Searches of light dark matter at PandaX-4T experiments

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On behalf of PandaX Collaboration

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PANDA X

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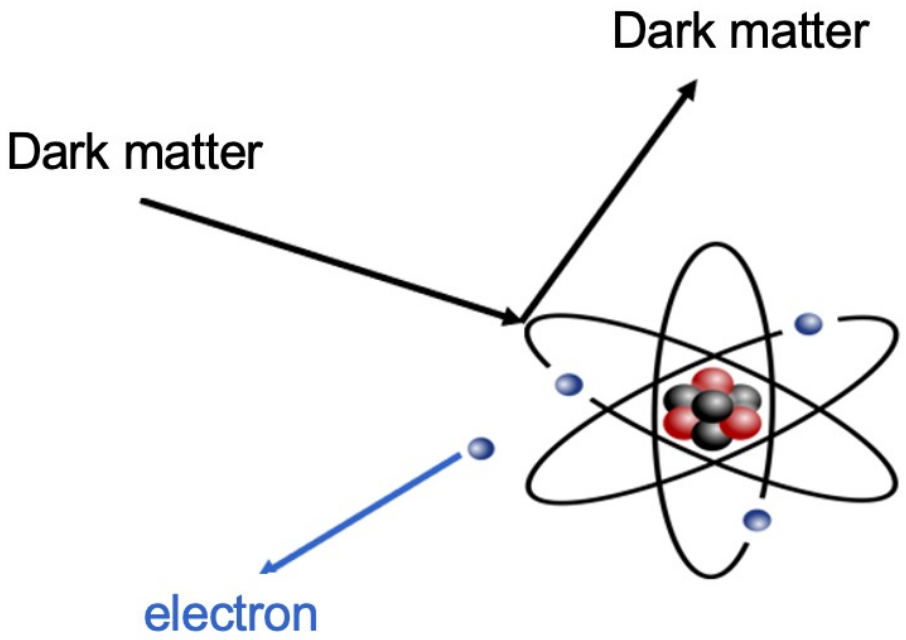
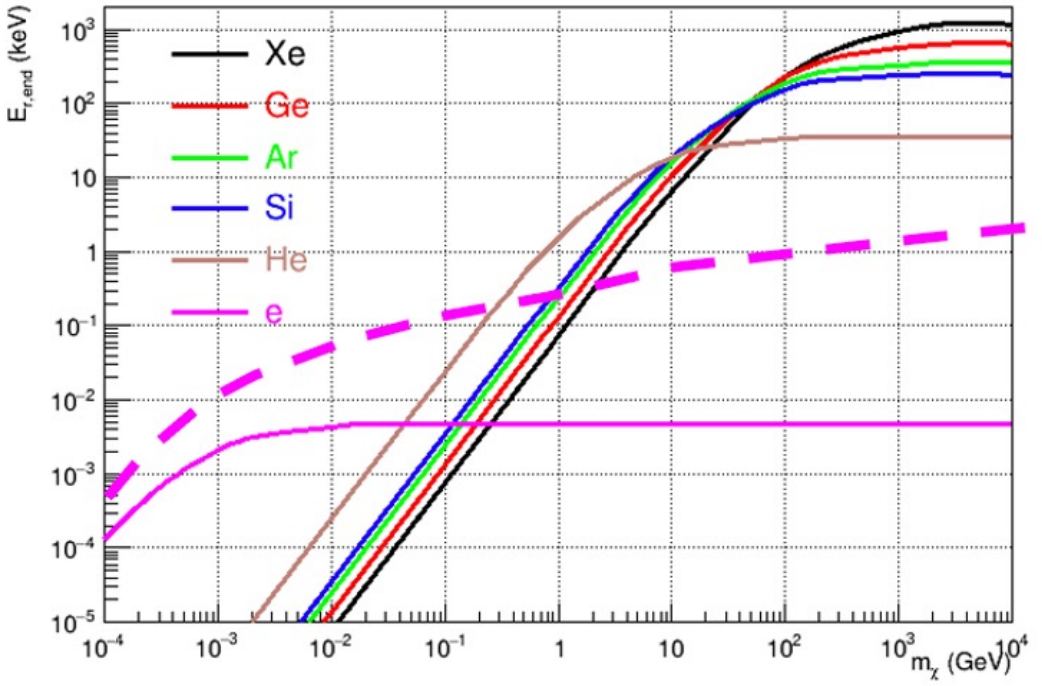
PART ONE

Introduction



The interaction of dark matter and shell electrons



Recoil energies of dark matter and different targets

Lower energy threshold, more sensitive to low-mass dark matter.

PART TWO

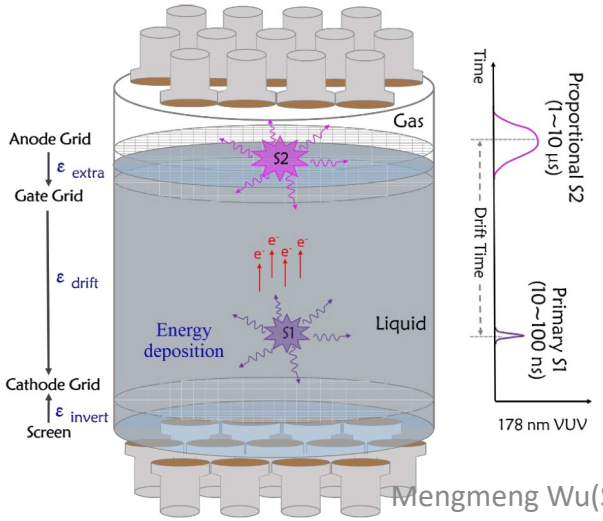
Dark Matter interactions in the PandaX-4T Experiment

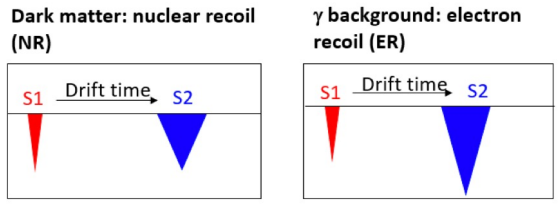
Conventional DM search

- **S1 + S2 paired event analysis**
  - –Electron recoil background rejection by ratio of charge(S2)/light(S1)
  - –Z position from S1-S2 drift time
  - –X-Y positions from S2 light pattern

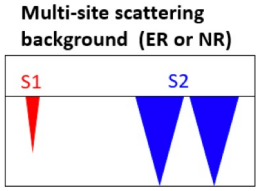
Light DM search

- S2 only analysis
  - –Lower energy threshold ~ 80 eV in the PandaX-II Experiment [1] (comparing energy threshold ~1 keV with paired analysis)
  - –Sensitive to light DM interaction.





$(S2/S1)_{NR} << (S2/S1)_{ER}$



[1] Chen Cheng, Search for Light Dark Matter-Electron Scatterings in the PandaX-II Experiment.

