

## Update on ESS polarisation work from 2019 Q4 - present

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### Centralised polarisation service and polarisation upgrade project

The ESS has established a centralised polarisation support service in the Instrument Technologies Division to facilitate the incorporation and subsequent operational support of polarisation capabilities for the neutron scattering instruments at ESS. The incorporation of the capabilities is a project running concurrently to the instrument schedule; the decision to run this project concurrently was drawn from the experiences of incorporating polarised neutron capabilities at many facilities worldwide.

All instruments continue with the design and construction in their respective current scope. In fact, during the scope setting of the respective instruments, ESS explicitly considered a centralised project and removed scope, which could be centralised, from the individual instrument construction project. Consequently, there is no scope change to any instrument. Necessary accommodation in the instrument design to incorporate polarisation is however encouraged to ensure a seamless upgrade process and a smooth operation in the future. The instrument teams and the centralised polarisation project team are expected to closely coordinate and collaborate to ensure the project's success.

### 2019.Q4 – 2020 Q1

In October 2019, Wai Tung (Hal) Lee started working at ESS as the lead scientist for the centralised polarisation support. His experience includes polarised neutron instrumentation R&D at ORNL, managing a project to incorporate polarisation capabilities at multiple instruments at ANSTO. Hal's instrumentation expertise includes solid state polarising devices, MEOP and SEOP polarised  $^3\text{He}$  techniques as well as magnetic field devices.

From October 2019 to February this year, initial discussions were held with instrument scientists of all of the 15 approved instruments of the NSS project. Subsequently, detailed discussions on polarisation were held with teams of 12 instruments (see Table 1) that would provide polarisation. The 12 instruments include all instruments that had included polarisation in their initial scope prior to scope setting as well as additional instruments that will significantly benefit from having polarisation capabilities. As two instruments are dedicated polarised neutron instruments, the bulk of the work required will focus primarily on those 10 instruments with necessary support provided to the 2 dedicated instruments.

Diffraction	Large-Scale Structures
DREAM	LoKI
HEIMDAL	SKADI
MAGiC*	ESTIA*
	FREIA
Spectroscopy	Engineering & Industrial
BIFROST	ODIN
CSPEC	
MIRACLES	
T-REX	

Table 1. Instruments potentially with polarisation capability. ESTIA and MAGiC have polarisation in their respective scope (\*).

For Diffraction instruments, MAGiC is a dedicated polarised neutron instrument and we continue to assist the instrument team where applicable. DREAM has recently received approval for its proposal

to Röntgen-Ångström Cluster, which includes an *in-situ* polarised  $^3\text{He}$  neutron polariser. We are coordinating with the DREAM team on the polarisation setup to ensure a smooth incorporation and future operational support of the polarisation setup. The analyser for DREAM and the polarisation setp for HEIMDAL will potentially provided by the ESS centralised polarisation support.

Fact-finding visits to 7 institutes and 5 major equipment builders were done to get the latest instrumentation experiences and gauge the equipment supply capacity. Information has also been received from 3 manufacturers outside of Europe. Coordination with DMSC has also begun to develop the data processing methodology and baseline reduction routines using Scipp.

A polarisation workshop was initially planned for 26th - 27th of March. The workshop would bring together researchers representing future user community, experts in polarisation instrumentation R&D and operation from institutes around the world and our instrument teams. The workshop was for

- (1) researchers representing the user community to present science studies that would be carried out with polarised neutrons on ESS instruments.
- (2) world experts in polarisation instrumentation and operation to share their experiences and latest developement.
- (3) instrument scientists to present the polarisation layout of their respective instruments
- (4) discussions to give the advices on the ESS polarisation scope and road map.

A workshop report would advise the ESS on the polarisation road map and the scope-setting of the polarisation work plan. The workshop will be held on the 21st – 22nd of September due to coronavirus pandemic. At the time when we decided to postpone the workshop, 23 external speakers and 24 ESS scientists have already committed to participate in the workshop.

### Polarisation work package

To facilitate the scientific case and incorporation of polarisation to the respective instruments, a polarisation work package is being developed. Instrument teams will be fully involved in its development. It is planned that the work package will be funded as part of the Initial Operation budget hence no funding will be drawn from individual instrument budgets. The indicative timeline of the work package is shown in Table 2.

2019 Q4 – 2020 Q1	Discuss with instrument teams
2020 Q2 – Q3	Conceptual design & evaluation to develop work package with instrument teams
2020.09.21-22	Polarisation workshop
2020 Q4	Approval and preparation
2021 Q1 – 2025 Q4	Implement

Table 2. Timeline of the polarisation work package development

The work package will contain information on

- (1) the science case for each instrument included in the work package,
- (2) conceptual design and evaluation of the options of layout and equipment for each instrument.
- (3) infrastructure to support the operation,
- (4) list of equipment, key specifications and sourcing of equipment.

For example, solid state devices embedded in neutron guide upstream of sample hub are not shareable between instruments. With some exceptions, equipment located inside an instrument hub or in dedicated accessible area can be shared. For the shareable equipment, a rough count indicated one copy of an equipment can be shared among 2 to 4 instruments, depending on the anticipated usage. Details will be developed as part of defining the scope of the work package.

- (5) equipment control and data processing developmental plan,
- (6) a timeline of activities, resources and budget. The scheduling priority of the work package is based on the instrument schedule.

### What is happening now

At present, a draft timeline of the work package is being formulated as a starting point of discussion with ten instrument teams. We are starting the conceptual design and evaluation work on some of the instruments. The conceptual design and evaluation includes

- (1) the layout of the polarisation setup in the instrument model
- (2) the evaluation of the magnetic field and r.f.-field setup (where applicable) from the polariser to the sample and to the analyser
- (3) Monte Carlo simulations as the polarisation components will in all likelihood affect the beam characteristics

To support this work, dedicated computational resource was acquired including the well-established COMSOL multiphysics software to be able to carry out the evaluation of spatially extended combination of permanent magnets, magnetic materials and magnetic field coils both static and radio-frequency. Coil heating and cooling loop setup will be part of the computation. Monte Carlo simulations will be carried out using McStas in close cooperation with instrument scientists.

Preparation for developing data reduction routines has been done with helps from colleagues at DMSC at the ESS and at STFC in UK. We are also preparing to start surveying the ambient magnetic field environment in the instrument and lab areas in the D and E buildings.