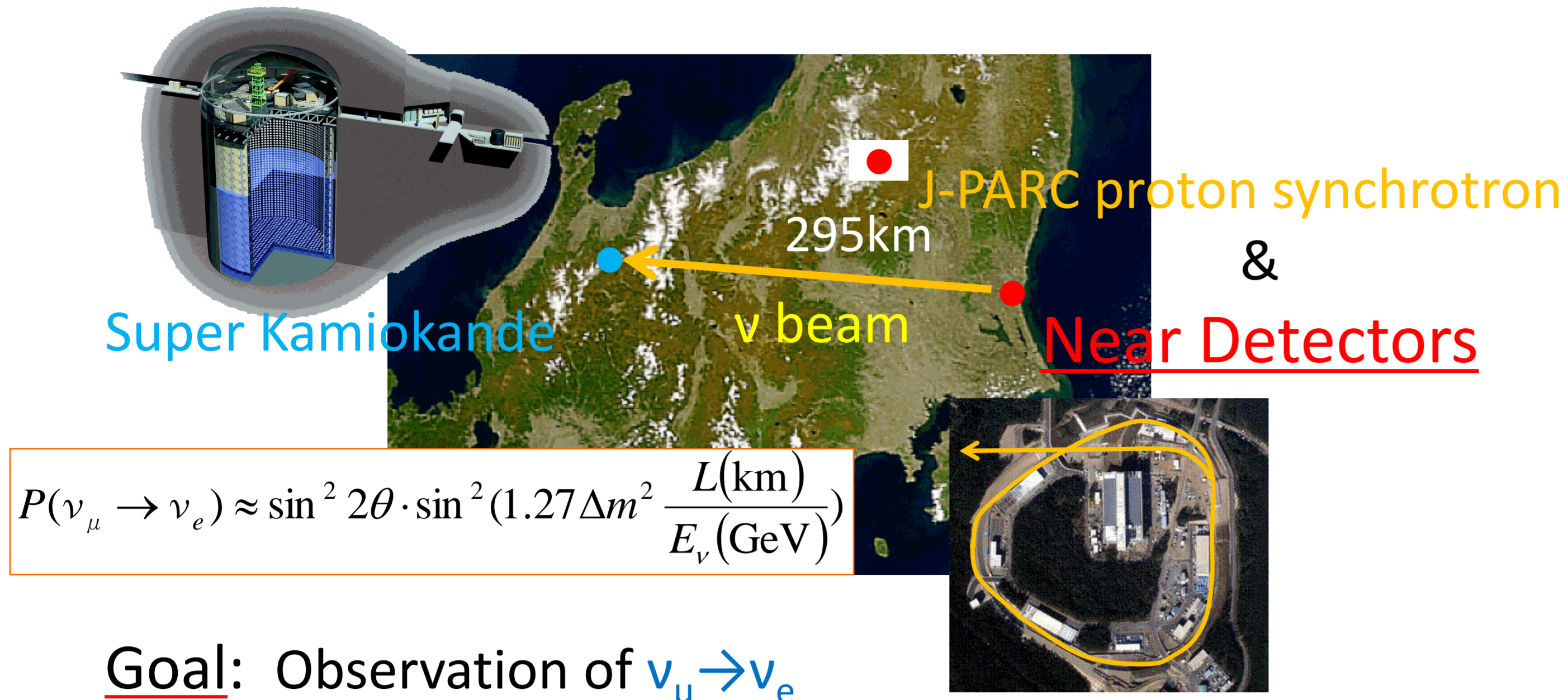




Fine-Grained neutrino detector for the T2K neutrino oscillation experiment

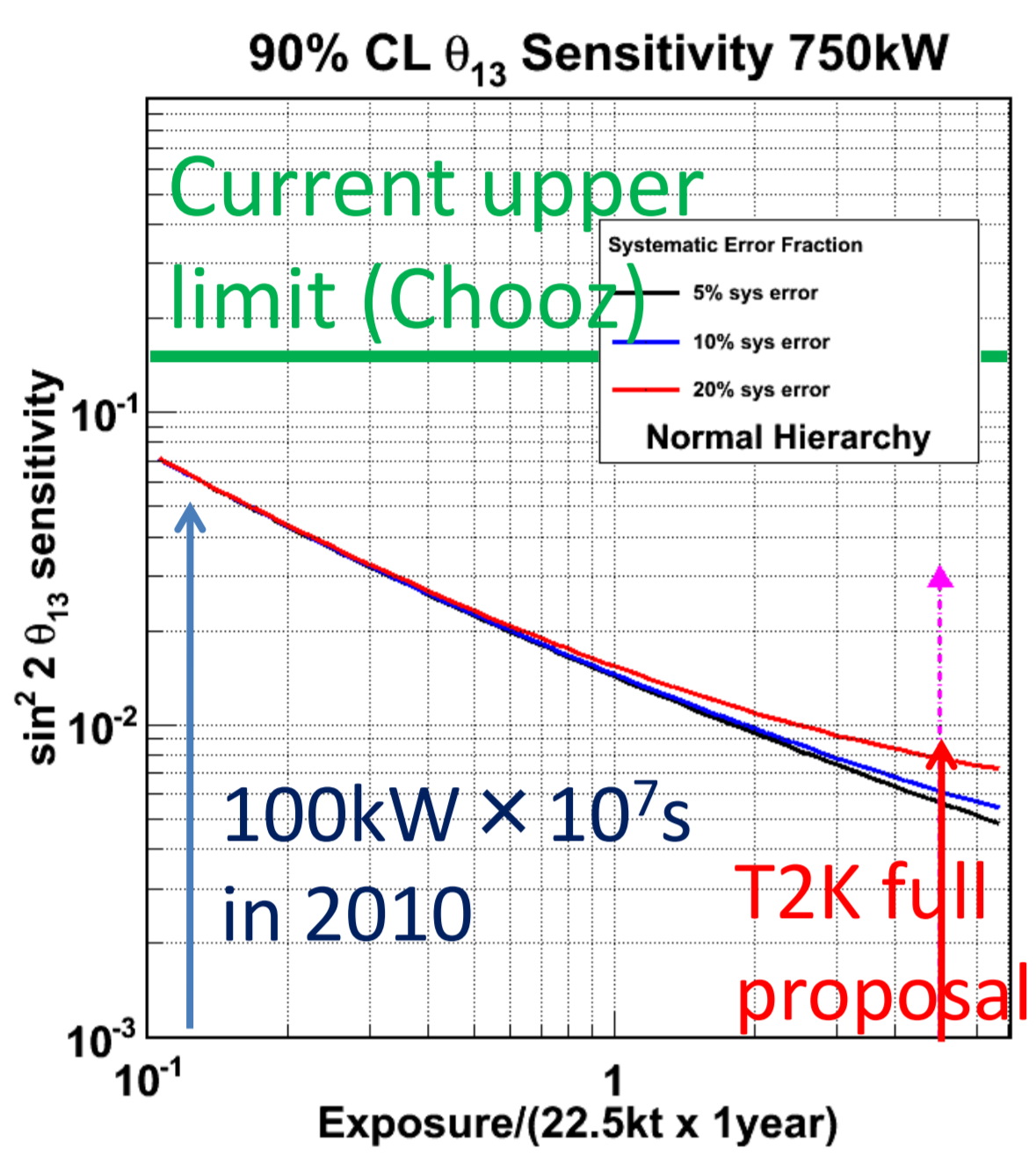
Kei Ieki and Akira Murakami for T2K collaboration

1. The T2K experiment



$$P(\nu_\mu \rightarrow \nu_e) \approx \sin^2 2\theta \cdot \sin^2(1.27 \Delta m^2 \frac{L(\text{km})}{E_\nu(\text{GeV})})$$

Goal: Observation of $\nu_\mu \rightarrow \nu_e$
⇒ Measure un-known mixing angle θ_{13}

