

K-GBAR Meeting (CUP, IBS)
(28 July 2016)

Simulation of TOF system

Jongwon Hwang (SNU)

Outline

- Purpose
- Setup: Setup, Beam, Physics
- Progress: Cosmic-ray effect, Secondary particle study, ...
- To-do

Purpose

- Simulate the reactions of an anti-p or a anti-H.
- Check the efficiency and the resolution.
- Check the effect from background (e.g. cosmic rays).
- Help to determine the setup geometry of the detectors.

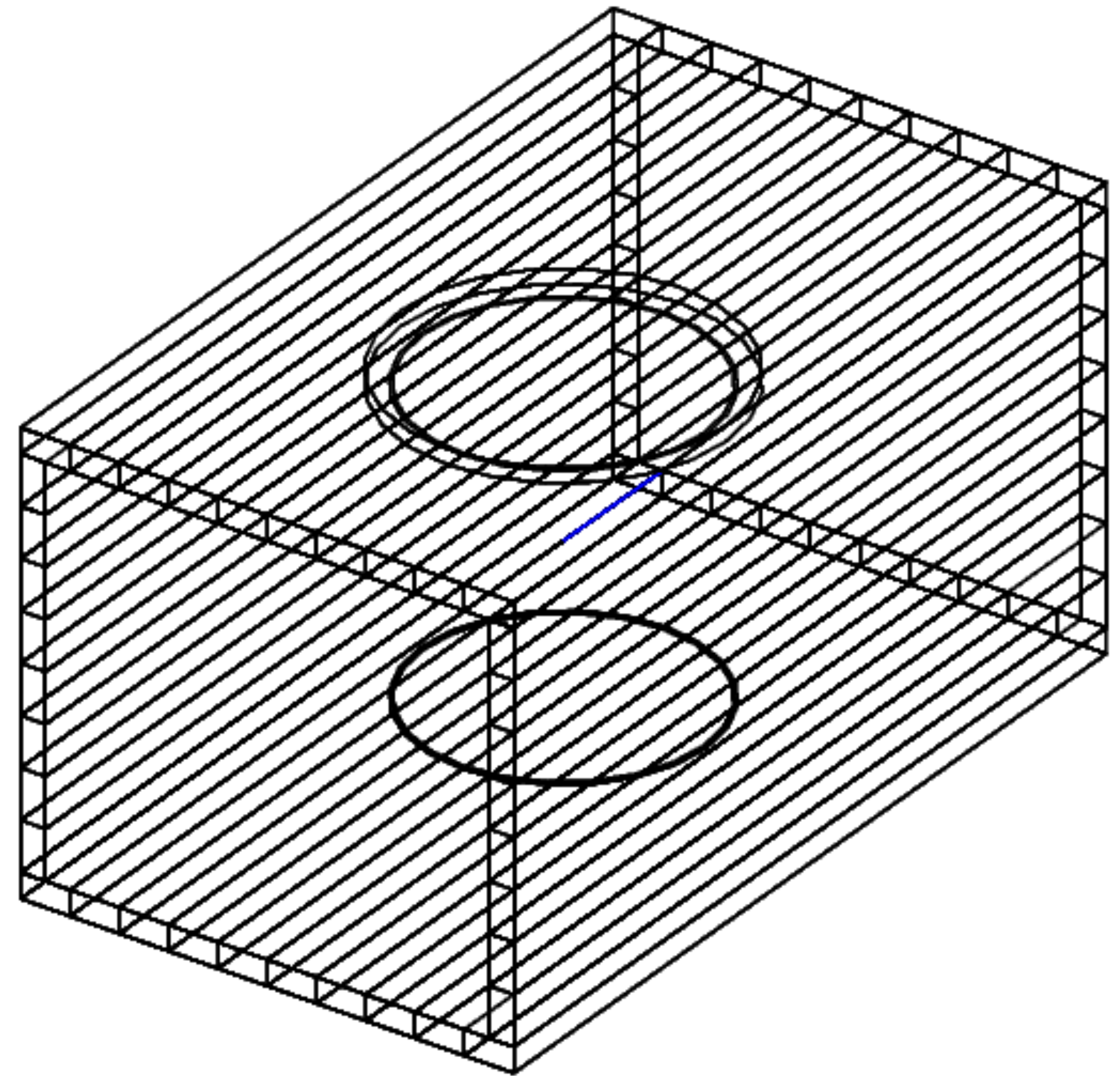
Setup: Geometry

- **Chamber**

- A cylinder of SUS
- $r = 29\text{ cm}$, $l = 60\text{ cm}$, $t = 6\text{ mm}$
- Top: $t = 30\text{ mm}$ / Bottom: $t = 3\text{ mm}$

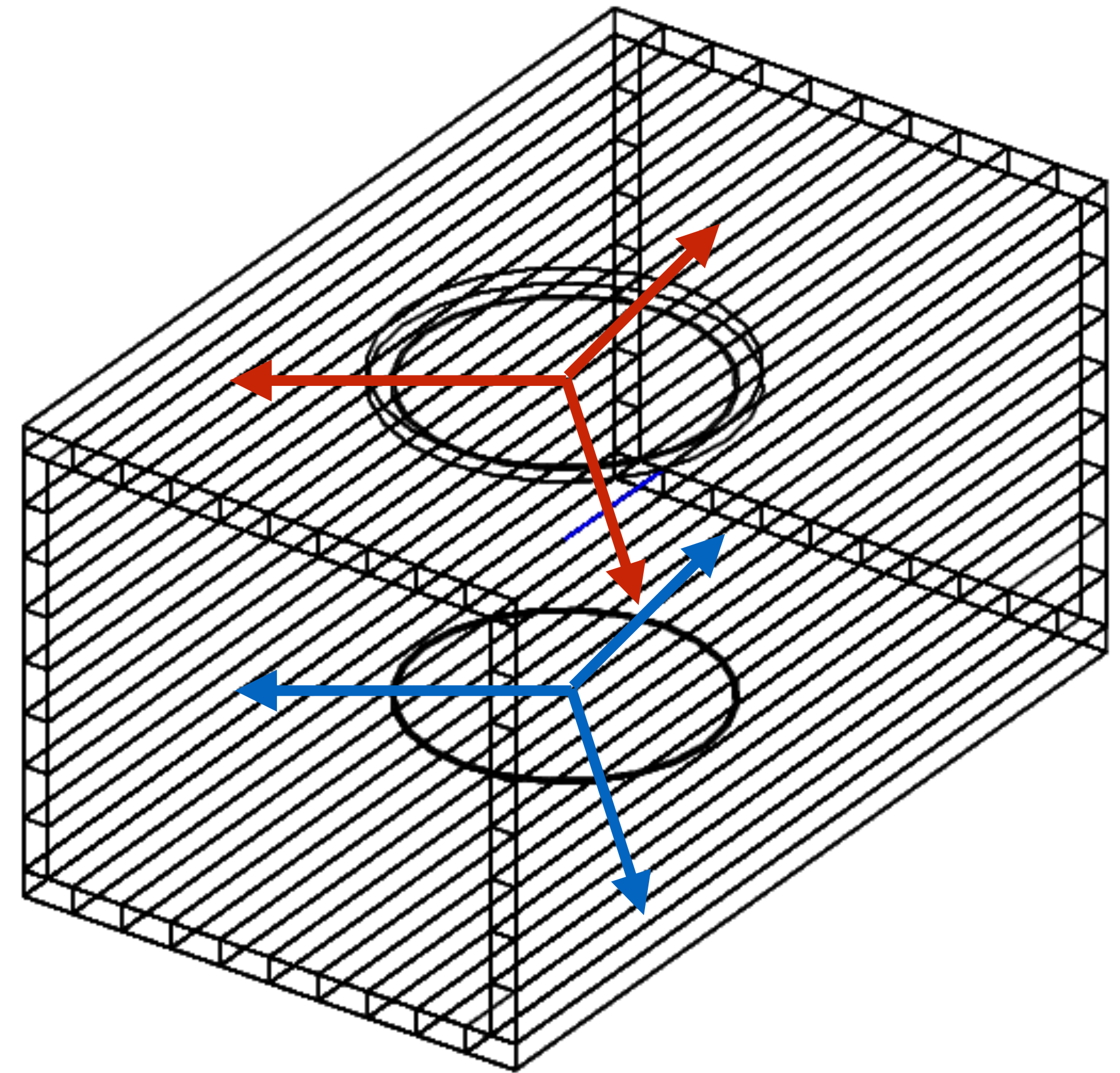
- **Detector**

- Bars of plastic scintillation
- $10 \times 5 \times 170\text{ cm}^3$
- Four walls from the center by 42.5 cm



