Super FRS Hot Cell
Layout & remote handling in the Super FRS Hot Cell

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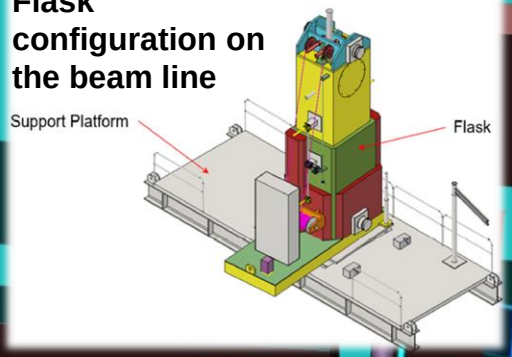
- The Super FRS
- Super FRS hot cell overview
- Remote handling components
- Remote handling Processes

The FAIR Facility / Super FRS

Super FRS target area

Flask configuration on the beam line



The components will be moved in the shielding flask from the beam line to the hot cell and be indserted through the slider of the HC roof

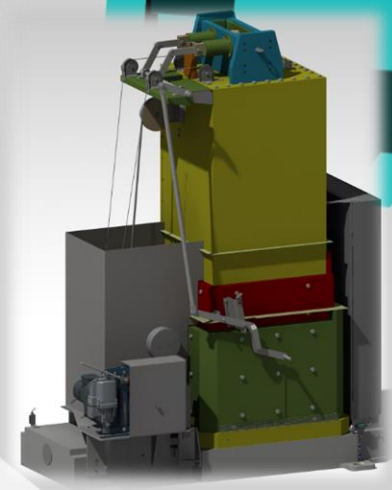
Target chamber

pillow seals

BC chambers

Pillow seal plugs parking cell

Shielding Flask:
Dimensions (m): BxLxH: 2,2x4,7x5,5
Weight: 56t
Positioning accuracy: <5mm

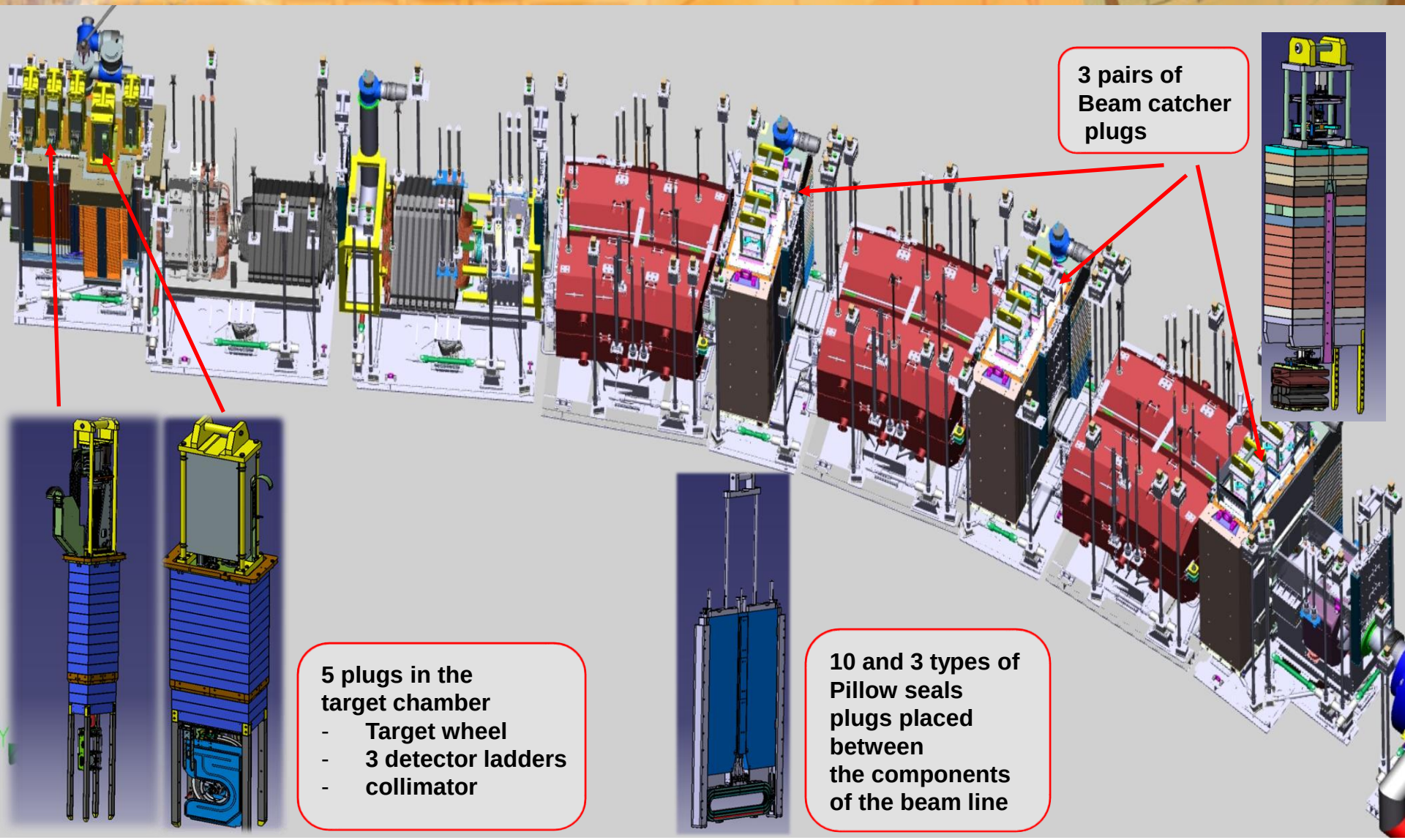


Plugs parking cells

Hot cell slider

Hot and decay cell

Super FRS target beam line



3 pairs of Beam catcher plugs

5 plugs in the target chamber
- Target wheel
- 3 detector ladders
- collimator

10 and 3 types of Pillow seals plugs placed between the components of the beam line

Activation of the super FRS target components

Operation foreseen for the Super FRS facility:

- 90 days run

- 120 days break

3 days		120 days	
Bq	mSv/h	Bq	mSv/h
1,40E+11	9,00E-01	4,87E+10	1,96E-01

graphite target wheel

3 days		120 days	
Bq	mSv/h	Bq	mSv/h
1,35E+11	9,93E+00	5,10E+10	1,89E+00

target plug shielding

List of the components after a worst case scenario of 180 days beam time with U-238 and intensity of 5E+11 Ions/s and energy of 1,5GeV/u and then 120 days break. The table shows the activation of the parts after 3 and 120 days of decay. These parts are stored in 200l barrels in the floor of the decay cell.

3 days		120 days	
Bq	mSv/h	Bq	mSv/h
2,54E+13	2,52E+03	1,17E+13	5,64E+02

Graphite absorber

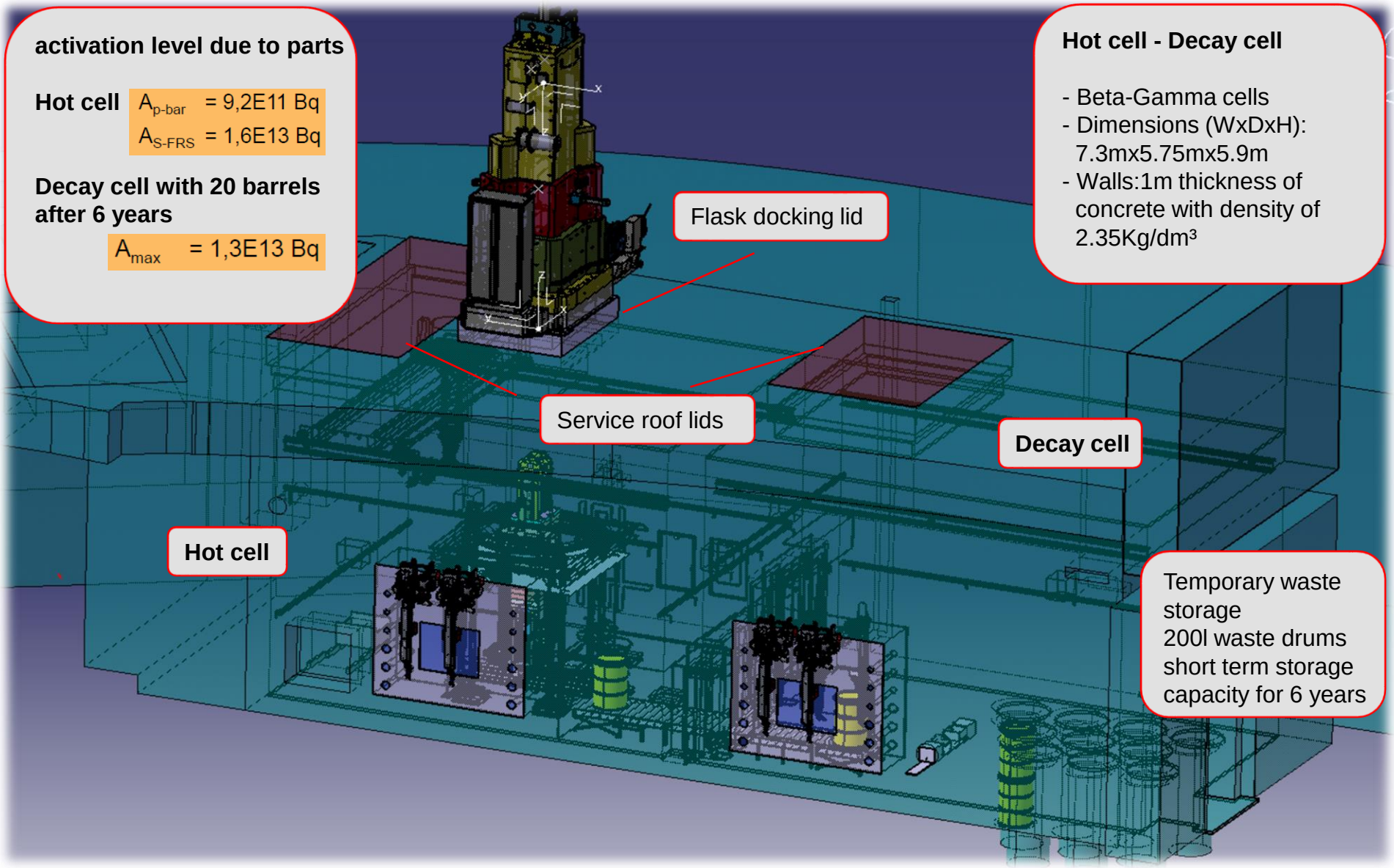
3 days		120 days	
Bq	mSv/h	Bq	mSv/h
4,44E+12	3,69E+02	2,67E+12	1,24E+02

