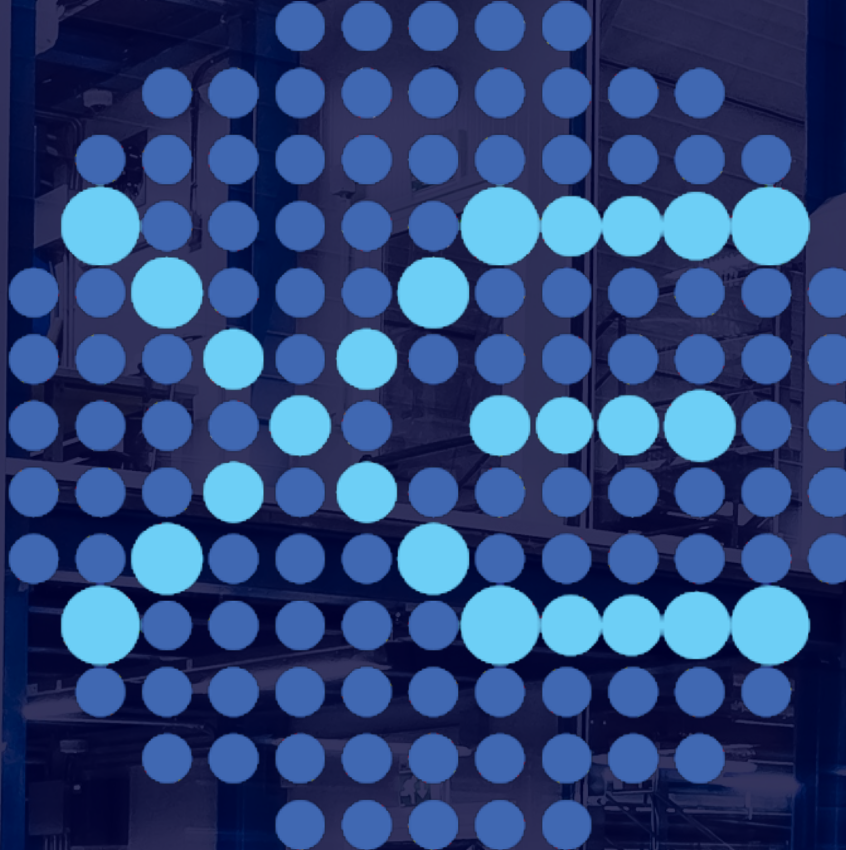


# Lake Louise Winter Institute 2022

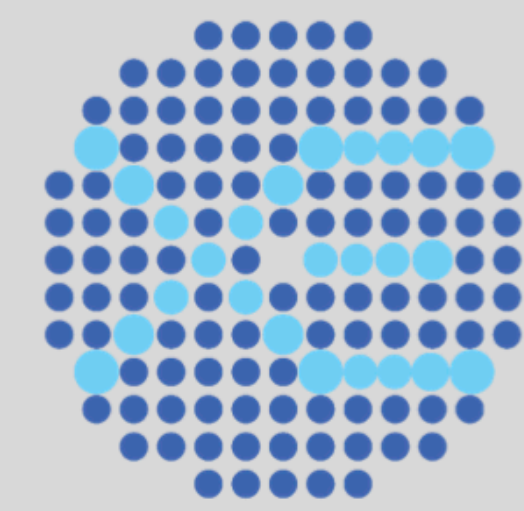


XENON

# Latest XENON1T results and XENONnT status

VASILE CRISTIAN ANTOCHI, STOCKHOLM UNIVERSITY, 2022-02-21





**XENON**

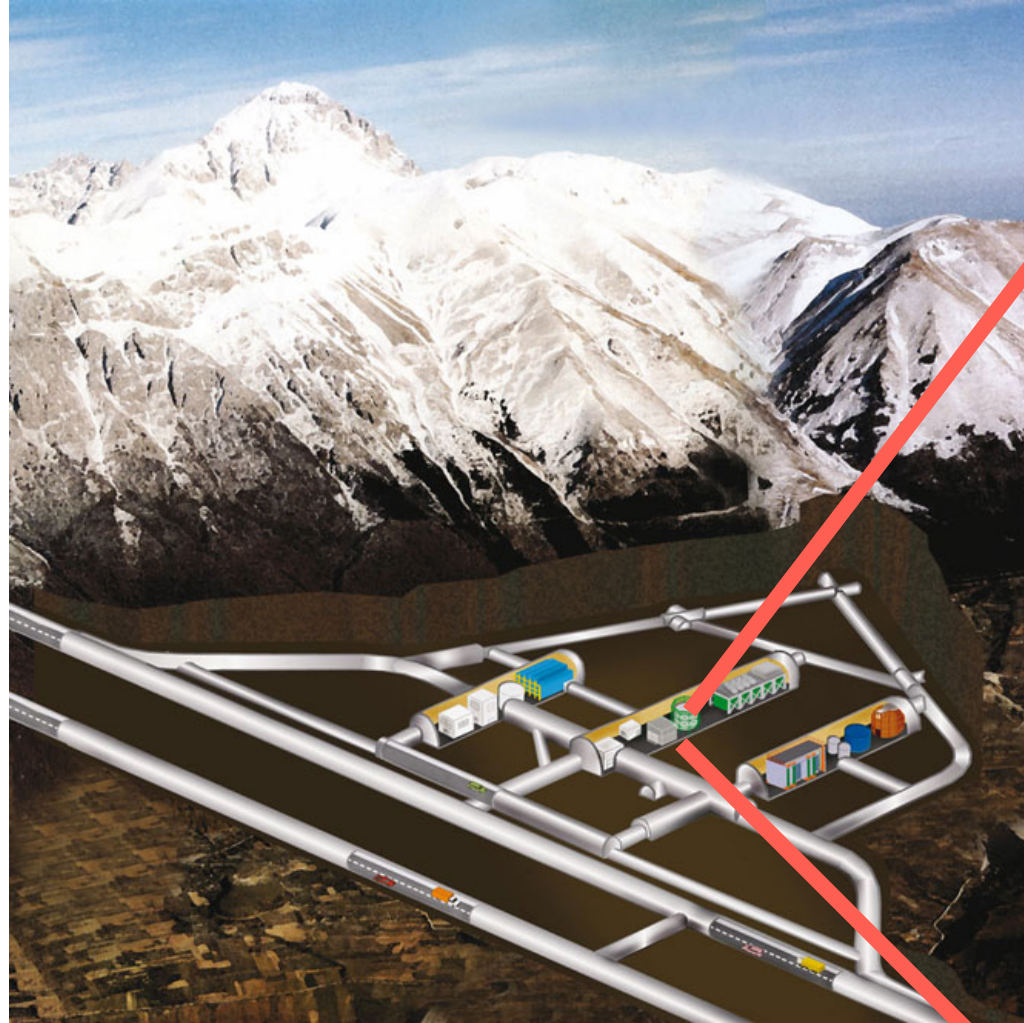
**Collaboration Meeting**

**Feb. 7-11, 2022**

ChengjieJia

# XENON1T 2016-2018

LNGS, ITALY



~1500m rock  
~3600m.w.e.



