EUROPEAN SPALLATION SOURCE

Engineering realities

Good practices

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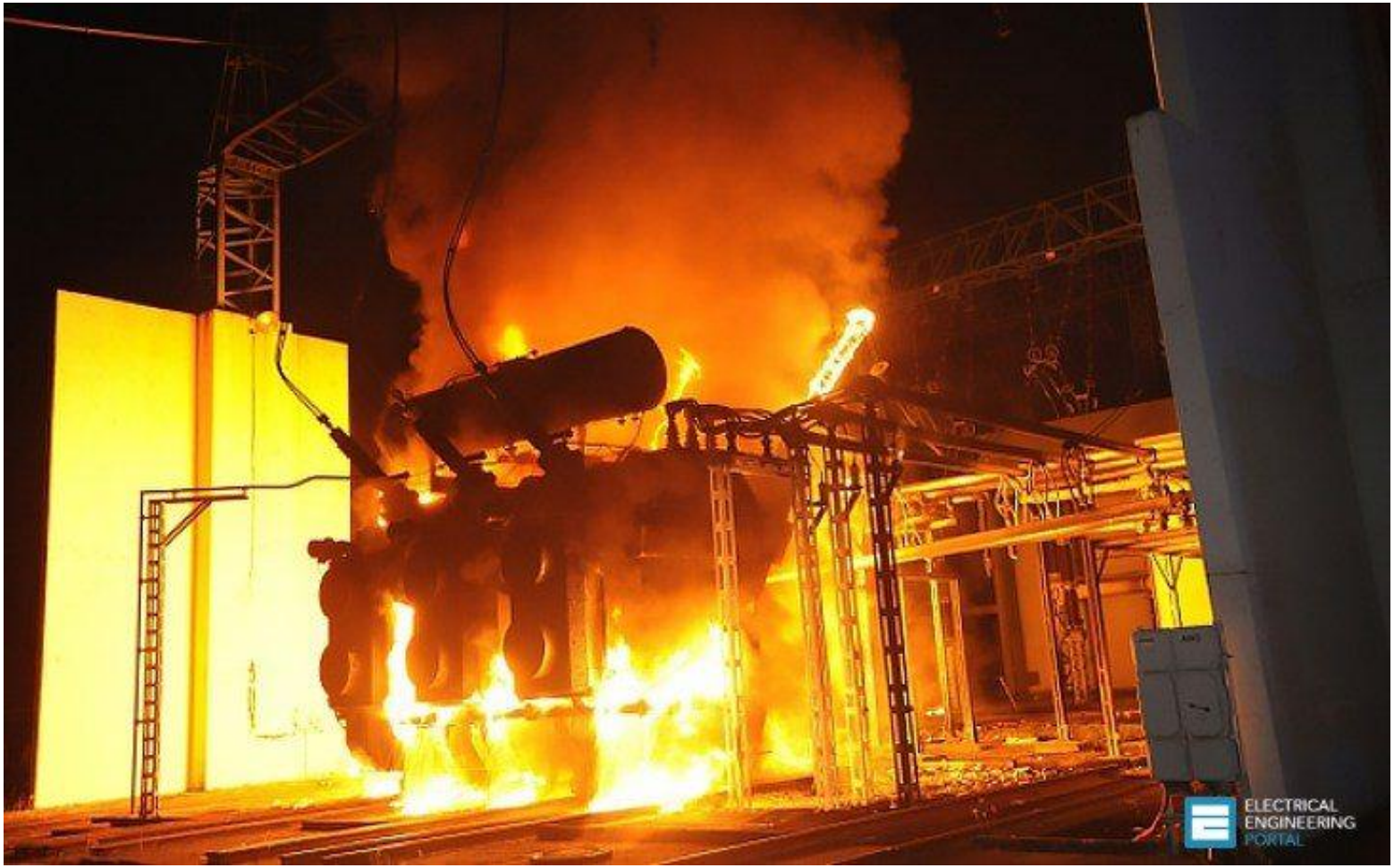
www.europeanspallationsource.se

7 July, 2018

Unexpected events!!



Unexpected events!!

Earthquake & Tsunami J-Park 2011.02
300km from the epicenter (magnitude 9)
2011.03.11 Earthquake (Seismic Intensity 6+)

In front of Linac

Immediately after the Earthquake

Many pipes for cooling water were damaged.

Unexpected events!!
Earthquake & Tsunami J-Park 2011.02

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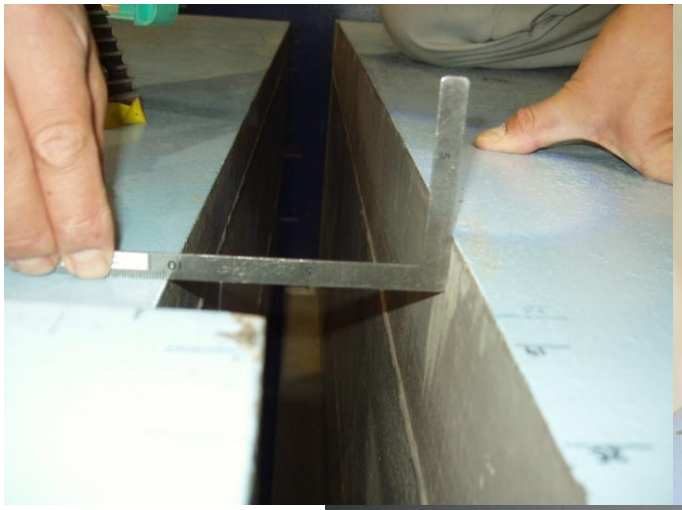
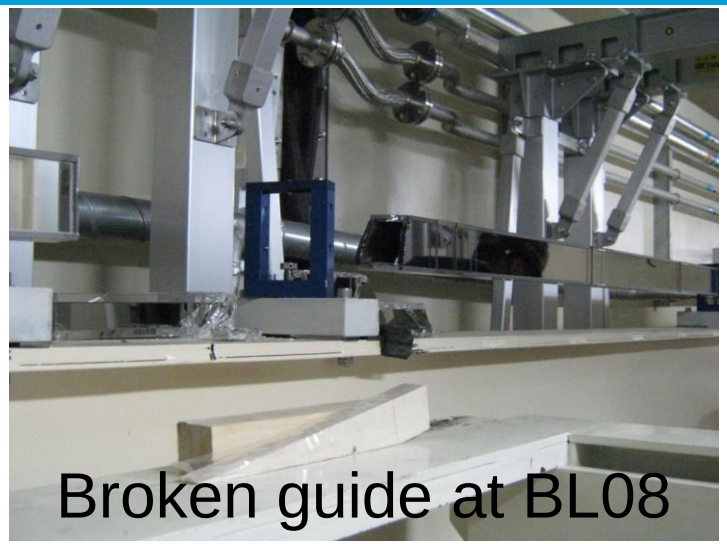


Displacement of Bunker shields
(designed for a tolerance
to 0.25G of Seismic Int. 5+)

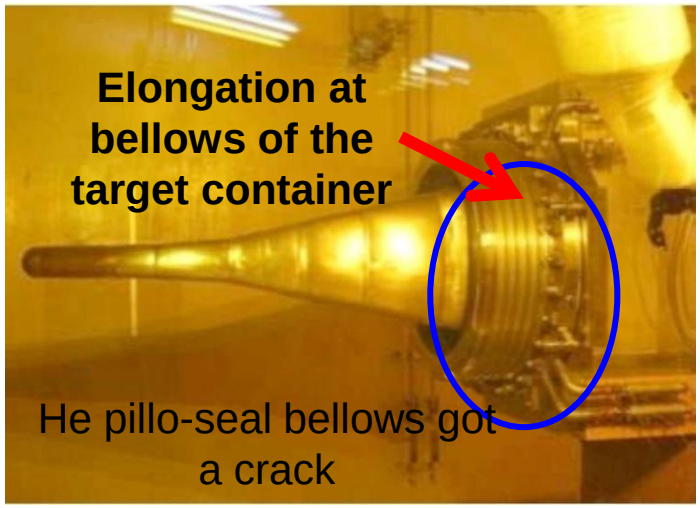
Collapsed steel shields

Unexpected events!!
Earthquake & Tsunami J-Park 2011.02



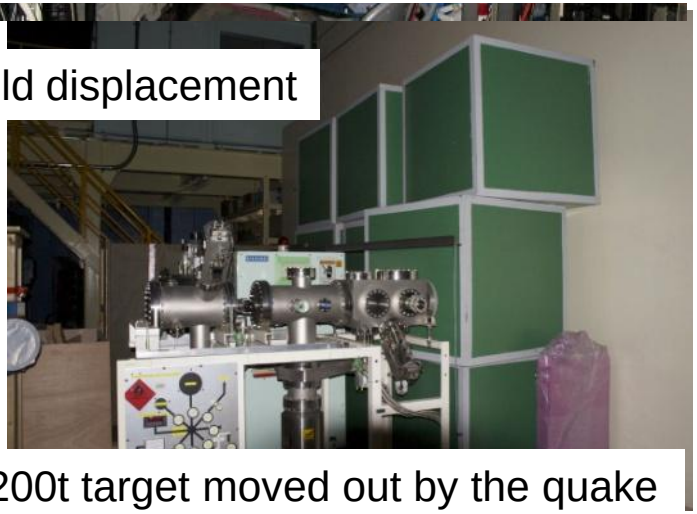
Broken guide at BL08

BL04 : Ge Detector Shielding collapsed



He pillo-seal bellows got a crack

Muon Shield displacement



200t target moved out by the quake by breaking a stopper.

