# Materials Science and Physics Support MSPS
# Update for the STAP (Spring 24)

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Since the 1st of February, polarisation has moved out of the MSPS group. The group is now fully focusing on the delivery of sample environment systems needed for first science, setting up the new lab spaces in D08 and the SLIME lab in E03 and preparing for operation.
The team is now composed of:

- **2 technicians**: Richard Ammer (AM) and Lauritz Saxtrup (LJS)
- **2 control engineers**: Niklas Ekström (NE) and Andreas Hagelberg (AH)
- **4 sample environment engineers**: Alexander Holmes (ATH), Oleksiy Zadorozhko (OZ), Damian Paliwoda (DP) and Caroline Curfs (CC)

In addition, we have the support of Luca Sagliano (LS) as mechanical designer and Yulia Pedersen (YP) as technical writer.

A **new position** is currently open for a **sample environment engineer for high temperature**. The closing date is end of April.
We are also planning to recruit **2 more technicians** before the end of 2024.

In November 2023, we presented the MSPS vision for **steady state operation (SSO)** to the SSO review committee. A list of responsibilities and tasks for the group was presented, as well as the role for each category of personal and the number of resources envisioned. The scope, responsibilities and tasks for the MSPS will be:

- **Provide, maintain and operate** sample environment systems (SES) in the fields of
  - Low and Ultra low temperatures
  - Magnetic and electric fields
  - High temperature
  - High pressure
  - Mechanical processing
- **Support instruments** in installing and running complicated SES
- Provide **mechanical integration**, **control electronics** and **control integration** of complex systems (not directly integrable in EPICS)
- Provide **users support** for quantum materials, physics and mechanical engineering.
- Run and operate the **mechanical processing users workshop** (BEER and ODIN) and the only **mechanical workshop** in the supervised zone
- Organise the **liquid helium cycle** and monitor helium consumption

The roles have been defined as followed:

- **Line manager**
  - Manage the group (recruitment, administrative tasks)
  - Coordinate the efforts: organise the tasks, schedule the SES use (planning) during operation
- **Sample environment engineers =** Expert in one of MSPS scope fields (B, E, HT, HP, LT, MP)
  - Develop, procure, commission, calibrate and operate sample environment systems
  - Manage projects and take care of the documentation requested to be able to operate the systems
  - Procure sample environment systems
- **Control engineers**
  - Develop electronics and control systems for sample environment systems
  - Control integration of complex systems, not directly integrable in EPICS
- **Technicians**
  - Operate, maintain, refurbish, repair sample environment systems
  - Operate and maintain workshops, including mechanical workshop
  - Mechanical integration of sample environment systems

The resources needed to fulfil these tasks have been estimated to:

| | **Engineers** | **Technicians** |
|---|---|---|
| **Low and ultra low temperature** | 1 | 3 |
| **Magnets** | 1 | 2 |
| **High temperature** | 1 | 1 |
| **Mechanical processing** | 1 + 1 (for lab) | 1 |
| **High pressure** | 1 | 1 |
| **Control** | 2 | |
| **Total** | **8** | **8** |

The technical resources are presented in the above table for each domain of expertise. However, the technicians are not expected to be dedicated to one engineer and will cover the engineers needs depending on their knowledge. To limit the number of people on call at nights and during the week-ends, interchangeability of resources for the simple tasks will be encouraged.

The SSO review panel suggested that more resources should be allocated and a full service should be provided. This includes the installation of the SES on the instruments, as well as the cooling down when needed, and the refill of the magnets and cryostats during operation.

## Training, conferences and collaborations:

### *Visits, training and experiments at large facilities*

In October 2023, DP and Joel Hagman (polarisation) participated in the ISSE workshop in Japan.

