Update on semileptonic diboson WW,WZ →W(lν)+jj analysis

Analysis Note: AN-11-151

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Introduction

✦In the last meeting I gave a detailed status of the analysis:

https://indico.cern.ch/conferenceDisplay.py?confId=160356

✦There were two questions for which I gave succinct answers and promised to get back with more details:

- Why not apply b-veto on the (leading) two jets ?

Because the top background is well understood and well simulated. We are fine with not applying explicit top veto. If we do, the systematics increase slightly.

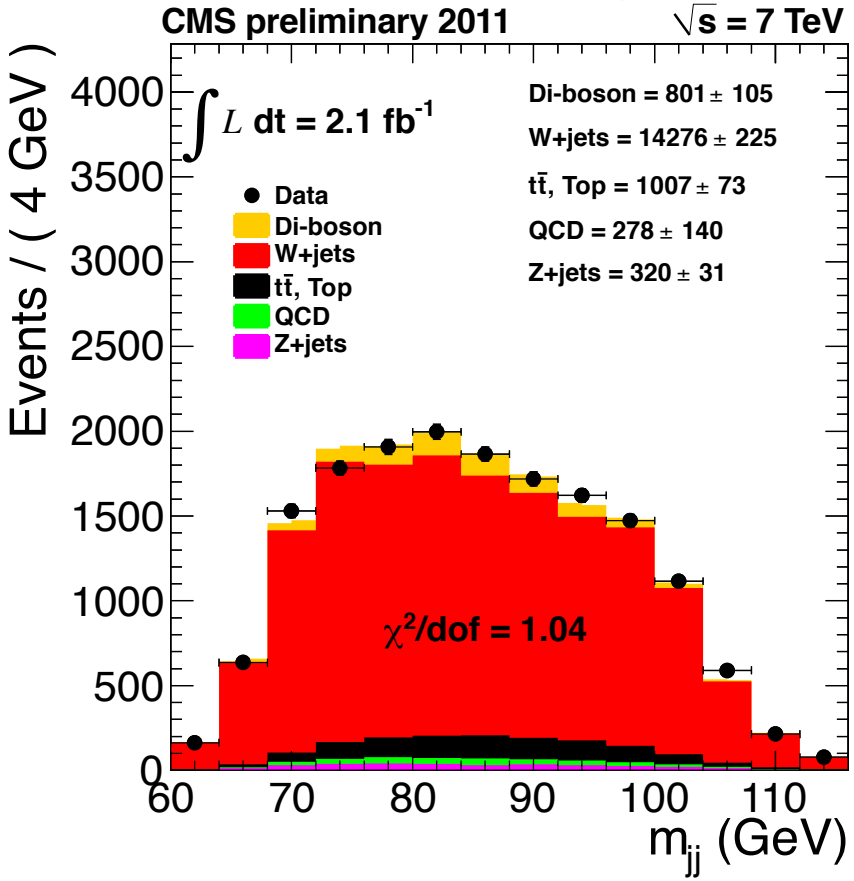
- Can we assume that LO diboson MC gets the m_{jj} lineshape correct ?

Yes, because the lineshape is dominated by jet resolution and detector effects. Intrinsic width of the W/Z boson is smaller than 3% of its mass, while jet energy resolution is ~20%. Modeling of the JER in MC is checked in top quark events.

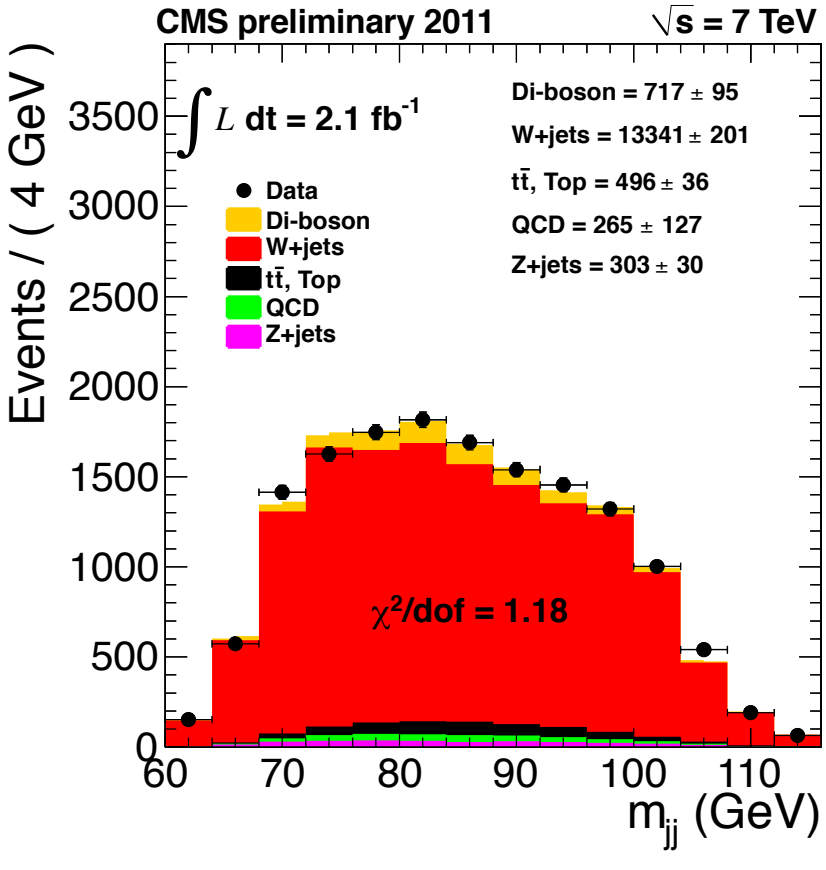
Today I will elaborate on both these questions.