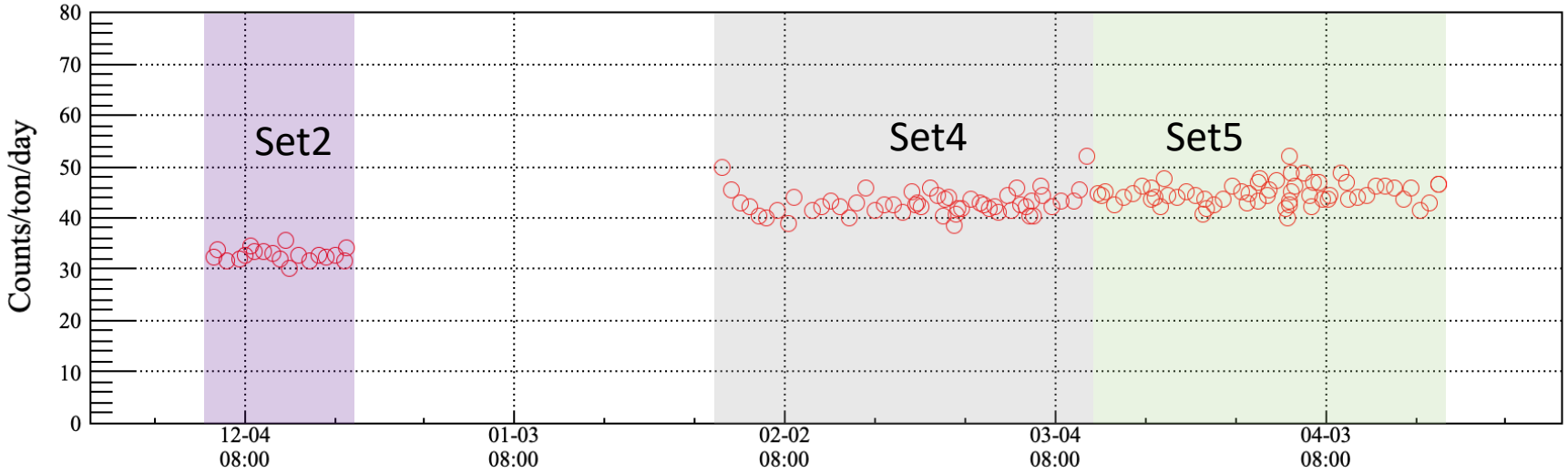
PART THREE

Analysis in PandaX-4T experiment

—— Datasets

- Blind analysis is performed for this S2 only analysis, using previously released first commissioning data of PandaX-4T, but with 7.5-day(set1, set3) data removed for the sparking run.
- Data of about 10-day are randomly selected to investigate the data selections, signal efficiencies, and background composition with S2 range from 60 and 200 PE.

Only Basic Cuts apply
60~200 PE

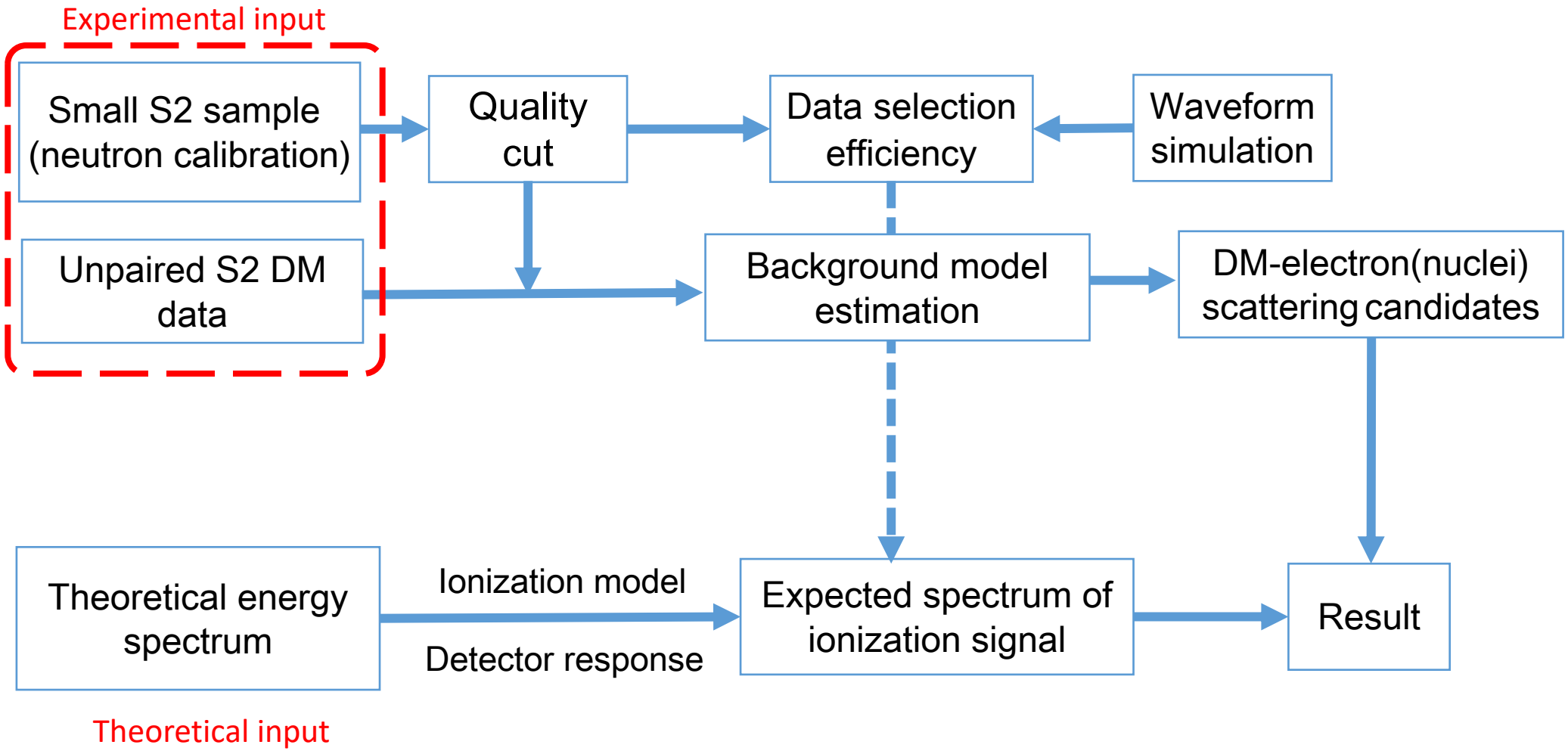


PART THREE

Analysis in PandaX-4T experiment

- Analysis flow

—— Analysis flow



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Analysis in PandaX-4T experiment

