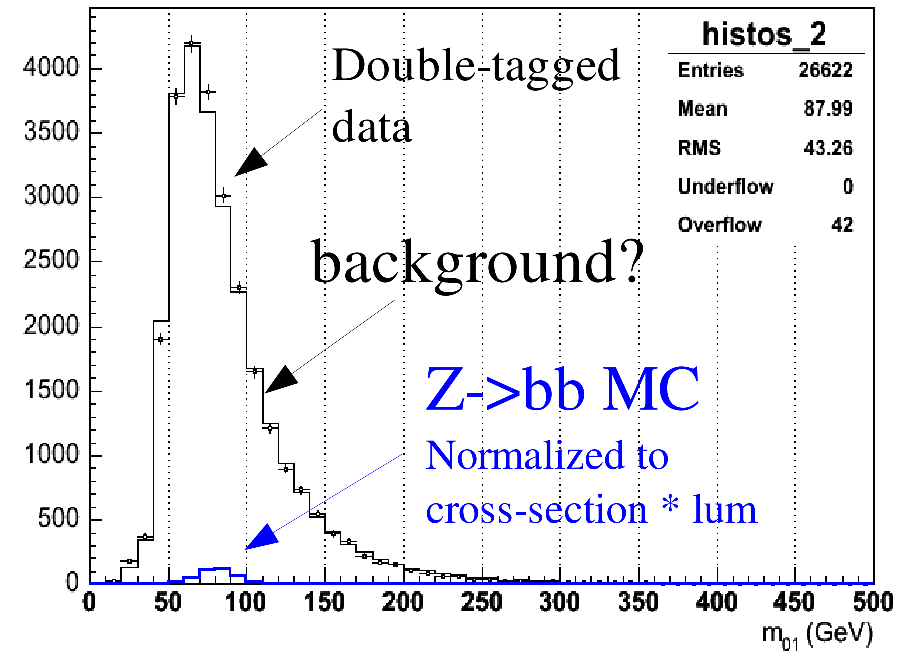
Z->bb Studies / Overview

- *Objective:*
  Find a good way of determining the background to Z->bb.
  Must be determined from data!
- *Last week:*
  - *reviewed the TRF method*
  - *compared peak in d(phi)>2.9 to <2.9*
  - *tested it on some Pass2 data (100/pb)*
  - *showed a sneak peak of the full Pass2 data set (no pun intended!)*
- *This week:*
  - *Full Pass2 data set*
  - *Some cross checks with MC samples*
  - *Cross-check with 0-1 tag TRF*



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

A Heavy 2-jet Dataset

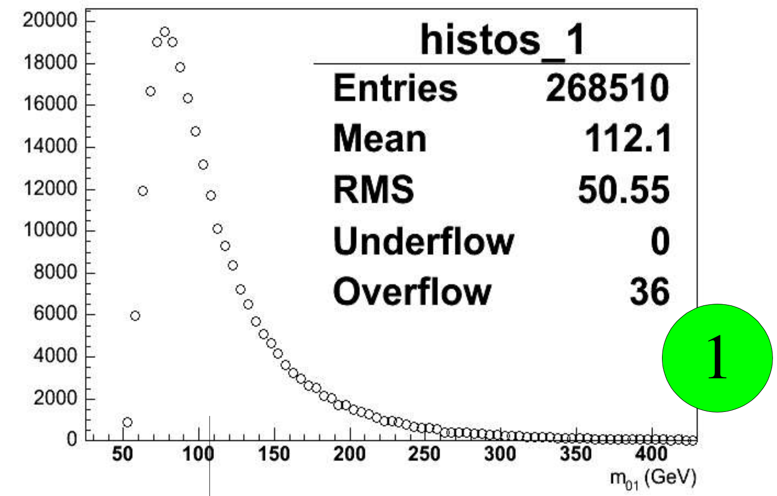
- I'm playing around with the following dataset:
  - "BID" skim – PASS2
    - Loose mu, pT > 4 GeV
    - Matched to JCCB jet, dR < .7
  - JES 5.3 (results shown include mu corrections)
  - 90M events -> higgs_multijet rootuples
  - ~300/pb ?
  - Many triggers are overlapped