2-jet sample: fit results

No anti b-tag



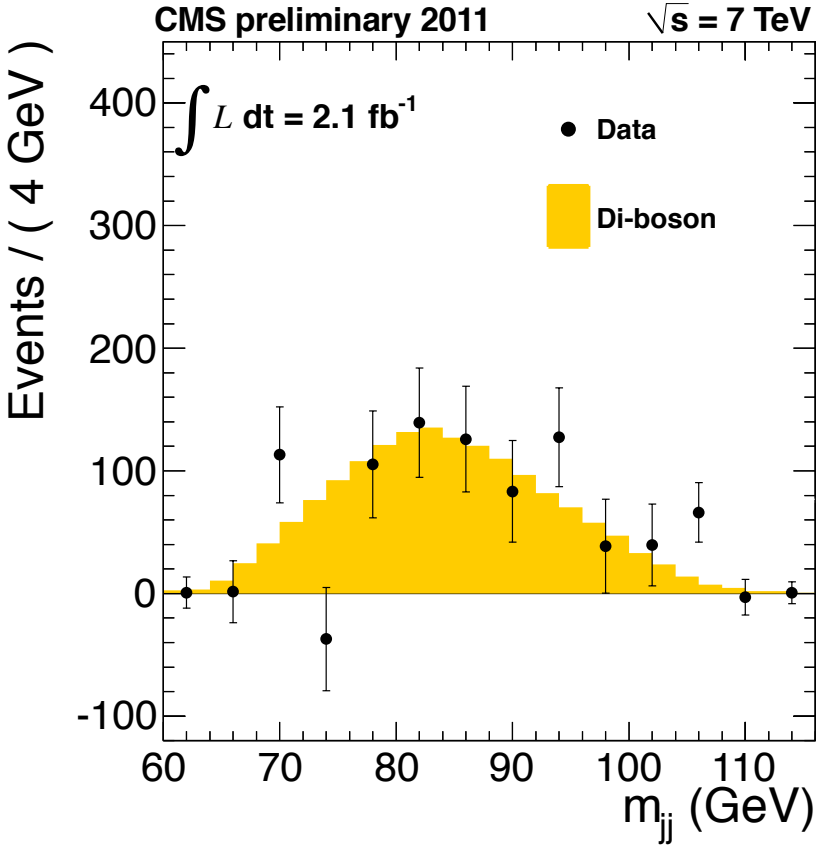
Anti b-tag



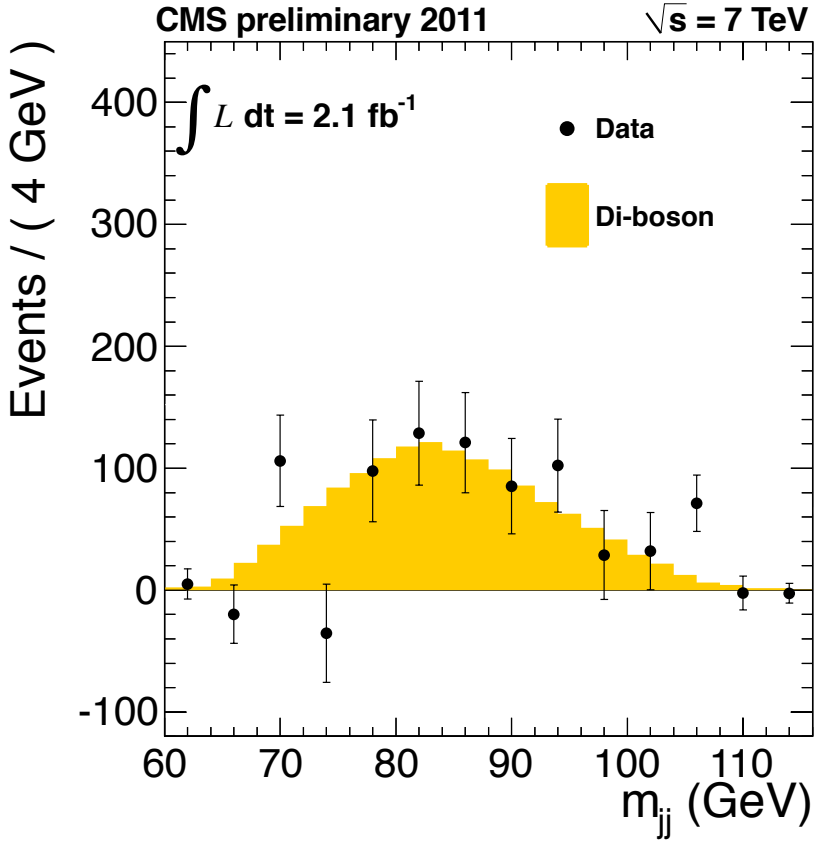
With anti b-tag we lose a fraction of signal (~10%, all WZ) and W+jets (~6% is heavy flavor) and top backgrounds (~50% because b-tag eff ≈ 70%). The diboson uncertainty doesn't improve. Additional uncertainty from b-tag efficiency.

