SCIENCE & TECHNOLOGY FACILITIES COUNCIL
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3T Horizontal Magnet with Neutron Polarisation Transport Specification UK SBS PR19049

This document provides an outline tender specification for a 3T horizontal field magnet optimized for polarized neutron transport measurements, with a broad wavelength band (2- 16Å). This magnet is for use across the polarised SANS and Reflectivity instrument suite. The information given in this document is subject to a preliminary design review, to be undertaken following placement of the purchase order from this contract.

Specification for 3T Horizontal Magnet with Neutron Polarisation Transport

1. Introduction

1.1 ISIS pulsed neutron and muon source is a world-leading centre for research at the Science & Technology Facilities Council (STFC), Rutherford Appleton Laboratory (RAL) near Oxford, in the UK. Our suite of neutron and muon instruments give unique insights into the properties of materials on the atomic scale.

During the last decade ISIS has made a great effort in increasing its polarised neutron capabilities. On the target station 1 (TS1) only CRISP was capable of offering a polarised beam, however a clear investment has been done in the target station 2 (TS2) to nurture and develop such properties of the neutron beams. On the TS2 during phase 1 Polref and Offspec had been designed and during Stage 2 Larmor and Zoom have been built to exploit this neutron property. In addition a 3He filling station has been built and an upgrade on LET has been carried out in order to expand the polarisation capabilities.

Despite the great investment in building beamlines offering polarisation of the neutron beam, ISIS lacks sample environment optimised to exploit the full potential of the techniques. Until now, a set of room temperature electromagnets have been used in experiments requiring polarisation. These set of electromagnets offer a modest maximum field of 1.2 T perpendicular to the beam (even less if a cryostat needs to be added to the experiment) or 0.4 T parallel to the beam, and poor polarisation transport at low fields. This is a region of the utmost importance since most of the applications will work in absence or very small fields. Therefore for fully exploiting this appealing property of the neutron beams, ISIS needs to make an effort in expanding the available sample environment in order to provide larger fields and better polarisation transport at low fields.

1.3 Therefore a 3T horizontal magnet which transports the polarisation is required which will tackle both issues at once: it will multiply the maximum field by a factor or 2.5 (a factor 7.5 parallel to the beam), meaning that less experiments would have to be redesigned to accommodate the existing sample environment instead of the optimum scientific case; and the increase of the polarisation transport at low fields will allow the users to explore the regions closer to the working conditions for many prototype devices.

This document provides the outline specification for a 3T horizontal field Magnet optimized for neutron polarisation transport to be purchased following placement of the contract.

2. Scope

2.1 The scope of supply is for a 3T horizontal field magnet optimized for polarised neutron beam transport into and out of the magnet. This will be mainly used for polarised SANS and Reflectometry measurements, with the following constraints:

2.2 This should be compatible with the constraints for space and weight of the beamline with the strictest constraints.

2.3 It should also be compatible with the beamline with the strictest polarisation transport constraints, due to the use of polarisation optics such as Helium 3 cells that are susceptible to stray fields.

2.4 It should also allow for the future addition of sample environment such as cryostats for non-ambient environment measurements such as low temperatures, etc.

2.6 Training must be provided on 2 levels, i.e Superuser training for those responsible for maintaining and training further users; and User training for current group meetings detailing how to set up and run the equipment.

3. Requirement

3.1 A minimum field range +/- 3 T is mandatory, and higher is preferable.

3.2 The magnet must optimise polarisation transport. This is a mandatory requirement, particularly the following:

3.2.1 Zero field nodes must be outside of the magnet body for the full field range of the magnet.
3.2.2 The polarisation of the neutron beam must be preserved inside the body of the magnet across the full wavelength range (2-16Å), for all operation fields of the magnet.

3.3 It is a requirement that there are Low stray fields (fringe fields) outside of the magnet shielding, to allow the use of 3He analyser systems on LARMOR and ZOOM. (<10 G at 0.4 m in the direction perpendicular to the field.)

3.4 A wide room temperature (RT) bore to allow the addition of a cryostat at a later date is mandatory, with a vertical 80mm diameter RT bore as the minimum requirement. A larger bore of 100mm would be preferred if possible.

