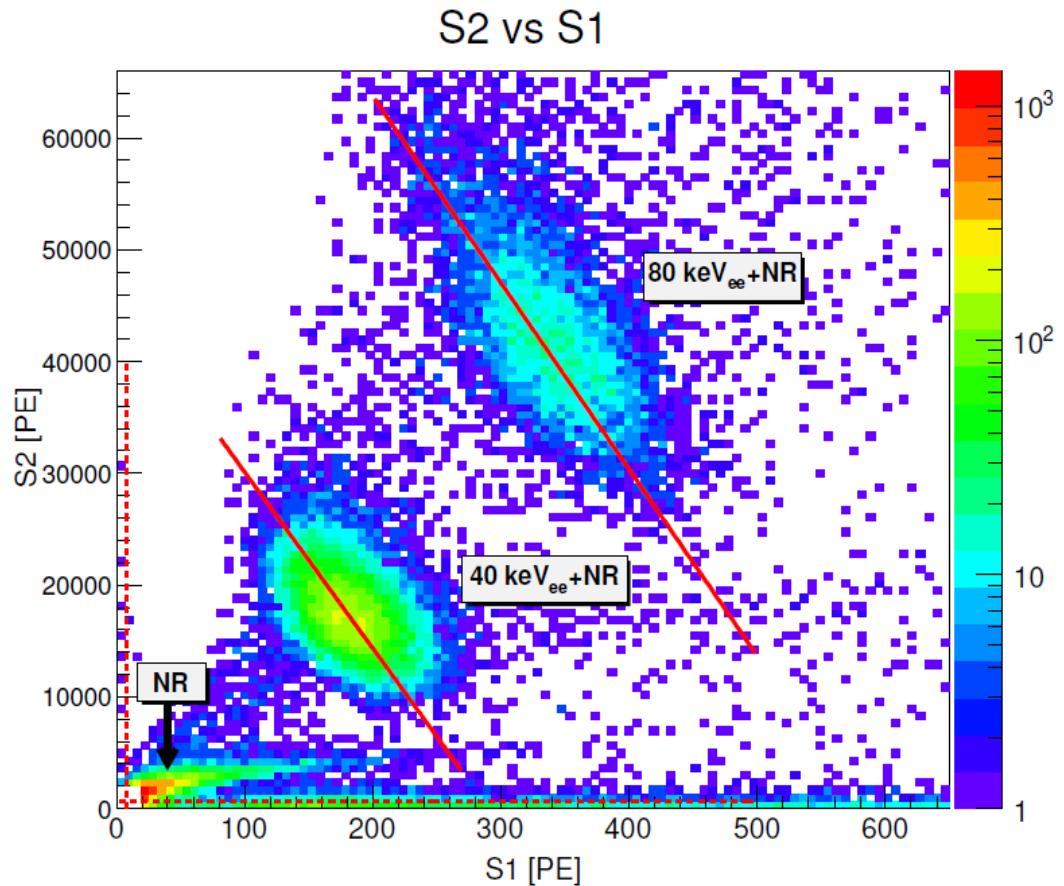
- 17 live-day X FV mass 37kg released in summer 2014
- Our results disfavor previously positive signals
- At low mass region, our results significantly better than XENON100 first results with similar exposure

# Full dark matter run: May 26 to Oct. 16

arXiv:1505.00771, submitted to Phys. Rev. D

- 80.1 live-day x fiducial mass 54 kg (x7 exposure)
- FV and energy window defined **blindly** using background expectation!
- Calibrations with much larger statistics (ER/NR)
- Updated energy modeling at low recoil energy and improved treatment to low mass WIMPs
- Better understanding/modeling of background
- Likelihood approach to final results

# Anti-correlation between S1 and S2



$$E_{ee}^{ce} = w \left( \frac{S1}{PDE} + \frac{S2}{\text{gas gain} \times EEE} \right)$$