Several visits to ISIS were organized at the beginning of 2024: DP in January 24 and LS, OZ and CC in March 24. The aim of these visits was to have a look at the labs and sample environment systems used at ISIS but also to discuss with the technicians and engineers. DP discussed in particular the H2 loading, high pressure and SANS cells development. OZ and CC participated in activities to check the calibration of thermometers in temperature ranges lower than 1K. They also discussed issues regarding high and low-temperature measurement, as well as high pressure. Additionally, they studied the assembly of the recovery line for helium gas. Moreover, they discussed the design of He3 wide-angle polarised cell. OZ visited AS Scientific Products Ltd. During this visit he discussed issues regarding manufacturing “wet” and “dry” cryostats as well as cryofurnaces. LS and CC met the Engin-X team to discuss the UHT furnace. It was also a good opportunity for CC to discuss more in depth about the organization and roles of people during operation. The ISIS team has been extremely helpful and shared their knowledge very easily with the ESS people.

In February 24, DP, LS and RA went to LLB, France for a training organized within the In-Kind project framework on high pressure. They were trained on the machining of liquid and gas cells and their testing using the manual Top-industrie compressor.

ATH travelled to Tokai, Japan for two weeks in March 2024. His travel was funded by the SAKURA scheme and hosted by the J-PARC sample environment group. He took part principally in a pulsed magnet experiment, part of a long-term collaboration between ISSP, university of Tokyo, and J-PARC. This is the type of experiment that ESS will need to support in future, so very valuable experience. He also took part in a number of other experiment changeovers on three different beamlines in total, as well as visiting the JRR3 reactor.

### *Conferences and workshop*

In December 23, CC went to the HiRES conferences hosted by ILL, France. It gave her the opportunity to visit the sample environment labs, discuss with Eddy and have a look at the MEOP station for polarization.

In March 24, NE and Anders Petersson (ECDC) went to PSI, Switzerland, for a meeting on SECOP.

ESS will organize 2024 IUCr High Pressure Workshop in Lund between September 25$^{th}$ and 28$^{th}$. The workshop has been announced in public and some invited speakers confirmed their attendance. During the visit to ISIS, Damian was asked to organize half-day long satellite meeting of the League of advanced European Neutron Sources (LENS) High Pressure Sub Working Group. This is a closed event for high pressure scientists, engineer and technicians

from European Neutron Sources that are working on development of high-pressure experimentation. It will be held onsite at ESS on September 24th. The registration is now open.

ESS is also participating, in collaboration with MAX IV, in the organization of the next ISSE (International Society for Sample Environment) meeting in September 2024, which will take place in Båstad, Sweden.

***Grants and external project***

ESS is a partner in the 10M€ EC INFRATECH proposal BOBINE. If this is successful it will fund the development of a new generation of High-$T_c$ superconducting magnets, and high repetition rate pulsed magnets which will can be hosted on ESS beamlines. ESS will also provide expertise from our own staff (OZ and ATH) in dilution fridge development and transportable cryomagnets shared between facilities, the latter to maximise utility of such equipment. This grant proposal contains funding for additional resources to enable ESS to be an effective partner in the project.
ESS is also participating, mainly as an observer, in the THEIA INFRATECH proposal on the development of new tribometers dedicated to in-situ experiments at large facilities.

Unfortunately, the STRESSCON proposal, a Danish national project on residual stress measurements, was not granted. If successful, ESS would have got a post doc for 2 years to work on the alignment system for BEER. We are working with the Danish Technological Institute if other national calls could help us to fund this project.

The inaugural meeting for the NEXT competence center will take place via zoom on the 11th of April.

## Labs and Workshops:

The SLIME lab in the E03 building has been cleaning and is now being furnished to host the mechanical processing and high temperature pieces of equipment. It is currently being used by the instruments to tests some equipment before their installation in the cave such as detectors and choppers.

The installation of the utilities in D08 has just started and should be finished before summer 2024. We are planning to occupy and use these labs, especially the high-pressure labs, during fall 2024.

The pressure bunker, which is actually in the D01 experimental hall, will be moved closer to the D08 lab, just behind the DREAM cave.

