

Market consultation

For: closed-cycle refrigerator cryostat system

Contracting authority:

TNO, Netherlands Organisation for applied scientific research

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1. Introduction

The document describes the organisation TNO, its content and objective of the market consultation, the schedule, preconditional and procedural matters.

TNO, department Quantum Technology intends to purchase a closed-cycle refrigerator cryostat system. TNO would like to gain more information from the market by conducting this market consultation. The gained information might be used as input for the formal tender process. Therefore, any party which is able to deliver such system for the purposes described in section 3 is invited to contact TNO to present the costs and (technical) possibilities of their stitching interferometer.

After this market consultation TNO will decide which Tender procedure is the most appropriate choice to buy a closed-cycle refrigerator cryostat system.

1.1 TNO

TNO, the Netherlands Organisation for applied scientific research, was founded by law in 1932 to enable business and government to apply knowledge. As an organisation regulated by public law, we are independent: not part of any government, university or company.

TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way. This is our mission and it is what drives us, the over 4,500 professionals at TNO, in our work every day. We work in collaboration with partners and focus on nine domains.

1.2 Organisational structure

TNO's high level of ambition demands an appropriate organizational structure and corporate culture. Staff must be given every support as they pursue innovation and productive cooperation. The current organisational unit structure is shown below:



All units are concerned with issues which are high on the national and European innovation agenda. The themes form the focus of the organization's nine units, each of which is responsible for acquiring and performing contract research relevant to its specific theme and innovation areas.

If you would like further information about a domain or a specific subject, please take a look at: www.TNO.nl.

1.2.1 Procurement

On behalf of TNO, the Procurement department supervises all procurement, purchasing and tendering procedures and works closely together with the Quantum Technology department in this market constellation. As part of the Finance, Procurement & Legal (FPL) division, the Procurement Department is also responsible for organizing and implementing all procurement processes in keeping with the corporate objectives of the organisation.

1.3 NanoLabNL

NanoLabNL is the Dutch national facility for nanotechnology research. Its mission is to provide a full-service and Open-Access infrastructure for R&D in nanotechnology. It has an open character and it hosts many public-private partnerships. NanoLabNL is coordinated as one infrastructure while its facilities are distributed over five cities or 'hubs': Groningen,

Enschede, Amsterdam, Delft and Eindhoven. NanoLabNL is part of the national programme on quantum technology. In that capacity NanoLabNL is dedicated to keeping its basic infrastructure 'state-of-the-art' to enable breakthrough-developments in the fabrication of quantum devices. In addition more specific focus is placed on high TRL infrastructure to serve the quantum agenda.

As such NanoLabNL supports scientists in their research and supports companies in improving or renewing their products/production process and/or developing new products. Finally, it aims to contribute to strengthening the Netherlands as a knowledge economy.



The hubs cooperate and share information on all possible activities, such as procurement. As a result a procurement working group has been established, within this working group, documentation, best practices, and investments plans are discussed and shared.

This Tender procedure, on behalf of TNO, contributes to the achievement of this ambitious mission.

1.4 Purpose of the market consultation

Before proceeding with the preparation of a possible tender, TNO wants to consult the market on how this tender can best be structured (broadly speaking). Within the scope of the market consultation advice is sought to gain insight into the potential market for the delivery of a stitching interferometer for TNO. The market consultation is open to all players in the market.

With this market consultation TNO wishes to gain insight into what is technically feasible on the basis of the functional & technical specifications as specified in chapter 4. In this way we want to give parties the opportunity not only to get involved at an early stage but also to think along with us about what the best solution might be for TNO. After all, the insights obtained can be taken into consideration in the final formulation of the specifications for the (possible) future Tender and allows participants to contribute to the success of the Tender.

The purpose of the market consultation is covering the following aspects:

- To gain more insights in the pricing models of the different closed-cycle refrigerator cryostat systems;
- To gain more insights in discriminating factors for different configurations of closed-cycle refrigerator cryostat systems;
- To gain more insight into the current possibilities and the choice on the market; to get a clear understanding of the visions, ideas and suggestions of market participants;
- To gauge market interest for this Tender;
- To decide which procurement strategy is best suited to our functional requirements in the current market.

TNO wishes to be advised about on how the existing situation (see section 3.1) the best can be requested.

The results of the market consultation may be processed in the Tender documents, without being traceable of participants of this market consultation.

