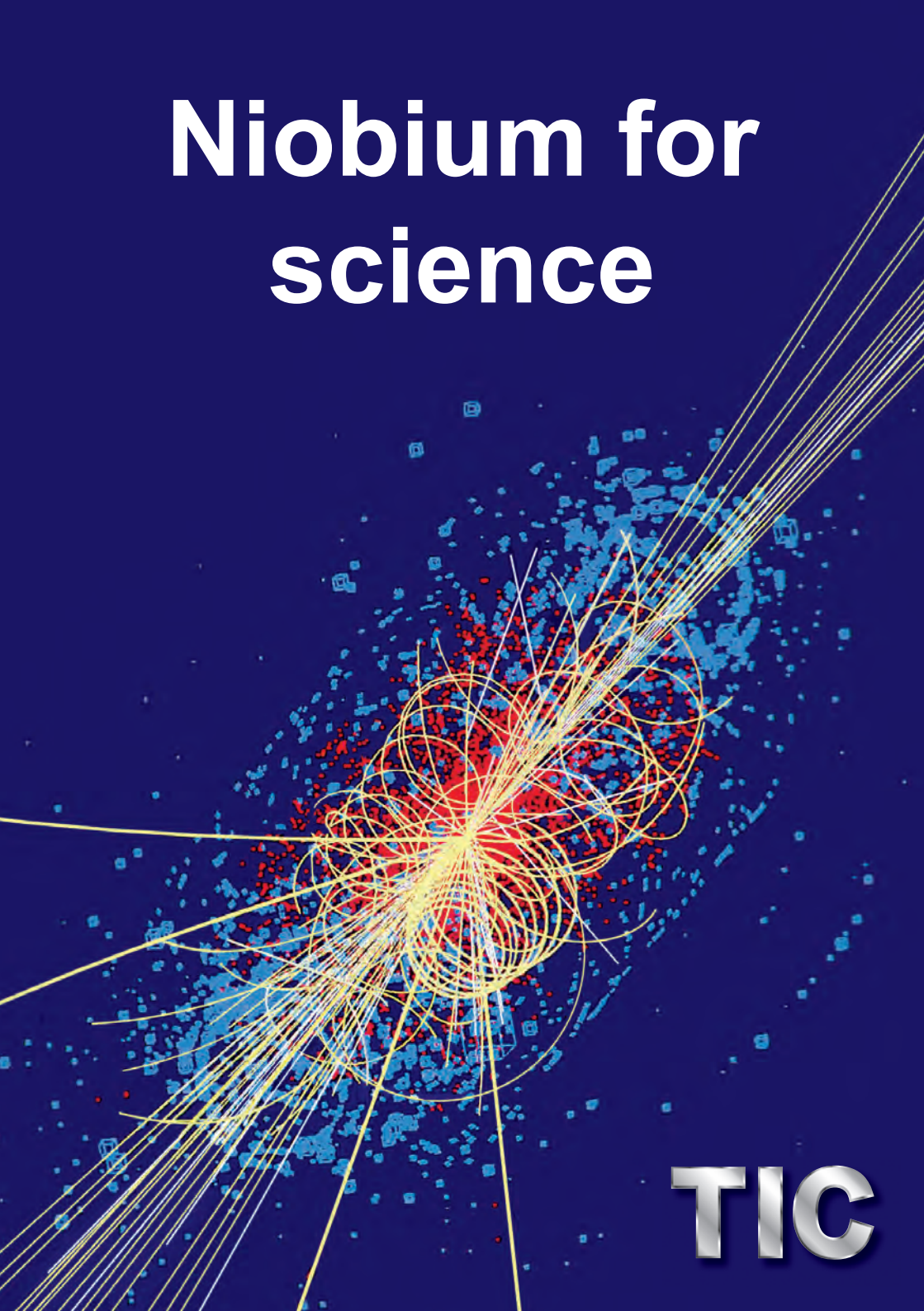
Niobium for science



TIC

Niobium (Nb)* is a rare grey metal with a number of unique and important qualities. In the periodic table it is element no. 41 and the majority is mined from Brazil and Canada.

Niobium alloys for superconducting electromagnets

Niobium plays a vital role in the advancement of science through its use in superconducting electromagnets.

Niobium-based superconductors have allowed a host of exceptional technologies to be developed, including life-saving MRI machines, magnetic levitation trains, and mass spectroscopy. They are also used in particle accelerators and nuclear fusion reactors - applications that are pushing back the boundaries of science.

Two niobium-based materials act as superconductors when cooled to almost absolute zero (0 kelvin or minus 273.15°C):

Niobium-titanium (53% Nb, 47% Ti) is the most common material and generates magnetic fields up to 10.5 Tesla (T). It is relatively inexpensive, has excellent mechanical properties and produces stable and uniform magnetic fields.

