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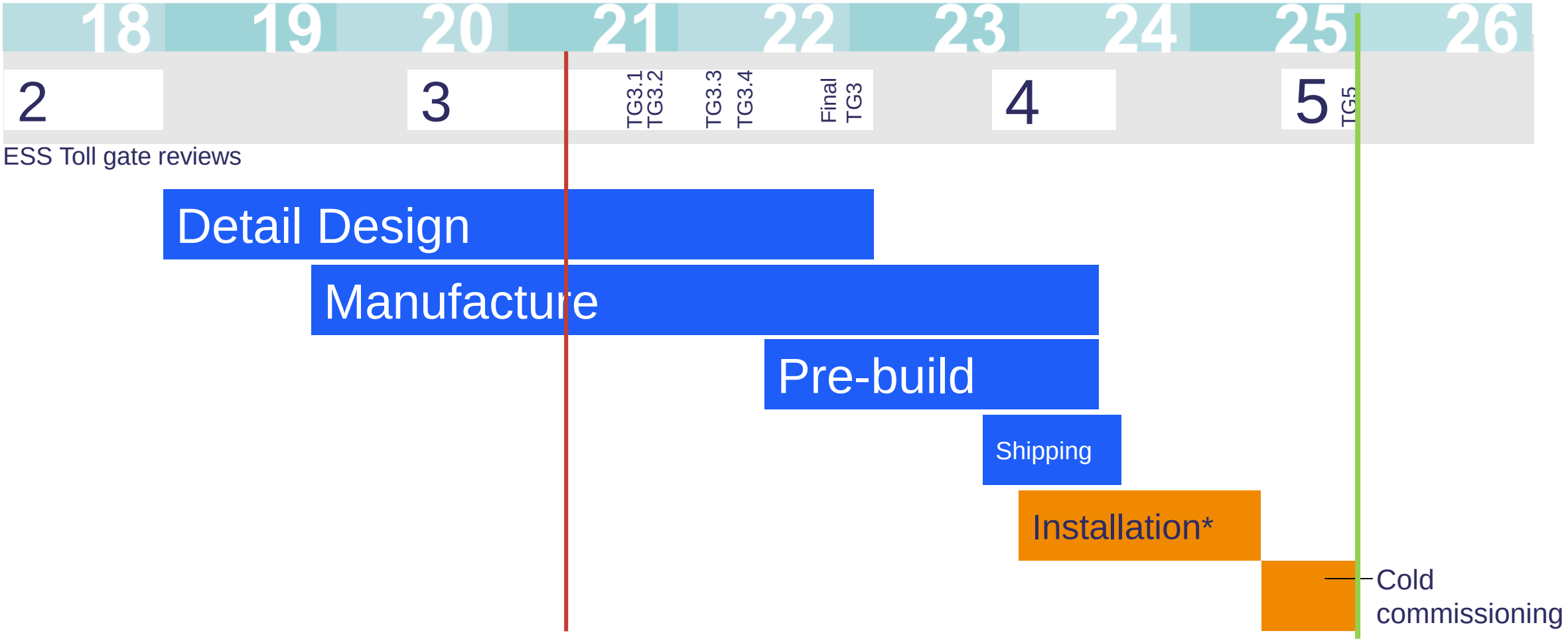
FREIA Update
Reflectometry STAP

April 2021

Jon Elmer – Lead Engineer

Tom Arnold – Lead Scientist

Schedule Overview



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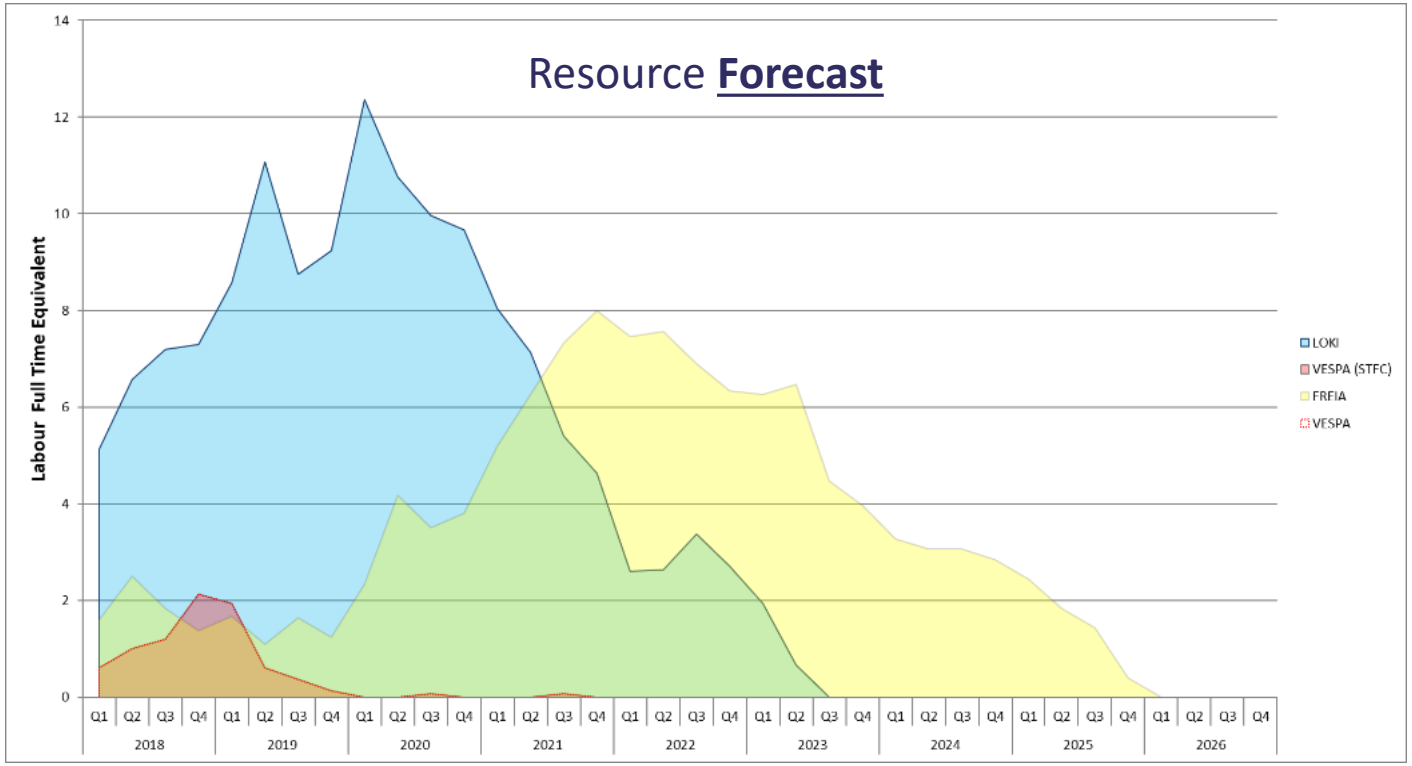
* Carried out by ESS with advice from ISIS

