



XENON1T

Latest WIMP results and status update

Lake Louise Winter Institute 2019

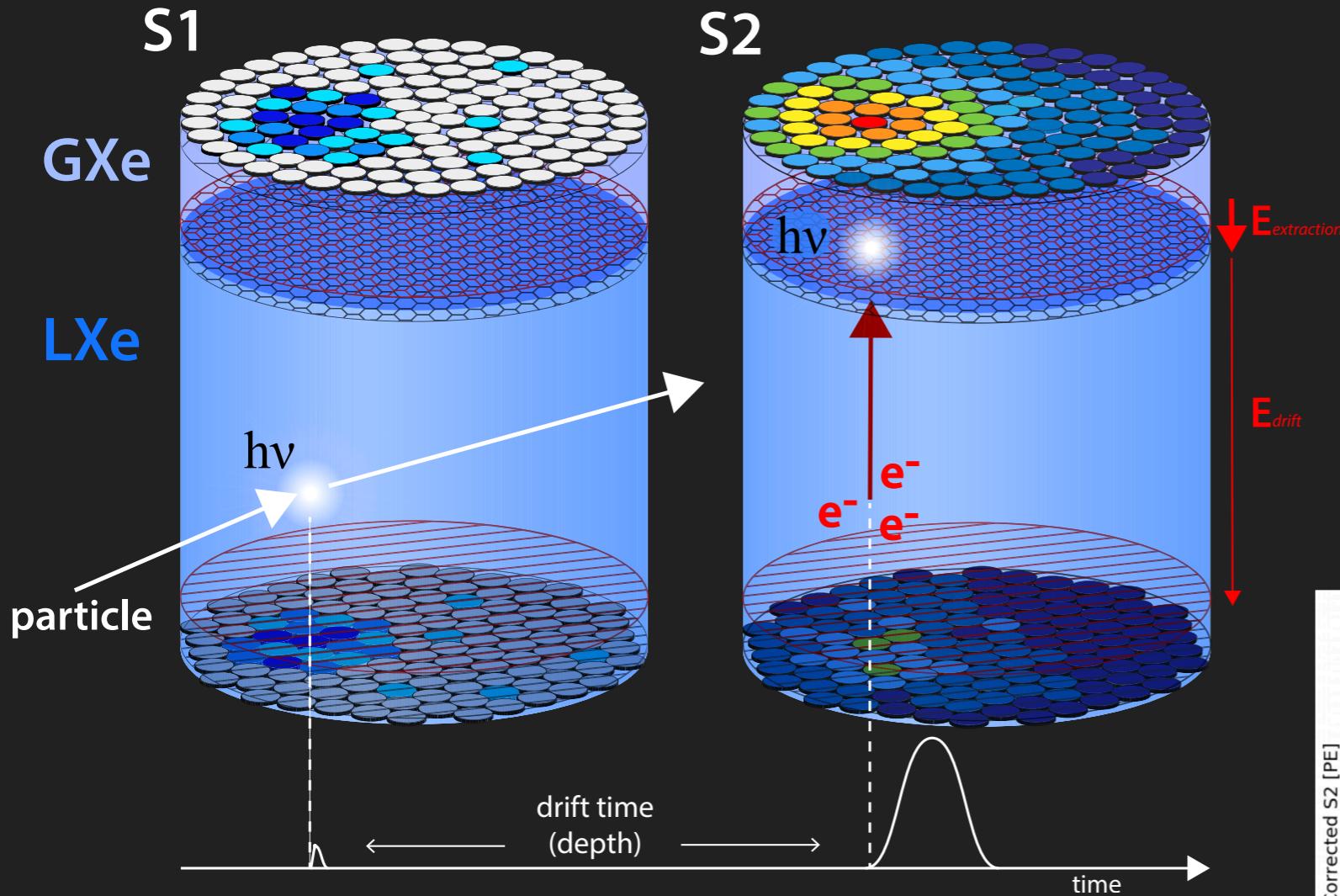
Evan Shockley
KICP & University of Chicago
For the XENON collaboration

XENON Collaboration



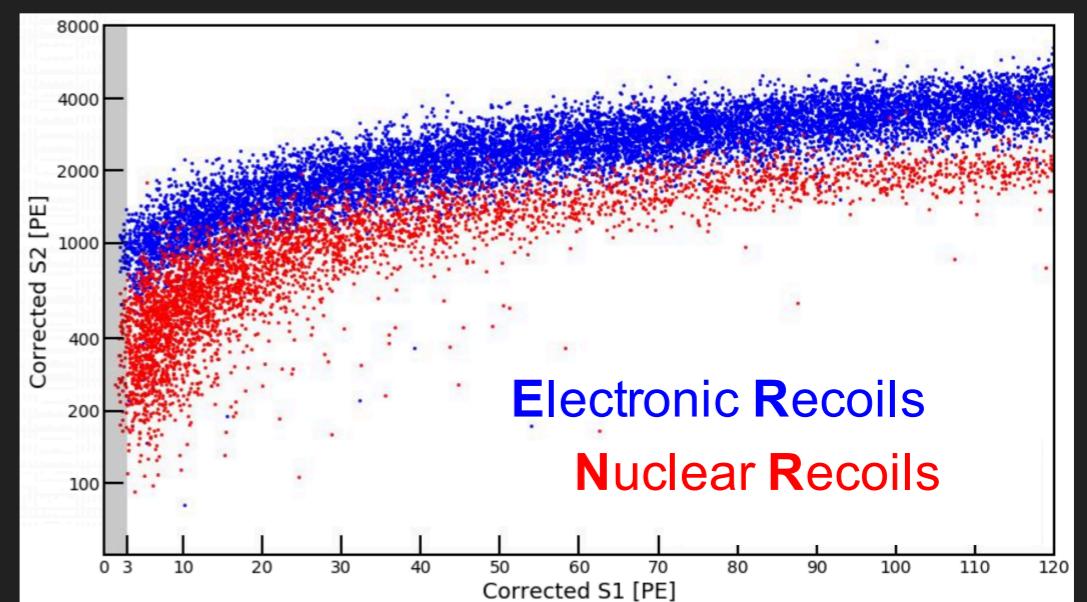
~160 scientists from 25 institutions

XENON1T TPC

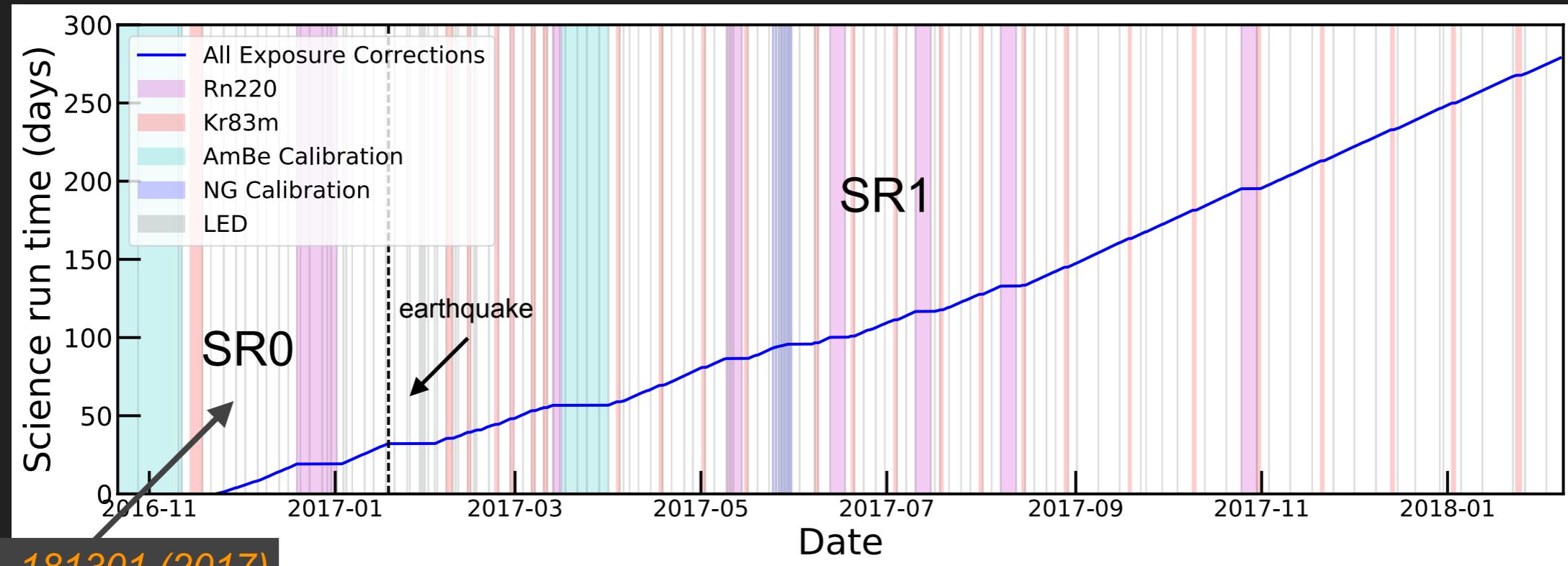


2-phase xenon TPC

- Energy from S1, S2
- 3D position reconstruction
 - x, y from S2
 - z from drift time
- Particle ID
 - ER from γ , β
 - NR from neutron, WIMP

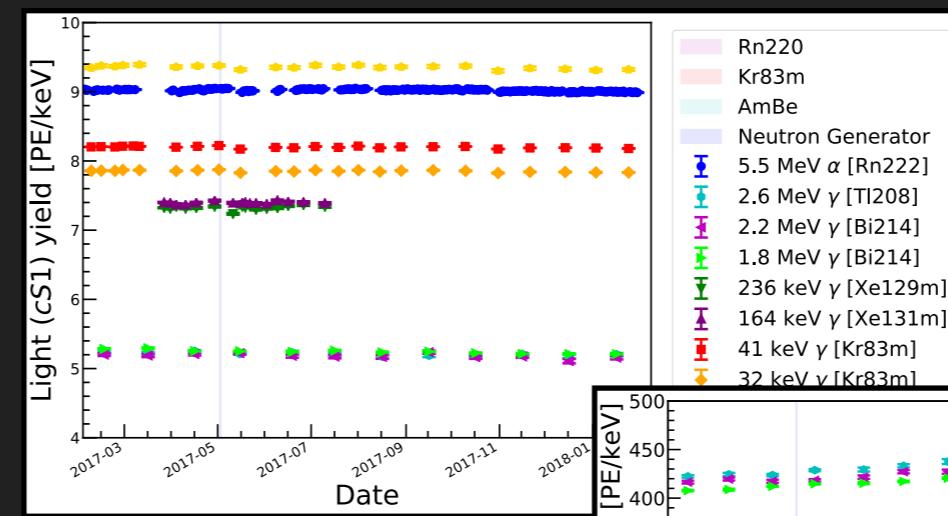


A Tale of Two Science Runs



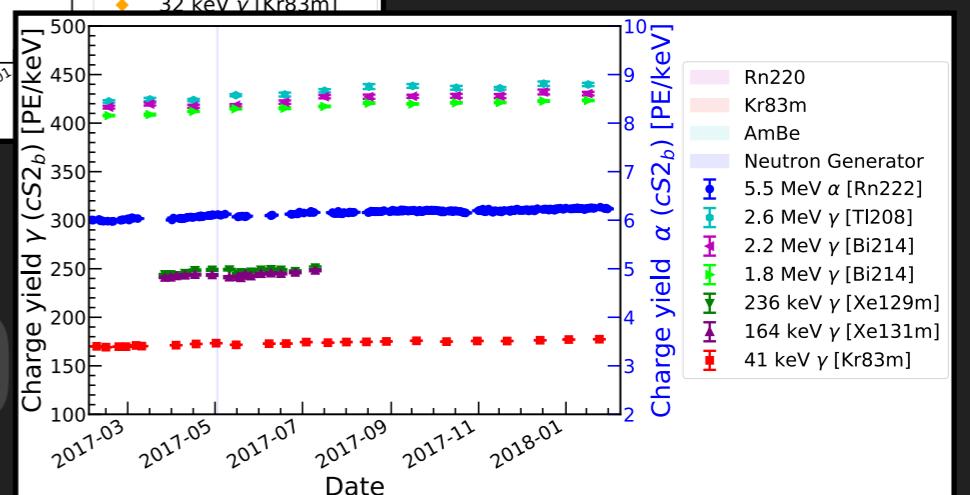
PRL. 119, 181301 (2017)

- 278 live-days of science data
 - 32 from SR0
 - 246 from SR1
- Stable detector conditions



