

Self-consistent Modeling Of Coherent Synchrotron Radiation From Electron Beams In Bunch Compressors



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<https://github.com/lanl/cosyr.git>

Abstract

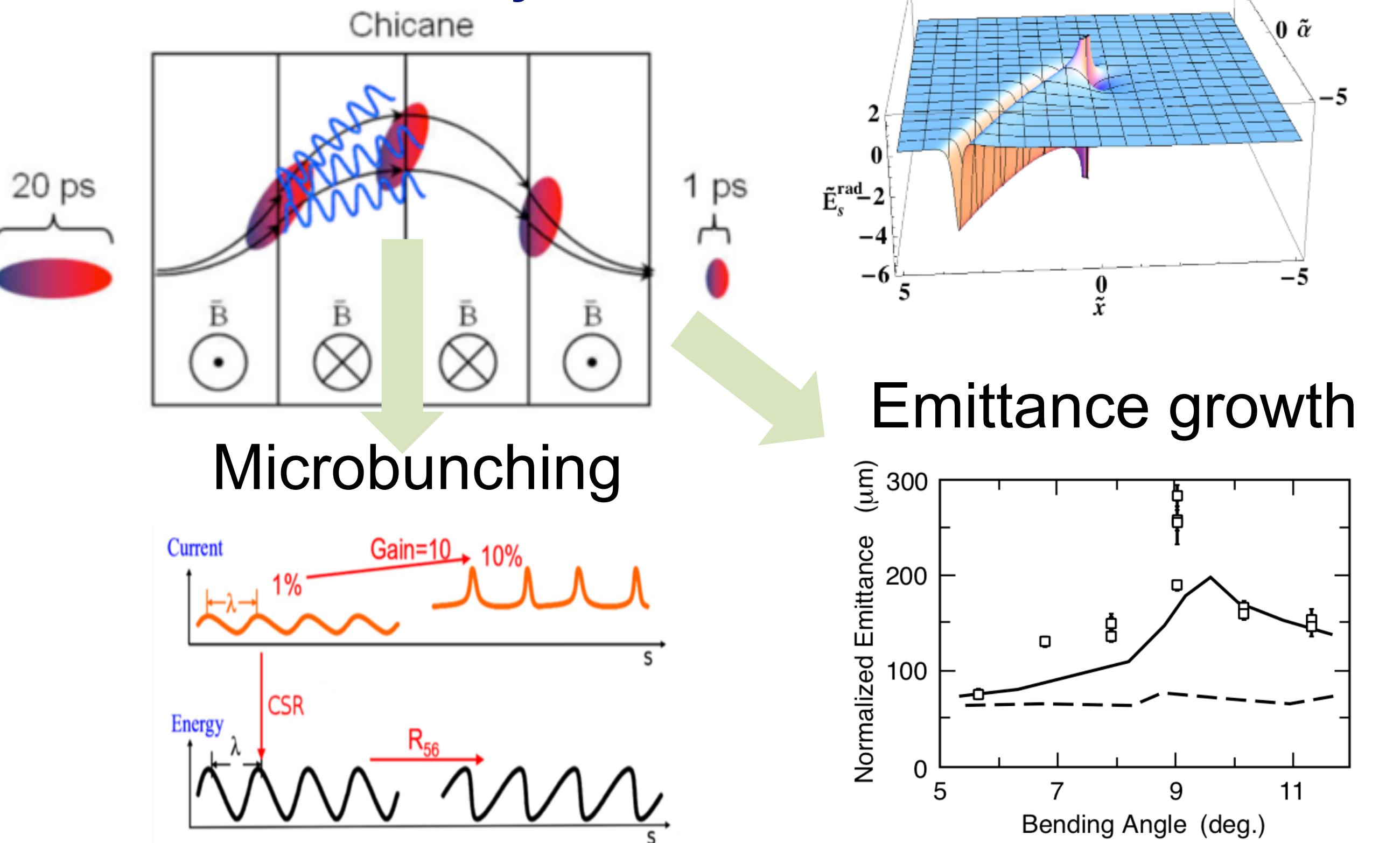
The self-consistent nonlinear dynamics of a relativistic particle beam interacting with its complete self-fields is a fundamental problem underpinning many of the accelerator design issues in high brightness beam applications, as well as the development of advanced accelerators. Particularly, synchrotron radiation induced effects can lead to collective beam instabilities and emittance growth. We are developing a novel Lagrangian method for the calculation of the particles' radiation near-fields on adaptive meshes, which are then interpolated onto a global mesh. This method allows simulation of radiation co-propagation and interaction with the beam at greatly reduced errors. Multiple levels of parallelisms inherent in this method are implemented in our code CoSyR to enable at-scale simulations of the nonlinear beam dynamics on modern computing platforms using MPI, multi-threading, and GPUs. CoSyR has been benchmarked with other coherent synchrotron radiation models and used to evaluate the transverse and longitudinal effects on the beam. Beam optics designs proposed for the mitigation of beam brightness degradation in a magnetic compressor are also investigated and discussed.

