W/Z + jets theory progress

Daniel Maître

CERN/IPPP
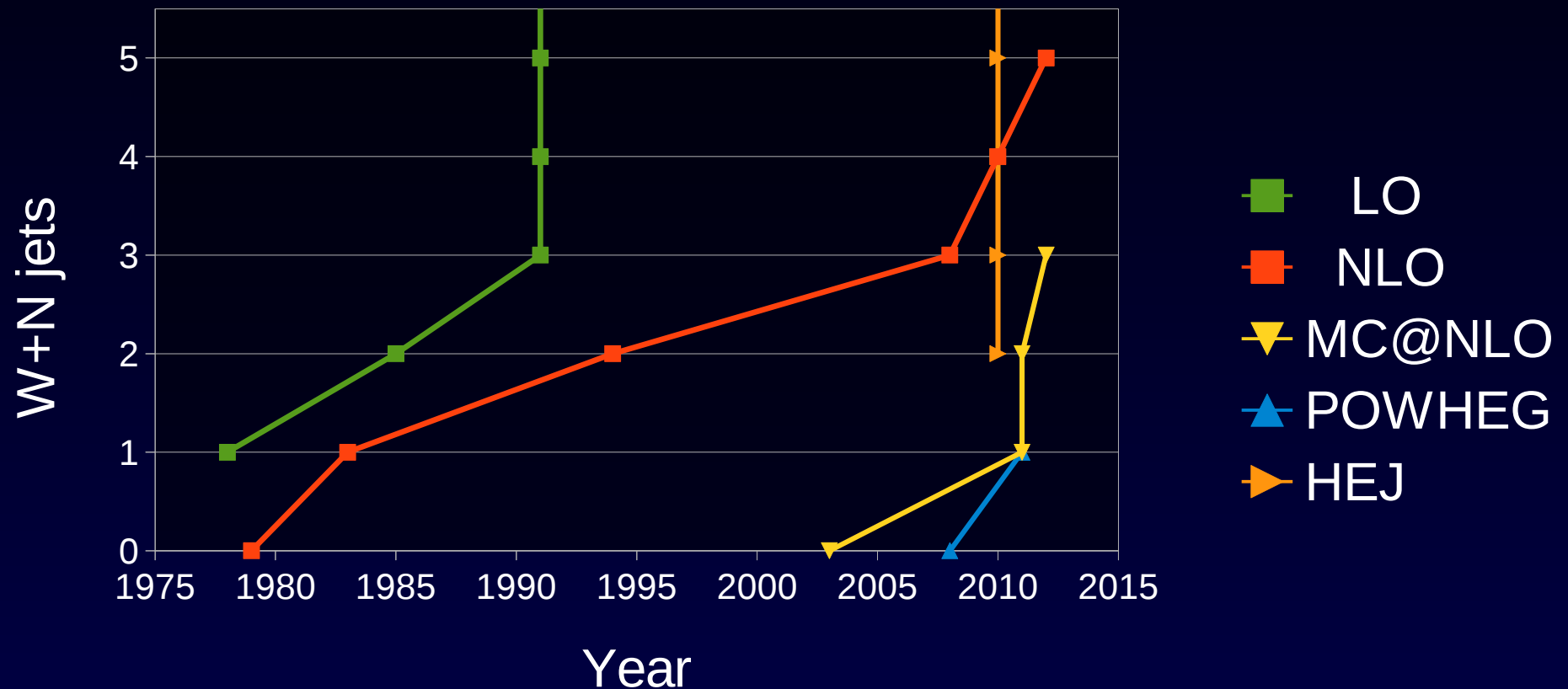
SM@LHC, Copenhagen, 12 April 2012

Motivation

- V+jets can be measured precisely
- Well understood process
  - Used as validation of tools and methods
- Calibration
  - Jet energy scale
  - Underlying event
- Background to (almost) anything

Recent progress

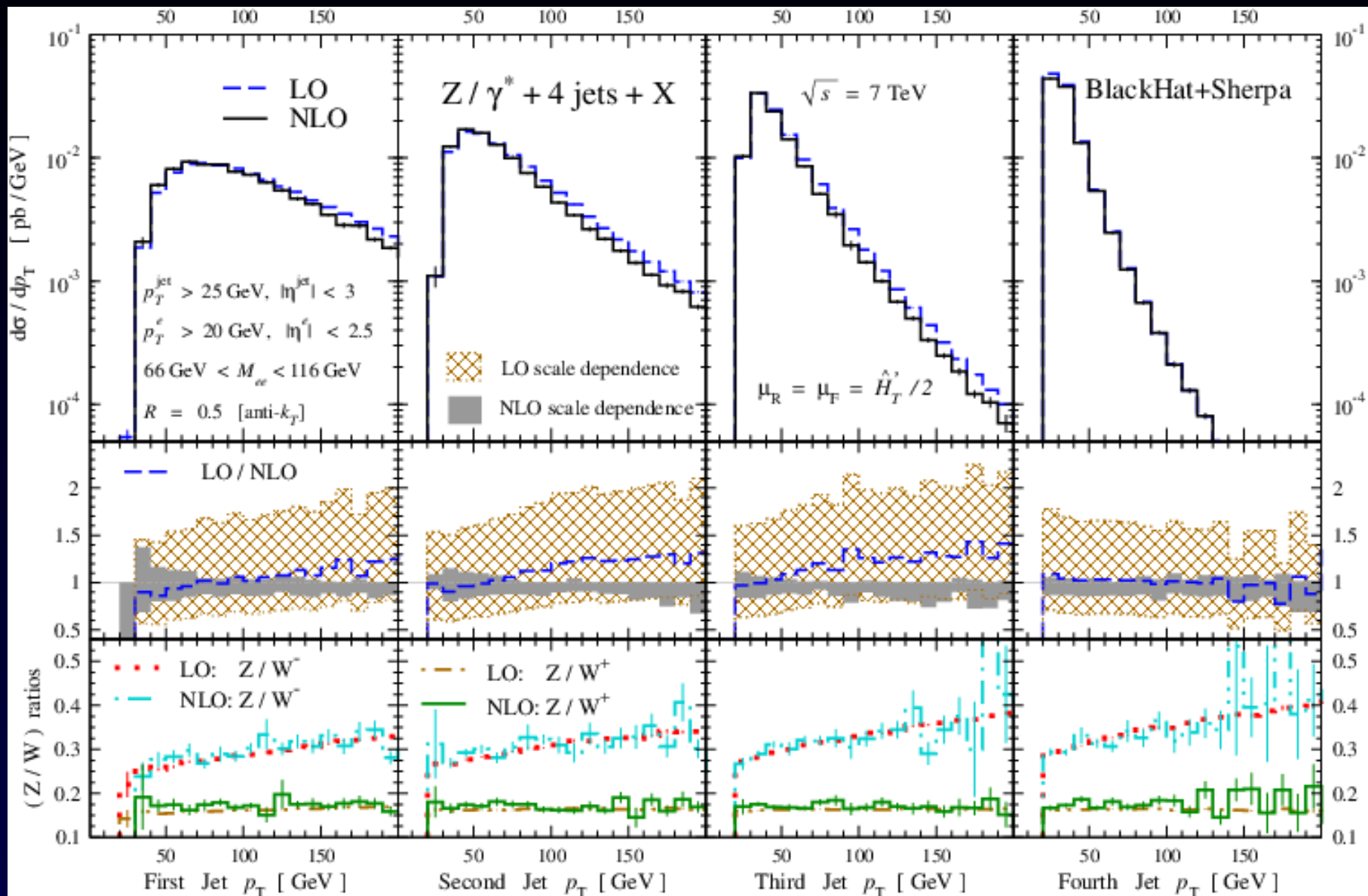- Number of jets in addition to the vector boson

