

CMS Search Plans for Contact Interactions using DiJets

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for the CMS Collaboration



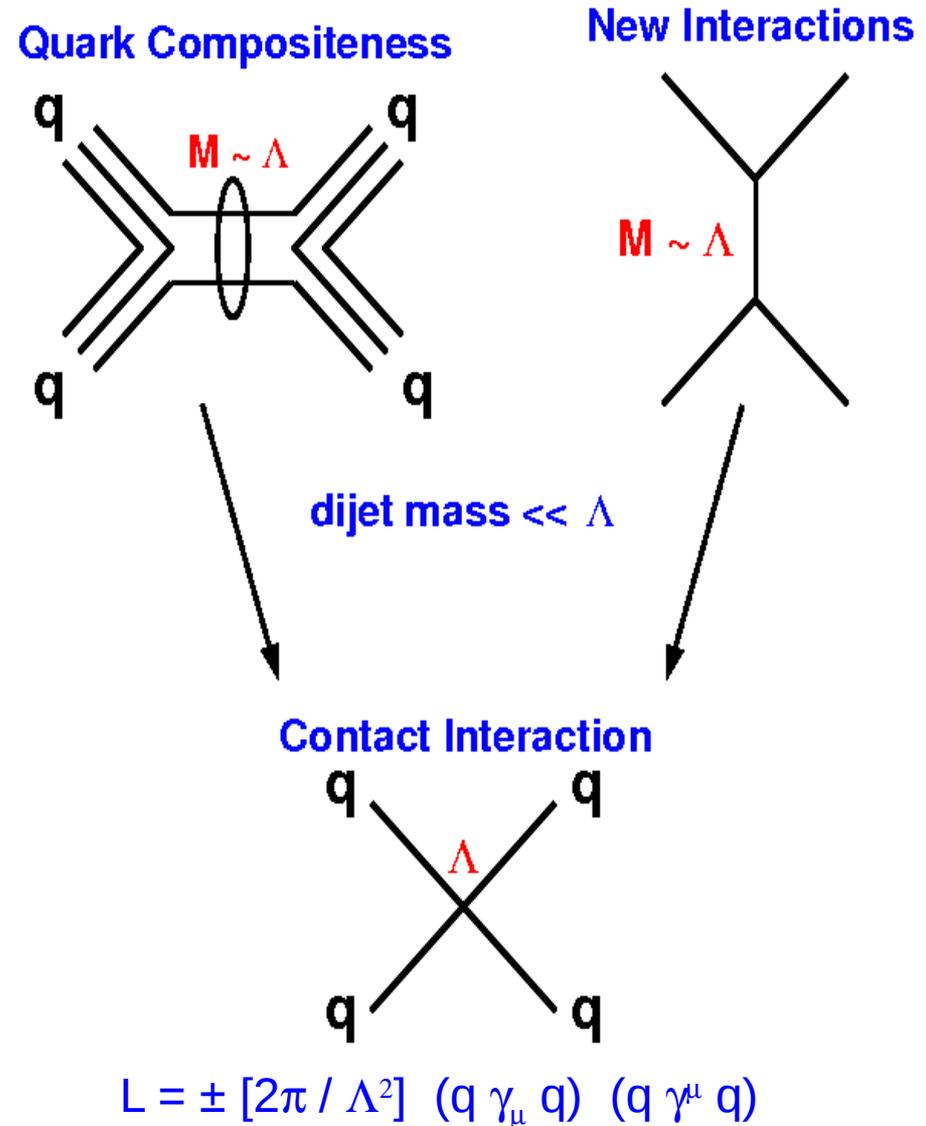
Outline

- Contact Interactions and Jets at CMS
- Results from Monte Carlo Studies
 - Event cleanup & jet corrections
 - Inclusive jet cross section measurement
 - Dijet ratio
 - All studies presented use $\sqrt{s} = 14$ TeV



Quark Contact Interactions

- New physics like quark compositeness or some new interaction at a high scale (Λ) can be modeled by a contact interaction at much lower dijet mass or jet p_T .
- Such an interaction would manifest as differing from standard model QCD:
 - Jet spectrum would be enhanced at high transverse momentum
 - Jet angular distribution would be very different.
- CMS has access to Λ above what has been excluded so far ($\Lambda^+ = 2.7$ TeV from D0, PRL 82, 2457 1999)