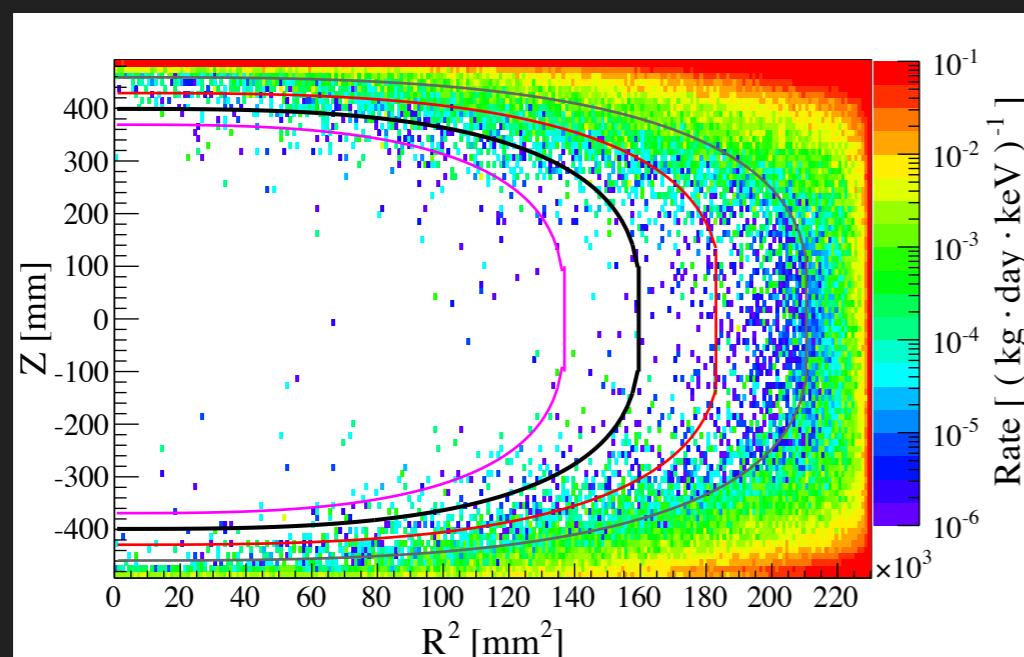
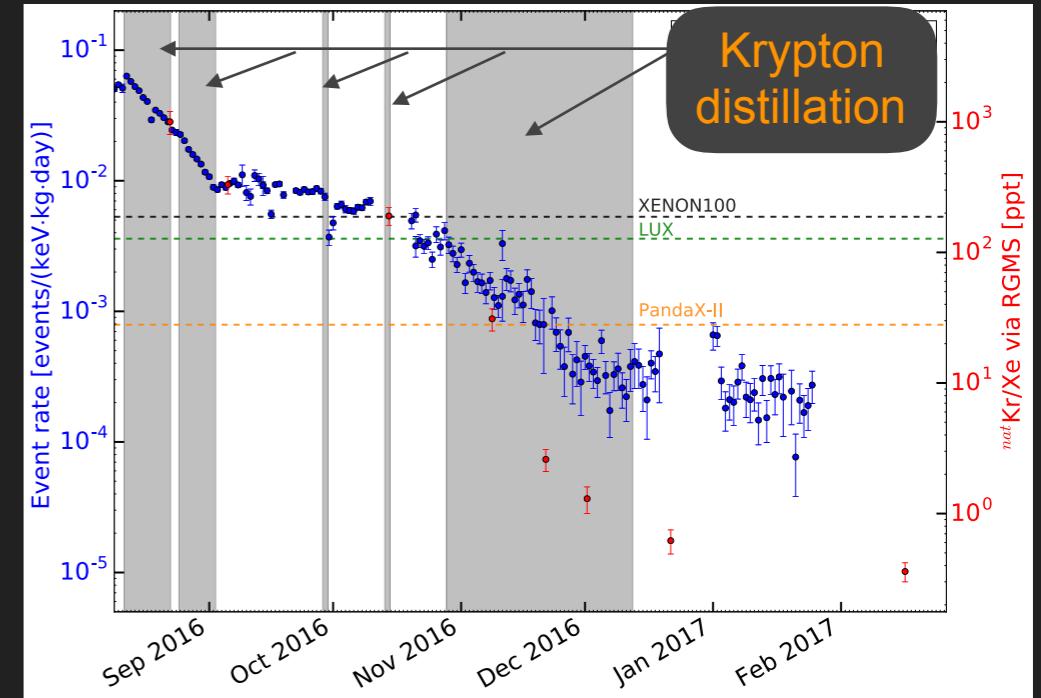
Light yield

Charge yield



Background Suppression

1. Material selection
2. Shielding
 - Underground in Gran Sasso, Italy
 - Passive water shielding + active muon veto
 - Self-shielding of xenon
3. Fiducialization of active volume
 - Self-shielding + 3D position reconstruction
4. Krypton distillation column
5. Background discrimination



Backgrounds

Electronic Recoils

- Dominated by Pb214
 - › not removed by fiducialization
- ER ‘leakage’ into NR region
- Flat energy spectrum in ROI

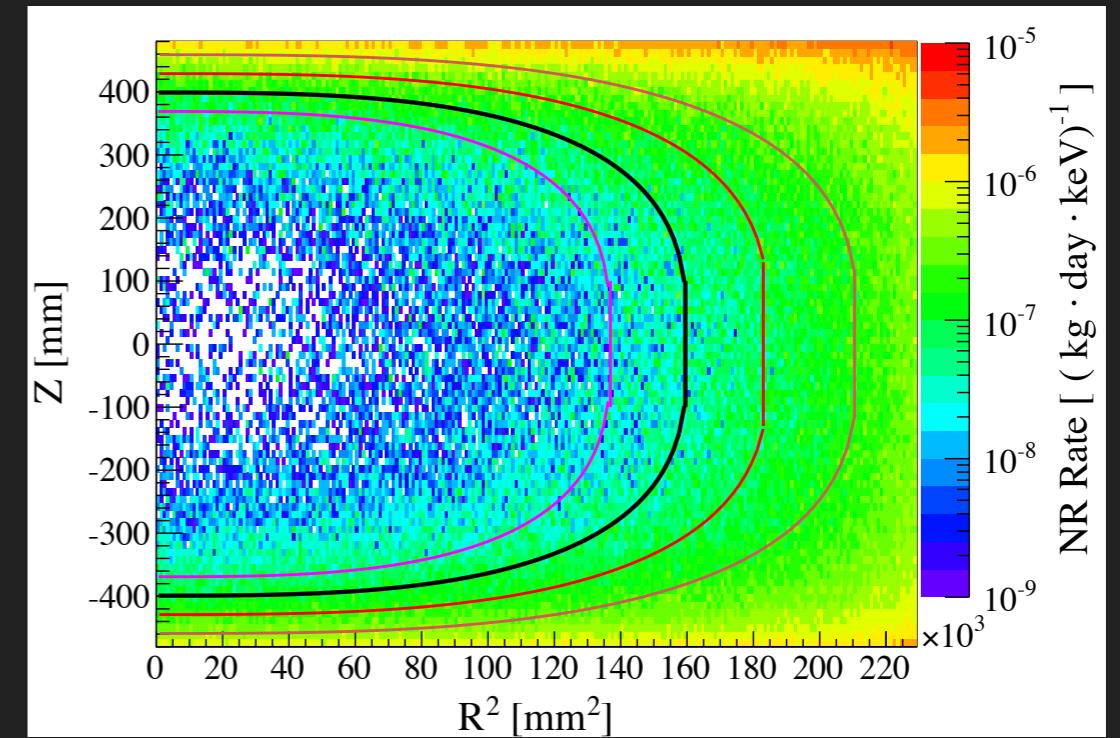
Component	Rate [$t^{-1} y^{-1} \text{ keV}^{-1}$]
Pb214	56 ± 6
Kr85	7.7 ± 1.3
Materials	8 ± 1
Solar v	2.5 ± 0.1
Xe136 $2\nu\beta\beta$	0.8 ± 0.1
Total	75 ± 6

Nuclear Recoils

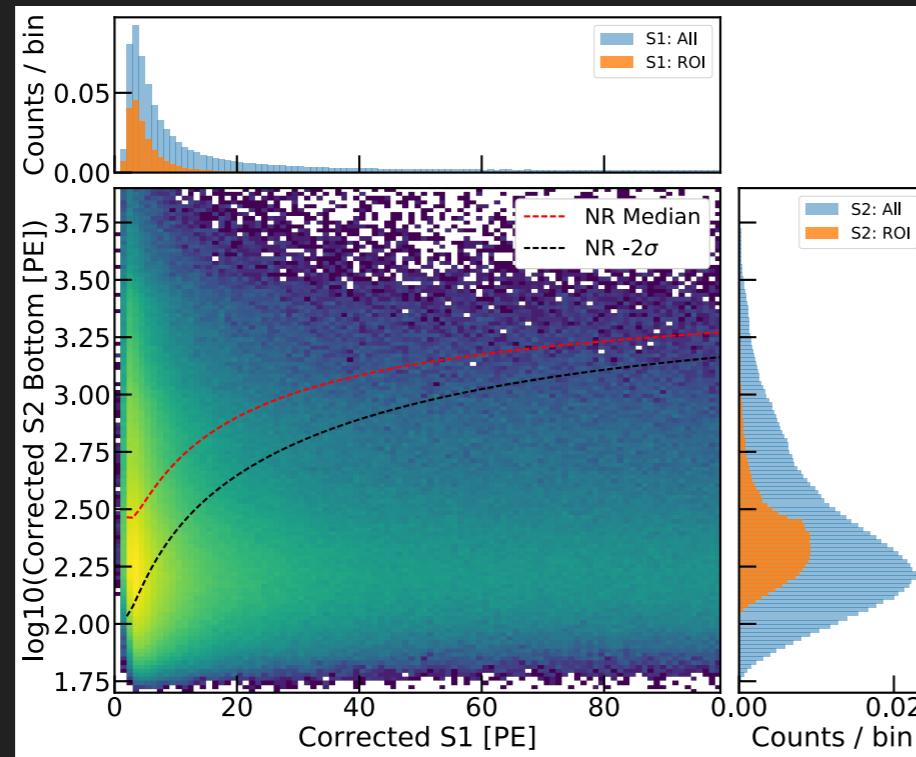
Component	Rate [$t^{-1} y^{-1}$]
Neutrons	1.48 ± 0.07
Neutrinos	0.1

Neutrons

- Spatial dependence
- Suppressed with muon veto (+ neutron veto in the future)



Backgrounds

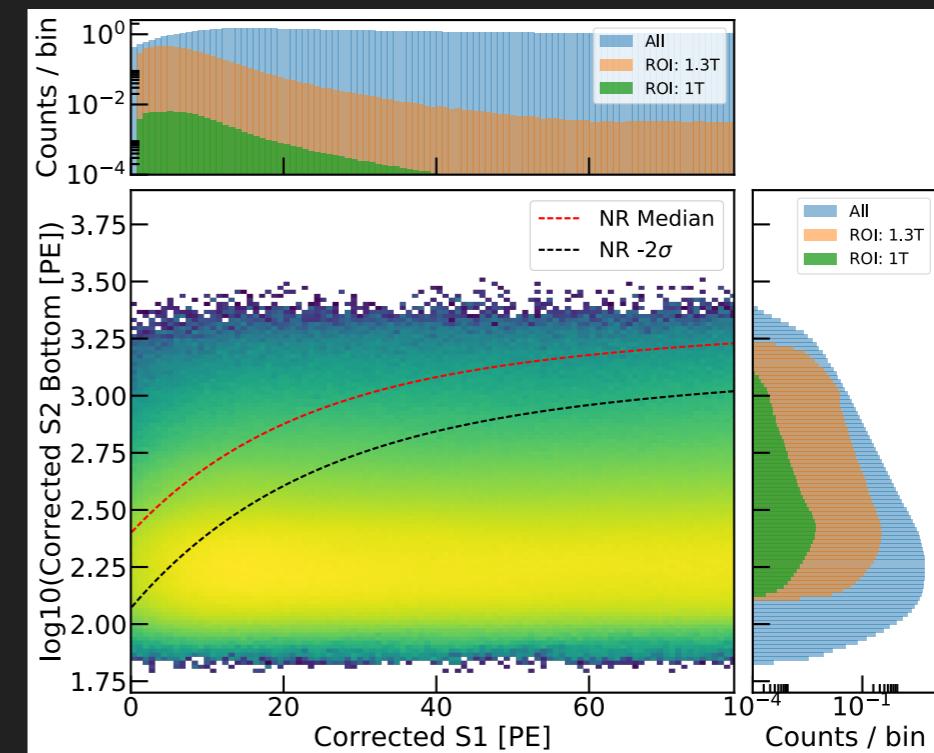


Accidental Coincidence (AC)

