Higgs and Effective Field Theory - HEFT 2025

Report of Contributions

Contribution ID: **1** Type: **not specified**

jelli - a JAX-based EFT likelihood

Monday 2 June 2025 14:20 (15 minutes)

We discuss a novel open-source Python package, jelli: a JAX-based EFT likelihood, which provides an easy-to-use and highly efficient framework particularly suited to global SMEFT/WET analyses and the phenomenology of heavy new physics models. The nature of the tool is generic, allowing a differentiable high-dimensional likelihood to be constructed from any set of observables and measurements provided in a standardised format. Renormalisation group evolution in the SMEFT and WET is automatically taken into account to consistently combine observables defined in different EFTs at various scales. As an example use case, we discuss a major new release of the Python package smelli, which leverages jelli to construct a generic SMEFT likelihood, free of any flavour assumptions, using a diverse set of observables, including quark and lepton flavour physics, Higgs physics, beta decays, electroweak precision observables, and high-mass Drell-Yan tails. New features include the new physics dependence of theory uncertainties, while the optimisations significantly increase the speed of likelihood evaluation, opening the door to highly efficient advanced analyses in high-dimensional EFT or new physics model parameter spaces.

Author: SMOLKOVIC, Aleks (Jozef Stefan Institute)

Presenter: SMOLKOVIC, Aleks (Jozef Stefan Institute)

Session Classification: Global EFT Analyses I

Contribution ID: **3** Type: **not specified**

Towards the HEFT-hedron: the complete set of positivity constraints at NLO

Tuesday 3 June 2025 14:30 (15 minutes)

We present the complete set of positivity bounds on the Higgs Effective Field Theory (HEFT) at next-to-leading order (NLO). We identify the 15 operators that can be constrained by positivity, as they contribute to s^2-growth in the amplitude for longitudinal gauge-Higgs scattering, that is to all possible 2-to-2 scattering processes involving longitudinal gauge bosons, $V_L = W_L^{\pm}, Z_L$, and the Higgs boson, h. We find two sets of constraints: (i) specific linear combinations of CP-even Wilson coefficients (WCs) must be positive, and (ii) the magnitudes of some WCs—including all CP-odd ones—must be smaller than products of other CP-even WCs. We present our final constraints on the 15 dimensional HEFT space and show how known positivity bounds on the 3 dimensional space of dimension 8 SMEFT can be recovered from them. We find that only about 5% of the parameter space for WCs of HEFT operators at NLO complies with these positivity constraints. Additionally, we obtain double-sided bounds on these WCs by fully exploiting the implications of unitarity and st-crossing symmetry. For WCs contributing to the vector boson scattering process our final constraints are in most cases significantly stronger than the experimental ones. For the $V_LV_L, hh \to hh$ and $V_LV_L, hh \to V_Lh$ process, there are no reported experimental limits and our theoretical constraints provide the first bounds.

Authors: CHAKRABORTY, Debsubhra; CHATTOPADHYAY, Susobhan (Tata Institute of Fundamental Research (TIFR), Mumbai); GUPTA, Rick S

Presenter: CHATTOPADHYAY, Susobhan (Tata Institute of Fundamental Research (TIFR), Mumbai)

Session Classification: Geometry / Positivity

Contribution ID: **4** Type: **not specified**

Evanescent schemes and prescriptions

Tuesday 3 June 2025 12:00 (15 minutes)

In Effective Field Theories, evanescent operators are introduced to compensate for the breakdown of four-dimensional Dirac identities (e.g. Fierz Identities) when used in combination with dimensional regularization.

In this talk, we provide an alternative approach where contributions of evanescent operators are viewed as corrections to d=4 Dirac relations. This new perspective not only simplifies computations but provides a clearer understanding of the treatment of these evanescent contributions in the context of NLO change of operator bases. Furthermore, we propose a novel method for treating the effects of evanescent operators, which allows for the elimination of evanescent-to-physical mixing contributions in NLO ADMs computations. (Arxiv: 2208.10513, 2211.01379, 2306.16449 , 2401.16904)

Authors: AEBISCHER, Jason (CERN); PESUT, Marko (University of Zürich); POLONSKY, Zach

Presenter: PESUT, Marko (University of Zürich)

Session Classification: RGEs III

Contribution ID: **7** Type: **not specified**

Connecting Scales: RGE Effects in the SMEFT at the LHC and Future Colliders

Monday 2 June 2025 14:00 (15 minutes)

We assess the impact of Renormalisation Group Equations (RGEs) in global SMEFT fits, incorporating QCD, electroweak, and Yukawa corrections. By assigning characteristic energy scales to LEP and LHC cross-sections, we quantify RGE effects on current and projected fits at the HL-LHC and FCC-ee. Additionally, we evaluate the role of RGEs in the sensitivity of these colliders to UV models matched onto SMEFT at tree and one-loop levels. Our findings highlight the necessity of a consistent energy-scale treatment for precise indirect searches for heavy new physics.

Author: MANTANI, Luca (IFIC, Valencia)

Presenter: MANTANI, Luca (IFIC, Valencia)

Session Classification: Global EFT Analyses I

Contribution ID: **8** Type: **not specified**

New Physics contamination to precision luminosity measurements

Thursday 5 June 2025 17:00 (15 minutes)

The absolute machine luminosity is a crucial parameter for high-precision measurements at future colliders. Its determination relies on the precise prediction of the cross section of some reference process, which is calculated within the Standard Model (SM). It is therefore crucial to have under control the uncertainties induced by possible New Physics (NP) effects on this reference process. We here investigate the possible NP contamination on small-angle Bhabha scattering at future electron-positron machines, by considering that NP contributions can arise due to either heavy degrees of freedom or light mediators with small couplings to SM particles.
In the first scenario, we parametrise the effects in a model-independent way through the Standard Model Effective Field Theory (SMEFT), while in the second case we consider different models. We show how four-electron SMEFT operators affect the Bhabha cross section in a non-negligible way and discuss possible strategies to reduce this contamination.

Author: DEL PIO, Clara Lavinia (Brookhaven National Lab)

Co-authors: UCCI, Francesco Pio (INFN Pavia); PICCININI, Fulvio (Pavia University and INFN (IT)); MONTAGNA, Guido (University of Pavia e INFN, Pavia (IT)); CHIESA, Mauro; NICROSINI, Oreste (Dipartimento di Fisica Nucleare e Teorica)

Presenter: DEL PIO, Clara Lavinia (Brookhaven National Lab)

Session Classification: Future Colliders

Contribution ID: **9** Type: **not specified**

Effective Field Theory fits of the electroweak sector CMS data

Tuesday 3 June 2025 17:10 (15 minutes)

The contribution will report on recent results on global EFT fits of the CMS data, with particular focus on a dimension-6 SMEFT interpretation of the measurements performed in the electroweak sector of the Standard Model, including results built upon likelihoods constructed from reconstructed-level information and properly including all correlations among the various input channels.

Author: LAVIZZARI, Giulia ((INFN Milano-Bicocca))

Presenter: LAVIZZARI, Giulia ((INFN Milano-Bicocca))

Session Classification: Higgs and Electroweak I

Contribution ID: **10** Type: **not specified**

Renormalization of the SMEFT to dimension eight: Fermionic interactions I

Monday 2 June 2025 09:55 (15 minutes)

This is the third of a series of works aimed at renormalizing the Standard Model effective field theory at one loop and to order $1/\Lambda^4$, with Λ being the new physics cut-off. In this occasion, we concentrate on the running of two-fermion operators induced by pairs of dimension-six interactions. We work mostly off-shell, for which we obtain and provide a new and explicitly Hermitian basis of dimension-eight Green's functions. All our results can be accessed in SMEFT Dimension-8 RGEs.

Authors: VILCHES BRAVO, FUENSANTA (Universidad de Granada); CHALA, Mikael (Universidad de Granada); Dr DAS BAKSHI, SUPRATIM (Granada University); REN, Zhe (The high-energy physics group (FTAE) of the University of Granada); Mr DÍAZ CARMONA, ÁLVARO

Presenter: VILCHES BRAVO, FUENSANTA (Universidad de Granada)

Session Classification: RGEs I

Contribution ID: **11** Type: **not specified**

t'Hooft-Veltman Scheme in the Functional Approach

Tuesday 3 June 2025 12:20 (15 minutes)

The ‘t Hooft-Veltman scheme is the only consistent prescription for handling γ5γ5 at all orders in the perturbative expansion, which is crucial for multi-loop computations. However, its application within EFT frameworks has been limited due to technical challenges.

