TRIUMF	4004 WESBROOK MALL, VANCOUVER, B.C. V6T 2A3		PAGE 1
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SUBJECT

Two-fold symmetric ILC Damping Ring based on OCS6 cells

Abstract

We describe our first attempt for a damping ring with similar parameters as the Reference ILC damping ring, but having a periodicity of two. The dynamic aperture obtained is large and compatible with the reference design.

I. INTRODUCTION AND GOALS

This note describes the optics of a racetrack-type Damping Ring lattice named, very provisionally, OCS2. We use as a base the 6-fold Reference Damping Ring OCS6 [1]. The OCS2 optics files, in MAD [2] format, can be found in:

http://www.triumf.ca/people/kaltchev/DampingRing.

The MAD-files describing OCS6 are: OCS6.xsif and OCS6.Run.mad.

Our goal, at this stage, is very limited – to show that the dynamic aperture of a racetrack can be large and compatible with the one of OCS6. To this end, the length and compaction factor of the new ring have been only roughly adjusted to be close to the ones of OCS6. This is done simply by varying the number of idle straight cells.

We shall assume that the exact ring length and/or a smaller compaction than the one given below can be achieved without much additional efforts and in a OCS2 lattice similar to the one presented here.

II. OCS2 LATTICE

The OCS2 lattice (file `OCS6.ADD.xsif`) contains the same optical cells and sections as the six-fold OCS6, but regrouped into a racetrack shape. The arc cell of OCS6 with 90-degree phase advance is used to build each of the two arcs. The total number of bending magnets is preserved. One of the OCS6 dispersion suppressors (SUPS) joins the arc with a new long straight section composed of empty (idle) straight cells, wiggler cells, RF and injection cells and the same sequence reversed, implying a mirror symmetry within the long straight. The only new components are two matching sections: (idle-cell)-to-wiggler and wiggler-to-injection.

The MAD run is organized as follows. The OCS2 setup is described in file: `OCS6.ADD.xsif` which is an addition to the original OCS6. One executes `OCS2.Run.mad` which calls `OCS6.xsif`, and then `OCS2.strengths` and `OCS6.ADD.xsif`.

A. OCS2 long straight section and ring length

Matching within the long straight is illustrated on Figure 1. This figure shows in fact a dummy long straight that contains one “cell” of each kind: one idle straight cell, one RF cell, one wiggler cell and a full injection section. The real long straight section of OCS2 contains 8 idle straight cells and 20 wiggler cells. By varying the number of idle straight cells other racetracks have been tried, e.g. with a larger length and a smaller compaction.

B. OCS2 ring

Figure 2 shows the lattice functions of OCS6 and OCS2 and Table I compares parameters relevant to this study.

Parameter	OCS6	OCS2
Energy [GeV]	5.0	5.0
Circumference [m]	6695.06	6734.28
Momentum compaction	4.2 10^{-4}	4.32 10^{-4}
Natural chromaticities, hor./vert.	-62.6/-61.7	-61.2/-60
Natural emittance [nm]	0.515	0.520
Sextupole strengths, SF/SD [m^{-2}]	0.622/-0.96	0.6/-0.94
Working point (ν_x/ν_y)	52.397/49.306	53.84/46.82
Transverse damping time [ms]	25.7	25.8
Longitudinal damping time [ms]	12.8	12.9

Table I:

C. Dynamic aperture

For both lattices, chromaticity is corrected with the arc sextupoles (SF and SD) and tracking performed with MAD8 at injection emittance. Interleaved sextupoles arranged in 90-degrees cells produce zero or very small second order