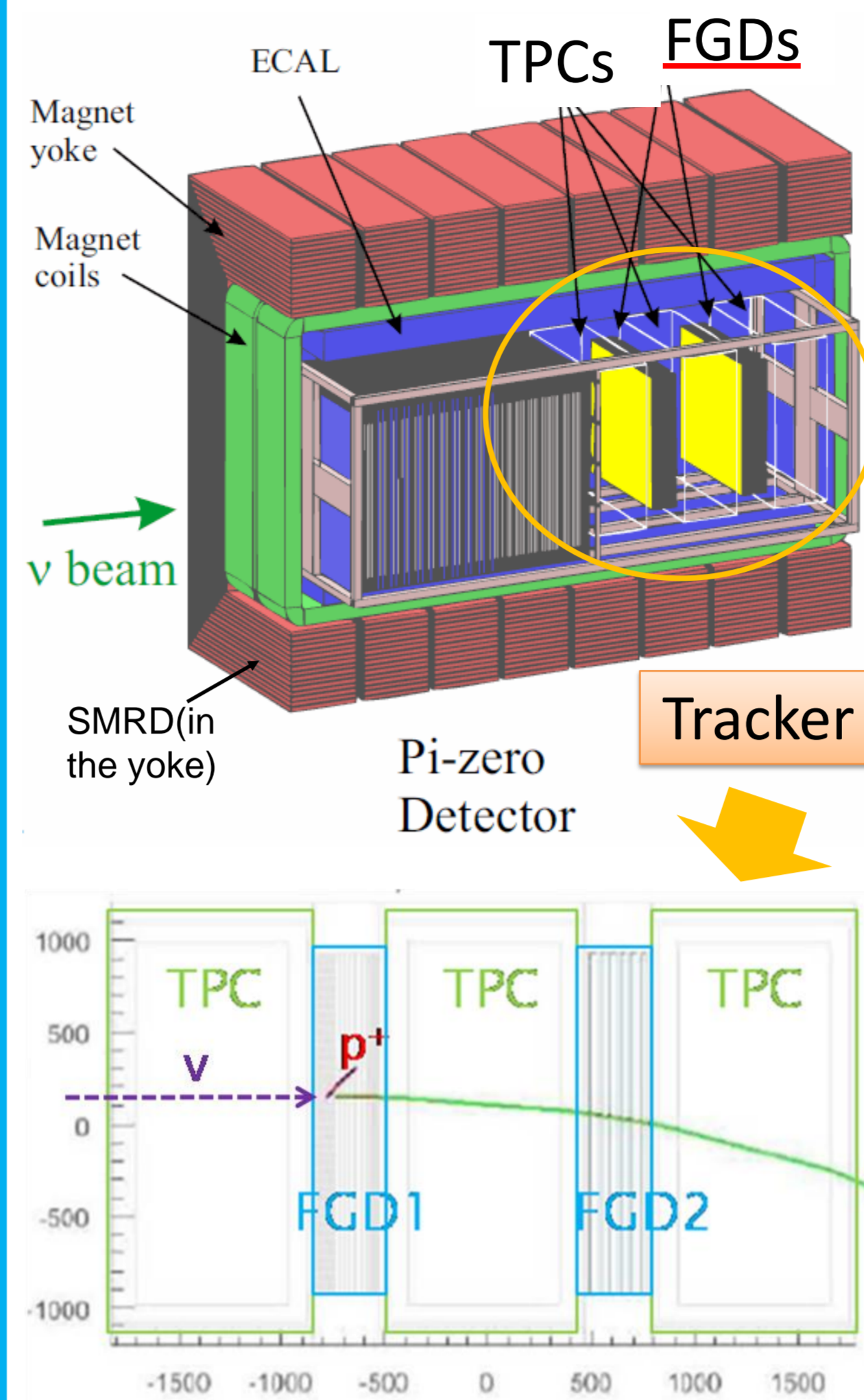


High sensitivity required!

- Intense neutrino beam
- 50kt giant water Cherenkov detector
- Precise beam measurement & monitoring by near detectors

Started commissioning run from 2009 Apr
1st Physics run from Mar 2010!

