IDM UID
E663JT

VERSION CREATED ON / VERSION / STATUS
08 Jul 2025 / 1.0 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Technical summary for VV alignment metrology Works

Preliminary technical description of the scope of the metrology contract for VV alignment issued to the market to check the interest and capabilities of potential tenderers.

1 Purpose

The ITER Organization (IO) intends to perform a Market Survey for the definition of the Vacuum Vessel (VV) alignment metrology monitoring method that shall later be implemented in the frame of the Welding Preparation in Pit (WPP) contract.

The information and technical details provided in the present document are preliminary with the purpose to assess the interest and capabilities of potential candidates for this scope of works.

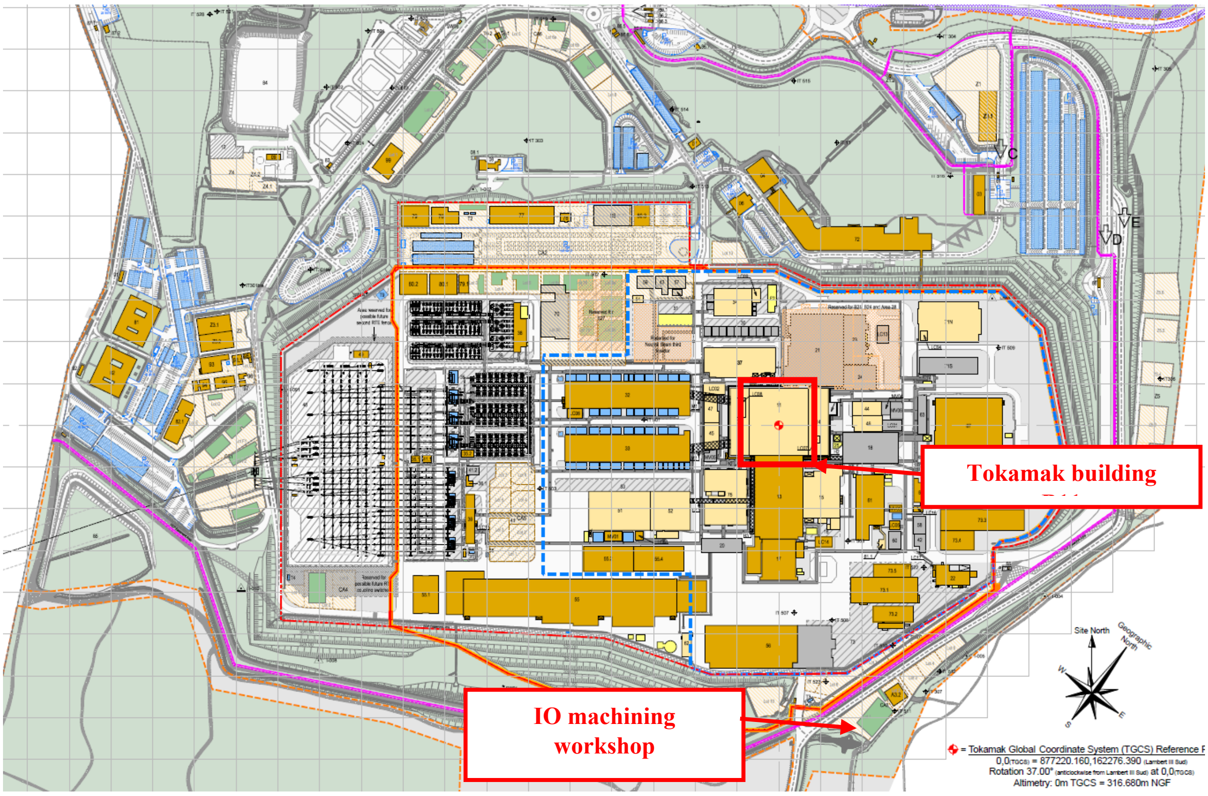
2 Background

The ITER Organization (IO) is a joint international research and development project for which the initial construction activities are underway. The seven members of the IO are: the European Union (represented by Fusion For Energy (F4E)), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

The project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain necessary data for the design, construction and operation of the first electricity-producing fusion plant. It will also test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a full-scale fusion power station.

