

**CADRE DE RÉPONSE TECHNIQUE  
  
 COMPLIANCE MATRIX**

**APPENDED TO THE CONSULTATION RULES**

*MATRICE DE CONFORMITE*

*ANNEXEE AU REGLEMENT DE LA CONSULTATION*

* All the specifications expressed in the CCTP as minimum requirements are listed in this table and must be complied with in the bidder’s technical proposal, failing which the offer will be declared inadmissible;
* Only admissible offers will then be evaluated according to the award criteria and their weighting;
* For each specification, the bidder must indicate the corresponding page in their technical proposal.
* *Toutes les spécifications exprimées dans le CCTP en termes d’exigences minimales sont reportées dans ce tableau et doivent être respectées dans le mémoire technique du candidat à peine d’irrecevabilité de son offre ;*
* *Seules les offres recevables font ensuite l’objet d’une évaluation selon les critères d’attribution et leur pondération ;*
* *Pour chaque spécification, le candidat doit renseigner la page correspondante de son mémoire technique*

| Req. | Specification | Flex | Requirement | Goal | CCTP Page | Supplier’s Response/Performance | Supplier’s technical description page |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **3.1. Cryogenic performance** | | | | | |  |  |
| 3.1.1 | Minimum temperature | 0 | <10 mK | 8 mK | 5 |  |  |
| 3.1.2 | Cooling power at the cold plate stage with the mixing chamber regulated at 14mK. | 0 | 320 𝜇W |  | 5 |  |  |
| 3.1.3 | Cooling power at the mixing chamber stage with the temperature stabilized at 20 mK | 0 | 12 𝜇W |  | 5 |  |  |
| 3.1.4 | Cooling power at the mixing chamber stage with the temperature stabilized at 100 mK | 0 | 450 𝜇W |  | 5 |  |  |
| 3.1.5 | Temperature stages | 0 | Cold plate < 100 mK  Still plate < 1K  4K plate < 4.2 K  60K plate < 70 K |  | 5 |  |  |
| 3.1.6 | Controlling the temperature of the mixing chamber plate up to 30 K while maintaining a pulse tube temperature at 4.2 K | 0 |  |  | 5 |  |  |
| 3.1.7 | Galvanic isolation from the gas-handling system and the pulse tube compressor | 0 | Complete ground isolation between the dilution refrigerator and the gas-handling system, and between the dilution refrigerator and the pulse-tube compressor (isolation resistance > 1G) |  | 5 |  |  |
| 3.1.8 | The detector box temperature with 500 nW heat load in nominal fridge operation. See **Sec. 3.10**. | 0 | <=12 mK |  | 5 |  |  |
| **3.2. Pulse-Tube cooler/vibration dampening** | | | | | |  |  |
| 3.2.1 | The pulse tube cooler should have a cooling power ≥ 1.3W at 4.2K. | 0 | ≥ 1.3W at 4.2K |  | 6 |  |  |
| 3.2.2 | The cryocooler shall be equipped with a remote valve option. | 0 |  |  | 6 |  |  |
| **3. Gas-handling system** | | | | | |  |  |
| 3.3.1 | The compressor used for condensing the mixture must be able to operate with an outlet pressure of up to 3 bar without risk of failure | 0 |  |  | 6 |  |  |
| 3.3.2 | Scroll pumps are not allowed in the dilution circuit. | 0 |  |  | 6 |  |  |
| 3.3.3 | Two separate vacuum circuits for the OVC and the dilution are required, with therefore two different turbo pumps and two different primary pumps. | 0 |  |  | 6 |  |  |
| 3.3.4 | Safety | 0 | The gas-handling system, together with monitoring system, shall ensure automatic recovery of the mixture in case of trouble |  | 6 |  |  |
| **3.4. He-3 and He-4 mixture** | | | | | |  |  |
| 3.4.1 | The dilution refrigerator must be delivered with the correct amount of 3He-4He mixture to achieve the specifications listed in the CCTP document | 0 |  |  | 6 |  |  |
| **3.5. Monitoring system and operations** | | | | | |  |  |
| 3.5.1 | Elapsed time for each of the component requiring maintenance (pulse tube cryocooler, pumps, compressor, etc.) shall be recorded and easily accessible. | 0 |  |  | 7 |  |  |
| 3.5.2 | The system shall provide an automatic cool down procedure of the dilution refrigerator from room temperature to base temperature | 0 |  |  | 7 |  |  |
| 3.5.3 | The system shall provide an automatic warm up procedure of the dilution refrigerator, including mixture recovery | 0 |  |  | 7 |  |  |
| 3.5.4 | The dilution refrigerator shall be equipped with a pressure gauge to control the outer vacuum chamber. | 0 |  |  | 7 |  |  |
| 3.5.5 | It is required that we can extract the pressure and temperature data from the fridge computer to be stored in a database owned and managed by the customer | 0 |  |  | 7 |  |  |
