CLIC 380 GeV BDS design and tuning

Fabien Plassard[1,2], Rogelio Tomás García [1], Eduardo Marin [1]

[1] **CERN**, *Switzerland, Geneva* [2] **Université Paris Sud**, *France, Orsay*

June 26^{th} 2017

SLAC, USA

OUTLINES

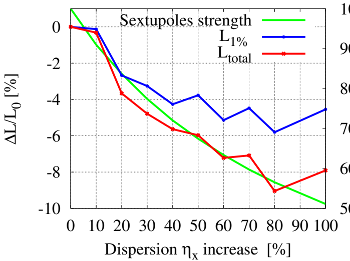
Introduction

- The nominal 380 GeV BDS design with L^* = 4.3 m was optimized based on the previous 500 GeV BDS design
- A long L^* design has been design as well, allowing QD0 to be located outside of the Detector (see motivations for longer L^* in the talk *"Status of the CLIC 3 TeV BDS with L^* = 6 m"*)
- For both L^* design options, the dispersion level along the FFS was optimized according to the maximum luminosity achievable as well as their tuning efficiency (Tuning-based design optimization)
- The final performance of both designs and their tuning efficiency under transverse misalignment of the optics and under more realistic error conditions will be presented

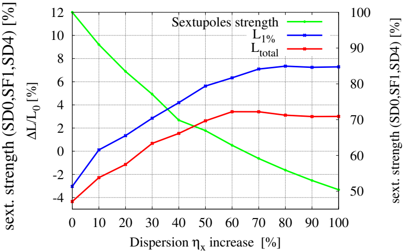
BDS design optimization with L^*= 4.3 m and L^*= 6 m

- For L^*= 4.3 m, the FFS is based on the previous 500 GeV lattice and the optics strengths were rematched for 380 GeV
- For L^*= 6 m, the length of the FFS has been scaled according to the increase of L^* (length increased from 550 m to 770 m)
- For both L^* designs, the dispersion level along the FFS was optimized in order to maximize the luminosity :

L^*= 4.3 m



L^*= 6 m



BDS design optimization with L^*= 4.3 m and L^*= 6 m

- It was found for both L^* designs **uncorrected residual 2nd order chromaticity** which strongly impact the beam size (mainly σ_x^*)
- The chromaticity correction along the FFS was not optimal was the residual **aberrations were fully corrected by optimizing the distance between QF1 and QD0**

L^*= 4.3 m

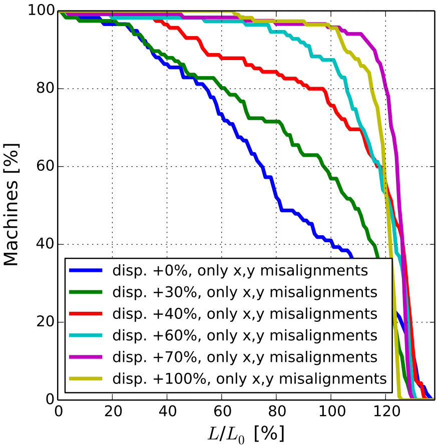
η_x increase (%)	σ_x^*/ (σ_y^*) (nm) **(before L_{FD} optim.)**	σ_x^*/ (σ_y^*) (nm) **(after L_{FD} optim.)**
0	149.7 / 2.75	**144.8 / 2.55**
10	150.5 / 2.72	**145.0 / 2.58**
20	151.4 / 2.81	**145.2 / 2.43**
30	152.1 / 2.80	**146 / 2.41**
40	153.2 / 2.8	**145.5 / 2.40**
50	153.7 / 2.8	**146 / 2.45**
60	154.6 / 2.77	**147.3 / 2.42**
70	155.2 / 2.76	**148 / 2.38**
80	157.1 / 2.83	**149 / 2.38**
90	157.4 / 2.85	**150.4 / 2.39**
100	160.1/ 2.87	**152.6 / 2.40**

