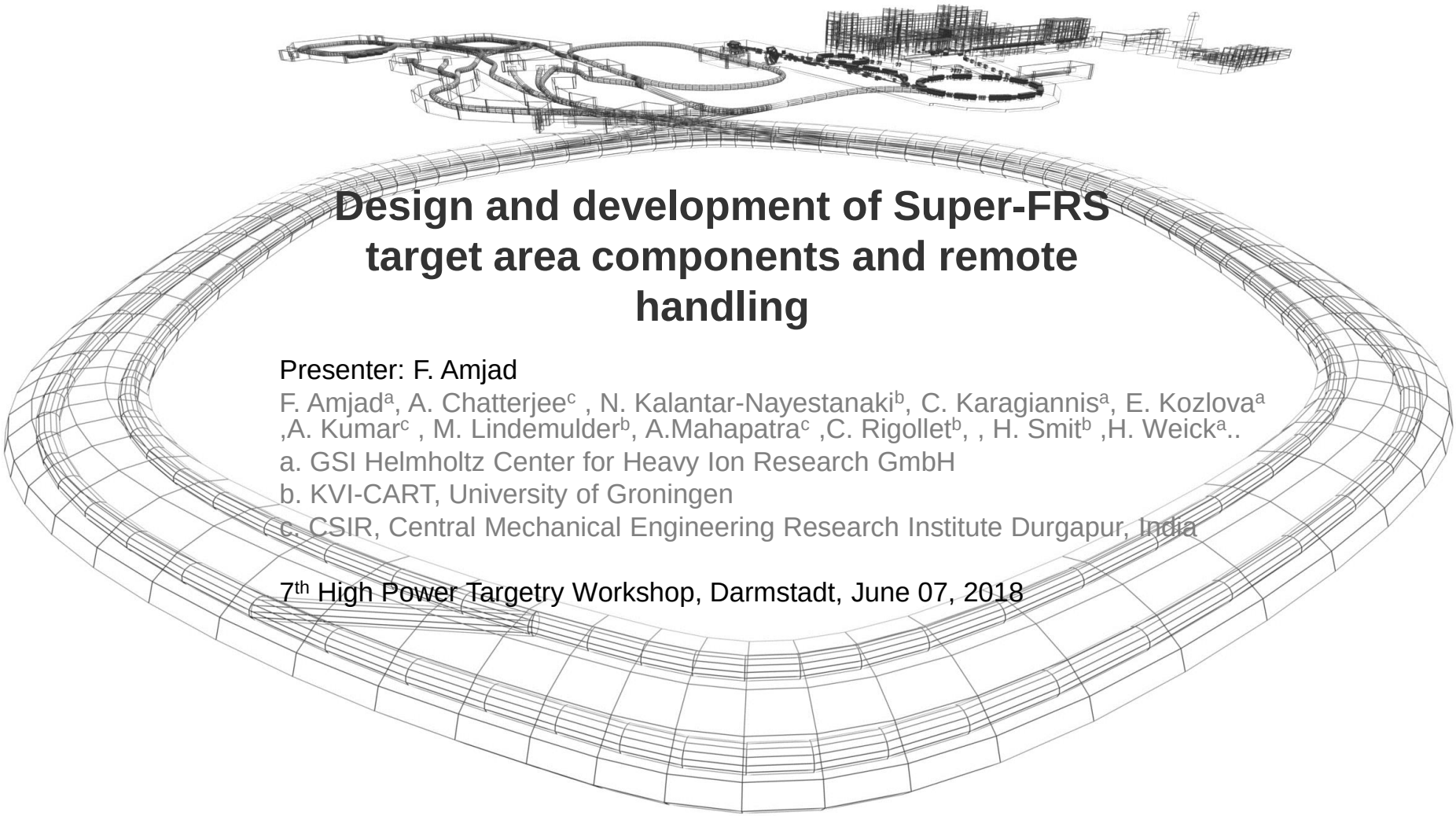

Design and development of Super-FRS target area components and remote handling

Presenter: F. Amjad

F. Amjad[a], A. Chatterjee[c] , N. Kalantar-Nayestanaki[b], C. Karagiannis[a], E. Kozlova[a] ,A. Kumar[c] , M. Lindemulder[b], A.Mahapatra[c] ,C. Rigollet[b], , H. Smit[b] ,H. Weick[a]..

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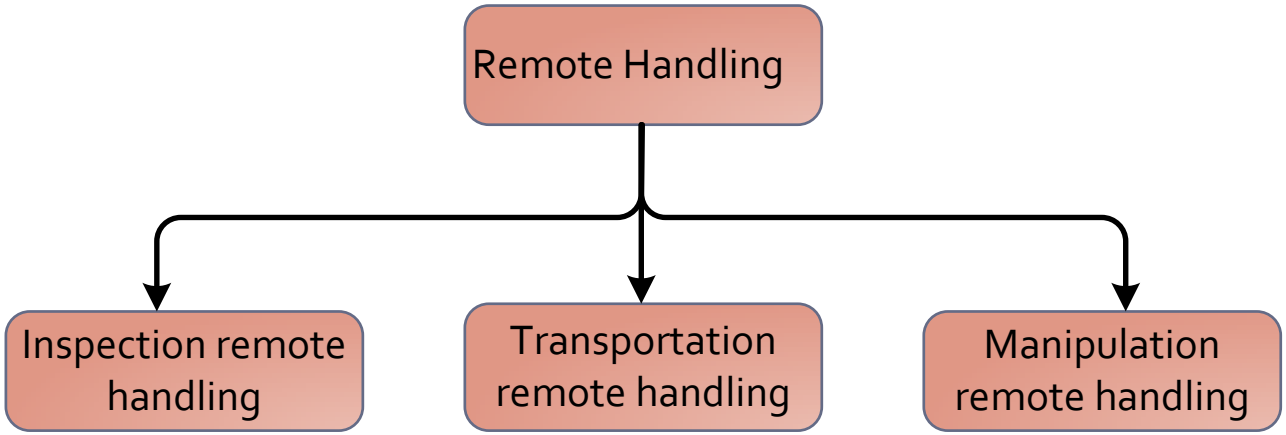
7th High Power Targetry Workshop, Darmstadt, June 07, 2018

Presentation Outline

- Introduction to Remote handling at GSI
- Remote handling at particle accelerator facilities
- Super-FRS scenario
- Super-FRS components remote handling
- Summary
- Future outlook

Remote Handling introduction

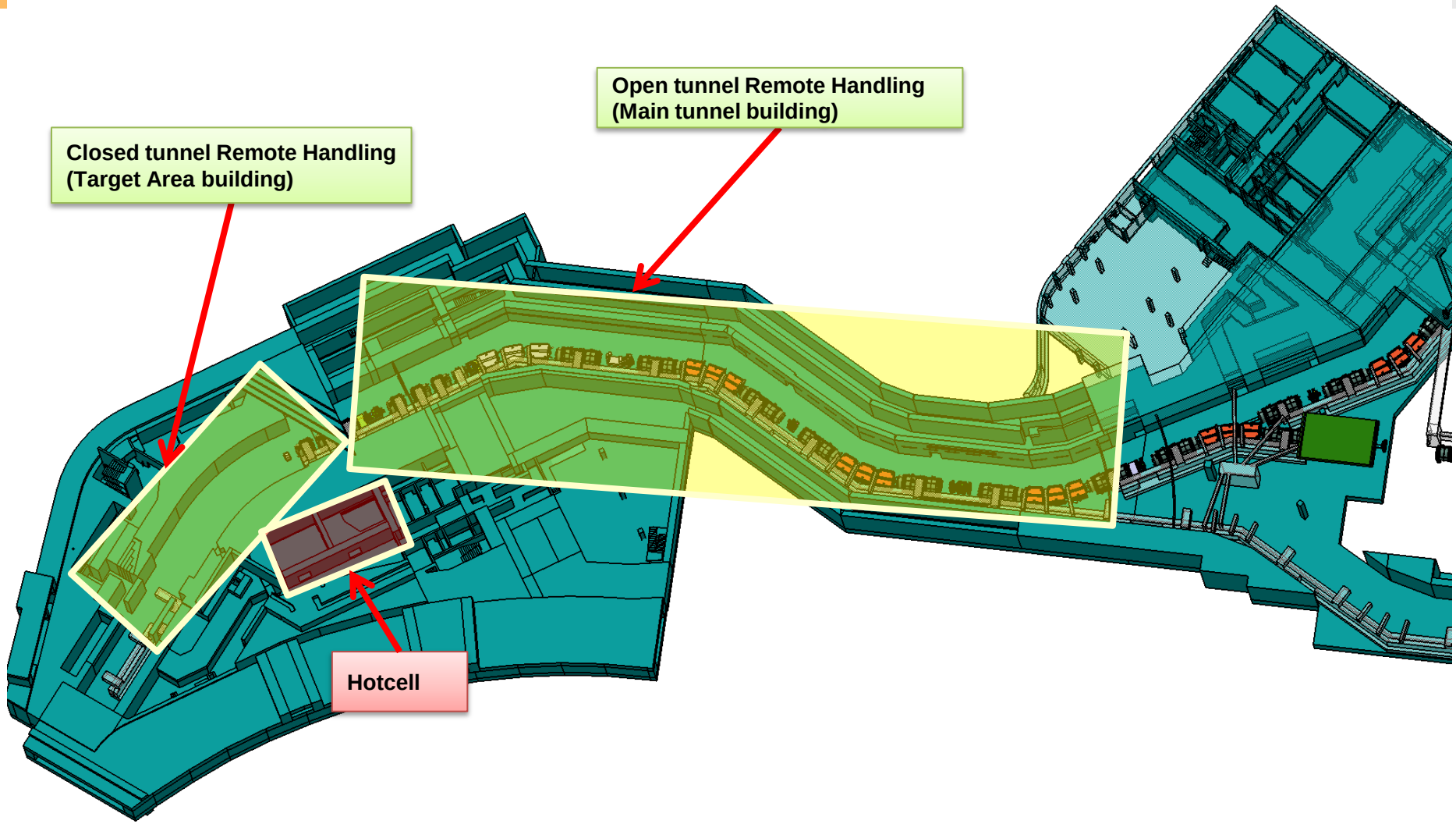
- Where to use remote handling?
  - It is used in hazardous environment with radioactive components where hands-on inspection and maintenance is not possible.
- Remote handling categories:
  - Inspection of hazardous environment
  - Transportation (Transfer of activated parts)
  - Manipulation (Maintenance / disposal of activated parts)



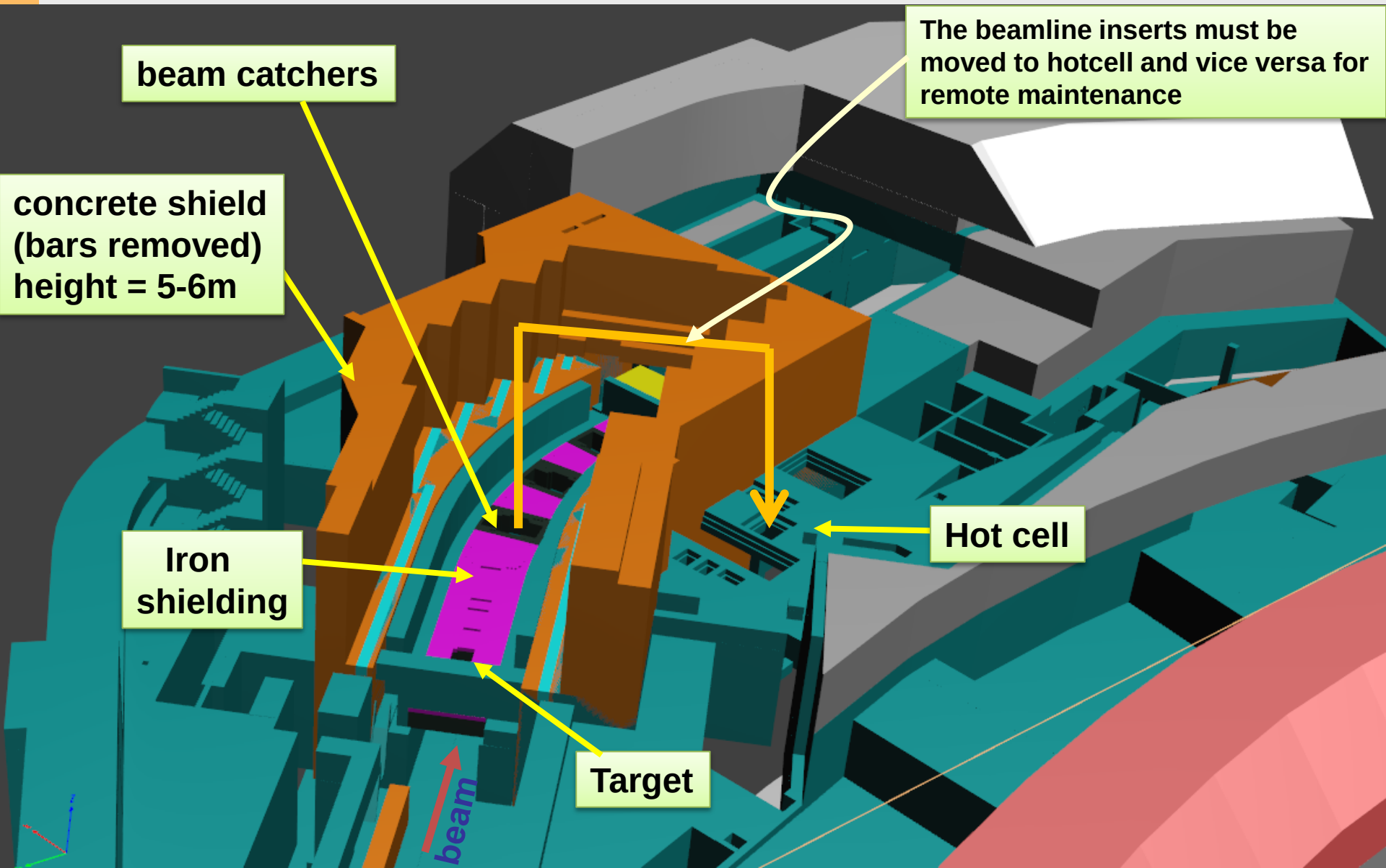
Classification of facilities based on remote handling setup

- Four main type of remote handling facilities
  - **Closed tunnel:** facility is developed with a closed tunnel design concept and a vertical plug system (e.g. PSI, J-PARC)
  - **Integrated hotcell and target area:** facility builds the hotcell on top of the target area (e.g. SNS, JSNS, SPIRAL 2, FRIB)
  - **HEP facilities:** facility uses very high-energy beams (LHC) are built with open underground tunnels to provide natural shielding as shielding.
  - **Open tunnel:** facility was developed with an open tunnel that uses localized shielding around the target area (e.g. FRS, ISOLDE)

