ILC Damping Ring Design: Changes from TDR

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Change of ILC DR Design from TDR

- For Higher Luminosity (especially at 250 GeV ECM)
  - Normalized horizontal emittance 6.3 um → 4 um

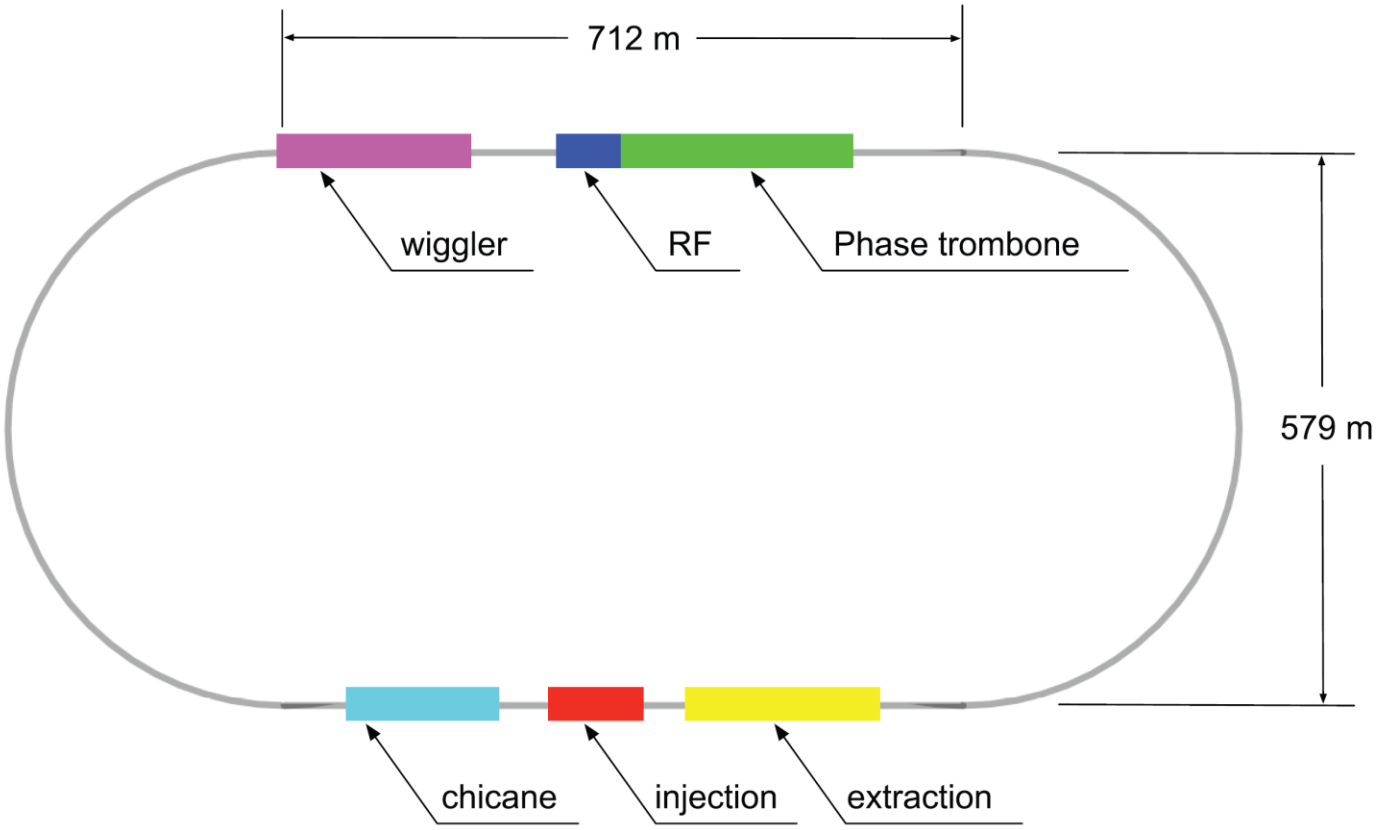
(Already reported and approved)

e.g. Presentation in ALCW2018
(https://agenda.linearcollider.org/event/7826/sessions/4644/#20180531)

- Make Design Realistic
  - Change positions and lengths of magnets

TDR

Figure 6.1
Damping-ring layout: the circumference is 3238.7 m; the length of each straight is 710.2 m.



