

# **Annex II**

## **Technical Specifications**

***“Fusion Diagnostics Optical Design Consultancy”***

**ITER\_D\_TZRPF5 v. 1.1, dated 14 November 2016**

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# 1 Abstract

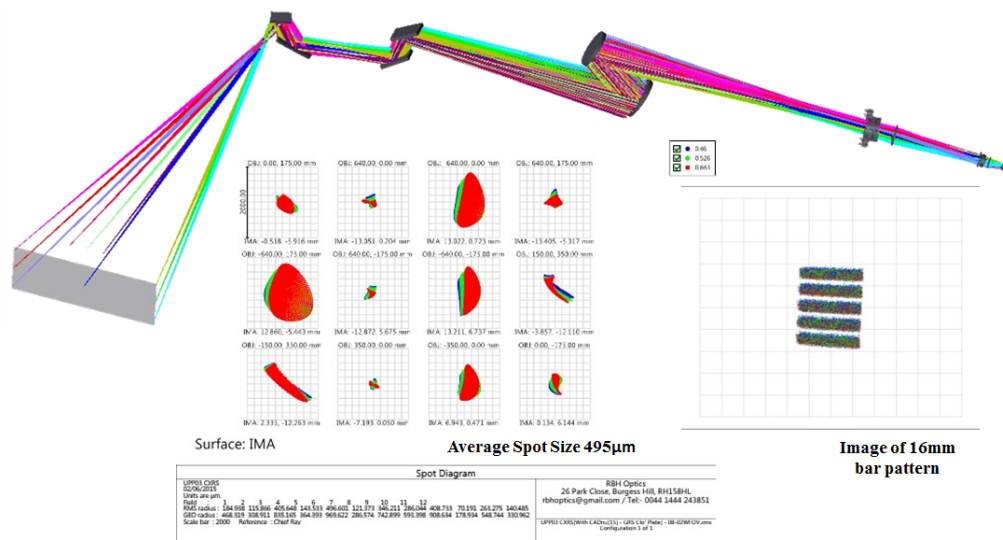
This document describes technical needs of **Fusion Diagnostics Optical Design Consultancy**, including activities and follow up activities.

# 2 Background and Objectives

ITER is a major new device under construction in Cadarache, Provence, France. This device will study the Fusion concept on a scale previously unequalled on earth. The ITER Organization (IO), which consists of the Central Team (IO-CT) located in Cadarache and Domestic Agencies (IO-DA) located with the 7 partners (China, EU, India, Japan, Korea, Russia and US), is bringing together people from all over the world to be part of this unique project and to contribute to building the ITER device which requires the best people from many disciplines. The work environment is flexible and dynamic with opportunities to work closely with many people and cultures from around the world. The device will study the potential of controlled nuclear fusion to provide energy for the future of mankind.

In order to study the behaviour of this device, a set of monitoring systems (called Diagnostics) are required. These systems will provide the information required to understand and control the performance of the device. Many of these systems are based on optical effects and as a result light is required to be collected from the tokamak and transported to an area where it can be sampled and analysed.

The work described below is related to the design and analysis of optical diagnostics. For diagnostics within the scope of IO-CT this implies the definition of optical components and their location to achieve the measurement requirements and analysis of the optical performance of the proposed optical scheme. For diagnostics within the scope of the IO-DA's this implies technical support to the IO-RO's to review the optical designs and analysis reports provided by the IO-DA.



**Figure 1: Typical example of optical design with ray tracing, spot size and imaging quality assessment**

### 3 Scope of Work

The objective of this contract is to provide the Diagnostic Team with Optical Design, Analysis and Review of various systems, both to support the In-kind Procurements as well as the in-house diagnostic development. The work would be mostly (approximately 90%) carried out at the IO-site. More than one person may be considered to fulfil the total requirements of this contract.

### 4 Estimated Duration

The duration shall be for up to 1 year.

### 5 Work Description

The work will consist of 3 types of tasks:

- To provide **Optical Design** development deliverables for optical diagnostics within the scope of IO-CT. Under optical design following tasks are understood (list is indicative and not exhaustive):
  - Definition of type (reflecting/refracting), number, location, size and shape of optical elements to image (or just collect) light emitting/reflecting surfaces or volumes to detectors (photodiodes, PMTs, cameras) or optical fibre bundles.
  - Develop this optical path taking into account non-optical requirements such as integration in confined spaces (this includes importing CAD design of the environment setting the constraints) and passing light through labyrinths to ensure nuclear shielding.
  - Optimizing the optical design based on merit functions, depending on the optical requirement of the system.
  - Both sequential and non-sequential optical design. The latter to allow easier (re-) integration of the optical design in the CAD system of ITER.

