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Search for charged lepton flavor violation with the COMET experiment at J-Parc

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The Standard Model (SM) of particle physics describes the fundamental particles and the interactions governing the universe. While it has been remarkably successful in providing experimental predictions, several phenomena remain unexplained, such as the matter/antimatter asymmetry, the nature of dark matter, and even the oscillation of neutrinos. In particular, neutrino oscillation experiments have demonstrated that lepton flavor can be violated for neutral leptons, a phenomenon known as **neutral lepton flavor violation**. However, **flavor violation** has not yet been observed in **charged leptons**. In the Standard Model, **charged lepton flavor violation (cLFV)** is strictly forbidden, and even in minimal extensions to account for neutrino oscillation, it is highly suppressed by the large mass of the W boson.

The **COMET experiment** seeks to detect cLFV through a process involving new physics: the **coherent, neutrinoless conversion** of a muon bound to a nucleus into an electron. It targets a single event sensitivity of 10^{-17} over two phases, which is an improvement by four orders of magnitude of the current world limit (SINDRUM-II, 2006).

One of the primary challenges for COMET is mitigating background noise from cosmic rays. Atmospheric muons could enter the detector and produce electrons that mimic signal events or be misidentified themselves as electron candidates. A subsystem known as the **Cosmic Ray Veto (CRV)** is designed to distinguish cosmic ray-induced events from genuine signal events. A detailed study of the radiation environment impacting the CRV has been conducted to optimize its efficiency, exploring various geometric configurations and shielding materials. This analysis was carried out using **ICEDUST**, the simulation software utilized by the experiment.

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