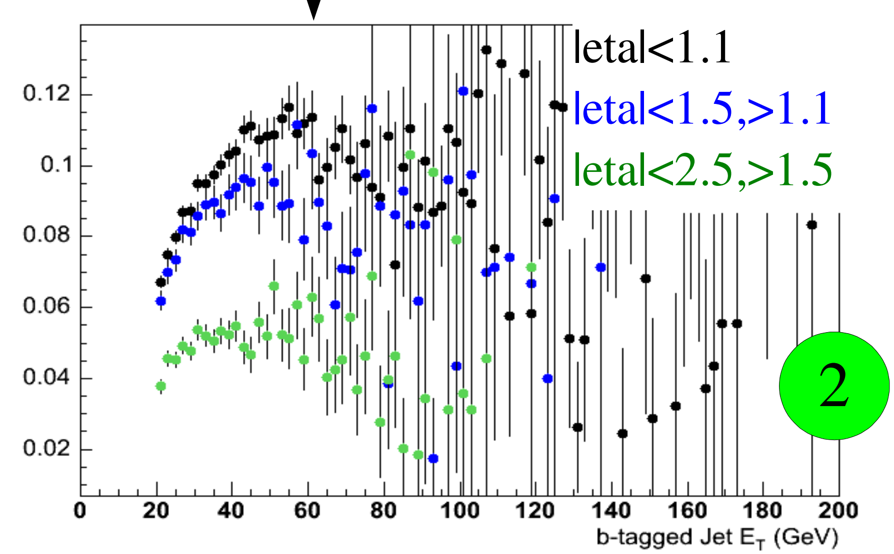
- MC: Pass2 ->
  - ~200k Z->bb
  - ~200k bb (direct- Pythia, pT>40GeV)

- **Cuts:**
  - No Bad Lum Block
  - Jet Quality Cuts
  - Taggable jets
  - Exactly 2 good, taggable, jets with (corrected) pT>20 GeV
  - Good primary vertex (>=4 tracks)
  - Often separate by d(phi) of the jets, >< 2.9

A TRF-based Method

1. *Select a di-jet data sample with a leading b-tag and d(phi)>2.9*
2. *Calculate the TRF :*
   prob. to tag the second jet,
   as a func. of pT, 3 eta regions
3. *Apply the TRF back to the same single-tag sample*



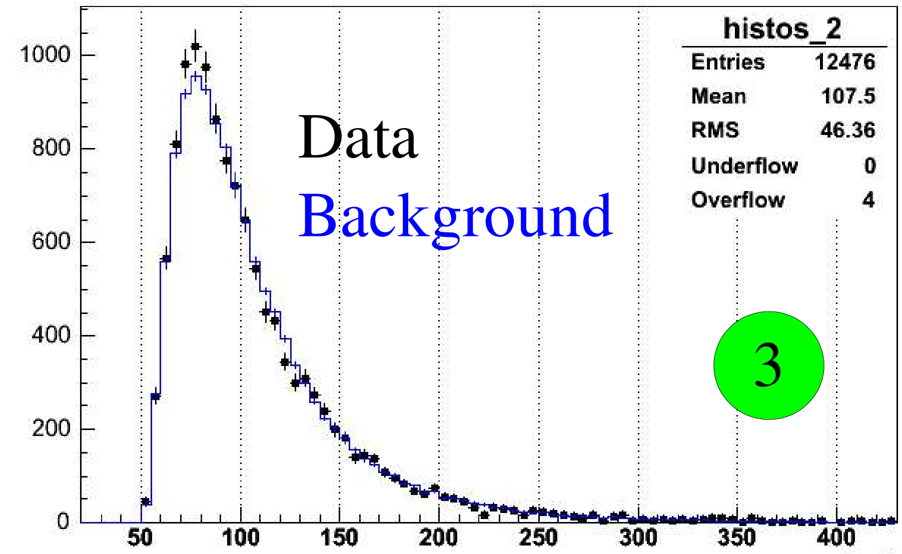


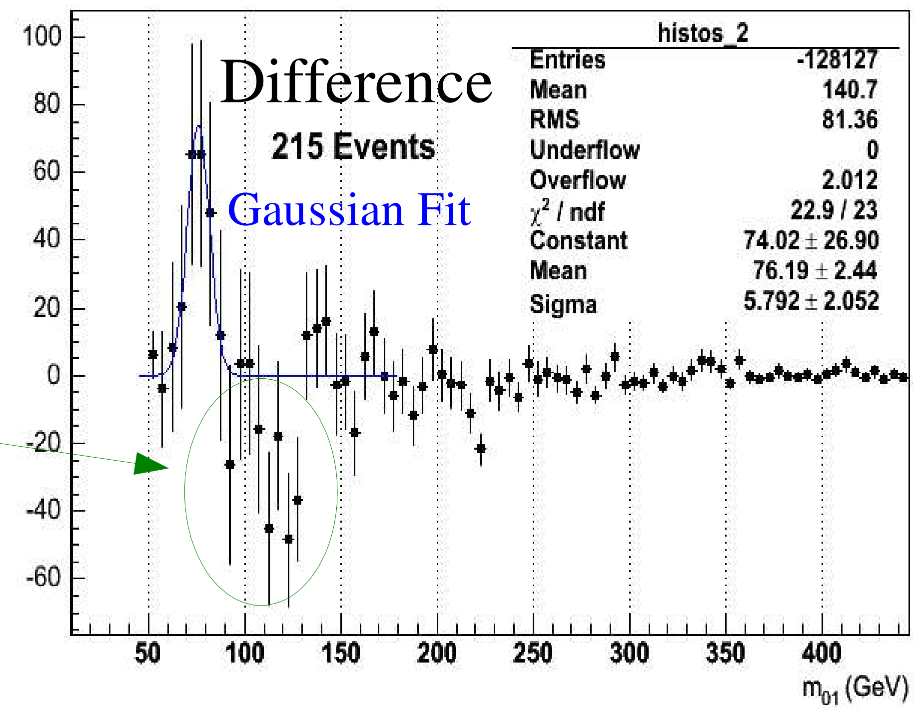
and then make these corrections (discussed later…)

