Tuning Simulations for the CLIC Traditional Beam Delivery System

R.M. Bodenstein, P.N. Burrows, John Adams Institute – University of Oxford, Oxford, UK
E. Marin, F. Plassard, R. Tomás – CERN, Geneva, Switzerland

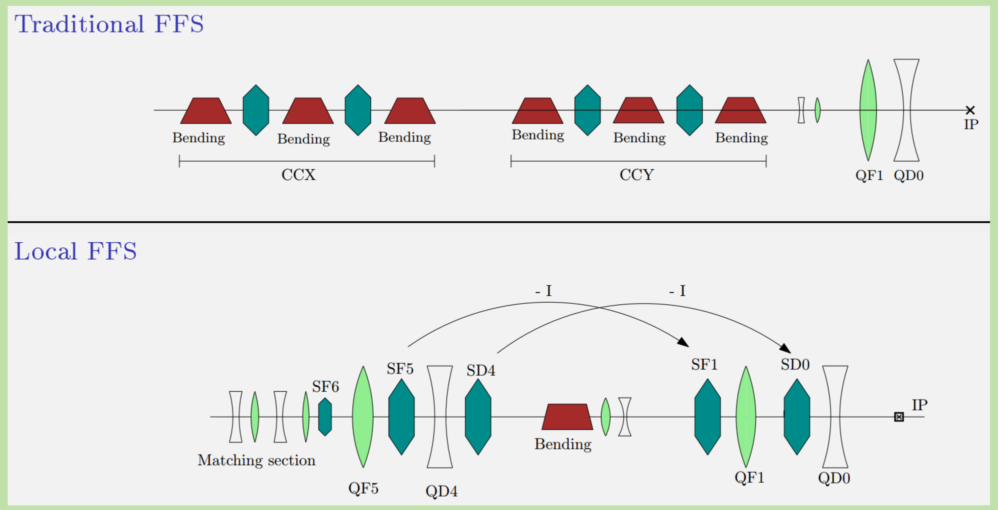
IPAC17

Abstract

As the design of the CLIC beam delivery system (BDS) evolves, tuning simulations must be performed on each of the proposed lattice designs to see which system achieves the highest luminosity in the most realistic manner. This work will focus on the tuning simulations performed on the so-called Traditional lattice design for the center-of-mass energy of 3 TeV. The lattice modifications required to target the most important aberrations and the latest tuning results will be presented.

