

$e^+e^- \rightarrow \text{HA} \rightarrow b\bar{b}b\bar{b}$  study



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- Aim is first cross-section and mass measurement for  $e^+e^- \rightarrow HA \rightarrow b\bar{b}b\bar{b}$  at  $\sqrt{s} = 1$  TeV.
- Later setting limit independent of  $\tan\beta$  and Higgs masses.
- Generated sample of  $HA \rightarrow b\bar{b}b\bar{b}$  signal using Whizard
  - $m_H = m_A = 400$  GeV
  - $\tan\beta = 10$
  - x-section:  $\sqrt{s} = 1$  TeV 2.7 fb
  - Branching fraction for  $H \rightarrow b\bar{b}$  77%
  - $A \rightarrow b\bar{b}$  65%

## Today:

- Signal study for  $m_H = m_A = 400$  GeV at  $\sqrt{s} = 1$  TeV
- Jet clustering and flavor tagging.
- 4 jets selection
- Mass reconstruction of  $m_H$  and  $m_A$ .
- Beam background included

## Looked at various methods:

- Reconstruction using truth-matching
  - associate the reconstructed jets to generated b-quarks from H/A decays using minimum  $\Delta R$  between the jet and parton.
  - in case of duplication, next minimum  $\Delta R$  is selected.
- Reconstruction using thrust
  - pair of jets selected based on sign of product of  $\cos\theta$  of jets coming from H or A.

- Reconstruction using ChiSquare minimization

- same mass is assumed for both particles

$$\chi^2 = \sum \frac{(M_{ij} - M_{kl})^2}{\sigma_H^2}$$

- two pair of jets with minimum ChiSquare are selected

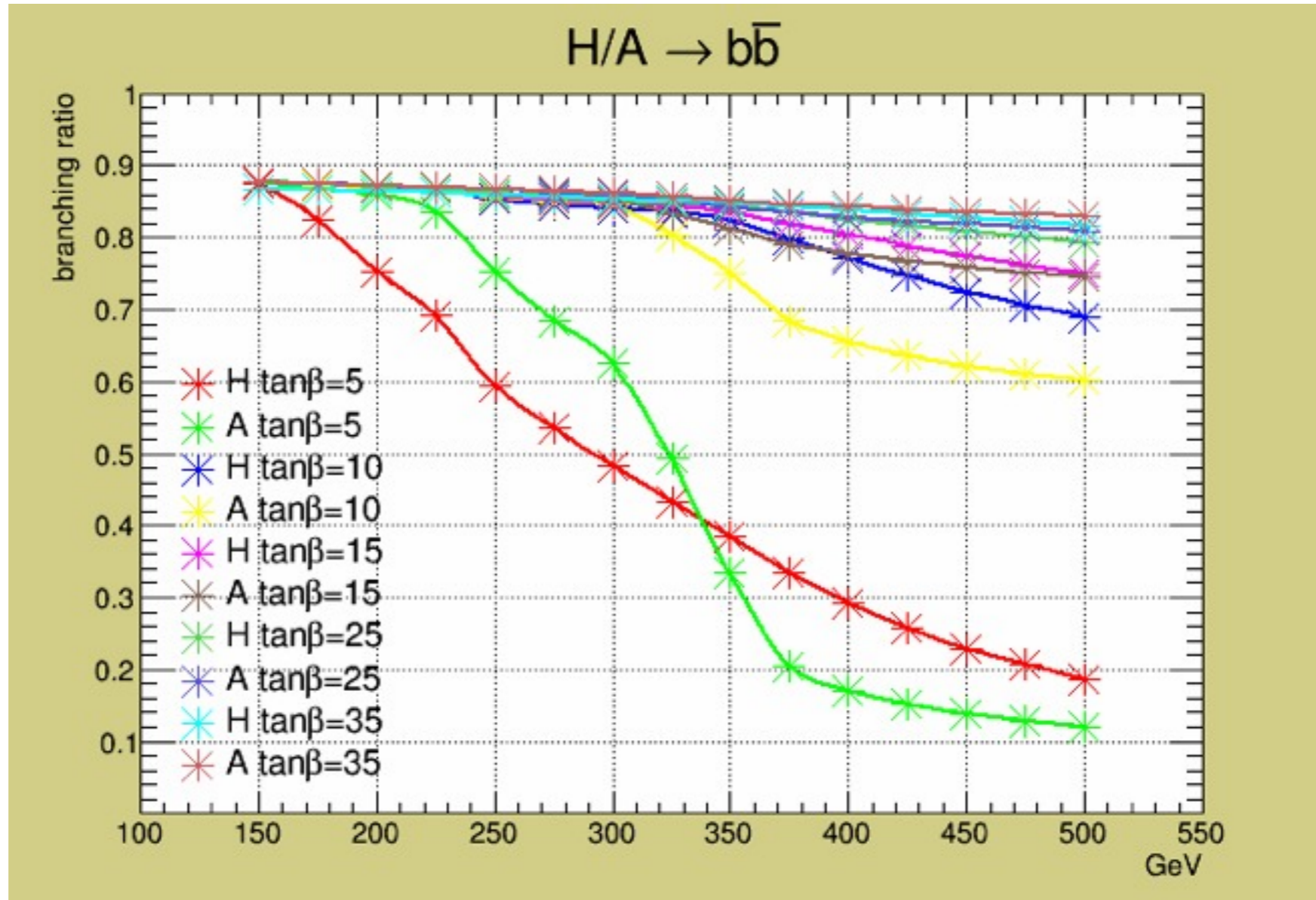
- Reconstruction using ChiSquare minimization