4. *Correct TRF for Z in single-tag sample*
5. *Compare to d(phi)<2.9 sample*
6. *Compare to shift from 0->1 tag sample*

TRF Method (cont.)

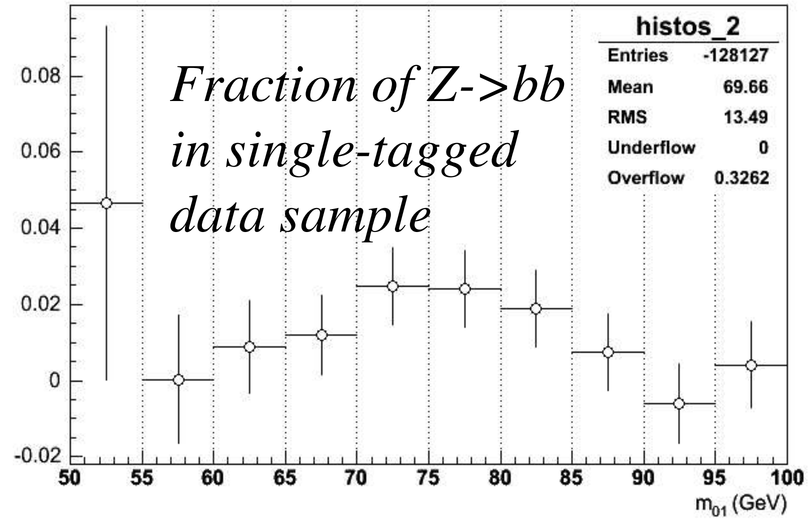
- What were the assumptions?
  - There's no Z->bb in the single-tag sample
    - Wrong, but we can correct for this!
    - Use measured Z-peak to remove its contribution from the original TRFs
    - Turns out to be a small correction
  - Inv. mass spectrum of the cc/bb background is the same as that of the light QCD background
    - This depletion indicates a shift
    - We can correct for this by:
      - comparing to the d(phi)<2.9 data sample
      - looking at the shift from the 0->1 tag spectra in data

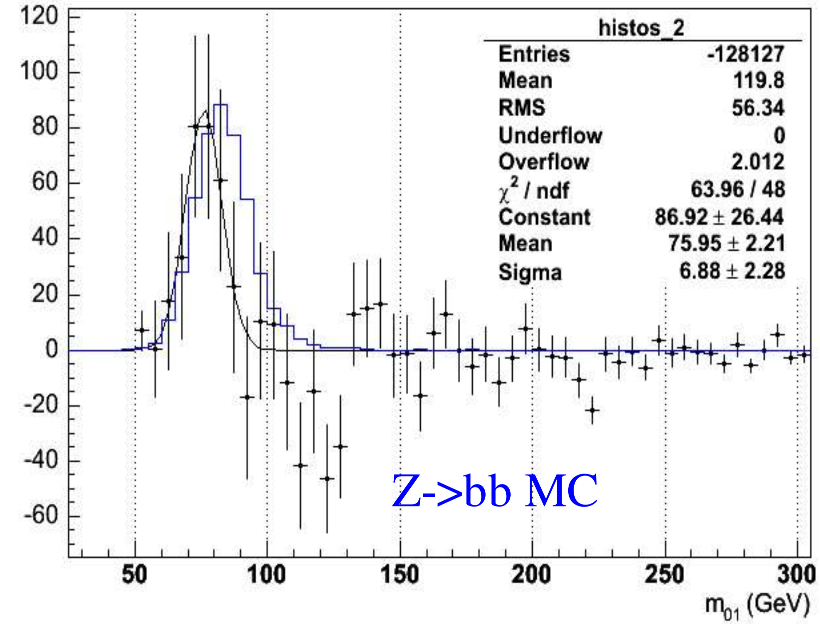




Z TRF Correction

- *Initial Z peak measured in data*
- *Get ratio of Z peak size in single/double-tag Z->bb MC (~6.5)*
- *Scale initial Z peak back to the amount of Z->bb expected in the single-tagged data*
- *Re-calculate the TRF after subtracting expected single-tagged Z peak from the single-tagged data*
- *Re-apply the new TRF to the single-tagged data*
- *The peak is not shifted very much*
  - *This is confirmed by following MC simulations of this correction*





