



Horns at LAL

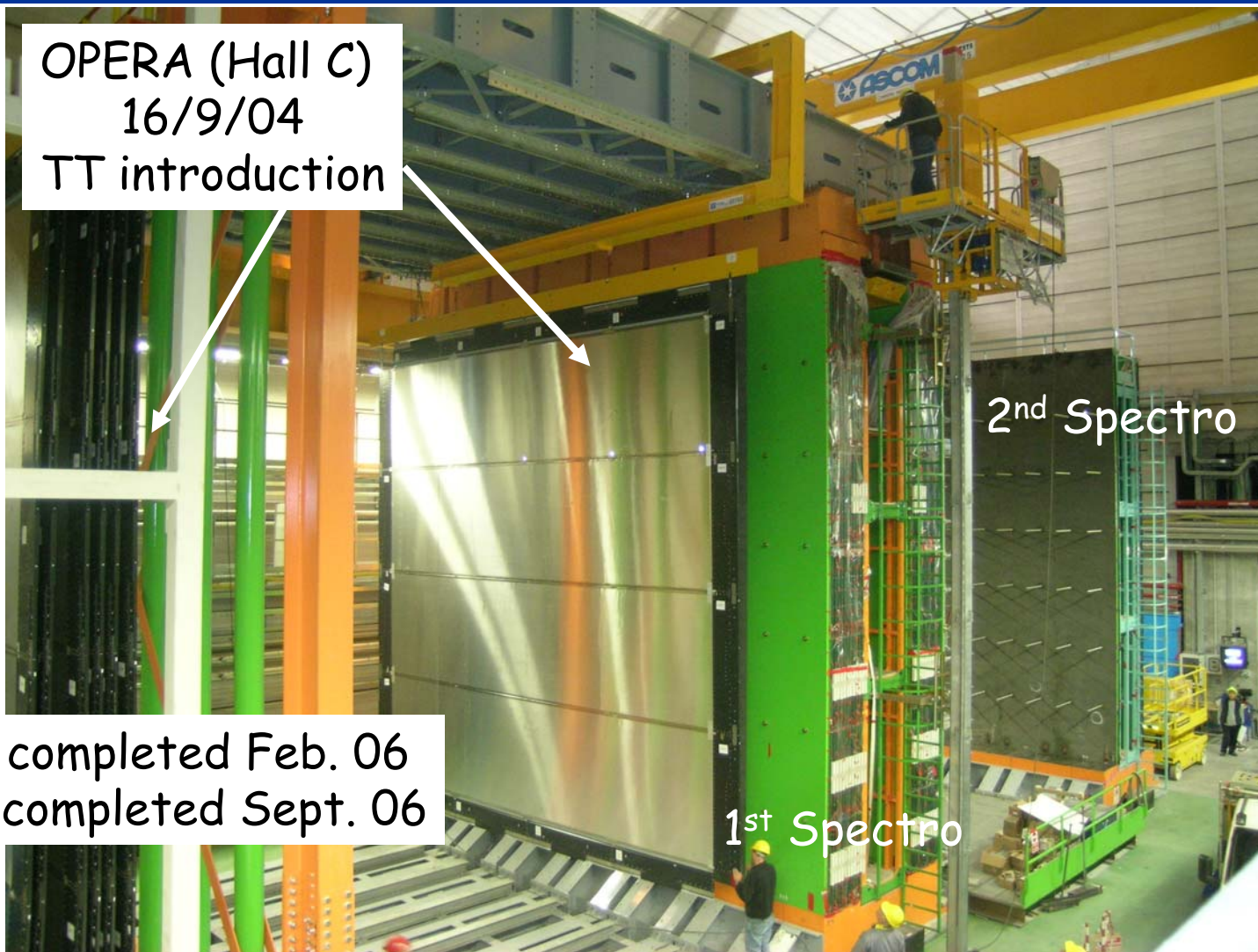
- CNGS: realisation
- SuperBeam/ ν Fact: thinking

CNGS

Project Leader: J.E Campagne
Mechanics Responsible: J.L Borne
Engineers: S. Jenzer, J. Forget
Draftsmen: M. Briere, R. Marie
Technicians: A. Blot, E. Herry, E. Takacs

Present team

OPERA status at LNGS



OPERA (Hall C)
16/9/04
TT introduction

1st SM completed Feb. 06
2nd SM completed Sept. 06

2nd Spectro

1st Spectro

Horn Management at LAL



- Reminder: The Horn/Reflector and their equipments (FCS, Strip-lines, cooling) was "in kind" contributions of the IN2P3 institute (delegate to LAL).
- From 2000 to end of 2003: G.Macé and then S. Wallon, engineers at LAL, were in charge of the conception with a know know transfer from CERN expertise (namely S. Rangod & J.M Mauguin).
- End of 2003 :
 - G. Macé has left the laboratory for personal conveniences; S.Wallon was on sick-leave;
 - B. D'Almagne, asked me to lead the team. I was in charge of the OPERA-LAL team and we had finished the design and production of the front-end chip of the Target Tracker.

First Horn at CERN 7th April 04



BA7

The 1st Horn had **successfully** passed during 1 week electrical pulses test at nominal values. The water cooling of the Inner and Outer Conductor has also been controlled (Ok).

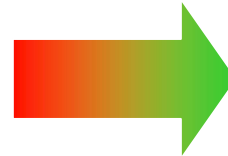
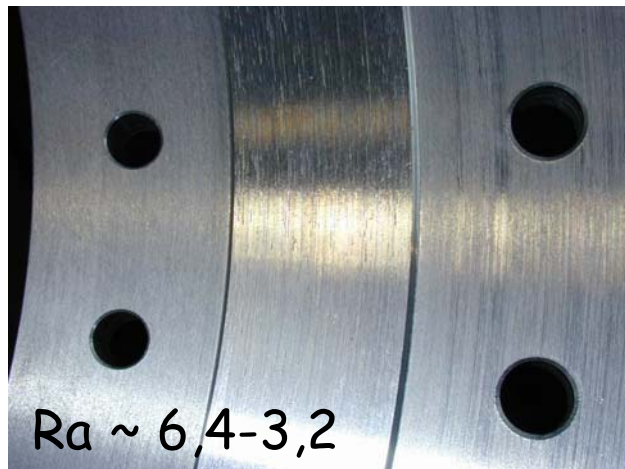
First Horn : some details...



We had to face major problems :

- a) **Non conformity** of the cabling system which able to align the Horn Inner Conductor Cured by G. Macé before his leave
- b) **Very bad quality of the electrical surface** machined by **SIMIC** company 3 FT technicians during 2 months
- c) **SIMIC welding** quality questionable for some pieces Checked with LAL expertise

First Horn : electrical surface



Hand polishing at LAL
during 2 months by
3 FT technicians





LAL Responsibility:

- 1) Horn & Reflector Supports
- 2) Fast Coupling System (FCS)
- 3) Reflector Inner Conductor (RIC)
- 4) Reflector and Horn-2 assembly/modifications
- 5) Horn & Reflector + FCS + Supports drawings

IN2P3 contribution
1MFCH material
+
Missions

CERN Responsibility:

- 1) Striplines
- 2) Water cooling systems
- 3) Horn-1 modifications and the specifications for Horn-2 & Reflectors

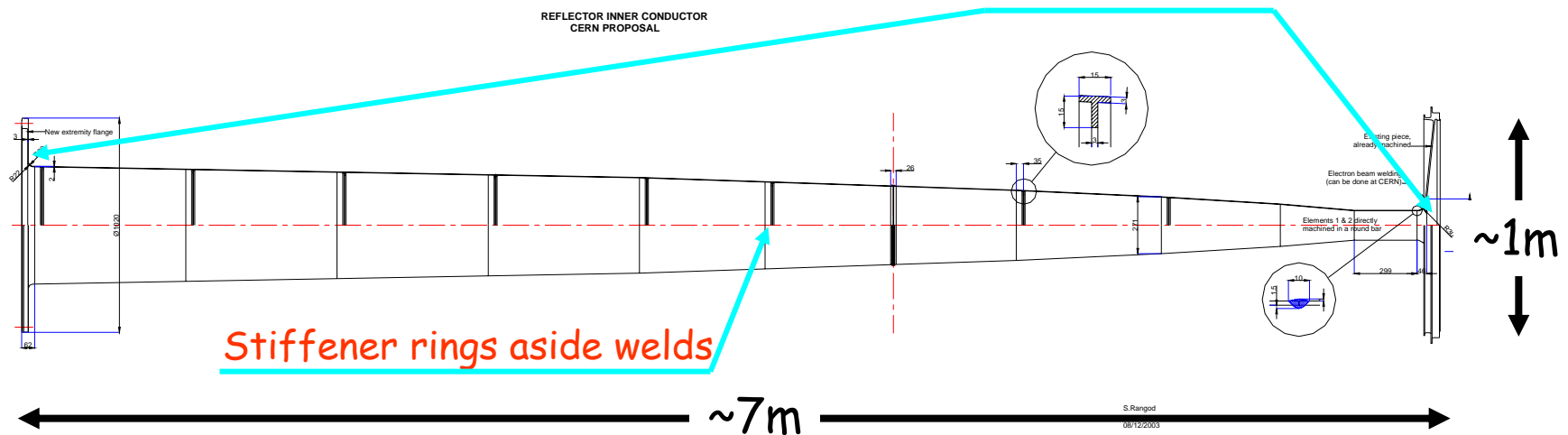
Estimate at
~ 300k€
+
manpower

R.I.C : problems pointed out by CERN



25th Nov. 03, S. Rangod send a red light concerning the machining of the flanges (at least) that does not allow good and robust welding. He ask him for postponing the work.

