NSRL
中国科学技术大学
国家同步辐射实验室
NATIONAL SYNCHROTRON RADIATION LABORATORY

COMPLEX UNIT LATTICE CELL FOR LOW-EMITTANCE SYNCHROTRONS

12th International Particle Accelerator Conference
May 24-28, 2021

- The beam emittance:

$$\varepsilon_x = F \cdot \frac{E^2}{J_x N_B^3}$$

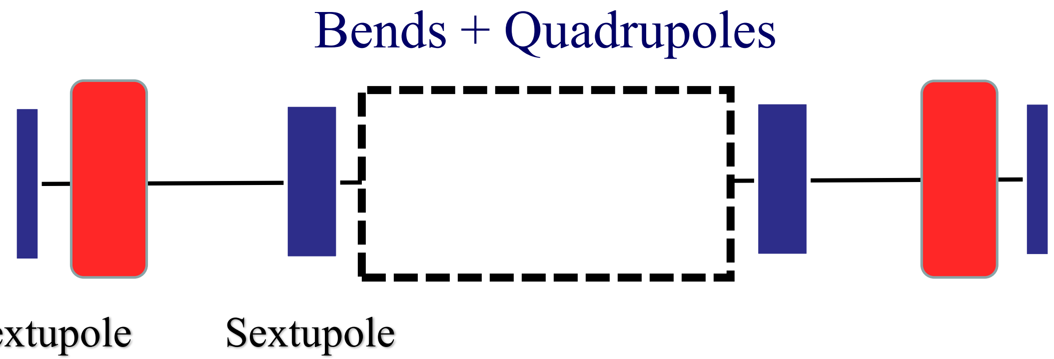
$N_B \Uparrow$ { stronger quadrupoles; stronger sextupoles }

- The equations for chromaticity compensation by sextupoles：

- $$\begin{cases} \xi_{x1} - \xi_{x0} = \oint \lambda(s)\eta\beta_x ds \\ \xi_{y1} - \xi_{y0} = \oint \lambda(s)\eta\beta_y ds \end{cases} \Rightarrow \begin{cases} I_{SF} = \dfrac{4\pi[\beta_{yD}(\xi_{x1}-\xi_{x0}) + \beta_{xD}(\xi_{y1}-\xi_{y0})]}{2\eta_F(\beta_{xF}\beta_{yD} - \beta_{yF}\beta_{xD})} \\ I_{SD} = \dfrac{4\pi[\beta_{yF}(\xi_{x1}-\xi_{x0}) + \beta_{xF}(\xi_{y1}-\xi_{y0})]}{2\eta_F(\beta_{yF}\beta_{xD} - \beta_{xF}\beta_{yD})} \end{cases}$$

Increasing the length of the drift section and forming the dispersion bumps helps to keep the integrated strength of sextupole small.

- Several bends are combined into a lattice unit cell and share a family of chromatic sextupoles:

