

A review of Instrument technologies @ ESS

ESS/J-PARC workshop

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18/1/2018

NSS Engineering integration team

On behalf of instrument technologies
division and many others

Challenges

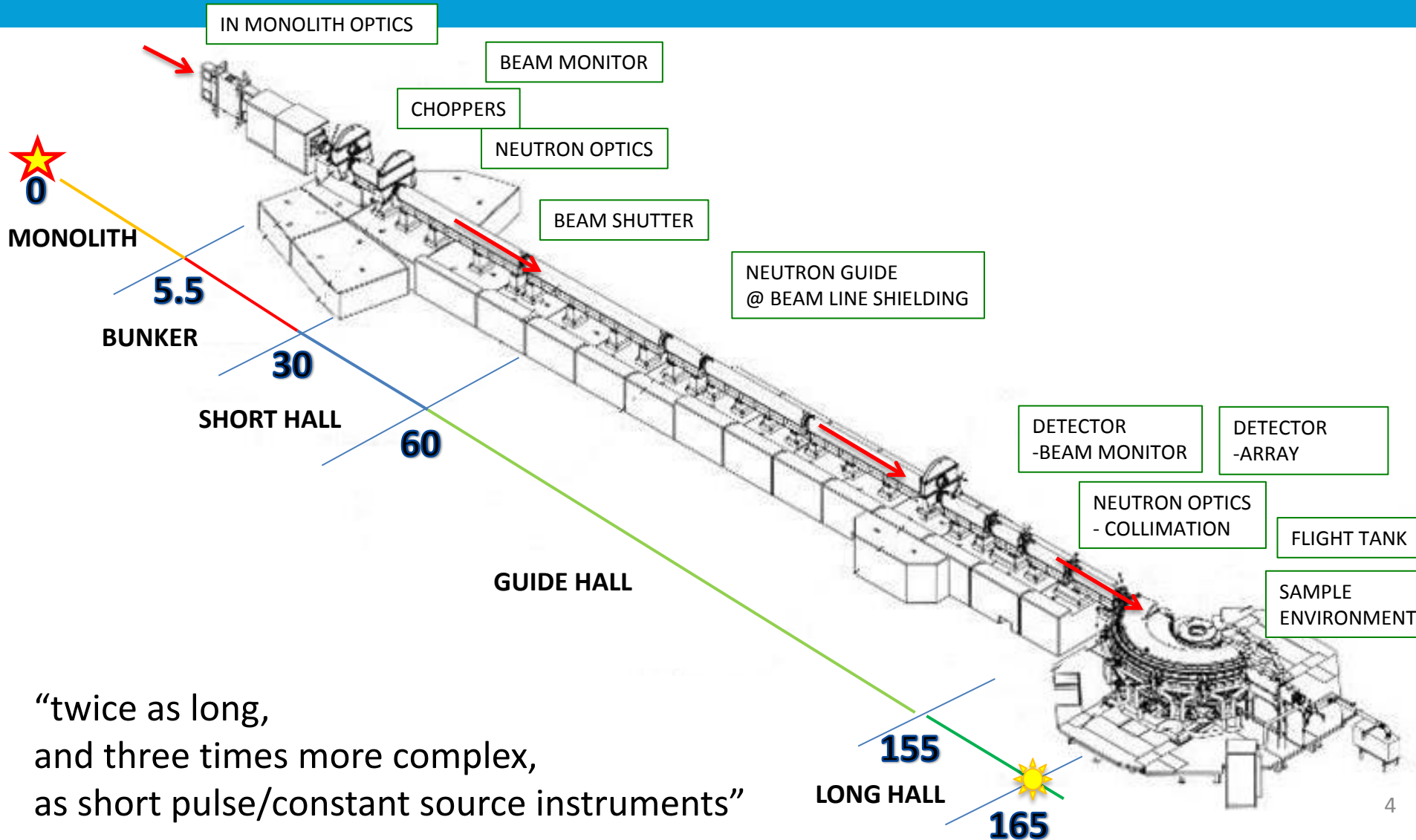
Technical challenges

- Radiation damage
- Long beamlines
- Neutron chopper cascades

Operational challenges

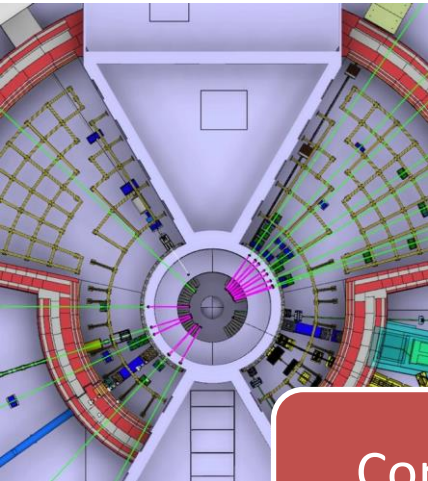
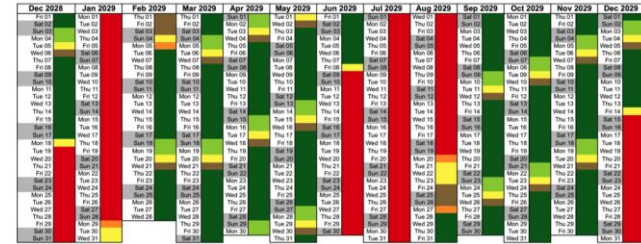
- Constructing, operating and maintaining

ESS instruments



“twice as long,
and three times more complex,
as short pulse/constant source instruments”

ESS unique source, setting unique boundary conditions.



