ILC Damping Ring Lattice – OCS8

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Presented at GDE meeting
Mar 4th, 2008

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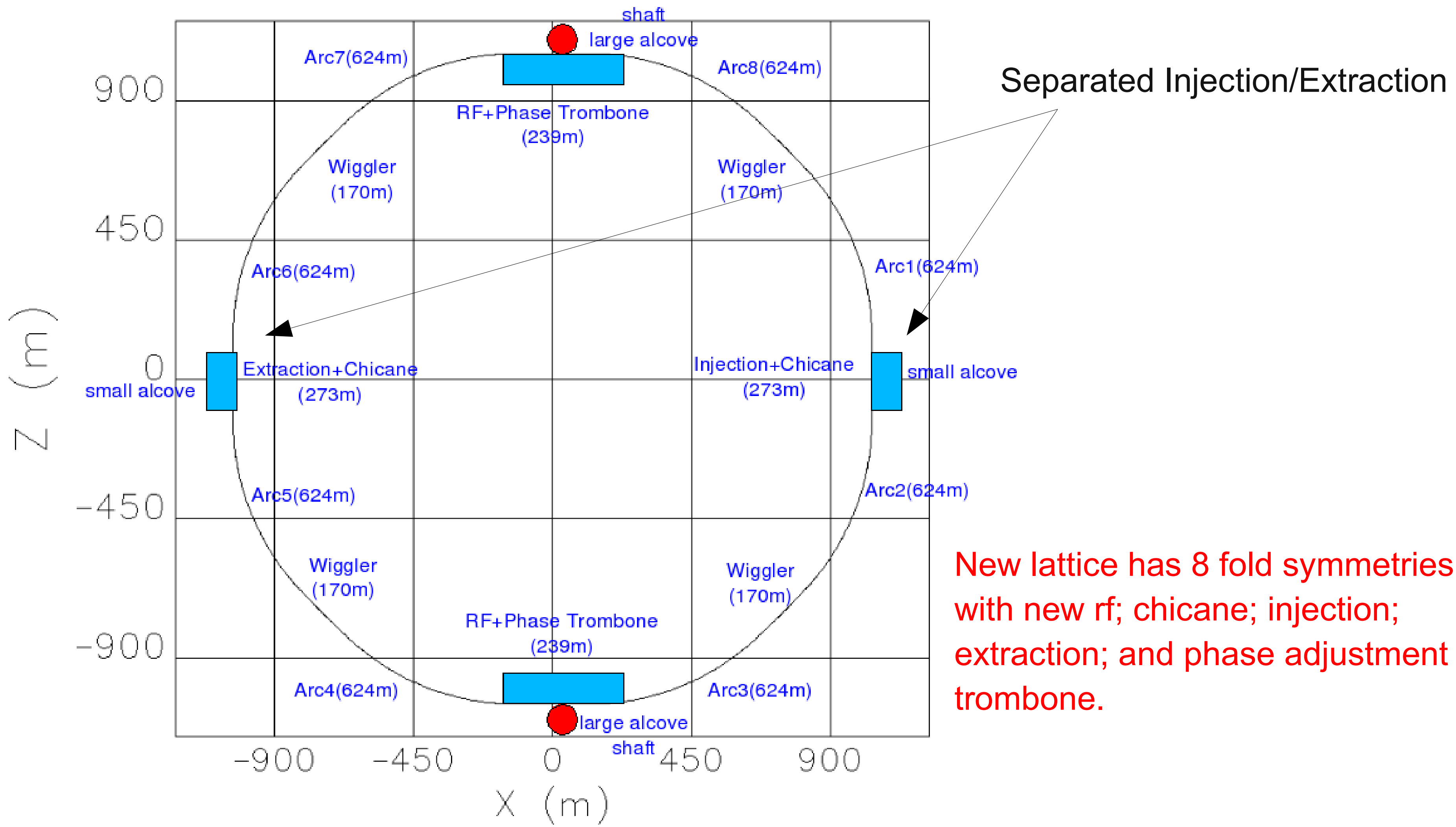
Outline

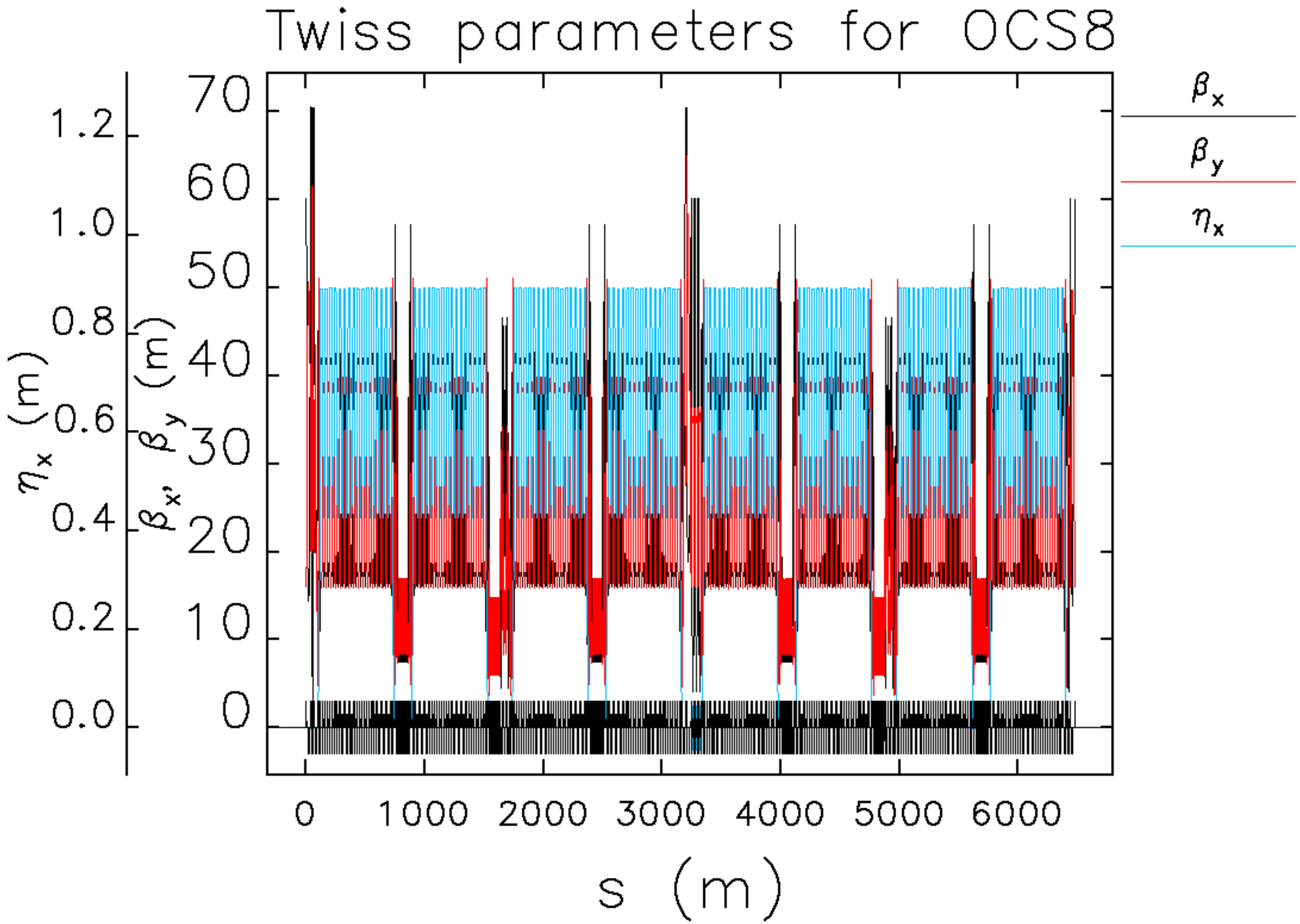
- Feature of OCS8 lattice
  - 8-fold symmetric lattice based on TME cell
  - Separated asymmetric injection/extraction line
    - *Separated injection kickers (7kV pulser)*
    - *180^0 insertion for accumulated injection*
    - *Lumped extraction kickers*
  - RF sections adjusted to accommodate SC rf cavities
  - Phase trombone
  - Circumference-adjustment chicane
  - Dynamic Aperture
- Comparing of TME (OCS8) and asymmetry FODO (DCO) lattice

