

NBI2003@KEK
Nov. 10, 2003

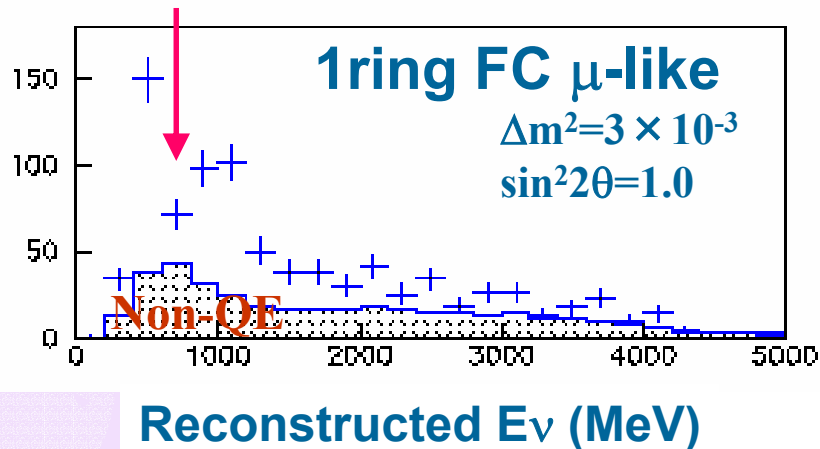
JHF ν Near Neutrino Detectors

T. Nakaya (Kyoto)

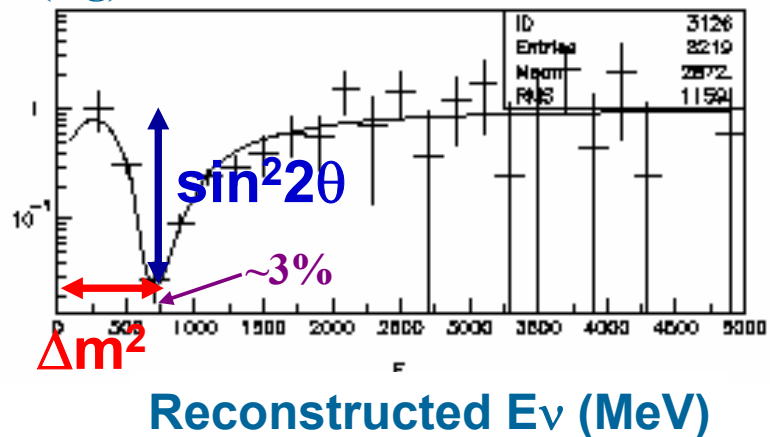
1. Introduction

- Precision measurement of $\nu_\mu \rightarrow \nu_x$.
 - Neutrino flux and spectrum (CC-QE).
 - Signal purity (CC-QE events) and the estimation of background (Non CC-QE).

oscillation



(log) $N_{obs}/N_{exp(w/o\ oscillation)}$

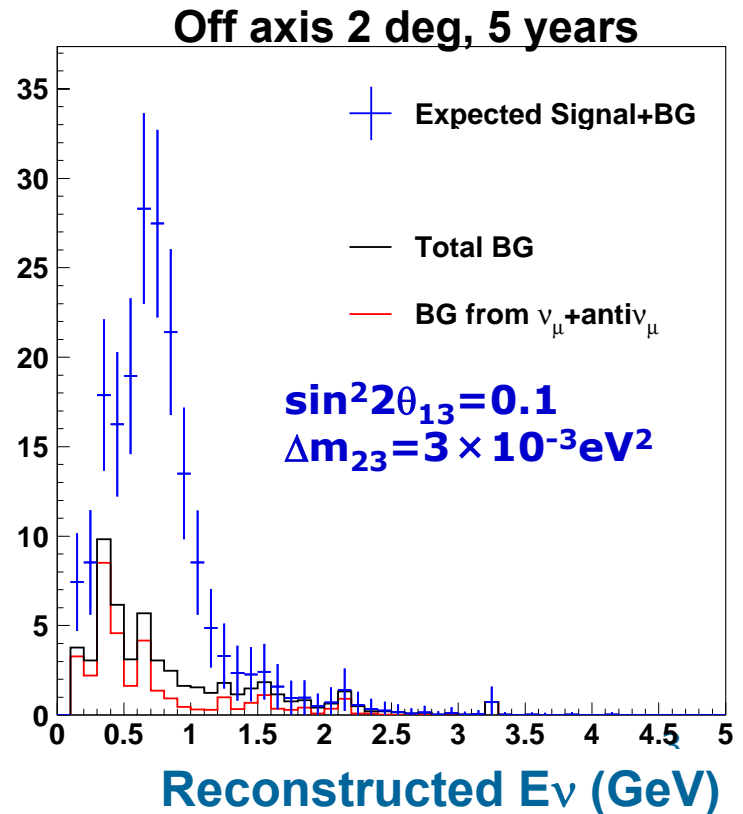


- Search for a rare process: $\nu_\mu \rightarrow \nu_e$.

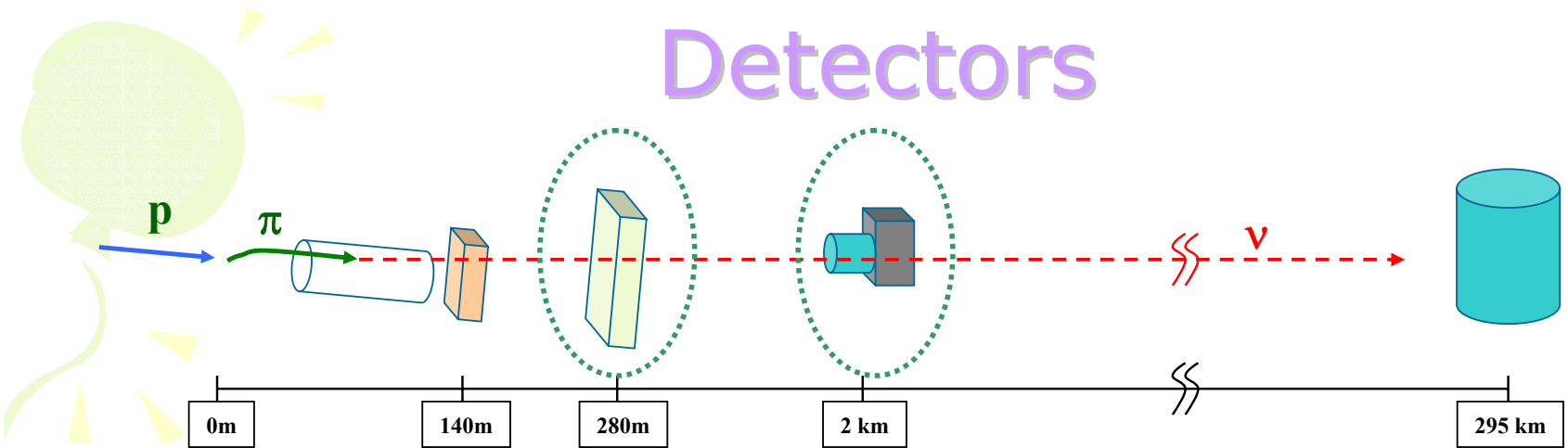
$\sim 15,000$ ν_μ interactions in 5 years

