20th ESS Industry Liaison Offices Network

ESS, Lund

09-10 Sept. 2024

Updates on ESS Engineering Status

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Head of Mechanical Measurements Lab (MML)

www.europeanspallationsource.se

Agenda

1 Introduction to ESS

2 Mechanical Engineering & Design

3 Requirements & Engineering Flow

4 Simulations, FEA & Engineering Analysis

5 Mechanical Measurements Lab (MML)

6 Future upgrades

1

Introduction to ESS

Contributions building ESS

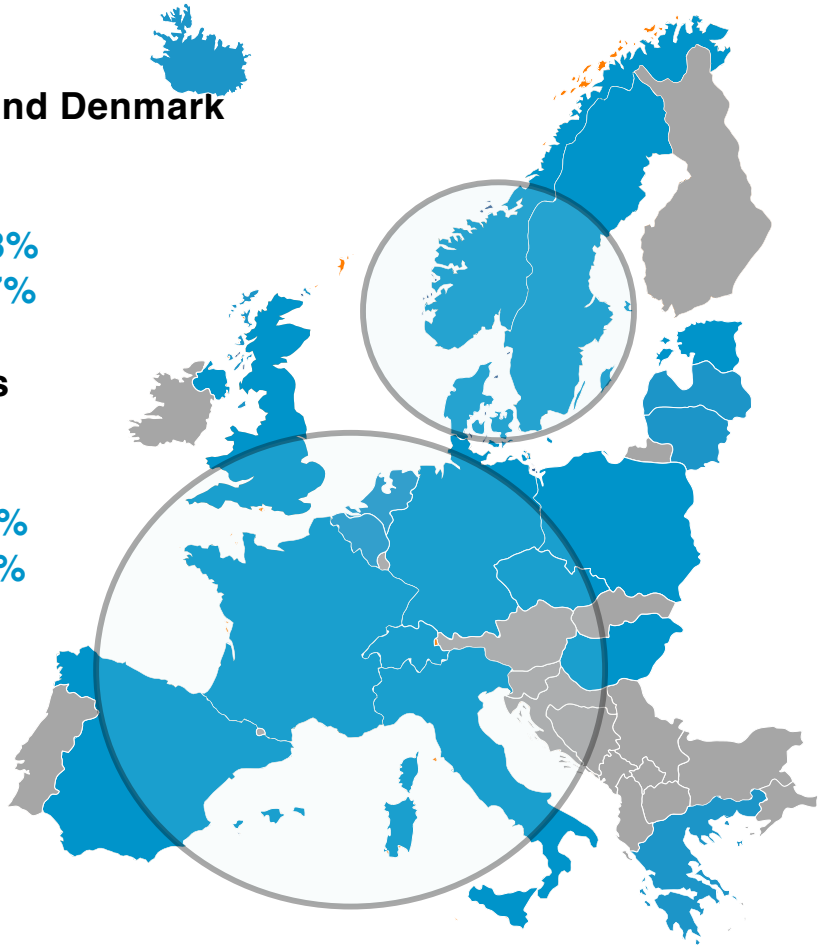
Countries with In-Cash, In-Kind & Observers

Host Countries of Sweden and Denmark

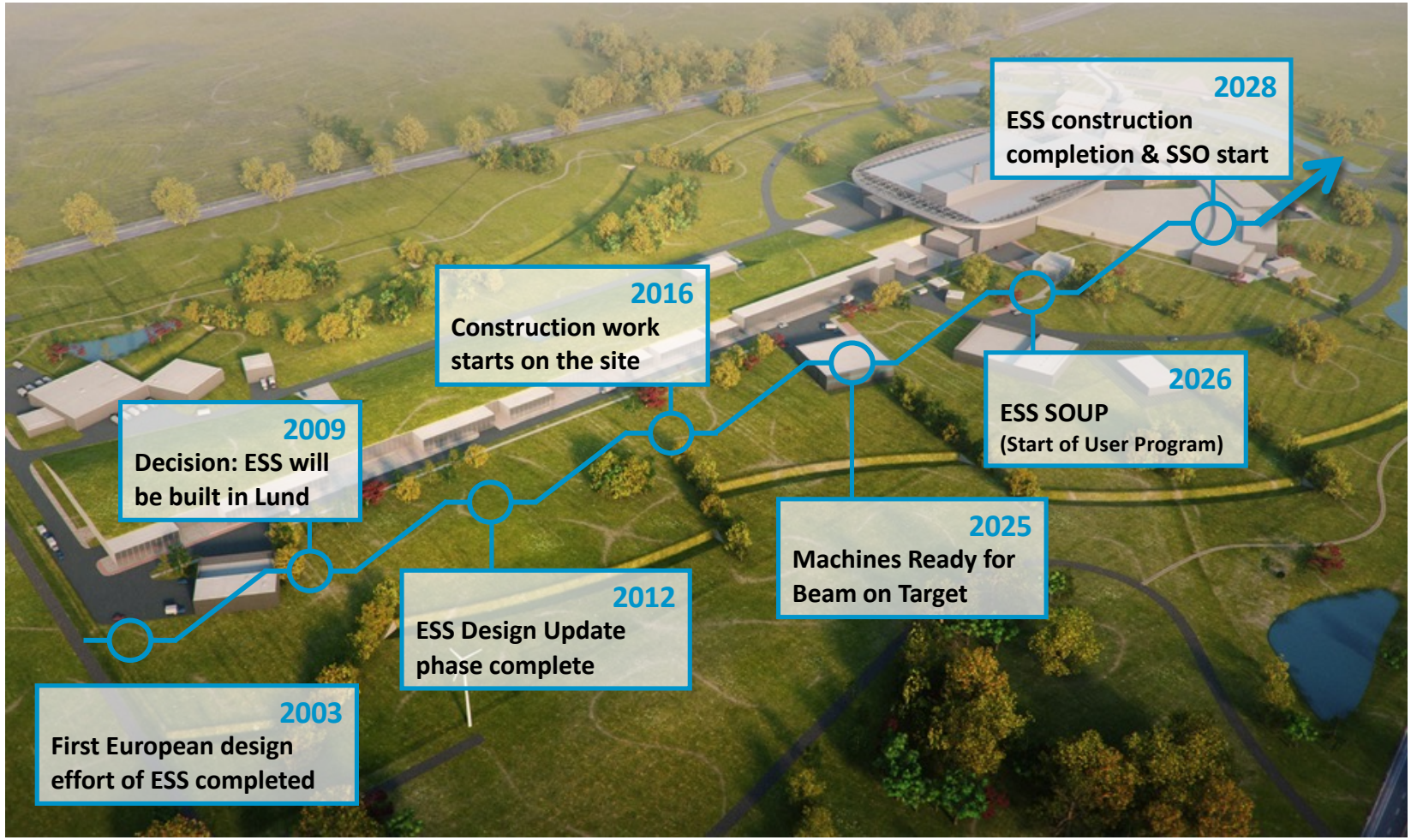
47,5% Construction
15% Operations
In-kind Deliverables ~ 3%
Cash Investment ~ 97%

Non Host Member Countries

52,5% Construction
85% Operations
In-kind Deliverables ~ 70%
Cash Investment ~ 30%

