

Direction-sensitive dark matter search using lower pressure gaseous TPC

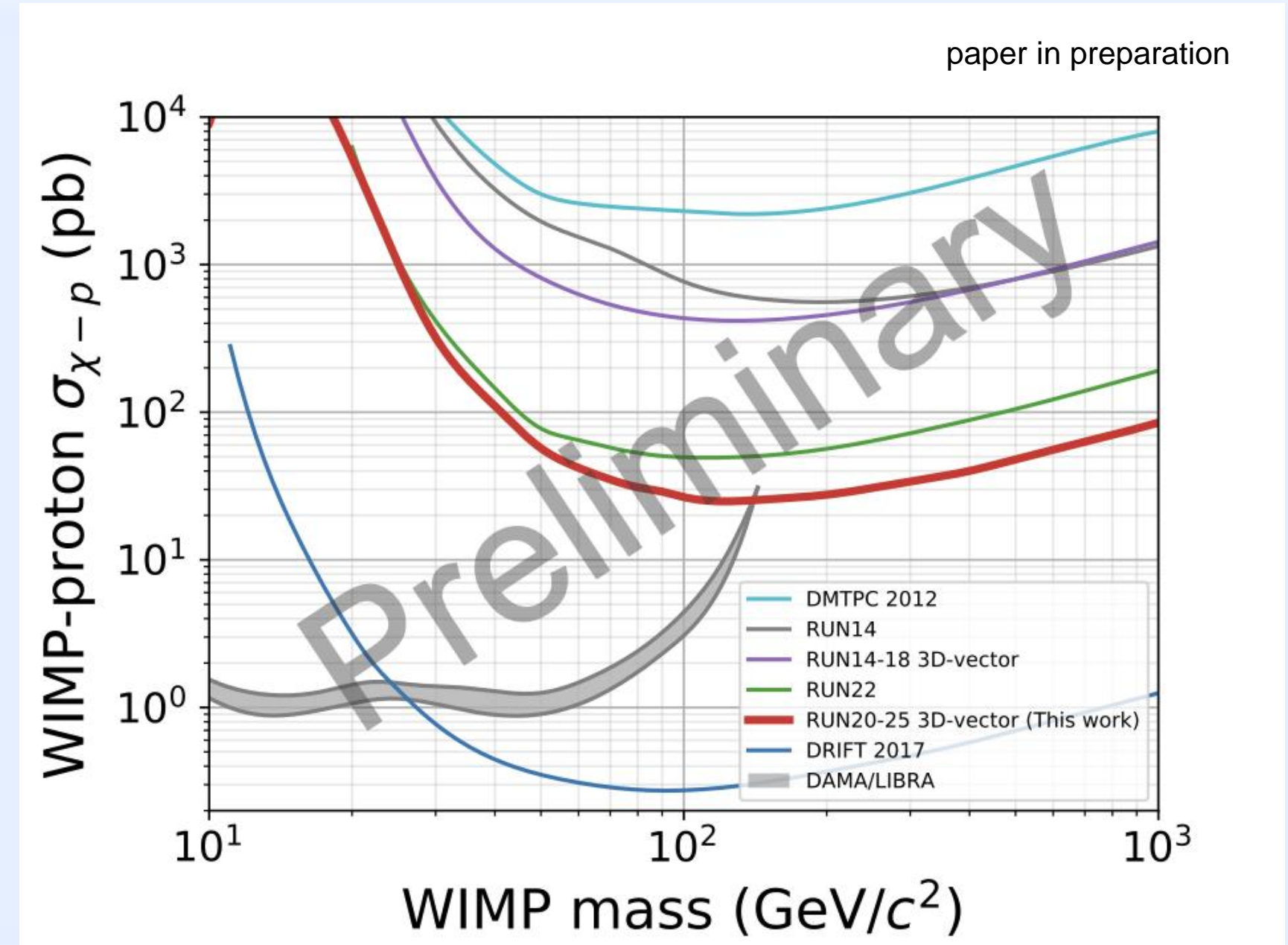
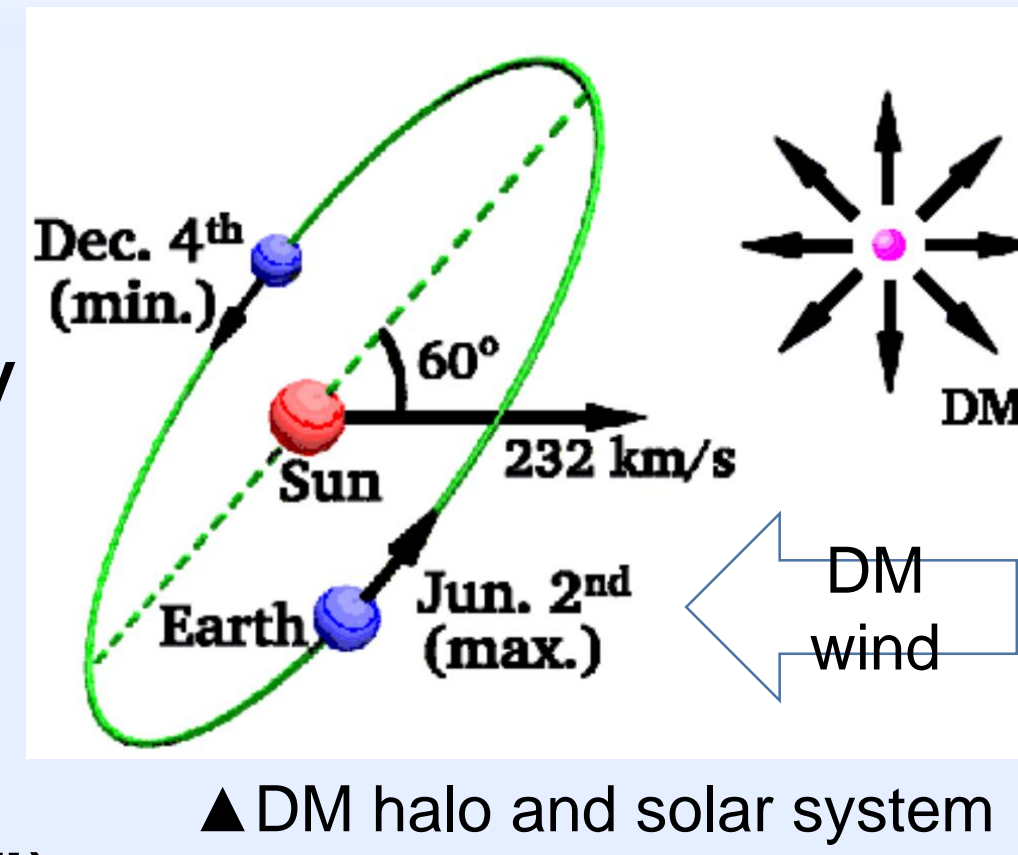
Ayaka Nakayama