Unexpected events!!!

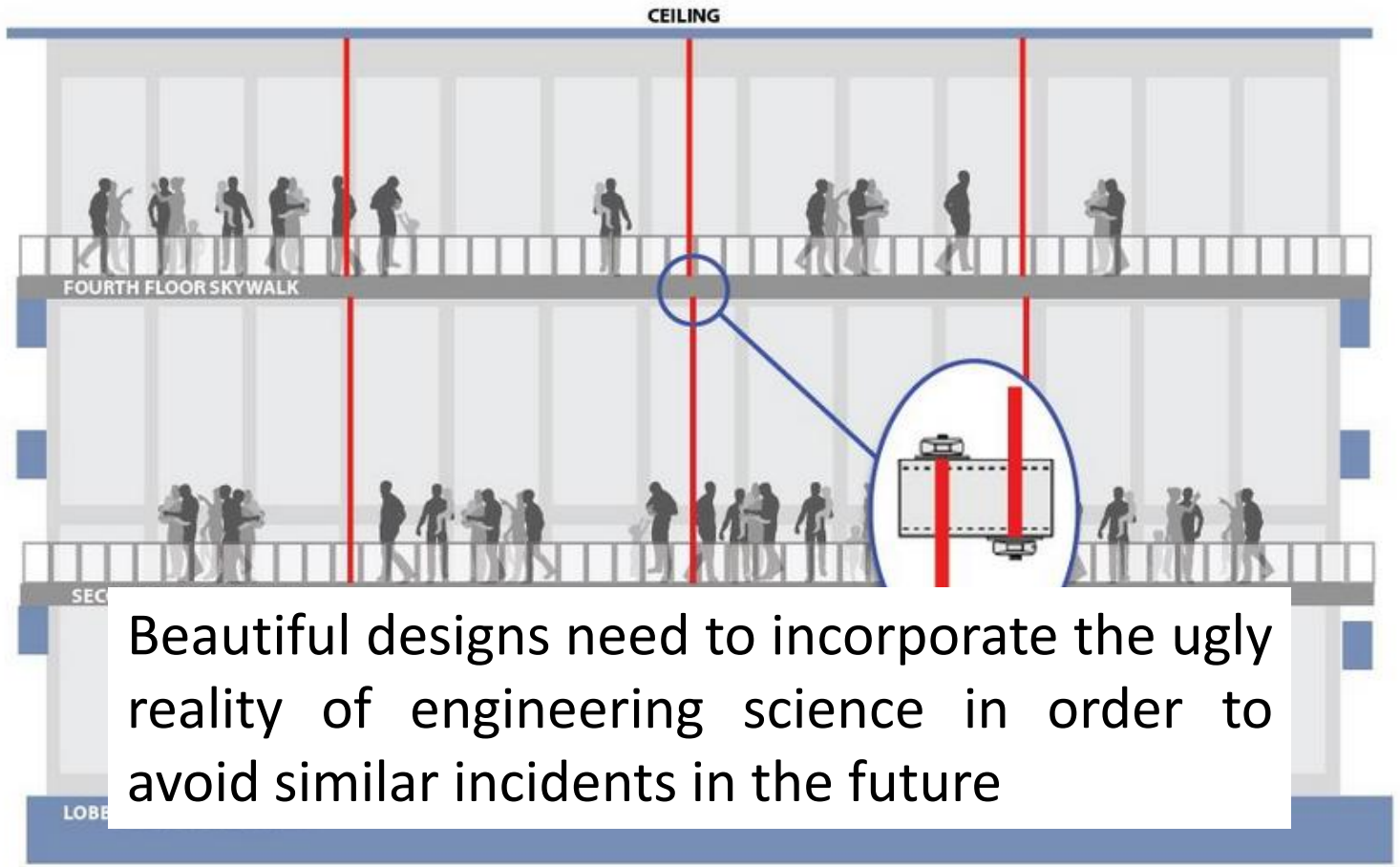
Key answer:

Risk evaluation and contingency plans!!!!!

Unacceptable mistakes!!

Engineering Disasters: Hyatt Regency Hotel Walkway Collapse (1981)

114 fatalities and 200 injure people



Beautiful designs need to incorporate the ugly reality of engineering science in order to avoid similar incidents in the future

Requirements

- Functional requirements: requirement which specifies **what** the system should do

- Non-functional requirements: requirement which specifies **how** the system performs a certain function

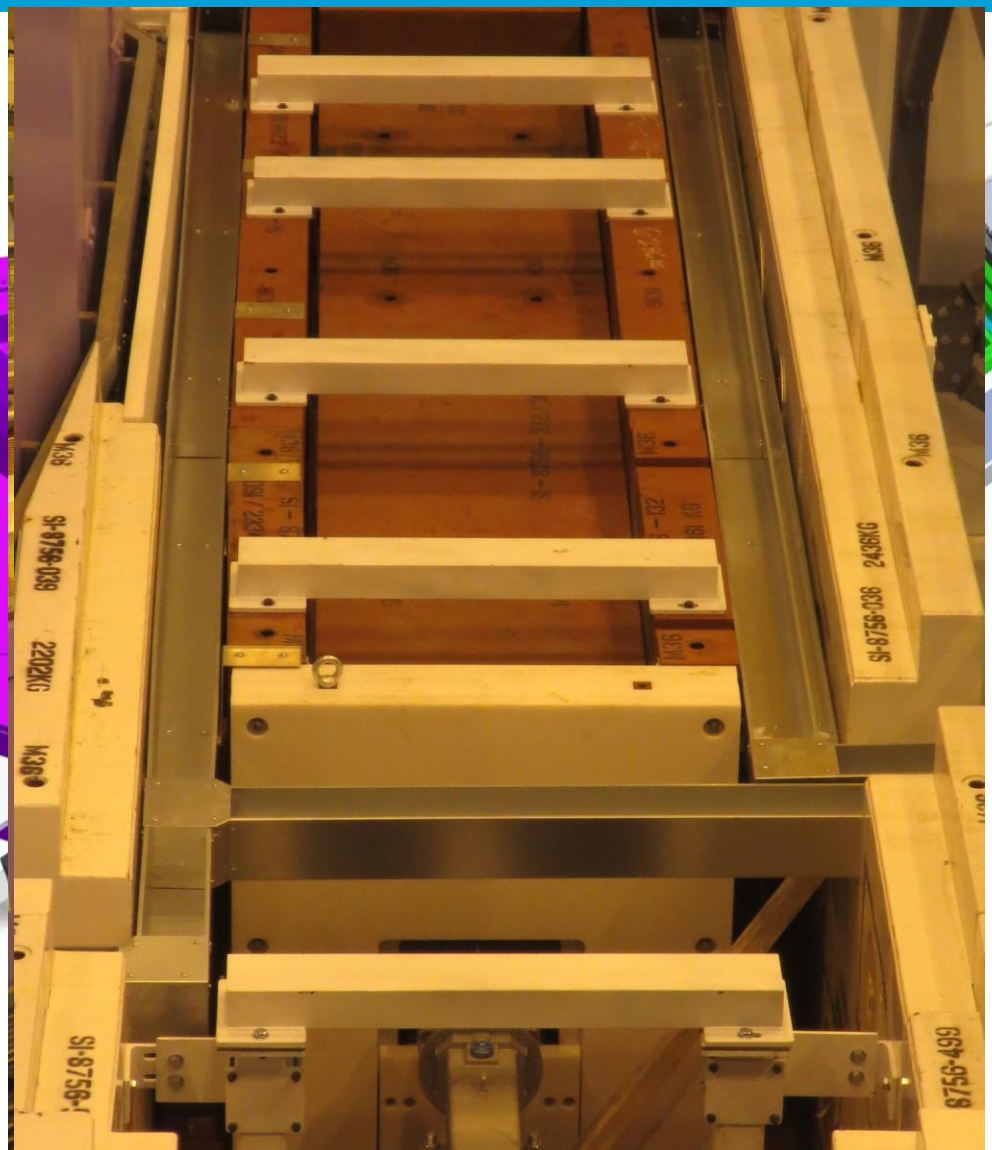
Non – functional Requirements

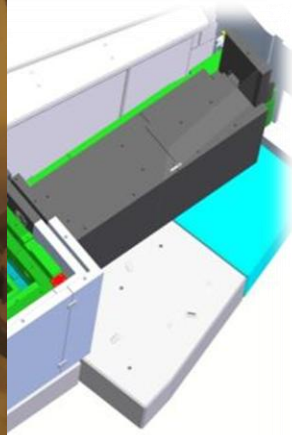
- Performance
- Upgradeability
- Capacity
- Availability
- Reliability
- Recoverability
- Maintainability
- Serviceability
- Security
- Regulatory
- Manageability
- Environmental
- Data Integrity
- Usability
- Interoperability

Shielding

- Manipulation and difference between 3D and reality
- Limit weight, lifting features
- Storage and inventory
- Tolerances for manufacturing and complexity
- Provision of space
- Transportation costs
- Provisions for installation
- Shielding normally increase, no opposite!

