

CNGS Horns & Handling



• Horns

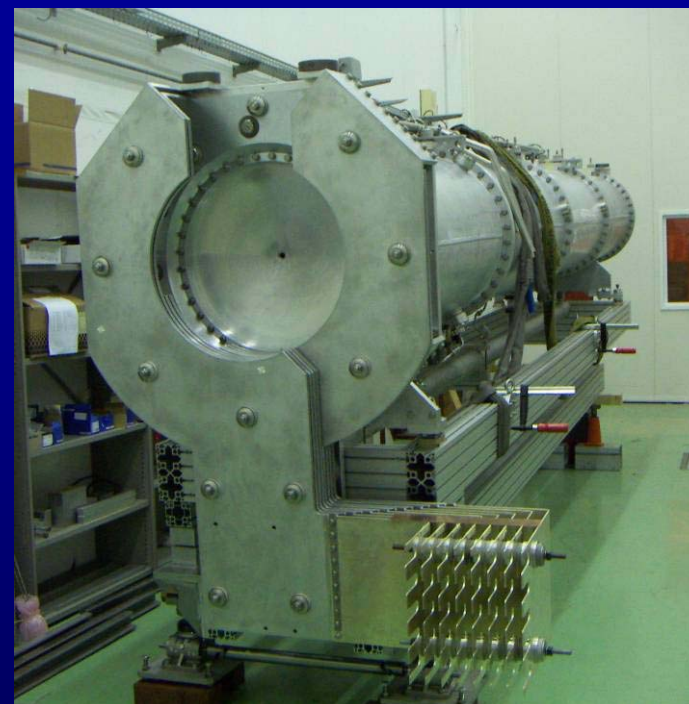
- Design
- « Remote »
- Horn Lifetime

• Hot handling

- Procedure
- Exchange Exercise
(incl. crane, trailer, resources)
- Radiation Dose

• What we've learnt...

CNGS Horn Assembly



- Length 7 meters, Weight 1500kg
- 2 cradles for handling (centre of gravity)
- Electric (manual) & water connections (automatic)
at downstream end

