3.2 km Damping Ring Lattice

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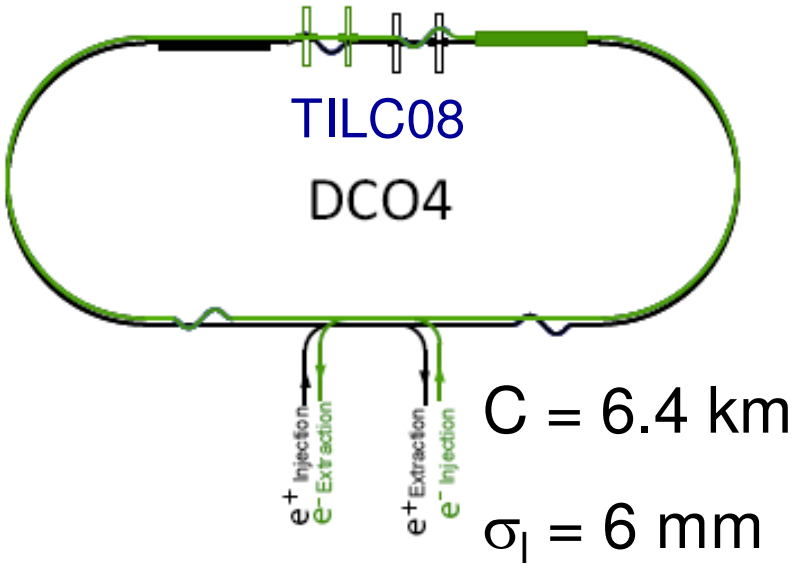
SB2009 DR Lattice

Low Power option

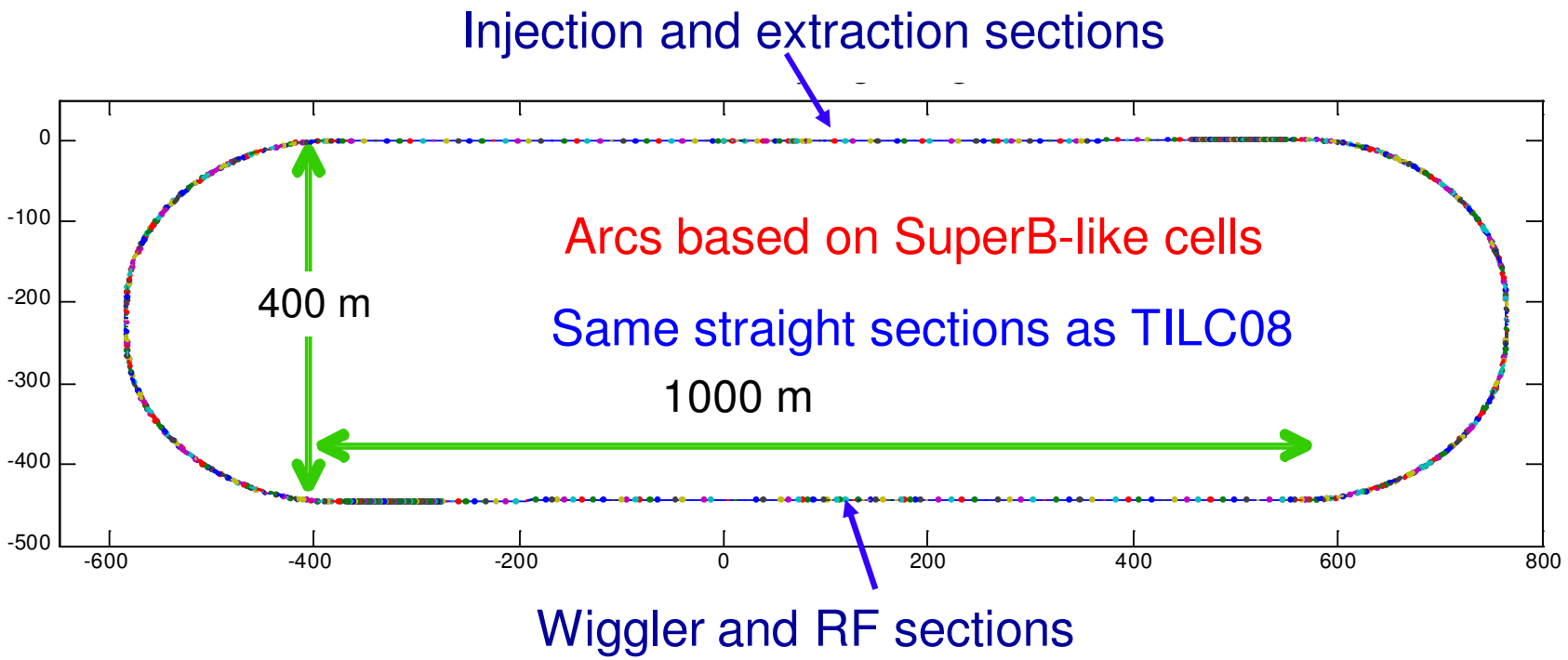
$N_{bunches}$ 2600 → 1300

Circumference 6.4km → 3.2km

SB2009 lattice has same layout, bunch length and momentum compaction as TILC08 DCO lattice



