National Institutes of Natural Sciences
Institute for Molecular Science

UVSOR III since 2012

Lattice Design for a Future Plan of UVSOR

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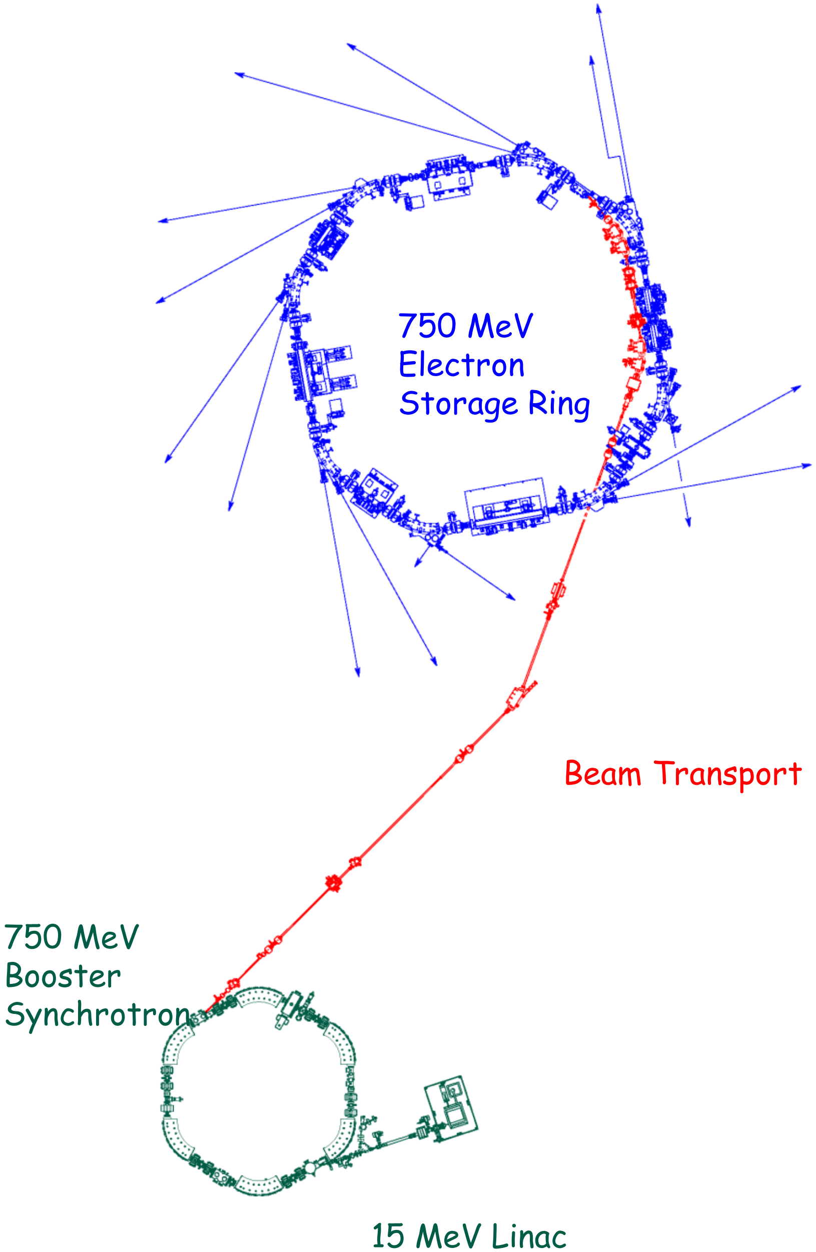
ABSTRACT: UVSOR is a low energy synchrotron light source with a moderately small emittance of about 17nm. We analyzed the present magnetic lattice as drawing "tie diagram", which indicate the parameter areas of quadruple magnets where a periodic solution of the beam optics exists. Its goal is to search a possible low emittance solution without a major change of the lattice. Although, we could not find a solution which has a drastically small emittance, we have found a few solutions which has a significantly smaller emittance than present value. They may be useful for some special low emittance operation modes dedicated to developments on new light sources technologies and their applications. We are investigating the dynamic aperture and beam injection.