| **3.6. Temperature measurement** | | | | | |  |  |
| 3.6.1 | The system shall comprise at least the following calibrated thermometers:  - 1 full range thermometer at the MC level  - 1 RuO2 thermometer at the cold plate level  - 1 CERNOX thermometer at the still plate level - 1 CERNOX thermometer at the 4 K plate level - 1 CERNOX thermometer at the 50 K plate level  - 2 RuO2 thermometer at the end of the 10mK cold finger  - 1 RuO2 thermometer at the payload cold flange  - 1 CERNOX thermometer at the bottom of the payload still canister | 0 |  |  | 7 |  |  |
| 3.6.2 | The temperature controller must be able to monitor a temperature as low as 8mK | 0 |  |  | 7 |  |  |
| 3.6.3 | The system shall comprise at least 3 heaters: - 1 heater at the mixing chamber level - 1 heater at the still plate level  - 1 heater at the detector plate | 0 |  |  | 7 |  |  |
| **3.7. Weight loading** | | | | | |  |  |
| 3.7.1 | Weight that the 300 K thermal stage shall be able to support | 0 | 550 kg |  | 8 |  |  |
| 3.7.2 | Weight that the 50 K thermal stage shall be able to support | 0 | 390 kg |  | 8 |  |  |
| 3.7.3 | Weight that the 4K thermal stage shall be able to support | 0 | 355 kg |  | 8 |  |  |
| 3.7.4 | Weight that the still thermal stage shall be able to support | 0 | 325 kg |  | 8 |  |  |
| 3.7.5 | Weight that the cold plate thermal stage shall be able to support | 0 | 110 kg |  | 8 |  |  |
| 3.7.6 | Weight that the mixing chamber thermal stage shall be able to support | 0 | 60 kg |  | 9 |  |  |
| **3.8. Vibrations** | | | | | | | |
| 3.8.1 | documentation about the vibration minimization and associated data that the customer can use in a comparative review of the offers. The vibration data – measured with an accelerometer on the mixing chamber plate – should come from a standard system without the customizations discussed in Sections 3.9 and 3.10 of the CCTP. | 0 |  |  | 9 |  |  |
| 3.8.2 | Cold head mechanically decoupled from the cryostat frame at room temperature with the use of an edge-welded bellows and a dedicated frame for maximum decoupling. | 0 |  |  | 9 |  |  |
| **3.9.1 Implementation in the experimental room** | | | | | |  |  |
| 3.9.1.1. | Distance between pulse tube and compressor | 0 | The distance between the pulse tube remote valve and the compressor is estimated to be 17m. The tubing must be compatible with 20m. Final tubing length will have to be defined precisely during the engineering study between customer and vendor. |  | 9-10 |  |  |
| 3.9.1.2 | Distance between Gas-Handling System (GHS) and the top of dilution refrigerator (DR) | 0 | GHS will be located outside the cleanroom. The distance between the GHS and top of the DR is estimated to be 17m. The tubing must be compatible with 20m. Final tubing length will have to be defined precisely during the engineering study between customer and vendor. |  | 10 |  |  |
| 3.9.1.3 | DR integration in the cleanroom at LPSC | 0 | The dilution refrigerator system has to fit within 3.5 m from the platform flooring with enough clearance to open and close the cryostat canisters. The cryostat frame will be bolted to the LPSC cleanroom flooring, below the platform. |  | 10 |  |  |
| 3.9.1.4 | DR equipped with lifting rings or an equivalent mechanism to allow its handling with the crane. | 0 | the DR can be integrated via the crane from the ceiling cleanroom trap |  | 10 |  |  |
| **3.9.2. Mechanical support of the Dilution Refrigerator** | | | | | |  |  |
| 3.9.2.1 | DR frame has to be non magnetic | 0 |  |  | 10 |  |  |
| 3.9.2.2 | Frame criteria to allow shielding opening | 0 | The fridge frame must accommodate below it a 1700 mm wide by 2225 mm tall (includes the height of shielding and platform) box which will be the warm shield. The frame must be open on all four sides: two sides to allow shielding movement, the other two sides to allow access to the cryostat when the shield is open |  | 10 |  |  |
| 3.9.2.3 | Adds-on frame | 0 | Any additional frame to hold parts, e.g. rotary valve motor, need to be built around the shield and allow the shield to close around the dilution refrigerator. |  | 11 |  |  |
| **3.9.3. Fluid interfaces** | | | | | |  |  |
| 3.9.3.1 | Port for mixture filling | 0 | The gas-handling system shall include one port of NW/KF type (e.g. NW/KF25) |  | 11 |  |  |
