Translation of Le Monde article:

The last neutrino comes out of the shadow.

An international team of scientists has announced Friday July 21st evidence for the tau neutrino.

The Standard Model, which theoreticians use to describe the internal structure of the universe is from now on complete; an international team of scientists has announced the first evidence for the tau neutrino in a seminar, Friday July 21 at Fermilab in Chicago.

This news may appear to be a little esoteric to the non-initiated. However, for scientists this marks the end of a long search for the elementary particles that make up matter. These "primordial bricks", were already known. They consist of six quarks (baptized up, down, top, bottom, charm and strange) and six leptons (the electron, the muon and the tau as well as the electron, muon and tau neutrinos.)

Since the discovery of the electron, April 30th 1897, physicists have little by little dreamt up and then showed to exist these elements with the help of their odd machines, the enormous accelerators – like the one at Fermilab or its European competitor CERN at Geneva – in which they conduct violent particle collisions. The last of the quarks – the top – was detected six years ago (*Le Monde* April 27th 1994). The neutrinos have been particularly difficult to "see". They appear, in effect, as "ghost" particles practically not interacting with matter: they are capable of crossing the earth from side to side without interacting!

Frederik Reines and Clyde Cowan were able to confirm experimentally the existence of the electron-neutrino in 1956. Six years later Leon Lederman, Jack Stienberger and Melvin Schwartz achieved the goal of the muon neutrino, but the smallest of the family resisted.

What was necessary to produce the evidence came down to a search for a minute needle in a haystack. The idea of the experiment conducted by Byron Lundberg and his team (54 physicists from 4 nations) at Fermilab consisted of bombarding plates of tungsten and thus to produce jets of all types of neutrinos. These then crossed plates of iron between which are placed photographic emulsions. From a number estimated to be one hundred thousand million tau-neutrinos, one hundred have probably interacted and of these four have been identified with certainty by the scientists! The experiment needed an enormous energy that only Fermilab is capable of producing.

The discovery of the first two neutrinos was earned the Nobel Prize for their authors. That will, without doubt, not be the case this time: "This is a very beautiful experiment, which will go into the books, but it amounts really to an anticipated discovery, which tells the theorists nothing", was the opinion of Luigi Di Lella of CERN. According to Michel Cribier, Physicist with CEA, "if a third Nobel prize is to be given for neutrinos, it

will most likely for the demonstration that they have mass. That could be possible, thanks to the results from Superkamiokande in Japan”

Pierre Barthelemy and Jean-Paul Dufor

Le Monde Saturday Juky 22nd 2000.