- ~ 10 BG events from $\nu_\mu \rightarrow \pi^0 + X$.
- ~ 10 BG events from ν_e in the beam.

– Background estimation.

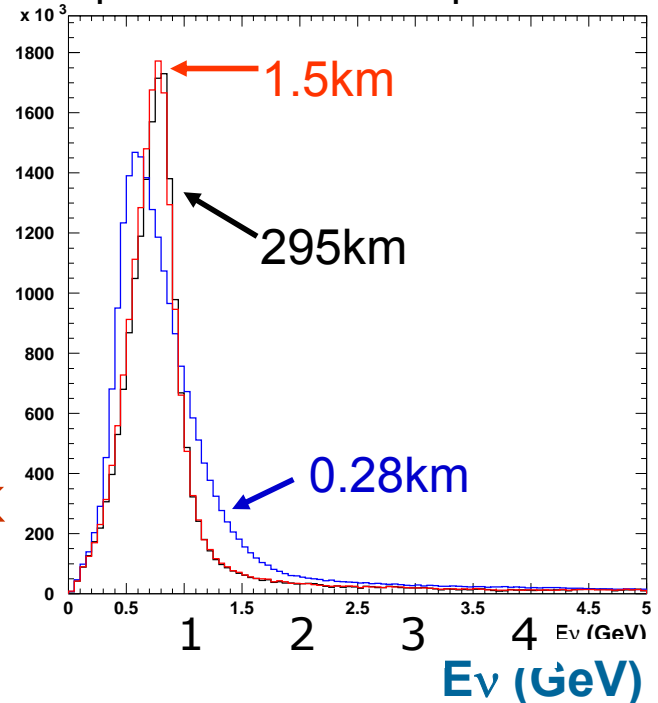


Detectors



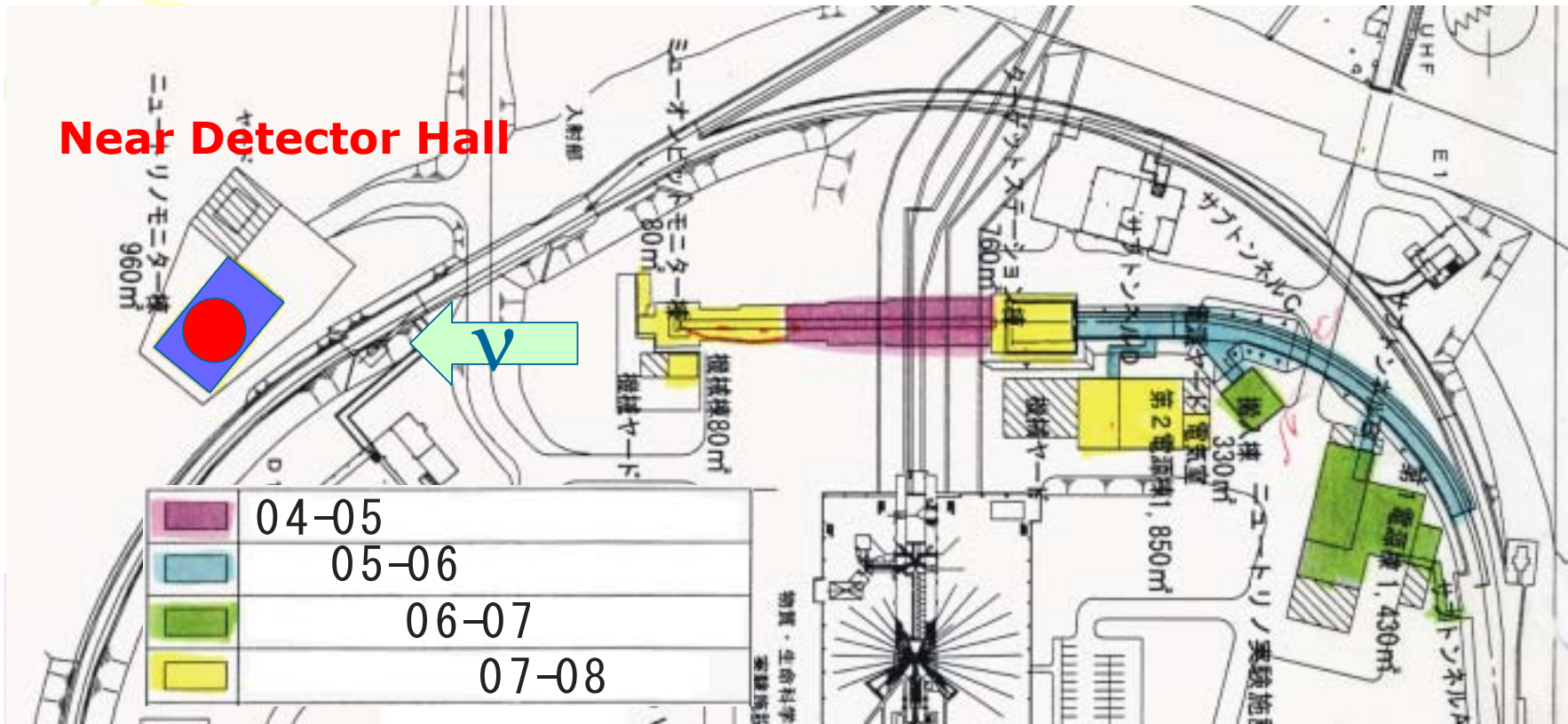
- Muon monitors @ $\sim 140\text{m}$
- **Near detectors @ 280m**
 - Neutrino intensity/direction
 - Neutrino interaction study
- **Medium Detector @ $\sim 2\text{km}$**
 - Almost same E_ν as SK
 - Water Cherenkov can work
- Far detector @ 295km
 - Super-K

Spectra at different positions



Near neutrino detector @280m

Near Detector Hall



Function of the detectors

- **On-axis (0 degree)**

- Beam direction
- Beam stability
- (Spectrum)?