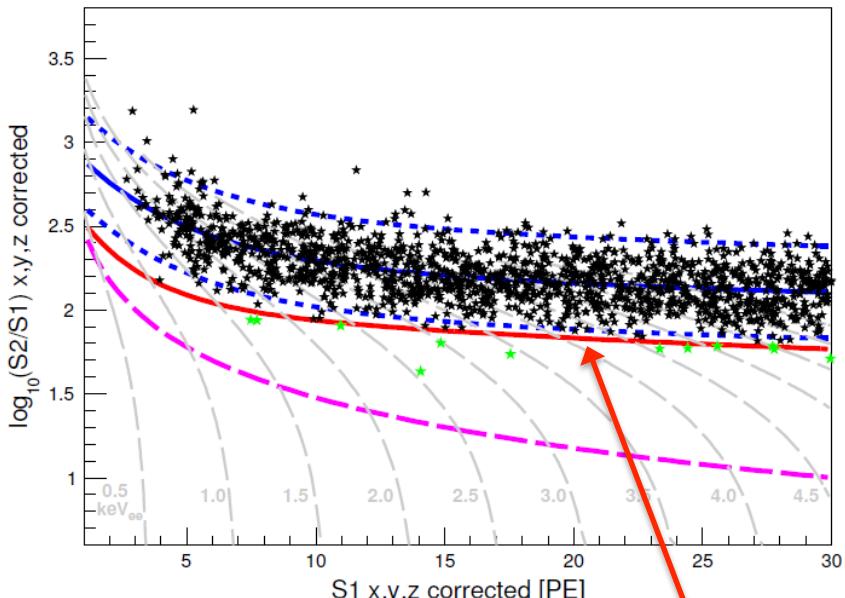
W = 13.7 eV (global fit)

Photon detection efficiency (PDE):  
**9.55(1.0)%**

Electron extraction efficiency (EEE):  
**82.1(7.4)%**

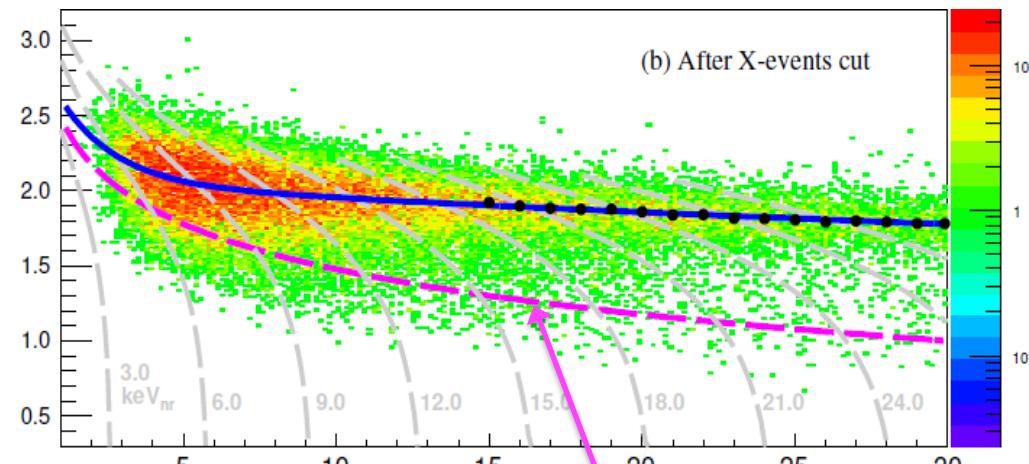
# ER/NR Calibration

ER band



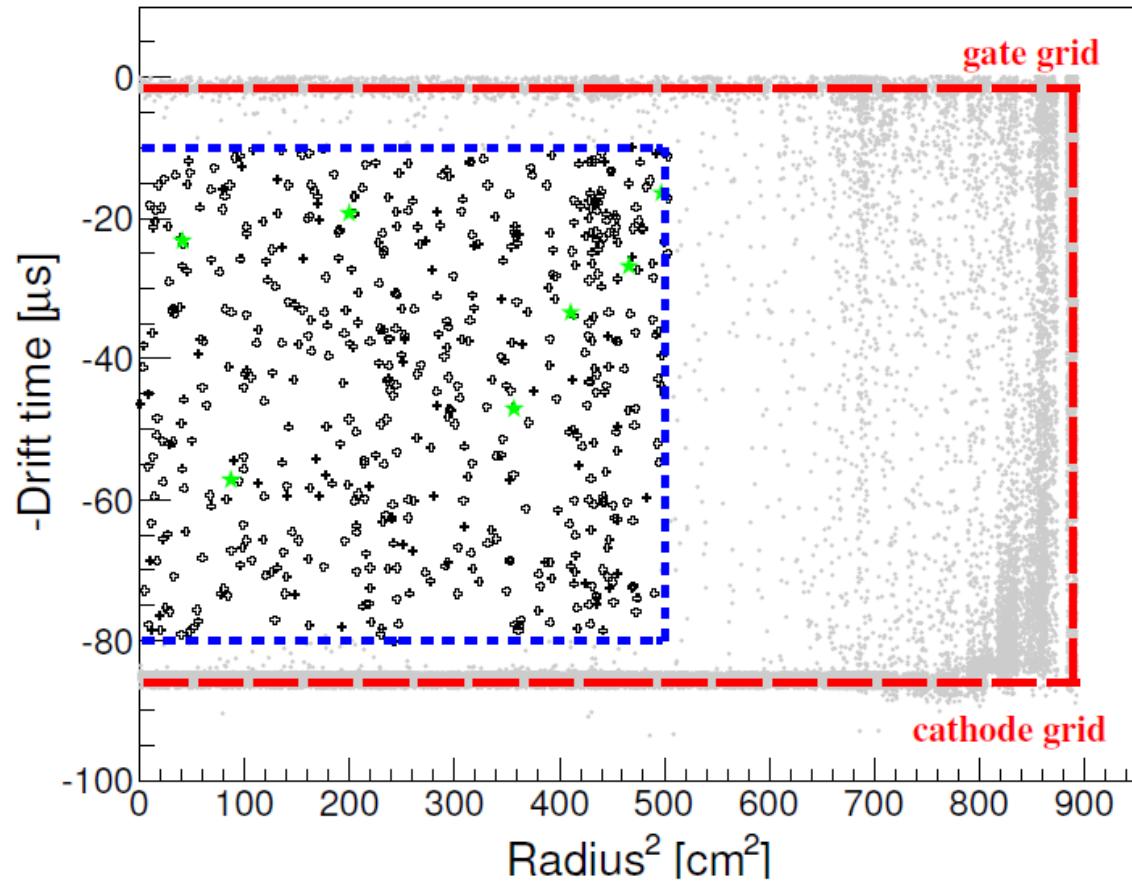
**NR Median:**  
**ER rejection  $99.32 \pm 0.23\%$  in data**  
**(Gaussian expectation: 99.5%)**