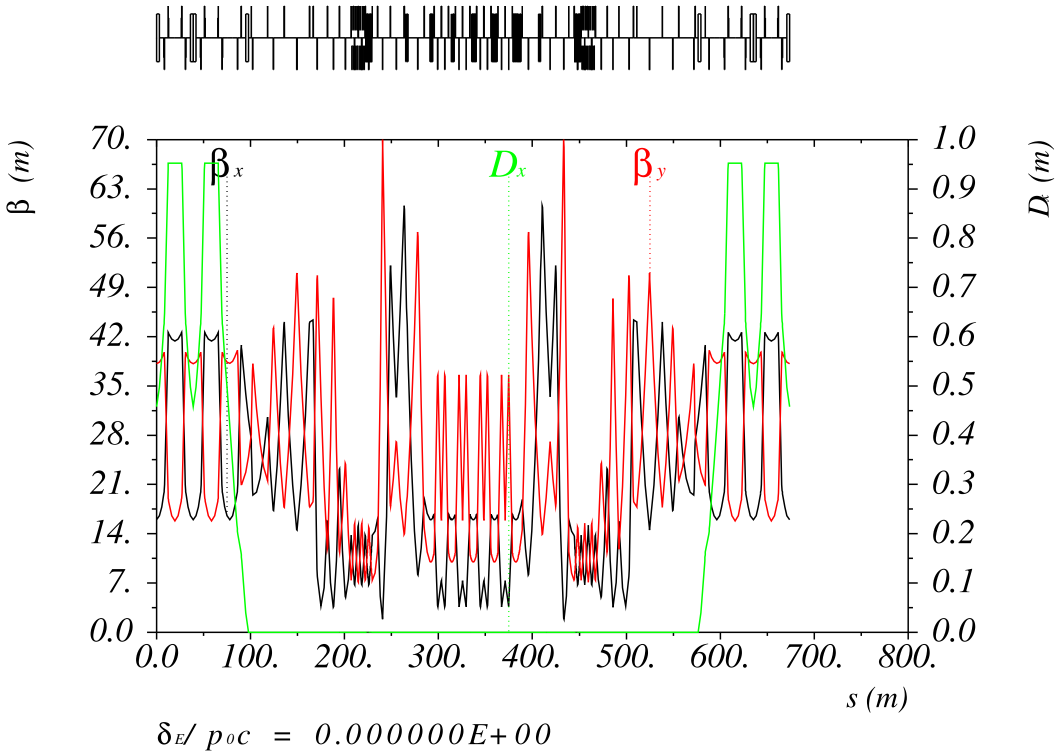


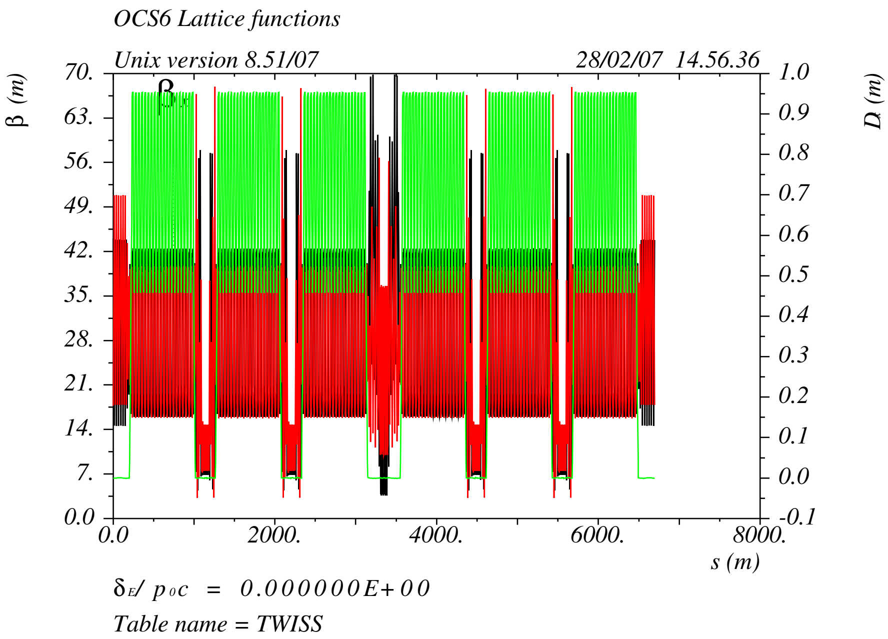
Figure 1: A dummy representative of the OCS2 long straight section showing one cell of each kind with matching sections in between.

transport terms. This has been verified for both rings by computing the second order map with MAD Static and with the code LieMath [4]. Sample output (for OCS6) is shown on Figure 3.