70T WATER TANK

CRYOSTAT & TPC

WATER CHERENKOV MUON VETO  
84 8' PMTS

HALL B

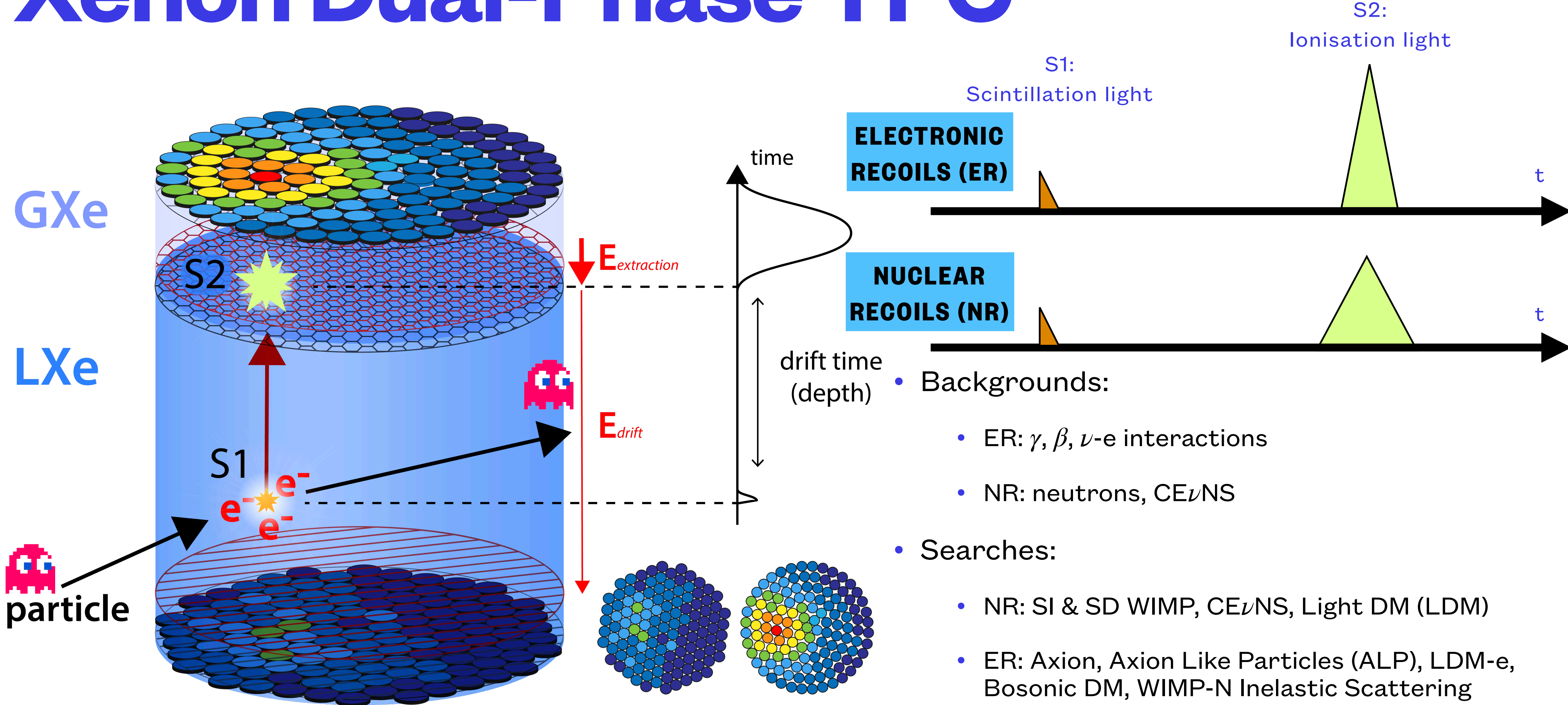
PURIFICATION AND  
CRYOGENICS

DAQ AND  
SLOW CONTROL

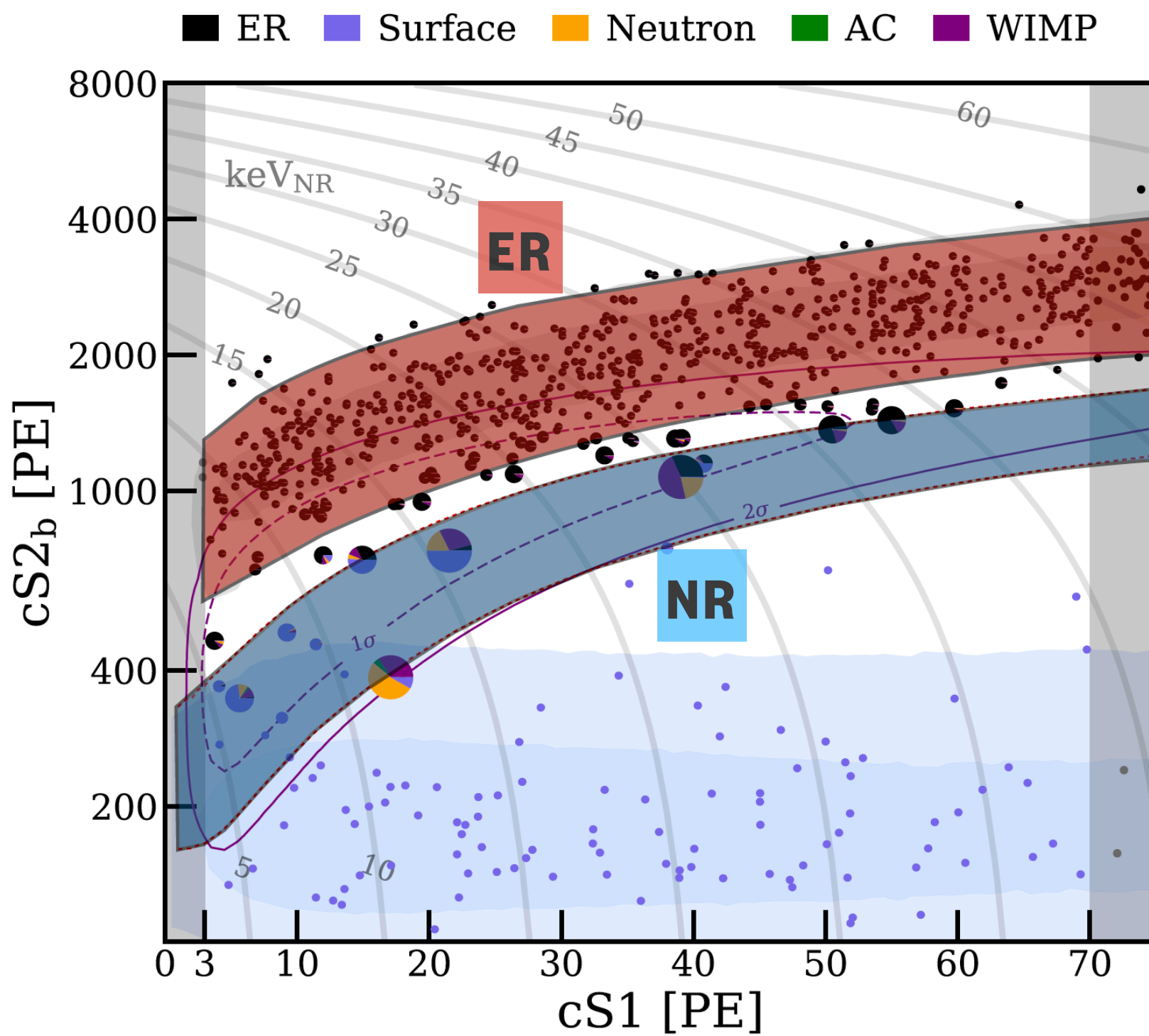
KRYPTON  
DISTILLATION

XENON  
STORAGE

# Xenon Dual-Phase TPC



# NR searches



- XENON1T main result:

- SI WIMP

$$\sigma_{\chi N}^{SI} = 4.1 \times 10^{-47} \text{ cm}^2 \text{ for } m_{\chi} = 30 \text{ GeV}/c^2$$

- Other notable results

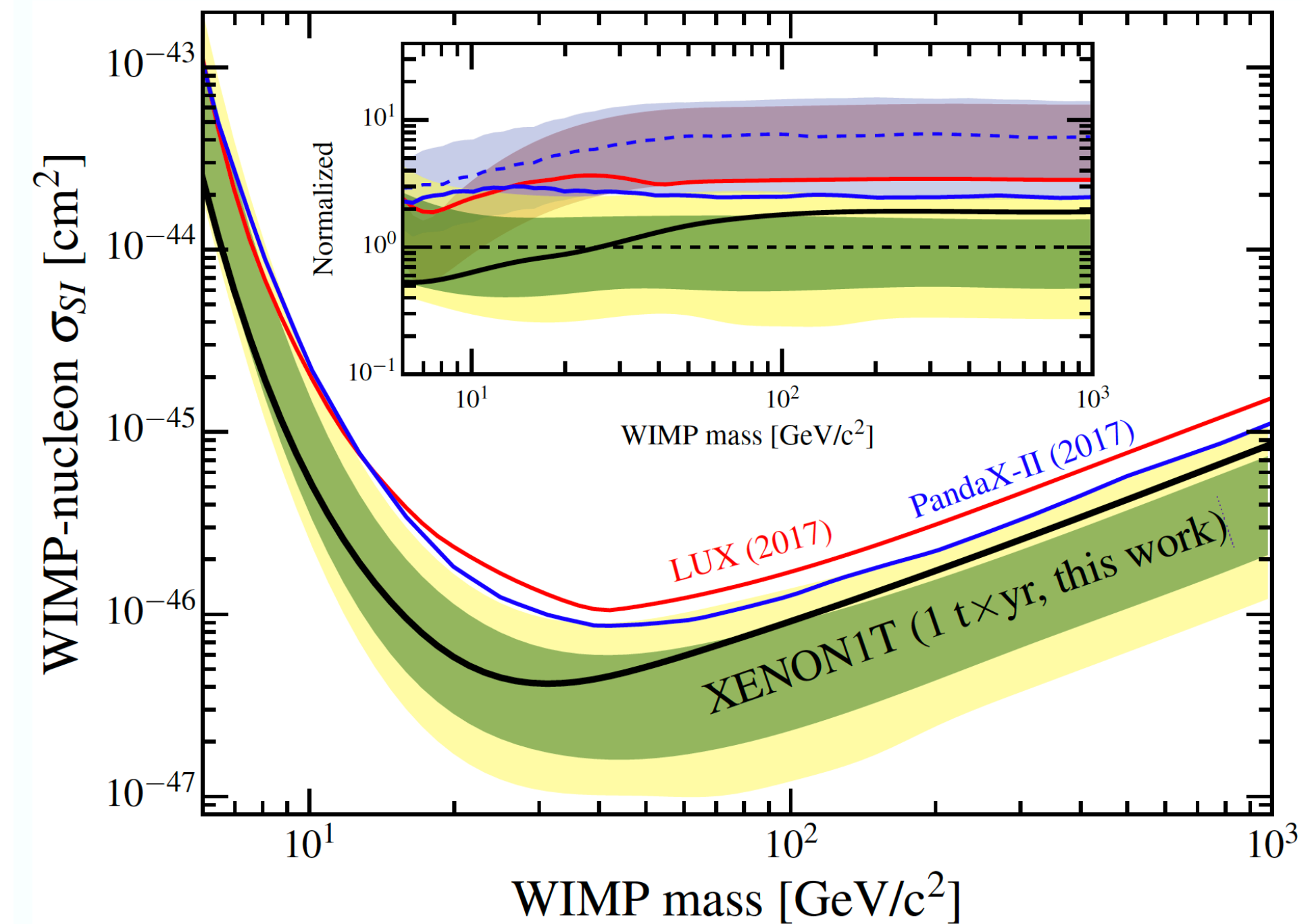
- Spin dependent analysis

PRL 122 (2019) 141301

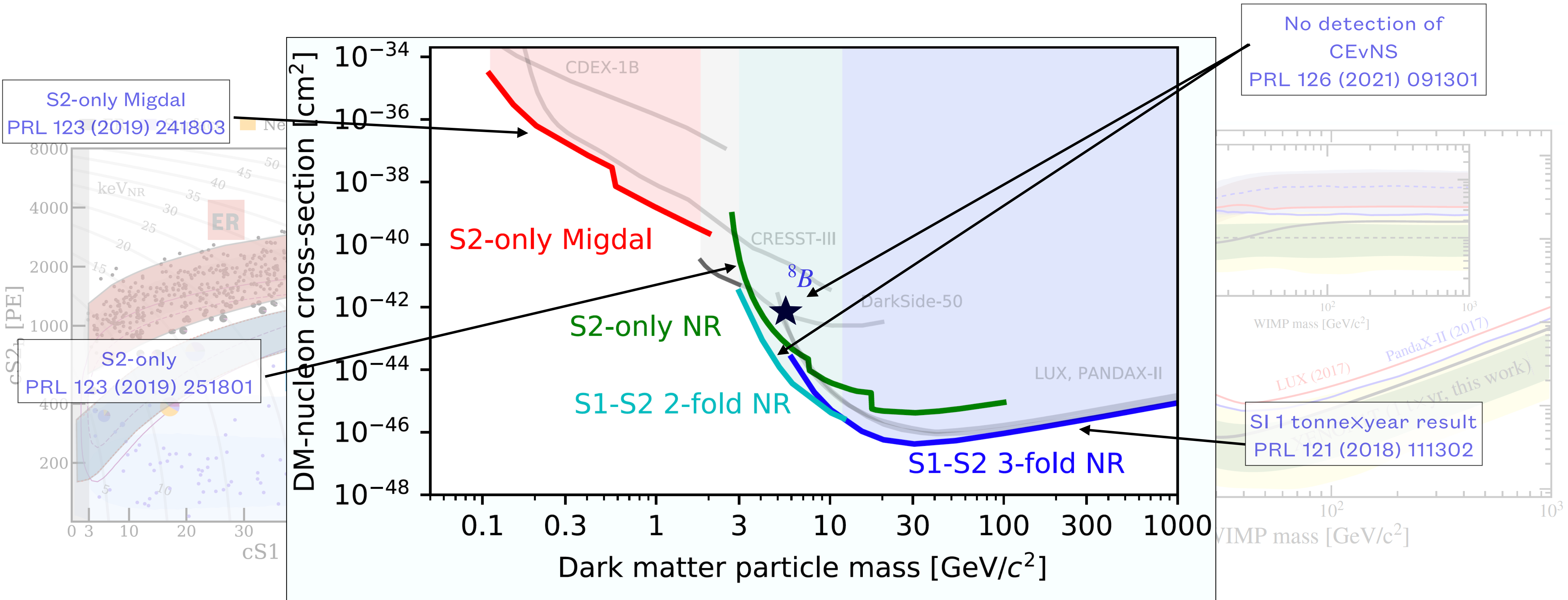
- First constraints on WIMP-pion interaction

