



Helac-Phegas validation against standard ATLAS MC generators for ZZ+jets

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European Union
European Social Fund



MINISTRY OF EDUCATION, LIFELONG LEARNING AND RELIGIOUS AFFAIRS
MANAGING AUTHORITY



Co-financed by Greece and the European Union



Outline



- Motivation for this study
- Comparison of HELAC-PHEGAS with Madgraph/Madevent in $p p \rightarrow Z Z + n$ jets
- Study of kinematical parameters in parton and hadron level



HELAC



- 1999: First code to calculate recursively tree order amplitudes for arbitrary number of particles
- Tree level generator
- Amplitude computation
- Implementation of the algorithm based on Dyson-Schwinger equations



PHEGAS



- Phase-space generator
- Constructs all possible phase-space mappings
- Channels: one-to-one correspondence to the Feynmann diagrams
- Overall: HELAC-PHEGAS
 - Parton level events
 - any SM process in hadron and lepton colliders



Madgraph/Madevent



- Madgraph: Matrix element creator

- Madevent: multi-purpose, tree-level event generator



Z Z +n jets: Why jets?



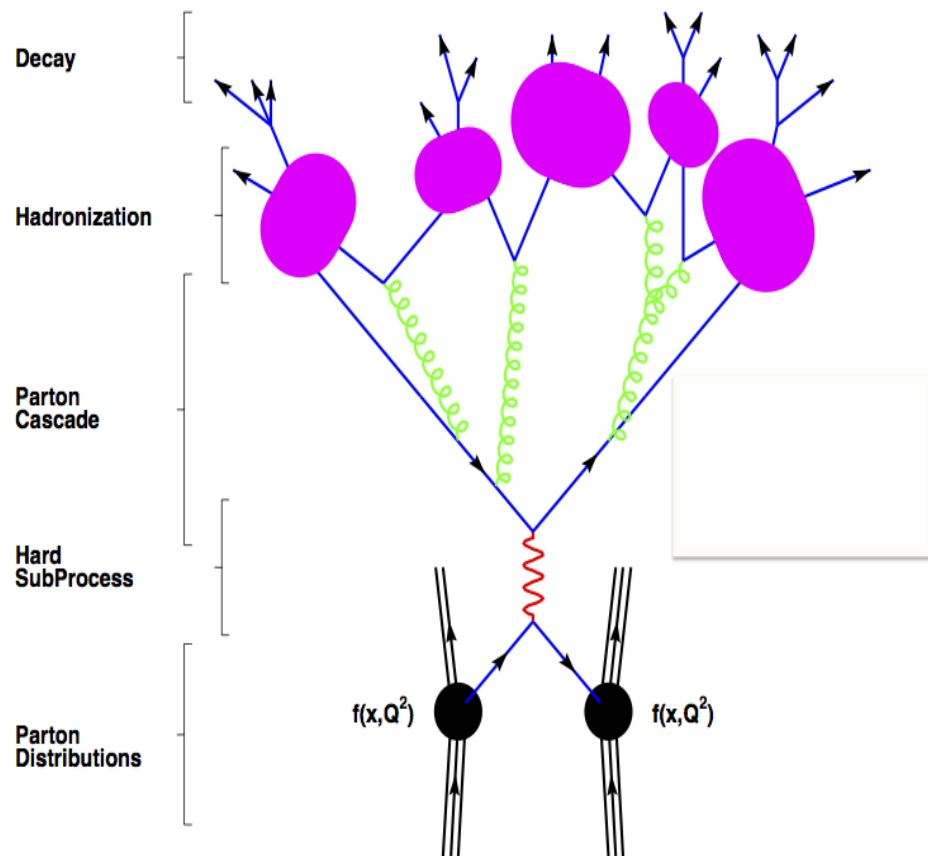
- LHC: Many events with several hard jets
- Phase-Space + large acceptance of detectors
- Final states with ten or more jets
- Important to predict their features
- Understanding of the background



Jet Evolution



- Matrix elements for the hard processes
- Hard partons \rightarrow jets of hadrons
 - Showering
 - Hadronization
- Matching to avoid double counting





