Latest FFS Tuning Results for 500 GeV

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Latest FFS Tuning Results

CLIC Parameters

Parameter	Units	CLIC500
Beam energy E_0	GeV	250
Bunches per beam n_b		354
$e^{\pm}$ per bunch N	10^9	6.8
Repetition rate f_{rep}	Hz	50
Hor. emittance ϵ_x^N	nm	2400
Vert. emittance ϵ_y^N	nm	25
Hor. beta β_x	mm	8.0
Vert. beta β_y	mm	0.1
Hor. beam size σ_x^*	nm	200
Vert. beam size σ_y^*	nm	2.26
Bunch length σ_z	μm	72
Energy spread δ_E	%	1.0
Luminosity $\mathcal{L}_T$	$10^{34} \cdot \mathrm{cm}^{-2}\mathrm{s}^{-1}$	2.3
Peak Luminosity $\mathcal{L}_{1\%}$	$10^{34} \cdot \mathrm{cm}^{-2}\mathrm{s}^{-1}$	1.4

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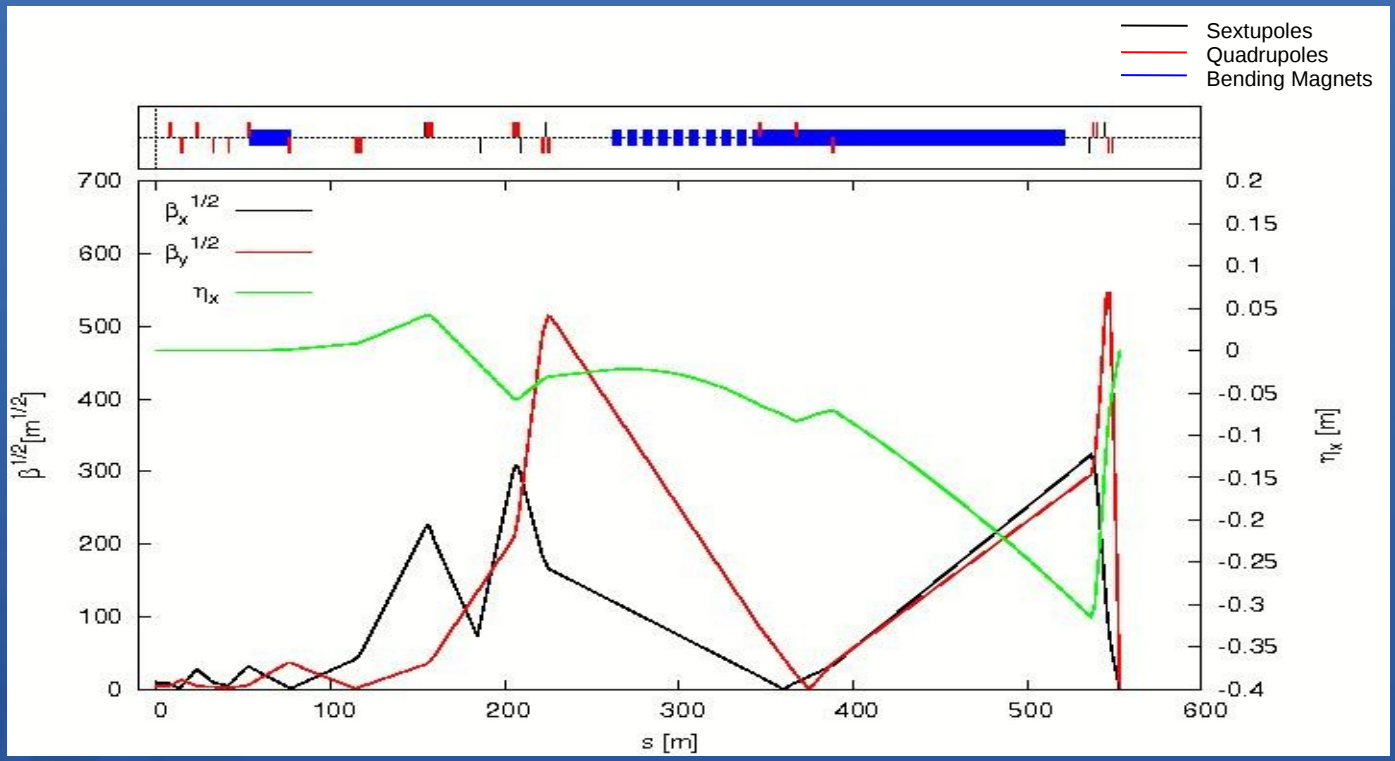
FFS Lattice



