

1/3 Էլեմենտար Մասնիկների Ֆիզիկա

2/3 Կոսմոլոգիա

3/3 Նյութաբանության Ֆիզիկա

Իրանիսյան Արա

Armenian Teacher Programme CERN24

Հայաստանի Ֆիզիկայի Ուսուցիչներ

CERN24

3/3 Նեյտրինոնային Ֆիզիկա

Standard Model of Elementary Particles

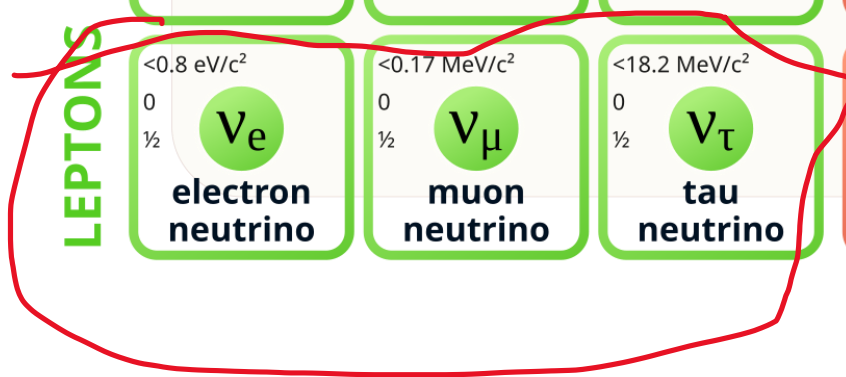
| | three generations of matter (fermions) | | | interactions / force carriers (bosons) | |
|--------|--|--|--|---|---------------------------------|
| | I | II | III | | |
| mass | $\approx 2.16 \text{ MeV}/c^2$ | $\approx 1.273 \text{ GeV}/c^2$ | $\approx 172.57 \text{ GeV}/c^2$ | 0 | $\approx 125.2 \text{ GeV}/c^2$ |
| charge | $\frac{2}{3}$ | $\frac{2}{3}$ | $\frac{2}{3}$ | 0 | 0 |
| spin | $\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{1}{2}$ | 1 | 0 |
| | u up | c charm | t top | g gluon | H higgs |
| | d down | s strange | b bottom | γ photon | |
| | e electron | μ muon | τ tau | Z Z boson | |
| | ν_e electron neutrino | ν_μ muon neutrino | ν_τ tau neutrino | W W boson | |