Radial welds in the most stressed area, not accepted



LAL has stopped SIMIC contract in Jan. 04

R.I.C : SDMS (France) fabrication



16th April 04, contract signed between LAL/IN2P3 and SDMS (St Roman, France)



2mm Al thick plates rolled

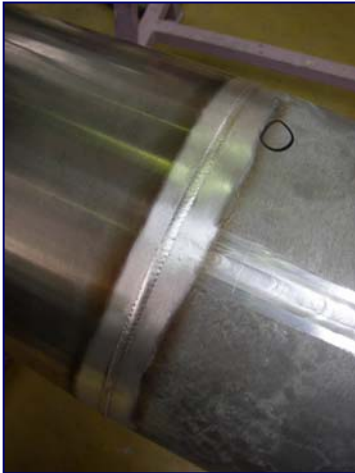
8 October 2004

LAL Scientific Committee
Presentation by J.E Campagne

R.I.C : SDMS (France) fabrication



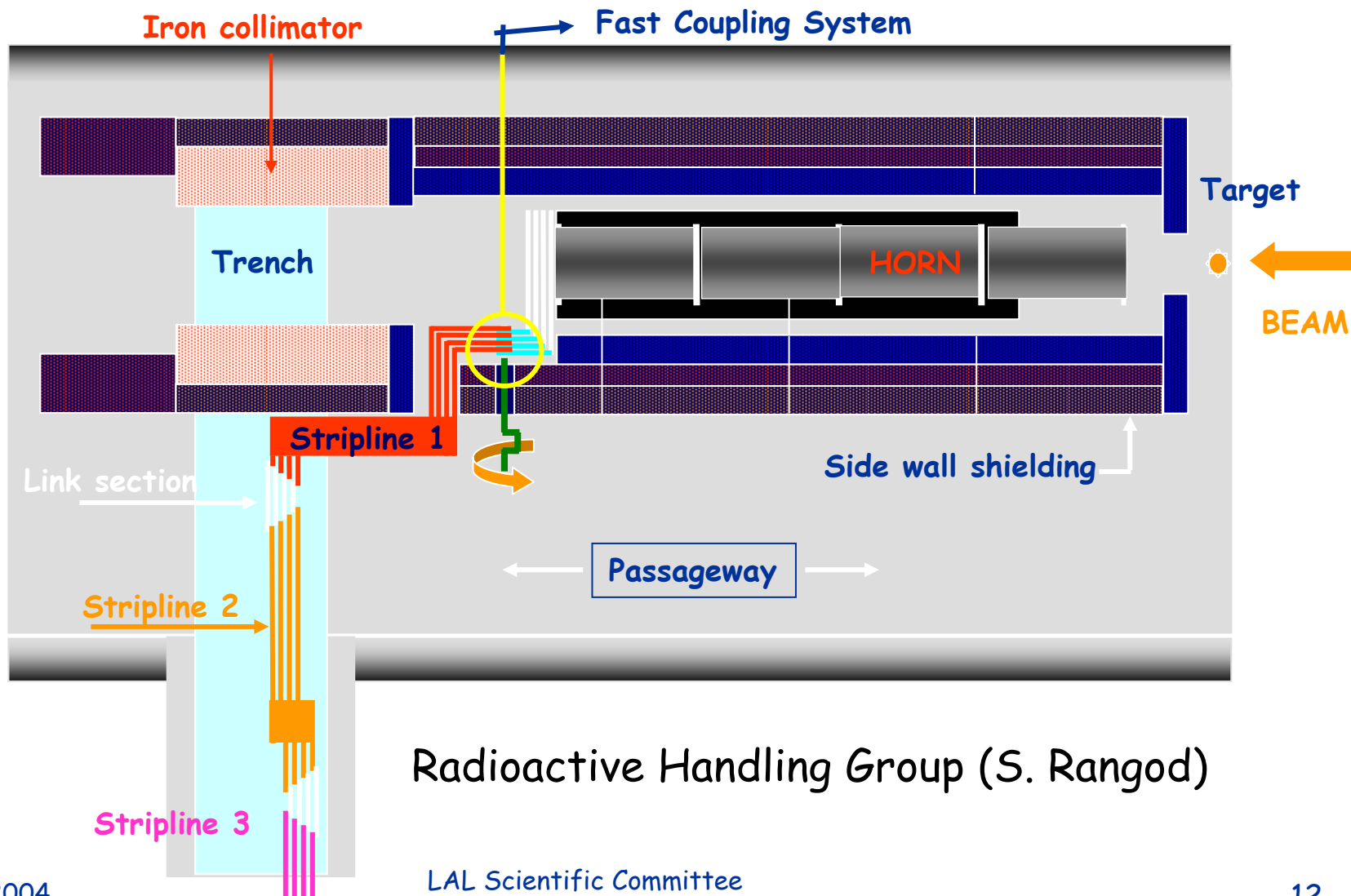
Orbital welding



SDMS supplier has some problems with the flanges.

Delivery estimated mid-Nov 04.

Fast Coupling System

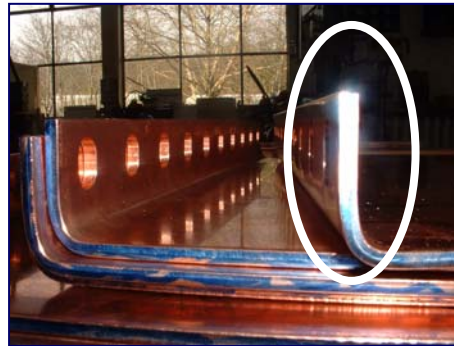


Radioactive Handling Group (S. Rangod)

