Updates for DREAM instrument

The following report describes major activities of the instrument project since the last STAP meeting in October, 2019.

ICEB meeting

The instrument consortium executive board (ICEB) for DREAM was formed and the first physical meeting took place on December 9th, 2019. During the meeting held in Jülich, the schedule, progress and issues were discussed between FZJ, LLB and ESS. The following work package exchange was agreed: LLB will manufacture entire elevated floor, not only inside the cave, while in return FZJ will take responsibility of constructing the sample preparation laboratory. The next ICEB meeting is scheduled in June via video.

Schedule update

The date for the final TG3 review was moved to December 2020. Currently, we are responding to the comments of ESS for the call for tender verification (CTV) of control hutch & sample preparation lab. CTV of beam monitors and sample environment (cryofurnace) were accepted by ESS. The most recent schedule of reviews preceding the final TG3 is outlined in Table I.

Dec'18	Mar'19	May'19	Aug'19	Nov'19	Mar '20	June '20	Oct '20	Dec'20
IDR - Bi-spectral switch - Bunker wall feedthrough - Detector support structure - Detectors - Sample vessel - Vessel support **CTV** - Chopper system (excluding T0 chopper)	**Sub-TG3.1** - Bi-spectral switch and BBG optics - Detector support structure - Detectors - Sample vessel - Vessel support	**CTV** - Cave - Bunker wall feedthrough - Neutron guides inside the bunker **Sub-TG3** - NBOA	**CTV** - Neutron guides outside the bunker	**CTV** - SEE (ESS response received)	**CTV** - T0 Chopper - Beam monitors - Hutch + Sample preparation lab	**Sub-TG3.2** - BWI -PSC + OC choppers -Heavy Shutter -Beam monitors	**Sub-TG3.2** - T0 Chopper	**Sub-TG3.3** - BC Chopper - Neutron guides (in-bunker and out-of-bunker) - Beam stop - Instrument control systems (EPICS) - Vacuum systems (ESS solution) - Relevant MCA - PSS - Interface of the ESS vacuum system - Facility infrastructure connections and utilities (not yet dealt with) - Drawing package of complete system **Final TG3**

Table 1. TG3 review schedule for DREAM. Where, IDR is the intermediate design review and CTV is the call for tender verification.

The current schedule allows DREAM to enroll into the user operations by 2024, as previously agreed with ESS (see Table 2).

Installation Milestones	Date
Guide shielding (delivery to ESS)	June - 20
Bi-spectral switch + BBG	Aug - 21
Sample Vessel Support	Sept. - 21
Neutron guides inside the bunker	Oct - 21
Heavy Shutter	Oct - 21
Beam Stop	Dec - 21
Neutron guides outside the bunker	Mar – 22
Beam Monitors	Mar – 22
Cave + Utilities + PSS	June - 22
Sample Vessel	June - 22
Hutch + sample prep. lab	June - 22
Choppers	June – 22
Detector Support	June - 22
Detectors	Sept. – 22
Start of Hot Commissioning	Jan. - 23

Table 2. Installation milestones for DREAM.

In-bunker optics: NBOA and BBG

The order for Neutron Beam Optics Assembly (NBOA) and Bridge Beam Guide (BBG) has been placed to Swiss Neutronics (SN). The design was finalized and NBOA manufacturing has begun. The fabrication of parts for shielding jackets and alignment devices are completed. The manufacturing of substrates is in progress. SN informed us that the new manufacturing schedule, updated according to the current COVID-19 situation, will be available in the second half of 2020. This should enable SN to delivery most of the NBOA guide by the end of 2020, which should not affect start of hot commissioning and user operations.

Bi-spectral switch

The order to Nob Nano Optics Berlin GmbH was placed for 200 Si wafers with dimensions of 11.8 mm x 44 mm x 0.13 mm, with NiTi-supermirror coating of m=3. Our original plan was to test the quality of the first wafers by neutron reflectivity measurements at TREFF instrument at FRM-II in April 2020. The tests will be rescheduled for the next cycle of FRM-II starting on May 25th.