In this talk, we will explore a practical approach to implementing this regularization scheme using functional methods. This will enable automation, making its use more feasible in the context of future EFTs computations.

Author: Mr MORENO SÁNCHEZ, ADRIÁN (Universidad de Granada)

Presenter: Mr MORENO SÁNCHEZ, ADRIÁN (Universidad de Granada)

Session Classification: RGEs III

Contribution ID: **12** Type: **not specified**

Chiral Anomaly Cancellation and Neutral Triple Gauge Boson Vertices in the SM EFT

Wednesday 4 June 2025 11:30 (15 minutes)

We demonstrate diagrammatically the cancellation of chiral anomalies in the Standard Model Effective Field Theory (SM EFT), achieved through by a consistent choice of loop momentum routing in triangle diagrams with dimension-6 operator insertions. By enforcing gauge invariance and Bose symmetry, we show that Goldstone boson contributions cancel anomalies arising from massive gauge boson vertices, preserving the consistency of the SM EFT. We compute neutral triple gauge boson vertices at one loop, revealing dominant contributions from dimension-6 operators at all energies below the EFT cutoff. A UV-complete anomaly-free model with a heavy vector-like electron validates our approach, illustrating how heavy fermion decoupling generates SM EFT operators while maintaining anomaly cancellation. Our results highlight the phenomenological relevance of these vertices for probing new physics at colliders, particularly through dimension-6 effects that scale as the inverse of the centre of mass energy squared, $1/s$, offering a viable pathway for experimental detection.

Author: DEDES, Athanasios

Presenter: DEDES, Athanasios

Session Classification: Higgs and Electroweak II

Contribution ID: **13** Type: **not specified**

Exploring the EFT Alps: HEFT, SMEFT, and ALPs in Multi-Boson Production

Thursday 5 June 2025 11:30 (15 minutes)

Recently, the ATLAS and CMS experiments have been accumulating increasing statistics on the production of two electroweak (EW) bosons or more, such as HH and WWZ. These multi-boson final states are essential for probing the nature of the EW symmetry-breaking sector and its potential extensions within the framework of Effective Field Theories (EFTs), both in the linear realization (SMEFT) and the non-linear realization (HEFT). It is well established that SMEFT is a subset of HEFT, with the former imposing correlations among Wilson coefficients that can be tested through the study of multi-boson signatures.

Moreover, if the Standard Model (SM) is embedded in a larger symmetry group that undergoes spontaneous breaking, the resulting (pseudo)-Goldstone bosons may leave detectable imprints on SM observables. These effects can be systematically analyzed within the ALP EFT framework, considering both linear and non-linear EW symmetry-breaking scenarios.

In this talk, I will present comprehensive results on multi-boson production within both SMEFT and HEFT, along with the constraints that can be extracted from experimental data. Additionally, I will discuss a global fit of ALP parameters in the linear case using ATLAS and CMS multi-boson measurements and discuss the non-linear case.

Author: Dr SALAS-BERNÁRDEZ, Alexandre (Universidad Complutense de Madrid)

Presenter: Dr SALAS-BERNÁRDEZ, Alexandre (Universidad Complutense de Madrid)

Session Classification: Extended Scalars

Contribution ID: **14** Type: **not specified**

Electroweak corrections in the SMEFT: four-fermion operators at high energies

Wednesday 4 June 2025 12:10 (15 minutes)

In the Standard Model (SM), electroweak (EW) corrections become significant at high energies, particularly at the tera-electronvolt scale and beyond, due to the presence of Sudakov logarithms. At these energy scales, the Standard Model Effective Field Theory (SMEFT) framework provides an enhanced sensitivity to potential new physics effects. This motivates the inclusion of EW corrections not only for SM predictions but also for analyses within SMEFT.
In this work, we compute EW corrections in the high-energy limit for a selected set of dimension-six operators, specifically the class of four-fermion contact interactions, in key hard-scattering processes relevant to both current and future colliders: top-quark pair production at the Large Hadron Collider (LHC) and in a muon collider scenario, as well as the Drell-Yan process at the LHC. We first discuss the technical details and challenges associated with evaluating EW Sudakov logarithms in SMEFT, contrasting them with the SM case. We then present phenomenological results for the aforementioned processes, highlighting the non-trivial effects introduced by EW corrections arising from the insertion of dimension-six, four-fermion operators. Importantly, the resulting k-factors exhibit significant deviations from their SM counterparts, with dependencies not only on the process but also on the specific operators considered.
Finally, we explore the potential to lift flat directions in the SMEFT parameter space by incorporating higher-order corrections, using Fisher information techniques.

Authors: PAGANI, Davide (INFN, Bologna (IT)); VRYONIDOU, Eleni (The University of Manchester (GB)); EL FAHAM, Hesham (The University of Manchester); MIMASU, Ken; ZARO, Marco (Università degli Studi e INFN Milano (IT))

Presenter: MIMASU, Ken

Session Classification: Higgs and Electroweak II

Contribution ID: **15** Type: **not specified**

Higher-order-operator corrections to phase transitions in dimensionally reduced EFTs

Thursday 5 June 2025 09:30 (15 minutes)

The potential observation of a gravitational wave background compatible with a first-order phase transition (FOPT) would be a striking signature of BSM physics. In order to be able to reconstruct the underlying fundamental model, however, it is crucial to increase the precision of theoretical predictions from the thermal QFT side.

The usual approach to the computation of FOPT parameters is through matching to a dimensionally reduced effective field theory (3D EFT), where the effect of the temperature only enters the Wilson coefficients. The construction of 3D EFTs has been taken to umprecedented levels of precision in the recent years, considering effects up to 3-loop order both in matching and renormalization group running of the renormalizable operators. However, as far as the authors know, the effect of higher-dimensional effective operators (EO) that arise at the same order in the power counting have been generally neglected in the literature.

In this talk, we will make a comparative analysis of the contribution of higher-order EO in a full 3-loop order FOPT computation. For concreteness, we shall inspect a model resembling the Higgs sector of the SMEFT up to dimension 6 in the strong transition regime, which has the most interest for its potential for detection, and where EO are expected to be non-negligible. Finally, we will also highlight the challenges to overcome in order to extend these computations to more complex models.

Authors: GIL, Luis (Universidad de Granada); CHALA, Mikael (Universidad de Granada); REN, Zhe (The high-energy physics group (FTAE) of the University of Granada)

Presenter: GIL, Luis (Universidad de Granada)

Session Classification: Cosmology

Contribution ID: **16** Type: **not specified**

Constraints on four-light quark operators in the SMEFT

Wednesday 4 June 2025 16:40 (15 minutes)

Among the dimension-six operators in the Standard Model Effective Field Theory (SMEFT), the four-light quark (4LQ) ones introduce four-fermion contact interactions that are not present in the Standard Model (SM), featuring the (anti-) quarks that are lighter than the top one. At Leading Order (LO), they do not contribute to the main Higgs and top processes, so they are almost never included in global fits. They can, though, induce corrections to virtually any process at Next-to-Leading Order (NLO), if two of the fermionic lines in the diagrams they introduce are closed into a loop. In our study, we aim to get better constraints on them by checking their contributions to dijet production and Vector Boson Fusion (VBF) processes where a photon, a Z or a W boson are generated together with jets. We include the interference with the SM for ten operators in this study, with different colour and helicity structures: $O_{qq}^{(1)}$, $O_{qq}^{(3)}$, O_{uu}, O_{dd}, $O_{ud}^{(1)}$, $O_{ud}^{(8)}$, $O_{qu}^{(1)}$, $O_{qu}^{(8)}$, $O_{qd}^{(1)}$, $O_{qd}^{(8)}$. For each process and phase space region, we investigate which directions in the coefficient space can be constrained through the comparison with experimental data, and which flat ones can be lifted with the inclusion of higher-order corrections. The most recent developments in b- and c-jet tagging are also exploited to boost the sensitivity to some subprocesses. This work is still in progress and yet to be published.

