CLIC Parameter working group

Comparison between NLC, ILC and CLIC Damping Ring parameters

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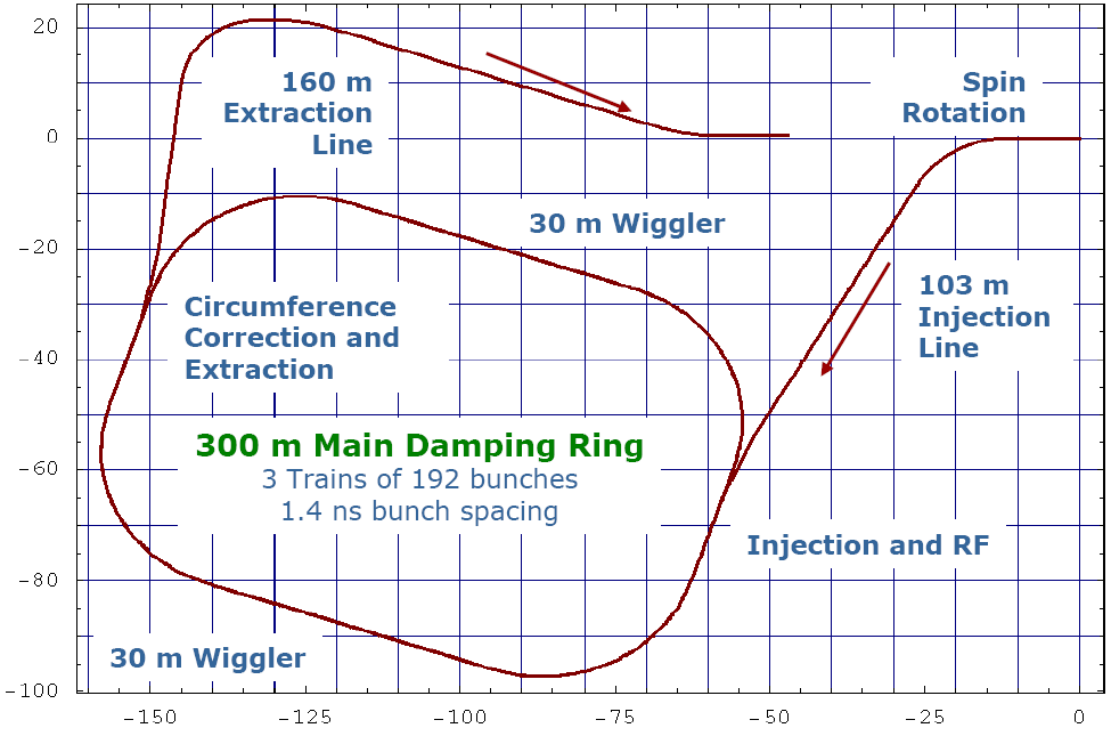
NLC damping rings

(A.Wolski et al. 2003)

- Lattice with 32 TME arc cells and wigglers of 62m total length
- Increased momentum compaction results in a bigger bunch length, reducing charge density and IBS growth rates

