ILC Beam Physics Simulation in AMR/CD

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Outline (P.L.)

- Low Emittance Transport (LET) in the Main Linac.
  - **The preservation of the transverse emittance is a necessary condition for high luminosity of the collider**
  - **“Parasitic”: ... details could (or simply don’t) matter**
- Simulation Tools & Benchmark Studies.
  - **Software Frameworks:**
    - FNAL (CHEF) + other institutions + Industry.
  - **Computing System**

Outline (P.S.)

- Damping Ring Simulation.
  - **Collective effects: Electron Cloud.**
- SuperConducting Crab Cavity Simulation.

The Team

- Joint Effort with TD and AD:
  - **in AMR/CD:**
    - Gustavo Cancelo, LLRF Simulation.
    - Lynn Garren: Code Benchmark, CHEF support & porting to MAC
    - Valentin Ivanov: Beam steering algorithm in linear systems, Crab-cavity simulation.
    - Paul Lebrun: Benchmark on LET, Steering algorithms
    - Leo Michellotti : CHEF development.
    - Panagiotis Spentzouris: Damping Ring, e-cloud.
  - **In TD and AD :**
    - M. Church , Kirti Ranjan, N. Solayk, Alex Valishev,
  - **Integrated into the ILC Beam Physics group**
    - Leaders: Kiyoshi Kubo (KEK), Daniel Schulte (CERN)

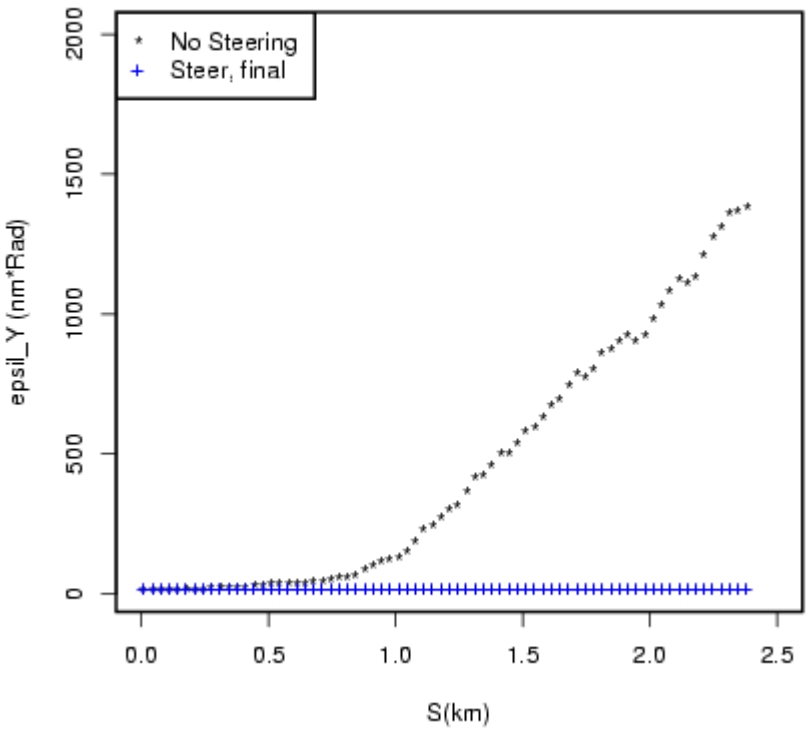
Low Emittance Transport

- Major Sources of emittance dilution in the RTML/Main Linac:
  - **Misaligned lattice leads to spurious dispersion.**
    - Mis-alignement are both “static” (e.g., construction defects, or tolerance) and dynamic: vibrations and ground motion.
  - **Acceleration off-axis causes wake-fields, which in turns disrupt the bunch.**
- Mitigation:
  - **Cavity shape**
  - **Steer the beam to tune the dispersion to its design value and center the beam in the cavity.**

Benchmarking LET Simulation Codes

- Is the emittance growth “real” or comes with fake “parasites”, i.e. bugs in our codes?
  - **Extensive and thorough benchmarks between codes**
    - to convince newcomers…
    - Improve our codes, compare programming techniques.
  - **Integrate: need for dynamical simulation, from Damping Ring.**
    - Complexity of this integration has been perhaps under-estimated.
    - CPU intensive: We will need to run on farms.
  - **Local code (i.e., CHEF) vs codes from other institutions (Desy, SLAC, CERN)**