Authors: DEGRANDE, Celine Catherine A; MALTONI, Matteo

Presenter: MALTONI, Matteo

Session Classification: Top / Quarks

Contribution ID: **18** Type: **not specified**

Automating the computation of (generalized) functional supertraces beyond one loop

Monday 2 June 2025 11:50 (15 minutes)

There is growing interest in using functional methods for multi-loop calculations, such as effective field theory matching and the calculation of renormalization group equations. Beyond one loop, instead of evaluating functional traces, one must perform tensor contractions associated with certain graphs. In this talk I will discuss my ongoing work on FunGraphs, a package that aims to automate these computations.

Author: FONSECA, Renato (University of Granada)

Presenter: FONSECA, Renato (University of Granada)

Session Classification: RGEs II

Contribution ID: **19** Type: **not specified**

ABC4EFT: Amplitude Basis Construction and Automated Basis Conversion for Effective Field Theories

Friday 6 June 2025 09:20 (15 minutes)

ABC4EFT is a mathematica package aiming to achieve the construction and conversion of operator bases in general effective field theories. The initial release of the package integrated the automatic construction of the physical bases in general Lorentz invariant effective field theories, and now we are going to make a major update to the package to integrate the conversion among different physical bases at a certain mass dimension and the construction of the Green's basis. In this talk, I will briefly introduce the method we use in the package and show how to use the package with concrete examples.

Author: REN, Zhe (The high-energy physics group (FTAE) of the University of Granada)

Co-authors: Dr LI, Haolin (CP3/UCLouvain); Prof. YU, Jianghao; Prof. XIAO, Minglei; LI, Xuxiang (University of Utah)

Presenter: REN, Zhe (The high-energy physics group (FTAE) of the University of Granada)

Session Classification: Tools / Amplitudes

Contribution ID: **20** Type: **not specified**

Two-loop running in the SMEFT

Monday 2 June 2025 11:30 (15 minutes)

The Standard Model Effective Field Theory (SMEFT) provides a powerful framework for parameterizing potential new physics in a model-independent way. In order to analyze data from experiments across different energy scales and extrapolate UV physics effects, it is crucial to know the renormalization group evolution (RGE) of SMEFT operators. In this talk, I will present the results for the two-loop running of the purely bosonic dimension six operators in the SEMFT as well as our recent progress toward the RGE of the full dimension six SMEFT at two-loop order. I will elaborate on the functional methods that we use to perform these calculations, our custom code built on top of the Mathematica package Matchete and the various challenges we encountered in this project.

Author: BORN, Lukas

Co-authors: KVEDARAITE, Sandra (University of Granada); FUENTES-MARTIN, Javier (Universidad de Granada); Dr THOMSEN, Anders Eller (University of Bern)

Presenter: BORN, Lukas

Session Classification: RGEs II

Contribution ID: **21** Type: **not specified**

Higher-dimensional operators at finite-temperature affect gravitational-wave predictions

Thursday 5 June 2025 09:50 (15 minutes)

We investigate the effect of higher-dimensional marginal operators on the thermodynamics of cosmological phase transitions. Focusing on the Abelian Higgs model, we systematically match these operators, which arise at higher orders in the underlying high-temperature expansion of thermal effective field theory, and use field redefinitions to construct a complete, minimal, and gauge-invariant operator basis. We argue that for strong transitions, temporal gauge modes, which enhance the transition strength, should be treated on equal footing with spatial gauge modes in perturbation theory. Marginal operators are found to weaken the transition strength and induce significant uncertainties for strong transitions. For even stronger transitions that could potentially produce a gravitational wave background detectable by LISA, the validity of the high temperature expansion is uncertain, which may impact the applicability of effective theory techniques, including their use in non-perturbative lattice studies.

Authors: BERNARDO, Fabio; KLOSE, Philipp; SCHICHO, Philipp (University of Geneva); TENKANEN, Tuomas V. I.

Presenter: SCHICHO, Philipp (University of Geneva)

Session Classification: Cosmology

Contribution ID: **22** Type: **not specified**

Faking neutral triple gauge vertices with vector-like quarks

Thursday 5 June 2025 14:40 (15 minutes)

Neutral triple gauge couplings (NTGCs) provide important tests of the gauge sector of the SM and are searched for at the LHC via the process $pp \to ZZ \to 4l$ with two on-shell Z bosons.
In the SMEFT, NTGCs are produced at dimension-8 and at 1-loop order, making them doubly suppressed.
A promising alternative interpretation to NTGC searches are SM extensions with vector-like quarks (VLQs), which produce ZZ final states at tree-level.
I will discuss example models with VLQs and explain constraints on the model parameters from low-energy measurements.
Then, I will present the current and future sensitivities of the parameters from $pp \to ZZ \to 4l$ searches.

Authors: ESSER, Fabian; HIRSCH, Martin; Dr CEPEDELLO, Ricardo (Universidad de Granada); Prof. SANZ GONZALEZ, Veronica (Universities of Valencia and Sussex)

Presenter: ESSER, Fabian

Session Classification: Higgs and Electroweak III

Contribution ID: **23** Type: **not specified**

Dimension-eight operator basis for Universal Standard Model Effective Field Theory

Tuesday 3 June 2025 16:30 (15 minutes)

I will present the basis of dimension-eight operators associated with universal theories. Without imposing C nor P the universality assumption reduces the number of independent SMEFT operators at dimension eight from 44807 to 175. 89 of the 175 universal operators are included in the general dimension-eight operator basis in the literature. The 86 additional operators involve higher derivatives of the SM bosonic fields and can be rotated in favor of operators involving fermions using the SM equations of motion for the bosonic fields. I will then describe how one would incorporate the finite renormalization effects introduced to the input parameters from these operators and compute amplitudes consistently to $O(1/\Lambda^4)$. I will finalize by showing how some simple UV models match onto the universal operators.

Authors: DESAI, Jay (Stony Brook University); Prof. GONZALEZ-GARCIA, Maria Concepcion (YITP, Stony Brook and ICREA, U. Barcelona); EBOLI, Oscar; CORBETT, Tyler (University of Vienna)

Presenter: DESAI, Jay (Stony Brook University)

Session Classification: Higgs and Electroweak I

Contribution ID: **24** Type: **not specified**

Drell-Yan and Electroweak Precision Observables Analysis in the Universal SMEFT

Tuesday 3 June 2025 16:50 (15 minutes)

Under the assumption that new physics lies beyond the current energy reach of the LHC, deviations from Standard Model predictions are expected to appear in the tails of kinematic distributions. In particular, neutral- and charged-current Drell-Yan (DY) processes are useful to study such effects, given the large amount of data collected during Run 1 and Run 2 of the LHC. However, a fully model-independent analysis using the Standard Model Effective Field Theory (SMEFT) is impractical due to the large number of parameters. This challenge can be addressed by assuming universal new physics, which reduces the number of independent Wilson coefficients at dimension-six and dimension-eight compared to the general case. In this talk, I will present an analysis of DY and Electroweak Precision Observables (EWPO) data within the Universal SMEFT framework, incorporating both dimension-six and dimension-eight effects. Additionally, I will discuss the interpretation of the results in terms of the generalized oblique parameters, as well as the complementarity between DY data and EWPO.

Author: MARTINES, Matheus

Presenter: MARTINES, Matheus

Session Classification: Higgs and Electroweak I

Contribution ID: **25** Type: **not specified**

Tailored PDFs for new physics searches

Wednesday 4 June 2025 10:10 (15 minutes)

Given the known non-negligible interplay between large-x PDFs and new physics signals, what PDFs are suitable for new physics searches?
In this talk I discuss the fine balance between the benefit of constraining PDFs with high-energy observables to reduce their uncertainties in the large-x region that is relevant for new physics searches and the risk of fitting away potential signs of new physics within the PDF parametrisation by doing so. I explore two solutions: fitting simultaneously the PDFs and the SMEFT and fitting them separately in a "conservative way", meaning by only adding to the PDF-fit dataset observables which can be safely considered SM-like. I compare the performances of the two strategies in a closure test for the Drell-Yan and top sectors and conclude by identifying a general set of good practices and recommendations.
I also discuss preliminary results yielded by this approach in the analysis of a real-data discrepancy in the jet sector.

