Status and plans of CLIC FFS tuning with L*=6m

380 GeV & 3 TeV designs

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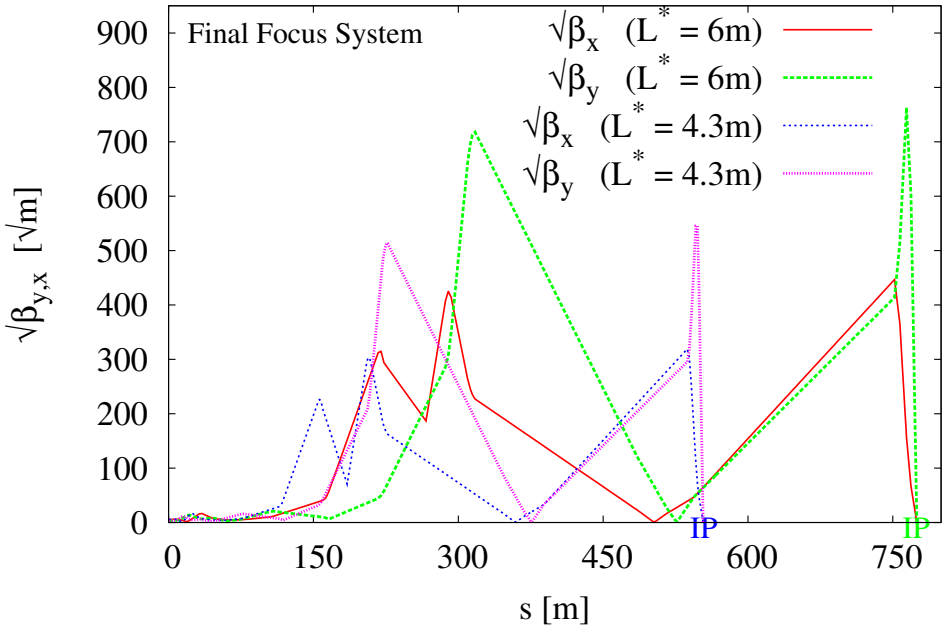
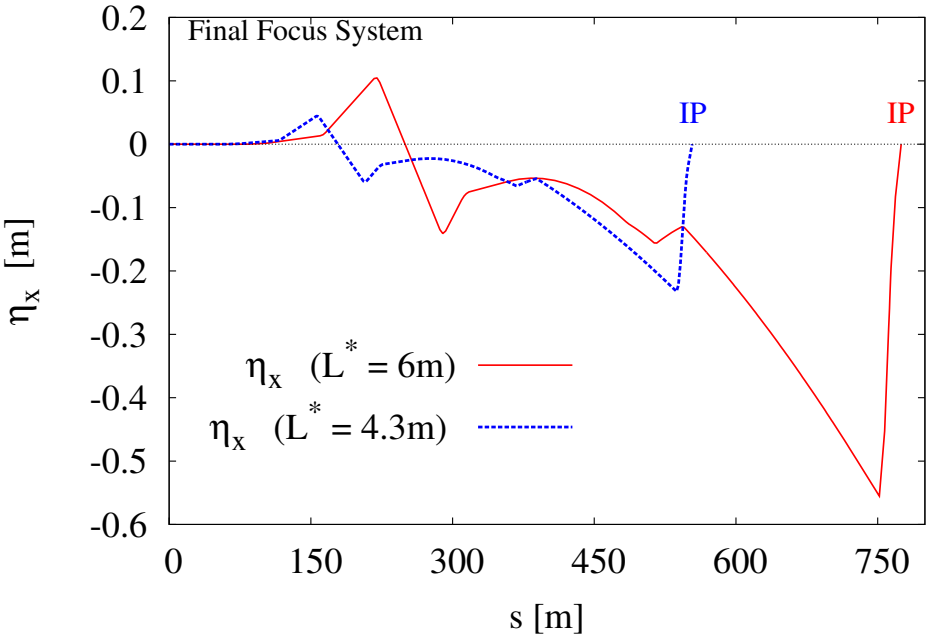
OUTLINES

1. 380 GeV FFS tuning : L^* = 4.3 m vs 6 m
   - Presentation of the lattices
   - Tuning performance comparison
2. 3 TeV FFS tuning : L^* = 6 m
   - Presentation of the lattices
   - Tuning performance comparison
3. Plans

