Intra-beam IP Feedback Studies for the 380 GeV CLIC Beam Delivery System

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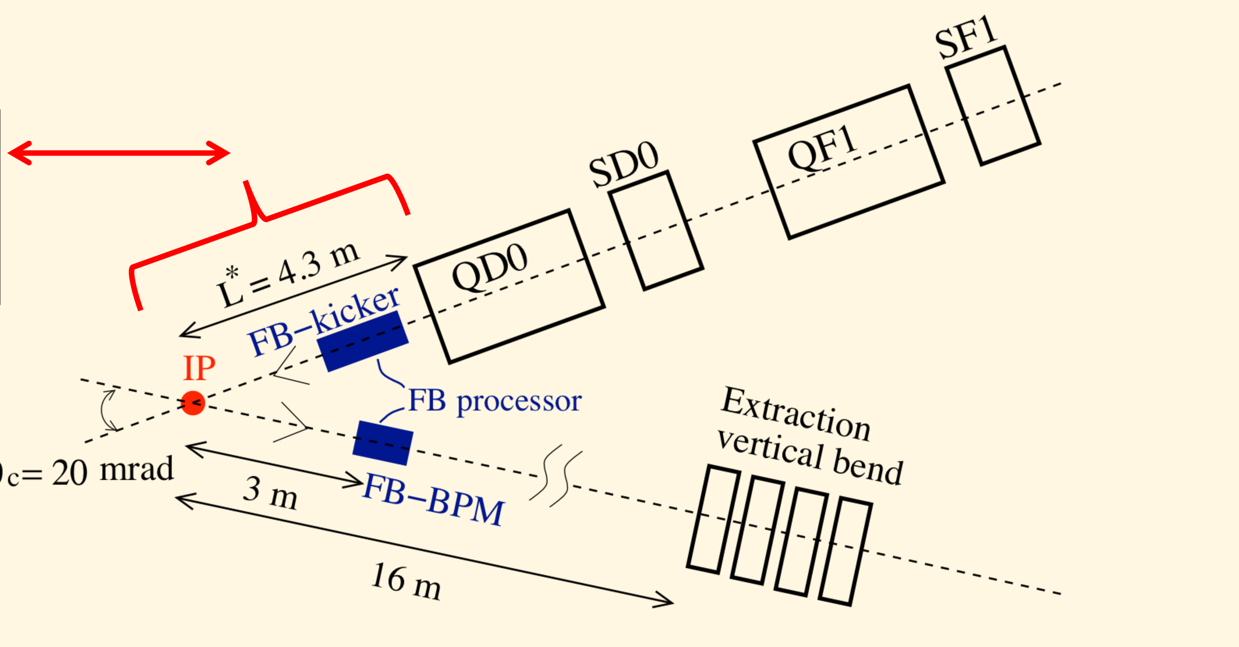
Abstract

In its currently-envisaged initial stage, the Compact Linear Collider (CLIC) will collide beams with a 380 GeV center of mass energy. To maintain the luminosity within a few percent of the design value, beam stability at the interaction point (IP) must be controlled at the sub-nanometer level. To help achieve such control, use of an intra-pulse IP feedback system is planned. With CLIC's very short bunch spacing of 0.5 ns, and nominal pulse duration of 176 ns, this feedback system presents a significant technical challenge. Furthermore, as part of a study to optimize the design of the beam delivery system (BDS), several L* configurations have been studied. In this paper, we will review the IP feedback simulations for the 380 GeV machine for two L* configurations, and compare luminosity recovery performance with that of the original L* configuration in the 3 TeV machine.

Introduction

- Current plans for CLIC involve phased commissioning with lower-energy lattice for 380 GeV collision energy.
- Previous studies focused on a BDS lattice designed for a 3 TeV collision energy.
- New BDS designs have two L* configurations:
  - 4.3 meters, 6 meters.
- Previous ground motion (GM) studies of 3 TeV machine performed for both 380 GeV designs.
- Intratrain IP feedback system used to correct perturbations from GM.

In the new 380 GeV BDS designs, L* is 4.3 meters or 6 meters.