QUARKS

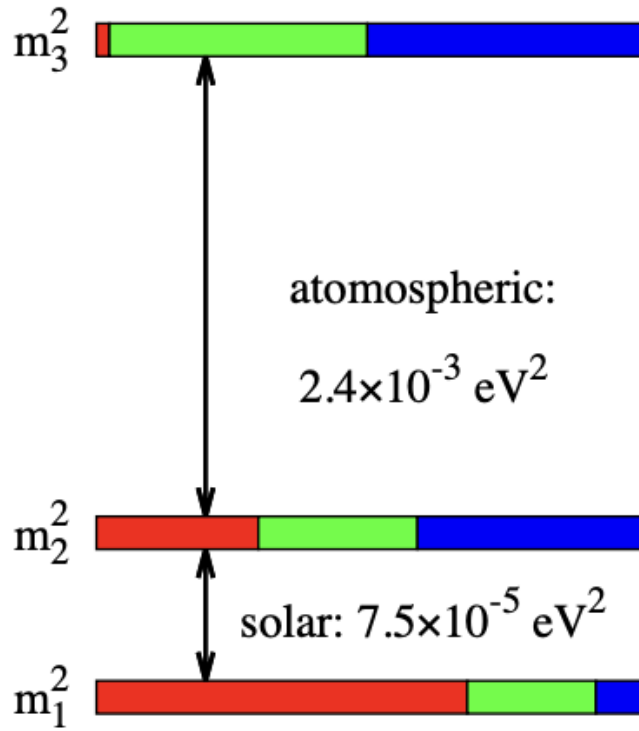
LEPTONS

SCALAR BOSONS

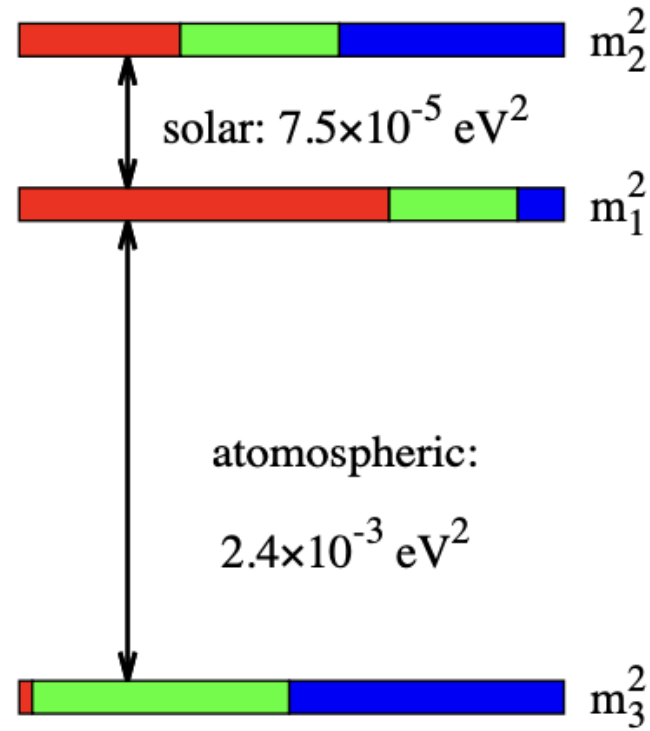
GAUGE BOSONS
VECTOR BOSONS



Normal



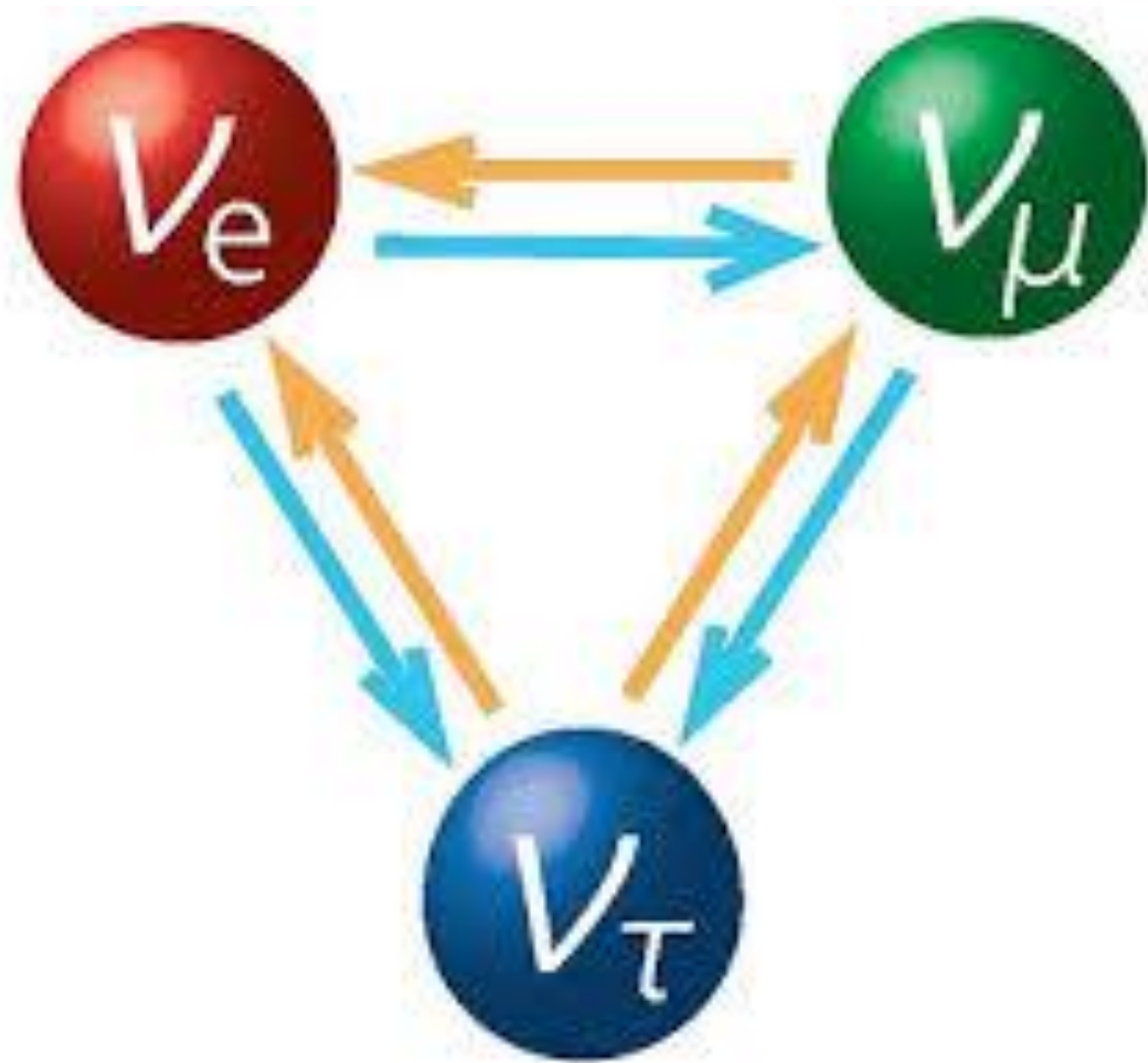
Inverted



 ν_e

 ν_μ

 ν_τ



$$\begin{aligned}
& \begin{bmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{bmatrix} \begin{bmatrix} c_{13} & 0 & s_{13}e^{-i\delta_{\text{CP}}} \\ 0 & 1 & 0 \\ -s_{13}e^{i\delta_{\text{CP}}} & 0 & c_{13} \end{bmatrix} \begin{bmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{bmatrix} \\
& = \begin{bmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta_{\text{CP}}} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta_{\text{CP}}} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta_{\text{CP}}} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta_{\text{CP}}} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta_{\text{CP}}} & c_{23}c_{13} \end{bmatrix}
\end{aligned}$$

$$\theta_{12} = 33.41^{\circ} \begin{matrix} +0.75^{\circ} \\ -0.72^{\circ} \end{matrix}$$

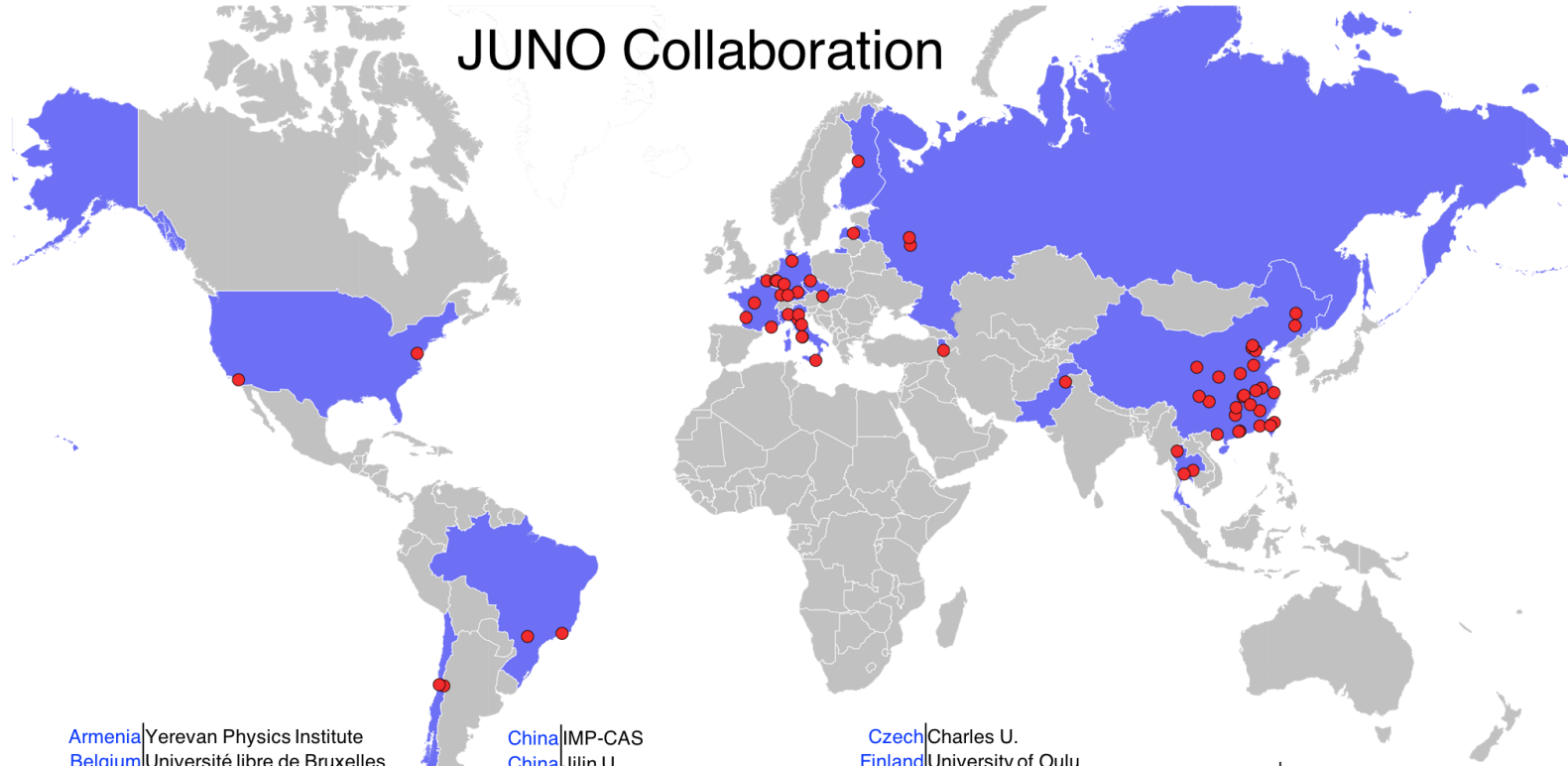
$$\theta_{23} = 49.1^{\circ} \begin{matrix} +1.0^{\circ} \\ -1.3^{\circ} \end{matrix}$$