Engineering Effort Ramping Up

As of March 2021:

Core Team

- Jon Elmer
- Miguel Campos (Uppsala)
- Federico Masi (20% → 80%)
- Ben Hicks (20% → 80%)
- Zoë Clark (until July)



Choppers

- Peter Galsworthy (~20%)

Motion Control

- Nick Webb (~10%)
- Ben Withers (~10%)

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Status Update

NBOA: in manufacture

Chopper discs: Coating trials underway

Chopper discs: ADSF prototype in re-work

Chopper housings: In-house designs progressing

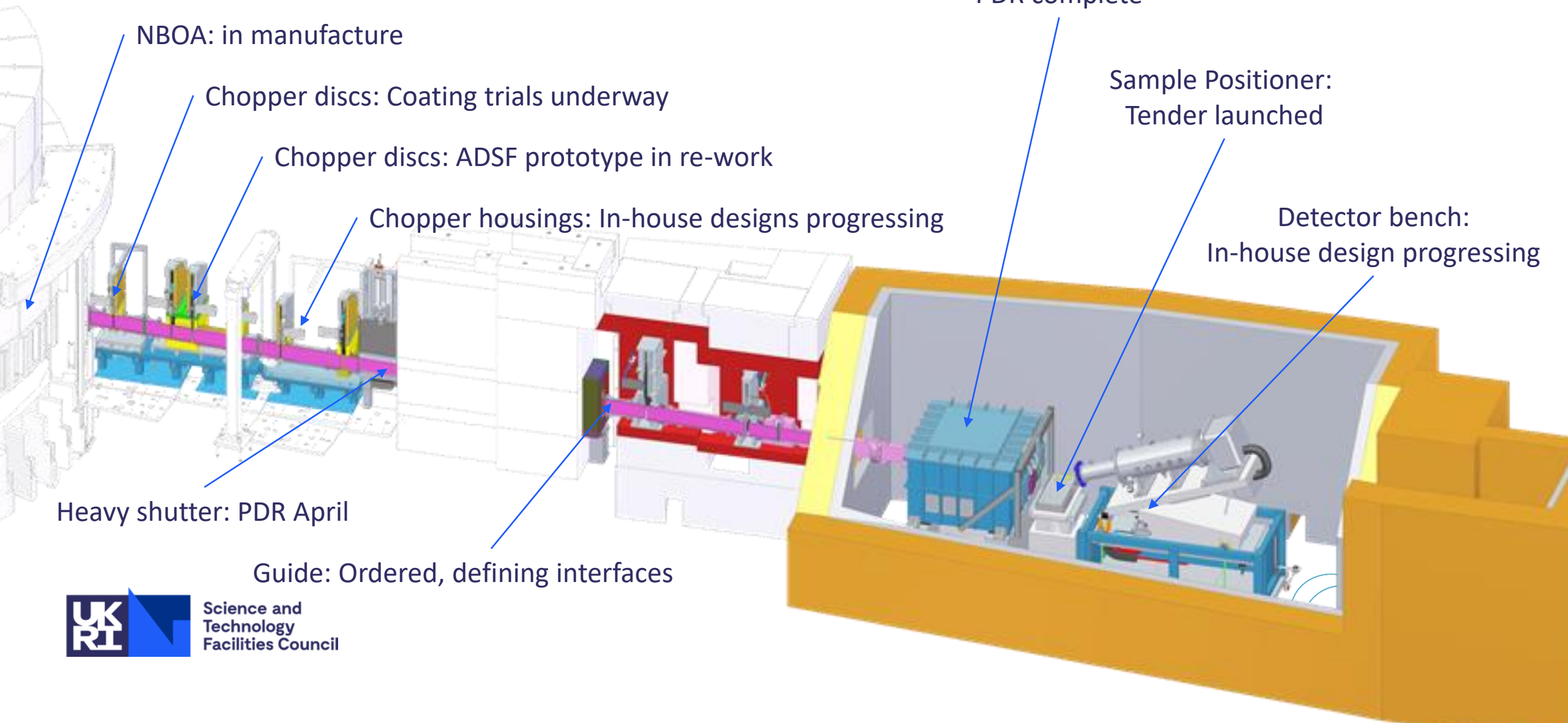
Heavy shutter: PDR April

Guide: Ordered, defining interfaces

Collimation system:
PDR complete

Sample Positioner:
Tender launched

Detector bench:
In-house design progressing