Designed for remote handling



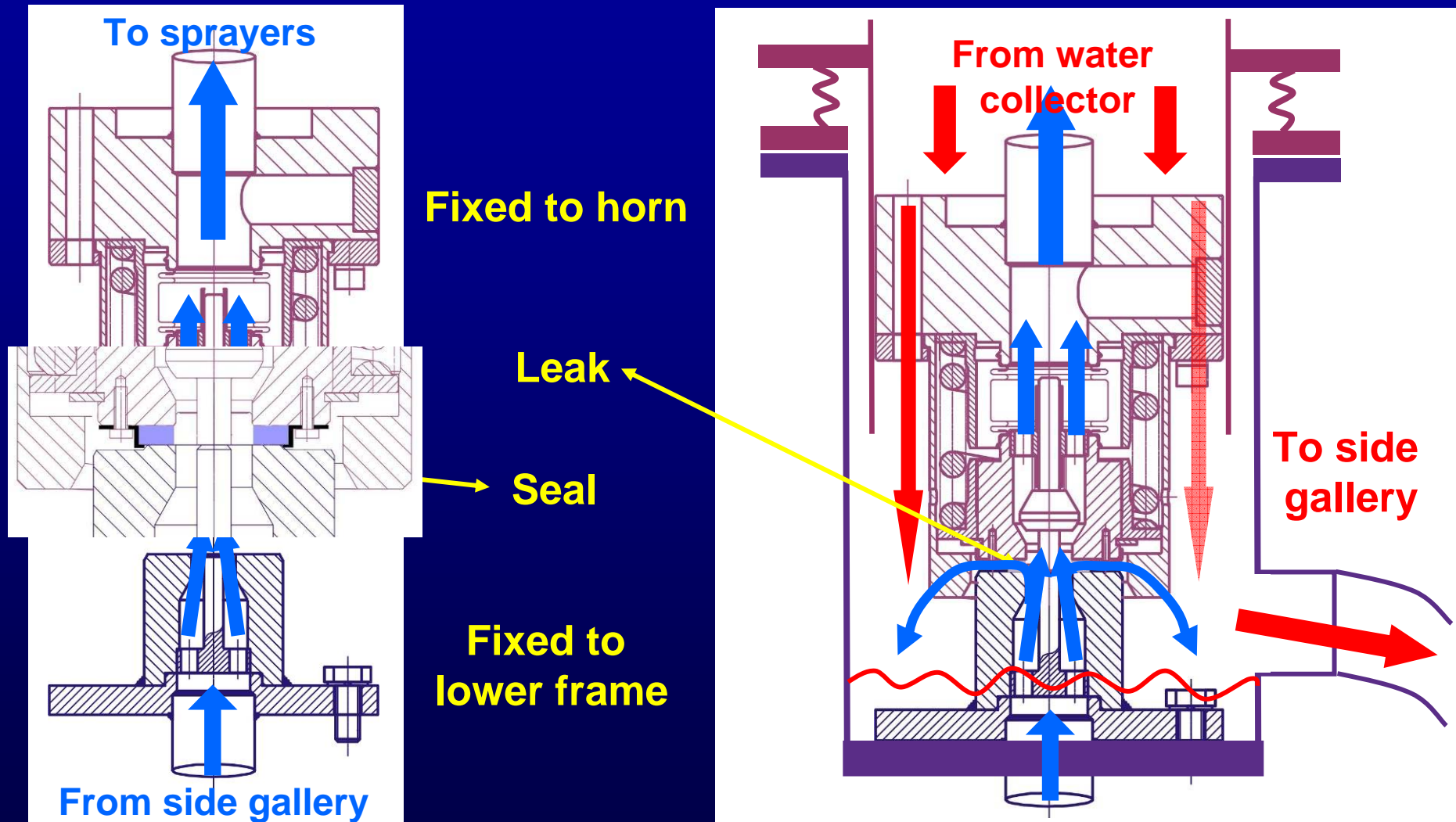
Pre-guiding elements, cameras, remotely steered crane, cameras, plug-in water connection...



