Dijet Resonance Search with 36 pb^{-1} Data

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on behalf of Authors

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Authors

Search for Dijet Resonances in the Dijet Mass Distribution in pp Collisions at $\sqrt{s} = 7$ TeV

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DRAFT

Outline

- Measurement of Dijet Mass Spectrum
  - ✓ Data Sample and Event Selection
  - ✓ Trigger Efficiency and Basic Distributions
  - ✓ Dijet Mass Distribution and QCD
  - ✓ Fits for Background
- Search for Dijet Resonances
  - ✓ Signal Modeling
  - ✓ Limits on Dijet Resonances
    - Statistical Error Only
    - Including Systematic Uncertainties
- Conclusion

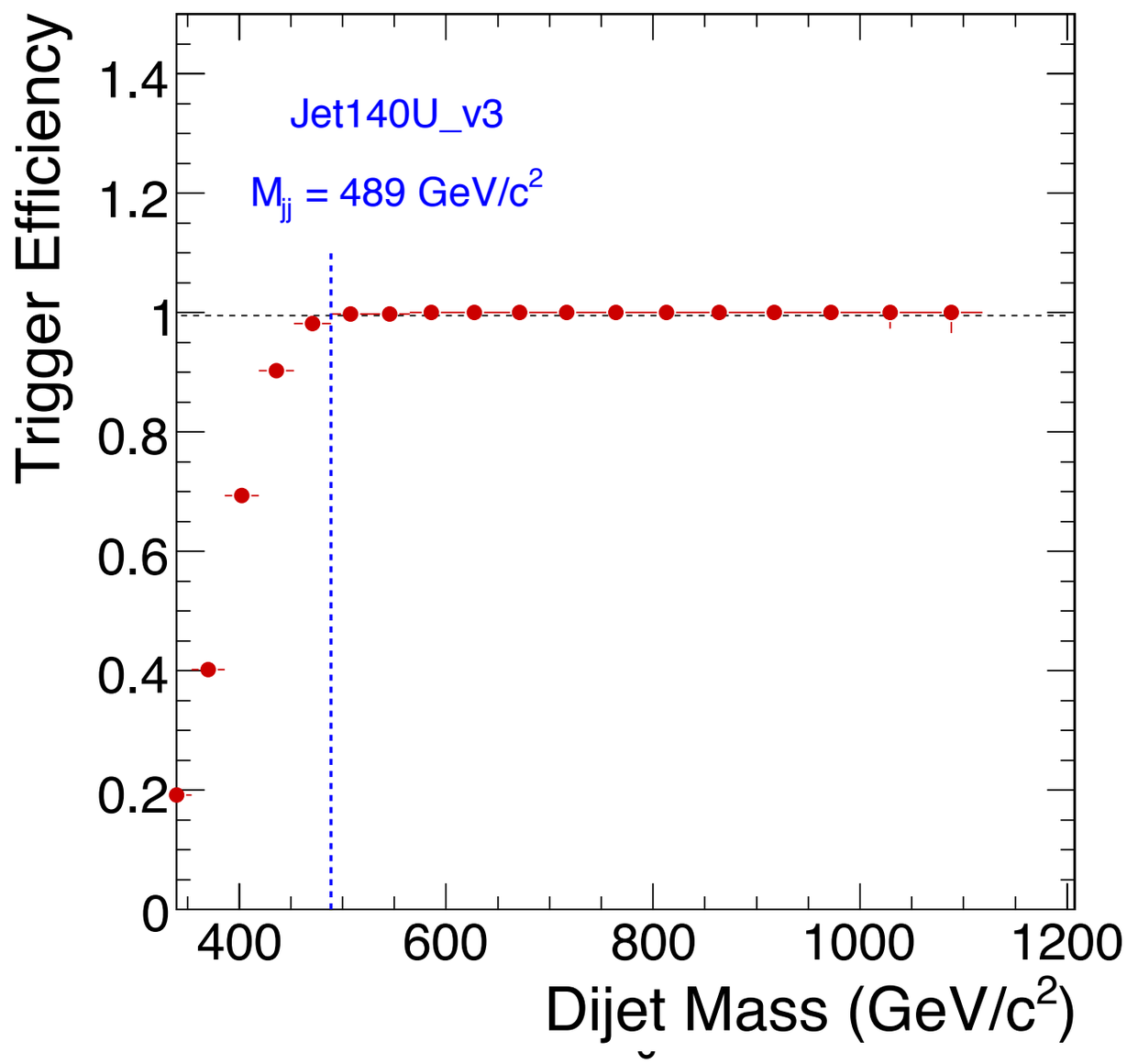
Part I.
Measurement of Dijet Mass Spectrum

Data and Event Selection

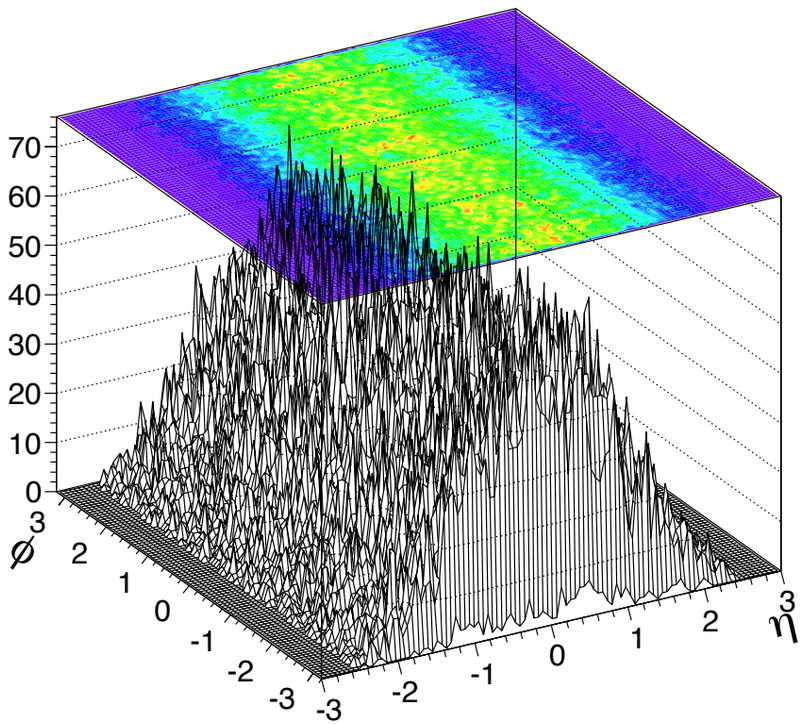
- Dataset
  - ✓ (135808 - 141949) /JetMETTau/Run2010A-Nov4ReReco_v1/RECO
    (141950 - 145761) /JetMET/Run2010A-Nov4ReReco_v1/RECO
    (145762 - 149442) /Jet/Run2010B-Nov4ReReco_v1/RECO
  - ✓ Official JSON Files
  - ✓ Estimated Integrated Luminosity: 35.8 pb^{-1} (with 11% uncertanity)
- Trigger
  - ✓ Technical Bit TT0 (for bunch crossing)
  - ✓ HLT_Jet140U_v3 (un-prescaled)
- Event Selection
  - ✓ Good primary vertex
  - ✓ At least two reconstructed jets
    - AK7caloJets
    - JEC: L2+L3, "Summer10" + Residual (v2) data-driven relative
  - ✓ Require both the leading jets to satisfy $|\eta|< 2.5$ and $|\Delta\eta|<1.3$
    - Suppress QCD process significantly.
  - ✓ Require both leading jets passing the "loose" jet id & Mjj > 489 GeV

