INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

MATERIALS MANAGEMENT DIVISION

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PR No.1000022328 **RFx No. 6100000972**

Technical Specification
Pulse-tube-based cryofree refrigerator

Tender specification for pulse-tube-based cryofree refrigerator, capable of cooling to 300 mK or lower, with a 12 Tesla superconducting magnet.

1. PERFORMANCE
1.1 Temperature Control (of the basic VTI system)
1.1.1 Temperature control range: 1.6 K to 300 K 1.1.2 Temperature control stability: +/- 0.05 K 1.1.3 Temperature sensors on PT1, PT2, variable temperature insert (VTI) and the superconducting magnet for continuous monitoring on temperature.
1.2 Operating Cycle
1.2.1 System cooldown time before superconducting magnet can be used (from 300 K to 4 K): 55 hours or less 1.2.2 Sample probe cooldown time: 2 hours or less (standard) 1.2.3 Magnet ramp up time (to full field): 45 min or less 1.2.4 Uninterrupted operation of the system with sample at base temperature: 4 weeks or more
2. PULSE TUBE REFRIGERATOR
2.1 Pulse-tube cold head should be provided with a three-phase water-cooled compressor and suitably long gas lines. 2.2 Cooling power: 1 W or more, at 4.2 K
3. THE VARIABLE TEMPERATURE INSERT (VTI)
3.1 The VTI cooling circuit should be separate from the gas used for heat exchanging between VTI and sample probe. 3.2 He gas circulation for cooling from 4.2 K to 1.6 K should be driven by a scroll pump, with a recoverable zeolite trap to filter the possible contamination in the loop. 3.3 No liquid N_2 trap should be necessary 3.4 The available sample space diameter should be 50 mm or more. 3.5 The closed-loop cooling circuit should be fitted with a pressure gauge on the pumping line, and an automatic needle valve, or a manual valve for flow control. 3.6 Remote temperature control should be possible over USB, TCP/IP and GBIP IEEE488 interfaces. Complete operation of the VTI cooling and sample cooldown and bringing to room temperature should be

possible without any manual intervention.

4. SUPERCONDUCTING MAGNET AND POWER SUPPLY

4.1 Central field of magnet: Variable, with maximum value of 12 Tesla or more

4.2 Operating current (nominal): ≤ 120 A

4.3 Magnetic field homogeneity: ≤ 0.1% total variation over a 10 mm diameter sphere (DSV)

4.4 Persistent mode switch should be fitted, with switch heater control and intelligent magnet quench detection.

4.5 Magnetic field stability in persistent mode: ≤ 1.0 x 10E-4 relative/hour measured at 12 T

4.6 Magnet Power Supply: Fully bi-polar, 4-quadrant superconducting magnet power supply

4.7 Interface using USB, TCP/IP and GBIP IEEE488.

4.8 The magnet power supply should monitor the magnet temperature, and the temperature sensors fitted to the PTR cold head.

4.9 Magnet power supply should come with configurational slots for future upgradation.

4.10 Magnet power supply should allow automatic rundown, in event of over temperature or low cryogen levels.

4.11 Magnet should have Cernox sensor fitted to the magnet assembly, along with magnet quench protection circuit, which should have an integral diode and resistor

5. THE BASIC PROBE

5.1 The system should come with a simple insert, with sample mount block, on which customized sample holder can be fitted.

5.2 It should be usable between 1.6 K to 300 K

5.3 At least 12 DC constantan wires must be available up to the sample block

6. PROBE WITH FIXED CELL

6.1 Should be of **both sample-in-exchange-gas and sample-in-vacuum configurations**, which should be electrically isolated from the rest of the system to enable separation of the measurement ground and the cryostat protective ground.

6.2 Temperature range of the probe should be between 1.6 K to 300 K, fitted with a calibrated Cernox temperature sensor and a heater on the sample mounting block.

6.3 Sensor and heater should be monitored and controlled by the temperature controller.

6.4 Should have experimental wiring of at least 18 twisted pairs of enamelled constantan wire. The wires should terminate at solder pins just above the sample mounting block and 24 pin Fischer connector at the top of the probe.

