



NBI2006

Starting OPERA data-taking
with the CNGS beam

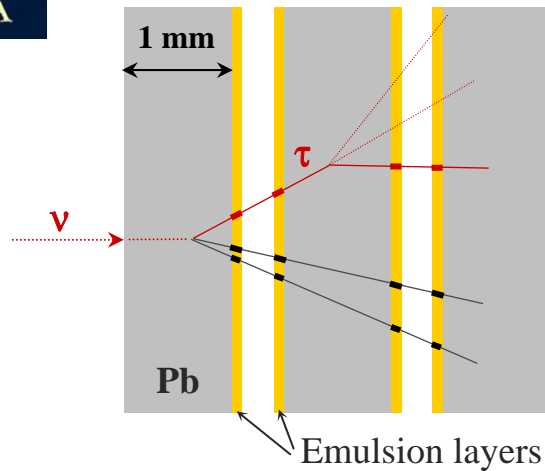
D. Autiero IN2P3/IPN Lyon

5/9/2006





The basic unit : the « brick »

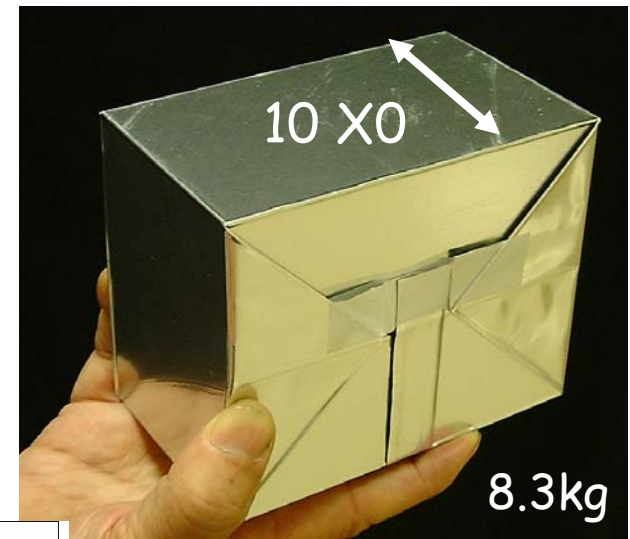


- Based on the concept of the Emulsion Cloud Chamber (**ECC**)
- **56 Pb sheets 1mm + 56 emulsion layers**
- Solves the problem of compatibility of **large mass for neutrino interactions + high space resolution** in a completely **modular** scheme

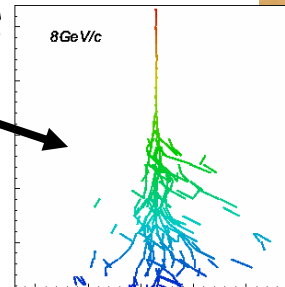
ECC are completely stand-alone detectors:

- Neutrino interaction vertex and kink **topology** reconstruction ($\delta x < 1\mu\text{m}$, $\delta\theta < 1\text{mrad}$)
- Measurement of the **momenta** of hadrons by multiple scattering
- **dE/dx** pion/muon separation at low energy
- **Electron identification** and measurement of the energy of the electrons and photons

ECC Technique validated by the direct observation of ν_τ :
DONUT 2000



10.2 x 12.7 x 7.5 cm



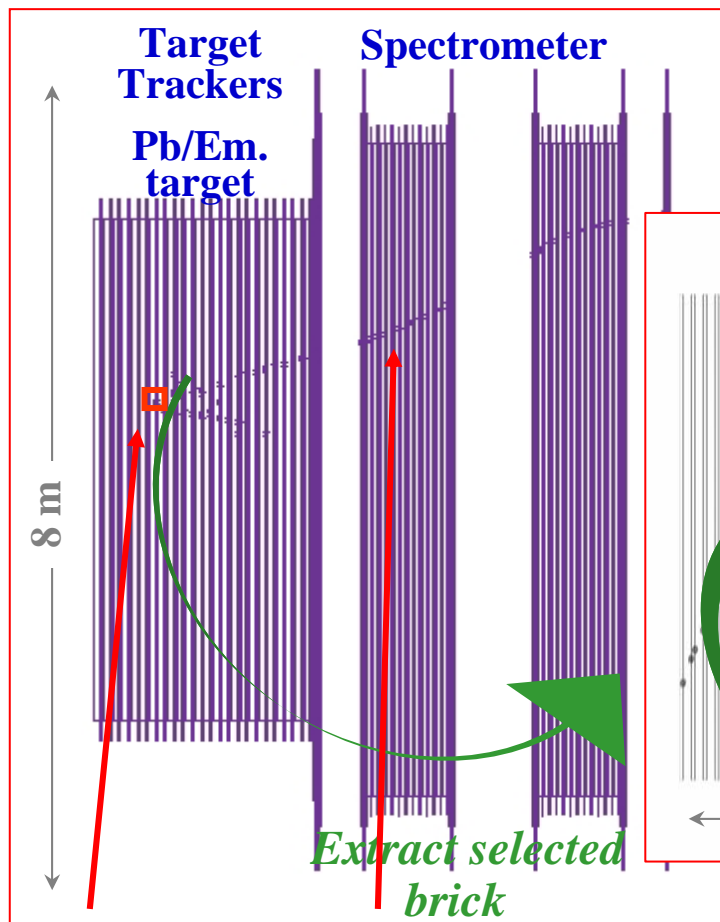
Use of the Electronic detectors



- **trigger** and **localization** of neutrino interactions
- **muon** identification and momentum/charge measurement

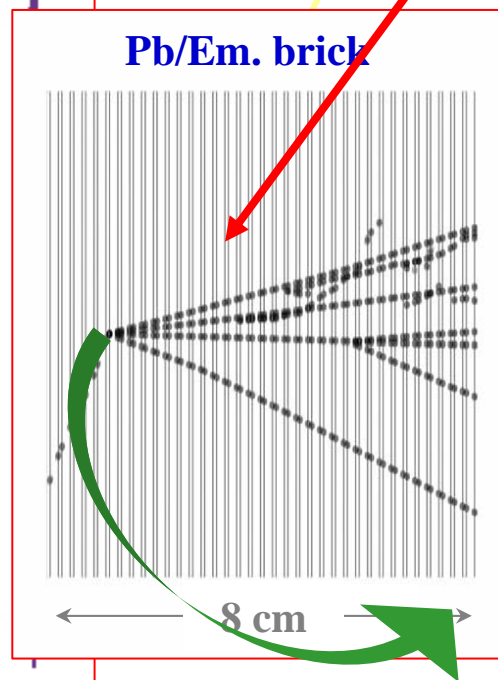
➔ need for a **hybrid** detector

Electronic detectors:

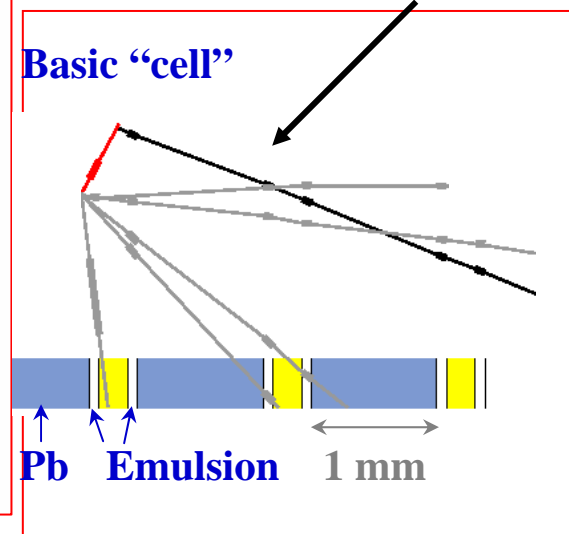


ECC emulsions analysis:

Vertex, decay kink e/γ ID,
multiple scattering, kinematics



Link to mu ID,
Candidate event

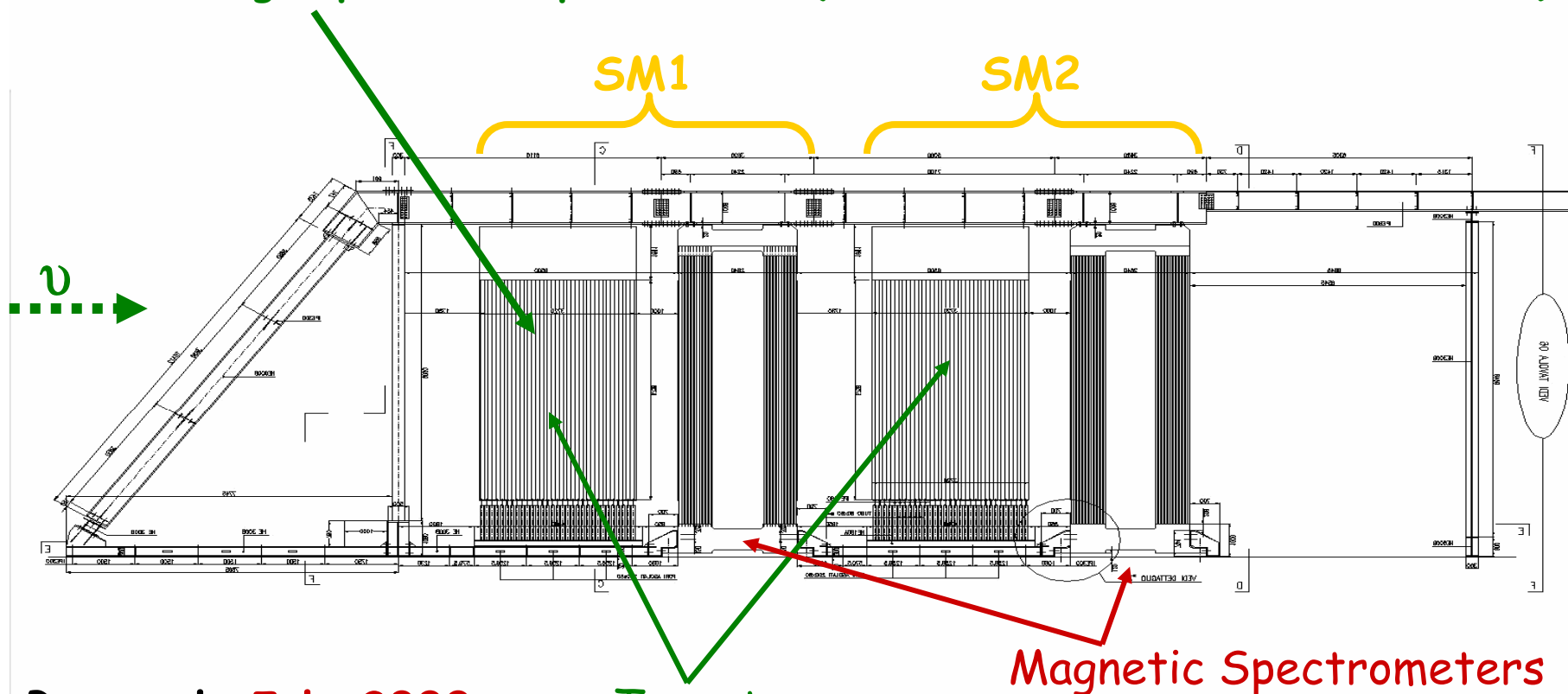


Brick finding, muon ID, charge and p

Structure of the OPERA Experiment



31 target planes / supermodule (in total: 206336 bricks, 1766 tons)



Proposal: **July 2000**,

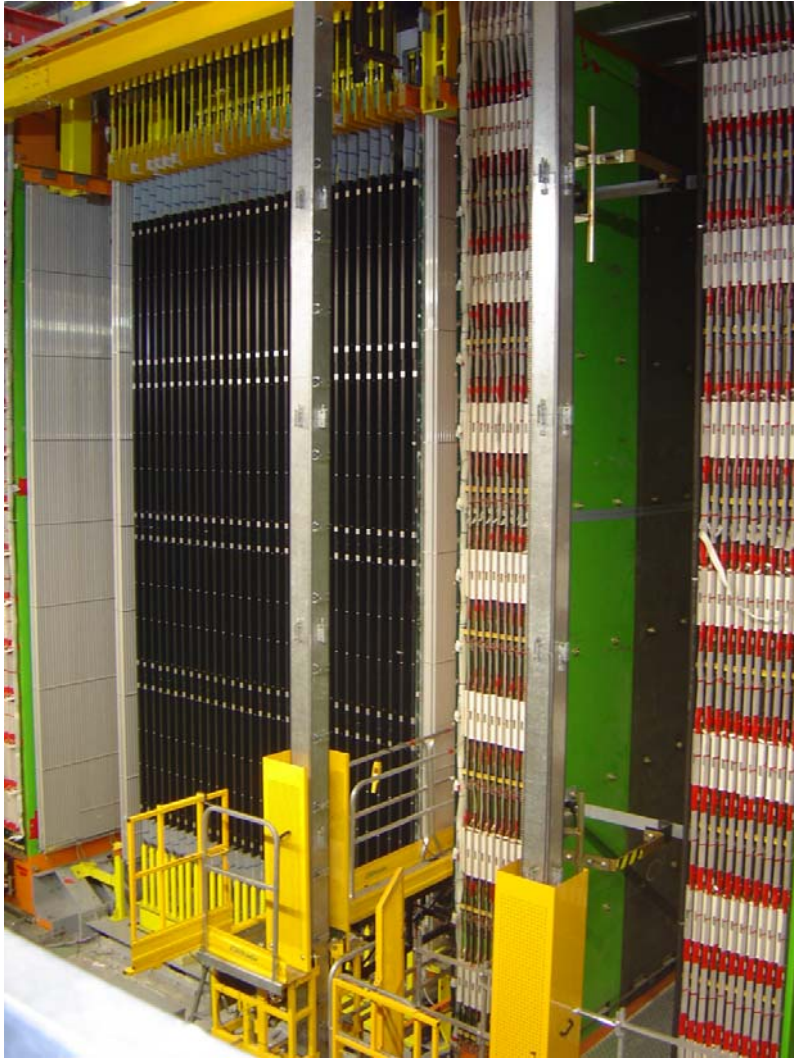
installation at LNGS started in **May 2003**