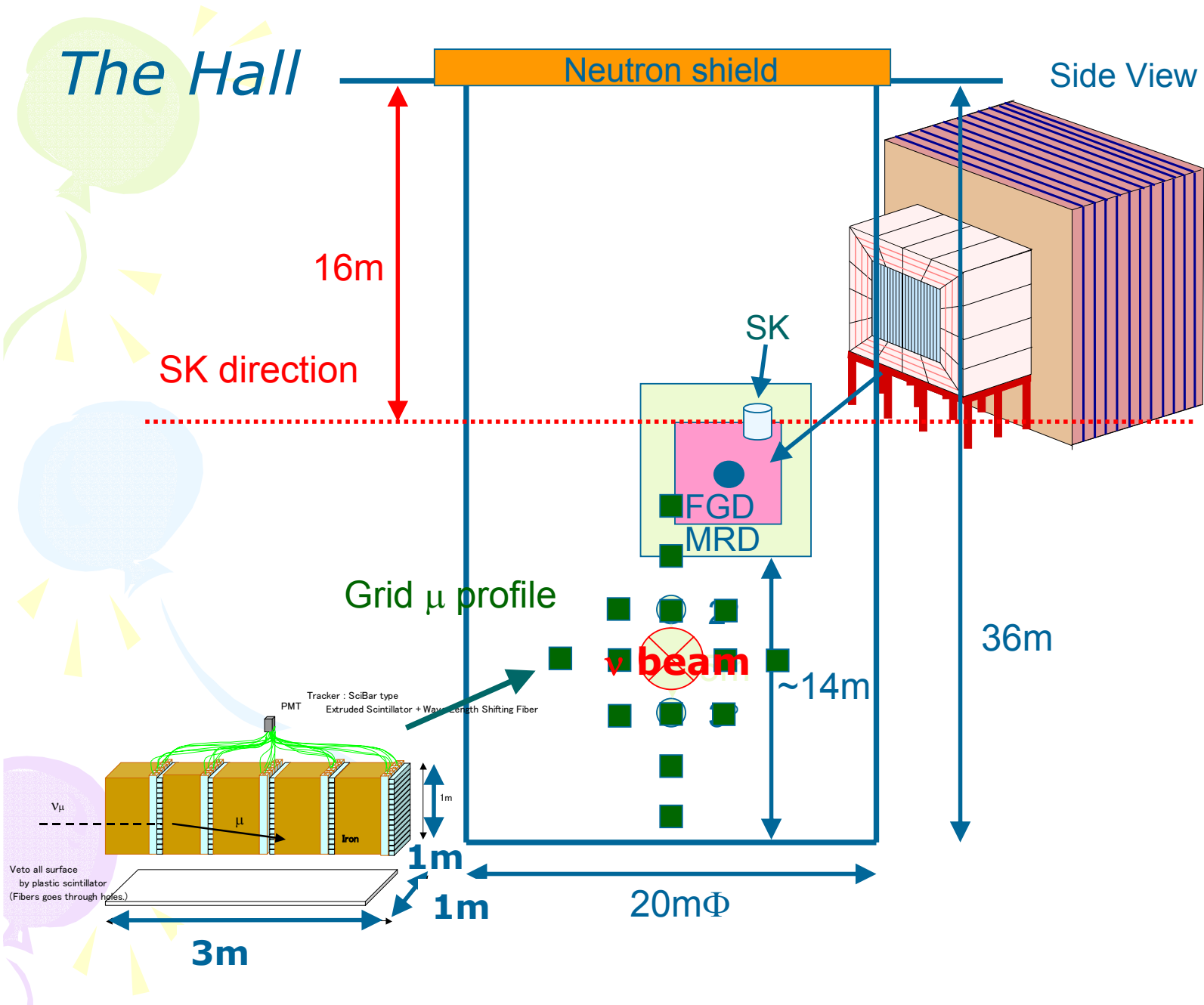
- **Off-axis (2~3 degrees)**

- ν_μ and ν_e neutrino fluxes and the spectra.
- ν interaction study (CC-QE, non-QE, π^0 ,)
- Kaon Contributions
- (Nuclear dependence (Carbon v.s. Oxygen))?

The detector design is just starting!!

⇒ The design is not fixed yet, and we have many options at this stage.

