Comments on Dynamic Aperture and Symmetry

Andy Wolski

Lawrence Berkeley National Laboratory

2nd ILC Workshop, Snowmass
WG3b Parallel Session

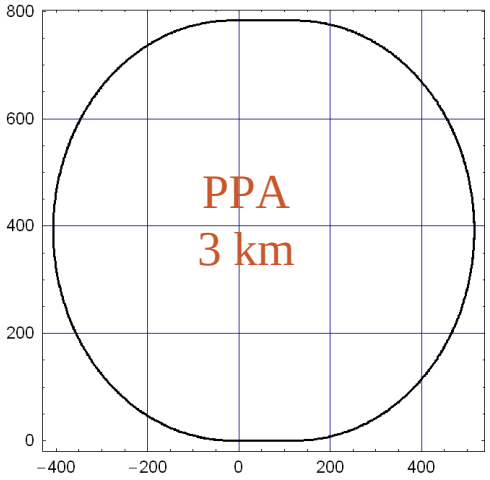
August 16, 2005

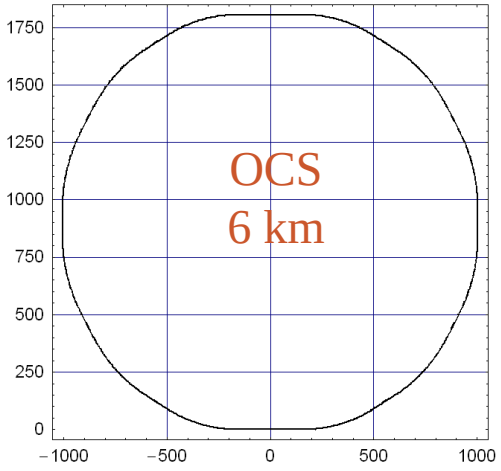
OCS has the best dynamic aperture of those studied so far

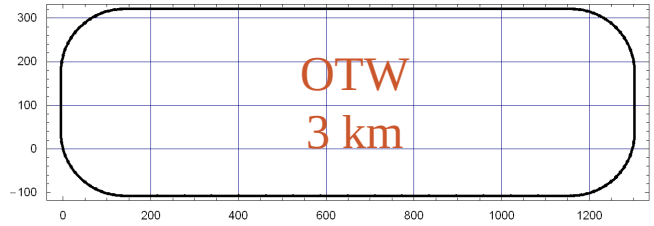
The OCS designers have done an excellent job in optimizing the dynamics.

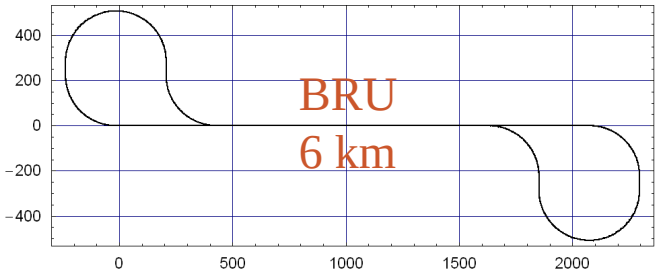
The energy acceptance is particularly good.

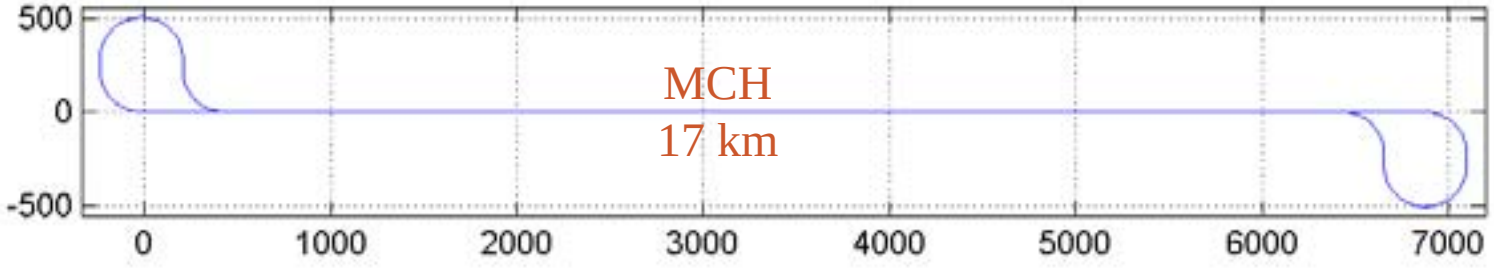
OCS is also one of only two lattices in the DR configuration study that has a high degree of symmetry.











