Targeting Cancer with High Power Lasers

T. Kluge, M. Bussmann, A. Huebl, R. Widera

At Helmholtz-Zentrum Dresden Rossendorf (HZDR), research focuses on making laser-driven ion beams available as compact sources for ion beam therapy of cancer. This research is part of a national translational research program together with the National Center for Radiation Research in Oncology (OncoRay). In order to reach deep seated targets, a high ion kinetic energy is needed, exceeding the energies currently achievable with high-power lasers. Thus research is focusing upon pushing the limits.

Here we present simulations of experiments on micron-scale droplets which compared to conventional targets have small mass that can completely be pushed forward by the laser.

With our 3D particle-in-cell code PIConGPU we perform for the first time realistic 3D simulations that take into account picosecond pre-pulse effect, full 3D geometry of the target, few femtosecond-interaction with the laser and attosecond plasma response physics. The multiscale physics necessitates high spatial and temporal resolution of the simulation which in turn makes long-time stability of the code and particle definition and storage a demanding task. A typical 3D run thus takes approx. 8k GPUs with 12 MCPUh and 100TB accumulated data each. For parallel and compressed output we implemented ADIOS, achieving up to 5 times less file I/O size and 25% gain in CPUh, allowing for a 4 times higher temporal resolution in our simulation.