- mH and mA are forced to 400 GeV

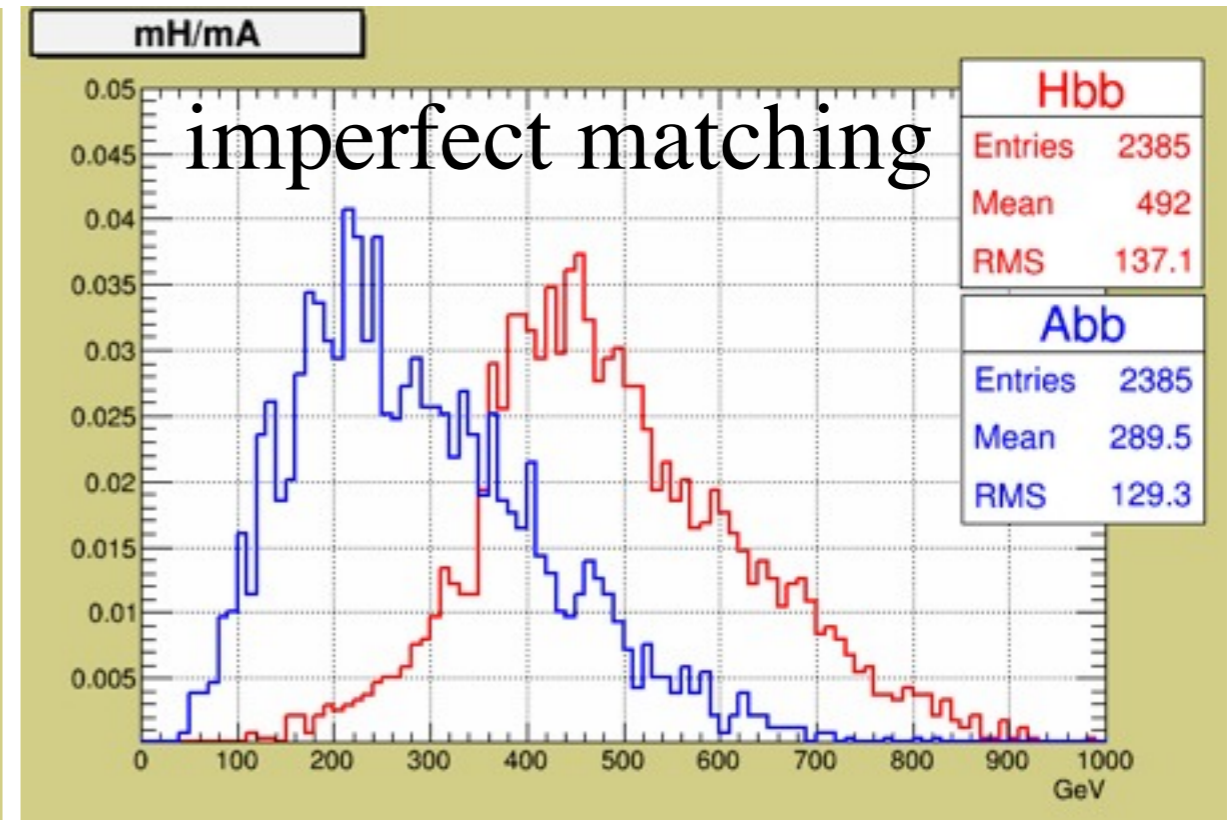
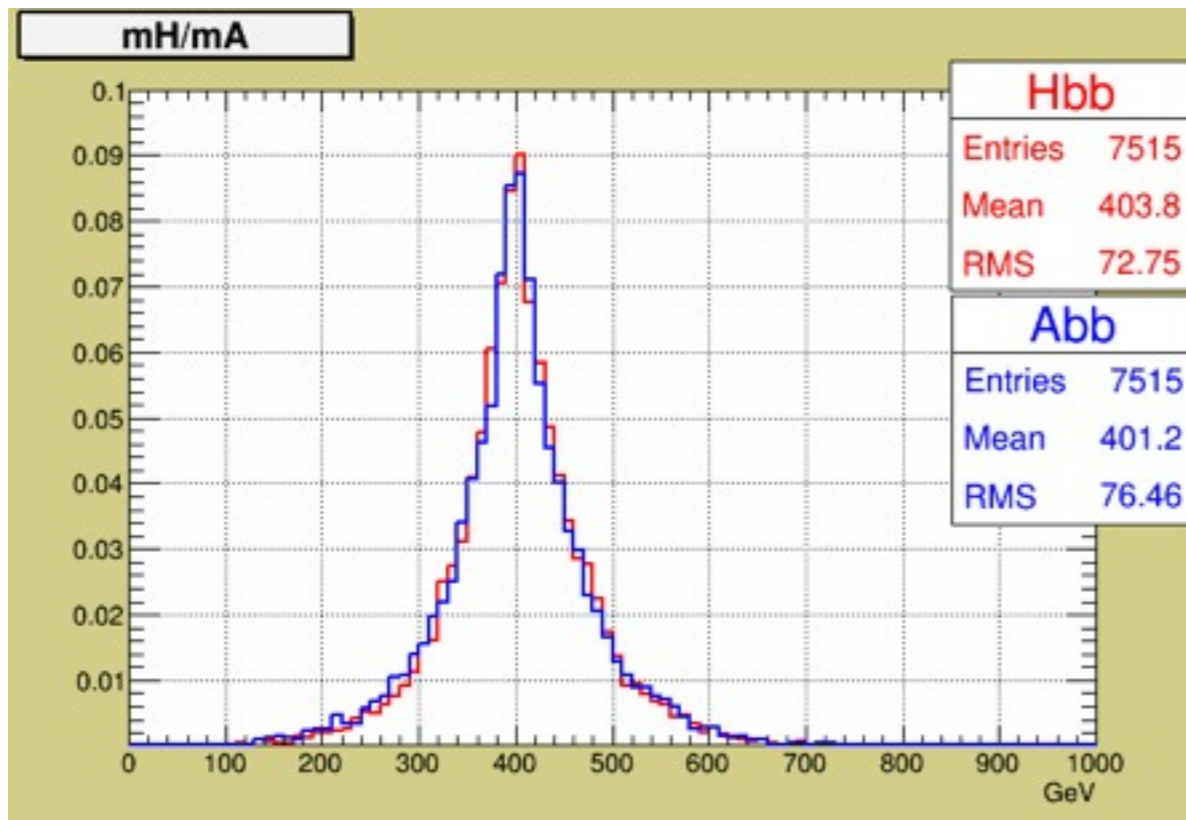
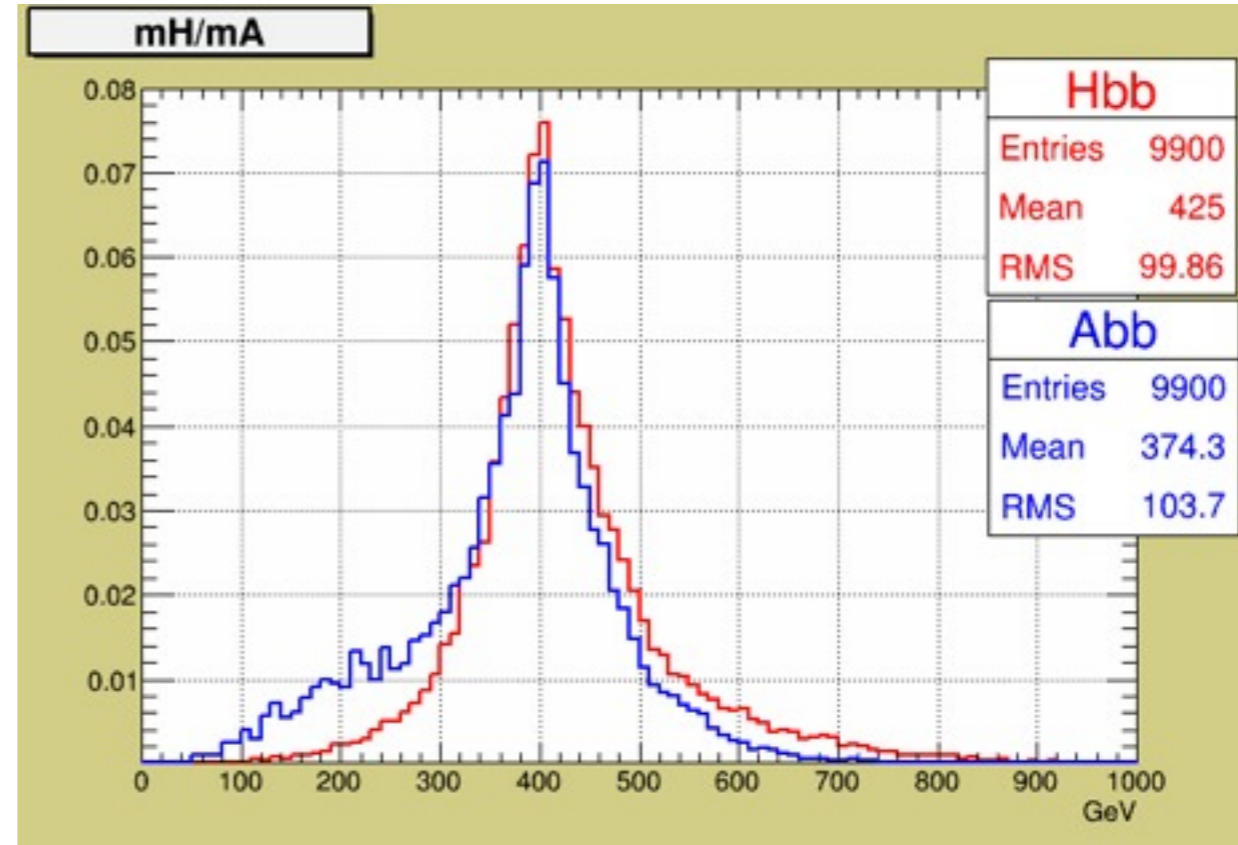
$$\chi^2 = \sum \frac{(mH - M_{ij})^2}{\sigma_H^2} + \frac{(mA - M_{kl})^2}{\sigma_A^2}$$

- two pair of jets with minimum ChiSquare are selected.

