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Jean-Luc Vay – Report on the WARP code/framework/module

Talk (some keywords/notes)

WARP: PIC modeling of beams, accelerators and plasmas.
Electrostatic solver supporting multi-grid and AMR (adaptive mesh refinement) and full electromagnetic solver.
Parallel 3D solver scaling linearly up to 10^5 CPUs.
Sample applications: space charge dominated beams, beam dynamics in rings, multi charge state beams, electron cloud effects, multi-pacting, lase plasma acceleration, 3D coherent synchrotron radiation (in development), free electron lasers (in development).
Remark on the emittance computation: AMR (adaptive mesh refinement) allows to recover the results of a high-resolution grid, with a speedup of 10.
UMER: scaled model for space-charge dynamics – fully described in WARP (UMERGeometry WARP module). Successes with UMER: transverse, longitudinal, three-dimensional dynamics.
WARP and Posinst integrated in a modular package. Enables fully self-consistent modeling of electron cloud effects: build-up and beam dynamics.
For e-cloud effects, comparisons made with experimental data, collaboration with SLAC and CERN.

Remark/discussion from Jean-Luc: collaboration between the codes. Sharing between WARP and Posinst already existent. Further sharing could enhance capabilities and reduce duplications. Some codes have Python modules and collaboration between them would be possible *via* these Python frontends. Modularity should be much higher than with PTC/Orbit as it is now.

- *Remark from audience:* One should be careful using somebody else code potentially developed for a more specific application. Dangerous.
- *Question:* What format is used to describe the lattice or the particles coordinates (following Jean-Luc statement about sharing data structures with pointers)?
    - ⇨ Common format should be discussed.

Concluding remark again about collaborative development of codes.

Questions

- Stitching codes together with e.g. Python interface. What is the impact on massively parallel aspects?
    - ⇨ For example for e cloud simulations there is a class (in warp) handling this with MPI.
- Possibility of handling electron cooling in WARP?
    - ⇨ Yes, uses a routine in ICOOL. ICOOL based on Geant4.

Stephen Webb – Space charge effects in nonlinear integrable lattices: mitigation of halo formation

Talk (some keywords/notes)

Linear lattices
Integrable behavior, but… resonances and tune spread.
Nonlinear decoherence versus Landau damping
Definition of Landau damping. Example with a pure quartic oscillator. This Hamiltonian is Integrable and has a huge tune spread. With an added resonant term, it is not integrable but the motion is bounded. Distinction with Landau damping.

- ⇨ *Discussion about Landau damping:* for later.

Nonlinear integrable optics
Hamiltonian becomes a conserved quantity (s-independent), with bounded orbits. Nonlinear integrable optics, including a linear harmonic oscillator, plus a strongly nonlinear part.

- ⇨ *From a question of Giuliano*: the sensitivity to perturbations is not big, even if the integrability is lost the invariants is still close to be conserved.
- ⇨ *Question*: what is the actual shape of the potential? The picture shown in slide 15 is not quite clear.

One problem is to find a matched beam distribution that is not filamenting. General KV-type distribution leading to a generalized notion of emittance for these kind of beams. It is stationary in the zero space charge limit.
Halo formation
First, overview of halo formation in a linear lattice. In the integrable nonlinear lattice there is no halo formation in a space charge regime.

- *Question*: how to characterize space charge in that case?
  - ⇨ Not with a simple tune shift formula… Because the beam is really not “round”.

Questions

- *Question from Giuliano:* Link with MTE? Strong detuning to confine the motion ?
- *Question about Landau damping*. There is a tune spread (coming for example from an energy spread) in the first simulation. The other case is non-integrable lattice case.
- *Question:* Extension to 6D?
  - ⇨ Fermilab is building a test machine… Synchrotron motion will break the integrability.
- *Remark from Alexei:* In this case we still have the concept of phase space density. We may then compare standard linear optics with this nonlinear integrable one. Comparing results for halo and also add *e.g.* resisitive impedance to see what is the threshold impedance. Very different thresholds would be a huge result.