

Market consultation

for: a Optical telescope for Free Space Laser Communication

Contracting authority:

The Netherlands Organisation for Applied Scientific Research TNO

Document ref. : TNO 2018 FPL/INK 146
Date : 30-07-2018

Contents

1. Introduction	3
2. Basic principles and preconditions.....	6
3. Background of the demand	7
4. Questionnaire	13

1. Introduction

This document describes the organisation TNO, and the content, objective, schedule, preconditions and procedural matters of the market consultation.

TNO, department Space Systems Engineering intends to purchase an Optical Telescope for Free Space Laser Communication purposes. TNO would like to gain more information from the market by conducting this market consultation. The information gained might be used as input for the possibility of a formal tender process following the market consultation. Therefore, any party which is able to deliver such a system for the purposes described in section 3 is invited to contact TNO to present the answers on the questions posed in section 0 and other relevant information they would like to share with TNO.

After this market consultation TNO will decide which tender procedure is the most appropriate choice to buy an Optical Telescope.

1.1 TNO

The Netherlands Organisation for Applied Scientific Research, hereafter ‘TNO’, is a modern, theme-led Research & Knowledge organisation. It was established in 1930 by Act of Parliament with the intention of maximizing the practical relevance of scientific research to the public sector, industry and society at large. The government of the day believed that this would enhance the innovative strength of the Netherlands and contribute to long-term economic growth. TNO is an independent research organisation. We believe in the joint creation of economic and social value.

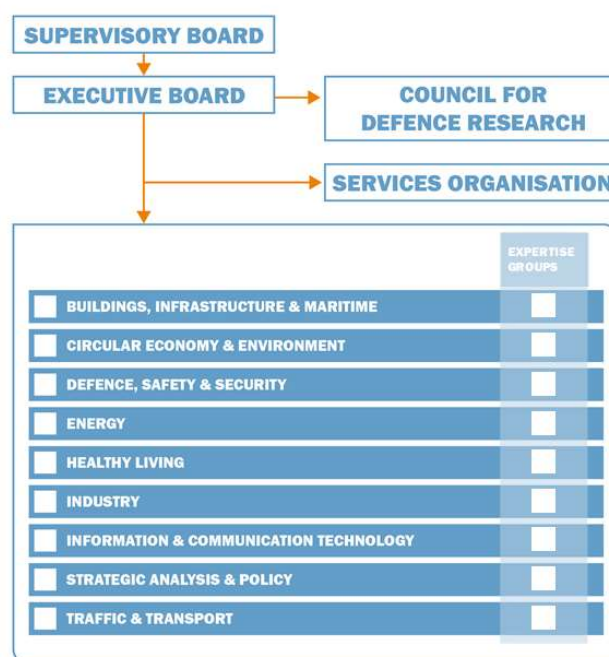
TNO connects people and knowledge to create innovations that boost the competitive strength of industry and the wellbeing of society in a sustainable way. This is our mission and it is what drives us, the over 2,600 professionals at TNO, in our work every day.

Effective innovation is what TNO stands for. We do not do that alone but with companies, governments and a whole range of organisations. Through collaboration we create innovations that sustainably strengthen the competitiveness of companies and the wellbeing of society. We develop knowledge not for its own sake but for real applications. We work on issues that concern our environment, safety and security, the energy transition, innovations in industry and how to keep the ageing population actively engaged. These are the challenges that TNO researchers take up every day in their drive to produce impactful innovations.

1.2 Organisational structure

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

TNO STRUCTURE



We focus on transitions or changes in nine societal themes:

- Buildings, Infrastructure & Maritime: 'Robust constructions, sustainable use'
- Circular Economy and the Environment: 'Directing and accelerating sustainability'
- Defence, Safety and Security: 'We're putting our knowledge and technology to work for safety and security'
- Energy: 'Faster towards a sustainable energy supply'
- Healthy living: 'Focussing on participation, not on the disease'
- Industry: 'Innovating for employment, welfare and well-being'
- Information & Communication Technology: 'Interpreting and accelerating digital transformation'
- Strategic Analysis & Policy: 'Turning complex issues into concrete innovations'
- Traffic and Transport: 'Helping to create liveable, sustainable cities'

Innovation with purpose is what TNO stands for. We develop knowledge not for its own sake, but for practical application. For further information, see: www.tno.nl.