THPAB089

UVSOR Synchrotron, Institute for Molecular Science

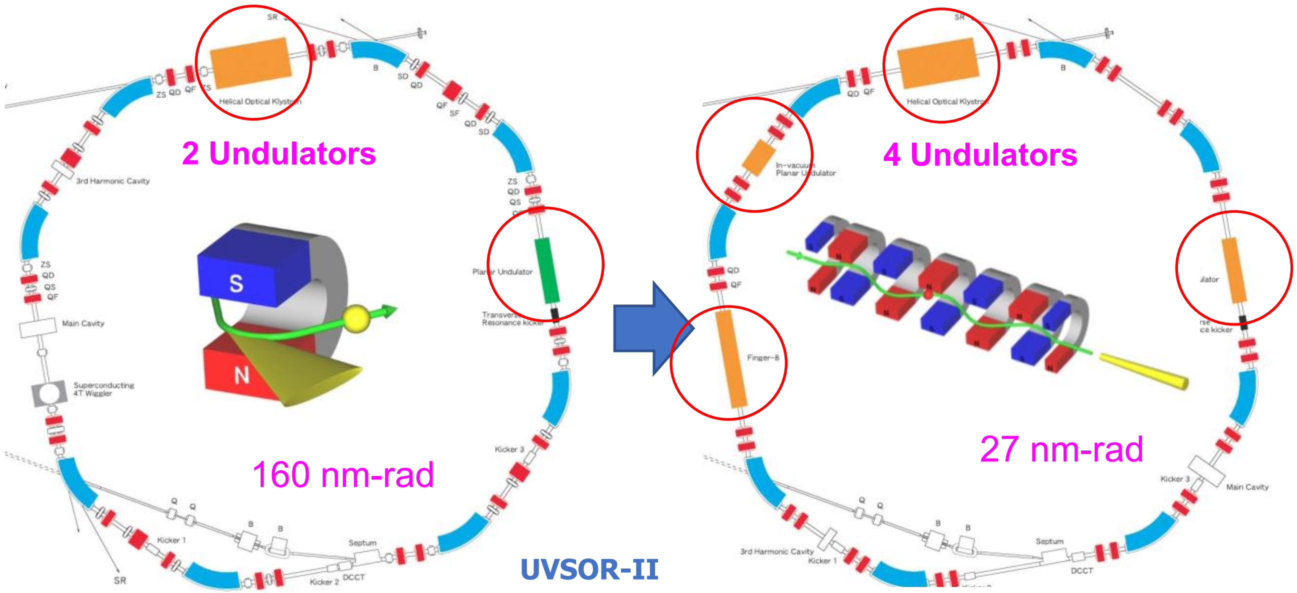


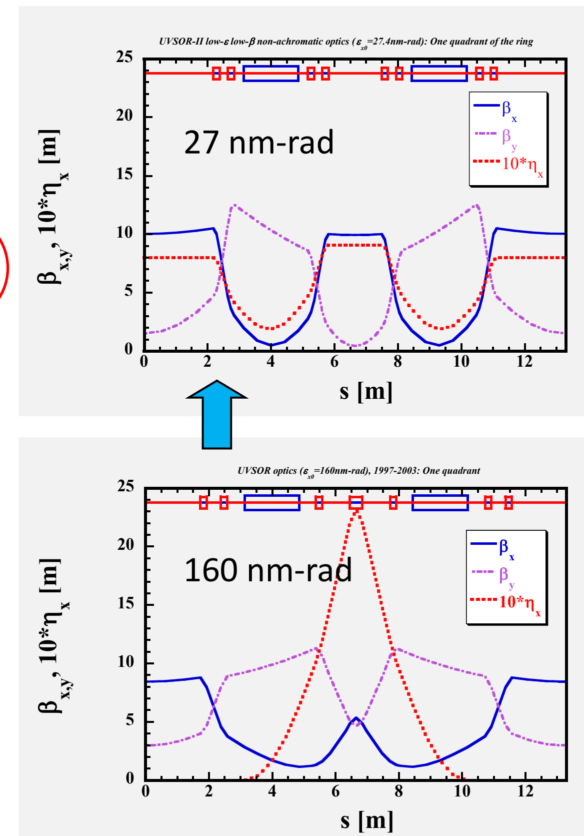
UVSOR-I ⇒ UVSOR-II

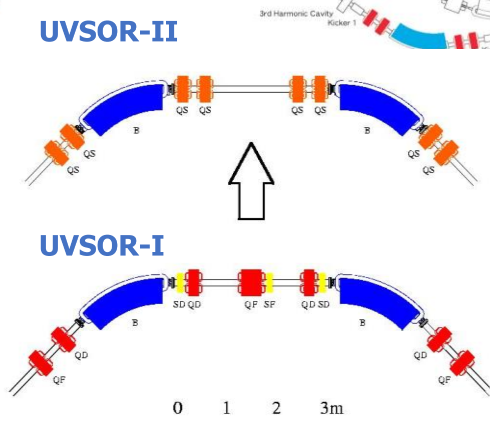
2002~2003

2^{nd} Gen. ⇒ 3^{rd} Gen.

- Brilliance Upgrade by improving Magnetic Lattice (from 160nm-rad to 27nm-rad)