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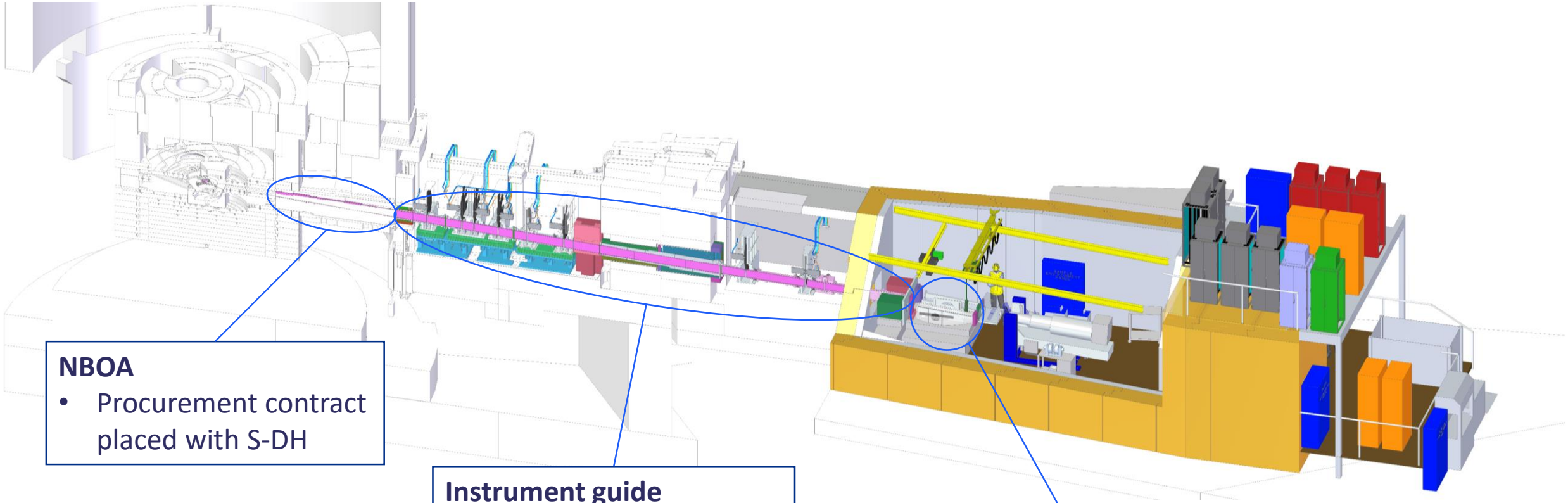
Status: Guide



NBOA
- Procurement contract placed with S-DH

Instrument guide
- Procurement contract placed with SNAG

Collimation guides
- Concept design under way

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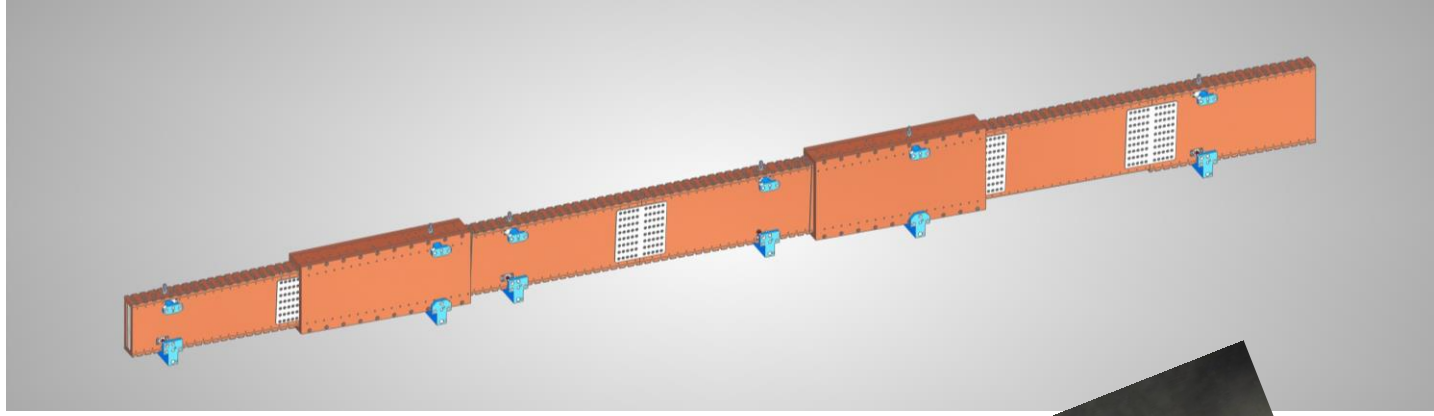
Status: NBOA



- Manufacture delays due to availability of neutrons
  - BNC – some cycles cancelled (Covid)
  - PSI – cycle commenced 16th April
- ~~Delivery expected 2021Q2~~
- 12/04: Machine failure at S-DH
  - Further delays expected
  - Delivery not needed until late 21 at earliest

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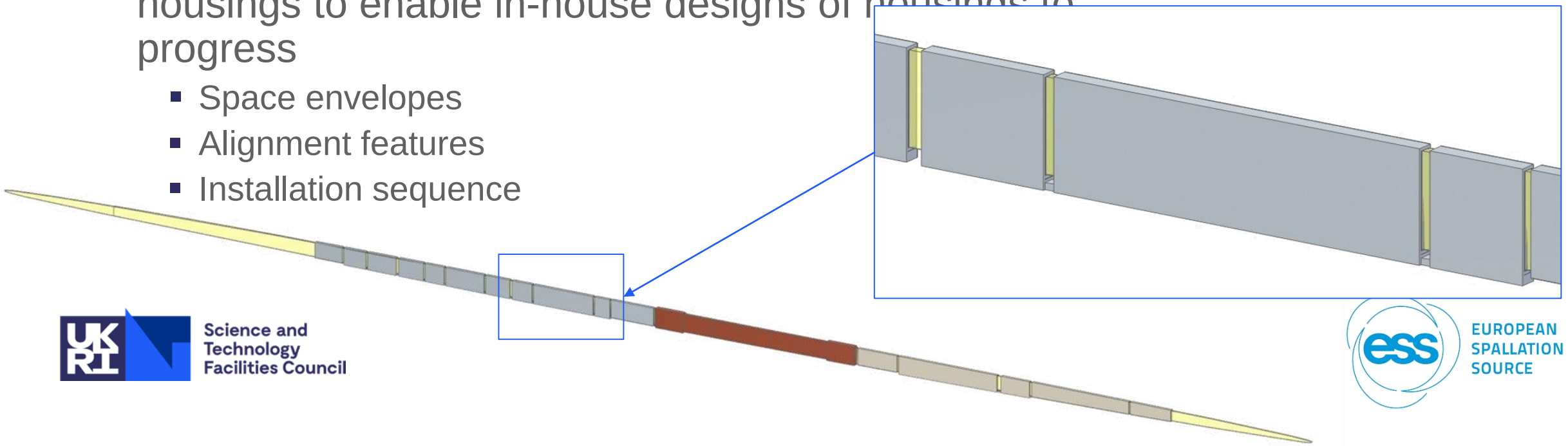
Status: Instrument Guide

