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Strong and Robust Searches for Millicharged Particles at the Energy Frontier with LHC FPF and FORMOSA

We identify potentially the world's most sensitive location to search for millicharged particles in the 10 MeV to 100 GeV mass range: the forward region at the LHC. In this location, we propose constructing a scintillator-based experiment, FORward MicrOcharge SeArch (FORMOSA) [1], and estimate the corresponding sensitivity projection. We show that FORMOSA can discover millicharged particles in ample and unexplored parameter space and study strongly interacting dark matter that ground-based direct-detection experiments cannot detect. The newly proposed LHC Forward Physics Facility (FPF) [2] provides an ideal structure to host the FORMOSA experiment; however, alternative locations may be possible.

The FORMOSA detector is proposed to be constructed of plastic scintillators; however, the exciting possibility of using alternative scintillator material with significantly higher light yield will be studied in the coming years. One such material is a CeBr3 scintillator (available from Berkeley Nucleonics). This provides a light yield approximately factor 30 times higher than the same length of plastic scintillator with excellent timing resolution. This would allow much lower charges to be probed with the FORMOSA detector. Further updates to the detector design can be studied with a FORMOSA demonstrator in the forward region of the LHC.

[1] PRD (2021), https://arxiv.org/abs/2010.07941
[2] Phys. Rept. (2022), https://arxiv.org/abs/2109.10905
[3] milliQan, PLB (2015), https://arxiv.org/abs/1410.6816
[4] FerMINI, PRD (2019), https://arxiv.org/abs/1812.03998

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