Diffraction & Imaging Division update

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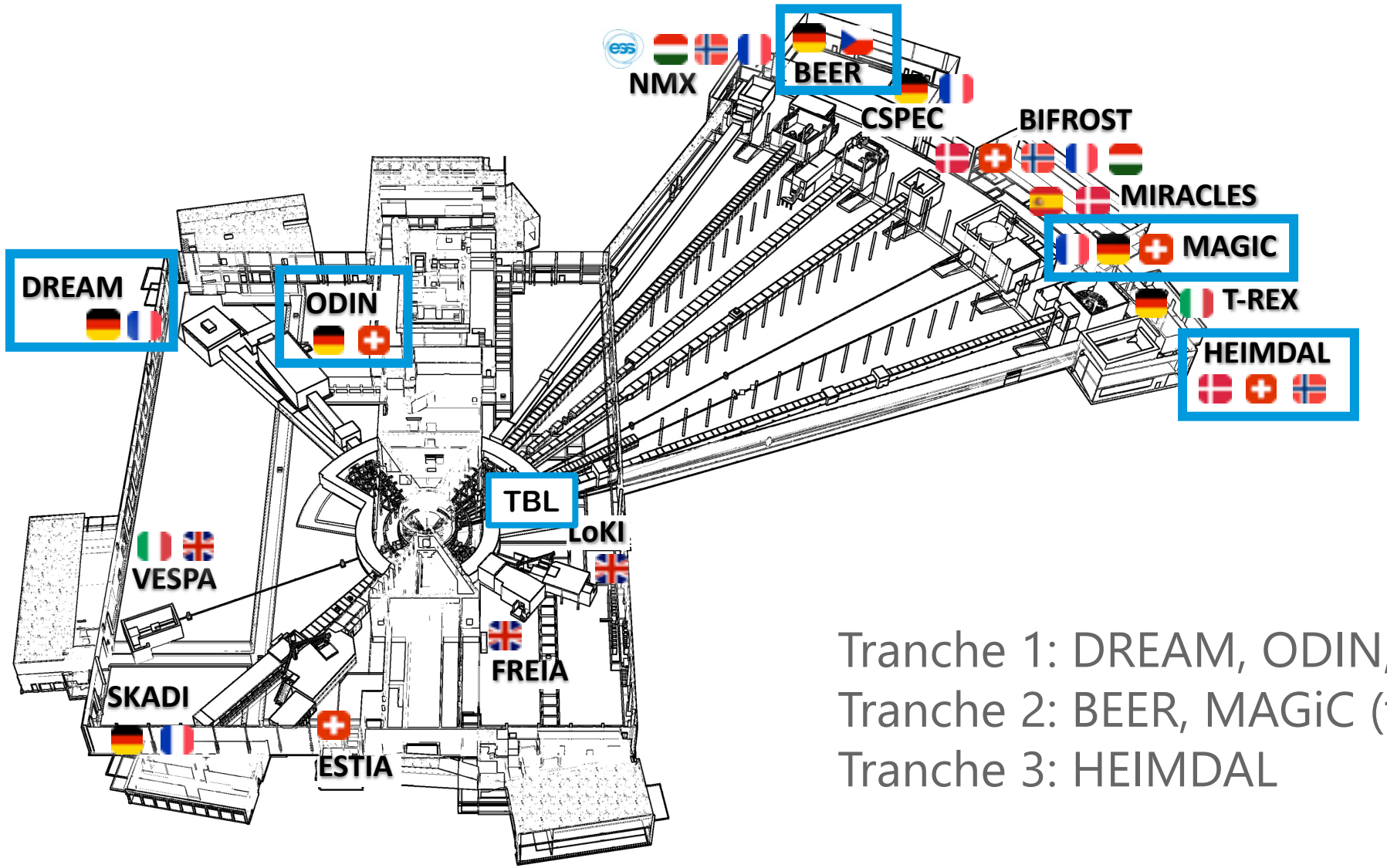
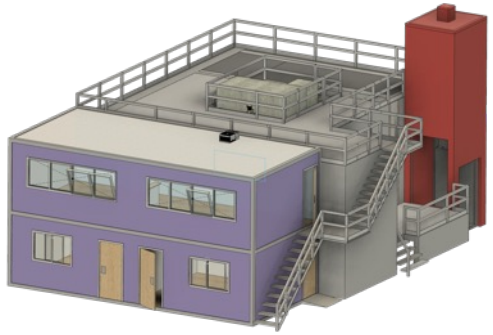
Instruments



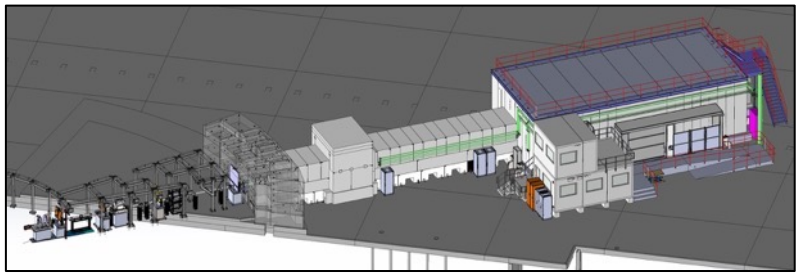
Tranche 1: DREAM, ODIN, TBL
Tranche 2: BEER, MAGiC (tbc)
Tranche 3: HEIMDAL

Instruments

MAGiC
Denis Vasiukov*



ODIN
Robin Woracek*
(Robin.Woracek@ess.eu)



BEER
Premek Beran
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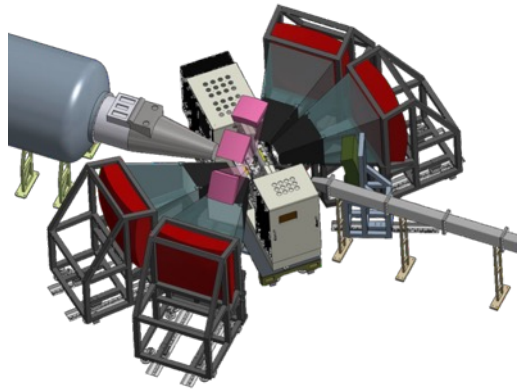

HEIMDAL
Dan Mannix
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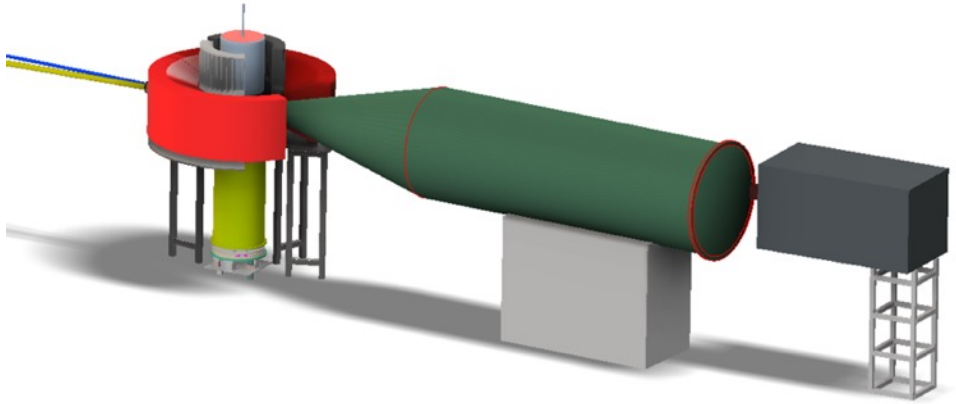

TBL
Thawatchart Chulapakorn
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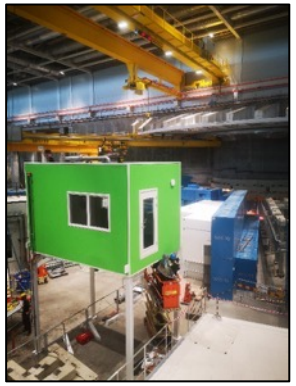