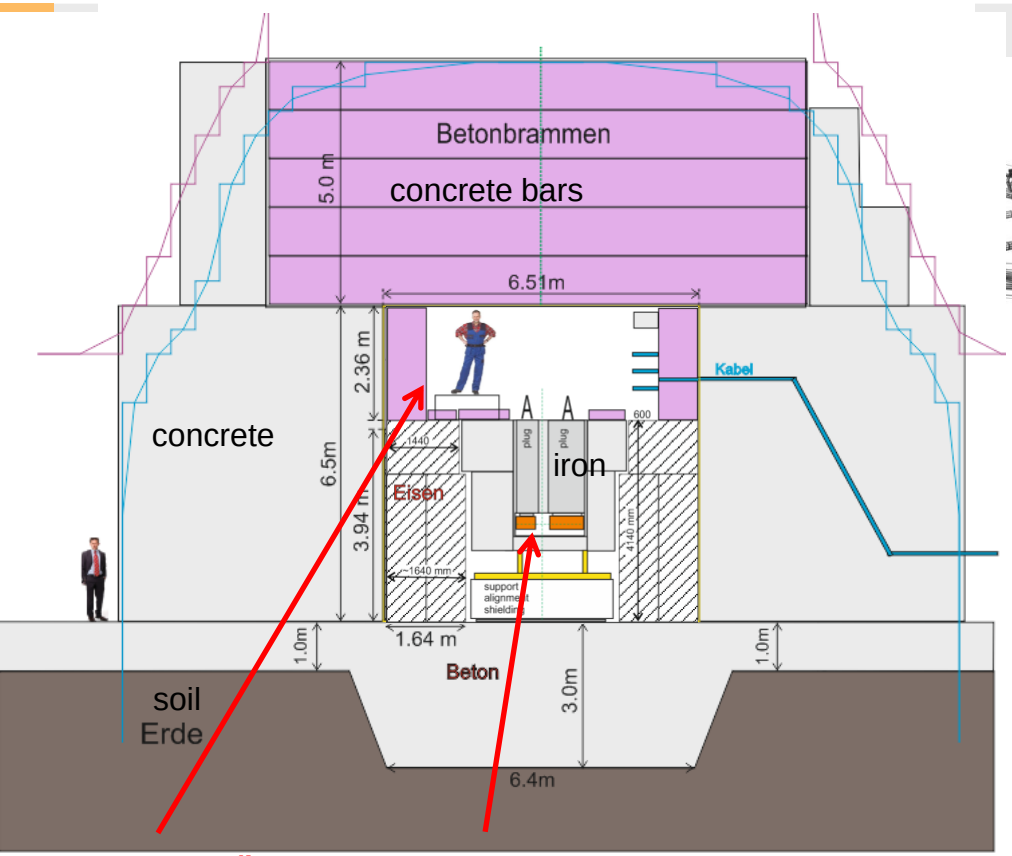
Super-FRS Remote handling scenario

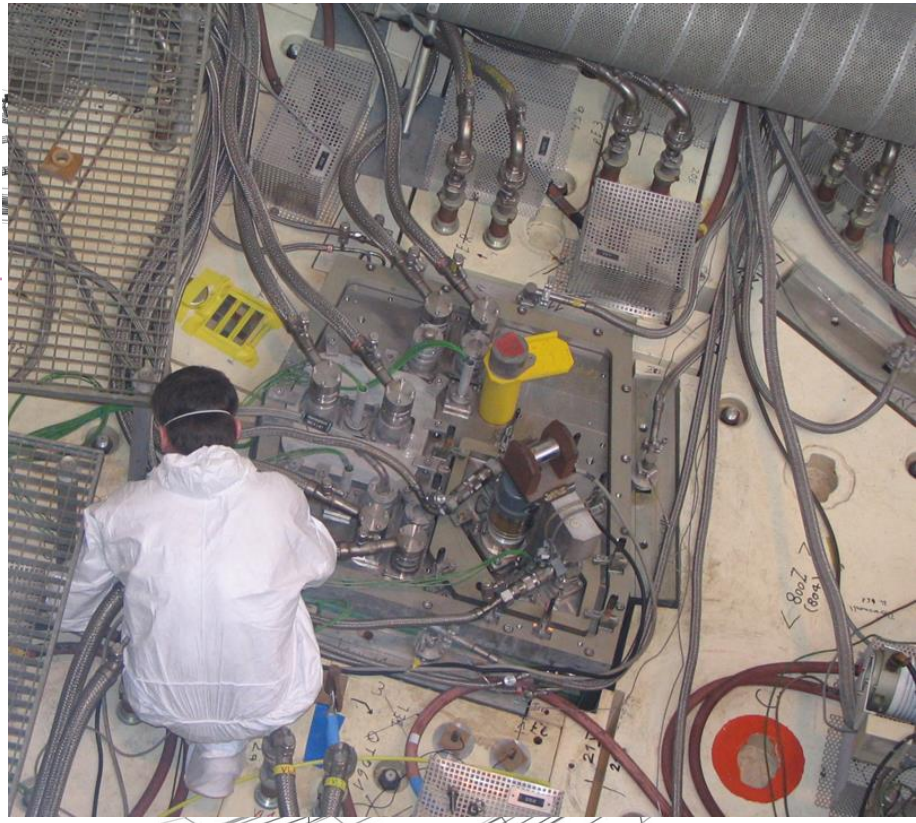


Target area buidling



Radiation Shielding





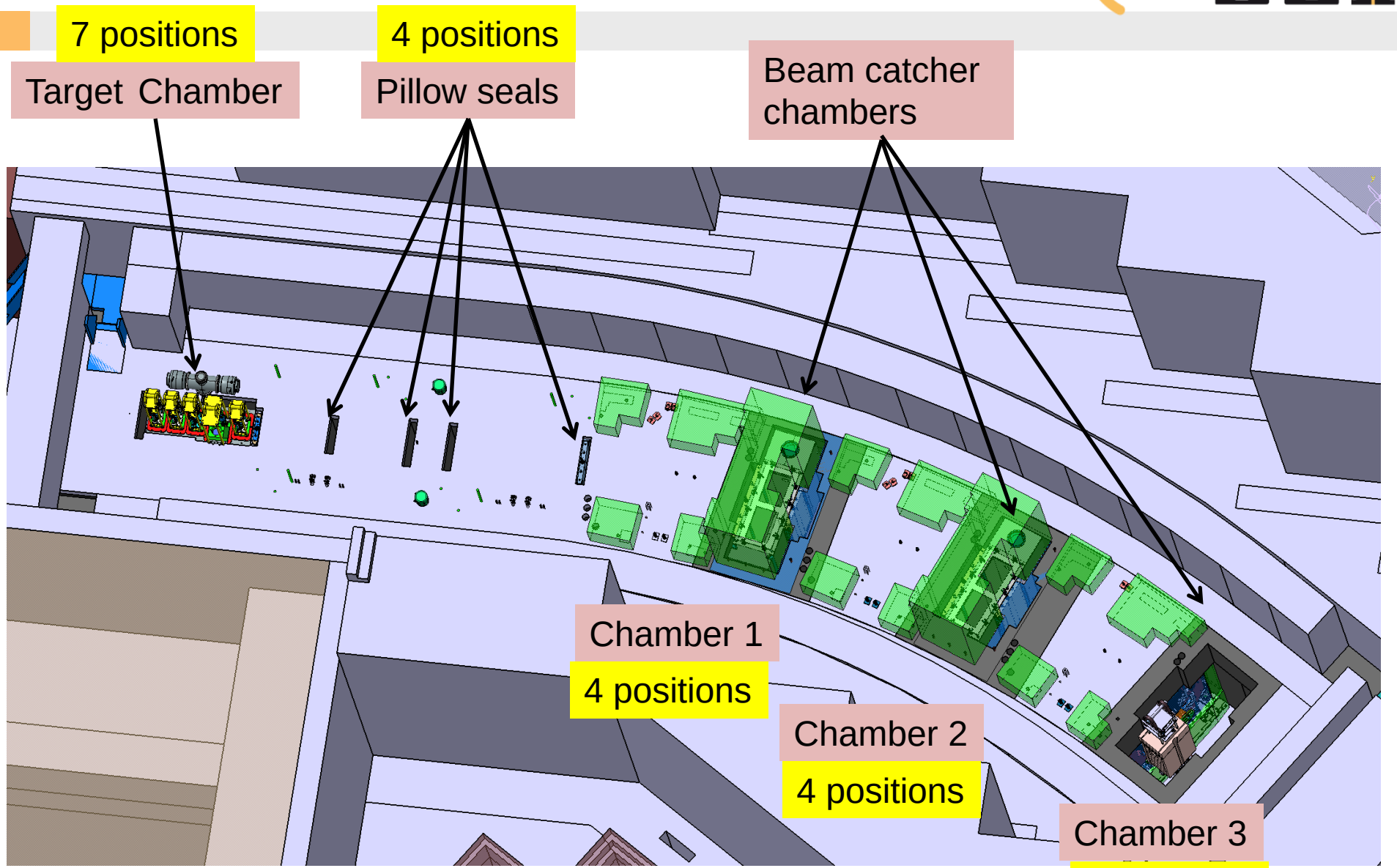
~ 10 μSv/h 7 Sv/h

Activation after beam times,
but access to maintenance tunnel
possible thanks to integrated shielding.
Also shielding becomes activated.

PSI Switzerland
same concept,
top of chamber

H.Weick

Super-FRS target area beamline remote handling positions for shielding flask (60t)



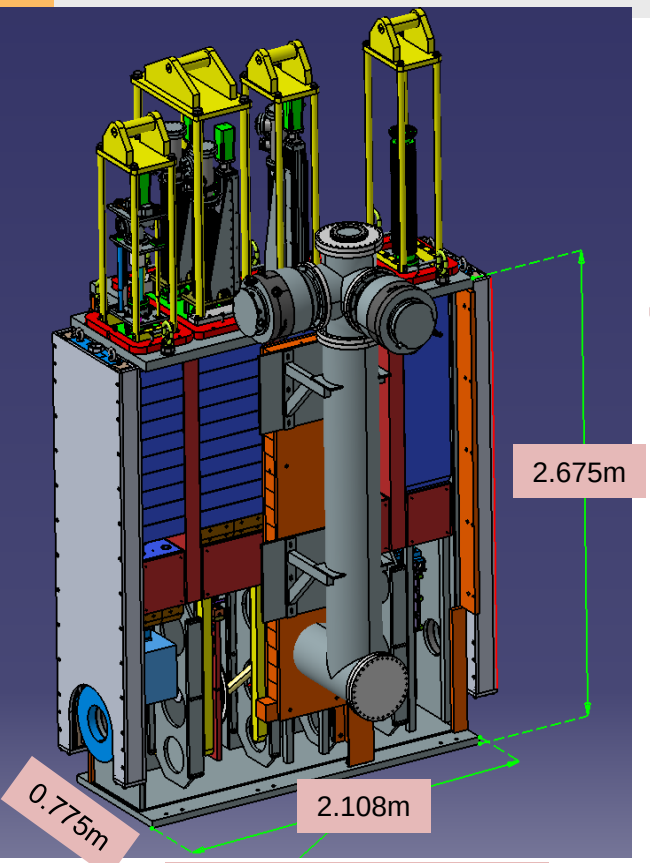
Remote handling classes for Super-FRS components

RH classes for components	
RH Class	Description
1	Components requiring regular planned replacement.
2	Components that are Likely to require repairs and replacements.
3	Components that are not expected to require maintenance or replacement during life time of facility but would need to be replaced remotely in case if they fail.
4	Components that do not require remote maintenance

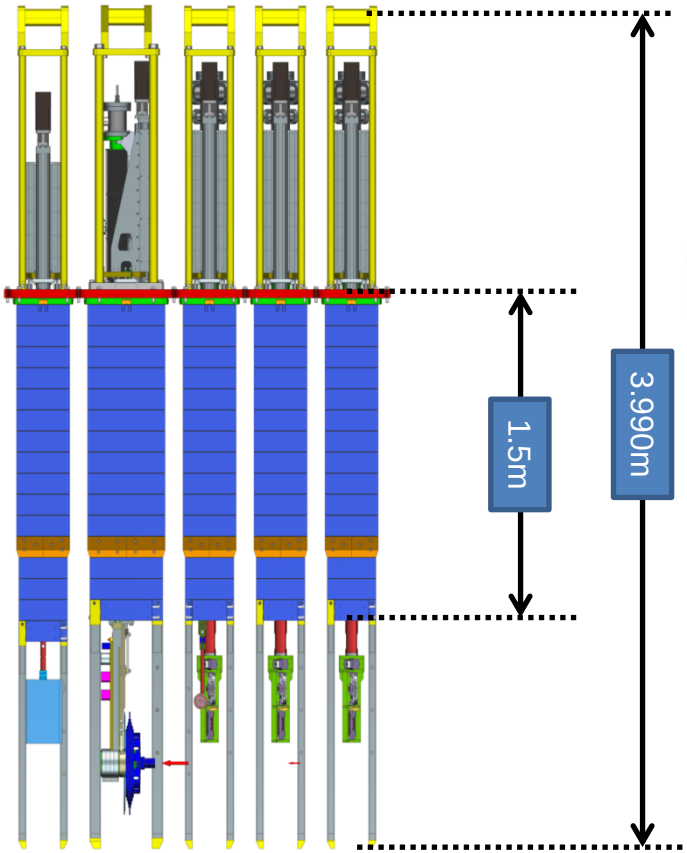
System	Major components	RH class
Magnet system	Magnets	3
	Alignment support	3
Plug system	Vacuum chamber	3
	Alignment support	3
	Plugs	1, 2 and 4
Working platform	All components (vacuum pumps, drives, media connections, among others).	4

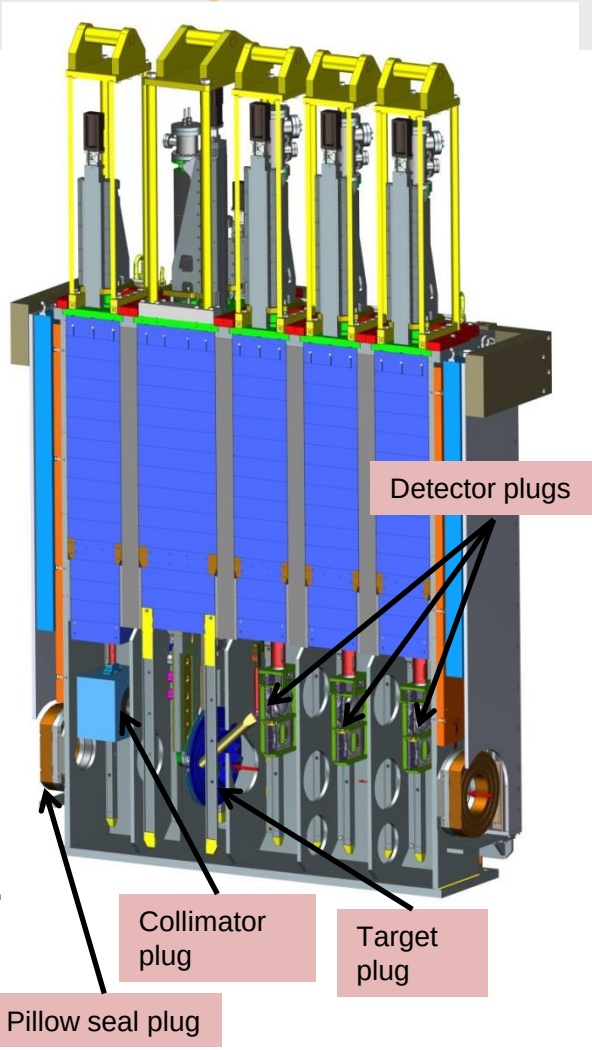
Table 1. RH class for each major component in the target area