2-jet sample: after background subtraction

No anti b-tag



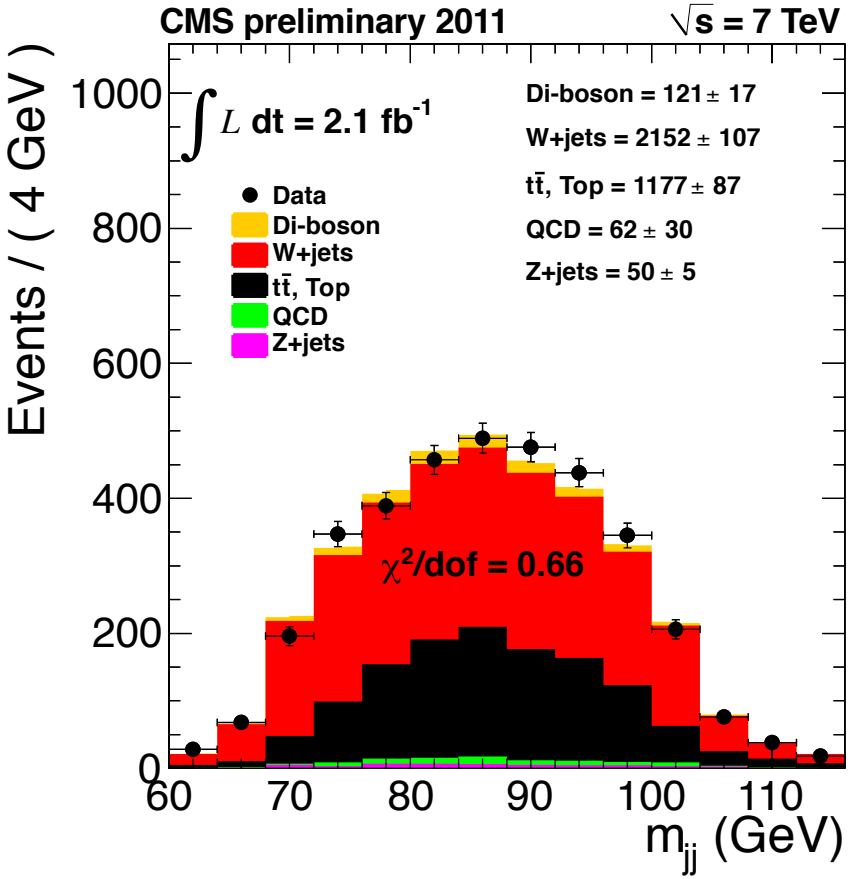
Anti b-tag



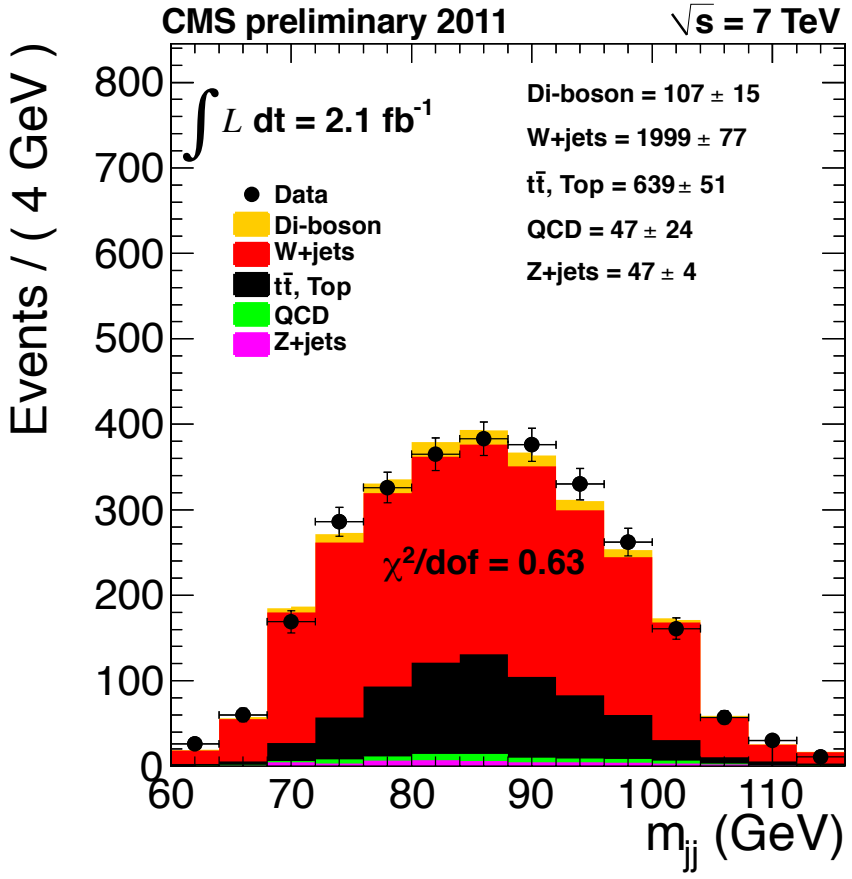
Requiring the two jets to be anti b-tagged improves S/B. However, one has to correct for b-tagging data/MC scale factors (which depend on nJets, nTags, and jet p_T) and incur additional systematics.

