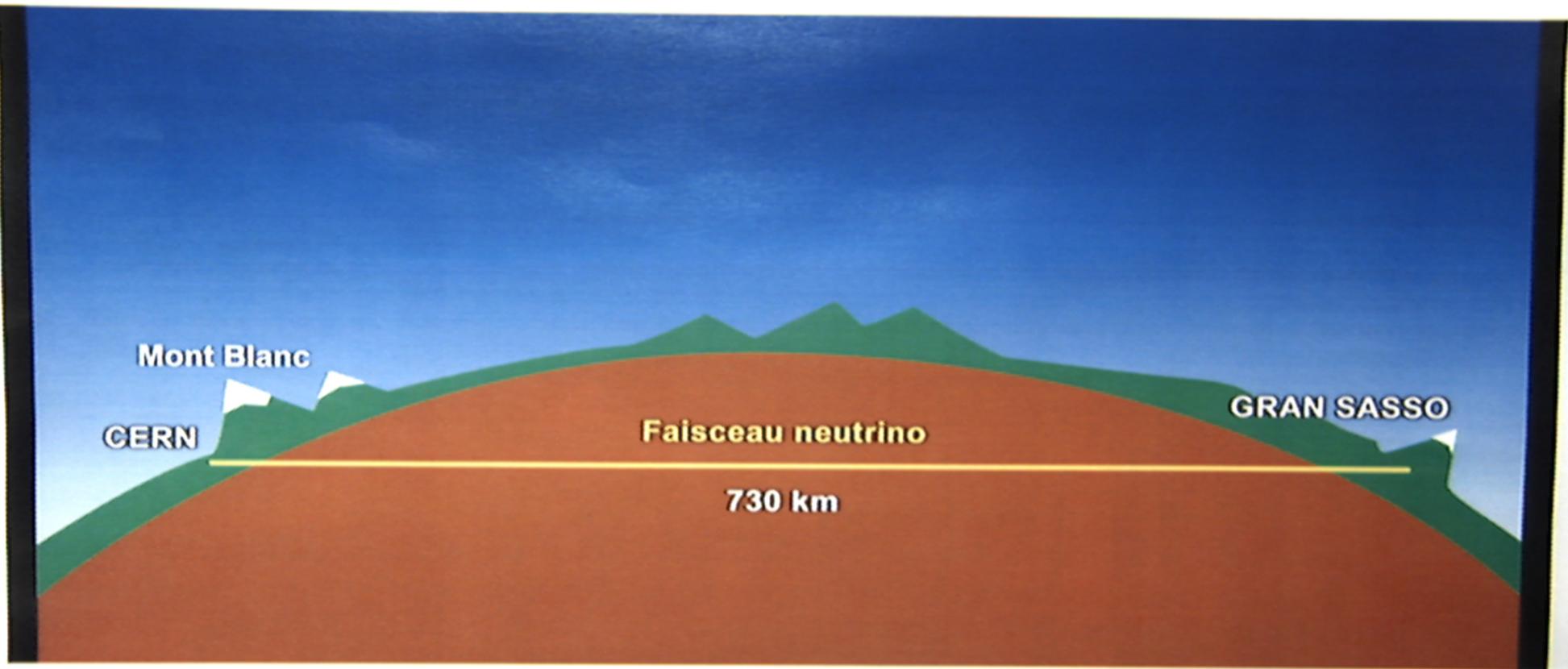


Title: P.I. Chats: Faster-than-light neutrinos?

Date: Sep 28, 2011 12:15 PM

URL: <http://pirsa.org/11090135>

Abstract: Can neutrinos really travel faster than light? Recently released experimental data from CERN suggests that they can. Join host Dr. Richard Epp and a panel of Perimeter Institute scientists in a live webinar to discuss this unexpected and puzzling experimental result, and some theoretical questions it might raise.