Cu-absorber

Isotope	Aktivität (A) Bq	Freigrenze (F) Bq	A / F ---	Halbwertszeit d
^{54}Mn	1,65E+13	1,00E+06	1,65E+07	312,27
^{51}Cr	1,40E+13	1,00E+07	1,40E+06	27,7
^{55}Fe	1,30E+13	1,00E+06	1, 30E+07	996,41
^{52}Mn	6,14E+12	1,00E+05	6,14E+07	5,59
^{48}V	5,06E+12	1,00E+05	5,06E+07	15,97

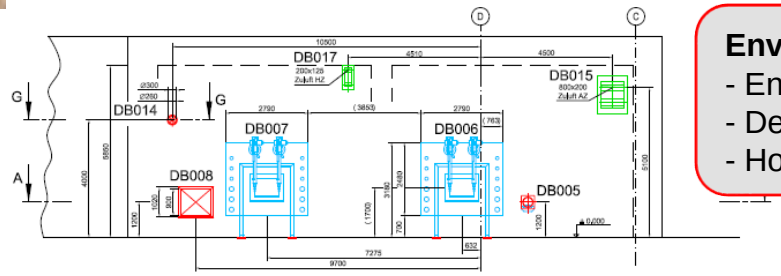
Table shows the activation of the main isotpes which are responsible for the activation of the components

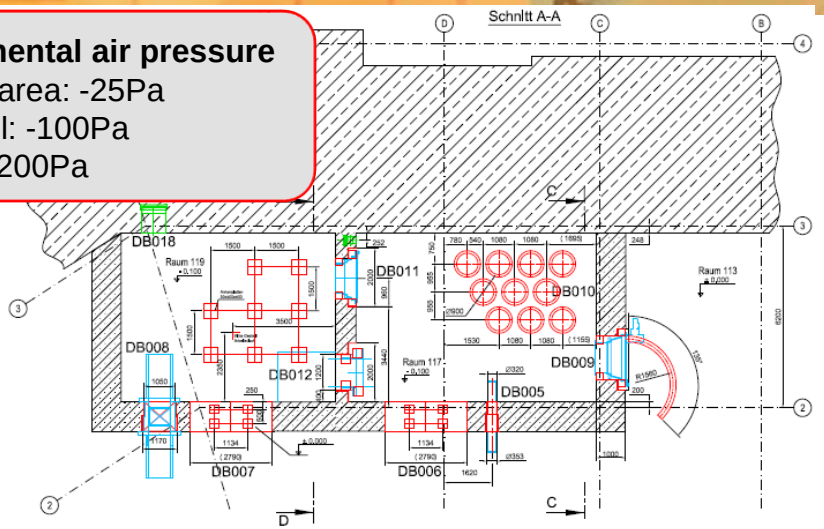
The hot cell lay out

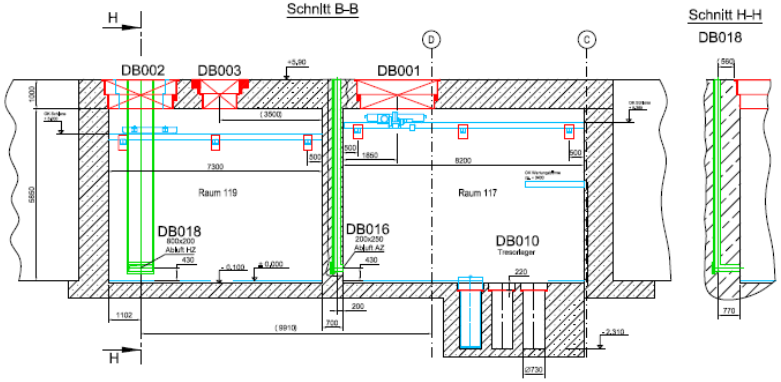


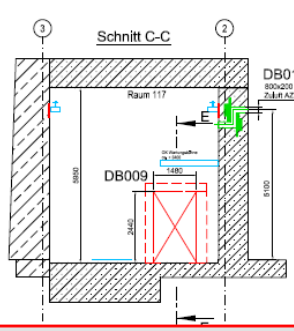
The hot cell ventilation

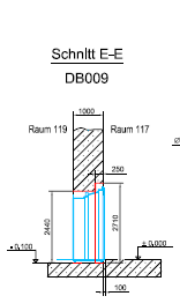
Envoironmental air pressure
- Entrance area: -25Pa
- Decay cell: -100Pa
- Hot cell: -200Pa

