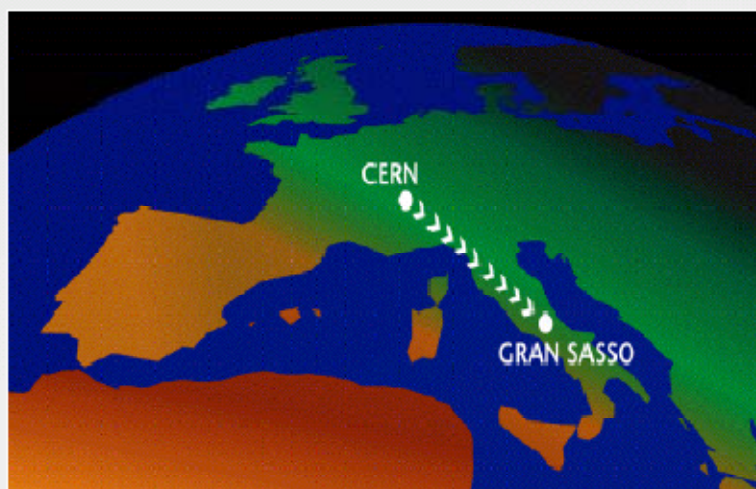


Oscillation Project with Emulsion tRacking Apparatus

International Collaboration (Europe + Japan)

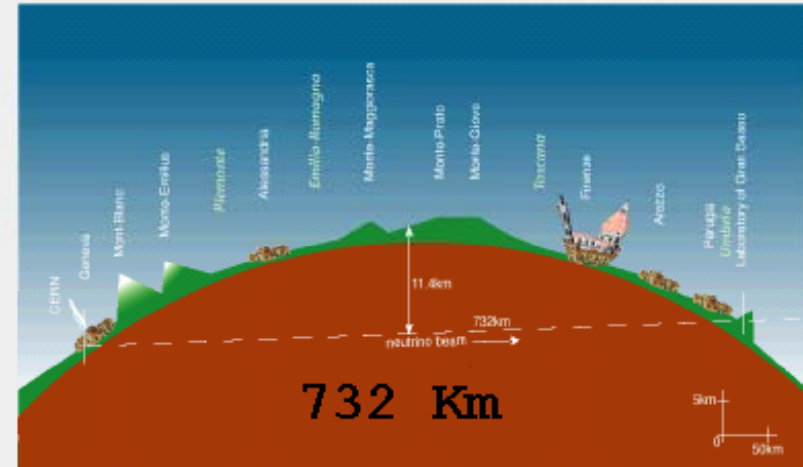


	IIHE (ULB-VUB), Brussels
	Sofia
	IHEP Beijing, Shandong
	IRB Zagreb
	LAPP Annecy, IPNL Lyon, LAL Orsay, IRES Strasbourg
	Berlin Humboldt, Hagen, Hamburg, Münster, Rostock
	Technion Haifa
	Bari, Bologna, LNF Frascati, L'Aquila, LNGS, Napoli, Padova, Roma La Sapienza, Salerno
	 Aichi, Kobe, Nagoya, Toho, Utsunomiya
	INR Moscow, ITEP Moscow, JINR Dubna, Obninsk
	Bern, Neuchâtel, Zurich
	METU Ankara

- Long baseline experiment
- CNGS pure ν_μ beam, $\langle L \rangle = 732$ km, $\langle E \rangle = 17$ GeV
- Appearance signal $\nu_\mu \rightarrow \nu_\tau$ (by product $\nu_\mu \rightarrow \nu_e$)
- Hybrid setup (Nuclear Emulsions + electronics)
- Atmospheric neutrino data allowed region oscillation search

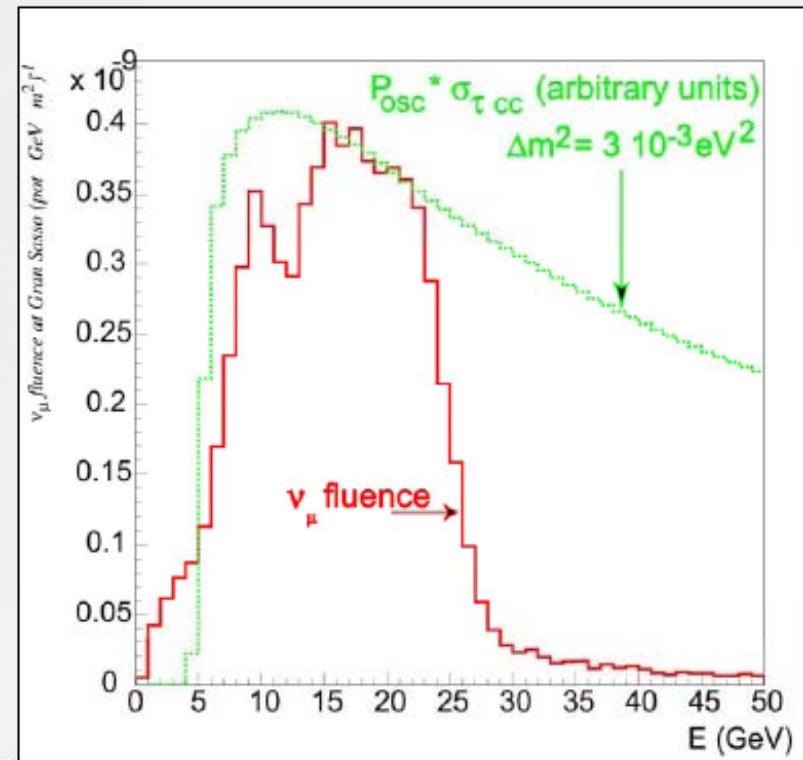
CNGS beam

The beam was optimized to maximize ν_τ CC interaction rate at LNGS.



We will have 4.5×10^{19} p.o.t./year, 200 days/year

$\langle E_{\nu_\mu} \rangle$	17 GeV
$(\nu_e + \bar{\nu}_e) / \nu_\mu$	0.87%
$\bar{\nu}_\mu / \nu_\mu$	2.1%
ν_τ prompt	negligible
ν_μ CC + NC int/year	~ 6200
ν_τ CC int/year	~25 ($\Delta m^2 = 2.4 \times 10^{-3} \text{ eV}^2$, maximal mixing)

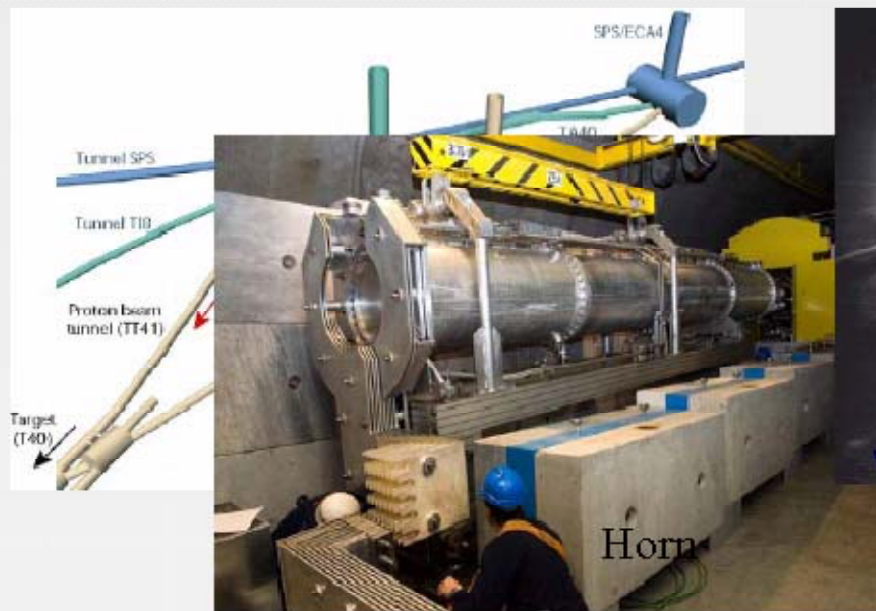
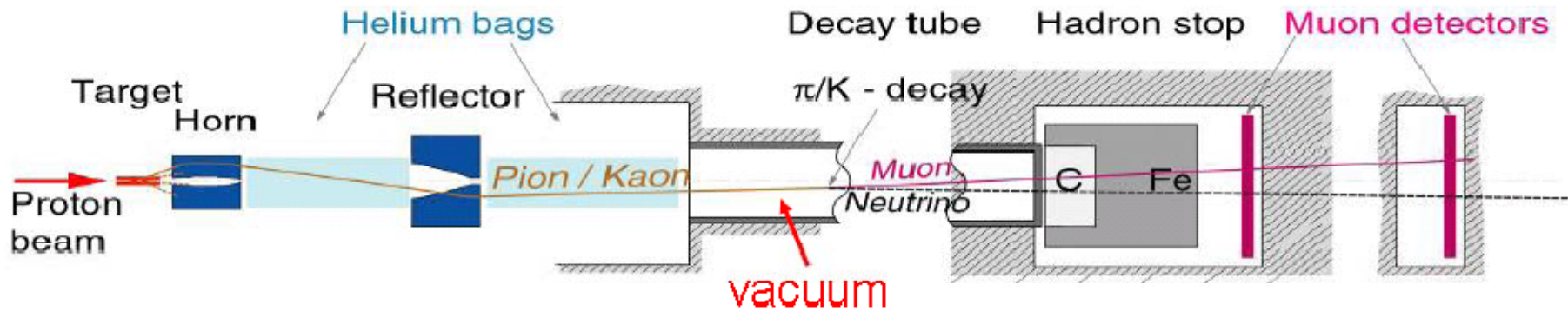


