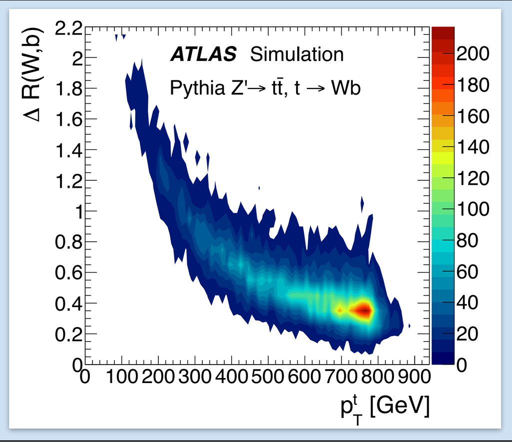
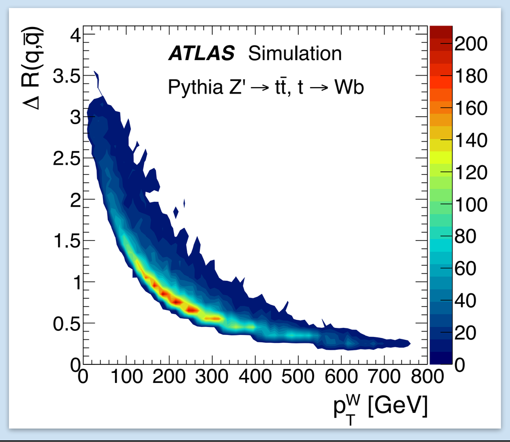
ICHEP Poster Session - 4 July 2014

Performance of Jet Substructure Techniques and Boosted Object Identification in ATLAS

Introduction

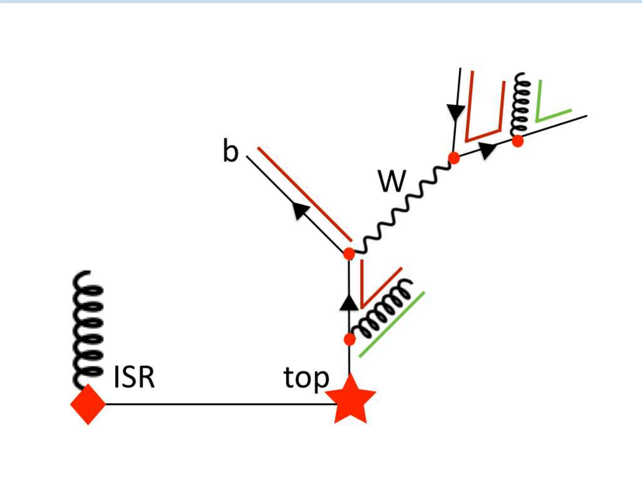
At the LHC, $\sqrt{s}$ >> electroweak scale, therefore massive particles like top, W, Z and Higgs are often produced with a significant boost with the decay products reconstructed as a single jet. Jet substructure techniques mitigate pile-up and probe inside the jet to identify the boosted objects. Important for exploring the boosted kinematic regime, extending understanding of the SM and searching for new physics.

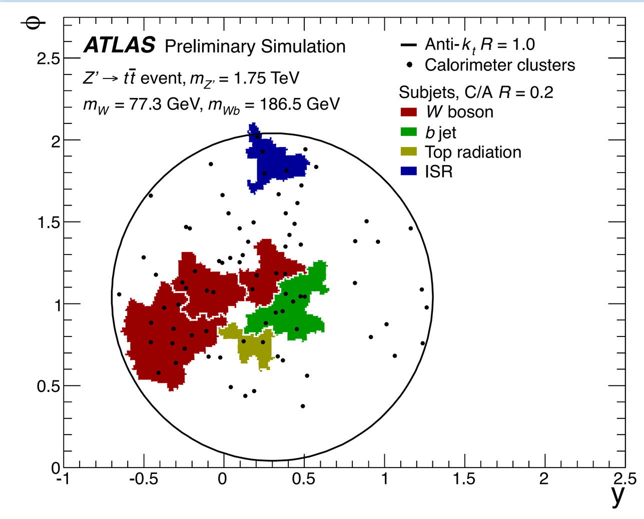




Top Tagging

Shower Deconstruction categorizes a jet into N sub-jets, representing a possible showering history. The probability that a given history was realized is used to distinguish jets originating from boosted heavy particles from QCD backgrounds.