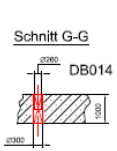


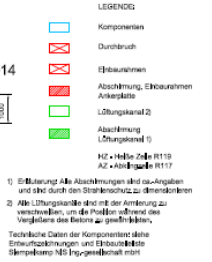


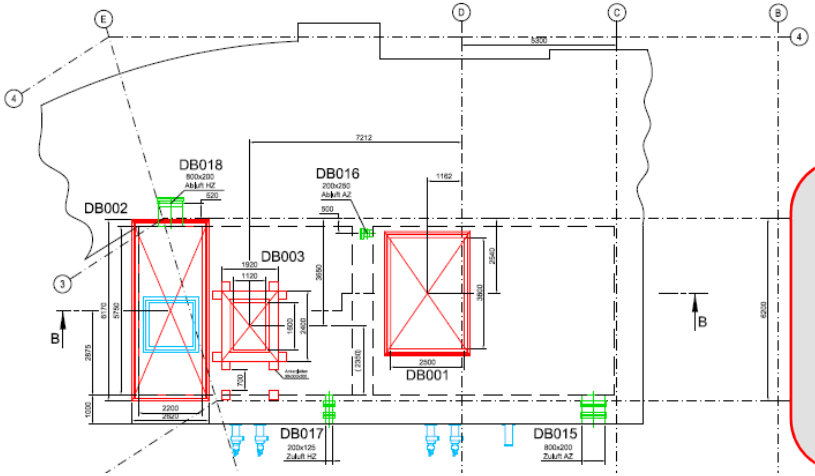




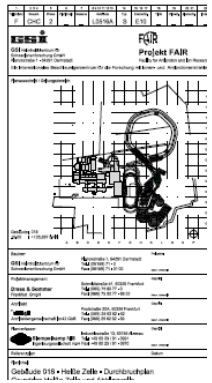








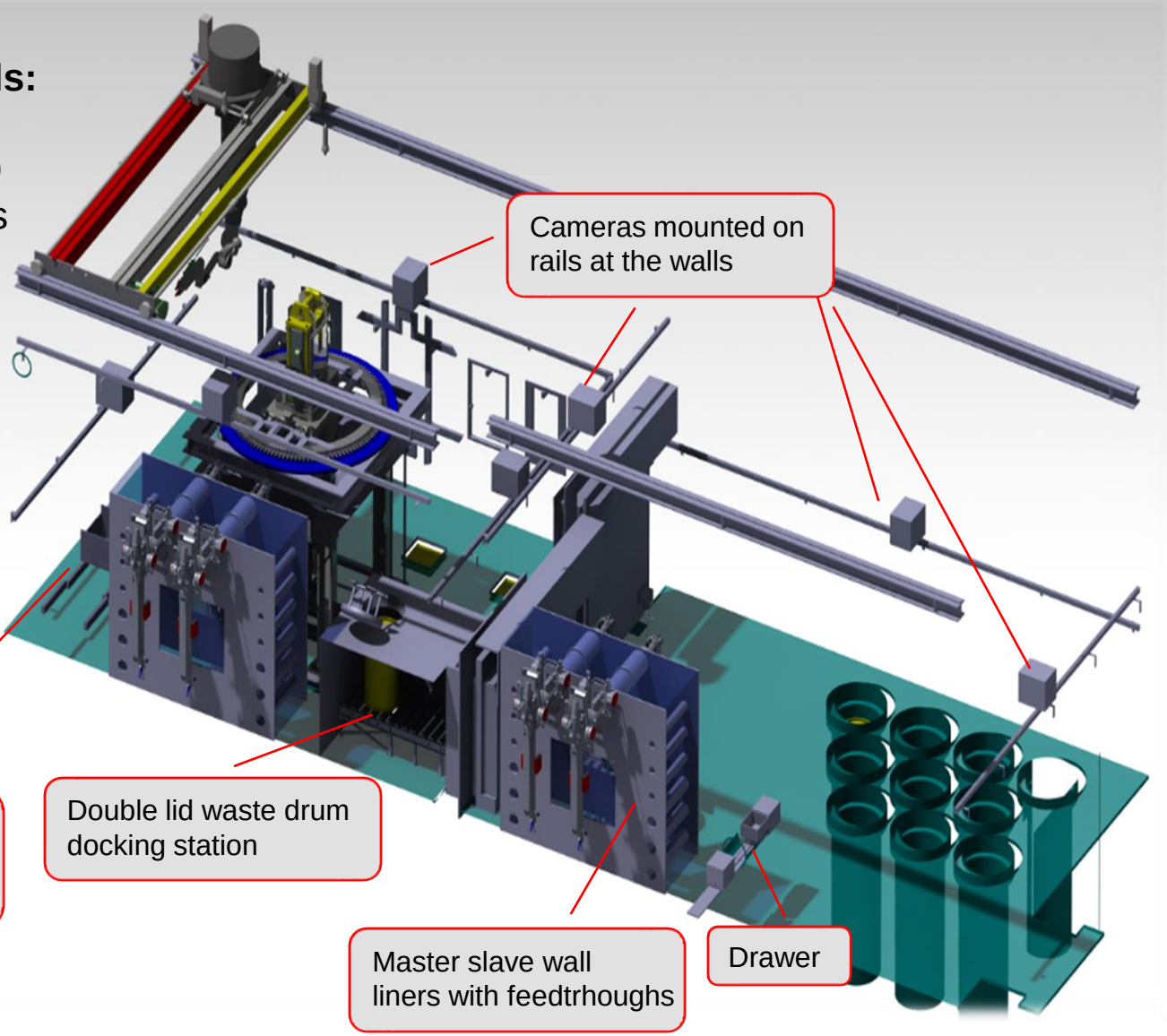
Air flow
- Entrance area: 3-5 x air volume/h
- Operator area: 3.200 m³/h
- Decay cell: 1-3 x air volume/h
- Hot cell: 2 x air volume/h
- Hot cell in intervention: 16 x air volume/h



The equipment of the HC / DC

The main manipulation tools:

- 2 pairs of Gettinge MT200 Master-slave manipulators
- Power manipulator Wälischmiller A1000
- Plug turntable with integrated Z- axis lifter
- Hydraulic Scissors
- BC extractor
- Waste drum convey with double lid gate
- Funnel drawers
- General purpose small tools



Master slave and power manipulators

Gettinge MT200 Technical Specs
- Max load capacity: 20daN
- Max tongs force: 22daN
- Max tongs opening: 90mm
- Total length extracted: E+F+Z: 3270mm
- Detachable gripper and tongs
- Booting on slave side

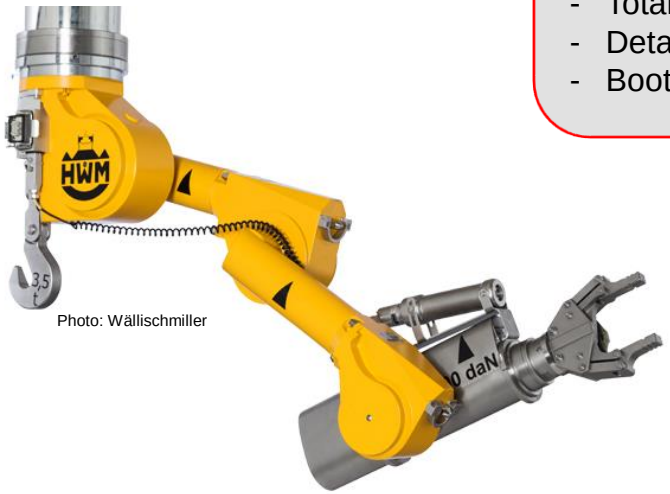
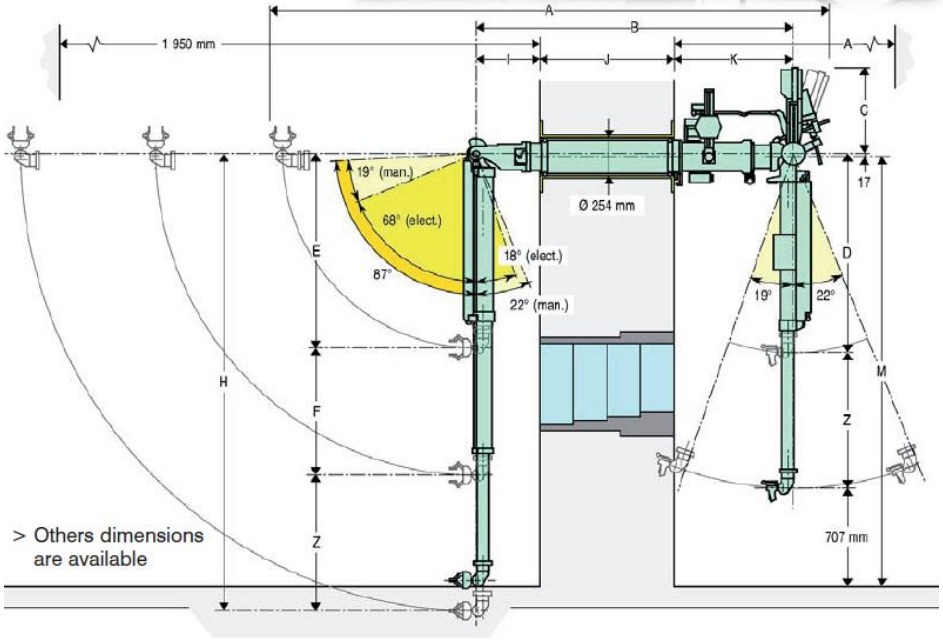
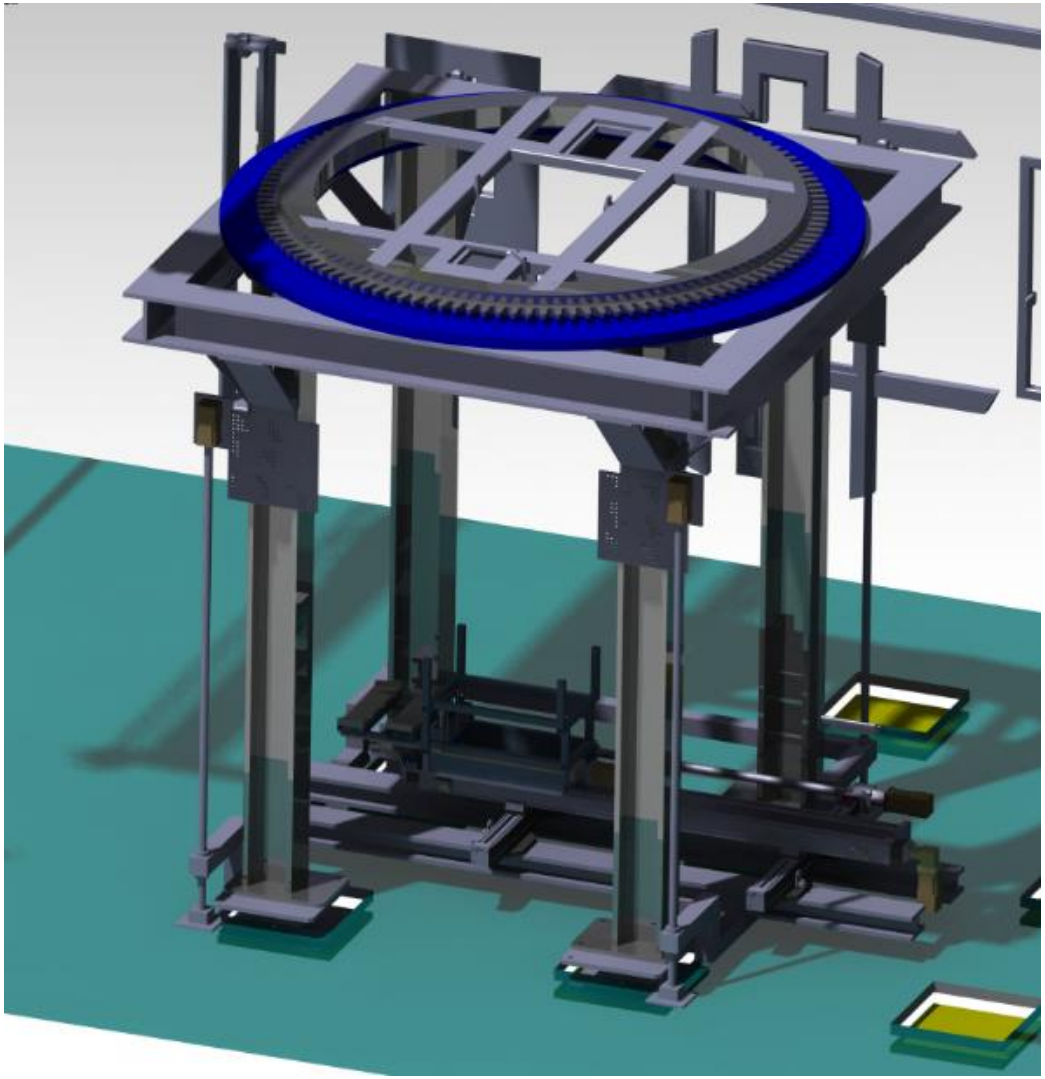


