



Generator studies for W+jets/Z+jets

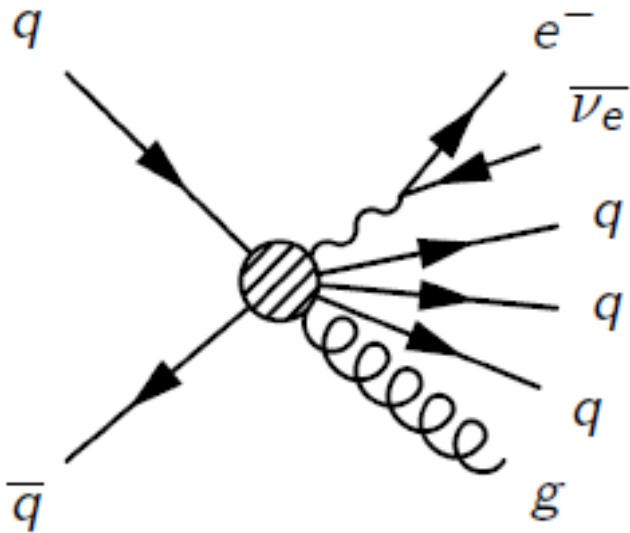


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Technical help from Torsten Harenberg and Philipp Sturm



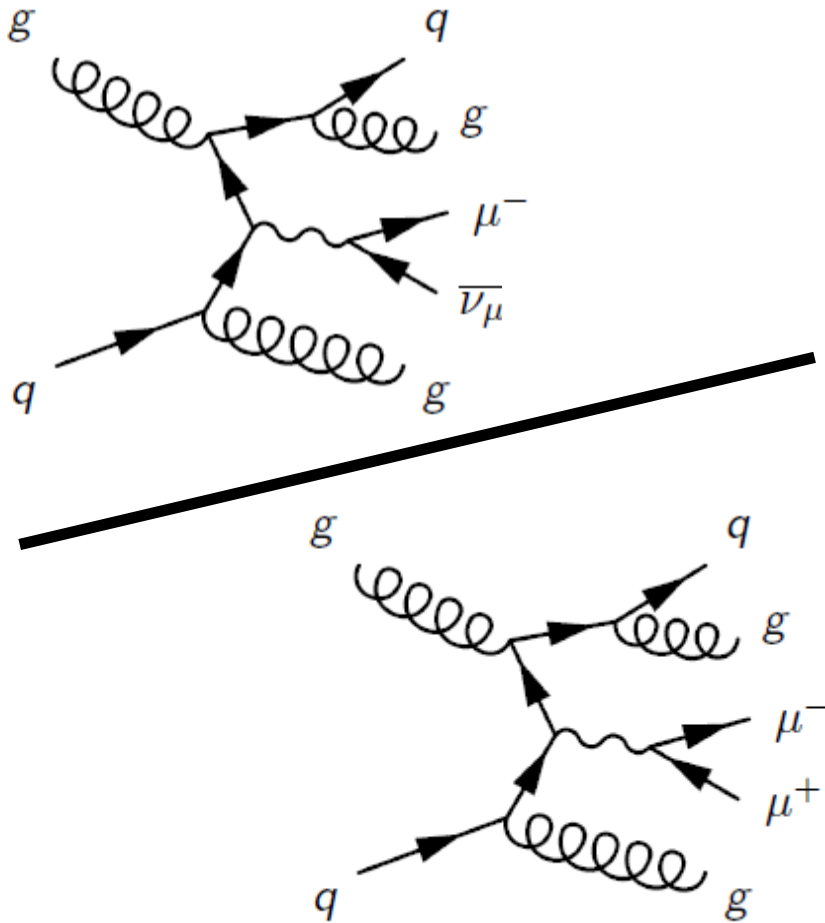
Content



- Generators
- Basic comparisons
- W+njet/Z+njet comparison
- Incl. Jet multiplicity studies
- Initial states



W+jets/Z+jets ratio



- Experimental: Estimate W+jet background (Top, Susy ...) with Z+jet events
- Incl. Measurement: Earla measurement (300 Z+3jets events in 100 pb⁻¹ after selection)
- Many experimental uncertainties cancel out (luminosity, energy scale)

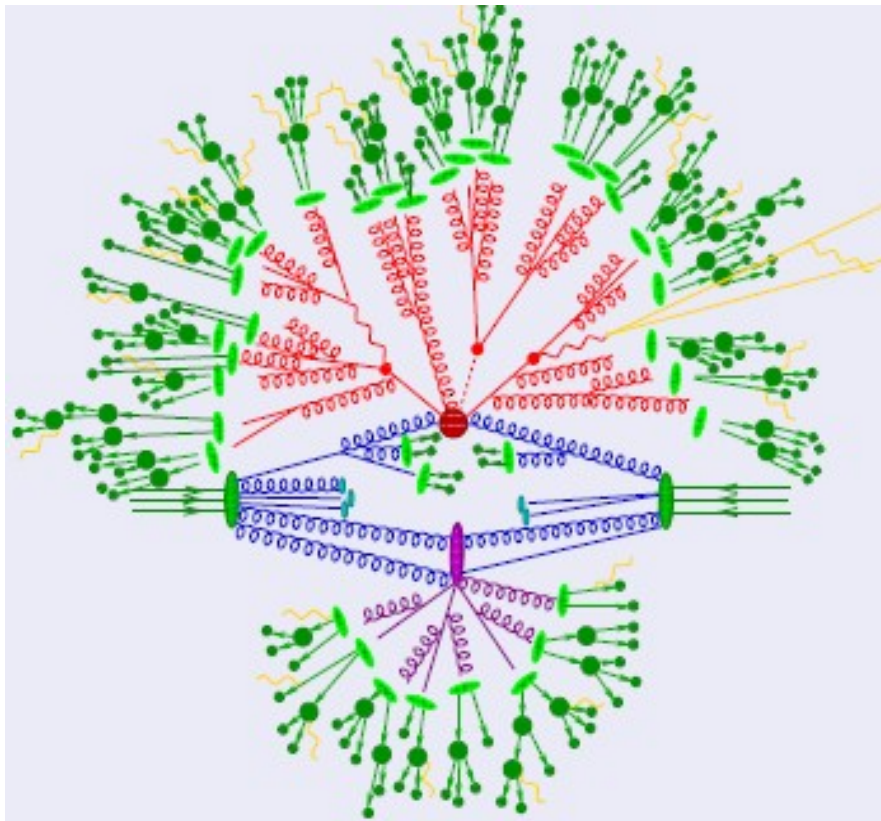
Sensitive to deviation from Standard Modell, test of QCD