- 500 GeV
- Local Design
- L^*= 3.5 m

Tuning: Motivation

- Final Focus System (FFS) has to focus the beam in the Interaction Point (IP)
- Luminosity L_0 at the IP for experiments
- Misalignment and imperfections of the lattice
- Tune in BDS and FFS
- Non linear terms in FFS Optics make optimization difficult

Tuning: Method

- 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 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

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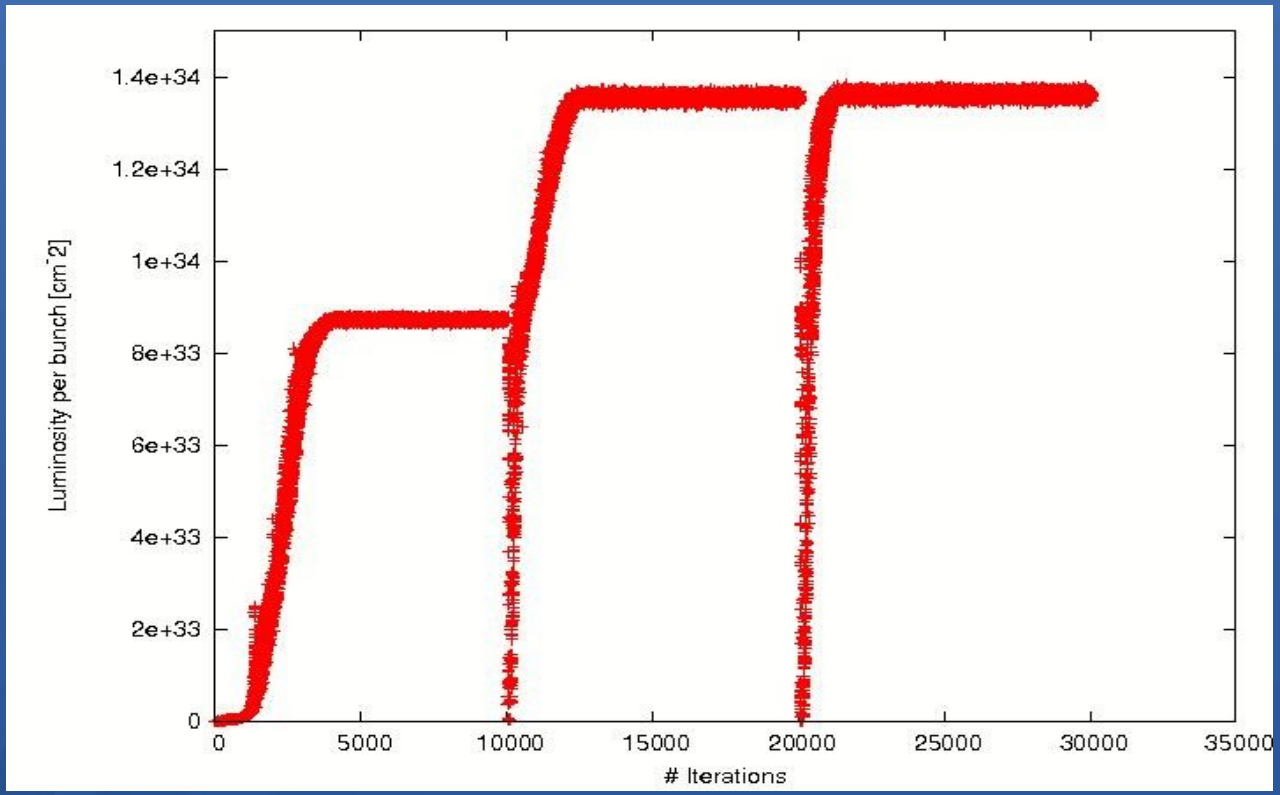
Luminosity Optimization



