PAUL SCHERRER INSTITUT

PSI


Matthias Frey :: PhD student :: Paul Scherrer Institut

# Exascale Amr SolvER (ErASER)

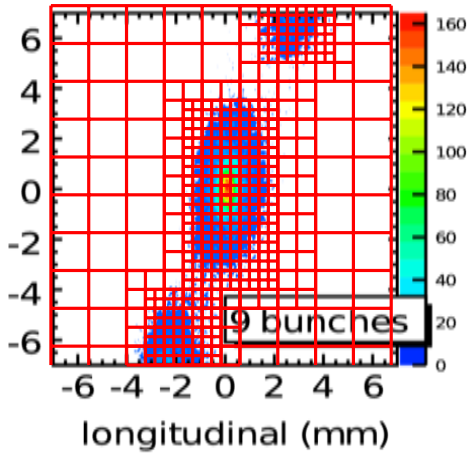
02/10/2018 :: EuroHack18 GPU Programming Hackathon

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

# Problem Description

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

# Current Status & Plan

- We're able to ...
  - run the mini-app on $> 10'000$ cores
  - compile Trilinos with GPU support
  - compile the mini-app with GPU support
- We're planning to ...
  - get it to run with GPUs
  - do a performance study of the solver
  - run a 2D/3D Landau damping example (challenge: memory usage $\gg 120$ GB)