



Americas Workshop on Linear Colliders



Latest CLIC FFS Tuning Results

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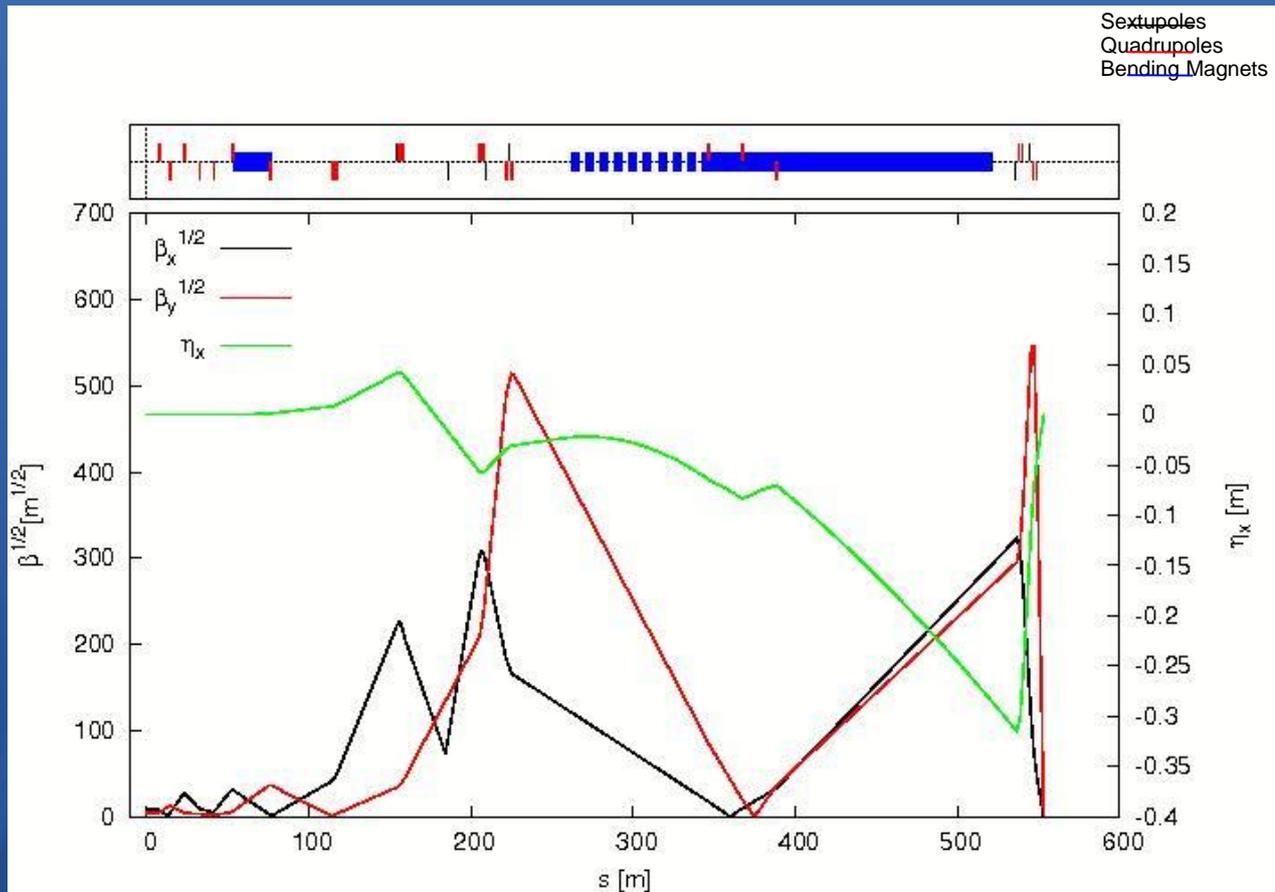
Thanks to: Rogelio Tomas Garcia, Yngve Inntjore Levinsen,
Andrea Latina, Oscar Roberto Blanco Garcia

Guglielmo Giambelli & Hector Garcia
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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}_T [$10^{34}\text{cm}^{-2}\text{s}^{-1}$]	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