$$\theta_{13} = 8.54^{\circ} \begin{matrix} +0.11^{\circ} \\ -0.12^{\circ} \end{matrix}$$

$$\delta_{\text{CP}} = 197^{\circ} \begin{matrix} +42^{\circ} \\ -25^{\circ} \end{matrix}$$



JUNO Collaboration

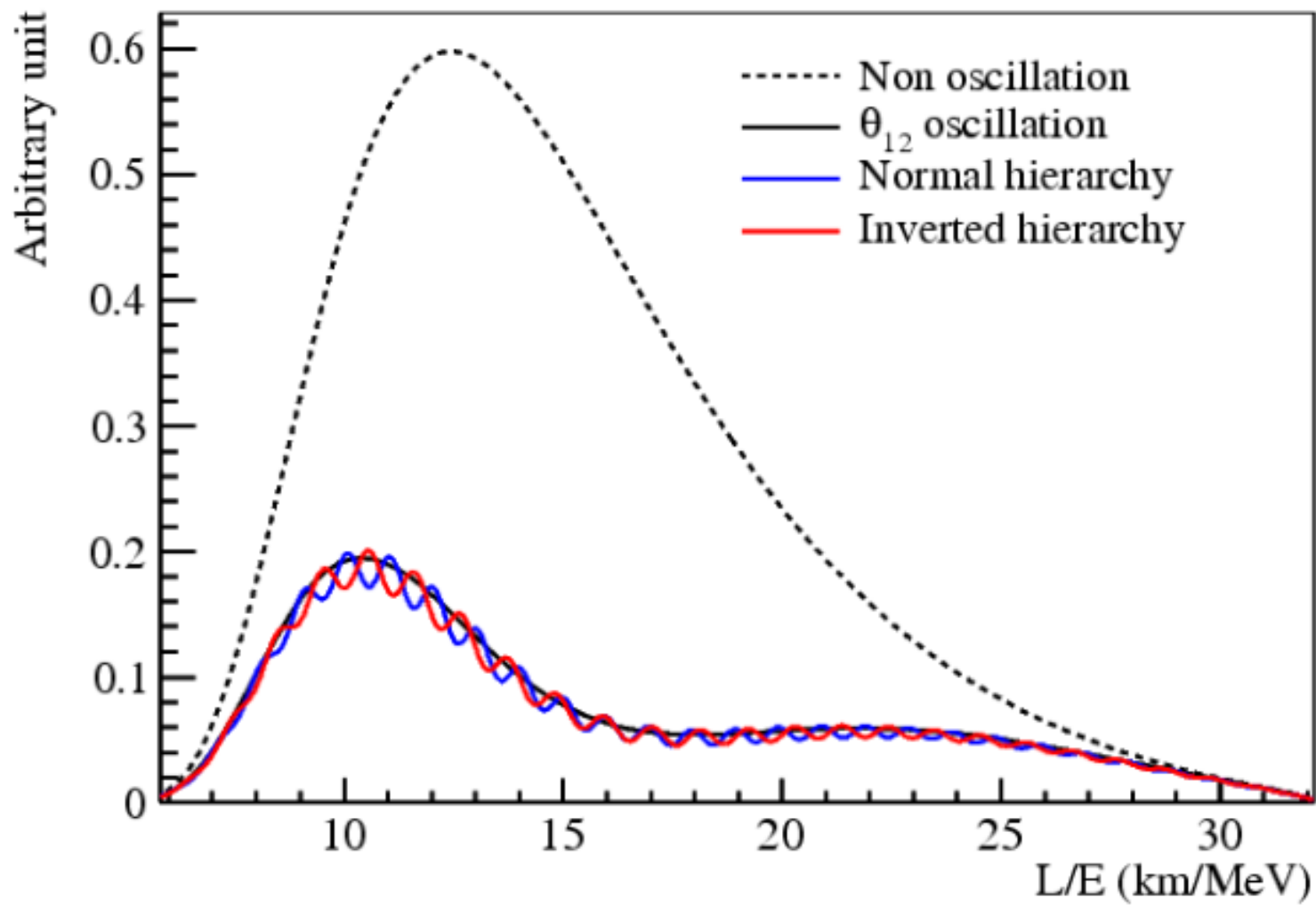


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 Chile|UTFSM
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 China|Beijing Normal U.
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 China|CIAE
 China|CUG
 China|DGUT
 China|ECUST
 China|ECUT
 China|Guangxi U.
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 China|IGG
 China|IGGCAS
 China|IHEP

