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The Chilling Recount of an Unexpected Discovery: First Observations of the Plasma-Cascade Instability in the Coherent Electron Cooling Experiment

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Coherent electron Cooling (CeC) is a sophisticated technique which has the potential to significantly reduce the cooling time in high-energy hadron machines and provide a substantial luminosity boost in high-intensity hadron-hadron and electron-hadron colliders. The CeC Proof of Principle (PoP) accelerator is a unique facility which is currently under commissioning at Brookhaven National Laboratory (BNL). The accelerator utilizes one of the few currently operating superconducting RF (SRF) photo injectors with a warm cathode, which has demonstrated an exceptional performance over the last few years.

In this dissertation we present the main results of the CeC PoP commissioning with an emphasis on the performance of the SRF photo injector. Special focus will be given to unexpected experimental results obtained during the last year of operation, and the discovery of a previously unknown type of microwave instability. We call this new phenomenon a micro-bunching Plasma Cascade Instability (PCI).

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