

Hardware: reducing loss, activation and dose

Remote handling experience and prospects

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Slow Extraction Workshop 2017

Introduction

This workshop considers several ways of reducing doses.

- One way is optimising interventions
- Remote handling is one way of optimising interventions

I'll go through what I have understood about interventions on the Septa

Then give some examples of work done in other areas on optimized design to reduce doses / allow remote handling

Then give some recommendations based on these examples

ZS exchange



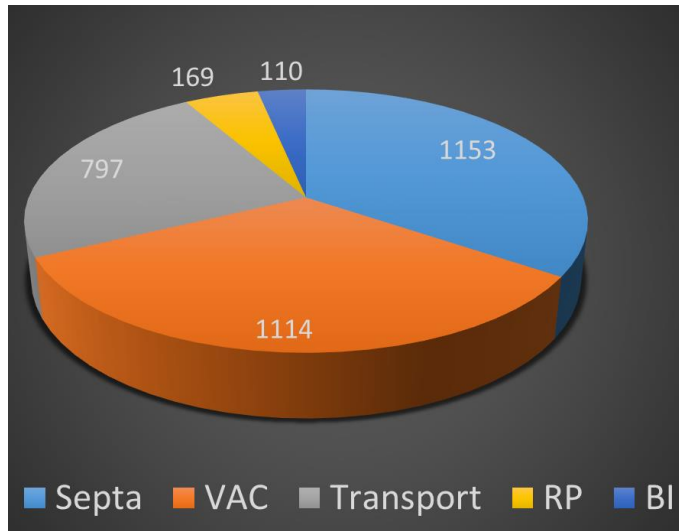
The environment: SPS LSS₂
(note: no crane)



The transport and handling
equipment (side-loader fork-lift)

ZS replacement during YETS

Collective Dose : 3343 μSv



ZS21671 Replacement

SHiP requirements will greatly increase dose rates if nothing is changed

ZS21639 ZS replacement impact 77134				Collective dose	Collective real dose
Mise à la PA secteur ZS 231. Remplacement du ZS 21639 par l'équipement de réserve préalablement préparé au 867, transport en LSS2 via le Ba3, installation en utilisant le PRAT muni de palonnier MP, rapatriement du ZS défectueux au 955, pompage /detection fuite secteur ZS/MST.				[man. μSv] 3755.4	[man. μSv] 209
1.3	Remplacement du ZS				
1.301	Ouverture bride ZS21639 upstream retrait colier	TE/VSC	17 18	198	
1.302	Flux azote upstream	TE/VSC	14	5	
1.303	Installation Ecran capton / tendeurs sur MP amont	TE-ABT	3	37	
1.304	Ouverture bride ZS21639 downstream retrait colier	TE/VSC	17 18	216	
1.305	Installation Ecran capton / tendeurs sur MP aval	TE-ABT	2	43	
1.306	Roulage du Pratt entre le TA et proximité ZS	EN/HE	9	7	
1.307	Positionnement Pratt devant ZS	EN/HE	5 8	60	
1.308	Flux azote downstream	TE/VSC	15 16	60	
1.309	Positionnement palonnier sur ZS	EN/HE	9 8	6	
1.310	Engagement palonnier sur ZS et verouillage pt levage	EN/HE	9 8	112	
1.311	Levage ZS	EN/HE	9 8	12	67
1.312	Roulage ZS sur Pratt jusqu'à TA	EN/HE	9 8	40	
1.313	Alignement Pratt devant remorque	EN/HE	9 8	160	
1.314	Transfert ZS sur remorque	EN/HE	9 8	4	
1.315	Arrimage ZS sur remorque (2 elingues)				32
1.316	deverouillage palonnier	EN/HE	10	19	44
1.317	Roulage ZS jusqu'au BA3 avec volk blindé	EN/HE	10	11	
1.318	Roulage ZS jusqu'au 955 avec volk blindé	EN/HE	10	10	
1.319	Déchargement ZS au 955	SMB-SC	27 28	50	
1.320	Fermeture ZS tapes ahu	TE-ABT	3 4	62	
1.321	Preparation des portées de joints sur MP2 et MP3 sous flux N2 (2 minute max)	TE/VSC	16 17	248	
1.322	Livraison ZS remplacement jusqu'à TA depuis BA3	EN/HE	10	34	
1.323	Alignement Pratt devant remorque	EN/HE	11 12	54	66
1.324	Accrochage palonnier	EN/HE	11 10	40	
1.325	Transfert ZS sur Pratt	EN/HE	11 12	54	
1.326	Roulage ZS avec Pratt jusqu'à position d'installation	EN/HE	11 12	40	
1.327	Alignement Pratt devant position installation	EN/HE	11 12	20	
1.328	Levage et transfert ZS	EN/HE	11 12	75	
1.329	Alignement final et pose sur pieds	EN/HE	11 10	75	
1.330	Deverouillage palonnier	EN/HE	1 8	24	
1.331	Accrochage remorque				
1.332	degagement palonnier et repli Pratt vers TA	EN/HE	11 12	75	
1.333	Retrait des caméras				
1.334	Remise en place du palonnier				