→ 500 meters

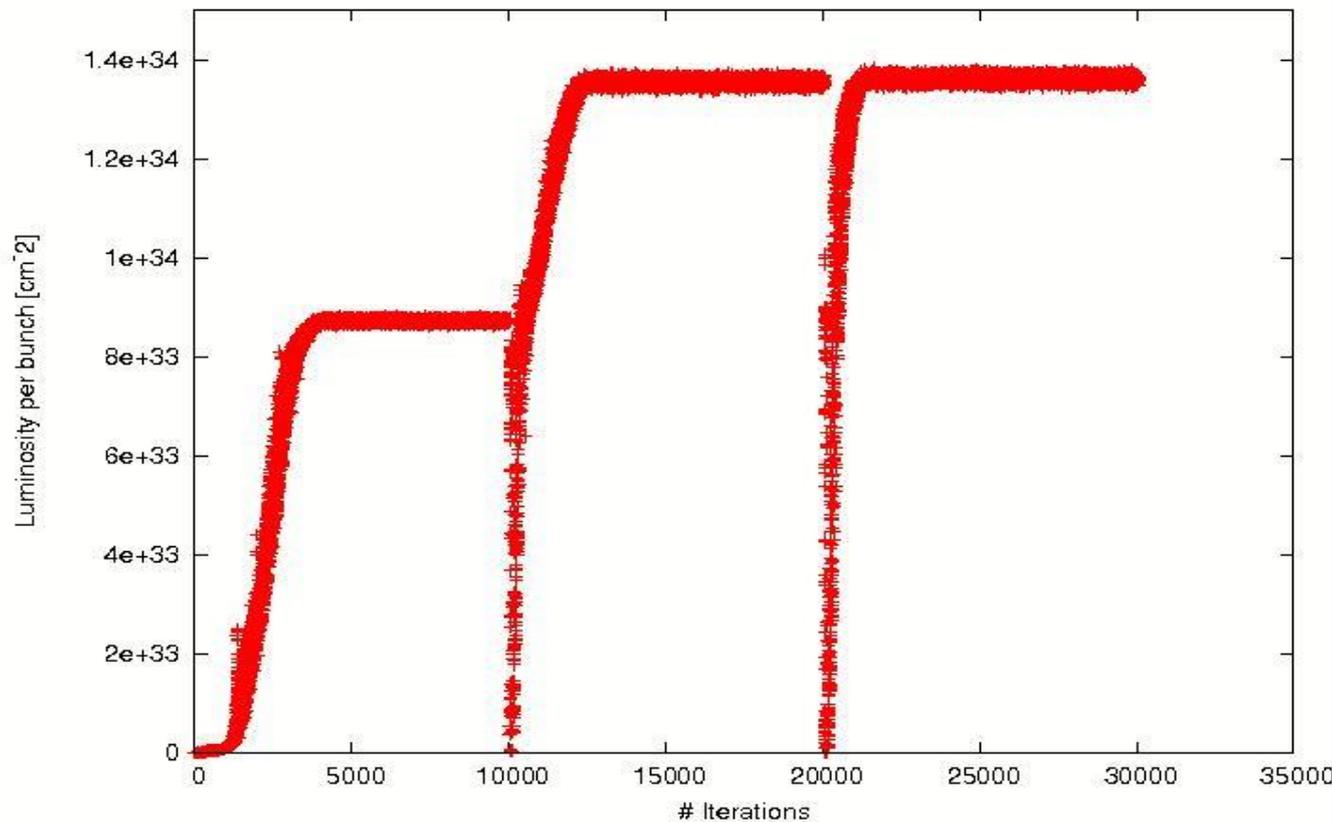
Tuning motivation

- 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

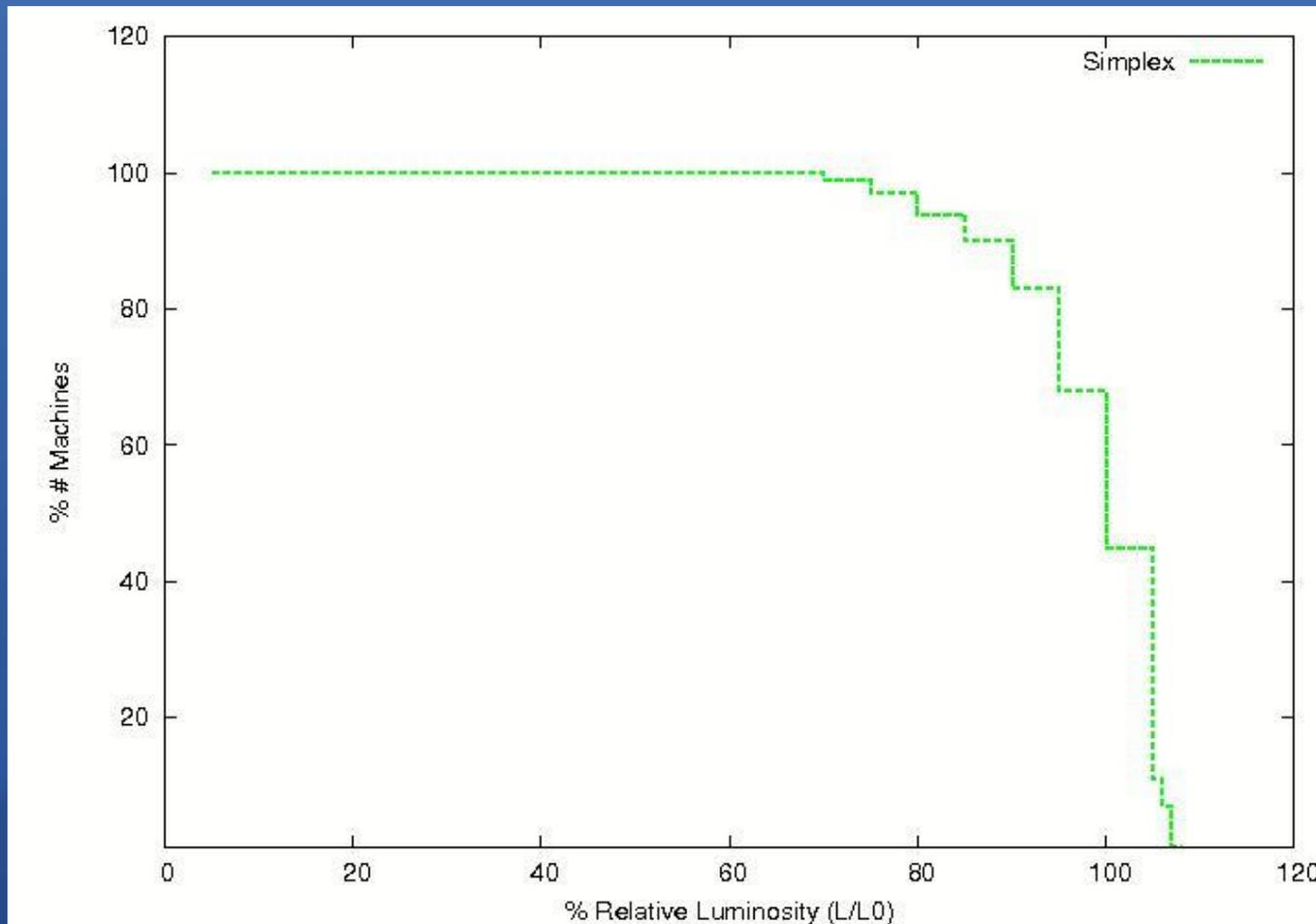
- Tuning simulations at 3 TeV and 500 GeV.
- Misalignment (Gaussian with $\sigma = 10 \mu\text{m}$)
- Tuning with Simplex algorithm, a non-deterministic algorithm for optimization of the luminosity
- Variables: horizontal and vertical plane displacement, roll, magnet strength
- Observable: Luminosity, calculated with GuineaPig 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

Luminosity optimization 500 GeV



- The parameters 'step' determines the initial conditions for the simplex algorithm
- 3 steps used;
- Luminosity increases after each steps;
- Each step required 10000 iterations.

