Updates for DREAM instrument (April 2023)

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

Recruitment
The DREAM project scientist position has been opened. Potential candidates were selected and interviews were scheduled.

Schedule update
The current planning assumes a complete installation of DREAM by July 2024, which is still before the current beam-on-target (BOT) date estimates (2025). This date was moved by six months, due to a delay in delivery of the high-resolution detector by CDT GmbH. CDT has experienced a loss of personnel; thus, additional time is needed for hiring and finishing the manufacturing of the last batch of detector modules.

In-bunker optics: NBOA, BBG and Bi-spectral switch
The neutron beam optical assembly (NBOA) and bridge beam guide (BBG) were manufactured by SwissNeutronics (SNAG). The NBOA was delivered to ESS and integrated into the neutron beam port insert (NBPI). The installation of NBPI inside the bunker was completed (Figure 1).

Figure 1 DREAM NBOA is being installed.

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. The tests confirmed the expected performance of the switch, however additional measurements will be carried out in May 2023 to verify the performance with improved mechanical assembly of the wafers.

Neutron guides

The mechanical installation of the in-bunker guides is completed by FZJ and SNAG teams (Figure 2a). The guide integration with T0-chopper and the heavy shutter was done. The vacuum tests were successful. Alignment verification report and electrical isolation tests will be performed as a part of the site acceptance tests (SAT). It was agreed with the ESS that the first few meters of the in-bunker guide will be removed and re-installed by ESS to accommodate the installation of the light shutter, also performed by ESS.

The mechanical installation of the out-of-bunker guide is completed, except for the last piece of the guide entering the cave. The last section of the guide has an interface with a polarizer and magnets array for the guiding magnetic field. Factory acceptance tests (FAT) of this last piece are expected at SNAG in June 2023. The installation is scheduled after the summer break of the same year. The installed portion of the out-of-bunker guide has passed the vacuum tests (Figure 2b).

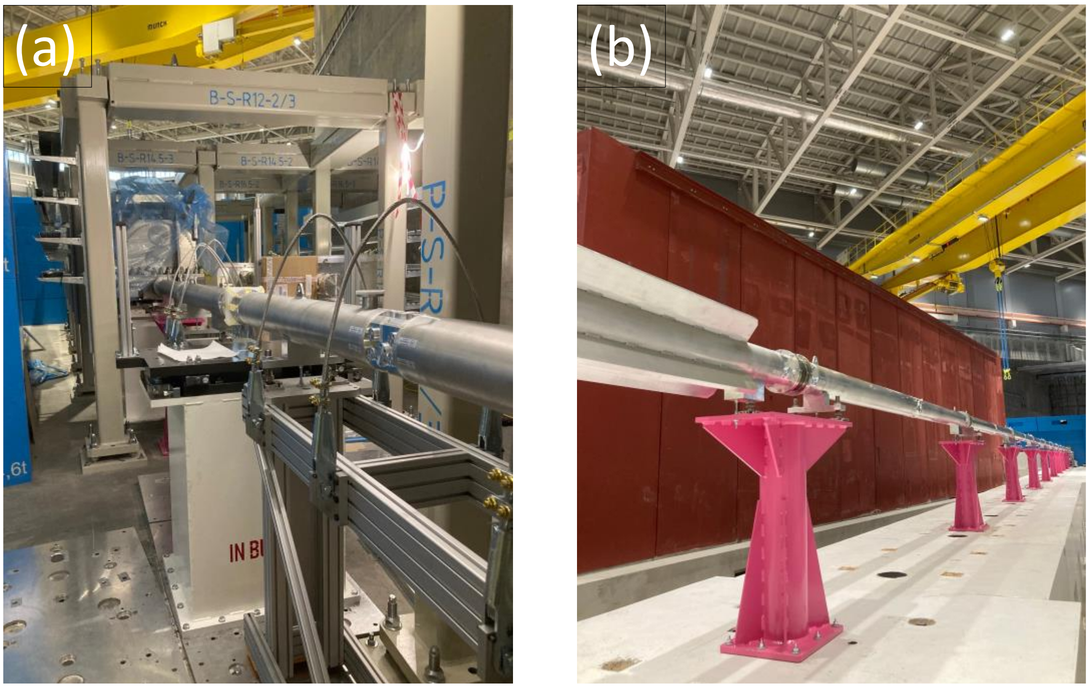

Figure 2 (a) In-bunker guides of DREAM. (b) Out-of-bunker guides of DREAM installed on the supports (pink), next to ODIN cave (red).