BlackHat+Sherpa

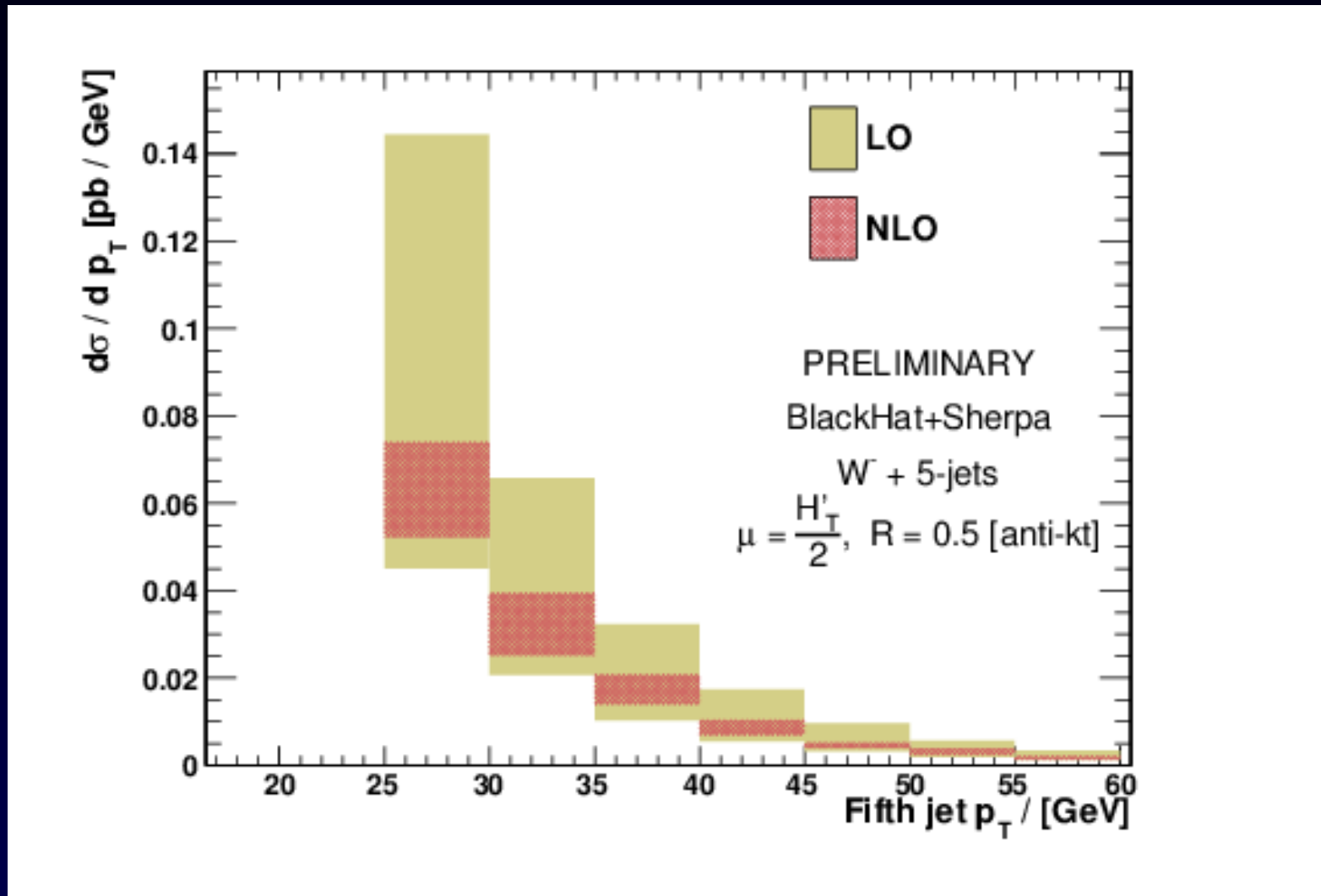[Bern, Dixon, Kosower, Febres Cordero, Hoeche, Ita, Maître, Ozeren]

