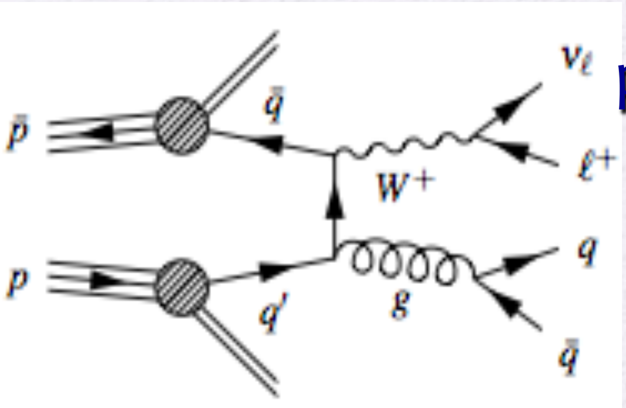
Update on Wjj from CDF

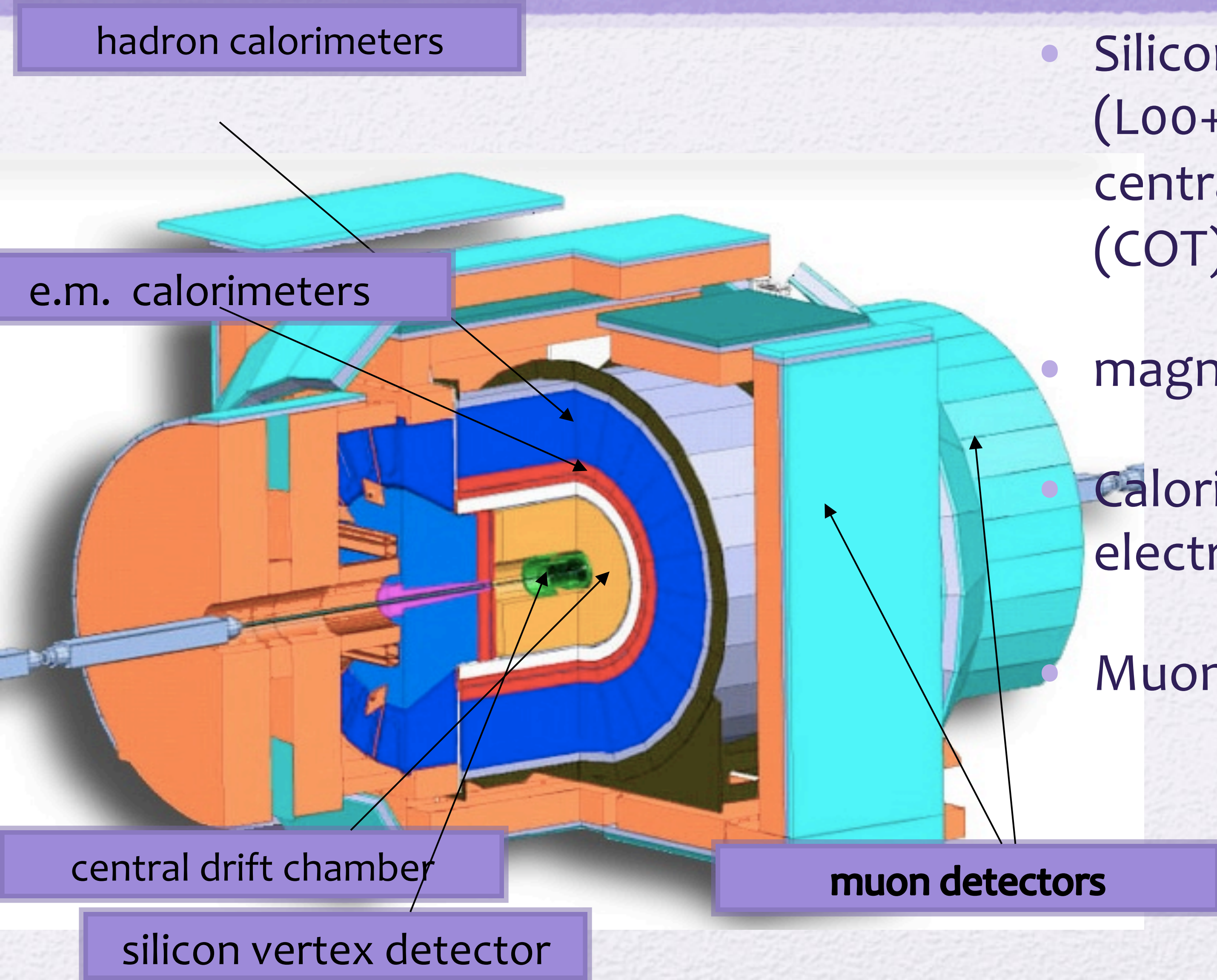
Viviana Cavaliere for the CDF Collaboration

W+jets Final State



- Measurements of associated production of a W boson and jets are important test of Standard Model
- $l\nu$ + jets signature shared by several important processes:
    - WW+WZ
    - single top
    - WH
- W+jets is a background for several searches beyond the SM
- Crucial to understand tools:
    - Event Generators
    - Analysis techniques

CDF Detector



- Silicon detectors (L00+SVX+ISL) and central drift chamber (COT) in 1.4 T
- magnetic field
- Calorimeters for electrons and jets
- Muon chambers

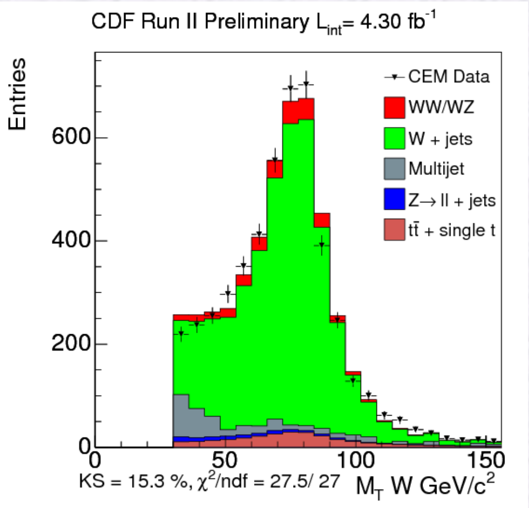
W reconstruction

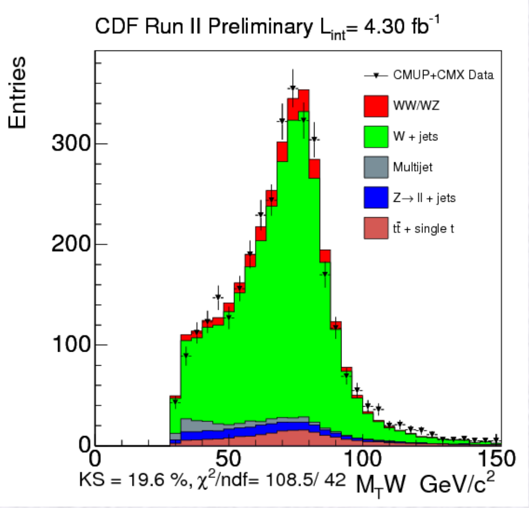
- Electron ET > 20 GeV and $|\eta| < 1$:
  - Require that 90% of energy is deposited in the EM calorimeter
  - calorimeter showers consistent with electromagnetic interaction

- Muon PT > 20 GeV/c and $|\eta| < 1$:
  - Require high quality track and matching between the track and muon chamber hits

- Both required to be isolated: i.e. no jets

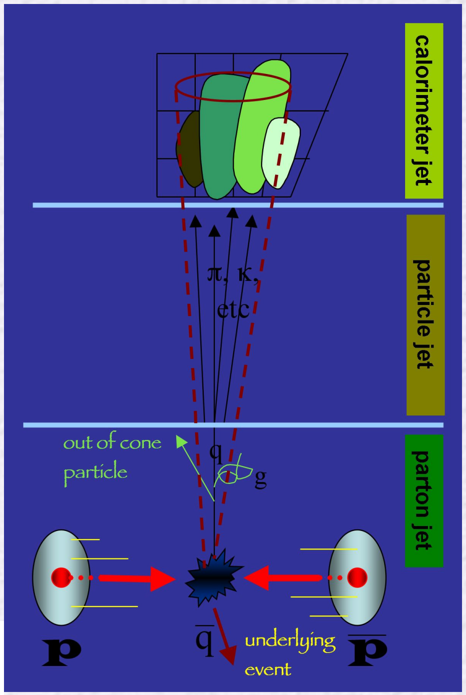
- We further require MET >25 GeV and MTW > 30 GeV/c2 to ensure the presence of a real W

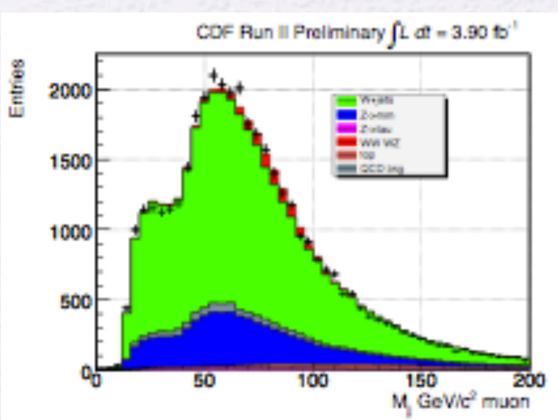




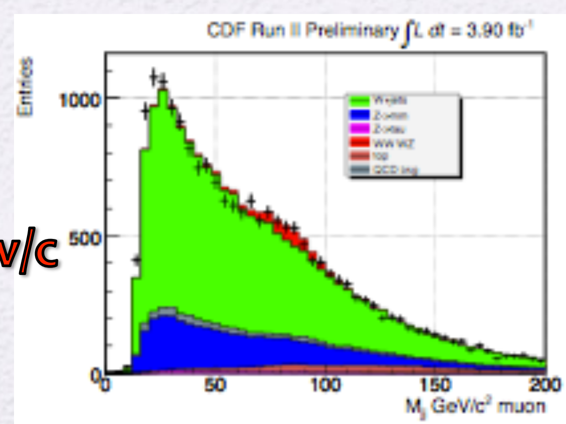
Jets Definition and Selection

- Jets are reconstructed using the JETCLU algorithm (standard at CDF)
- Cluster the Energy in cones $\Delta R<0.4$
- Calorimetric signature inconsistent with electron signature
- Select exactly 2 jets with ET > 30 GeV and $|\eta| < 2.4$
- Require PT(dijet) > 40 GeV/c: to smoothen Mjj





