Simulation of Laser Powder Bed Fusion (L-PBF) using CUDA

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Outline

Introduction

A multiphysical modeling approach has been employed to simulate the selected laser sintering (SLS) process for a single layer of particles. A discrete element approach was implemented using CUDA to model particle-to-particle and particle-to-wall mechanical and thermal interactions. The modeling approach can be characterized in two parts.

1. Dynamic simulation of the deposition of the powder particles.
2. Thermal simulation of the temperature evolution of the particles after a single pass of a laser beam.

All the codes are uploaded to below Github repo.

`https://github.com/zhangyaqi1989/Simulation-of-LPBF-using-CUDA.git`

CUDA (Dynamic)

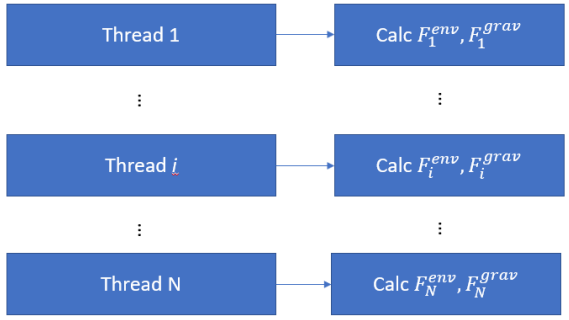

Figure: Dynamic simulation parallelism schematic: each thread calculate its environmental drag and gravity

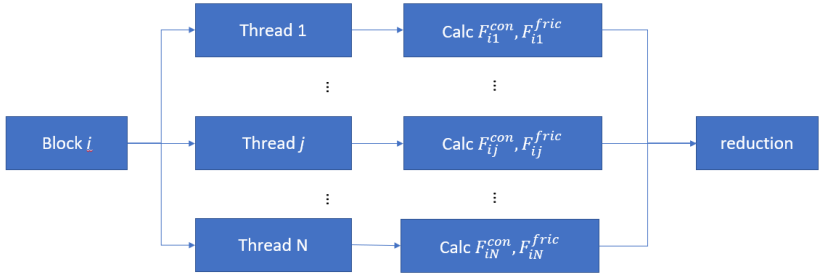

Figure: Dynamic simulation parallelism schematic: each block correlate to a particle, each of its thread calculate a potential collision pair with other particles

Dynamic simulation

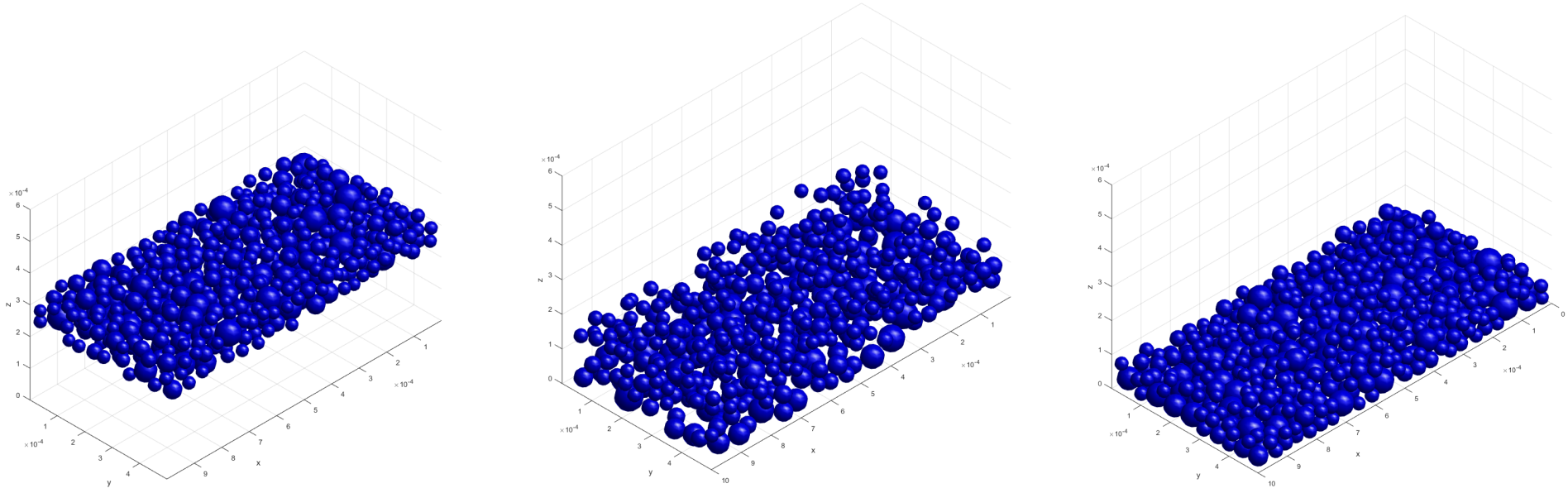

Figure: 512 Particles at $t = 0$, $t = 0.07$, $t = 0.3$

Scaling analysis (dynamic)

