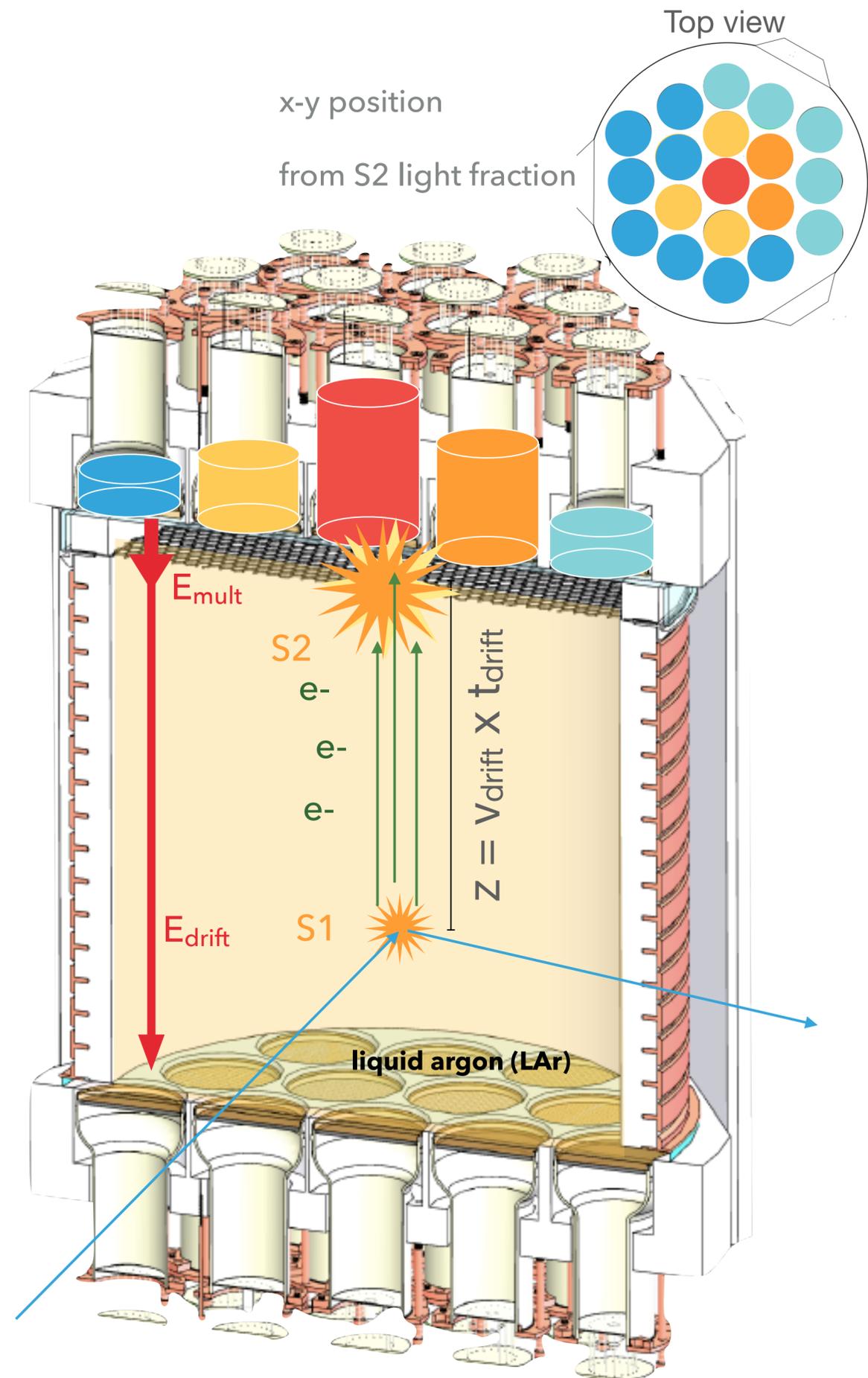


# Spurious Electron Backgrounds in Dark Matter Searches

# DS-50 Liquid Argon TPC

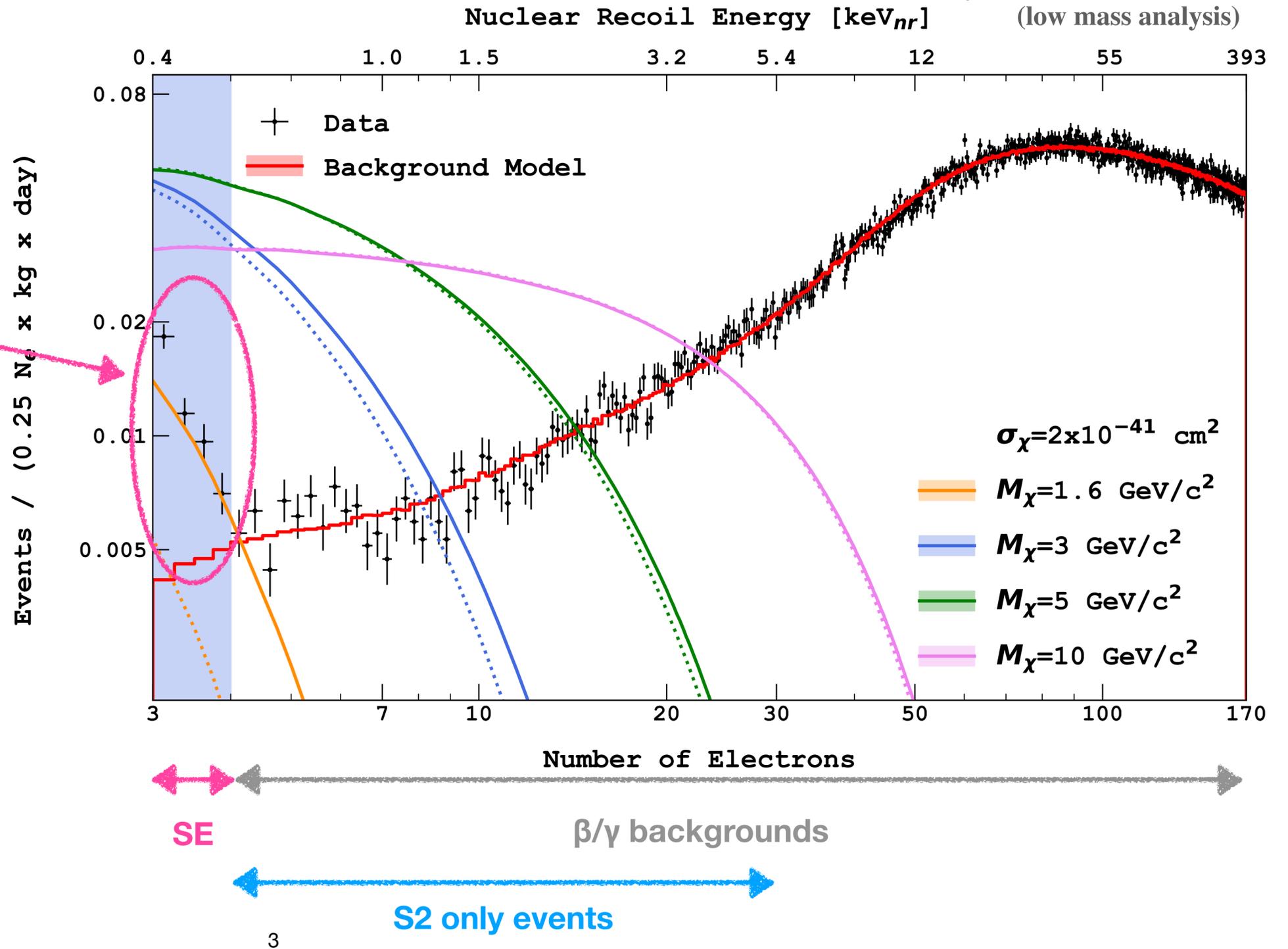
- Double-phase liquid argon TPC (see [Physics Letters B 743, 456 \(2015\)](#)).
- Readout **S1** and **S2** light signals with PMTs.
- Drift field is 200 V/cm.
- Electroluminescence field is  $\sim 5.6$  kV/cm (at the x-y center) and 4.2 kV/cm (at the edge).
- The hexagonal meshed grid at 5 mm below the liquid surface to apply the extraction field of 2.8-3.7 kV/cm (due to deformation of anode).
- Argon is purified in gas phase by a hot getter and a Rn trap, then directly brought back in the TPC from a condenser.