Introduction

Synchrotron radiation and 3rd/4th generation light sources

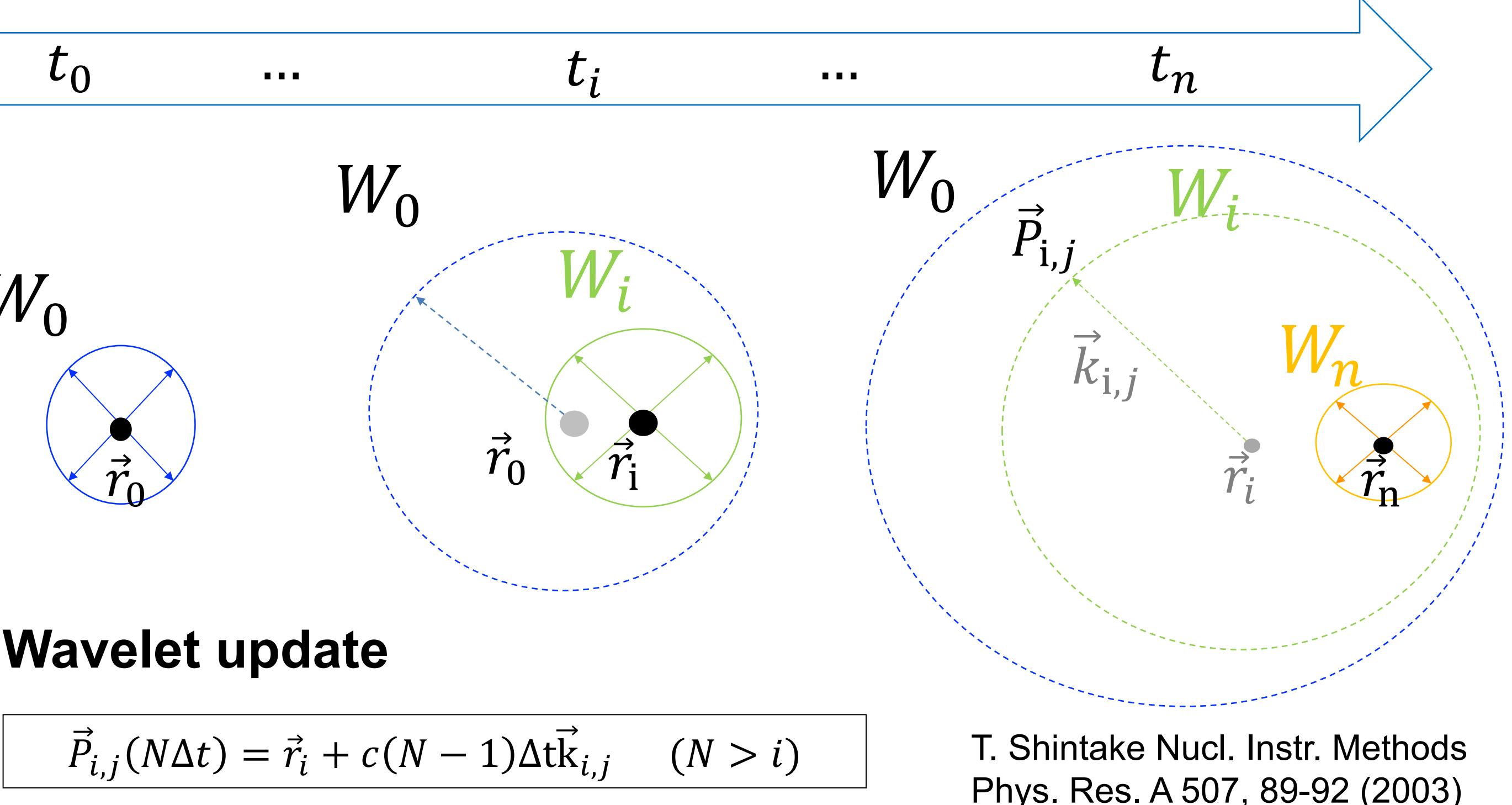