Overall Luminosity Optimization 500 GeV

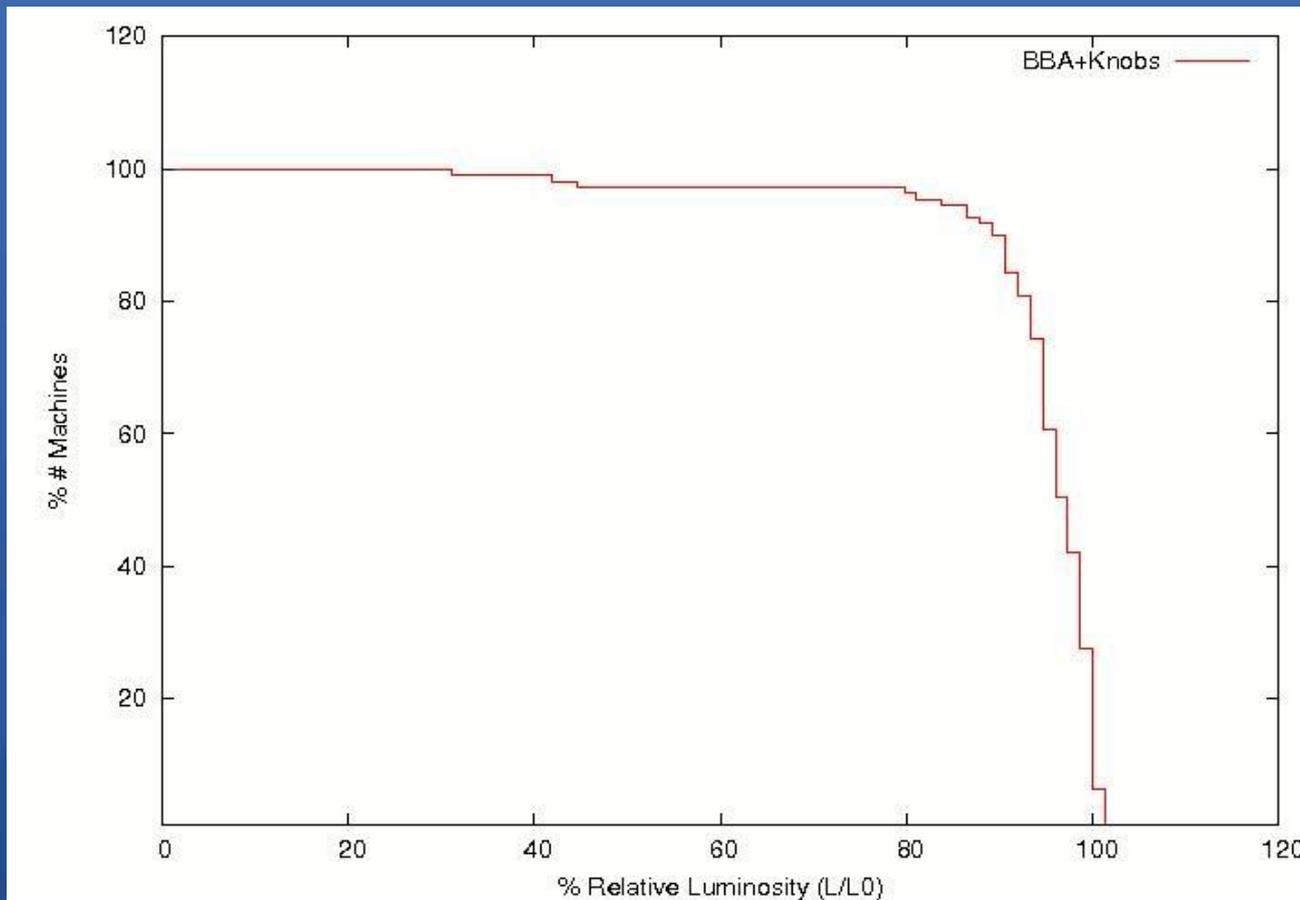


- Our goal now: 90% machines get to 110% L_0
- 90% machines reaches 90% L_0
- All the machines can achieve at least 70% L_0
- Best result is around 108% L_0 (5% simulations)
- We didn't achieve our goal but we are getting close with Simplex.

