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Macroparticle merging algorithm for PIC MARIJA VRANIC, THOMAS GRISMAYER, JOANA L. MARTINS, GoLP/Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de, RICARDO A. FONSECA, DCTI/ISCTE Instituto Universitário de Lisboa, 1649-026 Lisbon, Portugal, LUIS O. SILVA, GoLP/Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de — With the development of large supercomputers (>1000000 cores), the complexity of the problems we are able to simulate with particle-in-cell (PIC) codes has increased substantially. However, localized density spikes can introduce load imbalance where a small fraction of cores is occupied, while the others remain idle. An additional challenge lies in self-consistent modeling of QED effects at ultra-high laser intensities ($I > 10^{23}$ W/cm^2), where the number of pairs produced sometimes grows exponentially and may reach beyond the maximum number of particles that each processor can handle. We can overcome this by resampling the 6D phase space: the macroparticles can be merged into fewer particles with higher particle weights. Existing merging scheme [1] preserves the total charge, but not the particle distribution. Here we present a novel particle-merging [2] algorithm that preserves the energy, momentum and charge locally and thereby minimizes the potential influence to the relevant physics. Through examples of classical plasma physics and more extreme scenarios, we show that the physics is not altered but we obtain an immense increase in performance.

[1] A. N. Timokhin, Mon. Not. R. Astron. Soc. 408 (2010)
[2] M. Vranic, T. Grismayer, et. al., to be submitted (2014)

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