

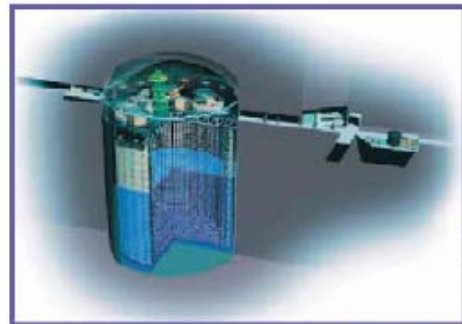
Near Detector (ND280) for the T2K experiment

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(Kyoto University)

20th / May / 2009

@ FFJPPL Workshop 2009

T2K Experiment



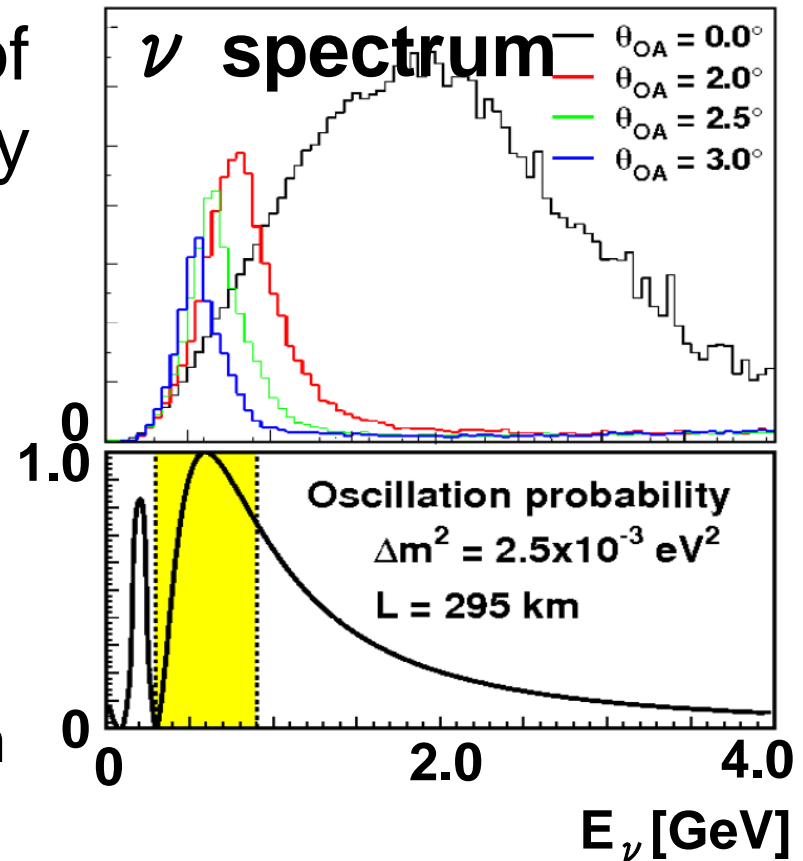
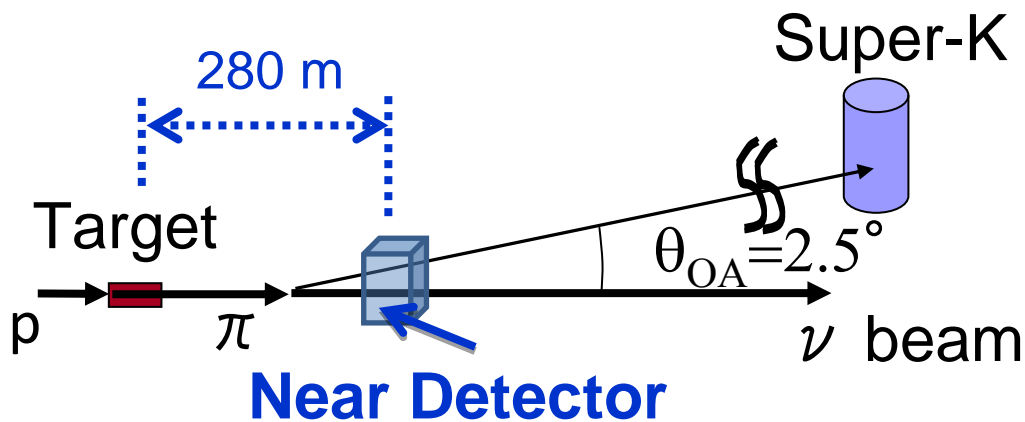
Super-Kamiokande
(ICRR, Univ. Tokyo)



- Long baseline neutrino experiment in Japan
 - Search for ν_e appearance from ν_μ beam
 - Precise measurement of ν_μ disappearance
- Started from April 2009

Off-axis beam

- Direction of Super-K is out of phase with the beam center by 2.5° to select sub-GeV ν for oscillation maximum.