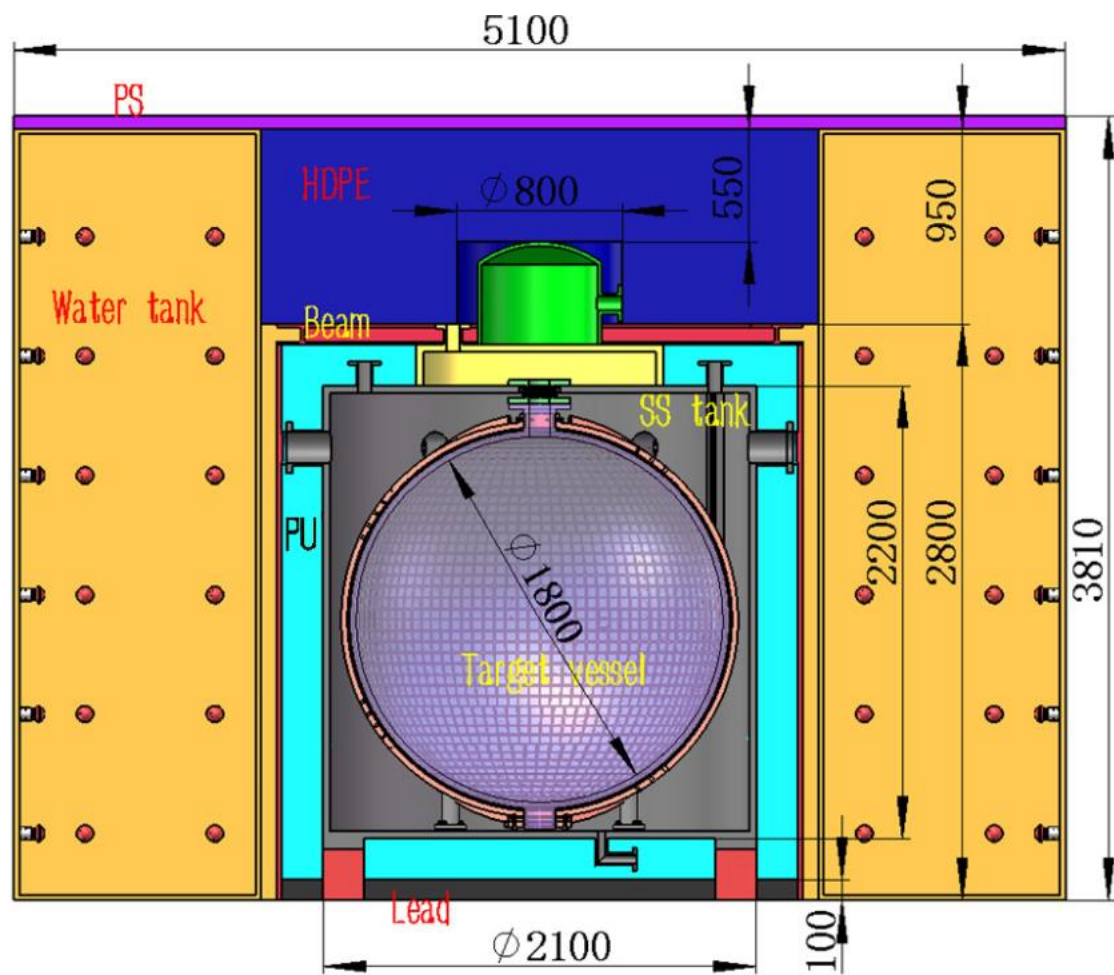
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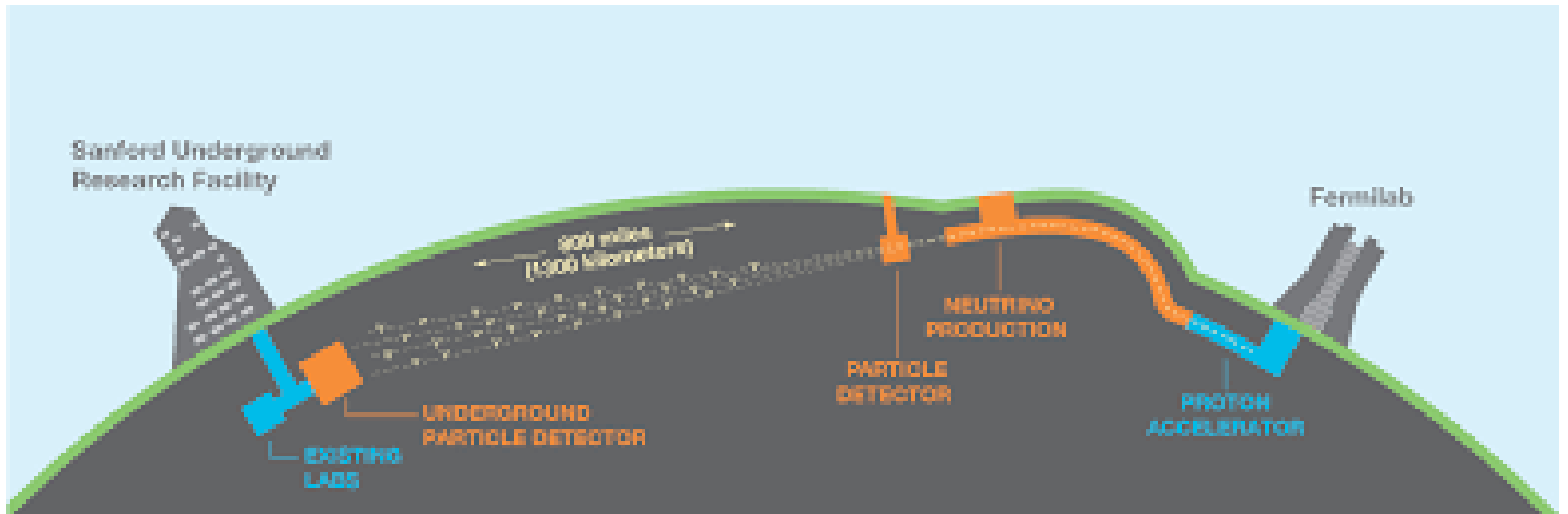
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 Russia|JINR
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 Slovakia|FMPICTU
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 Taiwan|National Taiwan U.
 Taiwan|National United U.
 Thailand|NARIT
 Thailand|PPRLCU
 Thailand|SUT
 USA|UMD1
 USA|UMD2
 USA|UCI