The working point of OCS2 (after some optimization) was set to $\nu_x = 53.84$ $\nu_y = 46.82$. Figure 4 compares the 1000-turn dynamic aperture.

III. CONCLUSIONS

By rearranging the cells of the Reference ILC damping ring OCS6, a symmetry-two damping ring lattice may be built with very similar character-



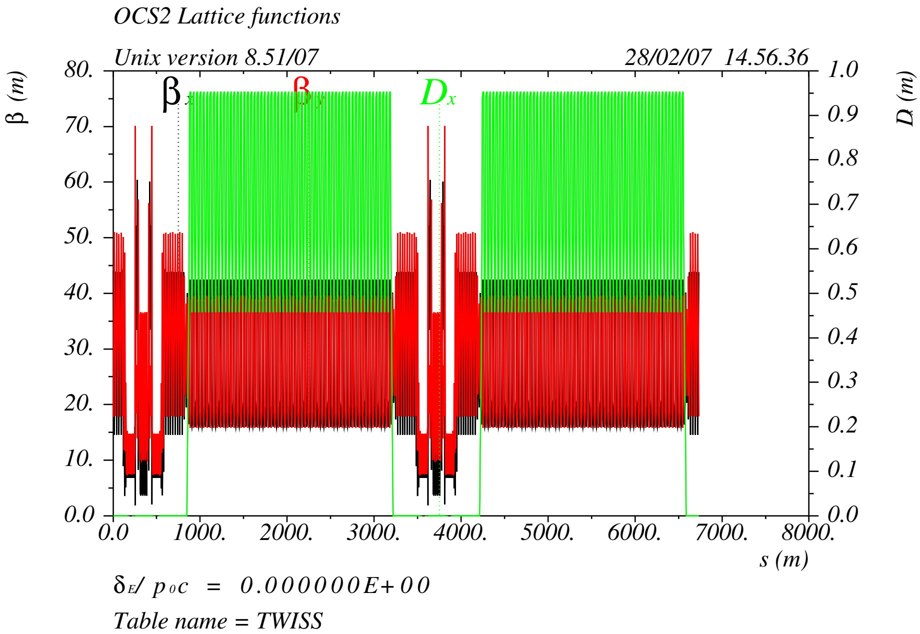


Figure 2: Six-fold lattice OCS6 (top) and a racetrack lattice OCS2 (bottom)

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x	px	y	py	τ	pt	
−0.79956	−0.0136409	0	0	3.11309×10^{-6}	0	{1, 0, 0, 0, 0, 0}
26.5073	−0.798461	0	0	−0.00178489	0	{0, 1, 0, 0, 0, 0}
0	0	−0.340635	−0.0529016	0	0	{0, 0, 1, 0, 0, 0}
0	0	16.7151	−0.339794	0	0	{0, 0, 0, 1, 0, 0}
0.0013446	0.0000268331	0	0	−2.81206	1.	{0, 0, 0, 0, 0, 1}
0.00183034	−0.000074145	0	0	−0.0672788	0	{2, 0, 0, 0, 0, 0}
0.0450071	0.00202835	0	0	−0.080536	0	{1, 1, 0, 0, 0, 0}
−0.144061	−0.0585527	0	0	−124.941	0	{0, 2, 0, 0, 0, 0}
0	0	−0.000748474	−0.000105607	0	0	{1, 0, 1, 0, 0, 0}
0	0	−0.0448601	0.00958005	0	0	{0, 1, 1, 0, 0, 0}
−0.00230135	−0.0000369973	0	0	0.0697524	0	{0, 0, 2, 0, 0, 0}
0	0	−0.0389374	−0.000118278	0	0	{1, 0, 0, 1, 0, 0}
0	0	2.19259	−0.0848313	0	0	{0, 1, 0, 1, 0, 0}
0.0623136	0.00358894	0	0	−1.5827	0	{0, 0, 1, 1, 0, 0}
3.63114	−0.10634	0	0	−0.00974899	0	{1, 0, 0, 0, 0, 1}
201.931	3.34432	0	0	−1.42276	0	{0, 1, 0, 0, 0, 1}
0	0	−1.79271	0.13113	0	0	{0, 0, 1, 0, 0, 1}
−0.470583	0.00148168	0	0	13.5615	0	{0, 0, 0, 2, 0, 0}
0	0	17.216	−1.97264	0	0	{0, 0, 0, 1, 0, 1}
0.694445	0.00590145	0	0	1.69309	0	{0, 0, 0, 0, 0, 2}