Complex Installed systems

Hazardous environment

Limited access opportunities

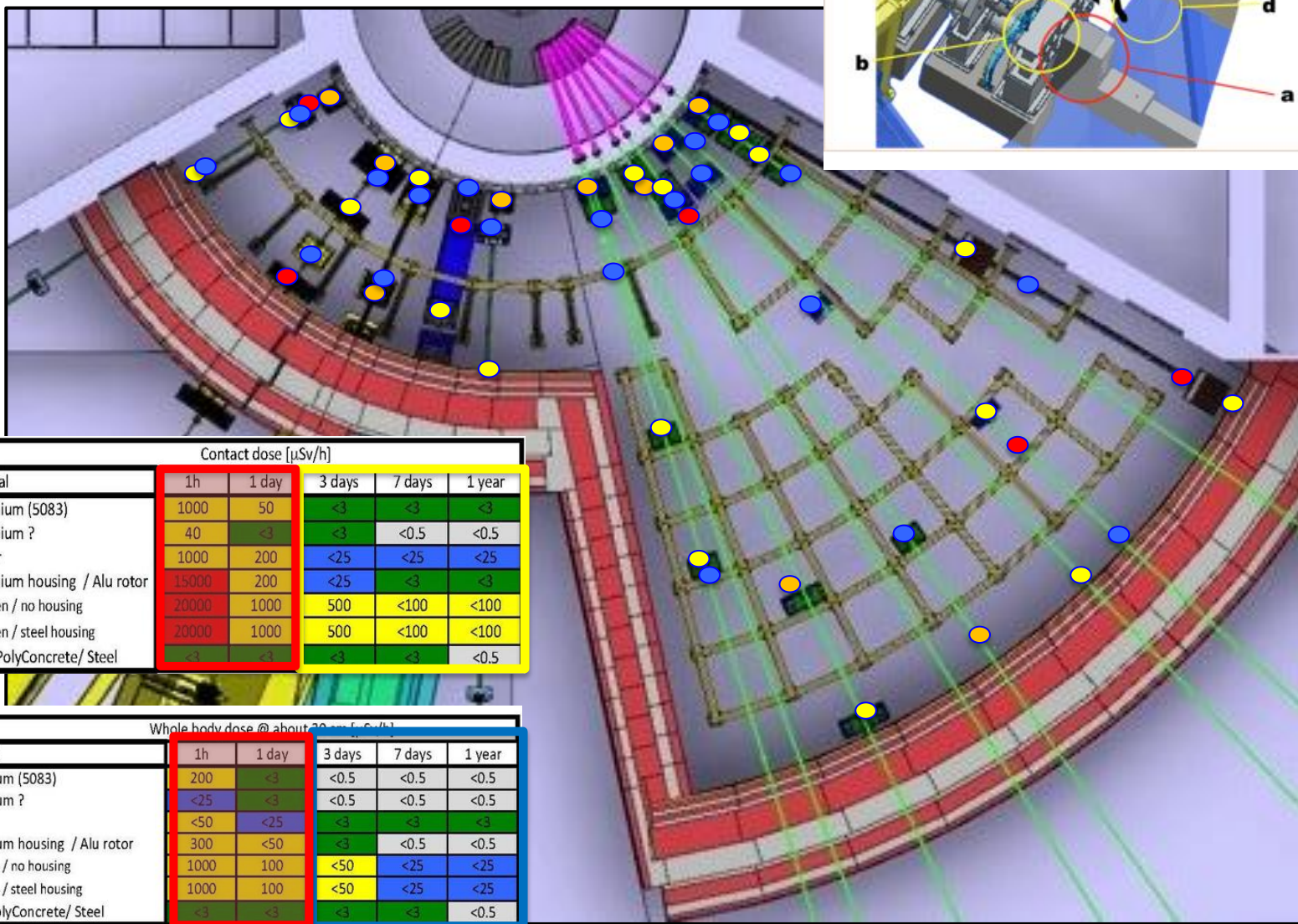
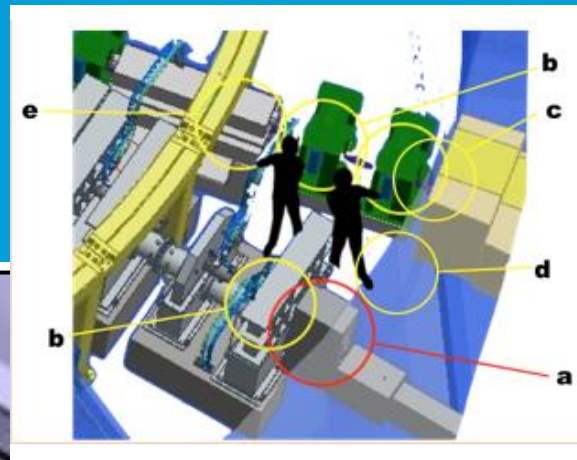
A challenging environment to operate equipment

