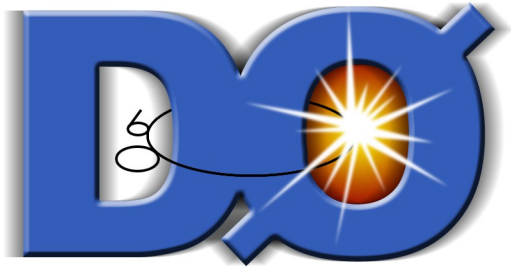


W/Z+jets MC and constraints from data

Samuel Calvet

October 24th 2008

Talk inspired from the J-F Grivaz's one
@10-25 years of DØ France, Paris

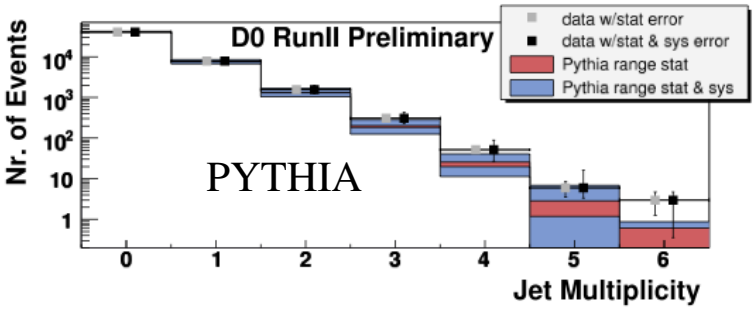
OutLine

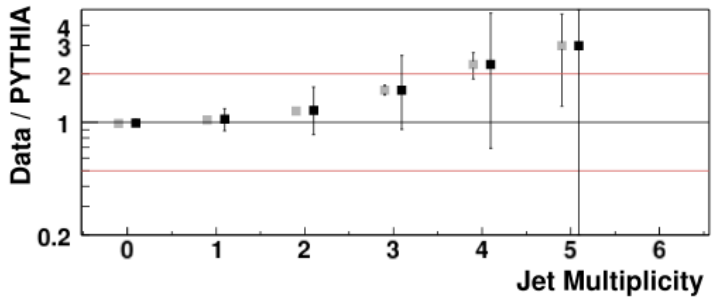
- Some definitions...
- Feedbacks from Z studies
  - Comparison data/MC
  - How do we improve our MC ?
- From Z to W
- Measurement of heavy flavor production (Z+b, W+b)

Some definitions... (boring but useful !)

- The MC based on Matrix Elements (ME) are LO/LL, so "k-factors" are needed
- Different ones for heavy flavor, for scaling data,... convention to avoid confusion, was adopted by D0 [J-F Grivaz]:
  - k-factor is purely **theoretical**, and denotes a (N)NLO/LO ratio of cross-sections
  - k'-factor is also **theoretical**, and denotes a (N)NLO/LL ratio of cross-sections. ALPGEN is ~LL
  - s-factor is **empirical**, and comes on top of k or k' to bring MC in agreement with data. (MC should be initially normalized to luminosity and all correction should be applied)
  - HF-factor is in principle theoretical, but in practice only **theory inspired**. It tells you by how much the heavy flavor production should be increased on top of k or k' and possibly s
  - s_{HF}-factor is **empirical**, and comes on top of k or k', s and HF to bring MC in agreement to data, after b-tagging

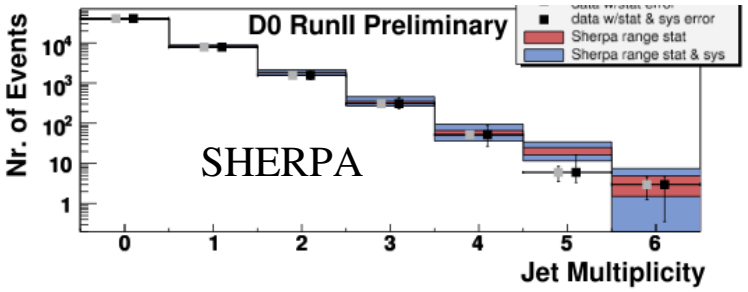
Data/MC comparison : Z→ee, jet pT>15GeV, detector level

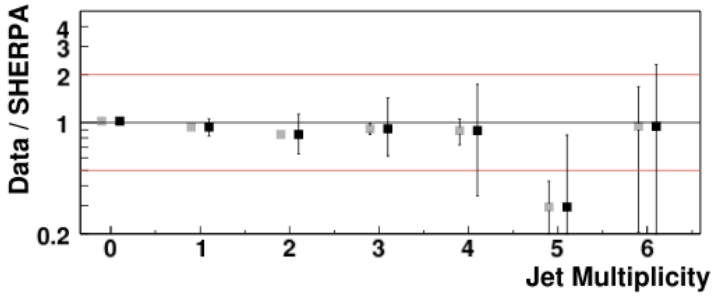




PYTHIA v6.314

PYTHIA too soft (As expected)