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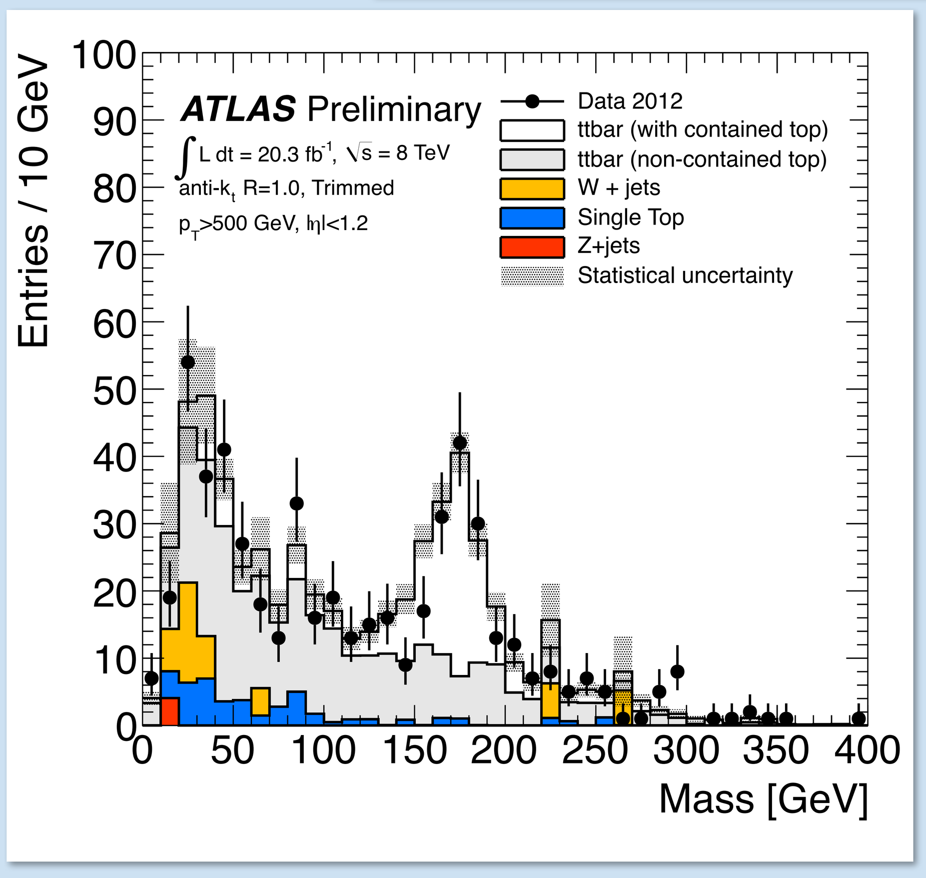