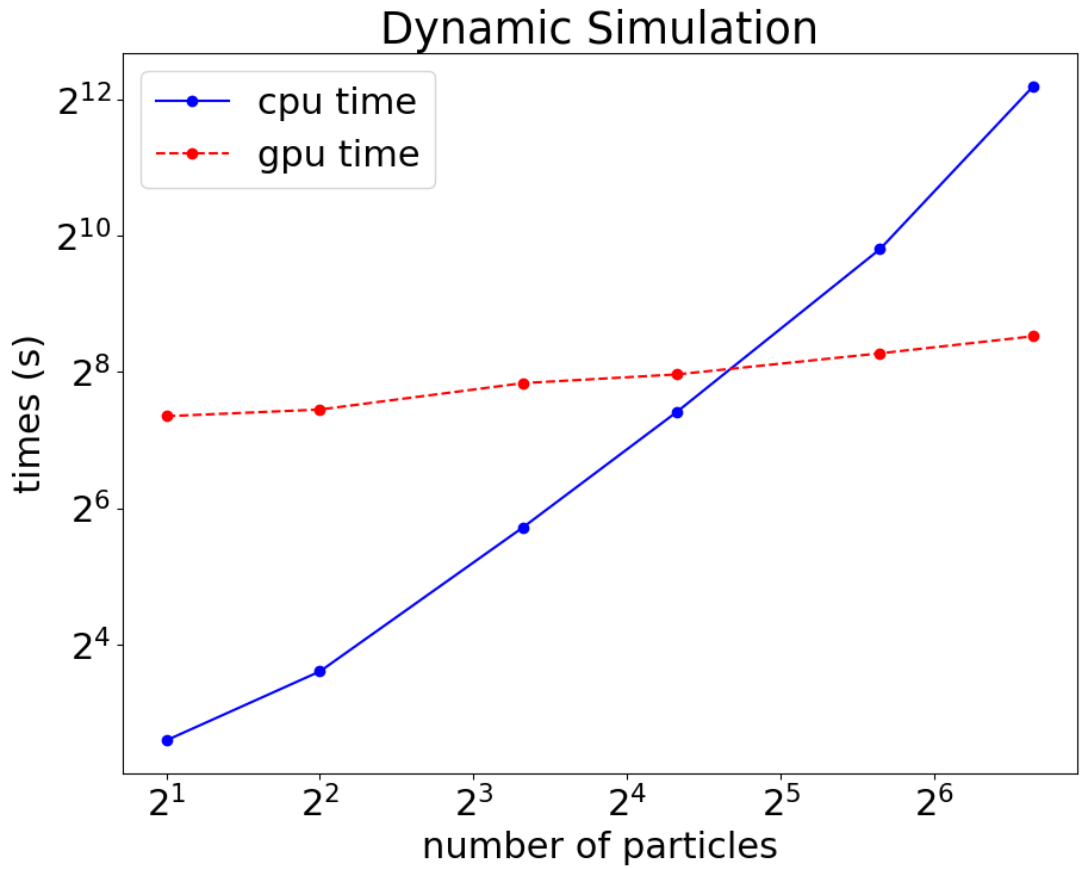

Figure: Comparison of CPU and inclusive GPU time. (CPU: Intel Core i7-6500; GPU: NVIDIA GeForce GTX 980Ti)

CUDA (thermal)

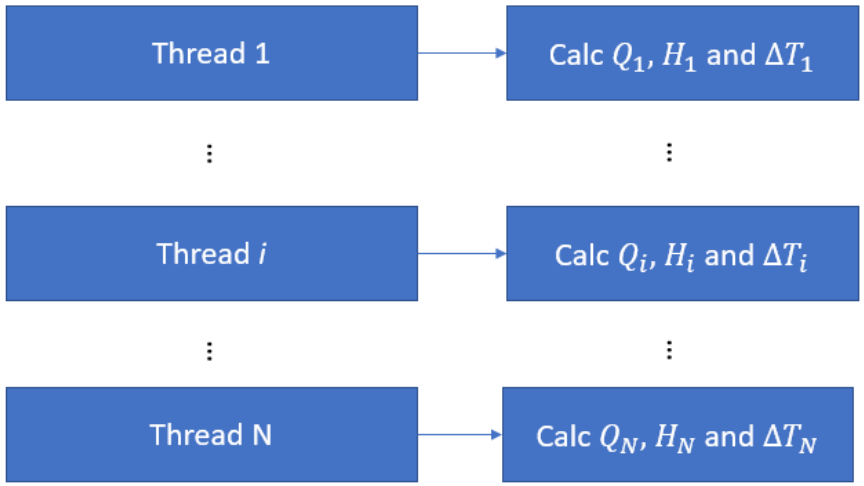

Figure: Schematic of CUDA parallelism for thermal simulation

Thermal simulation results (1)

