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TNSA proton maximum energy laws for 2D and 3D PIC simulations

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TNSA numerical simulations have many uncertainties, due to the large arbitrariness in input parameters, besides huge computational costs for 3D. The energy spectrum of the accelerated particles is exponential with a cut-off and is correctly reproduced, but the maximum energy obtained depends on many user-chosen parameters, for example the simulation end time. The growth in time of the maximum energy follows different laws in 2D and 3D, the former following a logarithmic growth while the latter converging to an asymptotic value: the determination of an ultimate value is often arbitrary. In a recent paper, we proposed two laws for these rise in time of the cut-off energies: we have considered both a 2D model in which the surface charge is located on a strip with infinite length and a 3D model in which the surface charge is located on a disc. Fitting simulation results with the appropriate law, one can obtain the a more robust numerical cut-off energy. Our method can give a more insightful meaning to 2D simulations and also allows to stop 3D simulations quickly, using our law to obtain the maximum energy asymptotic value without reaching it.

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