Target Chamber plugs



Target vacuum chamber

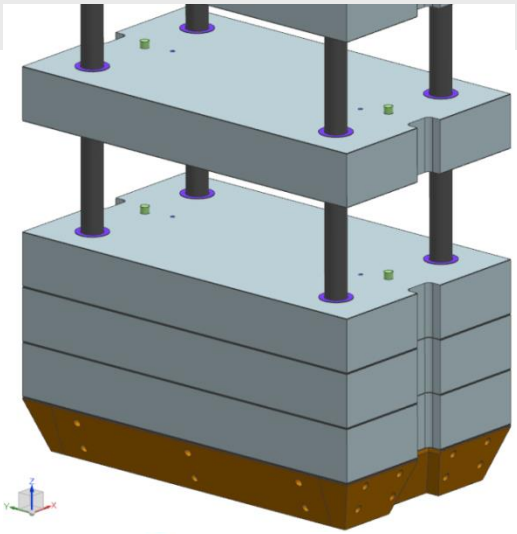


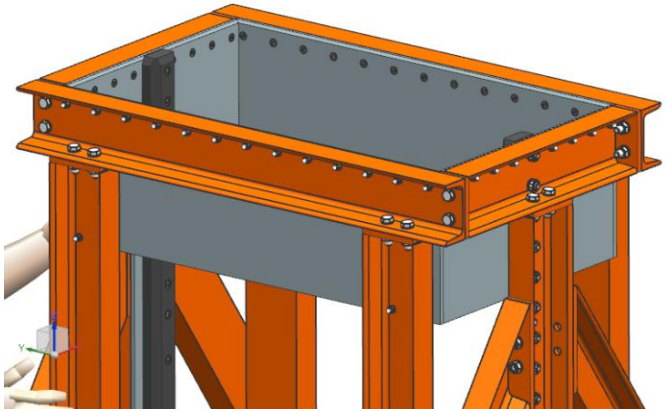


- The target station plugs have the same height, approximately 4000 mm.
- The 1,5 m shielding length is achieved by stacking 15 blocks of 100 mm thickness each.

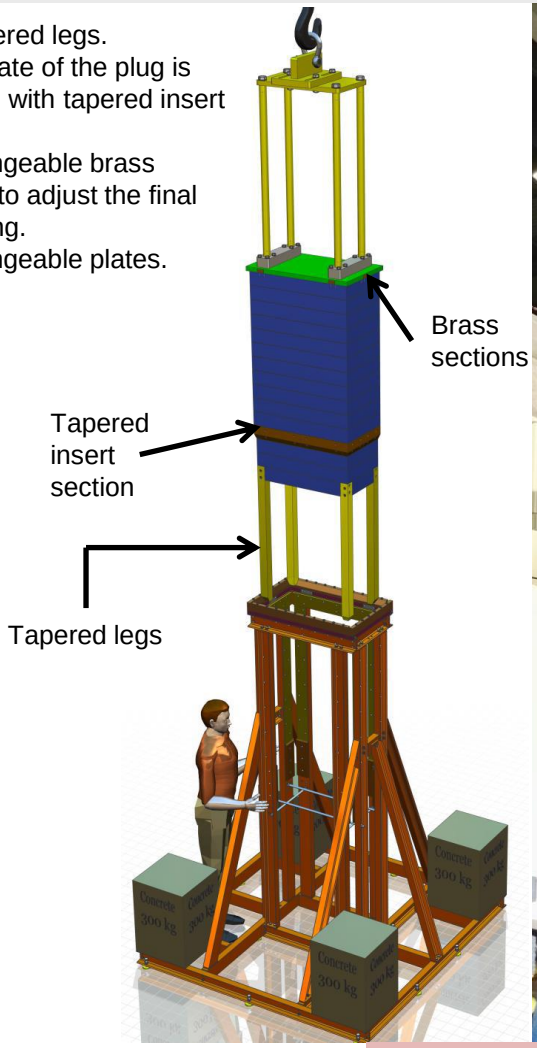
C.Karagiannis, M. Lindemulder, H,.Smit

Self-seeking plug guidance





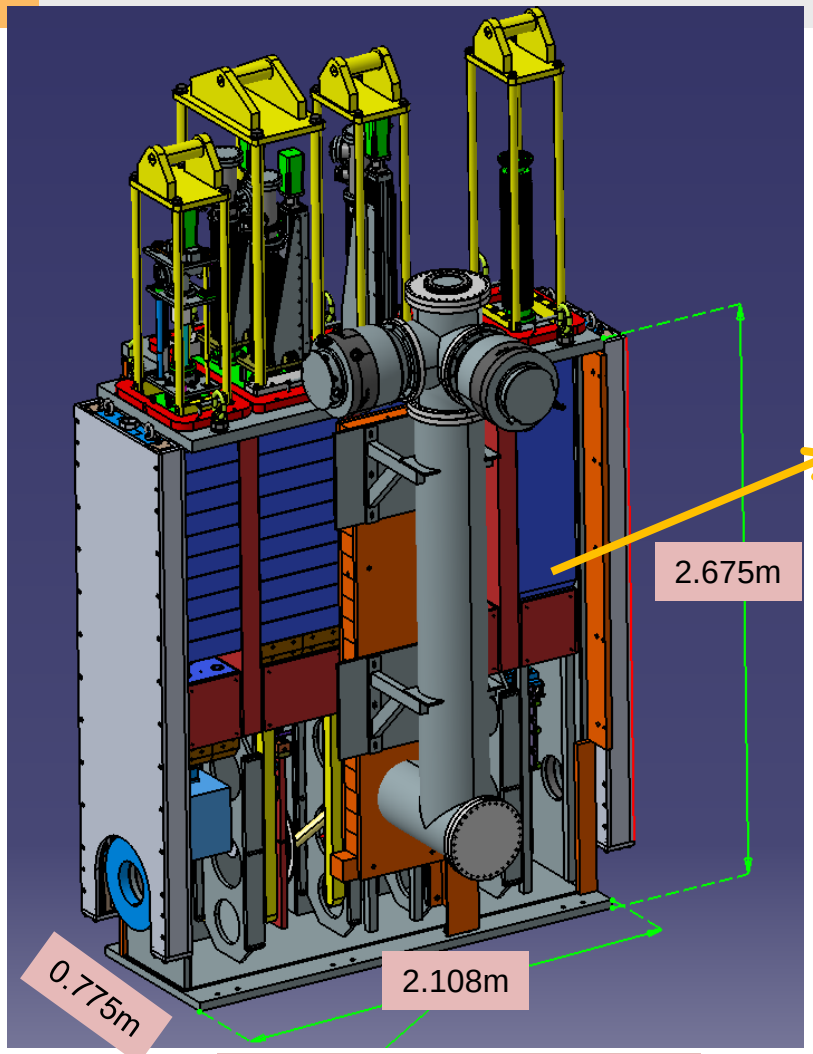
- Four tapered legs.
- Fourth plate of the plug is equipped with tapered insert parts.
- Interchangeable brass sections to adjust the final positioning.
- Interchangeable plates.



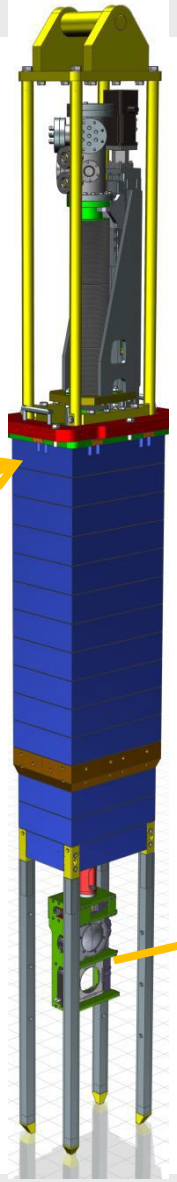
Plug Test Setup

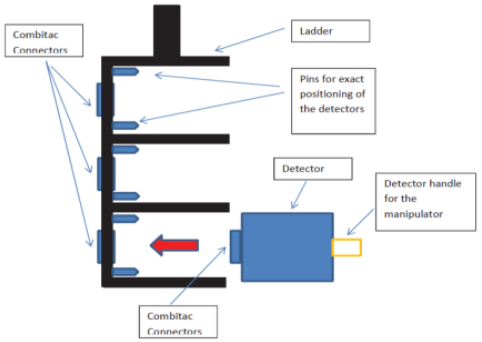
required: ± 20mm shift, 2 mrad tilt
tested up to 70mm and 7 mrad