ILC Damping Ring RDR Lattice (OCS8) – Ring's Layout



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

Optical Functions



Main Parameters

Table 1: OCS8 principal lattice parameters

Energy	E	5 GeV
Circumference	C	6476.4395 m
Betatron tunes	ν_x, ν_y	49.22,51.38
Chromaticity	ξ_x, ξ_y	-63.1,-60
Momentum compaction	α	3.97×10^{-4}
Natural emittance	$\gamma\epsilon_x$	4.99 μm
Damping time	τ_y	24.7 ms
RF voltage	V_{RF}	21.2 MeV
Energy loss per turn	U_0	8.7 MeV
Momentum acceptance	ϵ_{RF}	1.48%
Synchrotron tune	ν_s	0.06
Equilibrium bunch length	σ_z	9 mm
Equilibrium energy spread	σ_δ	0.128%

Realistic Septum and Kickers for Injection

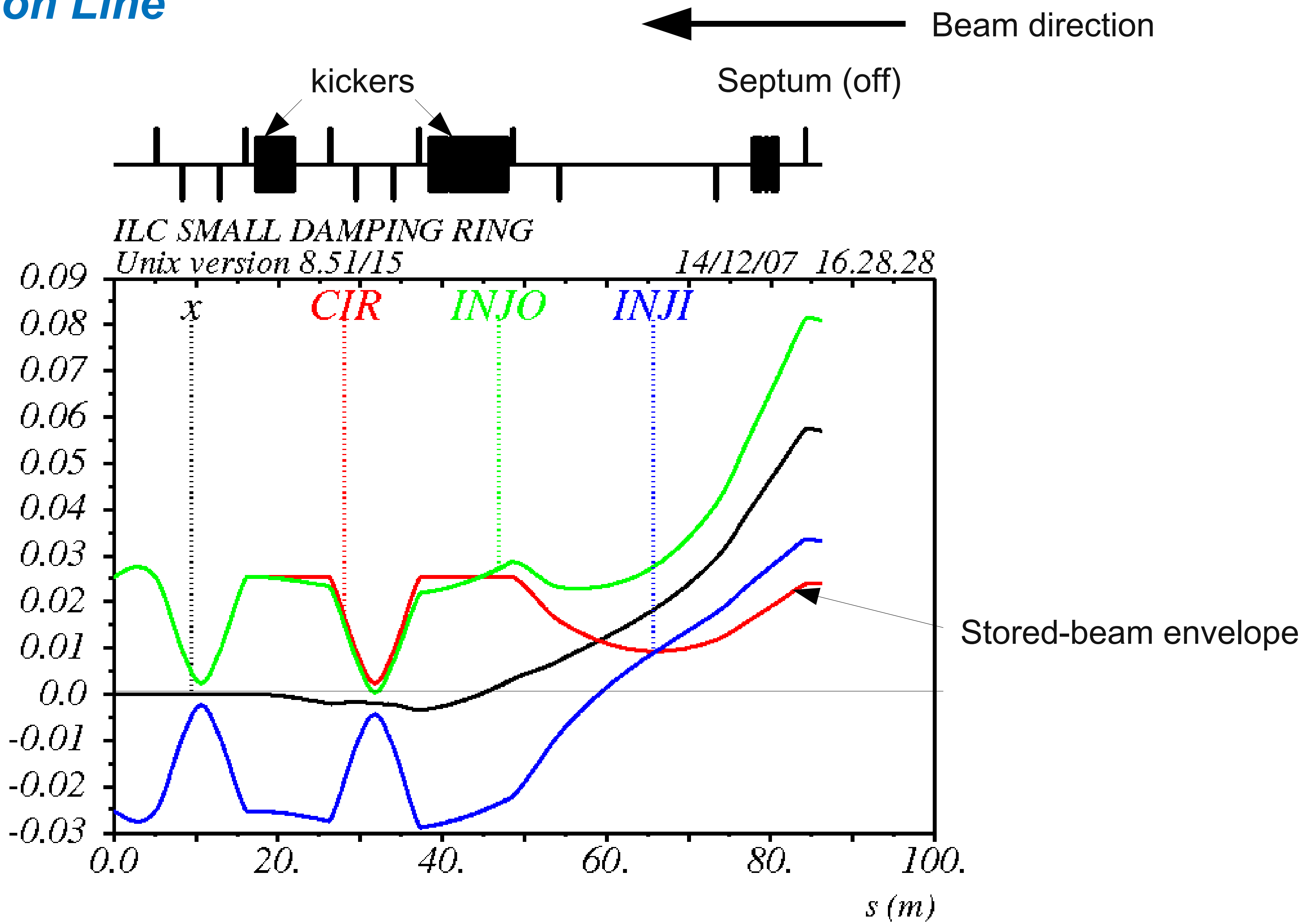
- Possible DC Septum performance (from Daphne)[1]

DC Septum	Beam Separation	Required Field	Length	Sheet Thickness
SPInj.1	4 mm	0.104 T	1 m	1.5 mm
SPInj.2	10 mm	0.4 T	0.5 m	6 mm (water cooled)
SPInj.3	23 mm	0.8 T	0.8 m	>= 12 mm (water cooled)

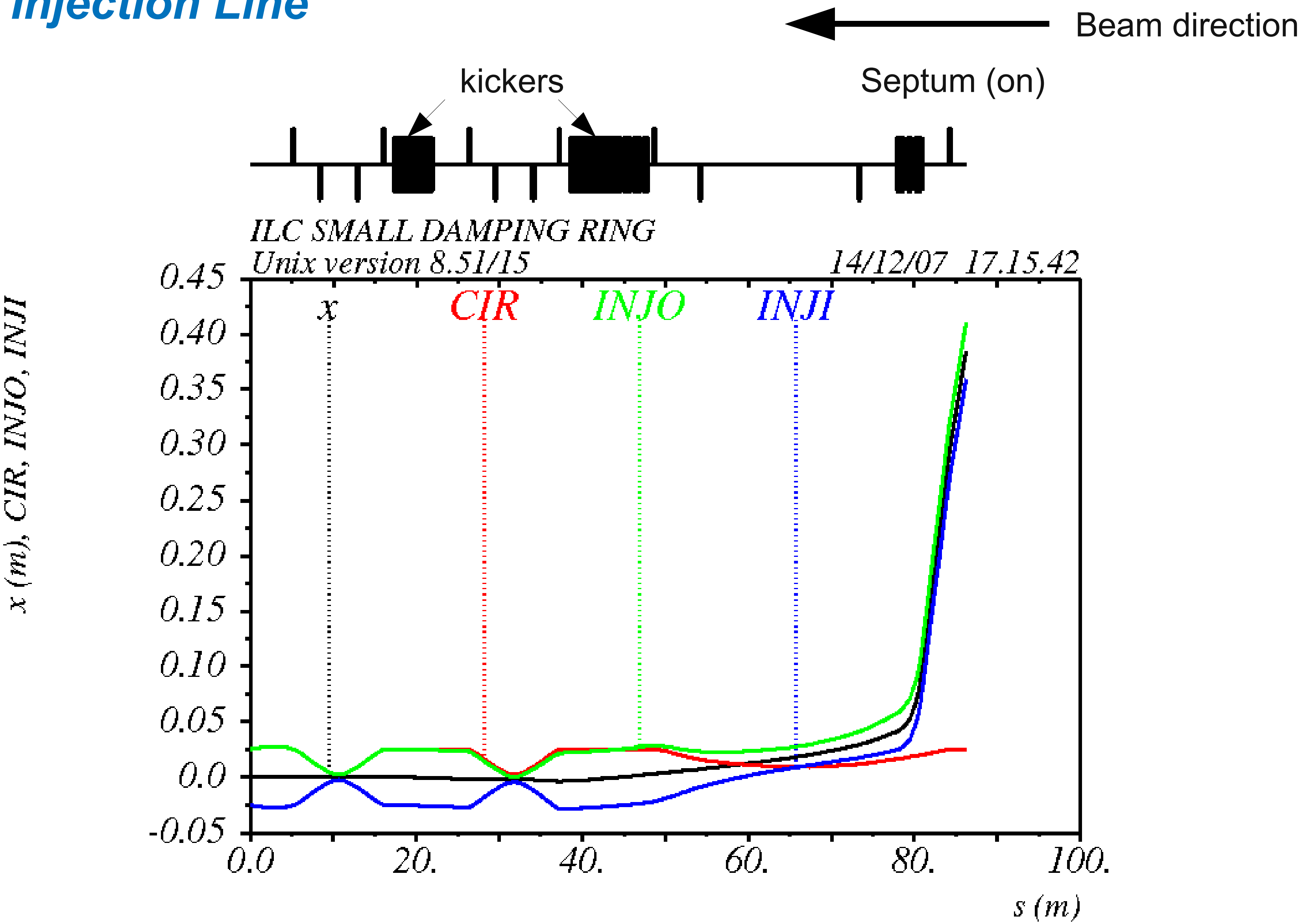
- Strip-line Kicker
  - ± 7.5 KV per strip-line
  - 35 mm radius
  - Beam occupy region < 28 mm (to avoid bad field region)
  - 36 strip-lines for injection; 22 strip-lines for extraction