Process: $p p \rightarrow Z Z + n \text{ jets}$



- Generation parameters

- 100.000 events
- Decay to e and mu
- $E_{\text{cm}} = 7 \text{ TeV}$
- Parton $P_{\text{T}} > 8.0 \text{ GeV}$
- $\min \Delta R_{q-q} = 0.4$

$$\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$$



Process: $p p \rightarrow Z Z + n \text{ jets}$



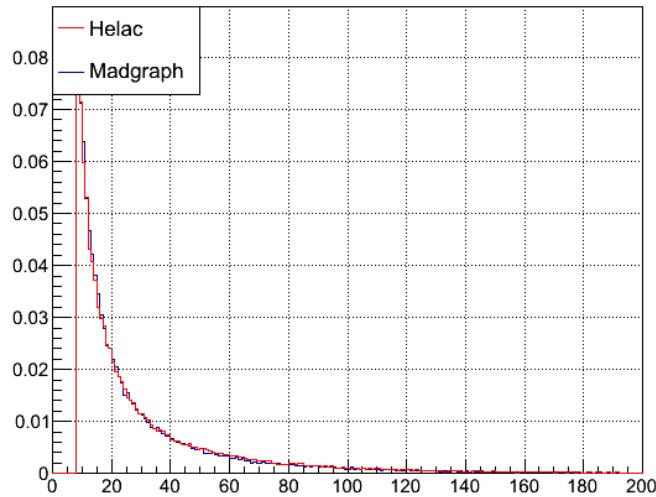
- Parton level Comparison between HELAC-PHEGAS and Madgraph/Madevent



