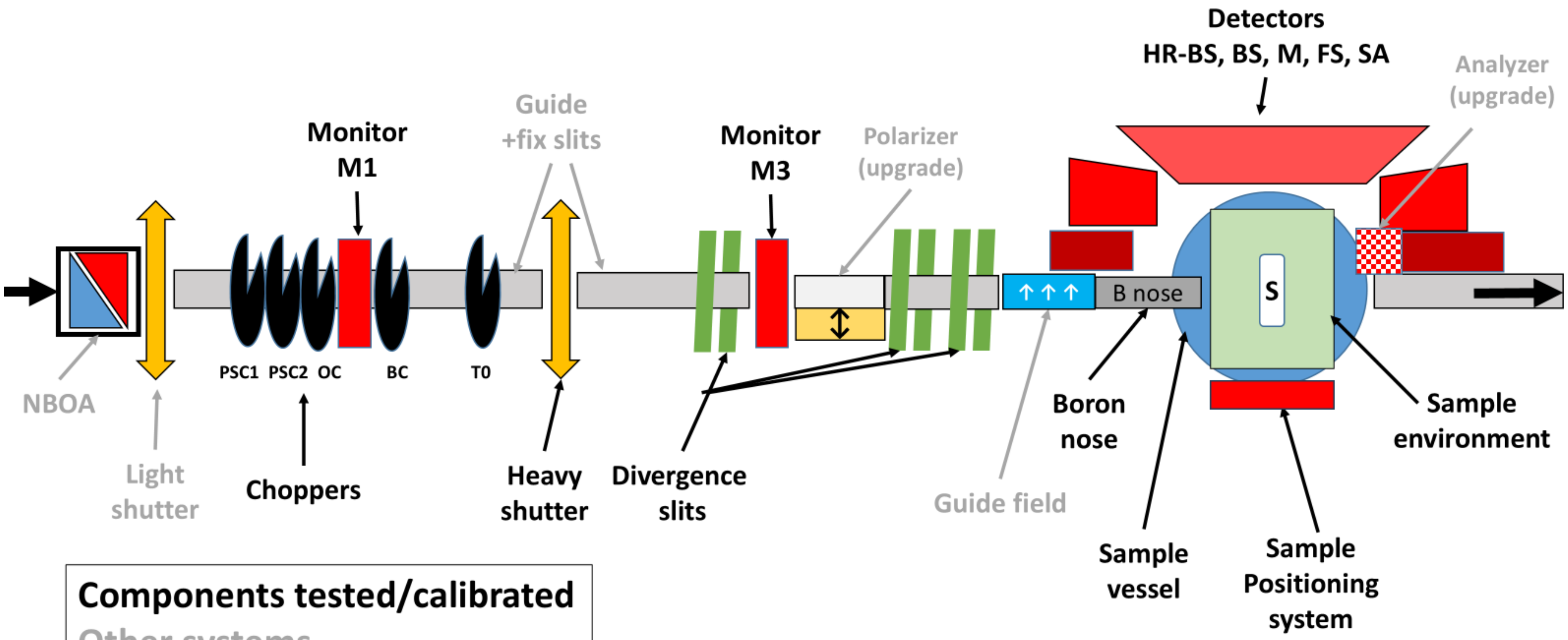
Instrument System Acceptance Review

DREAM: Hot Commissioning Plan

DREAM Team

DREAM overview



Components tested/calibrated
Other systems

Before Hot Commissioning:

- Fixing issues detected during SATs, iSATs
- Continue tests (robustness/repeatability)
- Improve tools for control, data reduction

DREAM - SYSTEM VERIFICATION AND VALIDATION PLAN

	Name	Role/Title
Owner	Anna Fornell	DREAM Instrument Operation Engineer
Authors	Paulo H.B. Brant Carvalho Florence Porcher	DREAM Commissioning Scientist DREAM Lead Scientist
Reviewer	Werner Schweika Celine Durniak Per Roos Helen Boyer Hanna Wacklin-Knecht Torben Roland Nielsen Vincent Hardion Irina Stefanescu	Instrument Scientist Instrument Data Scientist Radiation Protection Group Leader Occupational Health and Safety Group Leader Head Scientific Support Division DRAM Group Leader (DMSC) Experiment Control and Data Curation Group Leader Detector Scientist (representing Detector Group)
Approver	Mikhail Feygenson	Head of Diffraction and Imaging Division

FBS Tag	Description	SAT Report(s)	Integrated Test Report(s)
ESS.NSS.H01.DREAM	DREAM		
ESS.NSS.H01.DREAM.F01	Personnel Safety System (DREAM PSS)	Safety System	
ESS.NSS.H01.DREAM.A01	Beam Transport and Conditioning	Included in sub-nodes below	
ESS.NSS.H01.DREAM.A01.B01	Beam Validation	Included in sub-nodes below	
ESS.NSS.H01.DREAM.A01.B01.B01	Beam Monitor System M1 in Bunker Zone	ESS-5509304	ESS-6018288
ESS.NSS.H01.DREAM.A01.B01.B03	Beam Monitor System M3 in Instrument Zone	ESS-5509300	ESS-6018288
ESS.NSS.H01.DREAM.A01.R01	Chopper System	Included sub-nodes below	
ESS.NSS.H01.DREAM.A01.R01.R01	DREAM PSC1-PSC2-OC BC Choppers assembly	ESS-4969447 ESS-5584698	ESS-5975057
ESS.NSS.H01.DREAM.A01.R01.R02	DREAM T0 Chopper Mechanical assembly	ESS-5584698	ESS-5975057
ESS.NSS.H01.DREAM.A01.R02	Beam Geometry Conditioning	Included sub-nodes below	
ESS.NSS.H01.DREAM.A01.R02.R01	Collimation System	ESS-5030564 ESS-5642838	ESS-6013997
ESS.NSS.H01.DREAM.A02	Sample Exposure System	Included in sub-nodes below	
ESS.NSS.H01.DREAM.A02.W01	Sample Positioning	N/A	ESS-5840870
ESS.NSS.H01.DREAM.A02.AS01	Sample Conditioning	Outside of TG5 scope	
ESS.NSS.H01.DREAM.B01	Scattering Characterization System	Included in sub-nodes below	
ESS.NSS.H01.DREAM.B01.B01	Neutron Detector System	ESS-5167269 ESS-5830014 ESS-5830016 ESS-5167269	ESS-6017703
ESS.NSS.H01.DREAM.K02.K01	Experiment Control		
ESS.NSS.H01.DREAM.K01	Instrument Automation Control System	Included in sub-nodes below	
ESS.NSS.H01.DREAM.K01.K02	DREAM MCA2 (Collimation + Polarizer stage)	ESS-5477392 ESS-5642838	

