Simulations in PandaX

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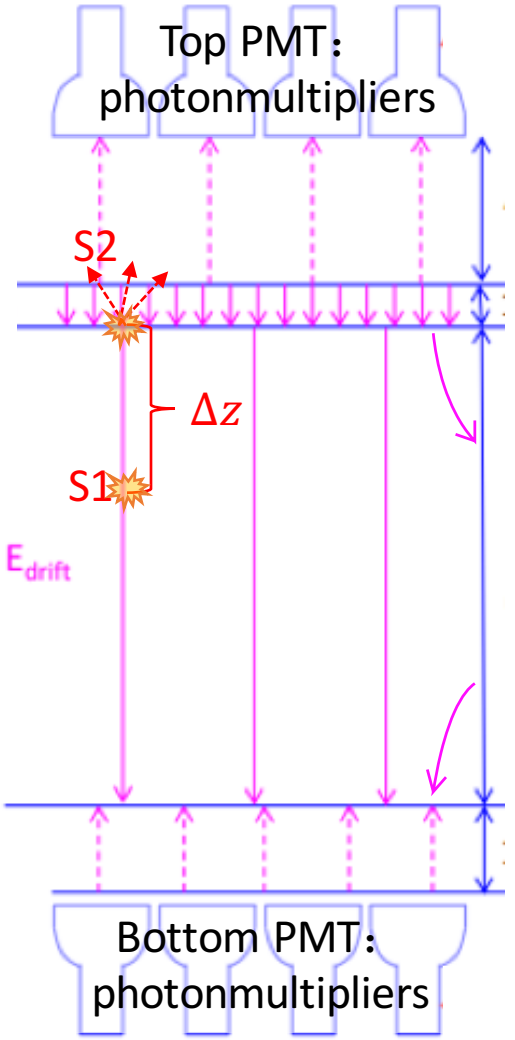
On the behalf of PandaX Collaboration

General scope

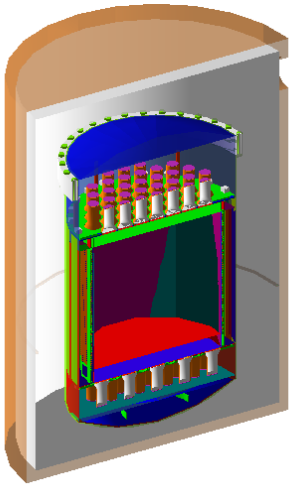
1. Energy deposition & kinetics
   - Recoiling energy spectrum, dR/dE
   - Stopping kinetics of particles
   - Energy spectrum + BambooMC (kinetics)
2. Light/charge signal model
   - Energy -> (excitation, ionization, heat) -> (S1, S2)
   - NEST1.0
3. Photon collection
   - Horizontal position reconstruction
   - BambooMC
4. Waveform



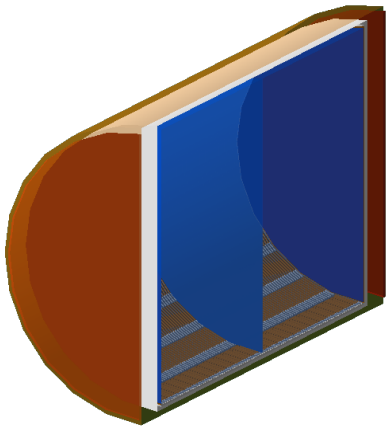
Platform - BambooMC

https://github.com/pandax-experiments/BambooMC

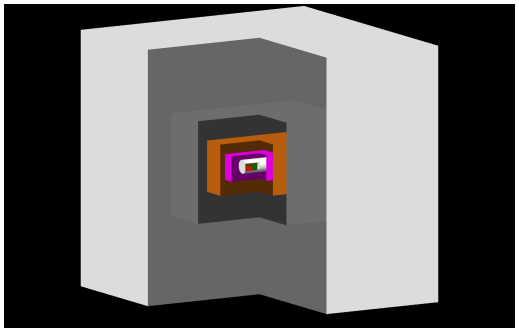
- Geant4-based Monte Carlo simulation program
- Structure
  - Generator
  - Detector Geometry and Material
  - Physics Analysis
- Integrate with other simulation toolkit



