Session Introduction & Damping Rings Baseline Lattice Decision

Mark Palmer

ILC Damping Rings Group

Outline

- Welcome to all who are able to attend (in person and via WebEx)
- Parallel Session Plans
  - **Baseline Lattice Evaluation – Tuesday Morning (8:15 am)**
    - OCS8
    - FODO4 ⇨ FODO5
    - DCO
  - **ATF Status and Plans – Tuesday Afternoon**
  - **CesrTA Discussion – Wednesday Morning (9 am)**
  - **Electron Cloud Status Reports – Wednesday Afternoon**
  - **DR Closeout – 4pm Wednesday Afternoon**

Baseline Lattice Decision

Introduction

- **The Damping Rings Group stated goal was to settle on a baseline lattice prior to this meeting**
- **Recent events have conspired to make this a difficult task**
  - Loss of key lattice design support for remainder of FY08
  - Adjusting to some slightly modified requirements
- **Our goal for this morning's session is to review the lattice options and try to move towards that goal**
  - Updates from lattice designers
  - Comparison of the lattice designs
  - Generate a lattice evaluation table
  - Discussion to pick a baseline design for the ILC Technical Design Phase

Baseline Lattice Choice

- A stable lattice is required for much of the technical effort that we hope will continue during the Technical Design Phase
  - **Conventional Facilities**
  - **Magnets**
  - **Vacuum**
  - **RF**
- All the lattice candidates have been designed to achieve the basic parameters:
  - **Equilibrium Emittance**
  - **Damping Time**
  - **Momentum Compaction Factor (but see next slide)**
  - **Dynamic Aperture**

Momentum Compaction Factor

- Conclusion of KEK DR Workshop
  - **α_p ~ 2×10^{-4} is acceptable**
    - Lattices should, however, incorporate capability to tune momentum compaction required in case instability issues do arise
  - **Relaxed α_p relaxes RF requirements and allows reconsideration of the ~6mm bunch length option**
    - Significantly eases bunch compressor requirements
    - Lattices should maintain space for additional RF just in case the momentum compaction needs adjustment to control instabilities

EDR Baseline Lattice Parameters

Main Parameters

Table 1: Main parameters of the baseline lattice for the RDR and proposed for the EDR.

	RDR [1]	Proposed for EDR		
		low rf	nominal	high threshold
Beam energy	5 GeV	5 GeV		
Harmonic number	14516	14042		
RF frequency	650 MHz	650 MHz		
RF voltage[1]	22.1 MV	13.2 MV	21.6 MV	25.8 MV
Number of rf cavities	18	8	16	16
Momentum compaction factor[1]	4×10^{-4}	1.1×10^{-4}	1.8×10^{-4}	2.7×10^{-4}
Natural rms bunch length[1]	9 mm	6.6 mm	6 mm	6.6 mm[2]
Natural energy spread	0.13%	< 0.13%		
Natural emittance	5 μm	< 8 μm		
Transverse damping times	25 ms	< 25 ms		
Betatron acceptance ($A_x + A_y$)	> 0.01 m	> 0.01 m		
Energy acceptance	± 0.5%	± 0.5%		

[1] These parameters should be variable over some range: see Table 2.

[2] Can be reduced to 6 mm with 30.8 MV total rf voltage (18 cavities): see Table 2.

Max. value for bunch compressors

Updated targe (previously 4×10^{-4})