ZS optimisation of handling & transport

Figures from ZS 21671

- Approx 80% of transport dose due to exchange
- Approx 15% due to surface transport

Modified side-loader to remote controls to increase operator distance (first use 2016)

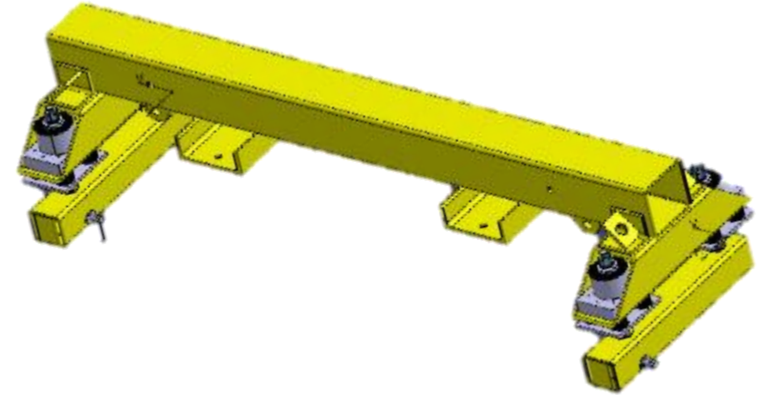
Takes longer but lower dose (1/2)

Video system needs improving



ZS handling optimisation continued

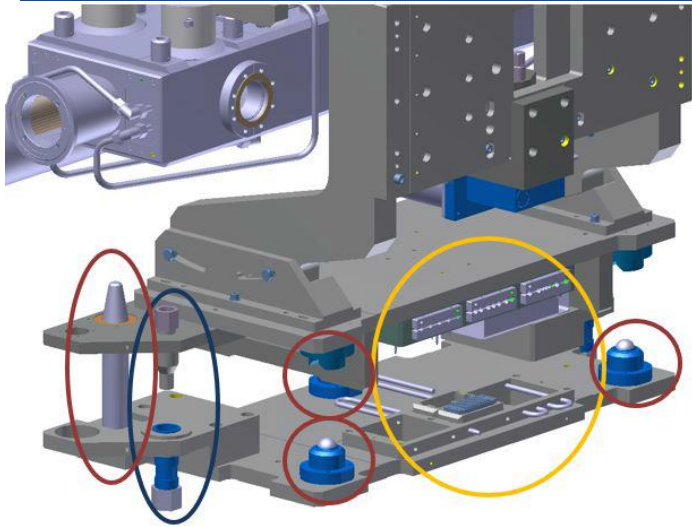
Improvement of lifting spreader interfaces underway



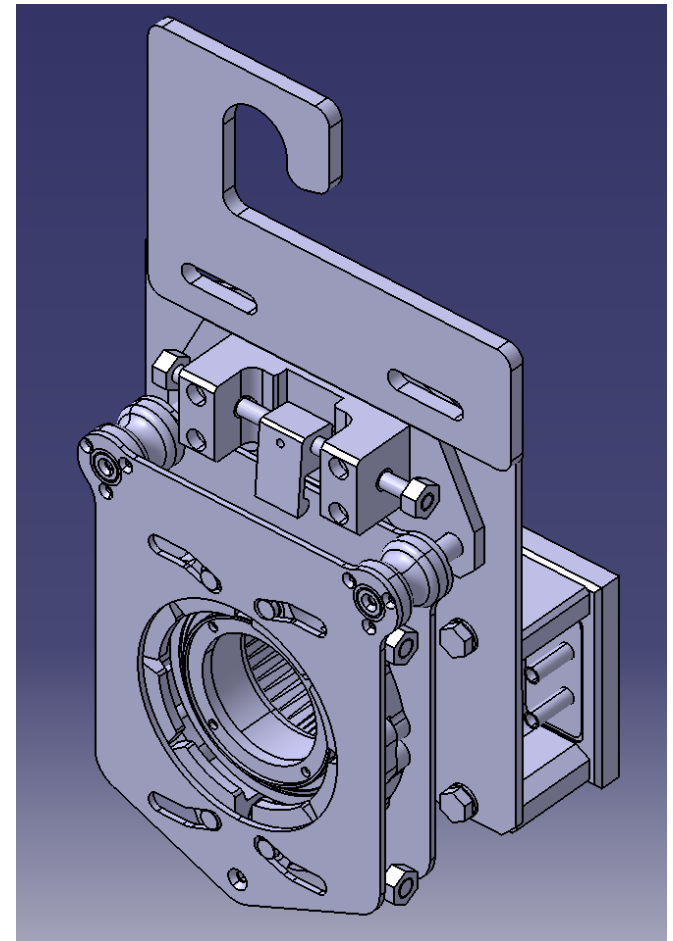
Building a mock up of the area (supports pumping modules and tunnel wall):

- Allow test & development of equipment and working procedures for all teams
- Train operators before an intervention

Example of LHC collimators

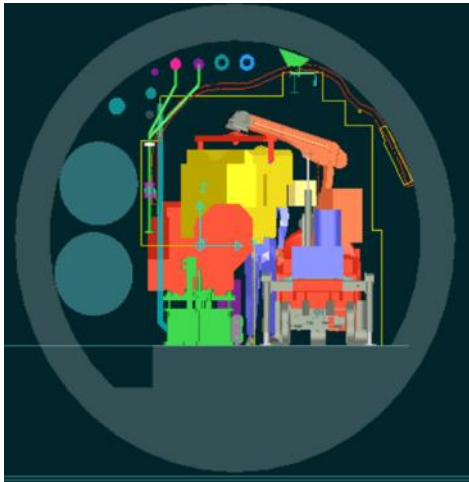


Installation guidance and connections



Remote vacuum disconnection chain clamp

LHC Collimator handling development



Initial studies



Installation – trailer/crane designed for “hands-on” use. Collimator and handling equipment designed in parallel.

