

# **Design, manufacturing and testing of optical fiber sensor and connector prototypes**

## **Call for Nomination**

### **Purpose**

The purpose of this contract is the following:

- to design, manufacture and test optical fiber sensor (OFS) prototypes for temperature, acoustic, strain and displacement measurements, based on Fiber Bragg Gratings (FBG's) technique,
- to design, manufacture and test optical fiber connector prototypes, welding and associated welding technology.

### **Background**

ITER is an international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power to generate electricity. Some of the most technically challenging components of the ITER machine are those, which directly face the thermonuclear plasma. A selected number of plasma-facing components will be equipped with instrumentation to monitor the temperature, strain, displacement and acoustic emissions in these components during ITER operation.

The measurements shall be performed during steady-state conditions and plasma fast transient events. During these latter events, there could be a very fast variation vs time of the magnetic field (up to 100 T/s).

The OFS offer significant advantages in comparison with the conventional electrical sensors, such as:

- high radiation resistance,
- immunity from electromagnetic interference (EMI),
- high sensitivity,
- possibility to have several sensors in one optical fiber.

Therefore, the OFS are considered as potential candidates for measurements during plasma fast transient events, both in the non-nuclear and in the nuclear phase of the ITER operation.

Moreover, the OFS based on FBG's technique are the most promising for the ITER operating conditions, for the following reasons:

- The FBG technique is based on spectral measurements, and not on amplitude measurements. This eliminates the effect of light amplitude reduction due to radiation-induced transmission losses in the optical fiber;
- The accuracy is high: 0.1°C for temperature measurements and  $10^{-6}$   $\epsilon$  for strains;
- FBG have a good radiation resistance and may work up to a neutron fluence of  $5 \cdot 10^{19}$  n/cm<sup>2</sup> and a total dose of ionizing radiation of  $2 \cdot 10^9$  Gy;
- Several FBG sensors may be used in one optical fiber (multiplex use);

- FBG sensors have full immunity to EMI.

Additionally, OFS can work in high vacuum and at high temperatures provided that the attachment of the FBG to the sensor body is designed for such a purpose. Recent R&D works have shown that such OFS can be designed and manufactured based on the concept of brazing optical fiber with a copper coating to a metal plate.

In the ITER machine, it is decided to use four types of OFS based on FBG technique – for strain, displacement, temperature and acoustic measures. In total, few thousands of OFS's are planned to be used. There is also the need to connect the cable from OFS with cables running in the Vacuum Vessel (VV) positioned in bundles inside cable channels (so called “cable looms”). For this purpose, it is planned to use box-type connectors, so-called “connector boxes”. These connector boxes will have as well the function to protect the welded (or spliced) part of the fibers.

## Scope of work

The following two tasks will be requested within this contract:

1. 10 (ten) prototypes of each type of sensor s (namely temperature, strain, displacement and acoustic sensors) shall be designed, manufactured and tested (i.e. a total of 40 prototypes). All these sensor prototypes will be based on FBG technology and should be designed for extended operation in ITER (high temperature – up to 350°C, neutron/ gamma irradiation and high vacuum).
2. Two prototypes of optical fiber connector boxes shall be designed and manufactured. Procedure of optical fiber welding, polyimide recoating to the fiber weld area and packing inside the connector box shall be developed and tested.  
Two different prototypes of optical fiber connector boxes shall be designed and manufactured. First prototype shall present the following features: at the entrance 10 optical fibers inside 10 protecting tubes of 1 mm diameter, and at the exit 10 optical fibers inside 1 protecting tubes of 4 mm diameter.  
The second prototype, shall present the following features: at the entrance 20 optical fibers inside 3 protecting tubes of 4 mm diameter and at the exit 20 optical fibers inside 1 protecting tubes of 4 mm diameter.  
Stainless steel (SS 316L(N)) is selected as connector box body material for the 2 prototypes. Procedure of optical fiber welding, polyimide recoating to the fiber weld area and packing inside the connector box shall be developed and the two prototypes shall be produced.

## Timetable

The tentative timetable is as follows:

Call for Nomination	August	2016
Tender submission	October	2016
Tender Evaluation	December	2016

Contract placement	February	2017
Completion	February	2019

## **Experience**

The companies shall have adequate experience in the following areas:

- Relevant experience in developing and manufactures of optical fiber sensors based on Fiber Bragg Gratings (FBG's) technique for high temperature and high vacuum applications
- Relevant experience and technical and engineering capability in accelerated temperature aging tests
- Relevant experience and technical and engineering capability in mechanical cyclic strain tests

## **Award of Contract**

According to ITER Organization rules, the contractor awarded for any component development phase cannot participate to the component series production phase. As a result, the company awarded of this Contract cannot participate to the optical fiber sensor and connector series production contract.

## **Language ability**

The language used at ITER is English. Fluency in spoken and written English is required.

## **Candidature**

Participation is open to all legal entity participating either individually or in a grouping (consortium) which is established in an ITER Member State. A legal entity 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 groupings shall be presented at the pre-qualification stage. The tenderer's composition cannot be modified without the approval of the ITER Organization after the pre-qualification.

Legal entities belonging to the same legal grouping are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Candidates (individual or consortium) must comply with the selection criteria. The ITER Organization reserves the right to disregard duplicated reference projects and may exclude such legal entities from the pre-qualification procedure.