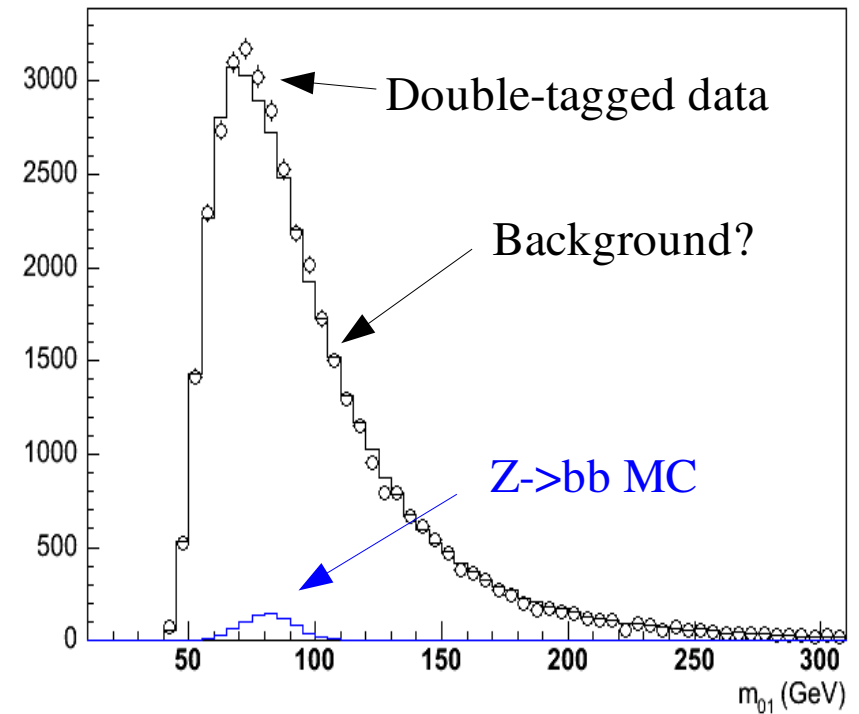


$Z \rightarrow bb$ Studies / Overview

- *Objective:*
Find a good way of determining the background to $Z \rightarrow bb$.
Must be determined from data!
- *Last week:*
 - *reviewed the TRF method*
 - *showed results from the full Pass2 data set*
 - *showed some MC checks of the TRF method*
- *This week:*
 - *Try the CDF method*
 - *Try a new variant of the CDF method*



We're trying to pull a signal out of a HUGE background with low systematics... !!!

A Heavy 2-jet Dataset

- I'm playing around with the following dataset:
 - “*BID*” skim – *PASS2*
 - Loose mu, $p_T > 4 \text{ GeV}$
 - Matched to *JCCB* jet, $d\mathcal{R} < .7$
 - *JES* 5.3 (results shown include mu corrections)
 - 90M events -> *higgs_multijet* rootuples
 - ~300/pb ?
 - Many triggers are overlapped
- *MC: Pass2* ->
 - ~200k *Z*->*bb*
 - ~200k *bb* (direct- *Pythia*, $p_T > 40 \text{ GeV}$)

This skim is really big!
(Loose mu -> medium mu) is bad for us!
I propose we make our own skim:

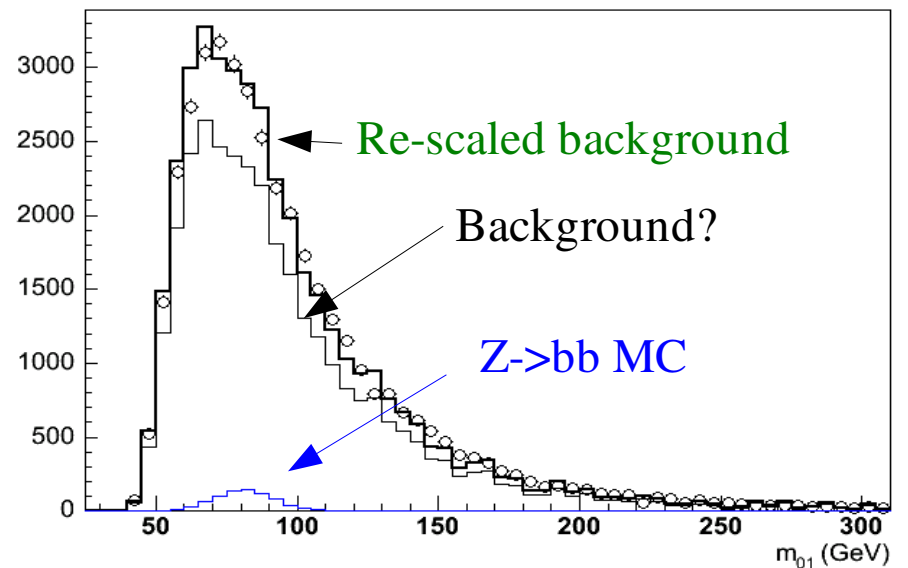
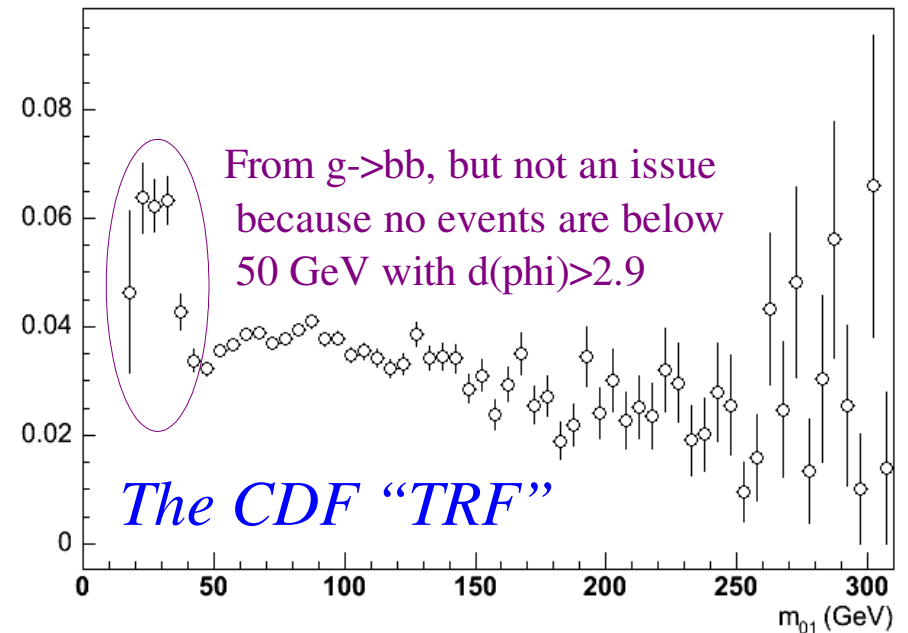
- no mu requirement
- 2 jets > 15 GeV,
- not more than 2 jets

* Cuts:

- * Good Lum Block
- * Jet Quality Cuts
- * Taggable jets
- * Exactly 2 good, taggable, jets with (corrected) $p_T > 20 \text{ GeV}$
- * Good primary vertex (≥ 4 tracks)
- * Often separate by $d(\phi)$ of the jets, $> < 2.9$
- * I use SVT Loose b-id