Kobe Univ. on behalf of NEWAGE group

2022/6/13-15 UGAP2022

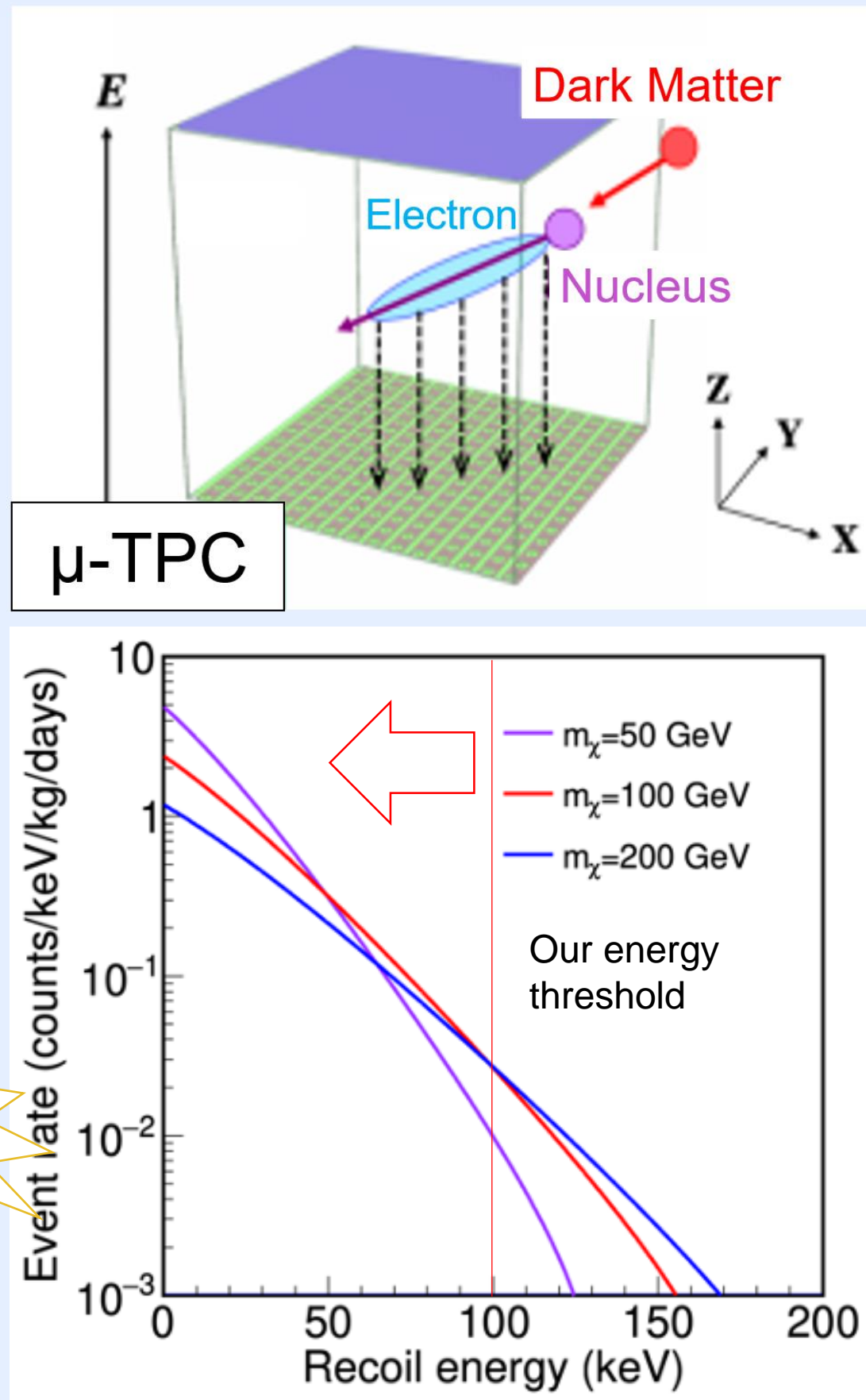
Introduction

- What is dark matter ?
 - Existence proven by astronomical observations and cosmology
- Direct dark matter search with directionality
 - Dark matter exists in the Milky Way Galaxy
 - Solar system moving in the Galaxy receives dark matter from the direction of movement ("Dark matter wind")
- NEWAGE
 - Direction-sensitive search by measuring scattering angle of nuclear recoil



Detector

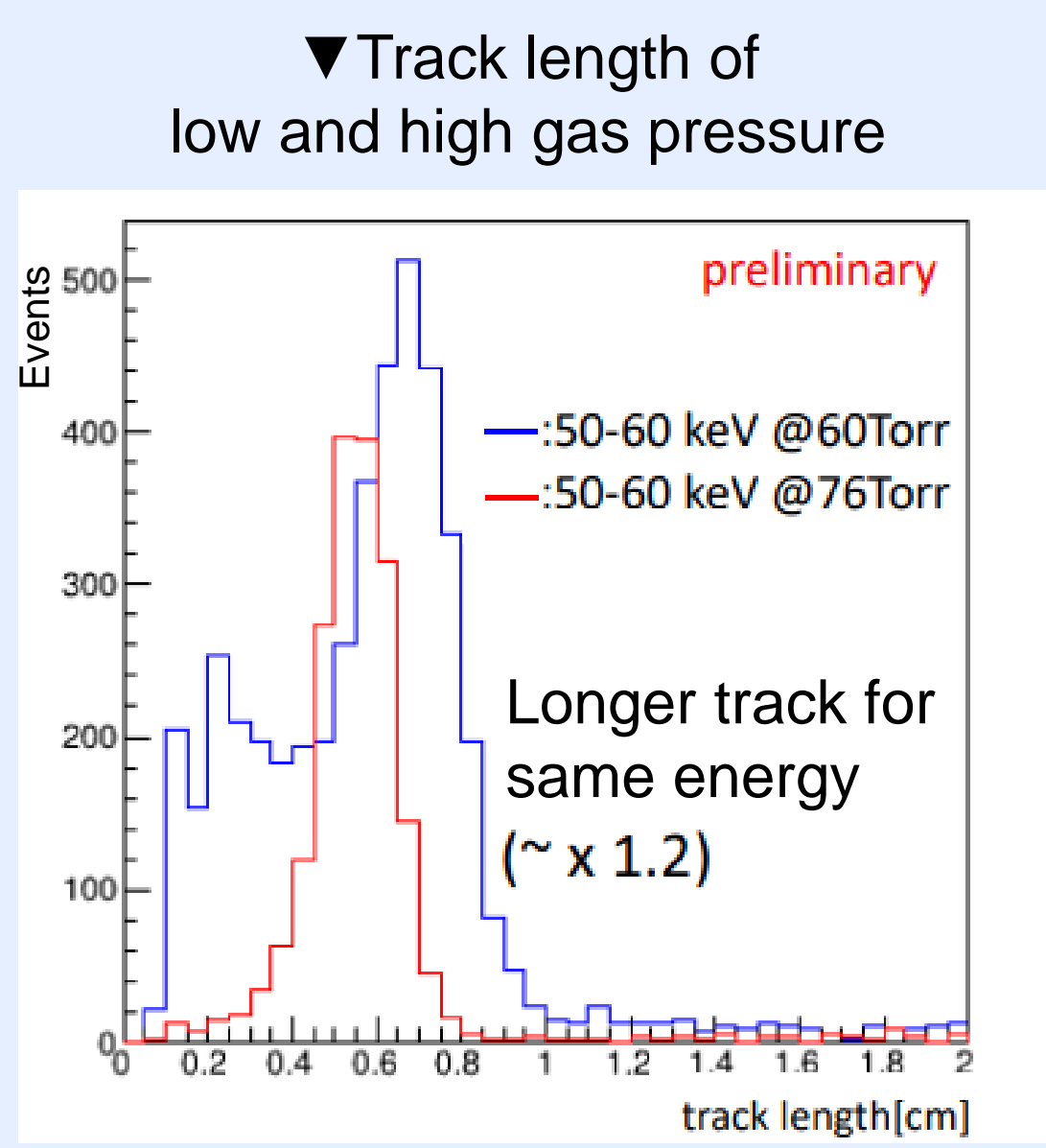
- Measurement at Lab-B in Kamioka
 - CF₄ gas
 - 30x30x40 cm³
 - 2D strip readout with 400 μm pitch (μ-PIC)
- Count rate of nuclear recoil is higher for lower energy
 - Especially for low mass DM
- We need lower threshold
 - ← Limited by track length
 - ← Limited by gas gain