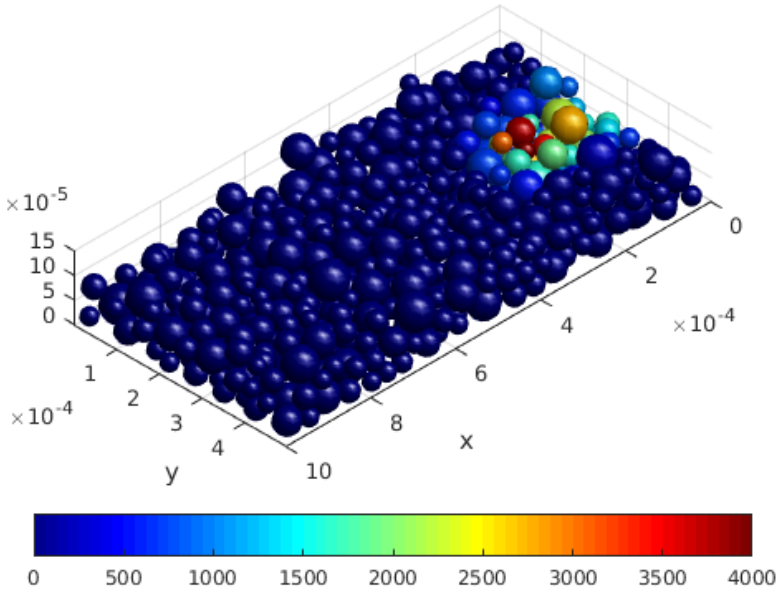

Figure: Screenshot at (# of steps = 20,000) showing the temperature evolution of a layer of 316L SS particles as a laser is passed over (temperature in K)

Thermal simulation results (2)

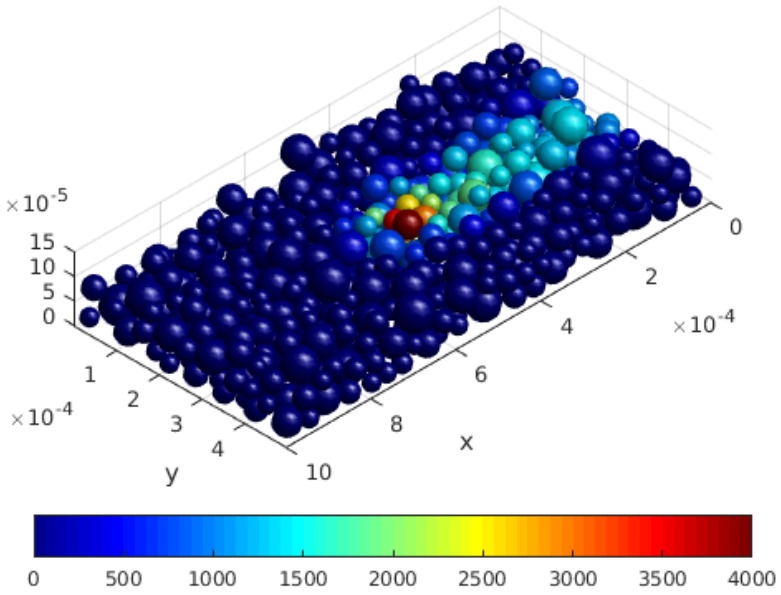

Figure: Screenshot at (# of steps = 50,000) showing the temperature evolution of a layer of 316L SS particles as a laser is passed over (temperature in K)

Thermal simulation results (3)