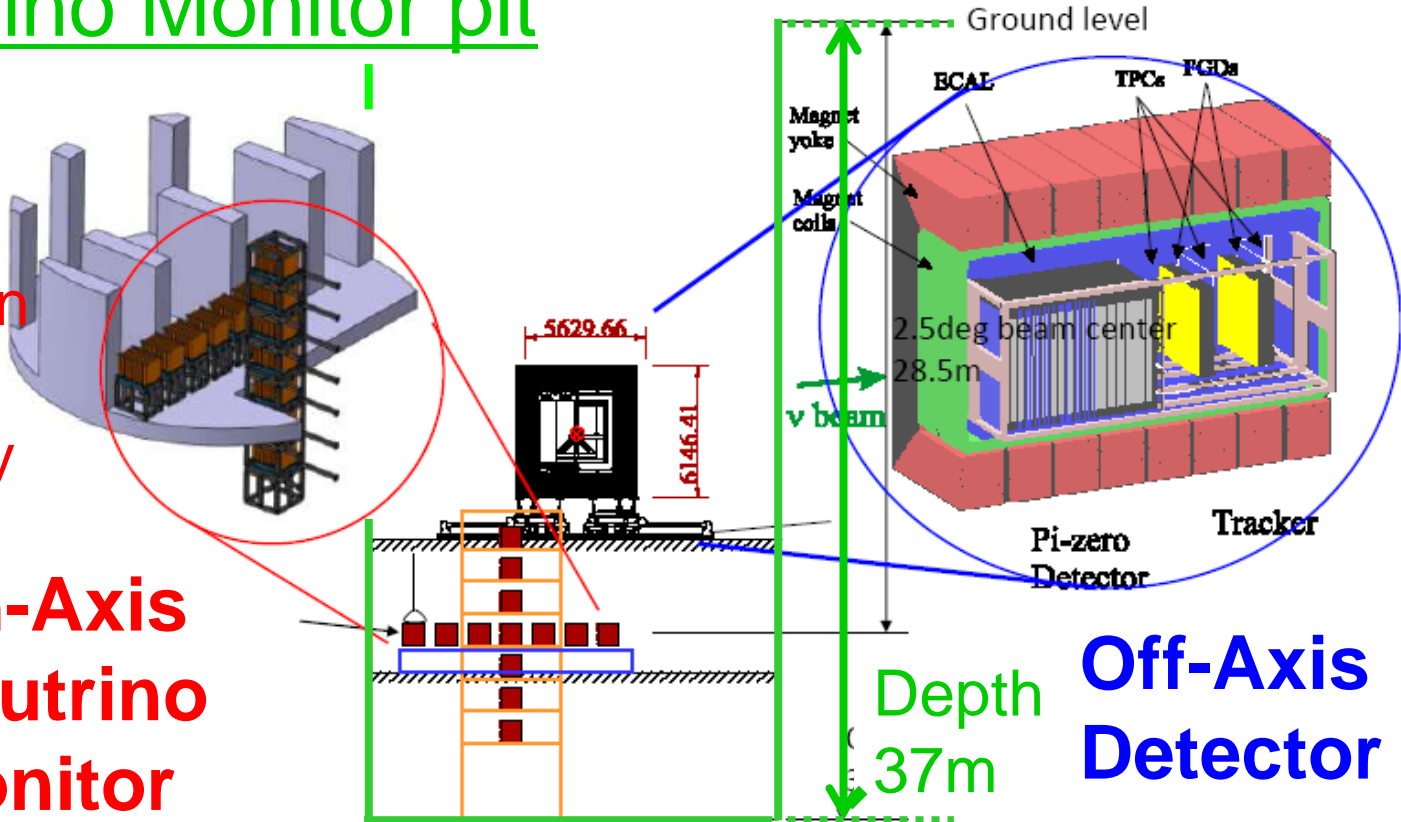
The beam direction has to be monitored with high precision. ($\sin^2 2\theta_{23} \sim 1\% \Rightarrow 1 \text{ mrad}$)

280m Near Detector (ND280)

Neutrino Monitor pit

- Monitor**
- Direction
 - Profile
 - Intensity

**On-Axis
Neutrino
Monitor**



**Off-Axis
Detector**

ν flux and σ in the SK direction

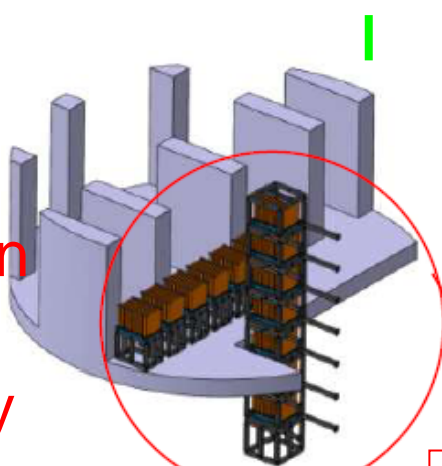
Characterize the neutrino beam at the origin

280m Near Detector (ND280)