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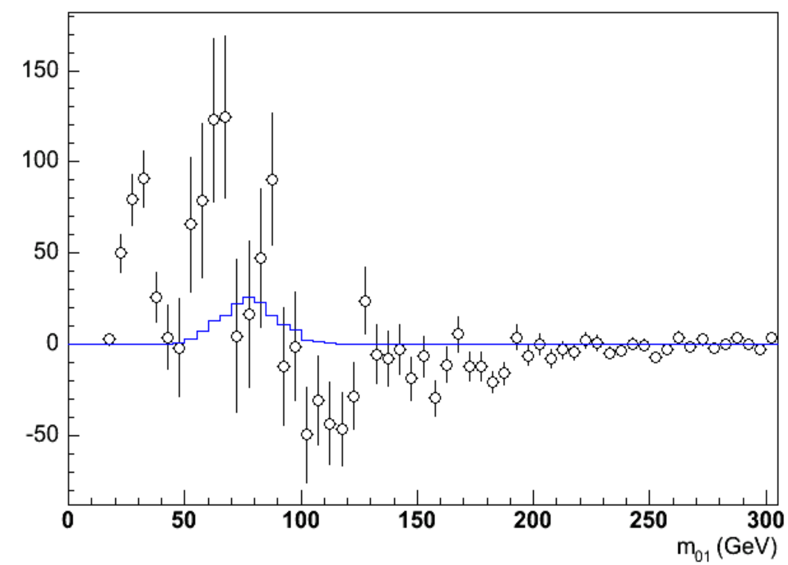
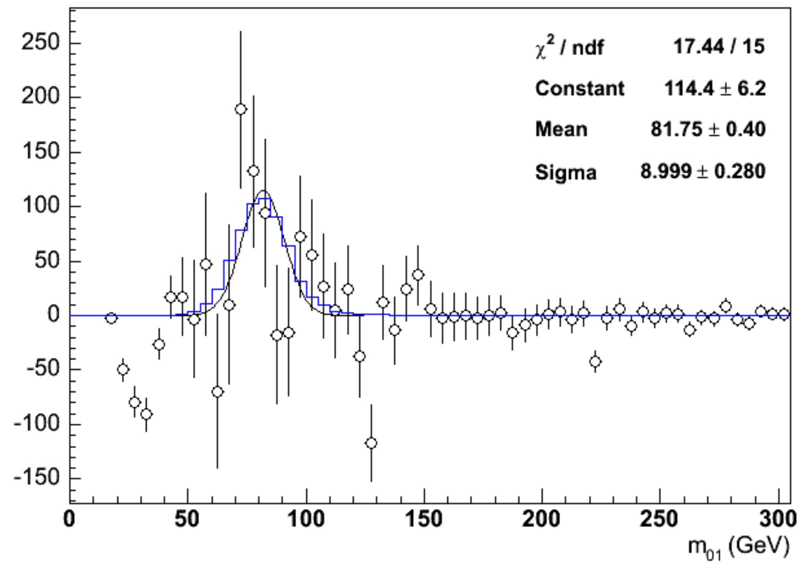
Comparison to d(phi)<2.9 Data

- There is less Z->bb (lower S/B) in d(phi)<2.9 data
  - Z->bb peak should be smaller
  - Background effects, like from differences in the bb/cc vs. QCD inv. mass spectrum, should not be reduced

