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Improving the Top mass: Run I matching studies

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We summarize here some of the studies we did in Run I aimed at improving the mass measurement. Here we discuss the different combinations we obtain when matching the four highest E_T jets to partons. This is called the 9-plots study.

1 Correlations between the 9 plots and their χ^2

This was an attempt to improve the mass measurement by identifying wrong combinations. The nine plots are obtained by looking at the GENP bank (now days the HEPG bank) and do jet matching. For each jet we searched the HEPG bank for a parton. We call this jet as matching if there is a parton within a cone of $\Delta R < 0.4$. This study was done for events with at least a b-tag.

See CDF-2485 for previous studies of the nine plots. In CDF-2485 we used $\Delta R <$ 0.5.

1.1 Mass distributions

Fig. 1 shows the results obtained on a large sample of MC events for M_{top} = 175 GeV. The numbers added in each plot give the median and σ_M (defined as 1/2 of the distance between the 34% points on each side of the median point).

The first row includes events with a match for all 4 jets used in the fit. The second row includes events for which one or more of the b-jets do not match. The third row corresponds to events for which one or more of the W-jets do not match.

The first column includes events for which the best (smallest χ^2) fit uses the correct combination for all the matched jets. The second column is for events for which the b's from the two tops are swapped (b-swap). The third column includes events for which a jet from the W is used as a b jet and viceversa (W-b swap).

How many events in each of the nine plots? The number of events in each plot is shown at the bottom of the plot. Table **??**stat) shows the situation.

We notice that the resolution is at its worse when the jets are misassigned, either when the b's of the two tops in the event are switched or when a W-b swap occurs.

