UNIVERSITY OF NOTRE DAME

Jet and Photon Physics at CMS

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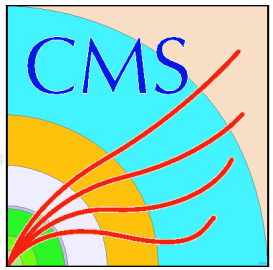
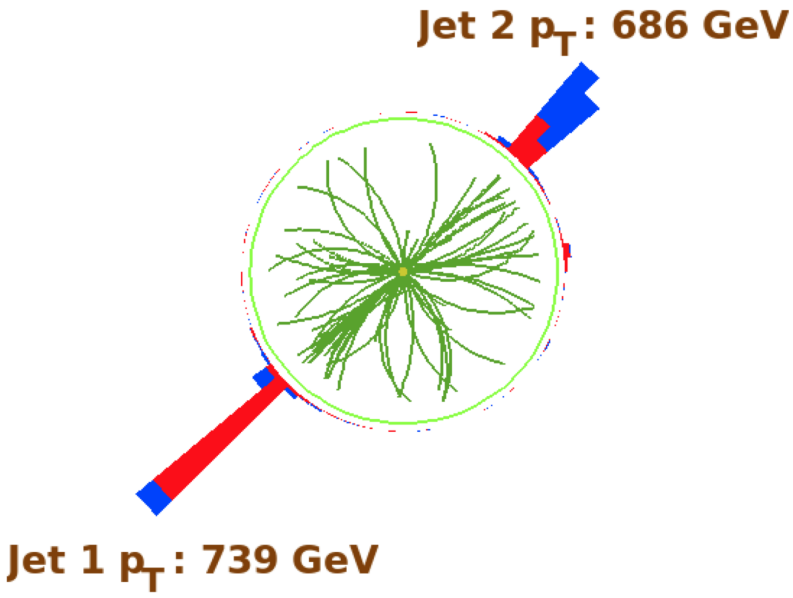
Motivation



Test the evolution of QCD to higher energies (and lower x)

Search for new particles with Quarks, gluons and photons in Final state

Jet production is dominant process at pp collisions by orders of magnitude
It is a background to many searches for rare physics



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2. Jet reconstruction and corrections

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6. Dijet Centrality Ratio
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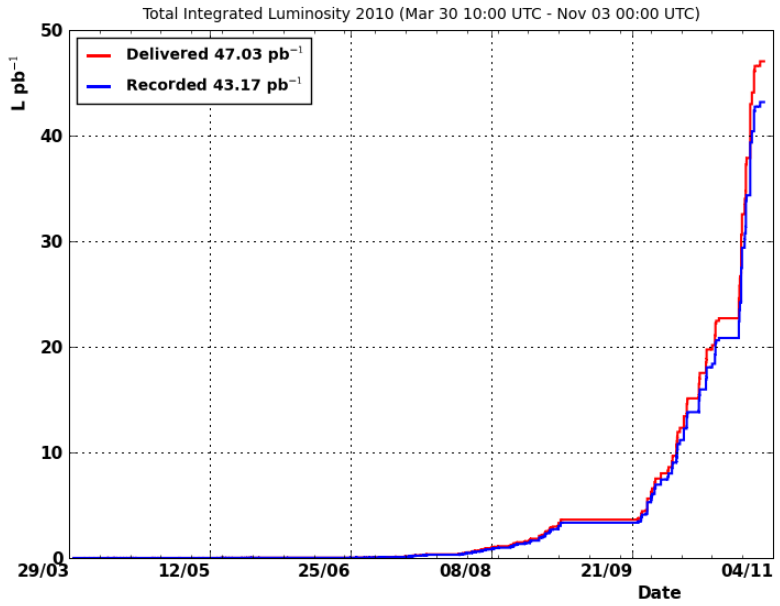
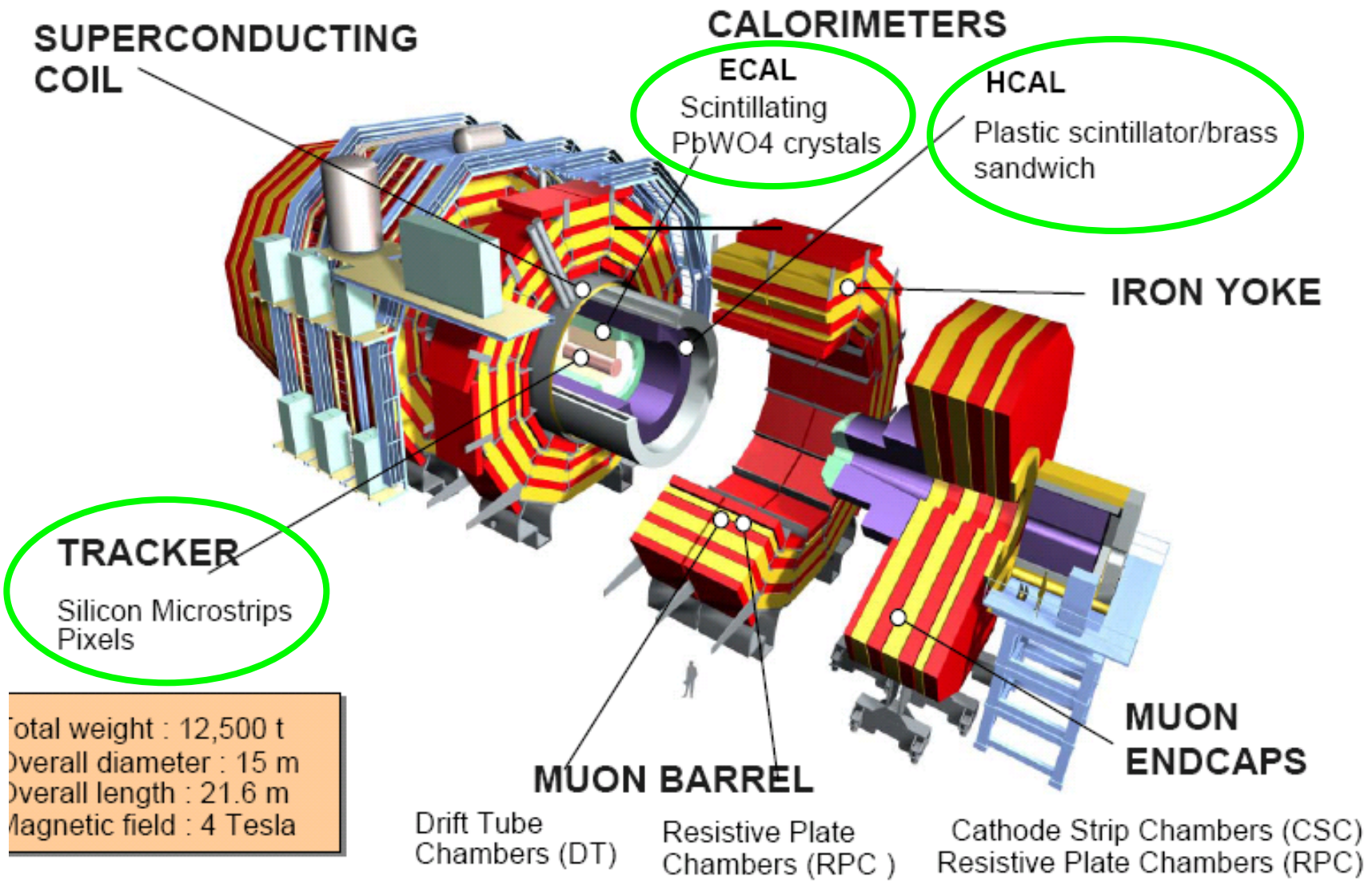
8. 3-Jet to 2-Jet Ratios



