Americas Workshop on Linear Colliders

Latest CLIC FFS Tuning Results

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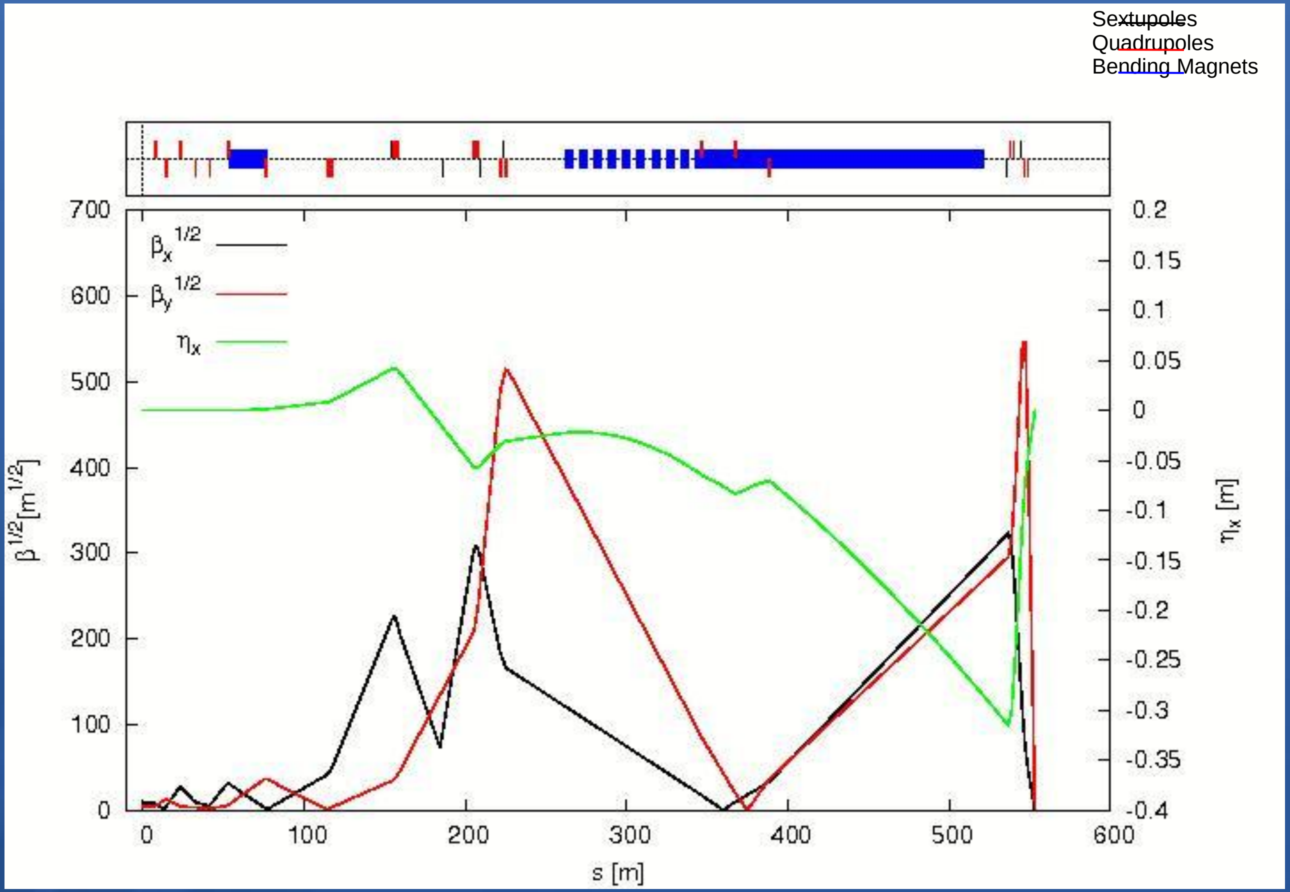
CLIC Parameters

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
- 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 σ = 10 μm)

- Tuning with Simplex algorithm, a non-deterministic algorithm for optimizaton of the luminosity