3-jet sample: fit results

No anti b-tag



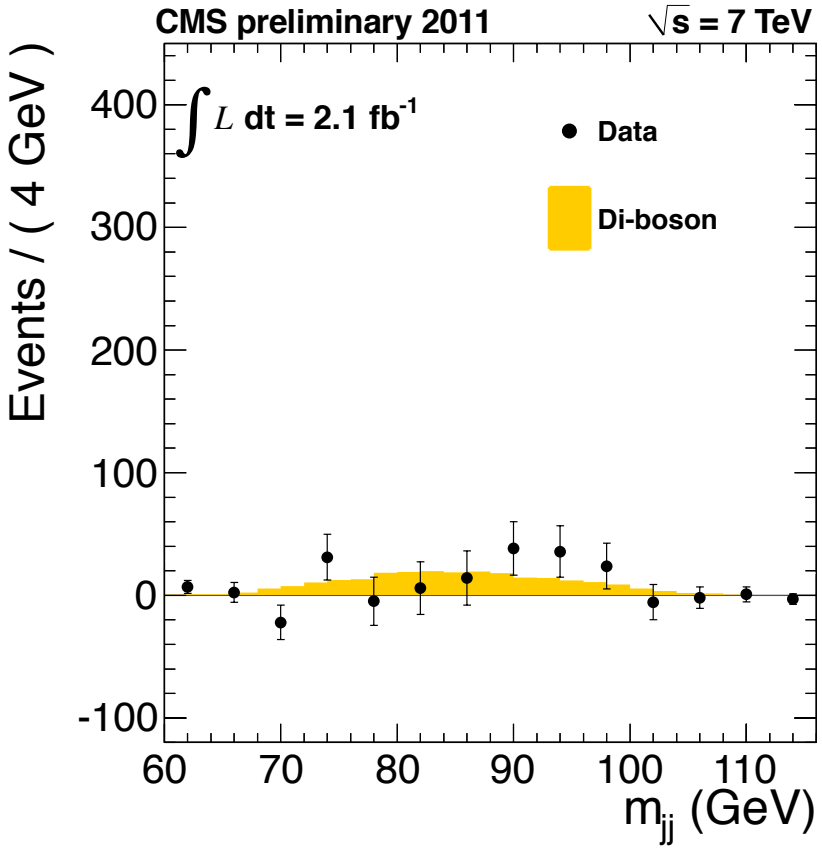
Anti b-tag



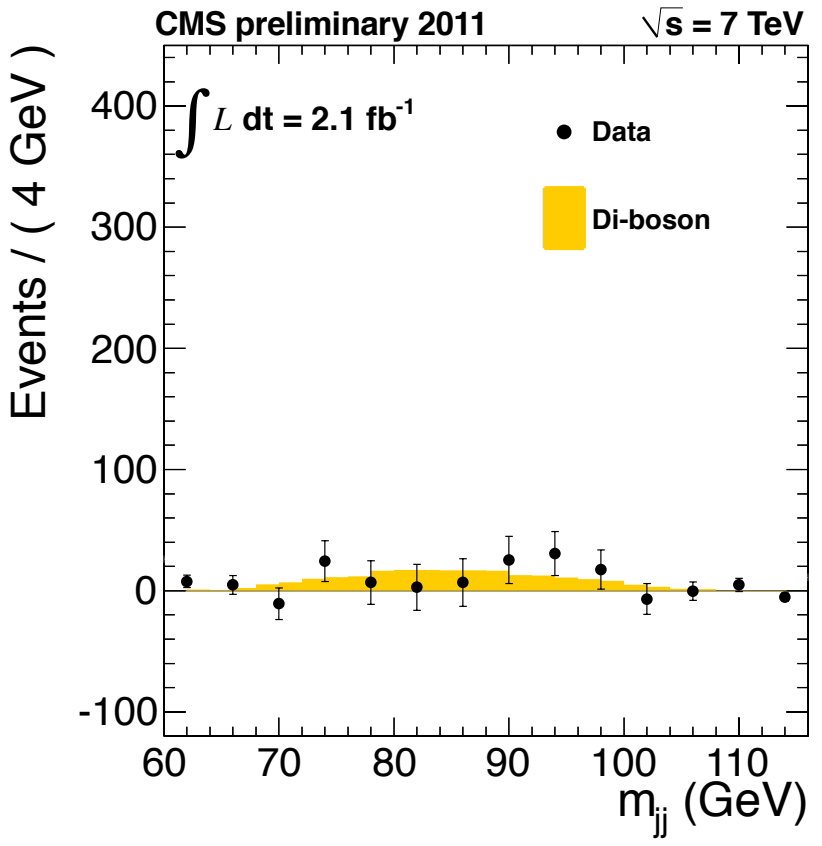
The same conclusion as before. The diboson uncertainty doesn't improve.