Pt(jj)>40 Gev/c



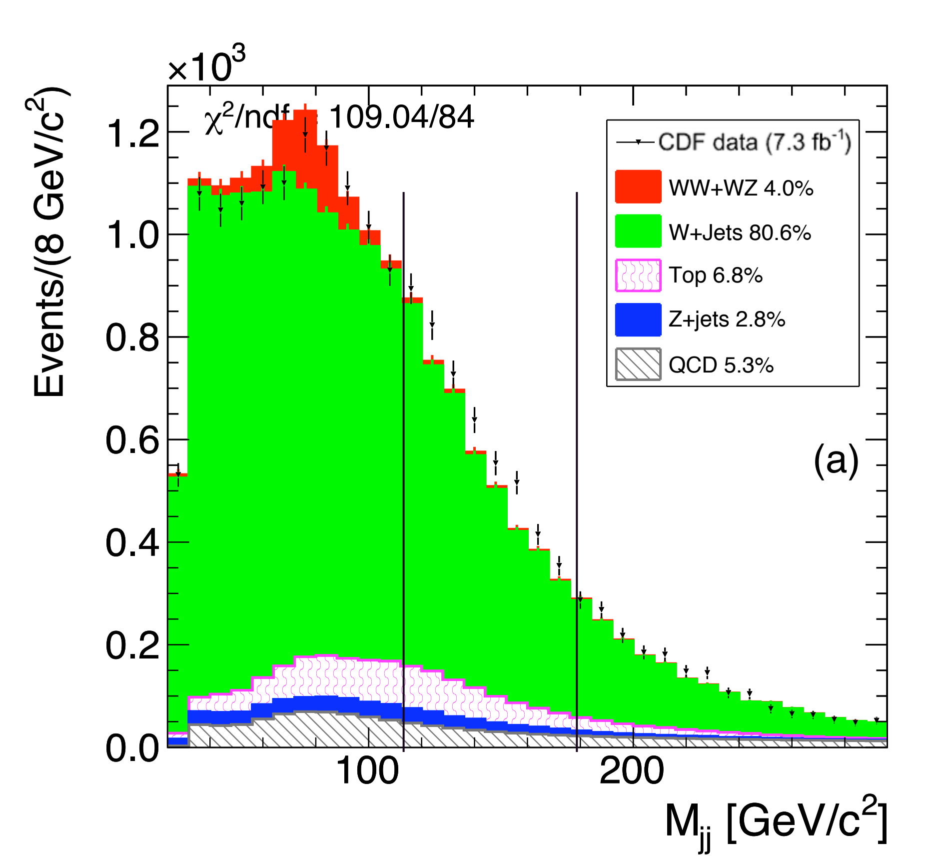
Sample Composition

- $W \to l\nu$ + jets ($l=e,\mu,\tau$):
    - high production xsec (2066pb), 80% of the sample
- $Z \to ll$ + jets ($l=e,\mu,\tau$):
    - one of the lepton escapes detection. Cross section 187 pb
- top + single top:
    - final state similar to signal with at least one real W + 2 jet. σ(tt) ~ 7.5 pb and σ(single top) ~ 2.9 pb
- QCD Multijet:
    - Events without a primary lepton from W decay: ex. Jet faking a letpon

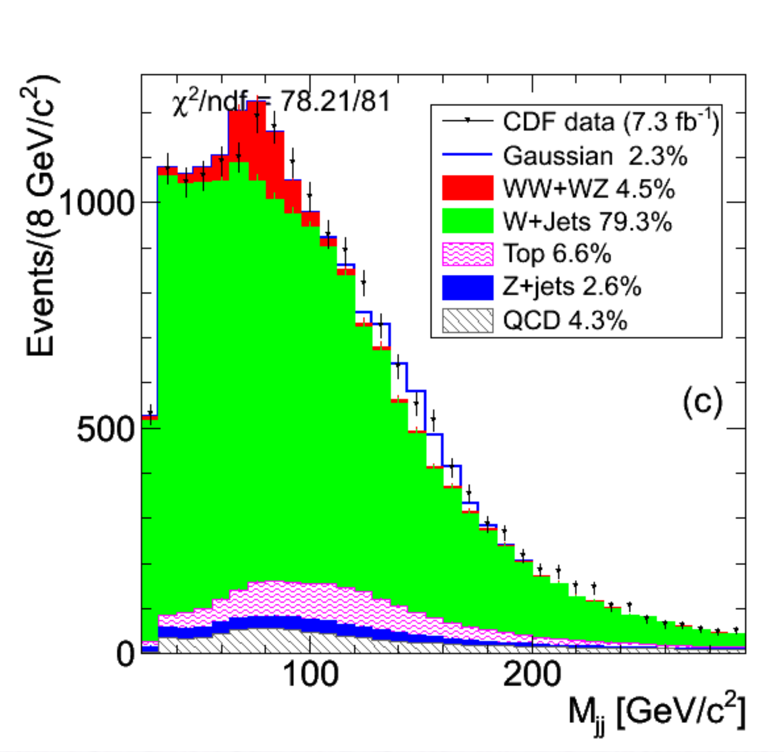
Process	Model	σ (pb)
WW/WZ inclusive	PYTHIA	15.9 ± 0.9
$Z \to e, \mu, \tau$+jets	ALPGEN+ PYTHIA	787 ± 85
$t\bar{t}$	PYTHIA	7.5 ± 0.83
single top	MADEVENT + PYTHIA	2.86 ± 0.36
W+jets	ALPGEN+ PYTHIA	from data
QCD multijet	from data	from data

Fitting the Mjj in 7.3 fb-1

- Check agreement of Data with out of the box MC (Alpgen with standard parameters)
- Excess of events in the 115-175 GeV/c2 dijet mass region, both in the electron and muon sample
- Fit the Mjj with SM templates.



SM Templates + Gaussian



- Data fitted with SM components plus a gaussian
- Fit range 28-200 GeV/c2
- Statistical significance (no systematics) 4.8σ, including trial factor

- Shape systematics on:
  - QCD, Jet Energy Scale
  - W+jets renorm. scale
  - The largest p-value is 1.9 * 10-5
  - Corresponding to a significance of 4.1 standard deviations

	muons	electrons
Excess events	158 +- 46	240 +- 55
Excess/exp. WW+WZ	42% +- 12%	47% +- 10%
Gaussian mean	147 +- 5 GeV (stat. only)	

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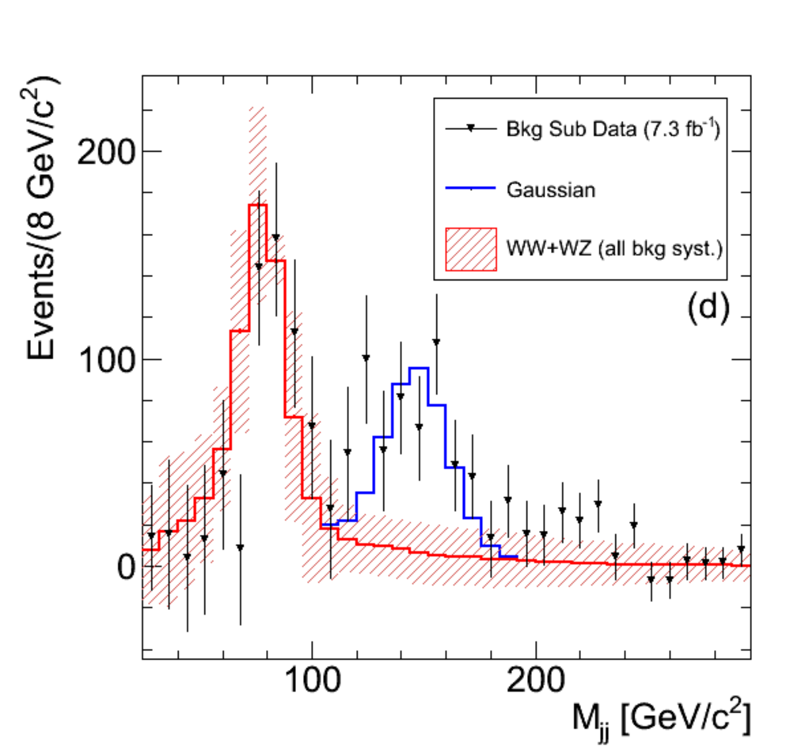

