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ILC Damping Ring Lattice – Status Report

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U.S. Department of Energy

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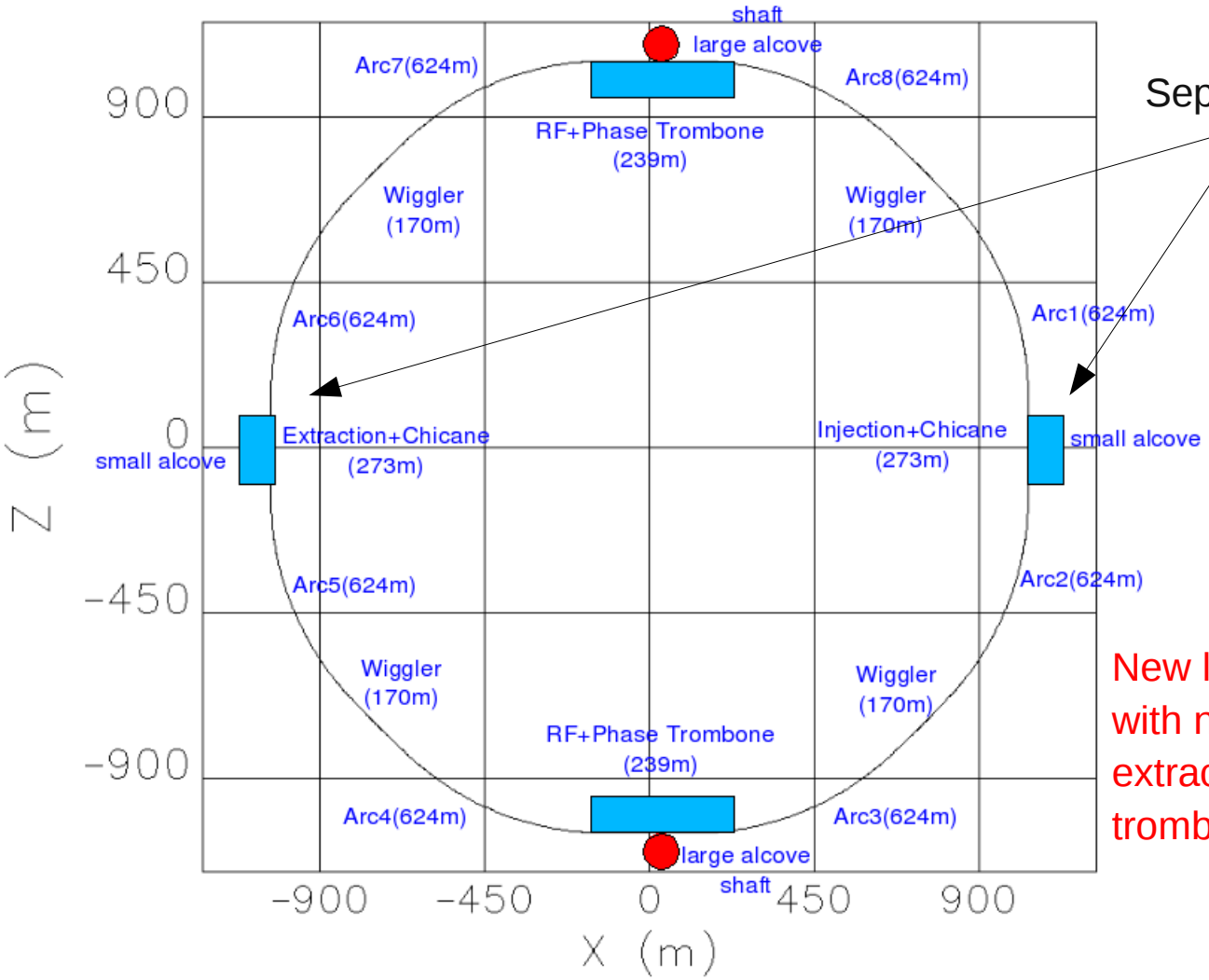
Outline

- New 8-fold symmetric lattice on ILC Cornell wiki pages, as of 12/18/2007
  - Separated injection/extraction line
  - Lumped injection/extraction kickers (10 kV pulsers)
  - RF sections adjusted to accommodate SC rf cavities
  - Phase trombone
  - Circumference-adjustment chicane
  - Dynamic Aperture
- Next iteration to be completed soon (not in time for 12/18/2007)
  - Go back to separated groups of kickers (7 kV pulsers)
  - Path length adjusters split unequally among injection and extraction section (from FODO cell alternative)
- FODO-cell alternative lattice (separate talk)
  - All straight-section features in two sections
  - DA performance comparison
- Near term deliverables

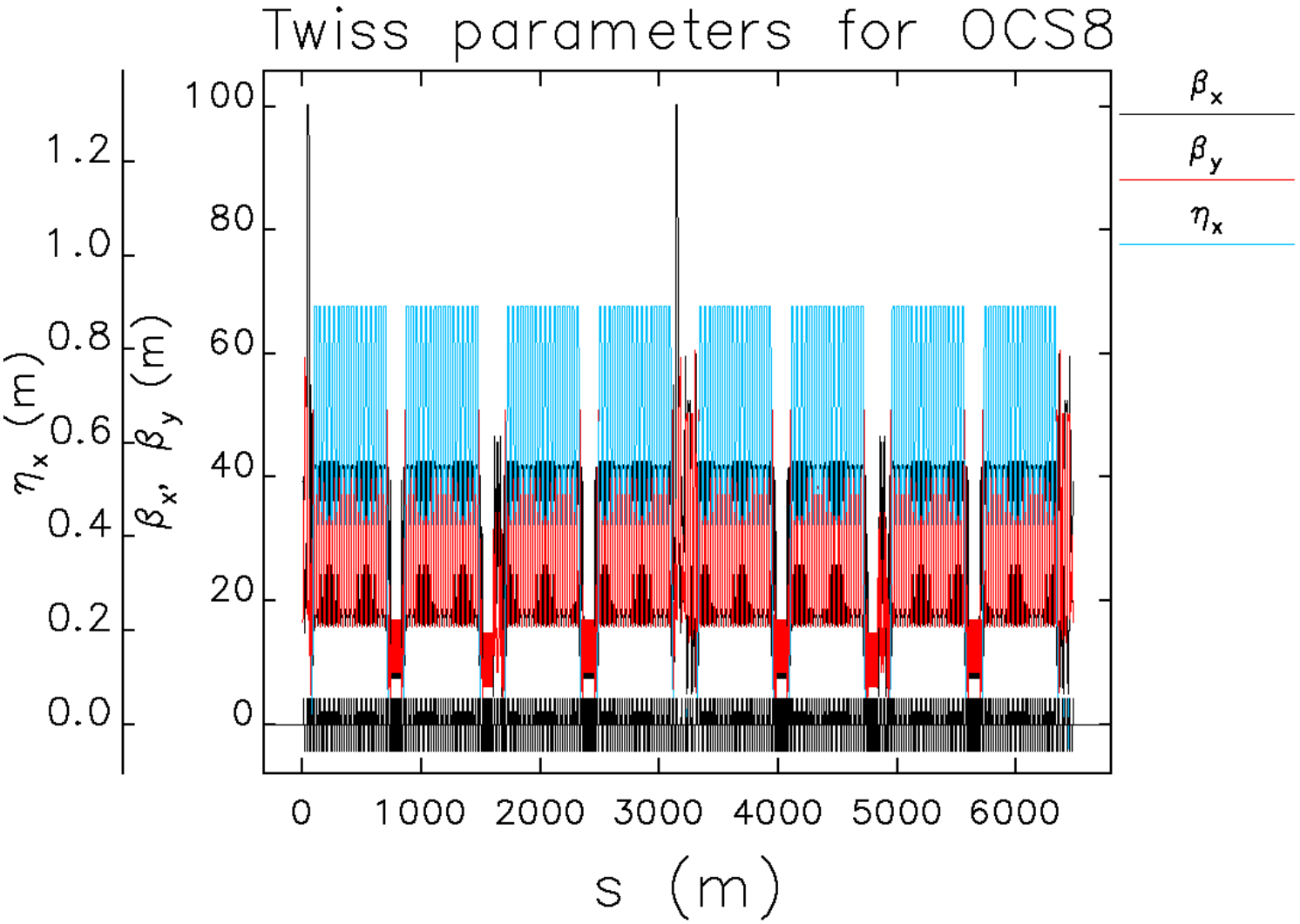
ILC Damping Ring RDR Lattice (OCS8) – Ring's Layout