Cern test 'breaks speed of light'

**0.0024 seconds**

time taken by neutrinos

**0.0000006 seconds**

faster than the expected time

**732 km**

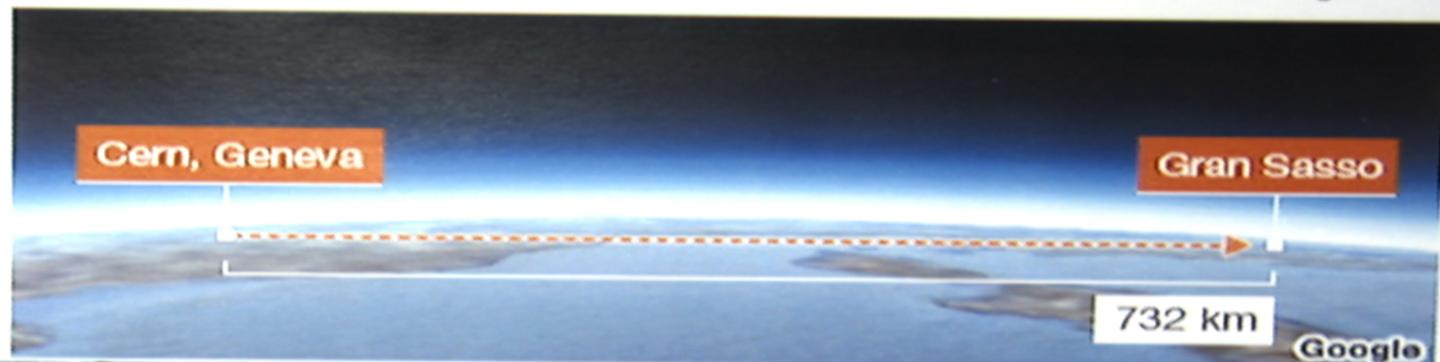
distance travelled through rock

SWITZERLAND

□ Geneva

ITALY

□ Gran Sasso



Cern, Switzerland: A beam of neutrino particles is sent through rock towards Italy



Gran Sasso, Italy: Bricks with ultrasensitive covering at underground laboratory detect arrival

$$St = 60.7 \pm 6.9 \pm 7.4 \text{ ns.}$$

(stat.)      (syst.)

$$\frac{\Delta v}{c} \sim 25 \text{ ppm}$$

6.0 σ

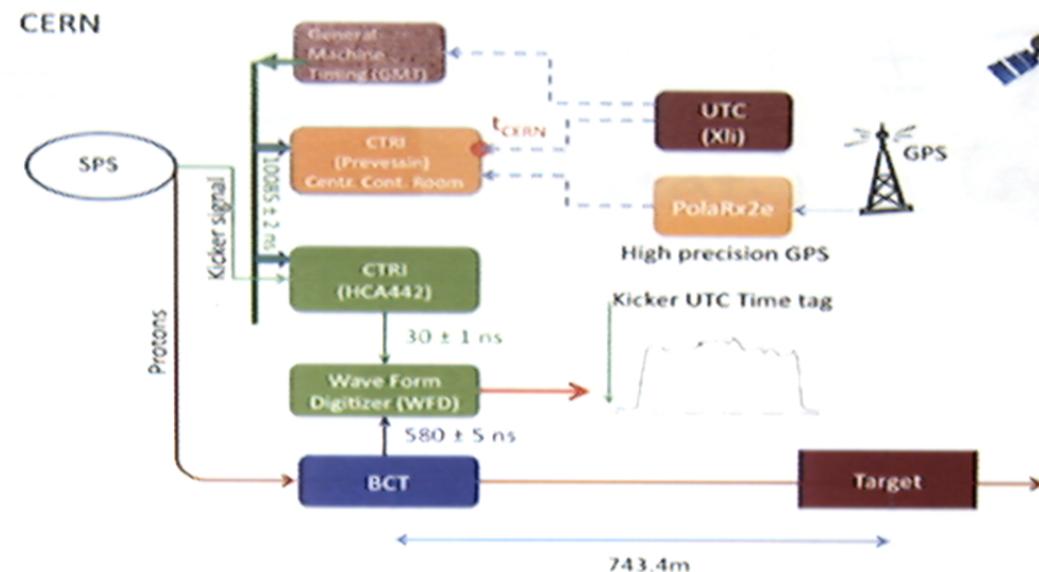


Fig. 3: Schematic of the CERN SPS-CNGS timing system. Green boxes indicate detector time-response. Orange boxes refer to elements of the CNGS-OPERA synchronisation system. Details on the various elements are given in Section 6.

