



# CNGS Operation Results in 2007

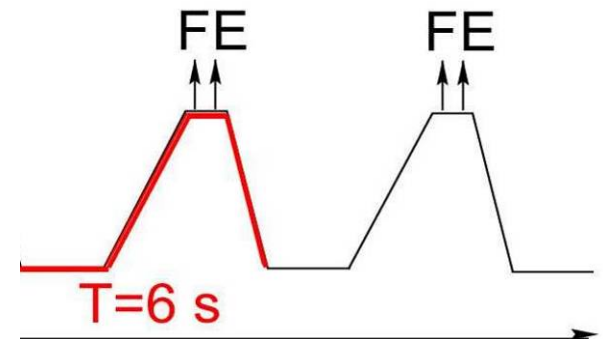
Edda Gschwendtner, AB/ATB

- **Modifications done during 2007 for the Horn and Reflector**
- **CNGS Run 2007**

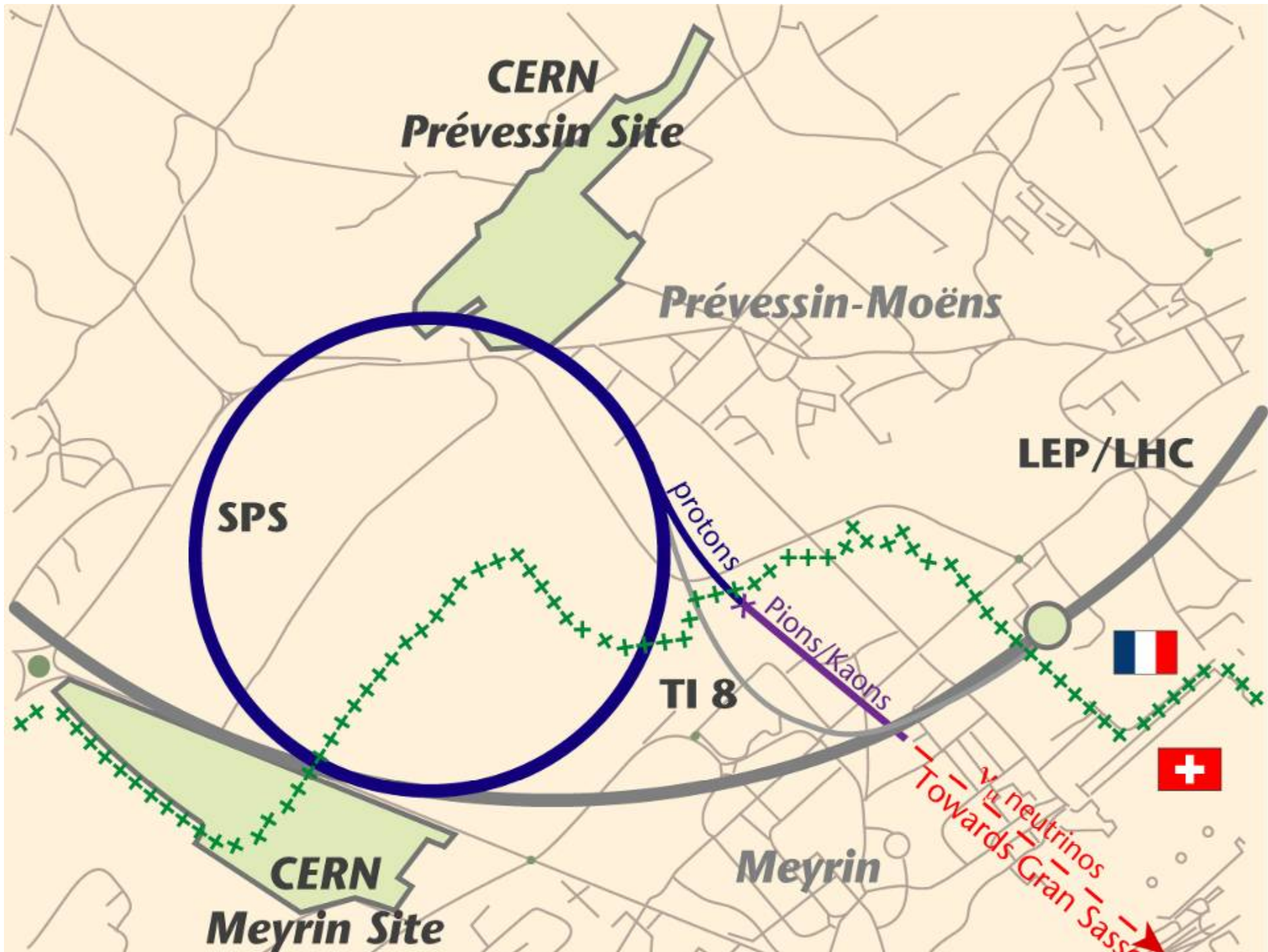
# CNGS Proton Beam Parameters



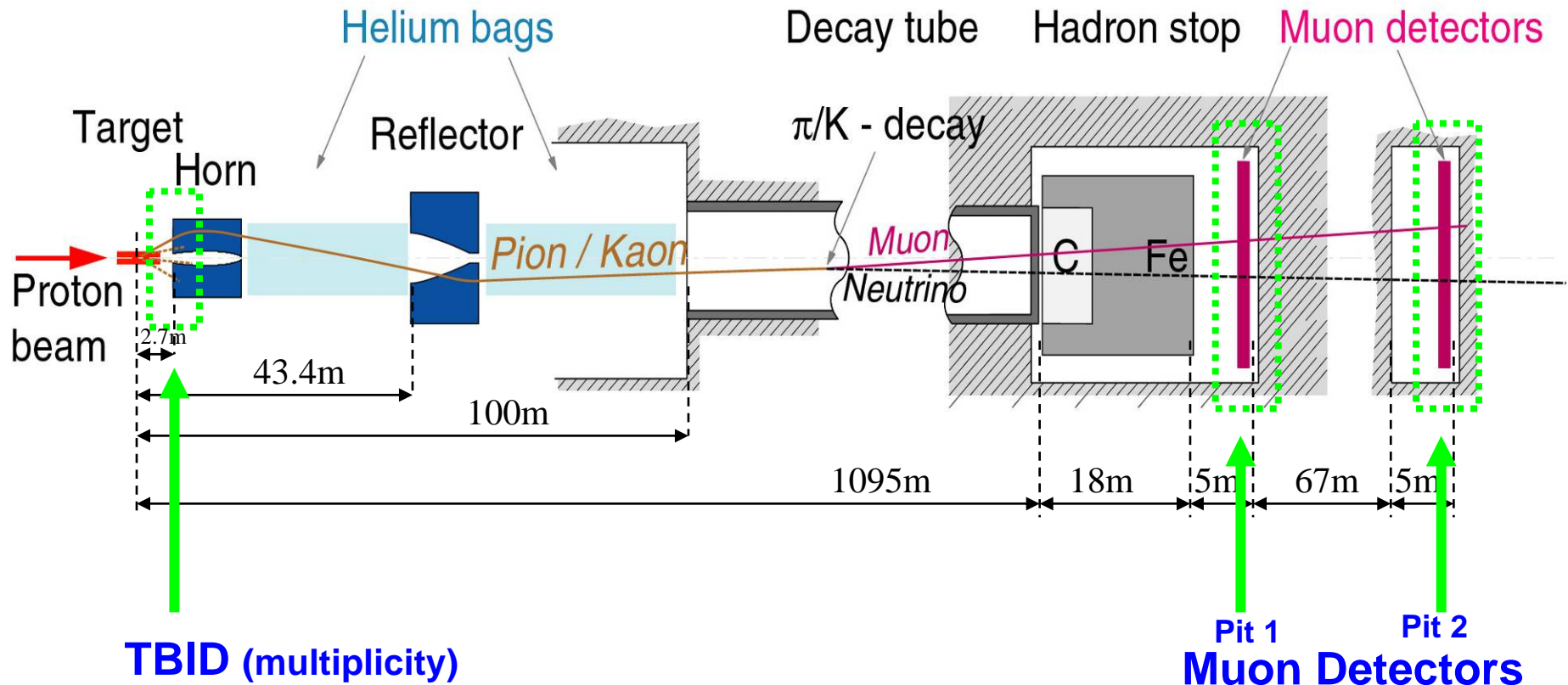
Beam parameters	Nominal CNGS beam
Nominal energy [GeV]	400
Normalized emittance [ $\mu\text{m}$ ]	H=12 V=7
Emittance [ $\mu\text{m}$ ]	H=0.028 V= 0.016
Momentum spread $\Delta p/p$	0.07 % +/- 20%
# extractions per cycle	2 separated by 50 ms
Batch length [ $\mu\text{s}$ ]	10.5
# of bunches per pulse	2100
Intensity per extraction [ $10^{13}$ p]	2.4
Bunch length [ns] ( $4\sigma$ )	2
Bunch spacing [ns]	5
Beta at focus [m]	hor.: 10 ; vert.: 20
Beam sizes at 400 GeV [mm]	0.5 mm
Beam divergence [mrad]	hor.: 0.05; vert.: 0.03