Separation in initial state: sensitive to PDF, etc ?

Generator studies: Are the LO ME generators (alpgen, sherpa) comparable



Generators



- Sherpa and AlpGen+Herwig
 - ◆ LO matrix element generators with up to 5 partons in Matrix element (ME) and add. Jets from parton shower (PS)
 - ◆ Prevent double counting: Matching between ME and PS with CKKW schema (sherpa) or AlpGen (MLM)
- Pythia
 - ◆ In ME only W/Z (+1jet), partons mostly from shower



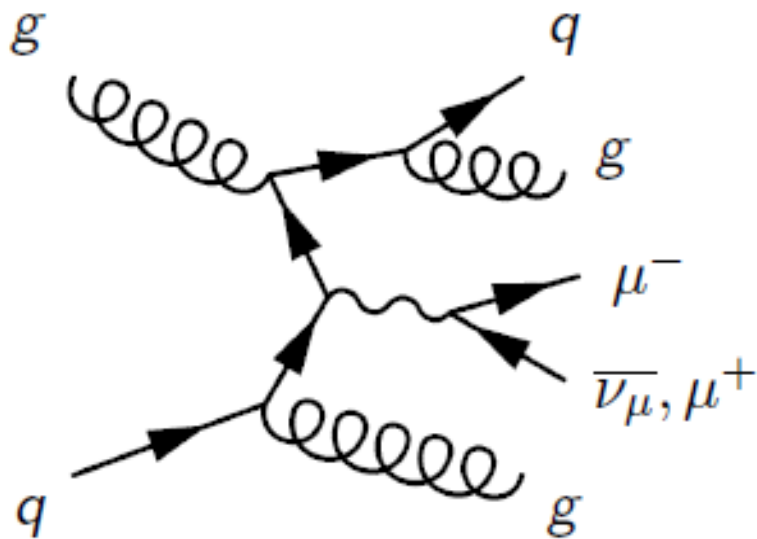
Generator (cont.)

- Baseline: Sherpa(1.1.13):
 - ◆ ME integration up to 4 partons possible (2 weeks paral. running)
 - ◆ Incl. Sample: use enhancement factors for parton bins, 400000 events per parton bin.
 - ◆ PDF: CTEQ6L1
- Comp: Alpgen (2.13)+Herwig (6.51)
 - ◆ 5 partons in separate files (but correct matching)
 - ◆ Only small enhancement for higher jet bins: about 30000 events in 4 parton bin
 - ◆ PDF: CTEQ6L1





Where are the differences between W and Z?



- Leptonic decay channel (ll vs $l\nu$)
- Electroweak couplings
- Different initial states \rightarrow different pdfs
- Boson Mass difference
- Phase space



Generator vs measurement

- Cuts for generator study:
 - ◆ Lepton $p_t > 7$ GeV
 - ◆ Take all primary leptons (even in jets)
 - ◆ Jets 20 GeV kt jets ($d=0.4$, reasonable agreement to atlas cone)

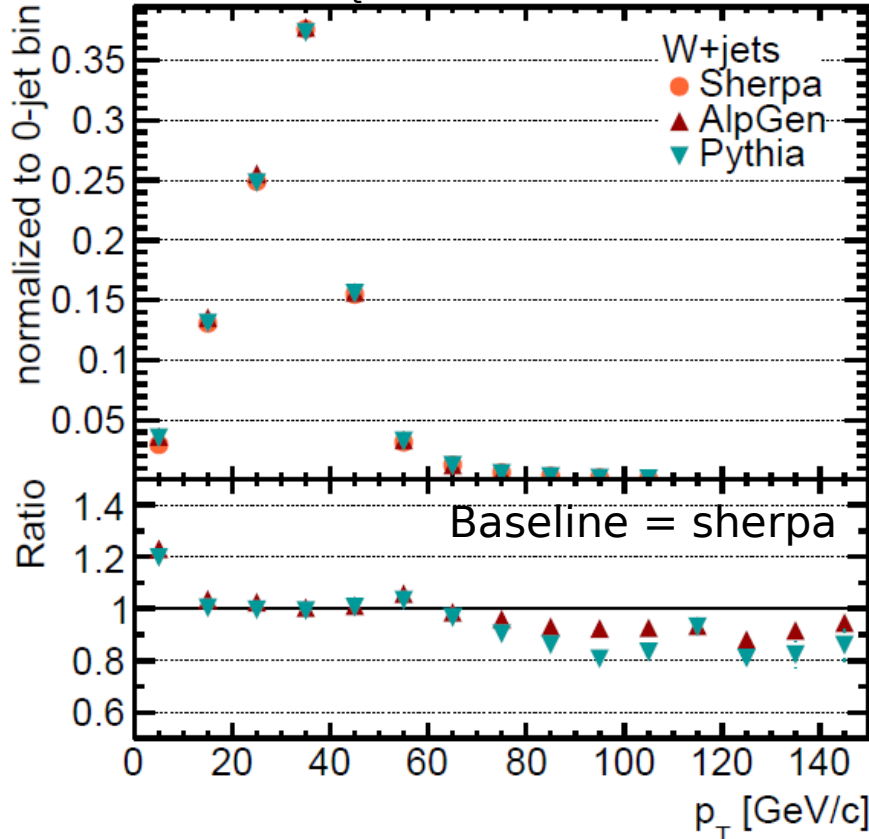
- Generator vs “realistic” conditions:
 - ◆ Jet p_t cut (> 20 GeV) higher
 - ◆ some kind of migration correction (truth vs reco) necessary
 - ◆ Leptons: higher p_t cuts on leptons and trigger (2 vs 1)
 - ◆ Removal of overlap between jets and leptons (2 vs 1)
 - Not all systematics cancel out

