ID de Contribution: **233** Type: **Doctorant: poster et présentation flash**

Impedance Modeling and Collective Effects in FCC-ee: Impact of Collimators and Optimization Strategies

mercredi 8 octobre 2025 18:53 (7 minutes)

Operating at 45.6 GeV with high beam current, low emittances, and long damping times, the FCC-ee low-energy machine is particularly sensitive to collective effects and impedance-induced beam instabilities. Controlling these effects requires a continuously refined impedance budget to guide design choices and establish reliable instability thresholds. Recent studies identify the collimation system as a dominant contributor to the total machine impedance, with geometric effects playing a critical role in beam stability. A flexible, modular, and comprehensive impedance model —including beam pipe, collimators, RF cavities, bellows, tapers, and beam position monitors —enables targeted optimization and systematic stability assessments. This work presents the latest FCC-ee impedance budget, emphasizing the impact of collimators'geometric impedance and ongoing advances in modeling, threshold evaluation, and instability mitigation.

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Classification de Session: Posters