60-70% of all 'mechanical' components on instruments are within bunker volume

High availability
High reliability

Access strategy

Controlled access

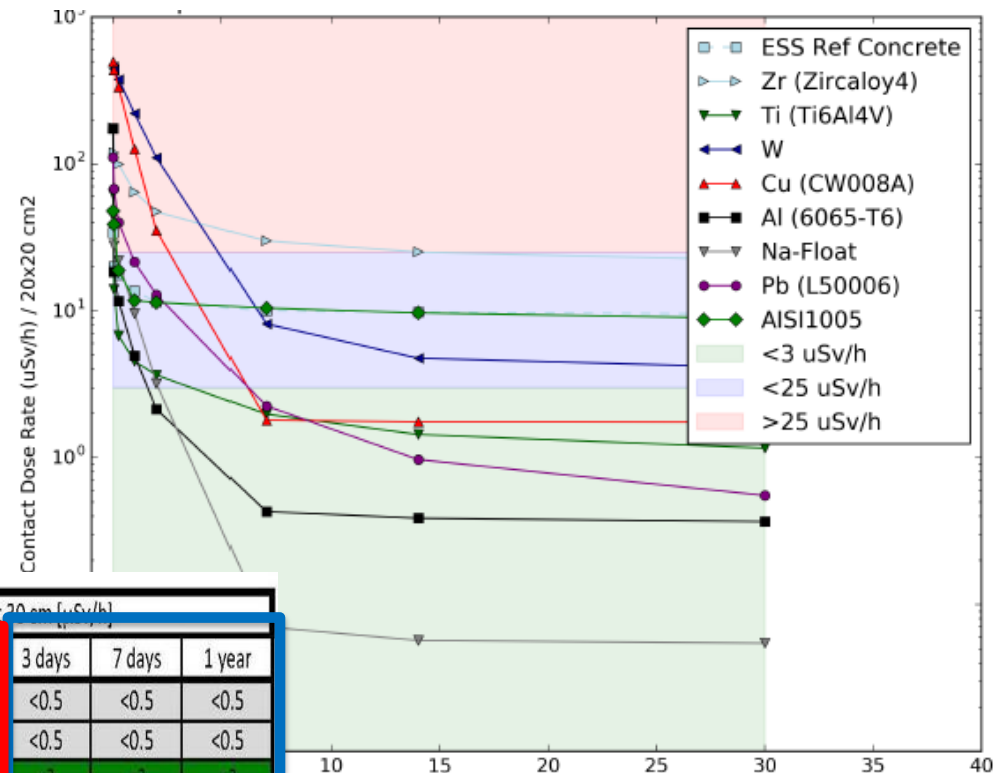


Delay following beam shutdown	Material	Contact dose [$\mu\text{Sv/h}$]				
		1h	1 day	3 days	7 days	1 year
Guide upstream of the 1st chopper	Aluminium (5083)	1000	50	<3	<3	<3
Guide downstream	Aluminium ?	40	<3	<3	<0.5	<0.5
Collimator (streaming)	Copper	1000	200	<25	<25	<25
Chopper (no steel)	Aluminium housing / Alu rotor	15000	200	<25	<3	<3
Heavy shutter	Tungsten / no housing	20000	1000	500	<100	<100
T ₀ chopper (Tungsten hammer)	Tungsten / steel housing	20000	1000	500	<100	<100
Inside rear bunker wall (with lead)	Lead / PolyConcrete/ Steel	<3	<3	<3	<3	<0.5

Delay following beam shutdown	Material	Whole body dose @ about 20 cm (Sv/L)				
		1h	1 day	3 days	7 days	1 year
Guide upstream of the 1st chopper	Aluminium (5083)	200	<3	<0.5	<0.5	<0.5
Guide downstream	Aluminium ?	<25	<3	<0.5	<0.5	<0.5
Collimator (streaming)	Copper	<50	<25	<3	<3	<3
Chopper (no steel)	Aluminium housing / Alu rotor	300	<50	<3	<0.5	<0.5
Heavy shutter	Tungsten / no housing	1000	100	<50	<25	<25
T ₀ chopper (Tungsten hammer)	Tungsten / steel housing	1000	100	<50	<25	<25
Inside rear bunker wall (with lead)	Lead / PolyConcrete/ Steel	<3	<3	<3	<3	<0.5

Activation mitigation

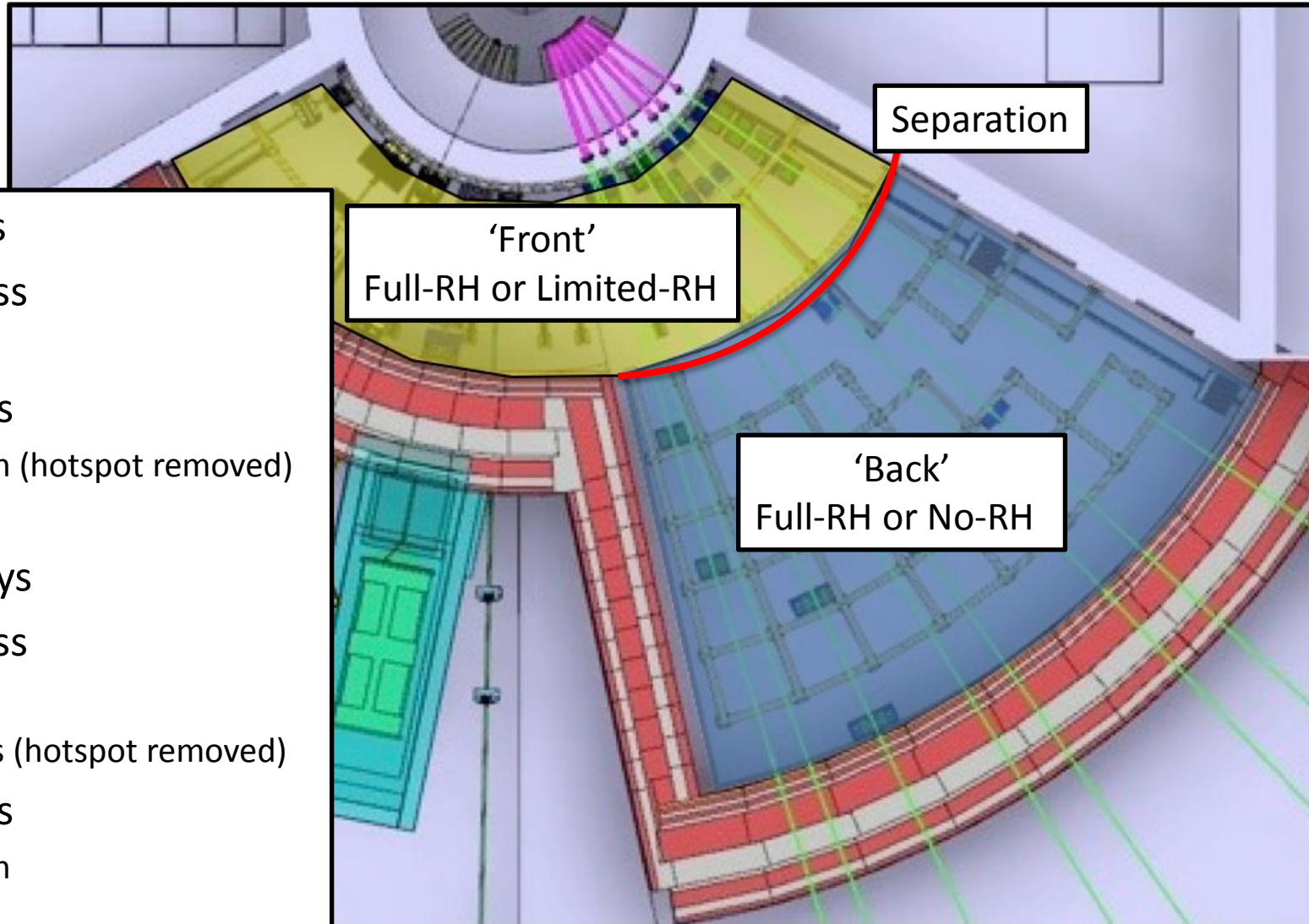
- Design
- Material choice
- ... remote handling