Overview of tasks

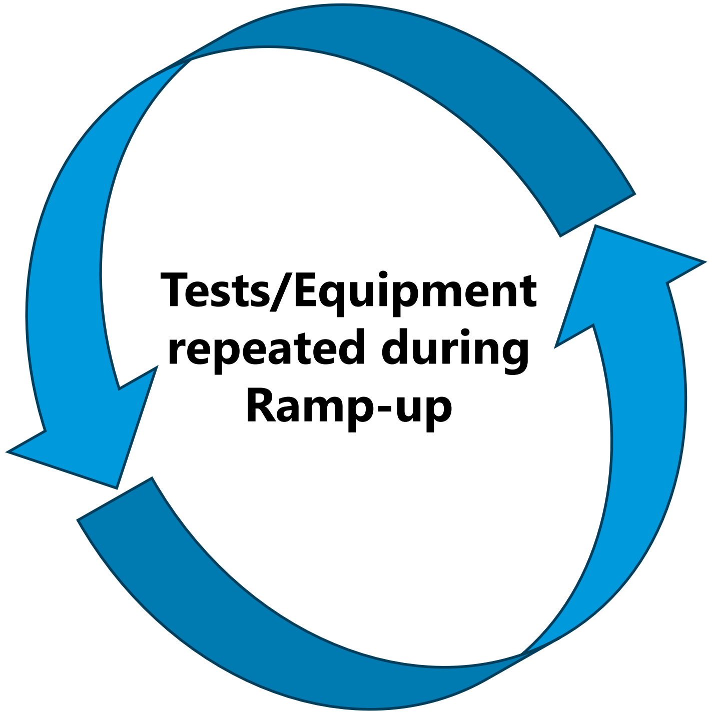
Fulfil radiation protection requirements
Validation of subsystems

- Beam monitors
- Slits system and Boron nose
- Sample position and primary flight path
- Choppers
- Detectors

Integrated test of the instrument

- Secondary flight path – Detector distortion map
- Instrument performance for various standard configurations
- Calibration of the instrument

Tests using standard sample environments



High Level Scientific Requirements

DREAM Concept of Operations" (ESS-0135206)

Concept of Operations (ESS-0135206)

- **Data collection up to Qmax=25Å^{-1}.**
- **Data collection down to Qmin=0.2Å^{-1} (with nanoSANS, Qmin=0.01 Å^{-1}).**
- **Flexible choice between high resolution and high intensity, resolution from ~10^{-2} ms to ~ms.**
- **Best resolution Δd = 0.00035Å near backscattering**