CLIC 380 GeV : Presentation of the lattices





L^* (m)	6	4.3
σ_x^*/σ_x^*(SR) (nm)	157 / **160**	150 / **150**
σ_y^*/σ_y^*(SR) (nm)	3.6 / **3.5**	2.78 / **2.7**
L_{tot} $(10^{34} cm^{-2} s^{-1})$	**1.52**	**1.86**
$L_{1\%}$ $(10^{34} cm^{-2} s^{-1})$	**0.94**	**1.09**

- Details on the lattices optimization :
  indico.cern.ch/event/449801/session/0/contribution/98

- For the L^* = 6m lattice, FFS length scaled and dispersion optimized
- The dispersion level have been increased by 70% leading to reduce the average sextupole strength of the FFS by **40%**
- Both designs achieve the design Luminosity L_{tot}= $1.5 \times 10^{34} cm^{-2} s^{-1}$ and L_{peak}= $0.9 \times 10^{34} cm^{-2} s^{-1}$

TUNING : Alignment procedure applied

- The tuning of the Final Focus System aims to **mitigate the static imperfections** (misalignment, magnet strength errors) by means of **BPM readings, magnet movers and dipole correctors** in order to recover the luminosity loss from these imperfections
- The alignment procedure consists of 2 iterations of **Beam Based Alignment (BBA)**, for the correction of the **orbit** using steering magnets, followed by a **sextupole knobs tuning**, for the correction of the **beam parameters at the IP** using sextupole movers :

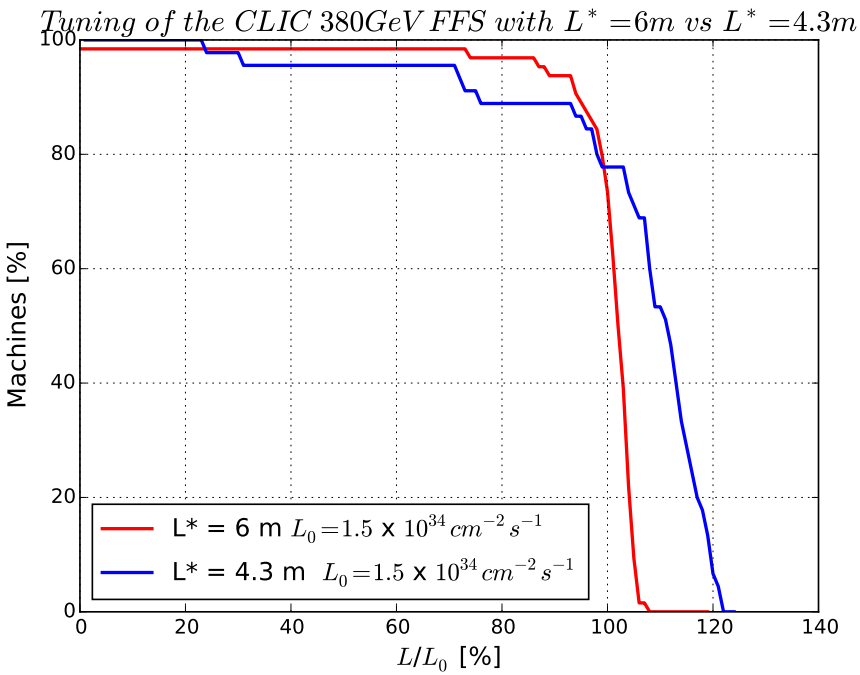
1. 1-1 correction
2. 1st Target Free Steering (TFS)
3. 1st Sextupole Knobs tuning
4. 2nd TFS
5. 2nd Sextupole Knobs tuning

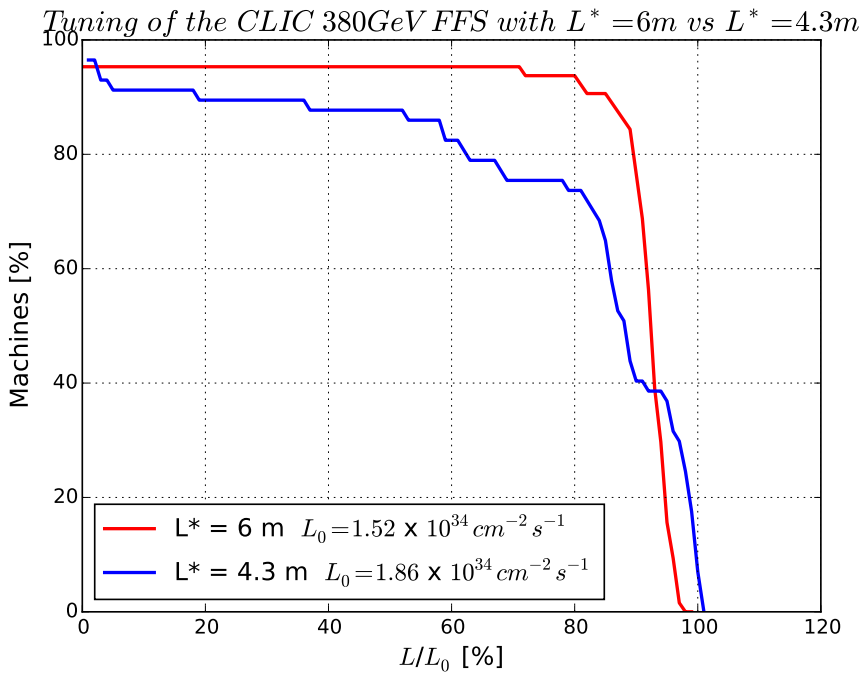
TUNING SETUP assumed for the simulations :

