Modeling of the EUV spectral response of the Full Sun Imager aboard Solar Orbiter

Jennifer Rebellato[1,2], Evgueni Meltchakov[1], Sébastien de Rossi[1], Xueyan Zhang[3], Frédéric Auchère[3] and Franck Delmotte[1]

[1] Laboratoire Charles Fabry, Institut d'Optique Graduate School, CNRS, Universite Paris-Saclay, 91127 Palaiseau cedex, France
[2] Centre National d'Etudes Spatiales, 18 Avenue E. Belin, 31401 Toulouse, France
[3] Institut d'Astrophysique Spatiale, CNRS, Universite Paris-Saclay, bât. 121, 91405 Orsay, France

The ESA Solar Orbiter is the next solar physics mission to be launched in February 2020. Its purpose is to study the solar corona close to the Sun (close as 0.28 solar radii) and out of the ecliptic (more than 30°) to image the poles with a much better resolution than ever. Understanding of the creation and the mechanisms of the heliosphere are the main motivations for this mission. The Extreme Ultraviolet Imager (EUI) is a suite of 3 complementary telescopes combining two extreme ultraviolet (EUV) and one Lyman-α imagers [1]. The Full Sun Imager (FSI) will be imaging alternatively at 17.4 nm (Fe IX/X line) and 30.4 nm (He II line), the High Resolution Imagers image respectively only at 17.4 nm (HRI-EUV) and at 121.6 nm (HRI-Ly-α).

In this work, we focus on the modeling of the spectral response of the FSI components including an Al entry filter, an Al/Mo/SiC dual-band multilayer mirror [2], two Al/Zr and two Al/Mg filters, as well as the spectral response of the entire instrument.

In order to calibrate the FSI telescope, the spectral response of each filter and mirror must be known over a wide EUV range from 1 nm to 100 nm to ensure that no other coronal emission line than those targeted would be detected. The efficiency of the FSI and the flight references for filters and mirror have been measured on synchrotrons (PTB, SOLEIL) and/or a laboratory qualification source (Institut d'Astrophysique Spatiale, Orsay). However, it was not possible to measure these components on the whole range from 1 nm to 100 nm. Therefore, we had to develop accurate simulations to fit the available experimental data and extend them over a wider EUV range. A global review of the tabulated optical constants in the EUV for materials used in such telescopes [3] led us to select the most accurate optical constants sets to model the spectral response of each component from 1 nm to 100 nm. Finally, we will compare the simulated and experimental values of the efficiency of the entire telescope over the EUV range. The effect of the uniformity of the dual-band multilayer mirror and filters on the FSI spectral response will also be discussed.

[1] P. Halain et al., "The extreme ultraviolet imager of solar orbiter: optical design and alignment scheme," in Proc. SPIE, Optical Engineering + Applications, San Diego, United States, 2015, vol. 9604, p. 96040H.

[2] E. Meltchakov et al., "Development of Al-based multilayer optics for EUV," Appl. Phys. A, vol. 98, no. 1, p. 111, Jan. 2010.

[3] J. Rebellato et al., "Analyses of tabulated optical constants for thin films in the EUV range and application to solar physics multilayer coatings," in Proc. SPIE, Advances in Optical Thin Films VI, Frankfurt, Germany, 2018, vol. 10691, p. 106911U.