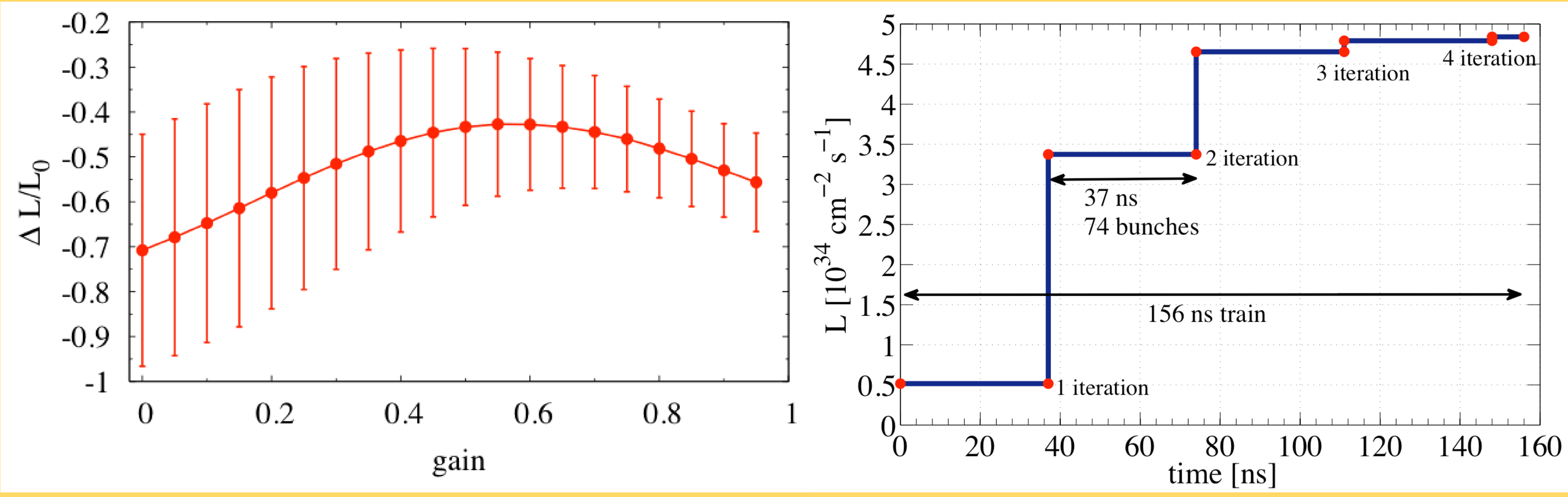


CLIC interaction region, highlighting IP feedback kicker and BPM positions.

Previous Study

- Last study (Resta-López, 2010) focused on 4 GM models; A, B, C, and K.
  - Only model C plots shown.
- PLACET and GUINEA-PIG used for simulation studies.
- 3 TeV collision energy.
- Train length = 156 ns.
- Gain scan performed using 100 random seeds of GM.
- Luminosity recovery plotted for single seed using best gain value.

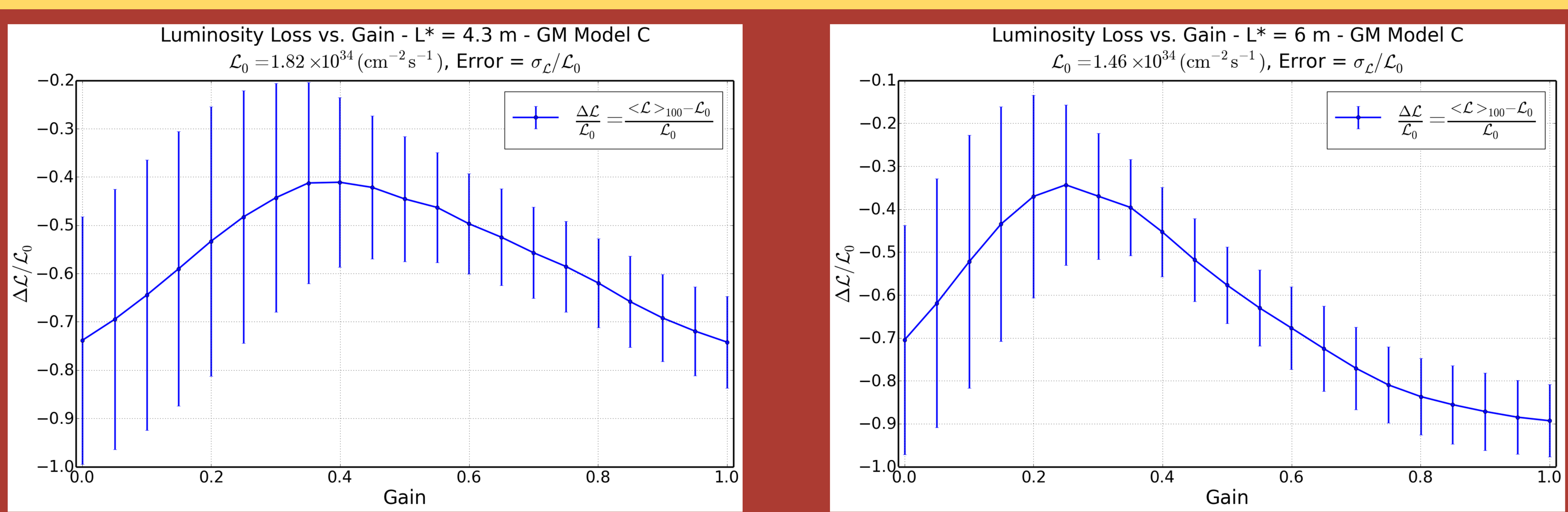
CLIC	380 GeV	380 GeV	3 TeV (2010)
L* (m)	**4.3**	**6**	**4.3**
$\mathcal{L}_{0,tot}$ ($10^{34}cm^{-2}s^{-1}$)	1.82	1.5	6
$\mathcal{L}_{design,tot}$ ($10^{34}cm^{-2}s^{-1}$)	1.5	1.5	6