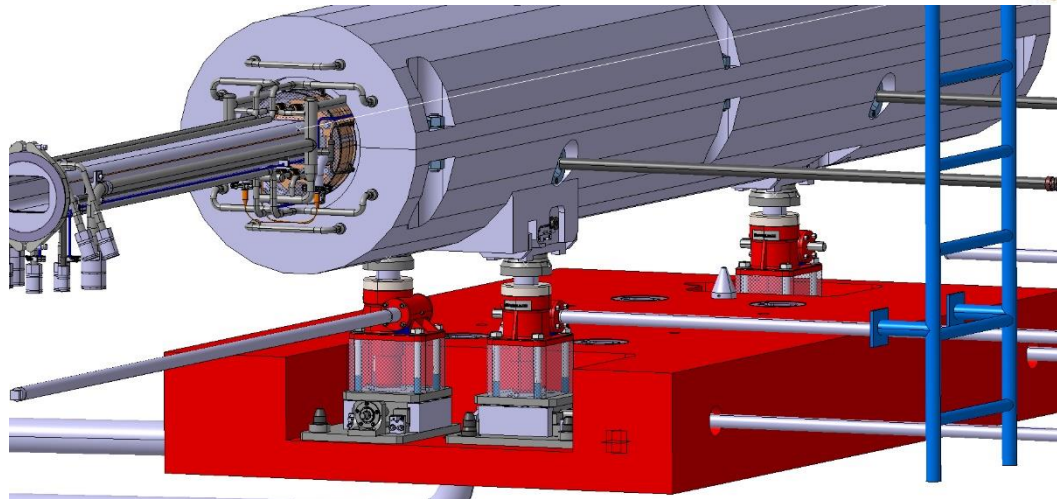
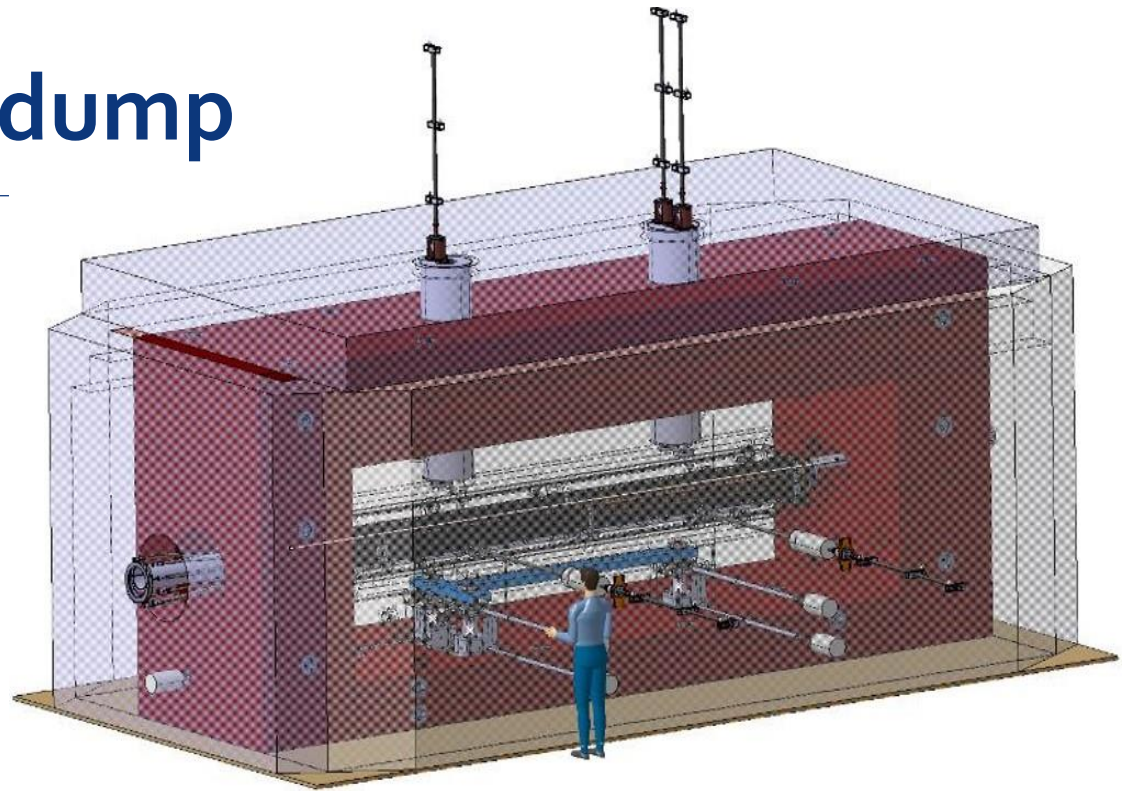