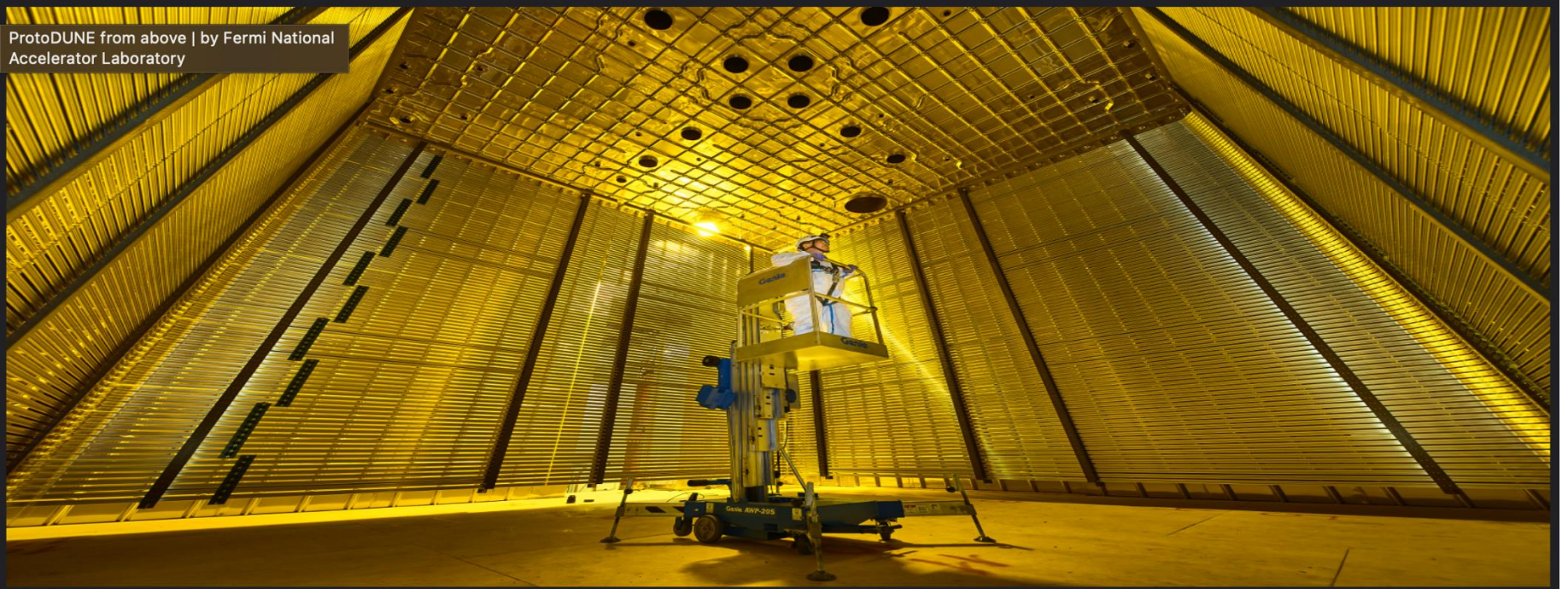




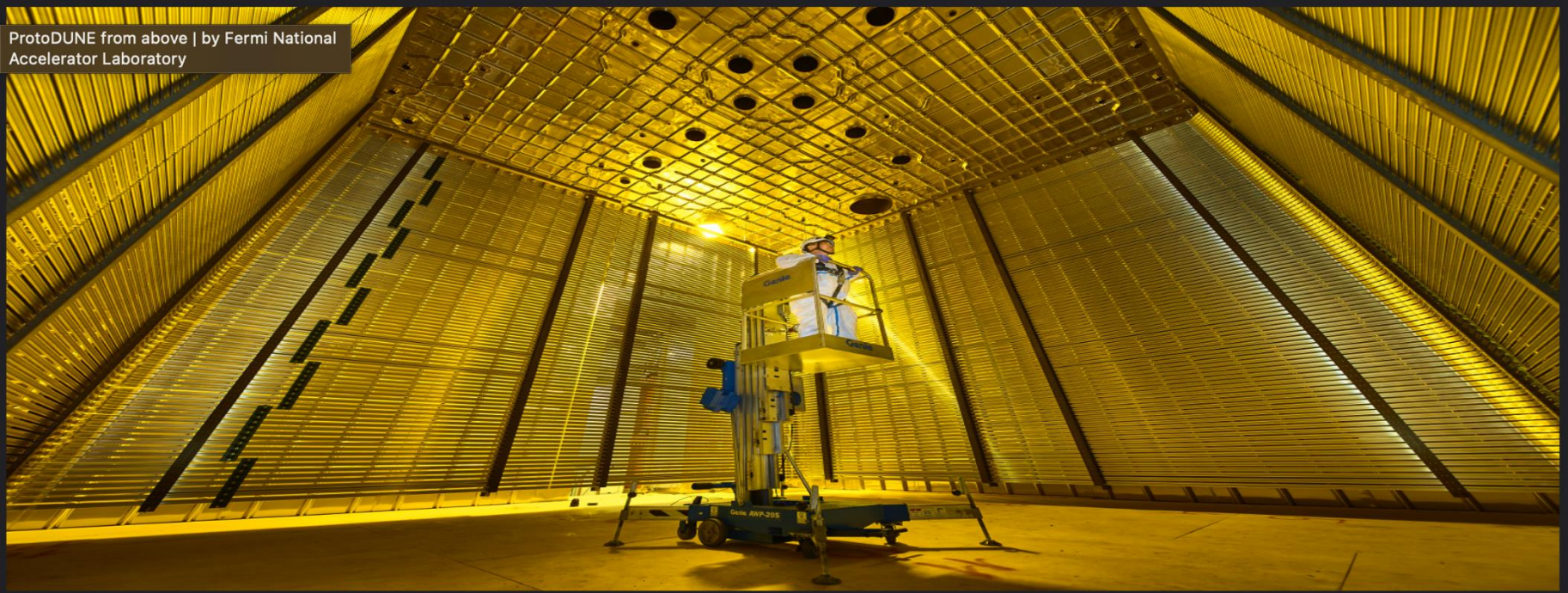




ProtoDUNE from above | by Fermi National Accelerator Laboratory



ProtoDUNE from above | by Fermi National Accelerator Laboratory



Long-Baseline Neutrino Facility South Dakota Site



Rise Shaft
1.5 km to surface

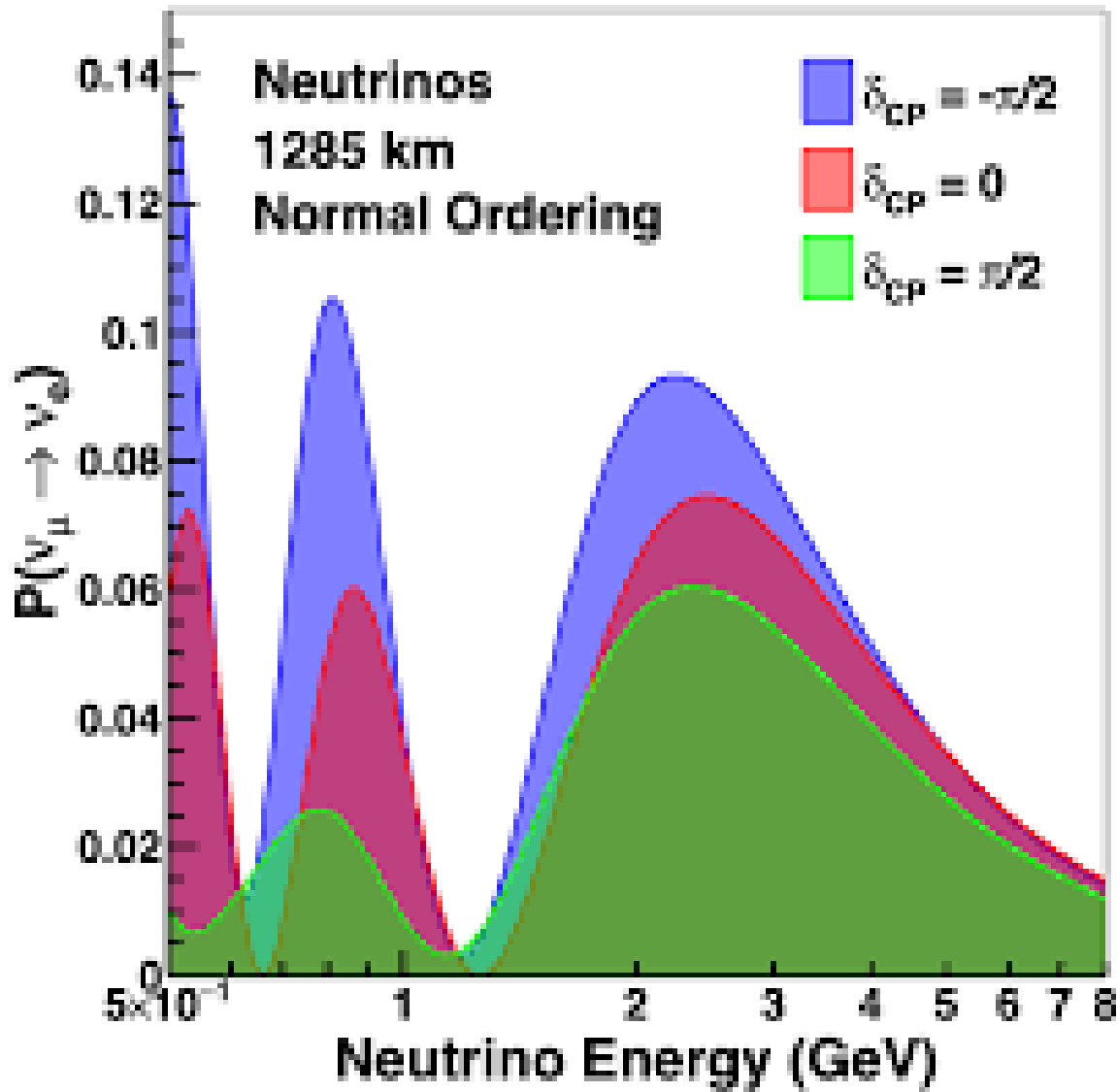
Neutrinos from
Fermilab
Accelerator Laboratory
in Illinois

Facility
and cryogenic
support systems

One of four
detector modules of the
Deep Underground
Neutrino Experiment