- Limitation on early data:
 - ◆ 0-2 jet bin: QCD background and systematics (Jet energy scale)
 - ◆ 4-X jet bin: $t\bar{t}$ background and statistics (about 250 events/100 pb⁻¹)
Z+3jets events per lepton after selection

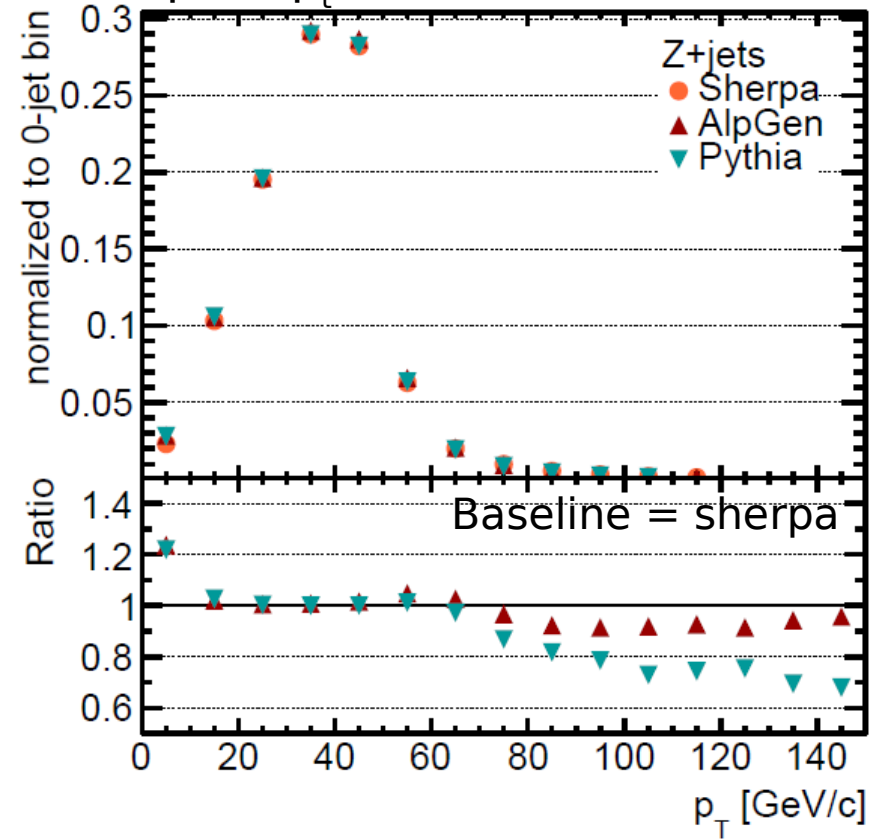


Leptons

Lepton p_t for W



Lepton p_t for Z

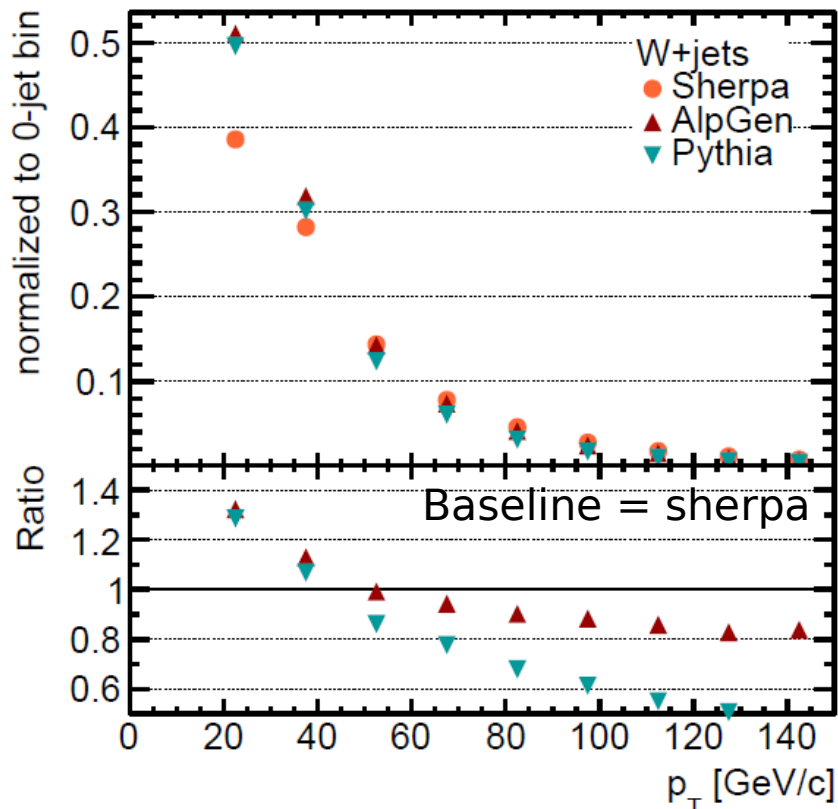


- Low p_t (resonant) agreement very good, boosted W/Z slightly different
- Slightly different p_t of leptons but cancel out in W/Z ratio