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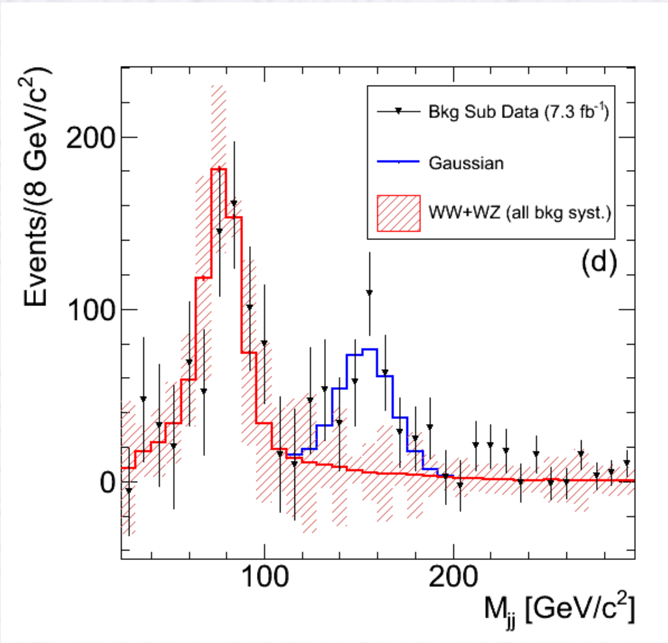
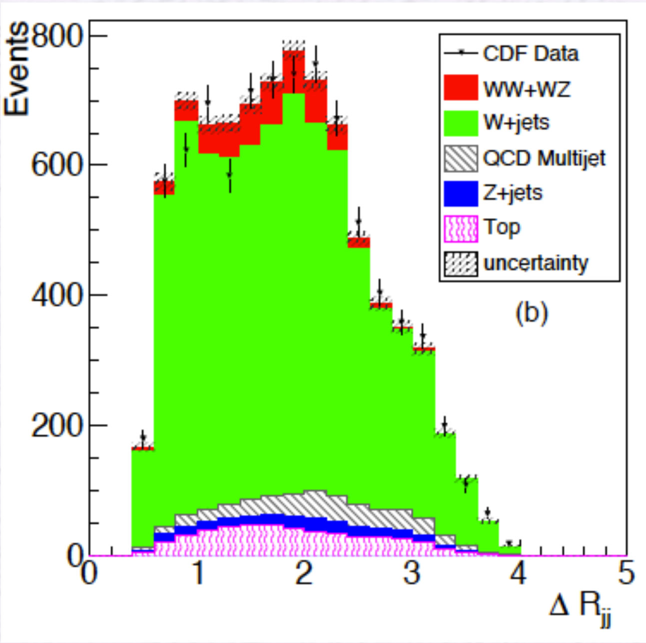
Best Fitting Syst. Combination

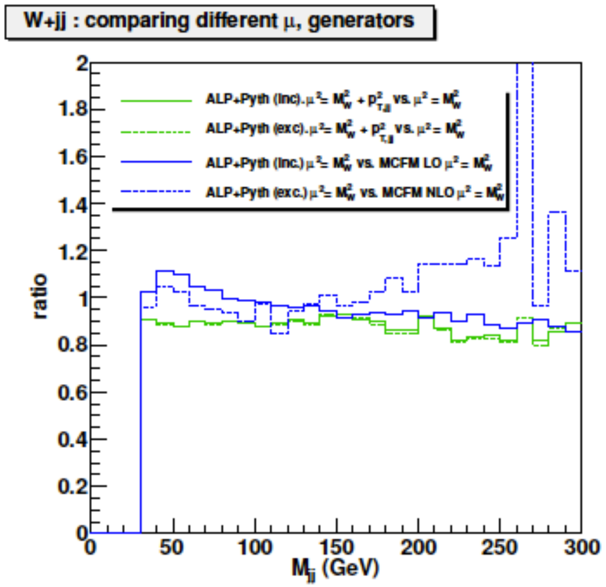




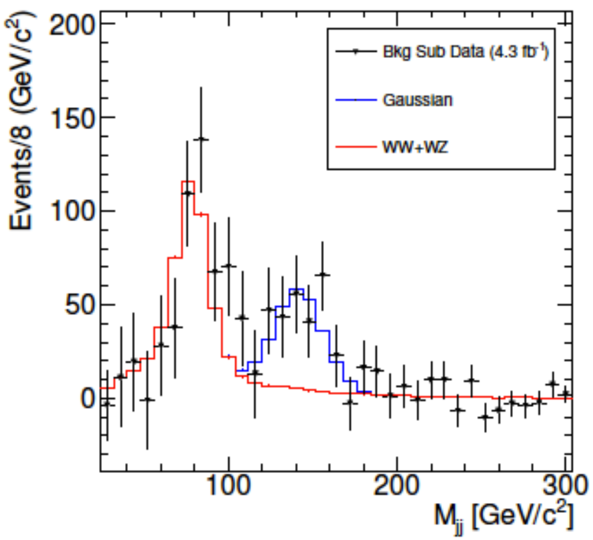
- Fit performed using the combination of systematics that fits the data best: lowest $\chi 2$
- ΔRjj (Mjj < 115 and Mjj > 175 GeV/c2) shown with the same combination of systematic

NLO Effects

- In order to test Next to Leading Order contributions to the W+2 partons prediction, we compare (private communication with J.Campbell, E. Eichten, K.Lane, A.Martin) ALPGEN and interfaced to PYTHIA for showering to a sample of W+2 partons simulated using the MCFM.
- We extract a correction as a function of M_{jj} that is applied to the ALPGEN + PYTHIA sample used in our background model.
- This procedure returns a statistical significance of 3.4σ.

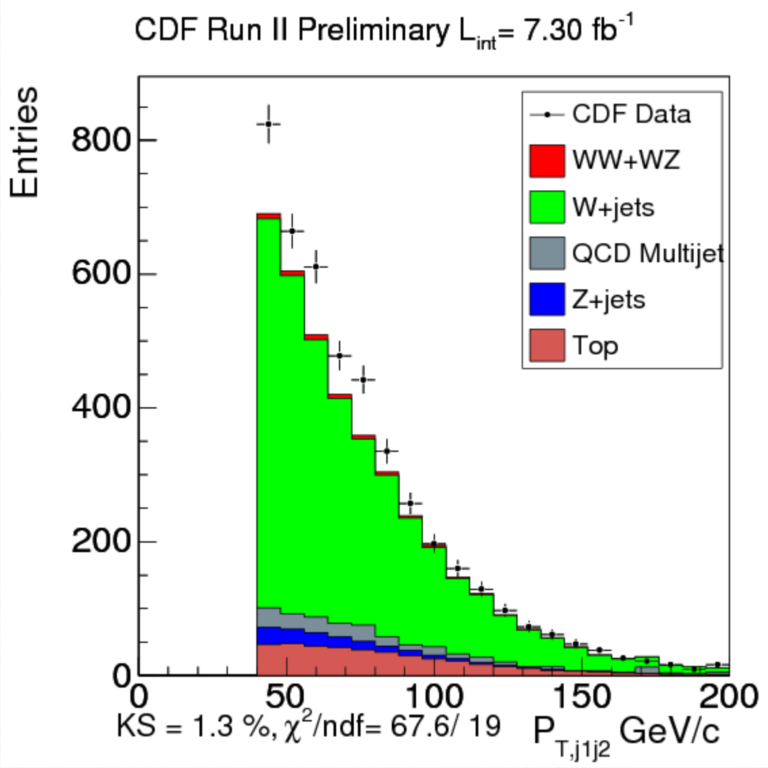


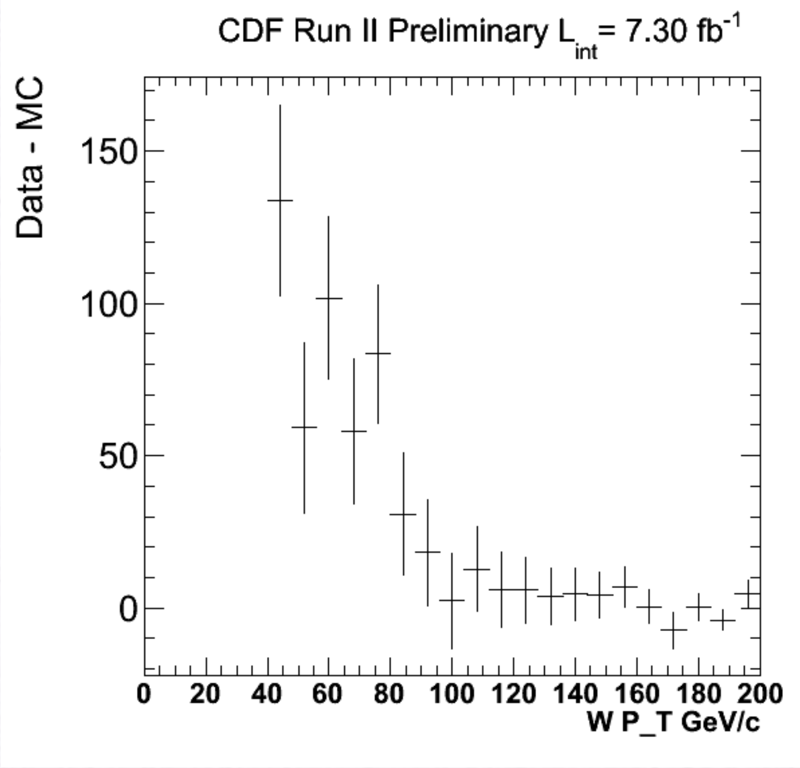
(4.3 fb^-1 data sample)



Excess Kinematics

Look into the 115 < Mjj < 175 GeV/c² region.
Numerical events excess comes from mjj fit.





Pt(jj)

Excess Kinematics

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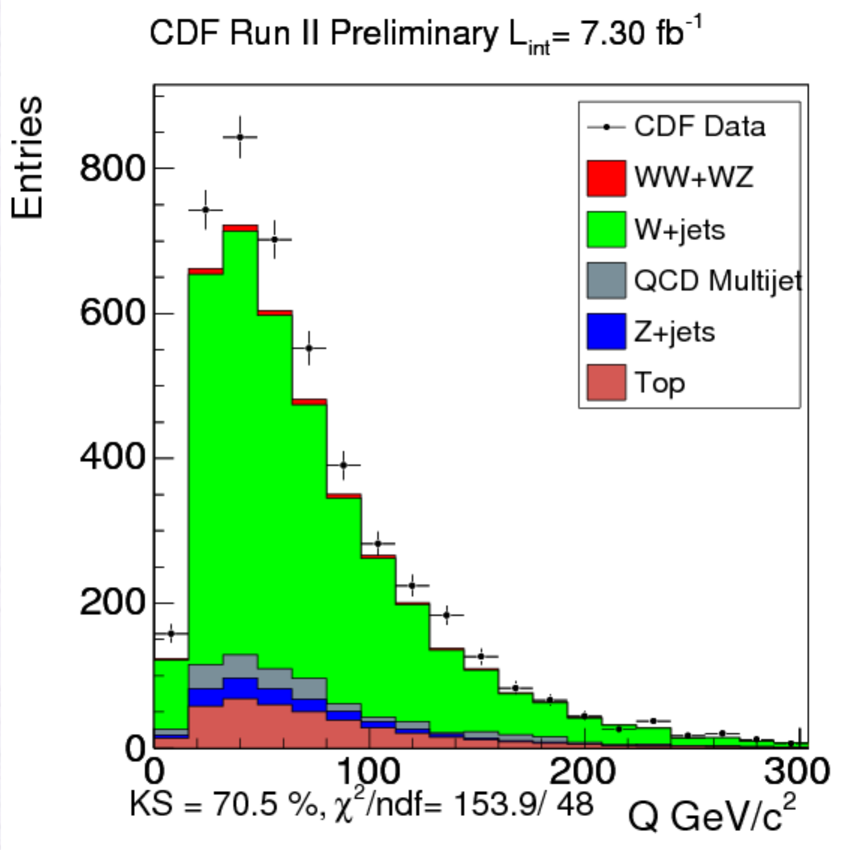

