

Technical Specifications (In-Cash Procurement)

CFE - Consultancy on X-ray atomic emission modelling

The purpose of this call is both consulting on and generating of the most relevant X-ray emission line spectra (and the impurities that emit them) for doing X-Ray Crystal Spectroscopy at ITER by taking into account emissivities, wavelengths, fractional abundance, et cetera.

Table of Contents

1	PURPOSE	2
2	SCOPE	2
3	DEFINITIONS	2
4	REFERENCES.....	2
5	ESTIMATED DURATION.....	2
6	WORK DESCRIPTION.....	2
7	RESPONSIBILITIES	4
7.1	Contractor's Responsibilities	4
7.2	IO's Responsibilities	4
8	LIST OF DELIVERABLES AND DUE DATES	4
9	ACCEPTANCE CRITERIA.....	5
10	SPECIFIC REQUIREMENTS AND CONDITIONS.....	5
11	WORK MONITORING / MEETING SCHEDULE	5
12	DELIVERY TIME BREAKDOWN.....	5
13	QUALITY ASSURANCE (QA) REQUIREMENTS.....	5
14	CAD DESIGN REQUIREMENTS (IF APPLICABLE)	6
15	SAFETY REQUIREMENTS	6

1 Purpose

The purpose of this call is to acquire physics based support for the development of the ITER X-Ray Crystal Spectroscopy (XRCS) diagnostics.

2 Scope

The scope of the work consists of both consulting on and generating of the most relevant X-ray emission line spectra (and the impurities that emit them) for doing X-Ray Crystal Spectroscopy at ITER by taking into account emissivities, wavelengths, fractional abundance, et cetera. This work would include physics modelling using ITER plasma scenario parameters as input. Also reviewing and verifying (against current tokamak measurement data and other modelling tools) of predicted emissions would be part of the work scope.

3 Definitions

C-TRO:	Contractor Technical Responsible Officer: responsible for technical content of the contract
C-RO:	Contractor Responsible Officer: responsible for the contract administration (can be the same person as the C-TRO)
DMS:	Disruption Mitigation System
IMAS:	Integrated Modelling and Analysis Suite
IO:	ITER Organization
IO-TRO:	ITER Organization Technical Responsible Officer: responsible for technical content of the contract
IO-RO:	ITER Organization Responsible Officer: responsible for the contract administration (can be the same person as the IO-TRO)
PCR:	Project Change Request
PIA:	Protection Important Activity (activity – e.g. analysis – critical for nuclear safety)
PIC:	Protection Important Component (component critical for nuclear safety)
XRCS:	X-Ray Crystal Spectroscopy

For a complete list of ITER abbreviations see: [ITER Abbreviations \(ITER_D_2MU6W5\)](#).

4 References

Links inserted in text.

5 Estimated Duration

The duration shall be for 12 months, with services – which are expected to be part time – predominantly carried out off site with some visits to the IO worksite for meetings and discussions.

6 Work Description

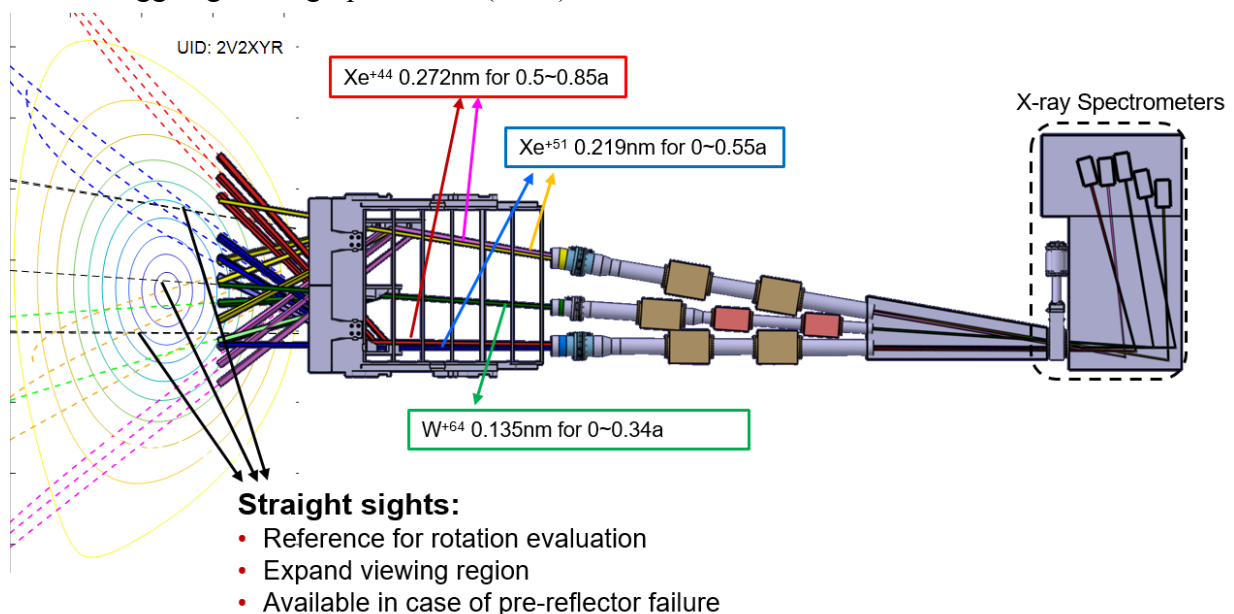
As part of the Disruption Mitigation System (DMS) rebaselining (PCR-001004), the ITER 55.E5 XRCS Core diagnostic was relocated to a different equatorial port with a different integration environment. As a result, the design needed to be updated with Bragg reflecting

