

THz diagnostics for the plasma density and charged particle self-modulation measurement in AWAKE experiments

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Plasma wakefield acceleration (PWFA) experiments using CERN SPS proton bunches are now under development within the AWAKE-collaboration. A density uniformity on the order of 0.2% is required to maintain the witness electrons on the accelerating and focusing phase of the wakefields. Fast and precise methods for single shot plasma density measurements with time windows of about 100ns are necessary. One method under study is the measurement of the cut-off at the electron plasma frequency. For the PWFA experiments the plasma electron density should be tunable between 10^{14} and 10^{15} cm⁻³, resulting in cut-off frequencies of 90GHz to 300GHz, respectively. To achieve a density sensitivity of 0.2% the cut-off frequency must be measured with a resolution better than 100MHz at 10^{14} cm⁻³. Two schemes for broadband microwave generation and detection are proposed: chirped photo-mixing and THz-time domain spectroscopy. As an alternative method optical emission spectroscopy is also investigated.

In addition, the dispersive Fourier Transformation and time stretching methods are studied for single shot measurements of proton bunch modulation in frequency domain. The conceptual ideas, initial simulations, the experimental setup and preliminary measurement results will be presented.

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