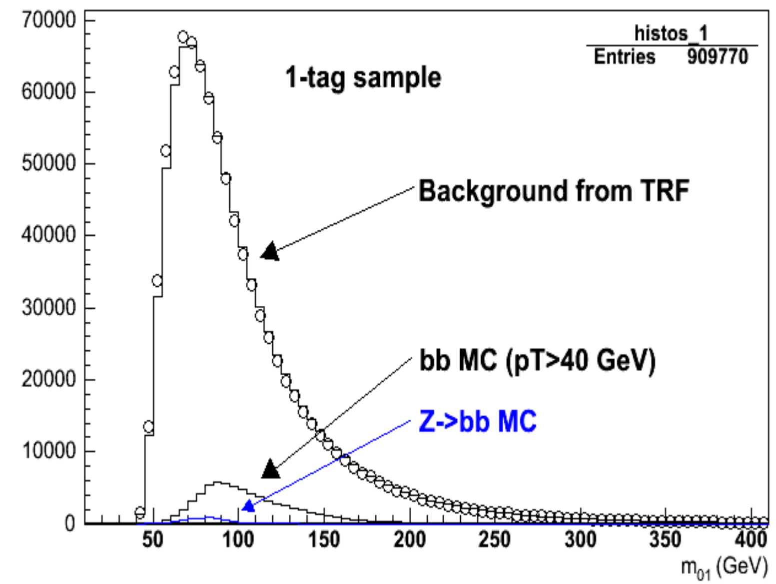


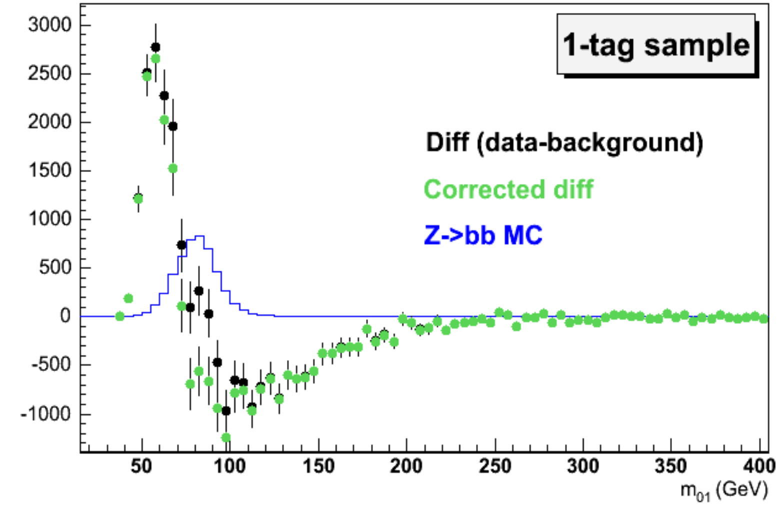
- We can use the difference in shape between the d(phi)><2.9 cut to correct for background biases…
  - This is the difference between the two d(phi) cuts
  - The result is still consistent with Z->bb MC
  - But statistics aren't great this way… since we subtracted off Z->bb signal!



0->1 Tag Invariant Mass Spectra

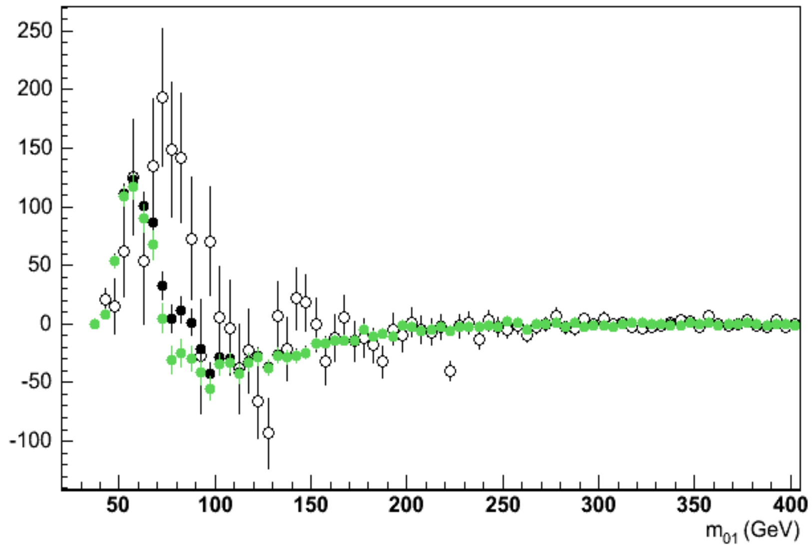
- *Investigate the single b-tagged data sample*
  - *Not much contamination from Z->bb there*
  - *Much less bb there as well*
    - *Compare to slide 9: 10% bb, instead of 50%*
    - *Starts out around 1% in untagged data*
    - *Each b-tag application increases bb/QCD by about a factor of ~5-10*
- *Background from "random" tagging can be estimated in the same way as for 1->2 tags*
  - *Calculate a TRF, derived on the 0-tag sample*
  - *Apply to the 0-tag sample*
- *The difference shows the same behavior as the bias we saw before in the 1->2 tag TRF comparison*
  - *This is not due to Z->bb, which would be small*