1.5 Schedule

No dialogue sessions are planned during this market consultation. However, if the input provided leads to additional questions at TNO, TNO will ask for a written and/or oral explanation.

The schedule of the market consultation is shown in the table below.

Deliverable / activity	Responsible	Date
Market Consultation document published by TNO	TNO	03-11-2023
Deadline for submitting your questions on the Market Consultation document	Subscriber	29-11-2023
Deadline for TNO to reply to the questions (anonymised) and publish any additional information or revision of this document on TenderNed	TNO	06-12-2023
Deadline for submitting your input	Subscriber	15-12-2023
Possibility for TNO to ask clarification to each party individually when necessary (information will be included in the summary)	Subscriber/TNO	during weeks 2 and 3 (2024)
TNO summary of market consultation results on TenderNed	TNO	Shortly after week 4

2 Basic principles and preconditions

2.1 The basic principles and preconditions

The basic principles and preconditions mentioned below apply to this market consultation:

- TNO observes the principles on non-discrimination and transparency when carrying out this market consultation;
- This document is solely intended for market consultation purposes and thus is not part of the possible Tender procedure. In short, just a consultation round;
- This market consultation does not serve to make a pre-selection from candidates or interested market parties in the context of the planned tender;
- Market participants who do not apply for this market consultation will not be excluded from participating in the (possible) final Tender. Similarly, market participants who join this market consultation will not be excluded or privileged from participation in the (possible) final Tender;
- This market consultation is non-binding, both for the participants and for TNO;
- Parties who may or may not participate in this market consultation cannot derive any mutual obligations or rights vis-à-vis TNO;
- Participating to this market consultation does not confer no entitlement at obtaining a contract award;
- TNO shall not reimburse any eventual costs in participating to this market consultation;
- Participating market parties agree that the information provided by them can be processed anonymized in the further elaborating program of requirements;
- In the context of the market consultation, provided information may differ from the information that will be provided in the (possible) Tender procedure;
- The contribution of participating Parties will be handled as much as possible with confidentiality and in any case TNO will take into account the legitimate interests of the parties;
- The official language during this market consultation will be Dutch and/or English;
- TNO is in no way bound by the outcome of the market consultation or obliged to realise and/or put out to tender the desired investment to which the market consultation is linked;
- No claim will be honoured for the use of information, confidentiality, or request for compensation herewith;
- All documents submitted by the participating Parties are considered public documents and shall be copy-right free. If copyrights are applicable, TNO is protected by the participating Parties;
- No value judgment can be attributed to TNO's answers to questions given by you;
- TNO reserves the right to:
 - o perform the proposed procurement process in a different way, in terms of content and style, than the process that may have been communicated;
 - o to cease publication of the market consultation temporarily or permanently.
- Participating in this market consultation, constitutes the Parties unconditional approval of the procedure as stated in this document.

2.2 Contact person and communication

All communication relating to the market consultation, will take place via TenderNed only and in the manner specified in this Procurement Guide. If direct contact with TNO is specified/necessary, communication will take place exclusively with the TNO contact person stated below, in writing at all times, via the TenderNed messaging module.

Name : Jelle van der Kooi
Position : Buyer
Department : Procurement
Postal address : PO Box 96800, NL-2509 JE The Hague
E-mail : via TenderNed, the messaging module for the present tender

Participating market parties cannot derive any rights from oral statements, undertakings and suggestions made by TNO employees and/or consultants in relation to the market consultation procedure and/or the market consultation documents. Participating market parties may only rely on information provided in writing by or on behalf of TNO.

In the heading of your e-mail and in all future correspondence relating to this market consultation should be clearly mentioned 'Market consultation 2023 FPL/INK 112_closed-cycle refrigerator cryostat'.

The information received may lead to more in-depth questions for TNO. Optionally, TNO may therefore decide to hold a second round of in-depth questions. For this second round of in-depth questions TNO will only invite those parties who also

participated in the first round. In addition, TNO leaves the possibility open to invite market parties without justified reasons and to ask for an additional explanation of the answers received.

2.3 Language

Tenders must be written in the English language. Tenders in languages other than English will be excluded from participation. Official documents that cannot be submitted in the English language may be written in the language of the document's country of origin. Upon request, the participating market party shall arrange a translation by a sworn interpreter-translator. The costs incurred shall be borne by the participating market party.