CSR and beam dynamics

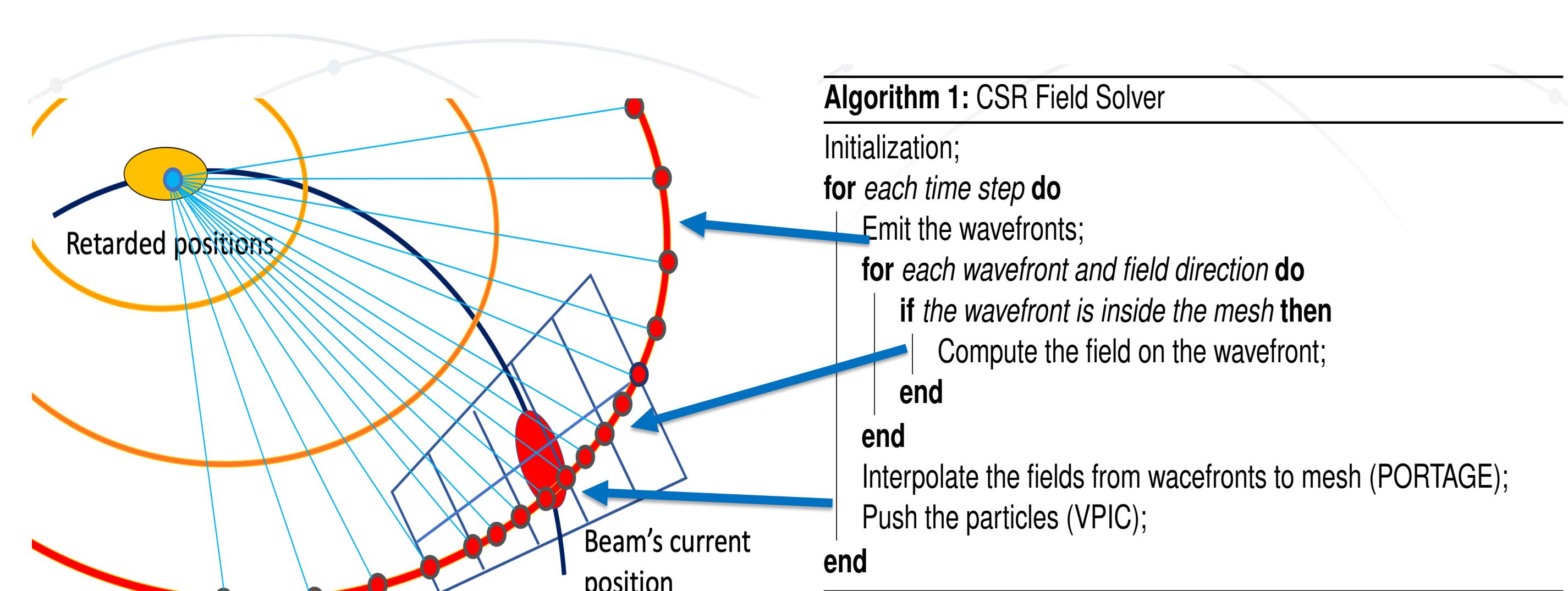


CoSyR: a novel CSR code

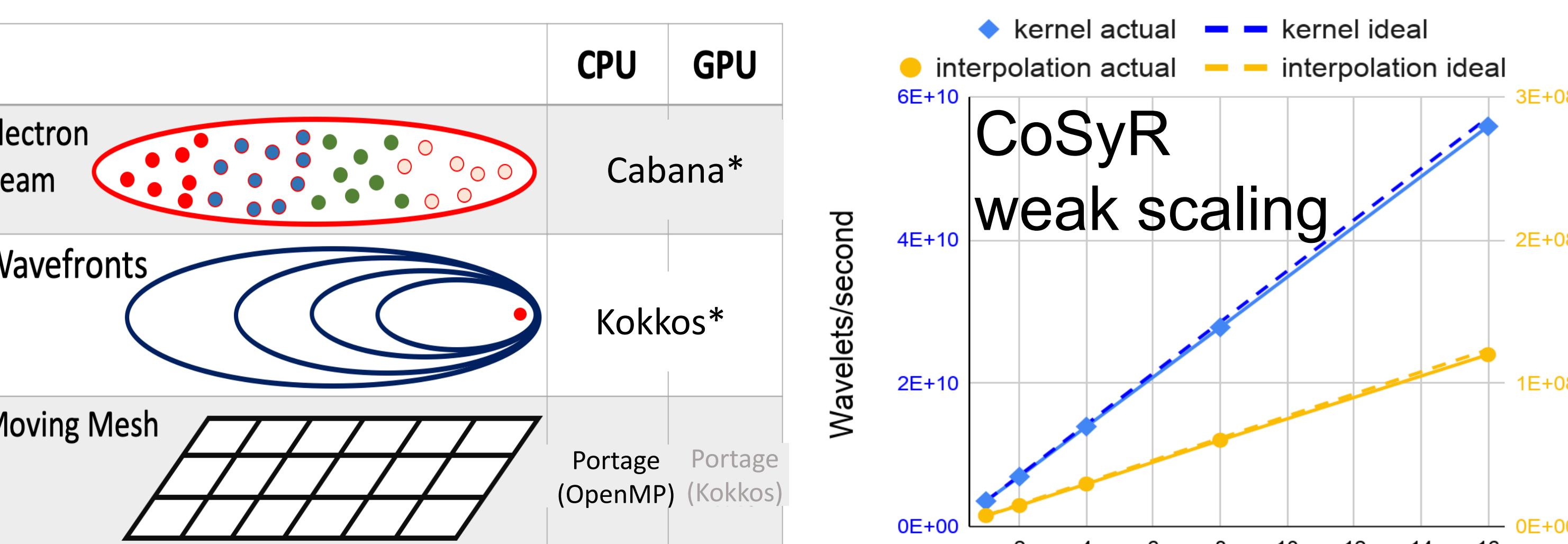
