Contribution ID: **694** Type: **Regular 15 minutes Oral Presentation**

Design of a dipole with longitudinally variable field using permanent magnets for CLIC damping rings

Wednesday, 30 August 2017 11:00 (15 minutes)

The latest CLIC damping ring lattice is based on magnets with longitudinally variable dipole fields in order to achieve ultra-low beam emittance, while keeping the ring circumference small. These magnets need to provide a focusing gradient of 11 T/m as well. The good field region radius is 5 mm. The field harmonics shall be in the order of 1E-4 of the main one. Since only a small variation of the field is requested, permanent magnets are the most cost-effective solution. Beam dynamics calculations have provided idealized field profiles and magnetic calculations have been performed to check their feasibility. FEM electromagnetic computations are complicated because the cross-section of the magnet is not constant. Therefore, iron poles cannot be modeled by extrusion and only 3-D computations are meaningful. Mechanical calculations have been also realized to evaluate the forces and design the support structure. Finally, this paper shows that small variations of field strength are possible by using moving parts.

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Session Classification: Wed-Mo-Or19

Track Classification: A2 - Resistive Accelerator Magnets