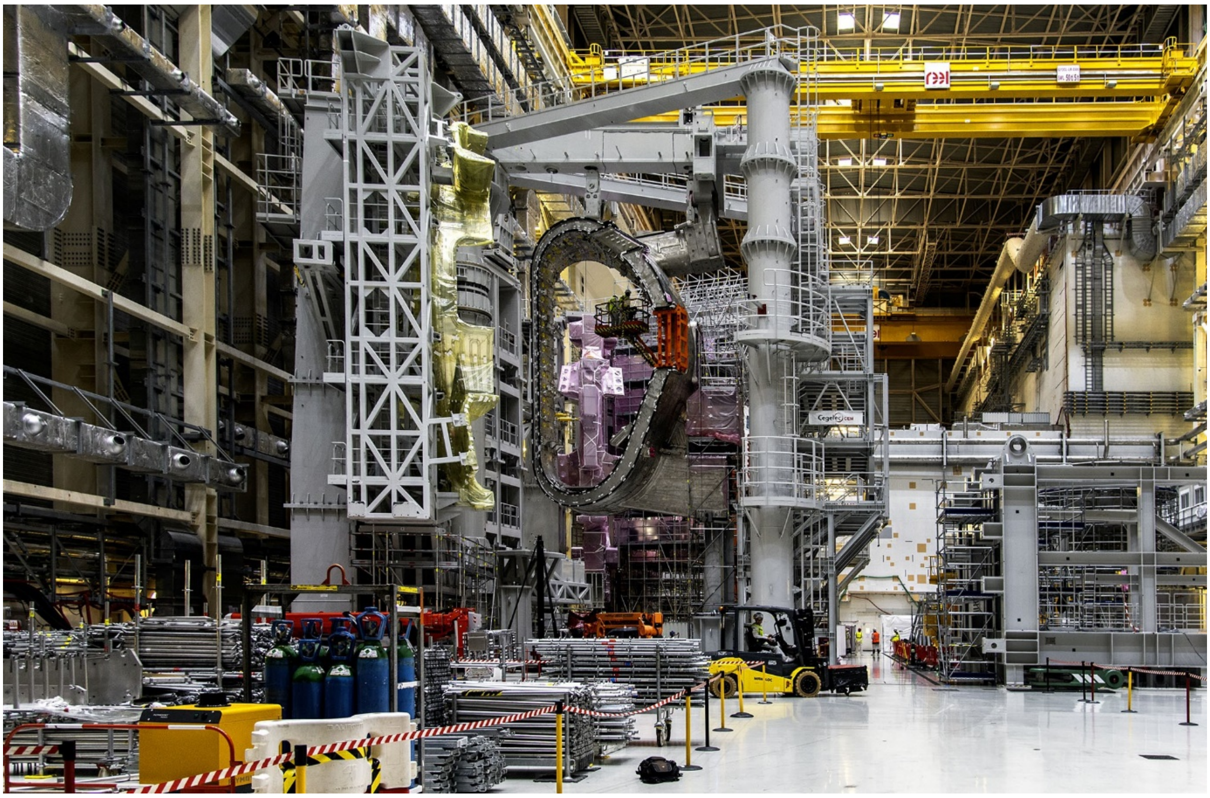
The ITER site is in the Bouches du Rhône district of France. It includes the Headquarters of the IO and a construction worksite. The construction of the facility is on-going. Further information is available on the IO website: http://www.iter.org.

The ITER platform is made of about 40 buildings serving the Tokamak machine located in the pit of the Tokamak building (B11). The location of works is shown in the figure below.



3 Tokamak assembly sequences

The Tokamak is assembled from nine Sector Modules, each encompassing a toroidal angle of 40°, and comprising a 40° Vacuum Vessel sector (VV), two Toroidal Field Coils (TFC), a 40° Vacuum Vessel Thermal Shield sector (VVTS), and the associated interconnections and supports. The components are delivered to the site individually, and sub assembled into Sector Modules using purpose-built jigs and fixtures in the Assembly Building as part of the Sector Module Sub-Sector Assembly (SMSA) contract. The Sector Modules are then transferred to the Tokamak Pit sequentially.