| 3.9.3.2 | Port for leak testing | 0 | The gas-handling system shall include one port of NW/KF type (e.g. NW/KF25) |  | 11 |  |  |
| 3.9.3.3 | Additional port | 0 | In case the gas-handling system would not include the auxiliary pumping unit, the gas-handling system shall include one separate port of NW/KF type (e.g. NW/KF25) to connect the auxiliary unit.  Ports required in 3.9.3.1 to 3.9.3.3 could be coupled in 2 or maybe even 1 single port fulfilling the three functions. |  | 11 |  |  |
| **3.9.4. Readout port** | | | | | |  |  |
| 3.9.4.1 | Feedthrough and ports | 0 | At the minimum, qty. nine (9) feedthrough ports with diameters ranging from 25 to 100 mm with at least qty. one (1) of 25 mm diameter, qty. two (2) of diameter 40 mm, qty. four (4) of diameter 50 mm, and qty. two (2) of 100 mm diameter - are required |  | 11 |  |  |
| **3.10. Mechanical structure** | | | | | |  |  |
| 3.10.1 | *Payload still canister* | 0 | The vendor should provide a payload still canister and a 10 mK cold finger, even if these items might be replaced by the customer after purchase with a thicker customized *payload still canister* and a hollow 10 mK cold finger.  The 10mK cold finger shall be removable. |  | 13 |  |  |
| 3.10.2 | Inner diameter of the *payload still canister* | 0 | The inner diameter of the *payload still canister* needs to be at least 285 mm in diameter and at least 458 mm high to ensure sufficient experimental volume |  | 13 |  |  |
| 3.10.3. | Support flange of the *payload still canister* dimension | 0 | The support flange of the *payload still canister* should be at least 25 mm thick, have a 395 mm diameter, and have a bolt circle diameter of 365 mm to mate to the canister below. It needs to support a 130-kg load with less than 1.0 mm of deformation. |  | 13 |  |  |
| 3.10.4 | Inner dimensions of the *payload 4K canister* | 0 | The inner dimensions of the payload 4K canister need to be at least 415 mm in diameter and 535 mm in height to allow the space for a customer-provided thicker still canister. |  | 13 |  |  |
| 3.10.5 | Required clearances for routing of readout cables and tubing for the detectors | 0 | The distance between the bottom of the mixing chamber plate and the top of the *extended mixing chamber plate* (see Figure 6, left) is at least 100 mm.  The distance between the top surface of the *still canister flange above the neck* (see Figure 6, left) and bottom of the *extended cold plate* is at least 20 mm.  The inner diameter of the *cold neck* needs to be at least 57 mm.  The radial distance between the inner diameter of the still neck and the outer diameter of the cold neck needs to be at least 20 mm. To state this a different way, the still neck inner diameter must be 40 mm larger than the cold neck outer diameter. |  | 13-  14 |  |  |
| 3.10.6 | Dimensions of the payload section of the outer vacuum chamber | 1 | Outer diameter of the canister (not including flange diameter) between 490 mm and 530 mm,  Outer height (from bottom to flange mating surface) between 590 mm and 630 mm. |  | 14 |  |  |
| 3.10.7 | Dimensions of the outer vacuum neck | 1 | Outer diameter of the neck region between 162 mm and 202 mm.  Height (from upper to lower flange mating surfaces) between 470 mm and 510 mm. |  | 14 |  |  |
| 3.10.8 | Outer Vacuum Chamber (OVC) distance from support platform | 0 | The bottom of the OVC shall be a distance from the *support platform* either 680 mm or equal to the height of the outer vacuum chamber Req. 3.10.6 plus 2.5 cm, whichever is greater. The platform flooring is 30 cm above the floor so the distance from the floor is either of the two values plus 30 cm. |  | 14 |  |  |
| 3.10.9 | Hole and feedthrough specifications | 0 | Holes are required in the following locations. Final dimensions and specifications will be provided by the customer upon contract signing:  Extended cold plate: mounting holes for vibration decoupler  Payload cold flange: mounting holes for thermal straps  Extended mixing chamber plate: mounting holes for a future customer-supplied cold finger  Extended cold plate and mixing chamber plate: feedthroughs for readout cables |  | 14 |  |  |