- Analysis flow

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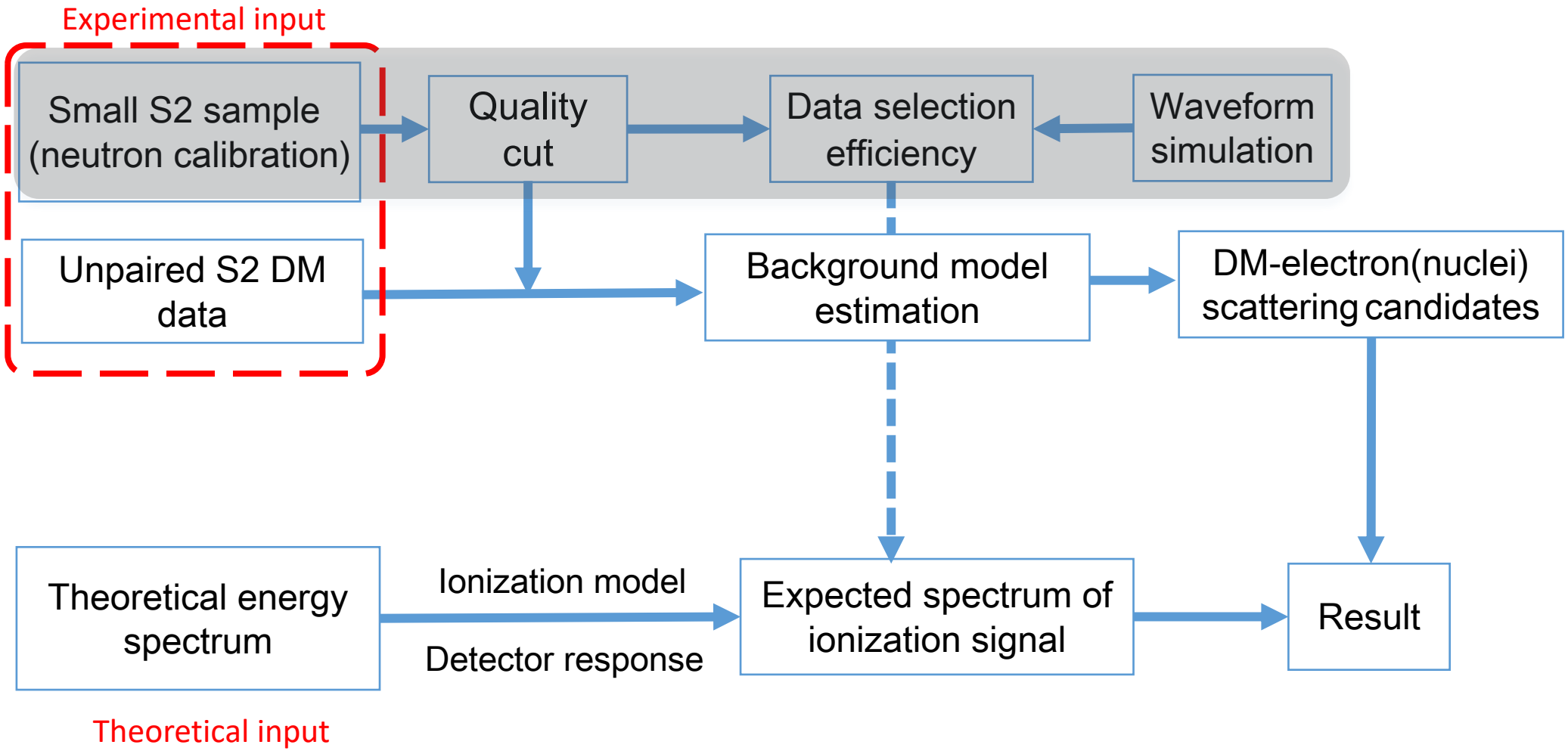
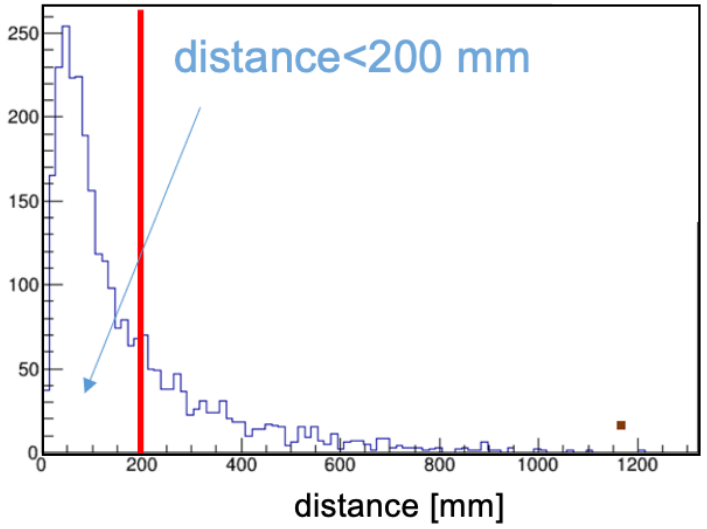
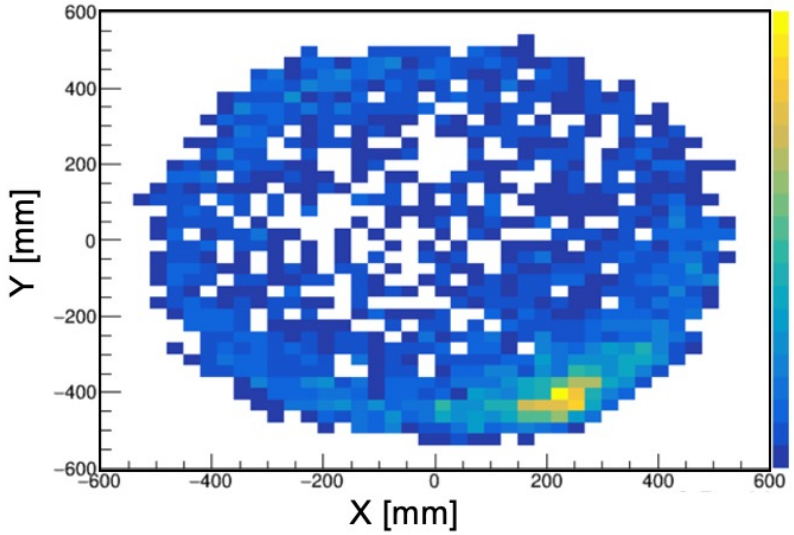