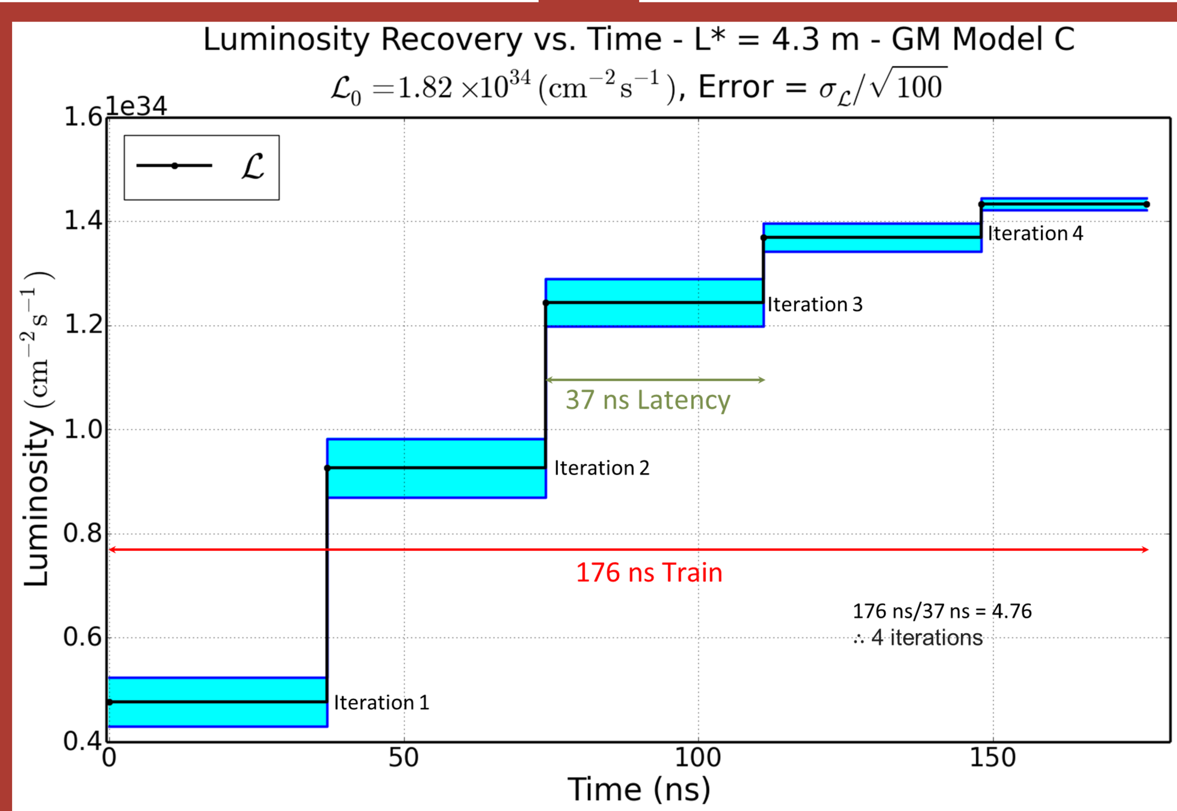


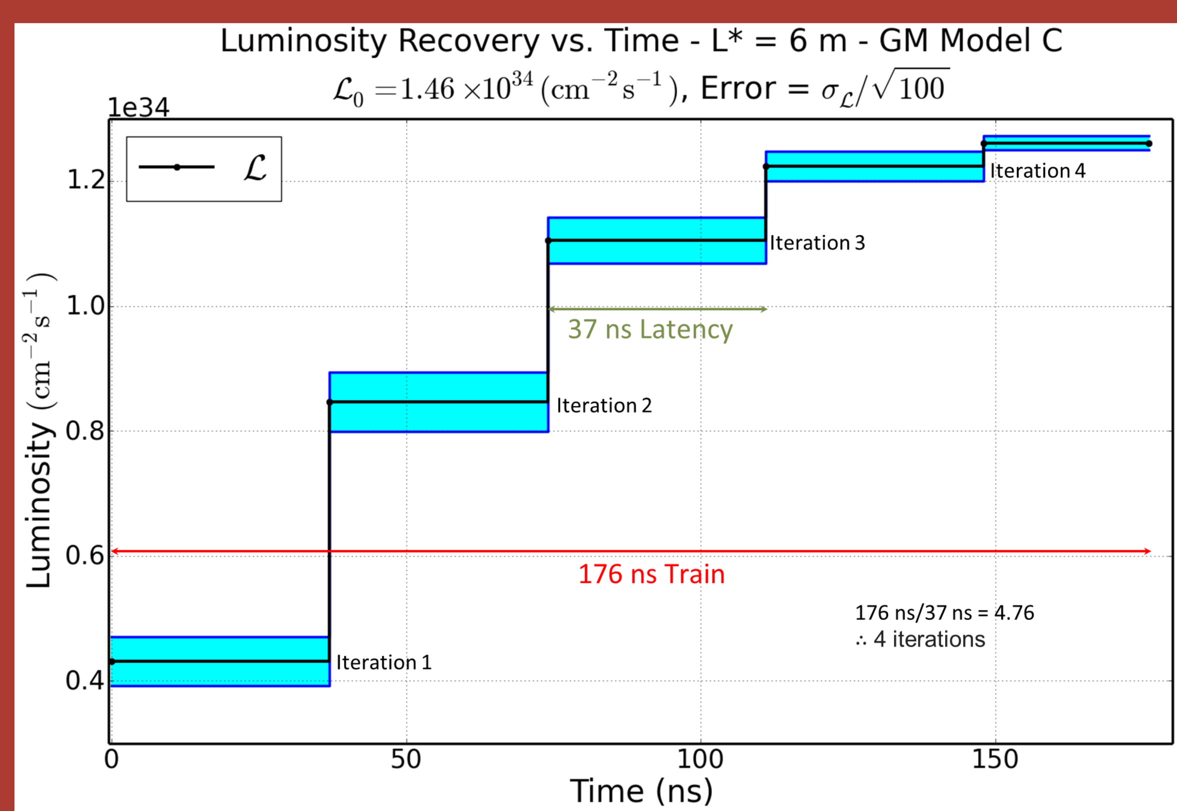
For GM Model C, previous studies achieved 4 correction iterations with the intratrain IP feedback system, and recovered significant luminosity.

Current Study

- Focused on 5 GM models; A, B, C, D (also called B10), and K.
  - Only model C plots shown.
- LinSim framework of PLACET and GUINEA-PIG used for simulation studies.
- 380 GeV collision energy.
- Train length = 176 ns.
- Gain scan performed using 100 random seeds of GM.
- Luminosity recovery plotted for average luminosity from 100 random seeds using the best gain value.
  - Shaded error bands represent the error on the mean.







Results and Future Work

- Initial studies completed for all 5 GM models.
  - Model C plots shown.
  - All results summarized in table below.
- For L* = 4.3 m, luminosity recovery same or better for 380 GeV.
- For L* = 6 m, luminosity recovery similar to 3 TeV study results.
  - 380 GeV achieves as good or better results than 3 TeV.
  - Appears to be best overall results for all GM models.
- Simulation occasionally overcorrects, causing slight reduction in luminosity.
  - Looking for solutions to stop corrections at maximum luminosity.
- For future:
  - Looking at more complex systems, including more errors.
  - Applying ground motion to two independent beamlines.
  - Alternative algorithms for the IP feedback system.
- Please see proceedings for references.

GM Model	3 TeV, L* = 4.3 m (2010)	380 GeV L* = 4.3 m	380 GeV L* = 6 m
A	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 0.1%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 0.1%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 0.1%
B	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 3%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 3%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 3%
C	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 45%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 42%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 35%
D	No Data	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 9%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 6%
K	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 35 %	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 20%	$\Delta\mathcal{L}/\mathcal{L}_0 \lesssim$ 18%

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