Can we observe $h^0 \to c\bar{c}$?

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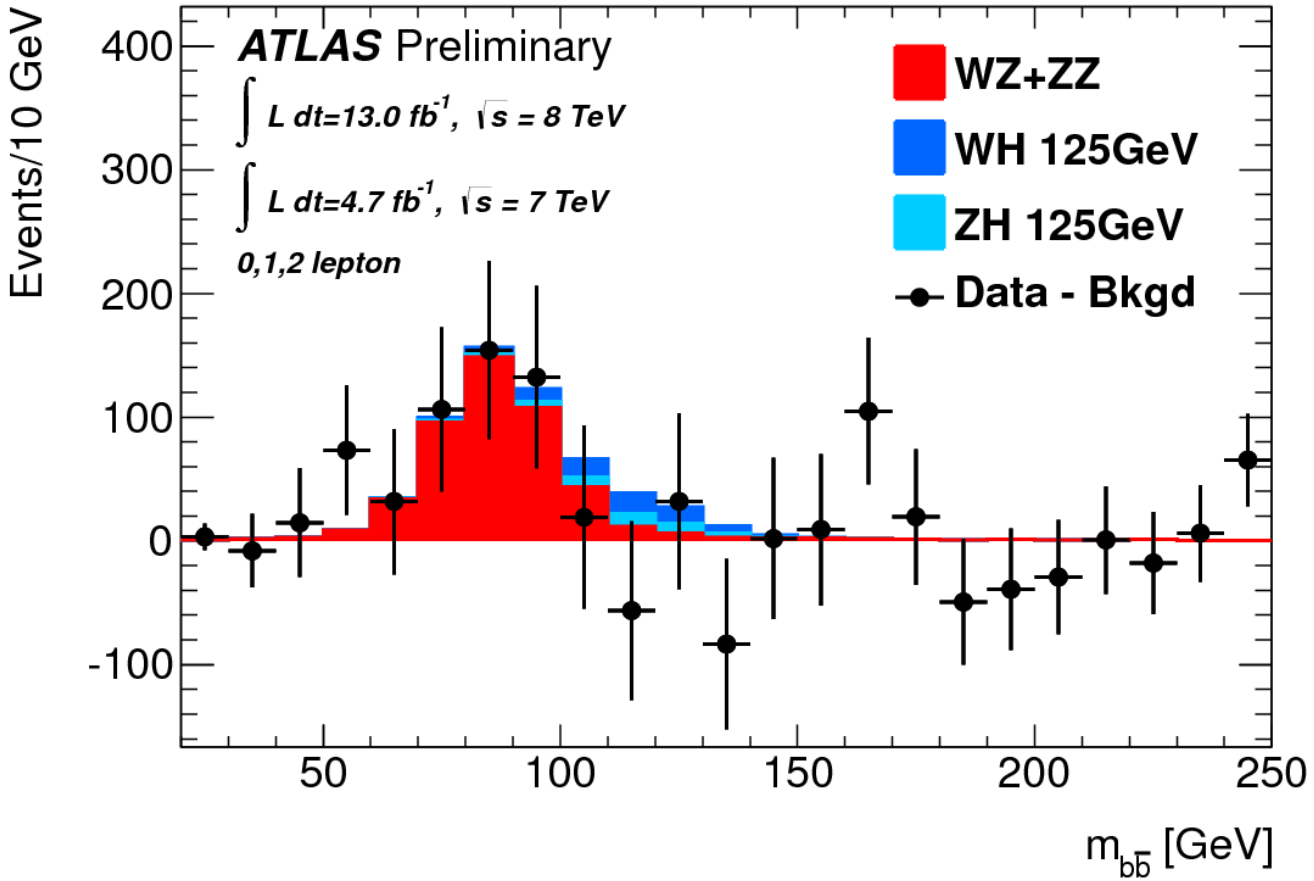
Can the LHC observe $h^0 \to c\bar{c}$?

- First, the LHC must observe $h^0 \to b\bar{b}$

Can the LHC observe $h^0 \to b\bar{b}$?

As seen yesterday, the present uncertainty, with ~18 /fb, is ~1 sigma:



Can the LHC observe $h^0 \to b\bar{b}$?