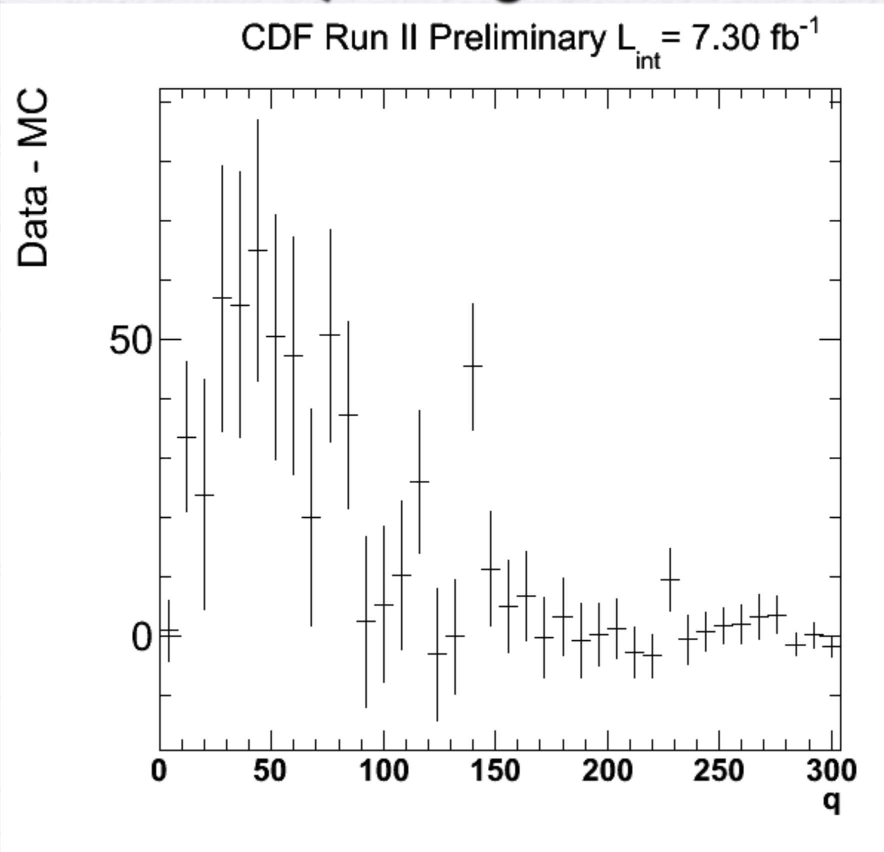

$M(l\nu jj) - M_W - Mjj$

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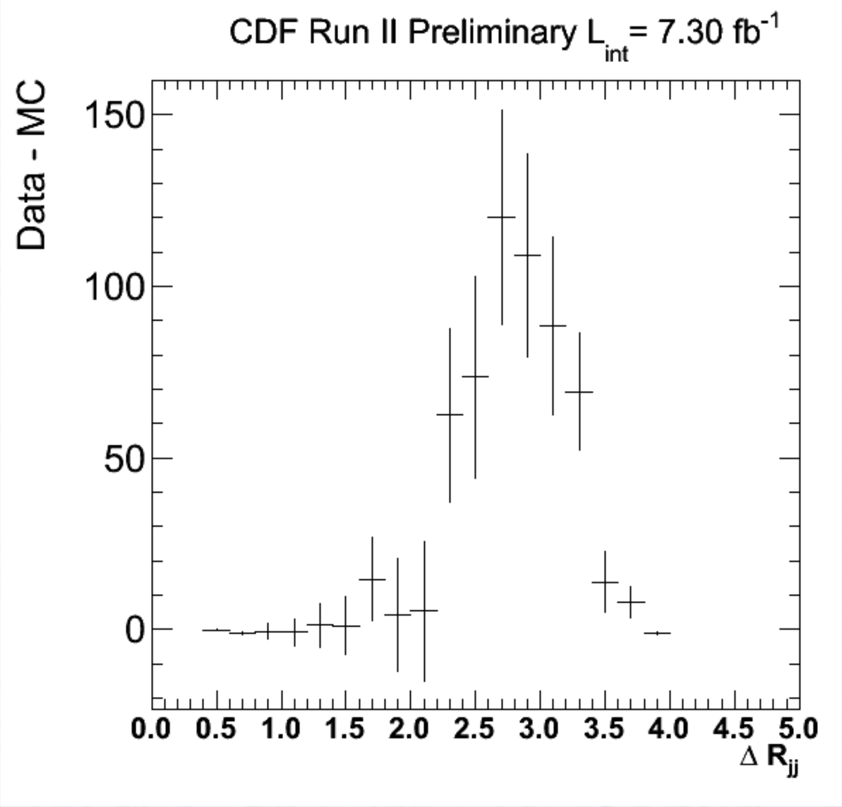
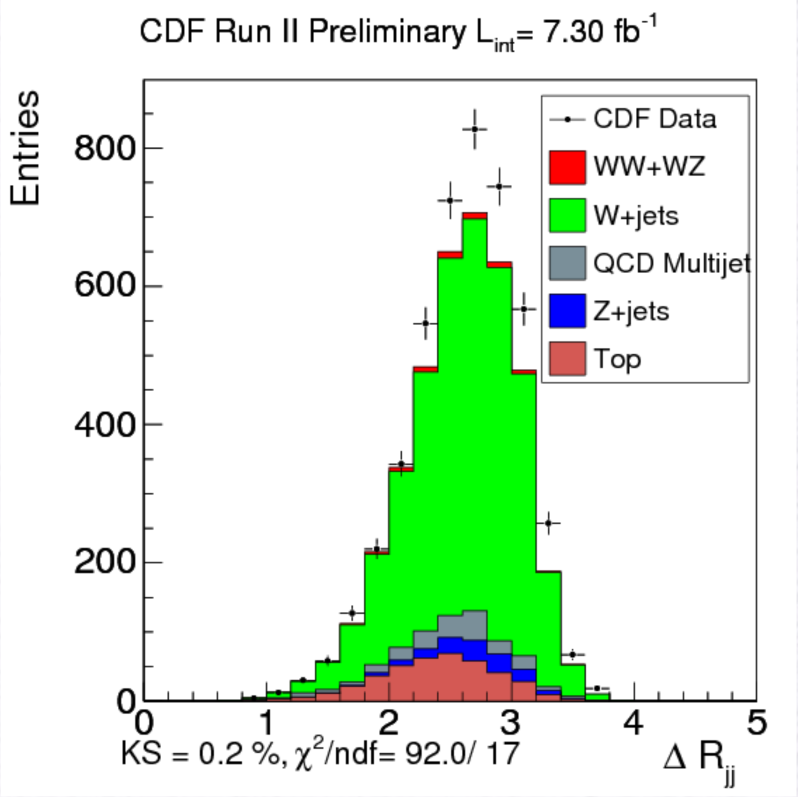
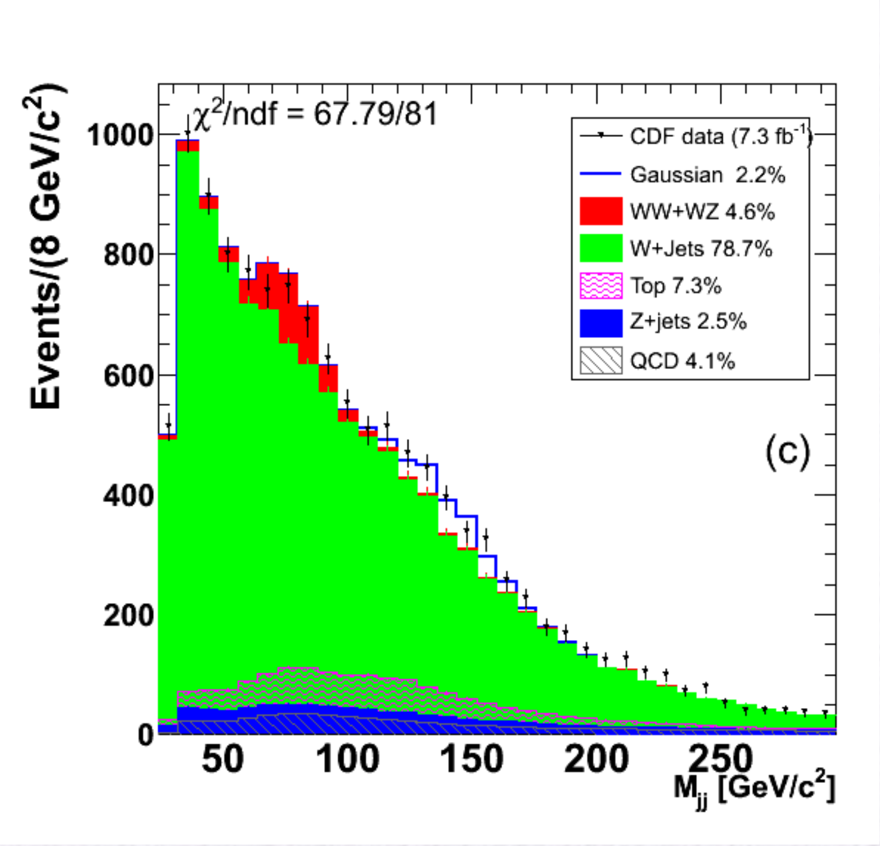


