Full-scale installation trial of ITER's in-vessel and marshalling area loom prototypes

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Outline

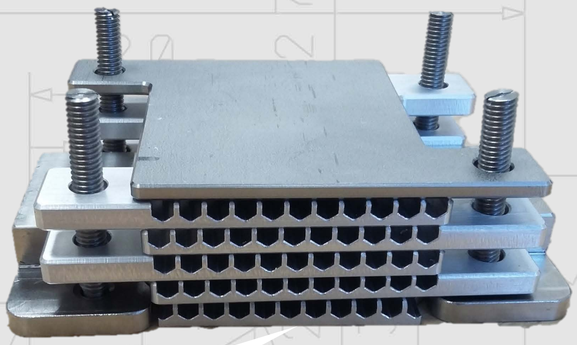
This poster gives an overview on the results of the manufacturing of prototypes and assembly trials of the in-vessel, in-port and marshalling area loom components on full scale mock-ups conducted by GEMS Engineering Ltd. under the service contract IO/21/CT/4300002352 concluded with ITER Organization.

Different kind of cable calmping components are used in ITER for the fixation of the mineral insulated cables of the diagnostic systems. Beside of that, during the operation of the machine these cable clamping components shall keep initial tightening preload in vacuum, under neutron irradiation, thermal cycling and vibrations, it is also crucial to be possible to place the cables into them during the assembly phase of the machine. For these reasons, to allow IO to assess feasibility, gain experience and obtain feedback with respect to the suitability of the current designs regarding handling and installation of in-vessel signal cables and loom components, GEMS Engineering has carried out a series of installation trials on full-scale mock-ups of in-vessel and divertor looms, upper and lower port marshalling area looms. Besides of installation trials, the scope of the work also covered the manufacturing and testing of in-port connectors, cable clamps and clips for in-vessel and divertor looms and marshalling areas.

Manufacturing of components

For the full scale tests GEMS first manufactured some dozens of the following components:

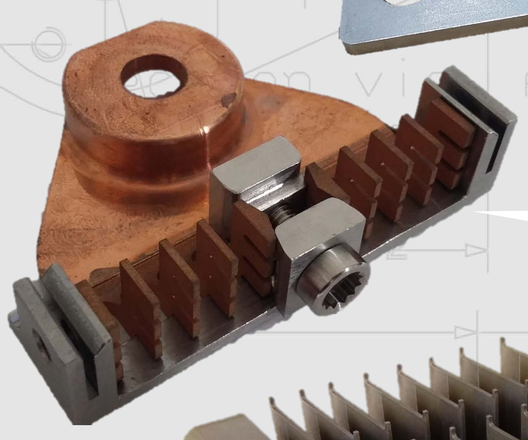
- In-vessel clamps (CuCrZr and 316L(N)),
- Divertor clamps from (316L(N))
- In-port connectors from (Al and polyimide)
- Cable clips (316L(N))
- Marshalling area clamps (316L(N) and Al)



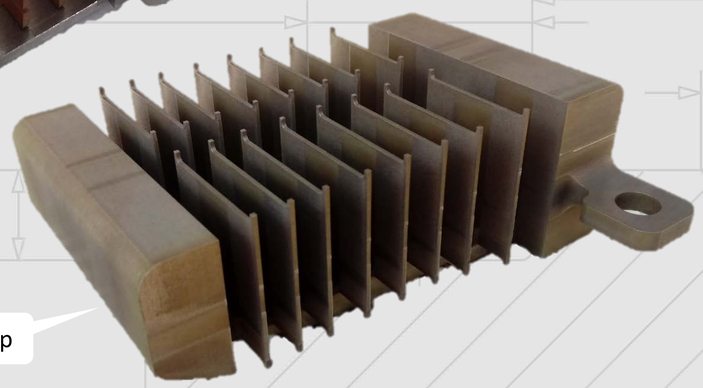
In-vessel cable clip

Marshalling area clamp

Marshalling area clamp



In-Vessel clamp

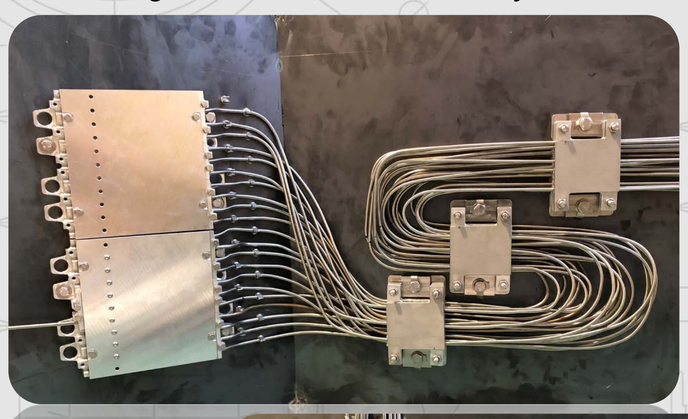


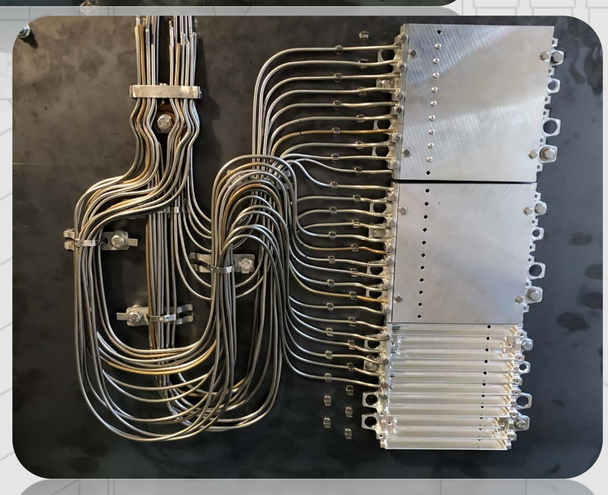
Divertor clamp

Manufacturing of parts included the optimisation of models and drawing from the manufacturing and available raw material point of view.