700 m

100 m

1000m

67 m



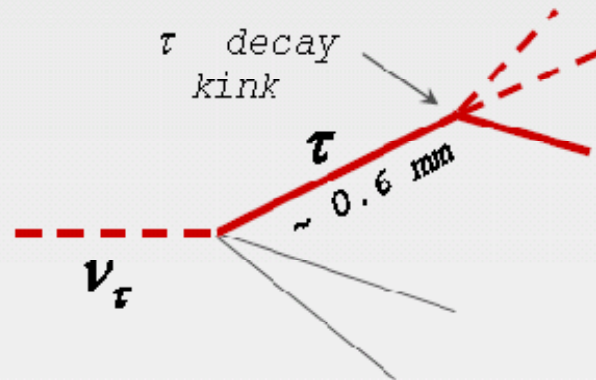
Civil engineering completed (June '03)

Hadron stopper and decay tube installed (June '04)

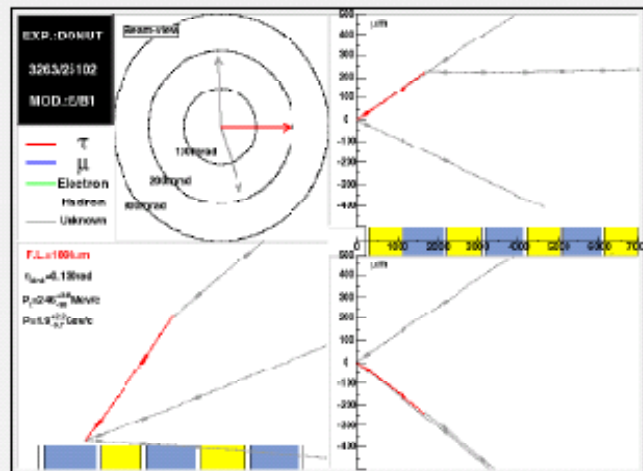
Target section completed (commissioning July '06)

ν_τ appearance signature

- Detection of ν_τ CC interaction and direct observation of decay topologies
- High background rejection

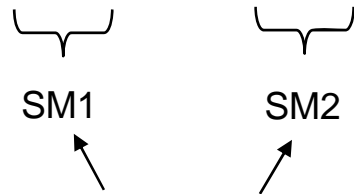
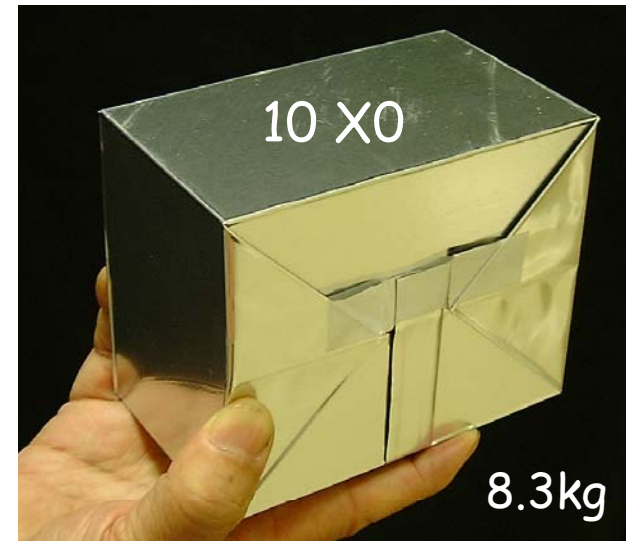
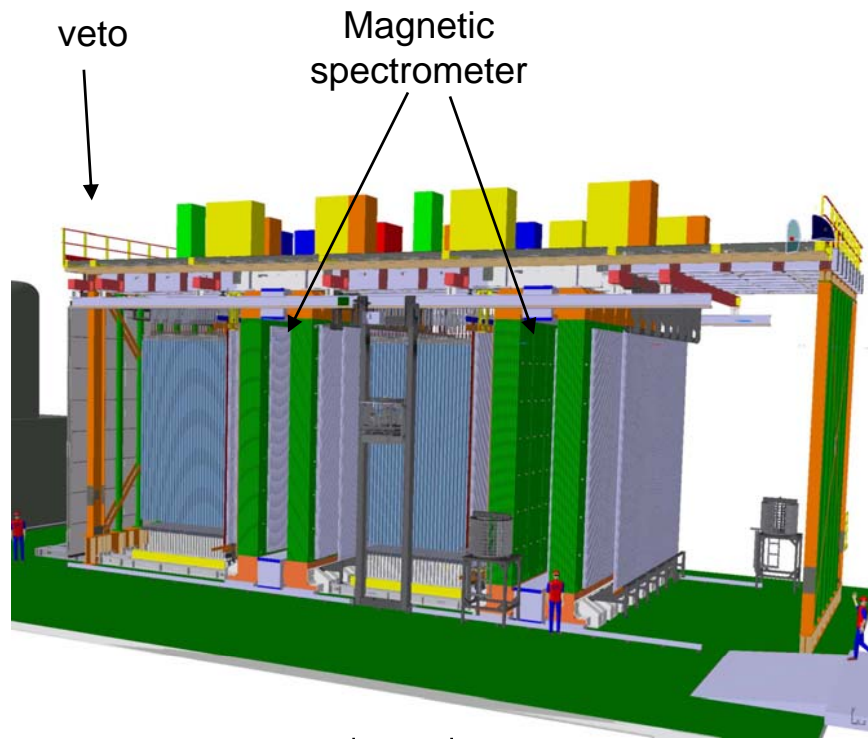


$\tau \rightarrow \mu^- \nu_\tau \nu_\mu$	(17.4%)
$\tau \rightarrow e^- \nu_\tau \nu_e$	(17.8%)
$\tau \rightarrow h^- \nu_\tau n(\pi^0)$	(49.5%)
$\tau \rightarrow \pi^+ \pi^- \pi^+ \nu_\tau n(\pi^0)$	(14.5%)



Nuclear emulsions (ECC)

- 3D particle reconstruction
- Sub-micron spatial resolution

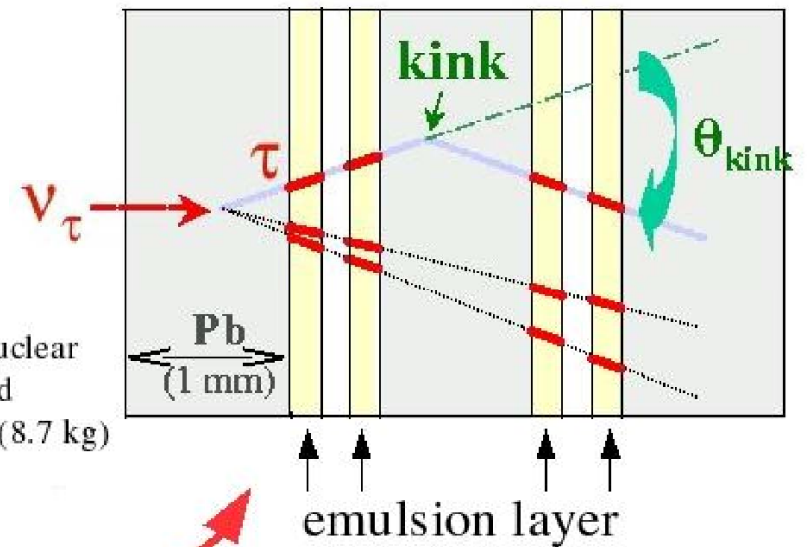
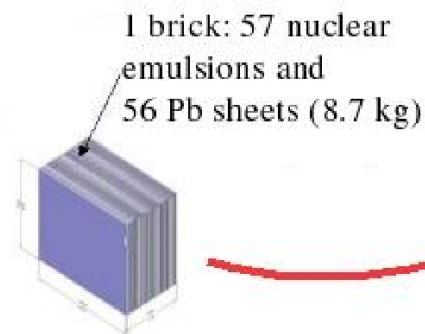