DREAM
Florence Porcher*
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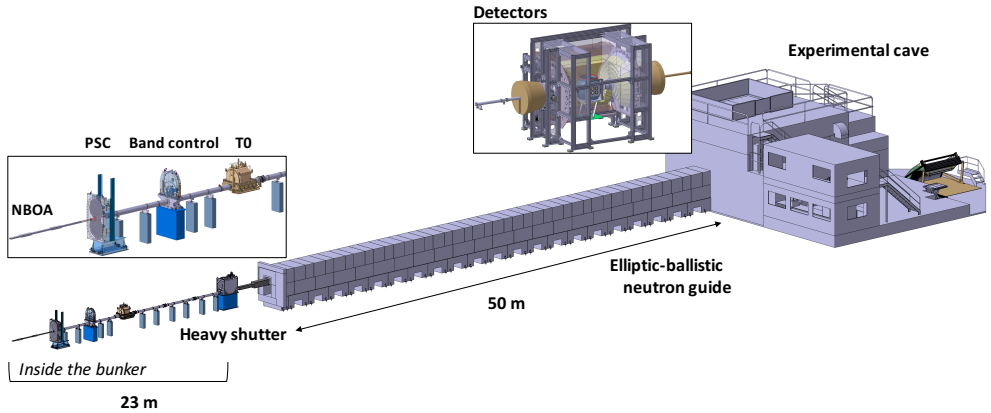


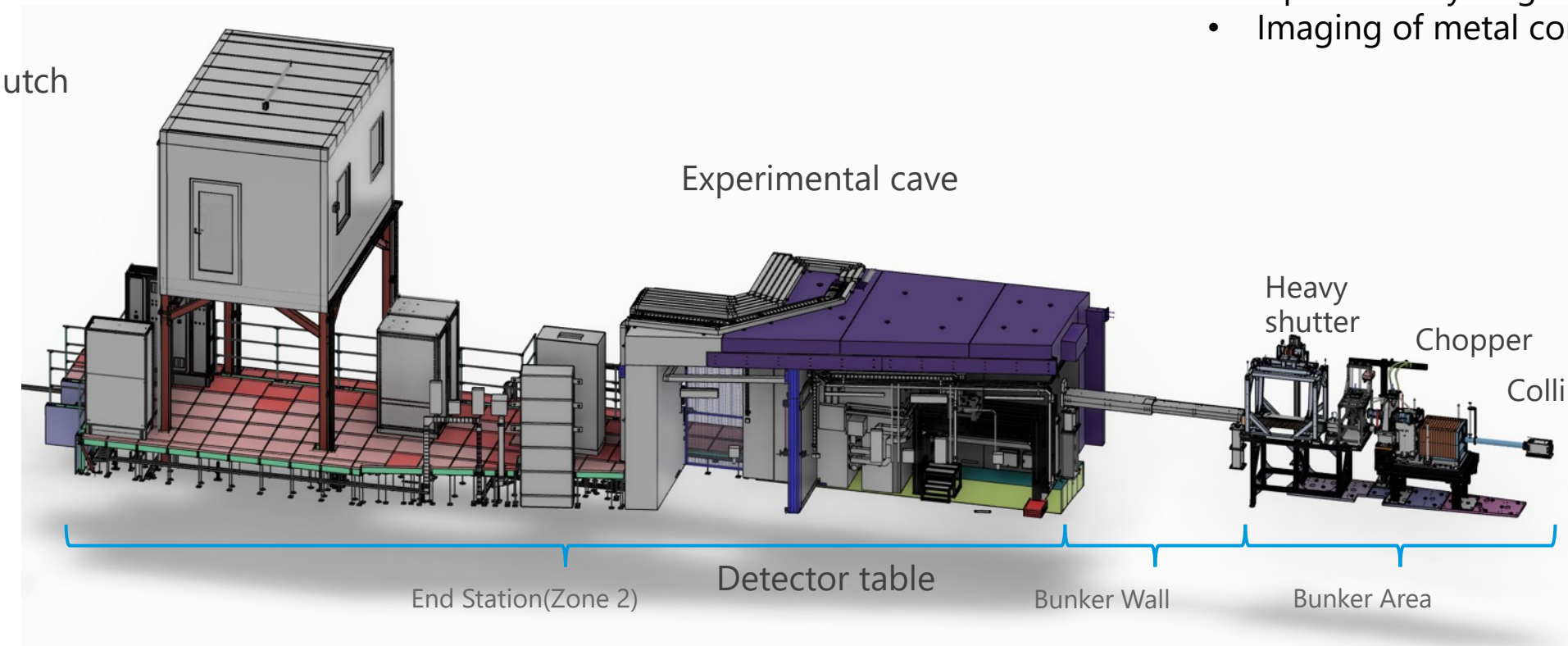
TBL Cold commissioning completed : Q1, 2025

ESS Test Beamline

- Characterization of the ESS moderator system
- Proton beam stability/Moderator stability
- Spatial distribution of neutron beam
- Fast neutron flux measurements
- Pulse-shape of cold-thermal neutrons
- Detectors and data processing systems
- Sample (e.g. single crystal) alignment
- Simple imaging and diffraction experiments

First Science

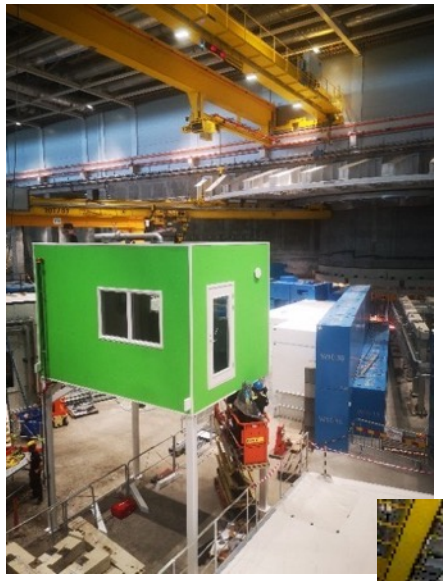
- Low-resolution transmission (e.g. parahydrogen)
- Operando Hydrogen Storage
- Imaging of metal corrosion



Status

- In-bunker supports installed
- CEP infrastructure installed
- False floor is installed
- All racks installed (except for Beam Monitor rack)
- All Sub-TG3s are completed
- Detector table is installed
- Replacement of lead IS is ongoing
- Design of automatic cave door has begun
- Second IS position will be open

Hutch



Cave

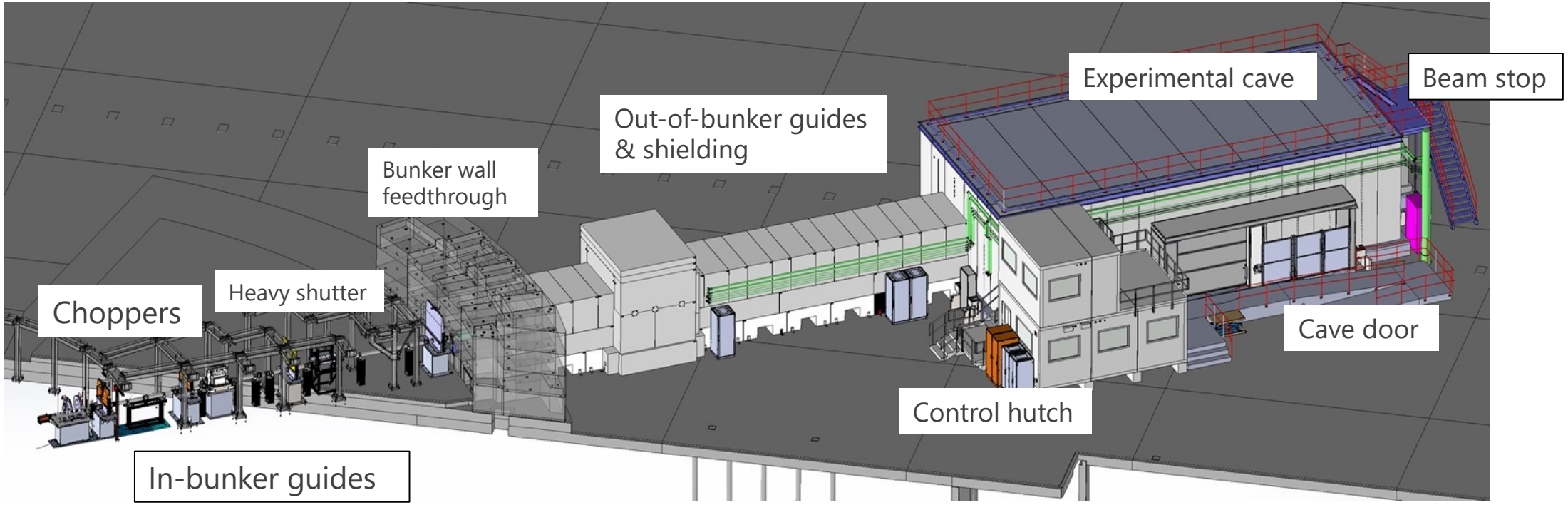
Issues

- Instrument operational engineer (IOE) has resigned/ Hiring ongoing
- Limited resources (since Oct 1 mech. Eng. + 1 IS)
- Late in-house collimation system manufacturing
- All collimators are delayed to Dec. 2024
- Many parallel QG for in-bunker components
- TimePix3 detector integration (same issue for ODIN)