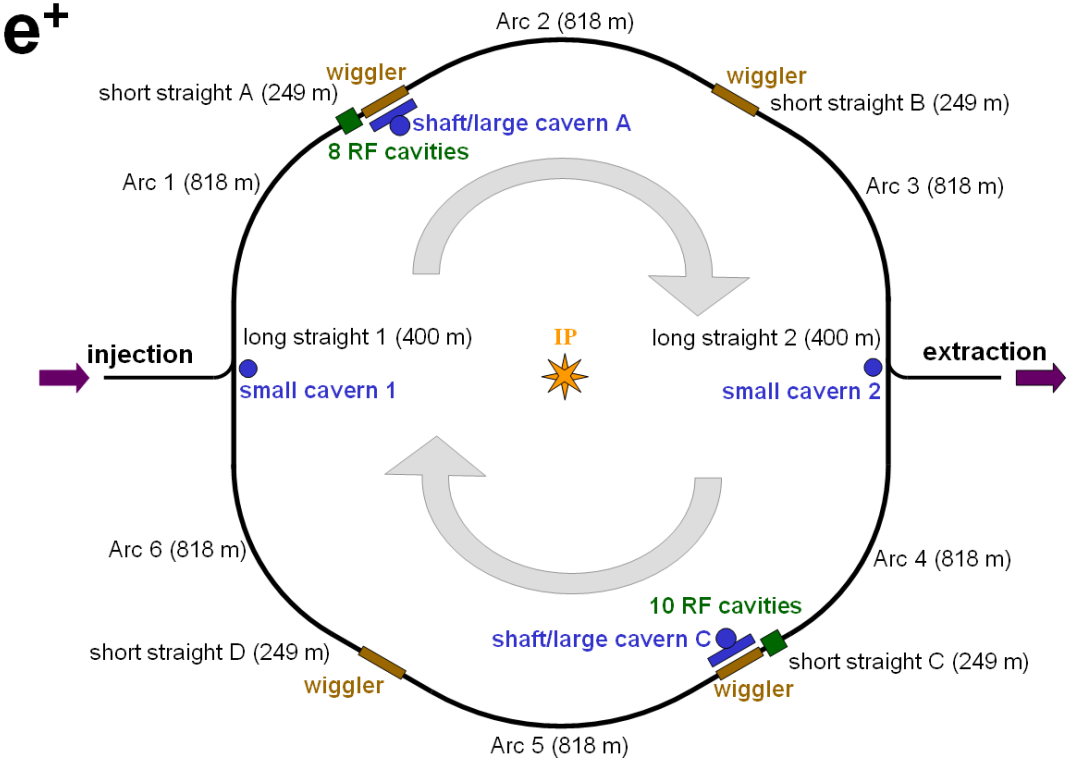


PARAMETER	NLC	CLIC
energy [GeV]	1.98	2.424
circumference [m]	299.79	365.2
bunch population	7.5E+09	5.20E+09
bunch spacing [ns]	1.4	0.667
number of bunches/train	192	311
number of trains	3	1
store time/train [ms]	6.11	20
rms bunch length [mm]	5.5	1.50
rms momentum spread [%]	0.1	0.137
hor. normalised emittance [nm]	2370	432
ver. normalised emittance [nm]	20	4.3
lon. normalised emittance [eV m]	10890	4993
arc beam pipe radius [cm]	2.4	2
no. of arc bends	64	96
arc dipole field [T]	0.6	0.932
arc dipole length [m]	2	0.545
number of wigglers	32	76
wiggler field [T]	2.15	2.5
wiggler period [cm]	27	5
Hor./ver. tune	21.15/10.35	69.82/33.8
energy loss/turn [MeV]	0.97	3.903
hor./ver./lon./ damping times [ms]	3.6/4.1/2.2	1.5/1.5/0.75
RF Voltage [MV]	2.0	4.345
repetition rate [Hz]	120	50
RF frequency [GHz]	0.714	1.499

ILC damping rings

(A.Wolski et al. 2007)

- Large ring of more than 6km for accepting large number of bunches with reduced e-cloud effect
- Higher energy to avoid collective effects
- TME and FODO lattice considered



PARAMETER	ILC (OCR)	CLIC
energy [GeV]	5.00	2.424
circumference [m]	6695.1	365.2
bunch population [E+09]	<20.0	5.20
bunch spacing [ns]	>3	0.667
number of bunches/train	>2820	311
number of trains	1	1
store time/train [ms]	200	20
rms bunch length [mm]	9.00	1.50
rms momentum spread [%]	0.128	0.137
hor. normalised emittance [nm]	5600	432
ver. normalised emittance [nm]	20	4.3
lon. normalised emittance [eV m]	57600	4993
arc beam pipe radius [cm]	3	2
no. of arc bends	220+40	96
arc dipole field [T]	0.16	0.932
arc dipole length [m]	6 or 3	0.545
number of wigglers	80	76
wiggler field [T]	1.67	2.5
wiggler period [cm]	40	5
Hor./ver. tune	52.397/49.305	69.82/33.8
energy loss/turn [MeV]	8.69	3.903
hor./ver./lon./ damping times [ms]	25.7/25.7/12.9	1.5/1.5/0.75
RF Voltage [MV]	24	4.345
repetition rate [Hz]	5	50
RF frequency [GHz]	0.650	1.499