## Sample Environment systems:

### *Magnets (ATH):*

- Instrument magnet meeting:

A meeting was held at the end of January with interested instrument scientists, and other stakeholders to reprioritise the next set of magnet investments for ESS, in the context of the currently available magnets, and those in production. The top priorities were found to be a high field >10T SANS magnet, a low field electromagnet (now being procured in collaboration with the instrument teams), followed by general purpose ~10 T large aperture magnets for spectroscopy and diffraction.

- 8T Magnet:

There are some concerns with progress of this magnet, after assurances that a manufacturer for the coil former had been found, we have not had further updates from Cryogenic Ltd. Xavier Fabrèges (LLB in-kind partner) is chasing them for a response. Some delays to delivery are expected, but difficult to quantify until we get an update from Cryogenic.

- 2.5 T Warm Bore Magnet:

The magnet is in the manufacturing stage, and is progressing according to schedule. The adapter for ESTIA, and other bottom loading instruments, has been designed and is ready to start manufacturing.

- 6.5 T HZB Magnet:

The 6.5T magnet has been tested to full field with original electronics, using SECOP to control it remotely, and NIKOS integration via Octopy/SECOP has been done and tested. This will form the basis for any future magnet control user interfaces. Updated (Mercury) power suppy electronics have been delivered. The updated rack design has been slightly simplified from the new VM1B rack, the Mercury iTC is not needed and all functions can be carried out with a combination of lakeshore temperature controller and Oxford power supply with some additional modules for needle valve control etc.

- 15 T HZB Magnet:

The 15T magnet VM1B has now been tested with both new (OxInst Mercury) and old electronics. Basic Octopy control of the new electronics has been tested. We are currently working on implementing full control logic into Octopy, when this is done the VM1 magnet will be tested directly with the new setup.

- Spectroscopy Magnet:

A design study is under way with Oxford Instruments for a low background 14T magnet adapted to the needs of CSPEC and TREX. Oxford will perform full electromechanical calculations of two proposed coil designs, and also simulations of magnetic materials and any quench effects.

- Magnetic Force Testing Rig:

Further non-conformities had been found in replacement parts for the rig, the manufacturer is providing further replacements. Whilst slightly out of specification, with minor modification we can still use the parts already supplied.

***Cryostats (OZ)***

- Dry Cryofurnace for Electrochemistry (ATH)

The procurement for this cryofurnace has been completed and was awarded to AS Scientific, kick-off was held in December 2023. The preliminary design is under way.

- DREAM cryofurnace:

Several meetings with the envisioned manufacturer took place during fall 23. Unfortunately, it has been impossible to obtain a quotation and after 3 months of trying, it has been decided to try again with an open call for tender via the ESS procurement. All the documentations are already written and the process should go fast.

- Other cryofurnaces and cryostats (wet and dry):

Requirements for 5 “wet” Cryostats, 3 “dry” Cryostats and 2 Cryofurnaces for Neutron Beam Instruments are specified in Statement of Work and sent to procurement department.

The tender for the design and manufacturing of these cryogenic systems is being prepared, attention is being paid to detail outlined in the Statement of Work. This includes not only the technical specifications but also factors such as durability, reliability, and compatibility with existing infrastructure.

- Dilution refrigerator (in-kind LLB with 8T magnet):

The tender for the design and manufacturing of the dilution stick was published by LLB, marking a next step in the procurement process. With the deadline for tender submissions set for March 13, the response was somewhat limited, with only one company expressing interest and providing an offer to fulfill the order. The interested party was ICEoxford Ltd.

Regrettably, despite ICEoxford Ltd.'s submission, their offer was ultimately rejected. The rejection of ICEoxford Ltd.'s offer underscores the challenges inherent in the procurement process, particularly when seeking specialized equipment tailored to unique specifications.

Moving forward, ESS reassess its approach to procurement. ESS is going to issue the tender itself which help to remove uncertainties by acting as a third party.