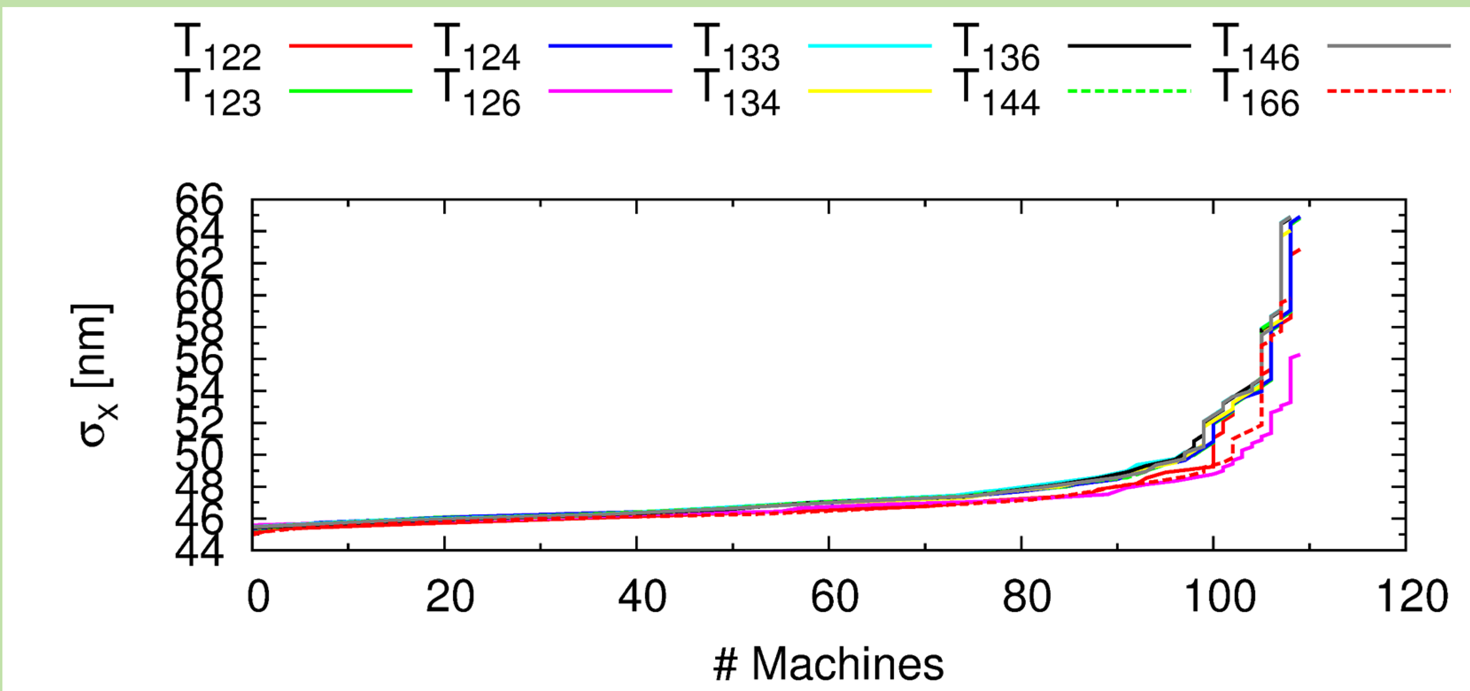
Introduction

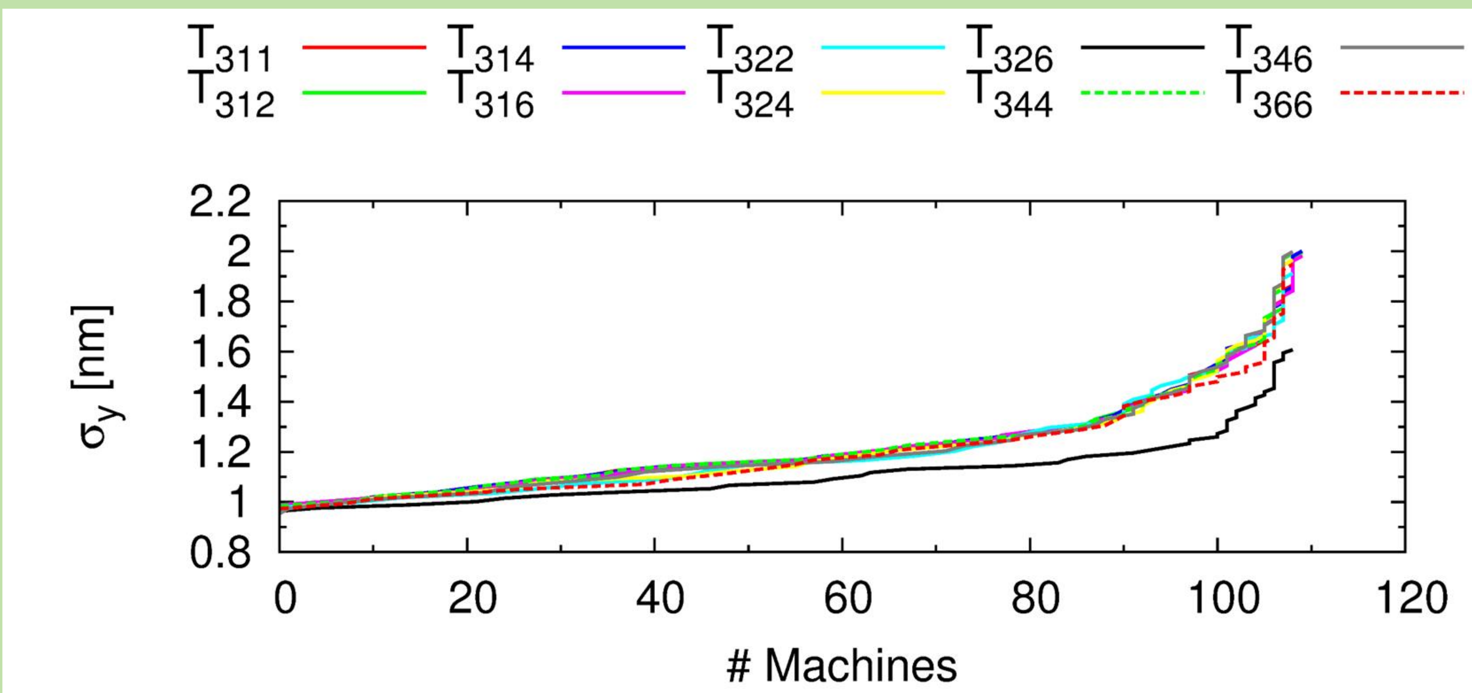
- Two designs for the final focus system of CLIC: Traditional and Local Chromaticity Correction.
  - This work focuses on the Traditional FFS for the 3 TeV center-of-mass collision energy CLIC machine.
- This is a study of single-beam tuning in the FFS.
- PLACET and GUINEA-PIG used for tuning simulations.