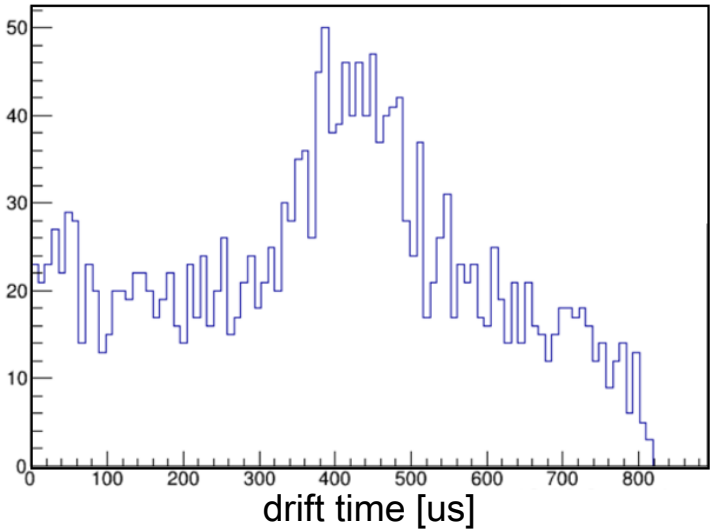
PART THREE

Analysis in PandaX-4T experiment

—— Selection of small S2 samples

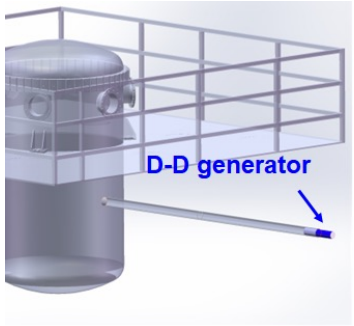


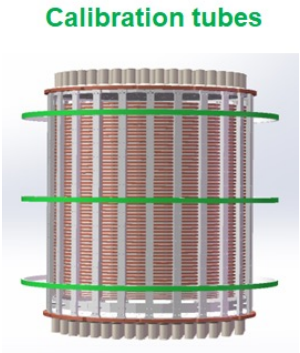




Using quality cuts only for max S1 and S2. Distance cut and charge cut are used for the smaller scattering selection.

Using all DD and AmBe 5kV calibration runs

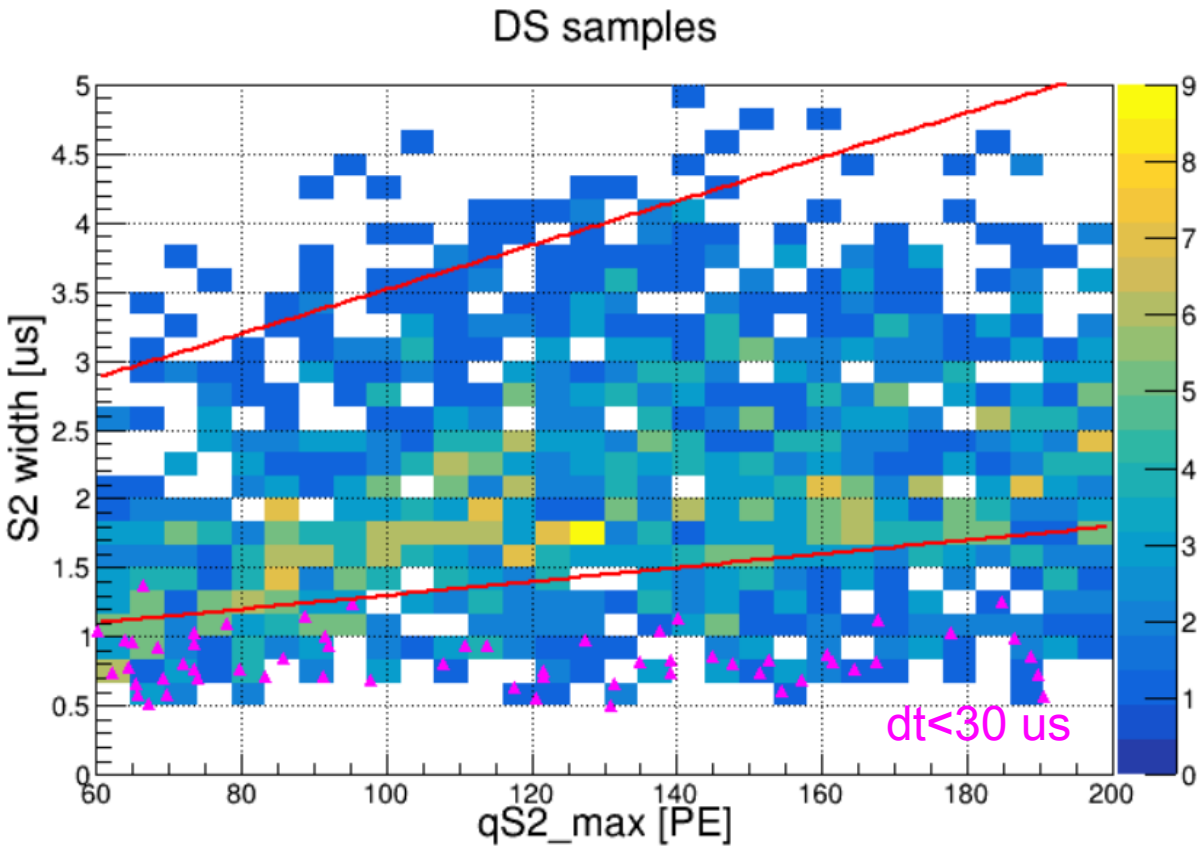




PART THREE

Analysis in PandaX-4T experiment

—— width cut



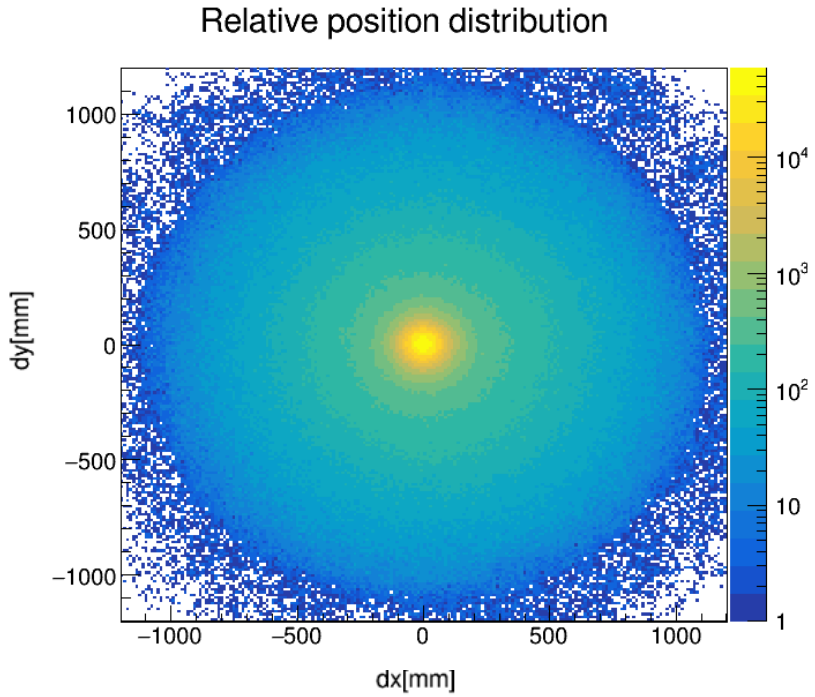
The lower limit of width cut can be used to remove "top" events that happen in the gate and gaseous region.