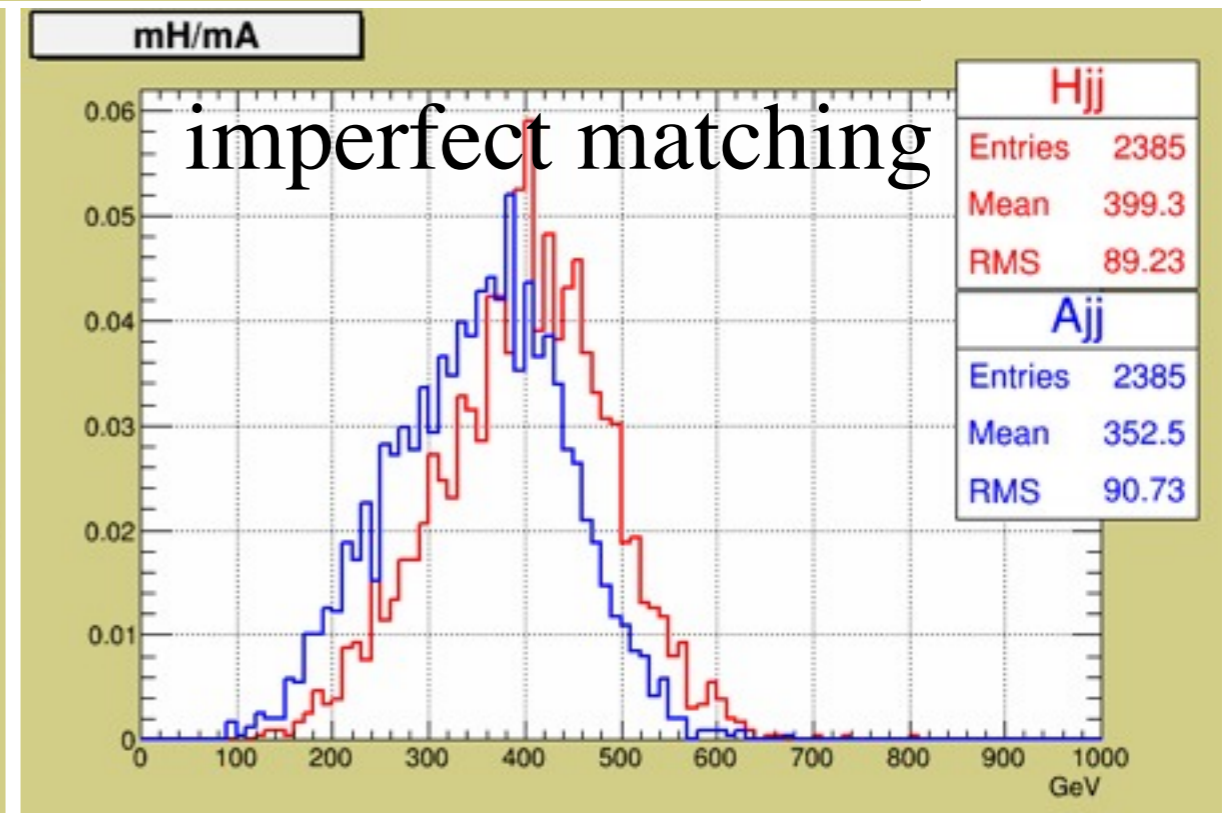
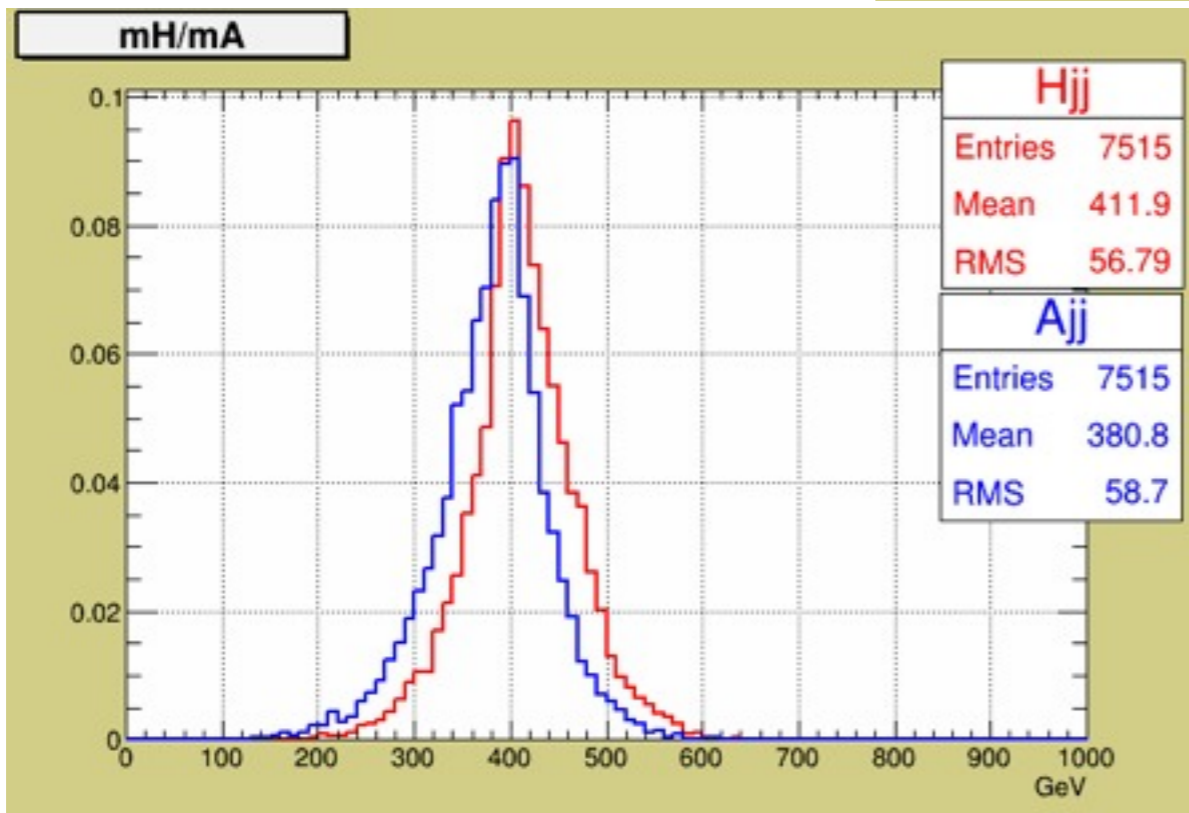
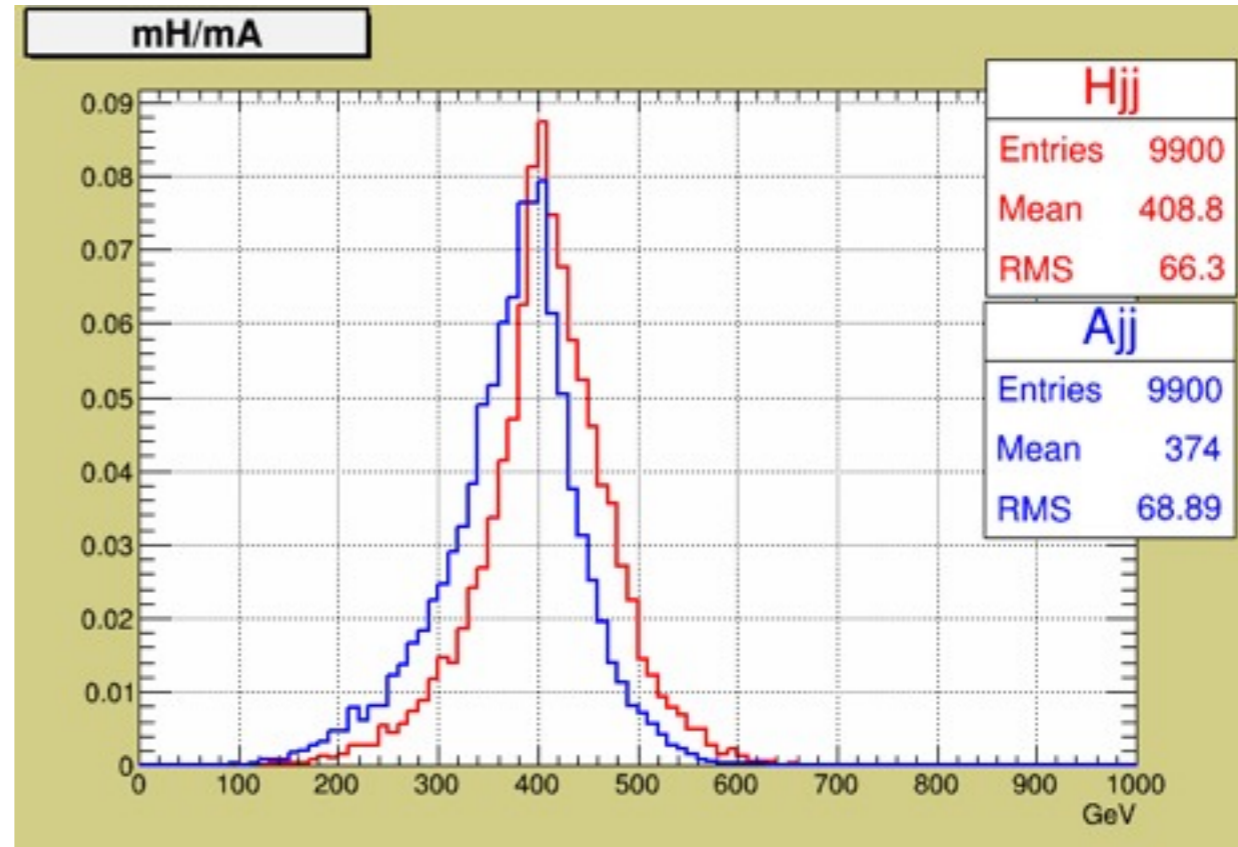
$\sigma_{H/A}$  from truth matching reconstruction is used.



