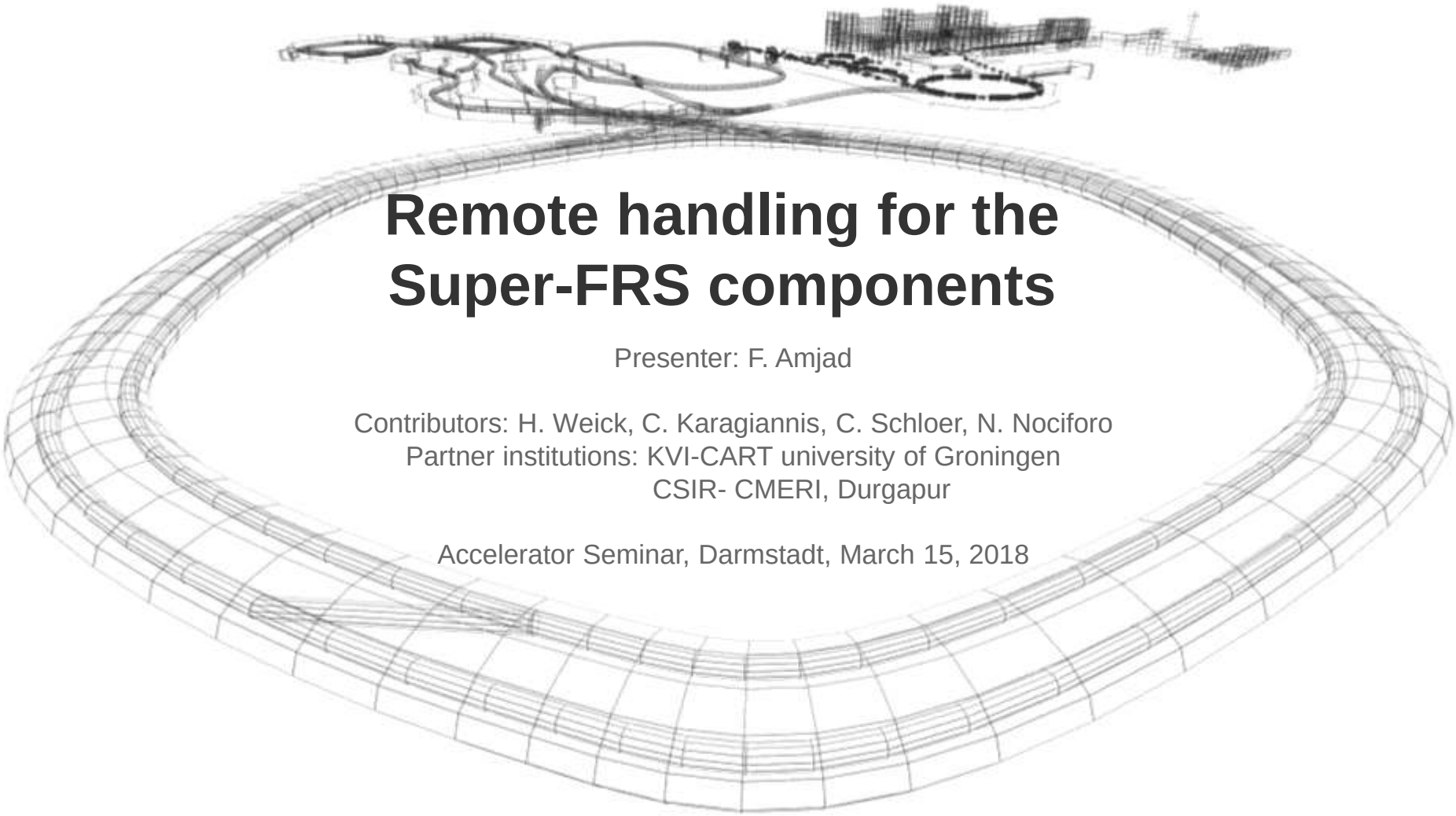


Remote handling for the Super-FRS components

Presenter: F. Amjad

Contributors: H. Weick, C. Karagiannis, C. Schloer, N. Nociforo
Partner institutions: KVI-CART university of Groningen
CSIR- CMERI, Durgapur

Accelerator Seminar, Darmstadt, March 15, 2018

Presentation Outline

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

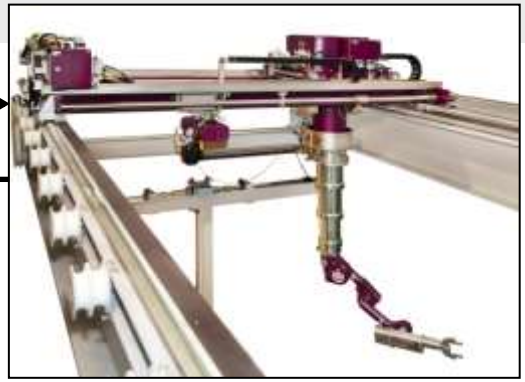
Remote Handling introduction and Background

- Combination of technology and engineering systems to enable operators to safely, reliably and repeatedly perform transportation and manipulation of hazardous items without being in personal contact with the handled items.
- Remote Handling enables an operator to do handling work at a particular work site without being physically present at that work site.
- “Human in the Loop": Unlike conventional robotics, Remote Handling always involves a human being with in the process.

Remote Handling introduction and Background: Philosophy

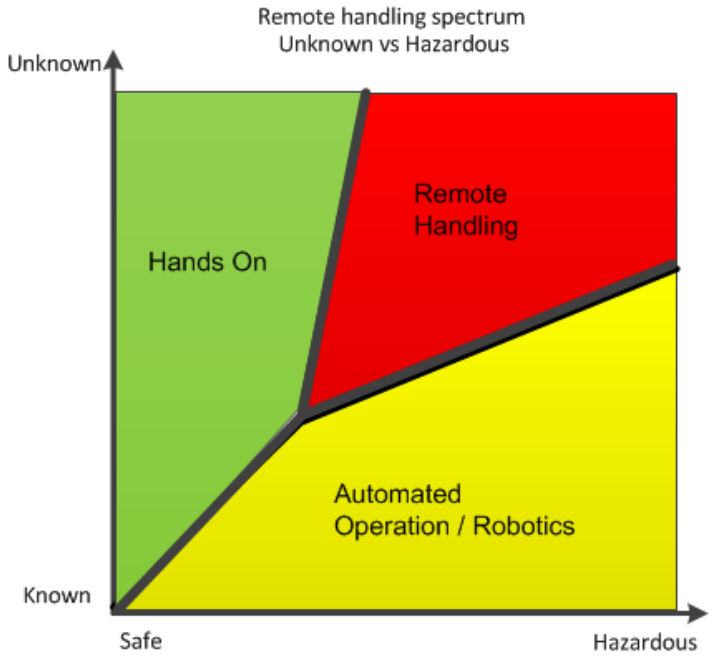
- What is remote handling?
  - Handling items from distance and safety
  - “Nuclear” association
- Unknown vs Hazardous
- What is important in remote handling?
  - Task identification
  - Remote viewing
  - Recovery (RAMS)
  - Design for remote handling

feedback



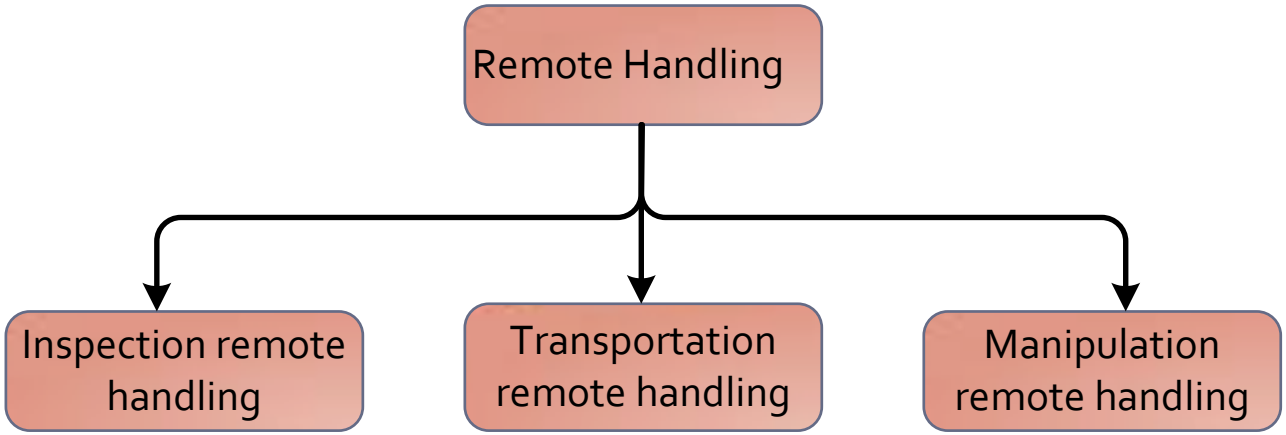
Remote control unit
Master unit

Remote handling unit
Slave unit

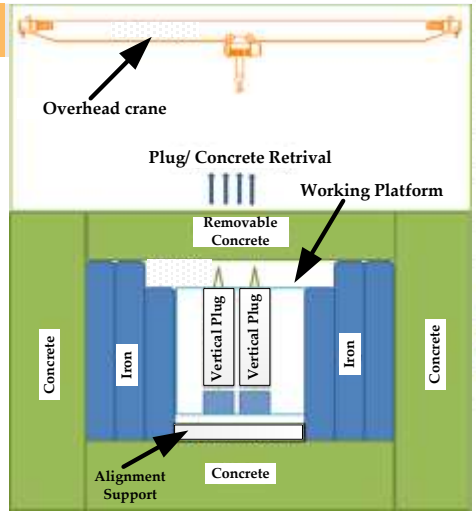


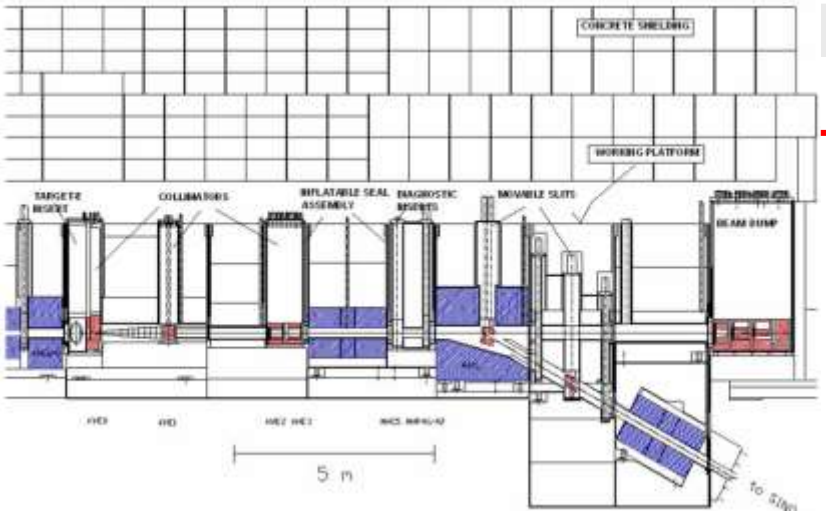
Remote Handling introduction

- 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)



Remote handling at particle accelerator facilities(1/4): Closed tunnel facility (PSI)

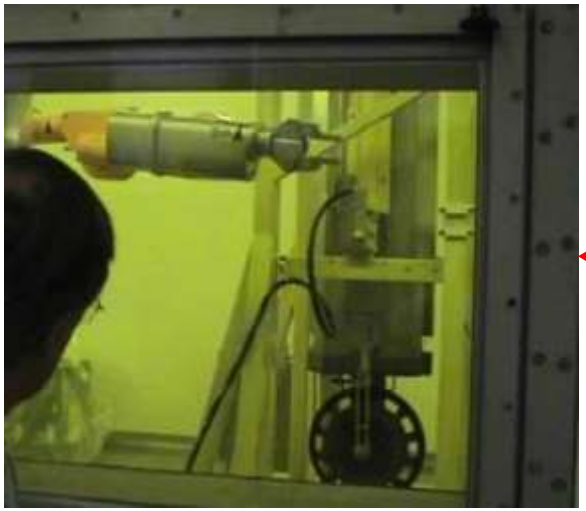




Vertical Cross-Section of PSI Beam Line

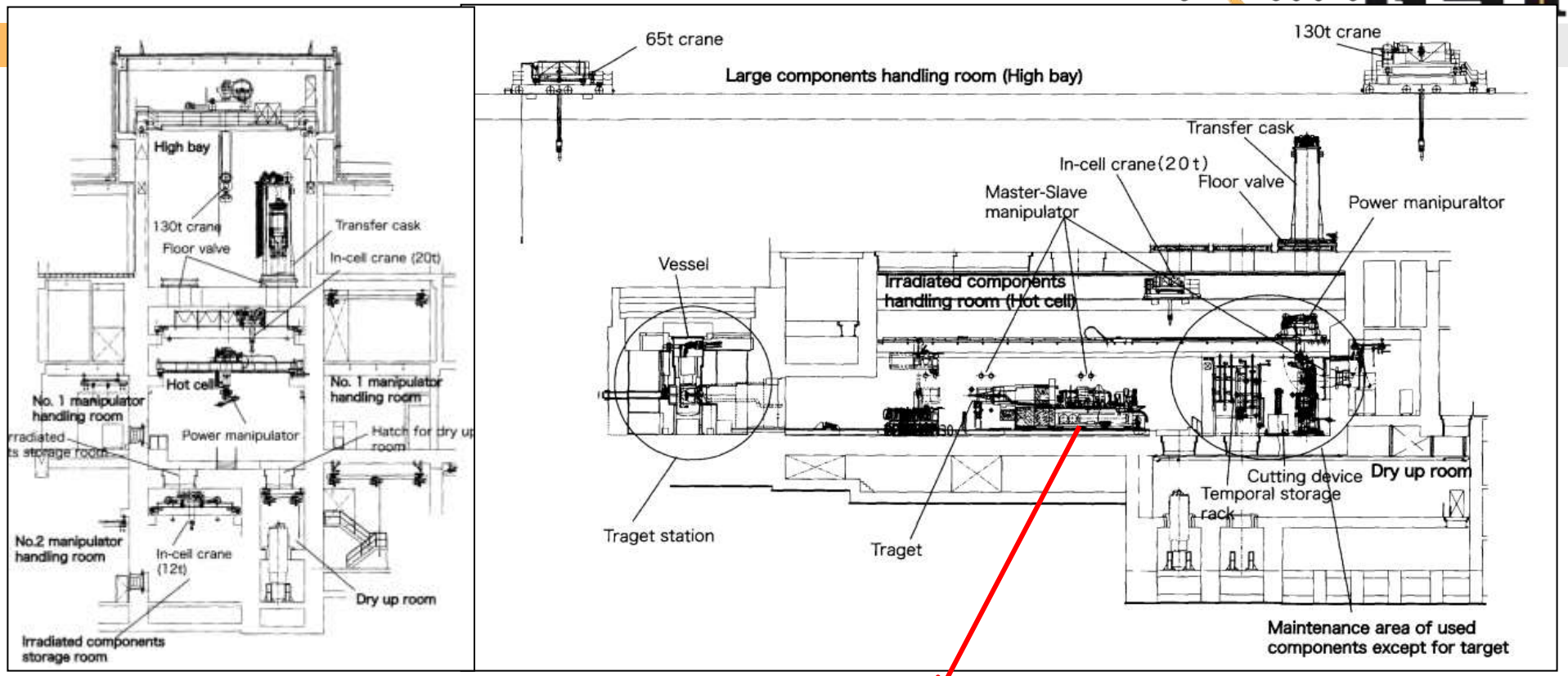
Shielding flask on top of beam line

Shielding flask on top of hot cell



Target lowered down in hot cell for maintenance

Remote handling at particle accelerator facilities(2/4): Integrated hotcell and target area JSNS

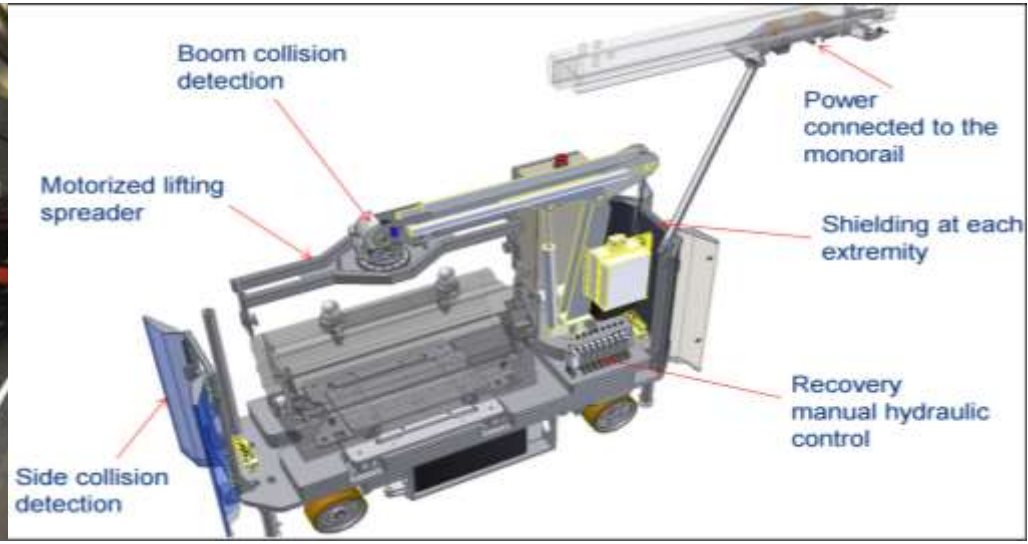


JSNS target area hotcell cross-sectional view

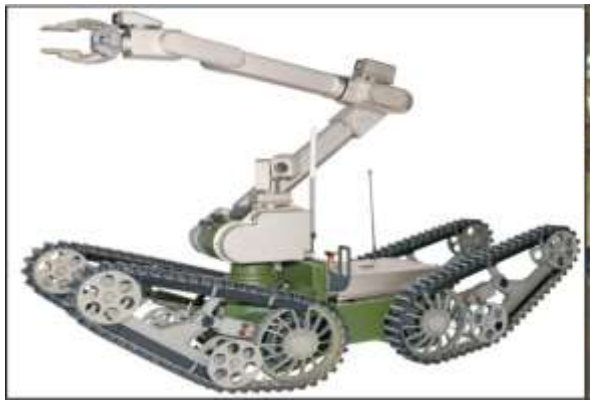
JSNS target and cart assembly

Remote handling at particle accelerator facilities(3/4): HEP facilities (CERN)