		Whole body dose @ about 20 cm (uSv/h)				
Delay following beam shutdown	Material	1h	1 day	3 days	7 days	1 year
Guide upstream of the 1st chopper	Aluminium (5083)	200	<3	<0.5	<0.5	<0.5
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Cool down

Implementation



After 48-72hrs

- Front access
 - RH only
- Rear access
 - Hands on (hotspot removed)

After 10-15days

- Front access
 - RH only
 - or Hands (hotspot removed)
- Rear access
 - Hands on

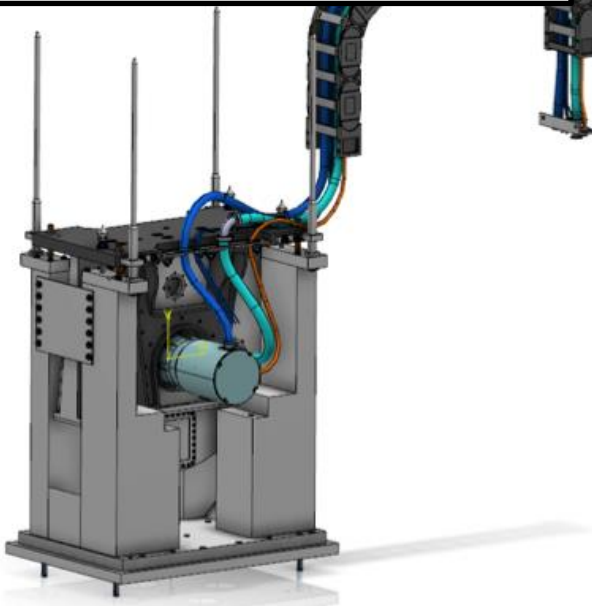
Remote handling

Simple as 1, 2, 3 ... (?)

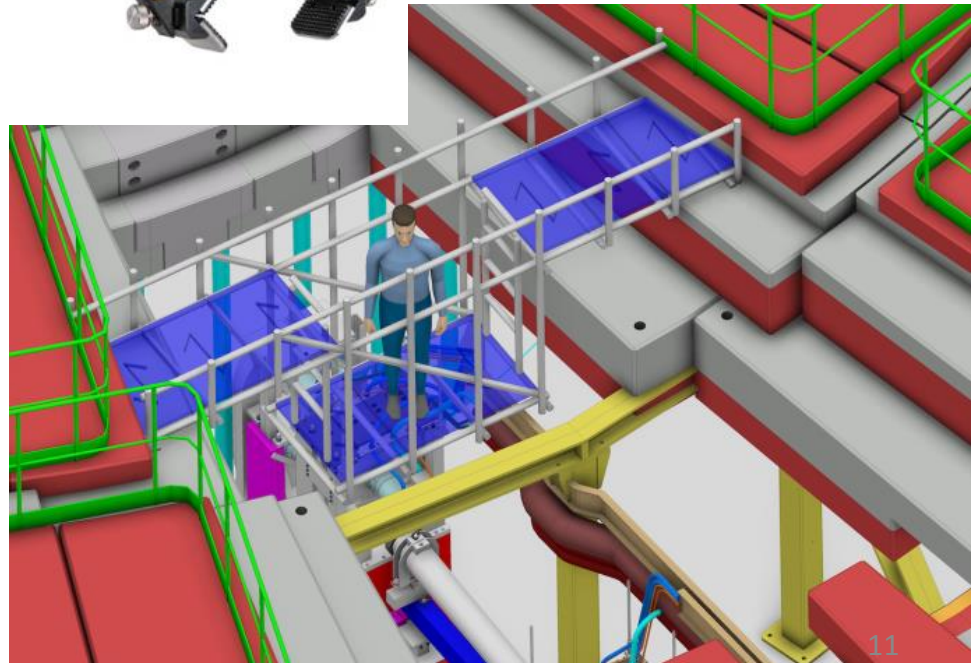
3. Long manual tools



2. RH Ready equipment



1. Vertical access



Radiation damage

Use of hardened components

Cables

Radiation spec cables:
Huber Suhner RADOX 125
(3 MGy)

AXON Polyimide TPI
(20MGy)



