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SPECIFICATION SHEET

SUPPLY, INSTALLATION AND COMMISSIONING OF A "MAGNETO OPTICAL CRYOSTAT" FOR ICFO'S LABORATORY.

FILE NUMBER: 2024.SU.029

Contents

CLAUSE 1. Object of the contract

The purpose of this contract is the supply, installation, and commissioning of an OPTICAL CRYOSTAT WITH A 7 TESLA (T) MAGNET, CAPABLE OF OPERATING UNDER PRECISE CONDITIONS FOR PERFORMING QUANTUM OPTO-ELECTRONICS EXPERIMENTS IN QUANTUM MATERIALS WITHIN THE QUANTUM NANO-OPTOELECTRONICS GROUP AT ICFO.

The system must comply with CPV (Common Public Procurement Vocabulary), **38000000-5** Laboratory, optical and precision equipment (except glasses).

CLAUSE 2. Needs to satisfy

The quantum nano-optoelectronics (QNOE) group has established ground breaking techniques in low-temperature photocurrent experiments in two-dimensional quantum materials. The experiments offer unique insights in to quantum phases, quantum geometry and more general opto-electronic phenomena which cannot be obtained by any other technique. Although cryogenic experiments have been performed already, temperature and magnetic field capabilities have been limited. Pushing these experiments to ultra-low temperatures (1 K) while bringing completely new functionalities offered by magnetic-field will open the doors to a multitude of exotic quantum phases that can be studied using photocurrent techniques.

A major challenge with previous systems is in obtaining a suitable system with simultaneously low vibrations (< 10 nm), high-magnetic field (7 T) and optical access with very short focal distances **i.e**, the distance from optical windows to the sample stage. Obtaining this type of cryostat is crucial for the QNOE group in taking the next steps in low-temperature photocurrent, an emerging but very powerful probe of quantum materials. In particular, this type of system will allow coupling of terahertz light to quantum materials, probing unique physics in the terahertz regime which so far has remained elusive.

CLAUSE 3. System overview

The Low-temperature optical cryostat will be used for performing photocurrent experiments at ultra-low temperatures (< 2 K), with magnetic-field. It will be used with the groups existing terahertz gas laser which will be coupled in through one of the optical windows available on the cryostat. The cryostat requires DC and RF lines allowing us to perform sensitive quantum transport and photocurrent measurements. It also requires a split-coil magnet to allow simultaneous magnetic-field and optical measurements in both sample perpendicular and parallel configurations. The system should also maintain ultra-low vibration stability < 10 nm, and have short working distances to sample stage < 10 cm. Finally, it should be compact and mountable on an optical table with a low footprint. The cryostat height should be no larger than 100 cm.

a. Variable Temperature Insert

Integrated sample loading chamber isolated from cold-head system with integrated cold finger and customizable sample stages.

1. Temperature range: <1.6 K to 350 K.
2. Temperature control stability +/- 0.1 K
3. Sample space diameter and height greater than 80 mm.
4. Sample Space pressure gauge integrated to know the always the pressure.
5. Ultra-low vacuum pressures should be achievable to allow clean measurements and minimize de-gassing while maintain ultra-low temperatures. Pressures of 10^{-6} mBar should be achievable with ultra-high vacuum and stable over multiple thermocycles within the cryostat.
6. De-gassing charcoal units should be secured and easily replaceable to reduce detrimental effects of de-gassing.
7. Nitrogen flow integrated to prevent contamination when cryostat is open and for purging the sample chamber. This is not done to avoid forming of ice or water inside.
8. Distance from the outer windows to the cold finger should be 10 - 20 cm, for parallel configuration.
9. Cool down time of 16 hours or less.

b. Temperature Controller

The temperature controller must have the following capabilities

10. Controller configured with two temperature PID loops for independent control of the sample probe and variable temperature insert heat exchanger. Also configured with a pressure PID loop for closed-loop cooling circuit flow control.
11. The temperature controller must have spare expansion slots for adding thermometry and heater read-out/control
12. The temperature controller must be controllable remotely using Python. Connection through a computer should not be GPIB but rather USB or Ethernet.

c. 7 Tesla horizontal field superconducting split coil magnet with power supply

The superconducting magnet should comply with the following requirements

13. The magnet must be 7T horizontal field with a large enough split to enable 30 mm diameter samples in the VTI. SHOULD BE A CLOSE WORKING DISTANCE. NOT NEEDED.

14. Magnet ramp to full field in less than 45 minutes

15. The magnet with power supply must deliver a stability of + 0.4 mT or better.

16. The magnet supply should have a satisfactory safety mechanism for quench protection to prevent damage to the system.

17. 0.3 % field uniformity over a 3 cm diameter spherical volume should be achieved.

d. Optical Windows

There should be 8 optical windows offering different measurement configurations. The windows on the inner shields should allow for transmission over a broad frequency range from visible to terahertz wavelengths (220 nm - > 400 μm).