Each optical design iteration shall be documented in an optical design report and the optical design model(s);

- To provide **Optical Analysis** and optimization for optical diagnostics within the scope of IO-CT. Under optical analysis following tasks are understood (list is indicative and not exhaustive):
  - Analysis of optical resolution, imaging quality and aberrations
  - Photometric and throughput analysis
  - Optical tolerances (tolerance against absolute displacements, rotations and deformations individual optical elements as well as relative displacements and shifts in orientation between optical elements)
  - Proposals for (minor) optical design optimization.

Analysis results shall be documented in an optical analysis report;

- To provide **Review of optical designs** and analysis reports provided by the IO-DA's for optical diagnostics within the scope of the IO-DA's. Under optical review following tasks are understood (list is indicative and not exhaustive):
  - Review of optical design and analysis reports (methodology, correctness, conclusions ...)

- Review of optical design files
- Proposals for (minor) optical design optimization to the IO-DA's.

Review reports will be provided.

For each type of task described above, deliverables in 3 categories will be foreseen:

- A. Major Task: For Optical Systems with high resolution imaging, wide field of view and high throughput requirements  
Or  
For Optical Systems located in a challenging integration environment (in terms of space, radiation ...)  
These systems would typically consist of order 10-20 optical elements, some of which might be free-form or adaptive optics. Non-sequential design is typically preferred for these tasks.  
The deliverable is expected 1.5 month after the input to commence the task is provided.
- B. Medium Task: For Optical Systems with high resolution imaging, wide field of view or high throughput requirements.  
These systems would typically consist of order 5-10 optical elements, some of which might be off-axis toroidal, spheric, cylindrical or parabolic. Non-sequential design is not a necessity, but might be useful.  
The deliverable is expected 1 month after the input to commence the task is provided.
- C. Minor Task: For Optical Systems with limited resolution, field of view and throughput requirements.  
These systems would typically consist of order 1-5 optical elements, mostly on-axis and standard (flat, spheric, parabolic ...). Non-sequential design is typically sufficient.  
The deliverable is expected 0.5 month after the input to commence the task is provided.

The Deliverables that are listed in Section 6 are combinations of a task type – Design, Analysis or Review – and task category – Major, Medium, Minor. They would need to be costed against this combination, based on the information regarding type and category given above.

During the execution of the contract, the IO-RO of the diagnostic concerned will provide the input for the task (in the form of external constraints to the design, requirements on the performance, passing on input from the IO-DA teams et cetera). Based on the input provided by the IO-RO's of the different diagnostics, the IO-TRO for optical design and analysis activities determines, in collaboration with the IO-RO's and the C-TRO, which Deliverable (type and category) is applicable as well as identifies the priority of executing the task and hence the due date for the deliverable.

The tasks will be commenced on Instruction to Proceed basis, which will identify which diagnostic system the work applies to and justifies the type and category of the deliverable(s).

## 6 List of deliverables and due dates

A total of 12 deliverables is expected over the duration of the contract.

Deliverable	Description	Deliver by*
D1	Major Optical Design 1 (Category A)	1.5 months after input

<b>Deliverable</b>	<b>Description</b>	<b>Deliver by*</b>
D2	Major Optical Design 2 (Category A)	1.5 months after input
D3	Medium Optical Design (Category B)	1 months after input
D4	Minor Optical Design (Category C)	0.5 months after input
D5	Major Optical Analysis 1 (Category A)	1.5 months after input
D6	Major Optical Analysis 2 (Category A)	1.5 months after input
D7	Medium Optical Analysis (Category B)	1 months after input
D8	Minor Optical Analysis (Category C)	0.5 months after input
D9	Major Optical Review 1 (Category A)	1.5 months after input
D10	Major Optical Review 2 (Category A)	1.5 months after input
D11	Medium Optical Review (Category B)	1 months after input
D12	Minor Optical Review (Category C)	0.5 months after input

\*Note deliverables to be commenced on Instruction to Proceed basis (ITP). The order of the deliverables does not reflect the priority. The ITP will identify the diagnostic system the work applies to and justify the choice of deliverable.

\*\*all deliverables will be in the form of written documents and should include optical design files etc where relevant

\*\*\*Should the requirements of the project change; the IO-CT may change the deliverables; this would be carried out by updating the contract.

## **7 Responsibilities**

### **7.1 Contractor's Responsibilities**

In order to successfully perform the tasks in these Technical Specifications, the Contractor shall:

- Strictly implement the IO procedures, instructions and use templates;
- Provide experienced and trained resources to perform the tasks;
- Contractor's personnel shall possess the qualifications, professional competence and experience to carry out services in accordance with IO rules and procedures;
- Contractor's personnel shall be bound by the rules and regulations governing the IO ethics, safety and security IO rules.