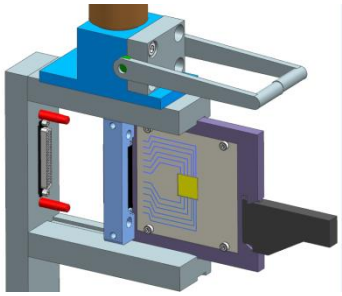
Target chamber
Detector plug



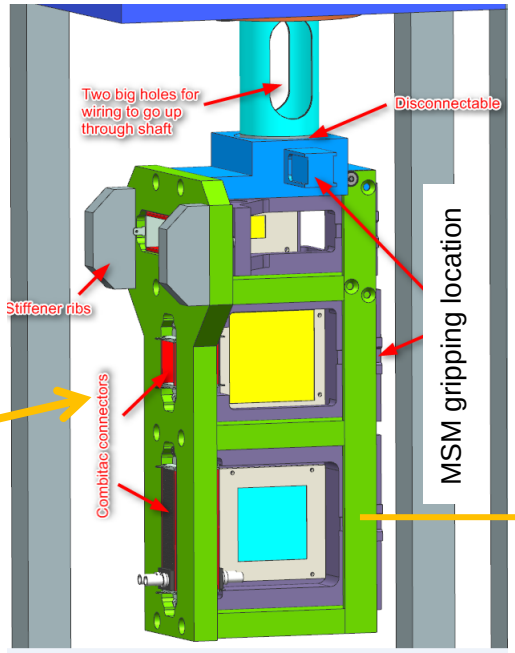
Target vacuum chamber





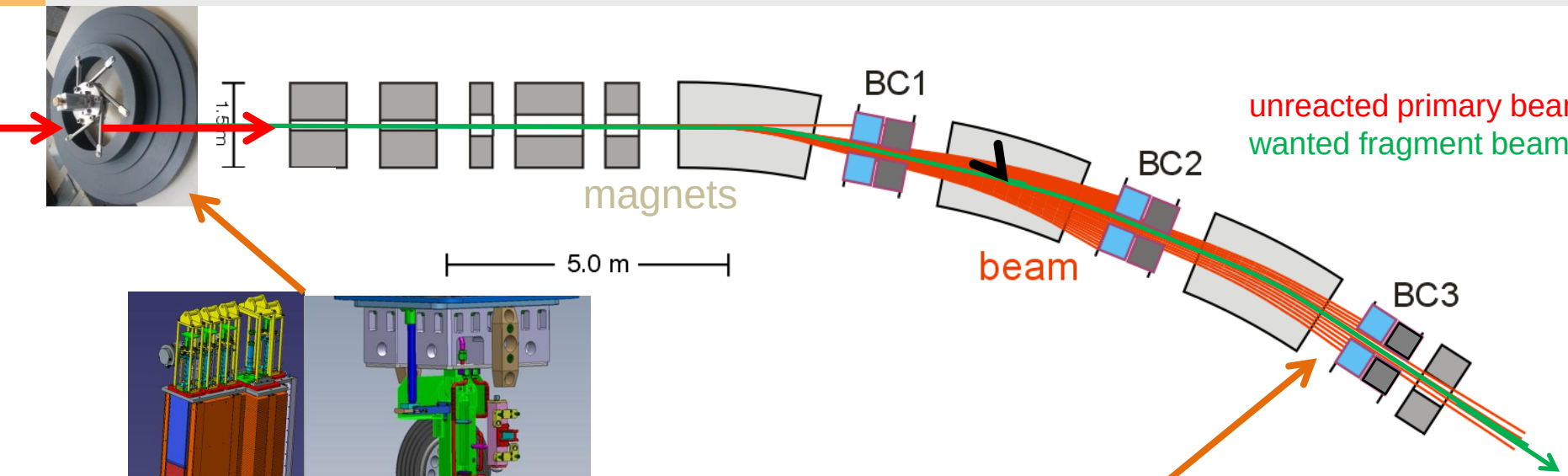


Detector ladder with slots for single detectors

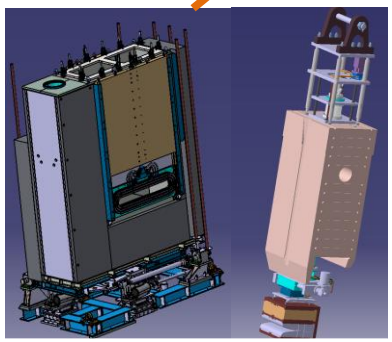


university of groningen

Beam Catchers
contribution of India to FAIR



Target Wheel

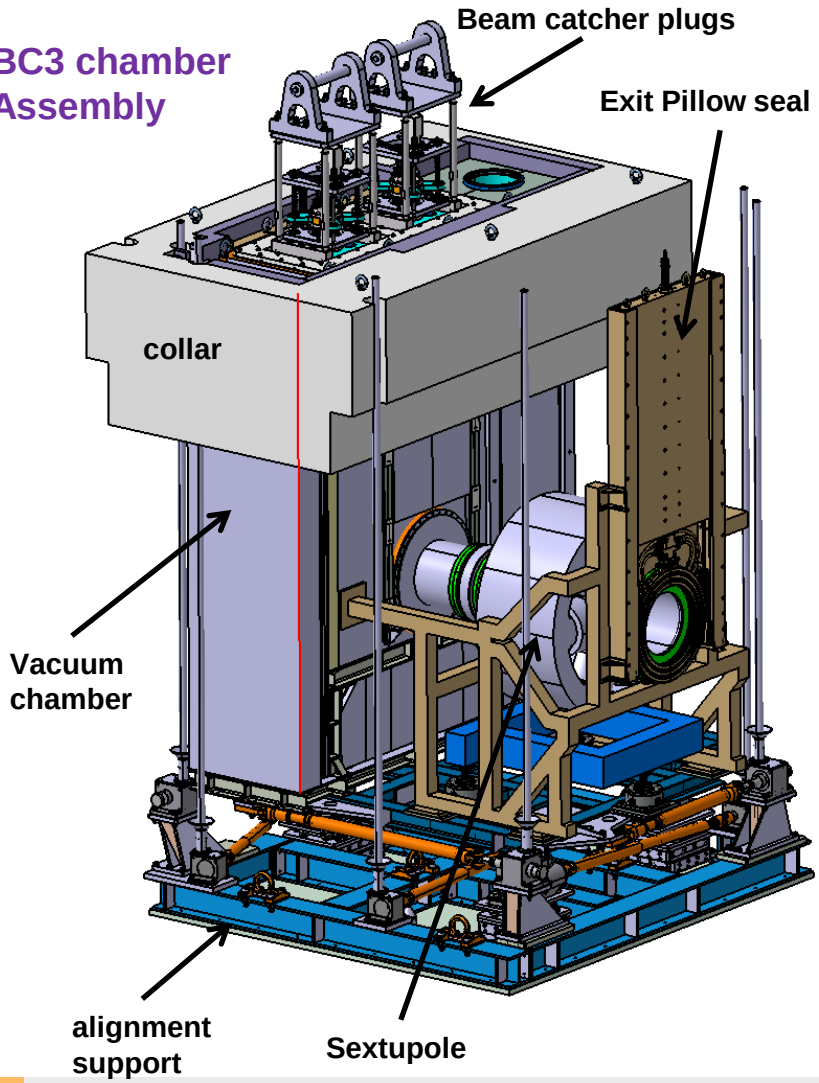


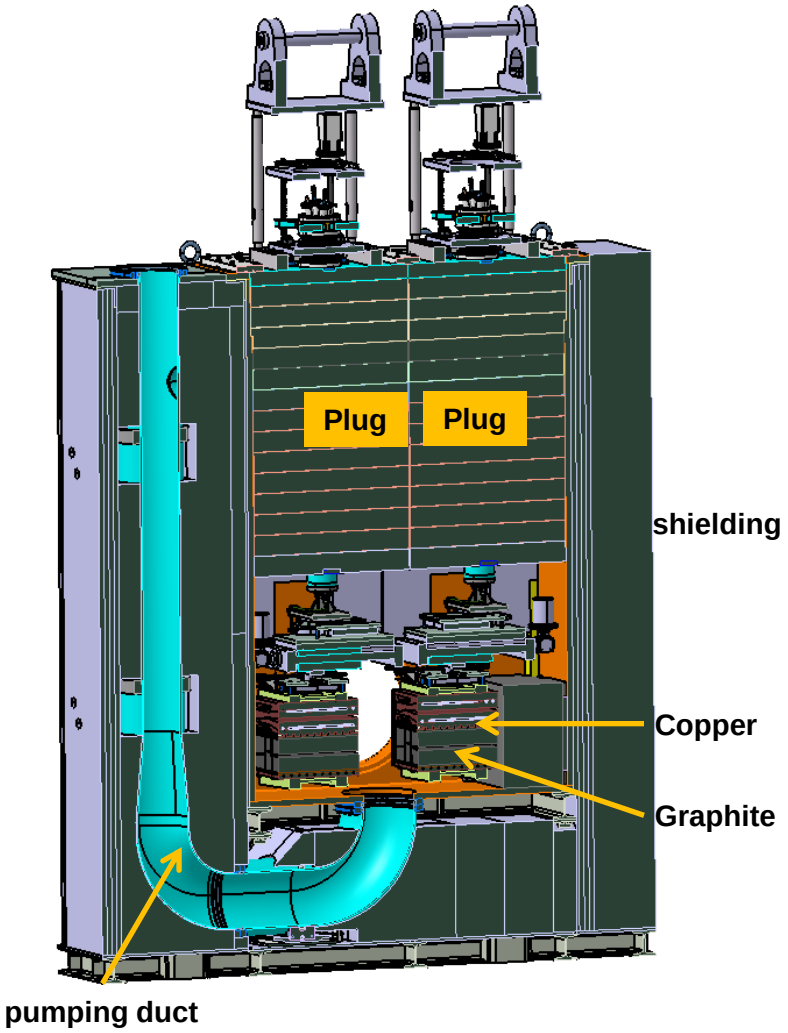
Beam catcher chamber and Plug

H.Weick

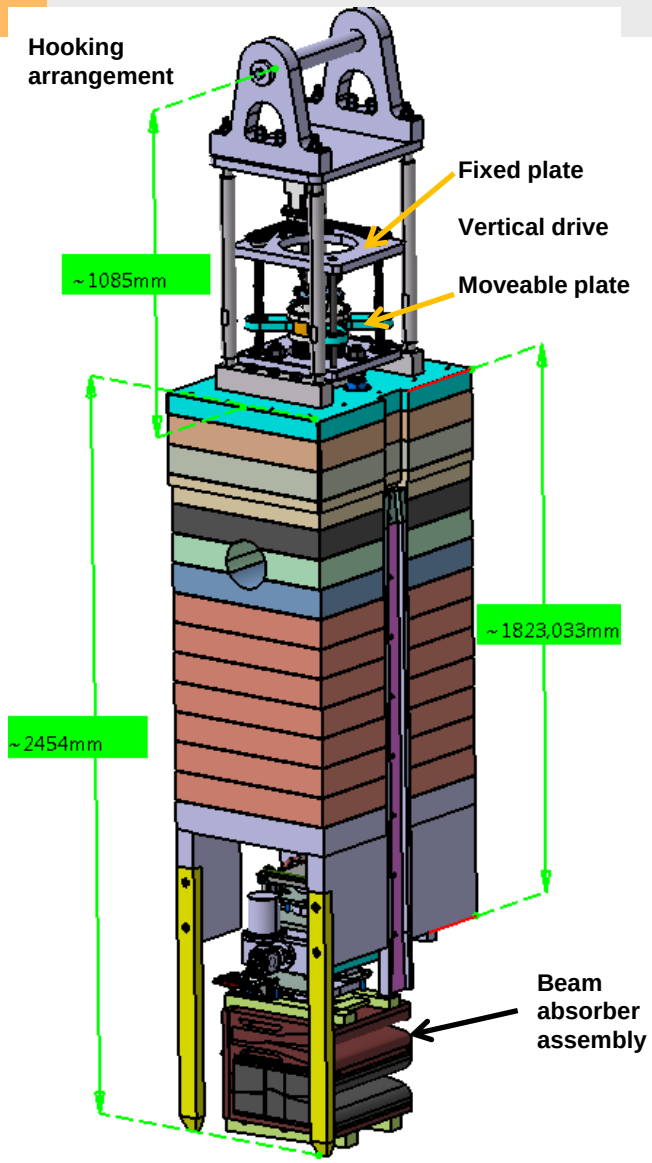
Beam Catchers
contribution of India to FAIR

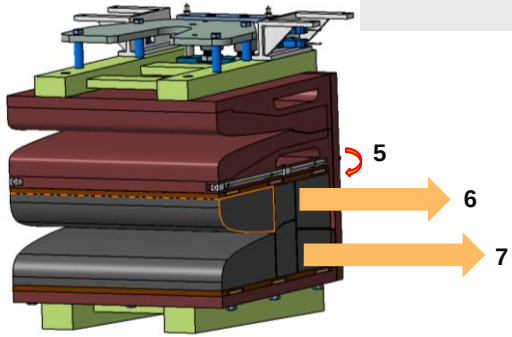
BC3 chamber Assembly

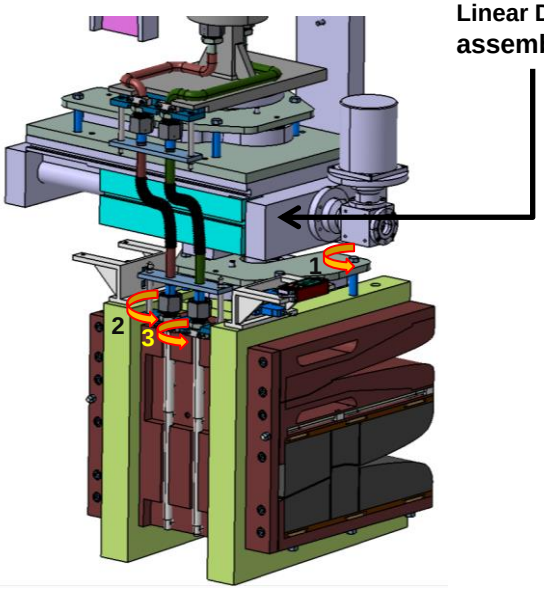


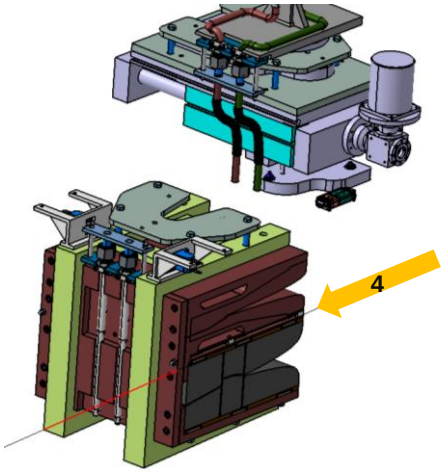


Beam catcher
Remote handling concept (Modular design)





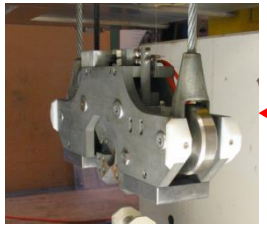




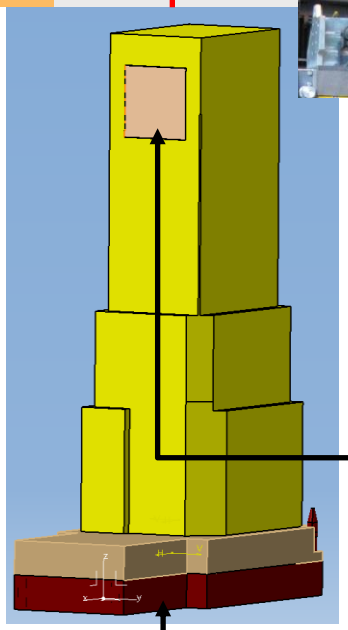
1 Release the connectors beam absorber assembly
2 & 3 disconnect the water cooling pipe connections
4 Disengage the beam absorber assembly
5 Uncouple the rods holding the graphite blocks in the absorber assembly
6 & 7 Remove the graphite absorber part
8 install new graphite parts and carryout assembly process.

Super-FRS Shielding flask (1/4)