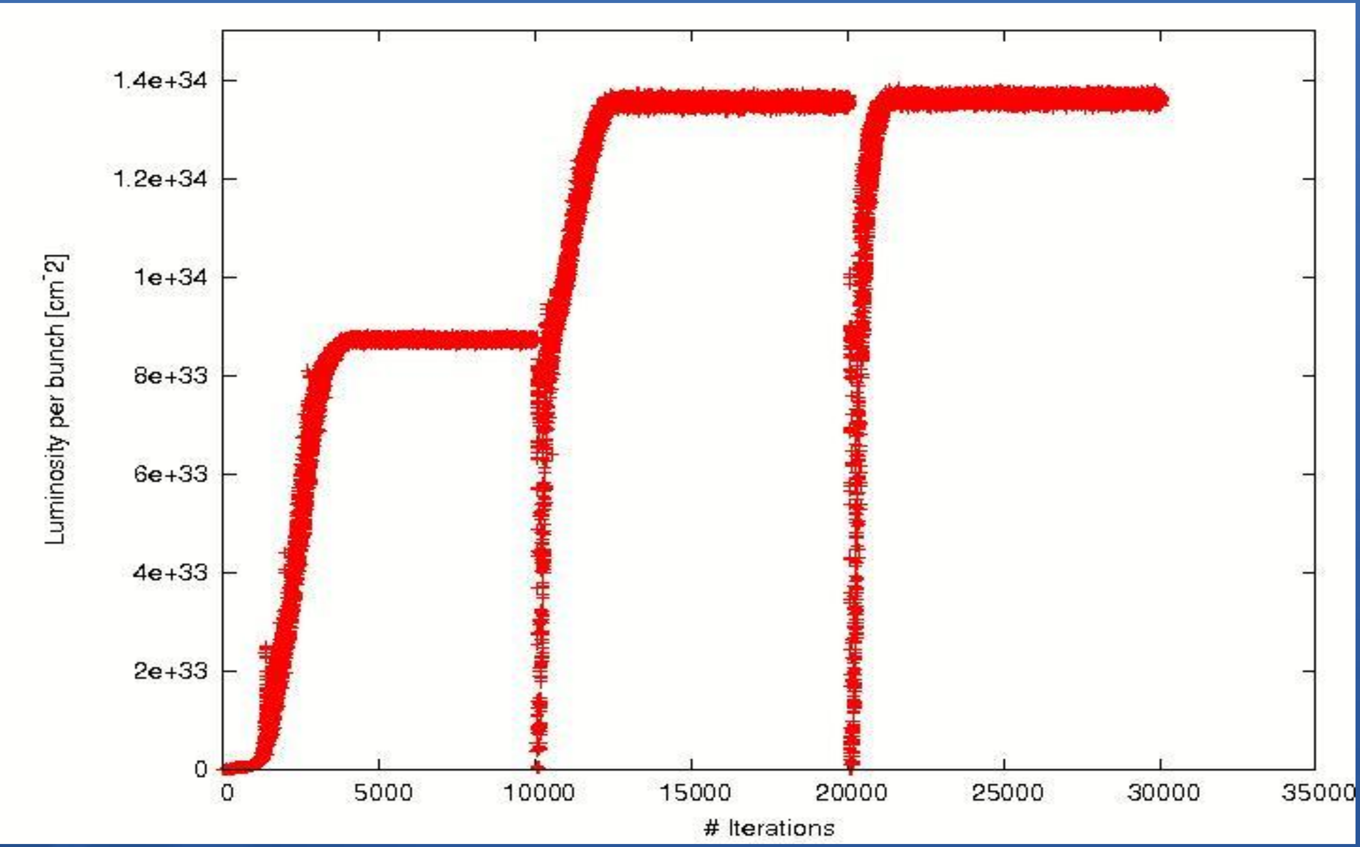
- Variables: horizontal and vertical plane displacement, roll, magnet strength