### **7.2 IO's Responsibilities**

The IO shall:

- Nominate the Responsible Officer to manage the Contract (IO-TRO);
- Organise a monthly meeting(s) on work performed;
- Provide offices at IO premises.
- Grant the access to the IDM as Author to the contractor, in order to upload documentations.

## 8 Acceptance Criteria

These criteria shall be the basis of acceptance by IO following the successful completion of the services:

- The deliverables will be in the form of reports as indicated in section 6 “List of Deliverables and due dates”.
- The deliverables will be posted in the Contractor’s dedicated folder in IDM.
- The IO-TRO is the Approver of the delivered documents.
- The Approver can name one or more Reviewers(s) in the area of the report’s expertise.
- The Reviewer(s) can ask modifications to the report in which case the Contractor must submit a new version.
- The acceptance of the document by the Approver is the acceptance criterion.

## 9 Specific requirements and conditions

The person(s) to carry out the work described in this document must have proven experience, as appropriate, in the following:

- Educated to minimum Degree level in optical design and analysis related discipline
- Demonstrable significant experience in the optical design and analysis work, e.g. in nuclear, scientific or space applications
- Familiarity with the Zemax ray-tracing code or similar optical code
- Experience with using CAD models (e.g. from CATIA) in combination with optical design
- Competent with the use of Light Tools, SPEOS or similar code for straylight simulations
- Demonstrated experience in balancing quality/risk/cost when providing design information.
- Demonstrated experience in working in multidisciplinary, international team environment.

## 10 Work Monitoring / Meeting Schedule

The work will be managed by means of Progress Meetings and through the formal exchange of documents and transmitted by emails which provide detailed progress.

Progress Meetings will be called by the ITER Organization or the C-TRO. They will be held as needed and at least bi-monthly, either on the IO site or via videoconference. Progress meetings will involve C-TROs and the IO-TRO. External experts will be invited to discuss technical matters. The C-RO will be invited in case of contractual discussions.

For all Progress Meetings, minutes, including action items, shall be written by the C-TRO and be stored in the ITER IDM in order to ensure traceability.

## 11 Payment schedule / Cost and delivery time breakdown

The deliverables are expected as defined in section 6 “List of Deliverables and due dates”. Interim payments will be made upon satisfactory completion and IO approval of deliverable reports uploaded onto IDM and upon submission of a valid invoice.

## 12 Quality Assurance (QA) requirement

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in [ITER Procurement Quality Requirements \(ITER\\_D\\_22MFG4\)](#).

Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see [Procurement Requirements for Producing a Quality Plan \(ITER\\_D\\_22MFMW\)](#)).

Documentation developed as the result of this task shall be retained by the performer of the task or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with [Quality Assurance for ITER Safety Codes \(ITER\\_D\\_258LKL\)](#).

## 13 References / Terminology and Acronyms

- C-R: Contractor Responsible. See Contract specifications for definition of duty.
- C-TRO: Contractor Task Responsible Officer. Carrying out the contract tasks. See Contract specifications for definition of duty.
- IO-CT: ITER Organization (Central Team)
- IO-DA: Domestic Agency
- IO-TRO: ITER Organization Technical Responsible Officer. See Contract specifications for definition of duty.
- PPD: Port Plug and Diagnostics Engineering Division

For a complete list of ITER abbreviations see: [ITER Abbreviations \(ITER\\_D\\_2MU6W5\)](#).

## 14 CAD Design Requirements (if applicable)

For the contracts where CAD design tasks are involved, the following shall apply:

The Supplier shall provide a Design Plan to be approved by the IO. Such plan shall identify all design activities and design deliverables to be provided by the Contractor as part of the contract.

The Supplier shall ensure that all designs, CAD data and drawings delivered to IO comply with the Procedure for the Usage of the ITER CAD Manual ([2F6FTX](#)), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings [2DWU2M](#)).

The reference scheme is for the Supplier to work in a fully synchronous manner on the ITER CAD platform (see detailed information about synchronous collaboration in the ITER [GNJX6A](#) - Specification for CAD data production in ITER Contracts.). This implies the usage of the CAD software versions as indicated in CAD Manual 07 - CAD Fact Sheet ([249WUL](#)) and the connection to one of the ITER project CAD data-bases. Any deviation against this requirement shall be defined in a Design Collaboration Implementation Form (DCIF) prepared



and approved by DO and included in the call-for-tender package. Any cost or labour resulting from a deviation or non-conformance of the Supplier with regards to the CAD collaboration requirement shall be incurred by the Supplier.

## 15 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 (“Installation Nucléaire de Base”).

For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.

In such case the Suppliers and Subcontractors must be informed that:

- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of external contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator.

For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012 ([PRELIMINARY ANALYSIS OF THE IMPACT OF THE INB ORDER - 7TH FEBRUARY 2012 \(AW6JSB v1.0\)](#)).