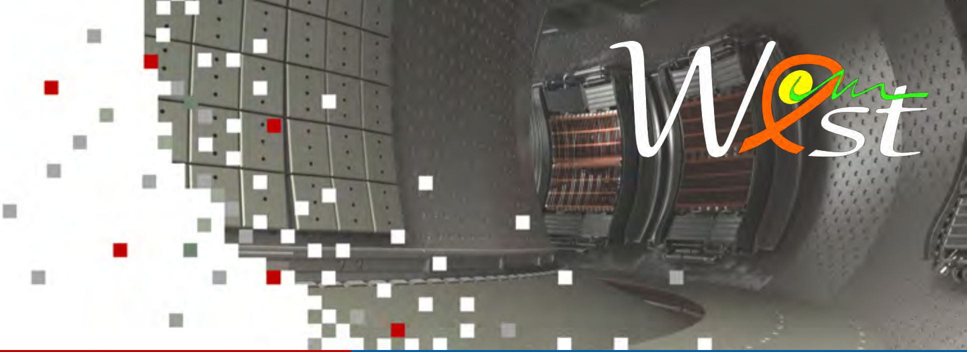
Institute for Magnetic Fusion Research



WEST Newsletter N°15 - November 2016

WEST in starting monoblocks

After four years of relentless work, Tore Supra is definitively turned into WEST: all new components are now installed in the vacuum vessel which has just been closed for the final commissioning before plasma operations.

To comply with the new plasma shape configuration and the tungsten environment, the tokamak vessel is hosting brand new elements: divertor coil windings, protection panels, antennas, diagnostics and of course the tungsten plasma facing components. All these components have been designed and produced to meet the hard requirements of a tokamak… as well as the numerous specific tools for their integration inside the vacuum vessel. The installation of the divertor plasma facing components ended up the assembly phase. The lower divertor target is now equipped with six ITER-like tungsten elements (3 from China and 3 from Japan) which are complemented with inertially cooled graphite elements with tungsten coating. The WEST construction endeavor mobilized more than one hundred people: IRFM staff but also WEST partners, in particular Chinese and Indian on site collaborators. The Tore Supra transformation began in 2013 and less than four years after the vacuum vessel is closed again. After the divertor coil impregnation and the integrated commissioning WEST will enter its scientific life focused on the preparation of ITER divertor operation.

The first 6 ITER-like tungsten monoblock elements ready for facing the plasma

Thanks to Pr. Bora, a WEST supporter from the very beginning

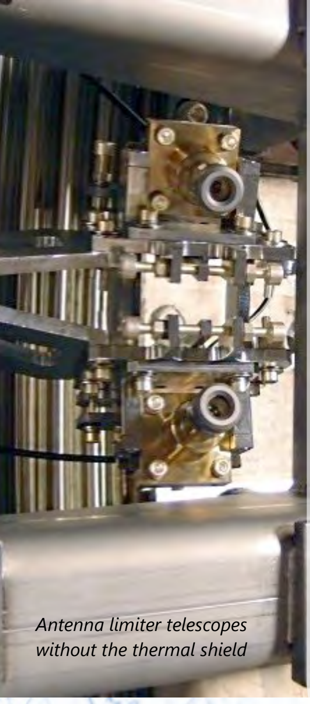
Professor Bora retired from his function of Director of the Institute for Plasma Research (IPR)

After receiving his Doctorate in Physics from the Physical Research Laboratory in Ahmedabad, Professor Dhiraj Bora has contributed very actively in research in the field of Plasma Physics and Fusion Science and Technology for almost four decades now. In his earlier career, Pr. Bora was involved in the development of microwave and bolometry diagnostics, and then took the responsibility of leadership of various projects at IPR, particularly the development of radio frequency heating and current drive. He was respectively a visiting researcher at Institut für Plasmaphysik in Jülich and Fusion Research Centre of the University of Texas at Austin.

Prof. Dhiraj Bora was the Director of IPR during the period 2013-2016. Prior to this function, Prof. Bora has joined the ITER Organization as Deputy Director General and Director of Diagnostics, CODAC, heating and current drive systems Department. Pr. Bora is also a member of several International Committees, such as the IAEA International Advisory Committee, the Indian delegation to the ITER Council, the ITER Management Advisory Committee.

Pr. Bora has always been a strong supporter to WEST. Under his direction, IPR has developed with IRFM a fruitful cooperation in scientific and technology program, especially IPR became a key and active partner of WEST.

IPR-CEA Agreement signature (D. Borha in 2013)



Antenna limiter telescopes without the thermal shield

In-vessel telescopes to probe tungsten sources

An important milestone reached with the installation and alignment of 13 in-vessel telescopes developed to monitor the tungsten erosion.

The visible spectroscopy system allows for measuring the W sources coming from the various Plasma Facing Components (divertor, antenna limiter and bumper). The principle is to collect the light emitted by the W atoms, ripped out of the wall by the incoming plasma particles. This radiation results from collisions between W atoms and plasma hot electrons.