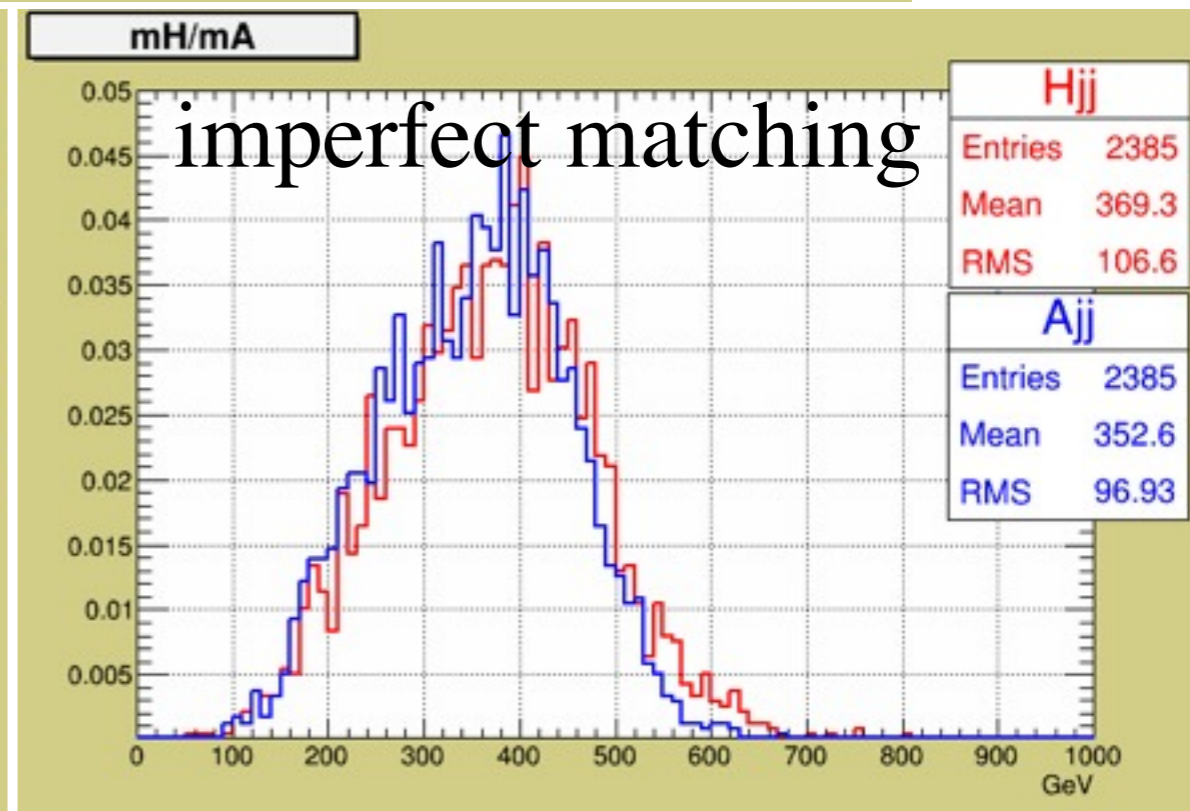
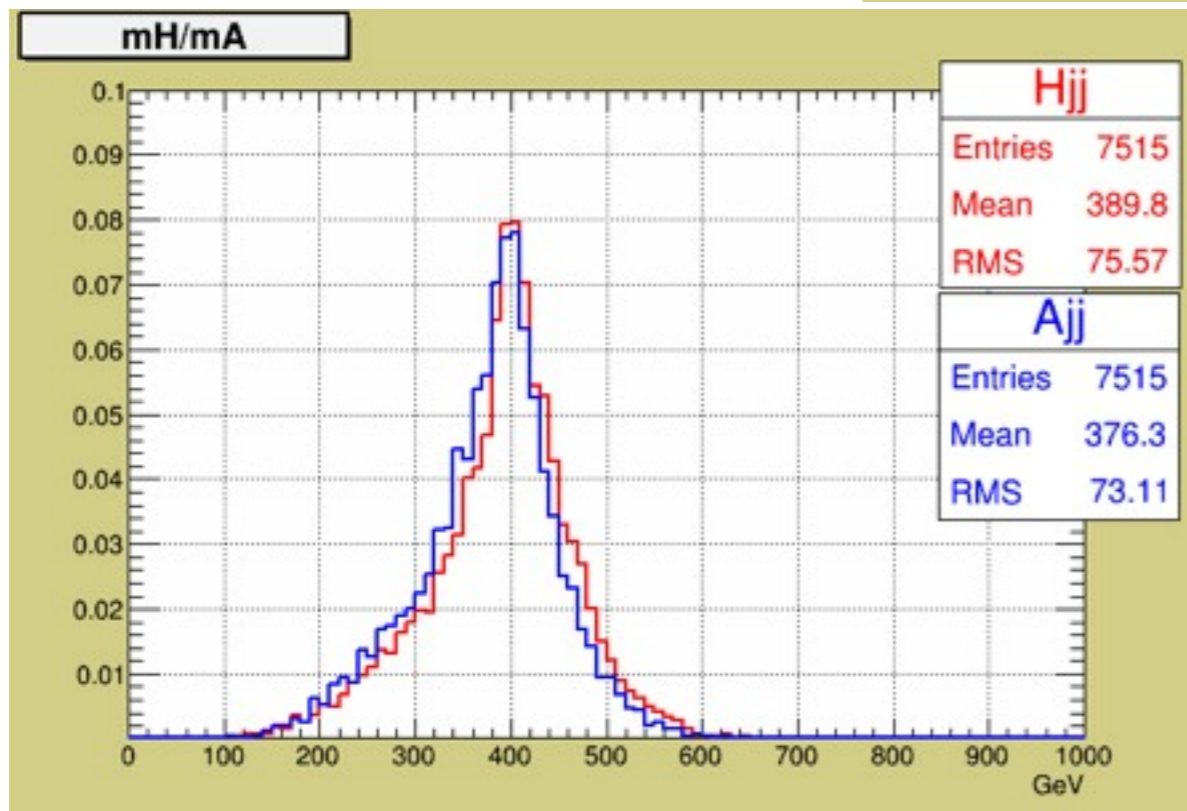
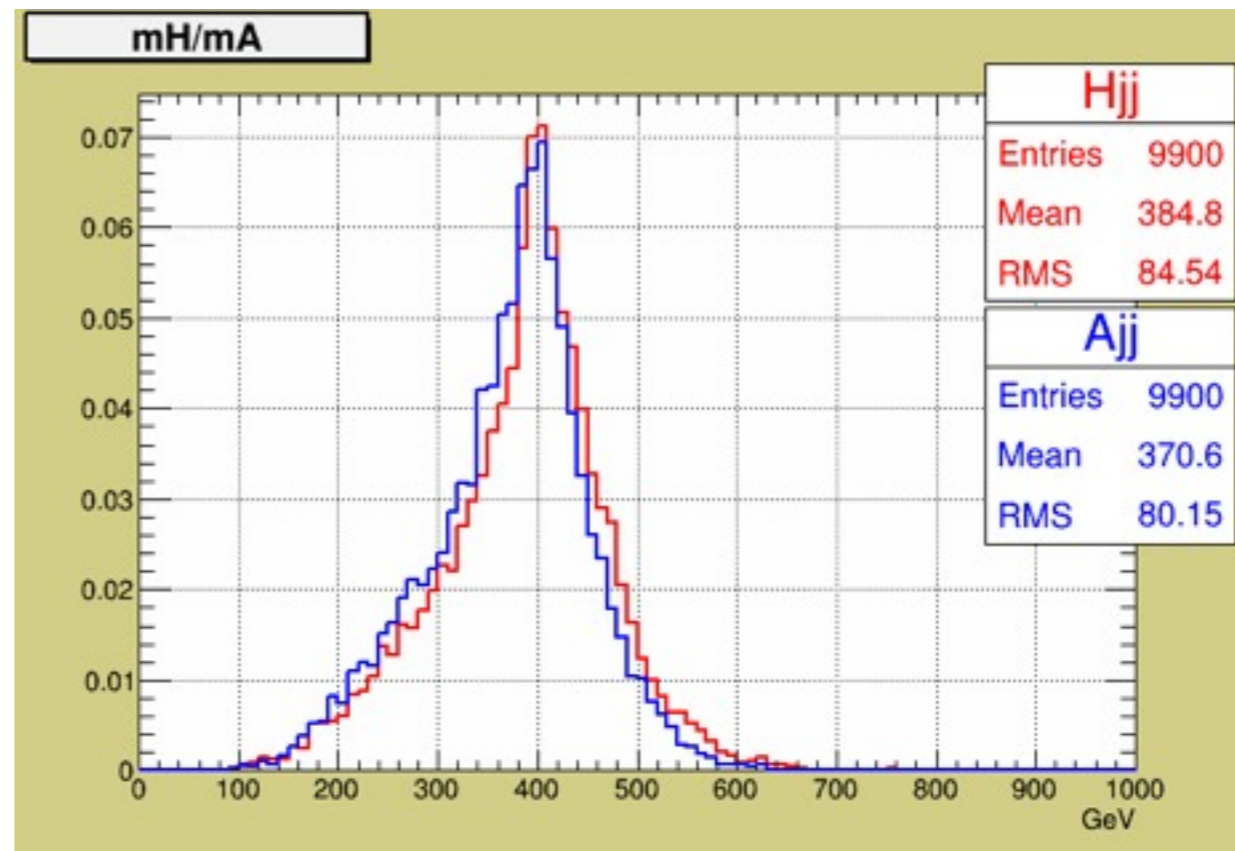
If  $\Delta R$  matching not good  
reconstruction is bad.