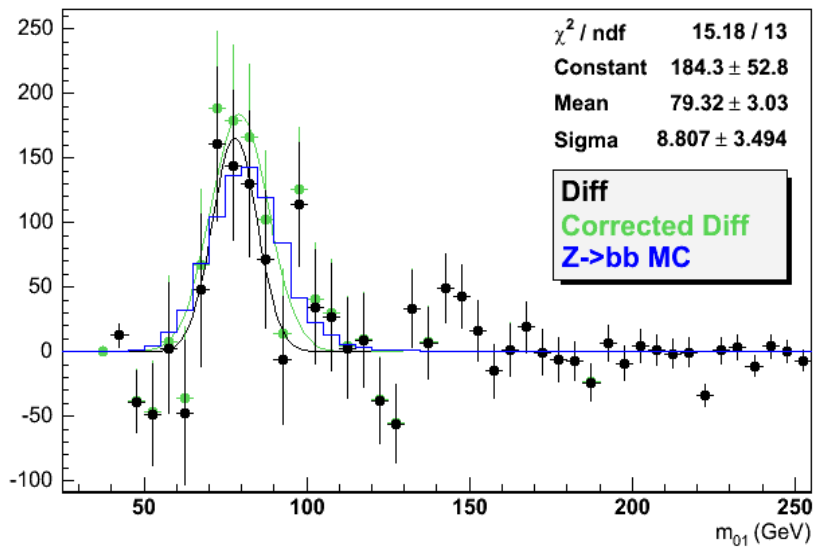




Subtracting the 0->1 Tag Spectrum

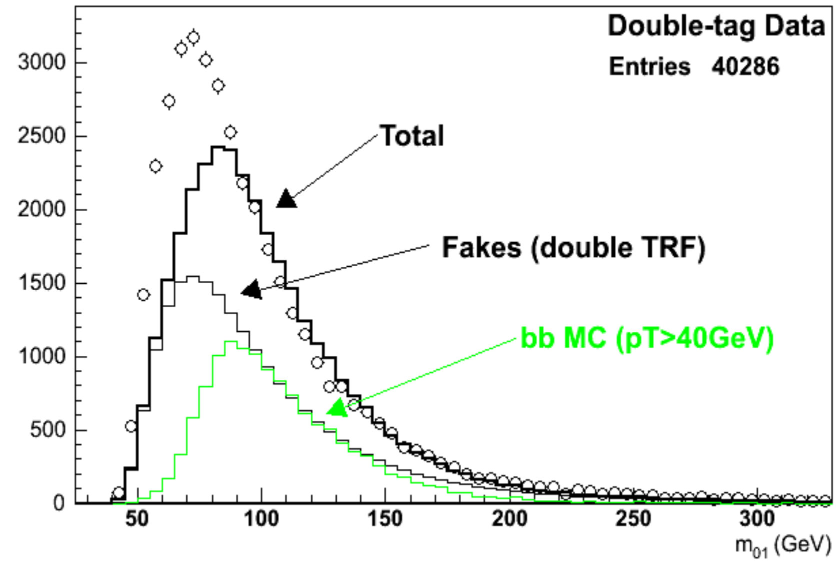
- *We actually used this fact to correct the background to Z->bb in the past! (see my ADM talk of May. '03)*
- *Compare:*
  - *0->1 tag difference (solid circles) (scaled to the number of 2-tag / 1-tag events)*
  - *0->1 tag difference correcting for Z->bb in single-tag sample using MC (scaled to the number of 2-tag / 1-tag events)*
  - *The 1->2 tag difference (open circles)*
- *The real Z->bb peak is the difference between the 1->2 tag difference and the 0->1 tag difference...*
  - *Resulting fit is consistent with MC, within statistical errors!*

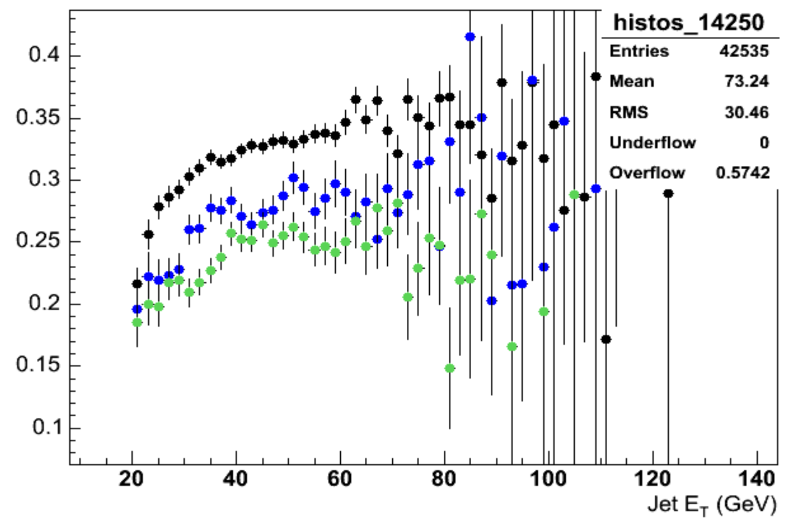




MC Cross-checks

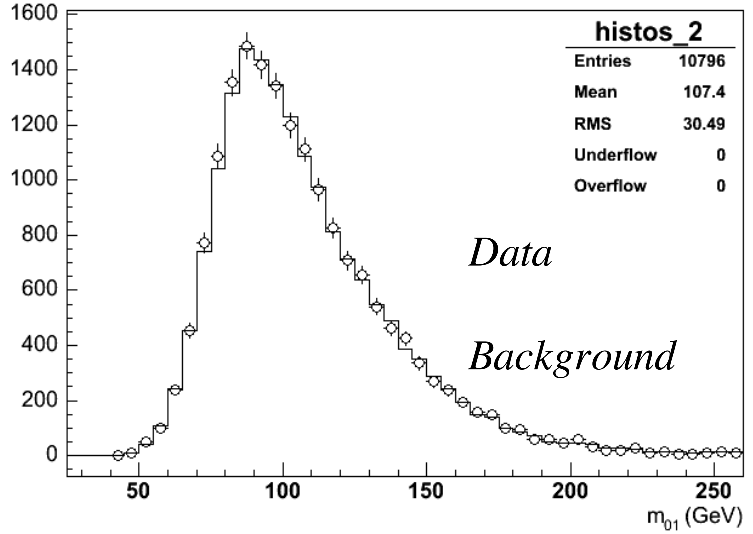
- Suyong made a very good suggestion last week that we try to test the method on MC samples
  - This is slightly difficult, because large statistics of QCD MC are not available (we would need ~1 million events)
- First investigate what the bb MC looks like:
  - The effect of the pT>40 GeV parton cut is clearly seen
  - Basic shape and normalization look good
- Calculate the bb MC TRF (for the 3 eta regions)