My topic!

1. Lower pressure gaseous TPC

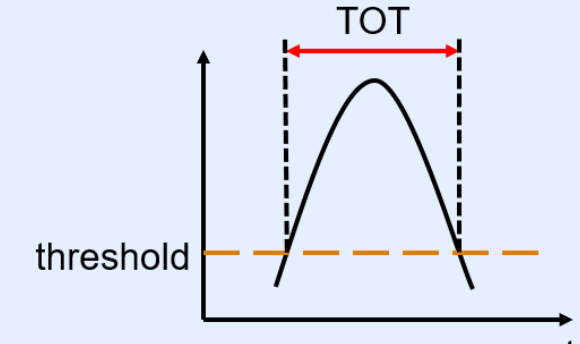
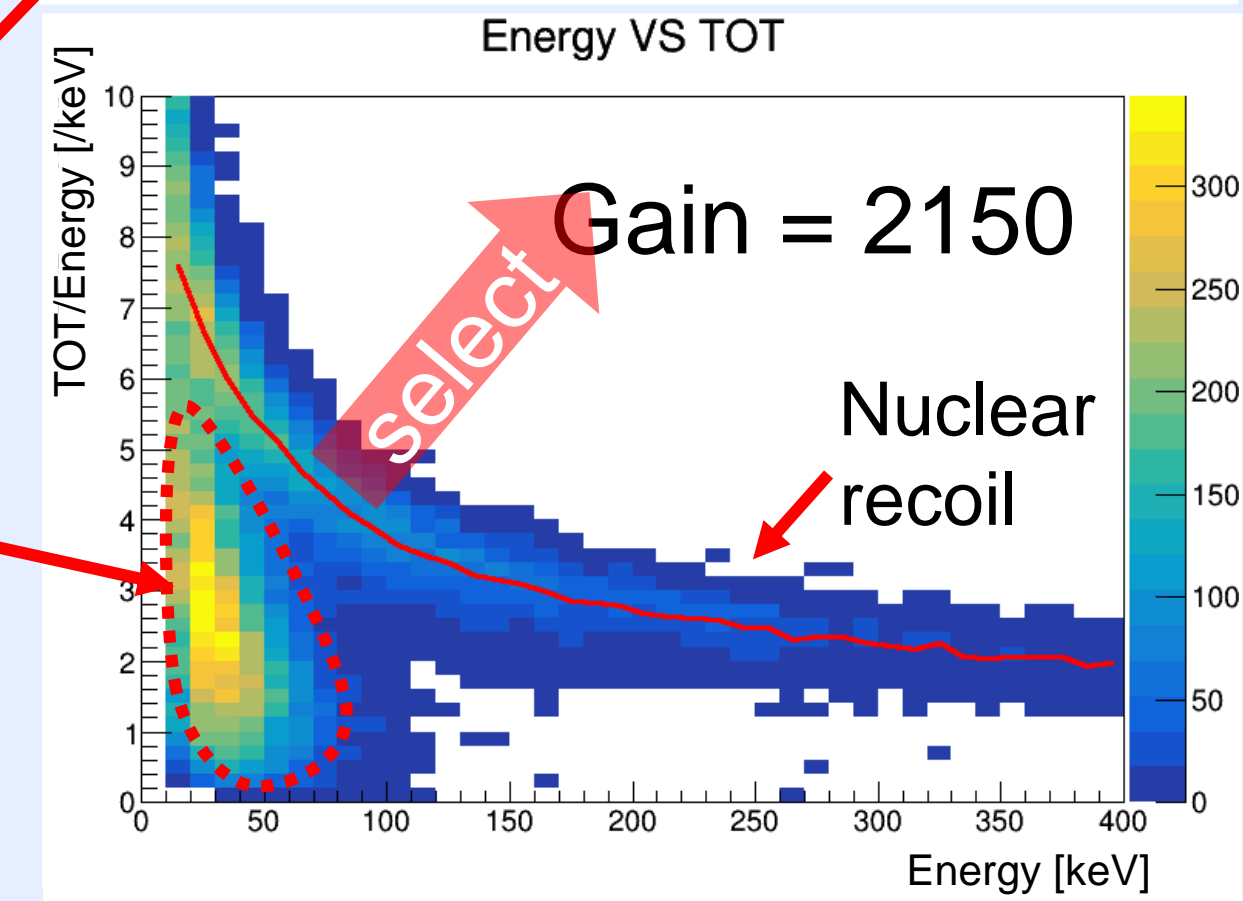
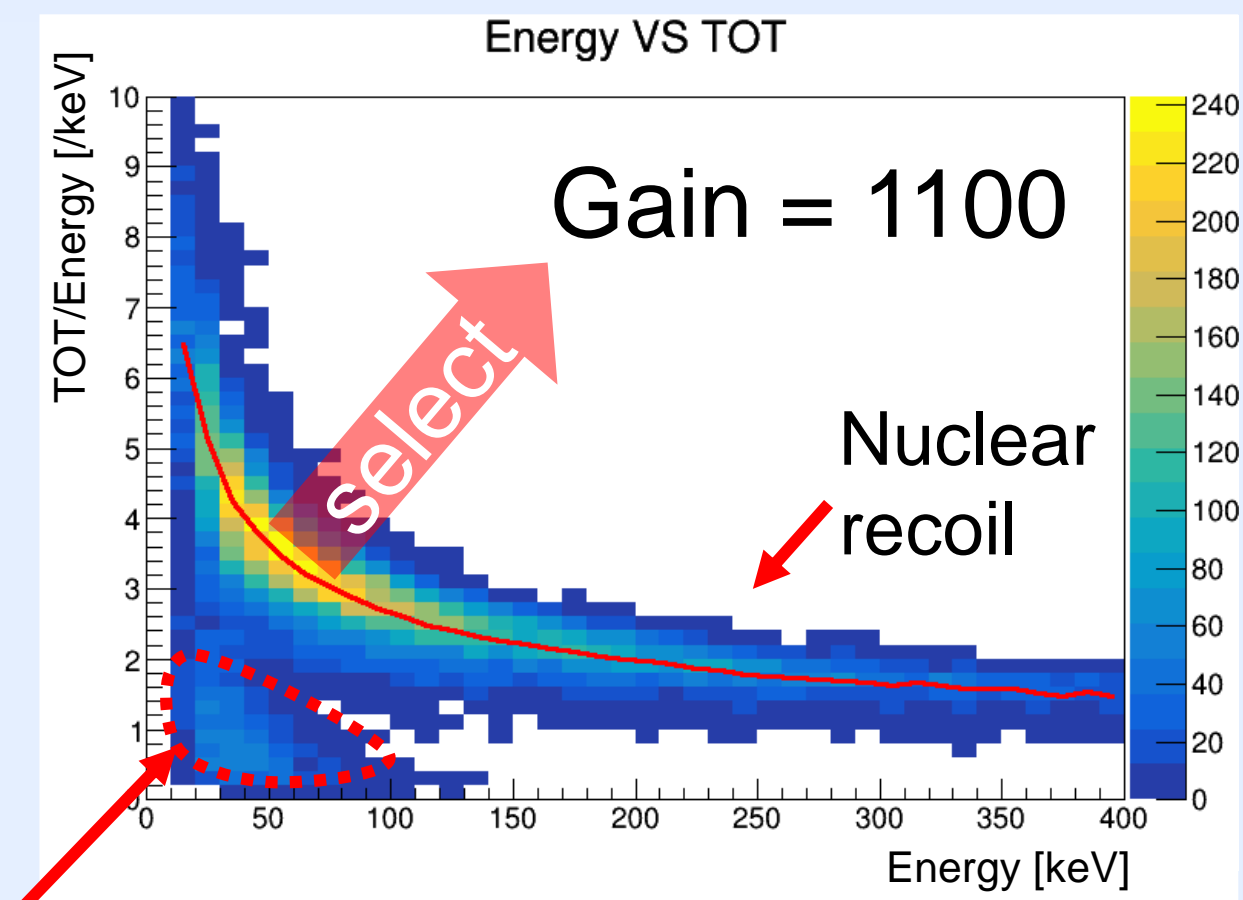
- Gas pressure : 76 → 50 torr
 - Allows lower energy event reconstruction
 - Threshold improvement is expected