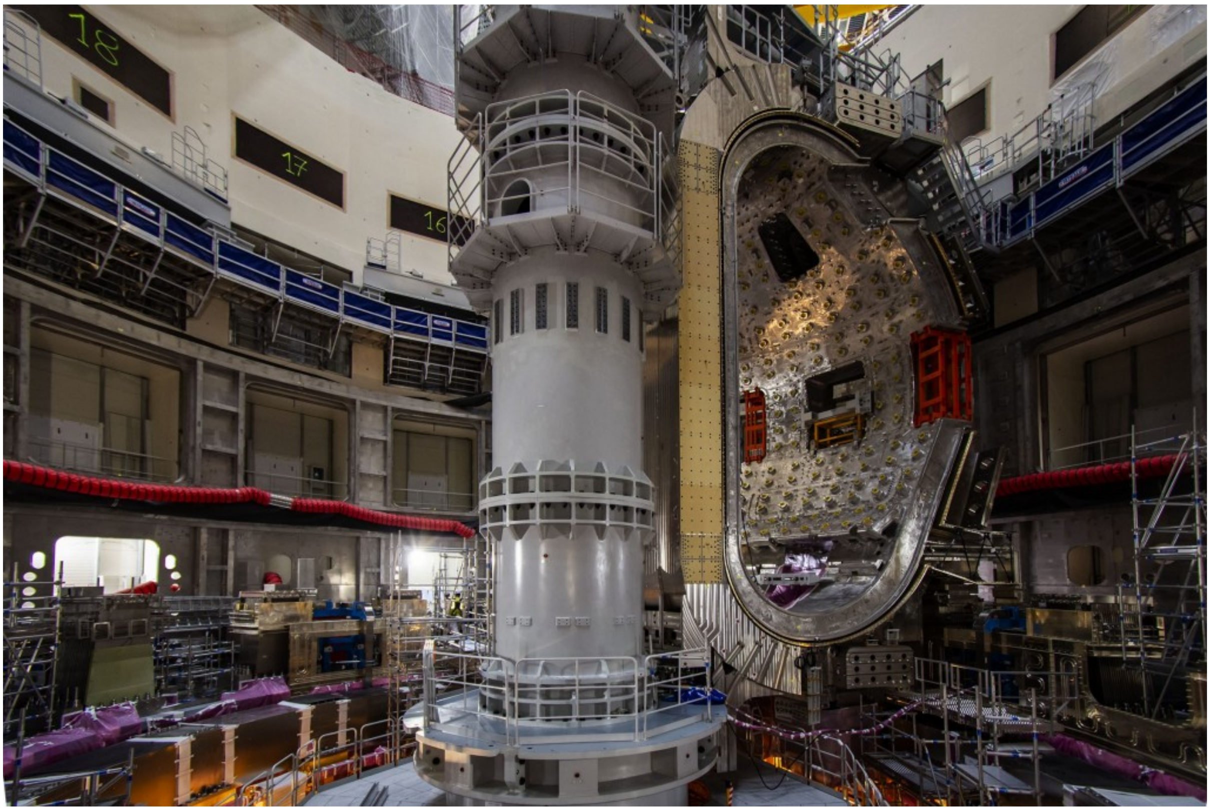


Once in the Tokamak Pit, the TFCs are precisely aligned and attached to their permanent supports as part of the Sector Module in-Pit Assembly (SMPA) contract. In addition, this contract performs the interconnections between the TFCs when the 2nd and subsequent Sector Module’s TFCs are lifted, aligned and secured to their gravity supports.
After the completion of the 9 sectors landing and the completion of all intercoil connections in the pit, the next main activity is embedded in the so-called A4 scope whose main objectives are:

- The load transfer of all TFC on their gravity support (SMPA scope).
- The installation and the tightening of all the Pre-compression rings upper and lower (SMPA scope).
- The load transfer of the VV on their gravity support (WPP scope).
- The removal of all associated tools (SMPA and WPP scopes).

The TFC load transfer can be performed in parallel to the WPP contract scope.
There is a potential indirect co-activities with the VV ports assembly and welding contract in case some work anticipation is possible with ports and bellows positioning and welding.

The same applies to the VV welding contract and diagnostic assembly contract which could be performed sequentially before and/or in between VVTS assembly and VV landing activities.



As part of the Welding Preparation in Pit (WPP) contract, three main activities are considered:

- The VVTS sectors are connected sequentially to each other between two Sector Modules in the Tokamak Pit. Technically, this scope of work can be performed as soon as 2 sectors are in the pit.
- The handling, positioning, and bolting of the VVGS between the cryostat and the VV sector.
- The alignment and the landing of the VV sectors on the Vacuum Vessel Gravity Support (VVGS), this operation is possible only once the interconnections on each of its neighbor TFCs are completed (three Sector Modules in the Tokamak Pit is the minimum pre-requisite to start this activity), the center VV sector is then aligned to its target position and secured to the VVGS.

Once all nine Sector Modules have completed their VVTS field joint connections and the VV has been secured to the VVGS, the Sector Welding (SW) contract will join the VV sectors welding the field joints according to a plan which aims to minimize deformations.
In parallel, SMPA will start the A4 scope which includes the load transfer of the TFC torus, removal of the Central Column tooling (no longer required to support the Radial Beams) and assembly of the upper and lower Pre-Compression Rings to the TFCs.