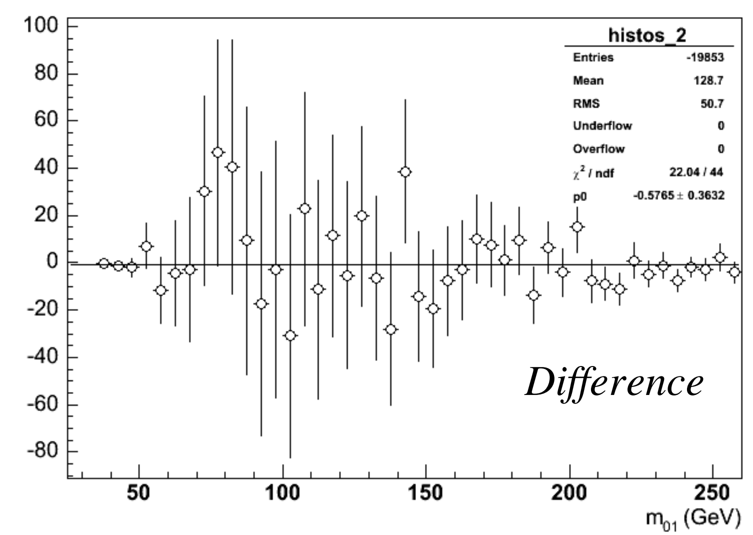




MC Cross-checks

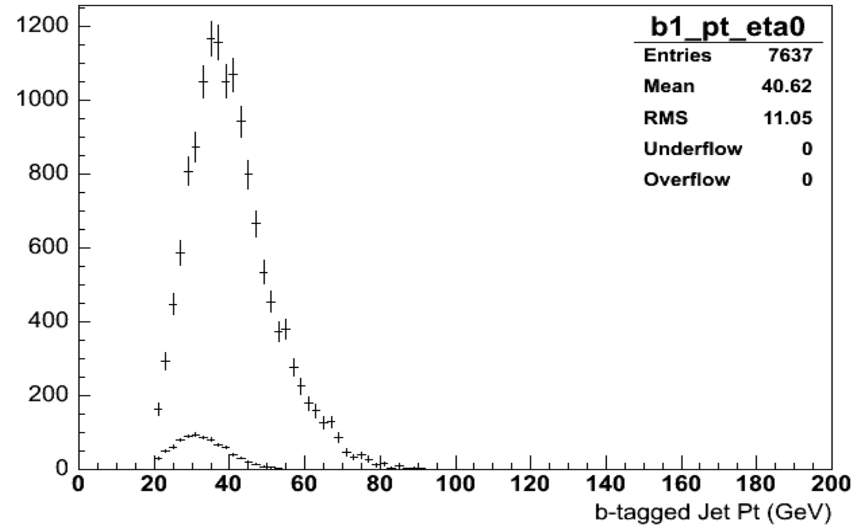
- *Apply the TRF back to the bb MC*
- *We get back the same thing (within statistical errors)*
- *OK, so at least there's no big bug in the TRF code! :)*

