Snowmass Expression of Interest – bottom quark mass

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The bottom quark mass is one of the parameters of the Standard Model that must be determined by experiment. A precise determination is important to reduce the parametric uncertainties in Standard Model predictions of, for instance, Higgs boson couplings.

The current world average for the bottom quark $\overline{\text{MS}}$ mass is $m_b(m_b) = 4.18$ GeV[1], with a relative uncertainty slightly under 1%. The world average includes a large number of techniques, the most precise of which are based on relatively low-energy measurements that determine the bottom quark mass at the bottomonium scale (~10 GeV) or below.

Quantum Chromo Dynamics (QCD) predicts that the bottom quark mass evolves with the scale at which it is evaluated. Experiments at the Z-pole at LEP and SLC have extracted the bottom quark mass at m_Z, comparing NLO predictions for three- and four-jet production[] with the observed rates. These high-scale measurements have achieved a precision of approximately 10% precision and – within uncertainties - confirm the evolution predicted by the Renormalization Group Equations.

We will assess the potential of a future electron-positron Higgs factory to provide further evidence for the "running" of the bottom quark mass. The study is based on a full simulation of $e^+e^- \rightarrow q\bar{q}$ production at a center-of-mass energy of 250 GeV in the ILD experiment[4] at the International Linear Collider[5]. We plan to present a complete projection for $m_b(250\text{ GeV})$, including estimates for the most important systematic uncertainties.

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