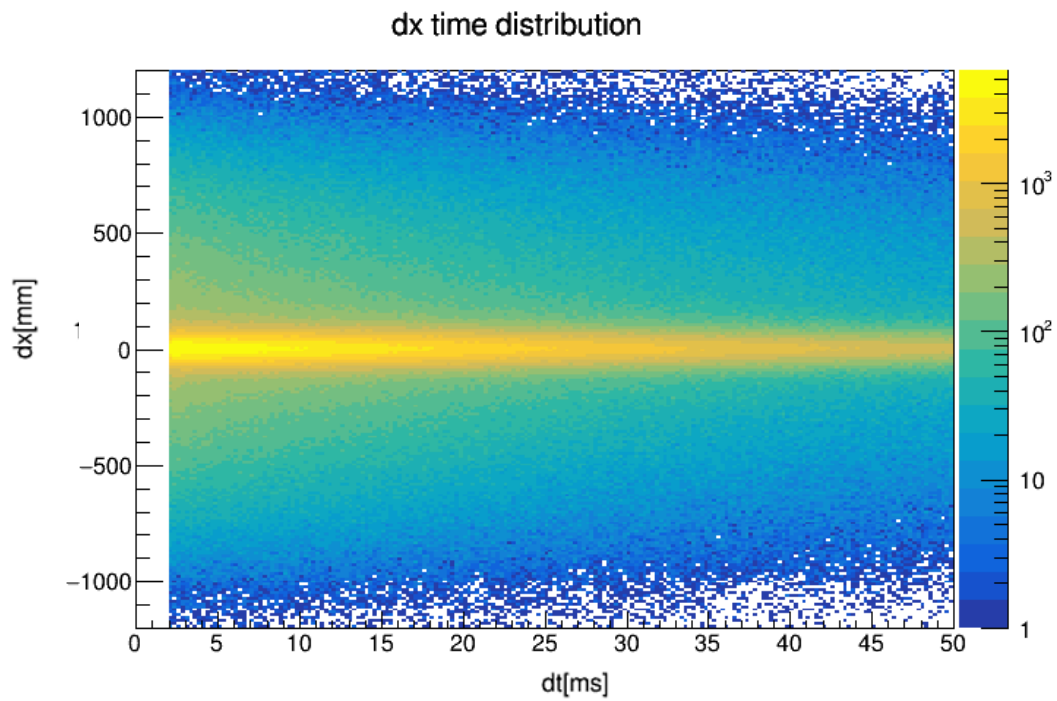
The upper limit of width cut can be used to suppress cathode events.

PART THREE

Analysis in PandaX-4T experiment

—— “eburst” cut



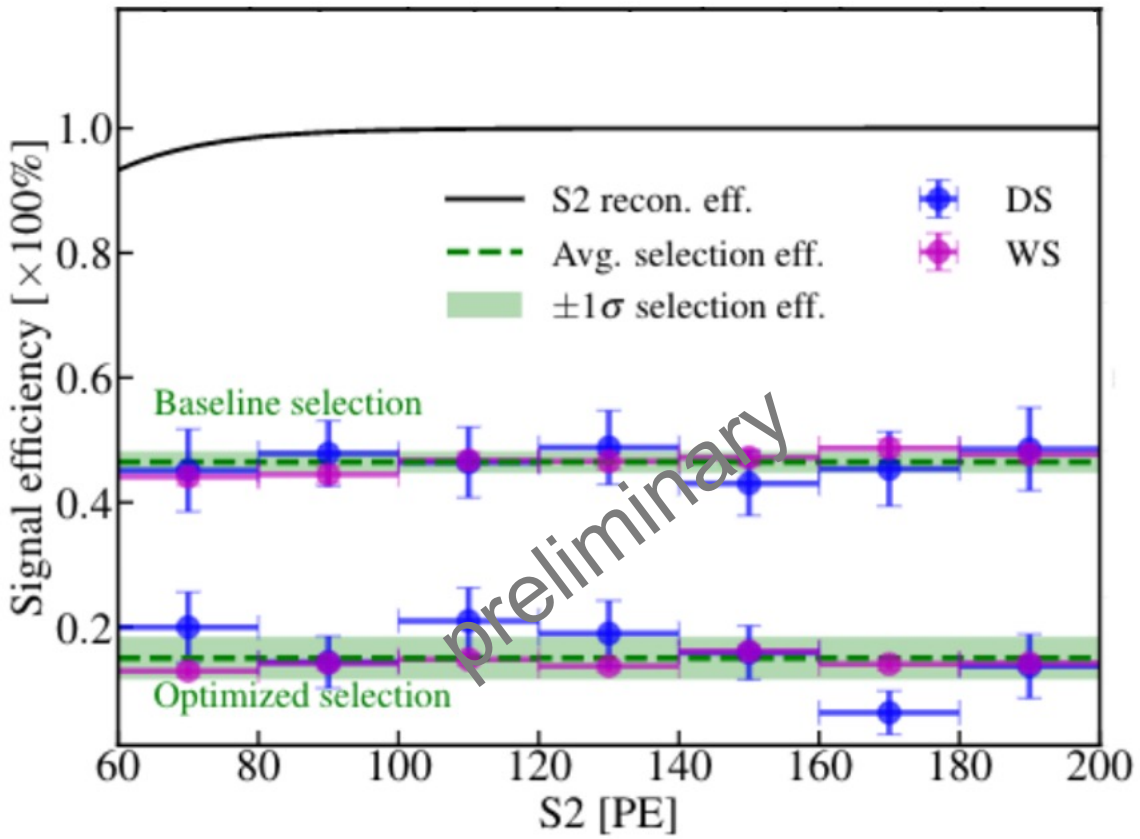


The “eburst” cut is used to remove the delayed electron cluster events which is correlated with a large S2 (time, position).

PART THREE

Analysis in PandaX-4T experiment

—— Cuts and efficiency



The cuts were used to further optimize according to the signal-to-noise ratio.