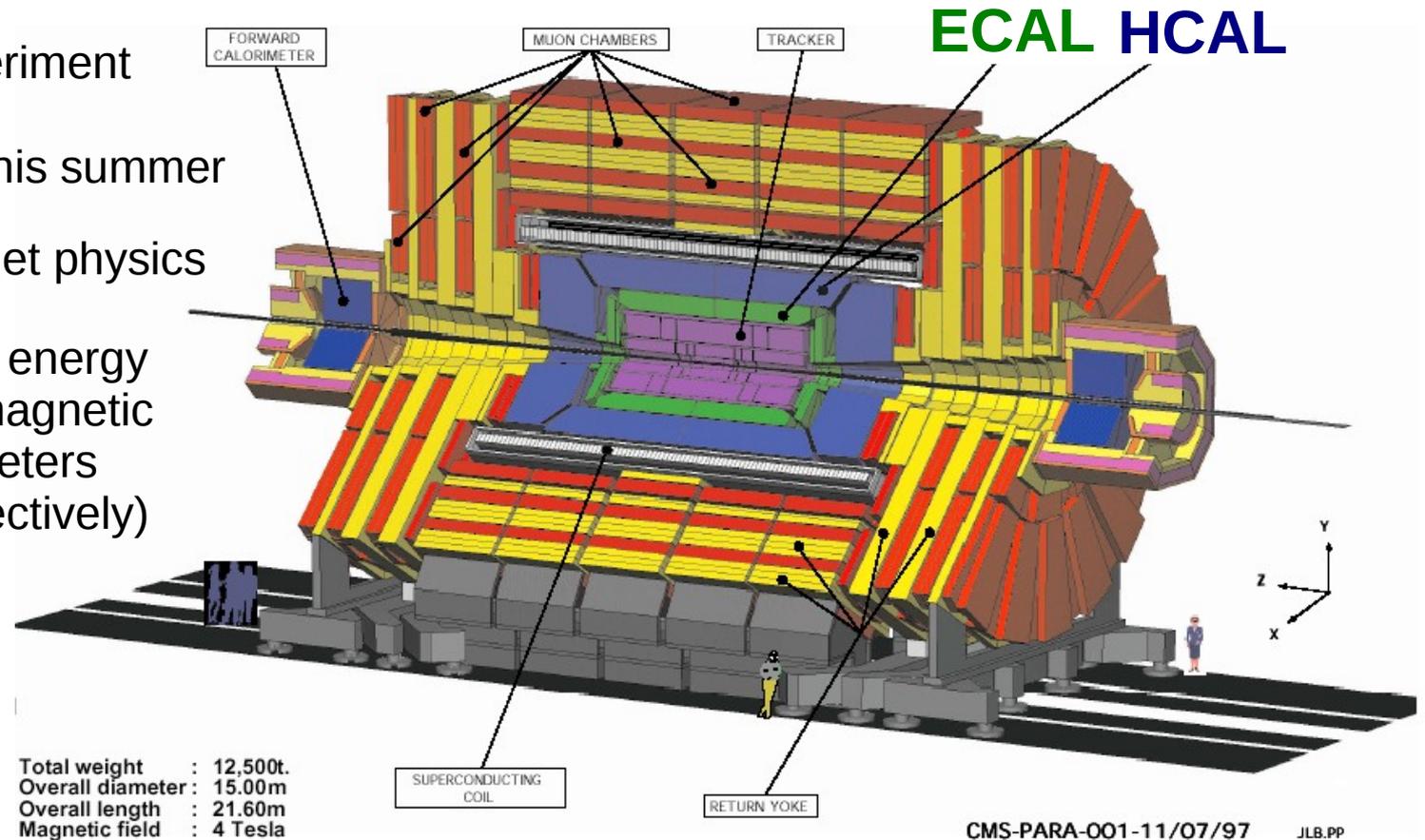
CMS

LHC p-p collider experiment

Datataking to begin this summer

Here we will discuss jet physics

Measured by particle energy deposited in electromagnetic and hadronic calorimeters (ECAL & HCAL respectively)

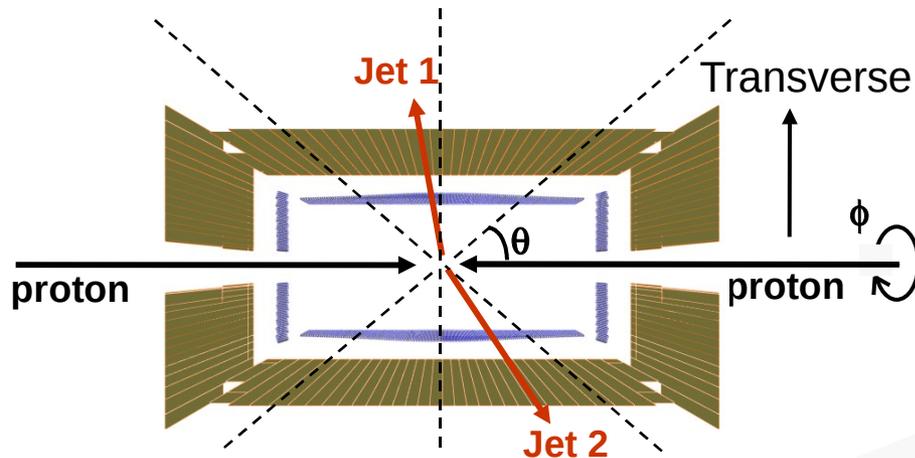


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Dijets in CMS

The Dijet signal dominates all others at CMS!