6.5 Should have diagnostic wiring including those required for thermometry

6.6 At least 2 stainless steel coax cables should be provided, one with SMA (18 GHz) and another one with SK (40 GHz) connector on top flange.

Sample cell design should be such that sample carriers can be mounted for measurement both parallel and perpendicular to the magnetic field of the superconducting magnet, but without option for mechanical rotation.

6.7 Sample cell must be compatible for both LCC44 and LCC20 sample carriers (in both parallel and perpendicular configurations) such that both carriers can be swapped depending on requirement. ESD protection plug should be present at least on one chip carrier either on LCC20 or LCC44.

6.8 One additional sample cell, without any sample carrier or sample holder should be provided.

6.9 At least 50 LCC20 and 10 LCC44 gold-plated, non-magnetic (free from Ni/Cr) sample carriers should be provided.

6.10 A 24-channel ESD-safe breakout box, using BNC connectors should be provided.

7. ^{3}He INSERT

7.1 Helium-3 sample-in-vacuum insert system should be compatible with 12 T cryostat VTI and supplied with

^{3}He gas. Insert diameter should be 50 mm.

7.2 The temperature range of the ^{3}He probe should be from 300 mK to 300 K, with temperature stability of +/- 3 mK at 1.2 K and +/- 0.1 K above 1.2 K, or better.

7.3 The sample should be accessible by removal of Inner Vacuum Chamber (IVC) at room temperature.

7.4 IVC should be manufactured from brass, with a minimum diameter of 43 mm and vacuum sealed by means of a suitable mechanism (for example – by means of silicone sealant).

7.5 Should be supplied with sliding seal for cold loading insert, clamp for holding sliding seal tube with basic system spares kit.

7.6 Wirings should terminate at room temperature in a Fisher connector (mating connectors should be included)

7.7 Should be provided with the required amount of ^{3}He, with chemical purity > 99.99 % and isotopic enrichment > 99.9 %

7.8 Diagnostic wiring: Should be terminated by Fischer connector at room temperature.

7.9 Temperature sensors: un-calibrated carbon sensor on the ^{3}He sorb, un-calibrated ruthenium oxide sensor on the 1 K plate and the ^{3}He pot, calibrated Cernox thermometer on the helium-3 pot

7.10 Experimental wiring: 24-way Fischer connector and mating plug at room temperature.

7.11 12 twisted pairs of Constantan wires

7.12 25-way miniature D-type connector and plug on the bottom of the ^{3}He pot

7.13 2 flexible stainless steel co-axial cables, one with SMA (18 GHz) connectors and one with SK (40 GHz) connectors, at room temperature,

7.14 A separate temperature controller for Helium3 insert for continues monitoring of temperature sensors on the insert

8. TEMPERATURE CONTROLLER

8.1 Should be configured with two temperature PID loops, for independent control of the sample-probes and the VTI-heat-exchanger temperatures

8.2 Should be compatible with both sample-in-gas and sample-in-vacuum configurations.

8.3 Should support all standard cryogenic sensors (ruthenium oxide, Cernox, silicon diodes, platinum, RhFe, thermocouples etc.)

8.4 Should control the auto needle valve on the VTI Considering the ^{3}He insert, the controller,

8.5 Should control the sorb temperature

8.6 Should control the sample temperature from base (300 mK) to 300 K

8.7 Should monitor all temperature sensors on independent channels

9. ESSENTIAL ACCESSORIES

9.1 Gas handling system: System should be supplied with gas handling system for the closed-loop cooling circuit, including manually (a) operated valves, (b) at least 10 m^3/ hour oil-free circulation pump, (c) helium gas storage tank with mechanical pressure gauge (tank should be supplied with helium gas filled) and (d) trap with integrated heater for regeneration. The operation of the manual valves should be required only during initial set-up, for system cool-down and warm-up. System should be supplied with all thermometry connecting cables.

9.2 OVC pumping station: Turbo pump with rotary vane backing pump should be provided.

10. TECHNICAL SUPPORT/WARRANTY/CUSTOMER REFERENCE

10.1 Warranty of 12 months or more from date of delivery should be provided

10.2 Bid should include packaging, shipment, on-site installation and training costs

10.3	Technical support should be available within India
10.4	One user reference from within India and 3 from abroad must be provided.