Updates for DREAM instrument (October, 2022)

The following report describes major activities of the instrument project since the last STAP meeting in April, 2022.

Relocations to ESS

The relocation of Florence Porcher (instrument scientist from LLB) to ESS is scheduled for the Q1 2023. Before that date she would continue visiting ESS on a monthly basis.

Schedule update

The access date for the DREAM in-bunker section opening was delayed to January 2023. We will use the early in-bunker access dates in November 2022 to install the heavy shutter and T0 chopper. ESS hold the first-ever Final TG3 (critical design) meeting for DREAM in September 2022. The current planning assumes a complete installation of DREAM by December 2023, which is still before the current beam-on-target (BOT) date estimates (2024-2026).

In-bunker optics: NBOA, BBG and Bi-spectral switch

The manufacturing of neutron beam optical assembly (NBOA) and bridge beam guide (BBG) were completed by SwissNeutronics. The NBOA was delivered to ESS and integrated into neutron beam port insert (NBPI), see Figure 1a. It is now sealed and stored for the future installation inside the bunker. The BBG was delivered to FZJ for further integration with the bi-spectral switch. 153 Si wafers coated with NiTi-supermirror (m=3) for the bi-spectral switch were manufactured by Nob Nano Optics Berlin GmbH and delivered to FZJ. The bi-spectral switch was assembled at FZJ and tested with TOF cold and thermal neutrons at IMAT beamline at ISIS in July 2022 (see Figure 1b,c). The tests confirmed the expected performance of the switch, however its mechanical assembly can be improved. We are applying for a continuation proposal at IMAT beamline to verify improved assembly and collect more data for a publication. We are still on time with the installation schedule of the bi-spectral switch inside the bunker, despite additional beam time at IMAT in Q1 2023.

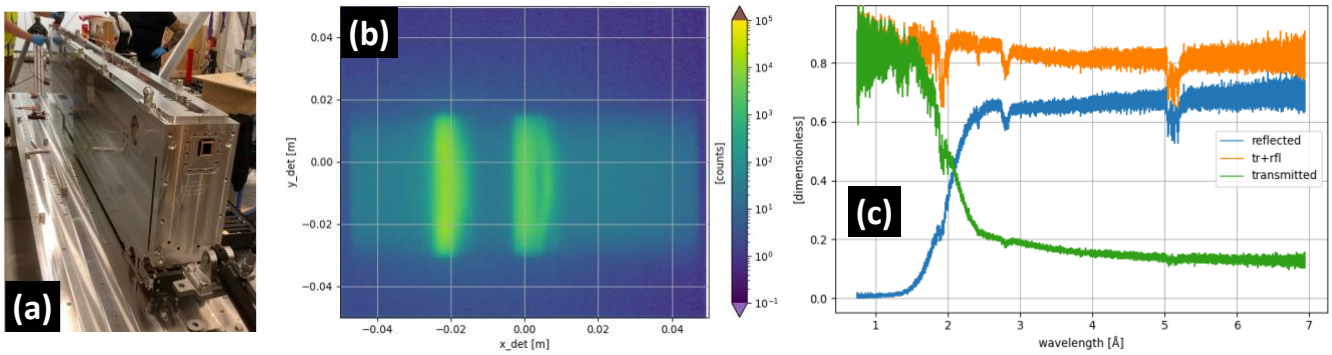

Figure 1 (a) Alignment of NBOA inside NBPI is being performed at ESS. Results of DREAM bi-spectral switch neutron tests at IMAT@ISIS beamline: (b) 2D detector image showing transmitted and reflected beams. (c) Normalized transmission (green), reflectivity (blue) and sum of both (orange) of bi-spectral switch as a function of the wavelength.

Neutron guides

The neutron guides inside and outside of the bunker have been procured as one package from SwissNeutronics, however the manufacturing was prioritized for the in-bunker guides. The final design (SubTG3 review) of the in-bunker and out-of-bunker guides was approved in November 2021 and February 2022, respectively. The last section of the guide has an interface with a polarizer and magnets array for the guiding magnetic field. The installation of the last section of the guide protruding the cave is coordinated with the cave installation.

The in-bunker neutron guides were manufactured. The factory acceptance test (FAT) was delayed because the vacuum housing had to be reinforced. The installation is planned for January 2023, after bunker is open. The installation of the in-bunker guides will be coordinating with the installation of chopper system bases.

For the out-of-bunker neutron guides, the coatings of substrates and assembly of guide units are ongoing. FAT is planned for December 2022. The installation at ESS is scheduled for Q1 2023.

Neutron guide shielding

The DREAM instrument is a part of the ESS Common Shielding project. The shielding blocks were manufactured and lower blocks were delivered and installed (Figure 2a). The upper blocks will be delivered Q1 2023. The installation of the ODIN cave, which is very close to DREAM neutron guide shielding (Figure 2a, on the left), has to be coordinated with the installation of the out-of-bunker neutron guides. Our aim is to avoid simultaneous installation of the expensive neutron guides for DREAM and heavy concrete work related to ODIN cave installation.