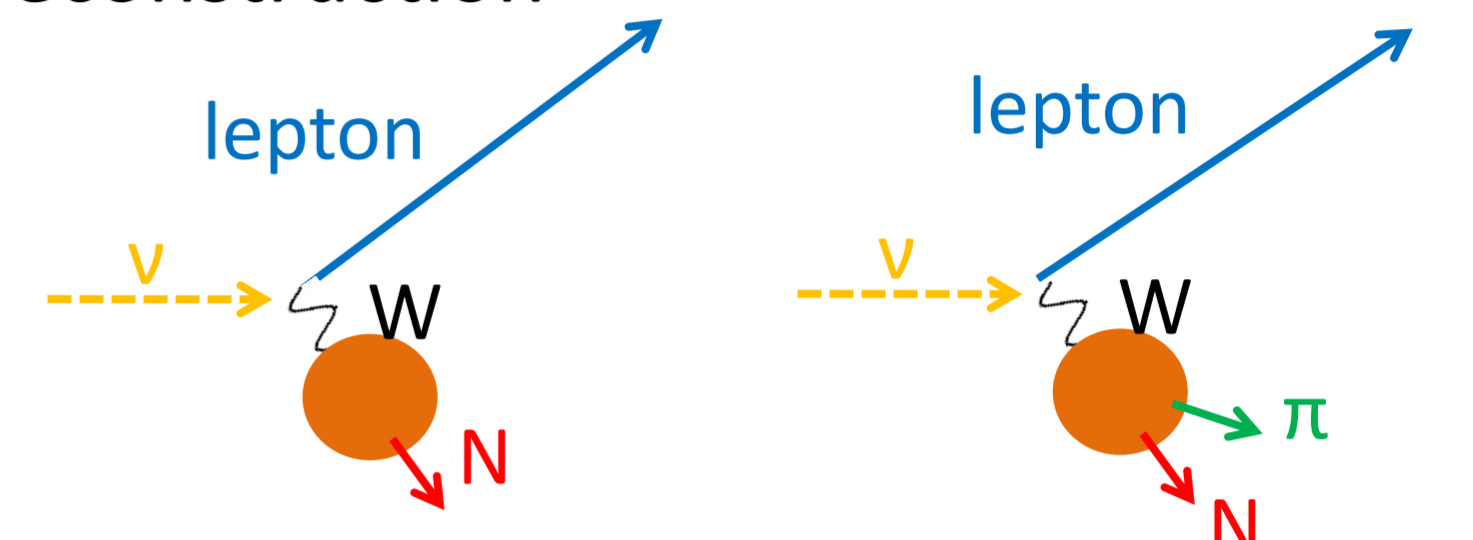
2. Near Detector complex



Measure initial ν energy spectrum from neutrino interaction rate

Neutrino interactions

- $\nu + n \rightarrow l + p$ (CCQE)
Main interaction, ν energy can be derived from lepton momentum
- $\nu + n \rightarrow l + p + \pi$ (CC-1π)
Main background for ν energy reconstruction