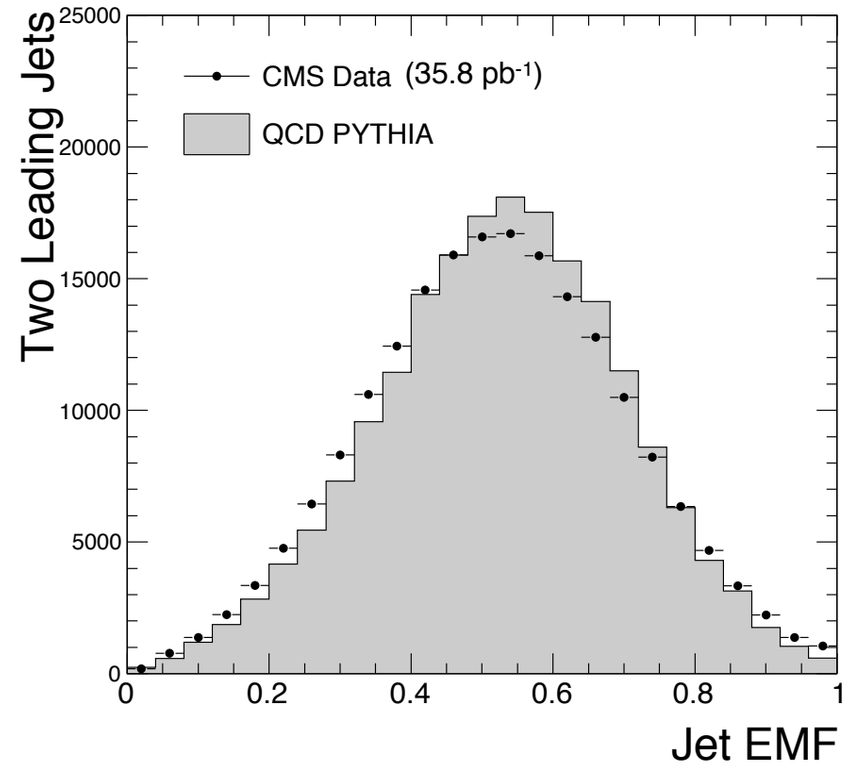
Trigger Efficiency

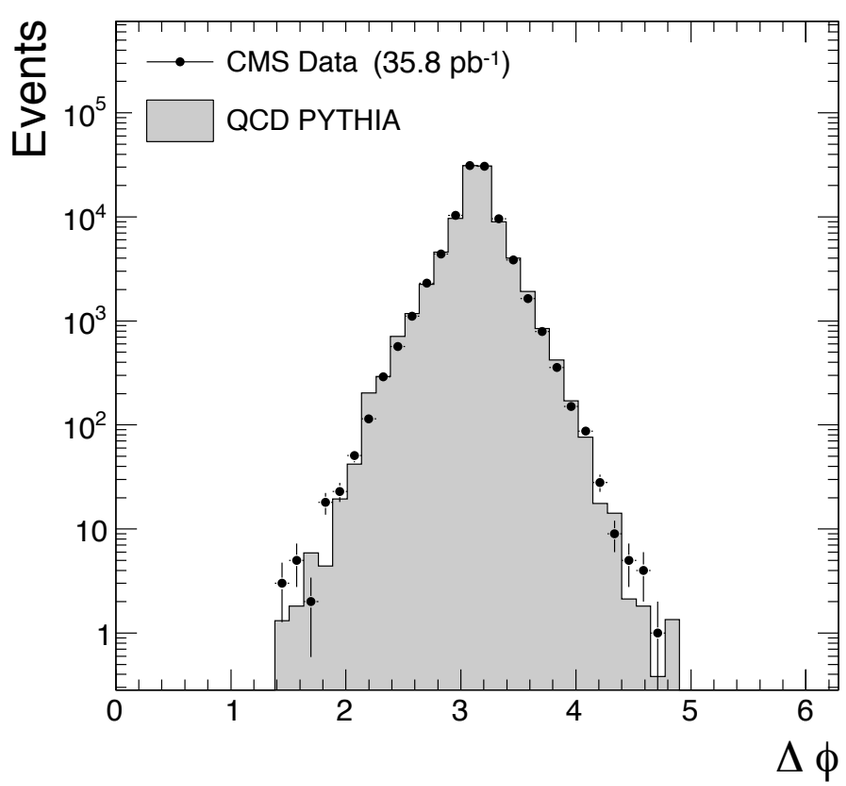
- Start analysis of Dijet Mass distribution at 489 GeV.
  - ✓ 489 GeV chosen for full trigger efficiency.