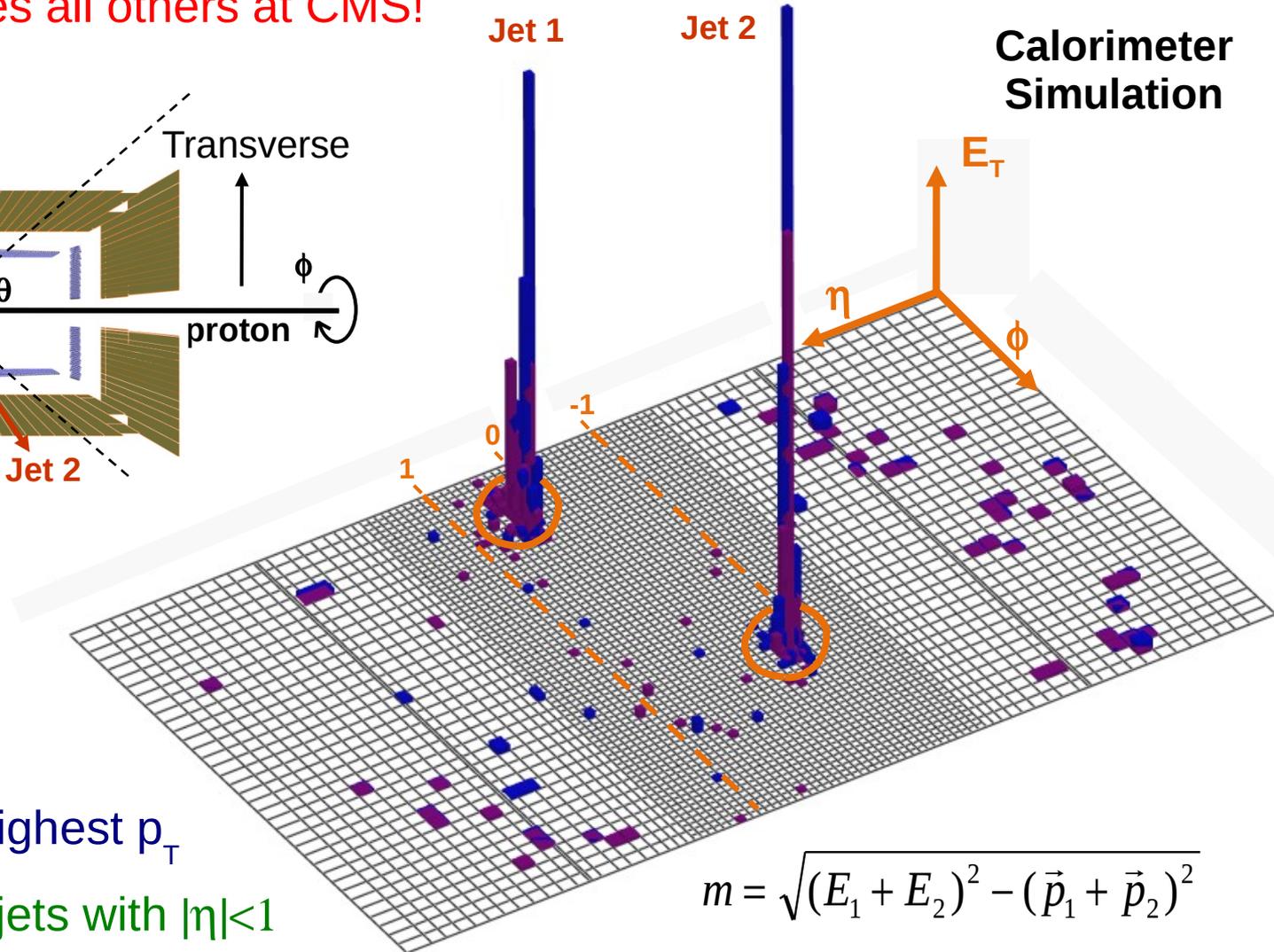


Jets defined as sum of calorimeter energy in a cone of radius:

$$R = \sqrt{\Delta\eta^2 + \Delta\phi^2} = 0.5$$

Dijet = two jets with highest p_T

Inclusive jets take all jets with $|\eta| < 1$

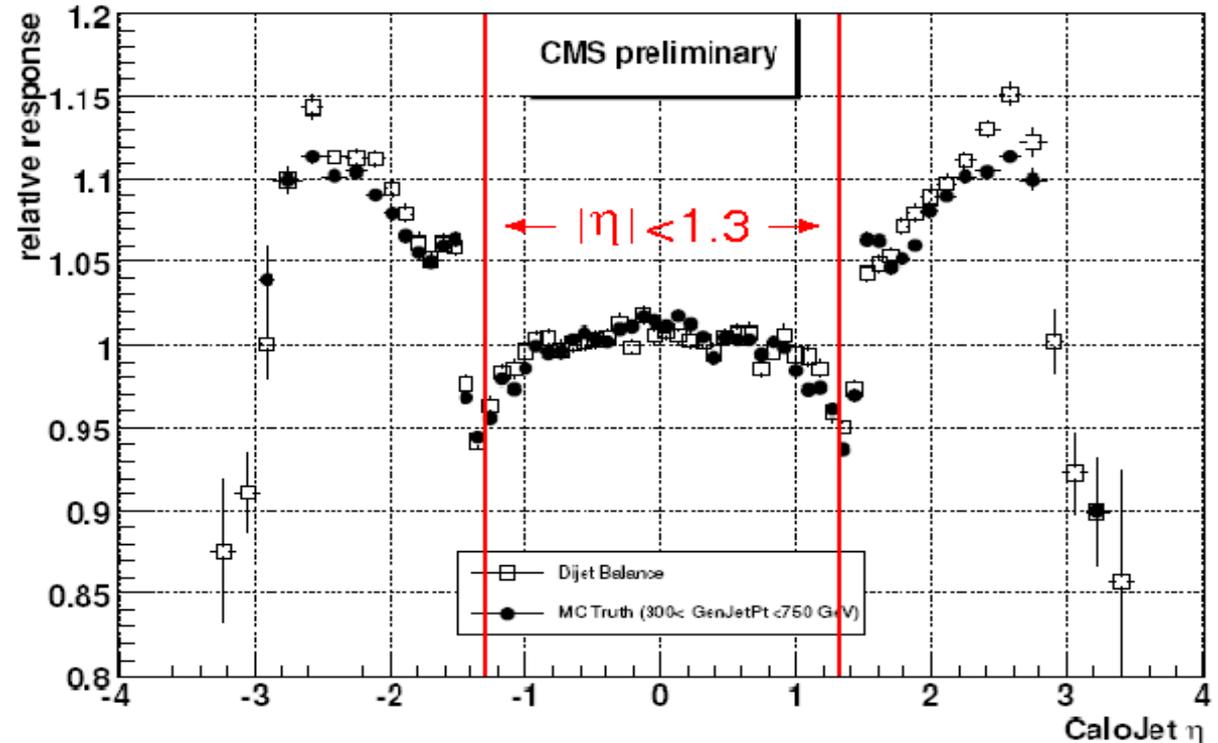


$$m = \sqrt{(E_1 + E_2)^2 - (\vec{p}_1 + \vec{p}_2)^2}$$



Event Cleanup, η cut

- New physics expected to manifest in central region of detector (hardest interactions)
- Want to concentrate early startup analyses on most uniform, best understood portion of calorimeters
- Response to jets in central barrel region constant within few percent
- $|\eta| < 1.3$ optimized for dijets in CMS detector, $|\eta| < 1$ used at Tevatron (and for inclusive jet studies presented here).

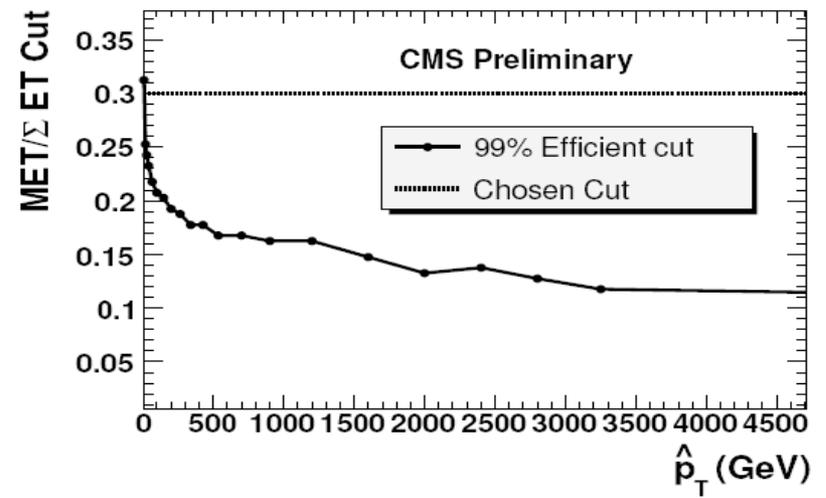
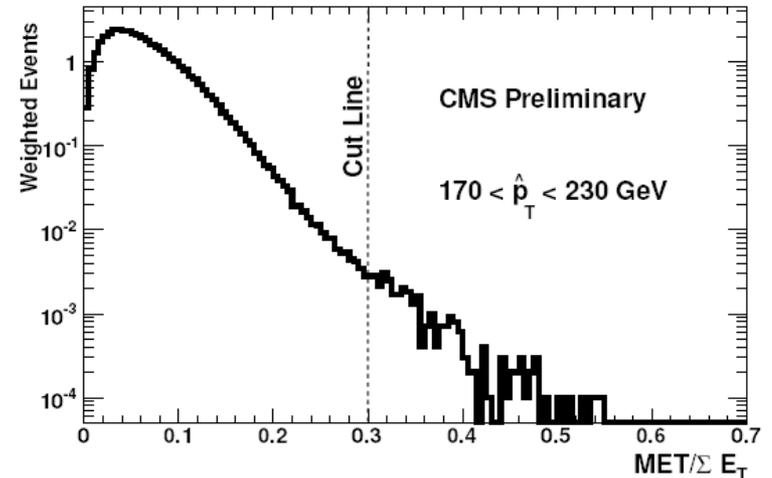