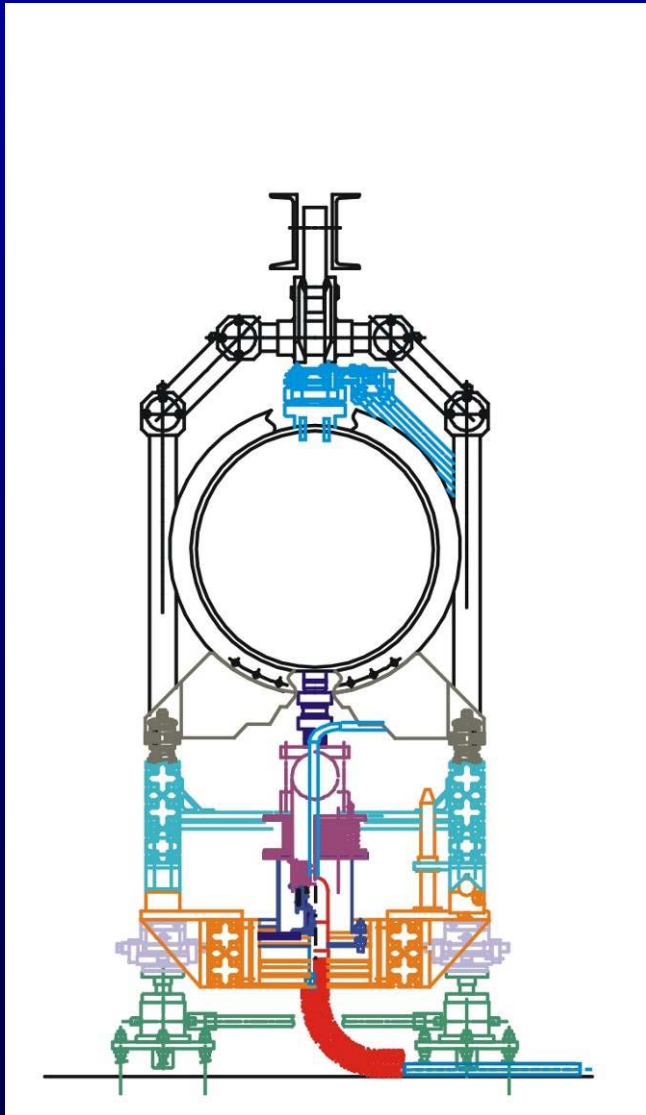
Pre-guiding upper frame vs. lower frame



Plug-in Water Connection



Decoupled Frames



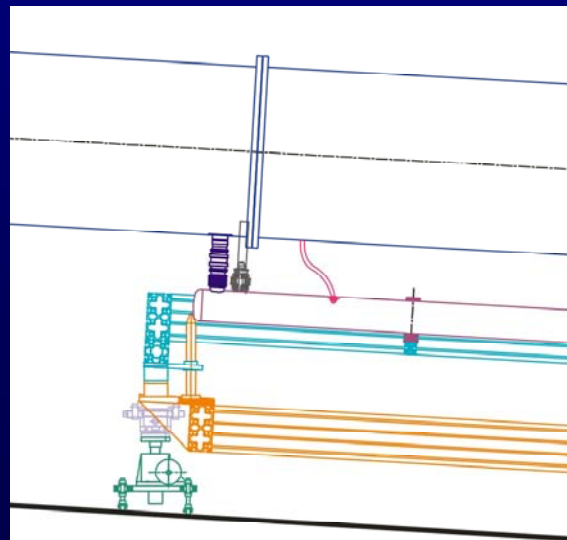
Seal contact force (from spring) = 2000N

To absorb force

- Need for rigid lower frame
- Fix collector tube to rigid upper frame

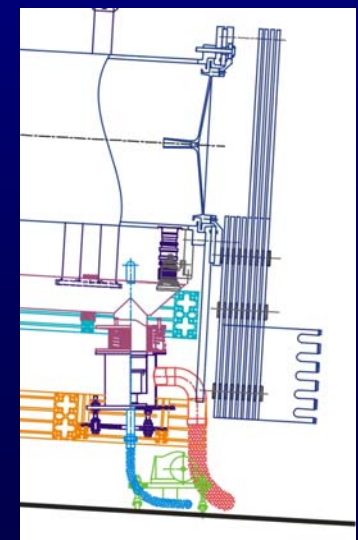


**In case
of horn
exchange**

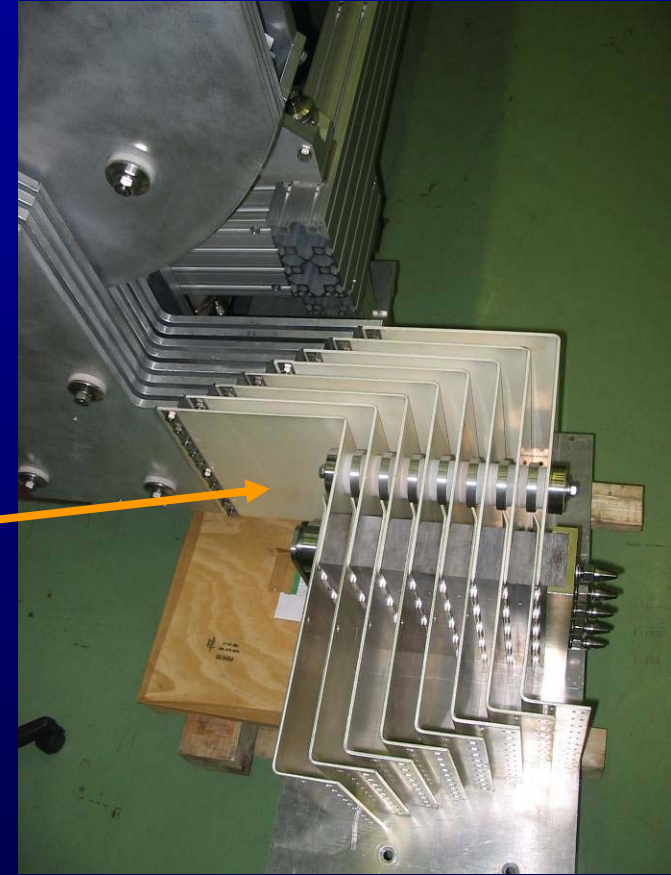


Goes away
with horn

Stays in
place



Electric connection



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Horn lifetime



Fatigue: Life time of CNGS horn (98% confidence):
20 million pulses = 5 years

Words of the wise (*):

If a horn is designed to survive fatigue,
corrosion will probably be what kills it.