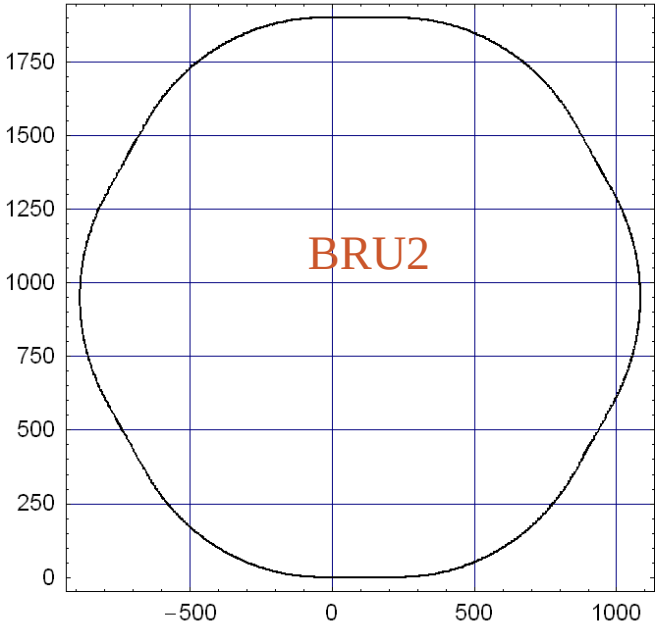
Can improving the symmetry improve the dynamic aperture?

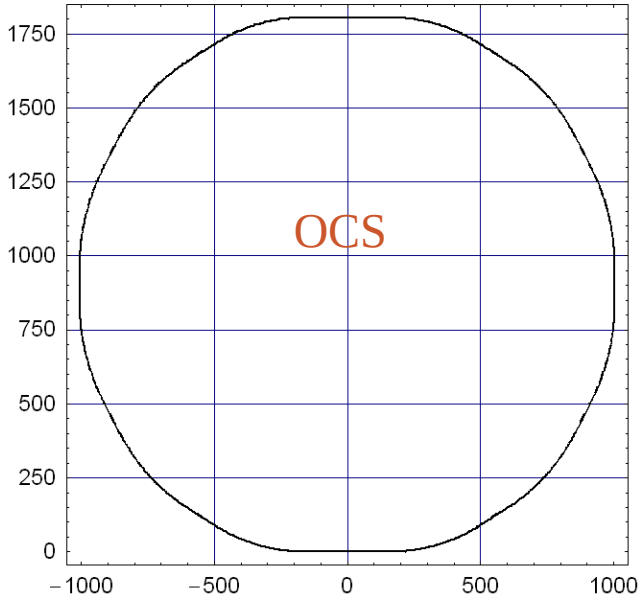
BRU is a “shortened” dogbone lattice.

Phase advances across the long straights are tuned to integer values in an attempt to restore the symmetry…

..but this only works on-energy. Off-energy, the local chromaticity in the straights destroys the symmetry.

Producing a truly symmetric lattice (BRU2) should reduce the chromatic symmetry breaking.