# Low Energy Backgrounds in DS-50

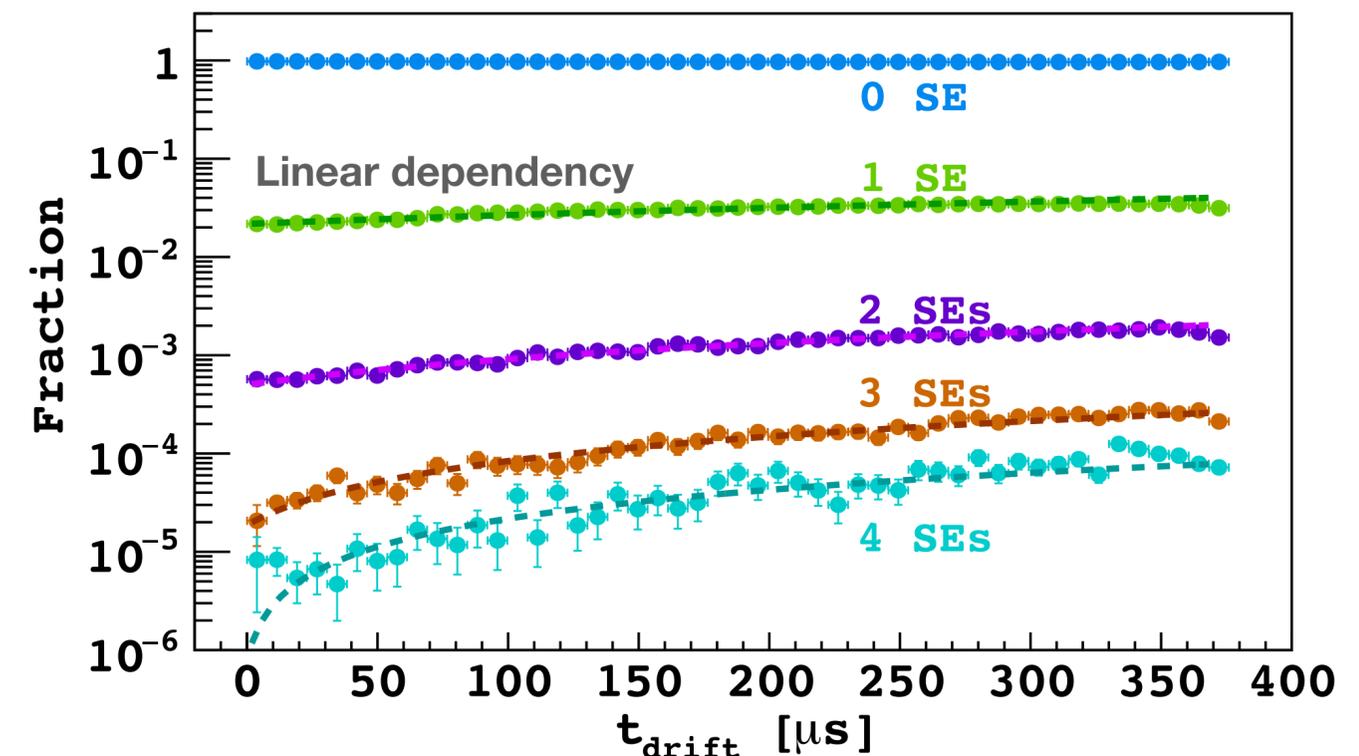