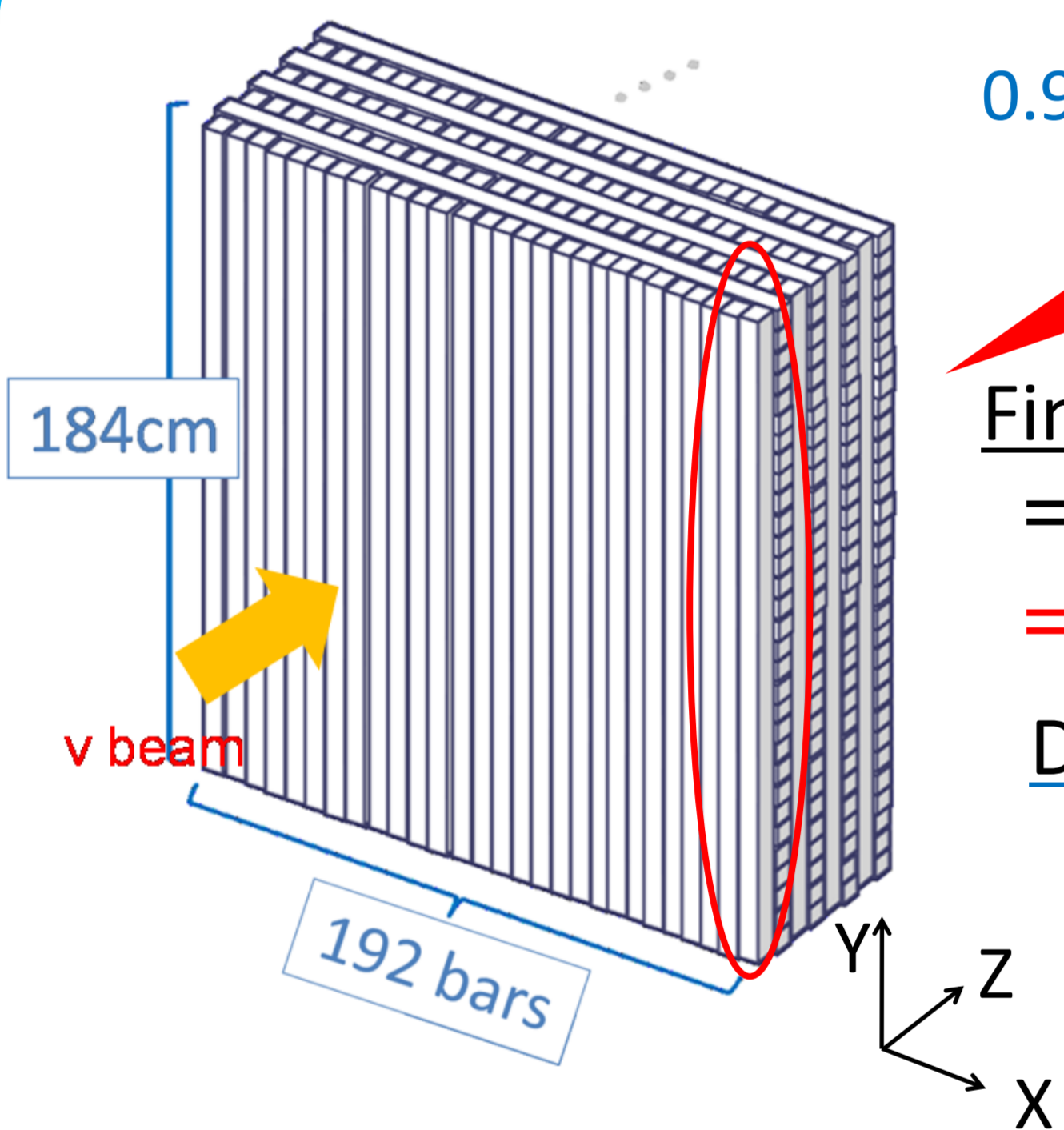


CCQE(Charged Current Quasi-Elastic)
CC-1π
Need to be distinguished

3 TPCs (Time Projection Chambers): Detect μ track in 0.2T magnet
⇒ reconstruct ν energy