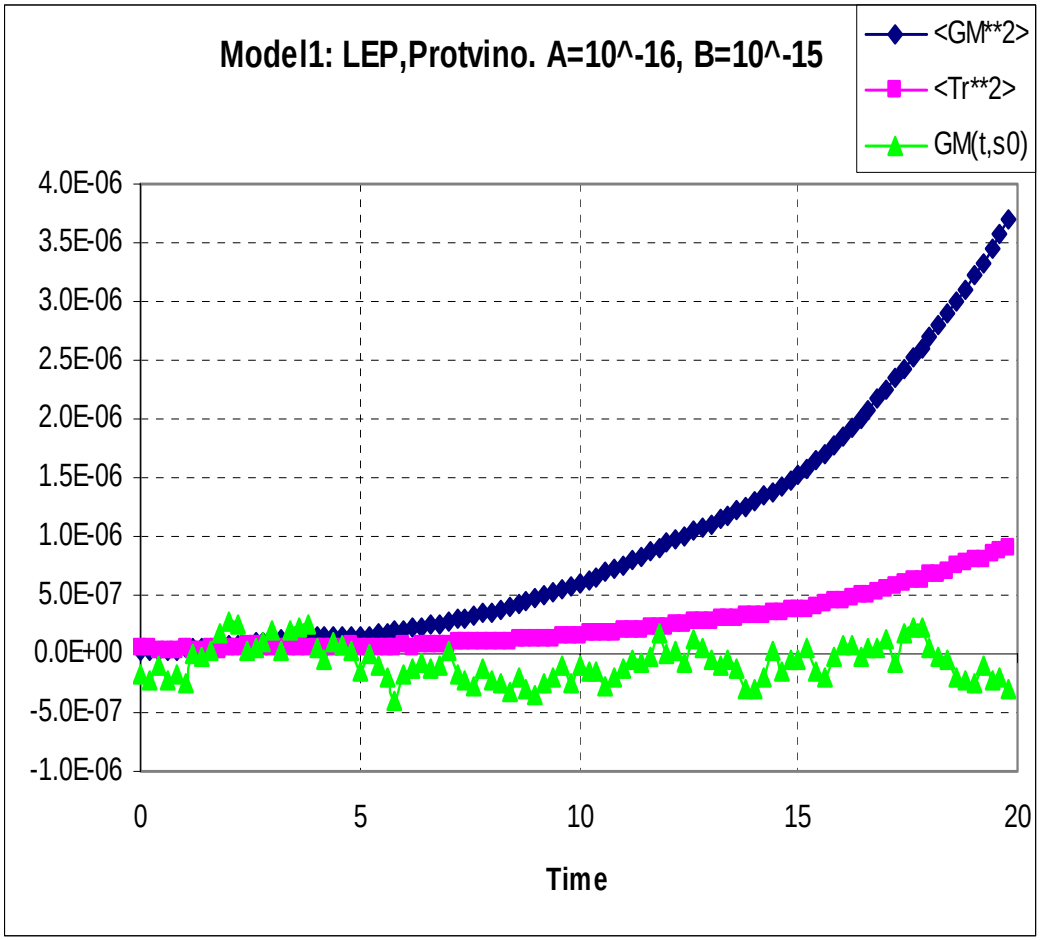
Steering to minimize Dispersion



Less than 0.5 nmRad growth. *But…*

- Recent results in CHEF
- Based on many previous studies, done with the other codes.
- First cheat a bit! : No cavity displacement, static problem, perfect BPM (resolution << 1 micron)
- Plan to relax many of these conditions and simulate many defects.
- Race condition: can we steer faster than the machine moves?

Dynamic Steering.