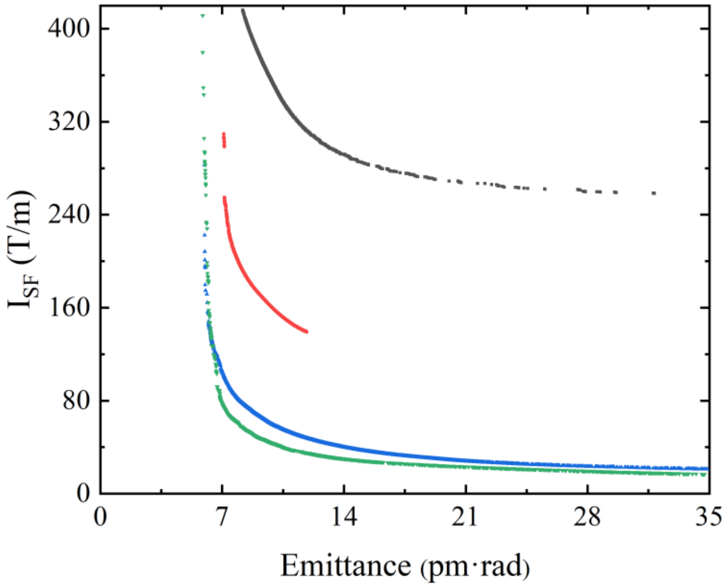


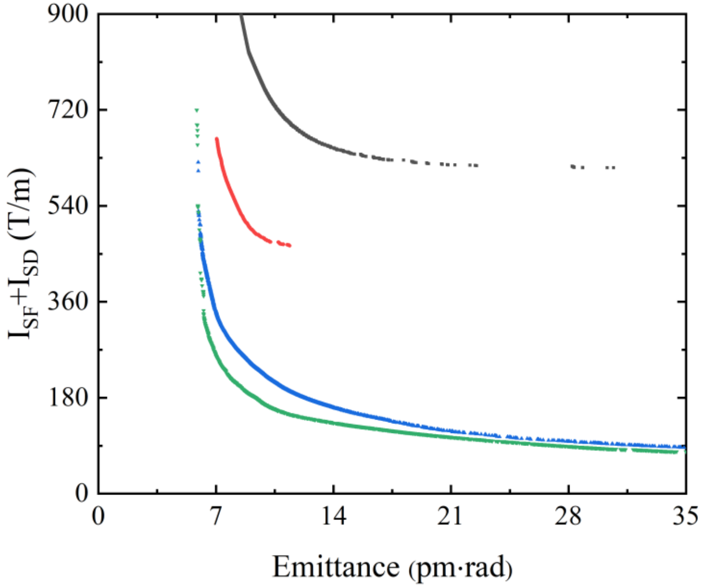
The magnet layout of the complex cell

- A simple ring with identical unit cells is created to study the characteristics of the complex cell.:
- 360 bends;
- 432 m;
- $Jx \le 2$;
- The normalized phase advance $\begin{cases} \nu_x = 108 \\ 0.1 \cdot \nu_x \le \nu_y \le 0.5 \cdot \nu_x \end{cases}$

Complex cell

- Compared with the TME cell, the complex cell can effectively decrease the integral strength of the sextupoles. There is no significant difference in the integral strength of the sextupoles with three and four bends complex cell. As the chromaticity will be raised, when the number of bends in an unit cell increased.

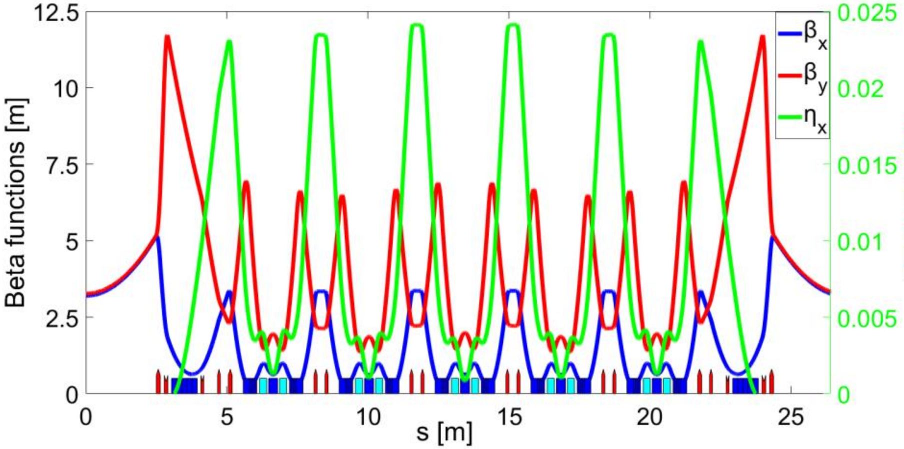


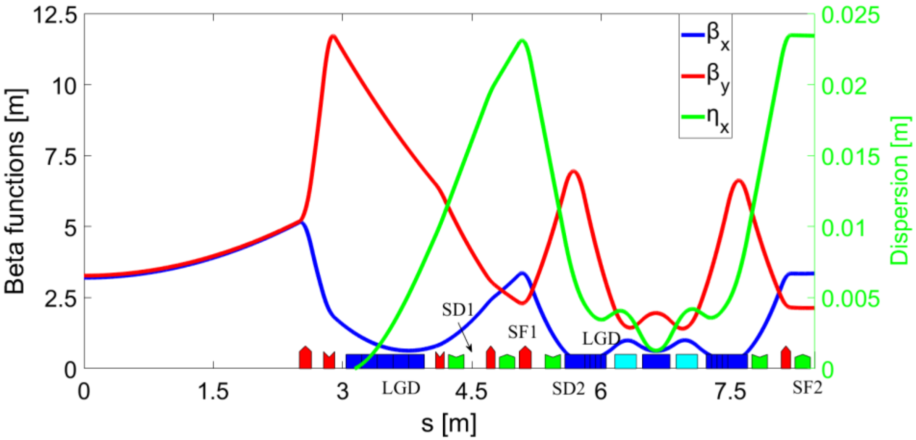


Black : TME cell; Red : Complex cell with two bends; Blue : Complex cell with three bends; Green : Complex cell with four bends