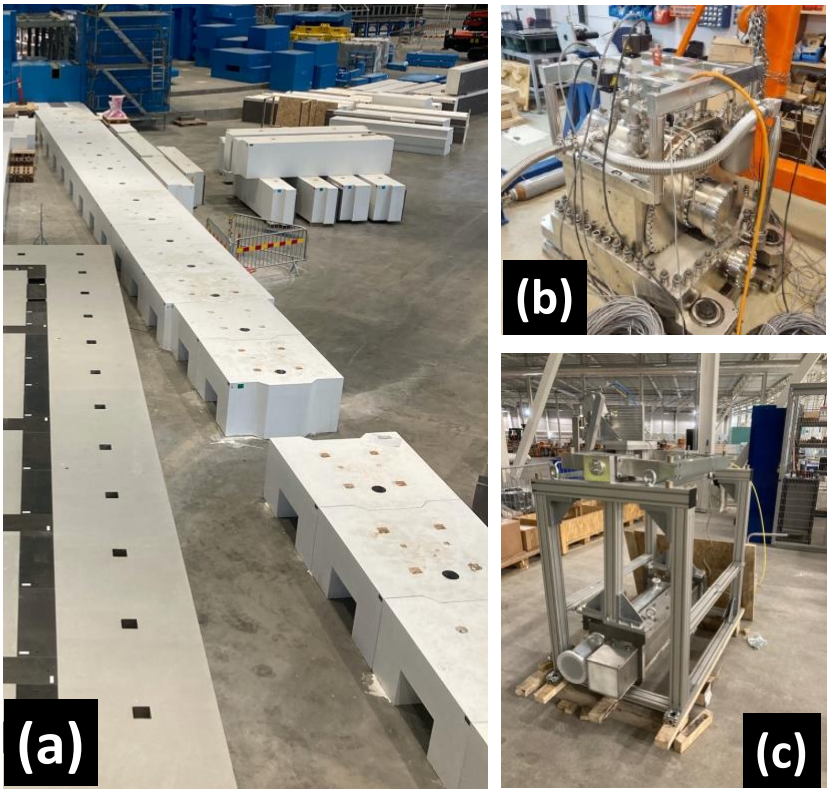

Figure 2 (a) Lower blocks of neutron guide shielding installed in D01 hall. (b) DREAM T0 chopper at the ESS Chopper group workshop and (c) DREAM heavy shutter at E01 hall.

Chopper system

The housing and base of pulse-shaping (PSC) and band-control (BC) choppers were manufactured at Jülich Chopper group workshop at FZJ. The disks were manufactured by Airbus and delivered to FZJ. After leak tests were completed, the housing and disks were shipped to Canada to the spindle manufacturer SKF. The problem with the BC chopper hub reported previously was resolved. The likely cause of the hub failure was a human error during the installation. The new hub was manufactured by Airbus and sent back to SKF to resume the tests of the BC chopper.

SKF was successful in the spinning of both PSC disks to the full speed of 308 Hz in a single direction. Other tests are currently ongoing. Once the tests of the BC and PSC choppers are completed at SKF, they will be shipped back to FZJ Chopper group. The FAT of the PSC chopper will be performed in FZJ by adding overlap chopper (OC) with the Juelich spindle. Entire assembly of PSC and OC choppers with SKF and Juelich spindles within the same housing will be tested at the given rotational speeds of PSC disks. Those speeds will be used to achieve low, medium and high resolution modes of the instrument during the user operation.

T0 chopper will be delivered by ESS Chopper group. The FAT of the chopper is completed at ESS (Figure 2b). T0 chopper will be installed before the end of this year by ESS Chopper group. The base for T0 chopper was already delivered to ESS. The bases of BC and PSC choppers are being shipped from FZJ to ESS for installation of the in-bunker neutron guides. They are not required for FAT tests of the choppers described above.

Heavy shutter

The ESS solution for the heavy shutter was based on neutronics simulations provided by the DREAM team. The heavy shutter is manufactured and passed SAT at the ESS site (Figure 2c). It will be installed in Q4 2022, using early in-bunker access.

Detectors

The serial production of mantle and endcap detectors is ongoing at CDT GmbH. The high-resolution backscattering and nm-SANS (RAC funded) detectors design is complete. Both detectors use the same ^{10}B-techology as mantle and endcap detectors, however they have different modular structure consisting of the interchangeable cuboids arranged around a neutron beam axis. Both detectors will offer a high efficiency and resolution, with nm-SANS detector being optimized for longer wavelengths (>2Å).

