CHARACTERIZATION OF THE COHERENT MICROWAVE EMISSION FROM THE SURF II ELECTRON STORAGE RING

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The temporal profile and frequency spectrum of the microwave emission from the SURF II electron storage ring at the National Institute of Standards and Technology have been studied to assess the utility of SURF II for long wavelength spectroscopic applications. SURF II is a 300 MeV storage ring with two electron bunches of approximately 1 ns ($\sim$0.2 m) length. The microwave emission between 8 GHz to 18 GHz is dominated by intense $\sim$0.2 ms bursts of radiation, which are random in time at high electron beam currents and nearly periodic in time ($\tau \sim 10$ ms) at lower beam currents. The radiation is predominantly polarized in the plane of the ring, consistent with synchrotron emission. The intensity of the radiation is several orders of magnitude greater than that calculated for incoherent synchrotron emission. Spectrally resolved measurements using a 2 MHz resolution (FWHM) microwave heterodyne receiver reveal that the radiation bursts consist of intense peaks at frequencies corresponding to even harmonics of the orbital frequency of an electron bunch. The odd harmonics are less intense by more than an order of magnitude. The origin of these effects is attributed to oscillations of the electron bunch lengths due to electrical coupling of the two electron bunches. During the minimum of this oscillation the bunch length is comparable to the microwave wavelength, giving rise to short bursts of coherent emission. The effect of bunch length compression is significantly reduced as the frequency increases toward 18 GHz, and is expected to have a negligible effect on the radiation properties of the far infrared emission spectrum of SURF II.