What happens when that fails?

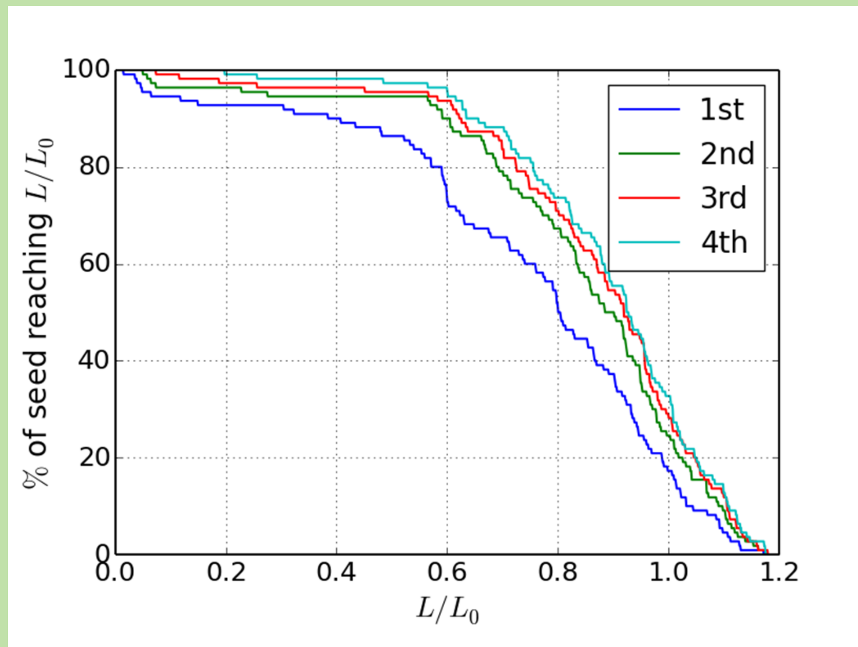
- After a while, luminosity does not increase with each iteration.
- Must identify dominant aberrations in order to address them.
- Since luminosity inversely proportional to beam size, identifying aberrations which, when removed, minimize beam size should maximize luminosity.
- This method works well for the local chromaticity correction scheme.