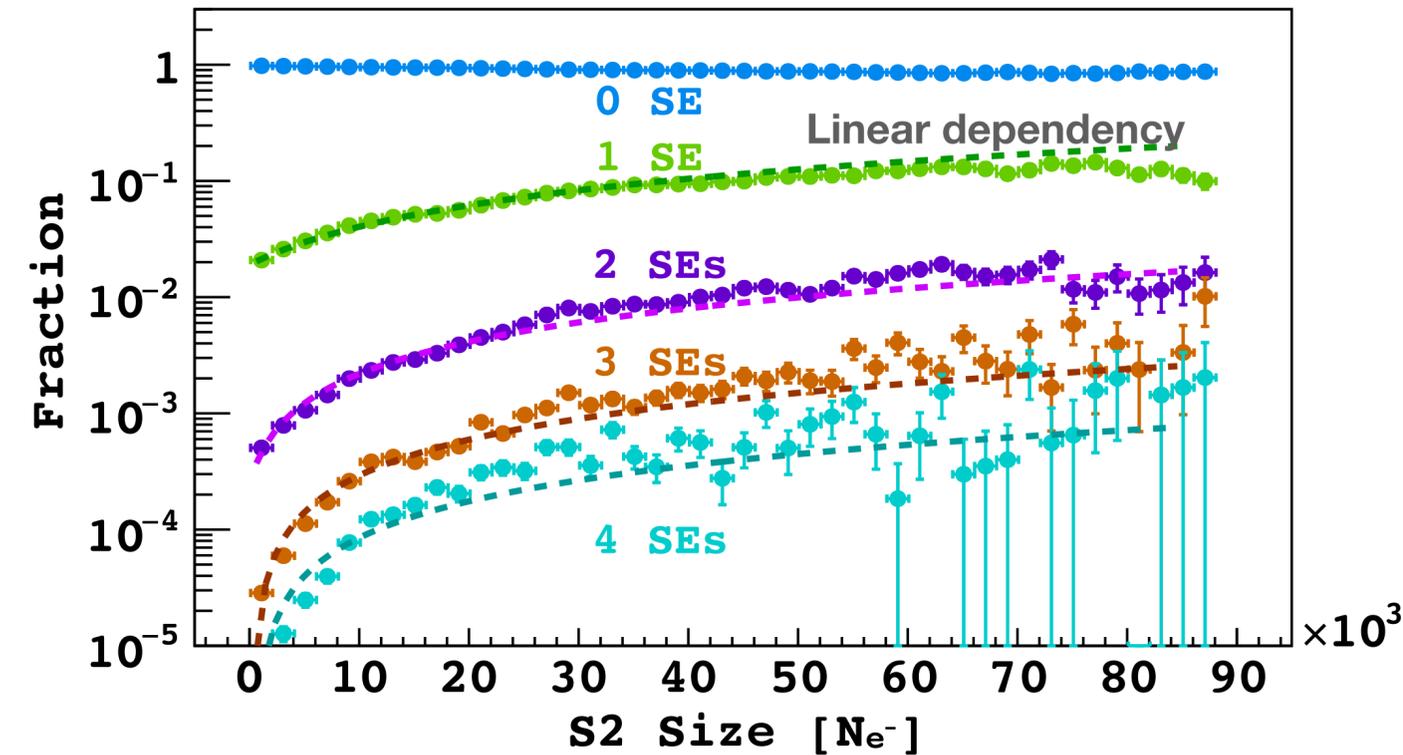
Phys. Rev. D 107 (2023) 6, 063001  
(low mass analysis)