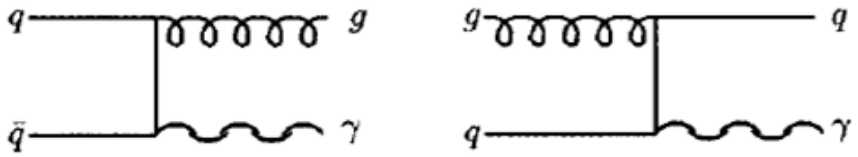
All analyses presented contain only a fraction of the full 35 pb^{-1} collected

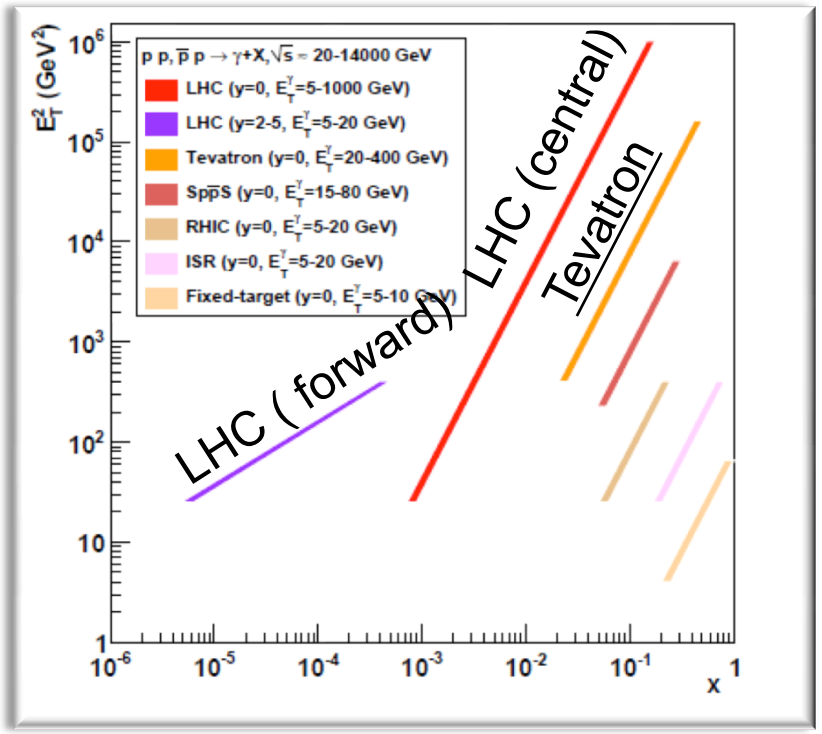
Each has an associated paper available in http://cdsweb.cern.ch/

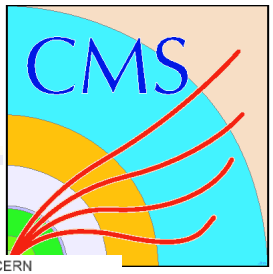
The CMS experiment



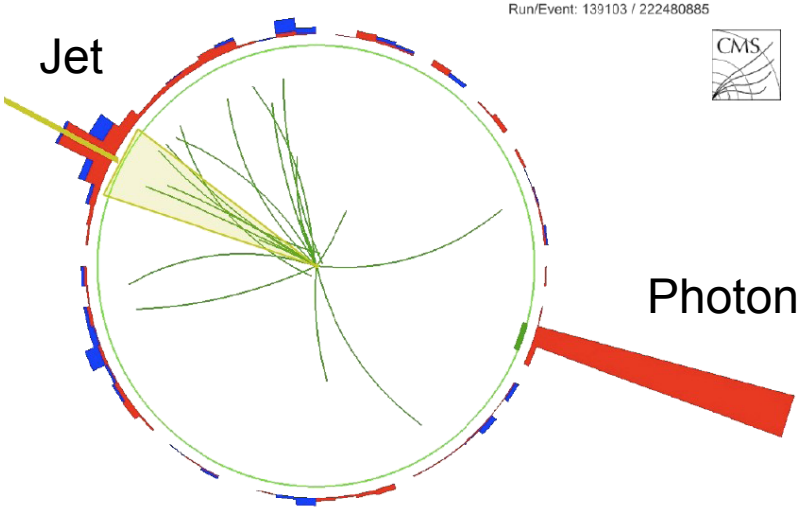
Measurement of Isolated Photon X-section: Motivation







CMS Experiment at LHC, CERN
Data recorded Thu Jul 1 09:08:48 2010 CEST
Run/Event: 139103 / 222480885



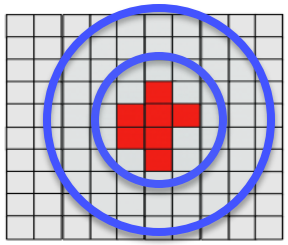
Probes lower x region than previously accessible

Helps constrain gluon structure function

Background to H->γγ

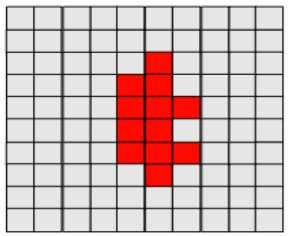
Measurement of Isolated Photon X-section: Technique

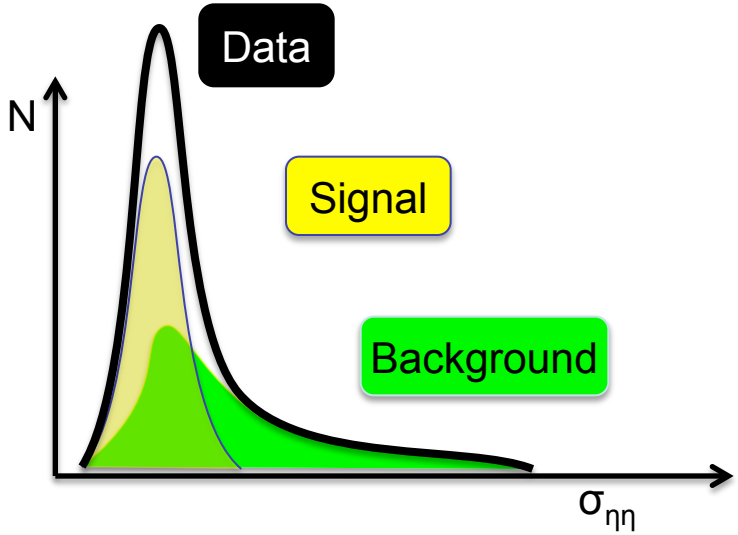
Signal



Isolation cones in EM energy, HAD energy and tracks

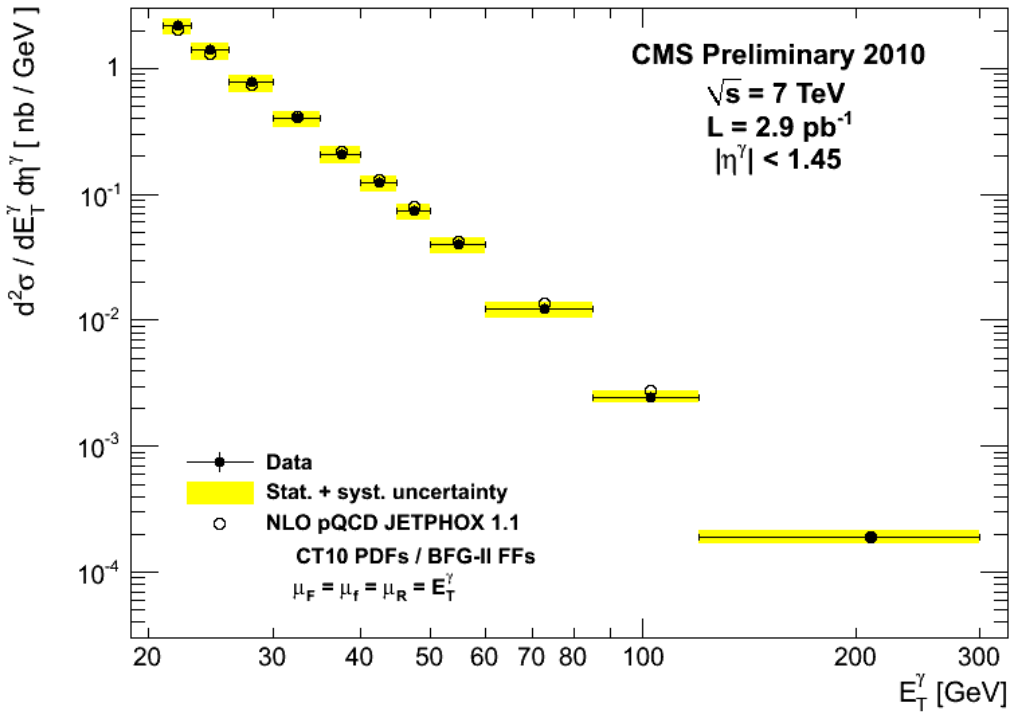
Background





Signal Variable is lateral shower shape. Relax isolation to get background templates from data. Fit signal and background templates to get yield