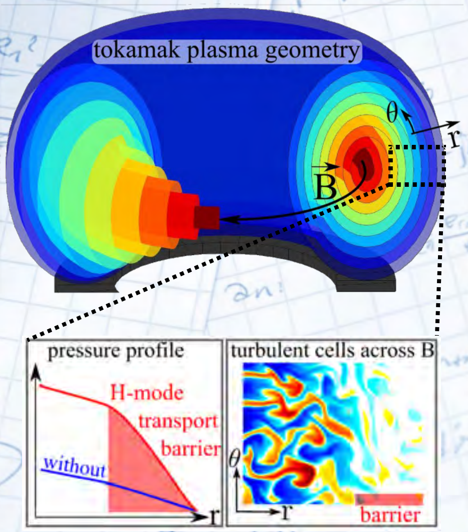
The originality of the system resides in the installation of optical elements directly inside the vacuum vessel. Therefore they have been designed to be compatible with the harsh tokamak environment. In situ large-aperture actively cooled optical systems have been implemented for each view and connected to optical fibers. A total of 240 optical fibers are then deployed to various detection systems such as the "Filterscope", developed and provided by Oak Ridge National Laboratory (USA) and consisting of photomultiplier tubes and filters, or imaging grating spectrometers dedicated to multiview analysis.

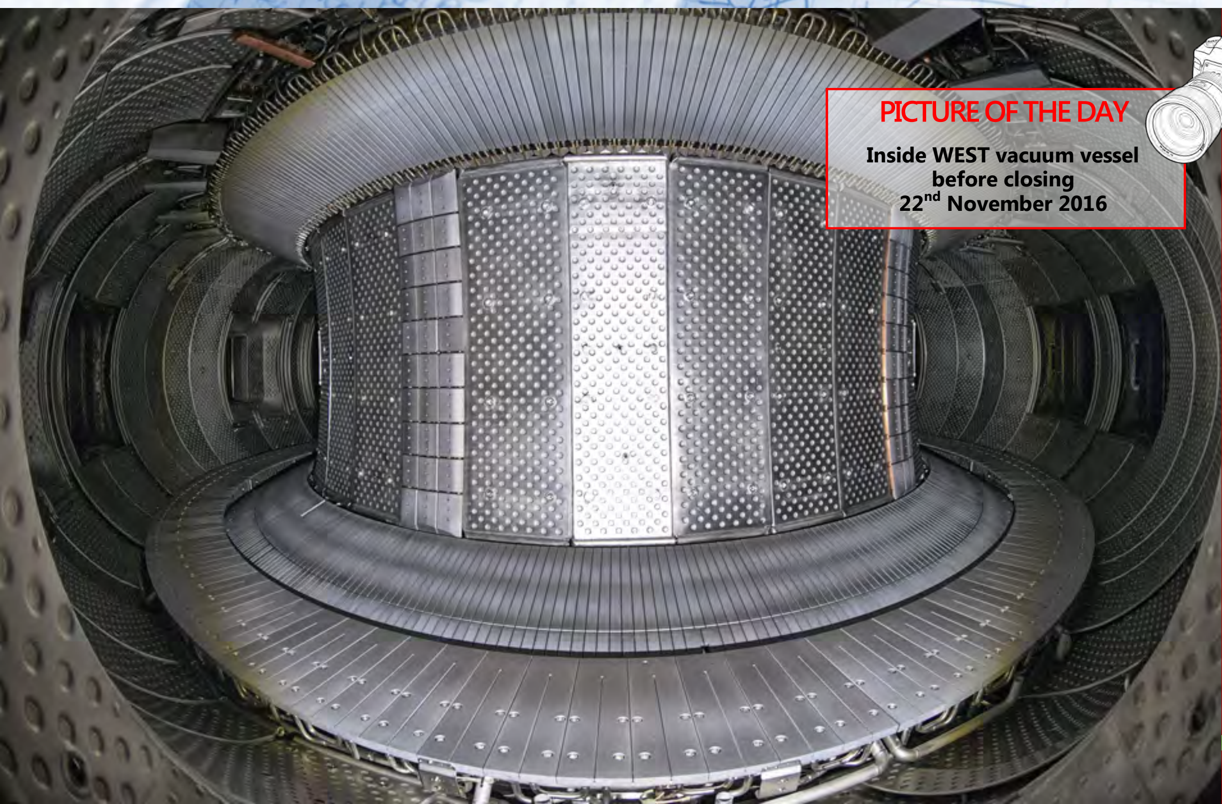
The visible spectroscopy team has completed the in-vessel work: 13 telescopes and associated optical fibers are installed including divertor view telescope. The careful alignment of the telescopes has been performed before mounting the thermal shields which hinder their accessibility. Initial optical specifications have been successfully achieved.

WEST Science

The mystery of H-mode

"Burning" hydrogen isotopes to produce energy requires extreme temperature, reached only if the injected heat does not escape the plasma too fast. On that purpose, tokamak reactors use magnetic fields to confine the charged particles. But the system tends to relax from this constrain: large pressure gradients across the magnetic field trigger turbulence, similar to convective cells developing in water when heated in a pan. As a consequence, heat escapes the medium faster than expected. About 30 years ago, ASDEX, a tokamak operating in an innovative magnetic configuration (X-point divertor) exhibited an unexpected confinement bifurcation, while raising the injected power. The discovered *high* confinement mode (H-mode) improved significantly performances, and soon became a standard mode of tokamak operation. Measurements showed that H-mode is caused by the disappearance of turbulence in a thin plasma layer at the boundary of the confined region, called edge transport barrier. Imagine a thermally insulating blanket wrapped around the confined plasma, slowing down heat escape from the medium. However, it is not yet understood how turbulence suddenly disappears within this plasma layer. Plasma rotation along the barrier seems to be the key ingredient that suppresses turbulence. WEST, with its diverted configuration, will access the H-mode and will contribute to unravel the mystery notably by experimenting it over very long duration in a metallic environment.





PICTURE OF THE DAY

Inside WEST vacuum vessel before closing 22nd November 2016

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