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Coherent transition radiation in a microwave millimeter band from AWAKE modulated proton bunch

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AWAKE project at CERN is an international collaboration of many institutes worldwide and it aims to accelerate electrons in a plasma wake excited by SPS proton bunch. The length of the proton bunch is much longer then plasma wavelength 1-3 mm for the considered plasma concentration (1-10)e14 cm-3, and various numerical simulations showed that charge density within a bunch tends to be radially (not longitudinally, no micro-bunches in a common sense) modulated with a plasma wavelength at the output of a 10 meter long plasma.

The experimental observation and quantitative analysis of a proton bunch radial density modulation would be an experimental proof of the efficient plasma wake excitation. Besides incoherent optical methods mainly based on streak camera measurements, the coherent transition radiation (CTR) detection technique in millimeter microwave range gives an access to a time-dependent information of the modulation vs. time.

The aim of this work is to calculate the yield of CTR for the real AWAKE experimental conditions. Calculations based on different approaches (simple Frank-Tamm formula, exact vector diffraction theory) are compared, far / near CTR field distribution as well as a finite target screen size are considered.

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