PRL 122 (2019) 071301

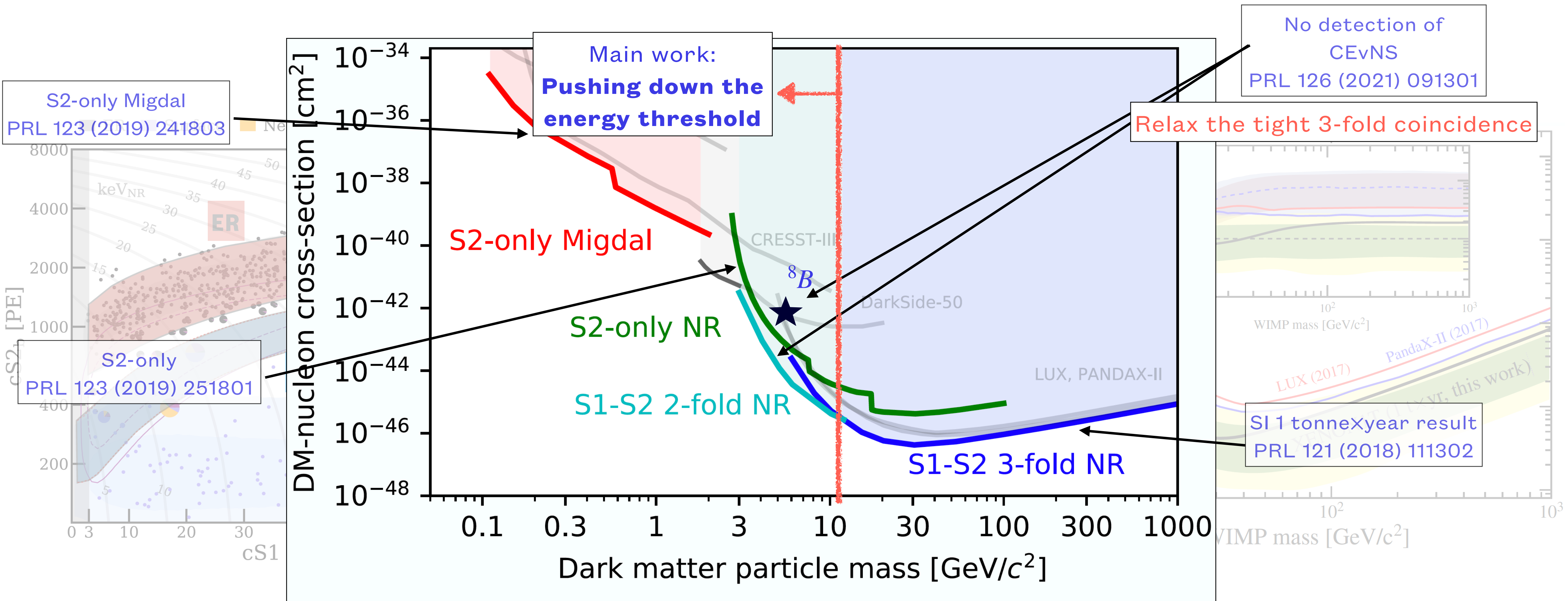
PRL 121 (2018) 111302



# NR searches



# NR searches

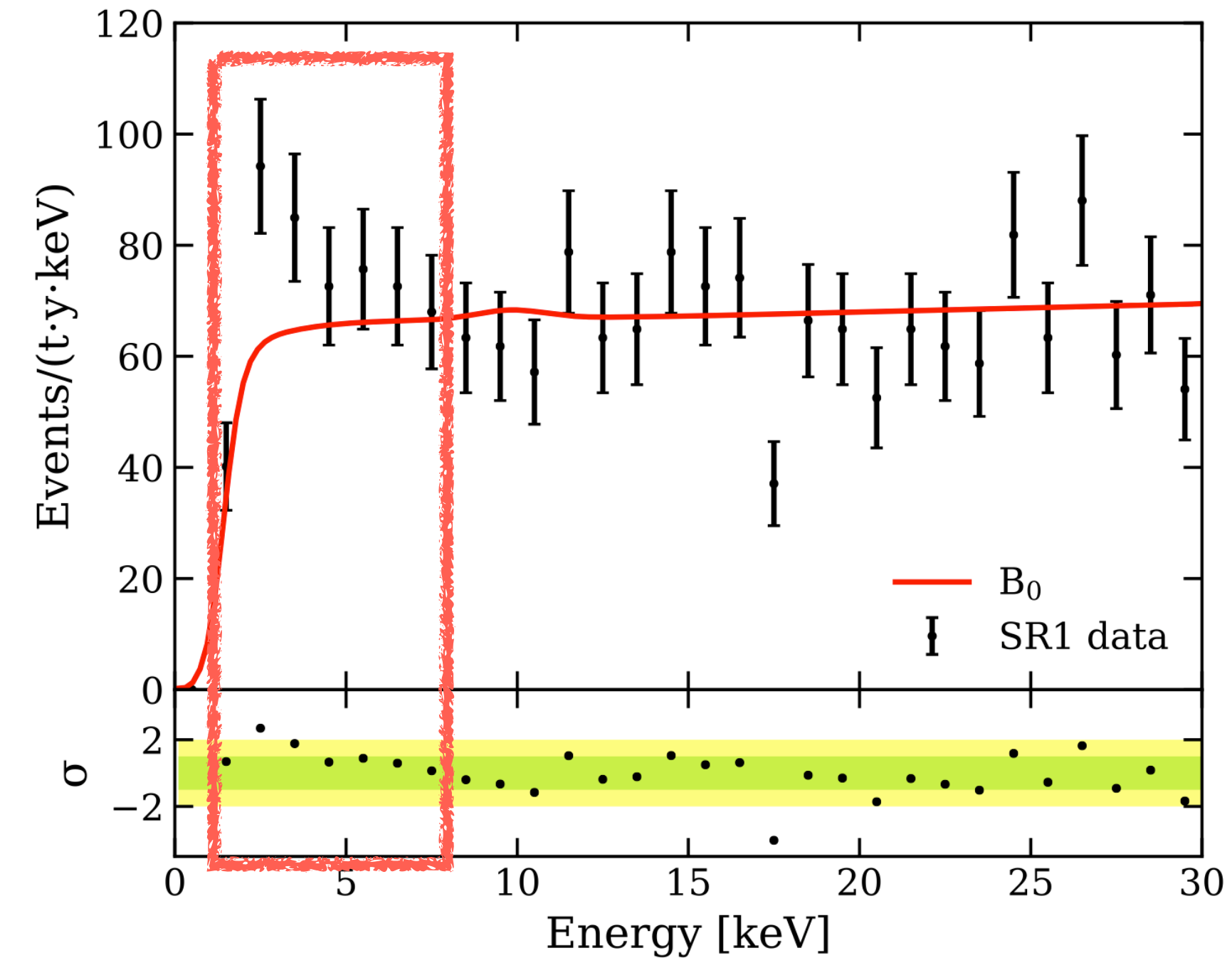




# ER searches: Low ER excess

PRD 102 (2020) 7, 072004

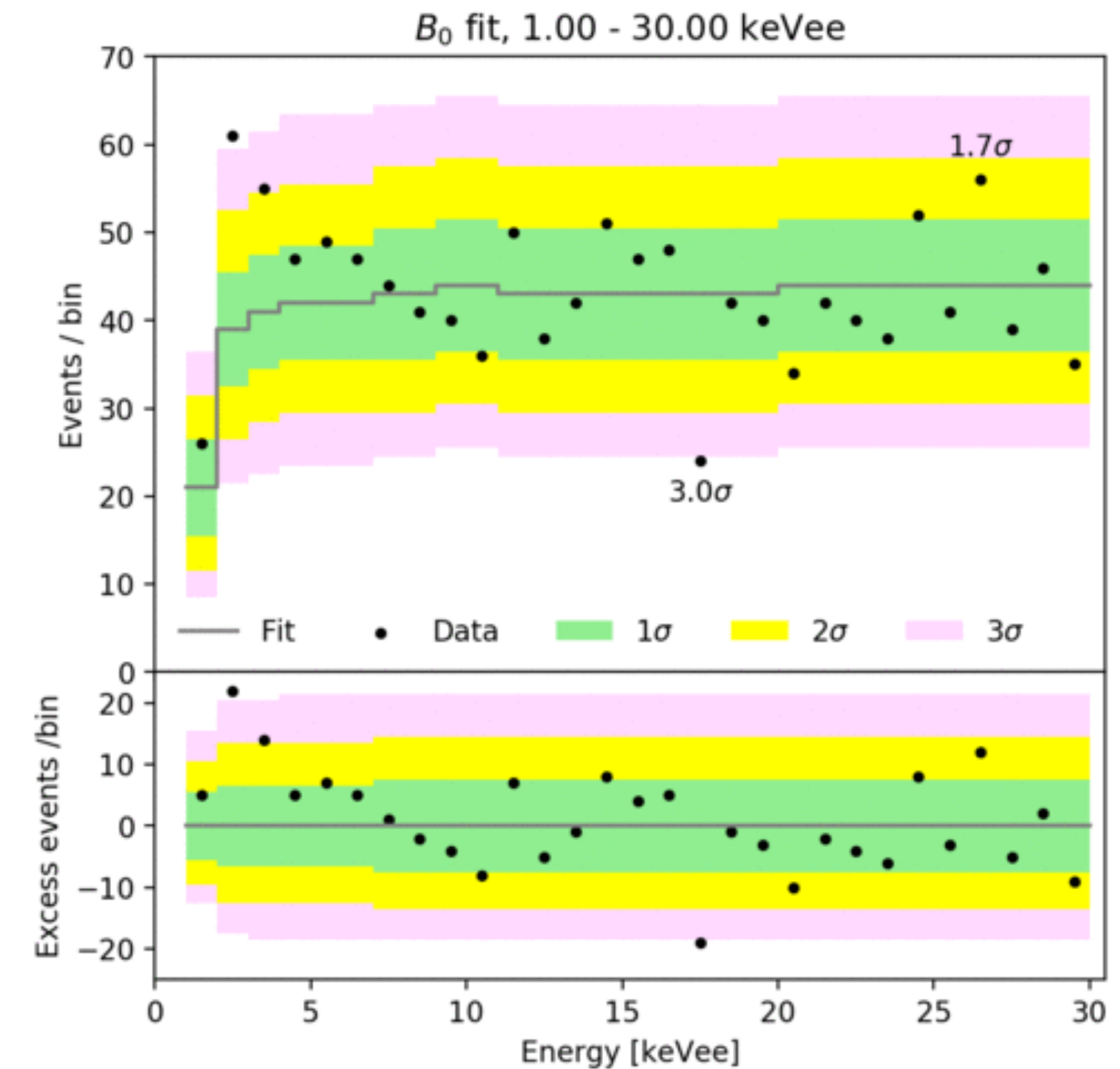
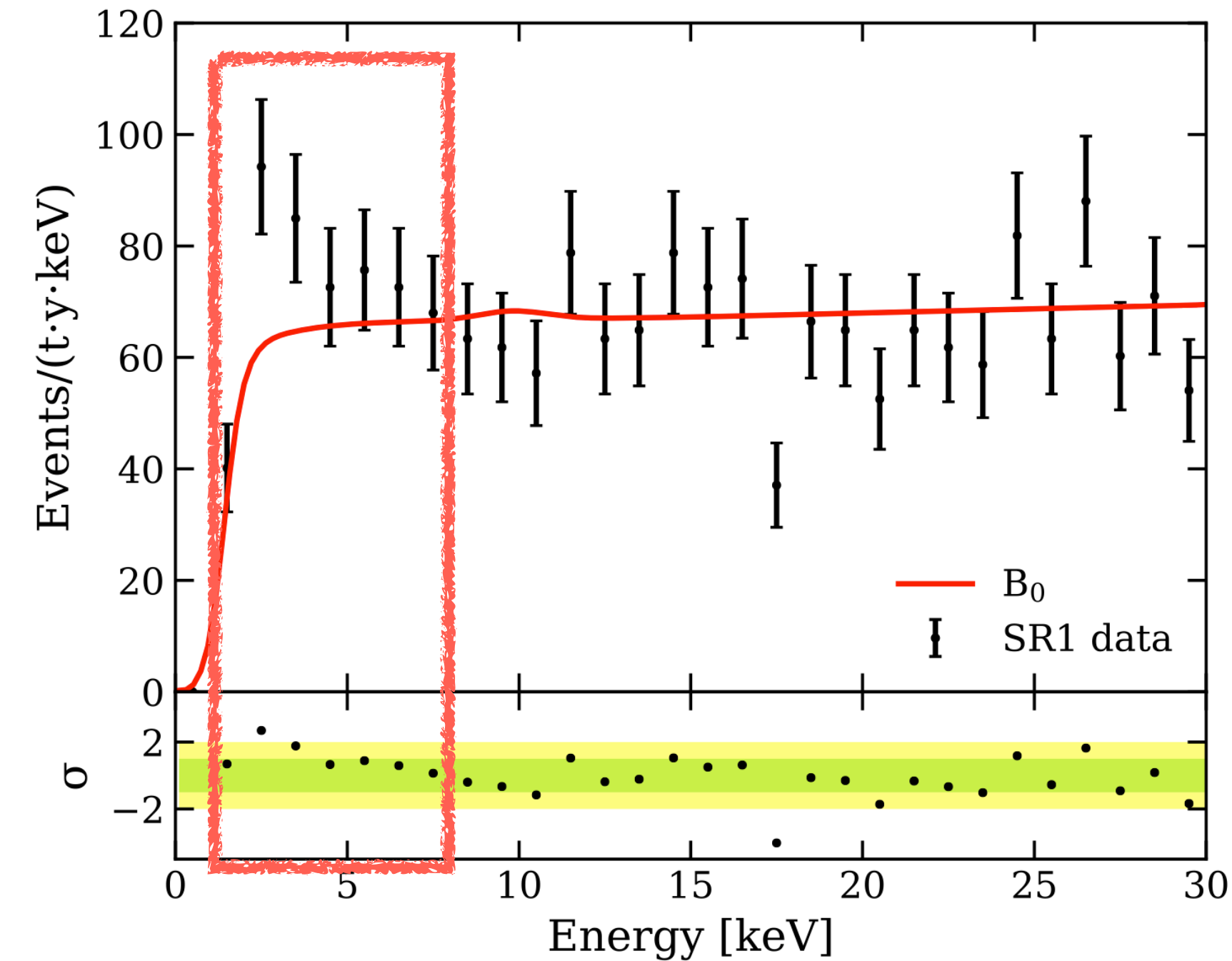
- Excess observed at low energy ER!