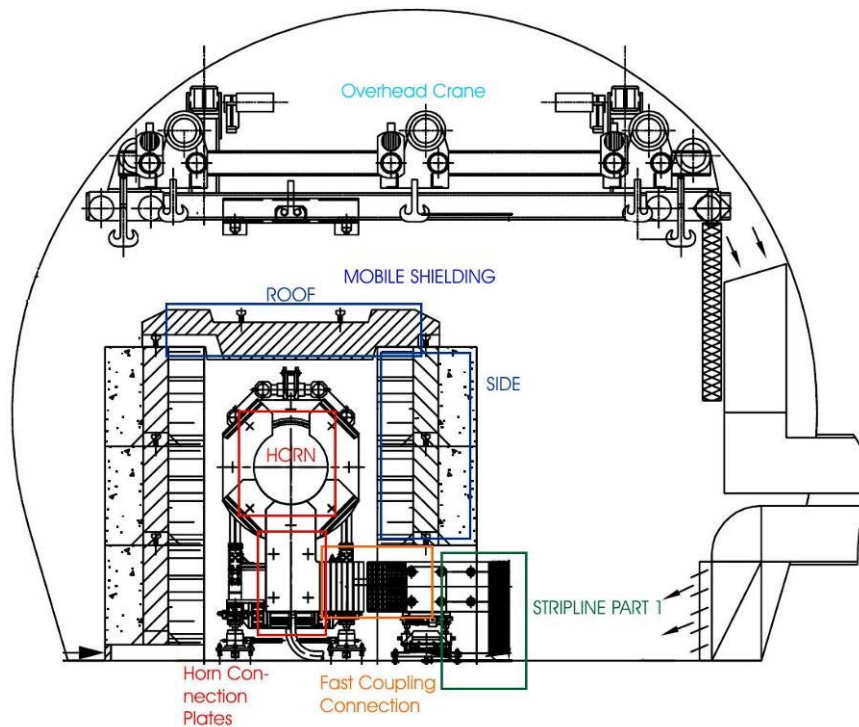


(*) Larry Bartoszek,
CERN, 2005

Horn exchange



BACK VIEW (UPSTREAM)