First observation of CNGS beam neutrinos : **August 18th, 2006**

OPERA in pictures

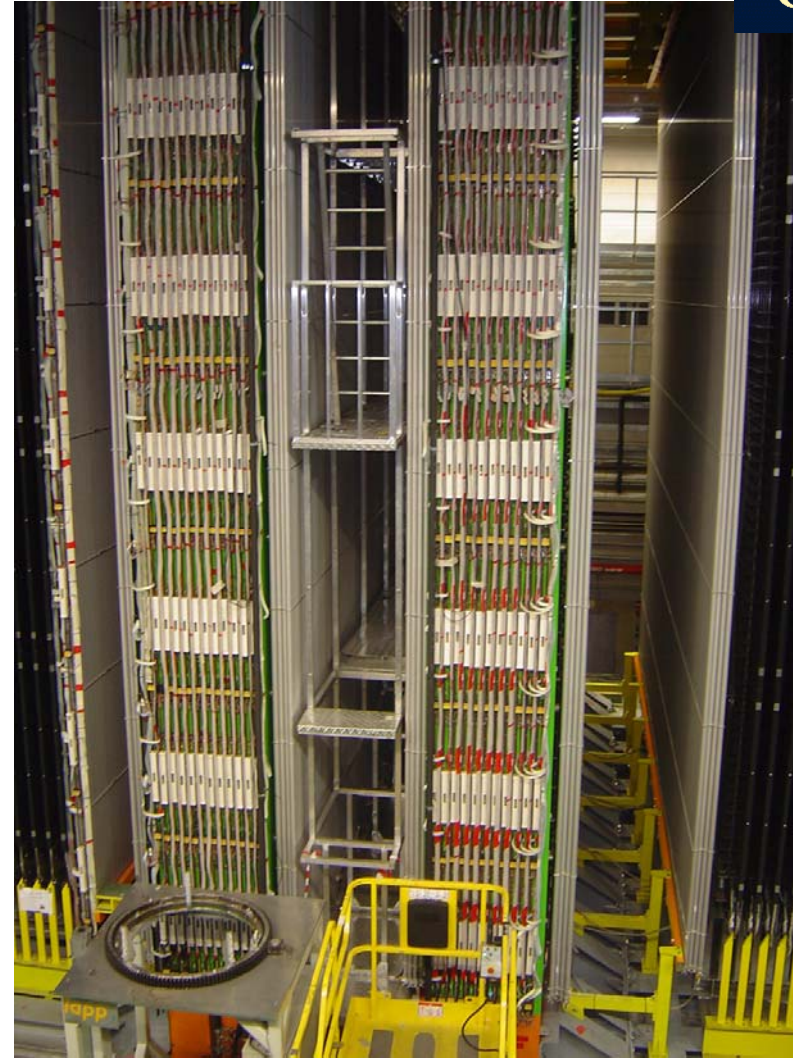


Second Super-module



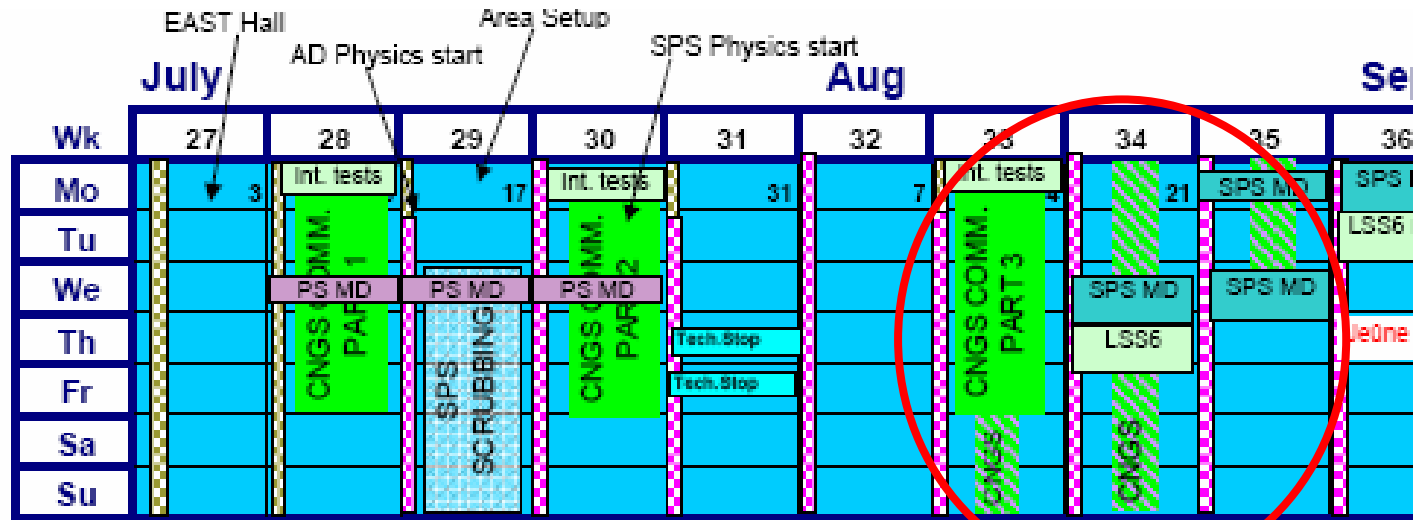
**Scintillator planes 5900 m²
8064 7m long drift tubes**

