(thoughts on)
Polarisation studies for VBS with MadGraph5_aMC@NLO

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VBSCan Polarisation Workshop

LLR, October 11th, 2018

MadGraph5_aMC@NLO

https://launchpad.net/mg5amcnlo,
Alwall et al, arXiv:1405.0301, Frederix et al, 1804.10017

- It is a meta-code (a code that generates process-specific codes) which make it possible to simulate possibly any process at LO and NLO (QCD and EW)
- Limitations are process complexity and running time
- No process-specific optimisations
- NLO QCD (v2.6.x): fixed-order computations, as well as matching and merging (CKKW, MLM at LO, FxFx at NLO)
- NLO EW (v3.y): only fixed-order simulations and no tagged photons in the final state (limitations to be lifted in the future)

Polarisation studies with MG5_aMC

- No dedicated effort (so far) has been established for polarisation studies (may be an excellent topic for some student)
- I will briefly review some tools that may be (more or less) related to polarisation

MadSpin

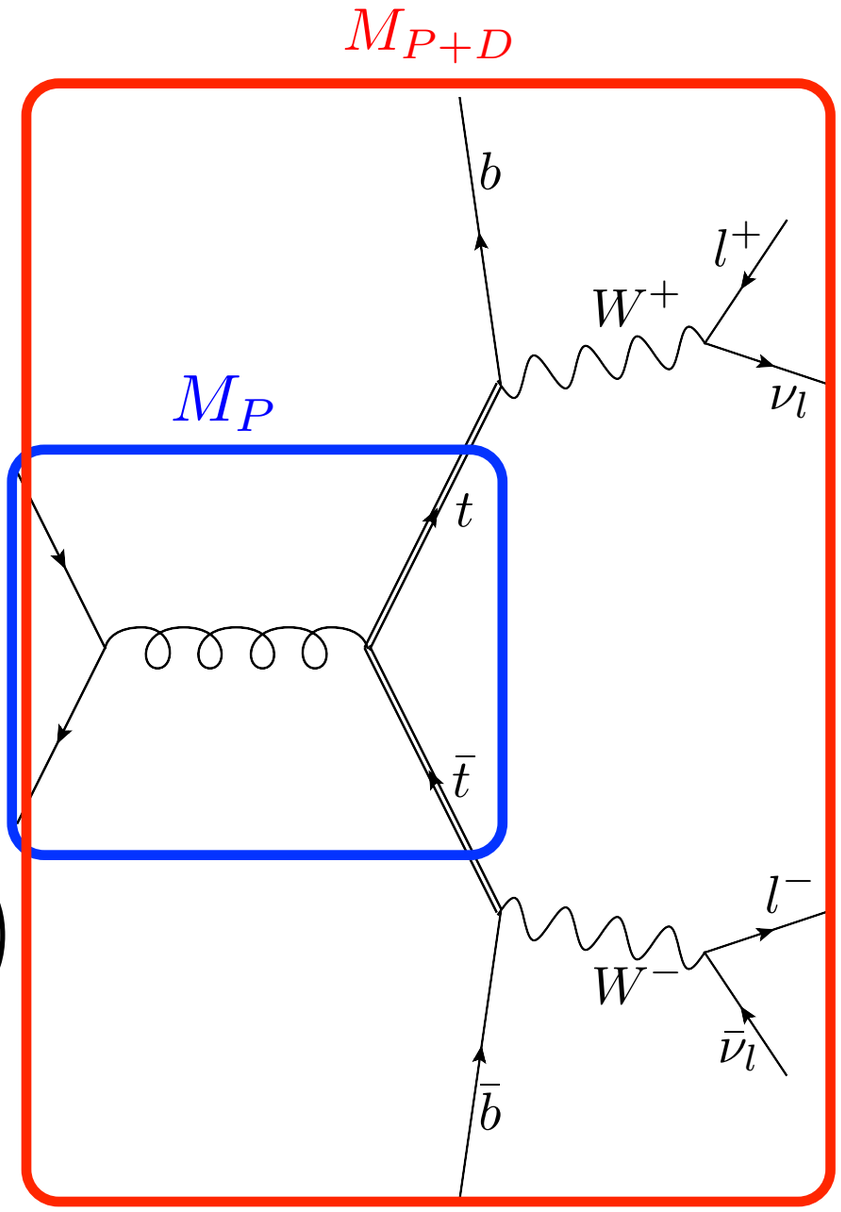
Artoisenet et al, arXiv:1212.3460

- Mostly useful to include (tree-level) spin correlations in NLO samples
  - Generate decayed unweighted events (assumed to be summed over helicities)
  - Read event
  - Generate decay-chain ME
  - Generate decay kinematics
    - Generate many decay configurations until

$$|M_{P+D}|^2 / |M_P|^2 > \mathrm{Rand}() \max\left(|M_{P+D}|^2 / |M_P|^2\right)$$