Near-field radiation on wavefronts



Code structure



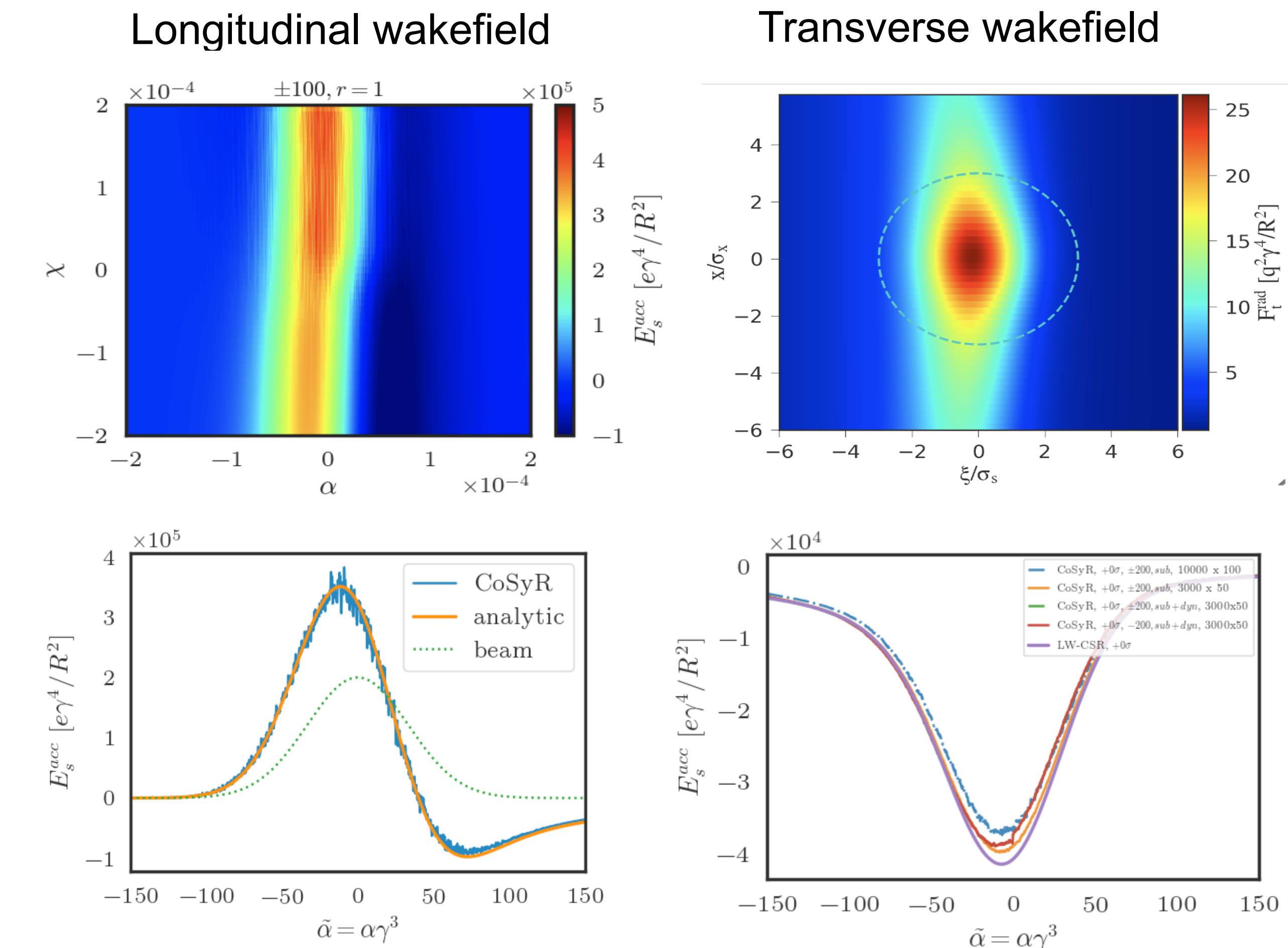
Parallelization and performance



