

# SK software training (Introduction)

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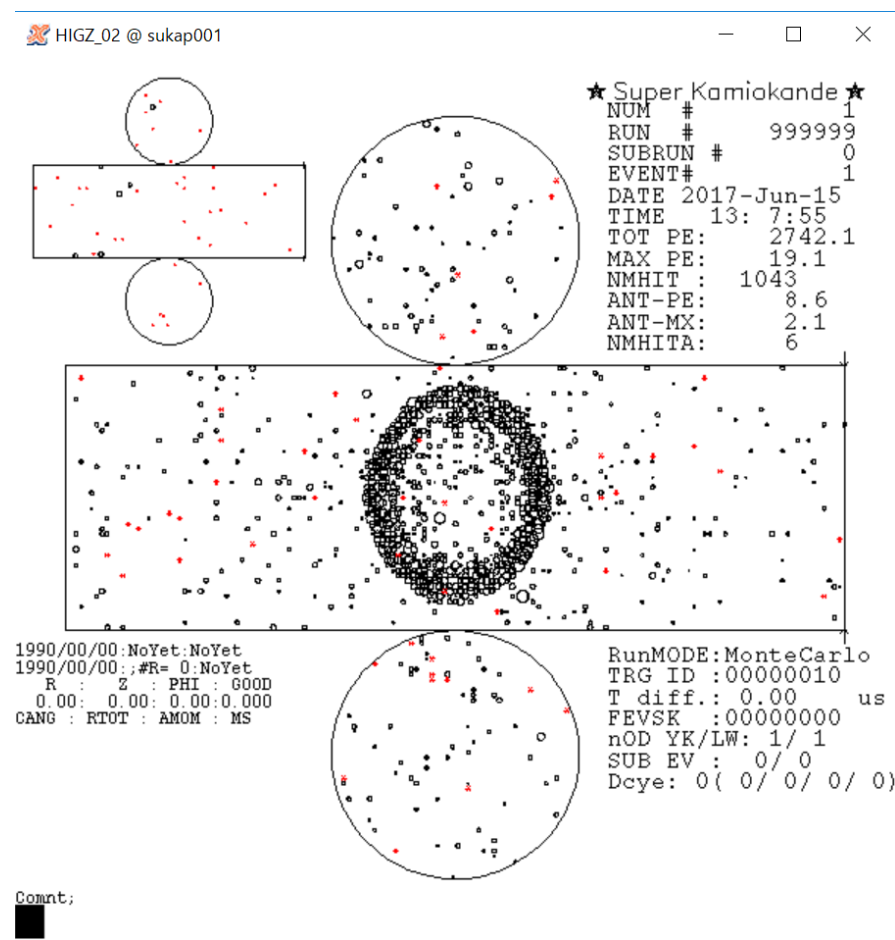
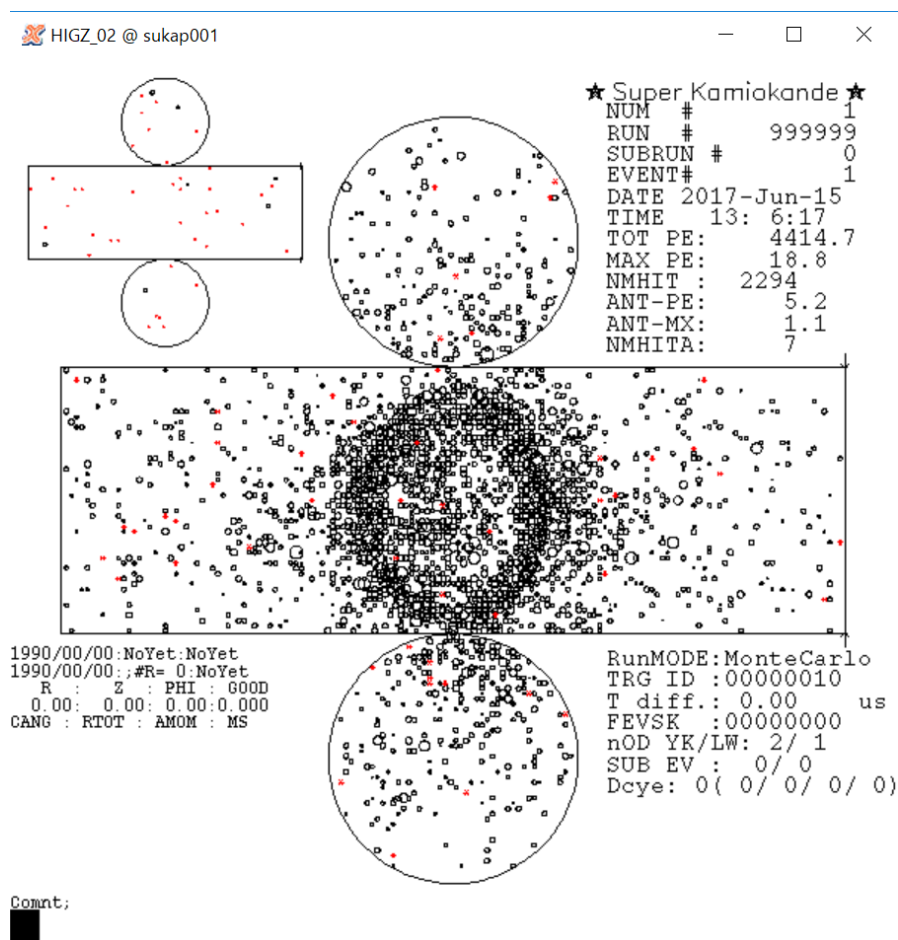
# 1. Continue from SK lecture