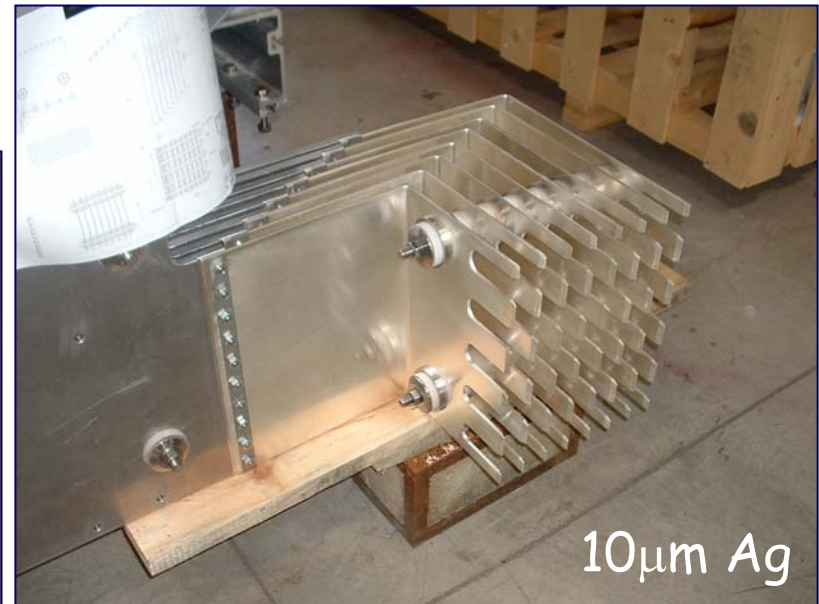
F.C.S : 1st realisation at LAL



at LAL



Feb.-Mar. 04



10 μ m Ag

M10 "La Clusienne" bolts

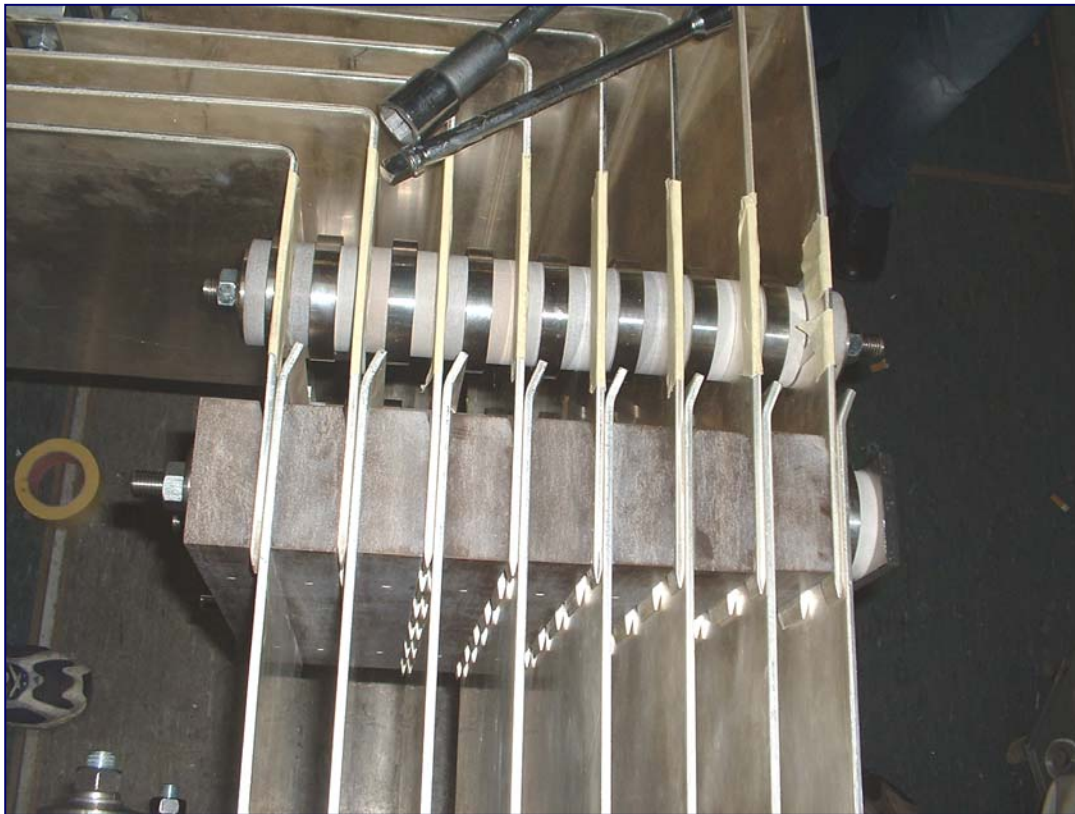
8 October 2004

LAL Scientific Committee
Presentation by J.E Campagne

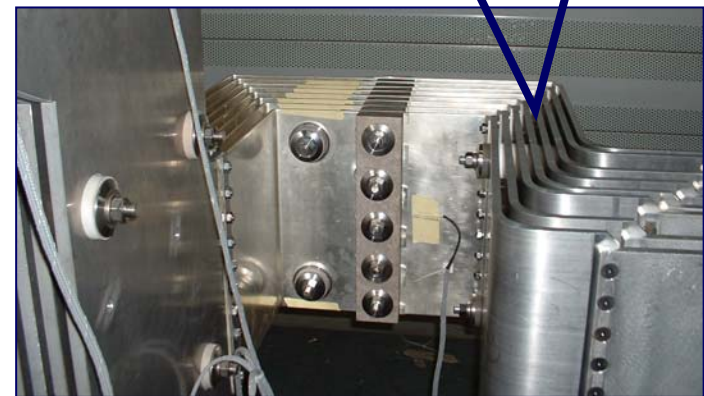
F.C.S : mounting at CERN BA7



With some difficulties, we have managed to work out and proceed to the Horn tests.



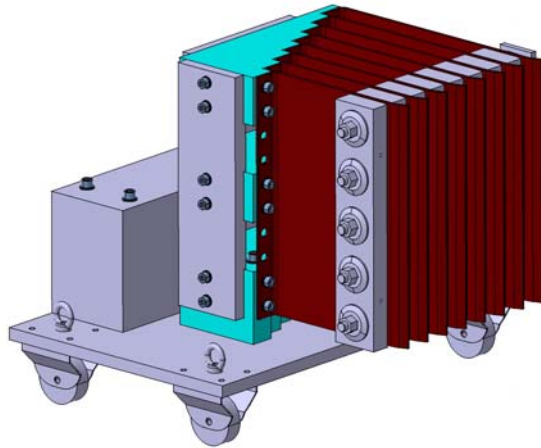
CERN "mécano"
strip-line in BA7



F.C.S : new prototype at LAL



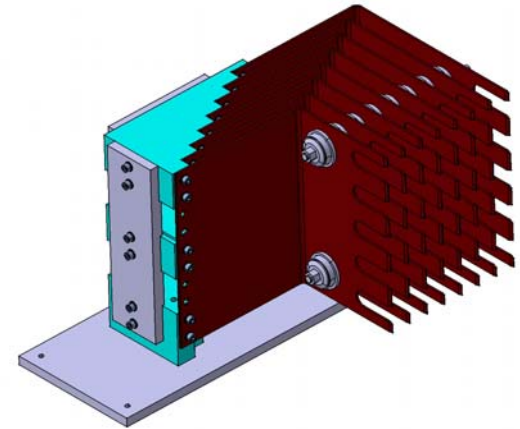
We are now engaged in a full scale prototype test bench at LAL



Strip-line "simulation"

Test the ARCLEX bar fixing, the spacing operation as well as the F.C.S plug in.

Start test early
October 04

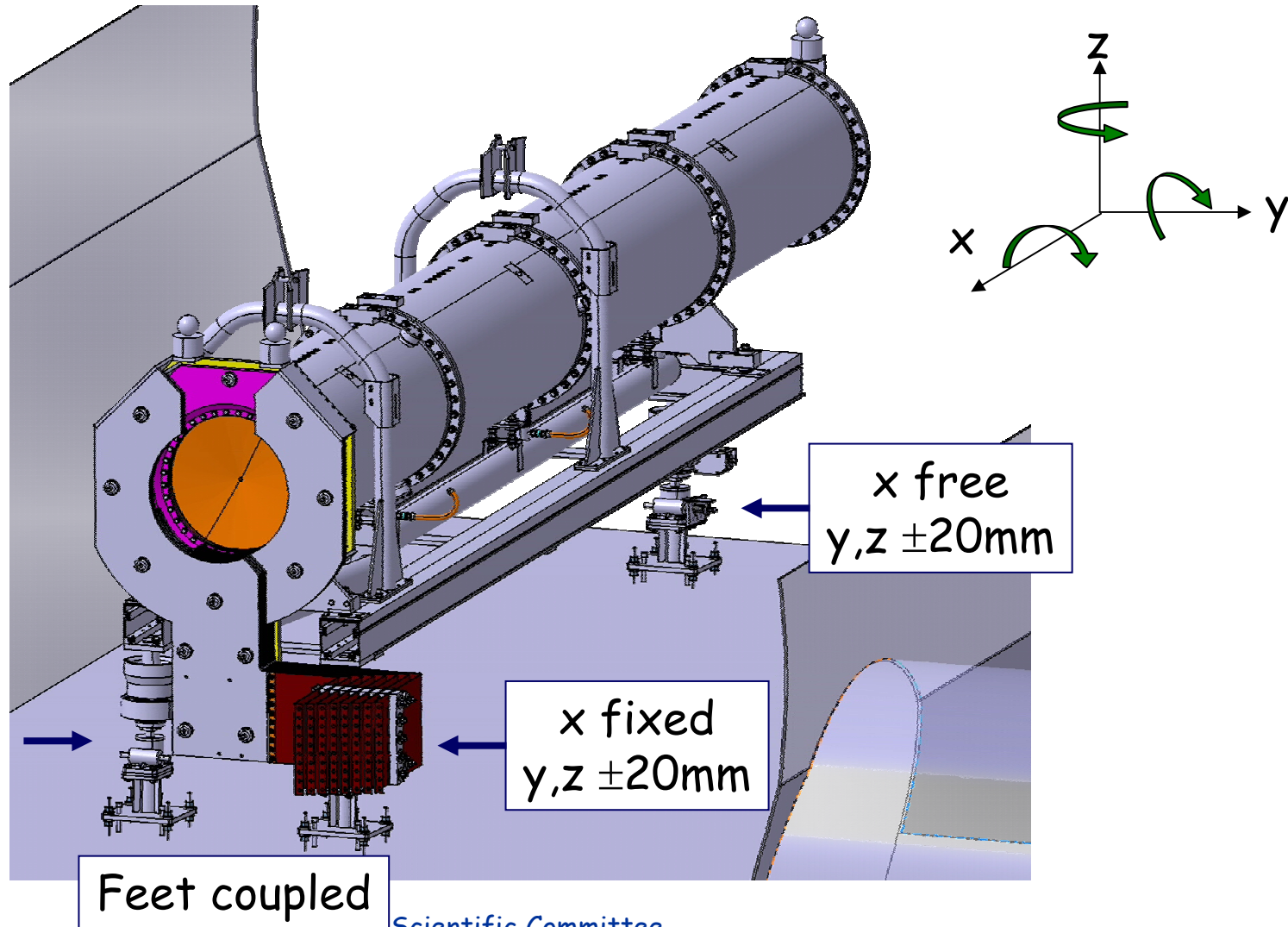


Horn "simulation"