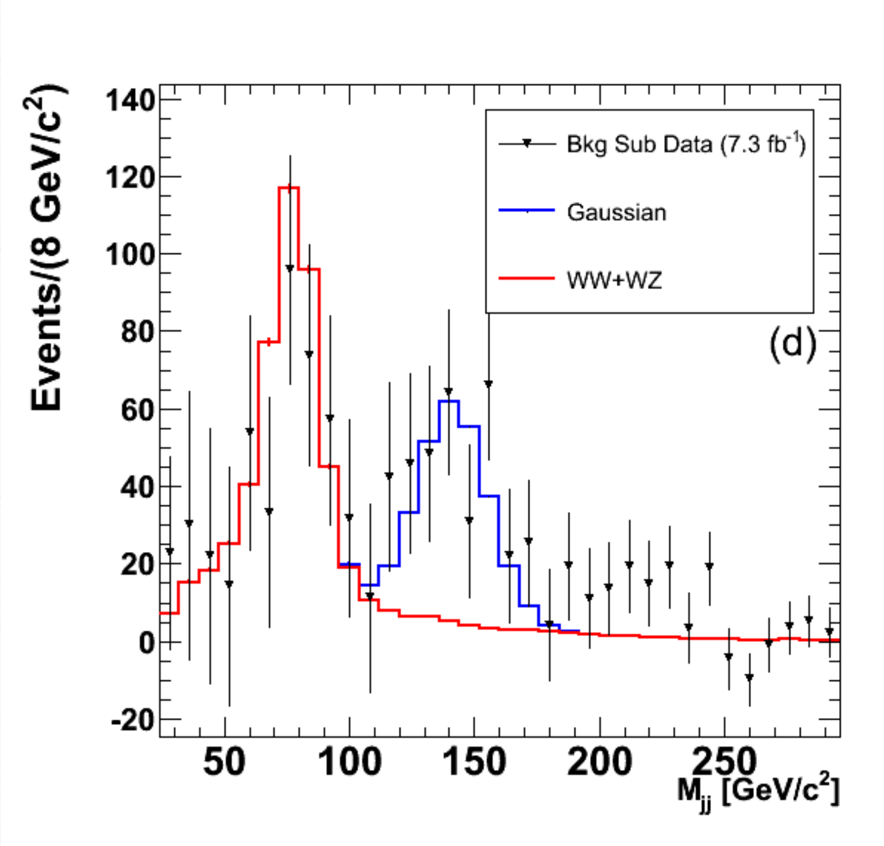


DRjj

Increasing P_T(dijet) > 60

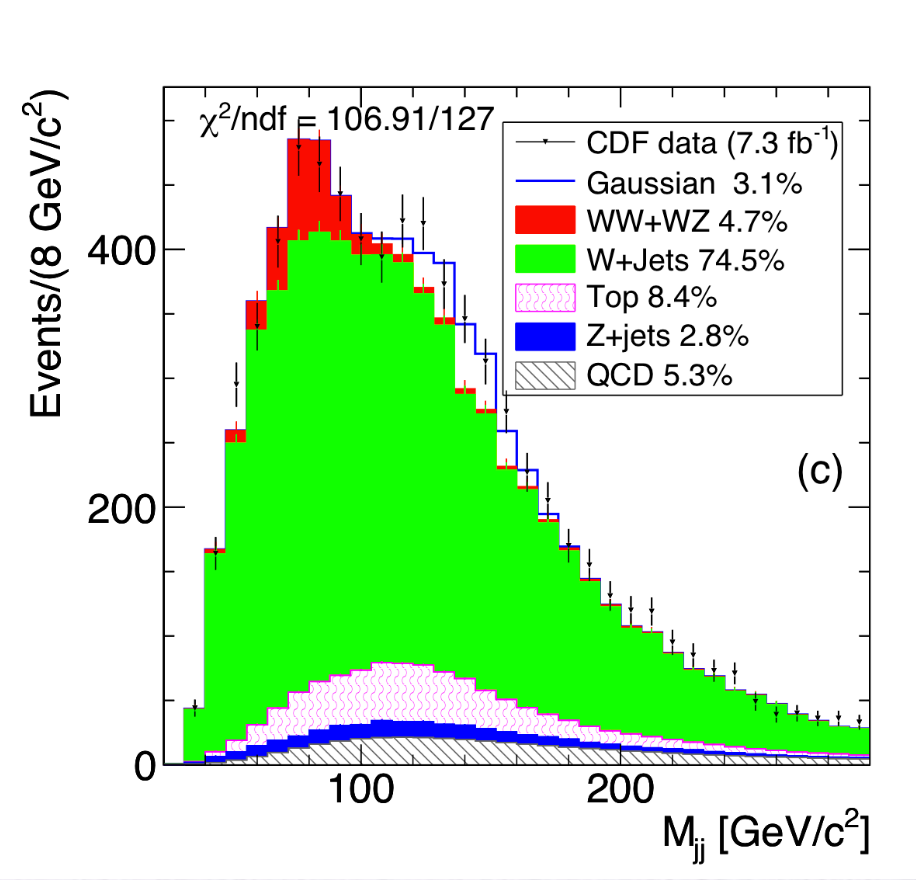
- Excess stays when we change completely the shape of the W+jets by applying a higher cut on the ptjj