NR band

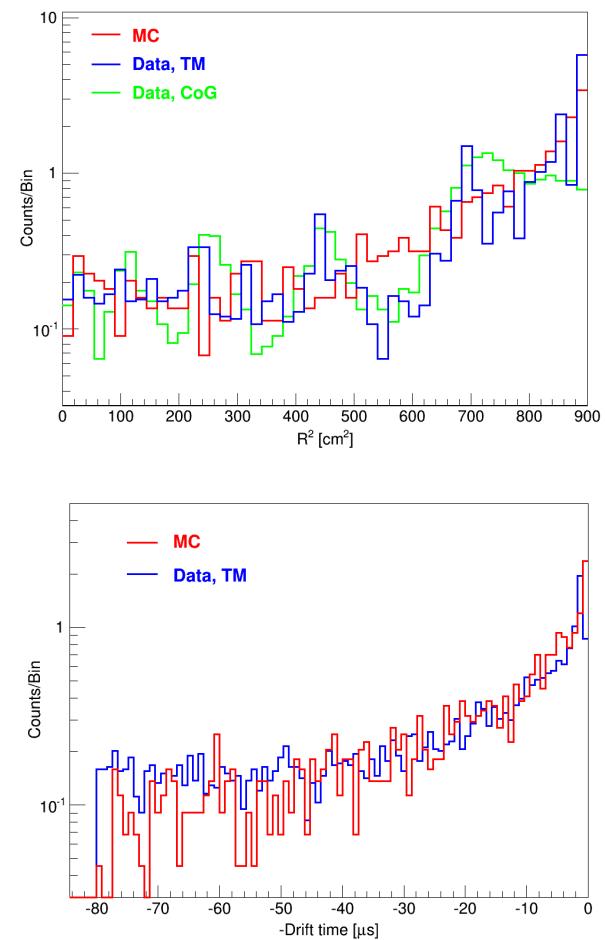


**300PE cut on S2**

# Vertex Distribution



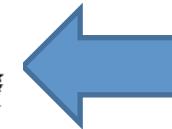
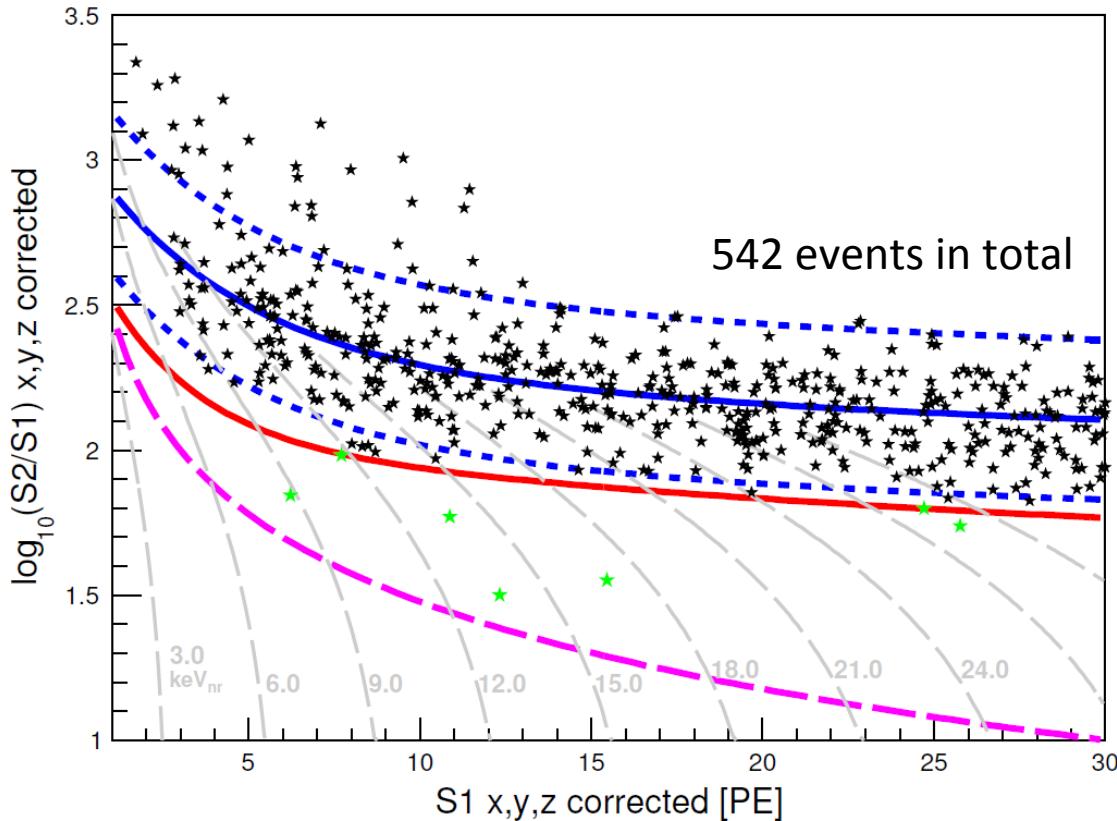
PMT and inner vessel dominates the background