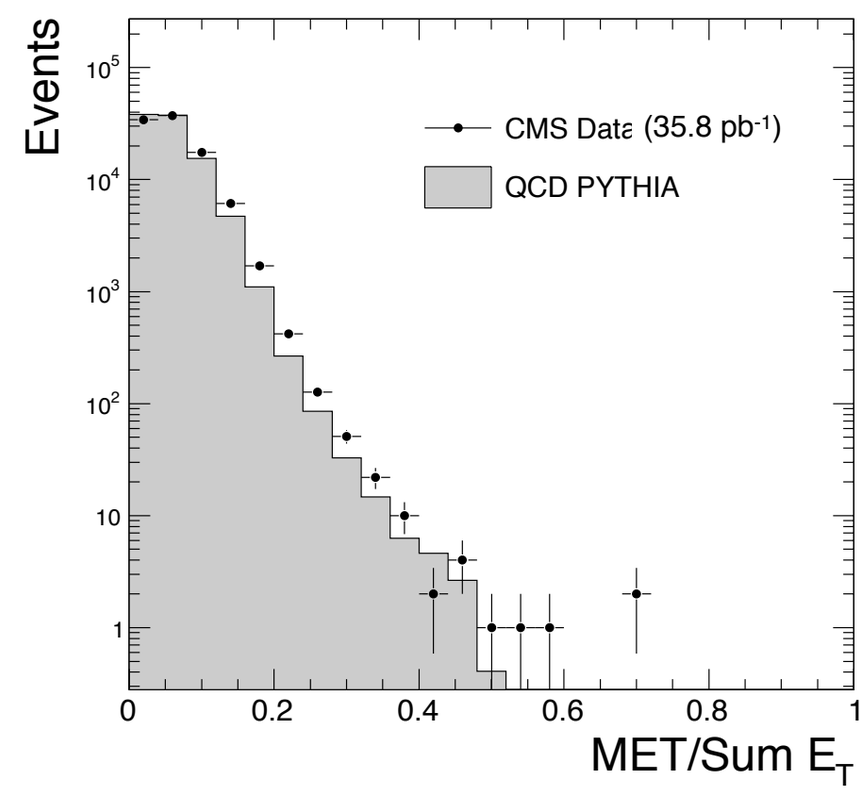


Dijet Data Quality



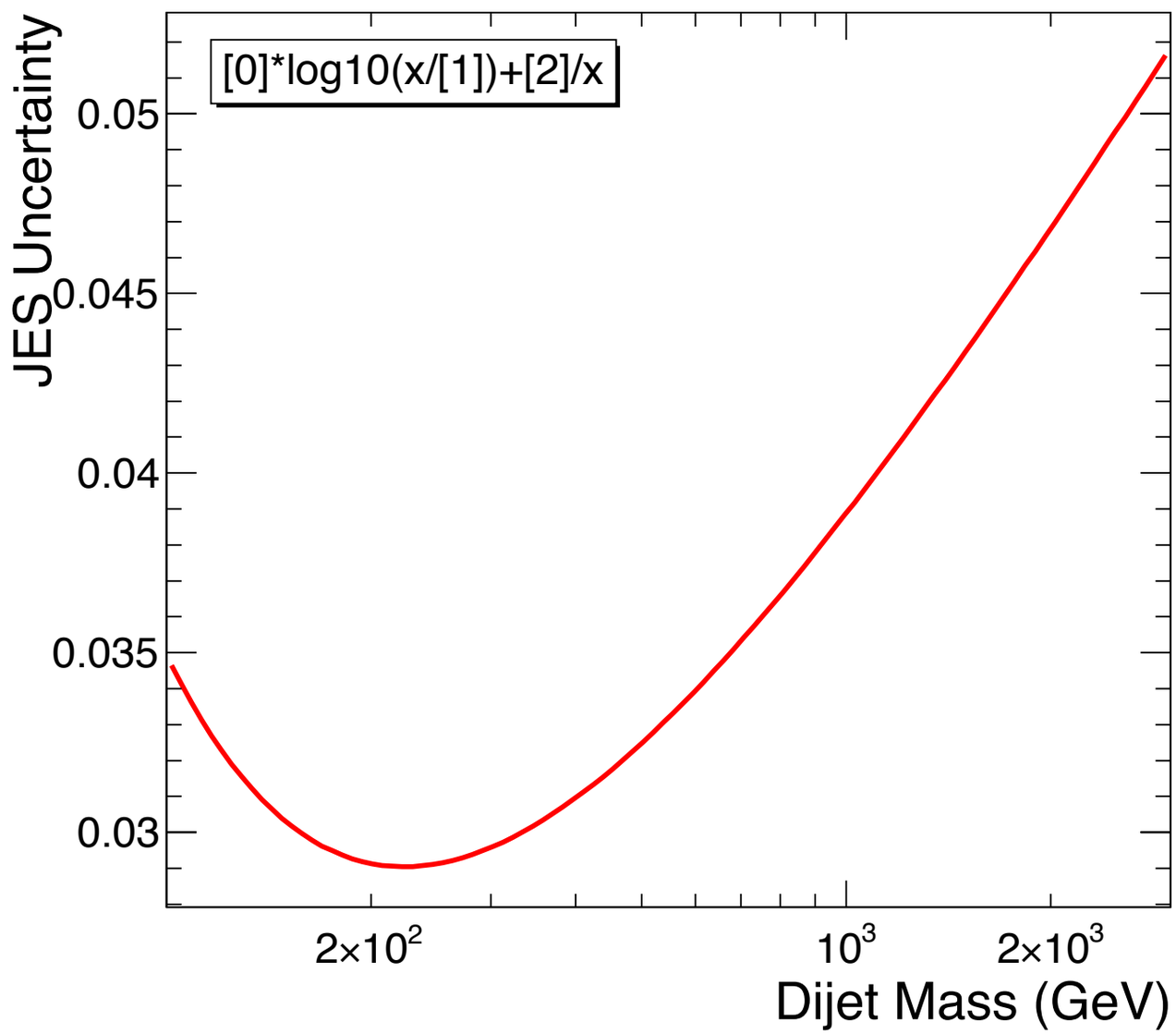






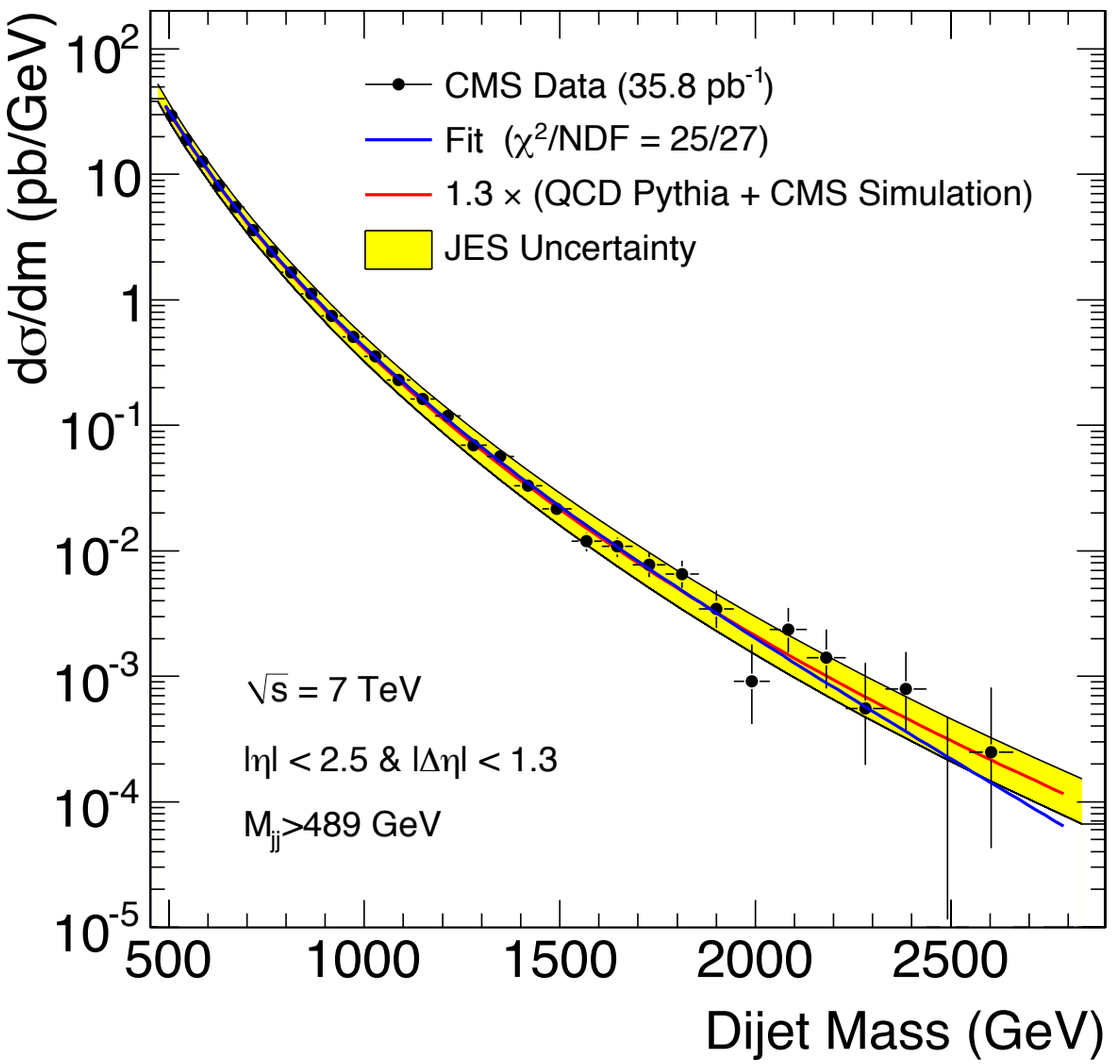
JES Uncertainty

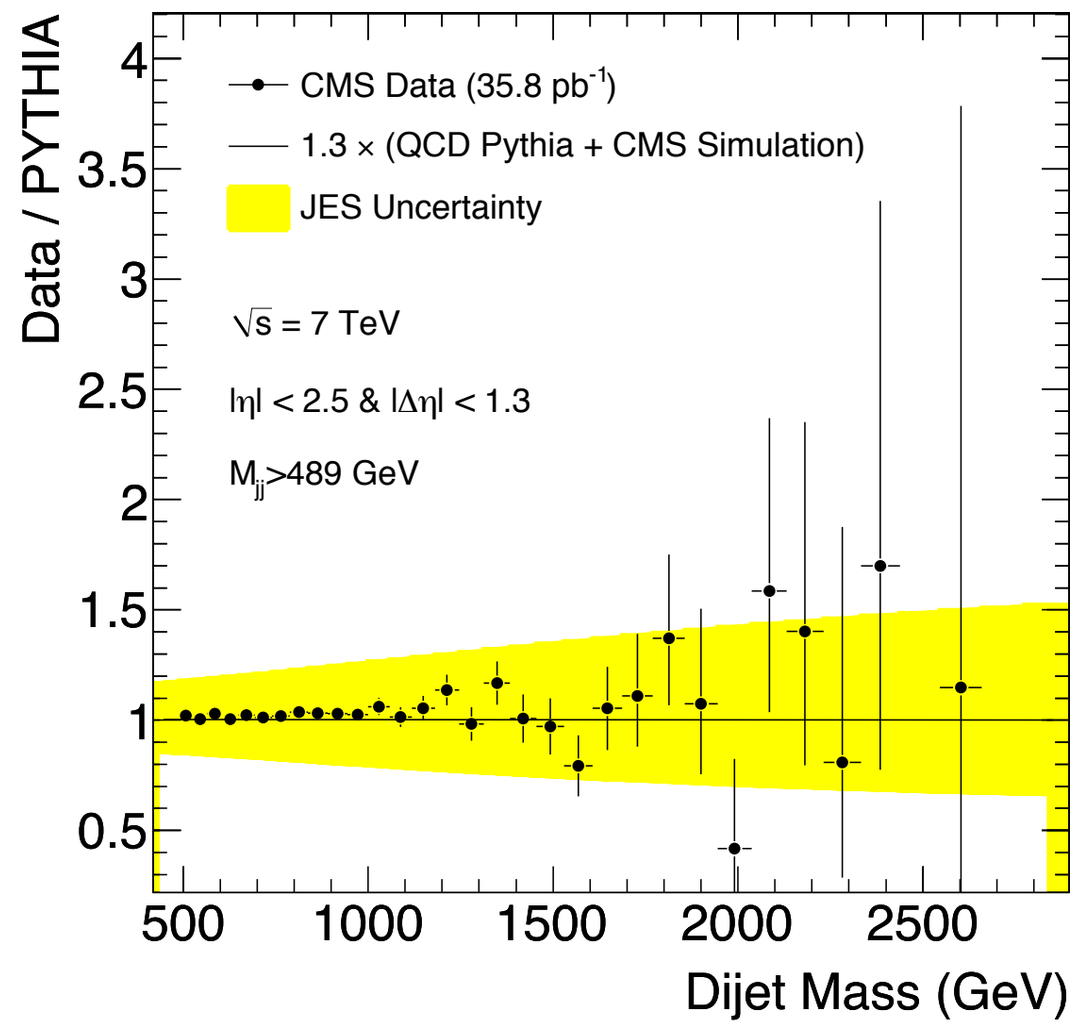
- We introduce new JES uncertainty.
  - ✓ It varies from 3% to 5 % as a function dijet mass.
  - ✓ It was considered as 10% in previous studies.



Dijet Mass and QCD

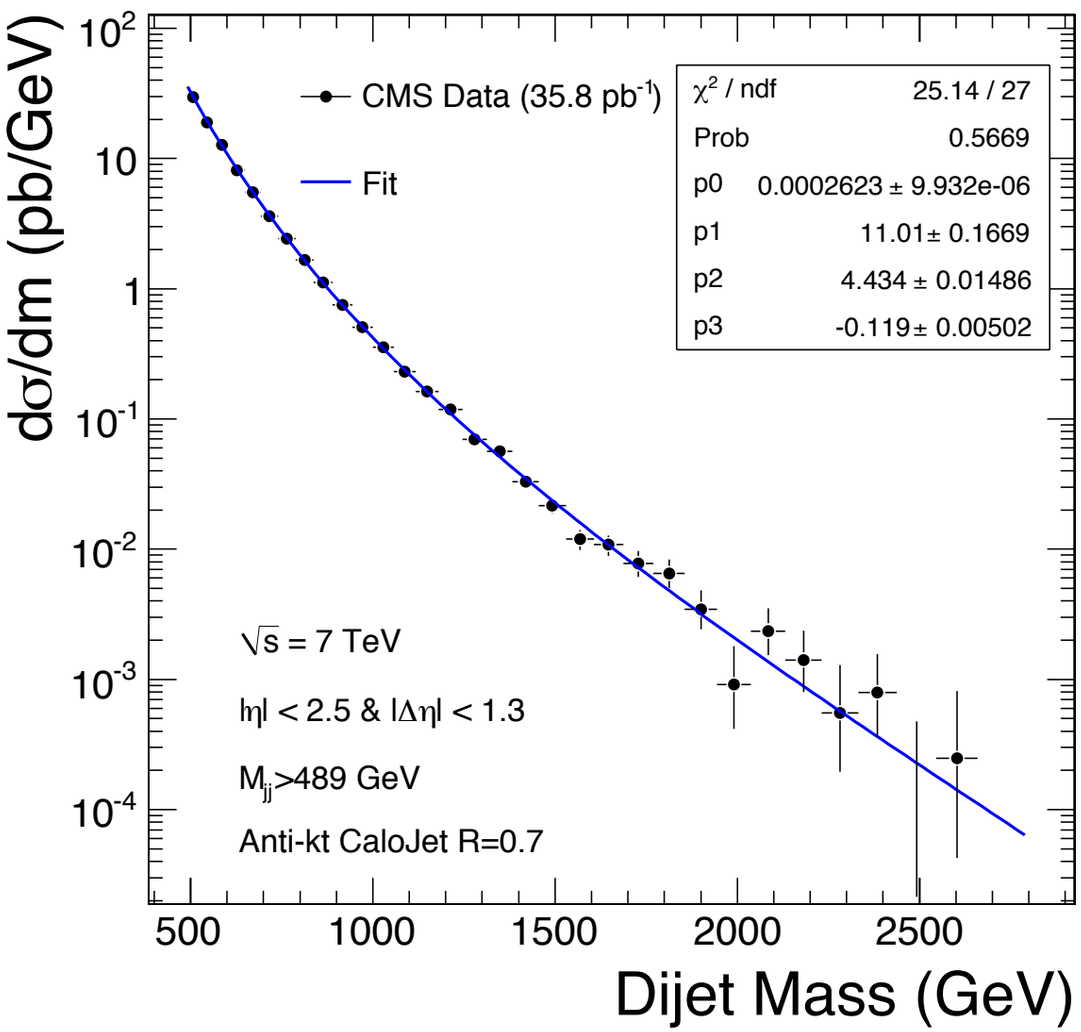
- The data is in good agreement with the full CMS simulation of QCD from PYTHIA.
  - ✓ PYTHIA QCD prediction is normalized by a factor of 1.3