Measurement of Isolated Photon X-section: Results



Total Error: 16%/11% at low/high E_t

Uncertainty in background template shape is dominant error.

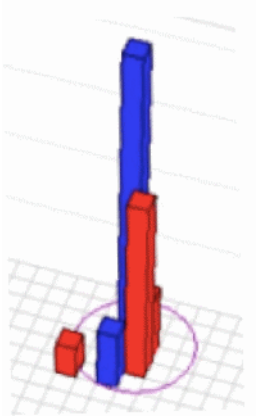
11% Luminosity Error not shown

Good agreement with NLO predictions from JETPHOX. Probes new region of $x_T \sim 0.02$

arXiv:1012.0799 ; CERN-PH-EP-2010-053 ; CMS-PAS-QCD-10-019

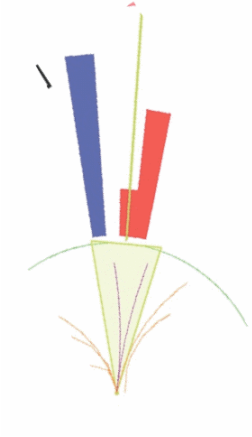
Jet Reconstruction

CaloJets



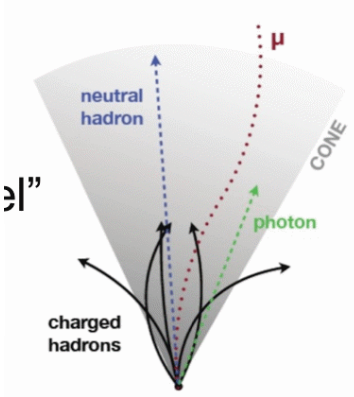
Calorimeter Only

Jets Plus Tracks

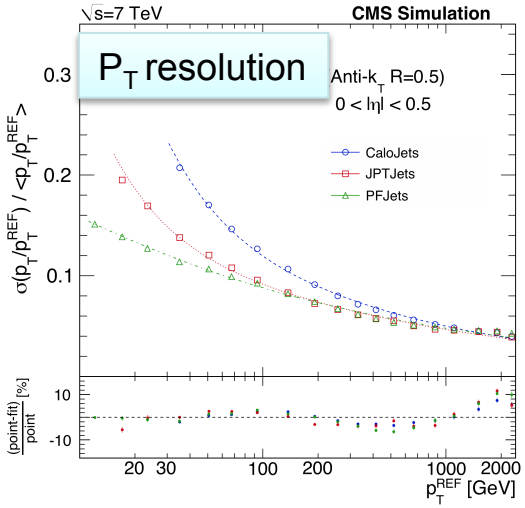


Calorimeter corrected With tracks

Particle Flow Jets



Reconstruct all particles in the event then cluster



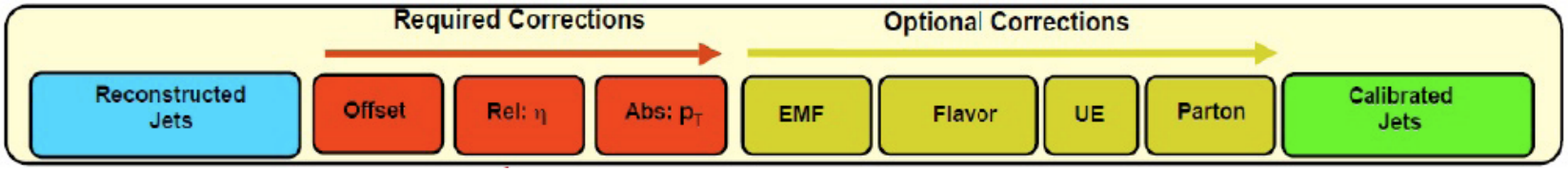
All use Anti-K_T clustering with a Radius of 0.5

Particle Flow and JPT give better response and resolution.

Jet Energy Scale and Resolution

Jet energy scale (JES) and resolution (JER) are typically dominant systematics in analysis involving jets.

JES correction is performed in several steps:

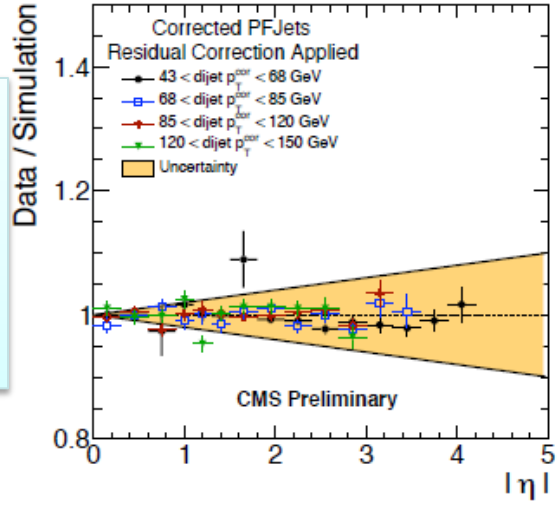


Corrections made with simulation but validated with data (γ+jets, di-jet balancing)
Systematics set by data-simulation comparison

Systematic Uncertainties

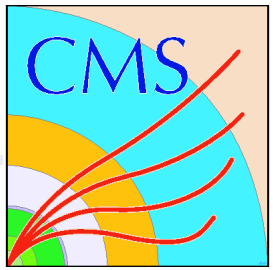
Jet Energy Scale: 5-10% (absolute) + 2|η|% (relative)

Jet Energy Resolution: 10%



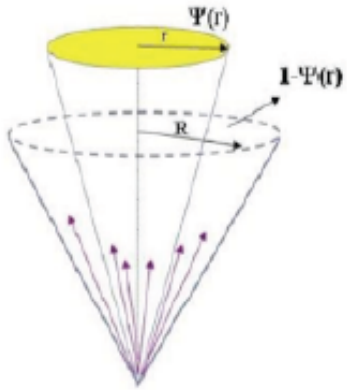
CMS-PAS-JME-10-003

Jet Shapes

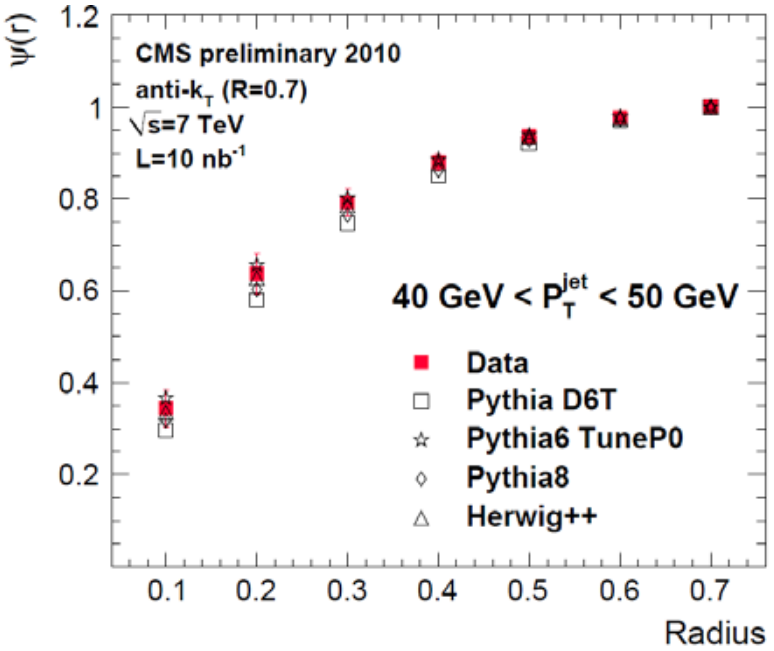


Evaluate whether our simulation accurately describes the features of jets produced in 7 TeV pp collisions.