VV Sectors overall dimension (m)	7.9 (Length) x 6.6 (Width) x 13.8 (Height)
Material	SS 316 L(N)-IG
Unit Mass	440 tons

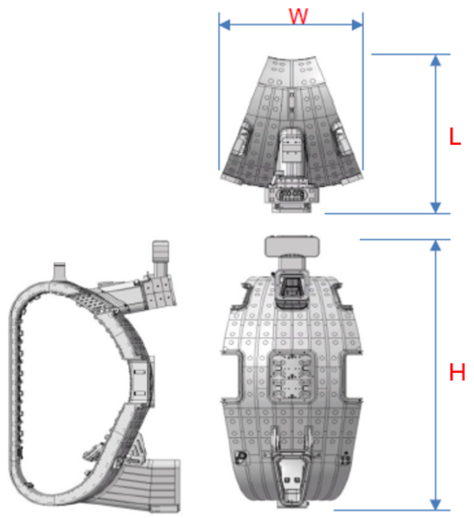


Figure 3-1: VV Basic Weight and Dimensions

Following this Market Survey, the objective of the related expected Contract will be to define a methodology to be applied in the metrology monitoring of the VV alignment operation. There will be coactivity with several other contracts such as, but not limited to:

- SMSA contract at the start (for the landing of the sector in the pit),
- SMPA contract for the sector interconnection and the A4 scope,
- In-vessel Diagnostic, Fueling and Instrumentation (IDFI) contract,
- Port Positioning Assembly and Welding (PPAW) contract (for Cryostat/Building Bellows assembly and welding scope),
- SW contract at the end,
- Transverse contracts including radiographic test, scaffolding, crane operation ...

<u>Cleanliness & FME:</u>

The ITER Tokamak machine is composed mainly of VQC (Vacuum Quality Class) components assembled and operated under clean conditions in order to comply with vacuum and with the machine operation requirements (i.e. comply with thermal shield emissivity requirement).

These clean conditions apply in worksite 1 (Tokamak pit and crane hall, B13 and B17) and a cleanliness protocol shall be applied. It defines rules necessary to maintain the requested level of cleanliness and establishes requirements regarding workers and material access, clean clothes, works (including dirty works) and housekeeping.

4 VV landing sequence

The main components and activities are shown in Figure 4-1:

1. Vacuum Vessel Alignment and Stability,
2. Radial Beam and VV alignment unit,
3. Upper Stability Rods and Outboard Bracing Tools,
4. VV Counterweights and Mid Plane Bracing Tool,
5. VVGS and Lower Strut Installation, and
6. Inboard Bracing Arms and Inter-VV Stops.