- Jan ‘20: CTV submitted
- May ‘20: OJEU launched
- July ‘20: OJEU failed
- Dec ‘20: Ordered from SNAG

- Developing design with SNAG
- Added bridges to reduce number of alignment devices
- Defining interfaces between guide and vacuum housings to enable in-house designs of housings to progress
  - Space envelopes
  - Alignment features
  - Installation sequence



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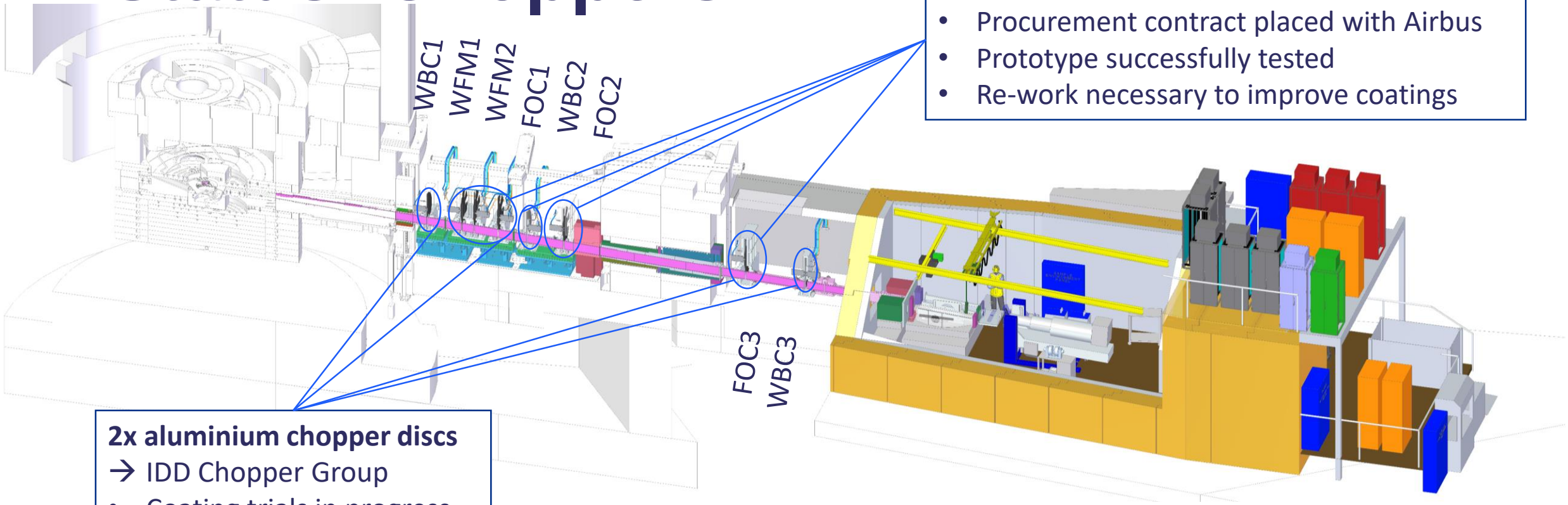
Status: Choppers



6x carbon fiber chopper discs
- Procurement contract placed with Airbus
- Prototype successfully tested
- Re-work necessary to improve coatings

2x aluminium chopper discs
→ IDD Chopper Group
- Coating trials in progress

Spindles, drives
- Ordered from SKF
- Delivery delayed
  → priority agreed with ESS
  = no impact to Freia schedule

Vacuum housings
→ IDD Chopper Group
- Concept designs developing
- Adapting lower housings to suit guide interfaces

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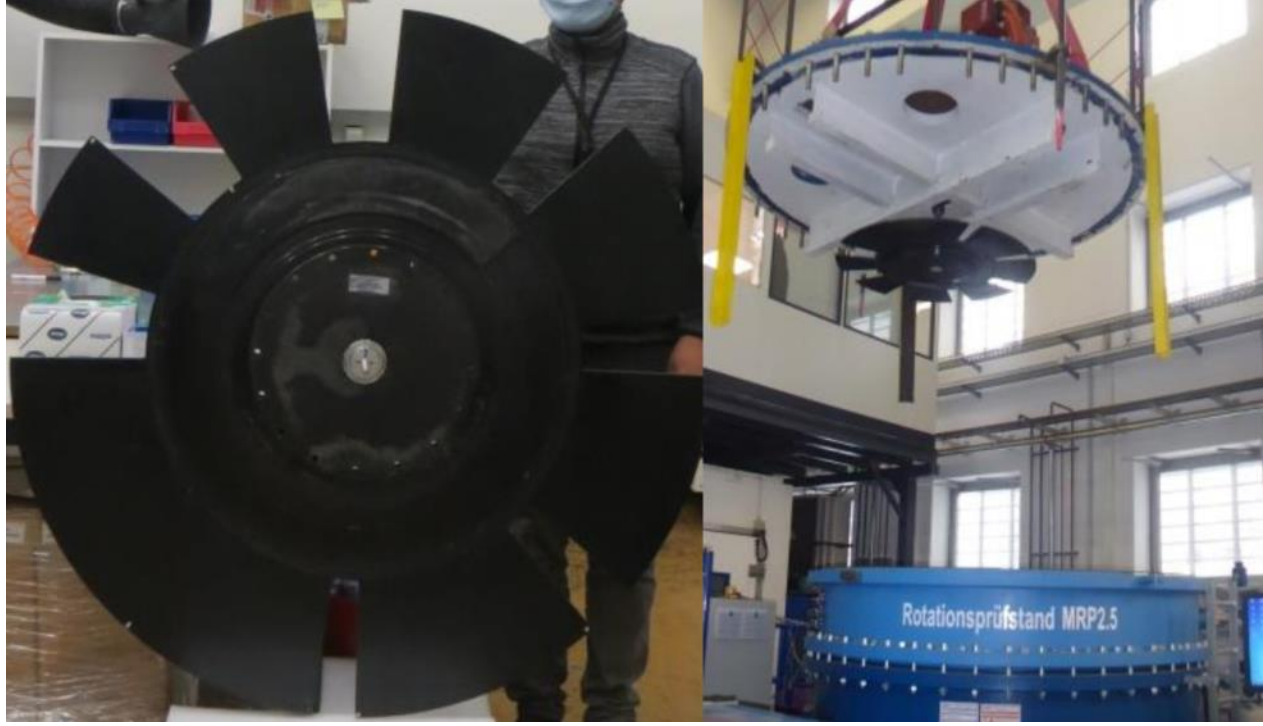
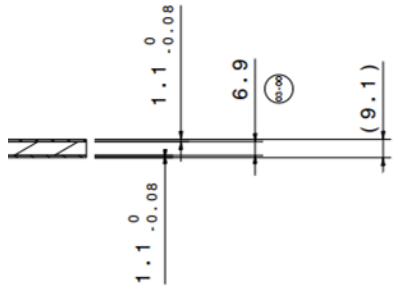
Status: WFM1 Disc