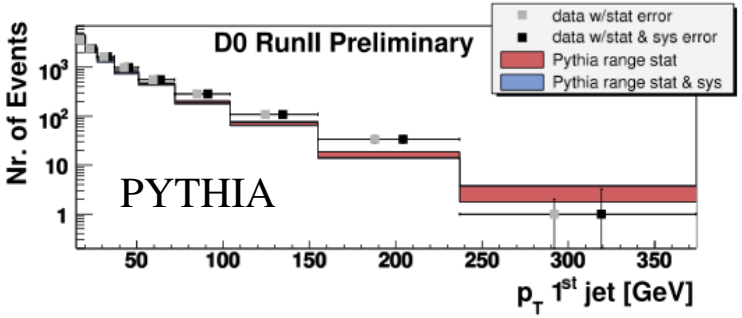


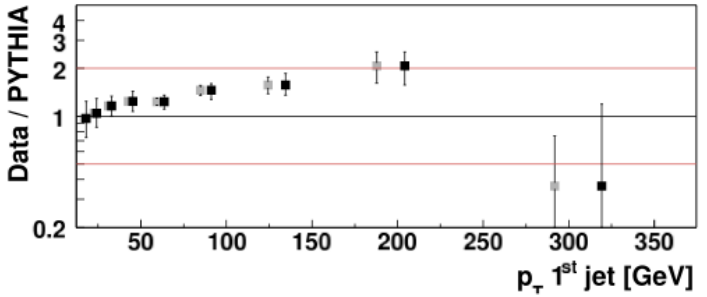
SHERPA v1.0.6

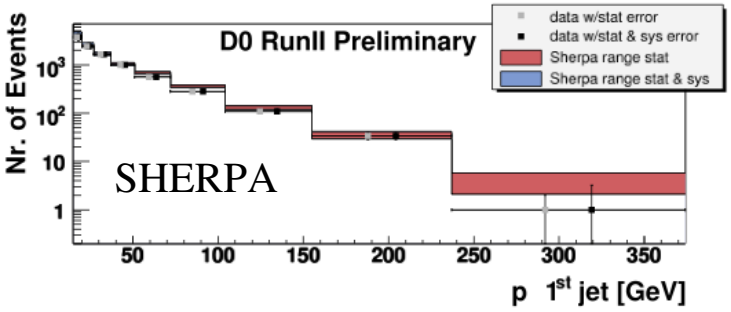
SHERPA a bit too hard

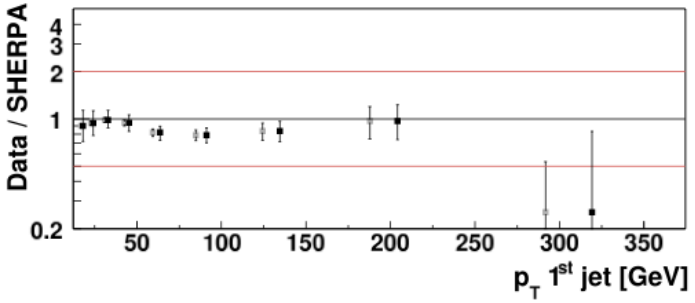
k(')-factors included

MC and constraints fro

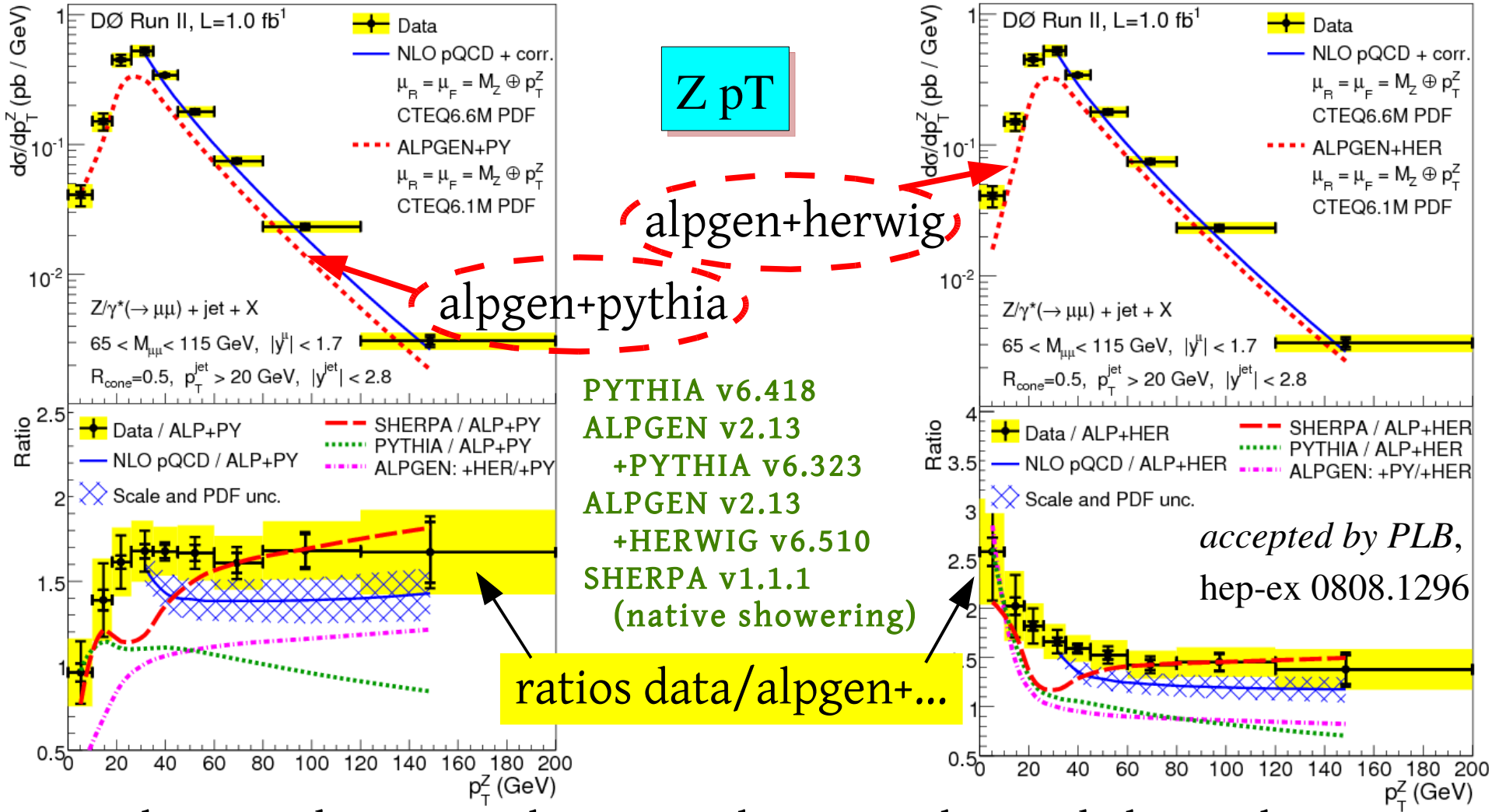








Data/MC comparison : Z→$\mu\mu$, ≥1jet, jet pT>20GeV, unfolded

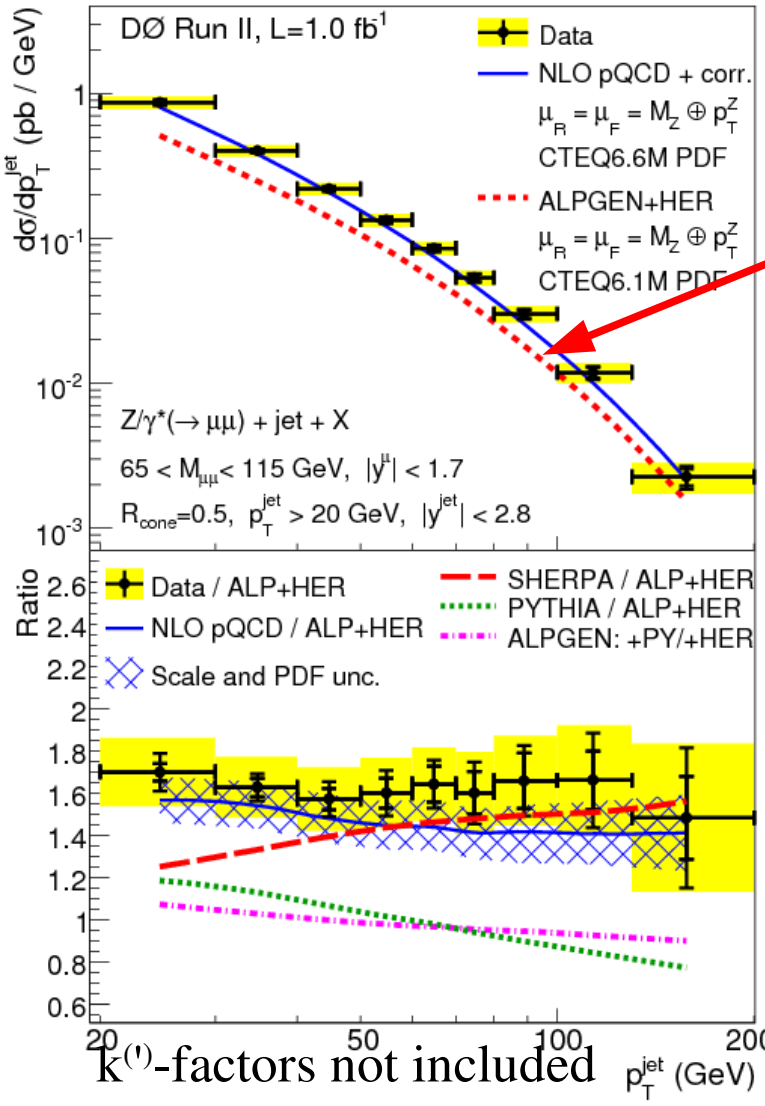


- At low pT, data are in between alpgen+pythia and alpgen+herwig
- Above ~40GeV the ratio is flat→ equivalent to a scale factor ~1.5

