W + light jets

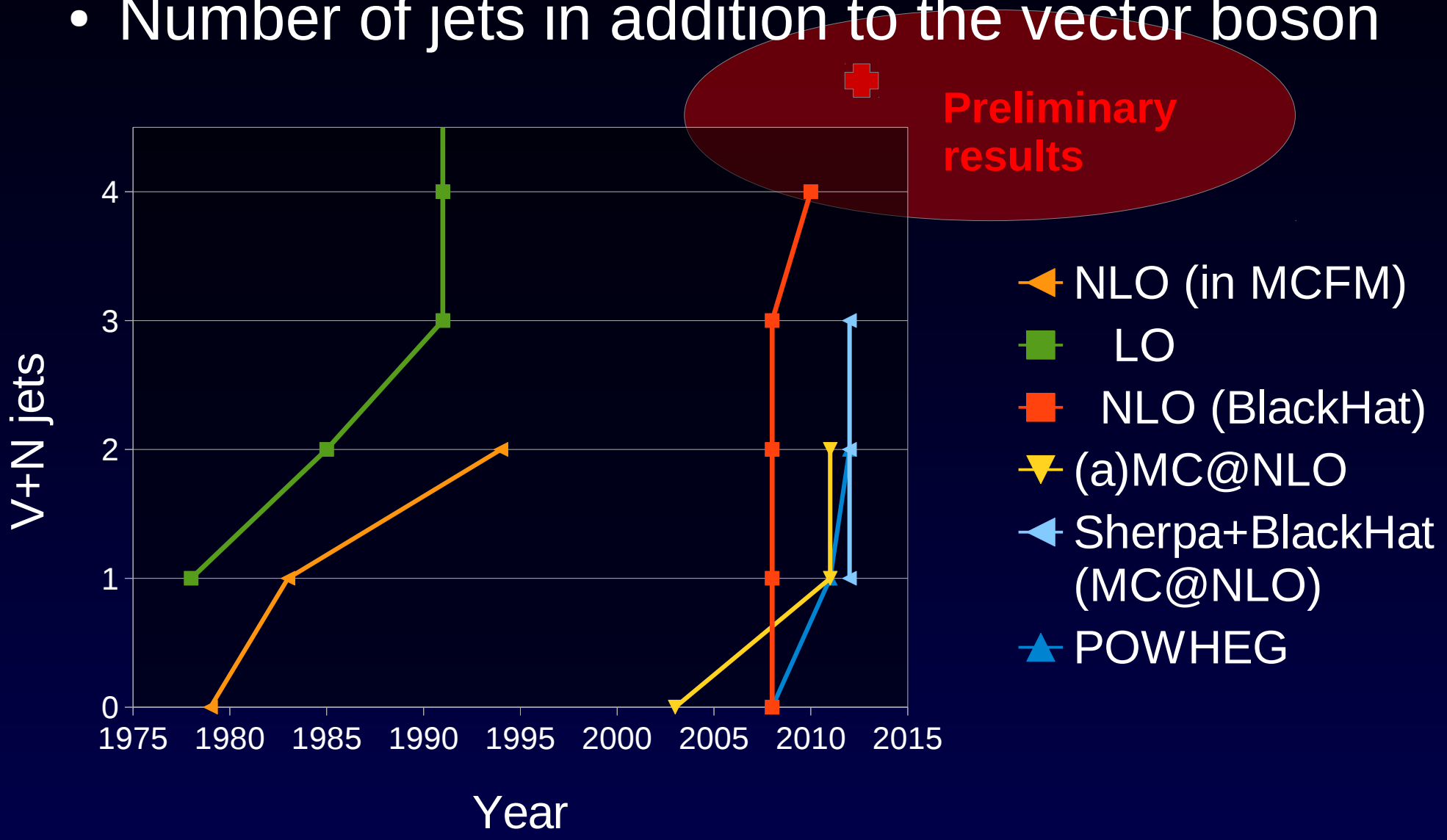
Daniel Maître

CERN/IPPP

LHC EW WG, CERN, 22 Mai 2012

Recent progress

- Number of jets in addition to the vector boson

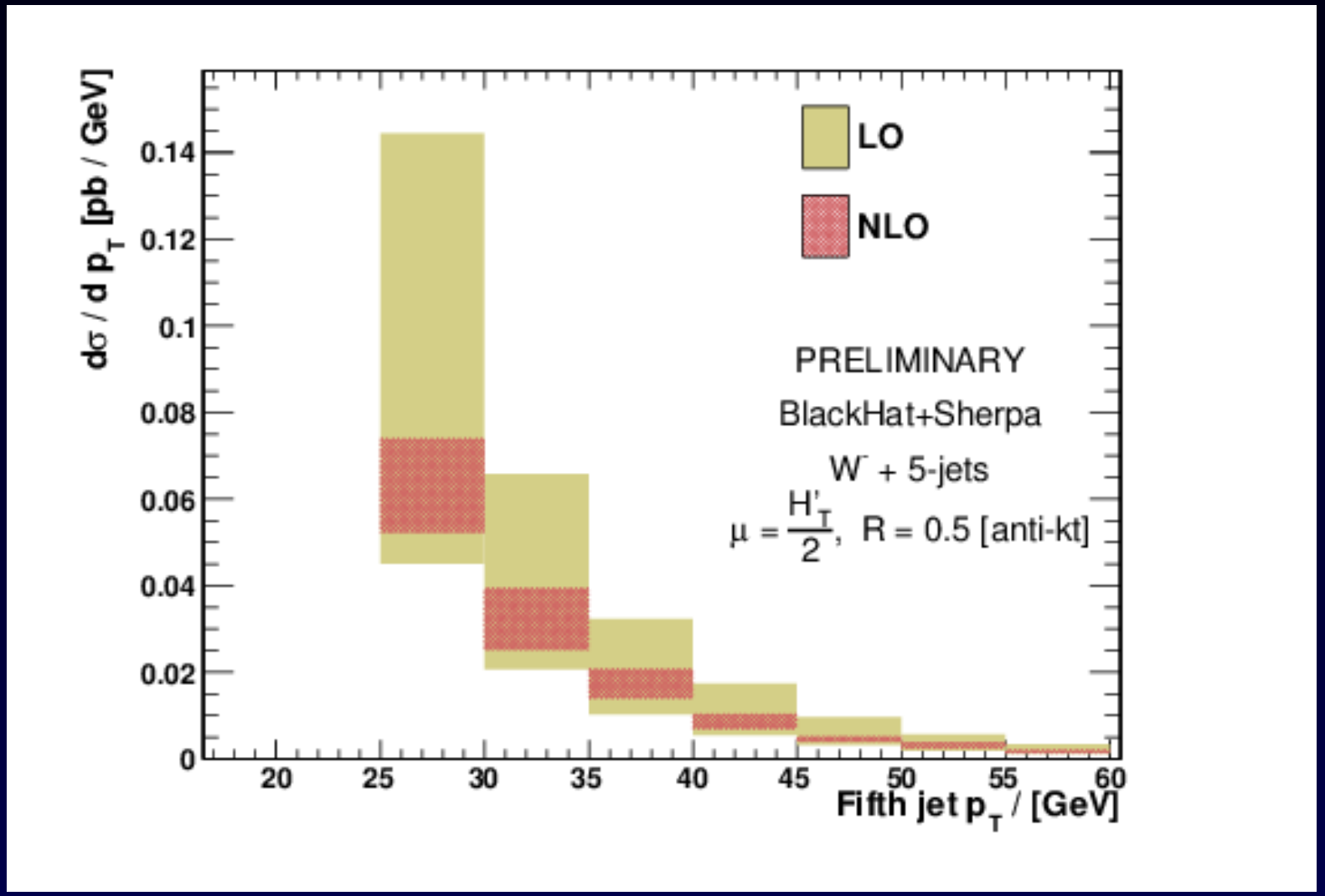


Availability

- W+0,1,2 jets are in MCFM
  [Campbell,Ellis [hep-ph/0202176], virtual matrix elements for W+2 from Bern,Dixon,Kosower [hep-ph/9708239]]
- W+3 jets (with a leading color extrapolation) with ROCKET [Ellis,Melnikov,Zanderighi]
- W+3,4 jets with BlackHat+Sherpa [Berger, Bern, Dixon, Febres Cordero, Forde, Gleisberg, Ita, Kosower, Maître [arXiv:0907.1984,arXiv:1009.2338]]
- W+5 jets in preparation
- ROCKET and BlackHat codes (not yet) public

Preliminary results for W+5 jets

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



Current issues

- Numerical integration CPU intensive for high multiplicities
- Not really doable 'on one desktop computer'
- Need lots of CPUs
- Can't afford to run too often

More availability: BH+S ntuples

- Files containing
  - Kinematic information
  - Information needed to change the factorisation and renormalisation scale, pdf
  - Change jet algorithm
  - Public files
  - C++ library to read them
  - W/Z + 0,1,2,3,4 jets @ LHC
- Already used by several groups