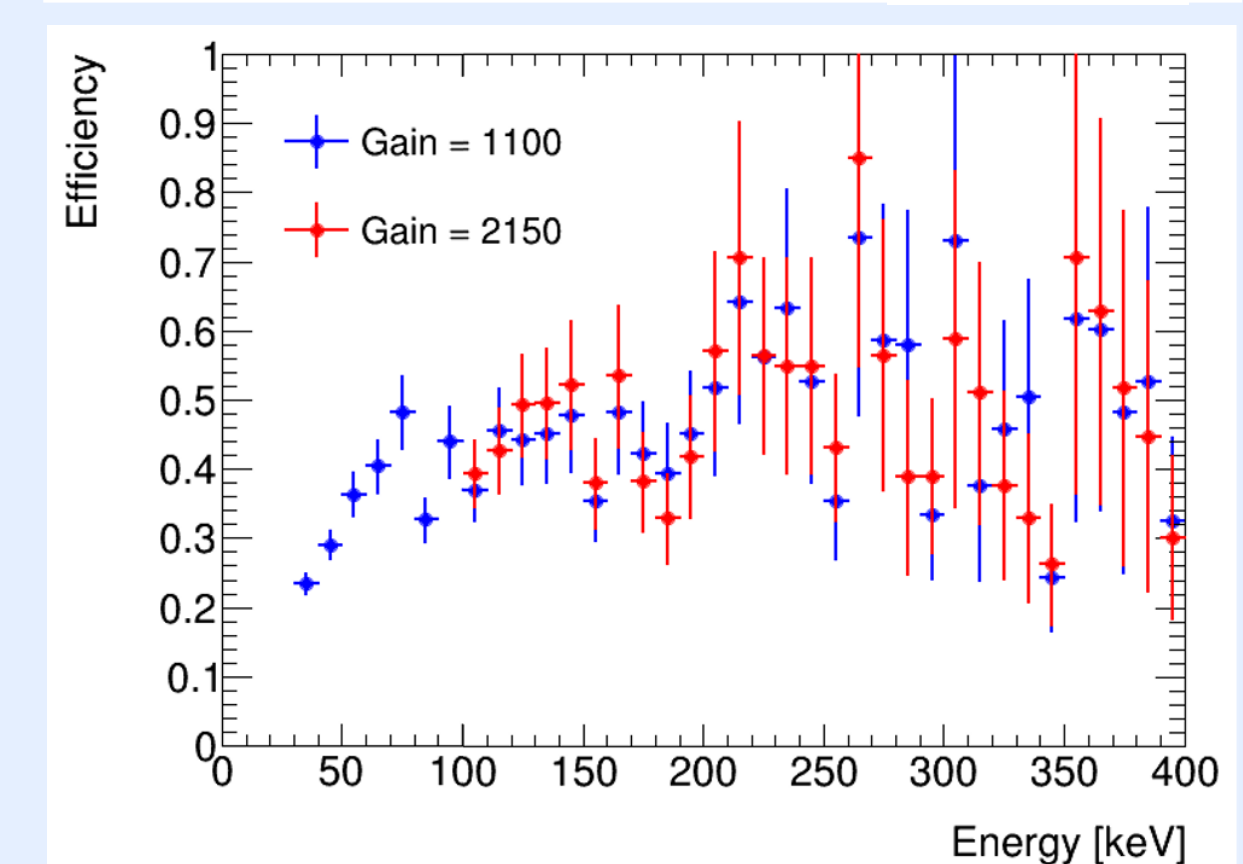
Ishiura, Kobe University JPS Autumn meeting, Sep 2020