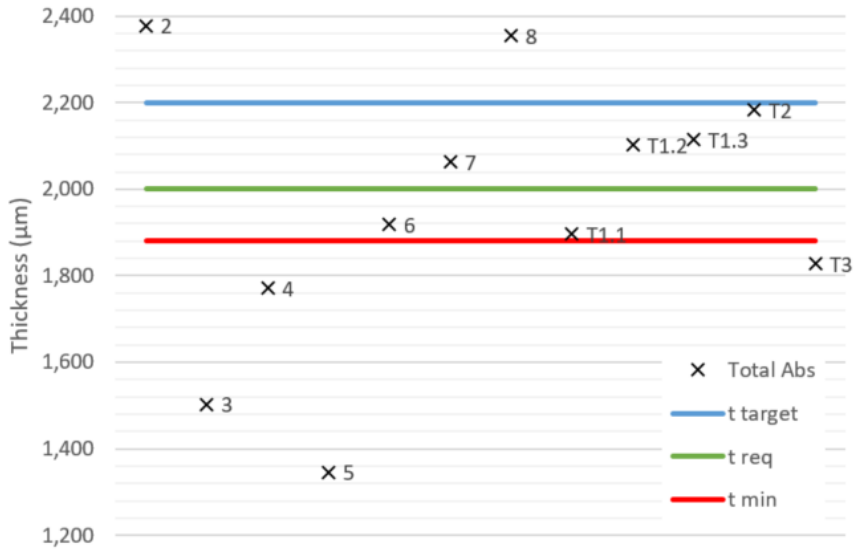
- WFM1 manufactured late 2020
- Over-speed testing of WFM1 shows technology is viable
- Concerns around absorbing coating thickness
  - ADSF to improve coating process
  - Apply additional coating to WFM1
- Decision to delay manufacture of remaining discs by 2 months to resolve coating issue
  - No impact to Freia schedule



Disc	Type	Transmission	Wavelength
FOC	Average*	≤ 10^{-9}	2 Å
	Peak**	≤ $5*10^{-9}$	2 Å
WFM	Average*	≤ 10^{-11}	2 Å
	Peak*	≤ $5*10^{-11}$	2 Å

*over entire absorbing blade area

**at any point on the absorbing blade



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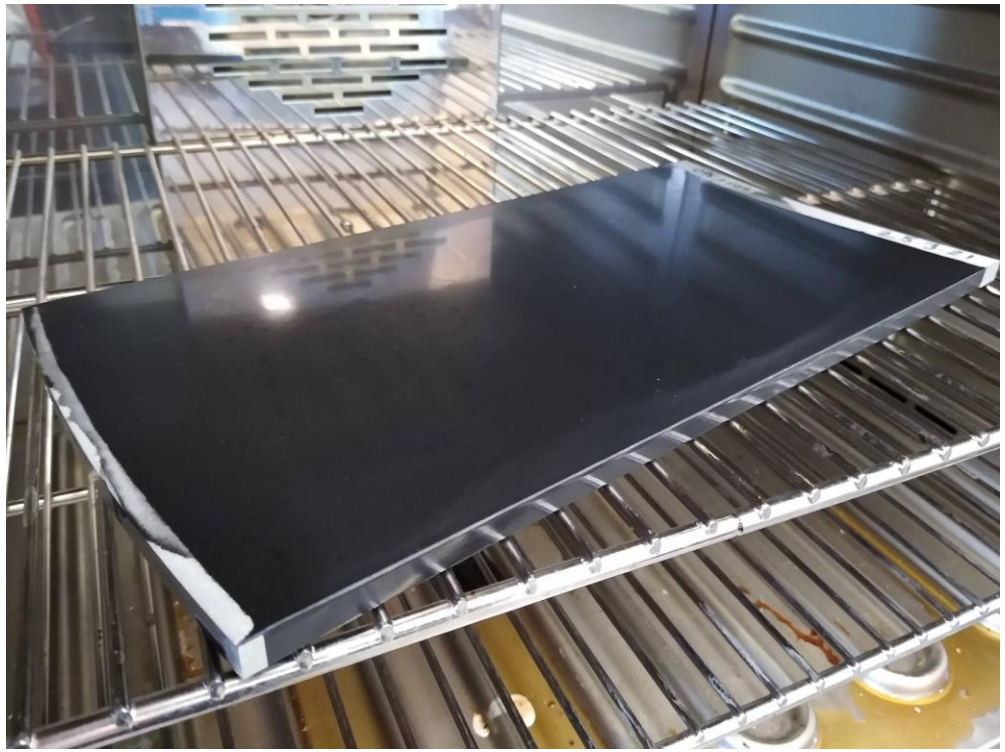
Choppers: WBC1&3 discs

- Design concept for aluminium discs with enriched $^{10}B_4C$ coating to reduce mass
- First trial of cast B_4C carried out (by STFC Technology Department)
  - Test used natural B_4C of same grade as available $^{10}B_4C$ (cost effective)
  - Epoxy used has previously been tested for radiation hardness