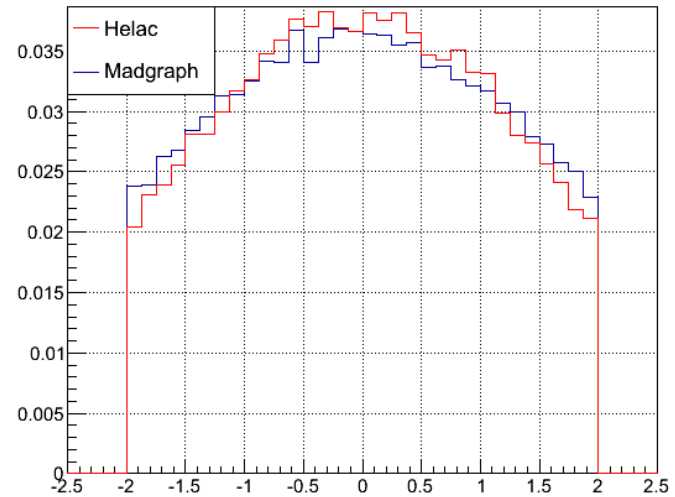
ZZ + 1 jet



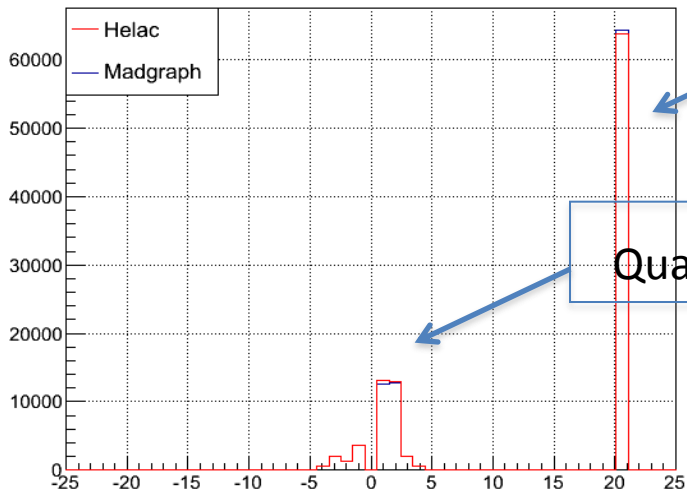
Parton pt



Parton rapidity



Parton Id



Gluons

Quarks



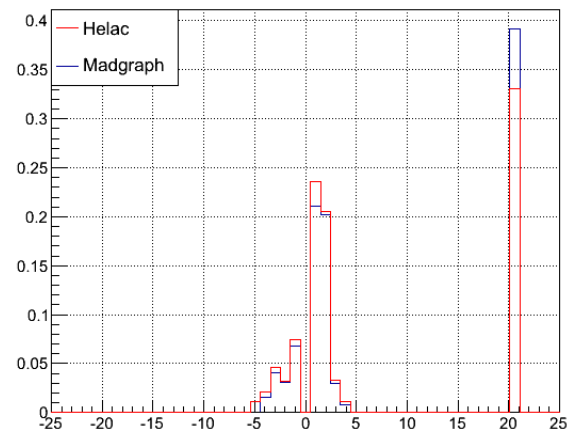
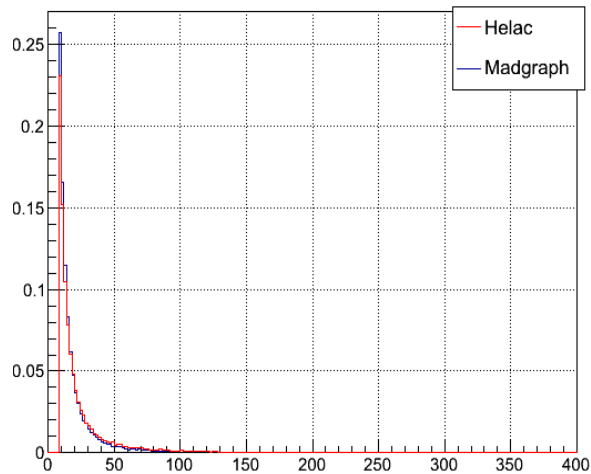
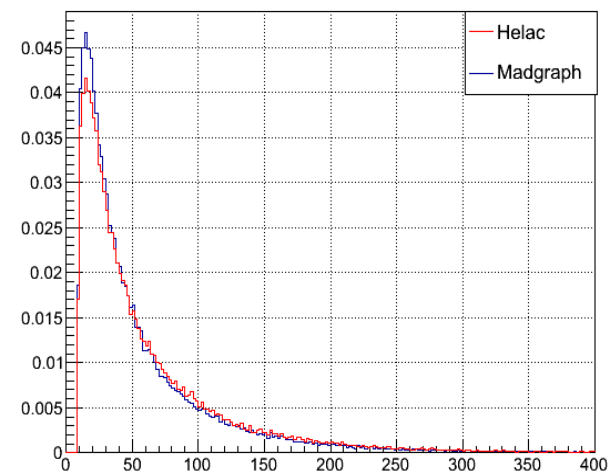
ZZ + 2 jet



1st Parton pt

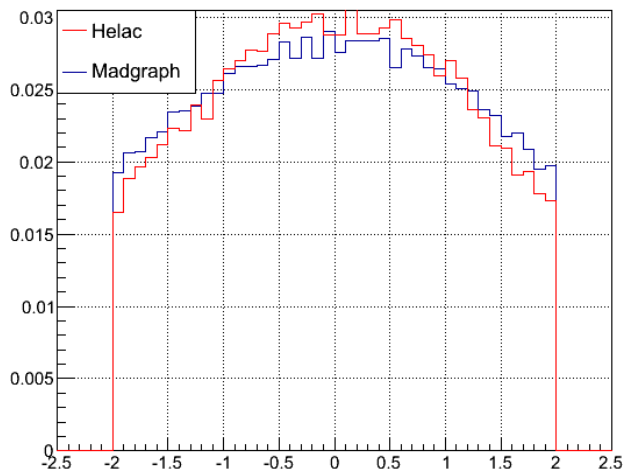
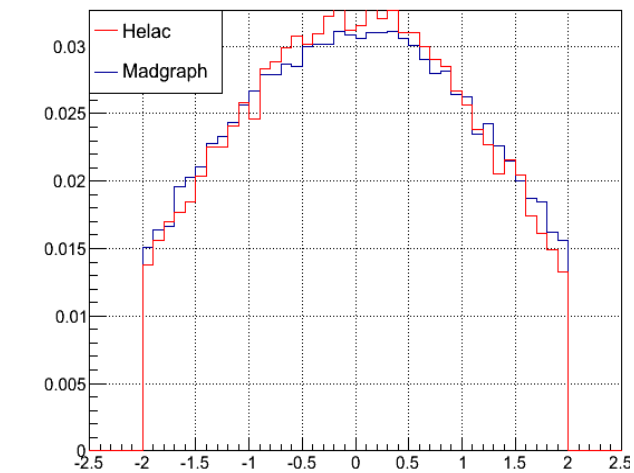
2nd Parton pt