Hall (80t)
crane interface

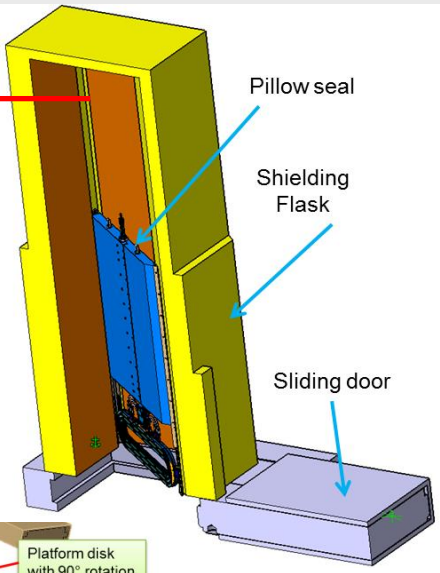


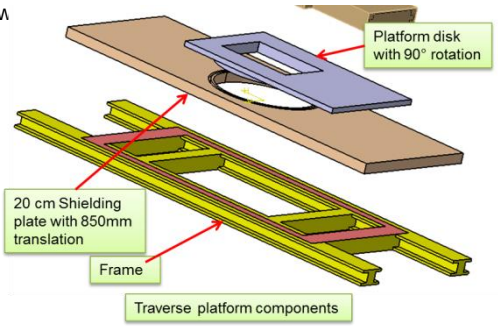
9t internal crane

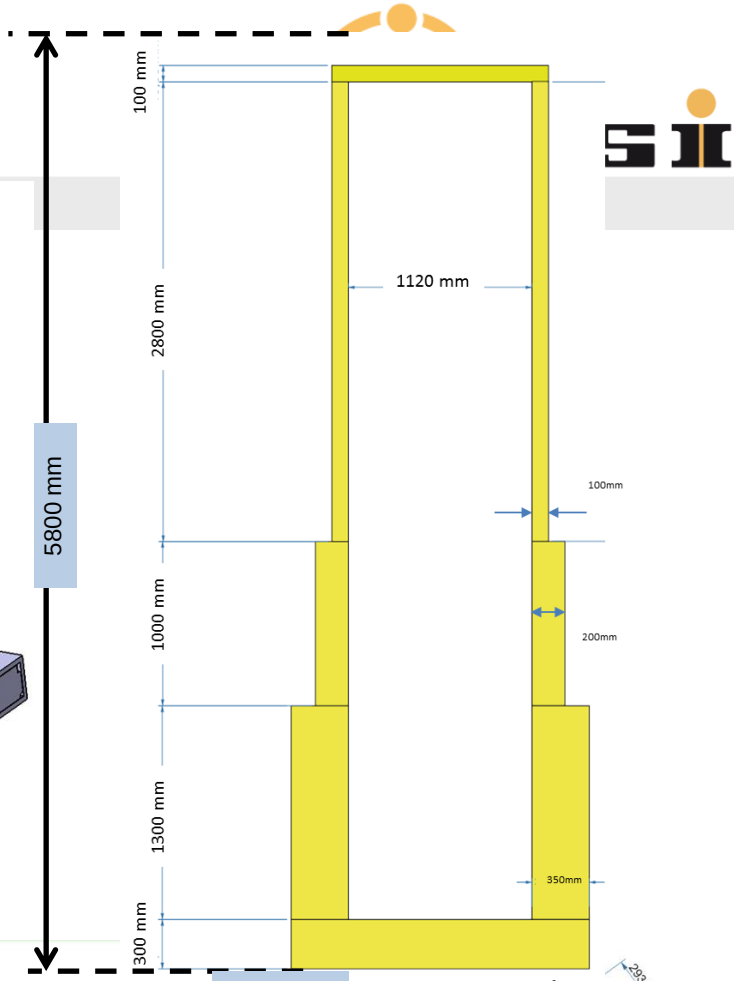


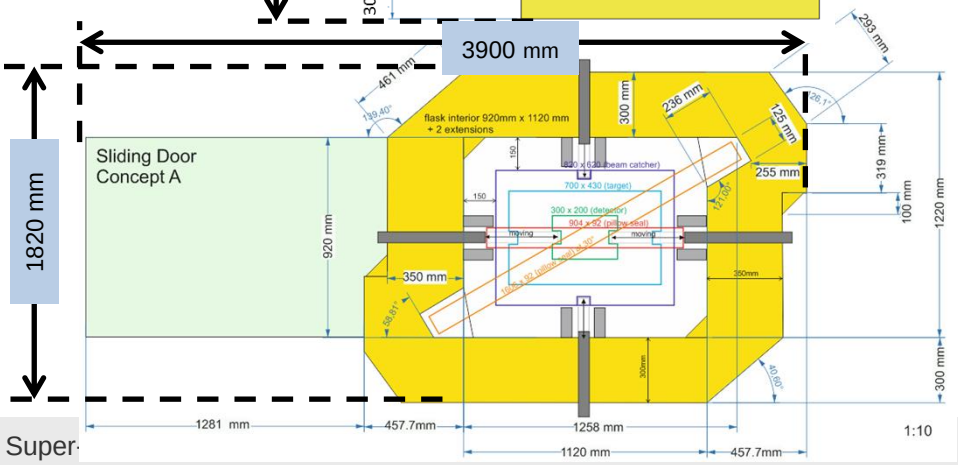
Emergency
access
window

Hotcell
interface



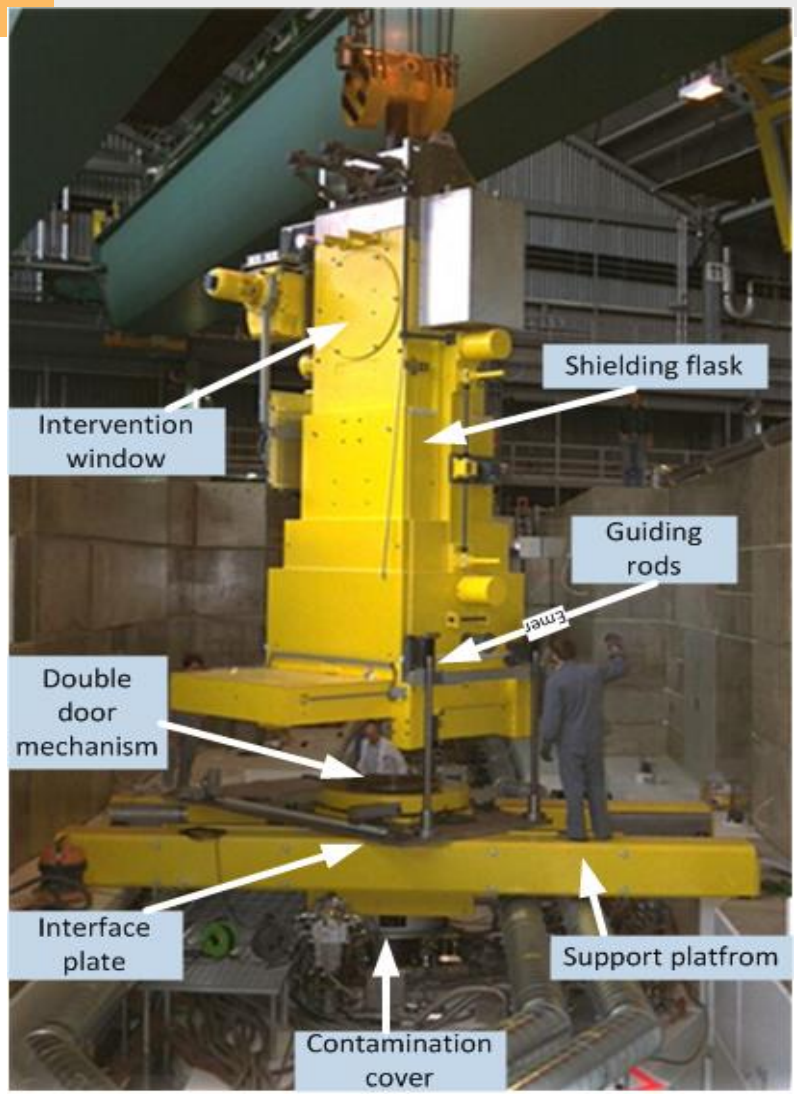






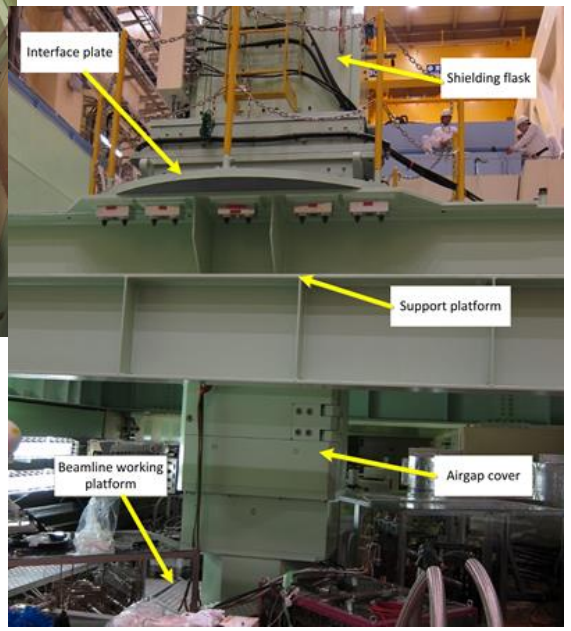
- Design and develop according to legal (KTA) standards
- Shielding flask height: ~5.8m (including internal carne installation)
- Foot print of shielding flask: 3.9m x 1.820 m (including the sliding door frame)
- Internal dimensions 5.1m x .820m x .904m
- Estimate weight of 66t
- In the designs (DN500) round pillow seal diagonal direction (tilted by ~30°)
- The design goal is a maximum dose rate of 10 µSv/h on the outside surface in all normal operation.