Les Houches studies

ArXiv: 1203.6803

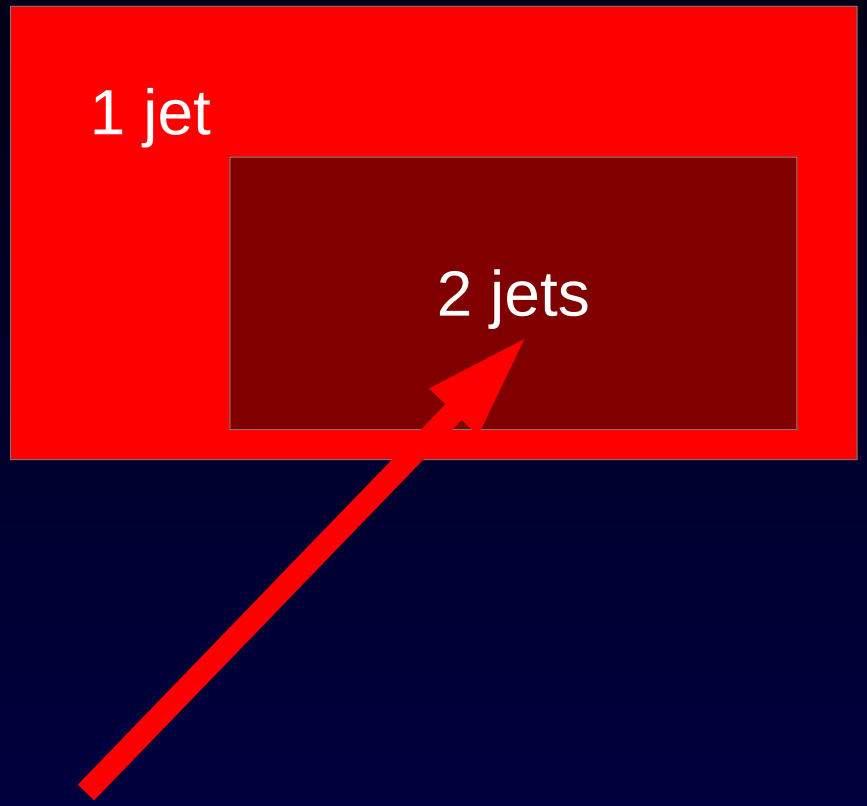
- W+jets production at the LHC : a comparison of perturbative tools
  [Andersen, Huston, Maître, Sapeta, Salam, Smillie, Winter]
- W production in association with multiple jets at the LHC
  [Andersen, Maître, Smillie, Winter]
- Uncertainties in the simulation of W+jets – a case study
  [Alioli, Andersen, 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