Static imperfections considered	transverse misalignment only
Elements misaligned	QUADRUPOLES, SEXTUPOLES, BPMs
Pre-alignment	$\sigma = 10\mu$m
BPM resolution	10 nm
Number of machines randomly misaligned	110
Goal	90 % of machines recover 90% of L_0

CLIC 380 GeV : Tuning performance comparison

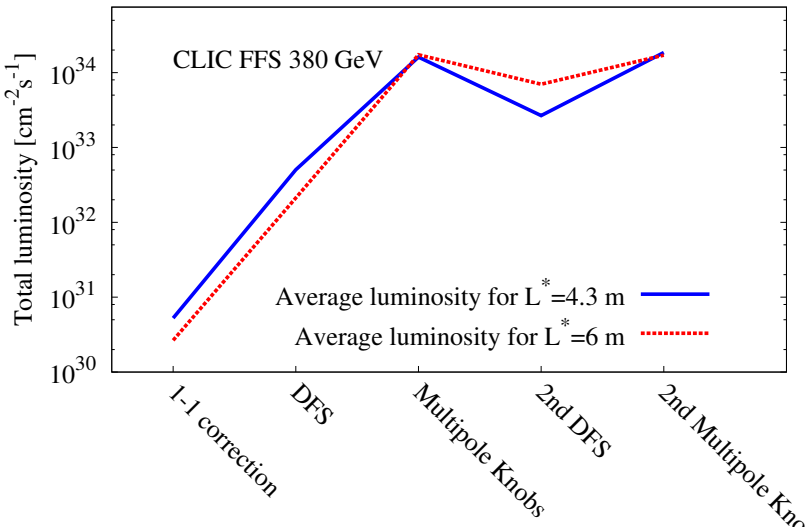
- For L^*=4.3m, for 1 iteration 88% of the machines achieves 90% of L_0= $1.5\times10^{34}cm^{-2}s^{-1}$ –> **The Goal is achieved**
- For L^*=6m, for 1 iteration 91% of the machines achieves 90% of L_0= $1.5\times10^{34}cm^{-2}s^{-1}$ –> **The Goal is achieved**
- When normalized to the maximum luminosity achievable by each lattice, one can see that the long L^* lattice shows better tuning performances

