CSPEC STAP report
1st April 2021

P. P. Deen, D. Noferini, F. Moreira, L. Loaiza, G. Fabrèges, G. Tucker.
W. Lohstroh, S. Longeville.

CSPEC is the cold chopper spectrometer of the ESS and is expected to come online with beam on target (BOT) which has recently been set to July 2023.. In this STAP report we provide an overview of the status of the main components. Comments and requests from the previous STAP report are provided within the report.
FAT = Factor Acceptance test
SAT = Site acceptance test

CTV/TG3/IDR = Internal ESS reviews.

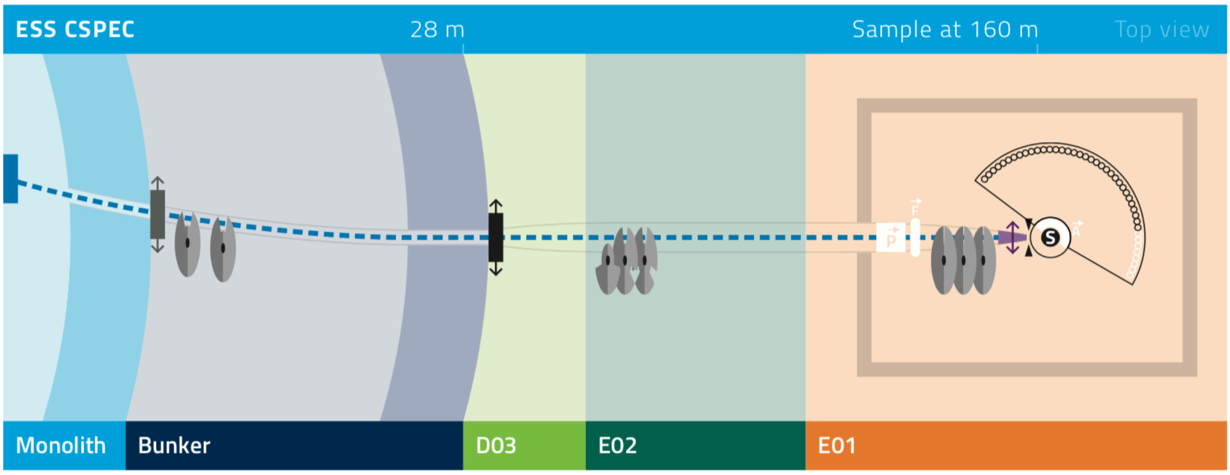

Figure 1: Cartoon overview of CSPEC. In white are upgrades (Polarisation analysis and detector coverage)

Guides.

To date we have manufactured 84 m of guides (out of bunker) and in the last few months no guides have been manufactured. The last sections to be produced have not yet been tested for conformity by neutron reflectivity since the FRM2 reactor has not been operational. We do not estimate that this will impact TG5. We are in close contact with the optics group of FRM2.
Installation September 2021.
Installation: 3 to 4 campaigns, 10 days each.

Outside bunker: 2 campaigns.

In-bunker + choppers: 1 or 2 campaigns.

External guide components, neutron beam optics assembly (NBOA) (SDH) & BGG Bridge beam guide (guide within the bunker wall) (Swiss neutronics) are expected to have a SAT in September/October 2021.

Guides housing and alignment.

The SAT for the first out of bunker guide housing has been performed (64 m received), February 2021.

Figure 2(a): Vacuum housing

Figure 2(b): Vacuum housing: details check

Figure 2(c):Vacuum housing and naming detail.

We are currently performing cycling tests of the vacuum windows (0.5 mm thick) : 2000 cycles. Cycling 2000 times of the 0.5 mm guide window, The window is under vacuum and returned again to atmosphere pressure every 1 minute. The deflection is measured. No problem to date.