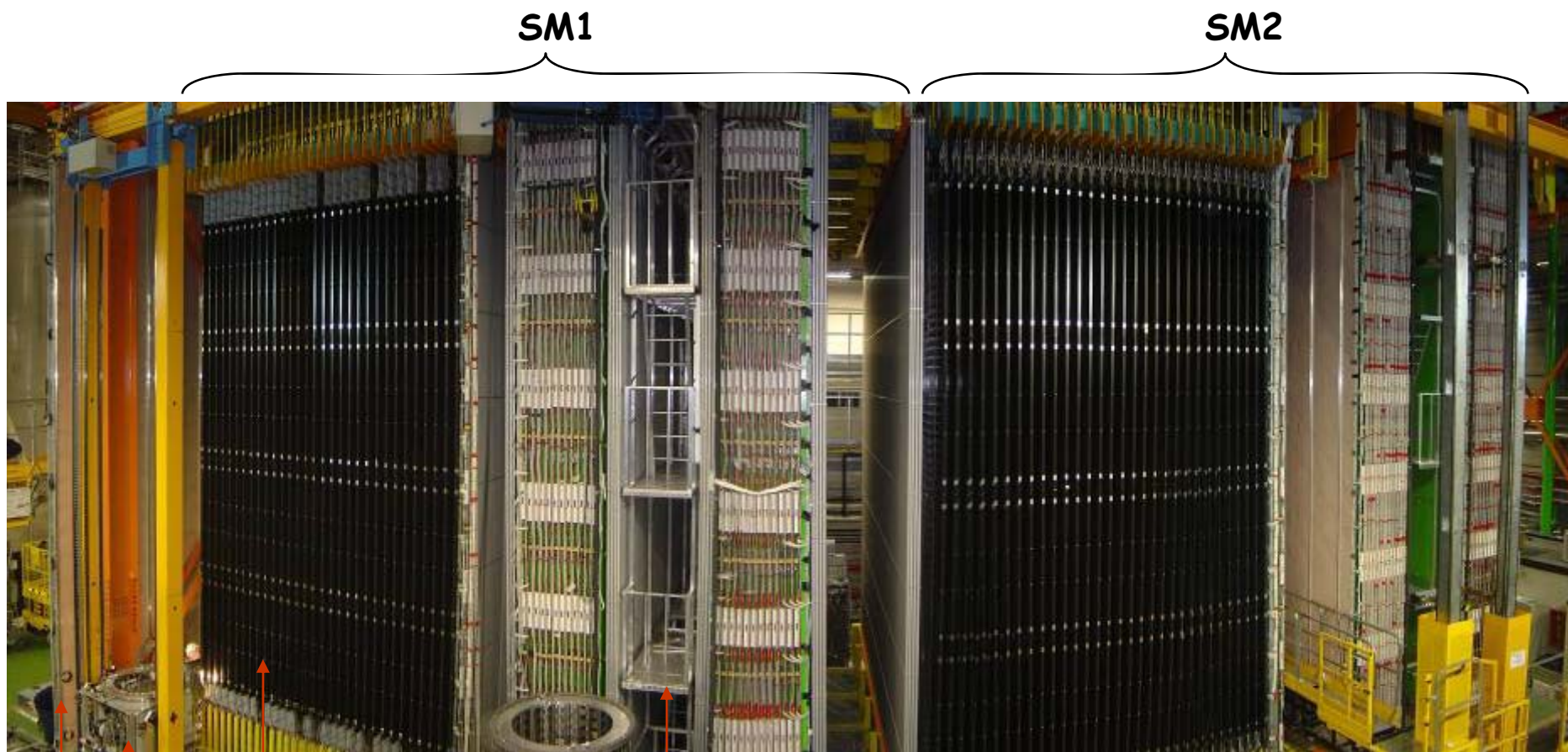
29 walls (brick walls+TT) each

2668 bricks in each wall

Total target

1.35 kt=154750 bricks





SM1

SM2

Veto

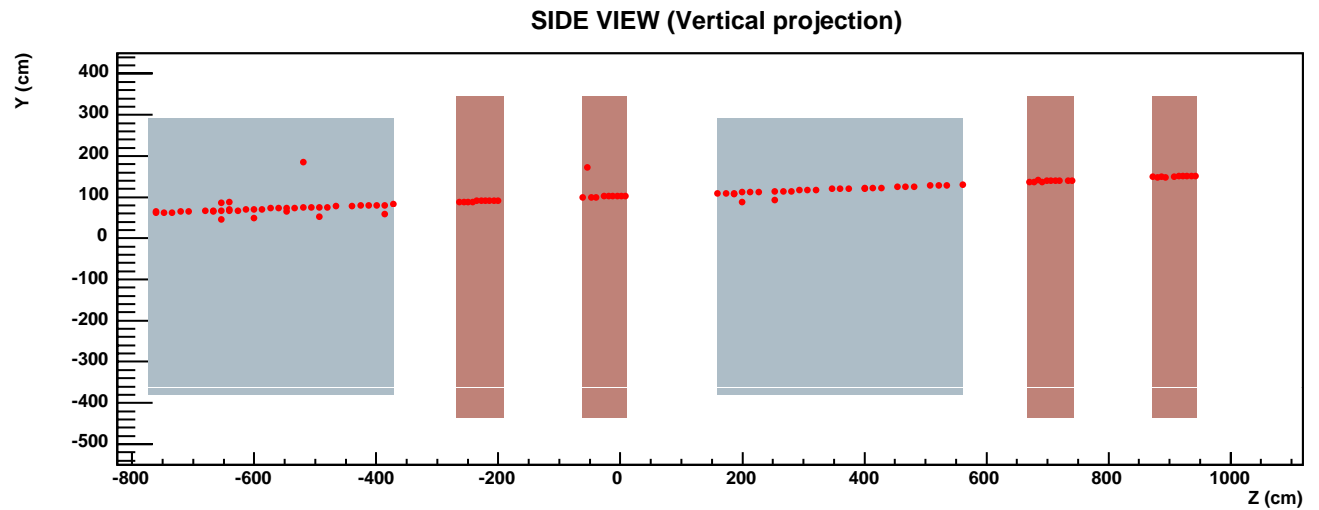
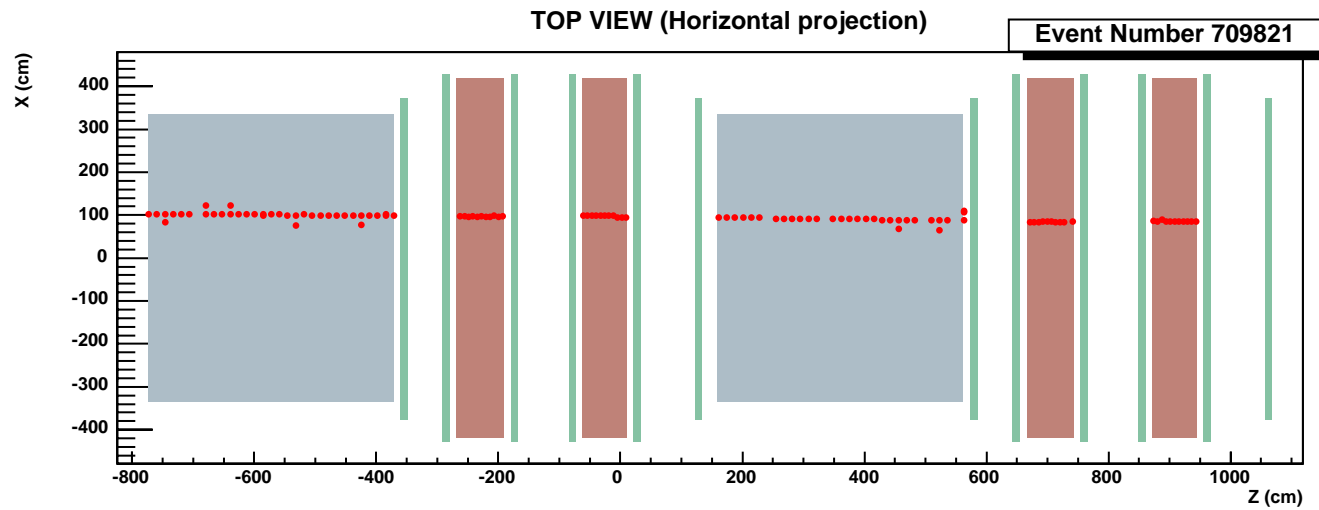
BMS