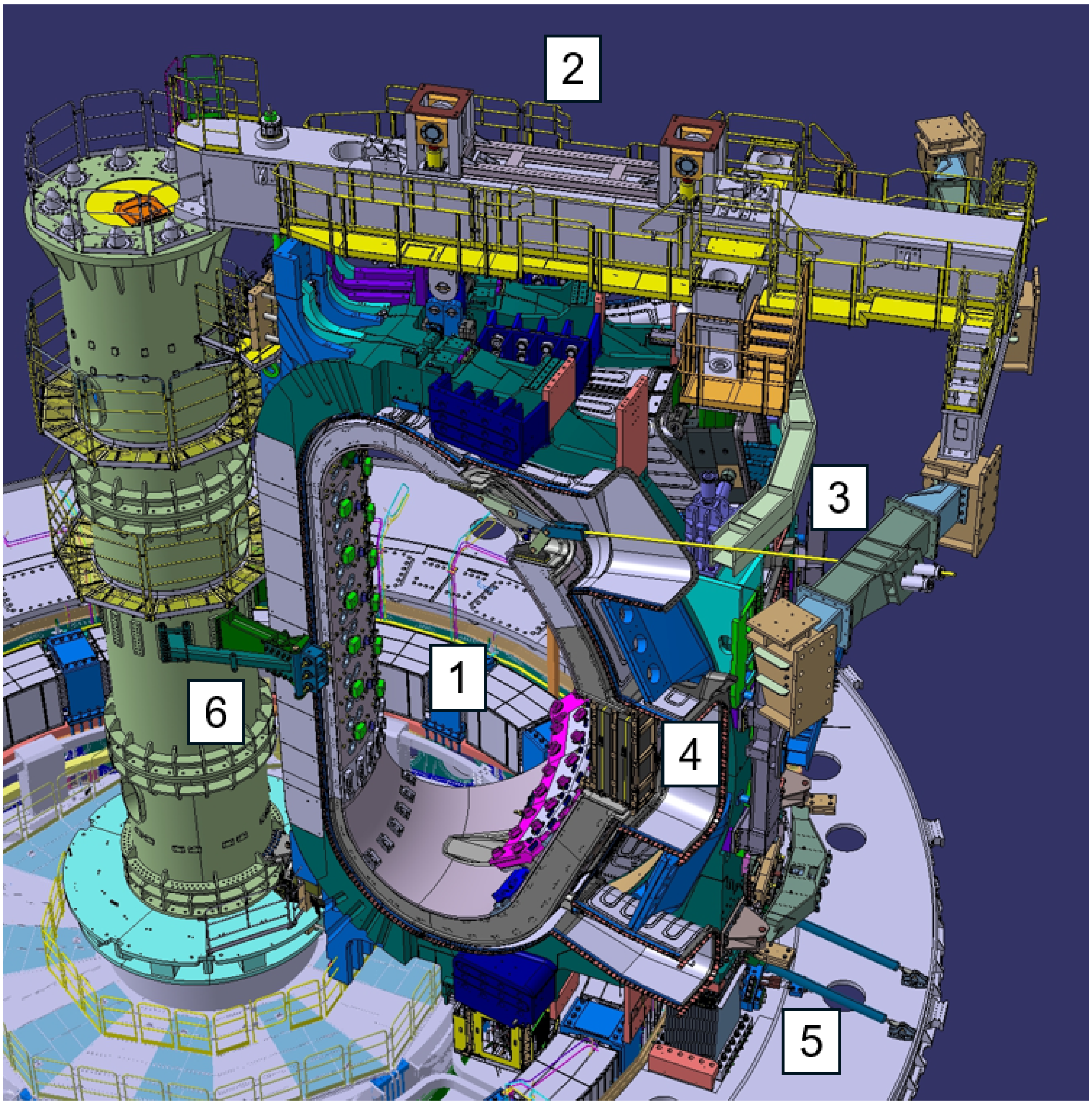


Figure 4-1: Single Sector Overview

In order to land the VV onto the VVGS sector by sector, the VV must be stabilized from tilting radially inboard by use of stability clamps that will be installed by the WPP contractor (see Figure 4-2).

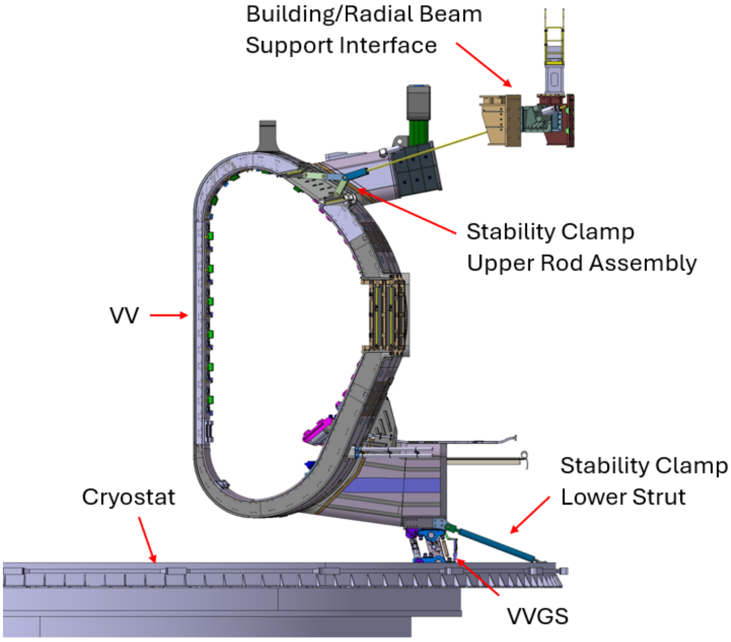


Figure 4-2: Landed VV Side View

The main activities related to the alignment of the VV will start when three side by side sectors are lifted to the Pit (SMSA scope) and the adjoining inter-coil connections are completed between the TFCs (SMPA scope). The main predecessor for the stability clamp installation is the installation of the IOIS (Intermediate Outer Inter-coil Structure) by the SMPA contractor.

The WPP contractor will implement the methodology for aligning the VV to its target position and tolerance. The target position and tolerance (expected to be in the range of +/- 3mm) will be provided by the IO. During the alignment, the VV will be continuously measured using the fiducial network in-vessel. Radial, vertical and toroidal adjustment can be performed using the jacks on the radial beam VV alignment unit shown in Figure 4-3. Radial and toroidal tilting of the VV can be adjusted by removing or adding weights to the counterweight frames in the equatorial port shown in Figure 4-4, or by engaging the stability clamp upper rods or lower strut.

