Effect of *b*-tagging Scale Factors on M_{bb} invariant mass distribution

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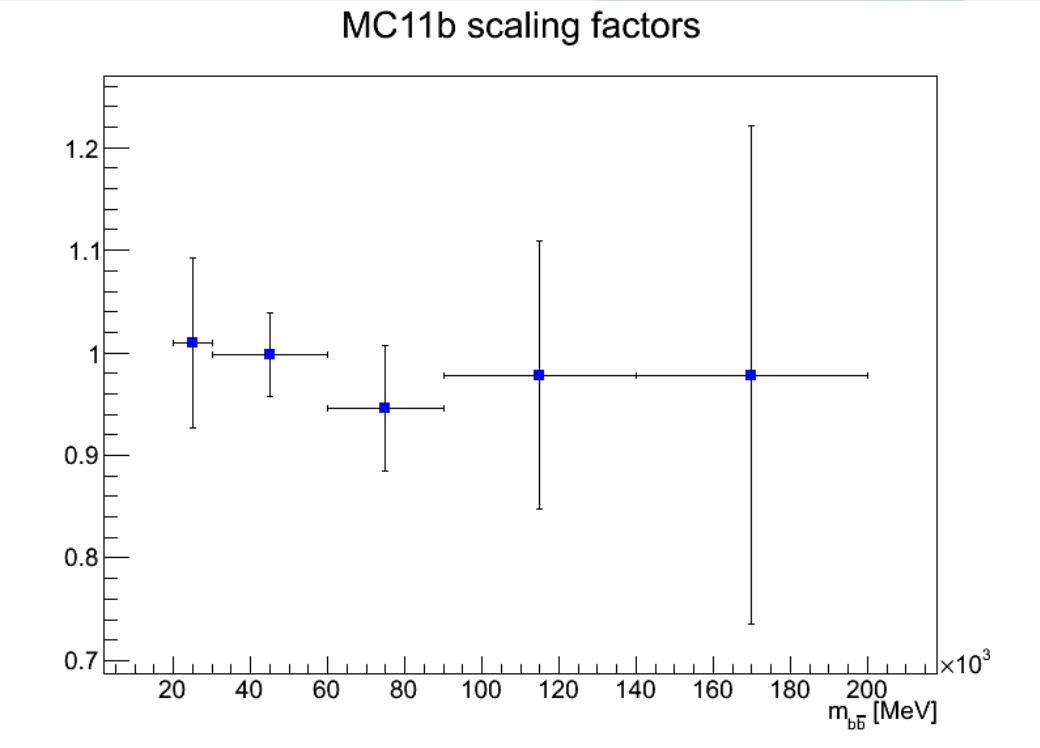
The problem

- B-tagging scale factors enter the analysis as a weight for each b-jet, and depends on the jet pT
- The event weight is taken as the product of the two weights (there are 2 b-jets per event)
- This introduces a distortion in the jet pT distribution, where some pT regions become enhanced
- Since m(bb) depends on jet pT this potentially introduces a distortion on the shape of the selected sample
- This may be important since we are looking for a small excess in the form of a wide peak in the m(bb) distribution
- We have a proposed way to deal with this effect by averaging the b-tagging scaling factors and propagating the factor uncertainties, which are used as systematic uncertainties
- This small toy-Monte Carlo study tries to evaluate the size of this distortion

B-tagging scaling factors

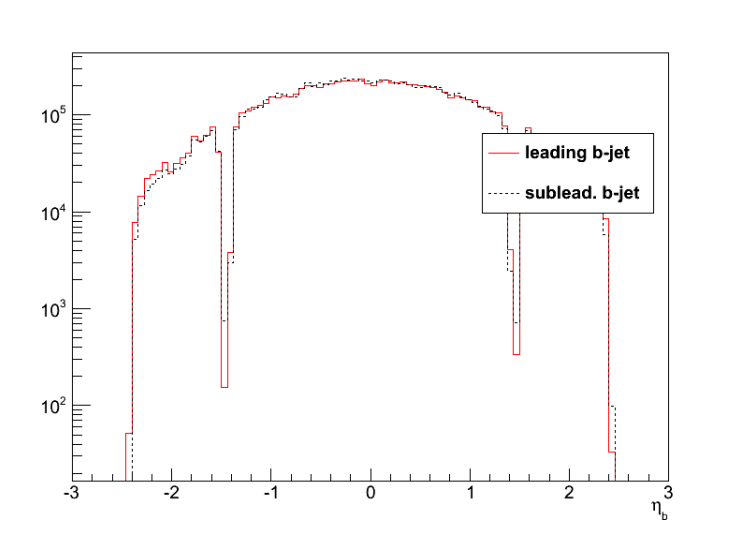
- The MC11b scaling factors at present show little evidence of a p_T dependence
- But such a dependence would clearly be possible
- New factors to be released also as a function of η

