CLIC Workshop 2015

Latest CLIC FFS Tuning Results

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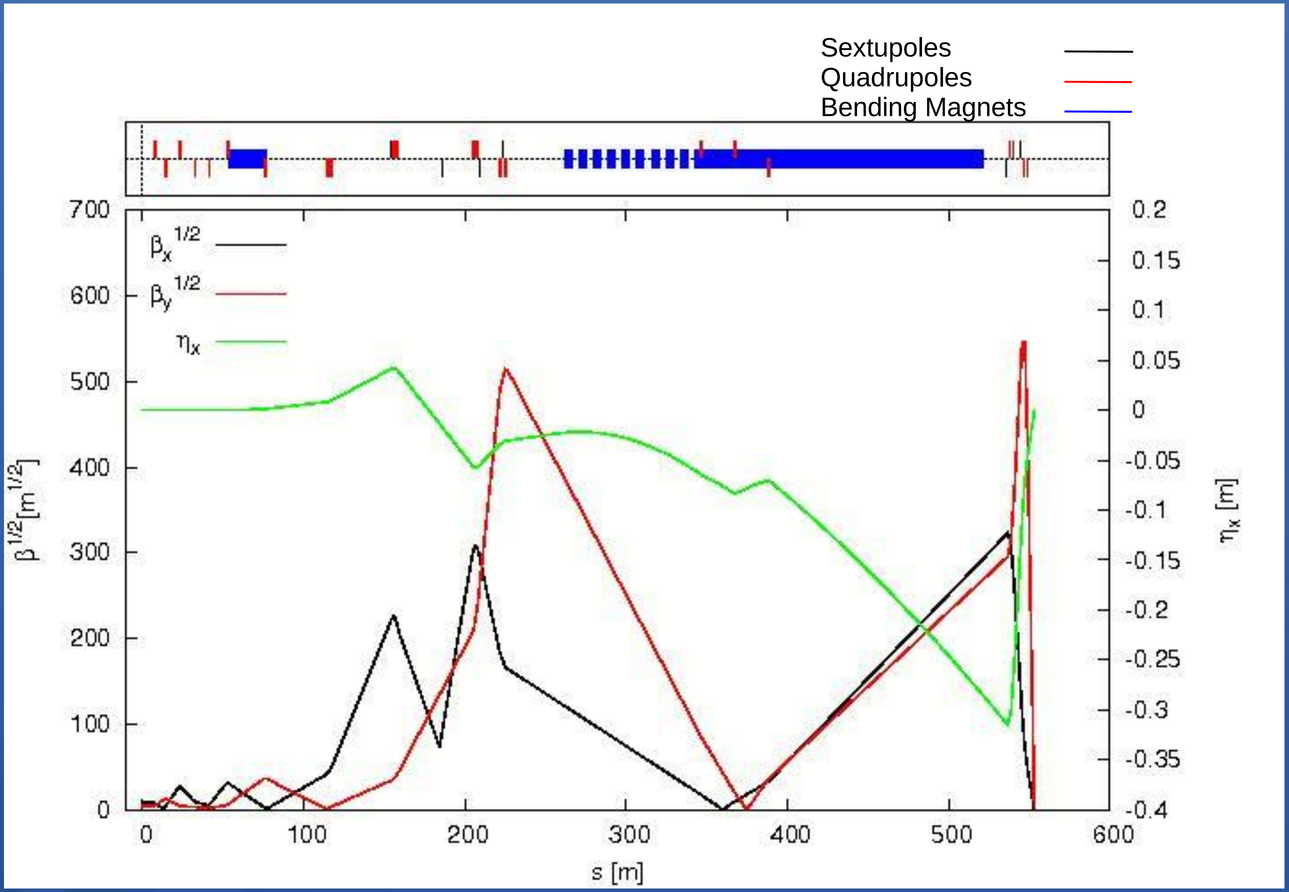
CLIC Parameters