details of the first spectrometer



**3050 m² Resistive Plate Counters
2000 tons of iron for the two magnets**

August 2006 pilot run

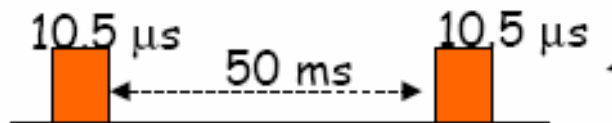
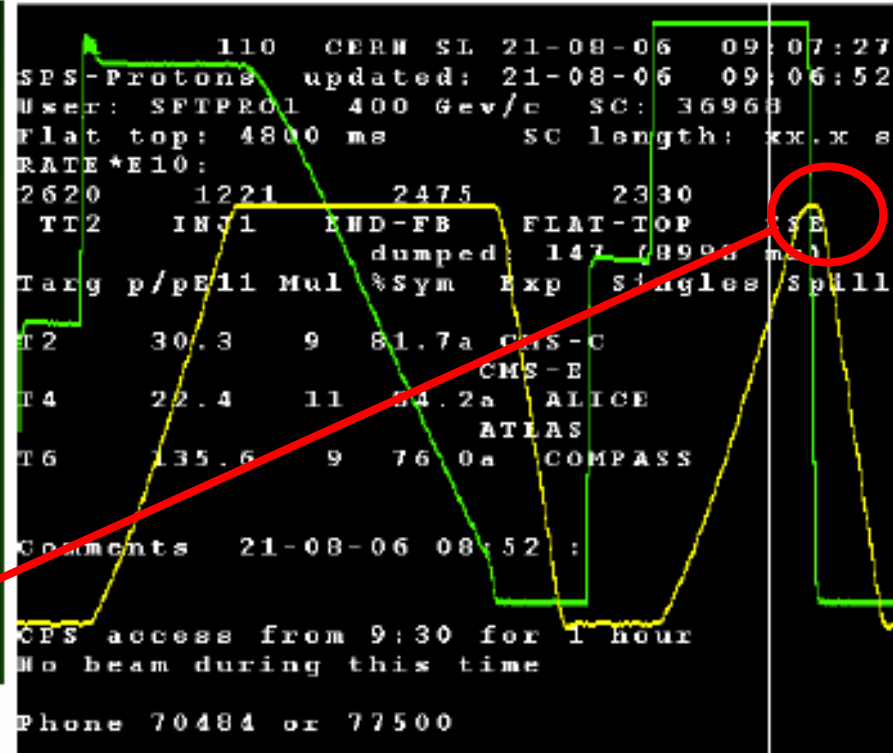
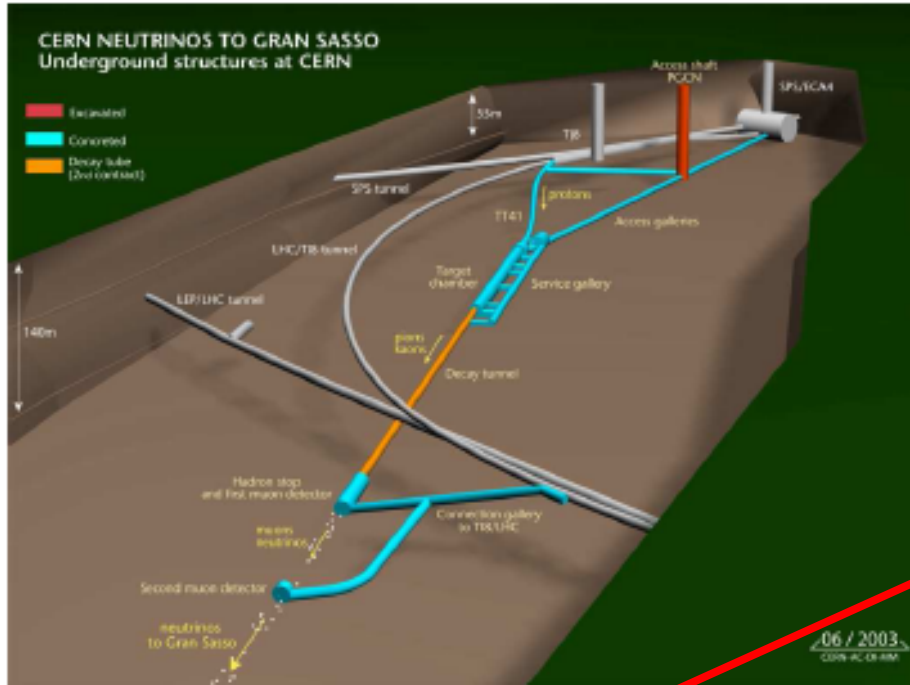


At the end of the third week of CNGS commissioning we took a first run with the CNGS beam to perform a global test of the electronic detectors in OPERA.

The run started on August 18th at 13:40 and lasted for 8.5 days (excluding MD), looking at the CNGS logging database we had beam for 121 hours (5 days)

The efficiency of the CERN machines complex (+CNGS) was around 60% (65% corrected for some data losses in the CNGS database)