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

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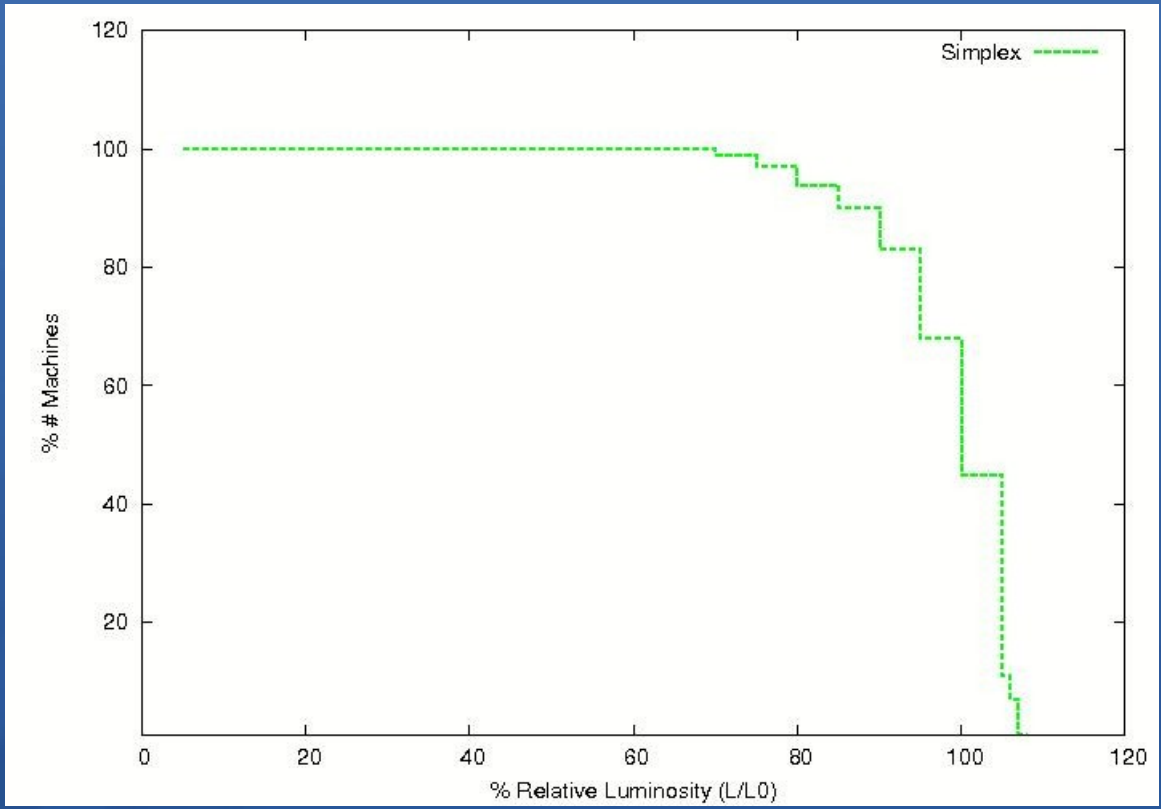
Overall Luminosity Optimization



- 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

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BBA+Knobs

- An other method taken in consideration is Beam Based Alignment + Knobs Sextupoles
- Next step: we got magnets positions from 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 Sextupoles: after measured the beam, we use the sextupoles as correctors in order to tune the luminosity
- Even in this case, we start with misaligned machines where the elements displacements follow a gaussian distribution with $\sigma = 10\ \mu m$