Super-FRS Shielding flask (2/4)
Examples / Arrangement

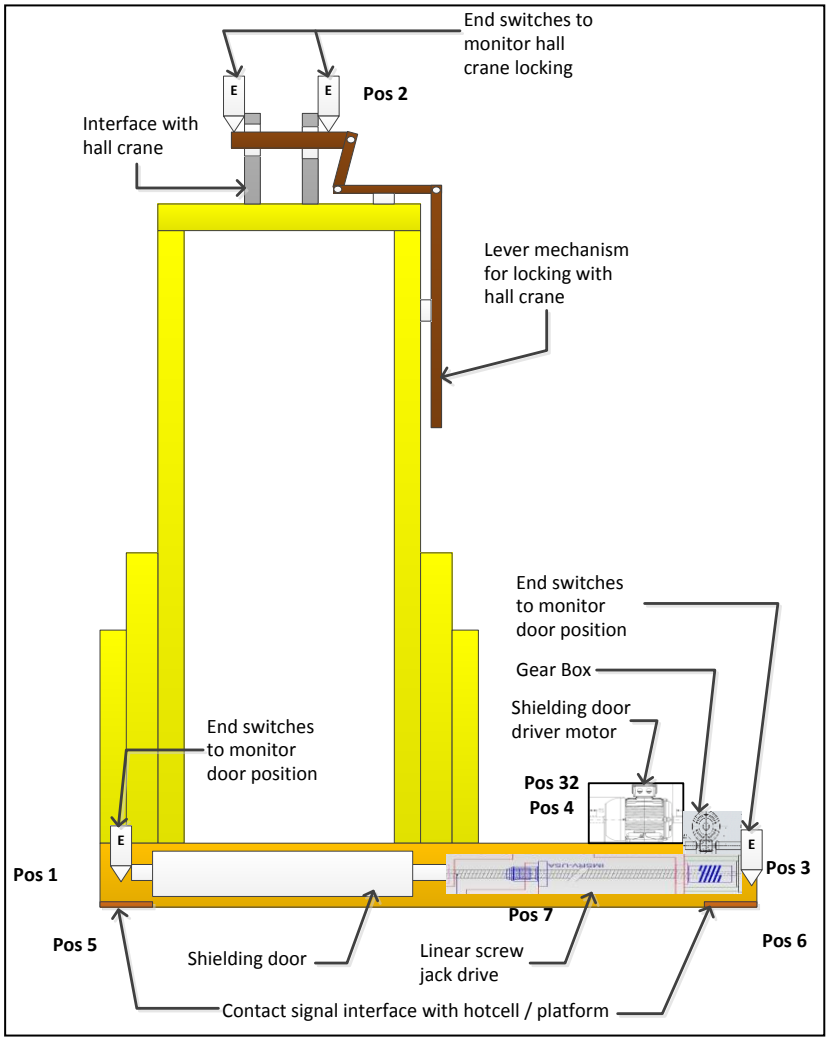


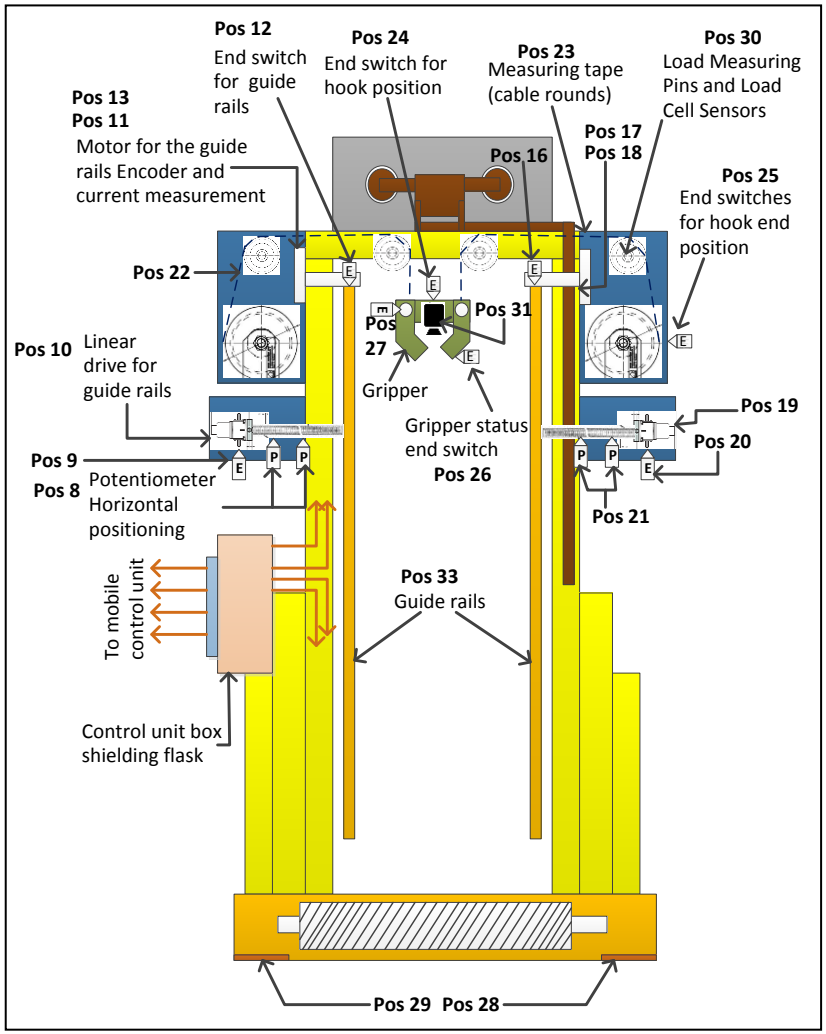
PSI shielding Flask

J-PARC shielding Flask



Super-FRS Shielding flask (3/4) control signals



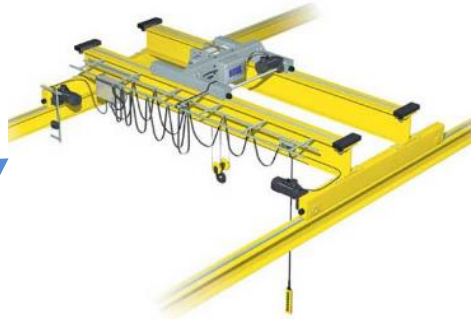


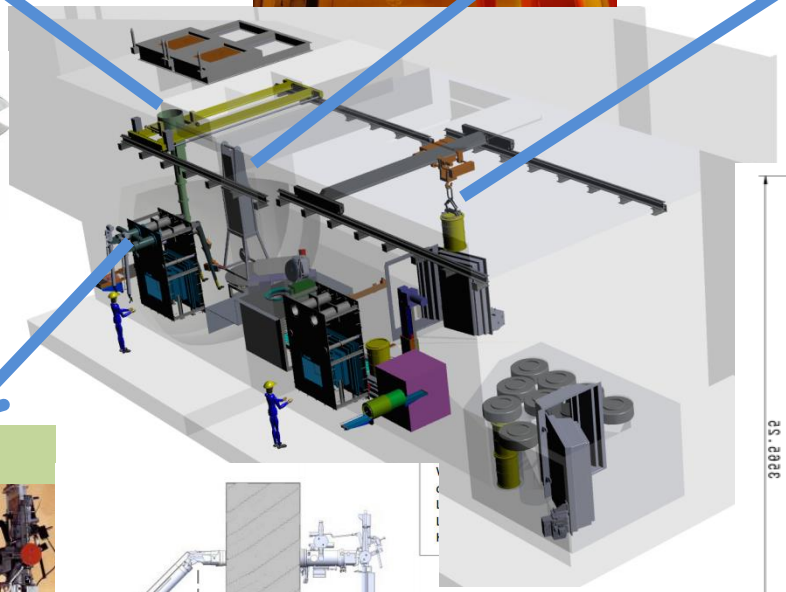
Super-FRS Hot cell

Plug Holder

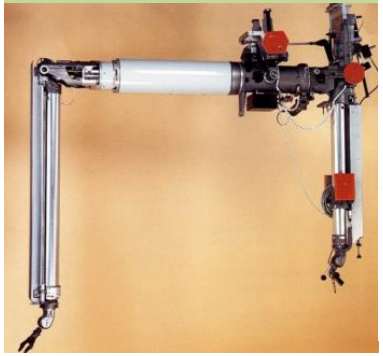
Power manipulator

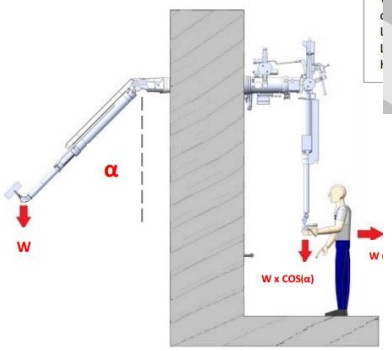
Indoor overhead crane

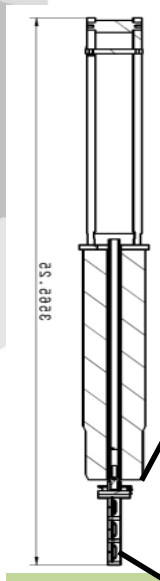




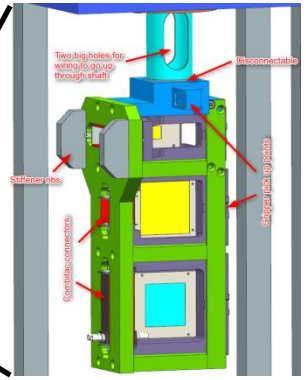
MT200 MSM





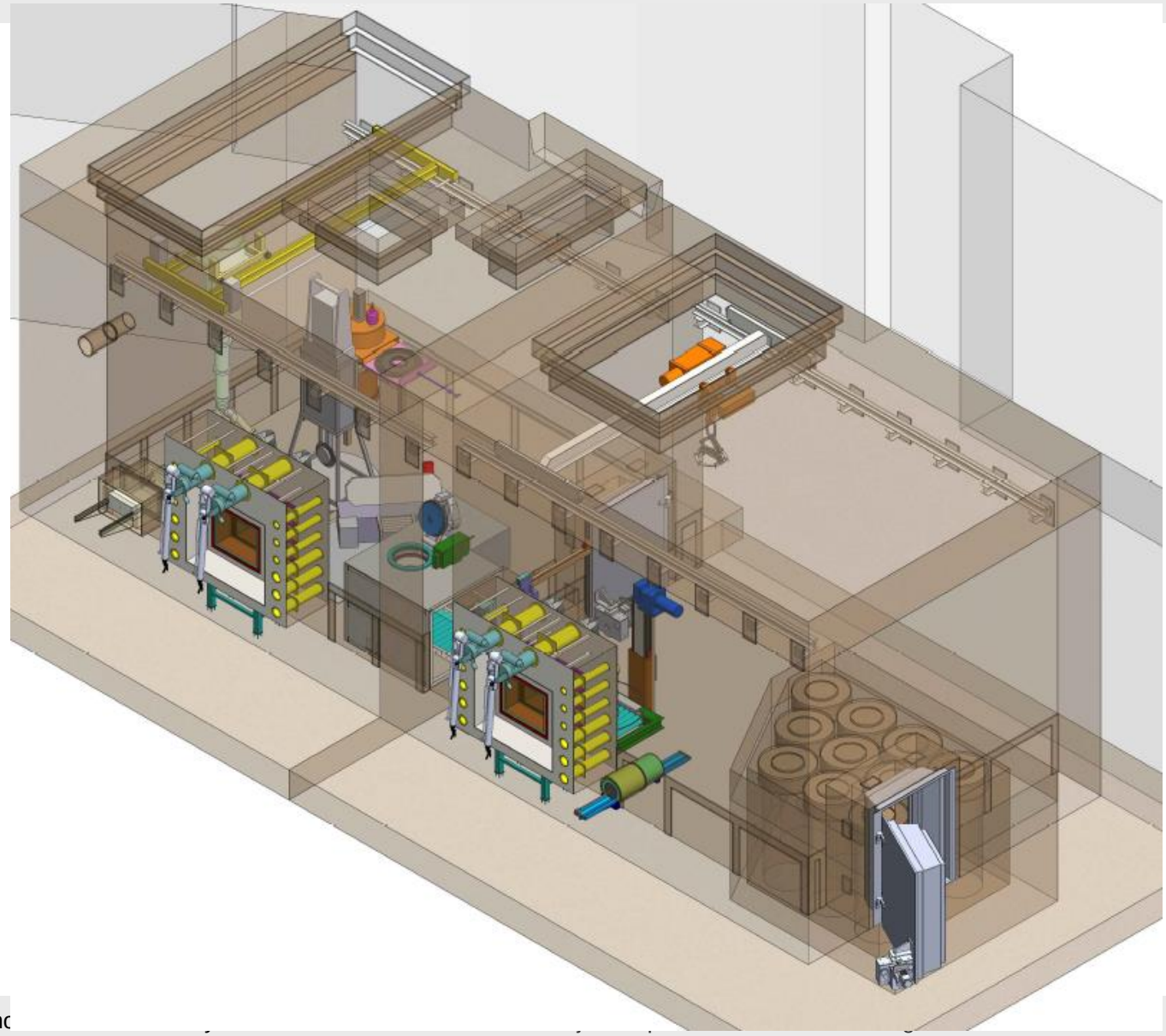


Detector plug



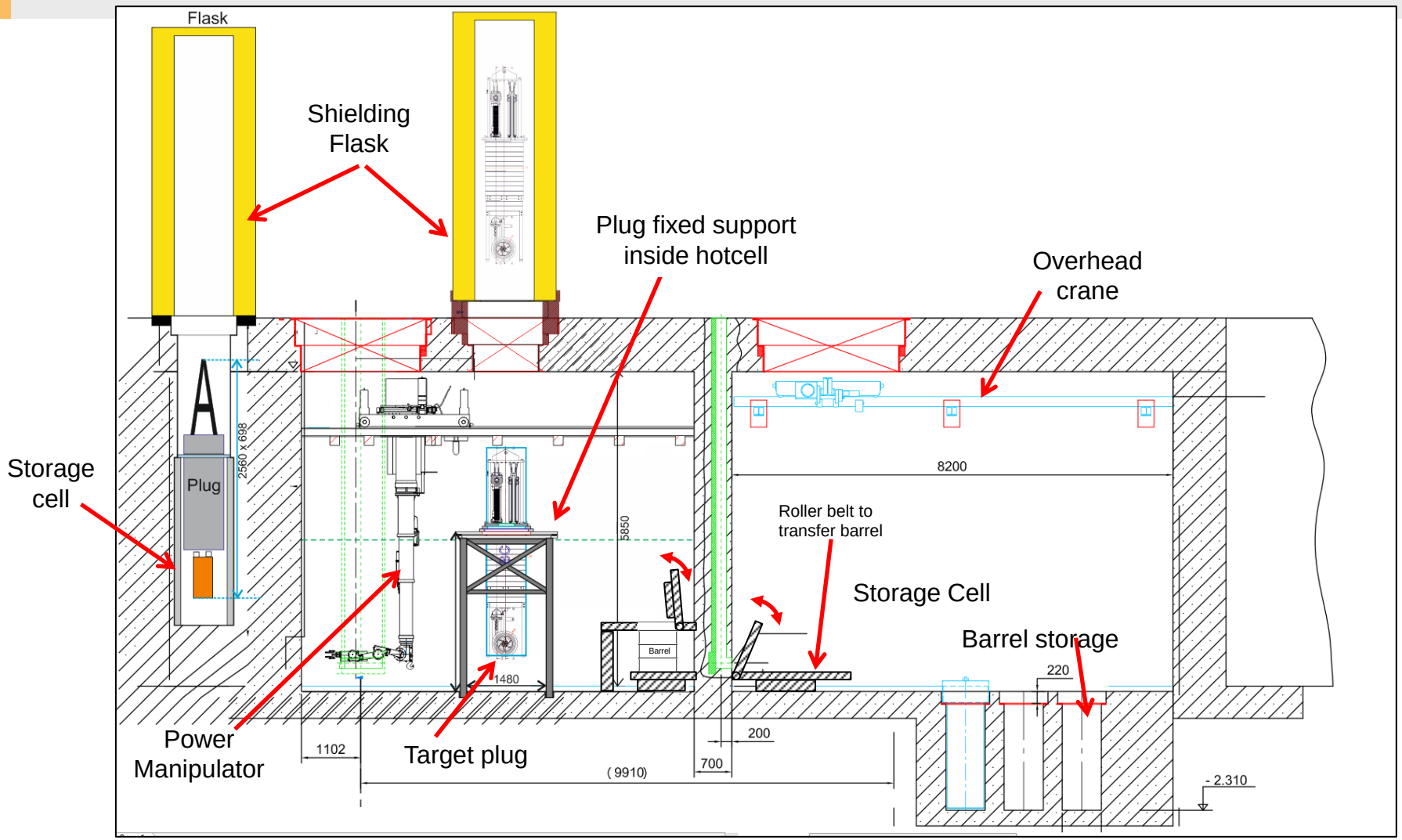
Modular Design

Super-FRS Hot cell

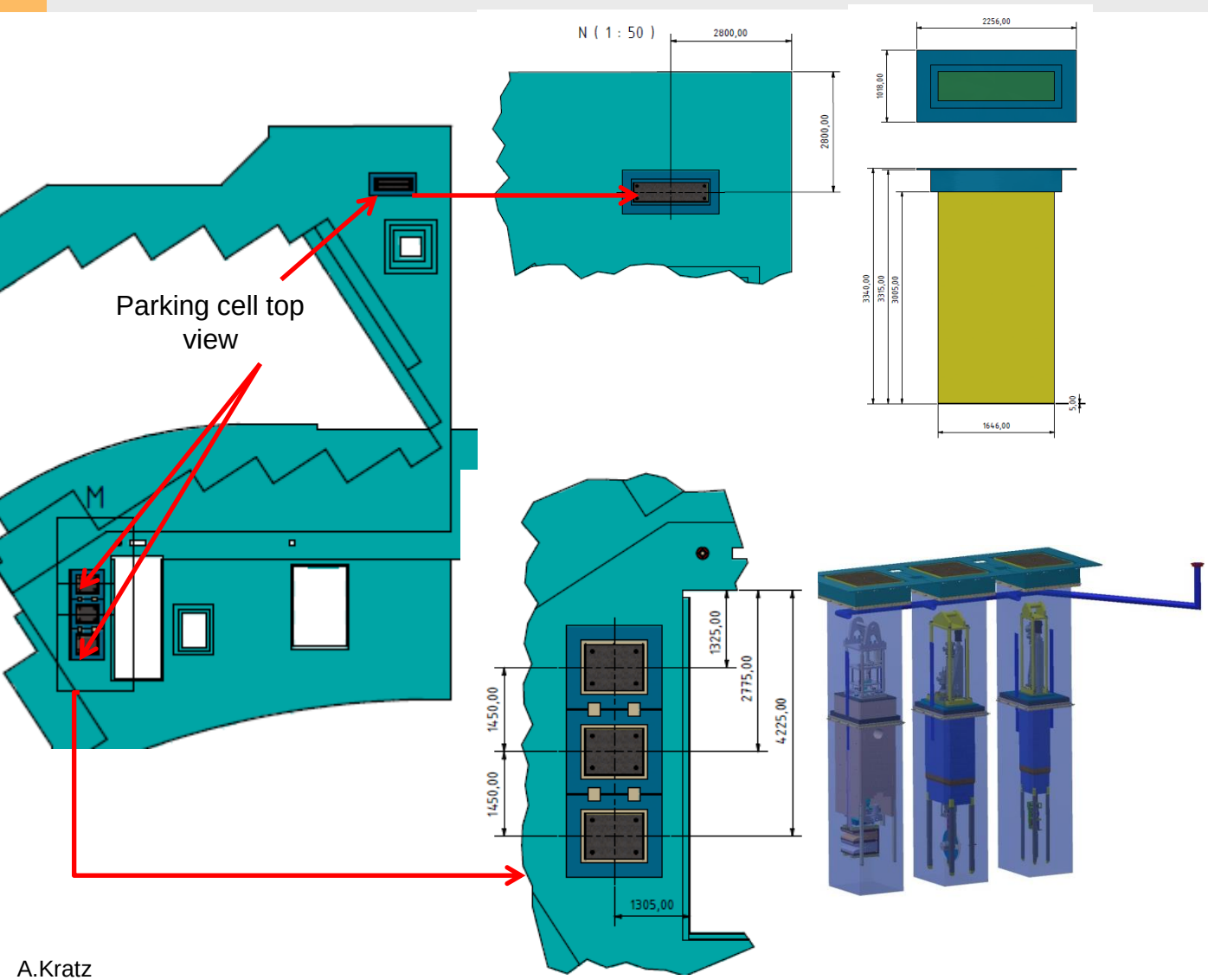


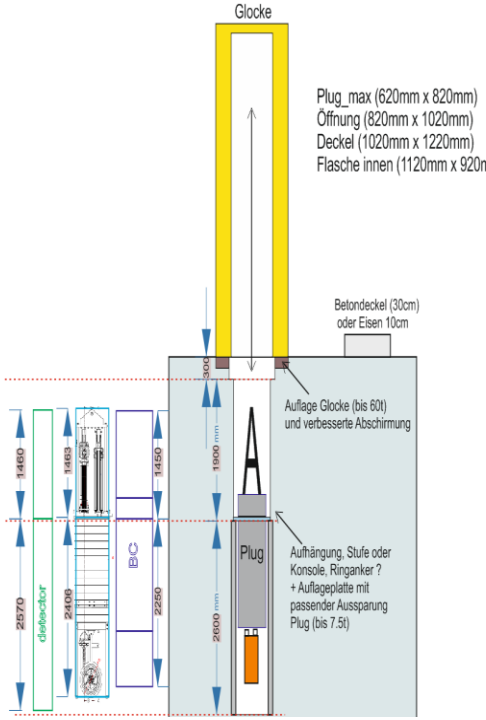
Siempelkamp
Nukleartechnik

Super-FRS Hot cell



Shielding flask parking cell interaction

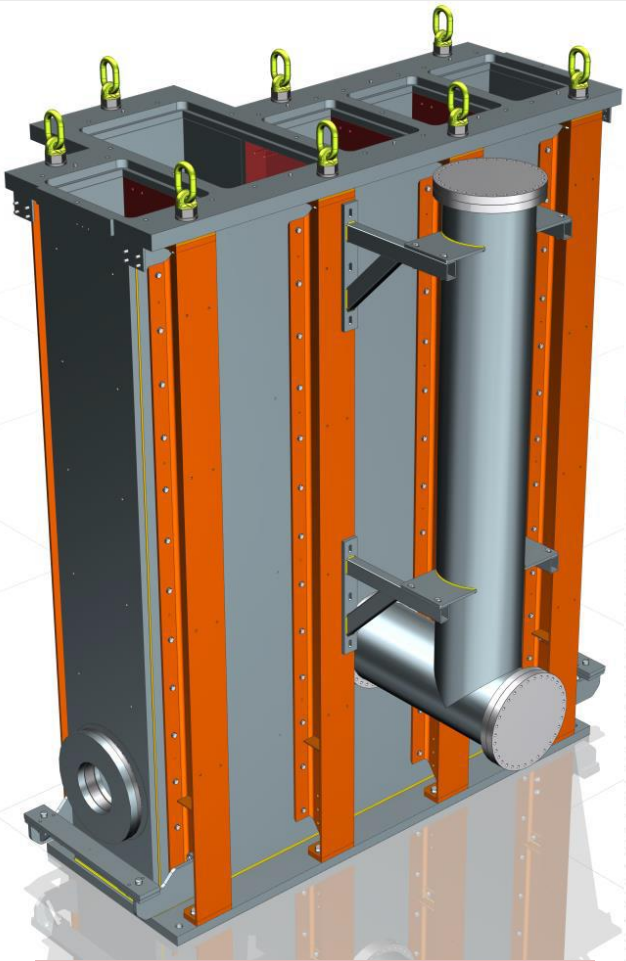




Plug parking cell design

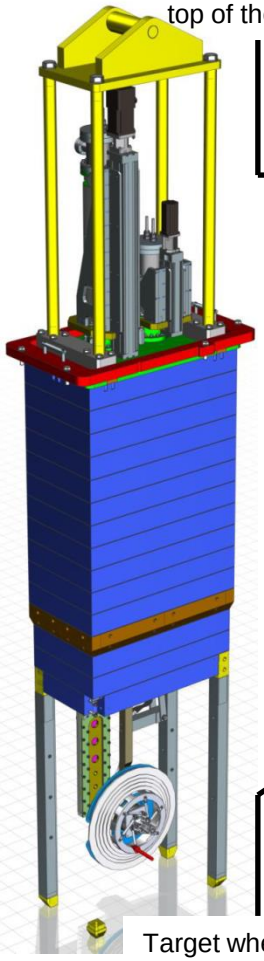
A.Kratz

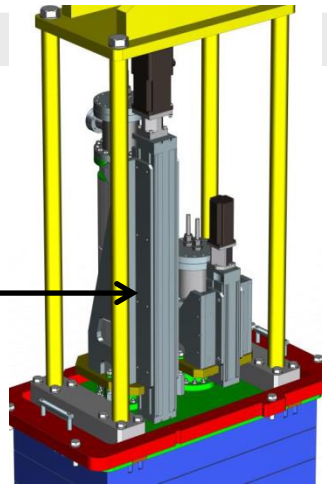
Target Chamber plugs
Design for remote handling



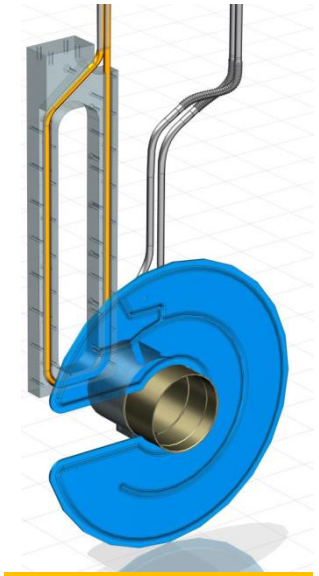
Target vacuum chamber

Linear drive maintenance at the top of the plug.