TIM inspection robot
- monorail system



Remote controlled trailer crane (collimator handling)
lifting capacities: 1t - Max speed : 3km/h (2600mm x 780mm x 2010mm)



TELEMAX used for inspection and visual support

Remote handling at particle accelerator facilities(1/4): Open tunnel facility

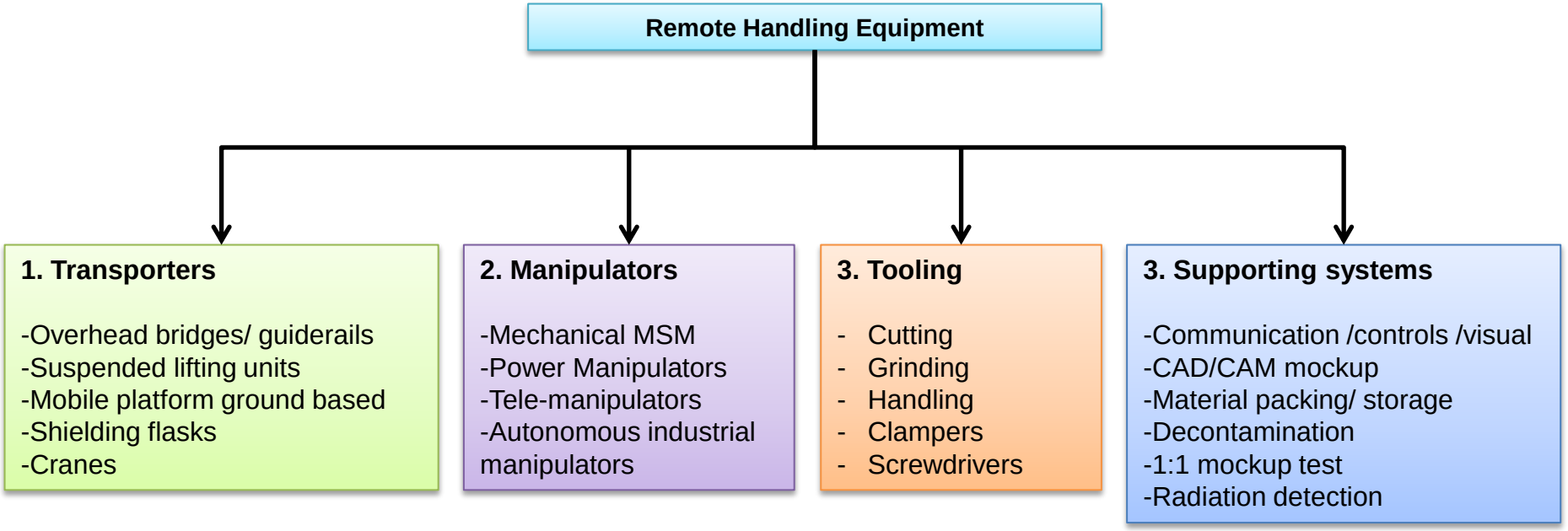
ISOLDE (KR 60L45) robots for remote handling

GSI FRS RH KUKA KR 350 robots

Classification of facilities based on remote handling setup

- Four main type of remote handling facilites
  - 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)

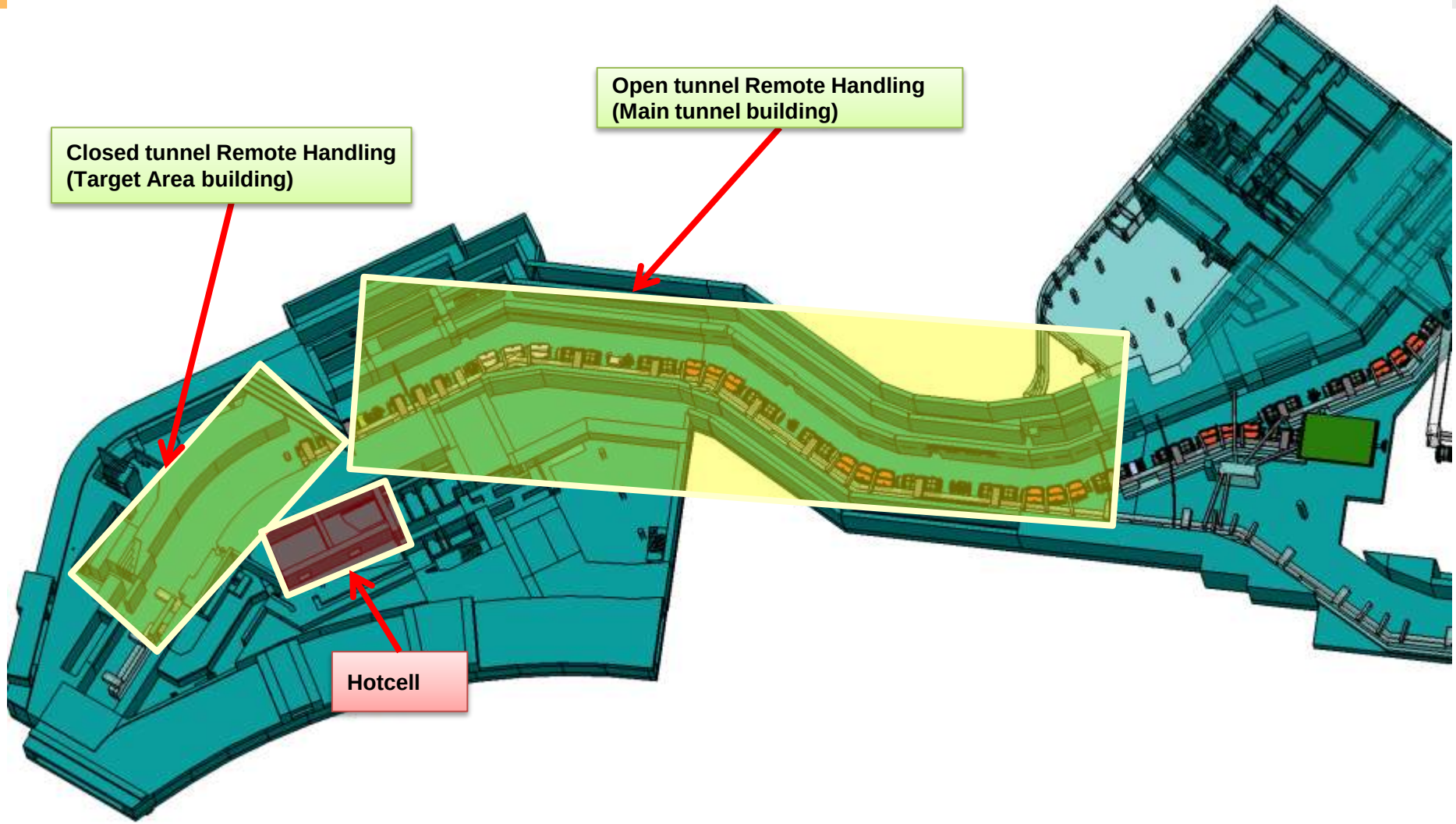
Remote handling equipment classification



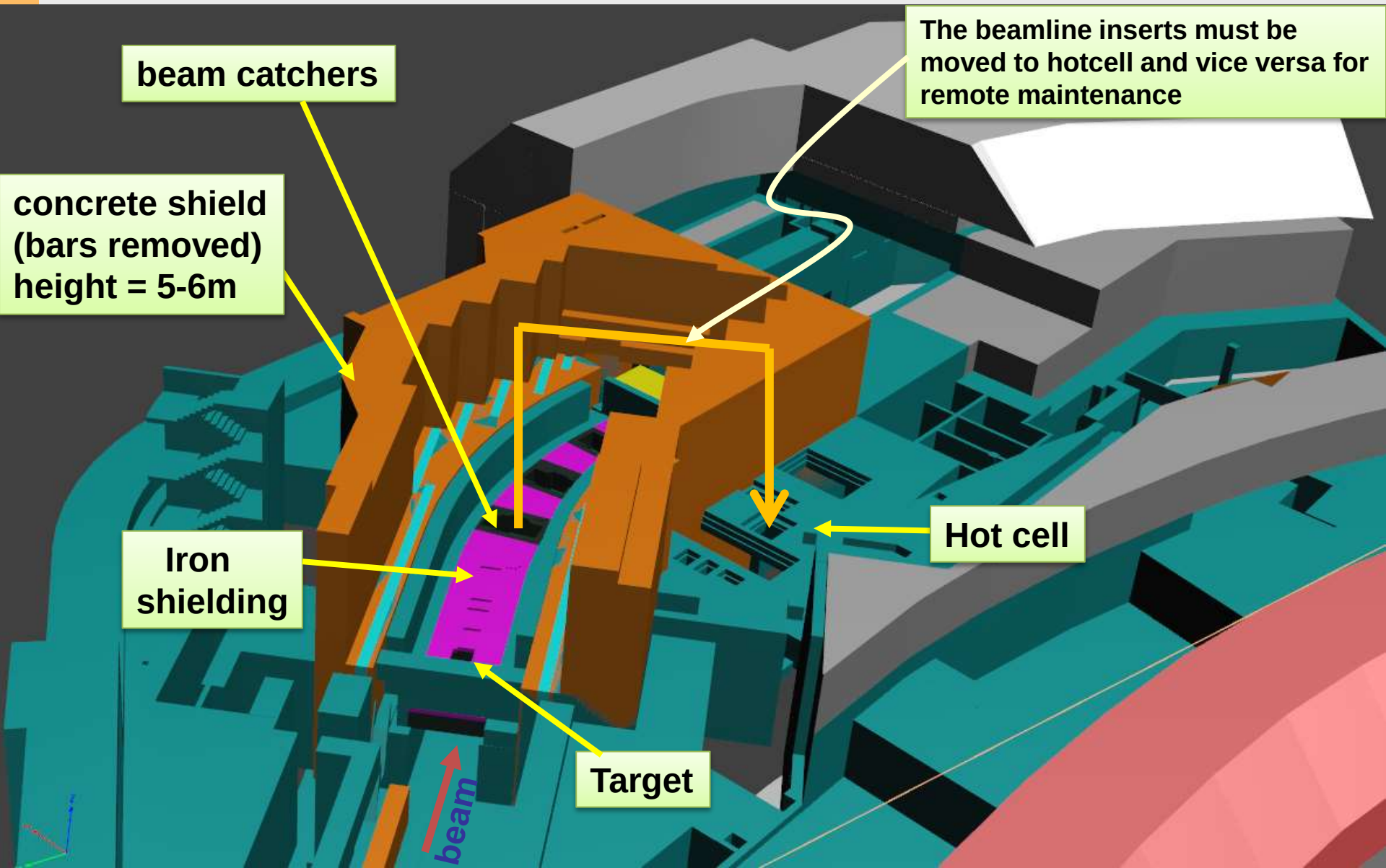
Remote handling classes for Super-FRS components