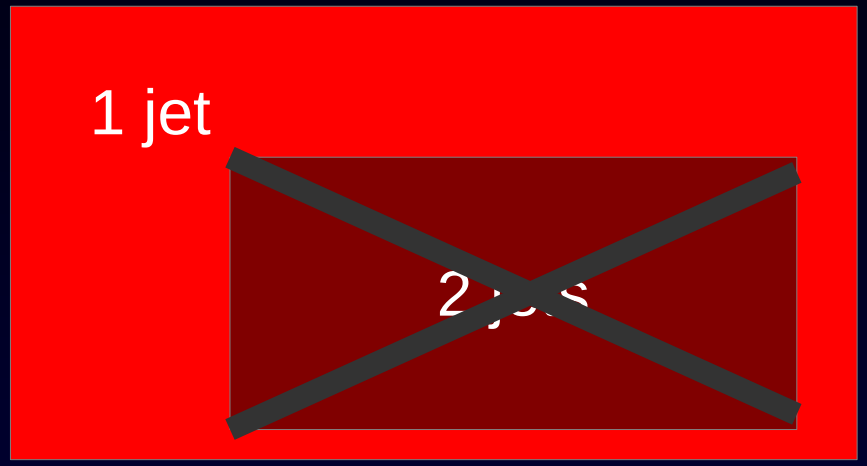
Exclusive sums

- W+1 jet at NLO



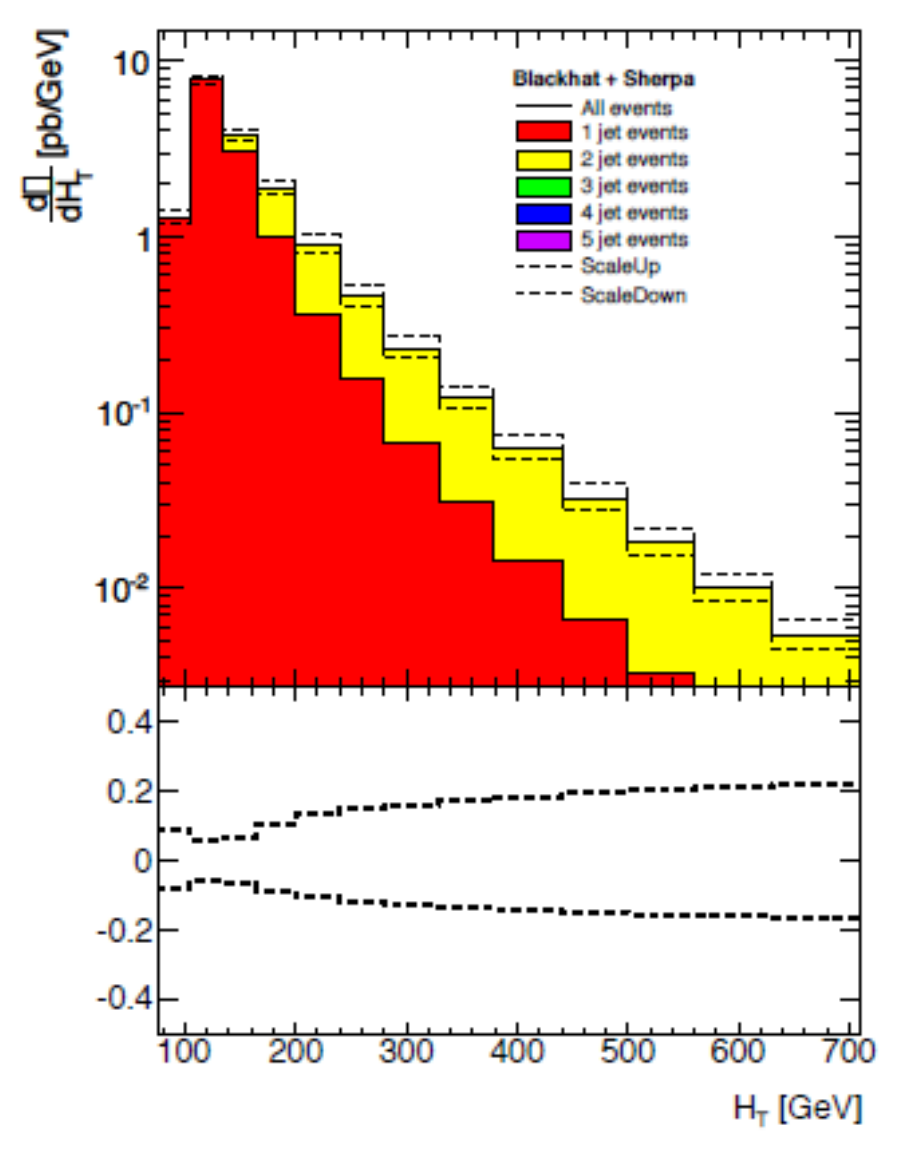
Exclusive sums

- W+1 jet at NLO



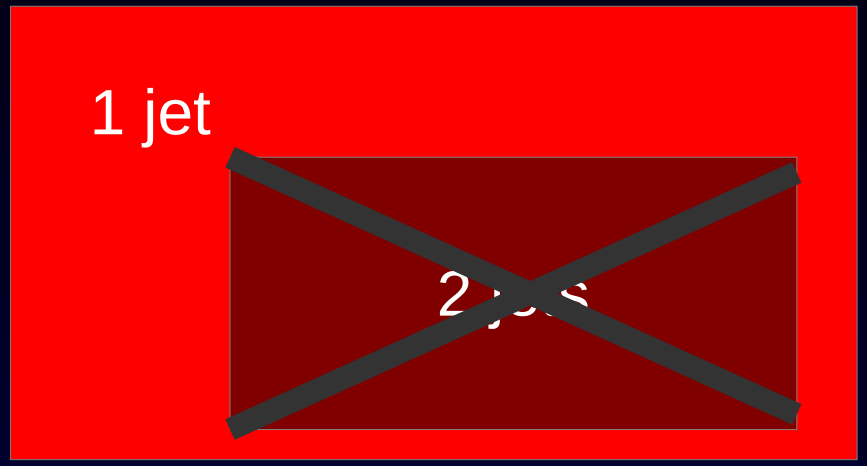
W+2 jets at NLO

W+1 jet

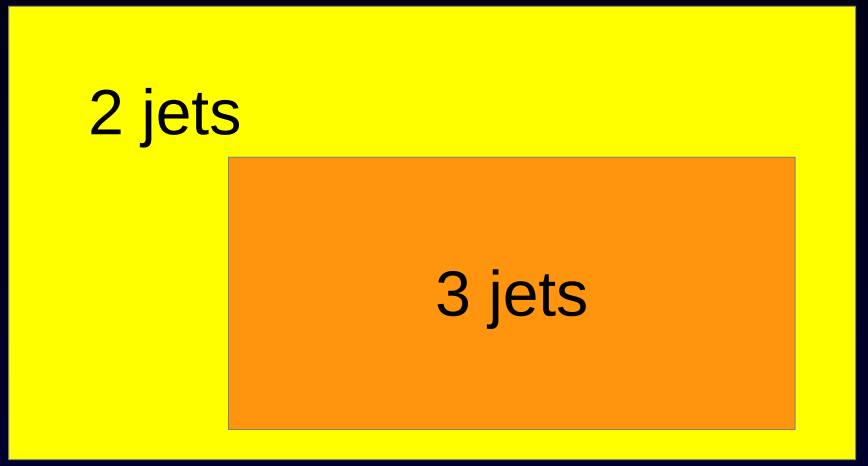

Blackhat + Sherpa
All events
1 jet events
2 jet events
3 jet events
4 jet events
5 jet events
ScaleUp
ScaleDown
$\frac{d\sigma}{dH_T}$ [pb/GeV]
10
1
10^{-1}
10^{-2}
0.4
0.2
0
-0.2
-0.4
100
200
300
400
500
600
700
H_T [GeV]