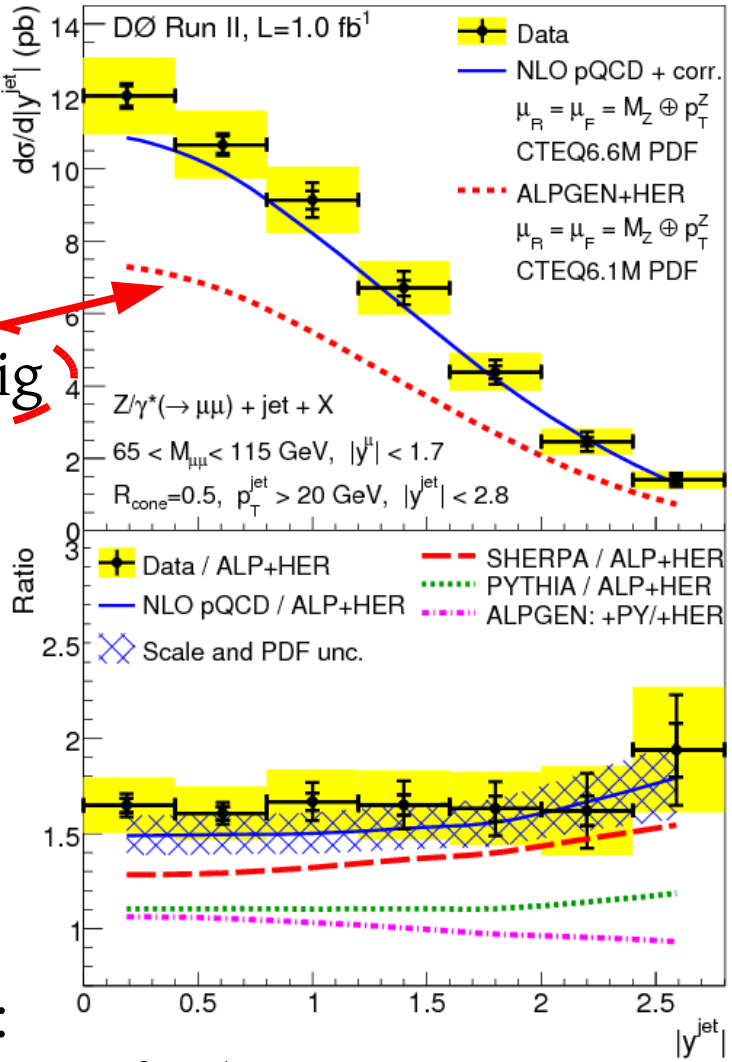
Data/MC comparison : Z→$\mu\mu$, ≥1jet, jet pT>20GeV, unfolded