2 FGDs (Fine-Grained Detectors): Detect p, π
⇒ Distinguish interactions

3. Fine-Grained Detector (FGD)



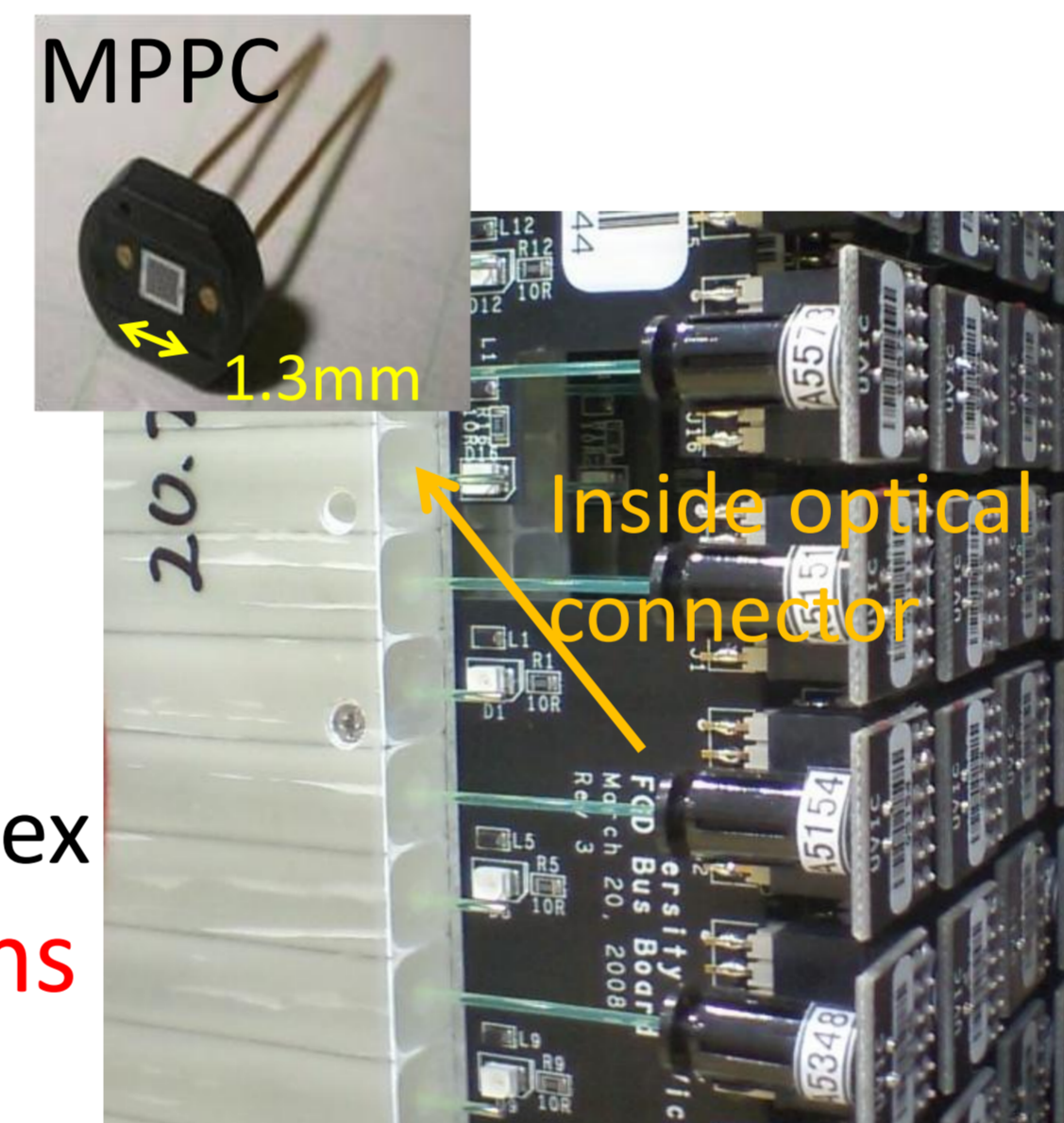
0.96 × 0.96 cm² Wavelength shifting fiber