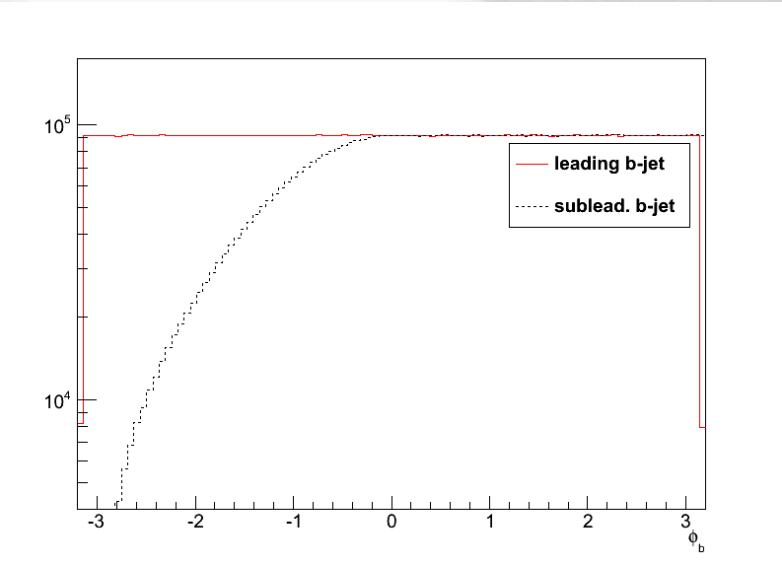


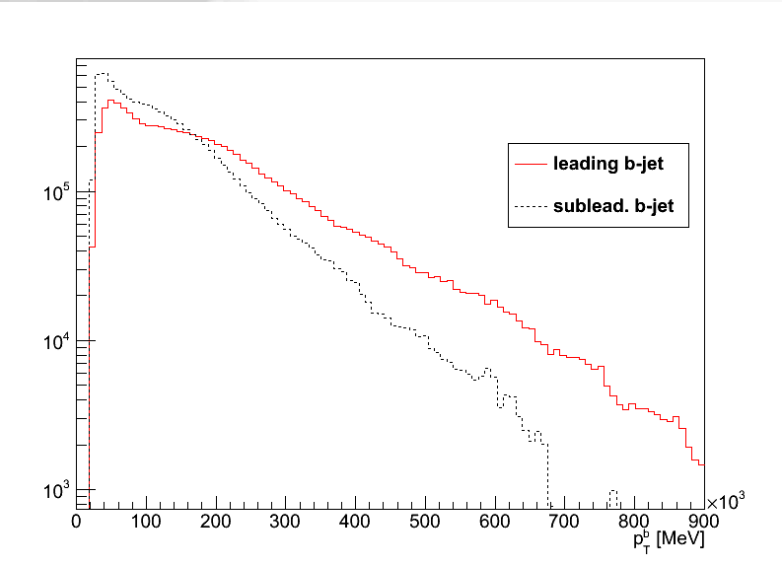
Toy Monte Carlo Study

- Toy MC to study the effect of b-tag scale factors
- Caveat: first study done with di-photon MC kinematics – a look at bb background later

1. Sample p_T and η of leading and subleading b-jets
2. Generate flat $\phi_{\text{lead b-jet}}$ and flat mass distribution
3. Calculate $\phi_{\text{sublead b-jet}}$ to be consistent with generated mass (and reject unphysical solutions