1.3 Procurement

The TNO Procurement Department is involved in the purchasing, procurement and tendering procedures on behalf of TNO. For the telescope that is done in close cooperation with the department Space Systems Engineering which is part of the unit Industry.

As part of the Finance, Procurement & Legal division, the Procurement Department is responsible for organizing and implementing all procurement processes in keeping with the corporate objectives of the organisation.

1.4 Purpose

Before proceeding with the preparation of a tender, TNO would like to consult the market on how this tender (in broad lines) can be structured. Within the scope of the market consultation, advice is sought to gain insight into the potential market for the delivery of an Optical Telescope for TNO. The market consultation is open to all players in the market.

The market consultation generates benefits for all parties involved. TNO observes what is possible and what the perception is of the market. So as to provide a more effective and coordinated response in how, for example, preferences and requirements can be formulated in the tender.

For interested players in the market an added advantage is that they get an early view of TNO and the tender which might follow. In addition, the market can affect requirements which will come back in the tender. This 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 discriminating factors for different configurations of Optical Telescopes;
- To gain more insight into the current possibilities and the choice on the market;
- To understand which are the cost drivers in relation to our functional requirements and configurations;
- To get a clear understanding of the visions, ideas and suggestions of market participants;
- To gauge market interest for this possible tender;
- To decide which procurement strategy is best suited to our functional requirements in the current market;
- To receive a price indication for the telescope and the mentioned options.

The results of the market consultation may be processed in the possible tender documents, without traceability of participants of this market consultation.

1.5 Schedule

There are no follow up sessions planned for this market consultation, although after the market consultation TNO may wish to contact subscribers for an explanatory interview on their reply.

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

Date	Deliverable / activity	Who?
30-07-2018	Market Consultation document published by TNO	TNO
03-09-2018 03.00 PM (CET)	Final submission date for questions	Subscriber
10-09-2018	Mailing of the final Memorandum of Information	TNO
17-09-2018 03.00 PM (CET)	Deadline for submitting your input	Subscriber
17-09 to 30-09	Explanatory interview	TNO and Subscriber

1.6 Explanatory interview

Based on the answers of the Questionnaire of section 4, TNO may wish to invite or visit parties for an explanatory interview. TNO will assess the received answers on content and relevance for an explanatory interview, as well as the need for (further) explanation. The location for the interview will be Stieltjesweg 1 Delft or the location of Subscriber.

2. 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;
- Market parties who do not join this market consultation are thus not excluded of participating the possible tender. Neither are market players who join this market consultation in any way excluded, or privileged in, the possible participation of the tender;
- If market parties are not joining this market consultation, although they are able to deliver such system, they are kindly requested to forward this information to the TNO contact person named in section 2.1.
- This market consultation is without any obligation, both for participants and for TNO;
- Parties who are participating or not in this market consultation cannot derive any mutual obligations or rights towards TNO;
- Participating to this market consultation does not confer an 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 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 is English;
- TNO is not bound in any way by the outcome of the market consultation or obliged in realisation and/or tendering of the project upon 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 unless otherwise marked by participating Parties. If copyrights are applicable, TNO is protected by the participating Parties;
- TNO reserves the right:
 - To perform the proposed procurement process in a different way, in terms of content and style, than the process that may have been communicated;
 - 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.

2.1 Form and content

The consultation is set up as follows:

Written responses

Any interested market party who believes that they can contribute to the market consultation, should respond to TNO via the TenderNed procedure. We request you to also e-mail your response, including the product information and price indications to the contact person mentioned below. Responses can be sent to:

Name : Ms. M. Mastop and/or Raymond Peddemors
Position : Senior buyer
Department : Procurement
E-mail : aanbesteden@tno.nl

In the heading of your e-mail and in all future correspondence relating to this market consultation should be clearly mentioned 'Market consultation 2018 FPL/INK 146'.