Neutron guides
The neutron guide system design was accepted by ESS. The neutron guides inside and outside of the bunker are being procured as one package. Quotes have been received and technical details are iterated before commercial negotiations start. The bunker wall feedthrough is the part of this procurement and it shall be installed among the first components. Once the manufacturer is chosen, we will prioritize design and installation of the neutron guides according to the access dates to the bunker and experimental hall. The guides inside the bunker will be given the highest priority.

Status of neutron guide shielding
DREAM team has accepted the offer resulting from the ESS Common Shielding project. Currently the project is in the initial detailed design phase. The manufacturing design is being done by the supplier. Neutronics validations of this design are ongoing. After design is validated, the critical design review will take place in Q2/Q3 of 2020 at ESS.

Chopper system
The order for designing and manufacturing pulse shaping choppers (PSC) and band control (BC) chopper was placed to Jülich Chopper group. The slit pattern of disks was finalized and order for disks was placed to Airbus. The design of PSC and BC choppers is finalized. The interface between chopper housings and neutron guides is clarified.
The installation of the choppers is divided into two steps: (i) pre-installation of the base frames and (ii) installation of disks. The pre-installation work is scheduled within the D01 bunker access dates (11.08.21 – 22.02.22), however the installation of disks is scheduled for June 2022, which is after the bunker closing date (22.02.22). Thus, we need additional 2 weeks of the bunker access to complete installation of choppers. This issue was communicated to ESS during ICEB meeting. Jülich Chopper group will use any possibility to speed up manufacturing, while ESS is working on the plan of accessing the bunker after closing.

Detectors
The first segments of endcap detectors were manufactured and successfully tested with neutrons. The manufacturing of Mantle detector segments will be done in April this year. The preparation of the neutron scattering tests at TRIGA reactor in May were completed. The mounting structure for Mantle segments was manufactured. The CAD model of the segments was used to generate a voxel map for data reduction. However, the tests are likely to be postponed (see the last section of this report). The procurement of entire detector system will begin in Q3 2020.

Experimental cave
The procurement of the cave has begun at LLB. The details of the roof opening, cabling, utilities are being finalized. The interface with the final design of the detector support structure is being verified.

Development of personnel safety system (PSS)
DREAM – PSS workshop was held in February 2020 at ESS. Based on discussions, the instrument hazard analysis, radiation hazard and operational scenarios have been updated and submitted to ESS. The confluence pages were created by ESS-PSS team to track the progress.

Sample vessel & Detector support structure

The first Al parts for the sample vessel were delivered to FZJ (see Figure 1). Neutron windows for the vacuum cones of the sample vessel has arrived. The detailed design of the swing door with viewports is ongoing. The order for neutron windows and bellows has been placed to external companies.

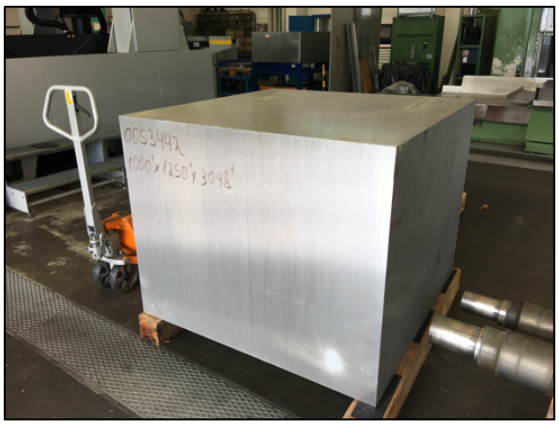

Figure 1. Al proto-material for the sample vessel inside FZJ workshop.

The design of the detector support structure was finalized and order for Al profiles was placed to ITEM. Assembly of entire structure is planned in May. The conceptual design of the Mantle detector assemble unit is ongoing.