ODIN

Cold commissioning completed : Q2, 2025

Optical and Diffraction Imaging with Neutrons



- Spatial resolutions down to the µm-range
- Engineering materials
- Geo-science
- Paleontology
- Energy materials
- Cultural heritage

- Fuel cells
- Magnetism
- Soft matter and biology
- In-operando studies
- Variety of imaging techniques (full scope)

Status

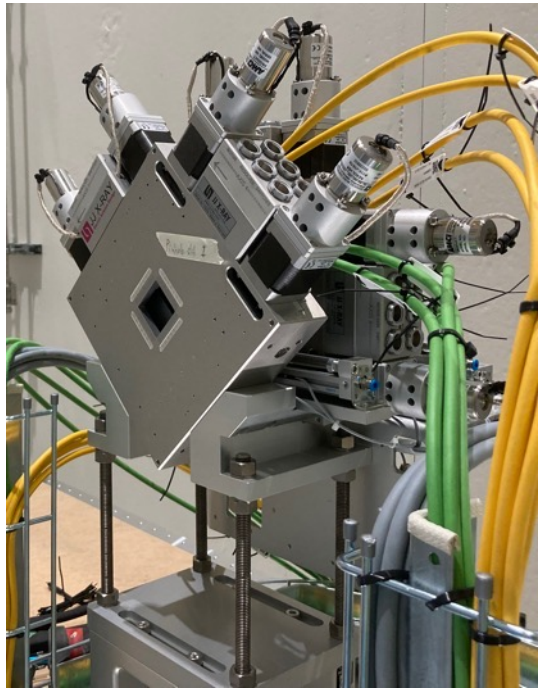
- Internal & external doors installed
- Slits and fast shutter inside the cave installed
- Cave interior & sample stages are being installed
- Re-installation of choppers will be completed in January
- Installation readiness review (IRR) for PSS completed
- IOE is hired (Richard Ammer)
- Lead IS is hired (Robin Woracek)

Issues

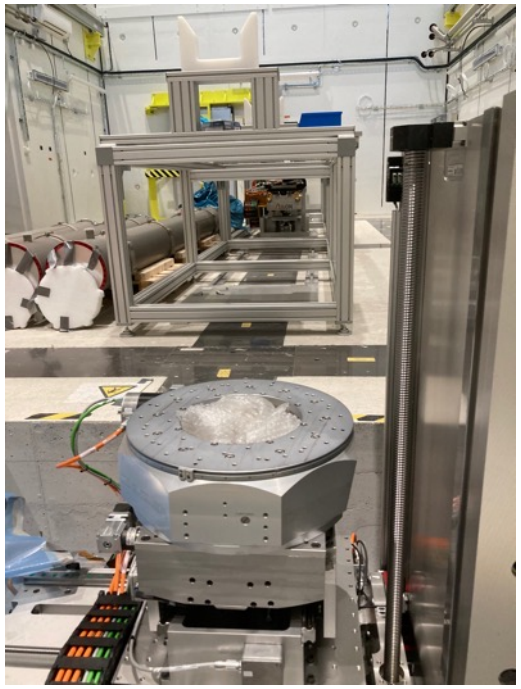
- Neutron guides & chopper system interfaces
- Beam stop misalignment
- TimePix3 detector integration into ESS pipeline
- ODIN data reduction is not yet implemented in scipp
- Lead engineer coming back to BEER this year

Cave and hutch

Slits



Sample stage



DREAM

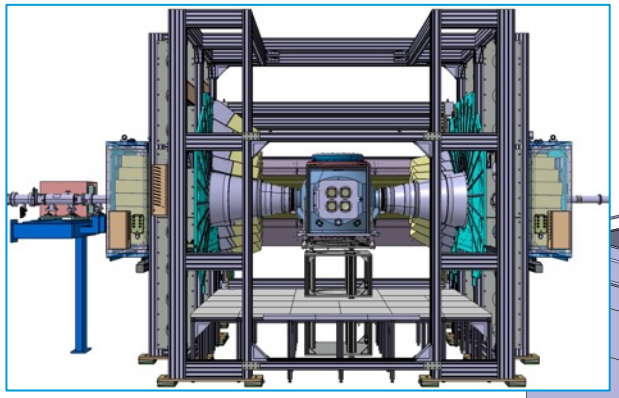
Cold commissioning completed : Q2, 2025

Diffraction Resolved by Energy and Angle Measurements

- Powder diffraction
- Flexible high flux/high resolution
- 2D Rietveld data/PDF/nm-SANS/Polarized
- Superconductors
- Multiferroics
- Weak moments
- Orbital ordering
- Charge ordering
- Energy materials
- Magnetic nanoparticles
- MOFs
- Li, H materials
- In-operando

Sample vessel

Detectors



Experimental caves

Status

- New lead IS (Florence Porcher)
- IOE hiring is ongoing
- Second IS hiring is ongoing
- all choppers are delivered and installed (SAT tests in Nov 2024)
- CUP & CEP installations completed
- PSS & ICS installations ongoing
- Beam monitors tested with neutrons and delivered to ESS