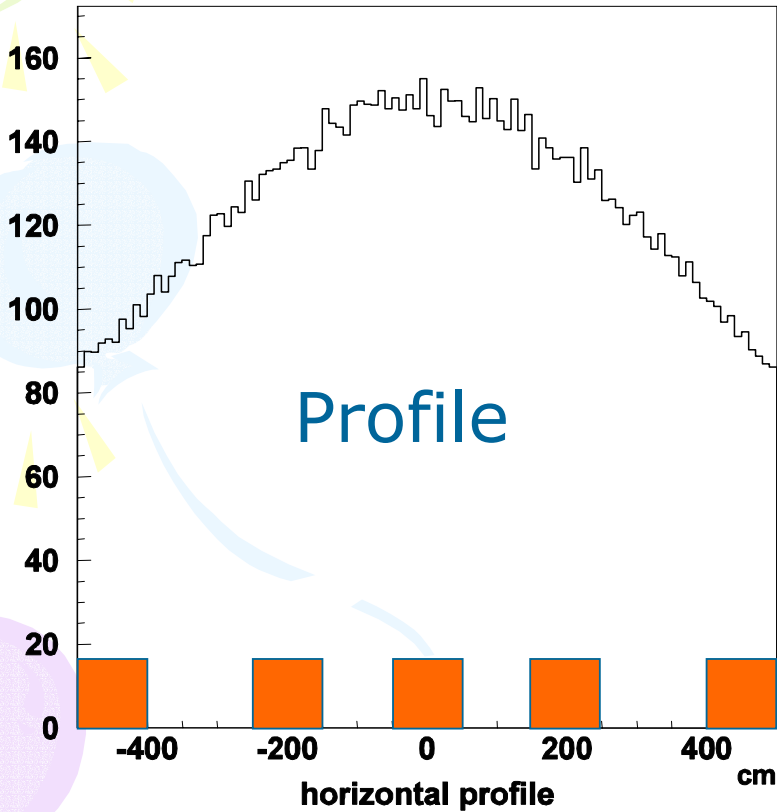
The Hall



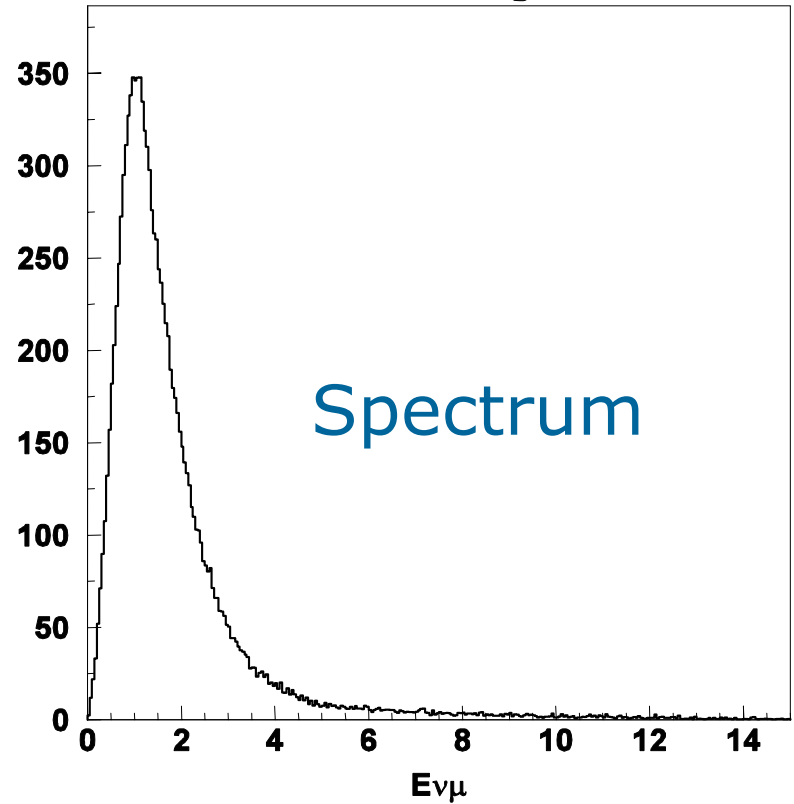
neutrinos at on-axis

~ 0.2 events/ton/spill

280m



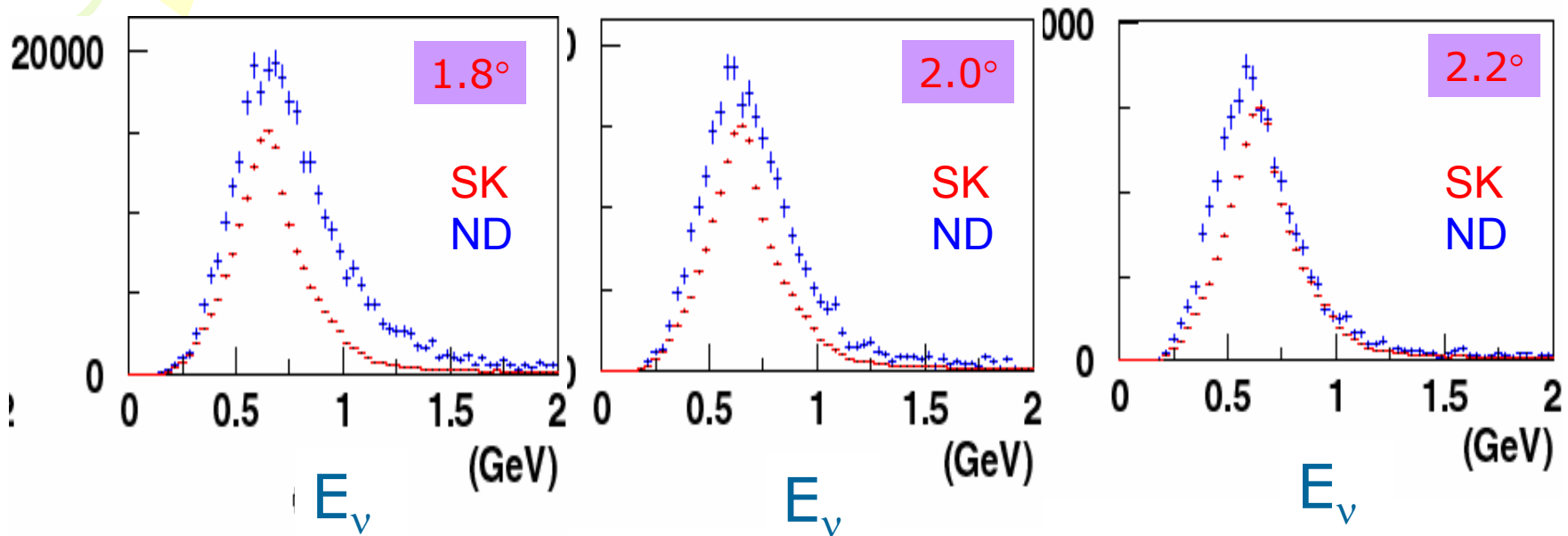
280m at 0degree



neutrinos at off-axis

Beam OA2.5deg

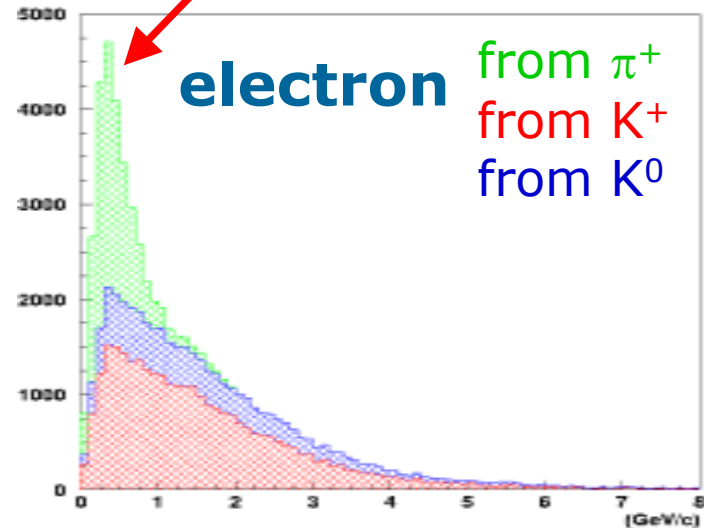