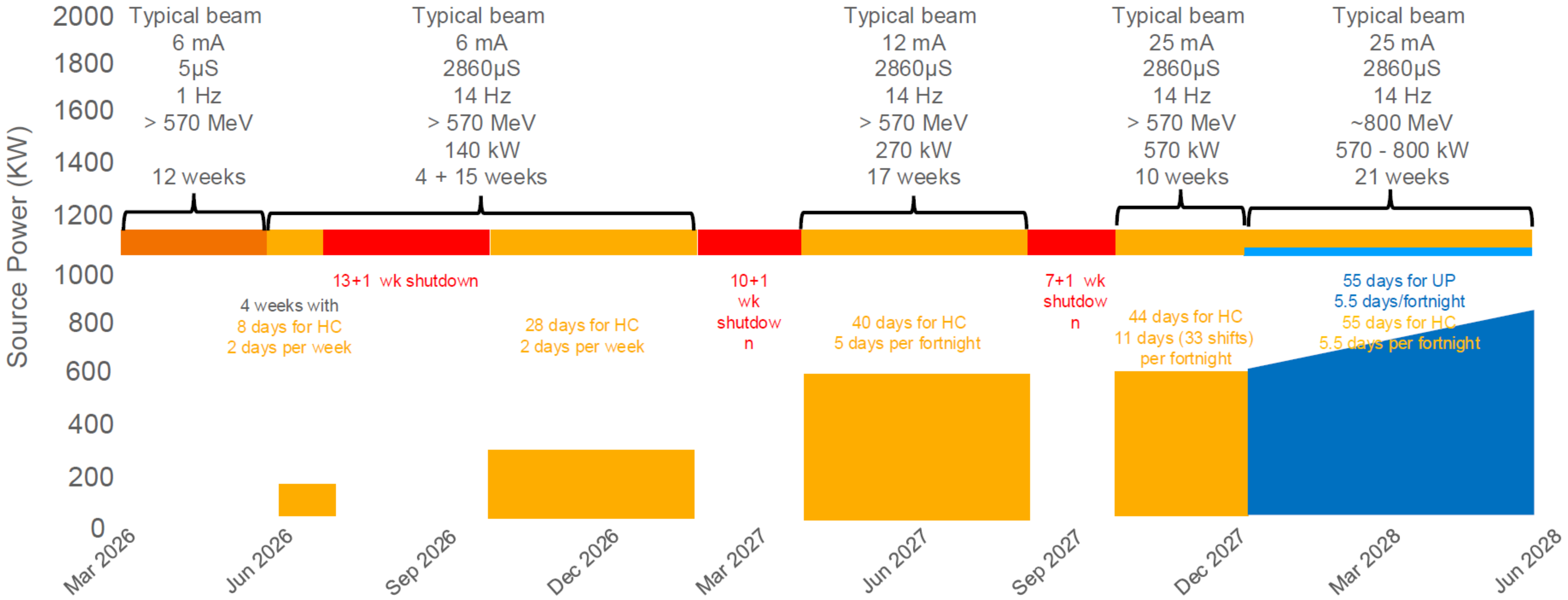
ESS Ramp Up

Assuming BOT Feb 2026

Indicative schedule to be updated

- Accelerator commissioning & TBL
- Hot commissioning
- Shutdown
- Users

First users

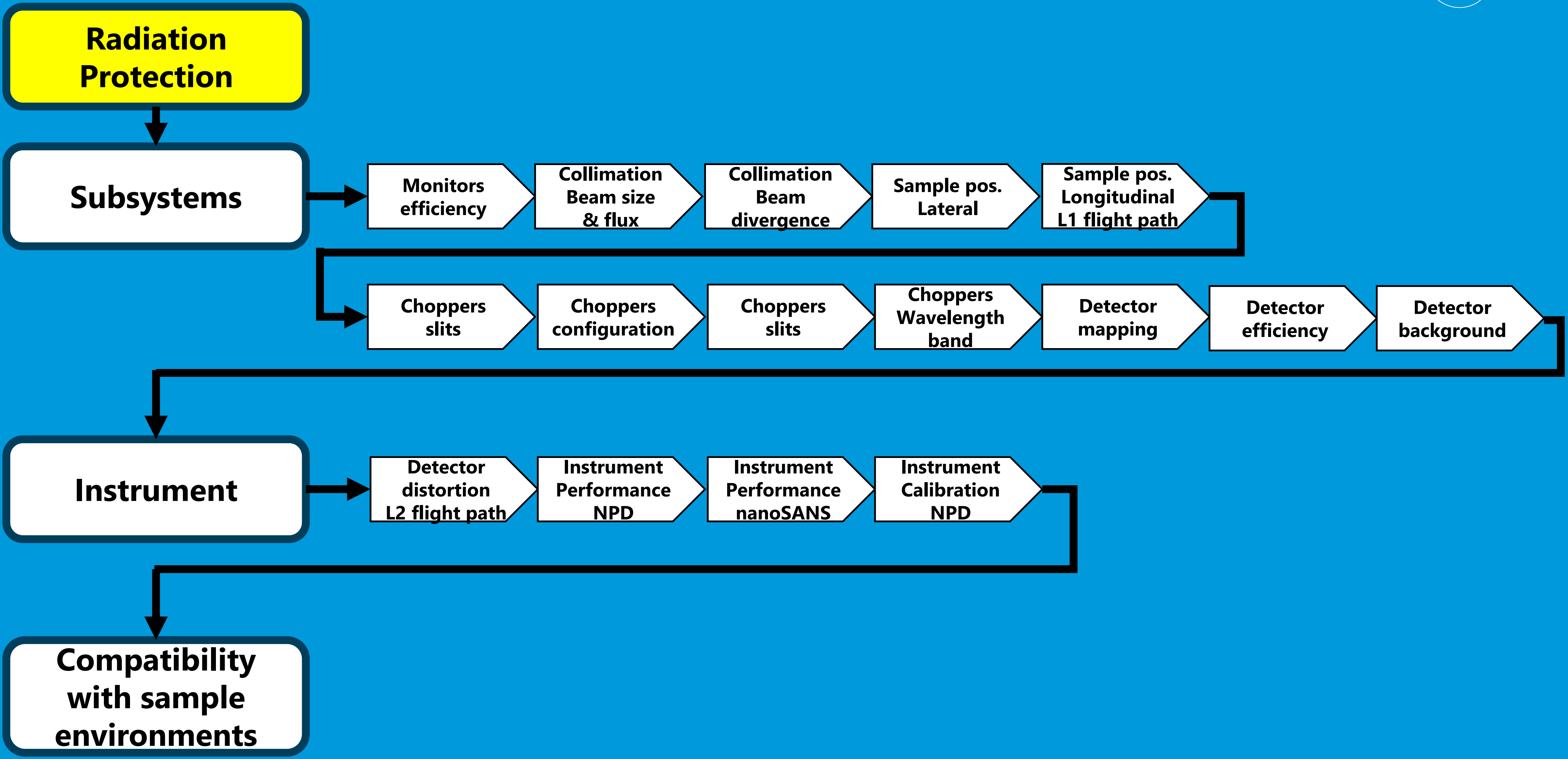


$$\frac{570\text{ kW at }570\text{ MeV}}{2000\text{ kW at }870\text{ MeV}} \rightarrow 10\ \%\text{ flux}$$

$$\frac{800\text{ kW at }870\text{ MeV}}{2000\text{ kW at }870\text{ MeV}} \rightarrow 40\ \%\text{ flux}$$

See ESS-0420218 "Early operations of ESS and prerequisites for first scientific results" for more details

Hot commissioning - overview



Validation of Radiation Protection requirements

Demonstrate the performance of the shielding to the Licensing Authority

Procedure

Light Shutter closed & Heavy shutter closed ➔ Check radiation level at various points of the instrument.

Light Shutter open & Heavy shutter closed ➔ Check radiation level in various points of the instrument wrt
- Proton current/energy
- ESS-6017800 Dream shielding verification Report
- ESS-0454189 DREAM - Radiation Safety Report
- ESS-5974655 Comprehensive Radiation Safety Report
- ESS-5146219 Generic ESS Instrument Commissioning Plan

Light Shutter open & Heavy Shutter open ➔ Check the radiation level of the instrument shielding (spec. around beam stop area + door of the cave)

Light Shutter open & Heavy Shutter open ➔ Verify cave shielding according to ESS-3486225 H1/H2 document

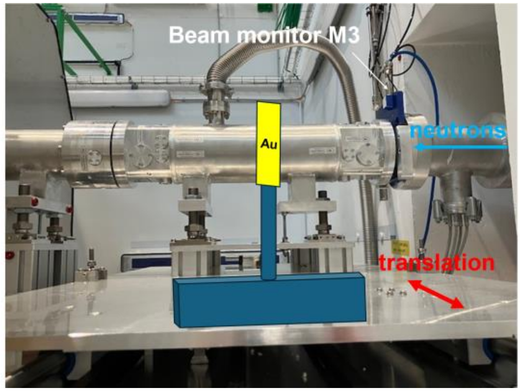
Checkpoint

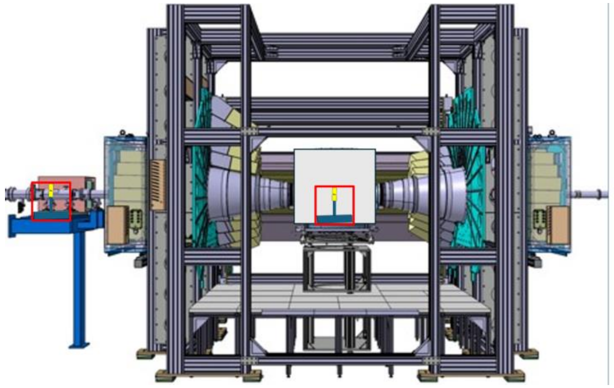
Measured dose outside any points of Bunker, Guide shielding and Cave is <3 μSv/h,
Cave roof is <25 μSv/h

Key personnel:	*RP, PSS, Instrument team.*
Requirements:	*Successful Cold Commissioning* *Neutron source stable enough*

Validation of subsystems: Beam monitors

Test 1: Verify functioning of monitors and quality of neutron transport





Procedure

Heavy shutter Open, Choppers parked open, Slits OPEN

- In-bunker Monitor M1:
  - Time structure and intensity of neutron pulse versus simulations.
- In-cave Monitor M3:
  - Time structure and intensity of neutron pulse versus simulations
  - Compare integrated flux on M3 with gold foil at polarizer position
  - Compare integrated flux on M3 with gold foil at sample position
  - ➔ Build up database for long term verification of instrument performance