**Expected beam performance:  $4.5 \times 10^{19}$  protons/year on target**



# CNGS Layout



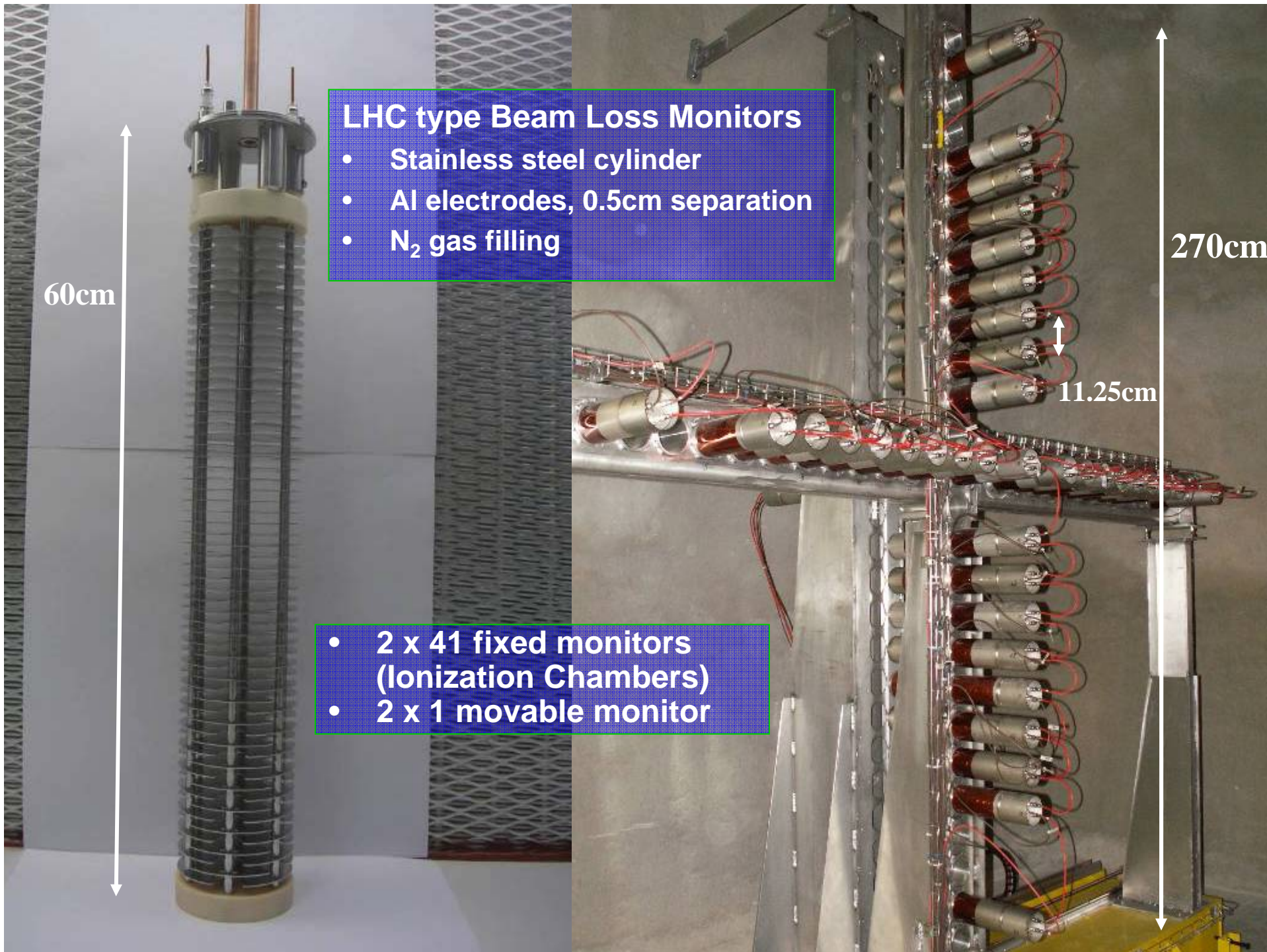


Target

Horn







### LHC type Beam Loss Monitors

- Stainless steel cylinder
- Al electrodes, 0.5cm separation
- N<sub>2</sub> gas filling

- 2 x 41 fixed monitors (Ionization Chambers)
- 2 x 1 movable monitor

# Modifications during 2007



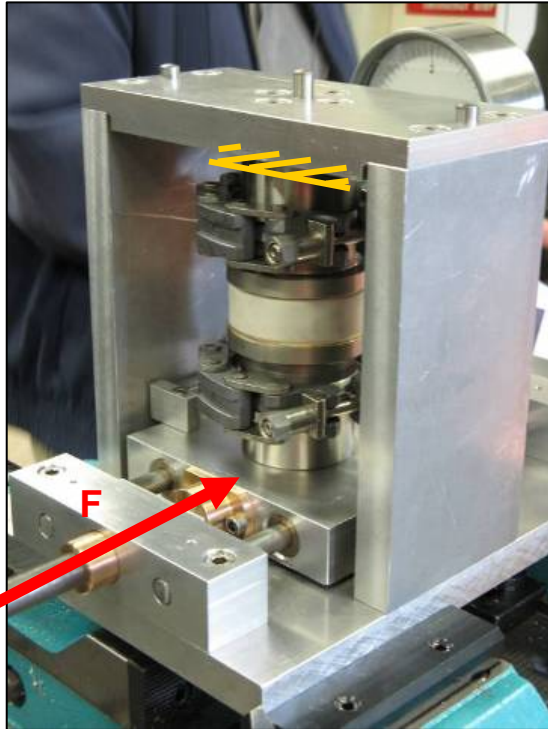
## 1. Horn and reflector modification done during 2007

- As consequence of the water leak in the reflector cooling circuit found during CNGS run Oct 2006

- **Other modifications:**

## 2. Modification of reflector stripline

# 1.) Water Outlet



## Reason for Leaking Water Outlet:

### Destructive test:

- Failure during destructive test at machined edge at small force: **~10MPa**
- Rupture limit of ceramic under bending/traction: **~300MPa**

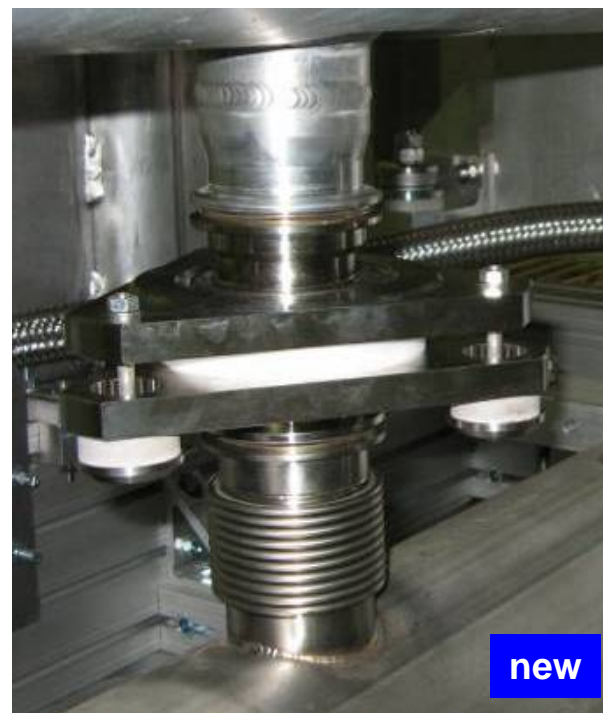
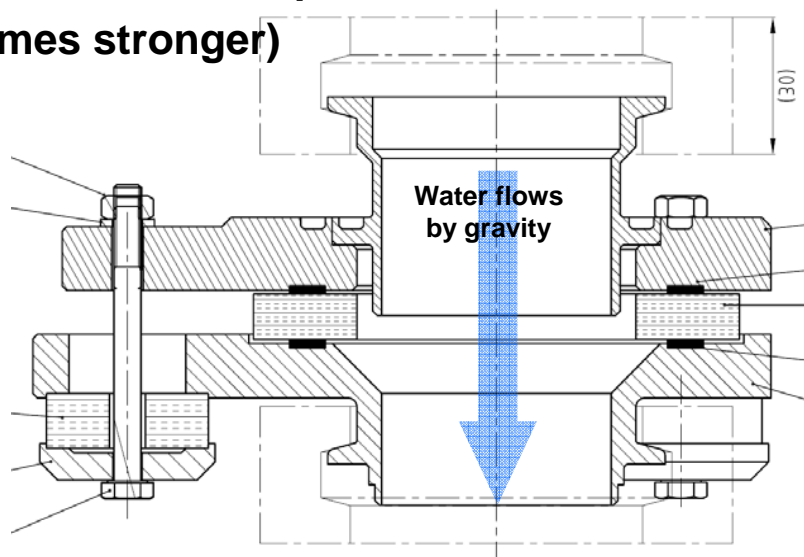
- **Brazing + machining induce stress equivalent to ~95% of ceramic stress limit**
- **Brazed assembly is at limit of failure**
- **Design not reliable (brazing, machined ceramic)**