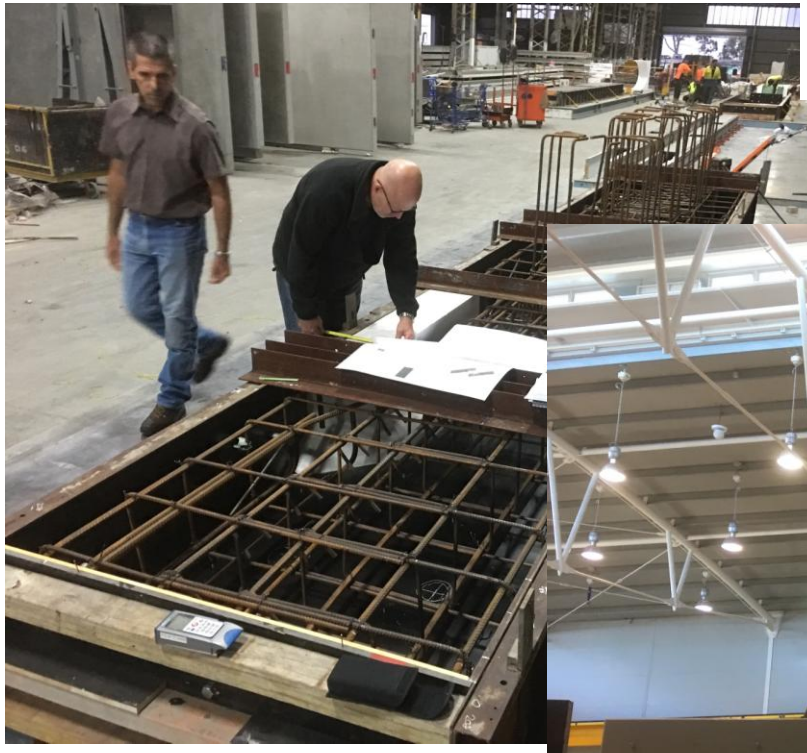
From 3D to installation





Source: ISIS

Plinths and complexities



Before

After

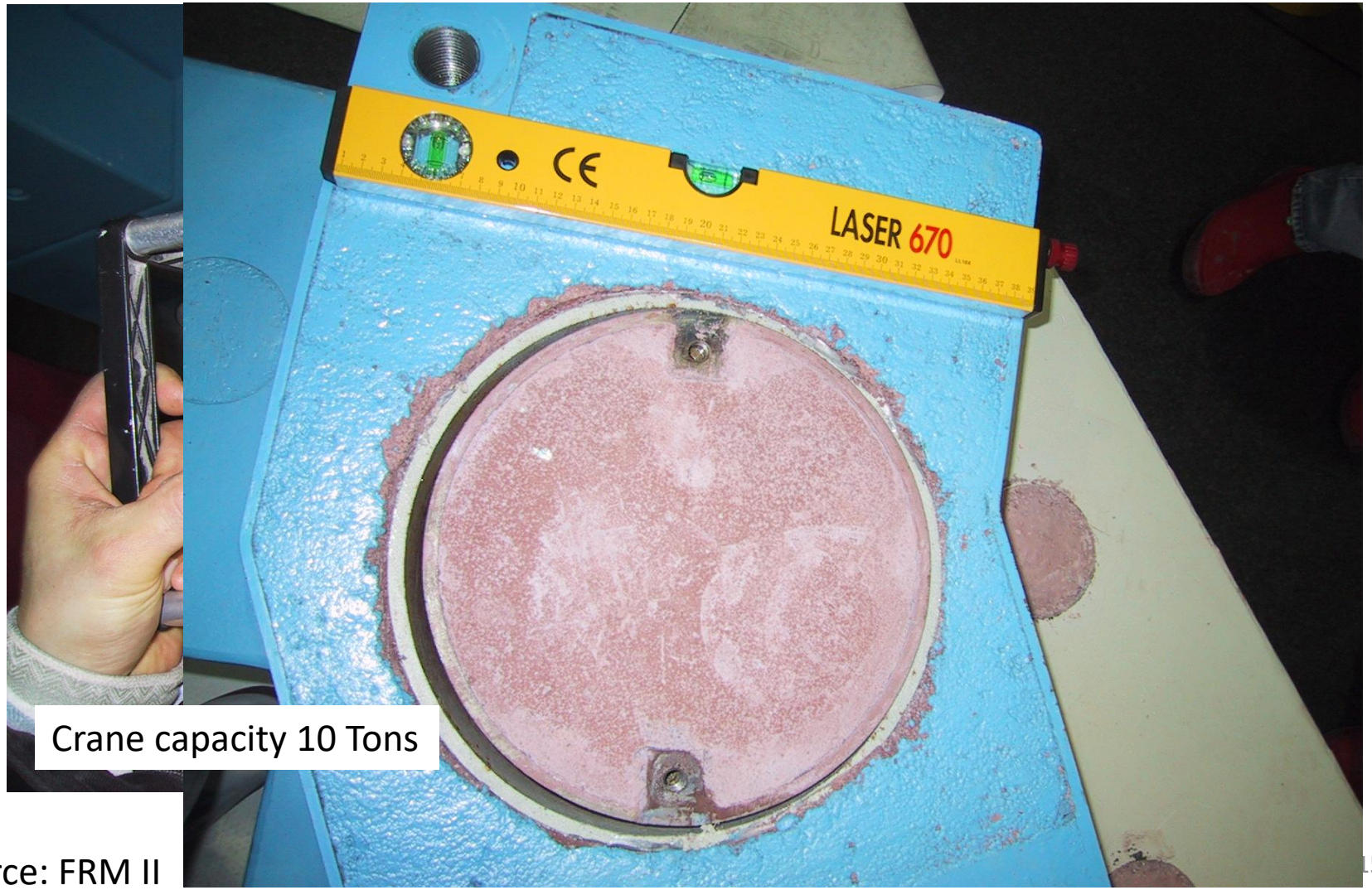
Plinths and complexities

Source: Ansto

Lifting: tests, capacity, eye lifts,

Source: Ansto

Crane capacity – safety factors



Crane capacity 10 Tons

Source: FRM II

Tolerances and streaming paths

Tolerances must be consider, fewer blocks as possible to reduce streaming paths

Tolerances and fitting

Source: ISIS

Integration and tolerances – cost of fix errors

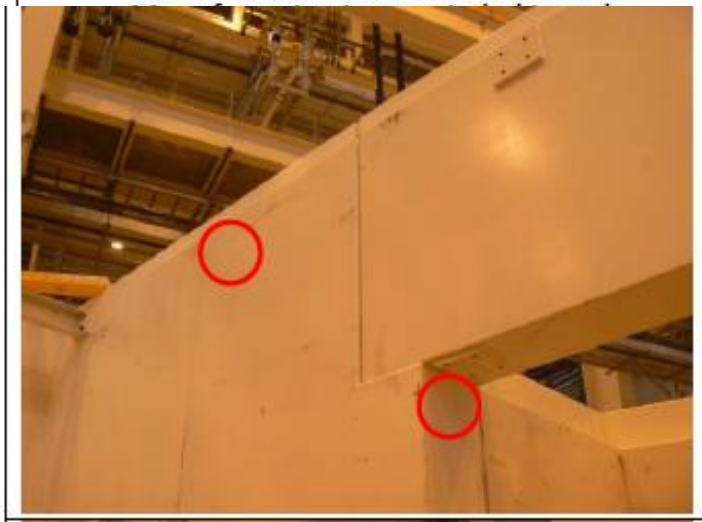
Rework caused by different level on the floor that was not in the drawings.

The importance of the as built drawings

Integration and tolerances – cost of fix errors

Source: FRM II

Integration and tolerances – cost of fix errors

Photo	Description
	Wax tank SI-8866-103 Does not have 2 off 4 threaded hole mounting plates.
	Wax tank SI-8866-104 150 x 150 x 300mm corner of tank missing.

Source: ISIS

Extra shielding!!

