WG E: Computational Challenges in High-Intensity Linacs, Rings including FFAGs and Cyclotrons

Summary

GISELA PÖPLAU

Conversers:
P. Ostroumov (ANL)
G. Pöplau (Rostock University)
R. Ryne (LBNL)

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What are the challenges?

"The computational challenge for RHIC beam-beam simulation is to get meaningful physics results with limited computing resources and computing time."
(Yun Luo)
Meaningful physics

- **model and simulate new phenomena, include more physics:**
  phenomena of beam-beam interaction for the future electron-ion collider eRHIC (V. Ptitsyn)
  Particle matter interaction model for simulations of the PSI 590 MeV Ring Cyclotron (Y. Bi)

- **Improve models, find appropriate models:**
  model of particle distributions - Gaussian generator to reduce statistical errors for RHIC simulations (Y. Luo)

- **Fit simulations and measurements**
  (A. Aleksandrov, joint session E & F)
More efficient simulations: more precise & fast

- **Apply and develop appropriate numerical methods:**
  - *Application of (in numerical maths) established methods:* Barnes & Hut Alg. for Particle-Particle Interaction (B. van der Geer)
  - *New methods:* semi-analytical method for space charge (A. Orzechkovskaya)
  - *New approaches:* nonlinear transfer map for space charge (E. Nissen)

- **Make use of new hardware:**
  - *parallel computing on GPUs* (P. Messmer)
  - *(massively) parallel computing:* beam-beam interaction (V. Ptitsyn, Y. Luo)
  - Simulations with "high resolution" (D. Bruhwiler, J. Qiang)

- **Efficient development of simulation software:**
  - *Combination of MaryLie/Impact-Code:* simulations of space charge for the proposed CERN PS (J. Qiang)
  - *Application of Synergia:* wake functions for laminated magnets (A. Macridin)
FEATURES OF BEAM-BEAM INTERACTION OF LINAC-RING SCHEME

Compared with “standard” beam-beam interactions in collider rings, the linac-ring collision scheme brings on very specific effects:

- Electron beam disruption.
- Fluctuation of electron beam parameters.
- Kink instability of the proton beam.
- Effect of electron beam pinch on the incoherent proton beam emittance growth.

Those effects are being studied in details using a dedicated simulation code EPIC, written by Y. Hao (Ph.D. Theses, 2008).

The goal was to have the time efficient code. The result should be obtained on the scale of hours, not days.
Towards Realistic Ring Simulations cont.

Compare Radial Beam Profile Simulations with Measurements

Effect of TC15

Y. Bi: Challenges in Simulating MW Beams in Cyclotrons
Synergia is a composite code containing modules from several sources
Synergia utilizes state-of-the-art numerical and general computing infrastructure

A. Macridin: Wake Functions for Laminated Magnets and Applications for Fermilab Booster Synchrotron
MaryLie/IMPACT (ML/I)

- Combines capabilities of MaryLie code (A. Dragt, U Md) with IMPACT code (J. Qiang, R. Ryne, LBNL) + new features
- Multiple capabilities in a single unified environment:
  - Map generation
  - Map analysis
  - Particle tracking w/ 3D space charge
  - Envelope tracking
  - Fitting and optimization
- Recent applications: ERL for e-cooling @ RHIC; CERN PS2

- Parallel
- 5th order optics
- 3D space charge
- 5th order rf cavity model
- 3D integrated Green func
- Photoinjector modeling
- “Automatic” commands
- MAD-style input
- Test suite
- Contributions from LBNL, UMd, Tech-X, LANL,…

J. Qiang: Simulation of Space-Charge Effects in the Proposed CERN PS

Map computation from surface data

Error in E-field computed w/ different algorithms applied to a 2D Gaussian elliptical distribution w/ 500:1 aspect ratio

Integrated Green Function on 64x64 grid is more accurate than Hockney on 64x2048, 64x4096, 64x8192.
Focused ion beams (FIB)

- Cross Section Imaging
- TEM sample preparation
- Machining, sputtering/milling
- Beam-induced deposition
- Channeling contrast for crystalline grain analysis
- (Logo) engraving

http://www.s3.infm.it/fib.html
Talks in WG E - Tuesday

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<td>Anna Orzhekhovskaya (GSI)</td>
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<td>Yuanjie Bi (Beijing)</td>
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<td>Bas van der Geer (Pulsar Physics)</td>
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