Damping Rings Baseline Lattice Choice

ILC DR Technical Baseline Review
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Introduction

- This talk will briefly review the motivations and goals for the 2011 Damping Rings Group Lattice Down-Select process
- We will briefly review the major lattice evaluation criteria and the results of the ALCPG11 evaluation process
- Finally we will discuss the down-select which took place on June 28th and where we presently stand

Goals for the Lattice Evaluation I

- Select a new baseline lattice consistent with the new ILC central region design
  - **Reduced circumference**
  - **New operating requirements**
  - **Preserve key design features of existing baseline (DCO4)**
- Be ready to begin the process of integrating this design into the final ILC Technical Design
  - **Detailed description**
  - **Costing**
  - **Performance Evaluation**

ALCPG11

Key Design Modifications

- Reduction in circumference – 6.4km ⇨ 3.2km
  - **"Low power" operation with 1300 vs 2600 bunches (new baseline)**
  - **Maintain beam current and bunch structure ⇨ minimal impact on performance with respect to collective effects**
- Pursue lower momentum compaction design (target a fixed momentum compaction somewhere in the range of 1.7 to 2.7 × 10^{-4})
  - **If the lattice allows the momentum compaction to be tuned, then we would be able, in the low power configuration, to go to higher momentum compaction if commissioning indicates problems with instability thresholds. Note that this depends on the fact that the baseline lattice leaves room for larger RF complements needed for high power and/or 10Hz operation.**
  - **Less conservative design with respect to collective effects**
  - **Smaller RF requirements for 6mm bunch length**
- Updated Specification for Straights
  - **Minimize length consistent with 3.2km design requirements**
  - **Maintain injection/extraction layout**
  - **Minimize phase adjustment trombone**
  - **Adjust circumference chicane**
  - **Space in RF & wiggler sections for all design options (low & high power, 10Hz ops)**
  - **Added space in wiggler section for photon absorbers**
  - **Preserve CFS interface**
- Energy Acceptance Specification
  - **Injection ±0.5%**
  - **For quantum lifetime desire at least ±0.75% ⇨ lattice evaluations at ±1%**

2011 Evaluation Criteria

Based on 2008 Evaluation Criteria

1. Lattice Design and Dynamical Properties
2. ~~Conventional Facilities and Layout~~
3. Magnets, Supports and Power Supplies
4. ~~Vacuum System and Radiation Handling~~
5. RF System
6. ~~Injection and Extraction Systems~~
7. ~~Space for Instrumentation and Diagnostics~~
8. ~~Control system, availability, reliability~~

Eliminated from Review Pre-ALCPG11

⇨No Distinguishing Criteria – ALCPG11

Lattice Evaluation – Item 1

- **Lattice Design and Dynamical Properties**

a) Is the design complete? Does it include all necessary systems, such as injection/extraction optics, RF, wiggler, circumference chicane, tune trombone, etc?

b) Is there sufficient margin in general dynamical parameters (damping times, equilibrium emittance and energy spread, etc.)?

c) Does the momentum compaction factor provide a good compromise between RF requirements, at 6 mm bunch length, and instability thresholds?

d) How does the lattice compare with others in terms of sensitivity to collective effects (such as impedance-driven instabilities, intrabeam scattering, space charge, ion effects, and electron cloud)?

e) How much flexibility is there in tuning the momentum compaction factor?

f) Is the dynamic aperture sufficient?

g) Are there any particular benefits or concerns with the dynamics, specific to the lattice?

Lattice Evaluation – Item 2

- **Magnets, Supports and Power Supplies**

a) How does the number of magnets, and the number of different styles of magnet, compare with the other lattices?

b) Are the magnet parameters (length, field strength or gradient, spacing) reasonable?

c) Compare the degree of magnet optimization required for the various lattices?

d) How do the alignment and stability sensitivities compare with other lattices? In particular, what is the sensitivity of emittance dilution due to these effects.

e) How do the numbers and types of supports required for the magnets compare with other lattices?

f) How do the numbers and types of individually powered magnets compare with the other lattice options?

g) Are there any particular benefits or concerns with the magnets, supports and power supplies, specific to the lattice?