- Dilution refrigerator (HZB):

Dilution stick was successfully cooled down in the 15T magnet. The base temperature was 27 mK. The sample was subjected to temperature cycles between 30 mK and 500 mK

***High-Pressure (DP)***

- 10 bar He gas pressure generator:

Several tests have been performed after successful SAT revealing serious issues with Top-Industrie compressor unit. Some sealings have been replaced upon request from 10 kbar He gas pressure generator’s manufacturer and the unit has been sent back to France for refurbishment. It has been returned back to Sweden, but it did not work again. SiTEC requested to send it back to Switzerland where the compressor has been rebuilt. It has been now shipped back to Sweden and we will install it back in April.

- Gas, liquid and clamp high pressure cells

Manual Top-Industrie liquid compressor up to 7000 bars is now ready for operation and tests of liquid cells are going to be performed by the end of March / beginning of April.

- Paris-Edinburgh Presses

The PE presses will be delivered (together with PE press gas loader) in April 2024 according to the LLB statement.

- High-pressure Paris-Edinburgh Gas Loading System

The Factory Acceptance Test was successfully performed at LLB on January 31st 2024. The E press gas loader will be delivered together with PE presses to ESS in April 2024. The Site Acceptance Test is planned on September 24th 2024, just before the LENS Meeting (this delay is due to other commitments of the IK partner).

- Cryostat for Paris-Edinburgh presses

The design details have been discussed with LLB IK Partner in the middle of January. Most parts are now delivered to ILL, where HP CCR is going to be assembled in the Fall 2024.

- High Pressure SANS cells

Discussion on the need for HP SANS experiments is ongoing between SE and Instrument Scientists. There is a possibility for close cooperation on the development of SANS hp cells with ILL, but the expertise in FEA engineering and additional resources are required.

***Mechanical processing (CC)***

- Uniaxal deformation rig:

The NPI rig is still not fully operational and we are still looking for some case studies to be able to improve it. Nevertheless, NPI has worked on the software and a new version should be sent to us very soon. Once implemented, we will do some tests to see how the new system is working and if it can be further improved. In the meantime, we have been contacted by a company which is willing to do some tests on the rig in compression with high temperature. It will be our first use case.

- Tortion/rotation rig:

LS is still working on the mechanical drawings done by Lund University through a SRESS project, to be able to manufacture the parts. The off-the-shelf parts will be purchased soon and we hope that the new rig will be built before the end of the year.

***High-Temperature (CC)***

- ILL-type furnaces:

The discharge from the reactor (LLB) of the 2 second hand ILL-type furnaces has been agreed. However, the agreement for their transfer to ESS is still under the CNRS scrutiny. In the meantime, we have started to look into the procurement of another vacuum furnace. The 2 second hand furnaces' heaters and thermal shields are made of Niobium, which enables to reach a maximum temperature of 1600-1800 C. However, the diffraction of the Niobium foils can be an issue for some experiments and, since the DREAM diffractometer will not have collimators at the beginning of operation, it has been decided to procure a fully vanadium

furnace. Despite a lower running temperature of 1100 C, it will enable a more uniform background.

- Induction furnace:

It has not been possible to find an external partner for this project. Consequently, the project is now on stand-by until a high temperature sample environment engineer is recruited.

- Hot air blower/cryojet system:

The design of the system has been finished before Quentin Borlet's departure in January 2024. All off-the-shelf parts have been purchased, except for the cryostream. The XY translation stage has just arrived at ESS and the ARINAX nozzle exchanger will be delivered at the end of May. The design of the base plate is being reviewed and once finalized, will be manufactured by ESS. The hot air blower has been integrated into EPICS. The control of the motors has already been discussed with the Motion Control group (MCA) and AH. To perform the first tests, we will use a second hand cryostream which has been donated to us by Oxford University

- UHT furnace:

It has been decided with Chalmers University that the final drawings, fabrication, mounting and tests of the furnace will be done by ESS. The conceptual design has been recently transferred to ESS and LS is working on implementing it in the NPI stress rig. The remaining fundings of the VR grants will be transferred from Chalmers to us. Once done, we will be able to get more design resources to support LS. During the last visit to ISIS, LS and CC met the Engin-X and the sample environment mechanical design teams. They discussed the lamp furnace they have and show the bulbs and reflectors which arrived recently at ISIS. Unfortunately, it has not been able to test them. ISIS is supporting ESS in this challenging project, which will be the first concrete SES development together.