Data and MC agree well

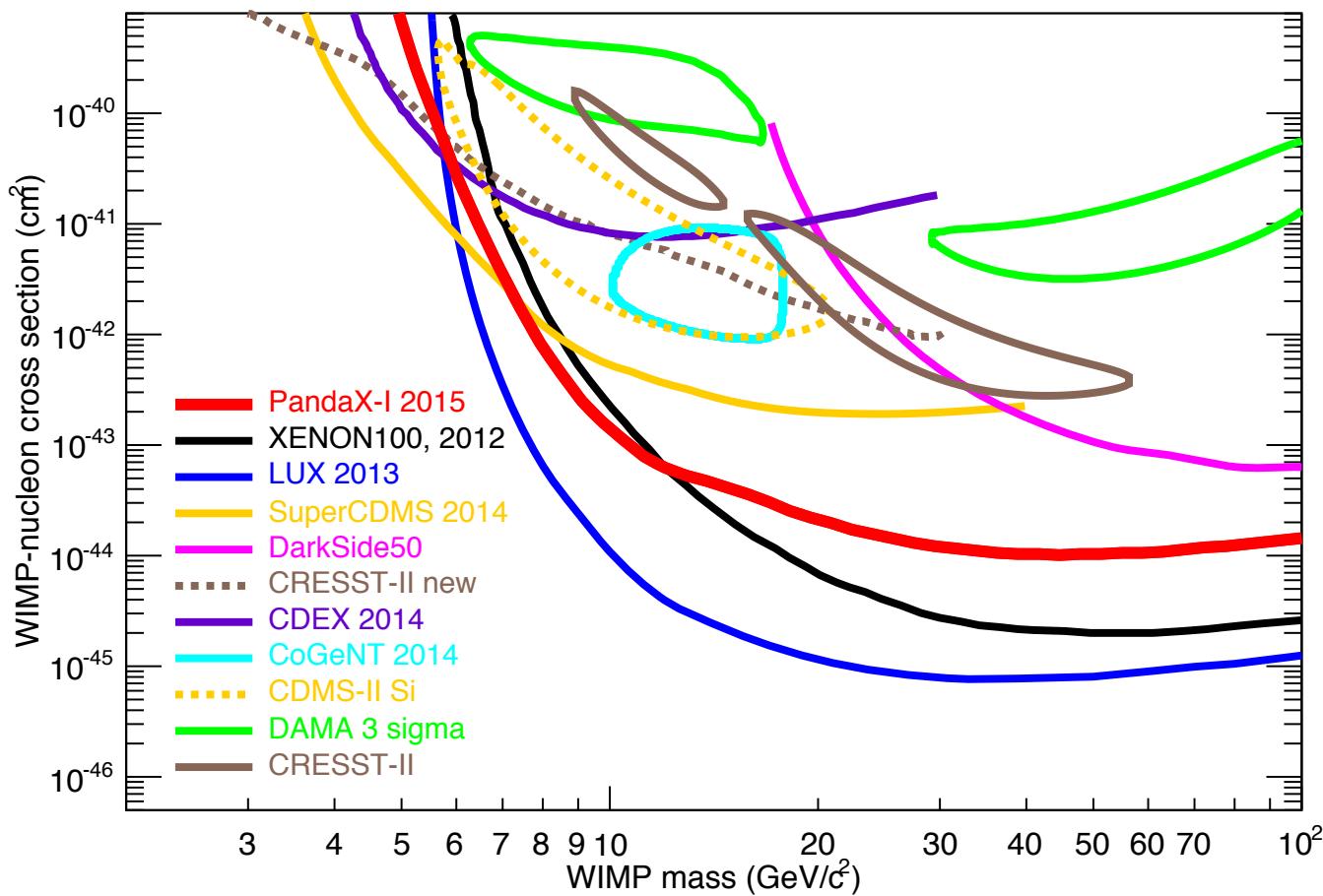
# DM candidate events

	ER	Accidental	Neutron	Total expected	Total observed
All	503.7	35.1	0.35	539.1	542
Below NR med	2.5	4.2	0.18	6.9	7



7 events found in the  
DM search region  
However, consistent  
with background  
expectation

# DM limits



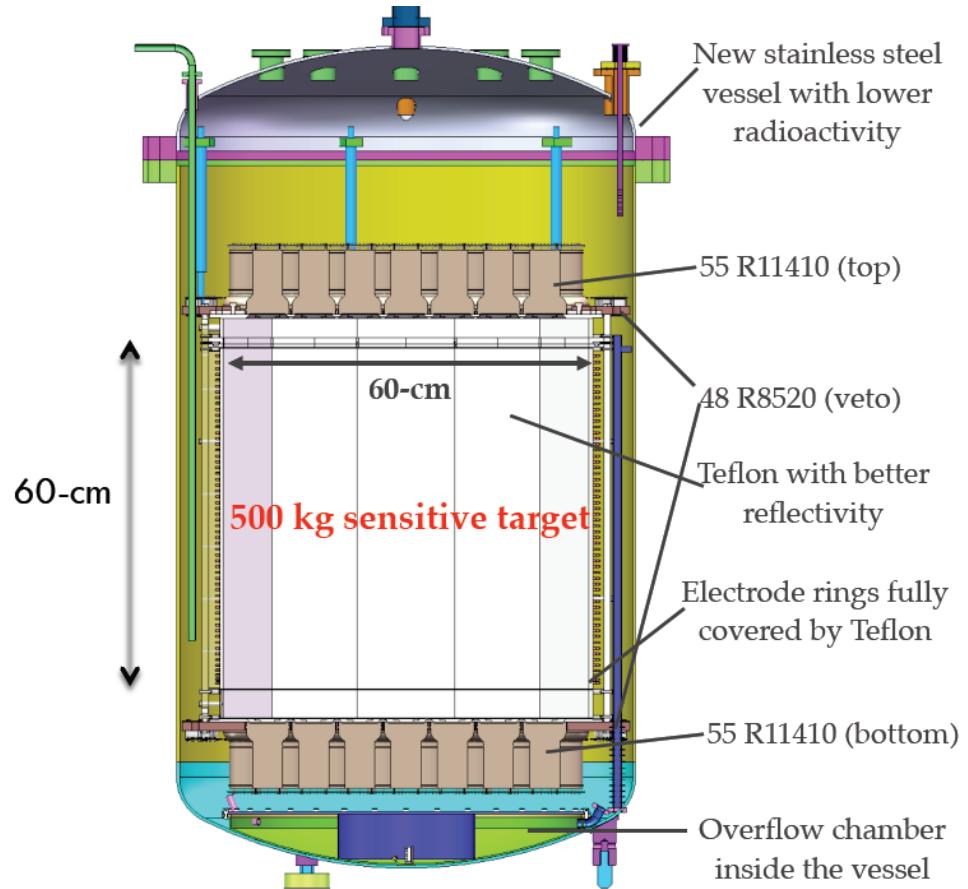
- Profile likelihood fit using DM and background distribution
- DM mass dependent efficiency taking into account
- Using NEST as the NR energy model