The OPERA DAQ+detector livetime was greater than 95%



SPS Supercycle 16.8 s

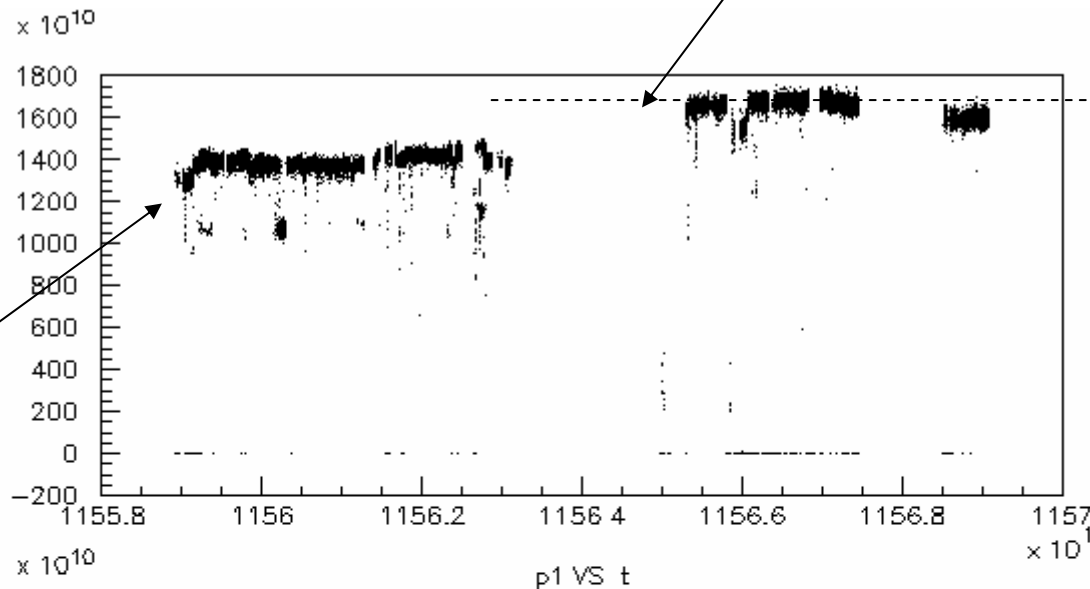
CNGS cycle 6 s

Two extraction/cycle lasting 10.5 us and separated by 50 ms

Extraction intensities as a function of time

Friday 25, restart after MD

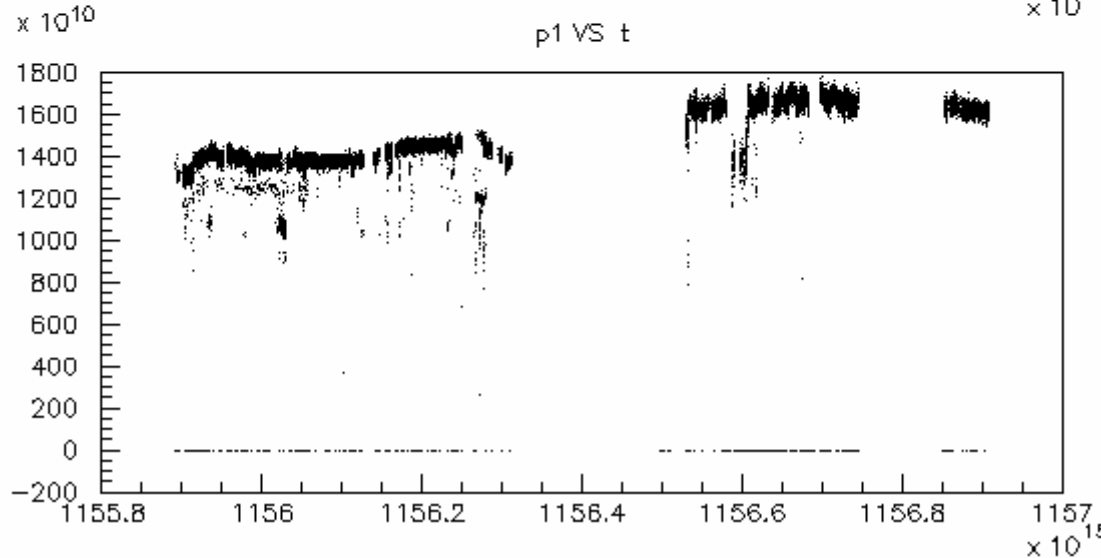
Extraction 1
Friday 18



1.7E13 pot

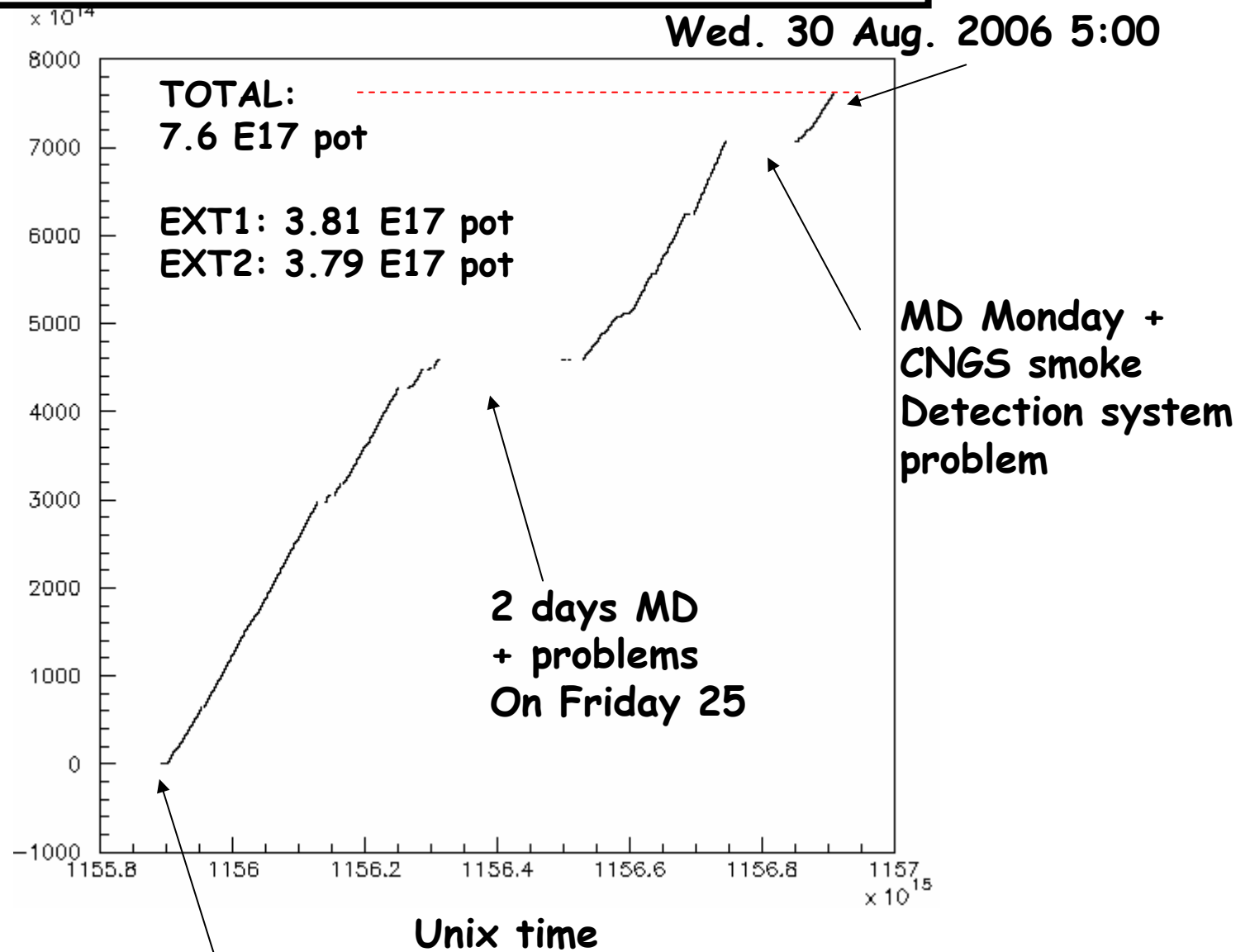
Increase
bringing to 70%
of the nominal
intensity after
improvement of
PS proton
intensity

Extraction 2



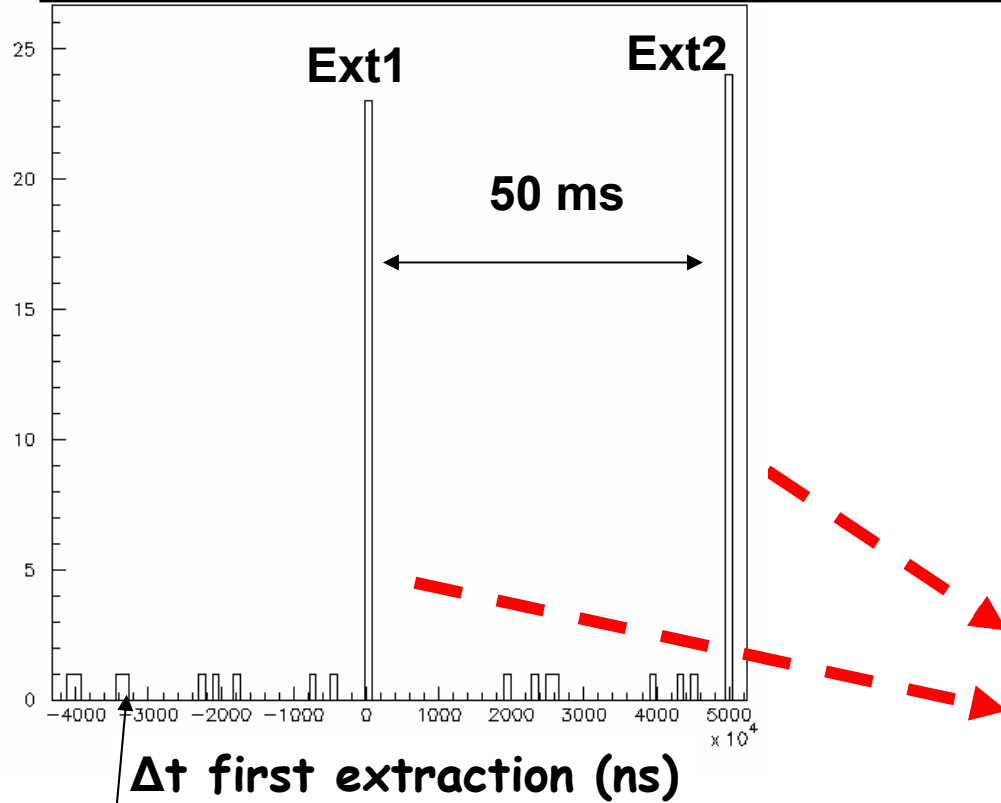
Unix time (ns elapsed since January 1st 1970)

