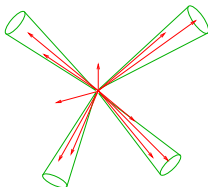


MultiJet Predictions for Higgs Studies

Jennifer Smillie
Higgs Centre for Theoretical Physics
Edinburgh



Marseille

23 April, 2013

MultiJet Studies at the LHC

- ▶ We have no choice but to do precision physics at the LHC!
Have plenty of data to work on...
- ▶ Key opportunity to tune analyses for Higgs-plus-jets: jet vetoes, angular correlations etc.
- ▶ Still learning from TeVatron too!
- ▶ Many theoretical descriptions with different specialities (and combinations!).

MultiJet Studies at the LHC

- ▶ We have no choice but to do precision physics at the LHC!
Have plenty of data to work on...
- ▶ Key opportunity to tune analyses for Higgs-plus-jets: jet vetoes, angular correlations etc.
- ▶ Still learning from TeVatron too!
- ▶ Many theoretical descriptions with different specialities (and combinations!).

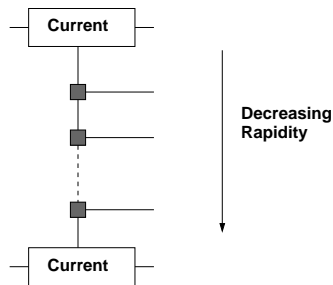
TODAY: High Energy Jets, W +jets analyses, Higgs+jets comps.

High Energy Jets

Andersen & JS – arXiv:0908.2786, 0910.5113, 1101.5394, 1206.6763 (+Hapola)

Amplitudes factorise in the High Energy limit:

$$s_{ij} \rightarrow \infty, p_{\perp i} \text{ fixed}, \forall \text{ partons } i, j$$



- ▶ Exploit this to approximate ME
- ▶ $2 \rightarrow n$ for any n is simply

$$j^\mu j_\mu \prod V^\nu$$

- ▶ Exact for $2 \rightarrow 2$

High Energy Jets

Andersen & JS – arXiv:0908.2786, 0910.5113, 1101.5394, 1206.6763 (+Hapola)

Factorisation also applies to virtual corrections
(also necessary to regulate soft real emissions)

⇒ Together all pieces give all-order resummation of $\alpha_s^n \log^n \left(\frac{s}{t} \right)$

High Energy Jets

Andersen & JS – arXiv:0908.2786, 0910.5113, 1101.5394, 1206.6763 (+Hapola)

Factorisation also applies to virtual corrections
(also necessary to regulate soft real emissions)

⇒ Together all pieces give all-order resummation of $\alpha_s^n \log^n \left(\frac{s}{t}\right)$

Fully flexible MC implementation available at

<http://cern.ch/hej>

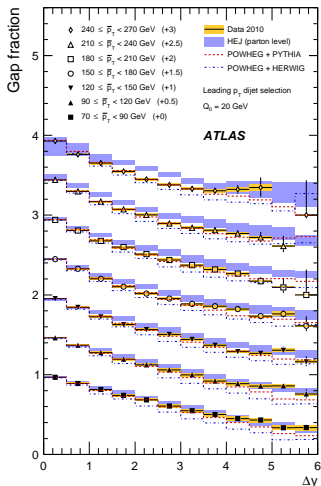
for Higgs+jets (**new!**), W +jets, pure jets

But what does it actually do?

- ▶ Sums the large contributions from hard emissions at wide angles, i.e. large s_{ij}
We cannot ignore higher orders in perturbation theory!
- ▶ “Opposite” of parton shower = soft/collinear
- ▶ Increasingly important with increasing collision energy
- ▶ Includes ME matching to LO for 2,3,4 jets

Can be combined, see [Andersen, Lönnblad, JS, arxiv:1104.1316](#)

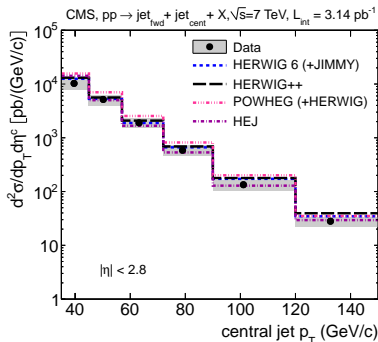
LHC Jet Analyses



Early jet analyses now well-known:

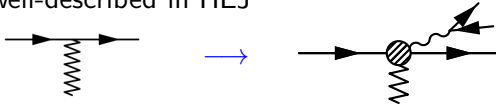
← ATLAS [arXiv:1107.1641](https://arxiv.org/abs/1107.1641)

↓ CMS [arXiv:1202.0704](https://arxiv.org/abs/1202.0704), [1204.0696](https://arxiv.org/abs/1204.0696)