2.2 Intellectual property rights

Except where expressly permitted under Copyright Law or where necessary for the successful preparation of a Market Consultation document, no part of the market consultation documents may be reproduced in any form, by print, photocopy, DVD, CD-ROM, microfilm or other means, without the prior written permission of TNO. Market consultation documents and all accompanying documents submitted further to the Market Consultation Procedure become the property of TNO upon receipt.

2.3 Use of TNO logo

It is not permitted to copy, modify or otherwise use the TNO logo on any documents submitted by the Market Party further to the Market Consultation Procedure.

3. Background of the demand

Since several years, TNO is involved in the domain of Free Space Optical Communication. This technology deals with the transmission of information between two different terminals located at a variable distance by means of laser beams.

In the most prominent application, the communication takes place between a terminal mounted on a satellite and a fixed installation located on ground. TNO is currently executing a number of projects related to this technology field, and is planning to expand its testing capability by building a dedicated facility.

As part of this facility, TNO wish to procure an optical telescope capable of point towards a satellite and ultimately allow the establishment of an optical link supporting transfer of information.

The facility will be located on top of a 45 m high tower which is part of the TNO site of Den Haag Oude Waalsdorpersweg, in the Netherlands, and is meant to support a broad set of optical communication tests. Due to the nature of the installation, and to the various user cases from existing and expected projects, TNO is investigating the possibility to build a facility that can be configured in different ways. The final decision on which configuration to select or whether multiple configurations can be implemented at the same time will be based on the following criteria:

- Cost/complexity of realization of various options;
- Compatibility of the various options with the selected location installation;
- Schedule impact of various options on the facility realization.

It is a goal of the present market consultation to get, from the interested parties, indication of cost drivers in relation to the proposed set of requirements for each one of the reported configurations. On the basis of the retrieved information, TNO will be able to detail further procurement activities.

Independently from the configuration, the telescope is expected to be comprised by the following parts:

- Telescope mount (inclusive of pier to be agreed upon)
- Optical Tube assembly
- Additional optical and optomechanical components (configuration specific)
- Telescope controller inclusive of software
- Tooling required for alignment, calibration and transport
- Manual of operation.

In the sections below more detail is given on the proposed telescope configurations, although it needs to be noted that many of the information mentioned are still under discussion and can also be influenced by the outcome of this market consultation.

3.1 Definition of telescope configurations

Three different configurations are considered for the facility in relation to the expected use. These are described here below:

1. Nasmyth configuration, receiver only →

- a. Light is received at the telescope entrance pupil and relayed to the telescope focal plane;
- b. The focal plane constitutes the interface between the telescope, subject of this document, and a breadboard developed by TNO, which is to be connected to the telescope mount;
- c. The focal plane lays on the telescope elevation axis and rotates along the telescope azimuth axis;

2. Nasmyth configuration, transmitter and receiver →

- a. Light is received at the telescope entrance pupil and relayed to the telescope focal plane;
- b. The focal plane constitutes the interface between the telescope, subject of this document, and a breadboard developed by TNO, which is to be connected to the telescope mount;
- c. The focal plane lays on the telescope elevation axis and rotates along the telescope azimuth axis;
- d. Light is transmitted from the telescope focal plane to the telescope entrance pupil;

3. Coude' configuration, receiver only →

- a. Light is received at the telescope entrance pupil and relayed to a laboratory space located one level below the rooftop floor where the telescope is placed;
- b. The entrance pupil is reimaged on a plane located in the laboratory space;
- c. The reimage of the entrance pupil constitutes the interface between the telescope, subject of this document, and a breadboard developed by TNO, which is detached from the telescope itself;
- d. The pupil reimage plane is integral to a fix world reference frame located in a laboratory space.

At present, the Nasmyth configuration 1 (Nasmyth, receiver only) is considered the baseline for the procurement, while configuration #2 (Nasmyth, transmitter and receiver) and configuration #3 (Coude', receiver only) are currently retained as

optional.

However, an ultimate decision on which configuration to realize, or whether all configurations can be implemented at the same time, will be taken by TNO on the basis of the input received from the present market investigation. The participant to the present market investigation is encouraged to suggest methods and design options that allow the integration of multiple configurations in the same telescope design.