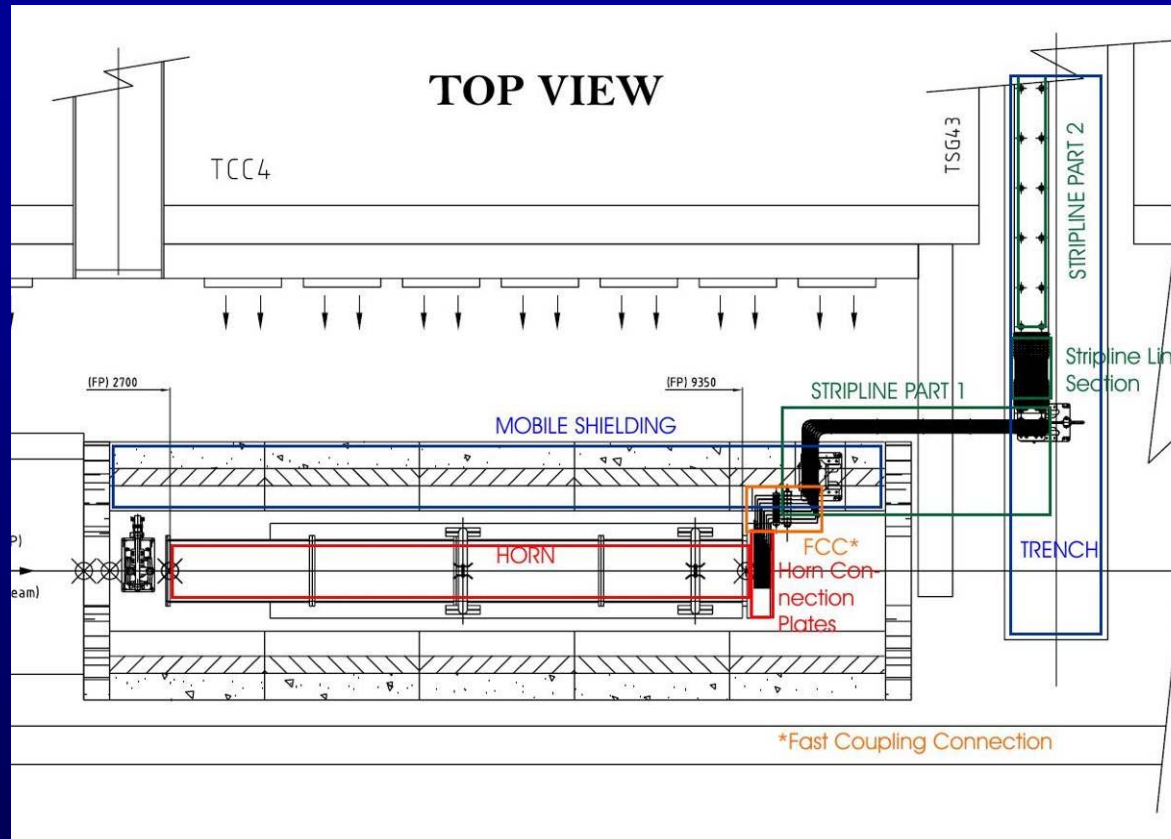


Highly radioactive zone:

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

(in 1 – 2 – 5 years... or 3 months?)

Horn exchange procedure



- Disconnect Fast Coupling
- Take out Stripline Link
- Move stripline part 1 (open)
- Remove shielding (roof & passage side wall)
- Exchange horn (*)
- Build up shielding
- Move stripline part 1 (close)
- Put Stripline Link back
- Connect Fast Coupling

(*) Take old horn from lower frame out and store.
Bring down new horn and install on lower frame.

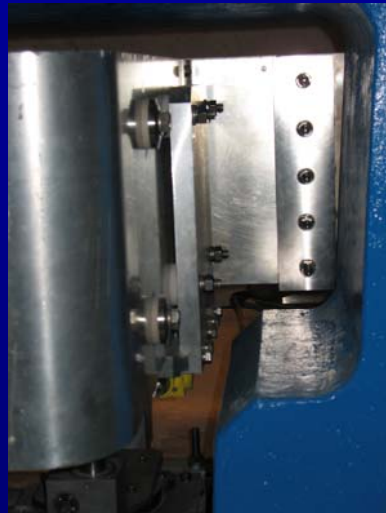
The road travelled



- 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

Disconnect Fast Coupling



Fast Coupling

Stripline Link

(with shielding in place)



before

after



Move stripline down
(open)



→ Fast Coupling is disconnected

Remove shielding



before



after

100% remote

Overhead crane with coordinates (2mm precision)