Integrated intensity (pot) as a function of time



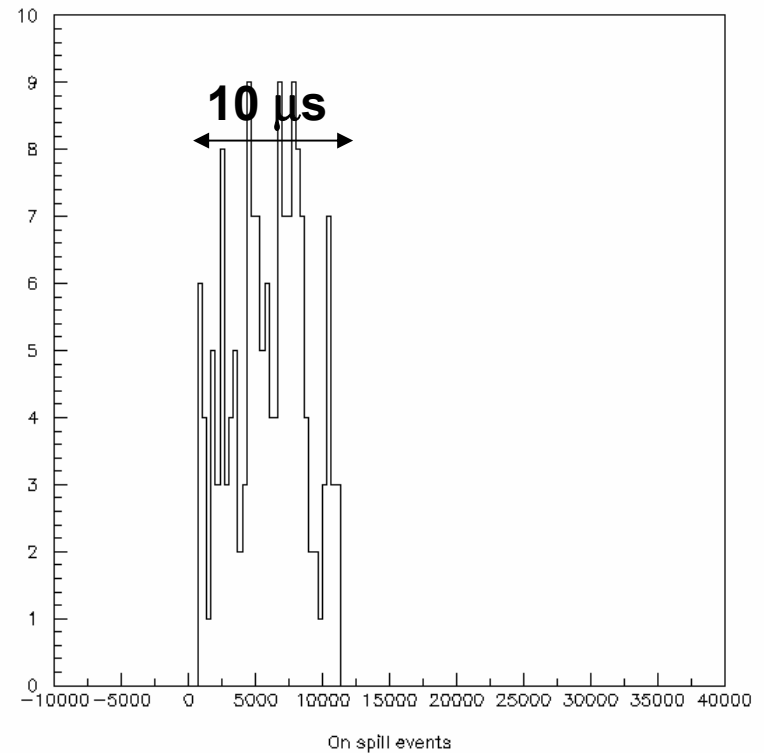
Fri 18 Aug. 2006 13:40

Event selection by using GPS timing informations



Cosmic rays background events

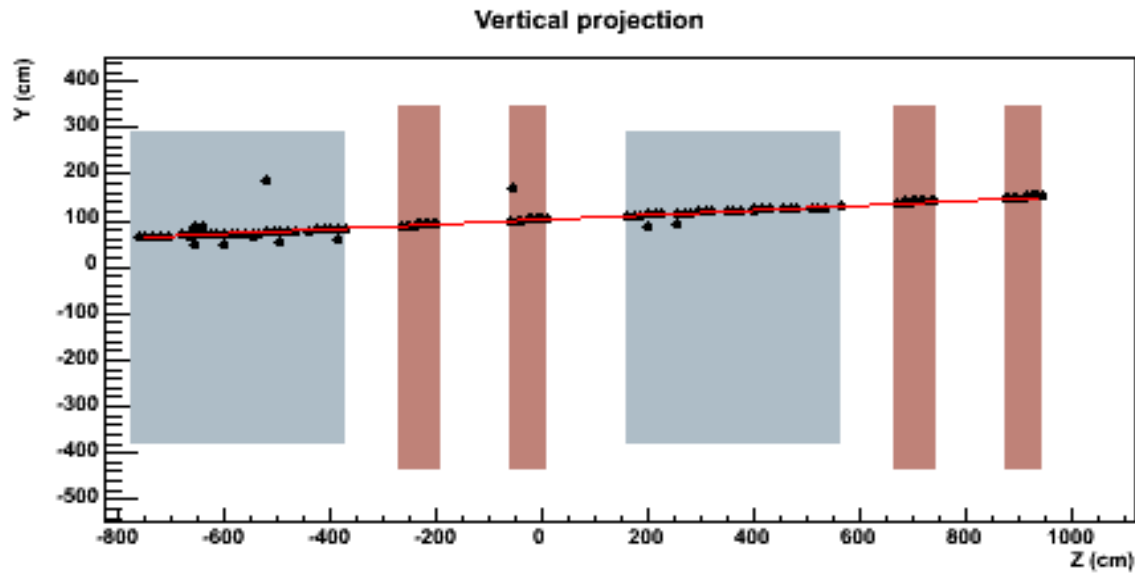
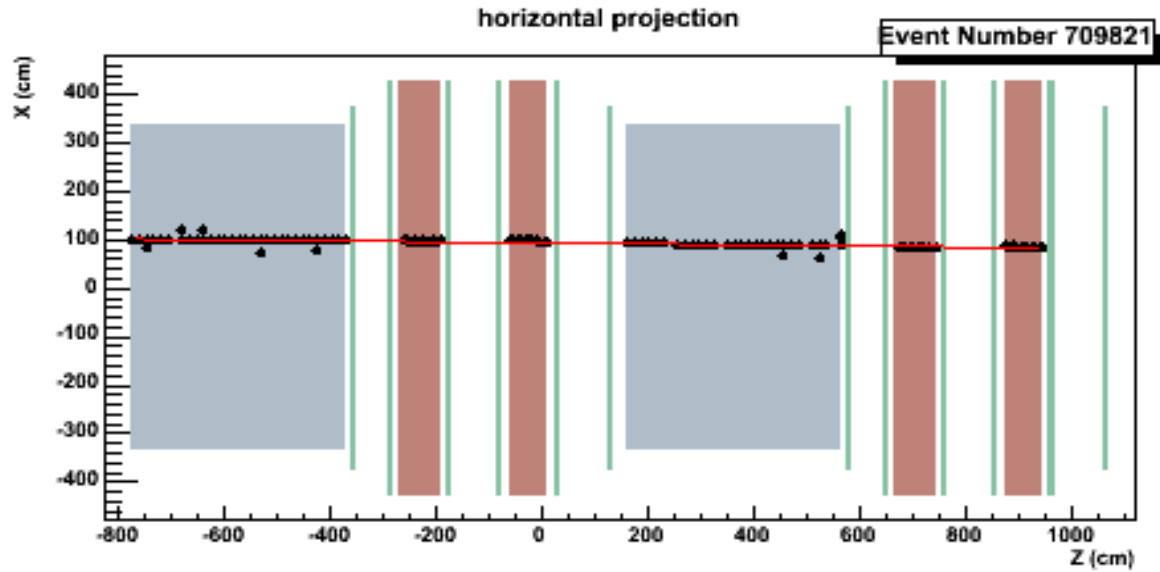
Zoom on the spill peaks



Δt closest extraction (ns)