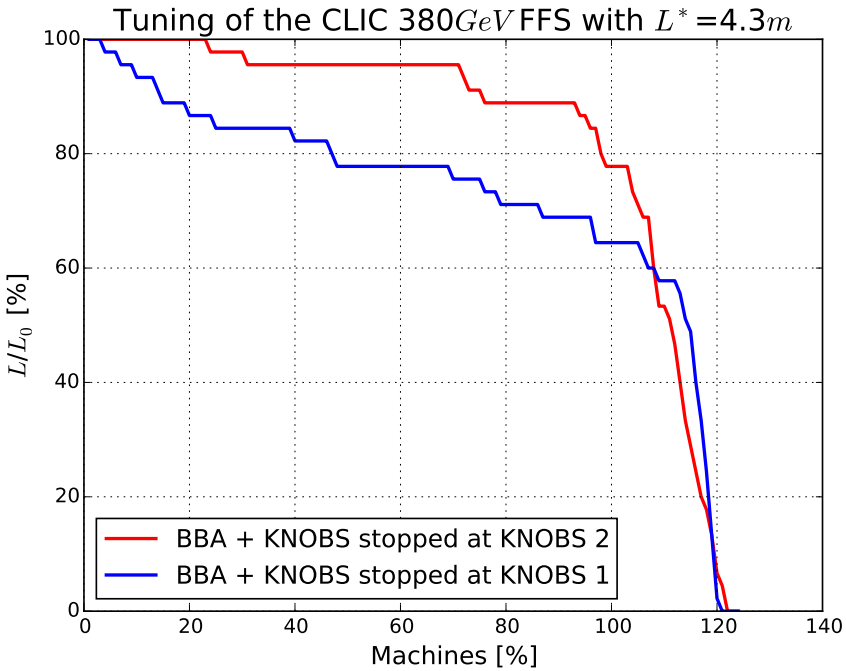


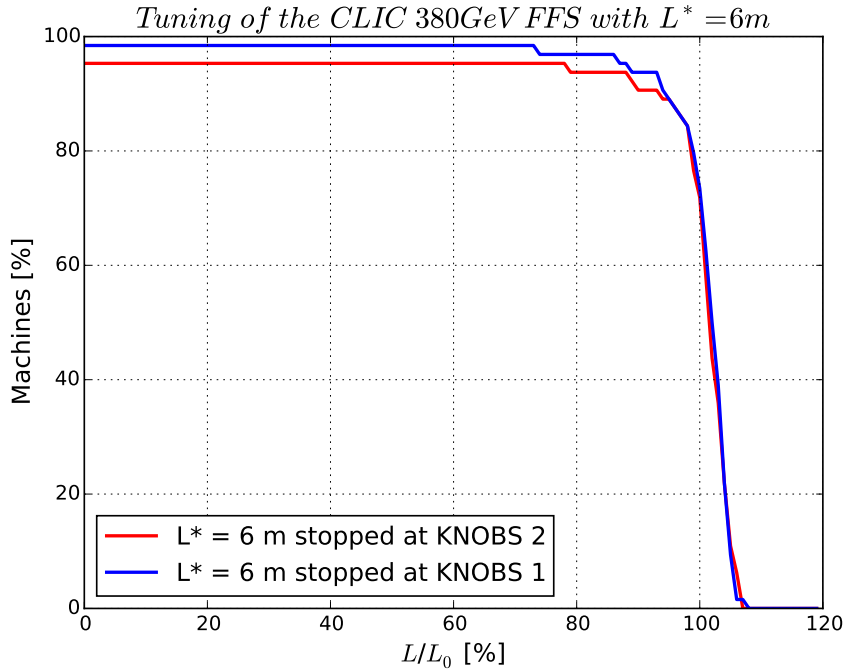


CLIC 380 GeV : Tuning performance comparison

- For L^*=4.3m the second DFS and multipole knobs improves significantly the luminosity
- For L^*=6m no major differences between the first and second DFS and multipole knobs
- The free parameters of the DFS can be further optimize or the number of iterations can be divided by 2

