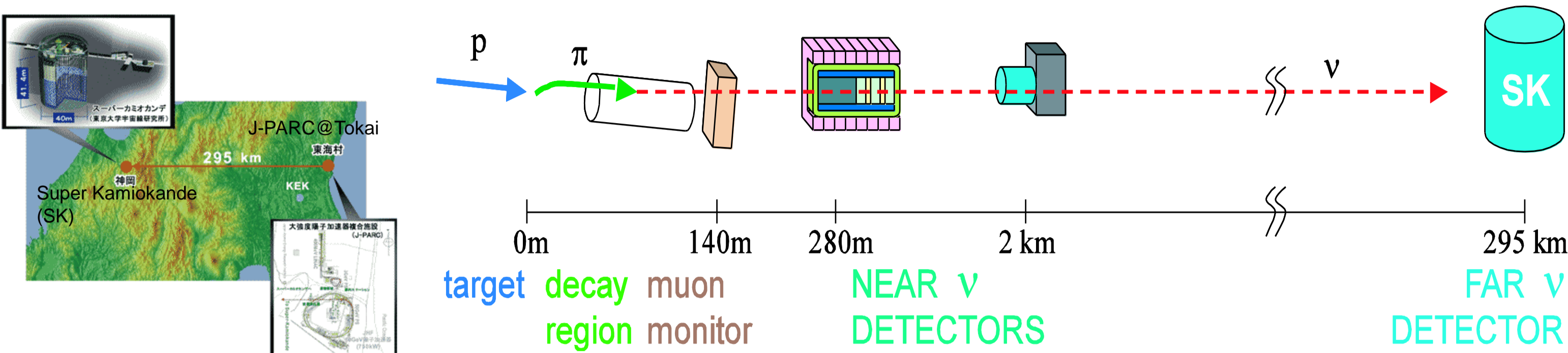


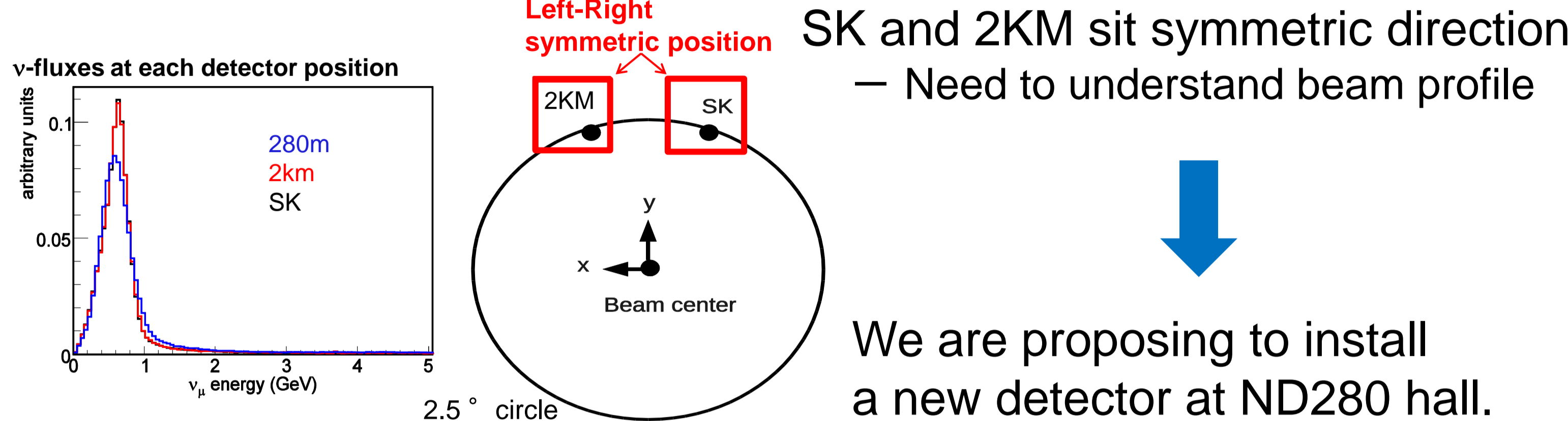
A detector to measure neutrino beam asymmetry at the T2K ND280 hall

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on behalf of 2KM Left-Right monitor subgroup

The T2K experiment (Long-Baseline Neutrino Oscillation Experiment)



Construction of 2KM detector ⇒ Upgrade plan in the 2nd phase



Left-Right monitor in the ND280 hall

The monitor consists of two identical modules.

- Simultaneous measurement of ν -flux for SK and 2KM directions
- Suppression of systematic uncertainty

Digital output by on board readout system - Ethernet connection

ν -flux is measured by counting ν -interaction occurred in the module.

Each module is sandwich calorimeter

Counter plane

- Iron plane: 108x108x1 (cm), 50 layer
- Scintillator plane: 100x100x1 (cm), 56 layer (incl. front 6)

Veto plane

- 100x185x1 (cm)
- Cover 4 sides of counter planes

Total size: 110x110x185 (cm)
Total weight: 8 ton (5.2 ton for counter plane)

