A V I S DE S O U T E N A N C E

Monsieur Thierry LOARER

Présentera oralement ses travaux pour l'obtention du :

DIPLOME D'HABILITATION A DIRIGER DES RECHERCHES

Le 18 avril 2014 à 10h30
Château de Cadarache
13108 Saint-Paul-lez-Durance cedex

Section CNU : 30
Milieux dilués et optique

JURY :

M. Jean-Marc LAYET, professeur des universités, Aix Marseille université

Mme Pascale ROUBIN, professeur des universités, Aix Marseille université

M. Jamal BOUGDIRA, professeur des universités, université de Lorraine

M. Guido VAN OOST, professeur des universités, université de Ghent (Belgique)

M. Philippe DELAPORTE, Directeur de recherche, Aix Marseille université

Mme Pascale MONIER-GARBET, professeur INSTN, CEA Cadarache

M. Michel CHATELIER, Directeur de recherche, IRFM CEA Cadarache

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LA SOUTENANCE EST PUBLIQUE

Abstract

Fuel retention constitutes an outstanding problem for fusion devices operations such as the tokamak ITER particularly for the choice of the plasma facing component (PFC) materials. In present day tokamaks, fuel retention is evaluated through two complementary methods: the particle balance and the post mortem analysis. The in-situ particle balance allows to evaluating how much fuel is retained during a discharge and up to a day of experiments. This method is particularly used to assess the retention as a function of the plasma edge resulting from different plasma scenario. Post mortem analysis is used to determine where the fuel is retained, integrated over an experimental campaign (from weeks to months of operation). The retention evaluated using this method corresponds to an average value integrated over the full experiment campaign including different plasma scenario, disruptions, vessel conditioning…In all the devices equipped with carbon as PFCs, using the two methods, the retention is demonstrated to result from both ion implantation and co-deposition with carbon in deposited layers. The carbon atoms originate from PFCs exposed to ion charge exchange fluxes and ELMs leading to erosion through both chemical and physical sputtering. High wall temperature limits the D/C ratio in the deposited layers, but as far as a carbon source exists, the dominant retention process remains the co-deposition of carbon with deuterium and also demonstrated to be proportional to the discharge duration. In full metallic device, co-deposition is strongly reduced and retention by ion and neutral implantation dominates. Retention below 1% of the fuel injection can be achieved compared to 10-20% in carbon devices. Fuel removal experiments through plasma operations (D to He and D to H change over experiments) are also reported for assessing the efficiencies of these technics for reducing the in vessel tritium inventory. It is shown that in fusion devices where retention takes place through copdeposition, the change-over technique increases the long term retention rather than decreasing it.

Finally, extrapolation to ITER shows that removing the carbon would decrease the long term retention by~50 allowing performing up to 2500 DT discharges with Q~10 before reaching the safety limit of T.