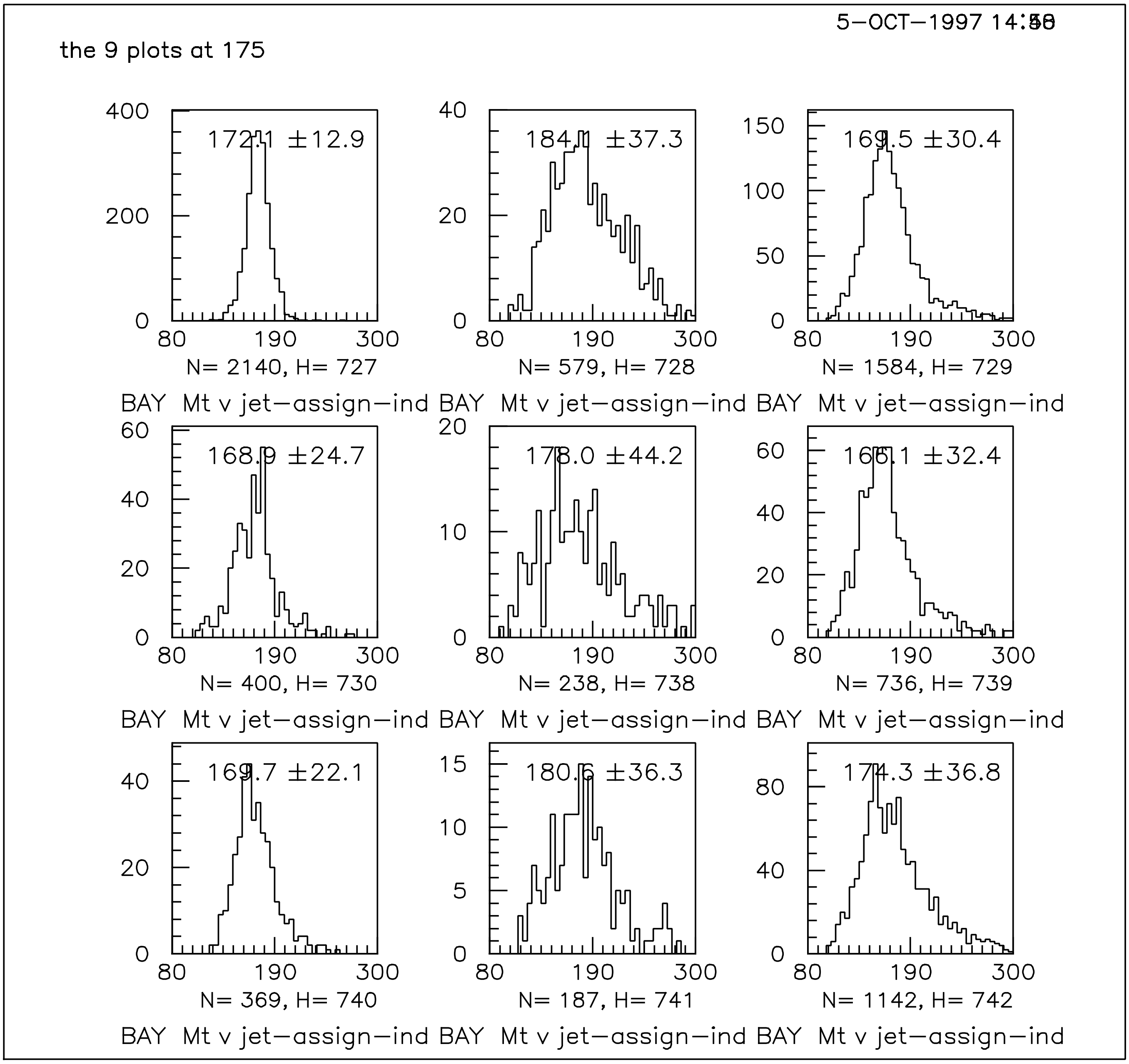

Figure 1: Distribution of best fit mass for the 9 plots. Value of the median and σ are shown on the plots. Row 1: all 4 jets are matched by a parton. Row 2: one b-jet not matching. Row 3: one W jet not matching. Column 1: matched jets have correct assignment. Column 2: b-swap. Column 3: W-b swap. HERWIG Monte Carlo events for M_{top} = 175 GeV were used.

Table 1: Number of events with best fit in different jet matching types

types	corr. assign	b-swap	W-b swap	Total	Fraction
4-jet match	2140	579	1584	4303	58.3%
1b jet no match	400	238	736	1374	18.6%
1 W jet no-match	369	187	1142	1698	23.0%
Totals	2909	1004	3462	7375	
Fraction	39.4%	13.6%	46.9%		

The mass shifts are also more severe when there are mismatched jets. However, the final mass peak is not much displaced from the expectation of 175 GeV. This can be seen in Fig. 2. The narrowest distribution is for events for which all 4 jets match to a parton and the best fit uses the correct assignment. Next we add the distributions for events with 4 jet matched and b-swap or W-b swap. The final distribution includes all 9 plots.