$$\Psi(r) = \frac{1}{N_{jets}} \sum_{jets} \frac{P_T(0,r)}{P_T^{jet}(0,R)}$$



Integrated Jet Shape

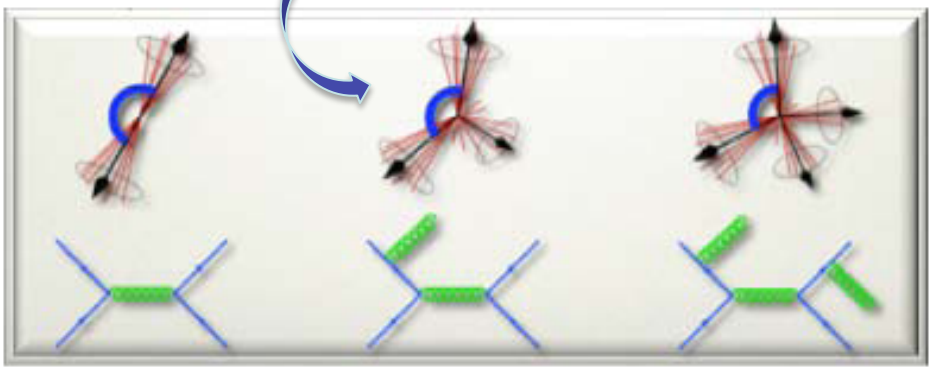


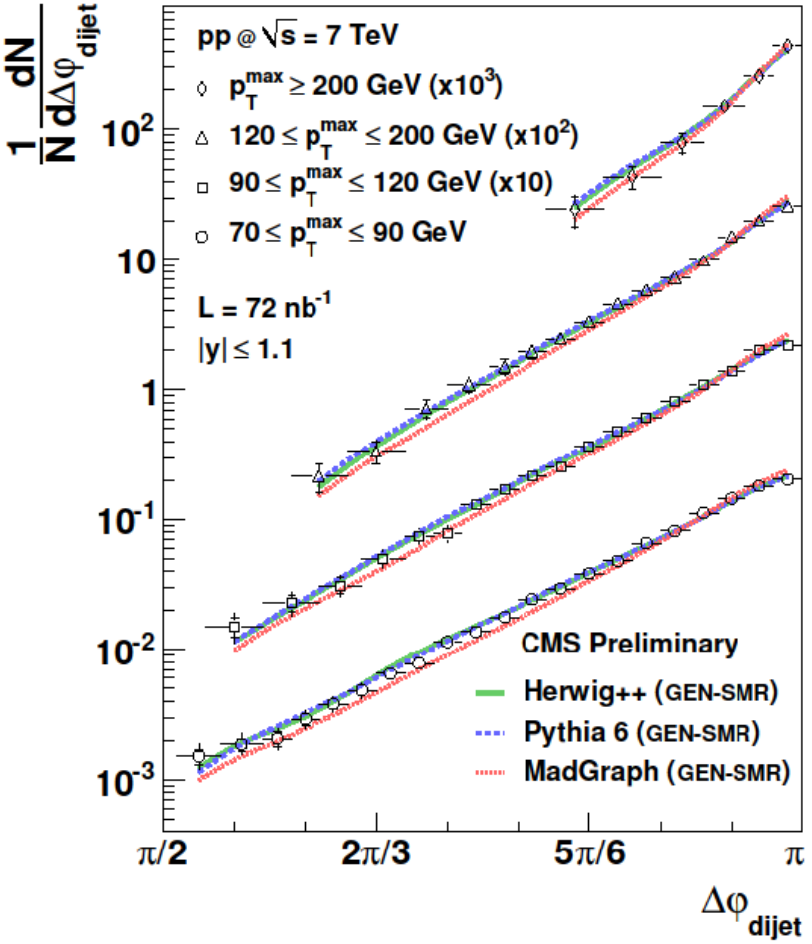
Find good agreement between data and simulation (Pythia & Herwig++)
Is a variety of variables that characterize the jet shape

CMS-PAS-QCD-10-014

Dijet Angular Decorrelations

$$\Delta\phi_{jet1-jet2}$$



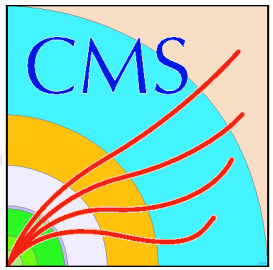


Tests pQCD at higher order without reconstructing additional jets

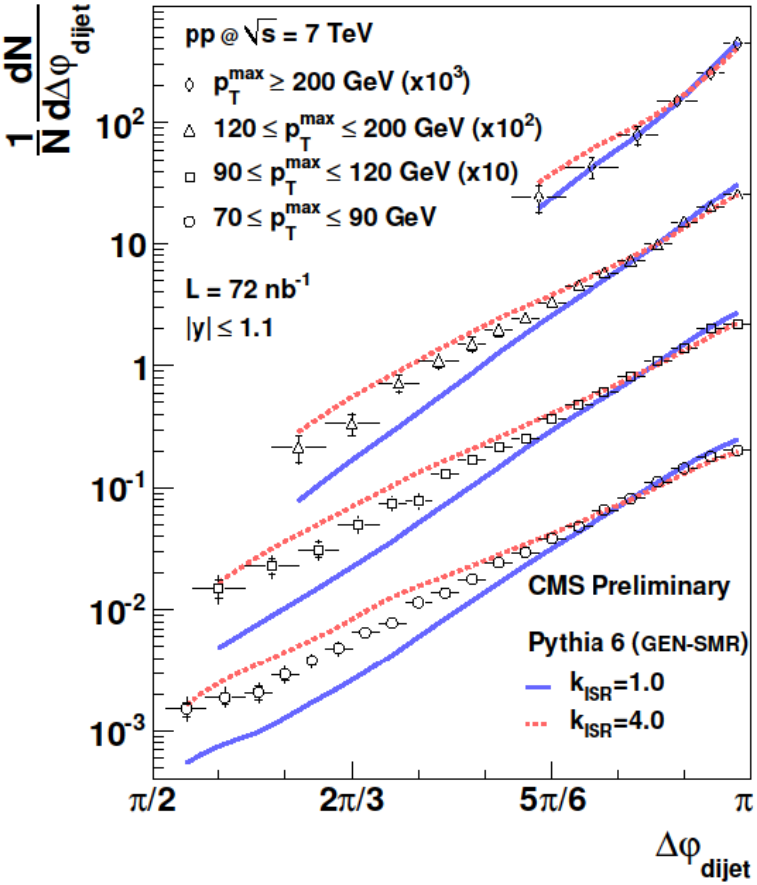
Results used to tune final state radiation in event generators.