Authors: HAMMOU, Elie (University of Cambridge, DAMTP); COLE, Ella (University of Cambridge, DAMTP); MERLOTTI, Francesco (ETHZ); MOORE, James Michael; MANTANI, Luca (IFIC, Valencia); MORALES ALVARADO, Manuel; UBIALI, Maria (University of Cambridge (GB)); COSTANTINI, Mark

Presenter: HAMMOU, Elie (University of Cambridge, DAMTP)

Session Classification: Flavour Symmetries / Neutrinos

Contribution ID: **26** Type: **not specified**

Anomalous Dimension of a General Effective Gauge Theory: Bosonic Sector at One Loop

Monday 2 June 2025 09:35 (15 minutes)

I will present the classification of physical operators in the most general bosonic effective gauge theory up to dimension six. Building on this classification, I will discuss the complete one-loop anomalous dimension, computed using both unitarity-based on-shell techniques and geometric methods. This analysis fully accounts for operator mixing across different dimensions and applies broadly to any effective field theory with arbitrary gauge symmetry and bosonic degrees of freedom. To illustrate the utility of these results, I will also present new findings on axion-like particles with CP-violating interactions.

Author: SELIMOVIĆ, Nudžeim (INFN Padova)

Co-authors: AEBISCHER, Jason (CERN); Mr BRESCIANI, Luigi Carlo (Università di Padova and INFN, Sezione di Padova)

Presenter: SELIMOVIĆ, Nudžeim (INFN Padova)

Session Classification: RGEs I

Contribution ID: **27** Type: **not specified**

The equivalent Electric Dipole Moment in SMEFT

Monday 2 June 2025 17:10 (15 minutes)

The Electric Dipole Moment of the electron (eEDM) is typically investigated in experiments using paramagnetic molecules. However, the physical observable in these searches consists in a linear combination of CP-violating interactions, rather than the eEDM alone, which is commonly referred to as the equivalent EDM of the system. Assuming the presence of new CP-odd physics from heavy degrees of freedom, we parameterize its effects within the Standard Model Effective Field Theory (SMEFT) framework. We systematically compute the contributions to the full low-energy direction probed by EDM searches, focusing on leading-order effects at dimension six and one-loop level, while also discussing selected two-loop and dimension-eight contributions. We find that eEDM experiments are sensitive to a broader class of SMEFT operators than previously recognized.

Authors: Dr ARDU, Marco (IFIC (University of Valencia - CSIC)); VALORI -, Nicola (University of Valencia & IFIC)

Presenter: VALORI -, Nicola (University of Valencia & IFIC)

Session Classification: Global EFT Analyses II

Contribution ID: **28** Type: **not specified**

Two-loop renormalisation of quark and gluon fields in the SMEFT

Monday 2 June 2025 12:10 (15 minutes)

We compute the contributions of CP-conserving operators in the dimension-six SMEFT to the two-loop renormalisation constants of quark and gluon fields. We work with the background-field method, which allows us to extract the contribution of these operators to the two-loop running of the top mass and the strong coupling constant. We discuss the mixing with the unphysical operators required for the renormalisation, and we present analytic results for the renormalisation constants of all relevant operators.

Author: VENTURA, Giuseppe

Co-authors: VÁSQUEZ, Andrés (University of Bonn); DUHR, Claude (CERN); VRYONIDOU, Eleni (The University of Manchester (GB))

Presenter: VENTURA, Giuseppe

Session Classification: RGEs II

Contribution ID: **29** Type: **not specified**

SMEFT Global Analyses at the Energy Frontier: LHC and Beyond

Monday 2 June 2025 16:30 (15 minutes)

Global analyses in the SMEFT framework provide a powerful tool to explore new physics. Combining diverse observables is essential to resolve degeneracies among Wilson coefficients, especially since measurements occur at different energy scales, accounting properly for renormalisation group evolution (RGE) is crucial. In this talk, I examine the impact of RGE on a global analysis under flavour symmetry assumptions using current data. I also explore its implications in lepton flavour violation (LFV) studies, highlighting how future experiments and high-energy colliders can enhance constraints—particularly through the "Higgsification" of cross-sections.

Author: BARTOCCI, Riccardo

Presenter: BARTOCCI, Riccardo

Session Classification: Global EFT Analyses II

Contribution ID: **30** Type: **not specified**

New methods to probe Standard Model Extensions via Proton Decay and Neutrino Masses

Wednesday 4 June 2025 09:30 (15 minutes)

Baryon and lepton number are excellent low-energy symmetries of the Standard Model (SM) that tightly constrain the form of its extensions. In this paper we investigate the possibility that these accidental symmetries are violated in the deep UV, in such a way that one multiplet necessary for their violation lives at an intermediate energy scale M above the electroweak scale. We write down the simplest effective operators containing each multiplet that may couple linearly to the SM at the renormalisable level and estimate the dominant contribution of the underlying UV model to the pertinent operators in the SMEFT: the dimension-5 Weinberg operator and the baryon-number-violating operators up to dimension 7. Our results are upper bounds on the scale M for each multiplet–operator pair, derived from neutrino-oscillation data as well as prospective nucleon-decay searches. We also analyse the possibility that both processes are simultaneously explained within a natural UV model. In addition, we advocate that our framework provides a convenient and digestible way of organising the space of UV models that violate these symmetries.

Authors: Mr BAS I BENEITO, Arnau (Institut de Física Corpuscular (IFIC) & Universitat de València (UV)); Dr GARGALIONIS, John (University of Adelaide); HERRERO GARCIA, Juan (IFIC, UV/CSIC); SCHMIDT, Michael (UNSW Sydney)

Presenter: Mr BAS I BENEITO, Arnau (Institut de Física Corpuscular (IFIC) & Universitat de València (UV))

Session Classification: Flavour Symmetries / Neutrinos

Contribution ID: **31** Type: **not specified**

Dispersive matching

Tuesday 3 June 2025 09:30 (15 minutes)

The matching of UV models on their low-energy EFT can be obtained from a dispersion relation, analogous to the one leading to positivity constraints but generalised beyond four-point amplitudes. Introduced in 2308.00035, this method is distinct from those based on the (functional) effective action and on (off- or on-shell) amplitudes. It takes cut amplitudes as input. In particular, one-loop matching essentially requires only tree-level inputs. All EFT orders can be obtained at once, from an integral along the cut which may however be difficult to perform. This extracts the hard region of the un-cut loop, so that no EFT contribution has to be calculated and subtracted. On-shell tree-level EFT amplitudes are obtained which fully characterise the low-energy theory. Some computations are facilitated and new insight is gained.

Author: DURIEUX, Gauthier (CP3 - UCLouvain)

Presenter: DURIEUX, Gauthier (CP3 - UCLouvain)

Session Classification: Geometry / Matching

Contribution ID: **32** Type: **not specified**

Scalar EFT Amplitudes using Fibre Bundles

Tuesday 3 June 2025 15:10 (15 minutes)

Scalar Lagrangians can be expressed as metrics on fibre (or jet) bundles, which in turn allows for the expression of individual vertices and diagrams in terms of geometric objects. In this talk we show how this leads to explicit covariance of on-shell amplitudes under permitted field redefinitions, as well as outlining the methods for the computation of the amplitudes.

Authors: BRIVIO, Ilaria (University & INFN Bologna); DAVIGHI, Joseph Enea; ALMINAWI, Mohammad (University of Zurich (CH))

Presenter: ALMINAWI, Mohammad (University of Zurich (CH))

Session Classification: Geometry / Positivity

Contribution ID: **33** Type: **not specified**

Bootstrapping the Chiral-Gravitational Anomaly

Friday 6 June 2025 10:00 (15 minutes)

We analyze causality and unitarity constraints
in graviton scattering amplitudes, aiming to establish new bounds on theories with $U(1)$-gravitational anomalies, such as axion models
or strongly-coupled gauge theories. For this purpose, we show the necessity of coupling these theories to gravity. We obtain a universal scale $\Lambda_{\rm caus}$ at which states with $J \geq 4$ must appear in the theory. We show that this scale can lie below the quantum gravity scale. For axion models, we get $\Lambda_{\rm caus} \sim \sqrt{M_P f_a}$ where f_a is the axion decay constant.
In strongly-coupled gauge theories in the large-N_c limit,
the presence of glueballs allows to evade these bounds, provided the number of fermions $N_F \ll N_c$ and the 'tHooft coupling is not large.
Nevertheless, for models that have a holographic 5D dual (large 'tHooft coupling), $\Lambda_{\rm caus}$ emerges as a new cutoff scale, unless certain conditions on the parameters of the 5D models are satisfied.