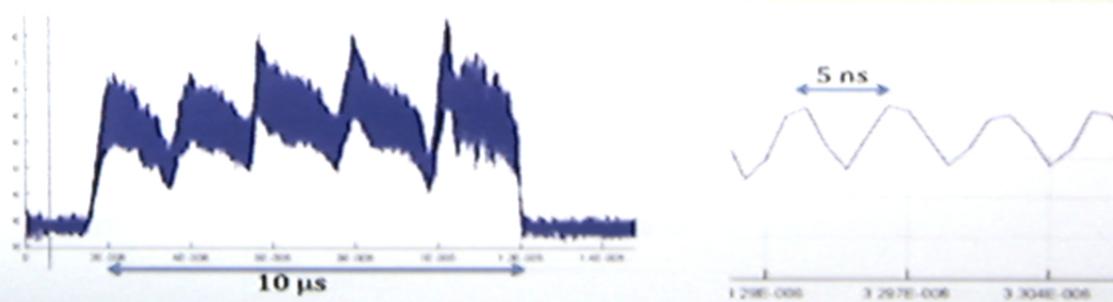


Fig. 4: Example of a proton extraction waveform measured with the BCT detector BFCT1400344. The five-peak structure reflects the continuous PS turn extraction mechanism. A zoom of the waveform (right plot) allows resolving the 200 MHz SPS radiofrequency.



