SPECIAL TECHNICAL SPECIFICATIONS CLAUSES

PROCUREMENT CONTRACTS FOR SUPPLIES AND SERVICES

The purchase of a closed loop cryostat for transport measurements around 1 K

N° consultation : F25F017

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Pour PHELMA

SUMMARY

1. Purpose of consultation

The current consultation concerns :
The purchase of a cryostat for quantum hall practical work, for the Grenoble INP - Phelma laboratory.

Grenoble INP – UGA Graduate schools of Engineering and Management is located in an outstanding place for sciences and a natural environment.

The Grenoble INP - Phelma school is an engineering school of the Grenoble Polytechnic Institute. It offers its students a wide choice of training courses at the cutting edge of scientific and technological advances: micro & nanotechnologies, instrumentation, energy, innovative materials, information technologies, biomedical engineering, process engineering and environment. It welcomes more than 1,400 students in 11 engineering courses, including one through apprenticeship and around 10 masters courses. The teaching team is made up of around a hundred full-time teachers and more than 300 part-time lecturers. The administrative and technical team has around fifty staff. The school is present on two sites, the Minatec site in Grenoble and the Saint-Martin d'Hères university campus site. While reaffirming its three main pillars, which are physics, electronics and materials, Phelma ensures an evolution of the training of its engineering students and its masters students in view of the evolution of professions, linked essentially to the energy transition and digital transition.

As a part of its pedagogy and research, the graduate school wishes to acquire a new "Cryostat operating with a closed-cycle helium circuit" for the electrical transport experiments at temperatures of 1 K or slightly above, and in a vertical magnetic field greater than or equal to 5 T.

2. Context

The practical works (TPs) of Phelma are two historical TPs named "Superconductivity" and "Hall Effect". Ultimately, we would like to develop these TPs to make them more in-line with the latest developments of quantum technologies.

At the beginning, we propose to develop the "superconductivity" TP, which currently focuses on the study of a "bulk" material, to move towards the study of quantum devices: SQUIDs (Superconducting QUantum Interference Devices). These are quantum devices which based on spin-polarized electron interference. These are devices that can be used as quantum sensors for magnetometry or building blocks of quantum information processing devices. We also want to develop a practical work about quantum Hall effect.

To carry out this development, therefore, it is necessary to acquire a Cryostat which is able to probe the quantum devices. This cryostat should work with a closed-cycle of helium circuit and operats at low cost, while the current cryostat requires refilling of the expensive liquid helium at each manipulation.

This cryostat allows practical implementation of a functional quantum device by the students. The TPs with this cryostat will also allow a concrete study of SQUIDs, whose operating principle is taught in class room and is seen in supervised TPs. It will also be an opportunity to review the notions seen in quantum physics lessons with a practical approach, particularly with regard to the transport of electrons. This TP would therefore be an excellent match with the courses of theoretical physics (at M1 and M2 level).

This envisioned TP would include device characterizations as following:

- Current-voltage characterization of different SQUIDs pre-existed on a wafer
- Study the effect of temperature
- Study the effect of magnetic field on the measured SQUID characteristics

3. Expected technical specifications

The technical specifications of the cryostat are composed of a set of requested characteristics and performances as a basic configuration. The requested basic configuration is described below.

3.1 Cryogen-free low-temperature high-field cryostat

Cryostat must be specifically designed to operate with a cryogen-free refrigeration without the need for liquid helium supply.

It is necessary that this cryogen-free cryostat has to reach temperatures below 3 Kelvin (K) and provide magnetic fields greater than or equal to 5 Tesla (T). It is essential for the cryostat to have a ratio of maximum magnetic field to the lowest temperature, B[Tesla]/T[Kelvin], under the same condition, greater than 2.5 T/K. The higher the B/T ratio, the more suitable for the study of quantum devices.

3.1.1 Closed-cycle refrigeration

The cryostat cooling must be based upon a closed-cycle refrigeration system, such as Pulse Tube or Gifford-McMahon cold head/ cryocooler, with base temperature below 3 K.

It is necessary that the cryocooler has to cooldown the superconduting magnet and the sample probe to the operating base temperature within no longer than 24 hours after switching on the system, and the shorter the cooldown time the better.

It is also necessary to isolate both the superconducting magnet and the sample platform from vibrations associated with the cryocooler, and the resulting vibrational level at the sample space must be less than 30 µm.

The cryocooler has to operate continuously without any maintenance, at least, for 20 000 working hours.

3.1.2 Superconducting magnet

The superconducting magnet must be specifically designed to operate in a cryogen-free low-temperature environment provided by the cryocooler. It is essential for this superconducting magnet to be able to generate a maximum vertical field greater than or equal to 5 Tesla.

The magnetic field homogeneity over the sample space region must be better than or equal to 0.1%. The superconducting magnet must also be designed for the operation at a field sweep rate faster than 100 milli-Tesla/minute without any risk of quenching.

3.2 Sample mount

The low-temperature sample supporting platform must be specifically designed for carrying out the electrical transport measurements on a sample device at the well-controlled temperatures and magnetic fields.

Therefore, it is necessary for the sample platform to have a minimum of 12 DC contacts, and more DC contacts up to 24 will be better. The sample platform must be oriented such that the sample out-of-plane direction is parallel to the magnetic fields.

Moreover, sample holders compatible with the sample platform must be provided. Samples, such as Quantum Hall and superconducting devices, with minimum size of 10 mm must be mountable on these sample holders.

3.2.1 Sample temperature variation

The sample platform must also be specifically designed for carrying out temperature dependent measurements on a sample device at the well-controlled temperatures.