| 3.10.10 | Cold Finger / Neck | 0 | The *10mK cold finger* and 100mK neck provided by the vendor will each extend a prescribed distance into the *payload still canister* as described below:  - Distance from bottom of 10 mK flange to payload still plate mating surface: 125 mm  - Distance from bottom of 100 mK flange to payload still plate mating surface: 30 mm |  | 14 |  |  |
| 3.10.11 | Cold neck thickness | 0 | The thickness of the 100 mK cold neck needs to be at least 2 mm (for thermal reasons to support later customer heatloads). Greater thicknesses would be much appreciated if practical. |  | 14 |  |  |
| 3.10.12 | Cryostat design review and customer approval | 0 | Once the engineering plan for the cryostat is finalized, the vendor will produce a report with the dimensions and technical designs for the client to review and, after 10 business days for review, a meeting will be organized for final approval. |  | 14 |  |  |
| **3.11. Reliability** | | | | | | | |
| 3.11.1 | Maintenance requirement | 0 | A list of elements requiring maintenance and provide technical details on the maintenance to be performed. |  | 15 |  |  |
| **3.12. Expected documentation and samples** | | | | | | |  |
| 3.12.1 | Specification of Required Resources | 0 | The vendor shall indicate the necessary resources: number and type of power supplies (mono-phase, 3-phase, type of plug), number of lines for compressed air and associated technical specifications (e.g. nominal pressure), number and type of water lines and associated technical specifications (e.g. flow rate), any other resources needed to operate the system: LN2 for nitrogen trap, etc. |  | 15 |  |  |
| 3.12.2 | Factory test report | 0 | The vendor shall provide a factory test report upon the successful completion of performance tests conducted at the vendor’s premises. |  | 15 |  |  |
| 3.12.3 | Documentation | 0 | This documentation in English includes at least:  User Manual with detailed operation instructions, troubleshooting, software description  Maintenance plan, list of elements requiring maintenance and maintenance procedures in Req. 3.11.1.  Calibration data for thermometers, flowmeter, etc  Interface drawings updated according to the “as built” system  Test protocol (for the test at customer’s premises)  Acceptance test report (after successful tests at customer’s premises)  Written procedure and photographic report on how to package the dilution refrigerator  STEP files of the dilution refrigerator  Certificates of conformity for the CE, calibration certificates, etc.  The samples from the same batch of the materials of thermal canisters and plates used in the dilution refrigerator construction process have to be provided to allow screening tests (LPSC responsibility)   * Report detailed in Req. 3.1.8. |  | 15 |  |  |
| **3.13. Packaging for the shipping** | | | | | | | |
| 3.13.1 | Packaging Retention | 0 | The original packaging will be left at the LPSC and need to be reused for the second transportation to LSM. |  | 15 |  |  |
| 3.13.2 | Sustainable Packaging Specification | 1 | The original packaging should be made with recyclable material. |  | 15 |  |  |
| **3.14. Installation and commissioning at LPSC** | | | | | | | |
| 3.14.1 | Installation and validation of DR onsite at LPSC | 0 | The vendor will install the dilution refrigerator at LPSC and will perform the first cool down to demonstrate the performance of the dilution refrigerator. |  | 16 |  |  |
| 3.14.2 | Customer Training | 0 | The vendor will perform a user training to use the system during the first cool down or during a dedicated meeting following it. A team of roughly 5 persons will need to be trained. |  | 16 |  |  |
| **3.15. Radiopurity** | | | | | | | |
| 3.15.1 | Radioactive contamination mitigation during fabrication process | 0 | Use gloves when handling the copper screens and plates in the neck and payload canister region of the dilution refrigerator |  | 16 |  |  |
| **Potential Supplementary Service - *Prestation Supplementaire Eventuelle* (PSE)** | | | | | | | |
| **PSE1** | Provision of relocation(packaging, shipment, integration at the LSM underground lab and onsite cryogenic performance validation)of the system from the LPSC (Grenoble, France) to Laboratoire Souterrain de Modane (Modane, France). |  |  |  | 16 |  |  |
| **PSE2** | EMI mitigations at each vacuum joint |  | quote for options:  - Metallic o-ring,  - Dual grooves to insert spira-shields  - Aluminium seals ISO-KF. |  | 16 |  |  |