Fixed  
 $m_H = m_A = 400 \text{ GeV}$

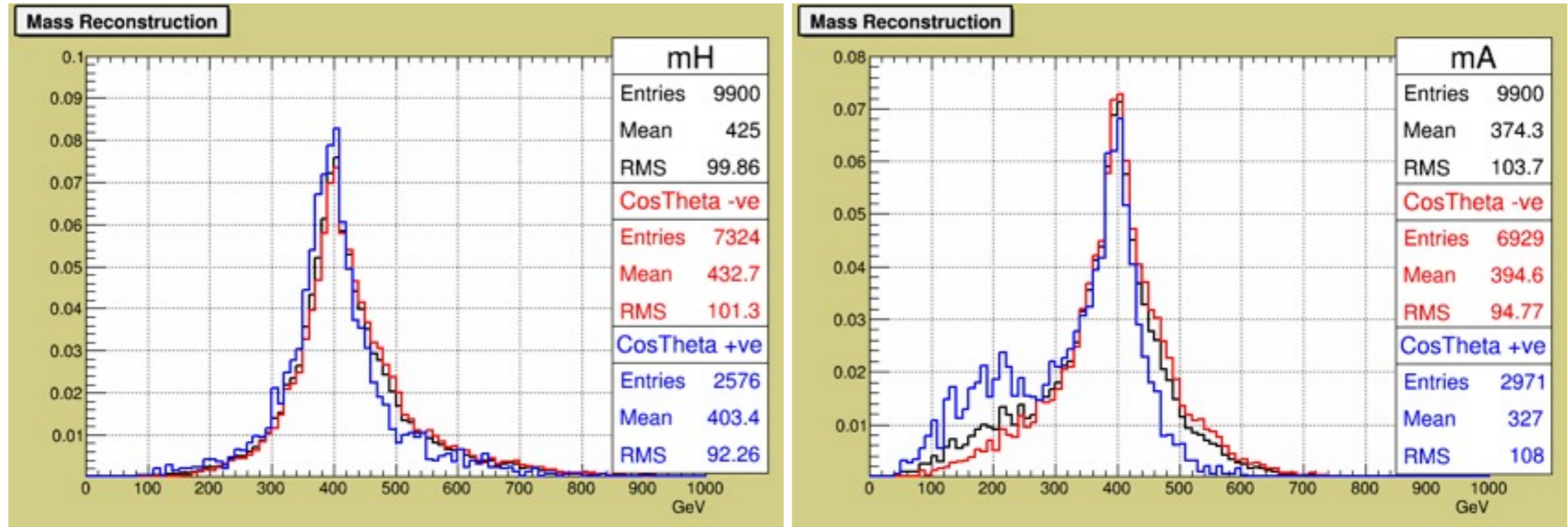


mH/mA not fixed.  
Difference of jets pair  
mass minimized.