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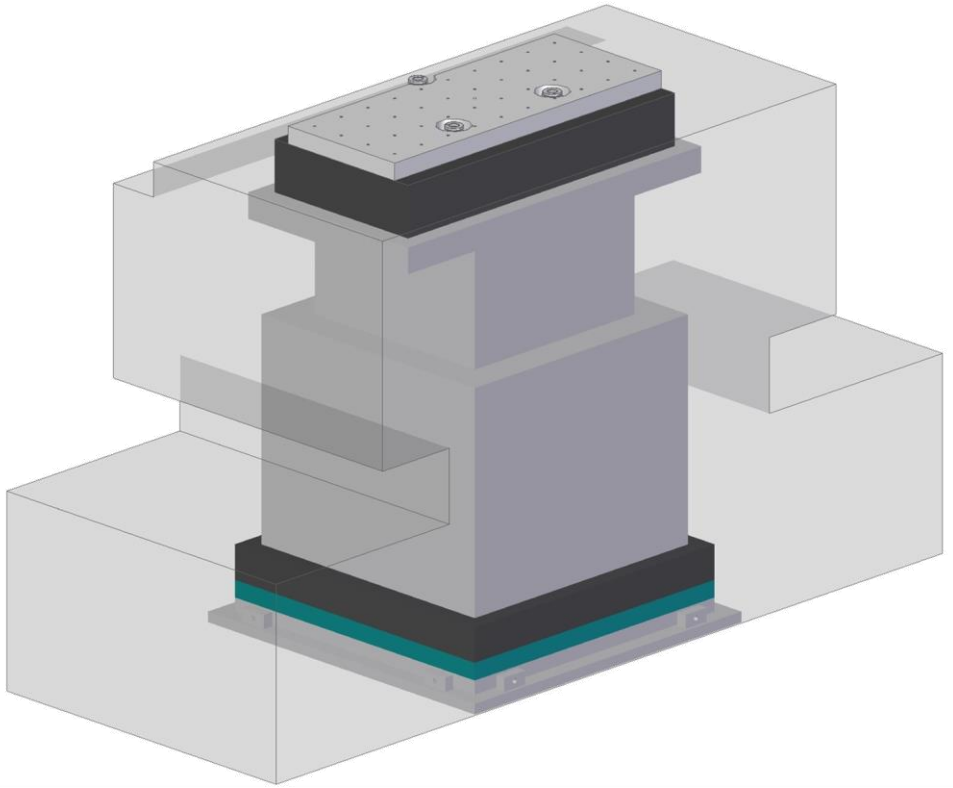
**Status: Heavy shutter

- Pneumatically actuated vertically translating shutter, loosely based on proven LoKI shutter concept
- Engineering design progressed to PDR
- Materials: molybdenum, B4C, borated poly, steel

Status: Sample Positioning System

- Specification finalised
  - Open to either traditional “stack of stages” or hexapod solution
- Tender launched March 24th
  - Closes May 21st



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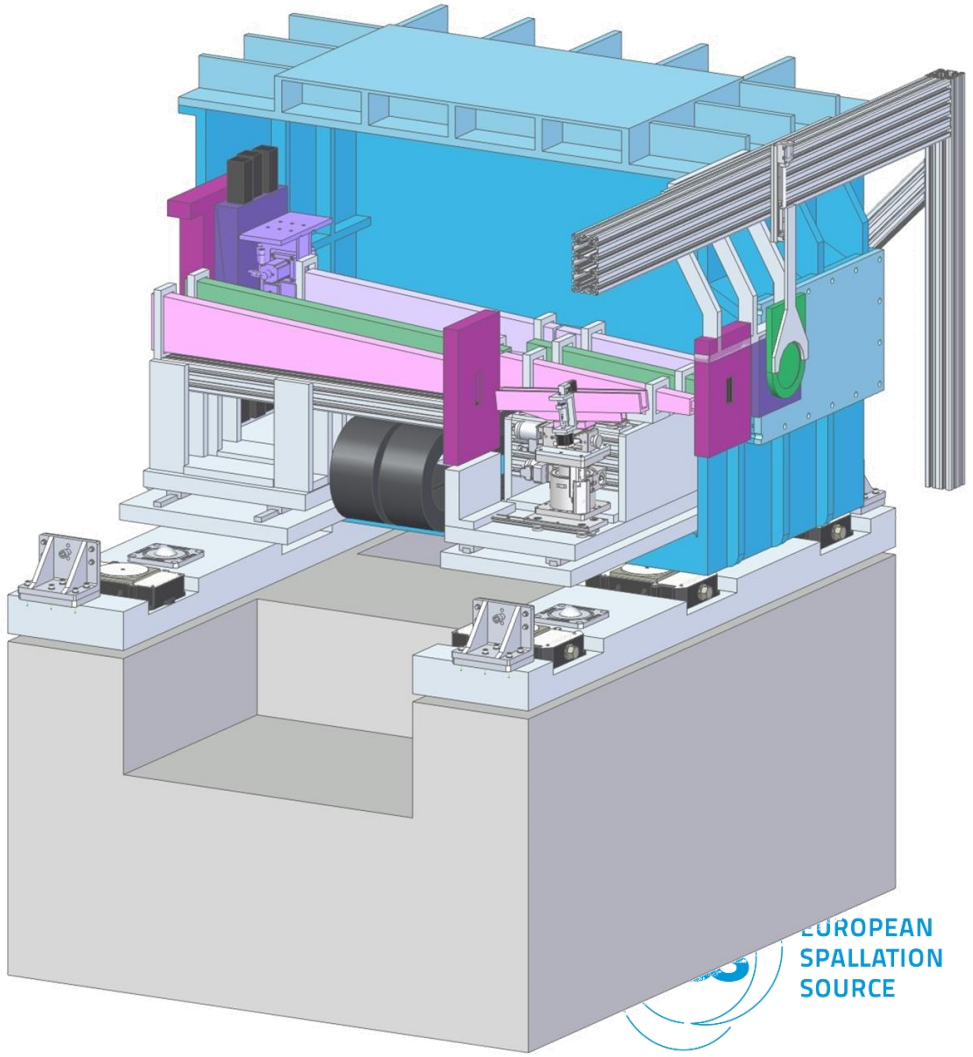
Status: Collimation system

- Final PDR held in April

  → Concept approved

- Next steps
  - Specification of sub-systems for procurement
    - Slits, vacuum vessel, guides
  - Detailed design of in-house sub-systems
    - Kinetics slits, translation stages