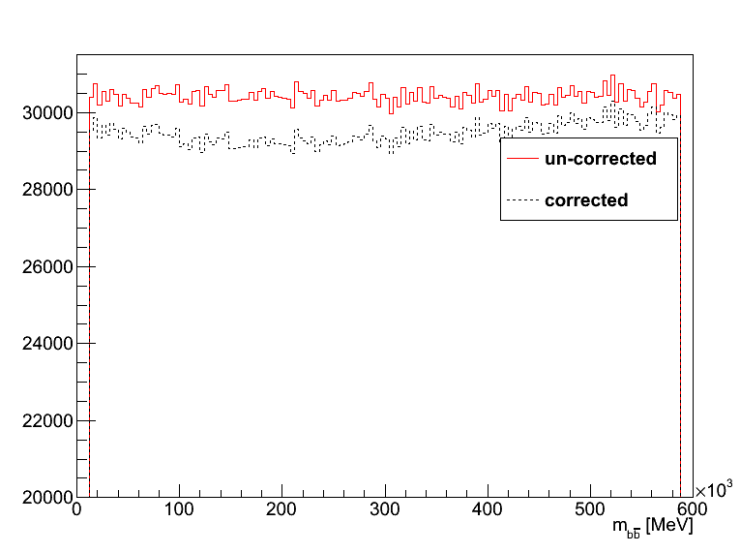


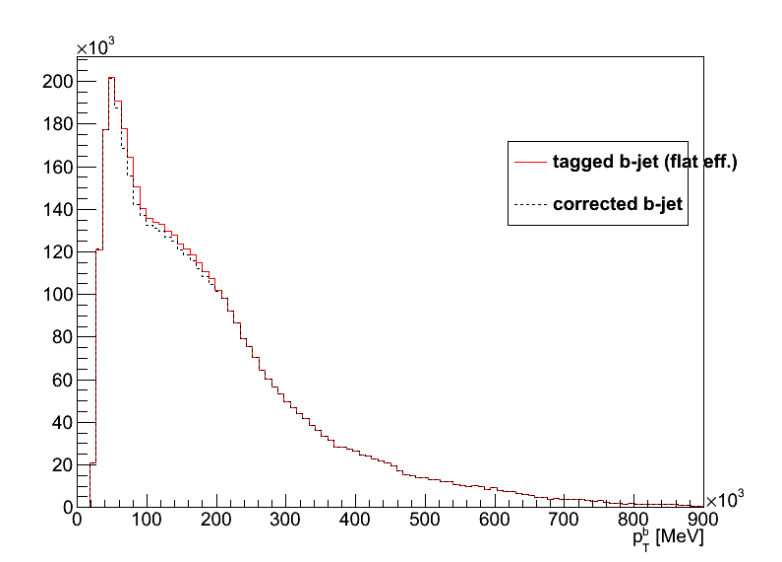


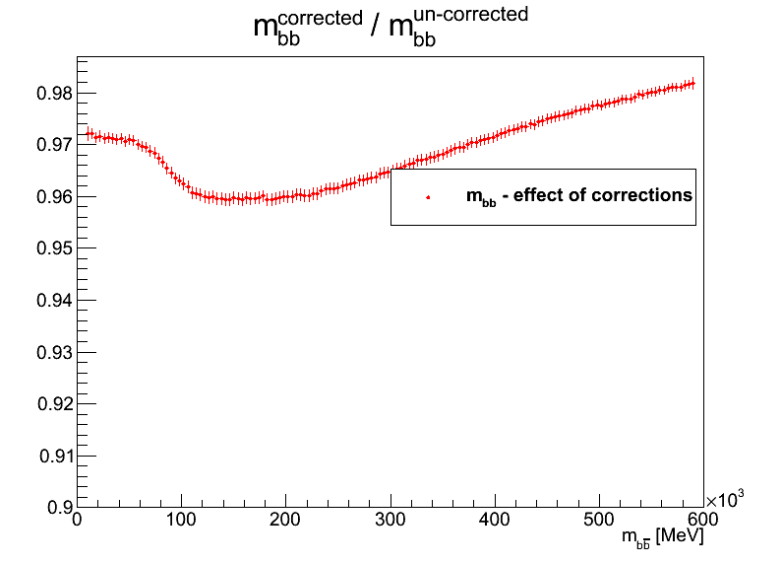


Effect of MC11b scaling factors

- Scaling factors applied as a statistical weight for each b-jet $\mathbf{W_{b1}}$ and $\mathbf{W_{b2}}$ ($\mathbf{W_b}$=1 for p_T^b>200GeV)
- Event weight is product $\mathbf{W_{b1}}$ x $\mathbf{W_{b2}}$
- The reweighting causes a distortion in the flat invariant mass distribution (plus constant term)
- The distortion is small, but then so is our signal compared to the background
- May be more serious if width comparable to m_{bb} resolution, as in our case ($\sigma_{m(bb)}$≈20GeV)