Photo: Wällischmiller

Wällischmiller A1000 Technical Specs
- Max load capacity: 200 daN
- Max crane load capacity: 2 Tonnes
- Force feedback
- 6 axis movement
- Radiation resistance: 1MGy



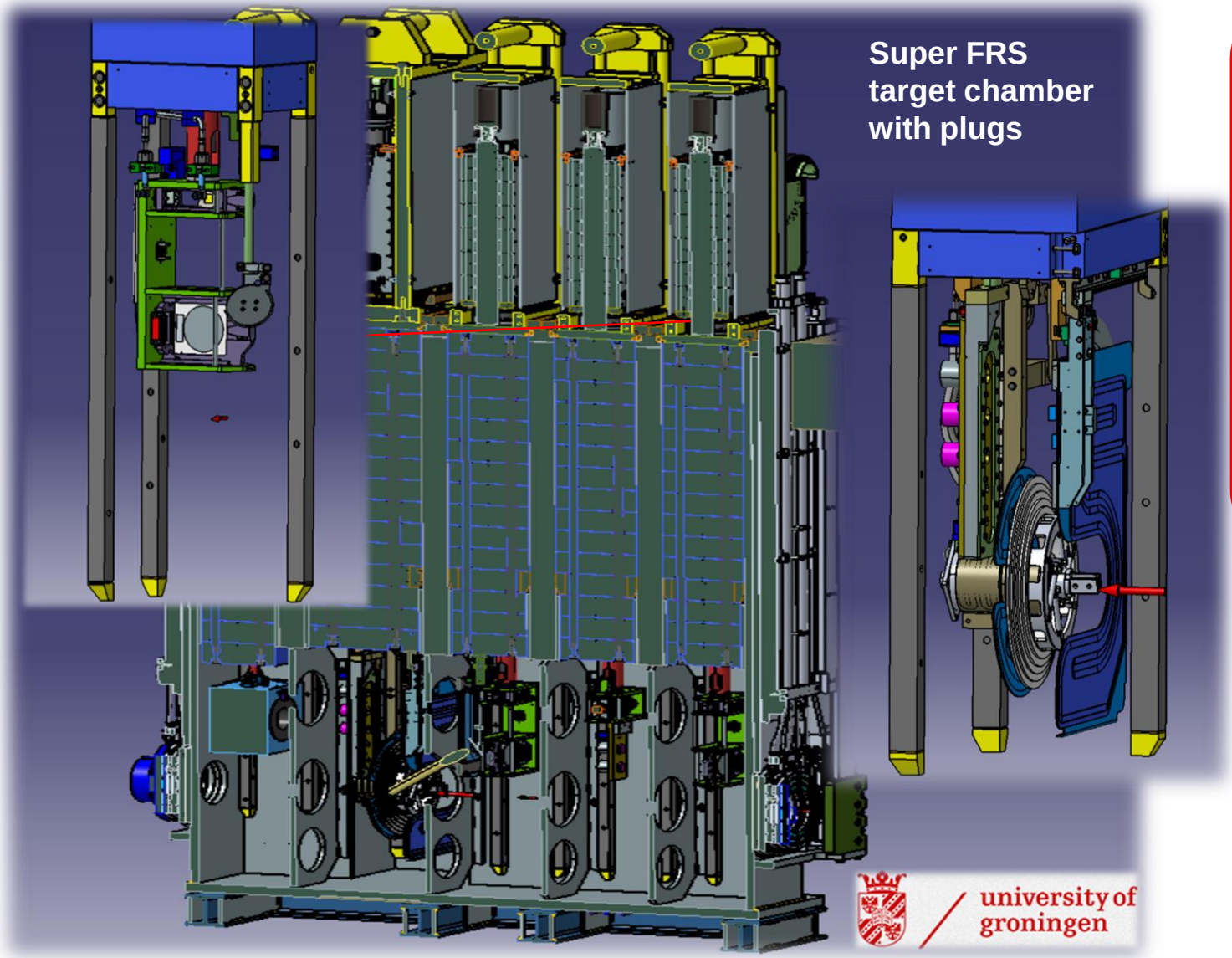
The turntable



Requirements

- Max load capacity: 10t
- Rotation: 360° infinite
- Z-axis frame (lifter) integrated
- Redundancy for both movements
- Footprint 1500mmx1500mm
- Compatibility with all plugs means of adapter plates
- Attachment of the BC extractor on the Z-axis frame
- Mounting of tools for the dissasembly/cuting p-bar parts
- Intagrated temporary tool / bolts storage

The target chamber components



Compnents of the target camber

- 3 detector plugs
- target plug
- colimator plug

Plugs dimensions

Height: 4m
Width: 420-760mm
Length: 295-430mm
Weight: up to 5400kg

Target wheel plug tasks

Tasks regarding the target plug in the HC

Service yearly	Failure	Optional
Target wheel	Cooling plate	Target ladder
Stepper motor	Linear sleigh	
	Cooling hoses	

Target / Striper ladder

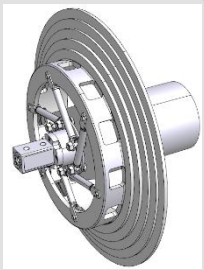
Material: Cu
Number of Targets: 5-8
Features: indirect water cooling

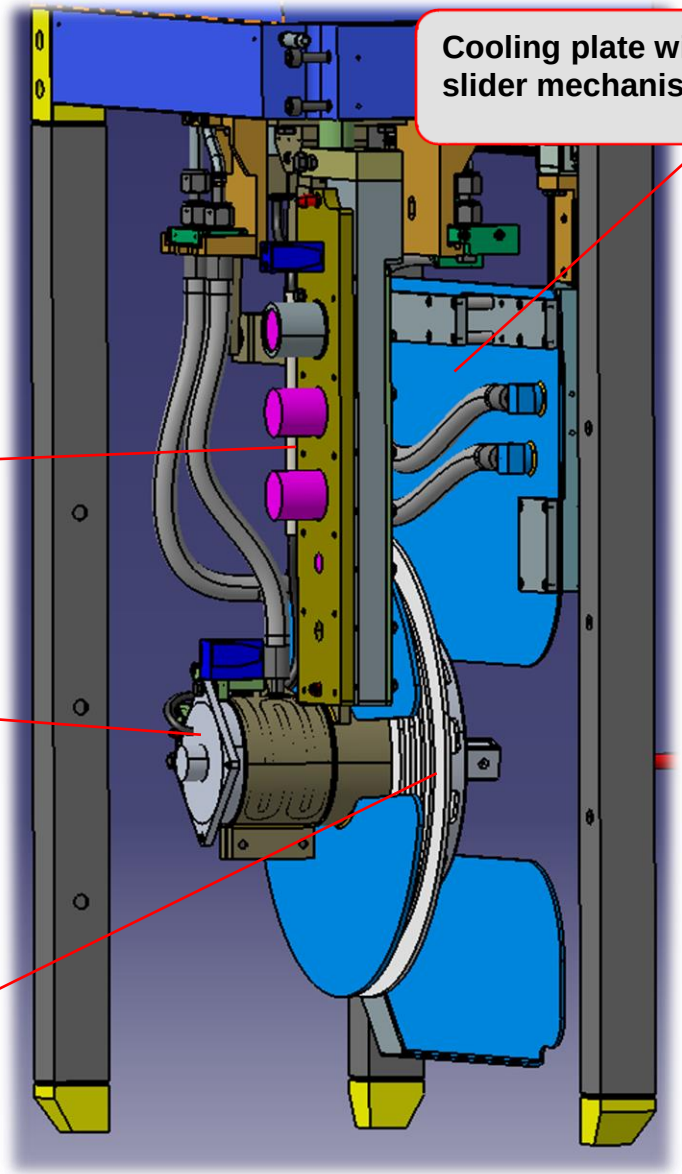
Stepper motor

Type: Phytron VSH 126 Motor
Custom Features: kapton insulated coil
ceramic bearings
indirect water cooling

