T 26: Higgs physics (theory)

Time: Tuesday 16:00–18:30 Location: Ta

T 26.1 Tue 16:00 Ta

Parton-shower effects in Higgs production via Vector-Boson Fusion — Barbara Jäger[1], Alexander Karlberg[2], Simon Plätzer[3], •Johannes Scheller[1], and Marco Zaro[4] — [1]Institute for Theoretical Physics, University of Tübingen, Germany — [2]Rudolf Peierls Centre for Theoretical Physics, University of Oxford, United Kingdom — [3]Particle Physics, Faculty of Physics, and Erwin Schrödinger Institute for Mathematics and Physics, University of Vienna, Austria — [4]INFN Sezione di Milano & TifLab, Italy

We present a systematic investigation of parton-shower and matching uncertainties of perturbative origin for Higgs-boson production via vector-boson fusion. To this end we employ different generators at next-to-leading order QCD accuracy matched with shower Monte Carlo programs, `PYTHIA8`, and `HERWIG7`, and a next-to-next-to-leading order QCD calculation. We thoroughly analyse the intrinsic sources of uncertainty within each generator, and then compare predictions among the different tools using the respective recommended setups. Within typical vector-boson fusion cuts, the resulting uncertainties on observables that are accurate to next-to-leading order are at the 10% level for rates and even smaller for shapes. For observables sensitive to extra radiation effects uncertainties of about 20% are found. We conclude that for vector-boson fusion processes an assessment of the uncertainties associated with simulation at next-to-leading order matched to parton showers based only on the variation of renormalisation, factorisation and shower scales systematically underestimates their true size.

T 26.2 Tue 16:15 Ta

Gauge-invariant description of the Higgs resonance and its phenomenological implications — •René Sondenheimer and Axel Maas — Institute of Physics, NAWI Graz, University of Graz, Universitätsplatz 5, A-8010 Graz, Austria

We investigate the phenomenological consequences of a strict gauge-invariant formulation of the Higgs particle. This requires a description of the observable scalar particle in terms of a bound state structure. Although this seems to be at odds with the common treatment of electroweak particle physics at first glance, the properties of the bound state can be described in a perturbative fashion due to the Fröhlich-Morchio-Strocchi (FMS) framework. In particular a relation between the bound-state Higgs and the elementary Higgs field is obtained within 't Hooft gauges such that the main quantitative properties of the conventional description reappear in leading order of the FMS expansion. In particular the pole structure of the elementary and the bound-state propagator coincide to all orders in a perturbative expansion. However, slight deviations of scattering amplitudes containing off-shell Higgs contributions can be caused by the internal bound state structure which will be discussed.

T 26.3 Tue 16:30 Ta

Effective Field Theory interpretations in Higgs boson pair production studies — •Christina Dimitriadi — Physikalisches Institut Universität Bonn, Germany — Uppsala University, Sweden

After the discovery of the Higgs boson in 2012, searching for the simultaneous production of two Higgs bosons (di-Higgs) in proton-proton collisions would enable us to establish evidence of the Higgs boson self-coupling which is directly linked to the shape of the Higgs potential.

Interpretations in Effective Field Theories (EFT) can be beneficial as they provide new physics contributions in a model-independent way. Two different approaches are popular in di-Higgs, the Higgs EFT (HEFT), which is described by the Electroweak Chiral Lagrangian and the Standard Model EFT (SMEFT), where the SM Lagrangian is extended to higher mass dimensions. Theorists have provided an analytical parametrisation for the total cross-section and the m_{hh} distribution as a function of the anomalous Higgs couplings including NLO corrections, and weights have been produced and made available. Some intermediate results will be presented concerning HEFT reweighting validation studies.

T 26.4 Tue 16:45 Ta

Probing standard-model Higgs substructures using tops and weak gauge bosons — •Axel Maas — University of Graz, Graz, Austria

Manifest gauge-invariance requires that observable states in the standard-model are described by composite operators, which involve additional (valence) Higgs contributions beyond perturbation theory. This field-theoretical effects has been supported in various lattice simulations, including for fermions. With current available and future experimental facilities it starts to become possible to probe this. This will be explored in this talk.

It will be shown how such a valence Higgs contribution can show up in production of final states like ttbar(Z) at both future lepton and future and current hadron colliders. Especially at the LHC this has been found to be compatible with run 2 data. The effect is expected to be much more substantial at the FCC-hh. Such a substructure can also affect precision observables, e.g. anomalous couplings, both of the Higgs and of the weak gauge bosons. It is therefore a natural candidate for an investigation at the ILC.

T 26.5 Tue 17:00 Ta

Investigating triple Higgs production in and beyond the SM at proton-proton colliders. — •Gilberto Tetlalmatzi-Xolocotzi[1], Andreas Papaefstathiou[2], Tania Robens[3], and Marco Zaro[4] — [1]University of Siegen, Walter-Flex-Str. 3, 57068 Siegen — [2]Higgs Centre for Theoretical Physics, University of Edinburgh, Peter Guthrie Tait Road, Edinburgh EH9 3FD, UK. — [3]Ruder Bokovic Institute, Bijenicka cesta 54, 10000 Zagreb, Croatia — [4]Tif Lab, Dipartimento di Fisica, Università di Milano and INFN, Sezione di Milano, 20133 Milano, Italy

In this talk we will discuss the production of three Higgs bosons in the LHC and at a proton-proton collider running at a centre-of-mass energy of 100 TeV. We will argue that the seemingly challenging 6-botton jets final state is a very good candidate to investigate triple Higgs production within and beyond the SM in proton-proton colliders.