Remote controlled vehicle/crane

New SPS beam dump

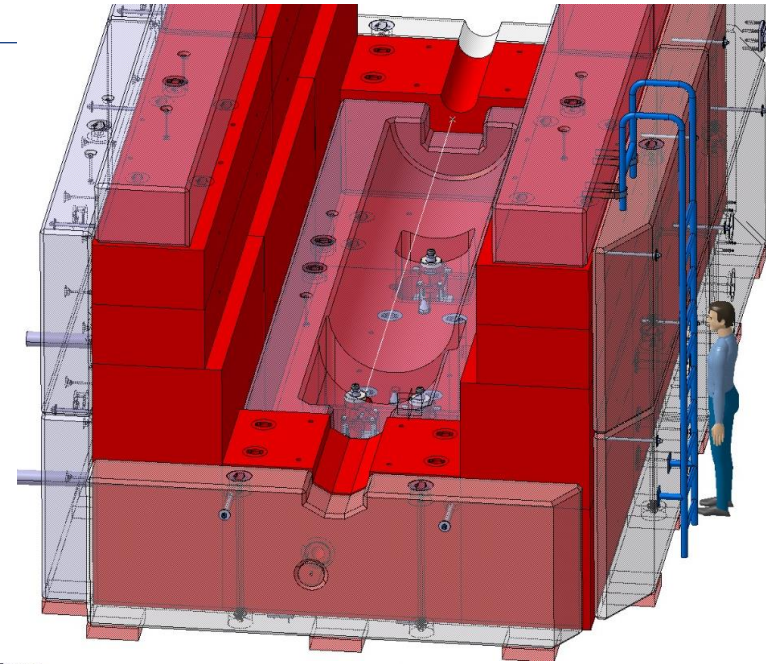
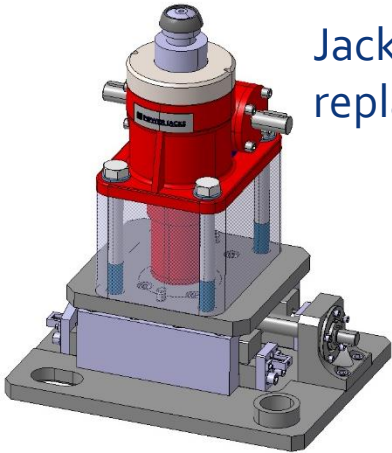
Design for:

- remote dump
- exchange with crane
- Remote alignment

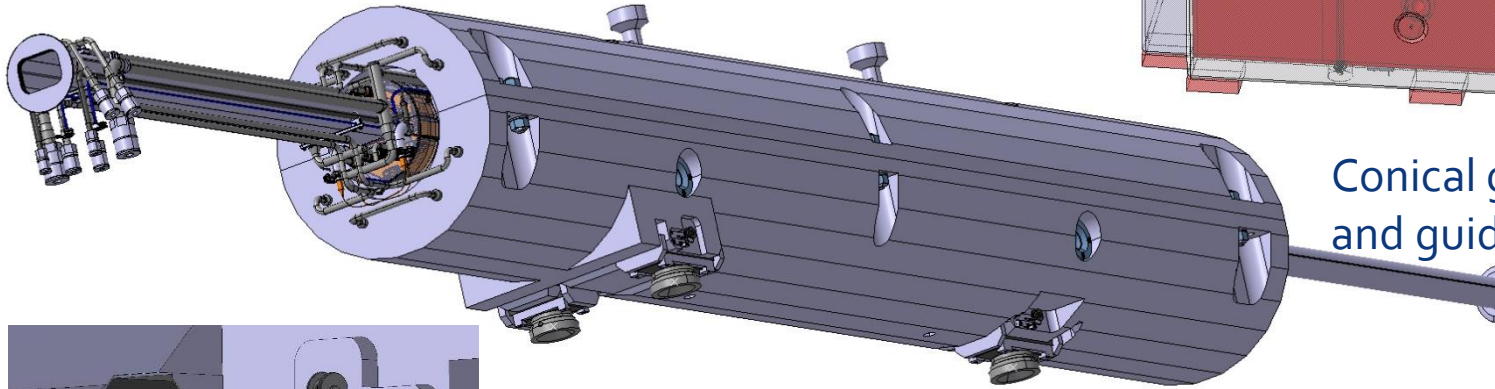


New SPS beam dump continued

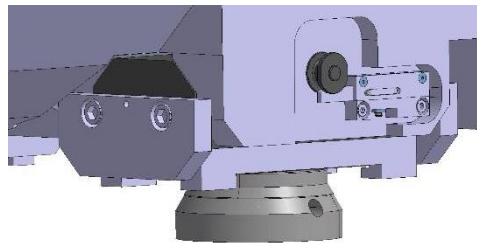
Jacks can be remotely replaced with crane