- NLO partonic cross section

- Virtual matrix elements from BlackHat

- Real emission + subtraction from Sherpa

- Up to W/Z+4(5) jets
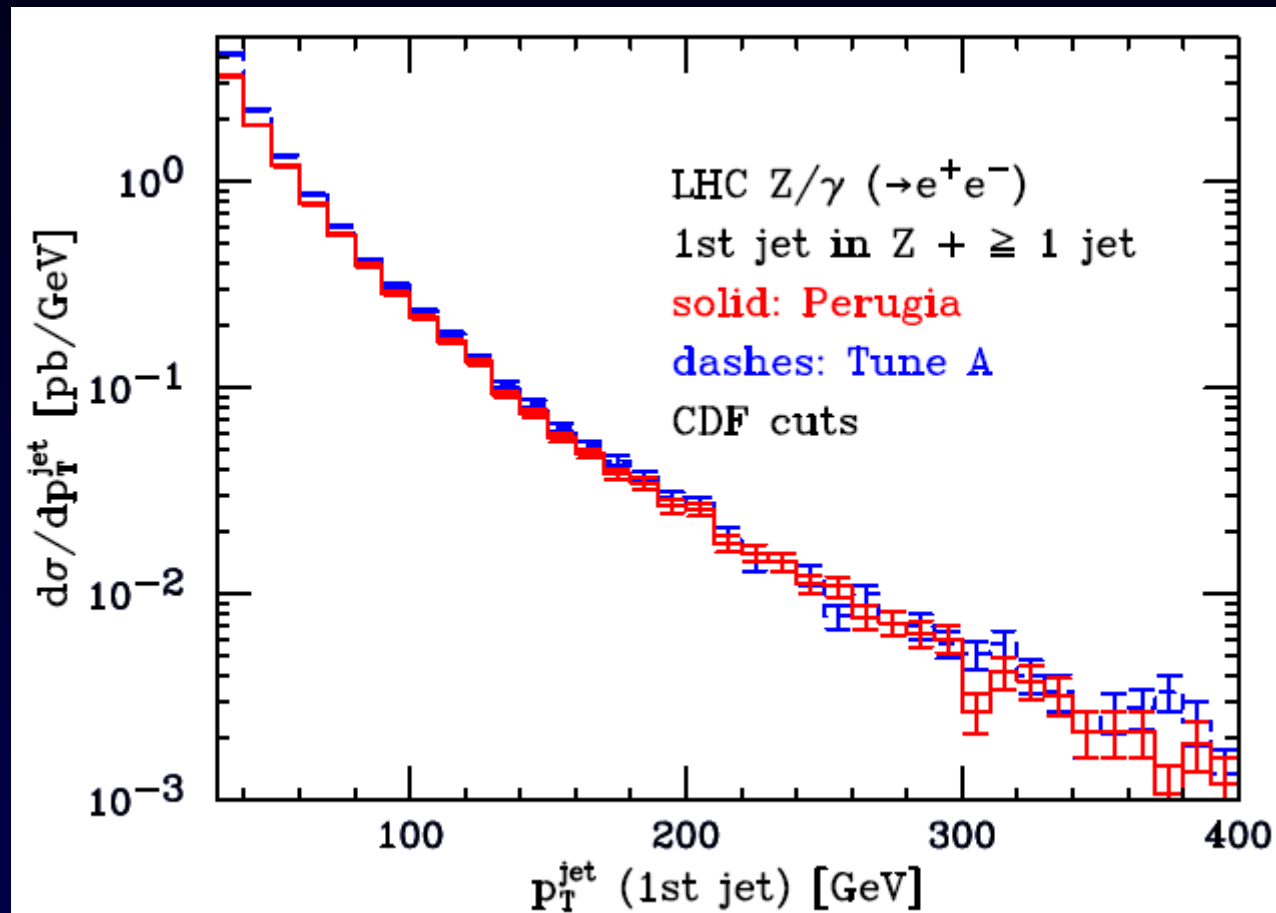
Z+4 jets

ArXiv:1108.2229

Preliminary results for W+5 jets

- First 2 --> 6(7) calculation at NLO for the LHC

POWHEG

- Generate the first emission with NLO accuracy

- Z+1 jet POWHEGBOX [Alioli, Nason, Oleari, Re; arXiv:1009.5594]

aMC@NLO

- NLO matched to a parton shower using the MC@NLO method in an automatic way, using MadGraph, MadLoop (using CutTools) and MadFKS

- W+2 jets at Tevatron
  [Frederix, Frixione, Hirschi, Maltoni, Pittau, Torrielli ; arXiv:1110.5502 [hep-ph]]

- W+ b pair
  [Frederix, Frixione, Hirschi, Maltoni, Pittau, Torrielli ; arXiv:1106.6019]

MC@NLO Sherpa

Hoeche, Krauss, Schonherr, Siegert [arXiv 1201.5882]

- MC@NLO variant

- W+up to 3 jets at the LHC

arXiv:1201.5882
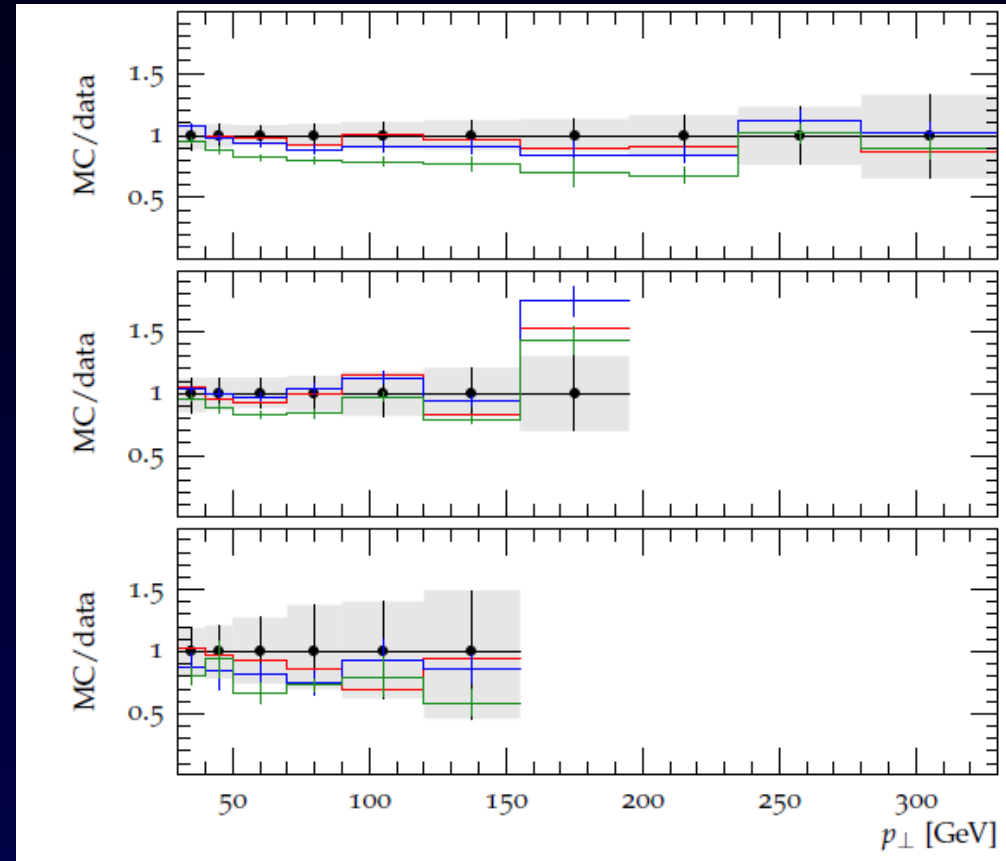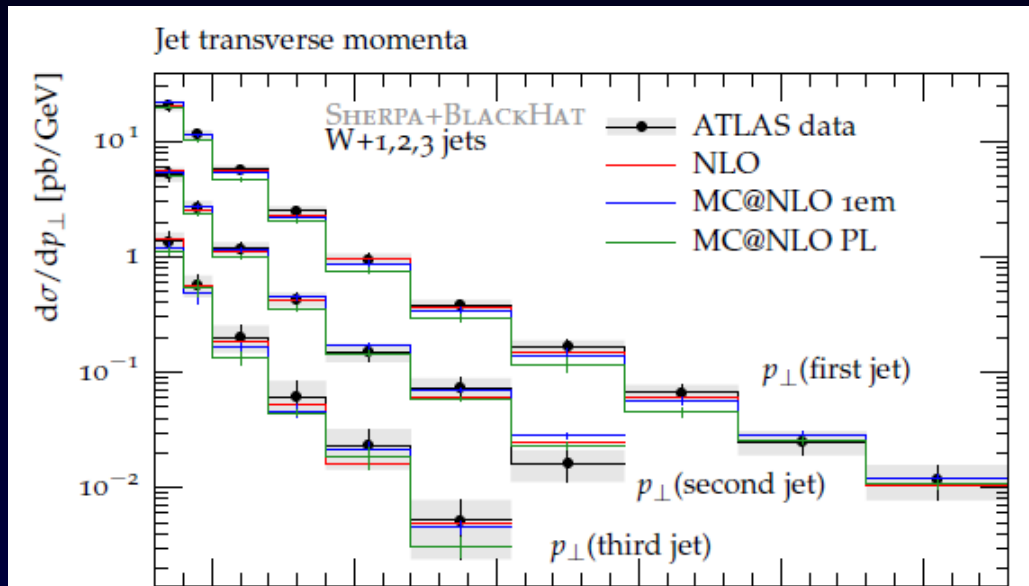
Les Houches studies

