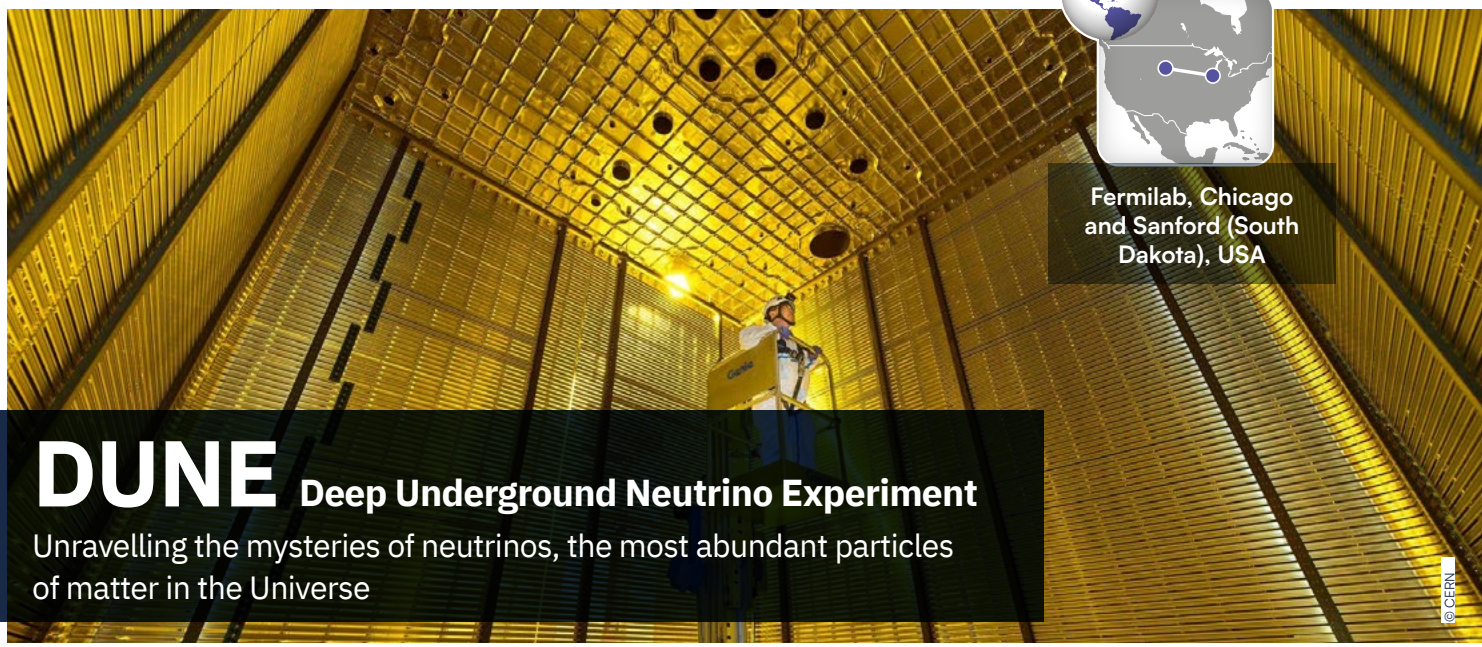
The origin, nature, masses and mixing of neutrinos



DUNE Deep Underground Neutrino Experiment

Unravelling the mysteries of neutrinos, the most abundant particles of matter in the Universe

Scientific leader: Dario Autiero (IP2I) *

Laboratories involved: APC (Paris), CC-IN2P3 (Lyon), CENBG (Bordeaux), IJCLab (Orsay), IP2I (Lyon), LAPP (Annecy), LPSC (Grenoble)

Nature: research infrastructure

Status: international project under construction

Website: https://www.dunescience.org/

Scientific objectives

The study of neutrinos is a major challenge: they could play a role in explaining the predominance of matter over antimatter in the Universe via CP violation. Thanks to the neutrino beam, DUNE should make it possible to determine the mass hierarchy of neutrinos and to search for CP violation in the lepton sector. The experiment will also study neutrinos from supernova explosions, and the stability of matter through the search for the lifetime of the proton. All these measurements will explore physics beyond the Standard Model and elucidate fundamental problems in cosmology and astrophysics.

Resources deployed

- A beam of muon neutrinos and antineutrinos produced by the accelerator complex at Fermilab (Illinois), of unprecedented intensity thanks in particular to a new linear accelerator (PIP-II), and directed towards the distant DUNE detector, 1 300 kilometres away.
- A set of nearby detectors at Fermilab, to precisely characterise the neutrino beam before it travels.
- A gigantic distant detector in South Dakota, 1 500 metres underground, with 4 detection modules. Each module is a 62x14x14m^3 parallelepiped, containing 17kt of liquid argon and instrumented in a Time Projection Chamber (TPC) to study in detail the interactions of neutrinos with argon.
- France, throught IN2P3, is the main non-american partner for the construction of the vertical drift module.

68kt of ultra-pure liquid argon	**15** years of operation
1 300 international contributors	**201** laboratories world-wide
15 years of study	**32** countries

IN2P3 CONTRIBUTIONS

- Design and construction of half of the second distant detection module, based on the so-called vertical drift technology. This is an evolution of the so-called double phase technology which has been the subject of R&D in France since 2006. The vertical drift technology has retained the main characteristics and advantages of the double phase technology.
- Development of algorithms for data analysis, event reconstruction and neutrino energy and kinematic measurements.
- Contribution to the computational efforts for data production and simulations at the IN2P3 CC.
- Contribution to the PIP II programme on the Spoke superconducting cavities of the linear proton accelerator.

Other french laboratories involved

Irfu (CEA Saclay)

2006 — Start of liquid argon TPC R&D at IN2P3

2008 - 2014 — European LAGUNA-LBNO programme

2015 — Launch of the DUNE collaboration

2018 — Installation of the 6x6x6m^3 dual-phase ProtoDUNE at CERN

2021 — Construction of the distant detector caverns begins

2029 — Data collection will start

2045 — Data collection will end

* Since 2015