Signal yield and field dependence study in PandaX-II experiment

Mr. Zhou HUANG
INPAC and School of Physics and Astronomy, Shanghai Jiao Tong University

Abstract
In this poster, I show the basic techniques searching for dark matter and the electron-recoil(ER) response of PandaX-II detector in different electrical field, which are the standards of a good detector. And I introduce the calibration sources that are used in my study. I also present the light yield at these fields as well as the NEST prediction. Comparing the event distribution, higher cathode voltage causes more uniform field.

Introduction
- It is believed that Dark Matter consists of 24% of the universe
- Three methods of Dark Matter detection: direct detection, indirect detection and detection in collider
- **PandaX** (**P**article **and A**strophysical **X**enon experiment) is one of the leading collaborations in direct Dark Matter detection.
- PandaX-II contains ~560kg LXe in fiducial volume. The upcoming PandaX-4T contains ~4 tons LXe in sensitive volume
- **TPC** (**T**ime **P**rojection **C**hamber) is the sensitive detector in our experiment which includes two critical electric field. Field intensities are ~5000V/cm and ~320V/cm for extraction field and drift field respectively

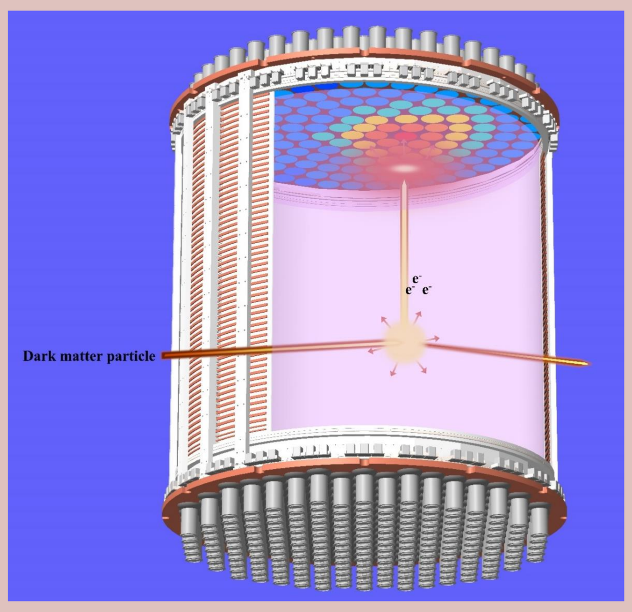

Fig 1: TPC diagram

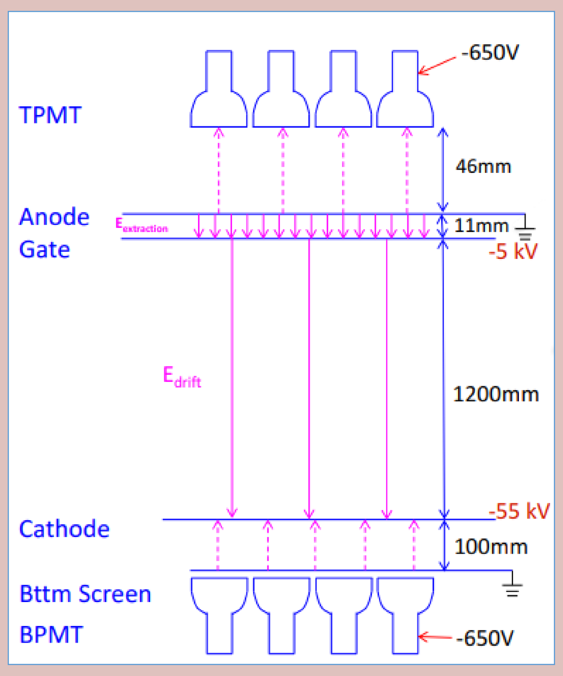

Fig 2: field configuration

Signal results comparison
- In PandaX-II, light yield results are consistent with NEST Model
- More calibration source will be used, like tritium Methane