jet 1 pT

accepted by PLB, hep-ex 0808.1296



alpgen+herwig



jet 1 pT and η: Alpgen+herwig in fairly good agreement with data

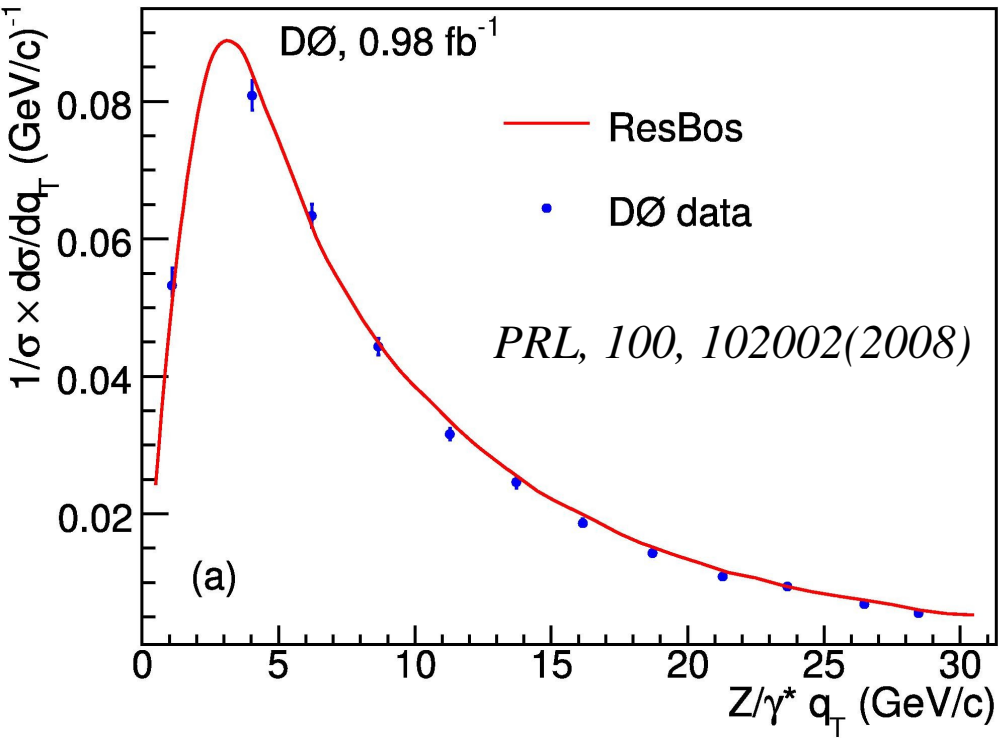
jet 1 |η|

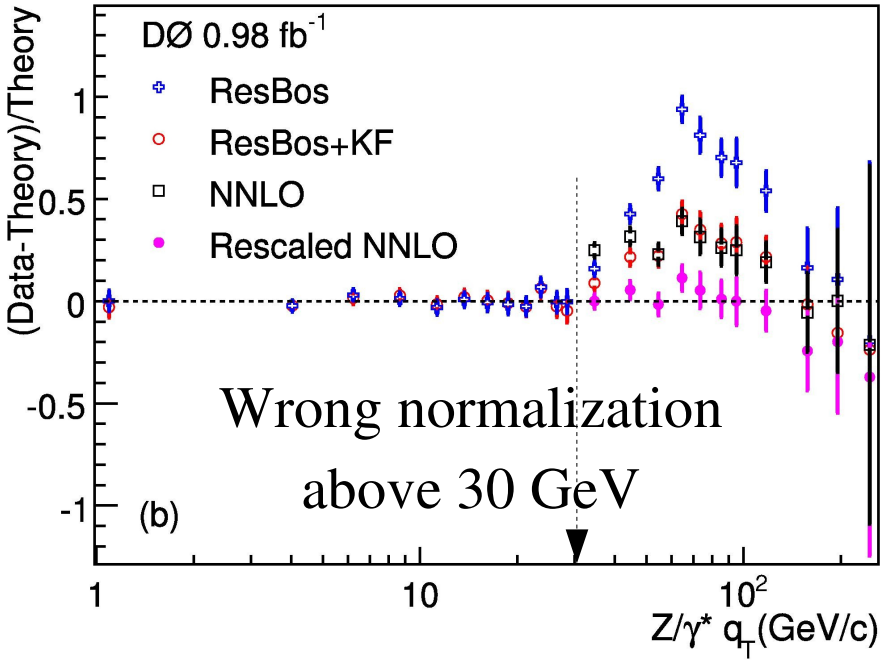
k(1)-factors not included

How do we improve our MC ?

- Sherpa, Alpgen+... are "improved LO" (almost LL) MC
- It is not surprising they can not describe perfectly the data

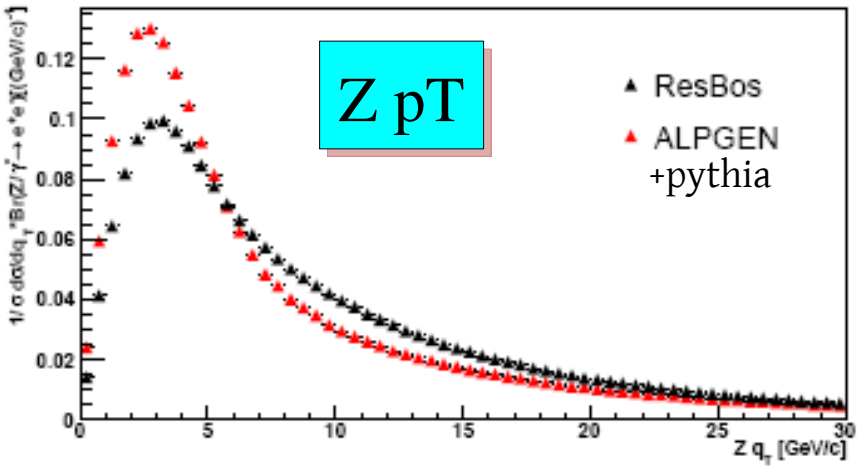
- Fix : include NLO information into our LO MC
  - ResBos gives a ressummed differential cross-section of the Z boson in agreement to the data, in the low Z pT region

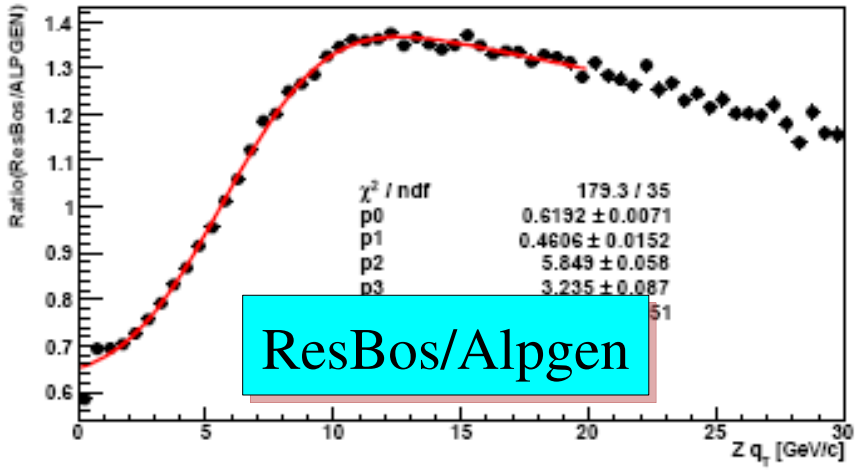




How do we improve our MC ? (here, alpgen+pythia)

- One can reweight alpgen events according to ResBos Z pT, in the low pT region
- Use the unfolded data to describe the pT above 30 GeV





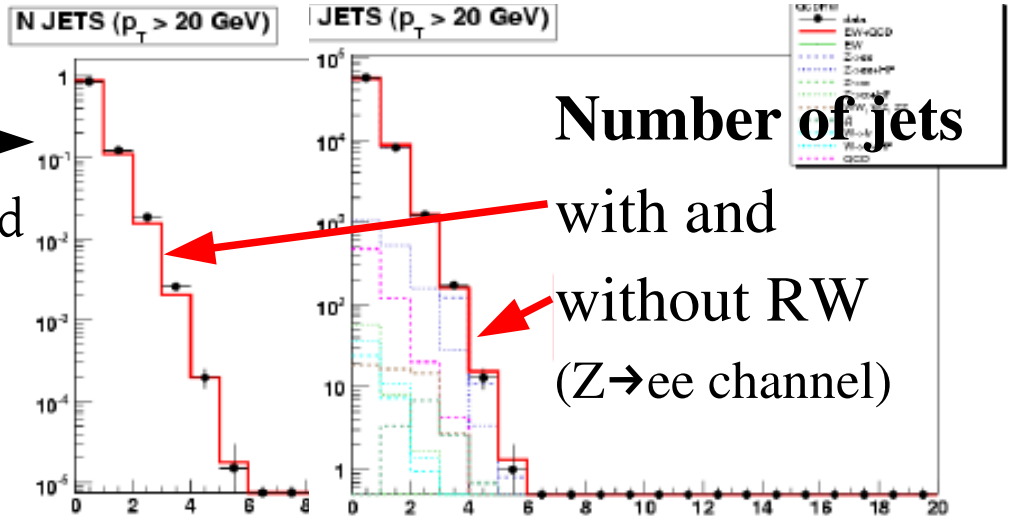
DØ WORK IN PROGRESS

How do we improve our MC ? (here, alpgen+pythia)