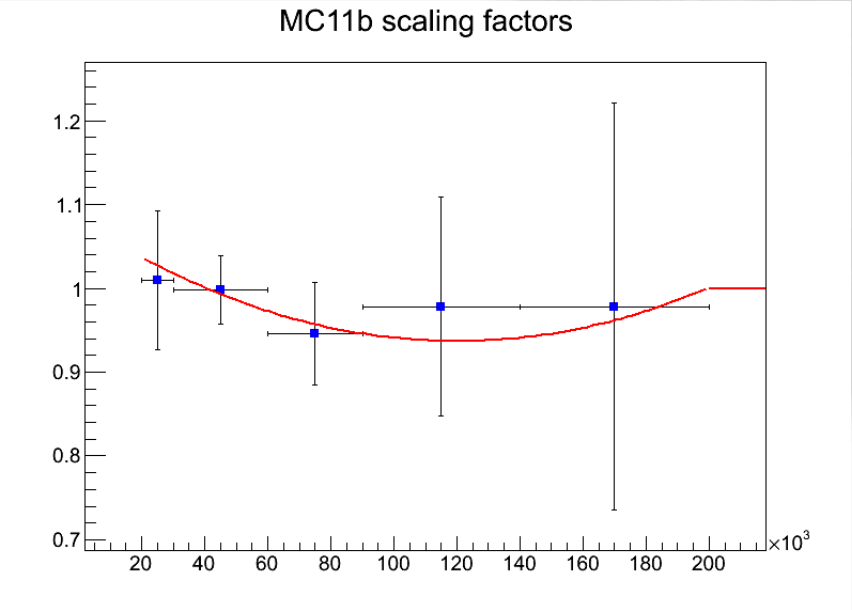


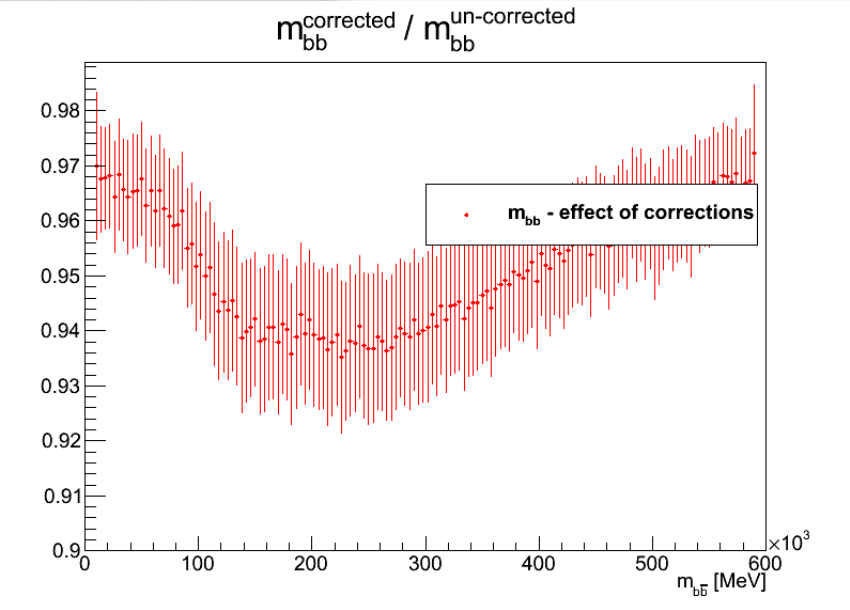




Binning effect?

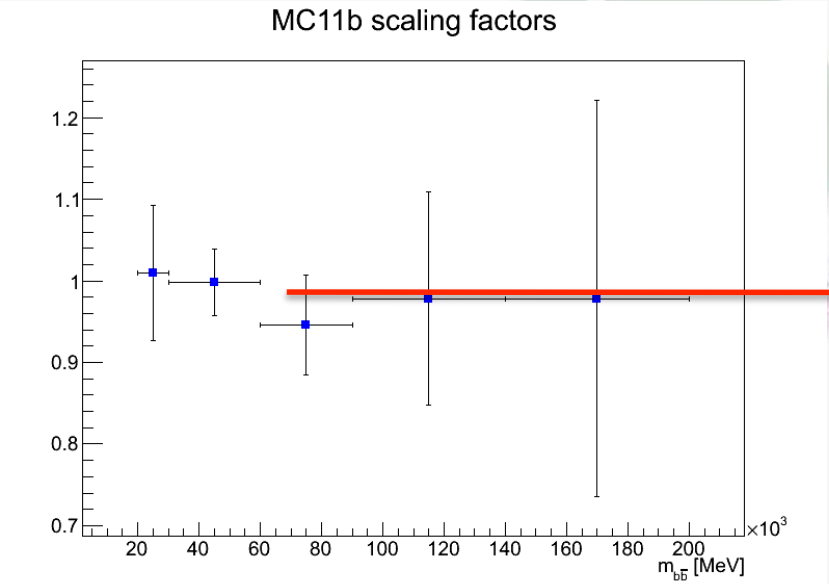
- To see whether this is an effect of the binning, fitted scaling factors (SF) with a parabola (and $\mathbf{W_b}$=1 for p_T^b>200GeV)
- Still get similar distortion => not (only) binning effect (notice lower statistics)