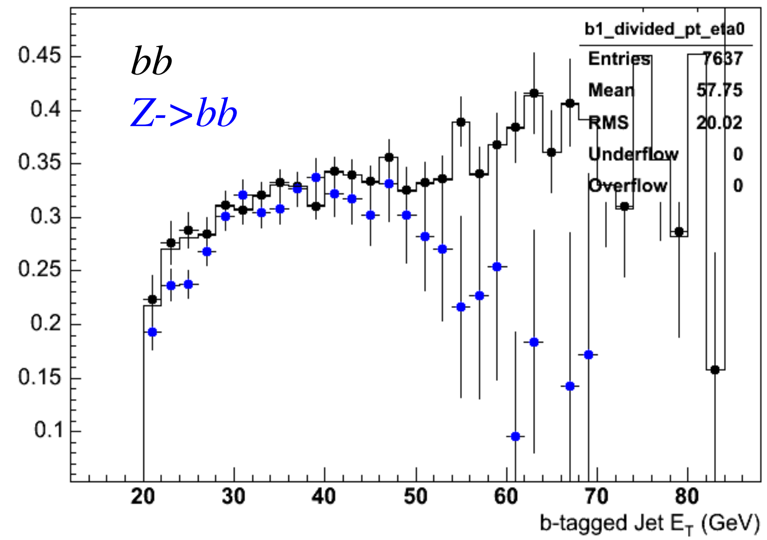




MC Cross-checks

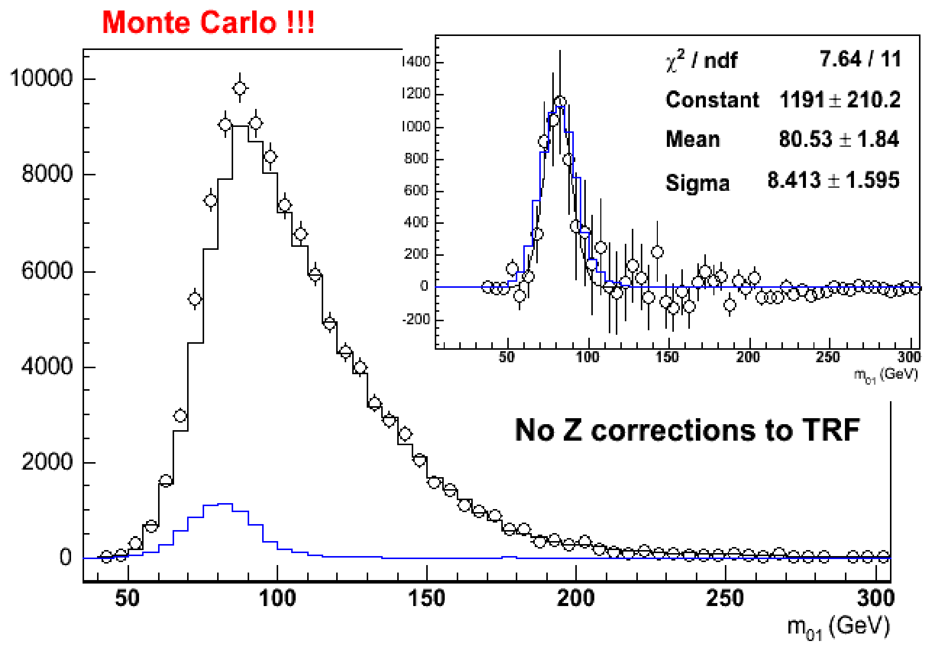
- We want to test the Z->bb TRF correction...
- Look at the pT spectra of the b-jets in bb vs. Z->bb events
  - Note how Z->bb influences mostly lower pT jets, as expected
- Calculate the TRF for the Z->bb
  - Compared to the bb, it's very similar (the plot is for the |eta|<1.1 TRF)
  - There are differences for jets far from the Z peak... weird events?



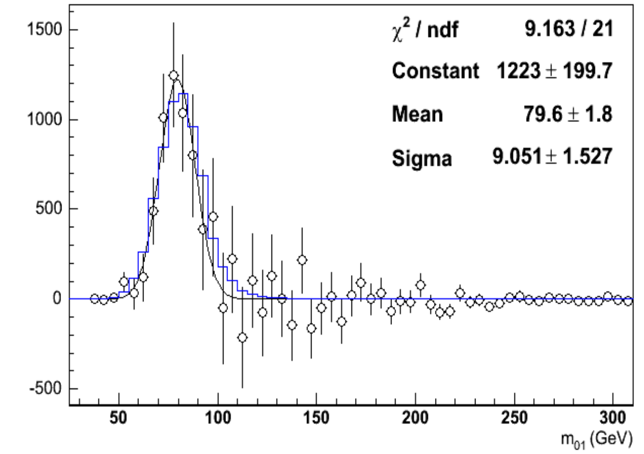


MC Cross-checks

- *Here's the simulated data (points), made from Z->bb plus the bb.*
- *Background is calculated from* *bb scaled six times + Z->bb* *without the Z TRF correction*
  - *We scale the bb by six to simulate the ratio of "QCD" to Z->bb in the single-tag data sample where TRFs are calculated*
- *The difference is also shown, it works!*



- *Now go back and do the Z TRF correction:*
  - *The peak is not shifted very much*



Summary

- The full Pass2 data set has been analyzed, roughly 300/pb, 90M events!
- Some checks have been performed on the TRF methods using MC samples
  - The method is internally consistent in simulations, so far...
  - Could do more:
    - Add/subtract MC Z->bb peak from data... see what happens?
    - Try QCD (light-jet) MC?
- The QCD to bb inv. mass spectrum bias is similar in the 0->1 tag samples
  - Can be used to understand the shape of the bb background to Z->bb!
- More work...
  - What are the systematic errors involved?
    - How dependent are the results on the exact TRF method used?
      - Bin sizes, number of eta regions, etc. ???
  - What's the trig. eff. for Z->bb, averaged over all Pass2 data?
    - Can we use the Andre trick ? : (see last week's talk...)