The various defined configurations, as long as the expected general performances common to all cases, will be described in the paragraphs below.

3.2 Configuration #1: Nasmyth focus, receiver

In Configuration #1, the light is entering at the telescope entrance pupil and is relayed in the telescope focal plane, which is laying on the telescope elevation axis. A sketch of this configuration is reported in the figure below for illustrative purpose only and does not necessarily reflect the final design of the intended facility.

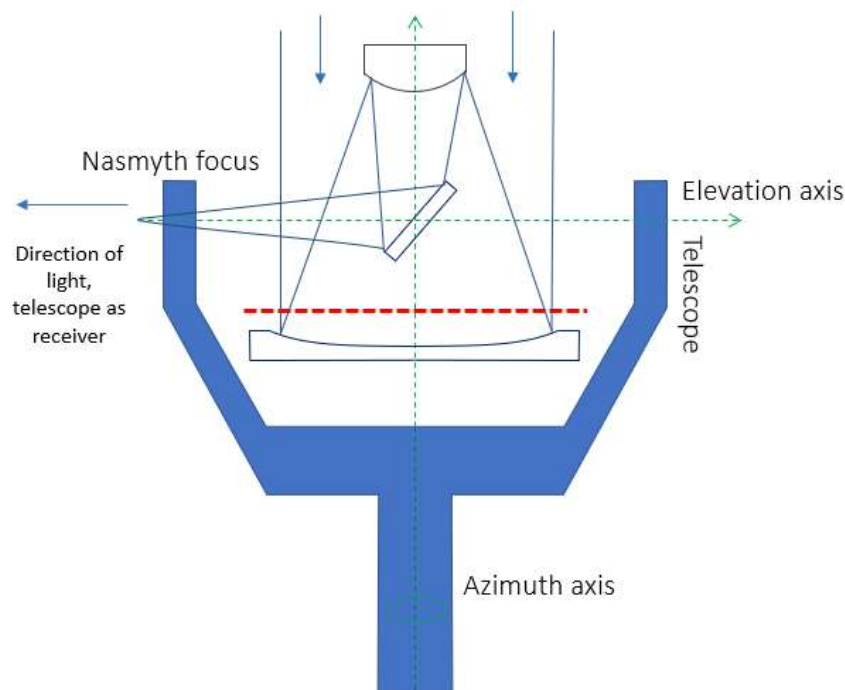


Figure 1 Configuration #1 Nasmyth focus, telescope as receiver

Optical and mechanical performances

The main mechanical and optical performances of the Configuration #1 are reported in the table below.

Table 3-1 Telescope optical and mechanical preliminary performances - Configuration #1

Optical		
Performance	Value	Note
Aperture diameter	[600-800]mm	600 mm is the preferred TNO aperture size
Obscuration	≤40%	Linear
Field of View	1.5 mrad	Half angle, circular
F number	[6-8]	
Field of view WFE	<75nm RMS	Inside the user FOV
Primary transmission band	[1530-1605]nm	
Secondary transmission band	[1055-1075]nm	
Transmission in primary and	92% [primary band]	Beginning of life

secondary band	85% [secondary]	
Mechanical		
Elevation angle range	-5° to 165°	Please specify a zenith avoidance angle, if any
Azimuth angle range	0° to 540°	
Tracking velocity	$\geq 1.8^\circ/s$	
Slew velocity	$\geq 10^\circ/s$	
Sun avoidance angle	$\leq 10^\circ$	
Open loop pointing accuracy	$\leq 25\mu\text{rad RMS}$	
Tracking accuracy	$\leq 5\mu\text{rad RMS}$	

Mechanical interfaces

The telescope optical tube assembly shall be equipped with at least two standard mechanical interfaces to connect auxiliary equipment. The supplier is encouraged to provide details of typical mechanical interfaces and maximum associated load. As per functionalities reported in 3.1, the telescope shall achieve its performance when a TNO custom breadboard is attached to the telescope mount at the Nasmyth focus position. Currently, the expected typical dimensions of the breadboard foreseen by TNO are 600mm x 900mm x 400mm, with the long side aligned along the vertical axis of the telescope mount. A maximum weight of 100kg is anticipated for the TNO breadboard. Most probably more refined specifications for the interface between the telescope and the optical bench produced by TNO and to be connected at the Nasmyth focus will need to be defined after contract award of the telescope, a condition that must be acceptable for the supplier of the telescope.