PSS racks

Motion racks

Cave and hutch

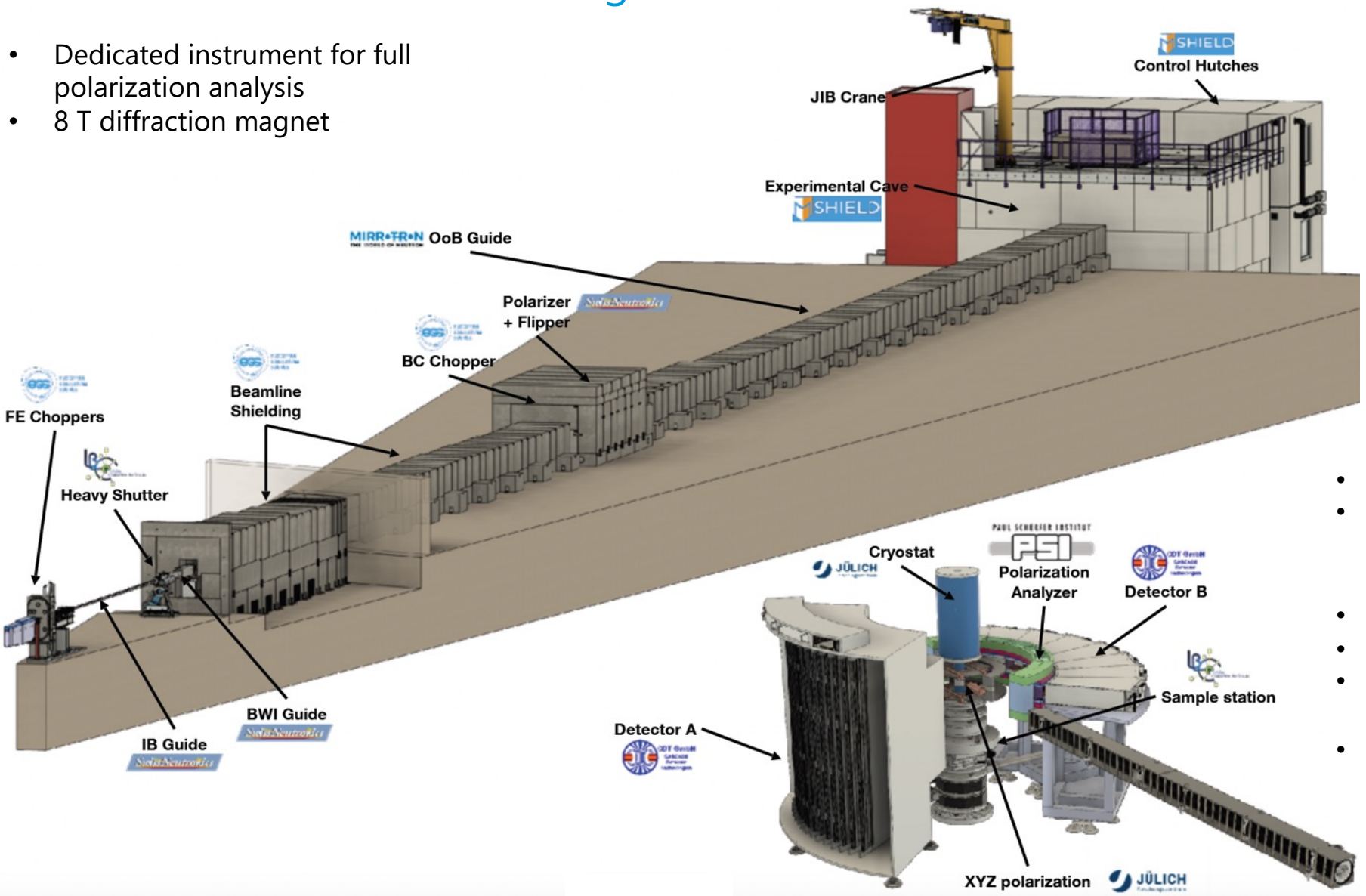
Issues

- Cave energization
- Delay in mantle detector delivery
- Firmware re-installation for installed detectors
- Gas mixing solution for detection gas
- Problems with cryofurnace sample changer procurement

MAGiC Cold commissioning completed : Q4, 2026

Polarised Diffractometer for Magnetism

- Dedicated instrument for full polarization analysis
- 8 T diffraction magnet



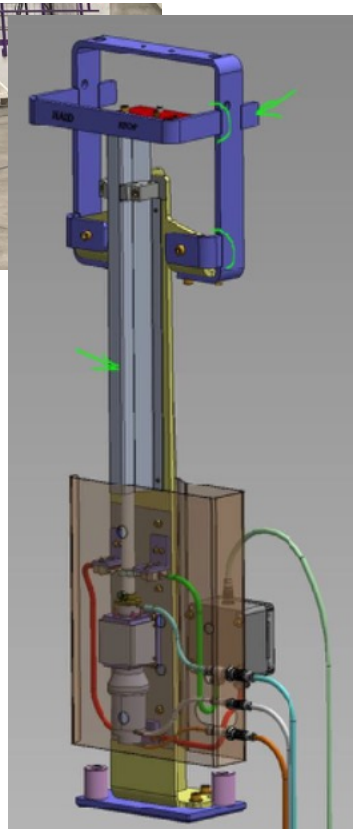
- Local susceptibility and spin densities
- Exotic magnetic structure (long range, non-collinear, anisotropic Hamiltonian)
- Multifunctional materials
- Superconductivity
- Frustrated magnets and quantum spin liquids
- Magnetism in thin films and at interfaces

Status

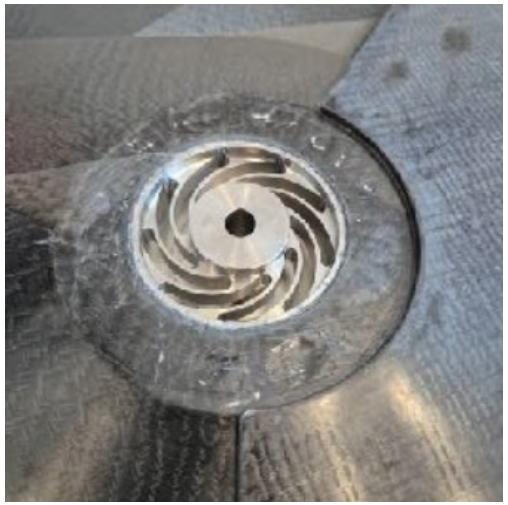
- New engineer started at ESS (Moritz Braun)
- Engineering support (Daniele Erbi)
- New lead IS (Denis Vasiukov, Dec. 1st)
- Cave & hutch installed
- Replanning is completed
- CEP/CUP requirements agreed
- New hub for PSC is manufactured
- monitors are successfully tested at ISIS (for MAGiC & DREAM)

Cave and control hutch

Solid state bender



New PSC hub



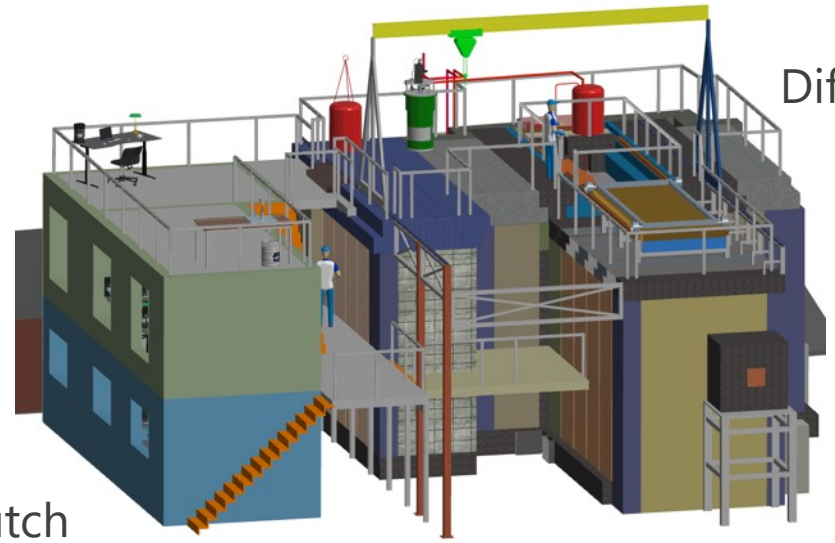
Issues

- Solid state bender delivery delayed to Dec 2024 (long lead time for missing motor)
- Vacuum housing redesign to be agreed with quality at ESS

