CLIC Workshop 2014

A non-interleaved sextupole scheme for the CLIC compact FFS

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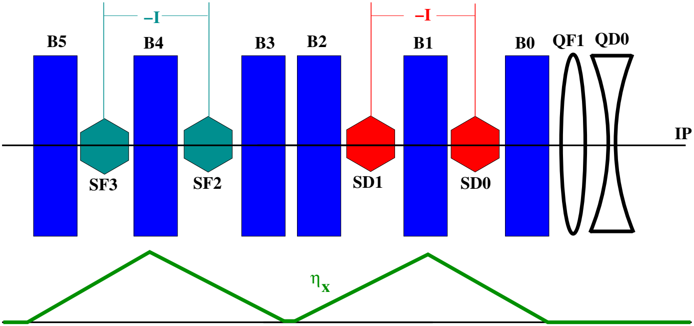
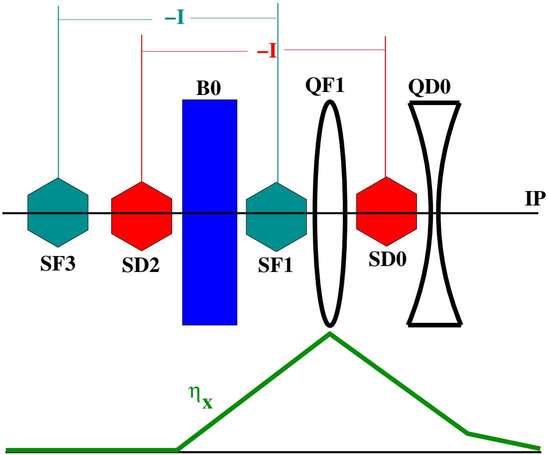
Non-local chromaticity correction



Local chromaticity correction

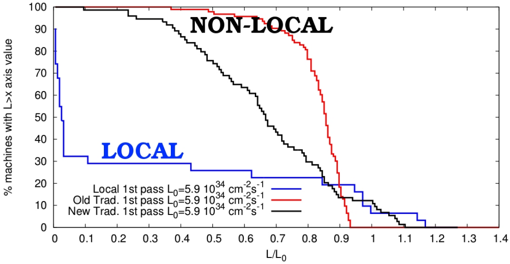


Both methods achieve similar luminosities

Scheme	Energy [GeV]	$\mathcal{L}_T$ [cm^{-2}s^{-1}]	$\mathcal{L}_{1\%}$ [cm^{-2}s^{-1}]	$\mathcal{L}_{1\%}/\mathcal{L}_{1\%}^{(w/o\ SR)}$
Local	3000	7.8	2.4	0.79
Old traditional	3000	5.3	1.9	0.76
New traditional	3000	7.5	2.4	0.76

Local method is shorter, non-local (traditional) is easier to tune

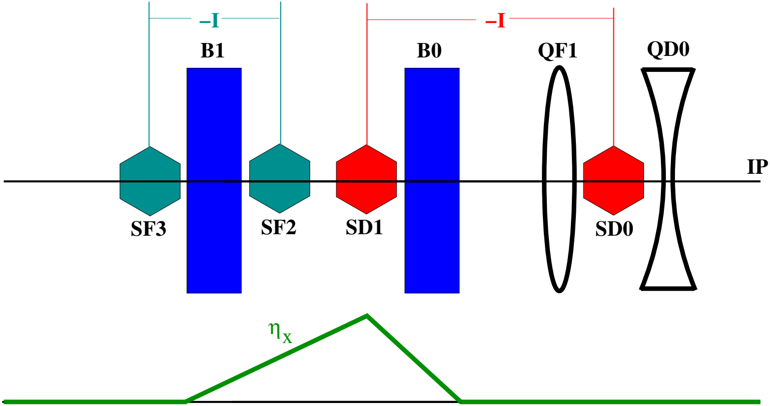
Scheme	Energy [GeV]	L_{FFS} [m]	ξ_y	$\sigma_y^*/\sigma_{y,0}^*$
Local	3000	450	23005	229.7
Old Traditional	3000	1500	39482	398.0
New Traditional	3000	1500	32242	327.1



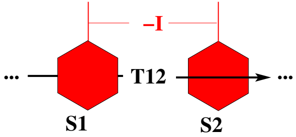
Courtesy of Hector García

Non-interleaved chromaticity correction

Design proposed by R. Tomás



Geometric Terms Cancellation



Having a lattice channel $S_1 T_{12} S_2$ where S_1 and S_2 are sextupoles with strengths k_{21}, k_{22}, and T_{12} the transfer matrix between S_1 and S_2.

$$T_{12} = \begin{pmatrix} t_{11} & t_{12} & 0 & 0 \\ t_{21} & t_{22} & 0 & 0 \\ 0 & 0 & t_{33} & t_{34} \\ 0 & 0 & t_{43} & t_{44} \end{pmatrix} \quad (1)$$

G. Xu [1] derived the conditions to cancel the geometric aberrations.

General Set of conditions

$$t_{12} = 0, \quad t_{34} = 0$$
$$t_{11} t_{22} = 1, \quad t_{33} t_{44} = 1$$
$$k_{21} = -k_{22} t_{11}, \quad t_{11} = \pm t_{33}$$