Authors: Prof. POMAROL, Alex (IFAE and BIST, Universitat Autonoma de Barcelona); Prof. MA, Teng (ICTP-AP, University of Chinese Academy of Sciences)

Presenter: Prof. MA, Teng (ICTP-AP, University of Chinese Academy of Sciences)

Session Classification: Tools / Amplitudes

Contribution ID: **34** Type: **not specified**

Matching On Shell-Calculator

Tuesday 3 June 2025 09:50 (15 minutes)

The calculation of the Wilson coefficients of an effective field theory (EFT) for specific new physics models is usually performed by matching off-shell one-light-particle irreducible Green functions, which requires an off-shell basis of effective operators. We introduce "mosca", a Mathematica package designed to perform the much less standarized macthing on-shell. This matching procedure allows to work directly on the physical basis, but requires a delicate cancellation between non-local contributions in both theories that we sidestep by evaluating the amplitudes with randomly generated physical momenta.

In its first approach, "mosca" is focused on the simplification of the reduction of Green's bases to physical bases in EFTs, as well as transformations between arbitrary bases. This package allows users to systematically convert any Lagrangian expressed in a Green's basis into a chosen physical basis by specifying the models for both representations. Thus, "mosca" provides a robust and efficient framework for basis transformations, streamlining calculations in effective field theory research. This initial version lays the foundation for future enhancements, including implementing renormalization of effective Lagrangians directly in terms of a physical basis and computing finite matching, including evanescent contributions.

Authors: VILCHES BRAVO, FUENSANTA (Universidad de Granada); LÓPEZ MIRAS, JAVIER

Presenter: LÓPEZ MIRAS, JAVIER

Session Classification: Geometry / Matching

Contribution ID: **35** Type: **not specified**

The Implications of a Large Electron Yukawa Modification

Thursday 5 June 2025 16:20 (15 minutes)

The electron Yukawa coupling is among the smallest parameters in the Standard Model, making it highly sensitive to even the most modest new physics effects. A dedicated Higgs pole run at FCC-ee offers a potential avenue to directly measure this coupling, though with considerable experimental challenges. In this talk, I will explore the indirect phenomenological implications of modified lepton Yukawa couplings both from an EFT perspective and in terms of simplified UV models. I will map out which extensions of the Standard Model, along with their flavour structures, can enhance these couplings at tree or loop level without violating current constraints, and how to narrow in on flavoured operators and models with correlated future measurements.

Authors: SMITH, Benjamin; ROCHA, Duncan Javier (Duke University (US)); ALLWICHER, Lukas; MCCULLOUGH, Matthew Philip (CERN); RENNER, Sophie Alice (University of Glasgow (GB))

Presenter: SMITH, Benjamin

Session Classification: Future Colliders

Contribution ID: **38** Type: **not specified**

Triple Higgs boson production in EFTs from on-shell amplitude techniques

Friday 6 June 2025 09:40 (15 minutes)

With the measurement of double Higgs production within reach, it is justified to expand our interest to more exotic processes, such as three Higgs boson production. This rare process is crucial for advancing our understanding of the Higgs boson, its interactions (including self-coupling), the Higgs potential, and the mechanism of electroweak symmetry breaking (EWSB). This talk explores the application of on-shell amplitude techniques to study triple Higgs production via gluon fusion and vector boson fusion in EFTs. We construct the relevant kinematic structures, match our results to both HEFT and SMEFT, and analyze the implications. The comparison provides valuable insights into Higgs dynamics and the interplay between EFT frameworks. The talk based on ongoing work.

Authors: ROSSIA, Alejo Nahuel (University of Padua and INFN Sezione di Padova); RYCZKOWSKI, Michal (Università di Padova and INFN, Sezione di Padova); GROEBER, Ramona (Università di Padova and INFN, Sezione di Padova)

Presenter: RYCZKOWSKI, Michal (Università di Padova and INFN, Sezione di Padova)

Session Classification: Tools / Amplitudes

Contribution ID: **39** Type: **not specified**

Scalars with non-decoupling phenomenology at future colliders

Thursday 5 June 2025 16:40 (15 minutes)

The nature of electroweak symmetry breaking remains one of the last theoretical unknowns of the Standard Model. New physics which significantly alters EWSB from the SM prediction must be non-decoupling and does not admit a SMEFT expansion. In arXiv:2409.18177, we extend the SM with a spanning set of scalar electroweak multiplets that gain the majority of their mass via the Higgs mechanism. These particles by definition are non-decoupling, many of them are not excluded by current data and they generate a pattern of deviations in low energy observables distinct from SMEFT (although they may be accommodated in HEFT). We show that any such scalar is discoverable at a future precision lepton collider and may leave imprints of a first order phase transition which are detectable by future gravitational-wave experiments such as LISA. This is a test of the assumption of decoupling NP that is built into the SMEFT.

Authors: SUTHERLAND, David; CRAWFORD, Graeme

Presenter: CRAWFORD, Graeme

Session Classification: Future Colliders

Contribution ID: **40** Type: **not specified**

The Higgs trilinear self-coupling at HL-LHC and FCC-ee from a global SMEFT point of view.

Monday 2 June 2025 16:50 (15 minutes)

Motivated by the updates of the ATLAS and CMS projections of Higgs pair production at the HL-LHC and the release of the Feasibility Study of the FCC-ee, we revisit the sensitivity of the global SMEFT analysis to deformations of the Higgs trilinear self-coupling λ_3.
We critically reassess the additional information that would be provided by the FCC-ee through NLO corrections to Zh production.
To achieve this goal, we determine the correlation pattern between SMEFT operators modifying single and double Higgs production, quantify the impact of quadratic EFT corrections, and include Renormalisation Group Evolution (RGE) in all processes considered.
We use the SMEFiT framework in full power. Our analysis finds that, in light of the new projections for Higgs pair production,
single-operator and global marginalised determinations of λ_3 are very similar at LHC and HL-LHC, while there is a clear difference at FCC-ee.
We also study the implications of the improved λ_3 determination for benchmark UV-complete models matched to the SMEFT, specifically for the custodial electroweak quadruplets model.
Additionally, we review the impact of FCC-ee in several UV-complete models matched onto SMEFT.
Based mostly on upcoming work.

Authors: ROSSIA, Alejo Nahuel (University of Padua and INFN Sezione di Padova); VRYONIDOU, Eleni (The University of Manchester (GB)); TER HOEVE, Jaco (The University of Edinburgh); ROJO CHACON, Juan (Nikhef National institute for subatomic physics (NL)); MANTANI, Luca (IFIC, Valencia)

Presenter: ROSSIA, Alejo Nahuel (University of Padua and INFN Sezione di Padova)

Session Classification: Global EFT Analyses II

Contribution ID: **41** Type: **not specified**

Counting and building operators in theories with hidden symmetries and application to HEFT

Friday 6 June 2025 11:30 (15 minutes)

Identifying a full basis of operators to a given order is key to the generality of Effective Field Theory (EFT) and is by now a problem of known solution in terms of the Hilbert series. In this talk my primary concerned would be the hidden symmetry in general and Higgs EFT in particular. I will try to make connection between some recent counting formulae in the CCWZ formualtion with the linear frame and make this connection explicit in HEFT. Also, present a new counting formula within the full SM gauge group for HEFT.

Author: Mr RAHAMAN, shakeel ur

Presenter: Mr RAHAMAN, shakeel ur

Session Classification: Symmetries / Amplitudes

Contribution ID: **42** Type: **not specified**

Dimension-8 operators in W+ W- Production at NLL

Wednesday 4 June 2025 11:50 (15 minutes)

The discovery potential of the Standard Model Effective Field Theory (SMEFT) can be enhanced by including dimension-8 operators and their impact on di-boson production at the Large Hadron Collider (LHC), particularly in the high energy tails of the distributions. Although W^+W^- production has a large leptonic cross section, it is subject to a tight jet-veto to suppress the otherwise overwhelming $t\bar{t}$ background. Therefore in this channel, both the background and operator mediated signal require at least a parton-shower or better full resummation of large logarithms. I present results from gluon fusion, photon fusion, and quark-antiquark annihilation and demonstrate the large size of these effects by presenting current constraints and sensitivity projections for the High Luminosity LHC, both with and without a jet-veto. Furthermore, I will present how the choice of the observable and theoretical uncertainty estimation play a role in the overall constraints from the tails of this channel.