[1] M. Modena, H. Hsieh and C. Sanelli, "High Current Density Septa for DAΦNE Accumulator and Storage Rings"

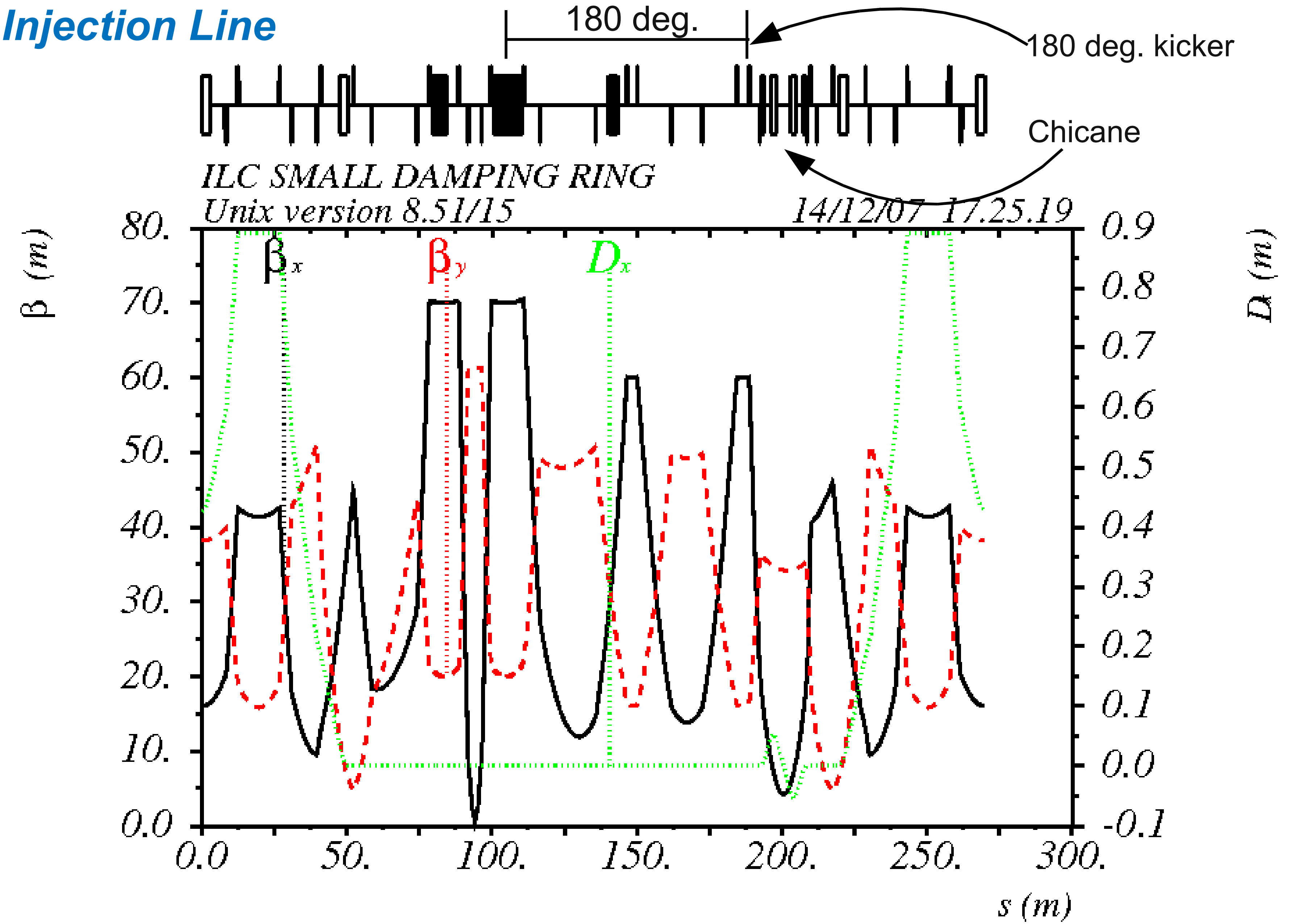
Injection Line



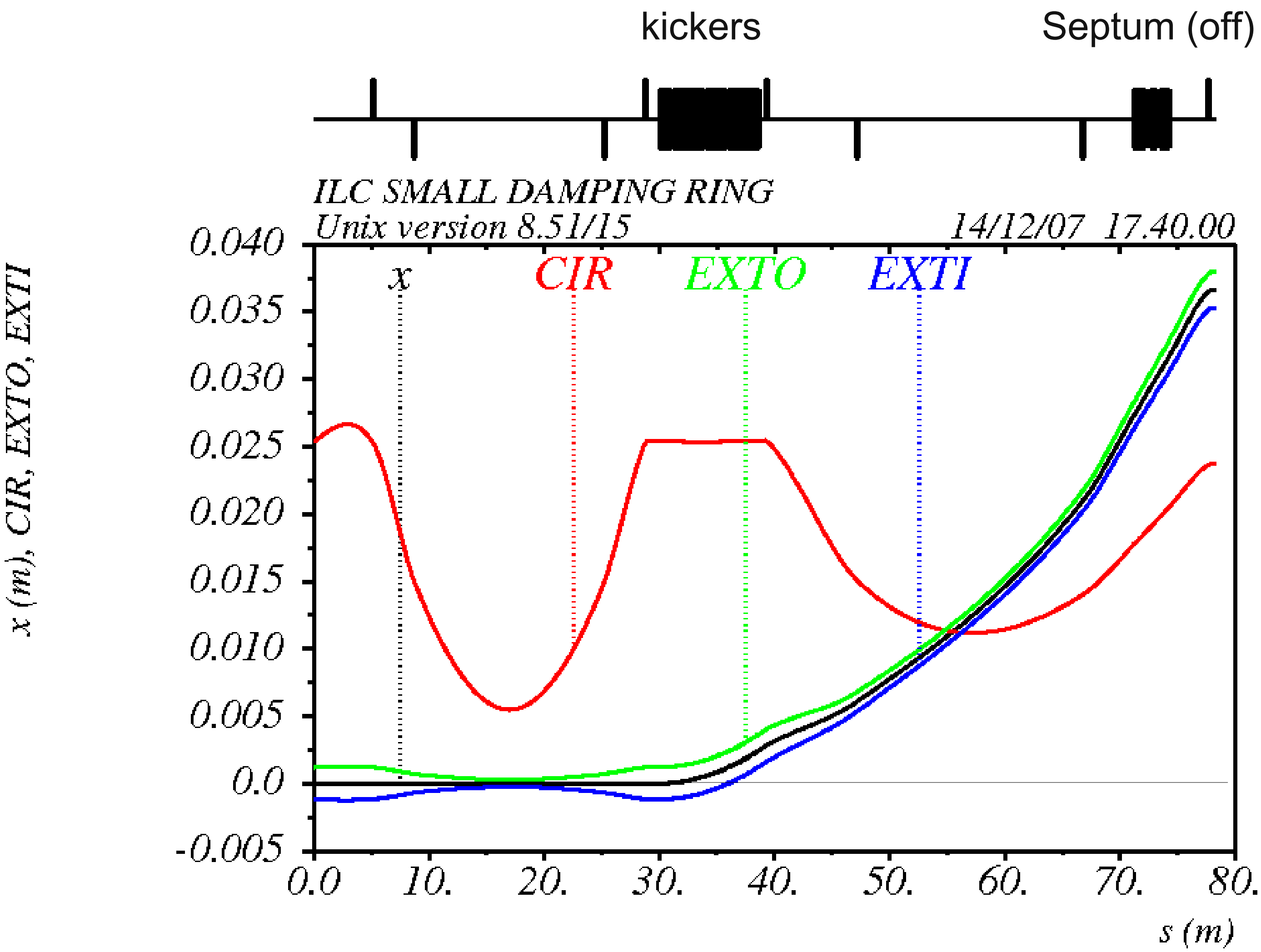
Injection Line

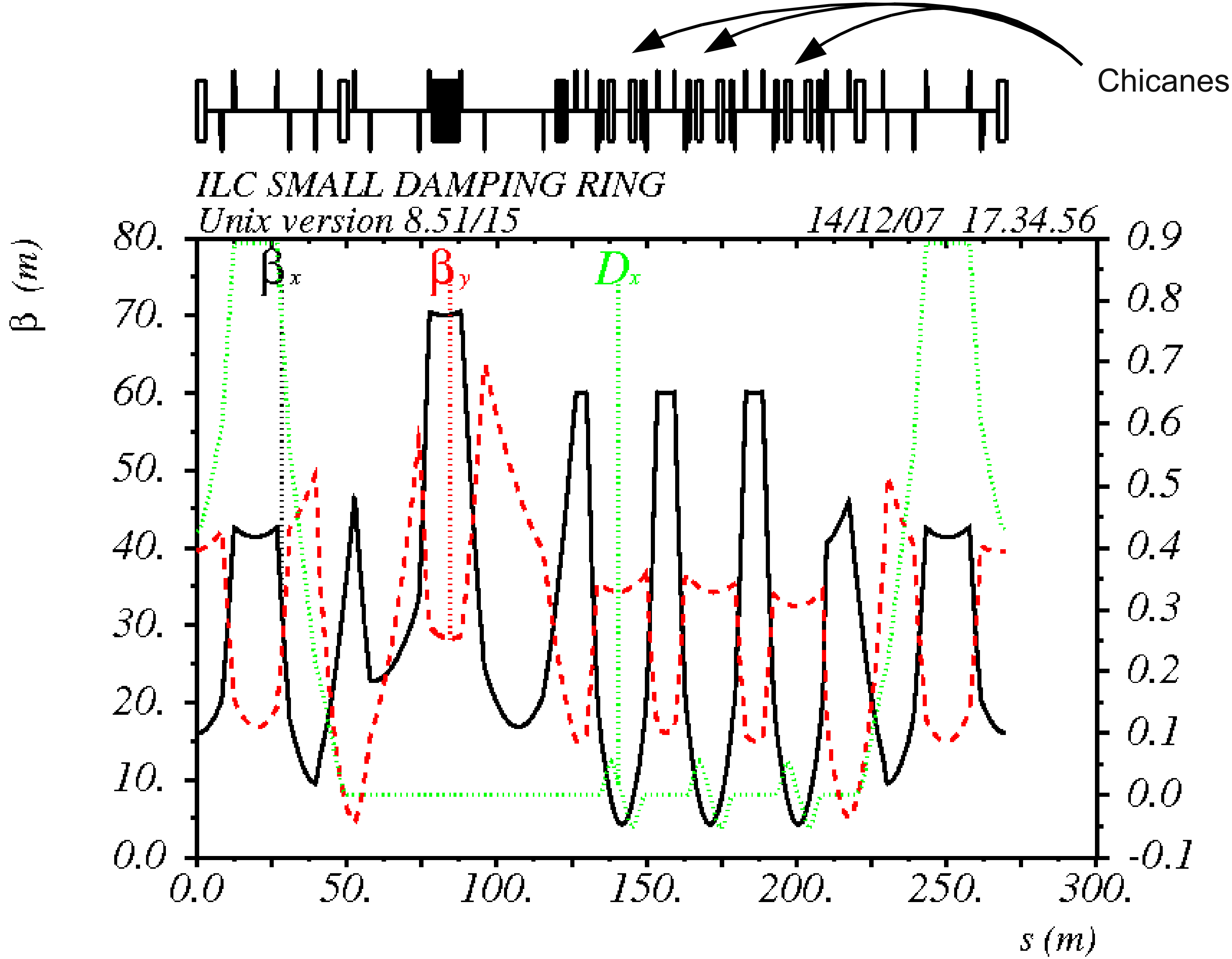


Injection Line