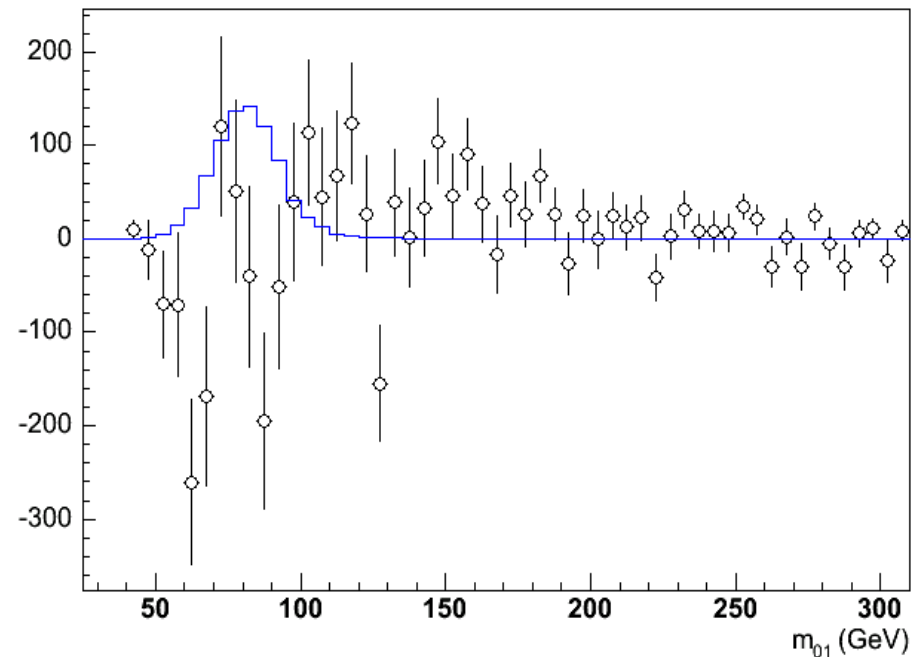
The CDF Method

- Look at the ratio of single-tag to double-tag events as a function of inv. mass
 - Do this in the “control data set”, which contains events failing final analysis cuts
 - I use dijet events, but take $d(\phi) < 2.9$
- Then apply this “TRF” back to the single-tag data sample in $d(\phi) > 2.9$
 - You get too few events expected as background!
 - The normalization is off by ~15%: There is more bb in $d(\phi) > 2.9$ than in $d(\phi) < 2.9$, so the average tag rate is higher?
- After a re-scaling, the background looks a lot like the data
 - But background statistics are very poor using this method



The CDF Method (cont.)

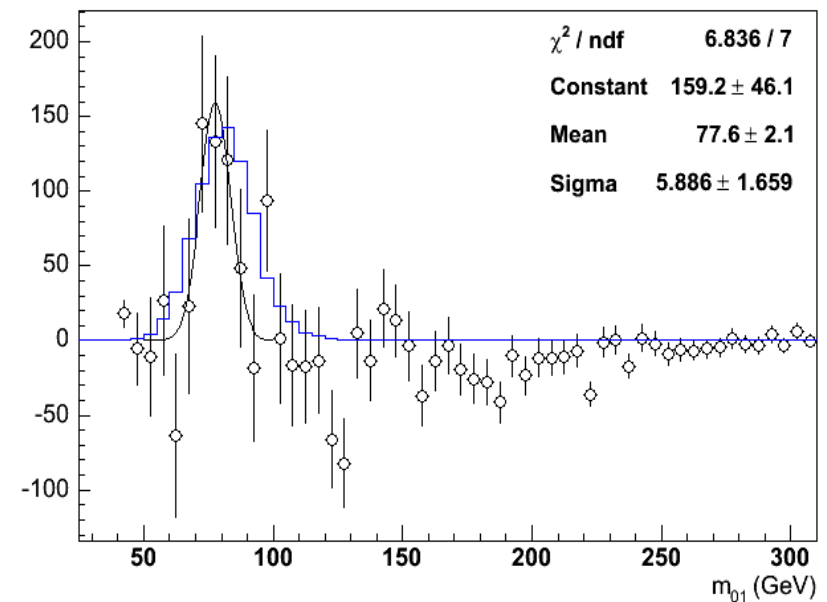
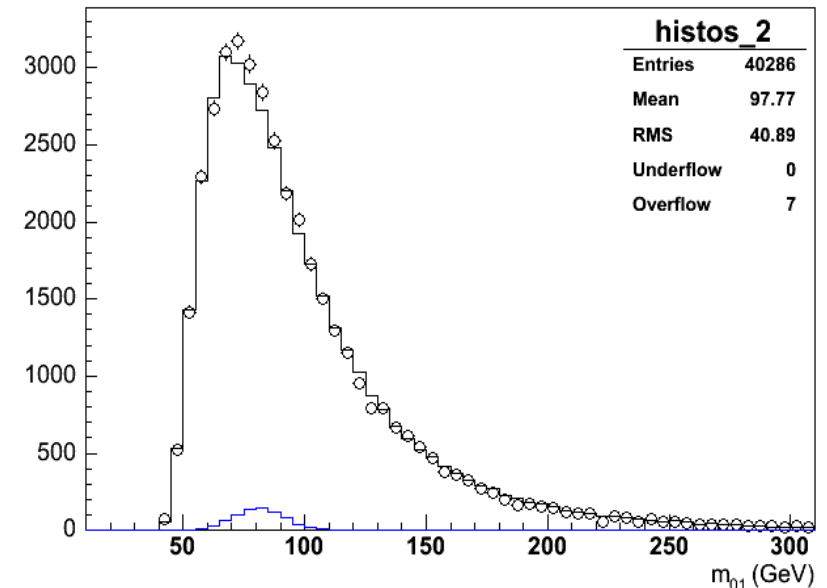
- The resulting difference between data and background (even after the re-scaling) shows little resemblance to the expected MC $Z \rightarrow bb$ peak
- There is a clear shift of data towards higher masses
 - A possible explanation is the re-scaling, which is done to account for less bb in the $d(\phi) < 2.9$ sample. If the shapes of bb and “QCD” are not identical, then a shift could occur. We saw this already when comparing the 0-1 tag spectrum with the 1-2 tag ...
- The $Z \rightarrow bb$ in the $d(\phi) < 2.9$ sample was not accounted for
 - There should be less than in the $d(\phi) > 2.9$ sample, but we scaled it up when we had to re-scale the background!



