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Ray trace study for visible spectroscopy reference system (VSRS) diagnostics in ITER

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The primary role of the visible spectroscopy reference system (VSRS) diagnostics is to measure the continuum visible light emitted by the ITER plasma, which provides information on the impurity content of the plasma and the potential transparency for neutral beam heating power. In the VSRS, it is planned to use a hole on the facing wall for an optical dump (OD). In this study, performance of the stray light reduction in the VSRS is investigated using a ray tracing simulations. One of the influential factors is the reflection property of the first mirror, on which deposition and erosion can change the property. In this study, the sensitivity of the reflection property on the first mirror is assessed using the simulation.

A 120 degree section model for VSRS was developed in the ray tracing simulation software LightTools (Synopsys, Inc.). The specular reflection (R_s) was defined by a Gaussian profile with a 1/e width, w_s, and the diffuse reflection (R_d) was defined by a Lambertian distribution. A retroreflector was embedded on the bottom of the hole on the blanket module (stainless steel). Different from pinhole configuration, which has been used to assess the stray light level in previous studies [1], collection optics was installed to the model to investigate the influence of the quality of the first mirror for the stray light reduction ratio.

Figure 1(a-c) shows the images for different reflectance property of the first mirror. In this calculation, the reflection property of the retroreflector mirrors were assumed to be R_s = R_d = 30% with changing w_s from 0.01 to 1 degree. The image was clear in Fig. 1(a) (w_s=0.01 degree), but the dark region became smaller in Fig. 1(b) (w_s=0.1 degree). Almost no retroreflector hole can be identified in Fig. 3(c) (w_s=1 degree). The result suggested that only small divergence of the field of view at the mirror angle distorts the image quality. This is understandable, because the distance from the first mirror to the retroreflector is ~ 13 m and the size of the retroreflector was 80 mm; roughly, the opening angle is 0.35 degree.

Figure 3(d) shows the stray light reduction ratio (SLRR) as a function of w_s. The SLRR is higher than 90% at w_s of 0.01 degree, and it decreases with increasing w_s when w_s is higher than 0.1 degree. When w_s is 1 degree, the SLRR decreases to 20%. The results suggested that the quality of the specular component is quite an important factor.

The results suggested that it is necessary to investigate the bidirectional reflectance distribution function (BRDF) or width of the specular reflectance after many discharges or plasma cleaning processes.

The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

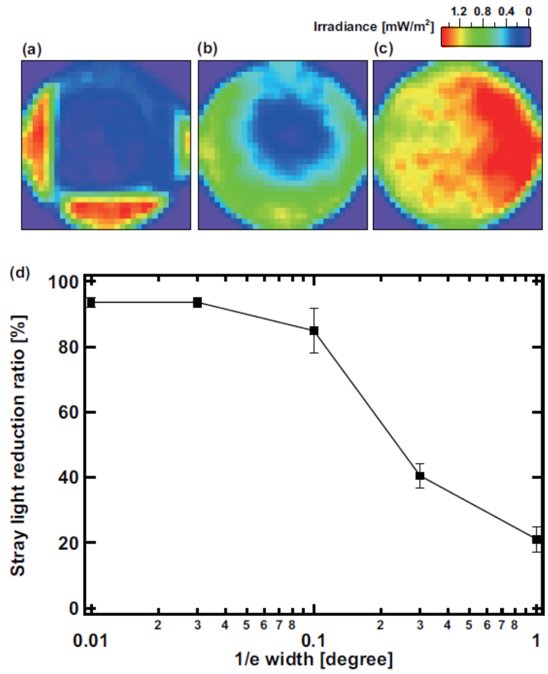

Figure 1: (a-c) Images for different reflectance property of the first mirror: the angle of the Gaussian for specular reflectance was (a) 0.01 degree, (b) 0.1 degree, and (c) 1 degree. (d) Stray light reduction ratio (SLRR) as a function of the 1/e width for the specular reflectance property.

Reference

[1] S. Kajita, *et al.*: Plasma Physics and Controlled Fusion 55 (2013) 085020.