3-jet sample: after background subtraction

No anti b-tag

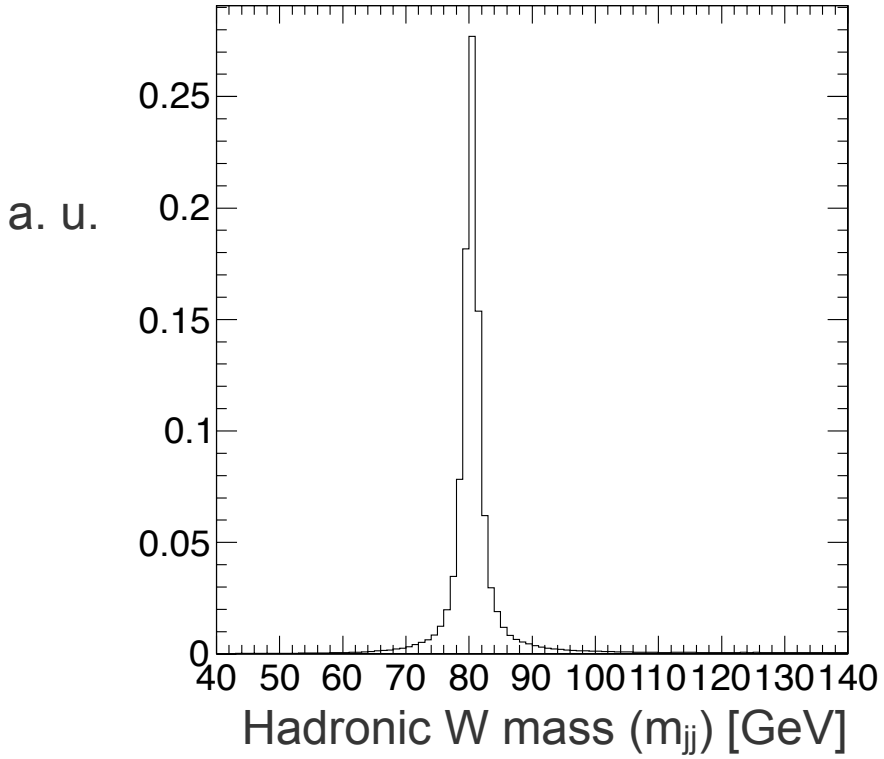


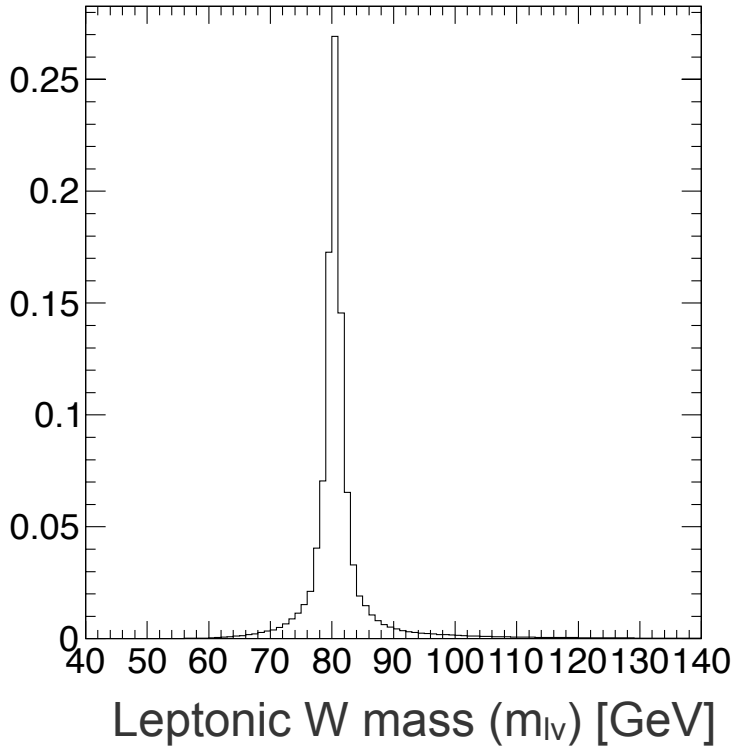
Anti b-tag



Diboson lineshape

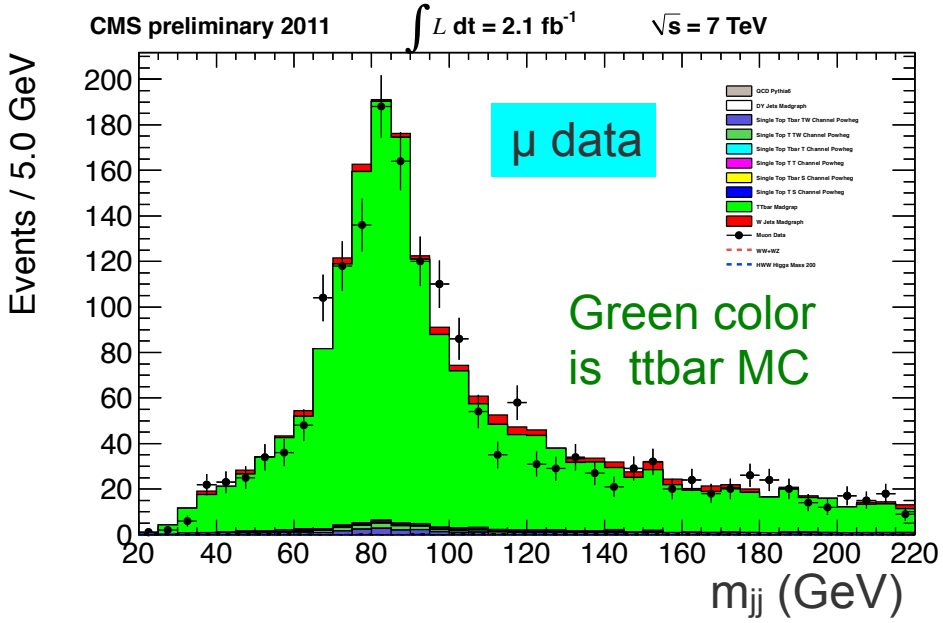
In order to get NLO shapes, we generated diboson samples using MCFM. But diboson m_{jj} shape is almost a delta function. Smearing this by detector resolution will get us a Gaussian shape which is not good. Need to explore some data driven shape.

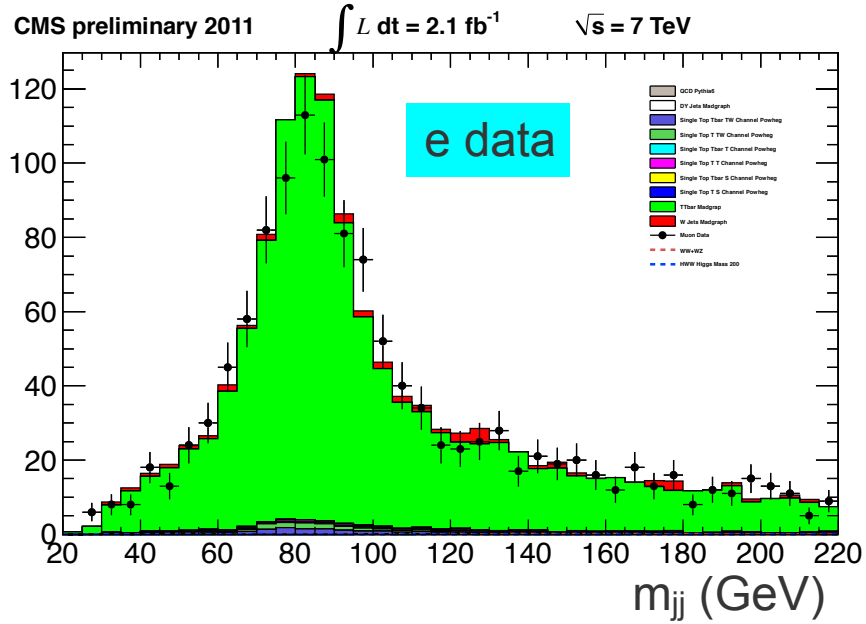




So far used top events for JES/JER

Can try to use the same hadronic W shape for template (caveats later).