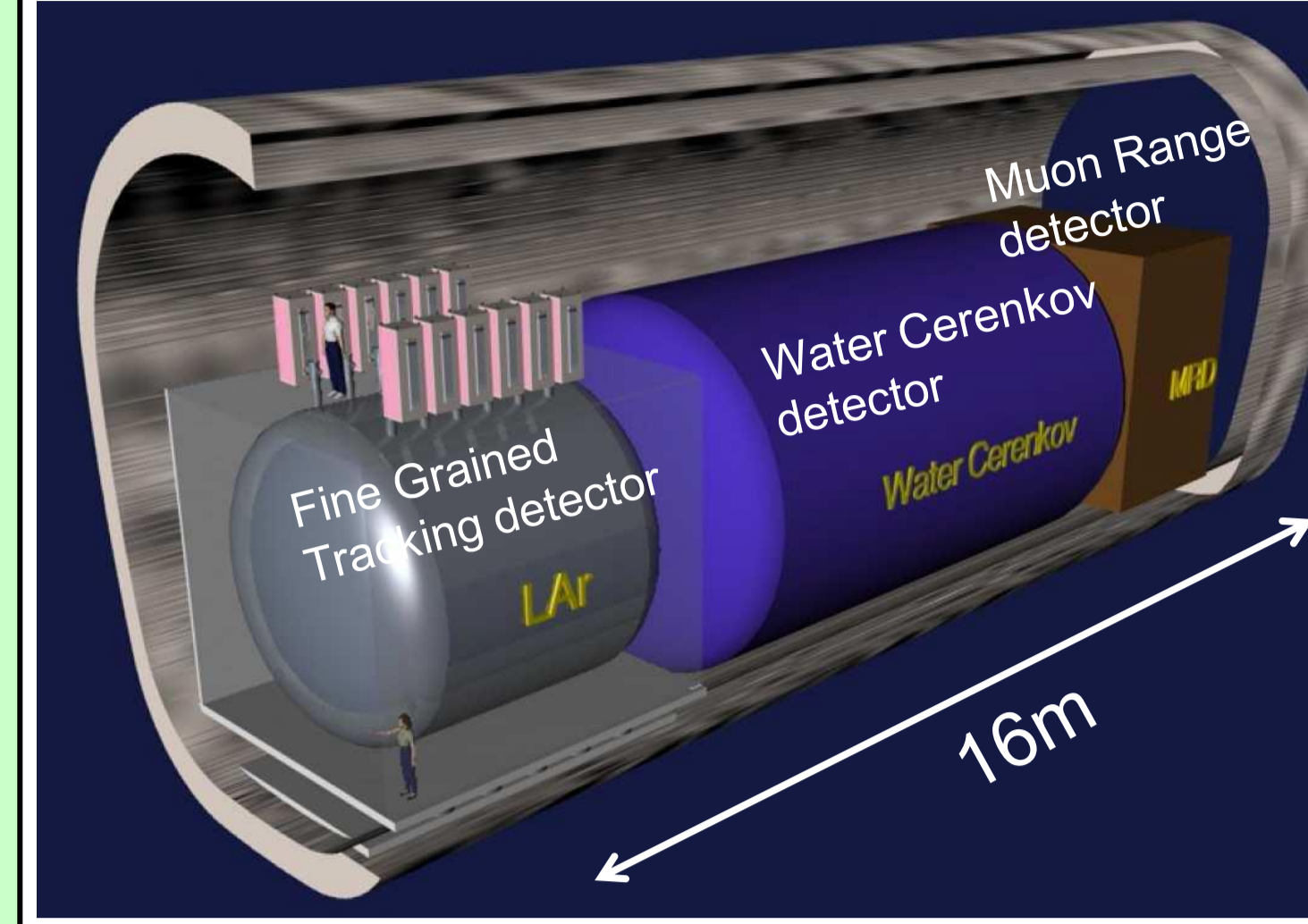
A Scintillator plane consists of 20 bars 100x5x1 (cm). Wave length shifting fiber is used for light collection.

Readout system

- Clear fiber is optically connected with WLS fiber
- 64ch multi-anode PMT (Hamamatsu H7546)
- OPERA ROC system: time resolution ~ 10 ns, dark noise < 1 Hz, very stable in operation

Cosmic Ray Test at ICRR

Proto-type will be constructed and tested in this month.



2KM detector

- Water Cherenkov detector: Same technology at SK.
- Measurement of beam background for ν_e appearance search before oscillation take place at SK
- ν_μ flux measurement

Study on Monte Carlo simulation

Signal: ν_μ interact inside the module

- no veto hit & ≥ 4 counter hits
- 78000 of fully contained events are expected in 120 days operation

$$E_\nu = \frac{1}{2} \frac{2M_p E_\mu - M_\mu^2}{M_p - E_\mu + \sqrt{E_\mu^2 - M_\mu^2} \cdot \cos \theta_\mu}$$

Background study

Left-Right monitor is planned to install at the most downstream part in the ND280 hall.

Neutrinos interact in the upstream components may be mis-identified as background event.

Fiducial volume selection to avoid background event

ν -interactions occurred in red region are selected as signal.

Vertex distribution (top view of ND280): L, R-monitor: 9.9 (10⁴ event/year), Magnet: 3893 (10⁴ event/year), Concrete: 2941 (10⁴ event/year)

Background particle from concrete wall (magnet) is dominant for L(R)-module.

No. of events after selection (120 day)

	Left	Right
Signal (N_{sig})	7.8×10^4	7.8×10^4
Background (N_{BG})	0.16×10^4	0.12×10^4
N_{sig}/N_{BG}	0.020	0.015

Background contamination is well suppressed.

Sensitivity to the asymmetry measurement

Variable, $r = N(R\text{-module})/N(L\text{-module})$, is used to measure flux asymmetry.

Systematic uncertainty

Following two are considered.

- background estimation
- detector position: Difference of expected fluxes if detector position is changed ± 5 cm, is considered. Uncertainty of BG estimation is dominant. $\Delta r(\text{total sys.})/r$ is at most ~ 5%

Total sensitivity, $\Delta r/r$, can be achieved to be < 5% at 0.3-0.8 GeV region with 120 days operation.