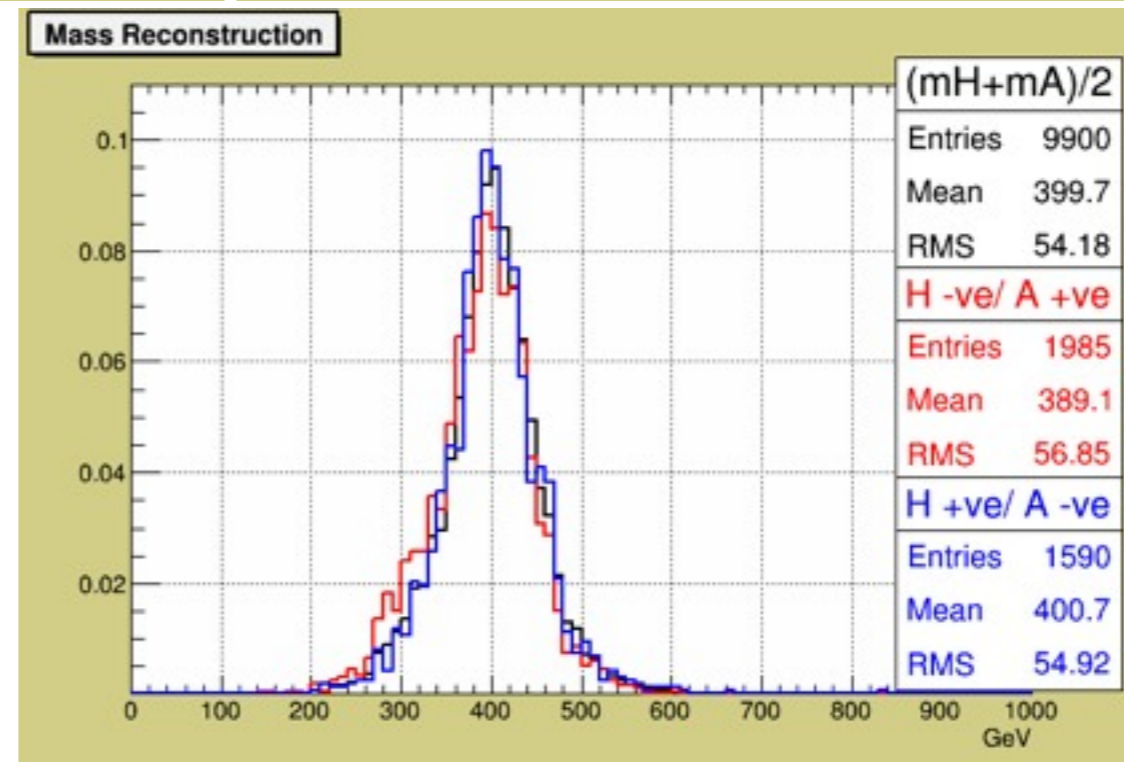


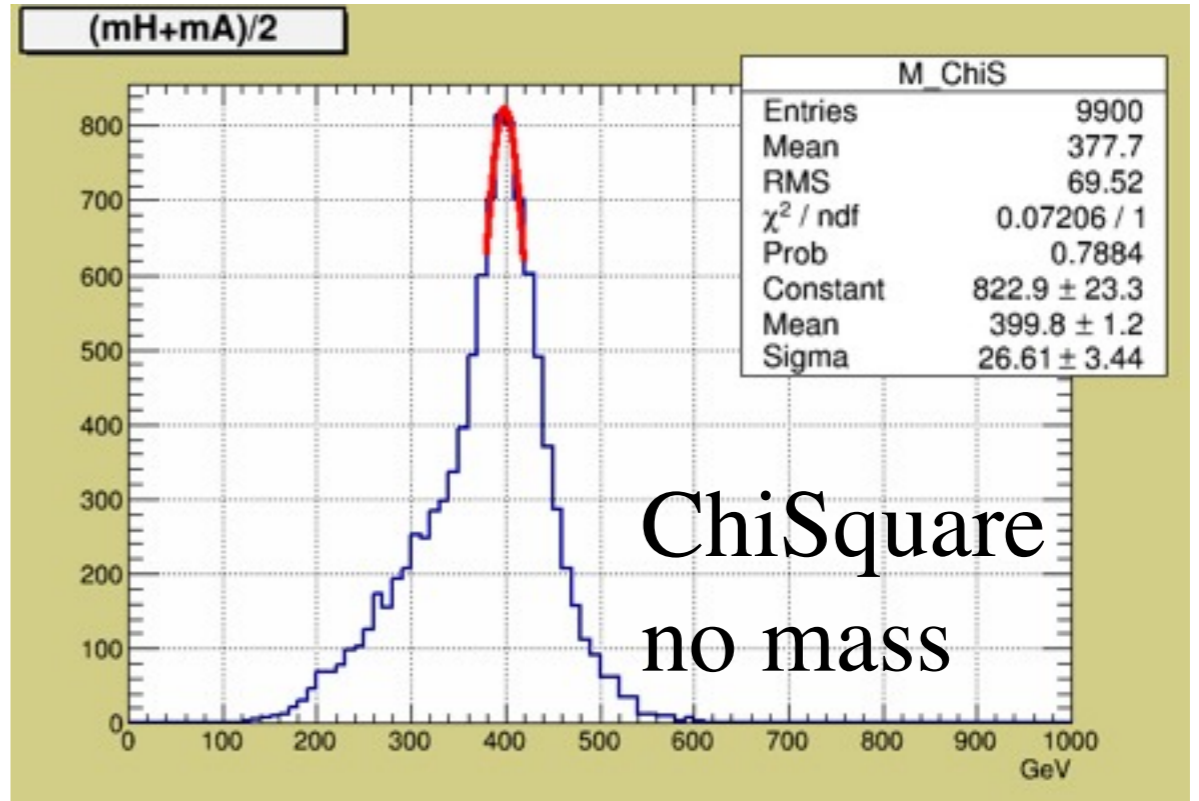
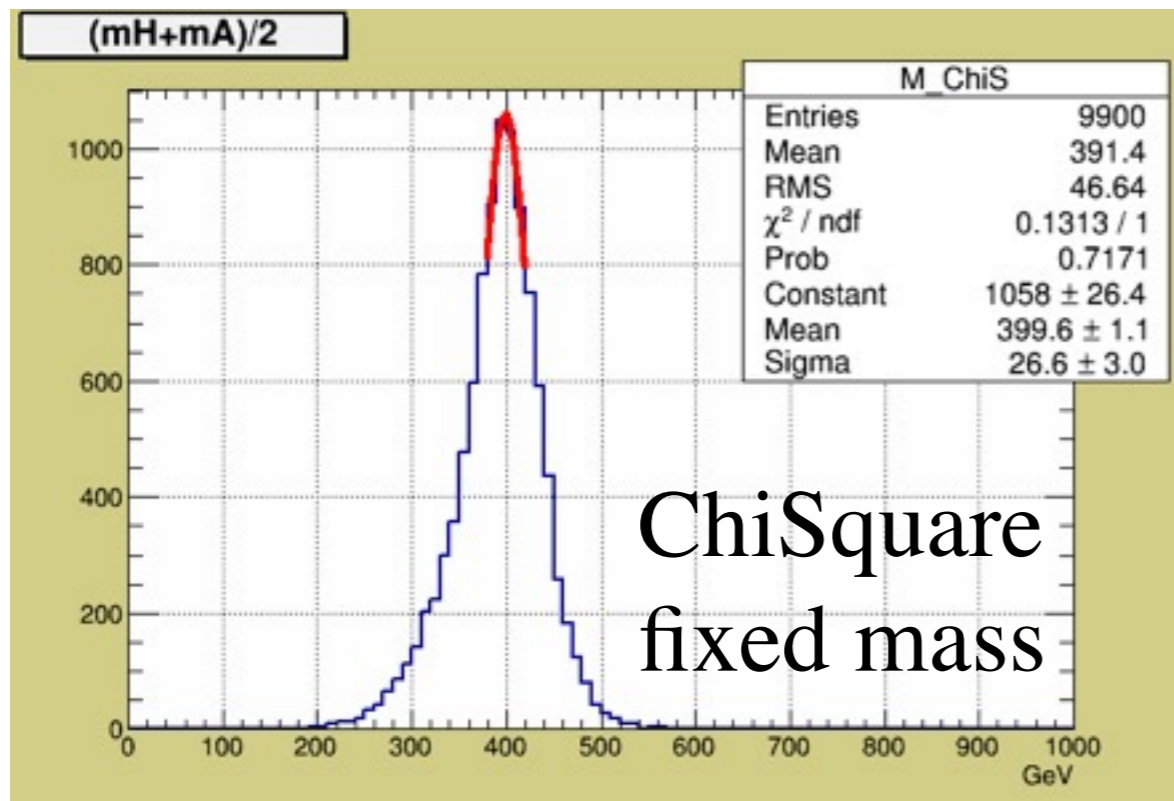
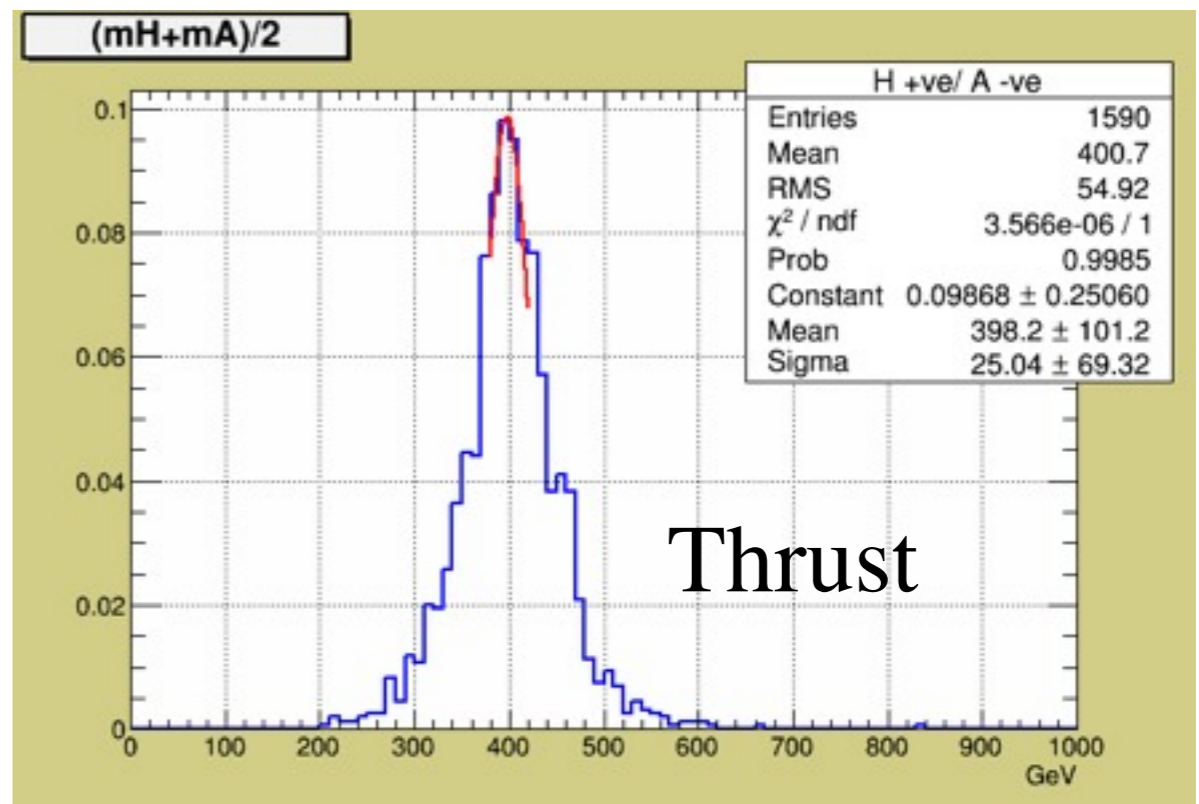
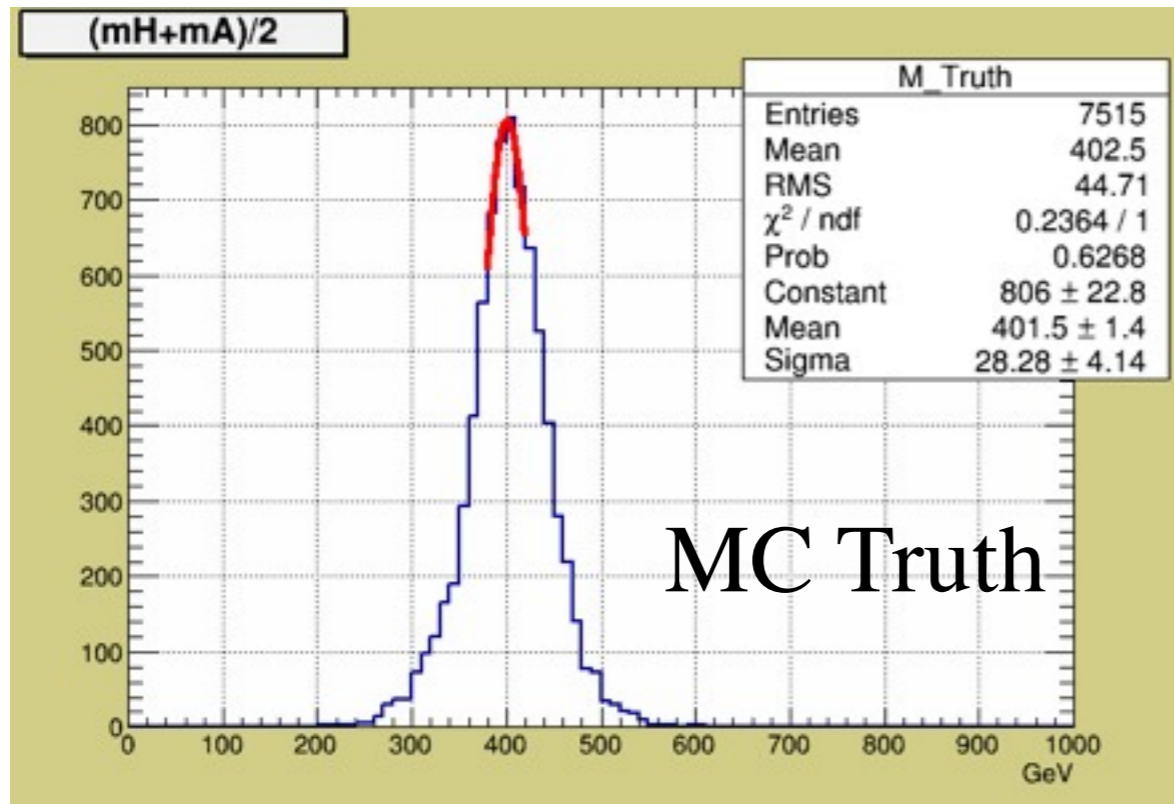


Selections using sign of  $j_1 \cos\theta * j_2 \cos\theta(H)$  and  $j_3 \cos\theta * j_4 \cos\theta(A)$