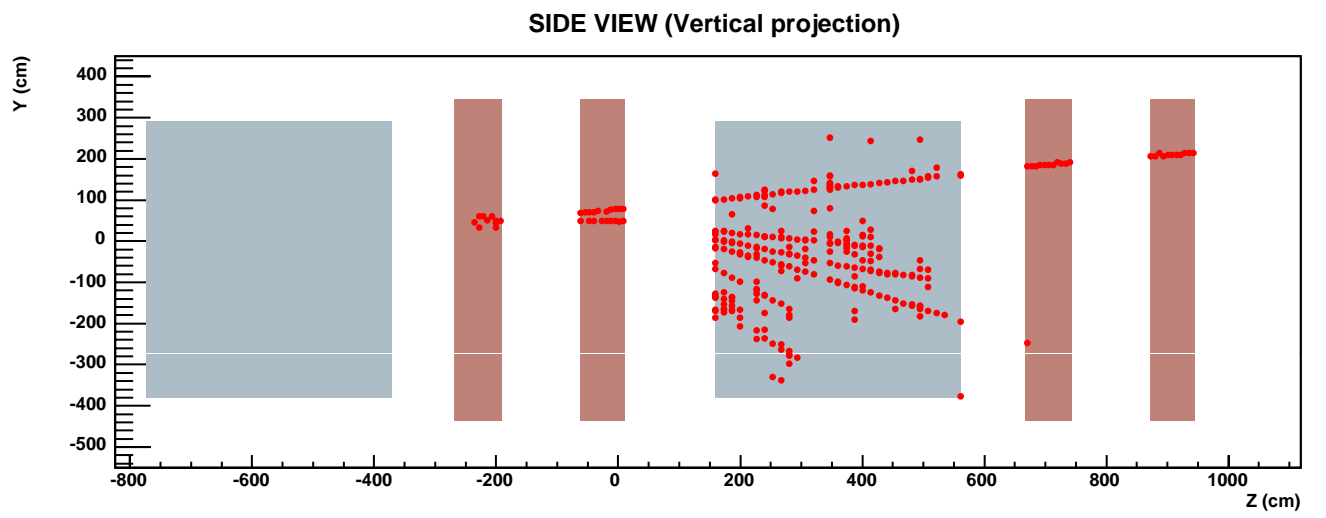
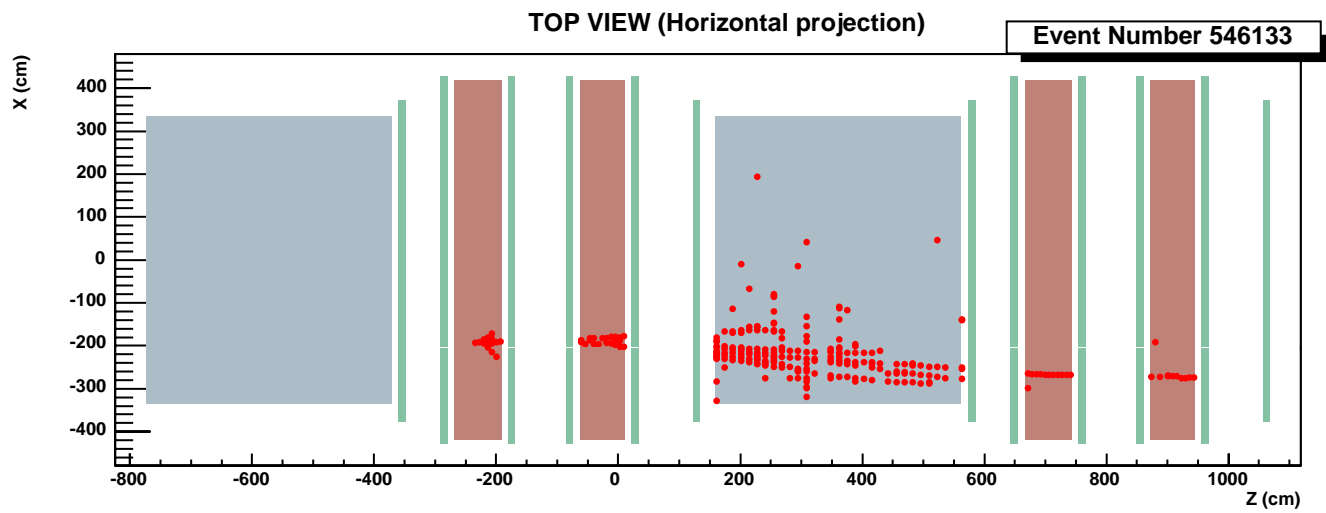
Target tracker

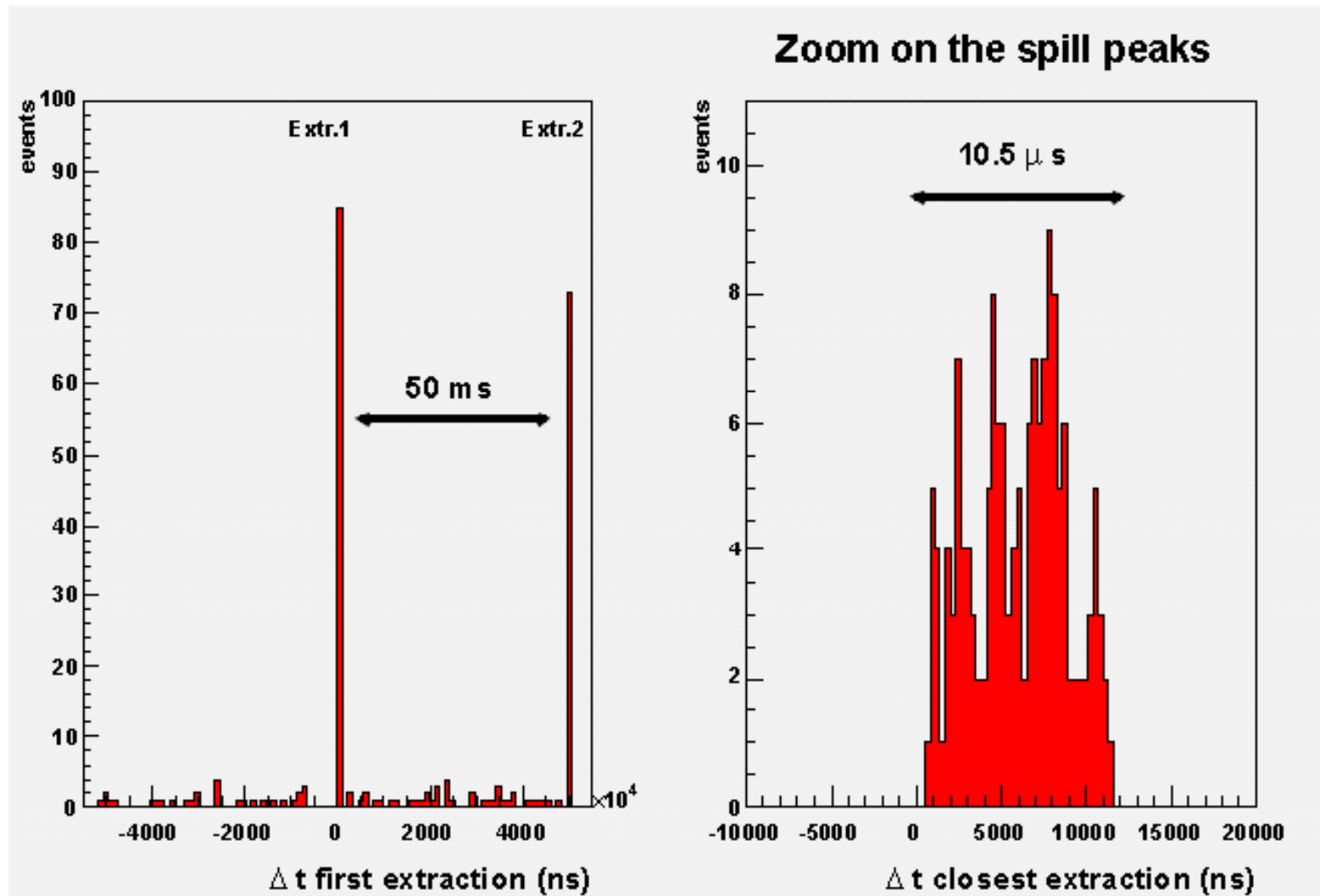
Spectrometer:
XPC, HPT, RPC, magnet

Electronic detector commissioned in 2006

August 2006 first beam
observe first ν_μ interactions in upstream rocks and detector
with electronics detector