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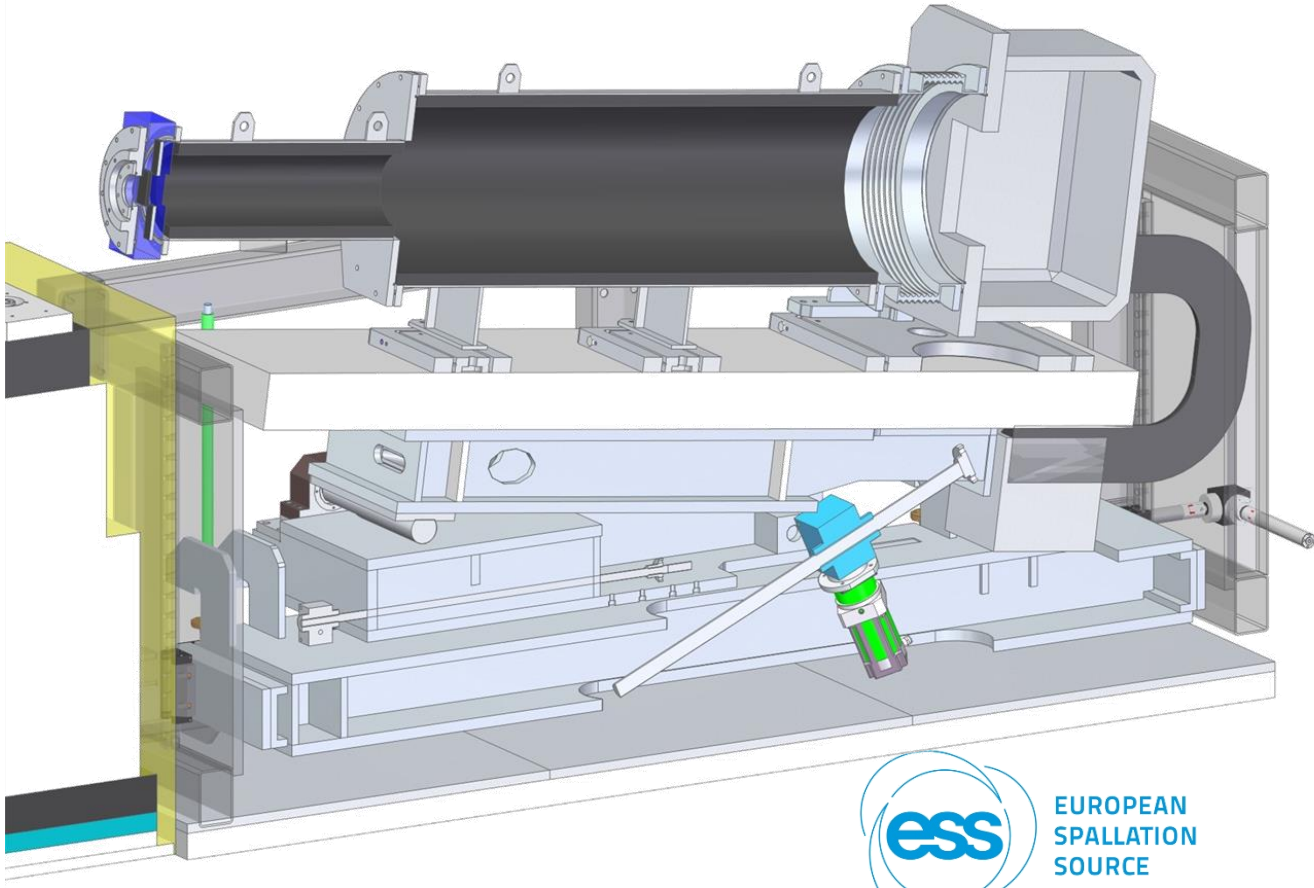
Status: Detector flight tube & bench

- Design RA – first pass complete
- Continuing to select motion control components
  - Ball-screws, servos, absolute encoders
- Flight tube on-hold pending input from ESS



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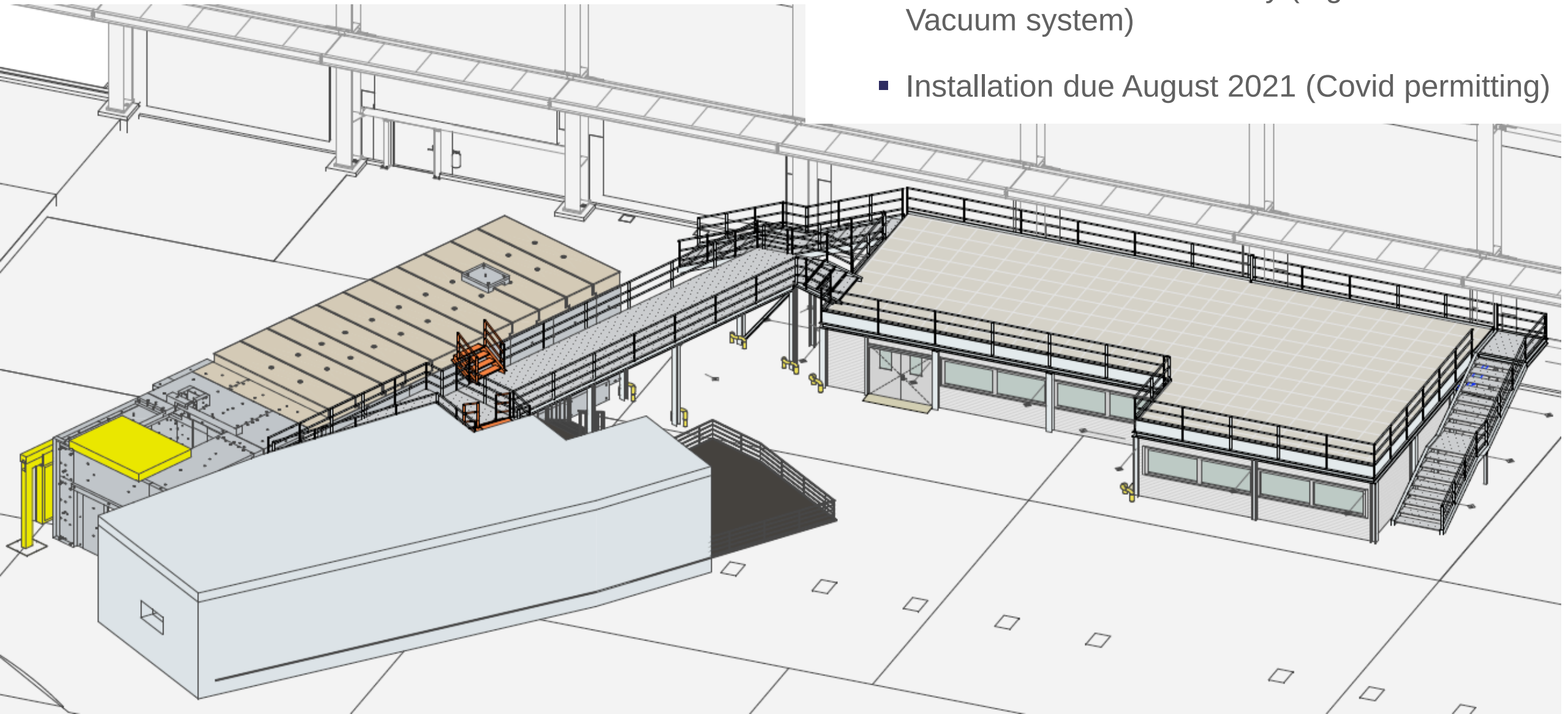
ESS deliverables