Layout of the 3.2km damping rings



- Injection/extraction lines of the two rings are superimposed
- RF cavities: 18 ⇒ 8
- Wigglers: 80 ⇒ 32

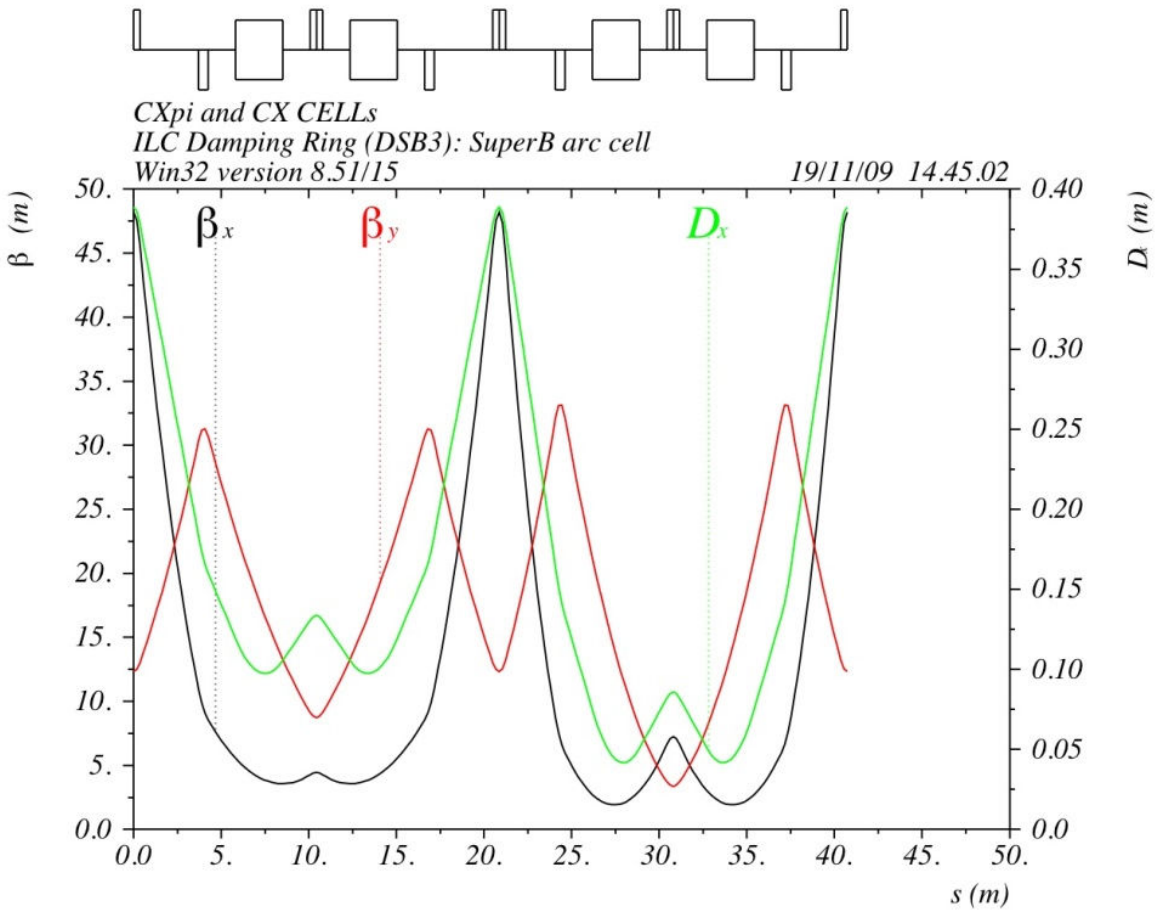
http://ilcagenda.linearcollider.org/materialDisplay.py?contribId=516&sessionId=11&materialId=slides&confId=2628

http://ilcagenda.linearcollider.org/contributionDisplay.py?contribId=119&sessionId=27&confId=3461

Parameter list for the RDR and the TILC08 version of the damping ring compared with the SB2009 3.2 km ring