Finely segmented scintillator bars
⇒ Detect the particle around interaction vertex
⇒ Capable of distinguishing ν interactions

Distinguish p and π by:

- dE/dx, track angle
- Delayed signal from π → μ → e decay

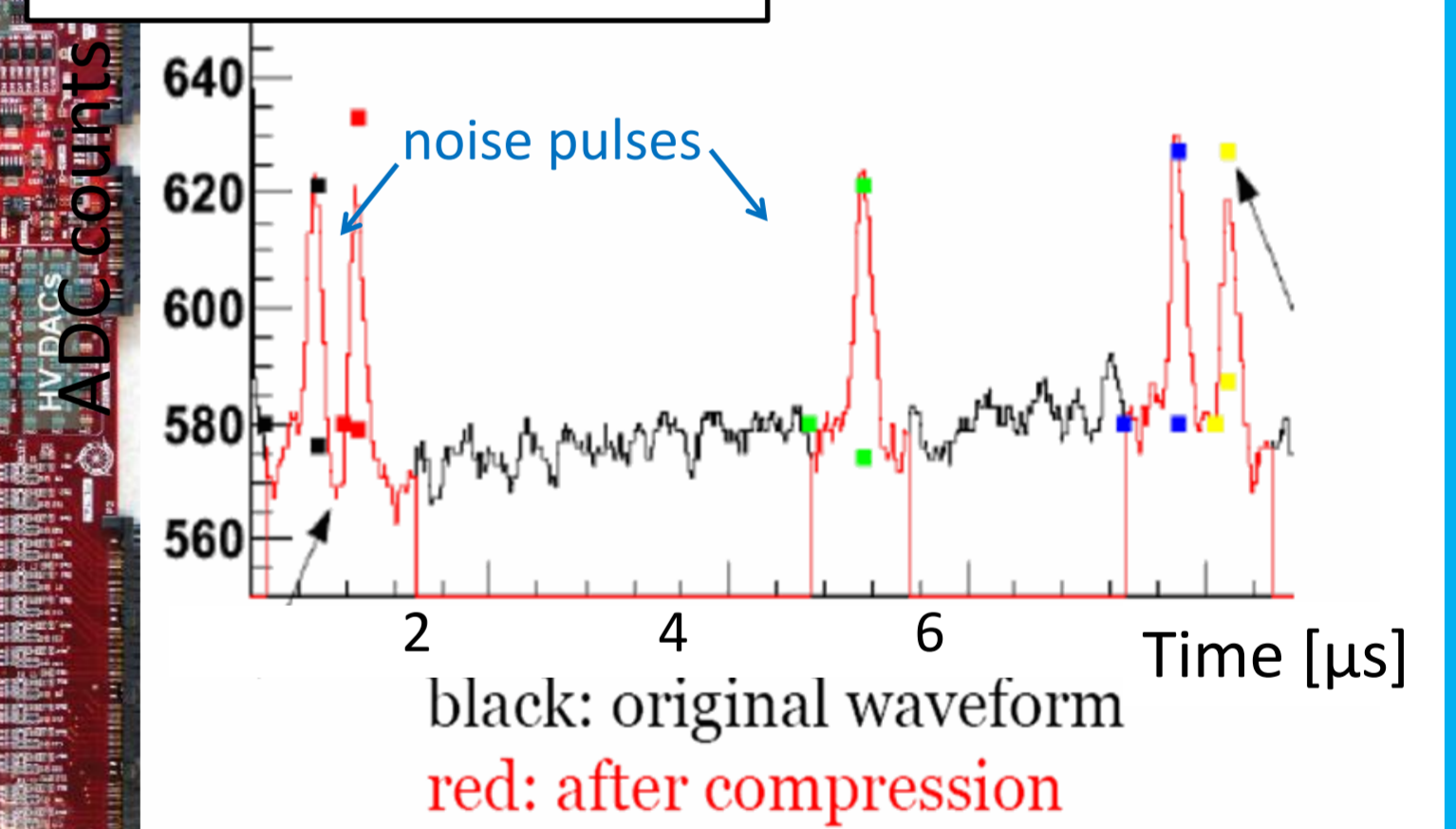
FGD1: 15X,Y scintillator layers
FGD2: 7X,Y scintillator layers
alternating with 6 water panels
⇒ Measure neutrino interaction rate at water (Super-K)