- The analysis threshold was determined by the excessive number of events at 1-4 Ne.
- Limits our sensitivity to lower WIMP mass range.
- Need to understand the few-electrons events, so called, spurious electrons (SE) events

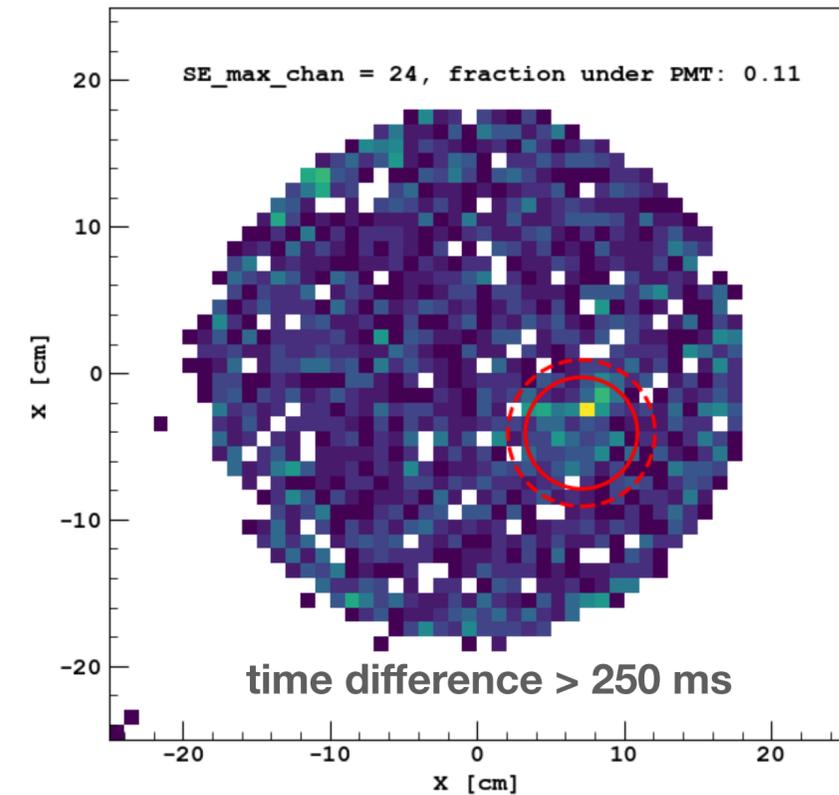
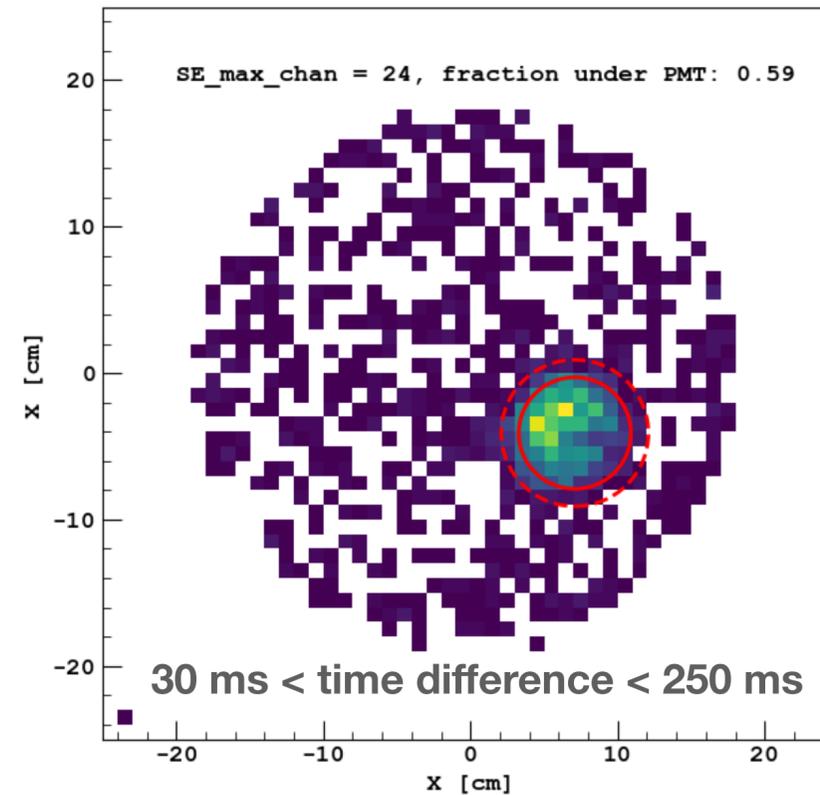
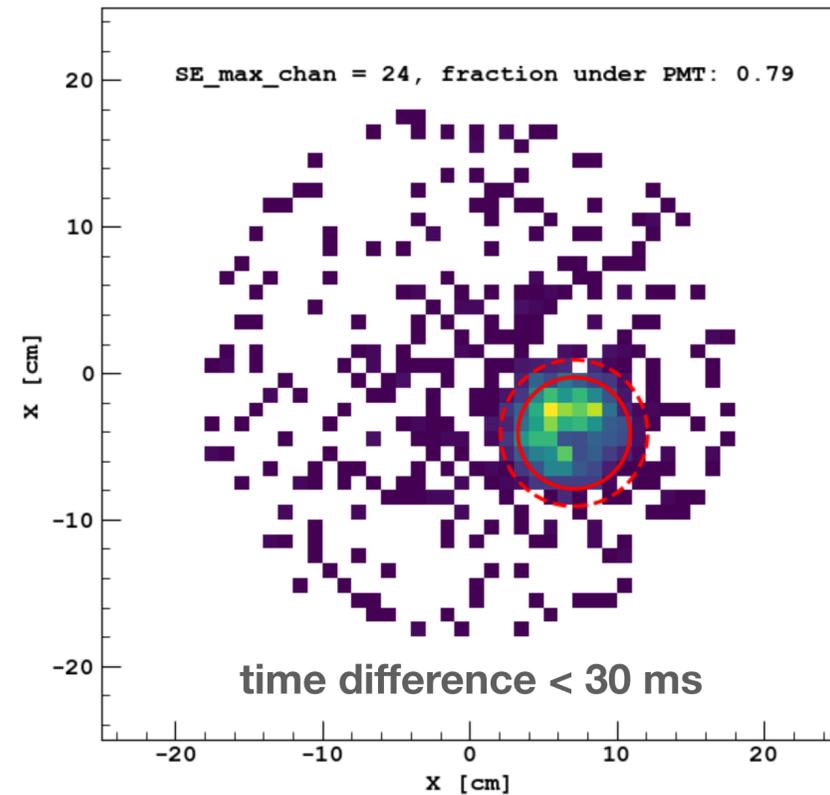