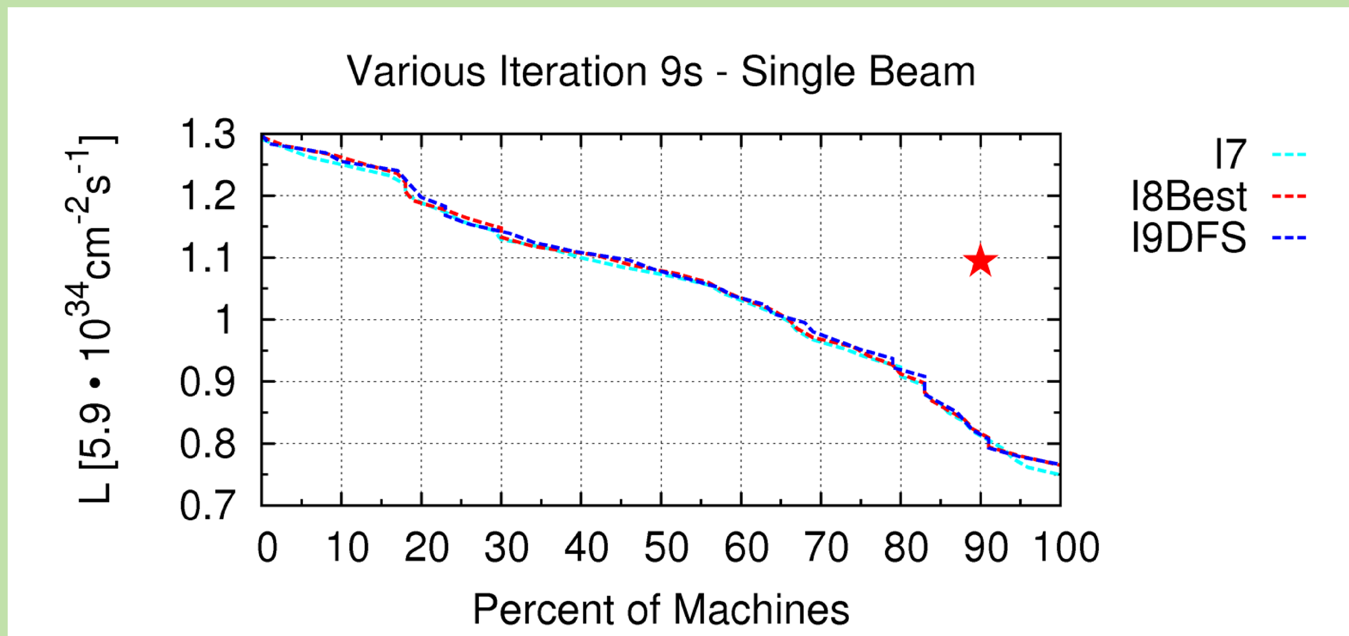
Tuning Procedure Overview

- Apply static transverse offsets (up to 10 μm) to the beamline.
- 1-2-1 tuning to re-steer beam.
- Dispersion-free steering (DFS1) to bring dispersion to nominal.
- 1st order tuning knobs to maximize luminosity.
- Dispersion-free steering (DFS2) to check dispersion without compromising luminosity.
- 1st, 2nd, and higher order tuning knobs to maximize luminosity. Iterate.
- Goal for early stage tuning: 90% of seeds reach 110% of the nominal luminosity.



Right, but you still haven't reached your goal.

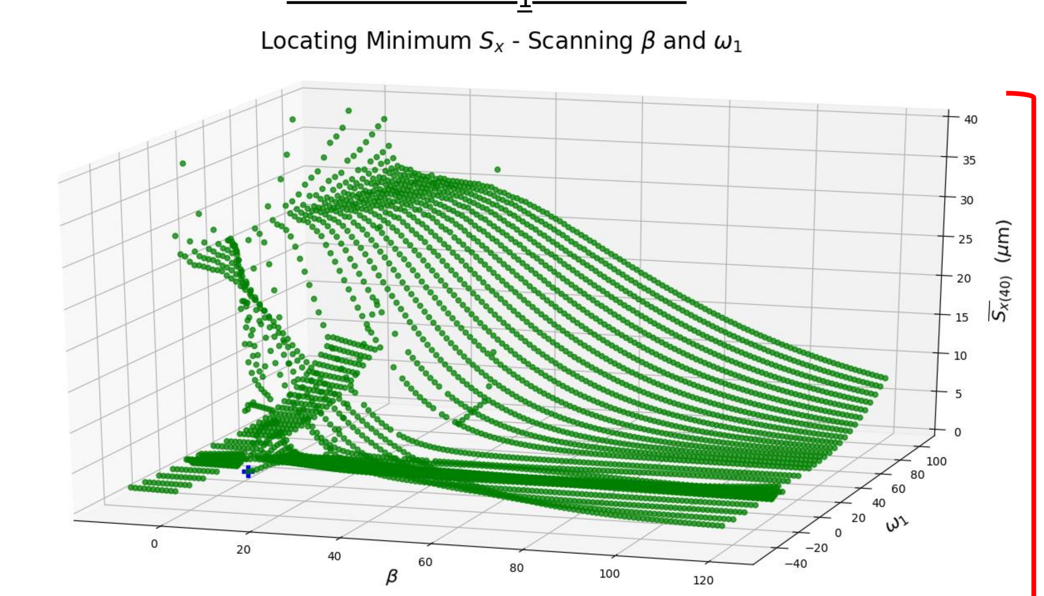
- Even with the introduction of thin lens skew sextupoles to the lattice, the removal of the nonlinear aberrations did not allow the Traditional FFS to reach its luminosity goal. There were large improvements, but it still isn't enough.
- Stumped, it is time to go back to the beginning and re-evaluate what may have been missed.

