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QCD uncertainties in the weak mixing angle extraction from e+e−>Z(b bbar) asymmetries

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The forward-backward asymmetry of b-quarks measured at LEP in e+e− collisions around the Z pole, $A_{FB}^{0,b}|^{exp}$=0.0992±0.0016, remains today the electroweak precision observable with the largest disagreement (2.8σ) with the Standard Model theoretical prediction, $A_{FB}^{0,b}|^{th}$=0.1037±0.0008, and thereby also the weak mixing angle $\sin^2\theta_W$ derived from it. The dominant systematic uncertainties are due to QCD effects — b,c-quark showering and fragmentation, and B,D meson decay models — that have not been revisited in the last 20 years. We reassess the QCD uncertainties of the eight LEP original $A_{FB}^{0,b}$ measurements, using modern parton shower simulations based on PYTHIA-8 and PYTHIA-8 plus VINCIA with different tunes of soft and collinear radiation as well as of hadronization. Our analysis indicates QCD uncertainties that are overall smaller but still consistent with the original ones. Using the reassessed QCD systematic uncertainties, we present updates of the $A_{FB}^{0,b}$ and $\sin^2\theta_W$ values derived from the LEP data, and future estimates for FCC-ee.

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