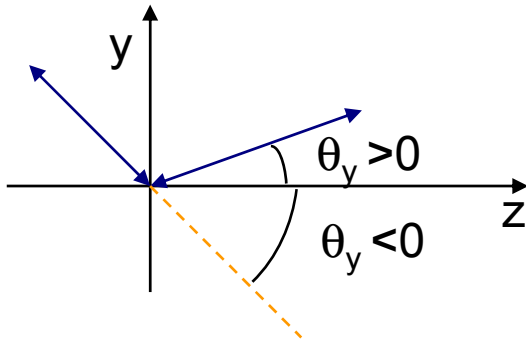




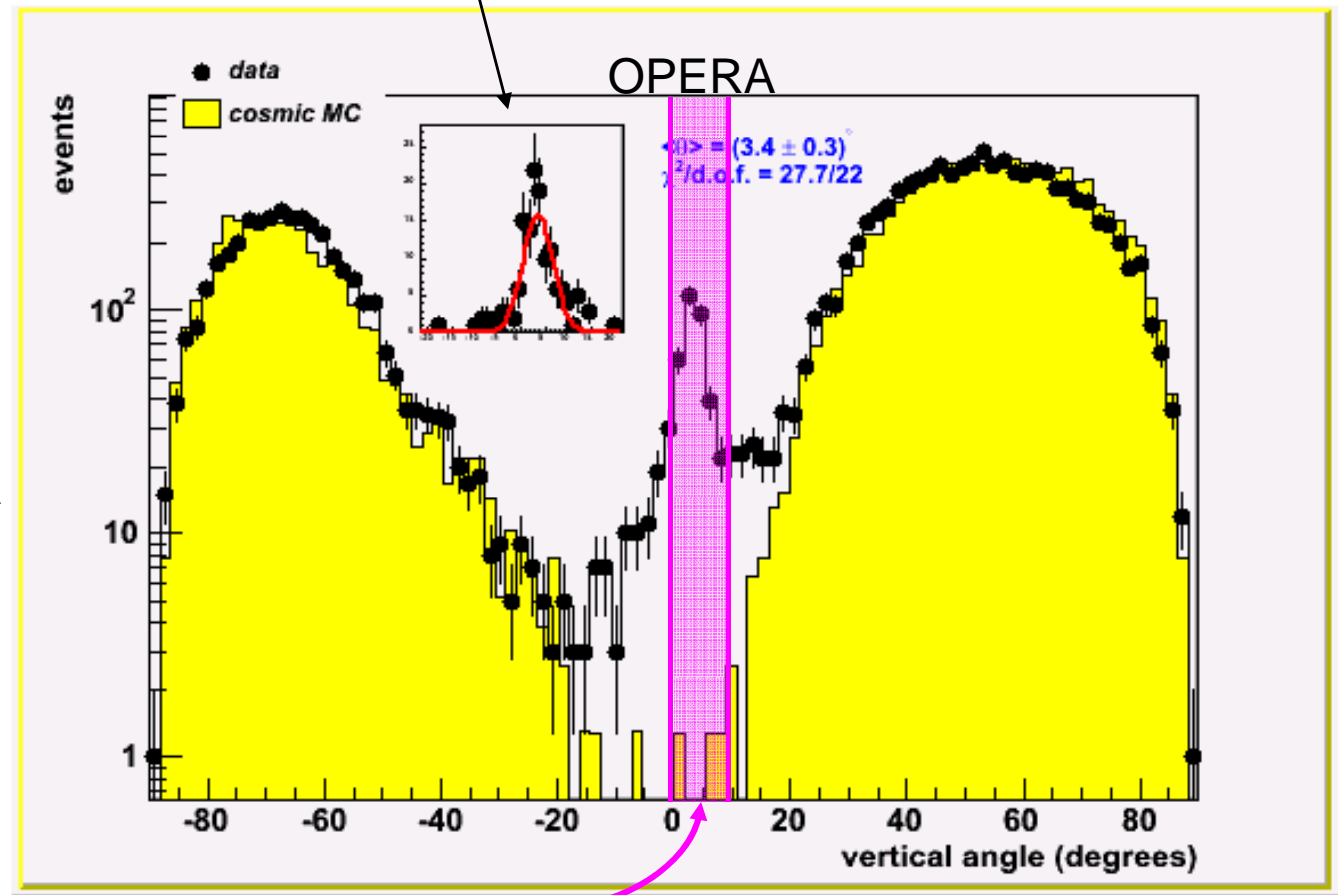
Use GPS clocks to synchronize with the beam
in future: portable Cs clock (ps precision)

in time window

Zenith angle of muon track

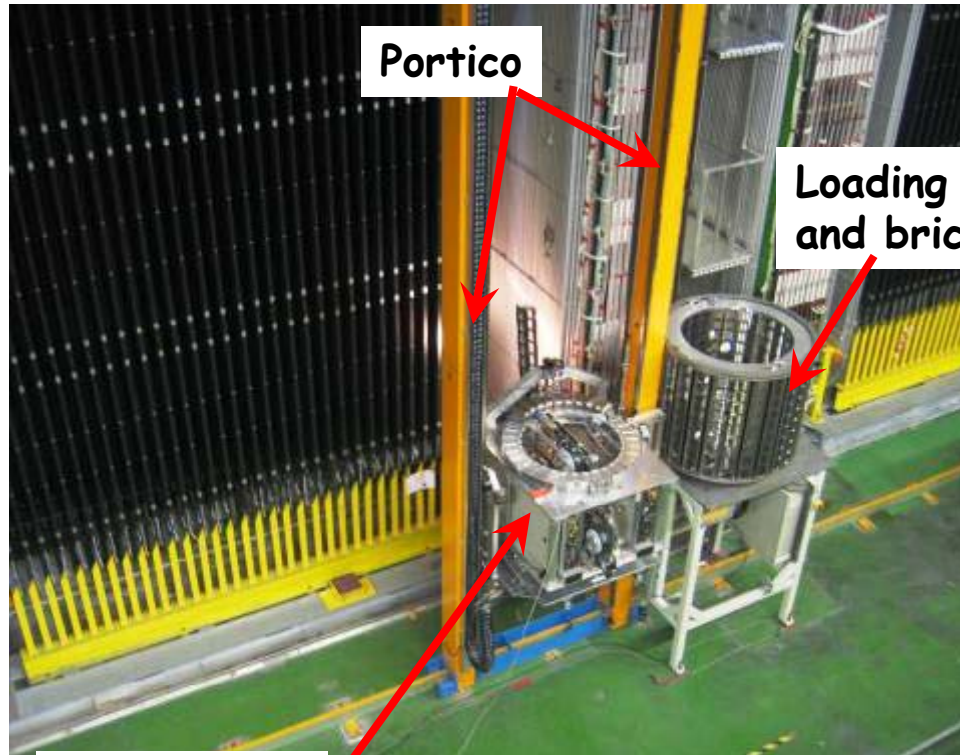


August Run result:
 $\langle \theta \rangle = 3.4 \pm 0.3$



Select events around beam ($0 < \theta < 0.15 \text{ rad}$) direction and check if there are on time