ArXiv: 1203.6803

- W+jets production at the LHC : a comparison of perturbative tools
  [Andersen, Huston, Maître, Sapeta, Salam, Smillie, Winter]

- W production in association with multiple jets at the LHC
  [Andersen, Maître, Smillie, Winter]

- Uncertainties in the simulation of W+jets – a case study

  [Alioli, Andersen, Ciulli, Cossutti, Hapola, Hoeth, Krauss, Lenzi, Lönnblad, Luisoni, Maître, Oleari, Prestel, Re, Reiter, Schönherr, Smillie, Tramontano, Winter, Zapp]

Exclusive sums

- Combine NLO event samples of different multiplicity

- Justified (if at all) for observables where higher multiplicities are important

- Avoid double counting by restricting the samples to a fixed multiplicity

- Formally not better than a NLO calculation

- No systematic study of uncertainties/stability
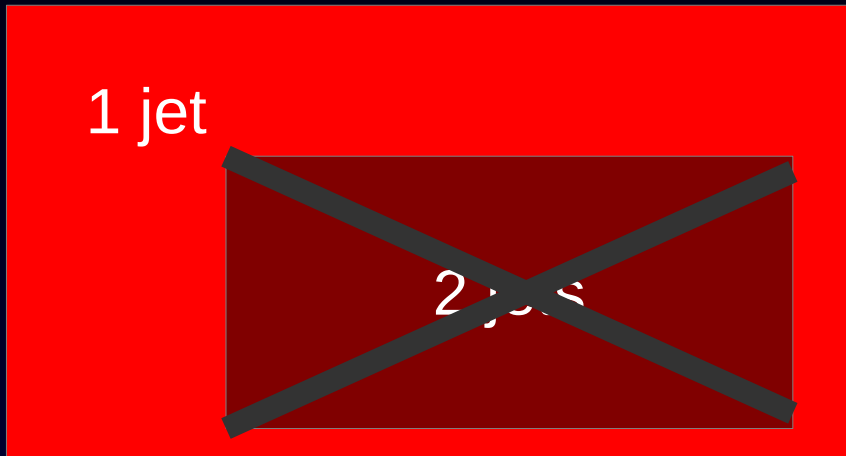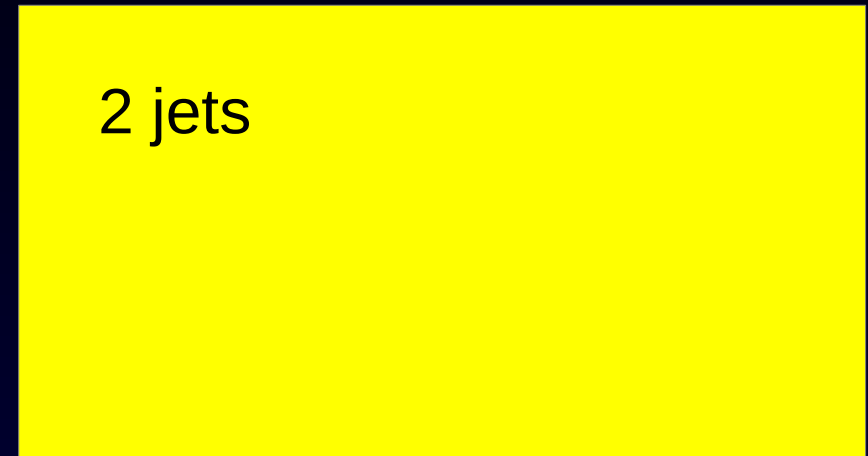 - In preparation