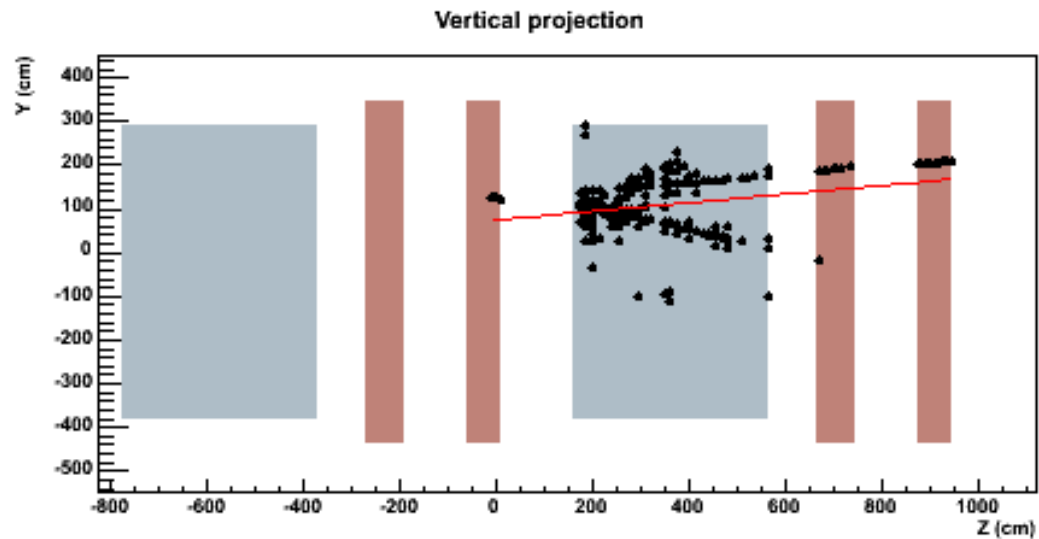
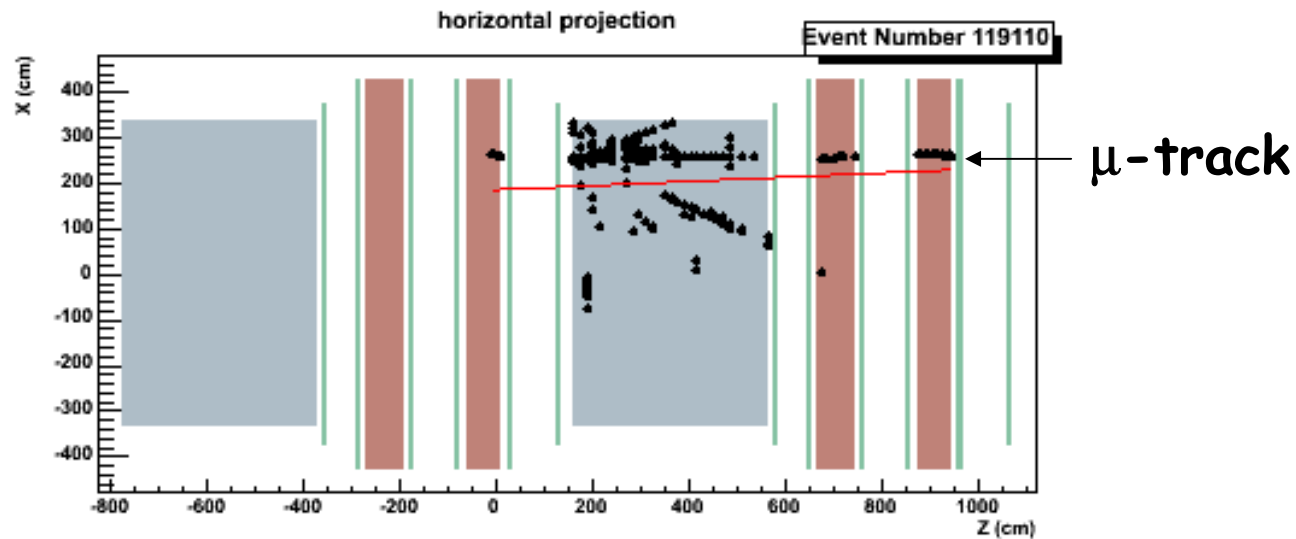


Beam event

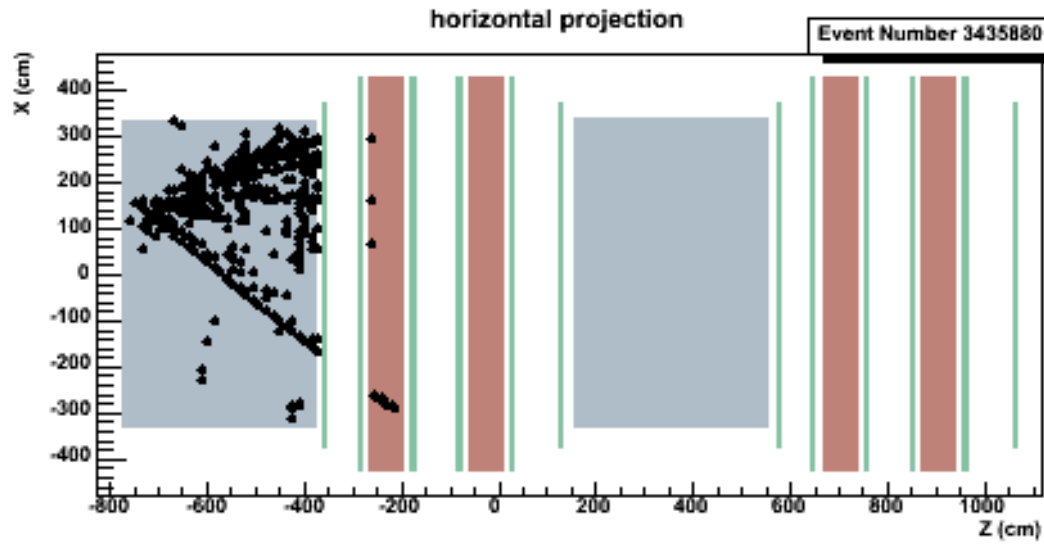


Muon from *CC* interaction
in the material in front of
the detector (BOREXINO,
rocks)

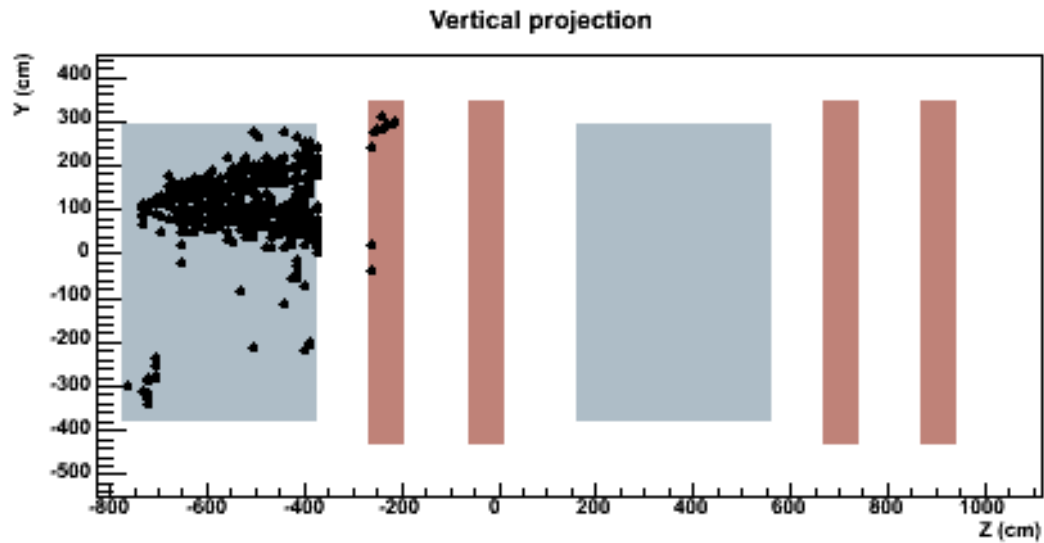
CC event in the first magnet



(forgive about the red-line fit)