Cameras

Démontage du blindage toit de la corne / Horn roof shielding removal					
Point	Détail des manoeuvres	X	Y	Z	Index
		Longitudinal	Transversal	Levage	Mural
Tous les blocs de blindage toit sont à prendre avec le palonnier "800mm". Le palonnier est accroché perpendiculaire à l'axe faisceau, avec les ouvertures de préguidages vers coté passage (TSG4)					
Actions pour accrochage du palonnier: voir "Horn exchange procedure". step xx, page xx					
T10	Bloc fonte Transfer toit corne -> depot				
12	0 Début: amont TCC4 "couloir" (garage, centre couloir, plafond)	2775	1200	0	
13	0 Transfert latéral (y) au point y_bloc_T10+150	2775	2880	0	
14	1 Transfert longitudinal (x) jusqu'au bloc (x_toit)	32900	2880	0	
15	2 Descente (z) jusqu'à la hauteur du bloc (position d'approche)	32900	2880	504	
16	3 Transfert latéral (y) pour insertion champignon vers passage (point TOIT T10)	32900	2740	504	33.5
17	4 Levage (z) du bloc jusqu'au "plafond"	32900	2740	0	
18	5 Transfert latéral (y) vers "couloir toit"	32900	520	0	
19	6 Transfert longitudinal (x) jusqu'au point de dépose (x_depot)	44824	520	0	
20	7 Transfert latéral (y) vers axe faisceau	44824	2740	0	
21	8 Dépose (z) sur toit tank hélium (point DEPOT T10)	44824	2740	70	45.4
22	9 Transfert latéral (y) pour dégagement champignon vers mur	44824	2880	70	
23	10 Levage (z) jusqu'au "plafond"	44824	2880	0	
24	11 Transfert latéral (y) au point y_toit_T9+150 (si besoin)	44824	2880	0	
T9	Bloc fonte Transfer toit corne -> depot				
27	1 Transfert longitudinal (x) jusqu'au bloc (x_toit)	31995	2880	0	
28	2 Descente (z) jusqu'à la hauteur du bloc (position d'approche)	31995	2880	555	
29	3 Transfert latéral (y) pour insertion champignon vers passage (point TOIT T9)	31995	2740	555	32.6
30	4 Levage (z) du bloc jusqu'au "plafond"	31995	2740	0	
31	5 Transfert latéral (y) vers "couloir toit"	31995	520	0	

NB: 2000 Ans PARDONS

- Crane handling -

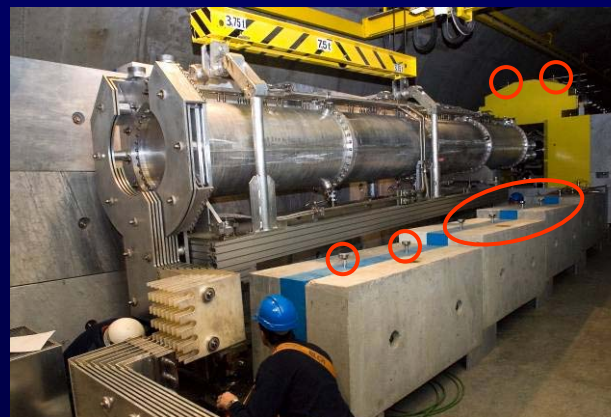
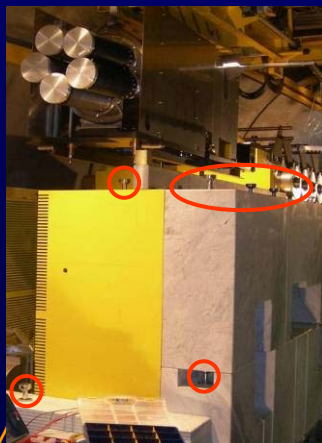
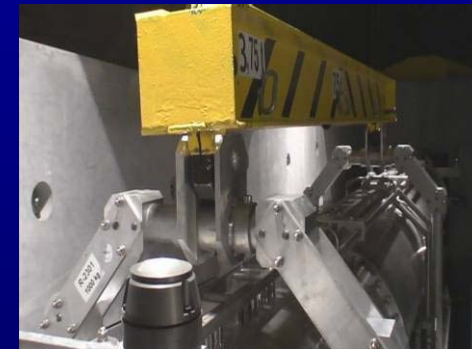


guiding for shielding blocks



« mushrooms »

guiding for crane hook



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20sec



- Crane handling -



Remove old horn



100 Remote



Horn vs. lower frame

from: target chamber
to : radioactive storage



- Trailer -



Mech. stop in TCC4



Optically guided vehicle



from: target chamber
to : radioactive storage



Remote disconnect



Install new horn



50% Remote



New, « clean » horn



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Install new horn



Build up shielding



before



100% Remote



Storage blocks



after



Coordinates recorded during exercise

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Connect Fast Coupling



Move stripline up



Fix 5 bolts,
install
8 plates

→ Fast Coupling is closed

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Connect Fast Coupling



Horn exchange exercise



Final test = complete exchange

- Realistic conditions: suits, gloves, mask, 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**

