PAUL SCHERRER INSTITUT

PSI

Matthias Frey :: PhD student :: Paul Scherrer Institut

Exascale Amr SolvER (ErASER)

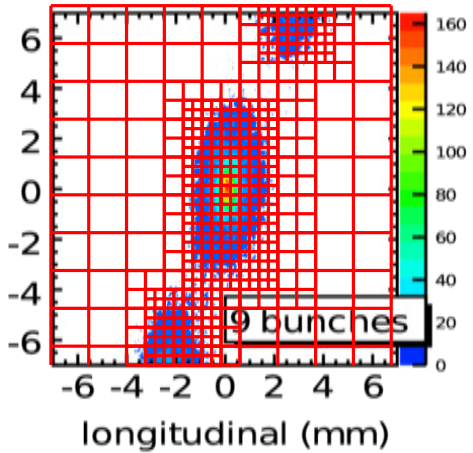
05/10/2018 :: EuroHack18 GPU Programming Hackathon

Thesis advisor: Prof. Dr. Klaus S. Kirch
Thesis supervisor: Dr. Andreas Adelmann

Problem Description

- Large scale N-body problems of $\mathcal{O}(\mathbf{10^9...10^{10}})$ **particles** coupled with Maxwell's equations
- Adaptive Mesh refinement Particle-In-Cell (PIC) models fine mesh of $\mathcal{O}(\mathbf{10^6...10^8})$ **grid points**

Yang, J. J., Adelmann, A., Humbel, M., Seidel, M., and Zhang, T. J. (2010). Beam dynamics in high intensity cyclotrons including neighboring bunch effects: Model, implementation, and application. Phys. Rev. ST Accel. Beams, 13:064201.



Implementation Overview

- Implemented fully in Trilinos with **2nd generation packages**, i.e.
  - Tpetra (matrix / vector data structure) $\rightarrow$ **Kokkos**
  - Ifpack2 (smoothers e.g. Gauss-Seidel, Jacobi)
  - MueLu, Amesos2, Belos (linear solvers)
- Kokkos allows **portable code** between hardware architectures **without changing your code!**
  - GPU
  - OpenMP / PThreads / serial

Status

- Before Hackathon:
  - working CPU-multrigrid solver
  - compiled Trilinos-GPU version
- At Hackathon:
  - compiled GPU mini-app
  - ran single GPU-node
  - tried to improve matrix setup

Results & Comments

- Result:
  - small test $> 4\times$ slow down
  - Kokkos-issue `https://github.com/kokkos/kokkos/issues/1831`
  - trial of improvement using Tpetra-Graph slowed down matrix setup even further ($2\times$)
- Comment:
  - nvcc sometimes unhappy with my C++
  - dependency on other libraries is a pain