- Increase of Straight Sections and Undulators (from 2 to 4)
- Construction of Undulator Beam-lines (BL3U, BL6U, BL7U)







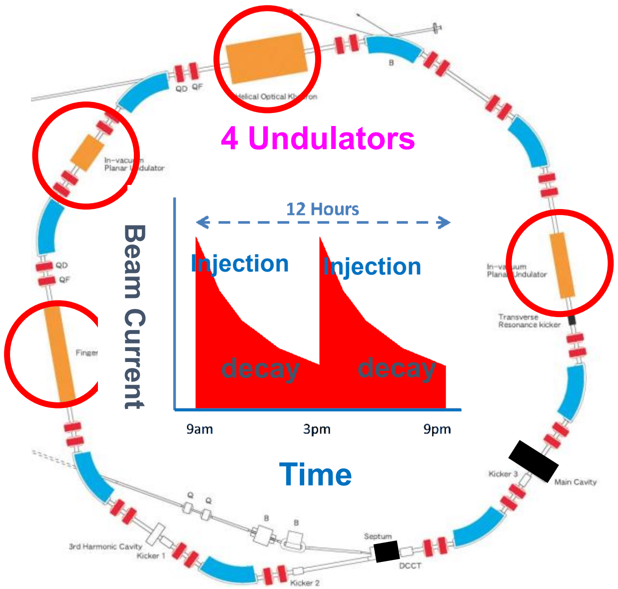
M Katoh et al., 467, 68 – 71, 2001

UVSOR-II⇒UVSOR-III

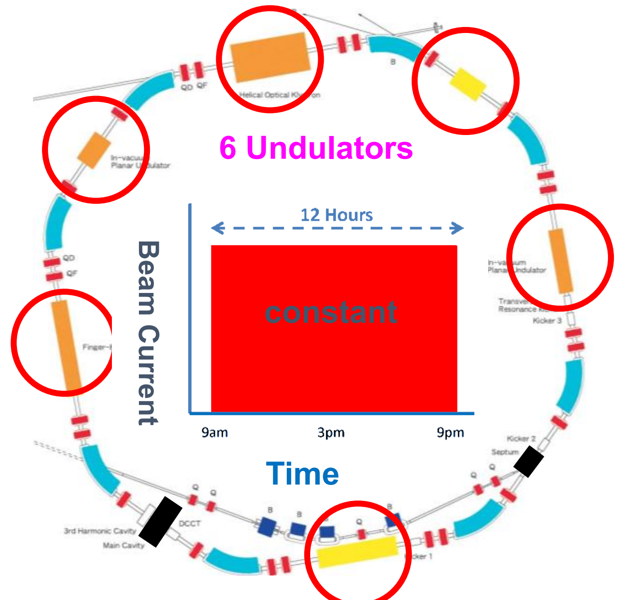
2010~2012

3rd Gen. ⇒ 3.5th Gen.