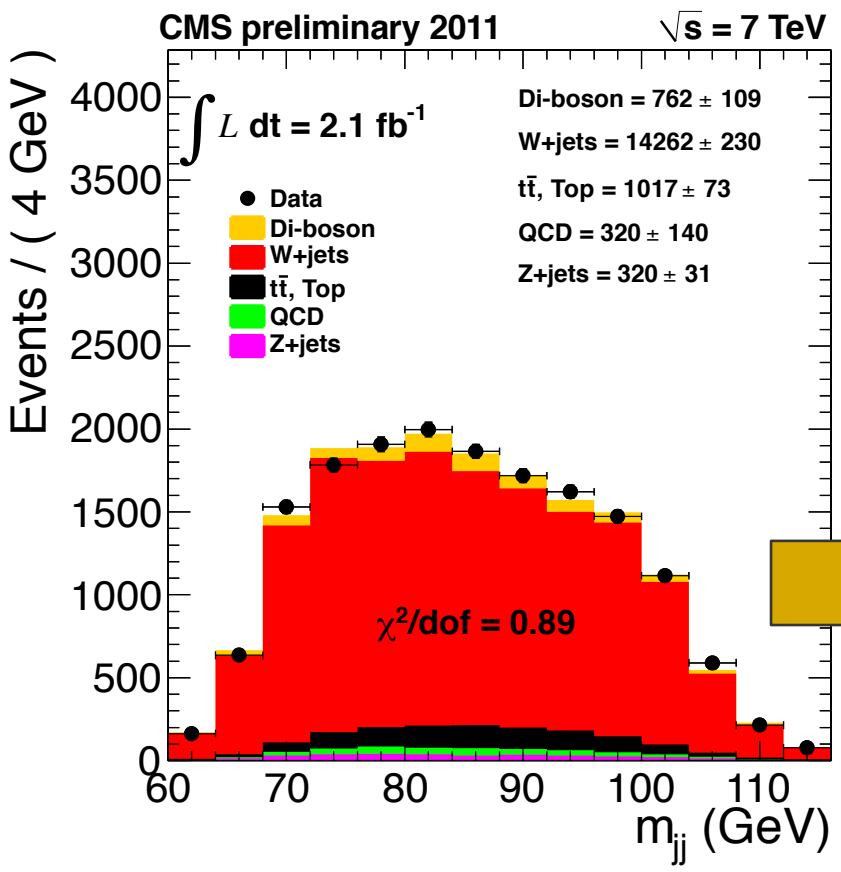




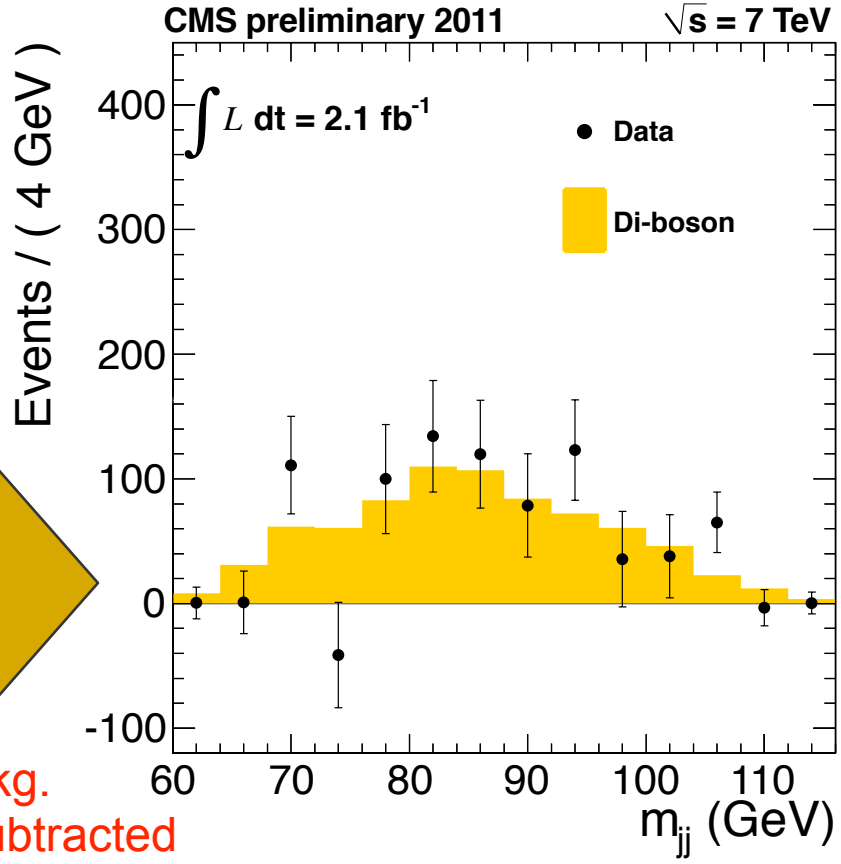
- Require exactly 4 jets, 2 b-tags (SSV-HE-M), and a leptonic W.
- Then plot m_{jj} of the two non b-tagged jets.
- The jet energy scale and resolution in data and MC match very well for these pure hadronic W events.

2-jet sample: fit using diboson shape from data

The shape works fine. The result is essentially identical to the one obtained using MC template (slides 3−4). The data statistics hurt.

