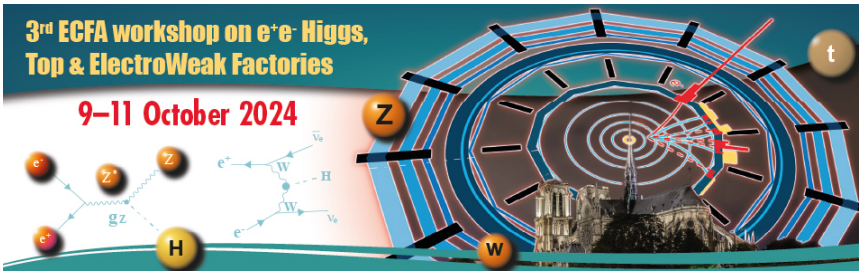

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A New Method for Measuring the Higgs Mass at Linear Colliders

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The Higgs mass as one of the fundamental parameters in the Standard Model has been already measured with a precision of 140 MeV with the data collected so far at the LHC. However in some cases of looking for small deviations from the SM, current precision or projection of the Higgs mass measurement at the LHC or HL-LHC may not be enough. One prominent example is for the SM prediction of the Higgs partial decay width H $\longrightarrow$ W W $*$ or H $\longrightarrow$ ZZ$*$, in which the Higgs mass uncertainty becomes one of the leading sources of parametric theory error. It is expected that at future e+e- colliders the Higgs mass precision can be significantly improved by the "recoil mass method", at least statistically. This research proposes a new method which may complement to the recoil mass method in terms of systematic errors. The new method employs the signal channel of Higgs decaying to a pair of fermions, in particular τ leptons, or 2 quarks bb and makes use of transverse momentum conservations alone instead of the 4-momentum conservation in the recoil mass method. The key experimental observables will be the momentum directions of tau leptons without any input from energy measurement, and the momentum directions can possibly
be measured by reconstructing the decaying vertex of the tau leptons. This new method can in principle be applied at linear colliders and the LHC as well. Another possible improvement is in the case of $\tau \longrightarrow 3-$ prongs, to reconstruct the decay vertex and use it to directly obtain the direction of the τ with the IP. This method was studied by performing realistic detector simulation and physics analysis with the ILC and ILD frameworks. This method can be used in conjunction with other methods to improve the Higgs mass measurements at colldiers.

Primary author: BERGER, Thomas

Co-author: TIAN, Junping (University of Tokyo)

Presenter: BERGER, Thomas

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