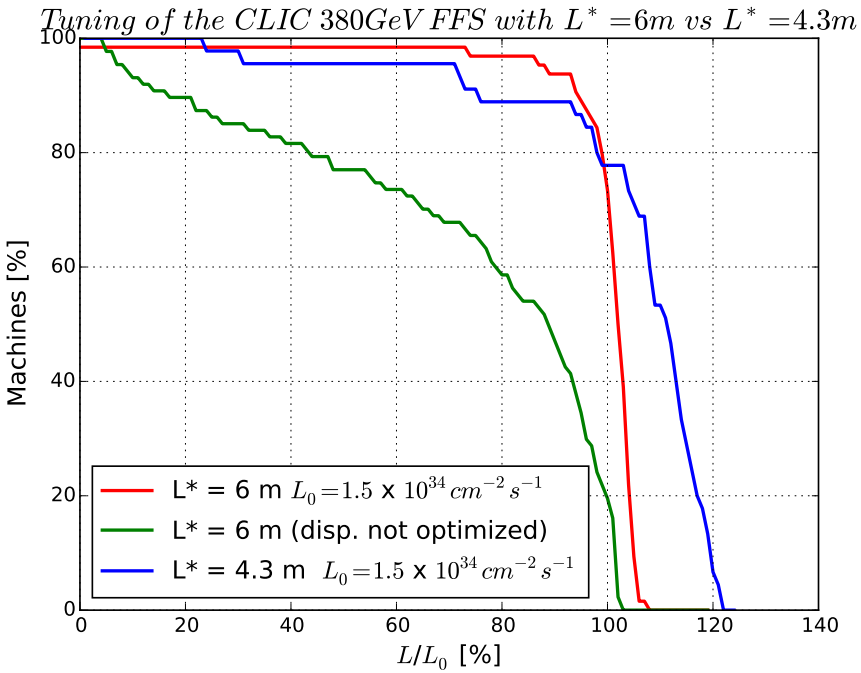


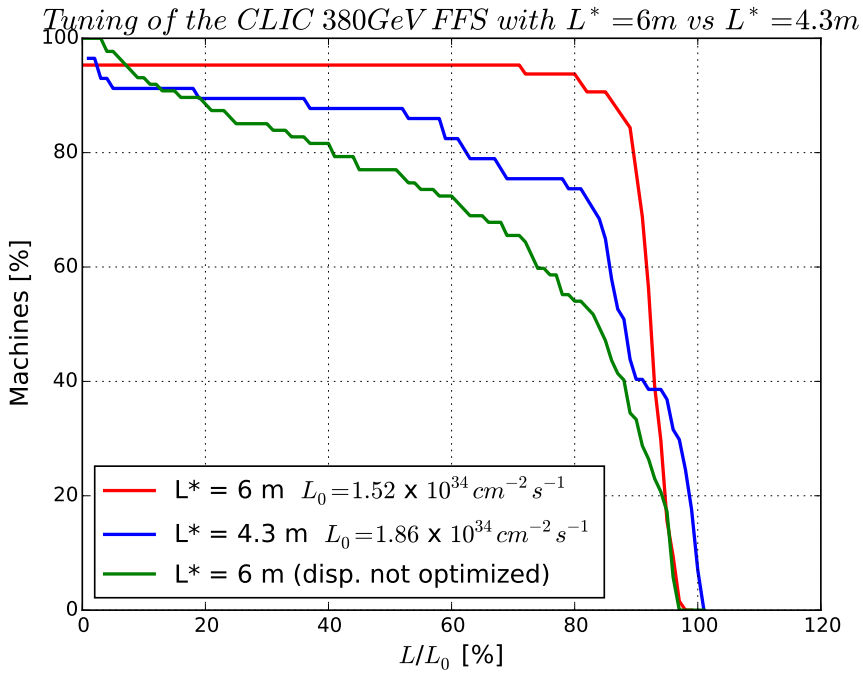




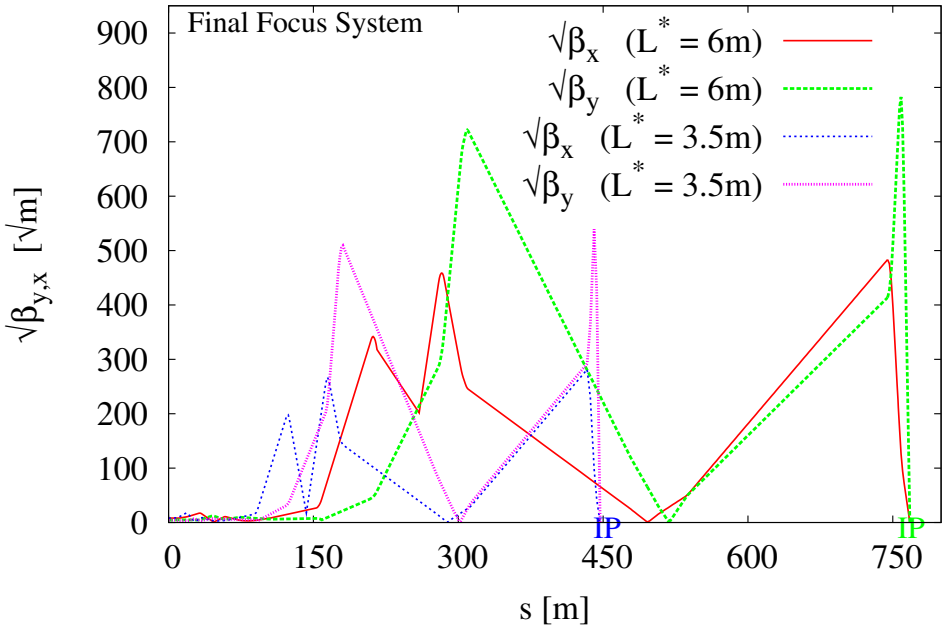
CLIC 380 GeV : Tuning performance comparison