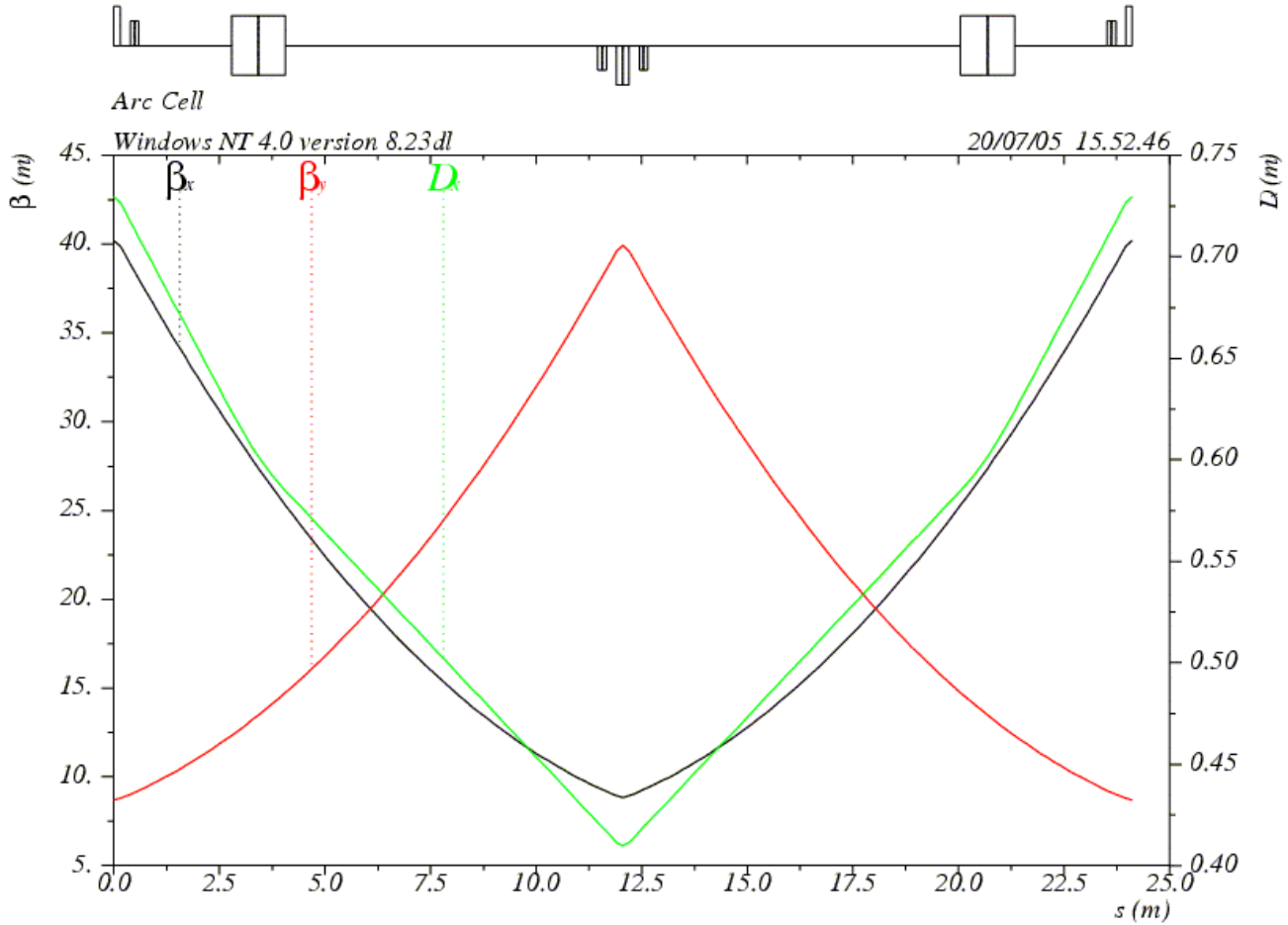




Arcs in BRU2 are essentially the same as in BRU

Arc (FODO) cell length increased from 17 m (BRU) to 24 m (BRU2)

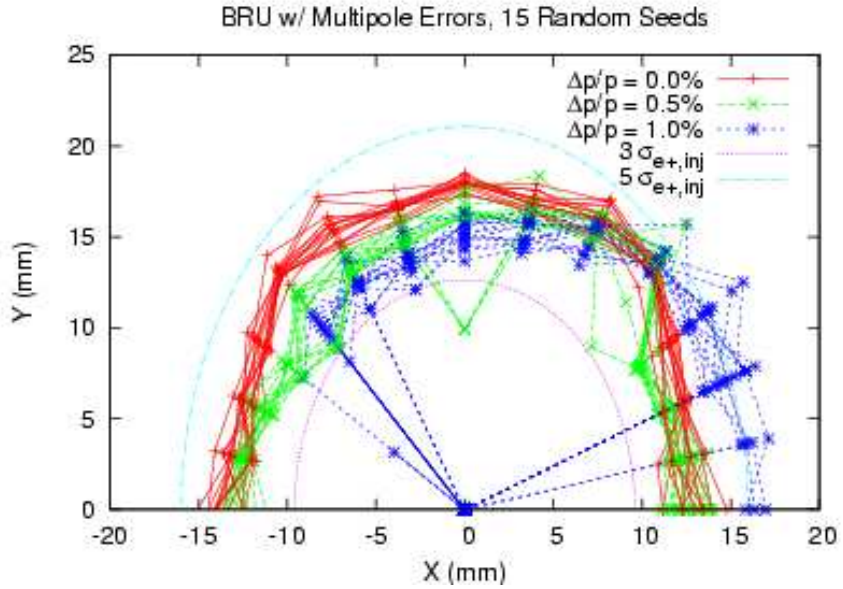
Phase advances across the cell the same in both versions (roughly 90°)