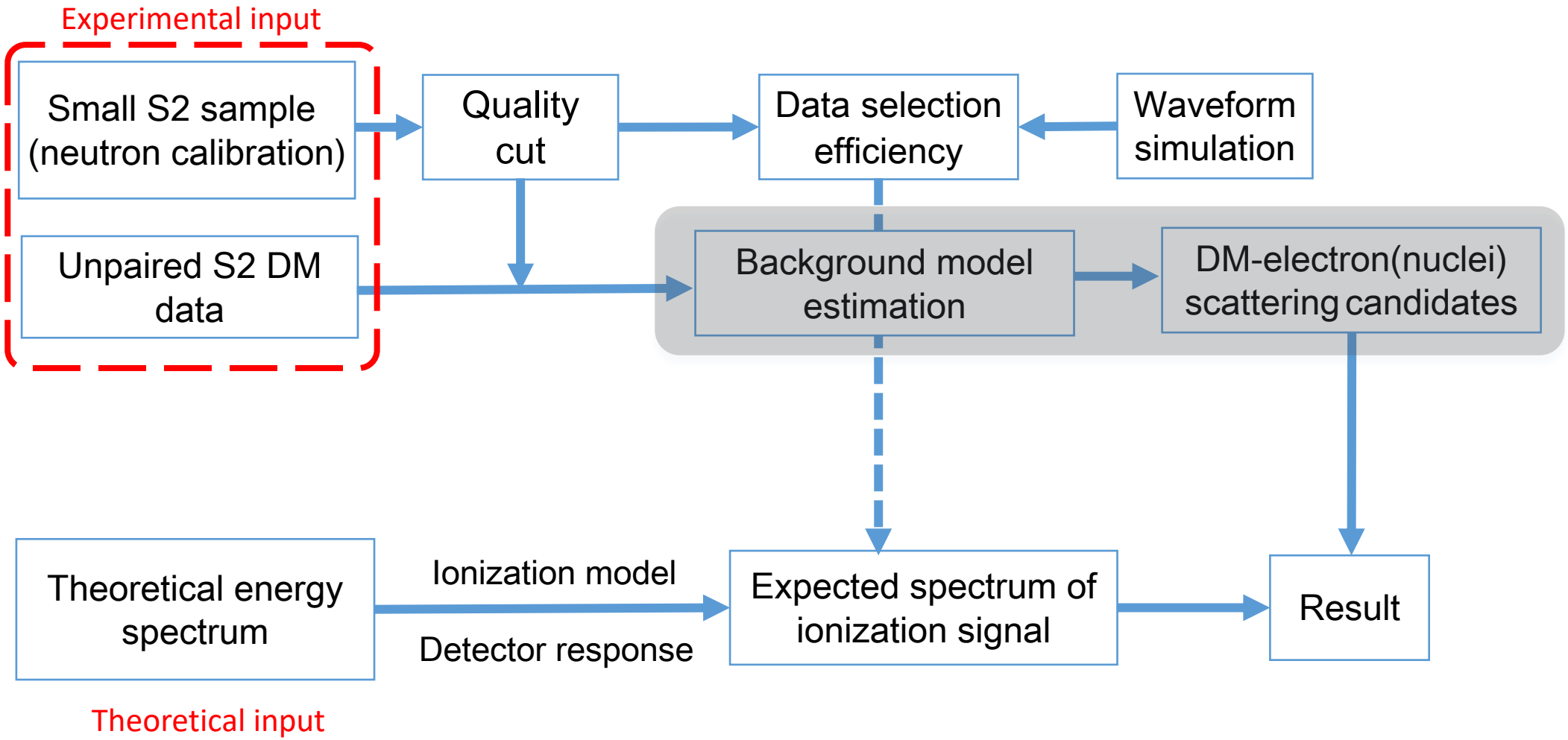
Signal selection efficiency of both the baseline and optimized data selections estimated using DS (blue) and WS (magenta) samples.

PART THREE

Analysis in PandaX-4T experiment

- Analysis flow

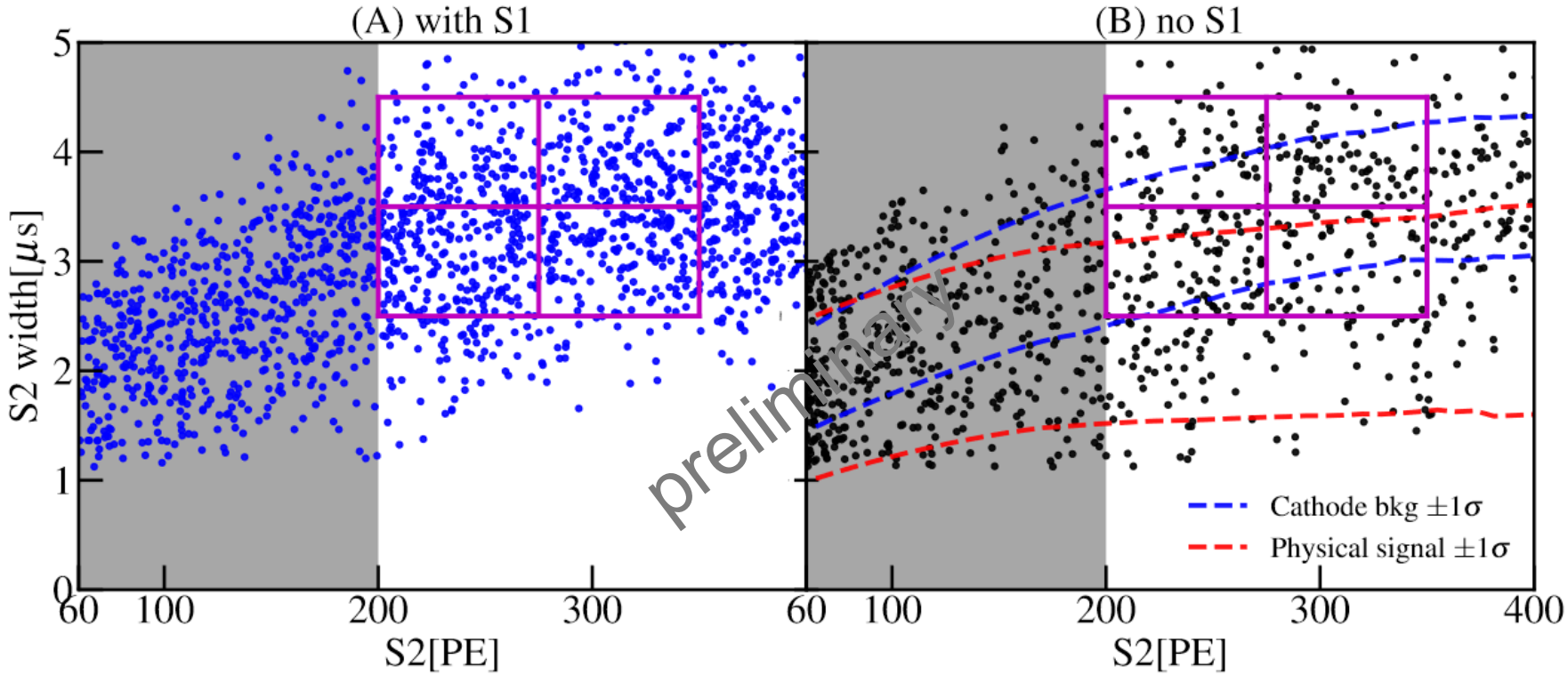
—— Analysis flow



PART THREE

Analysis in PandaX-4T experiment

—— cathode events estimation (Method 1)