Exclusive sums

- W+1 jet at NLO

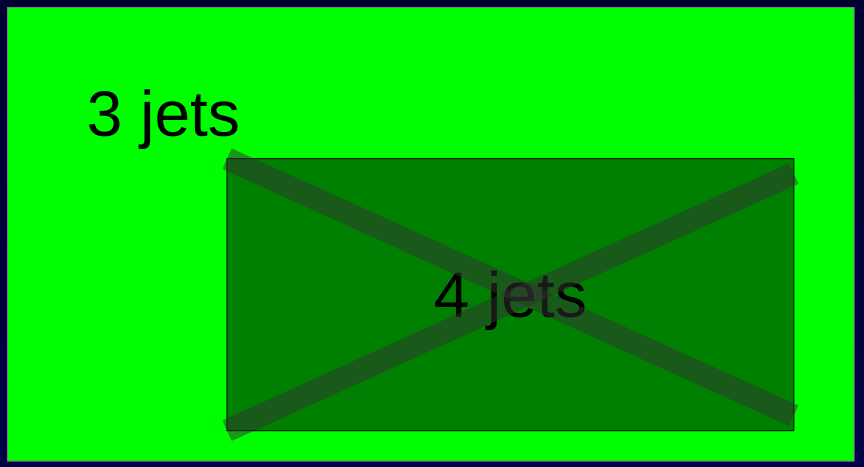


W+2 jets at NLO

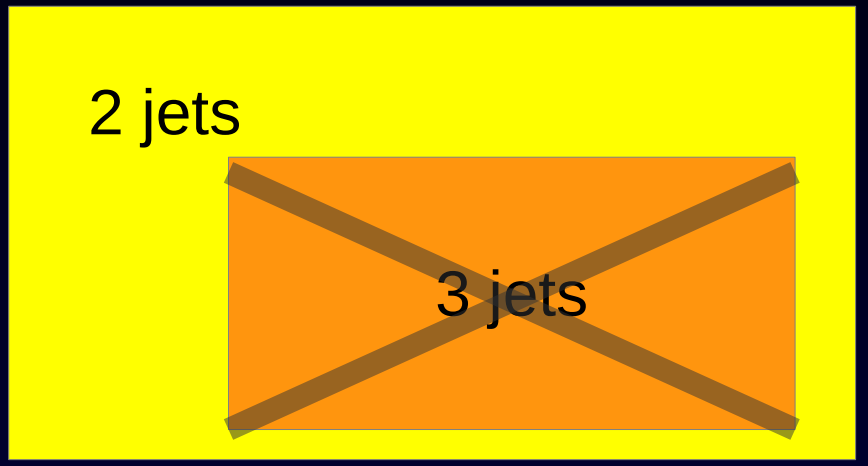


Exclusive sums

- W+1 jet at NLO

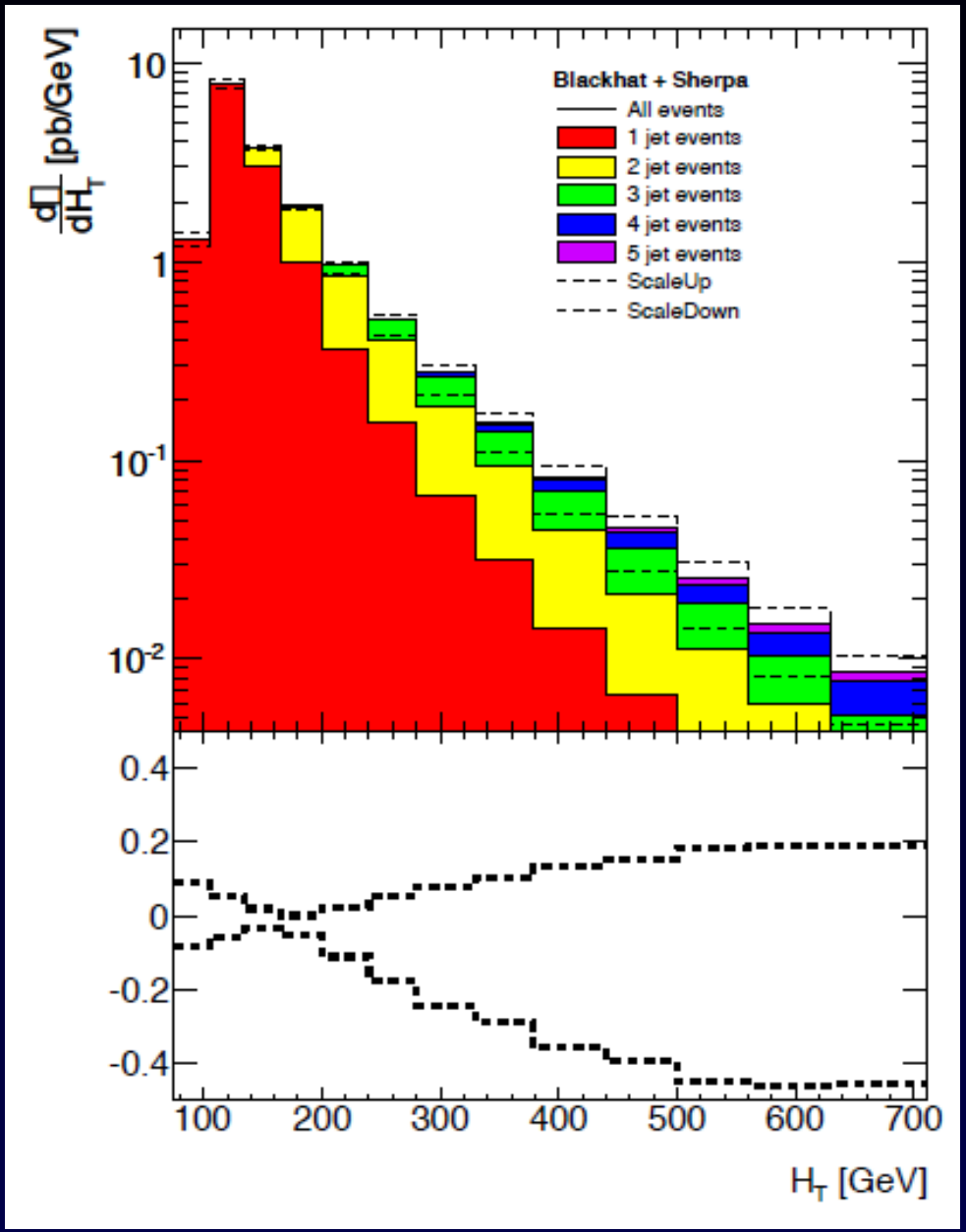


W+2 jets at NLO



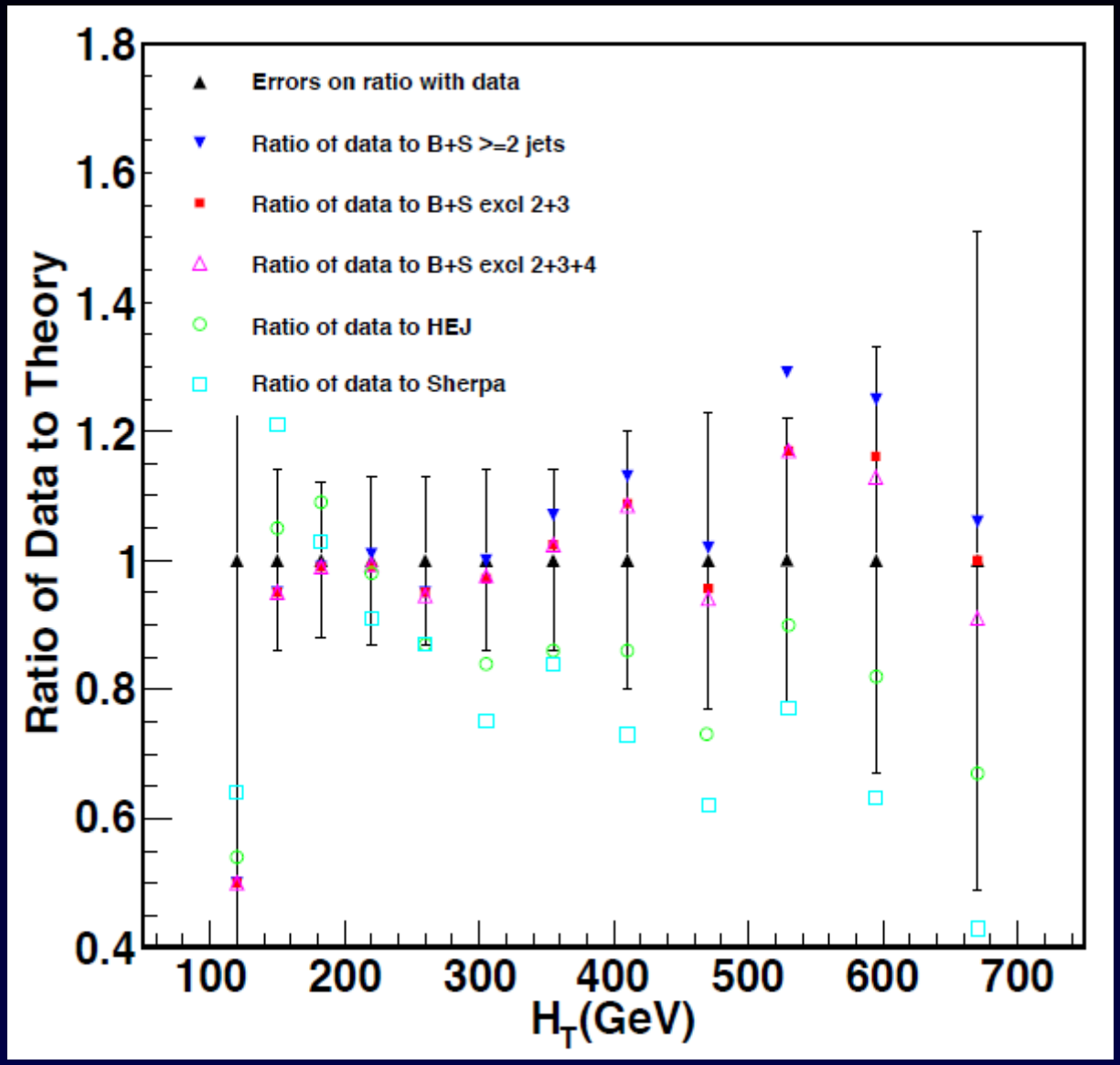