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

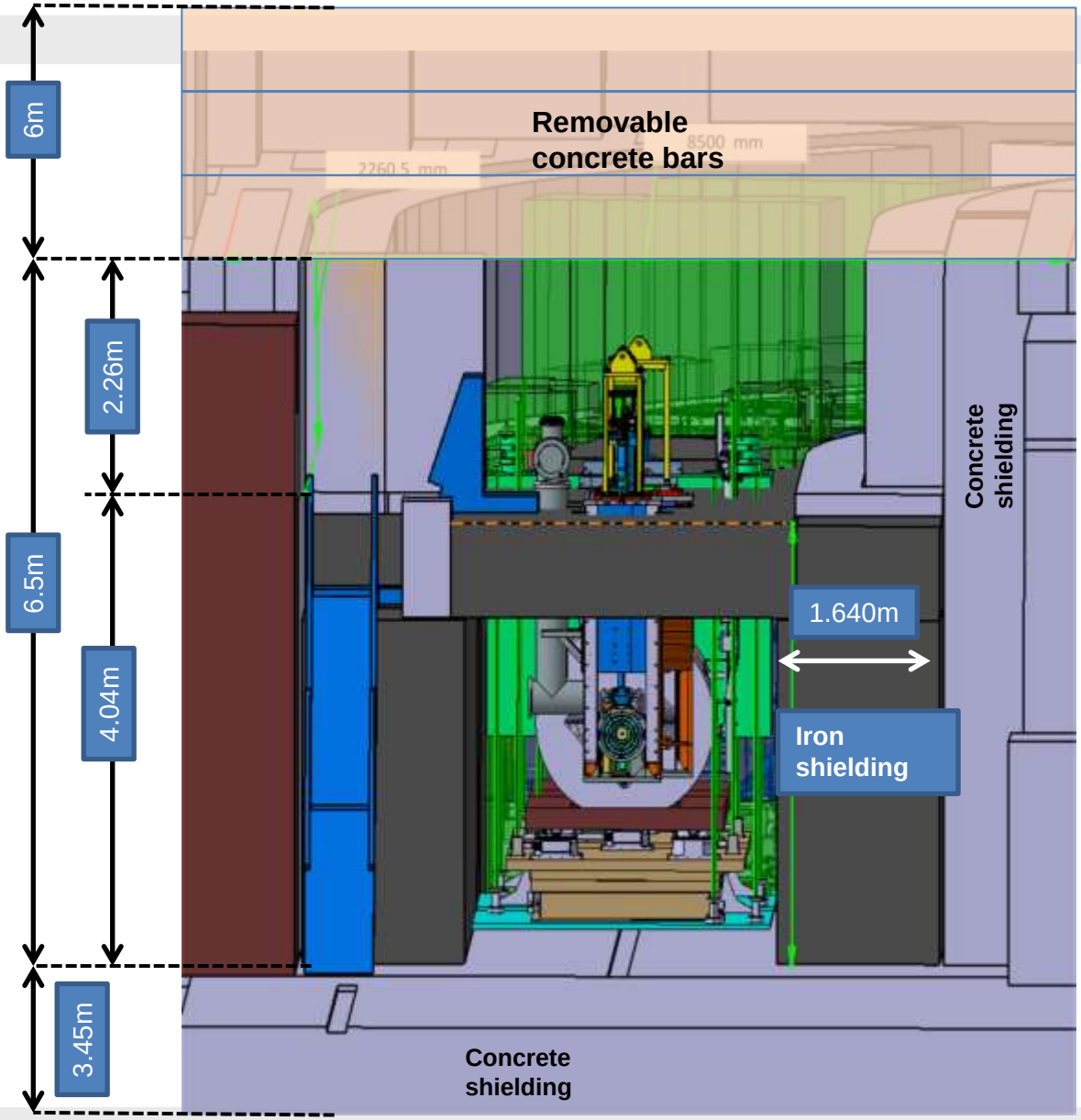
Super-FRS Remote handling scenario



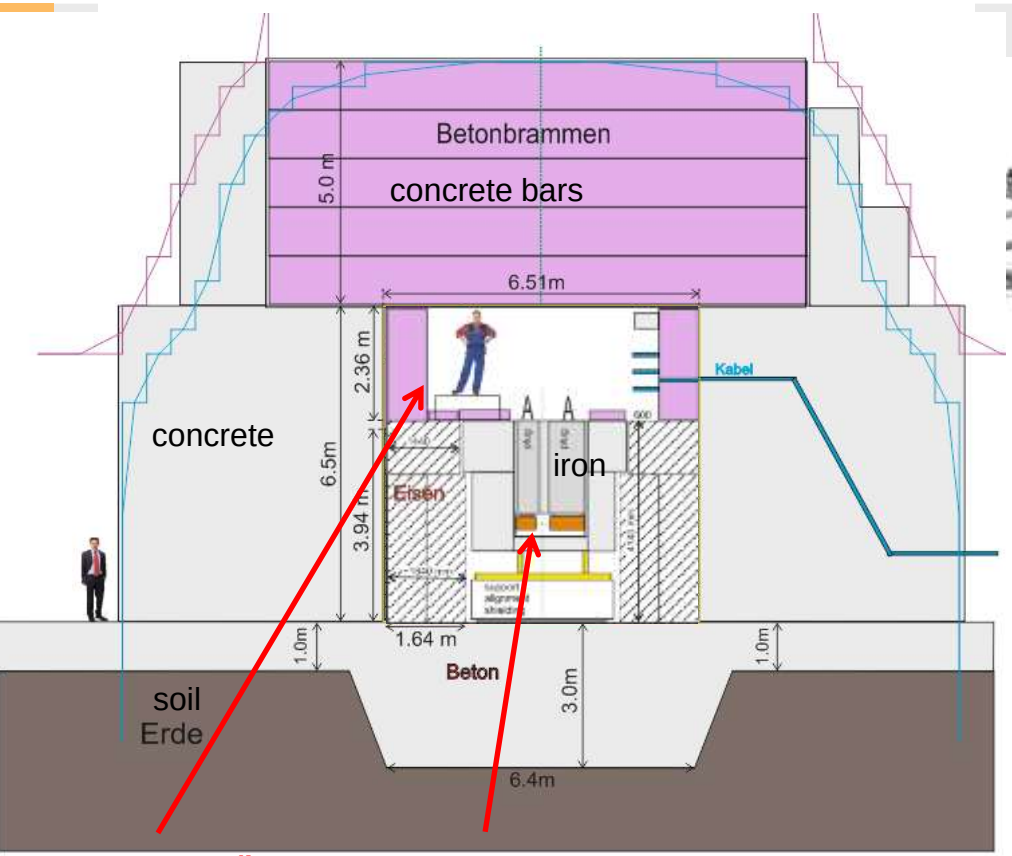
Target area buidling



Radiation Shielding



Radiation Shielding



~ 10 μSv/h

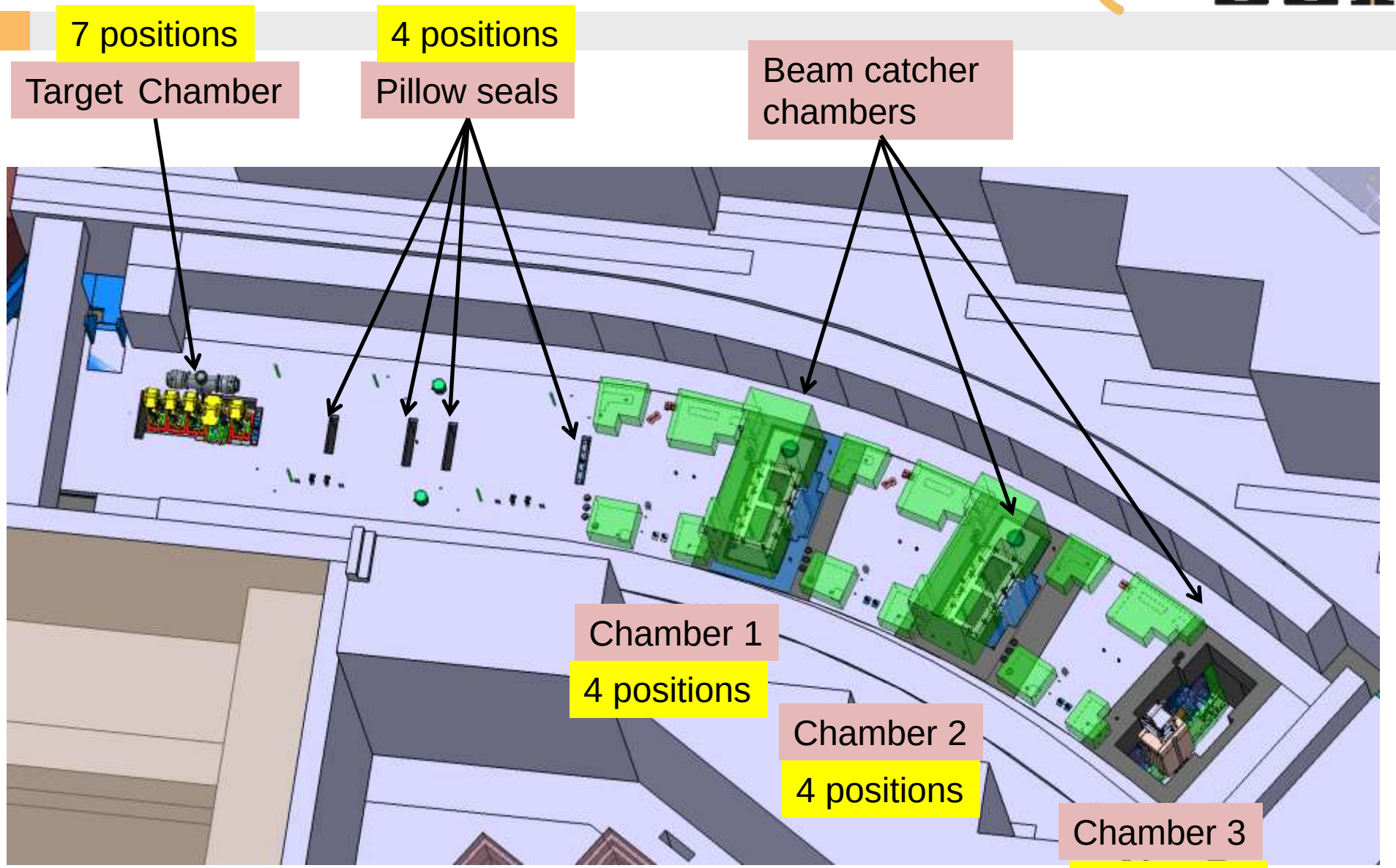
7 Sv/h

PSI Switzerland same concept, top of chamber

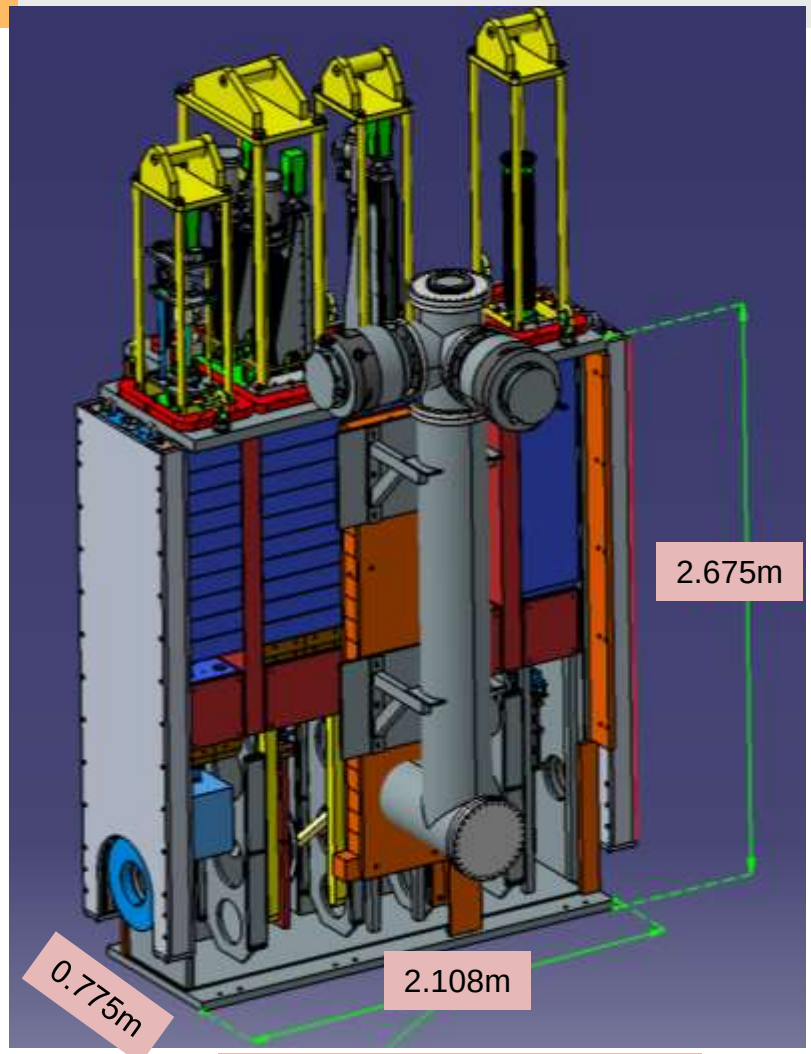
Activation after beam times,
but access to maintenance tunnel
possible thanks to integrated shielding.
Also shielding becomes activated.

H.Weick

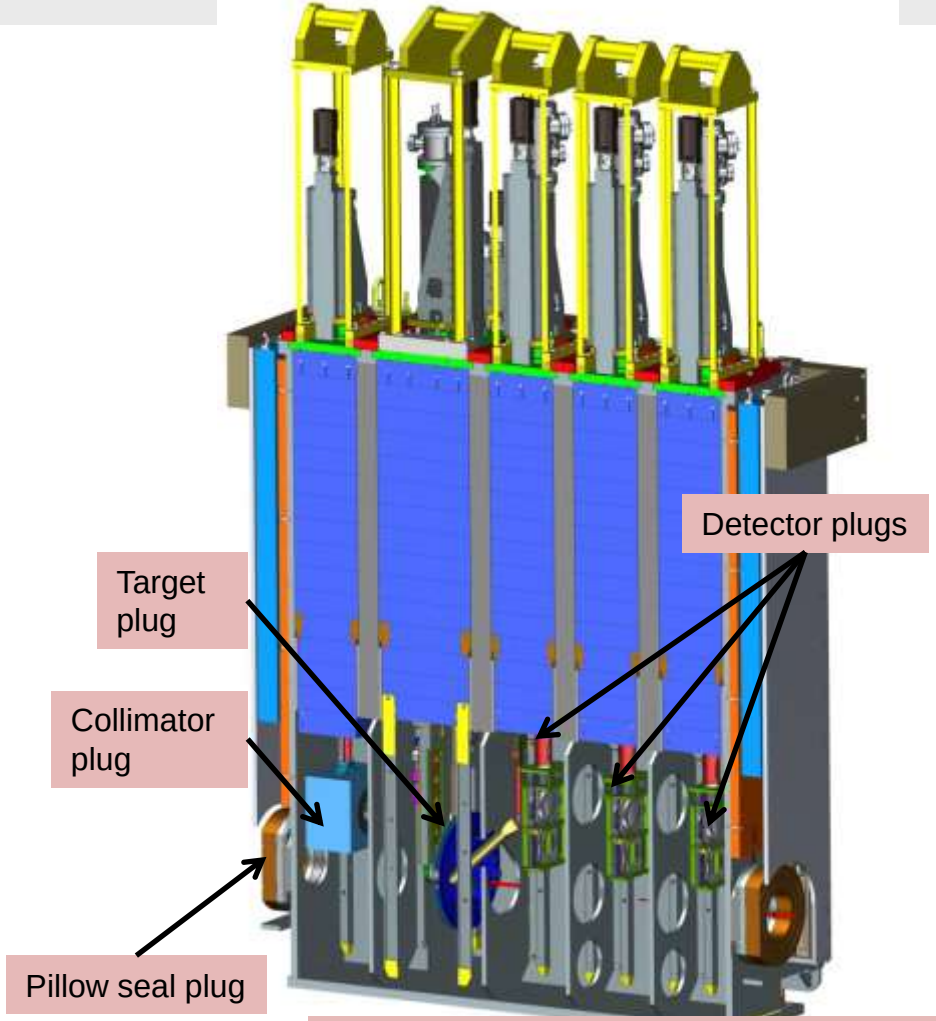
Super-FRS target area beamline remote handling positions for shielding flask (60t)



Target Chamber plugs



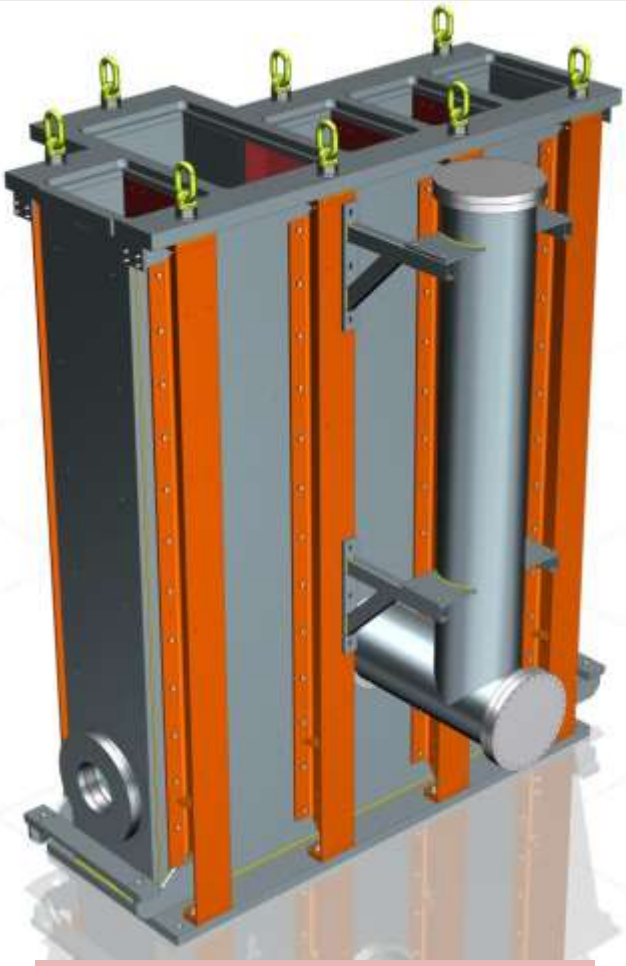
Target vacuum chamber



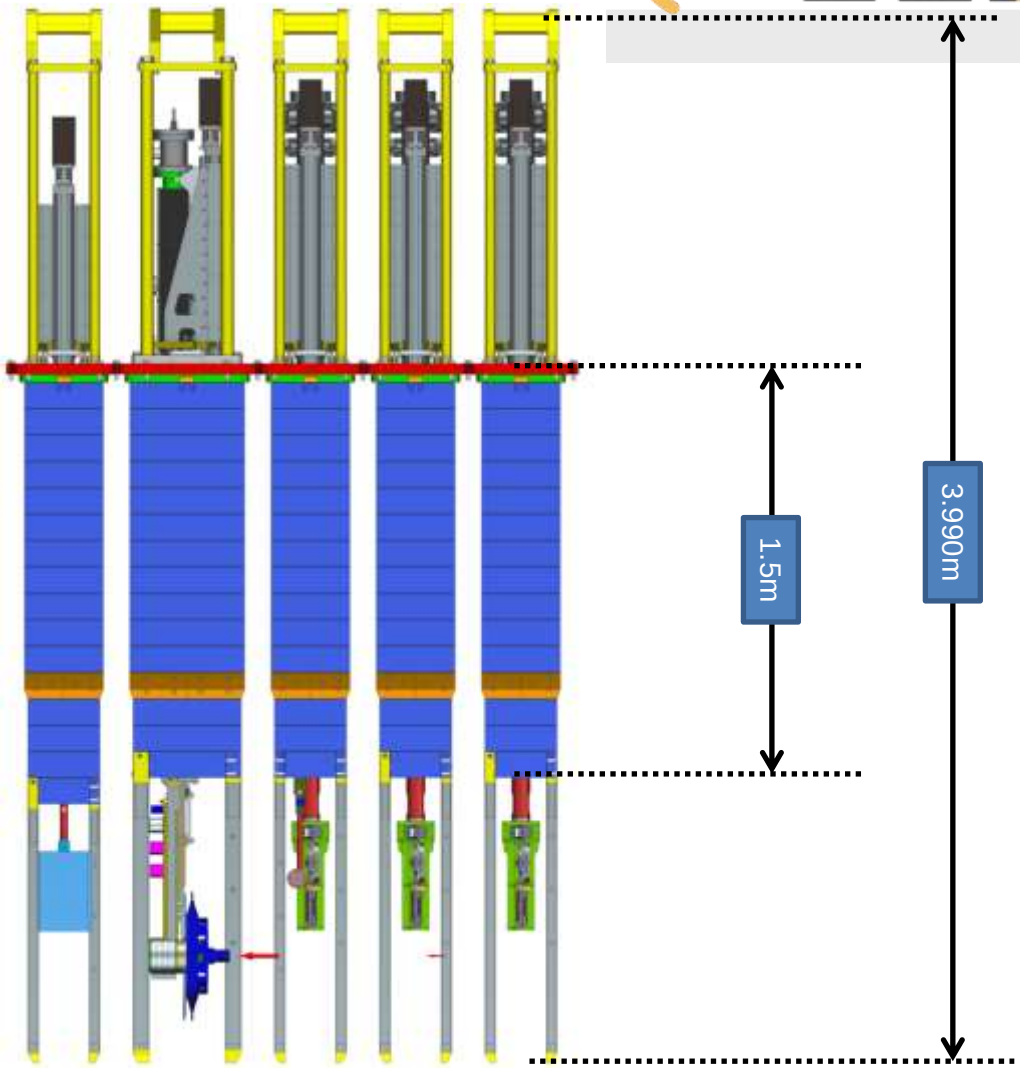
Target chamber
Michel Lindemulder, Henk Smit, KVI-CART

C.Karagiannis

Target Chamber plugs
Design for remote handling

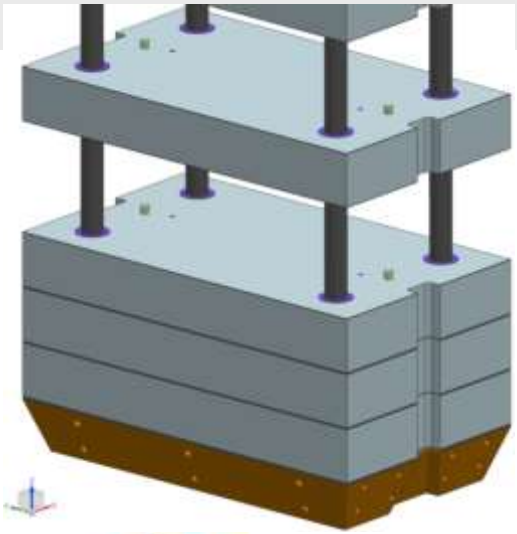


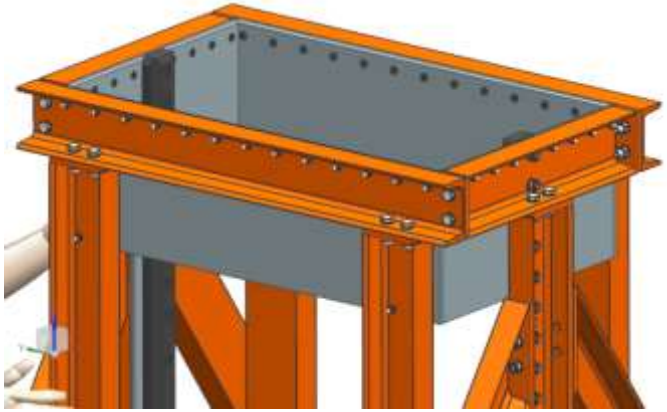
Target vacuum chamber



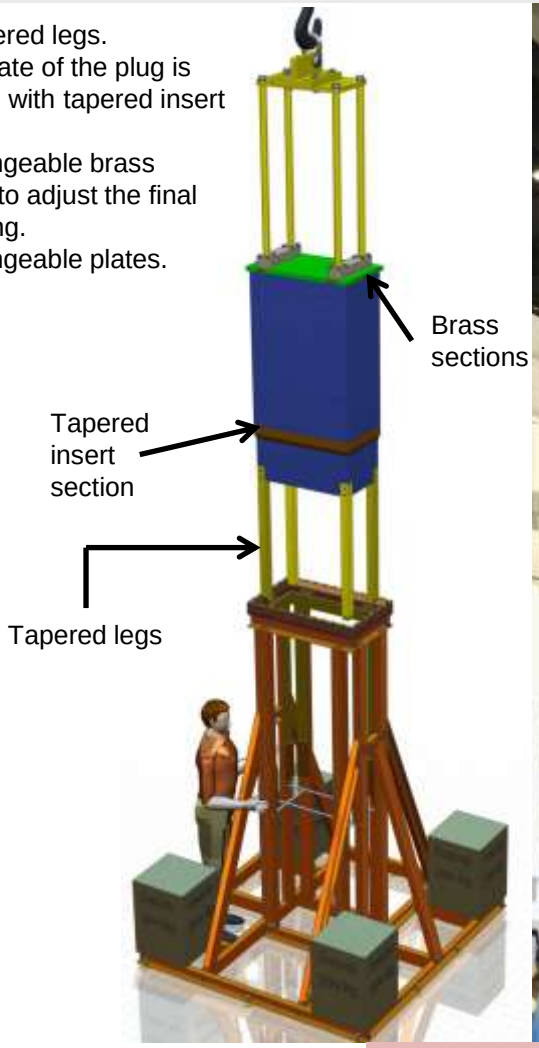
- The target station plugs have the same height, approximately 4000 mm.
- The 1,5 m shielding length is achieved by stacking 15 blocks of 100 mm thickness each.