Alignment tolerances

- Most critical for low (vertical) emittance tuning
- Detailed study and comparison made by A. Wolski et al. for NLC
- For ILC the following tolerances were considered, for a robust behaviour of the lattice (J.Jones EPAC2006)
- For CLIC similar tolerance considered (M.Korostelev PhD thesis 2006) achieving 0.1% of coupling and 0.25μm of dispersion invariant

	NLC MDR 2001	NLC MDR 2003	TESLA DR	ALS	KEK-ATF	SLS
Energy [GeV]	1.98	1.98	5	1.9	1.3	2.4
Circumference [m]	300	300	17,000	197	139	288
Damping time [ms]	5.0	3.6	25	7.3	10	9
Horizontal emittance [nm]	0.77	0.77	0.82	6.9	1.1	5.0
Vertical emittance [pm]	3.6	5.1	1.4	5	10	15
Sextupole alignment [μm]	31	53	11	30	61	71
Quadrupole roll [μrad]	322	511	38	200	1000	374
Quadrupole jitter [nm]	75	264	76	231	290	230

ILC	Δx (μm)	Δy (μm)	ΔΨ (mrad)
Quadrupole	30	30	0.3
Sextupole	30	30	0.3
BPM	100	100	20

Imperfections	Simbol	1 r.m.s.
Quadrupole misalignment	$\langle \Delta Y_{\text{quad}} \rangle$, $\langle \Delta X_{\text{quad}} \rangle$	90 μm.
Sextupole misalignment	$\langle \Delta Y_{\text{sext}} \rangle$, $\langle \Delta X_{\text{sext}} \rangle$	40 μm
Quadrupole rotation	$\langle \Delta \Theta_{\text{quad}} \rangle$	100 μrad
Dipole rotation	$\langle \Delta \Theta_{\text{dipole arc}} \rangle$	100 μrad.
BPMs resolution	$\langle R_{\text{BPM}} \rangle$	2 μm.

Impact of coupling on new parameters

- When coupling set to 0 hor. and ver. emittance of 312nm and 3.6nm
- When vertical dispersion set to 0 hor. and ver. emittance of 322nm and 3.4nm
- When both are zero hor. and ver. emittance of 328nm and 3.1nm
- Future work should be focused on re-evaluating the alignment tolerances and coupling correction schemes in order to restore nominal emittance

PARAMETER	2006	2006 revised	NEW
energy [GeV]	2.424		
circumference [m]	365.2		
bunch population [E+09]	2.56		**5.20**
bunch spacing [ns]	0.533		**0.667**
number of bunches/train	110		**311**
number of trains	4		**1**
store time/train [ms]	13.3		**20**
rms bunch length [mm]	1.51	1.50	**1.50**
rms momentum spread [%]	0.136	0.129	**0.137**
hor. normalised emittance [nm]	380	**308**	**432**
ver. normalised emittance [nm]	2.4	**3.9**	**4.3**
lon. normalised emittance [eV m]	5000	4724	**4993**
coupling [%]	0.6	**0.13**	0.13
ver. dispersion invariant [μm]	0	**0.248**	0.248
wiggler field [T]	2.5		
wiggler period [cm]	5		
energy loss/turn [MeV]	3.903		
hor./ver./lon./ damping times [ms]	1.5/1.5/0.75		
RF Voltage [MV]	4.25		**4.345**
number of RF cycles	2		**1**
repetition rate [Hz]	150		**50**
RF frequency [GHz]	1.875		**1.499**