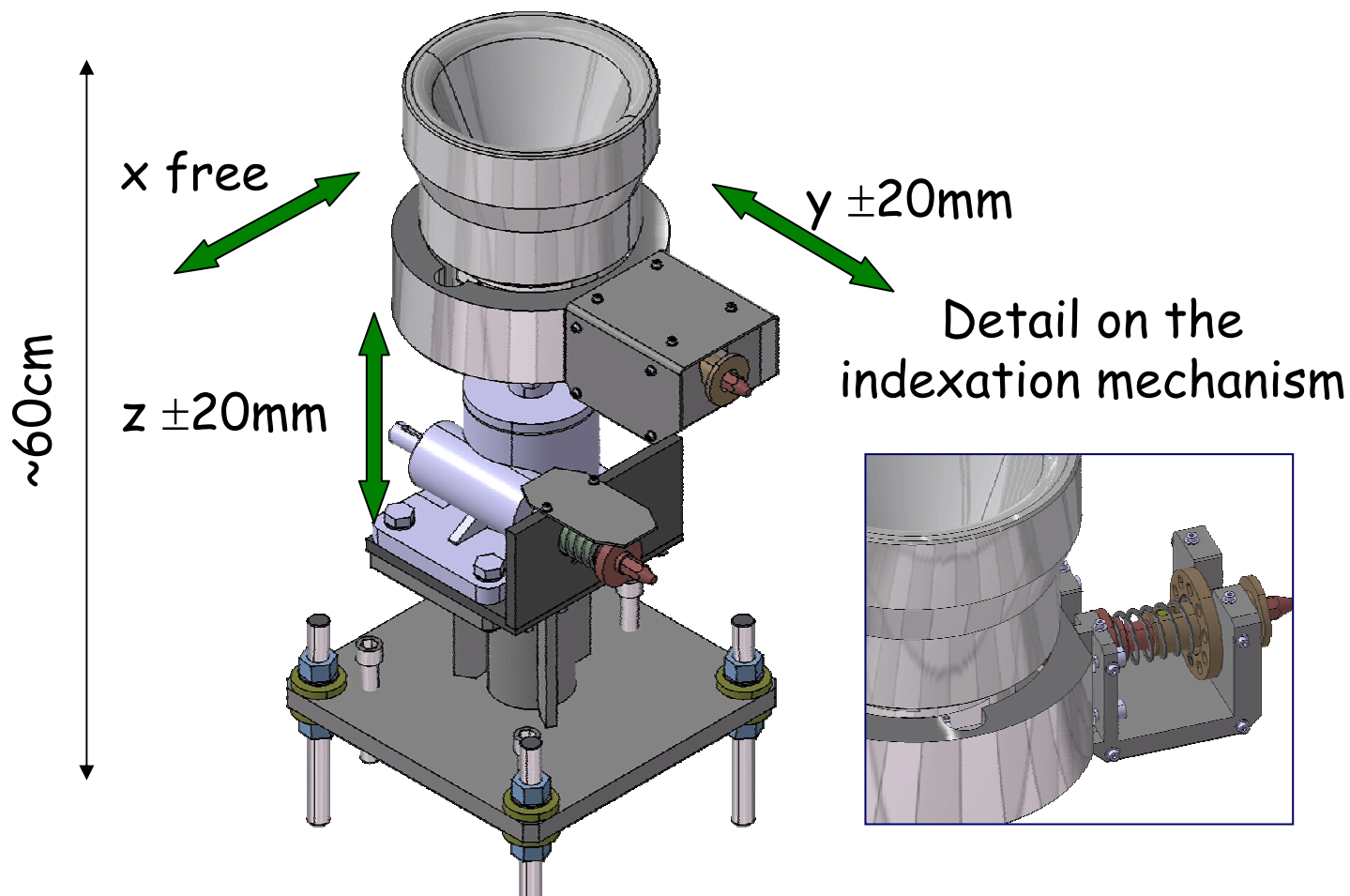
This should answer to: How to design a mounting tool and a mounting scenario to guaranty the geometry ?

Final plug-in test with Horn 2/Reflector: see Adjustable Feet test

Adjustable feet : conception



3. Adjustable feet: 1st Prototype



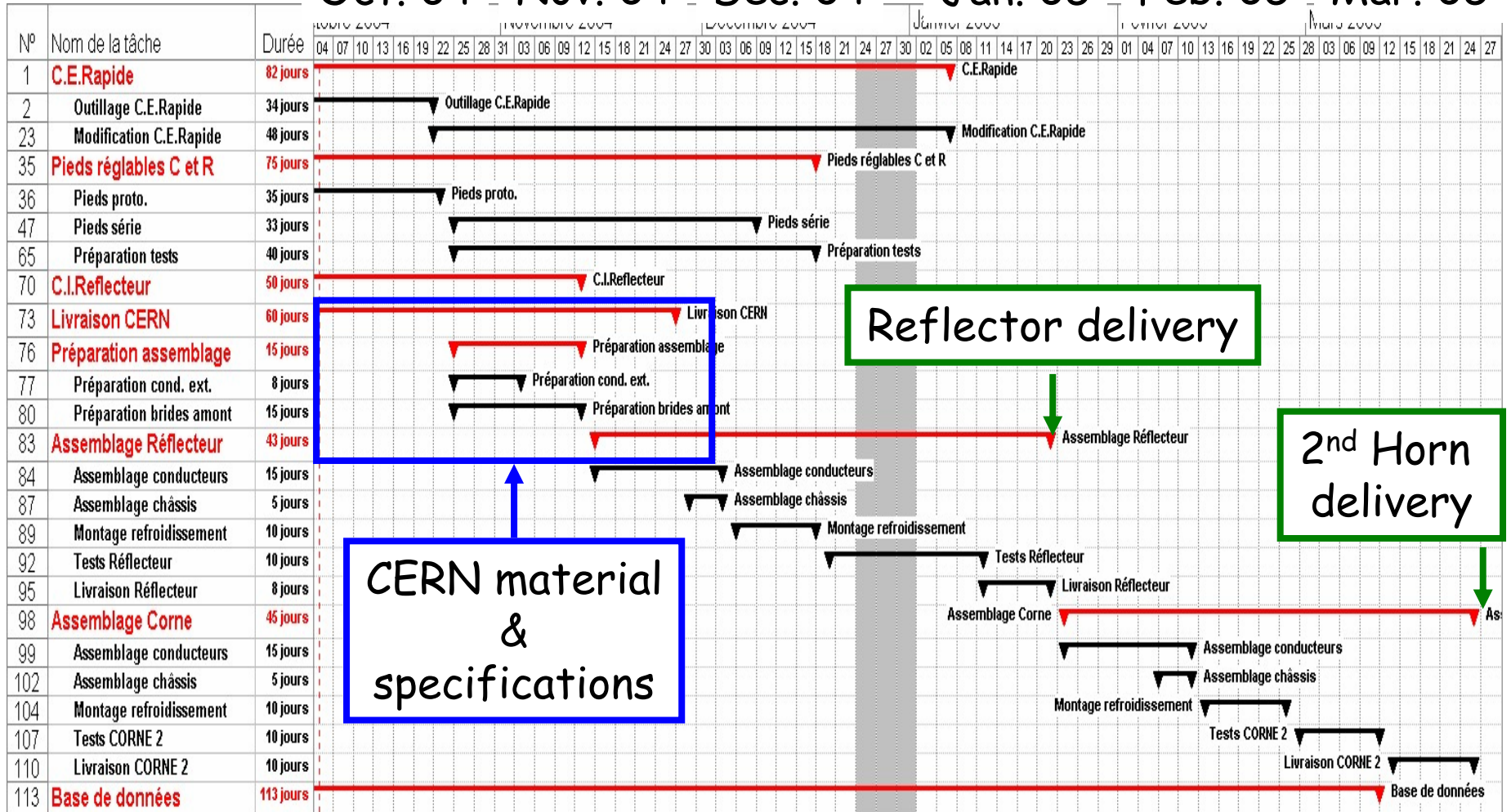
22th June 04

Ready to perform a test with 1tonne in Hall IN2P3

Planning (preliminary)



Oct. 04 - Nov. 04 - Dec. 04 - Jan. 05 - Feb. 05 - Mar. 05



CERN material & specifications

Reflector delivery

2nd Horn delivery

SuperBeam vFact

Physicists: J.E Campagne, A. Cazes (Ph.D)
Engineers: J. Bonis, M. Omeich

Present non official team

No R&D has been pushed up to now due to the CNGS project difficulties encountered at LAL. So only thinking may be presented here...

From CNGS experience

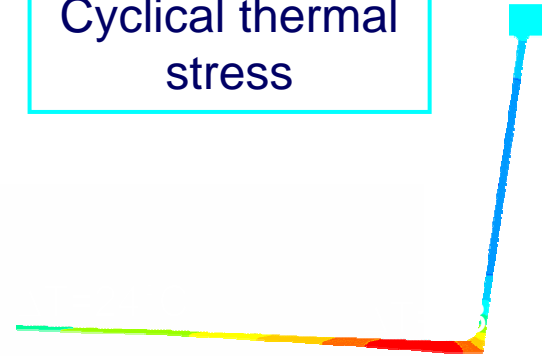


Realisation

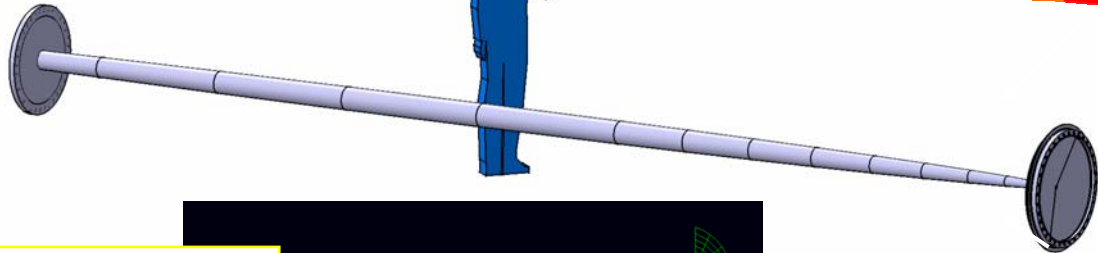


Thermal study

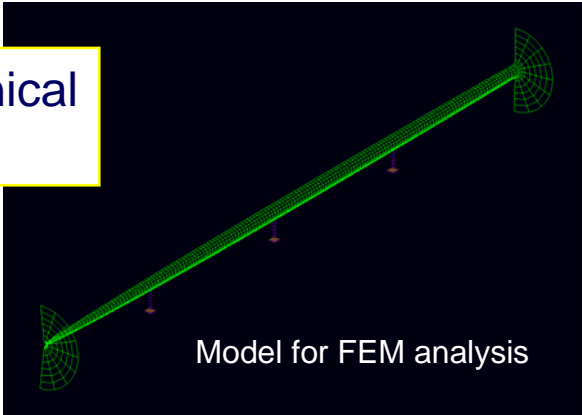
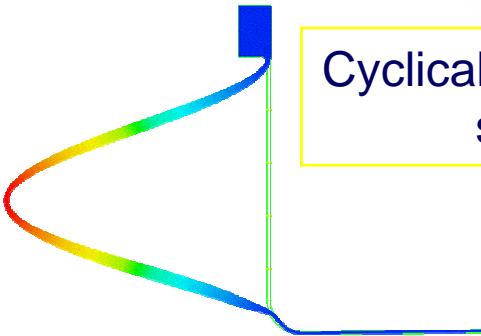
Cyclical thermal stress