	RDR	TILC08	SB2009
Circumference (m)	**6695**	**6476**	**3238**
Energy (GeV)	5	5	5
Bunch number	2625	2610	1305
N particles/bunch	2×10^{10}	2×10^{10}	2×10^{10}
Damping time τ_x (ms)	25.7	21	24
Emittance ε_x (nm)	0.51	0.48	0.53
Emittance ε_y (pm)	2	2	2
Momentum compaction	4.2×10^{-4}	1.7×10^{-4}	1.3×10^{-4}
Energy loss/turn (MeV)	8.7	10.3	4.4
Energy spread	1.3×10^{-3}	1.3×10^{-3}	1.2×10^{-3}
Bunch length (mm)	9	6	6
RF Voltage (MV)	24	21	7.5
RF frequency (MHz)	650	650	650
B wiggler (T)	1.67	1.6	1.6
Lwig total	200	216	78
Number of wigglers	80	88	32

Optical functions of the arc cells

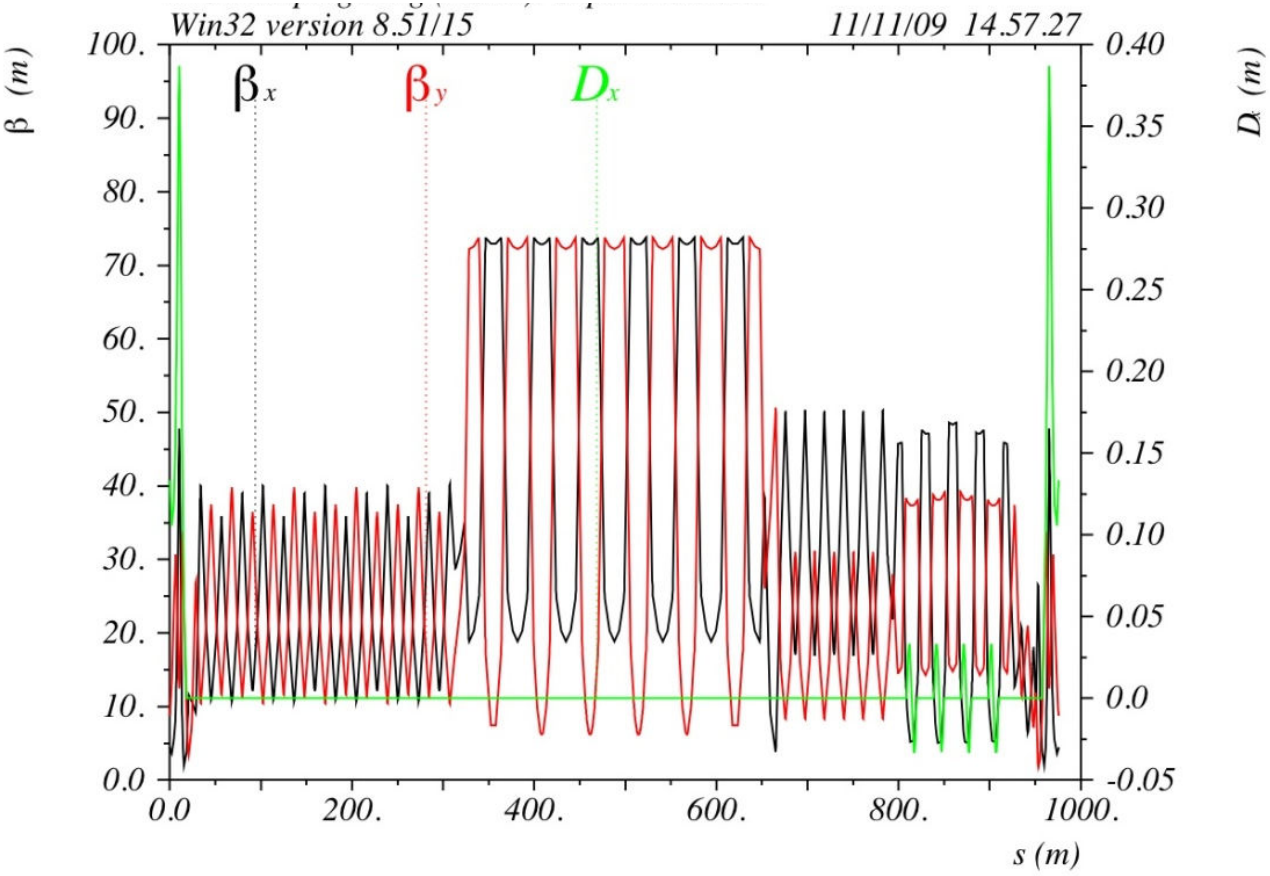


The arc lattice is based on the SuperB arc cells.