- 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

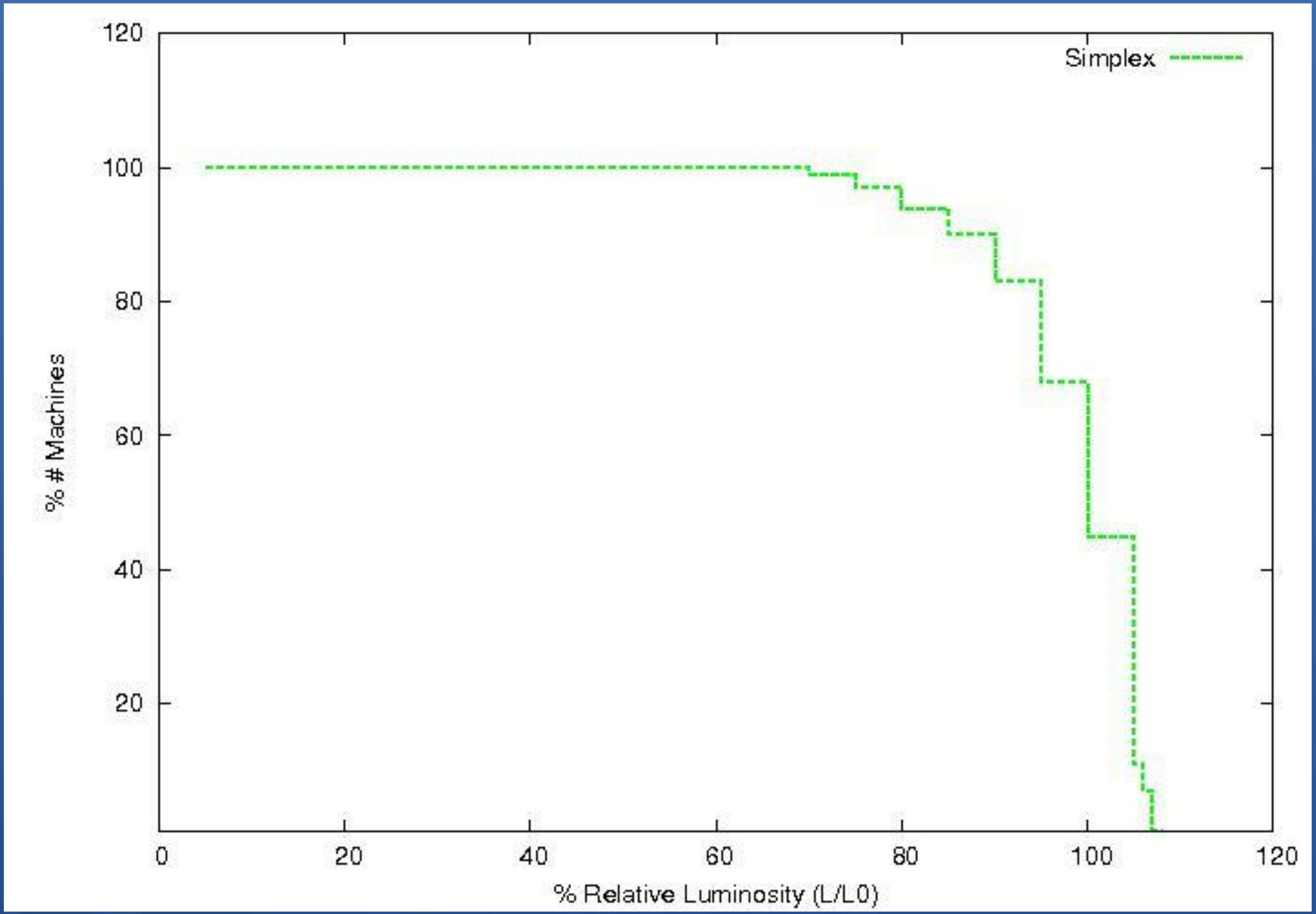
- Simplex starts to explore blindfold the space of configurations with randomly generated points and tries to get to the “nearest” zone of minimum

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 iteraions.