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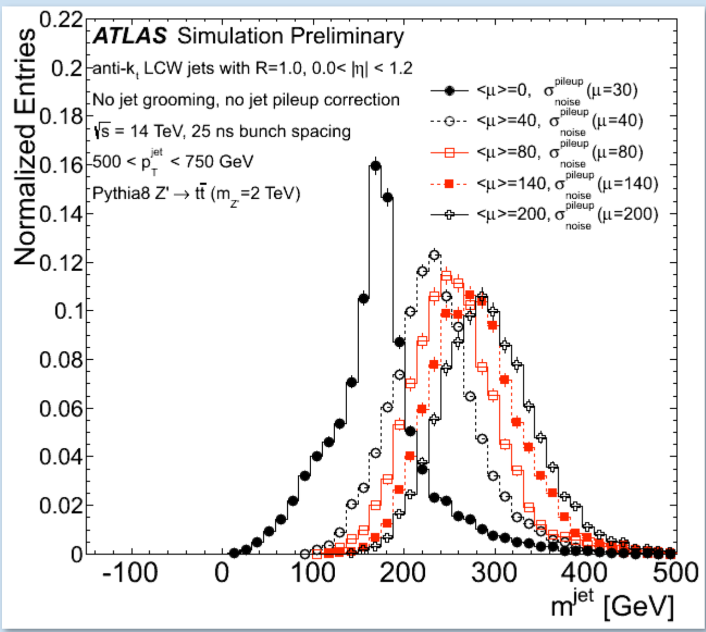
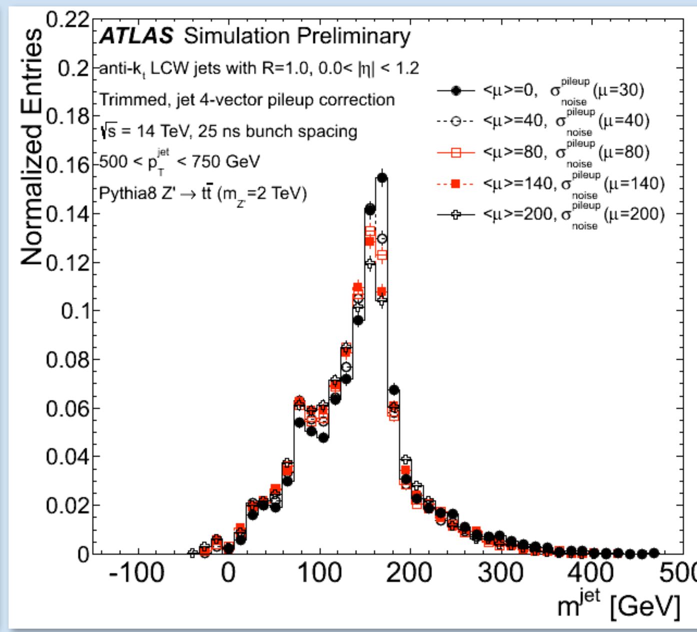
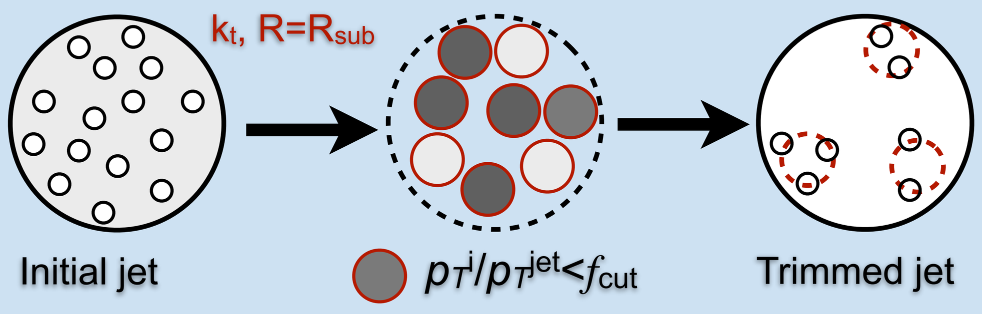
Jet Grooming

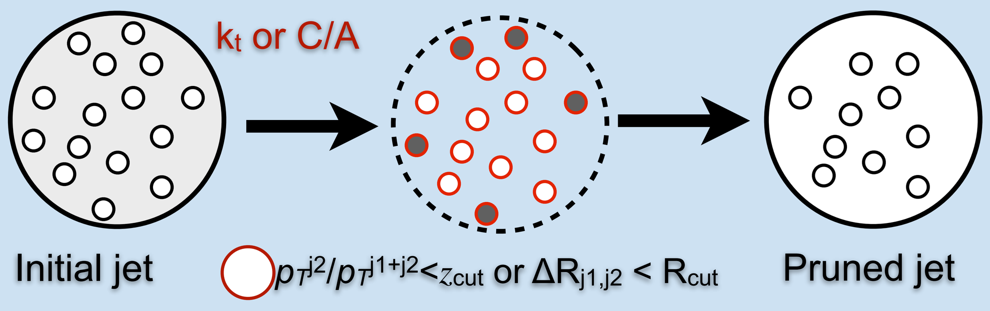
Jet grooming techniques are designed to improve the mass resolution of hadronically decaying boosted objects. ***Jet Trimming*** divides large-*R* jets into N subjets, removing soft components. ***Jet Pruning*** is similar to trimming in that it removes constituents with a small relative pT, but it additionally applies a veto on wide-angle radiation.