Parameter [Units]	3 TeV	500 GeV
Center of mass energy E_{CM}, [GeV]	3000	500
Repetition rate f_{rep}, [Hz]	50	50
Bunch population N_e [10^9]	3.72	6.8
Number of bunches n_b	312	354
Bunch separation Δt_b, [ns]	0.5	0.5
Accelerating gradient G, [MV/m]	100	80
Bunch length σ_z, [μm]	44	72
IP beam size σ_x^*/σ_y^*, [nm]	40/1	200/2.26
Beta function (IP) β_x^*/β_y^*, [mm]	7/0.068	8/0.1
Norm. emittance (IP) ϵ_x/ϵ_y, [nm]	660/20	2400/25
Energy spread σ_δ, [%]	1.0	1.0
Luminosity $\mathcal{L}_{\mathrm{T}}$ [$10^{34}\mathrm{cm}^{-2}s^{-1}$]	5.9	2.3
Power consumption P_{wall}, [MW]	589	272
Site length, [km]	48.3	13.0

FFS Lattice



- Local Chromatic Correction Scheme
- $L^* = 3.5 – 4.3$ m
- 5 or 6 sextupoles

Tuning motivation

- When we consider realistic imperfections in magnet alignment the performance of the collider in terms of Luminosity drops dramatically.

- The tuning is the procedure that brings the system to its nominal performance.

- Simulation of a realistic tuning is very important to understand the future performance of the real machine.

- Due to the large number of parameters and the precise measurement of luminosity, tuning simulation is expensive in terms of computing time.

Tuning method: Simplex

- Tuning simulations at 3 TeV and 500 GeV
- Misalignment (Gaussian with σ = 10 μm)
- Tuning with Simplex algorithm, a non-deterministic algorithm for optimizaton of the luminosity
- Variables: horizontal and vertical plane displacement
- Observable: Luminosity, calculated with Guinea-Pig code
- All the variables form a space of configurations which has zones of minimum where we want to go in order to achieve the highest value for luminosity
- Simplex starts to explore blindfold the space of configurations with randomly generated points and tries to get to the “nearest” zone of minimum