# Design of New Water Outlet

## Stress in ceramic strongly reduced:

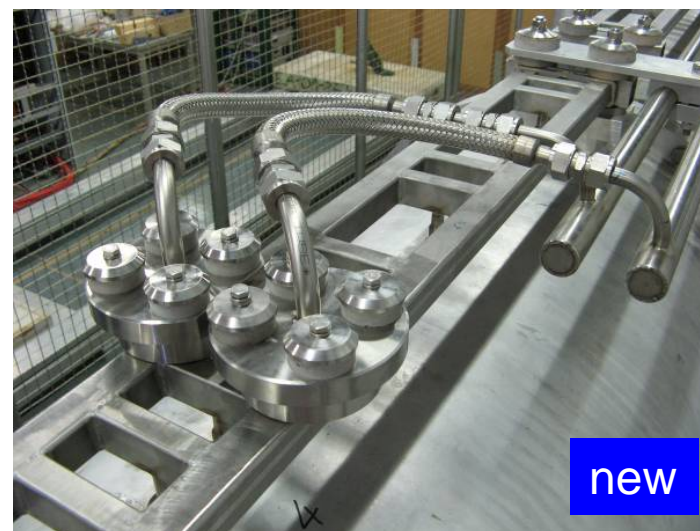
- No brazing
- No machined internal edges
- Ceramic under compression (10 times stronger)



- **Thorough technical study**
  - Detailed validation/calculations of the new design
  - Additional features optimized

2<sup>nd</sup> CNGS Reflector Leak Review, 5 July 07

# Water Inlet on top of the Horn / Reflector



→ Water inlet circuit not broken, but got ‘enhanced’

- Long & thin bellows
- Stainless steel foil brazed on ceramic sleeve
- Delicate welds
- Pressure: 1.3 bar

- Thin bellows replaced with metallic hoses
- Ceramic as for outlets:
  - No brazing
  - No edges
  - Under compression

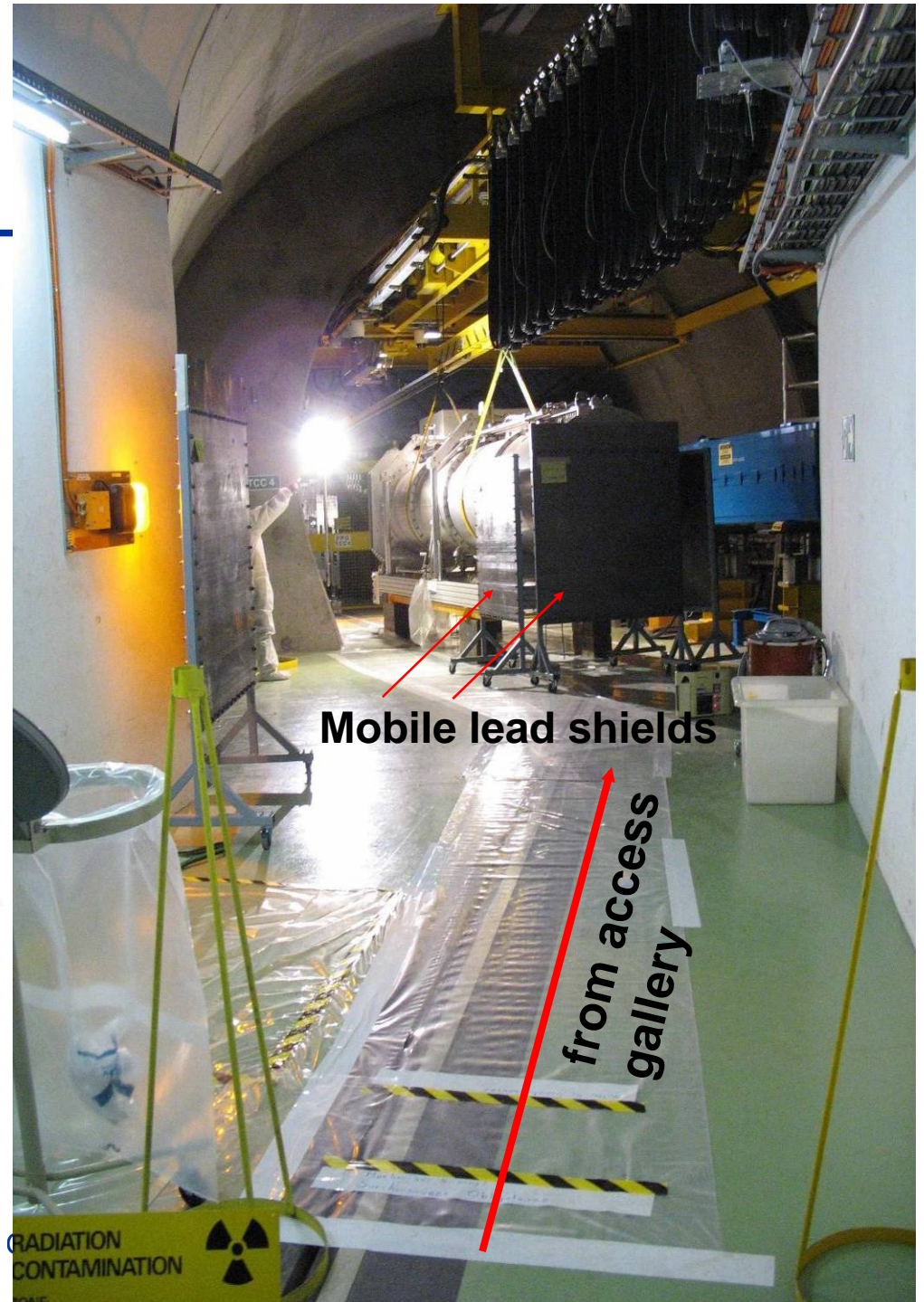
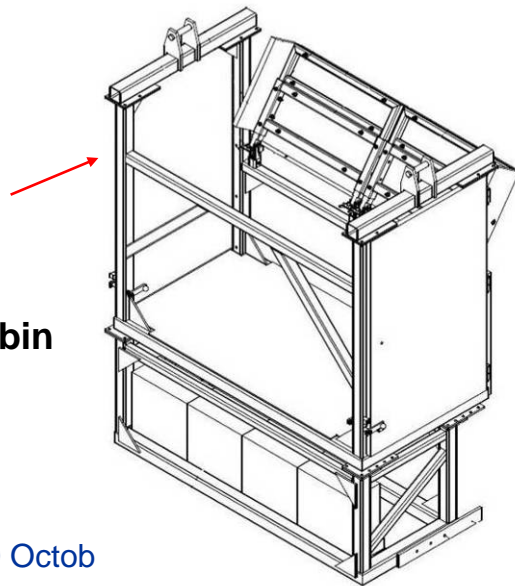
2<sup>nd</sup> CNGS Reflector Leak Review, 5 July 07



# Preparation

- Detailed radiation dose planning and minimization
- Practice of repair/improvement work on the spare horn in order to reduce exposure time
- Each work step executed by up to 4 persons to reduce individual dose
- Additional local shielding

- Mobile lead shields
- Shielded cabin for inlet exchange





# Water Outlet/Inlet Exchange

Total integrated dose:

→ ~1.6mSv



4<sup>th</sup> CARE07/BENE, 29 October 2007



Mobile lead shield

Shielded cabin

Edda C

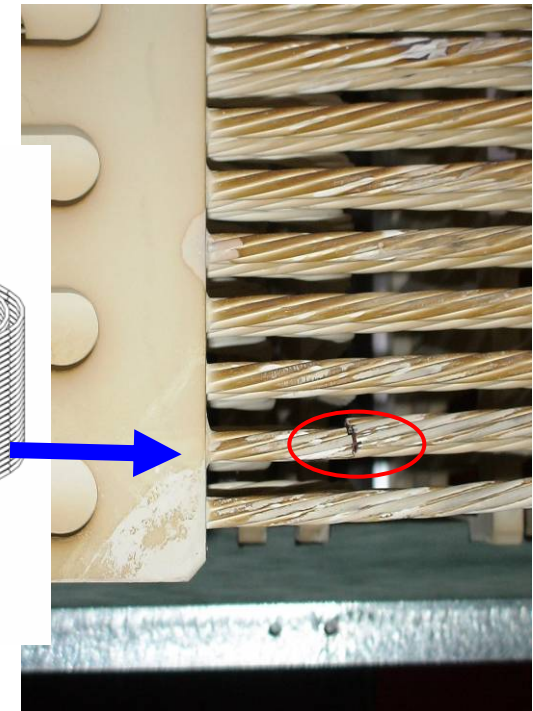
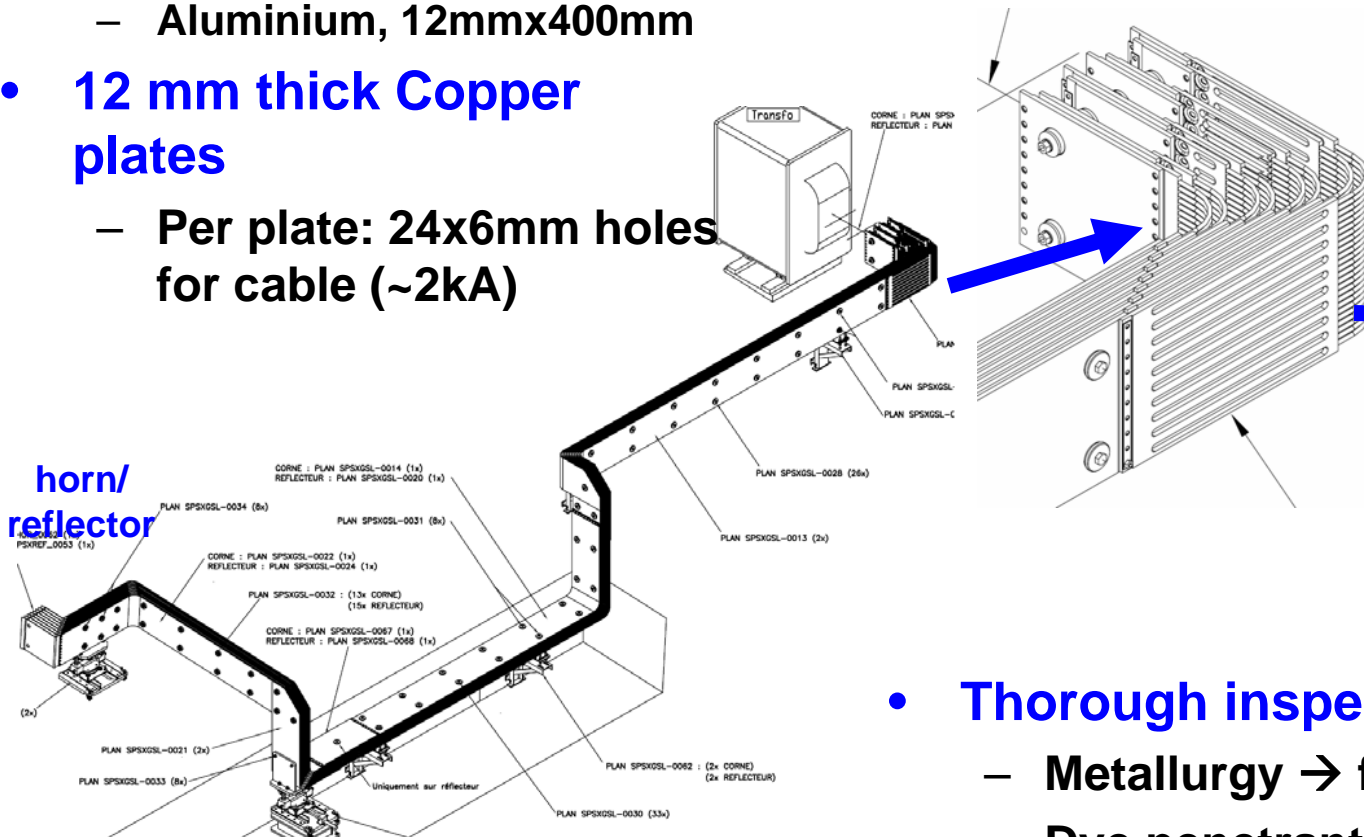


# 2.) Stripline Cable

## Reflector 180kA, Horn 150kA



- 8 Stripline plates:
  - Aluminium, 12mmx400mm
- 12 mm thick Copper plates
  - Per plate: 24x6mm holes for cable (~2kA)



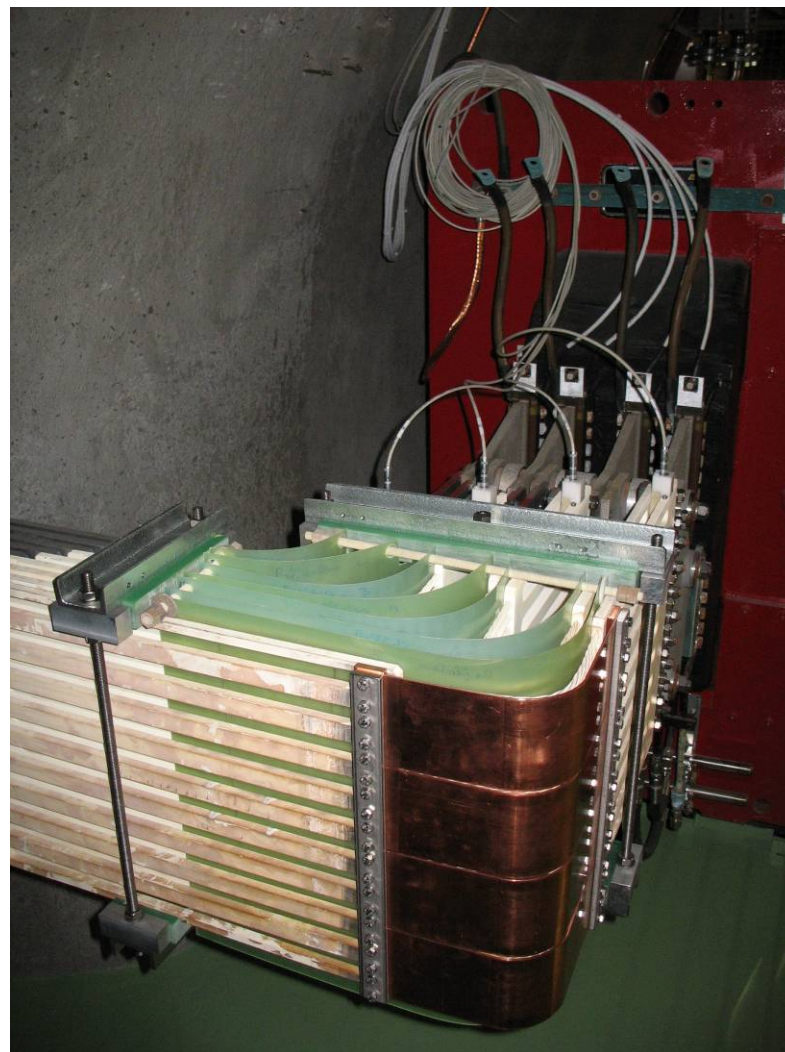
- Thorough inspection of the cables
  - Metallurgy → fatigue
  - Dye penetrant → cracks (~7) at outer plate of reflectors

# Stripline Modifications for Run 2007



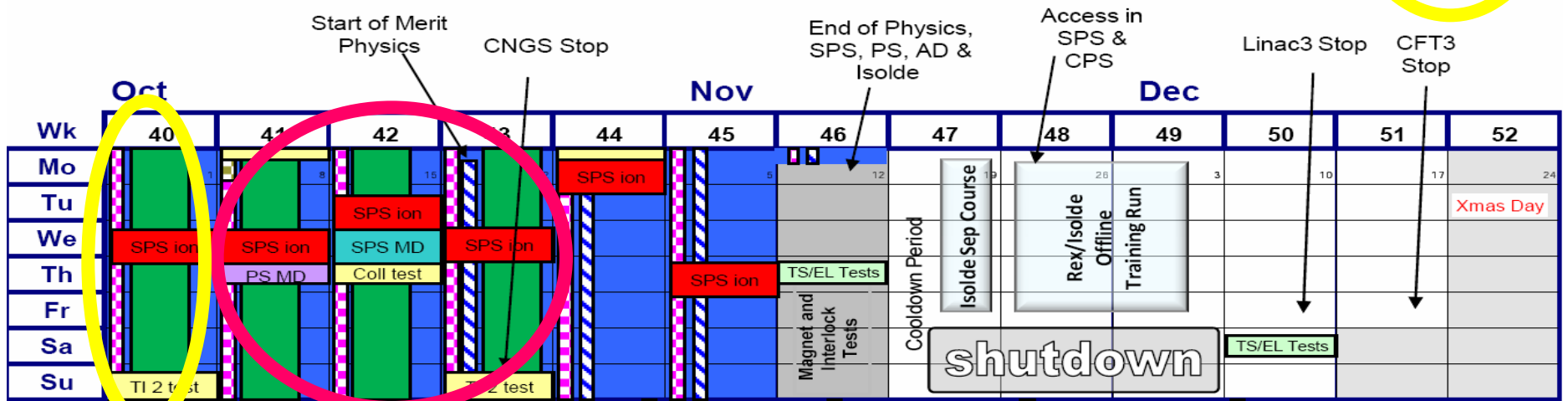
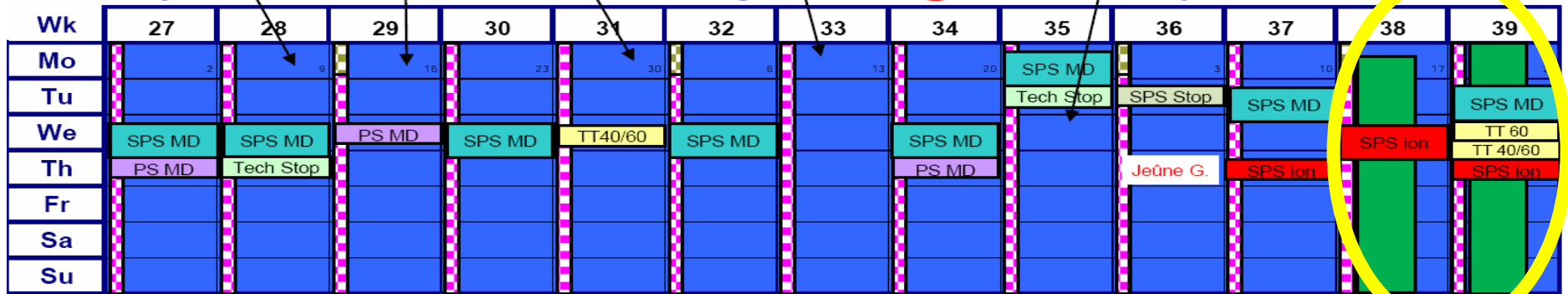
- **Insulating sheets installed on the flexible section**
  - Protect against short-circuits
  - Installed on horn and reflector
- **Put an electrical by-pass in place**
  - Ensure that current still flows in case last cable breaks
  - Installed on most outer reflector plate