Author: GILLIES, Daniel

Co-authors: MARTIN, Adam (Fermilab); BANFI, Andrea (University of Sussex); LIM, Matthew (University of Sussex)

Presenter: GILLIES, Daniel

Session Classification: Higgs and Electroweak II

Contribution ID: **43** Type: **not specified**

Double ALP production at the LHC

Thursday 5 June 2025 11:50 (15 minutes)

Axion-like particles (ALPs) are hypothetical pseudoscalar states that emerge as pseudo-Nambu-Goldstone bosons from the breaking of an approximate global $U(1)$ symmetry. They appear in several extensions of the Standard Model, offering potential solutions to the strong CP problem, the muon $(g-2)$ anomaly, neutrino mass generation, and dark matter. While most collider-based studies focus on the production of a single ALP, in this work I investigate scenarios involving the production of an ALP pair. These processes offer the opportunity to probe dimension-6 operators, which include either Higgs-portal interactions (if the ALPs are produced via exotic Higgs decays such as $h \to aa$) or shift-symmetry breaking couplings, like $a^2\, G_{\mu\nu} G^{\mu\nu}$, which are typically excluded in conventional shift-symmetric constructions of the ALP Lagrangian. In particular, I focus on the process $gg \to aa \to 4\gamma$, considering both the standard shift-preserving coupling and the shift-breaking gluon interaction. Our analysis simultaneously considers the presence of couplings to both gluons and electroweak bosons, including the standard dimension-5 operators as well as the dimension-6 interactions.

Authors: PAGANI, Davide (INFN, Bologna (IT)); BRIVIO, Ilaria (University & INFN Bologna); Mr MEONI, Simone (INFN, University of Bologna (IT))

Presenter: Mr MEONI, Simone (INFN, University of Bologna (IT))

Session Classification: Extended Scalars

Contribution ID: **44** Type: **not specified**

Amplitudes and perturbative unitarity bounds

Friday 6 June 2025 11:50 (15 minutes)

I will present a formalism based on spinor-helicity techniques that generalizes the formulation of perturbative unitarity bounds. I will discuss unitarity bounds for $N \to M$ scattering processes (with $N, M \geq 2$), which are important for high-energy future colliders. I will also address bounds for spin-2 and higher-spin theories, which are relevant for effective field theories of gravity and are not approachable by standard methods. Finally, I will emphasize the power and complementarity of positivity and perturbative unitarity bounds to constrain the parameter space of effective field theories.

Author: BRESCIANI, Luigi Carlo (University & INFN Padova)

Presenter: BRESCIANI, Luigi Carlo (University & INFN Padova)

Session Classification: Symmetries / Amplitudes

Contribution ID: **45** Type: **not specified**

OperatorToC++: Transpiling Matched EFT Coefficients to Low-Level Routines

Friday 6 June 2025 09:00 (15 minutes)

In recent years, significant progress has been made in the development of automated tools that match the parameters of new physics models and the Wilson coefficients of appropriate low-energy Effective Field Theories. This talk will shed light on an extensible, hybrid tool **OperatorToC++**, that combines the strengths of Mathematica and C++ to facilitate the next steps beyond the matching. OperatorToC++ efficiently ameliorates the complexities within the analytical matched expressions such as intricate loop-functions and lengthy sums and products involving tensor objects. It then translates and bundles the results into C++ classes and functions which provide a convenient platform for further numerical analyses.

Author: PRAKASH, Suraj (IFIC (UV-CSIC))

Presenter: PRAKASH, Suraj (IFIC (UV-CSIC))

Session Classification: Tools / Amplitudes

Contribution ID: **46** Type: **not specified**

Factorising Yukawa Structures in SMEFT with AutoEFT

Wednesday 4 June 2025 17:00 (15 minutes)

In the Standard Model (SM), flavour-specific effects originate from the Higgs couplings to fermions encoded in the Yukawa matrices. UV-complete extensions of the SM typically introduce additional flavour-dependent couplings, which can significantly affect precision collider and flavour observables. In this talk, we explore the flavour structure of higher-dimensional operators in the SM effective field theory (SMEFT) framework and investigate how the known hierarchies in the SM Yukawa sector can guide power-counting schemes for flavour-dependent Wilson coefficients. We extended the AutoEFT software package by implementing flavour spurions scaling in powers of the Wolfenstein parameter λ of the Cabibbo-Kobayashi-Maskawa (CKM) matrix. This approach enables us to systematically investigate flavour scenarios between Minimal Flavour Violation (MFV) and Froggatt-Nielsen (FN) models in the quark-flavour sector. Using an explicit example, we illustrate our method by deriving flavour power-counting hierarchies for dimension-six Wilson coefficients.

Authors: FELDMANN, Thorsten (University Siegen); HARLANDER, Robert (RWTH Aachen University); Dr SCHAAF, Magnus (Technical University of Munich); Dr TONG, Tom (University of Siegen)

Presenter: Dr SCHAAF, Magnus (Technical University of Munich)

Session Classification: Top / Quarks

Contribution ID: **47** Type: **not specified**

UV constraints on effective theories with extra vector bosons

Thursday 5 June 2025 15:00 (15 minutes)

The leading direct and indirect observable effects of arbitrary extra particles of spin 1 are conveniently described by a general effective theory with Proca vector bosons that belong to certain representations of the Standard Model gauge group. Assuming a good high-energy behaviour, we further restrict the possible representations of the extra vectors and derive constraints on their couplings to the Standard Model fields. Our method can be seen as a bottom-up approach to gauge model building.

Authors: FONSECA, Renato (Universidad de Granada); HERNÁNDEZ GARCÍA, Clara (Universidad de Granada); MARTÍNEZ LIZANA, Javier (IFT, Madrid); PÉREZ-VICTORIA, Manuel (Universidad de Granada)

Presenter: HERNÁNDEZ GARCÍA, Clara (Universidad de Granada)

Session Classification: Higgs and Electroweak III

Contribution ID: **48** Type: **not specified**

From the EFT to the UV: the complete SMEFT one-loop dictionary

Tuesday 3 June 2025 10:10 (15 minutes)

Effective field theories (EFTs) offer an efficient framework for the search
of heavy physics beyond the Standard Model, using the so-called bottom-up and top-down approaches. However, the vastness of possible UV scenarios makes the connection
between the two approaches challenging in practice, especially at loop-level. UV/IR dictionaries fill precisely this gap, readily connecting the EFT with the UV.

In this work we present the complete one-loop dictionary for the Standard Model EFT at dimension six for completions with heavy fermions and scalars. Our results are included in the package SOLD, as well as several new functionalities. In this new form, SOLD is prepared to serve as an important guiding tool for systematic
and complete phenomenological studies. As an example, we use the package to explore
possible explanations for the tension on the measurement of $\mathcal{B}(B\to K^{*})$.

Authors: GUEDES, Guilherme (DESY); OLGOSO, Pablo

Presenter: OLGOSO, Pablo

Session Classification: Geometry / Matching

Contribution ID: **49** Type: **not specified**

RG Improvement of the Scalar Effective Potential in Finite Temperature Quantum Field Theory

Thursday 5 June 2025 10:10 (15 minutes)

Its been demonstrated that "optimized partial dressing" (OPD) thermal mass resummation, which uses gap equation solutions inserted into the tadpole, efficiently tames finite temperature perturbation theory calculations of the effective thermal potential, without necessitating use of the high-temperature approximation. Even though it was shown that OPD has a similar scale dependence as 3D EFT approaches in the high-T limit, the calculated scale dependence of variables, in particular strength of gravitational wave signal from phase transition is sizeable. In this talk we will show a self-consistent way to RG improve scalar potential at finite temperature in the OPD formalism and demonstrate large reduction in scale dependence of physical observables in comparison to current techniques.

Authors: RASOVIC, Andrija; CURTIN, David Richard (University of Toronto); ROY, Jyotirmoy; LUKE, Michael (University of Toronto)

Presenter: RASOVIC, Andrija

Session Classification: Cosmology

Contribution ID: **50** Type: **not specified**

Multi-Higgs production as probes of HEFT interactions

Thursday 5 June 2025 14:20 (15 minutes)

Using the framework of the Higgs Effective Field Theory (HEFT), I will discuss multi-Higgs production via gluon-gluon fusion (ggF) and weak boson fusion (WBF). For ggF-induced multi-Higgs production, I will highlight the impact of one-loop HEFT modifications on the Higgs self-couplings and study their effects on the production rates. By including these one-loop radiative corrections and going up to $\mathcal{O}(p^4)$ in the momentum expansion, we provide a detailed motivation of the parameter range that the LHC (and future hadron colliders) can explore through accessing these non-standard coupling modifications and momentum dependencies that reveal Higgs boson nonlinearities.
In the second part of the talk, I will focus on multi-Higgs interactions with massive gauge bosons, parameterized within the HEFT framework, and discuss multi-Higgs processes via WBF. I will specifically highlight the enhancement of WBF triple Higgs production at the LHC and future colliders from the perspective of unitarity and demonstrate the radiative stability of such analyses under QCD corrections at hadron colliders. Taking unitarity bounds into account, I will discuss the expected sensitivity to electroweak triple Higgs production, considering $HHVV$ and $HHHVV$ effective couplings at future colliders.

