

CNGS Horns



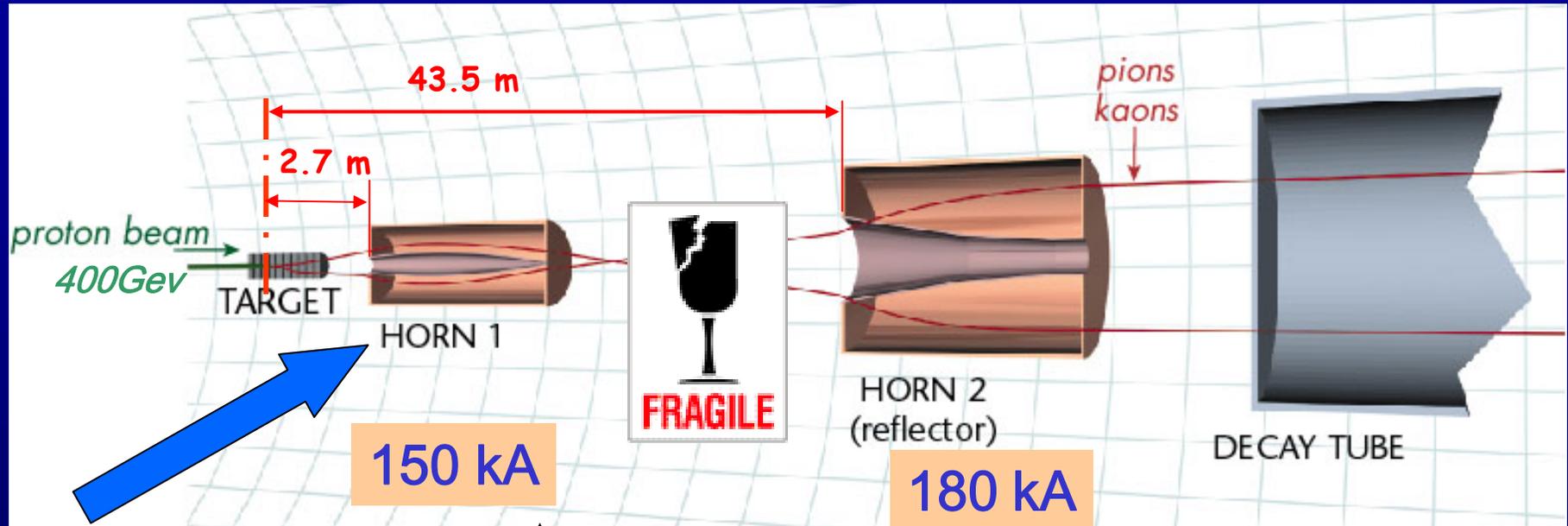
• CNGS Horns

- Introduction
- Design
- « Remote »
- Timing tests

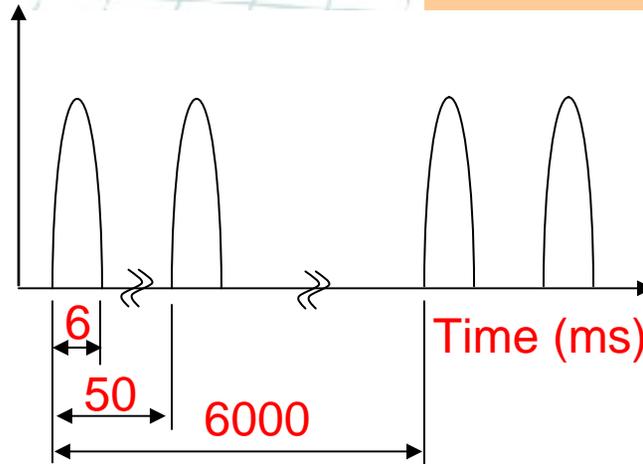
• Horn exchange

- Striplines
- Procedure
- Exchange Exercise

Introduction



Electrical
Pulse Timing



Beam Extraction
 2.4×10^{13} p.p.p.

Flat top
0.01ms

Introduction

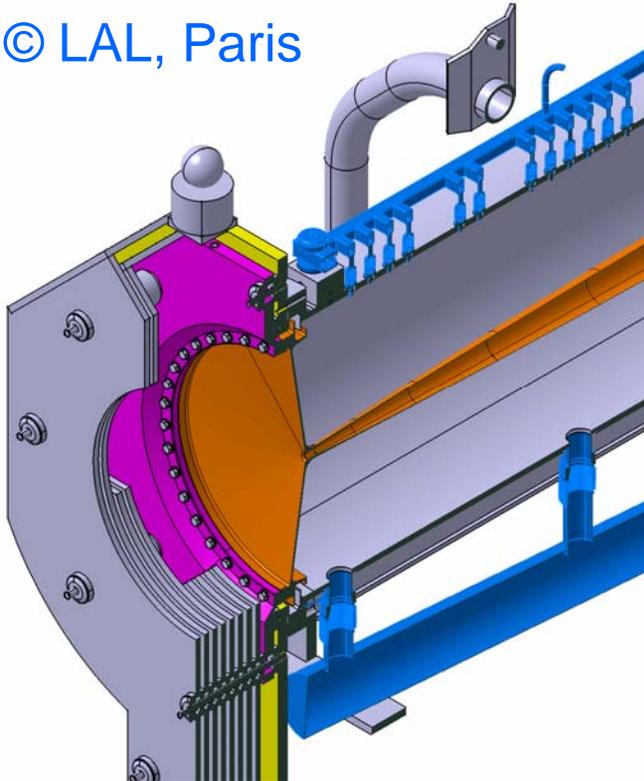


- Weight ~1.2t (Reflector: 1.8t)
- 7 meters long, inner & outer conductor
- Upper frame (exchange) & lower frame (align)
- **Electric (manual) & water connections (automatic)**
at downstream end