Conical guides on dump feet and guides inside shielding

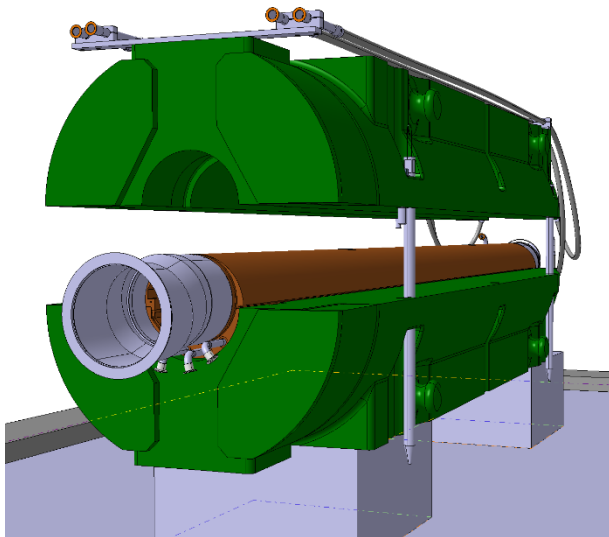


Dump feet can be remotely replaced

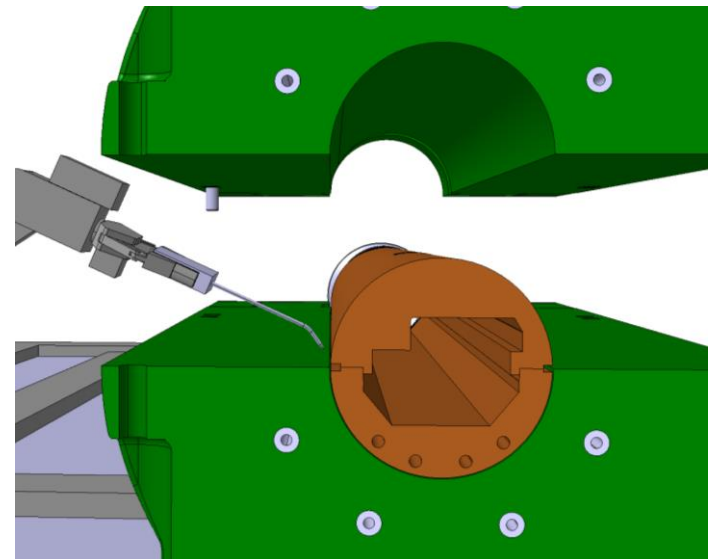


SPS failed beam dump remote inspection

- Remote handling needed as dose rates expected of several mSv/h with shielding open
- Initially considered removing core from shielding to inspect whole surface
- However, to simplify handling and reduce risks – lift upper shielding only to access top half of core and longitudinal welds



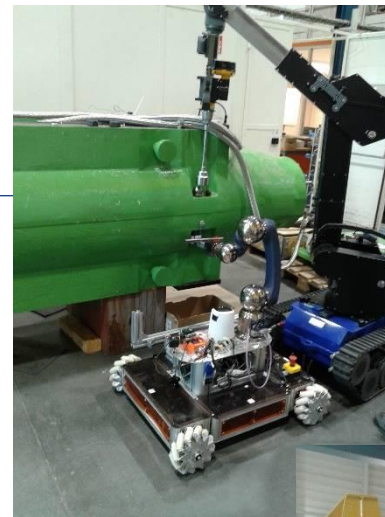
Images
from
sequence
document



Dump remote inspection

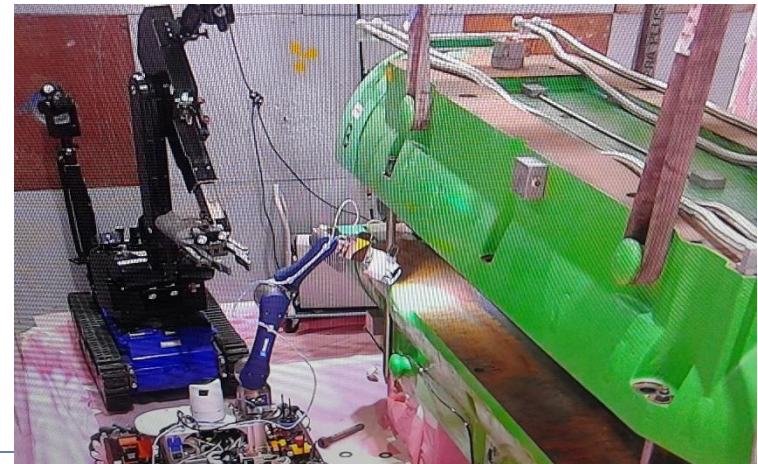
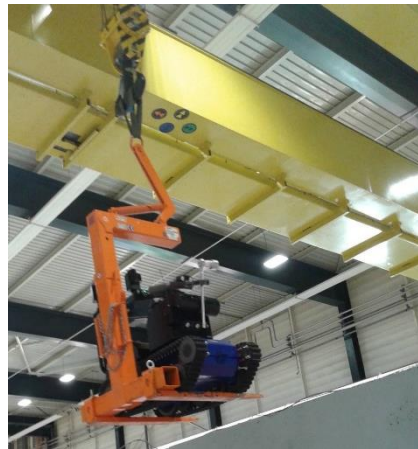
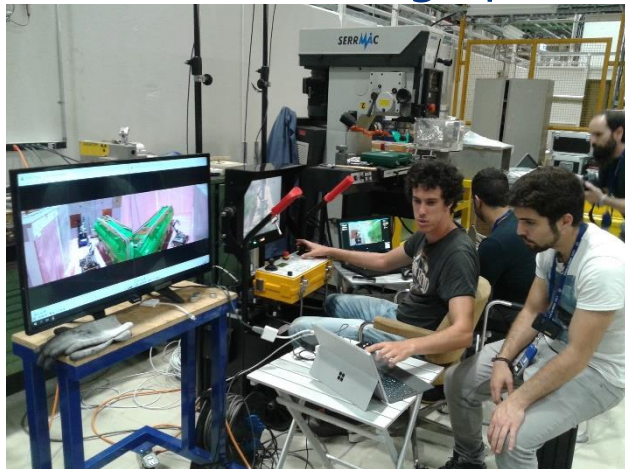
– mock-up preparation