HEIMDAL

Cold commissioning completed : Q2, 2027

Hybrid Diffractometer: Combined Diffraction and SANS and Imaging

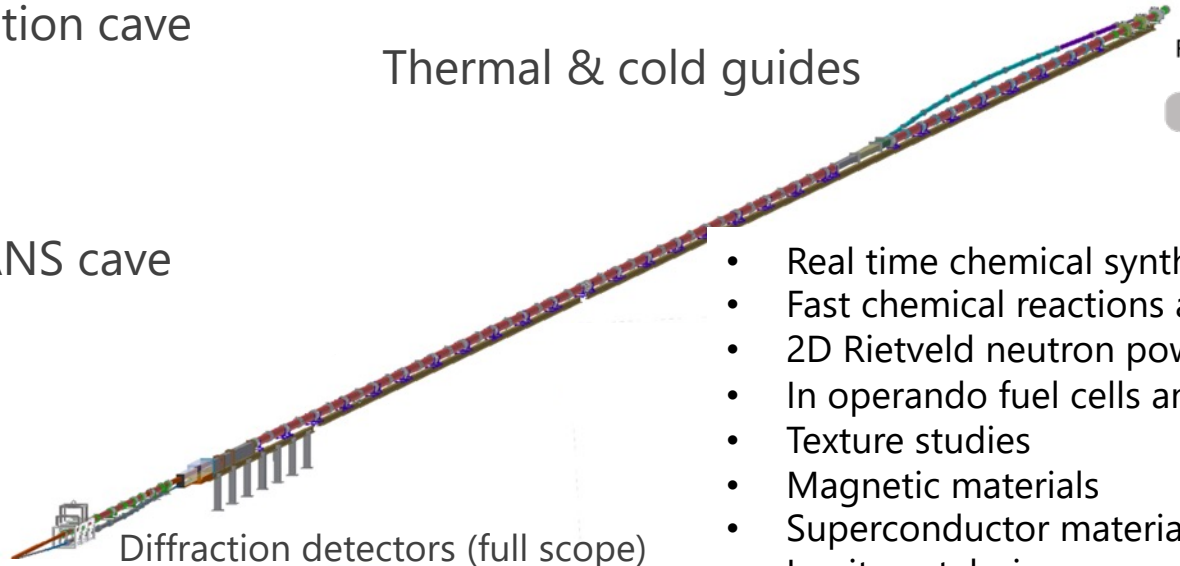


Diffraction cave

SANS cave

Hutch

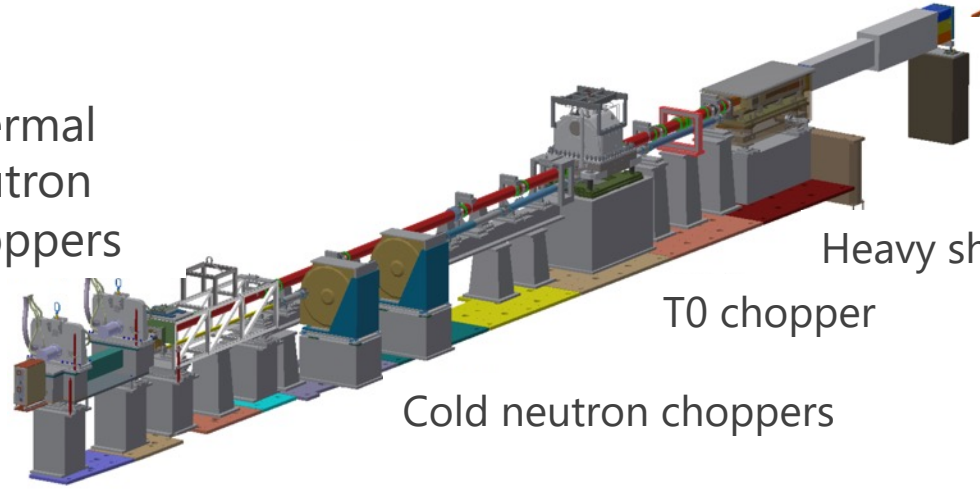
Thermal & cold guides



Diffraction detectors (full scope)

- Real time chemical synthesis
- Fast chemical reactions and kinetics
- 2D Rietveld neutron powder diffraction
- In operando fuel cells and batteries
- Texture studies
- Magnetic materials
- Superconductor materials
- In-situ catalysis
- Single crystal diffraction of small samples
- Nanoparticles and core-shell structures

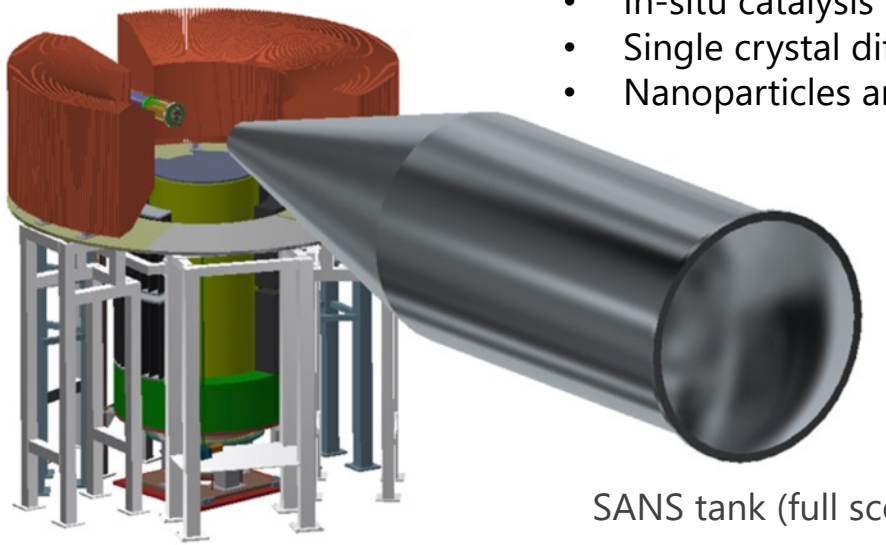
Thermal neutron choppers



Heavy shutter

T0 chopper

Cold neutron choppers



SANS tank (full scope)

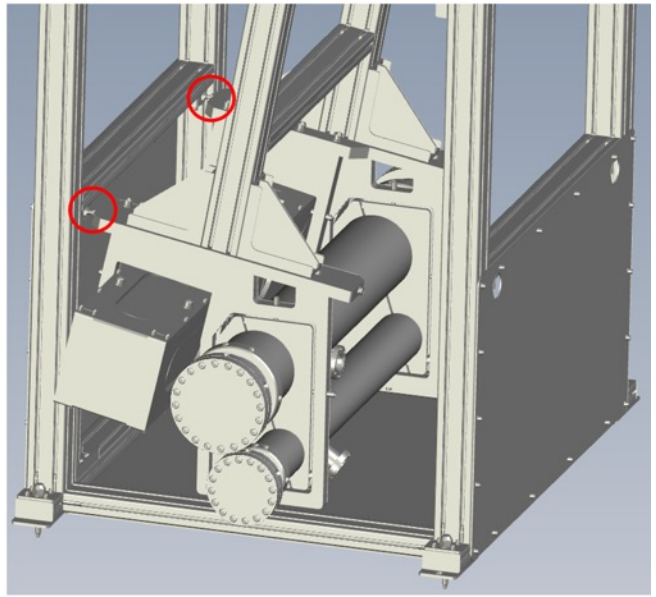
Status

- New lead engineer at ESS (Siamak Kianzad)
- Technical writer to be provided by a partner
- Cave procurement is ongoing
- Detector procurement completed
- IDR of heavy shutter completed
- Replanning completed
- New design of the cold guide accepted
- BWFI installed

Issues

- Still limited engineering resources
- Delay in SubTG3 of the detectors
- Interfaces for final detector design have to be provided by partners and ESS
- No offers yet from CUP, CEP, MCA, BM