The telescope shall further be interfaced with the tower floor by means of a to be defined pier and support. Most probably the interface between the telescope and the TNO tower will need to be agreed after contract award of the telescope, a condition that must be acceptable for the supplier of the telescope.

3.3 Configuration #2: Nasmyth focus, transmitter and receiver

Optionally, the telescope shall operate in bi-directional configuration, i.e. light travels from the telescope focal plane to the entrance pupil and viceversa. The light originating from the TNO custom breadboard will be coupled to the telescope via the Nasmyth focus interface and will be transmitted via the entrance pupil of the telescope to the target terminal located at distance.

A sketch of this configuration is reported in the figure below for illustrative purpose only and does not necessarily reflect the final design of the intended facility.

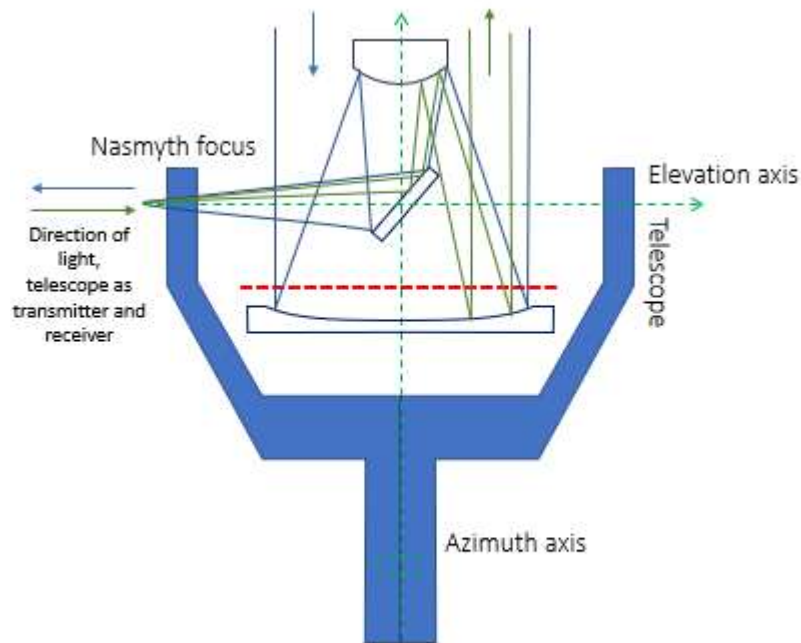


Figure 2 Configuration #2: Nasmyth focus, telescope as transmitter and receiver

On the basis of the information currently in possession of TNO, the configuration #2 can be implemented with a similar layout as the configuration #1. The additional optical requirements needed to implement the bi-directional functionality (transmitter/receiver) are reported in the table below.

Table 3-2 Additional telescope optical requirements to implement configuration #2

Optical		
Performance	Value	Note
Polarization extinction ratio	≥ 20 dB	
Maximum allowed back reflection	-40 dB	From entrance pupil backwards to the Nasmyth focus
Tx beam size at entrance pupil	120 mm	Diameter at $1/e^2$
Tx central field range	[0, 1.5] mrad	Variable in the specified range
Maximum average optical power of transmitted beam	20 W	At maximum 3 distinct transmitted optical beams are considered
Maximum peak power power of transmitted beam	200 W	With 1 ps pulse

For the configuration #2 (Nasmyth transmitter/receiver), the participant to this market survey is encouraged to propose methods to implement pupil de-rotation which will prevent the transmitted beams to rotate in the entrance pupil during tracking and pointing.