# Conclusions from PandaX-I Experiment

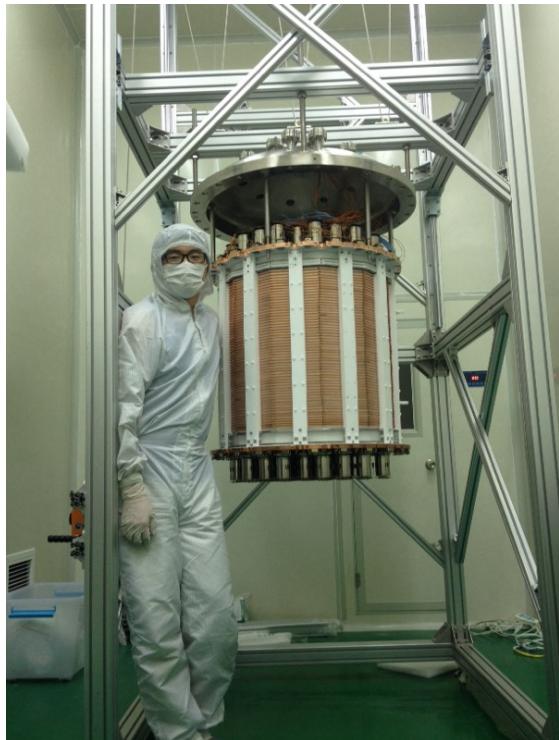
- Full exposure results with a much more elaborated analysis confirmed the finding from the first results, strongly disfavoring all positive WIMP claims
- Tighter bound than superCDMS above WIMP mass of 7  $\text{GeV}/c^2$
- Best reported WIMP limits below 5.5  $\text{GeV}/c^2$  in xenon community

# PandaX II Experiment

- Started construction in June 2014
- Completed detector assembly in CJPL Mar 2015
- Presently under commissioning
- Physics run starts this year
- Expected running time: 1-2 years