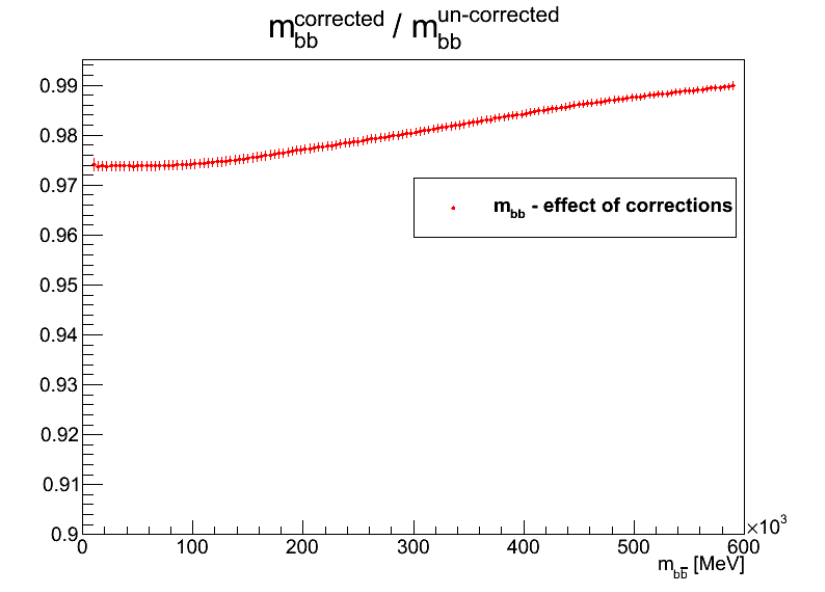




Effect of our averaging procedure

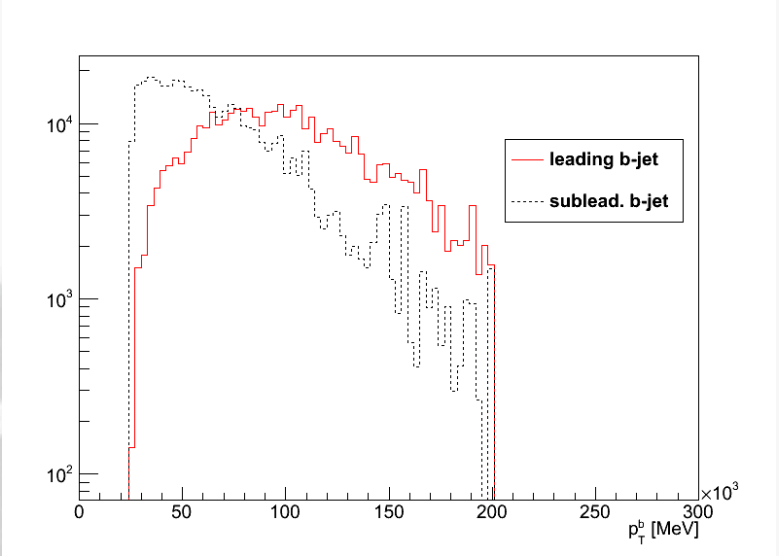
- We use the average of the scale factors (0.9865) and propagate the errors taking into account bin-to-bin correlations
- Small effect still visible (bottom right) looking at wide mass range
- But very smooth compared to the horizontal with of our signal peak