Tuning method: Beam Based Alignment + Knobs 500 GeV

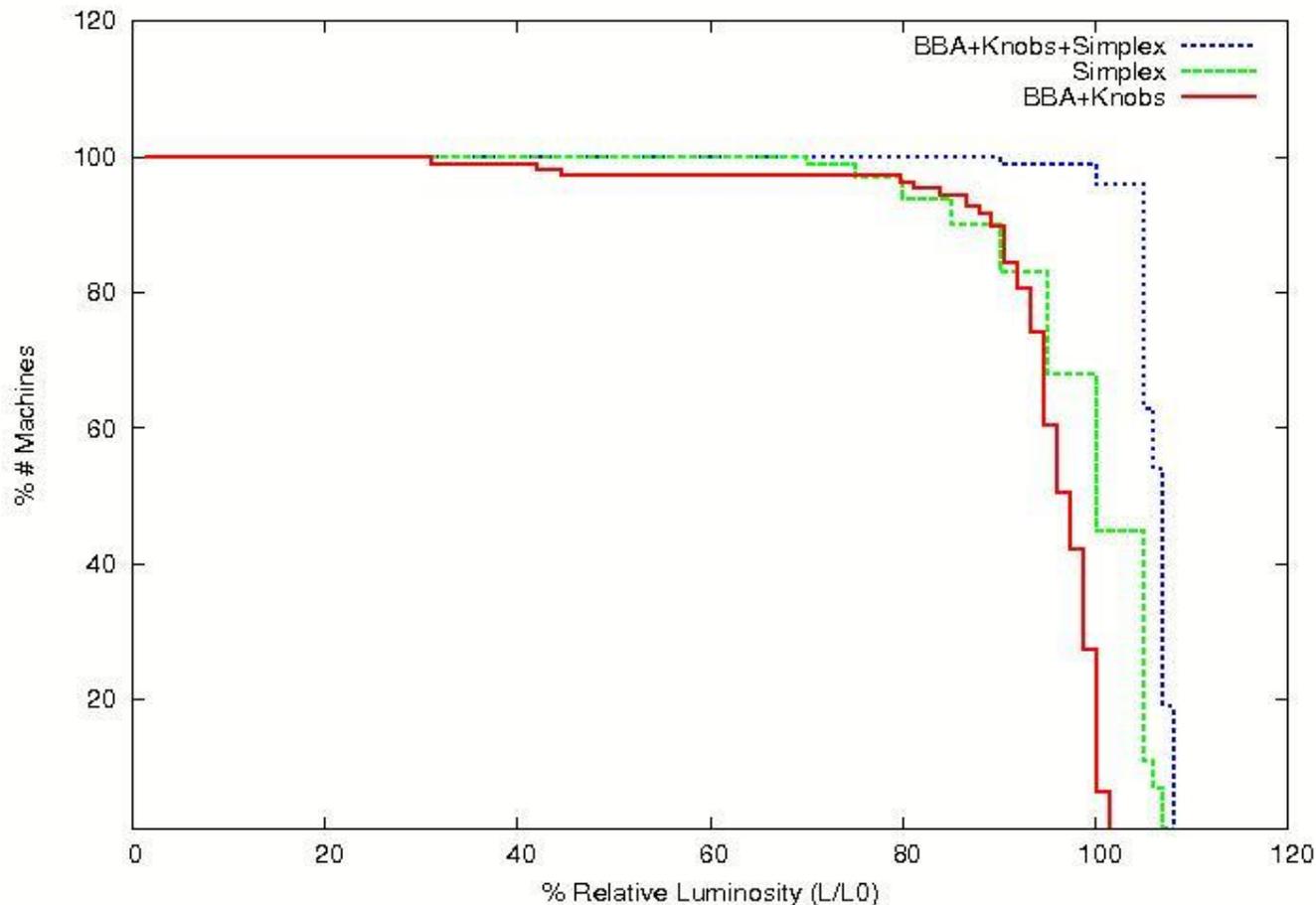
- Beam Based Alignment techniques+ Sextupole Knobs
- Next step: we got magnets positions after BBA+Knobs method and use them as input for Simplex
- Our goal is to see if Simplex can provide us a better tuning for the luminosity than BBA+Knobs
- BBA: with Beam Based Alignment we measure the orbit and the emittance of the beam
- Knobs based on sextupole transverse positions.