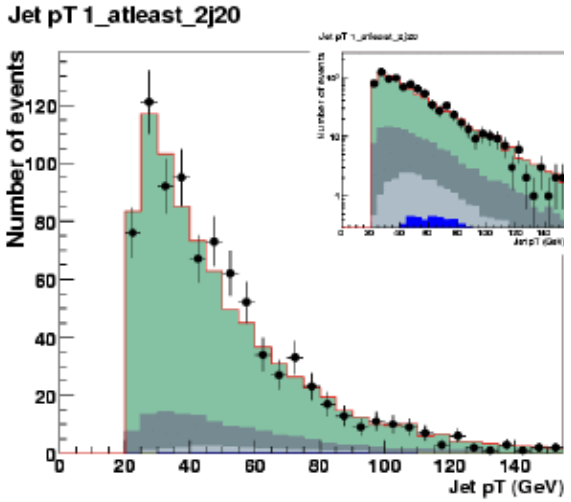
- After Z pT reweighting (RW):
  - Jet multiplicity improved
  - No additional scale factor needed

k'-factors included

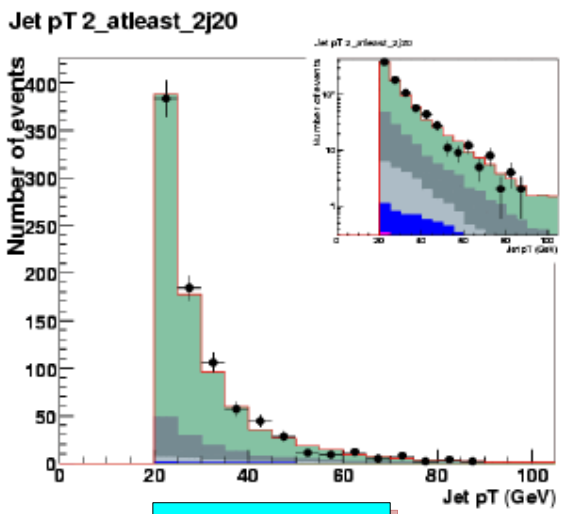
DØ WORK IN PROGRESS



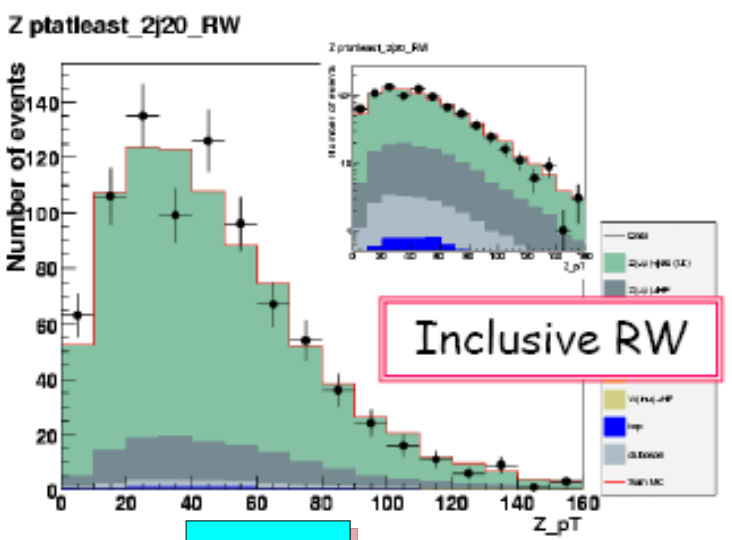
- Z→$\mu\mu$+≥2jets : no additional scale factor (~1.2 before reweighting)



jet 1 pT



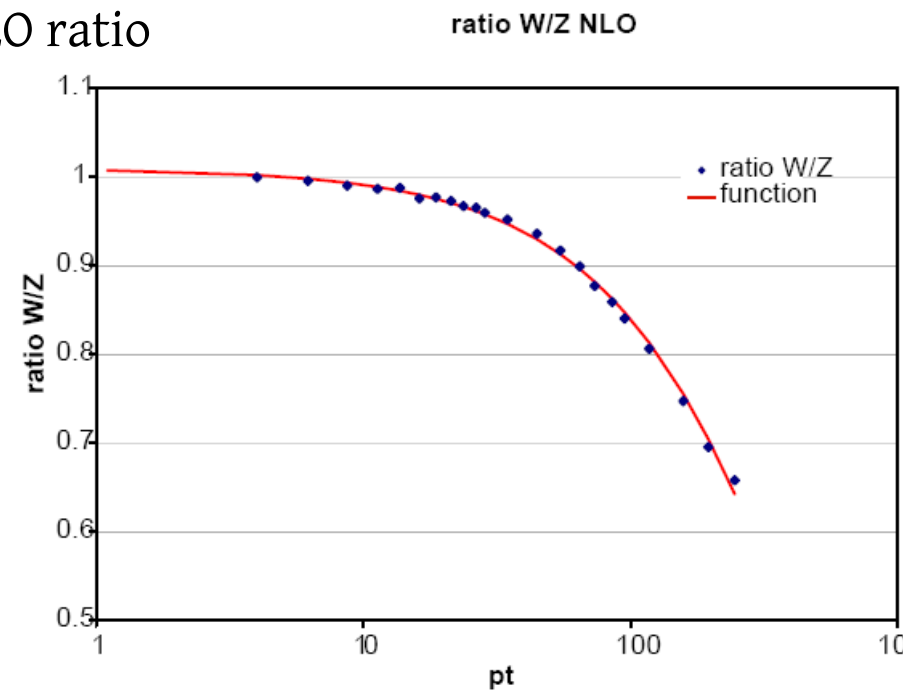
jet 2 pT



Z pT

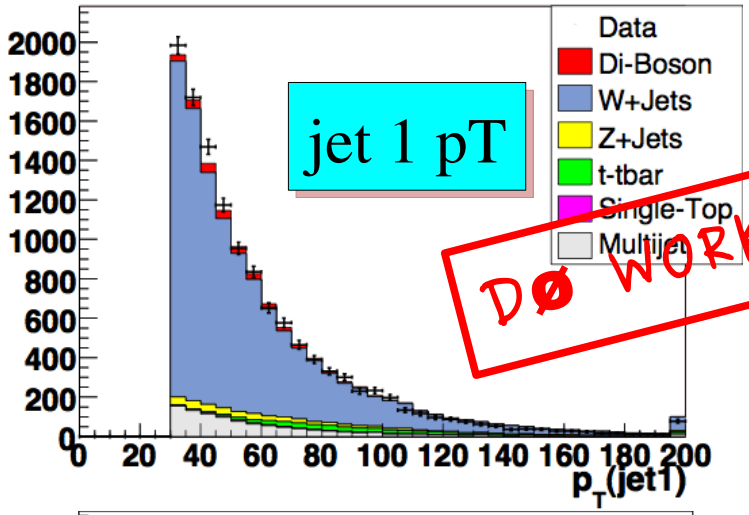
From Z to W simulation

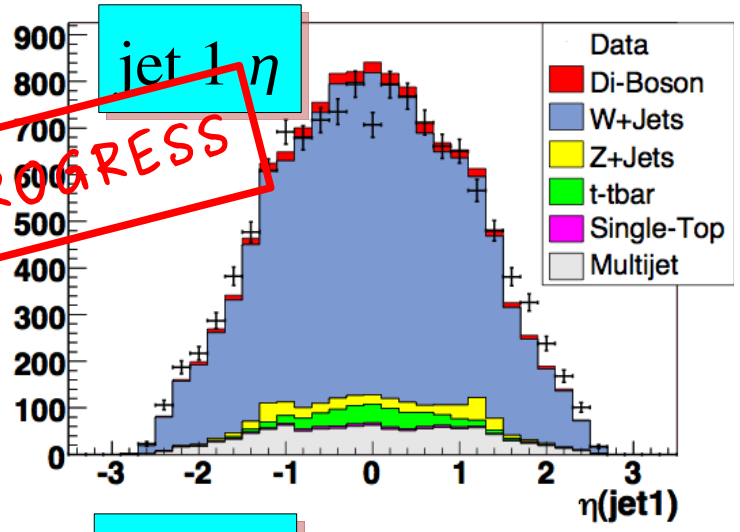
- We know the Z pT simulation is not perfect, so there is no reason to assume the W pT simulation to be correct
- Unfortunately there is not W pT measurement with similar precision as for Zee on the market
  - Rely on theory for the W pT/Z pT ratio (NLO) :
    - Melnikov-Petriello code
    - NLO ratio in agreement with NNLO ratio
    - use W pT from ResBos at low pT
    - use (*unfolded data Z pT)*
      x (*NLO ratio*) at high pT
  - At the moment, an additional scale factor is needed for W+2jets (~1.25)
  - Hopefully the W pT RW will fix it