Heavy shutter

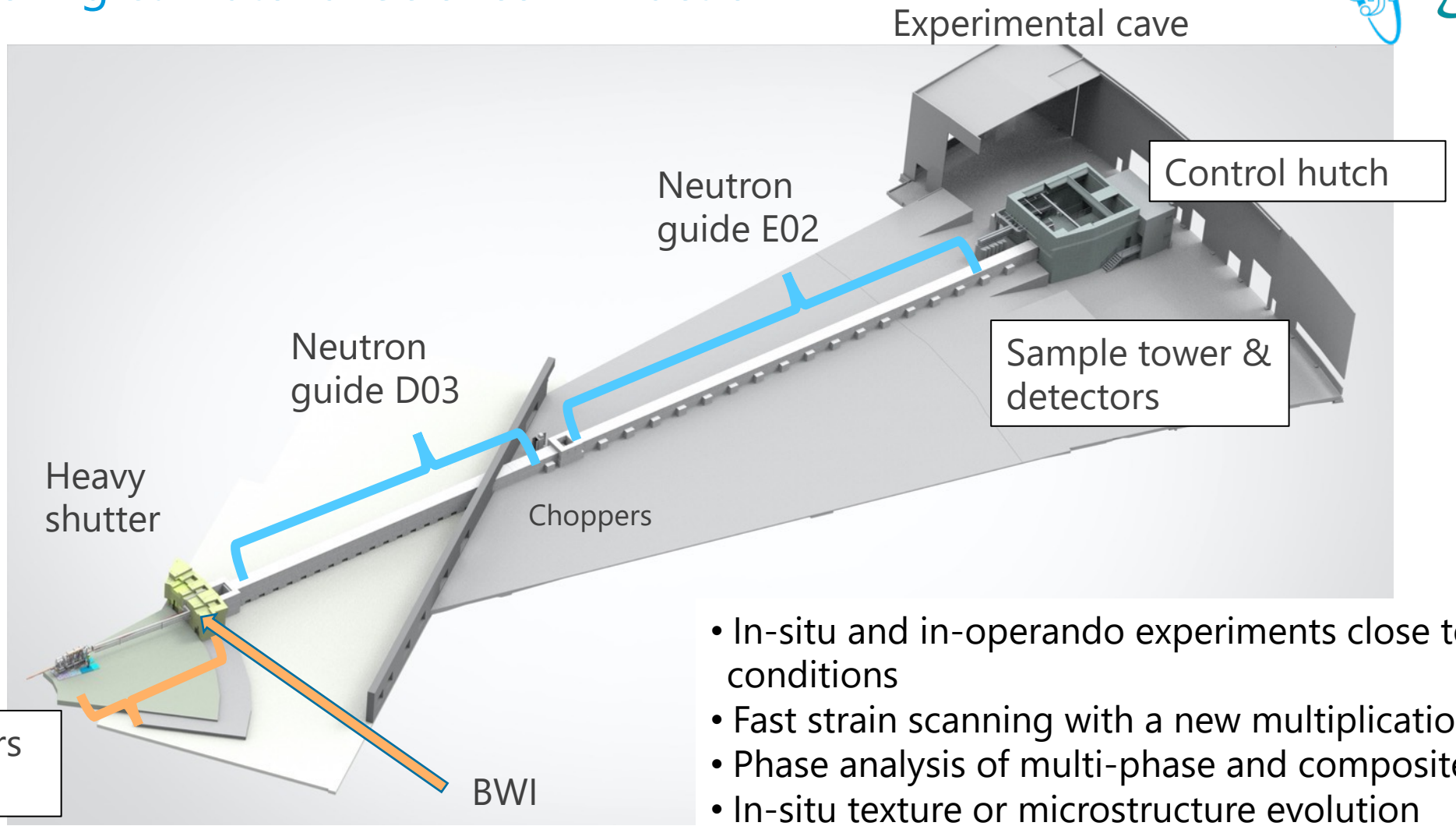


Bunker wall feedthrough insert is installed

BEER

Cold commissioning completed : Q4, 2026

Engineering & Material Science Diffraction

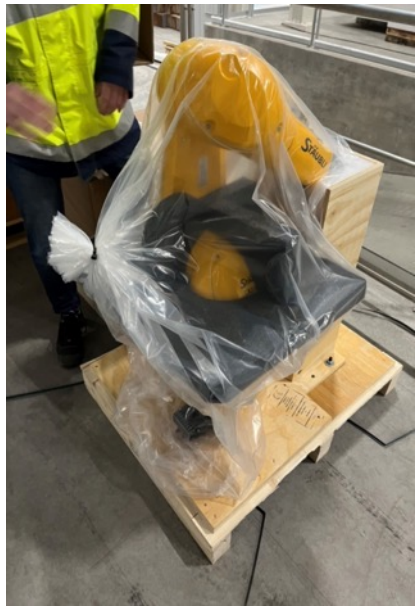


- In-situ and in-operando experiments close to the real conditions
- Fast strain scanning with a new multiplication technique
- Phase analysis of multi-phase and composite materials
- In-situ texture or microstructure evolution
- Multi-scale characterisation
- Long term experiments

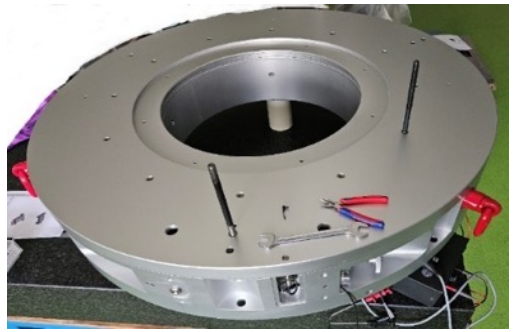
Status

- Hiring of the second scientist
- SubTG3 for Robot/Hexapod/Stage completed
- Hexapod & Rotary Stage delivered to ESS
- 6-axis Robot Arm and BBG delivered to ESS
- Replanning completed
- BWI & Choppers in manufacturing
- Bi-spectral switch neutron tests completed
- Cave IDR completed
- CEP requirements are being finalized

Robot



Rotary stage



Issues

- Temporary loss of the lead engineer
- Risk of delaying in-bunker installation due to limited resources
- Current PSS design interferes with user operation
- Not enough information from CUP
- Design of chopper section guides delayed due to lack of resources at supplier

Bridge beam guide (BBG)

Hexapod

Other updates

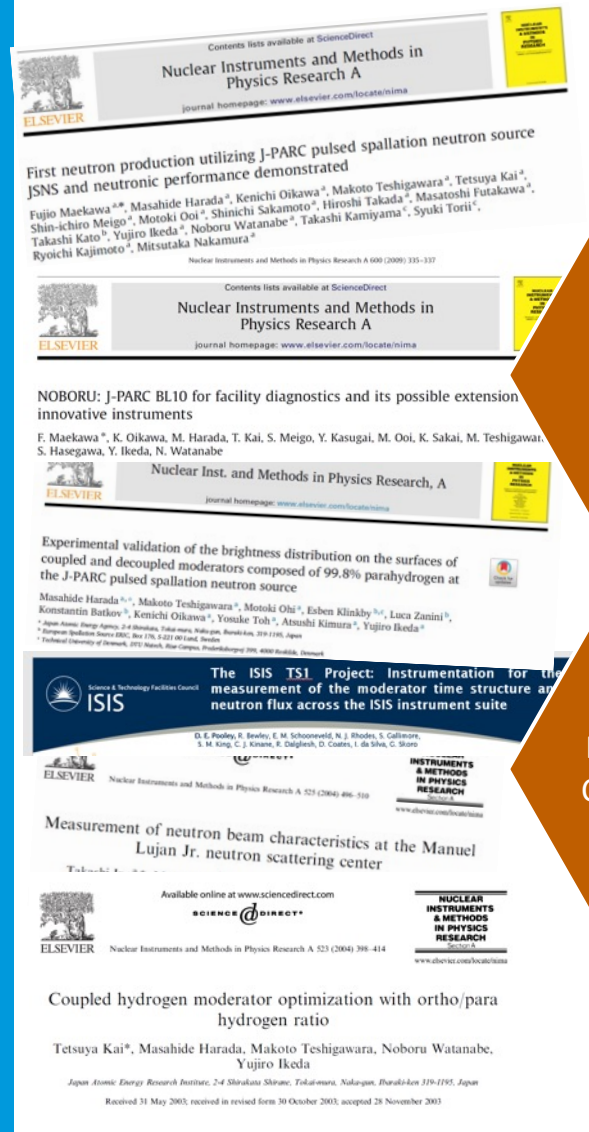
- Less hiring to be done next year, more time to engage with instruments
- DREAM and TBL teams are not yet fully staffed for TG5
- Three instruments to be completed next year: practical and day-to-day challenges
- Good experience in developing the first science paper with STAP (detailed science cases, planning of samples synthesis, preliminarily studies)
- Re-planning exercises provided more realistic end -of- completion dates
- Two division-relevant conferences in Lund (NEUWAVE-12, IUCr high pressure workshop)
- Regular meetings with NSS, DetG and SSD heads to address short - term challenges
- External funding proposals : more careful selection with SSD and DMSC

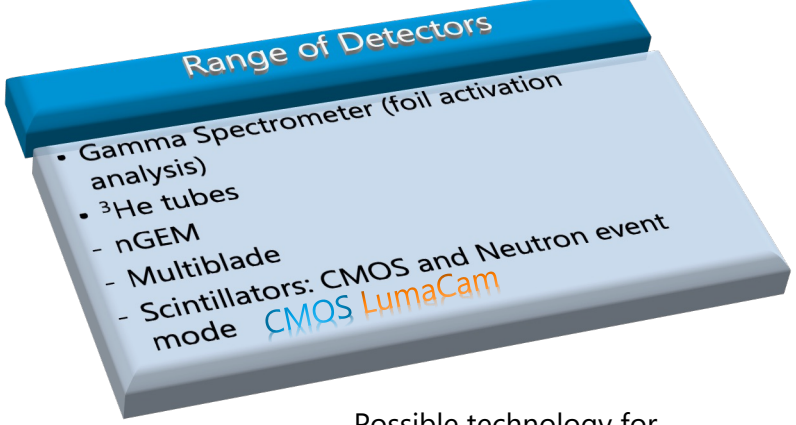
First Science ideas for DREAM, ODIN and TBL

Test Beamline

First Science

Slide by Thawatchart Chulapakorn & Robin Woracek





Encourage **innovative instruments and ideas** into ESS

Moderator Performance

Neutron Source Characterization

Single-Crystal Alignment

Science Support

Science

Detector Development + Testing

Camera based event mode technology

Possible technology for detectors at new ESS instruments

Inelastic Scattering Contrast

Extinction Contrast

Novel Contrast Mechanisms

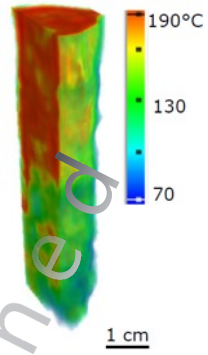
Neutron Cross Section simulationsS **NCrystal**

Imaging & Diffraction (low wavelength resolution)

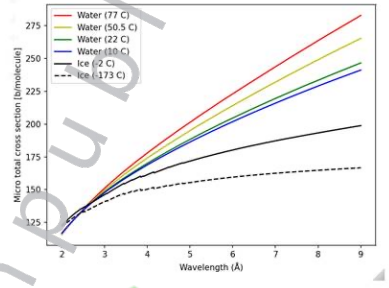
Total Cross Section measurem.