2 adjacent cells with very similar but with different phase advance: one is π and the other ~0.75π.

By tuning the phase advance in the second cell, emittance and momentum compaction can be tuned.

Optical functions in the Inj/Extr straight section

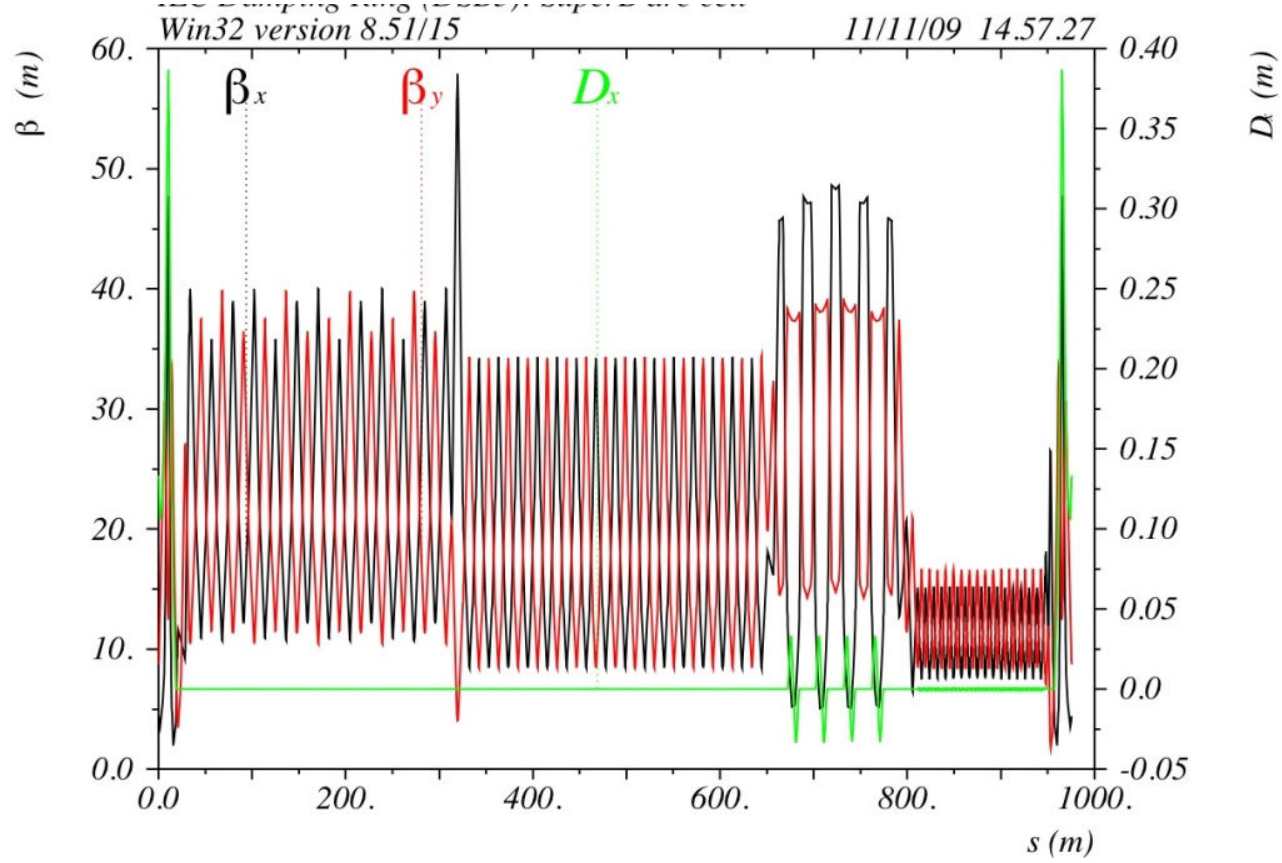


The e^- and e^+ ring are one on top of the other with counter-rotating beams

The injection line entering the electron ring is superimposed on the positron extraction line and vice versa

The lattice of the straight sections is made of the same building blocks as the 6.4km racetrack lattice (TILC08)