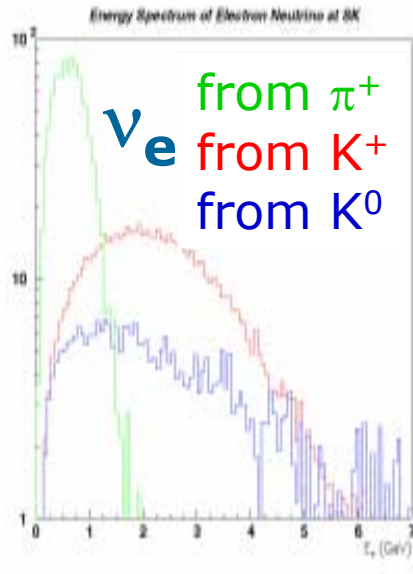
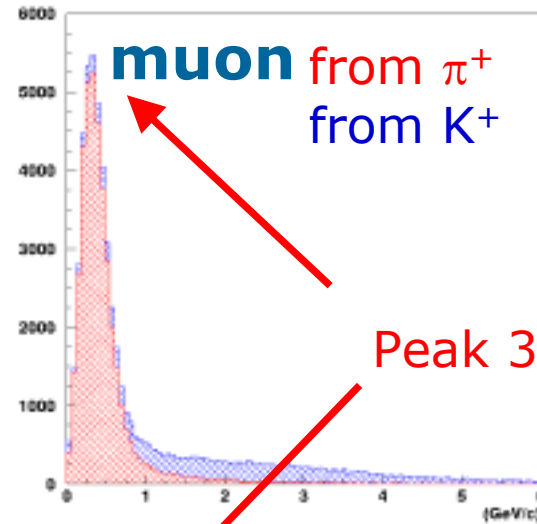
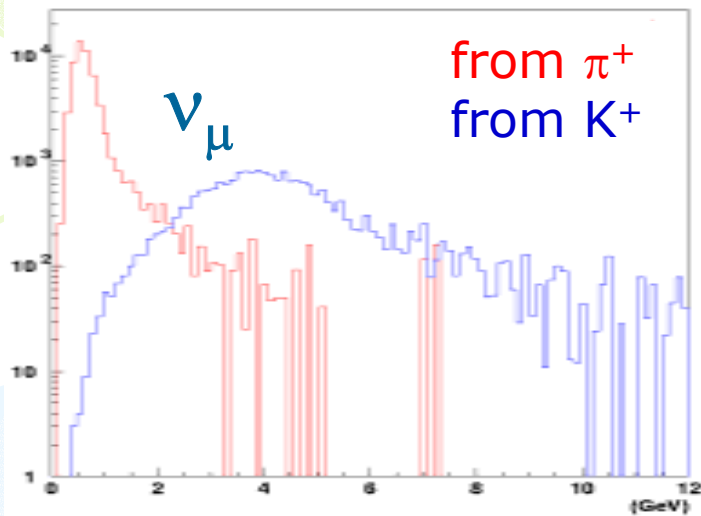
~ 0.06 events/ton/spill



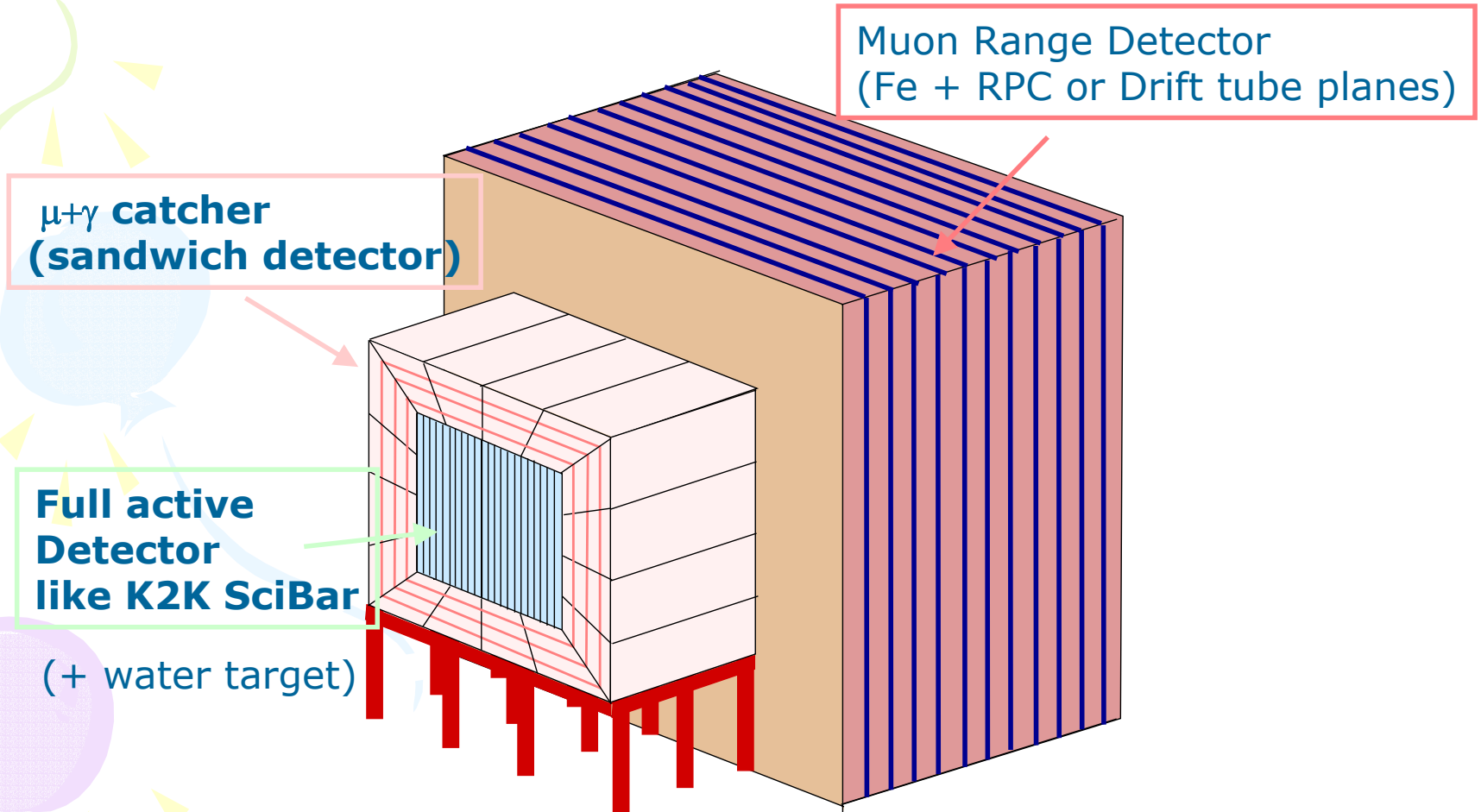
$0.2^\circ \Rightarrow 1\text{m}$ at the detector position.