- Even with the first upgrade, it will be hard, but the increase in energy and luminosity should make it possible

- For $h^0 \to c\bar{c}$ it should continue to be very difficult until perhaps the third upgrade: HE-LHC

Observing $h^0 \to c\bar{c}$ at a $e^+e^- \to Zh$ or a $\mu^+\mu^- \to h$ machine

- Consider a 240 GeV $e^+e^- \to Zh$ machine
- Or a 126 GeV $\mu^+\mu^- \to h$ machine

$h^0 \to c\bar{c}$ at a 240 GeV $e^+e^- \to Zh$ machine

- Can imagine 10^5 produced Higgs (1 million is promised with 5 ab^{-1} and 200 fb cross-section)
- $\Rightarrow$ 3-4 x 10^4 Higgs tagged by the Z
- ~ 1000 $h^0 \to c\bar{c}$ Z-tagged decays
- ~ 20,000 $h^0 \to b\bar{b}$ Z-tagged decays
- $\Rightarrow$ Need ~ x20 rejection of this background

Simulation of ccbar and bbbar jets from Higgs Decays

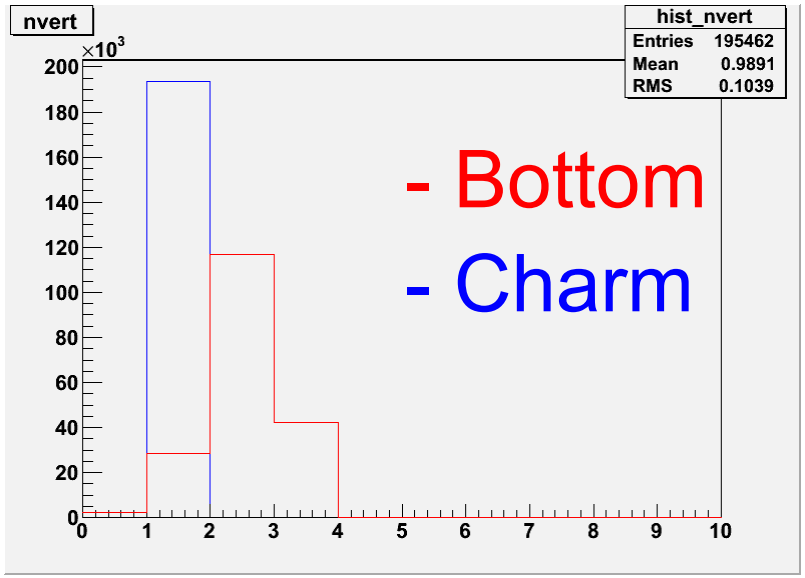
- Events were generated using PYTHIA 8.165
- h decayed to ccbar or bbbar
- Various jet variables studied to understand identification and rejection of b-jets:

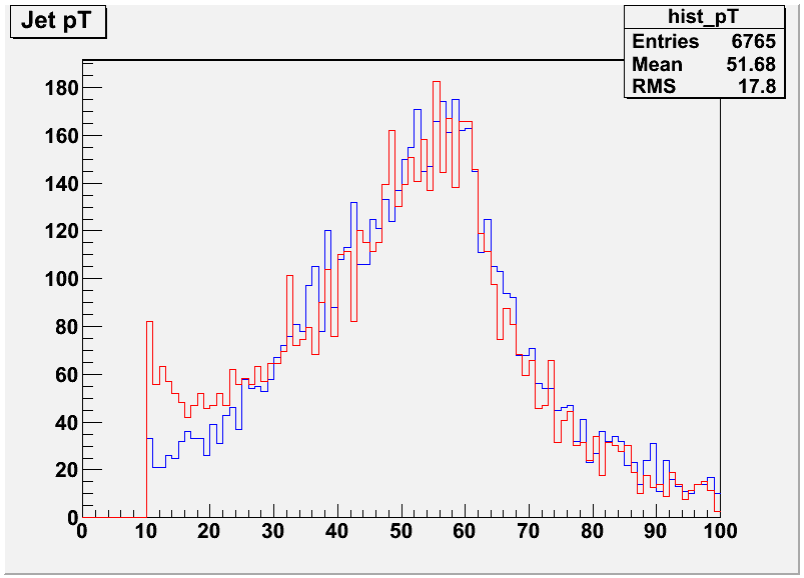
  match_chisq, e_jet, nD^+, nL_c, njets, p_T_jet, p_z_jet, nB, nD^0, nD_s
- Most interesting were:

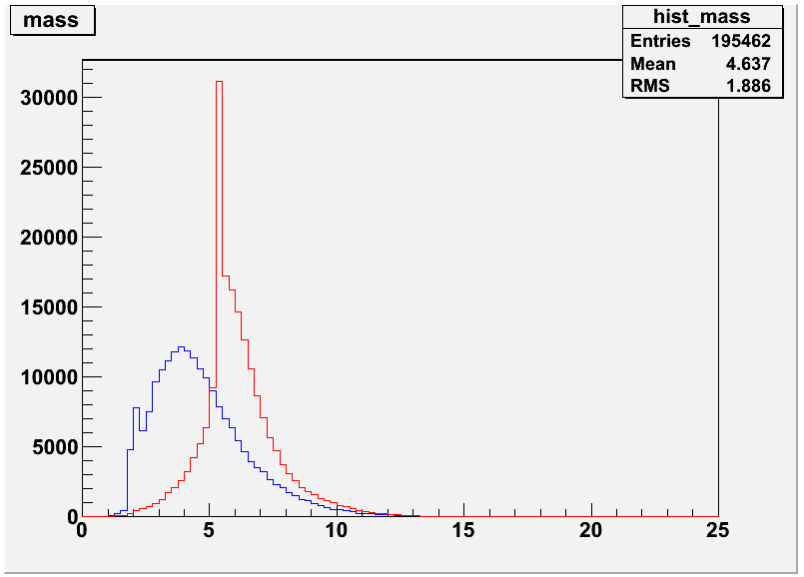
  evfrac (fraction of energy in vertices)

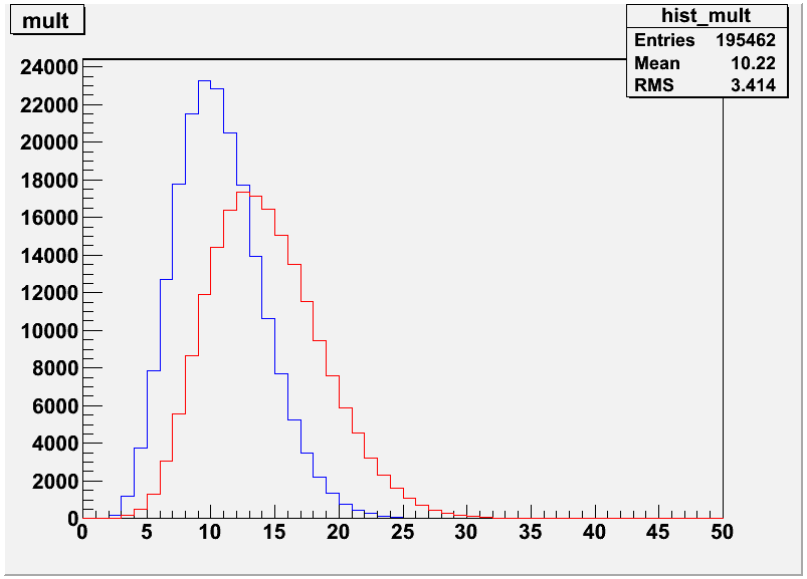
  jet_mass, maxsep, totsep, mult, nK, nvert