# ER searches: Low ER excess

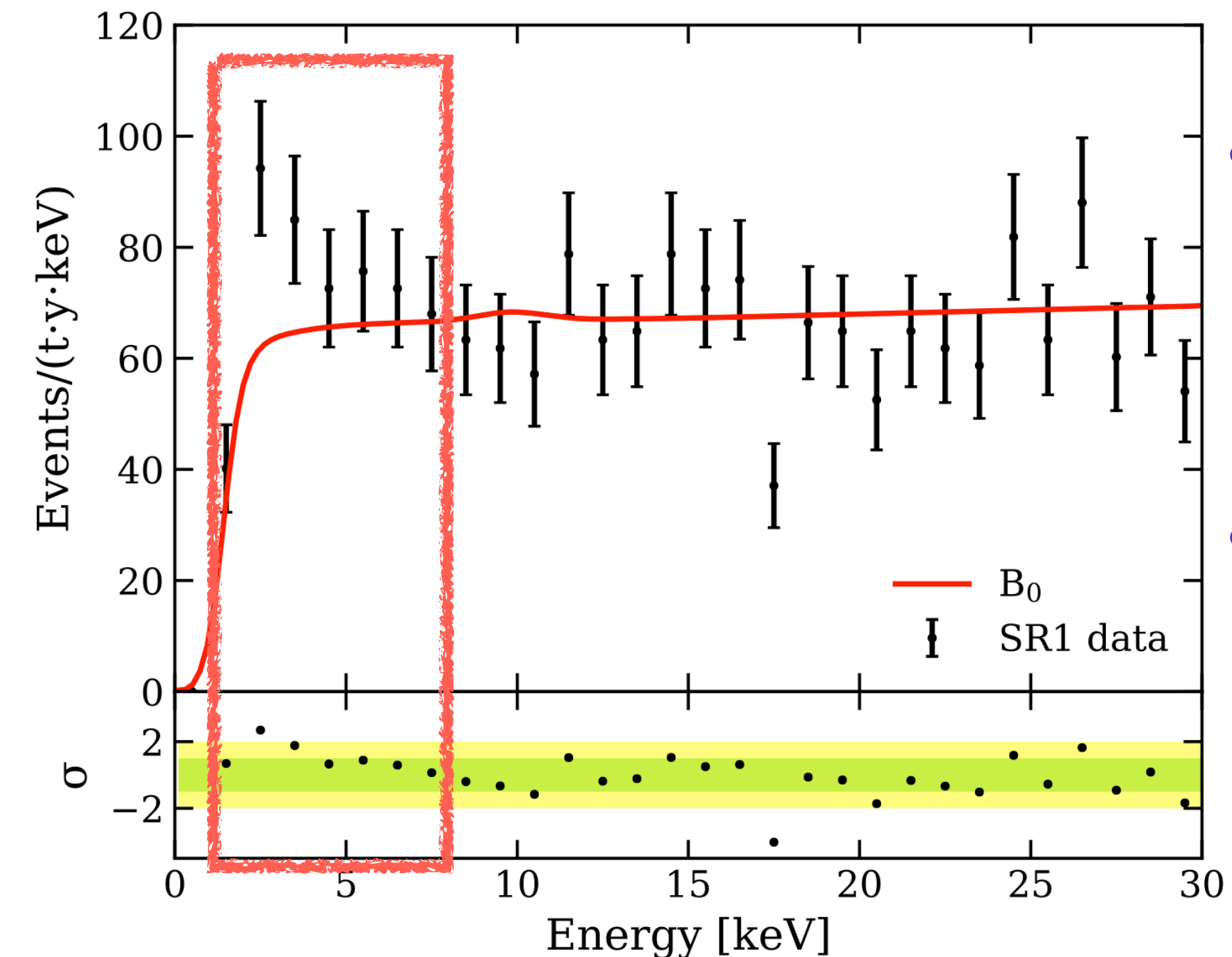
PRD 102 (2020) 7, 072004

- Excess observed at low energy ER!
- Can it be binning?
- **NO!** We use unbinned likelihood!



# ER searches: Low ER excess

PRD 102 (2020) 7, 072004



- Excess observed at low energy ER!
- Can it be binning?
- **NO!** We use unbinned likelihood!
- Background mismodelling?
- Unlikely: rate uncertainty not enough

# ER searches: Low ER excess

PRD 102 (2020) 7, 072004

- Excess observed at low energy ER!

- Can it be binning?