It will be a useful tool to study neutrino interaction.

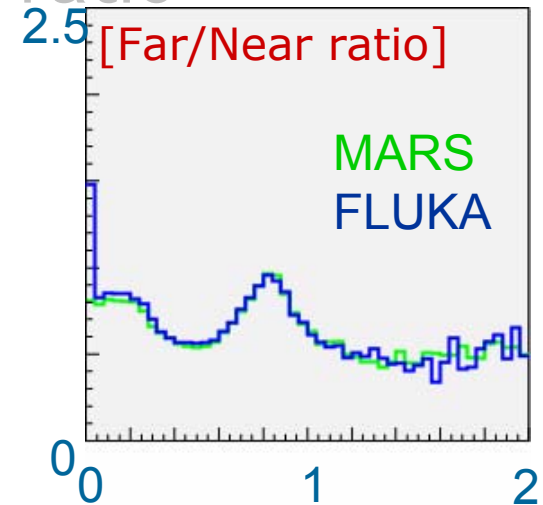
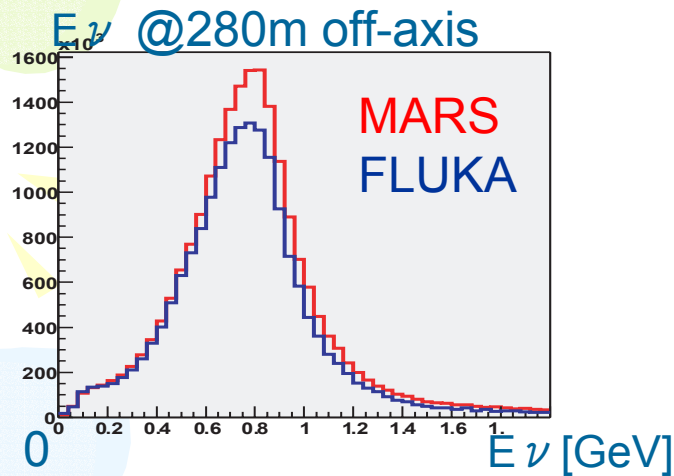
Physics objects (momentum) at off-axis



A detector Design



Hadron-Production Model dependence on the Far/Near ratio



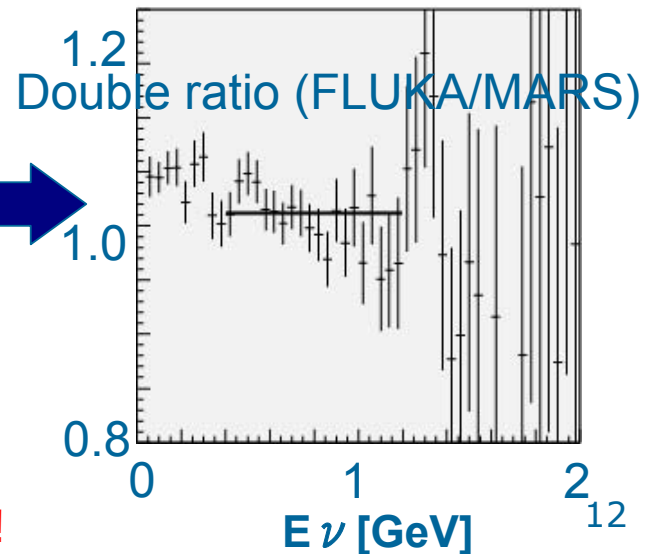
$$\text{Flux @SK} = \text{Flux @ND} \times [\text{Far/Near ratio}]$$

From MC simulation

**The Difference of Far/near ratio is
 $\sim 1.2 \pm 0.6\%$**

(Energy range: 0.4 ~ 1.2 [GeV])

The effect may be small! ← to be checked!

