Institute for Magnetic Fusion Research

WEST

Newsletter N°23 - December 2018

First EUROfusion sessions !

During the WEST fall campaign, the first experimental sessions supported by EUROfusion were successfully performed.

The sessions were dedicated to exploring divertor physics and testing the ITER like Plasma Facing Units (PFU). Scientific highlights include: the characterization of the tungsten divertor source as a function of plasma temperature, a scan in plasma parameters to assess the heat deposition widths on plasma facing components and a thorough database for checking the angular dependence of heat loads under grazing incidence, as will be the case for ITER. In addition, the first measurements of power deposition on leading edges of misaligned ITER like PFU were performed, using a very high resolution infrared camera, able to resolve submillimeter features. Experiments were supervised by scientific coordinators from various European laboratories (DIFFER, IPP.CR, FZJ, IPP), and a team of ~10 EU visiting scientists was welcome on site to participate in the campaign.

WEST controlled from Rokkasho, Japan

Located 10000 km away Japanese scientists took control of the WEST tokamak on Wednesday, 28 November.

The Remote Experimentation Center (REC) in Rokkasho, funded by Europe, was used for the first time to test remote participation in WEST experiments in view of ITER scientific exploitation. The experiment on that day was focused on the plasma exposure of the ITER like tungsten component prototypes, including those provided by Japan. Japanese researchers could familiarize themselves with the setting up of WEST plasma discharges, the visualization of data, and, more generally, with the organization of the experiments.

The ITER divertor team was there.

WEST Science

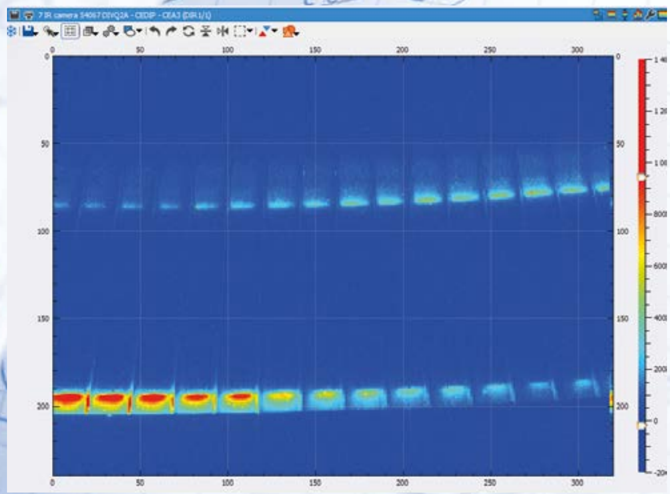
Infrared Monitoring

In fusion devices, the infrared (IR) thermography is used for monitoring surface temperature of the plasma facing components which are exposed to extreme heat fluxes. One of the main advantages of the IR thermography is the non-intrusive aspect for the experiments and the components themselves. However, interpretation and analysis should be carried out with a careful assessment of both the emissivity and the environment.