Parton Id



1st Parton rapidity

2nd Parton rapidity

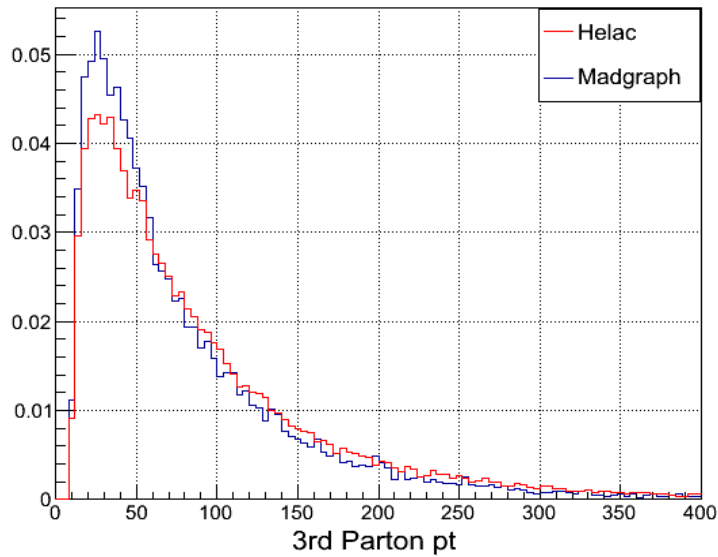




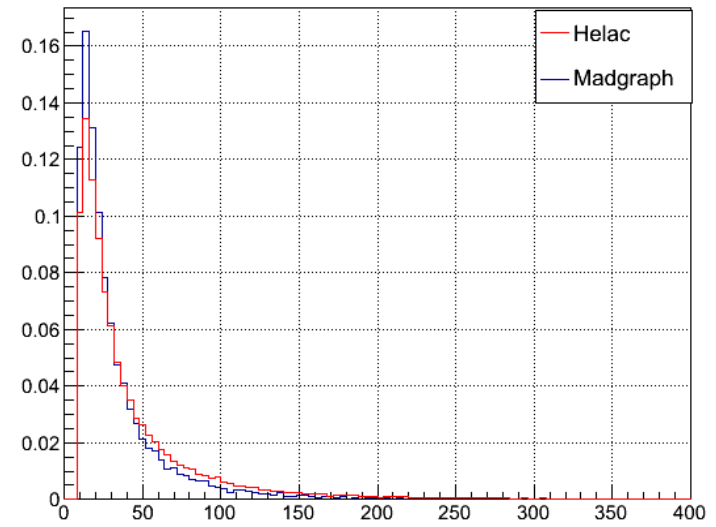
ZZ+3jets



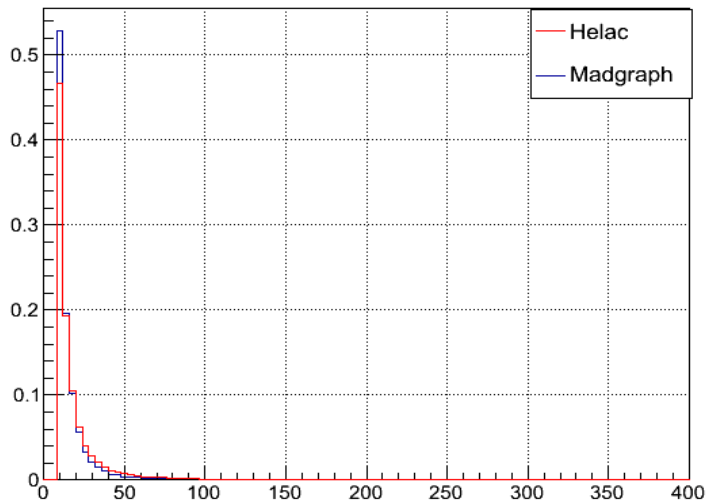
1st Parton pt



2nd Parton pt



3rd Parton pt

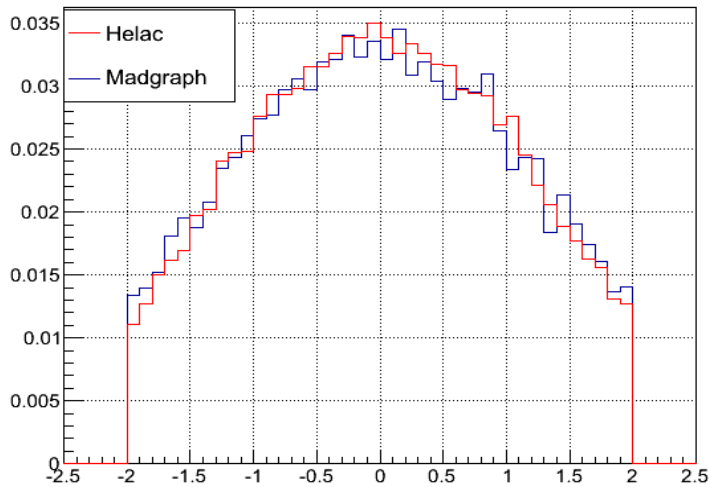




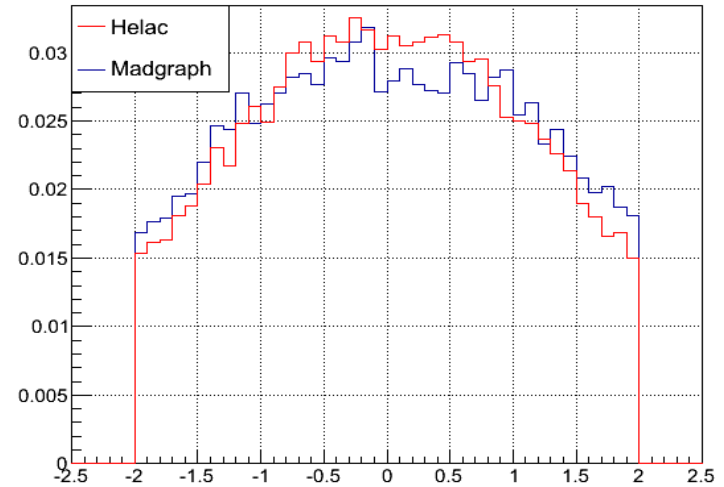
ZZ+3jets



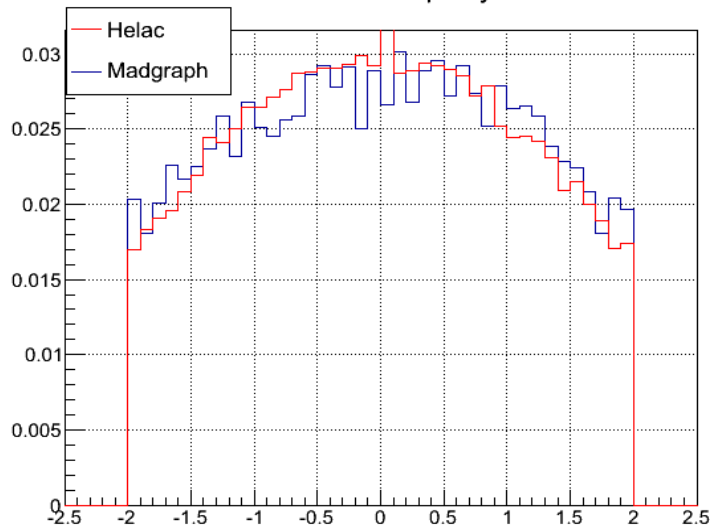