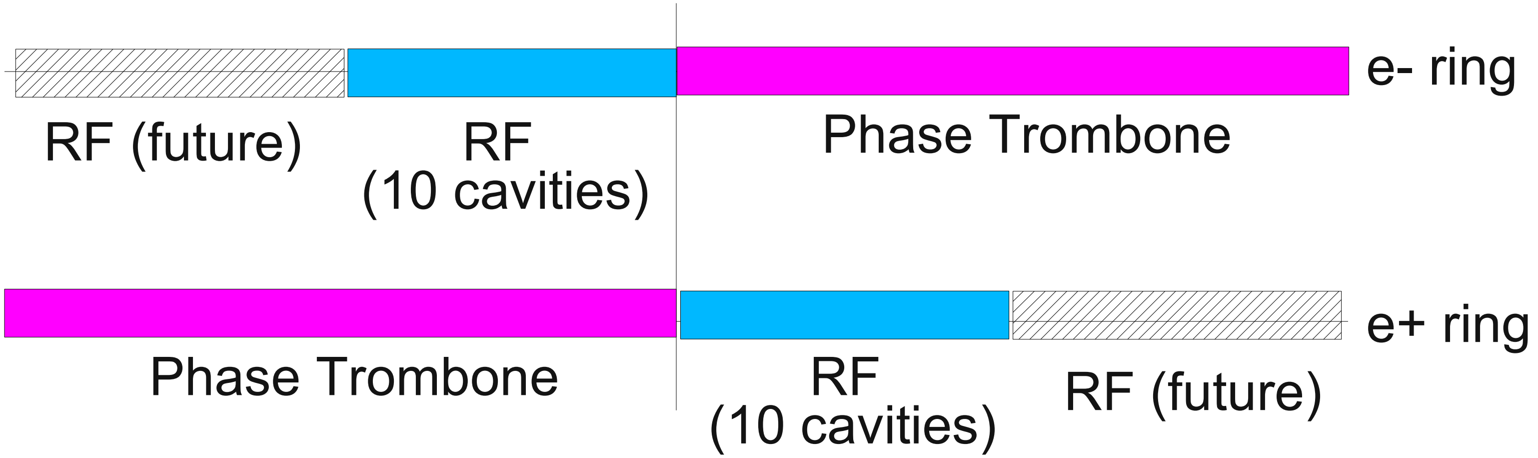
Extraction Line




Chicanes
ILC SMALL DAMPING RING
Unix version 8.51/15
14/12/07 17.34.56
β (m)
Dx (m)
βx
βy
Dx
80.
70.
60.
50.
40.
30.
20.
10.
0.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
0.0
50.
100.
150.
200.
250.
300.
s (m)