Source: ISIS

Inventory control

Inventory control

- Lost time
- Theft
- 2 x 18 tonne slabs missing

Science & Technology Facilities Council
ISIS

Very simple exercise

Lets consider LoKI cave: Ignore the roof – Just walls

L=15m W= 5m Thickness: 0.6 m

H= 5m Heavy concrete

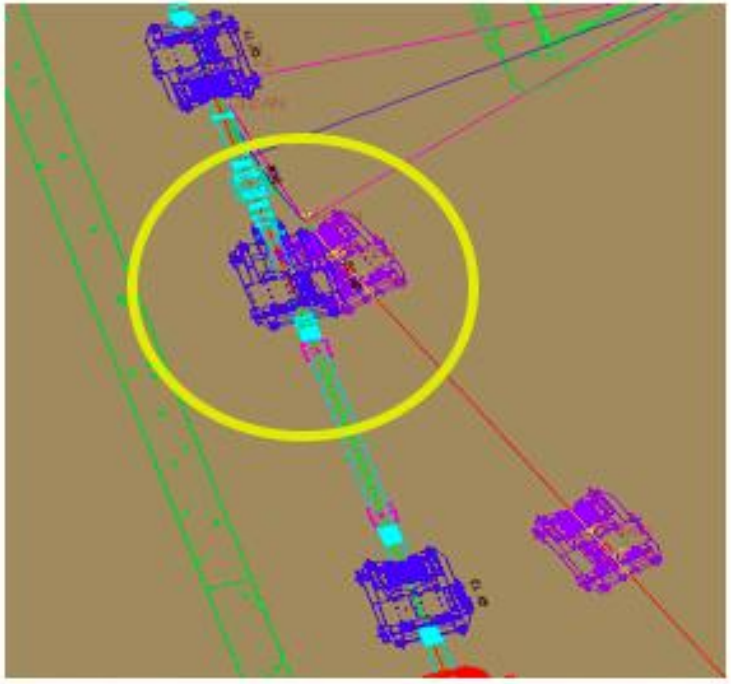
Calculate the weight of concrete to transport ?

Space provisions/ Integration activities

- Experimental halls are crowded
- Access to maintenance is required, some components more than other
- Space available for utilities – upgrades – spare cables services
- Consider properly space for envelops – ex: sample environment preparation and loading

The importance of integration – crowded halls- As build drawings

SAM's DRAWING/DATA INTEGRATION CAN STOP THE TRAIN WRECK BEFORE IT HAPPENS!