pre-reflector elements that only reflect a narrow wavelength band. Based on preliminary data, a choice was made for emission lines of Xe^{51+} and Xe^{44+} ions. However, this comes into conflict with the 55.EI XRCS Edge diagnostic relying on Ar emission lines; because having to seed both Xe and Ar for a full core to edge X-ray measurement would be very detrimental to plasma performance. Also the targeted emission line for Xe^{51+} in the plasma core is at the lower end of acceptable emissivity.

Therefore, the activities within this contract would consist of:

- The modelling of the different ionization stages of Xe in at least 4 ITER plasma scenarios (7.5 MA L-mode and H-mode and 15 MA L-mode and H-mode) as well as the spectral emission of these different ionization stages.
- Analysis of this modelling to
 - Identify other emission lines in the vicinity of the 55.E5 XRCS Core wavelength bands that could potentially be detected and help to increase the overall signal to noise
 - Identify other potential wavelength bands that could be considered for the 55.E5 XRCS Core diagnostic while still matching the overall design geometry set by the interface constraints of that diagnostic
 - Identify potential wavelength bands that could be considered for the changing or extending 55.EI XRCS Edge diagnostic towards (also) measuring Xe emission.
 - Identify the ratio between emissivity of the most promising Xe emission lines and the overall increase in radiated power
- Consulting on potential other impurities that have the potential to provide strong X-ray emission lines over both the plasma edge and core, while simultaneously being compatible with the design geometry set by the interface constraints of the 55.E5 XRCS Core diagnostic

In the figure below, the design layout of the 55.E5 XRCS Core diagnostic is sketched for information. The pre-reflectors angle, which is effectively frozen, is 19.05 degrees for the 0.219nm Xe^{51+} emission and 23.97 degrees for the 0.272nm Xe^{44+} emission, which corresponds to the Bragg angles on graphite with (0 0 2) Miller indices.



The above mentioned activities will be reported in quarterly progress reports that describe the work carried out over the preceding 3 months and a final report presenting the result of the whole contract period at the end of the contract (see section 8).

7 Responsibilities

7.1 Contractor's Responsibilities

In order to successfully perform the tasks in this Technical Specification, 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;
- Nominate a Responsible Officer to manage the Contract (the C-RO);
- Nominate a Technical Responsible contact person for the Contract (C-TRO – can the same person as the C-RO, but looks after technical matters rather than contractual matters).

7.2 IO's Responsibilities

The IO shall:

- Nominate the Responsible Officer to manage the Contract (the IO-RO);
- Nominate a Technical Responsible contact person for the Contract (IO-TRO – can the same person as the IO-RO, but looks after technical matters rather than contractual matters).
- Organise a monthly meeting(s) on work performed;
- Provide offices at IO premises.

8 List of Deliverables and due dates

D #	Description	Due Dates*
D1	Progress Report on X-ray spectroscopic modelling consultancy #01	T0 + 3 months
D2	Progress Report on X-ray spectroscopic modelling consultancy #02	T0 + 6 months
D3	Progress Report on X-ray spectroscopic modelling consultancy #03	T0 + 9 months
D4	Report X-ray spectroscopic modelling for the ITER 55.E5 and 55.EI XRCS Core and Edge diagnostics	T0 + 12 months

* T0 corresponds to the date of signature of the contract.

9 Acceptance Criteria

The deliverables will be posted in the Contractor's dedicated folder in IDM, and the acceptance by the IO will be recorded by their approval by the designated IO-TRO. These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of reports as indicated in section 8, Table of deliverables.

10 Specific requirements and conditions

The supplier shall have:

- Experience in atomic data modelling (ionization, recombination, excitation and emission rates, cross-sections etc.), especially for high-Z elements in fusion plasmas;
- Experience in plasma X-ray spectroscopic modelling, especially for fusion plasmas;
- Experience with supporting experimental data analysis at fusion facilities;
- Experience with scientific data processing software/programming languages (e.g. Matlab, IDL, Python, FORTRAN ...)
- Experience with creating technical documents and presentations

11 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-TRO(s) and the IO-TRO. External experts will be invited – if needed – to discuss technical matters. The C-RO and IO-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 (see also Deliverable D7 in section 8).

12 Delivery time breakdown

See Section 8 “List Deliverables section and due dates”.

13 Quality Assurance (QA) requirements

The organization 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 organization 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 \(ITER_D_258LKL\)](#).

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 \(AW6JSB v1.0\)](#)).

Compliance with [Defined requirements for PBS 55 - Diagnostics \(NPEVB6 v1.3\)](#) or its flowed down requirements in [SRD-55 \(Diagnostics\) from DOORS \(28B39L v5.2\)](#) is mandatory.

If tasks in this contract are PIA, then the supplier must comply with the all requirements expressed in “[Provisions for implementation of the generic safety requirements by the external actors/intervenors \(SBSTBM v2.2\)](#)”