Marshalling area mock-up

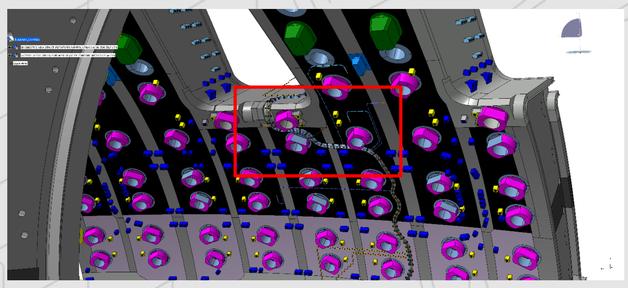
For testing the assemblability of the existing designs of the marshalling areas in upper and lower ports, two full scale mock-up have been prepared. Beside of Mineral Insulated cables, stainless steel tubes were used for the tests as they properly mimic the MI cables, which will be placed into the looms inside the vacuum vessel of the ITER machine. The manufactured section of the marshalling areas has been chosen by IO.



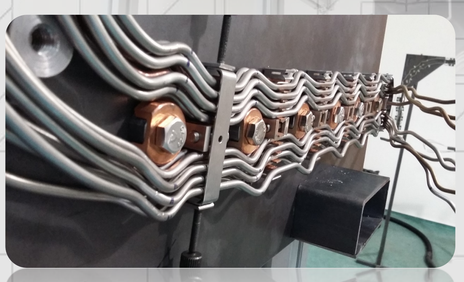


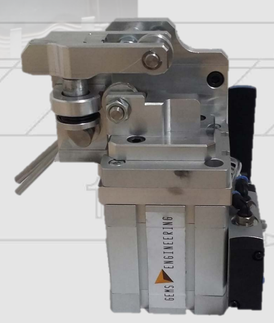
In-vessel loom mock-up

The task was to design, manufacture, assemble a piece of full scale loom mock – up according the outboard loom part has been chosen by IO.



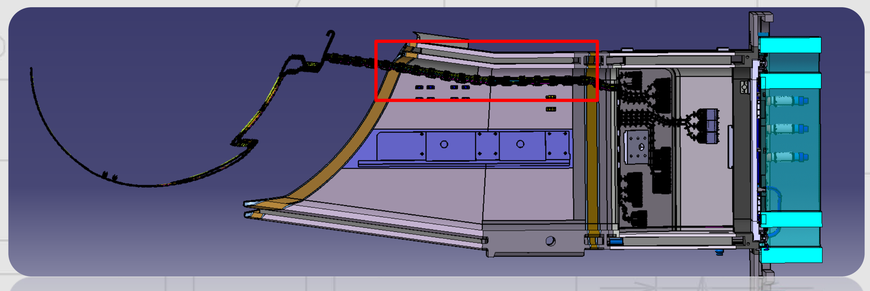
The most challenging part of the task was to fill the clamp up with cables one by one creating wobbles precisely next to each clamps without damaging the tiny fins of the clamps. Special tool has been developed by GEMS for creating the wobbles.



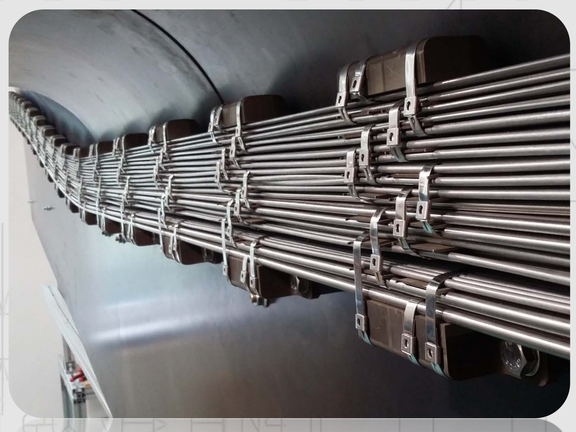


Divertor loom mock-up

Assembly test have been performed on the section of a full scale divertor loom coming from the VV to the marshalling area. Section was chosen by IO.



The test focused on the fixation of the cables into the clamp rather than the cables so for this reason and because of the huge amount of cables, instead of MICs tubes and pipes have been used.



Summary

The assembly of the looms (in-vessel, divertor, marshalling area) require attention and high precision from the staff who are working on them in order to avoid damaging the parts of the cable clamping components or the MI cables. However each loom has been assembled without a show stopper issue, some difficulties have been identified. The main difficulties have been found during the installation trials, can be divided into two categories which are the followings:

- The plain difficulty of manipulating the cables in order to be able to place them. These mineral insulated cables are quite stiff, almost like steel rods. Because of this reason it is very hard to create bend with small radius or straightened them after bending.
- The proper tools do not exist. These tools could be either pieces of plastic that can temporarily hold the cable in place or a more complex tools that can be used to properly bend the cables in place.

During the project we managed to find possible solutions for all the difficulties we faced during manufacturing of assembly. Either it is the modification of the existing component or the development of new tools.

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