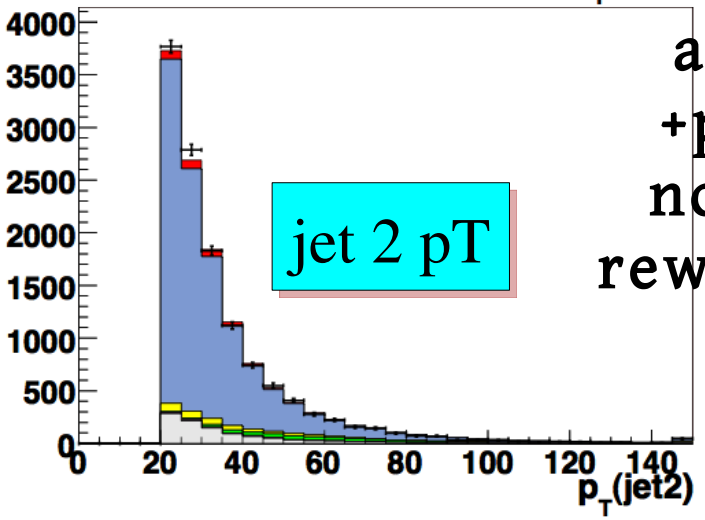
DØ WORK IN PROGRESS

W→eν, ≥2 jets, jet 1 (2) pT> 30 (20) GeV

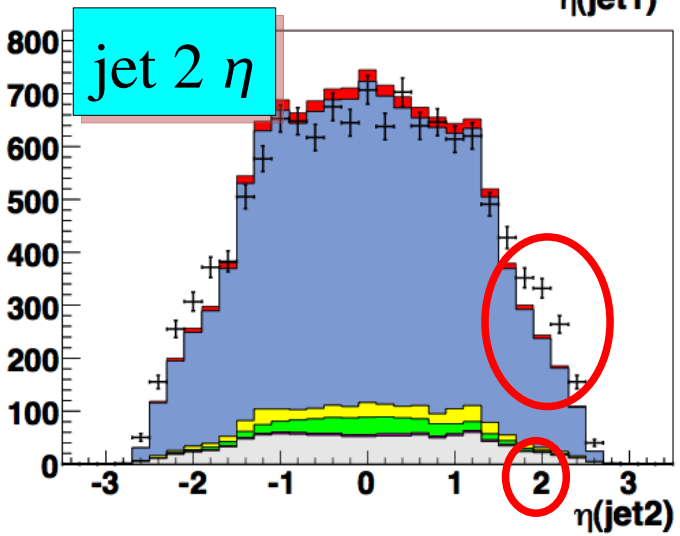




DØ WORK IN PROGRESS



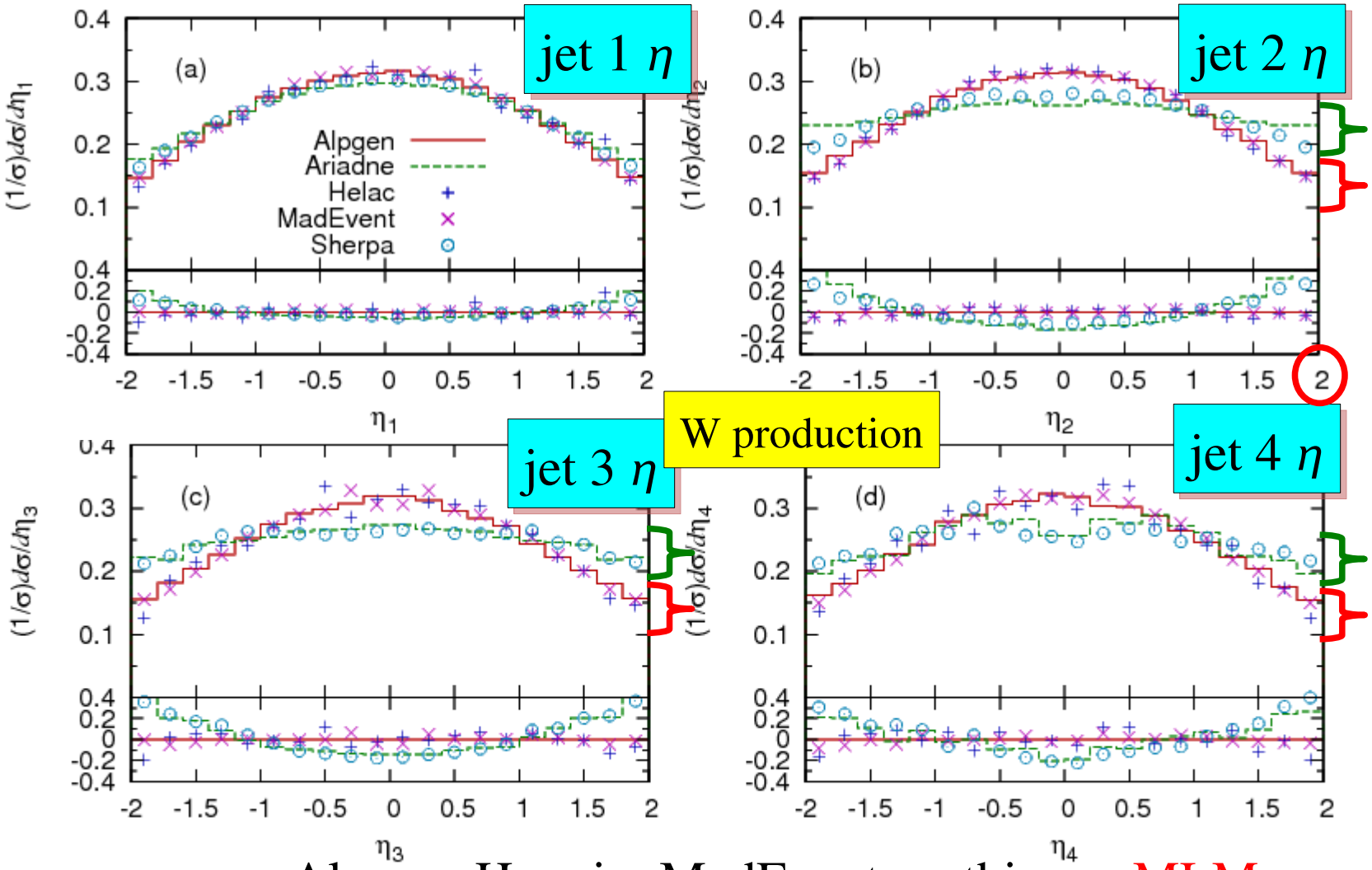
alpgen +pythia, no W pT reweighting



Good description of jet pT's

Jet η's broader in data than in MC (better in sherpa, see next slide)

MC comparison : is there a matching effect ?