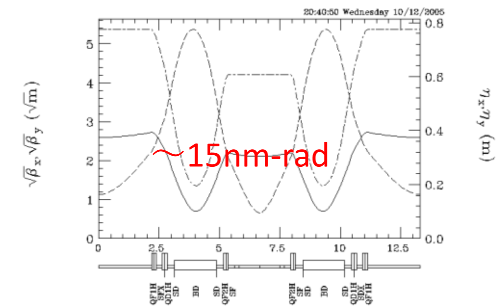
- Make all four long straight sections available for undulators (by moving the injection point) ‹2010›
- Further Brilliance Upgrade (by intoroducing combined function bending magnets) ; from 27nm-rad to ~15nm-rad ‹2012›
- Top-up operation (constant intensity operation) ‹2010›

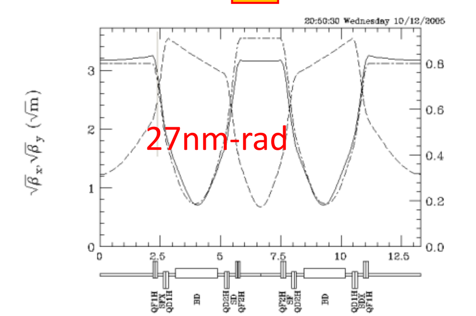


27 nm-rad

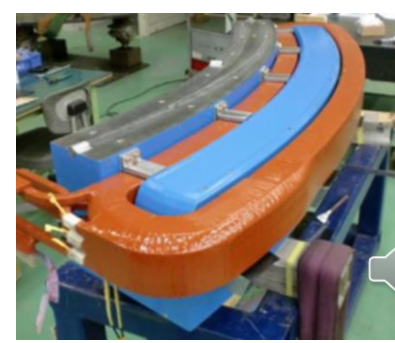


~15 nm-rad



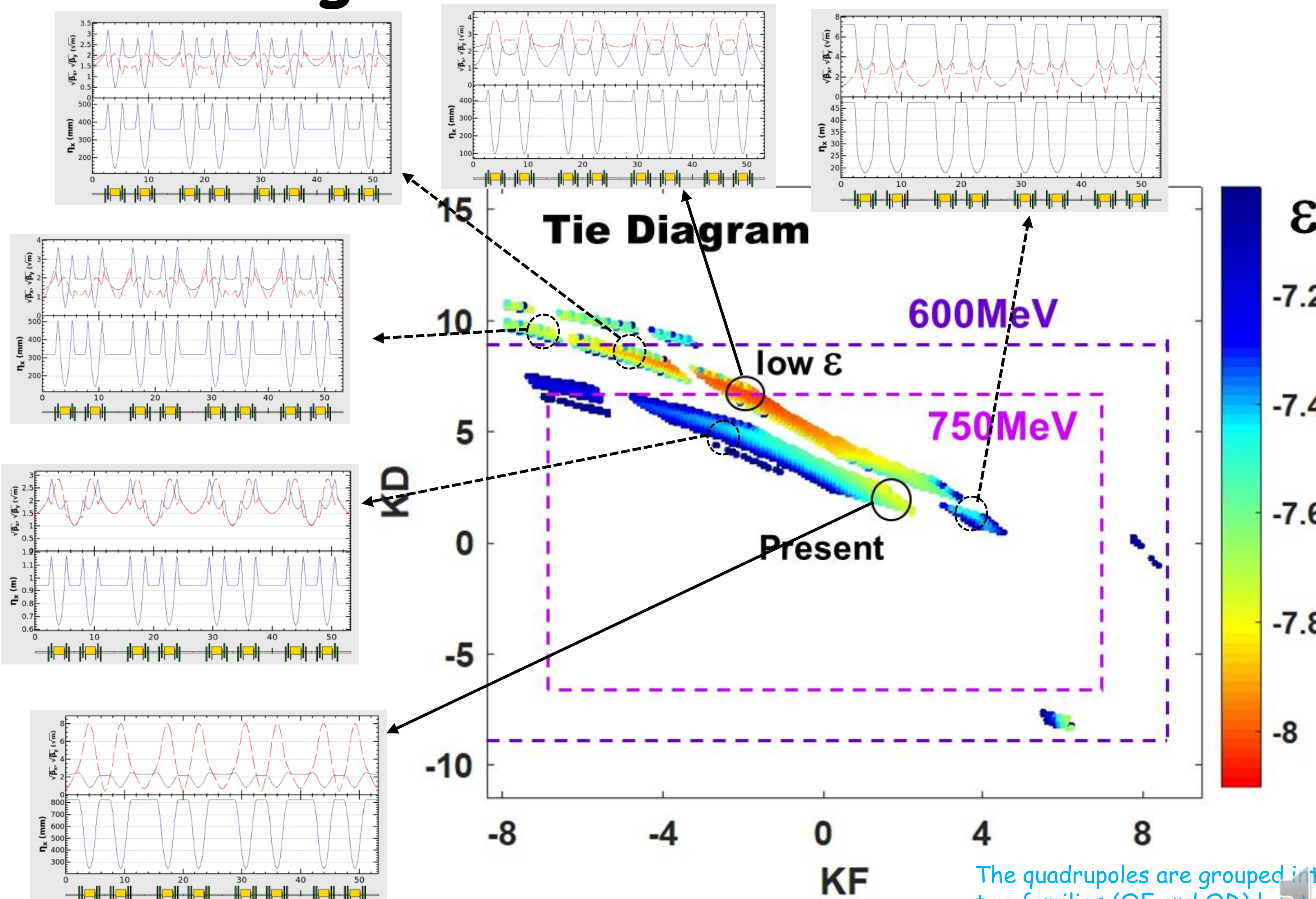


Combined-function Bend.	
Bending radius	2.2 m
Magnetic Length	1.728 m
Bending Angle	45 deg
Field Index (n)	3.36
K1(pole shape)	$-1.2\ m^{-1}$
K2(edge shape)	$-2.43\times2\ m^{-2}$
Pole Gap (Min.)	48 mm