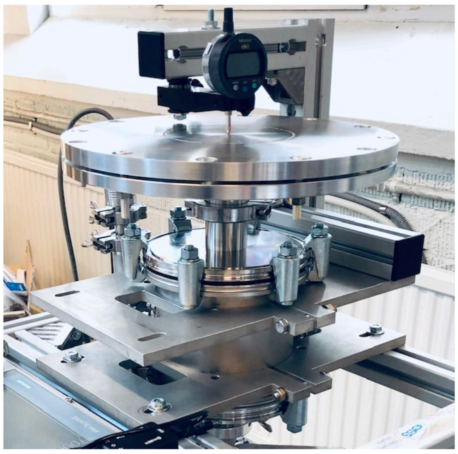

Figure 3: Fatigue testing of vacuum window.

Instrument shutter

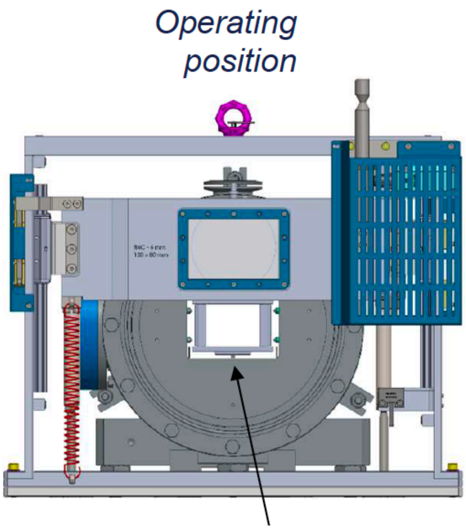

Figure 4: Detailed design of the instrument Shutter/ Monitor.

Previously we showed that a 6 mm thick shutter of B_4C density of 2.4g/cm^3 is sufficient to enable access to the PS chopper pit with an instrument shutter at 28.5 m. The preliminary shutter design, see Figure 4, contains both the instrument shutter and the monitor that can be placed independent from each other. The design is by L. Loaiza (TUM). The monitor in the image is an LND neutron beam fission monitor. The final decision on monitors technology has not yet been made. The shutter design is nearly complete, IDR in April 2021, and will be shortly manufactured at FRM2. The pneumatic mechanisms will be cycled and tested at FRM2.

Monitors

CSPEC received a second draft offer from the monitor group. There remain a lot of issues to clarify. Working together with the TREX monitor group to develop an optimised normalisation monitor for both CSPEC and TREX.

Shielding

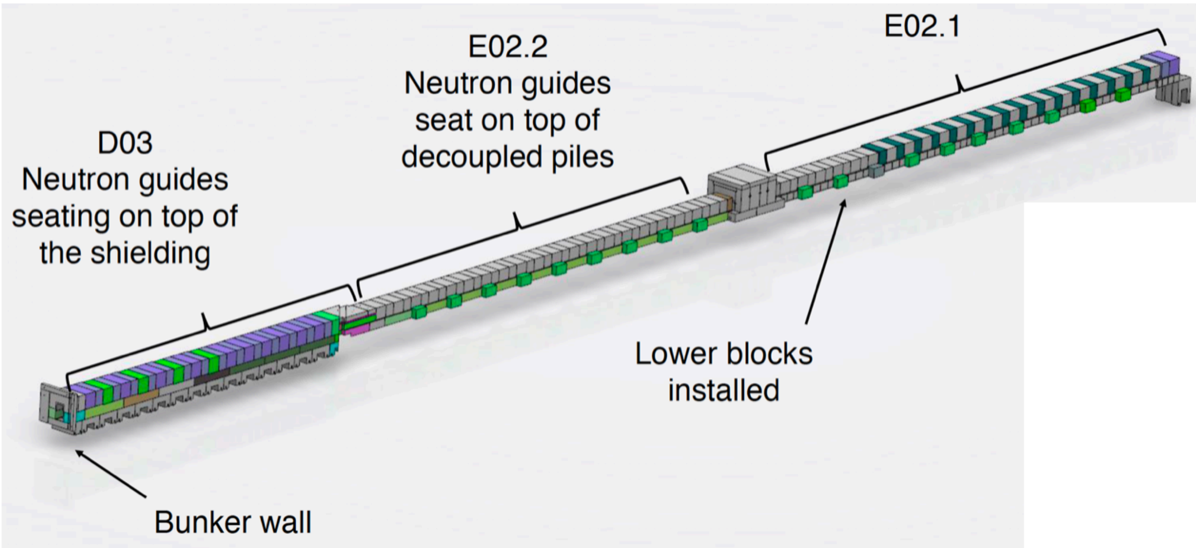

Figure 5: Overview of CSPEC primary spectrometer guide shielding.