2. High gas gain operation

- Measurement of Efficiency using a neutron source (²⁵²Cf)
 - Operation at a high gas gain to improve efficiency for low energy events
 - 50 keV threshold to be lowered
- Electron recoil rejection
 - Track length cut
 - TOT/Energy cut



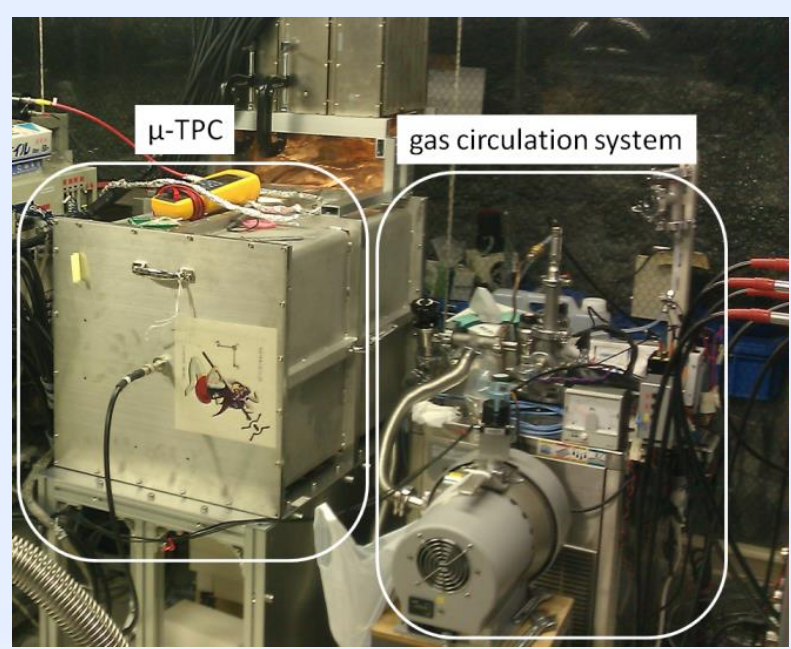
- Efficiency of nuclear recoil reaches plateau at >100 keV
- High gain : electron recoil events contaminate nuclear recoil events at <100 keV
- Low gain : lower efficiency, but pure nuclear recoil events are successfully selected



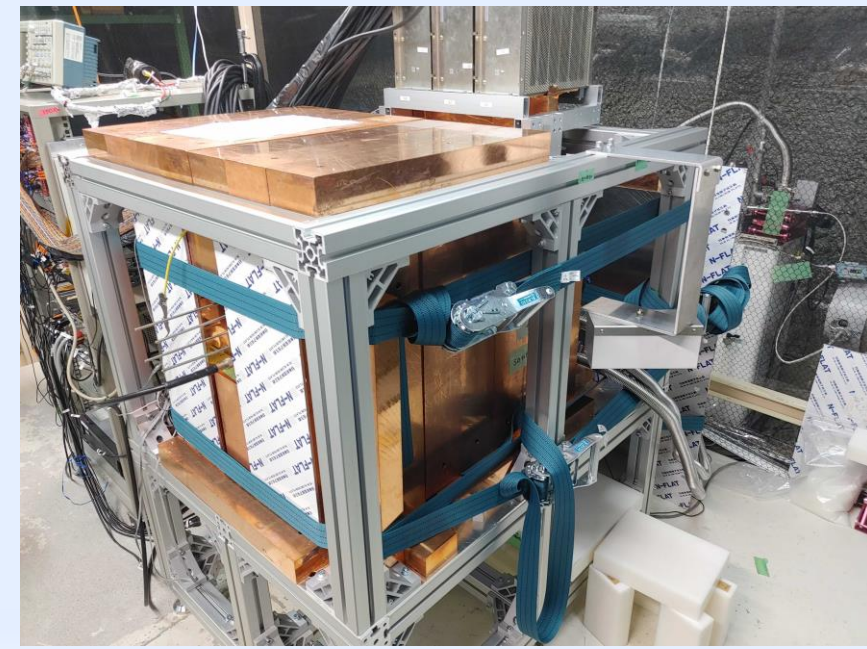
- Best gain selection
- Gamma rejection improvement

