Determination of the HZγ effective coupling at FCC-ee

Letter of Interest submitted to Snowmass 2021

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Thematic Areas:

■ (EF01) EW Physics: Higgs Boson properties and couplings
■ (EF02) EW Physics: Higgs Boson as a portal to new physics
☐ (EF03) EW Physics: Heavy flavor and top quark physics
☐ (EF04) EW Physics: EW Precision Physics and constraining new physics
☐ (EF05) QCD and strong interactions: Precision QCD
☐ (EF06) QCD and strong interactions:Hadronic structure and forward QCD
☐ (EF07) QCD and strong interactions: Heavy Ions
☐ (EF08) BSM: Model specific explorations
☐ (EF09) BSM: More general explorations
☐ (EF10) BSM: Dark Matter at colliders

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The FCC-ee is a frontier Higgs, Top, Electroweak, and Flavour factory. It will be operated in a 100 km circular tunnel built in the CERN area, and will serve as the first step of the FCC integrated programme towards 100 TeV proton-proton collisions in the same infrastructure [1]. With its large luminosity at the HZ cross section maximum ($\sqrt{s} \simeq 240$ GeV) and at and above the top-pair threshold ($\sqrt{s}$ from 340 to 365 GeV), and its several interaction points, the FCC-ee physics programme includes the measurement of the Higgs parameters with unrivalled accuracy. The high statistics of FCC-ee lead to demanding requirements on detector design or on theoretical calculations, the ultimate goal is that experimental or theory systematic errors match the statistical limit.

The Higgs factory, with over one million Higgs bosons produced at $\sqrt{s} \sim 240$ and 365 GeV, will allow many of the Higgs couplings to be determined for the first time in a model-independent and absolute way. For example, the HZγ effective coupling can be obtained from the measurement of the $\mathrm{H} \to \mathrm{Z}\gamma$ branching fraction in the ZZγ final state, on the one hand; and from the combined measurement of the $\mathrm{H} \to \gamma\gamma$ branching fraction and the $\mathrm{e^+e^-} \to \mathrm{H}\gamma$ cross section [2, 3], on the other. With the foreseen FCC-ee integrated luminosities, about 1500 $\mathrm{H} \to \mathrm{Z}\gamma$ decays are predicted, and the number of Hγ events expected to be produced at the WW threshold, at the HZ cross-section maximum, and above the top-pair threshold are approximately 200, 400, and 30, respectively. The requirements on the detector design (photon identification, photon energy/angular resolutions, in particular) to achieve a meaningful measurement of the HZγ coupling (e.g., with a precision significantly better than HL-LHC projections) will be studied.

References

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[3] W.-L. Sang, W. Chen, F. Feng, Y. Jia and Q.-F. Sun, *Next-to-leading-order QCD corrections to $e^+e^- \to H + \gamma$*, *Phys. Lett. B* **775** (2017) 152–159, [1706.03572].