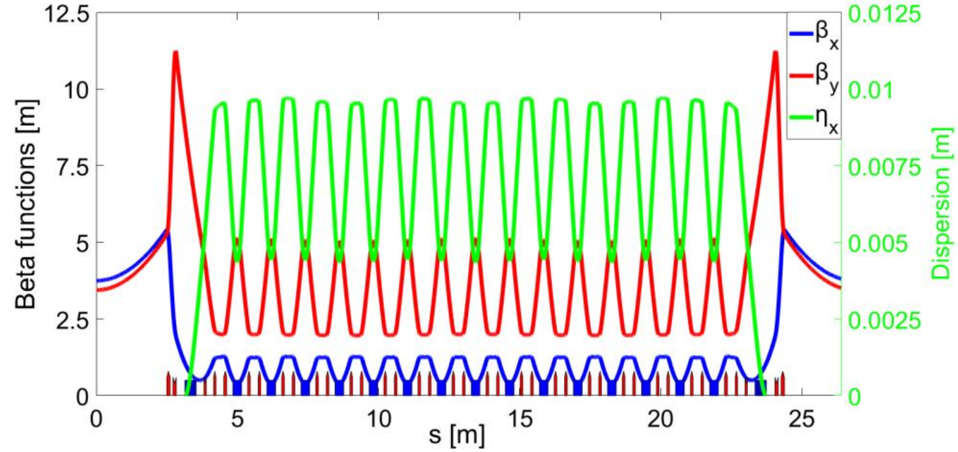
Complex Cell 17 BA vs Homogeneous 17 BA

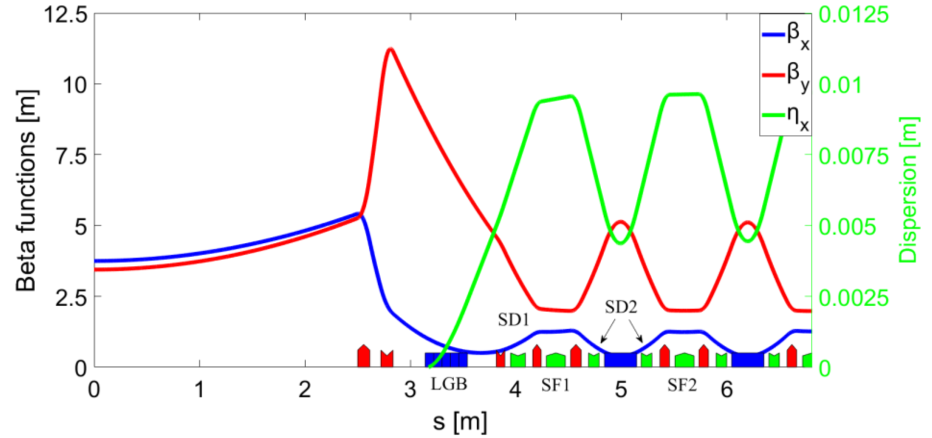
Complex 17BA





Homogeneous 17 BA





Complex Cell 17 BA vs Homogeneous 17 BA

Those two lattices realize similar emittance, about 21 pm·rad, but the Jx of complex cell 17 BA lattice is much lower than homogeneous 17 BA, and the momentum compaction factor is reasonable.

Table 1: Lattice Parameters: Complex Cell 17 BA vs Homogeneous 17 BA

	Complex Cell 17BA	Homogeneous 17BA
Circumference[m]	537.6	
Energy[GeV]	3	
Number of cells	20	
Emittance [pm.rad]	21.68	21.91
Transverse tunes	96.14/27.14	96.16/27.14
Chromaticity	-116.2/-128.8	-92.7/-123.1
Momentum compaction factor	4.1×10^{-5}	5.4×10^{-5}
Damping partition numbers	1.77/1.0/1.23	2.12/1.0/0.88
Damping time	13.9/24.6/19.9	12.0/25.4/28.8