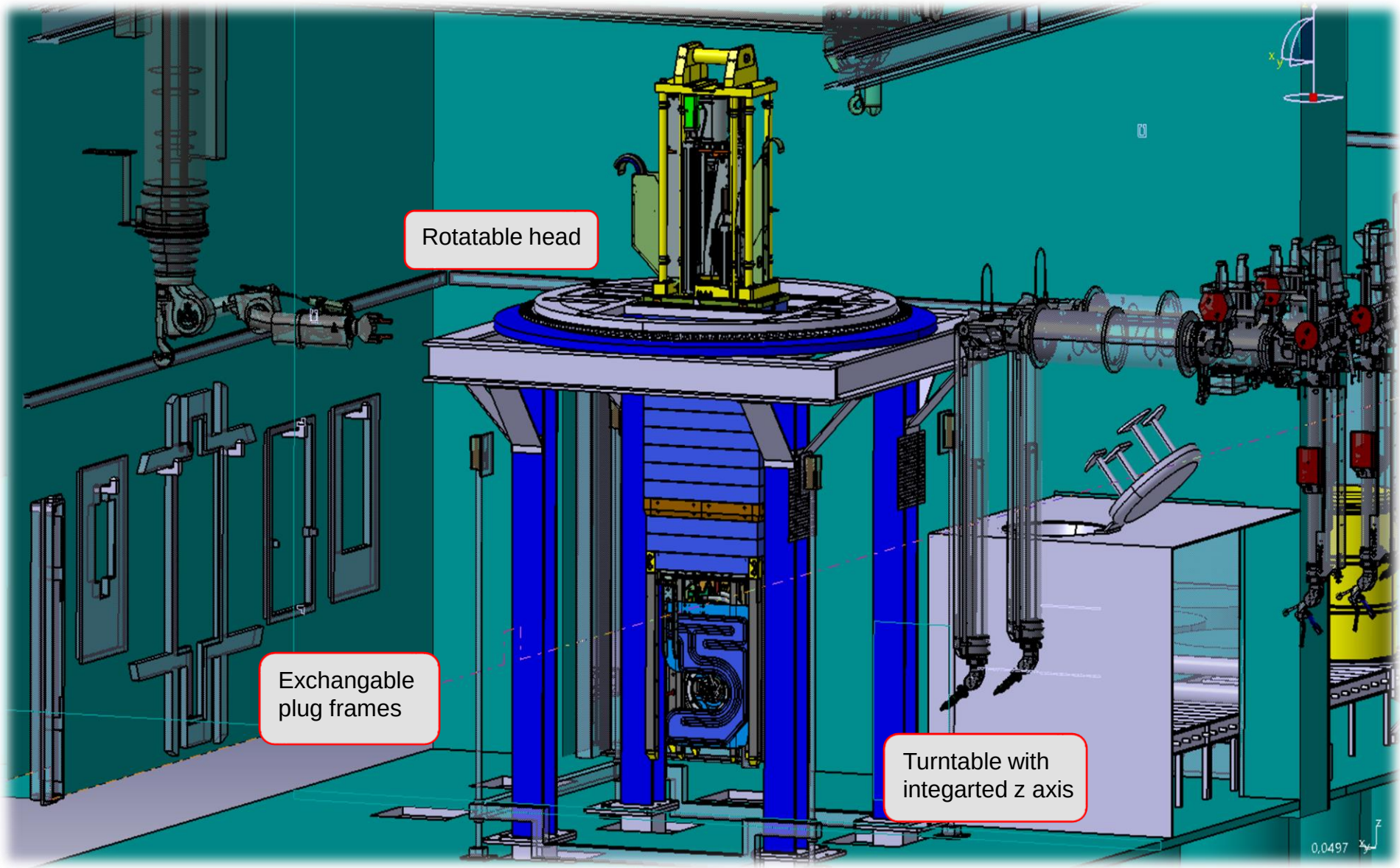
Target wheel

Material: Graphite
Diameter: 480mm
Weight: 12kg
Mount: quick release

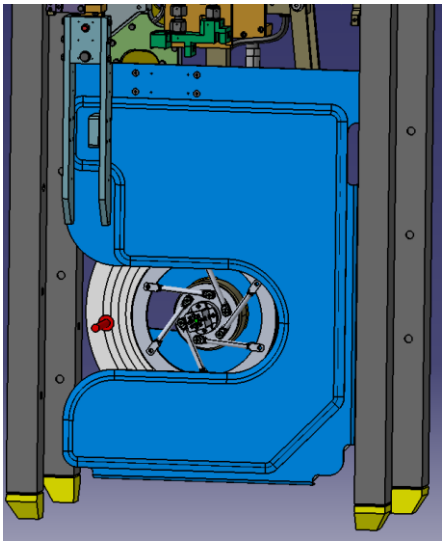




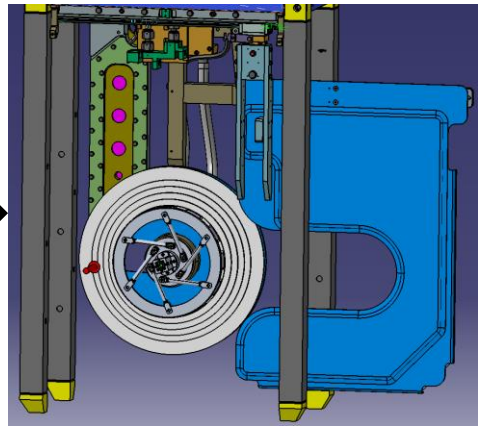
Target plug in the HC

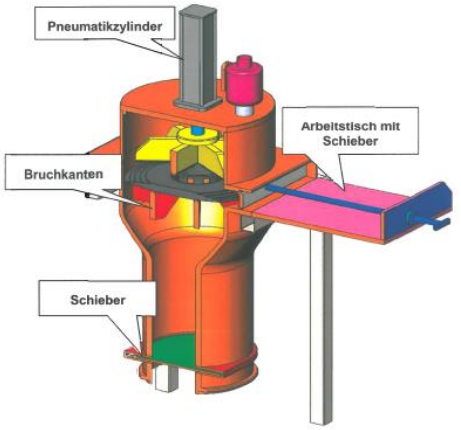


Exchanging the target wheel, Workflow



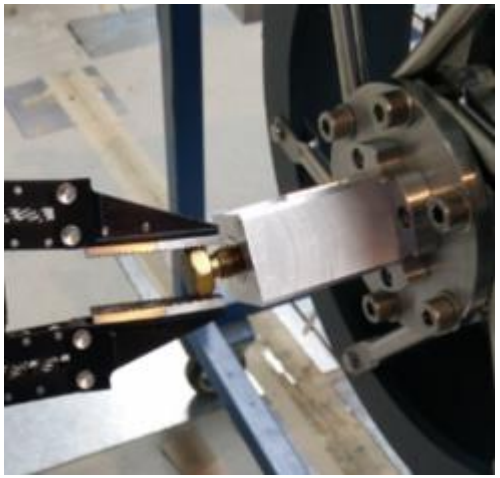
Step 1: cooling plate removal



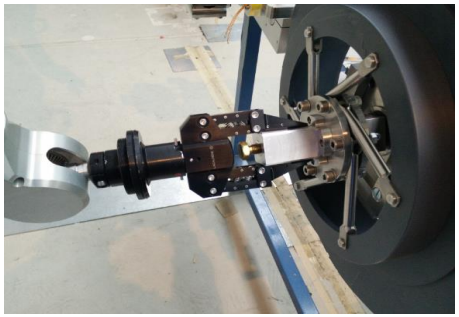


Step 4:
separation of the materials means a crusher above the double lid barrel docking station

Step 2:
release the quick lock mechanism by means of the MS manipulators



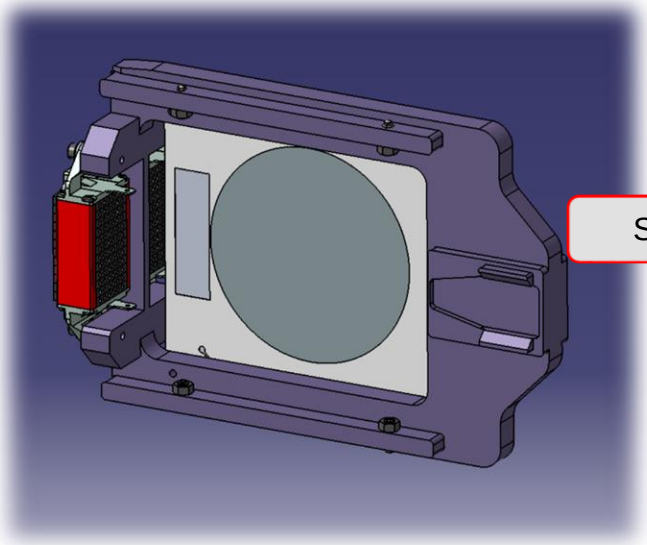
Step 3:
removal of the graphite target by means of the power manipulator