Figure 3: OCS6 second-order transport map computed with LieMath [4]

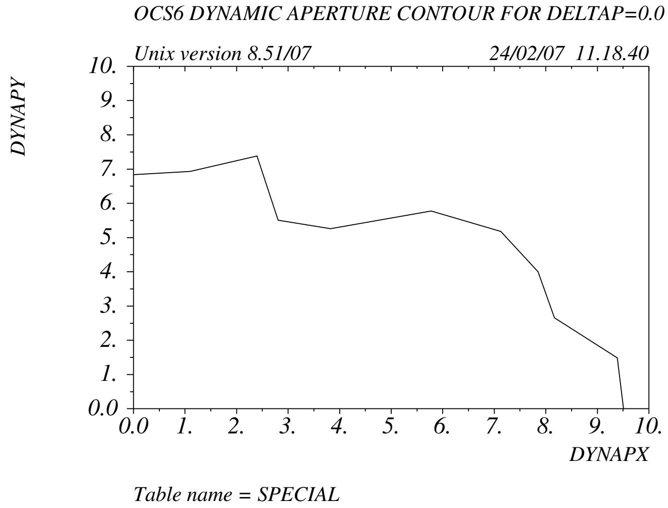
istics: length, momentum compaction, damping times and dynamic aperture.

[1] https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/ReferenceDesignReport

[2] hansg.web.cern.ch/hansg/mad/mad8/user/mad.html

[3] A. Wolski, J. Gao, S. Guiducci (eds.), Configuration Studies and Recommendations for the ILC Damping Rings, LBNL-59449 (2006)

[4] D. Kaltchev, *Implementation of TPSA in the Mathematica Code LieMath* in the Proc. EPAC 2006, Edinburgh, Scotland; see also F. Zimmermann, *Accelerator Physics Code Web Repository* in the same Proceedings.



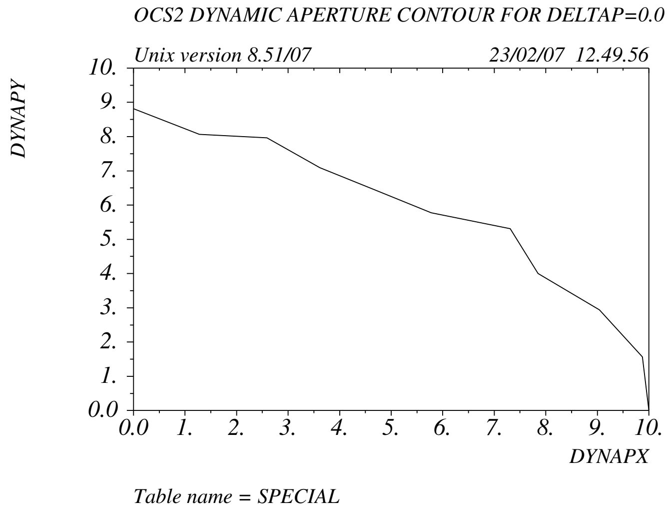


Figure 4: OCS6 (top) and OCS2 (bottom) 1000-turn dynamic aperture for an injected normalized emittance $\gamma\,\epsilon = 0.01$ m.rad. Here `DYNAPX,Y` are initial particle coordinates in sigma units.