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Stray light modeling for spectroscopy in ITER

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All plasma facing components of ITER will be made of metals during high-performance operation – tungsten in divertor and beryllium on the first wall. As a result, the reflection of light may play a significant role in spectroscopic measurements. Emissivity of some spectral lines from the divertor region could be by several orders of magnitude higher than those from elsewhere in the plasma volume, distorting measurements made in the main chamber. In this study, the influence of the stray light is modeled using the simulation code LightTools, and the impact of the stray light on the measurements is assessed quantitatively.

In Fig. 1, a schematic configuration of the model is shown, where a 20 degree toroidal sector was represented. Two perfect mirrors were limiting the boundaries of the sector and toroidal symmetry was assumed. A detector was installed at the equatorial port; the distance between the detector and the hole is 300 mm, and the size of the hole is 15 mm in diameter. In this report, one typical intensity profile from the scrape-off layer and divertor is shown on Fig. 2 for L-mode case assuming that the far scrape off layer (SOL) temperature is 10 eV and far SOL perpendicular velocity is 30 m/s. The emission from the SOL is very low while the emission from divertor is strong; the calculation would provide the worse case situation for stray light contamination in this case.

Figure 2 shows a comparison of the vertical intensity profile for H alpha at the receiver. A peak around 250 mm corresponds to the direct light from divertor. Several reflection models for ITER first wall tiles were used in the study: total absorption, i.e. no reflection; and 50 % absorption with specular reflectance fractions ranging from 0 to 49%. It is seen that the divertor stray light due to reflections is one to three orders of magnitude greater than the real emission from the main chamber sources. When the reflection is diffusive rather than specular, the stray light intensity profile becomes rather flat. Globally, the intensity due to divertor stray light can be roughly two orders of magnitude greater than the real signal intensity. Note that this is the worst case, and the divertor stray light signal can be comparable with the real signal intensity in other cases that have been investigated, in which the emission from the main chamber is higher.

To reduce the influence of the stray light, viewing dumps were embedded on the first wall and their effect was assessed. Three layered cylinders with a cone shaped bottom were used for the viewing dump in the simulation. Although the detailed results cannot be shown here, it was found that the viewing dumps can effectively decrease the stray light by an order of magnitude. However, it appears difficult to reduce the level of divertor stray light by more than two orders of magnitude with current dump design.

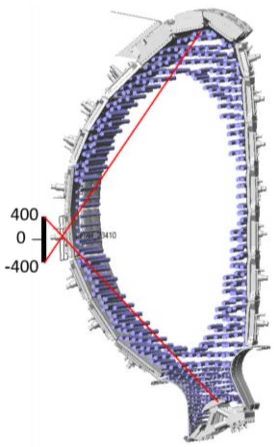

Figure 1: Schematics of the ray tracing model. Hundreds of sources are represented, distributed throughout the boundary plasma.

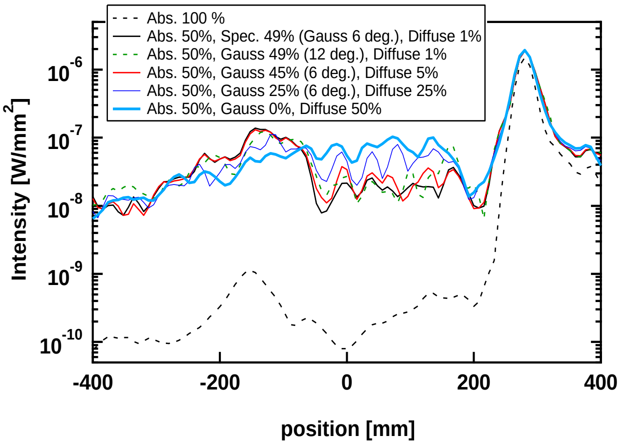

Figure 2: A comparison of the intensity profile at the detector. The emission from the divertor was taken into account.