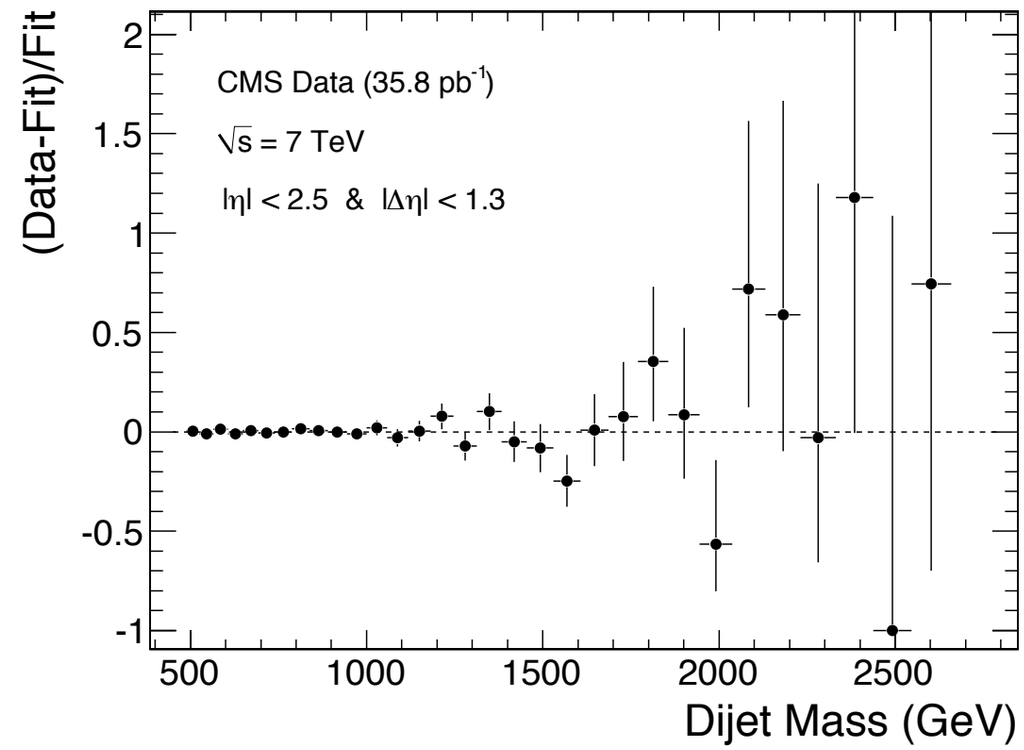


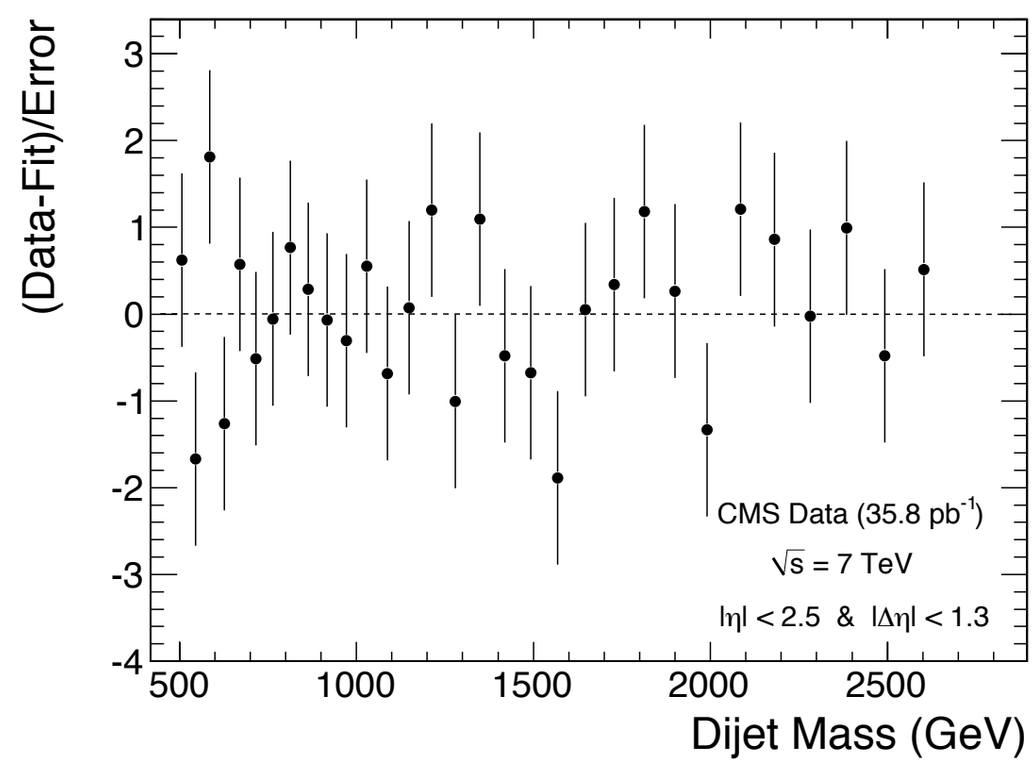


Dijet Mass and Fit

- We fit the data to a function containing 4 parameters used by CDF Run 11 and ATLAS.
- We get a good fit.
- No evidence for new physics

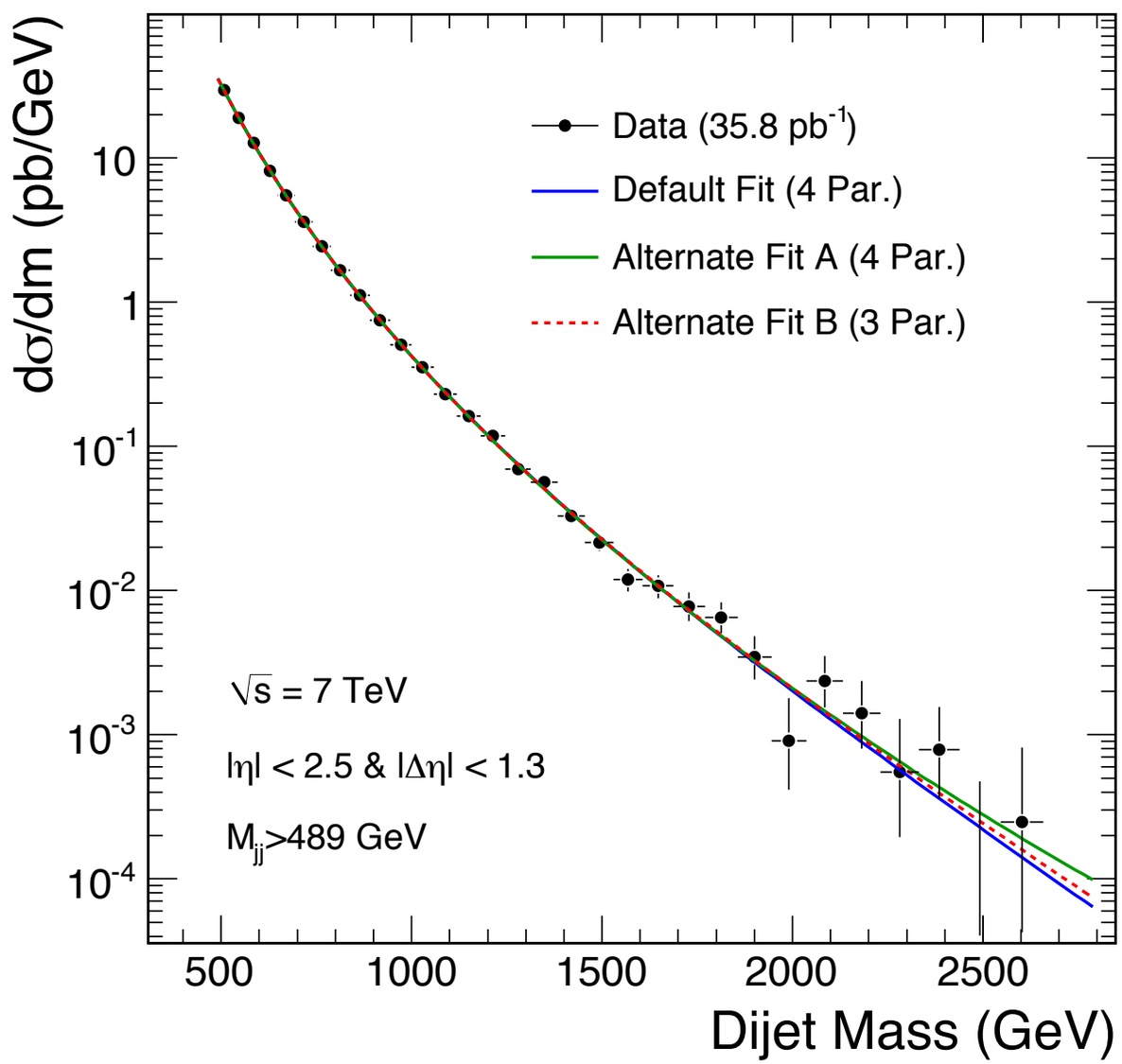






$$\frac{d\sigma}{dm} = p_0 \frac{(1-X)^{p_1}}{X^{p_2+p_3\ln(X)}} \qquad x = m_{jj}/\sqrt{s}$$

Another Fit Parametrization



- In addition to the default fit, two alternate functional forms are considered.
- The data is smooth and all considered fit parametrization give a good fit.