Alpgen+Herwig, MadEvent+pythia --> MLM

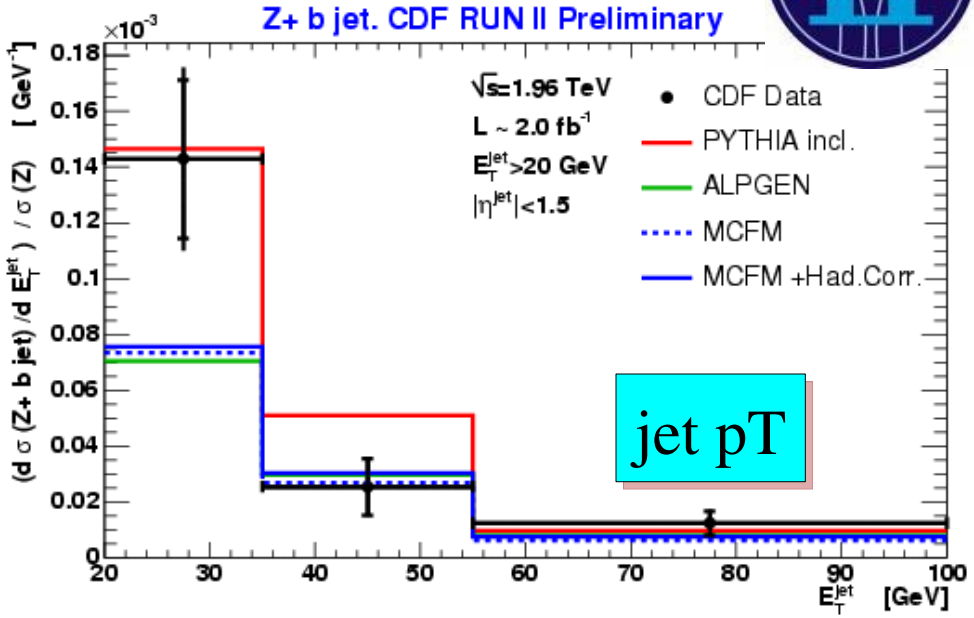
Sherpa, Ariadne+pythia --> CKKW

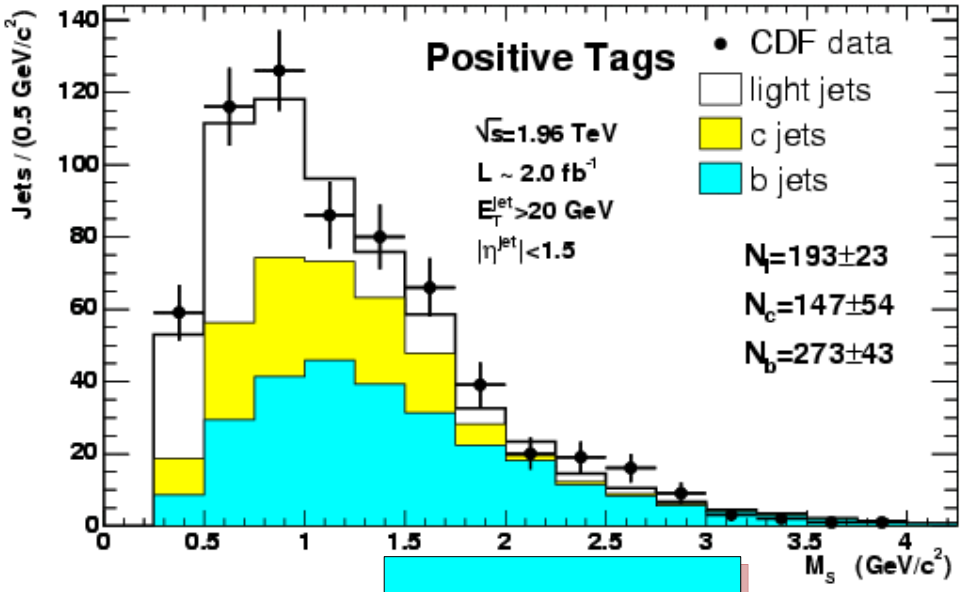
arXiv:0706.2569

What's about heavy flavors (HF) ?

Z+b-jets : Z→ee/μμ+b

- Secondary vertex tagging
- Data corrected to hadron level
  - R=0.7 cone jets
- Measurement
  σ(Z+b-jets)=0.93 $\pm$0.36 pb
  consistent with the theory
  0.45$\pm$0.07 pb
- Surprisingly, pythia does a good job to predict the Z+b fraction
- Statistic limited