Key personnel:	*DetG, ECDC, Instrument team.*
Requirements:	*Monitors Cold Commissioned – Gas System - Sample stage* *Gold-foil and gamma spectrometer* *Neutron source stable enough*

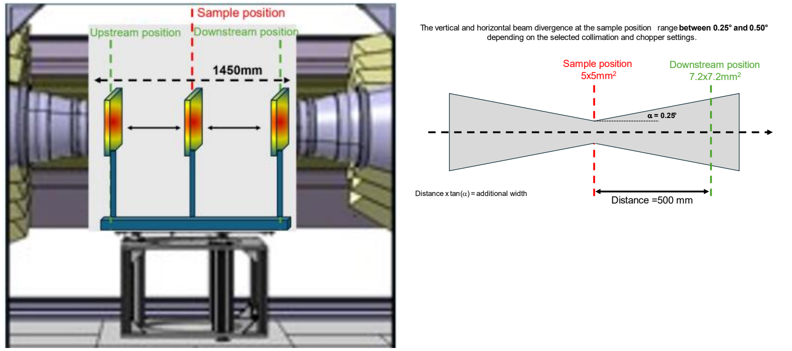
Validation of subsystems: Slits system and Boron nose

Test 4: Beam size and flux at sample position as a function of slits aperture

Procedure

Chopper parked Open, all slits OPEN / Chopper parked Open, all slits CLOSED
(or Medium resolution chopper setting, after Chopper calibration)
Boron nose installed or not

- 2D detector at the sample position
  - Measure beam size and compare with McStas simulations.
  - Estimate relative neutron flux by integration over the beam profile

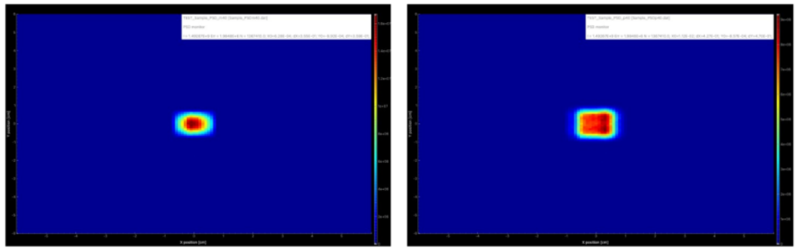


Position of 2D detector for measuring beam profile and divergence

Test 5: Beam divergence

Chopper parked Open, all slits OPEN / Chopper parked Open, all slits CLOSED
(or Medium resolution chopper setting, after Chopper calibration)

- 2D detector upstream/downstream sample position
  - Measure beam size and compare with McStas simulations.



Beam size at sample position, and 40cm downstream

Key personnel: *DetG, ECDC, Instrument team.*

Requirements: *Slits Cold Commissioned – Fe powder– Translation stage*
Portable compact detector with resolution <0.5x0.5mm + good efficiency
Neutron flux good enough

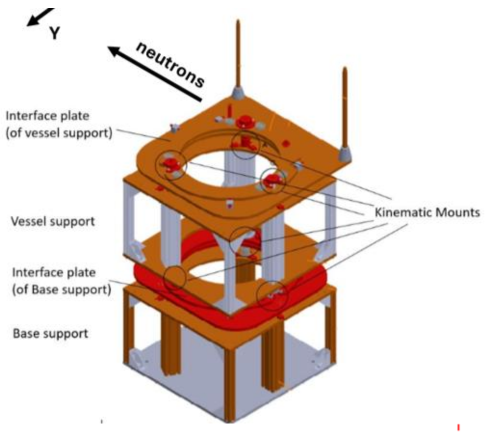
Validation of subsystems: Sample position and primary flight path

Test 6: Lateral position Y

Procedure

Chopper parked Open / Medium resolution chopper setting
Slits S1, S2 and S3 OPEN
Fe powder at sample position

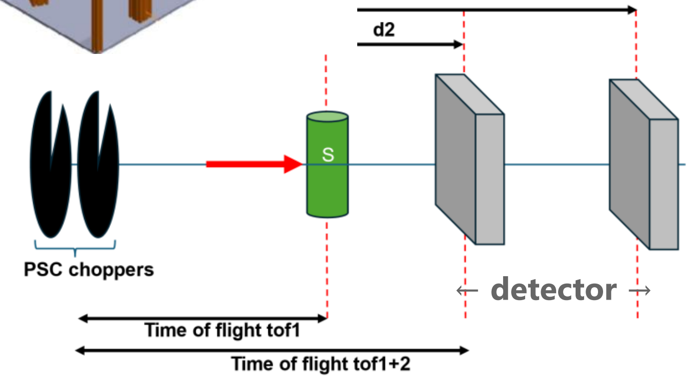
- 2D detector downstream sample position
  Adjust screws of sample table until the sample shadow is centered in the beam

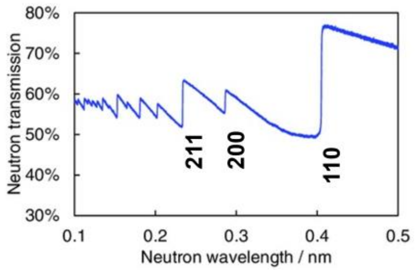


Test 7: Longitudinal position X – Primary flight path

Chopper parked Open / Medium resolution chopper setting
Bragg-Edge standard (Fe) at sample position

- TOF detector downstream sample position at distance d2 then d2'
  Calculate primary flight path from the change of Bragg edges between d2 and d2' positions