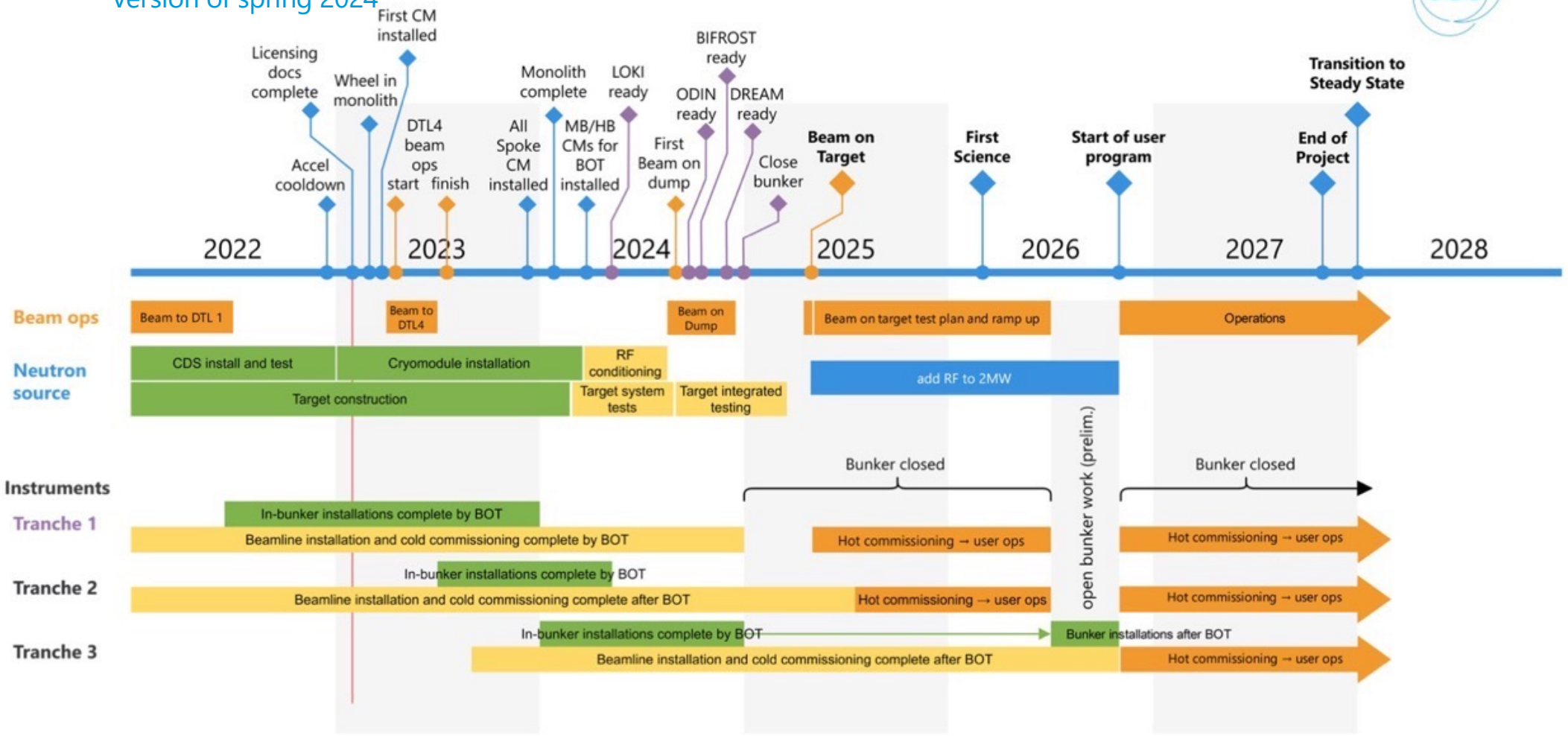


ESS timeline



High-Level Project Milestones

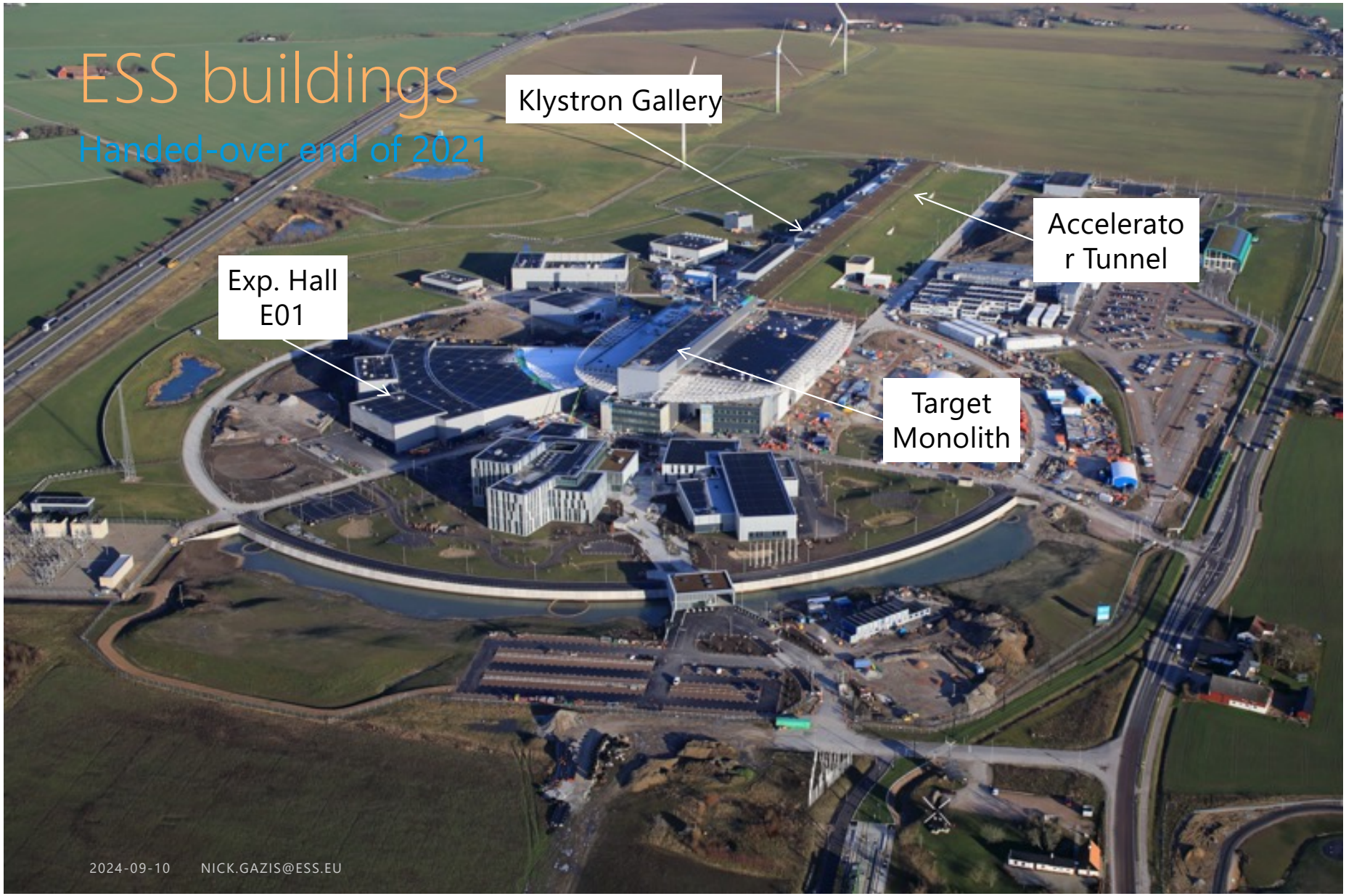
Version of spring 2024



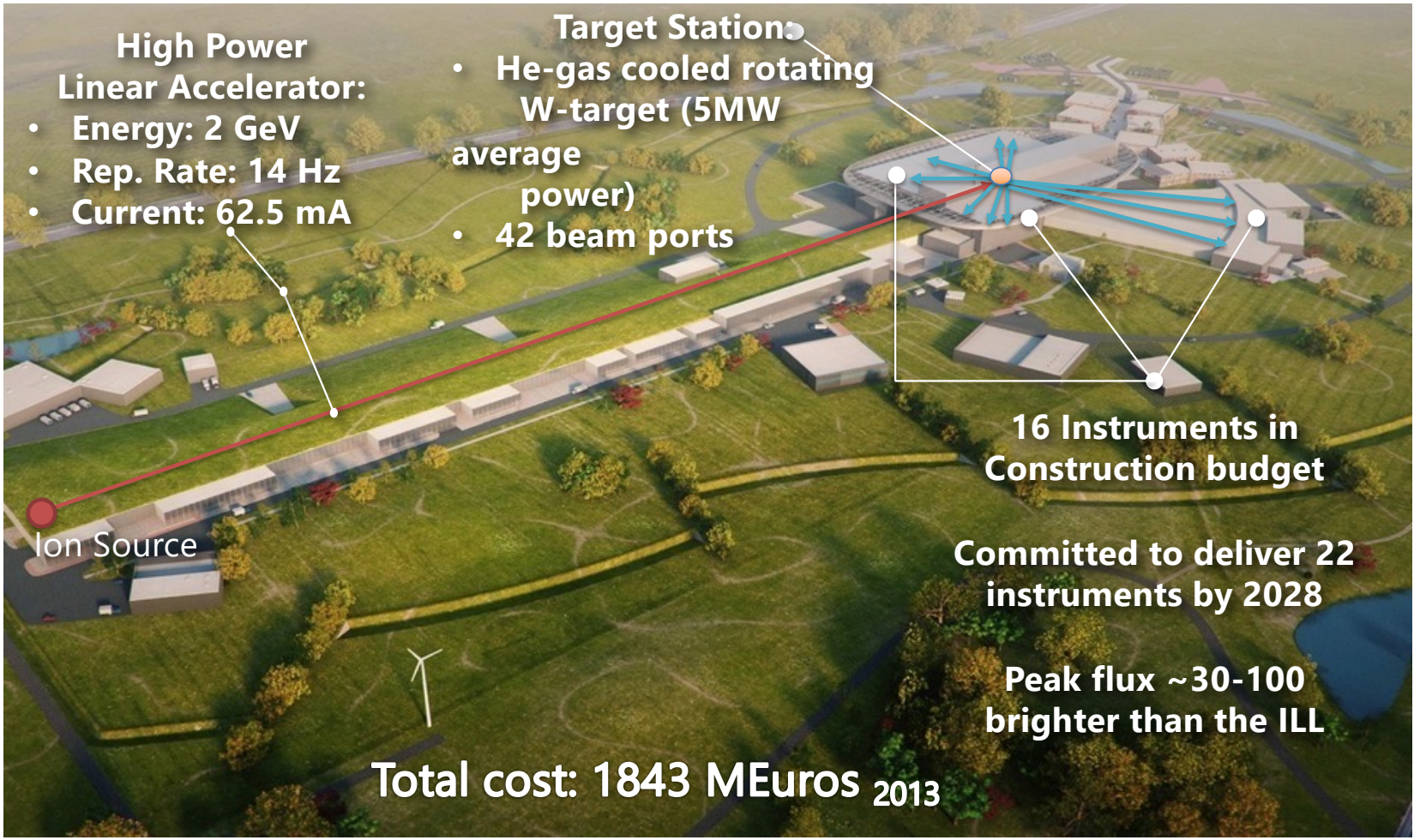
ESS – April 2014

ESS buildings

Handed-over end of 2021



ESS design


High Power Linear Accelerator:
• Energy: 2 GeV
• Rep. Rate: 14 Hz
• Current: 62.5 mA
Target Station:
• He-gas cooled rotating W-target (5MW average power)
• 42 beam ports
Ion Source
16 Instruments in Construction budget
Committed to deliver 22 instruments by 2028
Peak flux ~30-100 brighter than the ILL
Total cost: 1843 MEuros 2013

A visual example

by ANSTO

2

Mechanical Engineering & Design

Mechanical Engineering

Lessons learned

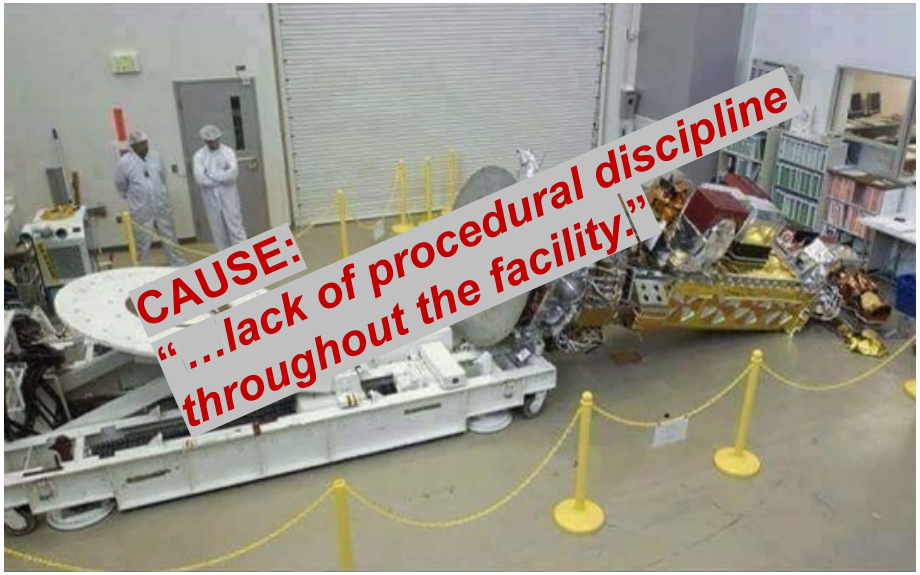
Implementing uniformly rules for engineering,

Keep realistic design costs with manufacturing advancing in parallel.