General Set of conditions (in twiss functions)

$$\phi_{x12} = n_x \pi, \quad \phi_{y12} = n_y \pi, \qquad n_x, n_y \in \text{integer}$$
$$k_{21} \beta_{x1}^{3/2} = -(-1)^{n_x} k_{22} \beta_{x2}^{3/2}$$
$$\beta_{y1}/\beta_{x1} = \beta_{y2}/\beta_{x2}$$

The $-I$ transformer

$$\beta_{x1} = \beta_{x2}, \quad \alpha_{x1} = \alpha_{x2}, \quad \beta_{y1} = \beta_{y2}, \quad \alpha_{y1} = \alpha_{y2}$$
$$k_{11} = k_{22}$$
$$\phi_{x12} = n_x \pi, \quad \phi_{y12} = n_y \pi, \qquad n_x, n_y \in \text{odd}$$

Tolerances

However, in practice there will be tolerances in the achievement of these restrictions.
Using $n_x = n_y = 1$, and defining $\Delta\phi_x, \Delta\phi_y, r_x, r_y$ as

$$\begin{aligned} \phi_{x12} + \Delta\phi_x &= \pi \\ \phi_{y12} + \Delta\phi_y &= \pi \\ k_{21}\beta_{x1}^{3/2} - k_{22}\beta_{x2}^{3/2} + r_x &= 0 \\ k_{21}\beta_{y1}^{3/2} - k_{22}\beta_{y2}^{3/2} + r_y &= 0 \end{aligned}$$

where $\Delta\phi_x$, $\Delta\phi_y, r_x, r_y$ are small, it is possible to evaluate how exact the cancellation is.

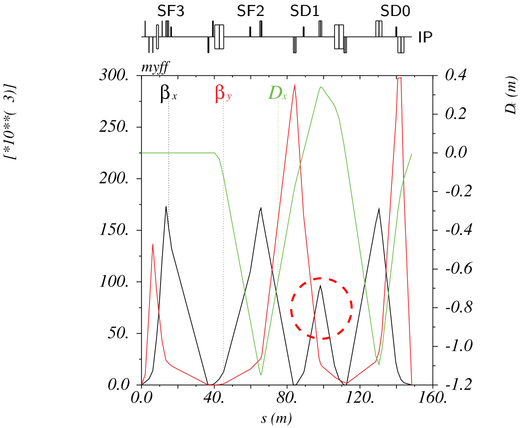
Tolerances (cont.)

To the first order in $\Delta\phi_x, \Delta\phi_y, r_x, r_y$

$$
\begin{aligned}
t_{11}t_{22} =& 1 - (\alpha_{x2} - \alpha_{x1})\Delta\phi_x \\
t_{33}t_{44} =& 1 - (\alpha_{y2} - \alpha_{y1})\Delta\phi_y \\
x_2 =& \sqrt{\beta_{x_2}\epsilon_x}\left[-1 + \alpha_{x1}\Delta\phi_x + \Delta\phi_x - \left(\frac{1}{2}k_{21}\beta_{x1}\Delta\phi_x x_1\right)\left(1 - \frac{y_1^2}{x_1^2}\right)\right] \\
y_2 =& \sqrt{\beta_{y_2}\epsilon_y}\left[-1 + \alpha_{y1}\Delta\phi_y + \Delta\phi_y + (k_{21}\beta_{y1}\Delta\phi_y x_1)\right] \\
x_2' =& \sqrt{\frac{\epsilon_x}{\beta_{x2}}}\left[1 + \alpha_{x1} - \alpha_{x2} - \alpha_{x2}\Delta\phi_x - (1 + \alpha_{x1}\alpha_{x2})\Delta\phi_x \right. \\
& \left. - \frac{1}{2}\epsilon_x^{1/2}\left(r_x - \frac{y_1^2}{x_1^2}r_y\right) + O(\Delta\phi_x) + O(\Delta\phi_y)\right]
\end{aligned}
$$

The factors in red are the most relevant

Lattice @ 500GeV (Preliminar)



- $\beta \sim 10^5$
  Due to distance to the IP
- $\alpha \sim 10^4$
  $\Delta\phi \sim 10^{-6}$, r$\sim 10^{-6}$
  Almost $-I$
  - β ratio $\sim$ 1.6, v. sext.
  - β ratio $\sim$ 0.8, h. sext.
- Length $\sim$ 150 m
- Strange dispersion matching due to extra horizontal β_x peak

Conclusions

- A new chromatic correction method is proposed
- Geometric aberrations cancellation depend mostly on factor $\alpha\Delta\phi$
- Lattice design at 500GeV has stopped and 3TeV case has started in order to compare luminosity and tuning capabilities.

I THANK YOU ALL!

References

Xu, G. General conditions for self-cancellation of geometric aberrations in a lattice structure. PRST-AB 8,104002, 2005.

Renier, Ives. Implementation and validation of the linear collider final focus prototype : ATF2 at KEK (Japan). Doctoral Thesis, LAL10-91. June 2010.