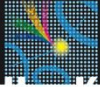
4650 Level of
Sanford Underground
Research Facility



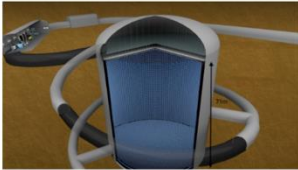


Hyper KamiokaNDE





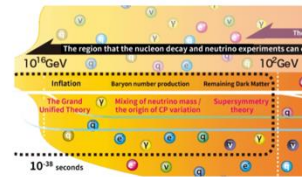
Overview



Detector



Physics

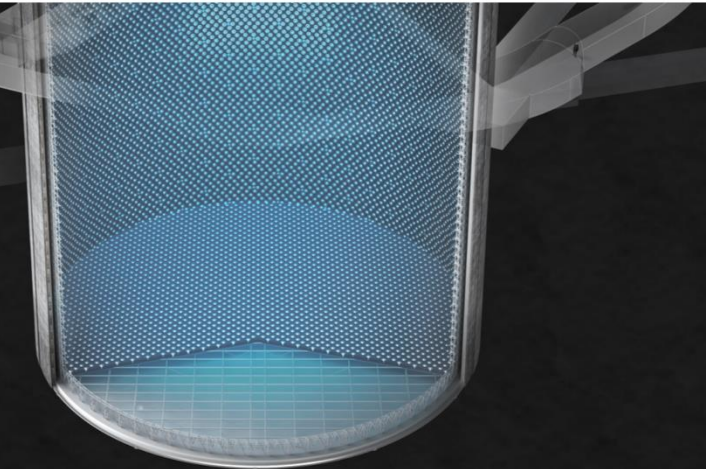


Collaboration Institutes



The next-generation project to unravel the tiny subatomic particles and the extreme universe.

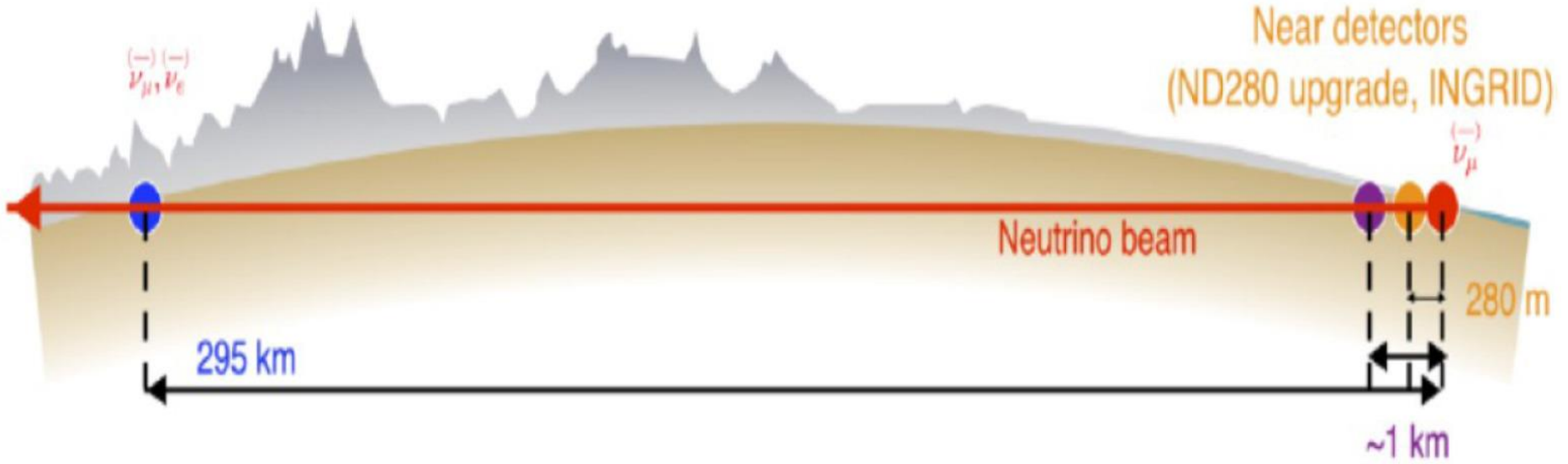
Toward a next stage of neutrino research and observation of proton decay