Default $$\frac{P_0 \cdot (1 - m/\sqrt{s})^{p_1}}{(m/\sqrt{s})^{p_2 + p_3 ln(m\sqrt{s})}}$$

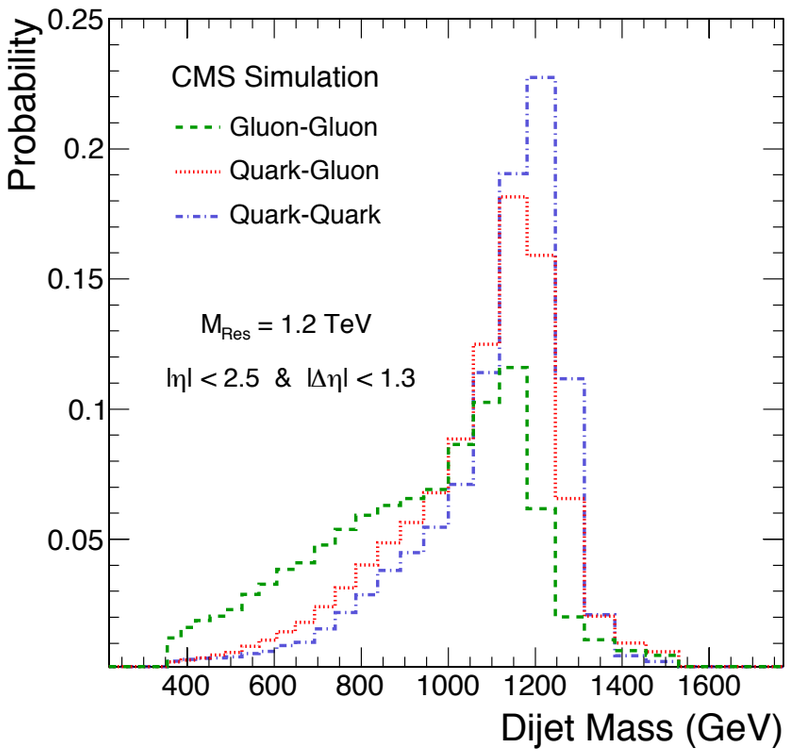
Fit A $$\frac{P_0 \cdot \left(1 - m/\sqrt{s} + P_3 \cdot (m/\sqrt{s})^2\right)^{P_1}}{m^{P_2}}$$

Fit B $$\frac{P_0 \cdot (1 - m/\sqrt{s})^{P_1}}{m^{P_2}},$$

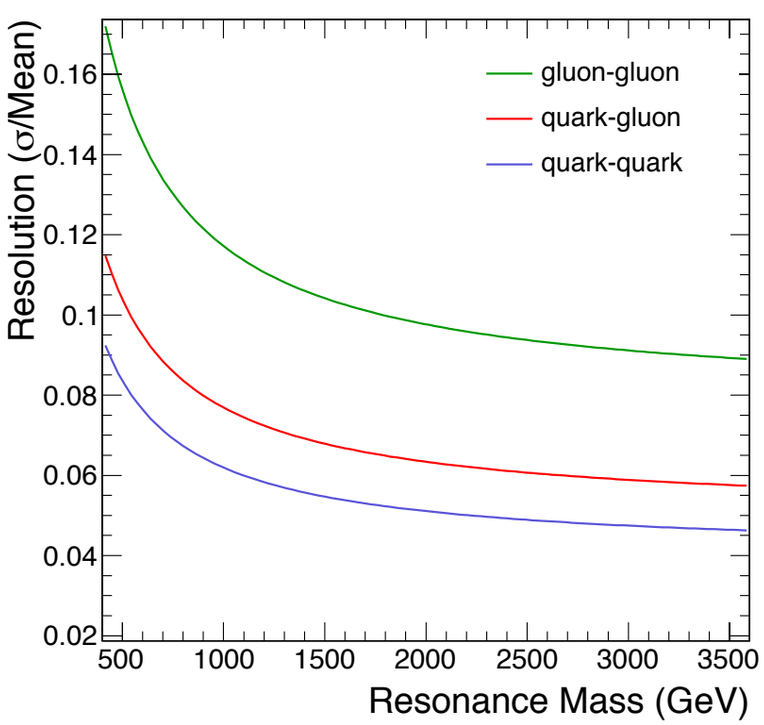
χ^2/NDF = 25.1/27
χ^2/NDF = 24.1/27
χ^2/NDF = 25.3/28

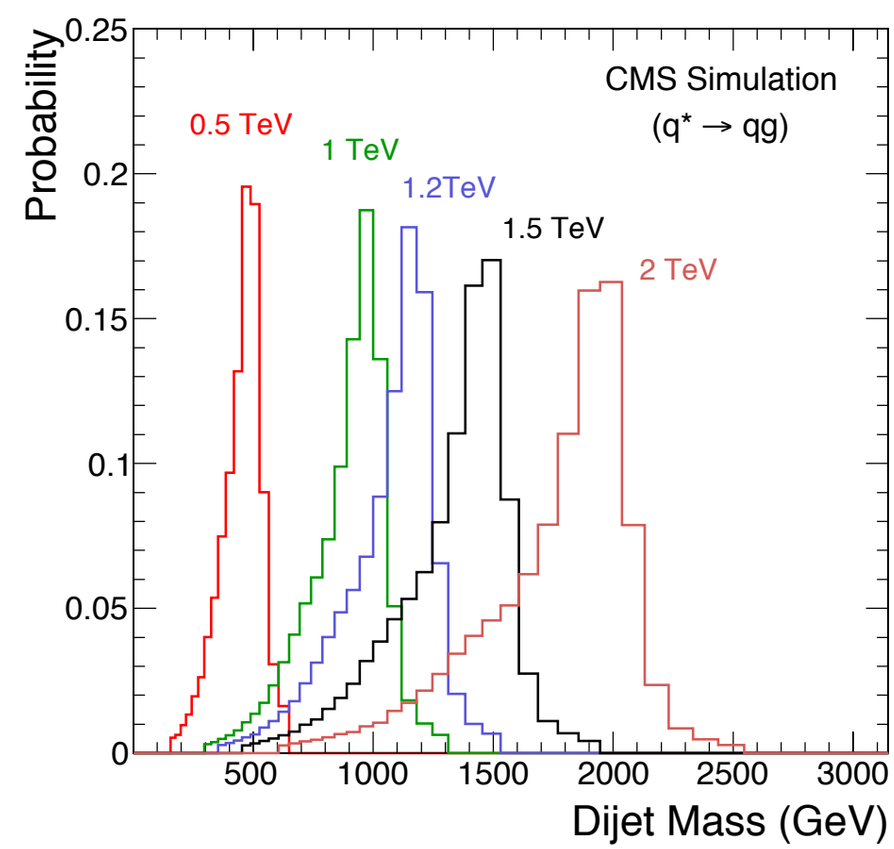
Part II.
Search For Dijet Resonance

Resonance Shapes



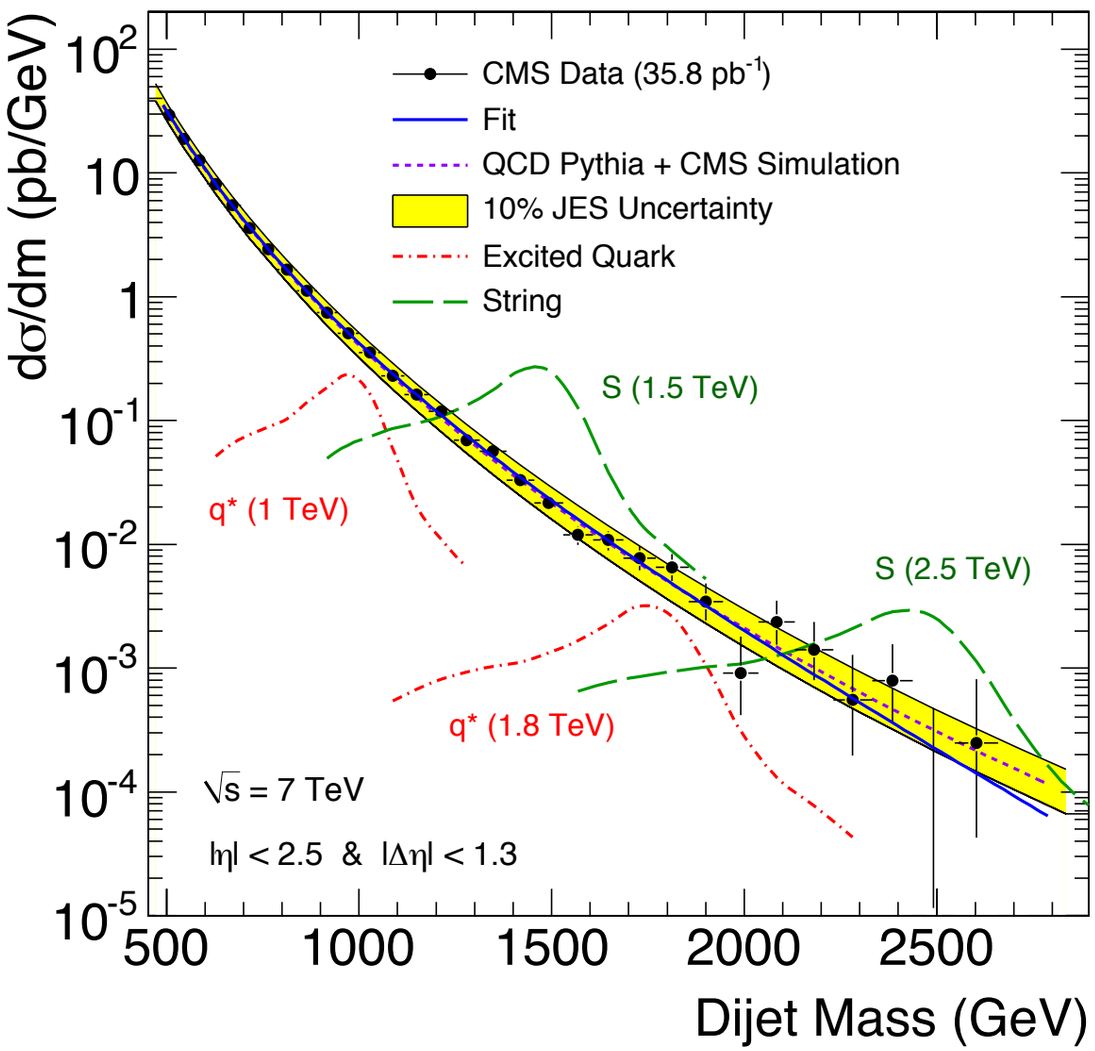
- We have simulated dijet resonances using CMS simulation + PYTHIA.
  - ✓ Three types of parton pairs
    - **gg→G→gg**, **qg→q*→qg** and **qq→G→qq**
- qq, qg and gg resonances have different shape mainly due to FSR.
  - ✓ The width of dijet resonance increases with number of gluons because gluons emit more radiation than quarks.
- We search for these three basic types of narrow dijet resonance in our data.