1st Parton rapidity



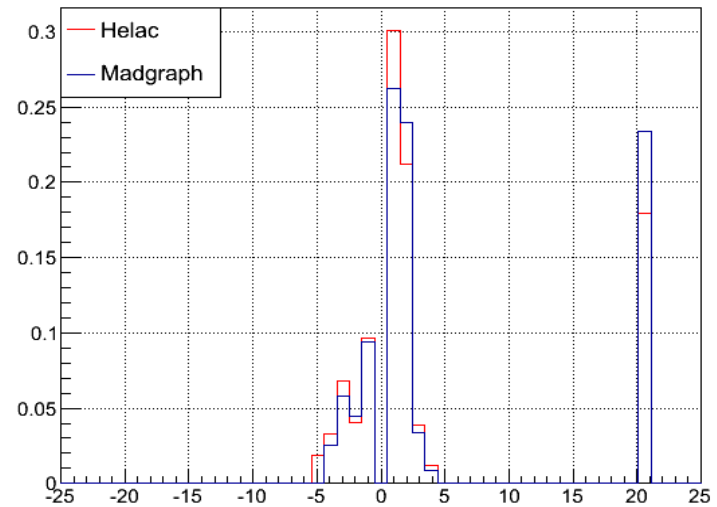
2nd Parton rapidity



3rd Parton rapidity



Parton Id





Parton Shower



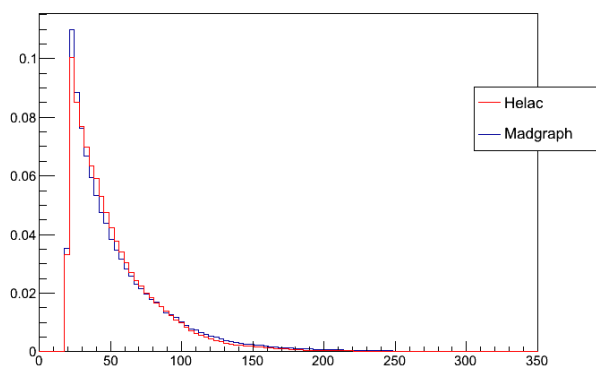
- Parton Shower through PYTHIA 6
- Hadronisation
- MLM jet matching (Mangano et Al.)
- Jet finding using FastJet 3.0.5
 - k_t algorithm
 - Jet $p_t > 20\text{GeV}$
 - Cone radius $R=1.0$