- CATIA sequence to check feasibility and communicate with different teams
- Prepare work dose planning (consider recovery from problems)
- Mock-up trials on identical shielding to develop techniques for key tasks using mobile robots and crane:
 - Lifting mobile robots (to get over wall into shielded bunker)
 - Undoing shielding bolts (six M36 threaded bars with nuts)
 - Lifting upper shielding
 - Vacuum leak testing
 - Replacing shielding bolts



Dump remote inspection - Operation

- Operations went well
- Personnel radiation doses less than estimate ($102\mu\text{Sv}$ vs $180\mu\text{Sv}$)
- Leak testing was able to identify leak points
- Visual inspection showed weld condition
- Note: shielding opened 3x (1x in WDP)



n-TOF target exchange

Handling task document

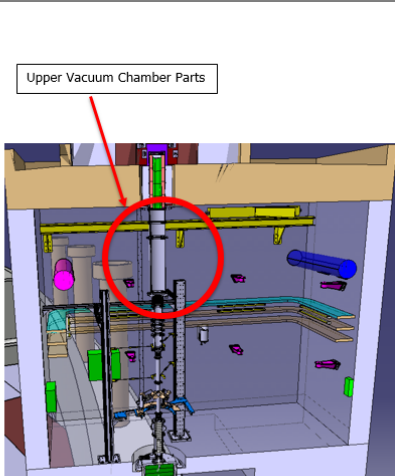
- Step-by step illustrations of tasks
- Dose rates
- No of people/hands needed
- Times needed
- Illustrated work-dose planning
- Used to decide where optimization and remote handling will be needed
- Communication tool.

CERN Engineering Department

REFERENCE: XXXX

EDITION: 0000000 REV: 0.0 VALIDITY: DRAFT

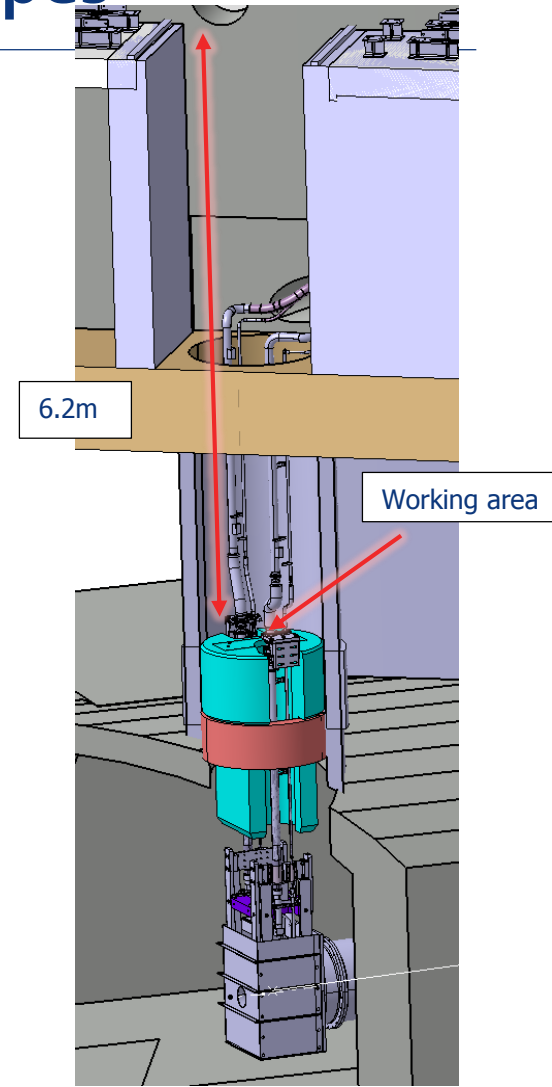
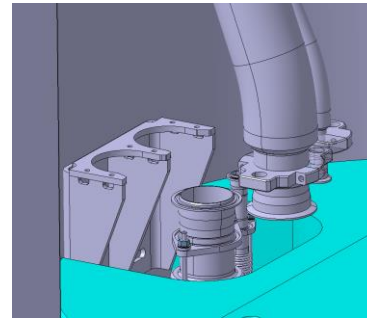
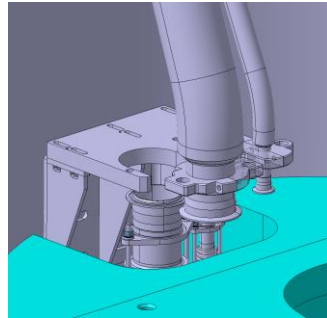
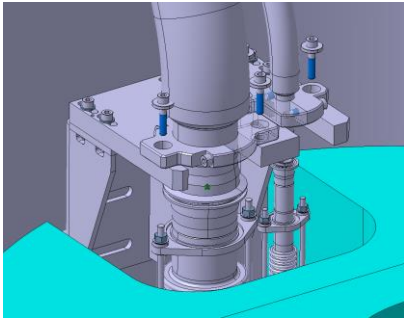
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	Name of task	70. Remove Vacuum chamber upper parts
	Scene number	
	Local dose rate	
	Hands needed	4 (2 to hold the chamber, 2 to remove nuts and bolts)
	Time needed	15 minutes
Calculated dose		
Comments: Vertical lifting platform and 2 chain hoist was needed for installation.		