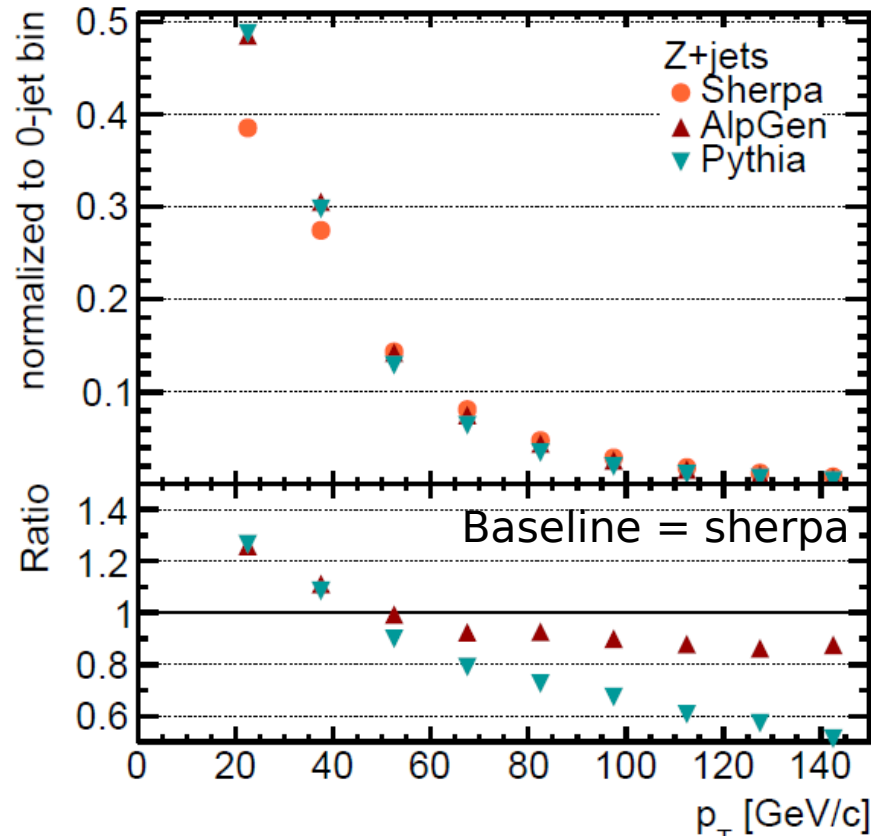


Jets

■ P_t of leading jet: W



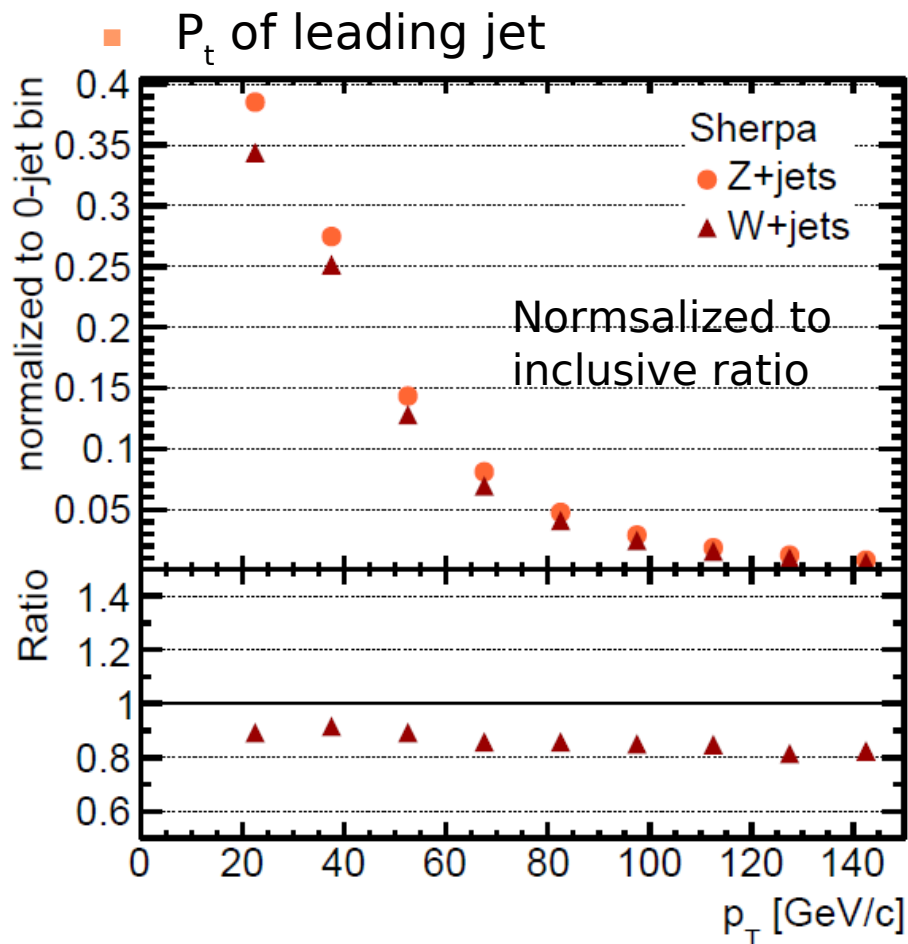
■ P_t of the leading jet:Z



- Sherpa has harder p_t spectrum than alpgen, but compatible for W/Z



Sherpa W/Z jet pt ratio

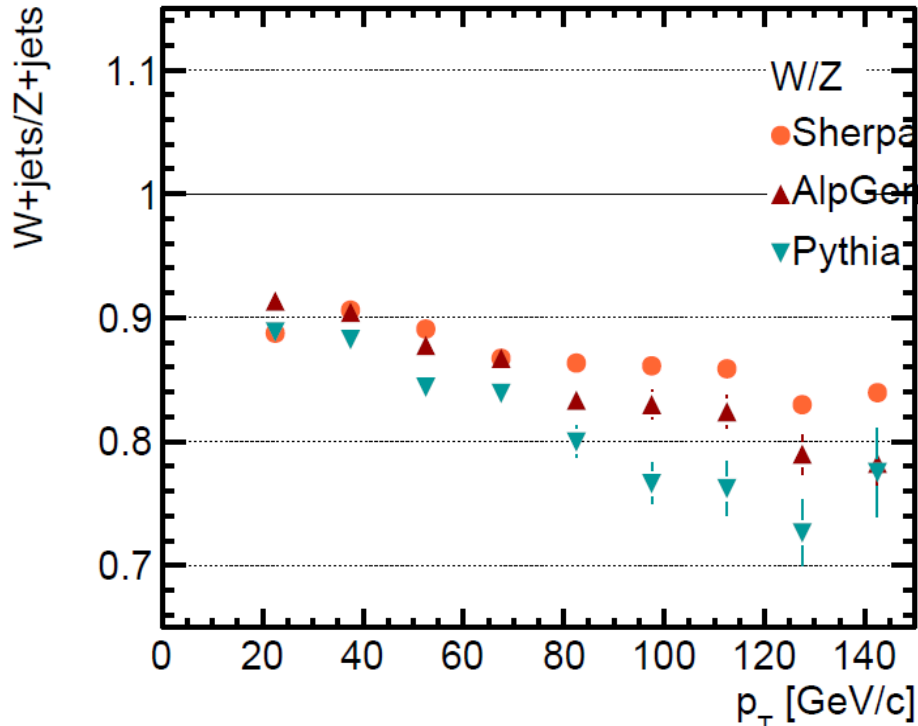


- Look at the W/Z ratio for a certain generator