3.5 Large opening angles for beams to enter and exit the magnet +/-10 degrees in both directions is mandatory but a larger opening angle is preferable.

3.6 Horizontal and axial field directions are mandatory requirements. This can be achieved by physical rotation of the magnet and does not require more than one split coil.

3.7 Magnet dimensions:

3.7.1 The ***maximum*** dimensions of the Magnet must be (600 mm x 600 mm x 1000 mm) to allow it to fit on all beamlines.

3.7.2 The ***maximum*** weight must be 450Kg. The magnet must be robust enough to hold the weight of the sample environment. The magnet must be able to hold up to 120 Kg.

3.7.3 The sample must sit no more than 300 mm from the base of the magnet to allow the sample to be placed in the centre of rotation (COR) of the current reflectometer and SANS beamline sample tables. Any higher than this allows no room for the COR to be corrected using the sample tables, and leads to geometrical effects that negatively affect data quality.

3.7.4 The sample space (active volume for the sample) should be no less than 20 mm.

3.7.5 The magnetic field homogeneity should be better than 5% over the active sample volume (see 3.7.4)

3.8 The ramp rate for the magnet when changing fields should be faster than 0.25 Tesla per minute (e.g. 12 minutes to go from 0 to 3T)

3.9 In the case of a superconducting magnet design the system should be dry (recondensing), avoiding the need for regular refilling with cryogenic liquids. The system should be able to run for at least one month without intervention.

3.10 The magnet should have lifting points for allowing its transport. It must be possible to lift the magnet in a “ready to use” state.

3.11 Training

3.11.1 Onsite training to be carried out for a minimum of two superusers within 2 weeks of commissioning the instrument. The superusers will be trained in using and maintaining the magnet, and they will be responsible of training the normal users in the normal operations of the system

Further training can be included along with prices in a separate document in the Pricing Schedule.

3.12 Computer (IT)

3.12.1 Communications for remote control of the power supply by the Plant Control System

3.12.1.1 The power supply must be capable of integration into an ISIS SCADA system, therefore the command set shall be made available.

3.12.1.2 The preferred communications interface for the integration is a RS232 serial protocol, with a baud rate that will be able to handle long cable runs. A typical value would be 9600 Baud.

3.12.1.3 If RS232 is not possible, Ethernet can be considered. Ethernet communications must support RJ45 port connections and be able to have an address assigned from a DHCP server.

3.12.1.4 Preference is given to serial over Ethernet.

3.12.1.5 Communication via USB is not acceptable.

3.12.1.6 The command set will ideally be in ASCII characters, and human readable. A defined termination character is required, a typical example is CR-LF (Carriage Return, Line Feed, ASCII characters 13 and 10).

3.12.1.7 All commands to a device should return some form of reply. This helps the control system to distinguish between a device which is unplugged and an incorrect or invalid command. Where no data needs to be returned, a device could generate an "ACK" or "OK" or similar response. Commands which are invalid or rejected could return a "NAK" or "NOK" or "error" or similar responses.

3.12.1.8 The device should not send any unsolicited messages in normal operation, as these will be discarded by the SCADA system. Any messages sent on startup should be repeatable with a command, as the startup message will likely be treated as an unsolicited message.

3.12.1.9 In addition, EPICS-compatible drivers provided to allow remote control and monitoring would be desirable (see https://epics-controls.org/), but the command protocol is still required.

3.12.2 It is essential that the proposed IT hardware will have sufficient processing speed, system memory & data storage capacity to allow the proposed system to operate at full functionality for a minimum of 2 (two) Years without either data acquisition or data processing being constrained in any way.

3.13 Installation and Assembly

The magnet must be easily liftable via a crane and appropriate lifting equipment such that it could be moved around the experimental hall while cold in the case of a superconducting solution. This is to allow the system to cool the coil down the offline before lifting onto the beamline for operations. The lifting equipment will be provided by ISIS. The assembly and installation will consist on operating the magnet, sweeping the field from maximum to minimum field.

3.14 Support

3.14.1 Must include at least 2 years warranty, including any preventative maintenance services required.

3.14.2 To avoid premature obsolescence, replacement and spare parts for components used in the proposed system shall remain available for a minimum period of 2 (two) Years from the date of their last manufacture.