# Correlation with Parent's S2 and z-position

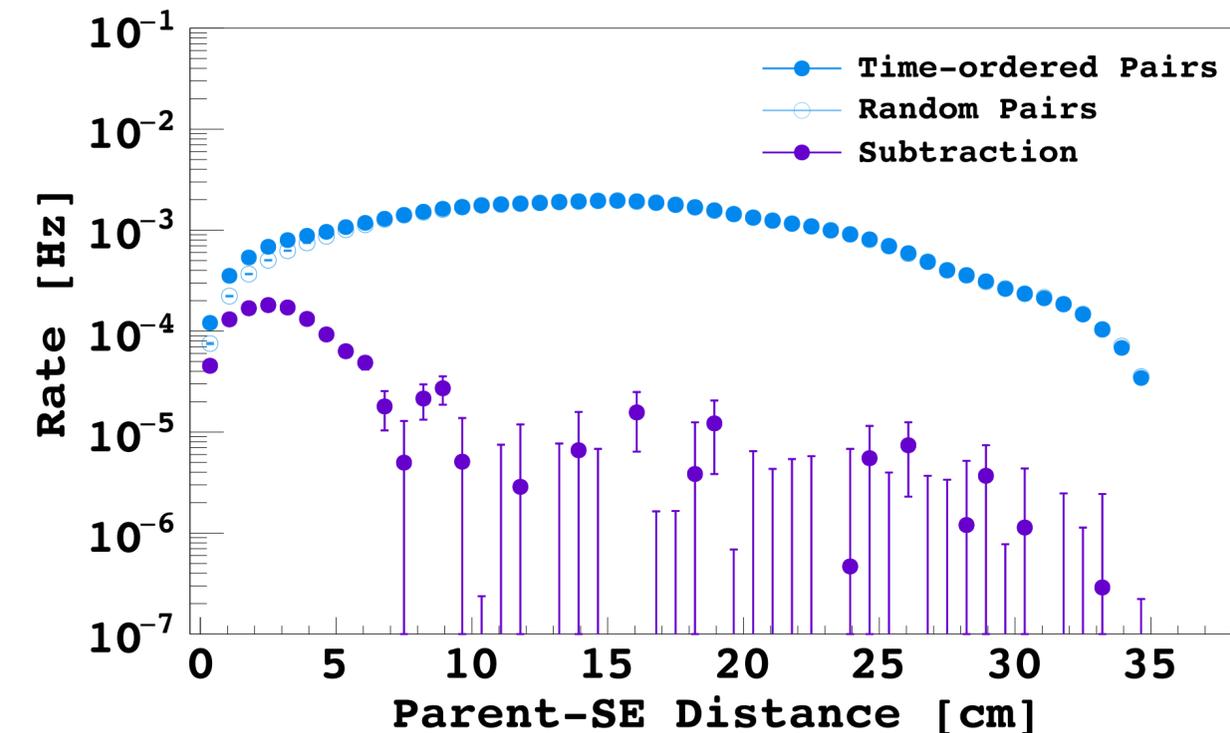
- For all parent events, count how many SE events follow until next parent event.
- The fraction of parent events with no SE events, one SE event, two SE events, so on, is calculated as a function of parent S2.
- **Large energy events create more SE events.**
- Clear linear relationship with z-position of parent. -> **The longer the drift time, the higher the chance of electrons to be captured.**
- Consistent with the correlated-events hypothesis, which originates from the charge released in previous interactions drifting along the field and being trapped along the route.