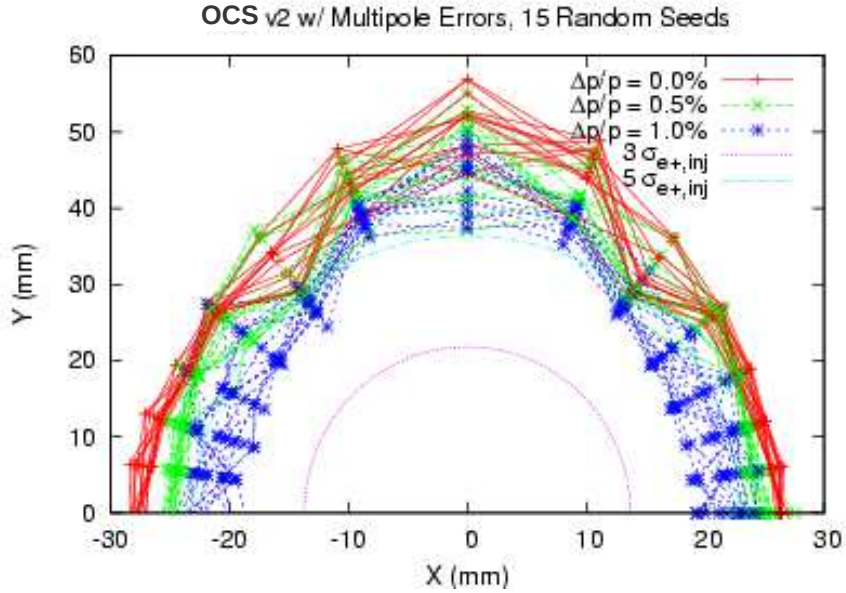


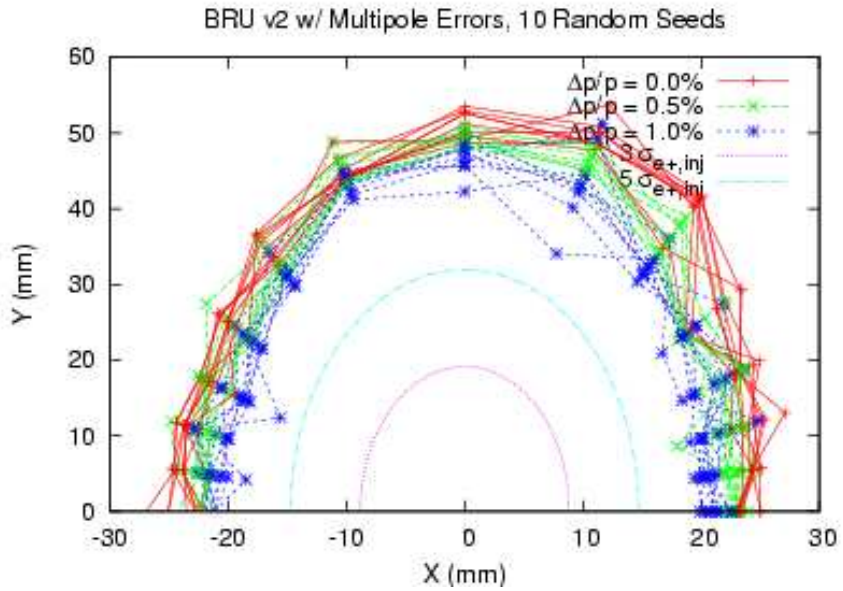
Full lattice has proper six-fold periodicity

	OCS	BRU	BRU2
Circumference	6114 m	6333 m	6114 m
Energy	5.066 GeV	3.74 GeV	5.0 GeV
Betatron tunes	50.840, 40.800	65.783, 66.413	63.69, 64.23
Natural chromaticity	-65, -53	-79, -87	-78, -81
Momentum compaction	1.62×10^{-4}	11.9×10^{-4}	5.44×10^{-4}
Bunch length	6 mm	9 mm	6 mm
Synchrotron tune	0.0337	0.120	0.115