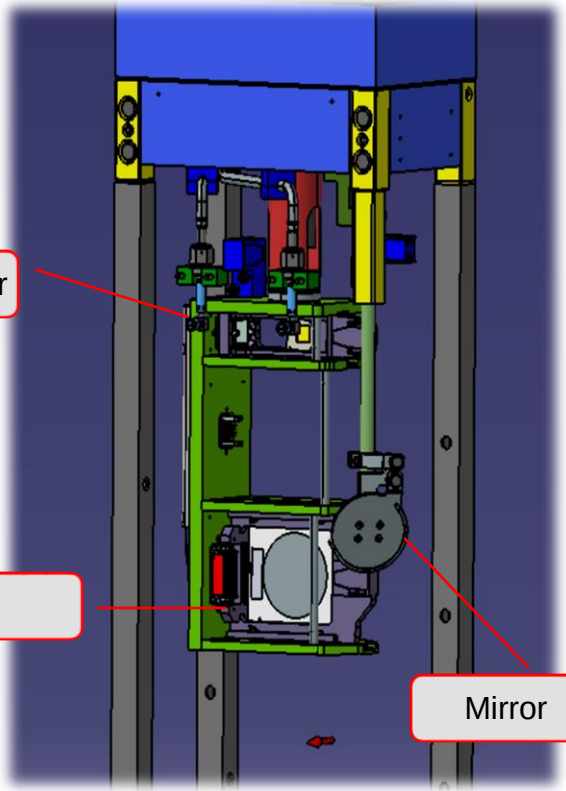


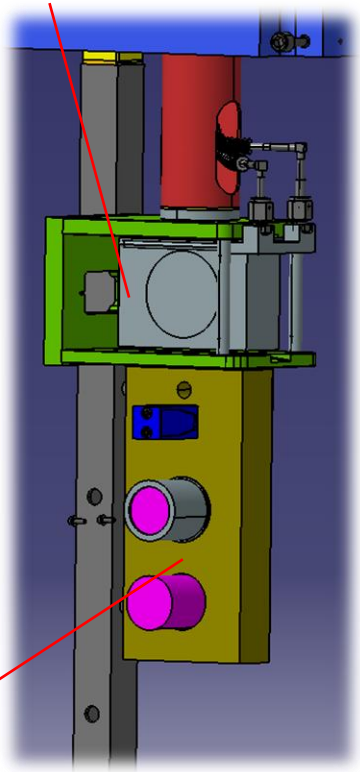
The detector plugs tasks

Tasks in the HC concerning the detector plug

Service	Failure	Optional
	Mirror exchange	Target ladder
	Cooling plate exchange	
	Detector exchange	
	CV DD	
	IC	
	SEM Grid	
	Seetram	







The BC plugs

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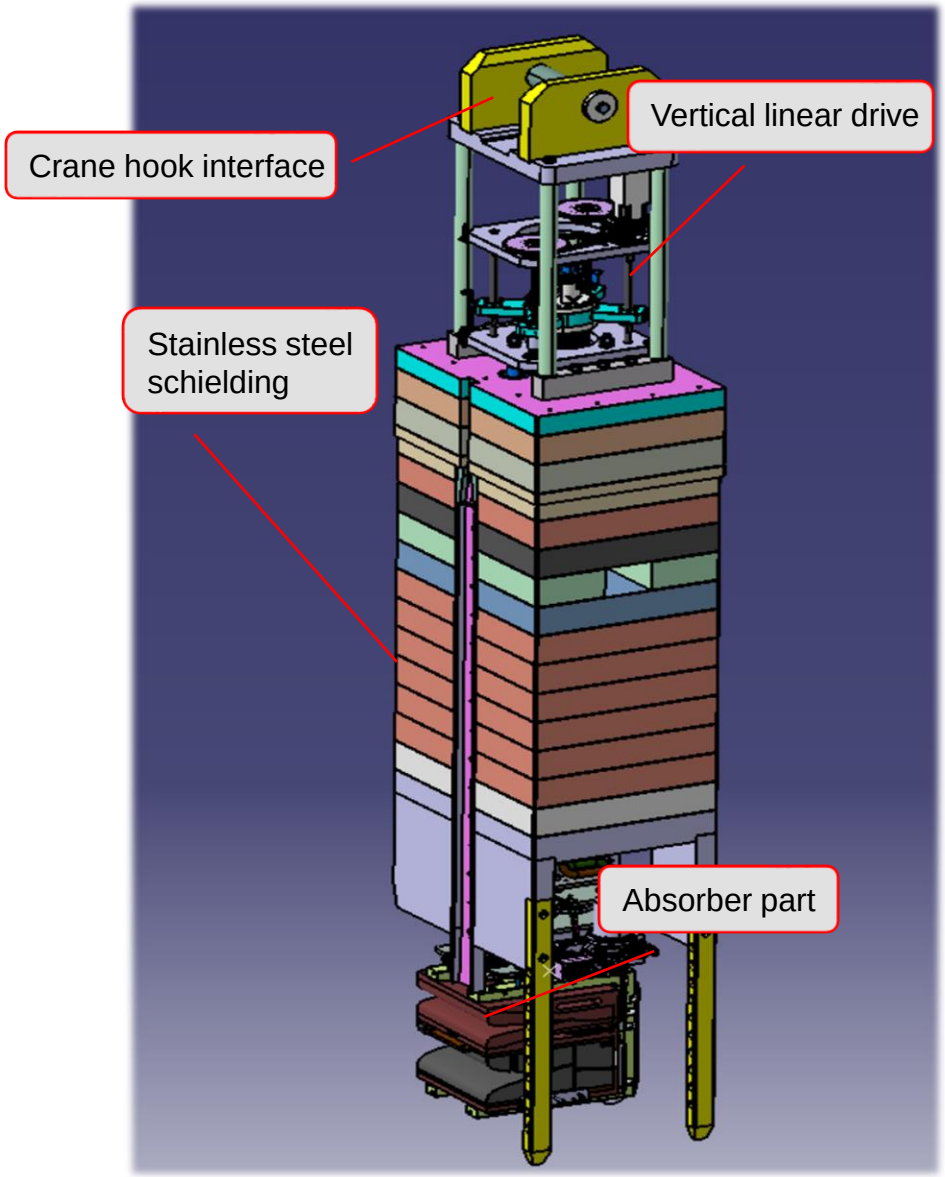
BC plugs:

Dimensions:(mm) BxLxH:803x615x3650
Weight: up to7800kg
Positioning accuracy: 200-400μm



Requirements of all plugs:

1. Radiation hardness of
- connectors
- cables
- sensors

2. Redundancy of sensors
3. accuracy of positioning of the exchangable parts

BC Tasks in the HC

Design:Abhijit Mahapatra

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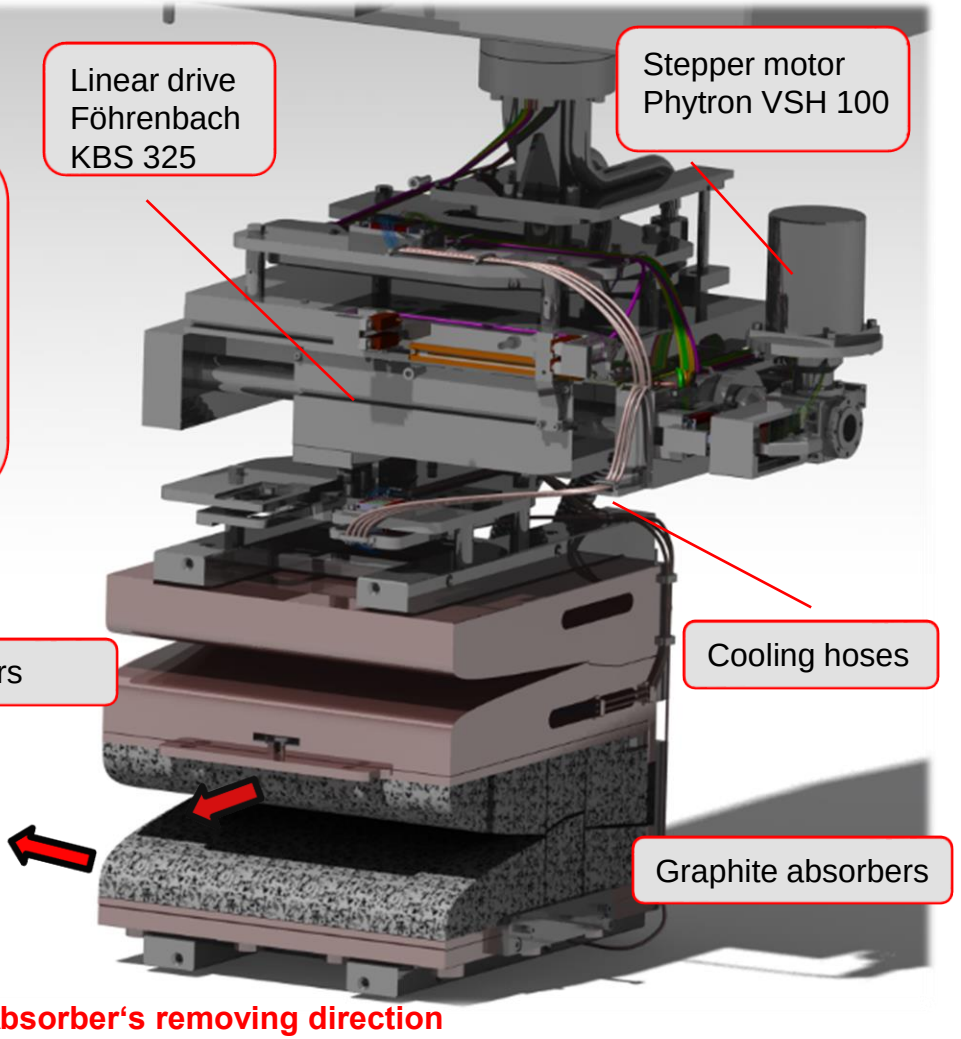
Beam catchers tasks in the HC