- Deviation less than 10% from a constant ratio
- Number of events normalized to 'W+0jet/Z+0jet=1

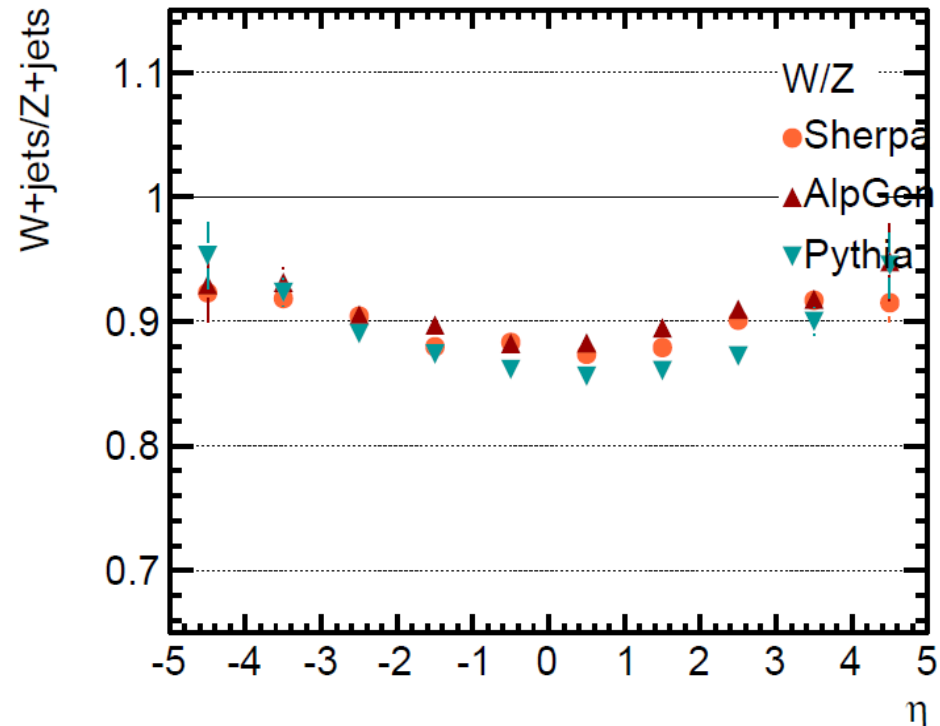


Compatibility of W/Z for different Generators ?

■ P_t of leading jet



■ Eta of leading jet

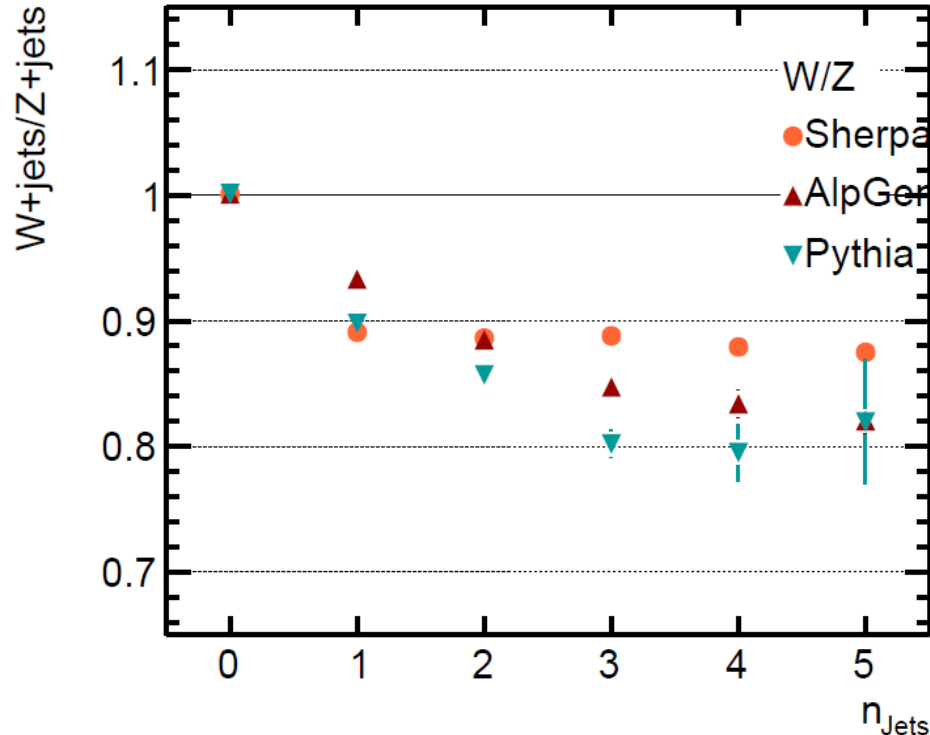


■ Better than 5% agreement for jet p_t and eta

◆ Differences would influence the ratio (cuts etc)