- Neutrino oscillation is phenomena which neutrino changes its flavor.
- **Neutrino** interacts in water and it produces **charged particle** which are detectable in water Cherenkov detector.
  - $\nu_e$  interaction in water makes electron:  $n + \nu_e \rightarrow p + e^-$
  - $\nu_\mu$  interaction in water makes muon:  $n + \nu_\mu \rightarrow p + \mu^-$
- Thus, particle identification is a key of neutrino oscillation analysis.

# 4. Features of electron/muon ring

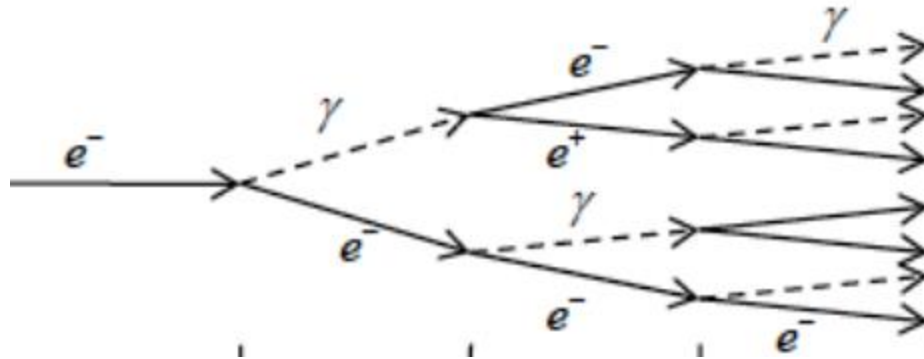
Electron 500 MeV/c

Muon 500 MeV/c



Same vertex (0,0,0) and direction (-1,0,0).