M. Adachi et al.,
Proc. 11th Internat. Conf. Synchrotron Rad. Instr. (SRI 2012), 425(PART 4), 2013

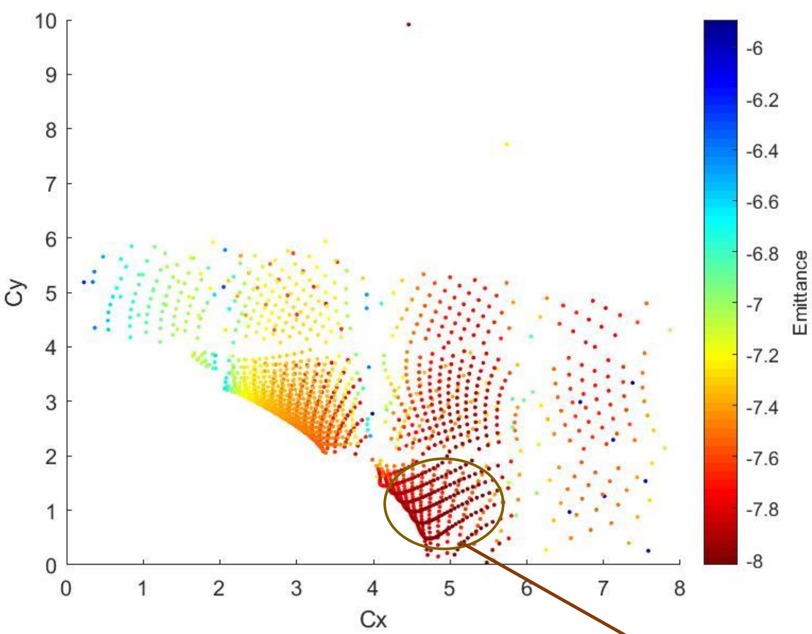
Tie Diagram of UVSOR-III Lattice

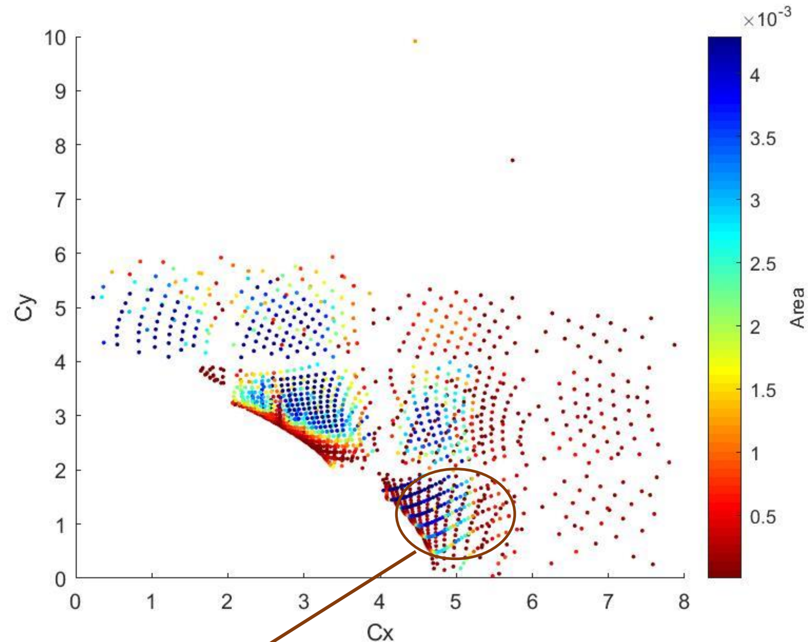


The quadrupoles are grouped into two families (QF and QD) located symmetrically around the bendings.

Tune Survey

To design a low emittance lattice, strong field quadrupole magnets are generally employed which result into a large negative chromaticity. For chromaticity correction, strong field sextupole magnets