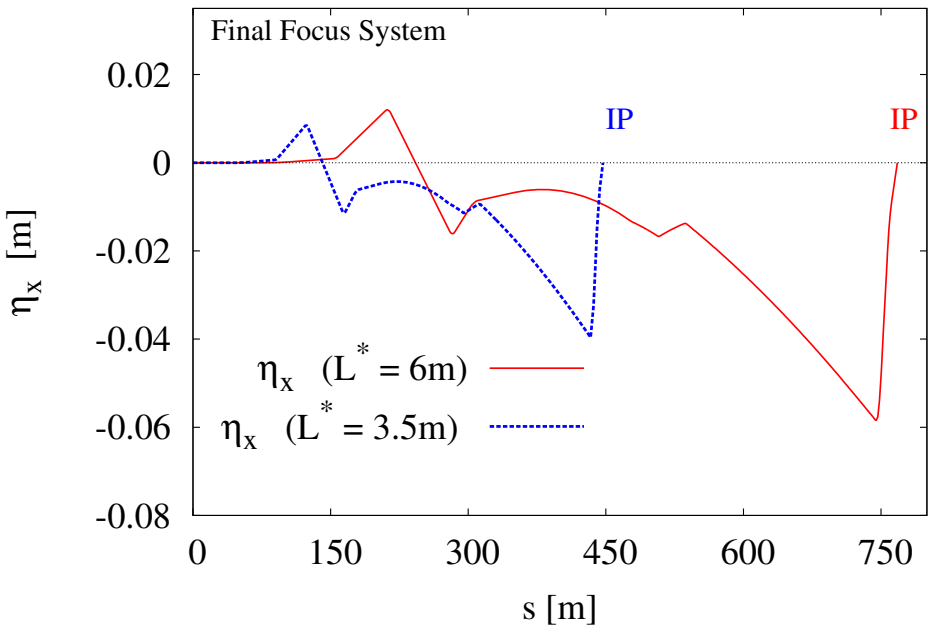
- The green lines show the tuning performance of the L^*=6m before dispersion optimization. The dispersion was 70% lower and the sextupole strengths 40% higher
- One can see the clear dependence and impact of the sextupole strengths (thus dispersion level) in the FFS on the tuning performance
- L^*=6m before optimization : 48% of the machines achieve 90% of L_0 / After : 91% of the machines achieve 90% of L_0





CLIC 3 TeV : Presentation of the lattices





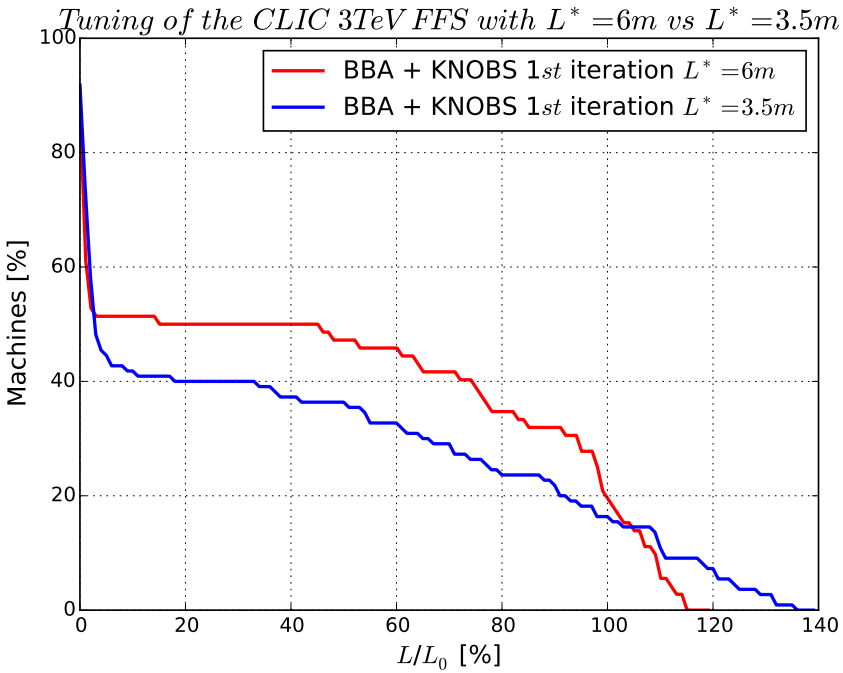
L^* (m)	**6**	**3.5**
σ_x^*/σ_x^*(SR) (nm)	41.2 / **49.7**	40 / **47.7**
σ_y^*/σ_y^*(SR) (nm)	1.44 / **2**	1 / **2.5**
L_{tot} $(10^{34} cm^{-2} s^{-1})$	**6.43**	**7.5**
$L_{1\%}$ $(10^{34} cm^{-2} s^{-1})$	**2.06**	**2.3**

