Steps toward an LHC tune

with contributions from

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Theory comparison: LHC tune

- Common LHC tune for different NLO MC generators: ***LHC tune***
  - Goal: provide a common benchmark tune for theory calculations
    - select data for the tune
    - select parameters to tune
    - common PDF
    - obtain PS, hadronization etc uncertainties
    - validate tune with measurements from 7 – 13 TeV
  - Time scale
    - first results during summer 2018
    - to be used for theory comparison

The problem

- comparison with theory predictions is tricky:
  - different tunes: affect multi-jet final states, hadronization, UE
    - α_s - settings, PDF, fragmentation etc
  - different pdfs: affect hard scattering x-section

- conclusion of theory comparison is often not conclusive

- need for benchmark predictions

- need for common, general, realistic and accepted parameter setting for MC generators, applicable for LO generators but also for matched merged higher order generators.

The goal:

- develop MC tunes which are
  - general:
    - applicable to all processes (no process specific tune)
      - only one tune per generator
    - provide a reasonable (maybe not the best) description
      - accepted by MC authors and experiments
  - universal
    - applicable to measurements of all (LHC) experiments
      - but also to other measurements at LEP, Tevatron, HERA ?
  - unique
    - make use of the same datasets (benchmark data) to tune relevant parameters
      - additional data might be used for different generators
    - have a comparable goodness-of-fit definition for benchmark data

Summary of discussion

- Discussion started at Meeting at June 20 2018

- SHERPA (M. Schoenherr)
  - comes with exactly one tune
  - tune hadronization parameters to LEP data
  - tune intrinsic transverse momentum parameters to LHC DY data
  - tune multiple interaction and beam remnant parameters to LHC data

- HERWIG (J. Bellm)
  - Light particles and hadronization (LEP).
  - Bottom and Charm to LEP with enhanced weights for sensitive observables (LEP).
  - Tune underlying event parameters and intrinsic pT separately (Tevatron & LHC).
  - Professor weights (how much weight is given to different distributions)
    - usually 1.0 for considered differential distributions 10 for considered PDG multiplicities
    - 50 for one of the n-charged multiplicities.

Summary of discussion (cont'd)

- CMS – tunes on UE (E. Yazgan)
  - based on Monash PYTHIA tune
  - systematic investigation of PDF dependence (make use of NLO, NNLO pdfs with corresponding α_s
  - tuned to min-bias and UE, validated against high scale measurements

- new approach to AutoTune (J. Bellm)
  - Tuning is a very physicist dependent procedure:
    - What data to tune to?
      - knowledge of data (Do we know some data is not „good"?)
      - Some data in rivet is same data (e.g. differential and integrated, updates...)
      - If many groups at LEP measure the same observable, does this enhance the weight in the next tune? (Only use one b-frag?)
    - Correlations in the model?
      - knowledge of model (Should be given... but e.g. influence of 2->3 jet rate on b-fragmentation?)

Next steps:

- create/provide a list of measurements which should be used for tuning:
  - hadronization from LEP
    - what about heavy flavor measurements at LHC etc ?
    - what about colored/uncolored initial state effects ?
  - UE/minbias from LHC and Tevatron at all energies (perhaps except lowest energy at 300 GeV)
  - intrinsic kt distribtuons: low energy DY or DY at LHC/Tevatron ?
  - parton shower parameters (lower scale cutoff)
    - final state from LEP
    - initial state ?
    - interference/color connections between initial/final state and interleaved MPI ?

Next steps:

- provide a common approach how to weight different measurements
- clarify goodness of fit: delta χ^2
- obtain and validate tune
  - provide proper documentation of the whole procedure
  - reproducebility of tune:
    - storage of all relevant information and software

Time scale

- Major effort of MC authors and gen-experts from experiments
- will be the first common general effort to make theory comparisons unified and uniform

- Goal
  - define benchmark measurements until September
  - perform tunes until November
  - validation until end of 2018

Appendix