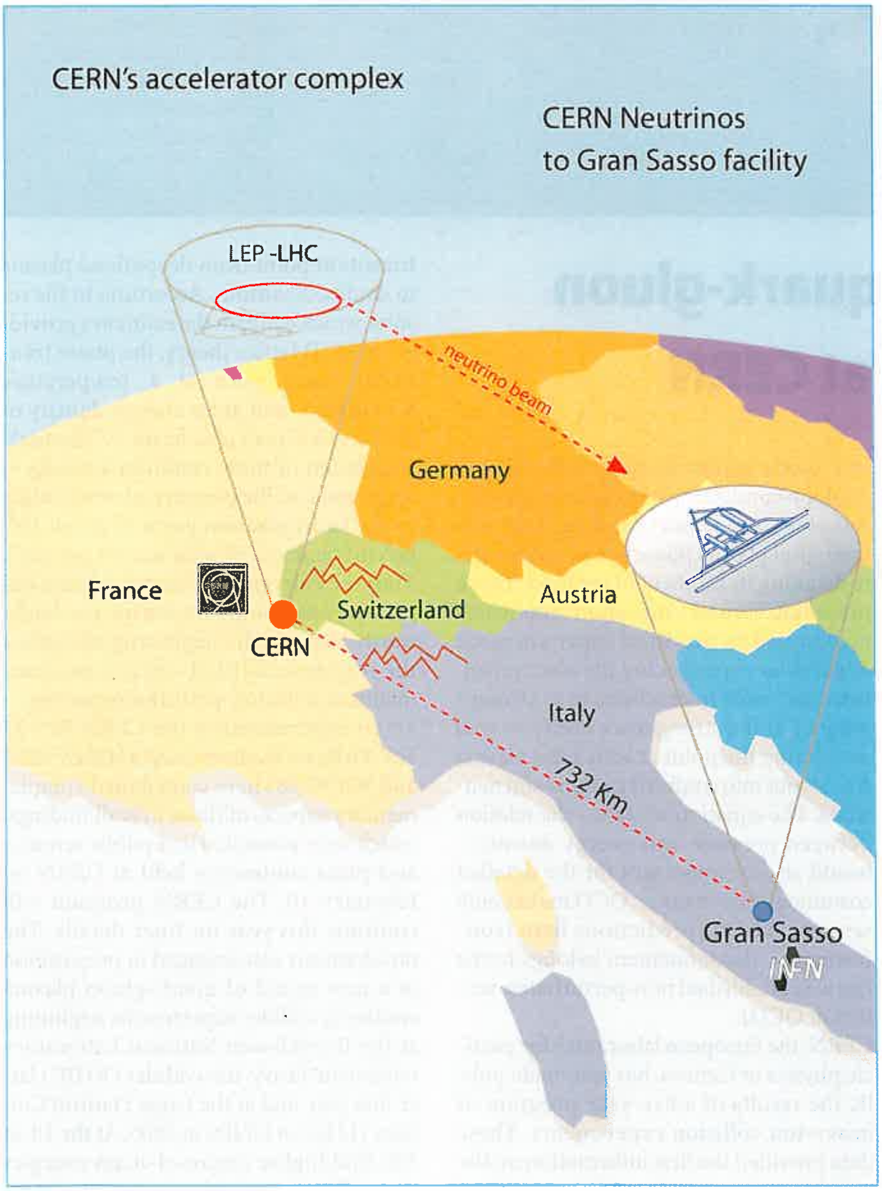
Neutrinos from CERN to Gran Sasso

Around 2005 CERN will start aiming pulses of neutrinos at INFN's Gran Sasso National Laboratory, the world's largest underground laboratory deep under a mountain about an hour driving East from Rome. During the 730 km trip, some neutrinos will change flavour, and two detectors at Gran Sasso will try to detect these changed neutrinos. At that time similar experiments will be well under way in the United States and Japan. Japan started sending neutrinos from the KEK proton synchrotron in Tsukuba over a distance of 250 km to the SuperKamiokande underground detector, and the Fermi National Laboratory (Fermilab) near Chicago is gearing up to aim neutrinos at a detector in the Soudan Underground Laboratory in Minnesota, also 730 km away, in 2003. However, unlike these two experiments that try to detect a deficit of a certain flavour of neutrino–a "disappearance experiment", the CERN-Gran Sasso experiments will try to detect different neutrinos than those produced at CERN–those that actually changed their flavour. The CERN Council approved the 60 million Euro experiment in December, and it will be financed by INFN for more than 50%.



"CNGS: Cern Neutrinos to Gran Sasso" a new facility to explore the physics beyond the Standard Theory

Neutrinos come in three flavours: electron neutrinos, muon neutrinos, and tau neutrinos. Several experiments suggest strongly that neutrinos may oscillate, that is, change from one flavour into another while travelling through space or matter. For example, less neutrinos are detected from the sun as predicted by theory--they probably escape the detectors by changing flavour. Also, the SuperKamiokande detector in Japan detects different ratios between electron and muon neutrinos produced in the atmosphere by cosmic rays if they travel over longer distances through Earth. And if neutrinos oscillate, they must have mass, according to theorists. But some particle physicists still doubt whether neutrino oscillation is a reality.

At CERN, a proton beam extracted from the SPS (Super Proton Synchrotron) will hit a graphite target, producing a variety of particles. Among them are pions that will be nudged by magnets into a beam pipe directed towards Gran Sasso. In the beam pipe they will decay into muons and muon neutrinos. The muons will be stopped while the neutrinos will travel on to Gran Sasso, whereby some of them will change into tau neutrinos. Two detectors, OPERA and ICANOE, will look for these tau neutrinos. Not only are the transformations from muon to tau neutrinos rare events, but because very few neutrinos interact with matter, scientists expect that only a few of them will be detected during a period of at least five years, says Paolo Strolin at the University of Naples. Therefore the background--events that mimic neutrino events--has to be extremely low for the experiments to be meaningful, says Stolin. The experimenters expect one such event every two years.

The great advantage of long-baseline experiments is that one controls the neutrino source and does not depend on unknown factors influencing neutrino production in the sun or by cosmic radiation, says Alessandro Bettini, Director of the Gran Sasso Laboratory. And Alessandro Pascolini of Padua University and INFN is confident that the long- baseline experiments will help settle the matter of neutrino oscillations. Especially, the positive detection of tau neutrinos at Gran Sasso will leave no doubt that neutrinos do oscillate and have mass, he says.

Article available at http://www.europhysicsnews.org or http://dx.doi.org/10.1051/epn:2000305