→ **In shutdown 2007/08:**  
**New flexible striplines designed, manufactured and installed.**



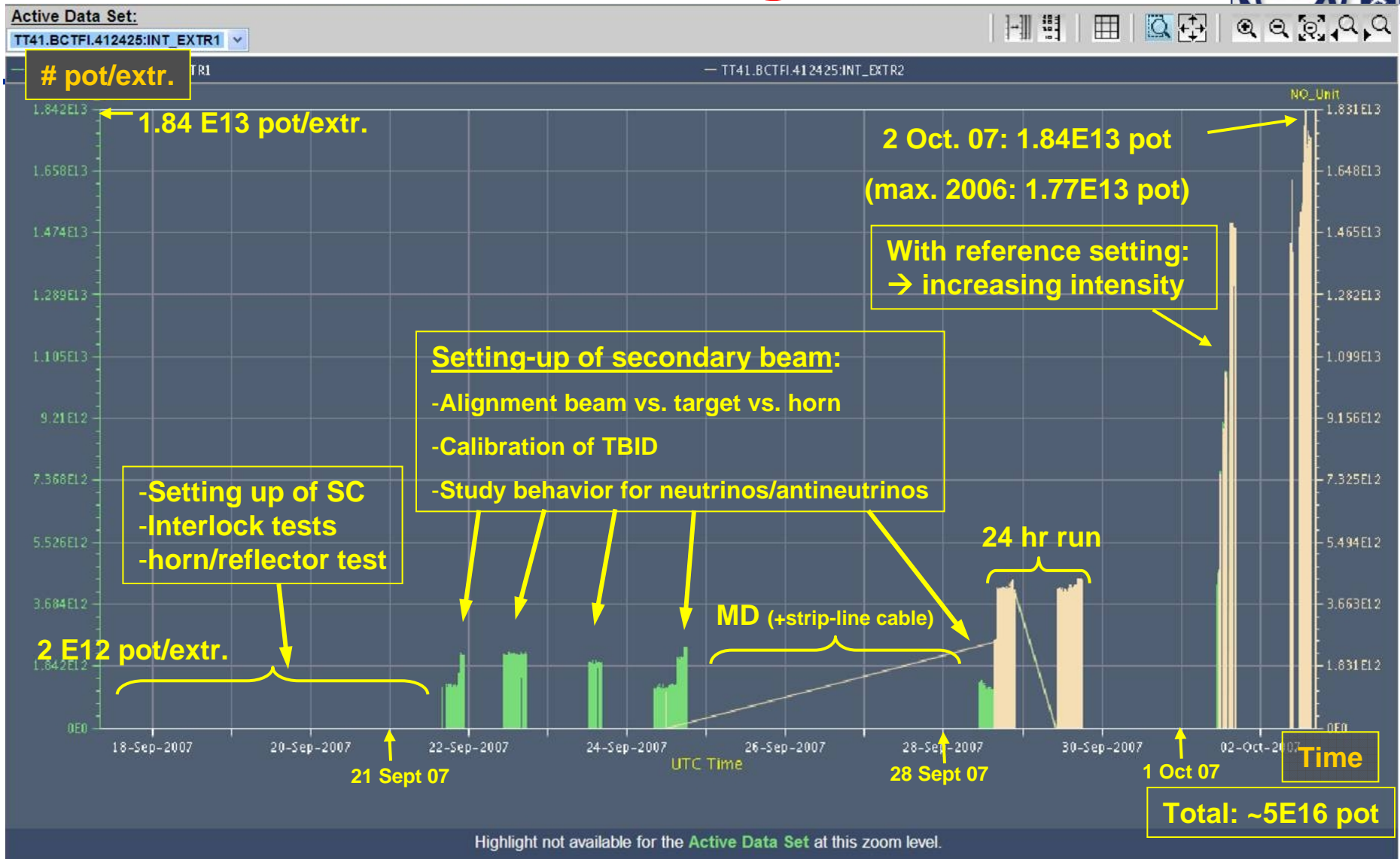


# CNGS Planning 2007

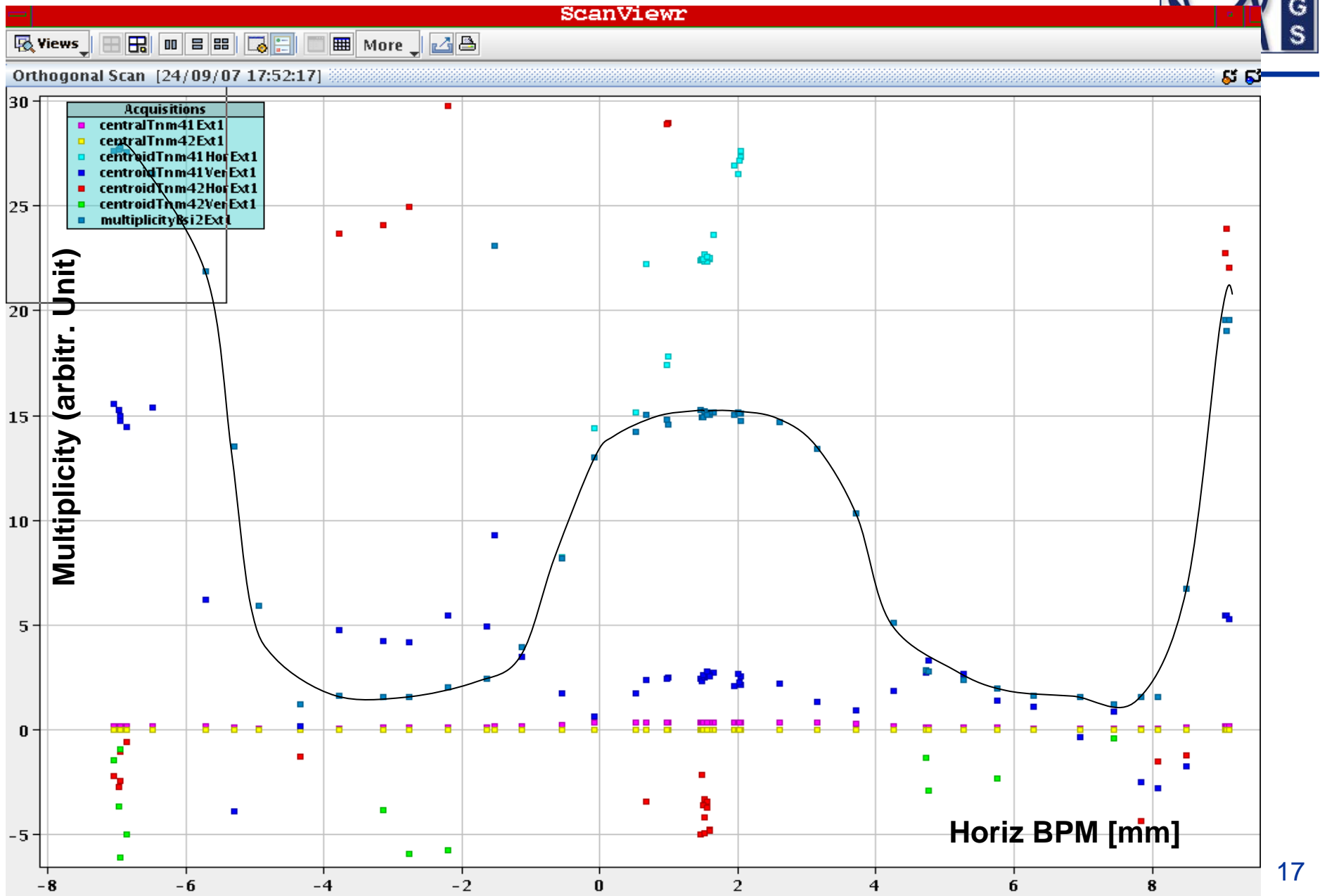


- **3 weeks of commissioning** → 1 SFTPRO, 1 CNGS, 1 Ion MD
  - Week 38, 39, 40
- **3 weeks of physics** → 1 SFTPRO (long), 3 CNGS, 1 Ion MD
  - Week 41-43

