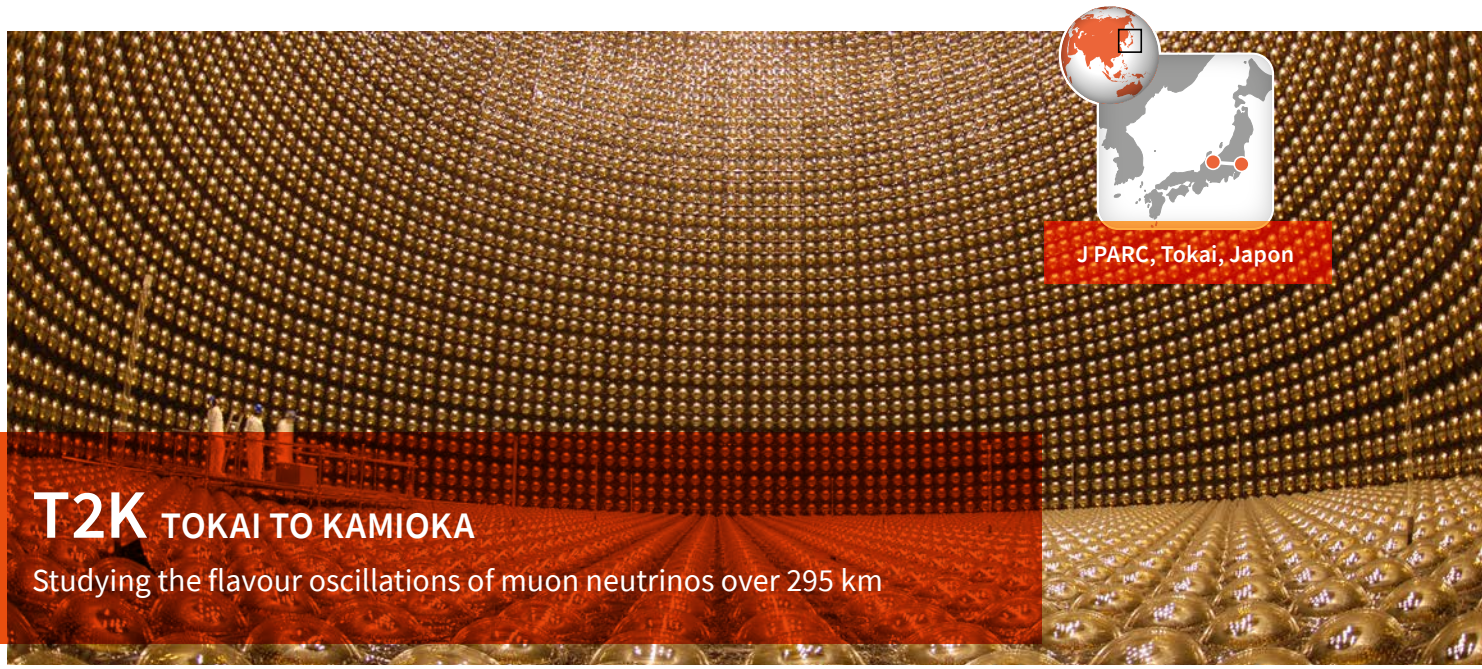
National Institute of Nuclear and Particle Physics

The origin, nature, masses and mixing of neutrinos



T2K TOKAI TO KAMIOKA

Studying the flavour oscillations of muon neutrinos over 295 km

© Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo

- **Scientific leader:** Claudio Giganti (LPNHE) *
- **Laboratories involved:** CC-IN2P3 (Lyon), LLR (Palaiseau), LPNHE (Paris), OMEGA (Palaiseau)
- **Nature:** research infrastructure
- **Status:** operating project funded mainly by Japan, with significant international contributions from Europe, Canada and the USA
- **Website:** https://t2k-experiment.org/

SCIENTIFIC OBJECTIVES

T2K is a pioneer experiment in the observation of the appearance of electron neutrinos in a muon neutrino beam. It also provided the world's best measurement of the θ23 oscillation parameter by observing for the first time a strong indication of a significant matter-antimatter asymmetry in the lepton sector. The measurement of an asymmetry between neutrino and antineutrino oscillations is an important step in the understanding of our Universe.

RESOURCES DEPLOYED

- T2K uses the 'off-axis' beam concept. The 2.5° angle maximises the probability of oscillation in the distant detector at a distance of 295 km from the neutrino production point.
- An intense beam of quasi-one-energy muon neutrinos and antineutrinos produced with a primary beam of protons at 30 GeV from J-PARC on the east coast of Japan at Tokai.
- A set of 3 near detectors (INGRID, ND280 and WAGASCI) measures the neutrino flux before oscillation and explores the interactions of neutrinos with matter.
- The Super-Kamiokande distant detector, located 295 km away, measures changes in the neutrino beam as it travels. This detector of 50 000 tonnes of water is monitored by 13 000 photomultiplier tubes and is buried at a depth of 1 000 m.

500 scientists

18 years of data collection

12 participating countries

4 detectors

50K tonnes of ultra pure water

IN2P3 CONTRIBUTIONS

- Design and construction of the INGRID proximal detector.
- Participation in the implementation of the magnet and the construction of the electronics of the time projection chambers (TPC) of the ND280 proximal detector.
- Design and development of the readout electronics and mechanics of WAGASCI to study nuclear effects in neutrino-matter interactions.
- Participation in the NA611/SHINE ancillary experiment at CERN to measure the production rates of charged particles by a proton beam on a target.
- Participation in the analyses and publication of effective cross-section measurements and oscillation parameters.
- Participation in the design and construction of the ND280 tools for the T2K II phase: electronics for SuperFGD and TPC, support mechanics.

OTHER FRENCH LABORATORIES INVOLVED

Irfu (CEA Saclay)

2010 First data with INGRID from the muon neutrino beam

2013 Discovery of the oscillation of muon neutrinos into electron neutrinos

2014 First antineutrino beam

2018 Complete refurbishment of the Super-Kamiokande detector

2020 Strong evidence of major asymmetry between matter and antimatter

2022 T2K phase-II data collection begins

* Since 2022

July 2023