With a ***pragmatic***, ***holistic*** and ***maintainable*** plan to:

- deliver with less delays
- Eliminate reworks
- Improve quality
- Kick-off operations
- With a long-term sustainable way of doing things

(also Ways of Working – WoW).



No need to drop the multiM$ projects on the floor (again)..
(lesson learned from Lockheed Martin NOAA-N Prime)

Mechanical Engineering

Graded Approach

Graded Approach implementation*:*

1. Most systems need to be built according to design standards with precision & tolerances [so-called *ISO-GPS* or *GD&T* rules] to eliminate:

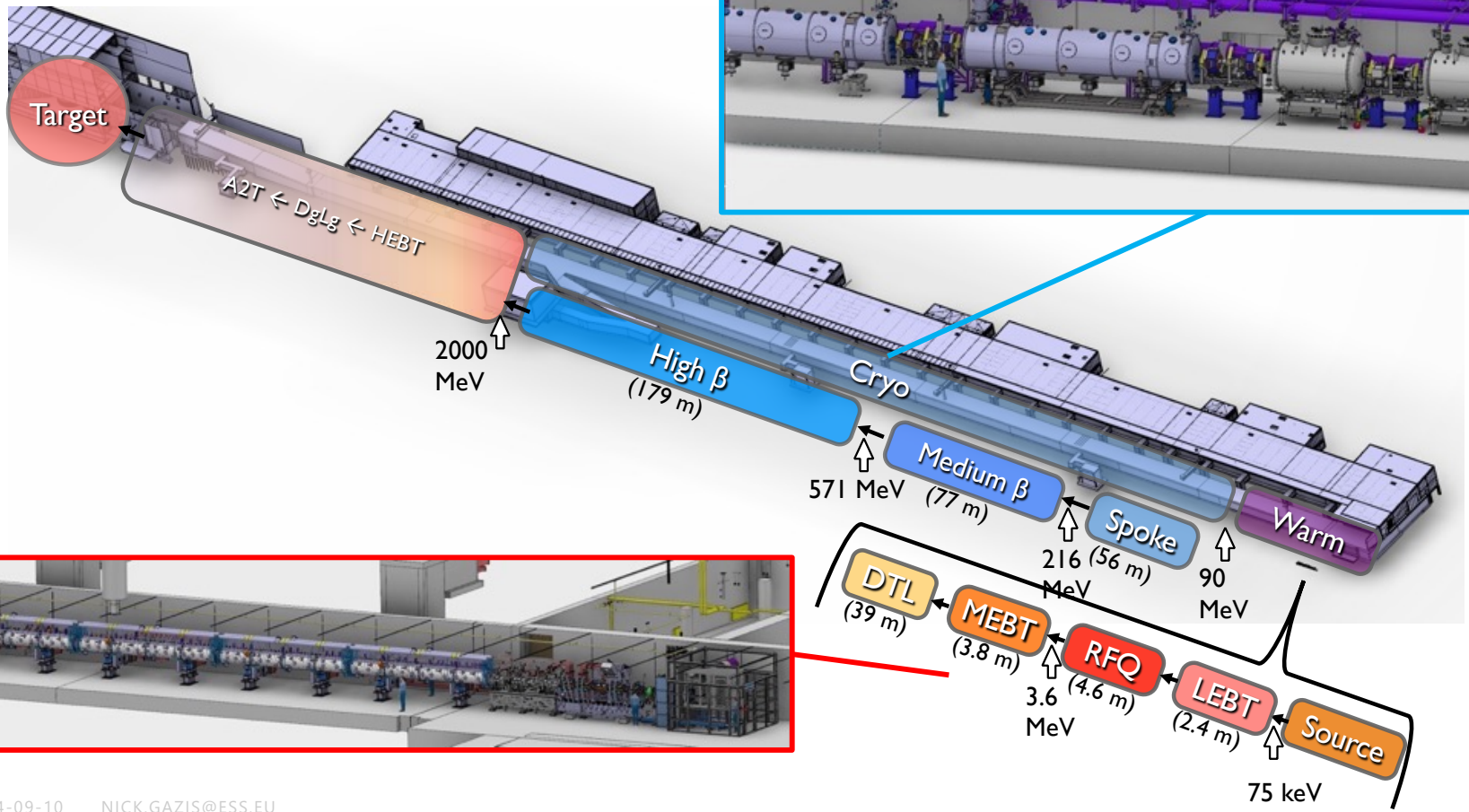
   - *ambiguity*
     (cause: lack of quality or engineering ways)
   - *delays*
     (cause: mistakes and known-unknowns)
   - additional *costs*
     (cause: repairs, reworks, orphan scopes)

