TECHNICAL SUMMARY

Call For Nomination

IO/20/CFT/70000546/LLU

Erosion Deposition Monitor: PDR, FDR and Manufacturing

1 Scope of work 55.G8

The work described here is related to the mechanical design, analysis and prototyping of the Erosion Deposition Monitor: the full system, from the in-vessel optics enclosure, which will be installed under the ITER Divertor dome, to the back-end data collection system installed in the diagnostic hall. The goal of this contract is to progress the Erosion Deposition Monitor (EDM) design from its current state (Conceptual Design Review, *CDR*) through the Preliminary Design Review, *PDR*, to the Final Design Review, *FDR* and deliver a full system prototype. This will involve iteratively progressing the hardware design by performing mechanical, nuclear, thermal and Electro-Magnetic analyses, including accident scenarios, implementing solutions to issues found in to the design, producing a full Structural Integrity Report (StIR) and building a prototype. At PDR a design for a prototype in-vessel optics box will be presented, this prototype will be built after any issues raised at PDR have been resolved. After any issues raised at FDR have been resolved a full system prototype will be produced.

A framework contract will be awarded with Task Orders covering different foreseen task of the project: completion of the PDR, FDR, manufacturing studies, procurement management, prototype work. Note that Instrumentation & Control (I&C) will not be included in this framework contract. I&C design and manufacturing will be handled by a different contract managed by IO.

2 Estimated Duration

The duration of the contract is estimated to be approximately 4 years in total; the first 11 Months to reach PDR, followed by a procurement and manufacturing of a prototype optics box. In parallel work will start on the FDR design, which is expected approximately 9 months after PDR. After FDR any outstanding issues, e.g. chits raised during FDR, will be resolved. Based on the FDR outcome a final design of the target reference surface plates will be produced and after a Manufacturing Readiness Review, they will be manufactured and delivered by end 2022.

Based on testing of the prototype optics box in the Cassette Assembly and the outcome of the FDR, the final optics box design is produced and following a Manufacturing Readiness Review (MRR) it will be manufacturing with delivery expected by the early 2024.

Based on the outcome of the FDR a full system prototype will be manufactured. This prototype will be assembled at the IO site, where it will be tested in a collaboration between the contractor and IO, any modification required will be documented and a final MRR will be organised followed by the manufacture of the modified components, to be finalised by end-2024.

3 Work Description

The tasks to be performed within this contract are the following:

- Update design to previously identified requirements

- Perform mechanical, structural, thermal, nuclear and EM analysis
- Iteratively update the design to incorporate findings of the previous steps and work towards a design able to survive the harsh ITER environment
- Produce a full Structural Integrity Report (*StIR*)
- Liaise with IO I&C contractor
- Some optical design work will be done by the contractor if they have the required expertise, otherwise liaise with an IO optical design engineer contractor
- Progress the design of the EDM from CDR (current status), to PDR
- In response to the outcome of the PDR the design will be updated, new mechanical, structural, thermal, nuclear and EM analysis will be performed and the design is progressed to FDR
- Provide detailed design prototype manufacturing and assembly drawings
- Construct and deliver a prototype of the in-vessel optics box and for the full system
- Construct and deliver final design in-vessel optics box and target reference surface plates

3.1 Description of the system

It is important for the operation of the ITER machine to know the amount of material that is eroded or deposited in the Divertor area of the vacuum vessel. For this reason ITER is designing a diagnostic system to measure this, the Erosion Deposition Monitor, *EDM*, the current design is based on speckle interferometry and digital holography.

As Figure 1 shows, the system extends over several ITER areas. The front-end optics box inside the vessel, which is normally at vacuum and access is virtually impossible once the components have been installed.

Radially out from the in-vessel optics box is the diagnostic rack and the closure plate, the diagnostic rack is still in vacuum, while the closure plate is the vacuum boundary and contains a set of double windows. Directly after the closure plate is the Interspace Support Structure, *ISS*, which contains radiation shielding (bioshield) and a set of “dog leg” optics. After the bioshield follows the Port Cell Support Structure, *PCSS*. Inside the PCSS is a number of relay optics, which directs the input laser light towards the machine and the collected light away from the machine. The light will travel through a set of pipes in the gallery between the PCSS and the diagnostic building, where the laser and data analysis systems are located.

Figure 1 below gives an overview of the full system, while Figure 2 gives a close-up of the front-end optics enclosure located under the divertor dome.