Exclusive sums

- W+1 jet at NLO

1 jet

2 jets

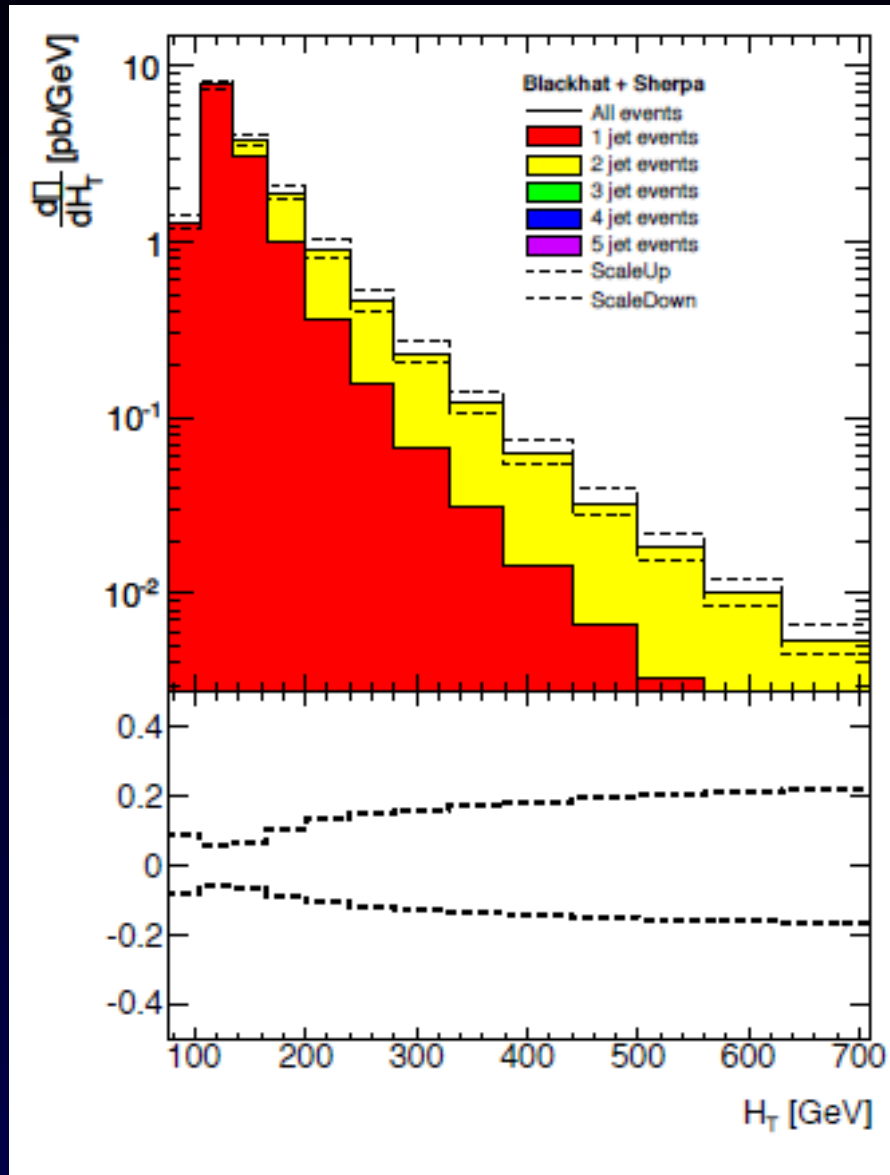'LO' only

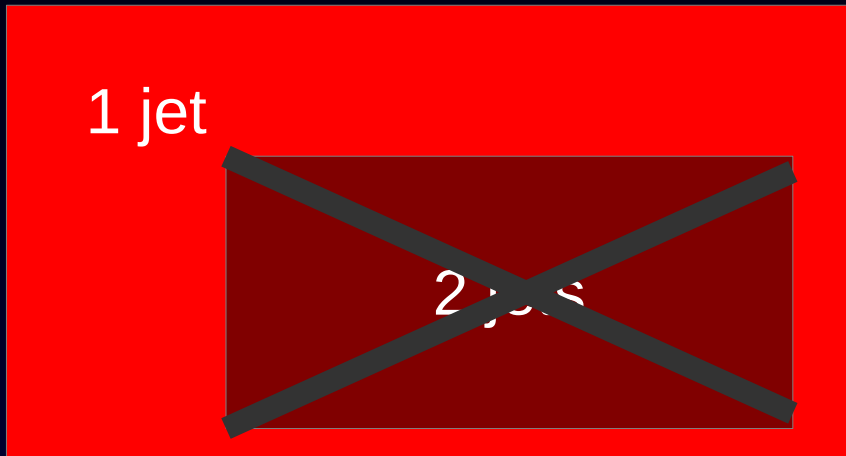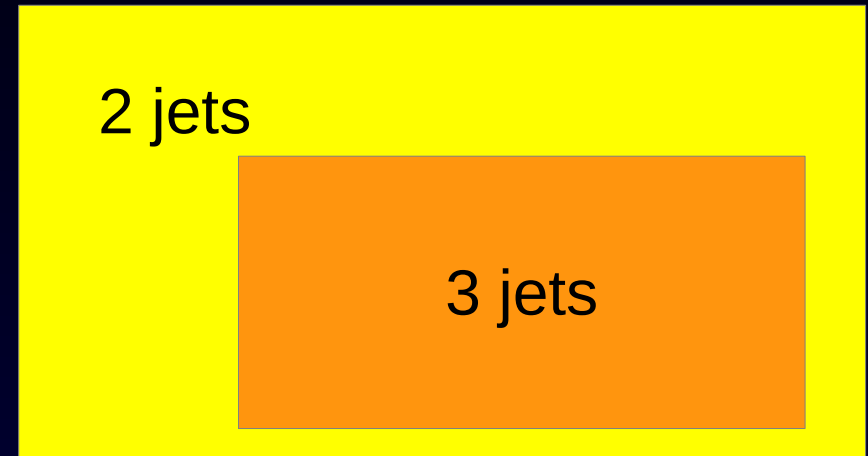# Exclusive sums

- W+1 jet at NLO

1 jet

2 jets

W+2 jets at NLO

2 jets

W+1 jet

Exclusive sums

- W+1 jet at NLO   W+2 jets at NLO

1 jet

2 jets

2 jets

3 jets

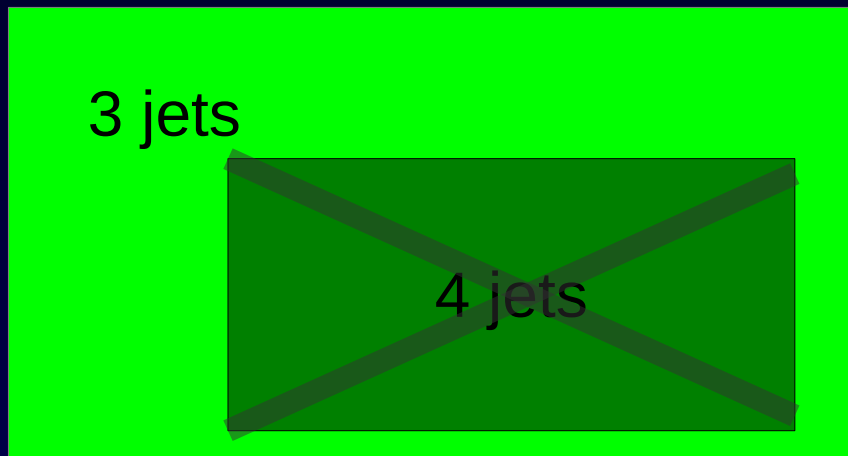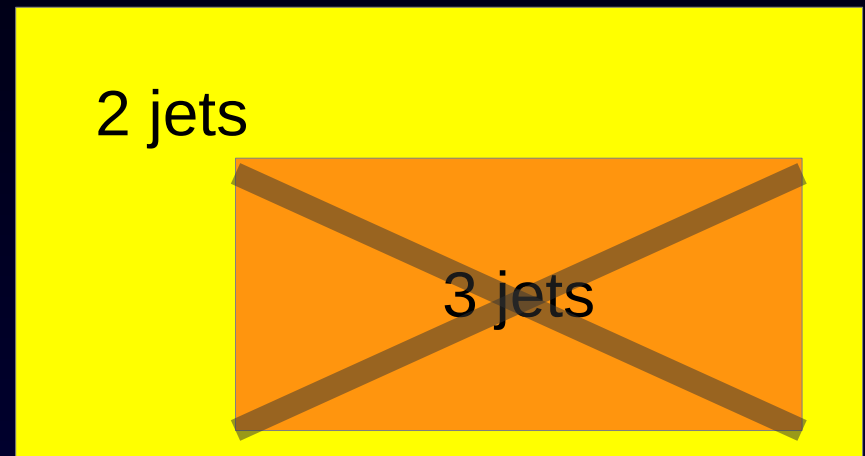# Exclusive sums