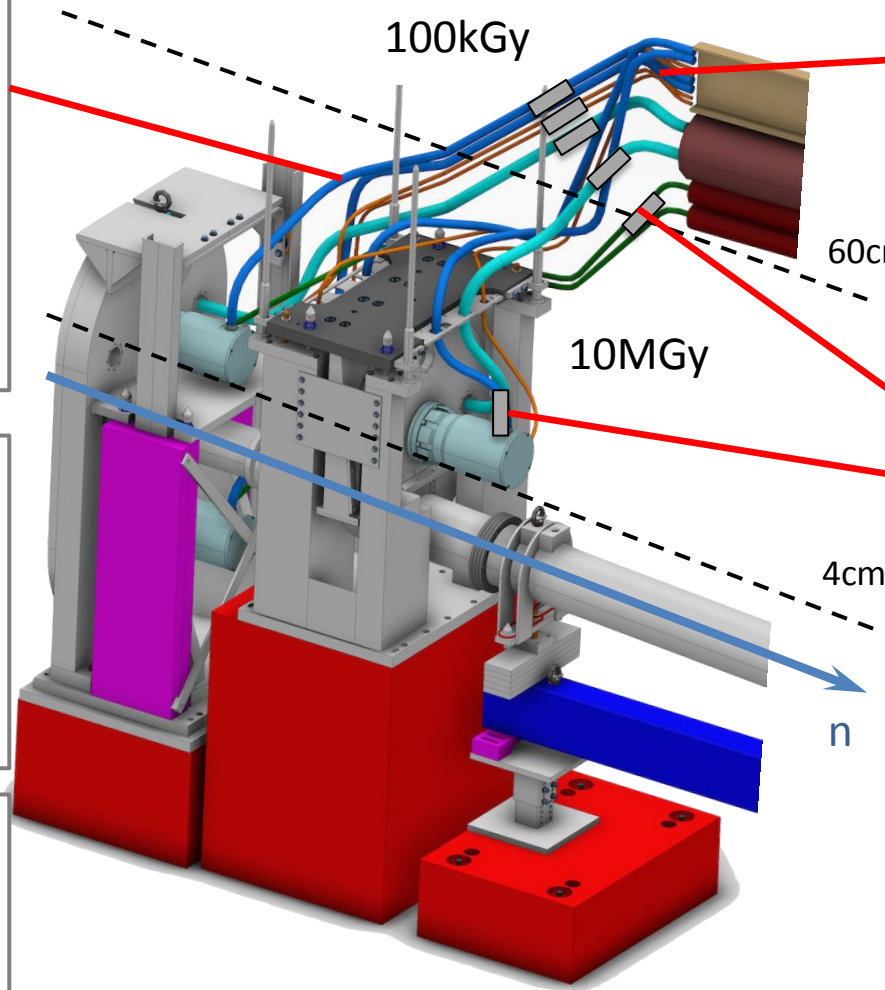
Sensors

Vibration Sensor:
Vibro-Meter CA901
(10 MGy)



Switches

Mechanical limit switch:
Crouzet 83151 **(10 MGy)**



Cables

Standard cables, PU isolated
(100 kGy, to be tested!)

Connectors

Push-Pull, RH ability:
Lemo B-series (Materials:
SS AISI 303 + PEEK plastics)
(10 MGy, to be confirmed!)



