Institute for Magnetic Fusion Research

WEST

Newsletter N°22 - October 2018

US researchers at Cadarache during C3 campaign

Large presence of US researchers at WEST site during the C3 plasma campaign for diagnostics operation and future developments and to initiate W transport and migration studies.

US MFES Researchers in the WEST control room, July 2018 :
Left to right: C.C. Klepper, J. Nichols, A. Neff , D. Donovan, E.A. Unterberg, A. Diallo and G. Wallace.

Overlapping July visits to the WEST fusion energy facility by US researchers, during its "C3" experimental campaign, highlighted the developing US partnership on the new, all-tungsten (W) superconducting divertor tokamak. The US personnel on site included C.C. Klepper (ORNL at Cadarache site), E.A. Unterberg (ORNL), D. Donovan (Univ-Tenn faculty), A. Diallo (PPPL), G. Wallace (MIT), J. Nichols (Univ-Tenn Postdoc & DOE MFE Fellow), A. Neff (ORNL postdoc & MFE Fellow).

ORNL is presently leading the US partnership with senior research staff onsite at Cadarache and diagnostic systems already in operation, including fast D-alpha and ELM-resolved W source characterization.

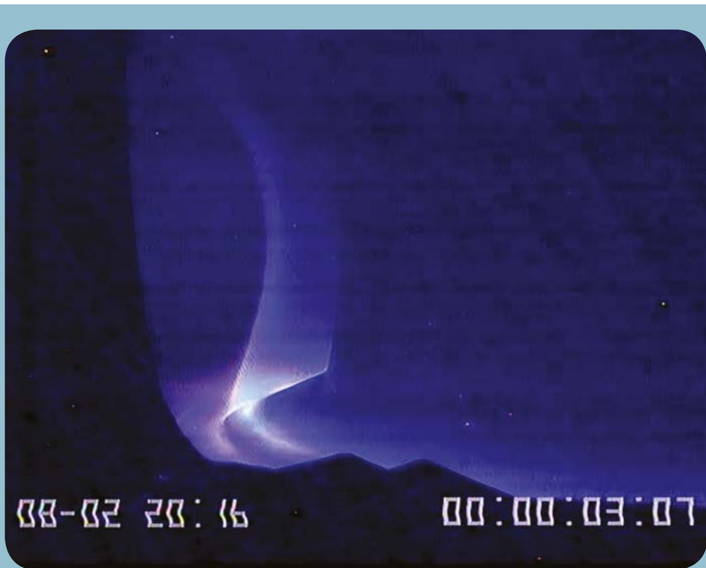
The visit by the ORNL/Univ-Tenn team included (a) working meetings to define collaborative tasks and responsibility roles in ORNL-led initiative to study W migration with ORNL technologies, including W isotopic coatings deposition on PFU/PFCs; (b) optimization of the ORNL Filterscope diagnostic system and calibration for the present campaign; (c) collaboration on interpretive modeling for W transport and migration data. The visit by MIT's Greg Wallace was in connection with an ORNL/IRFM/MIT initiative to deploy the dynamic Stark effect measurement approach (measurements and modeling), already established on Tore Supra and C-Mod, to guide optimization of LHCD coupling to WEST H-mode plasmas. Theses visits were the prelude of regular participations to the WEST campaigns.

The visit by PPPL's Ahmed Diallo was to discuss potential PPPL support of plasma pedestal Physics including new Thomson Scattering diagnostic contribution. All these activities by US personnel are supported by funding from US DOE Office of Fusion Energy Sciences.

C3 campaign to be continued

Due to a delayed start, the C3 plasma campaign initially planned until the end of July will continue in October

At the very end of the vessel conditioning sequence in May, a micro water leak appeared that forced the reopening of the vacuum vessel. Several weeks were necessary for draining the cooling water loop, locate and repair the leak, refill the cooling loop and recondition the vessel. Plasmas restarted in July. Some progresses in heating power, plasma density and heat flux onto the divertor test components can be noted and the campaign objective of getting an H-mode plasma (High confinement regime) is at hand. The deposition of a thin layer of boron (~100nm) on the tungsten plasma facing components (boronization) was decisive in reducing the light impurities in the plasma (O, C, N) and boosting the performance. Plasmas will resume by mid-October.



Plasma in WEST on 2nd August this year.

WEST Science

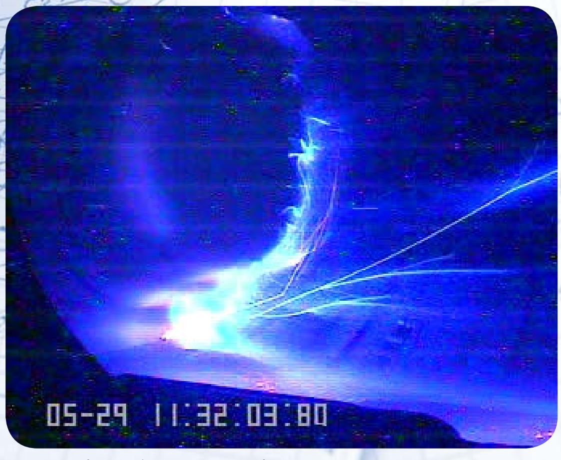
Dust in fusion plasmas

Plasma-surface interaction is amongst the most challenging topics currently studied in the fusion community.