- W+1 jet at NLO   W+2 jets at NLO

1 jet

2 jets

2 jets

3 jets

3 jets

4 jets

4 jets
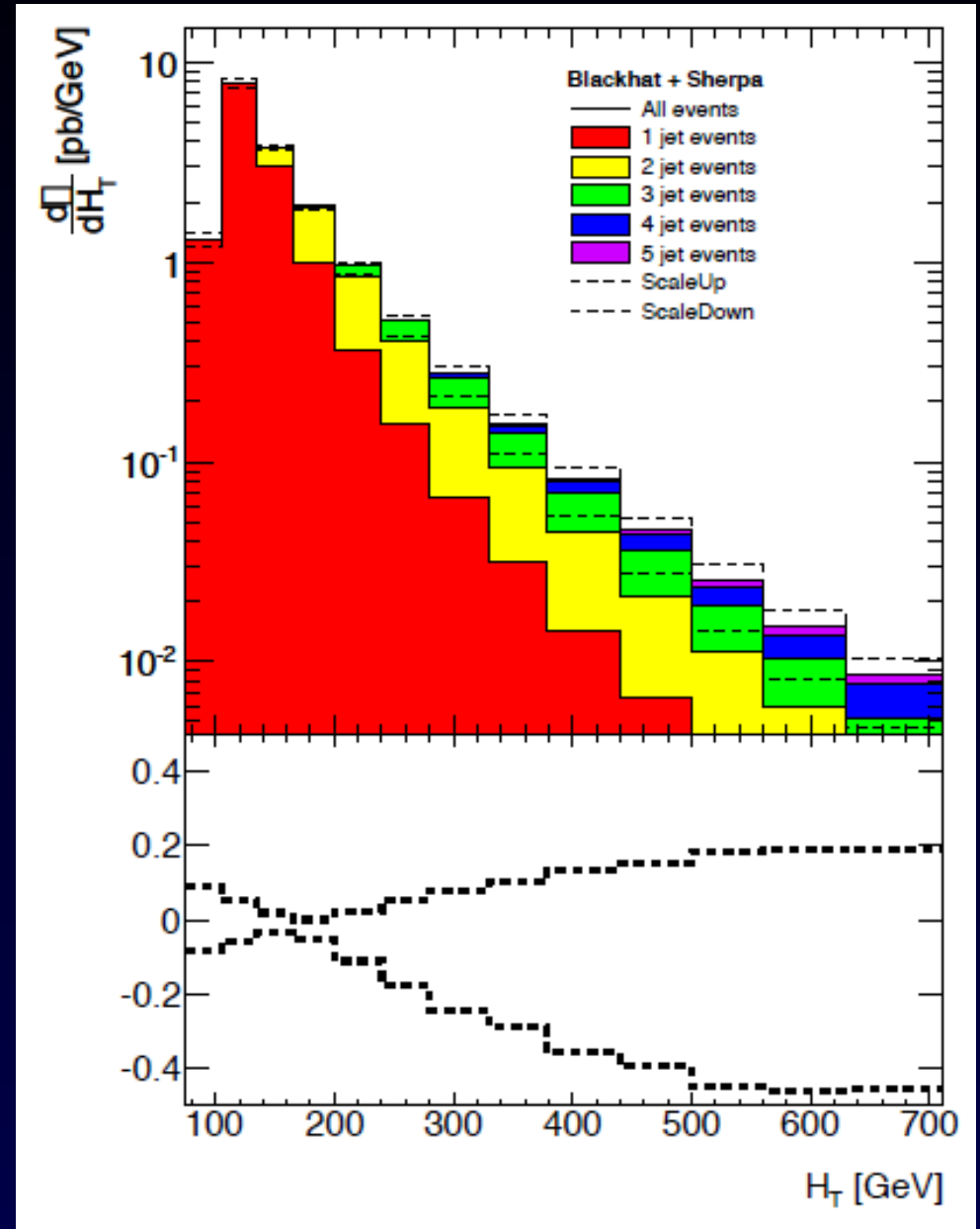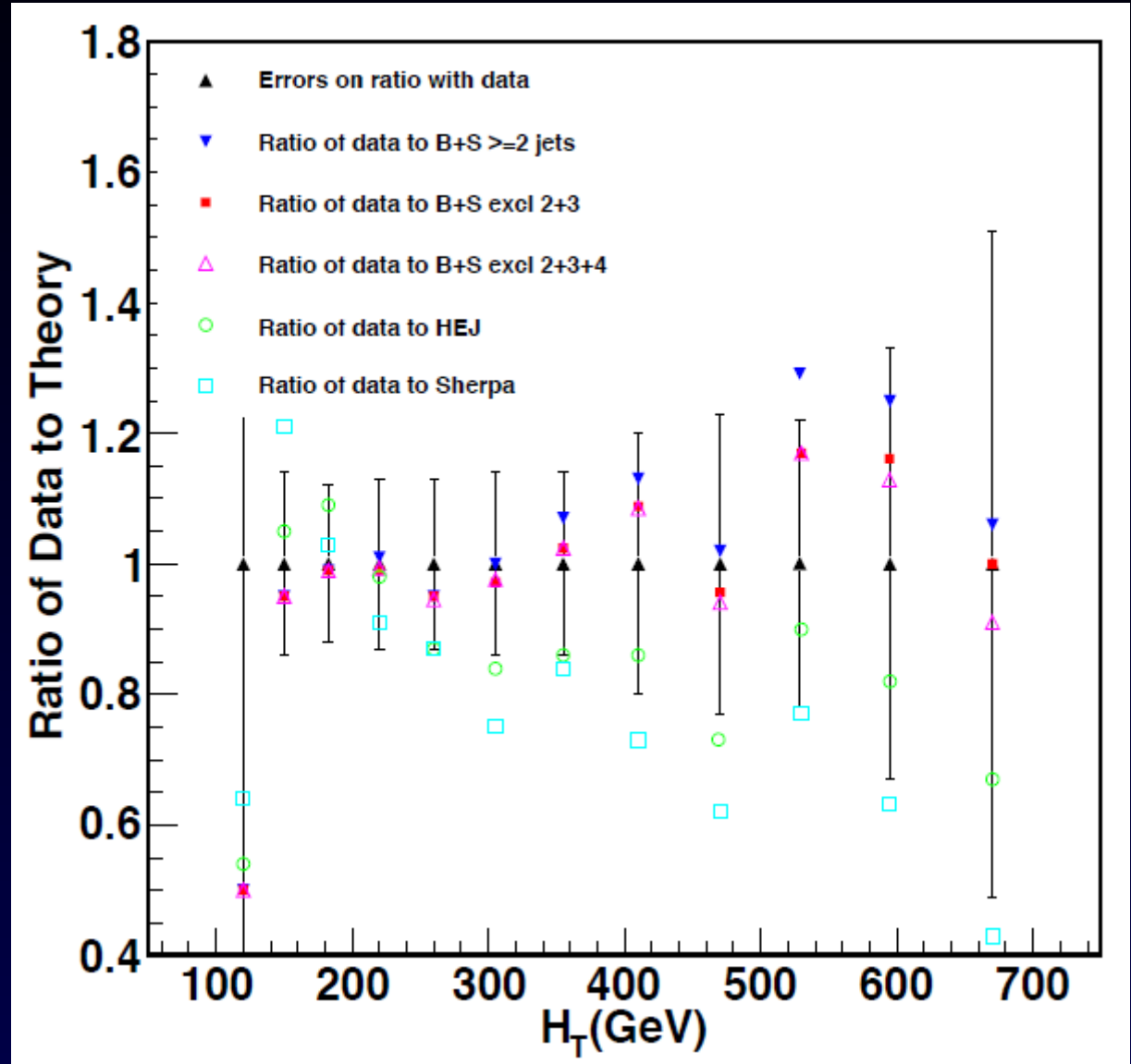
5 jets

