# T 70: Di-Higgs 2 (4b & other)

Time: Wednesday 16:00–17:45 Location: Geb. 30.41: HS 1

T 70.1 Wed 16:00 Geb. 30.41: HS 1

**Search for non-resonant Higgs Boson Pair Production in the $b\bar{b}b\bar{b}$ Final State using a Neural-Network based Background Estimation with the CMS Experiment** — Martin Erdmann, Peter Fackeldey, •Benjamin Fischer, and Dennis Noll — III. Physikalisches Institut A, RWTH Aachen University

The non-resonant Higgs boson pair production provides direct access to the triple Higgs coupling. With a branching fraction of about 1/3, the four-$b$-quark final state is a significant contributor to the overall sensitivity for a combined measurement.

However, this decay channel is dominated by Multijet-processes which are challenging to model. This is overcome through the use of a data-driven estimation of the entire background.

In this work, the viability of an alternative approach using Neural Network based reweighting is examined in detail using CMS experiment Data of Run II. Additionally, the performance of the signal extraction facilitated by a Neural-Network based multiclass classification is studied.

T 70.2 Wed 16:15 Geb. 30.41: HS 1

**Search for Higgs boson pair production via vector-boson fusion in final states with four b-quarks in the boosted regime using data collected by the ATLAS detector at $\sqrt{s} = 13$ TeV** — •Marcus Vinicius Gonzalez Rodrigues, Katharina Behr, and Kunlin Ran — Deutsches Elektronen-Synchrotron

Searches for Higgs boson pair production provide unique access to the Higgs trilinear coupling, and allow to set constraints on theories that predict Beyond Standard Model resonant production of heavy particles that interact directly with the Higgs boson. Searches targeting Higgs pair production via vector-boson fusion (VBF) additionally allow an examination of the coupling of a Higgs boson pair to a vector boson pair $\kappa_{2V}$ in great detail. The ultimate goal of this analysis is to improve the constraints on $\kappa_{2V}$ and search for heavy particles produced via VBF. For this purpose we consider the VBF di-Higgs pair production with final states containing four bottom quarks in the boosted regime, where a pair of particle showers initiated by bottom quarks from the decay of a high transverse momentum Higgs boson produces one single merged large-radius jet. Event reconstruction in this topology significantly benefits from a dedicated $X \to b\bar{b}$ tagger to identify jets from Higgs boson decays to a pair of b-quarks.

This analysis relies on data collected by the ATLAS detector at $\sqrt{s} = 13$ TeV with an integrated luminosity of 140 fb$^{-1}$. The results shown in this presentation for $\kappa_{2V}$ are the most stringent from the ATLAS collaboration and the resonant search is extended for masses up to 5 TeV for the first time.

T 70.3 Wed 16:30 Geb. 30.41: HS 1

**PAIReD jet: A multi-pronged resonance tagging strategy across all Lorentz boost regimes** — Gaetano Barone[1], Alexander Jung[2], Ming-Yan Lee[2], Spandan Mondal[1], Uttiya Sarkar[2], Alexander Schmidt[2], Jan Schulz[2], and •Ulrich Willemsen[2] — [1]Brown University, Providence, USA — [2]III. Physikalisches Institut A, RWTH Aachen University, Germany

Jet flavor tagging is still a major challenge in the search for the Higgs Boson decay into charm quarks. Although, there are several machine learning approaches for distinguishing between c-, b-, and light-flavor jets, for multi-pronged jets, many of them neglect crucial information on the correlations between the jets that can substantially enhance the reconstruction efficiencies of signal events containing heavy-flavor jets. Therefore, we introduce a new approach of jet-based event reconstruction that aims to optimally exploit correlations between the products of a hadronic multi-pronged decay across all Lorentz boost regimes. The new approach utilizes clustered small-radius jets as seeds to define unconventional jets, referred to as PAIReD jets. This results in light-flavor jet rejections at low Lorentz boosts that exceed conventional strategies, while maintaining similar rejection rates for high Lorentz-boost regimes based on large-radius multipronged jet classifiers.