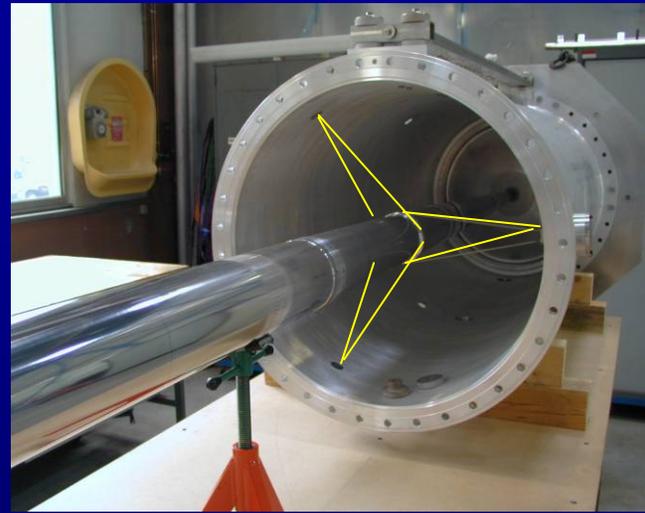
Inner conductor



© LAL, Paris



- Thickness 1.8 mm
- Aluminum grade 6082
- 9 machined sections
- Electron beam welds



Support Points (3)

3x3 grooves in inner conductor



SSteel cables



Insulator



Outer conductor

Heat load horn:

15 kW (Joule)

+ 6 kW (beam)

Cooling through top
sprayers, 1.2 bar

Magnetic field:
Max. 1.5 Tesla

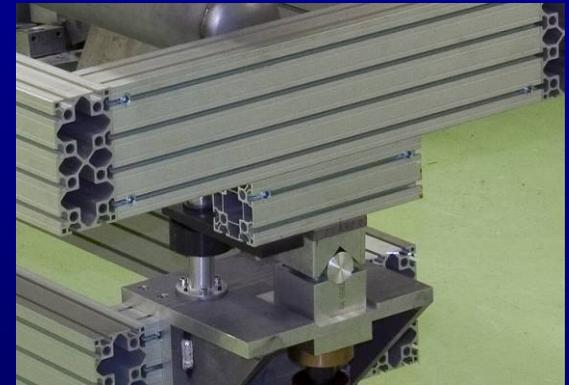
Designed for remote handling



Pre-guiding elements, cameras, remotely steered crane, cameras, plug-in water connection...



