8th General Meeting of the LHC EFT Working Group

Monday 2 December 2024 - Wednesday 4 December 2024

CERN

Book of Abstracts

Contents

Area 3 / **1**

EFT dimension-6 and dimension-8 study with VBS events at CMS

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A first measurement is presented of the cross-section for the scattering of same-sign W boson pairs via the detection of a τ lepton. The data from proton-proton collisions at the center-of-mass energy of 13 TeV were collected by the CMS detector at the LHC, corresponding to an integrated luminosity of 138 fb−1. Events containing two jets with large pseudorapidity and large invariant mass, one τ lepton,
one light lepton (e or μ), and significant missing transverse momentum were selected. In addition, a search is presented for the indirect effects of processes beyond the standard model via the effective field theory framework, in terms of dimension-6 and dimension-8 operators.

Area 2 / **2**

Electroweak corrections from Sudakov logarithms in the SMEFT

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Electroweak (EW) corrections, significantly influenced by Sudakov logarithms, become the predominant higher-order effect at the TeV scale and beyond. In this study, we compute EW corrections in the high-energy limit for selected dimension-six SMEFT operators. Our findings reveal that while four-fermion operators exhibit universally similar corrections as those seen in the Standard Model (SM), distinct structural variations emerge for other operators. We investigate the phenomenological implications of these findings through illustrative processes involving four-fermion operators and assess the impact of Sudakov EW corrections on the tails of differential distributions, both at the LHC and future lepton colliders. Given the complex effects of EW corrections within SMEFT, we caution against the use of simplistic K-factor approaches, which do not adequately capture the nuanced physics involved.

Area 1 / **3**

Evanescent operators at the one-loop level

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I will discuss general basis transformations in Effective Field theories at the tree- and one-loop level. To this end, the notion of Evanescent operators and their formulation in terms of one-loop Fierz transformations will be introduced. To illustrate the usefulness of this approach several examples will be discussed, including scheme factorization. Comments on Evanescence free renormalization schemes will conclude the talk.

Area 5 / **4**

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

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Effective field theories (EFTs) offer a rationale to classify new physics models based on the size of their contribution to the effective Lagrangian, and therefore to experimental observables. However, given the amount of UV theories, it is in practice difficult to identify the set of UV theories which can generate a particular low-energy pattern. While current matching softwares have made the top-down approach (once you have chosen a model) much more systematic, starting instead from a Wilson Coefficient and identifying the specific theories from which it can arise is still challenging. Dictionaries, which allow us to systematically go from EFT to the UV are the solution for this. In this talk I will present the first one-loop UV/IR dictionary of the complete SMEFT for extensions encompassing an arbitrary number of scalars and fermions. This dictionary is encoded in a Mathematica package called SOLD (SMEFT One Loop Dictionary), which includes further functionalities to facilitate the usage of the results. I will go over the relevance of dictionaries for phenomenological efforts and explore a particular scenario of how SOLD can help identify the UV source of an existing experimental tension.

General / **5**

SMEFT meets quantum gravity

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Area 2 / **6**

Staying on Top of SMEFT-Likelihood Analyses

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Area 2 / **8**

Wilk's theorem follow-up discussion

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Area 4 / 9

Round-table discussion on Likelihoods for EFT

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Area 1 / 11

SMEFT predictions for semileptonic processes

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The $SU(2)_L \times U(1)_Y$ invariance of the Standard Model Effective Field Theory (SMEFT) predicts multiple restrictions in the space of Wilson coefficients of $U(1)_{em}$ invariant effective lagrangians such as the Low-energy Effective Field Theory (LEFT), used for low-energy flavor-physics observables, or the Higgs Effective Field Theory (HEFT) in unitary gauge, appropriate for weak-scale observables. In this work, we derive and enumerate all such predictions for semileptonic operators up to dimension 6. We find that these predictions can be expressed as 2223 linear relations among the HEFT/LEFT Wilson coefficients, that are completely independent of the choice of the SMEFT flavor basis. These relations interconnect a wide array of experimental searches, including high-p_T dilepton searches, top decays, Z-pole observables, charged lepton flavor violating observables, non-standard neutrino interaction searches and semileptonic decays of B, K and D mesons. We illustrate how these relations can be utilized to impose stringent indirect constraints on several Wilson coefficients that are currently weakly constrained or entirely unconstrained by direct experiments. Moreover, these relations imply that any evidence of new physics in a specific search channel would generally be accompanied by correlated anomalies in other channels.