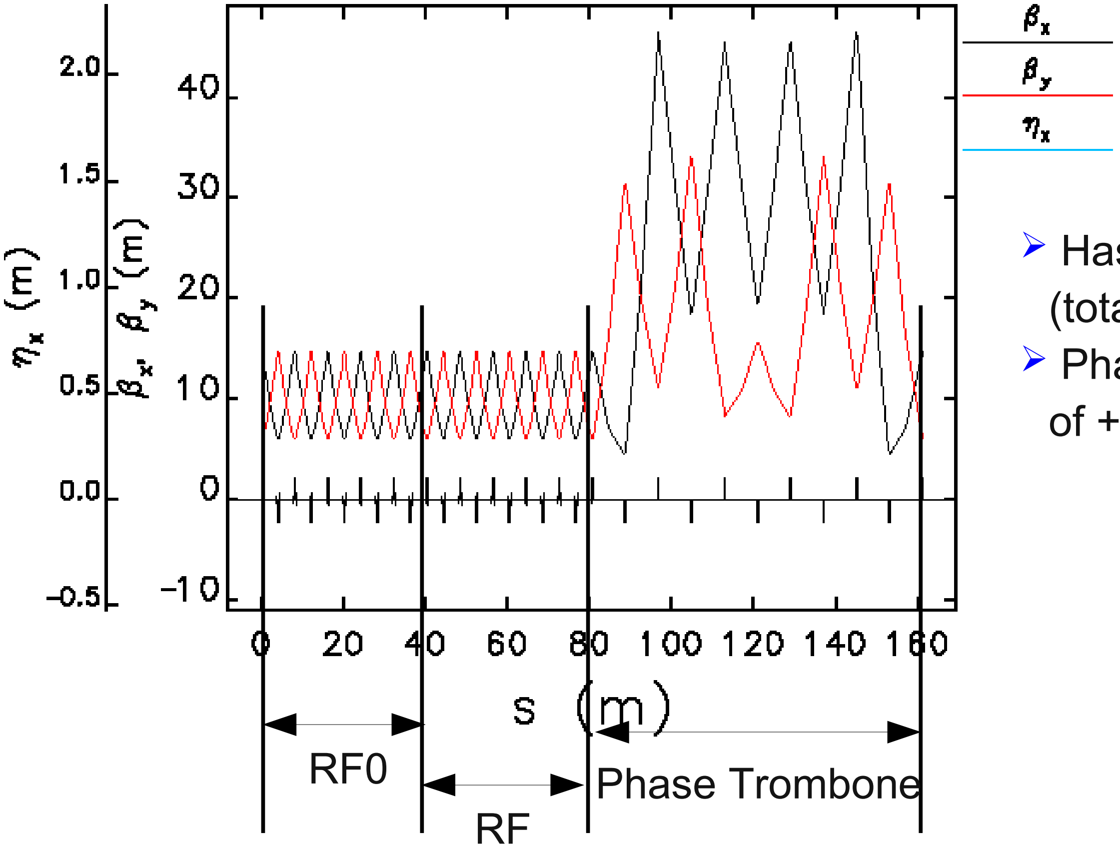
RF Section + Phase Adjustment Trombone

- Now have enough space for the SC rf cavities with end-components.
- Cavities from different rings can not be stacked on top of each other.
- Need to preserve free space for future 6-mm bunch length operation.
- The required rf section length is about 4 times of previous design and is suitable for occupying a stand alone straight section.



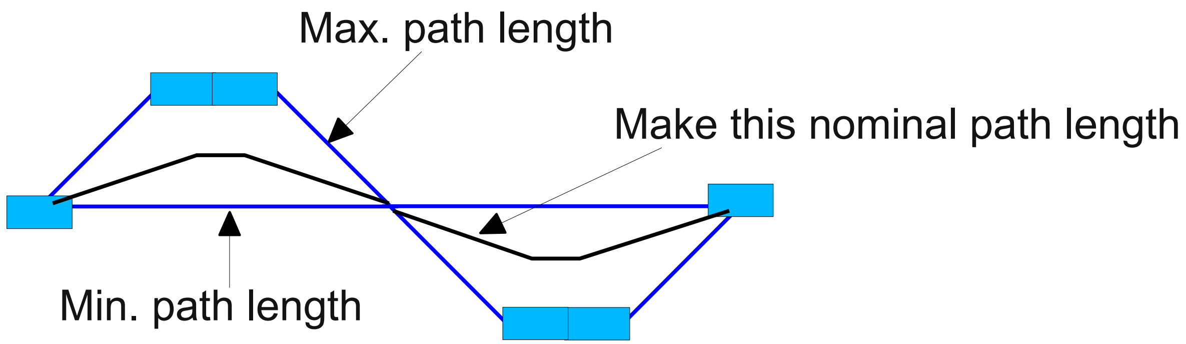
- Both section types have similar lattice configuration. So some quadrupole magnets are directly above another.
- Two rf section section in a ring

RF Section + Phase Adjustment Trombone

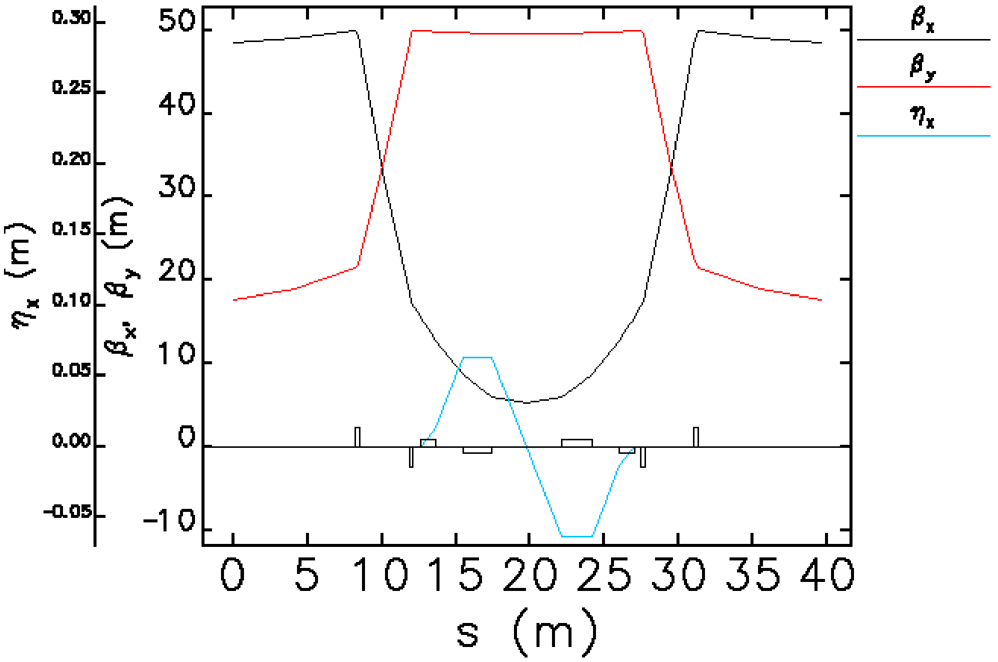


- Has ability to install 10 + 10 rf cavities (total 20 + 20)
- Phase trombone has adjustment ability of +/- 0.25 (total +/- 0.5)