Separated Injection/Extraction

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

Optical Functions

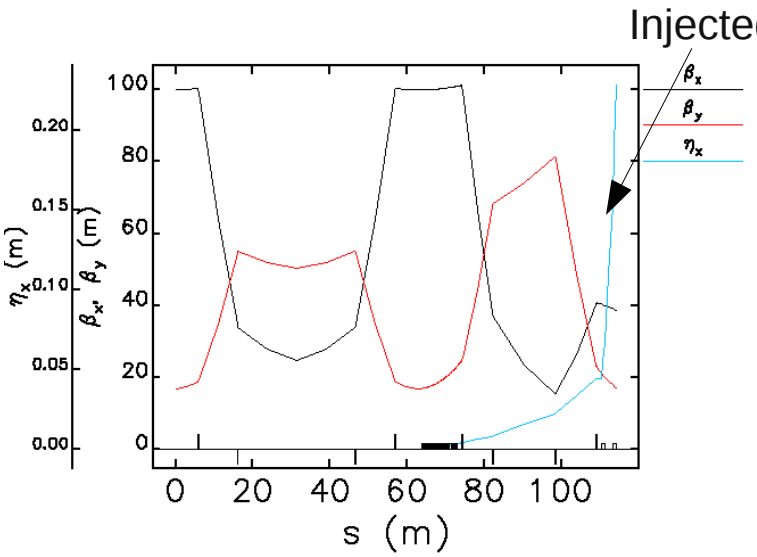


Main Parameters

Table 1: OCS8 Principal Lattice Parameters

Energy	E	5 GeV
Circumference	C	6476.4395 m
Betatron tunes	ν_x, ν_y	49.23, 53.34
Chromaticity	ξ_x, ξ_y	-63.7, -63.3
Momentum compaction	α	3.96×10^{-4}
Natural emittance	$\gamma\epsilon_x$	$4.95\mu m$
Damping time	$\tau_{x(y)}$	25 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	9mm
Equilibrium energy spread	σ_δ	0.128%

Lumped Injection/Extraction Line (now superceded)

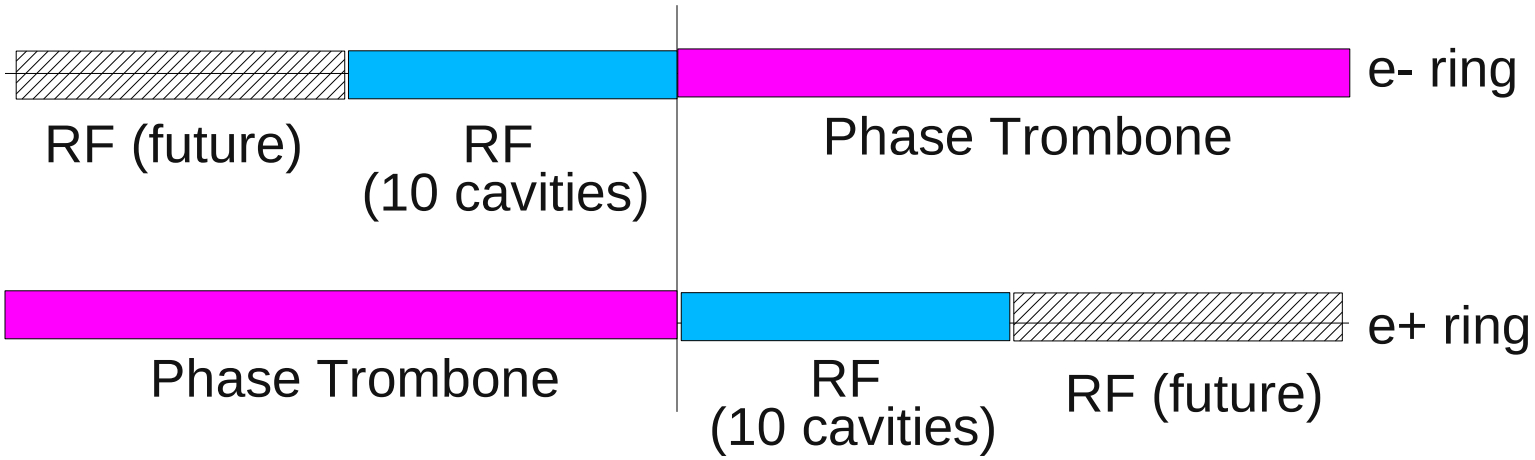


Design of Injection/Extraction

- Strength of fast strip-line kicker is very weak.
- With 70 mm gap and 10 kV pulser voltage on opposite strip-lines, 23 strip-line kickers are needed, and can be put into one straight section.
- Extraction line is the same as injection line but with fewer strip-line kickers.