- 'lone' S1 + S2 randomly paired together
- < 1 event expected in exposure

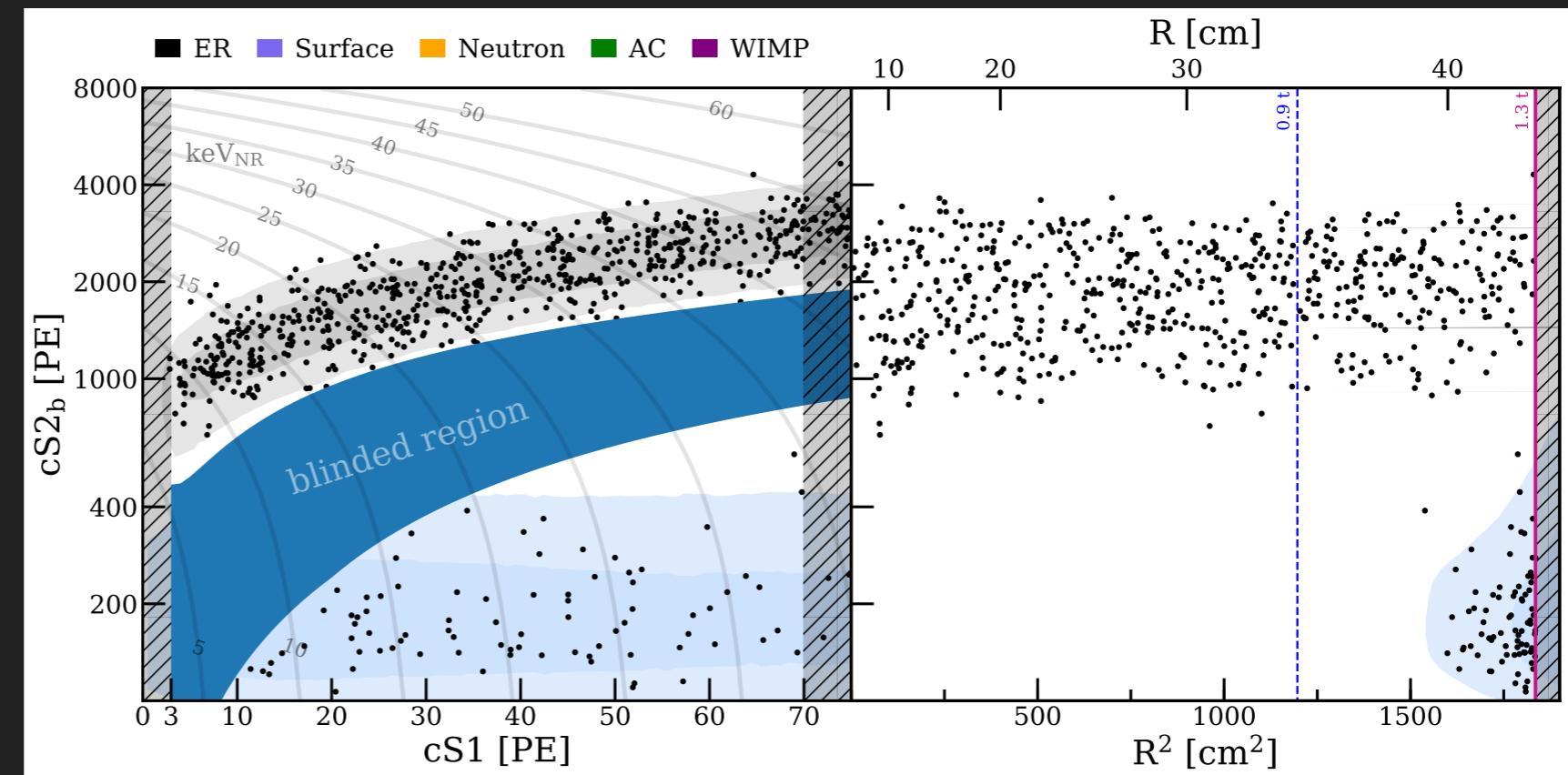
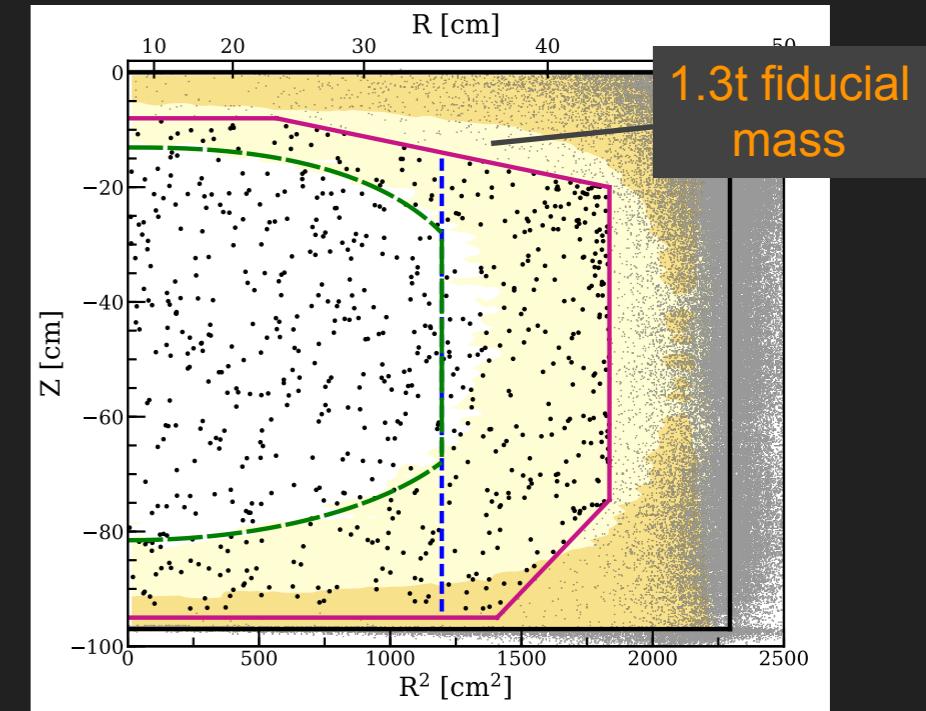
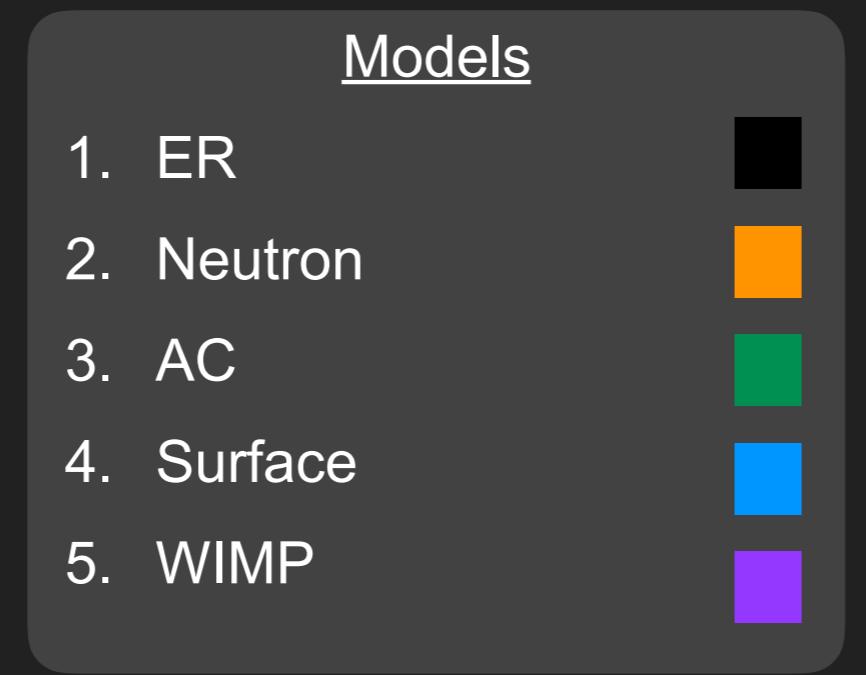
Surface Background

- ER with distorted S2 due to charge loss near the edge of detector
- strong spatial dependence
- expect ~ 100 events (1.3t)



WIMP Search: Blinded

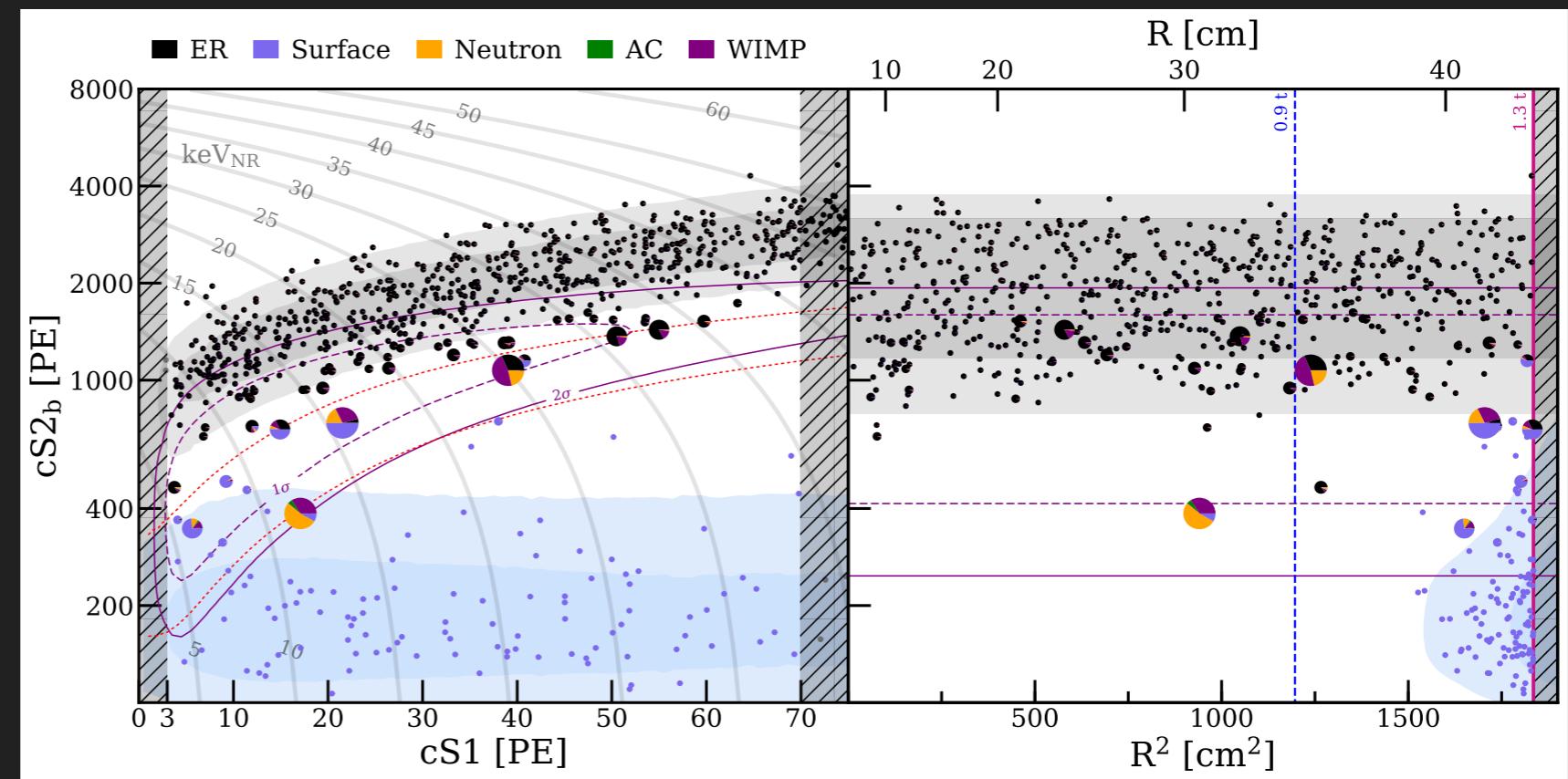
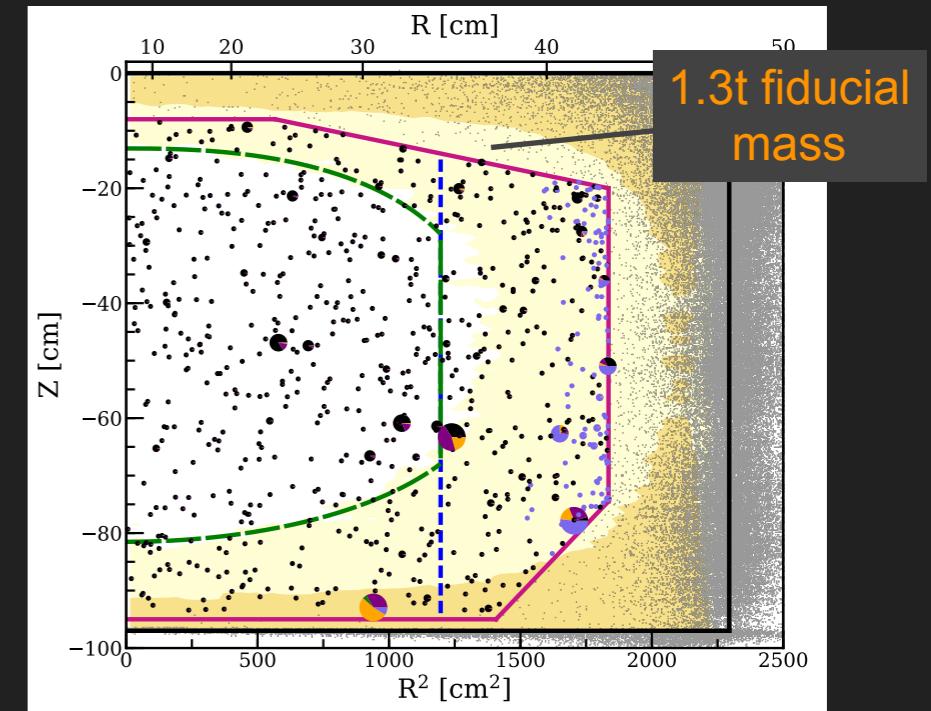
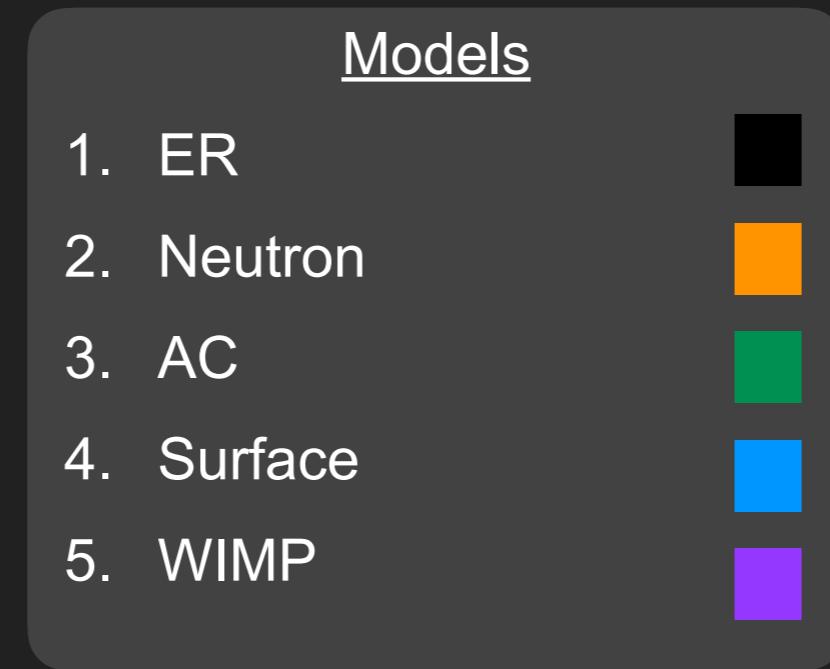
Component	Events
ER	
Neutron	
AC	
Surface	
WIMP	