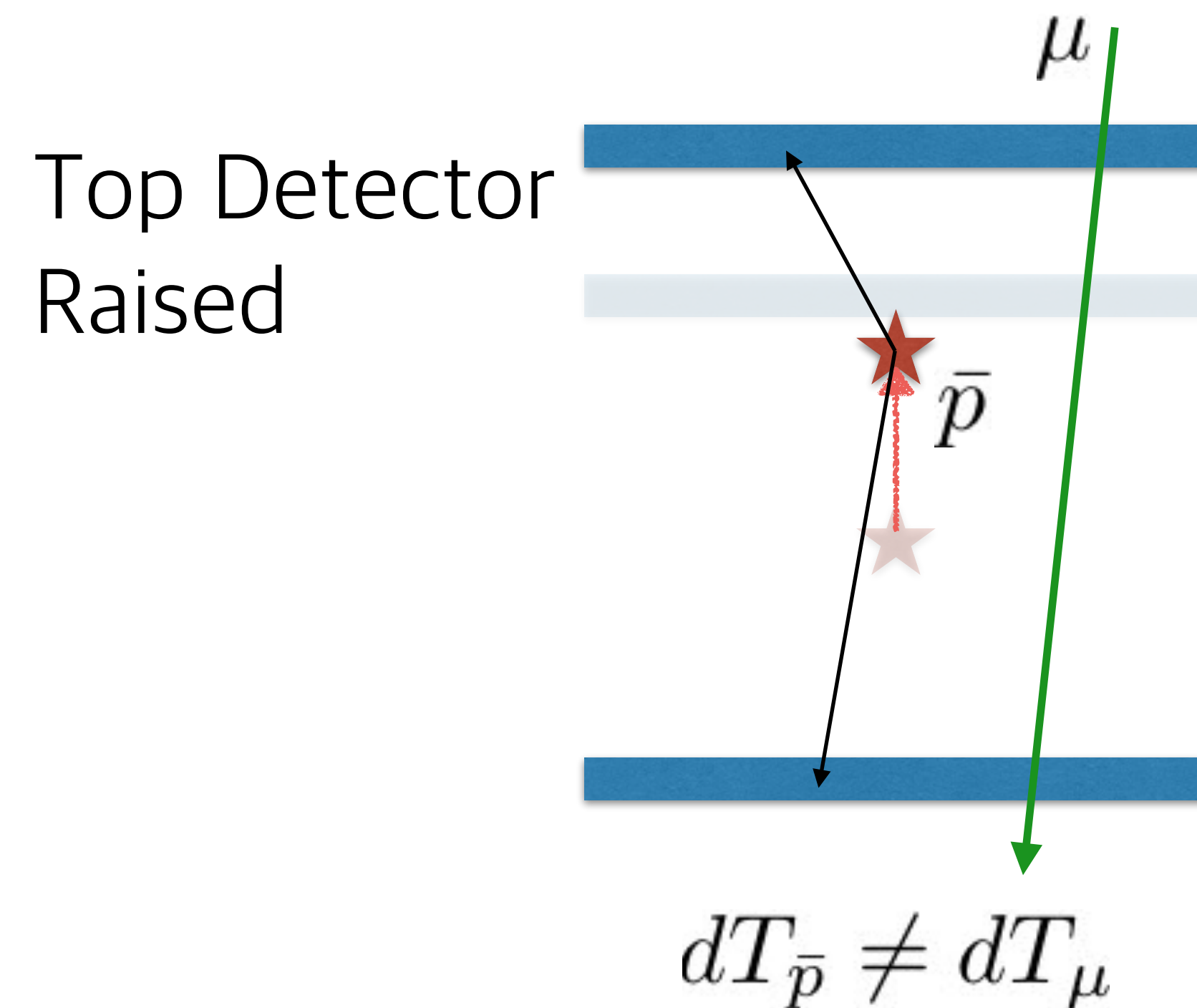
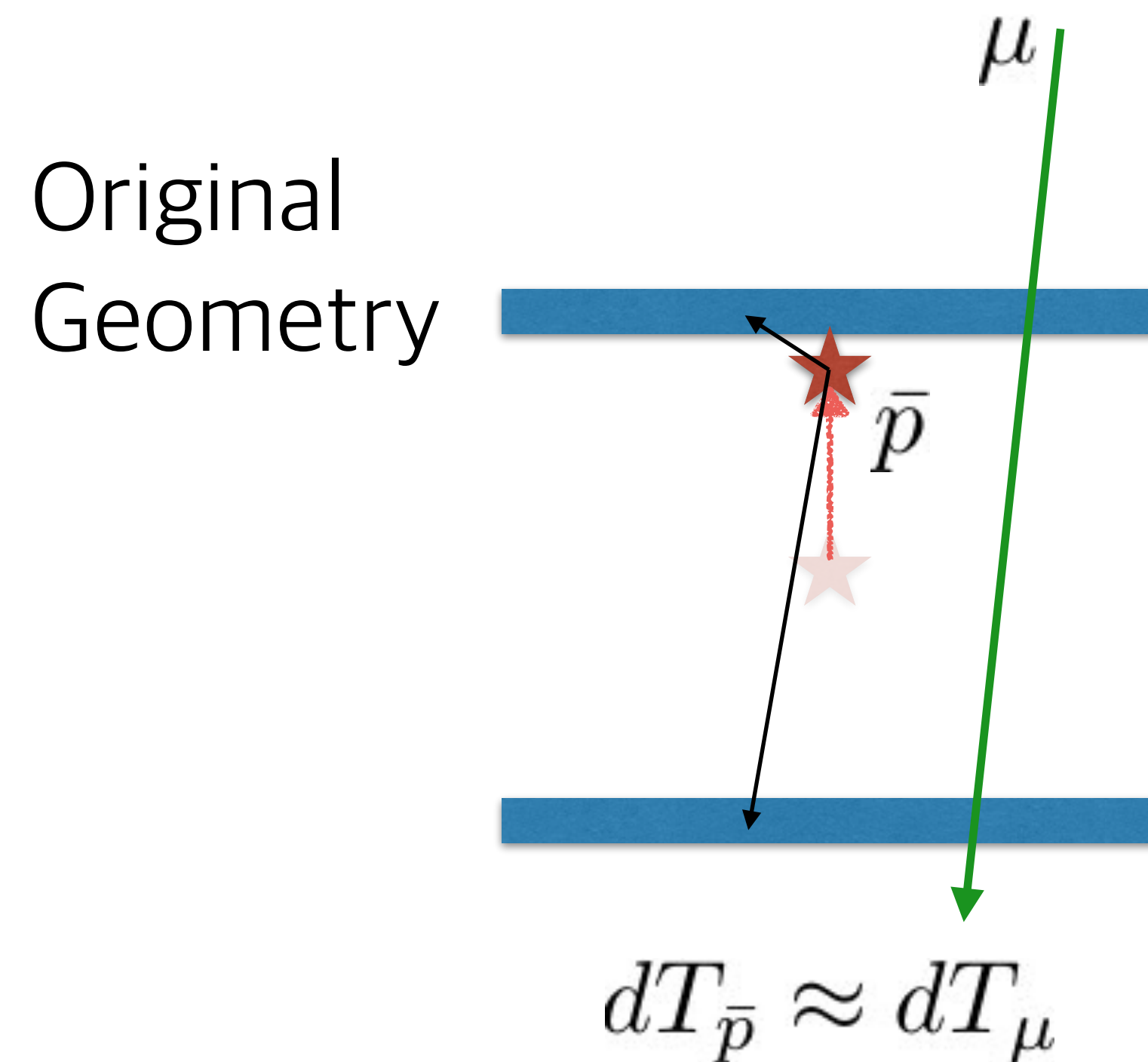
Setup: Beam & Physics

- **Beam**
 - anti-proton
 - at rest (no initial mom.)
 - center of the chamber top or bottom
- **Physics**
 - FTFP_BERT_TRV
 - FTFP: anti-proton inelastic process



Progress: Cosmic-ray effect

- “Can a cosmic ray be distinguishable from a real signal?”