W+1j

- 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



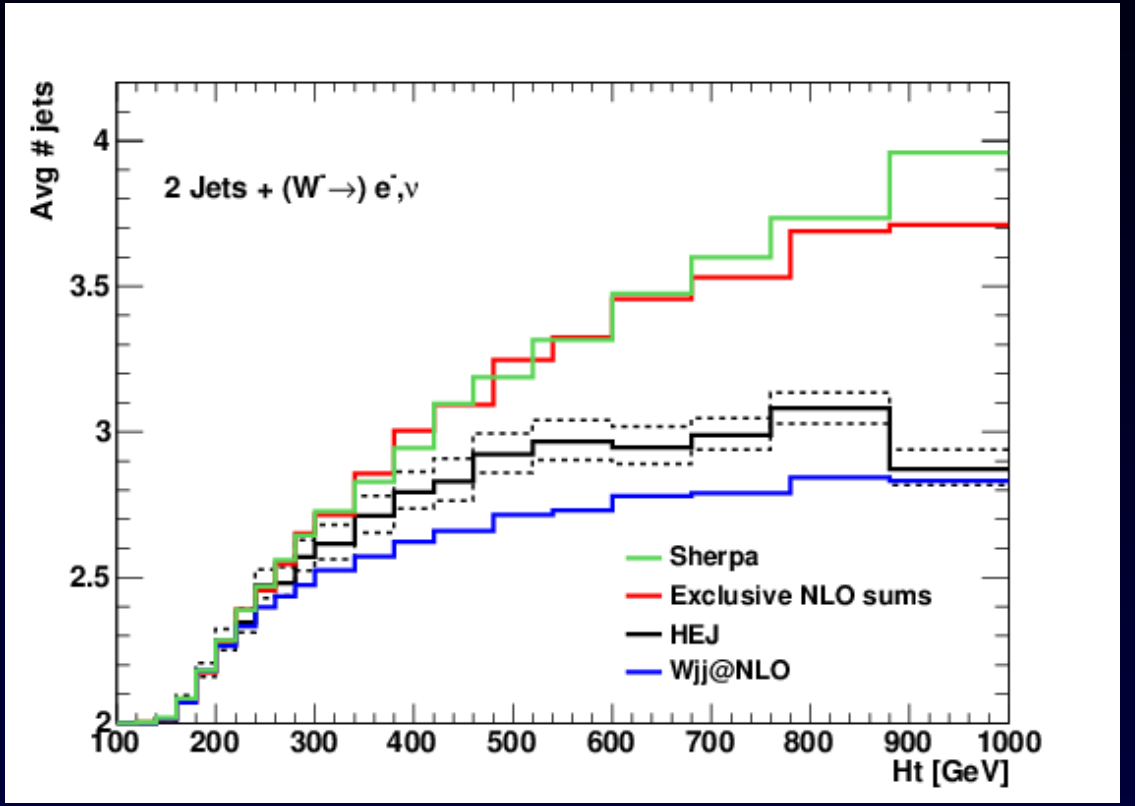
Les Houches W+2 jets

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

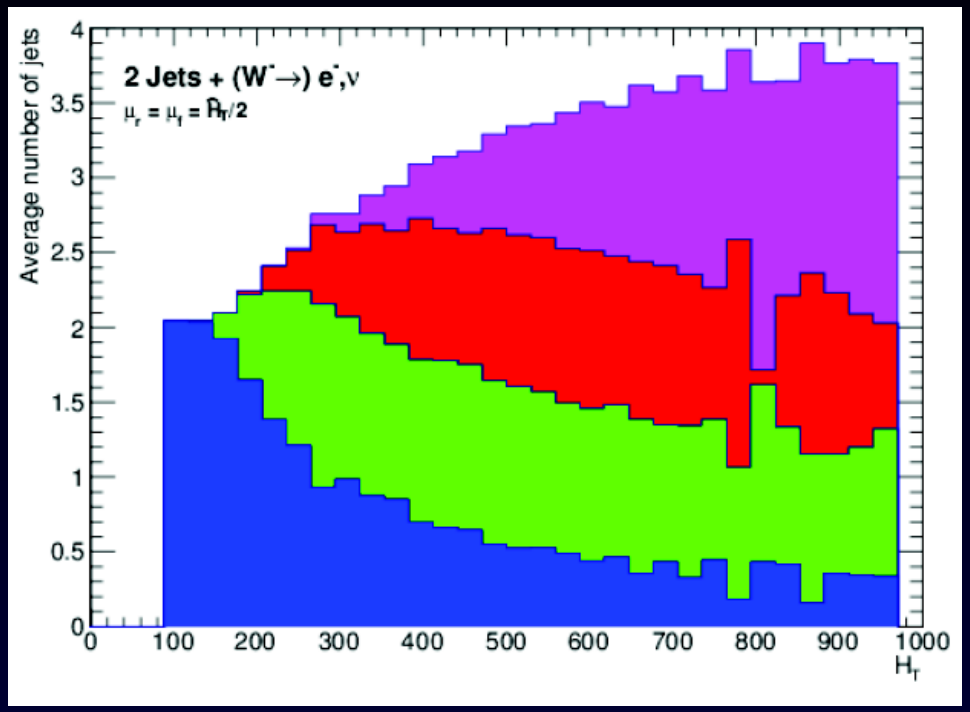


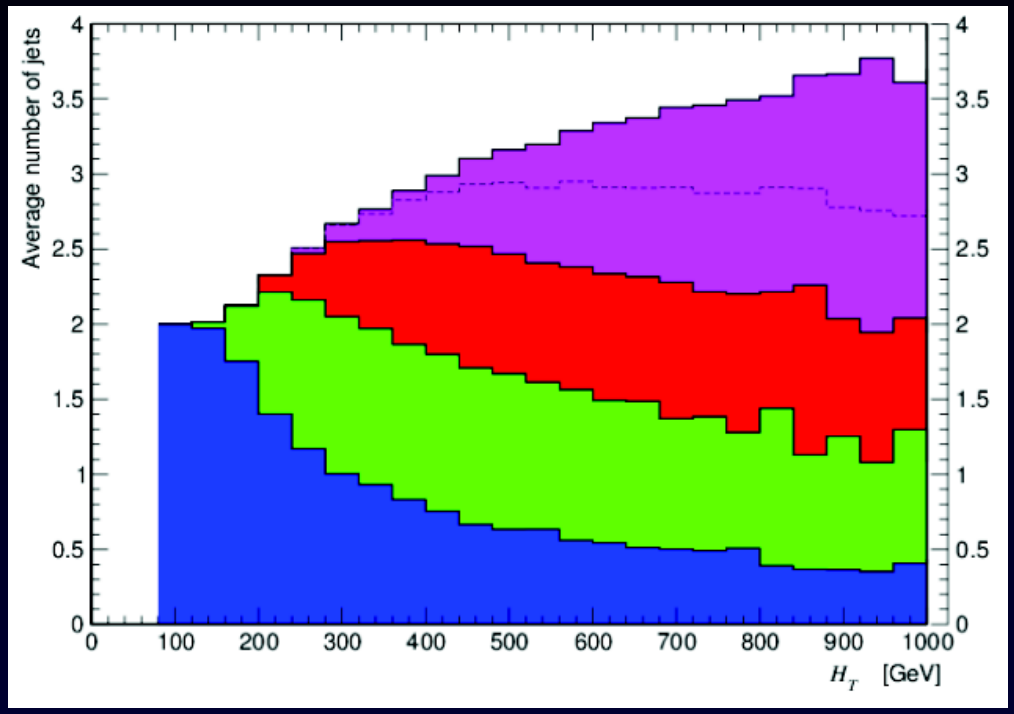