Hyper-Kamiokande

New intermediate detector (IWCD) J-PARC

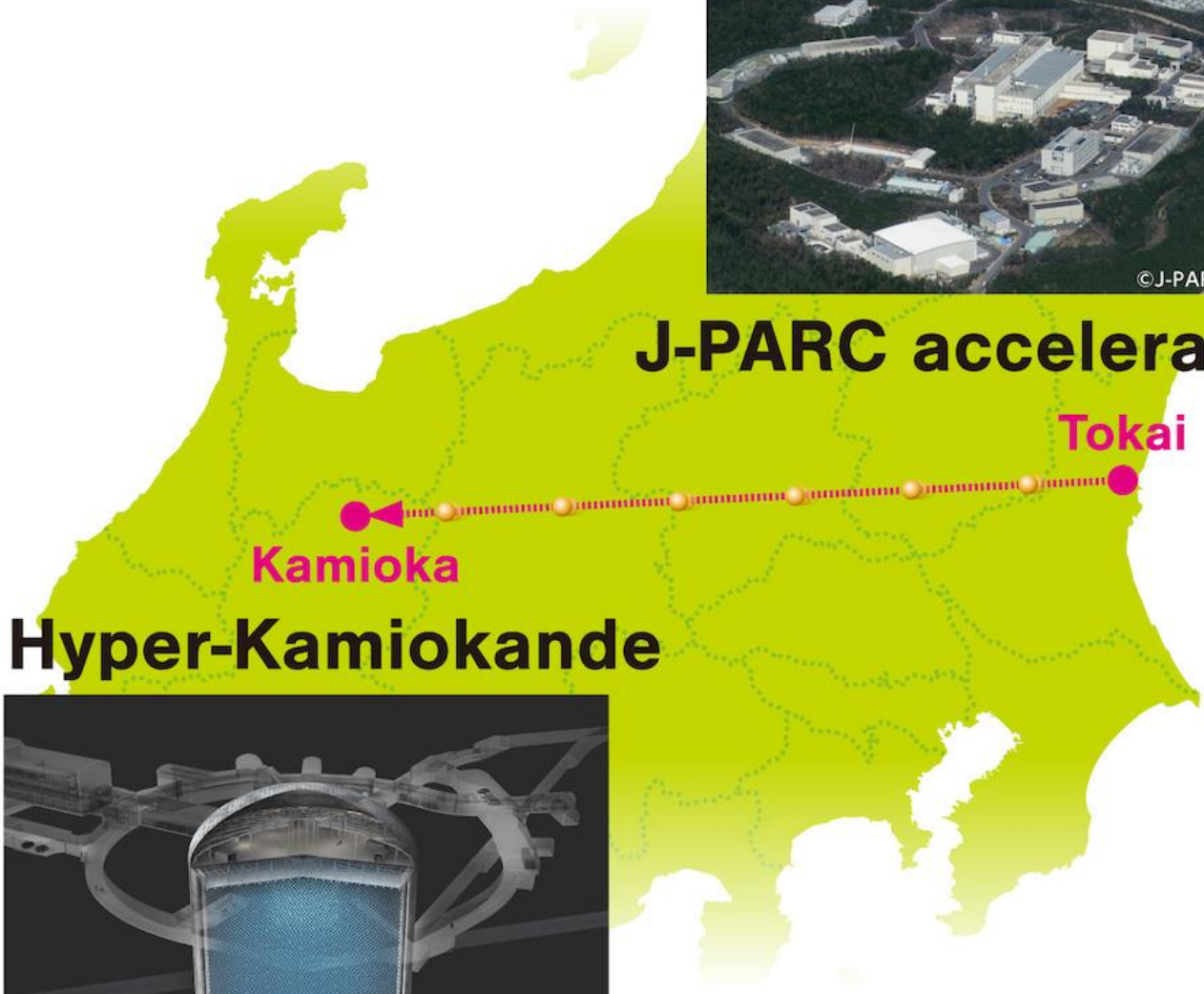
Near detectors (ND280 upgrade, INGRID)