2.4 Confidentiality

The participating market party will observe strict confidentiality in respect of all information that is or becomes known to it through TNO. It will not make the information available to Third Parties and will only disclose it to its staff, including consultants, subcontractors and Third Parties, to the extent necessary to submit the response to the market consultation.

2.5 Intellectual property rights

Subject to exceptions as specified in the Dutch Copyright Act [Auteurswet], no part of the market consultation documents may be reproduced (other than for the purpose of submitting an answer to the market consultation) in any manner whatsoever without TNO's consent in writing. Responses to the market consultation and all Annexes submitted by participating market parties as part of the market consultation procedure will become TNO's property upon receipt.

2.6 Use of TNO logo

The TNO logo may not be copied, altered or otherwise used on documents submitted by the participating market party as part of the Procurement Procedure.

3 Background of the demand

One of TNO's core tasks is to strengthen the earning power of the Dutch economy and increase employment¹. This core task is, to an extent, realized by the creation of test and measurement facilities.

This demand is regarding closed-cycle refrigerator cryostat for a test and measurement setup called the Low Temperature Characterization Tool (LTCT). The LTCT will be a system for the characterization and calibration of colour centers, and related devices and materials. By creating this setup, TNO will strengthen the Dutch and European ecosystem on quantum technologies.

3.1 The use of the cryostat within the LTCT

The device under test (DUT) will be located in the cryostat as the colour centers within the DUT require low (1 Kelvin) temperatures for coherent measurements. The possible DUT requires interfaces with optics (both fiber coupled and free-space), Microwave equipment and analogue & digital electronics. These interfaces should be accommodated by the cryostat in the form of fiber optics, MW cables and DC cables, and additionally a free-space path from the sample to the optics outside the cryostat.

The DUT will require an adjustable vectorial magnetic field from 0 to 1 Tesla in each possible direction. As this will require an electromagnetic bore, and the system should be accessible to various different types of DUT, the bore should have a leave an inner sample space open with a minimal usable diameter of 93 mm.

The DUT in the bore should be accessible to by focused light originated from the free-space interface. This light will be focussed using a lens system inside the cryostat. The whole light path should be a line of sight from the top of the cryostat to the sample with a 25.4 mm width, and feedthroughs through the various stages and housings.

3.2 Functional & technical desired requirements

Req. Number	Requirement	Rationale
System components		
R001	The system shall include the following components: • Fridge • Helium or Gas handling system • Control unit including software control • System support frames, including vibration damping. • Helium	Required for a complete and functioning system.
R002	The fridge shall include the following components: • Vacuum housing • Pulse tube • Cold plate • Vector magnet • Sample space • At least 10 RF feedthroughs and RF lines • At least 48 DC feedthroughs and DC lines • At least 5 optical fiber feedthroughs • Optical window and line-of-sight optical path	Required for a complete and functioning system.
General Fridge requirements		
R003	The system shall be a closed-cycle dry system.	Required by lab conditions.
R004	The system shall be monitored by at least one thermometer per stage with a resolution of 0.1 Kelvin or better, with the sample chamber thermometer being calibrated.	Required for monitoring during measurements for stability.
R005	The system shall be able operate continuously at the base temperature, for at least 1 week.	Required for the various measurements on the DUT.
R006	The system shall be upgradable to a working dilution refrigerator capable of base temperatures below 100 mK.	Required for the future perspective of the setup.
R007	The base temperature of the system, as measured at the cold plate within the fridge, shall be 1 kelvin or lower.	Required for the DUT.