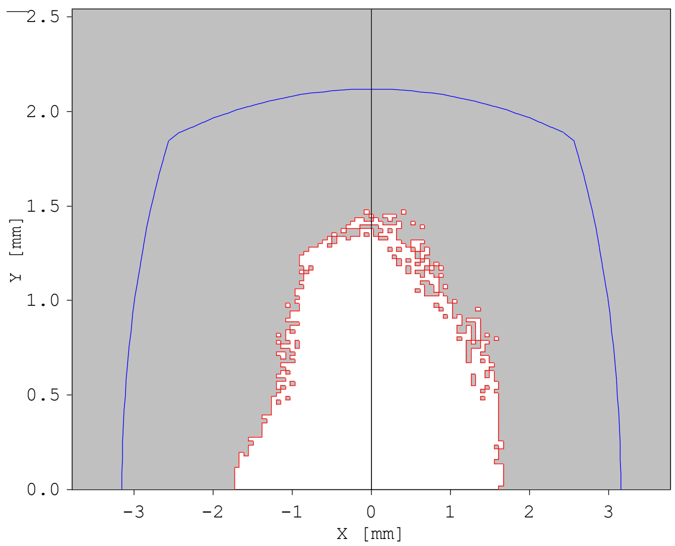
Table 2: The Integral Strength of Sextupoles

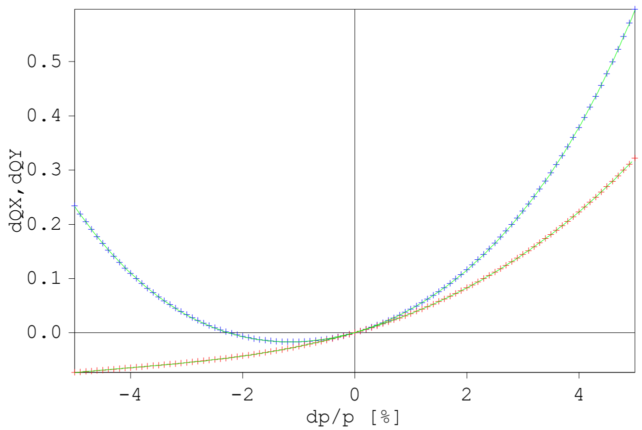
	Complex cell 17 BA	Homogeneous 17 BA
SF1	2193.5	6840.0
SD1	1620.9	3286.0
SF2	2801.6	6622.8
SD2	2221.6	3831.2

And the complex cell 17 BA lattice obtains much lower integral strength of sextupoles .

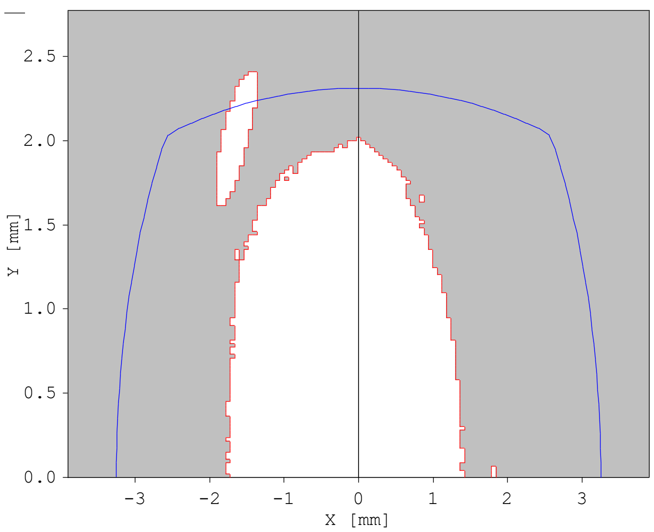
Complex Cell 17 BA vs Homogeneous 17 BA

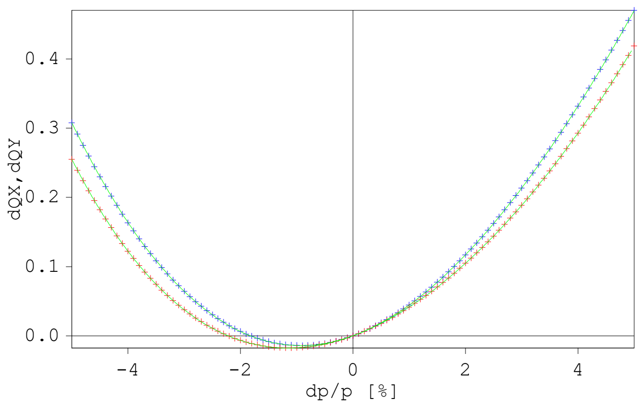
Complex 17BA





Homogeneous 17 BA





Thank you !