3.4 Configuration #3: Coude' path, receiver only

As an option, the telescope shall be equipped with a Coude' path able to provide a demagnified image of the telescope entrance pupil in a fixed frame reference coordinate system, in a laboratory space located one level below the TNO tower rooftop. This configuration is intended to operate as receiver only and to support a limited on-sky field on view in comparison to the Nasmyth one described in previous paragraphs. A sketch of this configuration is reported in the figure below for illustrative purpose only and does not necessarily reflect the final design of the intended facility.

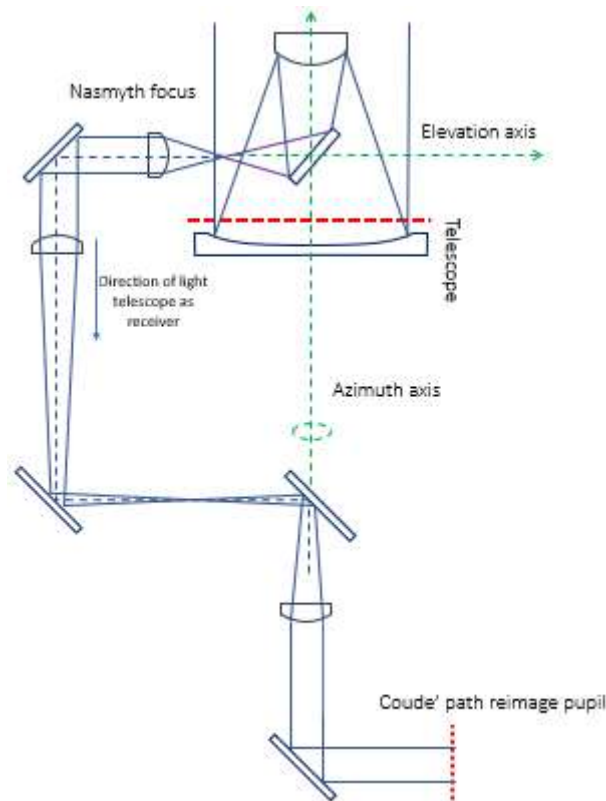


Figure 3 Configuration #3: Coude' path, telescope as receiver. Telescope mount is not shown for simplicity

The location of the reimaged pupil is provisionally placed up to 6 meters below the elevation axis of the telescope and up to 4 meters away from the azimuth axis. Most probably more refined specifications for the actual positioning of the reimaged pupil will need to be defined after contract award of the telescope, a condition that must be acceptable for the supplier of the telescope.

On the basis of the information currently in possession of TNO, this configuration can be implemented by introducing the additional optical components constituting the Coude' optical path at the Nasmyth interface location, as an add-on to configuration #1.

The main mechanical and optical performances of the additional optical components constituting the Coude' path are reported in the table below.

Table 3-3 Coude' path preliminary optical and mechanical performances

Optical		
Performance	Value	Note
Pupil size at Coude' path reimaged plane	20 mm	
On sky Field of view	300 μ rad	Half angle, circular. Goal 500 μ rad
Field of view WFE	75nm RMS	Inside the Coude' FOV specified here above
Primary transmission band	[1530-1605]nm	
Transmission in primary band	\geq 84%	Beginning of life
Mechanical		
Coalignment between	20 μ rad	

telescope and Coude' path optical axis		
Allowed exit pupil lateral shift	<1mm	

The Coude' path optomechanics need to interface with the TNO tower located in Den Haag. More refined specifications for the interface between the telescope Coude' path and the TNO tower will need to be defined after contract award of the telescope, which must be acceptable for the supplier of the telescope. The optical path shall be covered by appropriate baffles. The baffles are meant to reduce stray light and protect the optical components. The baffles shall be able to withstand outdoor conditions compatible with the expected installation on the TNO tower of Den Haag.

3.5 General performances

Environmental

The telescope shall be placed inside a dome located on top of the 45 m TNO tower in Den Haag, the Netherlands. As such, the telescope will be exposed to variable environmental conditions, will need to operate both at day and night and in different temperature regimes. The currently expected operational temperature to guarantee minimal downtime of the facility are between -10°C and +40°C. Furthermore, the telescope shall be able to operate with a wind speed of up to 15 m/s. TNO is open to discuss possible relaxations to the proposed environmental values if they differ largely from the performances of typical systems delivered by the participant to the market consultation.