Like the two faces of the same coin, the interplay between the tokamak wall and the plasma has severe consequences for both: the plasma damages the surface (via erosion, melting, tritium implantation...) whilst the surface pollutes the plasma with impurities.

A major phenomenon occurring at this interface is the production of dust, small particles of wall material that are, for various reasons, detached and transported into the plasma. Such particles may have wide ranges of sizes (from tens of nanometers to centimeters) and velocities (from nearly immobile to several kilometers per second). Dust is mainly harmful for tokamak operations since it is a source of impurities that can be located deep inside the plasma. For long pulse operation of a fusion power plant, the amount of impurities in the plasma must be knowable and controllable to some degree, thus it is mandatory to investigate how dust is created, transported and destroyed in fusion plasmas.

During its lifetime, a dust particle will be heated by the surrounding plasma and see its temperature increase. Thus a dust trajectory can end in no more than two ways: complete vaporization by plasma heating or collision with the wall surface. Dust transport in plasmas is studied at IRFM through image processing of films shot during discharges. Comparing experimental dust trajectories with known models is a good way to understand the underlying physics of dust transport and work towards mitigating their noxious effects.



Dust shower in Tore Supra plasma

First images from the wide-angle IR viewing system

The new tangential wide-angle infrared (IR) thermography system was commissioned this summer. The thermal scene of a fraction of the first wall, upper and lower divertor components is now monitored in real time with this valuable diagnostic.

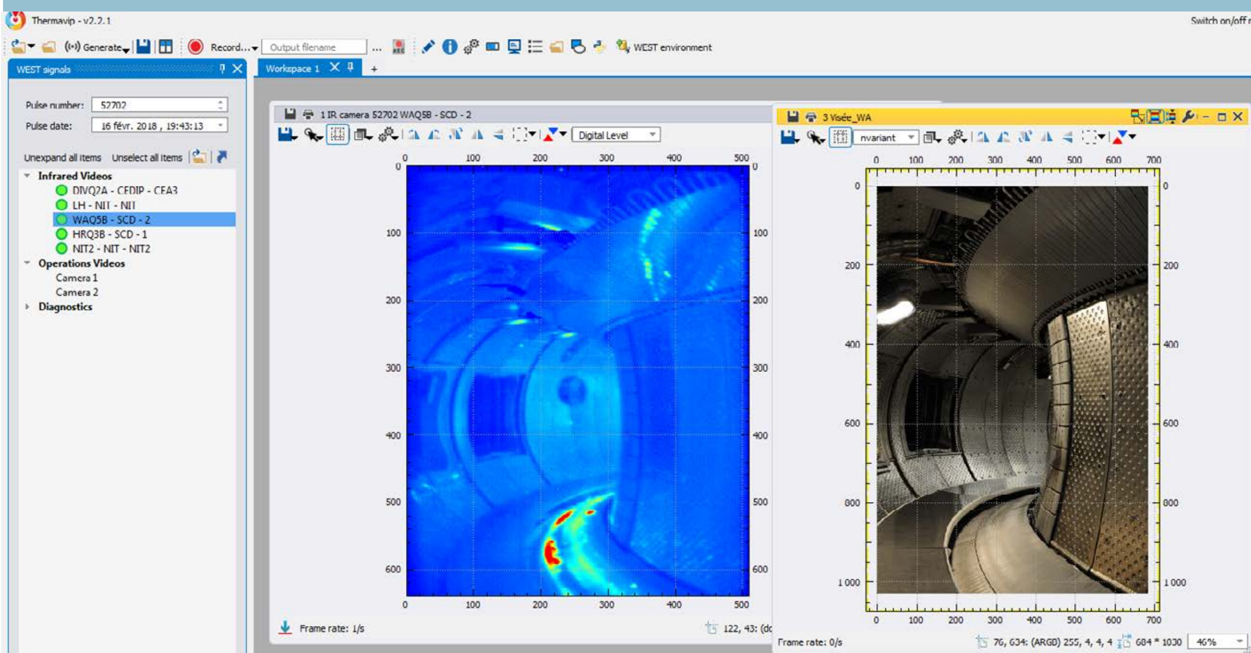
The objective of the system is to provide a thermal map of the plasma chamber and the inner components.

About one-sixth of the chamber is observed, including sectors of the lower and upper divertor targets and of the lower divertor baffle, one inner bumper, several upper port protections, some vacuum vessel protection panels and one ICRH antenna (in the next campaign).

Measurement is being used for machine protection by means of monitoring temperature thresholds in delimited region of interest, and for heat load analysis during operation and specific events such as vertical displacement events (VDE), edge localized modes (ELM), disruptions or runaway electron beams.

This wide-angle viewing system is based on an endoscope extending inside an equatorial port equipped with one aspherical and one on-axis plane mirrors, a sapphire window and 3 lenses for the objective of a home-made camera.

The optical path is optimized in the range 1.5 to 5µm. The field of view is 60 degrees on a 512*640 pixels focal plane array. Since the head of the endoscope is close to the surface of the first wall, it is actively cooled.



Thermal scene from C3 experimental campaign in July 2018 showing the heat load on the lower divertor target and spurious hot spots (reflexions) during the plasma.

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