

Microparticle cloud diagnostic (MCD) for data-driven plasma experiments

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Data-intensive discovery and technology development is sometimes known as the ‘fourth paradigm’, extending three previously established approaches: empirical or try-and-error, fundamental-physics-law based, and computationally intensive methods. Both experimental and simulation data are growing explosively in plasma science and technology, providing ample opportunities for discoveries and inventions. Here we describe recent progress in developing a microparticle cloud diagnostic (MCD) for laboratory plasma experiments. The microparticle cloud is created by sending a pulsed electric current through a metal wire of different thicknesses, lengths, and material composition. The wire explosively turns into a molten incandescent microparticle cloud with hundreds of particles of different sizes that can be tracked with high-speed imaging cameras. Analysis of the time-dependent microparticle trajectories give time-dependent three-dimensional (and therefore 4D) information about the ambient environment. The massive image and particle track data motivate development of machine-learning techniques for information extraction. Some initial results are highlighted. Possible applications of MCD include studying the Debye-length scale physics in plasmas.