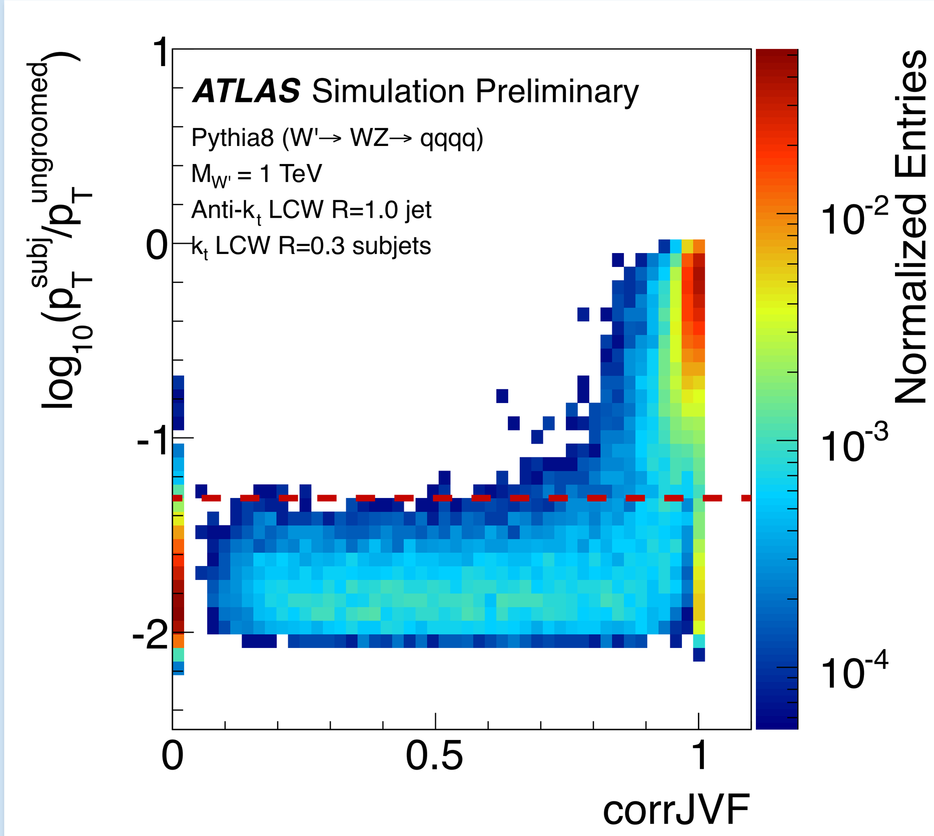


Trimming in combination with a jet-area-based jet 4-momentum correction are expected to be performant at the high luminosity and pile-up conditions expected during the 14 TeV running of the LHC.



Pure ***Track-based Trimming*** places a requirement on track-based variables of reclustered subjets. One such variable is the ***pile-up corrected Jet Vertex Fraction*** (corrJVF). Simulated $W' \rightarrow WZ \rightarrow$ qqqq events are used for performance evaluation.

$$\mathrm{corrJVF} = \frac{\sum_k p_T^{\mathrm{trk}_k}(\mathrm{PV}_0)}{\sum_l p_T^{\mathrm{trk}_l}(\mathrm{PV}_0) + \frac{\sum_{n\geq 1}\sum_l p_T^{\mathrm{trk}_l}(\mathrm{PV}_n)}{(k\cdot n_{\mathrm{trk}}^{\mathrm{PU}})}}$$