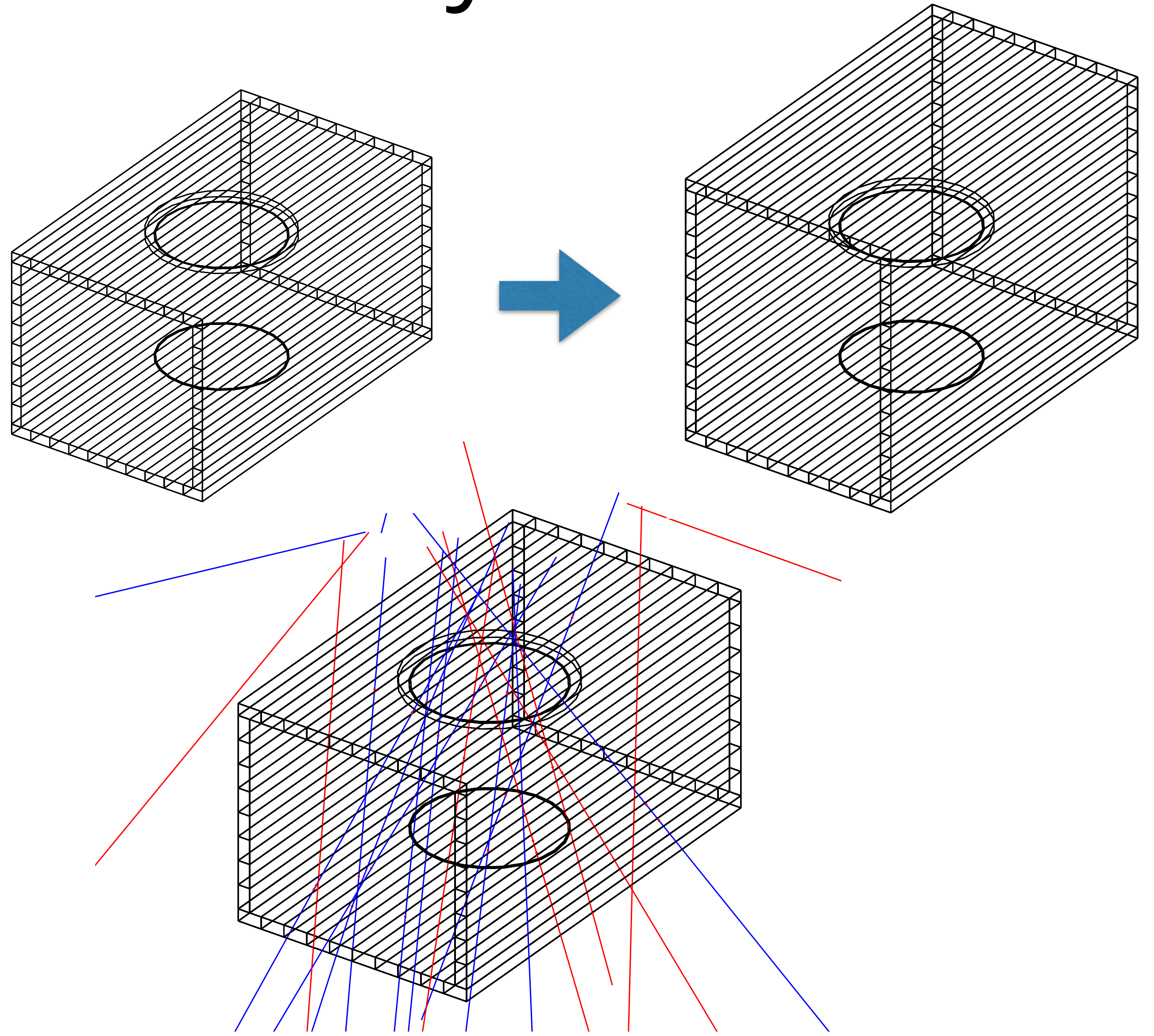


- Test: 3-pi decay events, 4 different height (0, 20, 30, 40 cm)