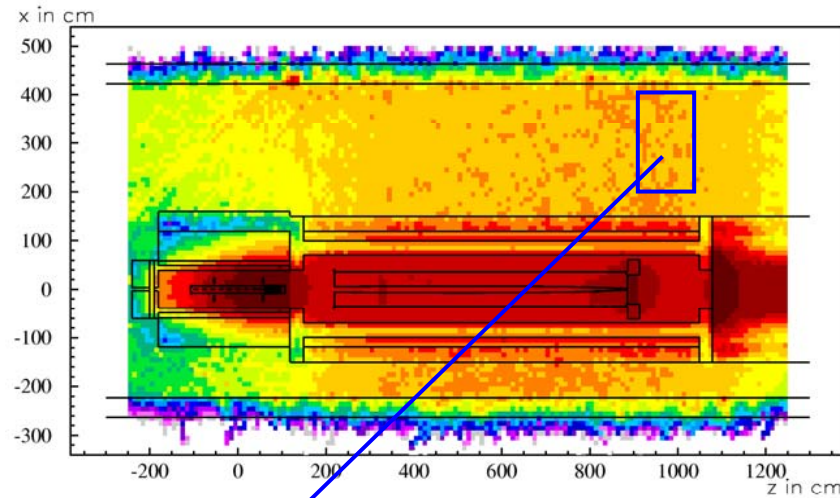
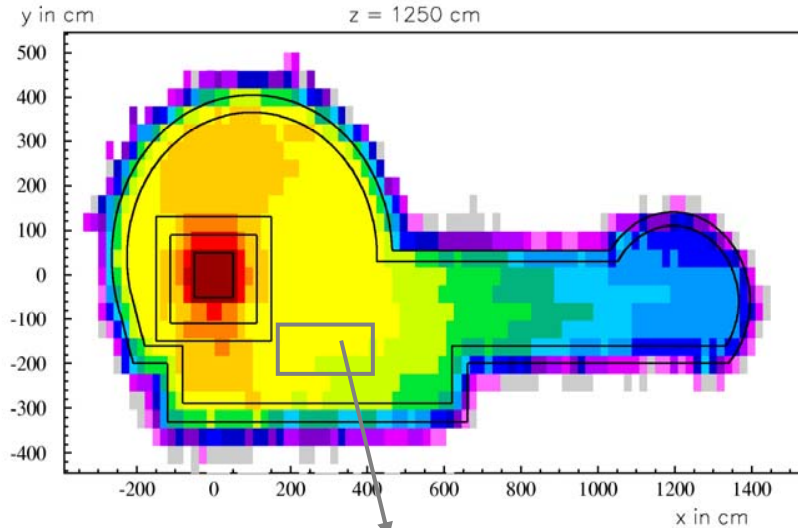
**Mock-up for
training**

Resources

- transport/handling: 2
- mechanics: 2
- technician: 1
- engineer: 1
- radioprotection technicians: 2

Radiation dose

S. Rösler, NBI 2005



Location

x (cm)
y (cm)
z (cm)