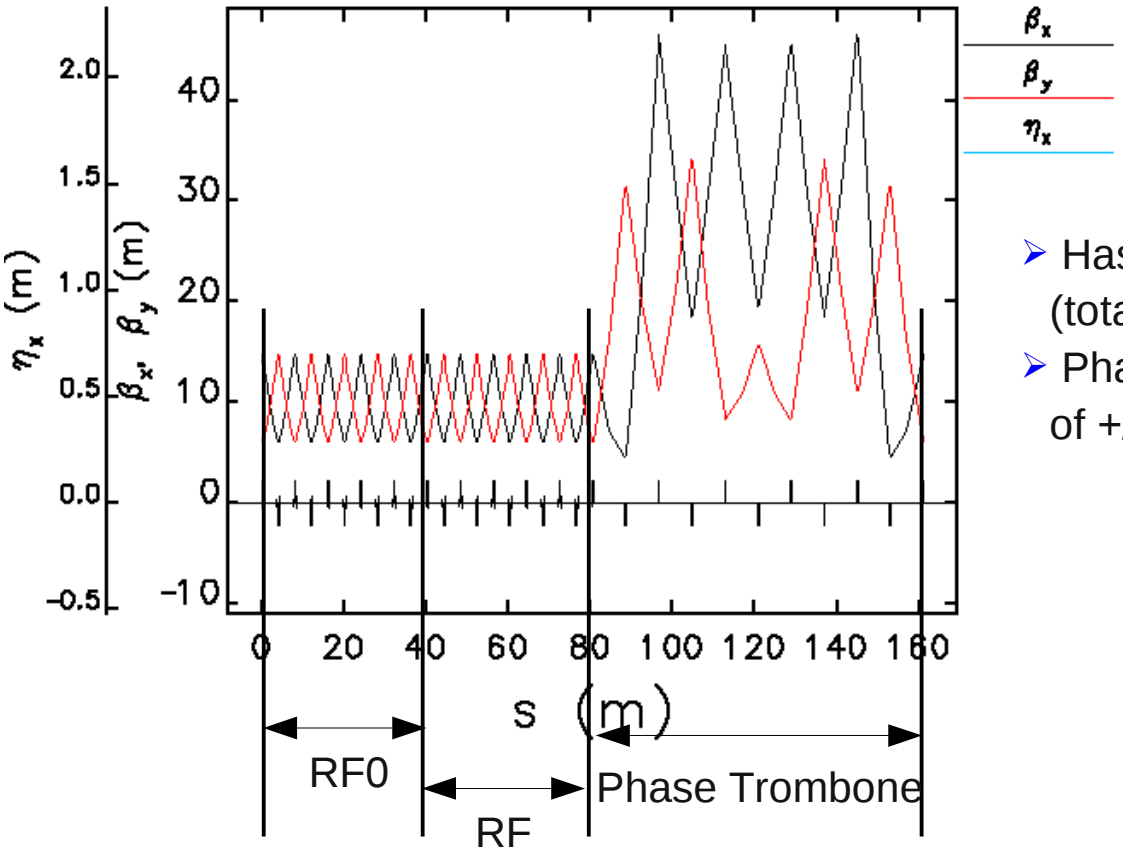
RF Section + Phase Adjustment Trombone

- 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.



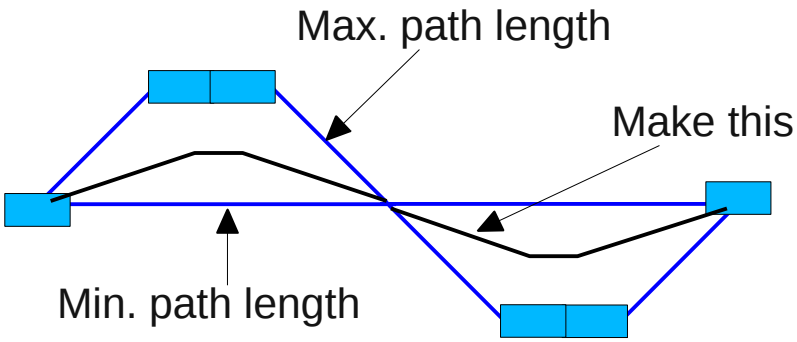
- Both section types have similar lattice configuration. So some quadrupole magnets are directly above another.
- Two rf section section in a ring

RF Section + Phase Adjustment Trombone

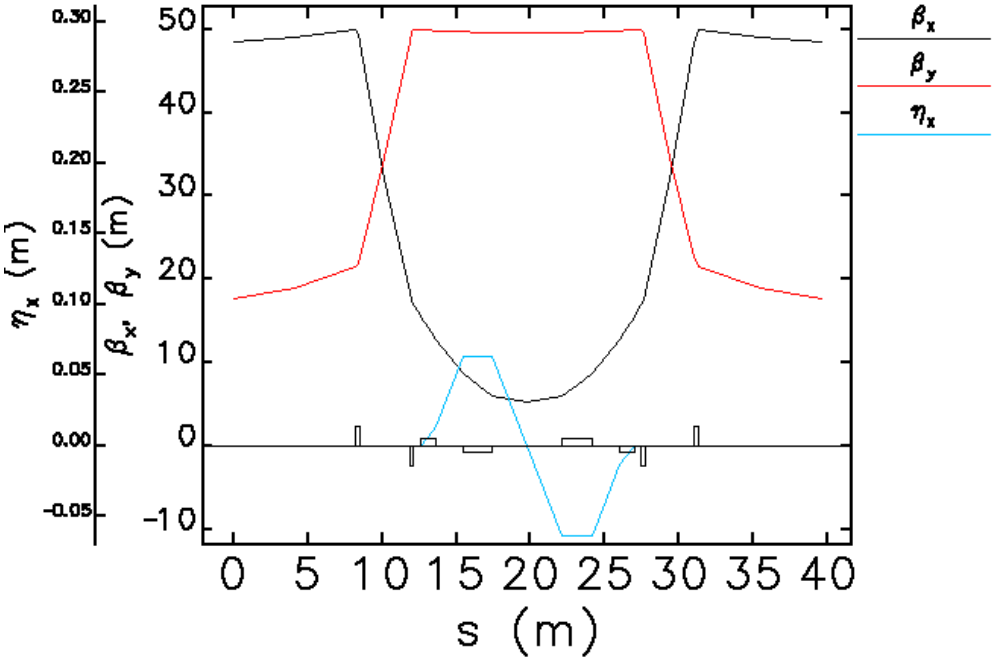


- Has ability to install 10 + 10 rf cavities (total 20 + 20)
- Phase trombone has adjustment ability of +/- 0.25 (total +/- 0.5)