Progress: Cosmic-ray effect

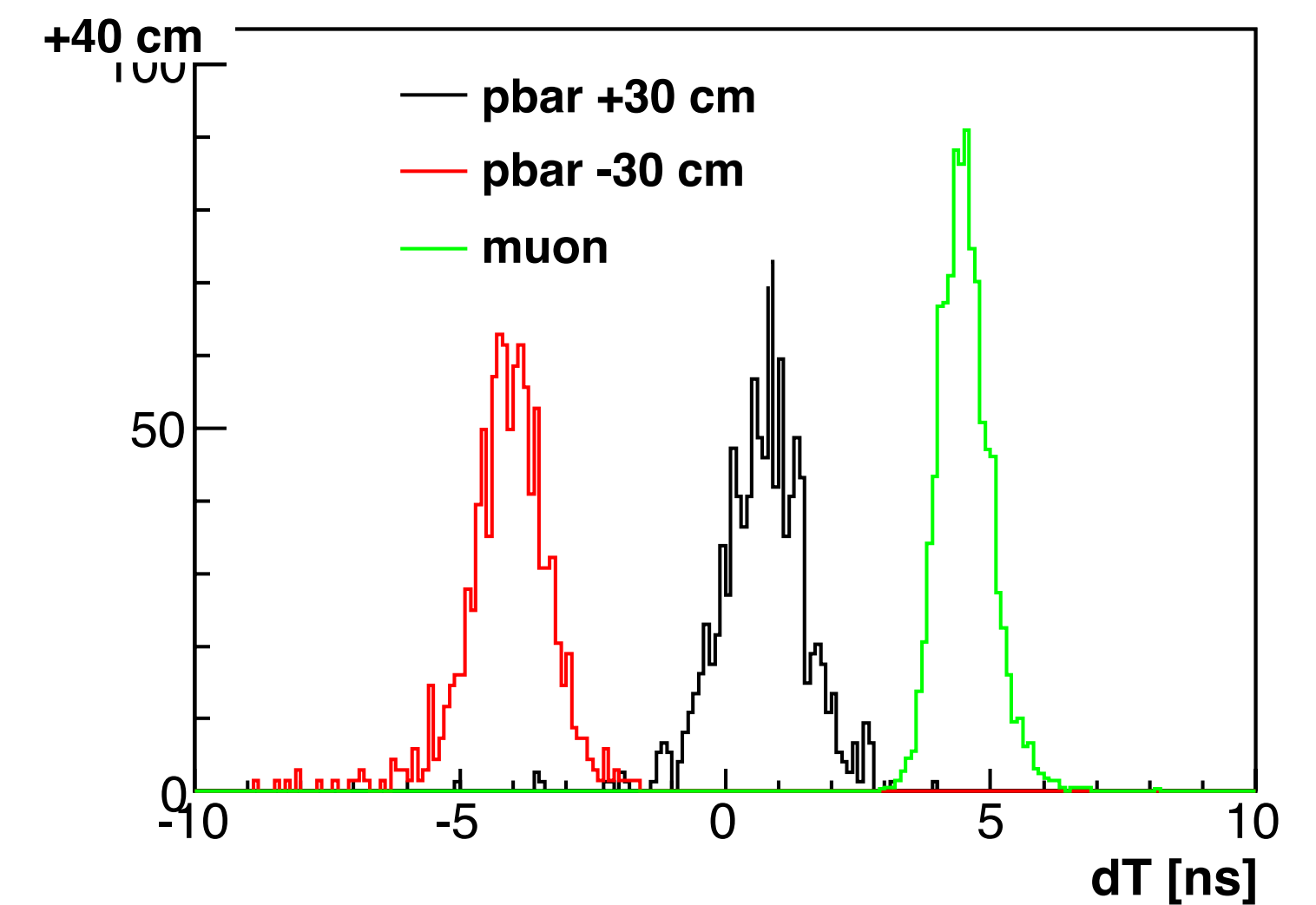
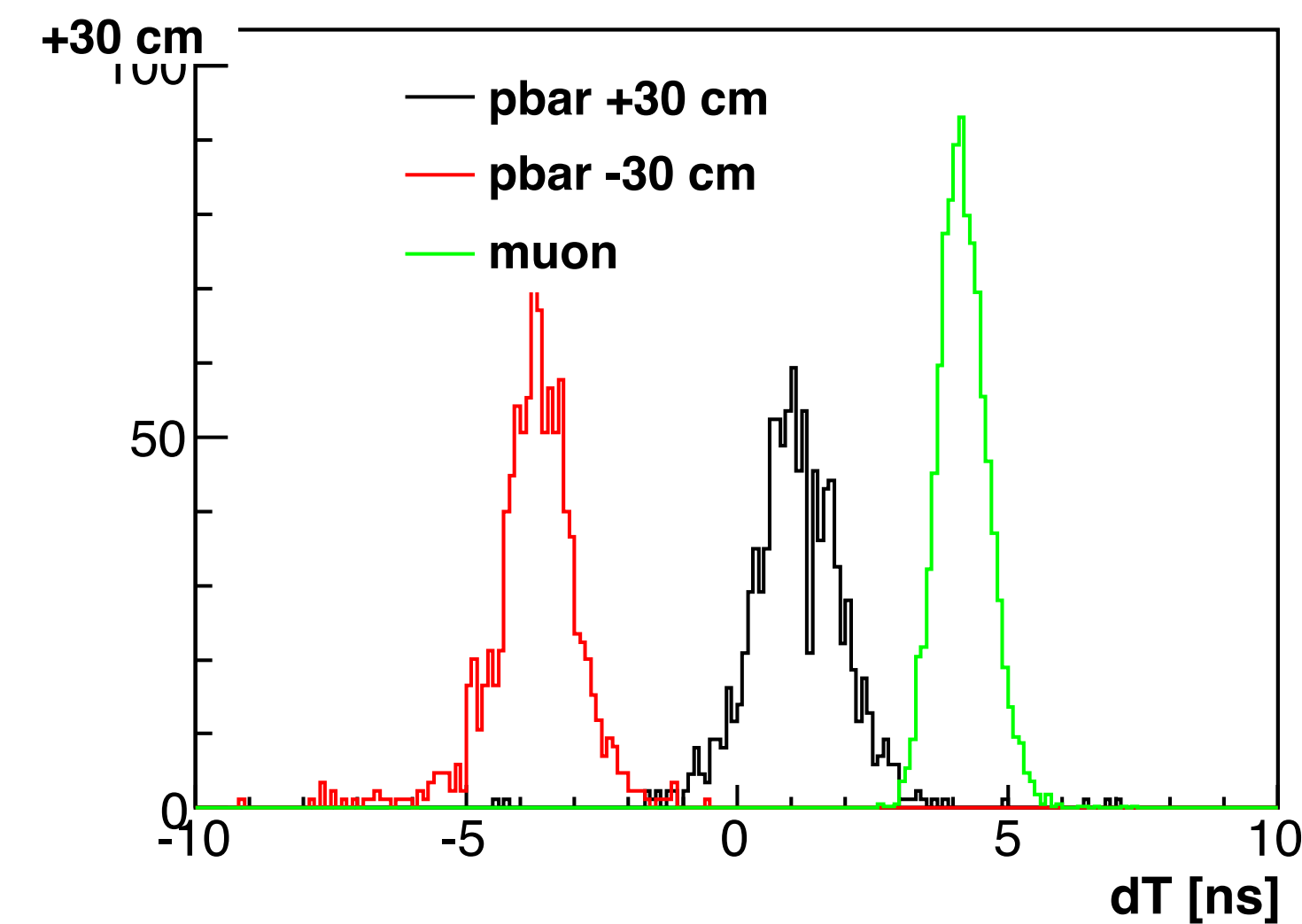
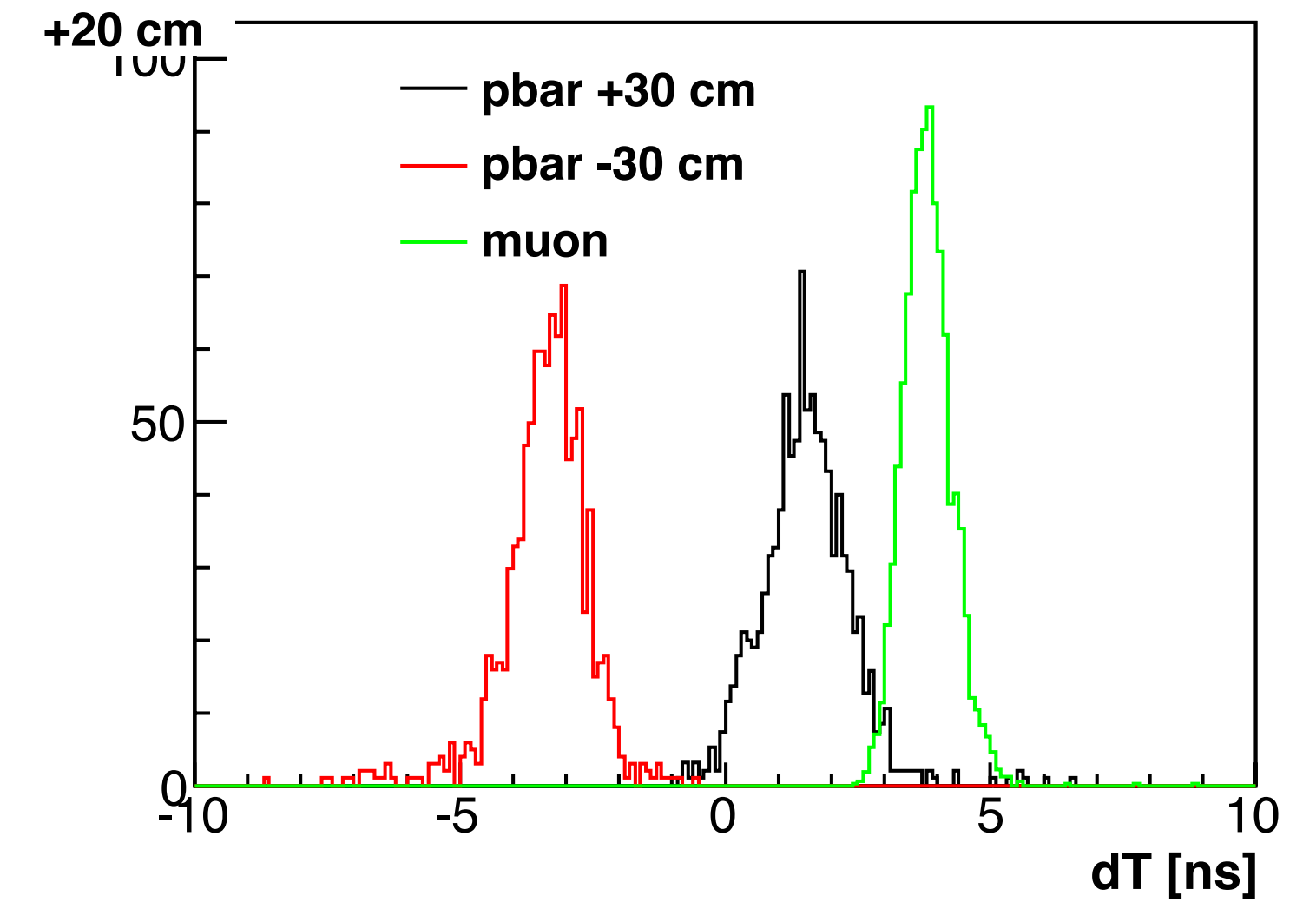
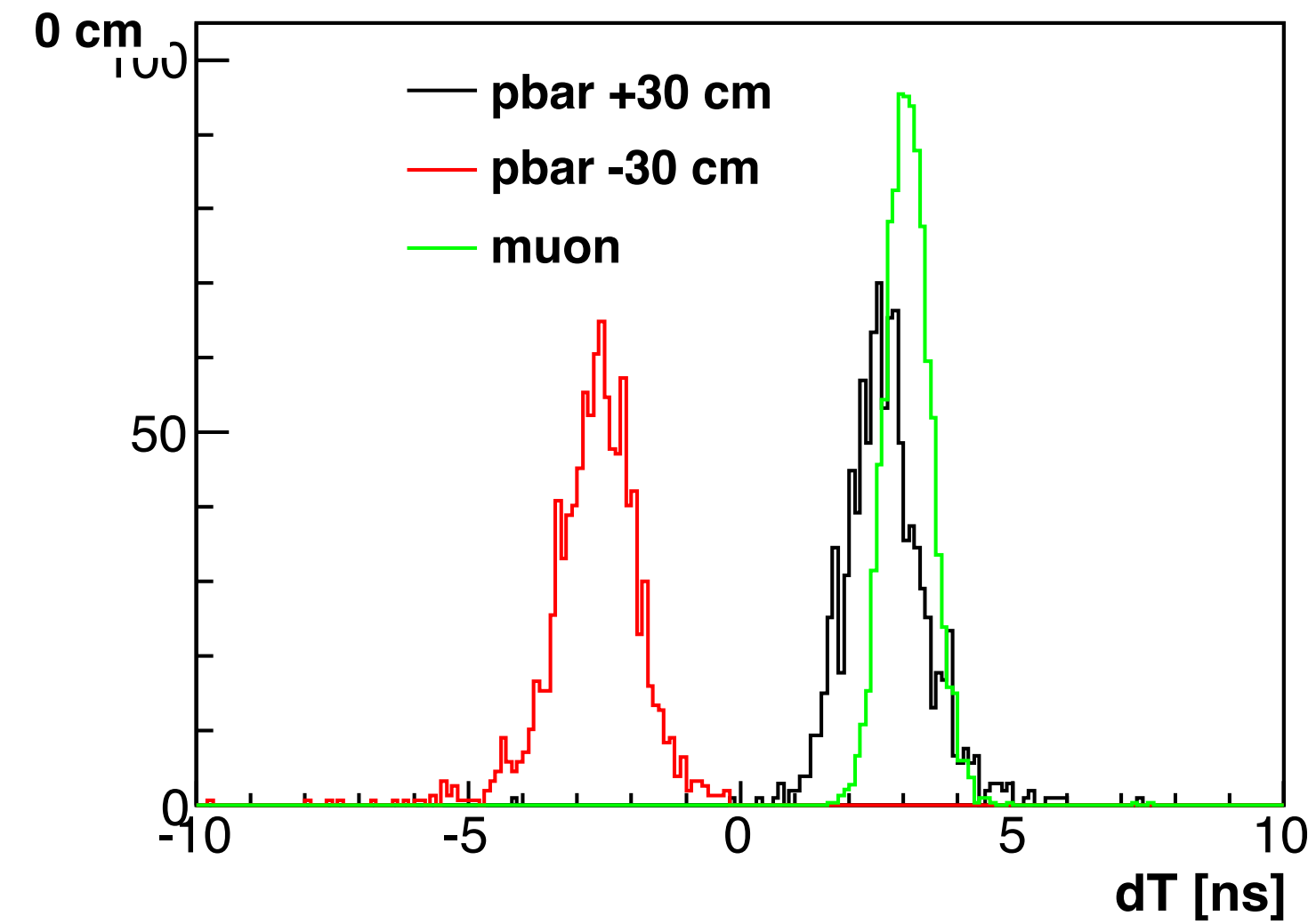
- **Modification of the code**

