INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
PhD-17 SHORT ABSTRACT OF THESIS

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Programme of Study : Ph.D.

Thesis Title: **Effective Field Theories to Probe Physics Beyond the Standard Model at Colliders**

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Thesis Submitted to the Academic Division : Physics

Date of completion of Thesis Viva-Voce Exam : 19/06/2026

Key words for description of Thesis Work : Effective Field Theory, Collider Phenomenology

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SHORT ABSTRACT

Physics beyond the Standard Model (BSM) is motivated from several observations like that of tiny but non-zero neutrino masses, evidences of a dark matter, matter-anti- matter asymmetry, stability of the Higgs vacuum, heirarchy problem, and many more. But, since the discovery of the Higgs boson, searches for TeV-scale New Physics (NP) at the Large Hadron Collider (LHC) have largely yielded null results, thereby placing significant constraints on fundamental theories that predict new resonances at the TeV scale. In this context, where no substantial increase in the LHC energy is expected in its future run, and relatively lower energy but high precision lepton colliders are on the horizon, Effective Field Theories (EFTs) emerge as a powerful and pragmatic framework for probing the effects of NP that remain kinematically inaccessible and thus manifest only virtually. The thesis explores the prospects of applying EFTs, with particular emphasis on the Standard Model Effective Field Theory (SMEFT), wherein the Standard Model (SM) is extended by higher dimensional effective operators constructed from its fields abiding by the SM gauge symmetry. We study several applications of SMEFT, where the deperture from the SM observation can hint towards the existence of NP. We investigate modifications to the Higgs boson couplings with SM gauge bosons, as well as flavor violating effects that are highly suppressed in the SM. In addition, we employ the Dark Matter Effective Field Theory (DMEFT) framework, which extends the SM by introducing a Dark Matter (DM) candidate whose interactions with SM fields are mediated by higher dimensional operators. While accounting for the observed DM relic abundance such operators can also encode imprints of the early Universe when produced during the reheating era, which may be probed through their signatures at the future collider experiments.