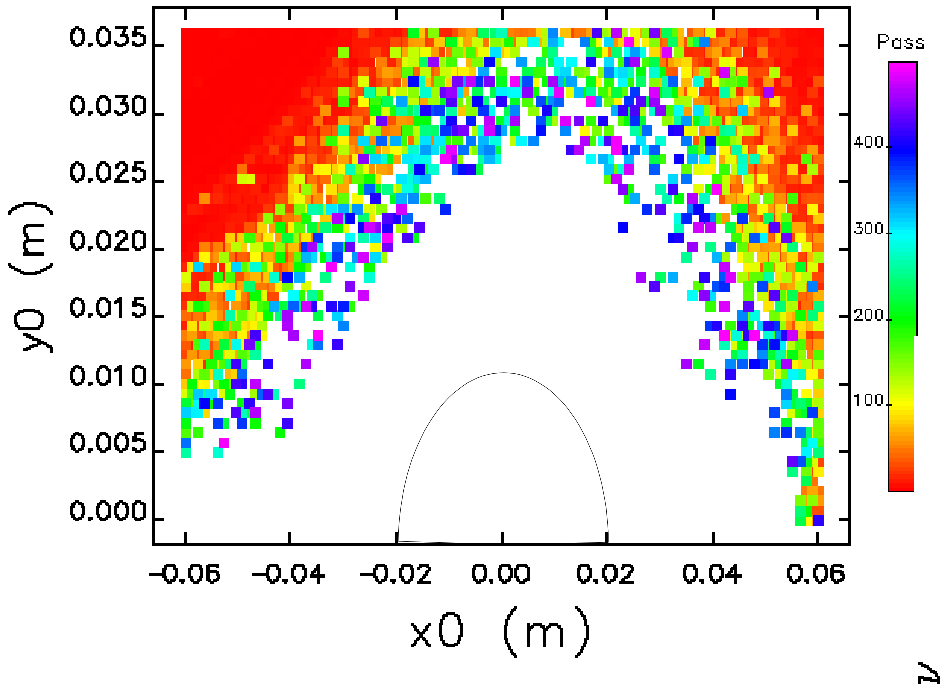
Circumference Adjustment Chicane



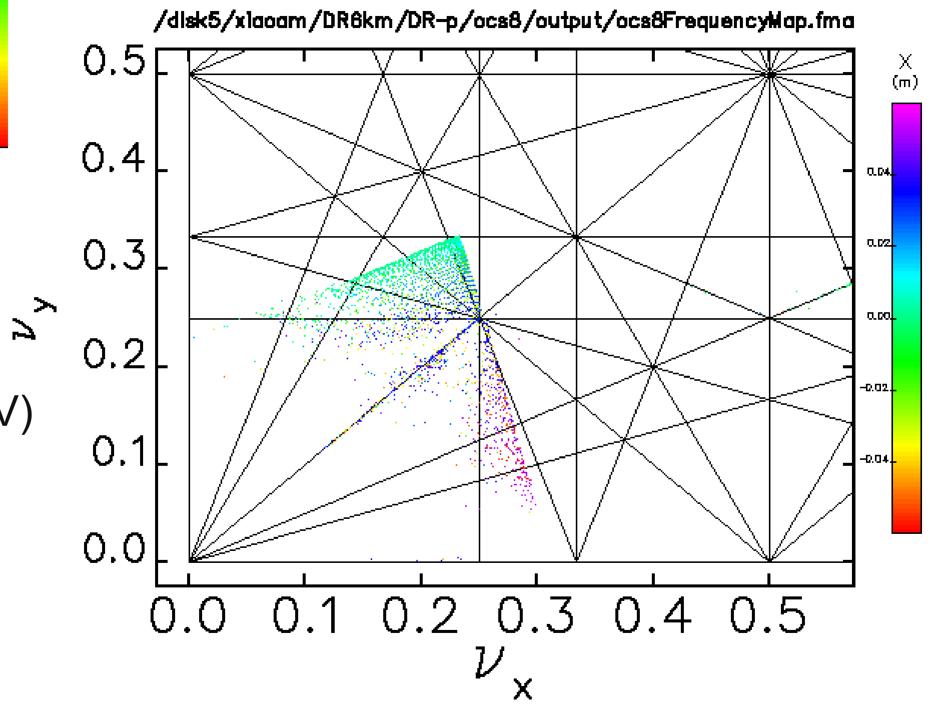
- Adjustment ability: ±7.5 mm
- Emittance dilution: ~15%
- Total 4 cells



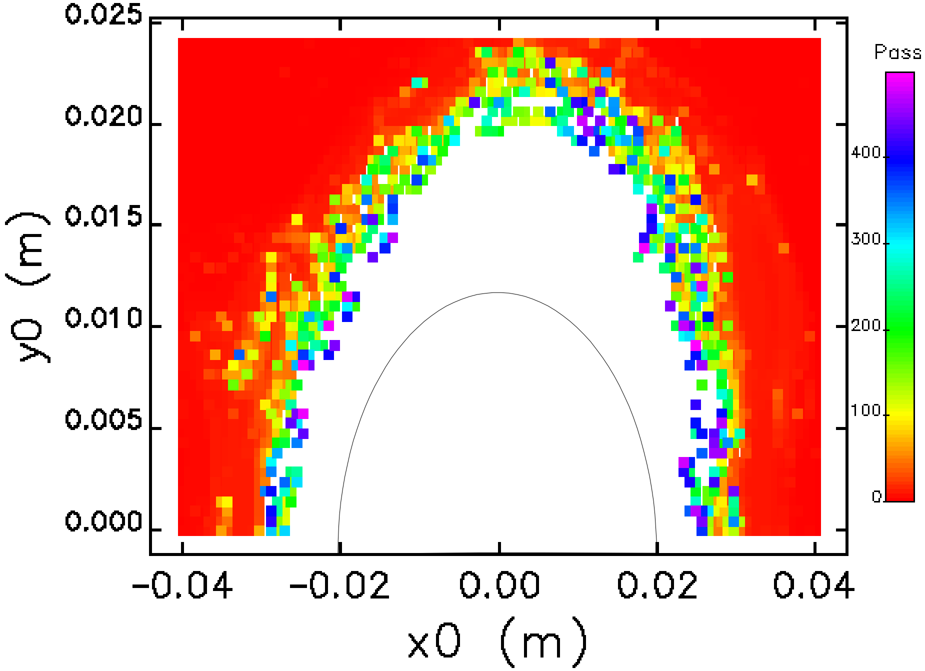
Dynamic Aperture – Without Multipole Errors



Injection beam size: 20 mm (H) x 12 mm (V)