1. Top Detector height can be adjustable
2. Cosmic-ray (muon) can be usable.
 - CRY library (developed by LLNL)



Progress: Cosmic-ray effect

$$\Delta T = 0.25 \text{ ns } (\sigma)$$

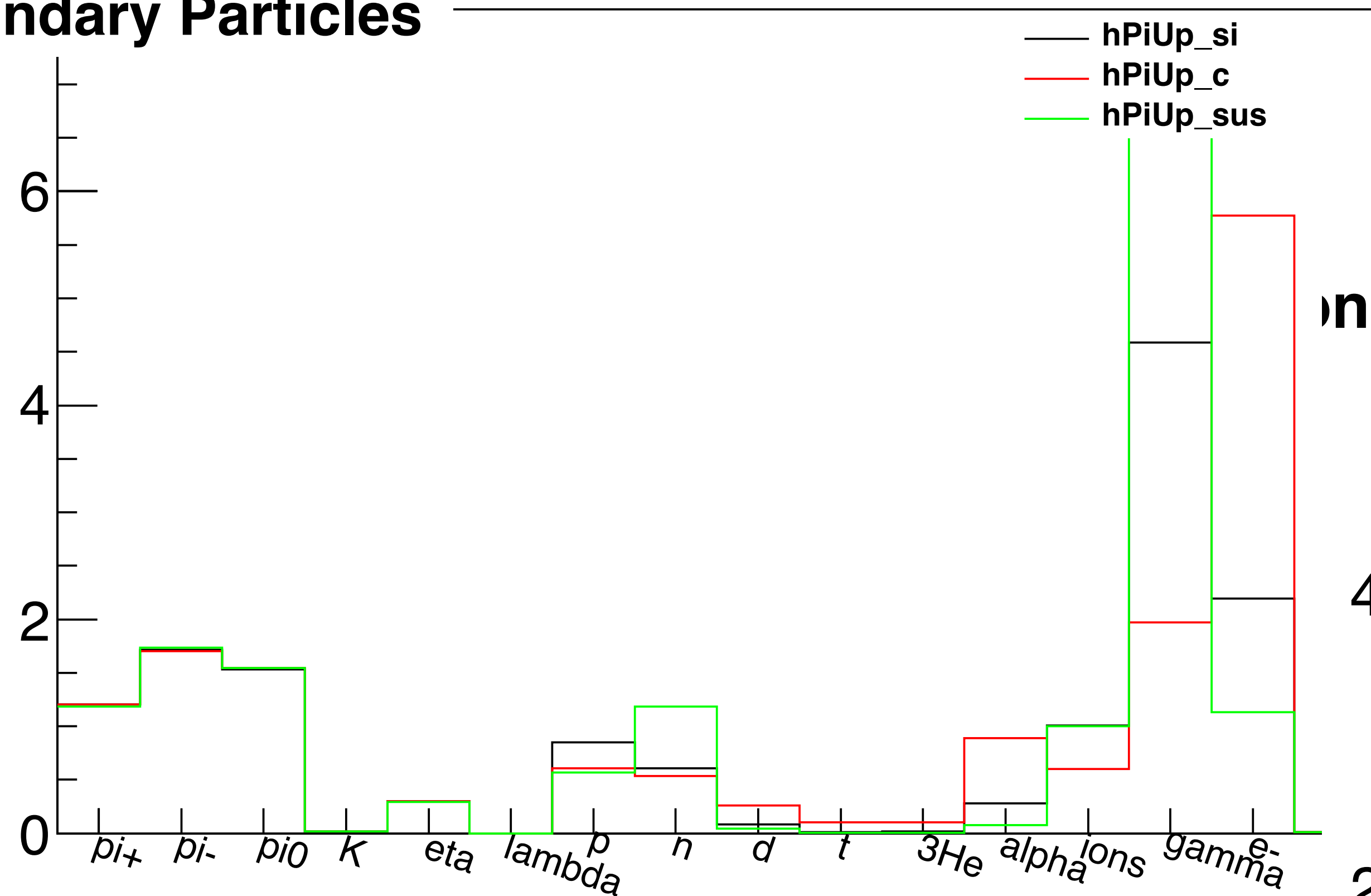


Progress: Secondary Particles

- Checked the secondary particles **from the primary anti-proton**.
 - In Si & C & SUS (for test, cylinder with $r = 5$ mm and $l = 10$ mm)
 - In the Chamber Top ($l = 30$ mm) & Bottom ($l = 3$ mm) (SUS)
 - Material dependency
 - No top / bottom dependency
 - No top detector height dependency