Tuning method: Beam Based Alignment + Knobs

- Beam Based Alignment techniques+ Sextupole Knobs

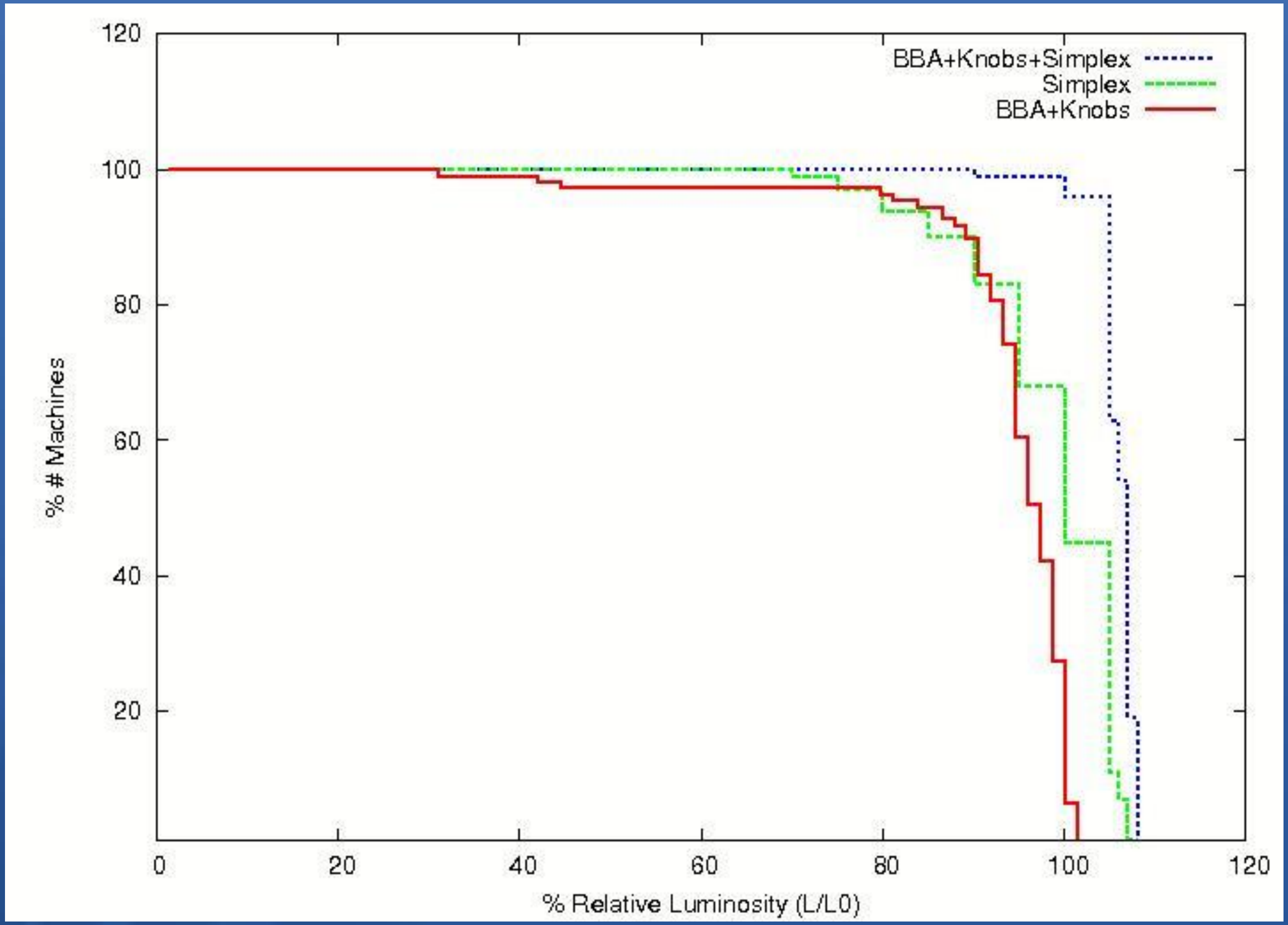
- Next step: we got magnets positions after BBA+Knobs method and use them as input for Simplex

- Our goal is to see if Simplex can provide us a better tuning for the luminosity

- BBA: with Beam Based Alignment we measure the orbit and the emittance of the beam

- Knobs based on sextupole transverse positions.

Overall tuning
500 GeV



- We see a significal improvement of the results with BBA+Knobs+Simplex wich is the best method until now
- Simplex and BBA+Knobs+Simplex reach about 108% relative luminosity but with Simplex we have less machines that can go above the 100%
- Another iteration of BBA+Knobs +Simplex could improve results

500 GeV tuning conclusions

- We need to optimize the luminosity with the tuning because of the misalignment end errors in the lattice.

- We used 3 methods to tune the luminosity for the FFS: BBA+Knobs, Simplex, BBA+Knobs+Simplex

- Our goal: at least 90% machines has to reach 110% nominal luminosity

- We didn't reach our goal in any case but we are getting closer and closer after each tuning method presented

