DISCUSSION

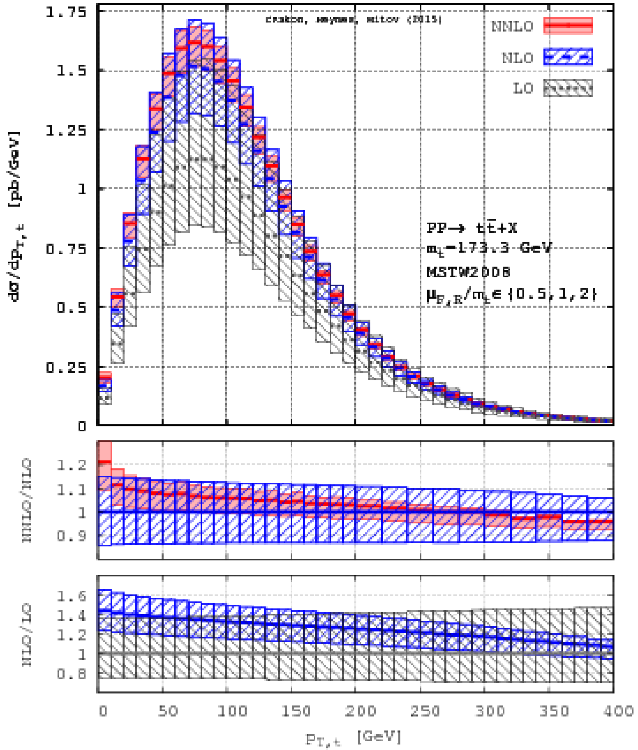
Theoretical uncertainties

- Multiple weights per event allow to evaluate scale variations and PDF
  - Relevant for ME
  - Usually, nominal x-section used for normalization: does this cover all relevant shape variations ? See next slide
- What Event weights cannot do: **matching/merging scale**
  - Often small wrt muR,muF
  - To avoid generation of multiple samples to assess this, we could have a coherent study of the impact for the most relevant processes to be shared as reference by both experiments in collaboration with MC experts
    - E.g. CKKW-L for MG5_aMC@NLO, CKKW in Sherpa → **feasible ? Reasonable ?**
- Also, event weights cannot do PS unc.: ISR/FSR variations, MPI and generally what we would call tune variations
  - In ATLAS: A14 tune used for general purpose, various studies to minimize the variations (ttbar, ttH etc). Similar studies for AZNLO tune, used for VV, VH processes
  - In CMS: Studies focused on MPI/UE

  → Common approach probably not possible…
- Specific shower difference: usually take Pythia vs Herwig – should this be done in addition to tuning variations and/or variations of PS scales?
- If all of the above applied, when to do generators comparison ?
  - E.g. diboson, ttbar but also V+jets, where “standalone” approach can be followed for each possible choice of nominal

"Scale Uncertainties"

- Factorization/Renormalization scale variations in the hard ME are intended to assess uncertainties associated with missing higher order corrections
- Per-event weights provide easy/fast means to evaluate ME scale variations
- **Problem:** Common prescription for xsec measurements or where normalization is fixed by data control regions is to take the scale variations but **renormalize** them to the nominal xsec. This does **not** necessarily cover all relevant shape variations
- Other caveats: does not include parton shower or UE uncertainties, does not include effect of higher order EWK corrections, etc



- Shape uncertainties: Procedure is **ambiguous** already from the theory side (How are scale uncertainties correlated from one bin of a distribution to another? Vary functional form of dynamic scales?)
- Renormalized NLO envelope clearly misses completely the relevant shape variation which is nevertheless covered by the full uncertainty band

Example on generator uncertainties …

- Say: we compare theory predictions of two samples in a signal region to assign an uncertainty, assuming the two samples come from different generators, the generators themselves may be at different orders or at least contain different diagrams. Examples:
  - Wt DR vs DS (same order and different diagrams)
  - diboson Powheg vs Sherpa (similar diagrams, but strict NLO vs multi-leg NLO + LO for even more legs).
- Various options considered in the past:
  - Normalize the samples in a control region that we have designed (in which case the answer depends on the control region)
  - Normalize the samples in an “inclusive region” that we have designed (in which case we should all in ATLAS get the same answer, but theorists and CMS might differ);
  - Normalize the samples to their generated cross sections (in which case one might include NLO diagrams and one might not, so the comparison might just return the k-factor);
  - Normalize the samples to the highest order available cross section
    - Most common approach
    - Cons: normally inclusive, sometimes not applicable if selections at generation are applied and “k-factor” depend on the topology

BSM samples

- How to handle theoretical uncertainties on BSM signal samples ? An example
- Say we search for new gauge boson signals in dilepton final states:
  - We take into account the PDF variations and PDF choice as a systematic uncertainty on the irreducible DY background to this signal.
  - What should be done for the Z' signal itself ?
    - (1) Do not apply theoretical uncertainties on signal models.
    - (2) Apply the full treatment of theoretical uncertainties to the signal models, as is done for the background. Correlations ?
    - (3) Only take the variations on the signal acceptance x efficiency due to theoretical uncertainties into account as a systematic uncertainty.