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**Numerical Uncertainty Estimation for Stochastic Particle-in-Cell Simulations Applied to Verification and Validation**[1]

KEITH CARTWRIGHT, Sandia National Laboratories

Numerical error estimation is a key component in verification, validation, and uncertainty quantification. For ParticleIn-Cell (PIC) plasma simulations, error estimation is complicated due to the presence of stochastic noise and multiple convergence parameters (grid size, time step, macro particle weight). In this talk, we will discuss recent developments for the Stochastic Richardson Extrapolation Based Error Quantification method (StREEQ). This method at its core is a multi-regression technique, where nine regression models and multiple bootstrap samples propagate uncertainties due to the fit and the stochasticity of the underlying data for an appropriate error model with unknown convergence rates. Recently, automation of the convergence parameter domain selection has been implemented; this enables efficient error estimation for large data sets, including analysis of multiple quantities of interest and time dependent data. This method is demonstrated for verification of both steady and time-periodic electron diodes, as well as validation of radiation generated plasma in an end-radiated cylinder.

In collaboration with Gregg Radtke, Sandia National Laboratories.

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