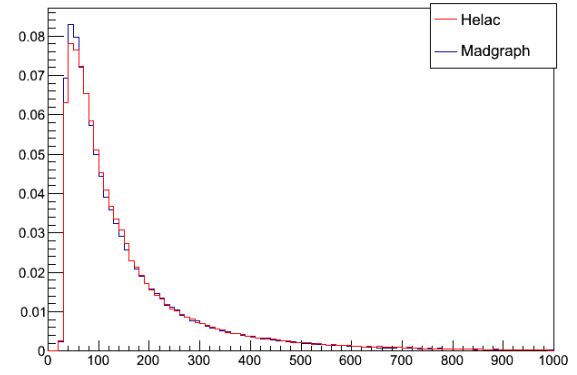
ZZ+1jet



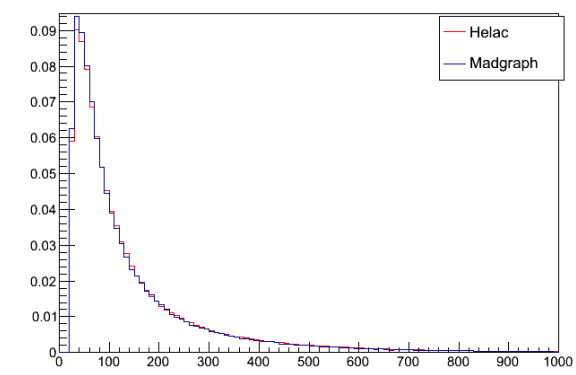
Pt



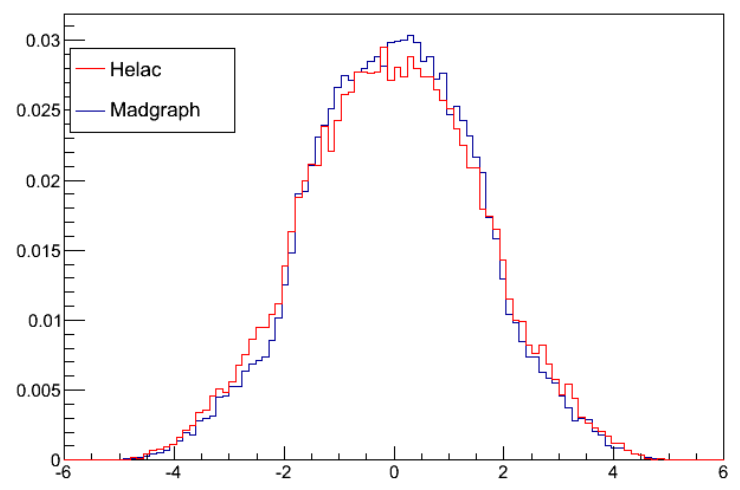
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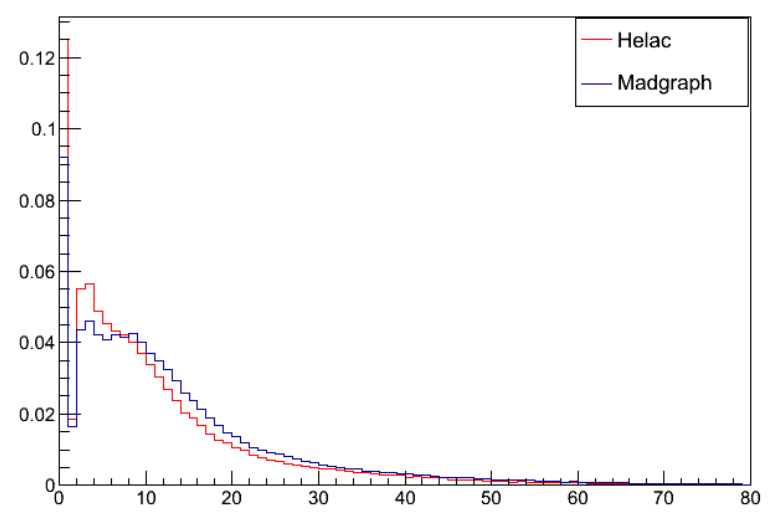
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Rapidity