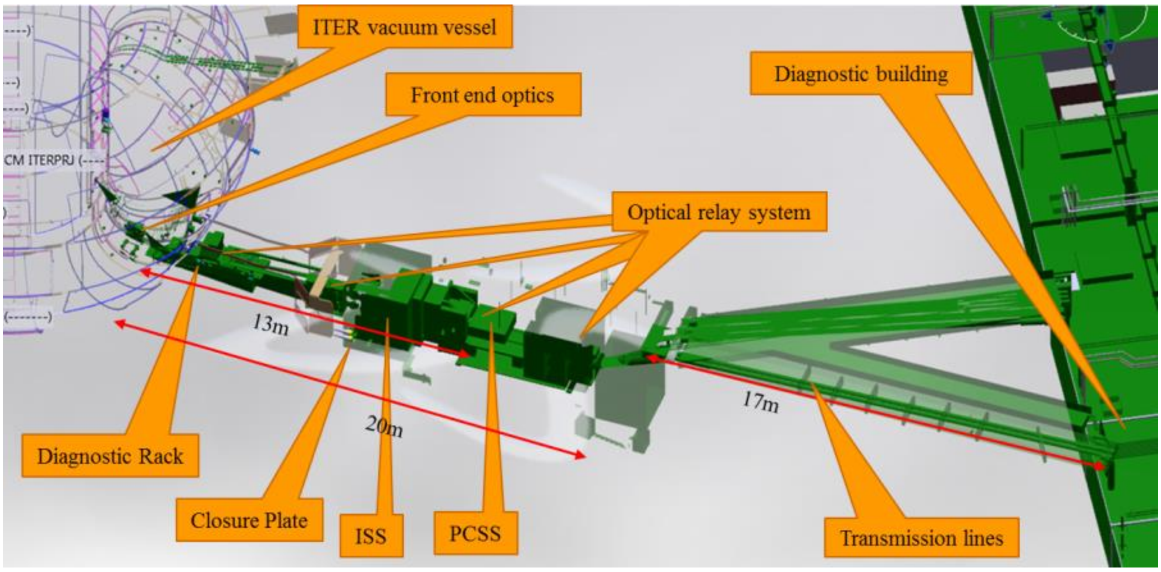

Figure 1: Overview of Erosion Deposition Monitor layout

The optics will send the laser beam in two directions, illuminating two sections of the ITER Divertor, the Inner Vertical Target, *IVT*, and the Outer Vertical Target, *OVT*, see Figure 2. In both cases the area to be measured is approximately 350 mm high and 100 mm wide. Both Vertical Targets have reference surfaces attached, which are recessed from the front surface, so they are less affected by the erosion and deposition.

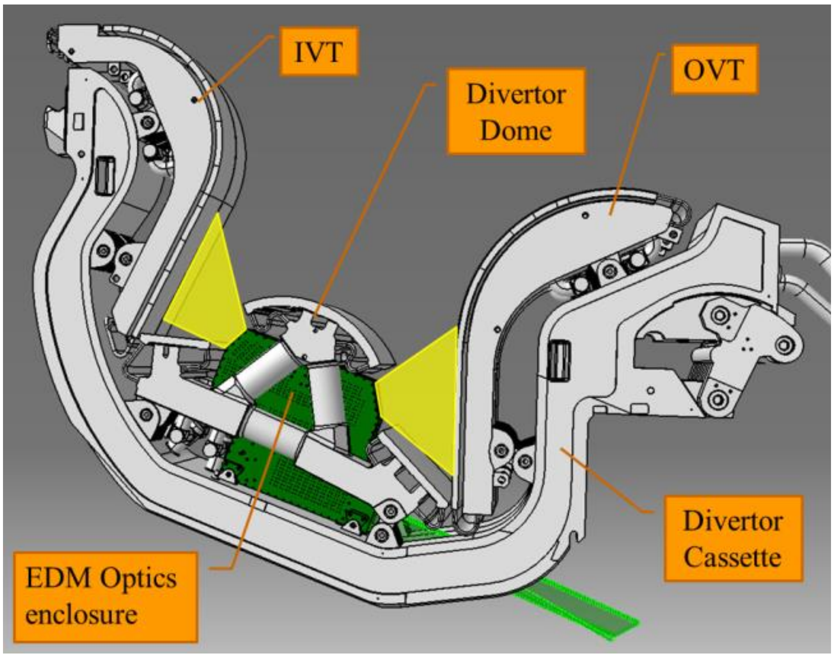

Figure 2: Front-end optics enclosure with Vertical Targets (IVT left, OVT right)

The light scattered from the targets will be relayed back to the rack via a separate set of optics, this light will then be relayed through another window and all the way back to the diagnostic building, where it will be analysed. The optics inside the under-dome optics box are permanently fixed in position and protected by shutters, the optics inside the rack and further back can be adjustable to aid alignment.