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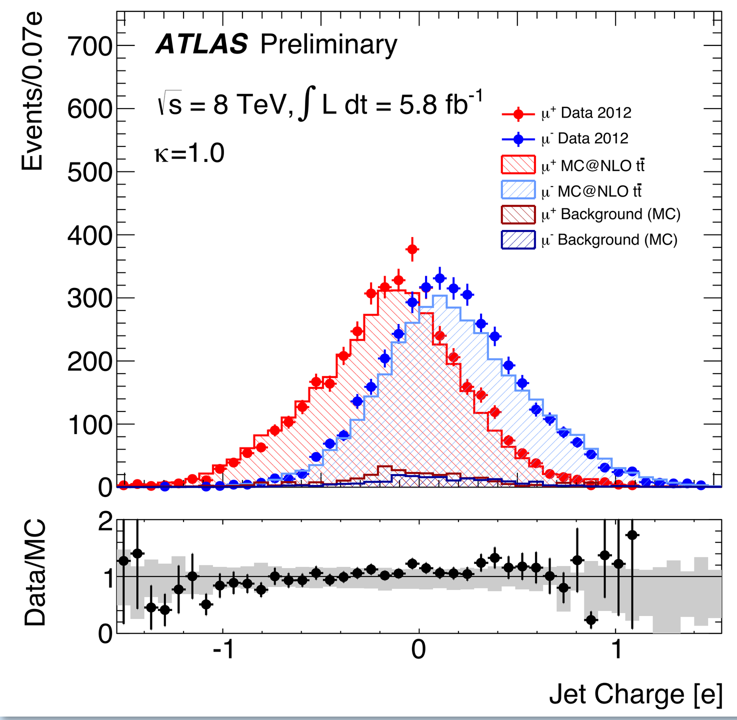
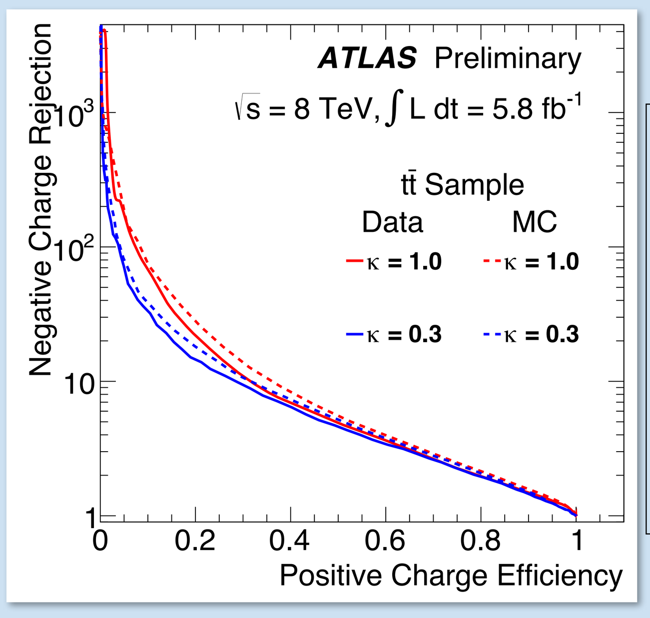
Jet Charge



Jet Charge is a quark-charge sensitive observable which can be used for identifying the charge of hadronically-decaying heavy particles.