# x-y correlation



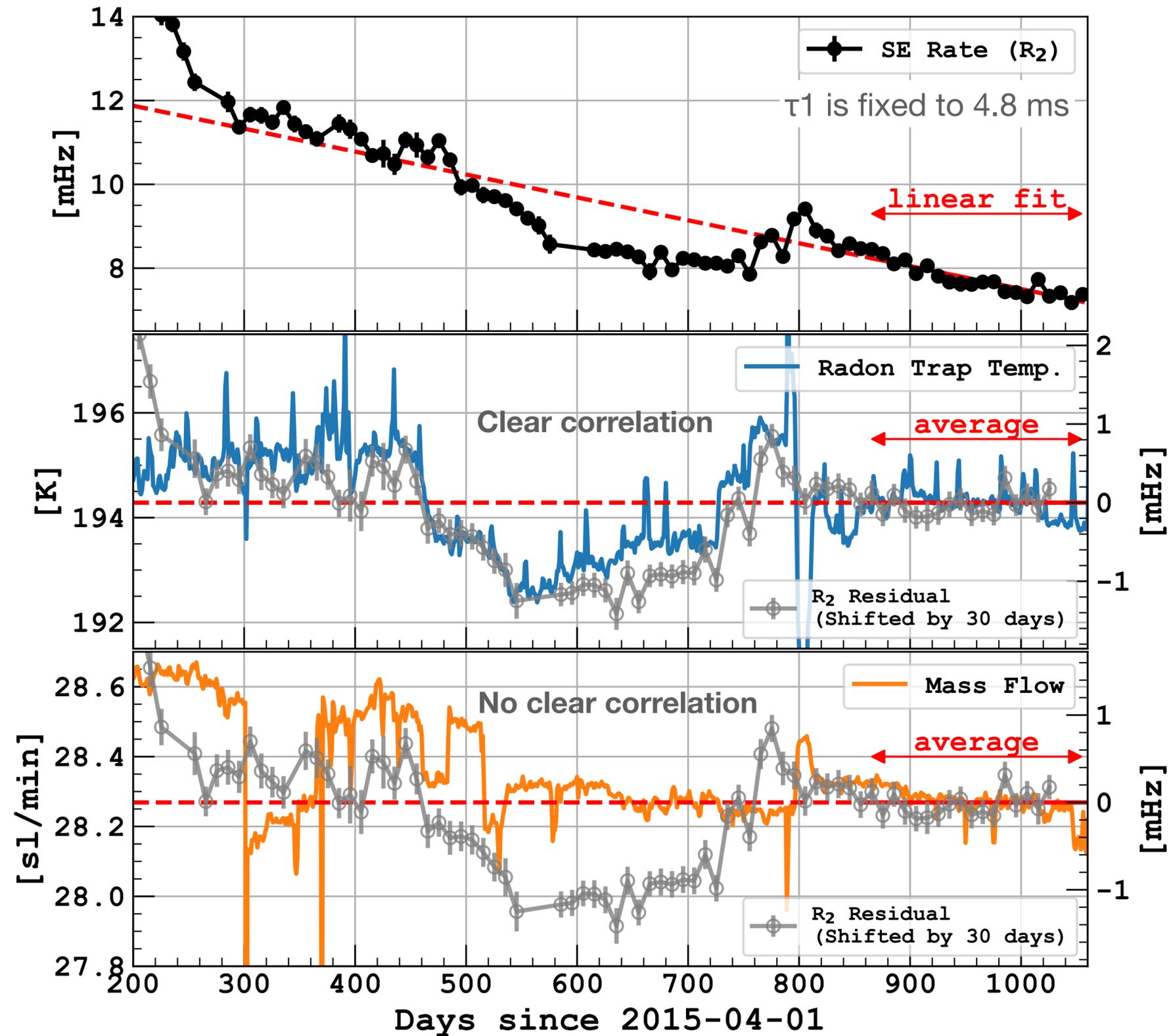
- Select SE events under PMT 24 and plot x-y position of parents, which have only one S2.
- **Strong correlations** are observed between S2\_Max\_chan of SE and x-y position of the parent events.
- **Temporary correlated pairs shows strong spatial correlation** as well. The fractions of parents reconstructed under the same PMT are consistent with the ones extracted from the time correlation.



