

Requirements / Specification Document

Use this document to detail the specifications/requirements for an item and/or ancillary services.

TITLE: Sub-Kelvin Cryostat

Requesting Laboratory / Division / Group:

Communications Technology Laboratory
RF Technology Division
Superconductive Electronics Group (672.06)

General Statement of Need:

This cryostat will be a flexible option for research and development of high frequency (10-100 GHz) and high temperature (20 mK to 1 K) quantum computing circuits. The optional 'bolt on' dilution refrigerator and 40 GHz wiring will complement and expand the custom wiring/cooling methods that we are using now. It supports the Hot Qubit IMS work, and 4 K classical control of quantum circuits work that we perform.

Item Specifications and Quantities:

Item 1:	Cryostat system with base temperature below 900 millikelvin	
Quantity:	1 EACH	
Specifications:	1.1	The cryostat system shall have a base temperature less than 900 mK at the coldest stage using helium-4, or base temperature below 500 mK using helium-3.
	1.2	The system must be equipped with a pulse tube cooler with greater than 1.3 W cooling power at 4.2 K (second stage) with low vibration remote motor.
	1.3	The cryostat system shall include all thermometry, support structures, pumps, and heaters necessary for continuous operation below 900 mK. As well as PID (or similar) controlled heater for operating at intermediate temperatures.
	1.4	The cryostat system shall include at least three KF25 or larger ports for user modification for coaxial connectors, optical fibers, and such. All bulkhead connectors provided by manufacturer for wiring shall be tested for vacuum leaks.
	1.5	The cryostat system shall have a thermal radiation shield at approximately 45 K and 4 K and base temperature stages. All vacuum cans and radiation shields must accommodate routine assembly/disassembly when the system is placed in a laboratory with 2.9 m floor-to-ceiling height. It must be possible for the vacuum can and shields to be removed and replaced when the cryostat is permanently mounted on its frame.
	1.6	The cryostat system shall be cryogen-free, that is, no additional cryogens shall be added by the user after delivery (excluding external liquid nitrogen trap(s)).
	1.7	The cryostat system shall have a water-cooled compressor. The cryostat system shall have flexible lines between the compressor and the cold head that are at least 5 m long
	1.8	No membrane pumps shall be used in the helium-circulation path
	1.9	The cryostat system shall include a vacuum pump and parts which are sufficient to evacuate the cryostat before cooldown to a pressure of 1e-4 torr.
	1.10	The cryostat system shall include all software necessary for automated cooldown, operation, and warmup procedures with computer controlled valves and pumps. The time to cool the system down with all ordered wiring (thermometry, heaters) shall not exceed 12 hours.
	1.11	The cryostat system shall be upgradable to a dilution refrigerator at a later date with minimal changes to vacuum jacket and existing cryogenic infrastructure – i.e. a dilution unit will be a 'bolt on' accessory as much as possible.
	1.12	The cryostat system shall have a gold-plated oxygen-free-high-conductivity (OFHC) copper base temperature plate to provide an experimental volume larger than 250 mm in height and greater than 125 mm in diameter.
	1.13	The cryostat shall be electrically isolated from the compressor.
	1.14	The cryostat system must be an established commercial product with at least one unit operating successfully in the field. Experimental or prototype items are not acceptable
	1.15	The cryostat system shall be a new (not refurbished or reconditioned) item covered by the original manufacturer's full warranty. The use of "gray market" components not authorized for sale in the U.S. by the proposer is not acceptable.
	1.16	Manufacturer will test system on their site before shipping and send all temperature and pressure data for verification.
Item 2:	OPTION to PURCHASE: Dilution Unit	
Quantity:	1 EACH	
Specifications:	2.1	A dilution refrigeration unit shall upgrade item 1 to have a base temperature than 25 mK at the mixing chamber and demonstrate a cooling power greater than or equal to 250