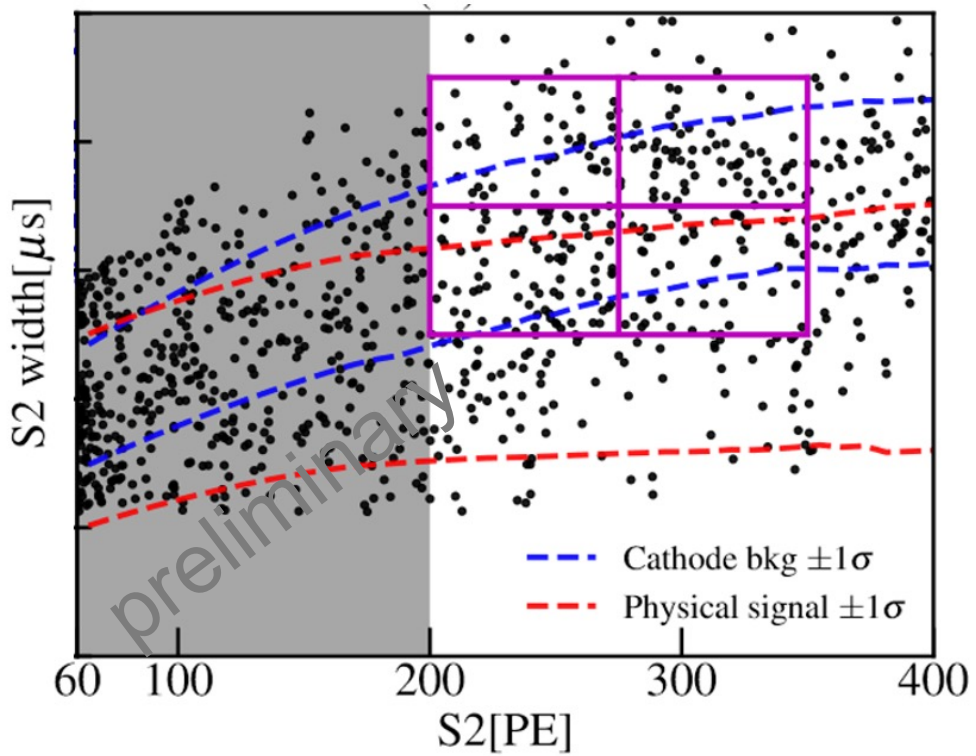
We assume the S2 only events after quality cuts are from the physical events and cathode events.

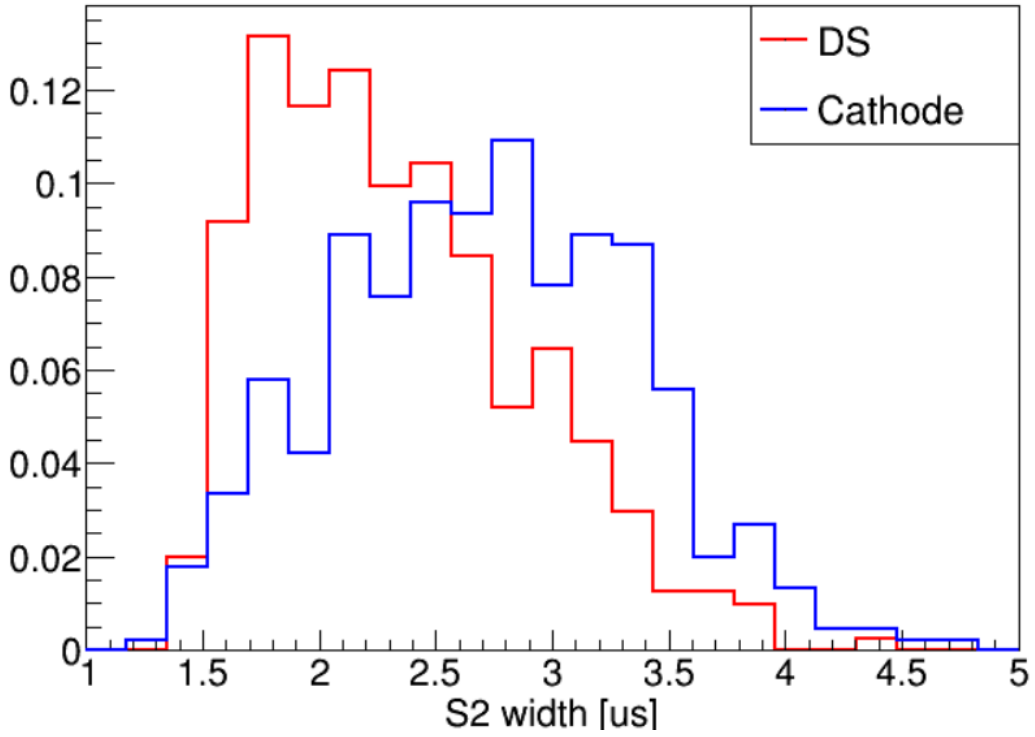
The ratio (S2 only cathode/paired cathode) is estimated: 0.36 ± 0.08.

PART THREE

Analysis in PandaX-4T experiment

—— cathode events estimation (Method 2)