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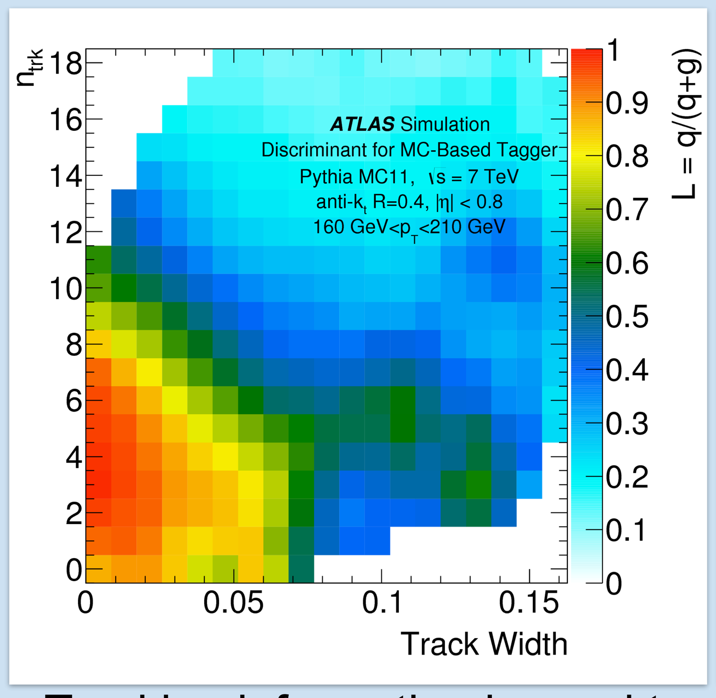
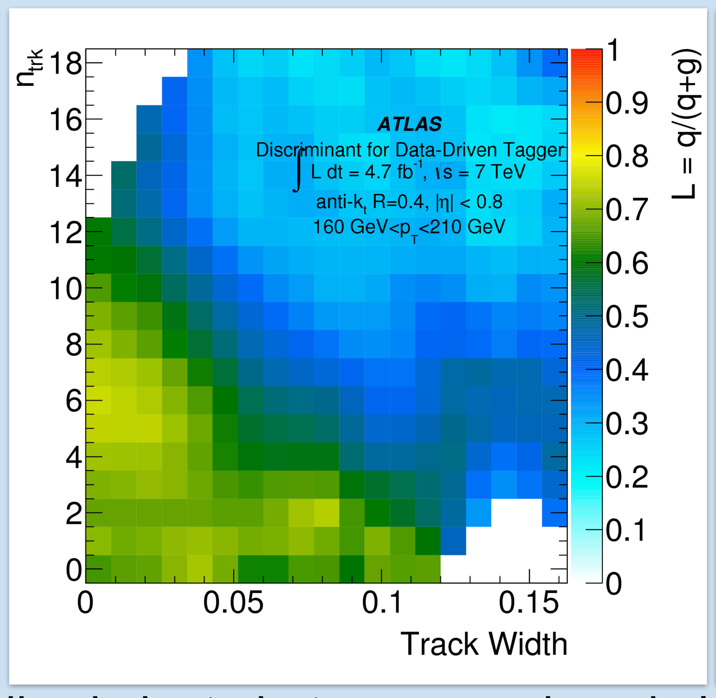
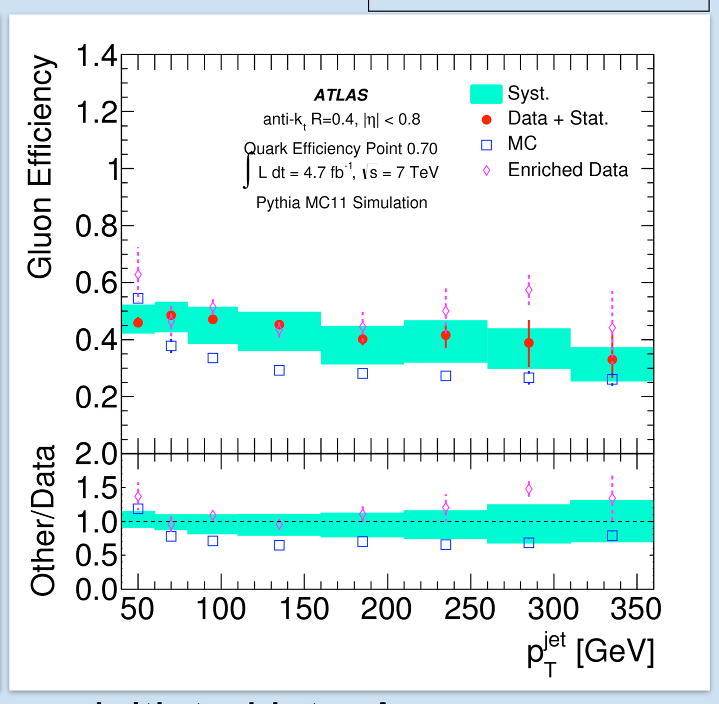
$$Q_j = \frac{1}{(p_{T\,j})^\kappa}\sum_{i\in\mathrm{Tr}} q_i \times (p_T^i)^\kappa$$