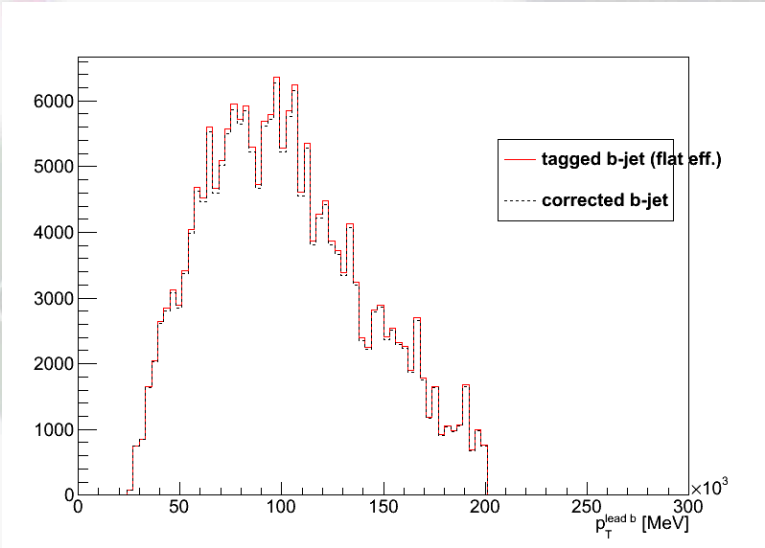


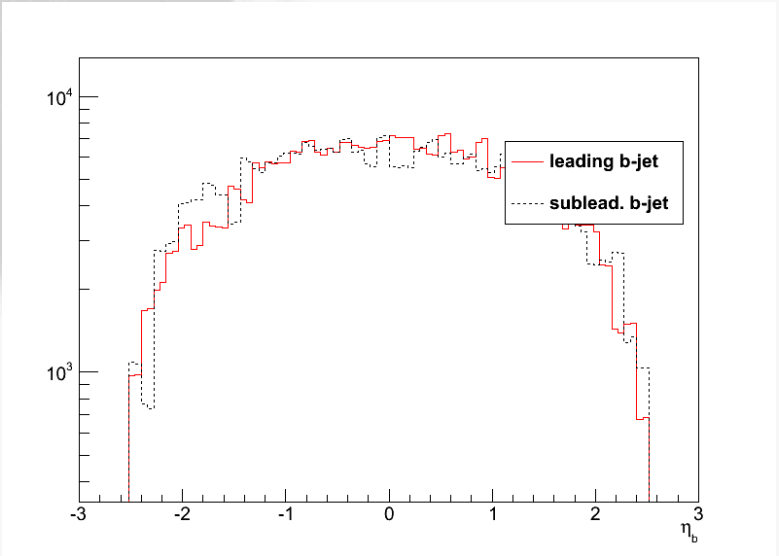


Using different input kinematics

- Re-did some plots with b-tagged jets from W+bb and top backgrounds
- Jet pT cutoff at 200GeV