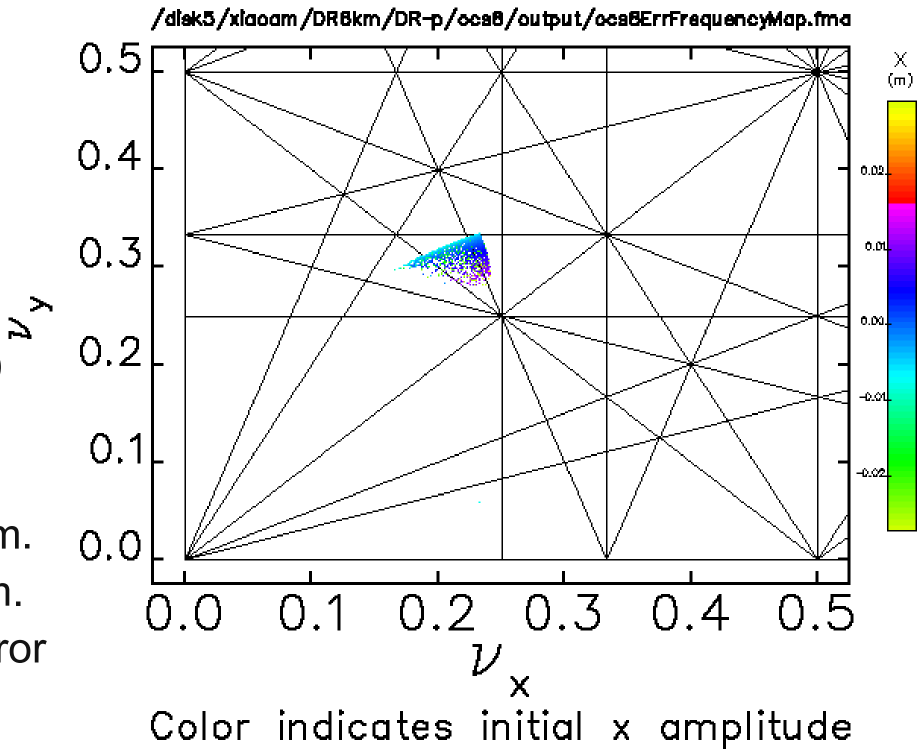
Dynamic Aperture – with Multipole Errors



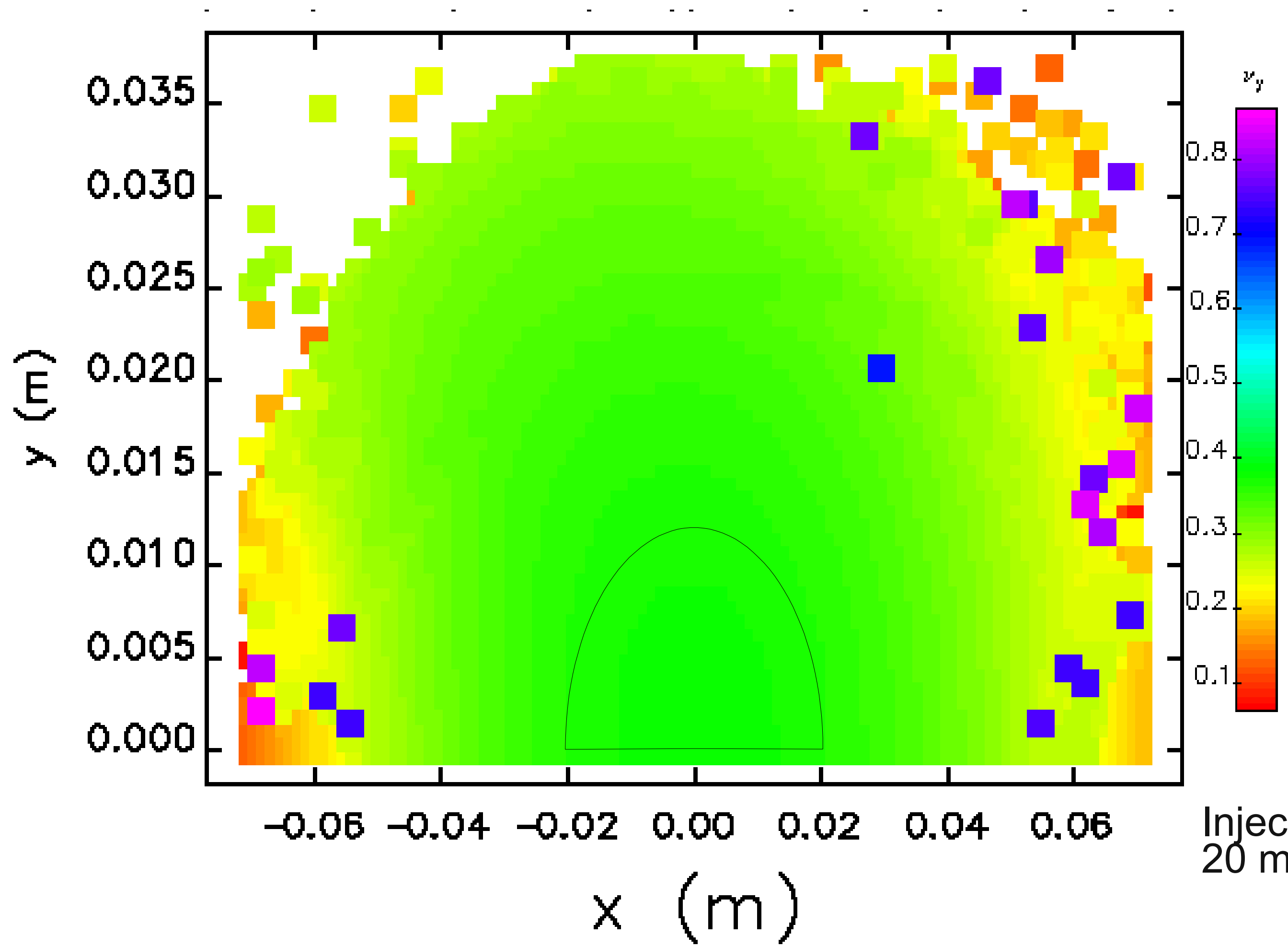
Injection beam size: 20 mm (H) x 12 mm (V)

Error specified by Y. Cai (SLAC).

- The original data is for bore radius of 50mm.
- We scaled the data to bore radius of 30mm.
- Larger magnet size (= weaker multipole error strength) gives larger dynamic aperture.



Dynamic Aperture



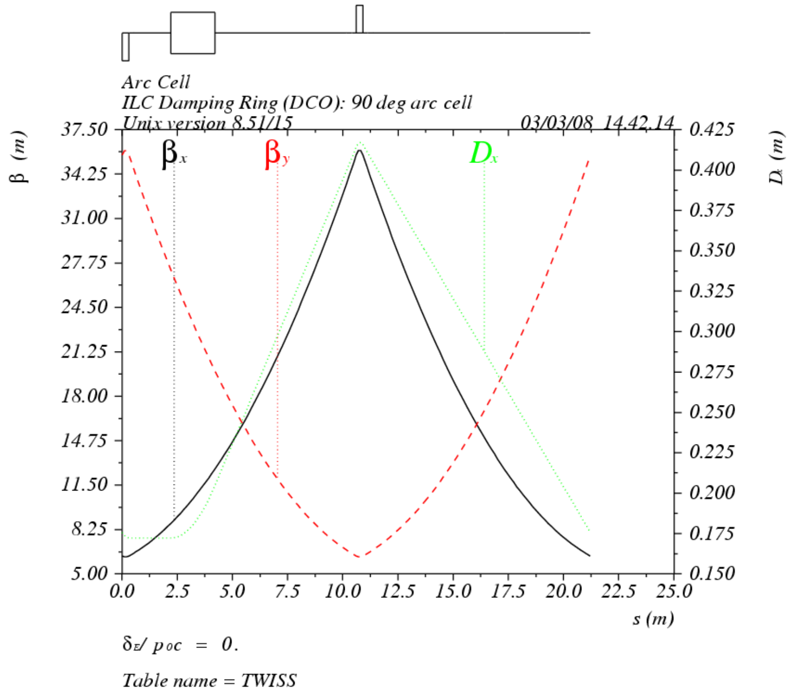
Color indicates y tune

Injection beam size:
20 mm (H) x 12 mm (V)