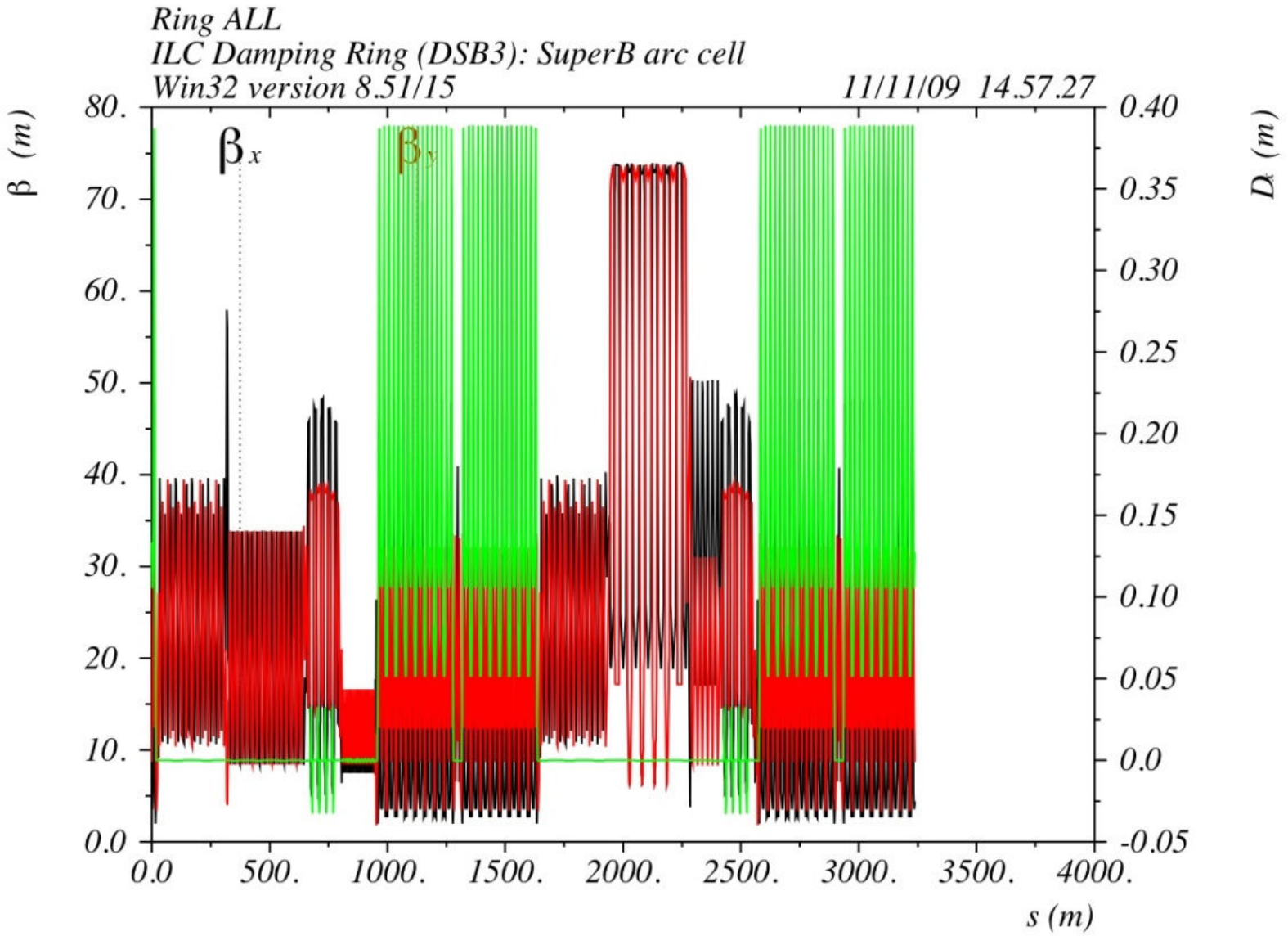
Optical functions in the RF/wiggler straight section



The wiggler straight is located downstream of the RF cavities in order to avoid damage by synchrotron radiation

The RF cavities for each ring are offset from the center of the straight so that they are not superimposed on top of each other

Optical functions of the 3.2km damping ring



M. Biagini

Magnet counts

	DSB3 (3.2km)	DCO4 (6.4km)
Arc dipole length	2.7 m	2.0 m
Arc dipole field (2 types)	0.26/0.36 T	0.27 T
Number of arc dipoles	128	200
Chicane dipole field	0.27 T	0.27 T
Number of 1 m dipoles (in chicanes)	48	48
Total number of quadrupoles	494	692
Quadrupole length	0.6 - 0.3 m	0.3 m
Maximum quadrupole gradient	17 T/m	12 T/m
Total number of sextupoles	408	392
Maximum sextupole gradient	150 T/m^2	215 T/m^2

Arcs vs. Straight sections

	Arcs	Straights
Length (m)	**1286**	**1952**
Number of quadrupoles, bpms, correctors	**290**	**204**
Q_x	**37.66**	**19.56**
Q_y	**14.88**	**18.22**
Chromaticity C_x	**-70.5**	**-29.9**
Chromaticity C_y	**-39.2**	**-24.4**