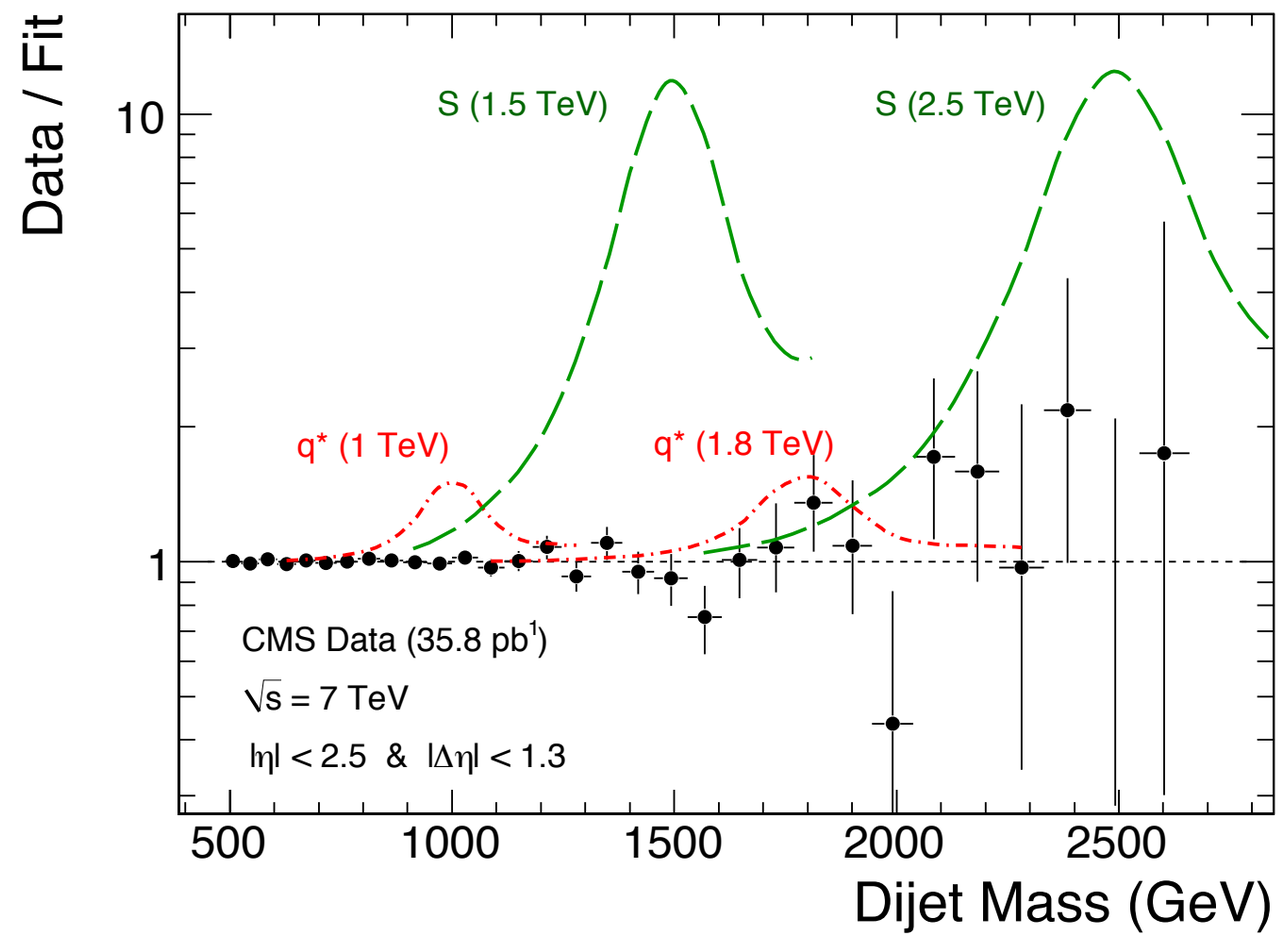




Fit and Signal

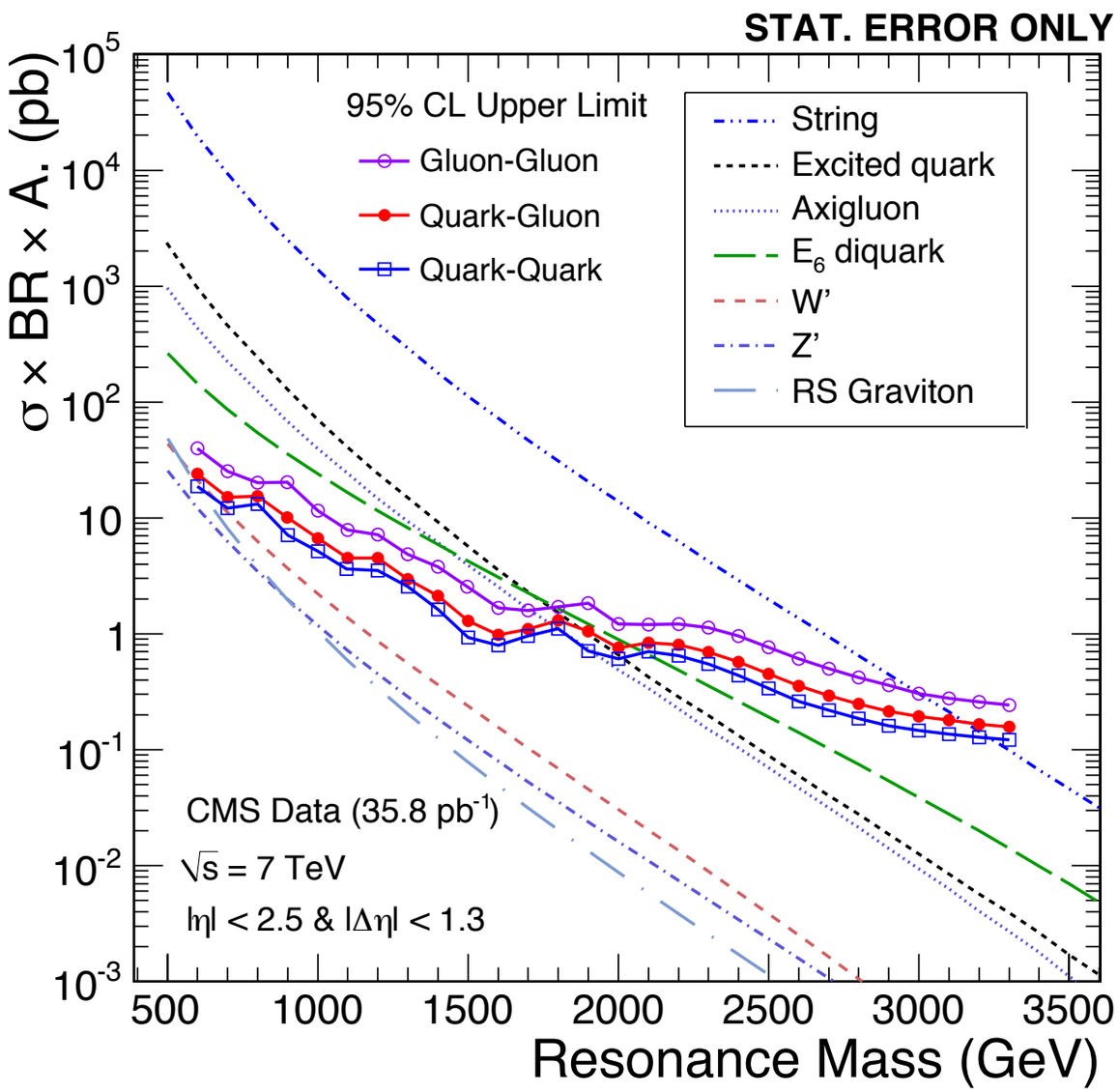
- We search for dijet resonance signal in our data.
- Excited quark signals are shown at 1 TeV and 1.8 TeV.
- String resonances are shown at 1.5 TeV and 2.5 TeV.





