Materials Science and Physics Support (MSPS) STAP Report – October 2024

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INTRODUCTION

This is a brief STAP report based on the MSPS update by Caroline Curfs and a Q&A session with the ESS on October 21. A summary ("bullet points") of this report was then submitted to the ESS SAC, October 23.

ORGANISATION

We welcome Hanna Wacklin-Knecht as leader of the Scientific Support Division, which includes both MSPS and CLS. It is our belief and hope that she will enable the team members of MSPS and CLS to grow into a cohesive group, working together towards a successful sample-environment support function.

On-site progress appears to be very good with a variety of relevant tasks being processed. There is an even balance of practical commissioning of equipment, in-house development, as well as external sourcing, and a good amount of training/networking with other institutes.

The number of MSPS engineers planned for 2027 is at a minimum level but includes at least one subject-matter expert for each major technique (provided that a high-temperature expert can be hired). However, the staff ramp-up plan to 2027 is lean on controls, integration, and especially technicians. Currently, they have only one technician, Lauritz Saxtrup, who is now supporting high pressure, low-temperature, magnets, and high temperature. Further technicians should be hired as soon as possible to work with Lauritz and learn the details of their sample environments in prepartion for first science at beamlines.

OUTREACH AND TRAINING

It's great that training of sample environment and instrument staff has started with conference attendance and training at other facilities. In user service you need failsafe procedures. This includes a long experience of the staff in handling of all the systems. So training should be (and seems to be planned as) a constant activity. We encourage a continuation with e.g. internship and participation in experiments that are focused on activities with direct relation to the work at the ESS.

Immersing some group members in standard procedures at other facilities like Oleksiy's visit to ISIS was a good move with the prospect of the startup of ESS in mind and should be kept up. Training lessons with the instrument groups are also important and will strengthen the links to the instruments.

We would like to congratulate MSPS for hosting the High Pressure IUCR meeting in Lund, and the collaboration with MAX IV to organise the 12th ISSE Workshop in Båstad this Autumn. These meetings were very successful and are great opportunities to highlight current and future capabilities and grow the user communities.

MAGNETS, CRYOSTATS, AND HELIUM MANAGEMENT

A meeting with instruments in January 2024 identified the prioritized magnets for first science. Questions remain on the high-field spectroscopy magnet. At ISIS the spectrocopy magnets (9 T and 7.5 T) are from Oxford Instruments and are based on the MD50 cryostats with pulse tube coolers, as well as MD20 cryostats with LN2 cooled radiation shields. The 9 T magnet has a helium bath capacity of 85 L and the 7.5 T a helium bath capacity of 20 L. The smaller MD20 type cryostats needs cryogen top up on a frequent basis which disrupt measurements, therefore the larger helium capacity of the MD50 is more advantageous for the ESS - but will cost more.

The magnet construction is a key factor for detector visibility and it is good to see this is being thought about, the higher the field the less the magnet opening, and a smaller magnet bore to accept the Variable Temperature Insert (VTI). Higher-field magnets tend to follow the concentric ring construction with a smaller opening of approximately 15°, while the wedge type design at ISIS allows a vertical opening of 30°. The spectroscopy community tend to want to see as much detector coverage as possible and favours the wedge design.
A recent ISIS enquiry with Oxford Instruments regarding a remake of the MD20 8 T at 4.2 K or 10 T at 2.2 K with lambda-plate cooling for diffraction in 2000 was estimated to cost of 800 000 GBP in todays costings. The significance of this is that the 10 T field is now offered at 4.2 K due to higher quality superconducting wire and improved coil winding techniques as opposed to 8 T in 2000. The 14 T magnet that the ESS is considering may be a remake of the ISIS system and improved construction methods and material qualities will reduce procurement risks compared to the systems purchased nearly 20 years ago.

Both ISIS spectroscopy magnets have tapped holes predrilled in the visible beam path on the magnet formers to allow for boron nitride tiles to be retrofitted for reduced background, which ensures the cleanest data sets for the user community and is an extremely important addition to the systems.