Quark/Gluon Tagging

arXiv:1405.6583v1







Tracking information is used to discriminate between quark and gluon initiated jets. A likelihood-based ***Quark-Gluon Tagger*** has been implemented and validated using 4.7 fb^{-1} of 7 TeV data. For data, a ***~45% gluon-jet efficiency*** is achieved for a ***70% quark-jet efficiency***.

Quantum Jets

The ***Q-Jets*** technique interprets jets through multiple sets of possible showering histories. Jet observables are evaluated as distributions and not simply as single quantities. The *volatility* provides powerful discrimination between boosted particles and QCD backgrounds.

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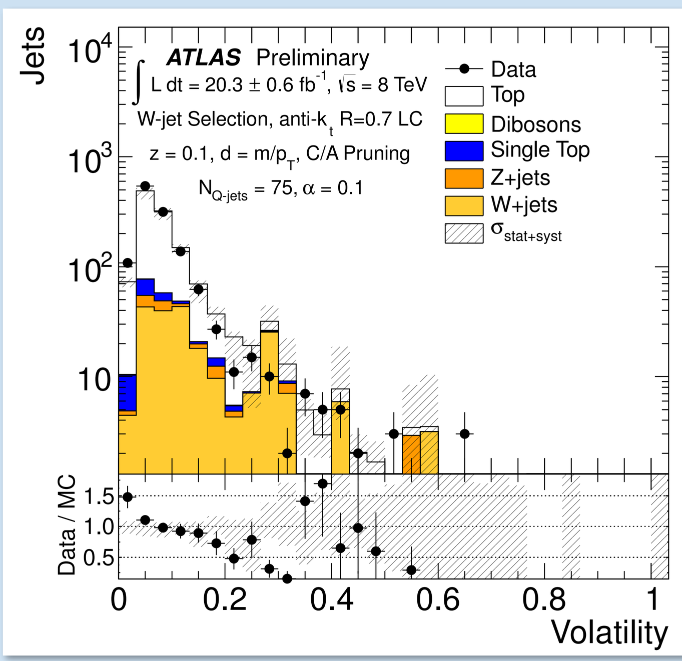
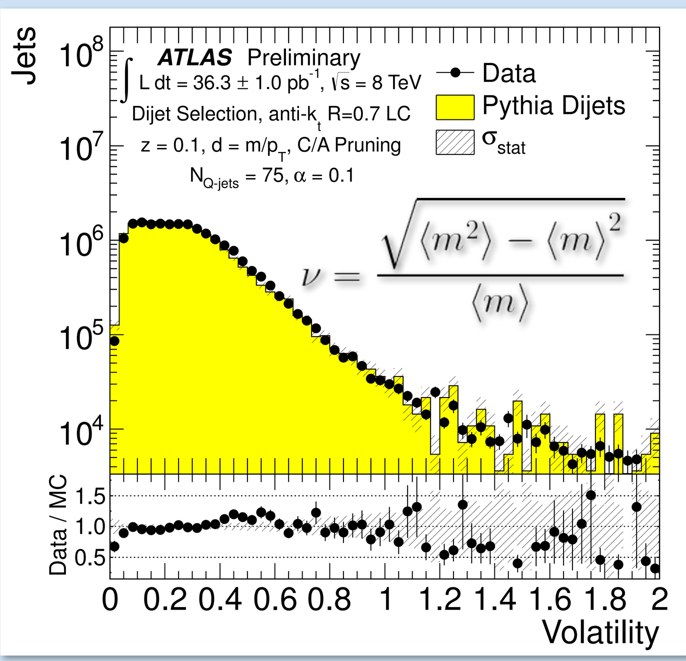
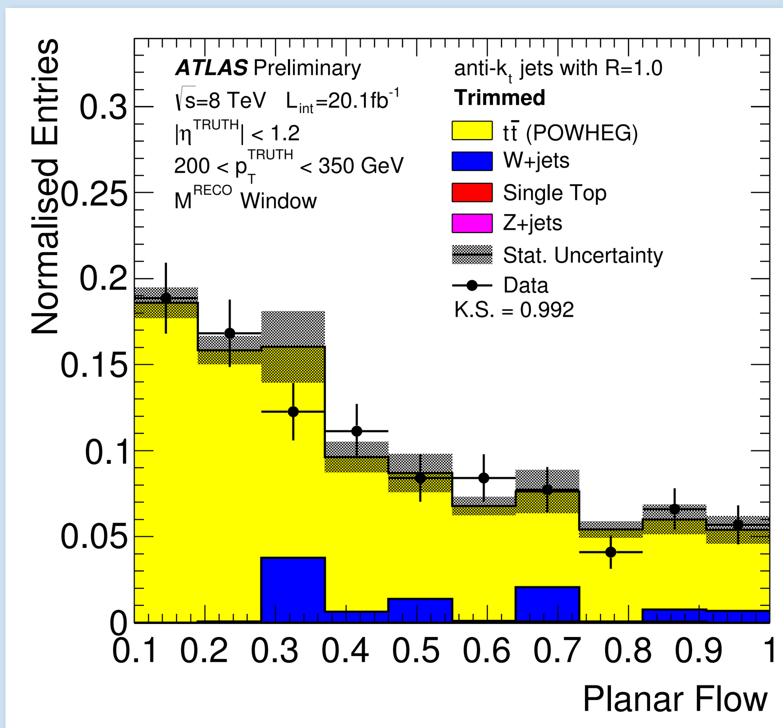
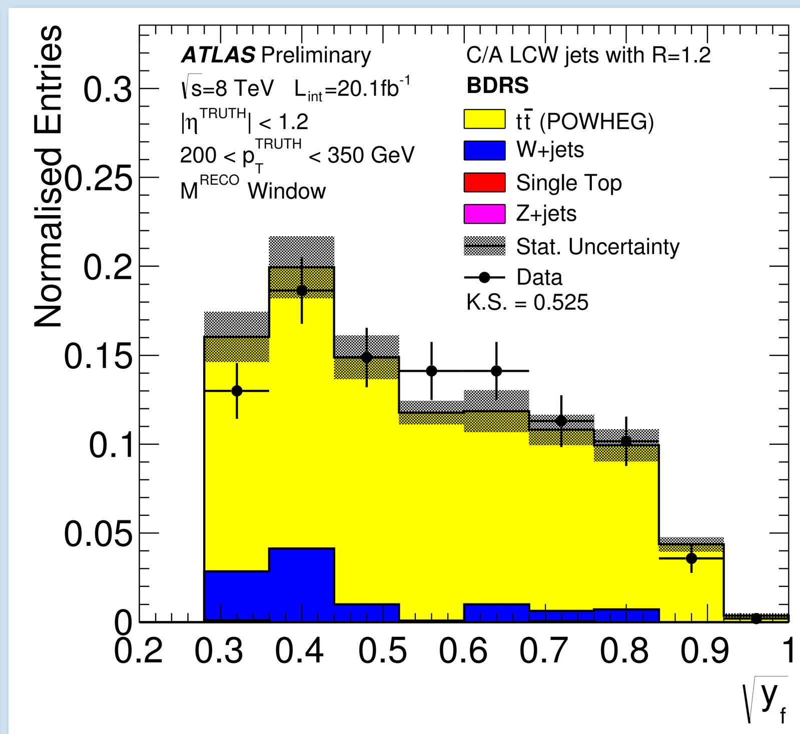




Boosted W Boson Identification

Boosted Boson Identification combines jet grooming techniques with jet substructure variables, improving the boosted object tagging efficiency and QCD background rejection. Data/MC agreement for tagging variables is verified using a high purity sample of *W* bosons from top decays.





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Jim Lacey (Carleton University), for the ATLAS Collaboration

ATLAS EXPERIMENT