L^*= 6 m

η_x increase (%)	σ_x^*/ (σ_y^*) (nm) (before L_{FD} optim.)	σ_x^*/ (σ_y^*) (nm) (after L_{FD} optim.)
0	153.8 / 4.74	145.4 / 3.8
10	155.2 / 4.3	145.5 / 3.9
20	156.6 / 4.0	145.4 / 3.45
30	157.7 / 3.75	145.7 / 3.13
40	157.6 / 3.66	145.8 / 3.4
50	160 / 3.44	146.6 / 2.94
60	160.6 / 3.3	147 / 2.88
70	162 / 3.3	148 / 2.7
80	163 / 3.2	149.2 / 2.75
90	164 / 3.17	150 / 2.7
100	167 / 3.14	152 / 2.72

Tuning the L^*= 4.3 m lattice under transverse misalignments

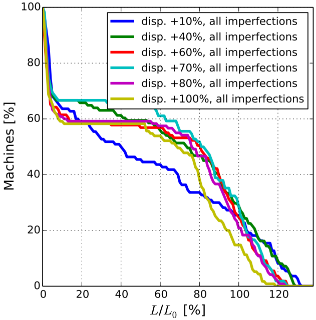
- Tuning-based optimization goal : find the optimal dispersion level along the FFS by taking as figure of merit the **tuning performance**



- The optimal dispersion level for L^* = 4.3 m according to the tuning performance under transverse misalignment imperfections was found by **increasing η_x by +70%**

Tuning the L^*= 4.3 m lattice under realistic errors

Errors	Value
Transverse misalignment (RMS)	10μm
roll	300 μrad
strength	0.1%

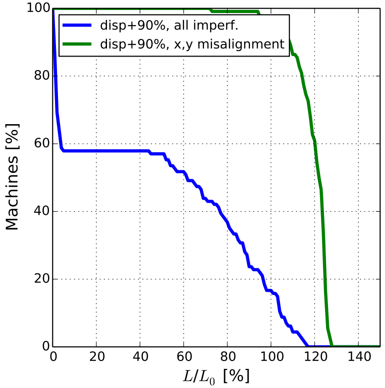


η_x increase (%)	$L_{\text{tot, average}}$ $(10^{34}\ \text{cm}^{-2}\text{s}^{-1})$ **(x,y mis. only)**	$L_{\text{tot, average}}$ **(all imperfections)**
10	1.28	0.845
40	1.62	0.997
60	1.7	0.942
70	**1.8**	**1.03**
80	1.71	0.93
100	1.7	0.85

L^* **(m)**	**4.3**
L_{total} / $L_{1\%}$ $(10^{34}\ \text{cm}^{-2}\text{s}^{-1})$	1.99 / 1.15
σ_x^* / σ_y^* (nm)	148 / 2.38

Tuning-based optimization of the L^*= 6 m

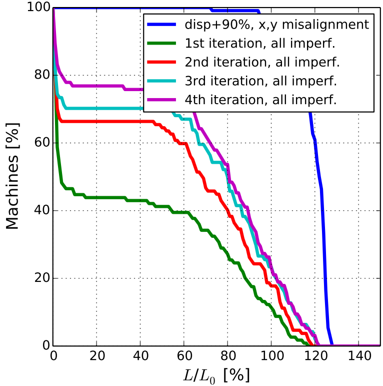
- Tuning-based optimization for L^*= 6 m found optimal dispersion by **increasing η_x by +90%**



L^* **(m)**	**6**
L_{total} / $L_{1\%}$ $(10^{34}\ \mathrm{cm}^{-2}\mathrm{s}^{-1})$	1.75 / 1.05
σ_x^* / σ_y^* (nm)	150 / 2.7

Tuning-based optimization of the L^*= 6 m

- Tuning-based optimization for L^*= 6 m found optimal dispersion by **increasing η_x by +90%**



- Iterations of tuning using only Linear Knobs under realistic error condition shows that the correction of linear aberrations is not enough to fully tune the beam
- **Non-linear knobs has to be constructed and implemented in the tuning procedure** (ongoing work)

Conclusions

- Both L^* option designs have been optimized, according to their maximum luminosity achievable and tuning efficiency, and **fulfill the design luminosity requirements as well as the luminosity budget** for static and dynamic imperfections
- The tuning simulations have shown that under only transverse misalignments, only 1 iteration of BBA and linear knobs are needed to reach the tuning goals
- Under more realistic error conditions, **non-linear knobs will be needed for both designs in order to correct the 2nd order aberrations generated by the strength and roll errors** (ongoing work)