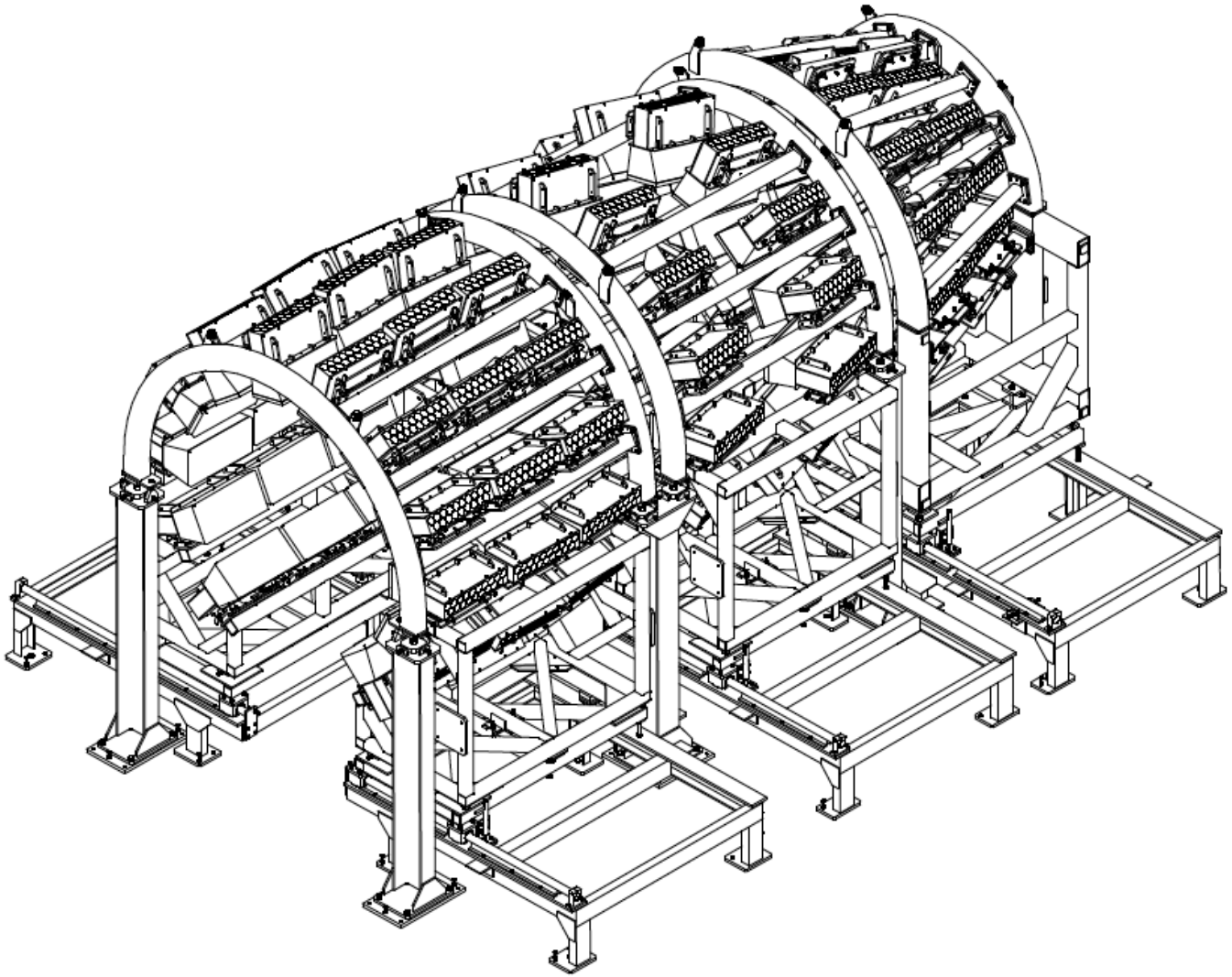


Neutron Sciences HFIR SNS Spallation Neutron Source

Oak Ridge National Laboratory
U. S. Department of Energy

UT-BATTELLE

From 3D preliminary design to detailed design for manufacturing



Source: ISIS

Integration, space provisions and proper tagging

Source: ISIS

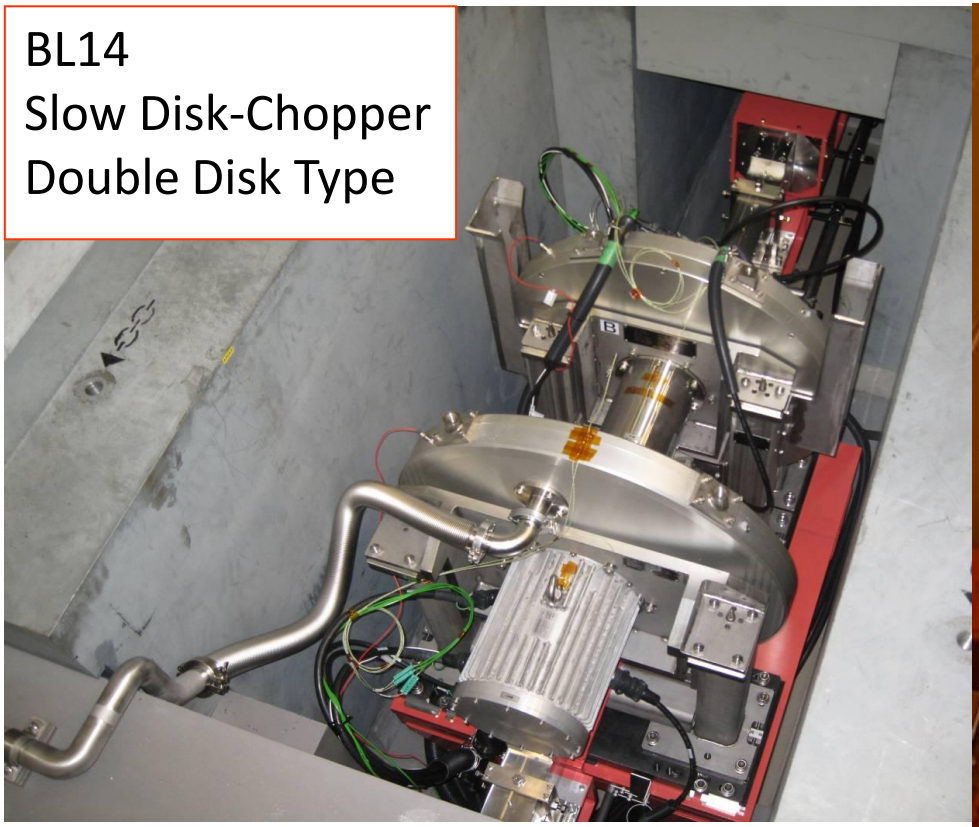
Space for utilities

TS2

Source: ISIS

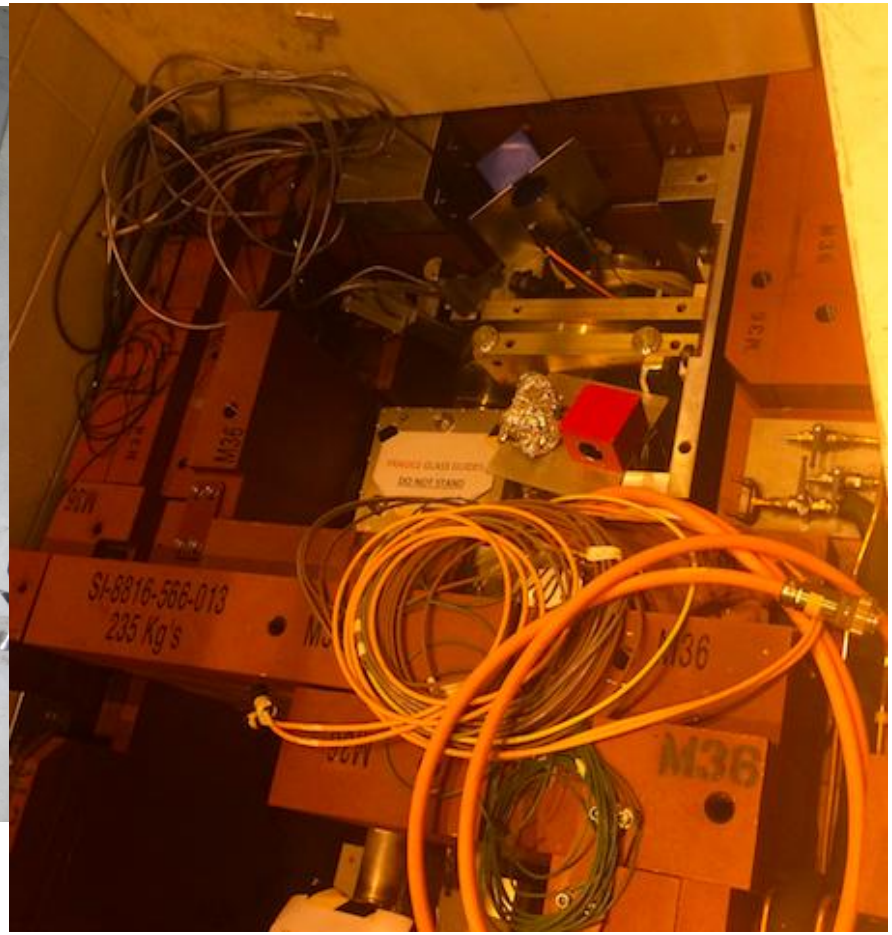
Access to maintenance

BL14
Slow Disk-Chopper
Double Disk Type



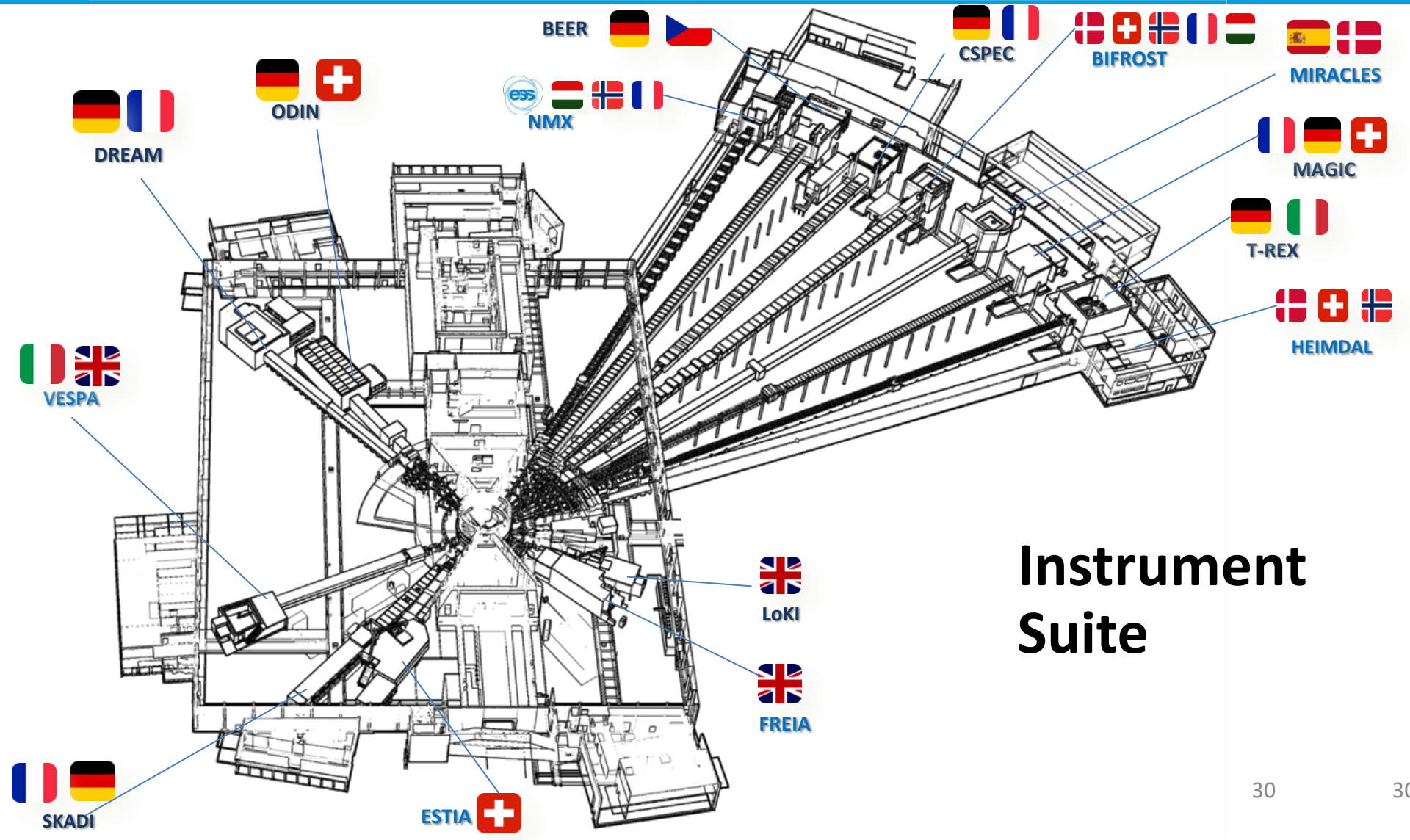
BL14
Fast Disk-Chopper
Single Disk Type

Source: J-Parc



Source: ISIS

Instrument overview main components



Instrument Suite

30

Chopper utilities ESS

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Cables

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

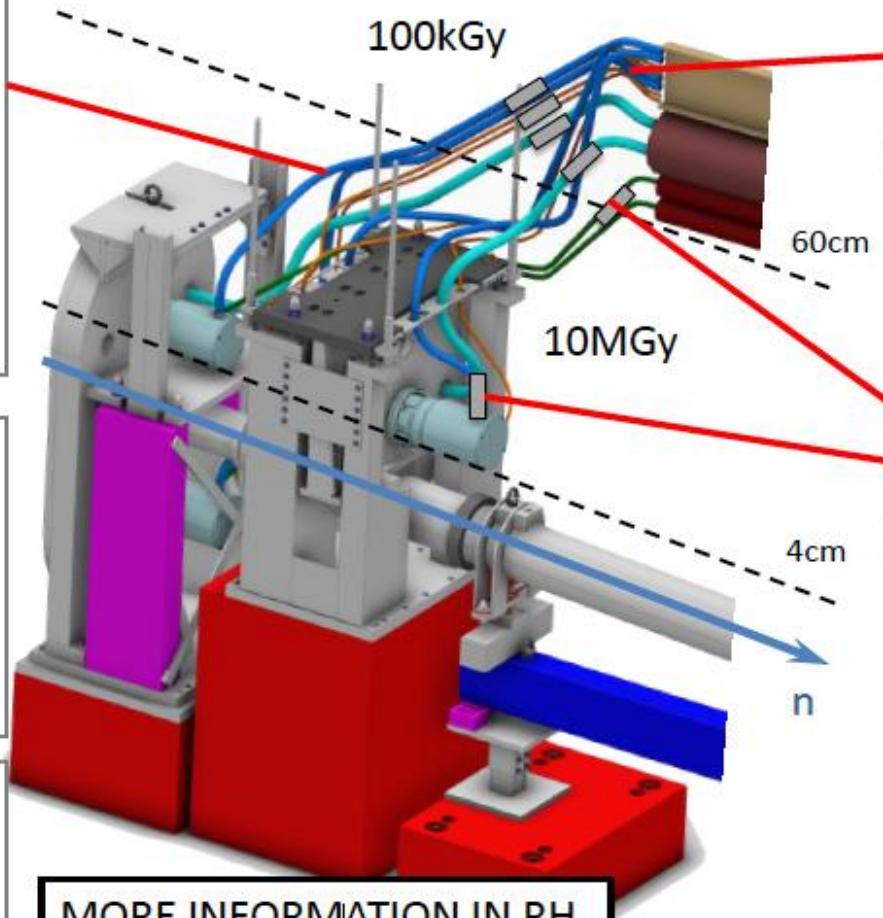
AXON Polyimide TPI
(20MGy)