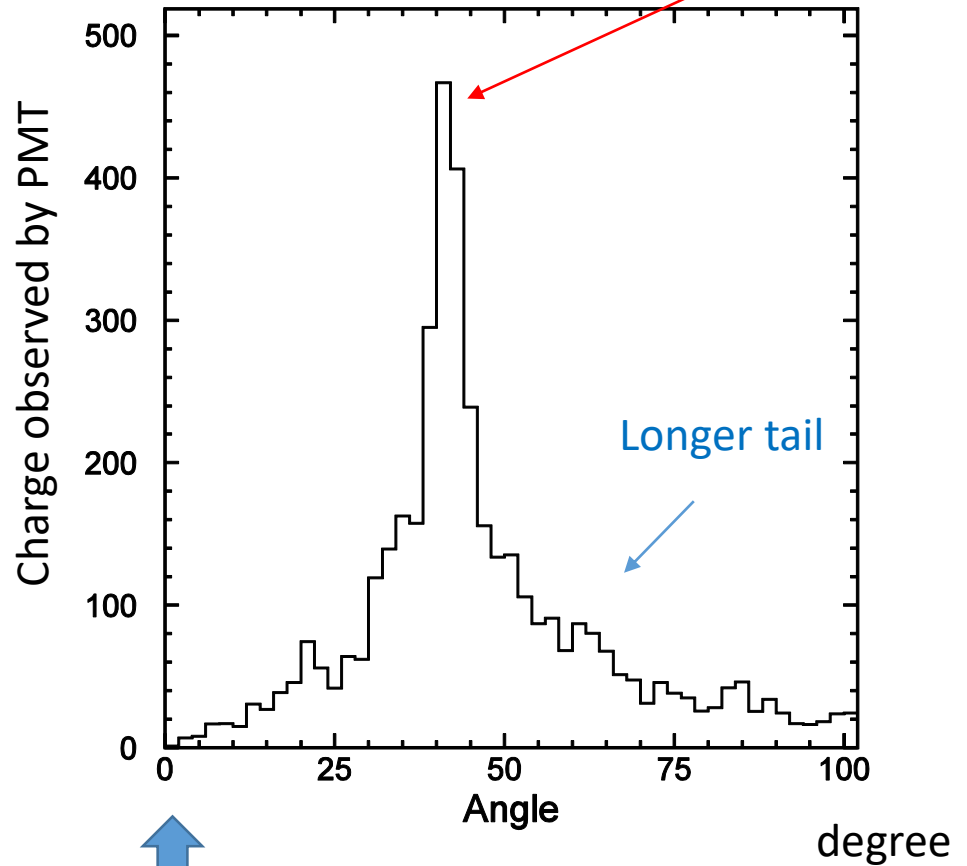
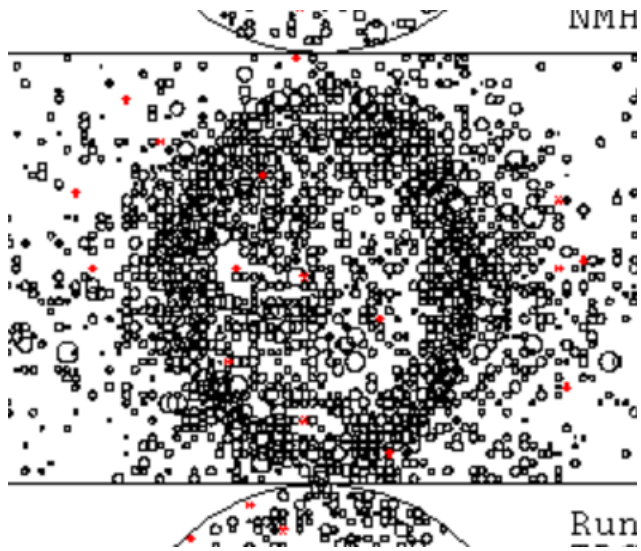
- Mass of  $e$  and  $\mu$  are different
  - Electron:  $0.51 \text{ MeV}/c^2$
  - Muon:  $105.6 \text{ MeV}/c^2$
  - $\mu$  is 200 times heavier than  $e$  !
- Electron (lighter charged particle) make electromagnetic shower in water and stop immediately.



- Each charged particles emits Chrenkov light → Ring pattern becomes fuzzy.

# Charge distribution

Cherenkov edge  
(41 degree).