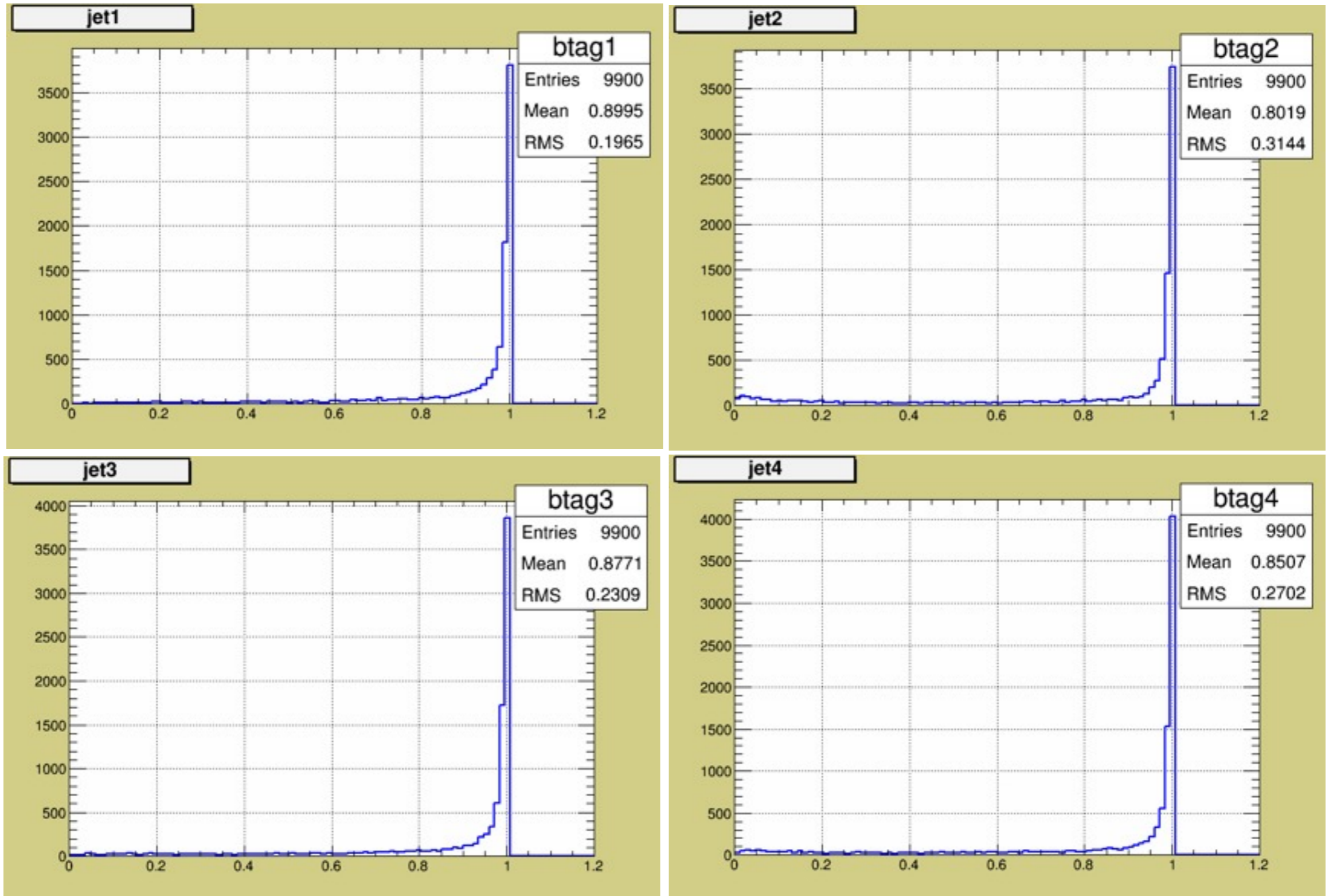


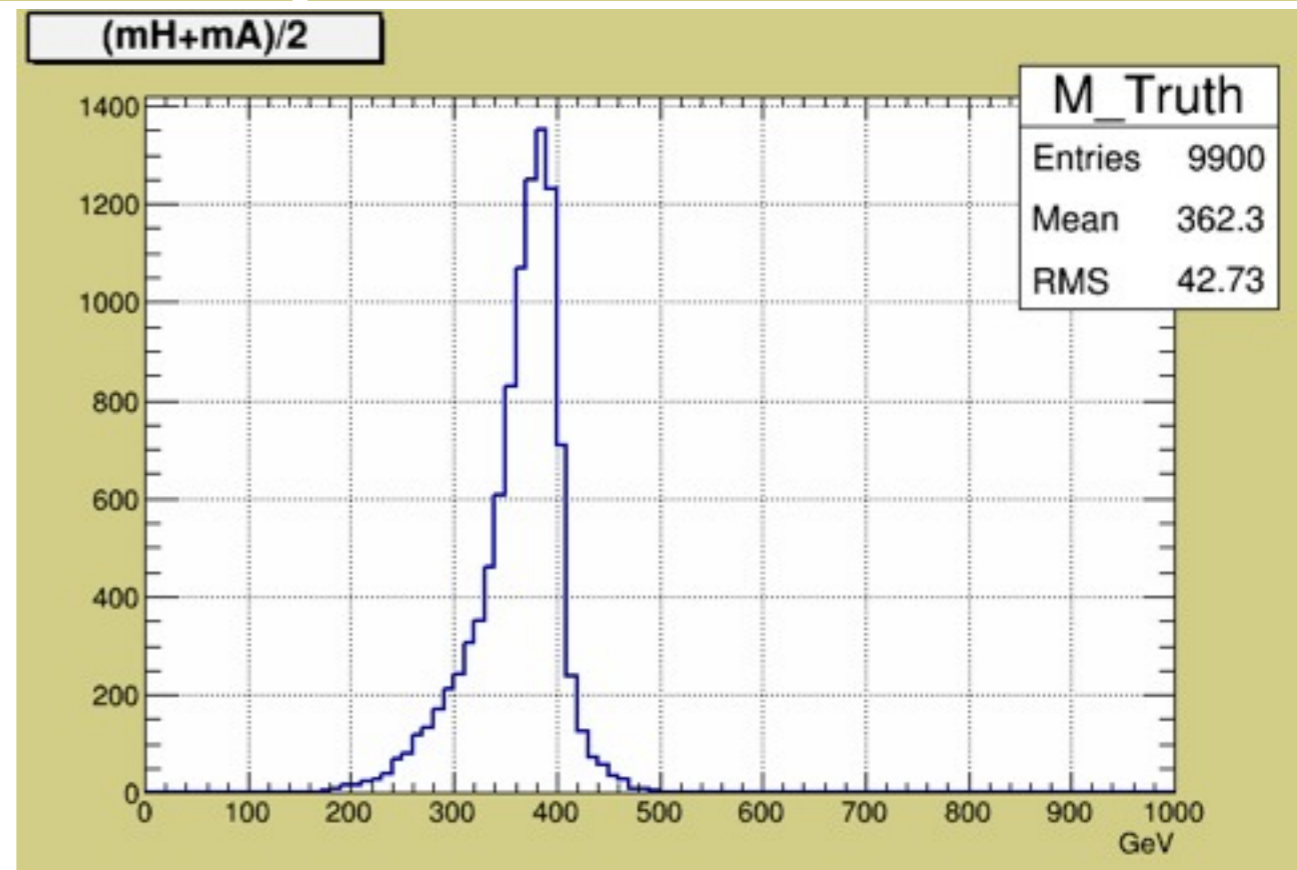
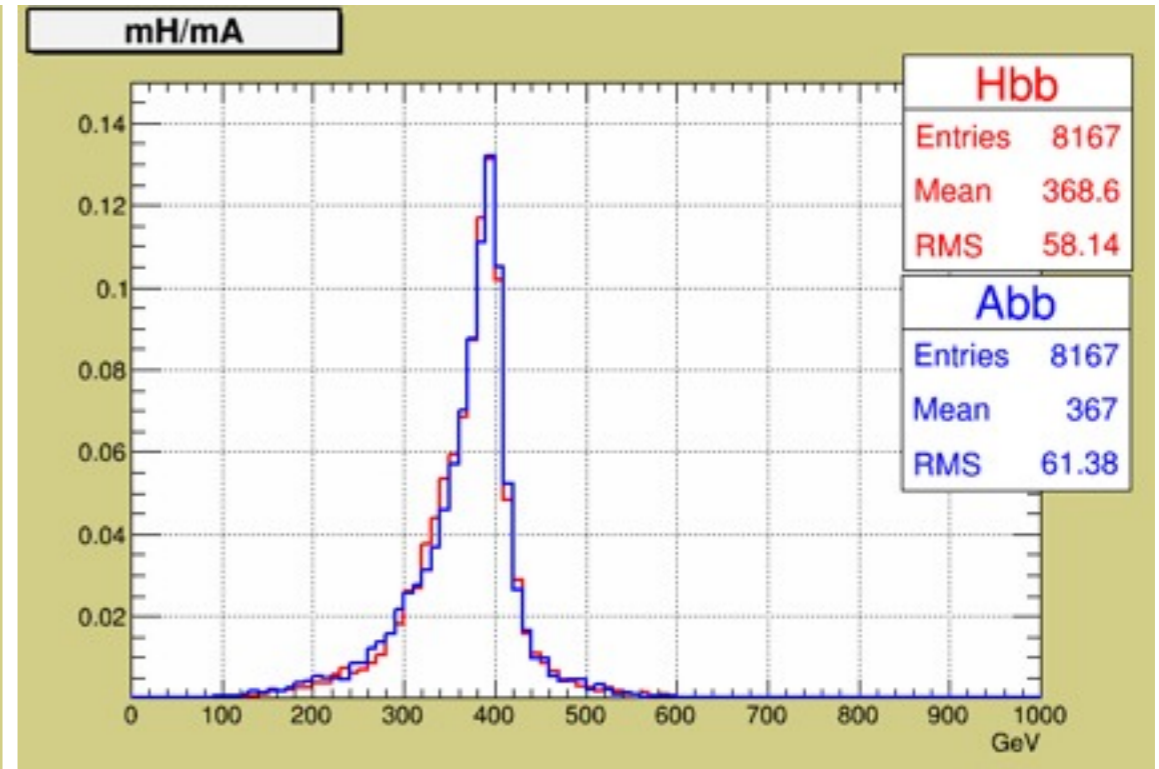
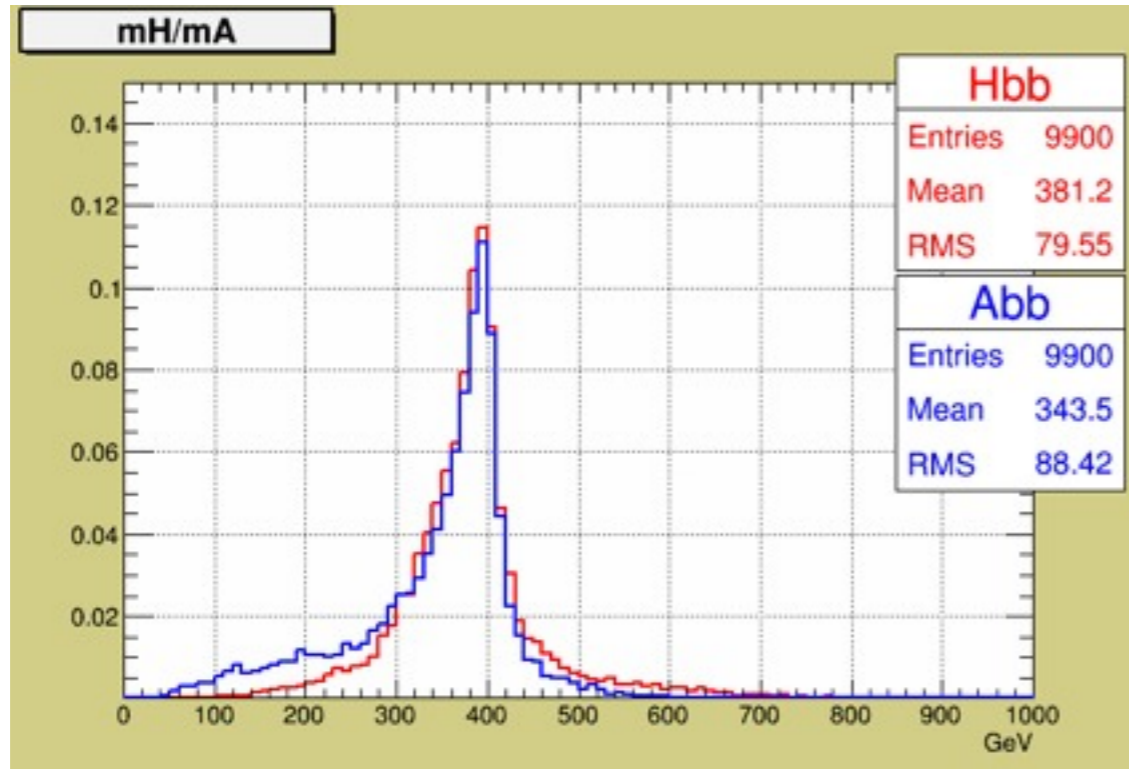
If  $j_1 \cos\theta * j_2 \cos\theta(H)$  +ve  
and  $j_3 \cos\theta * j_4 \cos\theta(A)$  -ve  
slightly better performance  
but efficiency not good.