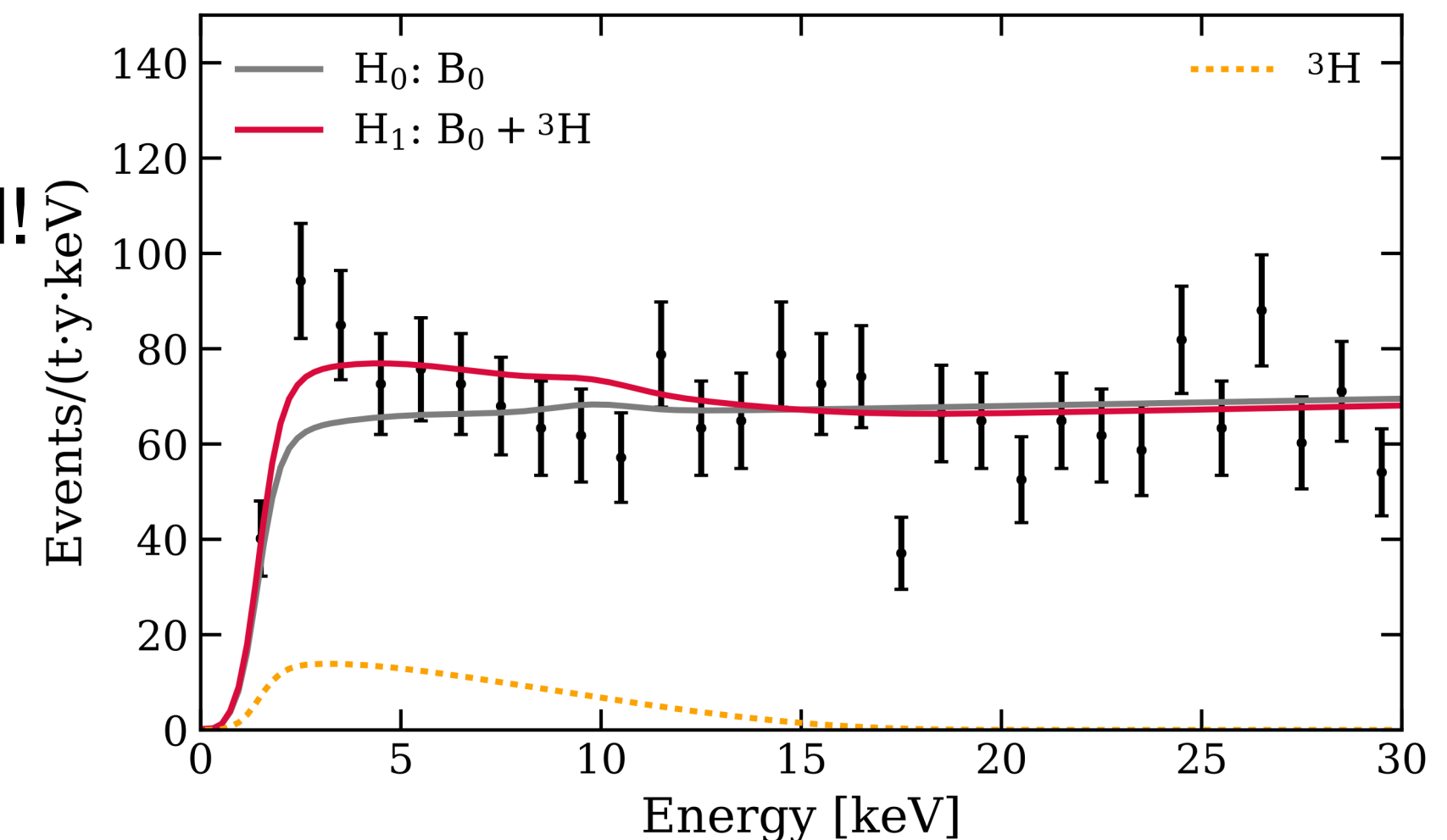
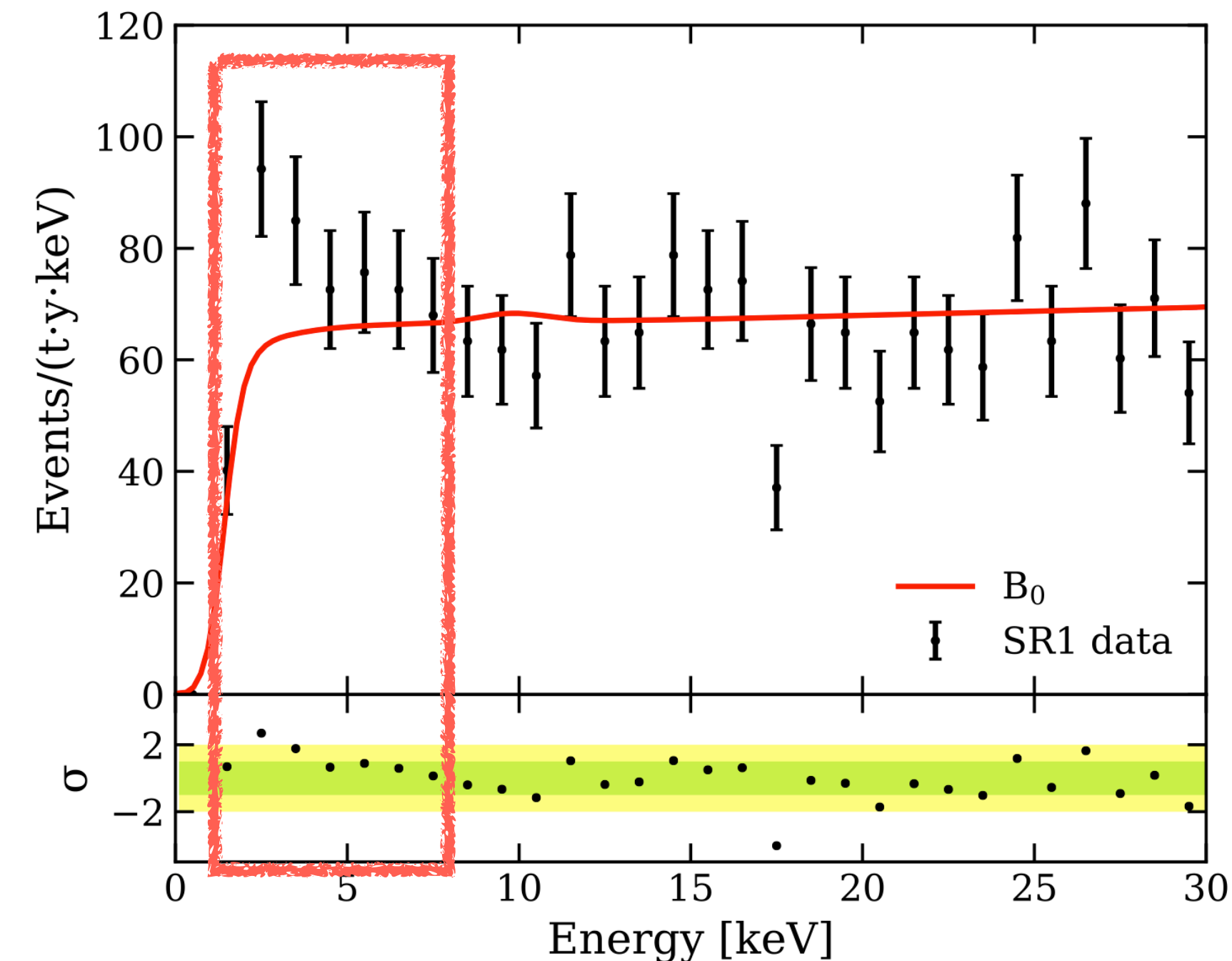
- **NO!** We use unbinned likelihood!

- Background mismodelling?

- Unlikely: rate uncertainty not enough

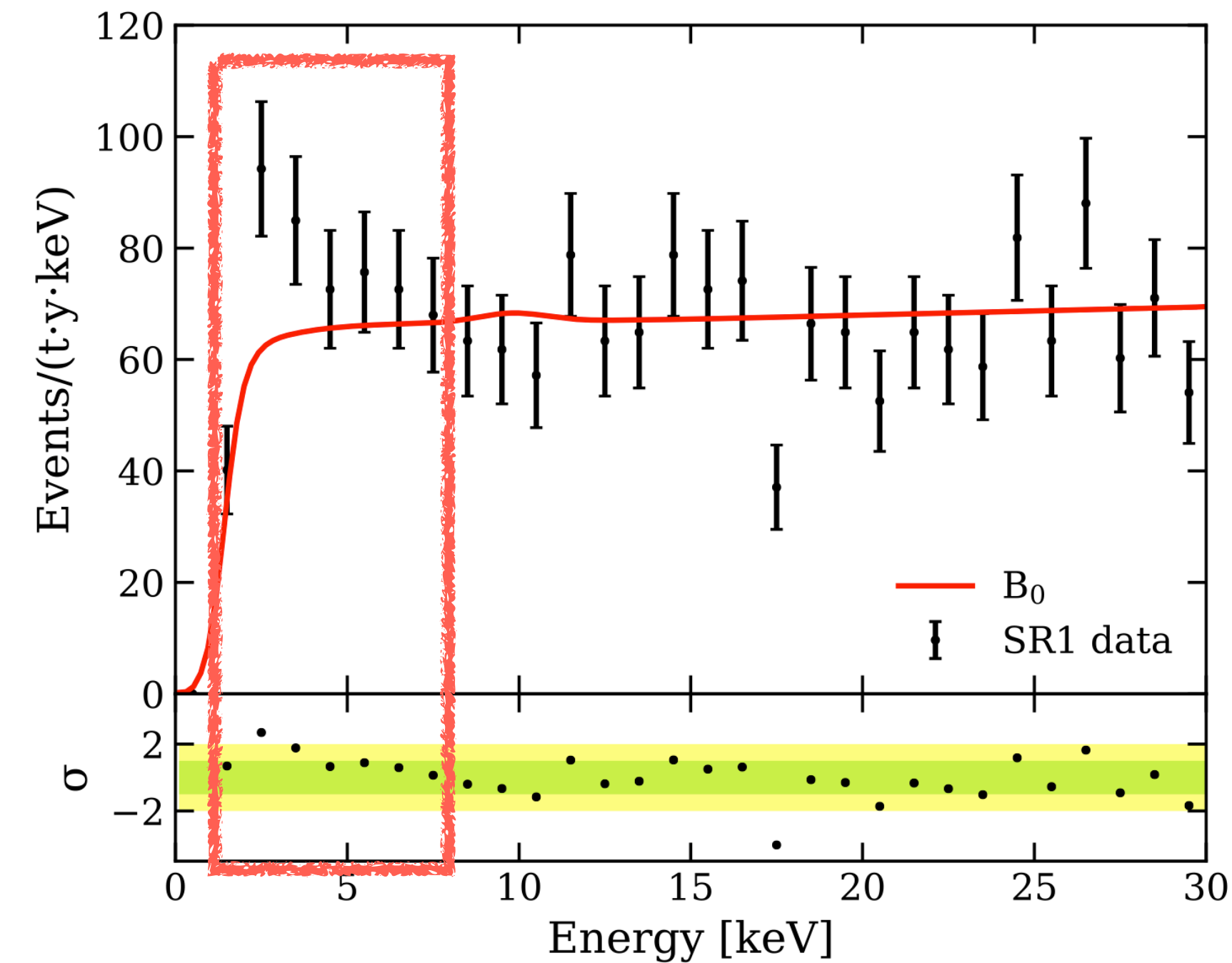
- Tritium?