Overall Luminosity Optimization 500 GeV

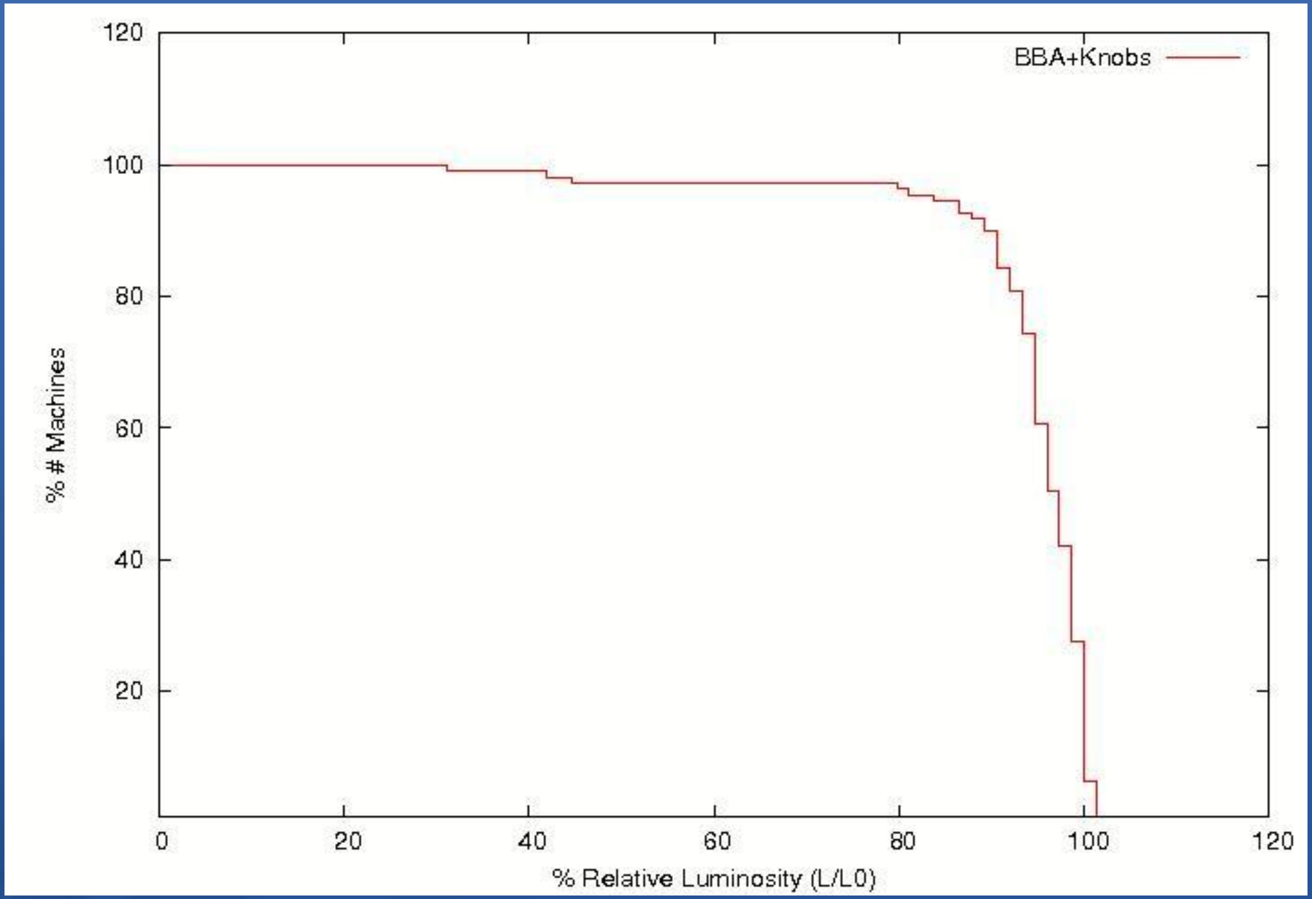


- Our goal now: 90% machines get to 110%L_0
- 90% machines reachs 90% L_0
- All the machines can achieve at least 70% L_0
- Best result is around 108% L_0 (5% simulations)
- We didn't achieve our goal but we are getting close with Simplex.

