1. The ITER Divertor

The main function of the Divertor is to minimize the impurity content in the plasma whilst exhausting part of the plasma thermal power (including alpha power). As the main interface component between the plasma and material surfaces, it shall tolerate high heat loads while at the same time providing neutron shielding for the Vacuum Vessel and magnet coils, in the vicinity of the Divertor.

The ITER Divertor is installed in the bottom part of the vacuum vessel. The Divertor is made from 54 Cassette Assemblies (CA). Each CA includes the cassette body (CB) and three plasma-facing components (PFCs), namely the inner vertical target (IVT), outer vertical target (OVT), and the dome (DO) (See Fig. 1).
F4E market survey on production of small scale mock ups and full scale prototype

for Iter IVT

The CB provides neutron shielding for the Vacuum Vessel and magnetic coils, and by incorporating internal cooling channels, acts as manifold for the PFCs.

The PFCs are actively cooled thermal shields devoted to sustain the heat and particle fluxes during normal and transient operations as well as during disruption and Edge Localized Modes events.

The PFCs are cooled in series and the water coolant is routed via the CB.

Each Divertor CA is connected to the Divertor primary cooling circuit through a pair of radial pipes.

2. THE INNER VERTICAL TARGET

The IVTs are one of the PFCs that, in their lower part, intercept the magnetic field lines, and therefore shall remove the heat load coming from the plasma via conduction and convection during the normal and transient operations as well as during off-normal events. The upper part of the IVTs provides a baffle for neutral particles.

The water coolant enters into the supporting structure via a cooling pipe made of austenitic stainless steel AISI 316L. The water is routed downwards and then flows into the cooling tubes of the PFUs via a parallel flow. The water runs upwards inside the PFUs until it reaches the upper part of the supporting structure. From there, it flows into the outlet tube towards the CB.

Figure 2: Coolant flow path

Total pressure drop: < 1.6 MPa
Total flow rate: ~950 kg/s
In order to reduce the electromagnetic loads, the IVT is split into two similar and independent components. Each component consists of eight Plasma Facing Units (PFUs) and one welded austenitic stainless steel supporting structure onto which the PFUs are mounted.

Each component of the IVT has two attachments to the CB. The attachments of the IVT to the CB consist of a series of lugs.

2.1. The Plasma Facing Units (PFUs)

The PFUs are single poloidal element, which directly faces the plasma. The PFUs are mounted onto the steel supporting structure via an array of pads, which are welded onto the front plate of the supporting structure.

The PFU geometry is based on the so-called “monoblocks” concept, which consists of armour tiles with a drilled hole. Then, a cooling tube, made of precipitation hardened copper alloy CuCrZr, is inserted into these holes, and is intimately joined to the tiles. Outside tungsten tiles the CuCrZr tubes are then joined to AISI 316L steel of the same diameter by means of an Inconel 625 adapter.

The armour material of the IVT is W because of its low sputter yield, low tritium retention, high melting temperature and good thermal conductivity. The W armour thickness of the full W PFUs is the same in the straight and the curved part.

A twisted tape is inserted into the cooling tube. Its aim is to increase the critical heat flux limit of the water coolant and, to a lesser extent, to increase the heat transfer coefficient.

To reduce the joint interface stress, a pure copper interlayer is envisaged between the W armour and the CuCrZr heat sink (See Fig 3).

![Figure 3: PFUs and cross-section of the PFU](attachment:image.png)
During normal operation a heat flux of 5-10 MW/m² is deposited onto the bottom segment of the IVT. However the capability to remove up to 20 MW/m² during the transient events ("slow transient" phase) of 10 seconds has also to be provided.

3. PURPOSE OF CURRENT MARKET SURVEY

F4E is currently manufacturing full scale (1:1) qualification prototypes of the IVT prior to launching the procurement of the series production. Due to the similarities of the two components forming the IVT, the full-scale prototype, which is required for the pre-production qualification, consists of only one of these components (See Fig4), therefore 8 PFUs and 1 steel supporting structure.