Changes keep

- Same beamline geometry
- Basically the same optics

Horizontal emittance design (normalized)

TDR

- At IP: 10 um
- In DR: 6.3 um
- Growth in RTML: 0.9 um (designed synchrotron radiation)

New

- At IP: 5 um
- In DR: 4 um
- Growth in RTML: 0.7 um (designed synchrotron radiation)
  (by changing turnaround design)

Possible choices for emittance reduction

- Stronger focusing (smaller beta-function) in arcs
  - Dynamic aperture significantly reduce.
    - Probably not acceptable.

- Longer and weaker bending magnets
  - Space exist for lengthening magnet from 3m (TDR) to 5 m
  - Simple and easy
  - No negative impact to dynamic aperture

  →This is chosen

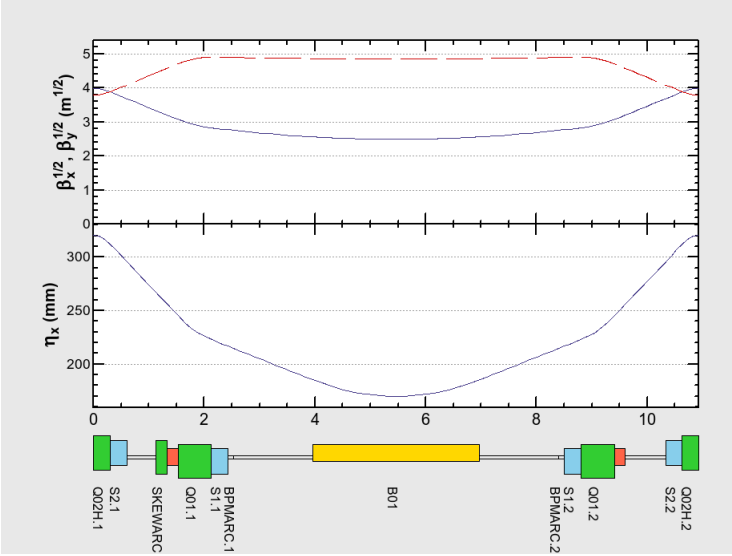
+ In Wiggler dominant ring (as ILC DR):

  emittance ~ 1/(radius)^2 in arc

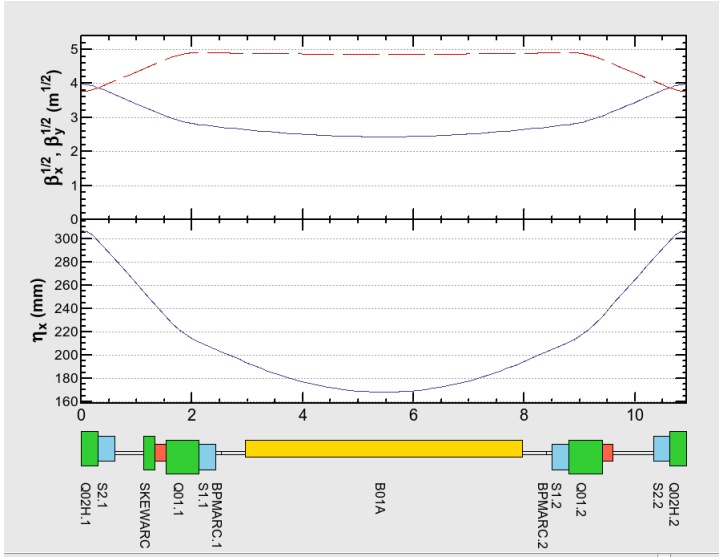
  damping time not changed significantly

Optics of Arc Cell

TDR, 3 m bend



5 m bend



	TDR	New (long bend)
Horizontal normalized Emittance (um) wo/w intra-beam scattering	5.74, 6.27 (IBS)	3.14, 3.97 (IBS)
Damping time x/y/z (ms)	23.9/23.9/11.9	25.5/25.5/12.8