	microwatts at 100 mK when loaded with (at a minimum) the included diagnostic thermometry and heater wiring
2.2	An additional still temperature radiation shield will be included with the dilution unit addition as well as additional thermal stage plates and other brackets, etc.
2.3	The dilution unit shall not have any soft solders. Soft solders are known to develop micro-fractures and cold leaks over time.
2.4	No modifications to the vacuum jacket, radiation shields, or support structure shall be required with the purchase of this option – i.e. existing infrastructure will be re-used.
Item 3:	OPTION to PURCHASE: 40+ GHz Bandwidth Wiring
Quantity:	1 EACH
Specifications:	3.1 The cryostat shall include wiring from 300 K to 4 K appropriate for powering at least two HEMT amplifiers
	3.2 At least 5 input microwave coaxial lines with bandwidth of 40 GHz (e.g. 0.86 mm cables with 2.92 mm connectors) and user-specified attenuation are required
	3.3 At least two 40 GHz bandwidth output lines with minimal attenuations are required (e.g. 2.19 mm coaxial cable with 2.92 mm connectors), NbTi cabling below 4 K.
	3.4 The cryostat system shall have a total of 24 resistive phosphor bronze dc wires; the resistance per wire shall be less than 100 ohms; the wires shall be in a looms of 24 wires each; the loom shall be terminated in a 25-pin microD connector at 4K and base temperature
	3.5 All wiring listed above shall be properly heat sunk such that the cooling power remains greater than 250 uW at 100 mK fully wired.
	3.6 When fully wired the cooldown time shall be less than 15 hours.

Ancillary Services:

Section	Requirements/Specifications						
Planning Considerations <input checked="" type="checkbox"/> N/A	<input type="checkbox"/> List any visits required to allow potential vendors to see site specific constraints. [Explain Requirements.] <input type="checkbox"/> US citizen required on-site (foreign nationals require pre-registration 30 days prior to visit.) <input type="checkbox"/> Vendor Representative On-Site more than three (3) days. <input type="checkbox"/> Other Considerations: [List other considerations to ensure an accurate quote.]						
Shipping & Delivery <input type="checkbox"/> N/A	Shipping Address: <input checked="" type="checkbox"/> NIST-Boulder ATTN: Adam Sirois Mail Stop: 672.06 325 Broadway Boulder, CO 80305 <input type="checkbox"/> NIST-Gaithersburg ATTN: Mail Stop: 100 Bureau Dr Gaithersburg MD 20899 <input type="checkbox"/> [Alternate Shipping Address] Shipping Criteria: <input type="checkbox"/> Partial Delivery Acceptable <input type="checkbox"/> [Enter Shipping and Delivery information by item.] <input checked="" type="checkbox"/> Direct Delivery to NIST Building Required [Explain Need for Requirement] Building /Room Number: 81/1D-112 <input checked="" type="checkbox"/> Building has Loading Dock Containerization Preference: [Enter Container Type] Other Requirements: [List Any Other Requirement] Delivery Date Criteria: <input checked="" type="checkbox"/> Delivery of Shall Be Competed No Later Than: 12/1/2023 <input checked="" type="checkbox"/> Delivery Shall Be Made No Earlier Than: 5/1/2023 <input type="checkbox"/> Scheduled Deliveries: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Item Number</th> <th>Due Date</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> </tr> </tbody> </table> <input type="checkbox"/> Other: [List Other Shipping, Delivery or Special Requirements.]	Item Number	Due Date				
Item Number	Due Date						
Electronic Media <input type="checkbox"/> N/A	[Enter Electronic Media Requirements by Item.] <input checked="" type="checkbox"/> Software <input checked="" type="checkbox"/> Electronic Manuals						

License Key
 Other:
 [List Any Other Electronic Media Requirements]
 US Government Email Address for Software Delivery:
sirois@nist.gov

Installation
 N/A
 [Enter Installation Requirements by Item]
 Vendor Technician on Site
 Rigging
 Uncrating / Unpackaging
 Removal of Packaging Material
 Equipment Set Up
 Start-Up Services
 Turnkey Installation
 Other:
 [Enter Details]
 NOTE: TPOC shall be the coordination sirois@nist.gov.

