Progress of upgrading alpha-ray imaging detector in low radioactivity background

H. Ito¹, H. Ishiiura², K. D. Nakamura³, and K. Miuchi²
¹Tokyo University of Science, Chiba, Japan
²Kobe University, Hyogo, Japan
³Tohoku University, Miyagi, Japan
*ito.hiroshi@rs.tus.ac.jp

Abstract: In underground particle physics, current detectors are required massive volume of target using ultra-pure material. Uranium or thorium impurities on the surface of the detector could be reduced fiducial volume and produced background source via emanation radon. So, α-ray imaging detector based on µ-TPC in a low BG has been developed to screening the material surface.

1. Alpha-ray Imaging Chamber (AICHAM)

2. µ-PIC: macro-pixel chamber

- Readout of anode (x) and cathode (y) simultaneously.
- 400 µm pitch strips
- Low-α µ-PIC developed by replacing PI to epoxy material, in order to reduce surface α emission.

3. Demonstration of Alpha-ray imaging measurement

- Condition -
  After installing cooled charcoal system. Masked PCB
  Not replacing new field cage in this time.
- Current Performance -
  Energy Resolution: \( \alpha_e = 7\% @ 5.3 \text{ MeV} \)
  Position Resolution: \( \alpha_p = 7 \text{ mm} \)
  Sensitivity: \( \sim 10^{-3} \text{ a/cm}^2\text{hr} \)
  @1 month measurement
- Unique point -
  1. Several samples can be measured in same time.
  2. Since the BG data has been taken simultaneously, sys. uncertainty for gas condition can be canceled out.
  3. Calib. source is put at edge in order to monitor gas status depending on a time.

4. Progress of Upgrading

(1) Installing Cooled Charcoal System

One month measurement
Unit: \( \times 10^{-3} \text{ a/cm}^2\text{hr} \)
ON: 0.765±0.02
OFF: 0.17±0.01

Alpha-ray rate from Rn was suppressed to 1/4.

(2) Suppressed PCB α-ray

- PCB: Print Circuit Board includes of glass fiber, with U/Th radioimpurities, alpha rays emitted at edge of fiducial area.
- The red shade area is masked then the alpha rays were shield.
- We compared image before and after the mask, and the edge events are reduced but it will be more suppressed in next plan.

(3) New field cage replacement

- New field cage was designed as a half length of previous height, \( h_{new} = 15 \text{ cm} \).
- Remained radon would be reduced to half, and diffusion due to the drift would be small, i.e., S/N and the position resolution would be improved.
- Replacement has been completed in this summer, and the performance test after the replacing is ongoing.

5. Conclusion

- We have been developing alpha ray imaging detector based on µ-TPC in low radioactivity background.
- The detector has been upgrading and the performance estimation is ongoing after the add new system.
- In parallel, the sample measurement have been done, e.g. MPPC and reflector sheet.