Self-seeking plug guidance





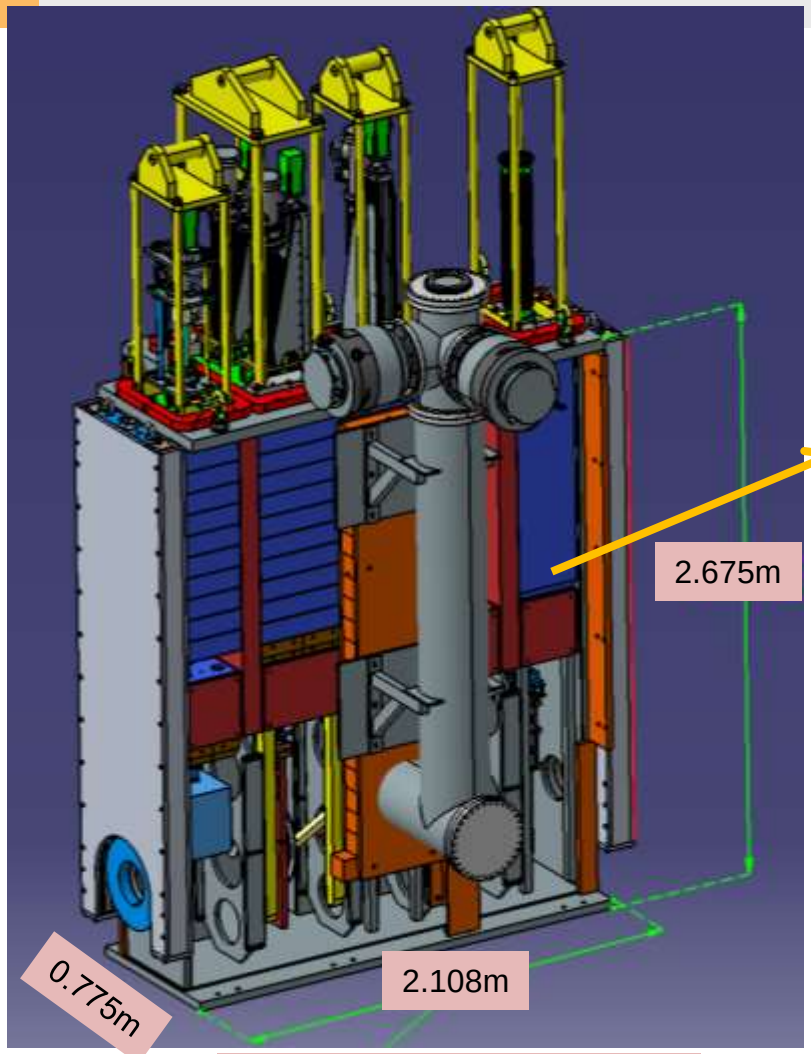
- Four tapered legs.
- Fourth plate of the plug is equipped with tapered insert parts.
- Interchangeable brass sections to adjust the final positioning.
- Interchangeable plates.



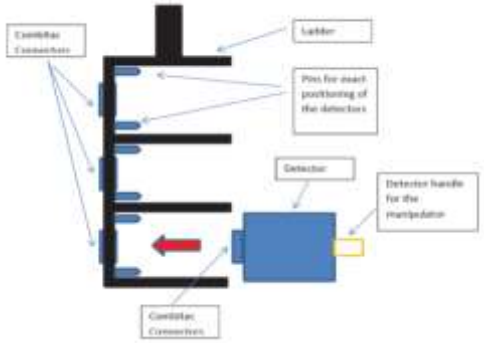
Plug Test Setup

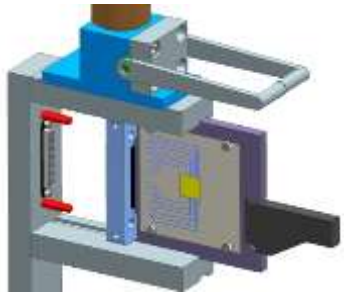
required: ± 20mm shift, 2 mrad tilt
tested up to 70mm and 7 mrad

Target chamber
Detector plug

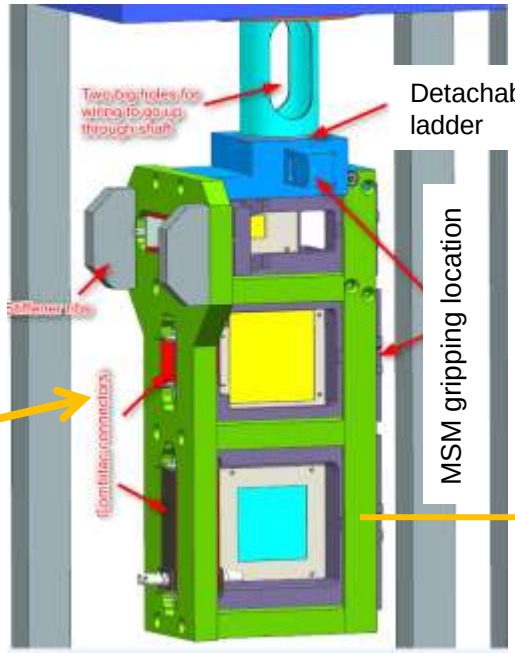


Target vacuum chamber



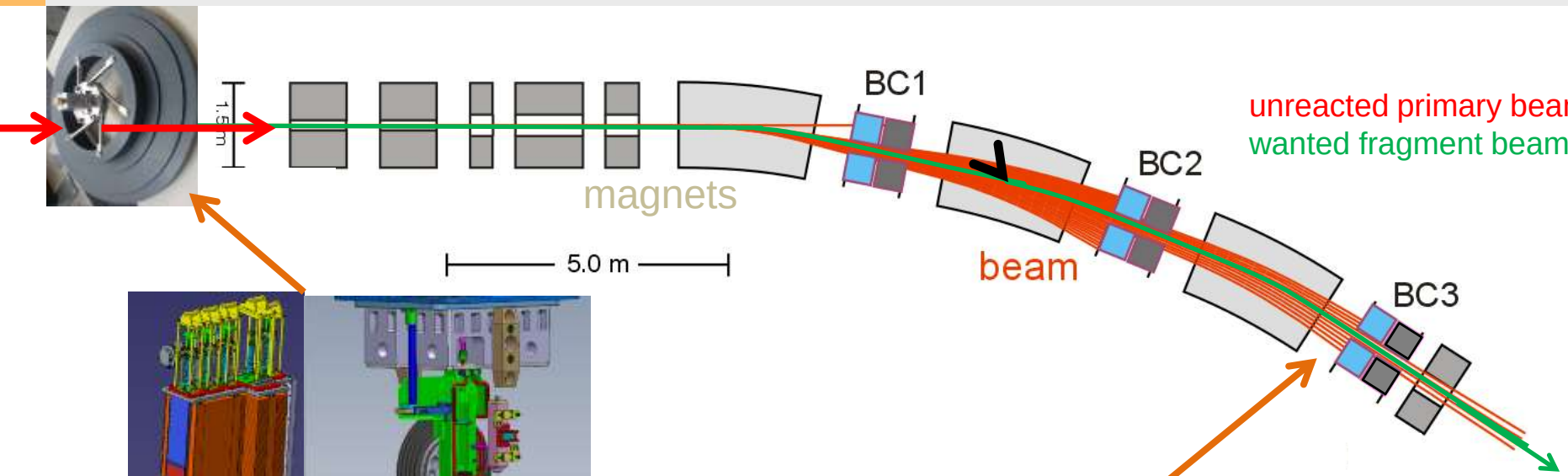


Detector ladder with slots for single detectors

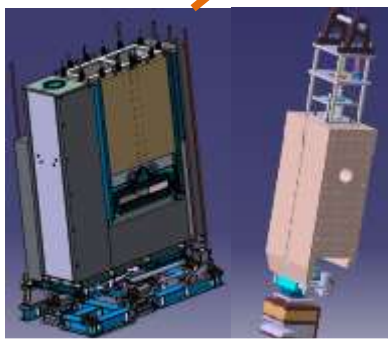


university of groningen

Beam Catchers
contribution of India to FAIR



Target Wheel

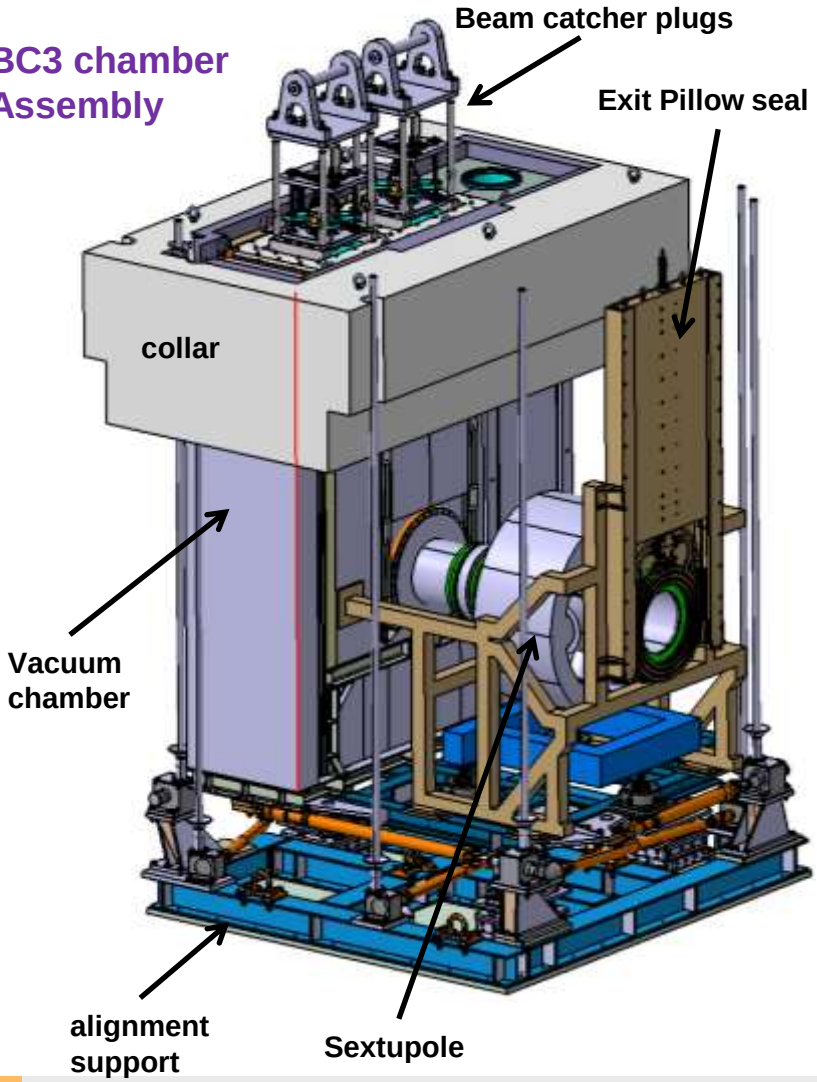


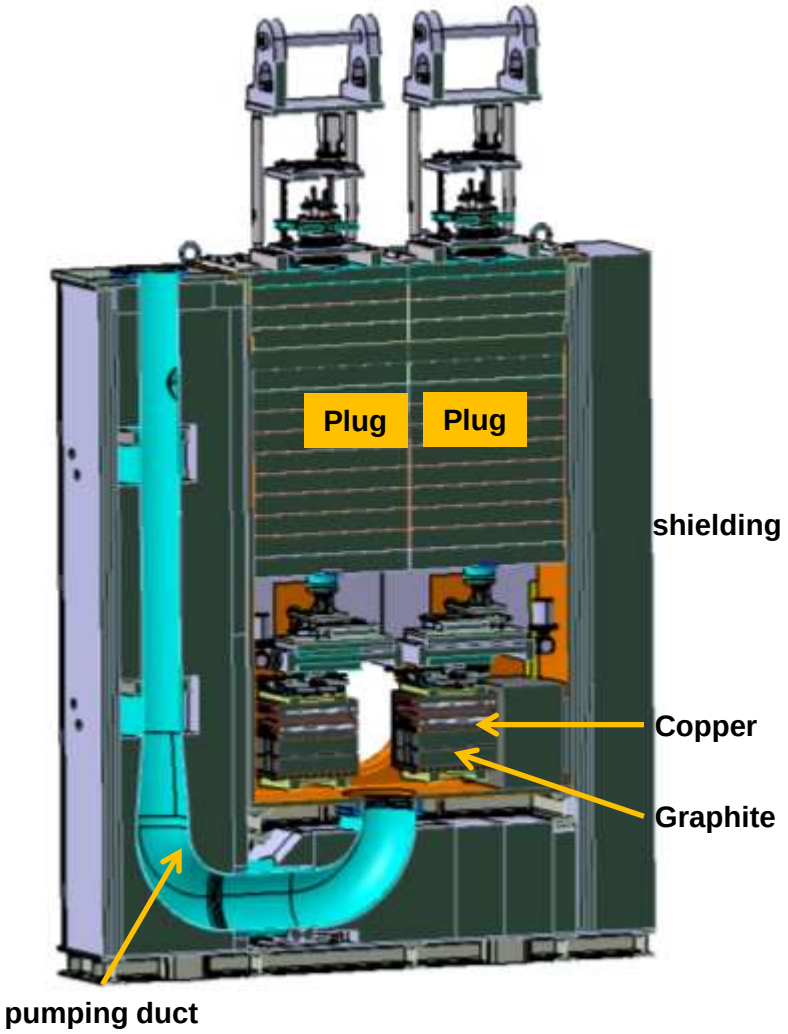
Beam catcher chamber and Plug

H.Weick

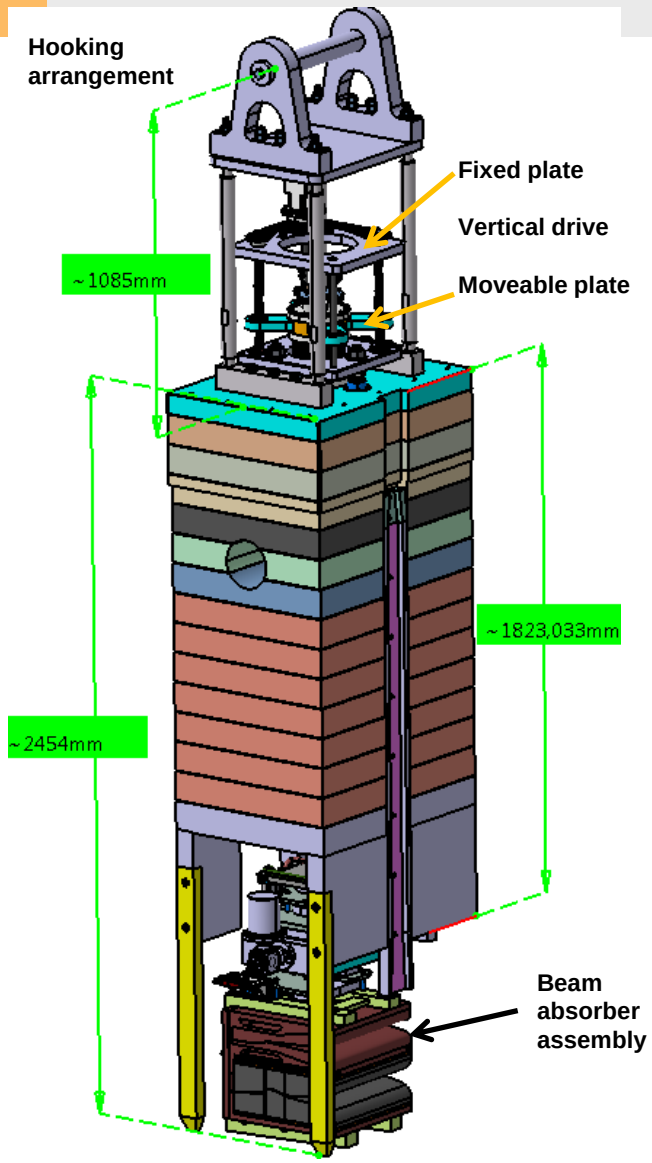
Beam Catchers
contribution of India to FAIR