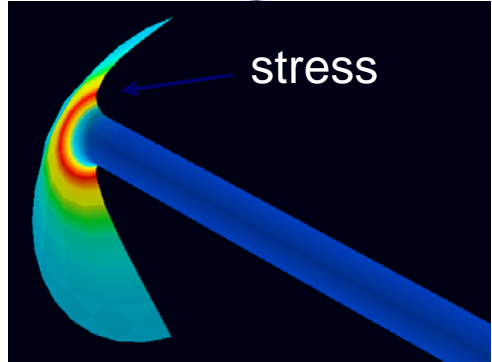
Dynamic study



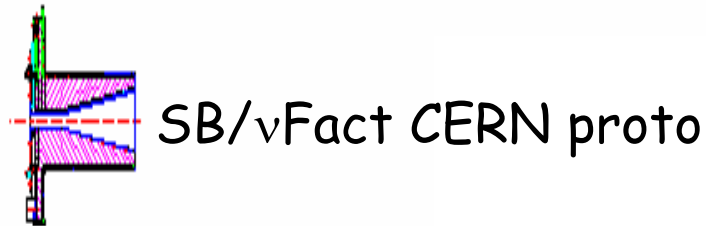
Cyclical mechanical stress



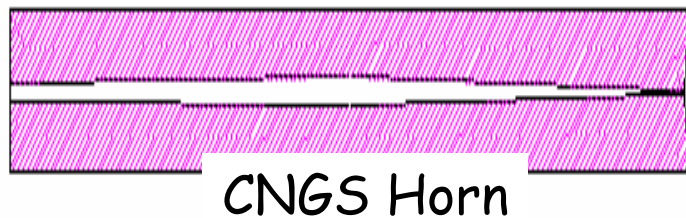
Model for FEM analysis



CNGS vs SB/vFact



$P_{\text{beam}} = 4\text{MW} / 2\div 3\text{GeV}$, Target inside
300kA/50Hz/100 μs
200 M pulses/6 weeks
Neck: $P_J = 7\text{kW}$, $P_B = 63\text{kW}$ (8mm Alu)
 10^{22} fast neutron/cm²/6 months



$P_{\text{beam}} = 0,4\text{MW} / 400\text{GeV}$, Target outside
150kA/2pulses 10 μs -6s
20 M pulses/5 years
IC: $P_J = 13\text{kW}$, $P_B = 5\text{kW}$ (2mm Alu)



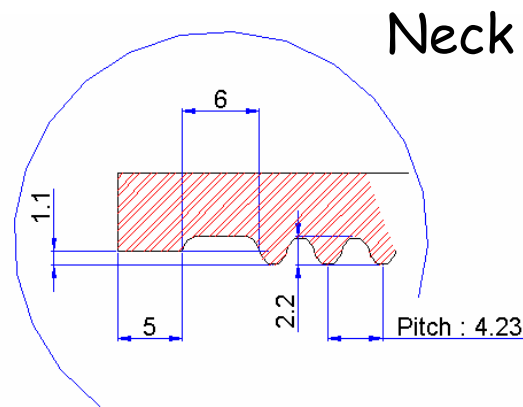
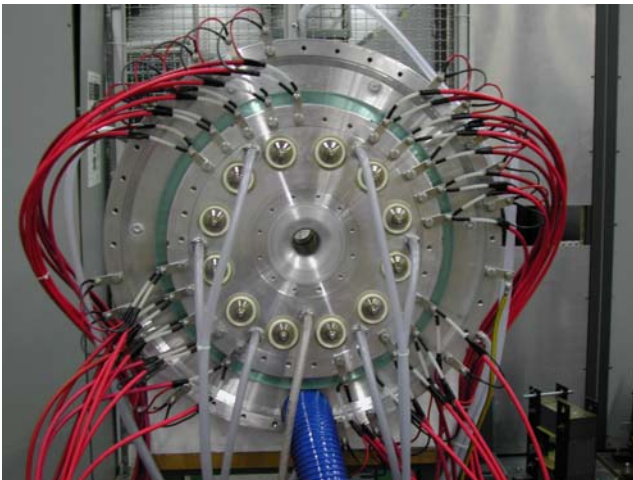
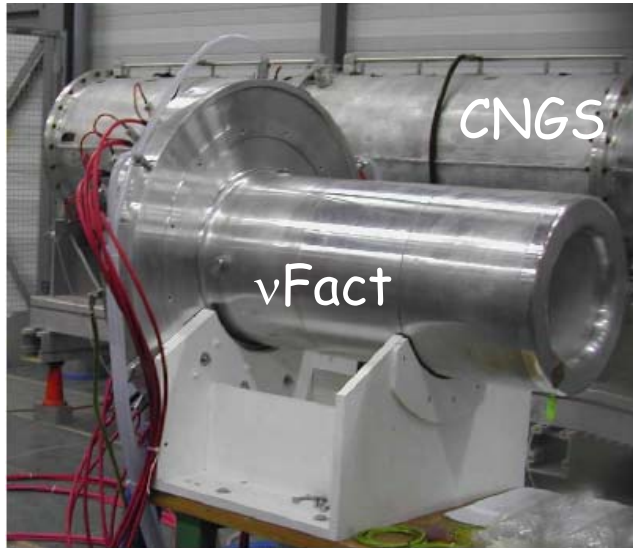
(m)

New R&D are required !



1. Define a geometry via the physics requirements, *eg. CERN proto + adaptations* (J.E.C/A.C)
2. Compute the magnetic pressure on the different pieces (G. Lemeur)
3. Compute the stress, static + dynamic (J. Bonis)
4. And so on

CERN prototype (2002)