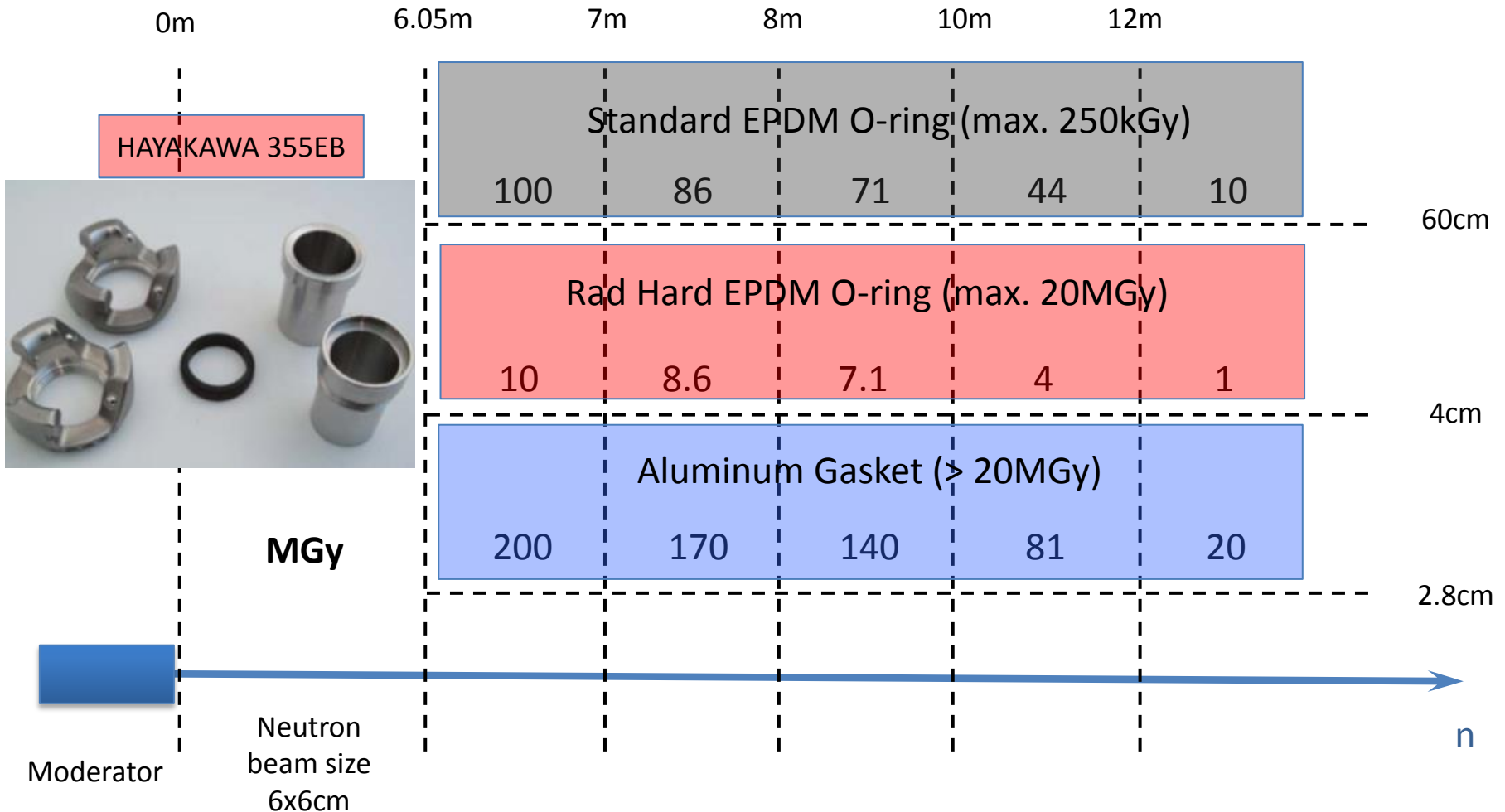
Positioning Motors

Stepper motors:
Phytron VSS **(1 MGy)**

Brushless DC motors:
Wittenstein MRSR **(10 MGy)**

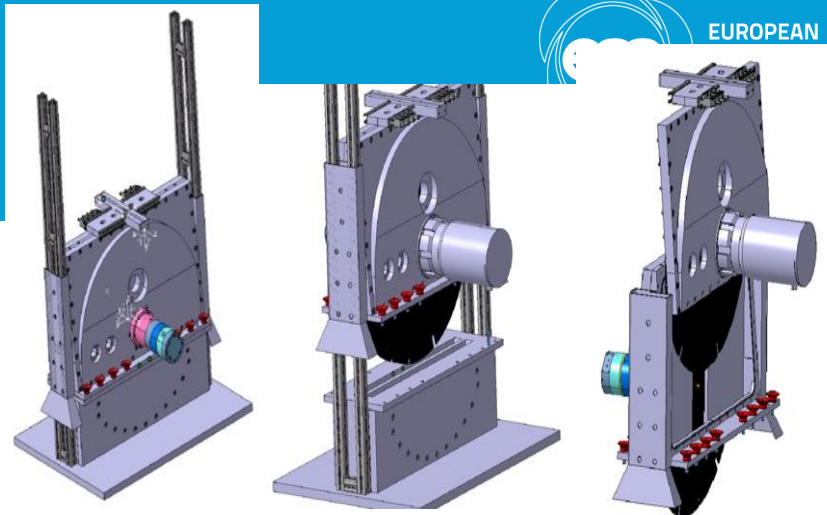


Deployment a graded approach



Neutron choppers

Current key enabling developments



In-kind collaboration in the field of high speed chopper systems

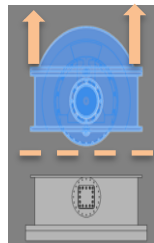
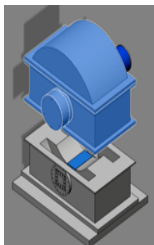
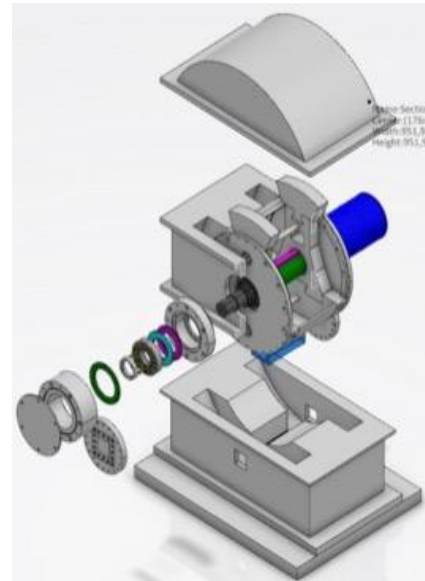
Key development challenges

- 1) >300Hz, 750mm \varnothing , CFRP based
- 2) 1xSKF + 1xJülich magnetic bearings
- 3) Interchangeable disk-motor coupling
- 4) CFRP radiation hardness
- 5) Mechanical assembly stiffness
- 6) Remote handling
- 7) Ease of repair

T0 chopper development

Key development challenges

- 1) 28 Hz, in vacuum, Long pulse source
- 2) 500 kg rotor weight (W, Ni, Cu, B)
- 3) Rad hard sensors, motor, lubricants
- 4) Mechanical assembly stiffness
- 5) Remote handling
- 6) Ease of repair
- 7) Exchangeable rotor

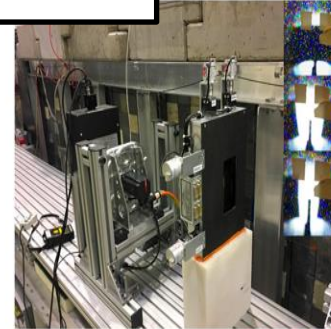
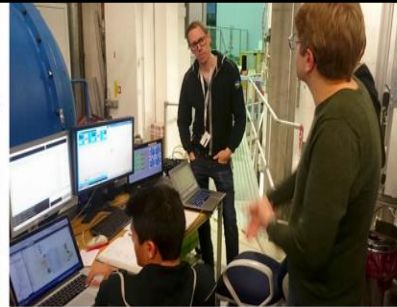
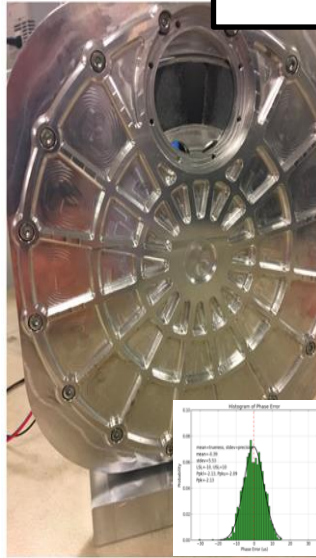