3. Cu shield

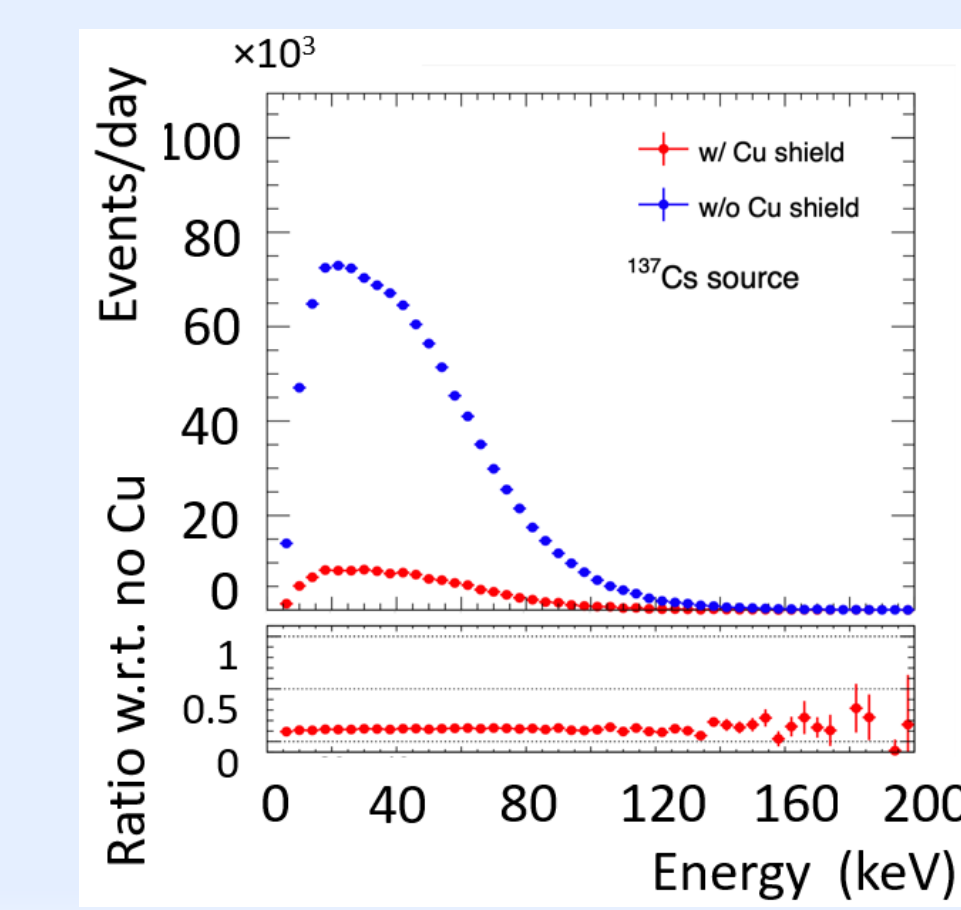
- Installed to reduce ambient gamma



+ Cu shield



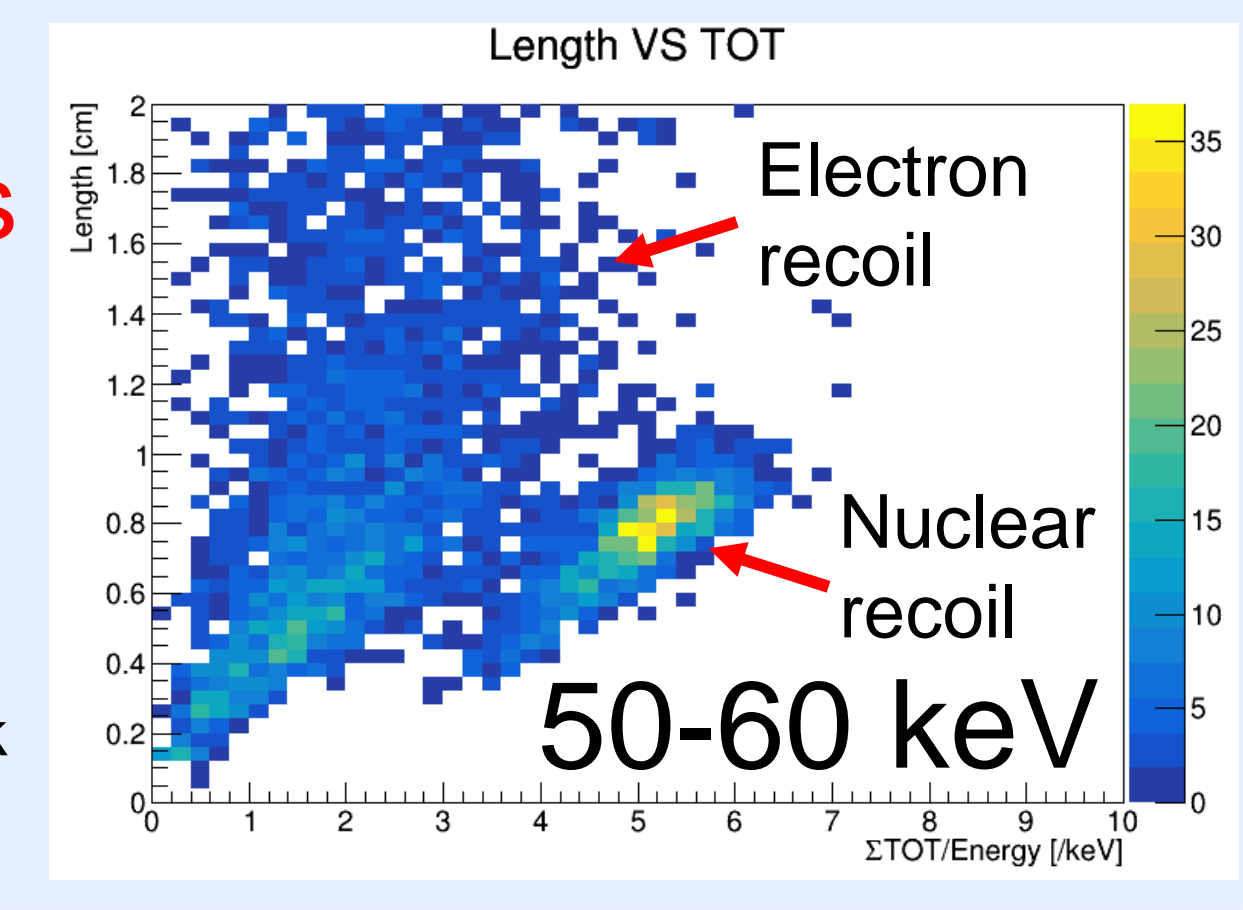
Gamma rejection by copper shield



NEXT STEP

- Additional event selection is needed to reduce more gamma BG

e.g. correlation between track length and TOT