What we work with may not be rocket science but the design comes close in terms of:

- *engineering complexity*
- *modularity*

High level overview of ESS Accelerator

In CAD



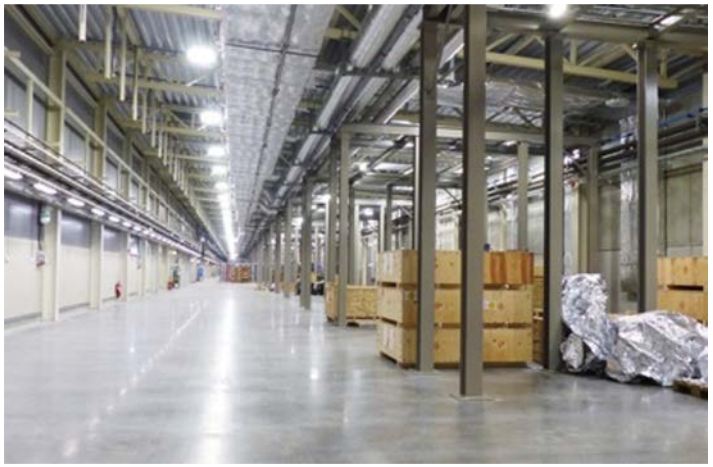
ESS tunnel views

Parts of Normal Conducting Linac Under commissioning

Cryo Distribution Line Testing underway, followed by cryomodule installation

Gallery hall for klystrons & power sources

Then vs now

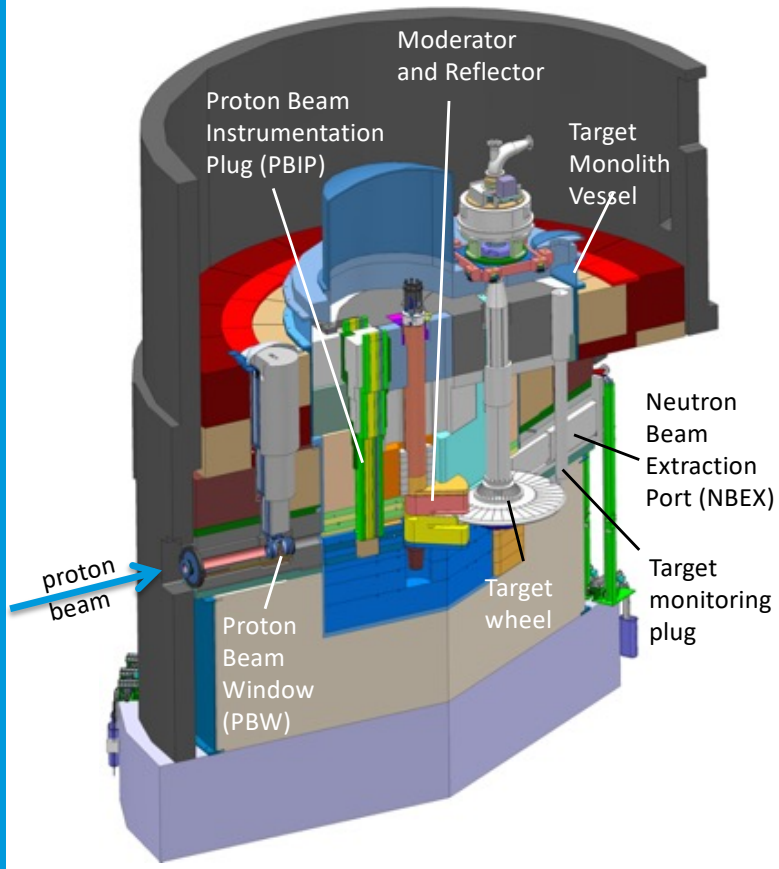


RF for normal conducting part installed and tested.

Installation and testing ongoing in superconducting part

ESS target

Key features



Target Safety System

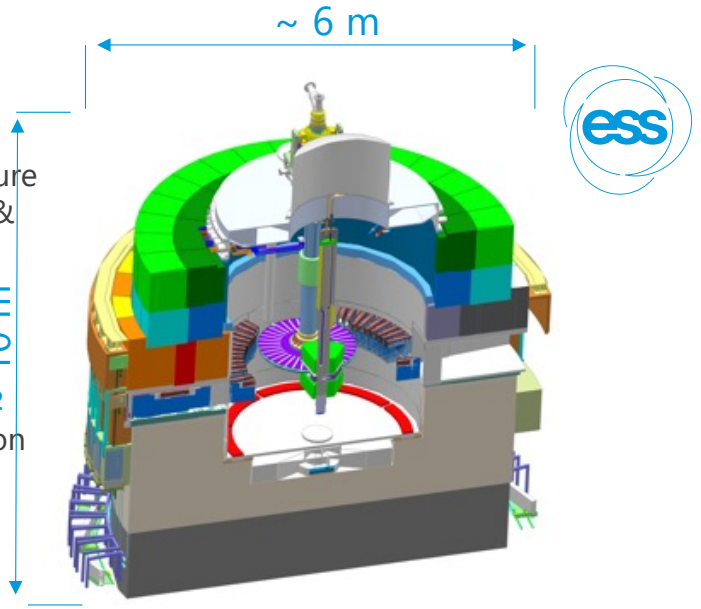
- Monitors target coolant flow, pressure & temperature, monolith pressure & target rotation

Rotating solid tungsten target

- 36 sectors
- Total mass: 11 tn (3 tn of W)
- Rotatation: 23.3 rpm (synchronized with the pulsed proton beam at 14 Hz)

Helium cooling of target material

- Mass flow: 3 kg/s
- Pressure: 11 bar
- Temperature inlet/outlet: 40°C/240°C



Moderators

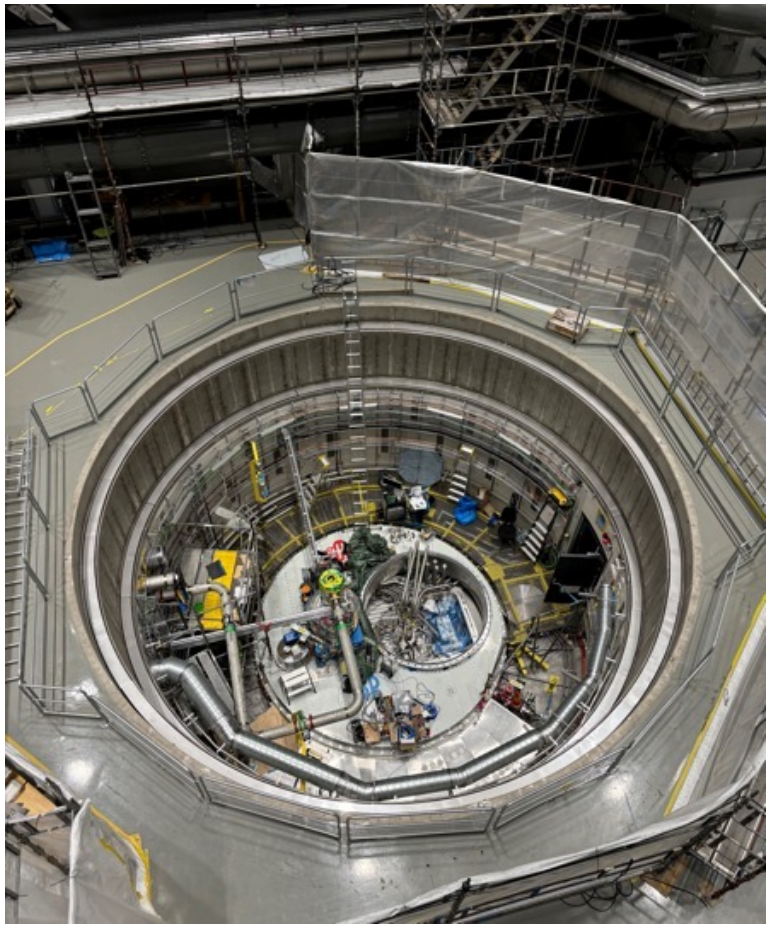
- Locations of moderators above and beneath of the target wheel, i.e. monolith centre
- 1st MR plug exploits the upper space, offering:
  - Cold, 30 mm high, liquid H_2 moderators, 1
  - Thermal, 30 mm high, H_2O moderator, 300