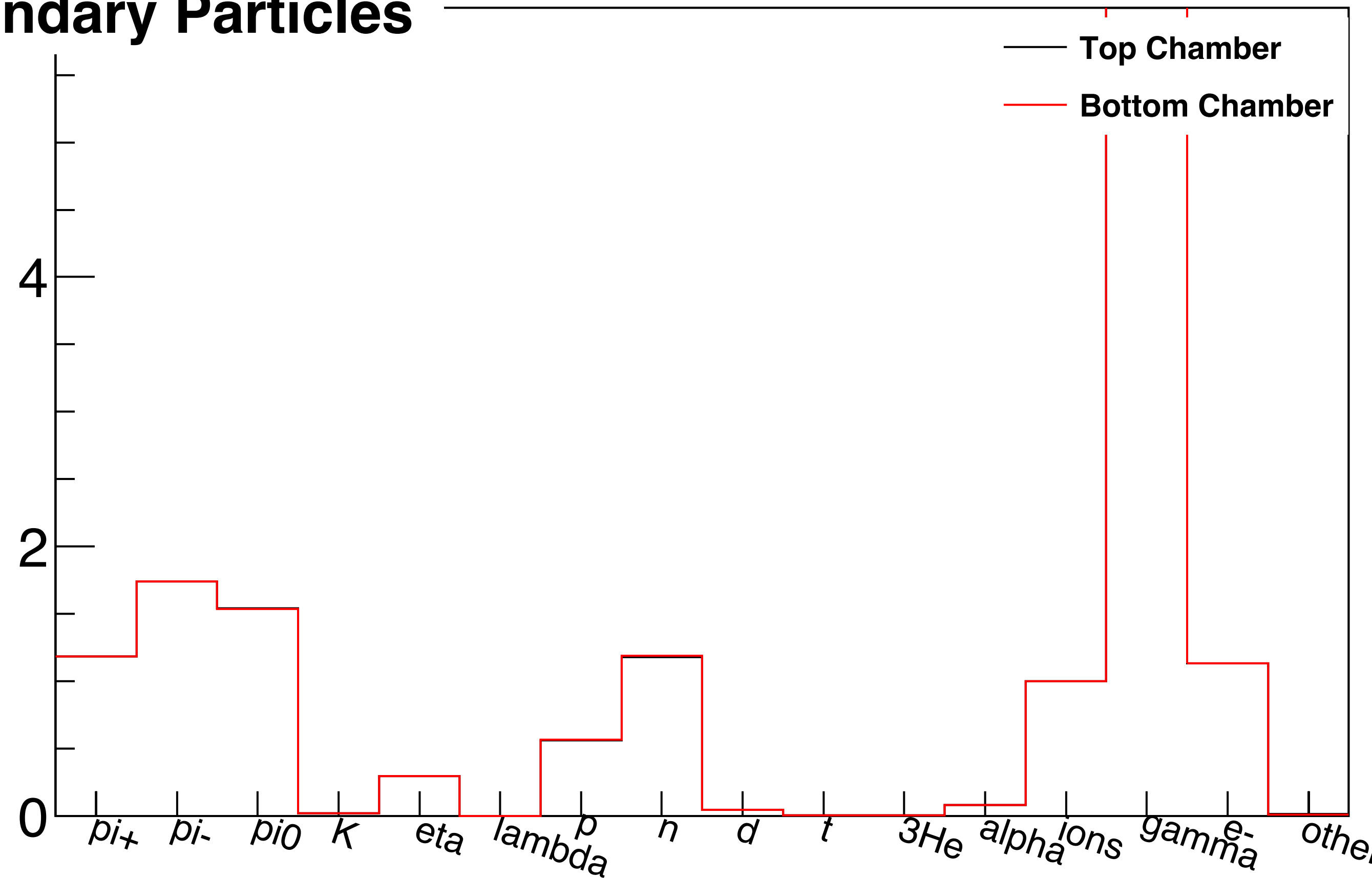
Progress: Secondary Particles

Secondary Particles



$$\langle N(\pi) \rangle \gtrsim 1$$

Secondary Particles

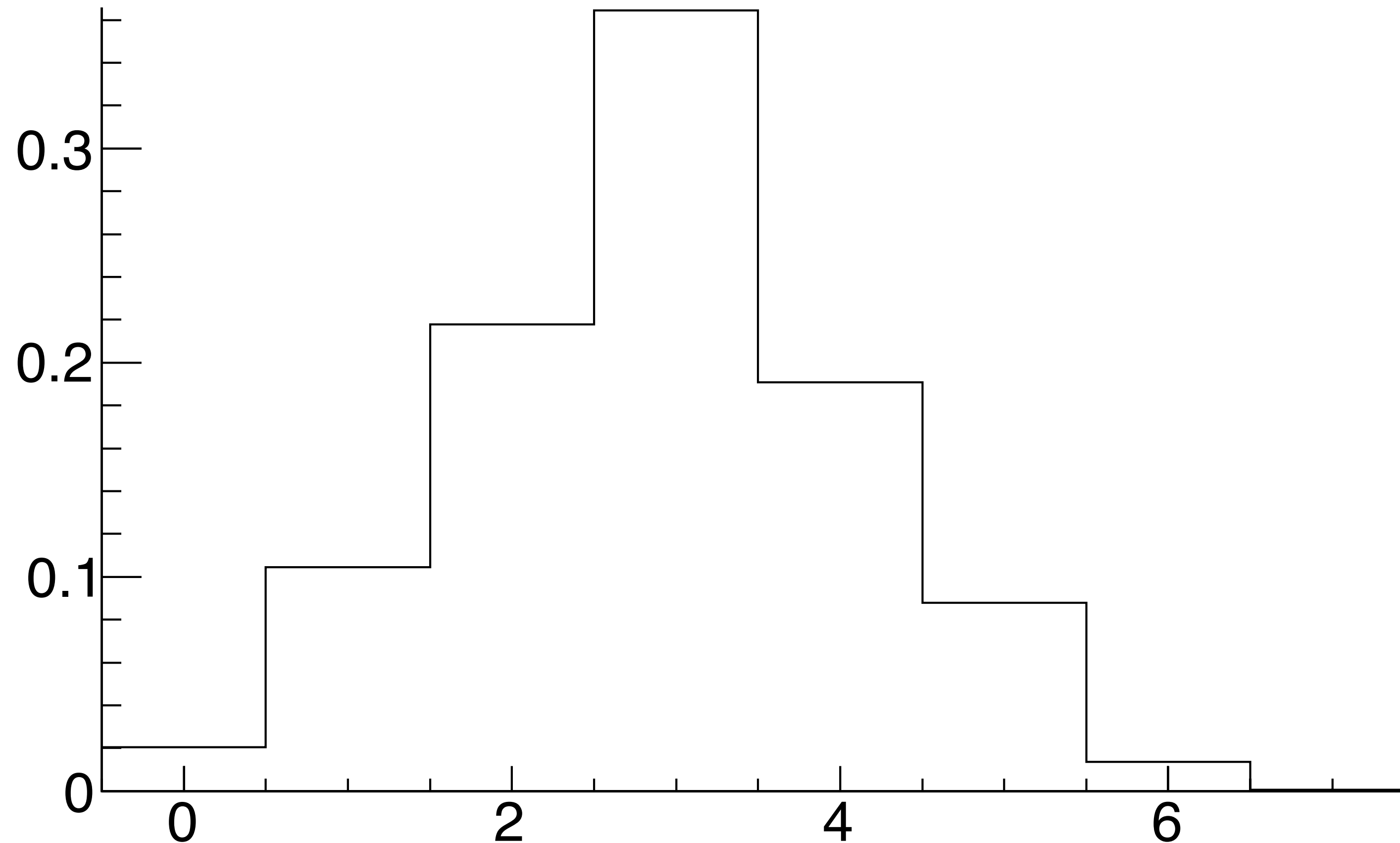


Progress: Charged Pion Eff.