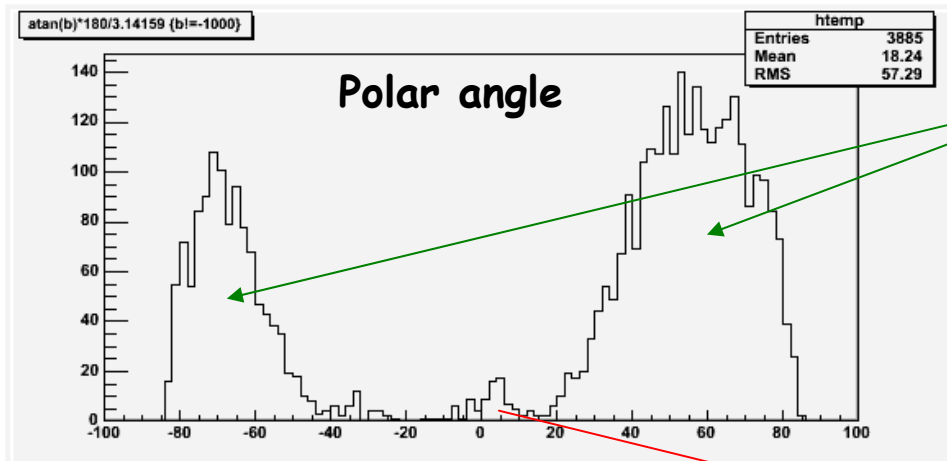
CC neutrino interaction
in the scintillator planes



Angular distribution of all events

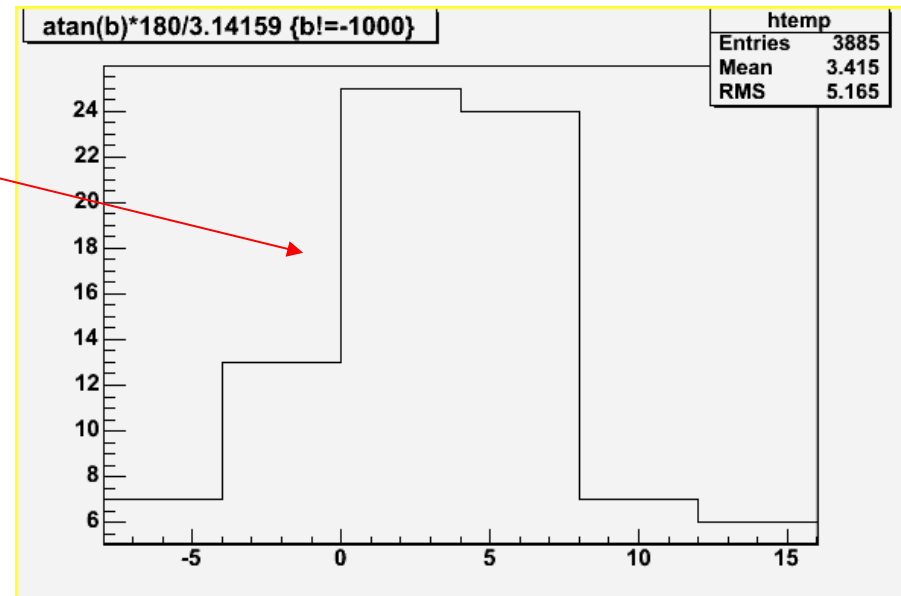
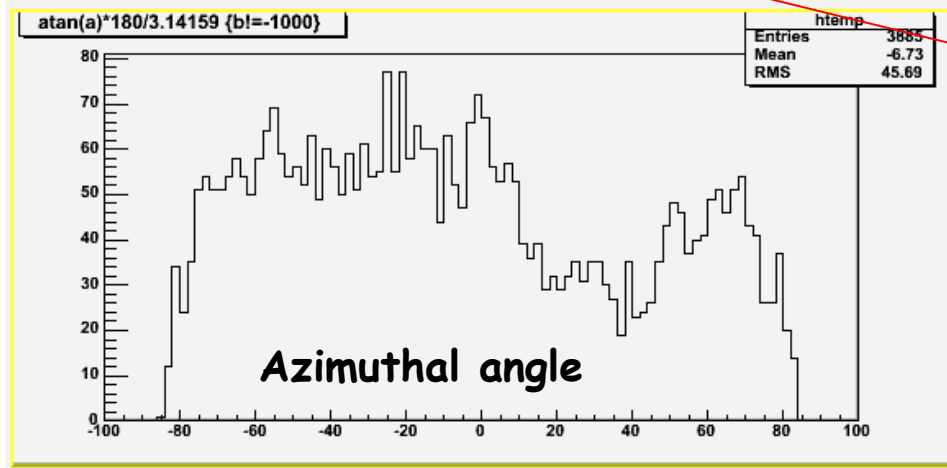


Clean selected events

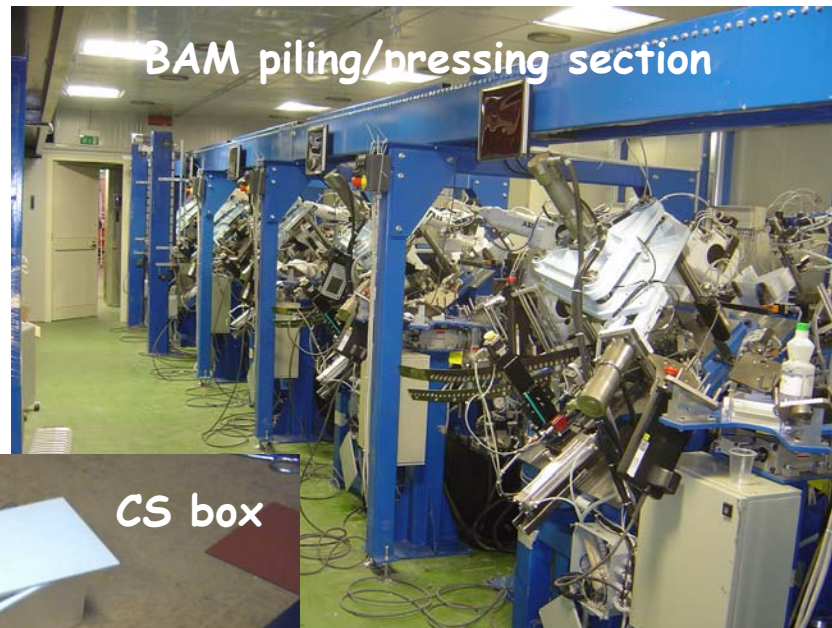


Cosmic muons

Zoom on Beam events
3.5° from below



Brick production



➤ Starting now:
12 10^6 emulsions & lead plates
200 000 bricks to be produced
Production rate 1000/day

10 months to fill the detector

Conclusions:

CNGS was operating **smoothly and with very good beam quality**.
The extraction intensity was limited by the PS.

The tracking detectors of OPERA took data from the very beginning of the run with **practically no dead-time**

More than 300 beam events were observed with a very clean time distribution

The recorded events show the **expected tracking performance** of the OPERA electronic detectors

OPERA is ready for the next step of observing neutrino interactions in the emulsion cloud chamber bricks, **looking forward to the October run**