DREAM-specific cryofurnace with sample changer

The design of a specific cryofurnace for DREAM, part of instrument project, has been extensively discussed with SAD. This close-cycle cryofurnace will allow handling up to 20 samples in a single loading procedure from room temperature, ambient pressure. It will provide an internal automated sample exchanger enabling to position any sample from the precooling stage to the scattering position and vice-versa. It will be either attached to the upper flange of DREAM sample vessel or floor mounted using an adaptor plate on the DREAM sample support table. The cryofurnace will be designed such as it can be operated on a trolley outside the cave and rapidly moved into the beam position without warming up the cryogenic/heating module nor disconnecting the tubes connected to the compressor stage. The tendering includes electronics compatible with ESS standards for the sample positioning, temperature control and temperature measurement.

Simulations of DREAM detectors response

In March, we started a collaboration project with ESS Detector group and DMSC. The goal of the project is to use McStas / Vitess to estimate the neutron transport on the sample position at various resolution settings of DREAM. Then, this information will be used in Geant4 to simulate the neutron scattering experiments using layout of DREAM detection system. Such virtual experiments will be used to develop the data reduction protocols in Mantid for DREAM in collaboration with DMSC. It will help us to prepare for the first day science by estimating parameters relevant for diffraction users (peak profiles, counting times, Q-range) at various instrument settings, long before the instrument takes first neutrons.

This project is not in the instrument scope, however we believe it is vital for the instrument team to get involved now, when the data reduction protocols are being developed by DMSC.

DREAM LLB scientist Dr. Florence Porcher is a project leader. The progress is documented in here: https://confluence.esss.lu.se/display/DREAM/Simulations+of+DREAM+detectors

External funding for SANS detector and polarizer

The external funding for construction of SANS detector and polarizer for DREAM was obtained via Swedish-German research collaboration Röntgen-Ångström Cluster (RÅC). The project titled "nPDFSAS: Simultaneous polarized SANS and NPDF methods to study novel electrode nanomaterials" is aimed to enable simultaneous PDF and polarized SANS measurements at DREAM of magnetic nanoparticles during cycling in electrochemical cell in order to provide a new in-situ tool for monitoring battery performance. The schedule foresees SANS detector and polarizer tested and installed in April 2023, before start of the user program in January 2024. Having both SANS detector and polarized neutrons will significantly enhance our capabilities to deliver first science. We are also working closely with a newly established ESS polarization group to design the analyzer as well, which might be delivered by ESS.

COVID-19 impact

As of now we do not foresee an impact of COVID-19 situation on starting of the hot commissioning and user operations at DREAM. The design work and communications between us and manufacturers, as well as with ESS are ongoing via phone and video conferences. The challenge is a limited access to neutron scattering facilities, which resulted in postponing neutron scattering tests for some of the instrument components.The neutron scattering tests of the first wafers for bi-spectral switch are postponed into late May or June. However, we still have quite some time before it has to be installed at ESS (August 2021). It is not officially cancelled, however, we foresee the postponing of the neutron scattering tests of the Mantle detector segments at TRIGA reactor, originally scheduled in May 2020. The Swiss Neutronics, manufacturer of NBOA, has informed us that there is an uncertainty with neutron scattering tests of m-coating of supermirrors as well. They are in contact with all potential facilities to follow their plans for neutron production and to evaluate the options for reflectivity measurements. The chopper manufacturer (Jülich Chopper group) does not foresee any delays at the moment. However, if the situation stays like today for more than 4 weeks or longer, they will have to re-think the impact on the schedule. At CEA, the COVID-19 crisis has frozen all scientific purchases. There is no impact, from LLB side, on the neutron guide shielding as it is part of the ESS common shielding project. However, the experimental cave and cryofurnace calls for tender will be delayed for about 2 months, which is still acceptable.