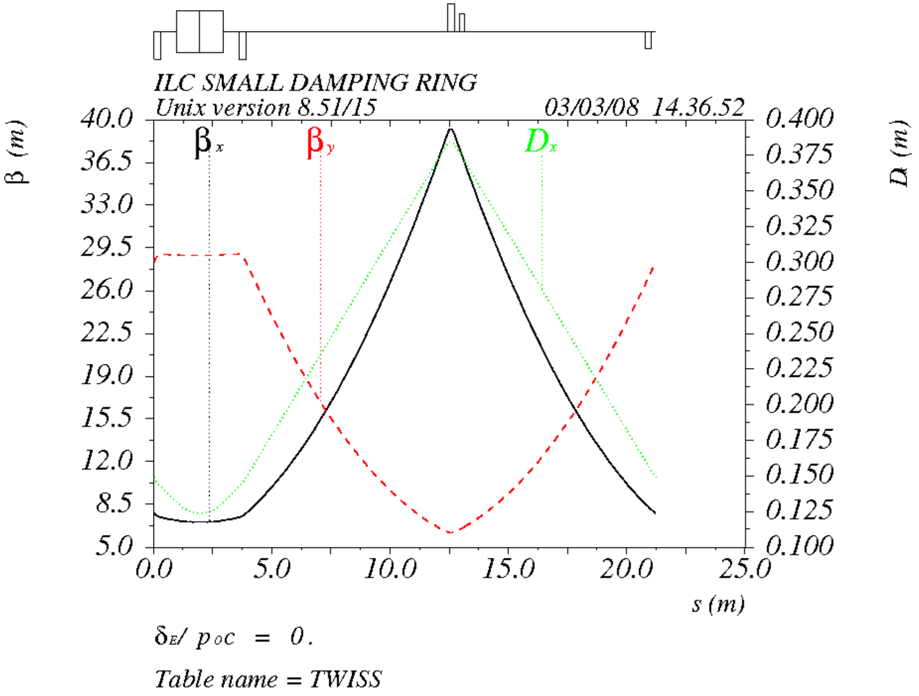
Aperture comparable to before the injection change

Comparing of asymmetry FODO (DCO) with TME (OCS8)

- Use of same dipole strength and cell length to compare radiation effect.
- Both cell provide same radiation damping.



2 quads per cell



3 quads per cell

Arc cell parameter

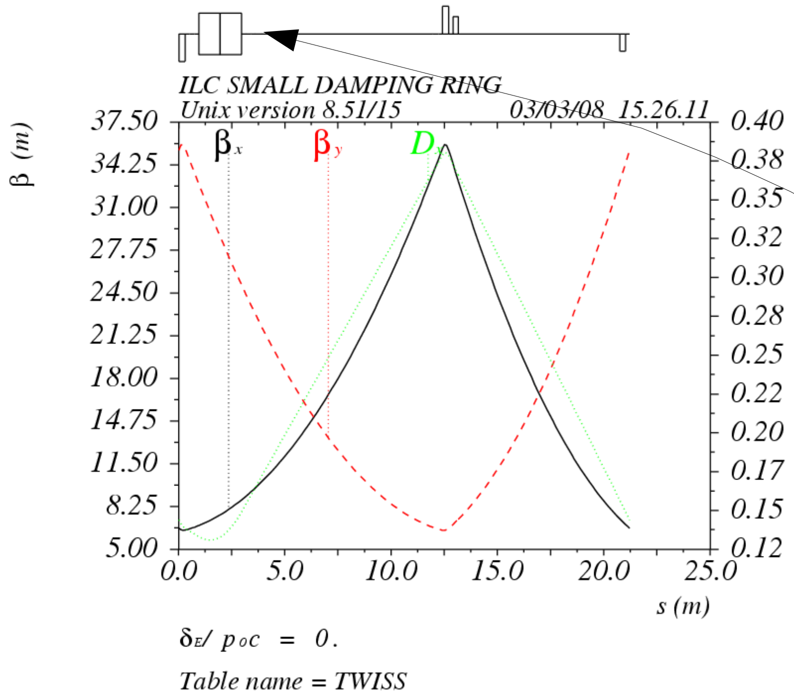
	Nux	I1(E-04)	I5(E-08)	Chrom-x0	Chrom-y0
DCO-High Alpha	0.206(74)	96.5	6.63	-0.24	-0.23
TME-High Alpha	0.186(67)	96.5	7.28	-0.23	-0.19
DCO-Mid Alpha	0.25(90)	60.0	3.46	-0.32	-0.32
TME-Mid Alpha	0.22(80)	58.7	3.75	-0.29	-0.24
● DCO-Low Alpha	0.279(100)	45.2	2.38	-0.38	-0.38
● TME-Low Alpha	0.25(90)	41.3	2.36	-0.35	-0.28

Note:

- For same required alpha(I1), both cell provide similar quantum excitation (I5).
- DCO has less quads (2/cell) than TME (3/cell).
- TME has less phase advance for low alpha (90 deg.) – probably would have better DA (?)

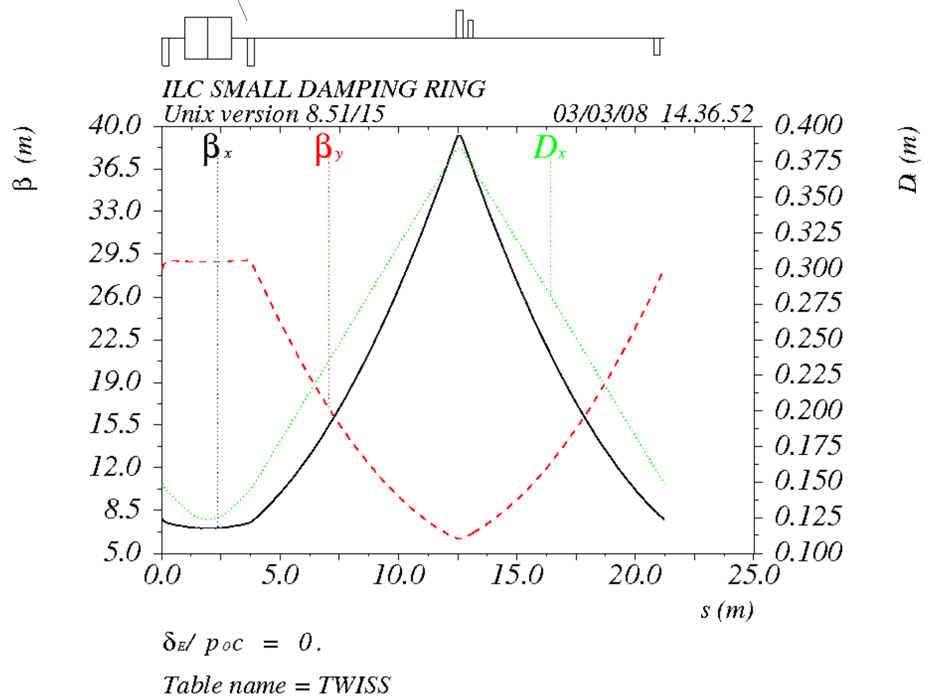
A FODO/TME cell (?)

- DCO has many advantage than TME (A. Wolski's note)
  - Less magnets (2 quads/cell)
  - Separation between dipole and downstream quad (positron ring) is large.
  - ...
- But it has DA problem for low-alpha optics
- TME cell provide same alpha with less phase advance per cell
  - 90 deg. for low alpha
  - Possible of using non-interleave sextupole to solve DA difficulty (?) (unfortunately we don't have time to confirm it)
- Can a cell be tuned between this two structures?



Turn off this quad.

TME become to asymmetry FODO (DCO)



Summary

- No much change to OCS8 lattice since last December.
  - OCS8 had been slightly changed to suit injection requirement.
- Compared asymmetry FODO cell (DCO) and TME. Found out that for same alpha, DCO and TME will do similar work.
- DCO has less quads number (2/cell) than TME (3/cell)
- TME may have better performance at low alpha operation (90 degree phase advance) (Not confirmed)
- TME can be changed to DCO by turning off 1 quad. May provide smooth optics change when change alpha (Not confirmed)