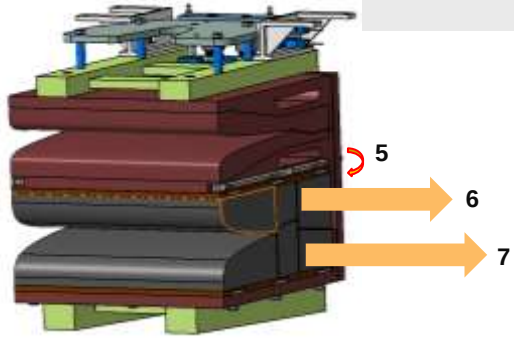
BC3 chamber Assembly

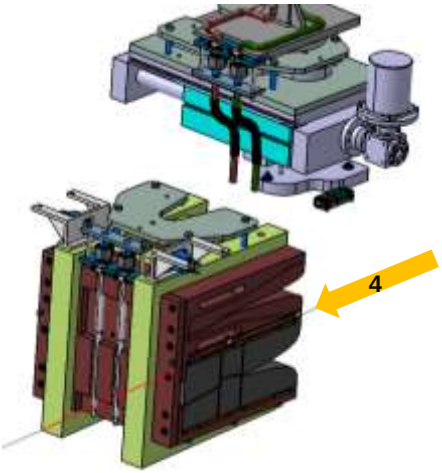


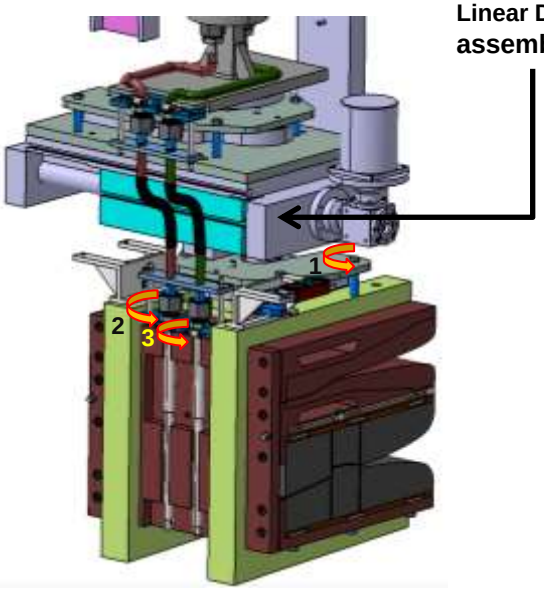


Beam catcher
Remote handling concept (Modular design)



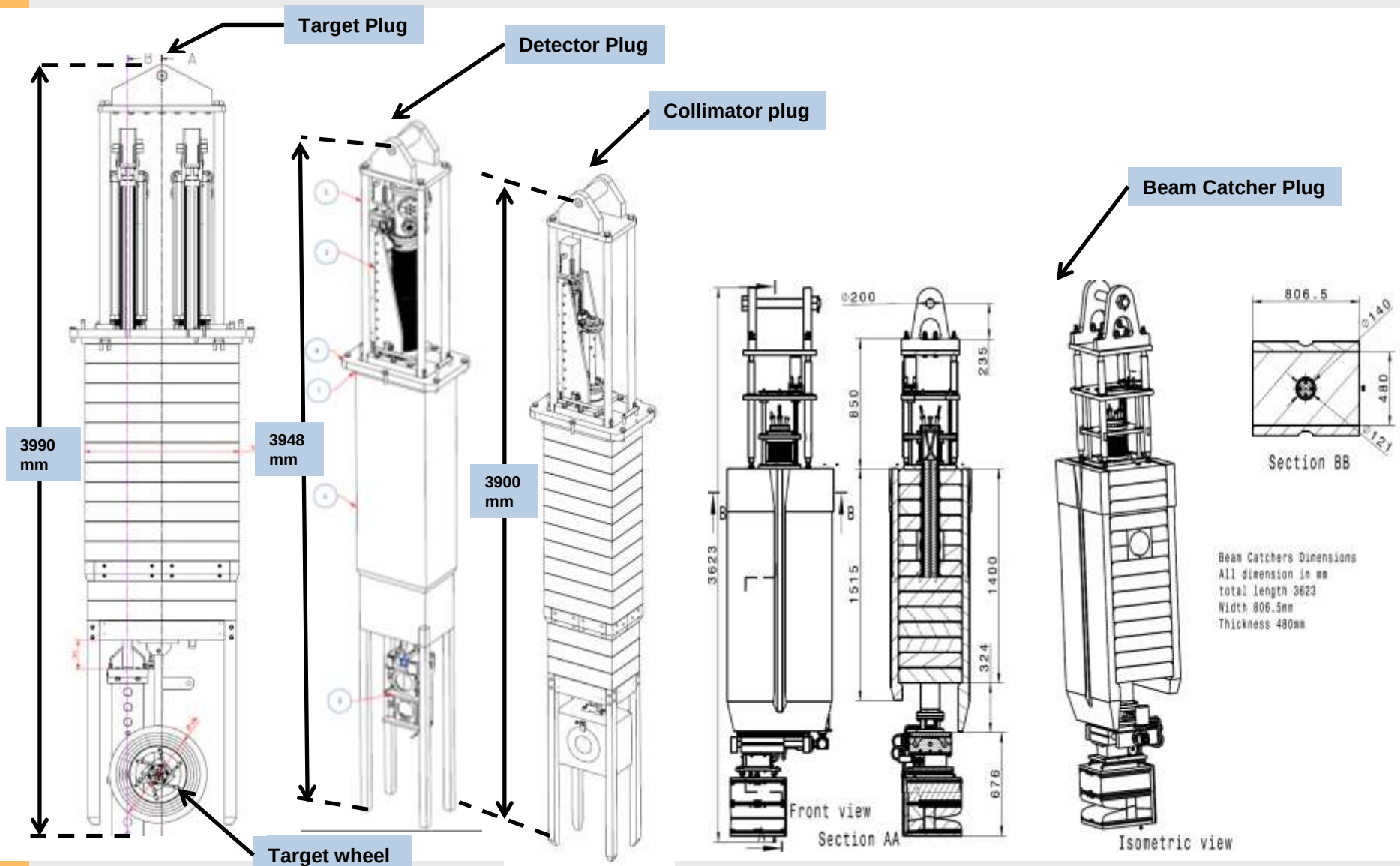






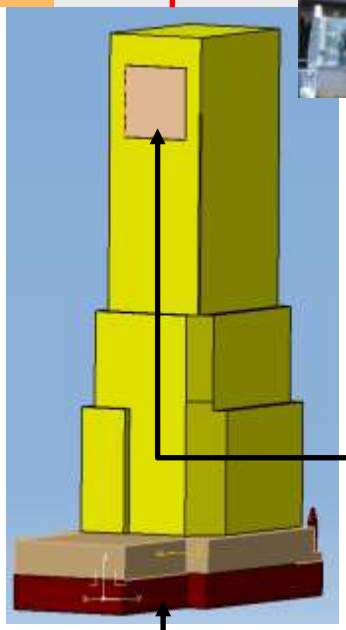
1 Release the connectors beam absorber assembly
2 & 3 disconnect the water cooling pipe connections
4 Disengage the beam absorber assembly
5 Uncouple the rods holding the graphite blocks in the absorber assembly
6 & 7 Remove the graphite absorber part
8 install new graphite parts and carryout assembly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

Super-FRS target area plug remote handling requirements



Super-FRS Shielding flask (1/4)

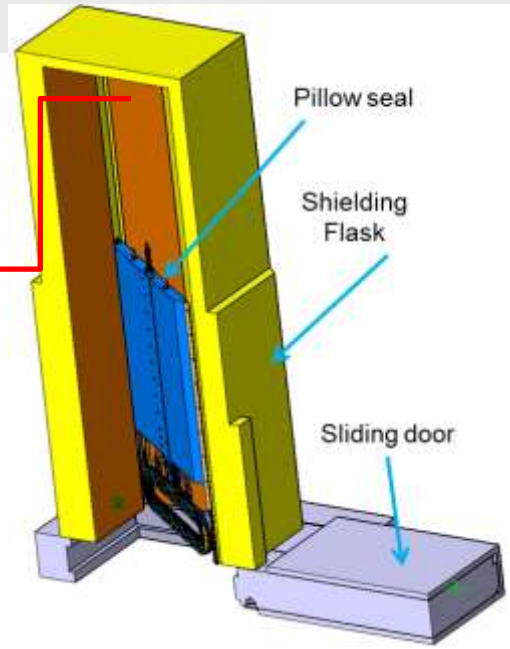
Hall (80t)
crane interface

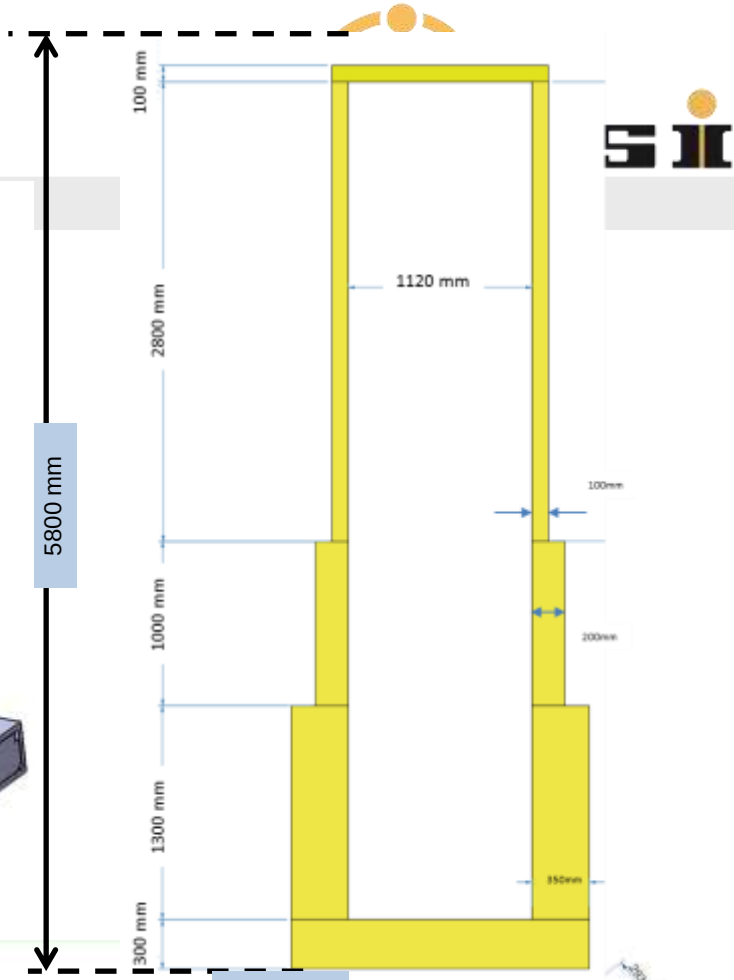


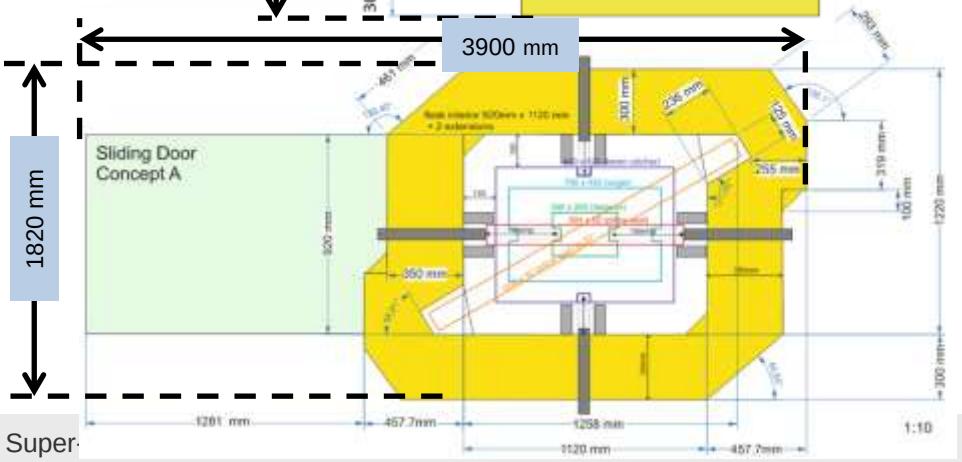
9t internal crane

Emergency
access
window

Hotcell
interface

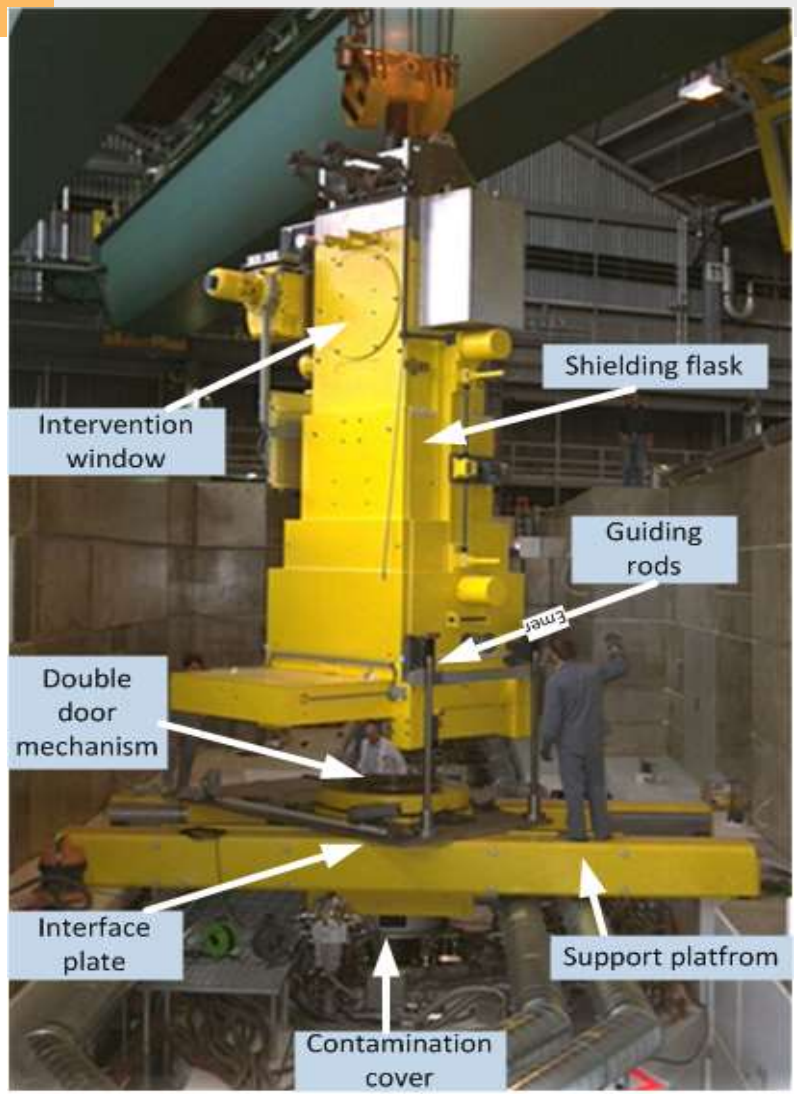






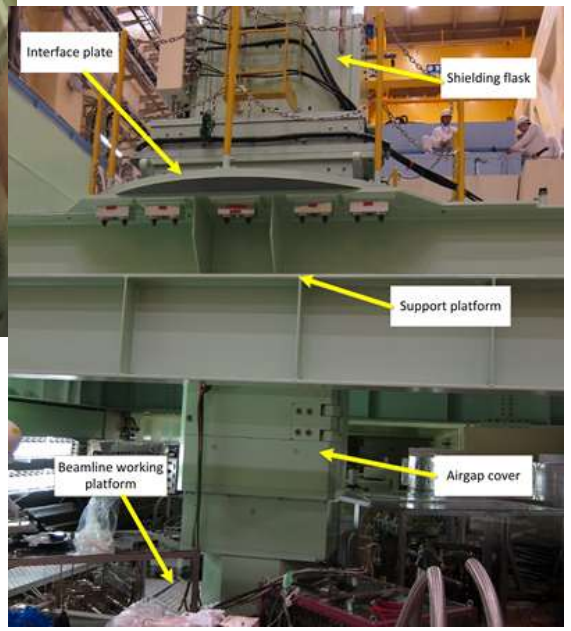
- Design and develop according to legal (KTA) standards
- Shielding flask height: ~5.8m (including internal carne installation)
- Foot print of shielding flask: 3.9m x 1.820 m (including the sliding door frame)
- Internal dimensions 5.1m x .820m x .904m
- Estimate weight of 66t
- In the designs (DN500) 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

