31 May 2010

(From the OPERA Collaboration)

After seven years since the start of construction of the OPERA experiment and three years of operation in the underground Gran Sasso Laboratory of the Italian National Institute of Nuclear Physics (INFN), one of the many billions of muon-neutrinos produced at the CERN accelerator complex (CNGS) has likely "transformed" into a tau-neutrino that has been observed by the OPERA apparatus. This is an extremely important result. The observation of a few more of these tau-neutrino events over a large number of conventional muon-neutrino interactions will represent the long awaited proof of the direct conversion of one type of neutrino into another: the so called "neutrino oscillation" mechanism.

The disappearance of the initial neutrino flavour has already been observed by several experiments in the last 15 years, but the "direct appearance" is still the outstanding missing tile of the puzzle, and the OPERA experiment is unique worldwide for this purpose. Neutrino oscillation is today the only indication of new, fascinating physics beyond the so-called Standard Model of particles and interactions, opening the possibility of unexpected implications in cosmology, astrophysics and particle physics.

The experiment was inaugurated in 2006, when the first "normal" muon-neutrinos were detected after a trip of 730 km from CERN, covered in about 2.4 milliseconds, at the speed of light. After then, a careful and tireless search started to find the tiny and very special signal induced by a tau-neutrino.

OPERA accomplishes its neutrino detection task with its "heart" made of more than 150000 small units called "bricks" (for a total mass of 1250 tons) each of them equivalent to a sophisticated photographic camera. Thanks to these bricks, made of a sandwich of lead plates and special photographic films, the OPERA researchers can detect all details of the "neutrino events" by accurately

measuring the elementary particles produced in the interaction of the neutrino with the brick.

OPERA has been designed, realized and being conducted by a large team of researchers from all over the world: Belgium, Croatia, France, Germany, Israel, Italy, Japan, Korea, Russia, Switzerland, Tunisia and Turkey.

The computer display of the first tau-neutrino candidate event is shown below. One can see a detail of the region around the point of interaction of the neutrino (coming from the left of the figure) producing several particles identified by their tracks in the brick. The detection of the track with a "kink" is the likely signature of a tau-neutrino interaction, with a probability of about 98%. The picture describes a volume of only a few cubic millimetres, but rich of valuable information for the OPERA physicists.

This is a crucial milestone for neutrino physics made possible by a complex scientific enterprise that has been realized thanks to the skill of a large number of scientists, engineers, technicians and students, and with the strong commitment of the various actors of the project. In particular, we mention the host laboratories LNGS/INFN and CERN, together with the major financial support of Italy and Japan, and with substantial contributions from Belgium, France, Germany and Switzerland.

The OPERA Collaboration presently includes about 170 researchers from 33 institutions and 12 countries:

IIHE-ULB Brussels, Belgium

IRB Zagreb, Croatia

LAPP Annecy, France
IPNL Lyon, France
IPHC Strasbourg, France

Hamburg, Germany
Münster, Germany
Rostock, Germany

Technion Haifa, Israel

Bari, Italy
Bologna, Italy
LNF Frascati, Italy
L'Aquila, , Italy
LNGS, Italy
Naples, Italy

Padova, Italy
Rome, Italy
Salerno, Italy

Aichi, Japan
Toho, Japan
Kobe, Japan
Nagoya, Japan
Utsunomiya, Japan

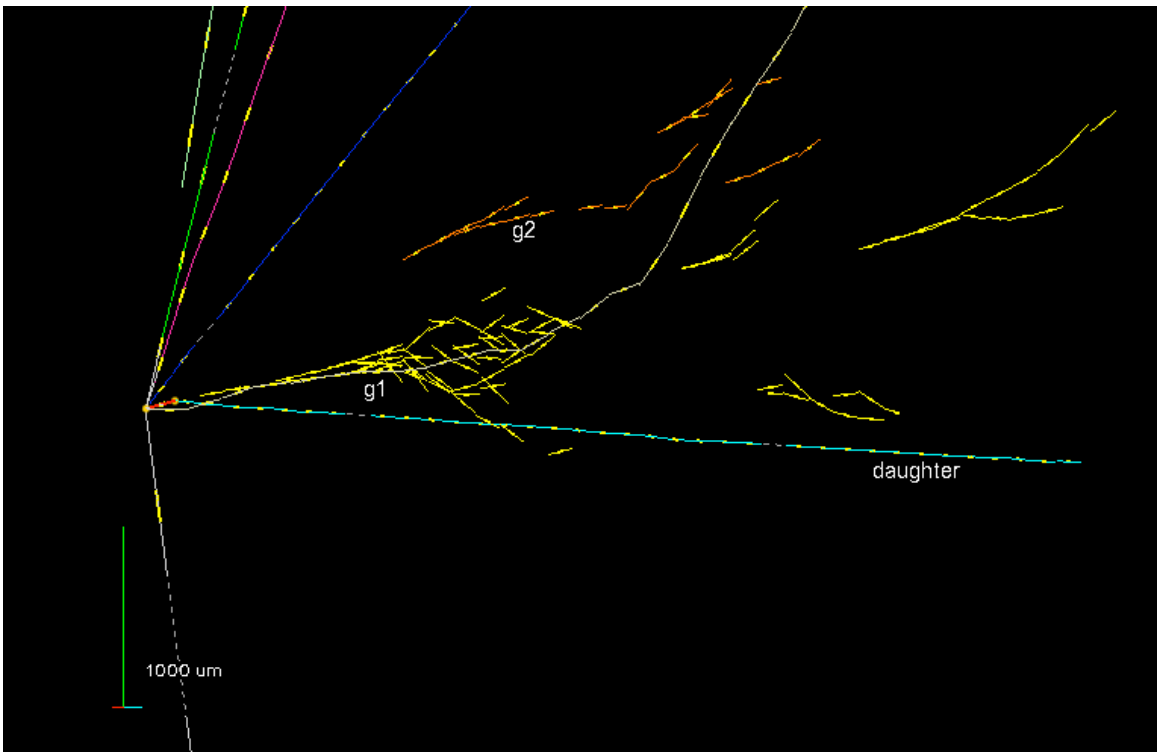
GNU Jinju, Korea

INR RAS Moscow, Russia
NPI RAS Moscow, Russia
ITEP Moscow, Russia
SINP MSU Moscow, Russia
JINR Dubna, Russia

Bern, Switzerland
ETH Zurich, Switzerland

CNSTN Tunis, Tunisia

METU Ankara, Turkey



Computer reconstruction of the tau candidate event detected in the OPERA experiment. The light blue track is the one likely induced by the decay of a tau-lepton produced by a tau-neutrino.