Damping Ring R&D

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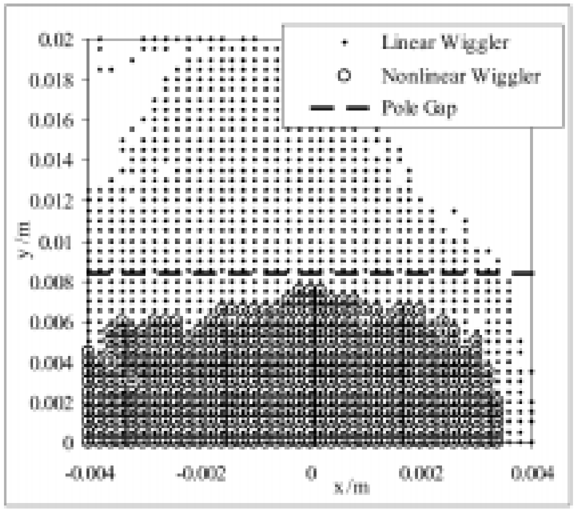
- Issues and methods of investigation:
    - Wiggler-related dynamic aperture limitations
    - Intrabeam scattering
    - Space charge effects
    - Other multiparticle beam dynamics investigations
    - Injection/extraction issues
    - Superferric wiggler option
- People, equipment, and budget

Wiggler-related dynamic aperture limitations

- No machine (yet) is operated in the regime where synchrotron radiation is dominated by wigglers.
- The linear collider damping rings will be wiggler-dominated.
- Dynamic aperture can be severly restricted by nonlinearities from wigglers.
- Studies in the wiggler-dominated CESR-c:
    - Develop a wiggler-lattice design algorithm to optimize dynamic aperture.
    - Perform particle tracking calculations.
    - Compare particle tracking with measurements of dynamic aperture, tune shifts, decoherence, and phase space distortion.
    - Apply algorithm and particle tracking to LC damping ring designs to demonstrate or optimize dynamic aperture.



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Intrabeam scattering

- Intrabeam scattering can be a significant source of emittance growth in the linear collider damping rings.
- Emittance growth due to IBS can be calculated using several theoretical models which agree well with each other.
- However, experiments at the KEK ATF damping ring show a vertical emittance growth 1.5 - 2× calculated growth. If due to IBS, linear collider damping ring redesign may be necessary.
- We plan to operate CESR-c in a low-energy, low-emittance mode to measure IBS growth rates (transient measurements) and equilibrium emittances (steady-state measurements). Bunch charge, bunch length, and *x*-*y* coupling will be varied.
- Measurements require a high-resolution beam size monitor (optical interferometer) and streak camera (existing).

Space charge effects

- Space charge tune shifts are large in the linear collider damping rings (*i.e.*, comparable to the limiting beam-beam tune shifts in e^+e^- colliders).
- A large tune "footprint" may overlap resonance lines, leading to particle loss, emittance growth, or growth of a beam halo.
- We plan to:
  - Simulate the effects of space charge in the damping rings and CESR-c using particle-tracking simulations (BMAD).
  - Determine optimum operating parameters.
  - Operate CESR-c in a low-energy, low-emittance mode. Measure particle loss, halo formation, and emittance growth and compare with simulation.

Other multiparticle beam dynamics investigations

We plan to investigate other multiparticle issues in CESR-c:

- Instability threshold for the electron-cloud effect in a low-emittance, wiggler-dominated regime.
- Strategies for the suppression of the electron cloud (*e.g.*, low-SEY coatings).
- Instability threshold for the fast ion instability in a low-emittance regime.
- Impedance-driven instabilities at the short bunch lengths characteristic of damping rings.
- Software feedback loops for long-term control of emittance coupling and vertical dispersion.

Injection/extraction issues

The large circumference of the TESLA damping ring is a consequence of the large number of bunches and the finite rise- and fall-time of the single-bunch injection and extraction kicker.

We plan to:

• Investigate alternative damping ring designs for TESLA.

• Develop the technology for a faster kicker, which could be used for TESLA or other damping rings

Superferric wiggler option

The baseline wiggler design for NLC and TESLA is based on permanent magnets.

We plan to re-evaluate the potential advantages and disadvantages of superferric wigglers, based on our experience with both permanent and superferric wigglers in CESR.

People, equipment, and budget

- Participants: Cornell LEPP accelerator group. Requesting support for new graduate students.
- Improvements to CESR diagnostic system: optical interferometer; streak camera.
- Extension of existing computational ability (software development, hardware).
- Budget (k$):

year	1	2	3
Grad students (2)	80	80	80
Computers	20	10	
Instrumentation	20	20	20
Kicker prototype		50	50
Totals	**120**	**160**	**150**