Creation of IMAS Plasma Simulator utilising components of JINTRAC Modelling Suite

Technical Specifications

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# Abstract

This document describes the technical needs of the ITER Science Division for the integration of the JINTRAC Modelling Suite into the ITER Integrated Modelling & Analysis Suite (IMAS).

# Background and Objectives

ITER is the world’s premier magnetically confined fusion experiment and is currently under construction at St. Paul-lez-Durance, near Marseille, in the South of France. The ITER Organization (IO) is drawing together the world’s experts from across many different disciplines to contribute to its construction and prepare for operations. As part of this endeavour, an Integrated Modelling (IM) Programme has been established building upon the modelling expertise from across all the ITER Members.

The Integrated Modelling & Analysis Suite (IMAS) is a framework that has been constructed to support the IM Programme and one of the principal components required within it is a Plasma Simulator capable of describing the behaviours expected in ITER. The JINTRAC modelling suite is a plasma scenario simulator that addresses many of the needs of the IM Programme. In particular, it couples descriptions of the core plasma with those at the edge and can describe plasma heating, fuelling and transient behaviour.

# Purpose

The purpose of this contract is to adapt the physics components within the JINTRAC modelling suite to the IMAS framework and construct a validated workflow for an ITER Plasma Simulator that utilises them. In the first stage the components will be implemented as a single closely coupled component before being decomposed into separate workflow components interacting through the IMAS infrastructure. Data will be passed following the structuring of the ITER Data Model and all code developments will be performed using the IMAS software management infrastructure.

# Scope

This contract concerns the development and further refinement of the ITER Integrated Modelling & Analysis Suite. It adds to and extends the functionality of the existing IMAS prototype to deliver a framework that meets the needs of the ITER Integrated Modelling Programme.

# Definitions

In the following table denominations and definitions are given of all the actors, entities and documents referred to in this Specification, together with the acronyms used in this document. For a complete list of ITER abbreviations see: ITER\_D\_2MU6W5 - ITER Abbreviations.

| **Denomination** | **Definition** | **Acronym** |
| --- | --- | --- |
| ITER Organization Responsible Officer | Person appointed by the ITER Organization with responsibility to manage all the technical aspects of this contract | IO‑RO |
| Contractor | Firm or group of firms organized in a legal entity to provide the scope of supply. |  |
| Integrated Modelling | A component-based approach to modelling in which separate codes are combined to produce a more holistic description of a system. | IM |
| Integrated Modelling & Analysis Suite | Infrastructure and suite of codes used for Integrated Modelling at ITER. | IMAS |
| Access Layer | Access layer used within IMAS to handle passing of data between software components and storage. Variously referred to as the Universal Access Layer (UAL) and the Physics User Access Layer (PUAL). | UAL/ PUAL |
| Interface Data Structure | Standard data entry for exchanging data between physics components and storage | IDS |
| Data Dictionary | XML file describing ITER Data Model and IDSs. | DD |
| ITER Database | Database storing experimental and simulation data | ITERDB |
| Control Breakdown Structure | Functional breakdown of entire control system. Serves as basis for naming ITER subsystems and process variables. | CBS |

# References

[1] “The ITER Integrated Modelling Programme”, IDM reference: [2EFR4K](https://user.iter.org/?uid=2EFR4K).

# Implementation Plan and Estimated Duration

This service contract is divided into two phases. Upon completion of Phase 1 and depending on its results the ITER Organization will decide whether to proceed with Phase 2.

Contract starting date: Signing of contract.

Phase 1 completion date: 12 months from date of signature

Phase 2 completion date: 24 months from date of signature

The Contractor shall propose an implementation plan, to be approved by the ITER Organization, for both phases of the work (as described in Section 8 below). The ITER Organization will provide the information needed and access to any relevant ITER files for executing this work when needed following the implementation plan.

The work is expected to require the presence of Contractor personnel at the site of the ITER Organization, 13067 St Paul Lez Durance, France. For Deliverable 1, a maximum of 2 visits of at most 1 week each are foreseen as necessary.  For Deliverable 2, the Contractor is expected to maintain a significant on-site presence at the ITER Organization site of at least 9 months.  For Deliverables 3, up to 2 visits of up to 1 week are foreseen, whilst Deliverables 4 and 5 are expected to require an on-site presence at the ITER Organization of at least 9 months. The associated cost for travel and subsistence expenses for the Contractor’s personnel should be included in the contract price. The Contractor will take care of all administrative formalities required for the presence of the Contractor’s personnel at the ITER Organization’s site with the authorities concerned (obtaining visas, etc.).

The Contractor will participate in a series of meetings with the ITER Organization for progress monitoring of the work on the deliverables in § 8. At least the following meetings should be foreseen:

|  |  |  |
| --- | --- | --- |
| **Scope of meeting** | **Point of check** | **Place of meeting** |
| Kick-off contract meeting | Initiation | ITER site, Contractor site or video conference |
| Coordination meetings (every ~2 weeks) | Questions and issues to address | ITER site, Contractor site or video conference |
| Monthly progress meetings | Progress and plans | ITER site, Contractor site or video conference |
| Closing contract meeting | Contract completion, final report | ITER site, Contractor site or video conference |

# Work Description

The first phase of this Service Contract consists of adapting the JINTRAC modelling suite to run within the IMAS framework and extending the framework’s capabilities to support this and is described in detail below.

Phase 1:

* Deliverable 1
  + Install (including hosting all software in ITER git software repositories), compile and run the JINTRAC modelling suite on ITER HPC cluster
* Deliverable 2
  + Implement the JINTRAC modelling suite within IMAS as a single workflow component with I/O principally structured following the ITER Data Model and passed through the Access Layer
  + Design an IMAS-adapted version of the JINTRAC modelling suite that utilises separate physics components and in which data is passed between components following the ITER Data Model
  + Report and propose extensions to the ITER Data Model as necessary
  + Demonstrate the predictive simulation of a 15 MA ITER baseline scenario using the IMAS-adapted implementation of the JINTRAC modelling suite with principal output data structured according to the ITER Data Model

There is no formal commitment within this contract to implement the second phase. If Phase 2 is implemented the following additional deliverables are currently foreseen with a second contract phase.

Phase 2 (Optional):

* Deliverable 3
  + Analyse and document the location and handling of device-specific data (e.g. JET) in JINTRAC workflow and replace with machine description data represented in ITER Data Model
  + Develop procedures and tools to derive, import and manage machine description data for use in physics workflows from site specific representations (including CAD)
* Deliverable 4
  + Decompose JINTRAC modelling suite into separate physics components within IMAS workflow
  + Analyse the data flow between the physics components and map data exchanged into IDSs
  + Migrate principal simulation-specific input parameters into IMAS workflow
  + Store Data Model compliant initialisation data (e.g. plasma profiles, equilibrium) in IDSs and read-in as part of workflow initialisation
  + Demonstrate the incorporation of other IMAS-adapted H&CD components within workflow and / or the use of an alternative IMAS-adapted core transport solver
  + Design and implement a simple regression test for complete workflow that can be run on ITER’s Continuous Integration server
* Deliverable 5
  + Validate predictive capabilities of IMAS-adapted implementation of JINTRAC modelling suite by re-creating a previous predictive simulation performed using the standalone code
  + Validate interpretive capabilities of IMAS-adapted implementation of JINTRAC modelling suite by re-creating a previous interpretive simulation performed using the standalone code
  + Provide documentation and demonstration of the installation and use of the IMAS-adapted JINTRAC modelling suite