# 500kg TPC in construction



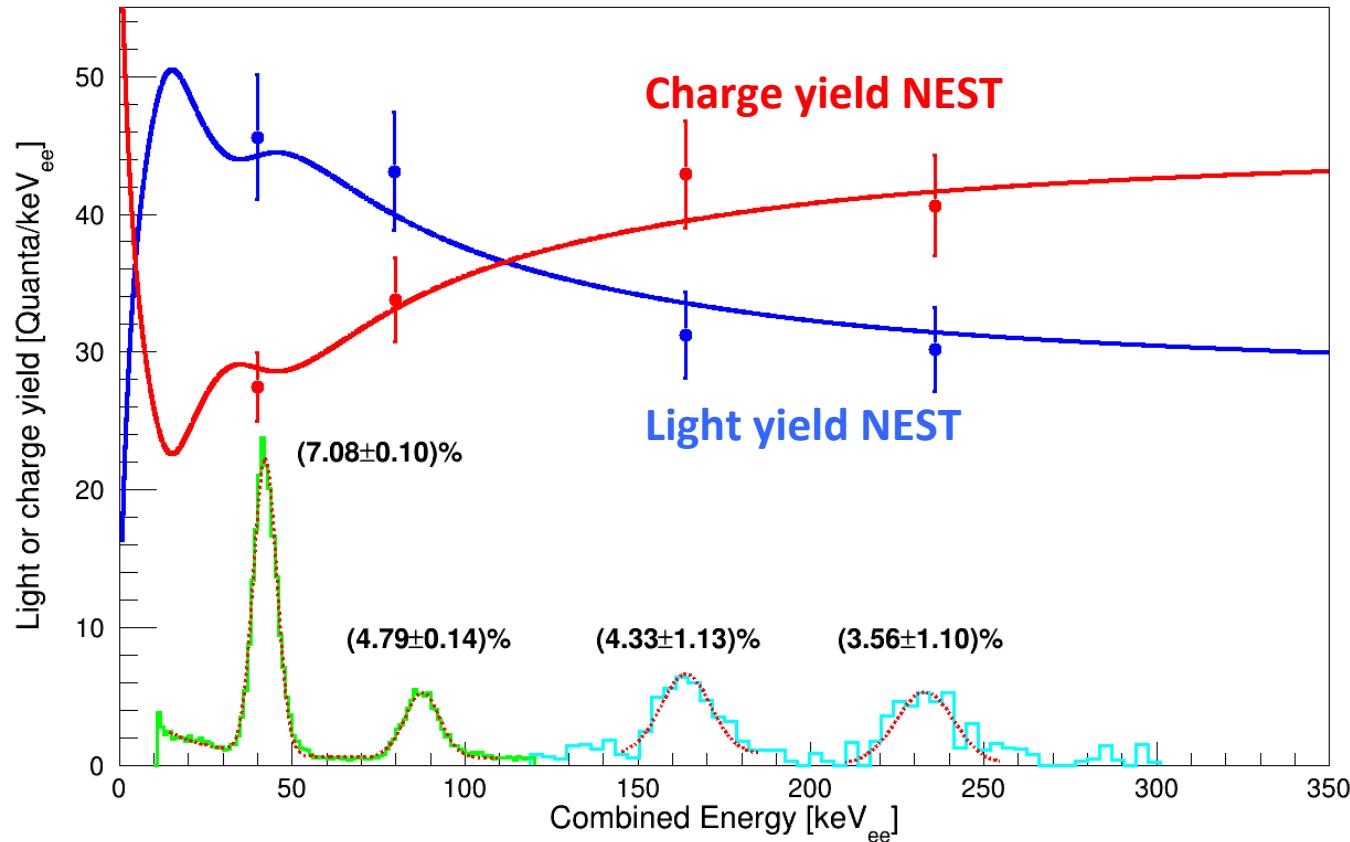
# Summary

- The PandaX project has made rapid progress over the past few years
- PandaX-I has completed with results strongly disfavoring all positive WIMP claims
- Good sensitivity down to very low recoil energy using Xenon detectors
- Learn A LOT from PandaX-I experience