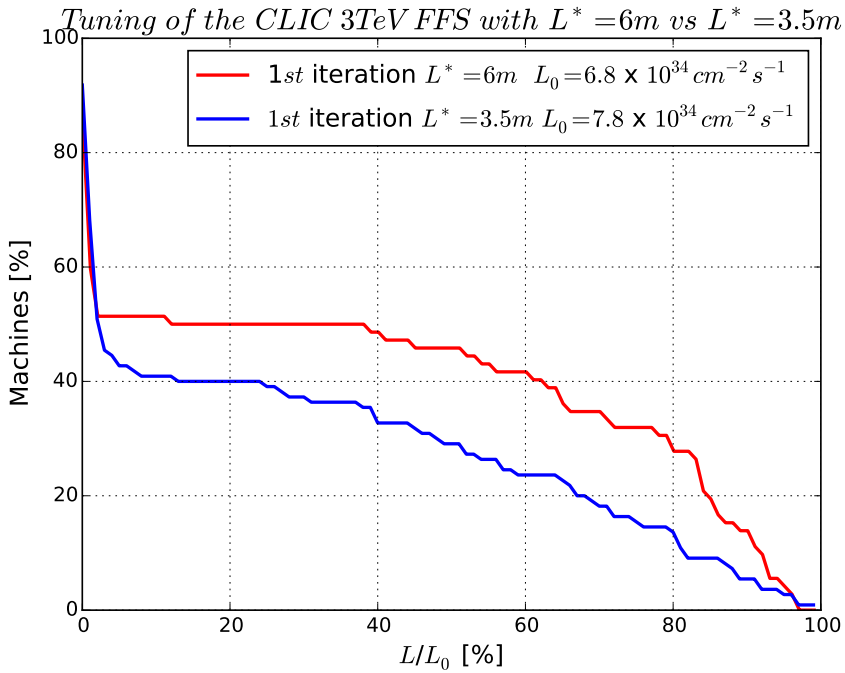
- Details on the lattices optimization :
  indico.cern.ch/event/449801/session/0/contribution/98

- For the L^* = 6m lattice, FFS length scaled and dispersion optimized
- The dispersion level have been reduced by 15% leading to increase the average sextupole strength of the FFS by **18%**
- Both designs achieve the design Luminosity L_{tot}= 5.9×$10^{34} cm^{-2} s^{-1}$ and L_{peak}= 2×$10^{34} cm^{-2} s^{-1}$

CLIC 3 TeV : Tuning performance comparison

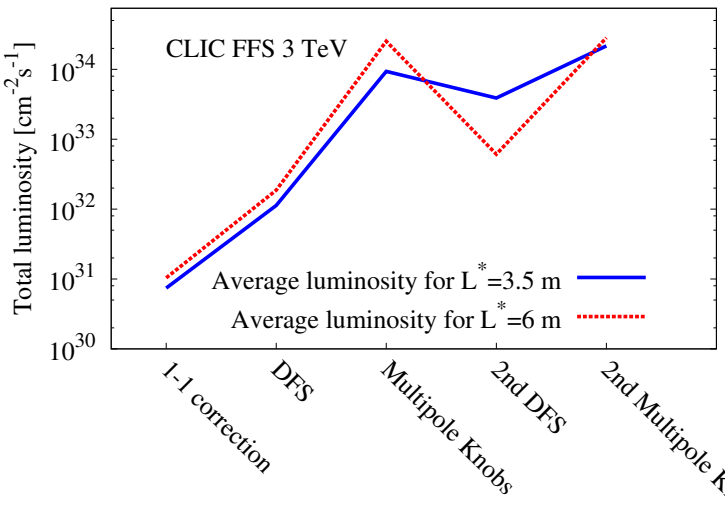
- For L^*=3.5m, for 1 iteration 22% of the machines achieves 90% of L_0= $5.9\times10^{34} cm^{-2}s^{-1}$ –> **Goal NOT achieved**
- For L^*=6m, for 1 iteration 32% of the machines achieves 90% of L_0= $5.9\times10^{34} cm^{-2}s^{-1}$ –> **Goal NOT achieved**
- When normalized to the maximum luminosity achievable by each lattice, one can see that the long L^* lattice shows slightly better tuning performances