Sensors

Vibration Sensor:
Vibro-Meter CA901
(10 MGy)

Switches

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



MORE INFORMATION IN RH DOCUMENT ESS-0042943

Cables

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

Connectors

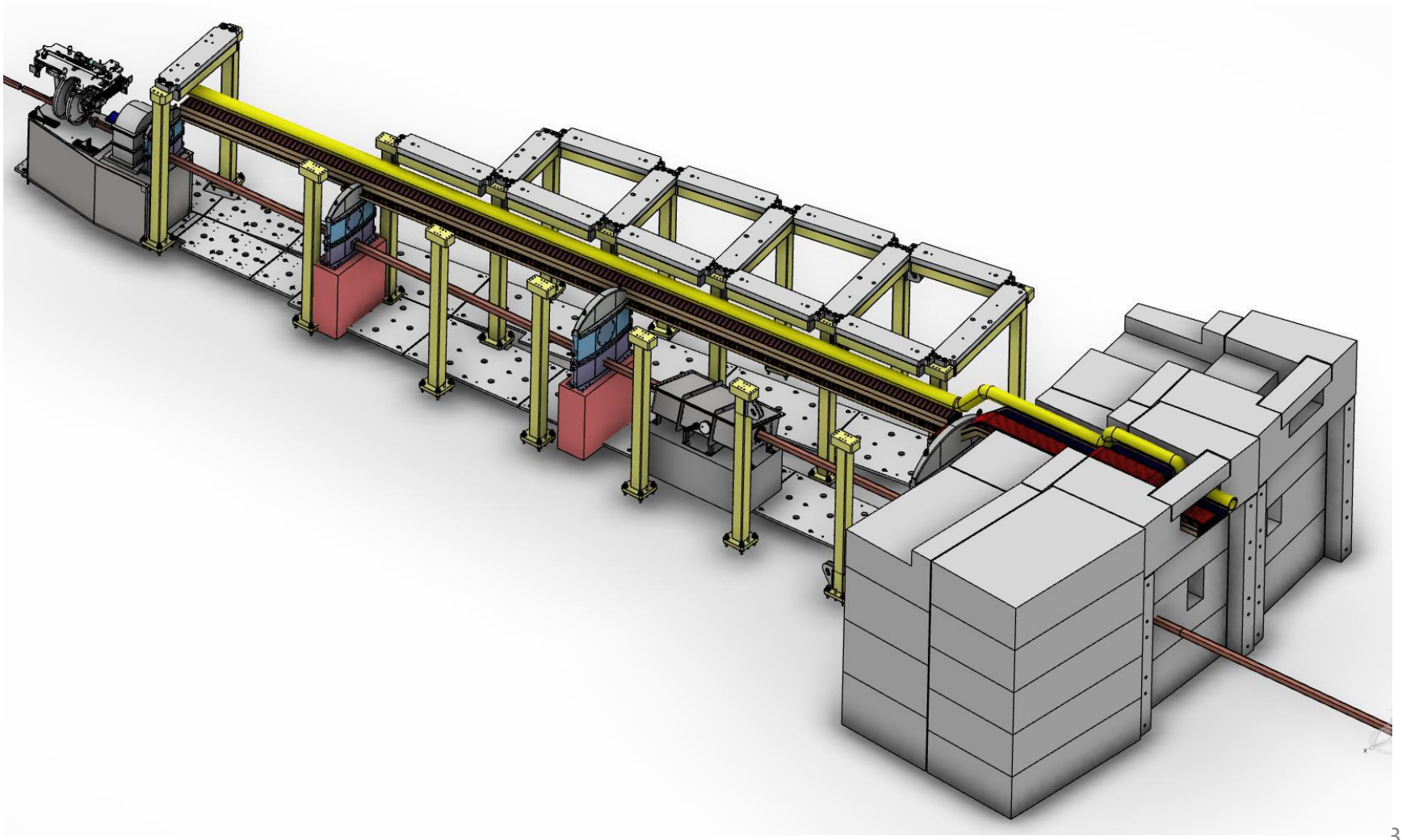
Push-Pull, RH ability:
Lemo B-series (Materials:
SS AISI 303 + PEEK plastics)
(10 MGy, to be confirmed!)

Positioning Motors

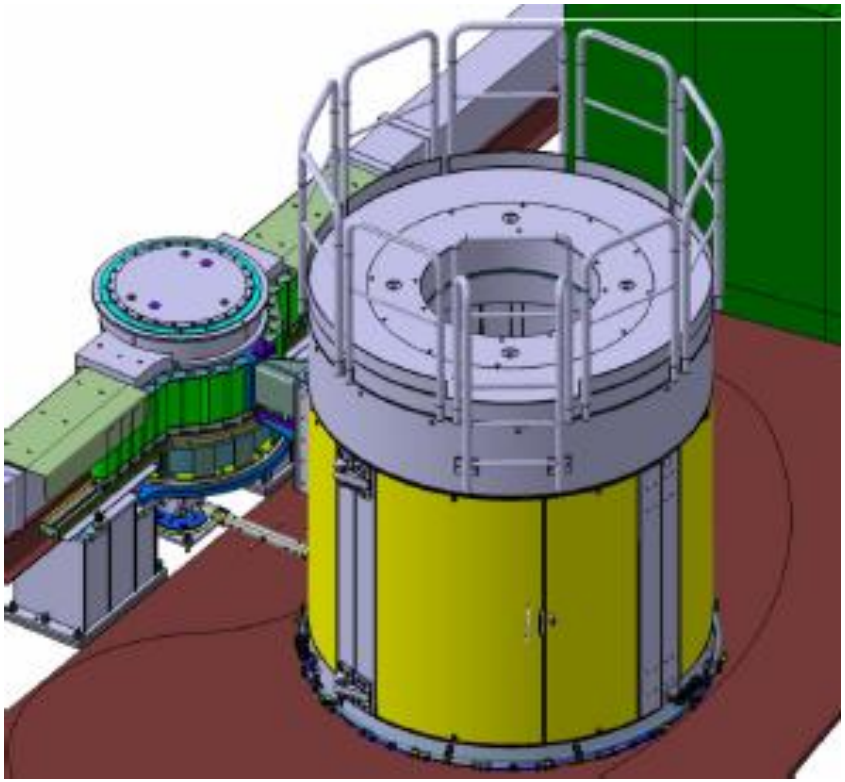
Stepper motors:
Phytron VSS **(1 MGy)**

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

Utilities considerations - ESS



From 3D to reality: cabling, piping space envelope and sample environment loading



Experimental halls- provisions for maintenance

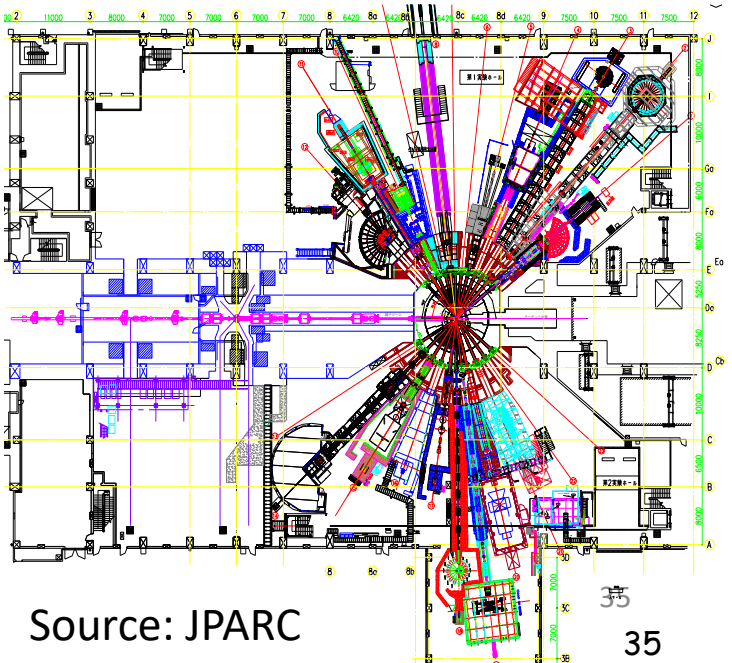
Source: Multiple sans instruments

Safety for construction and commissioning – Crowded spaces

2008

2010

- Lack of empty space for construction preparation
- Activities in narrow areas
- Busy schedule for cranes
- Limited period of time when beam off