N-jet ratio



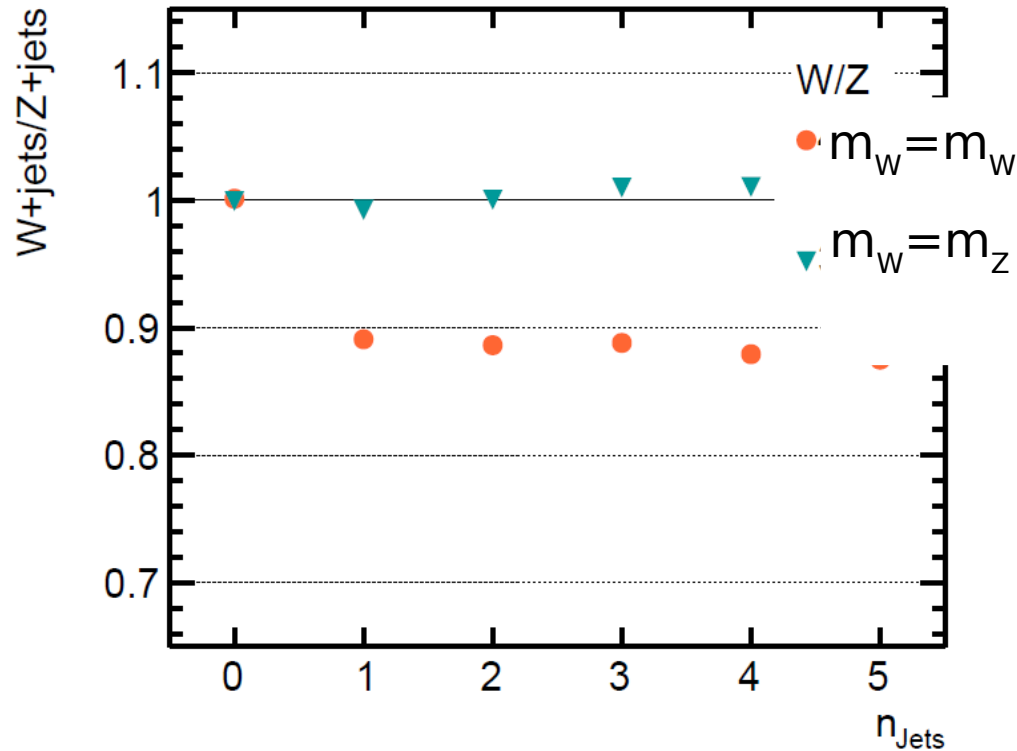
- General:
 - Ratio is smaller than 1, scale effect? $m_w \neq m_z$?
- Sherpa:
 - Big change from 0 to 1 jet, afterwards mostly flat
- AlpGen:
 - Evaluation of ratio over the different njet bins
- Different answers from different generators → input from data needed
- Reason for differences: Scale, phase space?



Njet ratio for $m_W = m_Z$

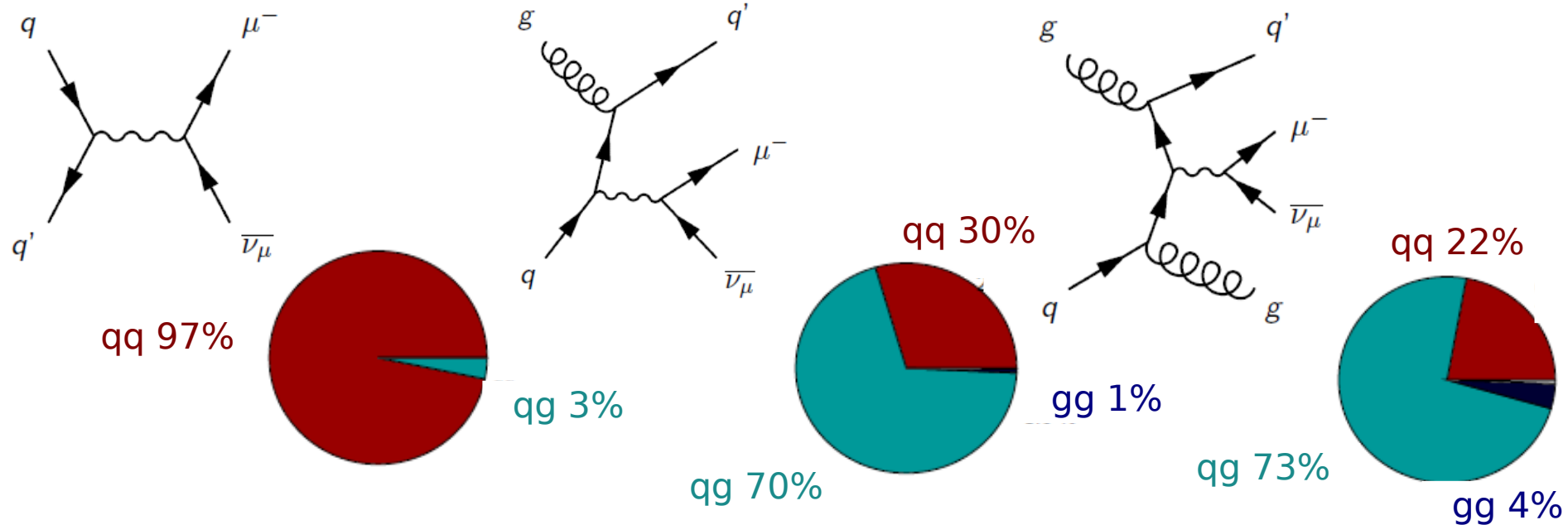
- Sherpa:

- ◆ MC: take $m_W = m_Z$ to estimate influence of boson mass
- ◆ \rightarrow njet evolution can be explained by the difference in the mass
- ◆ No simple phase space effect: then W should have more jets than Z
- ◆ Different scale for the QCD process because of different boson masses (m_W vs m_Z), more space for jets in the boson-jet rest frame





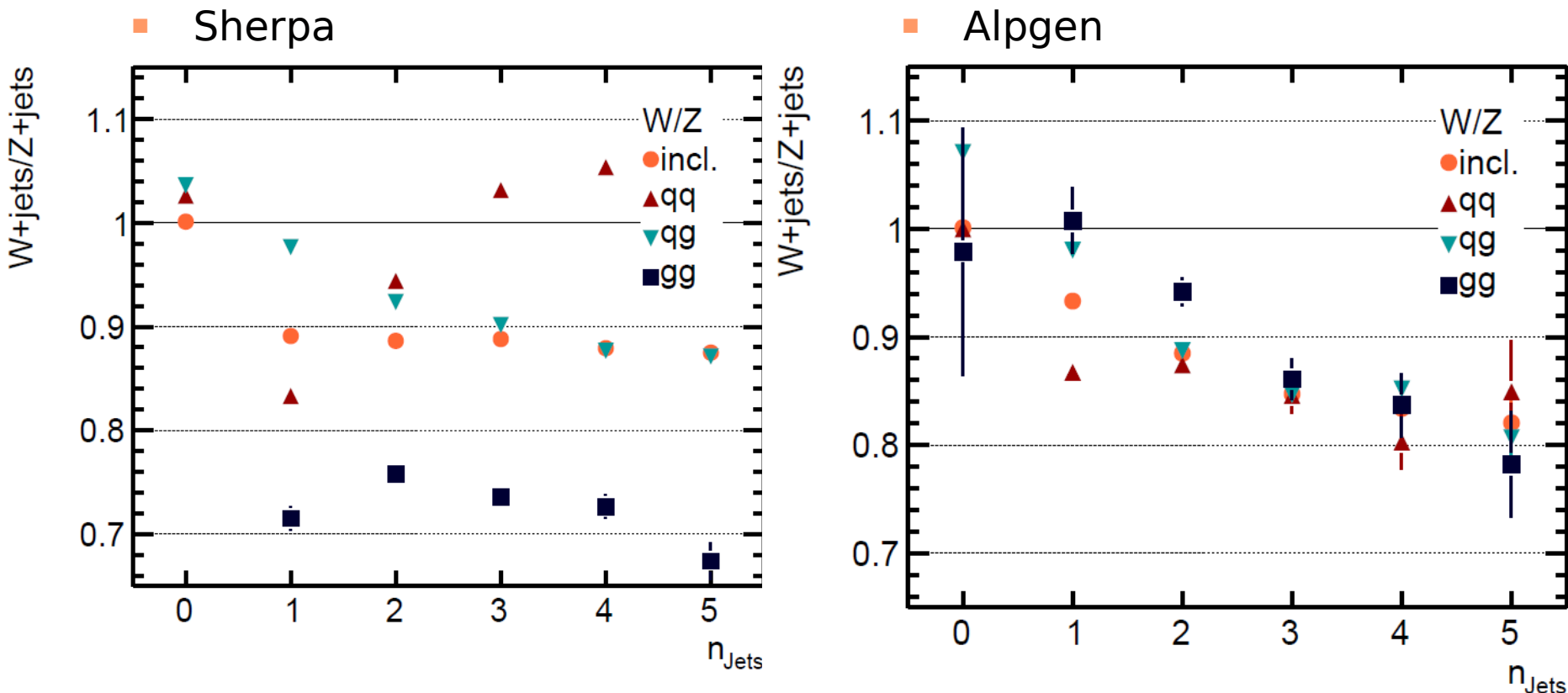
Initial state study



- Different initial state contribution to njet bins
 - ◆ Interplay of valence and sea quark contribution (at least 1 per reaction in pp)
 - ◆ Sensitive to pdf, pdf important for ratio of qq, qg and gg



