Study of Higgs Self-couplings at ILC

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status: full simulation

$$e^+ + e^- \rightarrow ZHH \rightarrow (l\bar{l})(b\bar{b})(b\bar{b}) \rightarrow 2 \text{ leptons} + 4 \text{ bjets}$$

- lepton selection was done, though not optimized.

- jet cluster algrithm was done, ANLJetFinder can be used in the Mars framwork.

- flavor tagging is not done, I need suggestions from experts.

main difficulty

- currently, there are no lepton + jets collections in the reconstructed dst file. we must start from the PFO collection.

- solution used by Yoshida-san: convert the original dst file into an new dst file which includes lepton collection and new jet collection (with a complicated program from Marks).

in the fact of fast simulation, we can use some common and independent libraries to select isolated leptons, do jet clustering and b-tagging. that's what I'm trying to do...

$$e^+ + e^- \rightarrow ZHH \rightarrow (l\bar{l})(b\bar{b})(b\bar{b}) \rightarrow 2 \text{ leptons} + 4 \text{ bjets}$$

selection criteria:

read out from PFOCollection

- energy of each track > 0.05 GeV, number of tracks > 25
- total visible energy between (300,600)
- at least two isolated charged leptons (the pair nearest to Z mass is selected)
- force the other tracks to four jets (ANLJetFinder used)
- combine the four jets by minimizing
- $\chi^2 = \frac{(M(b,\bar{b}) - M_H)^2}{\sigma_{H_1}^2} + \frac{(M(b,\bar{b}) - M_H)^2}{\sigma_{H_2}^2} + \frac{(M(l,\bar{l}) - M_Z)^2}{\sigma_Z^2}$

do not effect minimization

lepton selection (preliminary)

ECal and HCal informations can be read out straightforwardly for each track, then they are used for lepton identification.

$E_{total}=E_{ECAL}+E_{HCAL}$

P>15 GeV	e-identification	μ-identificantion
E_{ECAL}/E_{total}	>0.6	<0.5
E_{total}/P_{track}	>0.9	<0.3

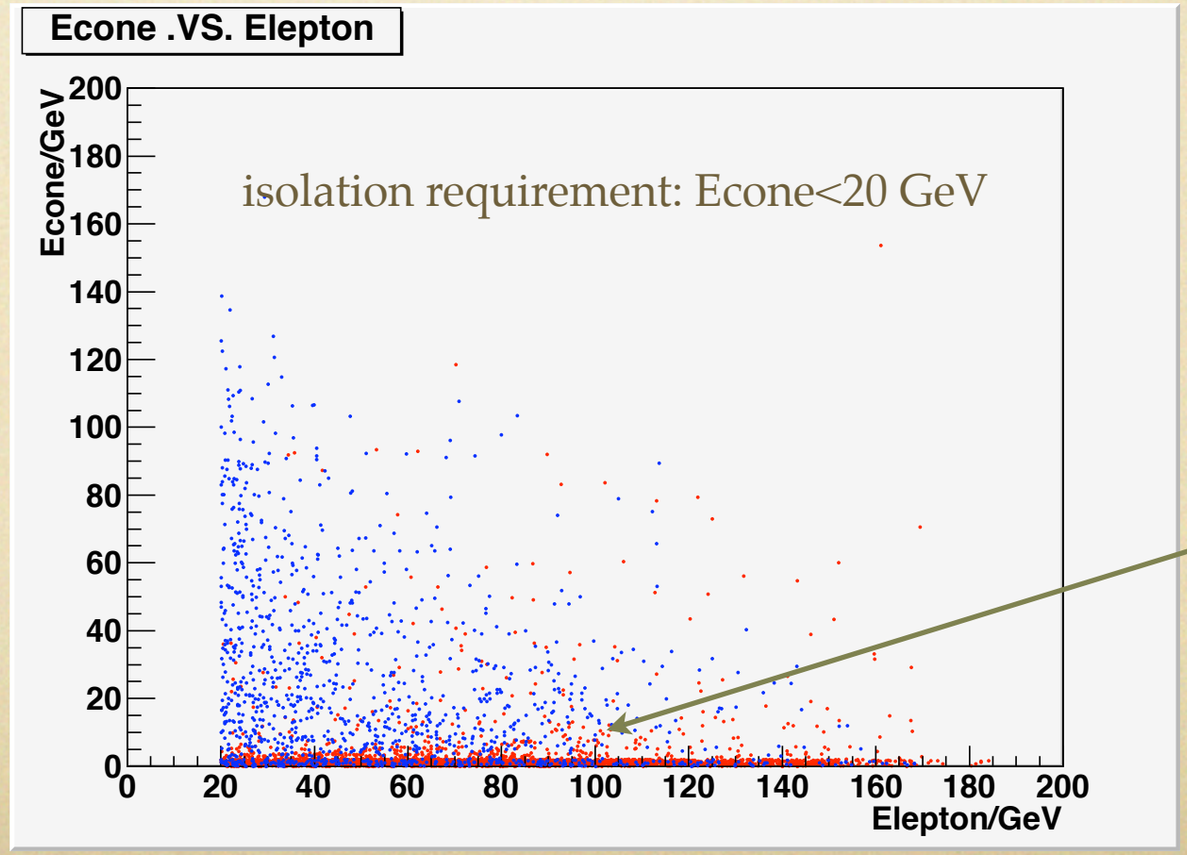
HZ recoil mass by ILD

P>20 GeV	e-identification	μ-identificantion
E_{ECAL}/E_{total}	>0.8	<0.5
E_{total}/P_{track}	[0.8,1.2]	<0.5