In the straights:

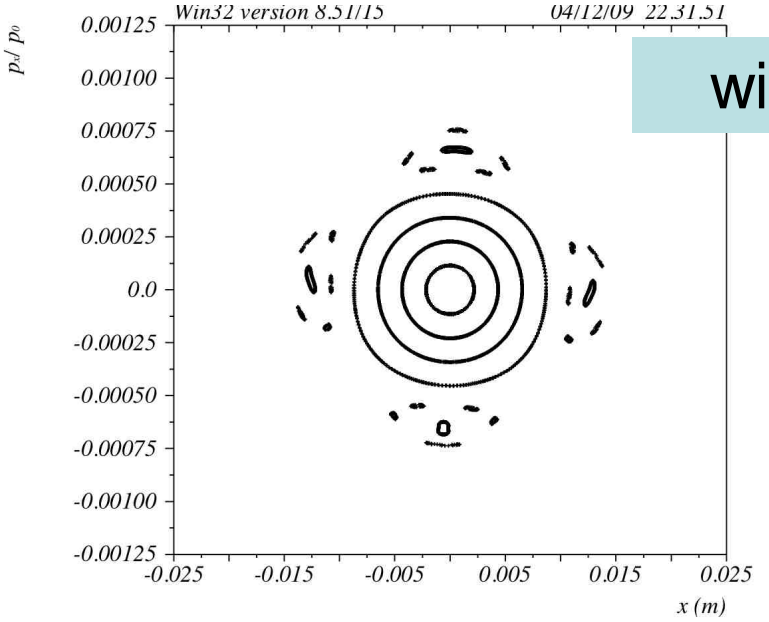
a large fraction of quadrupoles, bpms, correctors $\Rightarrow$ drives cost

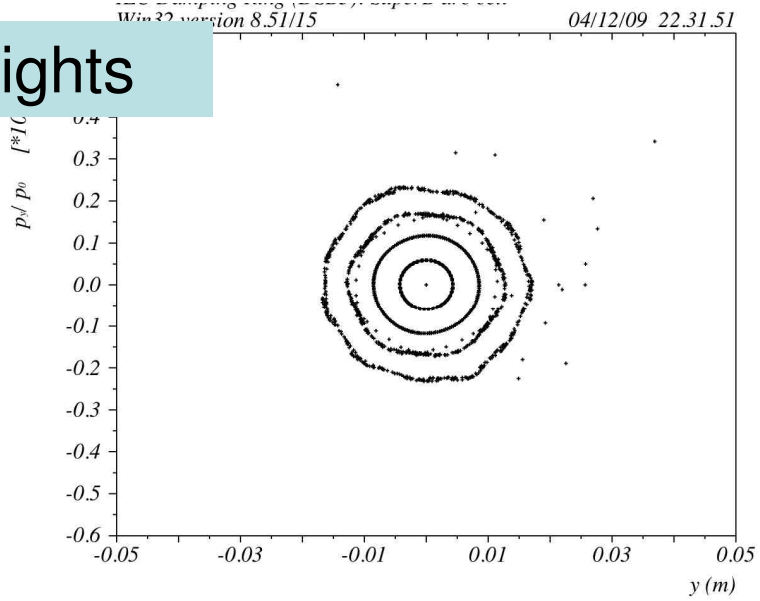
a large fraction of the chromaticity $\Rightarrow$ reduces dynamic aperture

We could try to reduce them by adopting similar straights as the 3.2 km FODO lattice