# Correlation?

## a hint of correlation

- When the temperature of the **radon trap decreased**, the rate of the **slow time constant  $R_2$  (~50 ms)** also decreased.
- It might mean the radon trap captured the impurity and reduce the rate of SE w/ the slow time constant.
- Other slow control parameters showed **no obvious correlation with the SE rates.**



# Summary

- In DS-50 TPC, we observed events with a few electrons emission, which set a threshold for low mass dark matter search.
- There are correlations between SE events and previous events in energy, time, and position.
- **The rate of SE shows a hint of correlation with the temperature of the Rn trap.**
- We will use this information to model this background better and reduce this type of backgrounds in the future experiments.
- We submit one paper based on this study <https://arxiv.org/abs/2507.23003>.

# Summary of Activities in 2025

## Conferences

- Jan. 2025 **TMEX2025** Quy Nhon, Vietnam Talk: DarkSide-20k: Liquid Argon-based Direct Dark Matter Search Experiment
- Feb. 2025 **Particle Astrophysics in Poland** Warsaw, Poland Talk: Development towards Light Dark Matter Searches and Medical Applications
- Apr. 2025 **High Energy Physics Seminar** University of Warsaw, Poland Seminar: Development towards Light Dark Matter Searches and Medical Applications
- Aug. 2025 **TAUP2025** Xichang, China Talk: Searches for Light Dark Matter with DarkSide-20k and DarkSide-LowMass
- Oct. 2025 **LIDINE2025** Hong Kong, China Talk: Update on 3Dpi: PET Scanner with Xenon-doped Liquid Argon and SiPM

## Publications

- Benchmarking the design of the cryogenics system for the underground argon in DarkSide-20k JINST 20, P02016 (2025).
- 3DPI: three-dimensional positron imaging, a novel total-body PET scanner using xenon-doped liquid argon scintillator, Phys. Med. Biol. 70 065015 (2025).
- Quality assurance and quality control of the 26m<sup>2</sup> SiPM production for the DarkSide-20k dark matter experiment, Eur. Phys. J. C 85, 534 (2025).
- Impact of extreme ultraviolet radiation on the scintillation of pure and xenon-doped liquid argon, Phys. Rev. D 111, 102001 (2025).
- Flow and thermal modelling of the argon volume in the DarkSide-20k TPC, JINST 20, P06046 (2025).
- Production, Quality Assurance and Quality Control of the SiPM Tiles for the DarkSide-20k Time Projection Chamber, Eur. Phys. J. C 85, 1334 (2025).

## Proposals

- **MAB-FENG** - co applicant, medical application (Granted).
- **Synergy ERC** - PI with prof. J. Monroe (Oxford U.) and prof. A. Aprile (Columbia U.), medical application (under evaluation).