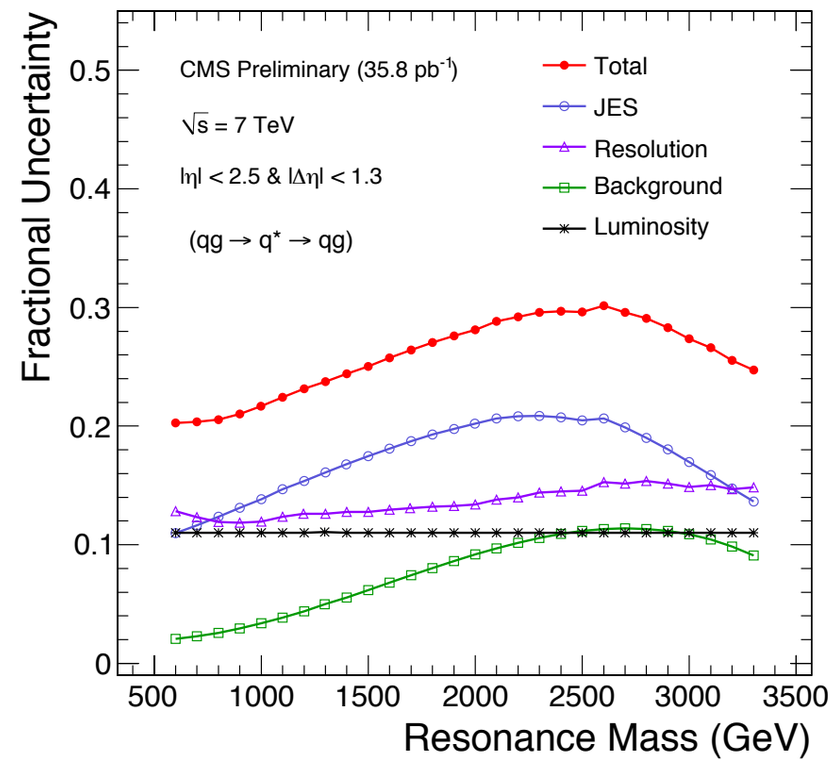
Limits with Stat. Error Only

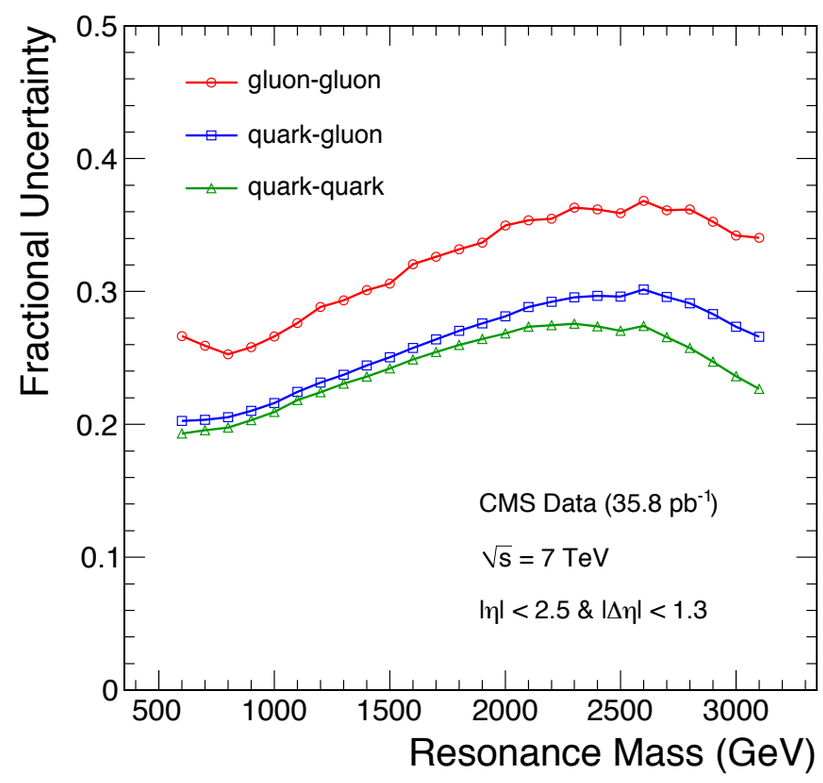
- 95% CL Upper limit with Stat. Error. Only compared to cross section for various model.
  - ✓ Show quark-quark and quark-gluon and gluon-gluon resonances separately.
  - ✓ gluon-gluon resonance has the lowest response and is the widest and gives worst limit.



Systematic Uncertainties

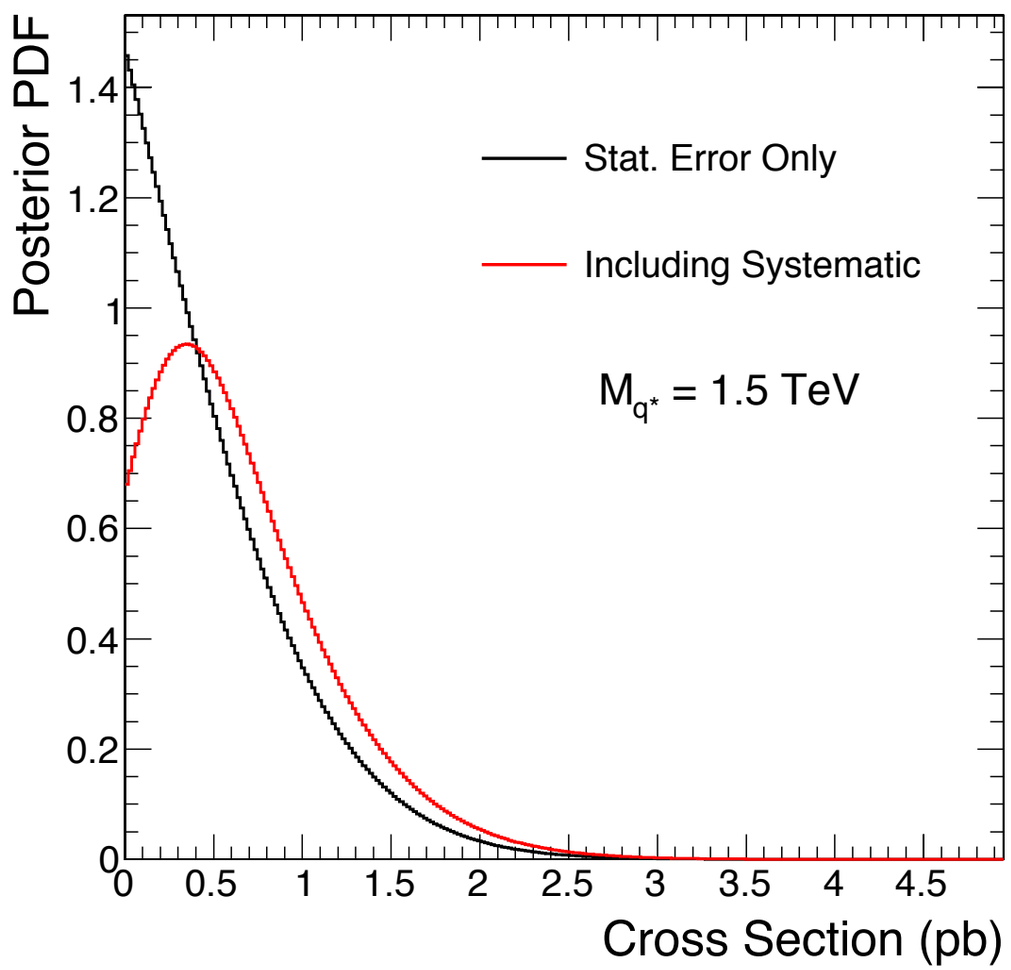
- We found the uncertainty in the dijet resonance cross section from following sources
  - ✓ Jet Energy Scale (JES)
    - Uncertainty varies from 3% to 5 % as function of dijet mass
  - ✓ Jet Energy Resolutin (JER)
    - JetMet guidance is 10% in JER uncertainty
  - ✓ Choice of background parametrization
    - We consider the functional form with 4 parameter
  - ✓ Luminosity
    - Uncertainty assumed to be 11%
- We add in quadrature the individual systematic uncertainties
  - ✓ Total systematic uncertainty varies from 19% to 37% depending on resonance mass and type





Incorporating Systematic

- We convolute posterior PDF with Gaussian systematics uncertainties.
  - ✓ Posterior PDF including systematics is broader and gives higher upper limit.