For further information
Acting Group Leader: Nikolaos Tsapatsaris

Neutron Technologies Division Head: Oliver Kirstein

Current key integration, installation and maintenance activities

- Chopper mechanical Integration
- Remote Handling of Active Components



ESS collaboration:
Neutron Chopper Group+
Integrated Control
Systems+
Detector Group+
DMSC++



- Chopper Control Systems Integration - EPICS
 - Timing, Vertical Integration tests and commissioning at HZB, DE



• Procedures for Chopper Installation
Commissioning and Maintenance

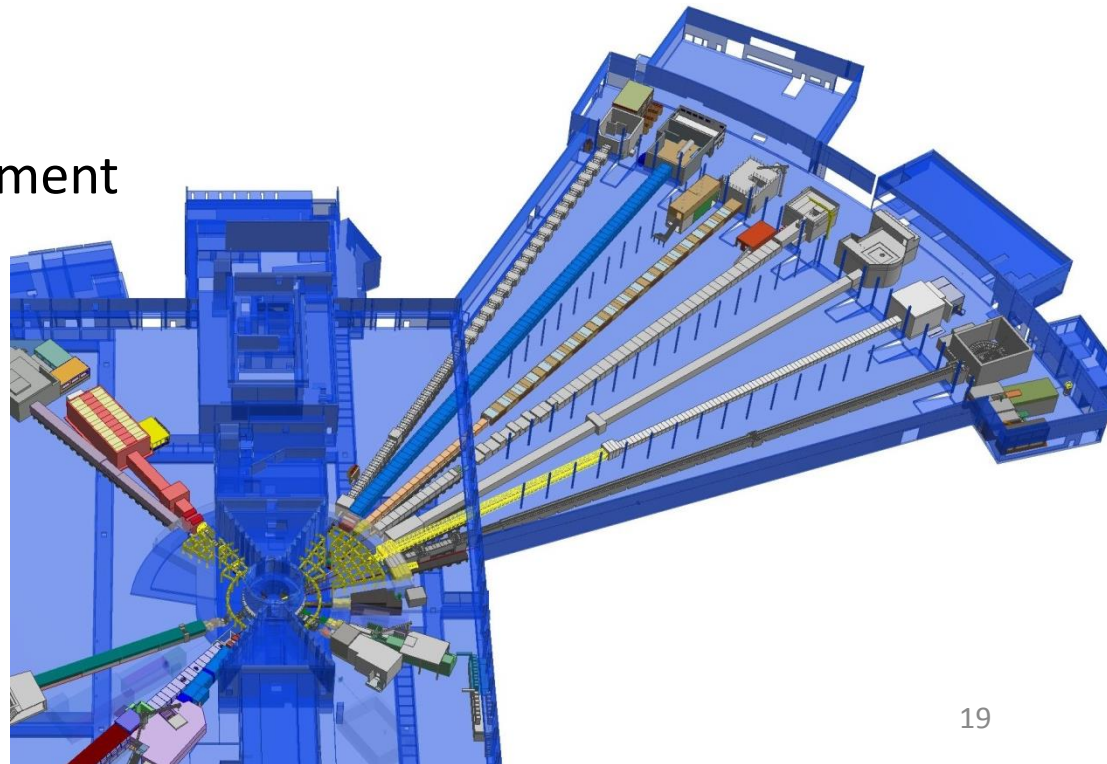
Very Long guides