Diagnostics and instrumentation

- Fluorescent coating of PBW and target front face
- Wheel monitoring including position, temperatu vibration, as well as internal structure

Target

Target connection cell from above, focusing on the Target monolith area

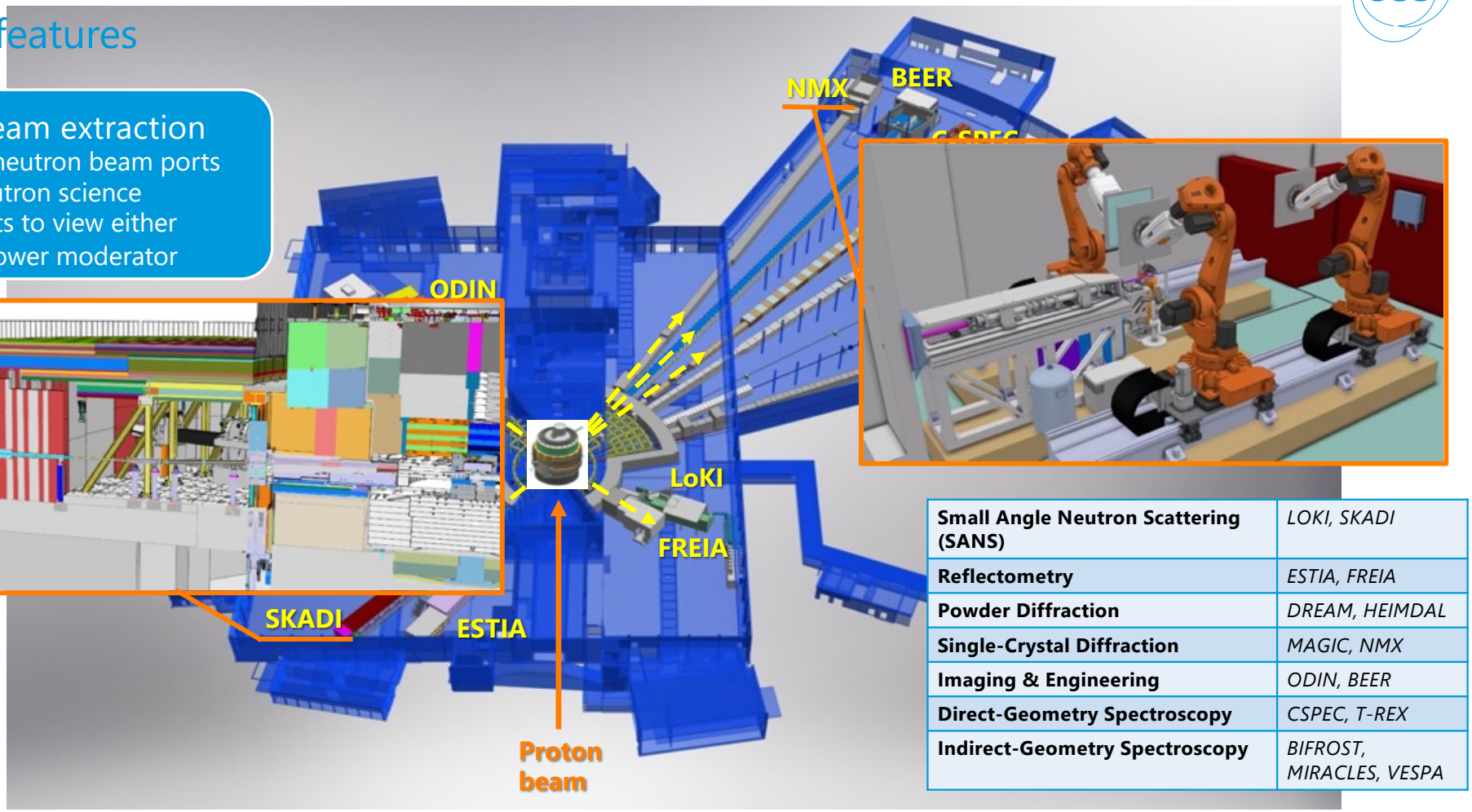


ESS Neutron Instruments

Key features

Neutron beam extraction

- Offers 42 neutron beam ports
- Allows neutron science instruments to view either upper or lower moderator



Small Angle Neutron Scattering (SANS)	*LOKI, SKADI*
Reflectometry	*ESTIA, FREIA*
Powder Diffraction	*DREAM, HEIMDAL*
Single-Crystal Diffraction	*MAGIC, NMX*
Imaging & Engineering	*ODIN, BEER*
Direct-Geometry Spectroscopy	*CSPEC, T-REX*
Indirect-Geometry Spectroscopy	*BIFROST, MIRACLES, VESPA*

Instruments Hall

SKADI - the sample cave is located between the collimator and the detector cave

NMX – Hutch installation

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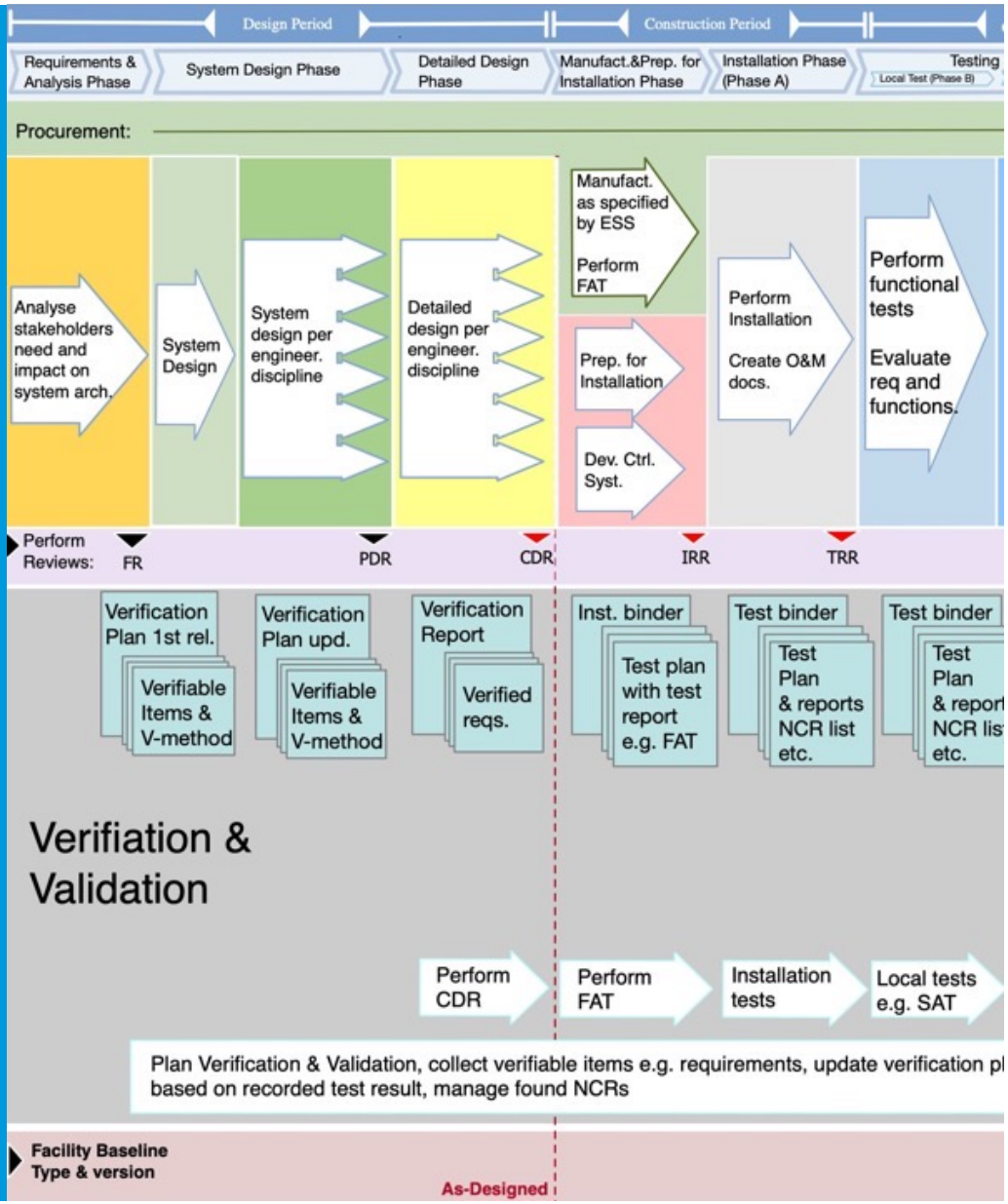
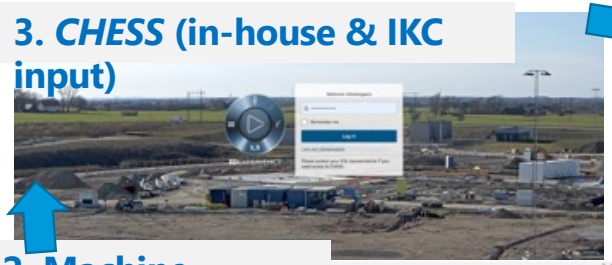
Requirements & Engineering Workflow