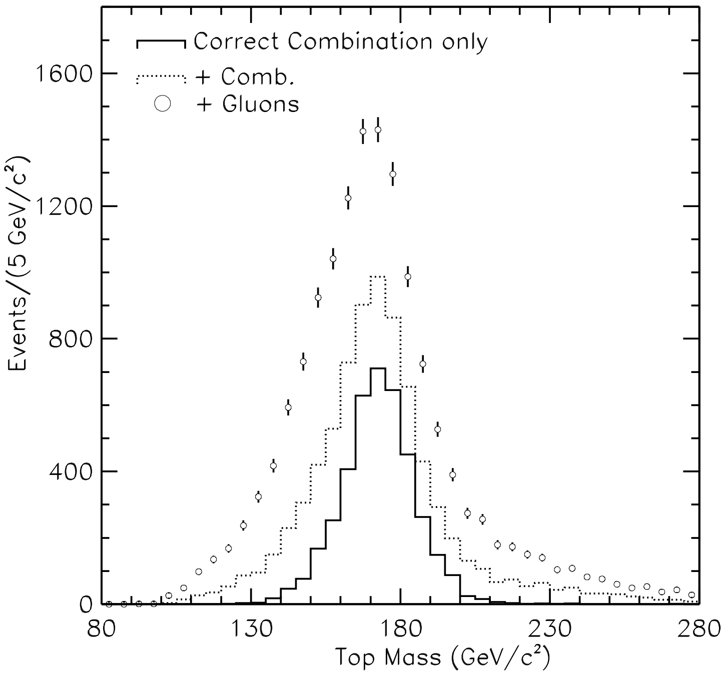

Figure 2: Reconstructed mass distributions. Solid: all 4 jet match and the fit uses the correct combination. Dots: we add events with 4 jet matched but the fit has a b-swap or a W-b swap. Circles: includes events from all the nine plots. HERWIG Monte Carlo events for M_{top} = 175 GeV were used.

The same distributions are shown in Fig. 3 for events with two b-tagged jets. Clearly the distributions are much narrower.

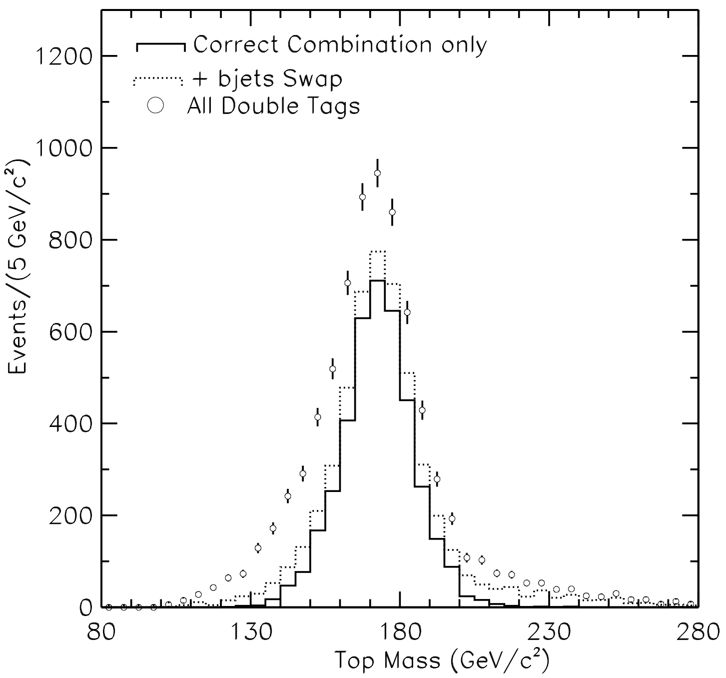

Figure 3: Reconstructed mass distributions for double-tag events. HERWIG Monte Carlo events for $M_{top} = 175$ GeV were used.

1.2 χ^2 distributions

Next we look at the χ^2 distributions for the events in each of the 9 plots for events with one b-tagged jet. These are shown in Fig 4.

We observe that the χ^2 distributions have larger medians and are wider when mismatched jets are present, i.e., in the presence of final state radiation (second and third row). Combinatorics, i.e., assigning the b jet to the wrong top or swapping a jet between the b and the W, the last two columns, give large tails in the mass distributions and in the χ^2 distributions as well.

Is there a way to reduce the contribution from wrong combinations by using the fit χ^2 information? This already would improve the situation considerably. Improved jet clustering (i.e. somehow adding close by energy to account for gluon radiation) should also yield reduced mass shifts and better resolution.

Fig. 5 shows the mass distributions for different χ^2 bins.