n-TOF target exchange sample task

Disconnecting and Securing of Water Pipes

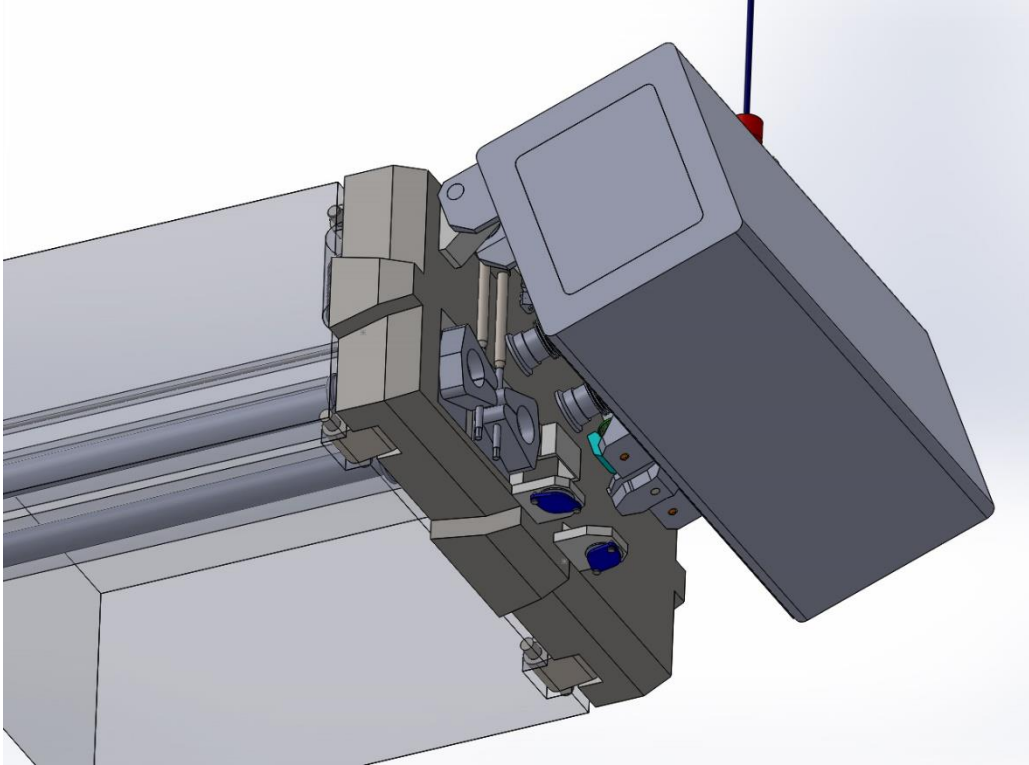
- 300. Disconnect water pipes
- 310. Remove pipe retaining screws
- 320. Pull pipes away from wall
- 330. Remove bracket top plates
- 340. Fix pipes against wall



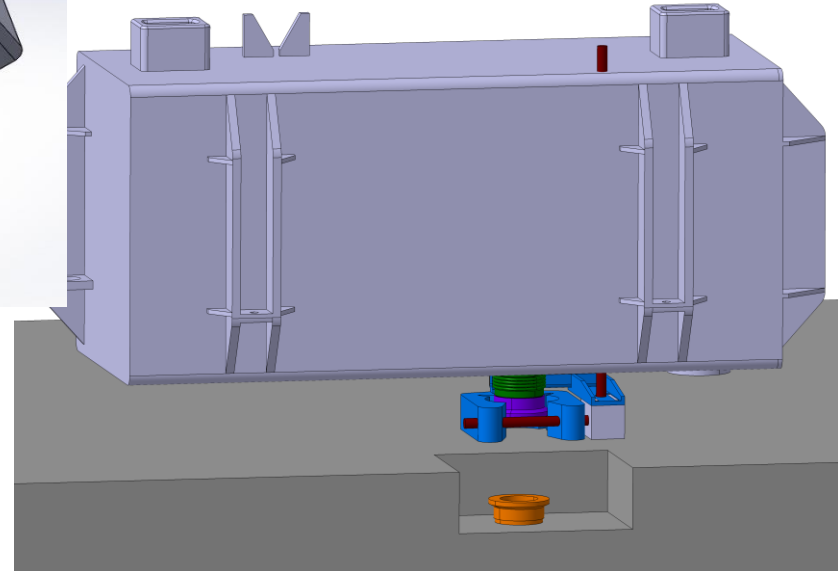
*Hole to target will need to be blocked.