- Possible:  $3.2\sigma$ ; more data needed

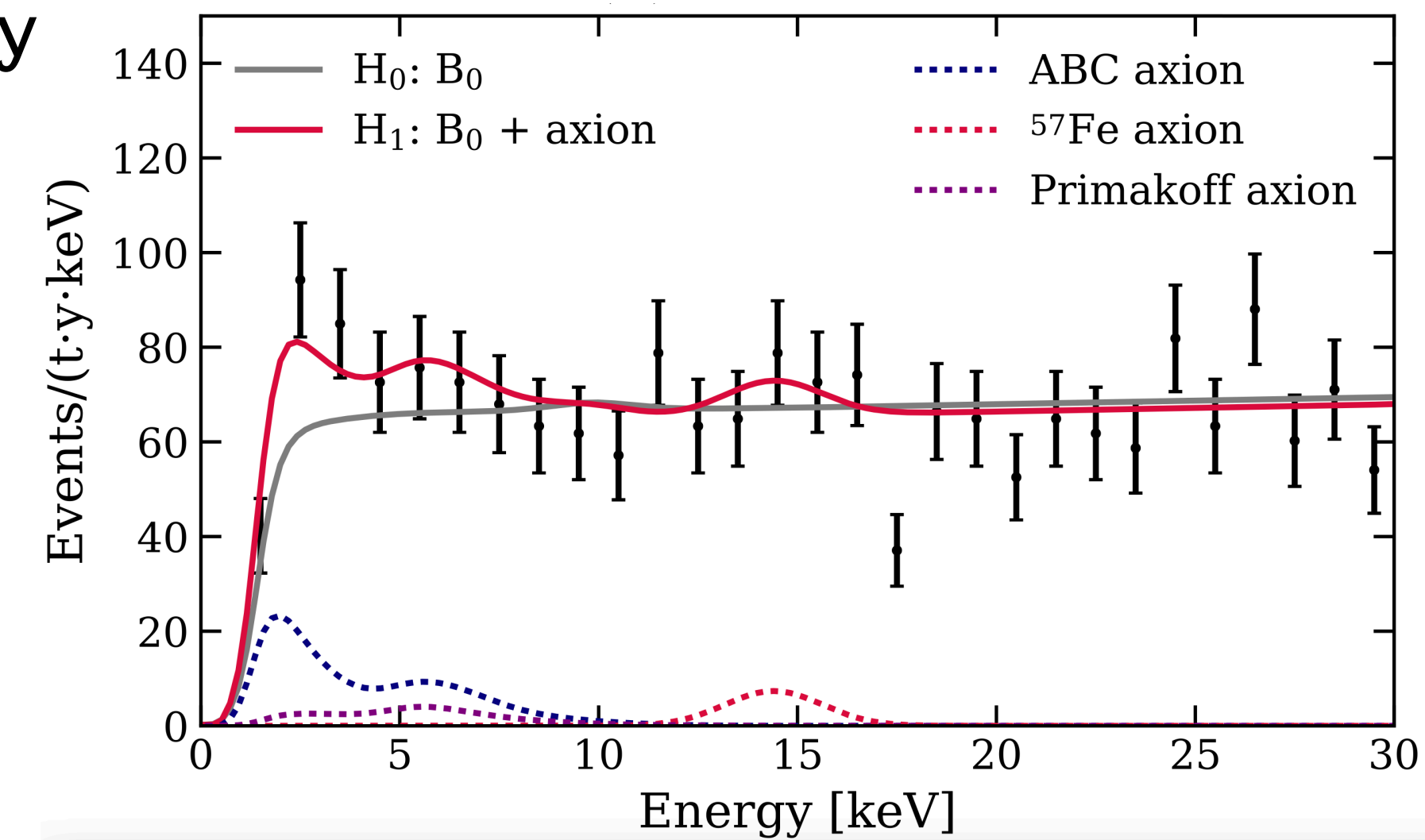


# ER searches: Low ER excess

PRD 102 (2020) 7, 072004

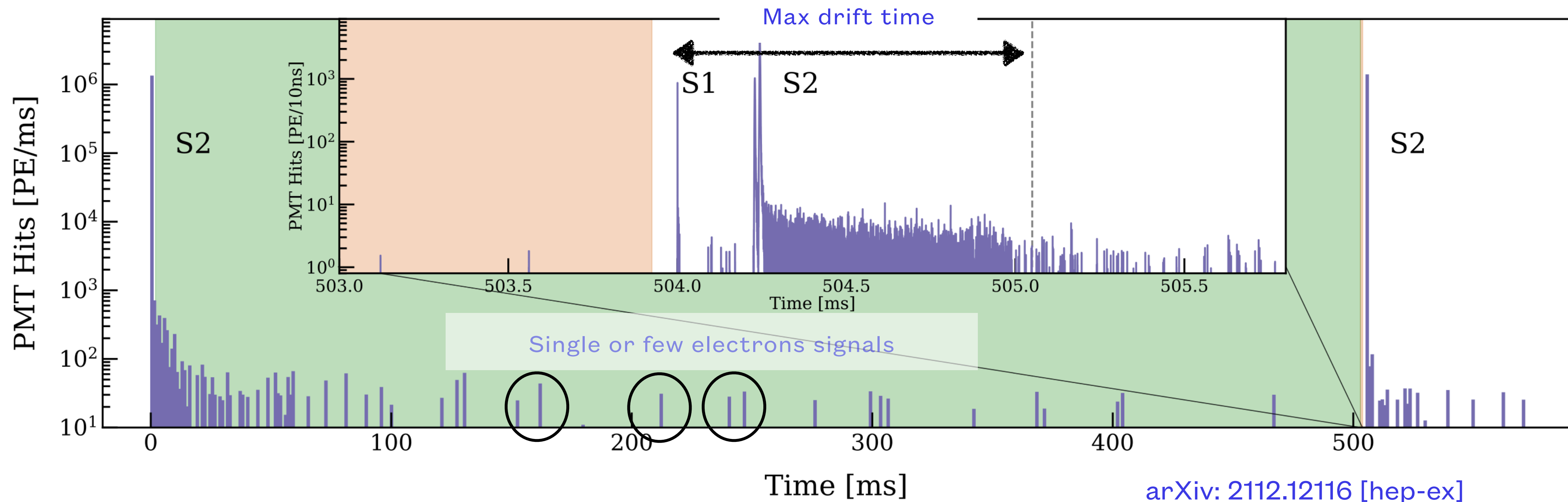


- Excess observed at low energy ER!
- Signal compatible with solar axion
- **Best fit:  $3.4\sigma$**
- More data expected from XENONnT



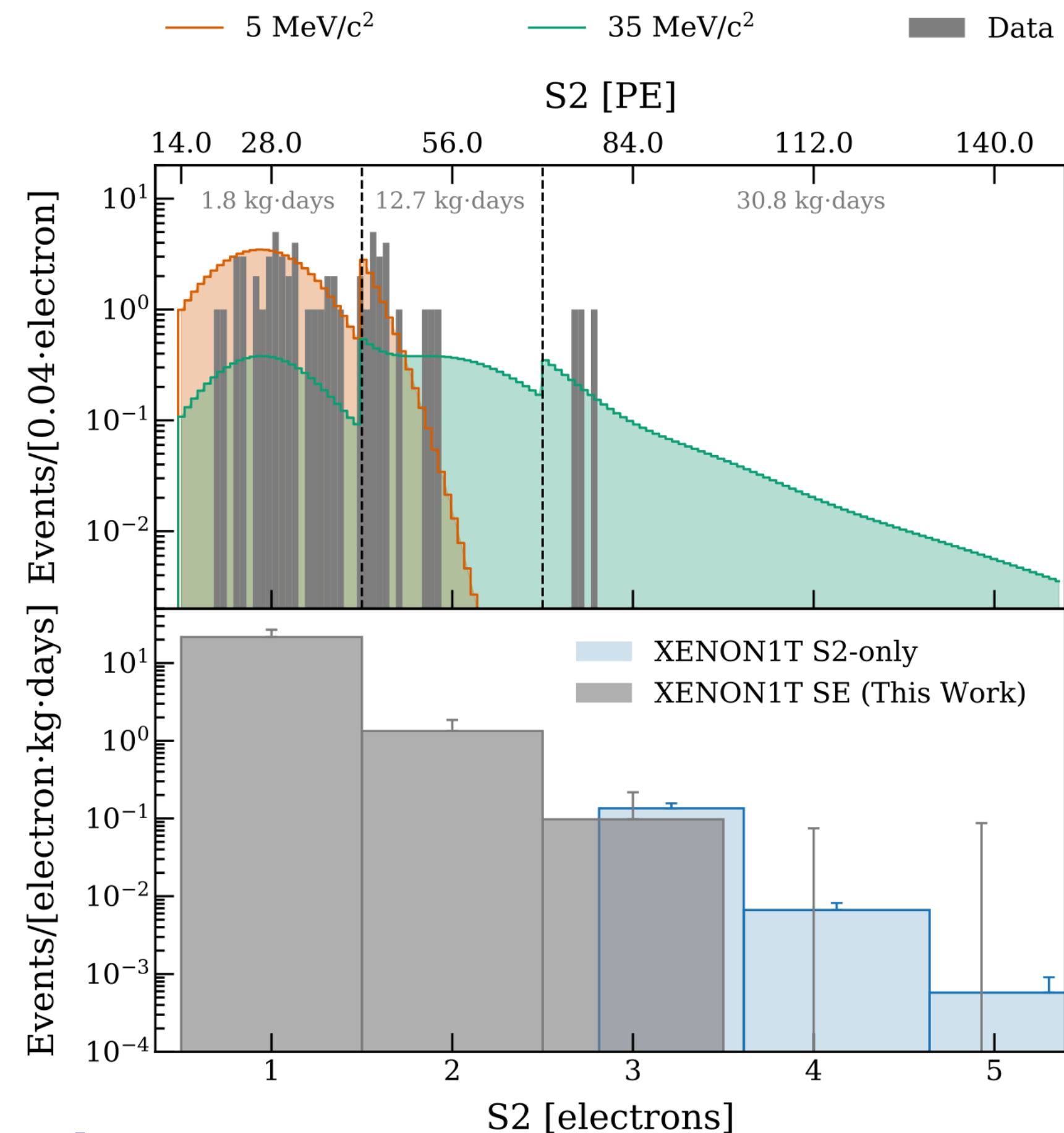
# ER searches: Single electron emission

- Single or few electron (SE) signals between Main S2s: data taken in *continuous mode*
- Very low energy signals: necessary energy to ionize Xe  $\sim 13.8\text{eV}$



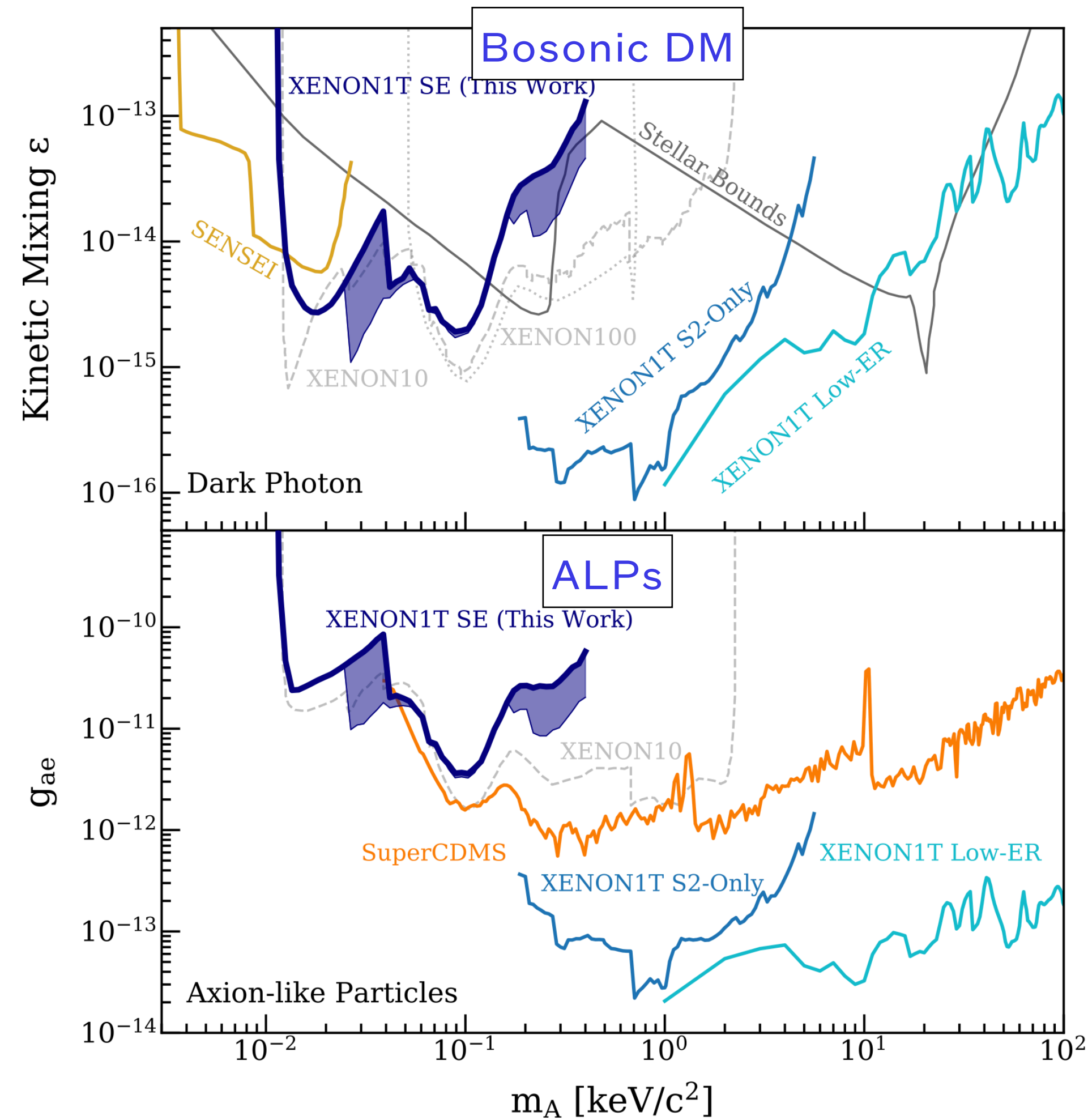
# ER searches: Single electron emission

- Physics reach: Light DM-e interactions, Axion Like Particles (ALPs), Bosonic DM
- Drawback: high SE backgrounds:
  - Cathode photoionisation
  - Impurities, etc.
- Cuts and data selection reduce the exposure:
  - 1e : 1.8kg days, 2e: 12.7 kg days, 3+e: 30.8kg days



