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## Improved symplectic particle tracking for modern vectorized architectures

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With modern accelerators encountering new physics regimes, 'elegant' code has added elaborate models of fringe fields, impedances, longitudinal gradient dipoles, and other elements to improve simulation accuracy. However, advanced models come with computational cost penalties. Fundamentally, elegant tracking is serial –it applies models to one particle at a time, preventing many compiler optimizations. This architecture is also inefficient on modern hardware because of two recent trends –a reduction in memory bandwidth per-core and strong push for vectorization (AVX-512, GPUs) to improve throughput. This paper describes our work on overhauling core symplectic tracking routines into a vectorized pipeline that works on 'tiles' of particles with size optimized based on cache size, element type, and other factors. We will show tests of HPC libraries like Kokkos, as well as hand-tuned AVX-512 intrinsics, and discuss profiling and testing techniques for finding bottlenecks. Overall, we archive a 2.5x speed-up in symplectic tracking, along with improved memory layout for future work, saving millions of core-hours on APS-U simulations.

### Footnotes

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**Primary author:** KUKLEV, Nikita (Argonne National Laboratory)

**Co-author:** BORLAND, Michael (Argonne National Laboratory)

**Presenter:** KUKLEV, Nikita (Argonne National Laboratory)

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