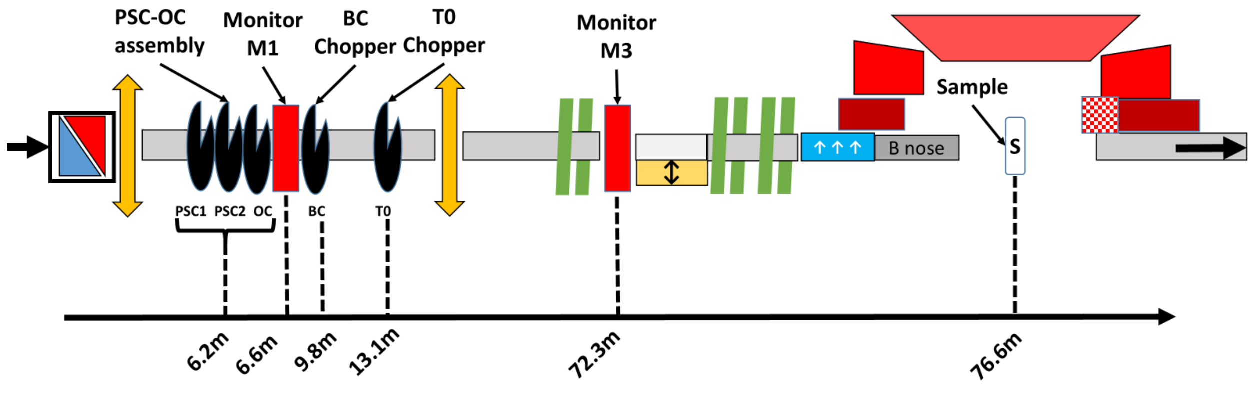




Key personnel:	*DetG, ECDC, Instrument team.*
Requirements:	*Reference sample for Bragg edge/line position (Fe) – Translation stage*
	Detector with TOF capability + good efficiency
	Neutron flux good enough

Validation of subsystems: Choppers

Test 8: Validation of slits/aperture positions



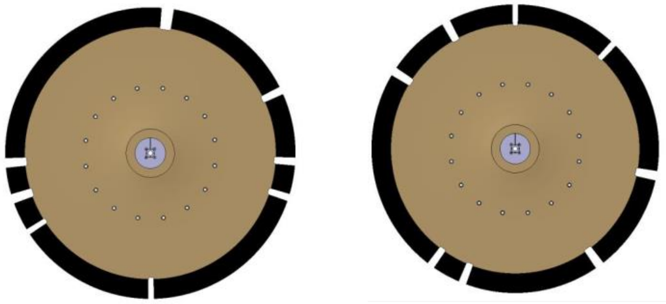
Procedure
All choppers parked open except that under test
Chopper speed to be adapted to available neutron flux

Case 1: PSC1, PSC2, OC

Fine sweeping of chopper phase (0<Φ< 360 degrees)
Identify the position of the slits from signal on monitor M1

Case 2: BC, T0

Coarser sweeping of chopper phase (0<Φ< 360 degrees)
Identify the position of the slits from signal on monitor M3



Fine slits patterns of PSC1 & PSC2 choppers

Key personnel: *ECDC, Instrument team*

Requirements: *M1 & M3 monitors functioning*

Neutron flux good enough

Validation of subsystems: Choppers

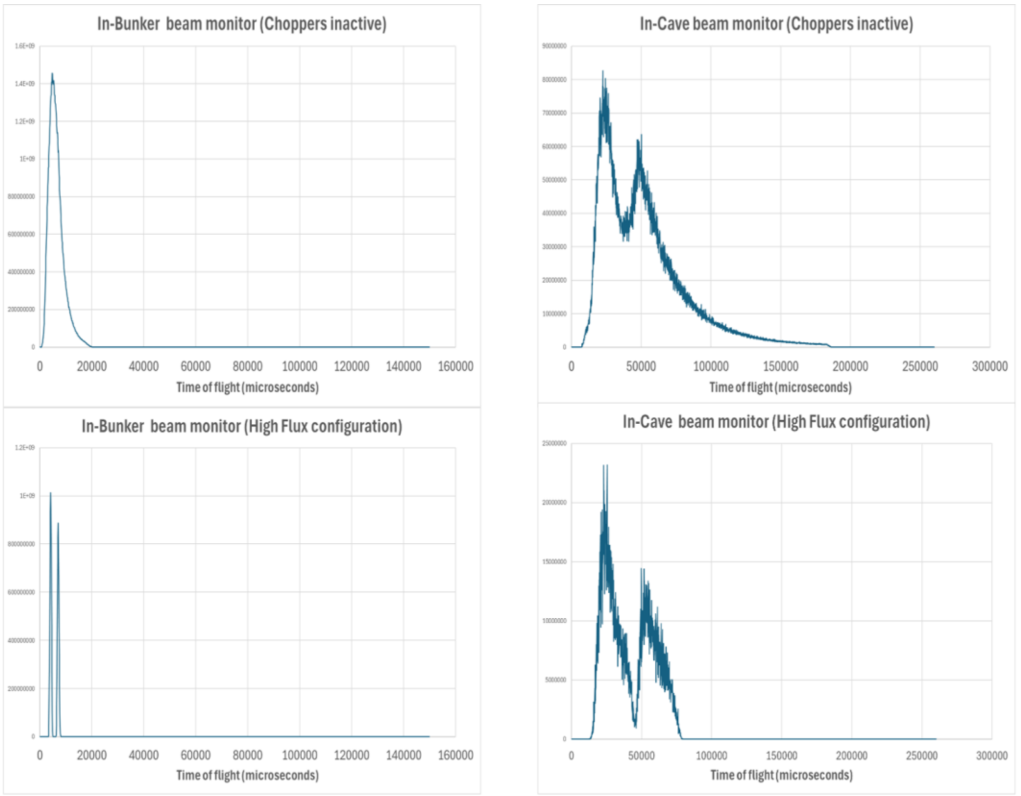
Test 9: Test of choppers configurations

Procedure

Select a configuration suitable to available neutron flux from ESS
Run McStas simulation ➔ Estimation of choppers phases

Choppers are sequentially started, starting with PSC1

1) Sweep PSC1 phase around estimated position
   Check transmitted signal on M1 monitor (see Test 1).
2) Sweep PSC2 phase around estimated position
   Check transmitted signal on M1 monitor (see Figure 2).
3) Sweep OC phase around estimated position
   Check transmitted signal on M1 & M3 monitors
4) Sweep BC phase around estimated position
   Check transmitted signal on M1 & M3 monitors
5) Sweep T0 phase around estimated position
   Check transmitted signal on M1 & M3 monitors



McStas simulations: TOF spectra at beam monitors M1 and M3 without (upper row) or with (lower row) choppers running

Key personnel: *ECDC, Instrument team.*

Requirements: *M1 & M3 monitors functioning*

Neutron flux good enough

Validation of subsystems: Choppers

Test 10: Changing of wavelength band (delay only) – Can be performed during Calibrations