1
trench

150 .. 400
-263 .. -183
1190 .. 1310

2
aisle

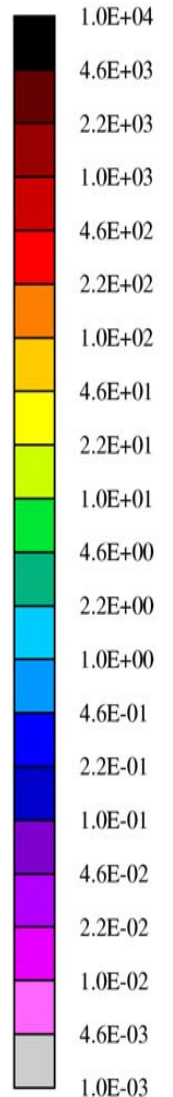
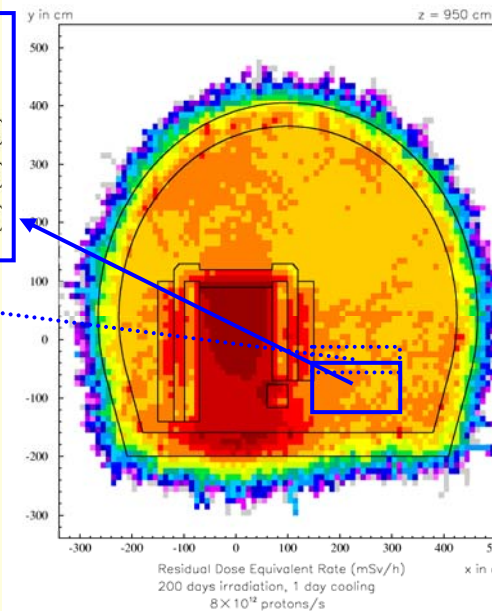
200 .. 380
-70 .. -20
880 .. 1030

3
aisle

200 .. 380
-160 .. -60
880 .. 1030

Dose Rate (uSv/h)

	1	2	3
1 day	24499	94422	96918
1 week	765	2886	3546
1 month	576	1870	2228
2 months	509	1574	1841
4 months	443	1181	1370
6 months	397	1020	1163



Radiation dose

S. Rösler, NBI 2005

Intervention step	Duration (min)	Location	Accumulated dose (uSv)					
			1d	1w	1m	2m	4m	6m
Install lights	1.	2	1573	48	31	26	19	17
Open fast coupling connection	4.	3	6461	236	148	122	91	77
Remove stripline link section in trench	14.	1	5716	178	134	118	103	92
Slide stripline downstream	3.	1	1224	38	28	25	22	19
Remove top shielding	-	remote	0	0	0	0	0	0
(Install lead protection on target side)	-	remote	0	0	0	0	0	0
(Install lead protection on collimator side)	-	remote	0	0	0	0	0	0
Remove side shielding	-	remote	0	0	0	0	0	0
Transport horn to trailer	-	remote	0	0	0	0	0	0
Transport horn to radioactive storage	-	remote	0	0	0	0	0	0
Install shielding in radioactive storage chamber	-	remote	0	0	0	0	0	0
Transport and installation of spare horn	-	remote	0	0	0	0	0	0
Install side shielding	-	remote	0	0	0	0	0	0
(Remove lead protection on target side)	-	remote	0	0	0	0	0	0
(Remove lead protection on collimator side)	-	remote	0	0	0	0	0	0
Install top shielding	-	remote	0	0	0	0	0	0
Slide stripline upstream	6.	1	2449	76	57	50	44	39
Close fast coupling connection	6.	3	9691	354	222	184	137	116
Take dimensions of new stripline link section	2.	1	816	25	19	16	14	13
Install stripline link section in trench	20.	1	8166	255	192	169	147	132
Remove lights	1.	2	1573	48	31	26	19	17
Total (uSv):			37700	1260	870	740	600	530

CERN design criterion : 2 mSv/person/intervention

From exchange
exercise: ~1mSv/2p

What we learned

(or knew already, but needed reminding of)



- Intervention people need to be on longer term contract (CERN staff)
In reality: some of the work was done by external staff, but CERN staff were actively involved in preparation & execution
- Importance of 3D vision (computer or old school) and make sure you use last version of drawings!
Example. Gruyere shielding block designed at late stage ... several drawings didn't have the latest version... rather embarrassing result
- Remote handling of shielding needs iteration & practise.
- There is an increasing interest for HAZOP, hot handling, ...
Why? safety rules become stricter, intensities go up.... more and more people realize the need of extensively documented exercises
- Seen the wide interest... should we have asked for an entrance fee?



Last advice



Start early, plan carefully and take the time you need.
Remind your superiors that Things Take Time. (*)



(*) Put up in a place
where it's easy to see
the cryptic admonishment
T.T.T.

When you feel how depressingly
slowly you climb,
it's well to remember that
Things Take Time.