Figure 6(left): Top blocks of the primary spectrometer shielding.

Figure 6(right): Top blocks of the primary spectrometer shielding.

Primary spectrometer shielding

In collaboration with the common shielding project the CSPEC lower shielding blocks have been installed in E02-2. The TG3 (detailed design) of the upper shielding blocks has been approved and pilots have been casted and approved, see Figure 6. Full manufacturing of the complete guide shielding is progressing.

Secondary spectrometer shielding

Detailed MCNPX calculations have been completed. The resultant cave shielding is near completion with an expected date for ESS CTV in May 2021 which will allow us to move towards the tender stage.
Space boundary for utilities and racks are provided.

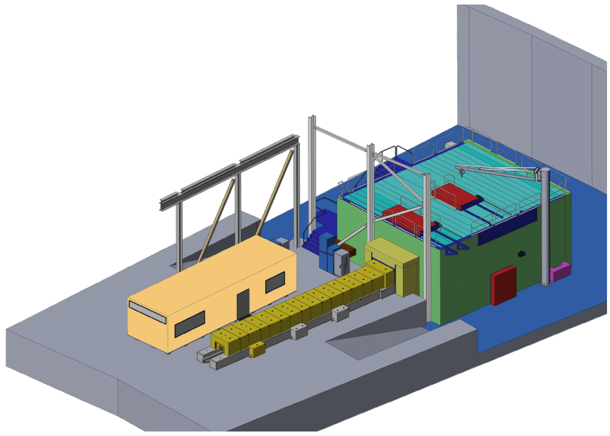	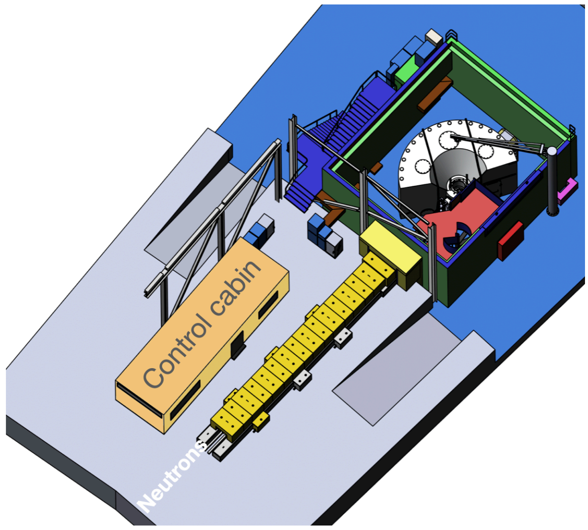
Figure 7(a): Instrument cave.	Figure 7(b): Instrument cave with roof removed.

Control cabin

Will be in the same tender as the instrument cave. CTV May 2021.

Detectors

LET Detector tests, November 2021:

- Electronic background level measured within the LET detector chamber provided a measurement of 0.376 Hz/m2 - close to the broad specification agreed within the CSPEC/DG contract (shall reach 0.35 Hz/m2, should reach 0.14 Hz/m2) but still above the background levels of He3 (0.1 Hz/m2).
- Vacuum issues with the CSPEC detector vessel prevented any further experimental verification. The detector group will provide more information.

There was a previous request to determine whether it would be possible to increase the horizontal, first day, coverage at the expense of the vertical coverage. This will be a discussion for the electronic engineer, to be recruited shortly, but it is not very likely.

Detector tank

The detector tank tender was closed on the 5th March. We received 2 suitable offers that conform to the scientific and technical requirements, see previous STAP report. Both offers will manufacture an Al. tank. We are following the contract procedure (LLB).

Detector alignment and vanes.