Author: ., Anisha (Karlsruhe Institute of Technology)

Presenter: ., Anisha (Karlsruhe Institute of Technology)

Session Classification: Higgs and Electroweak III

Contribution ID: **51** Type: **not specified**

Probing SMEFT via the Lam-Tung Relation

Thursday 5 June 2025 14:00 (15 minutes)

The violation of the Lam-Tung relation in the Drell-Yan process serves as a sensitive observable for probing dipole operators as well as three scalar and tensor types of four-fermion operators. Since these operators do not interfere with the SM, their leading contributions to the violation arise at order $1/\Lambda^{-4}$. In this talk, we explore different strategies for constraining these operators. Dipole operators are mainly probed through measurements near the Z-pole, while the four-fermion operators induce energy-growing effects that become significant in the high-energy (off-pole) region. By connecting angular distributions to specific operator sensitivities, the Lam-Tung relation provides a novel avenue for testing the SM and unveiling possible signs of new physics at the LHC and future colliders.

Authors: Prof. YAN, Bin (IHEP); Mr ROLLA, Lorenzo (University of Genova); TORRE, Riccardo (INFN e Universita Genova (IT)); GROSSI, Samuele (Università degli studi di Genova & INFN sezione di Genova); LI, Xu (INFN)

Presenter: LI, Xu (INFN)

Session Classification: Higgs and Electroweak III

Contribution ID: **52** Type: **not specified**

Electroweak Vacuum Metastability from Axion-Higgs Criticality

Thursday 5 June 2025 12:10 (15 minutes)

Self-organised criticality, realised through cosmological dynamics in the early universe, is an alternative paradigm for addressing the electroweak hierarchy problem. In this scenario, an unnaturally light Higgs boson is the result of dynamics driving the electroweak vacuum towards a near-critical metastable point where the Higgs mass is bounded from above by the vacuum instability scale. To lower the vacuum instability scale close to the weak scale, previous realisations of this mechanism introduced new vector-like fermions coupled to the Higgs. Here we show that an Axion-Like Particle (ALP) coupling to the Higgs is an alternative possibility for achieving criticality with another well-motivated and naturally light candidate for new physics, thus leading to an entirely different set of testable phenomenological signatures. Our Axion-Higgs criticality model predicts an ALP in the MeV to $\mathcal{O}(10)$ GeV range. The entire natural region of parameter space can be thoroughly explored by a combination of future colliders, flavour experiments, and cosmological observatories.

Authors: DETERING, Maximilian; YOU, Tevong (King's College London)

Presenter: DETERING, Maximilian

Session Classification: Extended Scalars

Contribution ID: **53** Type: **not specified**

ANATAR: AN Automated Tool for higher-order Amplitude geneRation

Monday 2 June 2025 10:15 (15 minutes)

We present a new Mathematica package with the purpose of performing multi-loop computations. ANATAR simplifies Dirac and colour algebras by using FORM and integrates several existing tools designed for higher-order computations, which makes it very efficient without compromising user-friendliness and flexibility. Support for any BSM model with the same gauge group as the SM is provided, and in particular ANATAR is optimised for computations in effective field theories. In this letter, we review the generation of amplitudes at multiple loops and the obtention of results with ANATAR that are well suited for further use in phenomenological applications.

Authors: VÁSQUEZ, Andrés (University of Bonn); Prof. DUHR, Claude (University of Bonn); Dr MUKHERJEE, Pooja

Presenter: VÁSQUEZ, Andrés (University of Bonn)

Session Classification: RGEs I

Contribution ID: **55** Type: **not specified**

CLEW: towards a truly global SMEFT analysis

Monday 2 June 2025 14:40 (15 minutes)

SMEFT global analyses commonly encounter two major challenges:
1. An incomplete set of observables.
2. Ad-hoc flavour assumptions.
These issues significantly undermine the reliability and applicability of the results.

In this talk, I propose the CLEW framework for a complete global analysis free of flavour assumptions. By integrating both high- and low-energy data, our framework is able to apply strong phenomenological constraints instead of flavour assumptions to reduce the number of operators involved in the analysis.

Moreover, to aid in model building and guide experimental searches, CLEW utilizes the Akaike Information Criterion (AIC) to identify the most relevant operators. AIC helps select a group of operators that not only fit well with the experimental data but also avoid unnecessary complexity.

Finally, I will introduce the implementation of CLEW within SIMUnet, a machine-learning based tool that fits SMEFT and PDFs simultaneously.

Author: Dr TONG, Tom (University Siegen)

Presenter: Dr TONG, Tom (University Siegen)

Session Classification: Global EFT Analyses I

Contribution ID: **56** Type: **not specified**

EFT results in the top quark sector with the ATLAS detector

Wednesday 4 June 2025 16:20 (15 minutes)

The exceptionally large dataset collected by the ATLAS detector at the highest proton-proton collision energies provided by the LHC enables precision testing of the Standard Model. Many-parameter fits to precise measurements in the framework of the SM Effective Field Theory (EFT) are becoming a standard interpretation of LHC and other collider data. In this contribution an overview is given of state-of-the-art EFT interpretations in ATLAS with particular emphasis on results in the top quark sector, where associated top quark production provides a particularly fruitful area for such interpretations.

Authors: CUNNETT, Betsy (University of Sussex (GB)); MCFAYDEN, Josh (University of Sussex)

Presenter: CUNNETT, Betsy (University of Sussex (GB))

Session Classification: Top / Quarks

Contribution ID: **57** Type: **not specified**

EFT analysis of New Physics at COHERENT with Dirac neutrinos

Wednesday 4 June 2025 09:50 (15 minutes)

We study the sensitivity of COHERENT-like experiments to non-standard contributions within the so-called νWEFT framework. The latter is the most general low-energy effective field theory that includes not only the light SM fields but also additional right-handed Dirac neutrinos.

Our analysis uses the framework presented at "Consistent QFT description of non-standard neutrino interactions", which makes use of the full freedom of EFT's. This allows us, for the first time, to include flavor-general New Physics effects in neutrino production (pion and muon decays) and neutrino detection (through Coherent Elastic Neutrino-Nucleus Scattering). The versatility of this framework also allows to easyly study different NP scenarios, as was shown in the letter "Muon-decay parameters from COHERENT".

Despite the generality, the results can be written in compact form and are easy to implement in existing or future analyses using effective nuclear charges. We use current COHERENT data to set constraints on the corresponding effective operators, and we estimate the sensitivity of future measurements.

Authors: GONZALEZ-ALONSO, Martin (Universidad de Valencia); DE LA CRUZ ALZAGA, Sergio (PhD Student); Dr PRAKASH, Suraj (IFIC (UV-CSIC)); BRESÓ PLA, Víctor (University of Heidelberg)

Presenter: DE LA CRUZ ALZAGA, Sergio (PhD Student)

Session Classification: Flavour Symmetries / Neutrinos

Contribution ID: **58** Type: **not specified**

Geometric Building Blocks of EFT Amplitudes

Tuesday 3 June 2025 14:50 (15 minutes)

The analogy between field redefinitions in EFTs and coordinate transformations suggests that EFT amplitudes can be interpreted as geometric invariants, constructed from fundamental building blocks. We identify these building blocks as geometric quantities derived from the covariant derivatives of the action, which remain covariant in the on-shell limit under derivative-dependent field redefinitions. By restricting to two-derivative theories and applying a field-space-metric-compatible connection, we reproduce the amplitudes being expressed in terms of covariant derivatives of the Riemann curvature tensor and the scalar potential formulated from these building blocks. This geometric perspective provides new insights into the structure of EFT amplitudes and the inherent redundancy associated with general field redefinitions.