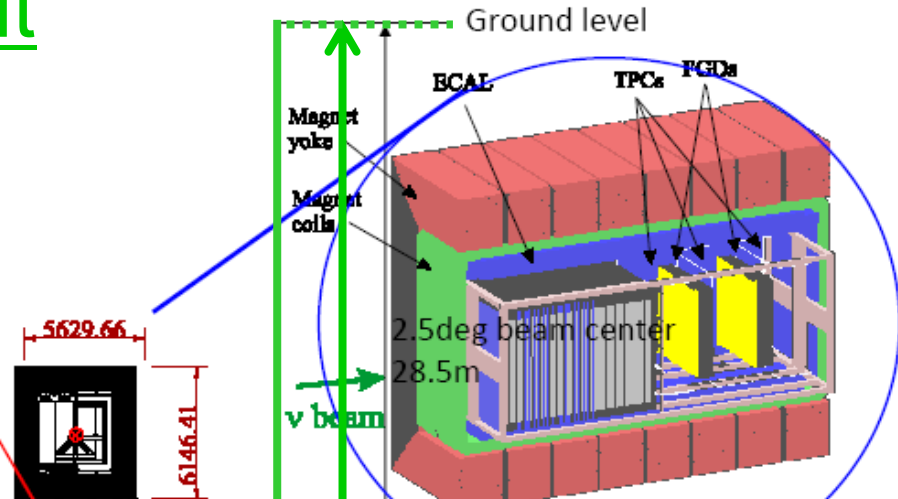
Neutrino Monitor pit

Monitor

- Direction
- Profile
- Intensity



On-Axis Neutrino Monitor

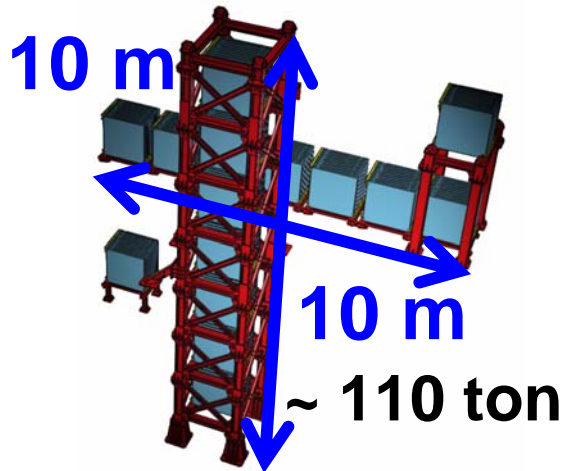


Kyoto University
LLR / Ecole Polytechnique
IPNL / LYON
Osaka City University

Characterize the neutrino beam at the origin

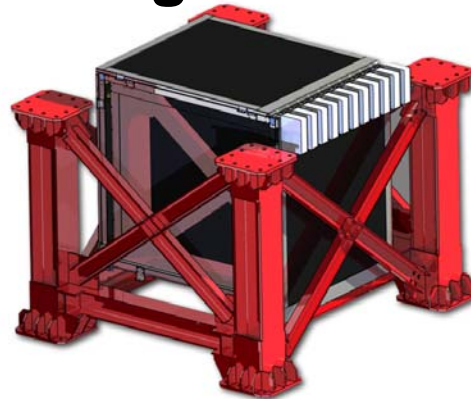
On-axis Neutrino Monitor (INGRID)

INGRID



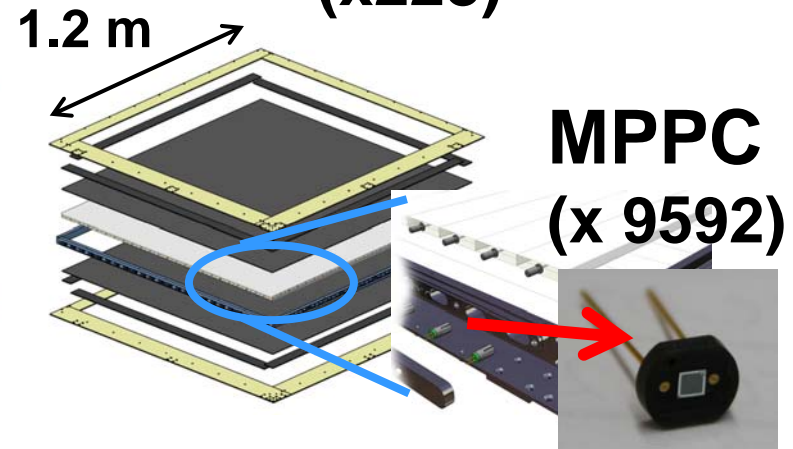
Module (x 16)

