Performance Simulations of a Phase Stabilization System Prototype for CTF3

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Abstract
The CLIC drive beam provides RF power for acceleration of the main beam, and hence the drive beam's longitudinal phase tolerances are very tight. A feedback chicane consisting of four electromagnetic kickers is proposed as a correction system for the phase errors, which should allow loosening of the tolerances. A prototype of such a chicane system developed by CERN, INFN and the University of Oxford, is planned to be installed at CTF3 in 2012. The present poster summarizes the parameters of the planned phase correction system and presents simulations, which are used to make predictions of the performance of such a feedback system at CTF3.

Introduction
CLIC is a linear e+e- collider based on the two-beam-scheme, in which the main beam is accelerated by the RF power extracted from the drive beam. The drive beam tolerances are very strict.

Phase correction system
Phase correction system is designed to reduce the bunch phase error at CLIC by a factor 10 before the drive beam decelerators. The system will send the beam in a chicane, varying the trajectory and time of flight of bunches in order to correct their phase.

Correction system for CTF3
CLIC Test Facility (CTF3) is a facility at CERN, constructed in order to test the central concepts of CLIC incl. the stabilization systems.

Performance simulation of feedback correction
• Measure train mean phase at TL2
• Correct this value on all bunches of the next train.

Figure of merit: standard deviation of train mean phase. Feedback is calculated with

\[ \sigma = \sqrt{\frac{1}{m} \sum (\varphi_m)^2 - \bar{\varphi}^2} \]

With \( a = 1 \) and \( \alpha = 0.85 \frac{\sigma_{TL2}}{\sigma_{TL1}} = 0.5 \). Also the limit of the maximal correction (\( \pm 17^\circ \) at 12 GHz) has been considered.

Performance simulation of feed-forward correction
In order to simulate the feed-forward we:
• measure the phase at TL1 (10 ns steps);
• apply correction on the same train at TL2.

Figure of merit: standard deviation of the bunch phase.

Feed-forward is calculated with

\[ Q_{\text{ff}}(\varphi) = Q_{\text{ TL1}} - \frac{1}{b} \sum_{i=0}^{b-1} a_i \cdot Q_i \]

b being the 20 ns corresponding to 50 MHz bandwidth. Average measured phase along one train (in deg at 12 GHz) of TL1 (left) and TL2 (right) have a correlation of 0.85, and measurements have different standard deviations. Hence we use \( a=1 \) and \( \alpha = 0.85 \frac{\sigma_{TL2}}{\sigma_{TL1}} = 0.5 \).

Summary and Outlook
The simulations predict a measurable effect of phase correction system prototype at CTF3, allowing the experimental test of its functionality. The feed-forward correction range of \( \pm 17^\circ \) seems to be sufficient and hence the feedback system is optional.