# CNGS Commissioning Week 38-40

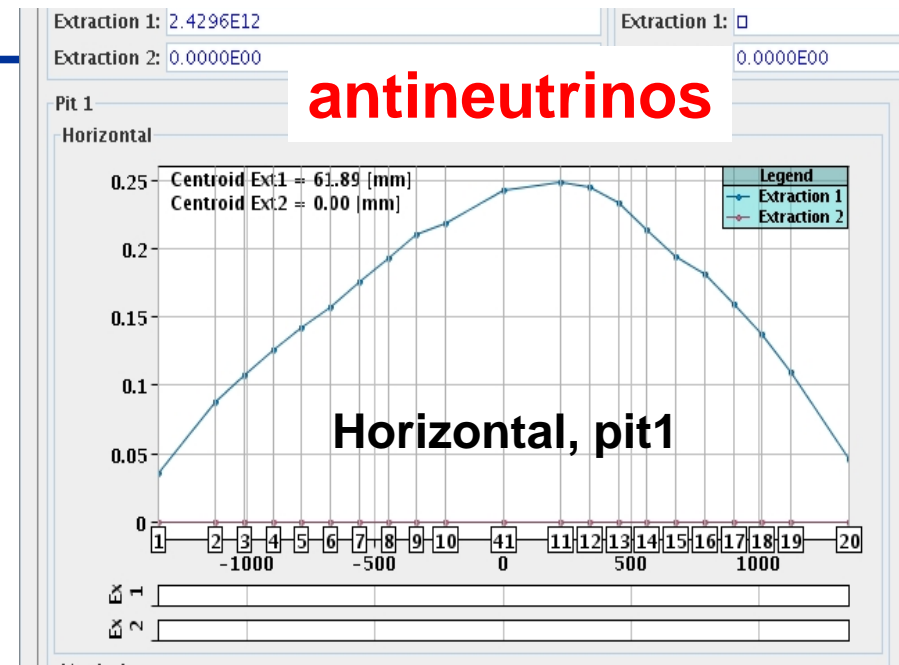
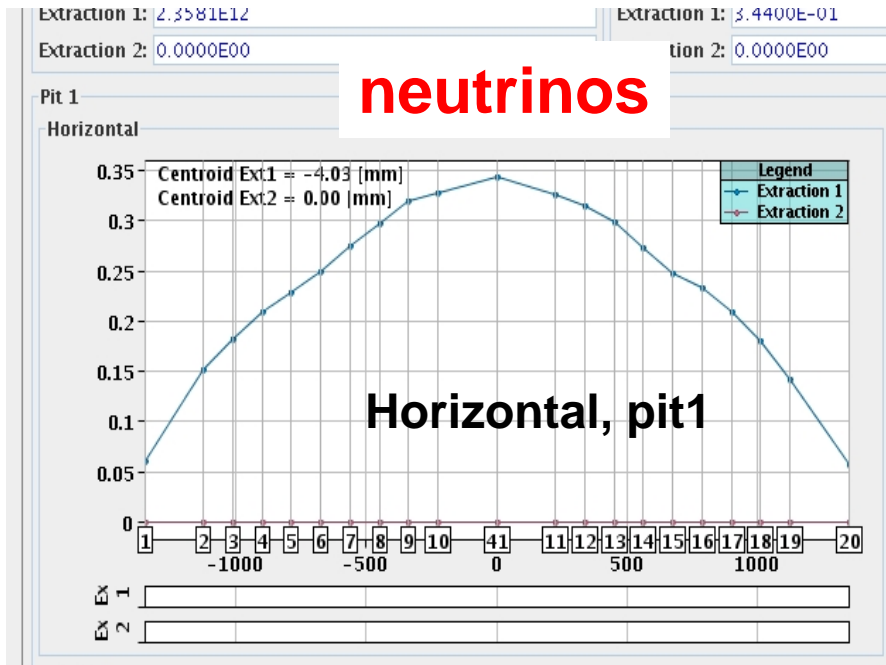


# Horizontal Target Scan





# Studies on Neutrino/Antineutrino Behavior



- **Many systematic measurements done:**
    - Different polarities with different currents in horn & reflector
    - Different target position
- analysis ongoing

# On-line Muon Profiles after Optimizations

User: SPS.USER.CNGS1 Time: 01.10.2007 17:03:03

BFCT

Extraction 1: **2 x 1.4E13pot/extr.**  
 Extraction 2: **2 x 1.4E13pot/extr.**

Movable Monitor Pit 1

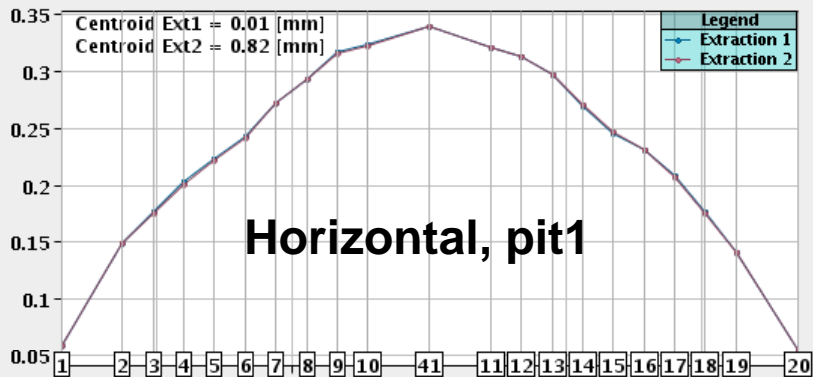
Extraction 1: 3.3658E-01  
 Extraction 2: 3.3637E-01

Movable Monitor Pit 2

Extraction 1: 1.1255E-02  
 Extraction 2: 1.1239E-02

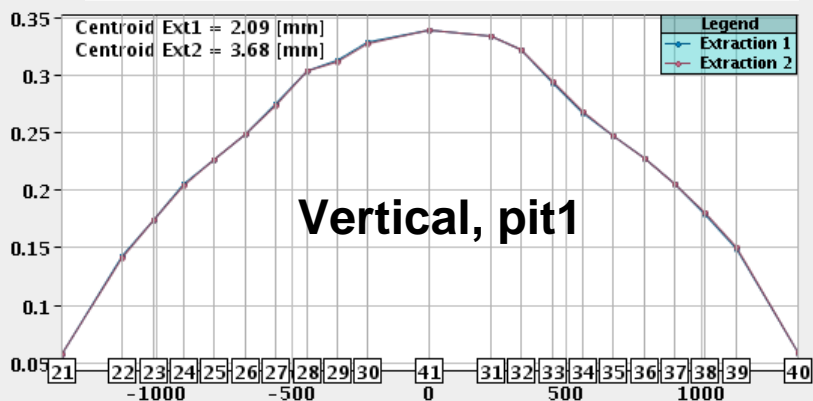
Pit 1

Horizontal



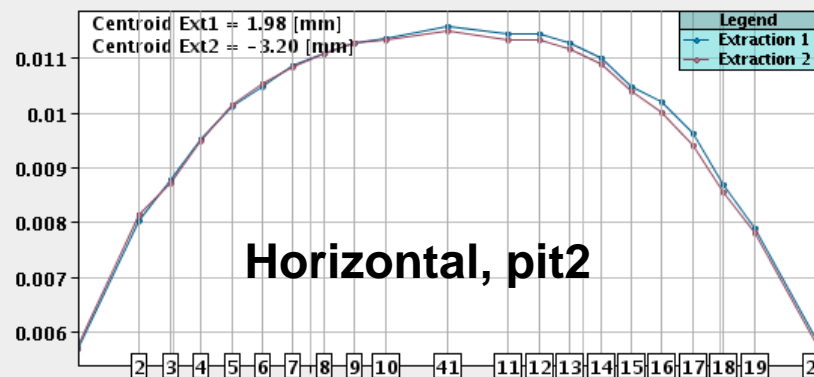
- Pit 1: sensitive to target vs horn alignment