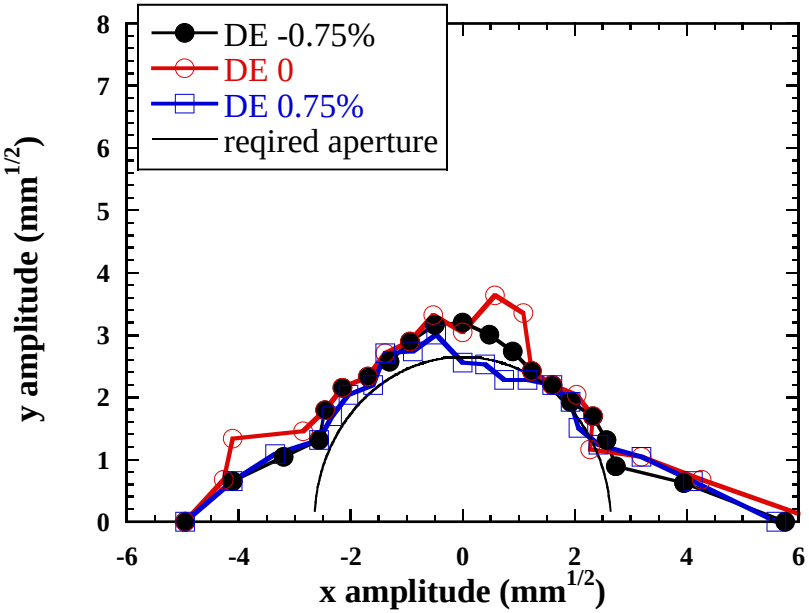
Dynamic Aperture calculation

Tool prepared in SAD

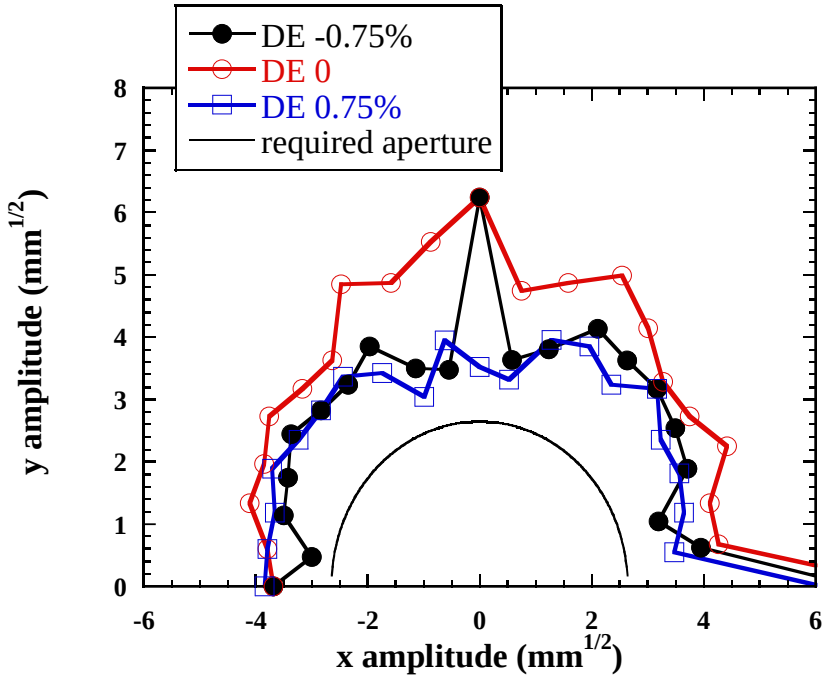
- Set initial orbit and energy deviation and perform tracking
- Survived in 1000 turns tracking → “accepted”
- No errors included.
- No special treatment of wiggler’s magnetic field.