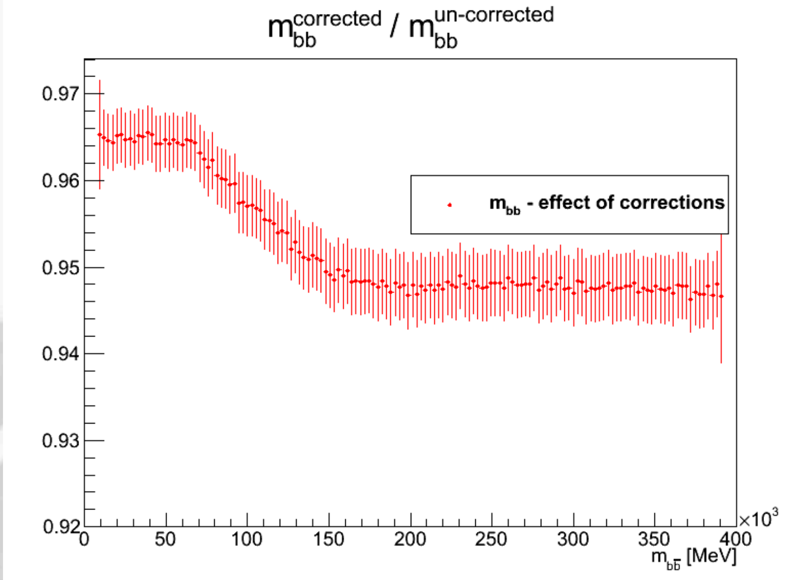


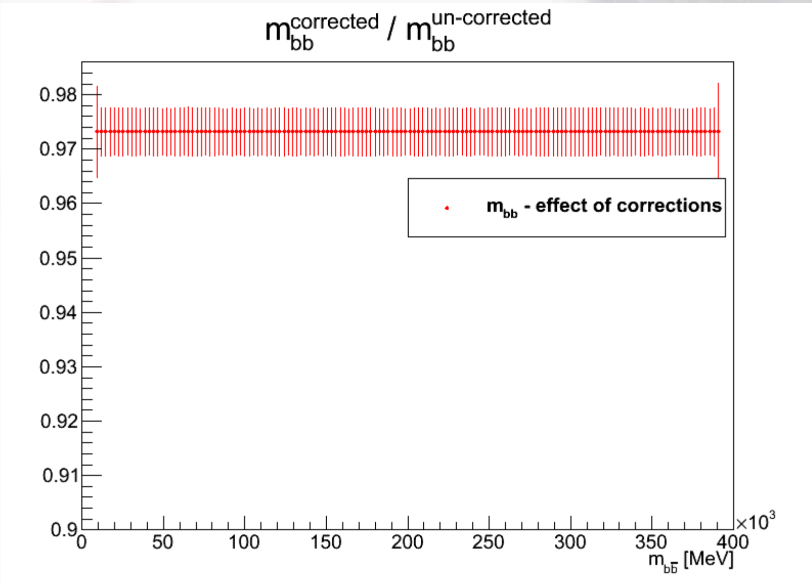


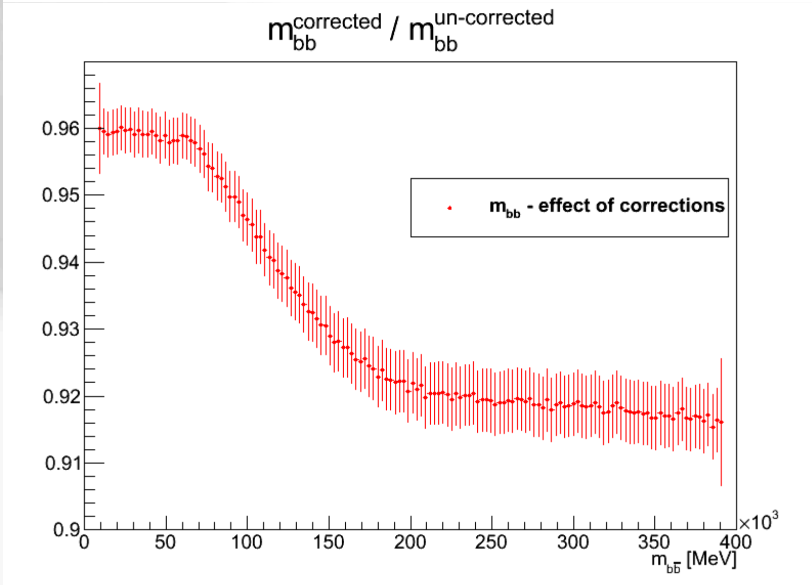


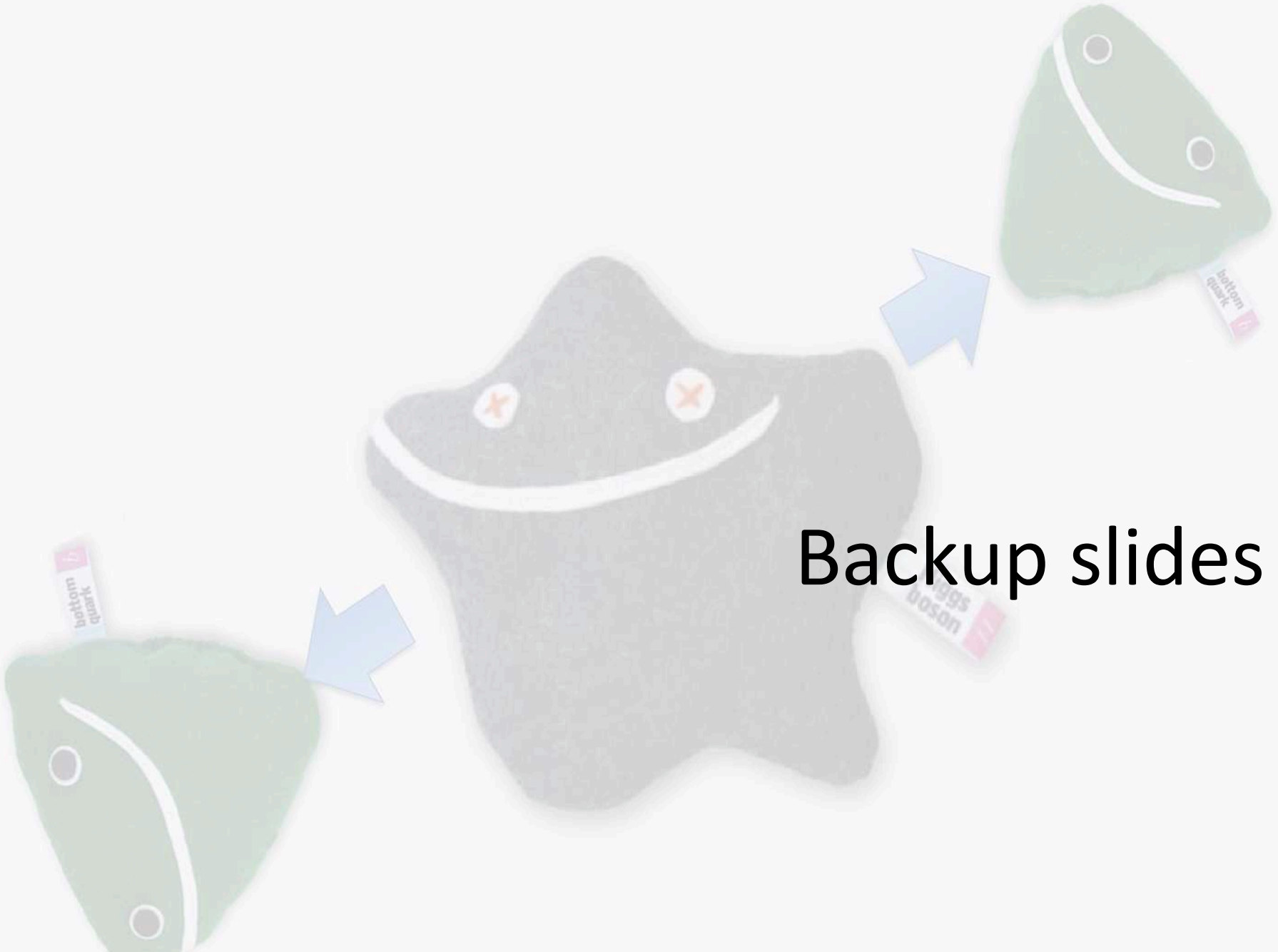
Results using background kinematics

- Basically same conclusion:
- MC11b scaling factors distort mass distribution (top right)
- Even if a parametrization is used (bottom right)
- Our averaging procedure removes shape distortion (bottom left) – note zero distortion in this case only due to jet pT cutoff at 200 GeV!