Target ~ 7 ton



Scintillator plane

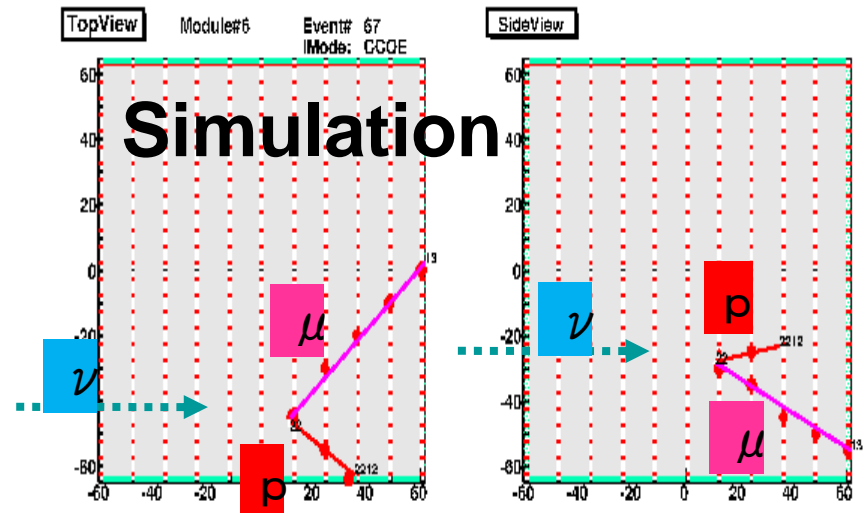
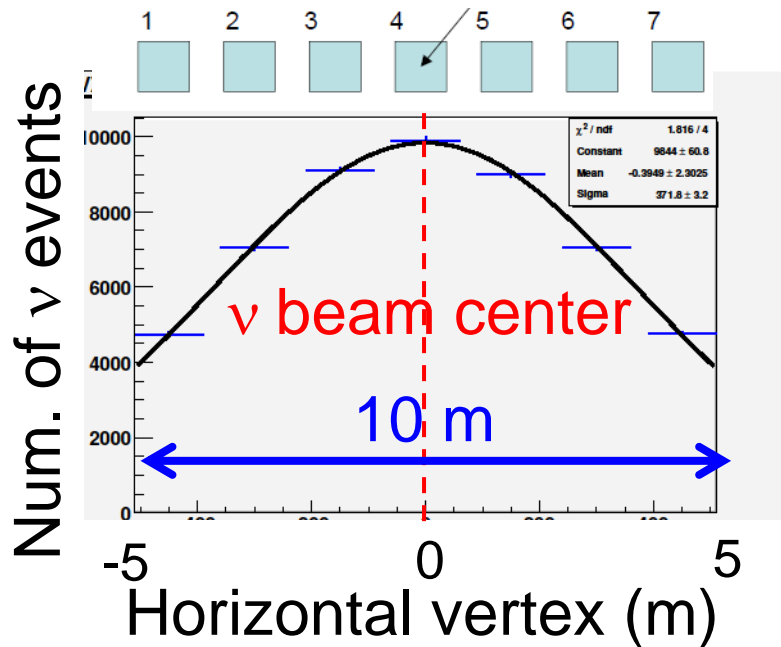
(x228)



- INGRID : 7 (Hori.) + 7 (Vert.) + 2 (Off-axis) modules
- Module : 9 Iron targets + 11 Scinti. planes + Veto planes
- Scintillator plane : 24 ch x 2 layers
 - Scintillator + WLS Fiber + MPPC

On-axis Neutrino Monitor (INGRID)

ν beam profile @ INGRID



ν event ($E_\nu < 3$ GeV)

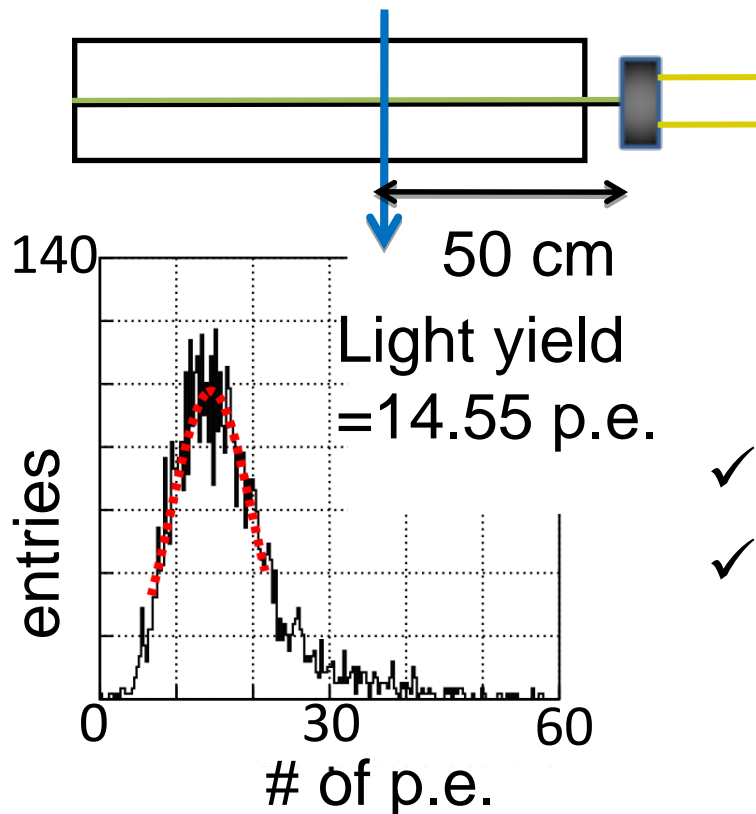
“No backward Veto hit” &
 “> 3 Layer hits” & “ $\theta_\mu > 20^\circ$ ”

- Cover a wide range near the beam center (± 5 m)
- Measure ν beam direction with 1 mrad accuracy
 → 1 mrad = 28cm @ INGRID (E_μ peak shift : 13 MeV)

Light yield of scintillator

We measured light yields of four scintillators used for INGRID with 3 GeV electron beam.

