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ILC Damping Ring Test Facilities at FNAL

Louis Emery, May 7th 2007

Previous Talks on Test Facilities

- "Some proposals of ILC Beam Test Facilities at FNAL," M. Church, April 19th 2006
- First ILC DR R&D Workshop at Cornell University, September 26-28, 2006, session on test facilities
  - "ILC Damping Ring R&D Using CESR," M. Palmer, Cornell
  - Utilization of KEKB for ILC R&D, Suetsugu and Oide, KEK
  - "The use of the HERA Electron Ring for the ILC Damping Rings," F. Willeke, DESY
- Second ILC DR R&D Workshop at IFNF, Frascati, March 5-7, 2006, session on low-emittance tuning

Most Important R&D for Damping Ring

- Electron cloud characterization and suppression in positron ring (increases effective y-emittance)
- Ion effects in electron ring (increases effective y-emittance)
- Vertical Emittance < 2 pm (norm. emitt. < 20 μm) after optics correction
- High-power fast kicker for injection/extraction
- Need to check first three on an accelerator that has close to the same electron beam and lattice
- Simulation codes and experience at other labs gives us an idea of predicted performance. Won't know until actual ring is built.

Extremes in Damping Ring Test Facilities

- Build an actual 6.5-km damping ring as specified by RDR to see if it works
- Do nothing until actual construction of ILC because no present ring could simulate exactly the real thing

- Think about intermediate situations to aid in the four R&D areas
  - 2-3 year term
    - *Validate simulation codes*
    - *Insert vacuum chamber components in present accelerators*
  - Longer term
    - *Build/assemble a damping ring?*

General Questions for Each Facility (M. Palmer)

- What is offered? (e.g. tunnel, magnets, beam energy)
- What modifications, if necessary?
- Experimental reach? (e.g., stored current, emittance, damping)
- Can important R&D results be provided in a timely fashion for the ILC TDR and (hoped for) start of construction?
- Provide an R&D program that is complementary to work going on elsewhere

CesrTF (M. Palmer)

- Offers wiggler-dominated ring (CESR-c wigglers are in DR baseline design) at 1.5 – 5.5 GeV
- Operations with electrons and positrons
- Ultra-low emittance operations and beam dynamics
- Electron cloud in wigglers
  - e^- cloud buildup and amelioration in wigglers
  - Instability thresholds
  - Validate the ILC DR wiggler and vacuum chamber design
- Other hardware testing (SC RF, kickers, alignment techniques)
- Much CesrTF design study already
- Available April 2008

HERA (F. Willeke)

- User HERA (6.3 km) e^- ring magnets as a damping ring
  - Hardware matches most of the DR specification
- Stage 0: HERA will be maintained as is (4 FTE)
- Stage I: Preparing the existing accelerator for its use as a DR
- Stage II: Demonstration of the most pressing accelerator physics issues of the DR with HERA with moderate R&D-scale investments
- Stage III: Modifying HERA into one of the ILC damping rings, commission it and demonstrate the required performance
- Stage IV: Disassemble and reinstall the ring at the ILC site, re-commissioning and operate it as one of the damping rings

KEKB (Oide)

- Examples of utilization of KEKB (3 km) for ILC R&D:
  - Low-emittance operation of KEKB-LER
  - Experiments on suppression of electron cloud effect
    - *Test of beam pipes and coatings*
  - Measurement of electron cloud instabilities
  - Effect of wigglers
  - Development of ring RF system with ILC spec, development of ring klystrons
  - Next generation of bunch-by-bunch feedback, ring BPM
- Do R&D during 2009-2014

ILC at FNAL (M. Church)

- 5 GeV linac, positron source and 6.3 km damping ring
- HERA magnets in Tevatron tunnel
- Fill the positron ring for beam stability/emittance studies
- Two DR configurations: change polarity for storing positrons, or keep polarity and double hardware

Summary of R&D topics at test facilities

- E-cloud
- Fast ion instability
- Vertical emittance
- Pulsers for injection (not needed in a ring test facility)

E-cloud (Summary at Sept 2006 Cornell WS)

- Test clearing electrodes
  - HCX in a quadrupole or drift region, A. Molvik
  - ESA preliminary to PEPII installation, M. Pivi,
  - PEPII in bend chicane, M. Pivi
  - CESR in wiggler section, M. Palmer
  - KEKB arc section bend or wiggler section, Y. Suetsugu
  - LHC arc section bend section, F. Caspers
- Test groove concepts
  - rectangular grooves drift SLAC, M. Pivi
  - triangular grooves in bend section SLAC, M.Pivi
  - triangular grooves in wiggler section CESR, M. Palmer

E-cloud (Summary at Sept 2006 Cornell WS)

- Test coating techniques (SEY measurement)
  - installation of test chambers in KEKB Cu, TiN, NEG, Y. Suetsugu
  - SEY conditioning test in PEP-II, M. Pivi
  - Installation of chambers in CESR, M. Palmer
- All 2007-2008 time scale

Vertical Emittance Tuning (Cai, Kubo, Zisman March 2007)

- Doesn't seem to be a single-particle beam dynamics obstacle to achieve target in several machines
- Do measurements at ATF, APS, CESR-TA, DAΦNE
- Do simulations to get tolerances, and correction configurations
- Should validate 2 pm at appropriate intensities with electrons and positrons to be safe

Fast Ion Instability (Venturini summary March 2007)

- Experimental demonstration that a ILC DR-like beam can be made immune to FII, desirable but less likely
- Check validity of simulation codes on existing rings (ATF, ALS, CesrTF)
- I add that including non-linearities, the effect seem to only double the vertical emittance in a bunch train

Where does FNAL fit

- Other accelerators may be used to validate codes that predicts performance of design
  - Change design as needed
  - Assume both e- and e+ damping rings will have similar designs (i.e. Same wigglers, vacuum chambers)
- Could build one damping ring for testing both beams at different times (as Church suggested)