DOUBLE-CONFOCAL RESONATOR FOR X-RAY GENERATION VIA INTRACAVITY THOMSON SCATTERING*

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There has been a growing interest in developing compact X-ray sources through Thomson scattering of a laser beam by a relativistic electron beam. For higher X-ray flux it is desirable to have the scattering to occur inside an optical resonator where the laser power is higher. In this paper I propose a double-confocal resonator design optimized for head-on Thomson scattering inside an FEL oscillator and analyze its performance taking into account the diffraction and FEL gain. A double confocal resonator is equivalent to two confocal resonators in series. Such a resonator has several advantages: it couples electron beam through and X-ray out of the cavity with holes on cavity mirrors, thus allowing the system to be compact; it supports the FEL mode with minimal diffraction loss through the holes; it provides a laser focus in the forward direction for a better mode overlap with the electron beam; and it provides a focus at the same location in the backward direction for higher Thomson scattering efficiency; in addition, the mode size at the focal point and hence the Rayleigh range can be adjusted simply through intracavity apertures; furthermore, it gives a large mode size at the mirrors to reduce power loading. Simulations as well as analytical results will be presented. Also other configurations of intracavity Thomson scattering where the double-confocal resonator could be useful will be discussed.

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