Digital Mock-Up

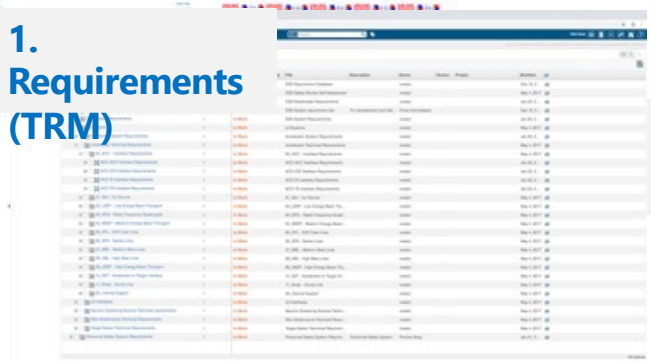
ESS engineering information path

3. *CHESS* (in-house & IKC input)



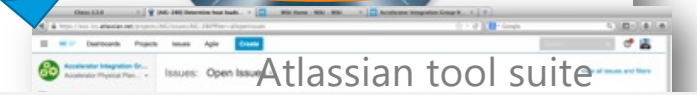
2. Machine Skeleton (Lattice)

1. Requirements (TRM)

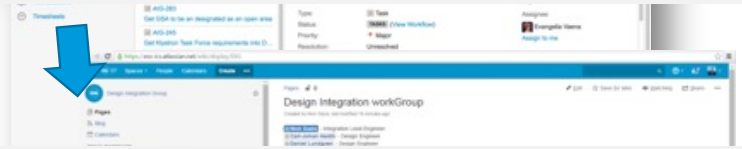


4. Mechanical Design

Atlassian tool suite



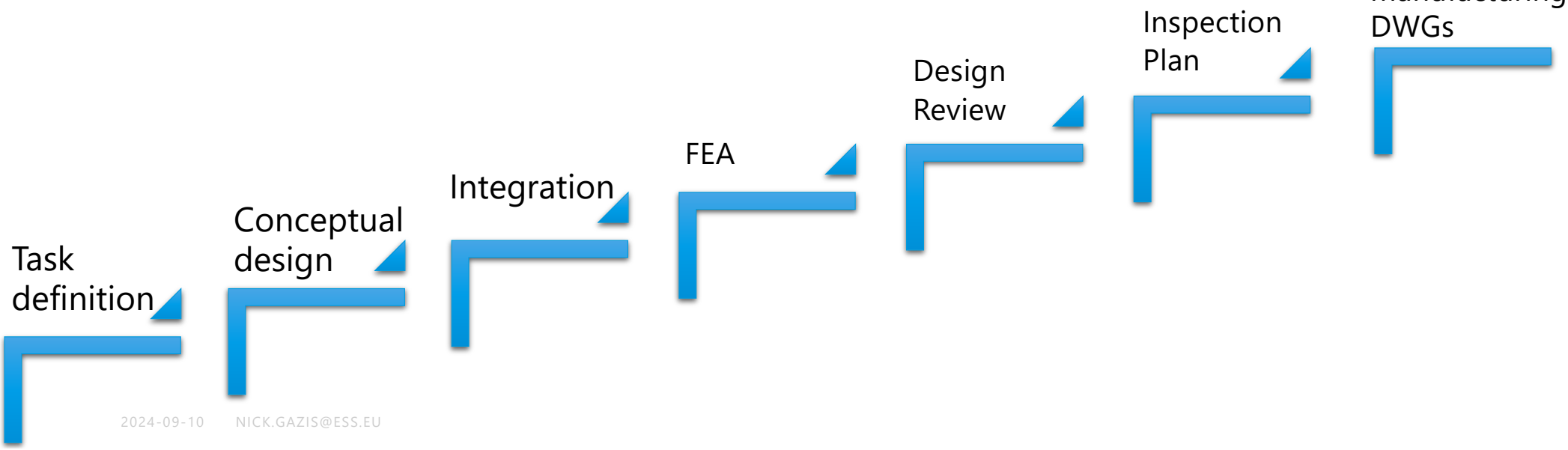
5. *JIRA* tasks



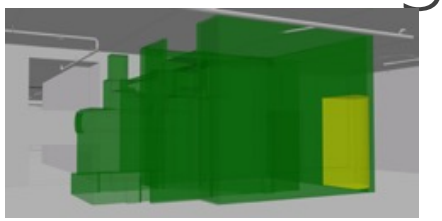
6. Released *CHESS* DWGs
7. *Confluence* monitoring for Eng. Deliverables