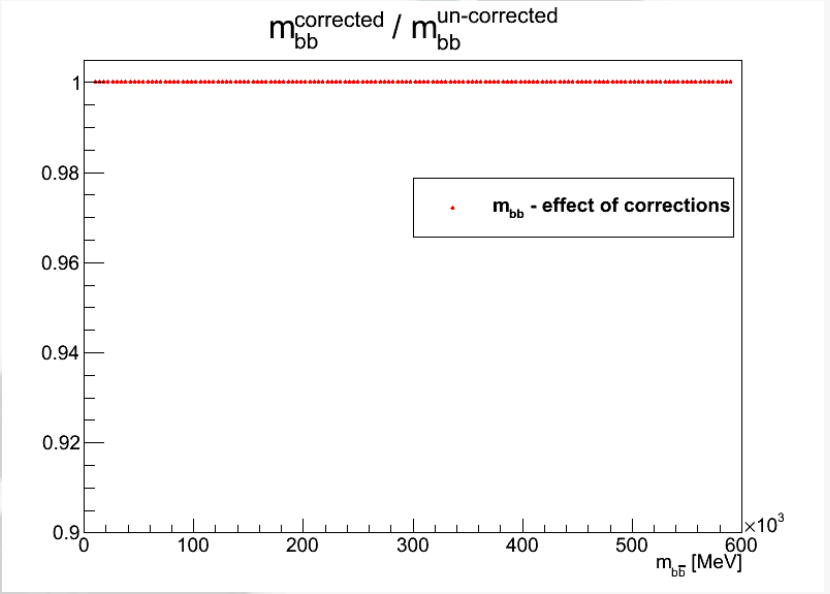


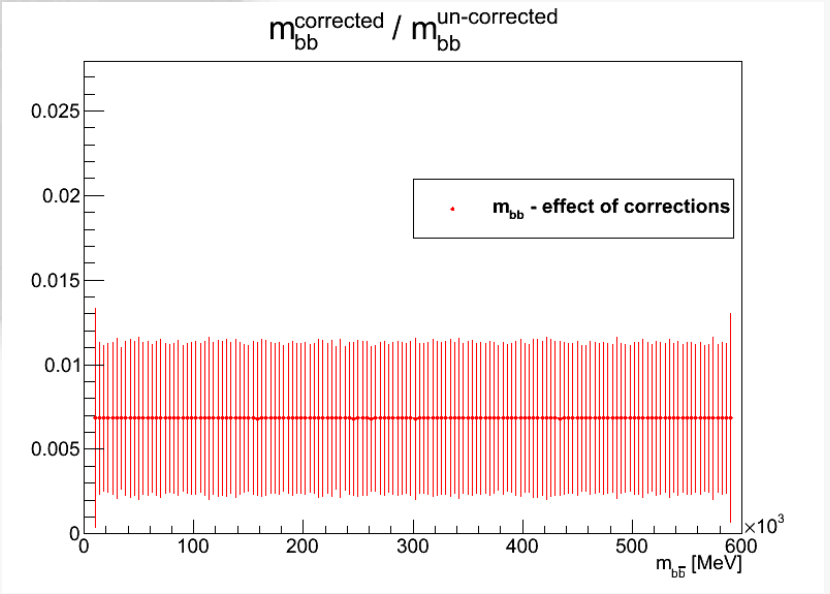


Backup slides

Cross checks

- If all b-tagging scale factors are set to 1 there is no effect on the mass distribution, as expected (top right)
- If they are all set to the average (0.9865) including for jets with p_T^b>200GeV, effect on mass is flat, also as expected (bottom right)





Other scaling factors

- Using preliminary scaling factors from MC11a (December 2011) get even larger effect