18. There should be one window with a short working distance from the window to the sample centre < 10 cm for which the measurements can be performed with sample plane perpendicular to the optical axis and magnetic field.

19. There should be other optical windows placed to enable different optical axes allowing for a different configuration. This is including for example the sample perpendicular to magnetic field and optical axis, or the being sample parallel to magnetic field but perpendicular to the optical axis.

20. The external windows should be interchangeable by the user.

21. The windows should have diameters greater than 30 mm.

e. Liquid Helium free closed-cycle cooling

The system should be cryogenic free and a closed-cycle system with manually adjustable high pressure helium hoses that can be connected and disconnected freely by the users. The compressor and cooling system should satisfy the following needs.

22. The helium lines should be pressurized according to the requirements of the designated compressor

23. System cool down should be less than 16 hours from room temperature to 1.6 K

24. The system should have the capacity to remain cold (< 1.6 K) under continuous operation for more than 720 hours

25. The cryocooler should be optimized to have ultra-low vibration levels < 10 nm peak to peak in x and y, and < 4 nm vibrations peak to peak in z.

26. The system should be compatible to be mounted on an optical table.

f. System Dimensions

The cryostat should have a low footprint with a height less than 100 cm including space for sample loading and should be mountable on an optical table.

27. Bench to shelf clearance should be 100 cm or less
28. The occupied space of the cryostat on the optical table should be less than 100 x 80 x 80 cm (height, width, length)
29. A mounting tower may be used adjacent to the optical table but should not be larger than the 200 cm.

g. Training

System use and process training to ICFO research users and specific maintenance and service training to ICFO lab technicians at ICFO's facilities should be included. The number of training days and approximate schedule will be specified in the proposal.

h. Timing conditions

After the Commissioning of the acquiring procedure (T0) these are the required activities that should be within 1 month of the installation.

30. Factory Acceptance test
31. Hands-on ICFO research personnel training.
32. Site Acceptance Test (ICFO laboratories).

i. Initial transportation, installation and start-up

List of essential requirements:

33. The proposal will include transportation to ICFO's facilities and all export/import and customs duties.
34. The contract winner will cover all costs, organization, and coordination of machines' placement, including any required specialized equipment or vehicle and any required component dis-assembly and re-assembly for systems unloading and transportation inside the buildings/facilities, following the route specified by ICFO and its partners, if it applies.
35. The contract winner will be responsible for checking the compatibility with the operation of the systems already installed on the site and user mobility will also have to be guaranteed.

36. Installation and start-up of the system, including system checking, functional tests and process qualification.

37. The contract winner will be responsible for the removal and proper disposal of the packaging when the machine is delivered and unpacked, or its storage during the warranty period in case the original packaging needs to be kept.

j. Documentation

38. Complete set of manuals, drawings, schematics and layouts about system assembly and configuration

39. Complete systems user manual, including routine servicing, troubleshooting and basic repairs.

40. Systems components spare list, specifying quantity, manufacturer, part number, etc.

41. All the above documentation will be supplied in English, in electronic format (USB drive) and in paper copy

k. Warranty and Support

42. A 1-year full warranty, starting at system acceptance. The warranty will include the replacement of any faulty or damaged part(s) during the normal use of the system, no matter the manufacturer of the component(s). It will cover any cost related with the disassembly, transportation, reparation and re-assembly of the damaged component(s), including all travelling and living costs of the required service engineer(s). An on-site repair, or a justified alternative to reduce the system down time to the minimum, will always be the first service option. A team of properly qualified and skilled service engineers will have to be available. It will also cover the costs and the maintenance related to the machine move and installation on the new building.

43. System lifetime support: By phone and e-mail with a response within 48 hours. Emergency visit after a system breakdown within 10 working days, once the parts are available and shipped to the customer.

44. Application support within 10 working days.

l. Financing

This equipment was supported by QTwist

CLAUSE 4. Target price

- The target price for the system is 370,000 € (VAT excluded).
- Payment terms:
    - 50% upon sending of the purchase order,
    - 40% upon delivery,
    - 10% after installation training and acceptance.

CLAUSE 5. Delivery time

The system must be delivered and installed at ICFO within a maximum period of **8 months**. A discount should be provided when delivery exceeds the maximum period. After 4 weeks this should be 5 %. After 6 weeks this should be 10 %.

- Delivery time is defined as the time elapsed since the signature of the contract until the system delivery at ICFO facilities. It includes the manufacture of the system, the transportation, the installation and the acceptance test at ICFO's premises.

Castelldefels, 10th of December 2024

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