WIMP Search: Results

Component	Events
ER	627
Neutron	1.43
AC	0.47
Surface	106
WIMP	3.56

Best-fit values for 200 GeV WIMP. Does not mean we detected 3.5 WIMPs



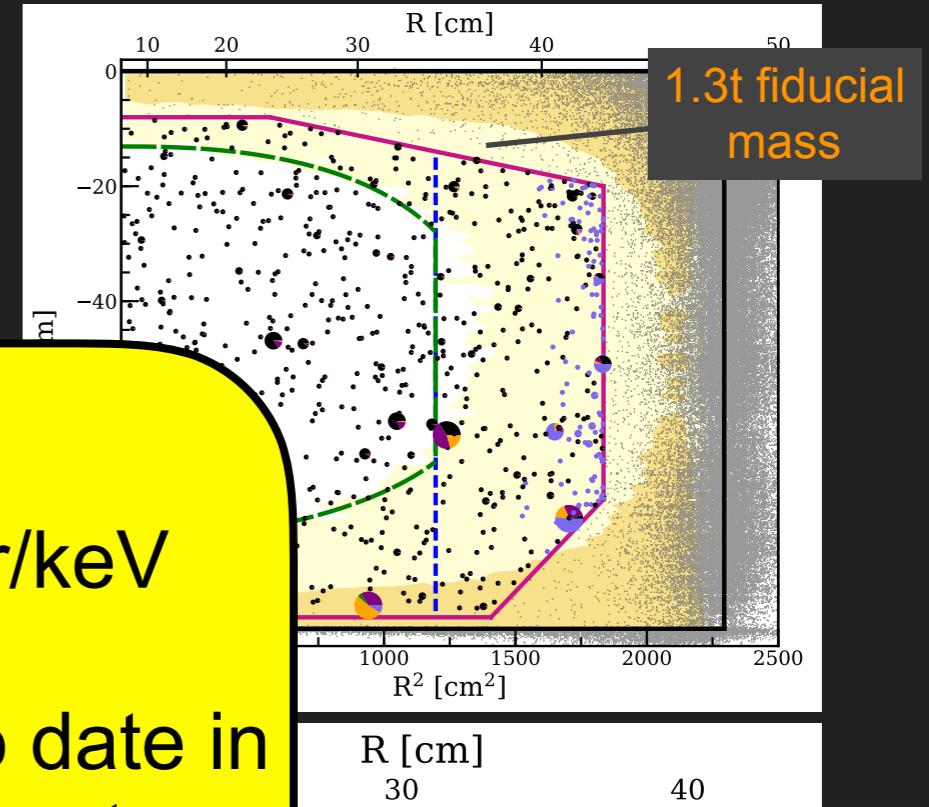
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Models

1. ER
2. Neutron

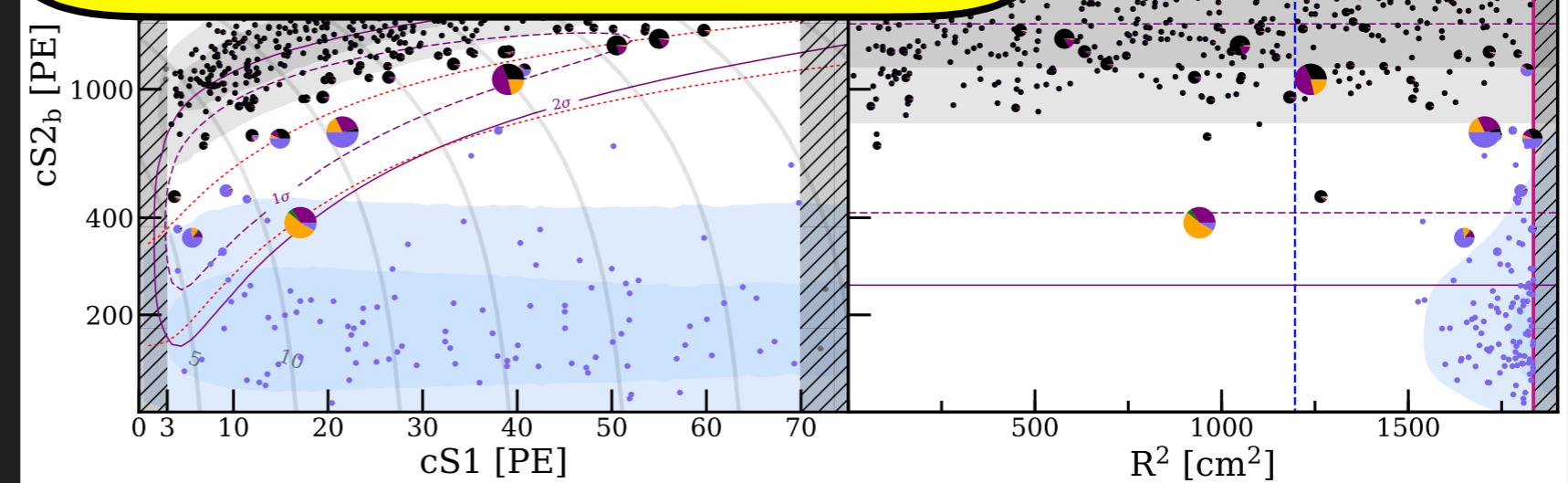


~ 82 events/tonne/year/keV

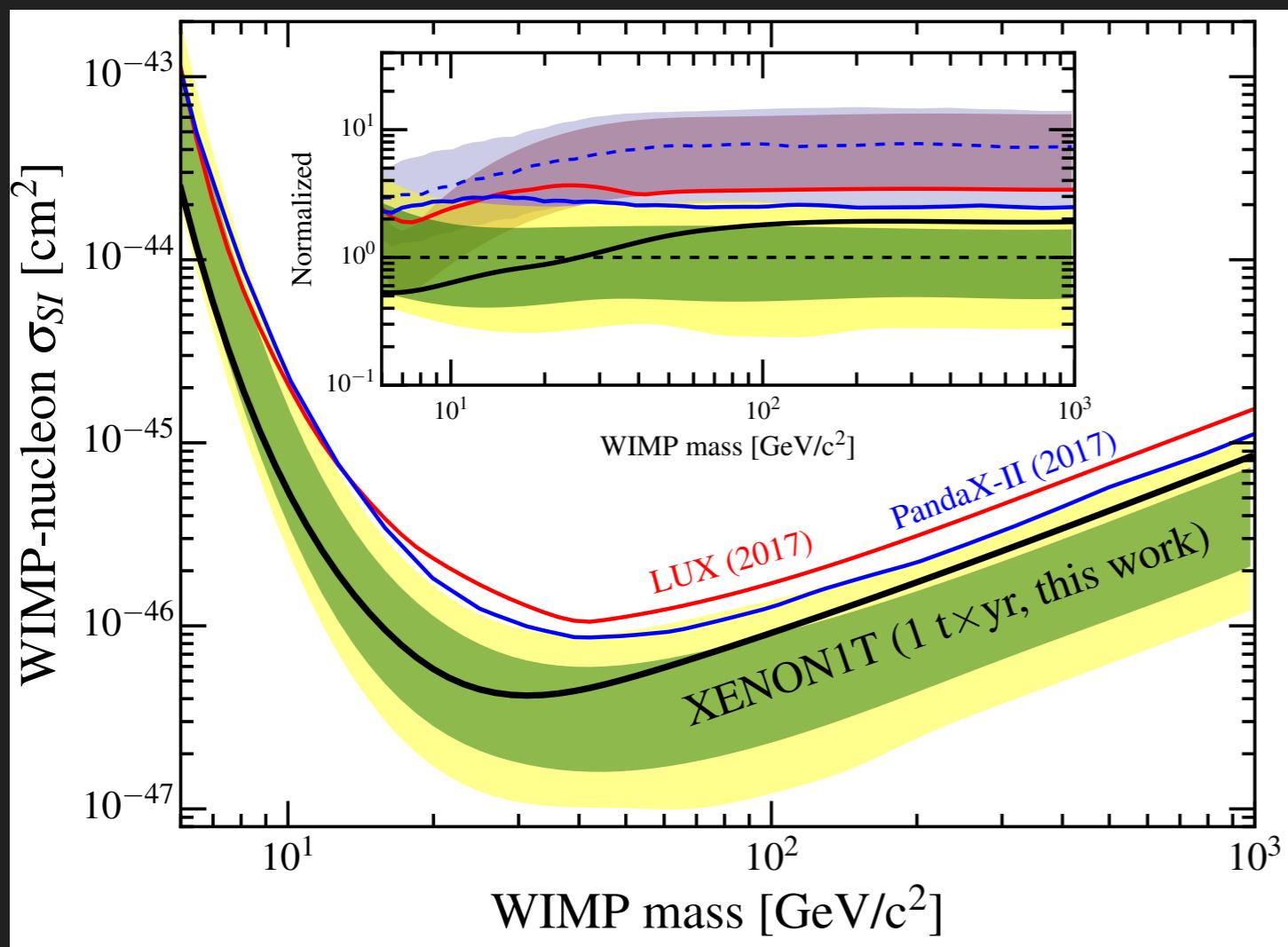
The lowest background to date in a dark matter experiment

Inference

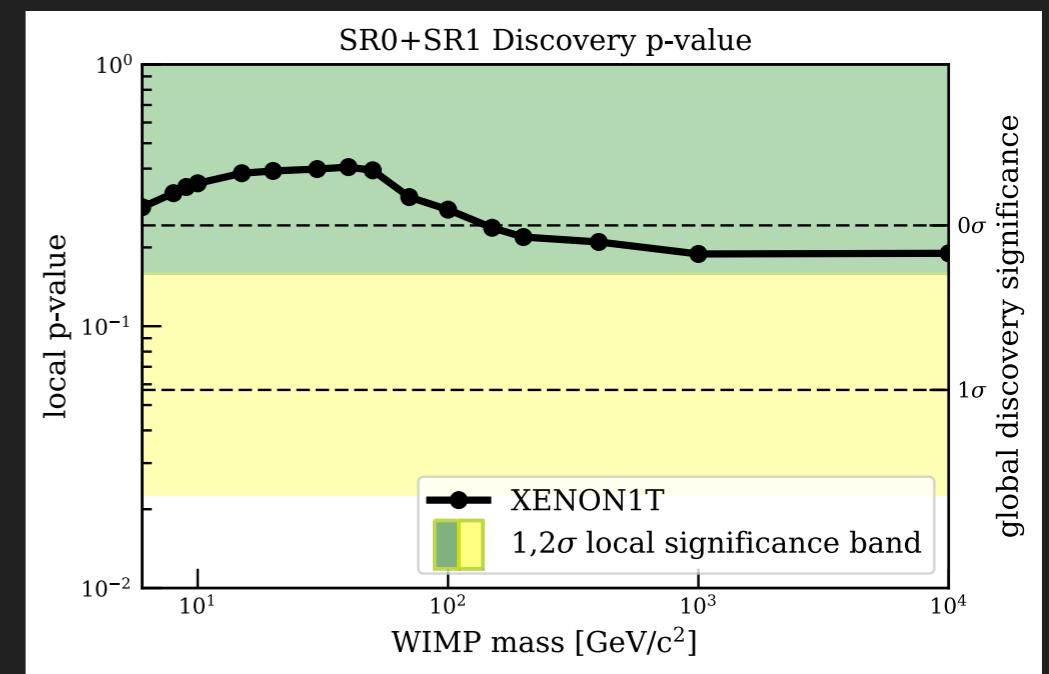
- Unbinned extended profile likelihood
- “Probabilities” assigned to each event for each model