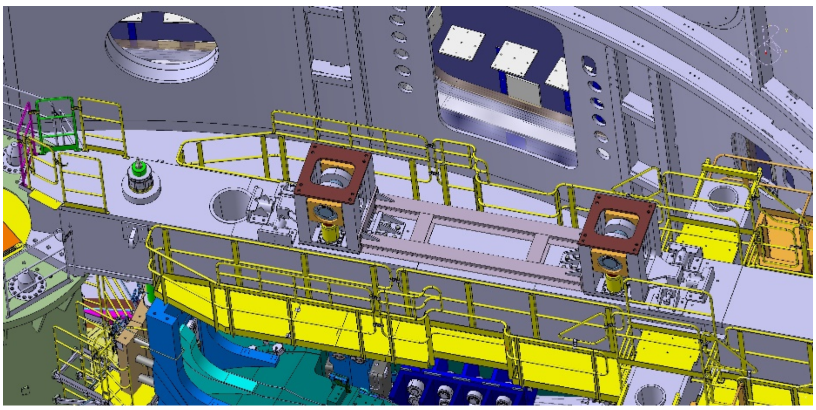


Figure 4-3: VV Alignment Unit

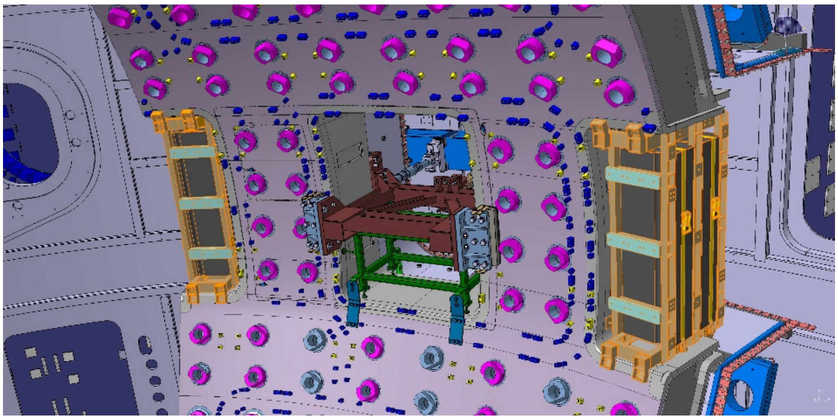


Figure 4-4: VV Counterweights

The VV must be unconstrained during the alignment to the target position. Therefore, the bracing tools must be disengaged by the WPP contractor before the start of the alignment or load transfer. The Mid-Plane Bracing tool (MPB) and Divertor Level Stabilizer (DLS) will be dismantled and removed by the WPP contractor since they are no longer required for seismic restraint when the VVGS is connected to the VV.

The Inboard Bracing Arms shown in Figure 4-5 are disengaged only by retracting the yellow bolts. The Outboard Frames, also shown in Figure 4-5, are disengaged by retracting the orange pads.

The MPB, shown in Figure 4-6, is installed in the center of the Sector Module in the equatorial port. The DLS, shown in Figure 4-7, is installed in the VV Lower Port Stub Extension. The MPB weighs in total ~10 tons while the DLS weighs in total ~6 tons. Both the DLS and MPB are removed by dismantling sub-assemblies (~1 to 5 tons) and lifting them out of the pit.