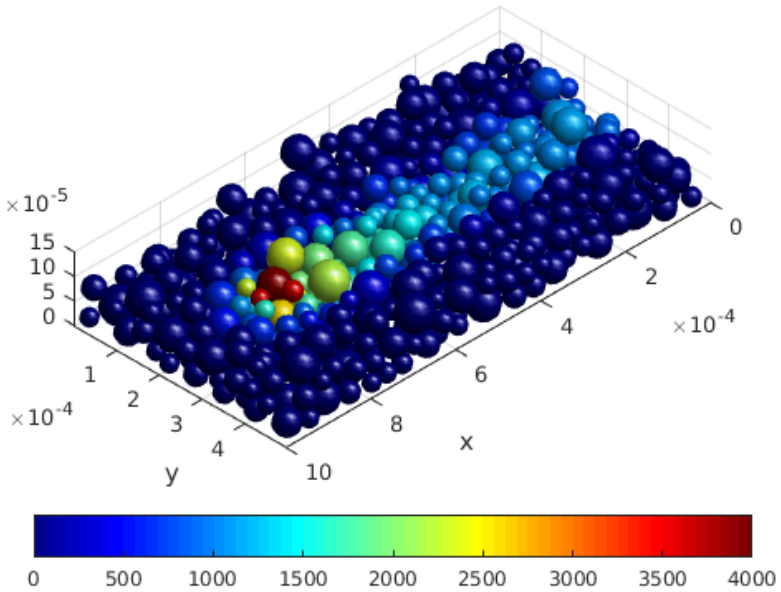

Figure: Screenshot at (# of steps = 80,000) showing the temperature evolution of a layer of 316L SS particles as a laser is passed over (temperature in K)

Scaling analysis (thermal)

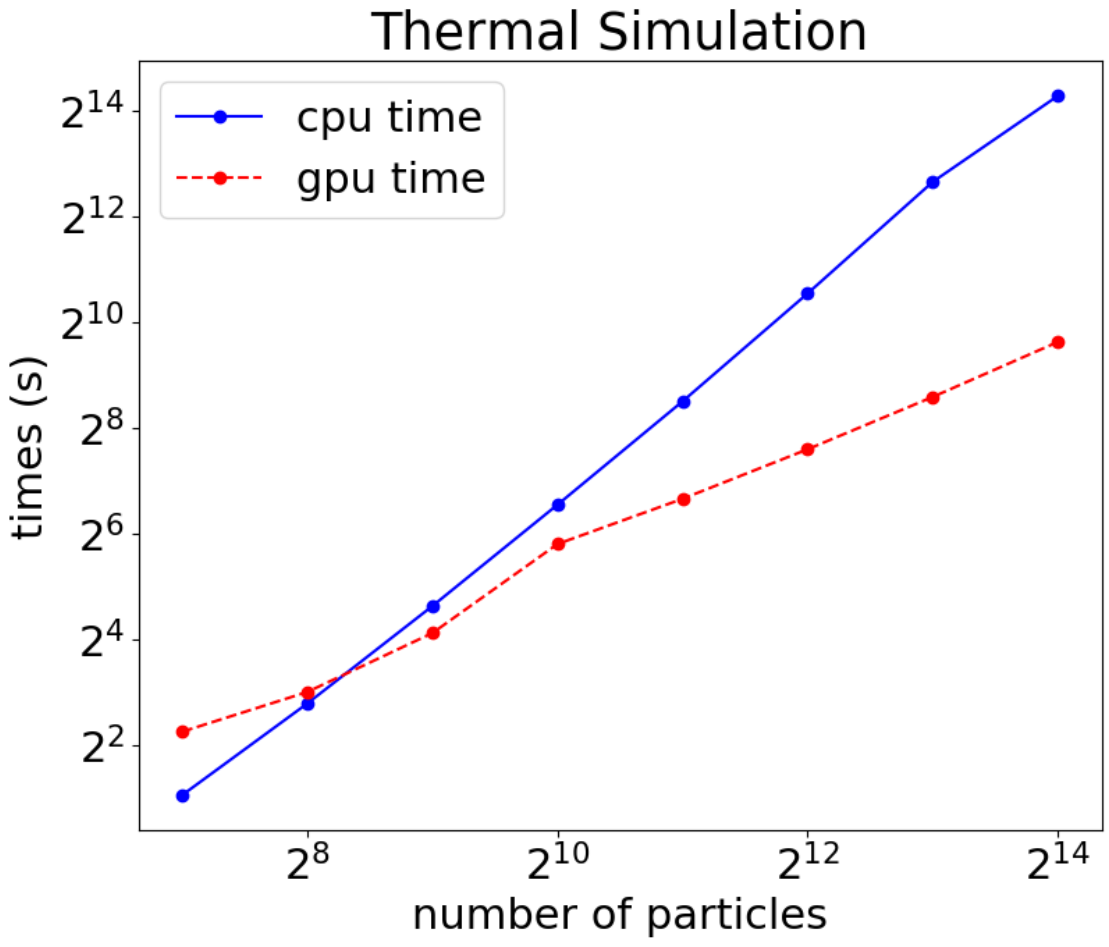

Figure: Comparison of CPU and inclusive GPU time. (CPU: Intel(R) Xeon(R) CPU E5-2650 v3 @ 2.30GHz; GPU: NVIDIA GeForce GTX 1080)