PandaX-I, II, 4T dual-phase liquid xenon detector



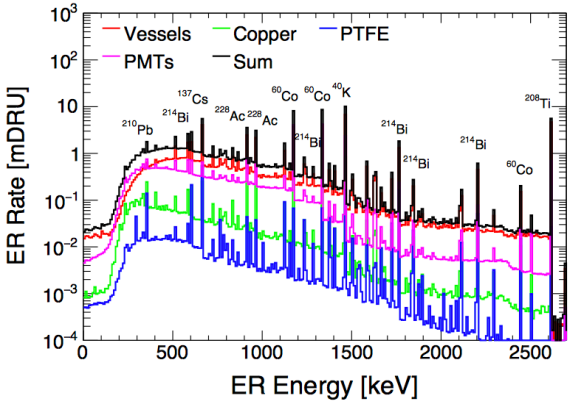
PandaX-III gaseous xenon detector

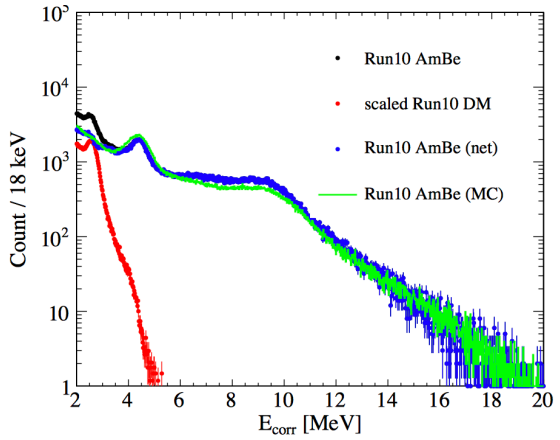


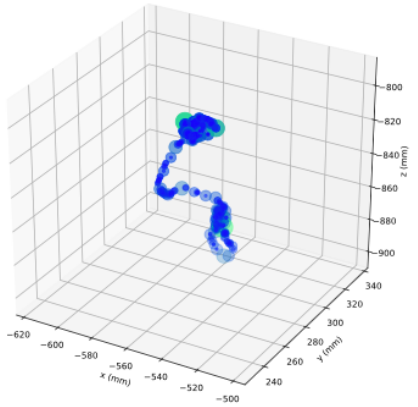
PandaX germanium counting station

1. Energy deposition & kinetics

- Electron recoil backgrounds in DM search
  - GEANT4 gps generator
  - Hongguang Zhang et. al., PandaX-xT sensitivity estimation (2018)
- Neutron backgrounds in DM search
  - JENDL database (neutron energy spectrum) + BambooMC (kinemics)
  - Qiuhong Wang et. al., Neutron background in PandaX-II (2019)
- Neutrinoless double beta decay
  - DECAY0 (kinetic energy of two outgoing electrons) + BambooMC (kinetics for the track in gaseous xenon)
  - Qiao Hao et. al., Signal-background discrimination in PandaX-III (2018)

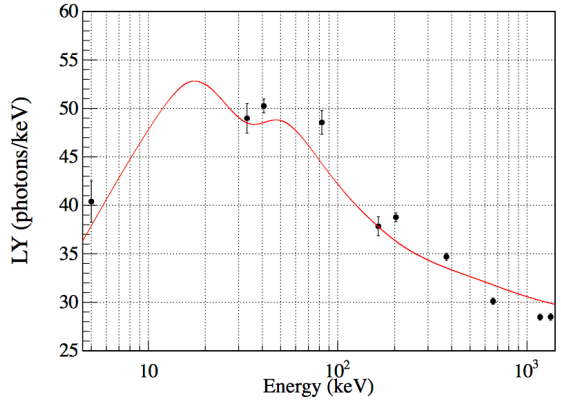


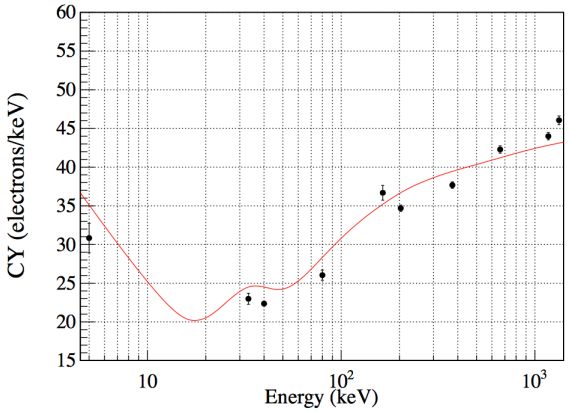




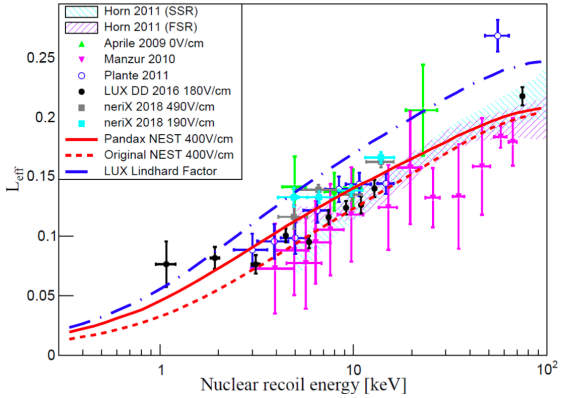
2. Light/charge signal model

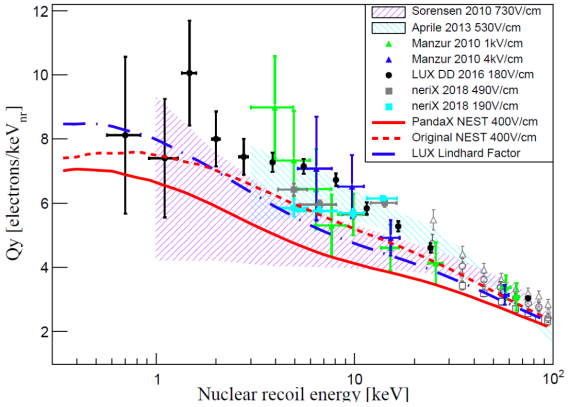
- PandaX-II uses NEST1.0
  - Andi Tan et al. (PandaX-II Collaboration) Phys. Rev. Lett. 117, 121303 (2016). Supplements
  - Brian Lenardo et al. (NEST) IEEE Tran.s on Nucl. Sci. (2014)
- CY or QY – charge yield, L – charge yield





