Measurements and Impact of Stray Fields on the 380 GeV Design of CLIC

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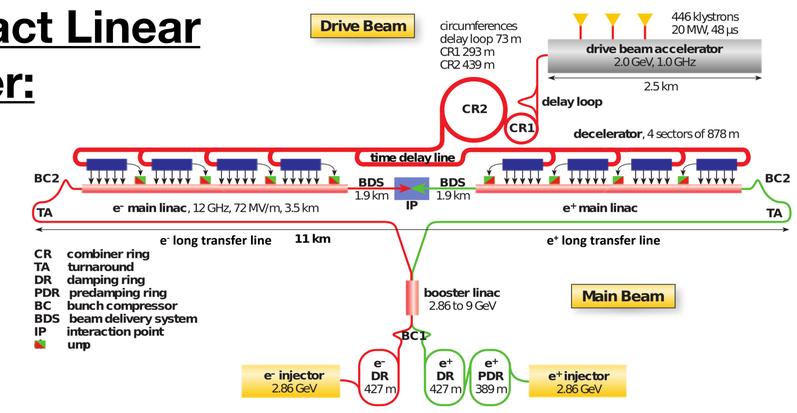
Introduction

The Compact Linear Collider (CLIC) is a e^+e^- collider proposed for the CERN site. The implementation will take place in three centre-of-mass energy stages: 380 GeV, 1.5 TeV and 3 TeV.

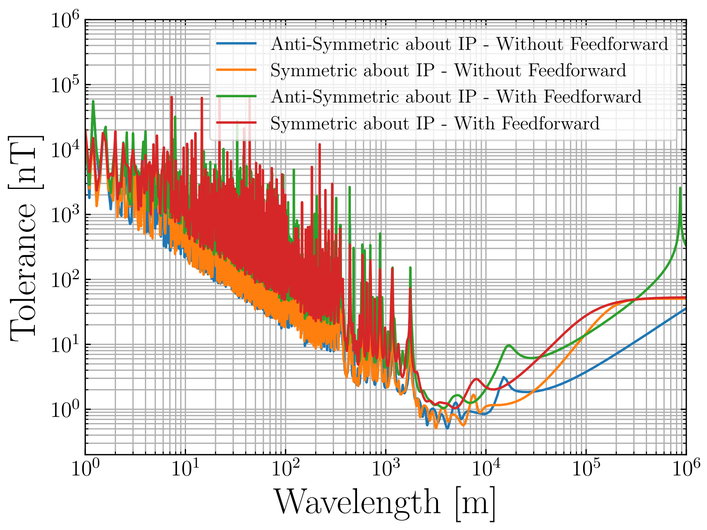
The effect of external dynamic magnetic fields (stray fields) on the 380 GeV CLIC design are considered.

Compact Linear Collider:

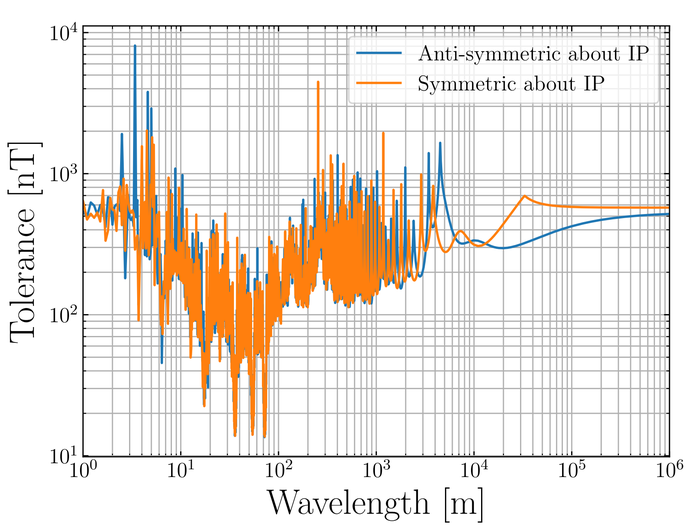


Tolerances

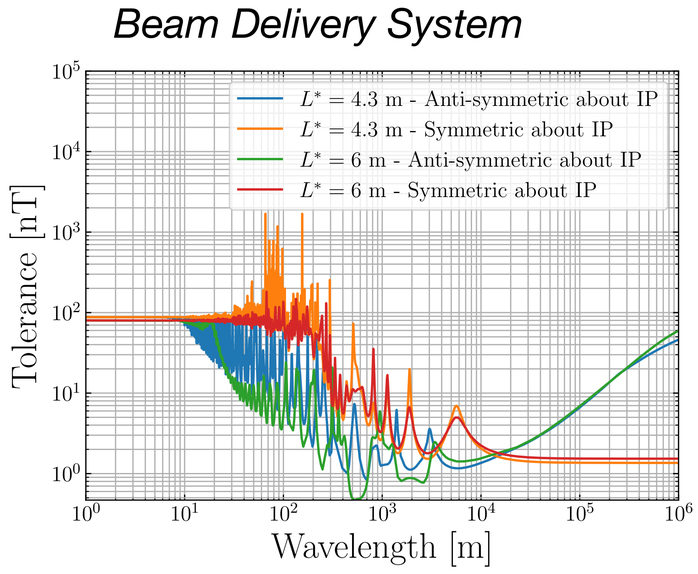
Long Transfer Line



Main Linac



Beam Delivery System



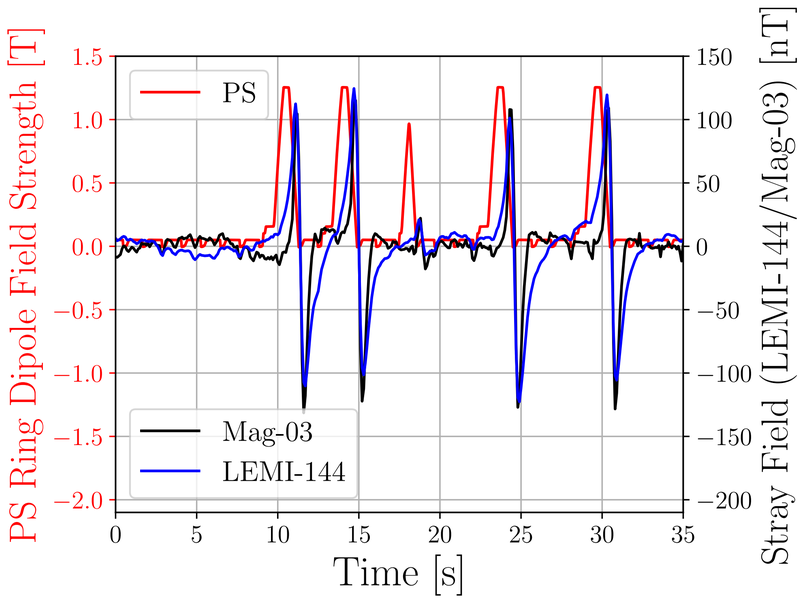
Simulations were performed with the particle tracking code PLACET. Sinusoidal stray fields of varying wavelength were considered. Tolerances were calculated as the stray field amplitude that corresponds to a 1.2 nm normalised emittance growth (equivalent to a 2% luminosity loss).

Sensors

Due to the nT level tolerances, sensors capable of measuring stray fields to a sub-nT precision are required. Details of the sensors used in this measurement campaign are below.

Technical Parameter	LEMI-144	Mag-03
Frequency bandwidth	0.1-300 Hz	0-3 kHz
Noise level (at 1 Hz)	0.06 pT/√Hz	6 pT/√Hz
Resolution (16-bit DAQ)	8 pT	31 nT
Magnetic field range	±250 nT	± 1 mT

CERN Linear Electron Accelerator for Research Facility

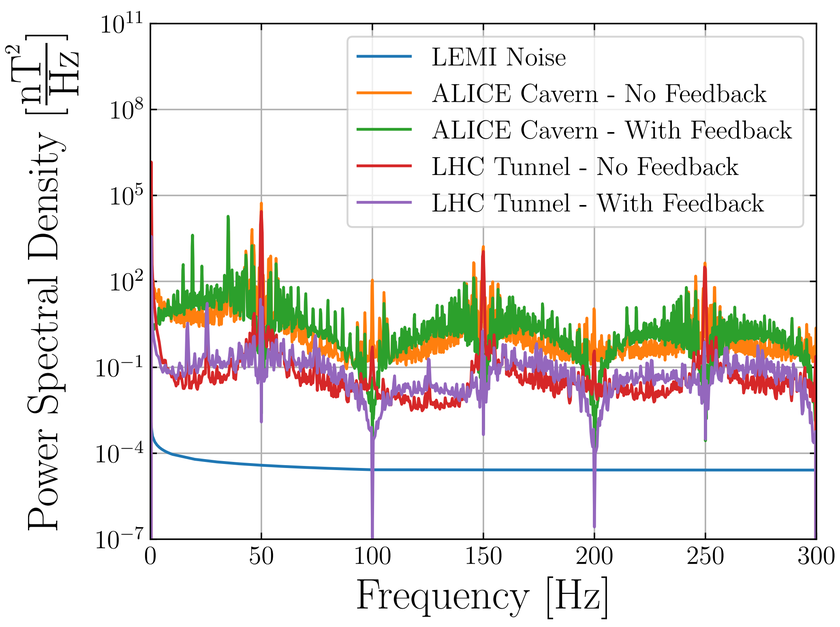


A clear signal from the pulsing of the dipole magnets in the Proton Synchrotron (PS) ring could be observed.

In the absence of any shielding material, a distance of 370 m from the PS ring would diminish the signal to a sub-nT level.

Measurements

LHC Tunnel and ALICE Detector Cavern



Background magnetic field variations were recorded with the LEMI-144 at 8 different locations in the LHC tunnel and ALICE detector cavern. Above is the average across all locations.

Conclusions

In order to evaluate the effect of stray fields on CLIC, realistic measurements of their 2D power spectra are required. These can only be obtained with multiple sensors measuring simultaneously to get the spatial variation as well as the temporal variation.

Due to the tight tolerances, a combination of passive and active mitigation systems will be required. The temporal variation of stray fields must be known in the design of an active system. The above figure shows a simple dead-beat feedback system can amplify certain frequencies.