- Checked the geometrical eff. of charged pions from the anti-proton.
- anti-proton in the Chamber Top ($l = 30$ mm) & Bottom ($l = 3$ mm) (SUS)
 - Number of generated ones: about three π^{+-}
 - Top / Bottom: Different result
 - No top detector height dependency

Progress: Charged Pion Eff.

Generated Pic

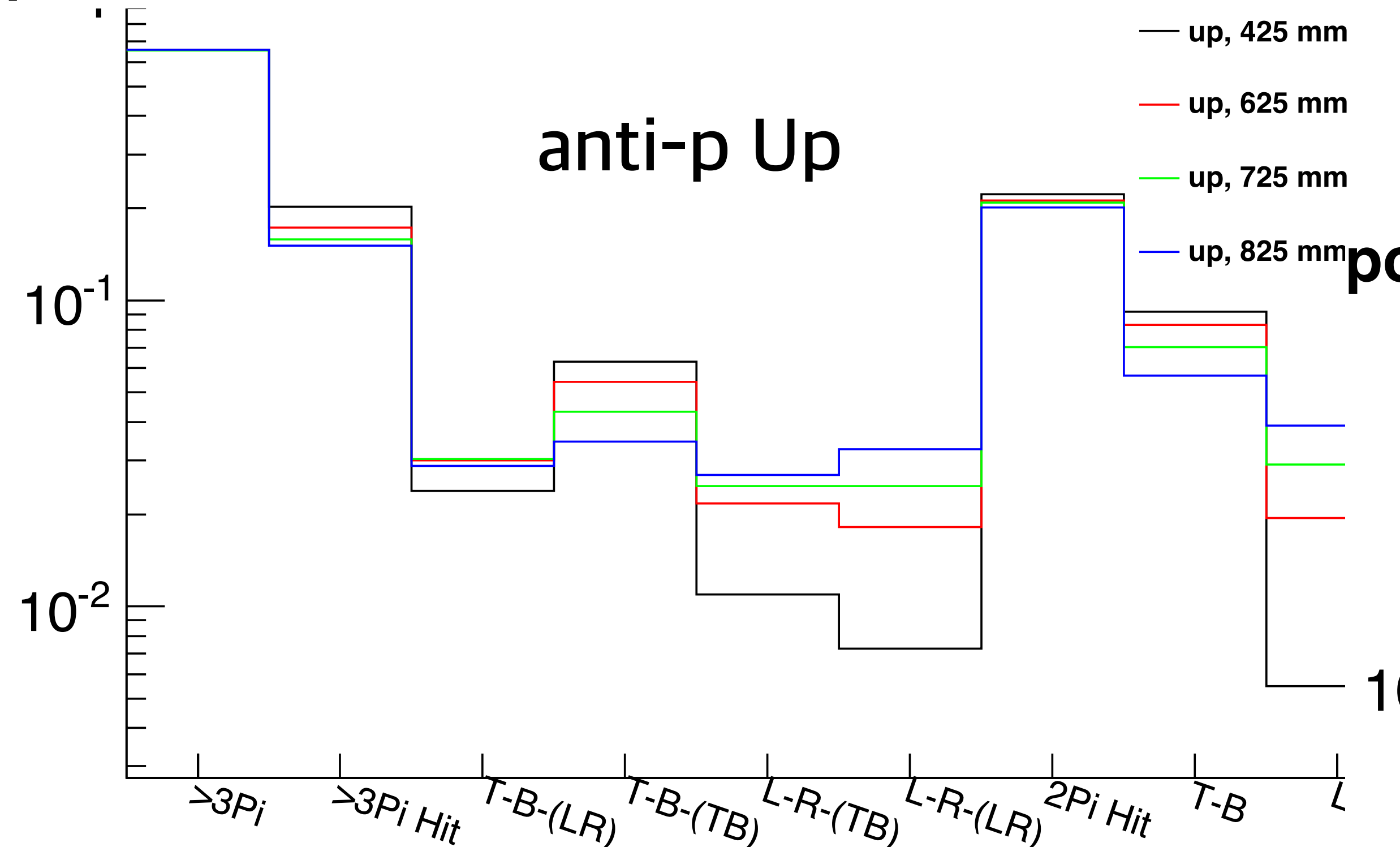


Number of generated
charged pions

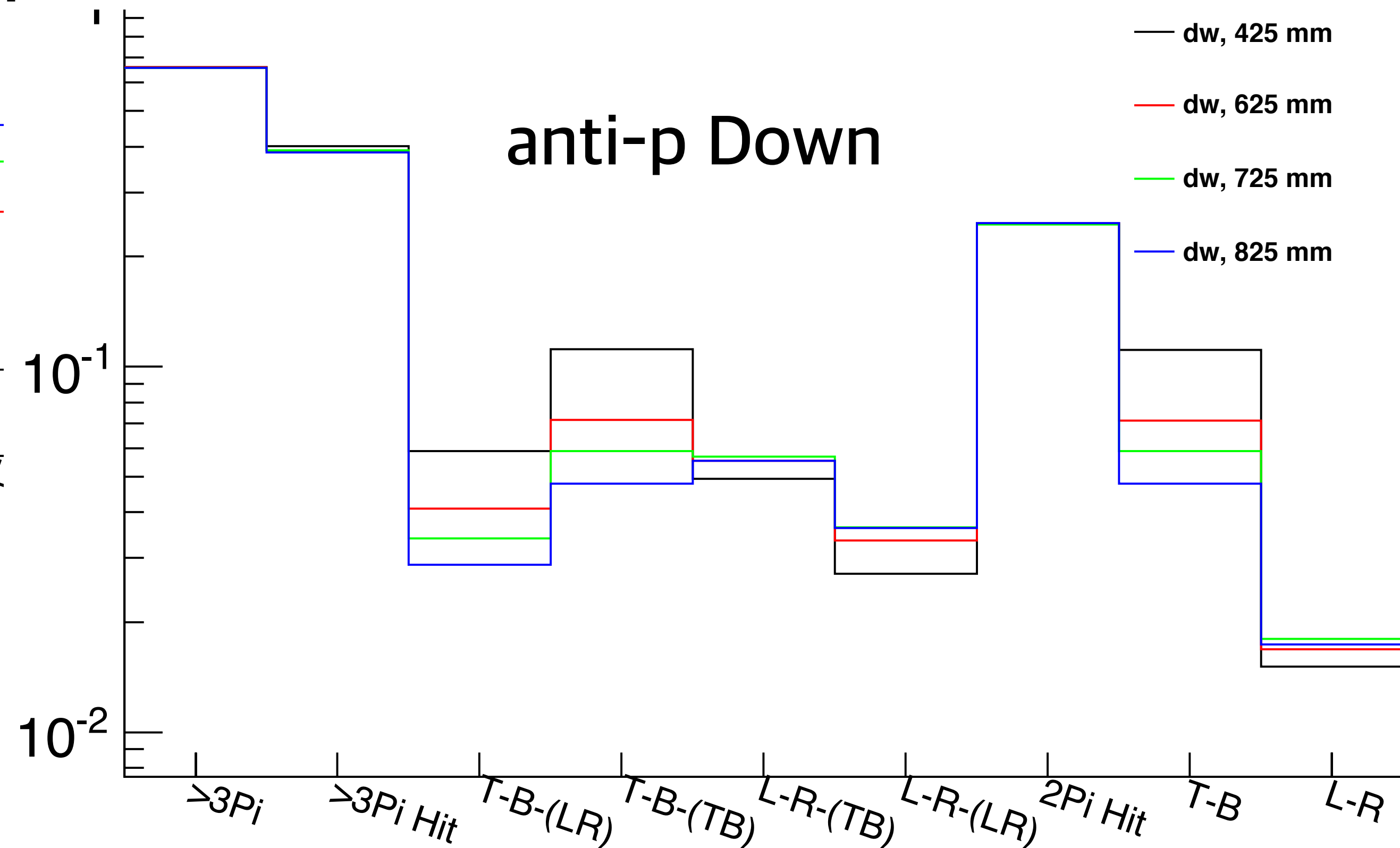
$N \sim 3$

Sim.: 3-Pion Events

Important Hit. Patt.