3 GeV electron beam



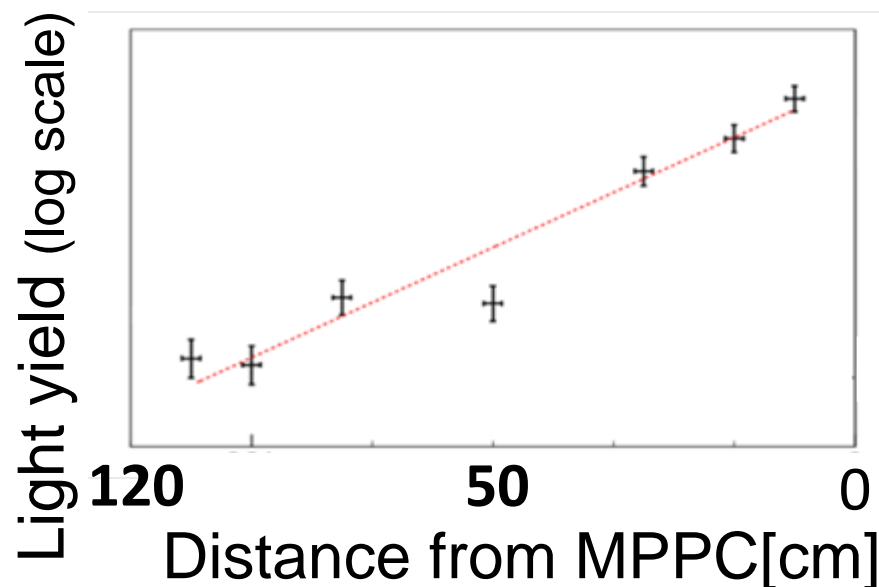
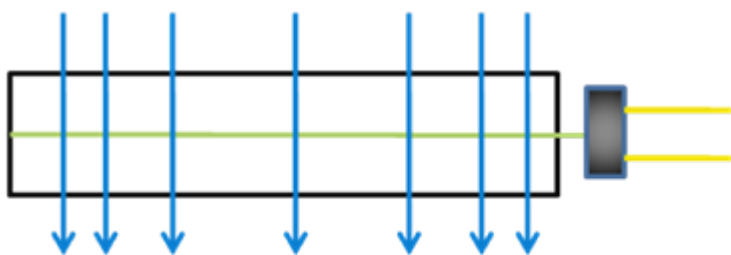
| scinti. # | light yield (p.e.) |
|-----------|--------------------|
| 1 | 14.55 ± 0.15 |
| 2 | 15.24 ± 0.13 |
| 3 | 15.34 ± 0.12 |
| 4 | 14.75 ± 0.1 |

- ✓ The light yields is large enough.
- ✓ Expected efficiencies > 99.9 % with 1.5 p.e. thre. which satisfies our requirement.

Attenuation length of WLS fiber

We measured a attenuation length of fiber used for INGRID with 3 GeV electron beam.

3GeV electron beam



- ✓ Attenuation length of fiber = 238cm
- ✓ Light yield > 14 p.e. at 50 cm from MPPC
- Light yield > 11 p.e. everywhere (efficiency > 99.9 % with 1.5 p.e. thre.)

Production of scintillators

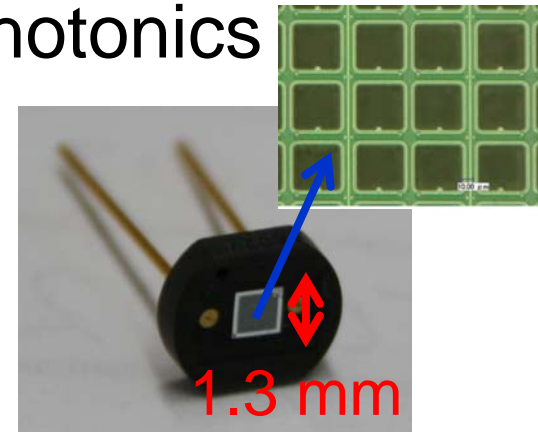
~10000 scintillators were produced at Fermi Lab from Dec. 2007 through Feb. 2008



Photosensor for Near Detector

- We have developed a special **M**ulti **P**ixel **P**hoton **C**ounter for ND with Hamamatsu Photonics