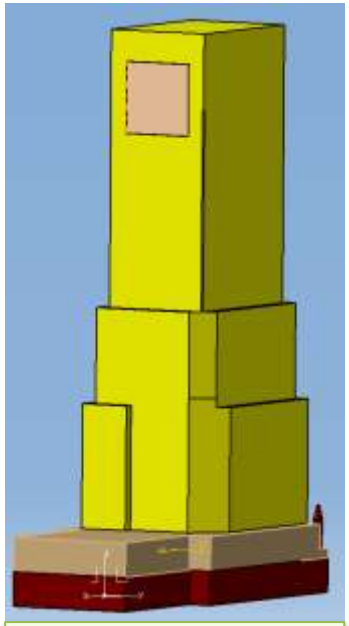


PSI shielding Flask

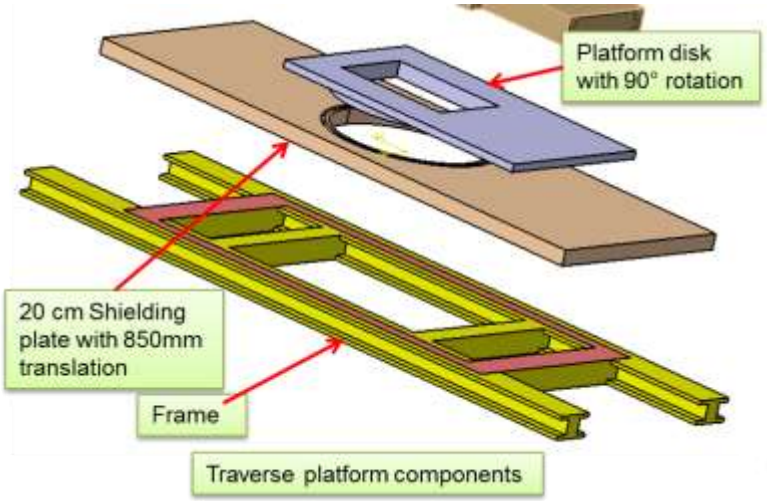
J-PARC shielding Flask

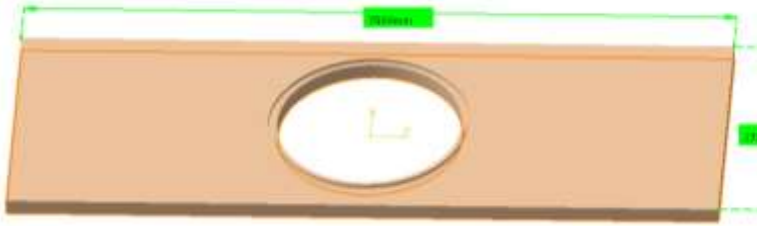


Super-FRS Shielding flask (3/4)
Traverse platform

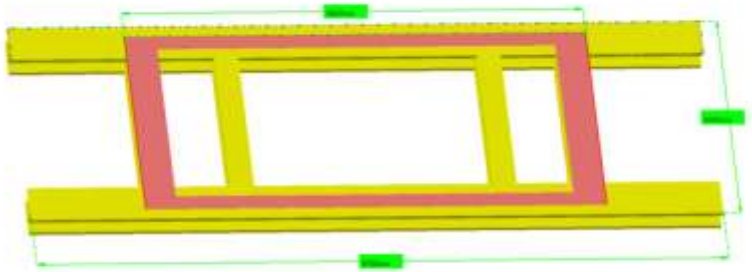


Shielding Flask





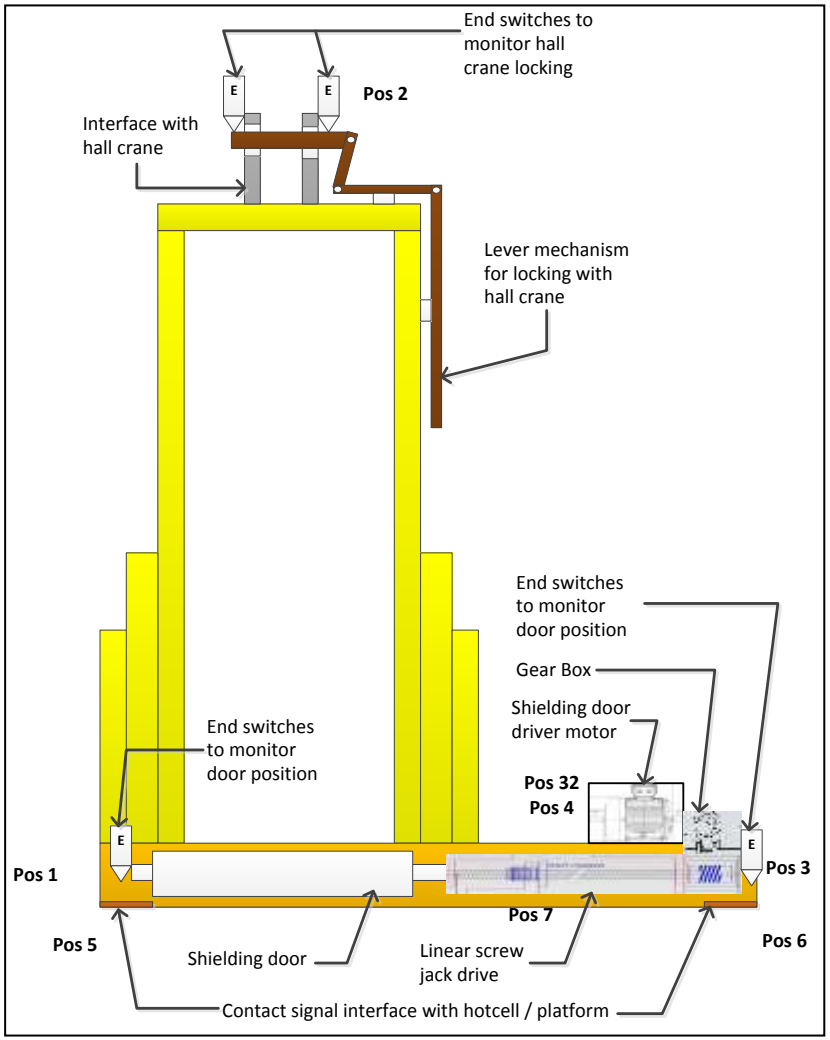
Frame 7500mm x 24000mm x 200mm (27tons)
Shielding plate

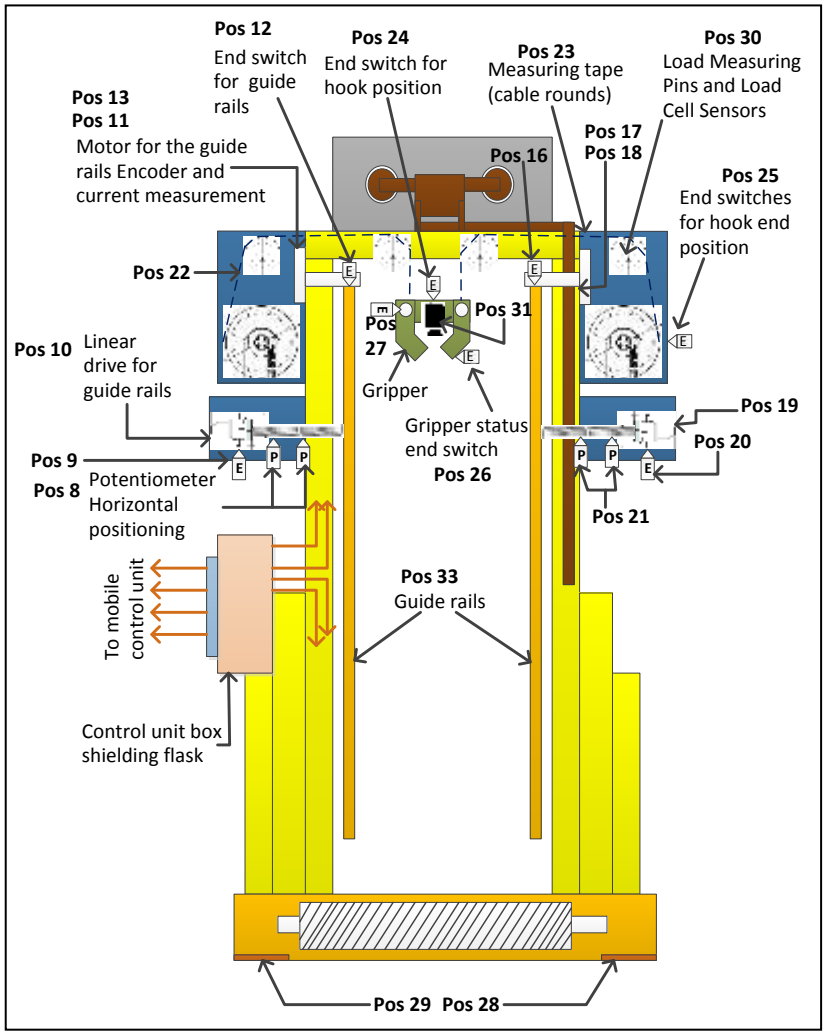


Frame 8700mm x 3000mm x 300mm (19.5 tons)
Traverse plate

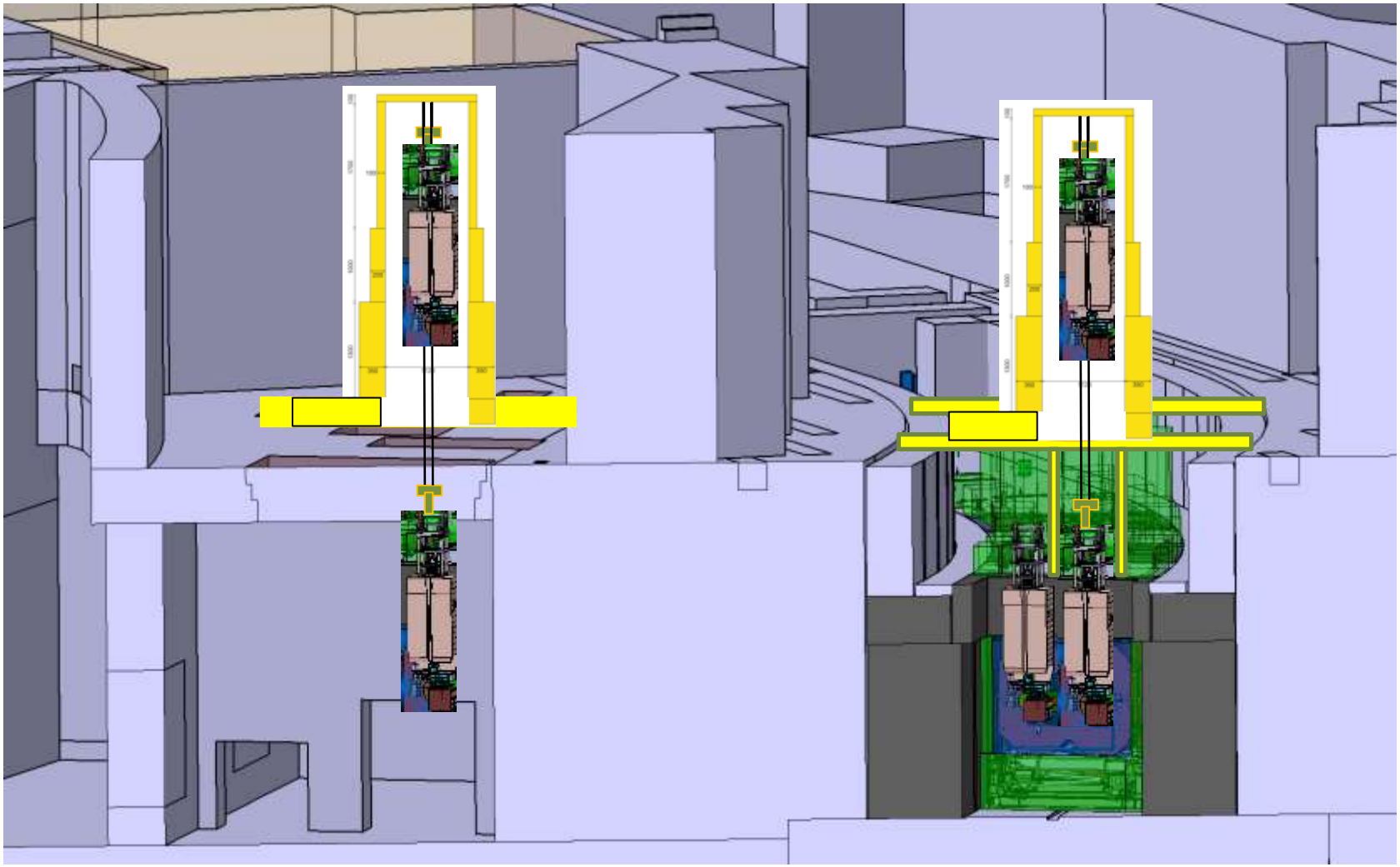
- Air gap cover to prevent contamination
- Detachable control unit

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





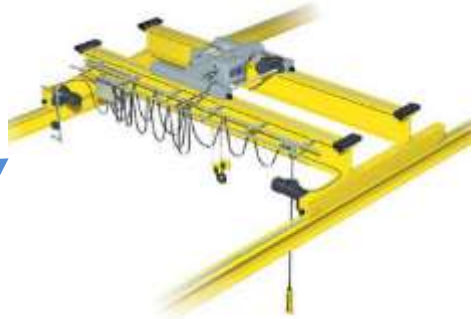
Super-FRS Remote handling scenario (Closed tunnel)