Vertical



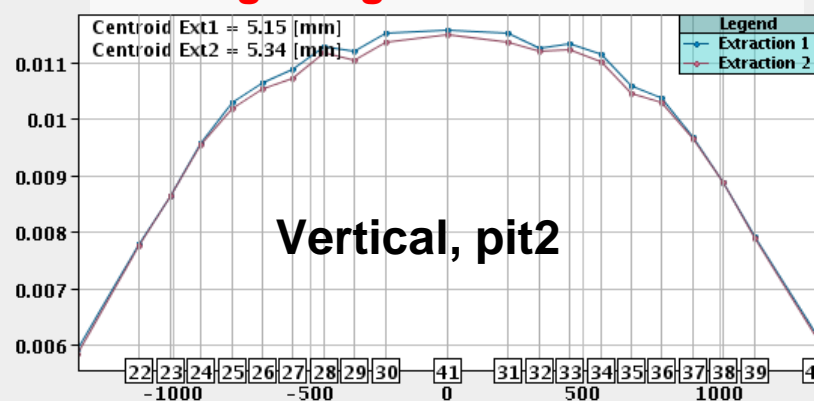
Pit 2

Horizontal

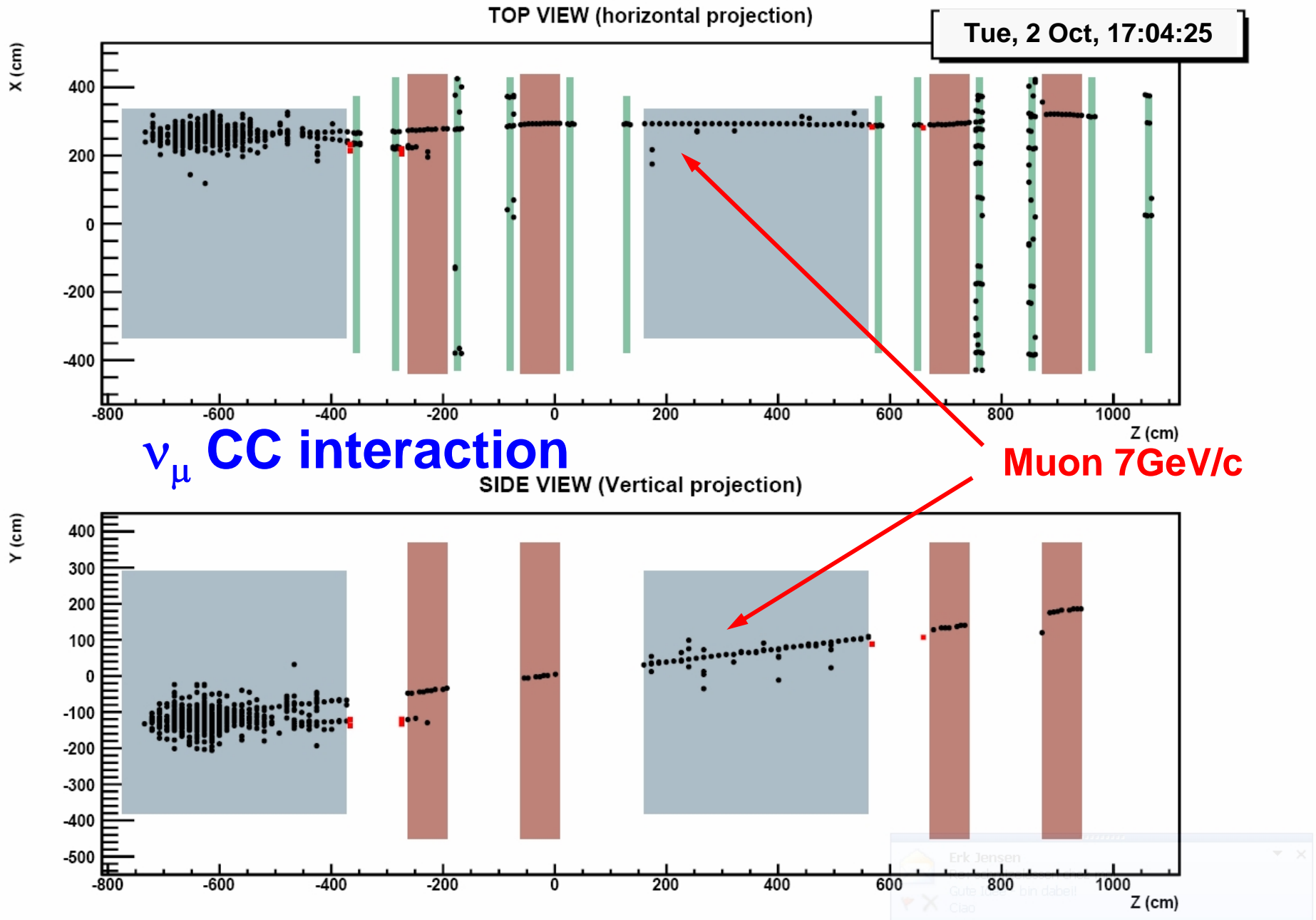


- Pit 2: sensitive to beam vs target alignment

Vertical

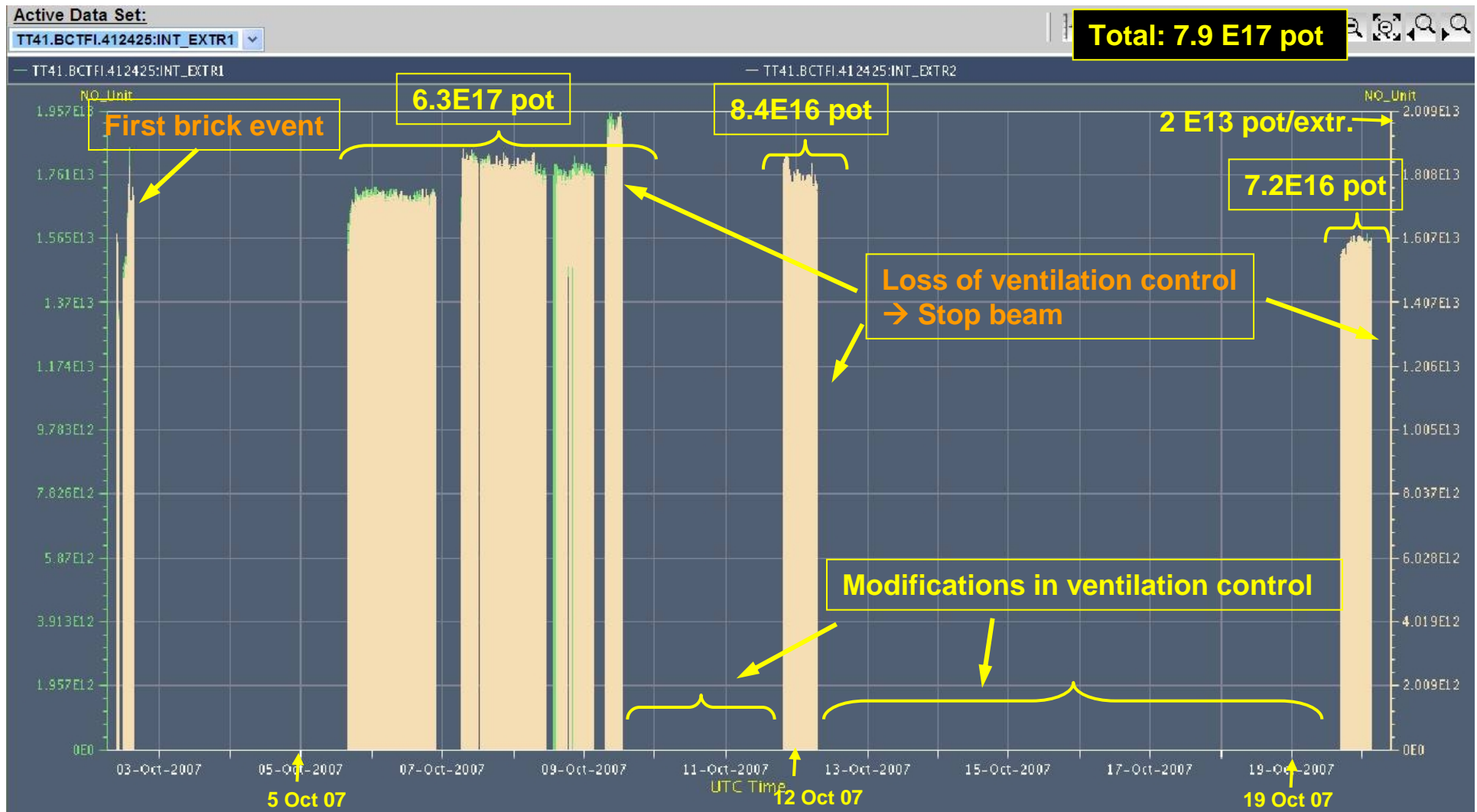


# First CNGS Event inside OPERA Target

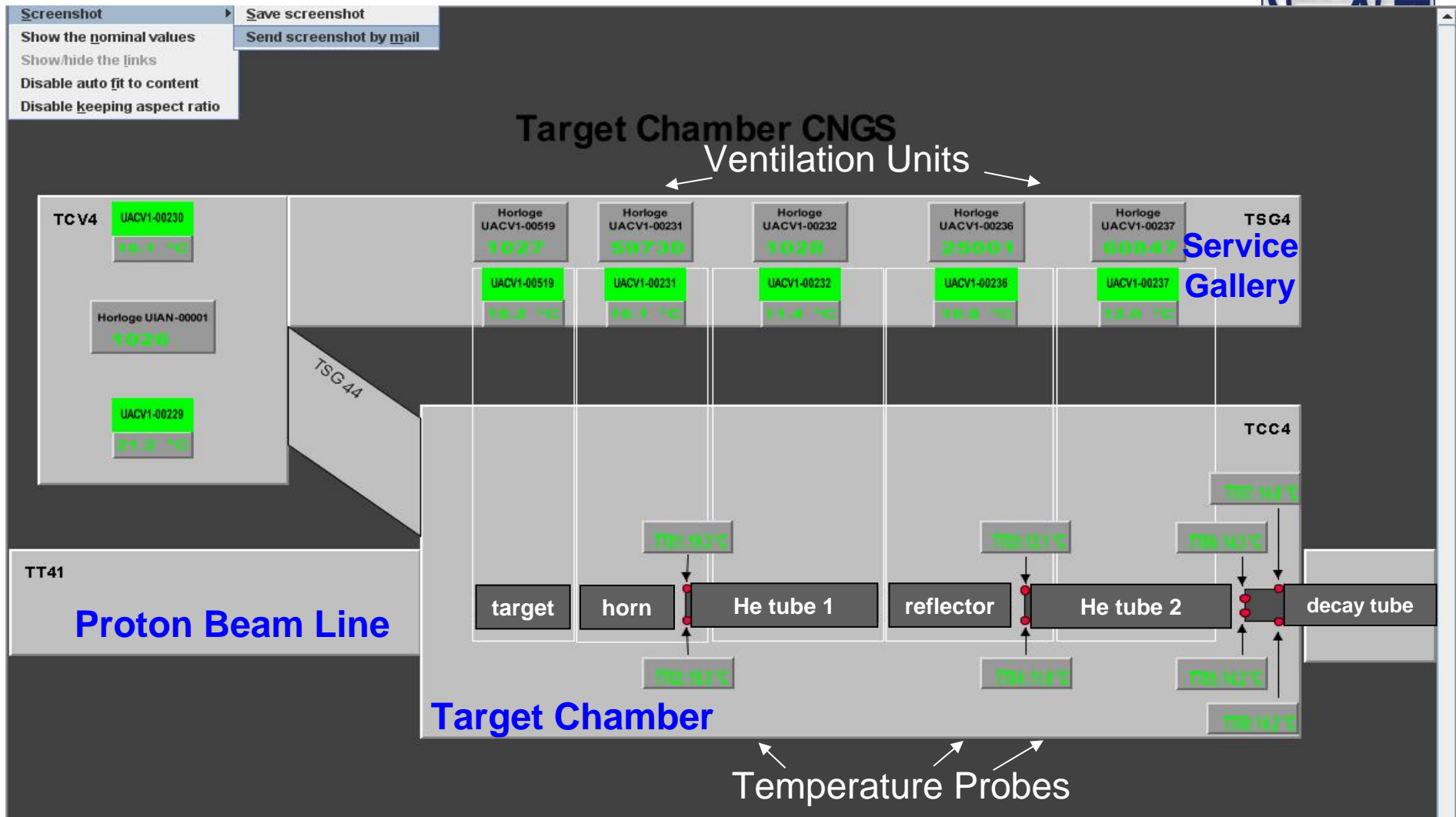




# CNGS Physics Run 2007



# CNGS Target Chamber



Single event upsets in ventilation electronics: caused ventilation control failure and interruption of communication

→ Strong efforts were made to implement an intermediate solution!

# Shutdown 2007/08



- **Critical Review on all installation of electronics in CNGS for all systems**
- **Analysis of dose measurements**
- **Detailed simulations of the dose**
- **Assess the impact of radiation on electronics**

**→ Major modifications of controls and electronics**

**Coordinated in the framework of the CNGS  
Secondary Beam Working Group**

**→ Kick-off meeting Wednesday, 31 October 2007**



# Summary



- **Successful repair and modification of the horn and reflector**
- **CNGS 2007 run**
  - **Excellent Beam Performance**