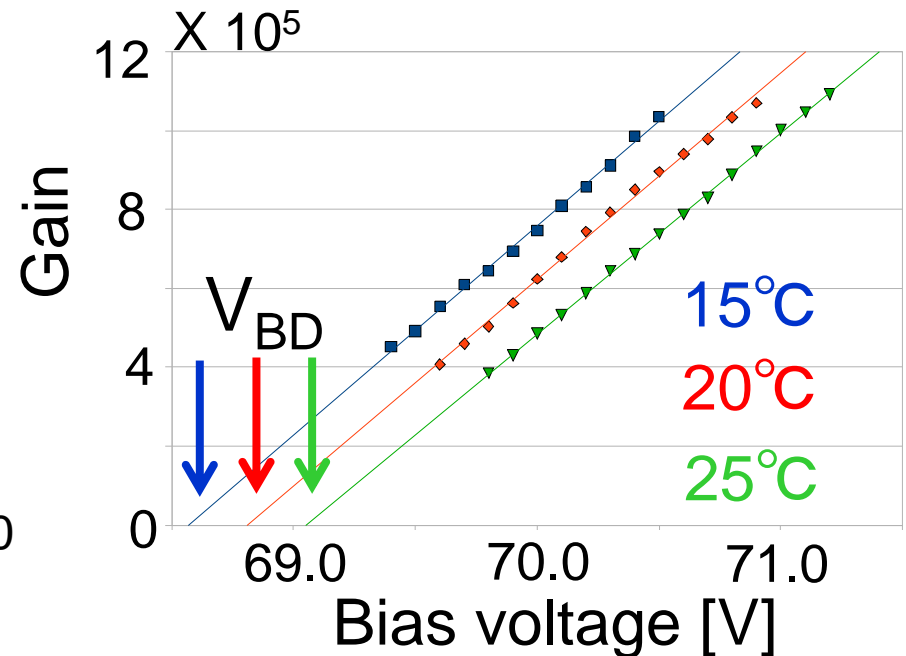
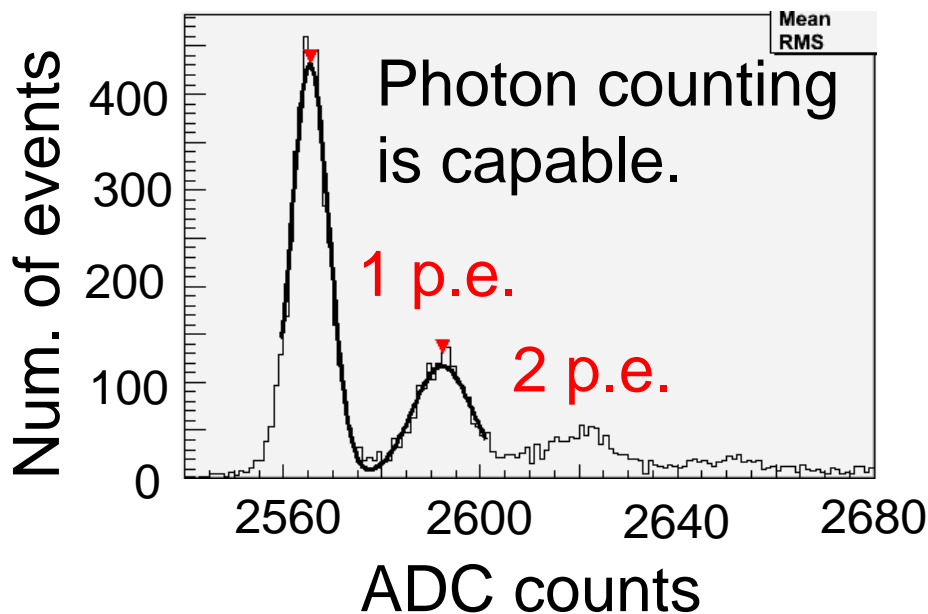
- Active area : 1.3 x 1.3 mm
- Num. of pixels : 667 (50 x 50 μm^2 each)
- Operation voltage : 70 V (typical)
- PDE @ 550nm : > 15 %
- Dark count : < 1.35 MHz @ 25 deg. (Gain = 7.5×10^5)
- Operational in magnetic field (0.2 T)



- Delivery of **63500 MPPCs** for ND was completed in Feb. 2009!

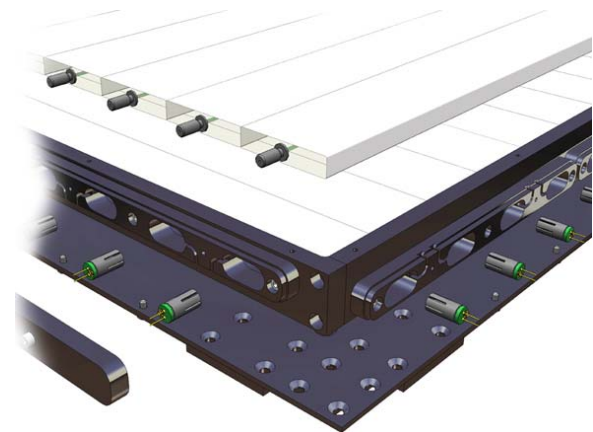
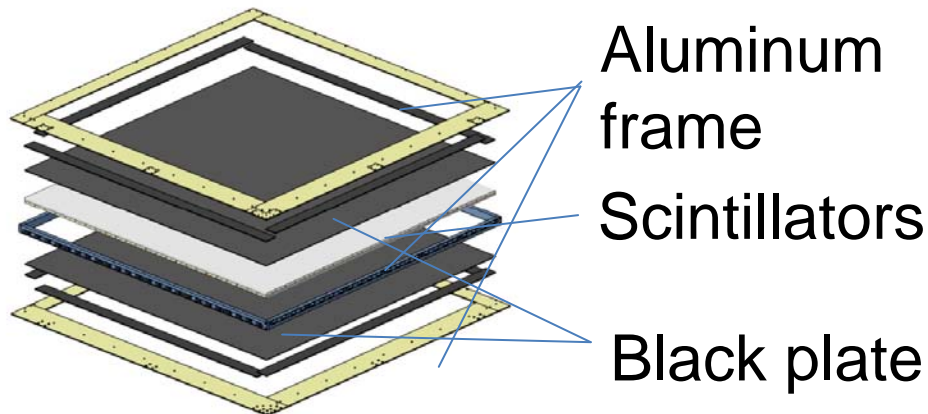
Mass test of MPPCs

- The performances of ~12000 MPPCs used for INGRID were tested at Kyoto & LLR at several voltages and temperatures before installation.
- Rejection rate is 0.07%.