is needed to insert in the lattice at proper locations.. Due to the nonlinear effects arising from sextupole magnets, the dynamic aperture decreases. Therefore, it is necessary to estimate how large is the dynamic aperture. by performing the tune survey, we can obtain a reasonable operating point which gives a large dynamic aperture and low emittance.



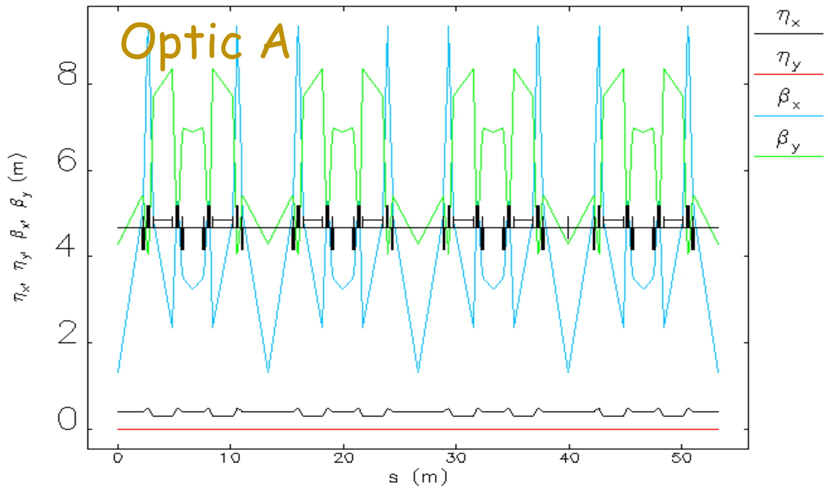


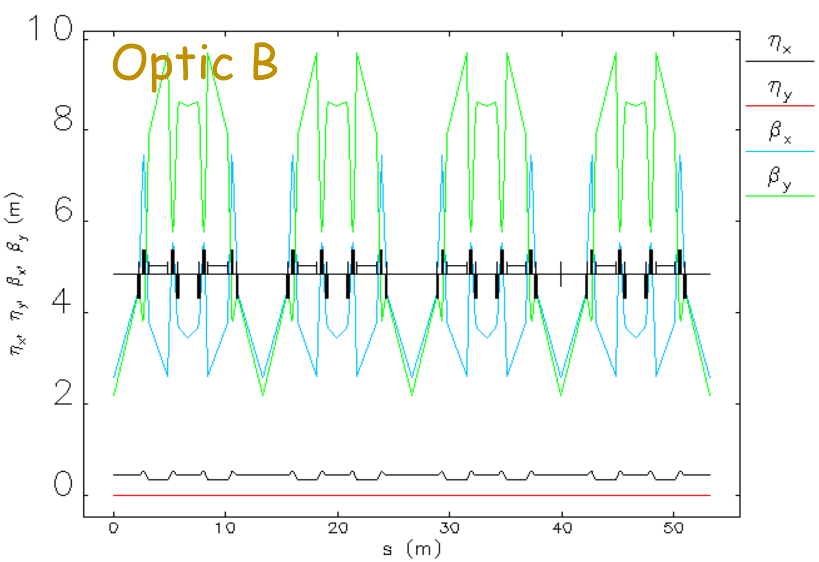
Best region to find an operating tune point with large dynamic aperture and low emittance