Tuning method: Beam Based Alignment + Knobs 500 GeV

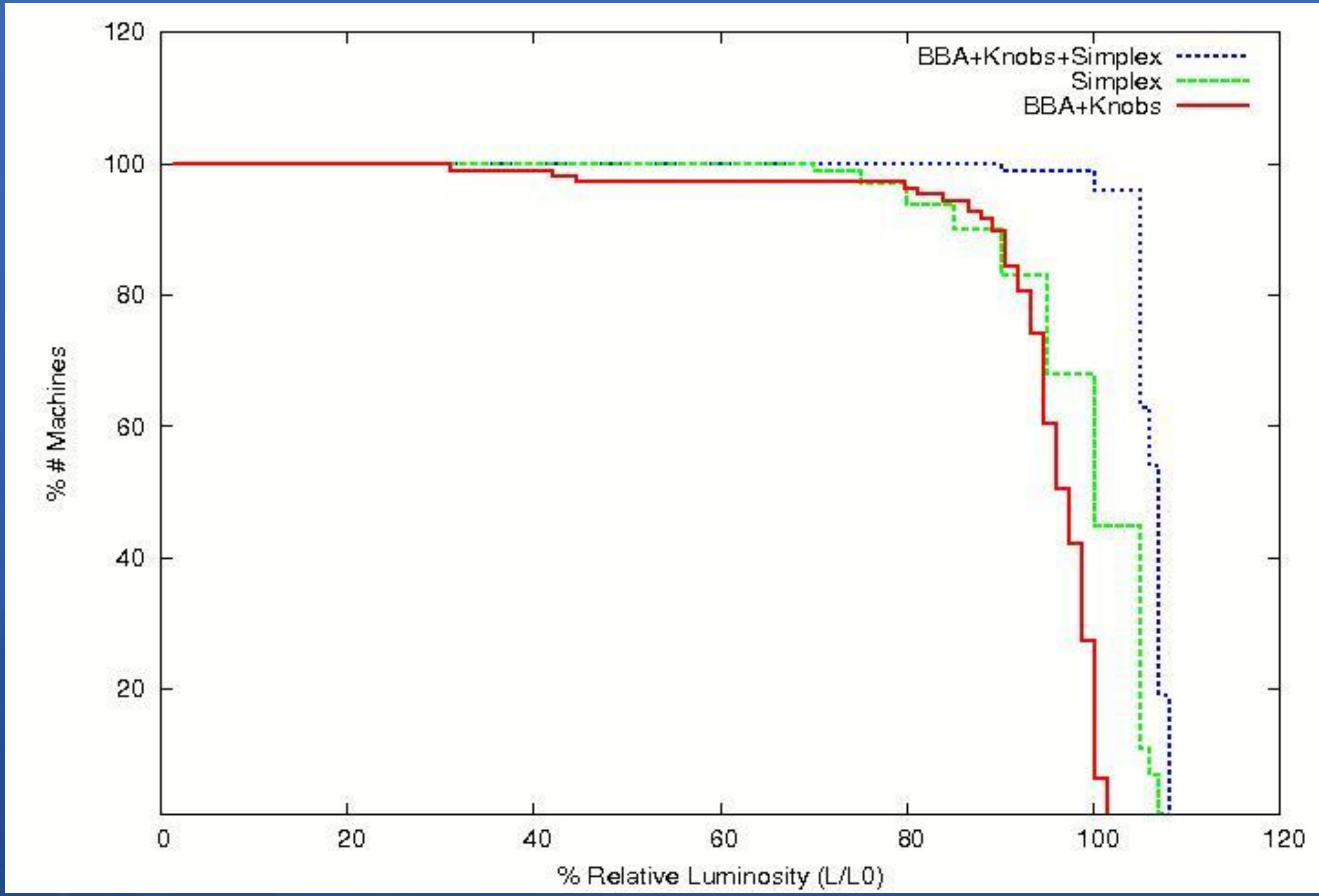
- Beam Based Alignment techniques+ Sextupole Knobs
- Next step: we got magnets positions after BBA+Knobs method and use them as input for Simplex
- Our goal is to see if Simplex can provide us a better tuning for the luminosity than BBA+Knobs
- BBA: with Beam Based Alignment we measure the orbit and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