- Method originally used for $t\bar{t}$ and singletop

Frixione, Leanen, Motylinski, Webber, arXiv:hep-ph/0702198

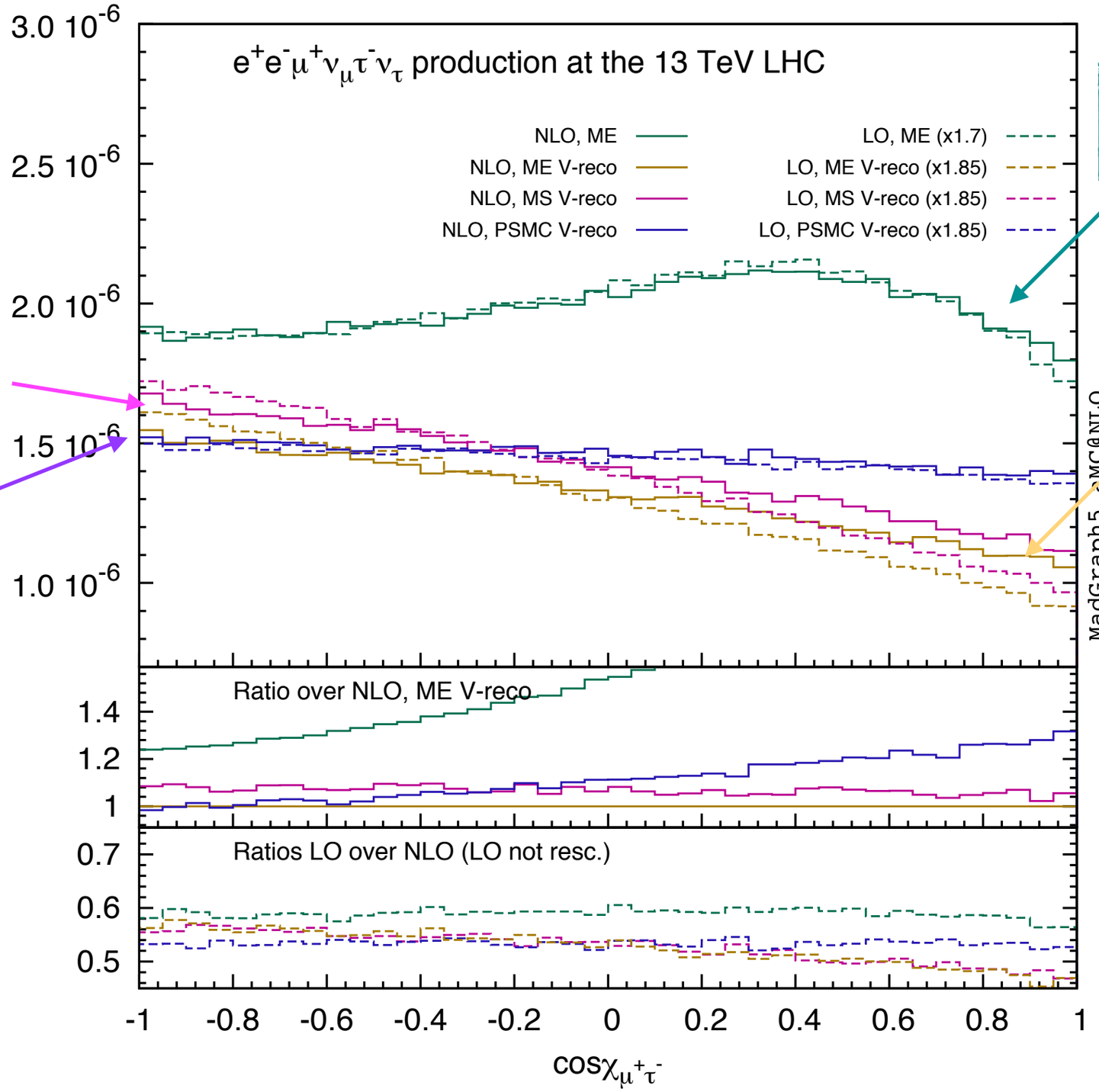


Spin correlations in VVV production

Alwall et al, arXiv:1405.0301

VVV, decayed with MS (spin-correlations, no off-shell)

VVV, decayed with Pythia (no spin-correlations, no off-shell)