Area 1 / 12

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

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We present the complete set of positivity bounds on the Higgs Effective Field Theory (HEFT) at next-to-leading order. 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 the $VV \to VV$, hh, Vh, and $hh \to VV$, Vh processes, where $V = W^{\pm}, Z$, h is the observed Higgs boson, and s is the center-of-mass energy squared. We find two categories of constraints: (i) specific linear combinations of CP-even Wilson coefficients must be positive, and (ii) the magnitudes of some

Wilson coefficients–including all CP-odd ones–must be smaller than products of other CP-even Wilson coefficients. Our results can thus provide indirect upper bounds on Wilson coefficients of the second category. Additionally, we obtain double-sided bounds on these Wilson coefficients by imposing unitarity and st-crossing symmetry. We present our final constraints on the 15 dimensional HEFT space as well as on the space of anomalous couplings and show how known positivity bounds on the 3 dimensional space of dimension 8 SMEFT can be recovered from them. For the $VV \to hh$ and $VV \to VV$ channels, we find that a significant portion of the parameter space is excluded by these requirements. In particular for quartic gauge couplings we find that less than 8% of the experimentally allowed parameter space is consistent with our positivity bounds. Furthermore, positivity constraints of the second category above imply upper bounds on Wilson coefficients contributing to the $VV \to Vh$ process from collider bounds on $VV \to VV, hh$ searches.

Area 3 / **13**

New physics effects at colliders via HEFT

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Due to the lack of direct evidence in the search for new physics (NP), the Effective Field Theory (EFT) framework offers an indirect and model-independent approach to parameterize NP effects. In this talk, I will focus on the non-linear EFT framework, also known as Higgs Effective Field Theory (HEFT), and include next-to-leading order (NLO) bosonic operators to study Higgs-related processes at current and future colliders. First, using the Higgs propagator corrections, I will revisit the measurement of off-shell Higgs boson contribution in massive gauge boson pair production. Then, by including radiative corrections within HEFT, I will discuss the sensitivity of single-Higgs data to quartic Higgs-gauge interactions. Finally, I will highlight the impact of one-loop HEFT modifications to the Higgs-self couplings and their effects on multi-Higgs production.

Area 2 / **14**

SMEFT NLO correction to Higgs decay in an events generator

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In recent years, particle physicists have actively constrained potential new physics contributions by leveraging the Large Hadron Collider (LHC) data and the SMEFT framework. Measurement of the properties of Higgs boson is central to this program. However, the robust analysis hinges on the inclusion of higher order (NLO) Electroweak (EW) and QCD corrections arising from dimension-6 SMEFT operators for a more accurate picture. While significant progress has been made in calculating NLO QCD corrections within SMEFT, and some EW corrections exist, there is a crucial gap: a lack of event generators incorporating these corrections for optimal data analysis. This talk addresses this gap by proposing the implementation of these corrections into an event generator like SHERPA. This is an important step for a more realistic framework for analysing LHC data.

Area 3 / **15**

SMEFT meets Quantum Gravity

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Area 3 / **16**

Interplay between LHC and EIC for SMEFT (remote)

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Area 6 / **17**

Long-distance QCD contributions in rare b→sll decays

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Area 1 / **18**

On the SMEFT basis for Anomalous Quartic Gauge Couplings

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Area 1 / **19**

Quantifying EFT Truncation Uncertainties at the LHC

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Area 1 / **20**

Discussion on truncation

Area 6 / **21**

Power to the RGE!

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Area 6 / **22**

Probing third-generation New Physics with $K \to \pi\nu\nu$ and $B \to K(*)\nu\nu$

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Area 6 / **23**

EFT in semileptonic decays at LHCb

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Area 5 / **24**

EFT Analysis of Composite Higgs Models

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Area 5 / **25**

Matching the MSSM to the SMEFT

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Area 5 / **26**

Two-Higgs Doublet Model Matched to Nonlinear Effective Theory

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General / **27**

Highlights from ATLAS

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General / **28**

Highlights from CMS

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General / **29**

Highlights from LHCb

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General / **30**

RG effect in SMEFT (fits)

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General / **31**

NLO SMEFT predictions (for Zh and beyond)

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