A method of characterizing narrow-band filtered radiometers using synchrotron radiation

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Abstract. Synchrotron radiation is a primary source standard for a broad spectral range from x-rays to infrared [1,2] because synchrotron radiation can be accurately calculated by using the Schwinger equation and three parameters of the storage ring. In terms of spectral range, synchrotron radiation complements another primary standard source, black body sources, which are also calculable by using the Planck equation and temperature and emissivity. Beyond that, the two standard sources exhibit quite different characteristics. Black body source radiation is emitted in all directions uniformly with the same spectral distribution, whereas synchrotron radiation is highly concentrated in the direction parallel to the electron beam orbital plane. The angular divergence in this direction is also a strong function of the wavelength, i.e., narrower for shorter wavelength radiation and wider for longer wavelength radiation. Shown in Fig.1 is the calculated angular distribution for the storage ring of Synchrotron Ultraviolet Radiation Facility (SURF III). Typically, this phenomenon is treated as a complication and has to be dealt with carefully for radiometric applications.

Here, we propose a new technique by taking advantage of the calculable angular distribution of synchrotron radiation for the characterization of narrow-band filtered radiometers. For this technique, the narrow-band filtered radiometer under study will be used to scan the synchrotron radiation in the direction perpendicular to the orbital plane and the signal from the filtered radiometer versus the emitting angle of the synchrotron radiation is measured. Because the measured angular width depends on wavelength, one can deduce the mean wavelength of the filtered radiometer. In addition, because the incident synchrotron radiation can be accurately calculated, one can also derive the absolute integral response of the filtered radiometer. Currently, measurement of such quantities of a filtered radiometer requires very fine, and time consuming, spectral scanning of the filtered radiometer using a monochromator or, better, with a tunable laser and the transfer of the irradiance scale to the filtered radiometer. With this technique, the measurement is simple and fast. Furthermore, it can be used for any filtered radiometers in a broad spectral range from VUV to IR. We will provide detailed mathematical basis for this technique and the challenges involved in such measurements. Preliminary experimental results will be presented.

References

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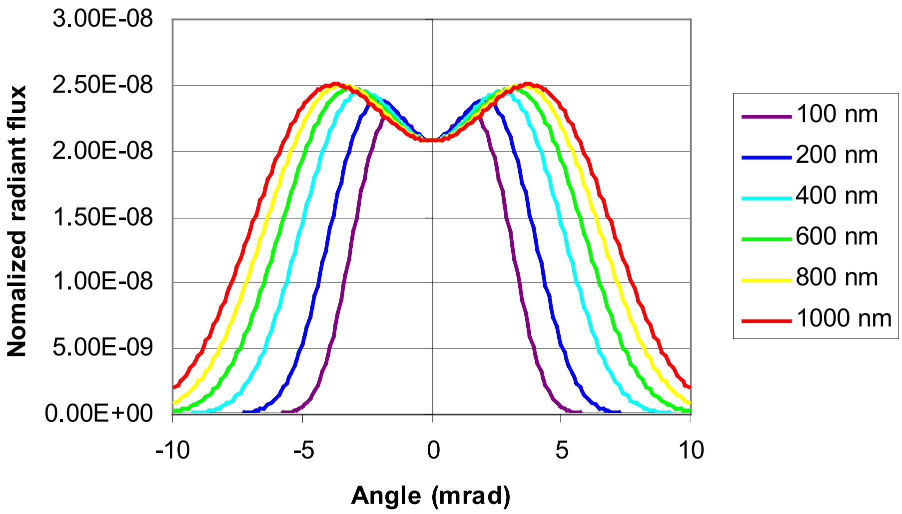

Figure 1 Calculated angular distribution of synchrotron radiation for different wavelengths using typical parameters of SURF III with 380 MeV electron energy and 84 cm of electron beam orbital radius.