Service	Failure	Optional
Lower Graphite-Absorber	Absorber frame	
Upper Graphite-Absorber	Cooling hoses	
	Linear drive	
	Stepper Motor	

C-Absorbers:

Dimensions (mm): BxLxH: 403x420x100
Weight: 40kg
Positioning accuracy: 100-200μm
Indirect cooling
Mounting: bolted

Absorbers activation:
Beam of 3x10^{11} U/s for run of 4x90days + 1 year cooling:
Ac (217 kg Cu) = 107 mSv/h
Ac (41 kg C) = 0.12 mSv/h

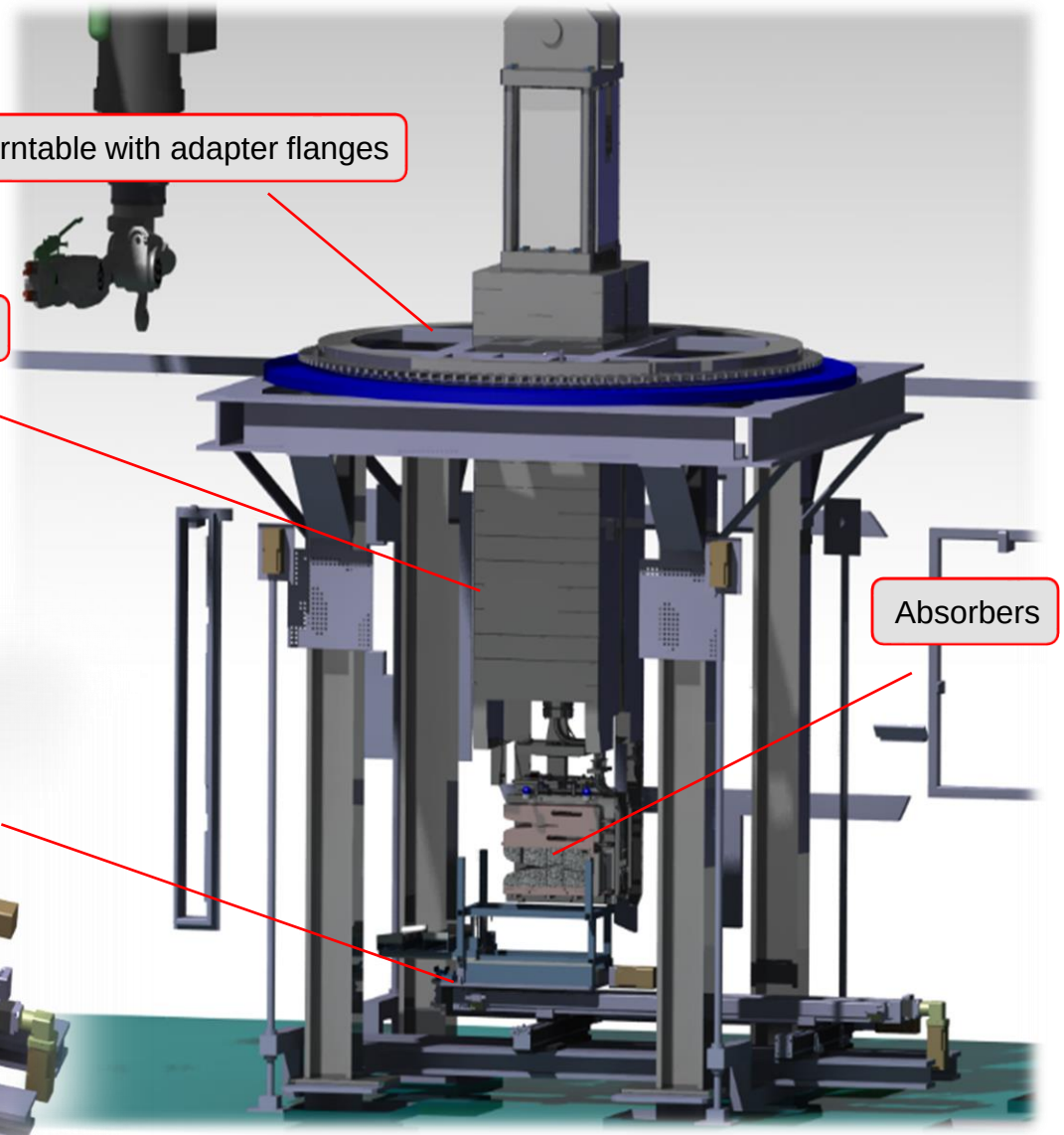


Separation of materials is required

Required tools for BC plugs in the HC

Technical specs:

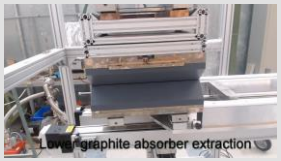
- Double x axis with a stroke of 400mm and 1200mm
- Motion by means of stepper motors
- Compressed air driven gripping pins
- handled by the power manipulator
- Connections by a remote handled media board