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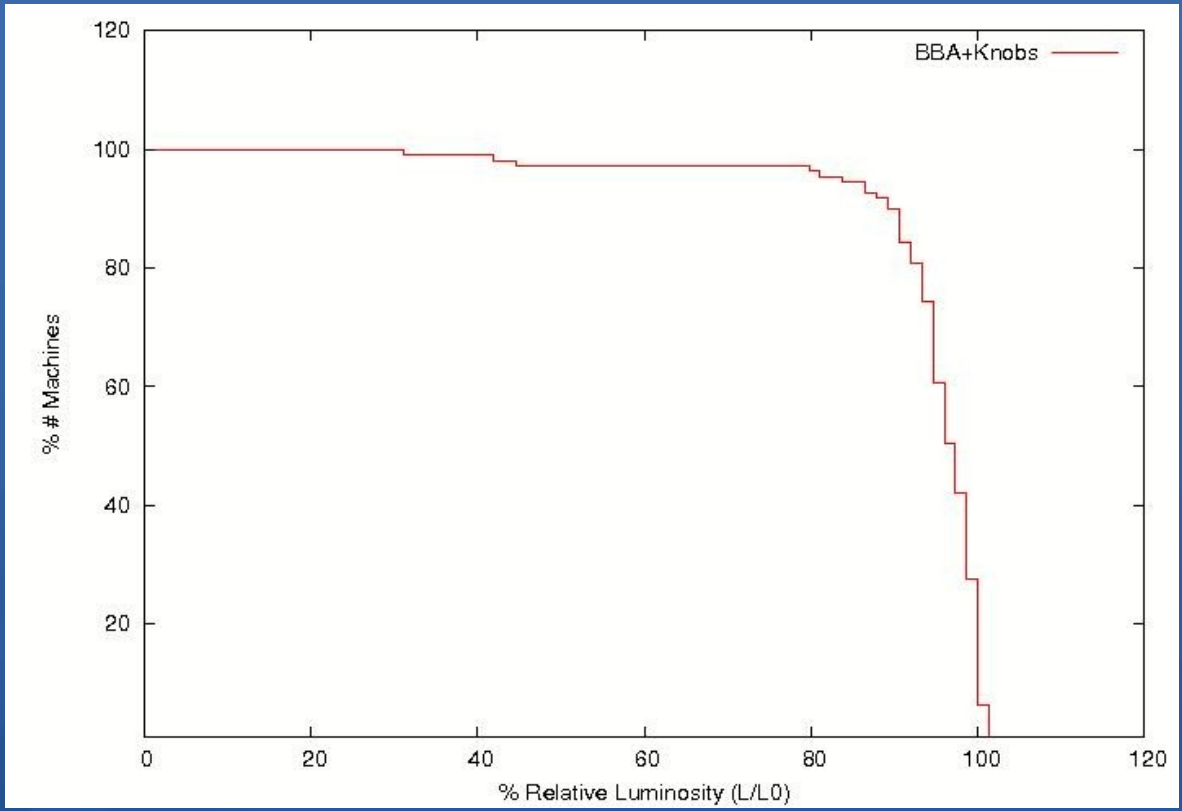
Overall BBA+Knobs Optimization



- 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

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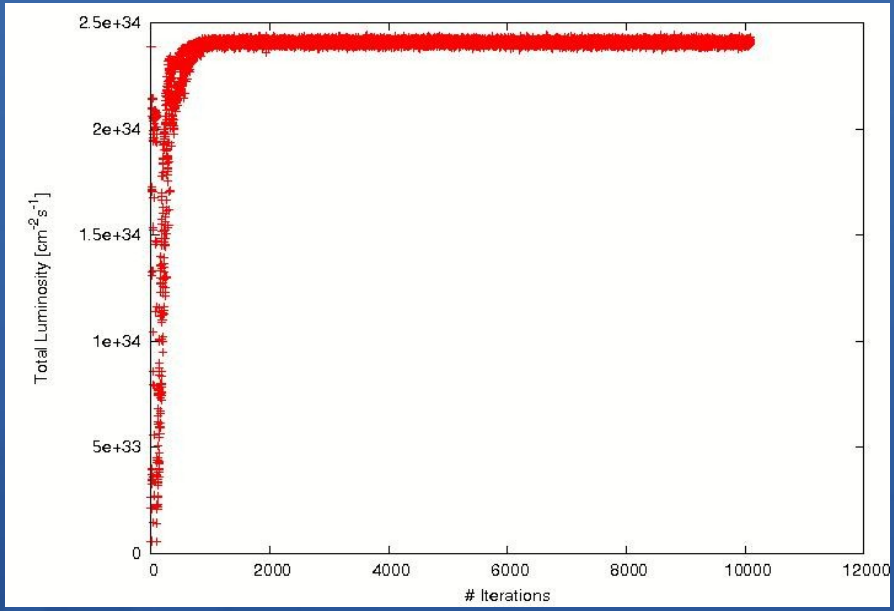
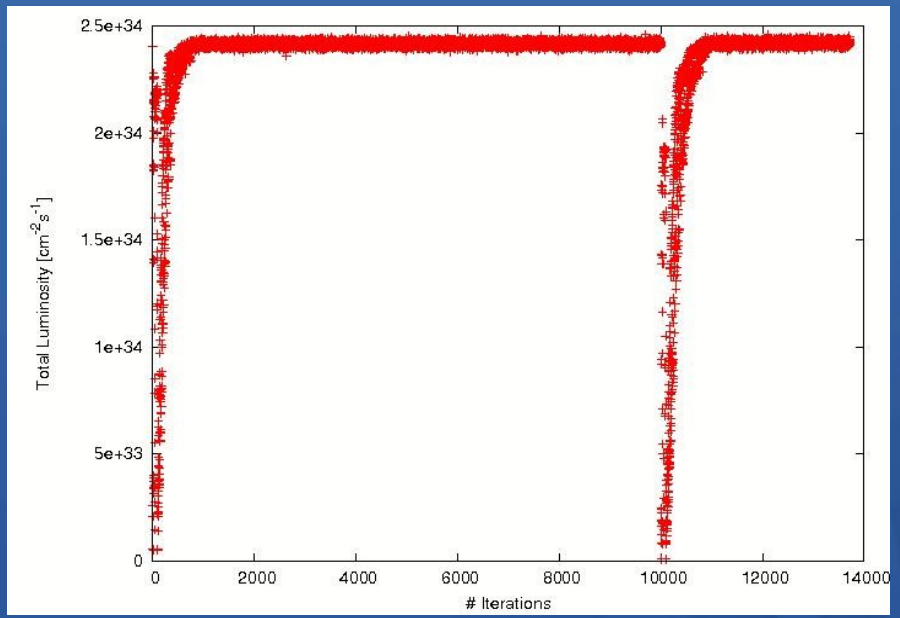
BBA+Knobs+Simplex Luminosity Optimization