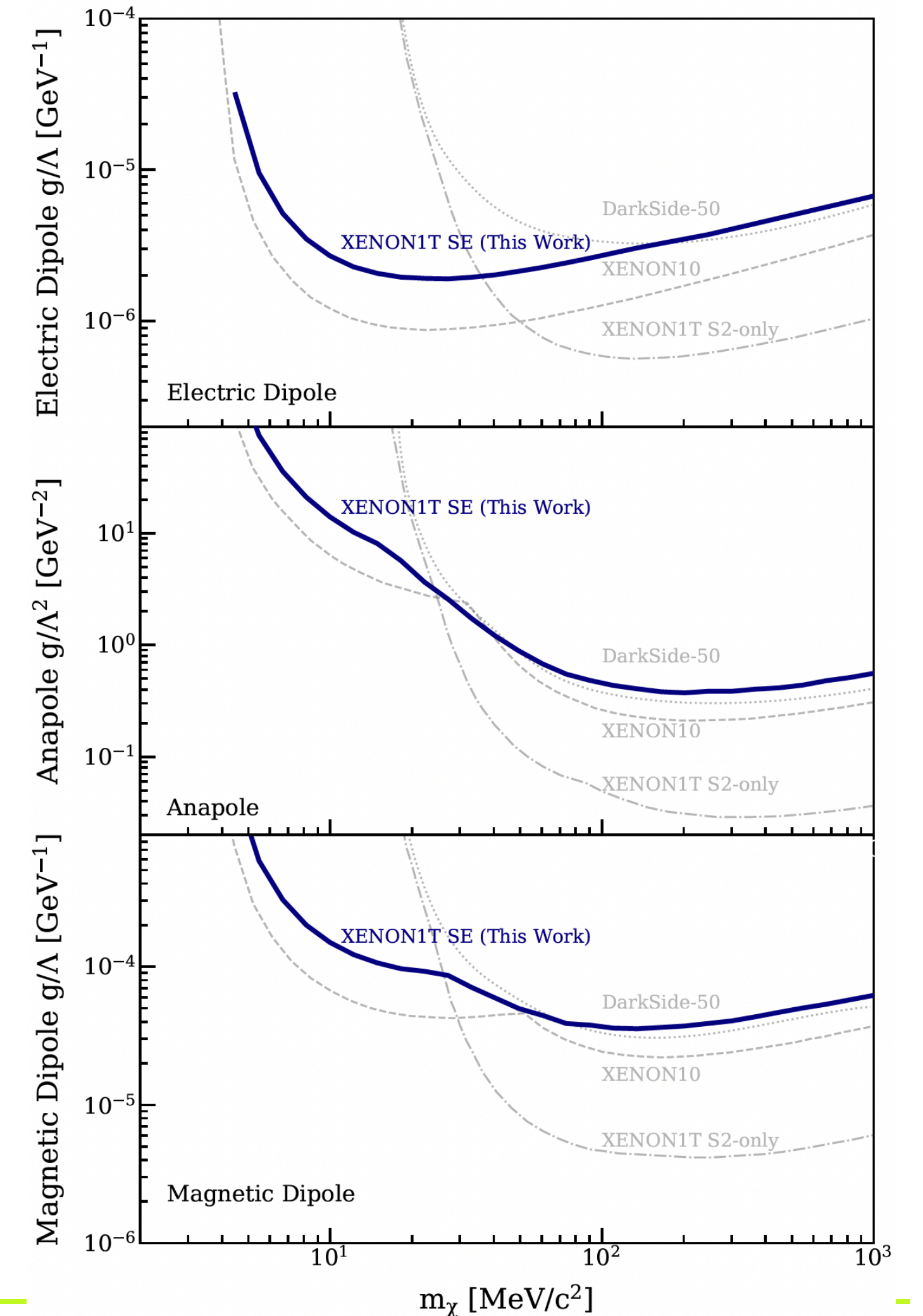
arXiv: 2112.12116 [hep-ex]

# ER searches: Single electron emission



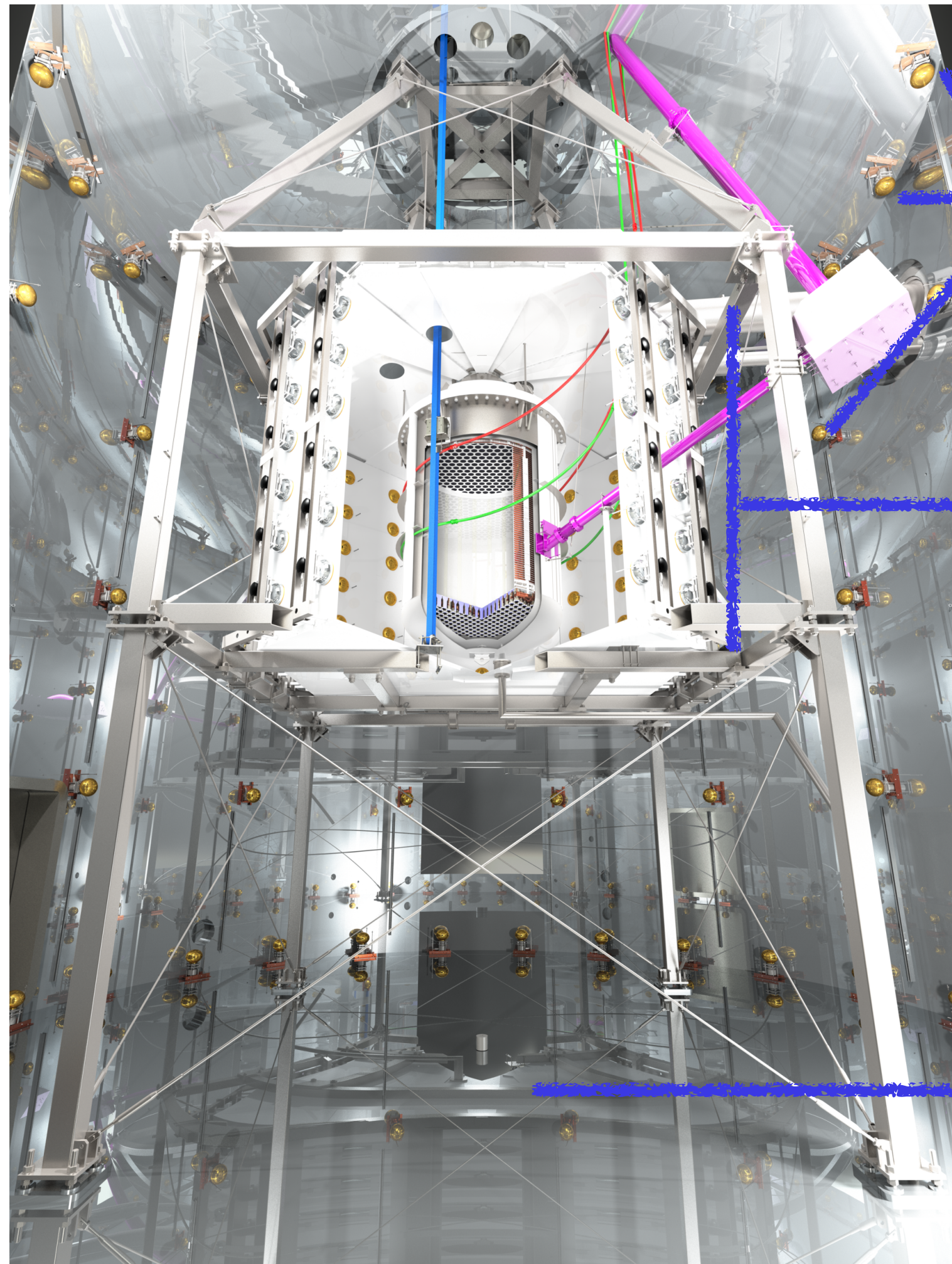
- Limits on Bosonic DM and ALPs
- First experimental limits on Light DM-e effective interactions:
  - Electric dipole
  - Magnetic dipole
  - Anapole

arXiv: 2112.12116 [hep-ex]