Difference between data and background using the CDF method... hmmm. :)

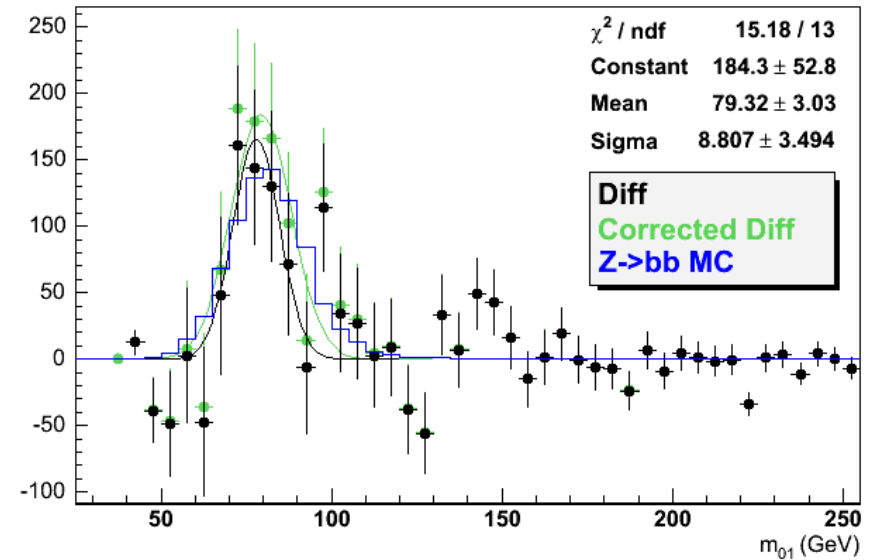
A Modified CDF Method

- The real trouble with the CDF Method is that the $d(\phi) < 2.9$ sample is very different from the $d(\phi) > 2.9$ sample
- Try getting the “TRF” from the $d(\phi) > 2.9$ sample, but use 0- \rightarrow 1 tag data
 - The background still has to be re-scaled, to the integral of the 2-tag data
- The resulting diff between data and background looks a lot like the MC $Z \rightarrow b\bar{b}$
 - Statistics of background are very good, since there's lots of 0-tag events
 - There's less shift in inv. mass since the shift from 0- \rightarrow 1 is already applied when using the “TRF” to go from 1- \rightarrow 2 tags
 - There is not as much interference from $Z \rightarrow b\bar{b}$ in the “TRF” since the 1-tag sample has very little (compared to the 2-tag $d(\phi) < 2.9$ sample)



Summary

- *Several background estimation methods have been compared*
- *I think the basic CDF method has serious flaws*
 - *A variant of it using the 0-1 tag data in the same $d(\phi)$ and N_{jets} ranges has some hope*
- *The TRF method makes the fewest assumptions and has the most statistical power, but is certainly the most complicated*
- *We need to come up with a smarter skim for $Z \rightarrow bb$...*
- *We should also take a look at our new triggers and make sure that they allow us to compute the $Z \rightarrow bb$ background without added bias*
 - *We may need a large and unbiased, untagged data sample! :)*



Resulting $Z \rightarrow bb$ peak using the TRF method... derived last week