Lattice Evaluation – Item 4

- **RF System**

a) How feasible is the RF voltage required, for the targeted momentum compaction factor, to provide a bunch length of 6 mm?

b) Is there sufficient space in the lattice for all required RF cavities (allowing some margin for klystron failure)?

Ranking System

- Same system as previously used in 2008
- All criteria are evaluated on a scale of 1 to 5

5: Item has been addressed in the lattice design and fully meets the DR specifications…

4: Item has been addressed in the lattice design but some refinement is still required to meet the DR specifications…

3: Item has only been partially addressed. Significant work remains in order to meet the DR specifications…

2: Item has not been directly addressed in the lattice design… With reasonable expectations…

1: Item has not been directly addressed in the lattice design… With serious questions…

Full description at:
https://wiki.lepp.cornell.edu/ilc/pub/Public/DampingRings/WebHome/2011DRLatticeEval.docx

Ranking Criteria Clarifications

For questions where relative rankings are required, the ranking of the *best* lattice will be calibrated with the above absolute rating scale. For cases where insufficient information exists to make an evaluation, an entry of "Ins." (insufficient) will be recorded.

Within each major evaluation item, a weighted average of the rankings for each sub-item will be used to generate the overall ranking for that item. Setting the weights of each sub-item was carried out as part of the TILC08 evaluation process and we propose to maintain the same weights for the present evaluation. ~~In order to obtain an overall score for each lattice, each of the overall item rankings will be summed.~~ Each major evaluation item will be looked at separately between the lattices to evaluate both the absolute and relative preparedness of each.

ALCPG11

Lattice Design and Dynamical Properties

Evaluation Item	Weight	DMC3-90	DSB3	TME-style	----
1. Lattice design and dynamical properties.					
Completeness	1.0	4	4	4	
Margin - general parameters	1.0	3	4	3	
α_p choice	1.0	5	5	5	
Compare lattice sensitivities to collective effects	1.0	Ins	Ins	Ins	
α_p flexibility	1.0	5	4	4	
Dynamic aperture	1.0	3	3	3	
Sensitivity to Errors	1.0	Ins	Ins	Ins	
~~Particular benefits/concerns~~	~~1.0~~	-		-	
Overall		2.86	2.86	2.71	

As of ALCPG11, *NO* Lattice was deemed ready for a final down-select

The updated straights designs, while needing refinement, were acceptable

Magnets, Supports and Power Supplies

2. Magnets, supports and power supplies.					
Compare magnet counts and types	1.0	3	4	3	
Reasonableness of magnet parameters	1.0	5	5	5	
Compare degree of optimization needed	1.0	3	4	3	
Compare alignment & stability sensitivities	1.0	4	4	4	
Compare support counts and types	1.0	Ins	Ins	Ins	
Compare individual PS counts and types	1.0	4	4	4	
Particular benefits/concerns	1.0	2	4	3	
Overall		3.0	3.57	3.14	

RF System

4. RF system.					
Low Power RF Voltages (MV)		15	8	11	
RF voltage requirements	1.0	3	5	4	
Space in lattice for RF cavities	1.0	4	5	5	
Overall		3.5	5	4.5	

June 28 Down-Select

- A consensus was reached on the basis of design completeness
  - **Acceptable momentum compaction and RF complement**
  - **Acceptable DA evaluation for all 3 configurations**
  - **Implementation of key features of new reduced-length straights**

- Baseline Lattice Choice:
  DTC Lattice with TME-style arc cells

  DSB and DMC Lattices remain alternates

Status and Expectations

- During the month of June, information about the updated straights concept was provided to the CFS group
  - **Updated layout of key systems**
  - **Re-evaluation of beam line spacing ⇨ impact on tunnel diameter**
  - **Review of key utilities criteria**
- As of 1 week ago, a new baseline lattice, that meets the critical requirements for the damping ring design, was accepted
  - **Provides a basis for more detailed physics evaluations planned for the remainder of this year**
  - **Many design details still being refined and brought into full compliance with ILC specifications/needs**
  - **Key evaluations (eg, DA including errors) need to be evaluated over the coming months**
  - **Anticipate that any necessary adjustments to systems specifications are possible on the 6 month timescale**