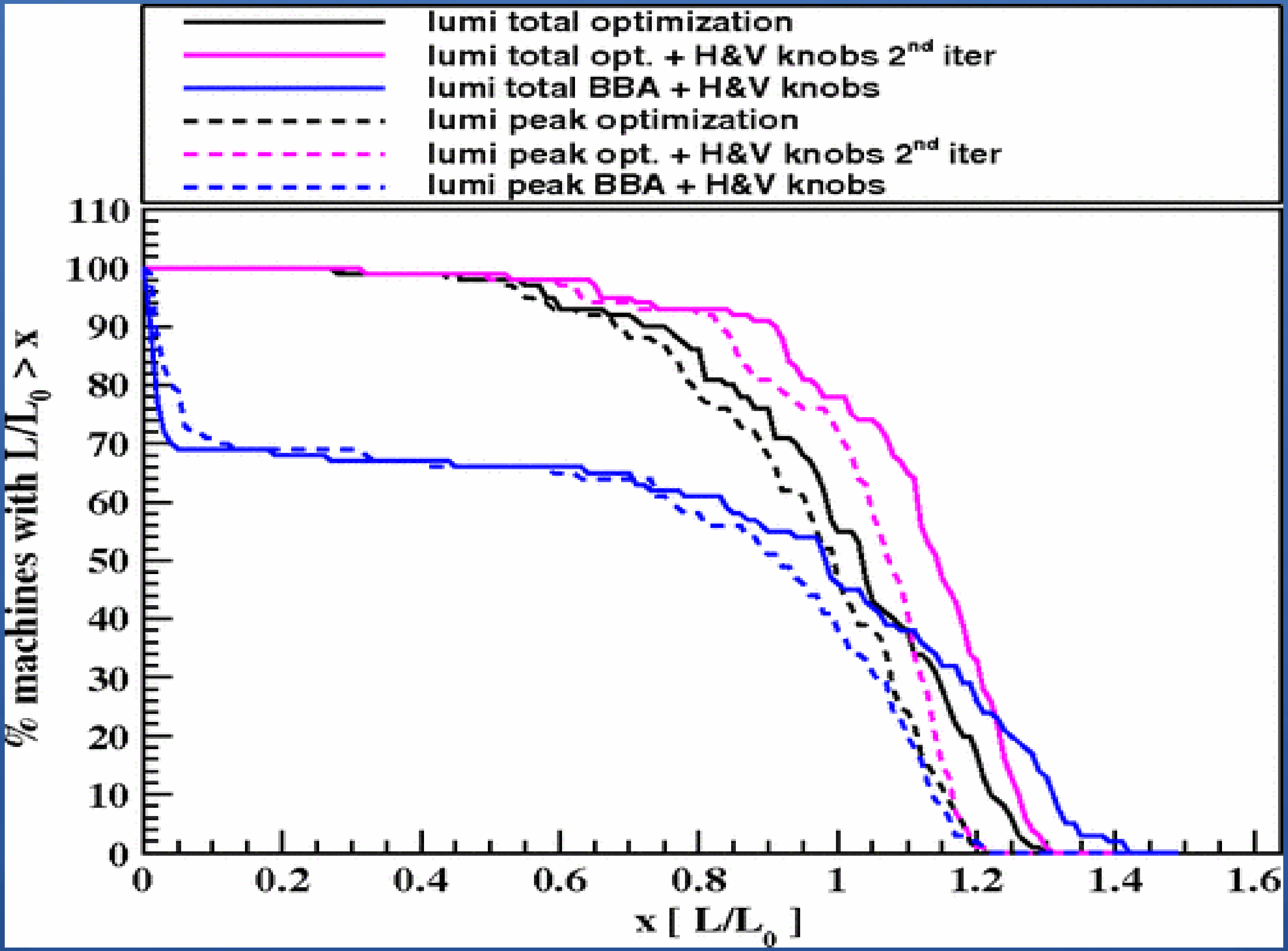
- The simulation comprised 5 iterations of the BBA+Knobs algorithm and oneiteration of the optimization techniques based on Simplex algorithm

- In spite of requiring a lot of luminosity measurements, the final result reached the goal.