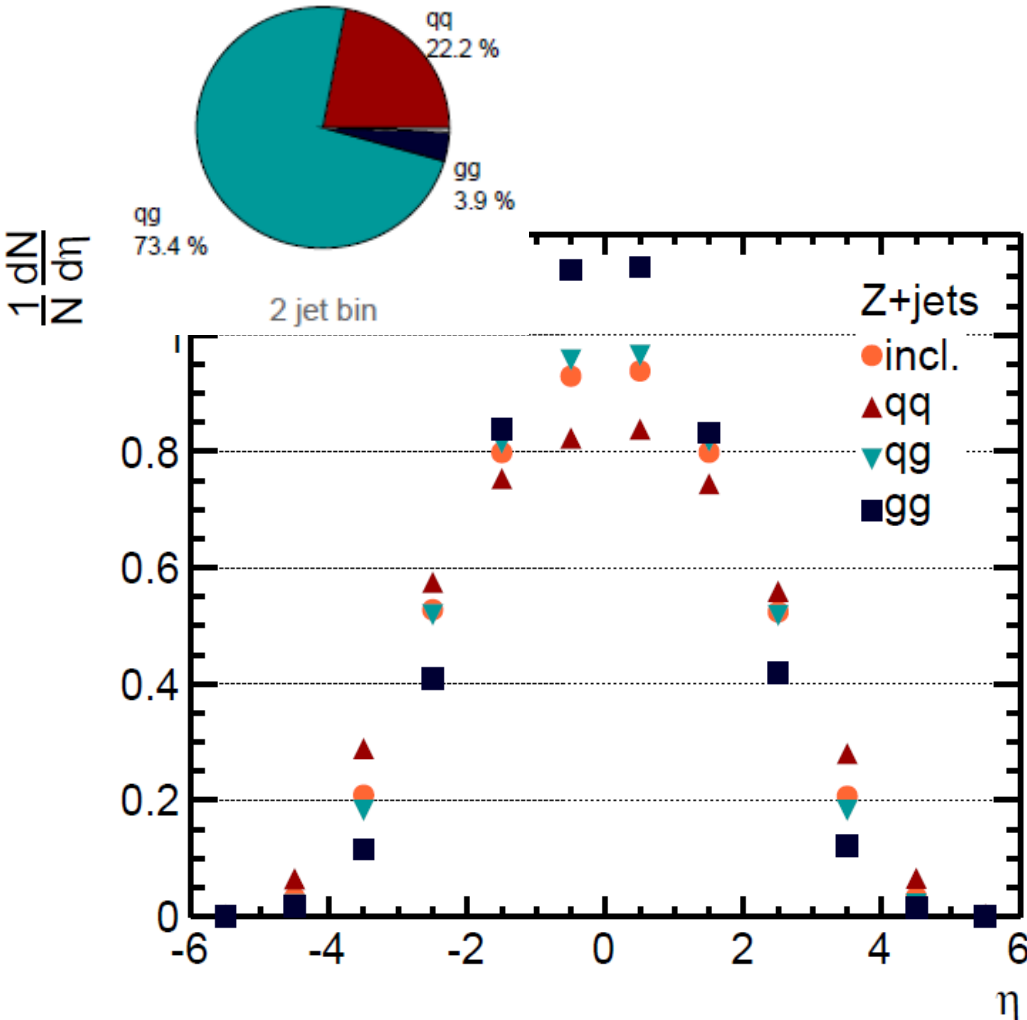
Initial states comparison



- Sherpa: different gg and qg njet evolution, which cancels out in average, much less gluons in W than in Z
- Alpgen: much less differences for different initial state



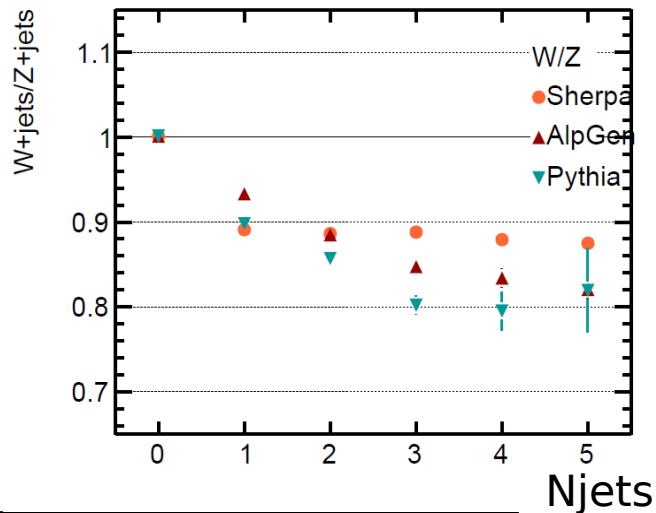
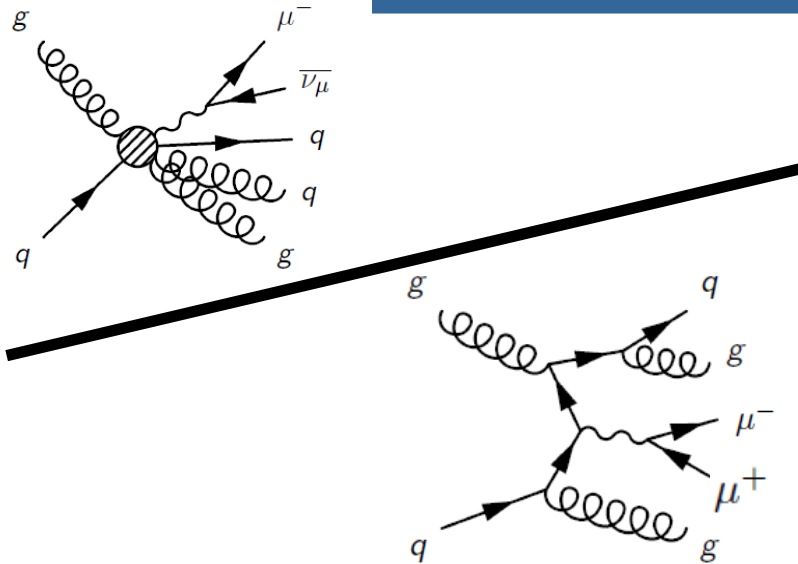
Possible to measure ?



- Separation of leading jet eta in initial state contributions
- angular variables, e.g eta first jet (more forward boost in qq)
- Eta shapes different but large qg contribution dominates
- Needs good understanding of detector and physics



Summary



- Show prospect of measurement W+njet/
Z+njets
 - First data (100pb^{-1}), measurement up to
N=3 should be possible
 - N=4 challenging (ttbar background for W,
simultaneous measurement?)
- Evolution of ratio in njet is different for
alpgen and sherpa → need data input
- Sherpa: driven by boson mass difference
 - Sherpa/AlpGen show different initial states
contributions, direct measurement could
be difficult
 - Higher precision: kinematic variables
have to be included beside N_{jet} ratio