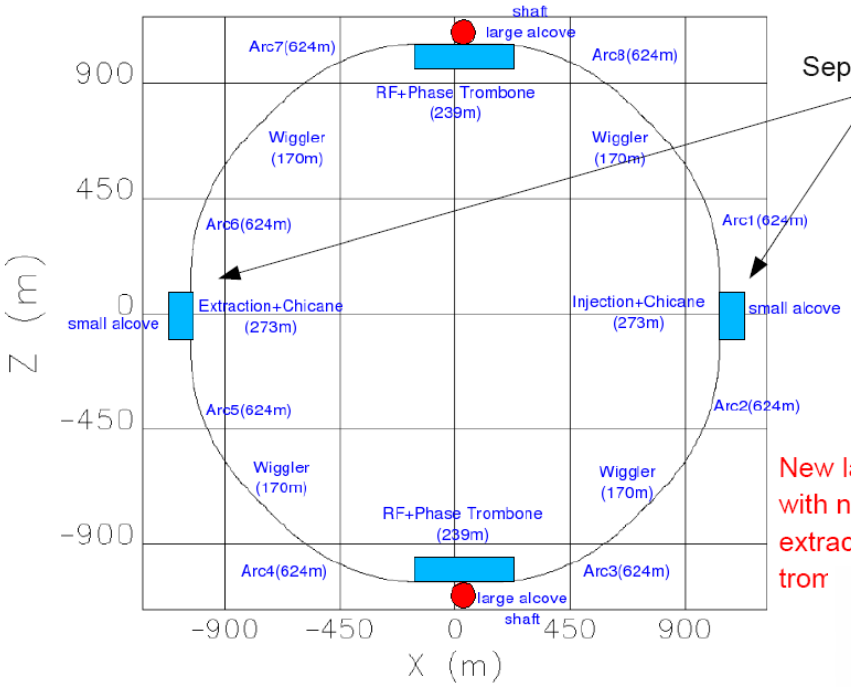
Since the KEK DR WS

- OCS8
  - **Work on hold due to US funding situation**
- FODO4

  ⇨ FODO4b
  - **Dispersion suppressor and matching sections modified to provide variable momentum compaction without varying the ring circumference**
  - **Chicane added**
  - **Other refinements**

  ⇨ FODO5
  - **Lower momentum compaction and shorter bunch length**
- A new entry
  - **DCO**
  - **Wolski and Korostelev**
  - **Lower momentum compaction and shorter bunch length**

Lattice Options



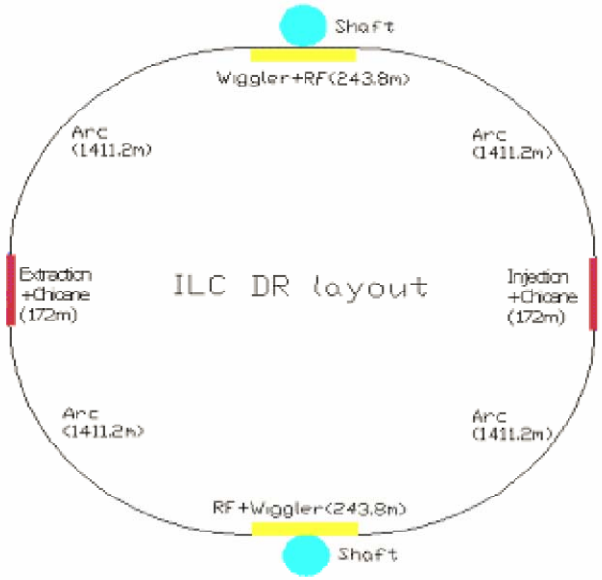
Separated Injection/Extraction

From the Damping Rings R&D Workshop at KEK, A. Wolski, December 2007

OCS8 (TME)

New lattice has 8 symmetries, with new rf; chicane; injection; extraction; and phase adjustment from

FODO



4 arc sections.