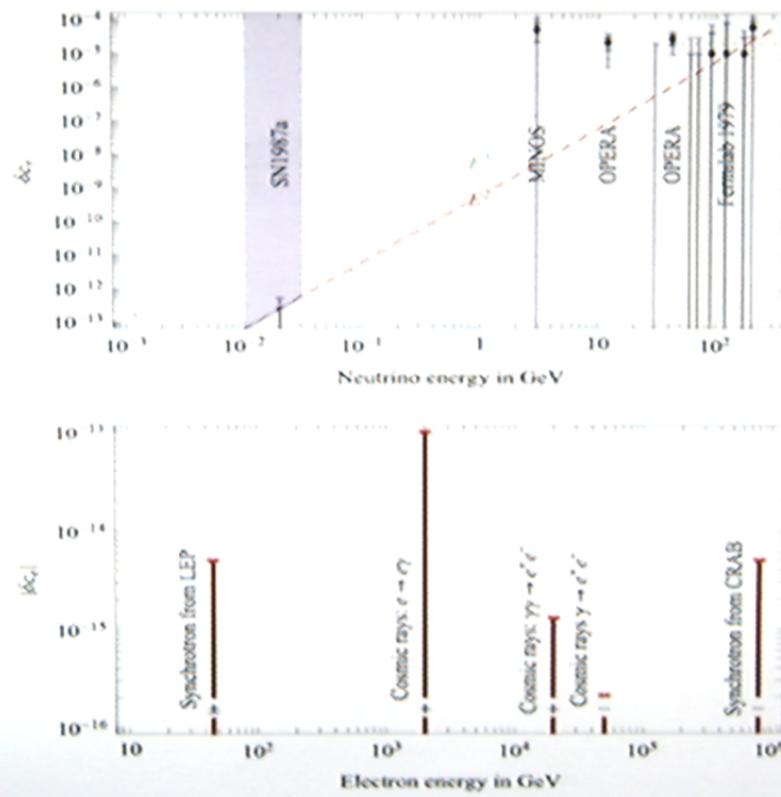
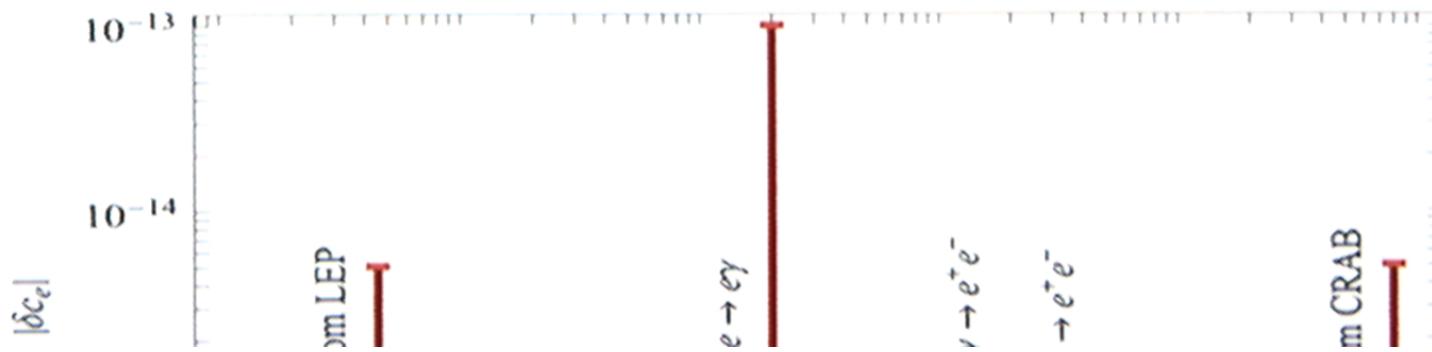
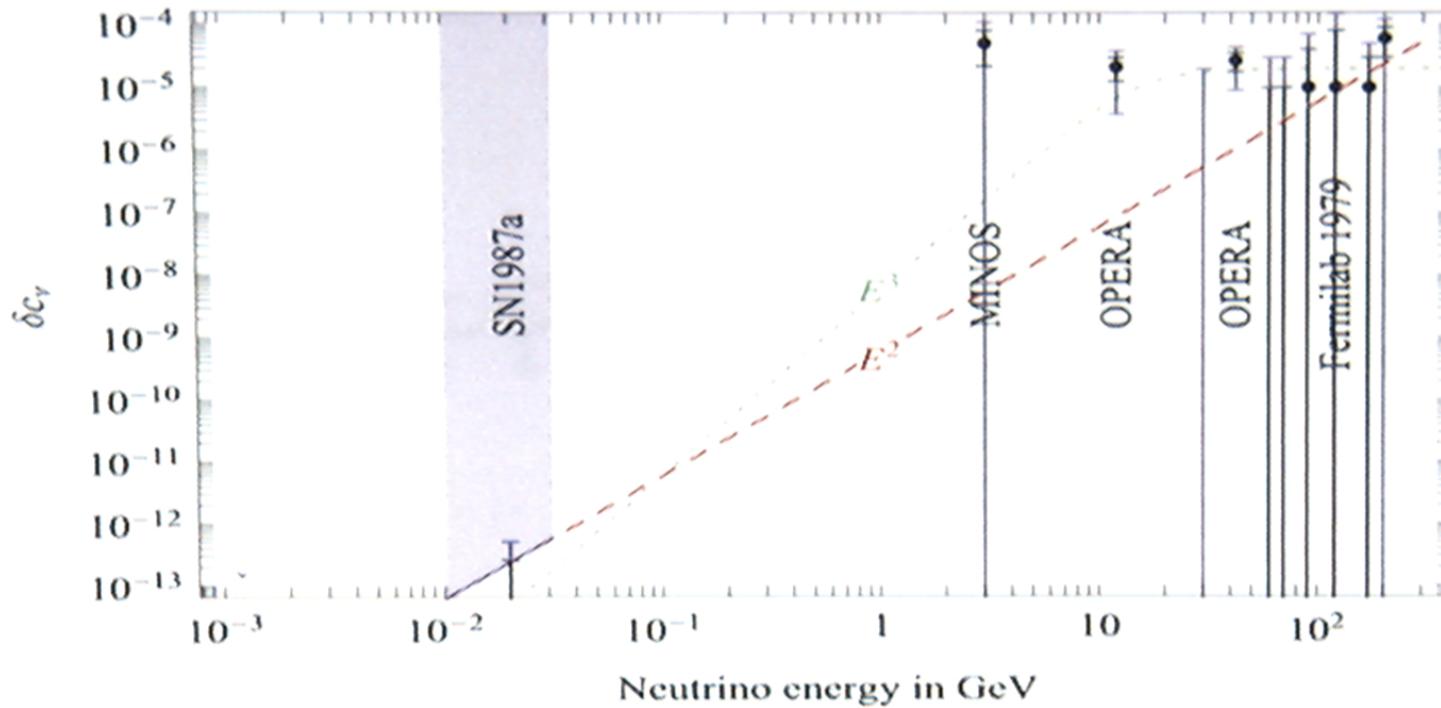