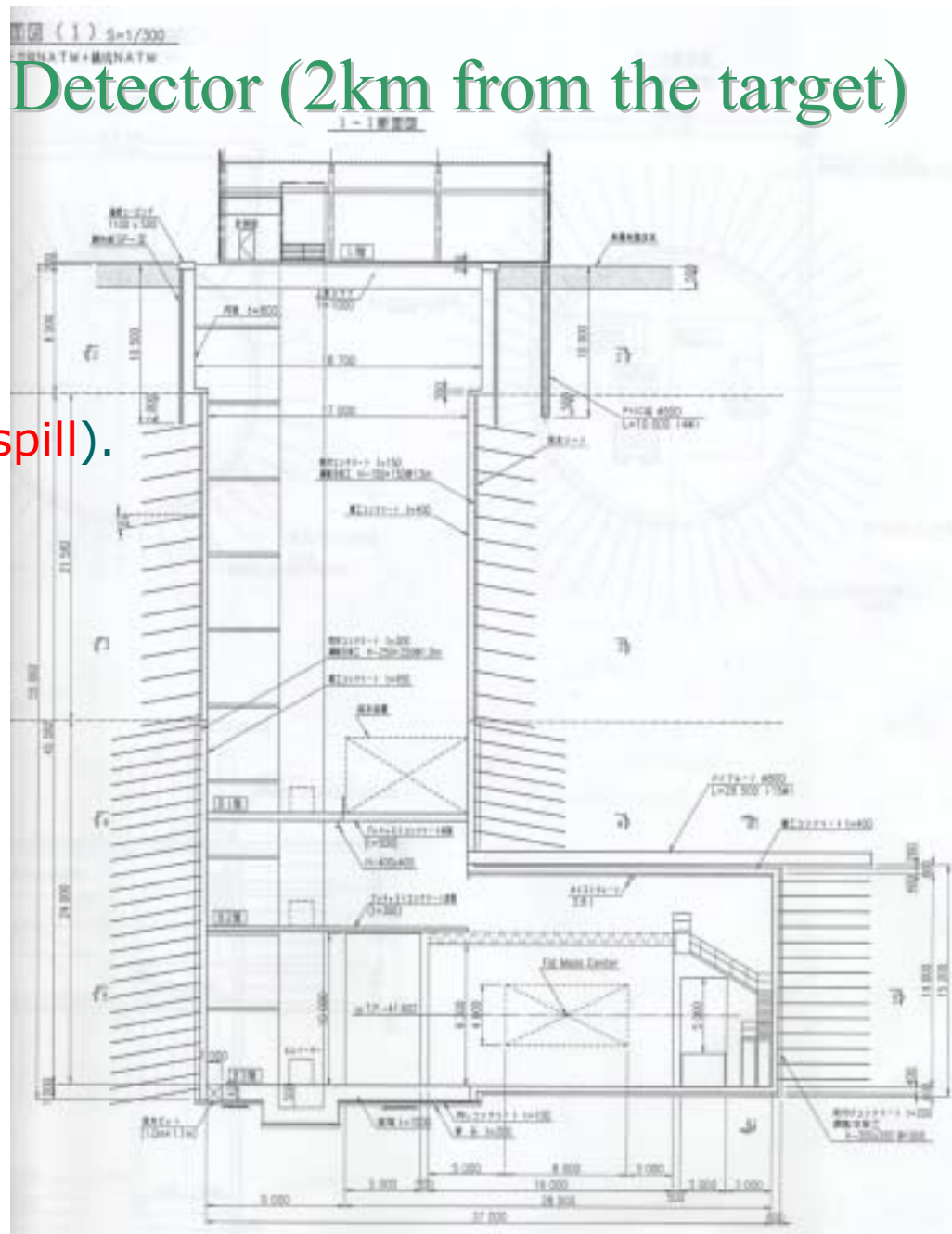
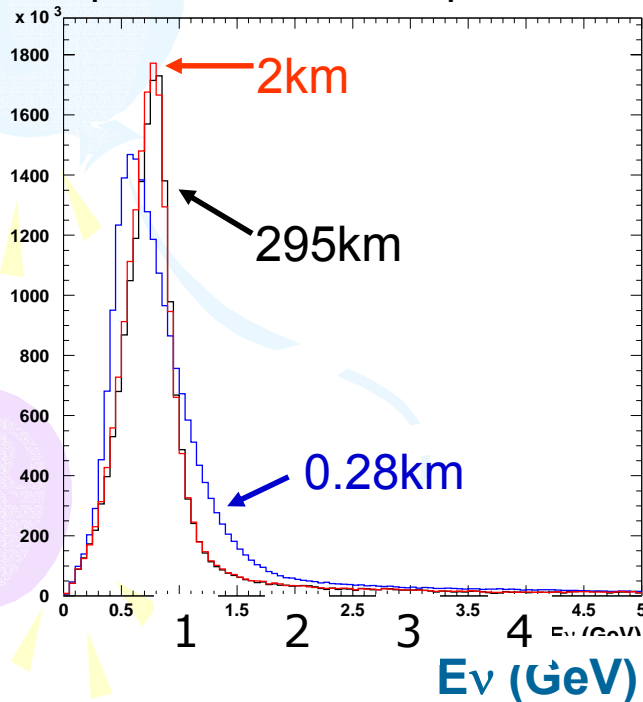


3. Medium Neutrino Detector (2km from the target)

There is a place to be rent
for the experiment.

- Almost same E_ν as SK
- Water Cherenkov can be operated (~ 1 events/kt/spill).