- PandaX-II data imminent, stay tuned for future excitement!

# Thank you!!!

# Backup Slides

# Comparison with NEST model

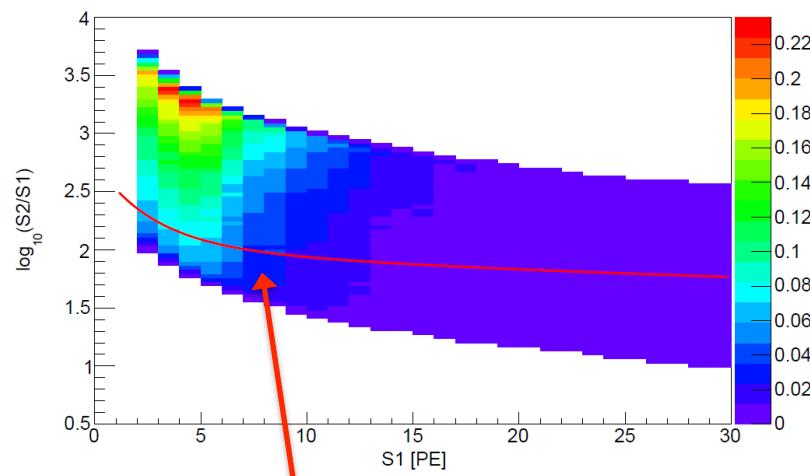
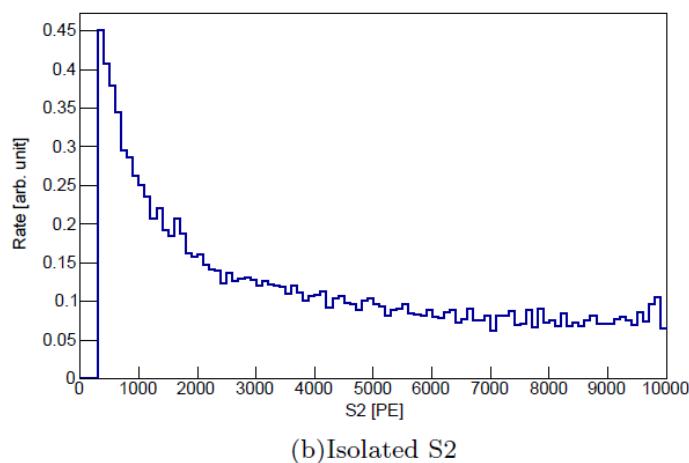
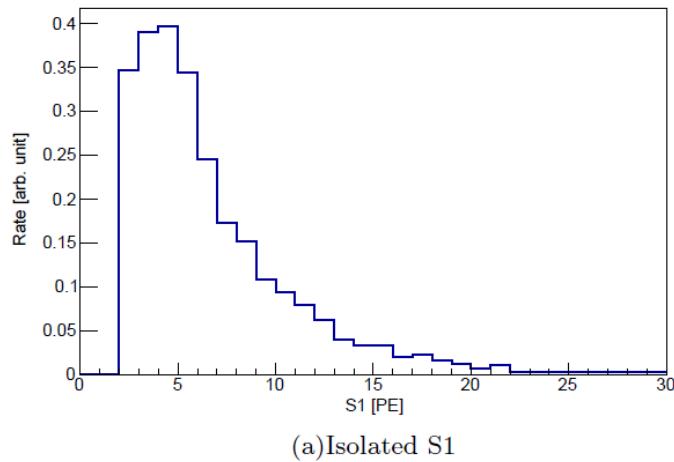


NEST prediction consistent with our measurement within uncertainty

Energy resolution of detector is not bad!

