

# Making SUSY Natural Again – Investigating the Naturalness Reach of the International Linear Collider

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When designing and selecting future collider projects, it is important to understand the physics potential of the different alternatives. Here, we investigate the naturalness reach of the International Linear Collider (ILC) in simple constrained supersymmetric models, and compare it to the reach of the High-Luminosity Large Hadron Collider (HL-LHC), based on the results in 1. The reach is quantified both in terms of the range of naturalness covered, given by the Barbieri-Giudice measure, and in terms of the information gained about naturalness, quantified by the Kullback-Leibler divergence.

Two particular scenarios (parameter choices) for the Constrained Supersymmetric Standard Model (CMSSM) are studied, and one for the second Non-Universal Higgs Mass (NUHM2) model. We find that the HL-LHC in general has a higher naturalness reach than the ILC in the two CMSSM scenarios. However, for the NUHM2 scenario, it is the other way around. In this scenario, we find that the information gain from the 1 TeV ILC searches are over ten times as large as the information gain from the HL-LHC searches. Post HL-LHC naturalness scores below  $c \sim 20$ , or a tuning to no worse than 5%, are allowed. Thus, the particular variant of the NUHM2 model studied in this work motivates building the ILC.

## Summary

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