W Plus Jets

W+jets also well-described in HEJ

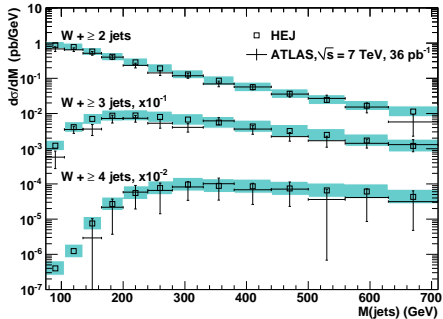


Andersen, Hapola & JS arXiv:1206.6763

ATLAS data

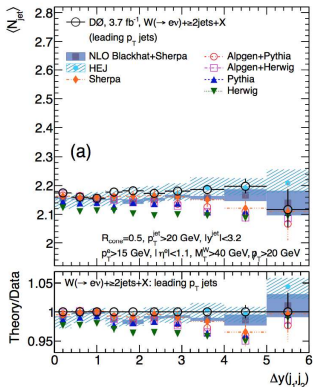
arXiv:1201.1276

Note large impact of higher orders!



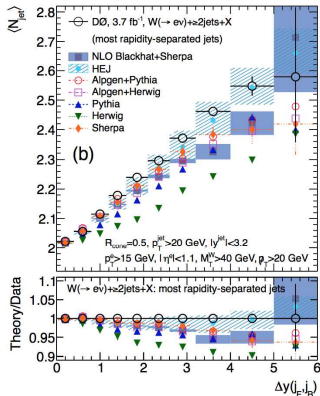
Recent TeVatron $W+{\text{Jets}}$ Results

D0 arXiv:1302.6508



Difference between:

Leading jets



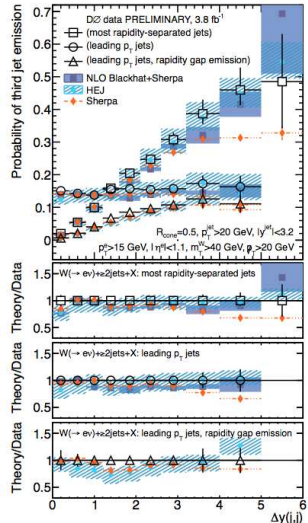
Most forward/backward jets

Recent Tevatron $W+J$ ets Results

D0 arXiv:1302.6508

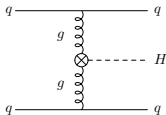
Probability of third jet emission
vs. Δy of

1. most forward/backward jets
2. hardest jets
3. hardest jets, counting only jets between

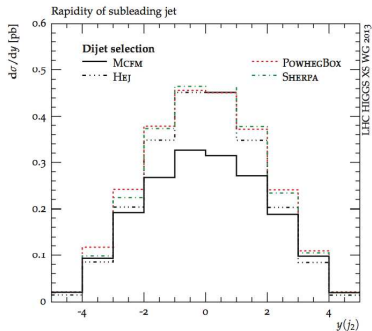
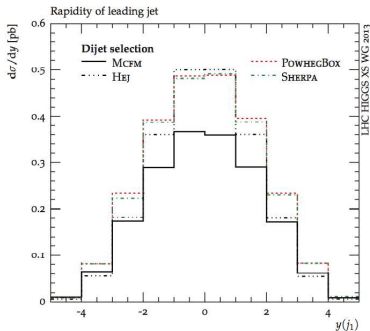


Preparation for Higgs+Jets Data

Have seen large rapidity spans = large jet activity



From YR3 Higgs XS WG 2013:

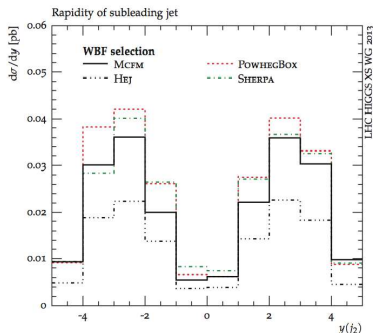
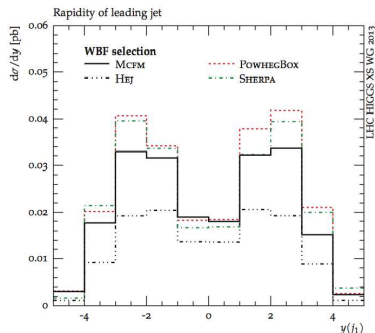


Inclusive 2 jets, $p_T > 25$ GeV, $|y| < 5$

Preparation for Higgs+Jets Data

Add weak boson fusion cuts, $|\Delta\eta_{jj}| > 2.8$, $m_{jj} > 400$ GeV

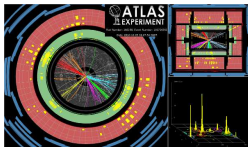
From YR3 Higgs XS WG 2013:



Roughly 10% for MCFM, POWHEG & SHERPA, 6% for HEJ.

Summary

- ▶ Have already seen effect of hard QCD radiation in 7 TeV data
- ▶ High Energy Jets offers flexible MC description of this
- ▶ Recent and ongoing studies show effects beyond pure NLO
- ▶ Important applications to Higgs-plus-jets studies:
Currently see deviations in theoretical descriptions



testing