Key numbers

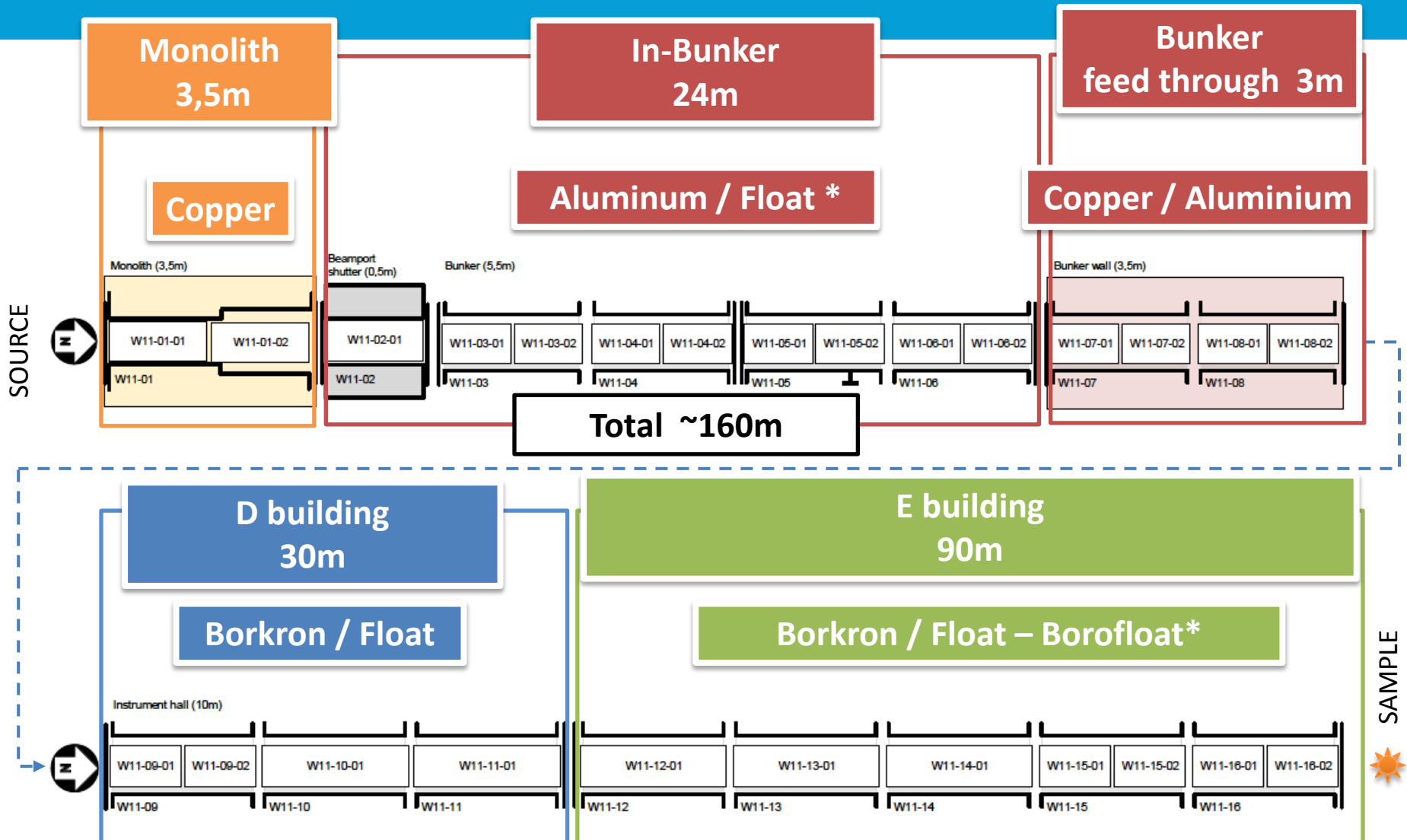
- 160m
- 5 sections
- 4 buildings
- Complex geometry
- low tolerance to mis alignment

Alignment tool

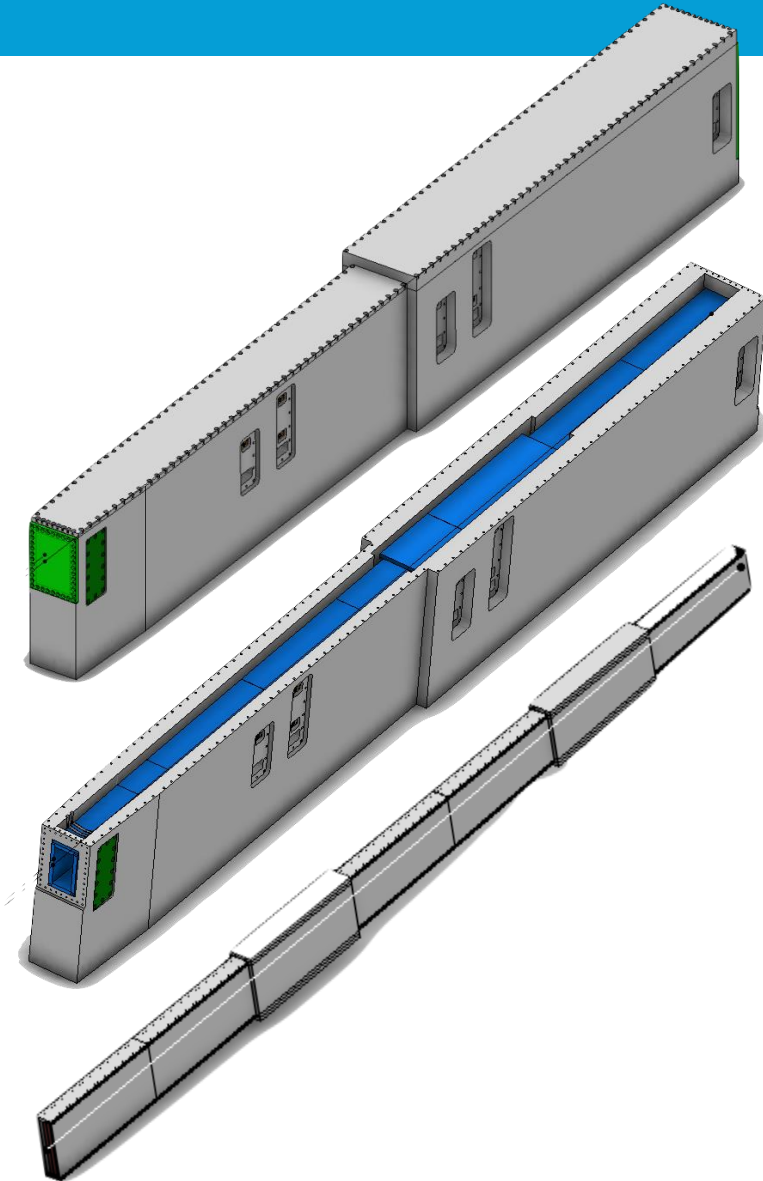
- Lazer tracker



Neutron guides



In-monolith optics



Key requirements

Performance

Long life

High Reliability

- Copper substrates
- Low pressure He atmosphere
- Limit on M value coating

Guide systems special features

Features

- Support on piles
- Separation of loads
- 4m sections

Under consideration

Monitoring

- Critical interfaces
- Fogale water network

Remote alignment

- positioners