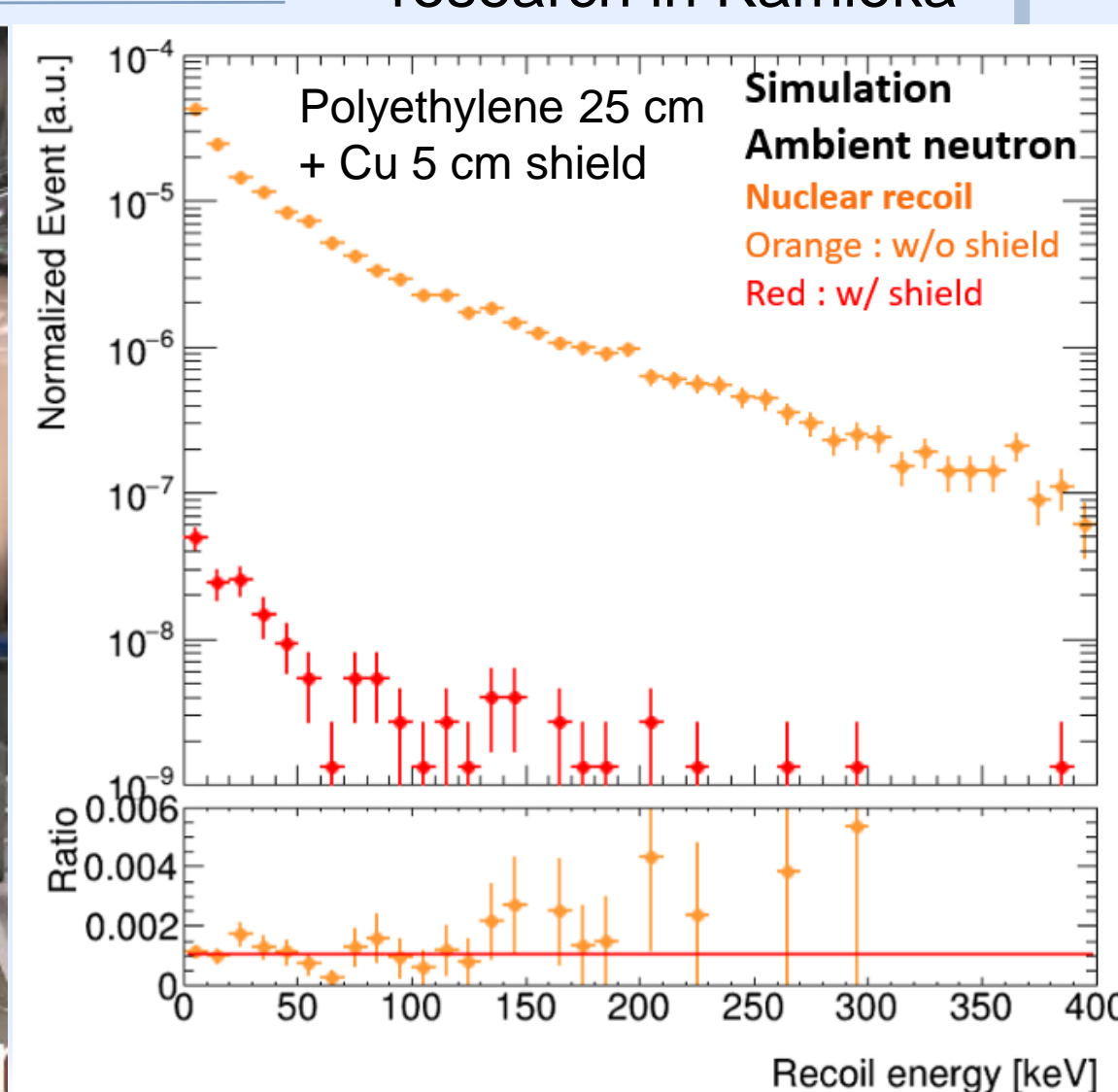
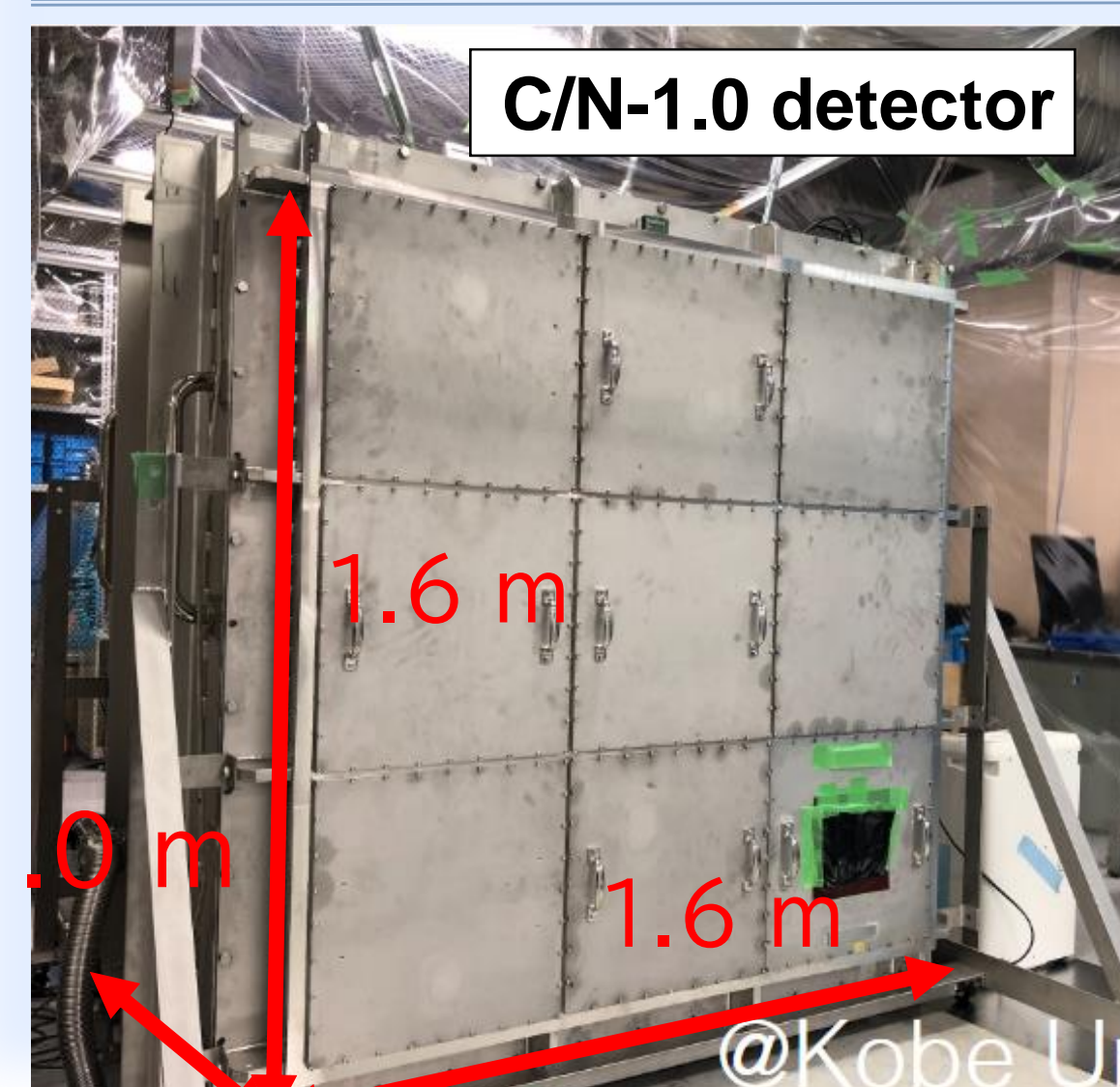


C/N-1.0

- C/N-1.0 : Large detector we're going to install in Lab-B in Kamioka

External BG	Counts/100 days
Ambient gamma	27
Ambient neutron	6.3

◀ The number of expected BG events for C/N-1.0 in the energy region of 50-60 keV from prior research in Kamioka