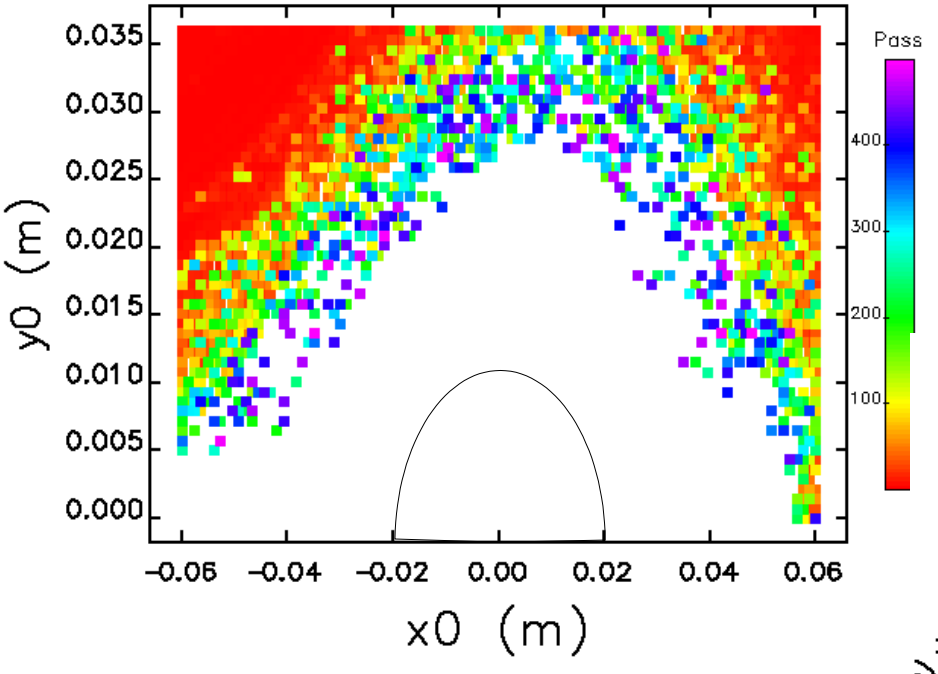
Circumference Adjustment Chicane



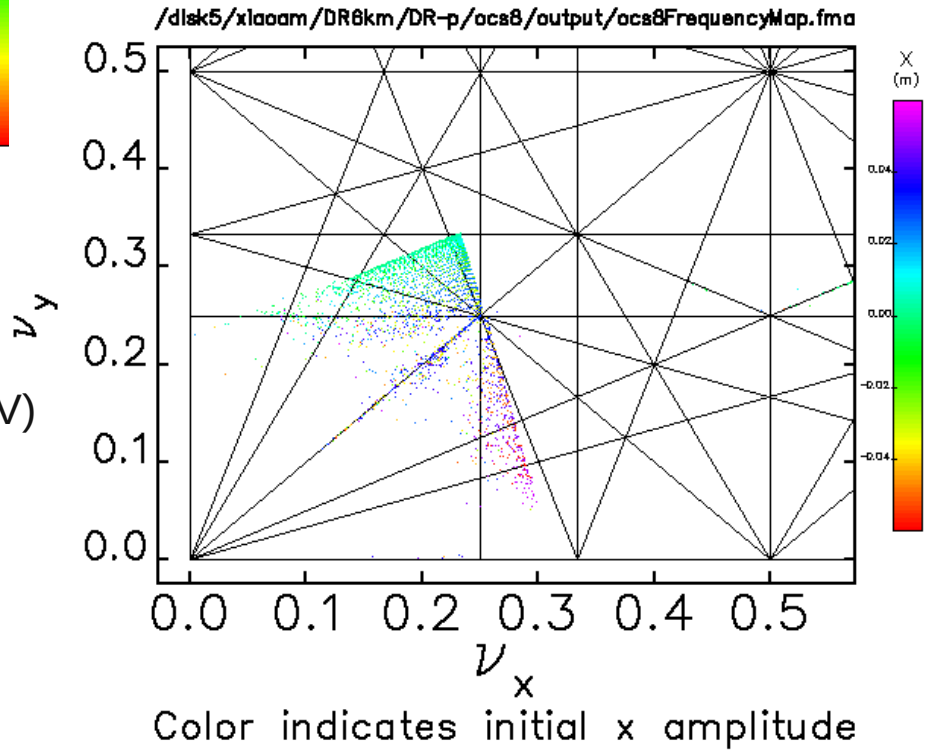
- Adjustment ability: ±7.5 mm
- Emittance dilution: ~15%
- Total 4 cells



Dynamic Aperture – Without Multipole Errors

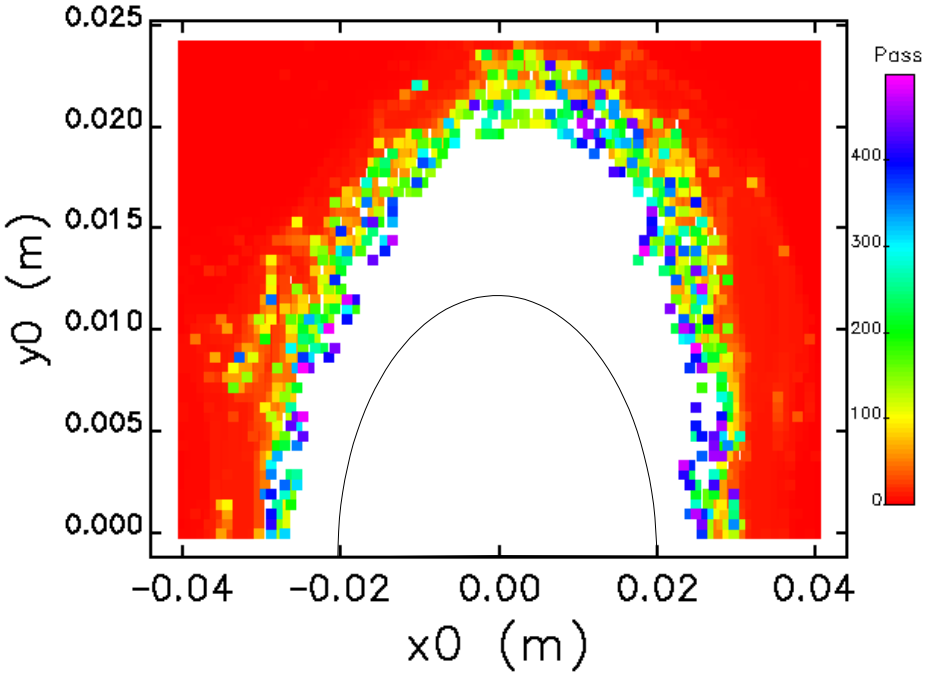


Injection beam size: 20 mm (H) x 12 mm (V)