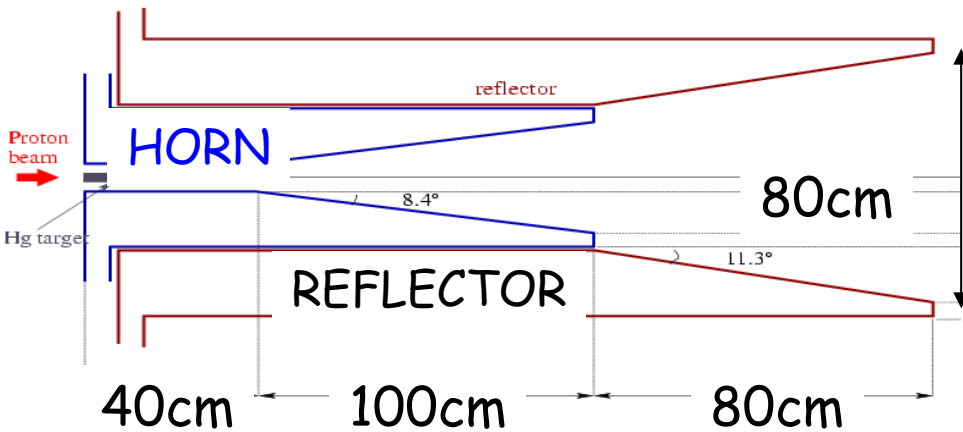


8 October 2004

LAL Scientific Committee
Presentation by J.E Campagne

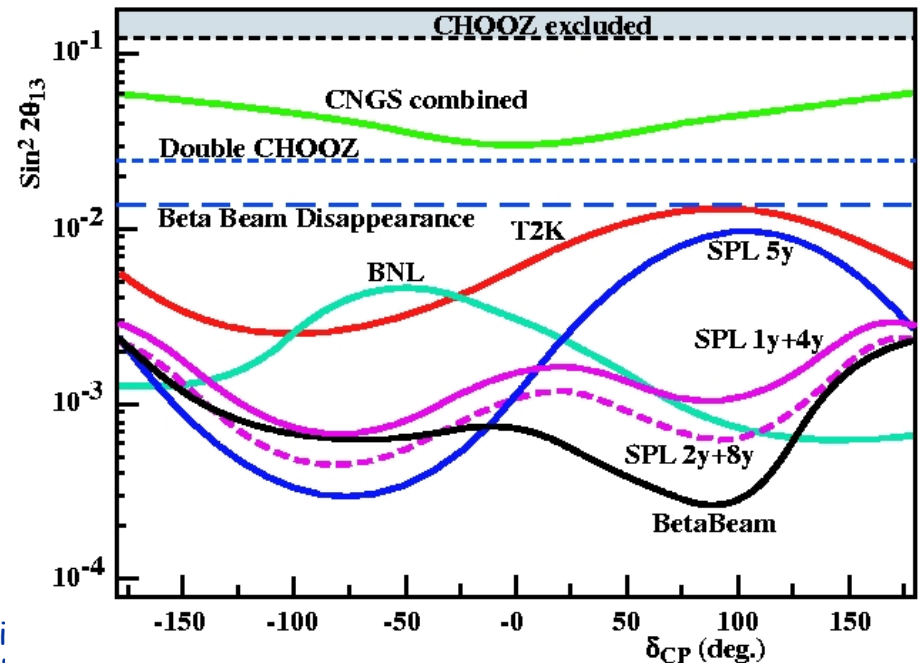
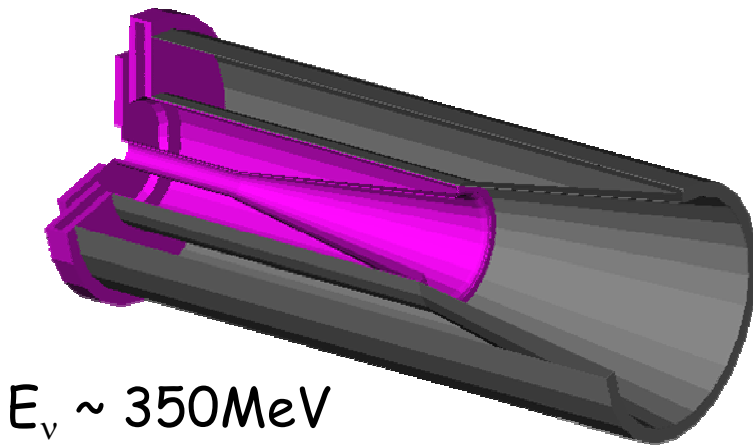
S. Gilardoni
S.Rangod, J.M Mauguin...

Optimisation of the focusing (+ SPL)

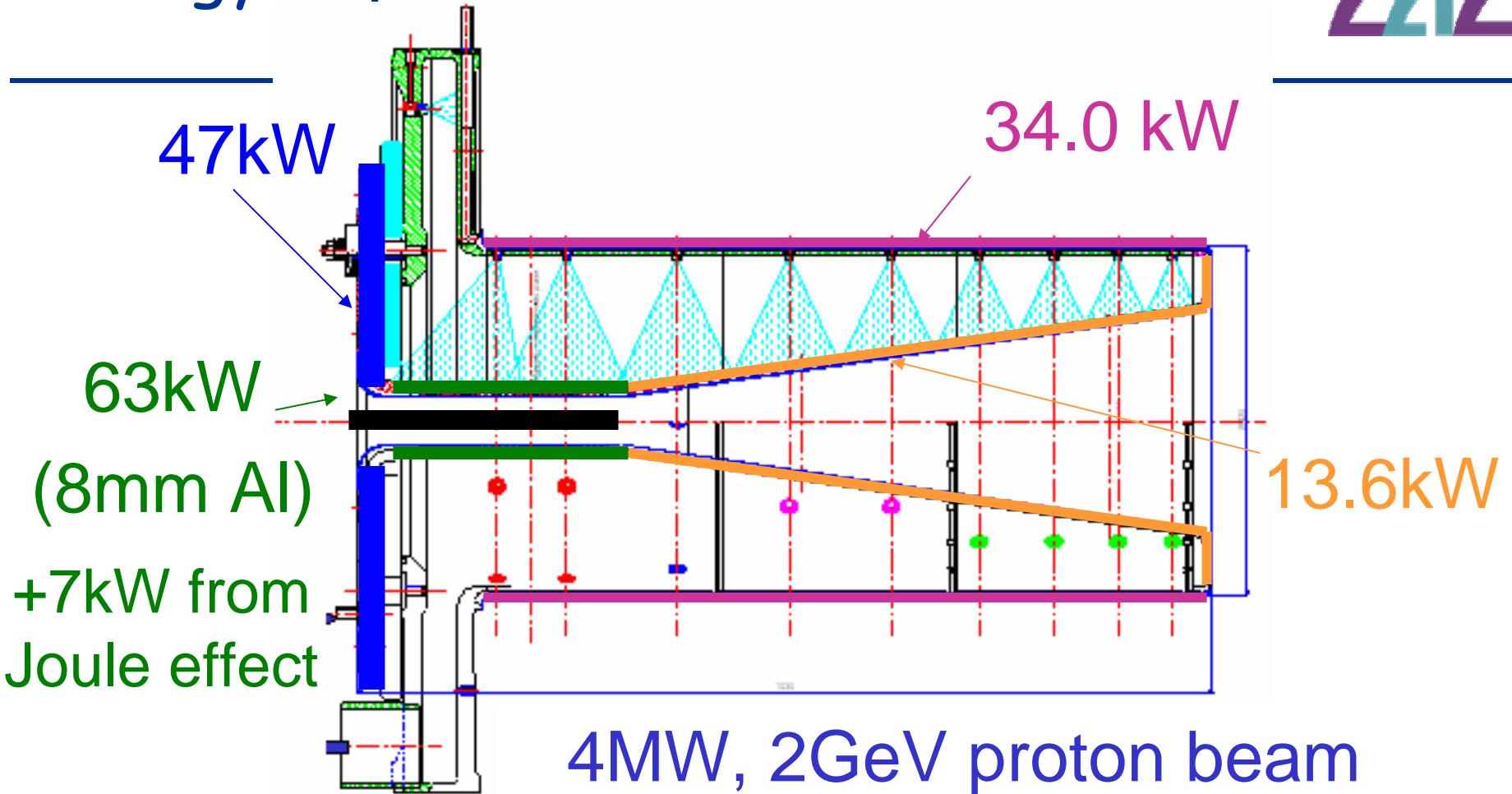


SPL: 2.2GeV \rightarrow 3.5GeV
 Decay tunnel: L = 40m, R = 2m
 SPL-Fréjus 130km + UNO-like

A.Cazes + JEC (submitted to EPJ C)



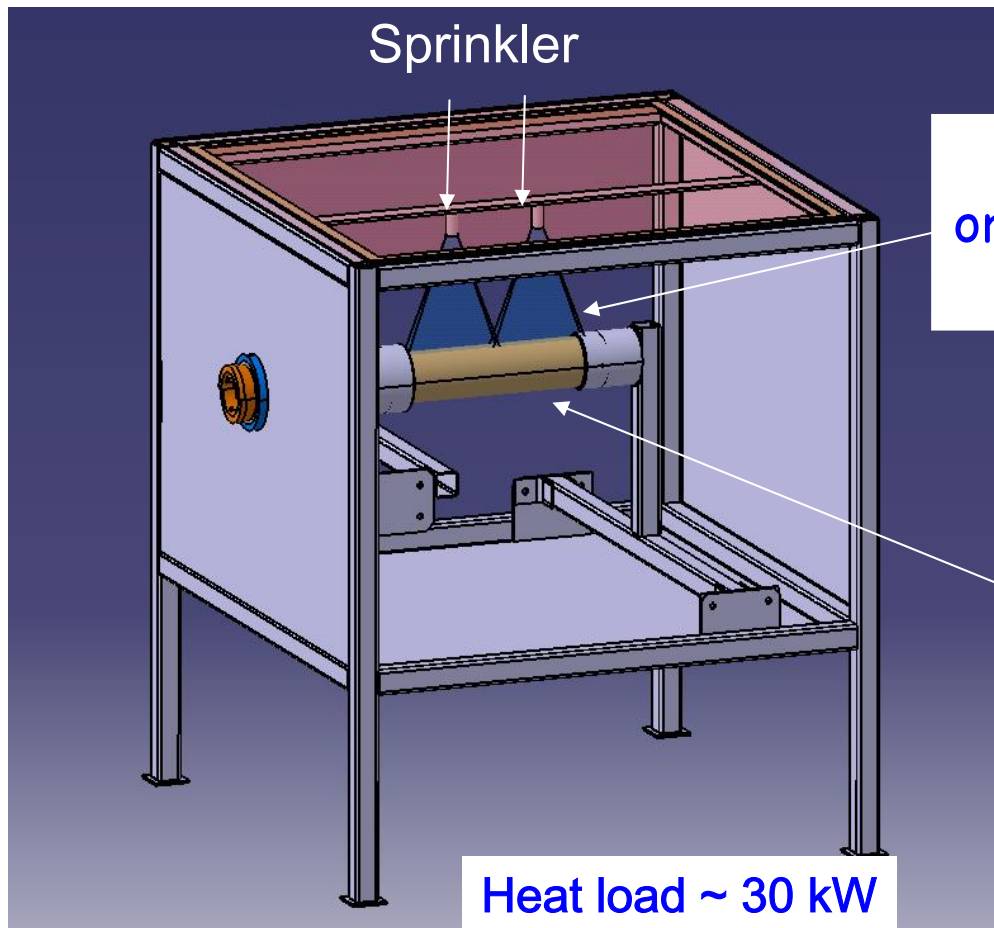
Energy deposition in the horn



Solution under investigation : reduced Al thickness (3mm Al) + strength rings

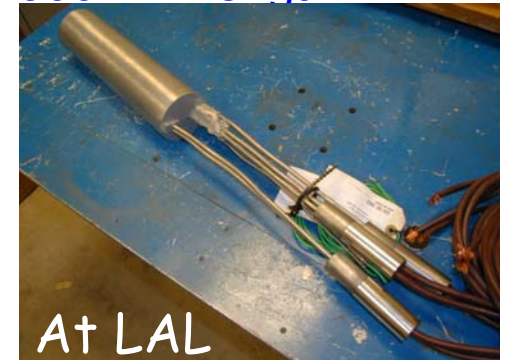
A. Cazes + JEC

R&D: water cooling



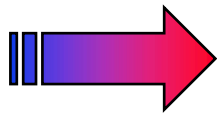
Water curtain
or other water jets
configuration

Aluminum alloy cylinder
80 mm ext. diameter
300 mm length



Need green light to continue...