Jet detector response relative to average within $|\eta| < 1.3$



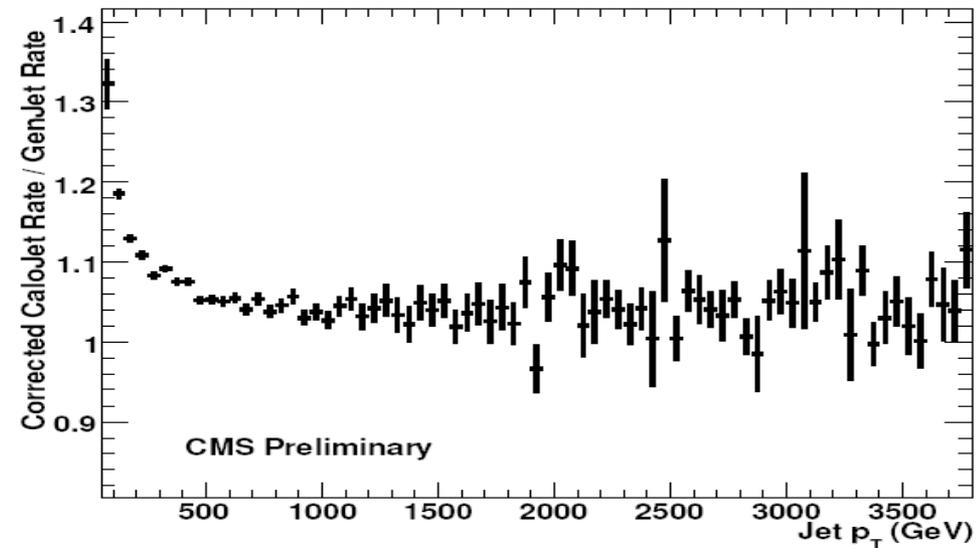
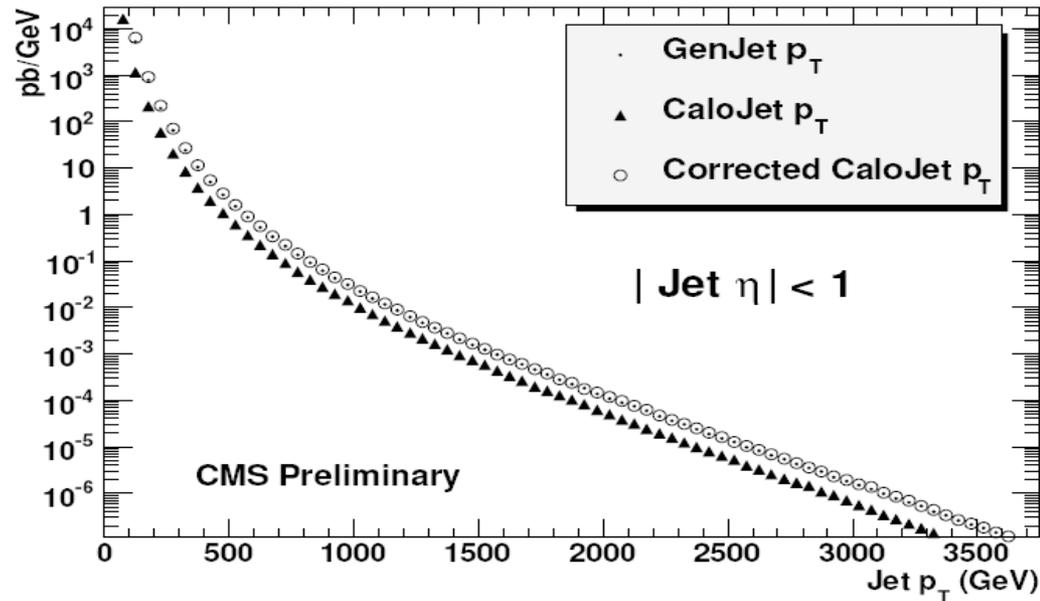
Event Cleanup, $MET/\Sigma E_T$

- Dijet events from hard scatters tend to balance E_T
- When jets do not balance E_T we say there is “missing E_T ”, or MET
- Many unwanted effects manifest in large MET relative to the total E_T of an event.
 - Catastrophic detector noise
 - Cosmic rays
 - Beam halo
- A conservative $MET/\Sigma E_T$ cut of 0.3 is possible such that more than 99% of dijets are preserved without biasing the QCD spectrum.