***Control integration (NE and AH)***

VM2 has successully been integrated all the way to NICOS via EPICS using Octopy.

Work on updating the documentation of Octopy has been going on for a while, the aim is to look similar to the new SECoP documentation. LJS is involved in this to increase the number of people in the team with deeper knowledge of the Octopy API and SECoP.

We have successfully deployed Octopy on a Beckhoff PLC. This means that for systems that uses a PLC we may not need to have a separate computer as well, which can reduce the complexity and required maintenance.

Octopy continues to be developed as new needs comes up, for example a generalized way to create a common SECoP status from several data sources is under development.

***Mechanical integration (LJS and LS)***

- Sample Environment Vacuum Tank (LJS)

Ongoing request for quotations for the design and construction of a vacuum tank intended for testing the mechanical integration of Sample Environment equipment into top-loaded instruments. Additionally, this tank will serve as a reference for testing both new and modified equipment offline when we are in operation.

- Mechanical integration (LS)

The Warm bore Magnet has been mechanically integrated. Other integrations are going on: Stress torsion rig, ASM sample changer and 8T magnet (after receiving final design).

**Helium management**

- Helium recovery:

We have received from HZB a supply of level meters, ILM readout modules, gas counter modules and other electronics which will be used for the helium management system. ICS has agreed to host the database and maintain the software side of the helium management system. The HZB helium level meters and ILM modules have been tested with existing helium storage dewar with two different types of probes, and appropriate readout parameters found. The database and HZB software are installed and have been tested.

**Miscellaneous**

- Pumping cart:

We have built the controller boxes for five pumping carts. The carts themselves are in the process of being assembled. The controller boxes have the same basic make-up as the prototypes with a Beckhoff PLC and a Fitlet computer. They also have an helium meter from HZB built-in. It's not connected to the rest of the system, but put inside the box to have a more compact system. Some of the vacuum valves that were chosen for our prototypes are no longer available for purchase so we have had to replace them different, more expensive models. We also discovered issues with the MKS vacuum transducers used making them report incorrect measurements when used in the way we use them. We will replace them with similar transducers from Sense4 instead.

- Ceramic 3D-printing (AH):

We have successfully done our first 3D-printing in ceramic (Zirconia). We think 3D-printed ceramic parts will be of benefit for users doing high-temperature experiments so we want to build up the experience and know-how for doing this before SOUP.

- Electronics:

We have constructed a control box and done much of the wiring for a solid/liquid cell sample changer that is being built for ESTIA and FREIA. The box controls the six electro-magnetic valves and measure the temperature of each of the seven cells, with option to add another three cells in the future. Integration will be done by ICS.
A control box for reading multiple PT100 temperature sensors was constructed for BIFROST. It will be used to measuring the level of liquid nitrogen and monitoring temperatures of a N2-tank. Interation will be done by ICS.

**Questions/Charges**

- The first MSPS plan for steady state operation (SSO) has been presented at the beginning of this report. ESS management will optimize the developed SSO model following, when appropriate, advice from the reviewers. In this context we would like the STAP to comment on the completeness of the tasks presented (did we forget tasks which will require resources?)

- The SSO review panel suggested to provide a full service to the users carrying out experiments on neutron instruments, including the full installation of thesample environment equipment on the instruments and the refill of dewars, cryostats and magnets. Those services would be in addition to the more complex tasks (e.g. dilution fridge) which were originally foreseen. STAP is invited to comment on this service approach and advice on a possible implementation method. What are the advantages and drawbacks of this type of full service model? What tasks would be better performed by the instrument staff?

- The SSO review panel suggested to increase the number of technicians. What would be an appropriate number for each planned task?

- The need for Paris-Edinburgh press high pressure high temperature synthesis / operation has been expressed by the potential high pressure user community. At the moment this will need additional resources for developing high temperature equipment. What is the advice of the STAP members regarding such development?