Mech Eng Task Exec Coord - mETEC

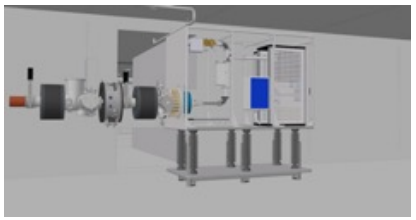
"We need a quick design..." means



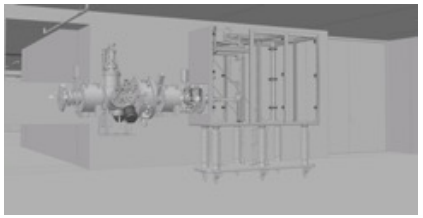
Machine design cycle



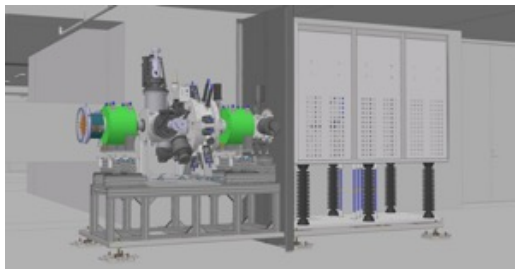
1. Space reservation



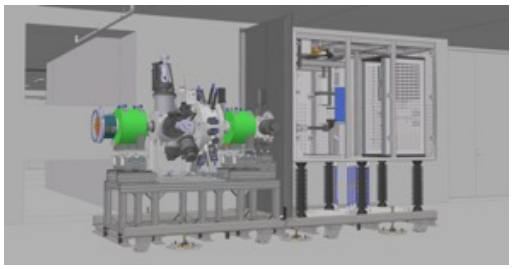
2. Preliminary Design



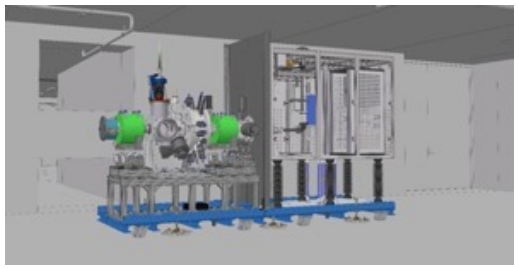
3. Detailed Design



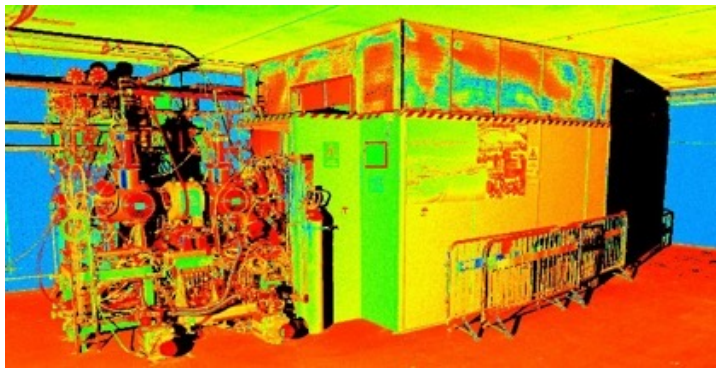
4. Manufacturing launch



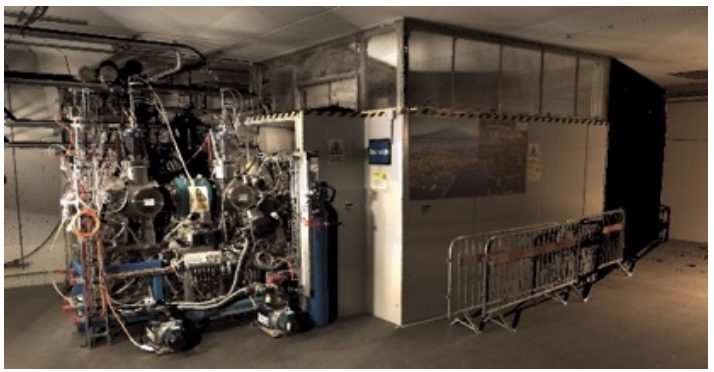
5. Installation Review



6. Testing



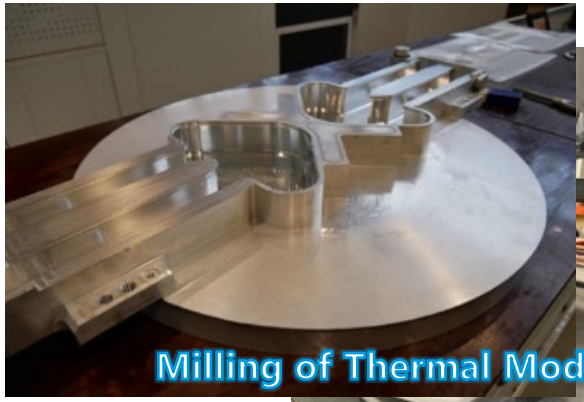
7. As-Scanned



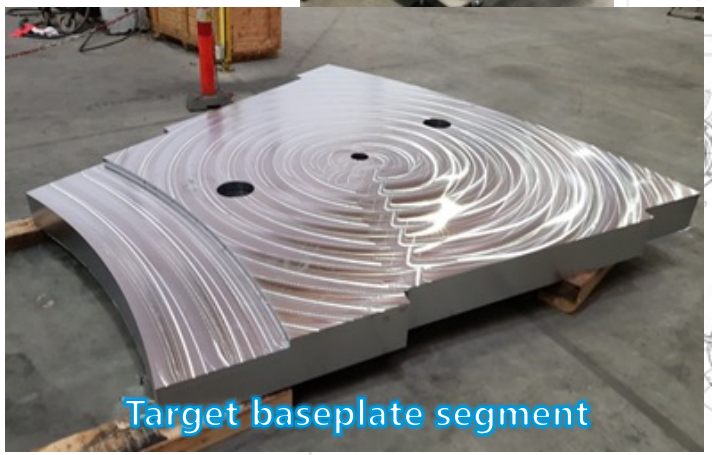
8. As-Built & Commissioned

Parts & Prototypes Design

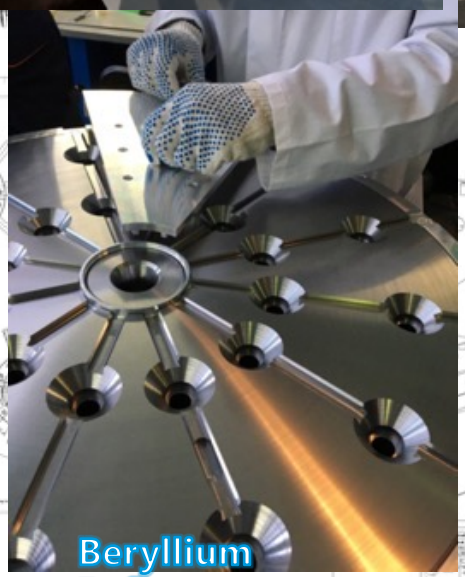
Manufacturing, Repairs & Modifications



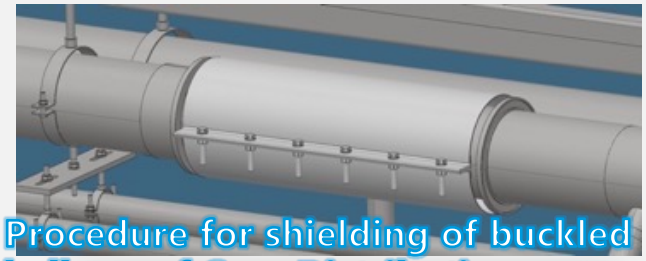
Milling of Thermal Moderator



Target baseplate segment



Beryllium



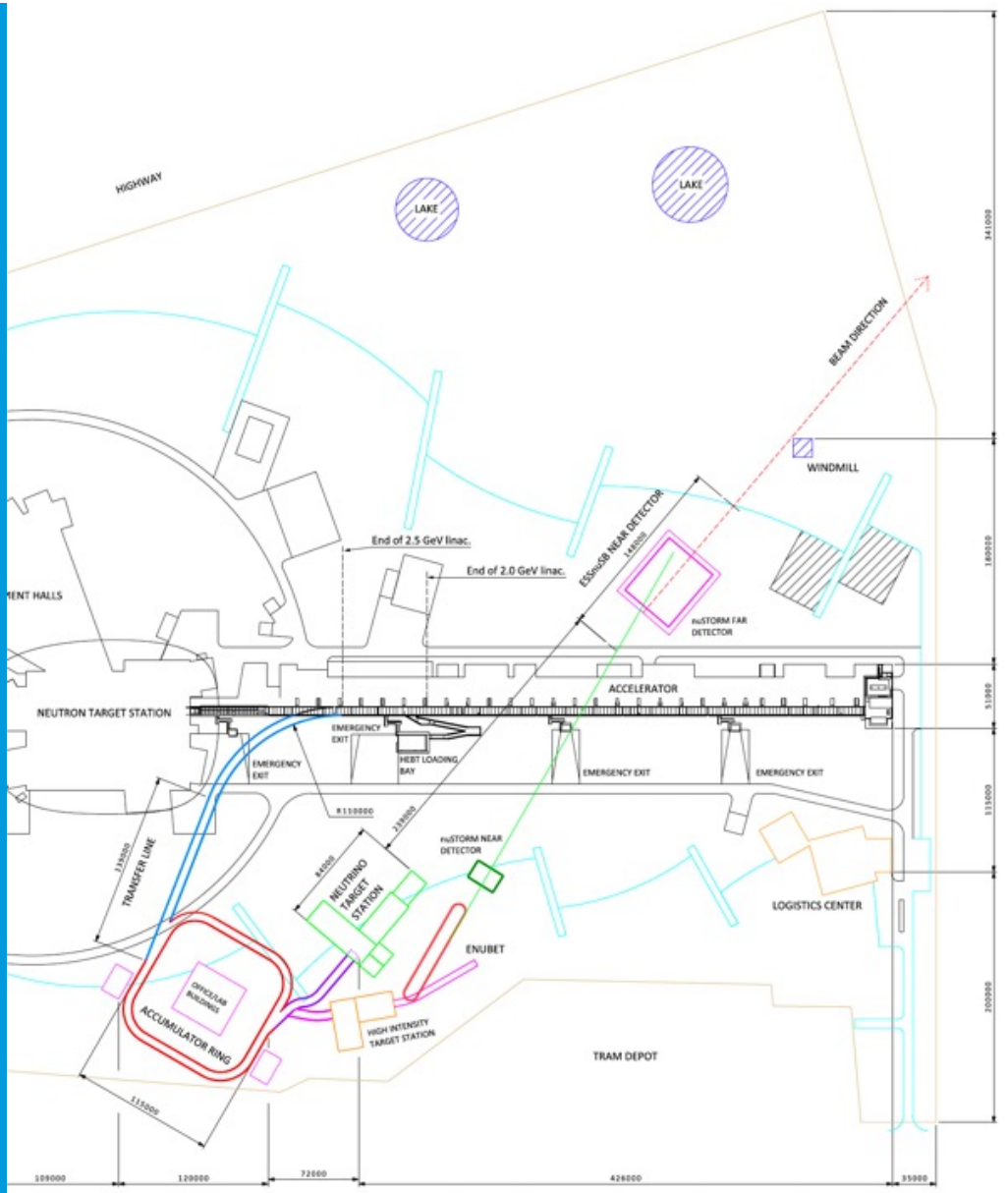
Procedure for shielding of buckled bellows of Cryo Distribution System –(CDS-SPK) failed auxiliary line