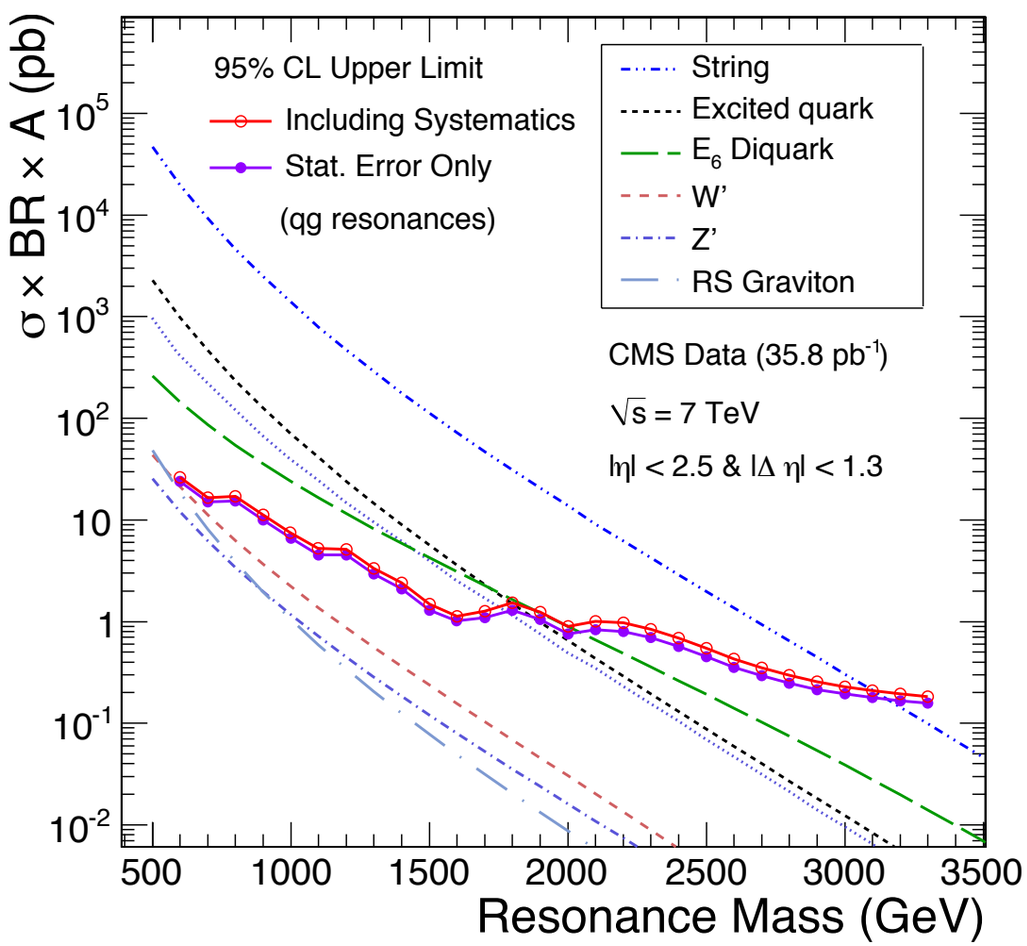


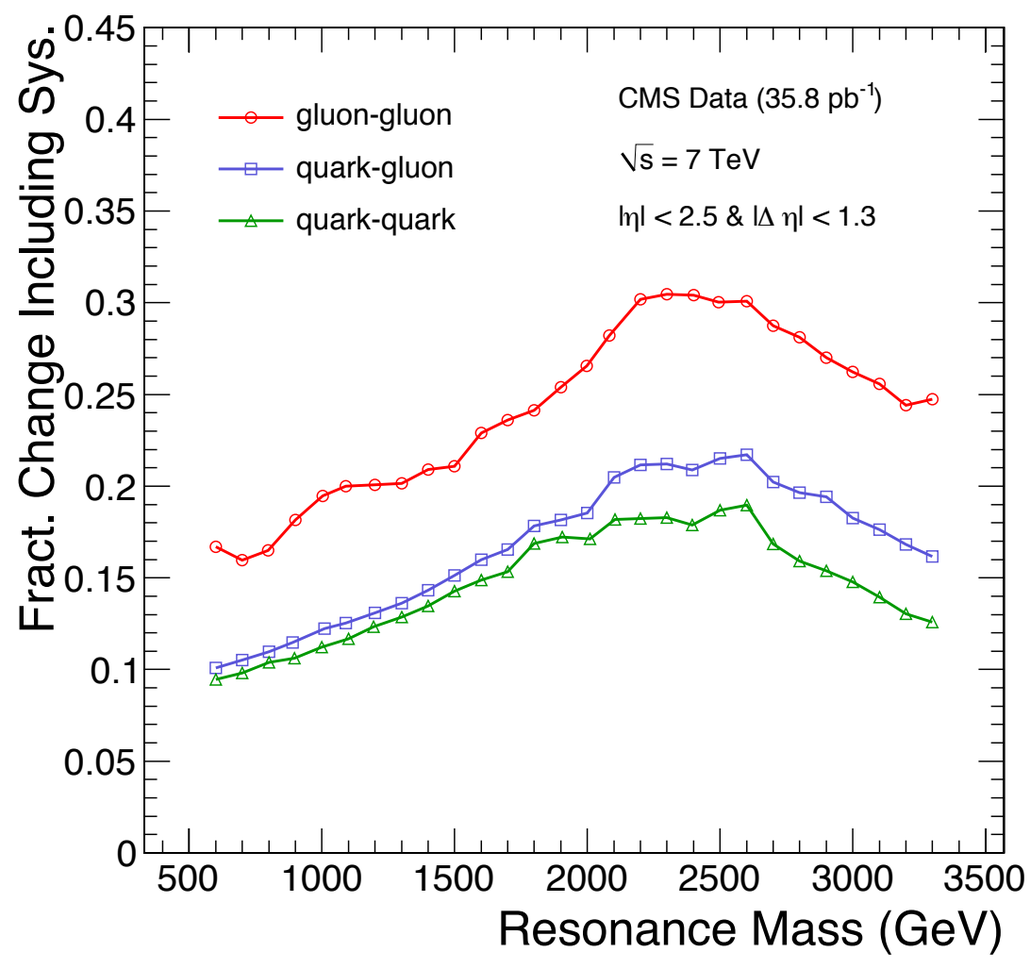
$$L(\sigma) = \int_0^\infty L(\sigma')G(\sigma,\sigma')d\sigma'$$

G: Gaussian distribution with RMS width equal to systematic uncertainty in cross section

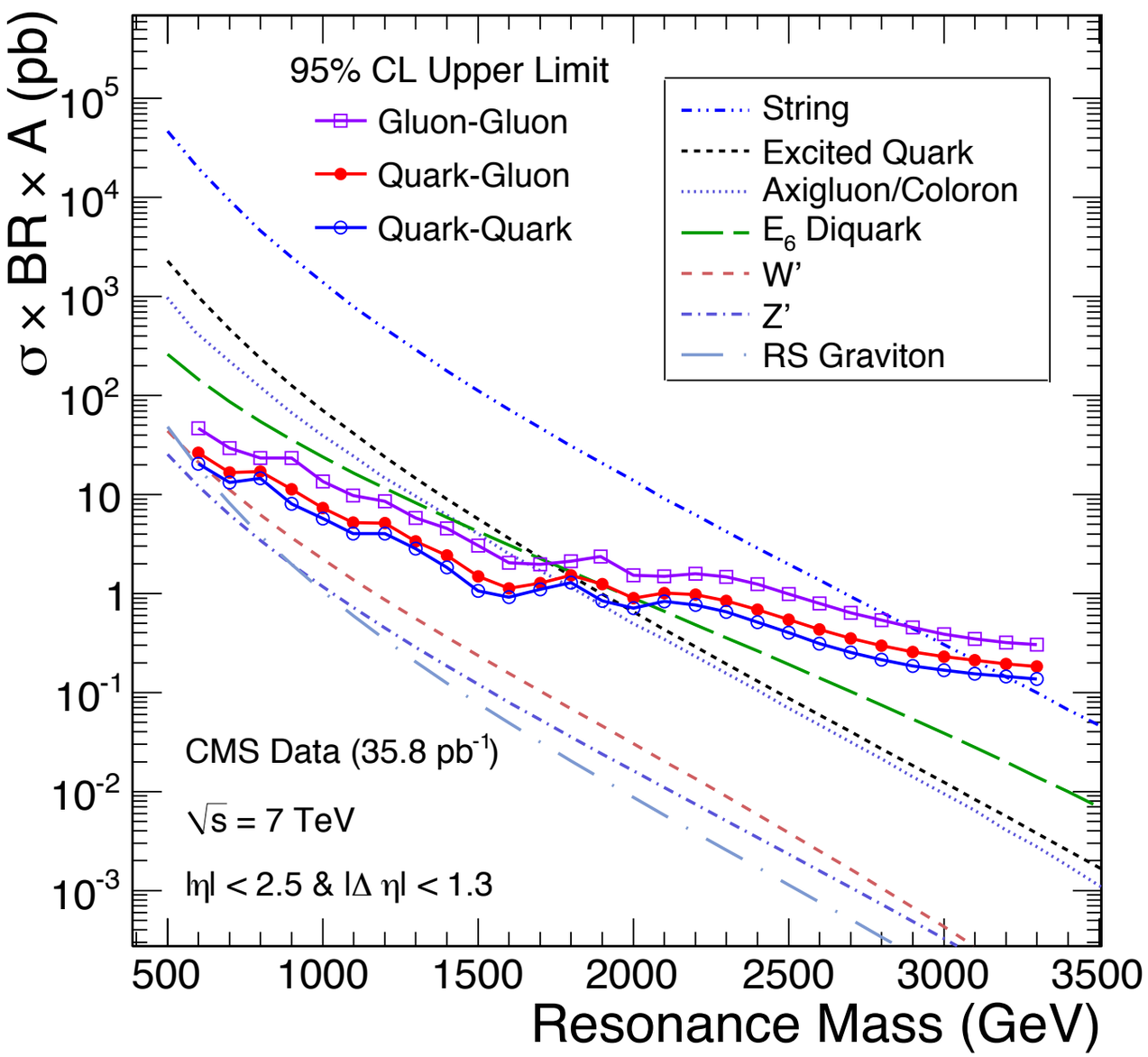
Effect of Systematics on Limit

- 95% CL Upper limit with Stat. Error. Only and Including Sys. Uncertainties are shown separately
- Systematic uncertainties reduce the mass limit by 60 GeV for both string resonance and excited quark.





Results



- We exclude the following mass ranges with 35.8 pb^{-1} data:
- String
  - ✓ **0.60<M(S)<3.10 TeV**
- Excited Quark
  - ✓ **0.60<M(q*)<1.80 TeV**
- Axigluon/Coloron
  - ✓ **0.60<M(A)<1.78 TeV**
- E6 Diquark
  - ✓ **0.60<M(D)<2.06 TeV**
- W`
  - ✓ **0.60<M(W`)<0.62 TeV**

Conclusion

- We have presented an update on dijet resonance analysis based on full 2010 data.
- The CMS dijet mass spectrum extends to 2.7 TeV with 35.8 pb^{-1} data.
- The dijet mass data is in good agreement with a full CMS simulation of QCD from PYTHIA.
- There is no evidence for dijet resonances.
- We have generic cross section upper limits on qq, qg, gg resonances that can be applied to any model.
- We have significant extension on mass limits on dijet resonance models, beyond published results.
- We will seek approval of this analysis for the winter conferences.