Pre-guiding upper frame vs. lower frame

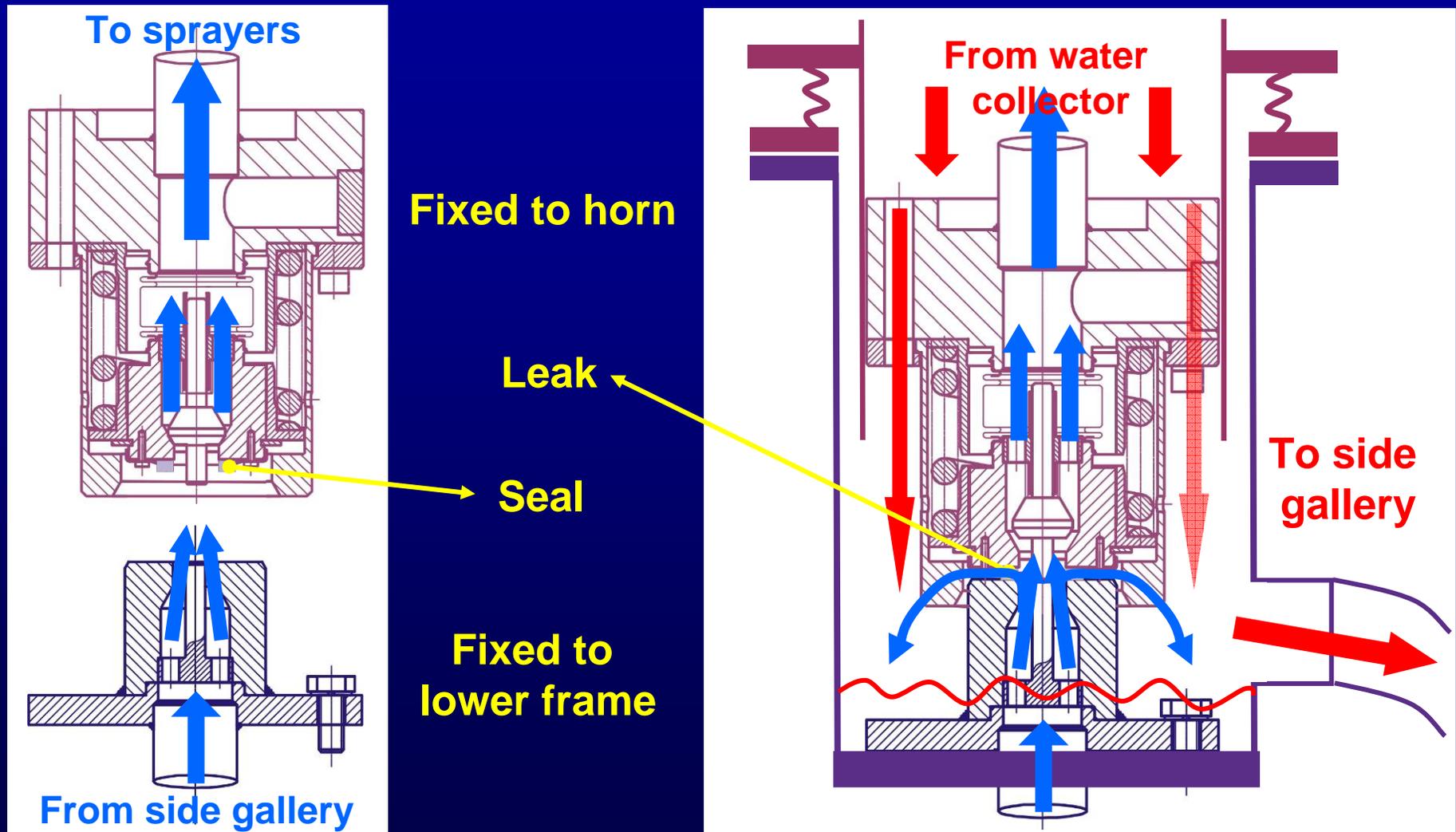


28/08/2006



Crane with coordinates

Plug-in Water Connection



28/08/2006

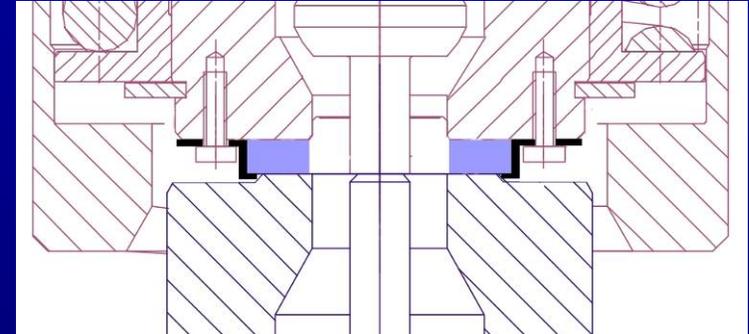
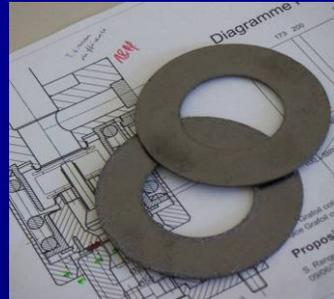
Ans PARDONS

Grafoil seals



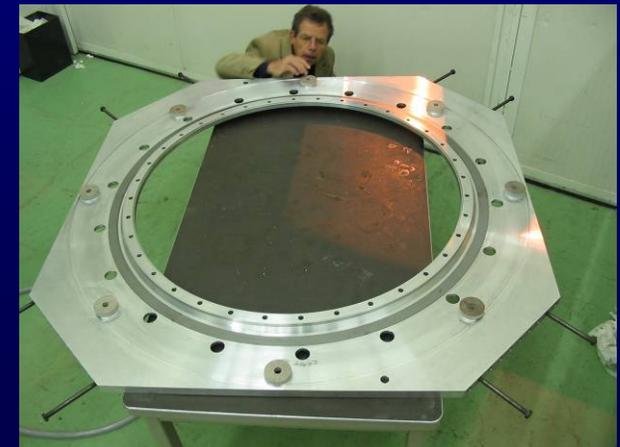
Grafoil seal

- 98% pure graphite
 - Resists high radiation
- Needs only ~5MPa contact pressure

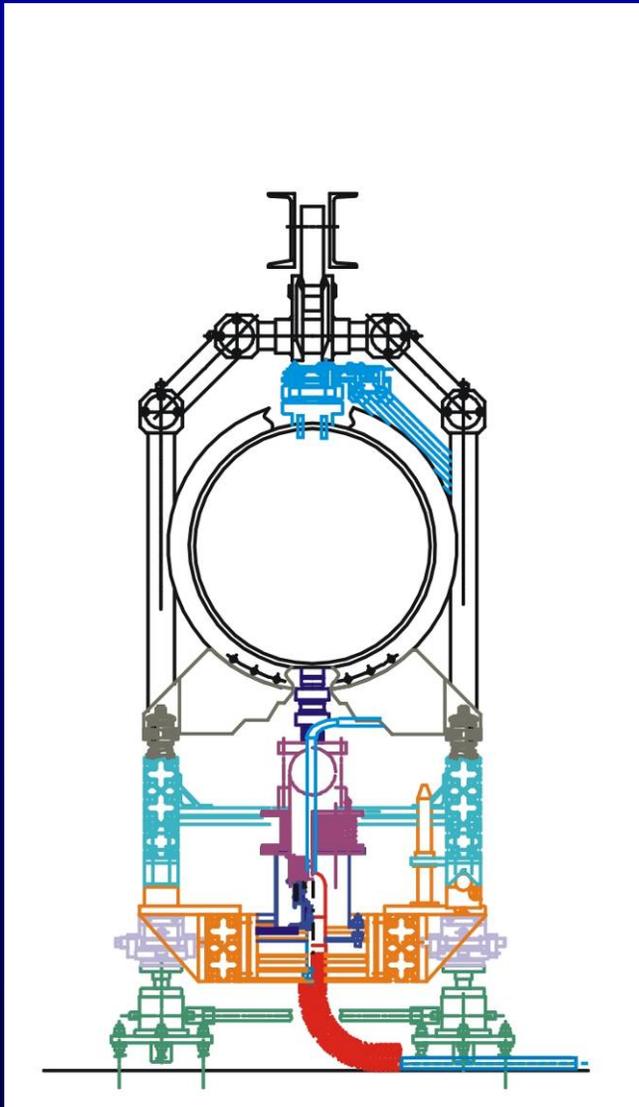


Other applications:

- Two way-valve with spherical graphite seal (switching between water feed circuits)
- Seal between insulating glass disk and plates of electrical connection



