

Neutrinos under the Alps

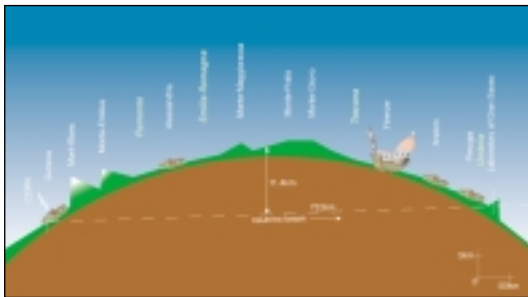
The CERN Neutrino beam to Gran Sasso (CNGS) project, now under construction, will send a beam of high-energy neutrinos from CERN to the Italian underground Gran Sasso laboratory, a distance of 730 km. The first neutrinos are expected in 2005. CNGS was approved by the CERN Council in December 1999 and construction is now well under way.

The CNGS project is motivated by recent results obtained at the Super-Kamiokande detector in Japan and supported by other experiments which see fewer neutrinos than expected. Explaining this requires new neutrino behaviour, called 'neutrino oscillation'.

Classically, neutrinos come in three varieties – electron, muon and tau, depending on their partner particles. These neutrino varieties are supposed to be immutable, so that a neutrino created with a muon should remain a muon neutrino for ever. However, experiments monitoring the arrival of neutrinos produced in the atmosphere by cosmic rays have suggested that some muon-type neutrinos are 'lost'. To account for this deficit, some neutrinos that start off muon-like could transform ('oscillate') en route into tau-like particles.

To maximize the chances of seeing such an effect, the experiment needs a long baseline, in this case the 730 km between CERN and the Gran Sasso laboratory. The neutrino beam, starting off purely muon-like as it left CERN, would contain tau neutrinos by the time it arrives at Gran Sasso. When they interact, these tau neutrinos can produce highly unstable tau leptons, which decay within 1 mm of the neutrino interaction point, producing a characteristic kink in the decay path.

At CERN, the CNGS project involves a major civil engineering effort, being undertaken by an international consortium. After excavation of a 55-metre vertical access shaft, the assembly cavern for the tunnel boring machine has been built. About three kilometres of tunnels and caverns – some 45,000 cubic metres of rock – had to be excavated, of which about half had been accomplished by the end of the year.



Schematic of the 730-kilometre neutrino beam trajectory from CERN to the Italian Gran Sasso laboratory, passing under the Alps.



Arrival at CERN of the tunnel boring machine for the CNGS work.