ILC Damping Rings: R&D Plan and Organisation in the Technical Design Phase

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ILC R&D Plan for the TDP

ILC Research and Development Plan for the Technical Design Phase

Release 2

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ILC Global Design Effort

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DR Objectives for the TDP

- The principle objectives for the Damping Rings R&D during the ILC Technical Design Phase are:

  1. **to consolidate the design described in the Reference Design Report, and develop a better understanding of the cost drivers and technical limitations;**
  2. **to identify and explore opportunities for reduction of cost and technical risk, and implement design changes to take advantage of such opportunities where possible;**
  3. **to demonstrate key technical performance goals (including electron cloud mitigation; ultra-low emittance operation; and performance of fast injection/extraction kickers) at the test facilities.**

Damping Rings Work Packages

WP 3.3.1: CesrTA

WP 3.3.2: Damping Ring Studies at KEK-ATF

WP 3.3.3: Damping Ring Studies at DAΦNE and Other Facilities

WP 3.3.4: Lattice Design and Beam Dynamics

WP 3.3.5: Technical Subsystems and Components

WP 3.3.1: CesrTA

1. Validation of electron cloud modelling tools (including build-up and instability simulations) in a parameter regime relevant for the ILC damping rings.
2. Demonstration of techniques for mitigation of electron cloud effects, which will allow operation of the ILC damping rings meeting specifications for beam quality and stability.
3. Demonstration of tuning techniques to achieve vertical emittance below 10 pm.
4. Development of x-ray beam-size monitor to characterise ultralow emittance beams.

WP 3.3.2: ATF

1. Demonstration of (low current) operation at 2 pm vertical emittance.
2. Characterisation of selected collective effects (including ions and intra-beam scattering) in the ultra-low vertical emittance regime.
3. Demonstration of fast kickers meeting the specifications for the ILC damping rings.

WP 3.3.3: DAΦNE

1. Collection of data on electron cloud effects, and tests of mitigation techniques.
2. Tests of fast kickers meeting the specifications for the ILC damping rings.

WP 3.3.4: Lattice Design and Beam Dynamics

1. Optimisation of baseline lattice design, including the damping rings and injection/extraction lines, identifying and implementing opportunities for reduction of costs and technical risks.
2. Characterisation of injection efficiency, taking into account magnet field and alignment errors and injected beam distribution and jitter.
3. Specification of electron-cloud mitigation techniques, based on results of studies from the test facilities (WP1 and WP3), and characterisation of safety margins using benchmarked simulation codes.
4. Development of an impedance model based on scaling from existing machines and technical design of vacuum and rf components (from WP5) as these become available. Characterisation of impedance-driven single-bunch and multibunch instabilities, and specification of feedback system requirements.
5. Characterisation of ion effects using simulation codes benchmarked against data from the test facilities (WP2).
6. Characterisation of other beam dynamics effects, as resources permit.

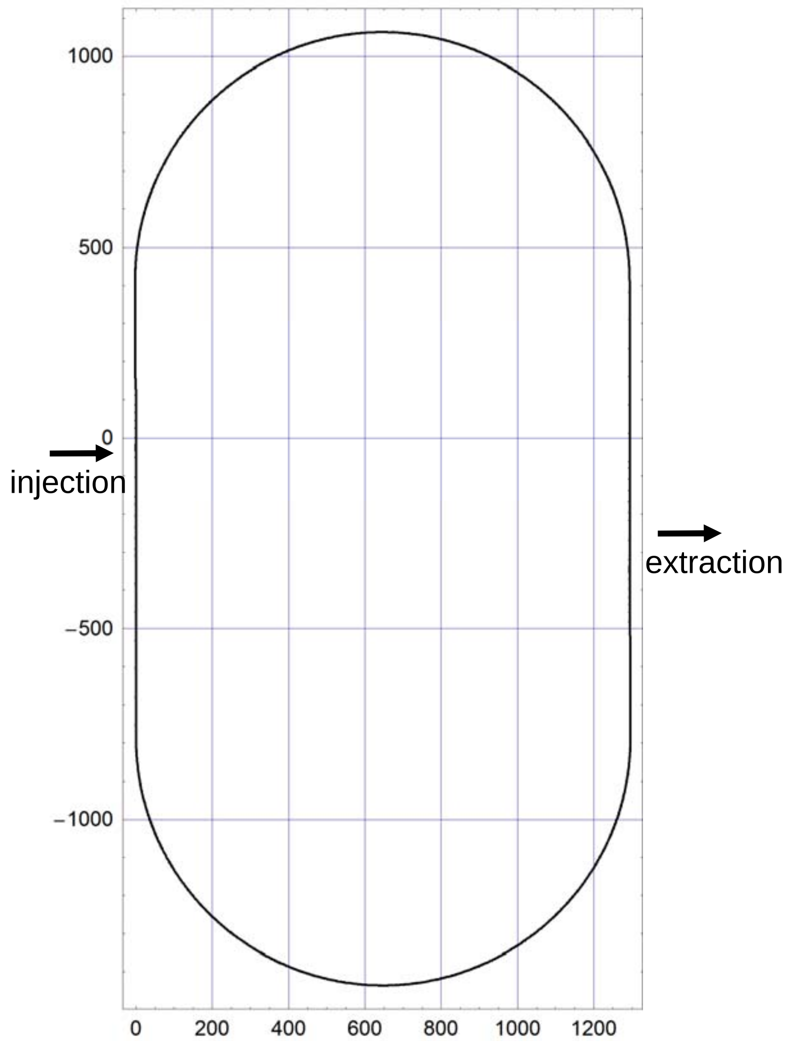
WP 3.3.5: Technical Subsystems

1. Development of technical designs and reliable cost estimates for subsystems and components, including:
   1.1. vacuum system;
   1.2. magnets (dipoles, quadrupole, sextupoles, orbit and skew quadrupole correctors);
   1.3. damping wiggler;
   1.4. magnet power system;
   1.5. magnet supports and alignment systems;
   1.6. injection and extraction systems;
   1.7. RF system;
   1.8. instrumentation and diagnostics;
   1.9. control system.
2. Identification of cost drivers and implementation of cost reductions where possible.
3. Provision of information for design and costing of conventional facilities and consideration of site-dependent issues.

Present Configuration: Key Parameters

Beam energy	5 GeV
Circumference	6476.440 m
RF frequency	650 MHz
Harmonic number	14042
Transverse damping time	21.0 ms
Natural rms bunch length	6.00 mm
Natural rms energy spread	1.27×10^{-3}

Present Configuration: DCO Lattice



- Two 'identical' rings in a single tunnel.
- Arcs consist of a total of 192 FODO cells
- Flexibility in tuning momentum compaction factor, given by phase advance per arc cell:
  - **72° phase advance: α_p=2.8×10^{-4}**
  - **90° phase advance: α_p=1.7×10^{-4}**
  - **100° phase advance: α_p=1.3×10^{-4}**
- No changes in dipole strengths needed for different working points.
- Racetrack structure has two similar straights containing:
  - **injection and extraction in opposite straights**
  - **phase trombones**
  - **circumference chicanes**
  - **rf cavities**
  - **"doglegs" to separate wiggler from rf and other systems**
  - **wiggler**

Coordination and Communication

- We plan to initiate regular WebEx teleconferences, every two weeks on a rotating time schedule:

West Coast US	East Coast US	Europe	Japan
8 AM	11 AM	5 PM	Midnight
11 PM	2 AM	8 AM	3 PM
4 PM	7 PM	1 AM	8 AM

- The format would be short technical reports and general updates from the working groups.
- We need to coordinate with the CesrTA meetings.
- We hope to get started soon…