White Beam Imaging

Example:
Neutron Thermography
2D+3D Temperaure mapping in metals (e.g. during welding)



Water at different temperaures (e.g. fuel cells, soil, concrete, ...)



Example:
Cross sections of liquids

Example:
Plastic deformation in metals

Example:
Hydrogen storage (e.g. metal hydrides)

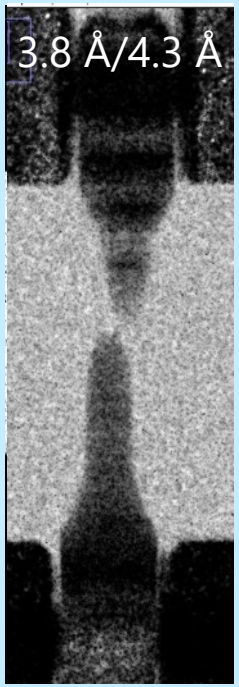
ODIN

First Science

Slide Robin Woracek

In-situ tensile testing of AM materials:

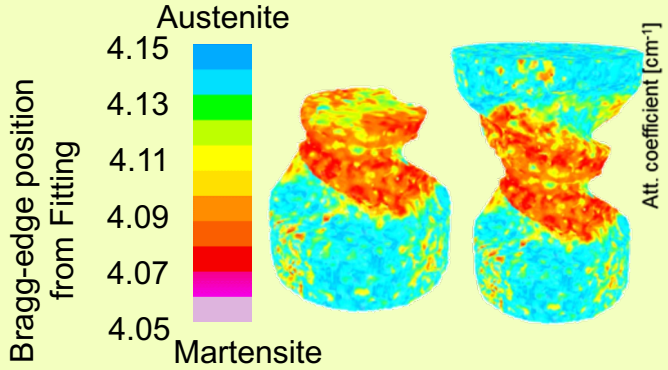
Texture, Strain, Phase

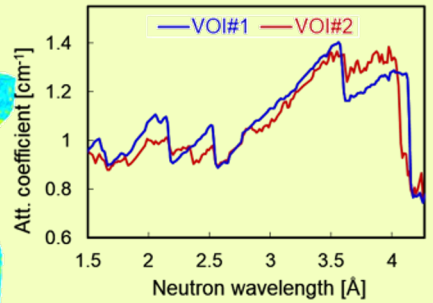


LumaCam

Spectral Tomography

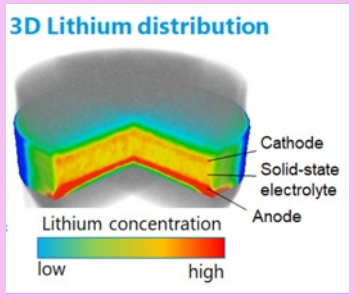
e.g. 3D Phase Mapping in Metals





LumaCam

Li transport in solid state batteries

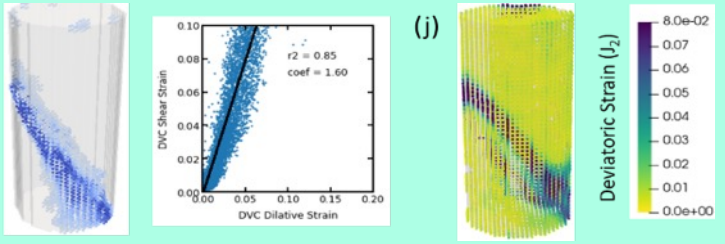


X+N
LumaCam
CMOS

Cultural Heritage

LumaCam
X+N
CMOS

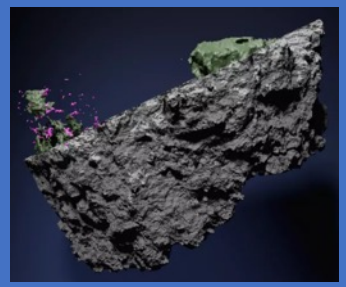
Mechanics and flow through granular media



X+N
CMOS

Planetary Sciences

Science Advances



X+N
LumaCam
CMOS

DREAM

First Science

- Pulse-shaping (flux vs ΔQ resolution)
- The highest resolution in backscattering
- Pair-distribution function with Q_{max} = 25A^{-1}
- nm-SANS down to 0.01A^{-1} + cold neutron polarization

Transition metal monoxides
Zeolites and MOFs
Electrode materials in pristine state
Perovskites and complex oxides
Small samples with cation disorder
Hydrogen-containing samples
Energy materials

Mix of new science and "classic diffraction" materials

EUROPEAN SPALLATION SOURCE

Document Type	Document
Document Number	ESS-0456238
Date	Oct 1, 2024
Revision	1
State	Preliminary
Confidentiality Level	Internal
Page	1 (5)

DREAM INSTRUMENT FIRST SCIENCE

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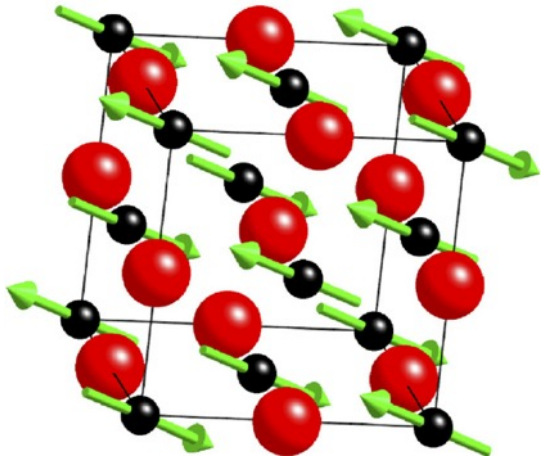
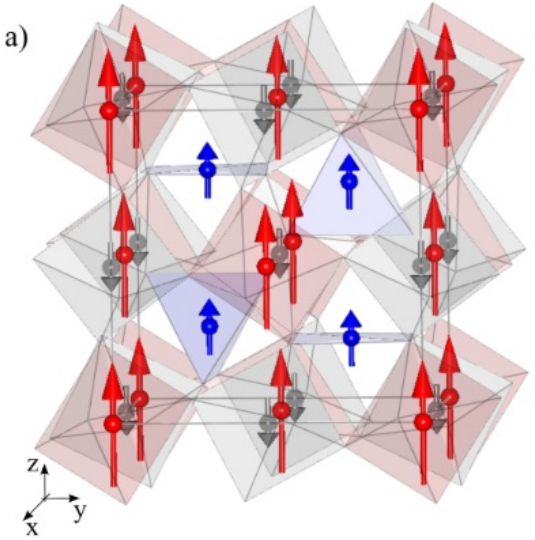
Transition metal oxides NiO