WIMP Search: Conclusions



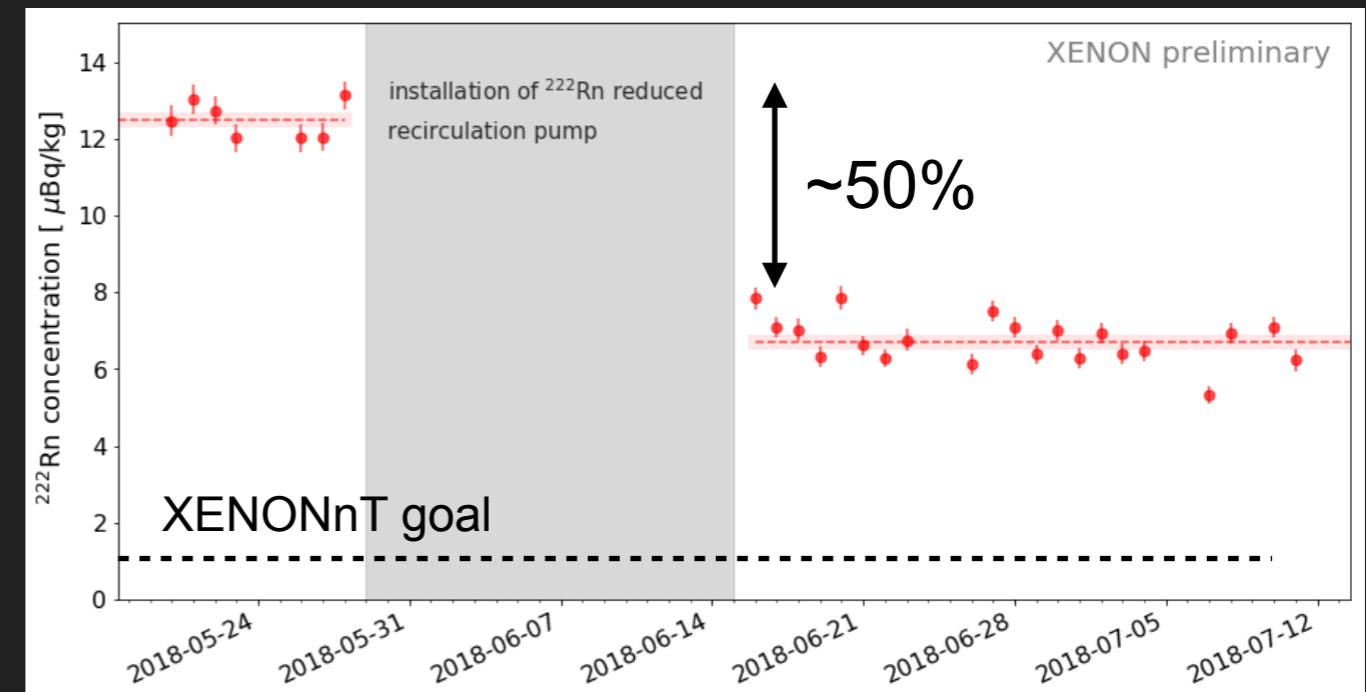
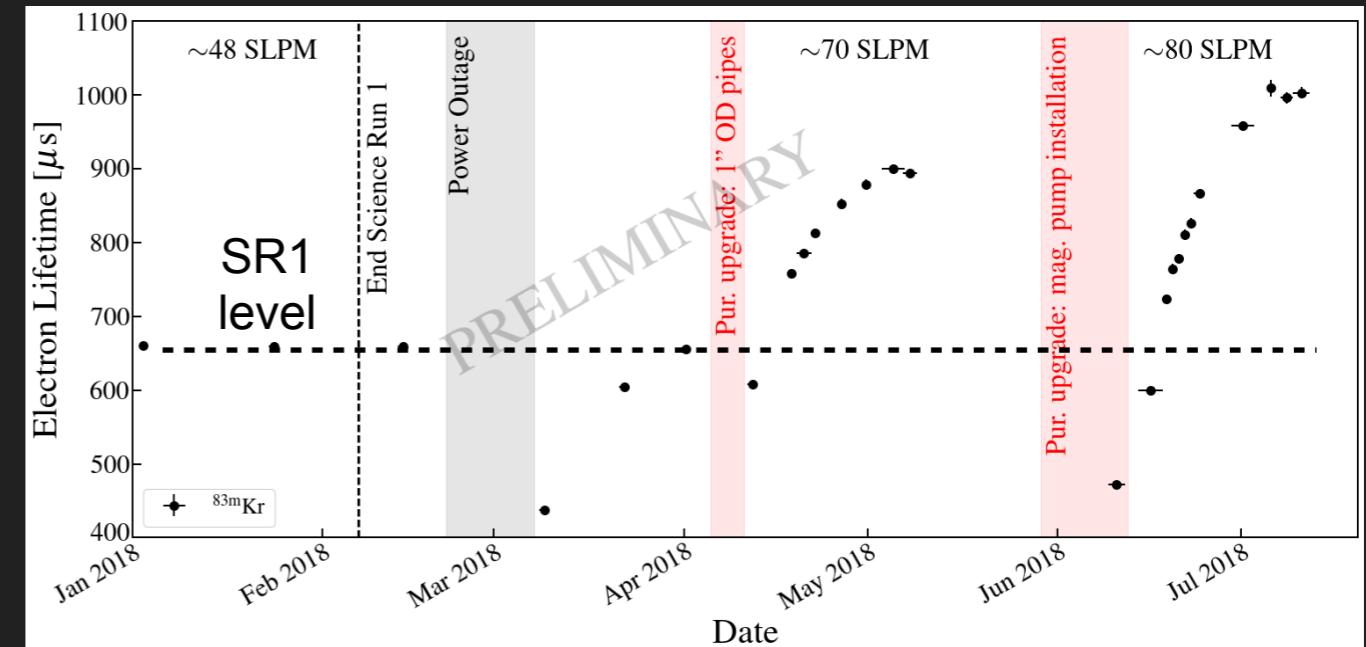
- Data compatible with background-only hypothesis
- Lowest local p-value within 1σ (200 GeV)
- Most stringent limit to date on SI WIMP-nucleon cross-sections for masses above 6 GeV



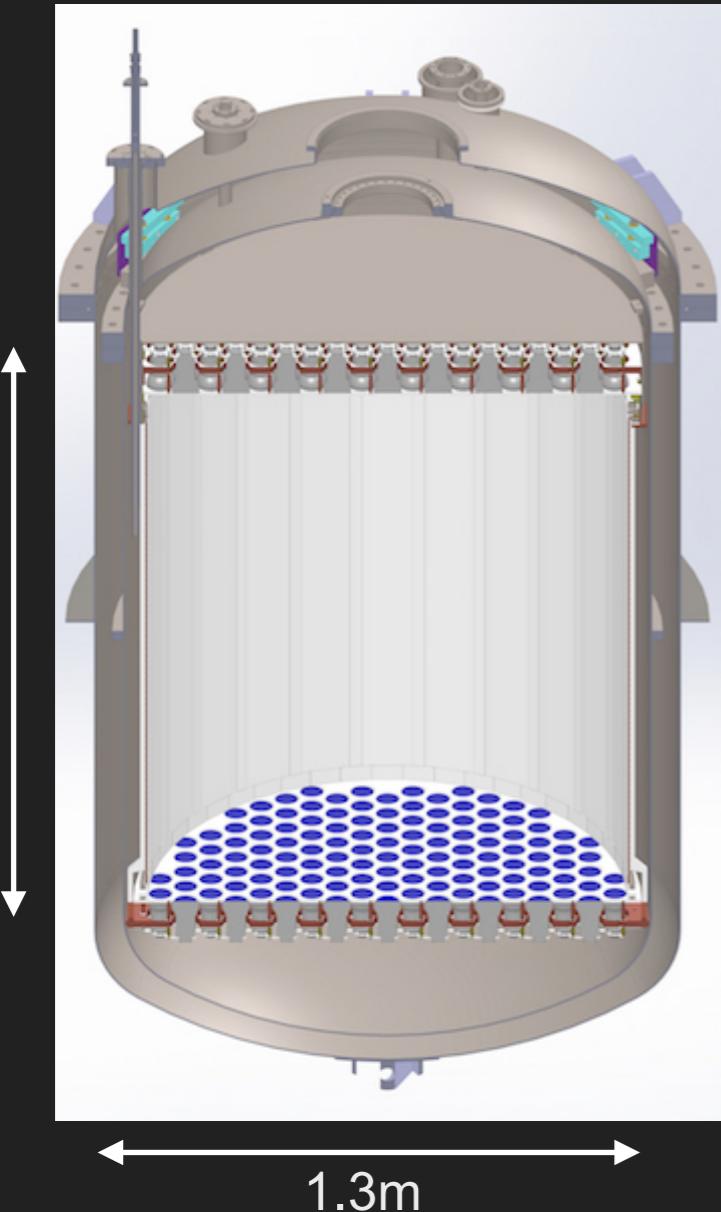
XENON1T After SR1

- Purification upgrade
 - Improved purity with faster recirculation
 - New pumps also reduced Rn222 background
- Ar37 calibration
- Several analyses ongoing
 - Spin Dependent (arXiv 1902.03234)