©J-PARC Center

J-PARC accelerator



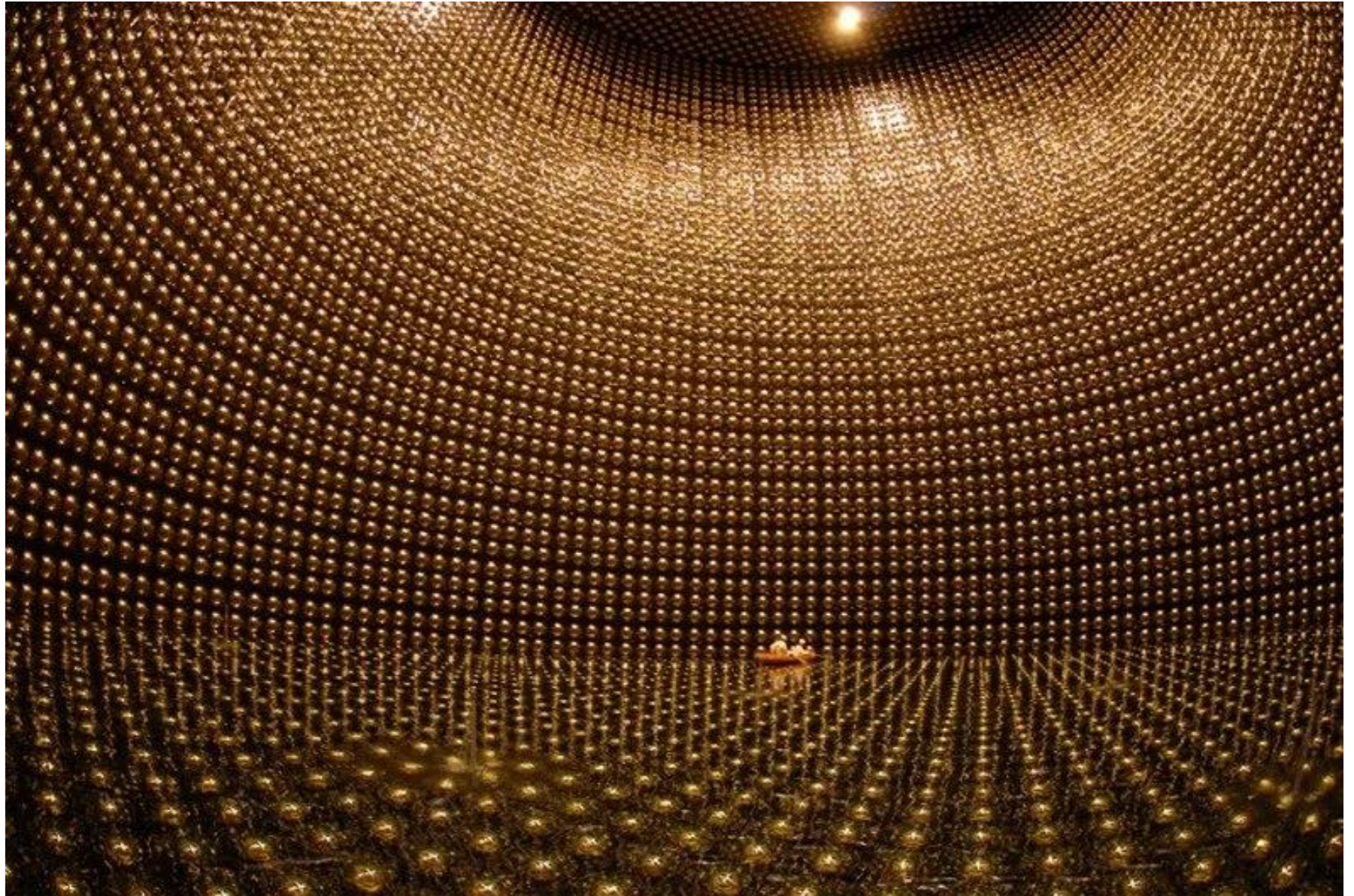
Tokai

Kamioka

Hyper-Kamiokande



NIKKEN SEKKEI



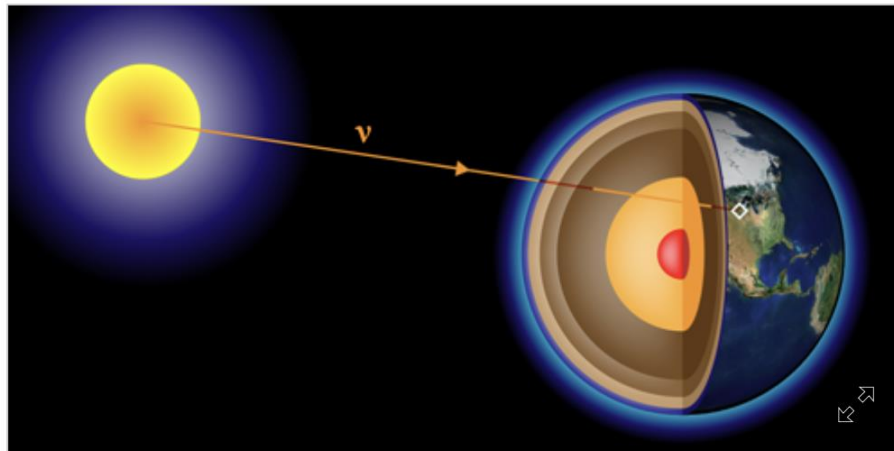


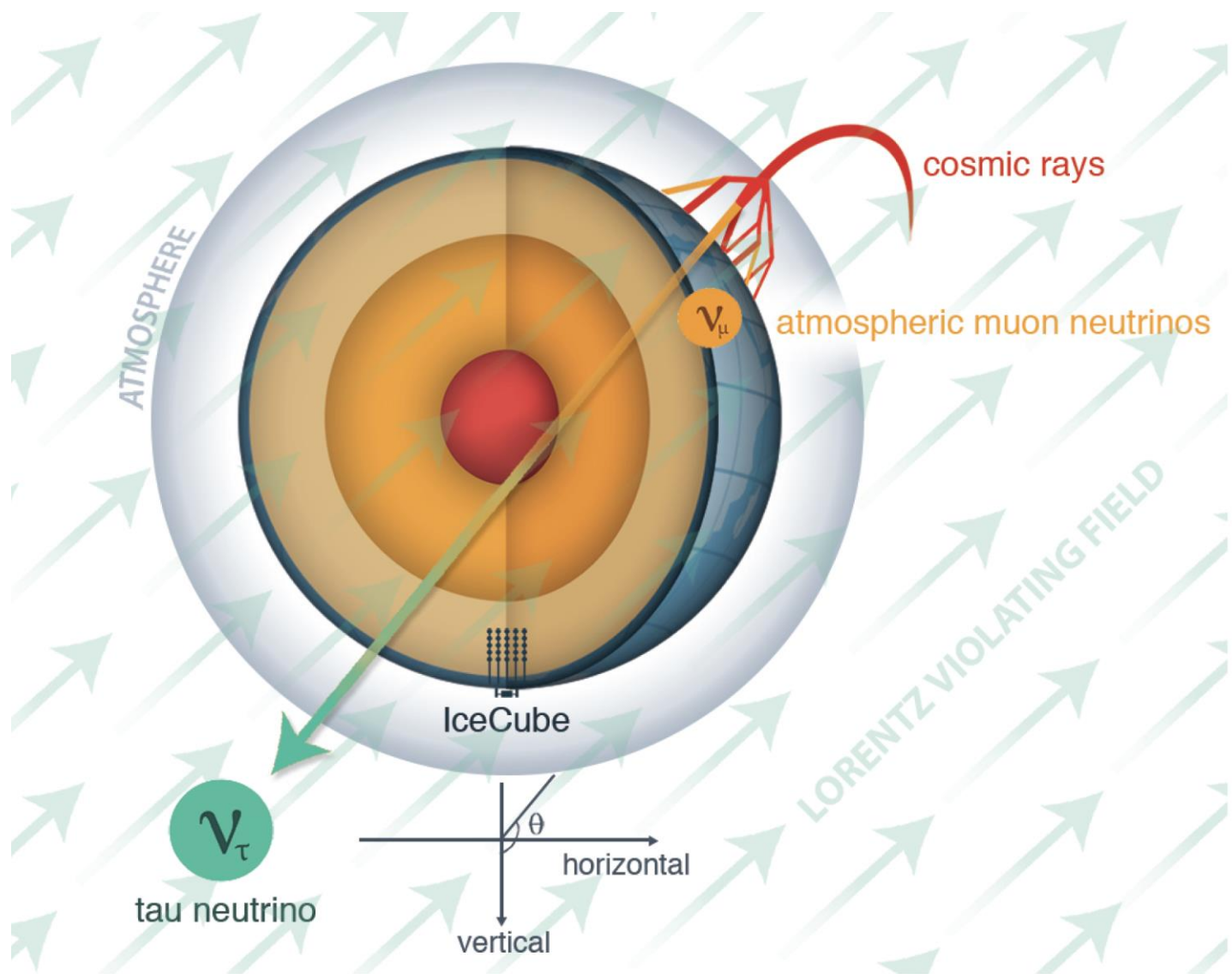
SYNOPSIS

Scanning Earth's Interior with Neutrinos

August 8, 2017 • *Physics* 10, s86

Future neutrino experiments may provide tomographic scans of Earth's interior by viewing solar neutrinos that pass through our planet's layers.





ATMOSPHERE

cosmic rays

ν_μ atmospheric muon neutrinos

IceCube

ν_τ tau neutrino

horizontal

vertical

LORENTZ VIOLATING FIELD

Շնորհակալություն