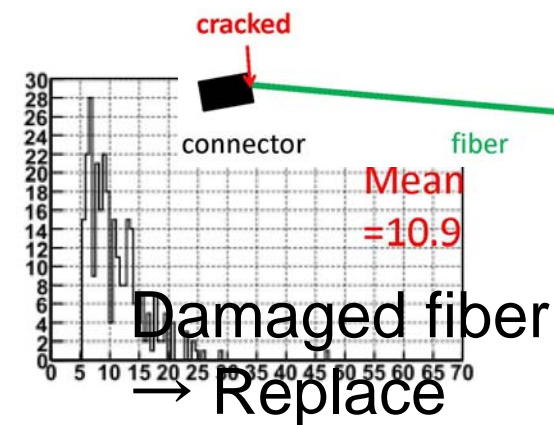
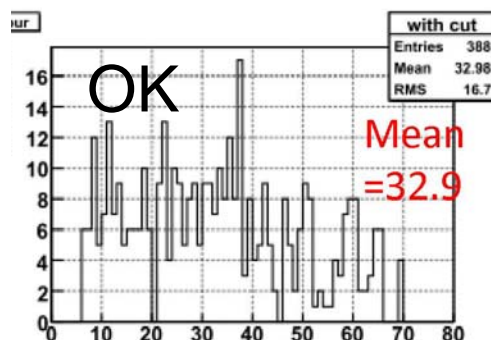
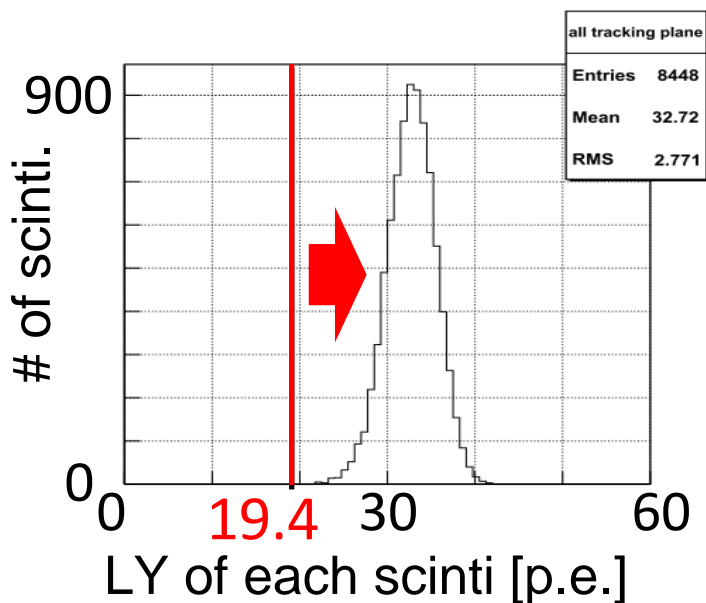
Assembly of scintillator planes

- Mechanical assembly of **all the scintillator planes (x 228)** was completed in Dec. 2008.



Testing of Scintillator planes

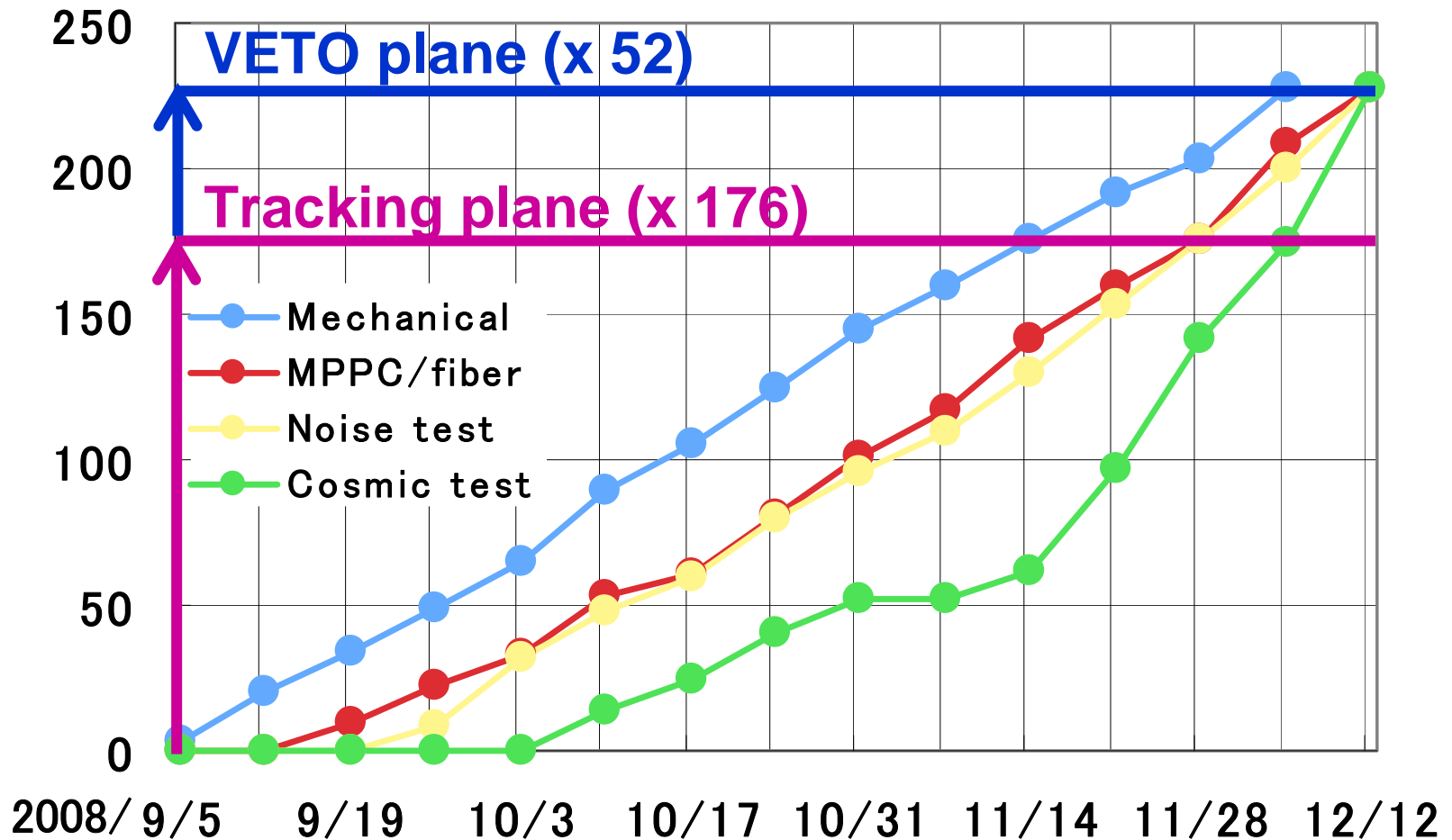
- All the channels (9592 ch) were tested using cosmic events. All OK.