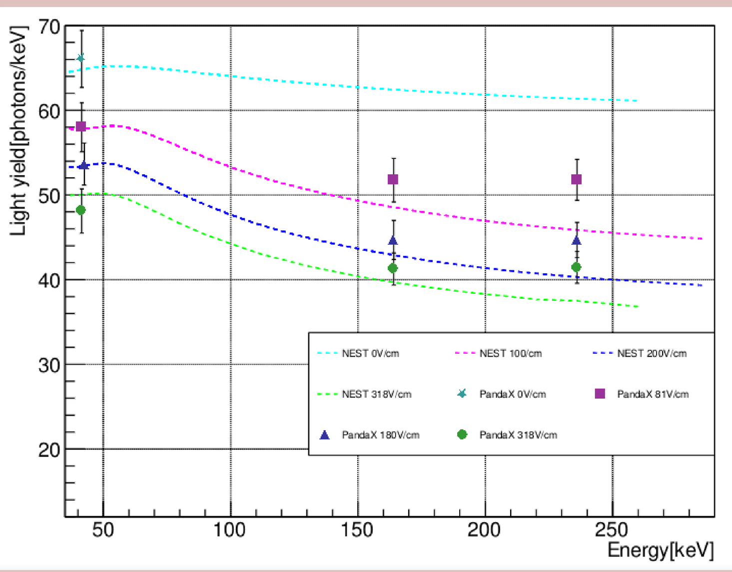

Fig 6: Light yield result, using PandaX-II detector

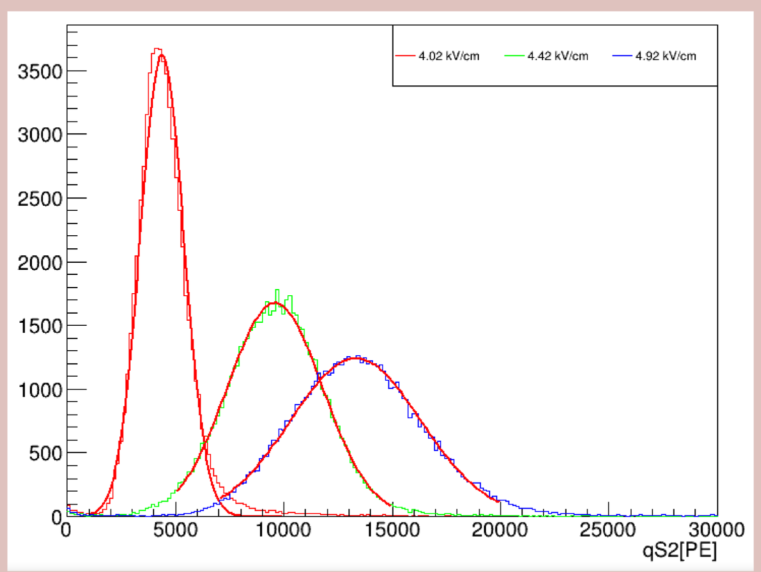

Fig 7: qS2 spectrum from krypton 83m events

- S2 resolution is extraction field dependent
- Higher extraction contributes higher EEE
- More electrons will be extracted and diffuse more

Acknowledgement
- The authors acknowledge the school of physics and astronomy of Shanghai Jiao Tong University for providing fundamental resources for experiments. This work was supported in part by a 985-III grant from Shanghai Jiao Tong University, grants from the National Natural Science Foundation of China (Grants No. 11365022, No. 11435008, No. 11455001,No. 11505112, and No. 11525522). All opinions and views in this paper are solely the responsibility of the authors and do not necessarily represent those of the sponsor organization.

Scintillation and ionization mechenism
- Scintillation signal S1, ionization signal S2 and heat signal (nuclear recoil only)
- Energy reconstruction principle
  - $E_{recomb} = L\, W_0\, \left({}^{S1}/_{PDE} + {}^{S2}/_{EEE\times SEG} \right)$
  - Lindhard factor L = 1 (electron recoil)
  - W_0 = 13.7 eV
  - Photon detection efficiency ()
  - EEE
  - SEG

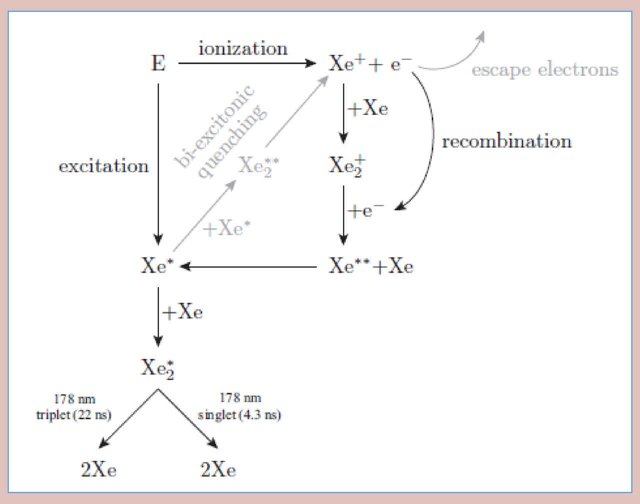

Fig 3: signal production

Calibration source
- Using mono-energy source to calibrate our detector
- Two internal source: krypton 83m and activated xenon (cosmic ray induced)
- 41.5 keV event from krypton 83m
- 164 keV event and 236 keV event from activated xenon (EC process considered)

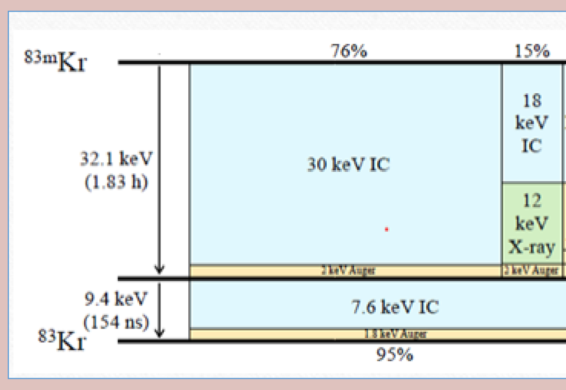

Fig 4: decay scheme of krypton 83m [1]

