EFT and EW Tools

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Workshop on the physics of HL-LHC, and perspectives at HE-LHC

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Status of tools for EFT calculations

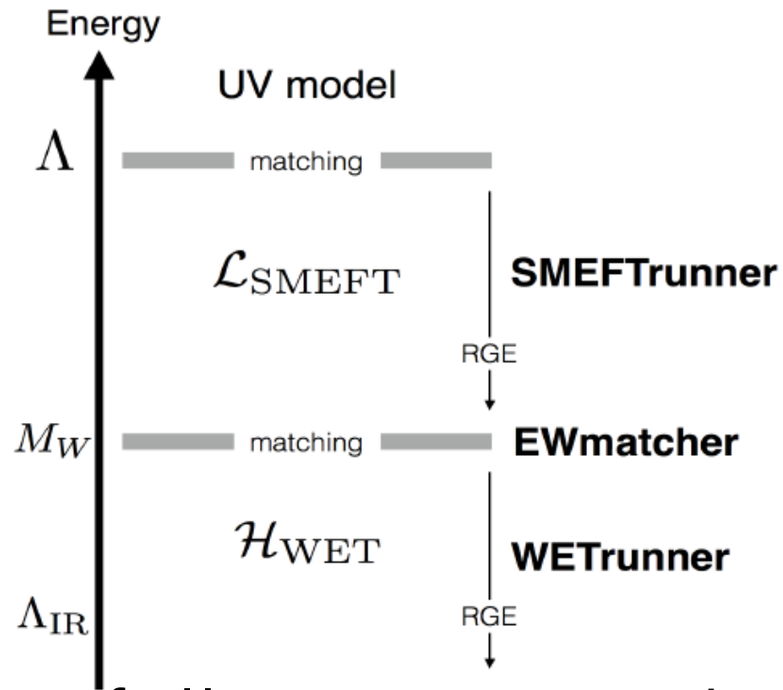
Well-tested chain:
Feynrules→UFO→Monte Carlo generator (MG5_aMC, Sherpa etc)
LO **done** (e.g. Full SMEFT implementation SMEFTsim package: arXiv:1709.06492)

NLO QCD in EFT: NLOCT arXiv:1406.3030 (provides the necessary counterterms)
Lots of examples of studies for subsets of operators (top, Higgs, gauge sectors) and specific processes already available with QCD corrections
Full SMEFT@NLO implementation in progress (should be available within the next few months)

EW corrections in EFT: First steps towards EW corrections in EFT calculations e.g. arXiv:1505.02646, 1505.03706, 1804.09766
Work needed to be able to fully automate this

Recent developments and future of EFT tools

Running and matching:
RGE known: Jenkins et al 2013
SMEFTrunner
(e.g. DsixTools arXiv:1704.04504)



To be incorporated into Monte Carlos in a fully automated manner: **work needed**

MatchingTools: UV complete model⟶EFT (tree-level/one-loop matching e.g. arXiv: 1710.06445 and 1711.10391)

Fitting Tools: e.g. HEPfit: a public framework that can perform EFT fits (used for example in arXiv:1803.00939)

EFT tools section outline

Review of currently available tools (1-2 pages):

- Models and Monte Carlo event generators
- RGE running tools
- Matching tools
- EFT fitting tools

Future of EFT tools:
Discussion of possible development directions expected in the next few years (1 page):

- Fully automated QCD+EW corrections in the EFT
- Running of coefficients within the Monte Carlo generators etc

EW Tools

NLO EW

- really NLO QCD+EW, as incorporation in existing NLO QCD frameworks
- mostly automated by now
  - Monte-Carlo integration, IR subtraction (MG5_aMC, SHERPA, several private codes)
  - Virtual corrections (GOSAM, MADLOOP, OPENLOOPS, RECOLA)

approximate $\mathcal{O}(\alpha_s\alpha)$ corrections

- available for DY in pole approximation
- constructable in factorised form (NLO QCD$\times$EW), valid in EW Sudakov regime

EW Tools

approximate EW corrections in event generators

- EW Sudakov appoximation in ALPGEN for V + jets and HERWIG++ for diboson production
- NLO QCD+EW_{virt} approximation in SHERPA's multijet merging (EW Sudakov approximation + some finite terms)

EW parton showers

- crude approximation for unpolarised partons exist in PYTHIA and SHERPA
  $\rightarrow$ EW Sudakov suppression (virtual correction) is well described
  $\rightarrow$ real emission details sketchy

EW parton evolution

- QED content pinned down (LUXqed ansatz, SF $\mathcal{O}(\alpha_s\alpha) + \mathcal{O}(\alpha^2)$)
- EW content started to be probed

EW Tools section outline

Review of existing tools ($\sim$2 pages):

- NLO QCD+EW automation
- appriximate $\mathcal{O}(\alpha_s\alpha)$ corrections
- crude EW parton showers
- EW parton evolution

Possible developments in the next few years ($\sim$1 pages):

- NLO QCD+EW matching and multijet merging
- mixed $\mathcal{O}(\alpha_s\alpha)$ corrections
- improved EW parton showers
- EW parton evolution