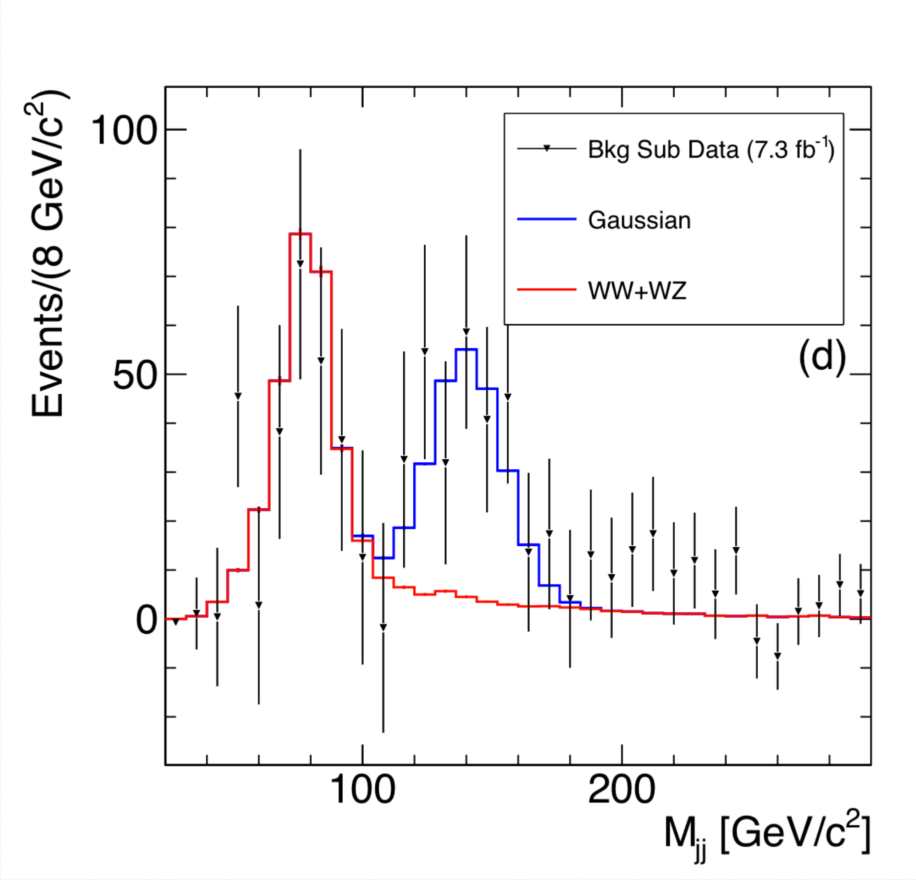




P_T(dijet) > 60 & $\Delta\phi$ > 1.0

We are able to select the region where the excess is more prominent





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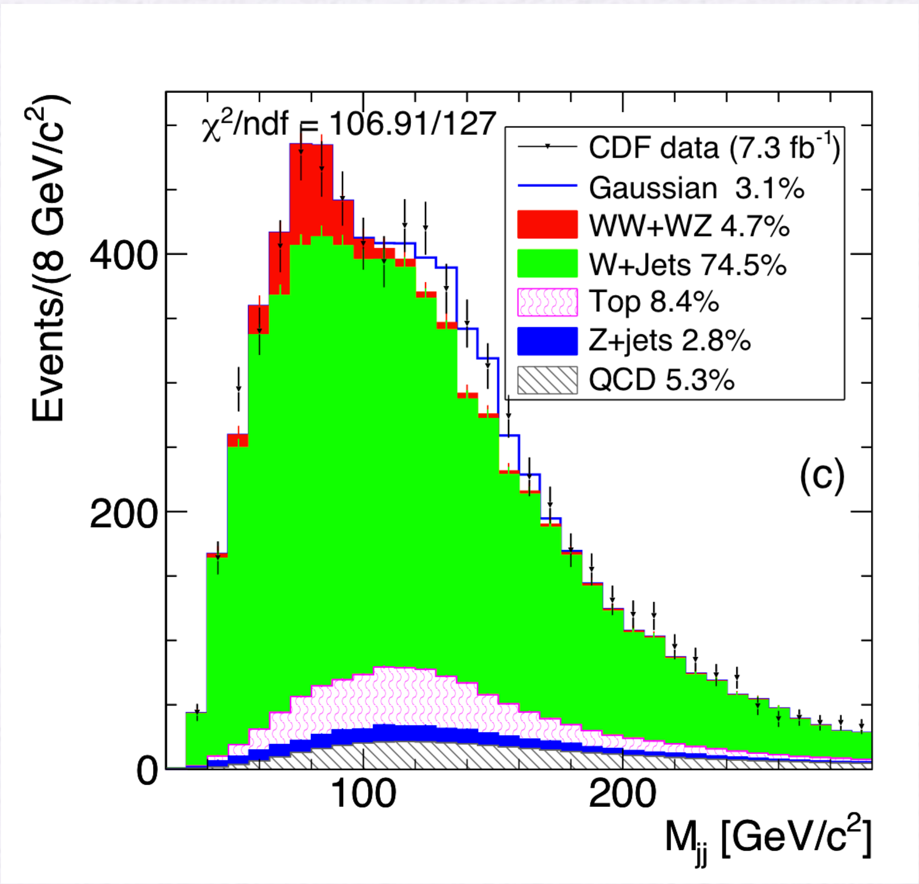
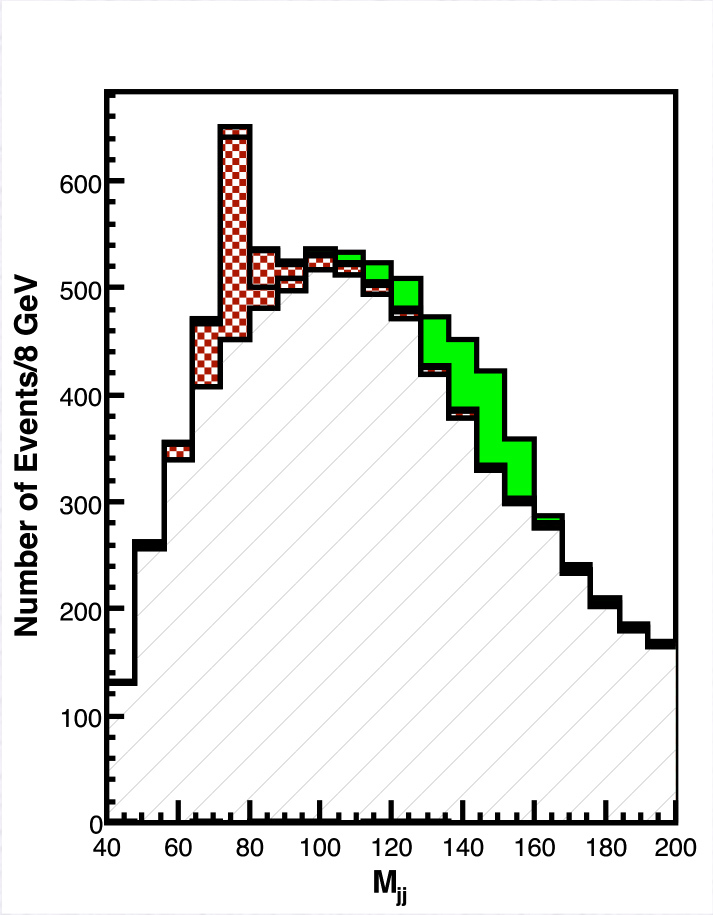
Technirho -> W + techniphi
Eichten, Lane, Martin



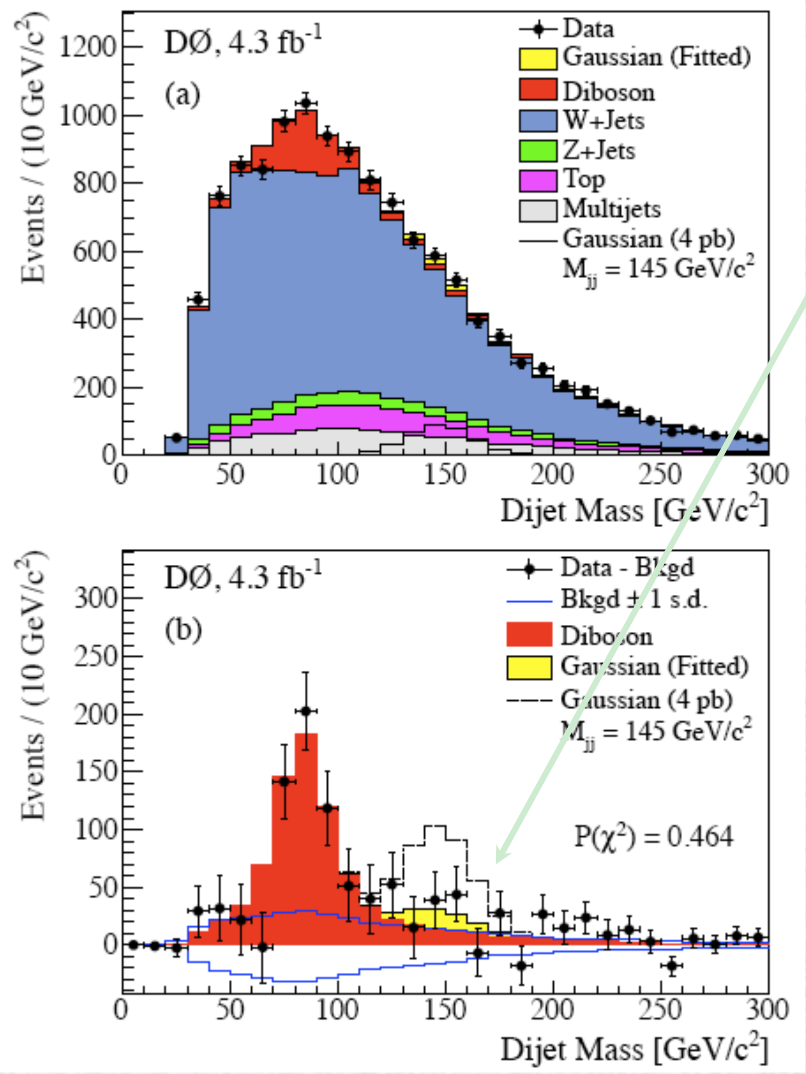


Meanwhile

- On the other side of the ring…

Do analysis

similar analysis with 4.3 fb^{-1} [arXiv:1106.1921]



$$\sigma(p\bar{p} \to WX) = 0.82^{+0.83}_{-0.82}\ \text{pb}$$

Calculated using WH150 acc*eff.

- D0 result clearly favors the null hypothesis:
  - No significant discrepancy w.r.t. background model
- Identified some differences:
  - D0 jets corrected for out-of-cone: effective jet threshold lower
  - Double QCD contamination from low purity electrons
  - Fit procedure morphs Mjj to correct for systematics
    - Quantitative effect on Mjj templates not available

Quantitave CDF vs D0 comparison

- D0 excludes a 4pb signal at 4.3σ level
  - doesn't account for uncertainty on CDF number "order of 4b xsec"
- Evaluated xsec using D0 procedure
  - 3.1 +- 0.8 pb (with 4.3 fb-1 data)
  - 3.0 +- 0.7 pb (with 7.3 fb-1 data)
- To be compared with D0 fit of:
  - 0.82 +- 0.83 pb
- While D0 favors the null hyptotesis, two results are only ~2σ apart → Interesting to see results with all the data

Conclusions

- CDF vs D0 difference to be understood
  - FNAL started a task force
  - Will compare results at each step
- Whatever we learn important for current and future analyses of W+jets samples
- CDF studies on going on other possible final states