*Pipes need to be closed and leave space for target lifting

Beam Dump facility – remote handling studies



Design study for future facility considers all (remote) handling operations during life of facility
- including recovery from failures

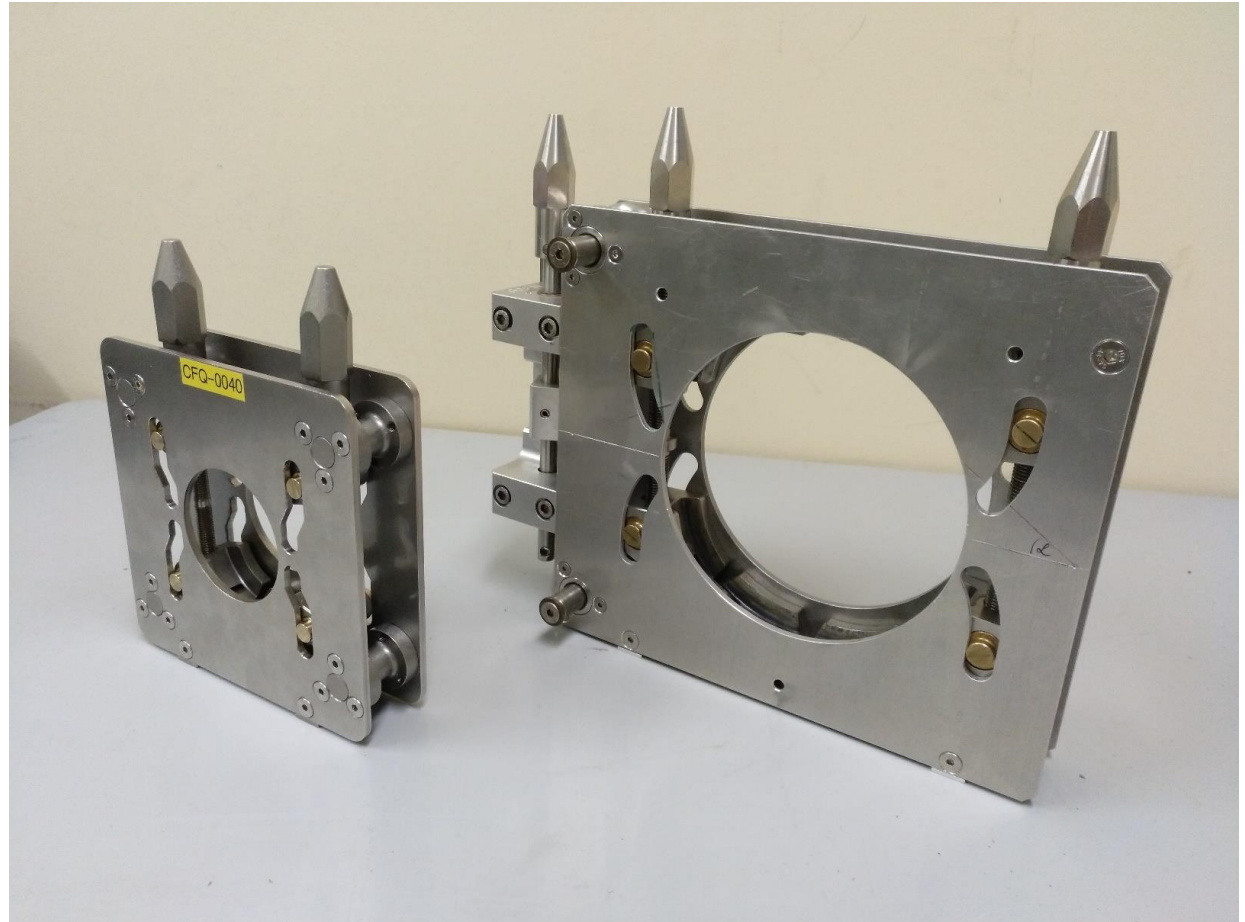


Two concepts for remote exchange of target including cooling water connections

Remote vacuum flange clamps

Based on the LHC collimator design, CERN's vacuum group have developed improved remotely operable clamps

100mm and 40mm designs shown



Recommendations

- **Consider all handling interventions during the lifecycle** of a piece of equipment at the **conceptual design phase onwards**
- Equipment teams must **work with the (remote) handling equipment designers/operators from conceptual design phase onwards**
- **Use mock ups to:**
 - Enable good communication between teams
 - Develop techniques and procedures
 - Demonstrate safety
 - Train operators

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