Average number of jets

- 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

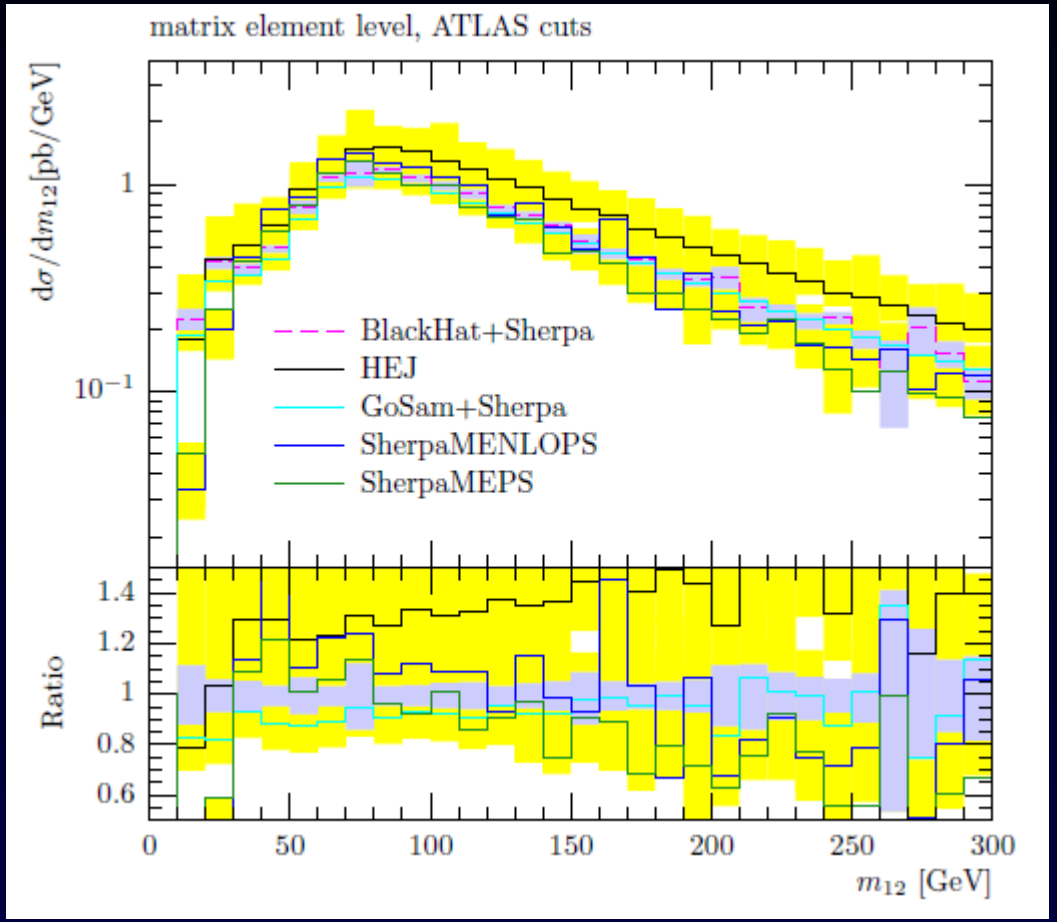
Only first order of Sudakov

Sherpa ME+PS

Sudakov suppression

Uncertainties study

- W+jets
- Uncertainties study
  - Different stage of the simulation
  - Different programs/methods
  - 50 pages !



Conclusions

- Higher multiplicities virtual matrix elements are becoming available at a fast rate for
  - Pure NLO
  - MC@NLO, POWHEG
- Event files are a practical way of making NLO results for high multiplicities available