  - **However, radiation effects in some electronics**
    - **Stop CNGS beam 5 days in advance**
- **Shutdown 2007/08**
  - **Review CNGS installation and perform modifications to**
  - **ensure full-year running of CNGS in 2008!**



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**MANY THANKS!!!!**

**to all people for their efforts and  
dedication in preparing and supporting  
the CNGS run 2007!!!**

**AB/ATB - AB/PO - AB/CO - AB/OP - RP/SL -  
PH/DT1 - TS/MME – TS/CV – TS/IC**



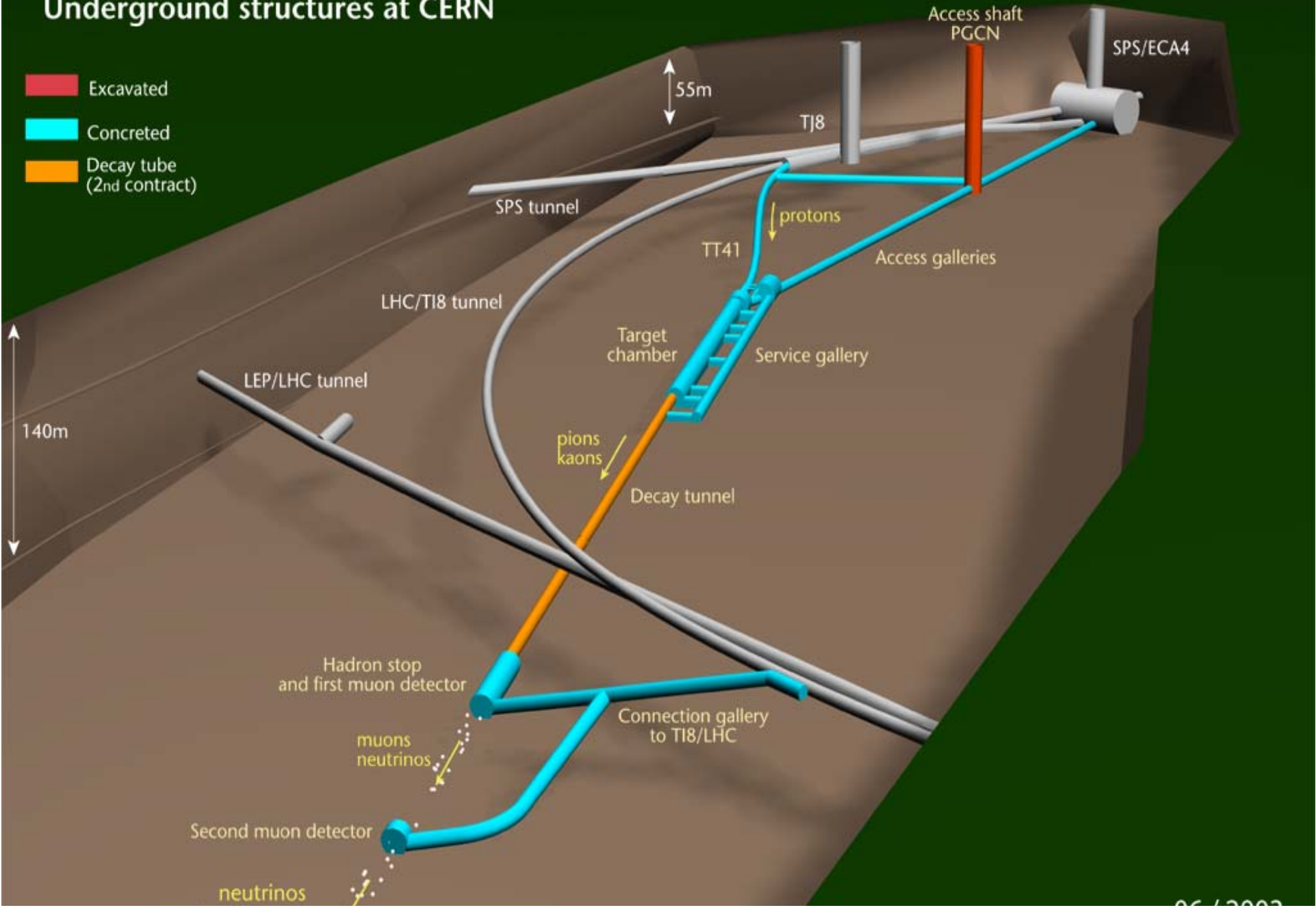
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# Spare Slides



# CERN NEUTRINOS TO GRAN SASSO

## Underground structures at CERN



# Proton Intensity PS



- SFTPRO intensity 1.6 E13
- Number of SFTPRO cycles 2
- CNGS intensity 2 E13
- Number of CNGS cycles 2 (6)
- Number of basic periods 19 (33)
- Proton flux per bp 0.379 E13 (0.461E13)
- Proton flux per sec. 0.316 E13 (0.384E13)
  
- Observations 2 Oct 2007: for a flux of 0.379E13/bp extracted → 8.6  $\mu$ Sv/hr on the route Goward

# Target Region Layout