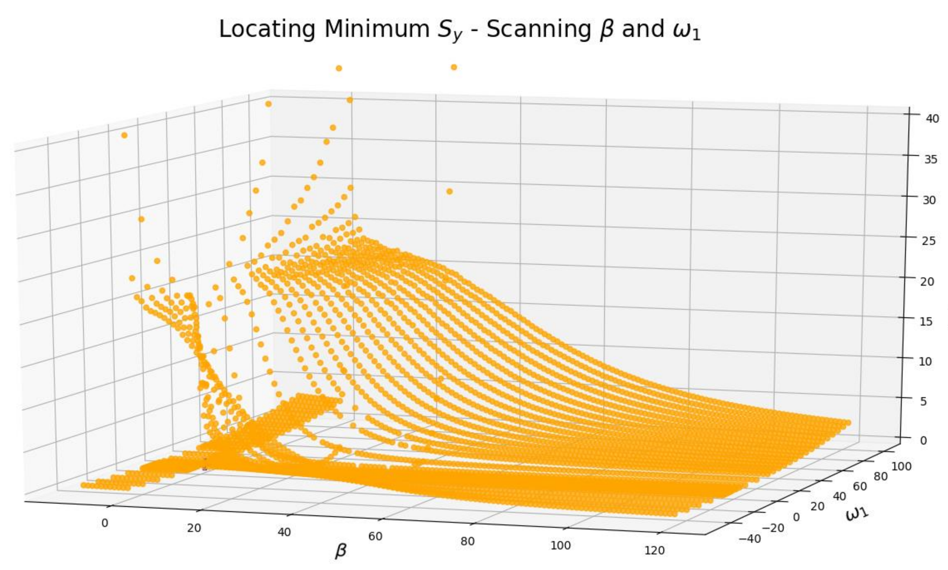


Time to Scan Simulation Weighting Parameters

- β is a parameter used in 1-2-1 tuning. For the Local FFS, this value is set to 11.
- ω_1 is a parameter used in DFS1 (with β). For the Local FFS, this value is set to 73.
- ω_2 is a parameter used in DFS2. For the Local FFS, this value is set to 5.
- Simultaneous scanning β and ω_1 to find the smallest beam size at the IP should determine the correct values. Each point is average of 40 seeds.