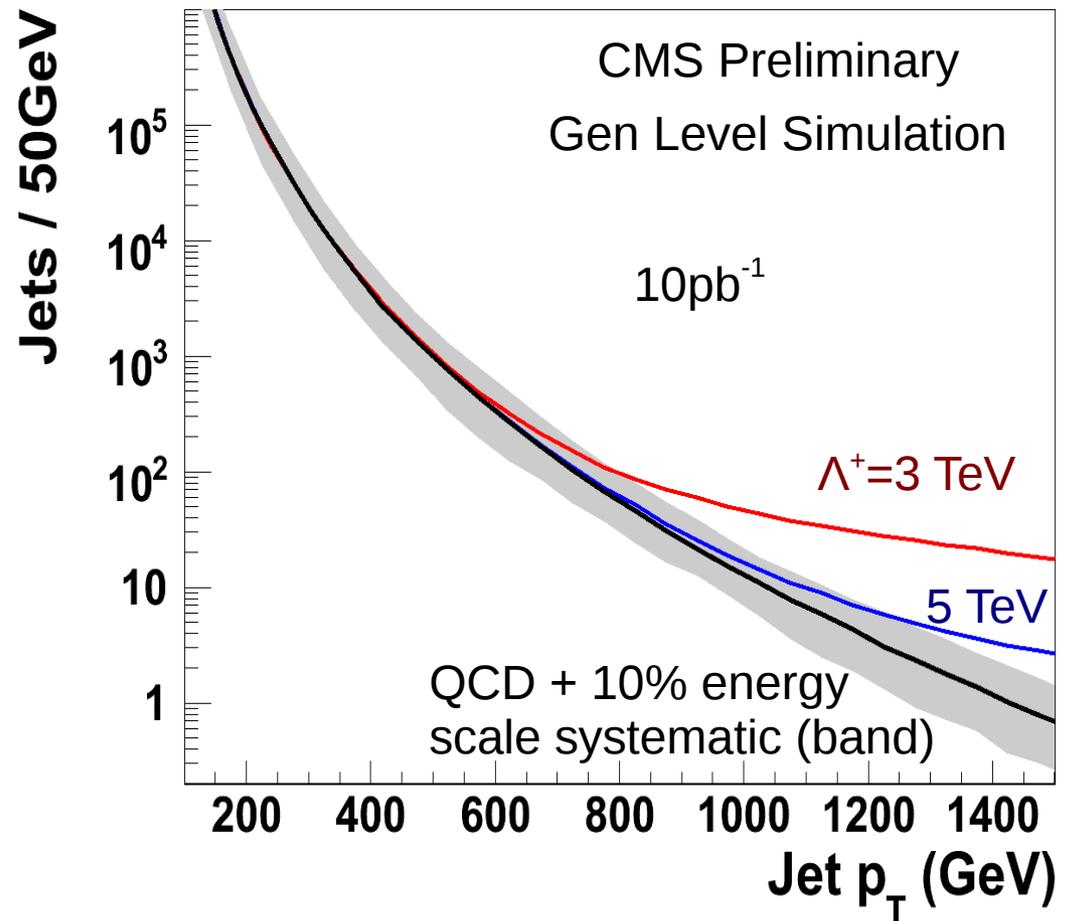
The Inclusive Jet Spectrum and Jet Corrections

- Inclusive jet cross section: All jets within specified pseudorapidity range
- Steeply falling inclusive jet cross spectrum vs jet transverse momentum, p_T , at right:
- Corrected calorimeter jets “CaloJets” agree well with particle level “GenJets”
 - Before correction CaloJets shifted lower than GenJets
 - After correction they agree within few percent above 500 GeV
 - Resolution smearing: More probable jets at lower p_T smeared to higher, less populated p_T bins. (ratio at right)