T 70.4 Wed 16:45 Geb. 30.41: HS 1

**Sensitivity study on the Higgs trilinear coupling with the ssWWhjj signal at ATLAS** — •Lisa Marie Lehmann[1,2], Joany Manjarres[2], Frank Siegert[1], and Maren Bühring[1] — [1]TU Dresden, Institut für Kern- und Teilchenphysik — [2]Université Paul Sabatier Toulouse, Laboratoire des 2 Infinis

The exact value of the Higgs boson's trilinear coupling is of particular interest since it is a central but unknown parameter of the Standard Model (SM) and fundamental to many Beyond SM scenarios. This study probes the sensitivity of Higgs boson production associated with the scattering of same-sign W bosons as a complementary approach to studies of Di-Higgs production to further constrain the value of the trilinear coupling parameter. This project presents the first detector-level study of ssWWhjj in final states with the W bosons decaying leptonically and the Higgs boson decaying into b quarks, using the full simulation of the ATLAS detector corresponding to $\sqrt{s} = 13$ TeV and an integrated luminosity of 140 fb$^{-1}$. This offers valuable insights into the prospects and potential challenges of this channel.

T 70.5 Wed 17:00 Geb. 30.41: HS 1

**Prospects for the search for Higgs boson pair production in the $WW\gamma\gamma$ channel at future hadron colliders** — Johannes Erdmann, Jan Lukas Späh, and •Jialiang Sun — III. Physikalisches Institut A, RWTH Aachen University

Measuring Higgs boson pair production is important because it allows for direct access to the Higgs trilinear coupling. In LHC run 3 and the HL-LHC, the most sensitive final states are $b\bar{b}\gamma\gamma$, $b\bar{b}\tau\tau$, and $b\bar{b}b\bar{b}$, since the decay $H \to b\bar{b}$ has the largest branching fraction. However, for higher center-of-mass energies and integrated luminosities at future hadron colliders, it may be beneficial to explore not only these prominent channels but also consider rarer but cleaner decay channels that comprise leptons, photons, and missing transverse energy.

In this talk, we present a sensitivity study for Higgs boson pair production in the $WW(\to e^{\pm}\mu^{\mp}\nu_e\nu_\mu)\gamma\gamma$ final state, in which both gluon fusion and vector boson fusion production channels are considered. The primary background for this final state arises from the associated Higgs boson production with a top quark pair. We train a classifier to distinguish the signal from the main backgrounds. A preliminary estimate for the expected sensitivity will be given.

T 70.6 Wed 17:15 Geb. 30.41: HS 1

**Study of di-Higgs couplings in the multi-lepton channel with the ATLAS detector** — •Janek Both, Volker Büscher, Christian Schmitt, and Duc Bao Ta — Johannes Gutenberg-University, Mainz

While numerous predictions about the Higgs boson have been tested after its discovery at the LHC, the functional form of the Higgs potential remains largely undetermined. After electroweak symmetry breaking, the Higgs potential gives rise to cubic and quartic terms in the Higgs field, inducing a self-coupling that can be probed experimentally in Higgs pair production. Due to the small cross-section, di-Higgs processes have mainly been studied in decay channels with high branching ratio in the past. However, with increasing data size, multi-lepton channels will become more important, as they are less affected by background processes than the established analyses. In view of small signal rates, refined and sophisticated analysis strategies are required to increase the sensitivity of these channels.
In this talk, an analysis of the $HH \to WWWW \to 3\ell + X$ process with the ATLAS detector is presented. By taking into account the distribution of the invariant di-Higgs mass, the event selection can be optimized depending on the assumption about the trilinear self-coupling and di-Higgs couplings in the Higgs Effective Field Theory. The expected sensitivity to di-Higgs couplings after Run 3 and at the HL-LHC are presented.

T 70.7 Wed 17:30 Geb. 30.41: HS 1

**NLO Yukawa and self-coupling corrections to $gg \to HH$** — Gudrun Heinrich[1], Stephen Jones[2], Matthias Kerner[1], Thomas Stone[2], and •Augustin Vestner[1] — [1]KIT ITP, Karlsruhe, Germany — [2]IPPP, Durham, United Kingdom

Higgs boson pair production is the prime process to constrain the trilinear Higgs boson self-coupling at the LHC, hereby testing whether the Higgs potential is Standard-Model-like. While full NLO QCD corrections to this process are available since some time already, calculations of NLO electroweak corrections have only emerged very recently

and are not yet available in a public Monte Carlo program. Working towards this goal, we present the status of the calculation of the Yukawa-type and Higgs self-coupling corrections to Higgs boson pair production in gluon fusion.