3.14.3 The Contracting Authority shall expect a Maximum On-Site Attendance Time of 5 (five) working days from first notification of a problem with the proposed instrument.

3.14.4 The Contracting Authority shall expect a Maximum On-site Fix Time of 10 (ten) working Days from first diagnosis of a problem with the proposed instrument.

4. Timetable and Delivery

4.1 Delivery, Installation and Commissioning:

Desirable delivery date is August 1st, 2020
Delivery of the instrument must be made no later than December 1st,2020

Delivery to:
STFC – ISIS
Rutherford Appleton Laboratory,
Harwell Campus, Didcot
Oxfordshire, OX11 0QX, UK

4.2 Installation and commissioning plan to be proposed and must be completed within 2 weeks from delivery

5. Acceptance test

5.1 Acceptance test: ISIS enters a long shut down in on the 1st of September 2020 with TS2 being switched off for 10 months and TS1 switched off for 15 months. These durations may change slightly due to engineering considerations.

As such it is highly preferable that the magnet be **delivered by the 1st of August 2020 to** allow for acceptance tests on a neutron beamline with polarised neutrons. The supplier may choose to send a representative to witness testing, and STFC will consider the advice of the supplier (at Milestone 1) when selecting test equipment.

5.2 At the point of delivery, ISIS will check that all the specifications **offered** by the winning company are met within 5% of tolerance. Failing these, the system will not be accepted.

The test will be a full system test:

1) The magnet will be cooled down of line and then transported and lifted via an internal beamline crane onto the beamline in line with specification 3.10

2) If the system is delivered by August 2020 then a simple empty beam (phi) measurement, as defined in the following A. R. Wildes (2006) Scientific Reviews: Neutron Polarization Analysis Corrections Made Easy, Neutron News, 17:2, 17-25, DOI: 10.1080/10448630600668738, using a full polariser analyser system will then be performed. This will be performed in several field regimes:
    a. Max Field (can the maximum offered field be achieved within 5%)
    b. 2 intermediate fields down between Max field and 500 Oe.
    c. 500 Oe
    d. 100 Oe
    e. 50 Oe
    f. 10 Oe

   This is to check the magnet is in line with Specification 3.2 and that the magnet transports neutrons across the whole wavelength band 2Å to 15 Å for the whole field range of the magnet. Within 2%

3) A robotic measurement will then be made using a 3D Gauss probe of the internal and external fields of the magnet at the fields specified at the point 2) in order to check field homogeneity and stray fields. This need to be within 5% of stated values
4) The field will then be rotated by 90 deg as per spec 3.6 and steps 1 to 3 repeated to check the magnet works for SANS and NR geometries.

5) Check instructions in supplied manuals correspond to supplied system, and provide sufficient information for operation and troubleshooting

6) Check functionality of computer software and that fields and temperatures can be set from the computer.

7) Check magnetic field calibration and setting accuracy at 10%, 50% and 100% of designed maximum field.

8) Check field homogeneity meets specification at a number of fields up to the maximum designed field.

9) Check long time field stability of system meets specification for persistent and non-persistent modes at a number of fields up to the maximum designed field.

10) Check magnet ramp rate meets specification at 10%, 50% and 90% set fields.

11) Ensure magnet construction meets all specifications given in engineering drawings, and weight of system falls within requirement. Check correspondence between system and supplied technical documentation.

6. Payments:

As a UK Government funded body, the Contracting Authority is not permitted to make any advanced or "time of order" payments.

Suggested milestones :

- Receipt of material : 20%
  - Receipt of delivery note and invoice required
  - Material marked as UKRI-STFC property and photographic evidence provided of ownership required
- Upon completion of installation and acceptance of the equipment: 80%

The milestones suggested above are fixed. However the Contracting Authority reserves the right to amend the % payment.

7. In the case of draw in the scoring points the tender will be awarded to the supplier that;

1st) Has the highest factor in the 6.3 question.
2nd) Has the highest scoring in the 6.3 question.
3rd) Has the highest scoring in the 6.15 question.
4th) All the factors achieved in the technical assessment will be added. The highest value.
5th) If the draw persist after the tender will be awarded by a lottery.