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Plasma instabilities in Fireball experiments at CERN

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The main objective of the project is the study of electromagnetic instabilities in plasmas in the ultra-relativistic regime, focusing on the interaction of electron/positron beams with electron and ion plasmas. This study will be conducted using particle-in-cell (PIC) simulations with the OSIRIS numerical code.

The aim is to reproduce, *ab initio*, the experimental conditions of the program at CERN and those planned at INFN, and their relevance to extreme phenomena present in astrophysical scenarios, such as gamma-ray bursts (GRBs), relativistic shocks, or magnetogenesis, where kinetic instabilities, such as the Weibel instability, may play a crucial role.

The initial steps are focused on developing reduced simulations to understand which types of instabilities are most relevant under the experimental conditions to be studied. Subsequently, the project will aim to generalize the simulations from 2D to quasi-3D and 3D, reproducing the conditions of the experiments carried out or under preparation at CERN and INFN.

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