Mass

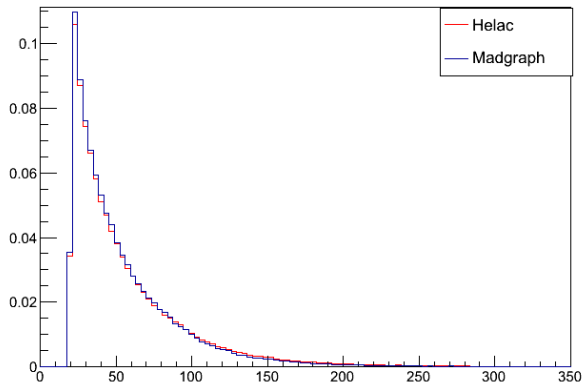




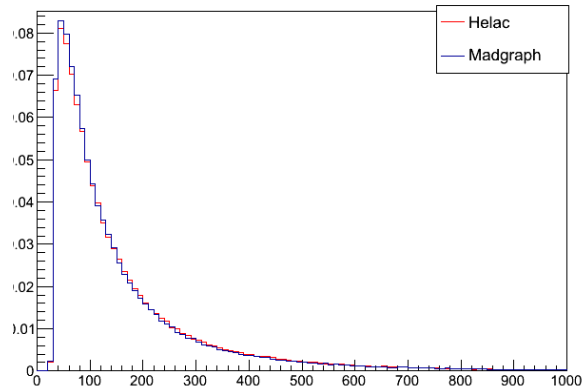
ZZ + 2jets



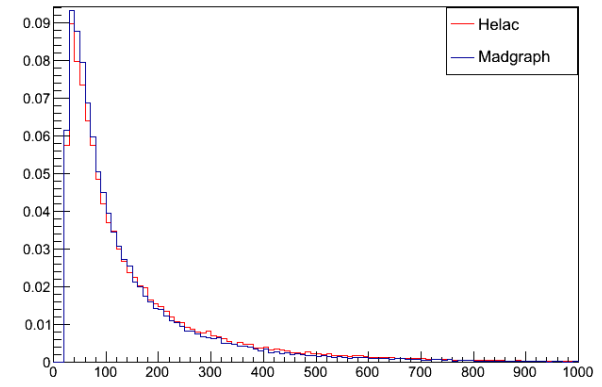
Pt



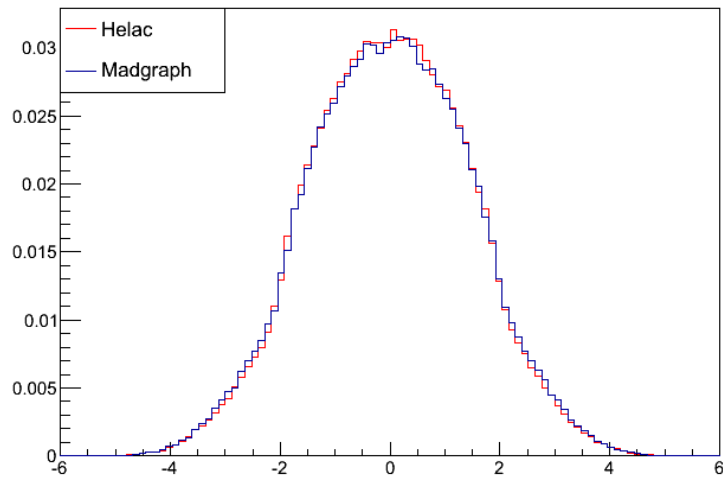
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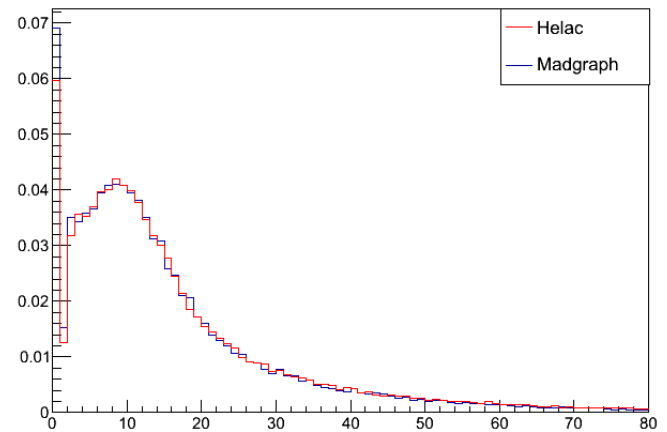
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Rapidity