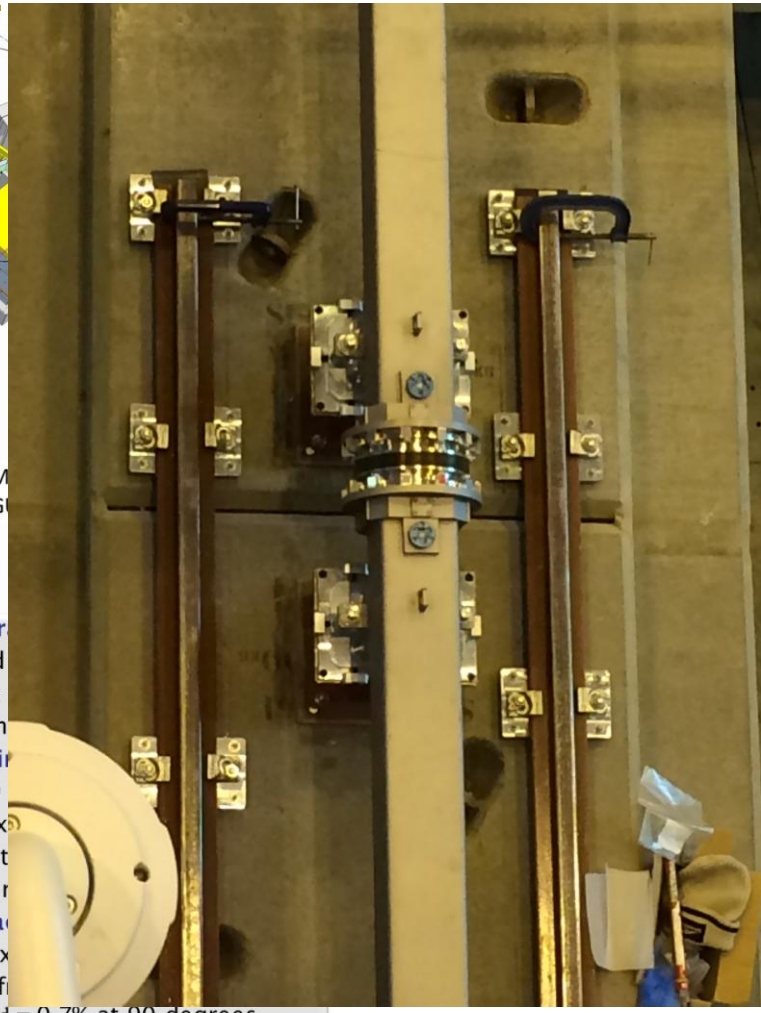


Source: JPARC

Design considerations

- Design for the whole lifecycle- even design of tools for assembly and installation considerations
- Proper consideration for lifting operations and fitting big vessels
- Levelling and alignment
- Tolerances: civil and mechanical
- SAG - Survey and alignment group: Fiducials (references), scans, VR visualization

Design for entire lifecycle



Design for entire lifecycle

Big vessels: lifting considerations

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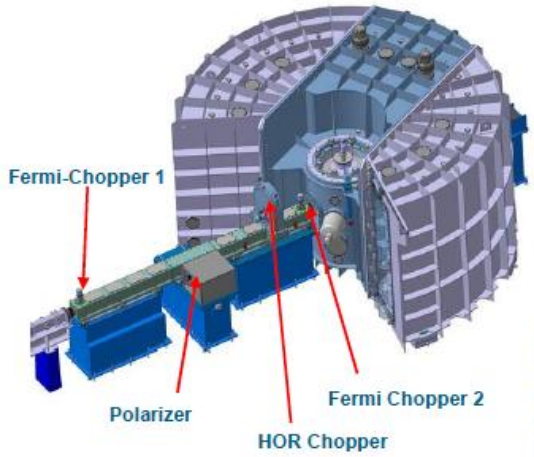
TOPAS

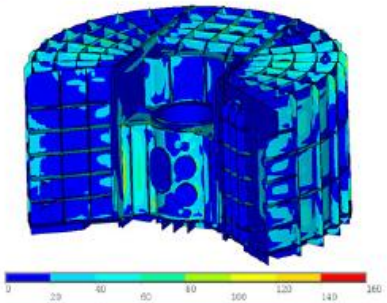
Time-of-Flight Spectrometer with Polarization Analysis

JÜLICH FORSCHUNGSZENTRUM



Spectrometer housing:

Vacuum housing	
Pressure	< 10^{-5} mbar
Material	1.4571 (1.4429)
Diameter	6.5 m
Height	3 m
Volume	75 m³

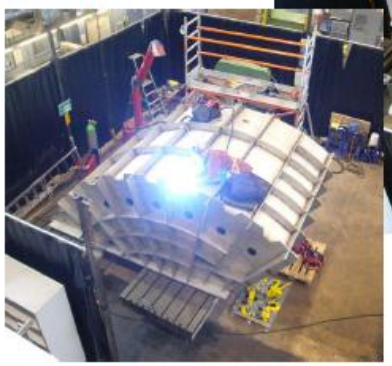


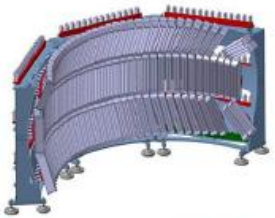
FE - calculation of the vacuum housing

Equivalent stress in N/mm²

Chopper systems:

Fermi Chopper 1: < 450 Hz
Fermi Chopper 2: < 600 Hz
HOR Chopper: < 225 Hz



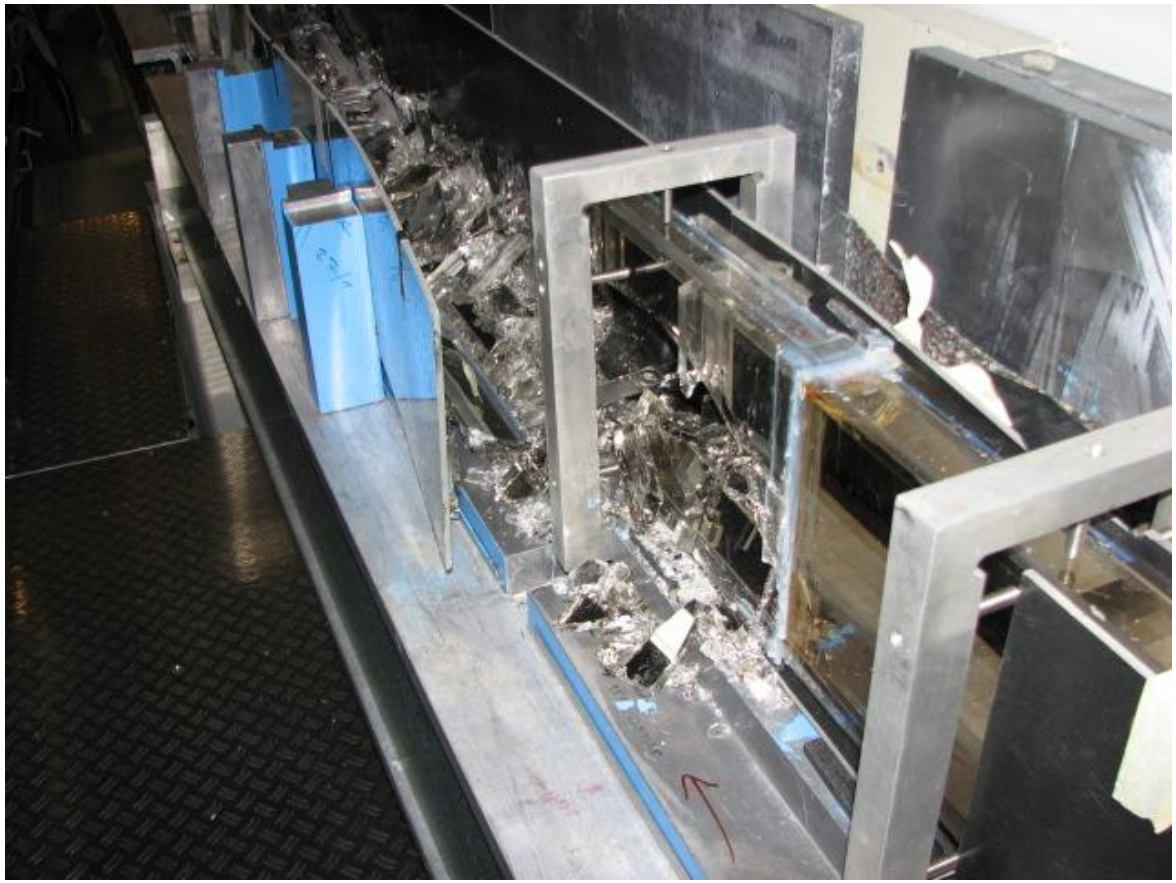


Detector system with ³He-Detectors

- Lifting equipment
- Access to halls
- Maintenance
- Floor distribution
- Levelling
- Tests after welding at site