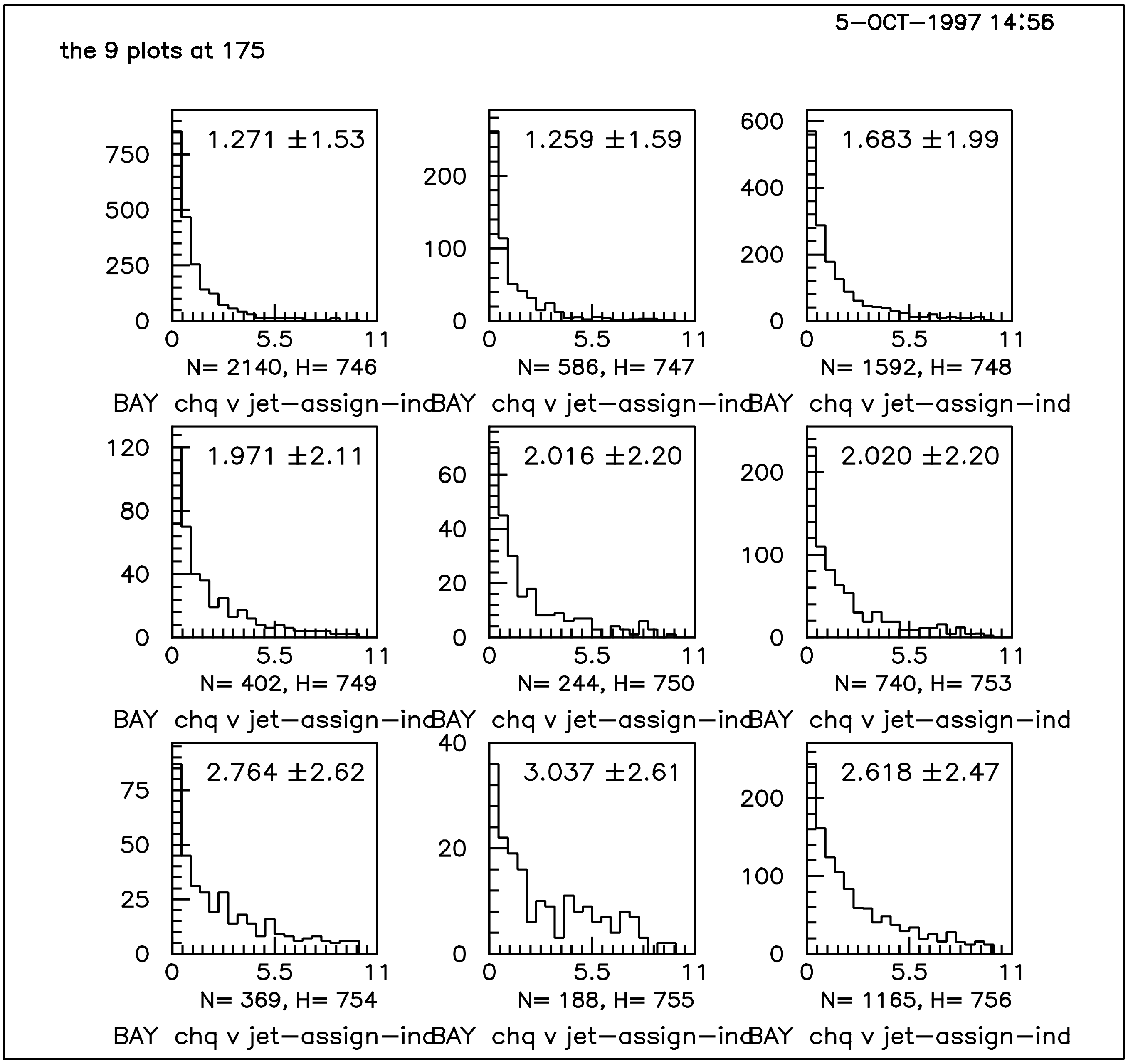

Figure 4: Distribution of best fit χ^2 for the 9 plots. Value of the median and the σ are shown on the plots. The definition of the 9 plots is explained in Fig. 1. HERWIG Monte Carlo events for M_{top} = 175 GeV were used.

We see a shift in mass and an increase in the tail fo the distribution as the χ^2 increases. Clearly additional studies need to be done.

- It does not seem that a simple χ^2 cut on the best solution would be sufficient to improve the situation.
- for the events with wrong jet assignment (61.6%), study the other solutions to see if the correct combination is among them and find some trends that can help on maximizing the events with the correct combination
- Consider including some combination of solution, or average all of them as Jeremy did in run I.

Clearly there are a lot of possibilities. Igor is exploring some of them.

