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×EW), valid in EW Sudakov regime
EW Tools

approximate EW corrections in event generators

- EW Sudakov approximation in ALPGEN for $V + \text{jets}$ and HERWIG++ for diboson production
- NLO QCD+EW$_{\text{virt}}$ 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 $O(\alpha_s\alpha) + O(\alpha^2)$)
- EW content started to be probed
EW Tools section outline

**Review of existing tools (~2 pages):**

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

**Possible developments in the next few years (~1 pages):**

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