Upon completion, there will be 32 detectors vessels within the CSPEC detector tank. Each detector set will be mounted in a vessel with individual alignment mechanism that can position the detector. The alignment mechanism consists of a top hook, with X and Y tilt and Z adjustment Figure 9(a,b) and a bottom mechanism that allows rotations (with a resolution of < 0.5 ^{o}) in all the planes including X and Y alignment and the final fixation of the system.

Prototypes of the mechanism and solutions have being manufactured at LLB and will be mounted in a mock-up of the detectors tank, simulating physical and spatial restrictions, see Figure 9(c) . The aim is to test and optimise the design and develop the alignment procedure for the detectors and vanes. We aim to simplify the installation and as such a full-scale detector vessel and 2 wooden dummies have been built for this purpose. These will also be used to check the detector alignment and vanes. Tests will take place June 2021.

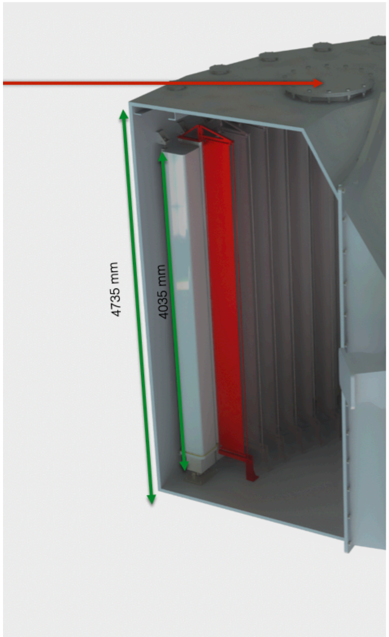

Figure 8(a). A detector vessel positioned in the detector tank. The arrow shows the extraction hole in the detector tank.

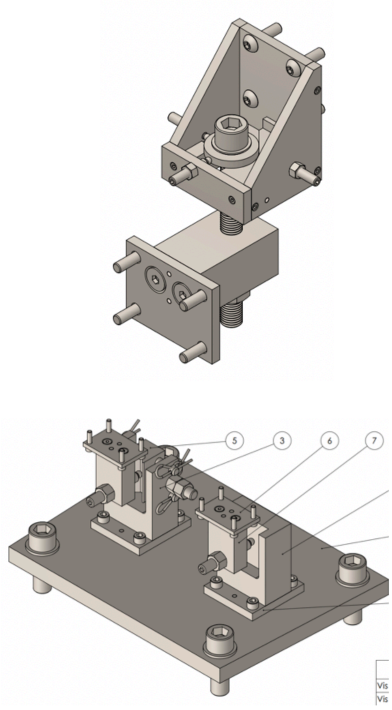

Figure 8(b). Alignment features for the detector vessels.

Figure 8(c) Prototype components for detector alignment.

Radial oscillating collimator

The CSPEC radial collimator enhances the signal to noise of the CSPEC instrument via the use of strategically placed oscillating absorbing septa starting at a radial distance of 504 mm from the sample position and extending out to 700 mm with an angular spacing of 0.8° extending from the sample position. These parameters ensure that any scattering beyond a radial diameter, from the sample, of 48.87 mm and with a scattering angle greater than 2.4° will be suppressed. Spurious scattering from sample environment tails will be absorbed. The coating of the collimator blades will be Gd_2O_3 . All surfaces of the collimator shall be covered with a neutron absorbing material layer of at least 0.025 mm of Gd_2O_3, Gadolinium of natural isotopic composition.The radial collimator will be moved +-1° with a frequency of 0.1 Hz. The oscillating mechanism is under development at the LLB/ we are considering motions developed at other facilities. The radial collimator process has closed with 2 interested companies. We are reviewing the tenders (LLB).

STAP comment: "Using Gd-loaded paint for collimation vanes in the vacuum tank raised a concern with the STAP. The CSPEC team will conduct tests to confirm that the paint is vacuum proof (as claimed by the vendor) and to assess the level of parasitic scattering that one can expect."

Parasitic scattering levels will be tested using TOFTOF.

Choppers

Contract has been signed with Airbus. Delivery March 2023. Kick off meeting: April 2021.