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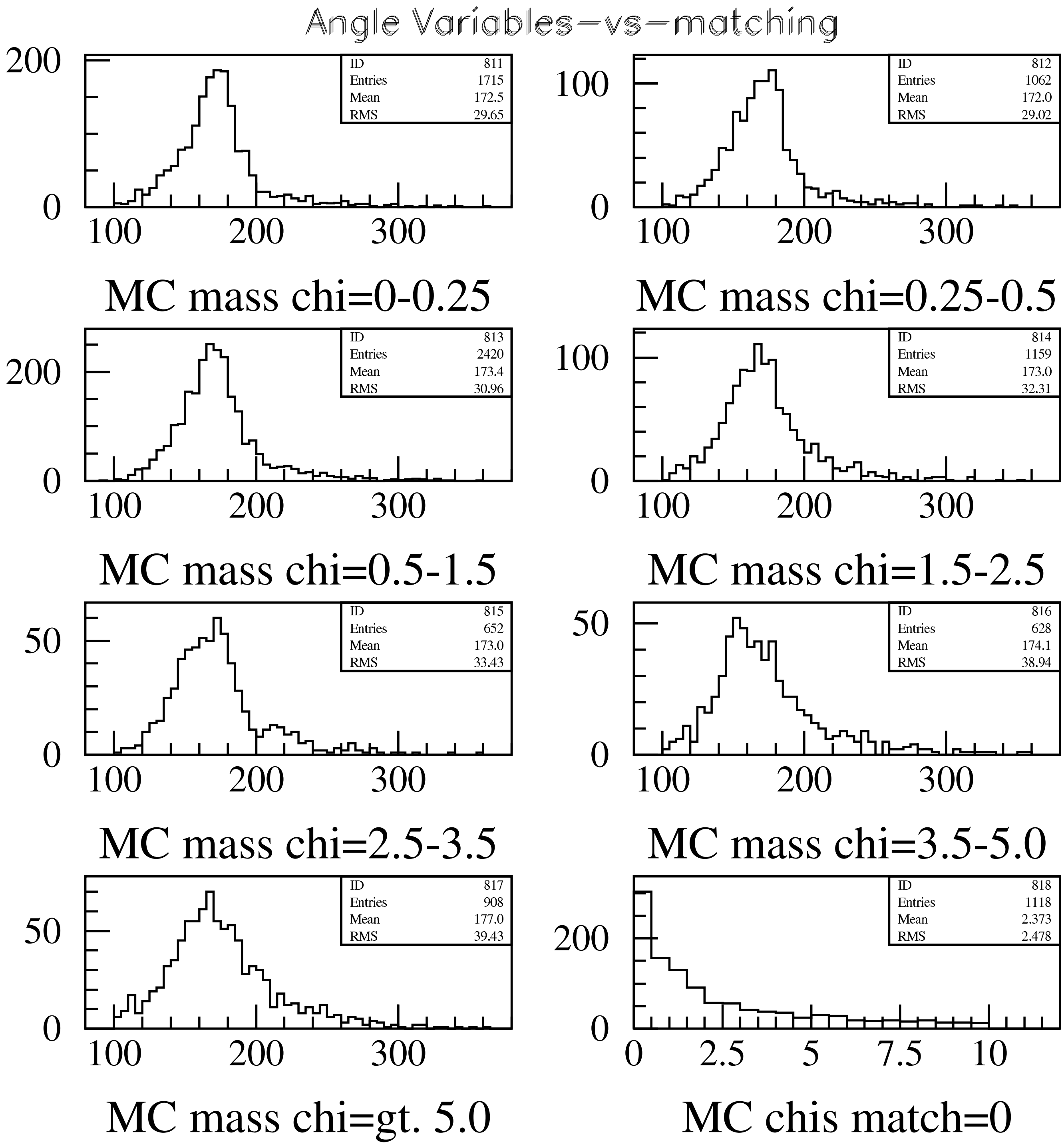

Figure 5: Distribution of best fit mass for several χ^2 bins. HERWIG Monte Carlo events for M_{top} = 175 GeV were used.