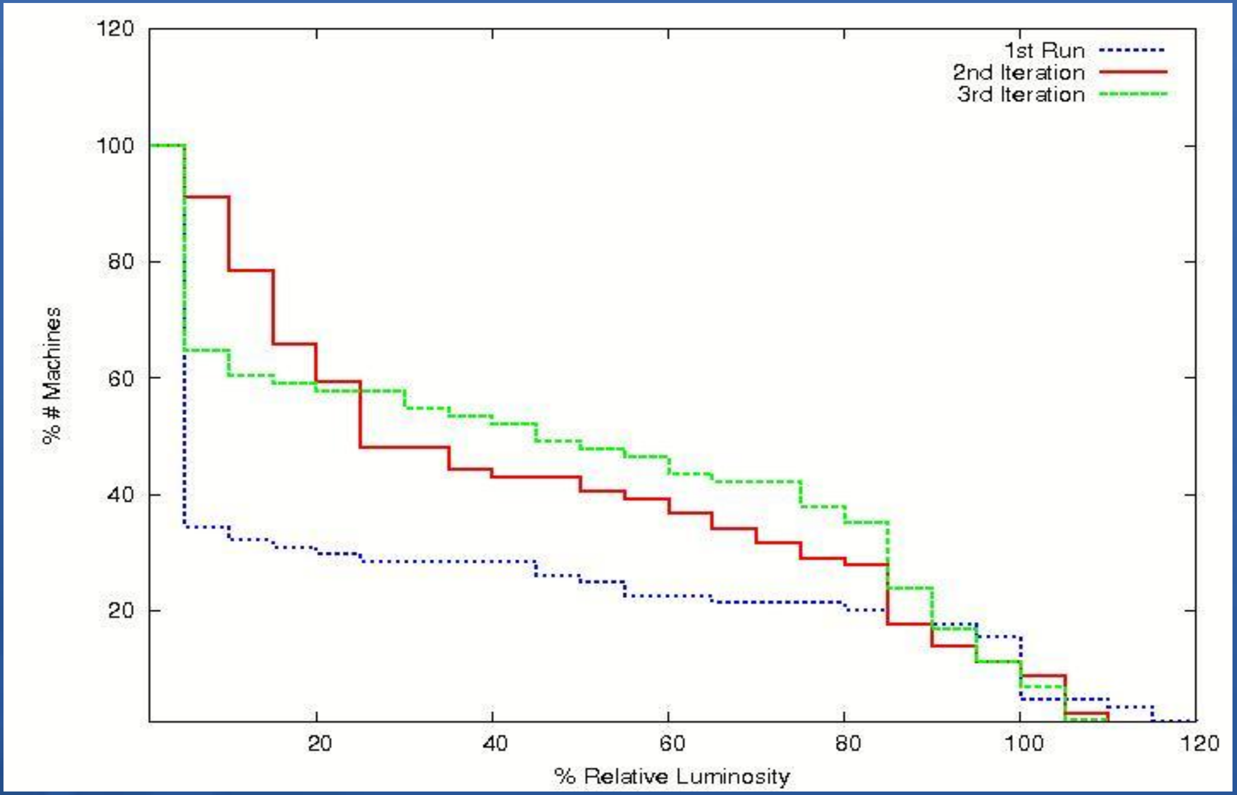
- Problem: the simulation was performed using higher charges than current nominal value (4.0e9 instead of 3.78e9).

- 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 leat 2 more Iterations and Simplex
- We can see improvements through the three iterations

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) we realized that the current simulations were performed at high charges.

❖ A new simulation at nominal charge is ongoing and the results seems to bea 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 algortihm is required.

❖ Some more details in H.Garcia presentation on Thursday.