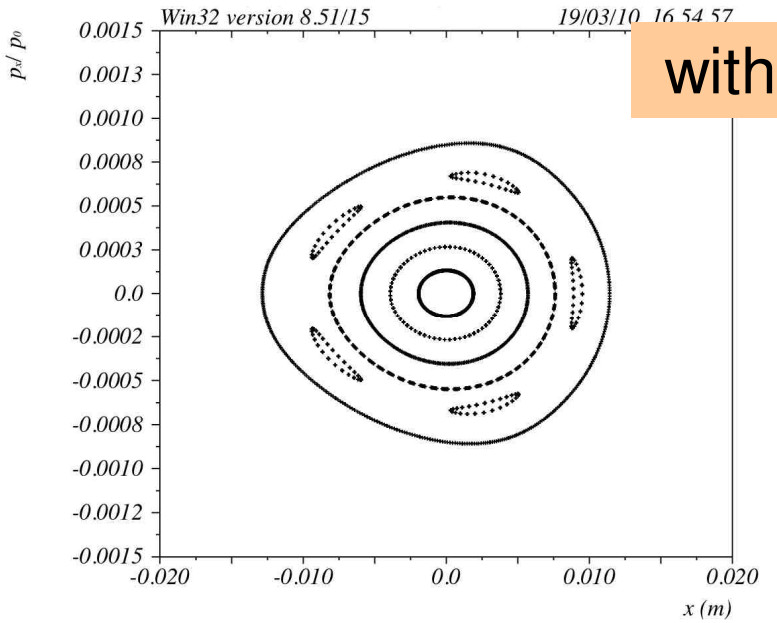
Phase Space Plots

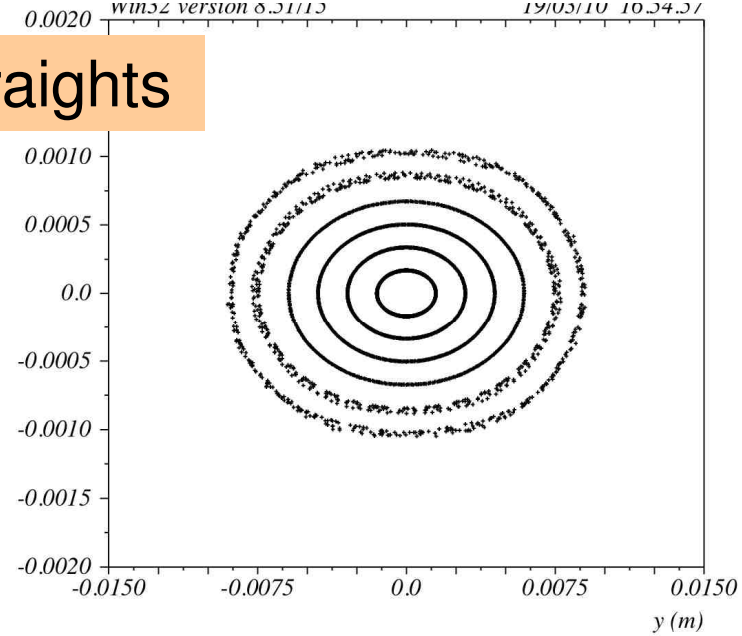
with straights



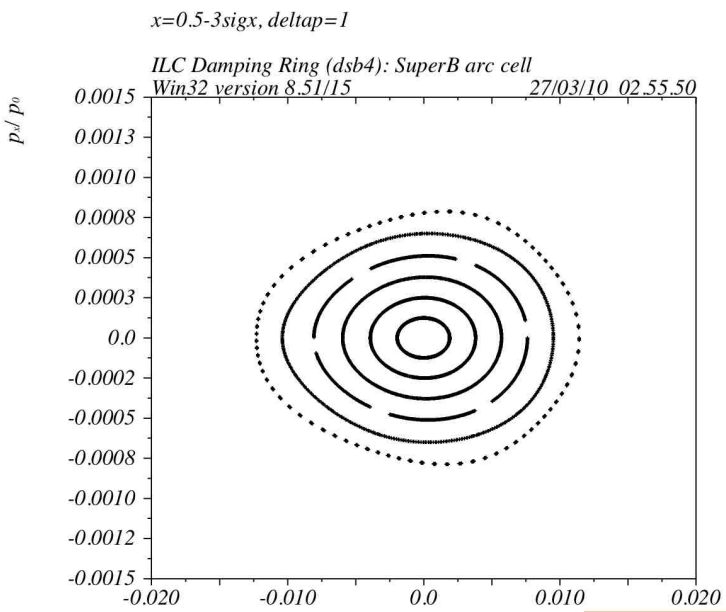


without straights

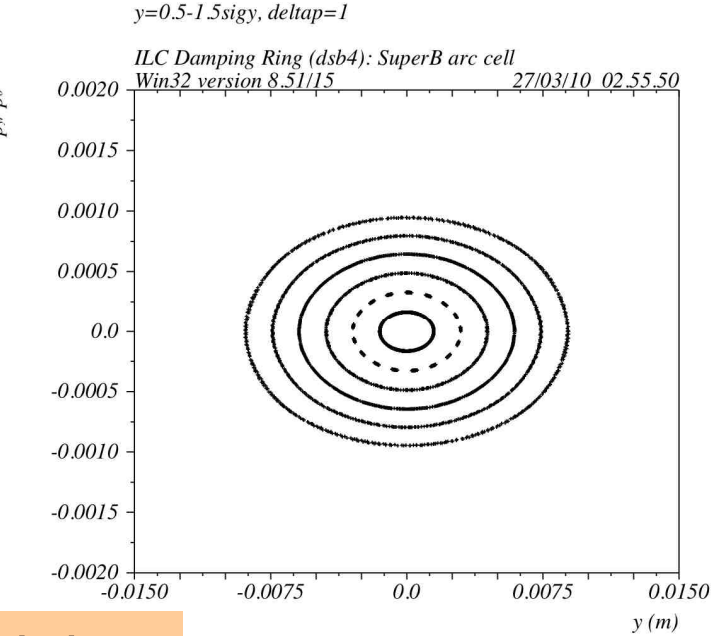




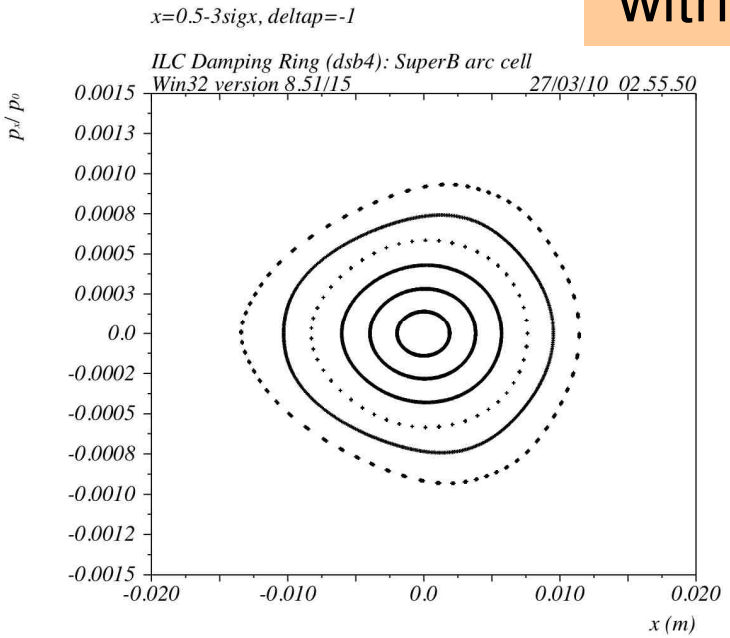
Phase Space Plots



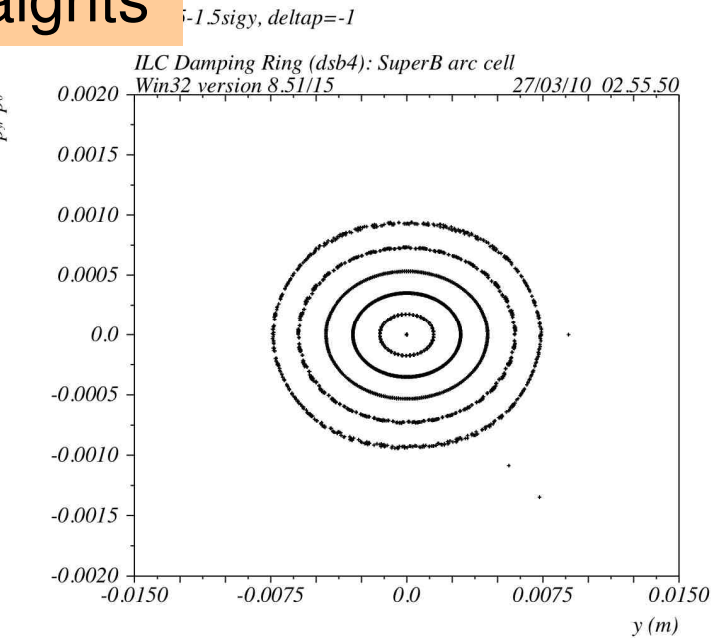
$\Delta p/p=+1$



without straights



$\Delta p/p=-1$



RF System Comparison

	DCO4	DSB3	FODO	DSB3	FODO
		Low Current		High Current	
Circumference (km)	6.4	3.2	3.2	3.2	3.2
Number of bunches	2610	1305	1305	2610	2610
Number of particles per bunch	2.0×10^{10}	2.0×10^{10}	2.0×10^{10}	2.0×10^{10}	2.0×10^{10}
Average current (amps)	.4	0.4	0.4	0.8	0.8
Energy loss per turn (MeV)	10.2	4.4	4.6	4.4	4.6
Beam power (MW)	4.1	1,8	1.8	3.5	3.7
Momentum Compaction (10^{-4})	2.9Ö1.3	1.3	2.6	1.3	2.6
Bunch length (mm)	6	6	6	6	6
Total RF voltage (MV)	33Ö17	7.5	14.4	7.5	14.4
Number of cavities	20	8	10	16	16