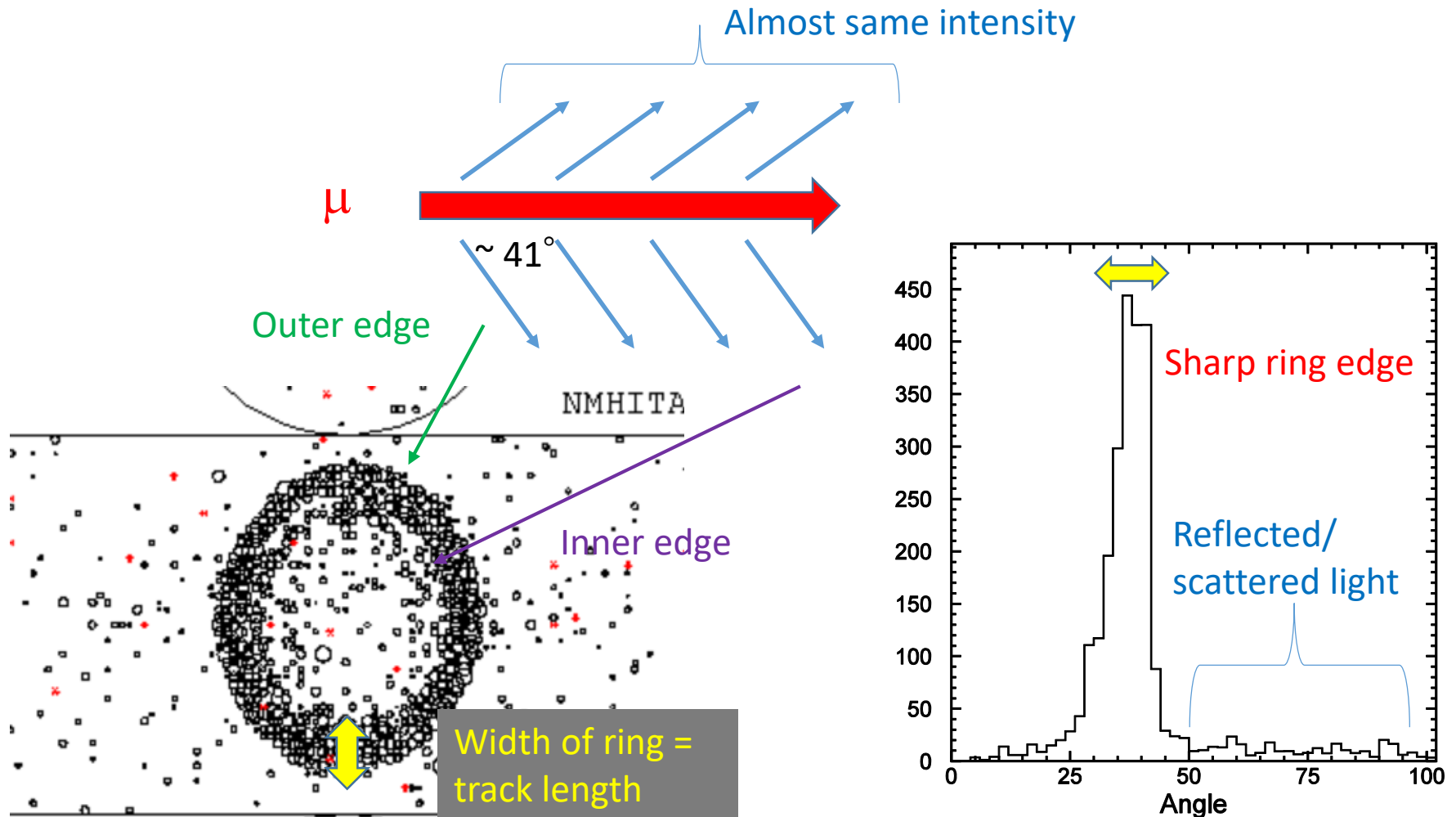


Longer tail



Particle direction

- Muon is 200 times heavier than electron and hard to make electromagnetic shower.
- Emit Cherenkov light until stop  $\rightarrow$  run longer distance than electron.



# In this training ....

- Let's scan only electron/only muon events to train your eyes.
  - Actually, people scan all data by eyes in old Kamiokande era (see Oyama-san's talk).
  - In SK analysis, PID program identifies electron and muon (~ 99 % accuracy).
- Let's try to identify samples which contain electron and muon randomly, by your eyes.
- Let's discuss among the group and decide answer of the group.
- How much accuracy can you achieve ?