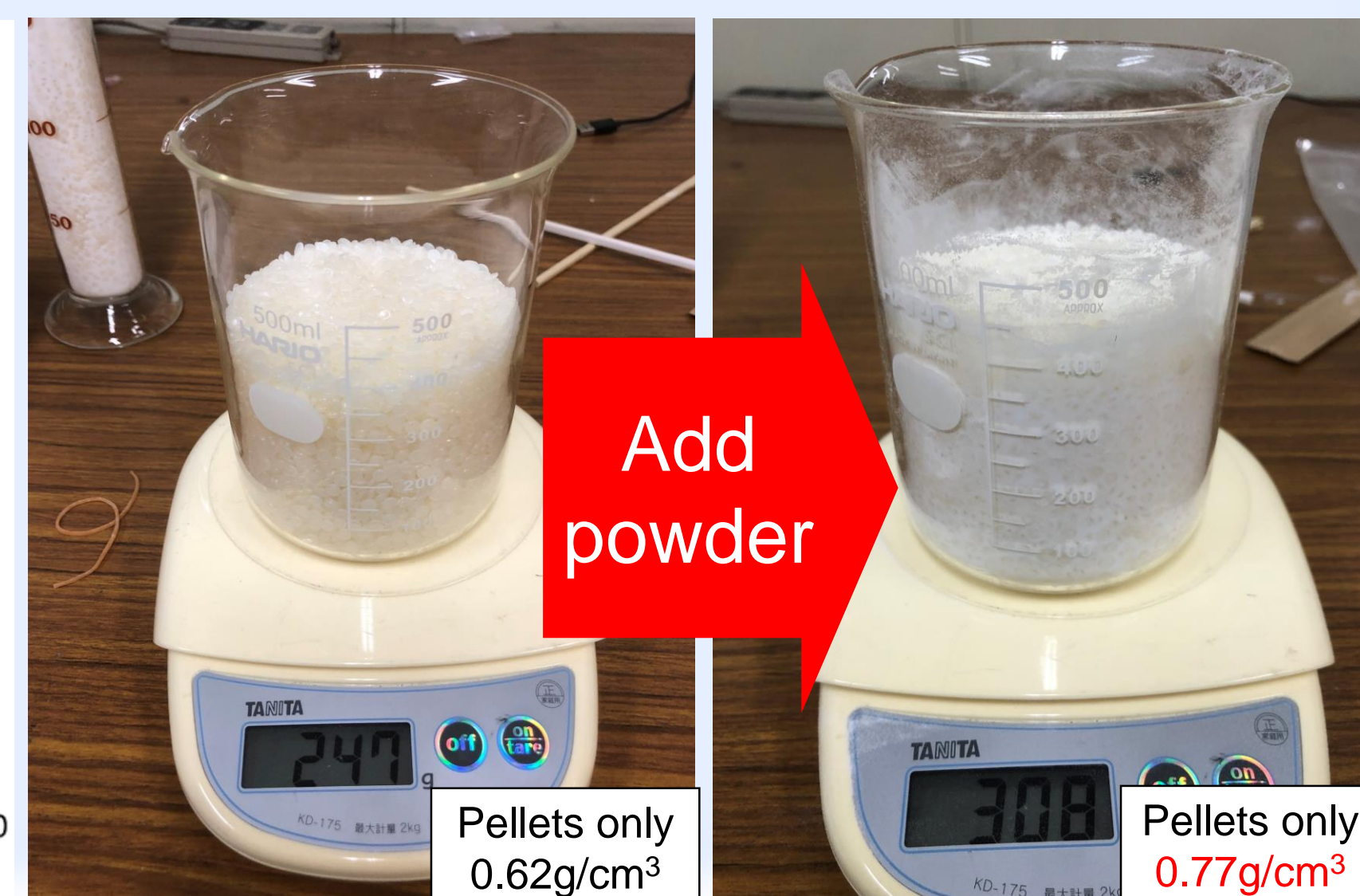
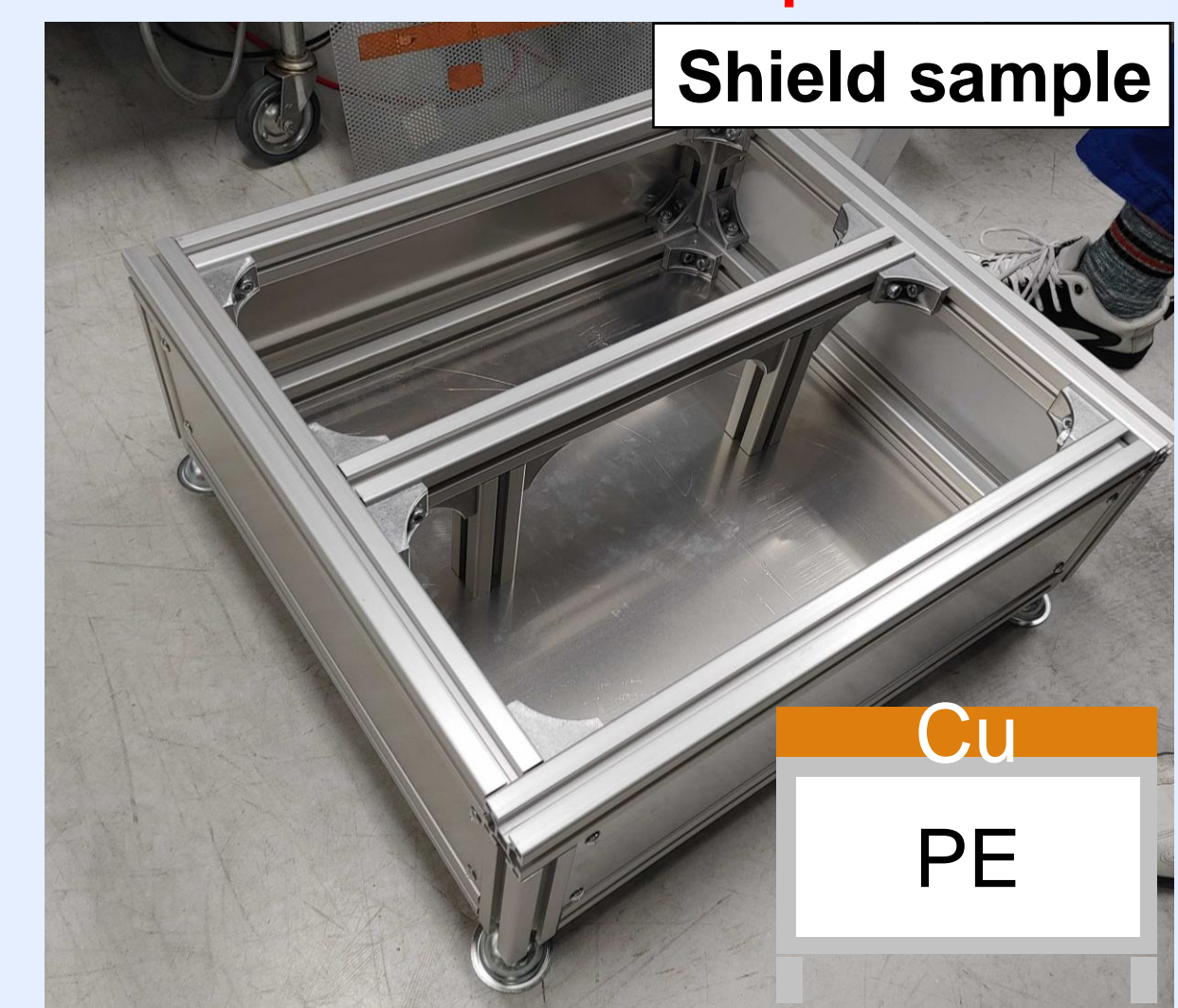


Large shield

- External BG reduction by shielding with...
 - Copper for Gamma
 - Polyethylene (PE) pellets for Neutron
- Rejection power is estimated by simulation, but...
 - Density (Block) 0.92 g/cm³
 - ← pellets 0.62 g/cm³
 - ← pellets + powder 0.77 g/cm³

Particle size 60 μm
¥ 1,100 /kg

Shield under development !



Summary

- We need lower energy threshold
 - Trying low pressure gas, high gas gain and Cu shield
 - Additional event selection needed
- C/N-1.0 shield under development
 - Decided to use PE pellets + PE powder