In particular we will consider three different scenarios: one in which the triple and quartic Higgs boson self-couplings are not affected by new physics phenomena besides the Standard Model (SM) and in addition, we will explore two possible SM extensions by one and two new scalars. We will show that a 100 TeV machine can impose competitive constraints on the quartic coupling in the SM-like scenario. In the case of the scalar extensions of the SM, we will show that large significances can be obtained in the LHC and the 100 TeV collider while obeying current theoretical and experimental constraints including a first order electroweak phase transition.

T 26.6 Tue 17:15 Ta

Two-Loop Higgs Boson Masses in the CP-Violating NMSSM — Nhung Dao[3], •Martin Gabelmann[1], Margarete Mühlleitner[1], and Heidi Rzehak[2] — [1]KIT, Karlsruhe, Germany — [2]Uni Freiburg, Germany — [3]ICISE, Vietnam

Imposing supersymmetry inevitably connects a theories Higgs-, gauge- and Yukawa-sector. Therefore, the discovery of a 125 GeV Higgs boson at the LHC puts tight constraints on parameter spaces of supersymmetric models which need to predict the correct Higgs boson mass.
The importance of higher-order corrections in this game cannot be overemphasised: in the minimally supersymmetric SM (MSSM), loop-corrections are known to be $\mathcal{O}(40\%)$ of the tree-level Higgs boson mass prediction.

In this talk, we report on recent progress in Higgs boson mass predictions at two-loop accuracy $\mathcal{O}\left((\alpha_\lambda + \alpha_\kappa + \alpha_t)^2\right)$ in the CP-violating NMSSM. We introduce the imposed renormalization schemes which combine minimal subtraction as well as on-shell conditions and discuss the size of the resulting scheme uncertainty. Furthermore, we discuss the appearance of infra-red (IR) divergences as well as three different IR-restoring methods in a subset of the two-loop tadpole- and selfenergy-diagrams. Finally, we compare size of the new two-loop corrections relative to the previously calculated $\mathcal{O}\left(\alpha_t(\alpha_s + \alpha_t)\right)$ contributions.

T 26.7 Tue 17:30 Ta

Calculations of one-loop corrections to decays for charged Higgs bosons in NMSSM — Thi Nhung Dao[1], Margarete Mühlleitner[2], Shruti Patel[2,3], and •Kodai Sakurai[2,4] —

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Despite the discovery of the Higgs boson with a mass of 125 GeV, the structure of the Higgs sector remains unknown. In light of the current situation that a second Higgs boson has not been discovered, indirect searches of such a new particle through observables for Higgs bosons are more and more important. This requires accurate theoretical predictions for such observables in order to compare them with the precision measurements in experiments. In this study, we calculated the full one-loop corrections to the decay widths for various charged Higgs boson decays in the framework of Next-to-Minimal Supersymmetric Model (NMSSM) with CP violation. In this talk, we discuss the impact of the NLO corrections for the branching ratio of each decay mode in a wide range of parameter space that is compatible with the experimental constraints.

T 26.8 Tue 17:45 Ta

A Two-Higgs-Doublet Variant of the Standard*Model*Axion*Seesaw*Higgs-Portal-Inflation Model — •Michael Matlis, Andreas Ringwald, and Gudrid Moortgat-Pick — Deutsches Elektronen-Synchrotron DESY, Theory Group, D-22603 Hamburg, Germany

The Standard Model (SM) suffers from five shortcomings: Dark Matter, Neutrino masses and mixing, Baryon asymmetry, Strong CP-Problem and Inflation. The latter is regarded as the seeds for structure formation. In this contribution, we introduce the 2hdSMASH (Two-Higgs-Doublet SM*Axion*Seesaw*Higgs-Portal-Inflation) model which aims at giving a complete and unified picture of the universe evolution from the inflationary epoch to today. In particular, we focus on parameter constraints for scalar masses and on the inflationary constraint for perturbative unitarity and provide an outlook for further collider phenomenology in 2hdSMASH.

T 26.9 Tue 18:00 Ta

Beyond the Standard Model Higgs bosons in the reach of the LHC — •Thomas Biekoetter[1], Alexander Grohsjean[1], Sven Heinemeyer[2], Victor Lozano[1], Christian Schwanenberger[1], and Georg Weiglein[1] — [1]DESY, Hamburg, Germany — [2]IFT, Madrid, Spain

Many extensions of the Standard Model (SM) contain additional Higgs bosons heavier than the Higgs boson at 125GeV. However, there is also the possibility of beyond the SM (BSM) Higgs bosons with masses below 125 GeV. In both cases there is room left for a discovery during the upcoming (HL)-LHC runs. Moreover, it is an interesting question whether there are hints for such BSM Higgs bosons already in the currently existing data. We interpret different collider excesses below the TeV scale in terms of scalar and pseudoscalar resonances in the N2HDM and the the NMSSM. We demonstrate for both models which of the excesses can be realized simultaneously, while still accommodating a SM-like Higgs boson at 125GeV and being in agreement with the other relevant theoretical and experimental constraints. We finally discuss how the scenarios can be probed in the near future.

T 26.10 Tue 18:15 Ta

Theoretical constraints on multi-Higgs scalar potentials: the case of the 331 model — •Margherita Ghezzi — Institut für Theoretische Physik, Eberhard Karls Universität Tübingen, Tübingen, Deutschland

Extensions of the Standard Model presenting a multi-Higgs potential are subject to a set of theoretical constraints in order to be physically viable. This talk reviews these constraints for the case of a general extension of the Standard Model that encompasses a $SU(3)_c \times SU(3)_L \times U(1)_X$ gauge symmetry. In this respect, the boundedness from below is analysed to identify the correct criteria for obtaining the physical minima of the Higgs parameter space. Furthermore, perturbativity and unitarity bounds are discussed in light of the exact diagonalisation of the scalar fields. Altogether, these constraints provide a restriction of the parameter space to be taken into account prior to any further experimental study.