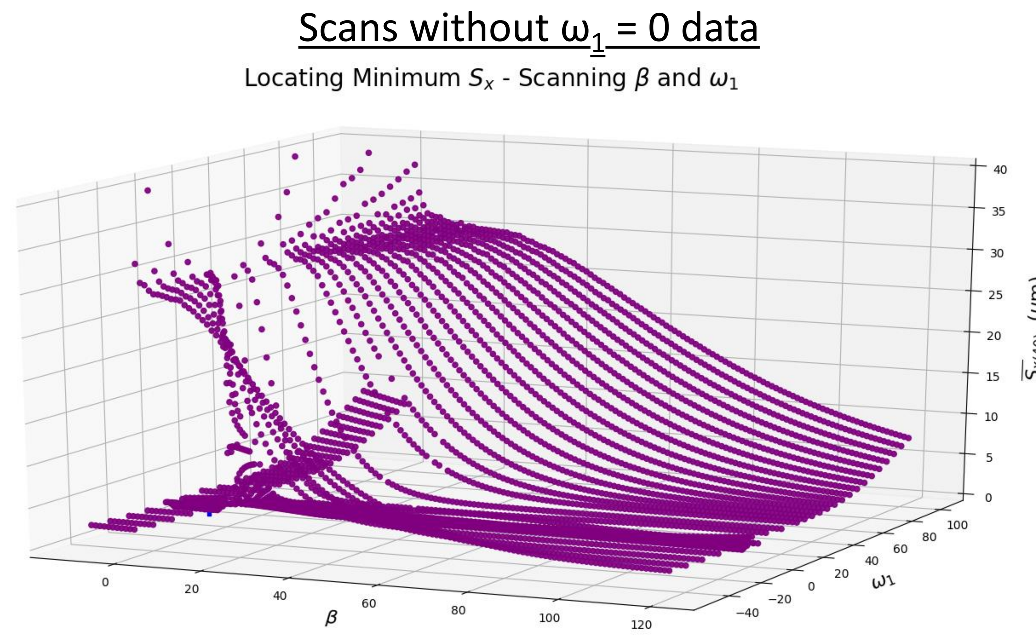
Scans with ω_1 = 0 data



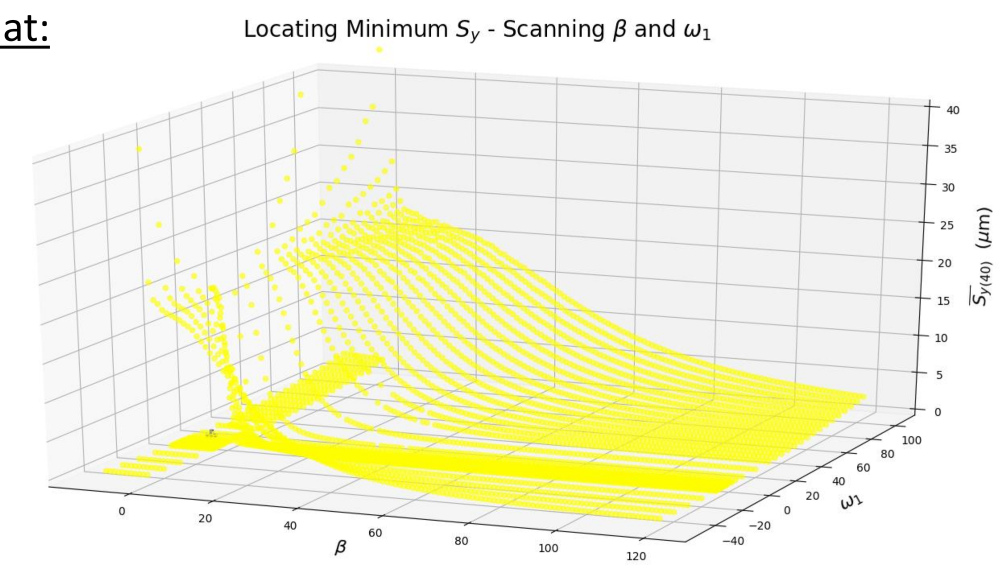


Both planes, S_{min} at:
β =1
ω_1 = 0

Scans without ω_1 = 0 data



Horizontal, S_{min} at:
β =118
ω_1 = -5



Vertical, S_{min} at:
β = 8
ω_1 = 1

What does it mean?

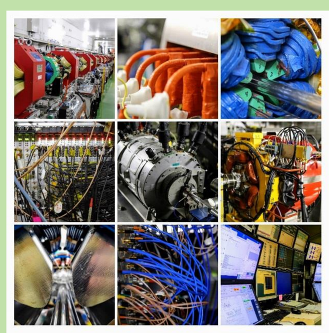
- Unexpected! While we thought the parameters may need to be changed, we did not expect these specific results.
- ω_1 = 0 results mean DFS1 may be unnecessary or detrimental to the overall tuning process.
- Having results depend upon plane may indicate the need to tune each plane separately.
- Further investigation required.
  - Will run simulations using new parameters to confirm.
- Could lead to new, plane-dependent tuning techniques.

Please see proceedings for references.

UNIVERSITY OF OXFORD

CERN

CLIC



JAI John Adams Institute for Accelerator Science