Overall BBA+Knobs 500 GeV



- Only a relatively small (25%) percentage of the machines can reach 100% total luminosity
- The best value of relative Luminosity is slightly above 100%
- We are a bit to far from the goal: 90% machines with 110% relative luminosity

Overall tuning 500 GeV



- We see a significant improvement of the results with BBA+Knobs+Simplex which 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

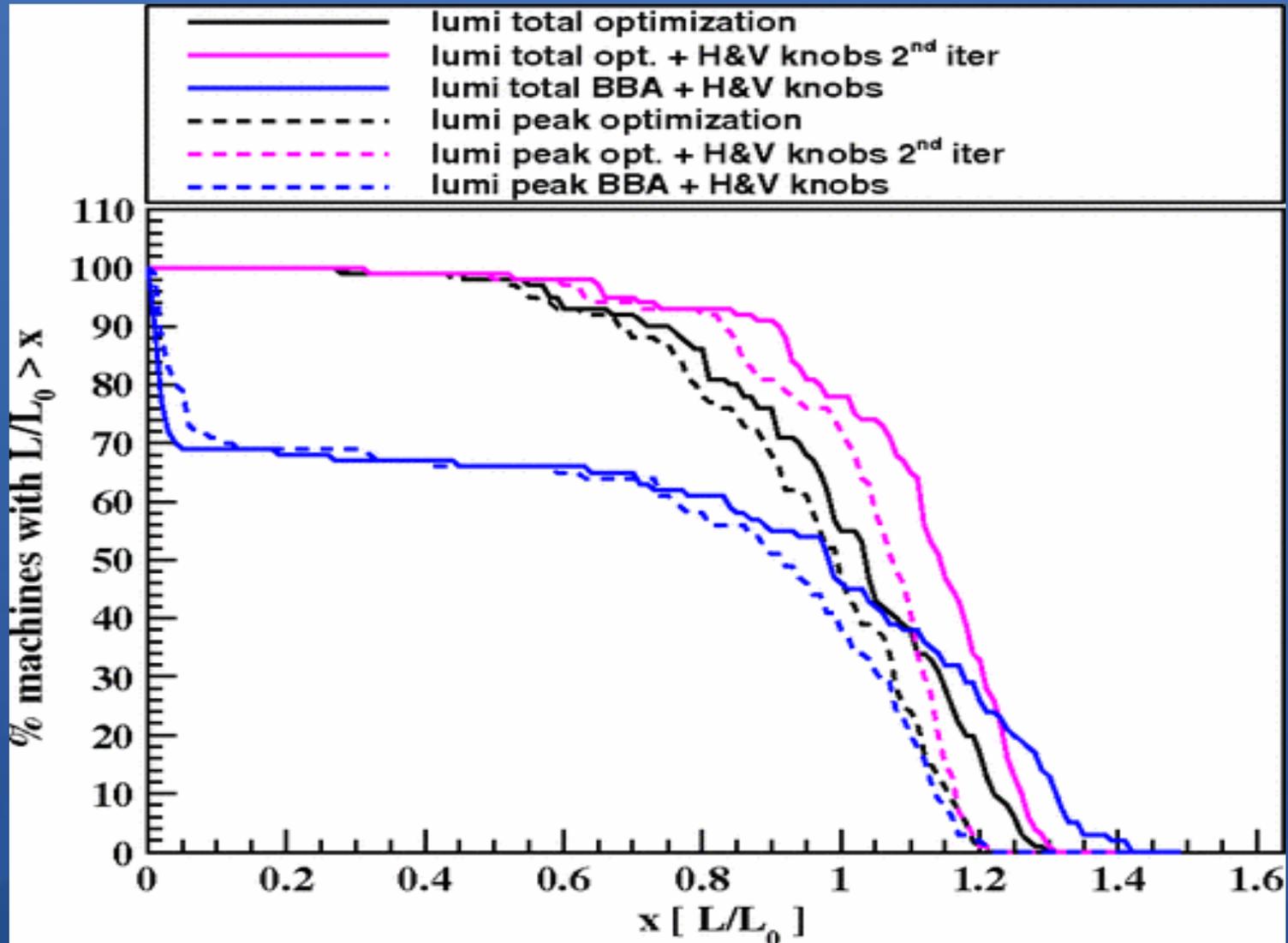
500 GeV tuning conclusions

- 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

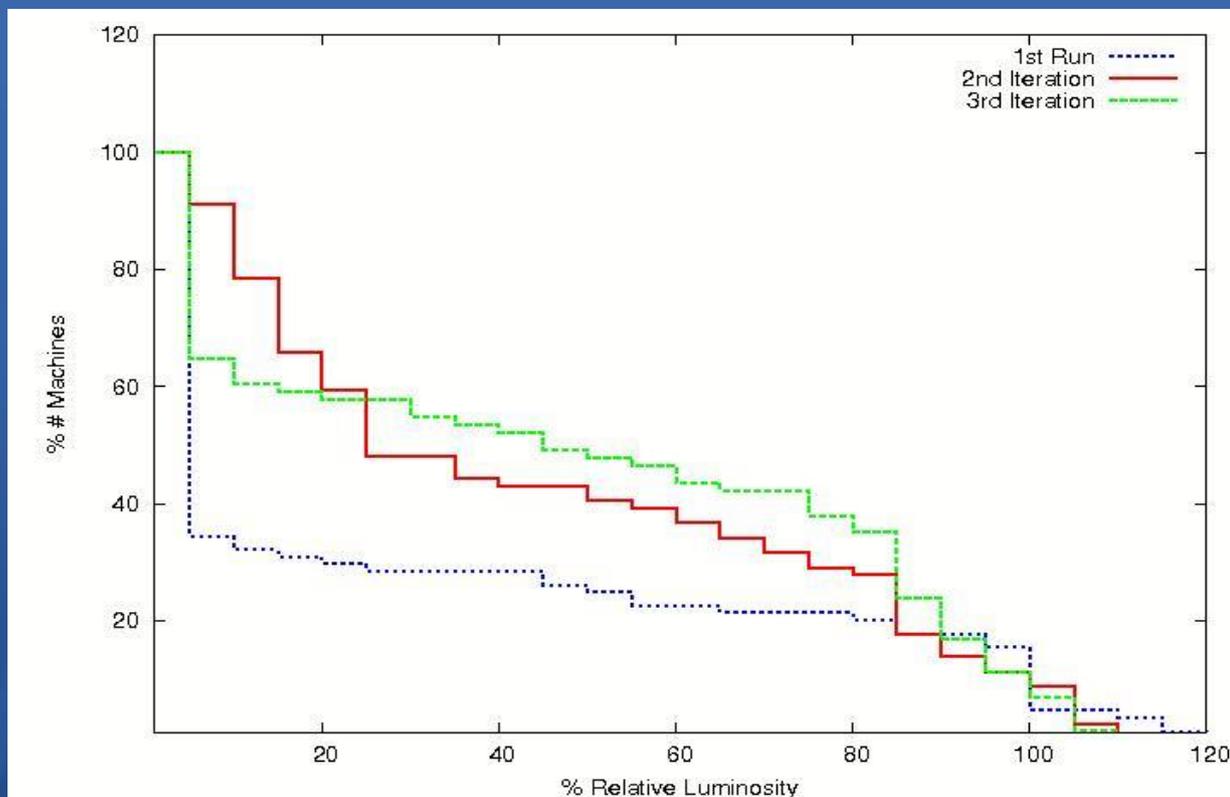
3 TeV tuning status

- 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 $3.78e9$).
- Since the above simulation is considered optimistic, a new full simulation with the nominal charge is required.

3 TeV tuning: previous results



BBA + Knobs at 3 TeV



- Optimization still in progress
- Results from 3 iterations
- Next: apply at least 2 more Iterations and Simplex
- We can see improvements through the three iterations

Conclusions

- ❖ The tuning of the FFS for CLIC is a delicate 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) we realized that the current simulations were performed at high charges.
- ❖ A new simulation at nominal charge is ongoing and the results seems to be a scaled down version of the ones at higher charges.
- ❖ Need to check whether we can still achieve the goal or more iterations of the algorithm is required.
- ❖ Some more details in H.Garcia presentation on Thursday.