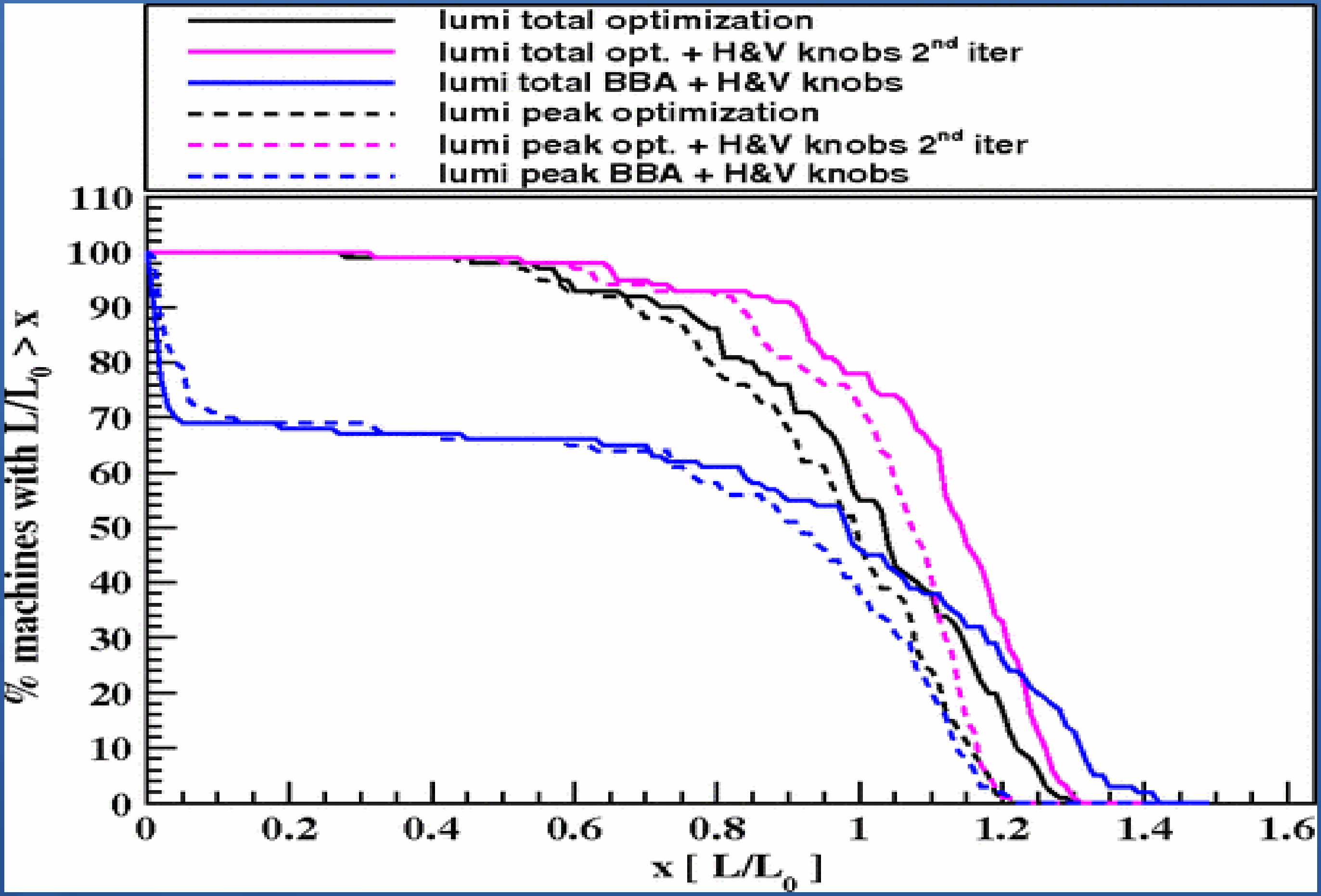
- The best result is achieved with the BBA+Knobs+Simplex method

- For future simulations for the tuning, it's better to start with BBA+Knobs to get the elements positions and then apply the other methods in order to improve the luminosity

3 TeV tuning status

- A complete tuning simulation was performed two years ago.
- The simulation comprised 5 iterations of the BBA+Knobs algorithm and one iteration of the optimization techniques based on Simplex algorithm
- In spite of requiring a lot of luminosity measurements, the final result reached the goal.
- Problem: the simulation was performed using higher charges than current nominal value (4.0e9 instead of 3.72e9).
- Since the above simulation is considered optimistic, a new full simulation with the nominal charge is required.