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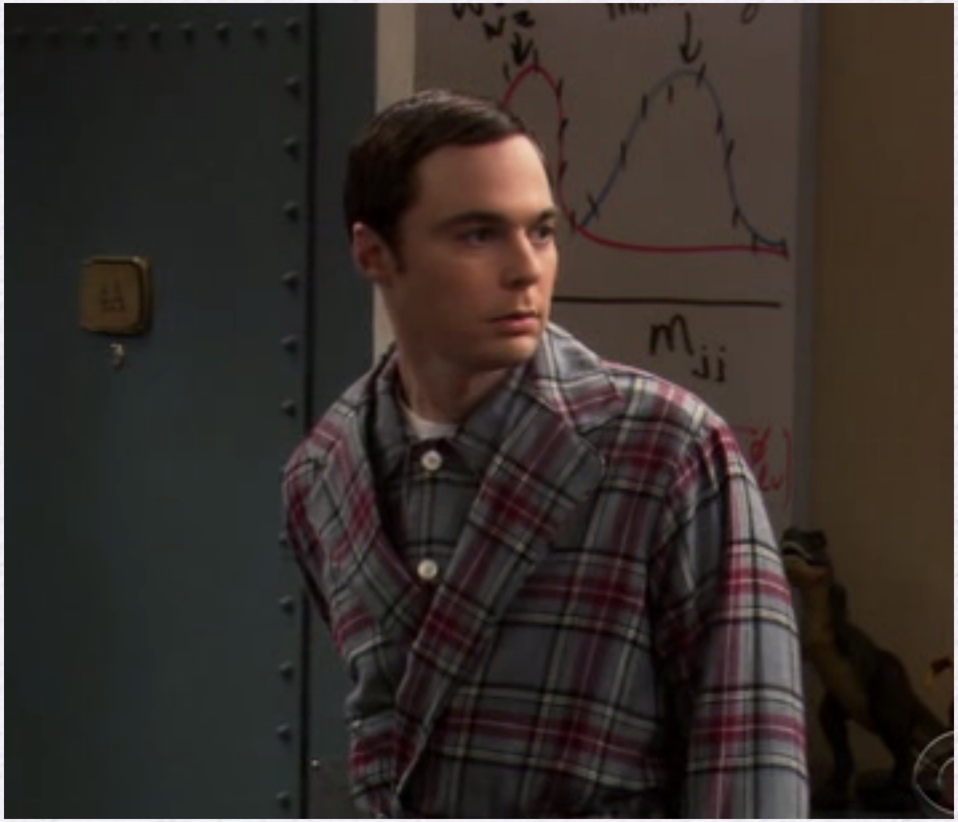
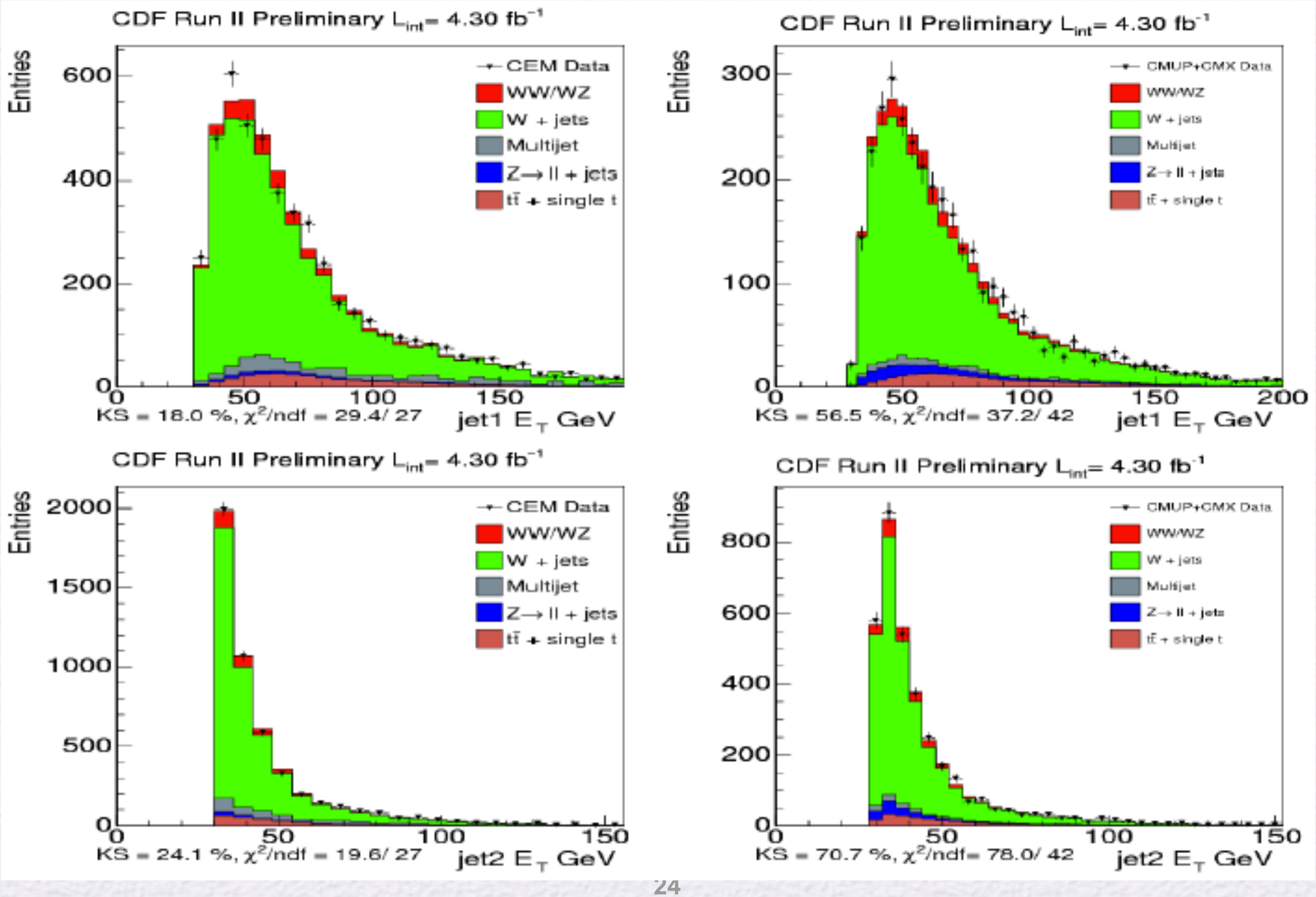


Backup

Mjj < 115 OR Mjj > 175



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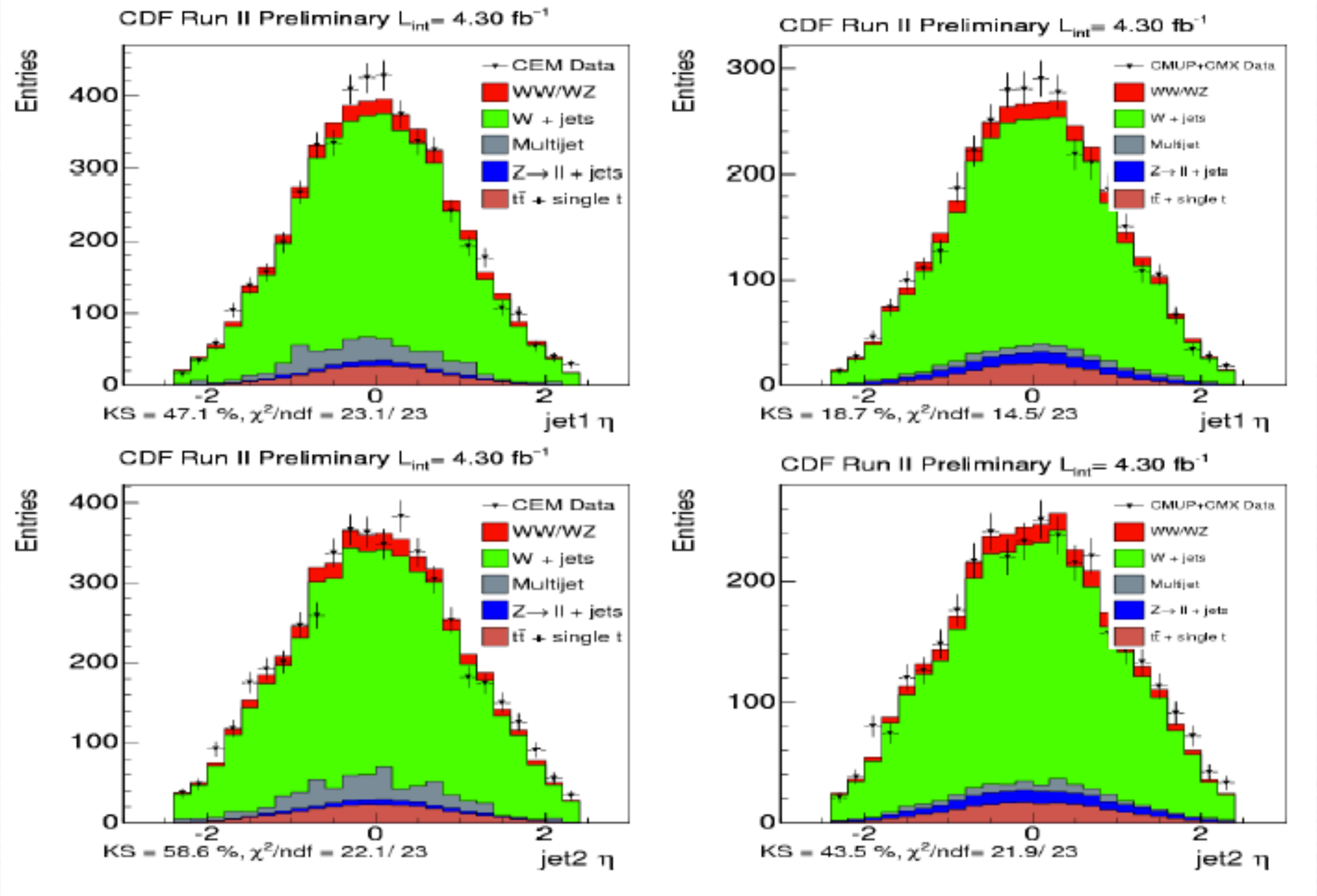
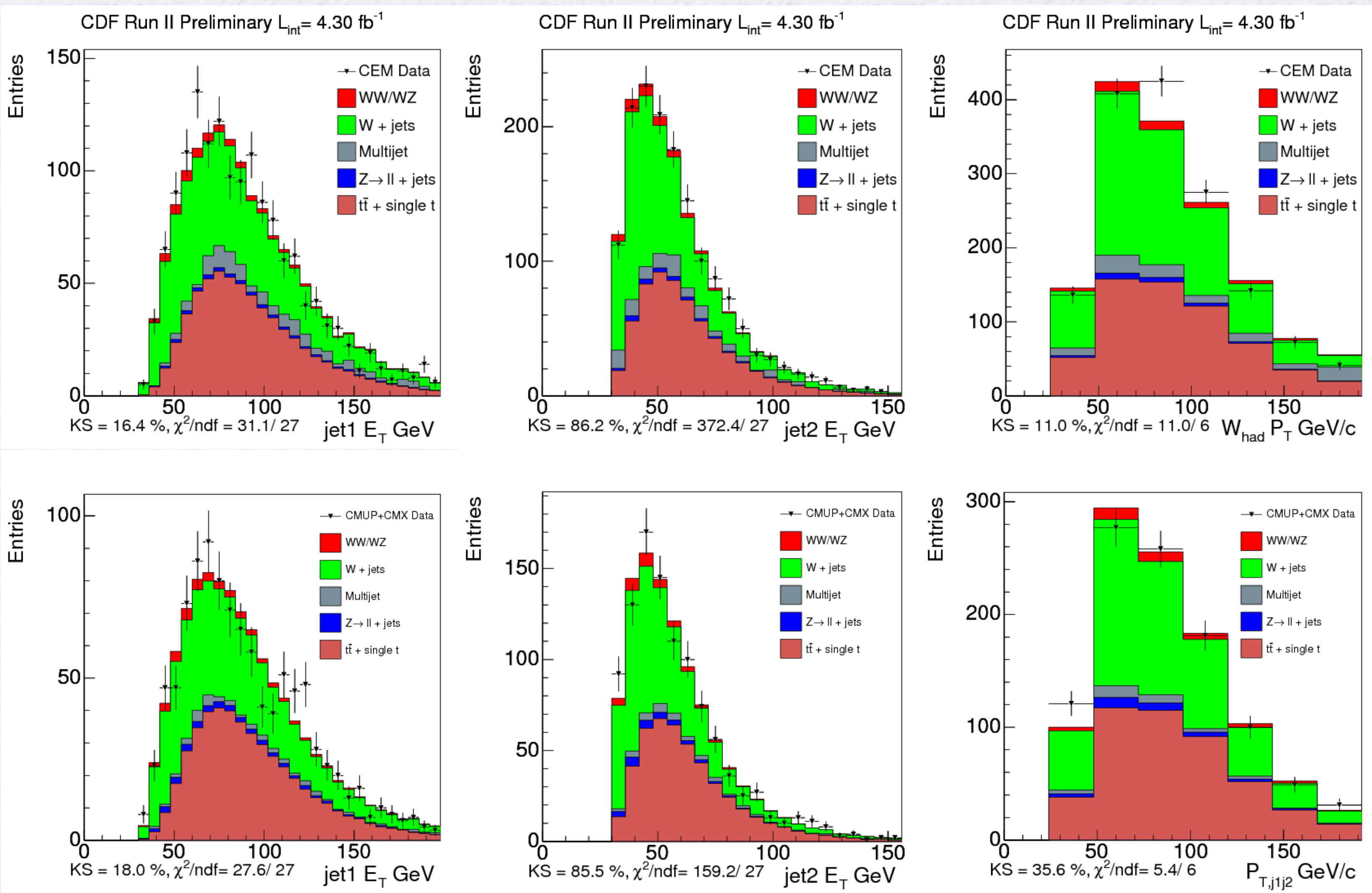