Design considerations

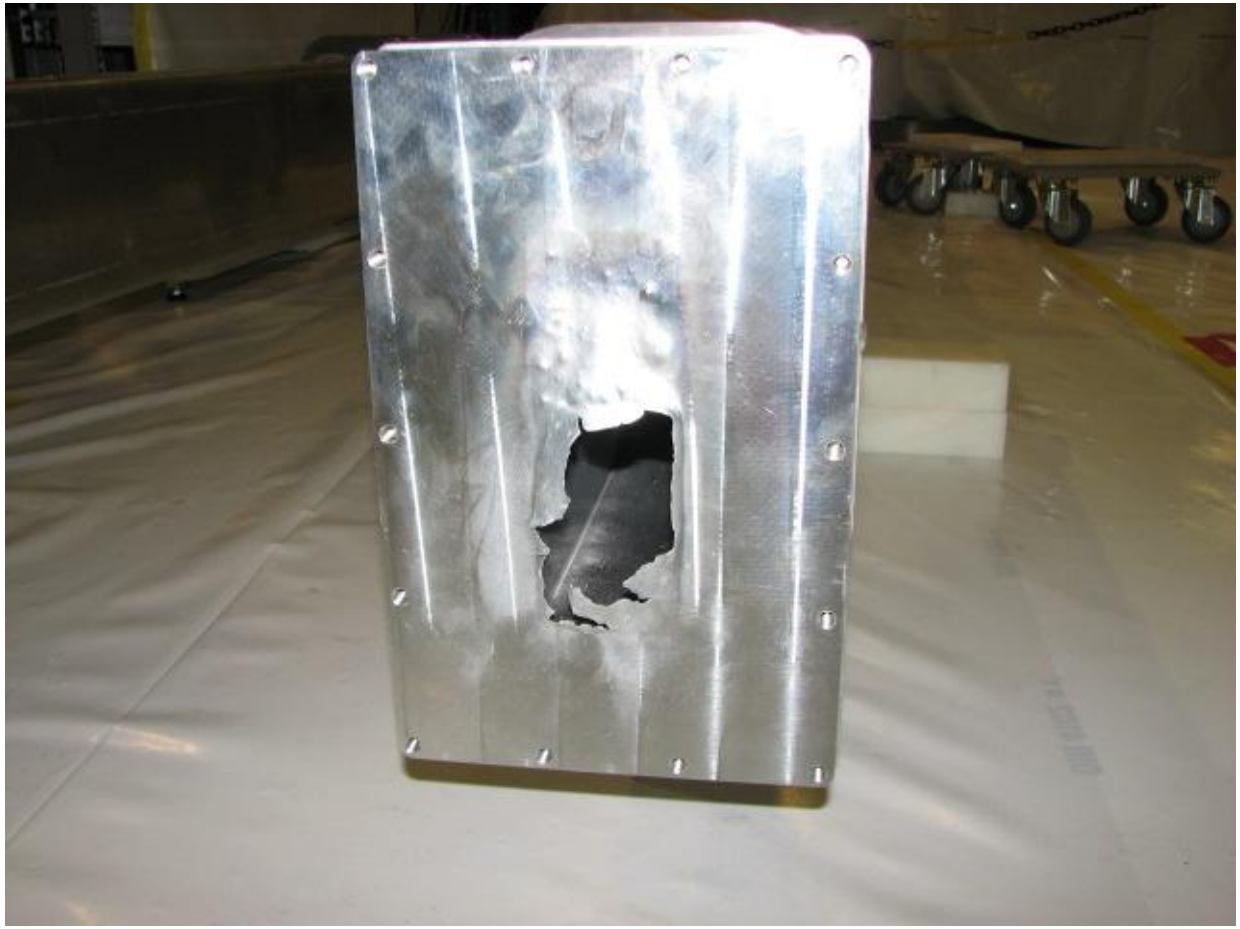
Pressure difference – specially when there is a damage caused by gamma radiation



Source: FRM II

Design considerations

Vacuum window caused by implosion of a neutron guide. The particles get a high acceleration and act like projectile



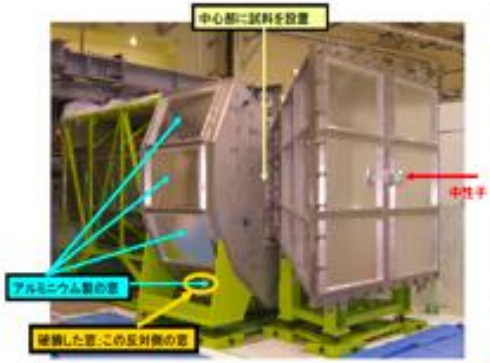
Source: FRM II

Consider proper space for assembly

J-PARC

Vacuum tank fracture

Importance of regulation
Differences in tests in manufacturor and defaults at installation

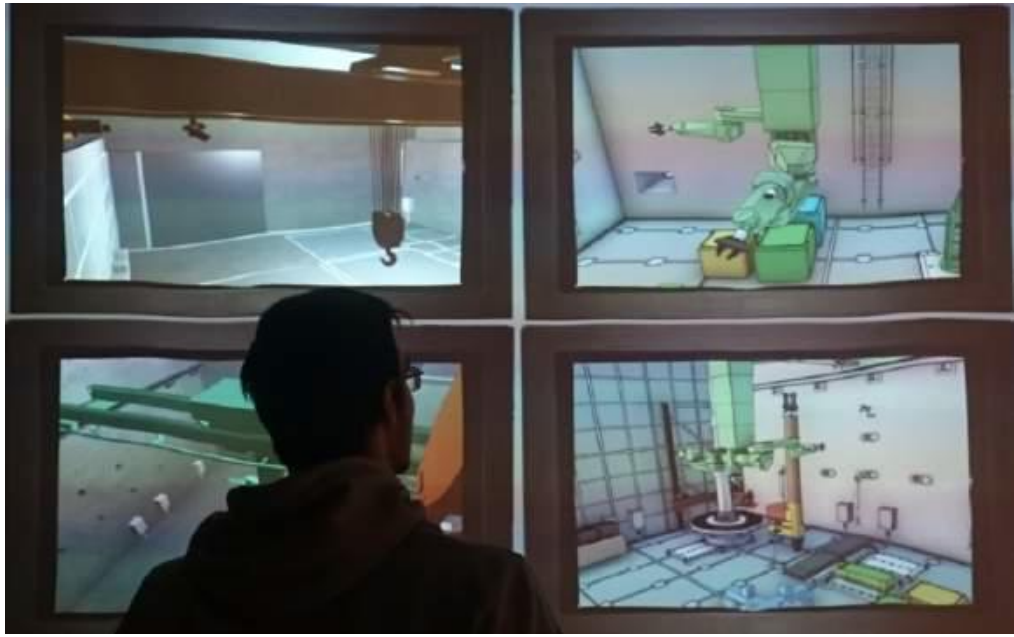


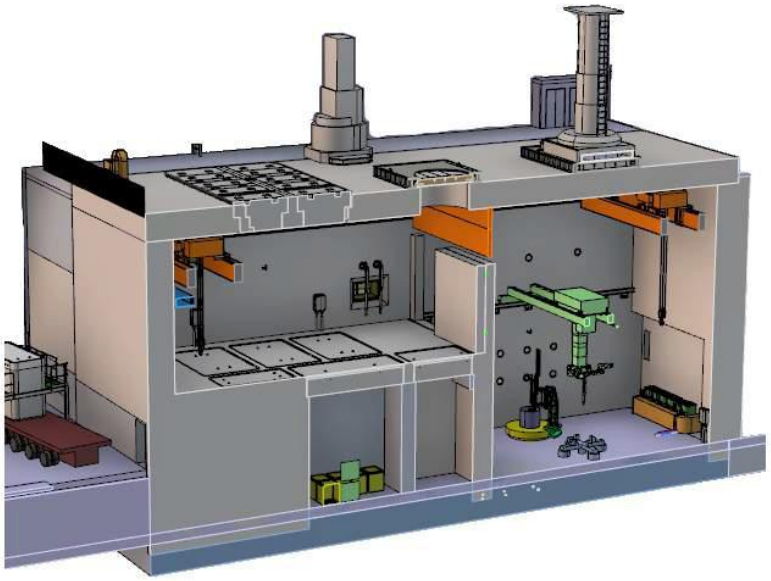
Aluminum window at 90 degree-bank of iMATERIA broken on Jan, 22, 2009

Narrow working space caused the defaults

Other integration activities

- Truview scans
- VR remote handling in Target and NSS
- Navisworks /CAD





Questions