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EX/P5-23: Improvement of the Spectroscopic Investigation of Pellet Ablation Clouds

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In magnetic fusion devices, pellet injection is seen as a major technique for deep fuelling and plasma control by mitigating edge instabilities like ELMs or triggering ITBs. Owing to its high efficiency in burning plasmas compared to gas fuelling, pellet injection will be the primary core fuelling system for ITER. Usually H/D pellets are used to extend the operational regimes to higher densities without deteriorating the quality of the plasma confinement. In parallel, pellets made from other materials like C, Al and Ti are used for other purposes like impurity transport studies. During the pellet ablation process (˜3 ms), a high-density plasma forms around the pellet core (the so-called ablation cloud) and emits a strong line radiation. In this context, spectroscopy helps in understanding the ablation physics. For instance, one can obtain the pellet penetration depth from spectroscopic measurements. Line intensities are used to extract population densities of excited levels which are compared to theoretical values calculated at LTE. Except for H/D pellets, line emission is due to ions at different ionization stages. For carbon pellets injected in LHD, the radiation from the ablation cloud which is dominated by C II and C III lines, is used to determine its parameters. The ablation cloud temperatures are obtained assuming LTE for both ions while the electron densities are determined from the Stark broadening and the optical thickness of the C II 723 nm and C III 117 nm lines. A two-layer model is assumed for the ablation cloud: a small high-density layer surrounded by a larger and lower density layer. Up to now, the density of the high-density layer, was determined by fitting C II 723 nm spectra whose shapes are dominated by Stark effect. Although all splitting and broadening effects have been included in the line profiles used for fitting, the calculated profiles will be improved in this work by using more accurate Zeeman-Stark profiles calculated with the PPP line shape code. Such calculations are justified by more recent measurements in which both Zeeman splitting and Stark broadening were visible on the spectra of the C II 723 nm line. This will increase the accuracy of the deduced pellet ablation cloud parameters. The link between the ablation cloud characteristics of pellets and those of the main plasma in which they are injected will be discussed.

Country or International Organization of Primary Author

FRANCE

Primary author: Mr KOUBITI, Mohammed (France)

Co-authors: Dr ROSATO, Joël (PIIM UMR 7345 CNRS/Université d'Aix-Marseille, France); Prof. GODBERT--MOURET, Laurence (PIIM UMR 7345 CNRS/Université d'Aix-Marseille, France); Dr GOTO, Motoshi (NIFS, Japan); Prof. STAMM, Roland (PIIM UMR 7345 CNRS/Université d'Aix-Marseille, France); Dr FERRI, Sandrine (PIIM UMR 73PIIM UMR 7345 CNRS/Université d'Aix-Marseille, France); Dr MORITA, Shigeru (NIFS); Dr MARANDET, Yannick (PIIM UMR 7345 CNRS/Université d'Aix-Marseille, France)

Presenter: Mr KOUBITI, Mohammed (France)

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