6-lep matrix-element, in the CMS, including off-shell effects

6-lep matrix-element, in the CMS, with cuts to select only the on-shell region

Decay package

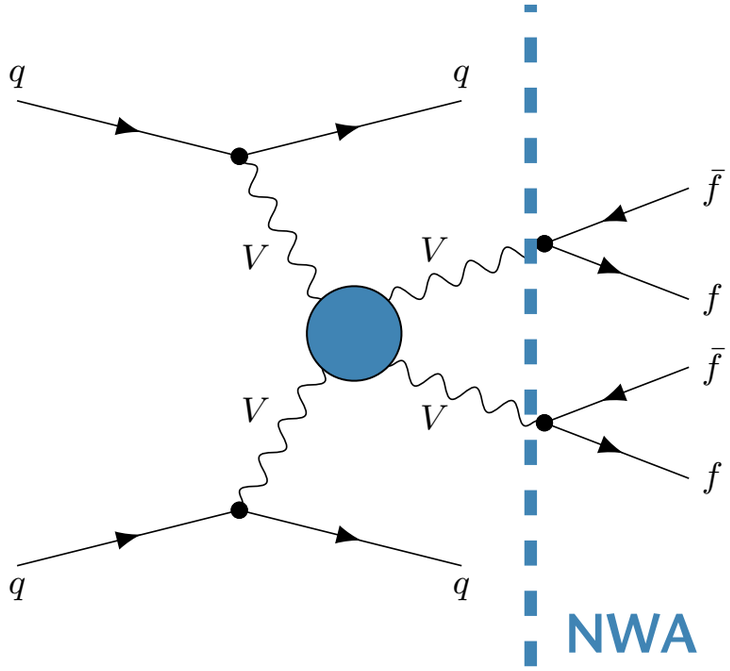
- Ancestor of MadSpin, written in Fortran, included in MG5 up to v1.5 (2012)
- With some hacks it can be used to decay polarised LO events including spin correlations
- See here for how to generate polarised events at LO
  https://answers.launchpad.net/mg5amcnlo/+question/251307
  https://answers.launchpad.net/mg5amcnlo/+faq/2243
- And here for how to use Decay
  https://answers.launchpad.net/mg5amcnlo/+question/257782
  https://answers.launchpad.net/mg5amcnlo/+question/267900
- Certainly not optimal, but it works (kind of)

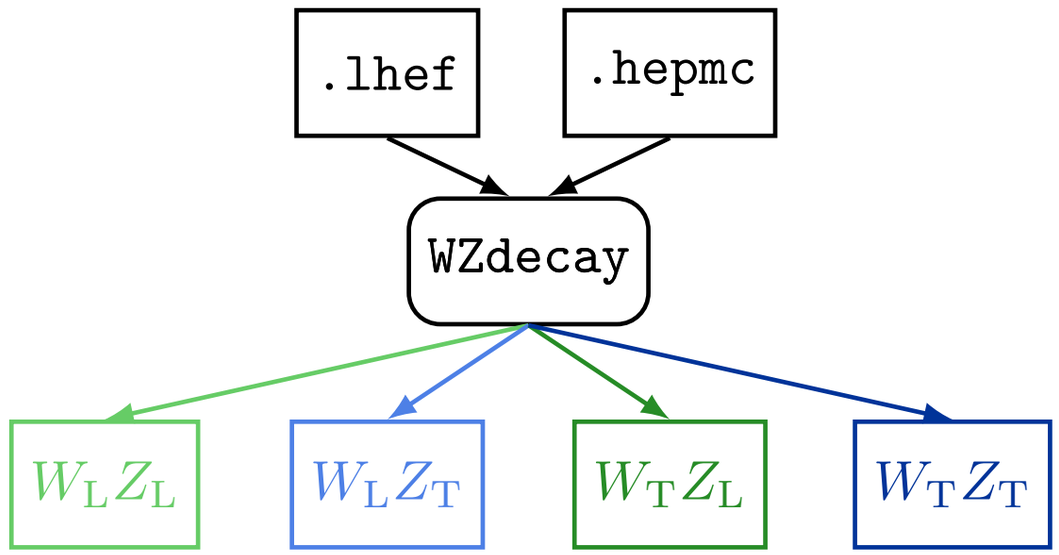
WZDecay

by Carsten Bittrich

https://cds.cern.ch/record/2014124

- Presented in Carsten Bittrich's talk
- Modern version of Decay package, works directly on the LHE/HepMC events (generator independent)





Outlook

- Madgraph5_aMC@NLO makes it possible to simulate arbitrary processes up to NLO QCD and EW (only limited by computer resources)
- Specific studies focused on vector-boson polarisation have not started yet
- Ideally, one should be able to retrieve polarisation informations from LHE files, but this is not the case yet
- Developments in the polarisation field can be excellent projects for master/PhD students and young researchers in general