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Search for new physics in dijet mass and angular distributions in pp collisions at $\sqrt{s} = 7$ TeV measured with the ATLAS detector

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We present a search for physics beyond the Standard Model in proton-proton collisions at a centre-of-mass energy of $\sqrt{s} = 7$ TeV, performed with the ATLAS Detector at the Large Hadron Collider (LHC). No evidence for new physics is found in dijet mass and angular distributions and stringent limits are set on a variety of models of new physics, including excited quarks, quark contact interactions, axigluons, and quantum black holes.

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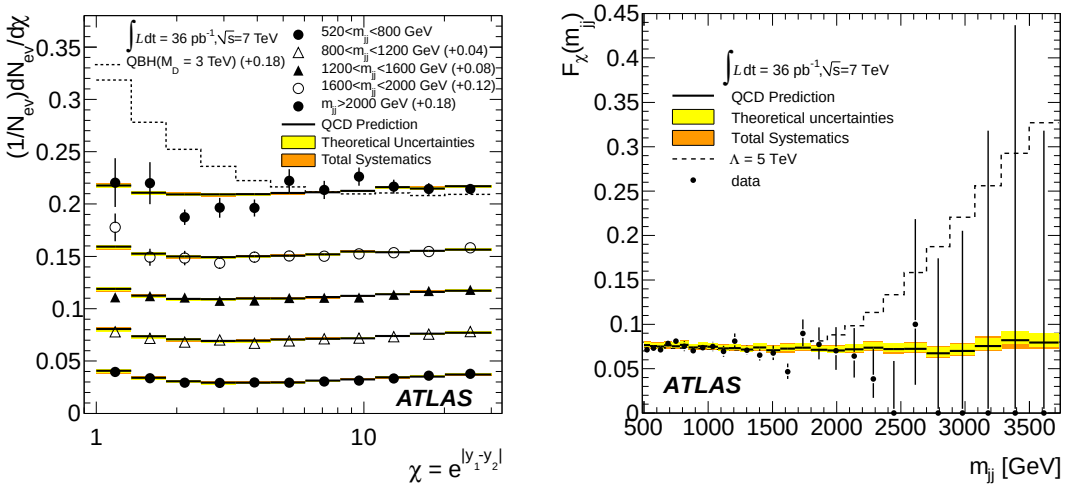
We present a search for new physics in the dijet mass and angular distributions in pp collisions at $\sqrt{s} = 7\,\text{TeV}$, measured with the ATLAS detector at the LHC.

Dijet angular analysis

In the dijet angular analysis, $36\,\text{pb}^{-1}$ of data collected in 2010 are studied in the two variables $\chi = \exp(|\Delta y|)$ and $F_\chi(m_{jj})$, defined[1] as $F_\chi(m_{jj}) = N_{events}(|\Delta y| < 1.2)/N_{events}(|\Delta y| < 3.4)$. The choice of these quantities is motivated by the expected deviations, in various new physics scenarios, from the flat QCD prediction in the differential χ spectra and in the $F_\chi(m_{jj})$ distribution. The analysis adopts a Monte Carlo-driven background estimation, achieving NLO precision by multiplying LO PYTHIA QCD simulations with bin-by-bin k-factors. Systematic uncertainties are convoluted via MC pseudo-experiments. The resulting distributions are depicted in Figure 1. No evidence for new physics is found. Table 1 shows the limits obtained on models of contact interactions and quantum black holes. The full analysis details, including limits on additional models, are given in Reference [1].