Brick Manipulator System



Portico

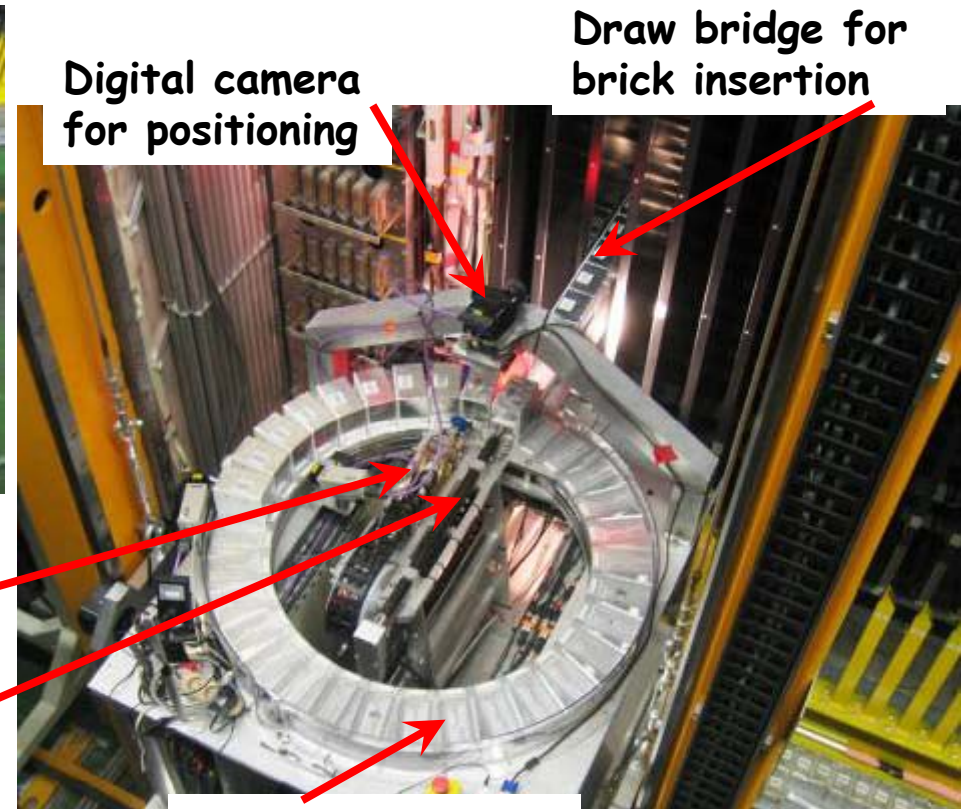
Loading station
and brick drum

Manipulating
platform

Vacuum sucker vehicle
to retrieve bricks

Electric jack to
insert bricks

*Spatial precision ≈ 0.1 mm
on ranges ≈ 10 m) using
digital camera vision*



Digital camera
for positioning

Draw bridge for
brick insertion

Storage Carrousel

Brick production (BAM) and bick filling in progress

October 2007: 65000 bricks in place

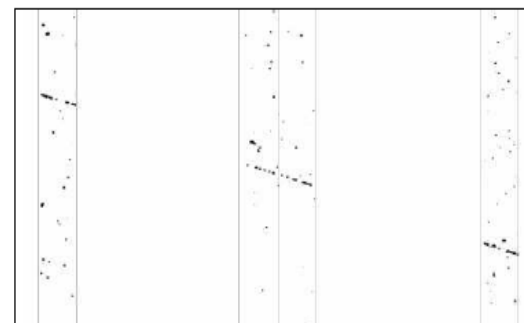
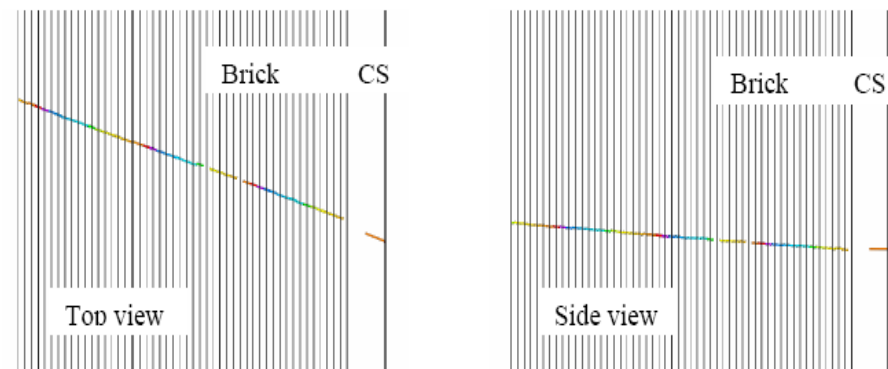
Early summer 2008: filling completed (154750 bricks)

October 2007 run started (50 % of nominal intensity)

Will allow to fine tune the brick finding efficiency using

1) the electronic detector (TT, XPC, RPC, HPT, cm resolution)

2) the changeable sheets (sub mm resolution)



Details of the CS scanning showing the reconstructed grains.

October 2007



Photo T. Strauss

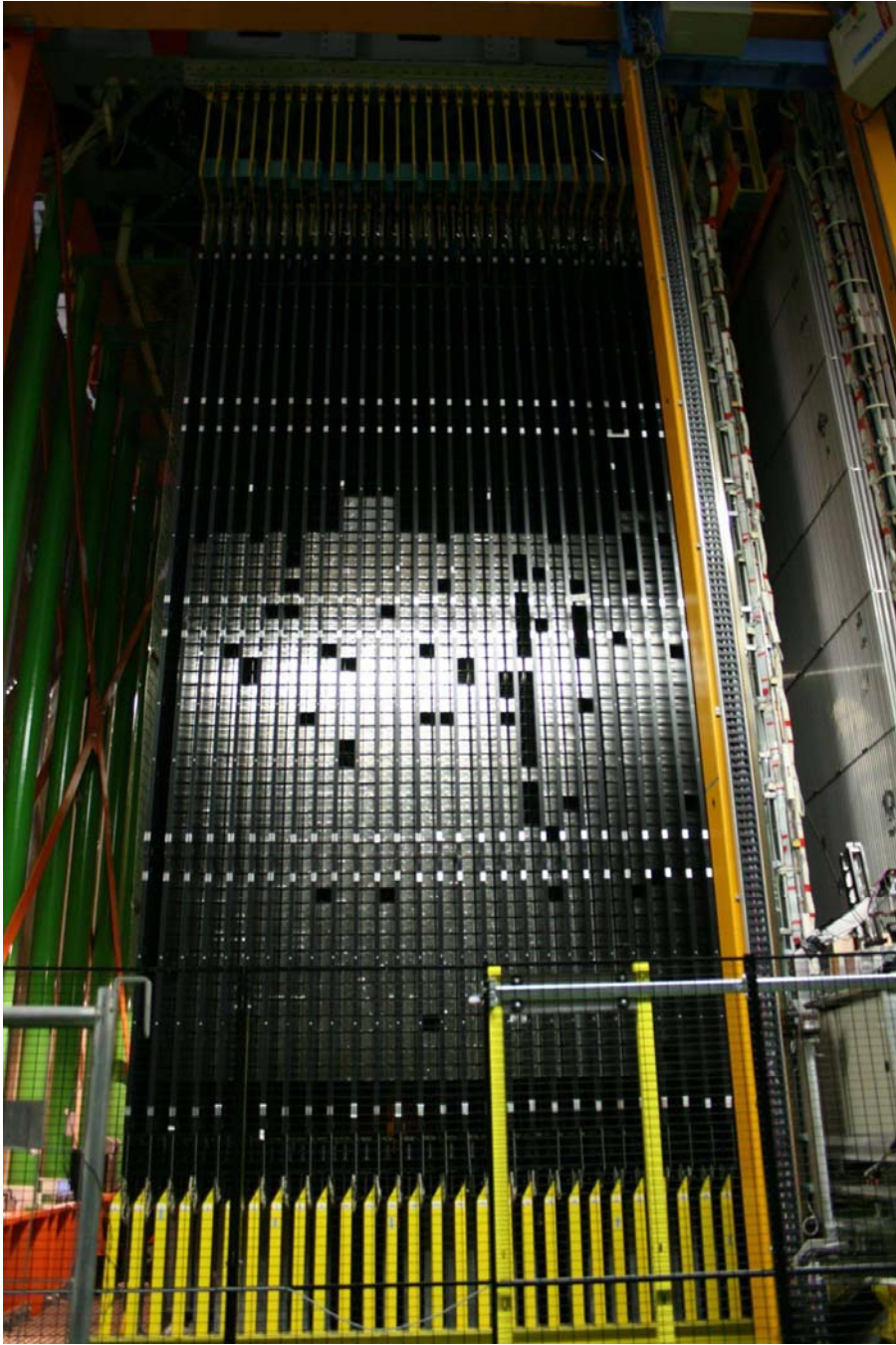
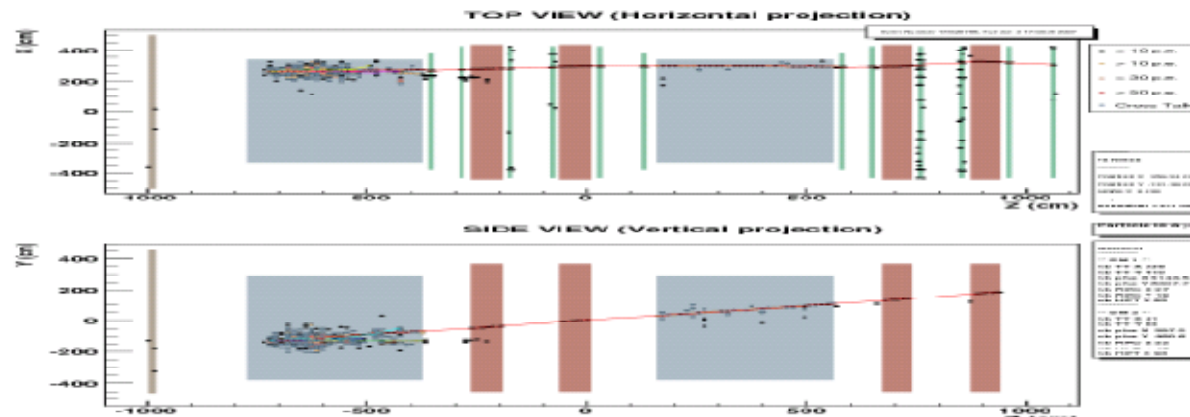