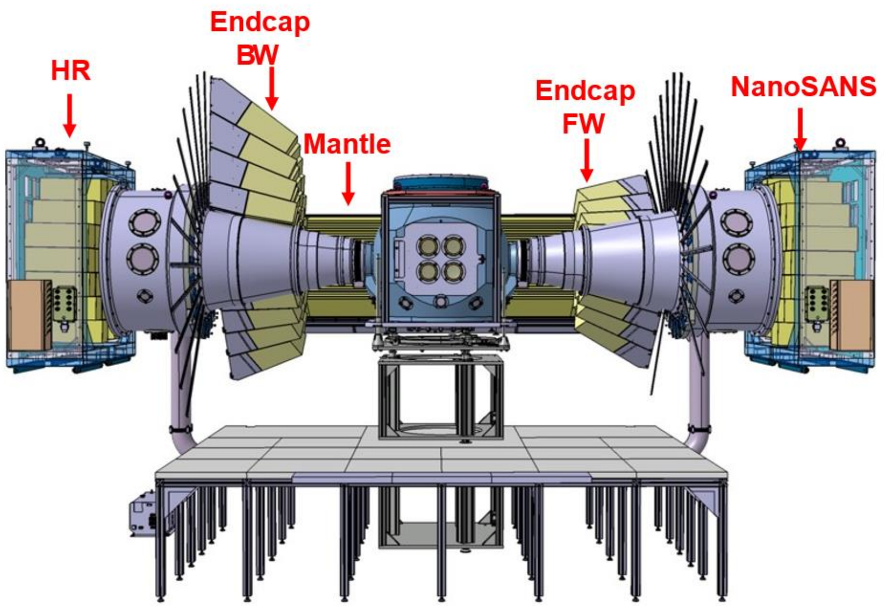
Procedure
Select a configuration optimized during Test 2

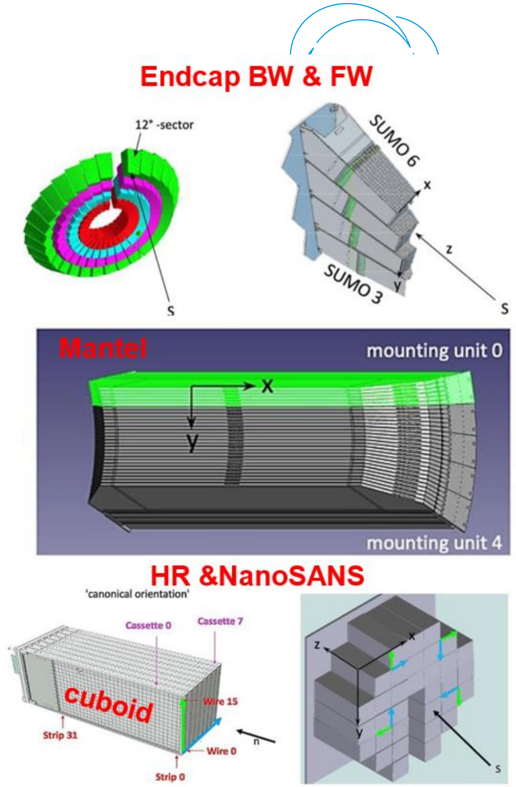
Sweep simultaneously the phases of all the choppers (NICOS script available)
Follow the shift of the TOF signal recorded on monitor M3

Key personnel:	*ECDC, Instrument team.*
Requirements:	*M1 & M3 monitors functioning*

	Neutron flux good enough

Validation of subsystems: Detector





Test 11: Mapping of detector elements

Procedure

Chopper parked Open

Slits S1, S2 and S3 OPEN

Vanadium rod at sample position

- Appose a Cd mask successively on a corner of each detector module
- Check position and orientation of the shadow wrt detector geometry

Key personnel: *DetG, ECDC, Instrument team & IDS*

Requirements: *Vanadium rod – Cd mask*

Neutron flux intense enough

Validation of subsystems: Detector

Test 12: Detector efficiency and uniformity

Chopper parked Open
Slits S1, S2 and S3 OPEN
Vanadium rod at sample position

- Perform a long enough measurement to get good statistics over the voxels
- Strip Bragg peaks (DREAM data reduction workflow)
- Compare with McStas simulation
- Integrate over TOF to produce the uniformity map
- Calculate Detector efficiency by rescaling the result of McStas simulation to the flux measured on monitor M3 (calibrated).

Key personnel: *DetG, ECDC, Instrument team & IDS*

Requirements: *Beam monitors Hot-Commissioned – Vanadium rod*

Neutron flux intense enough

Validation of subsystems: Detector

Test 13: Detector background in various conditions

Accelerator off and beam down for 24h

➔ Minimal background that can be achieved under operational conditions

➔ Indication of the activation of the detector components and surroundings
(comparison with the background measured during Cold commissioning)

Accelerator on, Light shutter open,
Heavy shutter closed,
All chopper discs closed, all slits in CLOSE position.

➔ Background of the detector in operational conditions
(record the accelerator intensity/power and the status of ODIN)

Key personnel:	*DetG, ECDC, Instrument team & IDS*
Requirements:	*Calibration of detector Efficiency*

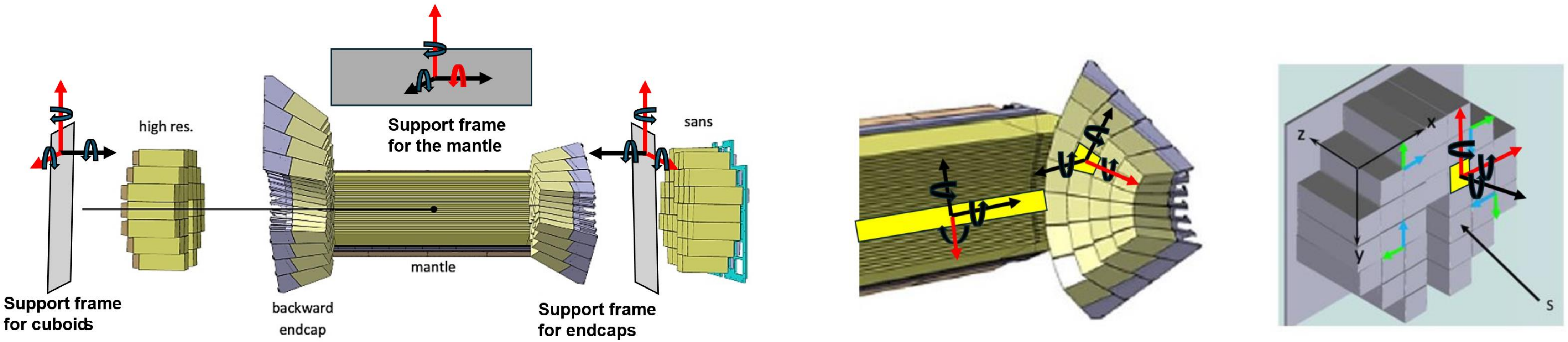
	Neutron flux intense enough and stable

Test 14: Calibration of Secondary flight path – Detector distortion

Choppers operation with Medium-resolution configuration

NAC or garnet powder at sample position

- Perform a measurement with good counting statistics on Bragg peaks.
- Refine the displacement/rotation of the 5 detector banks against Bragg peaks
- Refine the displacement/rotation of the modules inside banks against Bragg peaks
- Recalculate the distortion map and the secondary flight path



Displacements of detector banks (left) and modules (right). The strongest potential contributions are identified by red arrows

Key personnel:	*ECDC, Instrument team & IDS*
Requirements:	*Primary flight path calibrated – Special Calibration workflow*
	Cubic powder sample (NAC or garnet)
	Neutron beam stable and intense enough

Integrated test of the instrument

Test 15: Validation of instrument performance

Si or Diamond powder at sample position (linewidth standard)
Select a specific wavelength band e.g. 0.5-4.1Å.