Sample environment

BOT	HC= BOT + 3 months	FS= BOT + 6 months	SOUP=BOT + 12 months
Cryofurnace*	14 T magnet (access to)	High pressure (large samples)	Pump and probe setup*
He3 insert*	Automatic sample changer*	Humidity chamber	High pressure (small samples)
Sample stick rotation stage*		High temperature furnace (access to)	
6 T magnet*			

*Figure 9: Sample environment for CSPEC with respect to beam on target. * = in scope.*

On day 1 the CSPEC sample environment will consist of:
1. Cryofurnace (1.7 < T < 650 K) : CTV May 2021.
2. Dilution insert (0.3 K): CTV July 2021.
3. Sample changer (6 positions): Working with Sample environment group: CVT before end of year.
4. 6.5 T magnet: still not resolved. / higher magnetic fields : not resolved.

DMSC – ECDC (detector data acquisition)

STAP: We recommend a standardization of detector back-end electronics to the extent possible. This will be very impactful later on for detector maintenance by the facility. Consider initiating a common project at ESS.

There is a recruitment ongoing for an electronics engineer. This is essential for the electronics output via VMM which has not yet been defined or tested, step 1 in Figure 10. We are working with DMSC to define the the back end electronics, step 2 in Figure 10.

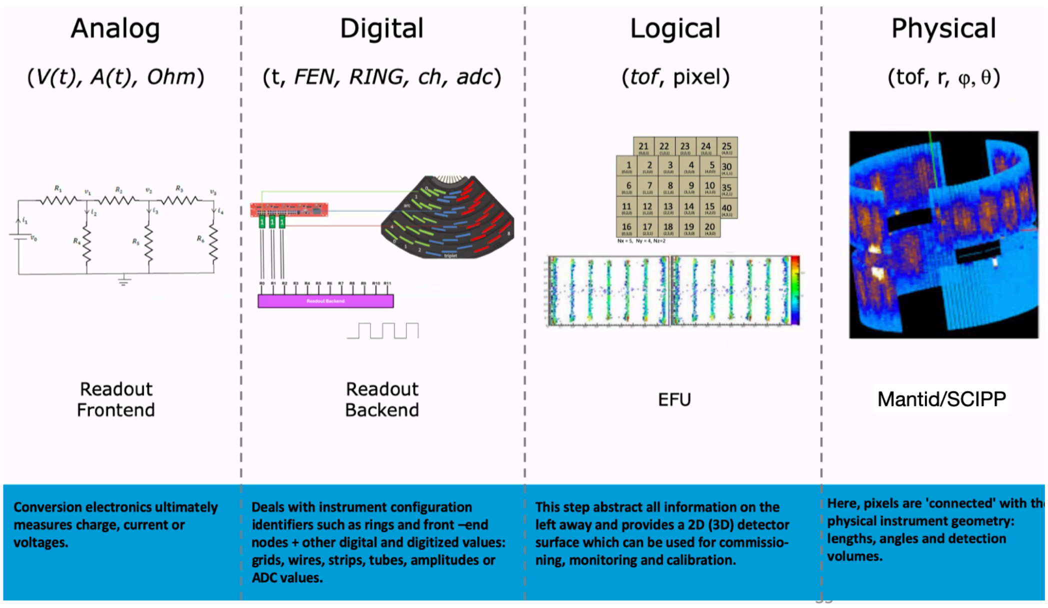

Figure 10: Workflow for data acquisition at ESS (Morten Christensen)