MPPC(Multi-Pixel Photon Counter)

- Compact photon detector
- Works in magnetic field
- Temperature dependent
- High noise rate (few hundred kHz)

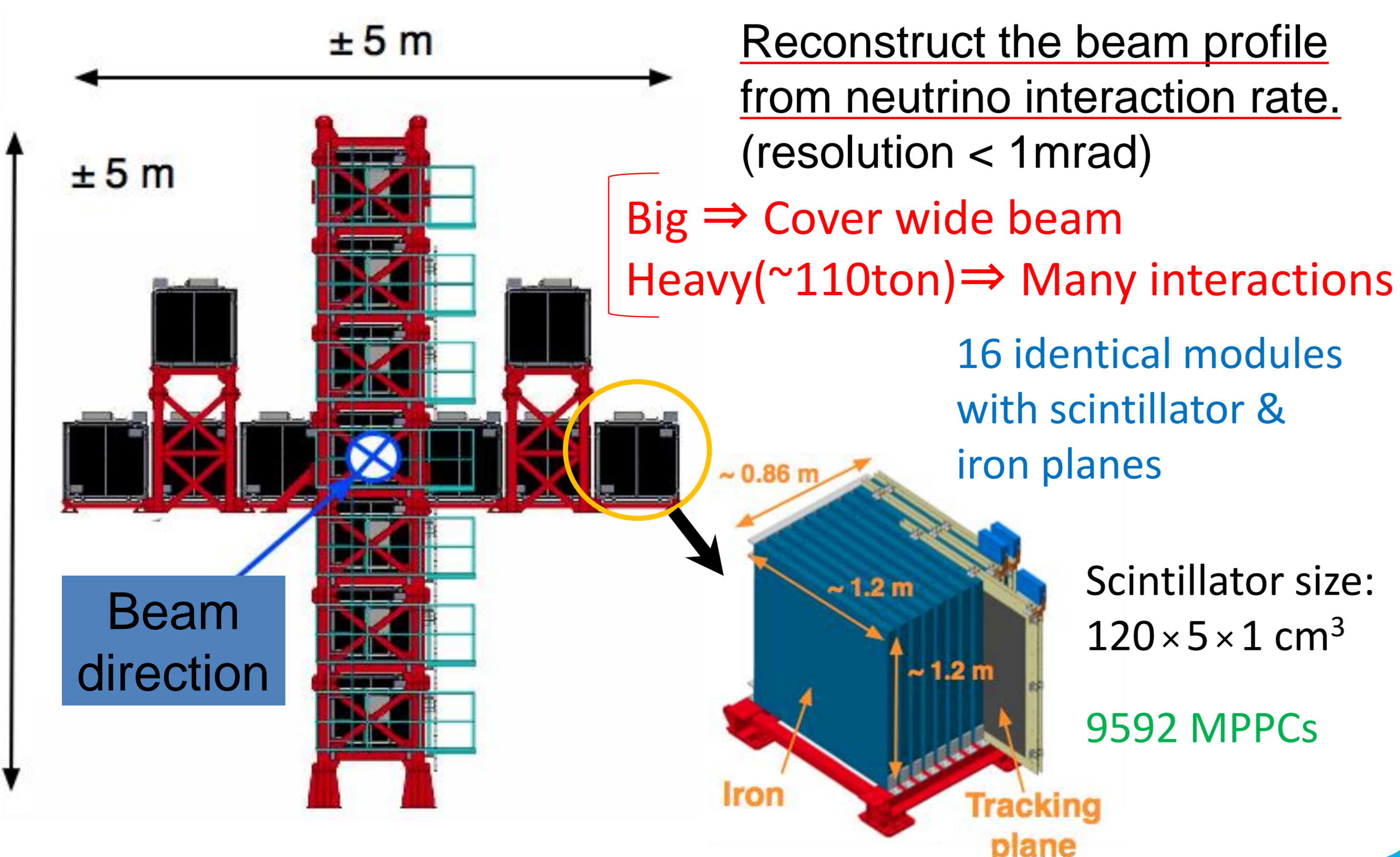
MPPC waveform



Special ASIC chip

- Control bias for 8448 ch
- Waveform digitization (50MHz, 10μs)
⇒ acceptance for delayed hit
- Data compression