Concept of Operations (ESS-0135206)

- **Data collection up to Qmax=25Å^{-1}.**
- Data collection down to Qmin=0.2Å^{-1} (with nanoSANS, Qmin=0.01 Å^{-1}).
- **Flexible choice between high resolution and high intensity, resolution from ~10^{-2} ms to ~ms.**
- **Best resolution Δd = 0.00035Å near backscattering**

Case 1: High resolution

Choppers running with Higher resolution configuration possible
All slits in CLOSE position

Perform a measurement with sufficient counting statistics
Check that resolution Q_{min}= 0.2Å^{-1} on Backscattering EndCap
Check that resolution Q_{max}=25 Å^{-1}
Check the resolution Δd near backscattering (depend on chopper setting)
Measure the TOF pattern on M1 and M3

Case 2: High Flux

Choppers running with High flux configuration
All slits in CLOSE position

Measure the TOF pattern on M1 and M3
➔Verify that *pulse shaping differs by two orders of magnitude*

Key personnel: *ECDC, Instrument team & IDS*

Requirements: *Instrument calibrated*
Standard samples (Si, Diamond)
Neutron beam stable and intense enough

Test 16: Validation of instrument performance

Case 3: nanoSANS

Silica nanospheres at sample position
Select a specific wavelength band e.g. 0.5-4.1Å.
All slits in CLOSE position
Choppers running with Medium resolution configuration

Perform a measurement with sufficient counting statistics
Check that data are measured down to Q_{min} of 0.01 $Å^{-1}$ on the nanoSANS detector

Concept of Operations (ESS-0135206)

- Data collection up to Qmax=25$Å^{-1}$.
- **Data collection down to** Qmin=0.2$Å^{-1}$ **(with nanoSANS, Qmin=0.01** $Å^{-1}$**).**
- Flexible choice between high resolution and high intensity, resolution from ~10^{-2} ms to ~ms.
- Best resolution Δd = 0.00035Å near backscattering

Key personnel: *ECDC, Instrument team & IDS*

Requirements: *Instrument calibrated*
Standard sample (Silica nanospheres)
Neutron beam stable and intense enough

Integrated test of the instrument

Test 17: Validation of instrument resolution function(s)

Calibration with standard powder

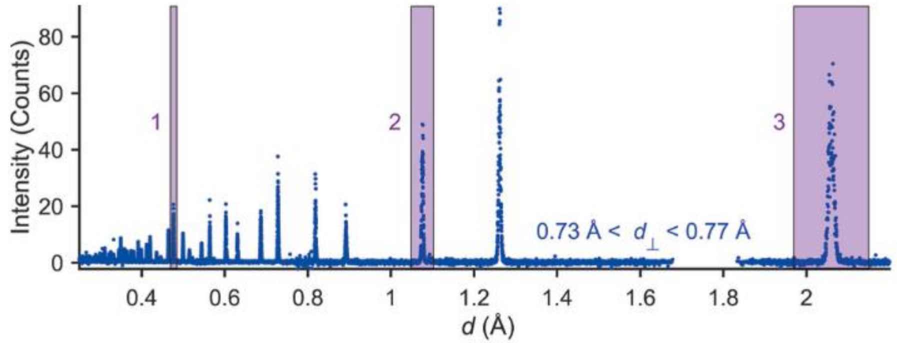
Si or Diamond powder at sample position (linewidth standard)

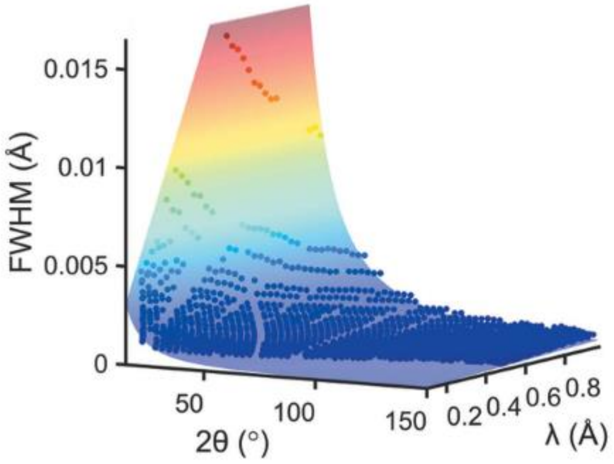
- Perform a measurement with a selected configuration
- Perform Data reduction
- Perform a Rietveld analysis using a standard software
- Extract the resolution function for this software

Verification on reference sample

Reference powder at sample position

- Perform a measurement with the same configuration
- Perform Data reduction
- Perform a Rietveld analysis using a standard software using the resolution function found
- Check the quality of the fit