Spectra at different positions

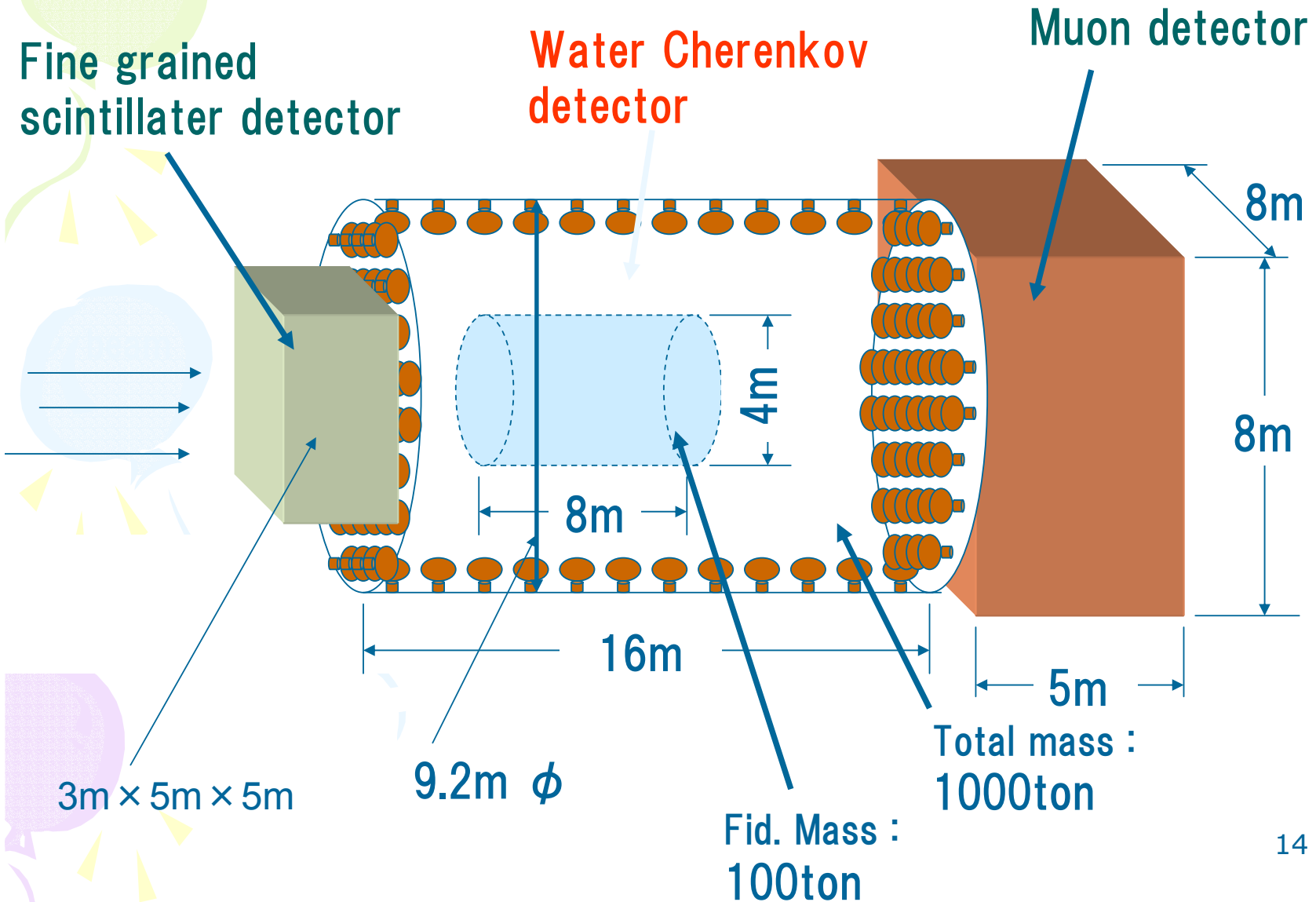


A 2km Detector

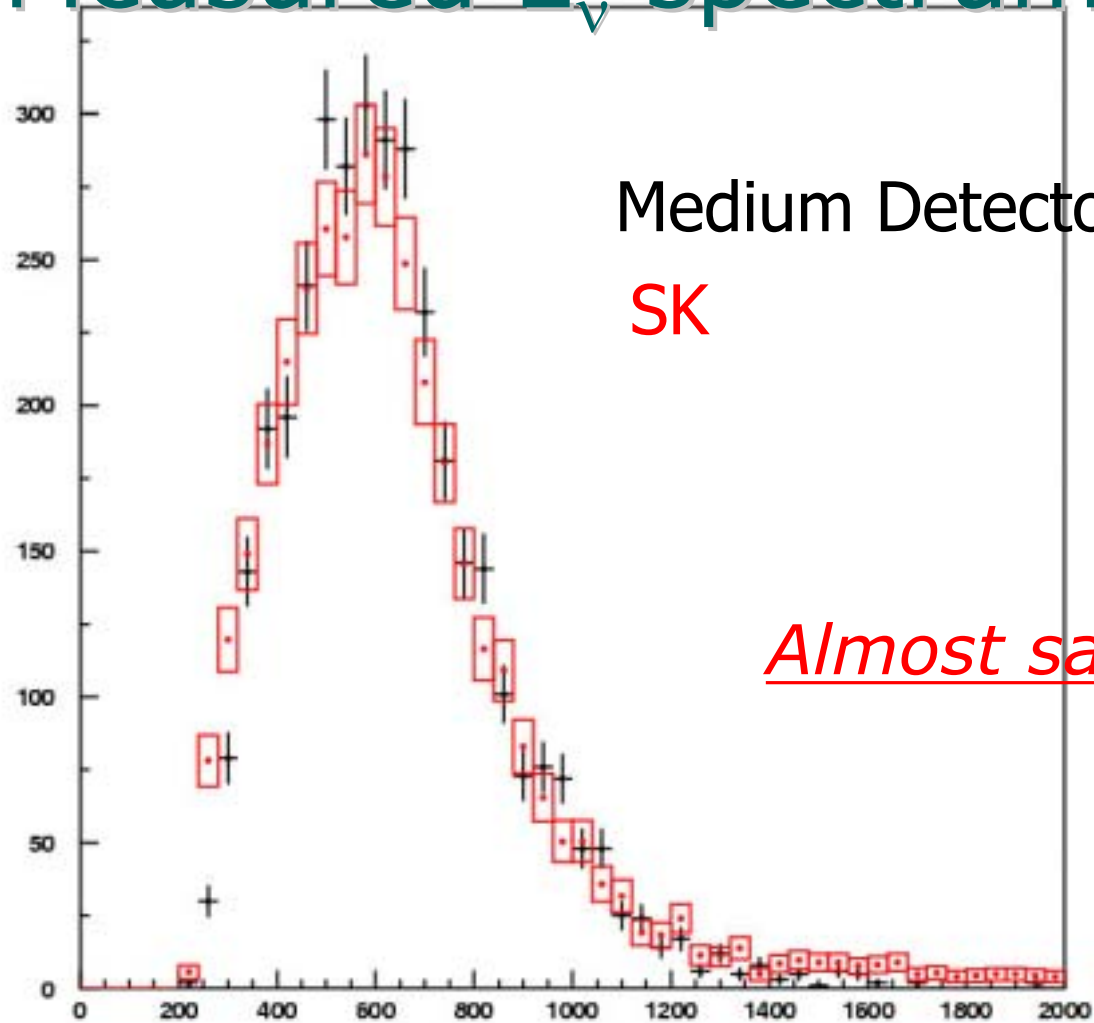
Fine grained
scintillater detector

Water Cherenkov
detector

Muon detector



Measured E_ν spectrum



Reconstructed E_ν (MeV)

4. Summary

- Two types of near neutrino detector at on-axis and off-axis is necessary to monitor the neutrino beam.
- A medium neutrino detector is essential to reduce the beam systematic and test the water Cherenkov reconstruction.