It is necessary that the sample temperature be variable from the base temperature up to around 10 K in a well-controlled fashion. A method for heating the sample along with sensing and controlling the sample temperatures, therefore, must be designed as an integral part of the sample probe. The sample temperature must be precisely controlled at any given value, from the base temperature up to 10 K, with a stability higher than ±50 mK. Moreover a temperature control above 10 K could be optional.

3.3 Electronics and software for cryostat operation and sample measurements

It is necessary to provide all essential electronic equipment and associated software suite, which are used for controlling all aspects of the cryostat operation and measurement protocols.

This cryostat instrument must also include following components:

- Superconducting magnet power supply
- Cryogenic temperature controller and monitor
- Electronics necessary for cryostat operation and sample measurements
- Software suite necessary for automated cryostat control and sample measurements
- Minimum/maximum of 12/24 DC wires essential for sample measurements

3.4 Helium compressor

The helium compressor unit must be compatible with the specifications requested for the cryocooler. The compressor has to operate continuously without any maintenance, at least, for 30 000 working hours. The compressor power consumption must be lower than 9 kilowatts/hour.

3.5 Optional additional services

The bidder can quantify the optional additional services listed below. The candidate will present the additional services in the documents provided for the response to the basic offer. The buyer will indicate to the contractor at the time of notification of the contract the additional services he intends to retain.

3.5.1 Possible additional service no. 1: Additional 12-month guarantee

Beyond the 12-month guarantee present in the basic service, the bidder will provide an additional 12-month guarantee under an optional PSE. In case the bidder can offer an additional 12 months guarantee at no additional cost, he will indicate 0 in the financial response box.

3.5.2 Possible additional service no.2 : Compressor maintenance

The bidder may propose a one-off maintenance service of the compressor, to be carried out after approximately 30,000 hours of operation. This operation must include at least the replacement of the filter and the absorber. The tenderer shall indicate a single fixed price for this intervention in its financial offer.

3.5.3 Possible additional service no. 3: Cold head maintenance

The bidder may propose a one-off maintenance service of the cold head, to be carried out after approximately 20,000 hours of operation. The tenderer shall indicate a single fixed price for this intervention in its financial offer.

4. Delivery

From the notification of the market, the maximum desired delivery time is 10 months.

The holders may propose a different delivery time as part of the technical response within the maximum delivery time set.

Place of delivery:

The instrument will be delivered to the Grenoble INP - Phelma Minatec site in Grenoble, at the following address:

Grenoble INP - Phelma Minatec

3 Parvis Louis Néel - CS 50257

38016 Grenoble Cedex 1

Drop-off point: Reception of the PHELMA building – Grenoble INP

Delivery times: working days, from 9am to 12pm and from 1.30pm to 4pm.

Before any delivery, the holder must contact the technical manager at least 48 hours in advance by email.

The name and contact details of the technical manager will be communicated to the holder when the contract is notified.

Delivery of the supplies shall be carried out under the conditions defined in Article 21 of the CCAG-FCS.

The contractor shall take care to limit the environmental impact of deliveries and the transport of the products supplied.

Delivery shall be acknowledged either by the issuance of a receipt to the contractor or by the signing of the delivery note.

5. Installation and commissioning

Installation and commissioning will be carried out by the holder within a maximum period of 15 working days from the date of delivery.

Remote installation is mandatory by following the installation instructions as well as the video demonstration requests if necessary. However, on-site installation might be possible instead of the remote installation.

The instrument will be installed in the building M of Grenoble INP-Phelma Minatec site. The cryostat and pumping systems will be installed in dedicated room, while the helium compressor and water chiller will be separated and installed at the helium technical room located on the 4th floor just above the room. The cryostat and compressor will be connected through helium supply and return lines.

The room available for the installation of the cryostat and the pumping stations has a free surface area of 3 m x 4 m with a ceiling height of 3 m.

6. Documentation

Equipment documentation must be provided (digital or paper format) in French and English.

7. Training

Training of three users must be included (in accordance with the availabilities of users) within no more than two weeks (excluding building closures) starting from the end of the acceptance and processes phase.

8. Warranty

A 12-month warranty from admission is included. During this period, the holder undertakes to ensure the availability of a dedicated contact person to respond to any difficulties encountered when using the equipment.

The candidate must describe in their technical proposal the associated warranty and support terms and conditions, specifying what is included and excluded, the conditions of application, the average lifespan of the equipment, the terms and conditions of access to support, the hours of operation, average response and resolution times, the language of assistance, as well as the level of expertise and location (in France or abroad) of the contact persons proposed according to the types of breakdowns that may occur.

9. After-sales service (beyond the warranty period)

At the end of the warranty period, whether it be the basic warranty or the extended warranty if PSE No. 1 is selected, after-sales service must remain available to answer users' technical questions, provide the necessary documentation, send corrective software updates, and inform the buyer about the availability and delivery times of spare parts.

The candidate must describe in their technical proposal the terms and conditions of their post-warranty after-sales service, specifying the services provided free of charge as well as the organization, responsiveness, and level of expertise of the proposed contacts.

10. Execution Modality

The holder specifies in his technical report the time required for manufacturing the equipment in his factory as well as the installation and commissioning times. The maximum planned execution times desired by the buyer are defined in article 3.1 of the CCAP.

11. Environmental protection

11.1 Repairability index

The bidder describes the repairability of the equipment, including: reasonable repair cost, dismantling/reassembly of spare parts, access to repairers, availability of spare parts over time.

11.2 Waste management

The bidder describes waste treatment linked to production and transport, including recycling of electrical and electronic equipment waste (WEEE). Commitments to reduce ecological impacts must be specified.

11.3 Transport

The bidder describes transport methods for deliveries and maintenance, specifying measures to reduce carbon impact (optimized logistics, recyclable packaging, grouped deliveries).