

# Transformer Ratio Studies for Single Bunch Plasma Wakefield Acceleration

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In the Plasma Wakefield Acceleration (PWFA) plasma oscillations are driven by ultra relativistic electron beams. The ratio of the maximum accelerating field behind the driving beam (bunch) and the maximum decelerating field inside the driving beam (bunch) is defined as Transformer Ratio, a key parameter that determines the energy gain in particle acceleration.

We investigate the transformer ratio for different shapes of a single driving bunch: one dimensional simplified, fluid, relativistic, cold plasma equations have been numerically solved. A complete map of the transformer ratio is obtained varying: bunch shape, bunch length and density ratio. The systematic scan highlights that the transformer ratio critically depends on the bunch shape and on the density ratio. Moreover the same systematic scan both in the linear as well as in the non-linear regime clearly verifies how the theoretical limit of 2 for the transformer ratio can be easily exceeded in the non-linear regimes for specific shapes.

The simplified model easily permits to find an optimal working point and can be straightforwardly extended to optimize the resonant multi-bunch wakefield excitation.

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