Light yields > 19.4 p.e.
(large enough)



Plane assembly progress



Assembly of 1st module

- Mechanical assembly of 1st module was completed on Feb. 2009



Installation of 1st module

- Installation of 1st module in the Neutrino Monitor pit was completed on May 2009.
- Commissioning of DAQ was completed on Apr. 2009.

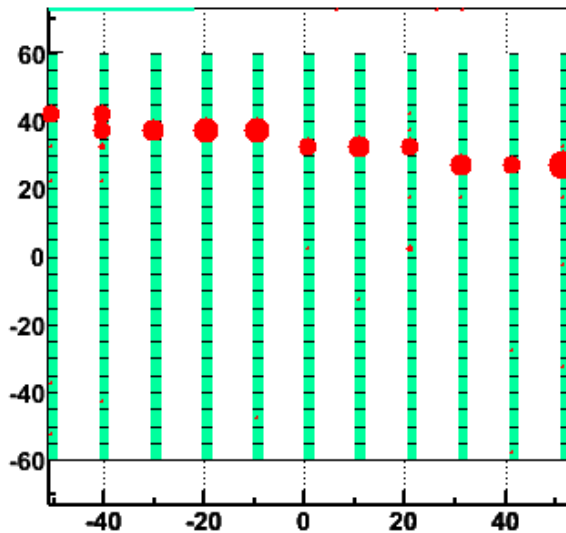


Installation of 1st module

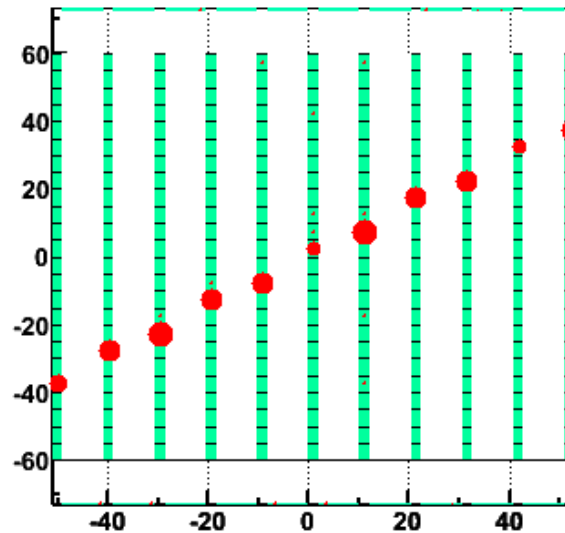
- Installation of 1st module in the Neutrino Monitor pit was completed on May 2009.
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Cosmic event with 1st module

Top view



Side view



T2K beamline started operation!



Beam commissioning (April 2009)

- Beam came to the neutrino beam line from Apr. 23rd to Apr. 28th.
- ~150 spills hit the target. (Intensities were 2 - 4 x 10^{11} proton / spill.)
- No neutrino event was found in the 1st module.
 - Expected num. of neutrino events : < 0.1
- We will keep on waiting for 1st neutrino event with the module during the beam commissioning in May 2009.

Summary and schedule

- 1st INGRID module was assembled and installed in the Neutrino Monitor hall.
- We are waiting for 1st neutrino event with the module during the beam commissioning in Apr. and May 2009.
- Assembly and installation of other 13 modules will be done from Jun. to Aug. 2009 and will be ready to accept beam from Oct. 2009.
- Publish first physics results with $100\text{kW} \times 10^7\text{s}$ data in 2010.