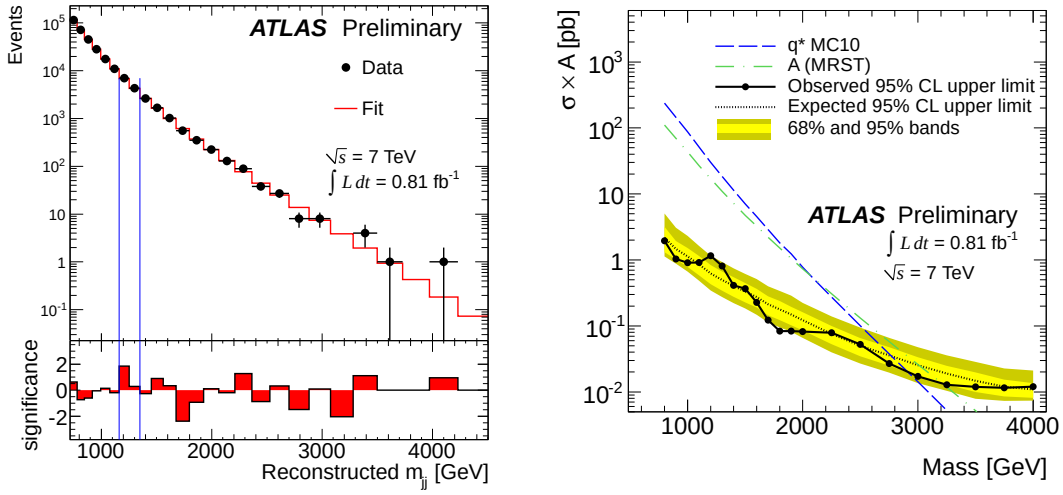
(a) (b)

Figure 1: The observed (filled points) and expected (histograms) distributions for χ (a) and $F_\chi(m_{jj})$ (b). QCD predictions are shown with systematic uncertainties (narrow bands), and data with statistical uncertainties.

Dijet resonance search

In the dijet resonance search, the invariant mass of the two leading jets, m_{jj}, is studied in $0.81\,\text{fb}^{-1}$ of data collected in 2011. An algorithm is applied that analyses the data for localized excesses with respect to a smooth background fit, $f(x) = p_1(1-x)^{p_2}x^{p_3+p_4\ln x}$,with $x \equiv m_{jj}/\sqrt{s}$ and the fit parameters p_i. No resonant structure is found (see Figure 2). The resulting limits on models of excited quarks and axigluons are presented in Table 1. Reference [2] contains further information, including the limits obtained on generic Gaussian resonance models.

[1] Δy denotes the rapidity difference of the two jets with the highest transverse momenta (p_T), while m_{jj} is their invariant mass.



(a) (b)

Figure 2: (a) The dijet mass distribution for the data and the background fit. (b) The 95% C.L. upper limit on $\sigma \times A$ as a function of the resonance mass. Predictions for excited quarks (q*) and axigluons (A) are shown, with MC10 referring to the Monte Carlo tune and MRST to the PDF choice.

			95% C.L. Limits [TeV]	
Analysis	**Model**	**Characteristic quantity**	**Expected**	**Observed**
Angular	Quantum Black Hole	Quantum gravity scale M_D	3.49	3.78
36 pb^{-1}	Contact Interaction	Compositeness scale Λ	5.7	9.5
Resonance	Axigluon	Axigluon mass	3.02	3.21
0.81 fb^{-1}	Excited quark q*	Excited quark mass	2.77	2.91

Table 1: The 95% C.L. lower limits on the characteristic mass and energy scales of some of the models of new physics, studied in [1, 2].

Conclusions

We have used the dijet mass and angular distributions to search for signs of new physics. In the absence of significant deviations from the expectation, we have set limits on various scenarios of physics beyond the Standard Model. With more LHC data to become available in the near future, we expect the dijet distributions to yield exciting new insights into the phenomenology of the smallest distance scales and the highest energies.

References

[1] ATLAS Collaboration. A search for new physics in dijet mass and angular distributions in pp collisions at $\sqrt{s} = 7$ TeV measured with the ATLAS detector. *New Journal of Physics*, 13(5):053044, May 2011.

[2] ATLAS Collaboration. Search for New Physics in Dijet Mass Distributions in 0.81 fb^{-1} of pp Collisions at $\sqrt{s} = 7$ TeV. *ATLAS-CONF-2011-095*, 2011.