W+n≥3 Jet: Top Enhanced



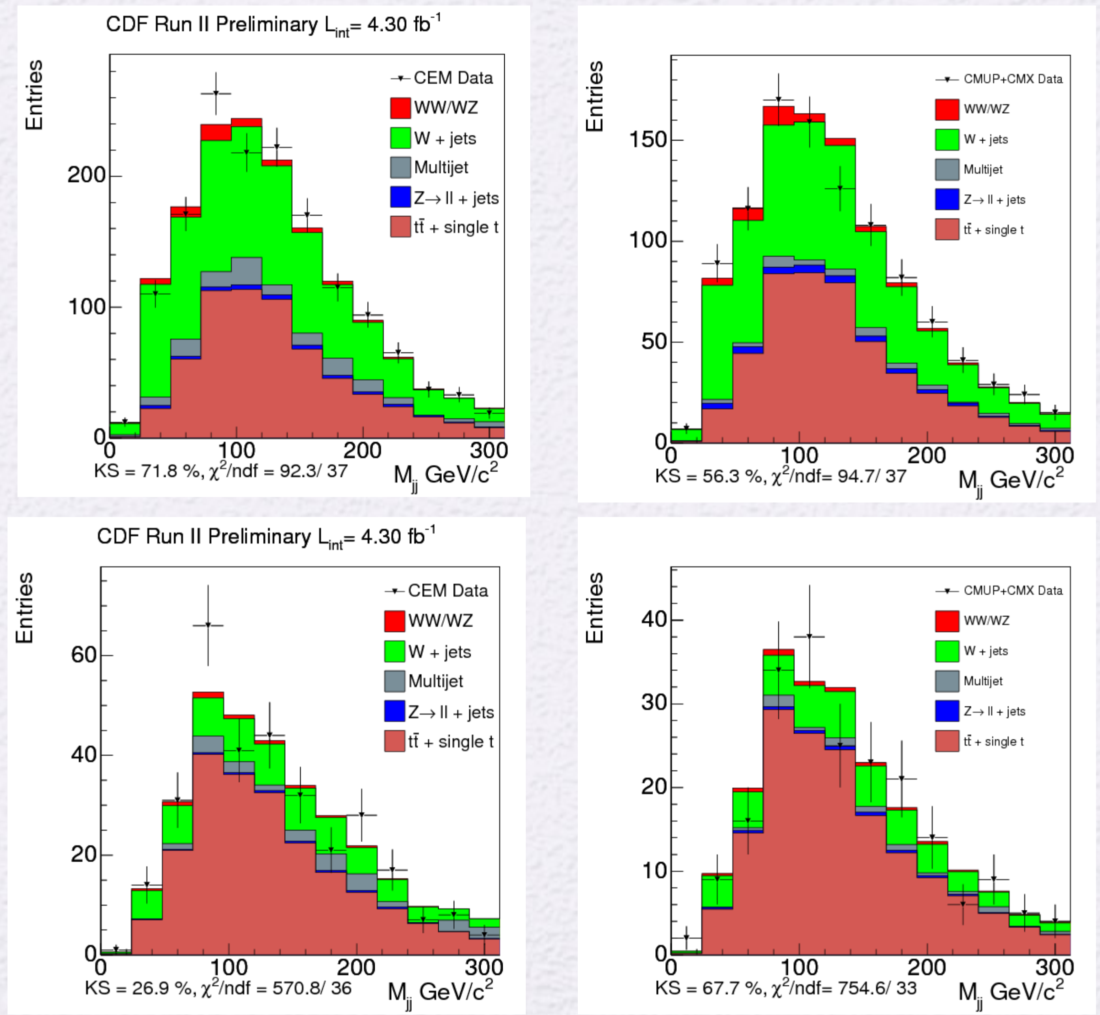
Mjj in 3 and 4 Jet Events

Computed with two leading jets

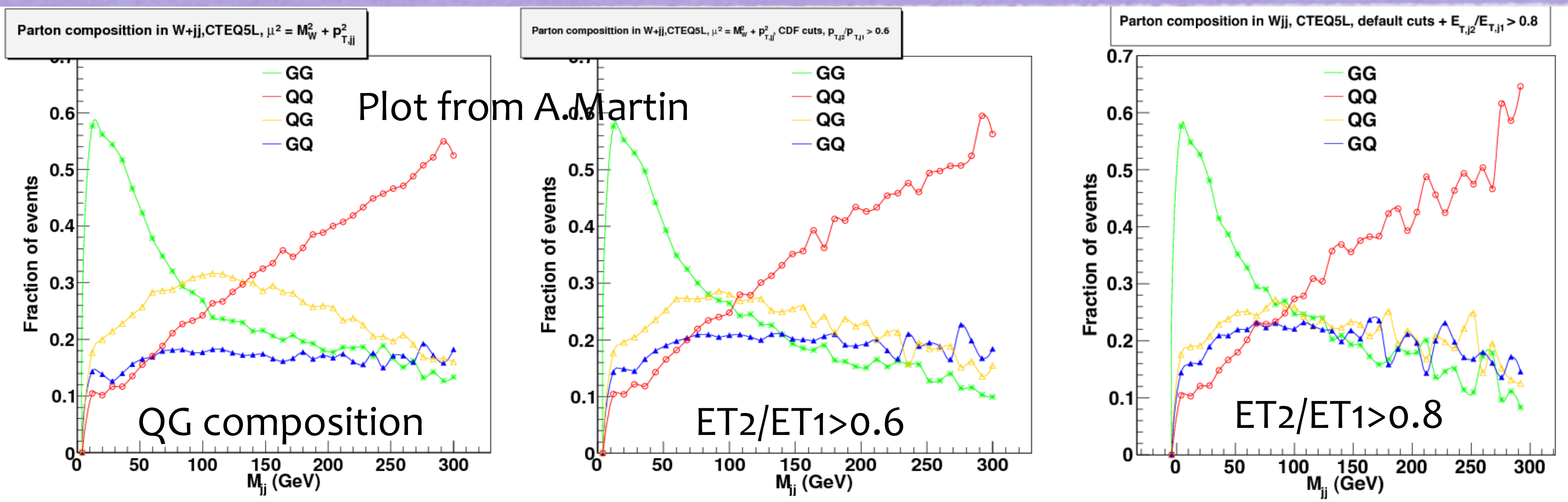
W + n≥3 jet

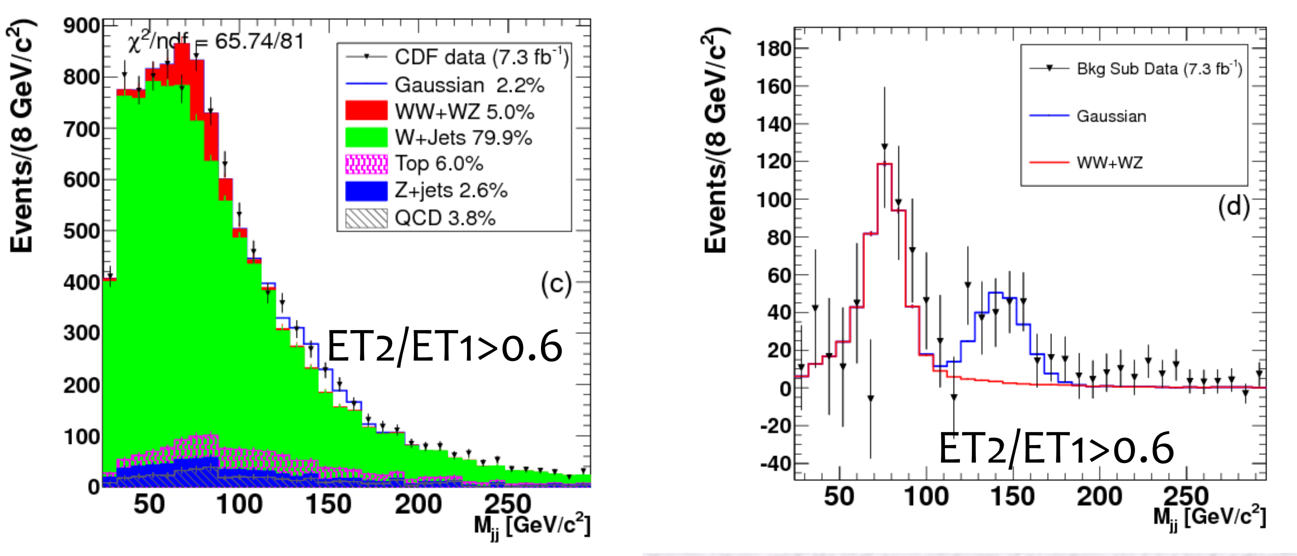
W + n≥4 jet

Good agreement between bkg model and data (this is true for any combination of jet)



quark/gluon composition studies





http://home.fnal.gov/~aomartin/jet%20composition/jet_compositon/deltaET_ETratio.html