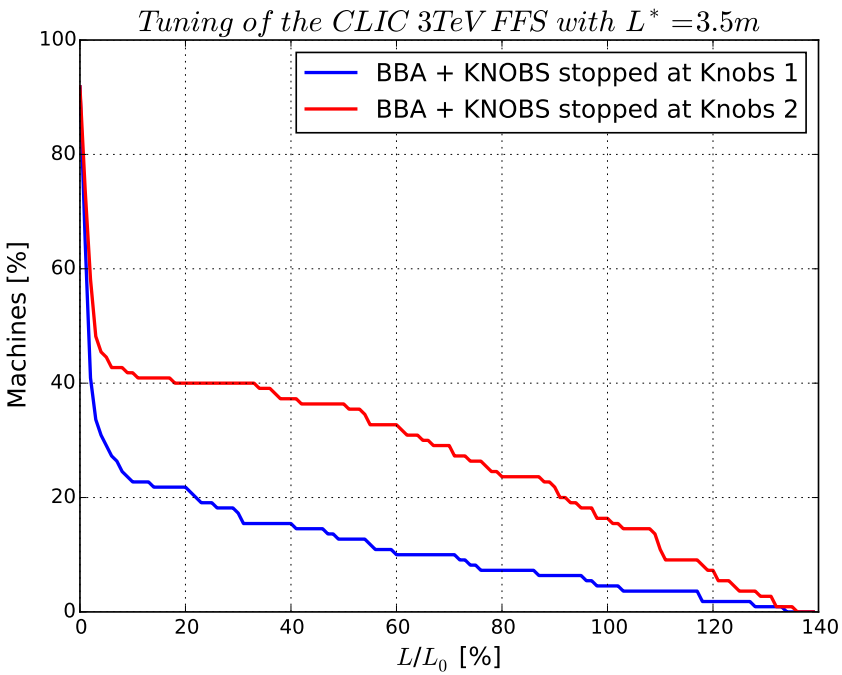


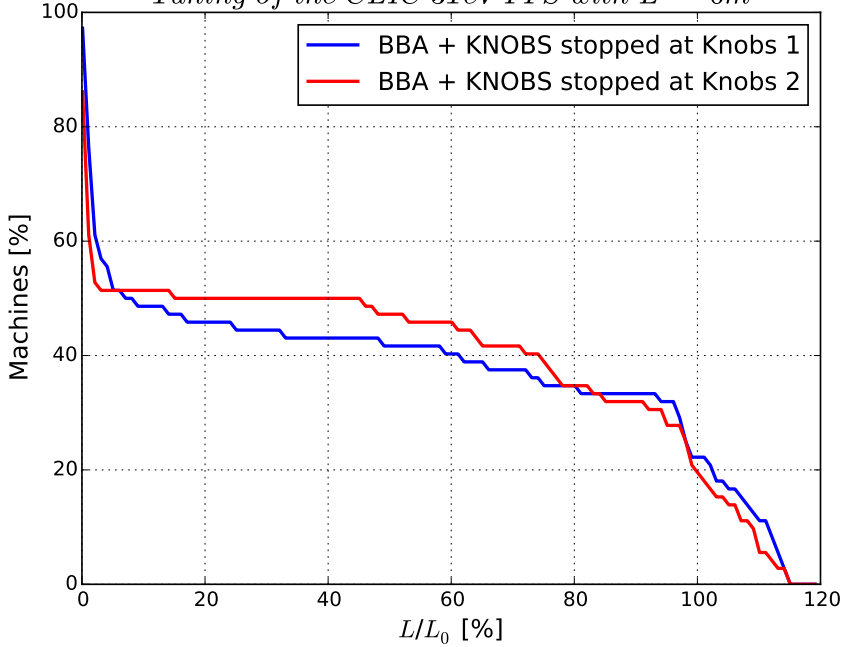


CLIC 3 TeV : Tuning performance comparison

- For L^*=3.5m the second DFS and multipole knobs improves significantly the luminosity
- For L^*=6m no major differences between the first and second DFS and multipole knobs
- The free parameters of the DFS should be further optimize







Summary and Plans

CLIC 380 GeV

- Tuning results are satisfactory for both L^* options and the dispersion optimization have shown good improvment in luminosity and in the tuning performance
- We can move to more realistic tuning by introducing magnet strength and roll errors to check their impact on the tuning
- A two-beam tuning for these lattices at low energy should conclude on the tuning feasibility

CLIC 3 TeV

- Both L^* options do not meet the tuning requirements
- The optimized L^*=6m lattice shows slightly better tuning performance. A tuning iteration is planned for the L^*=6m lattice BEFORE dispersion optimization to check if it had an impact on the tuning
- More iterations are needed for both cases as well as tuning algorithm improvments