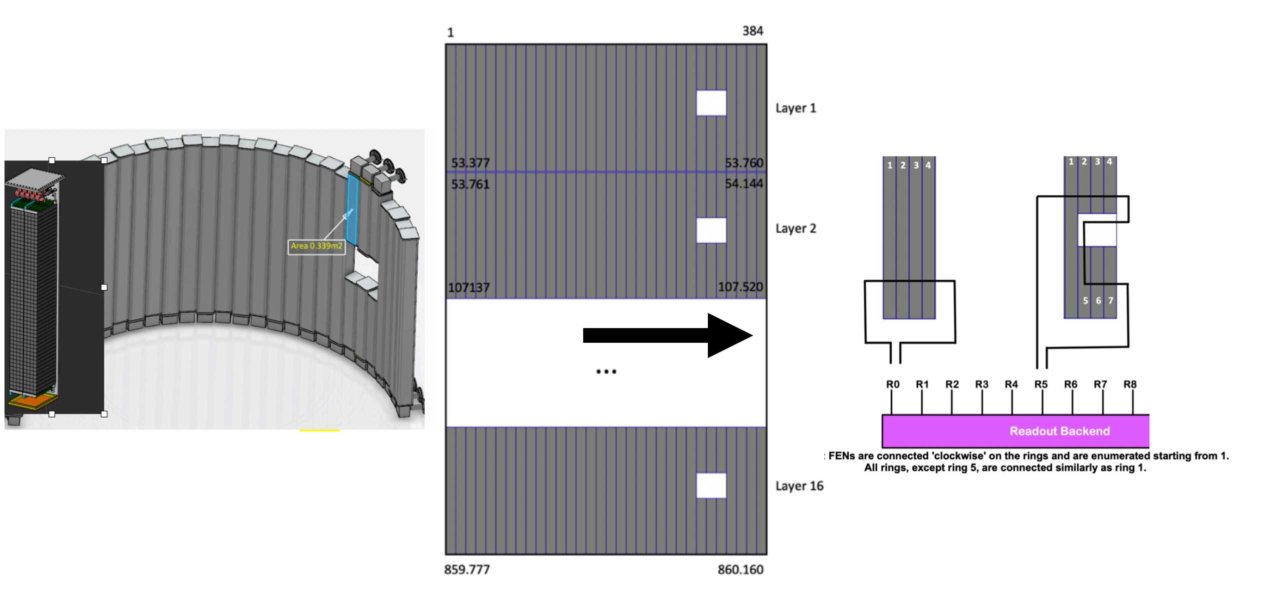

Figure 11: Definition of 860 160 detector voxels for CSPEC. Relevant for other direct geometry spectrometers.

The ICD (Interface control document) which assigns the voxel number in the readout backend has been completed and agreed upon with DMSC, see Figure 11. Waiting for agreement with the detector group.

Instrument control

We are working with the instrument control team to optimise NIKOS, the control and visualisation software, step 3 in Figure 10.

Data analysis (Cold/Hot commissioning):

We have recruited Greg Tucker as data scientist for spectroscopy for CSPEC and BIFROST. We are working on the realities of event recording and workflows for both instrument scientists and users, step 3-4 in Figure 10.

Data analysis:
We intend to have a range of packages to enable on-experiment data analysis (Incorporate instrumental resolution profile).
These include:

- Basic models for (e.g.) self-diffusion :
- Ficks law, Chudley-Elloitt (CE) – jumps on a lattice, Singwi-Sjölander (SS)- alternation between oscillatory motion and directed motion, Hall-Ross (HR) – jump diffusion within a restricted volume
- Molecular Dynamics simulations i.e. VASP (DFT): Working with Chalmers University on MDMC project: Molecular dynamics Tillväxtverket grant(Jan Swenson). Will test MDMC software on liquid water/ further real data with a first version.
- SpinW
- McPhase
- SPINVERT
- McStas simulation of sample environment.

Electrical installation

We join the ESS common electrical project led by S. Birch. We have not yet had a kick-off meeting. Plan for May 2021.

Utilities installation

We have joined the ESS common utilities project led by A. Kaplanov. Kick off meeting unclear.

Engineering tasks 2021

Procure In-bunker vacuum systems
Installation of guide Sept 2021.
SUB-TG3 Tank, Cave, Choppers, shutter, monitors, detectors.
Develop the integration of those systems.
Complete the design of guide exchanger, secondary shielding, collimation integration.
Produce and compile all mandatory documentation.
Procure sample environment equipment.
Monitors: look forward to contract and further discussions
Partake in common electrical project
Partake in common utilities project

Commissioning plan

See attached document for a preliminary commissioning plan.

Timelines & costing

CSPEC TG5 (hot commissioning date) is currently July 2023.
Full costing clarified July 2021.