In conversation with ISIS instrument scientists from the excitations community the statistics show that 35% of users require the full field of 9 T spectroscopy magnets. The remaining 65% use fields up to 5 T.

The ESS team have commissioned Oxford Instruments to do a design study for a 14 T system and we believe that it is a good idea to commission this work, but it is also important to ensure that a bidding company has the competency to produce a wide angle access magnet for spectroscopy - the contract and open tender should be pursued with caution.

MSPS charge question: Should MSPS take the technical risk of buying a very high field magnet (14 T) for spectroscopy or go for a more standard lower field one?
Our STAP strongly believes that the highest fields possible are needed in the long run. but as a start, a lightweight, easy to handle, medium-field system should be procured. However, in full user operation, both these types of systems will be required by users.

Testing of SE systems and procurement is ongoing which is good to see, the ESS already has a good range of inherited magnets and it is also good that testing for forces due to magnetic fields are being considered.

The procurement of pool cryostats for the ESS user program is in progress and AS Scientific has been awarded 10 systems. This is all good, but ISIS and other facilities have had considerable issues with the ILL fast-cooling upgraded cryostats offered by AS Scientific and caution needs to be taken to the point where these cryostats should not be procured due their complex design. AS Scientific are unable to produce these systems with any promise that they will give a good long service. ISIS has experienced many failures of the fast-cooling devices (the standard ILL design works fine).

Of general concern is the logistics involved in moving the recondensing systems. They are good if they are used in one place but disconnection of e.g. pulse-tube pressure lines and transportation of these big magnet systems and all of the ancillaries around the experimental halls are tedious, time consuming and come with a risk to the fragile magnet systems.

HIGH-PRESSURE, HIGH-TEMPERATURE, AND MECHANICAL PROCESSING

The arrival and site acceptance of the gas loader for the Paris-Edinburgh cells is a very positive development and we encourage the team to start using it to be fully comfortable with it in operation.

It is noted that the SITEC 10 kbar pressure intensifier has been remanufactured and successfully tested 10 times to the highest pressure. We hope that the previous issues with the Top Industries pump finally have been resolved.

We also positively noted the renewed communication with various instrument scientists on desired capabilities such as SANS pressure cells and uniaxial cells. We encourage such a direct communication with instrument scientists. Rough numbers form SNS suggests that at least 20% of pressure requests are from SANS instruments, 25% are clamped piston-cylinder cells and 35% are opposed anvil cells (that is Paris-edinburgh and diamond anvil cells). The remaining 20% use other types of cells (gas cells, uniaxial cells etc.).

There are several collaboration projects that appear to be progressing well (UHT furnace with Chalmers Univ. and ISIS, NPI stress rig with Alfa Laval). However, the contact with LLB on the high-temperature furnaces is not working well. Both status updates and LLB-ESS transfer plan is missing. With the lack of response from LLB, we think that the move to look for other options is the right way forward.

CONTROL AND MECHANICAL INTEGRATION

It's great to see that the idea of easy integration of sample environment equipment is working with Octopy (see Lund's 17 T SANS magnet). The training of parts of the sample environment staff to do fast adjustments on their own could be beneficial in user operation.

The use of Octopy is growing in the ESS and other facilities. An additional staff member may be required to support the development and maintenance of Octopy and other in-house software development.

It is recommended to share a common software and control electronics for the two mechanical rigs. It seems that Labview is used for the in-kind Czech rig and that the in-house constructed rig will use Beckhoff PLC control. The use of Beckhoff PLC on both rigs is recommended.

The purchase of a sample-environment vacuum tank is very much endorsed. It is fundamentally important for testing equipment that will operate in vacuum, such as top-loading CCR systems.
It is good to see that the ESS SE teams have procured a test tank. These types of vacuum tanks have proved invaluable in commissioning and baseline testing of equipment performed in ideal conditions, and will become useful when there are issues with kits that drop in performance.