Photo T. Strauss

OCTOBER 2007 RUN

Event 173520769 CC

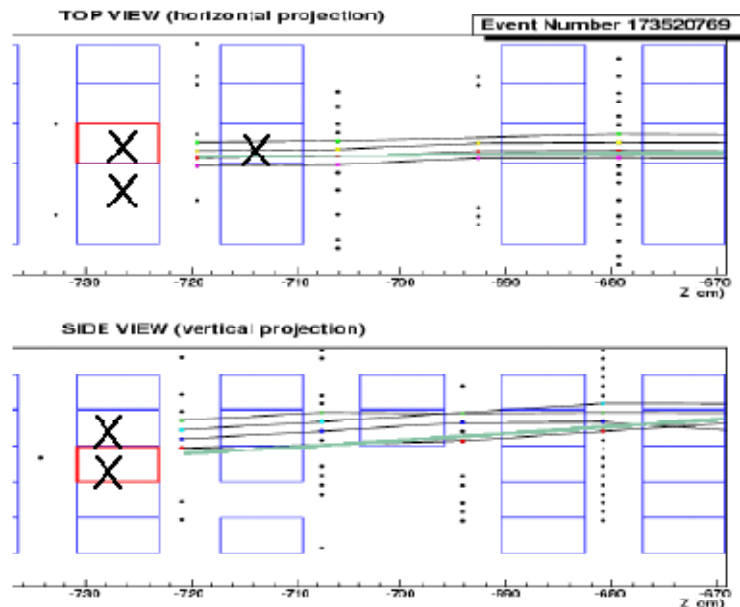


« Opera baby »

7.87 GeV/c

11451 p.e. tot

1579 p.e. muon



RS, Wall 5 Tray 24 Cell 6 prob= 0.9

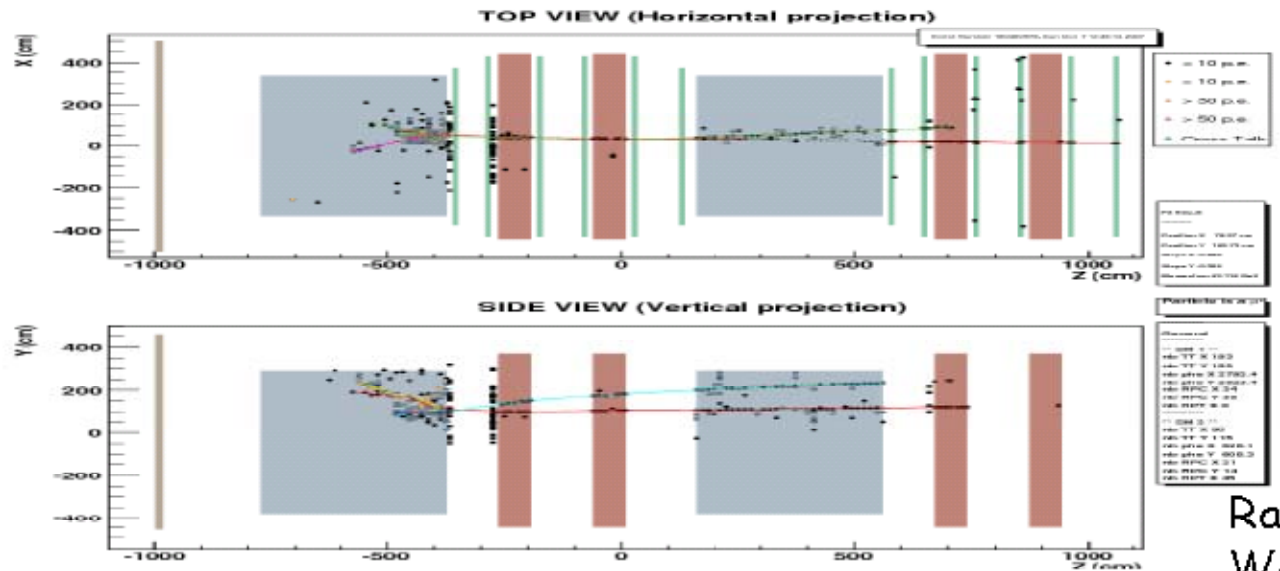
RS, Wall 6 Tray 24 Cell 6 prob= 0.09

[Extrap errors small but.. extract also ?

RS, Wall 5 Tray 24 Cell 7

[RS, Wall 5 Tray 25 Cell 6

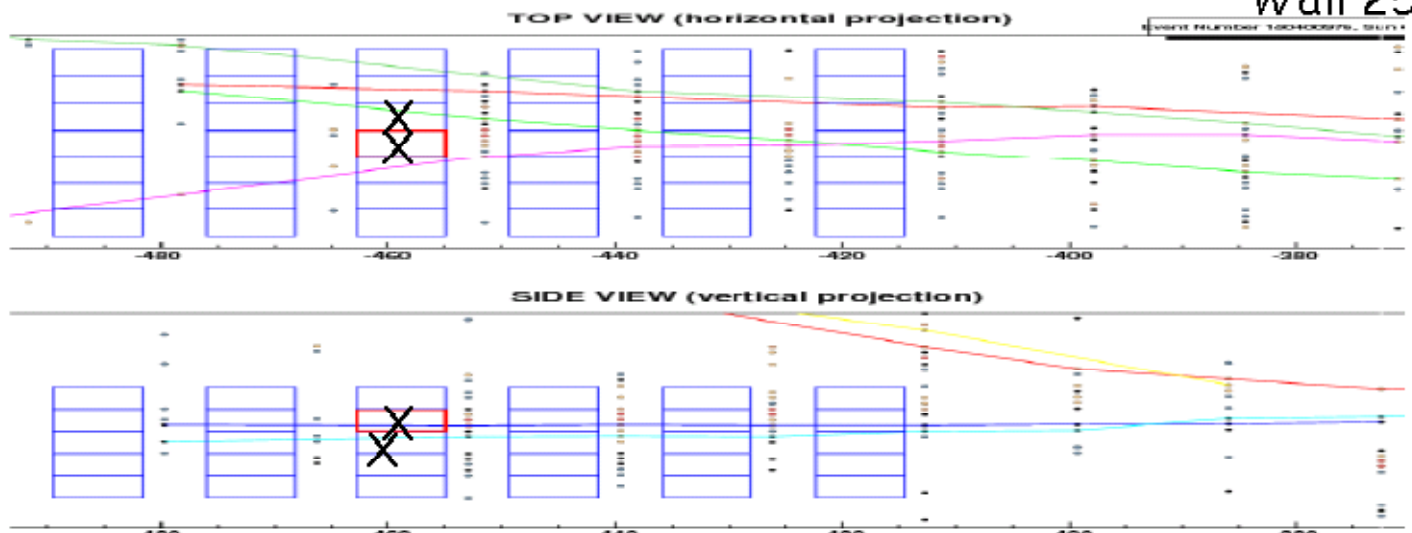
Event 180400976 dimuon candidate



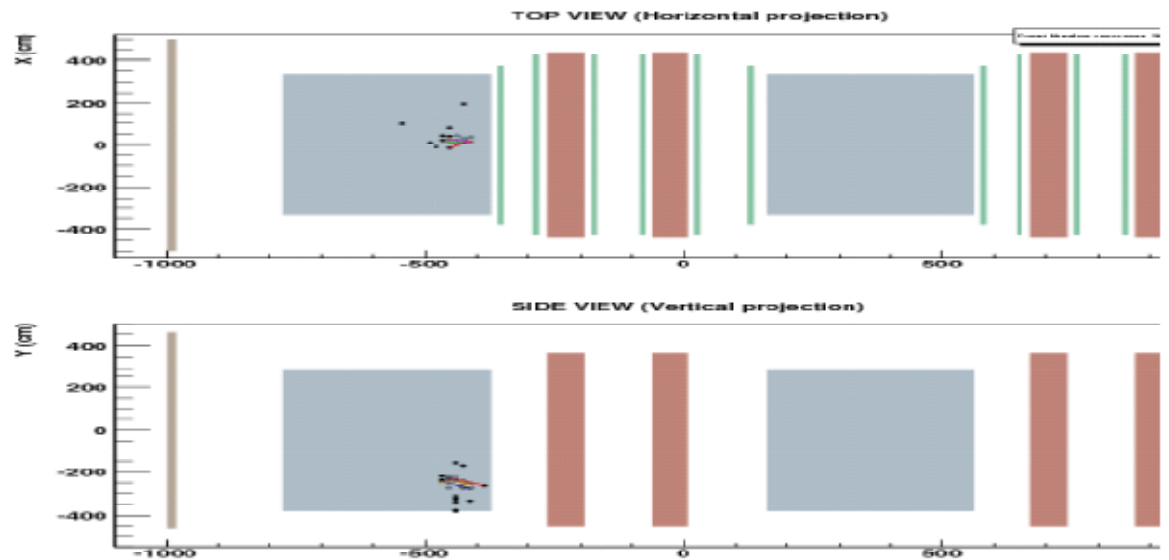
Main mu
 $M_{\mu\mu} = 43.4 \text{ GeV}/c$