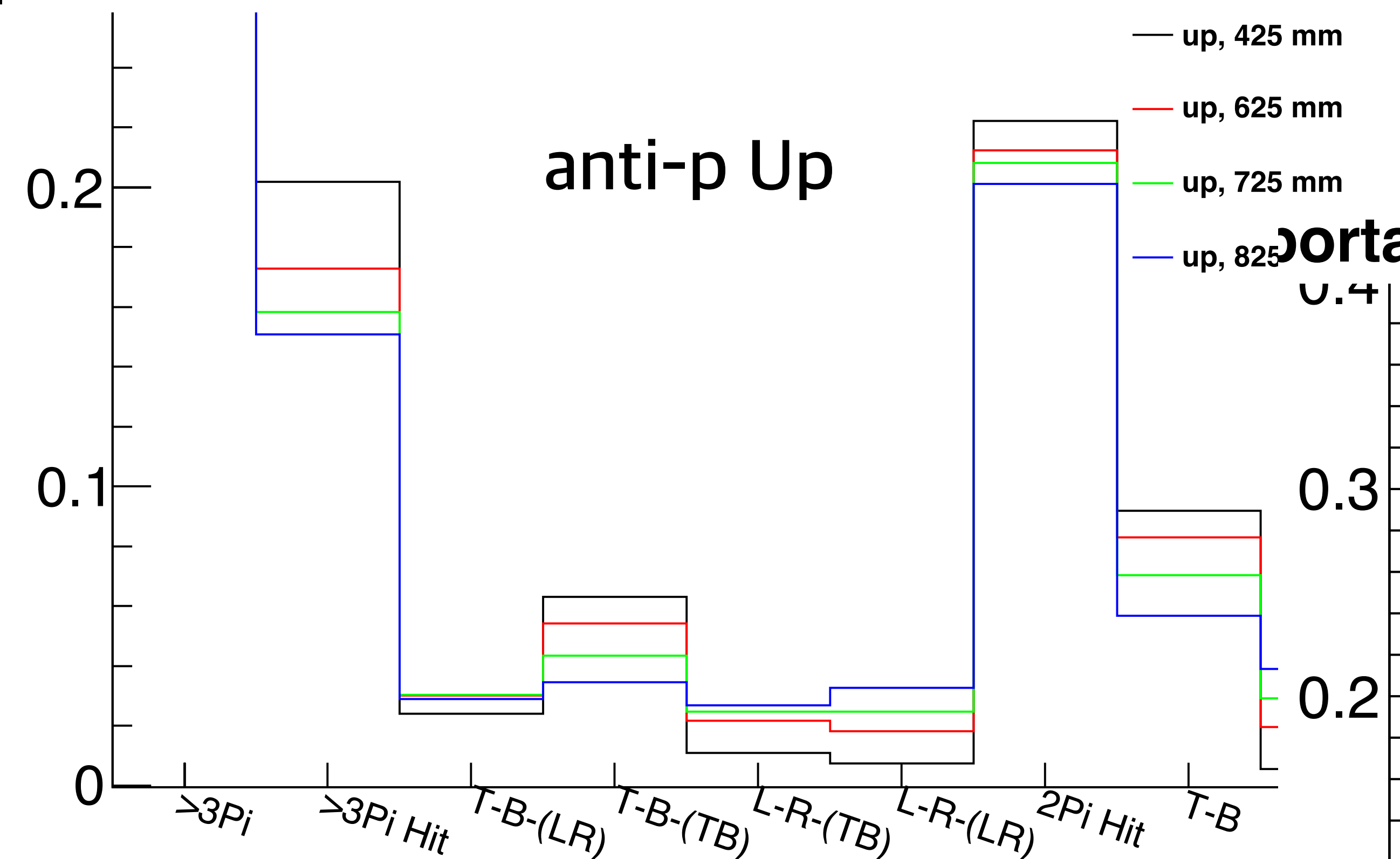
Important Hit. Patt.



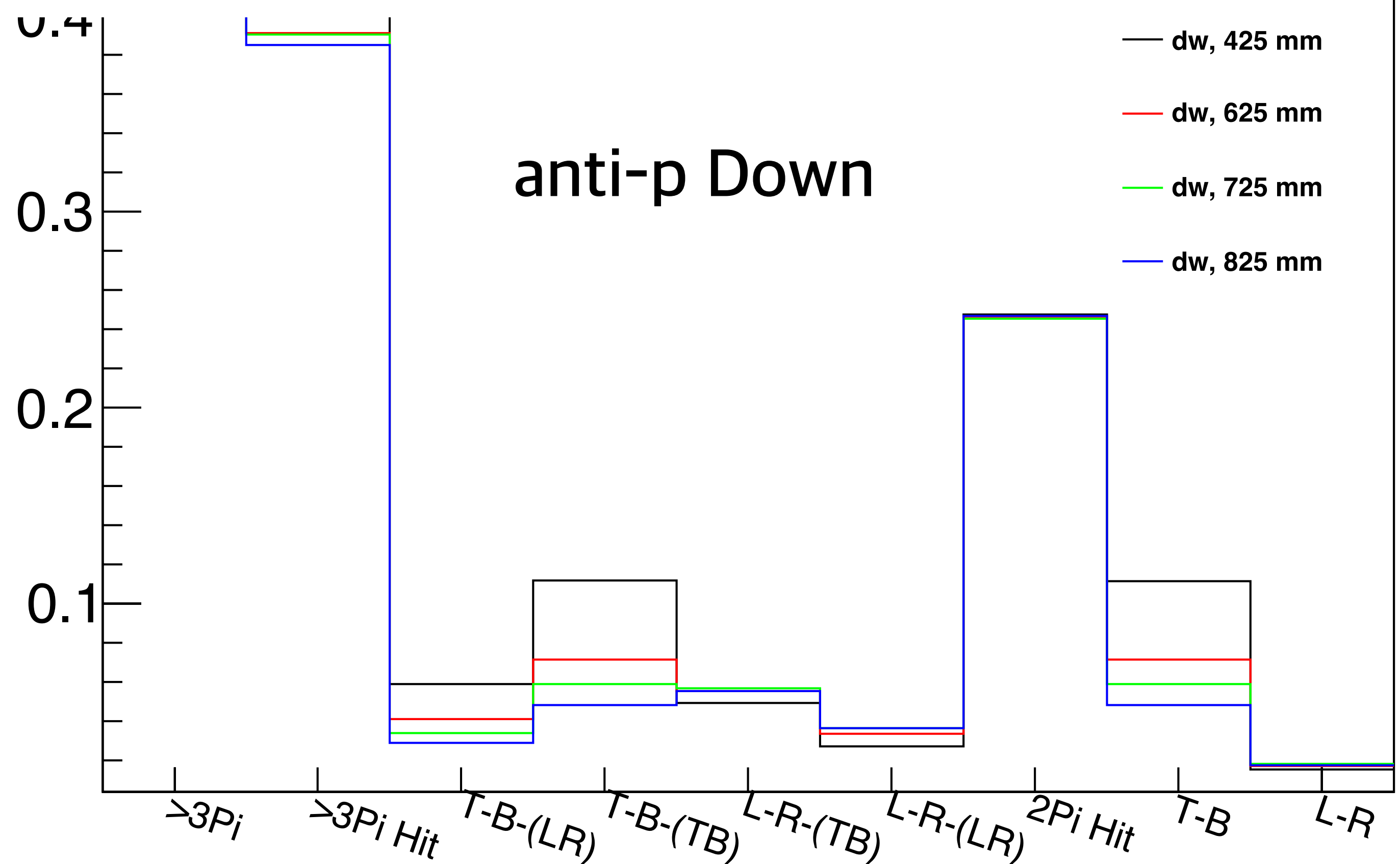
height $\uparrow$: L-R hits $\uparrow$ (area $\uparrow$)
T-B hits $\downarrow$ (Ω $\downarrow$)

Sim.: 3-Pion Events

Important Hit. Patt.



Important Hit. Patt.



To-do

- Study gamma rays from neutral pion.
- Study the details of the detectors (energy deposition, ...).
- How to reconstruct the position of an anti-proton?