¹ <https://www.tno.nl/en/about-tno/mission-strategy/>

Req. Number	Requirement	Rationale
R008	The cooling power at the base temperature on the cold plate shall be 30 mW or higher with the magnet and wiring in place.	
Vector magnet		
R009	The vector magnet shall have an inner bore diameter ² of 93 mm or larger.	Required to fit the DUT and piezo scanners.
R010	The vector magnet shall be able to create a magnetic field in the range of 0 to 1 Tesla in steps of 0.1 milliTesla or smaller in the X, Y and Z directions.	Required for the various measurements on the DUT.
R011	The vector magnet shall be equipped with the persistent switches for all three magnetic coils.	
R012	The temperature of the magnet shall be continuously monitored to ensure stable operation.	Required for monitoring during measurements for stability.
RF feedthroughs and lines		
R013	The RF feedthroughs in the housing shall be of the type SMA on the room and vacuum side.	Required for the DUT.
R014	The RF lines shall connect the feedthroughs to the sample space.	
R015	The RF lines shall have a bandwidth of 15 GHz or more.	
R016	The RF lines shall have connectors of the type SMA.	
DC feedthroughs and lines		
R017	There shall be at least 18 (3 x 3 stages x 2 lines) DC cables as 9 twisted pairs with a resistance <5 Ohm and a bandwidth of 100 kHz for piezo scanner stages. These values should be attained at base temperature and at room temperature. This wiring and feedthroughs needs to be compatible with Attocube linear positioners.	Required for the DUT and piezo scanners.
R018	There shall be at least 15 DC cables with a resistance <20 Ohm for resistive readout of the Attocube piezo positioners. These values should be attained at base temperature and at room temperature.	
R019	There shall be at least 15 extra DC lines that allow for voltages up to 300V (>100 Hz bandwidth).	
Vacuum housing		
R020	The vacuum housing and metal body of the fridge shall be electrically isolated from the mains ground. This is a requirement to avoid interference via ground loops.	Required for the various measurements on the DUT.
R021	The cryostat shall have ensure a maximum of 10 um peak-to-peak vibrations on the vertical direction and a maximum of 10 um RMS vibrations on the horizontal direction between the cold plate and the outside of the cryostat while the cryostat is in operation.	Required for the various measurements on the DUT.
Optical fiber feedthroughs		
R022	The optical fiber feedthroughs in the fridge shall be suited for FC-APC fiber connectors.	Required for the various measurements on the DUT.
R023	The fridge shall provide the ability to connect optical fibers from the feedthroughs to the sample space.	Required for the various measurements on the DUT.
Optical window and line-of-sight optical path		
R024	The optical window shall be located centered on the top of the fridge.	Required for the various measurements on the DUT.
R025	The optical window shall have a transmission of 95% or more for light in the wavelength range of 515 nm to 850 nm.	
R026	The optical window shall have a clear aperture with a diameter of 25.4 mm, such that it is compatible with 1 inch optics.	
R027	The fridge shall contain a removable optical window on each temperature stage with a diameter of 25.4 mm.	
R028	The fridge shall have a line-of-sight from the optical window on the top of the fridge to the sample space with a clear diameter of 25.4 mm or bigger.	

² Defined as the available space within the bore.

Req. Number	Requirement	Rationale
Infrastructure		
R029	The fridge (part in which the sample is located) shall be installed in a laboratory with a ceiling height of 320cm. An optical breadboard will be mounted on top of the frame for the coupling of the light in the fridge. For adjusting the optics, the frame of the fridge shall be at most 260cm in height.	Required by lab conditions.
R030	The system should be able to safely recover the helium in case of a failure of either the cooling water, electricity or compressed air.	
R031	After an upgrade to dilution refrigerator, the requirements on the dimensions should still hold.	Required for the future perspective of the setup.
Software		
R032	The system shall be controlled by either a control unit or remotely via a software package.	Required for the various measurements on the DUT.
R033	The software package shall be able to run on a windows computer.	
R034	The software package should be able to perform: - Cooling down the sample to a temperature specified by the user down to 1 kelvin - Warm-up the system to ambient temperature - Magnetic field magnitude and direction - Track vacuum pressure and temperature over time	
Service		
R035	The whole system and the upgrade shall already be an existing product and do not require considerable development.	Required to avoid delays and unforeseen measurement problems.

4 Questionnaire

Subscribers can be asked for additional explanation in a second round.

Subscribers are requested to limit their response with a maximum of 8 pages of A4.

Question on interest	
A1	Do you consider, based on the limited information of this document, to apply to the tender? If yes, why, if not, why not?
Questions on content	
B1	Can you deliver a system that meets the requirements stated in Chapter 3.2?
B2	Can you provide data (measurements) of the temperature and cooling power of an equivalent system to proof that your systems can meet requirements R007 and R008?
Questions regarding the tender	
C1	What is the track-record of your company in engineering/procurement/commissioning of cryostats that meet the requirements?
C2	Is your company ISO9001 certified?
C3	Does your company have a Non Conformances Management system in place?
Questions regarding planning	
D1	What would be the lead time from contract award to Installation in Delft?
D2	When would it be possible to perform the Site Acceptance Test at TNO?
Finally	
E1	Do you have ideas, suggestions, or comments regarding the viability of the requirements and possible technical solutions?
E2	Do you have other ideas, suggestions, or comments you want to share?