# XENONnT detector

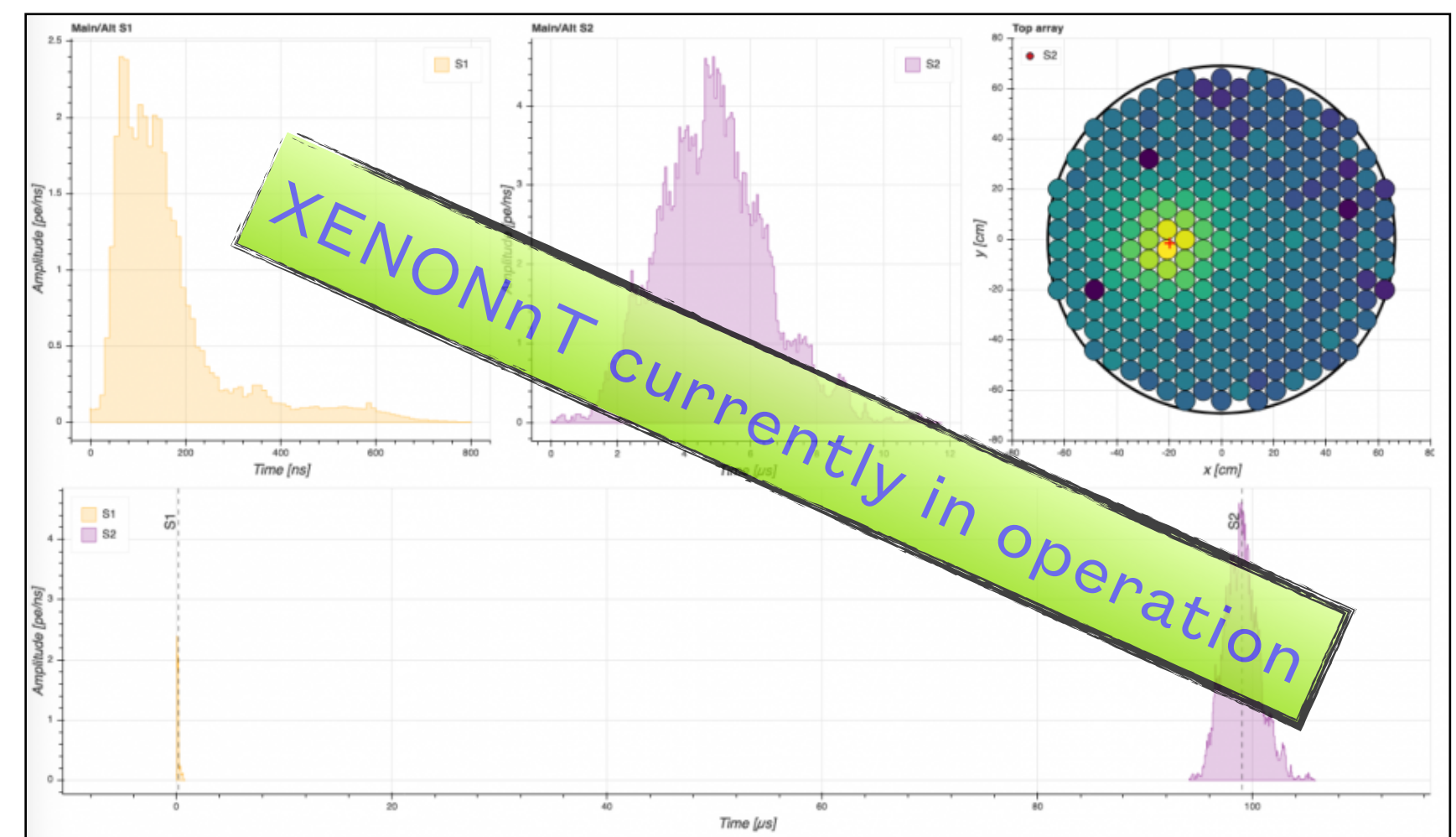
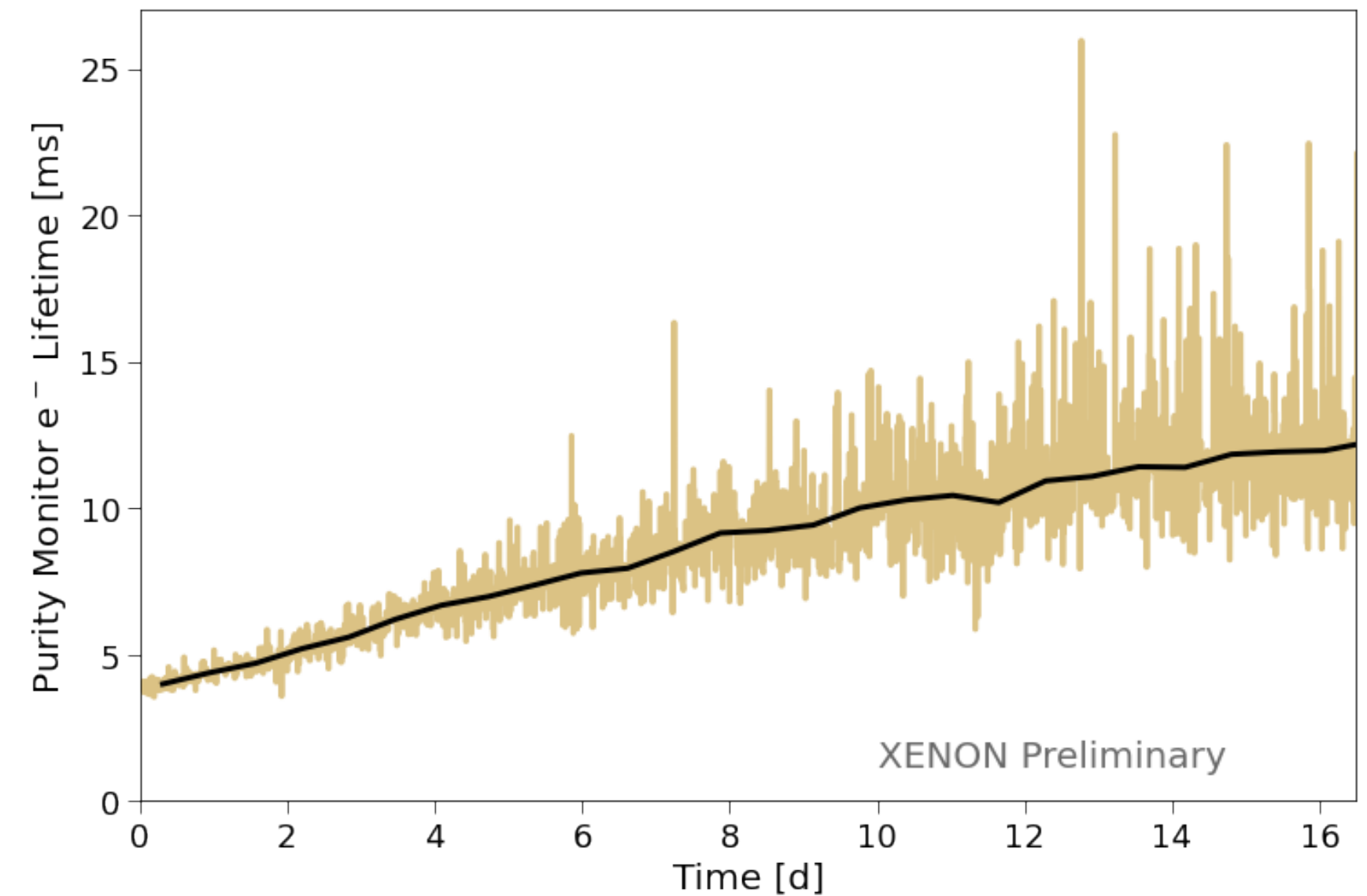


Muon veto  
PMTs

Neutron  
veto  
(Gd doping will  
be added)

Water tank

- Bigger TPC
- More PMTs
- Added neutron veto around the cryostat
- Improved purification system
  - Decreased  $^{222}\text{Rn}$  background
  - **Electron lifetime ~10ms!**

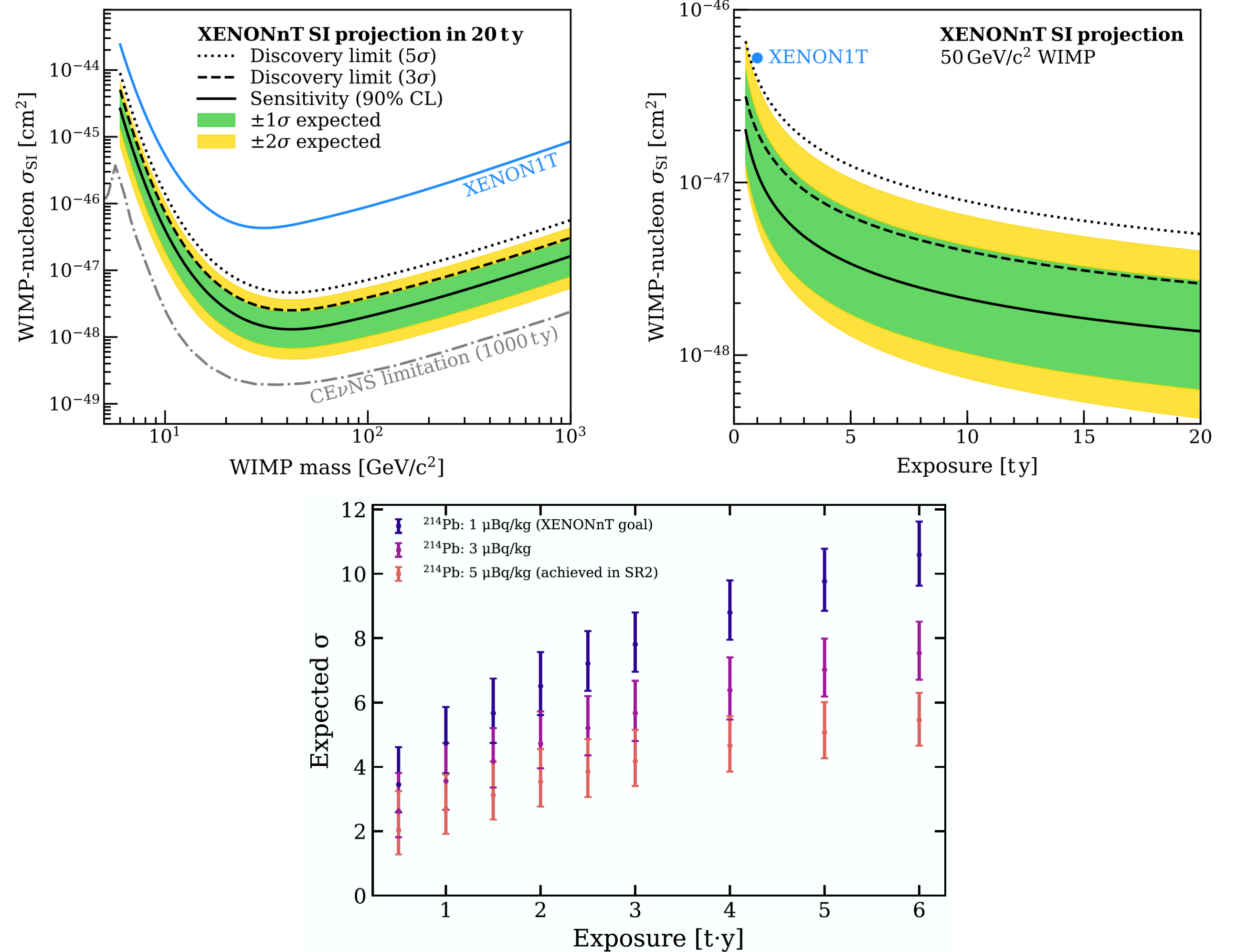


# XENONnT projections

- With the XENONnT improvements, expected SI projection for 20ty exposure:

- $\sigma_{\chi N}^{SI} = 1.4 \times 10^{-48} \text{ cm}^2$  for  $m_{\chi} = 50 \text{ GeV}/c^2$

- The Low-ER excess can be investigated
- $5\sigma$  discovery significance depends on background level
- Optimistic scenario 1ty exposure is enough



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# Conclusions

- XENON1T NR searches produced world leading results for SI and SD WIMP interactions
- Following analyses pushed down the energy threshold, further constraining low mass WIMP cross section
- XENON1T observed an excess in the ER, most consistent with the solar axion hypothesis
- Tritium background cannot be excluded
- SE emission produced experimental limits on DM-e effective operators, Bosonic DM and ALP
- XENONnT has been constructed, and operates successfully
  - reduced background and increased purity
- XENONnT will probe lower WIMP cross sections, and will hopefully be able to study the ER excess.