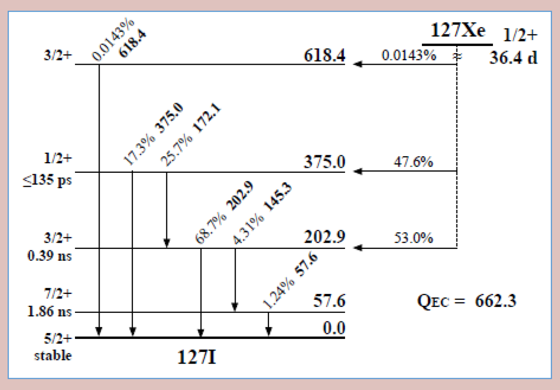

Fig 5: decay scheme of xenon 127 [2]

Event distribution in different fields
- Krypton 83m event distribution in the whole TPC
- It can be easily seen that lower cathode voltage case will cause more wrong reconstructed events

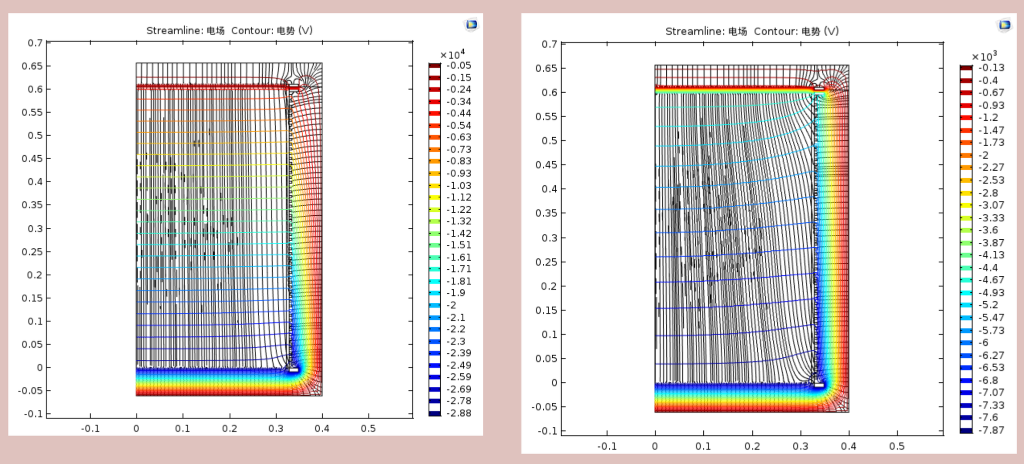

Fig 8: electric field simulation in COMSOL. Left is -28.8kV voltage case, right is -7.8kV case. The electric field is more uniform in the left case

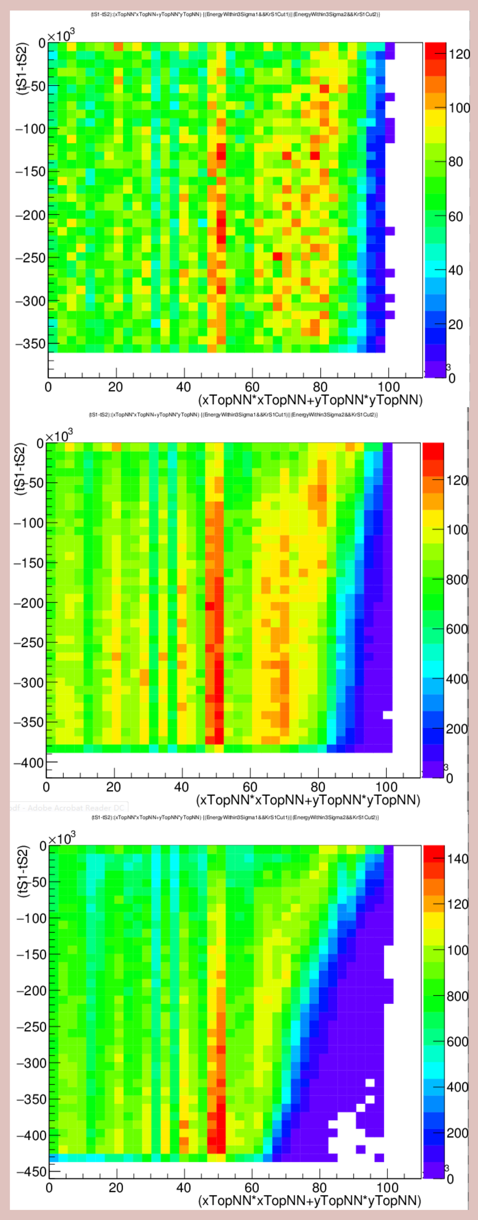

Fig 9: Kr 83m event distribution in different drift field. 318V/cm, 180 V/cm, 81V/cm, from top to bottom respectively.

Summary & reference
- PandaX-II detector performs good in 318V/cm drift field and 4.42kV/cm extraction field
- PandaX-II detector's signal yield is consistent with NEST model

[1] arxiv: 1708.02566 [2] arxiv:1403.1299