E. Ressouche et al., Physica B: (2006).

Double-double perovskites $CaCuFeReO_6$



E. Solana-Madruga et al. Angew. Chem., 61 9497 (2022)

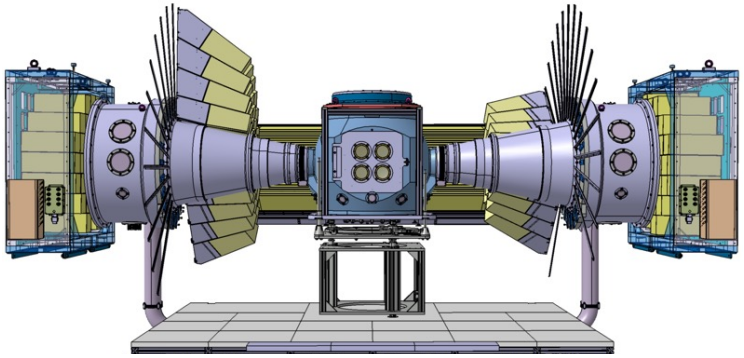
Rescoping priorities

1. Complete detector coverage for diffraction suite

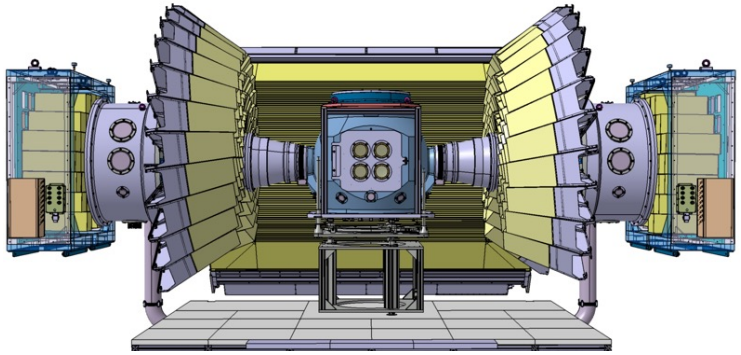
DREAM

Current scope (41 %)

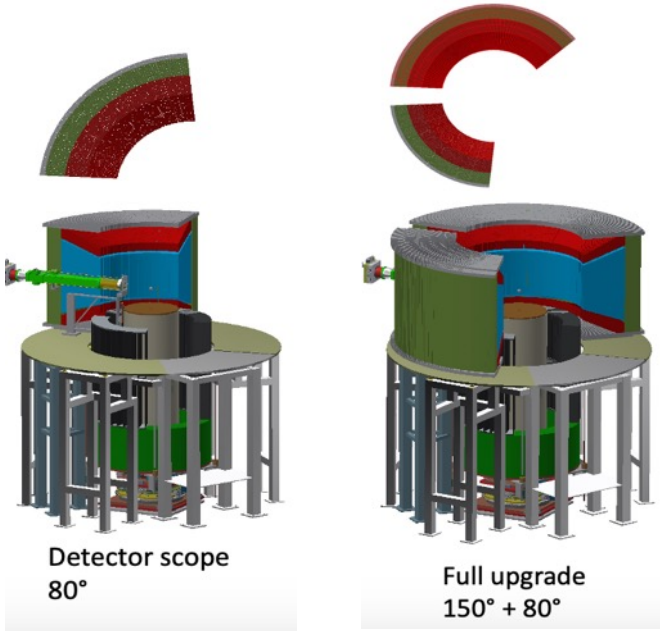
neutrons



Full scope (100 %)



HEIMDAL

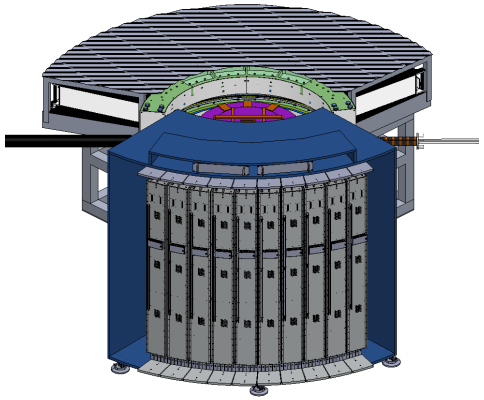


Detector scope
80°

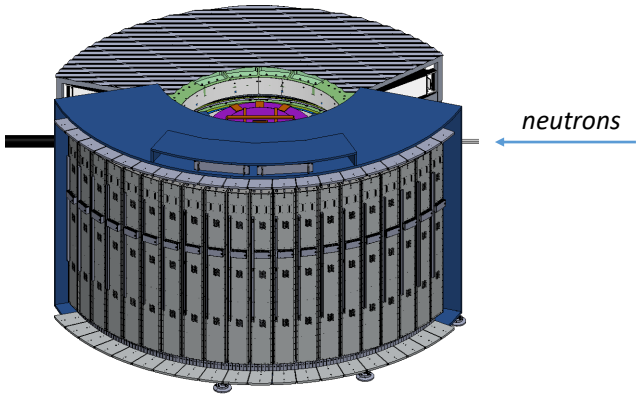
Full upgrade
150° + 80°

MAGiC

Current scope (50%)



Full scope (100%)

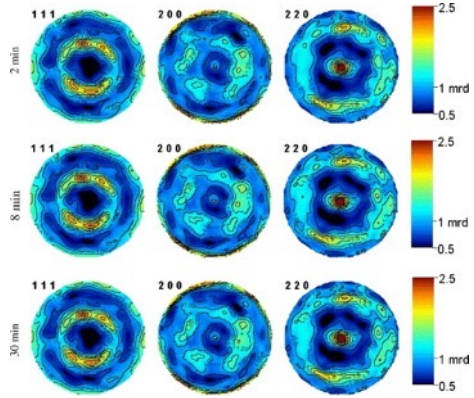


neutrons

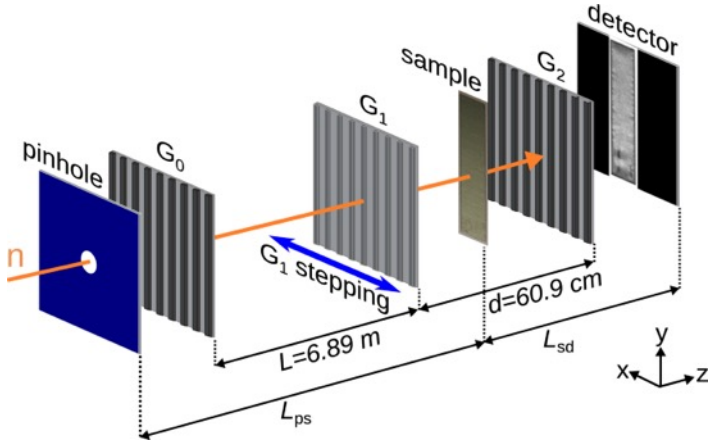
- To be competitive on day 1
- Low risk: same company, same technology

2. Recovering capabilities in engineering diffraction and imaging

BEER texture detectors & choppers

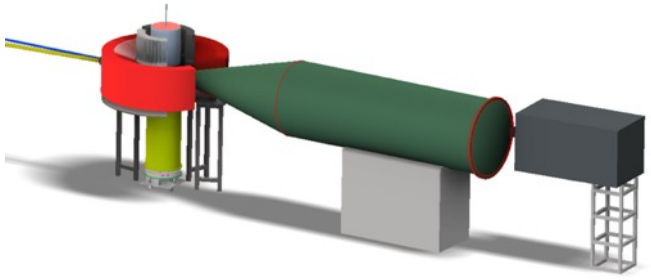


ODIN grating interferometer

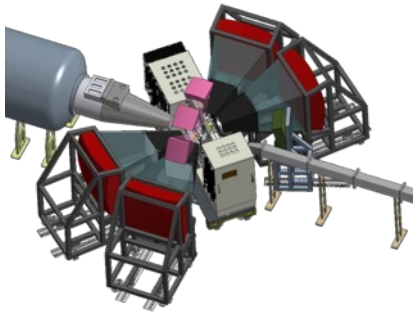


3. Recovering SANS options for HEIMDAL, BEER and ODIN

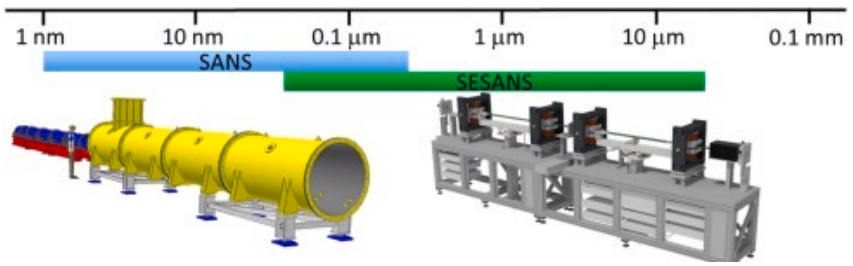
HEIMDAL



BEER



ODIN (SESANS)



4. Remaining scope: MAGiC spectroscopy choppers, BEER SEE handling, ODIN diffraction detectors, HEIMDAL imaging option