CMS-PAS-QCD-10-015

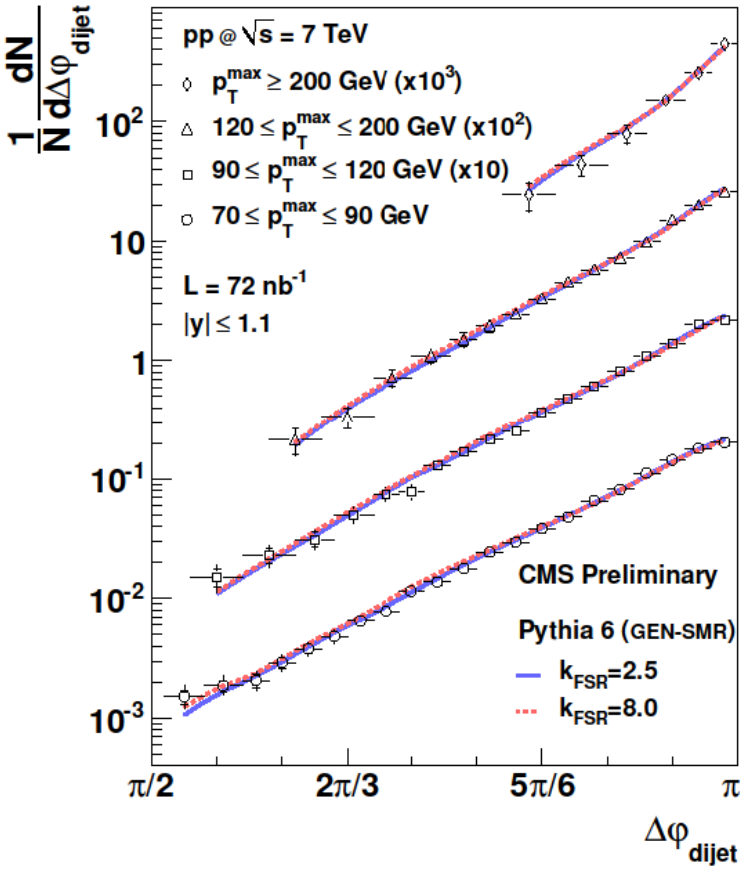
Tuning gluon radiation in Event generators



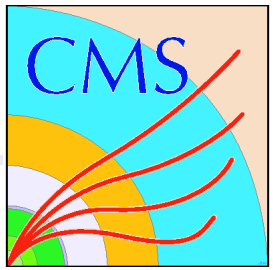
Before



After



Inclusive Jet Cross-Section



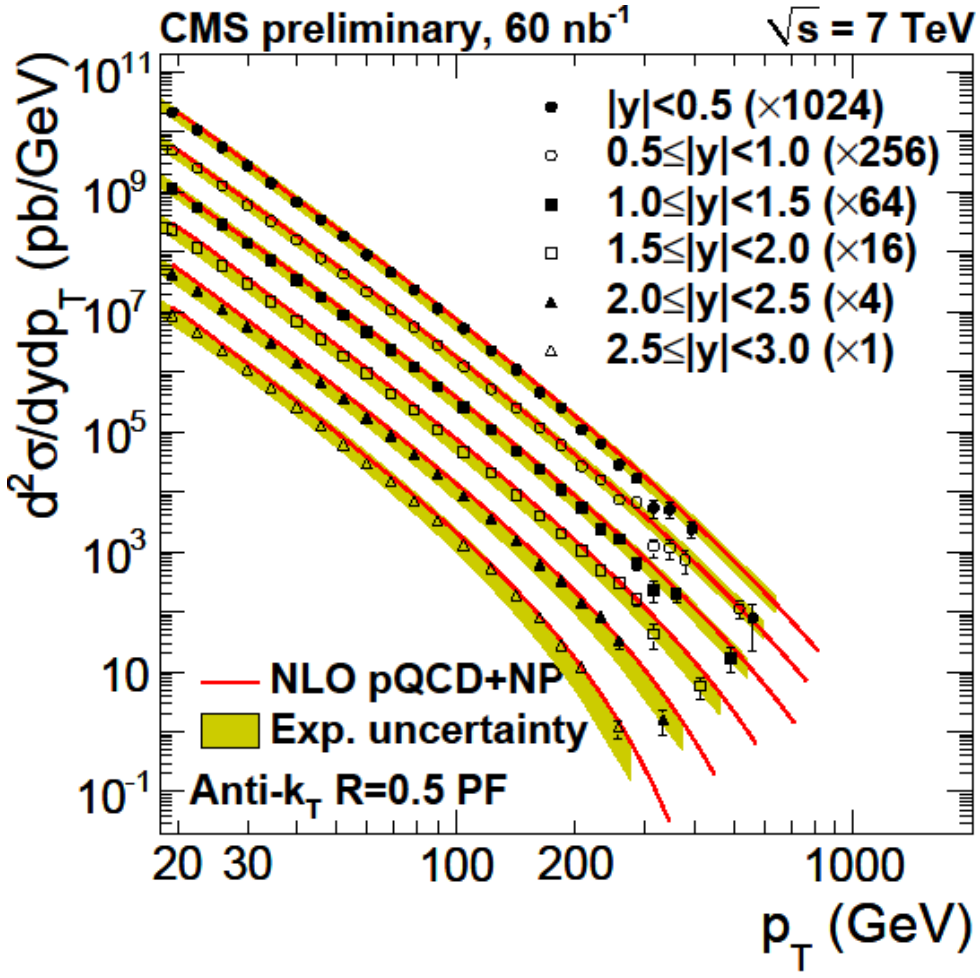
Standard Measurement to search for compositeness at high P_T

Not yet able to extend beyond Tevatron reach at high P_T

BUT

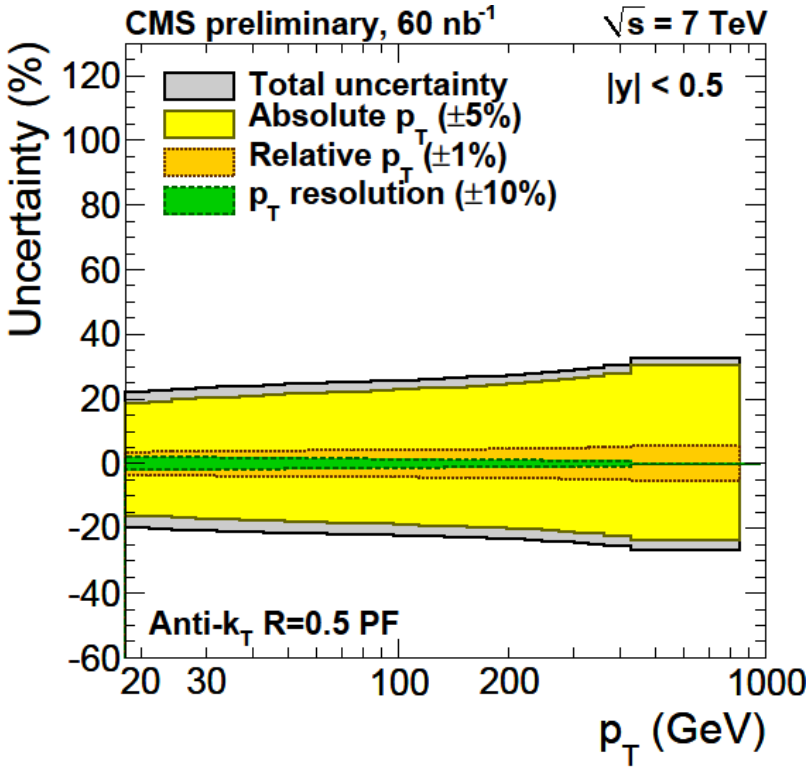
Particle Flow allows us to go to lower P_T (20 vs 50 GeV)