Mechanical Measurements Lab (MML)

B02 SPK CMs

4

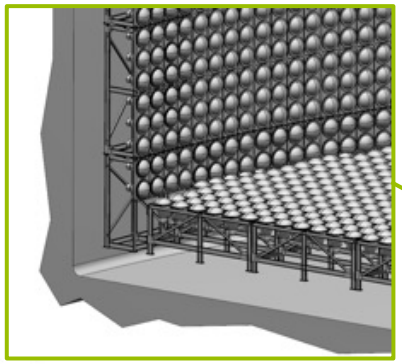
Future upgrades

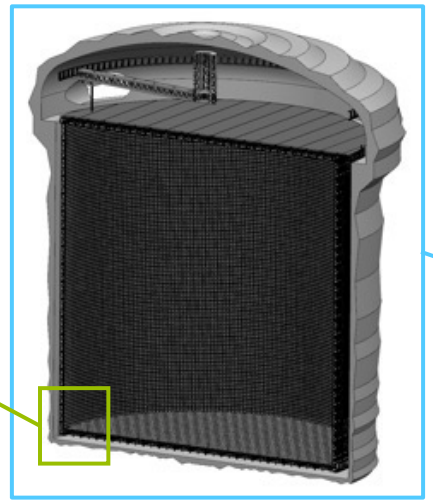


ESSnuSB+

WP2 – Engineering & Infrastructure

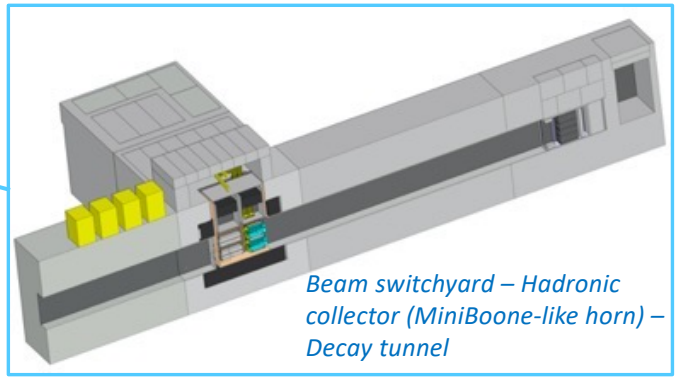
ESS NEUTRINO SUPER BEAM





Far Detector (FD): photomultiplier-based detector for neutrinos, D = 78 m ; H = 75 m

Proton Beam (Ep=2.5 GeV, 14 Hz)



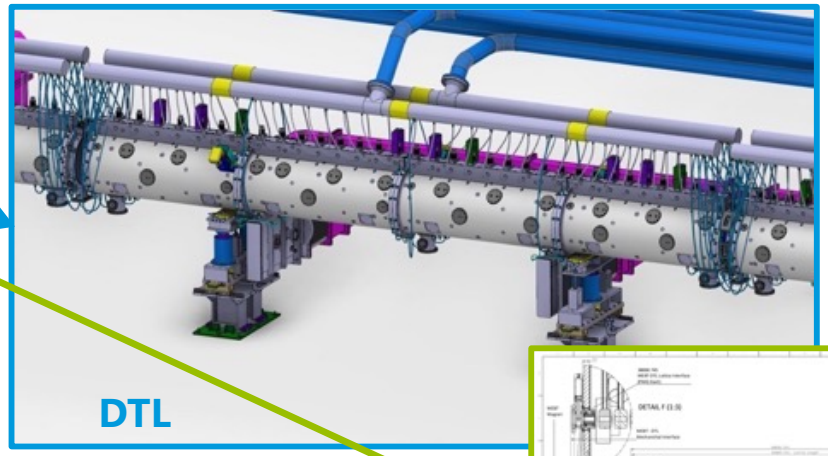
Beam switchyard – Hadronic collector (MiniBoone-like horn) – Decay tunnel

Design & technological solutions under exploration in order to support the proposal of installing the ESSnuSB+ at ESS site and its FD cavern 450 km in the north, in an old repurposed mine.

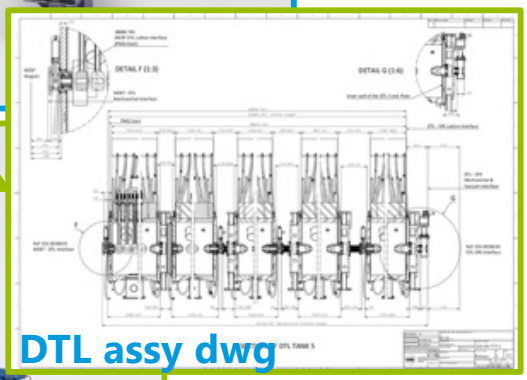
An example for consideration

More than meets the eye..

A linac does contain the **accelerator parts**
but also the power sources, electronics, controls,
waveguides, cooling sources etc
and accessiblity for side-operations such as
assembly, installation, maintenace etc,
that need also design effort and space to fit in.

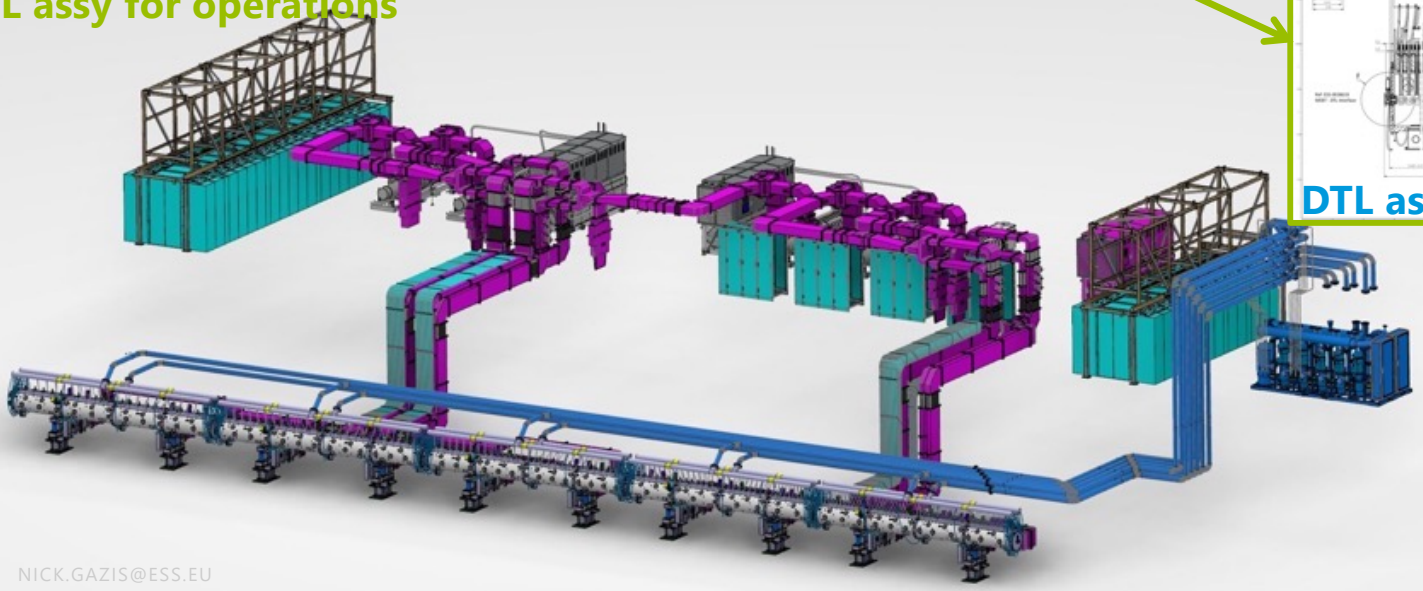


DTL



DTL assy dwg

DTL assy for operations




Many thanks to colleagues
for contributing to this material
Thank you

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SPALLATION
SOURCE