Dynamic aperture

TDR design 3 m bend



New arc cell: long (5 m) bend



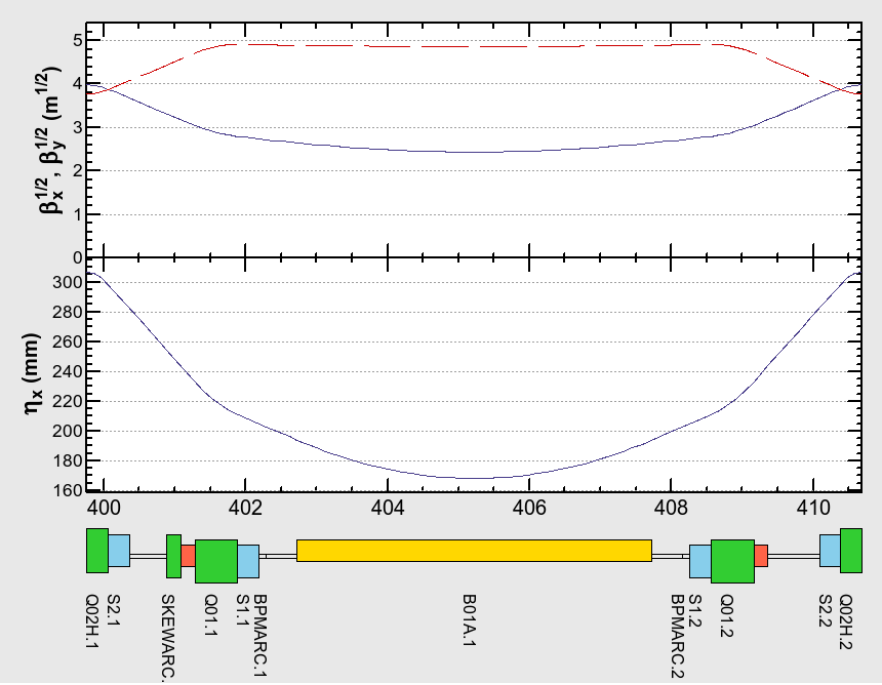
Aperture is larger than requirement

Additional Changes after ALCW2018

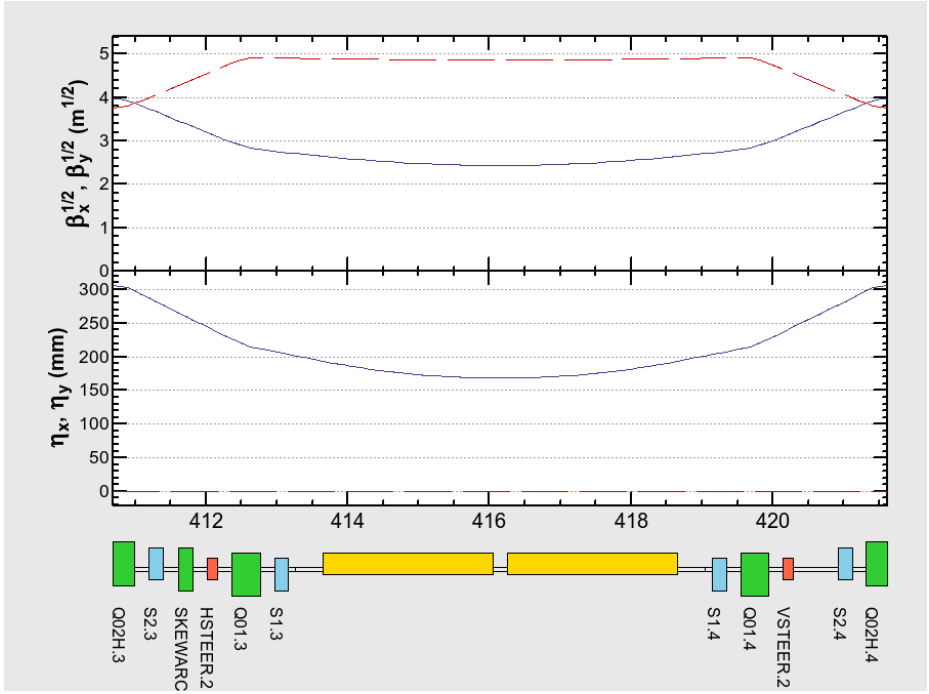
Realistic Design (consideration of construction, transportation, etc.)

- Insert spaces between magnets
- Divide one 5 m bend into two 2.4 m bends

Arc Optics Design in 2018



Present Arc Optics Design



Additional Changes after ALCW2018 cnt'd

- Basically the same optics
  - Dynamic aperture checked. No significant change.
- Reduction of total bend magnets length
  - emittance increase slightly, not significant

Horizontal normalized emittance

Bend	No intra-beam scattering	With intra-beam scattering ($\gamma\varepsilon_y = 20$ nm)
5 m	$\gamma\varepsilon_x = 3.14\ \mu$m	$\gamma\varepsilon_x = 4.00\ \mu$m
2.4 m+ 2.4 m	$\gamma\varepsilon_x = 3.27\ \mu$m	$\gamma\varepsilon_x = 4.08\ \mu$m

SUMMARY

- Longer and weaker bending magnet for lower horizontal emittance
- Divide long bending magnet into two

  (5 m → 2. 4 m + 2.4 m).
- Spaces between magnets
- Same beamline geometry
- Basically the same optics
- Changes give no negative effect to dynamic aperture

(However, more realistic estimation of dynamic aperture is desirable.)