Improving symmetry improves the dynamic aperture

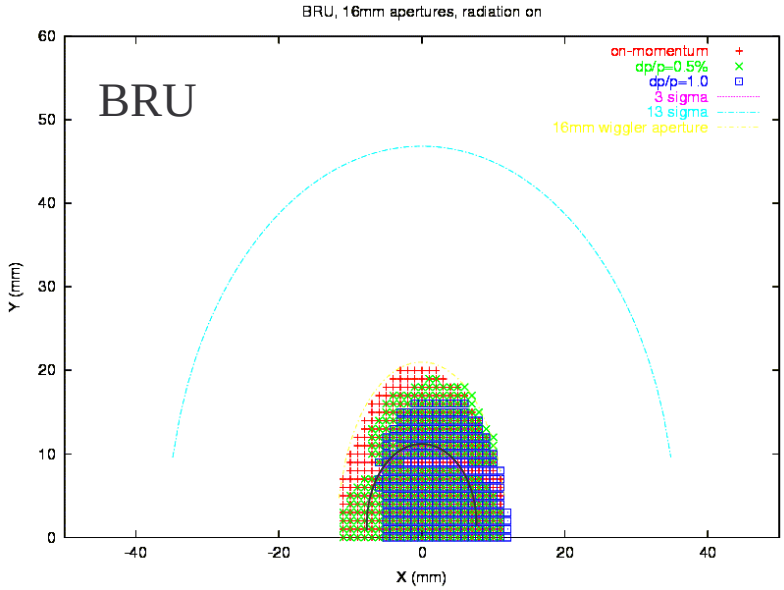


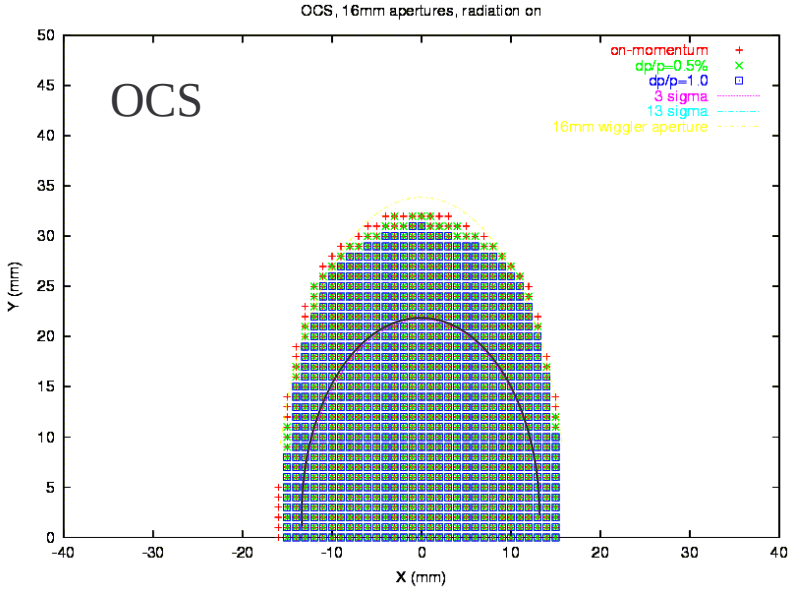


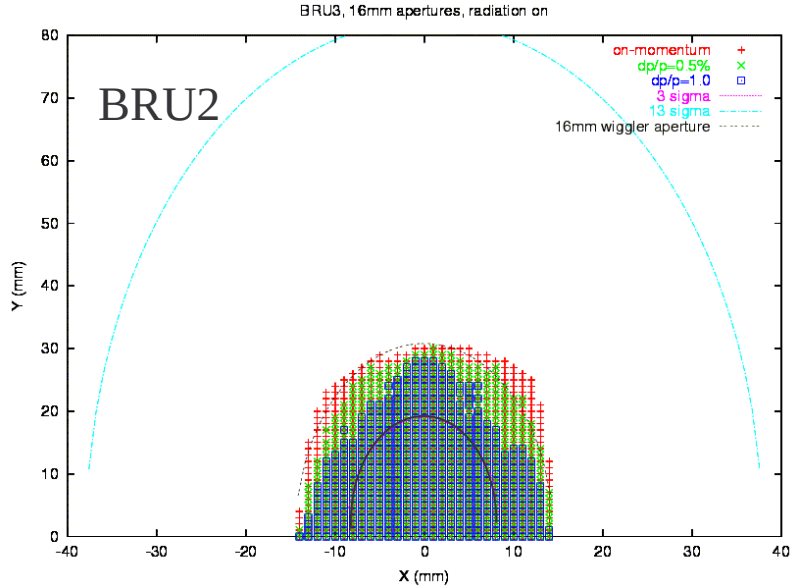


Tracking with multipole errors
by J. Urban (Cornell)