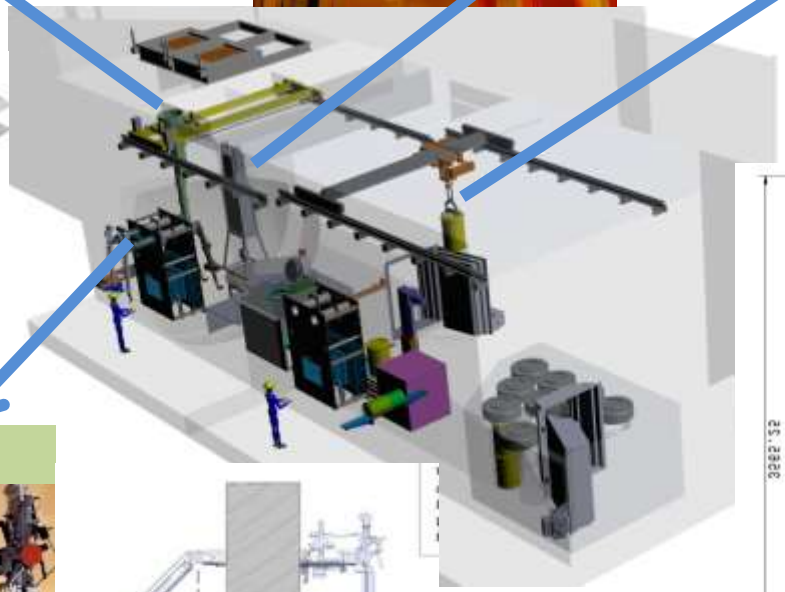


Plug Holder

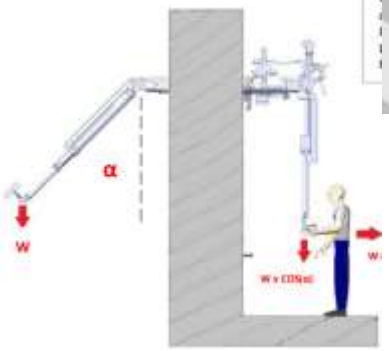
Power manipulator

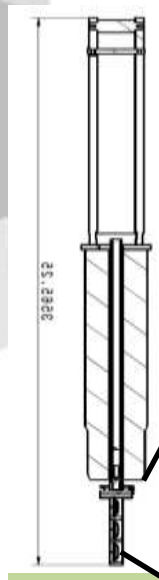
Indoor overhead crane



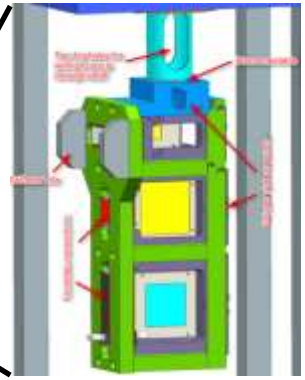


MT200 MSM



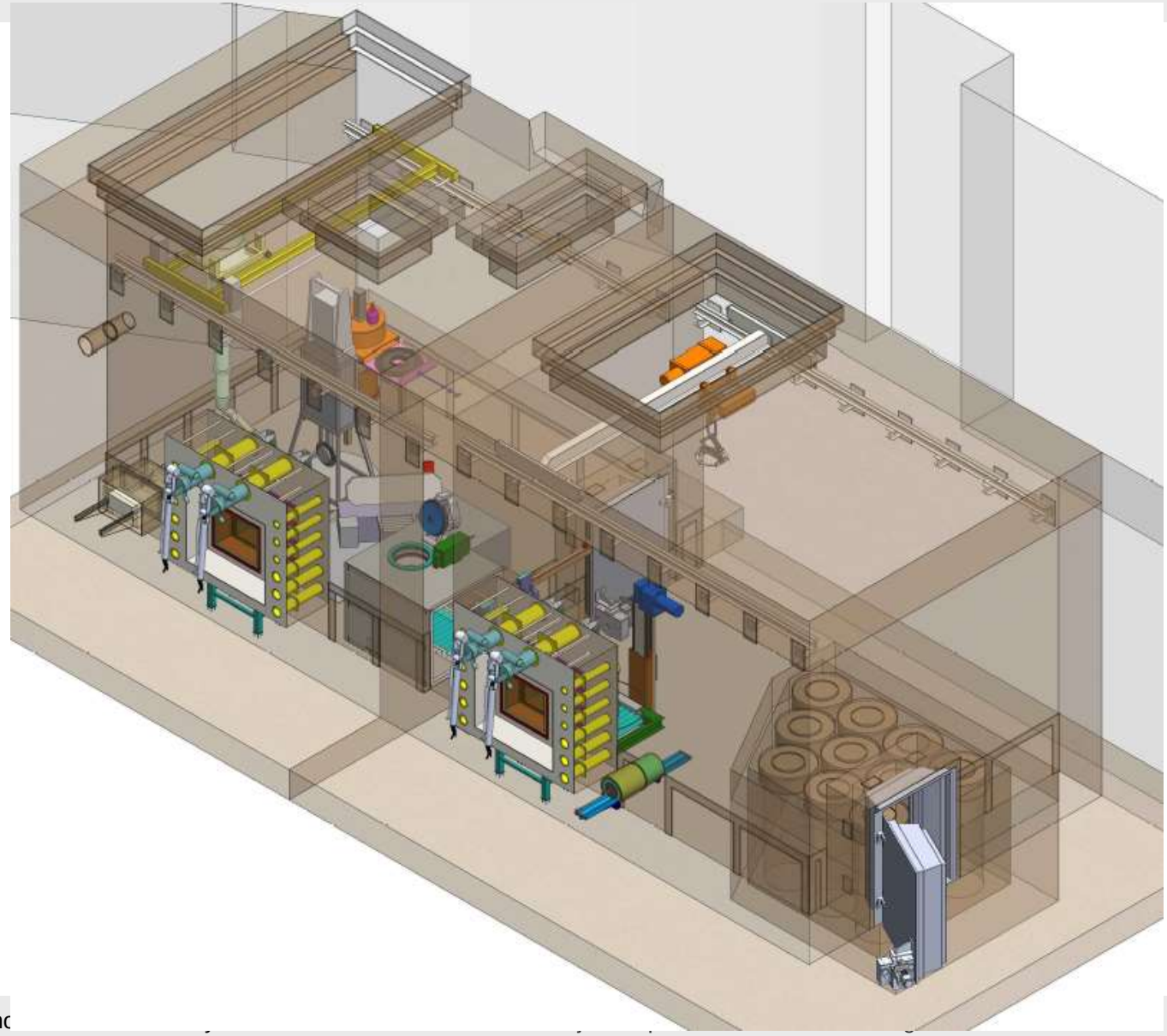


Detector plug



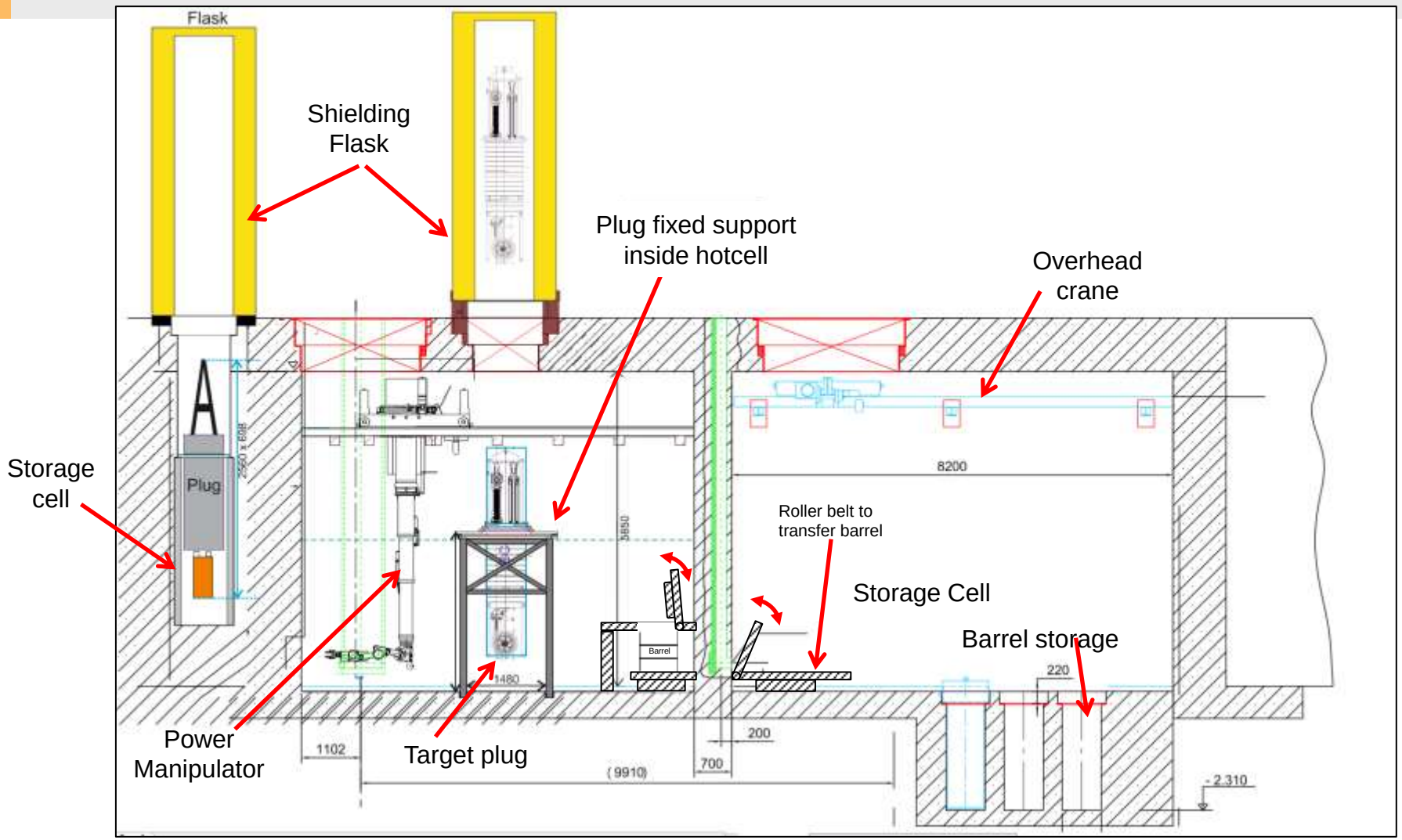
Modular Design

Super-FRS Hot cell

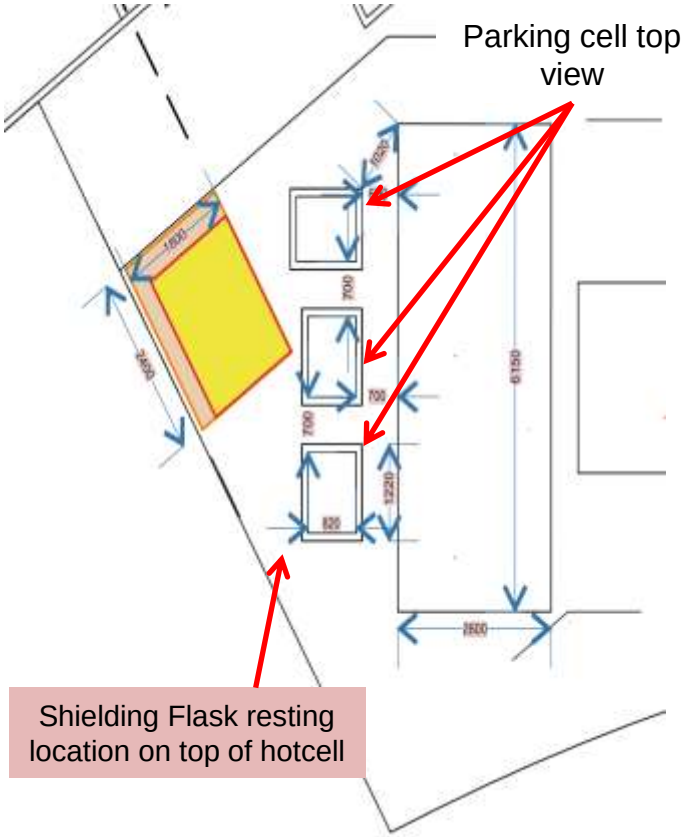


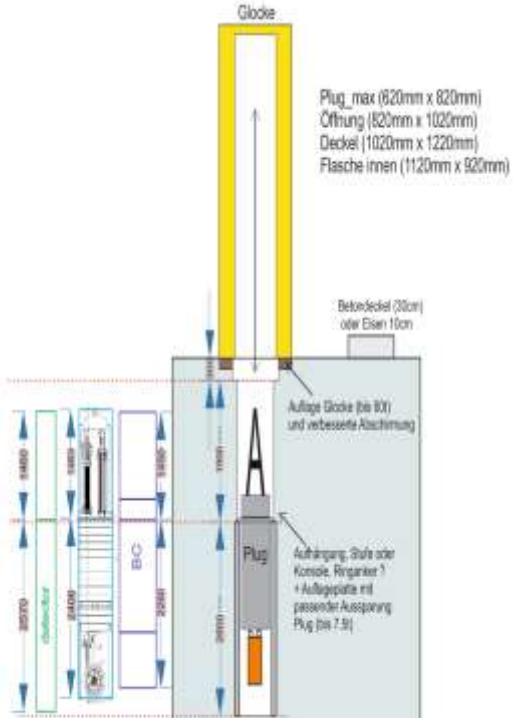
Siempelkamp
Nukleartechnik

Super-FRS Hot cell



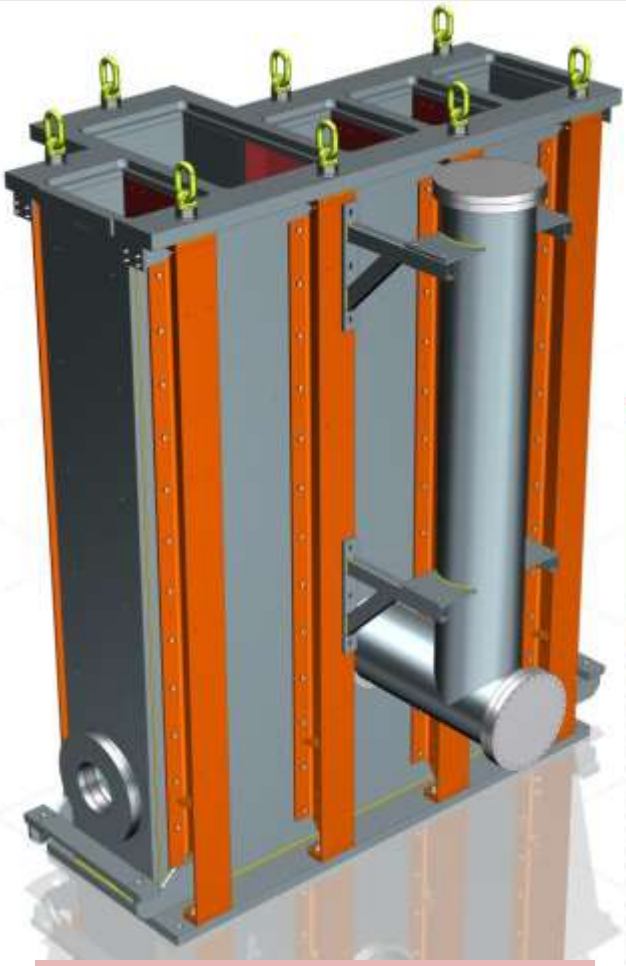
Shielding flask parking cell interaction





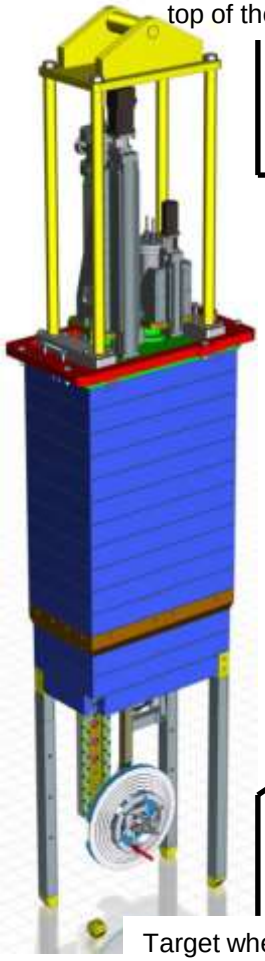
Plug parking cell design

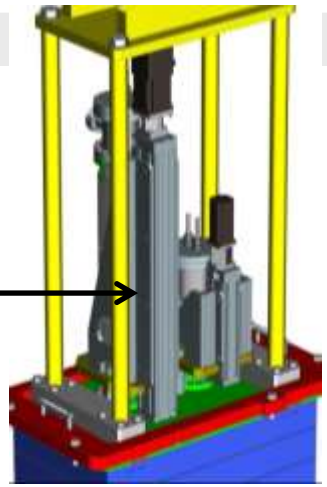
Target Chamber plugs
Design for remote handling



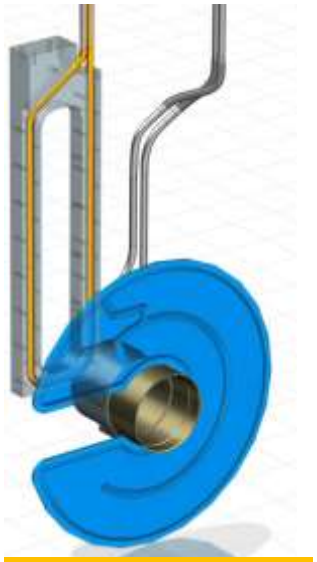
Target vacuum chamber

Linear drive maintenance at the top of the plug.





Target wheel and target ladder maintenance in hot-cell.

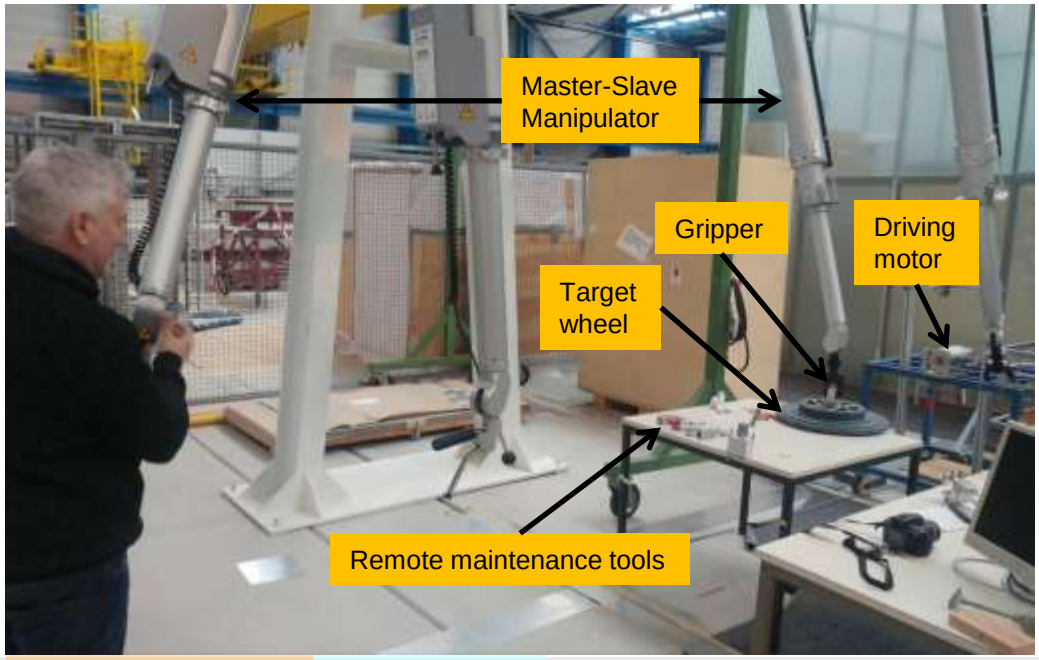


Target cooling system.

Target Wheel
remote maintenance

Target wheel and motor in vacuum
(regular replacement)

Tool adopted to fit MSM

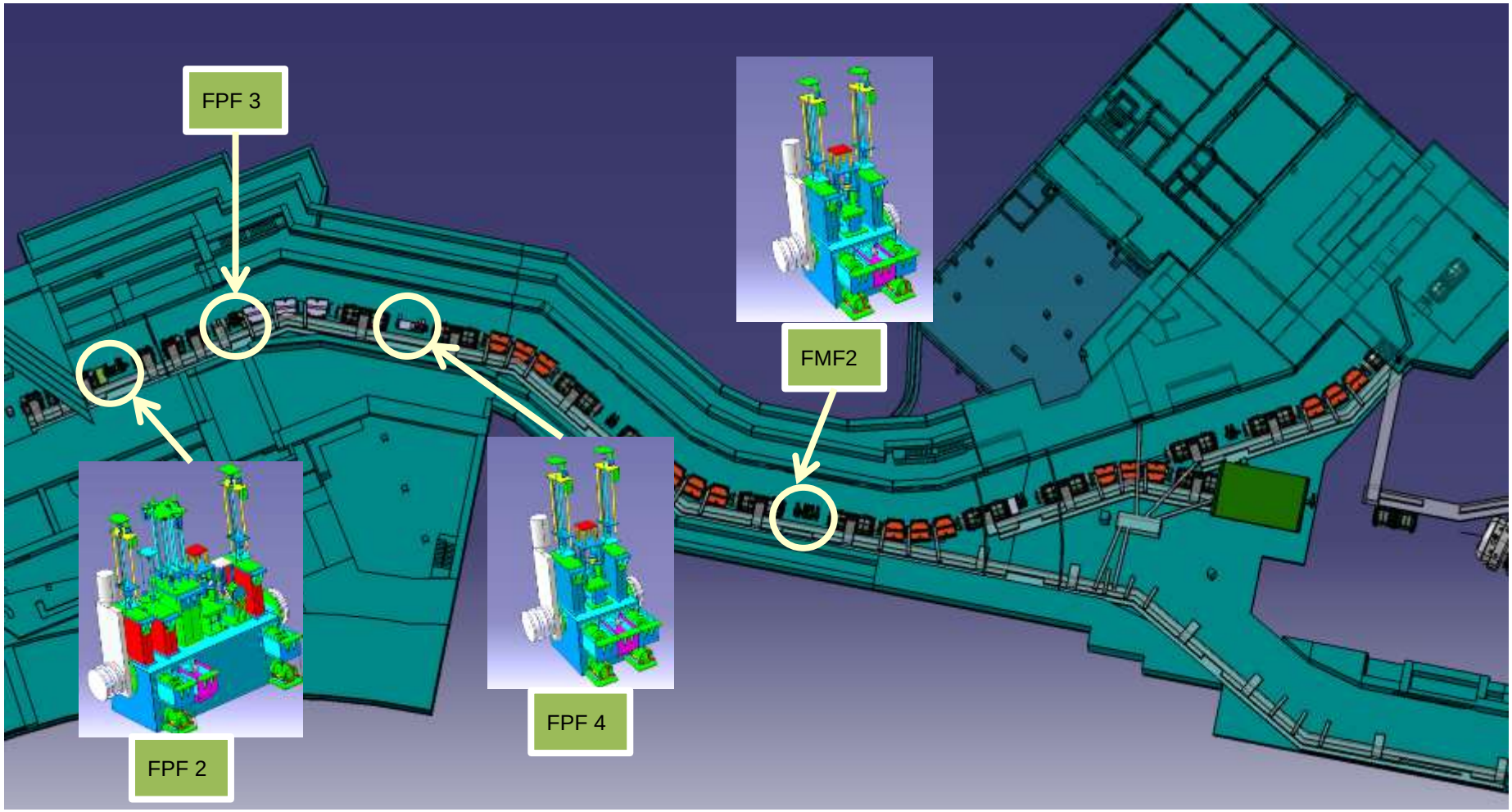


C.Karagiannis

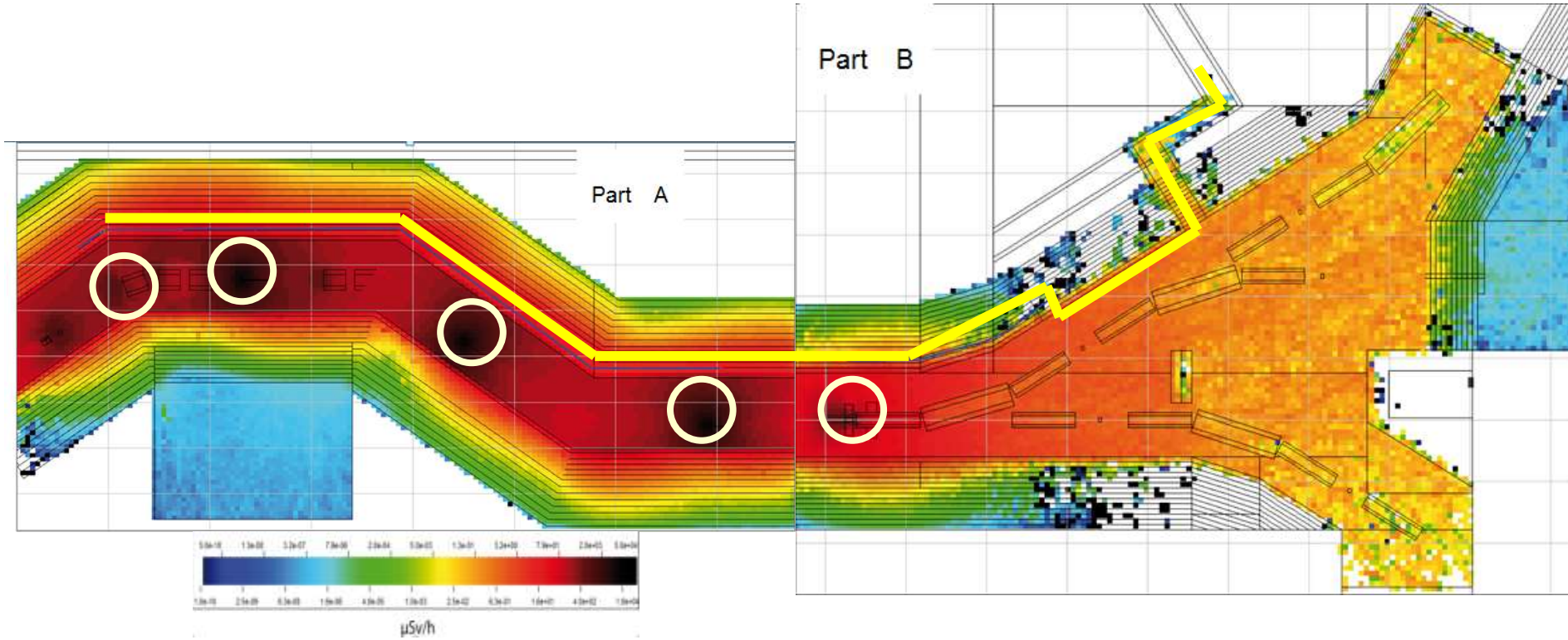
Remote Handling (video 1)