# Accidental Background

Isolated S1 and S2 events

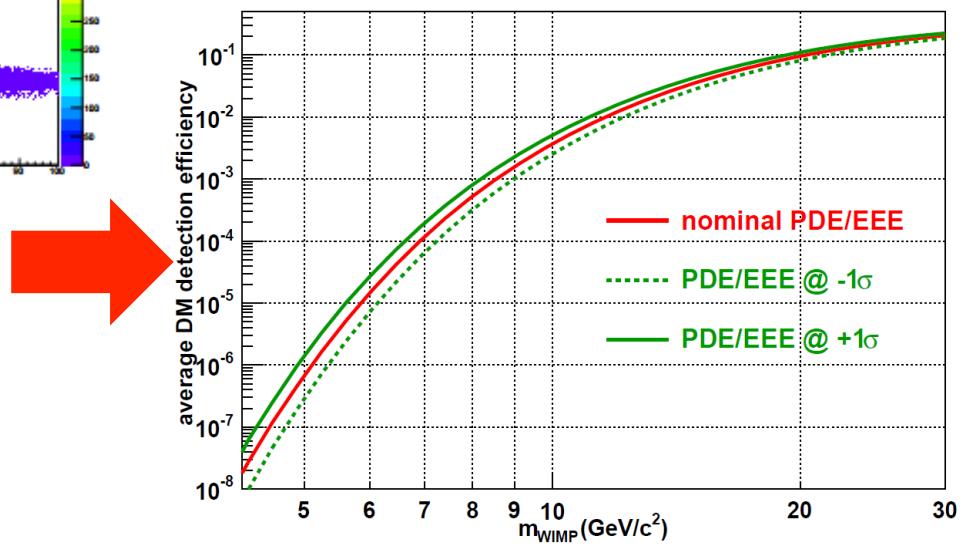
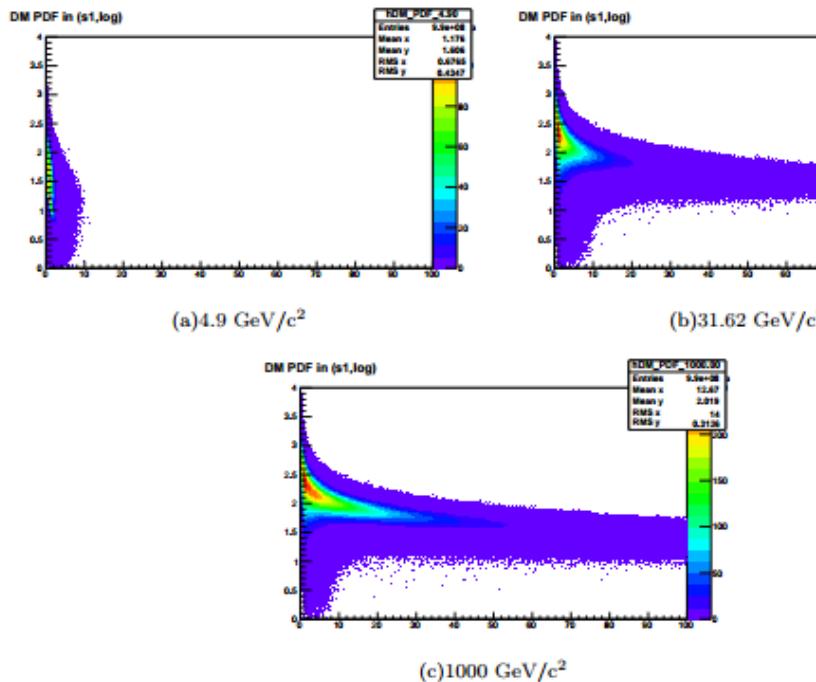


Accidental distribution:  
some do leak below the NR median

# Dark matter PDF

$$\prod_{i=1}^{i=N_m} \left[ \frac{N_{DM}(1 + \delta_{DM}) P_{DM}(s_1^i, s_2^i) \epsilon_{NR}(s_1^i, s_2^i)}{N_{exp}} \right]$$

$$N_{DM,exp} = M_{target} T \int_0^\infty \frac{dR}{dE_{nr}} dE_{nr} \quad \text{Function of } (m_\chi, \sigma_{\chi,n})$$



# PandaX-II Sensitivity Projection