XENON1T turned off Dec. 2018



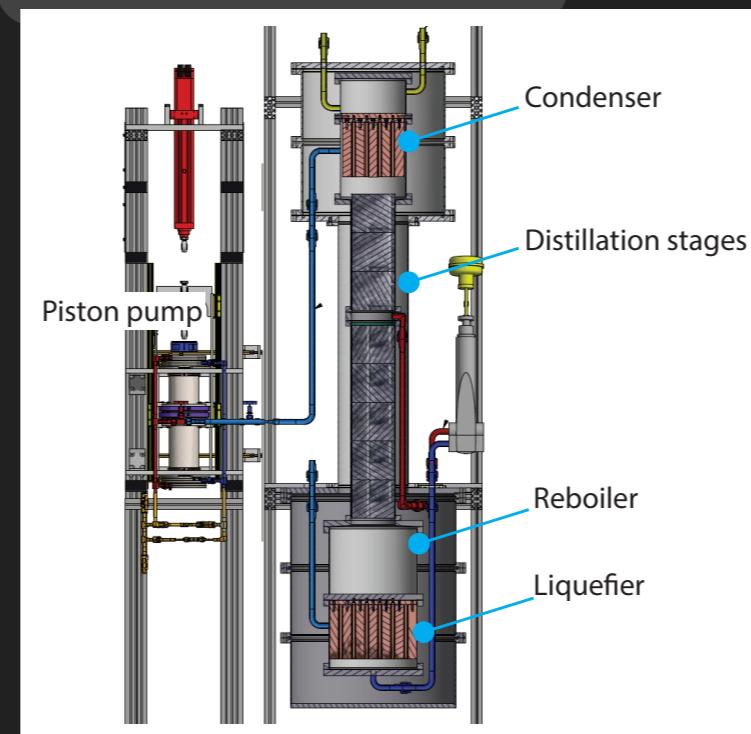
Coming Soon: XENONnT



- 5.9t active mass
- 494 PMTs
- 200 V/cm drift field
- 8kV/cm extraction field

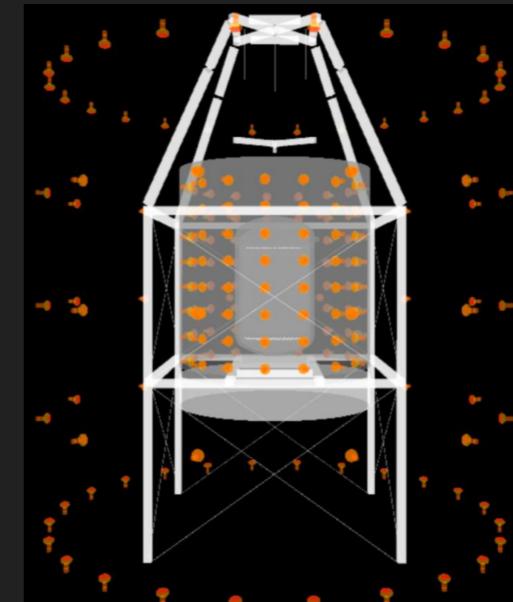
Radon distillation column

- Already tested successfully in 1T



XENONnT Upgrades

1. Larger TPC
2. Further x10 reduction in background
 - Rn distillation column for Pb214
 - Neutron veto

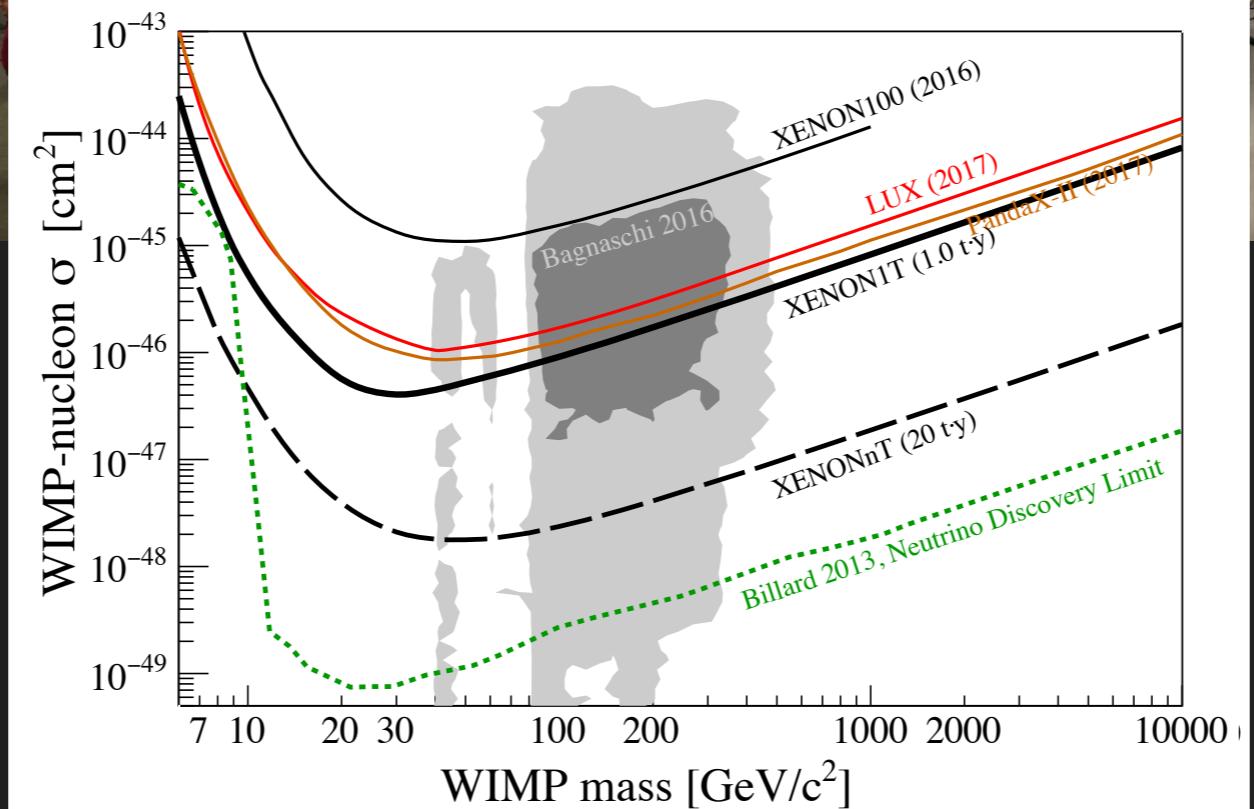


- 0.2% Gd-doped water
- < 1 neutron per 20 t*yr exposure

Coming Soon: XENONnT



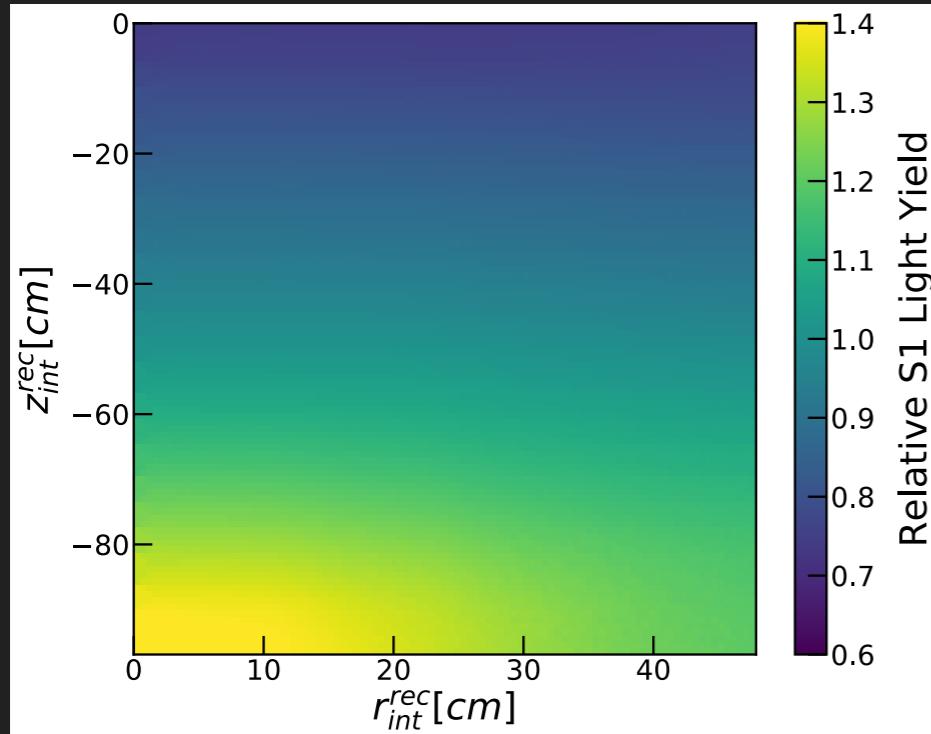
Installation and
commissioning later this
year!



Thank you.

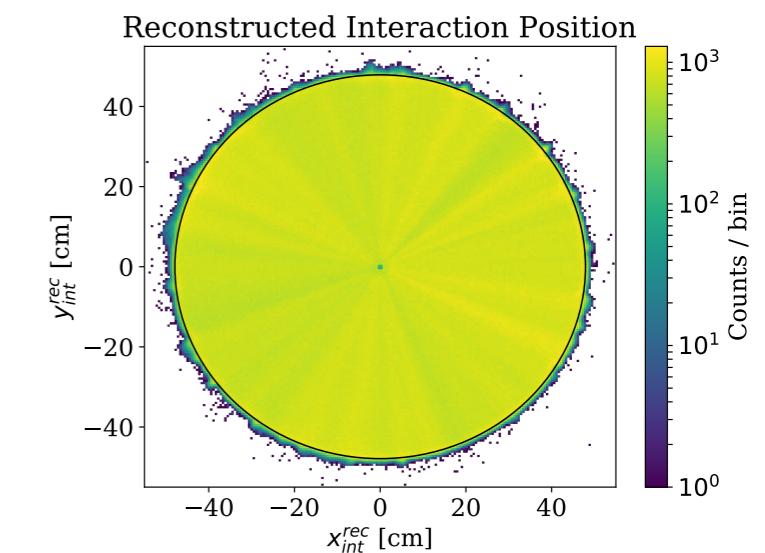
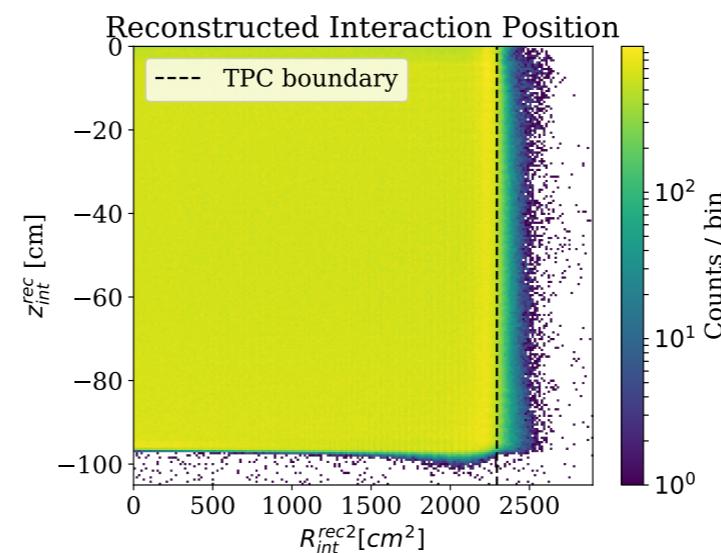
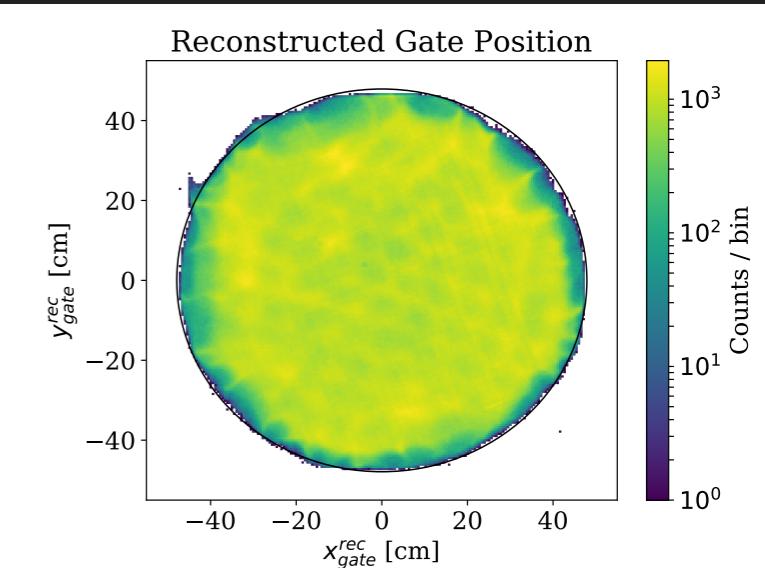
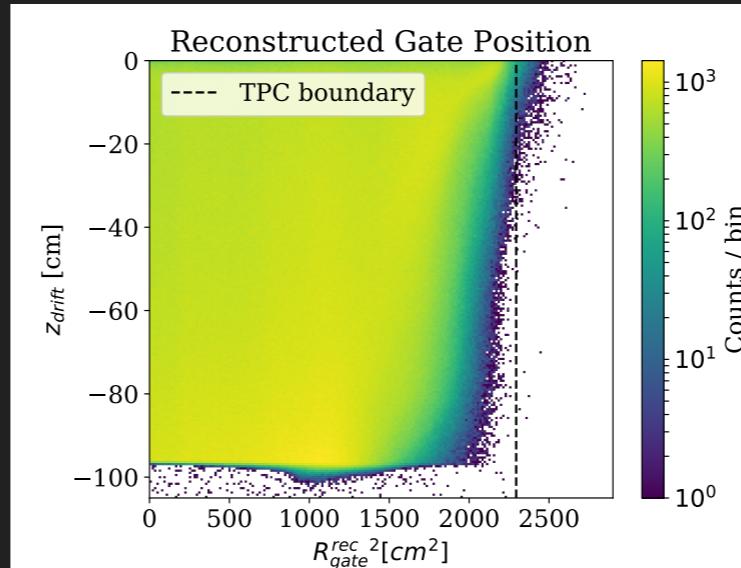
Backup