Facility / Utility Considerations
 N/A
 [List Site Specific Utility Considerations by Item]
 OFPM Work Order Numbers
 [List Work Order Numbers]
 Power Available
 Voltage: [Enter voltage] (V)
 Maximum Current: [Enter max current draw] (A)
 Phase: [Choose Phase]
 Frequency: [Typically 60Hz] (Hz)
 NEMA Plug Type: [Enter Plug Type] (i.e.: NEMA L5-20P)
 Environment: [Choose Environment]
 Other Power Considerations:
 [List Any Other Power Considerations.]
 Utility Connections:
 [List Relevant Available Utilities, Pressure(s) and Flowrate(s).]
 Other Considerations:
 [List Other Considerations to Ensure an Accurate Quote.]

Inspection and Acceptance
 N/A
 [Inspection Requirements Per Item (Who, When, What, Where)]
 On-Site
 Acceptance Expected to Not to Exceed 7 Business Days
 Acceptance Expected to Exceed 7 Business Days:
 [Duration]
 Inspection and Acceptance Plan:
 [Explanation]
 Other:
 [Enter Other Requirements]

Training
 N/A
 Training Requirements (Who, When, What, Where)
 Number of Trainees: [Enter Number of Trainees]
 On-Site
 Off-Site Location: [Enter Location(s)]
 Is Trainee Travel Required: [Choose Answer]
 Scope of Training
 Operation Maintenance Troubleshooting
 Safety Other
 [Enter Other Scope of Training Requirements]
 Training Materials to be Provided by Government:
 [Describe Materials]
 Training Materials to be Provided by Vendor:
 [Describe Materials]
 Other
 [Enter Other Training Requirements]
 NOTE: TPOC shall be coordination POC.

Warranty
 N/A
 Base Manufacturer Warranty is acceptable
 Warranty Length: **1-YEAR**
 What is included?
 Labor **Parts** Travel

Requirements / Specification Document

- Cost and Liability for Returns
- Other
[Enter Other Requirements]
- 1 Option Period
- 2 Option Periods
- 3 Option Periods
- 4 Option Periods (Maximum)

Calibration

N/A

[Describe Calibration Requirements Per Item]

Calibration Plan Length: [i.e. 3 - Years]

What is Included?

- Labor Spare Parts Consumables
- Travel Cost and Liability for Shipment
- Software Updates Manuals

Other

[Enter Other Requirements]

Requirements:

[Enter Requirements] (i.e.: On-Site Within 72 hours, etc.)

1 Option Period

Length: [i.e. 1 – Year / 6 - Months]

2 Option Periods

3 Option Periods

4 Option Periods (Maximum)

Maintenance

N/A

[Describe Maintenance Requirements Per Item]

Maintenance Plan Length: [i.e. 3 - Years]

What is Included?

- Labor Spare Parts Consumables
- Travel Cost and Liability for Shipment
- Software Updates Manuals

Other

[Enter Other Requirements]

Requirements:

[Enter Requirements] (i.e.: On-Site Within 72 hours, etc.)

1 Option Period

Length: [i.e. 1 – Year / 6 - Months]

2 Option Periods

3 Option Periods

4 Option Periods (Maximum)

Government

Furnished
Material /
Equipment

N/A

List Any Government Furnished Material / Equipment Per Item]

- Samples for Testing
- Equipment which will leave Government Site

Description: [Enter Description]

Serial Number: [Enter Serial Number]

NIST Property Number: [Enter NIST Property Number]

Other: [Enter Other Details]

Travel

N/A

[Describe any Travel Requirements Per Item]

Explain:

[Enter Justification / Requirement]

Other:

[Enter Other Requirements]

NOTE TO VENDOR: To the maximum extent possible, include travel requirement estimates as part of pertinent sections above (Installation, Maintenance, Repair, etc.). Otherwise, Travel will be a separate line item, reimbursable per the Federal Travel Regulation.