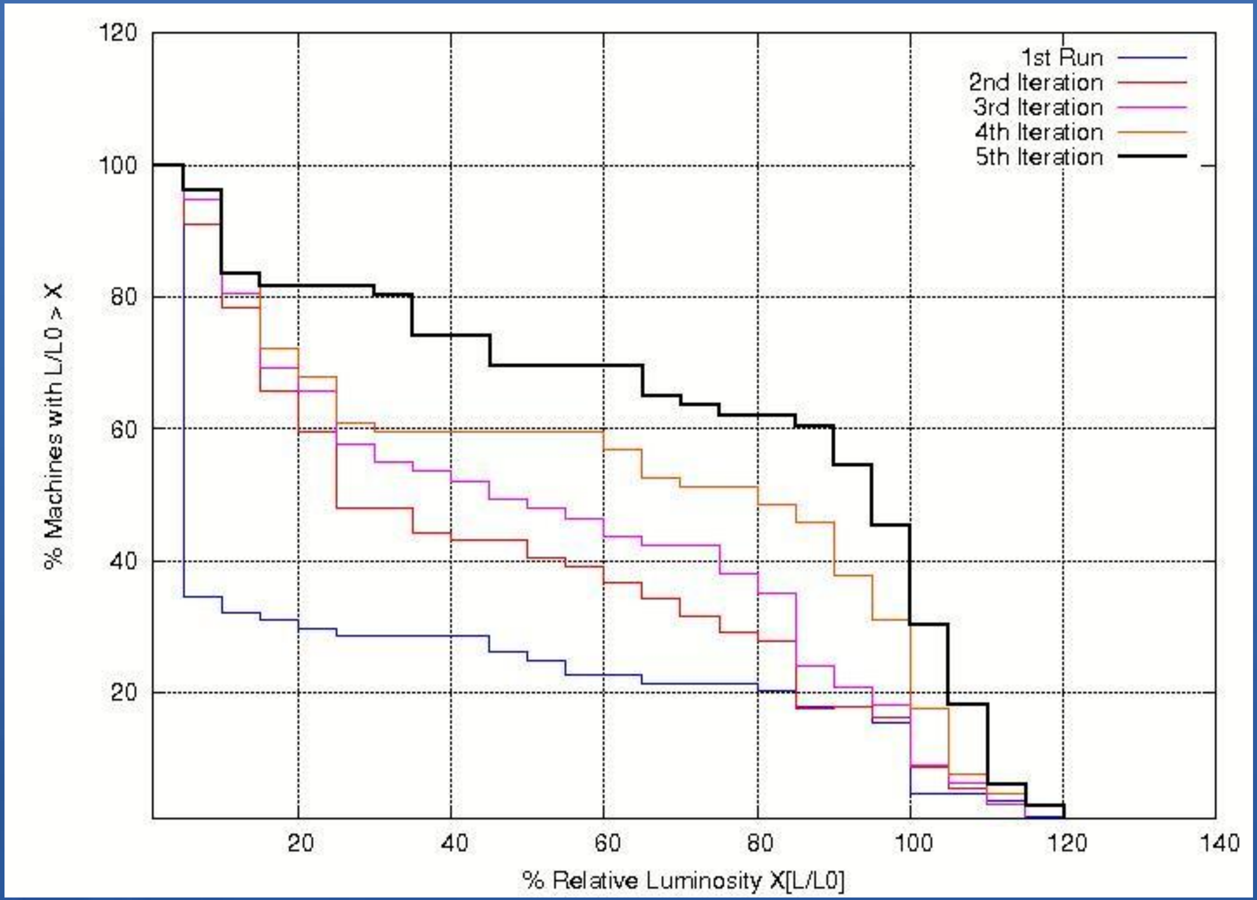
3 TeV tuning: previous results



Charge = 4.0e9

Simulations done by Barbara Dalena

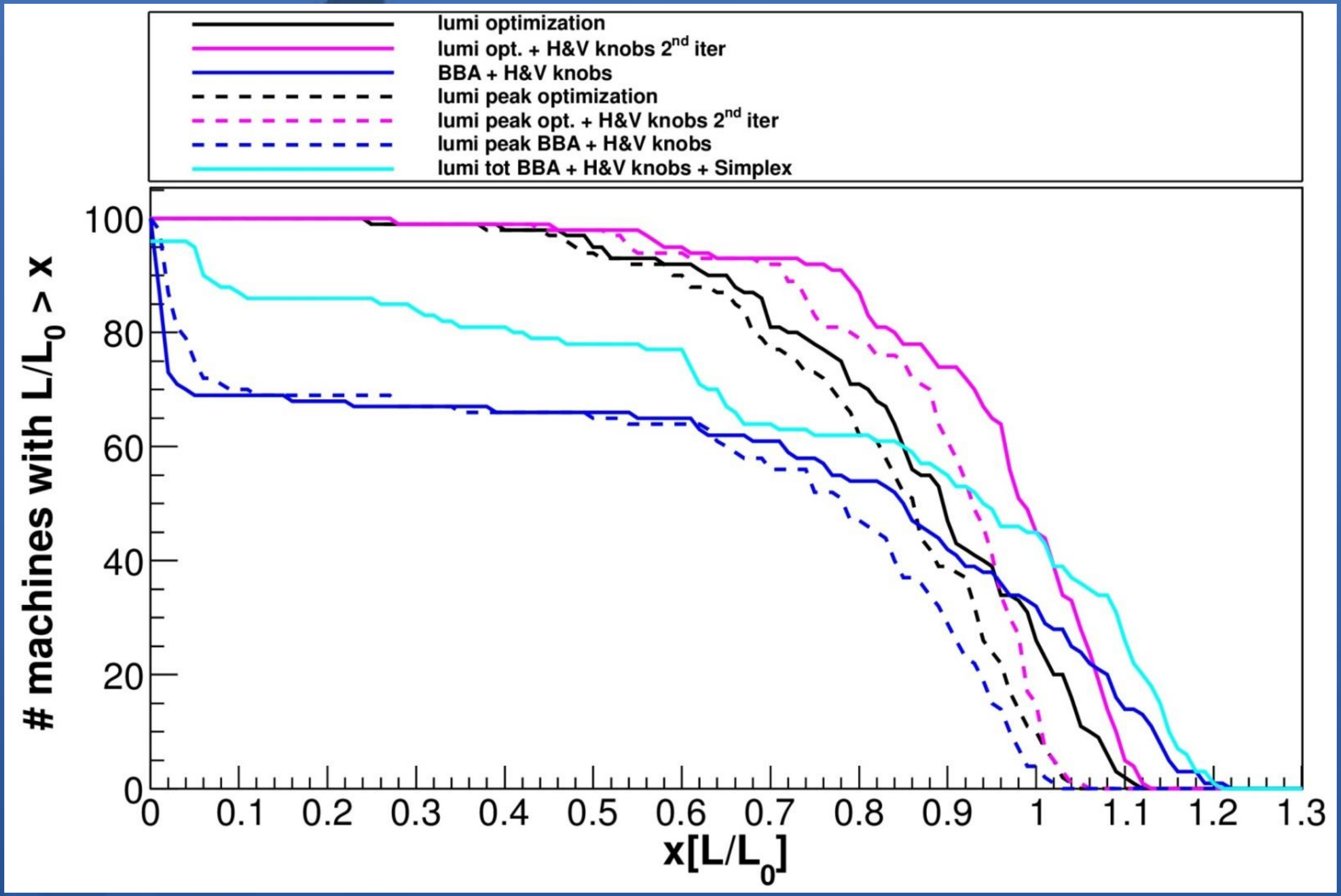
BBA + Knobs at 3 TeV



Charge = 3.72e9

- Optimization still in progress
- Results from 5 iterations
- Next: apply Simplex
- We can see improvements through the five iterations

3 TeV tuning: current results



Charge = 3.72e9

Simulations done by Barbara Dalena

Conclusions

- The tuning of the FFS for CLIC is a delicated and necessary task.

- At low energies (500 GeV) just one iteration of the BBA+Knobs+Simplex seems to be needed for a full luminosity recovery.

- At high energies (3TeV) the simulations were initially performed at high charges.

- The new simulation at nominal charge was done with several BBA + Knobs iterations.

- The FFS Tuning is not over and an improvements of the results is expected after the fifth iteration with BBA + Knobs and Simplex.

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