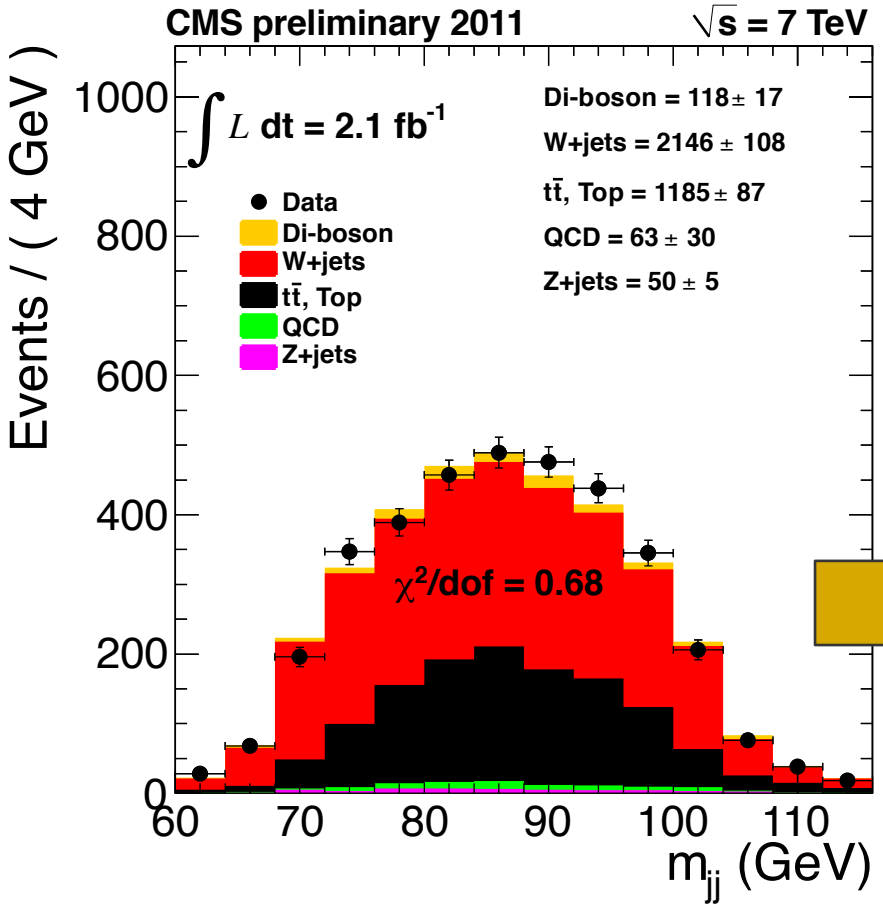


Bkg. subtracted

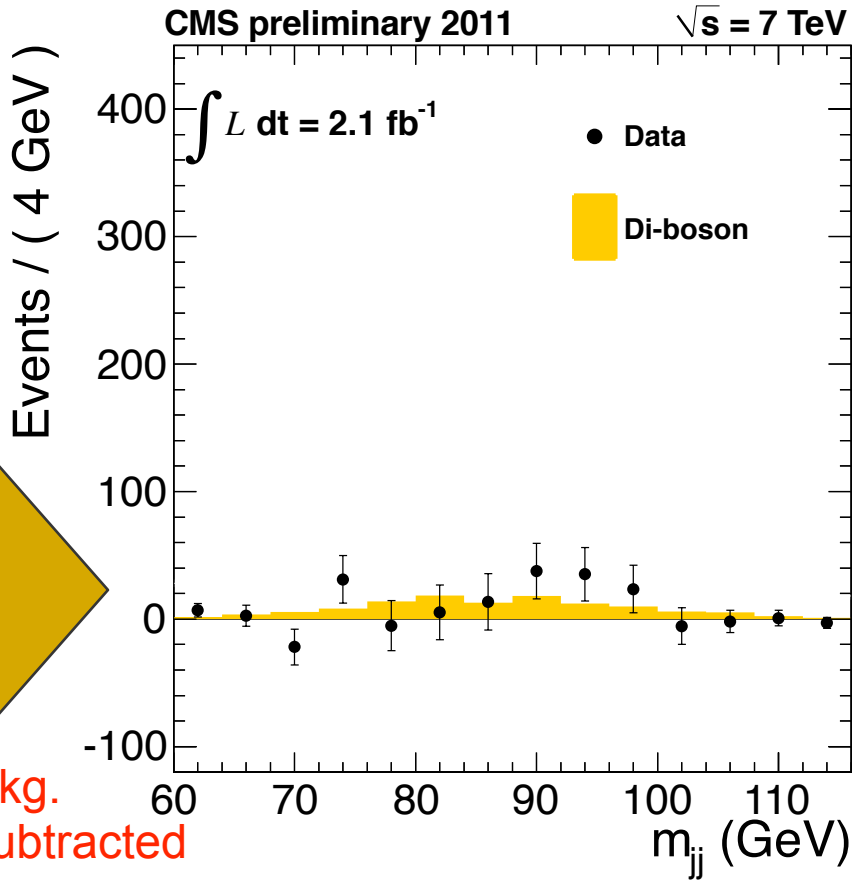


3-jet sample: fit using diboson shape from data

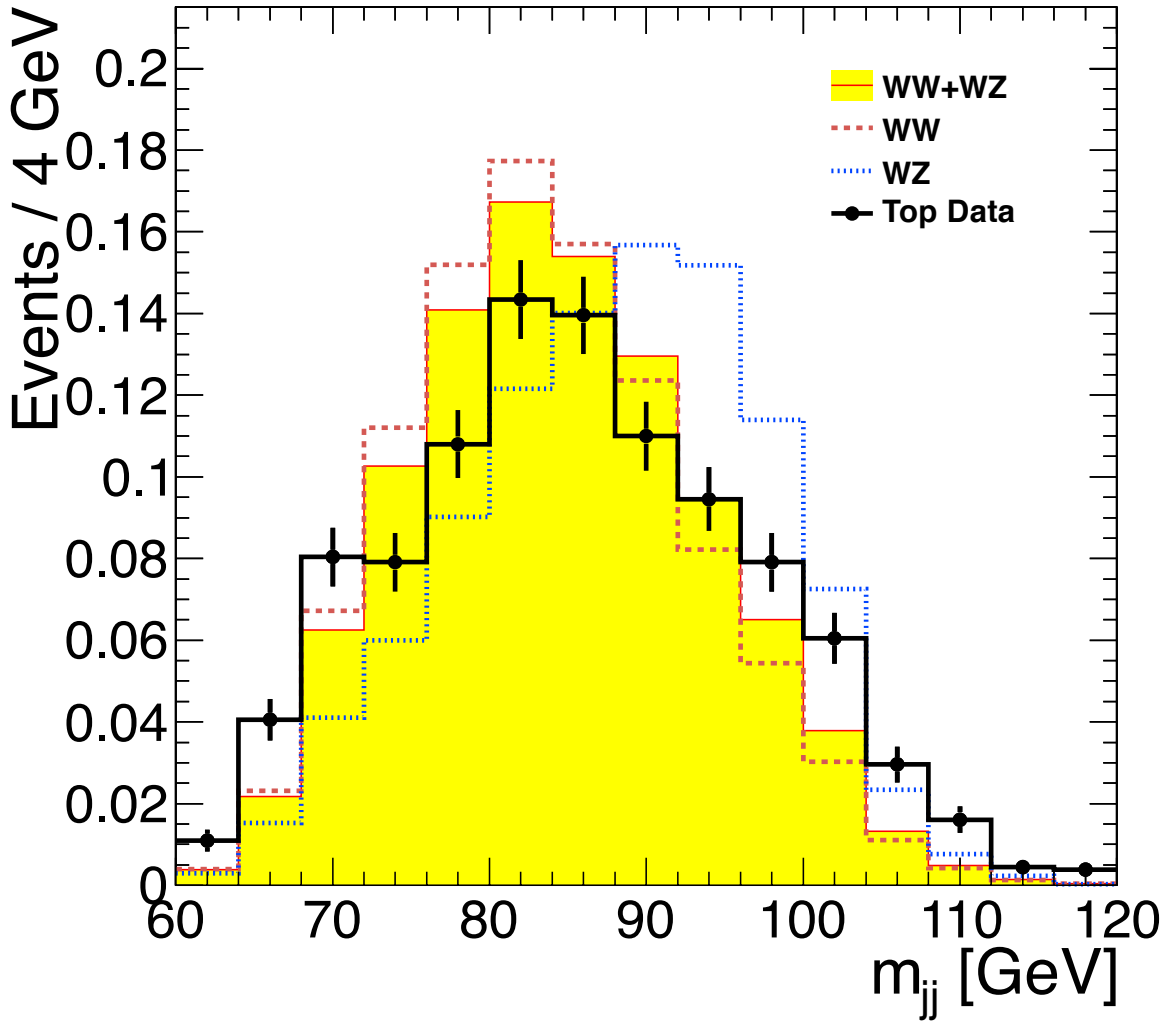
The shape works fine again. The result is essentially identical to the one obtained using MC template (slides 5−6). The data statistics hurt badly.