W+1j

- Scale variation much larger than at NLO

- Need to be investigated more precisely

- Combination can be made 'official' using LoopSim [Rubin,Salam,Sapeta] (under investigation)
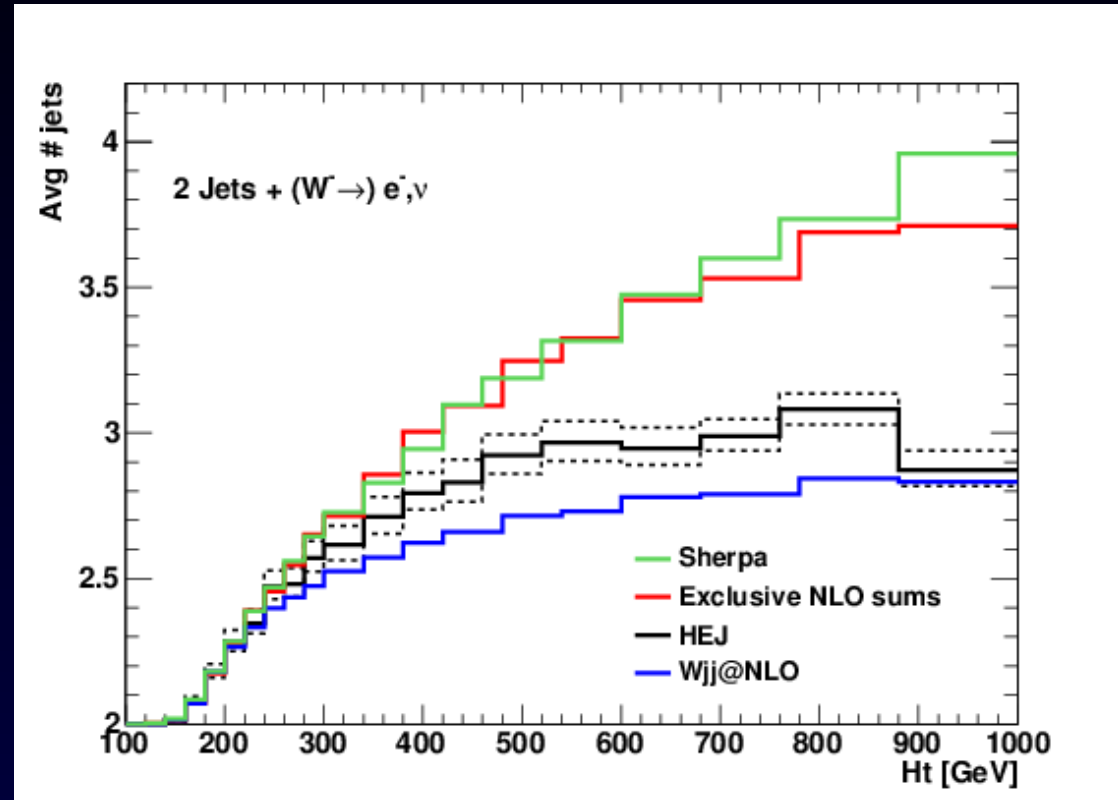
- Better : 'ME+PS'-type merging

Les Houches W+2 jets

- Compare
  - Data
  - BH+S
  - BH+S excl
  - Sherpa ME+PS
  - HEJ
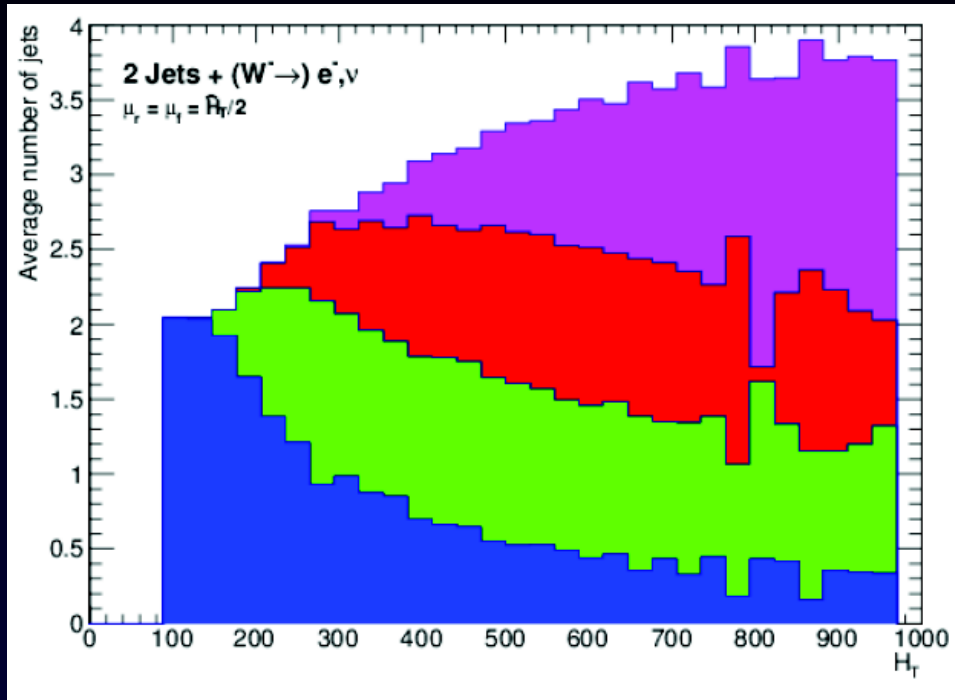- Investigate prospects of using Loopsim for BH+S ntuples