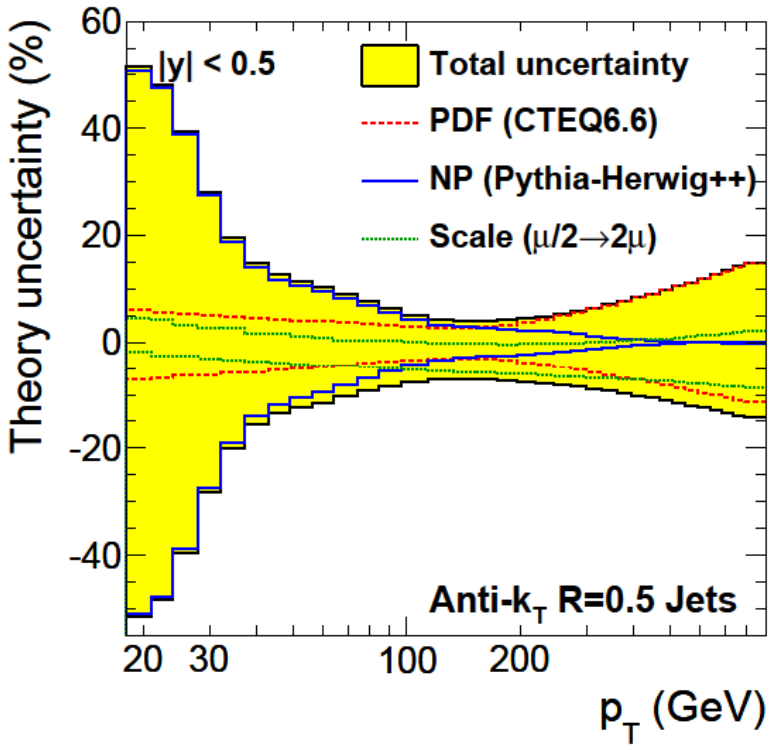
Good Agreement with NLO predictions from 20 GeV to ~500 GeV



CMS-PAS-QCD-10-011

Inclusive Jet Cross-section Errors



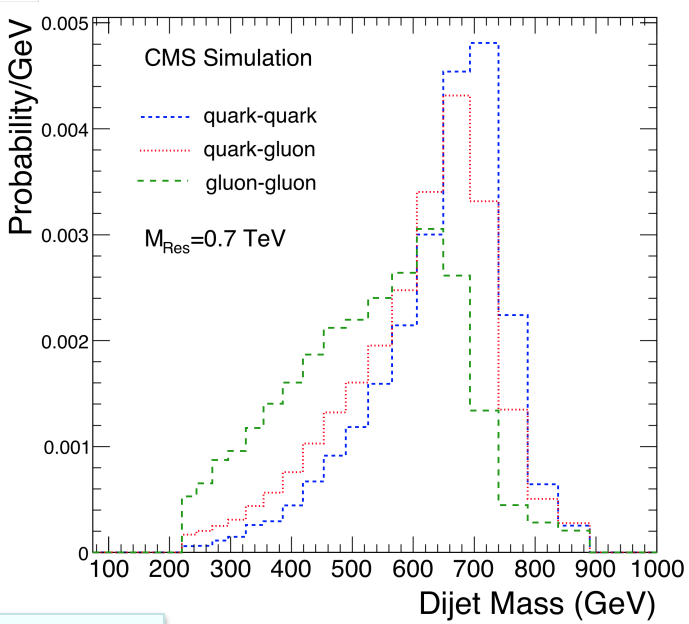


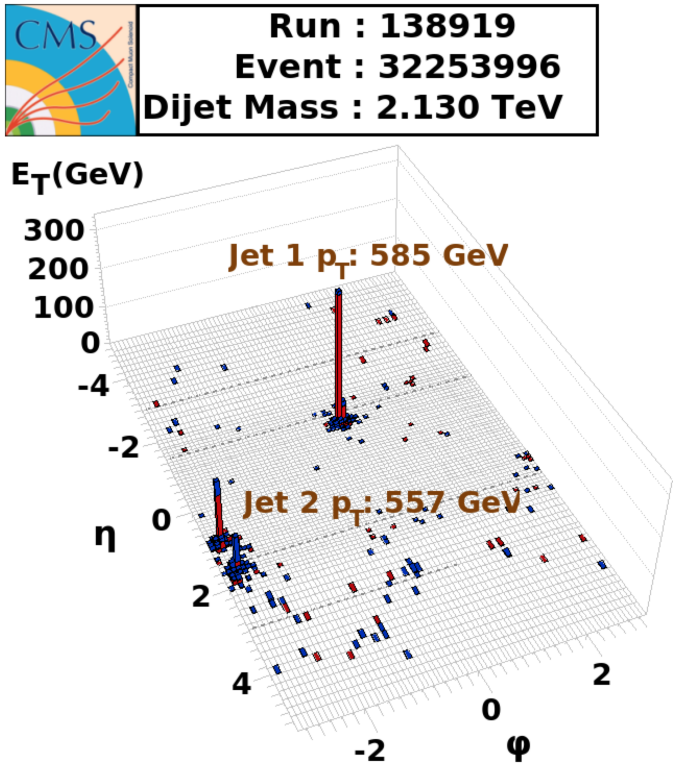
Experimental Errors dominated by JES,JER and Luminosity (11%) while theory errors controlled by Non-Perturbative effects at low P_T and parton density functions at High P_T

Search for Dijet Resonances

Construct invariant mass of two Leading Jets, M_{JJ}

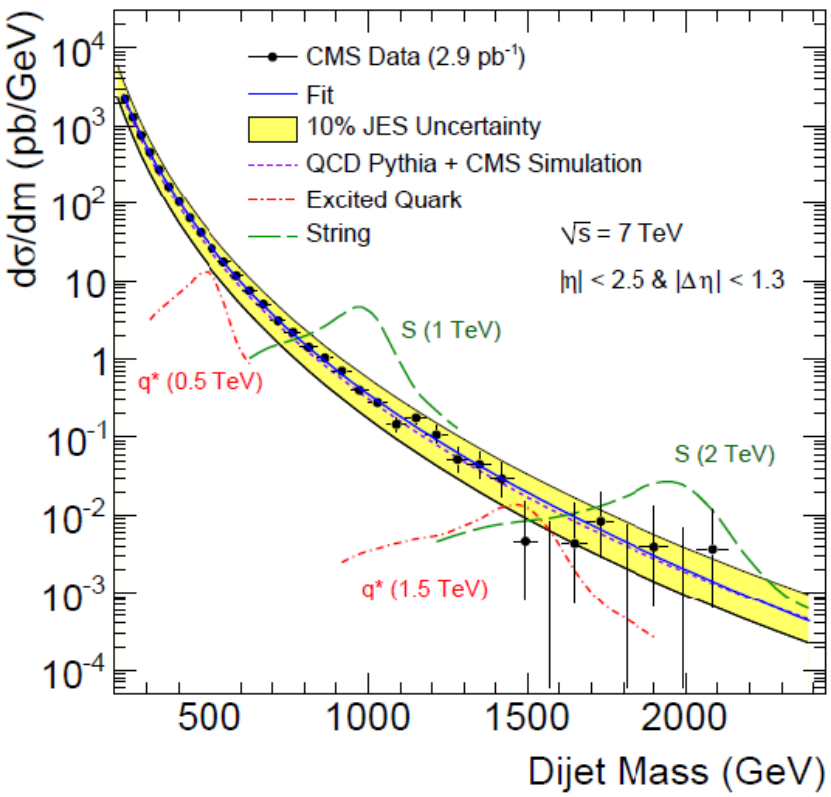
Look for resonance structures from e.g q* -> qg