Bkg. subtracted



Comparison of data and MC templates (2-jet)



There are caveats in using hadronic W shape from top:

- Only hadronic W, no hadronic Z. The two shapes have minor differences although we cannot resolve between them given JER.

- Top events have extra b jets that change the event topology somewhat. For example, the hadronic W p_T would be different.

I conclude that the result doesn't depend on choice of diboson shape (within reason) and we should stick with the MC shape.

Status on documentation

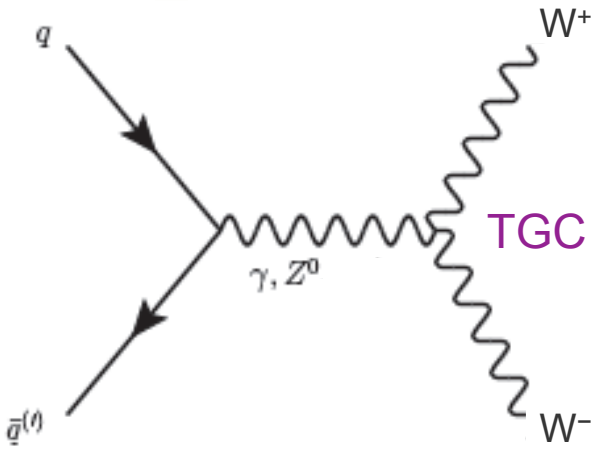
We have been working on documenting the analysis (updating plots/ results/verbiage) and finalizing the remaining systematics (e.g., account for trigger difference in data, correction for lepton selection efficiency data/MC scale factors, MET resolution etc.).

We expect to have a complete documentation of the analysis (using 2.1 fb^{-1}) ready for review in the next 10 days to two weeks time.

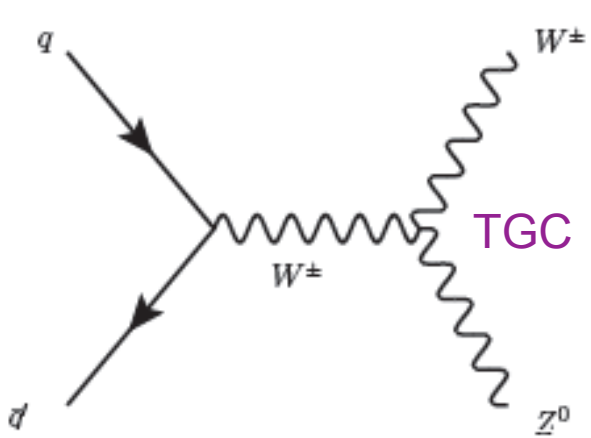
BACKUP SLIDES

Diboson production at LHC

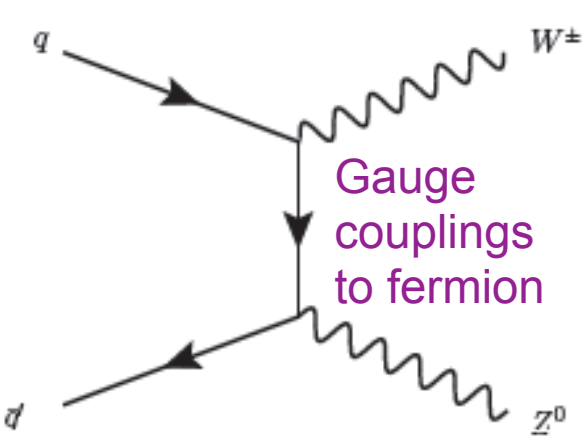
at Leading Order in α_S



s-channel WW production



s-channel WZ production



t-channel WW, WZ production

Some quick Observations

1. In standard model, the s- and t-channel diagrams are both divergent but when combined together divergencies cancel out miraculously. Sensitive to gauge coupling.

2. Because of qqbar initial state the production rate at LHC is only ~ 3x Tevatron.

3. One W or Z decays hadronically. Although W and Z boson masses differ by 10 GeV the dijet mass resolution is ~ 10 GeV ➜ cannot distinguish between WW and WZ.

Diboson production mechanism at NLO