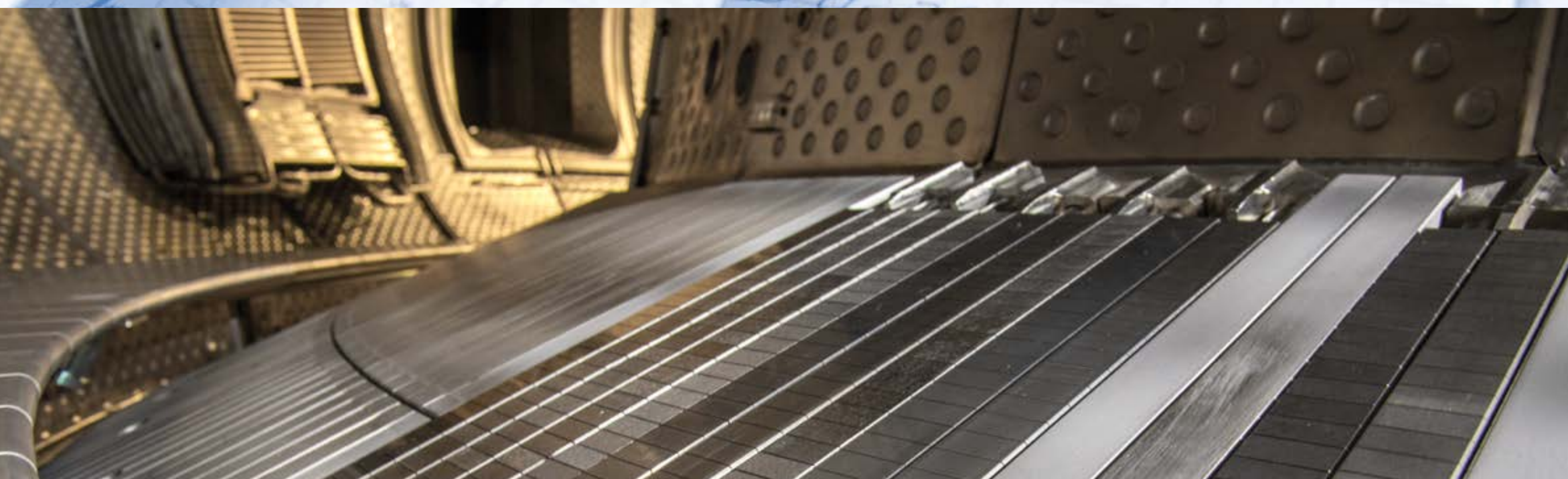
Indeed, the surface temperature is obtained through the measurement of the photon flux emitted by a surface at different wavelength. This emission strongly depends on the surface temperature and the emissivity which should be known with accuracy. This is one of the most difficult challenges of the IR thermography since the emissivity can vary with (at least) the surface temperature, the detection wavelength and the material roughness. For materials such as tungsten, which is now a reference material in fusion devices, emissivity variations over a range of 0.1 to 0.4 have been observed. In these conditions, preliminary calibration of the emissivity in laboratories allows for a better knowledge, reducing the uncertainty down to ~10% on a temperature range of ~1300°C.

In addition to the low and variable emissivity, reflected fluxes from the metallic surfaces are also collected by the IR camera. This parasitic flux should be taken into account for assessing the real surface temperature. This can be achieved and evaluated through modelling of the overall environment.

In short, surface temperature monitoring of plasma facing components by IR thermography requires a deep knowledge of both the target emissivity and of the environment. In carbon fusion devices, this method has proved its worth but in metallic fusion devices, its reliability for the protection of the plasma facing components remains to be demonstrated. WEST, with its new IR thermography system will therefore provide significant insight for ITER, which will also be equipped with an IR thermography system covering more than 80% of the surface exposed to the plasma.



IR emission from the WEST divertor during plasma experiment showing the heat fluxes on the tungsten coated plasma facing units.



Launch of the manufacture of the ITER-like PFU series

WEST lower divertor will be equipped soon with its 456 actively cooled tungsten Plasma Facing Units (PFU), last step towards the project completion.

The inertially cooled tungsten coated startup PFUs were installed to commission the divertor configuration and test prototypes of actively cooled PFU integrating ITER divertor technology. They will all be replaced by actively cooled PFU to access long pulse operation. Indeed WEST research plan focuses on physics phenomena that arise beyond hundreds of seconds of plasma exposure.

The fully actively cooled divertor is becoming a reality with the recent contract award for the series production to Huainam (China). This company has built a large experience with W monoblock concept technology through the production of a W/Cu divertor for EAST tokamak and more recently with the manufacturing of prototypes for ITER and WEST. The industrial follow-up will be supported by WEST Chinese partners (ASIPP and SWIP laboratories).

For the PFU reception at Cadarache, IRFM is implementing a high heat flux test facility (so-called HADES, which is a move and refurbishment of the FE200 facility). This facility together with the existing testbeds will be the place of an extensive qualification program of the PFU (visual and dimensional controls, IR thermography examination, high heat flux testing, 3D metrology, tightness tests, etc.) before their installation in the tokamak divertor in early 2020.

Institut for Magnetic Fusion Research
DRF/IRFM
CEA Cadarache 13108 Saint Paul lez Durance Cedex France

http://west.cea.fr
Contact Newsletter
Sylvie Gibert
sylvie.gibert@cea.fr