4. Beam monitor INGRID

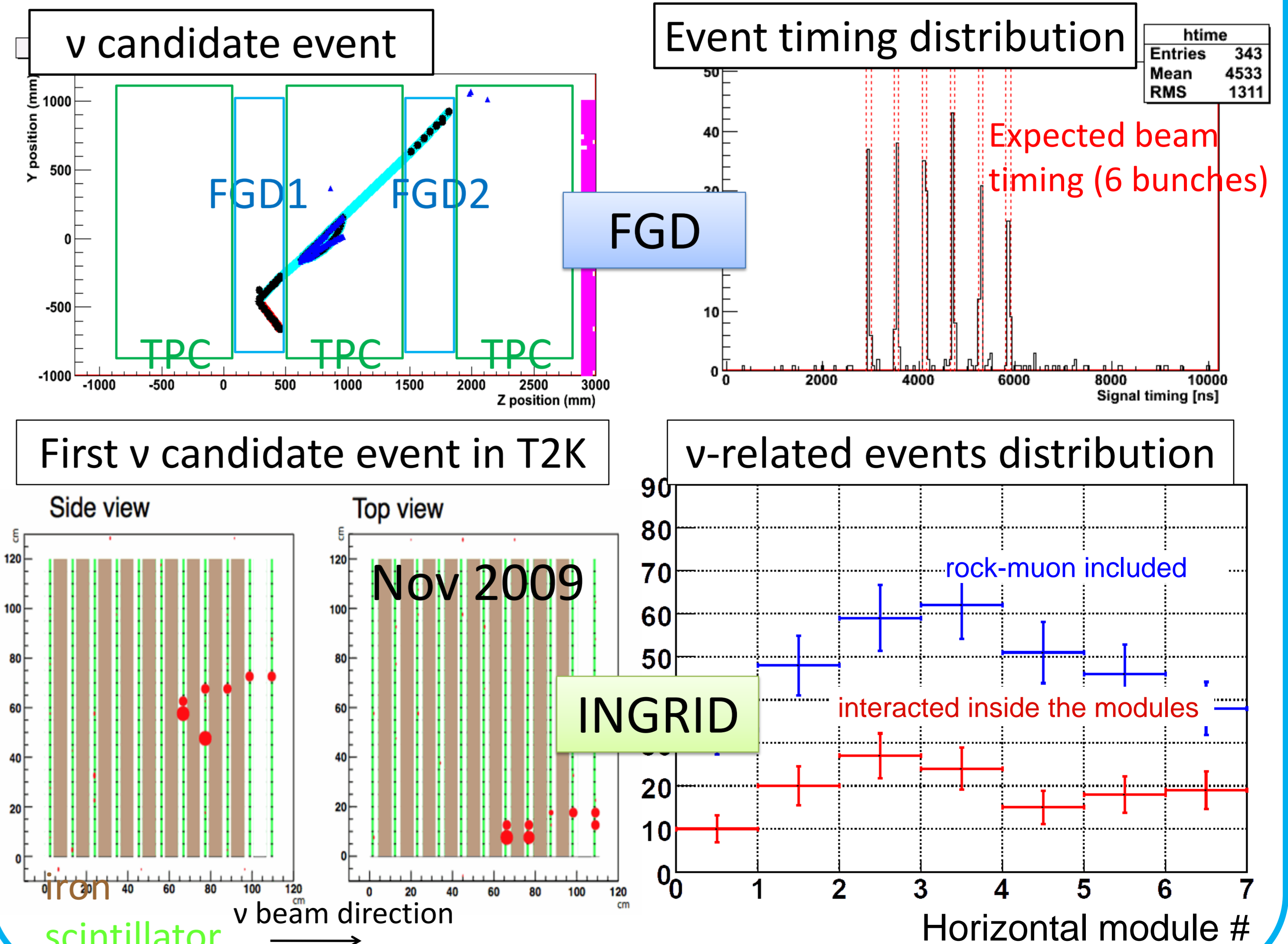


Reconstruct the beam profile from neutrino interaction rate.
(resolution < 1mrad)

Big ⇒ Cover wide beam
Heavy(~110ton) ⇒ Many interactions

5. Neutrino beam commissioning

Commissioning run started from Apr 2009.
Neutrino events were successfully observed.



Ready for physics run!