Acceptance with physical aperture is also improved





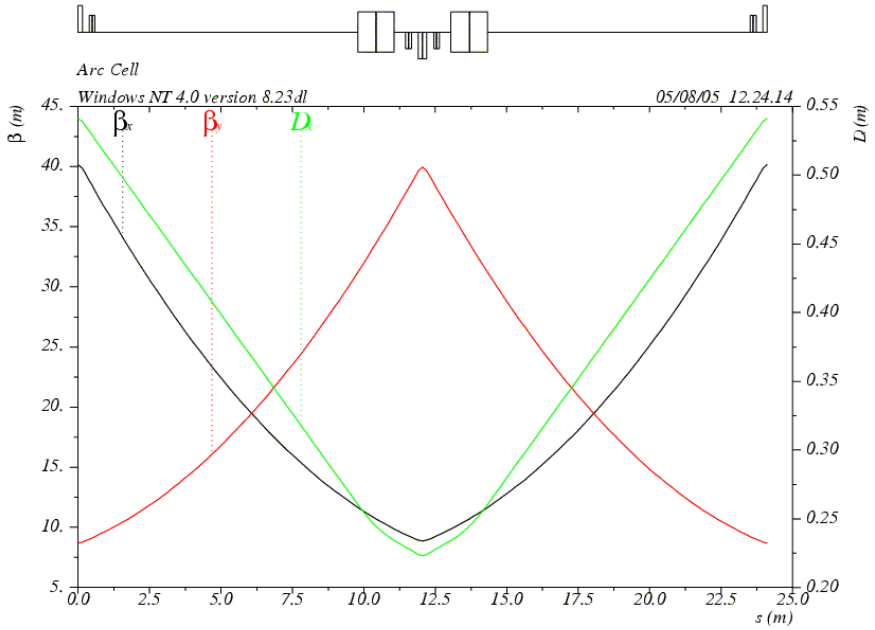


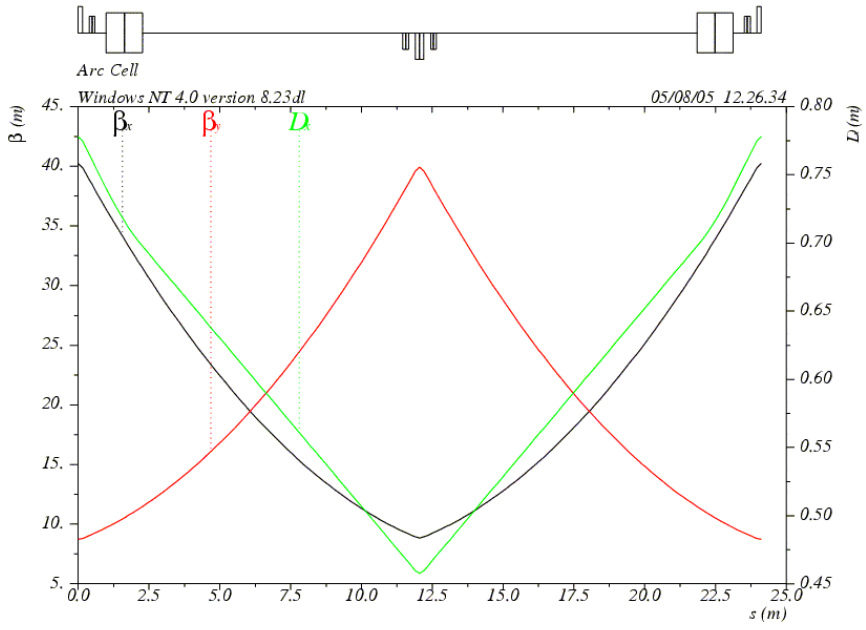
Tracking with physical apertures and synchrotron radiation, by I. Reichel (LBNL)

Flexibility allows possibility of further improvement

Moving dipoles within an arc cell allows variation of α_p by a factor ~ 2.7

Provides a "wrench-fix" solution if the need arises to trade off (for example) instability thresholds against synchro-betatron coupling.





$\alpha_p = 2.35\times10^{-4}$

$\alpha_p = 6.36\times10^{-4}$

Note: bend angle per dipole ≈ 1°

Conclusions

High degree of symmetry has a significant impact on dynamic aperture in the BRU lattice.

The need for a good acceptance favors a damping ring with a circumference ~ 6 km or less, where real symmetry can be achieved.