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Design and optimization techniques for a nano-positioning system

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The objective of this research project is the design of a long range nano-positioning system for the CLIC electromagnets (m $80kg$).

CLIC (Compact Linear Collider) is a next generation particle collider under study at CERN. The accelerator will operate beams of nanometric size ($1nm$ ×$40nm$) and produce a high density of collisions at the interaction cross section (2 x 10^{34} $hits/(m^2s)$). To guarantee this collision quality, the pre-alignment tolerance of the main components of the accelerator must lie within $10m$. In addition, the quadrupole magnets must be extremely stable ($1.5nm$ rms at $1Hz$). The beam further can be steered by displacing these quadrupole magnets in between beam pulses, with nanometric resolution. This critical process is the nano-positioning.

The positioning stage for the magnet must combine several features: a high stiffness ($400N/m$) and robustness against environmental disturbances (i.e. from the turbulent water cooling) and also fast positioning ($t_{settling} < 20ms$) with sub-nanometric resolution to perform beam trajectory correction and active vibration isolation. X- and Y- are the critical degrees of freedom for these processes. For the pre-alignment, all the degrees of freedom are critical except the translation along the magnet axis. For this process a long range of $\pm 3mm$ is required.

I will present the design techniques that will be used for the development of the long range nanopositioning system.

Summary

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