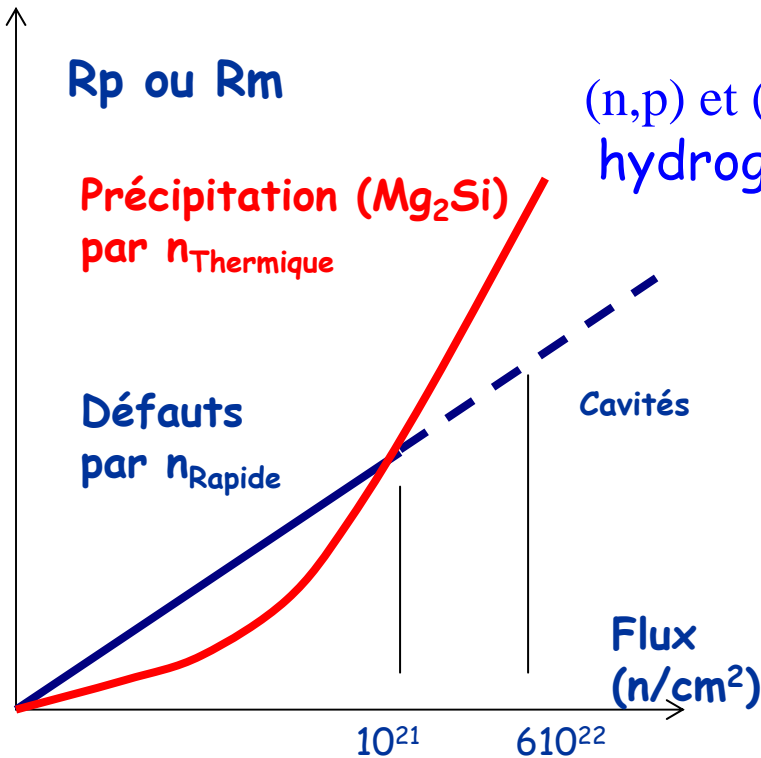
- CERN had successfully tested the Horn at 100kA/1Hz
- mid-June 03: « cahier des clauses techniques particulières de l'alimentation pulsée de la corne de Neutrino » document written by M. Omeich (13p) for a (300kA/100 μ s/50Hz) power supply.
- 1st industrial price feed back:
 1. Main power supply (7kV/130A): HAZEMEYER co.: ~ 160k€
 2. Swithes (300kA/100 μ s/50Hz): ABB co: ~ 3x2x50k€* = 300k€



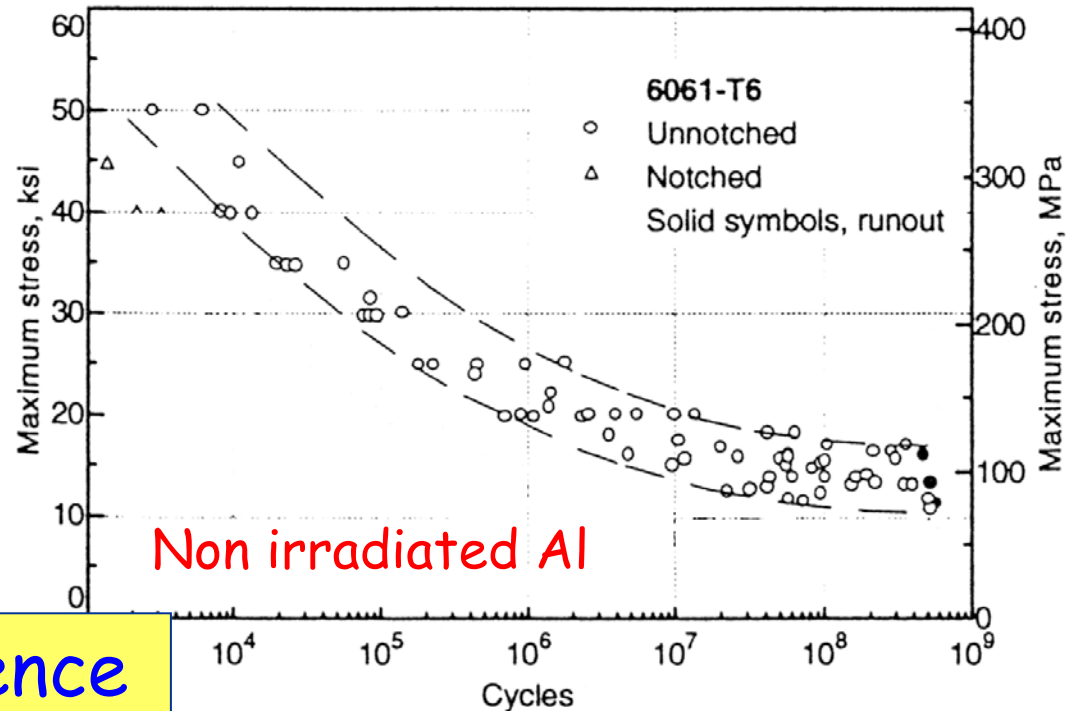
A solution exists for ~ 460k€ (700kCH)

But we think that a 300kA/1Hz may be a good next step to push the present CERN power supply prototype. A DRAFT of a possible transfer from CERN to LAL of some pieces exists.

Al alloy property modifications

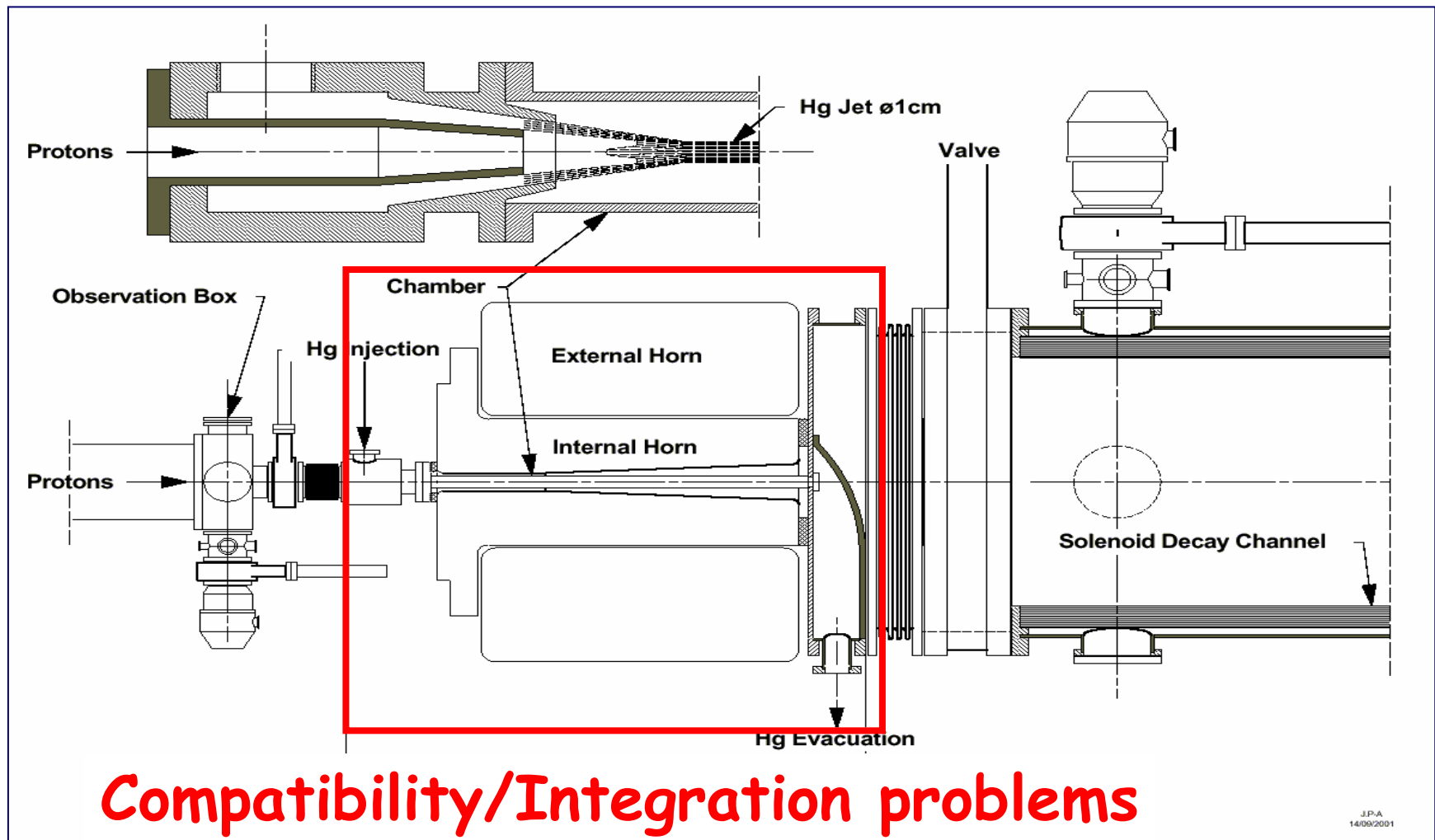


6082 or 6061 Al



No particular competence
at LAL

Hg-jet inside the horn





Water Cooled Striplines

Fabrication cost issues if the life time
of a horn is $< 1y$

Fast Coupling (cooling + electric)
remotely controlled

Nuclear waste management

...