Possible Low-emittance Optics

Candidates for further investigations

Optics





Optic A has moderately large vertical betatron function at the short straight sections but small emittance. This optics may be useful for some special experiments requiring small emittance as possible. (ε_{x0}=9.6nm@750MeV, 6.1nm@600MeV)

Optic B: A low emittance optics with small vertical betatron function at the short straight sections.

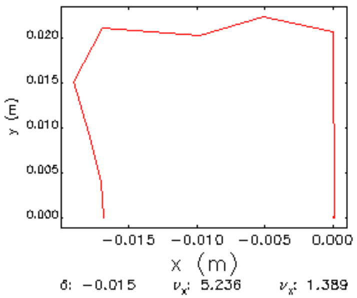
Parameters of New Optics

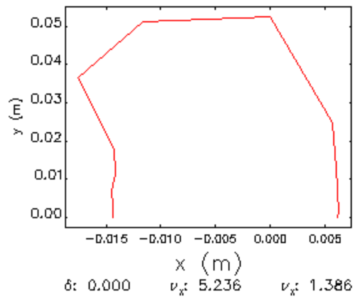
	UVSOR-III	Optic A	Optic B
Electron Energy	750 MeV	750 MeV	750 MeV
Emittance	16.9 nm	9.6 nm	11.1 nm
Betatron tunes (H, V)	(3.75, 3.20)	(5.23, 1.39)	(4.71, 1.70)
Dynamic Aperture Area		1.07 mm	4.27 mm

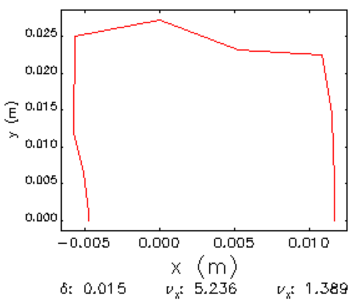
Possible Low-emittance Optics

Candidates for further investigations

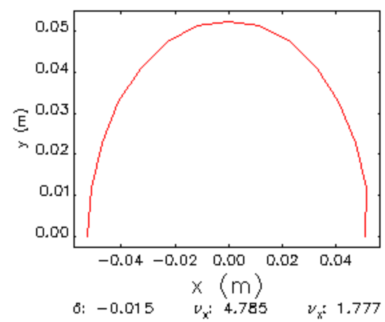
dynamic aperture

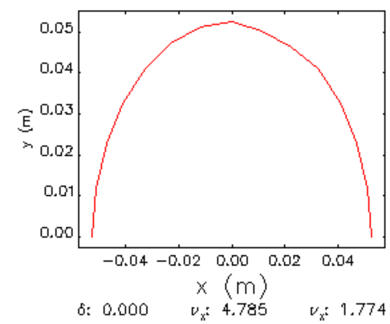


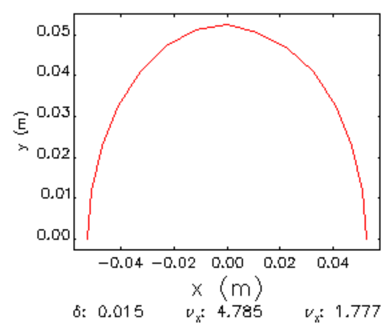




9.6nm







11.1nm

Summary and Prospects

- We have analyzed the optics of UVSOR for the present magnetic configuration.
- We have found a few optics which has significantly (but not drastically) smaller emittance than the present value (~17nm).
- We performed tune survey to find a reasonable operating point which gives a large dynamic aperture and low emittance.
- Although some of the optics require strong quadrupole fields which are marginal or beyond the hardware limitation, it may be interesting to consider low energy operation such as 600 MeV, in which the emittance would be further reduced.
- Some low emittance optics are not compatible with the operation of narrow gap undulators.
- However, they may be useful for some special experiments which need low emittance.
- Some other emittance optics we can consider for the following study