Mass

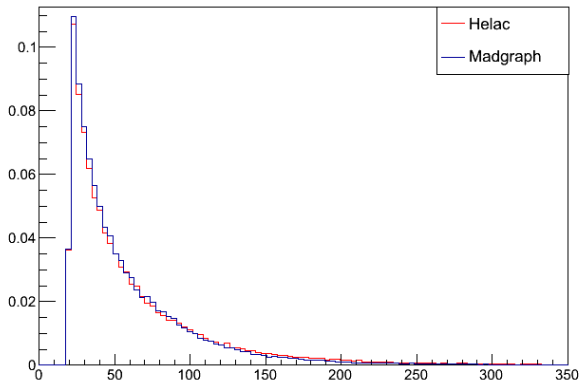




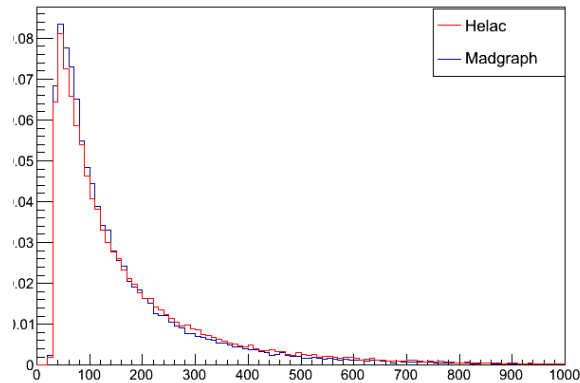
ZZ + 3jets



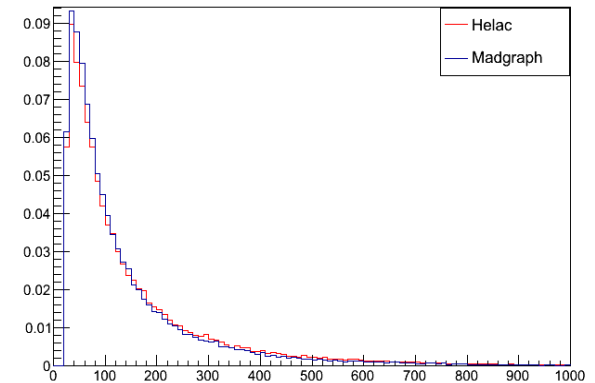
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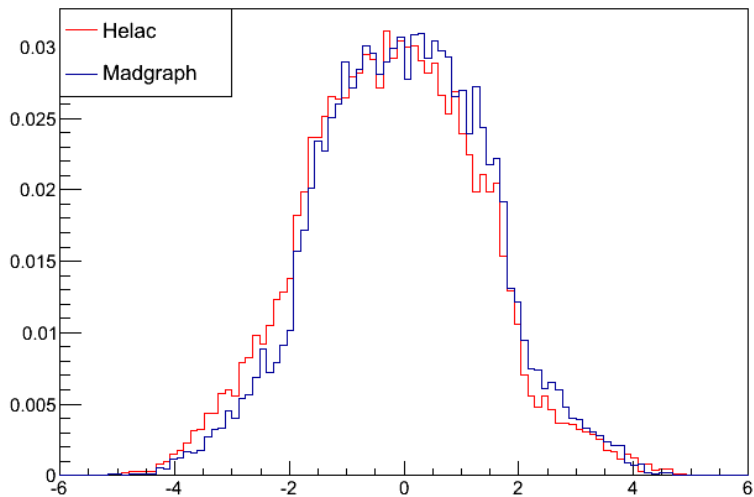
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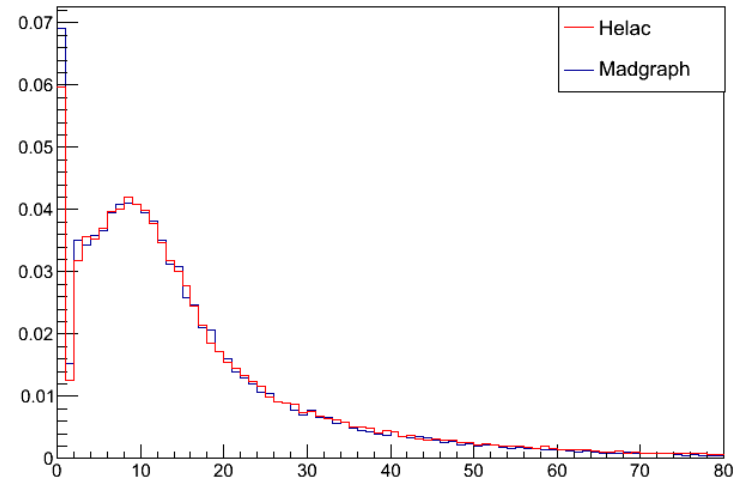
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Rapidity



Mass





Conclusion



- Good agreement between HELAC-PHEGAS and Madgraph/Madevent in parton level
- Very good agreement in hadron level, parton shower smooths out the few differences between the generators



Conclusion



Thank you!



K_t jet algorithm



- For each pair of particles $i, j \rightarrow k_t$ distance

$$d_{ij} = \min(k_{ti}^2, k_{tj}^2) \Delta R_{ij}^2 / R^2$$

- Find minimum d_{\min} of all d_{ij} and $d_{i\text{-beam}}$
 - If d_{\min} is a $d_{ij} \rightarrow$ merge particles i, j into a single particle
 - If d_{\min} is a $d_{i\text{-beam}} \rightarrow$ declare i to be final jet, and remove from the list
- Repeat