Decoupled Frames



Seal contact force (from spring) = 2000N

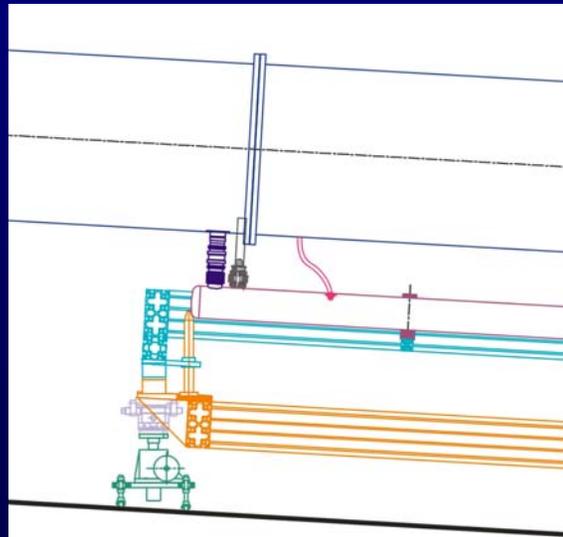
To absorb force

→ Need for rigid lower frame

→ Fix collector tube to rigid upper frame

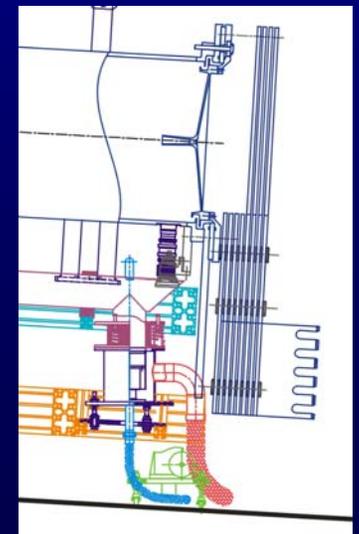


**In case
of horn
exchange**

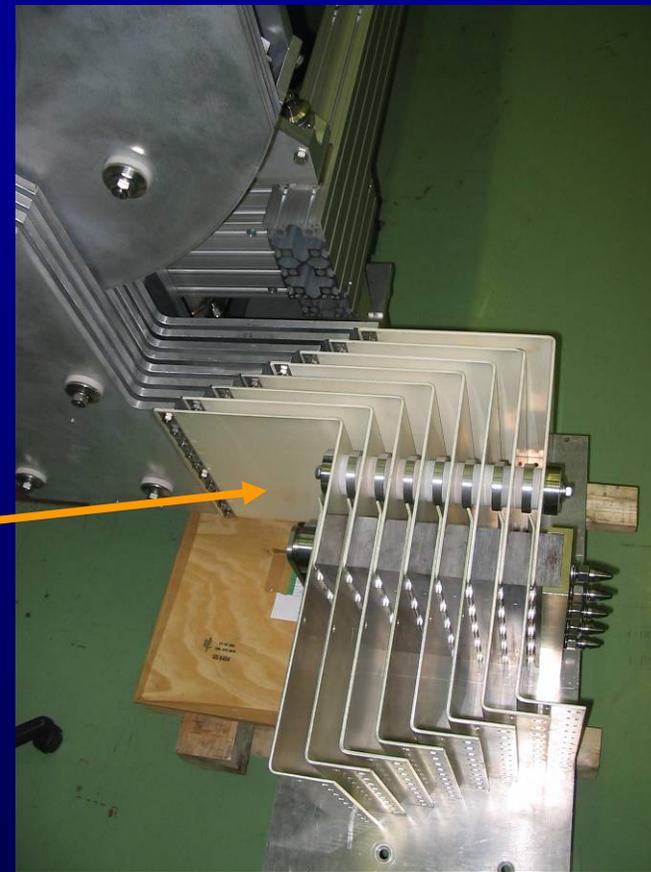
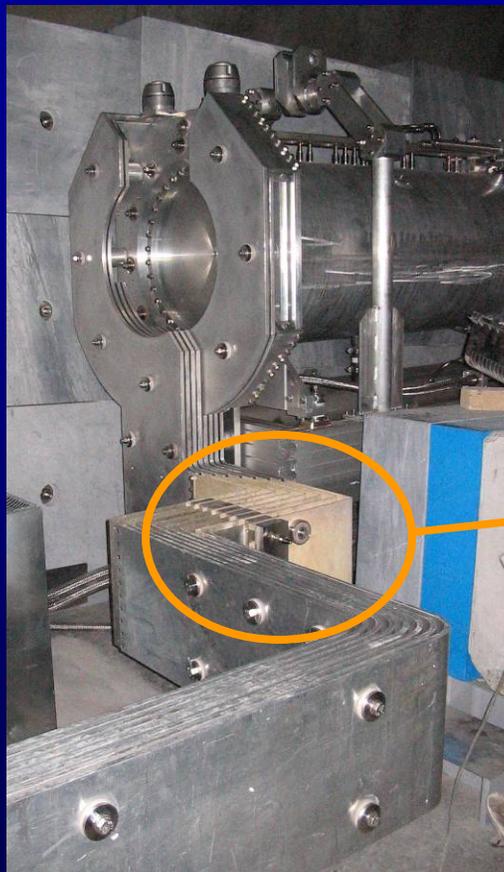