- 110 simulations from BBA+Knobs: we ran the same number of simulations for the tuning with Simplex algorithm
- In the BBA+Knobs+Simplex method we ran two groups of jobs: with 1 step and 2 steps to see how much we can improve the luminosity



1 Step



2 Steps

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Comments after BBA+Knobs+Simplex

- We saw that at the beginning of the tuning, the luminosity decrease rapidly. This happened due to the fact that initially Simplex explores blindfold the space of configurations. After that, Simplex goes on in order to find the nearest minimum.
- After the second step the optimization does not provide a significal improvement in luminosity than the first step.
- 8% of the machines didn't significantly improve the luminosity

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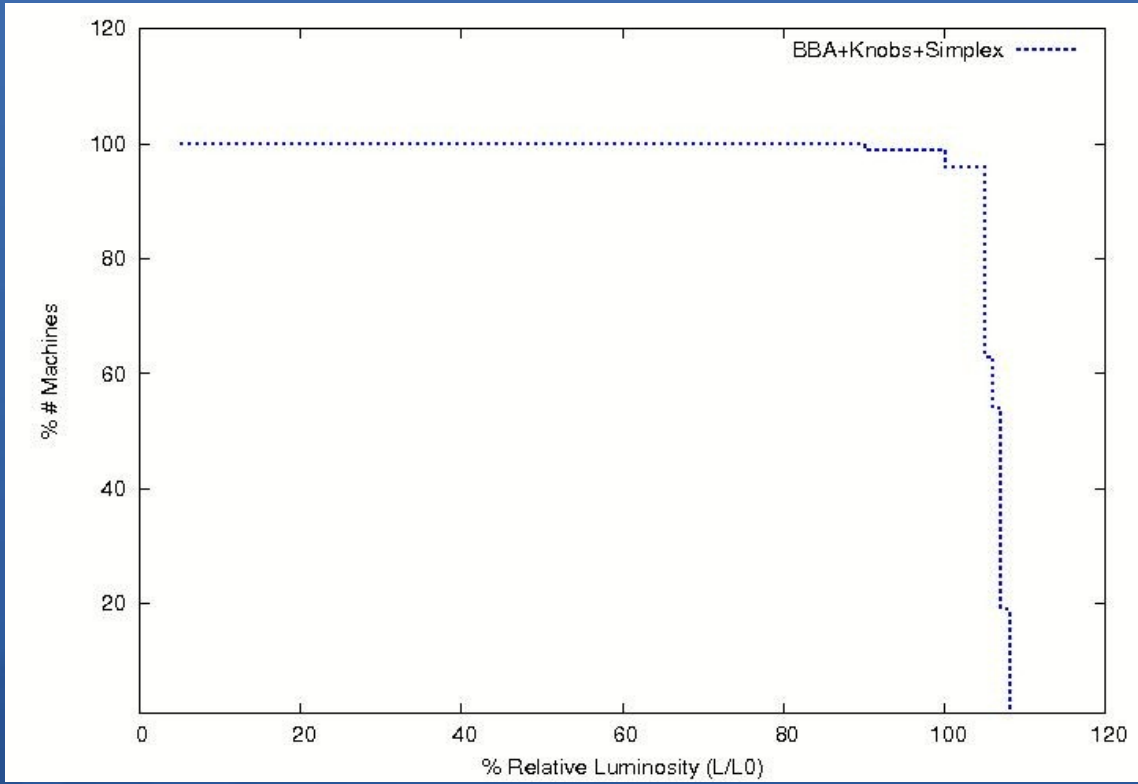
Overall BBA+Knobs+Simplex Luminosity Optimization



