Contribution ID: **487** Type: **Poster**

ITR/P5-27: Challenges of Integrating a Typical Diagnostics Port Plug in ITER

Thursday, October 11, 2012 8:30 AM (4 hours)

Diagnostics in ITER are mandatory to characterize the parameters of plasma and study its interactions with plasma-facing components. They thus play a crucial role for both the tokamak operation and protection.
Diagnostics components closest to the plasma are supported by big metallic structures called port plugs, located within the vacuum vessel. At the tokamak mid-plane, these components are installed in port plugs through intermediate structures called drawers. Indeed, apart from hosting the diagnostics, the port plugs act as shielding against neutrons and gammas, in order to limit the nuclear loads in crucial components (such as diagnostics and superconducting coils) as well as the dose levels in the controlled zones of the tokamak. The radiation shielding function of the port plugs is ensured through an optimized mixture of heavy metallic materials and water, forming shielding blocks surrounding the diagnostics.
The integration of diagnostics in ITER appears quite challenging. The major issue stems from the RAMI aspects (Reliability, Availability, Maintainability, Inspectability). Diagnostics maintenance will be exclusively performed in hot cell with a frequency of only 4 years, through remote handling devices. The diagnostics design must thus be compatible with such maintenance constraints. Another issue is relative to the consistency of the diagnostics with the neutron shielding efficiency of the port plugs. Indeed, to maximize the view towards the plasma, diagnostics need large fields of view, inducing big apertures in the shielding blocks and degrading their screen efficiency. Another issue is the perennity of diagnostics performance in ITER severe environment. Components in the plasma vicinity are submitted to high thermal loads requiring an active cooling. They are also subject to great electromagnetic loads, which can be prejudicial if they cause failures of cooling channels or irreversible displacement of sensitive objects. The design of diagnostics will inevitably result from a trade-off between integration constraints and performance requirements.
This paper presents an overview of the complex issues linked to the diagnostics integration in ITER, providing preliminary guidelines to address them. These issues have been recently tackled in the frame of a study performed in Europe regarding a specific port plug, the Equatorial Port Plug 1.

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Session Classification: Poster: P5

Track Classification: ITR - ITER Activities