Corrections

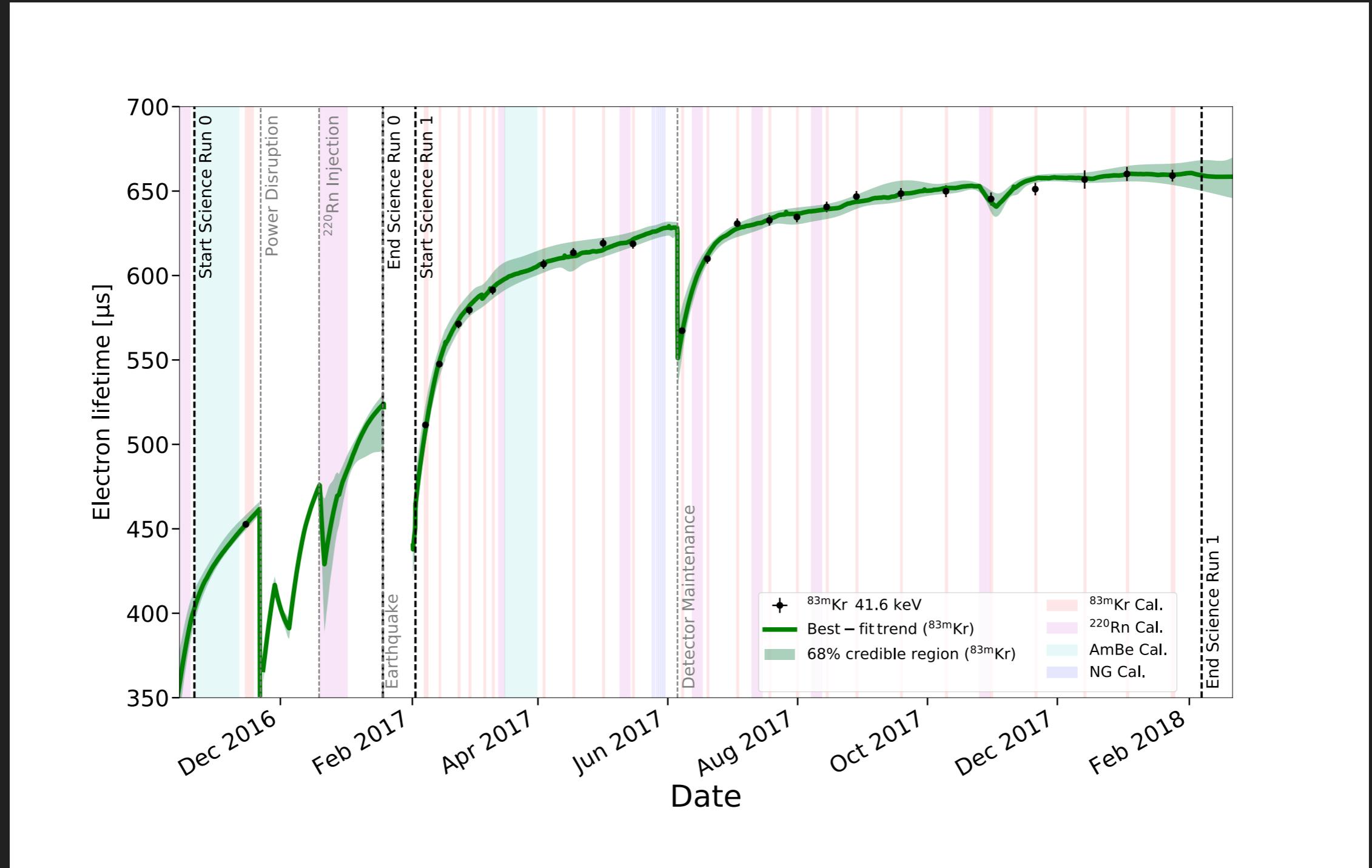


S1s corrected for light collection efficiency

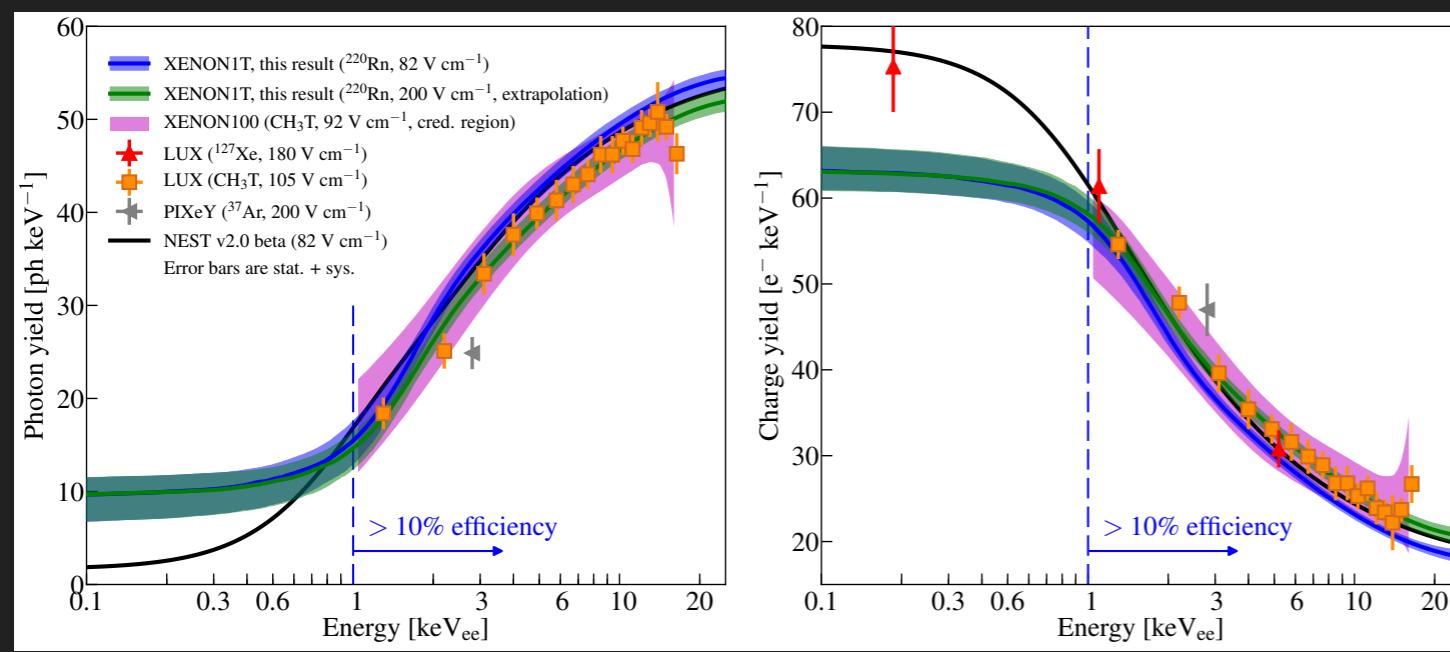
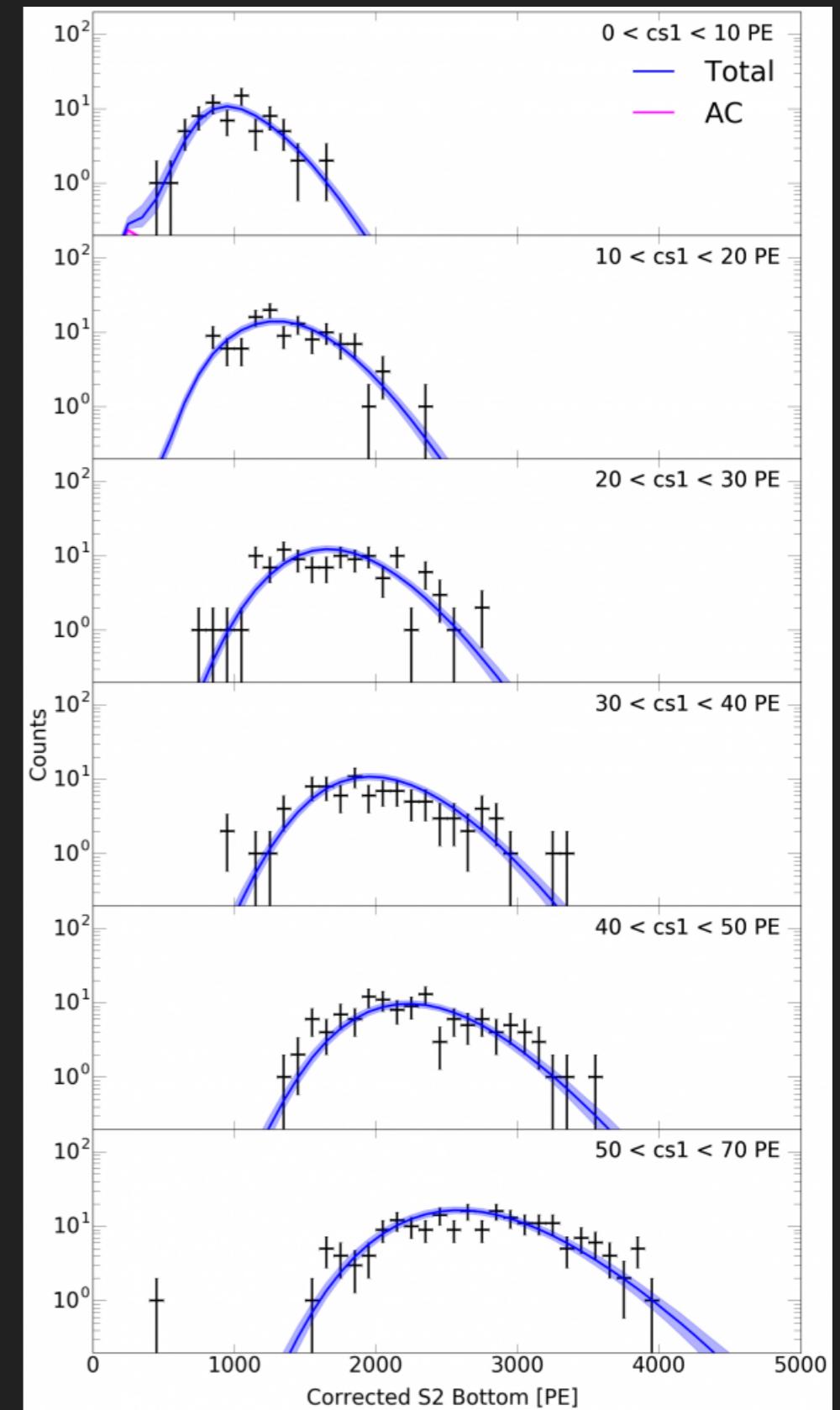
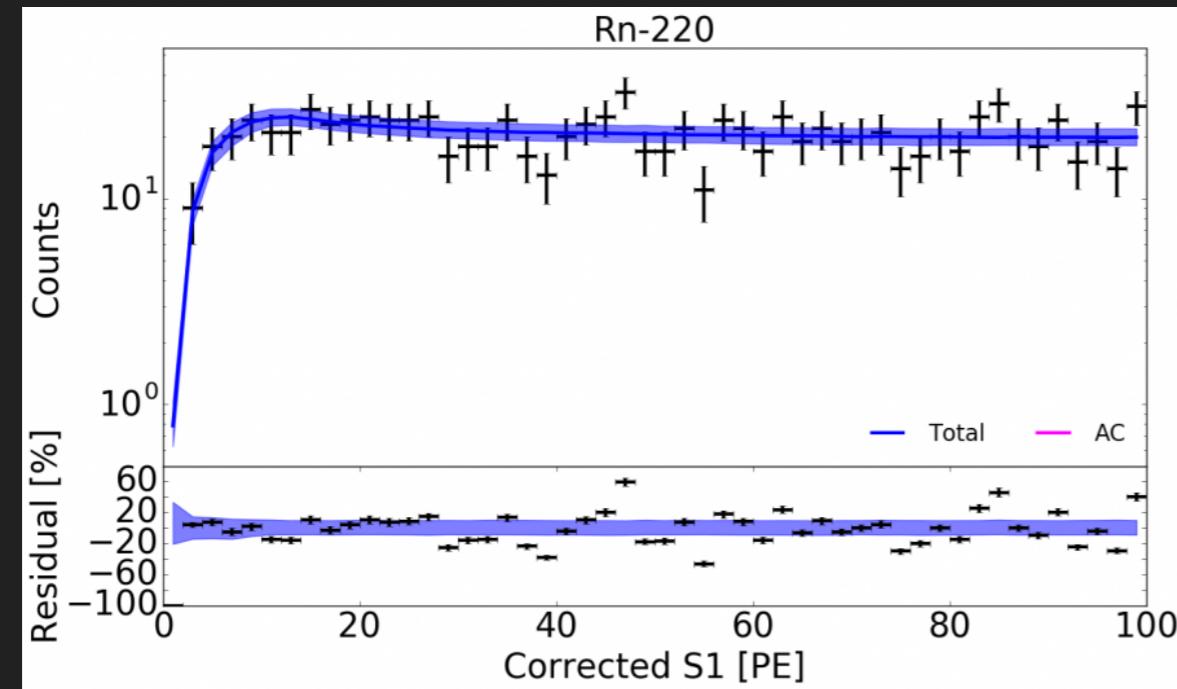
Position reconstruction corrected for field-distortion effects