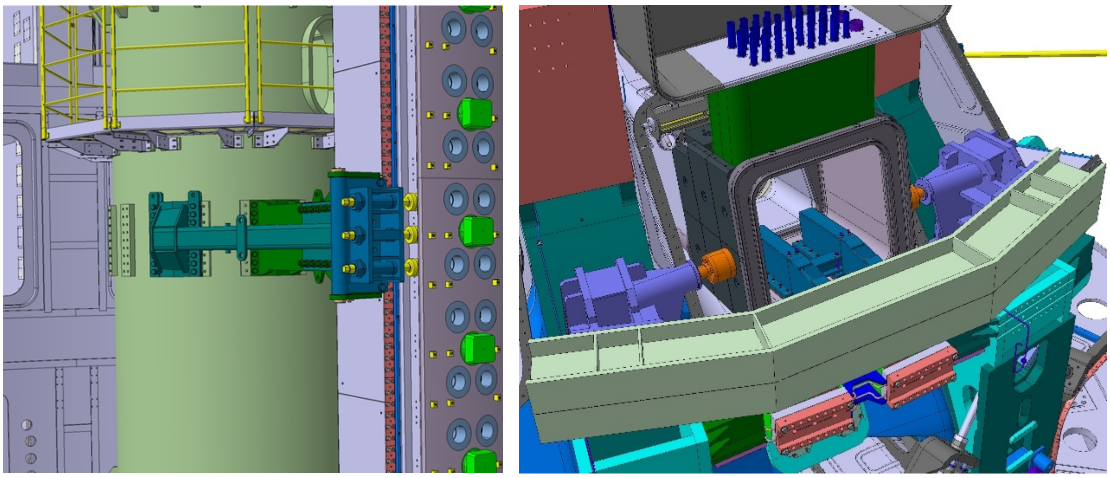


Figure 4-5: Inboard Bracing Arms and Outboard Frames

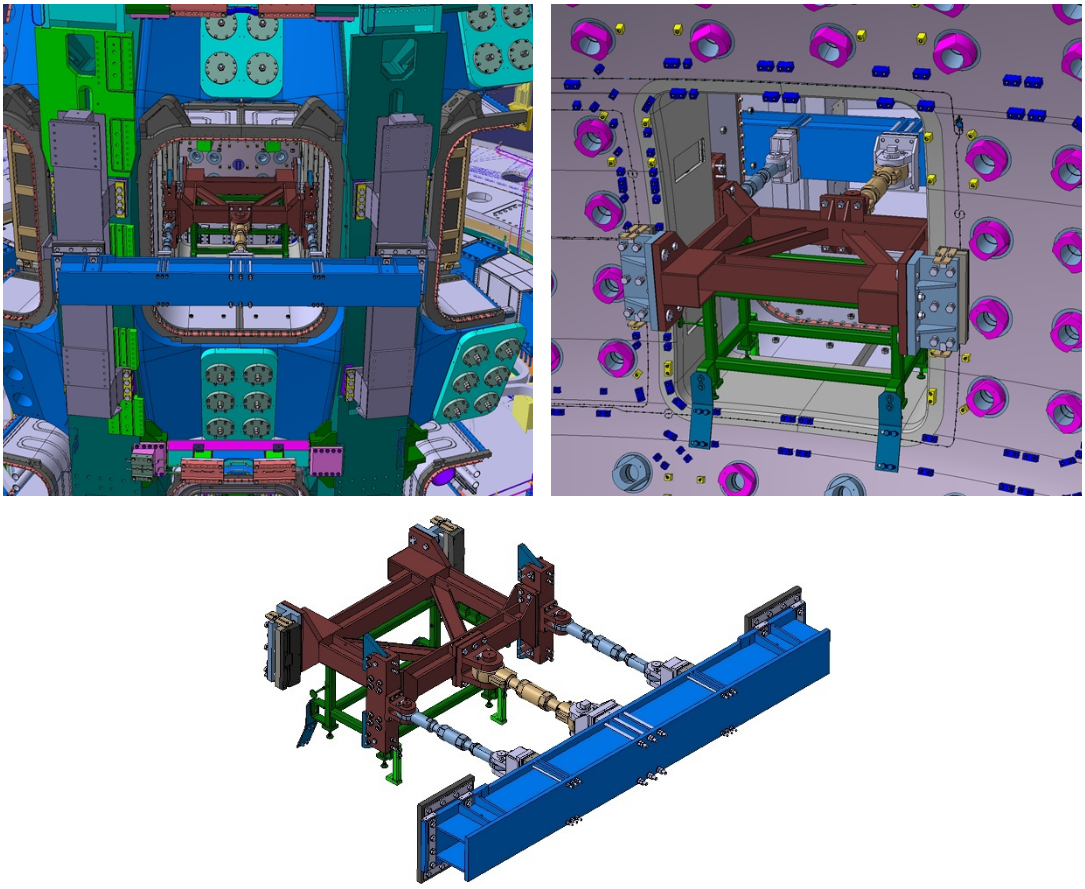


Figure 4-6: Mid Plane Bracing Tool

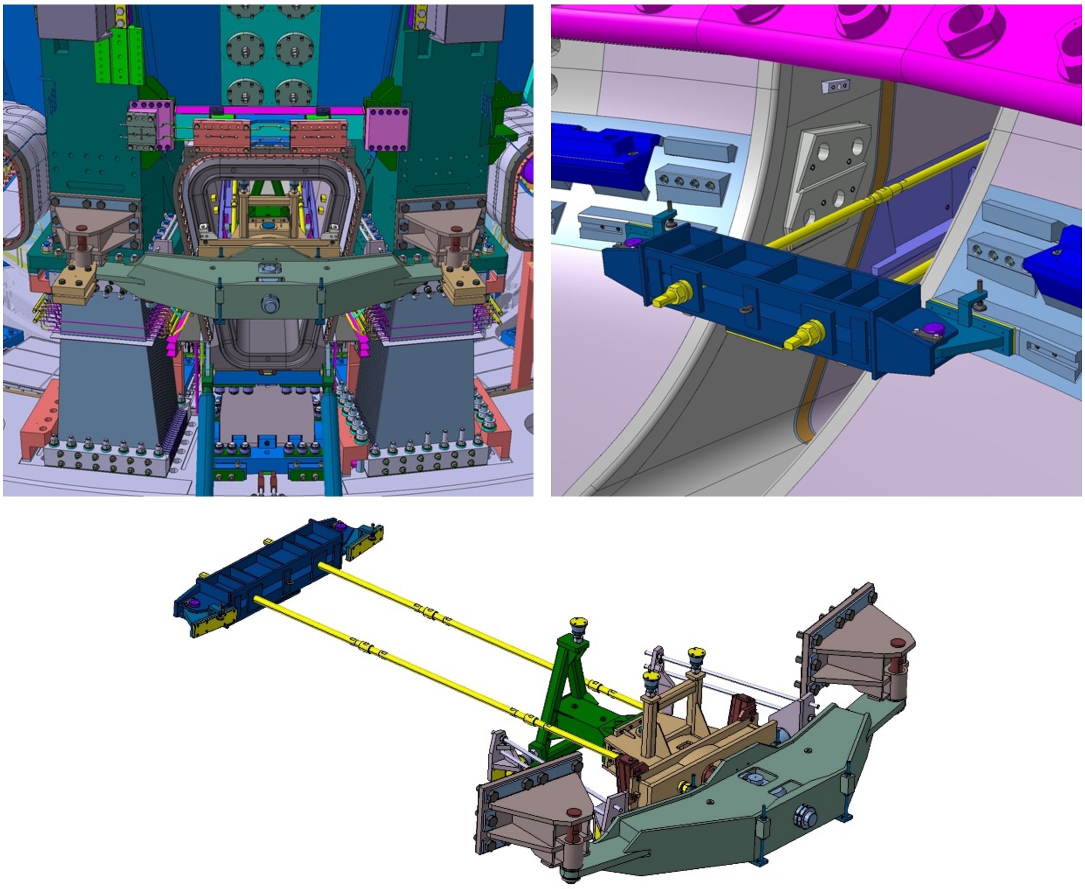


Figure 4-7: Divertor Level Bracing Tool Removal

5 Scope of works

The scope of the expected related Contract will be to define a principle of operation and prepare a procedure for the alignment of each of the 9 VV sectors, based on a predefined installation sequence (tentatively S7-S6-S5-S8-S4-S9-S1-S3-S2). This input shall be used for VV alignment activity to be performed by the WPP contractor.

This procedure shall include at least:

- Practical and creative methodologies for aligning the VV, including the specification of the tooling (laser tracker or other means).
- Definition of VV features to be used for the VV alignment, including the existing fiducials, new fiducials or controlled surfaces (e.g. machined plates with defined tolerances).
- Each VV alignment sequence shall be specific to its environment, notably the number of surrounding sectors in place in the pit. A generic procedure would likely not be detailed enough, which means that nine procedures are expected, unless justified to consolidate some activities (if work is parallelized). The study shall be evolutive to the assembly sequence.
- Details on the alignment procedure of the tools to the network and need for tethering shall be included in the assessment. The Contractor shall also assess the use of the building features, completed TFCs and/or completed VVS to align the tools to the pit network.

- Risk assessment and mitigation to be performed, such as redundancy to address evolution of the working environment affecting planned line of sights, or including a possible change of installation sequence, e.g. swap of SM9 and SM1.
- CAD resources to adapt IO's CATIA models to the working file type (such as spatial analyzer). The Contractor shall coordinate with the IO team to validate the correct environment and shall be able to manipulate the 3D model as needed.

6 Expected contract and main activities durations

This Contract shall cover all activities needed to define the methodology process to align the VV sectors. It is expected to be launched after Contract signature by the start of Q4 2025.

The scope of works as described in section 5 above is expected to be executed within an estimated duration of 3 months from the date of Contract signature.

7 Experience

The Candidate experience shall include the expertise in metrology and the resource capability to perform the monitoring of large mechanical assembly within precise tolerances. This includes engineering and design activities related to preparation of site execution and necessary tooling as well as suitably qualified and experienced personnel required to execute the works.

8 Eligibility

Participation is open to all legal persons which is established in an ITER Member State:

- European Union,
- Republic of India,
- Japan,
- People's Republic of China,
- Republic of Korea,
- Russian Federation,
- United States of America.

The ITER Organization may decide to broaden the eligibility to other countries as deemed appropriate.

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 from the tender procedure.