- About 99% of the machines fully recovered the 95% of the nominal luminosity
- At least 80% of the machines are above the 100% threshold
- We have not reached our goal of 90%/110% but we are close

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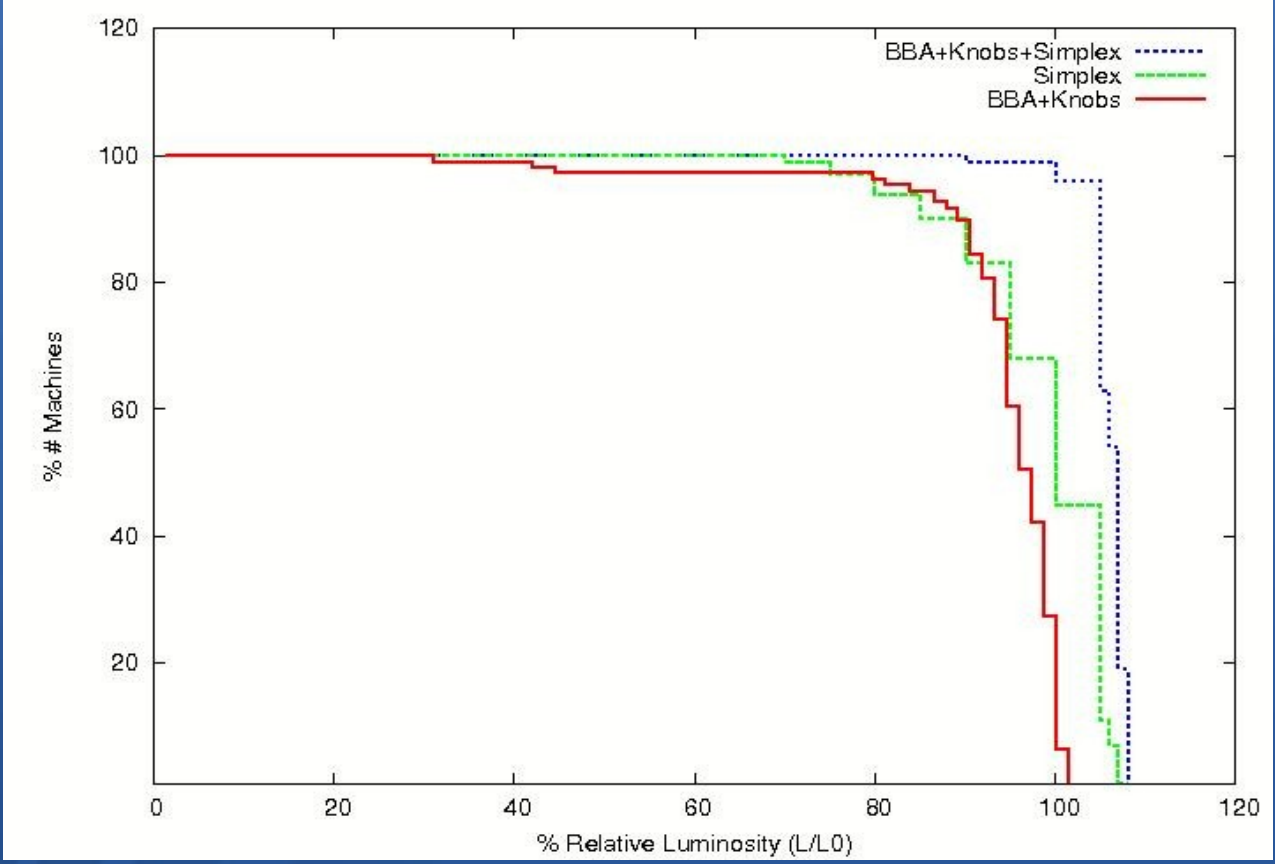
Overall Improvements



- 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

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 tuningmethod 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