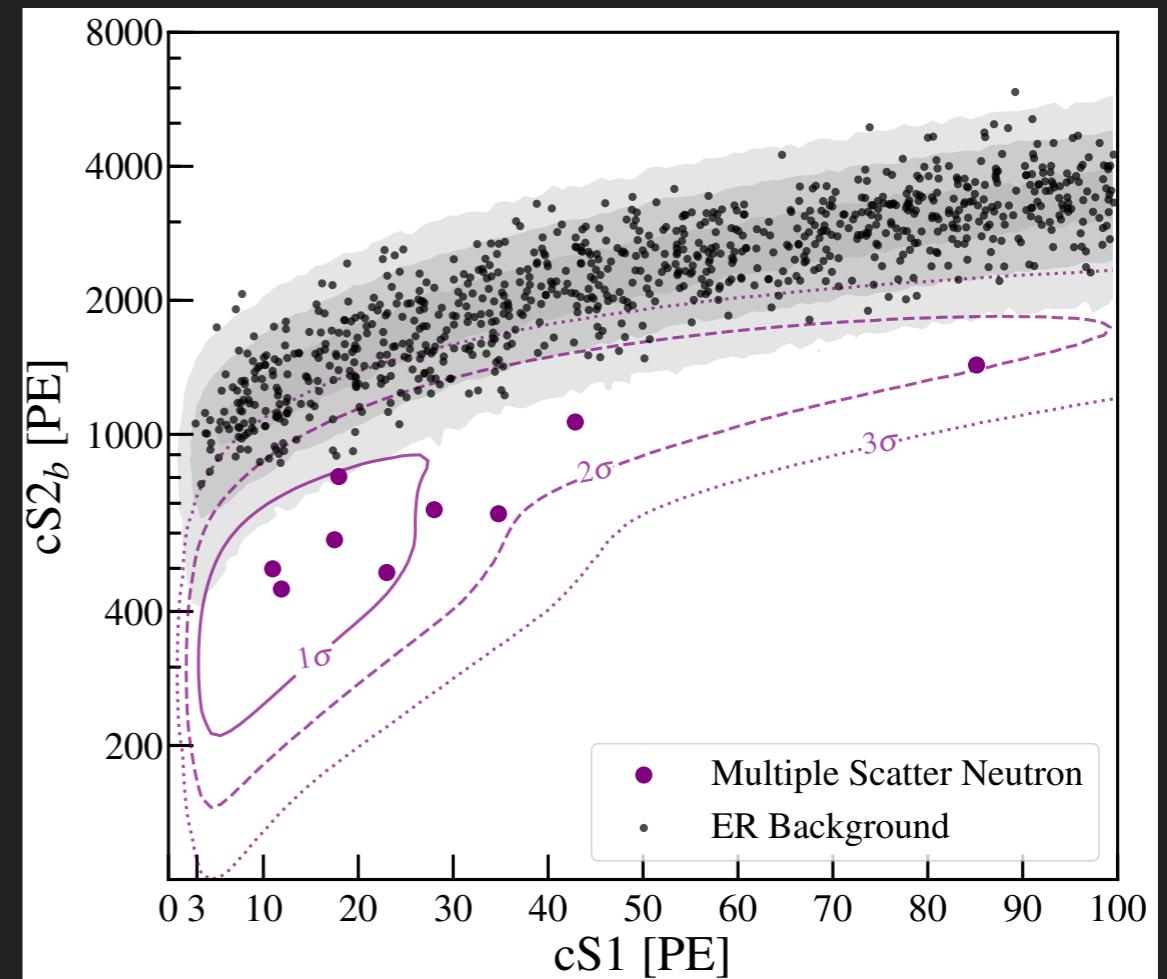
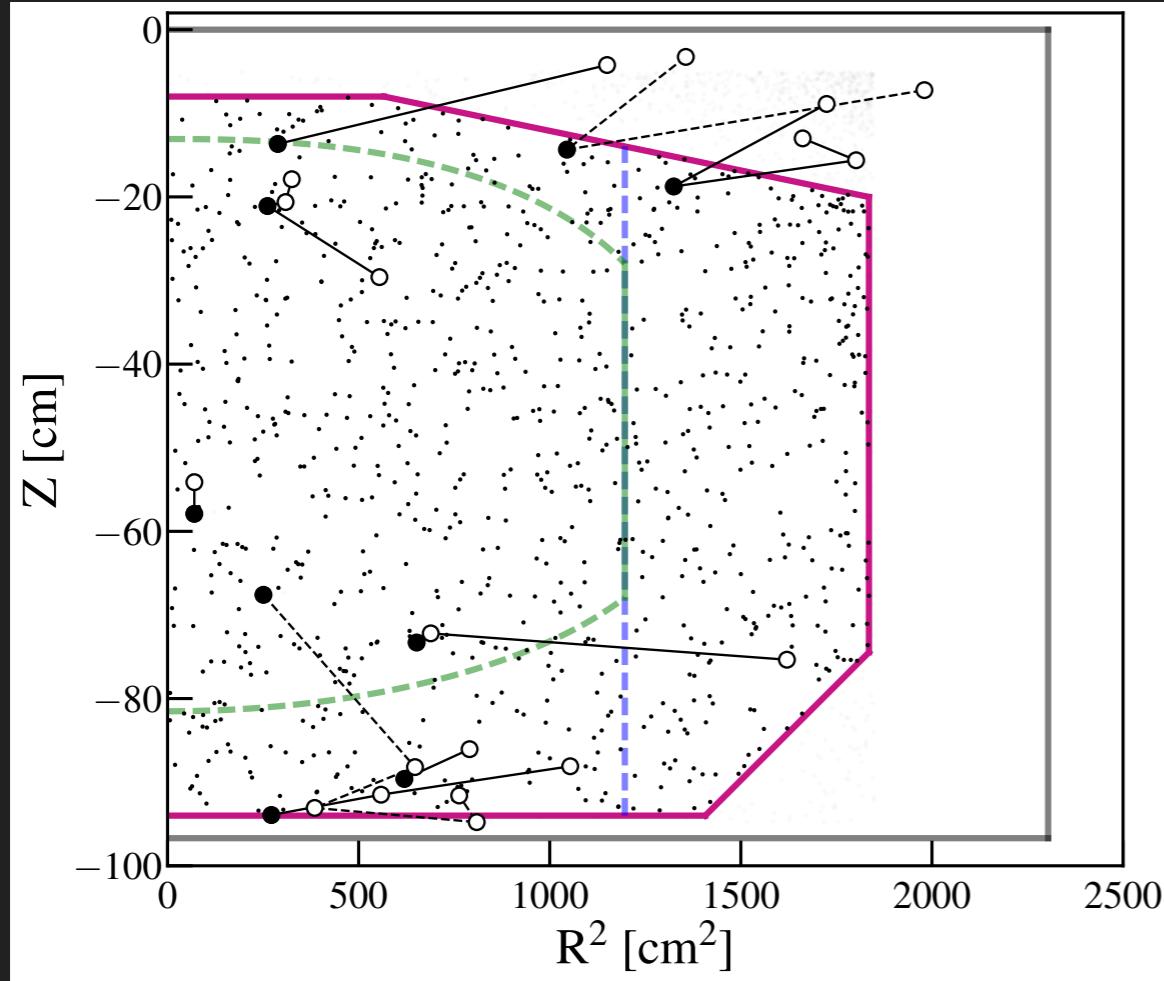
Electron Lifetime



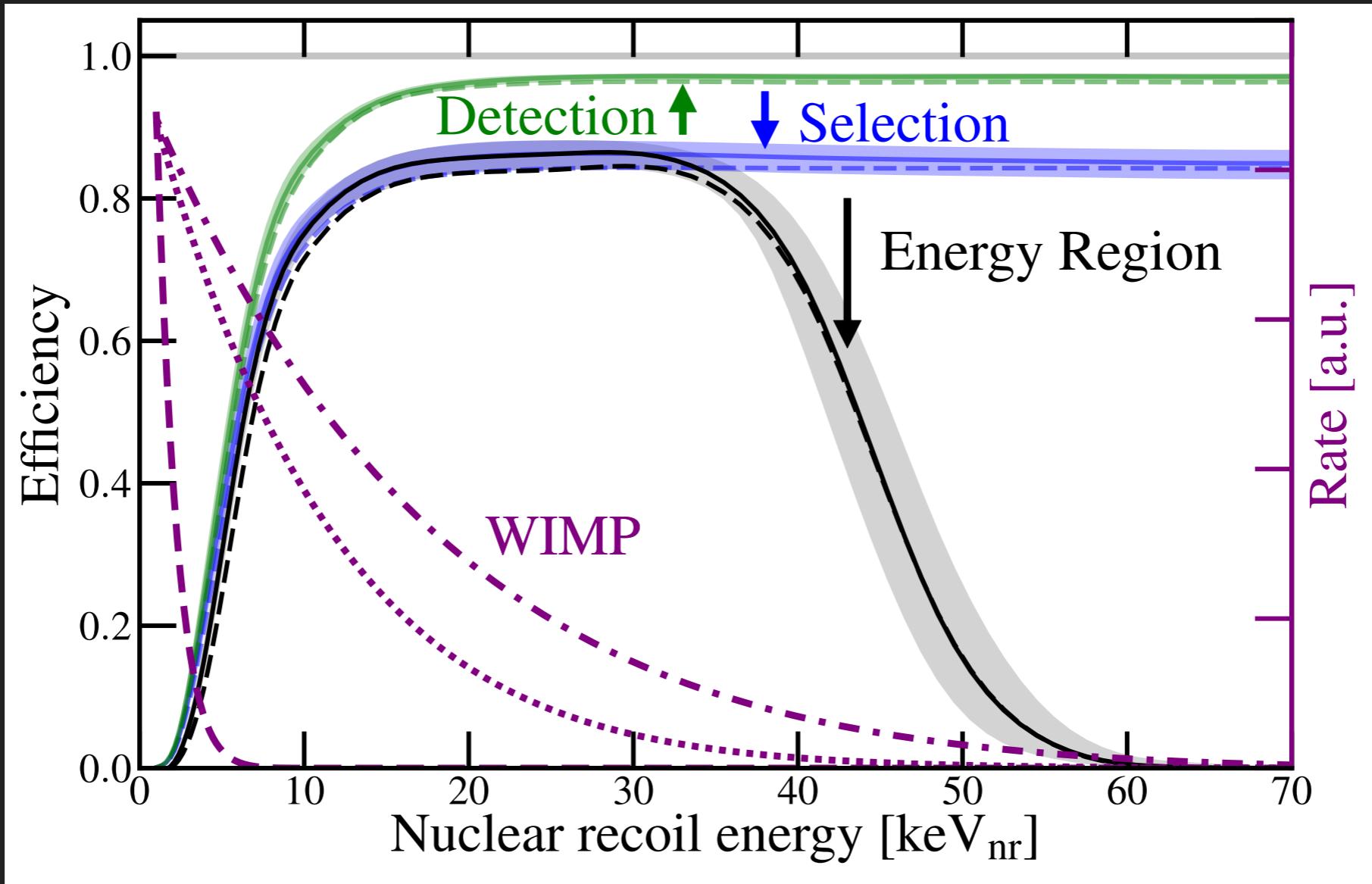
ER Model



Neutrons

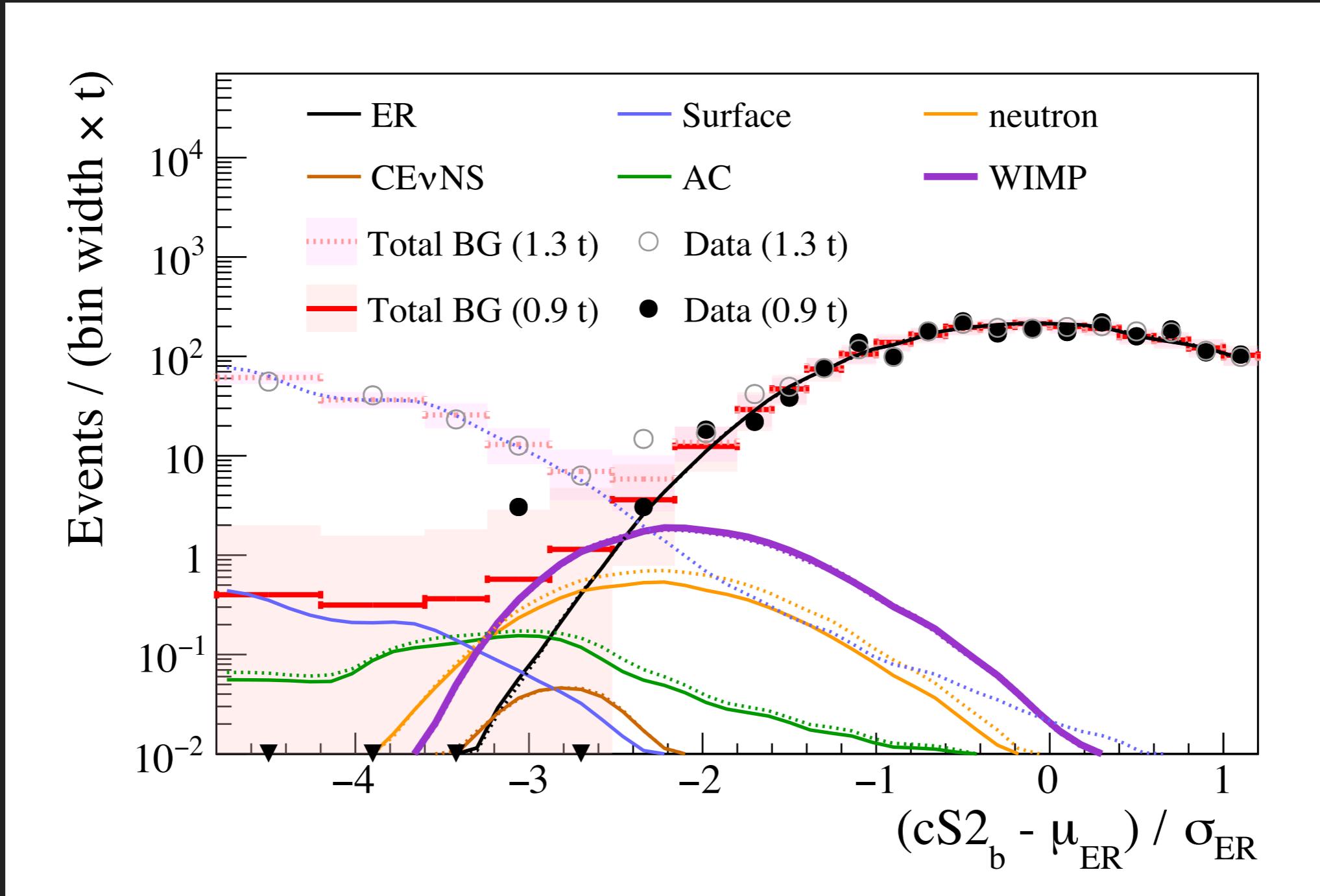


Efficiency



Dominated by requirement of coincident signals in 3 PMT channels

Best-fit projection



Spin Dependent