5316 tot pe
 303 pe main mu

Ranked by probability:
 Wall 25, tray 46, cell 23
 Wall 25, tray 46, cell 22
 Wall 25, tray 45, cell 23
 Wall 25, tray 45, cell 22



Event 179312944 NC



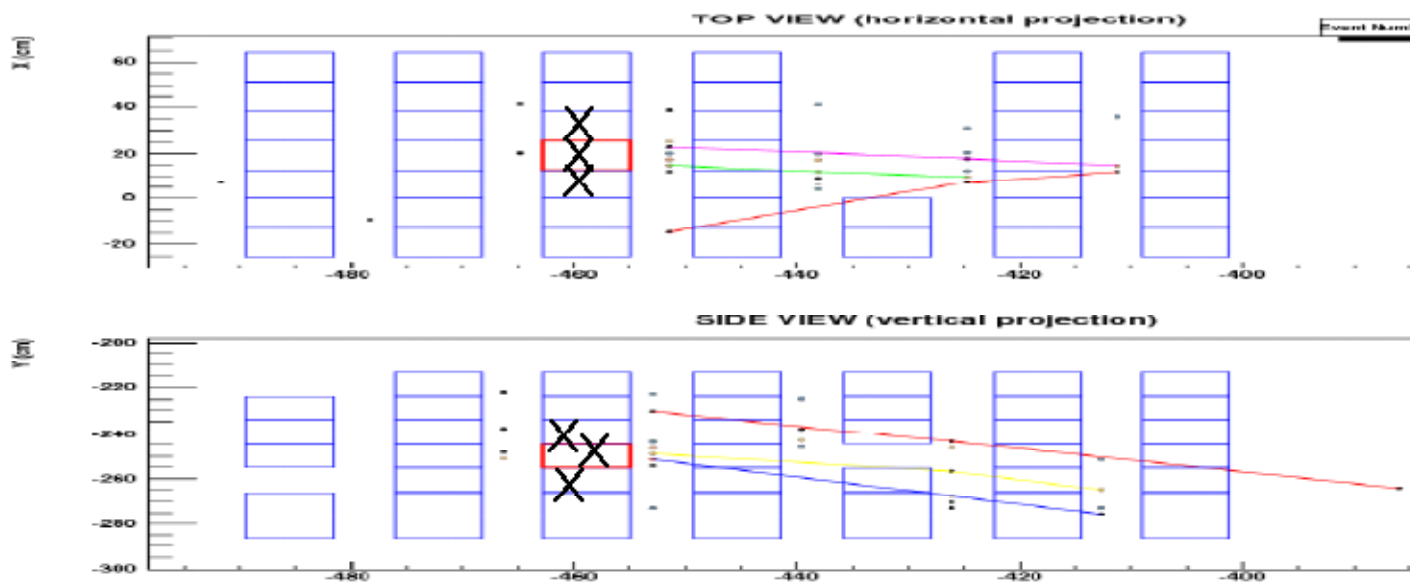
PW/ALL25>93%

centroid x= 20.4242935
Y= -249.820251

RS, wall 25 tray 13 cell 25 prob= 0.22
RS, wall 25 tray 13 cell 24 prob= 0.15
RS, wall 25 tray 13 cell 26 prob= 0.14

RS, wall 25 tray 14 cell 25 prob= 0.07

RS, wall 25 tray 12 cell 25 prob= 0.07



Summary table: Extractions 385, 390-393

Extraction 385:

Event 173520769 CC 4 bricks in 2 walls Bologna

Extraction 390:

Event 178684089 NC 4 bricks, same wall Japan
Event 178969961 CC 1 brick Salerno (QE like)

Extraction 391:

Event 179264151 CC 2 bricks, in 2 walls Japan
Event 179312944 NC 5 bricks, same wall Bern
Event 179351516 CC 2 bricks, same wall Japan

Extraction 392:

Event 179673325 CC 2 bricks, in 2 walls Napoli

Extraction 393:

Event 180277945 CC 1 brick, Japan (QE like)
Event 180309253 CC * scintillator event
Event 180400976 CC 4 bricks, same wall Bari dimuon candidate

Total 10 Events: 7 CC, 2 NC, 1CC in scintillator

Sharing parameters:

- 4 in Japan, 5 in Europe (4 in Italy, 1 Bern) → 14 bricks in Japan, 11 in Europe
 - ❖ 1 NC in Japan, 1NC in Europe
 - ❖ 1 QE like in Japan, 1 in Europe
 - ❖ 2 CC in Japan, 3 CC in Europe
- All CSd are developed at the same time, scanning performed according to the probability level²
- Bricks are processed in Batch following the probability level



Bern: 5 scanning stations, including that from Neuchatel, moved in June

Dry scanning

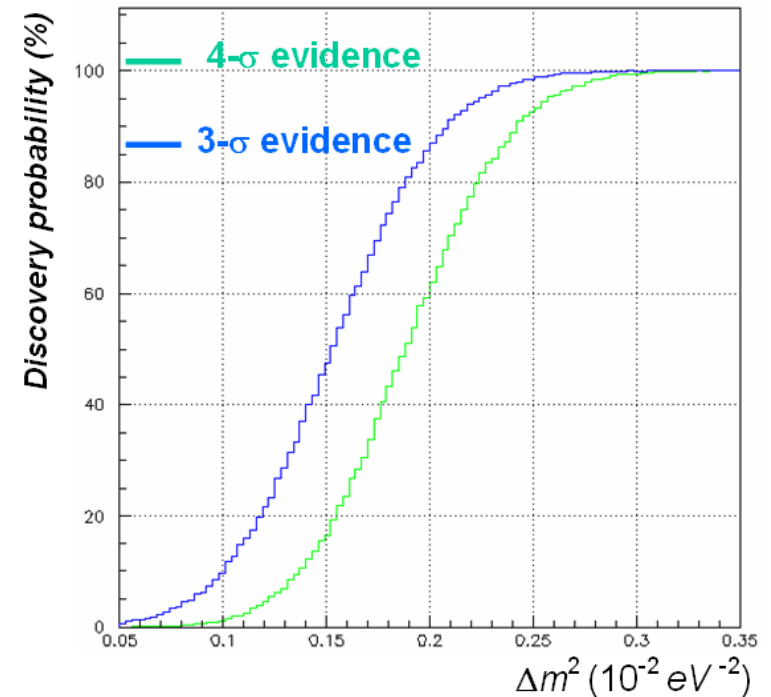
Robot allows fully automatized scanning



$\nu_{\mu} \rightarrow \nu_{\tau}$ sensitivity

full mixing, 5 years run @ 4.5×10^{19} pot / year, 1.35 kton fiducial

signal ($\Delta m^2 = 2.5 \times 10^{-3} \text{ eV}^2$)	signal ($\Delta m^2 = 3.0 \times 10^{-3} \text{ eV}^2$)	BKGD
10.4	15.0	0.76



Swiss group

ETHZ:

- DAQ at LNGS, handling of Oracle data base
- Software development, in particular for the calibration of the electronic detector (optimize brick finding efficiency), muon tracks and momentum, charm events

Bern+Neuchâtel NE joins BE in August 2008?

- Scanning and analysis of bricks:
from test beam exposure at CERN, PSI, NUMI and DESY, to optimize scanning, in particular electron identification and momentum determination,
from CNGS exposure, expect 15 bricks in 2007
- Software development, for brick analysis