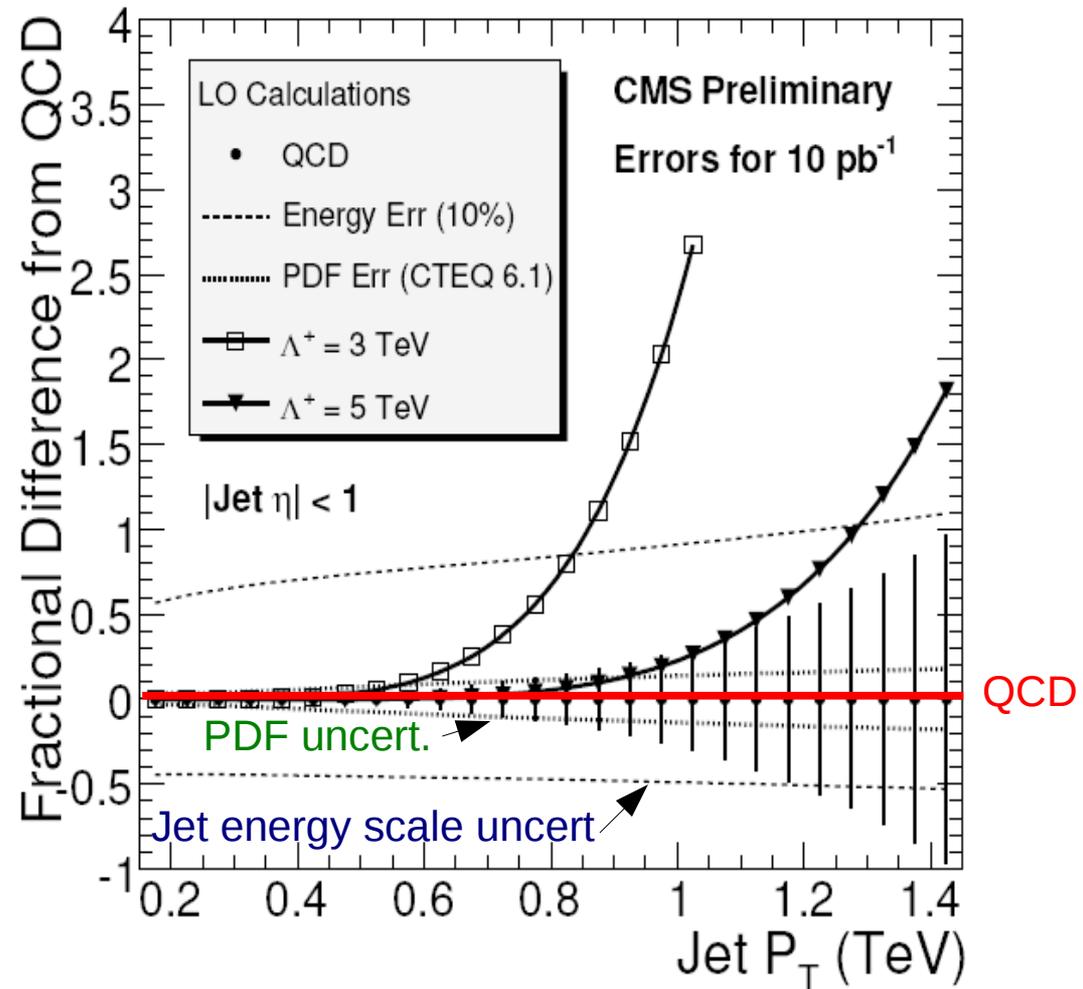
Inclusive Jets & Contact Interactions

- Inclusive jet rate in 50 GeV bins for integrated luminosity of 10pb^{-1}
 - QCD measurement that is sensitive to new physics
- Shaded area is a 10% estimated jet energy scale uncertainty at startup
 - Expected to be dominant uncertainty
- **Contact interaction discovery potential above Tevatron limits**