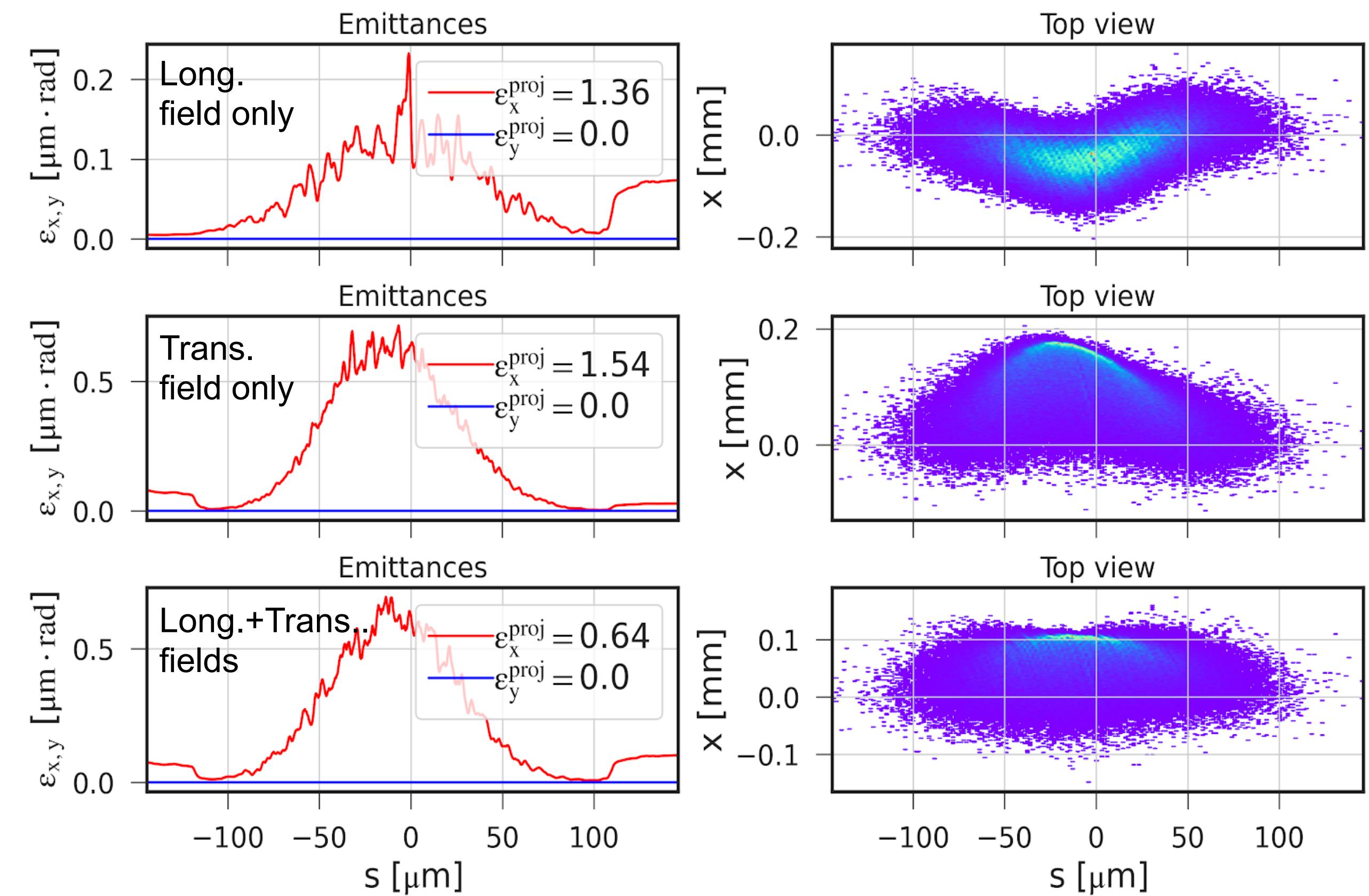
* Kokkos, CoPA-Cabana are DOE ECP projects supporting major platforms (CPU/GPU/KNL/ROCm)

Benchmarks

Round beam (200umx200um, 50MeV)



Simulations for longitudinal & transverse CSR effects



Microbunch CSR fields