Average number of jets

- Good agreement between Sherpa ME+PS and BH+S exclusive sum

- Clear difference with HEJ and pure NLO

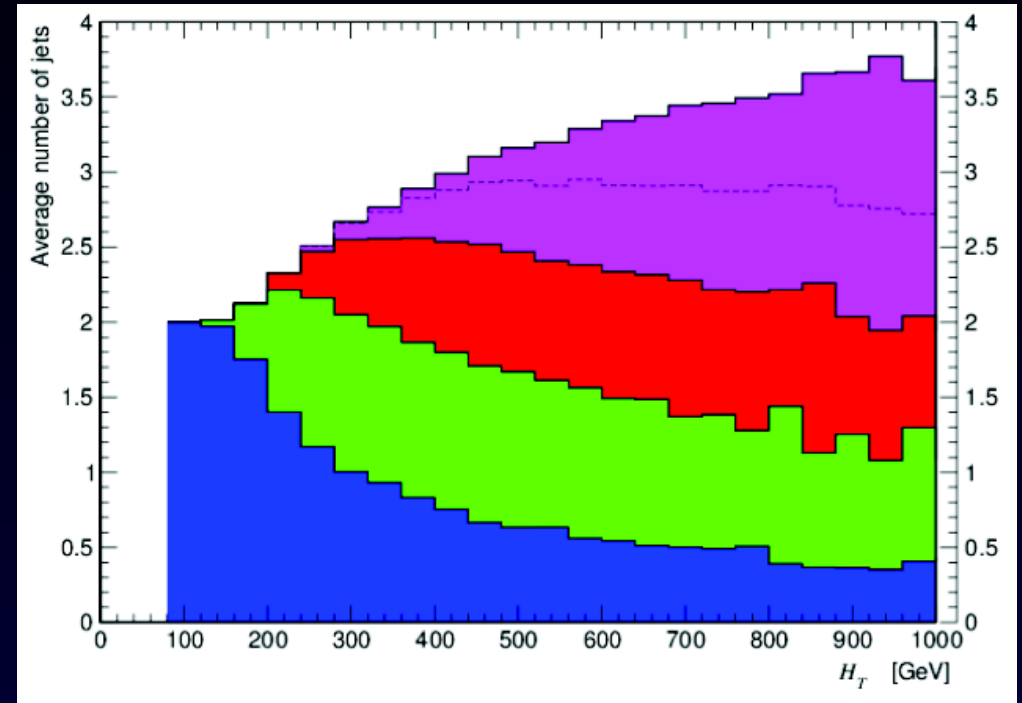- Looking forward to have data points on this plot !

Number of jets in W + >= 2 jets

BH+S exclusive sum
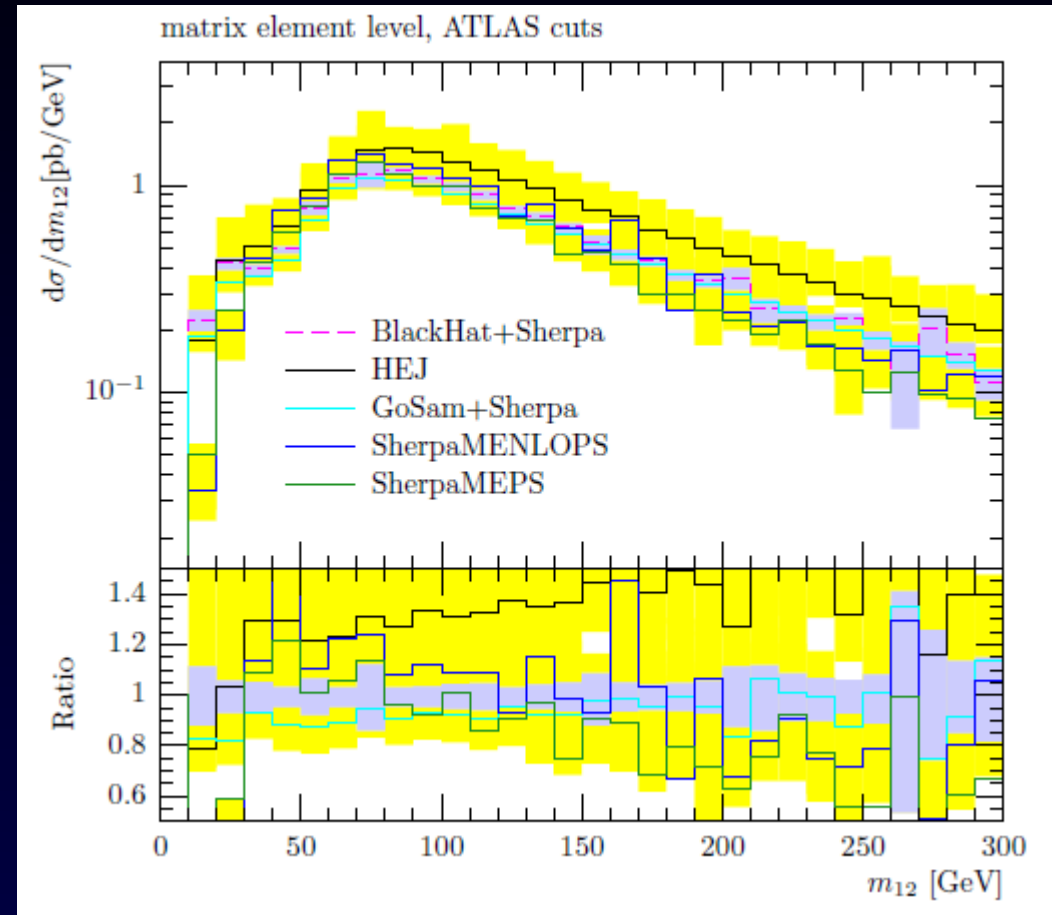
Only first order of Sudakov

Sherpa ME+PS

Sudakov suppression

Uncertainties study

- W+jets

- Uncertainties study

  - Different stage of the simulation

  - Different programs/methods

  - 50 pages !

Conclusions

- Many tools are available for W+jets

- Higher multiplicities available at an increasing rate

- Important to understand the limitations/differences/systematic errors of the different methods

- Good testing ground for theory tools