The manufacturing of the mantle detectors will be completed by December 2022, however they will be delivered to ESS in March 2022 in order to avoid exposure to the sub-zero temperatures. The DREAM team will work closely with the ESS Detector group to develop SAT procedures of the detectors after installation in the DREAM cave and before beam on target. SAT will be a multistep process including high-voltage calibration, cosmic neutrons measurements and test measurements with a portable neutron source inside the cave. The report on the firmware development for the CDT detectors and electronics was delivered. It was part of 0-series detector development for the DREAM instrument.

Detector support structure

The installation of the detector support structure was completed in FZJ. The entire frame with the detector mounting plates was then delivered and installed inside the DREAM cave (Figure 3). The precision was verified using a laser tracker system. The mantle detector mounting unit was installed as well, next to the DREAM cave. The installation of the mantle detectors inside the DREAM cave with the ESS hall crane was successfully tested using a mockup mantle detector modules.

Figure 3 Sample vessel installed on sample vessel support inside detector support structure in the DREAM cave.

Sample vessel and sample vessel support

Manufacturing of the sample vessel has completed with successful leak and vacuum tests in March 2022 in FZJ. The sample vessel and sample vessel support were consequentially installed inside the DREAM cave before the summer break (Figure 3). The sample vessel was successfully leak tested together with ESS Vacuum group. After completion of SAT of the vessel, it was removed inside the control hutch to avoid accidental damage during the final fit out of the experimental cave.

Experimental caves

The installation of the experimental caves is completed (see Figure 4a). The lift outside of the cave and movable platform were installed, albeit the motor for the platform had to be replaced. The cave crane was installed and certified. The sample vessel was installed using the cave crane and hence feasibility of operational routine was confirmed.

The electric and utility connections will be provided by ESS via common electrical project (CEP) and common utility project (CUP). Personal safety system (PSS) for the first cave will be provided by ESS as well. The requirements for all common projects are being finalized.

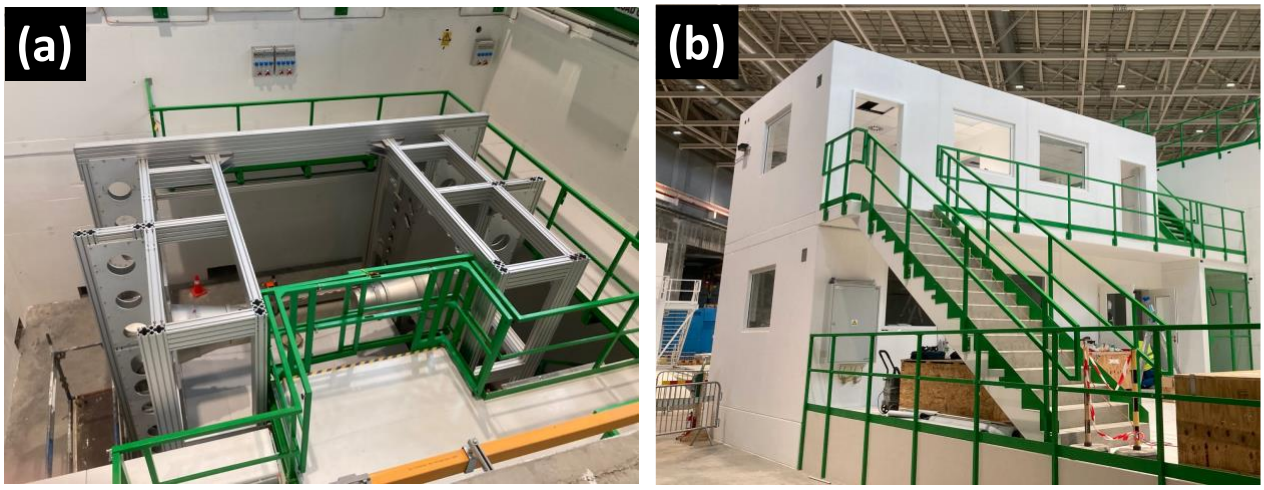

Figure 4 (a) Top view of the insides of the first experimental cave, showing the platform and detector support structure. (b) Control hutch and sample preparation lab of DREAM.

Control hutch and sample preparation lab

The construction of the control hutch and sample preparation laboratory is completed (Figure 4b). SAT will take place in the end of October 2022. The sample preparation benchtops will be procured first for the sample preparation lab.

Sample environment

So far, we were not successful in attracting bidders for the DREAM-specific sample changer cryofurnace. The scope of this project was moved to ESS sample environment group, with DREM team providing all the necessary support for procurement and contract negotiations. We will take advantage of ESS procurement rules that allow us to directly contact our preferred manufacturer, who has a relevant experience and working on delivering similar cryofurnace to another FZJ neutron diffractometer POWTEX at FRM-II. The call for tender was rewritten and approved by ESS. The formal agreement of moving the cryofurnace scope from LLB to ESS was reached.