Goes away
with horn

Stays in
place



Installation



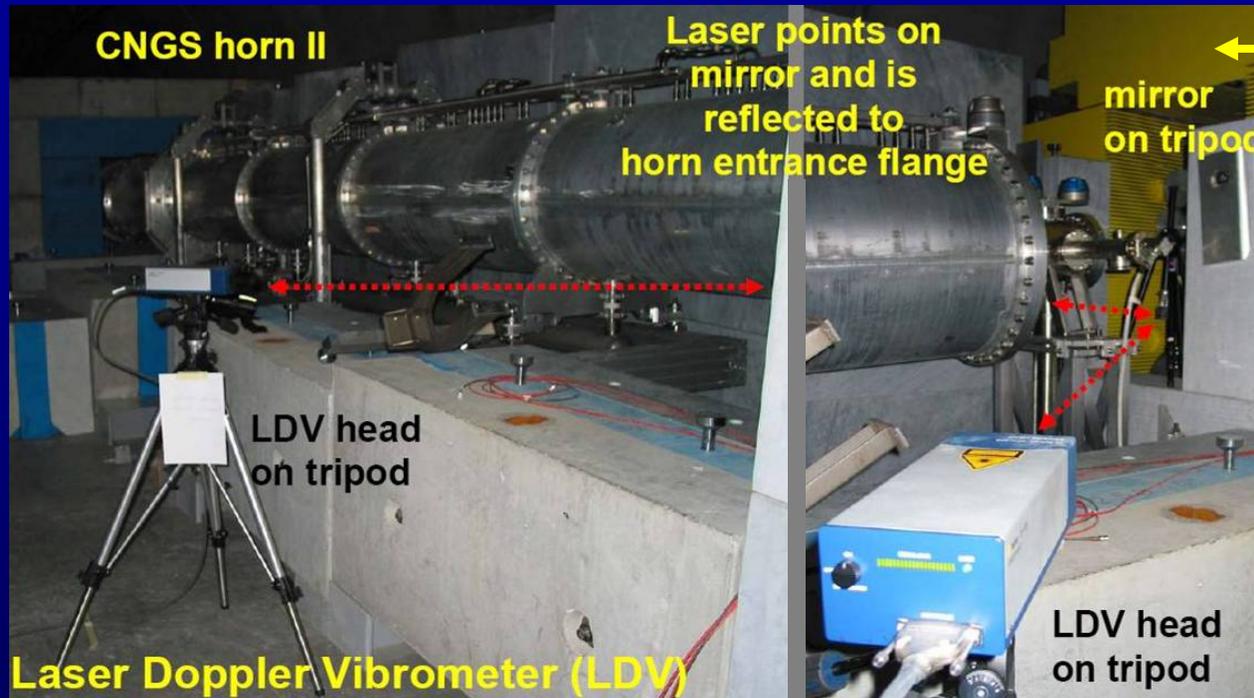
**Fast Coupling Connection
(horn exchange)**

28/08/2006

Ans PARDONS

Timing: Vibration tests

(courtesy of R. Wilfinger CERN/TU Vienna)



In target chamber (new horn)
In test stand (old horn & new horn)



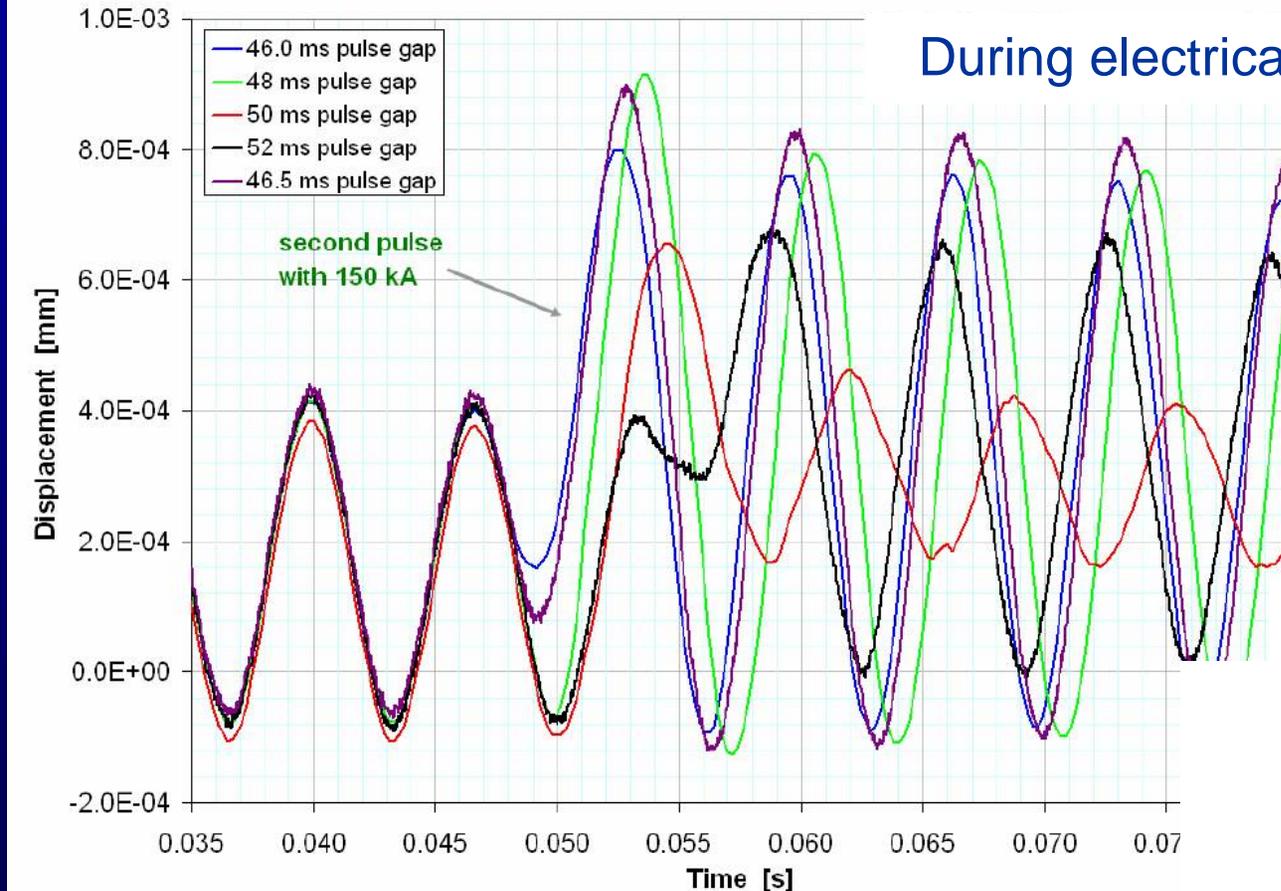
→ Natural frequency horn: 149Hz (reflector: 73Hz)