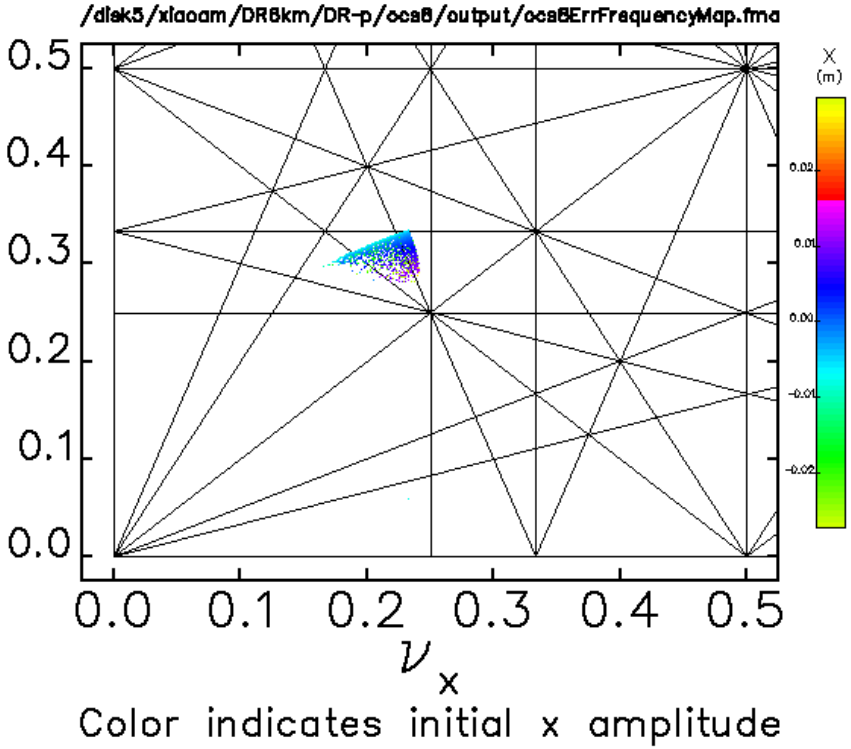


Color indicates initial x amplitude

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.

Summary of work as of Nov. 2007

- New injection/extraction configuration with one group of kickers
  - To be changed in next version
- The circumference was adjusted to suit the new rf harmonic number
- New rf region for accommodating large SC rf cavity
- Added phase trombone (may not be needed) and chicane
- The dynamic aperture had been checked with and without error

Realistic Septum and Kickers for Injection

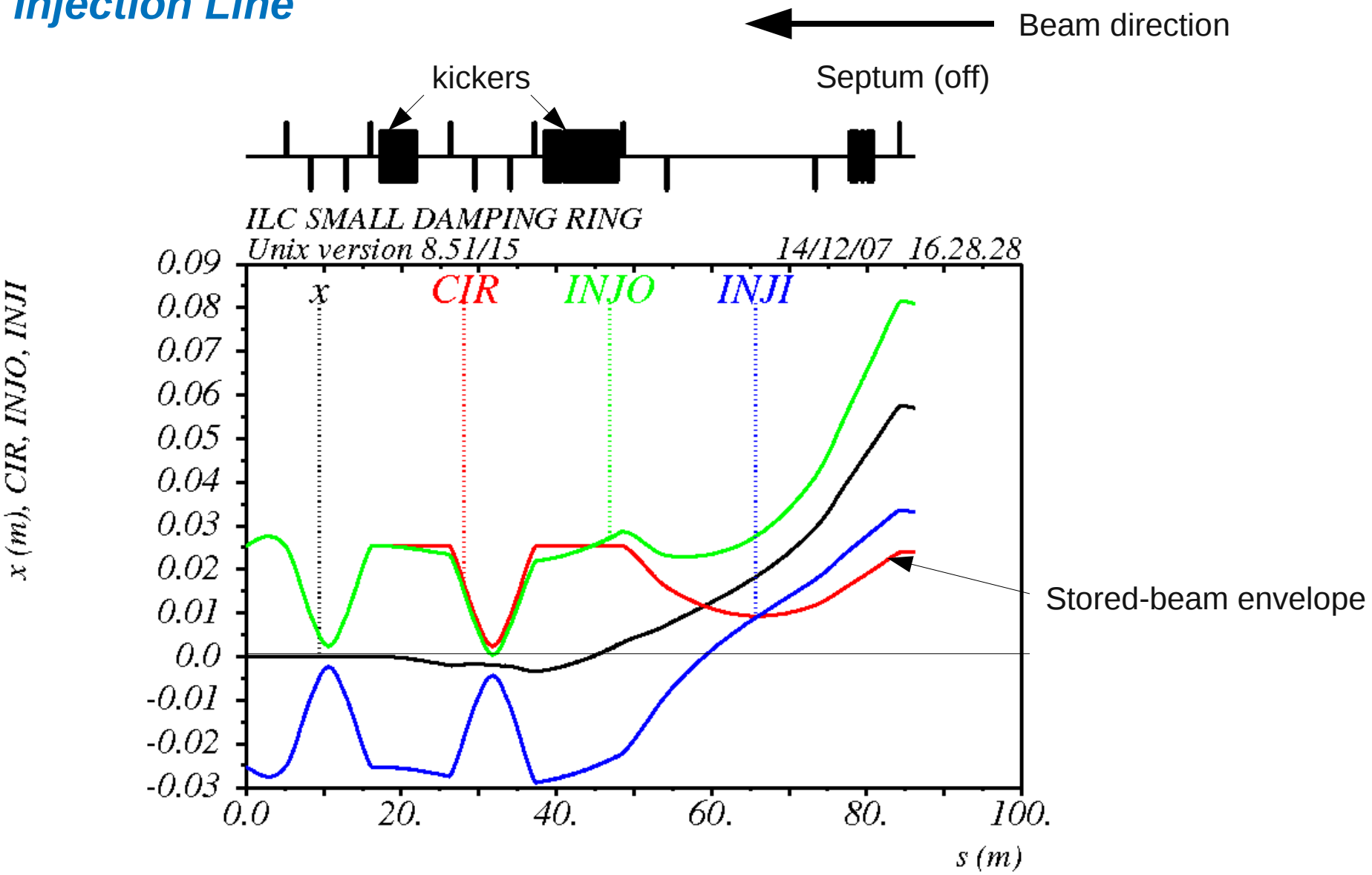
- Possible DC Septum performance (from Daphne)[1]

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)