Distributions for $e^+e^- \to Zh$

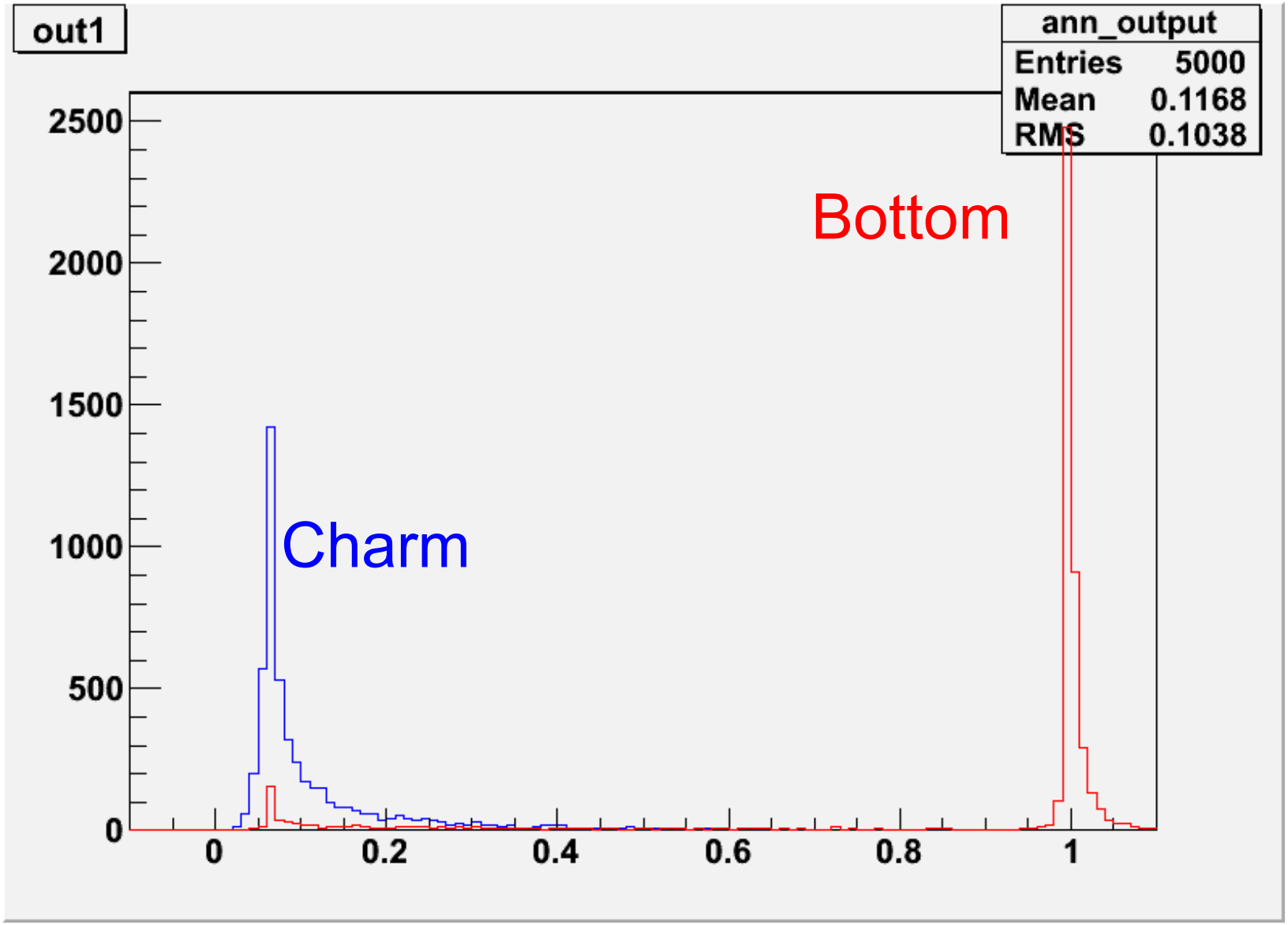




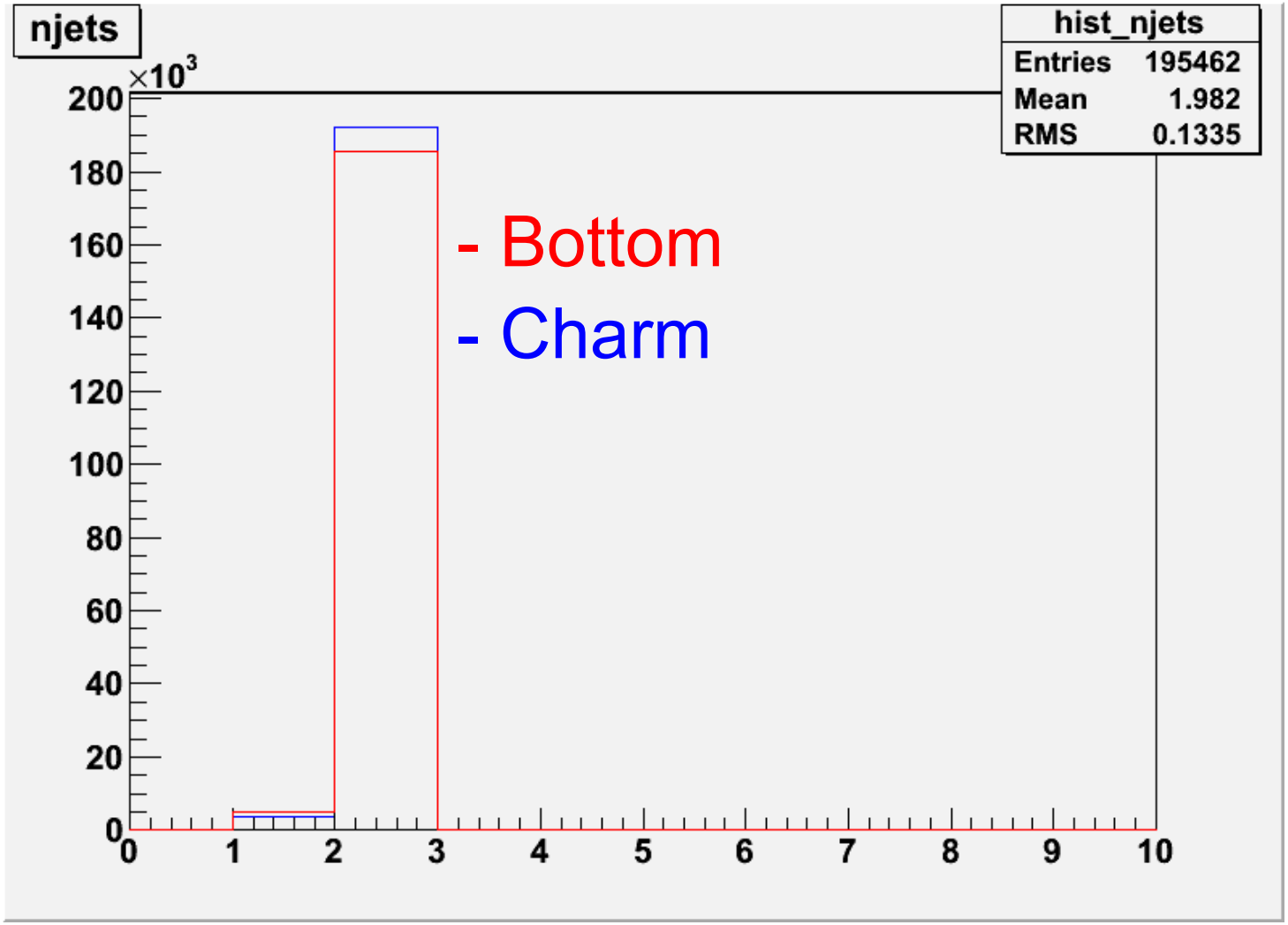




Multivariate combination: Neural Net for single jets $e^+e^- \to Zh$



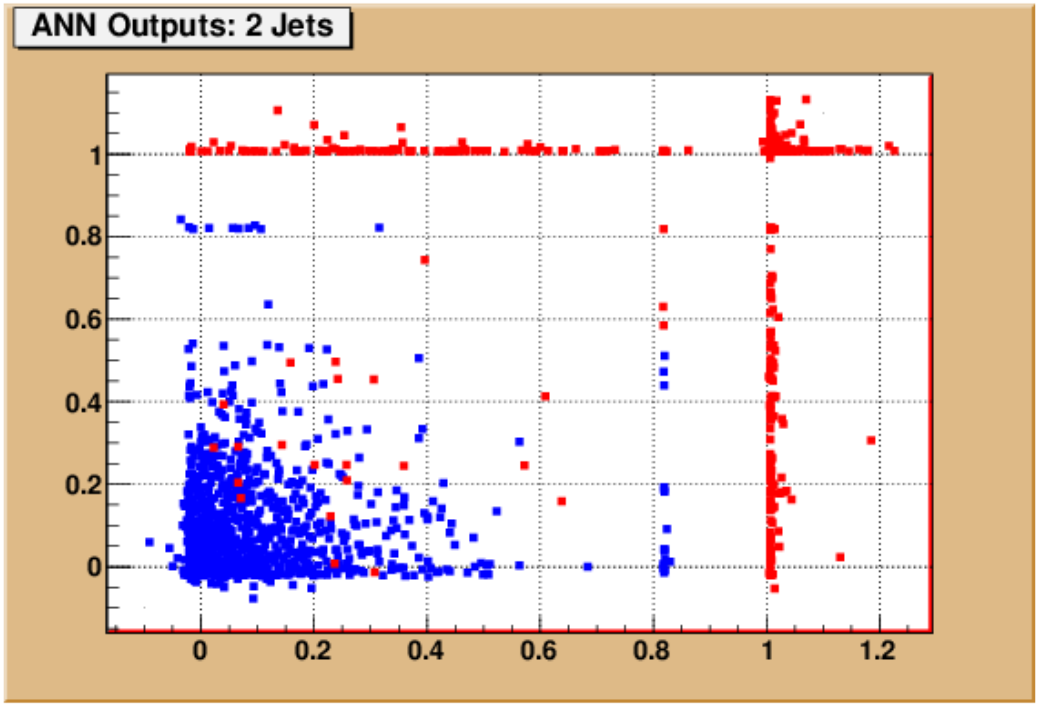
Jet multiplicity $e^+e^- \to Zh$



$e^+e^- \to Zh$

Rejection of bbbar with two jets

- Blue dots: ccbar (1000 events)
- Red dots: bbbar (1000 events)
- x20 rejection possible with > 90% efficiency