Software

The telescope shall include a system to allow open loop control of both azimuth and elevation angles. The telescope shall be able to select celestial objects for tracking by means of a catalog accessible from the interface software or by means of user input parameters. The overall pointing control system shall include both the necessary hardware and software components. The participant to this market consultation is encouraged to communicate whether the acquisition of dedicated software licenses is applicable.

3.6 Tooling

The telescope shall be delivered with an optical axis tooling and a focus tooling. The former shall enable the alignment of an optical beam with respect to the telescope optical axis with an angular error and lateral displacement of less than 25 μ rad and 25 μ m respectively. The latter shall allow aligning an optical beam with respect to focus position of the telescope to within \pm 40 μ m. The participant to this market consultation is encouraged to suggest adequate tooling to achieve these tasks.

3.7 First sketches

In Annex A a sketch of the TNO tower in Den Haag Oude Waalsdorperweg is reported. This is the designated location for the installation of the facility.

4. Questionnaire

Subscribers are not obliged to answer all questions of the market consultancy.

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.

	Questions 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?
A2	If you consider to apply as a combination of parties, which parties would that be and why would you choose for these parties?
	Questions on the content
B1	Would it be possible to realize a telescope in which the different configurations can be implemented at the same time?
B2	Would it be possible to realize a modular telescope design in which the Coude' path can be implemented at a later stage after realization of the Nasmyth configuration (both unidirectional and bi-directional)?
B3	TNO is interested in purchasing, together with a telescope system, also a dome. Is your company able to provide a price estimate including a dome?
B4	In relation to the preceding question B3, can you provide a suggestion about the best dome dimension/layout to support the various configurations?
B5	In case, after the tender phase, a contract is granted, are you prepared to discuss and agree to the optical and mechanical interfaces with TNO at a later stage?
B6	Do you have relevant experience in implementing a design involving the propagation of high power optical beams across the optical path of the telescope as requested by configuration #2?
B7	Do you have suggestions to implement de-rotation of the telescope pupil to prevent that transmitted beams are rotated in the telescope entrance pupil plane during tracking?
B8	What is your relevant experience in implementing different telescope configurations as Coude' and Nasmyth? Do you have specific examples from previous projects?
B9	Do you have a standard design that can be adapted to cover one or multiple configurations described in this document?
B10	In relation to the preceding question B9, in case of positive answer, can you indicate which of the requirements reported for the various configurations determine a major modification to your standard design, with large impact on cost/schedule?
	Question regarding the tender
C1	What is the track-record of your company in engineering/procurement/commissioning of telescopes and optical ground stations for laser communication?
C2	Which parts of the system will be developed by yourself, which will be outsourced to third parties?
C3	We consider the development of the telescope to consist of several phases: design, engineering, manufacturing, system integration, testing, commissioning. Which phases will be performed by yourself, which will be outsourced to third parties?
C4	What are your strongest added values?
C5	On the basis of the currently provided information, can you estimate how much time do you need to make a proposal during the tender?
C6	Is your organisation able to estimate the price-impact of still TBD requirements, and can you provide estimation per each TBD item?
C7	Which ones are the price-driving parameters/requirements in the execution of the project for the various configurations?
C8	Which ones are the schedule-driving parameters/requirements in the execution of the project for the various configurations?
C9	Can you provide a preliminary estimate of the time necessary to design and deliver the telescope for the various options?
C10	How will your organization ensure mastery of Engineering Procurement Construction for those subsystems of the telescope where a track record of competence is not available?

C11	Is your company ISO9001 certified?
C12	Does your company have a configuration control management system in place?
C13	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 Preliminary Design Review?
D2	When would it be possible to perform the Factory Acceptance Test at your premises?
D3	When would it be possible to perform the Site Acceptance Test at TNO?
D4	What do you consider as the greatest risk(s) of the development of the telescope for the various configurations?
	Finally
E1	Are you prepared to explain your answers to the questionnaire orally by invitation?
E2	Do you have other ideas, suggestions, or comments?

Annex A: Sketch of the TNO tower in Den Haag Oude Waalsdorpersweg.