Author: LI, Xuxiang (University of Utah)

Presenter: LI, Xuxiang (University of Utah)

Session Classification: Geometry / Positivity

Contribution ID: **59** Type: **not specified**

Accuracy Complements Energy: Impact of Electroweak Precision Tests on the Higgs Self-Coupling at FCC-ee

Thursday 5 June 2025 16:00 (15 minutes)

A Tera-Z factory, such as FCC-ee or CEPC, will have indirect sensitivity to heavy new physics up to the tens of TeV scale through higher-order loop contributions to precision measurements at the Z-pole. These provide complementary sensitivity to potential deviations from the Standard Model typically thought to best be constrained at leading order at higher energies above the Z-pole, leading to improved projected sensitivities for models such as the real singlet scalar, weakly interacting massive particles or the custodial quadruplet. The entanglement between the Z-pole and higher energy runs has a profound impact on the extraction of a bound on the Higgs Self-Coupling at FCC-ee, which is probed at next-to-leading order (NLO) via Single Higgs production. We determine the FCC-ee sensitivity to Higgs self-coupling modifications $\delta\kappa_\lambda$ within the SMEFT framework, including for the first time flavour, LEP, LHC, and FCC-ee observables in a global analysis with all leading NLO effects via one-loop renormalisation group evolution, as well as incorporating finite NLO contributions to electroweak precision and ZH observables. We find that, under reasonable assumptions, FCC-ee sensitivity to $\delta\kappa_\lambda$ can exceed that of the HL-LHC.

Author: MAURA BREICK, Victor (King's College London)

Presenter: MAURA BREICK, Victor (King's College London)

Session Classification: Future Colliders

Contribution ID: **60** Type: **not specified**

Gravitational Self-Force from Amplitudes and Effective Field Theory

Thursday 5 June 2025 09:00 (25 minutes)

Presenter: KOSMOPOULOS, Dimitrios

Session Classification: Cosmology

Contribution ID: **61** Type: **not specified**

Functional Methods: How and When to Use Them

Monday 2 June 2025 11:00 (25 minutes)

Functional methods are a popular choice for various RG and EFT matching calculations, although many of the techniques have so far been limited to one-loop calculations. With the increasing demand for precision calculations, we have developed new, practical methods for the multi-loop level. In this talk, I will discuss these new techniques, contrast and compare them with ordinary diagrammatic methods, and make the case that they provide for an efficient framework for RG and matching calculations. If time permits I will also sketch out a recent proof for the validity of the hard-region EFT matching formula at multi-loop order, which is fundamental to off-shell matching calculations both with functional and diagrammatic methods.

Presenter: Dr THOMSEN, Anders Eller (University of Bern)

Session Classification: RGEs II

Contribution ID: **62** Type: **not specified**

The art of counting: the HEFT expansion and HH production

Tuesday 3 June 2025 16:00 (25 minutes)

The Standard Model and Higgs Effective Field Theories (SMEFT and HEFT) are the two well-established theoretical frameworks for the parameterization of potential new physics signals from nearly decoupled BSM sectors. They differ in the scalar field content and - most notably - in the power counting, i.e. the way they organize BSM effects into a series expansion. While it's clear that in SMEFT one simply expands in inverse powers of the EFT cutoff, the HEFT power counting generates recurring confusion, which can be traced back to the simultaneous presence of linear and non-linear field representations in the theory.
This talk revisits general power counting rationales in EFTs to obtain a possible consistent (and simple) prescription for HEFT. It will also discuss an example application to double Higgs production in gluon fusion, which is one of the main test benches for HEFT-SMEFT comparisons at the LHC.

Presenter: BRIVIO, Ilaria (University & INFN Bologna)

Session Classification: Higgs and Electroweak I

Contribution ID: **63** Type: **not specified**

Matching and decoupling in extended scalar sectors

Thursday 5 June 2025 11:00 (25 minutes)

Presenter: SUTHERLAND, David

Session Classification: Extended Scalars

Contribution ID: **64** Type: **not specified**

An EFT mechanism for exact proton stability

Wednesday 4 June 2025 09:00 (25 minutes)

We propose a model in which the proton is rendered absolutely stable by an IR mechanism that remains robust against unknown quantum gravity effects. An anomaly-free linear combination of baryon number and lepton flavors is gauged and spontaneously broken to a residual Z_9 discrete gauge symmetry, enforcing a strict selection rule in the SMEFT: baryon number violation occurs only in multiples of three. Despite its minimal field content—a single $U(1)$ gauge group, three right-handed neutrinos for anomaly cancellation, and two SM-singlet scalars for symmetry breaking—the model successfully accounts for established empirical evidence of physics beyond the SM: neutrino masses and mixings, dark matter, and the baryon asymmetry of the universe.

Presenter: GRELJO, Admir (Universitaet Basel (CH))

Session Classification: Flavour Symmetries / Neutrinos

Contribution ID: **65** Type: **not specified**

Two-loop anomalous dimensions in the Low-Energy EFT

Tuesday 3 June 2025 11:00 (25 minutes)

I will discuss a few issues related to anomalous dimensions of the EFT below the EW scale at two loop order.

Presenter: VIRTO, Javier (Universitat de Barcelona)

Session Classification: RGEs III

Contribution ID: **66** Type: **not specified**

The LEFT in the HV scheme at next-to-leading-log accuracy

Tuesday 3 June 2025 11:30 (25 minutes)

Presenter: STOFFER, Peter

Session Classification: RGEs III

Contribution ID: **67** Type: **not specified**

One-loop renormalization of general EFTs

Monday 2 June 2025 09:05 (25 minutes)

Presenter: SANTIAGO, Jose (Universidad de Granada (ES))

Session Classification: RGEs I

Contribution ID: **68** Type: **not specified**

Interference in the SMEFT

Wednesday 4 June 2025 11:00 (25 minutes)

Suppression of interference between the SM and the dimension-six operators is well established and complicate the extraction of constraints from the LHC data. However, it can also be seen as an opportunity to motivate shape measurements. In this presentation, I will show a few examples of resurrection by differential measurements and show how they give more stable constraints when higher order corrections are added.

Presenter: DEGRANDE, Celine Catherine A

Session Classification: Higgs and Electroweak II

Contribution ID: **69** Type: **not specified**

Top entanglement

Wednesday 4 June 2025 15:50 (25 minutes)

Presenter: VRYONIDOU, Eleni (The University of Manchester (GB))

Session Classification: Top / Quarks

Contribution ID: **70** Type: **not specified**

Fermion geometry

Tuesday 3 June 2025 09:00 (25 minutes)

Presenter: PAGÈS, Julie (University of California, San Diego)

Session Classification: Geometry / Matching

Contribution ID: **71** Type: **not specified**

Accidental Symmetries, Hilbert Series, and Friends

Friday 6 June 2025 11:00 (25 minutes)

Presenter: QUILEZ LASANTA, Pablo (Universidy of California San Diego (UCSD))

Session Classification: Symmetries / Amplitudes

Contribution ID: **72** Type: **not specified**

(Geometry &) Cosmology, Confinement & Counting

Tuesday 3 June 2025 14:00 (25 minutes)

Presenter: ALONSO, Rodrigo (UC San Diego)

Session Classification: Geometry / Positivity

Contribution ID: **73** Type: **not specified**

EFT Interpretation of ATLAS Data

Monday 2 June 2025 16:00 (25 minutes)

Presenter: SAMPSONIDOU, Despoina (University of Oregon (US))

Session Classification: Global EFT Analyses II

Contribution ID: **74** Type: **not specified**

EFT Interpretation of CMS Data

Monday 2 June 2025 15:00 (25 minutes)

Presenter: CALANDRI, Alessandro (Università & INFN, Firenze (IT))

Session Classification: Global EFT Analyses I

Contribution ID: **75** Type: **not specified**

Geometrical Methods of Effective Field Theories

Wednesday 4 June 2025 14:00 (1 hour)

I discuss recent progress in using geometrical methods to compute radiative corrections in quantum field theories, and give some applications to SMEFT and ChPT.
I will also briefly discuss infinite anomalous dimensions in EFTs.

Presenter: MANOHAR, Aneesh Vasant (Univ. of California San Diego (US))

Session Classification: Theory Colloquium

Contribution ID: **76** Type: **not specified**

Welcome

Session Classification: RGEs I

Contribution ID: **77** Type: **not specified**

Welcome

Monday 2 June 2025 09:00 (5 minutes)

Presenter: COHEN, Tim (CERN)