Neutron guide shielding

The DREAM instrument is a part of the ESS Common Shielding project. The shielding blocks were manufactured and all blocks were delivered to ESS. After completion of SAT of the out-of-bunker guides the upper blocks will be installed to cover the guides.

Chopper system

The housing and base of pulse-shaping (PSC) and band-control (BC) choppers were manufactured at the 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. During the endurance tests of the BC chopper, the hub failed. Same problem occurred with a newly manufactured hub. At the same time, no issues were reported for the PSC chopper with a much higher rotational speed of 308 Hz.

All components are now delivered to FZJ from SKF for further tests and analysis. The group leader of the ESS Chopper group will visit the FZJ Chopper group in person to discuss the BC chopper hub issue. The impact on the final installation schedule of the choppers is not clear yet. The current plan is to conduct FAT of the PSC chopper together with a small overlap chopper (OC) with the Jülich spindle. The entire assembly of PSC and OC choppers with SKF and Jülich spindles within the same housing will be tested at the given rotational speeds required for operations. At least ten different speed settings were identified by the DREAM team for the FAT. Those speeds will be used to achieve low, medium, high-resolution and intermediate modes of the instrument during the user operation.

The PSC chopper base with the remote handling mechanism was delivered to ESS. The BC chopper base was installed inside the bunker, as well as the T0 chopper (Figure 3a).

Heavy shutter

The ESS solution for the heavy shutter was based on neutronic simulations provided by the DREAM team. The heavy shutter was installed using early in-bunker access dates (Figure 3b).

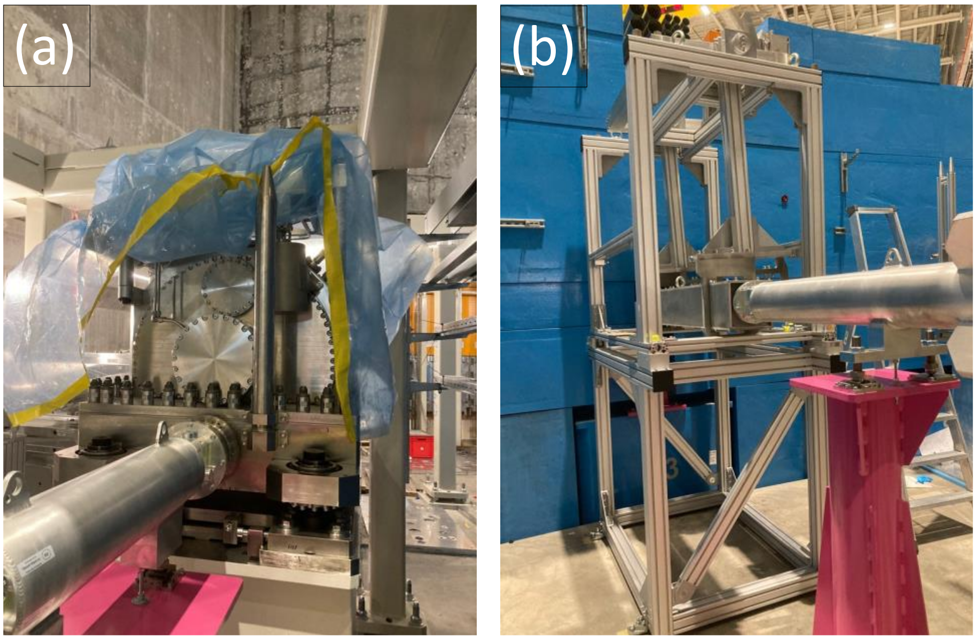

Figure 3 (a) T0 chopper and (b) heavy shutter for DREAM installed inside the bunker. The interface with the in-bunker guides is shown for both components.

Detectors

The serial production of the DREAM 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 technology as mantle and endcap detectors, however they have different modular structures consisting of interchangeable cuboids arranged around a neutron beam axis. Both detectors will offer high efficiency and resolution, with the nm-SANS detector being optimized for longer wavelengths (>2Å).

The last modules of the end-cap detector are being produced. The manufacturing of mantle detector modules is ongoing. The prototype of a cuboid module for HR and nm-SANS detectors was manufactured and successfully tested at CDT. The current planning assumes the start of the serial production in May 2023.

We expect the delivery of the mantle detectors to ESS in May 2023. It is not yet clear where to store the detectors considering their large size. We would like to avoid storing them outside of the cave, because of active construction within and around both caves initiated by the common electrical project team (see below).