Remote Handling (video 2)

Super-FRS Remote handling scenario (open tunnel)

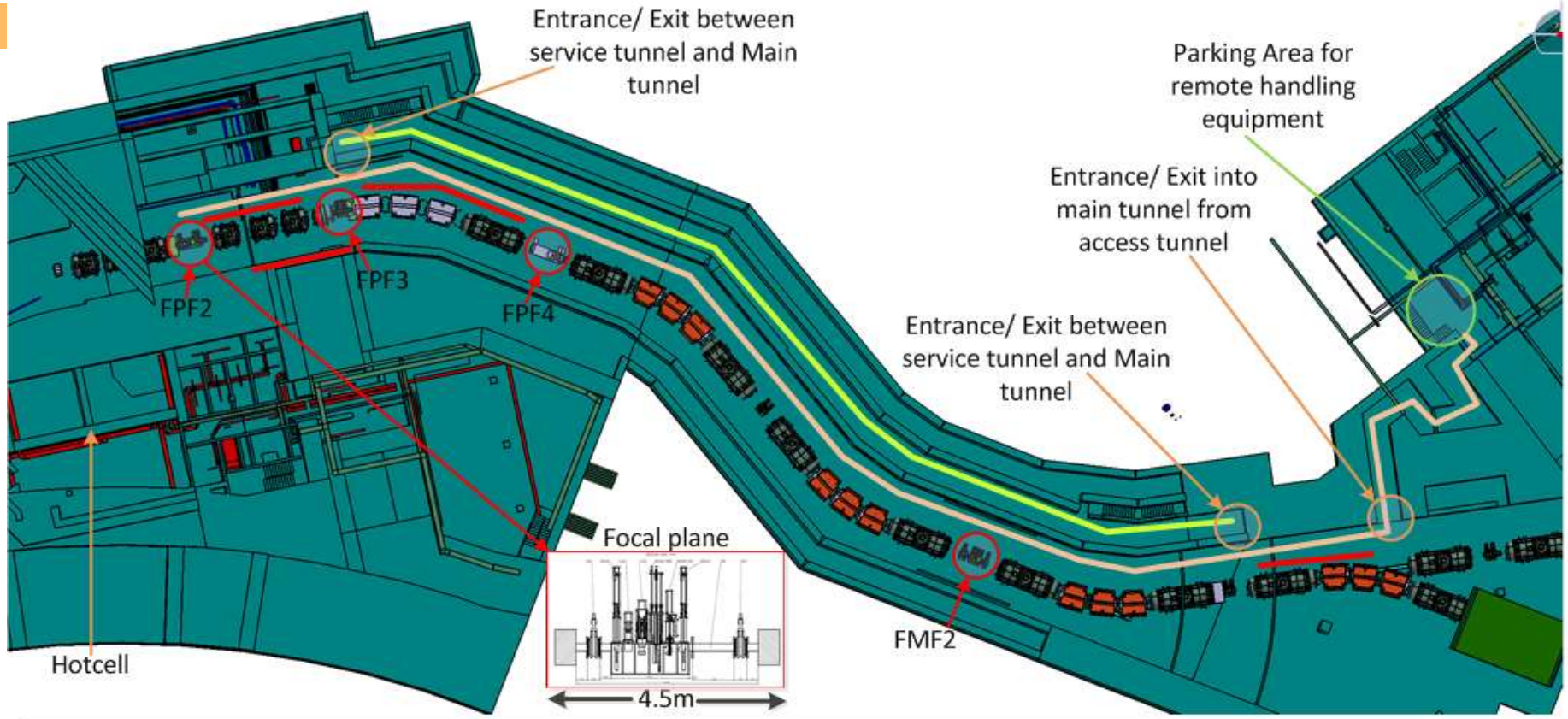


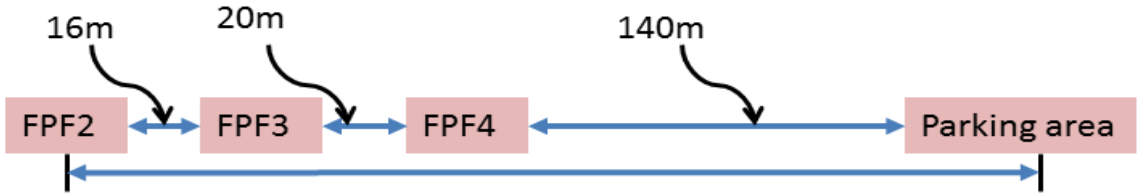
Super-FRS Remote handling scenario (open tunnel)



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

Super-FRS Remote handling scenario (open tunnel)

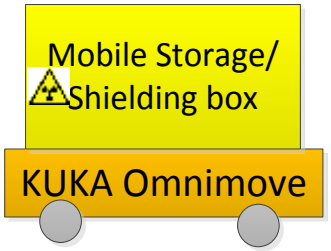


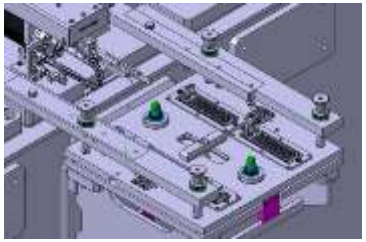


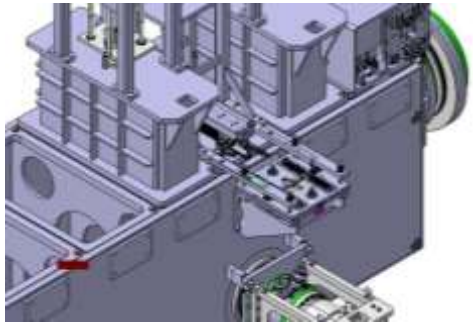
Super-FRS Remote handling scenario (open tunnel) Concept design

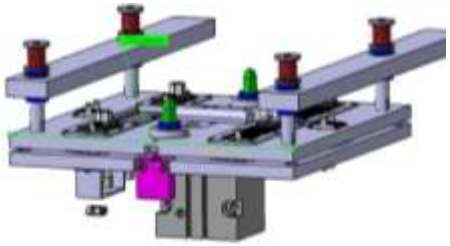
Main tunnel RH system

- 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

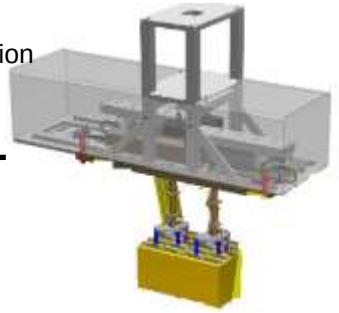








Automatic media board disconnection



Robot tools

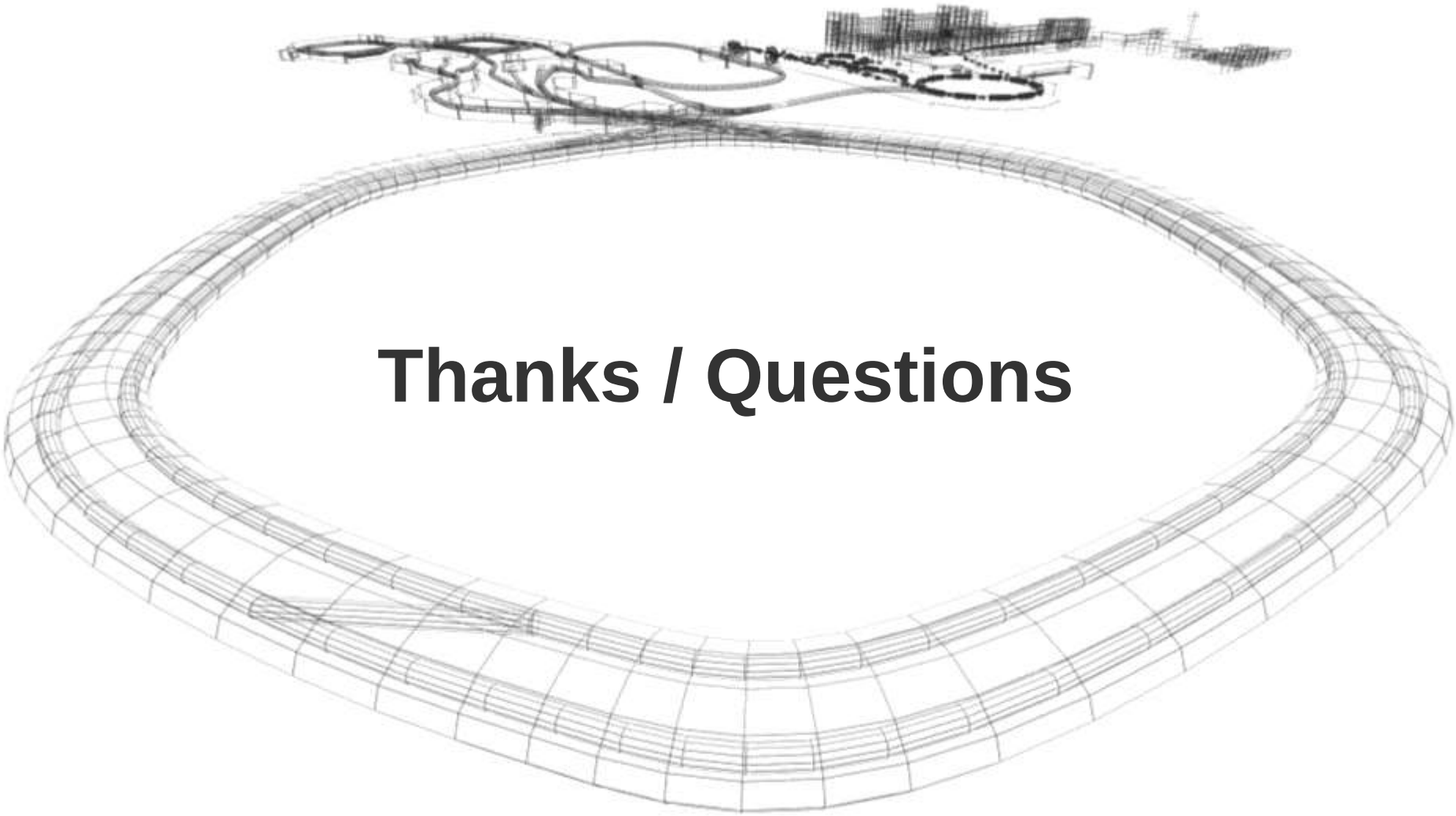
Remote Handling of beamline inserts (X and Y slits) example

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 has been developed at GSI.

Future outlook

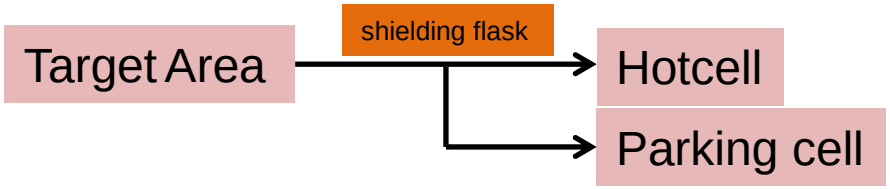
- Target area chamber design is in advance stage and will be go through CDR review.
- Beam catcher and detector ladder designs needs to be verified for remote handling using the MSM setup at GSI.
- Shielding flask specification are updated and MOU talks has been agreed to design and develop the Finland in-kind contribution to FAIR.
- Open tunnel remote handling system specification and design parameter are under development.
- Analyze - from the start - the assembly, failure and maintenance scenarios
- Analyze the big picture – do not rely on a mystic remote handling device



Thanks / Questions

Super-FRS target area plug remote handling requirements

Beamline Plug	Length	Width	Thickness
Detector Plug	3565mm (500 mm stroke)	457mm	330mm
Target Plug	3653mm (500 mm stroke)	767mm	465mm
Target wheel 450mm Ø			
Beam Catcher	3623mm	806.5mm	480mm
Pillow seal 500mm Ø	2761mm	900mm	90mm
Pillow seal 1200mm Ø	2635mm	1600mm	90mm

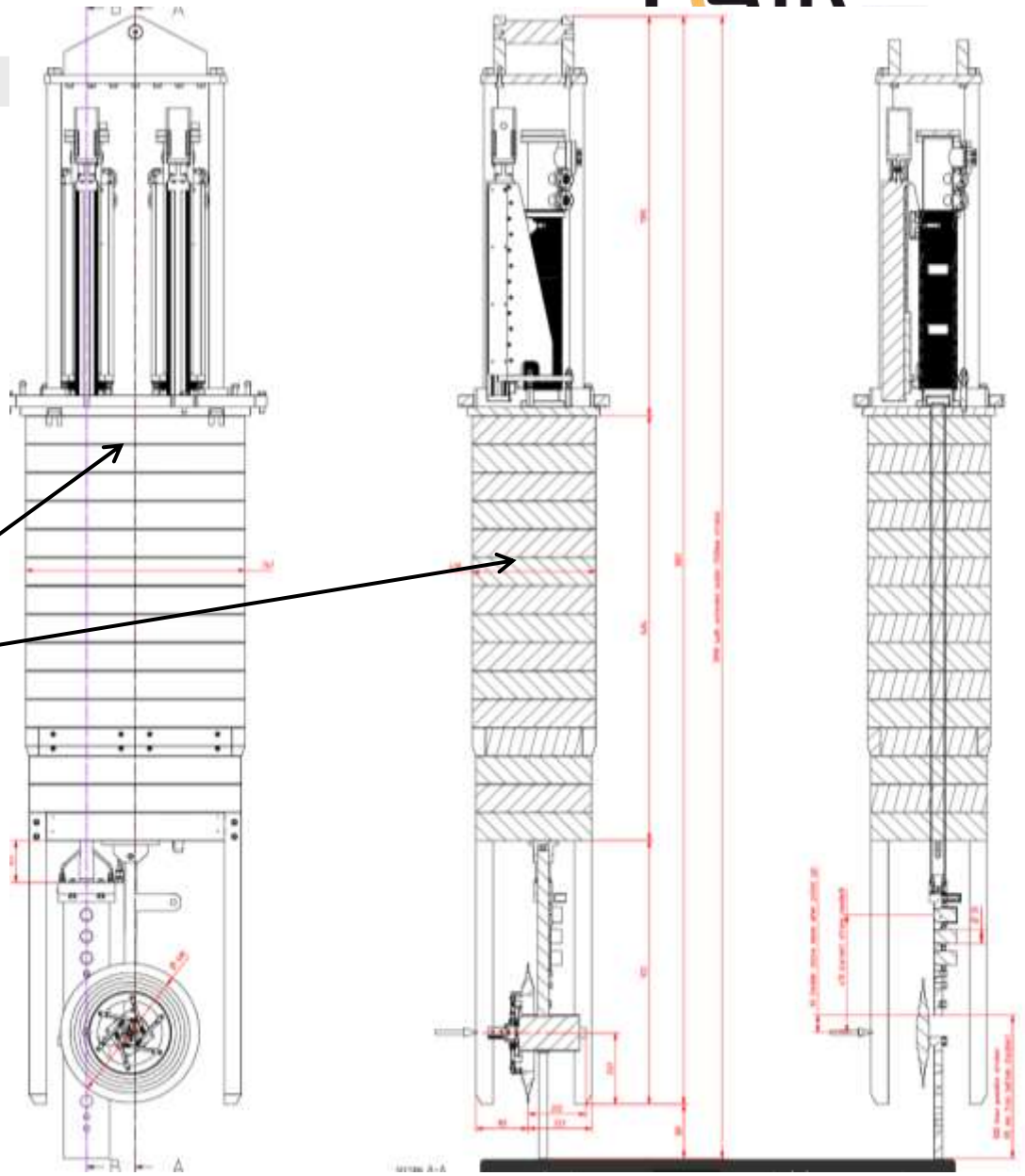


Target Plug dimensions

Plug dimension
3801mmx747mmx430mm

Plug dimension with 500mm stroke
4150mmx747mmx430mm

X-section of the target plug at top will be
770mmx465mm



Detector / collimator plugs dimensions

Plug dimension
3948mmx426mmx295mm

X-section of the target plug at top will be
465mmx350mm