Some costing



For a electrical test at 300kA/1Hz : >150k€

Striplines	Not yet estimated
Cooling (Horn + Striplines)	20k€ (from CNGS)
H.V.	~10k€
switches (300kA/1Hz/100ms)	2 x 50k€ (ABB)
Capacity (1500 mF)	24k€ Atesys)

CERN is ready (Draft MoU) to transfer some material to LAL (~110k€)

Horn	50k€ (CERN prototype cost)
H.V. + switches 300kA/50Hz/100ms	460k€ (ABB & Hazemeyer)
Cooling Test	5k€
Fatigue curves (non irradiated)	5k€ (CNAM)

World effort



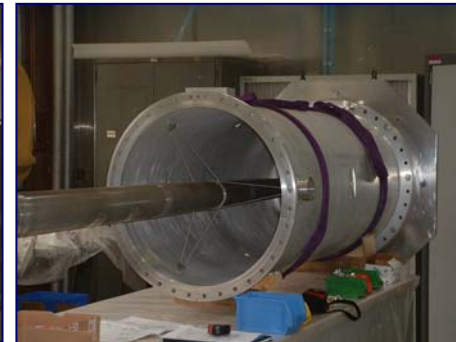
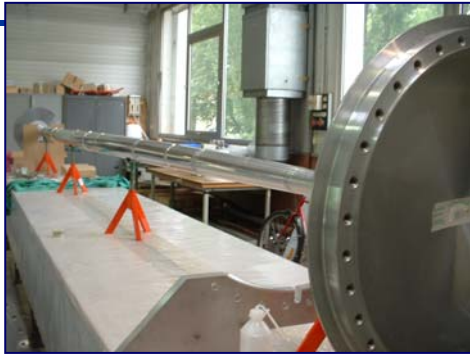
NuFact yearly meeting reports (next at Frascati)

CARE/BENE network organised in WGs:
join TARGET & COLLECTOR co-chaired
by R. Bennett (RAL) & J.E.C



Back up

First Horn: mounting phases (I)



Insertion of External Conductors around the Inner Conductor and tensioning of the cables. Then, installation on the frame.

8 October 2004

LAL Scientific Committee
Presentation by J.E Campagne

First Horn : mounting phases (II)

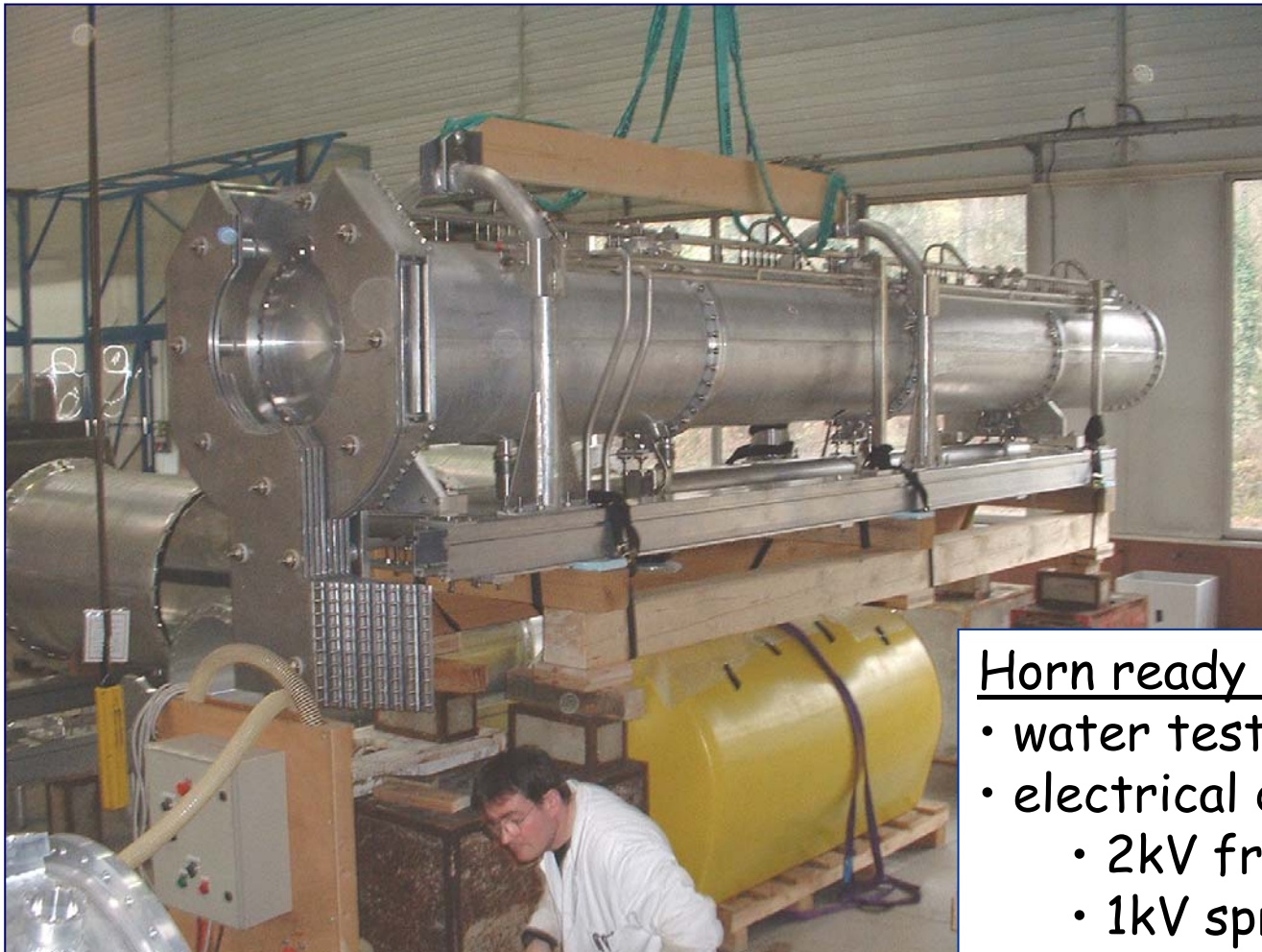


Checked at LAL



Welding of the water cooling system to avoid leak.

First Horn : mounting phases (III)



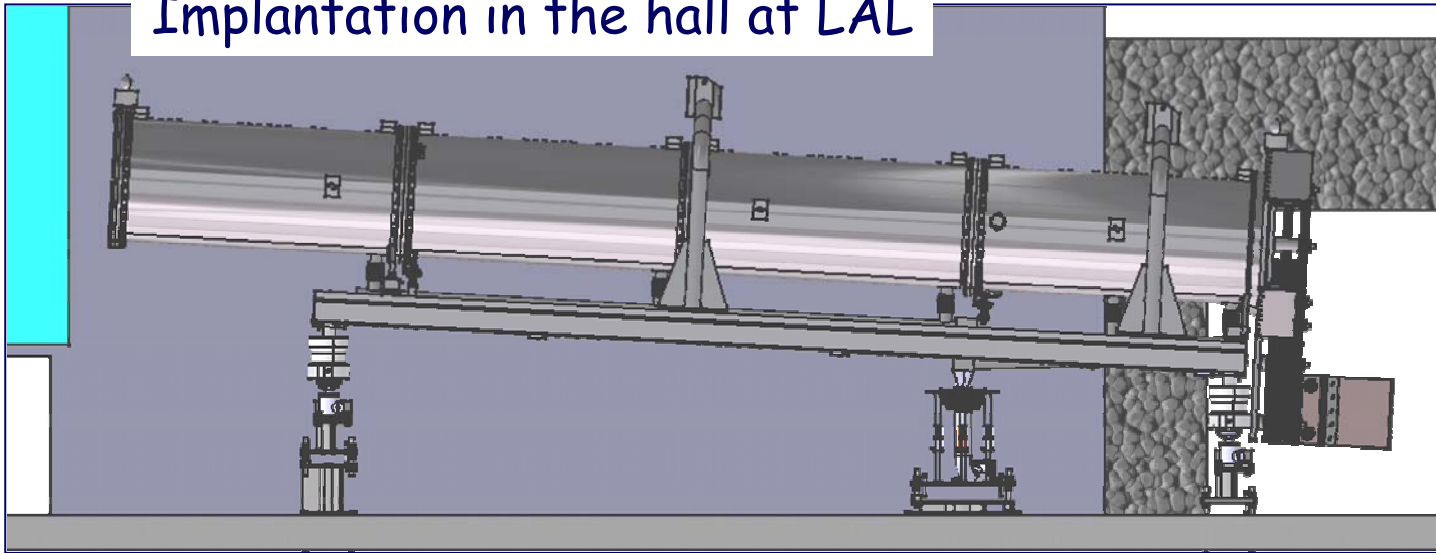
Horn ready for tests:

- water test for leakage search;
- electrical decoupling test:
 - 2kV frame-Ext. Cond.
 - 1kV sprinklers - Ext. Cond.

Adjustable feet: Manipulation Test



Implantation in the hall at LAL



This test bench will also be used for the F.C.S final plug in, as well as the water collection.