Figure 1: Top: MINOS, OPERA and FERMILAB1979 data on  $\delta c_\nu$ , together with the upper



## LNGS

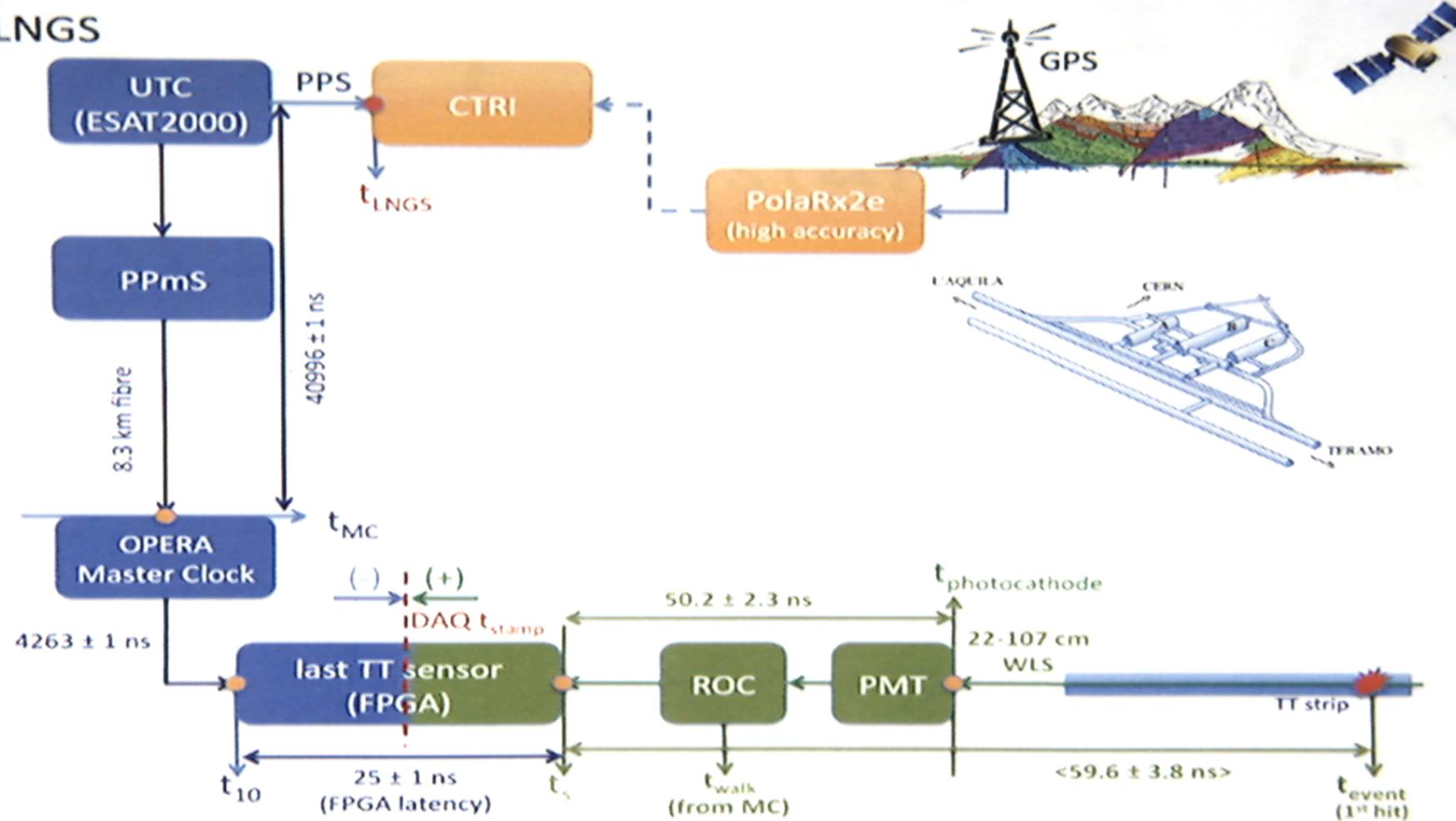
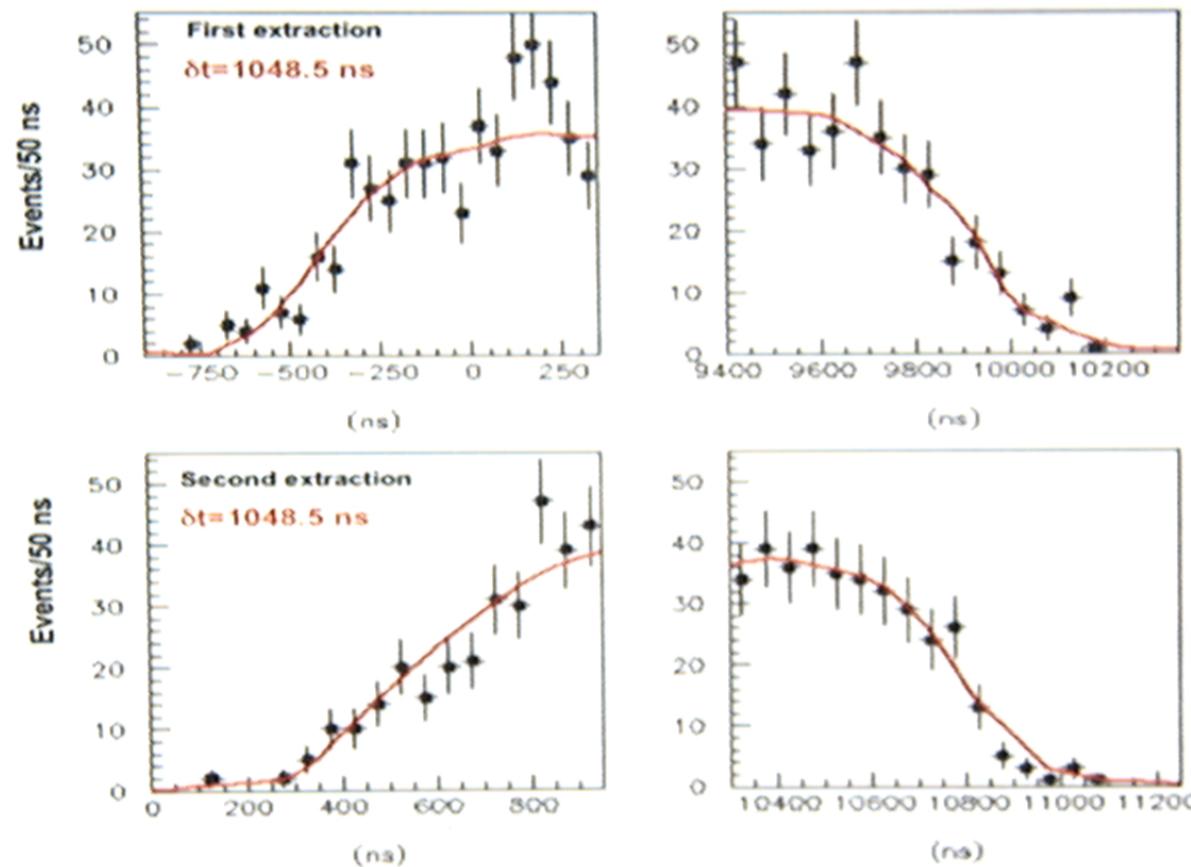


Fig. 6: Schematic of the OPERA timing system at LNGS. Blue delays include elements of the time-stamp distribution; increasing delays decrease the value of  $\delta t$ . Green delays indicate detector time-response; increasing delays increase the value of  $\delta t$ . Orange boxes refer to elements of the CNGS-OPERA synchronisation system.

ence from the BCT to the OPERA reference frame, and it is only determined by neutrinos and by protons and pions, which introduce negligible delays.



12: Zoom of the leading (left plots) and trailing edges (right plots) of the measured neutrino interaction time distributions (data points) and the proton PDF (red line) for the two SPS extractions after correcting for  $\delta t$  (blind).