- Control Hutch
- Detector
- Beam monitors
- Sample Environment
- Chopper controls
- Vacuum system
- DMSC – Data reduction / Analysis
- Control systems / EPICS
- EC/DC – Data Acquisition
- PSS

ESS: Control Hutch

- Hutch contract progressing well:
  - PDR completed in February
  - TG3 scheduled for 6th May (together with Loki Vacuum system)
  - Installation due August 2021 (Covid permitting)



ESS: Monitors

	Name	Type	Rev	Description	Title	Owner	Originator	State	Released Date	Publication	Actions
1.	ESS-3268808	0/1 Report	1	✔	Offer to the Freia Instrument - Beam Monitors Common Project	Wen Xiong	Wen Xiong	Released	Apr 9, 2021 (3 days ago)		ESS-3268808 - Offer to th

- Offer from ESS Detector group approved in Chess
- ESS are negotiating with Milano-Bicocca university to deliver these monitors

BM	zone	distance (m)	placement	beam profile (mm^2)	depth (mm)	efficiency	converter specification
1	bunker	6.82	air	231.5 × 30	<20	10^{-6}	N_2
2	bunker	8.81	air	246.2 × 30	<20	10^{-6}	N_2
3	out-of-bunker	14.87	air	240.4 × 30	<20	10^{-6}	N_2
4	out-of-bunker	17.88	vacuum	207.3 × 30	<20	10^{-6}	N_2
5	pre-sample	approx. 21	vacuum	180 × 30	<20	10^{-4}	B4C or N2
6	pre-sample	22.1	air	60 × 35	<20	10^{-4}	B4C or N2

Table 2: Engineering specifications for the FREIA beam monitors with indicative efficiency values.

A final design review (FDR) should take place by **December 2021** at the latest, so that the design can be approved at the appropriate instrument TG3 meeting.

BM	zone	module ready at STFC	monitor delivery	installation at ESS	cold commissioning	hot commissioning
1	bunker	Dec. 2023	+0 months	Jan. 2024	+1 month	Jan. 2026
2	bunker	Dec. 2023	+0 months	Jan. 2024	+1 month	Jan. 2026
3	D03	Dec. 2023	+0 months	Jan. 2024	+1 month	Jan. 2026
4	D03	Dec. 2023	+0 months	Jan. 2024	+1 month	Jan. 2026
5	D03	Dec. 2023	+0 months	Jan. 2024	+1 month	Jan. 2026
6	D03	Dec. 2023	+0 months	Jan. 2024	+1 month	Jan. 2026

Table 3: Delivery, installation and cold commissioning schedule for the FREIA BMs.

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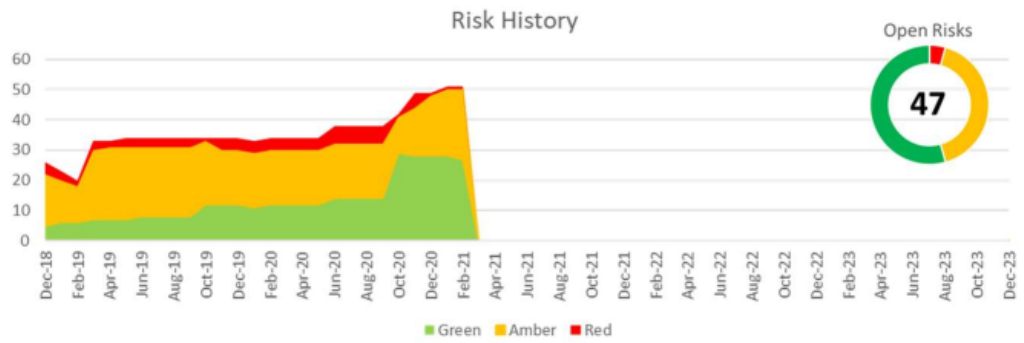
ESS: Sample Environment

- ESS Sample environment resources remain negligible for FREIA
- Sample Environment for LSS instruments to be managed by Instrument Scientists in coordination with SAD
- Out-sourcing in full progress
  - Solid-liquid cells transfer to Uppsala (Adrian Rennie) finally agreed using ESTIA construction budget + Tillväxtverket grant. This will deliver the ESTIA construction scope + FREIA development
  - Nordforsk post-doc application was successful – Nico Paracini will start in June
  - RÅC proposal for Air-liquid sample changing development imminent
  - Additional proposal for Tillväxtverket grant to coopt in-situ IR Ellipsometry project from Linköping

Risks

Top 5 Risks					
Title	Severity	Category	Responsible	Response	Trend
Neutronics resource	12	Quality	STFC	Accept	Rising
Loss of key instrument team specialist	10	Schedule	STFC	Accept	Steady
Lack of clarity over ESS roles and responsibilities	9	Schedule	STFC	Reduce	Falling
Engineer design effort unavailable	9	Schedule	STFC	Accept	Steady
Under-estimation of STFC project costs	9	Cost	STFC	Accept	Rising



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Thank you

Questions?