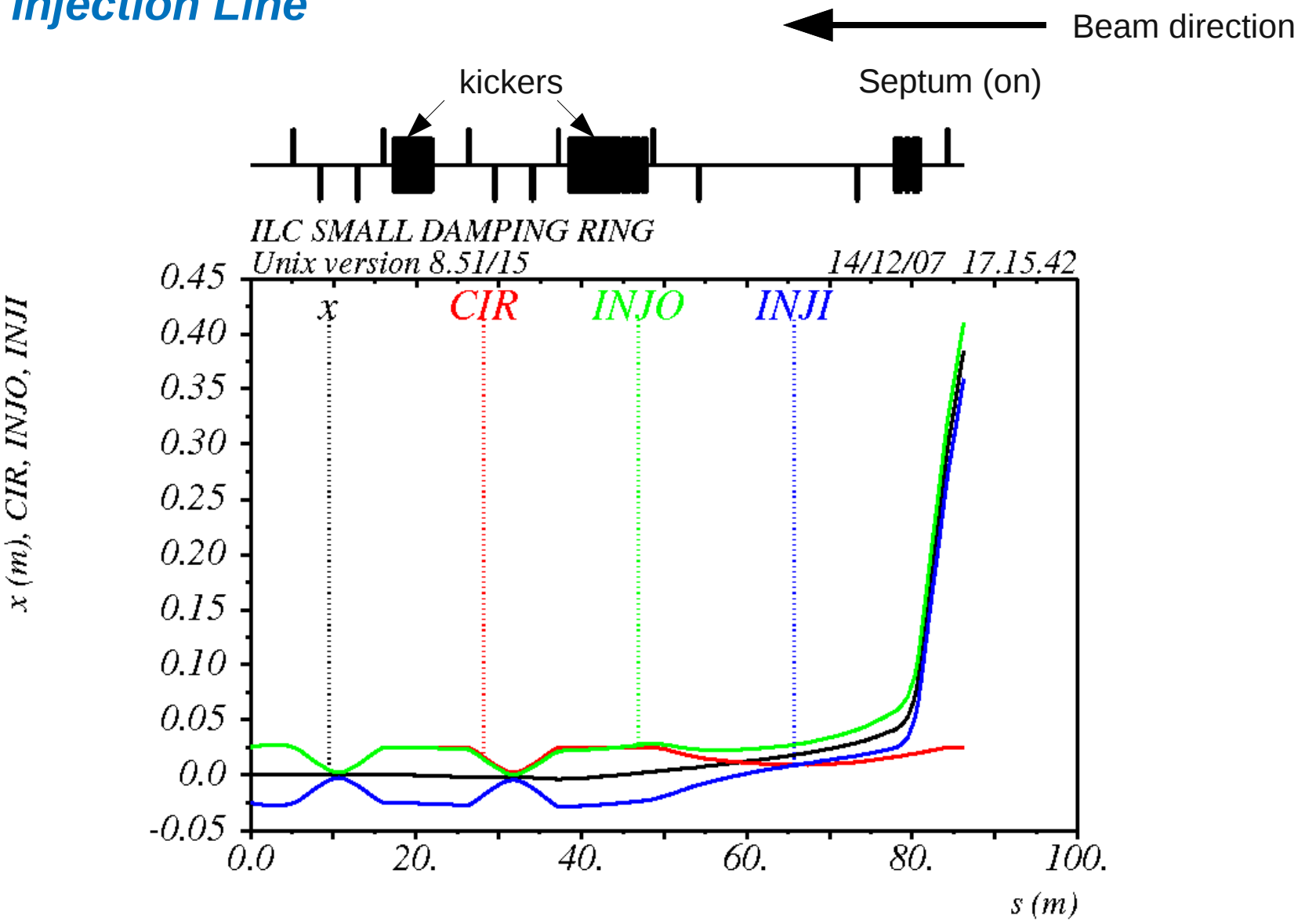
- Strip-line Kicker
  - ± 7.5 KV per strip-line
  - 35 mm radius
  - Beam occupy region < 28 mm (to avoid bad field region)
  - 36 strip-lines for injection; 22 strip-lines for extraction