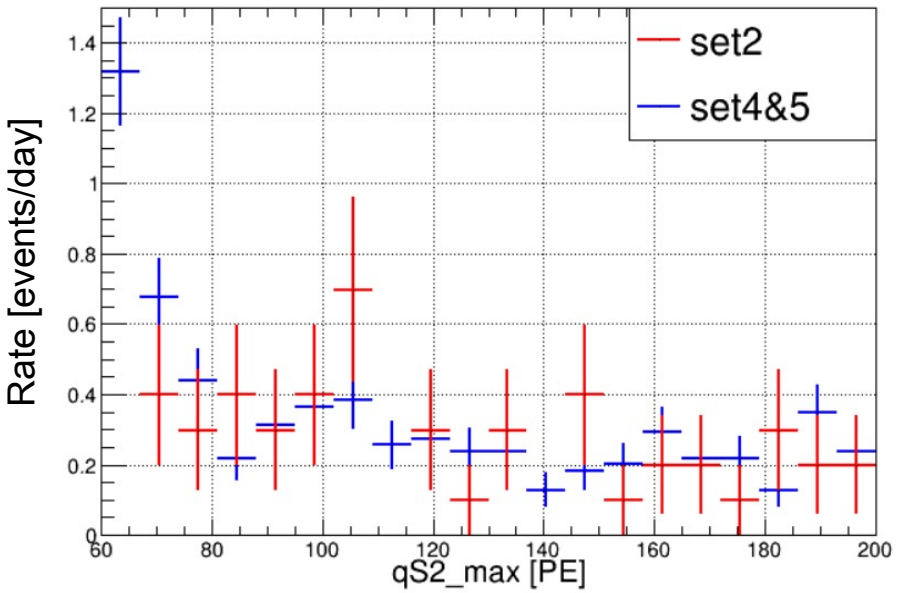


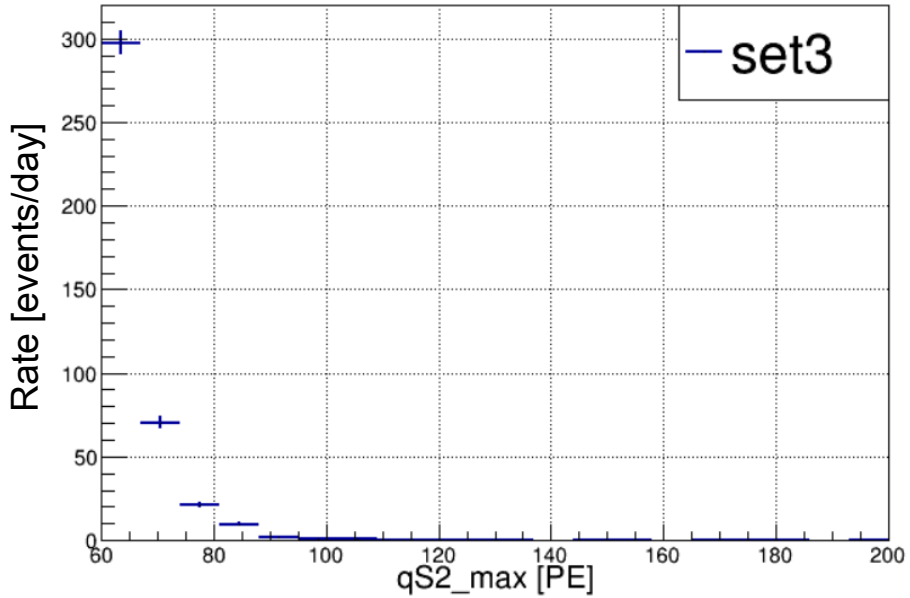
Cathode and physical events have the different width distribution which can be used to constrain the cathode background (ROI) in final statistic analysis.

PART THREE

Analysis in PandaX-4T experiment

—— micro-discharging(MD) events estimation

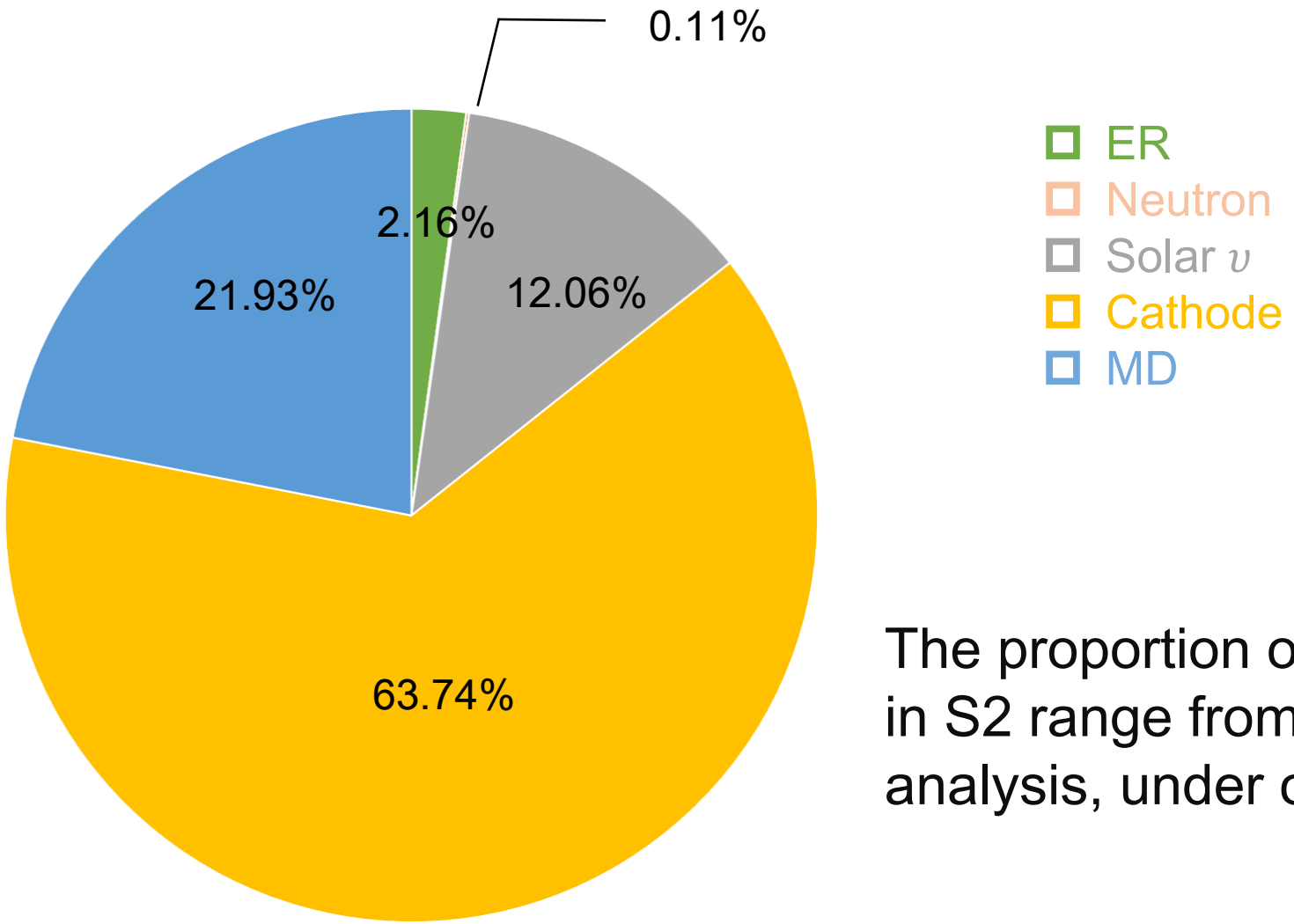




After unblinding, the exceed expectation events of small charge S2 was found. The exceed only happened at set4&5, which is after the typical spark set3. The spark events may be correlated with set3 sparking.
We get the MD estimation through building a spark model by using set3 data.

PART THREE

Analysis in PandaX-4T experiment



The proportion of background components in S2 range from 60 to 200 PE of this analysis, under optimized data selection.

PART FOUR

SUMMARY

- By studying the S2 only events, we reduce the threshold to search for light dark matter, using commissioning data from PandaX-4T liquid xenon detector.
- The small S2 of multiple scattering is used as the sample to study the cut and efficiency. Both the baseline and optimized data selections estimated using DS and WS samples.
- Cathode and MD background model are developed to handle the background composition with S2 only.
- The refinement of the background model and the final result of dark matter are in progress.


THANKS FOR
YOUR
ATTENTION !