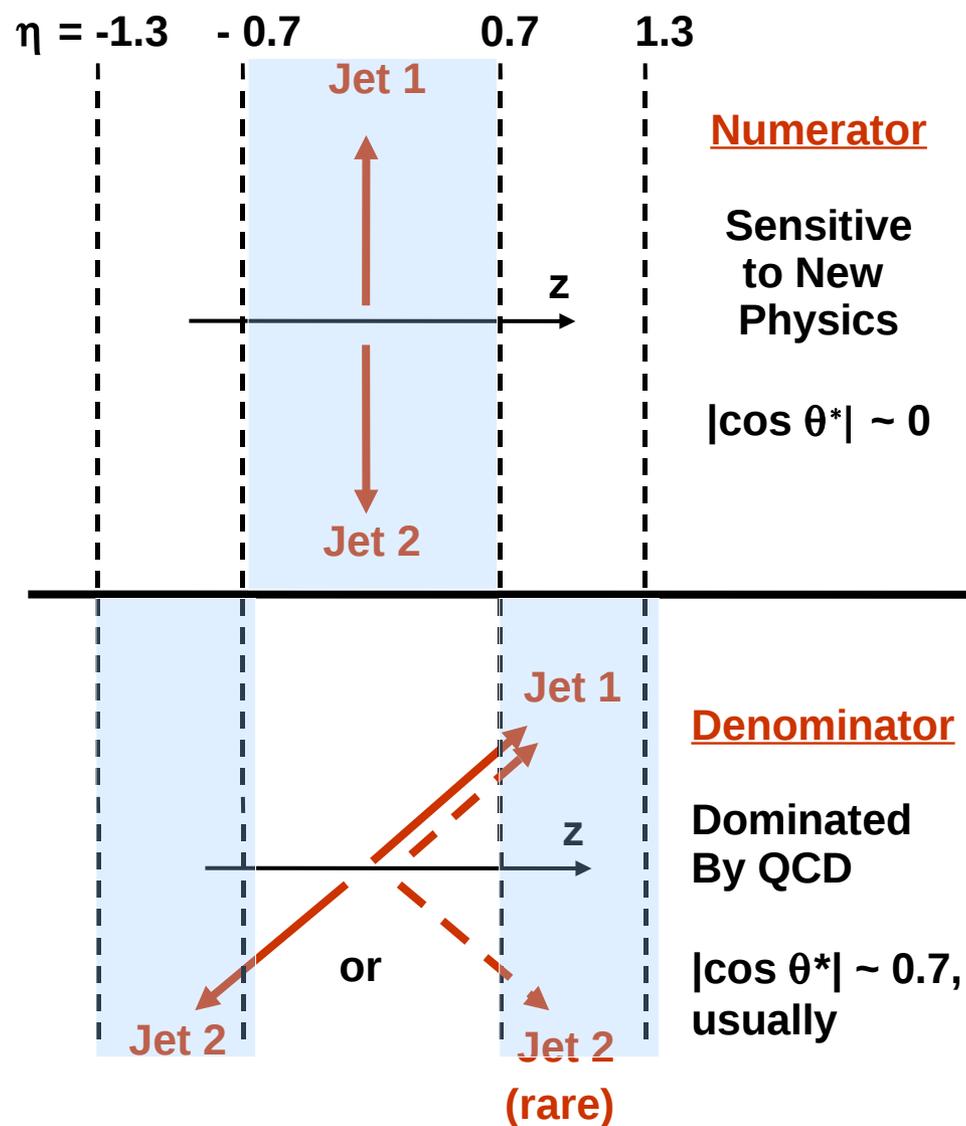
Inclusive Jet Sensitivity

- At right: lowest order calculation of fractional difference from QCD for inclusive jet cross section produced by 3 & 5 TeV contact interactions, compared to QCD.
 - With variation expected from pdfs (dotted)
 - With variation from jet energy scale error (dashes)
 - Error bars on **QCD line** are statistical for 10pb^{-1}
- Jet energy scale uncertainties will clearly dominate those from PDF's & statistics



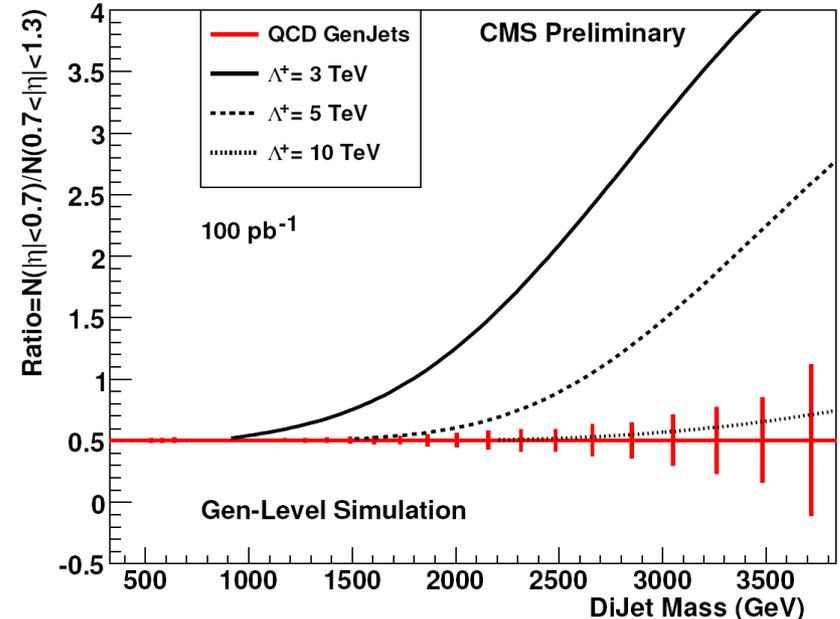
Dijet Ratio

- Hardest interactions will tend to produce high transverse energy jets, perpendicular to beam axis
 - QCD will dominate at high $|\eta|$
 - Higher probability of finding new physics at low $|\eta|$ than high.
- Dijet ratio defined as:
 $N(|\eta| < 0.7) / N(0.7 < |\eta| < 1.3)$
 (see shaded regions at right)
- Exploits differing angular distributions of QCD, new physics
- Systematic uncertainties like jet energy scale tend to cancel in the ratio.



Dijet Ratio Sensitivity to Contact Interactions

- Dijet ratio from QCD is flat vs mass at 0.5
- Dijet ratio from contact interactions rises with increasing mass
- **Early Discovery potential beyond Tevatron exclusions:**



	10pb^{-1}	100pb^{-1}	1000pb^{-1}
Discovery	$\Lambda^+ > 4.1 \text{ TeV}$	6.8	9.9
Exclusion	5.3	8.3	12.5



Summary

- CMS plans to search for contact interactions using jets
- With only 10 pb^{-1} , inclusive jet cross section is sensitive for $\Lambda^+ > 3 \text{ TeV}$ even with 10% jet energy scale uncertainty.
- Dijet mass ratio can discover $\Lambda^+ > 4, 7, 10 \text{ TeV}$ in 10, 100 and 1000 pb^{-1} with small systematics
- Sensitivity to contact interactions well above Tevatron limits
- Collision data to start rolling in this summer!