→ Data collected for future study of effect of

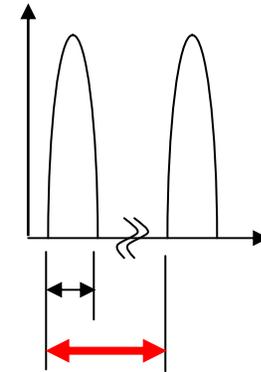
- Cooling water temperature
- Glass disk assembly

Vibration tests

(courtesy of R. Wilfinger CERN/TU Vienna)



Electrical
Pulse Timing



Vary from
46ms to 52ms,
Measure response

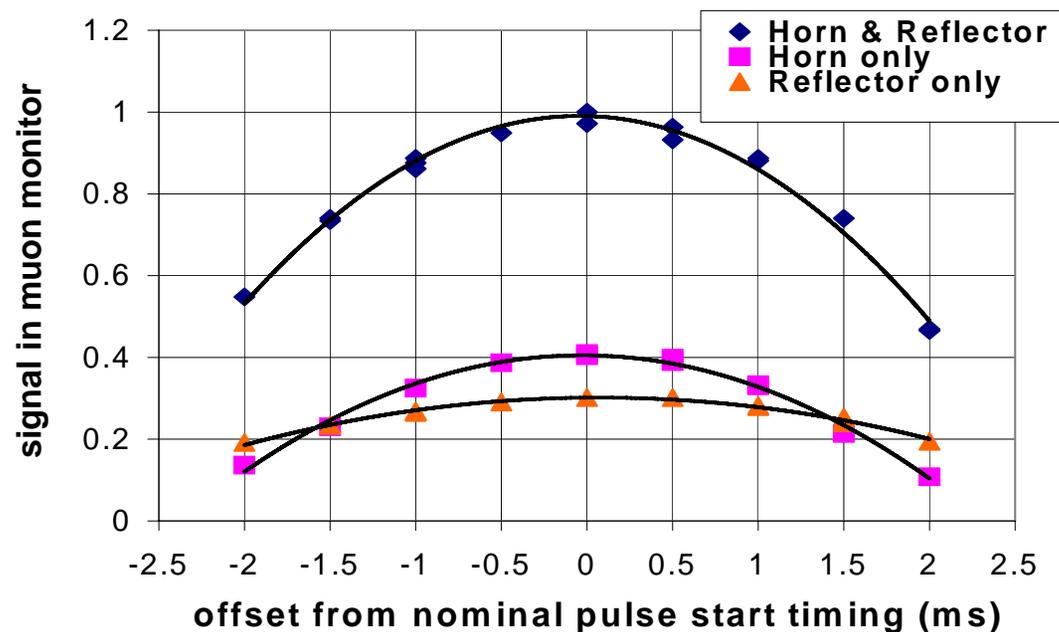
→ Optimum of 50ms gap for horn
(less fragile reflector: optimum @48ms, +20% @50ms)

Timing: pulse start

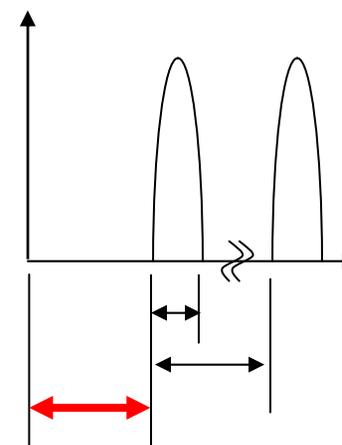


During commissioning:

timing tests horn/reflector pulse start



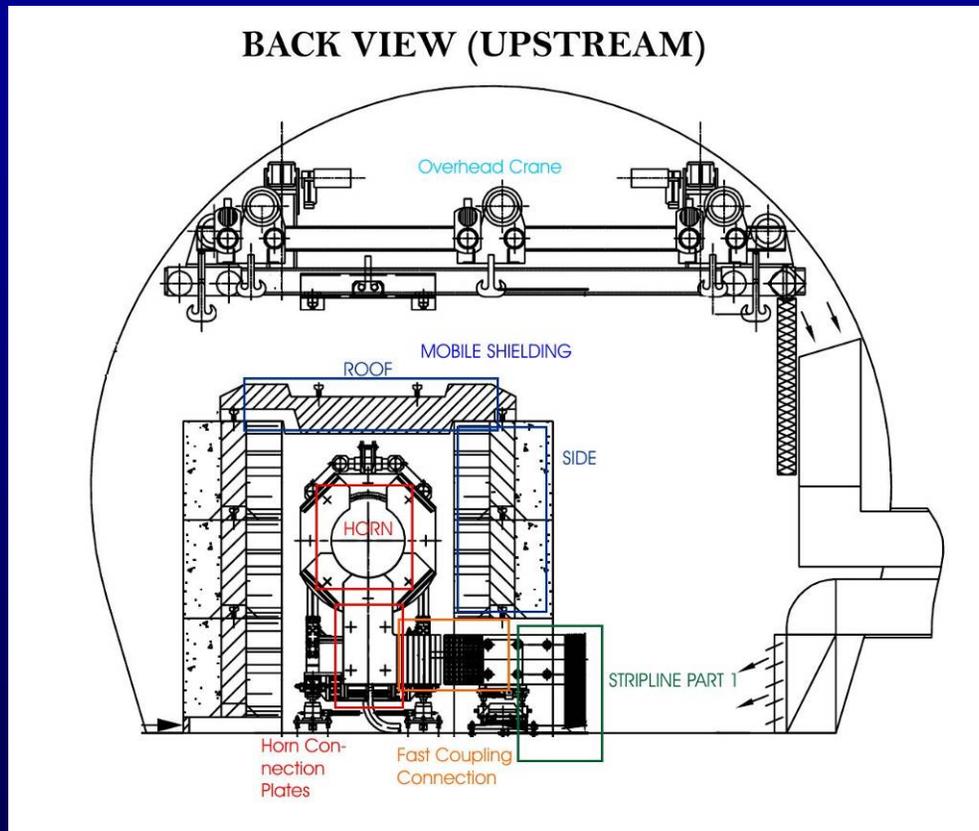
Electrical Pulse Timing



Vary from -2ms to 2ms
w.r.t. nominal,
Measure muons

Conclusion of successful commissioning (400000 pulses):
CNGS Horn design validated
(glass disk, water circuit, inner conductor,...)

Horn exchange



Fatigue → Life time of horn
(95% confidence):
20 million pulses = 5 years

Highly radioactive zone:
→ Maximize remote & automatic
→ Minimize dose

- Define detailed procedure
(interaction with RP^(*) experts)
- Do complete exercise
(realistic conditions)
- Documentation (photo, film)
is extremely important!

Define procedure



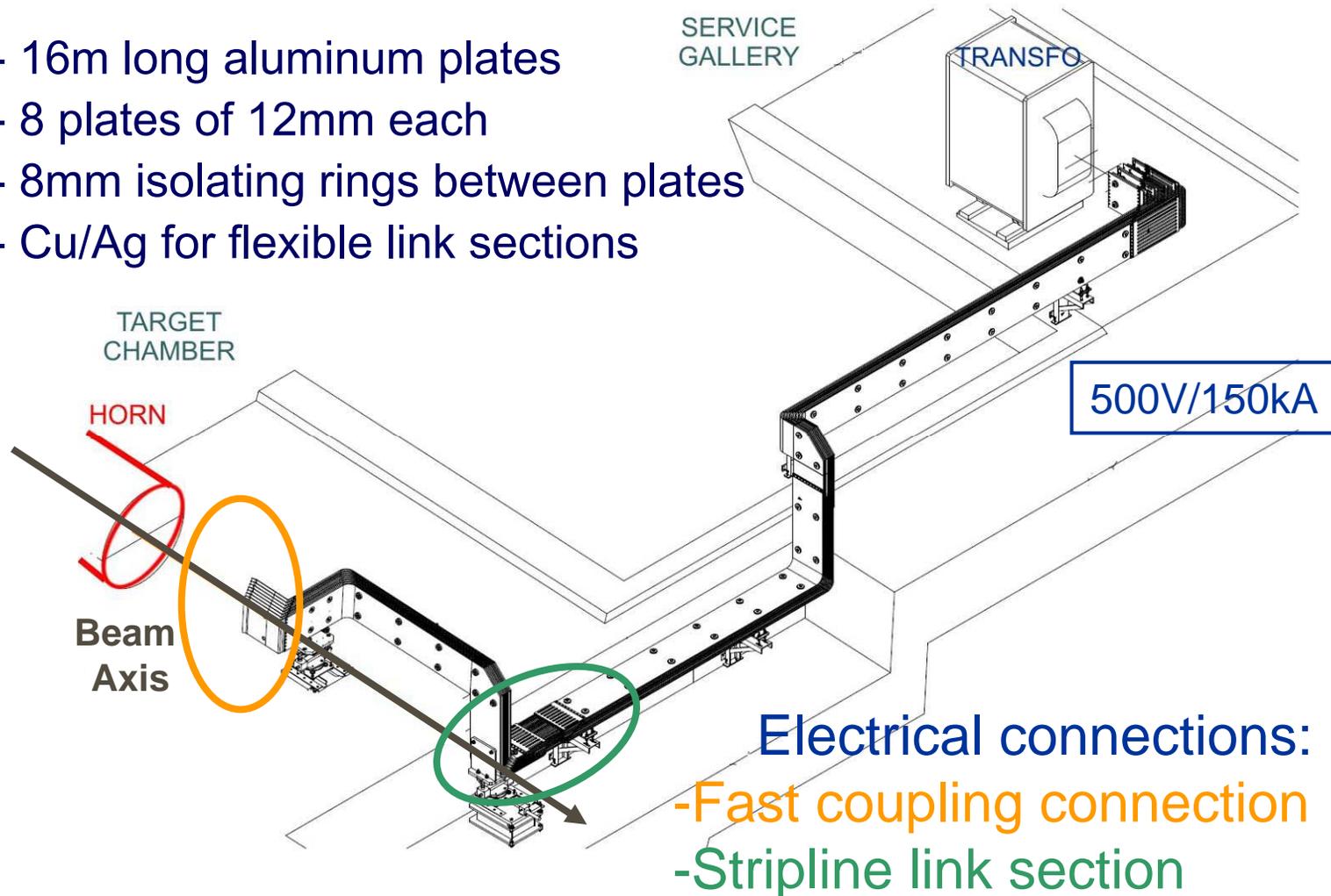
- Design phase: Optimization with respect to dose
- Experience → First draft of procedure
- Input to HAZOP study (*)
 - main remaining risks identified
- New version written with input from study & experts (radioprotection, handling, transport, ...)
- Tools designed, produced & tested
- Steps were tested & timed → optimisation
- 100% remote handling (shielding):
 - Tested → coordinates noted down in worksheets