3.2 Details of expected output

The purpose of this engineering Framework Contract is to progress the mechanical design, of the full diagnostic system, from its current status to PDR and FDR, by iteratively performing improvements until an acceptable level of output of the load analyses (mechanical, structural, thermal, nuclear and EM) is achieved. It should be emphasised that the different geographical areas have very different requirements.

As the positioning and shape of the optics has a great impact on the overall design of the diagnostic, the optics should, in principle, not be modified under this contract, i.e. the optics should retain their shape and location. Any modifications to the optics have to be agreed with IO and a separate optical design work package will be launched.

In-vessel (Cassette assembly and rack): The goal of the work is to further the design of the in-vessel components by performing calculations on load specification (thermal, EM, nuclear, mechanical) and structural integrity analysis, and reduce/remove temperature rise, temperature inhomogeneity and thermal deformation. Input the designed components into 3D CAD and check of clashes with other diagnostics by communicating with the port integrators. Consideration should be given to manufacturing methods and tolerances and to maintainability. After which the next step of design and analyses can be performed in order to iteratively reach an optimal design.

ISS, bioshield and PCSS: Design of the optical supports, frames and adjustable optical mounts of mirrors and beam splitters and their load specification. Design of beam transmission lines between the Closure plate, through the ISS and bioshield towards the Port Cell lintel penetrations, according to the existing optical design. Perform calculations on load specification (thermal, EM, nuclear, mechanical) and structural integrity analysis. Consider maintenance scenarios in the port cell, including manned access requirements. Ensure clash-free integration with penetrations, beam ducts, windows and other equipment owned by other PBSs.

Gallery and diagnostic building: Perform calculations on load specification (thermal, EM, nuclear, mechanical) and structural integrity analysis on gallery beam ducts, supports and wall penetrations. Design the optical tables with lasers, optics, detectors, ancillary equipment and cubicles containing diagnostic components and perform relevant analyses, identify equipment and components requiring testing/qualification.

Once a high level of maturity of the design has been reached, in agreement with IO, the contractor is to provide full manufacturing drawings and assembly specifications, followed by the manufacture of prototype optics box. After FDR and upon agreement with IO, the final optics box and target reference surface plates will be manufactured and a full system prototype for the rest of the EDM will be manufactured: This will include all the mechanical components of the EDM diagnostic and a skeleton structure to mount these components to, since the full diagnostic rack, closure plate, ISS, PCSS, Gallery, etc. will not be available for this. The full system prototype will include two simplified vertical targets, with reference surfaces, to which a vibration can be applied. This vibration will be adjustable between 15 Hz and 300 Hz with amplitude adjustable between 1 micrometres and 1 millimetre.

4 Specific requirements and conditions

- Experience in complex mechanical design for nuclear, or space industry
- Experience in mechanical, thermal, nuclear and EM load analyses
- Experience with plasma, space or high energy physics devices
- Experience in manufacturing complex optical instruments
- Experience with the technical follow-up of CAD activities

The contractor shall have their own licenced copy of MCNP and CATIA and adequate computer resources for the radiation transport simulations described herein.

5 Candidature

Participation is open to all legal persons participating either individually, or in a grouping (consortium), which is established in an ITER Member State. A legal person cannot participate individually, or as a consortium partner, in more than one application, or tender. A consortium may be a permanent, legally-established grouping or a grouping, which has been constituted informally for a specific tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization. The consortium cannot be modified later without the approval of the ITER Organization. Legal entities belonging to the same legal grouping are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Bidders' (individual, or consortium) must comply with the selection criteria. IO reserves the right to disregard duplicated references and may exclude such legal entities form the tender procedure.

On 31 January 2020, the UK left the EU and Euratom with a transition period from 1st February to 31 December 2020 to be used to determine the conditions of their future relationship. Euratom is the ITER Member and the withdrawal of the UK from Euratom leads to the fact that UK is not anymore party to the ITER project.

Until the 31 December 2020, current end date of the transition period, UK entities retain the right to participate in IO procurement procedures.

6 Tender schedule

Call for Nomination	Mid of May 2020
Issuing Invitation for Prequalification Applications	Mid of June 2020
Prequalification Application Submission Deadline	Mid of July 2020
Issuing Call for Tender	Beginning of September 2020
Tender Submission Deadline	Mid of October 2020
Award of Contract	Beginning of 2021