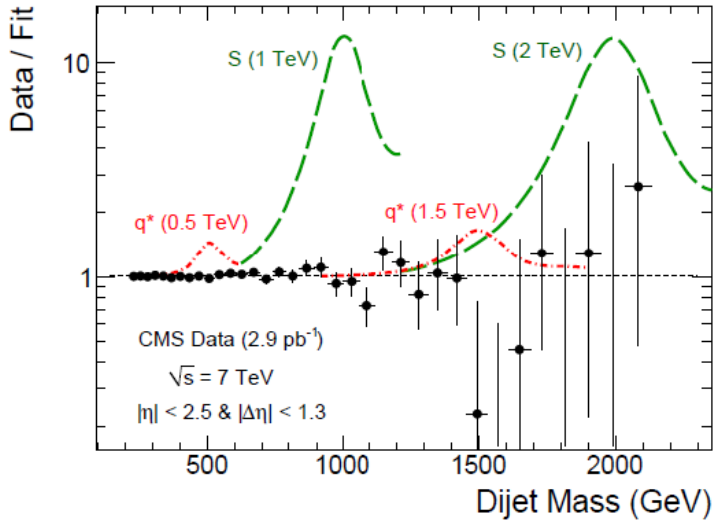




CMS-PAS-EXO-10-010

Search for Dijet Resonances





No evidence of resonances and set limits for various models

	Excluded Regions (TeV)
String Resonance	0.50–2.50
Excited Quark	0.50–1.58
Axigluon/Coloron	0.50–1.17, 1.47–1.52
E_6 Diquark	0.50–0.58, 0.97–1.08, 1.45–1.60

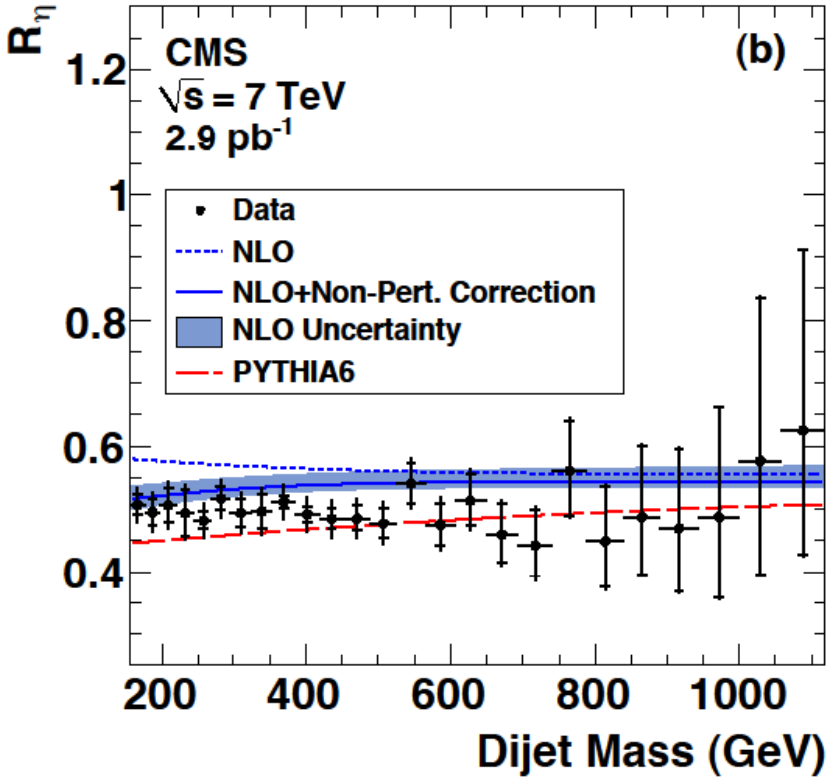
Measurement of Dijet Centrality Ratio

$$R_\eta = \frac{N_{events}\ with\ |\eta_{jet1}|<0.7\ and\ |\eta_{jet2}|<0.7}{N_{events}\ with\ 0.7<|\eta_{jet1}|<1.3\ and\ 0.7<|\eta_{jet2}|<1.3}$$

QCD peaks in forward direction (t-channel gluon exchange)

New Physics more isotropic (hard scatter)

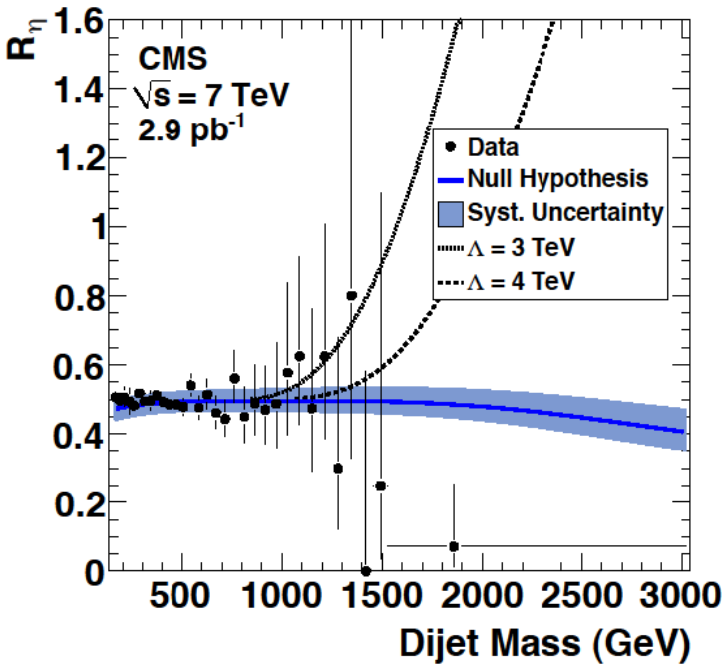
Measure R_η vs M_{jj} to look for dijet resonances and evidence of quark compositness via a contact interaction at scale Λ

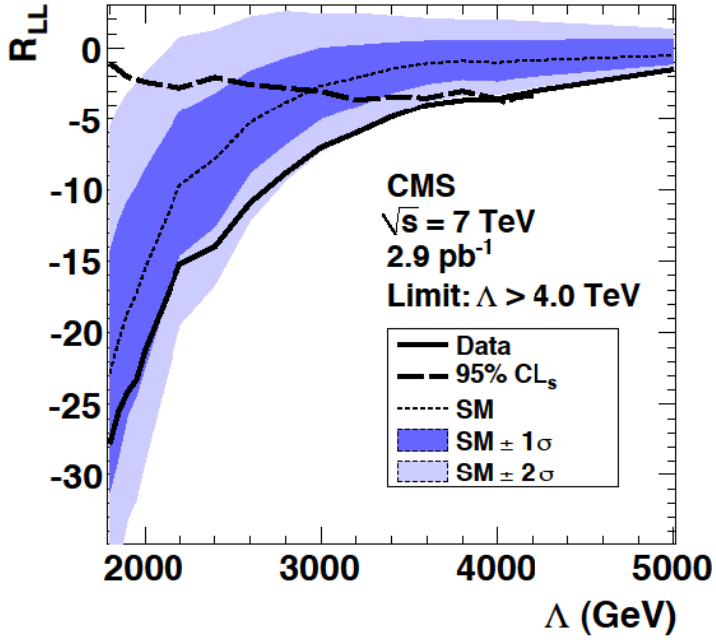


No evidence for deviation from QCD

Measurement of Dijet Centrality Ratio

Set Limits on contact interaction scale Λ using $R_{LL} = \ln(\frac{L_\Lambda}{L_{QCD}})$





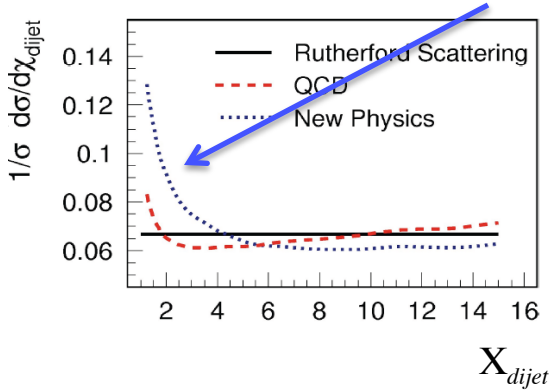
Exclude Λ< 4.0 TeV c.f. Tevatron Λ< 2.9 GeV
(expected exclusion is Λ<2.9 GeV