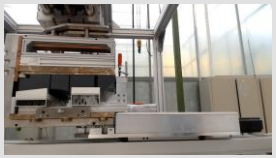
Maintenance of the absorbers
Testbench

4 steps to exchange the absorbers

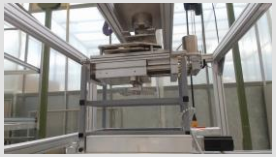
Step1
dismounting the lower C-absorber



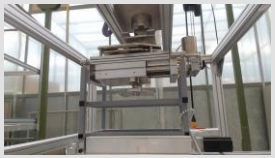
Step2
dismounting the upper C-absorber



Step3
removal of the absorber C-frame



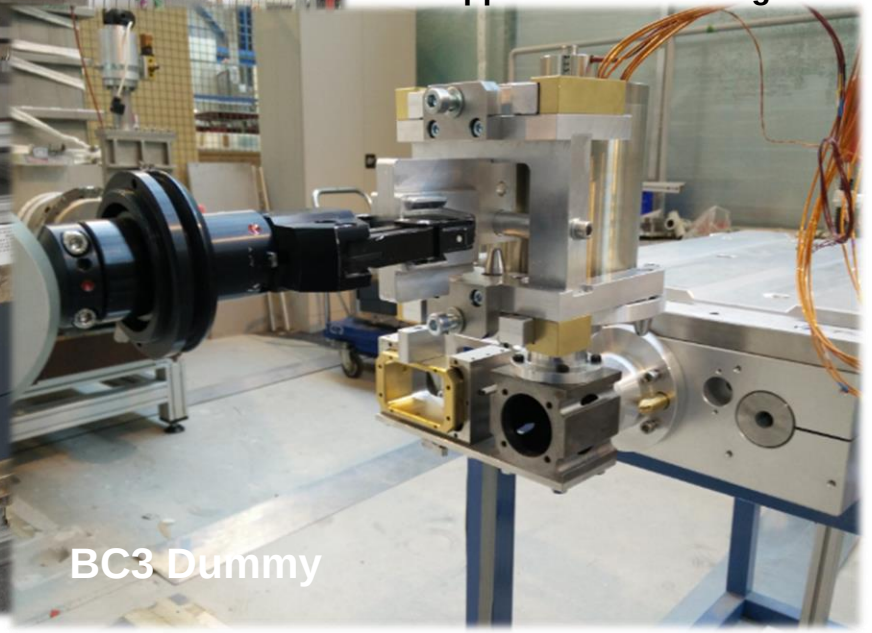
Step4
removal of the linear drive



BC3 Dummy

Lifter + BC extractor tool

Stepper motor exchange test



The Pillow-seal plugs

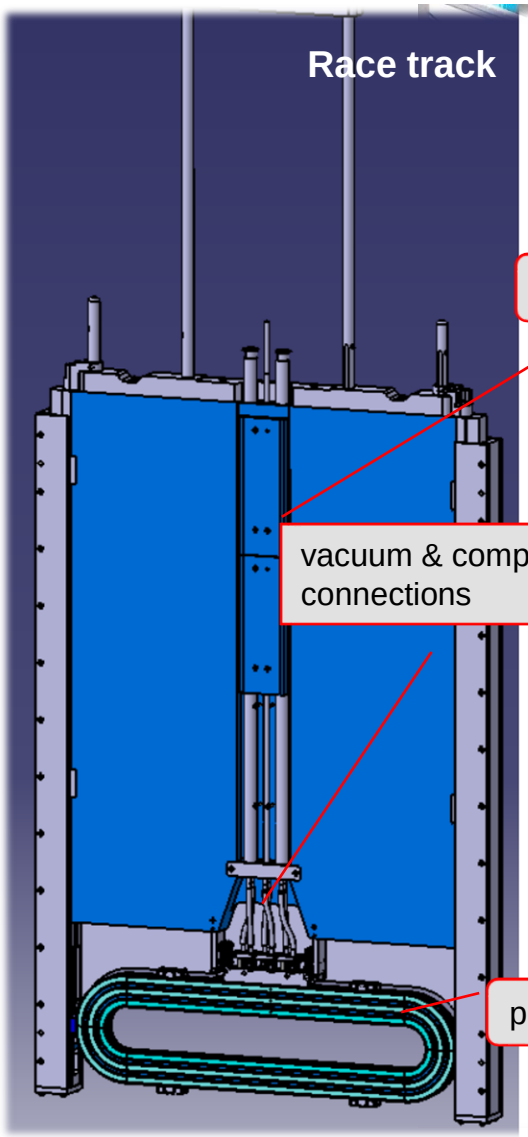
Plugs dimensions

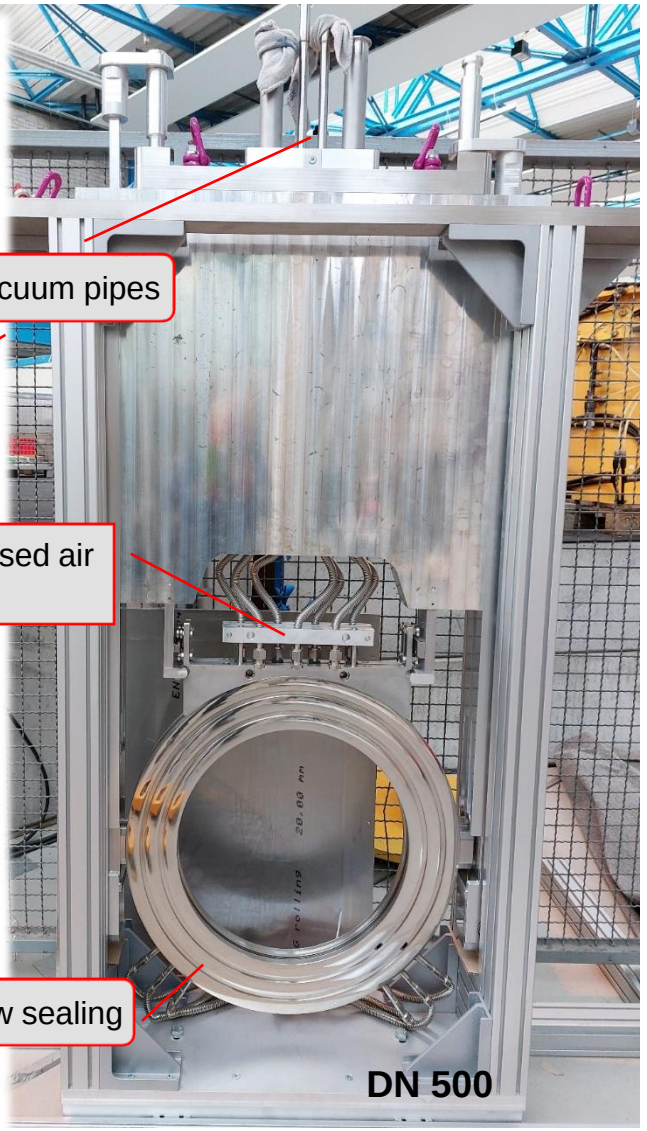
Total height: 4m
Width: till1760mm
Length: 120mm
Weight: up to 2t

Pillow seals Tasks in the HC

Service	Failure
	Pillow seal module
	Vacuum / compressed air pipes module

In case of a failure, the sealing flange has to be brought in HC from the entrance





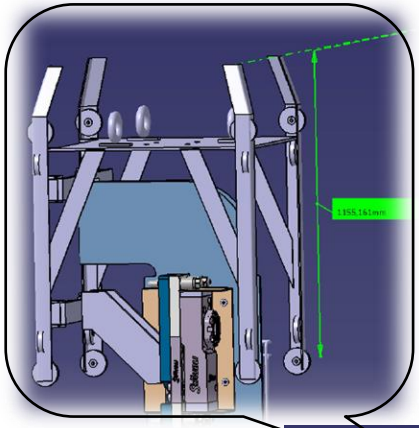
Antiprotons P-bar target & horn

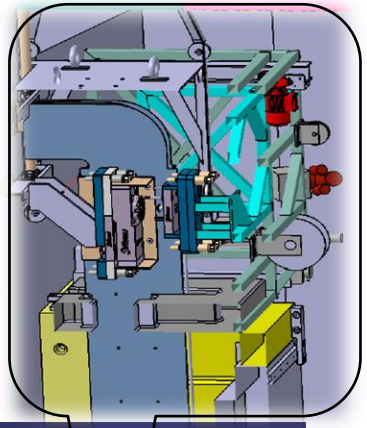
P-bar Tasks in the HC

Service/3 months
Target disposing
Horn disposing

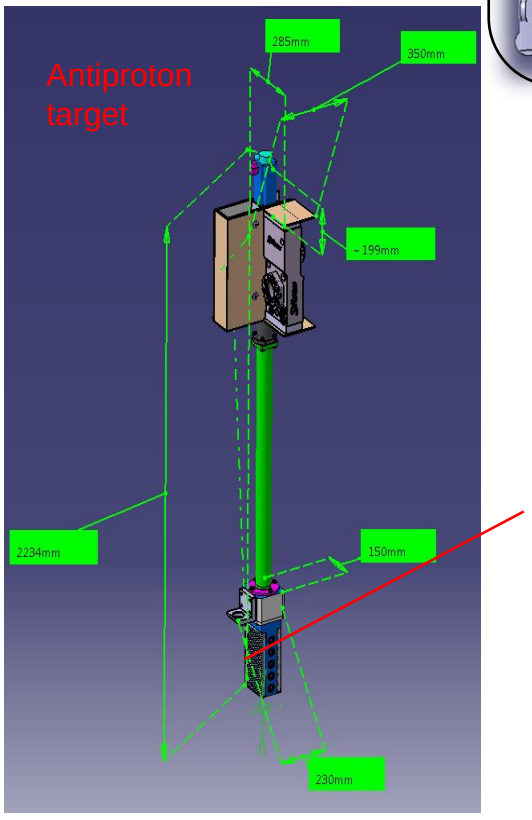
Antiptoton Target and horn are not foreseen to be maintained. After their insertion in the hot cell they will be cuted by a hydraulic scissors and disposed.
They are the main waste volume in the HC temporary waste storage

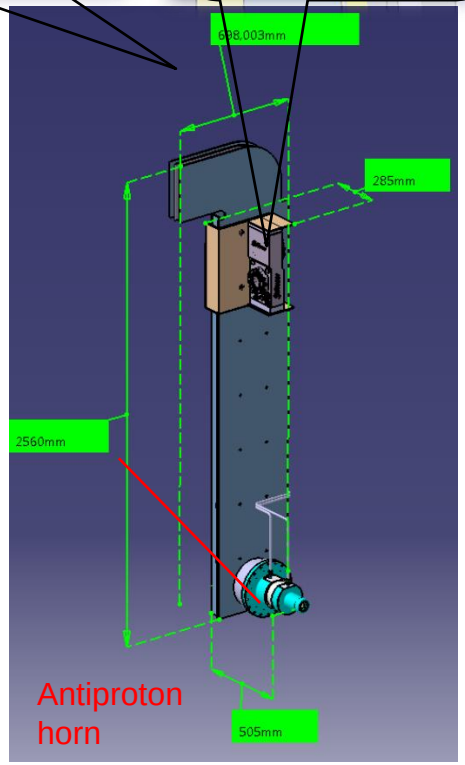
Horn cage mechanical interface of the horn





Horn coupling





Remaining tasks

- Specify and tender the turntable
- Tendering of the double lid shielding flask interface
- Tendering of the waste drum convey Detail the equipment of the HC (cameras, power supplies, tools, etc.)
- Development and tendering of the activation measurement station of the decay cell
- Detail of the workflow in the HC and documentation
- Documentation and approval of the authorities
- Tendering of the Super FRS special installation components
- Testing, testing, testing…

Thank you for your attention

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Thank you for your attention

Any questions?

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