Niobium-tin (Nb_3Sn) is a brittle intermetallic compound with poor mechanical properties, but generates far higher magnetic fields (up to 20T). Despite its higher cost and being difficult to work with, Nb_3Sn is seeing a growing number of applications, often as a replacement for NbTi.

Cross-section of niobium-tin cable, showing central cooling duct
(photo: © ITER Organization)

*** Is it niobium or columbium?**

Officially, it is niobium, but columbium is still widely used in the United States.

When element 41 was first identified in 1801, it was named 'columbium' (Cb). However, for many years chemists believed it was the same element as tantalum (Ta) and when, in 1844, it was rediscovered, it was named 'niobium' (Nb). It was not until 1865 that tantalum and niobium were proven to be two elements, and columbium and niobium to be one element, but by then all three names were already in wide circulation. In 1950 the International Union of Pure and Applied Chemistry officially adopted 'niobium'.

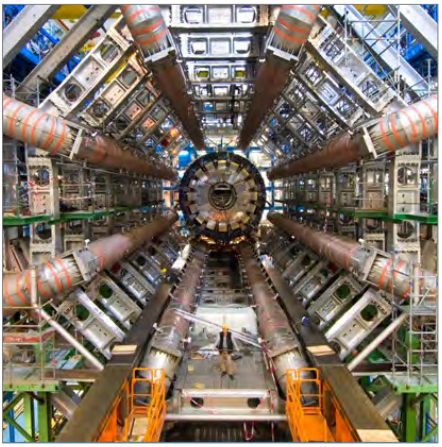
Cover photo: CERN

CERN: A giant particle accelerator

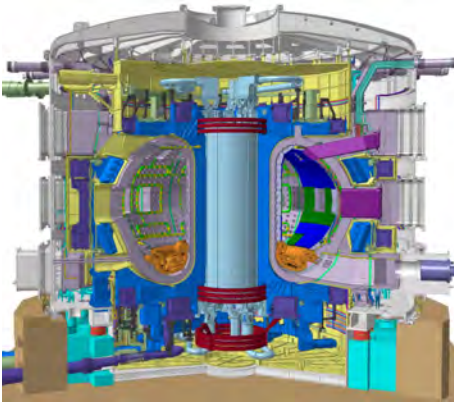
At CERN, physicists and engineers use super-conducting electromagnets (mostly NbTi) to contain and direct beams of highly accelerated particles.

Among its many successes, in 2012 CERN's Large Hadron Collider (LHC) detected the Higgs boson, an elementary particle in the Standard Model of particle physics (see cover).

LHC is currently being upgraded to include a new set of Nb_3Sn magnets, which will make it even more powerful. When the upgrade is complete in 2026, scientists will be able to explore the fundamental structure of the universe as never before.



The LHC at CERN required 8000 superconducting magnets using 1200 t of NbTi/Cu wire (Photo: CERN)



A cutaway showing the design of the ITER tokamak. The plasma ring is contained in the "D" shapes either side of the central column (photo: © ITER Organization)

ITER: power from nuclear fusion

ITER is an international project to build the world's largest tokamak, a magnetic fusion device that could be used to generate electricity.

The NbTi and Nb_3Sn super-conducting electromagnets imprison a doughnut-shaped ring of plasma (far hotter than the Sun's core) in which nuclear fusion occurs.

The total weight of the magnet system, including the steel support structures, is about 10,000 t, of which 500 t are Nb_3Sn strands and 250 t NbTi strands.

Construction is advancing on schedule and the reactor is expected to be ready for preliminary testing in late 2025. Watch this space!

For more information on many crucial uses of niobium visit www.TaNb.org.

TANTALUM-NIOBIUM

INTERNATIONAL STUDY CENTER

www.TaNb.org

The T.I.C. is the international trade body that represents the tantalum and niobium industries. We have around 90 members from over 25 countries involved with all aspects of the tantalum and niobium industry supply chain (from mining and refining through to OEMs and recycling).

OBJECTIVES

- Increase awareness and promote the remarkable properties of tantalum and niobium.
- Host the Anders Gustaf Ekeberg Tantalum Prize, an annual award that recognises excellence in tantalum research.
- Organize a General Assembly (conference) in October each year for business and technical presentations. Non-members may attend.
- Publish a quarterly Bulletin newsletter for members and stakeholders.
- Collect from the members (via an independent company to ensure confidentiality) statistics on the tantalum and niobium industries.
- Address key issues facing the industry, such as legislation, supply chain due diligence, and transport of radioactive materials (NORM).

Tantalum-Niobium International Study Center (T.I.C.)
Chaussée de Louvain 490, 1380 Lasne, Belgium.
Tel: +32 2 649 51 58; info@tanb.org; www.TaNb.org