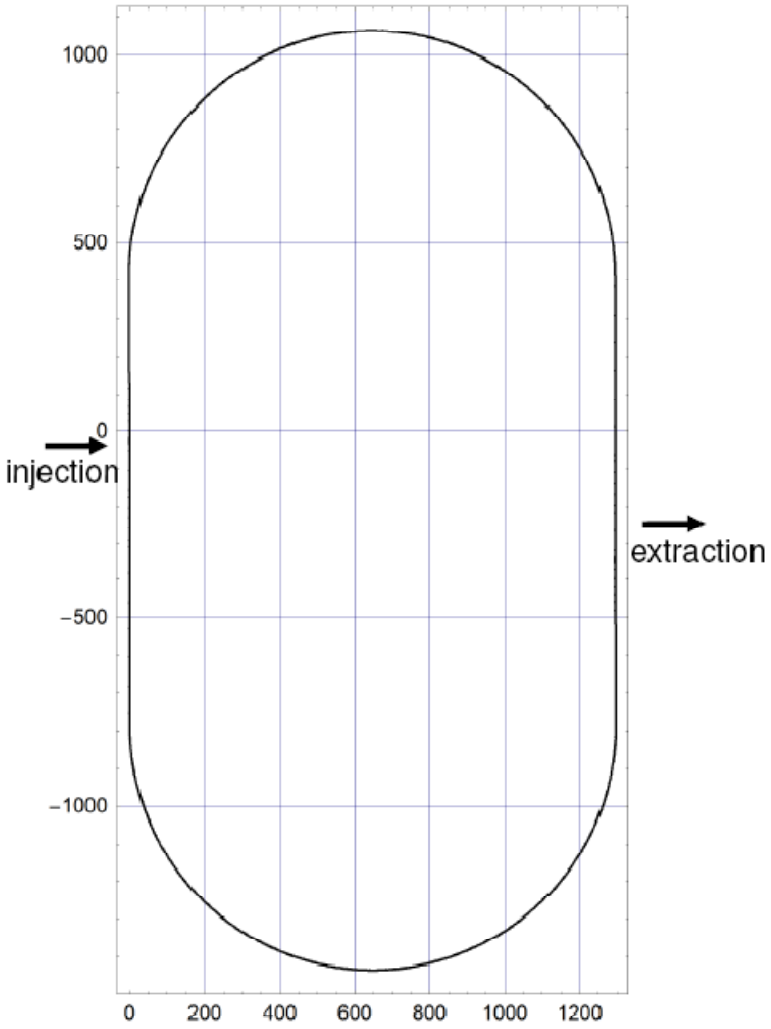
4 straight sections, one for injection, one for extraction, and the other two for RF/wiggler.

Two shafts in all and no TL.

Beam is counter-rotating.

Refined Version 4
⇨ Version 5

DCO at a glance



- 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**

Parameter Comparisons

	OCS8	FODO4			FODO5			DCO		
Beam energy (GeV)	5.00									
Circumference (m)	6476.440									
RF frequency (MHz)	650									
Harmonic number	14042									
Number of straight sections	8	4			8			2		
Arc cell type	TME	FODO			FODO			FODO		
Arc cell length (m)	38.9	29.4			28.4			21.0		
Number of arc cells	128	184			188			192		
Number of dipoles per arc cell	1	2			2			1		
Arc dipole length (m)	6	2			2			2		
Arc dipole field (T)	0.146	0.142			0.139			0.273		
Number of quadrupoles per arc cell	4	2			2			2		
Number of sextupoles per arc cell	4	2			2			2		
Natural rms bunch length (mm)	9.00	9.00			6.00			6.00		
Natural energy spread (10^{-3})	1.28	1.28			1.28			1.27		
Transverse damping time (ms)	25	25			25			21		
Approximate phase advance per cell	90	60	72	90	72	90	108	72	90	100
Momentum compaction factor (10^{-4})	4.0	6.0	4.0	2.0	4.00	2.5	1.7	2.8	1.7	1.3
Normalised natural emittance (m)	5.2	5.4	4.2	3.4	3.9	3.1	2.6	6.5	4.7	4.3
RF voltage (MV)	21.2	31	22	15	45	29	21	32	21	17
RF acceptance (%)	1.46	1.65	1.48	1.21	2.70	2.45	2.17	2.35	1.99	1.72
Synchrotron tune	0.059	0.091	0.061	0.038	0.089	0.056	0.037	0.061	0.038	0.028
Horizontal tune	49.23	40.29	46.28	58.29	50.30	61.30	72.28	64.75	75.20	80.45
Natural horizontal chromaticity	-64	-48	-54	-74	-63	-79	-108	-77	-95	-107
Vertical tune	53.34	41.25	47.24	57.25	51.26	62.24	69.23	61.40	71.40	75.90
Natural vertical chromaticity	-64	-49	-55	-73	-63	-80	-100	-76	-93	-104

Baseline Lattice Evaluation

- Propose to evaluate the lattices on the basis of 8 general criteria:
  - **Lattice Design and Dynamical Properties**
  - **Conventional Facilities and Layout**
  - **Magnets, Supports and Power Supplies**
  - **Vacuum System and Radiation Handling**
  - **RF System**
  - **Injection and Extraction Systems**
  - **Instrumentation and Diagnostics**
  - **Control System, Availability and Reliability**
- Are there other items that should be added?
- We will take time during the working portion of this meeting to review the evaluation criteria