Institute for Magnetic Fusion Research

WEST

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4th WEST Governing Board: considering future challenges

The 4th annual WEST Governing Board (GB), gathering WEST international partners, took place on May 19, 2017. It was a good opportunity to celebrate recent achievements, culminating with first plasma breakdown performed in December 2016, and look at future challenges, with the preparation of the WEST full actively cooled ITER like divertor.

The first part of the GB was focused on the last year achievements: it was a unique opportunity to appreciate the highly dedicated work performed by the WEST members. Jérôme Bucalossi, the WEST project Leader, presented an overview of the project and the commissioning status, followed by reports from WEST GB members: the French Fusion Federation (FR-FCM) and Aix Marseille University (AMU), the Chinese partners SWIP and ASIPP, the Indian partner IPR, Korean partners (UNIST and KAIST), the American partner ORNL and naturally the European partners either through the EUROfusion consortium or through direct collaboration, such as the Polish Institute IPPLM and the German Institute KIT[1]. With the production of the first plasma in December 2016, the way is now open to the experimental programme. Emmanuelle Tsitrone, WEST Task Force Leader, presented the content of the first phase of WEST scientific exploitation. But WEST is already considering longer term issues with the implementation of the full actively cooled lower divertor which will enable the experimental phase 2. An implementation scheme was proposed by Alain Bécoulet, Head of IRFM, on behalf on CEA, SWIP and ASIPP while Gyung Su Lee, ITER Organization Deputy Director General, evoked the ITER Research Plan and the role of WEST. ITER Organization will thus provide through its domestic agencies (F4E and JADA) a WEST divertor sector dedicated to ITER specific studies. Finally, two new deputy Task Force Leaders were appointed during the meeting: Thierry Loarer and Nicolas Fedorczak, and publication rules were also adopted.

The day before, Vincent Berger (Director of the CEA fundamental research Division), Bernard Bigot (ITER Director General), and Robert Aymar (former IRFM and ITER director) addressed the WEST GB participants, as well as industrials involved in WEST construction, in an intimate celebration for the first plasma.

[1]Other European laboratories : IPP Garching/Greifswald, FZ Jülich (Germany), IPP-CR (Czech Republic) and IFA (Romania) could not be represented at this meeting.

One of the six EUROfusion Plasma EXhaust projects

Late 2015, EUROfusion called for proposals on projects addressing plasma power exhaust, an important topic for future fusion devices. The WEST proposal, together with five other European projects, "made the cut"[1].

The EUROfusion call was targeted at closing gaps in the area of plasma exhaust (PEX) for future fusion devices, by upgrading present European facilities. It received ten proposals that covered conventional and alternative divertors, as well as conventional materials and plasma facing units as well as advanced materials. The proposals were evaluated by an independent panel of experts in summer 2016. Following a EUROfusion General Assembly in spring 2017, together with five other European PEX projects, the WEST proposal was selected for support . It consists in implementing the full ITER like actively cooled divertor, enabling large scale testing of the ITER divertor technology in tokamak conditions. It also includes associated diagnostic upgrades and the opportunity to test any future innovative high heat flux components in tokamak environment.

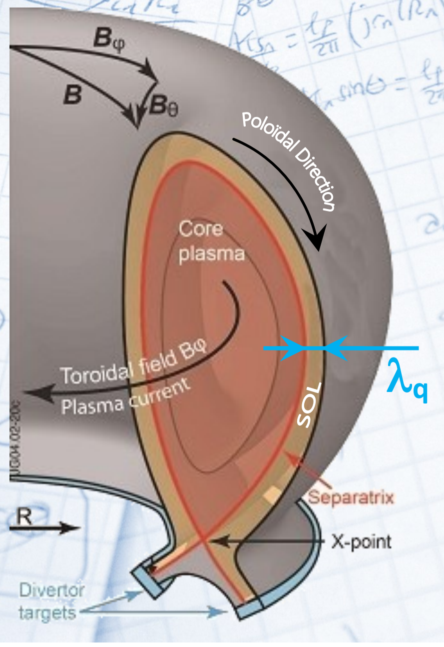
The EUROfusion support for the WEST proposal was announced to WEST international partners at the 4th WEST Governing Board, held in May 2017

[1] https://www.euro-fusion.org/2017/05/six-exhaust-systems-make-the-cut/

WEST Science — The key parameter that governs the heat load

The understanding and control of the plasma boundary width is a major concern for tokamak operation as it determines the power load amplitude on the plasma facing components.

After escaping from the hot plasma core, charged particles enter into the plasma region called "scrape-off layer" (SOL), and diffuse rapidly along the magnetic field lines toward the plasma facing component. During their flight through the SOL (typically over a hundred of meters in ITER), particles are, due to the combination of collision and turbulence processes, prone to jump radially from one magnetic field line to the other. This leads to cross-field particle heat transport at the origin of the SOL width, which ranges from cm down to mm size. All the power carried out by ions and electrons is actually driven in this narrow channel. Its width at the outer equatorial plane defines the well-known "heat flux decay length" parameter λ_q. The understanding and control of this λ_q is essential for tokamak operation for two reasons: first it determines the area exposed to the heat exhaust and second, more importantly, it establishes the power load amplitude itself. High λ_q is favourable to power spreading and moderate heat load while small λ_q leads to intense heat load to the target. In WEST, λ_q will firstly set the level of injected power needed to reach the 10 $MW.m^{-2}$ heat load required to test the ITER-like plasma facing components. With its specific features, WEST will also contribute to the multi-machine scaling laws in order to extrapolate the λ_q values in ITER and next fusion reactors.



Divertor coils connected to the grid

SWIP (Southwestern Institute of Physics, Chengdu) & NERCC Company (National Engineering Research Center of Converters) turned out in strength for new divertor power supplies commissioning.

The two WEST divertor coil power supplies arrived at Cadarache from China in July 2016. One responsible officer from SWIP and one from NERCC participated to the first two weeks of installation in August. A second team of 10 people were then present during several weeks at the end of the year 2016 to control and test the installation. They came back in mid-January until the beginning of March to participate to the first injection of current in the divertor coils. This third period was also dedicated to voltage control regulation and acceptance tests.

On March the 7th, Alain Becoulet, Head of IRFM, thanked SWIP and NERCC teams for their fruitful contribution with symbolic diplomas. The power supplies were then used during plasma operations and the polarity was also reversed for plasma start-up studies. In May, SWIP and NERCC came back again to complete the acceptance tests with the current regulation tests, and to train CEA operation and maintenance team. Finally, up to 10 Chinese collaborators were involved on site to the power supplies assembling and commissioning over a period of eight months.

Plasma hard to catch!

After the first plasma breakdown in December 2016, the vessel has been reopened to install the two modified LHCD antennas for plasma heating. Plasma operations restarted in April. Although the plasma breakdown is routinely achieved, the ramping up of the plasma current was found to be difficult due to induced currents in the passive structures which have been introduced inside the vacuum vessel to produce the divertor configuration. Indeed, stray magnetic field compensation is very challenging. It was thus decided to open the vessel again to modify the divertor baffle and reduce its electric conductivity to limit induced current. Experiments will resume by the end of June.

IRFM
Institute 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