→ Updated procedure = script for exercise

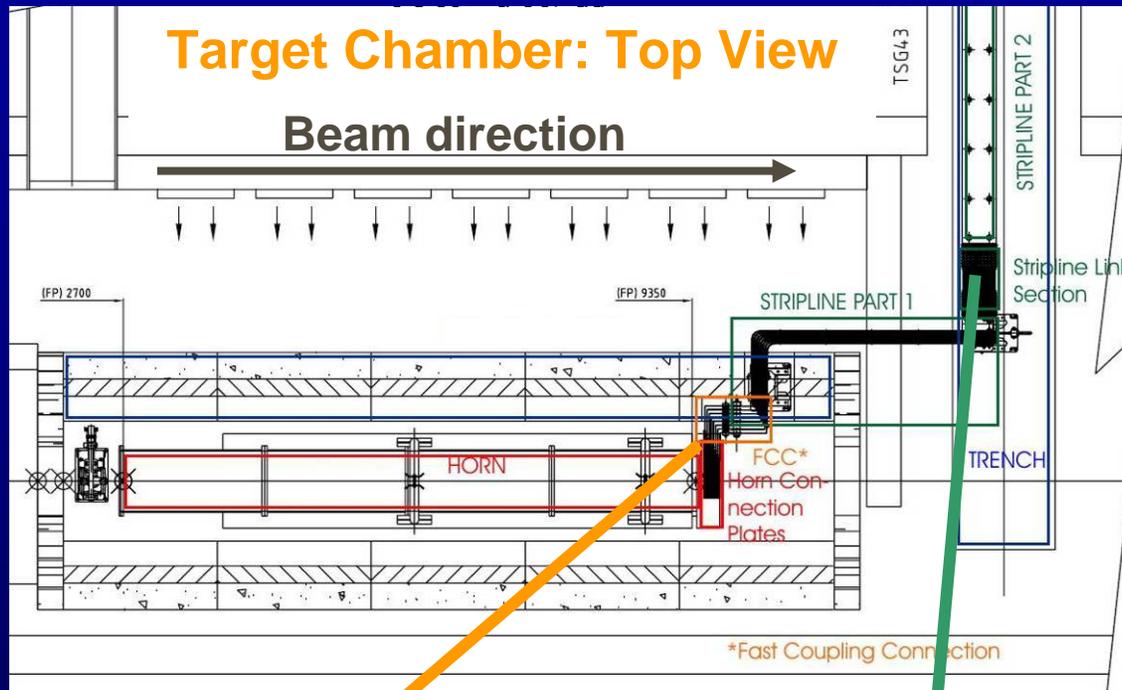
Striplines



- 16m long aluminum plates
- 8 plates of 12mm each
- 8mm isolating rings between plates
- Cu/Ag for flexible link sections



Horn exchange procedure

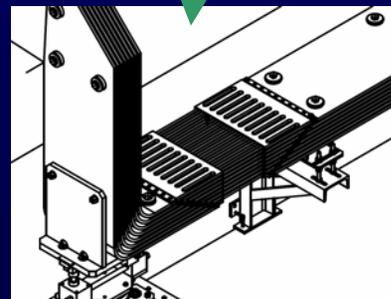


- Disconnect Fast Coupling
- Take out Stripline Link
- Move stripline (open) → horn disconnected
- Open shielding (roof & side wall)
- Exchange horn remotely
- Close shielding
- Move stripline (close) → horn reconnected
- Put Stripline Link back
- Connect Fast Coupling

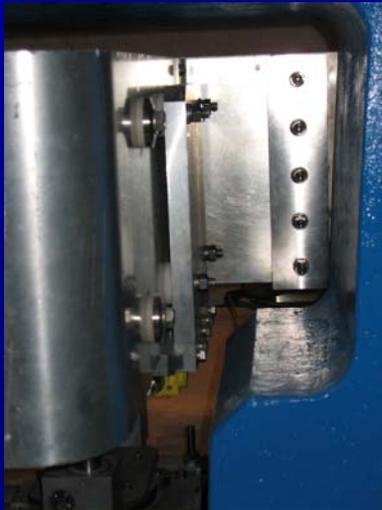


Fast Coupling Connection

Stripline Link Section



Disconnect Fast Coupling



Fast Coupling

Stripline Link
(rigid plates)

(with shielding in place)



before

after



Move stripline down
(open)



→ Fast Coupling is disconnected

Ans PARDONS

Open shielding



before

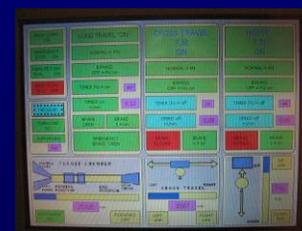


after

100% Remote



« mushrooms »
as guide



Overhead crane
with coordinates



Cameras

28/08/2006

Ans PARDONS

Remove old horn & Install new



100% Remote (radioactive)



50% Remote (clean)



from: target chamber
to : radioactive storage



28/08/2006

Ans PARDONS

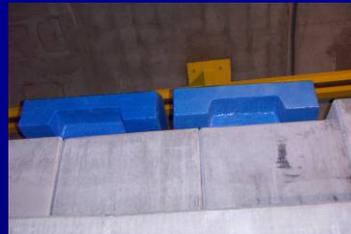
Close shielding



before



100% Remote



Storage blocks



after



Crane coordinates recorded during exercise



Connect Fast Coupling



Move stripline up



Fix 5 bolts,
install
8 plates

→ Fast Coupling is closed

Horn exchange exercise



Final test = complete exchange

- Realistic conditions:
 - Suits, gloves, masks
 - Lighting, location
- Locations photographed (storage, intervention)
- Every step filmed (except if 100% remote)
- Every step timed and observed by RP experts
- With last inputs → final documents



Detailed procedure **Worksheets (crane/human)** **Tools description** **Film Photos** **Mock-up for training**

Conclusion of successful horn exchange:
CNGS Horn exchange procedure validated
Through documentation, tools, mock-up → knowledge remains