$h^0 \to c\bar{c}$ at a 126 GeV $\mu^+\mu^- \to h$ machine

- Can imagine 23,000 produced Higgs for integrated L = 1 fb^{-1} according to "Accelerators for a Higgs Factory: Linear vs. Circular", arXiv:1302.3318.

- ~ 800 $h^0 \to c\bar{c}$ events
- ~ 13,000 $h^0 \to b\bar{b}$ events
- $\Rightarrow$ Need ~ x20 rejection of this background

- However, with a 19 pb tail of Z production of $c\bar{c}$ we get 19,000 $c\bar{c}$ events background
- $h^0 \to c\bar{c}$ should still be observable! (Barely 5_σ)

$\mu^+\mu^- \to h$

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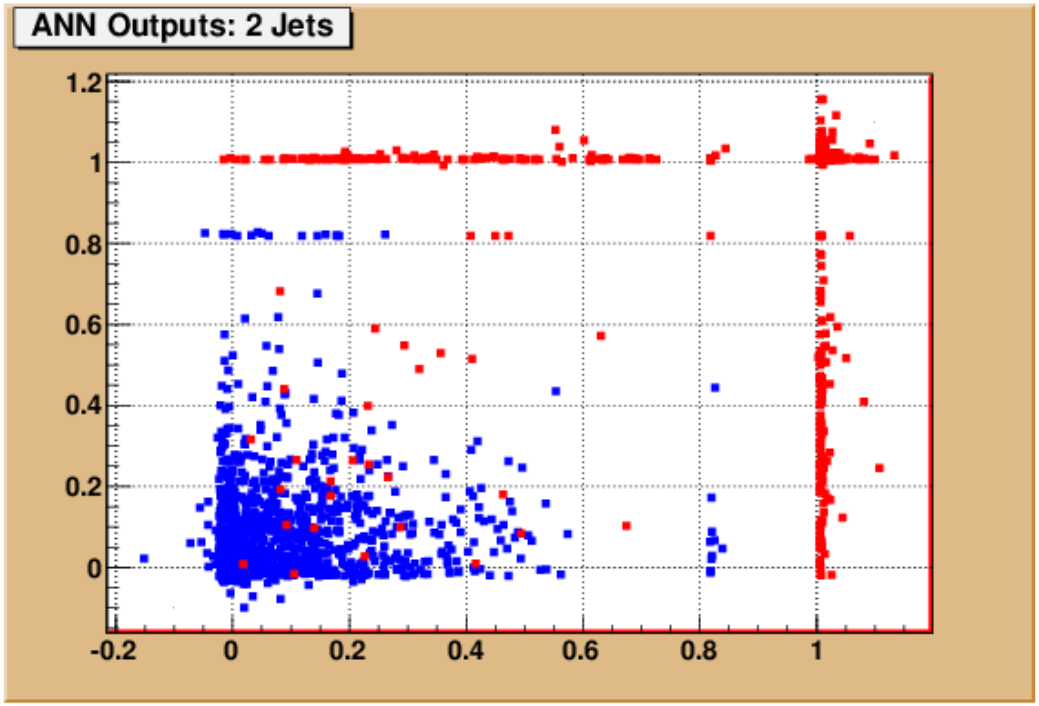

Conclusions

- Observation of ccbar should be simple at a 240 GeV machine for $e^+e^- \to Zh$

- Observation of ccbar may be possible at a 126 GeV machine for $\mu^+\mu^- \to h$

- Further studies with smearing simulating a real detector are needed