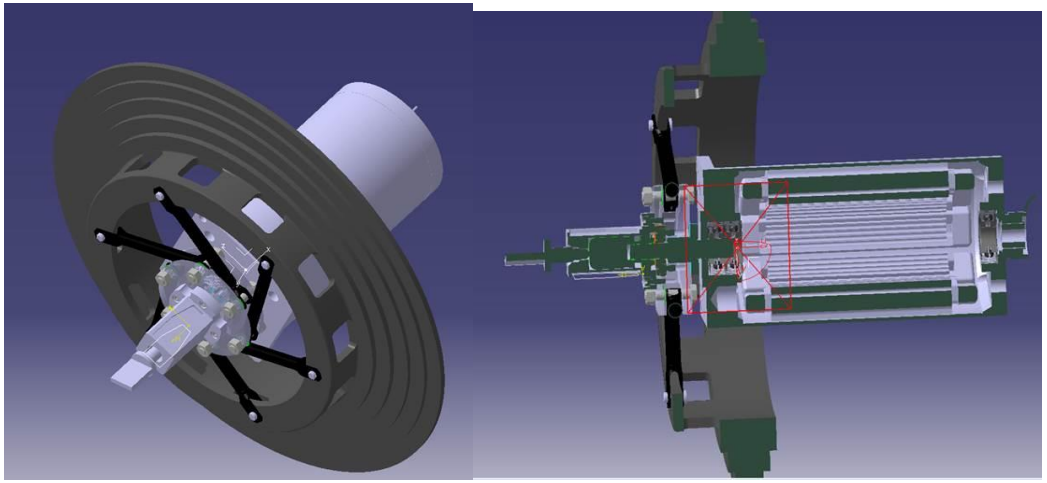


Target wheel and target ladder maintenance in hot-cell.

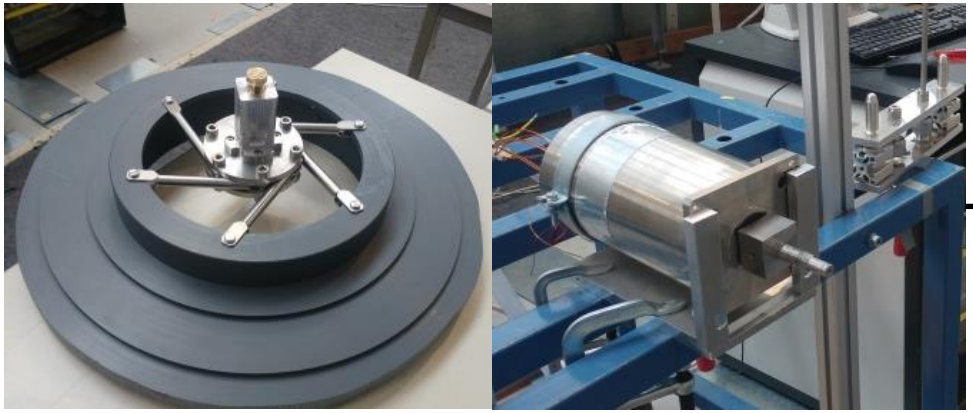


Target cooling system.

Super-FRS target developments

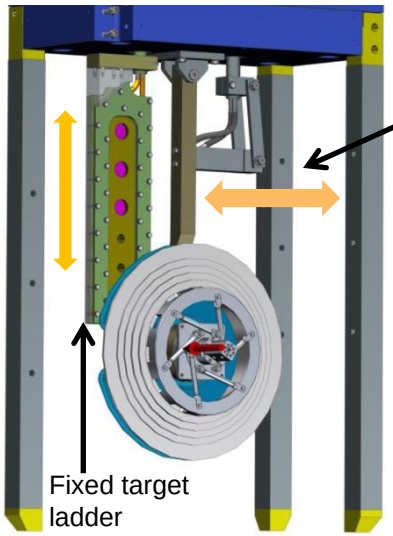


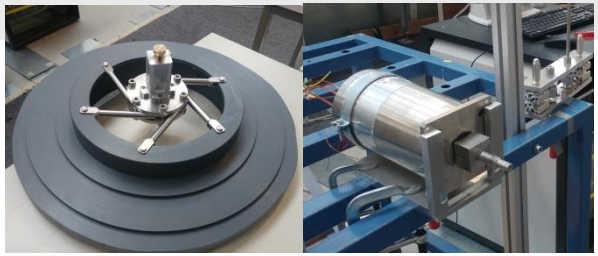
Ceramic bearing



Characteristics

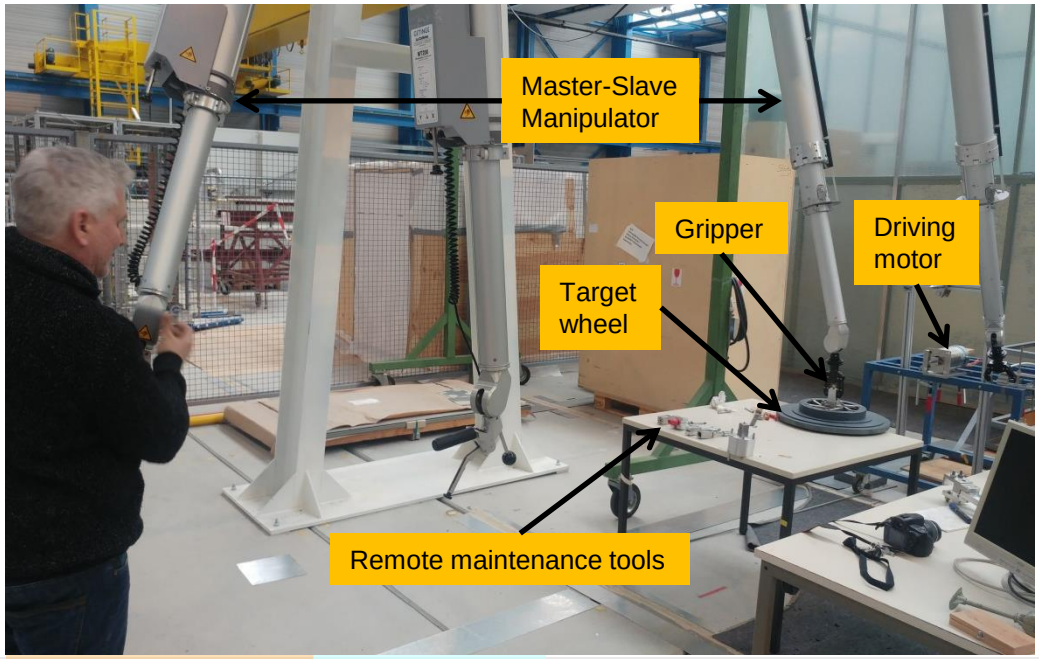
Target Wheel
remote maintenance





Target wheel and motor in vacuum
(regular replacement)

Tool adopted to fit MSM

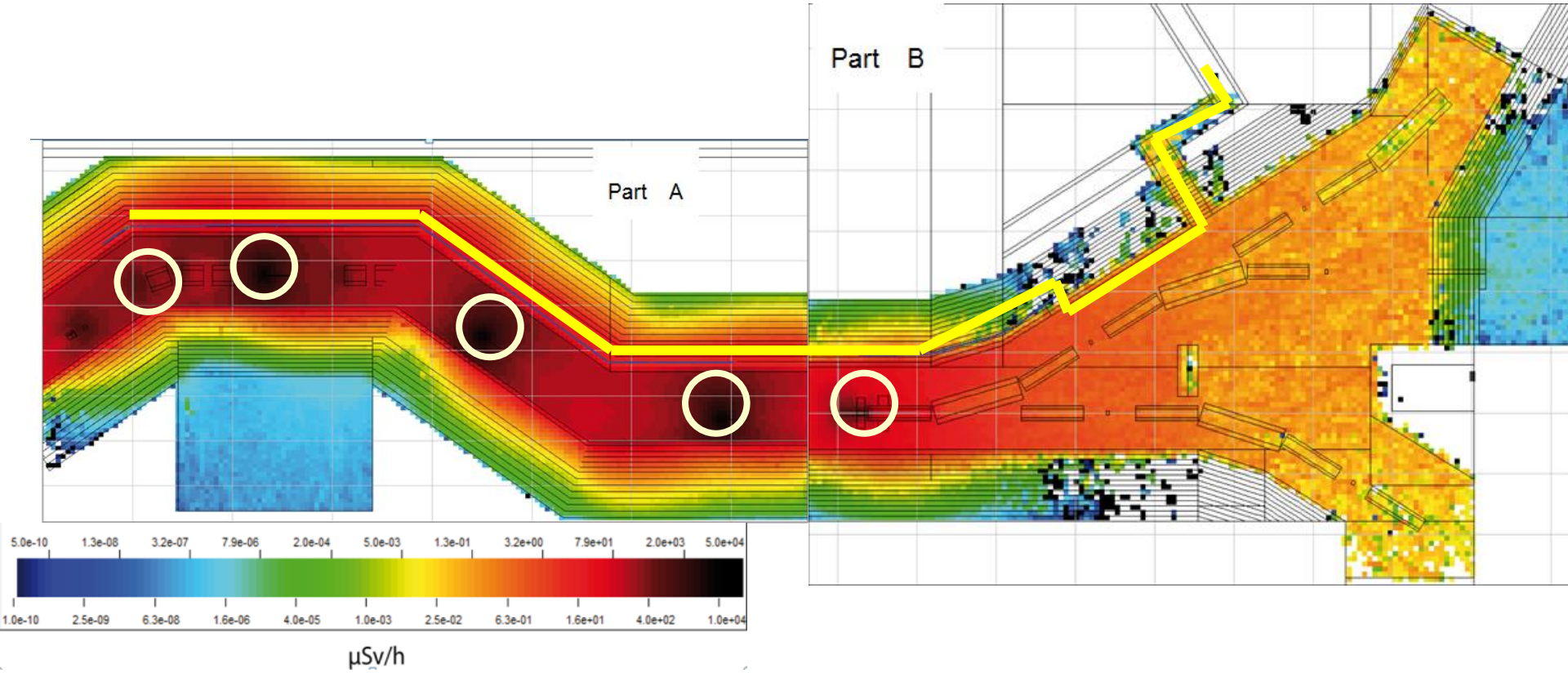


C.Karagiannis

Remote Handling (video 1)

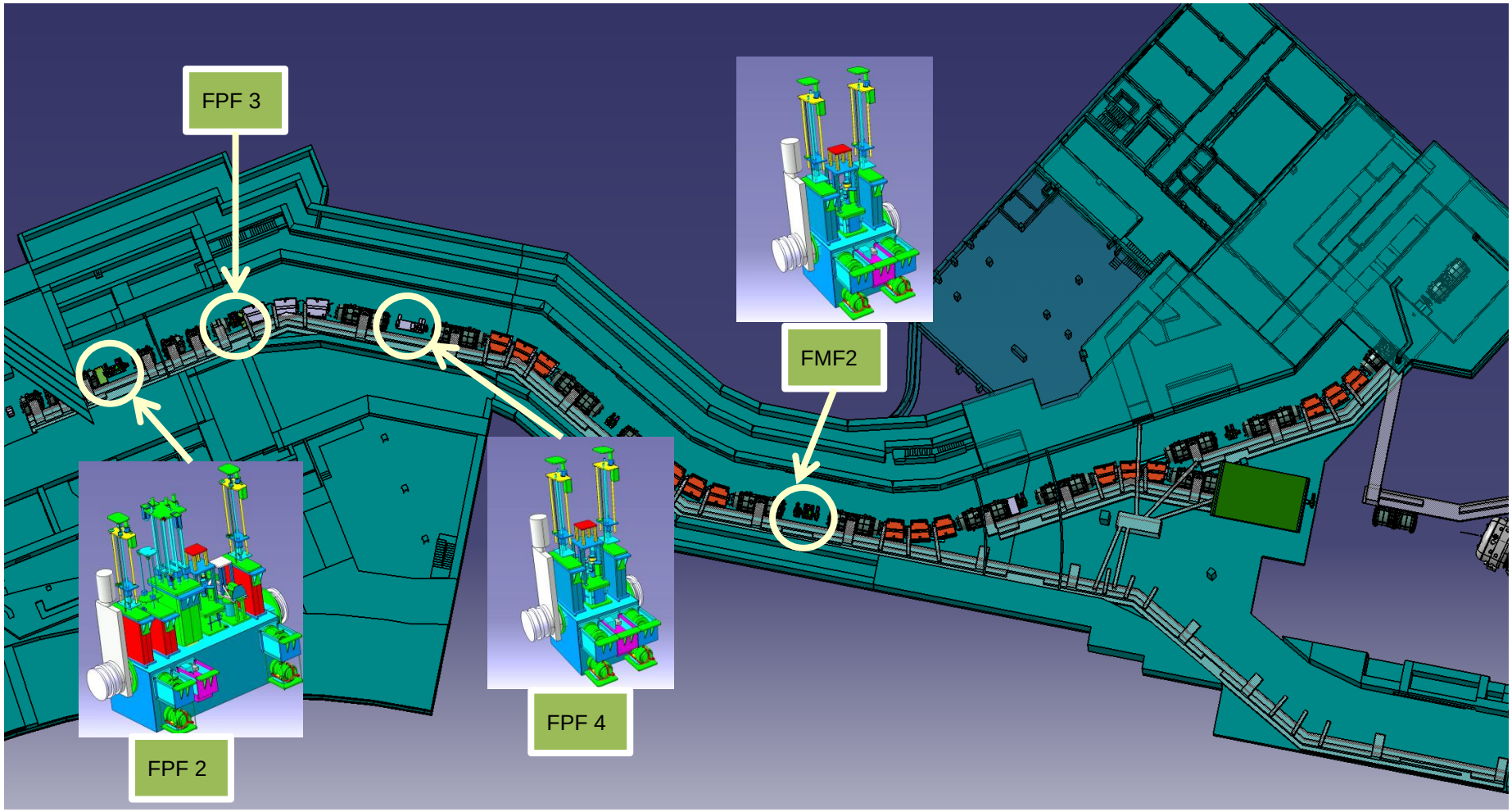
Remote Handling (video 2)