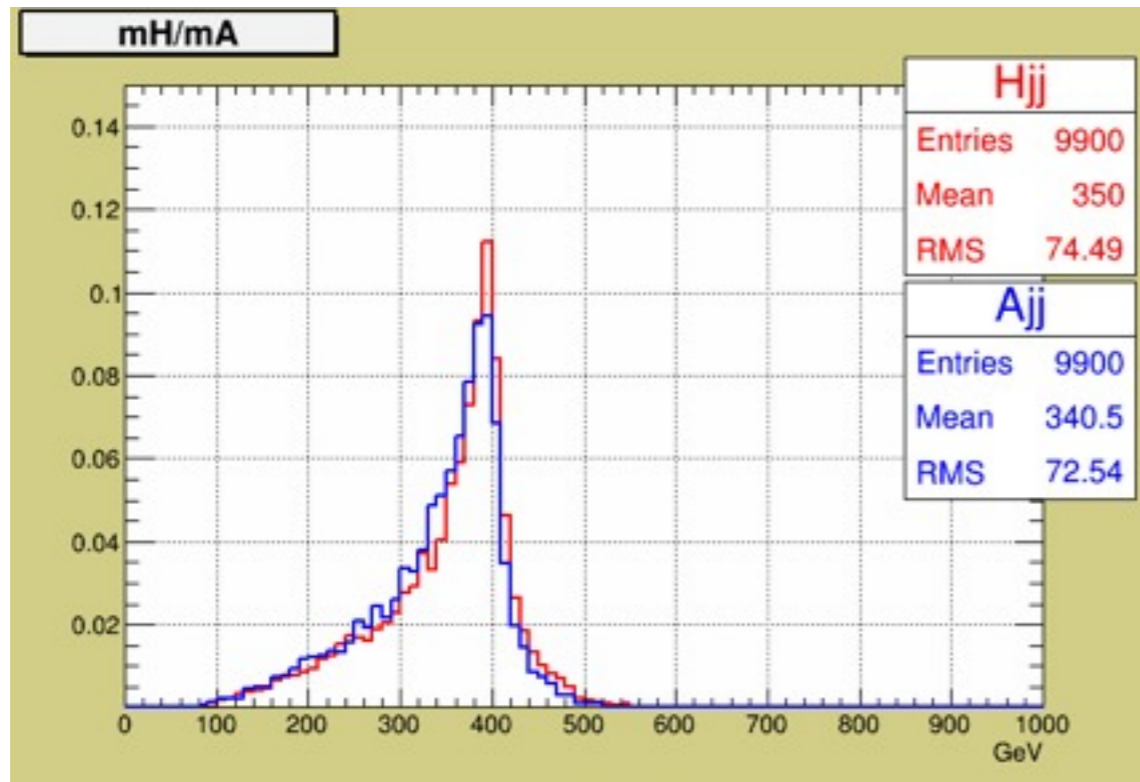




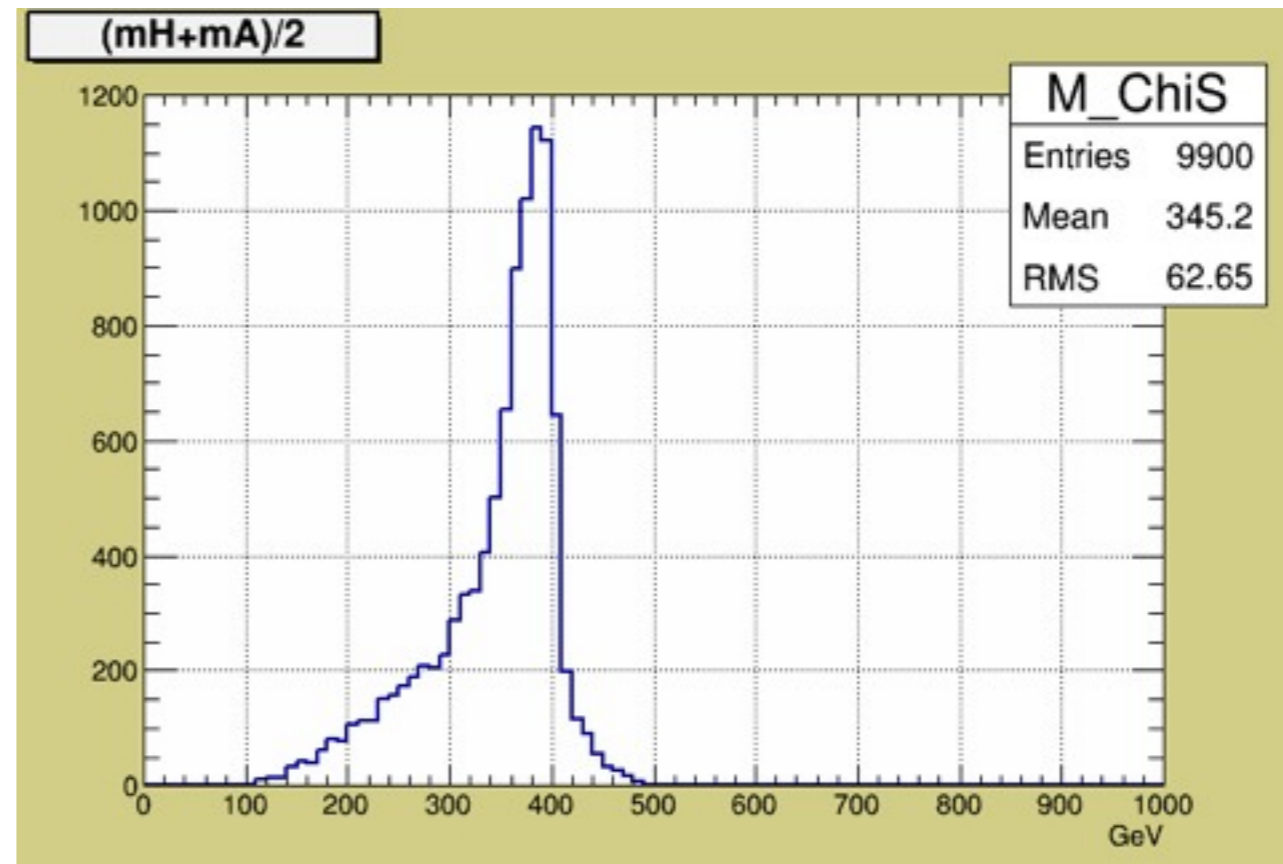
## High efficiency







Performance become worse after removing beam background.



- Signal sample is generated.
- Understanding reconstruction performance and possible improvements.
- Understanding beam background and overlay.
- Will start looking at SM background samples.

# BACKUP

# DeltaPhi of jet pairs