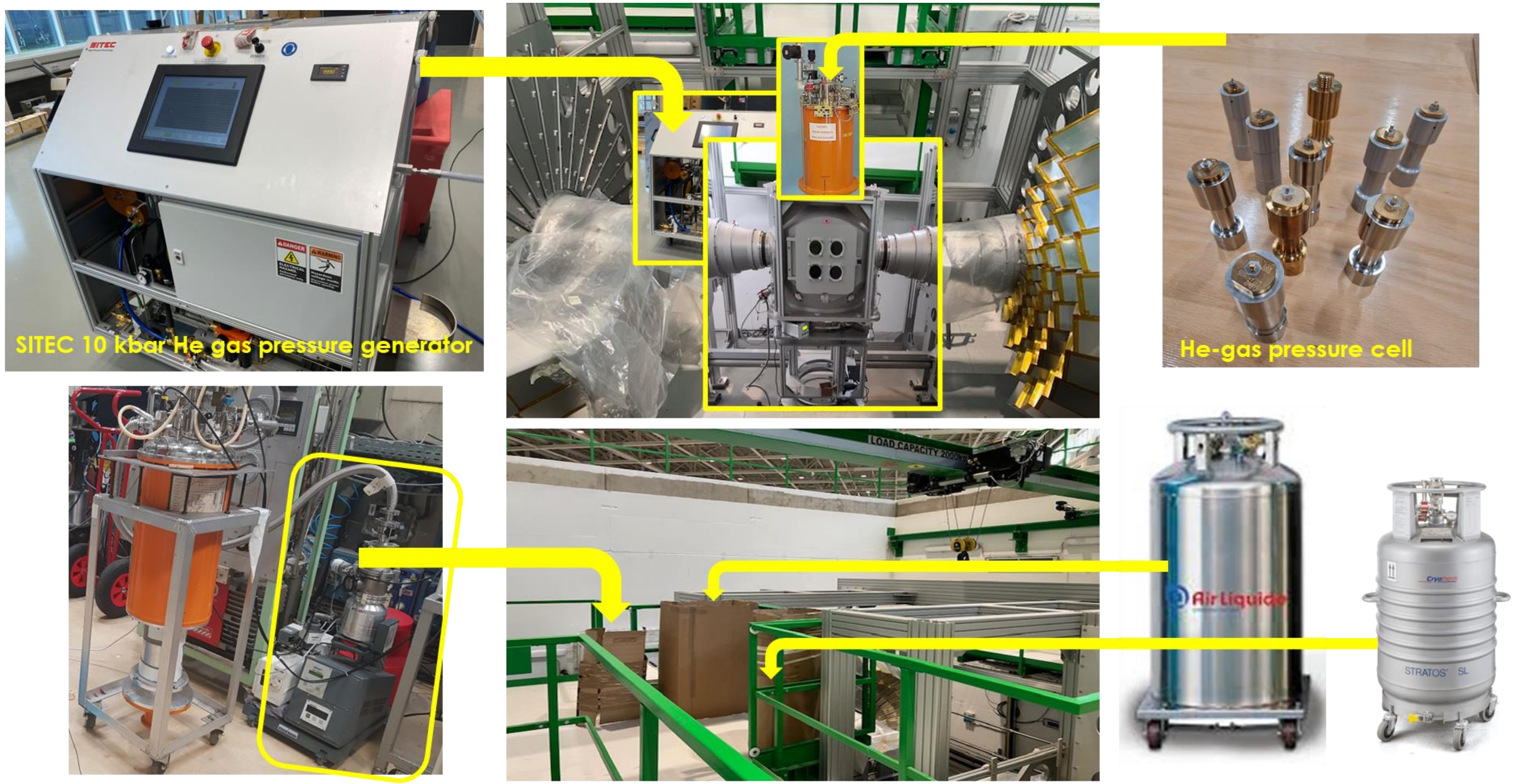


POWTEX - J. Appl. Cryst. (2017). 50, 866–875

Key personnel:	*ECDC, Instrument team & IDS*
Requirements:	*Instrument calibrated – Data reduction chain for powder diffraction*
	Standard (Si, Diamond) and reference (NAC, garnet, Al2O3,…) checked previously with X-Rays
	Neutron beam stable and intense enough

Test experiments using standard sample environments

Test 18: Validation of instrument flexibility



Concept of Operations (ESS-0135206)

9. DREAM shall provide the infrastructure to support fast in-situ measurements and quick user turnover.
10. DREAM should provide user community with the wide range of generic and instrument-specific sample environment within its upgrade path.
11. DREAM should reduce the sample environment turnaround time as much as reasonably achievable.
12. DREAM shall be compatible with high magnetic field sample environments.

Key personnel:	*Sample Environment group, ECDC, Instrument team*
Requirements:	*Instrument calibrated – Data reduction chain for powder diffraction*
	Sample
	Neutron beam stable and intense enough

Time planning

#	Activity	Expected duration (days)	Resources needed
1	Fulfil radiation protection requirements	5	RP
	Validation of subsystems		
2	Beam monitors	5	Detector group, ECDC
3	Slits system and Boron nose	5	Detector group, ECDC
4	Sample position and primary flight path	5	Detector group, ECDC
5	Choppers	20	Chopper group, ECDC, IDS
6	Detectors	10	Detector group, ECDC, IDS
	Integrated test of the instrument		
7	Secondary flight path – Detector distortion map	5	Detector group, ECDC, IDS
8	Instrument performance for various standard configurations	30	ECDC, IDS
9	Calibration of the instrument	10	ECDC, IDS
10	Test experiments using standard sample environments	10	ECDC, IDS
	Total	105	

THANKS!

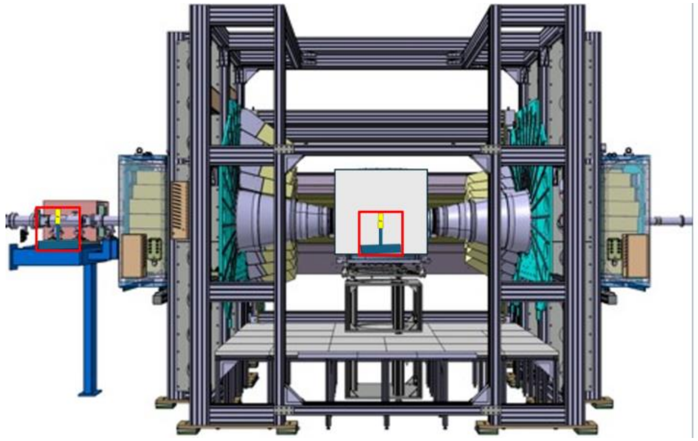
Validation of subsystems: Monitors & Choppers

Test 2: Intensity and time structure for a typical chopper setting (after Chopper validation)

Procedure

Heavy shutter Open, standard configuration of choppers (High Flux / medium)

- In-bunker monitor M1 & In-cave monitor M3:
  - Measure the TOF spectrum and compare with McStas simulations.
  - Shift the wavelength band and compare time structure of the pulses with McStas simulation.
  - Compare integrated flux on M3 with gold foil at the sample position.
  - ➔Reference for long-term verification of instrument performance



Test 3: Overall test (after Chopper validation)

Procedure

Heavy shutter Open, Choppers parked open, Slits OPEN

Heavy shutter Open, standard configuration of choppers (High Flux / medium)

- In-bunker monitor M1 & In-cave monitor M3:
  - Check the ratio between values measured by M1& M3 and gold foil for both configurations

Key personnel: *DetG, ECDC, Instrument team.*

Requirements: *Monitors Cold Commissioned – Gas System - Sample stage*
Gold-foil and gamma spectrometer
Neutron source stable enough