The installation of the end-cap detectors is planned for September 2023, contingent upon the installation of the final piece of the neutron guide inside the cave. The mantle detectors will be installed afterward.

Common projects

The DREAM instrument is part of a common utility project (CUP) and a common electrical project (CEP). Both projects are led by ESS with input from the instrument team. As names imply, both projects will deliver necessary gas, water and electrical supplies to experimental caves and control hutches (see Figure 4a). Critical design reviews of both projects were completed. The CEP team has started the installation within the caves and underneath the elevated floor (Figure 4b). CEP installation is planned to be completed before the summer break, in June/July 2023. The monthly coordination meetings between CEP, CUP and DREAM teams will start next month.

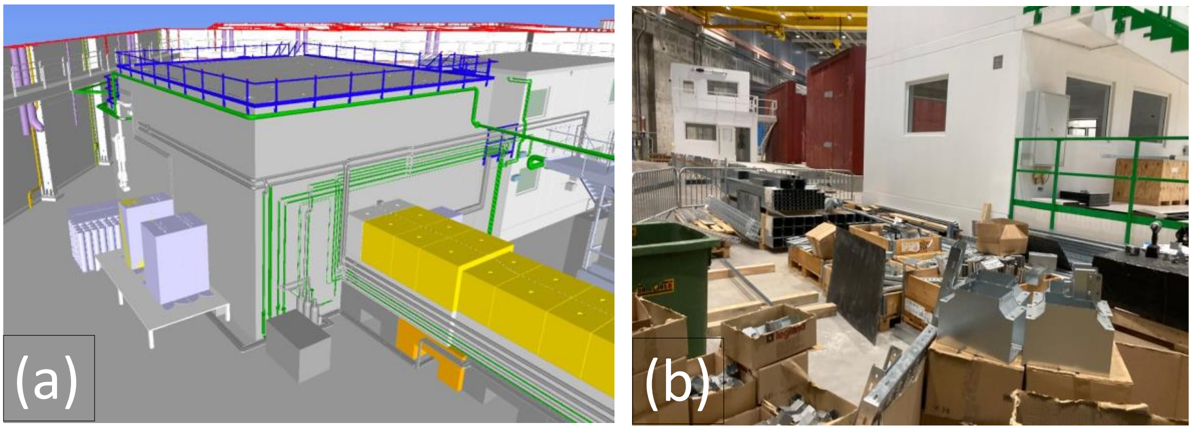

Figure 4 (a) 3D model of DREAM showing various utility connections developed by the CUP team. (b) Ongoing installation by CEP outside and inside of the DREAM cave.

Control hutch and sample preparation lab

Tests of lighting and electrical sockets inside the control hutch and sample preparation lab were successful, however the final SAT of both was delayed due to additional re-wiring. The basic sample preparation tables and chairs were ordered for the sample preparation lab.

Personnel Safety System

Personnel safety system (PSS) is developed by ESS. The PSS solution for DREAM includes a light-gate on the second level of the cave to avoid unnecessary search procedure is only the first level was accessed for a sample change. PSS solution has passed preliminarily design review.

Sample environment

The scope and budget of the DREAM-specific sample changer cryofurnace were moved to the ESS sample environment group, with the DREAM team taking a lead role in procurement and contract negotiations. Two pre-kick-off meetings took place between the chosen supplier and the DREAM team. The technical solution and limitations were discussed and communicated to the ESS sample environment team. Adding a high-temperature option to the DREAM sample changer will require additional R&D, thus the quote for the low-temperature option only was first requested.

Scientific Activities

In preparation for the first science at ESS, DREAM scientists together with the instrument data scientist from DMSC teamed up with the members of ESS Deuteration and Macromolecular Crystallisation, Chemistry and Life Science Support, and Materials and Physics Support groups to participate in the beamtimes at DESY and MAX IV facilities. We chose the synchrotron facilities to obtain data amounts that would be comparable with DREAM data rates when in full operation. Handling thousands of files Gb-size certainly requires a new approach to data management and data storage. Jupyter notebooks and Python routines were battle-tested during actual high throughput experiments. The sample synthesis and sample loading were done using ESS User Laboratories, i.e., replicating a regular DREAM user experience of preparing samples for the experiment. Moreover, we worked shoulder-to-shoulder with the sample environment group (Materials and Physics Support) members to run and troubleshoot a complex magnet setup, akin to the future setups at DREAM.