Electron recoil:
red NEST1.0 prediction,
black dots – data



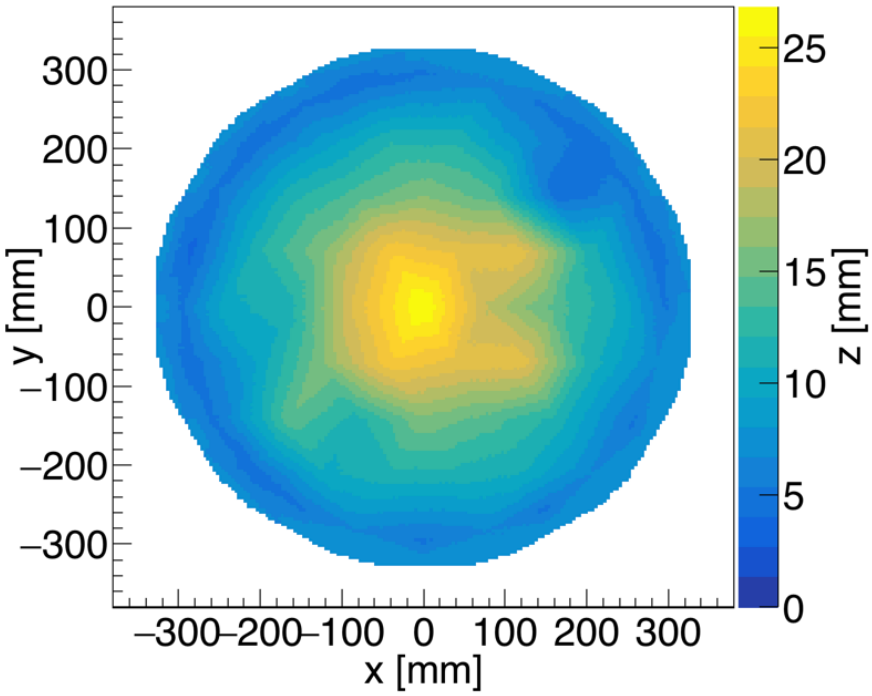


Neclear recoil:
low energy single scattering events

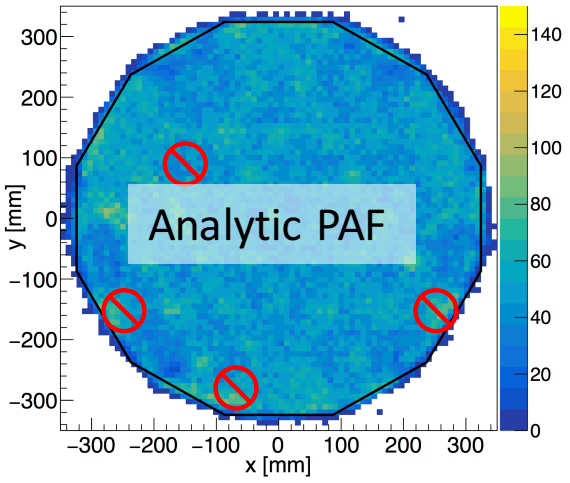
3. Photon collection process

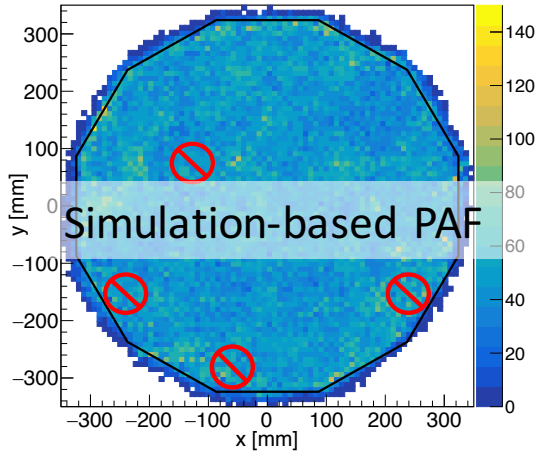
To be published

- Tune gaseous scattering points of S2, z, as a function of (x,y)
- Mitigate clustering under PMT center
- z=0 corresponds to liquid-gas interface



^{83m}Kr data in PandaX-II





Challenges

- Discussion 1:
- Lack of integrated low energy spectrum toolkit (E<100 keV)

- Discussion 2:
- How fast can we reach with a GPU based GEANT4?
- Time-consuming data transmission between host and device

Thank you!