Super-FRS Remote handling scenario (open tunnel)



IV planner screen shots of the FLUKA simulations for the Super-FRS tunnel

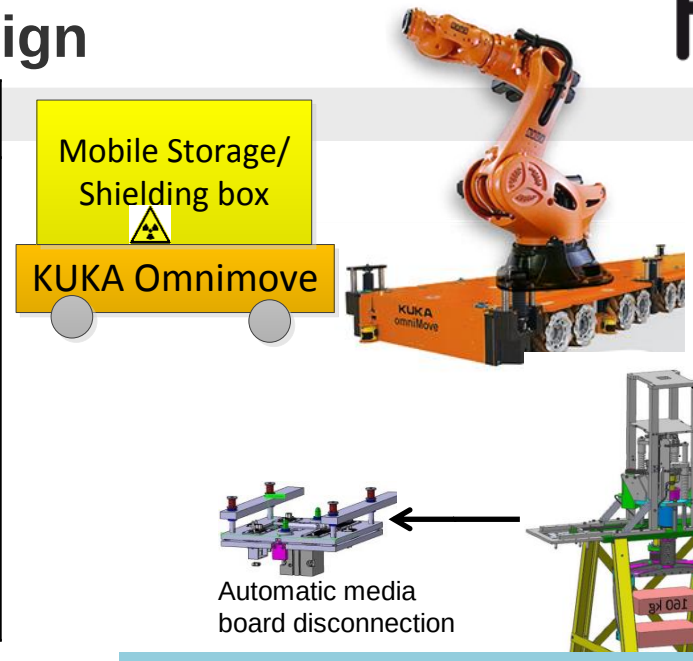
Super-FRS Remote handling scenario (open tunnel)



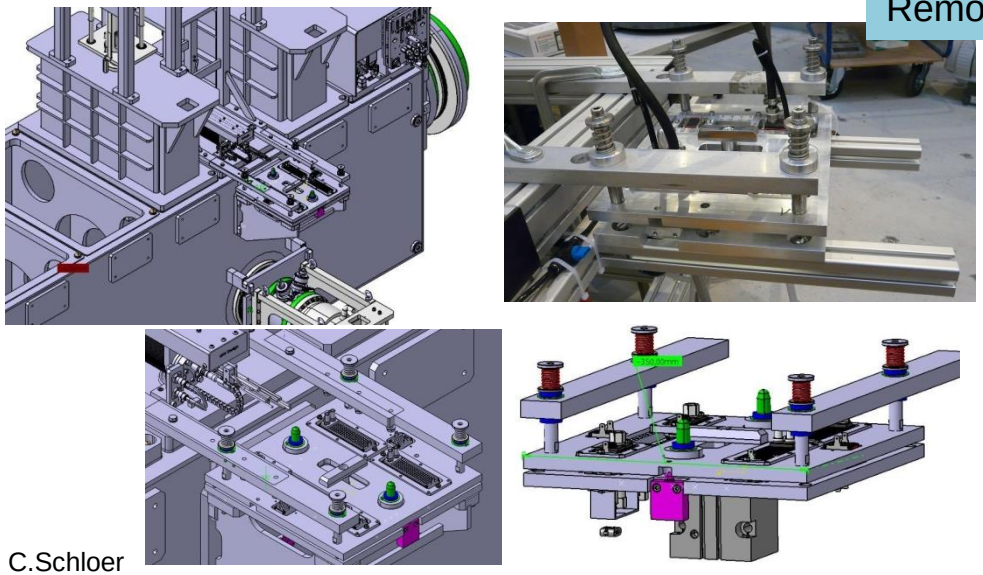
Super-FRS Remote handling scenario (open tunnel) Concept design

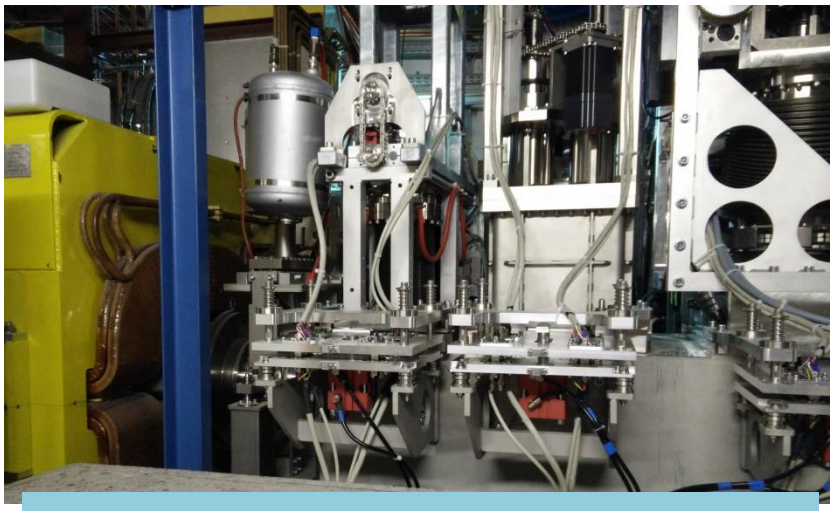
Main tunnel RH system

- Six axis (KUKA titan) robot to perform remote manipulation.
- Mobile platform (KUKA Omnimove / AGV) that can transport robot in-between parking position to maintenance region.
- Mobile shielding container to transport activated beamline inserts.
- Power supply, navigation and parking system.
- Automatic media board connection



Remote Handling of beamline inserts (X and Y slits) example

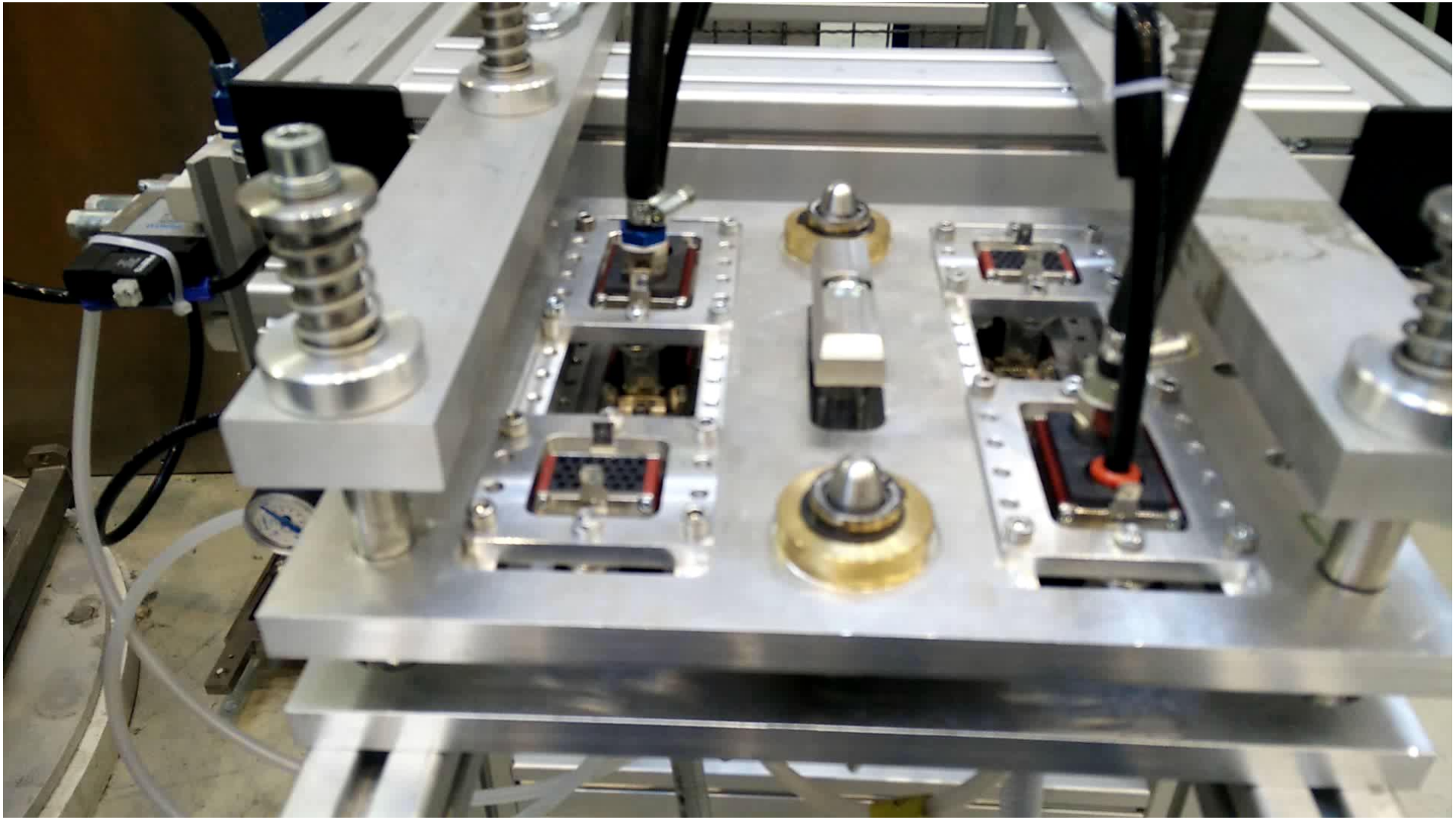




Media board installed t FRS beamline inserts

C.Schloer

Super-FRS Remote handling scenario (open tunnel) media board

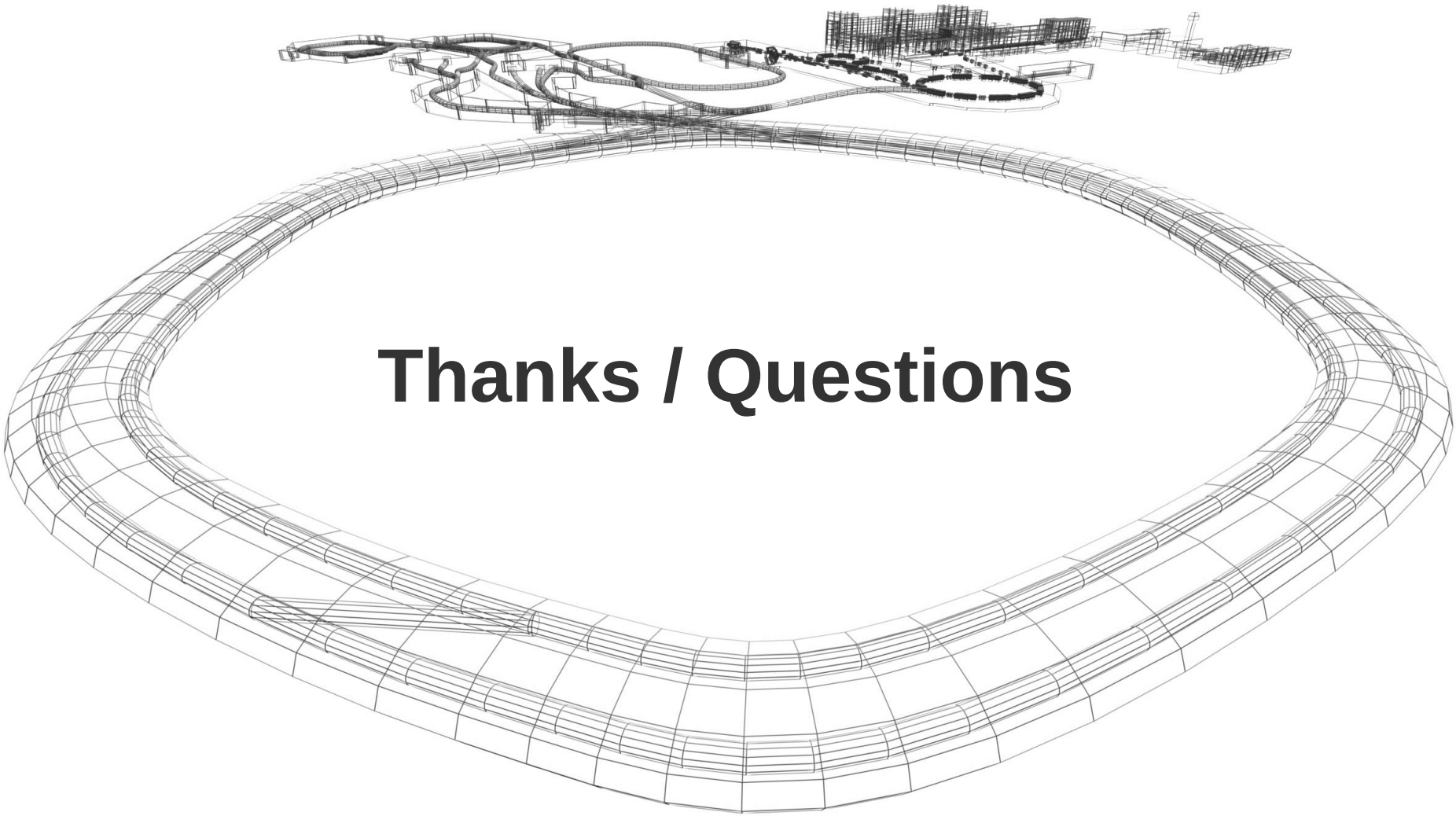


Summary

- Remote handling is required for Super-FRS facility to ensure the maintenance and operation of the facility.
- Super-FRS has both close tunnel and open tunnel remote handling scenarios.
- Super- FRS has both Transportation manipulation and Dexterity manipulation.
- Closed tunnel remote handling
  - Shielding flask will be used to for handling and transfer of activated beamline parts
  - Hotcell will be used to conduct remote maintenance
- Open tunnel remote handling
  - Industrial robotic systems will be used to manipulate and handle beamline inserts
  - maintenance / transfer task sequence needs detailed definition (shielding flask)
- Hot cell will be primary location to maintain, exchange, upgrade and store the beamline inserts activated parts.
- Automatic media board developed at GSI is now implemented at FRS target area.

Future outlook

- Target area chamber design is in advance stage and will go through CDR review.
- Beam catcher and detector ladder designs needs to be verified for remote handling using the MSM setup at GSI.
- Shielding flask specification are updated and MOU talks has been agreed to design and develop the Finland in-kind contribution to FAIR.
- Open tunnel remote handling system specification and design parameter are under development.



Thanks / Questions