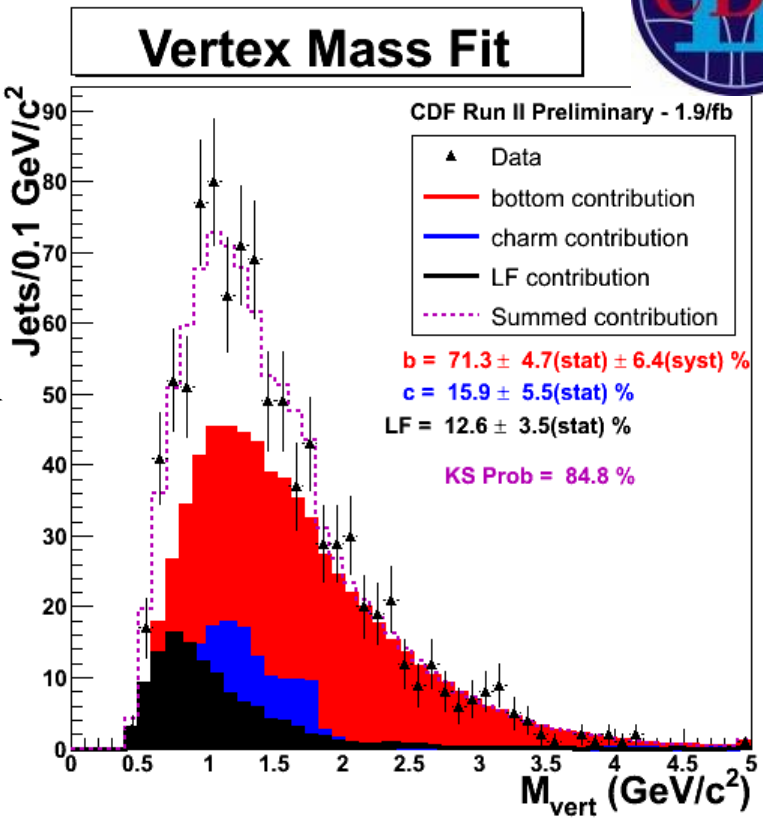


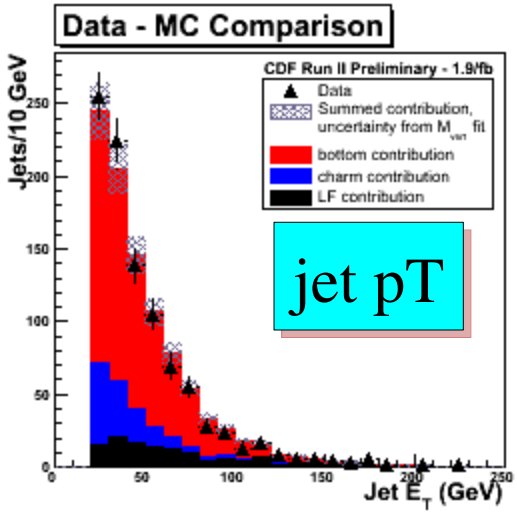
k(')-factors included

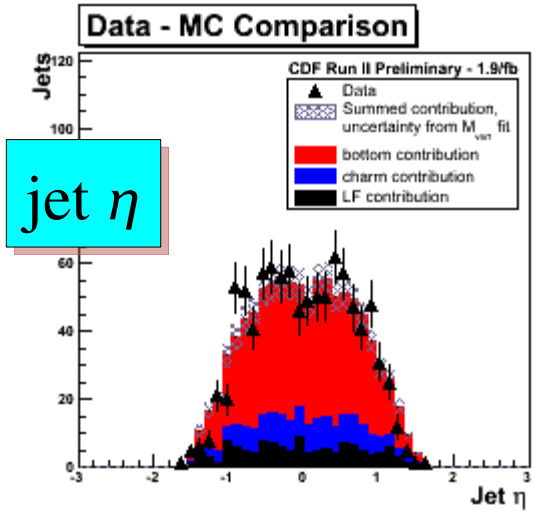
W+jets MC and constraints from data

W+b-jets : W→e/$\mu\nu$+b

- "Ultratight" secondary vertex tagging --> high *b* purity
- Templates : **light**, ***b*** and ***c***
  - Fit the vertex mass distribution
  - NB: R=0.4 cone jets
- Measured cross-section 3.5 times larger than the prediction by Alpgen+herwig
  - Investigations are underway





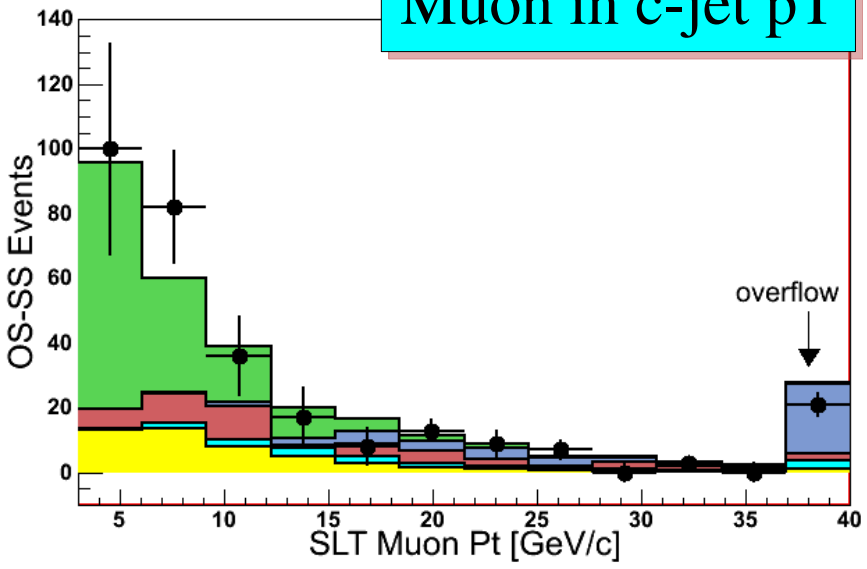


Check the fractions on other variables

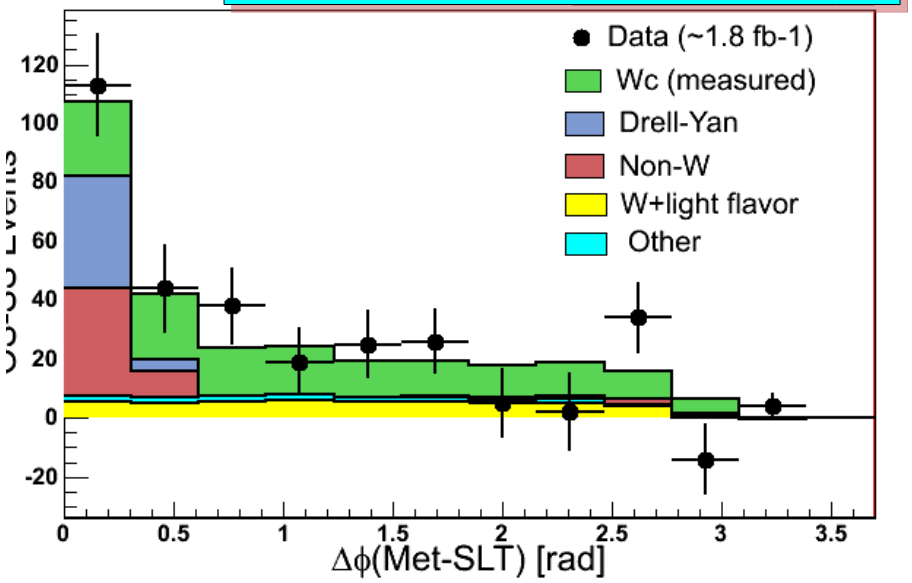
W+c-jets : W→e/$\mu\nu$+c

- "Soft muon tagger" to select the c-jets
- $N(W+c) = N^{OS-SS}_{tot} - N^{OS-SS}_{bkg}$ → Considering the 2 leptons:
  - OS : opposite sign
  - SS: same sign
- Result:
  - $\sigma(W+1c) = 9.8+/-2.8(stat)^{+1.4}_{-1.6}(sys)+/-0.6(lum)pb$
  - In agreement with NLO prediction : $11^{+1.4}_{-3.0}$ pb

Muon in c-jet pT



$\Delta\phi$(MET,Muon in c-jet)



k(') and s-factors included

Conclusion

- Tevatron experiments get enough events to test precisely the prediction of V+jets ~~signals~~ backgrounds
  - It is an unavoidable step on the road to discoveries / (top quark) precision measurements
  - Manpower dedicated on the understanding/modeling of these backgrounds (for example, V+jets task force @ DØ)
  - The needed massages of the MC's are better and better understood

- Measurements and data/MC comparisons of V+HF are still limited by the statistic
  - but the first steps have been done !

- LHC will reap the benefits from all these works

Backup