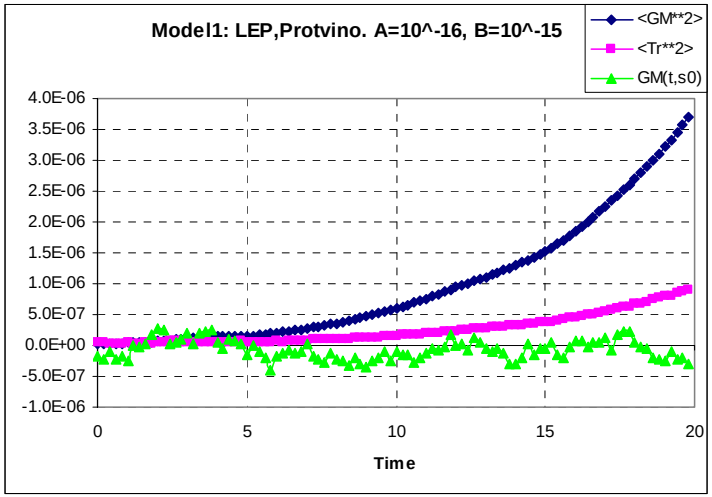


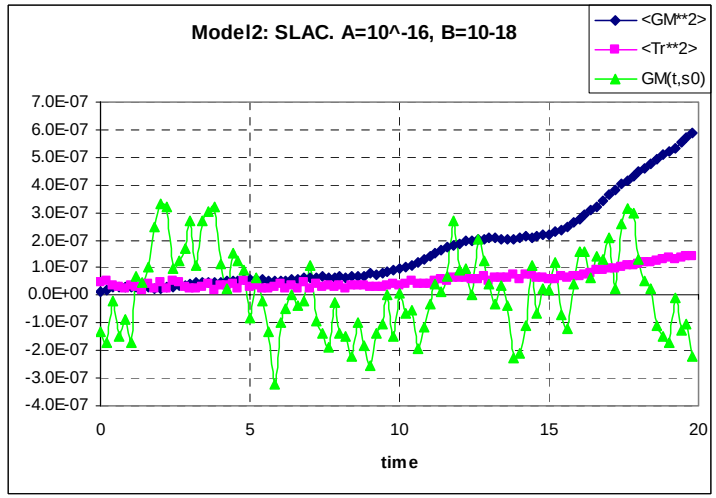
With a simpler model of the same lattice

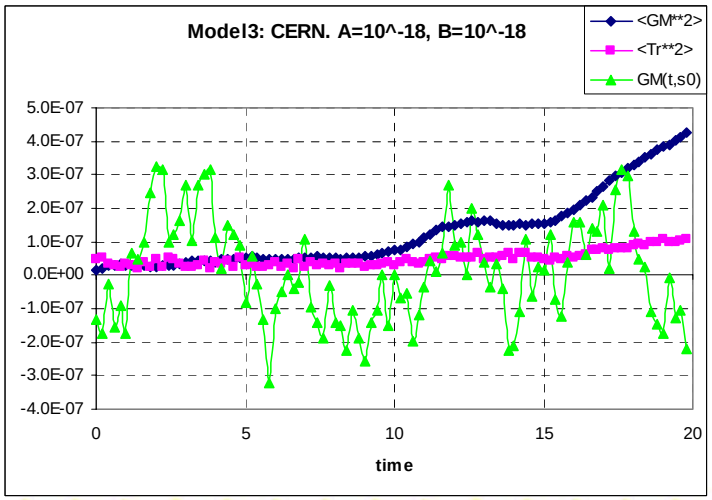
Units are in meter.

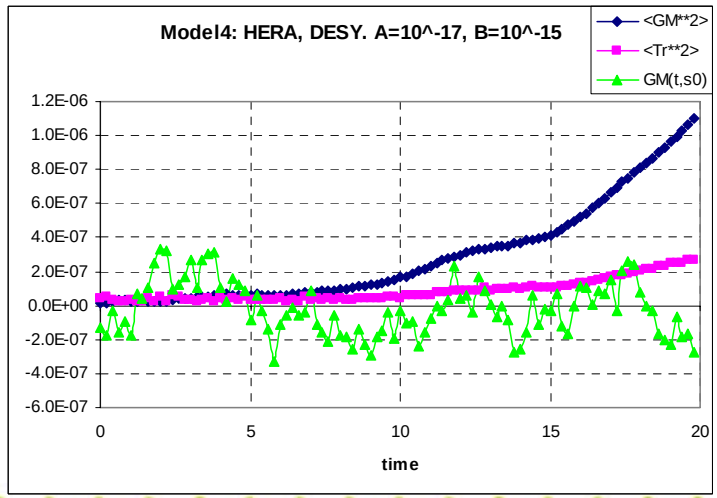
Yes, a fraction of 1 micron counts.

4 Models of Ground Motion, of typical sites









Conclusion

- In FY06: Investing..
  - **LET Code benchmark.**
  - **New Codes, new beam physics for us.**
  - **Implementation of Steering algorithms in our local codes.**
  - **Damping Ring e-cloud simulation started..**
  - **Crab Cavity simulation started.**
- Plans for FY07: Studying
  - **Purse dynamical aspect of LET in Main Linac, with increasing realism.**
  - **Study in more detail Crab cavity performance**
  - **E-Cloud problem.**