CMS-PAS-EXO-10-002

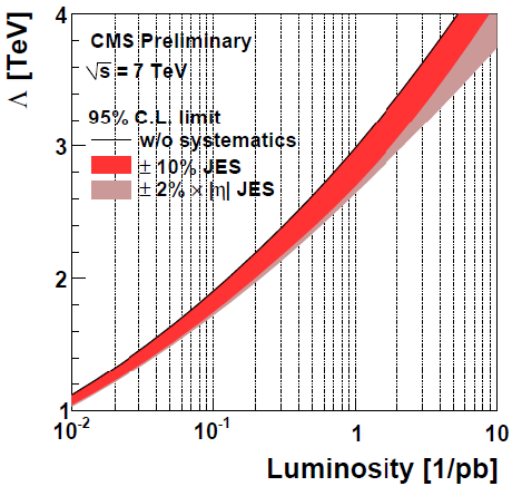
Dijet Angular Distributions

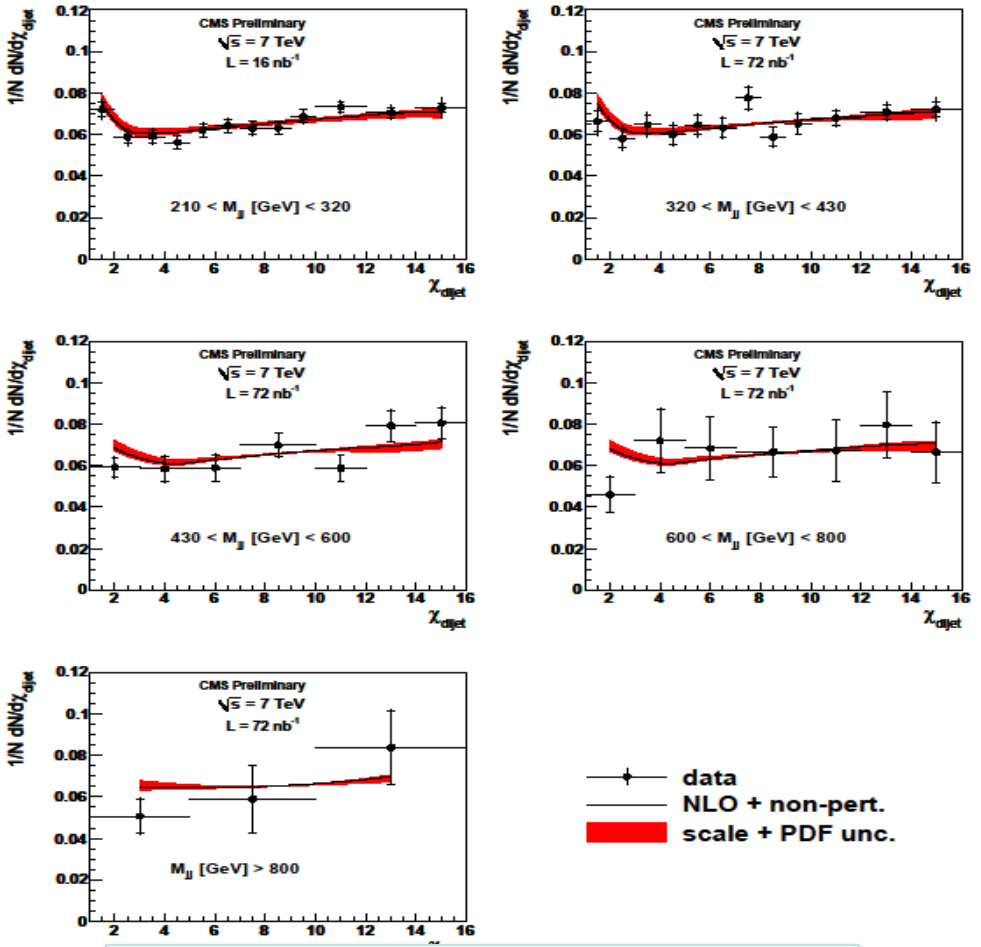
$$\chi_{dijet} = \exp(y_{jet1} - y_{jet2})$$

Also sensitive to Λ



Projected Sensitivity





No deviation from QCD observed

CMS-PAS-QCD-10-015

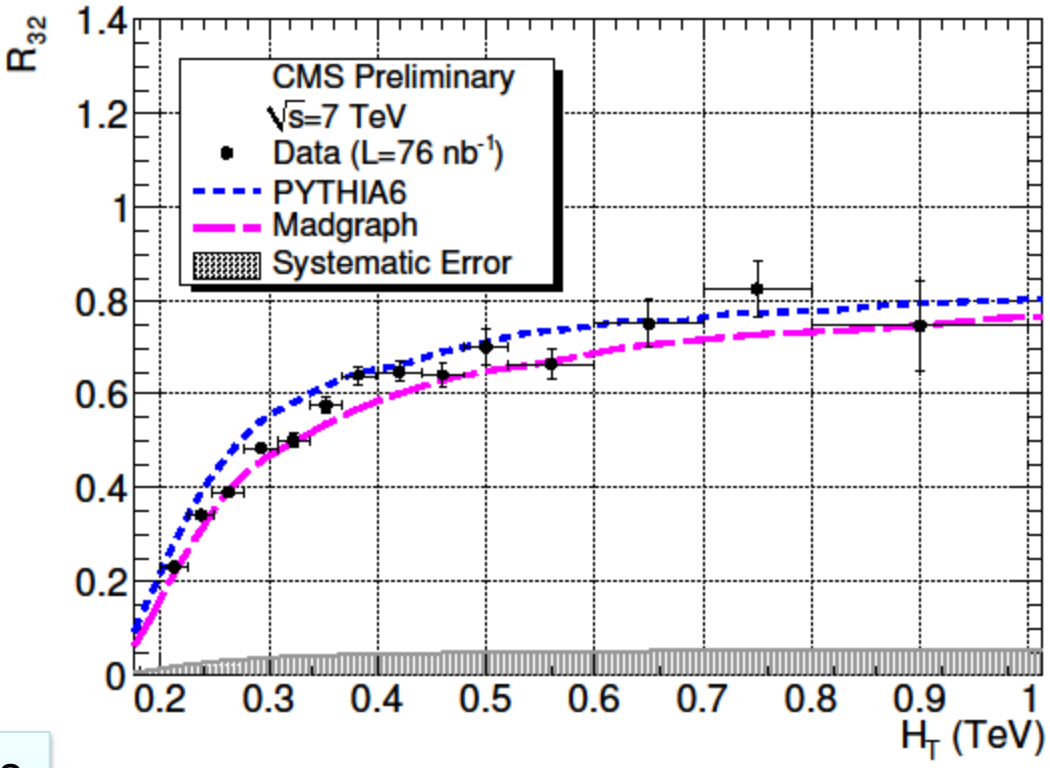
3 Jet to 2 Jet Ratio

$$R_{32} = \frac{d\sigma_3/dH_T}{d\sigma_2/dH_T}$$

$$H_T = \sum_{jets} |P_T| \quad (P_T > 50\ GeV, |\eta| < 2.5)$$

Tests pQCD. Sensitive to α_s

Insensitive to many systematics such as JES, PDF's etc



Good Agreement with predictions for H_T<900 GeV

CMS-PAS-QCD-10-012

Conclusions

CMS has begun a vigorous and comprehensive program to test pQCD and search for new physics with jets and photons in the final state

The detector, reconstruction software and algorithms and simulation are performing well

Results presented used only a fraction of collected dataset. Results on 35 pb^{-1} coming soon.