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

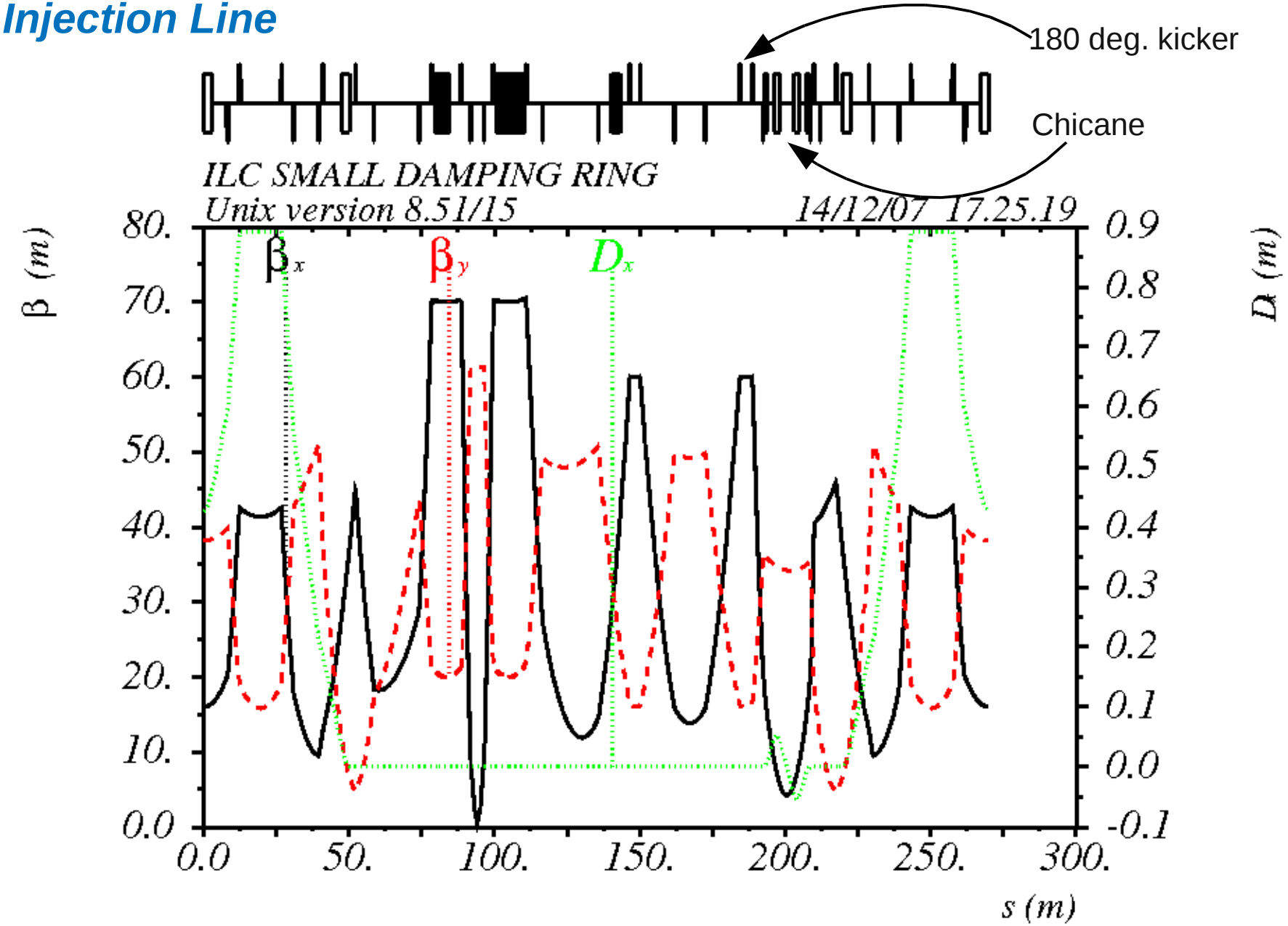
Injection Line



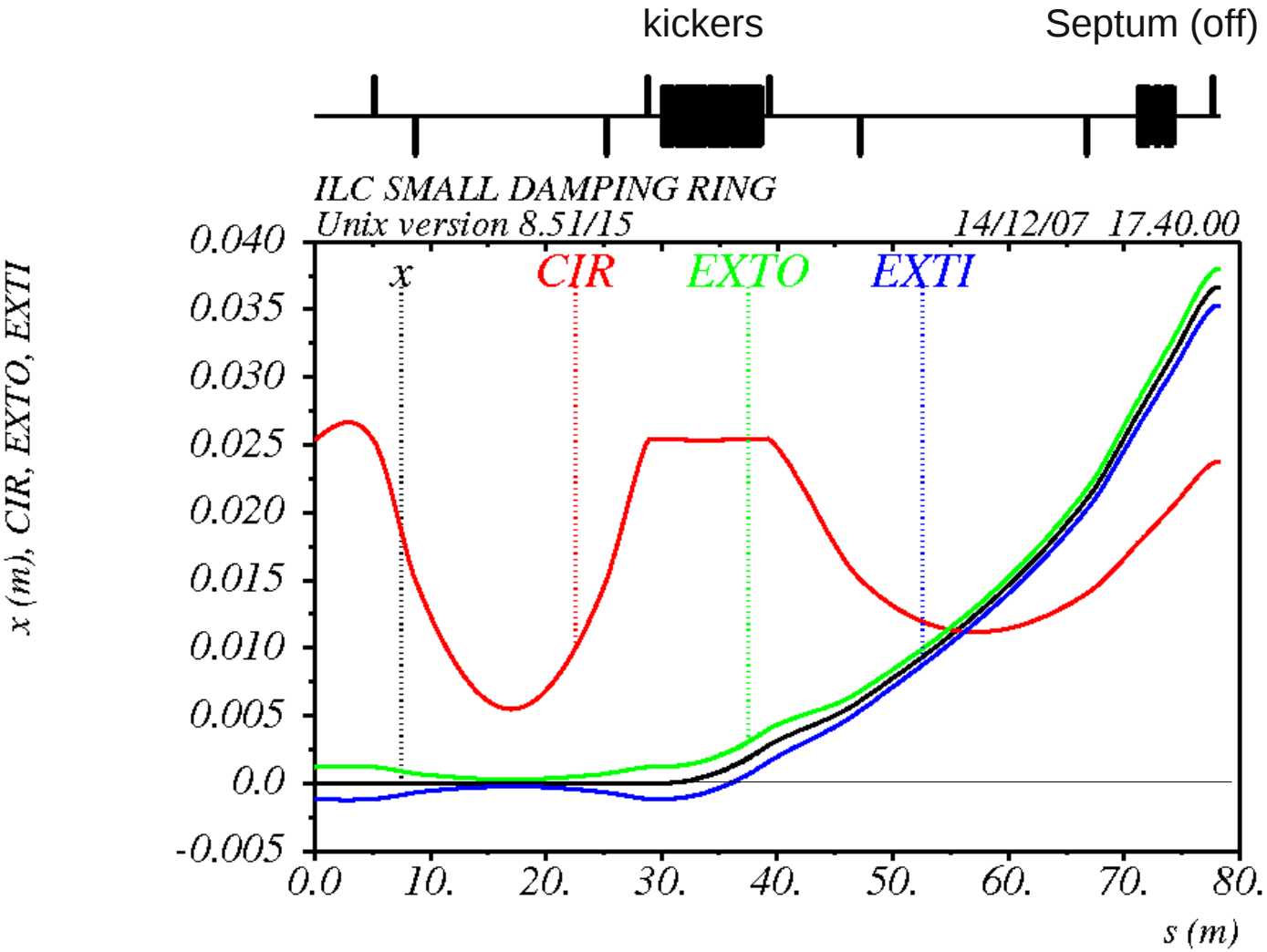
Injection Line

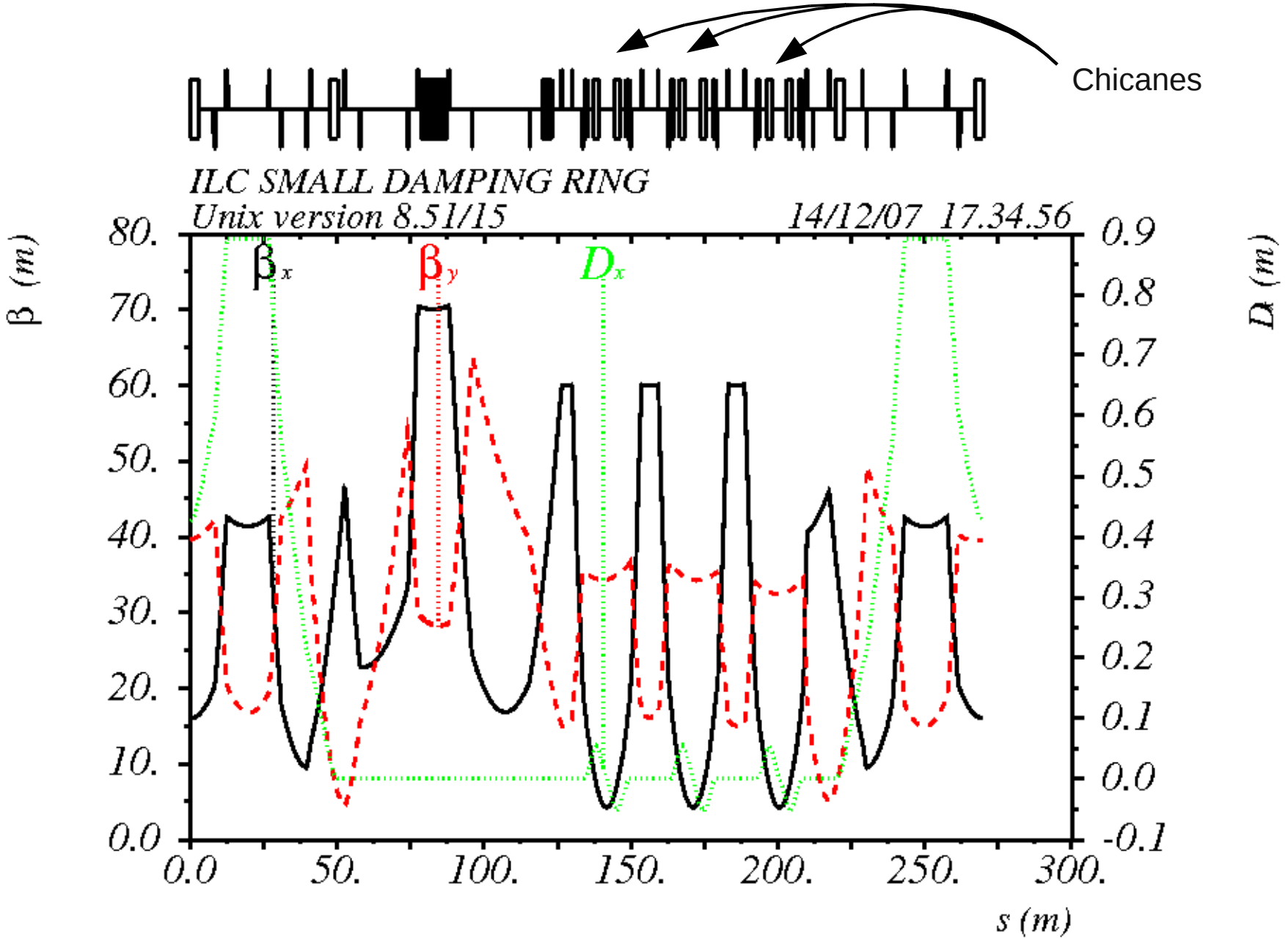


Injection Line

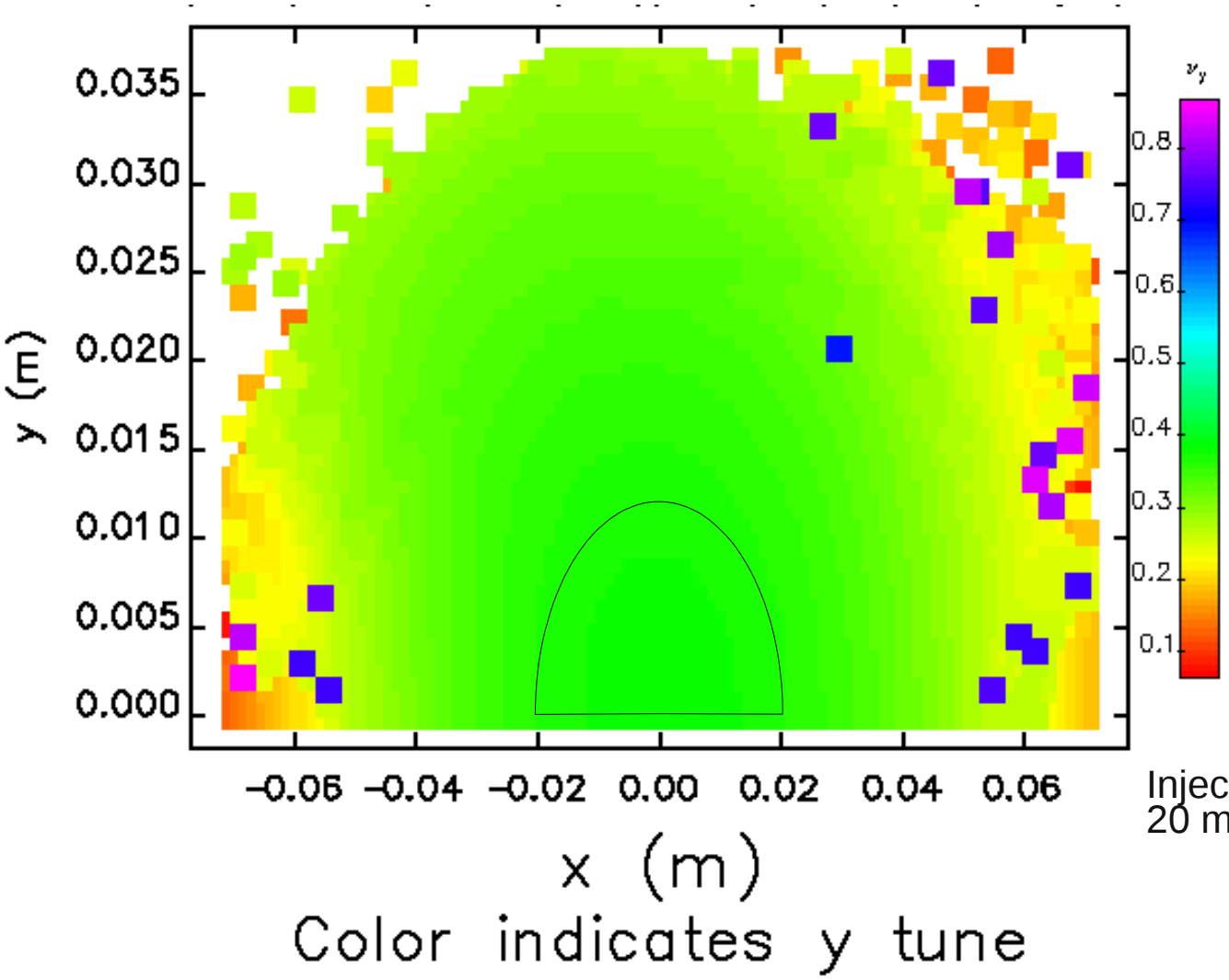


Extraction Line




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)

Dynamic Aperture



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

Aperture comparable to before the injection change

FODO cell Evaluation

- Alternate DR with FODO cells and differently-configured straight sections
- Fewer quadrupoles and more dipoles
- Initial estimate is that DA for FODO cells in arc by itself is really no worse or no better than TME cells
  - Result is that both lattices have DA that exceeds requirements
- Note that original gain in DA for TME-cell is due to phase advance optimization in straight-section
  - May be applicable to FODO cells
  - Not tried with FODO cells

Near-Term Deliverables

- Transfer lines
- Collimation