my requirement

currently, I can't obtain the information that if the track is a primary lepton or form jets. Here the red points only denote the tracks satisfy:

$$(p-p_{truth})^2 < 10$$

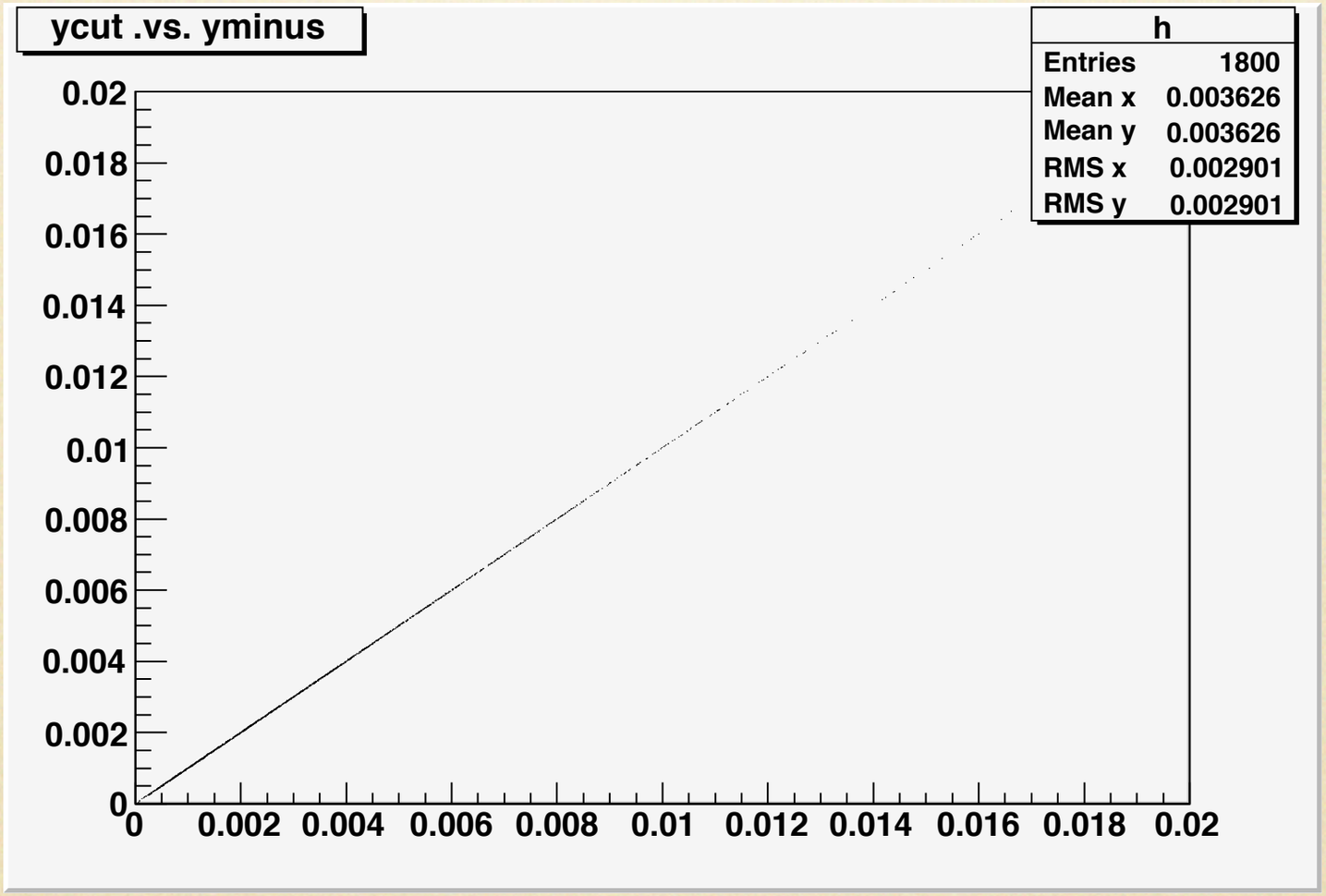


$\cos_{cone} = 0.99$

very small angle, still high cone energy

jet clustering

fortunately, ANLJetFinder can be directly used in the Mars analysis



I compared the ycut obtained by ANLDurhamJetFinder and the yminus read from the jet information in the collection Durham_6Jets using bbHH sample. They are exactly same.

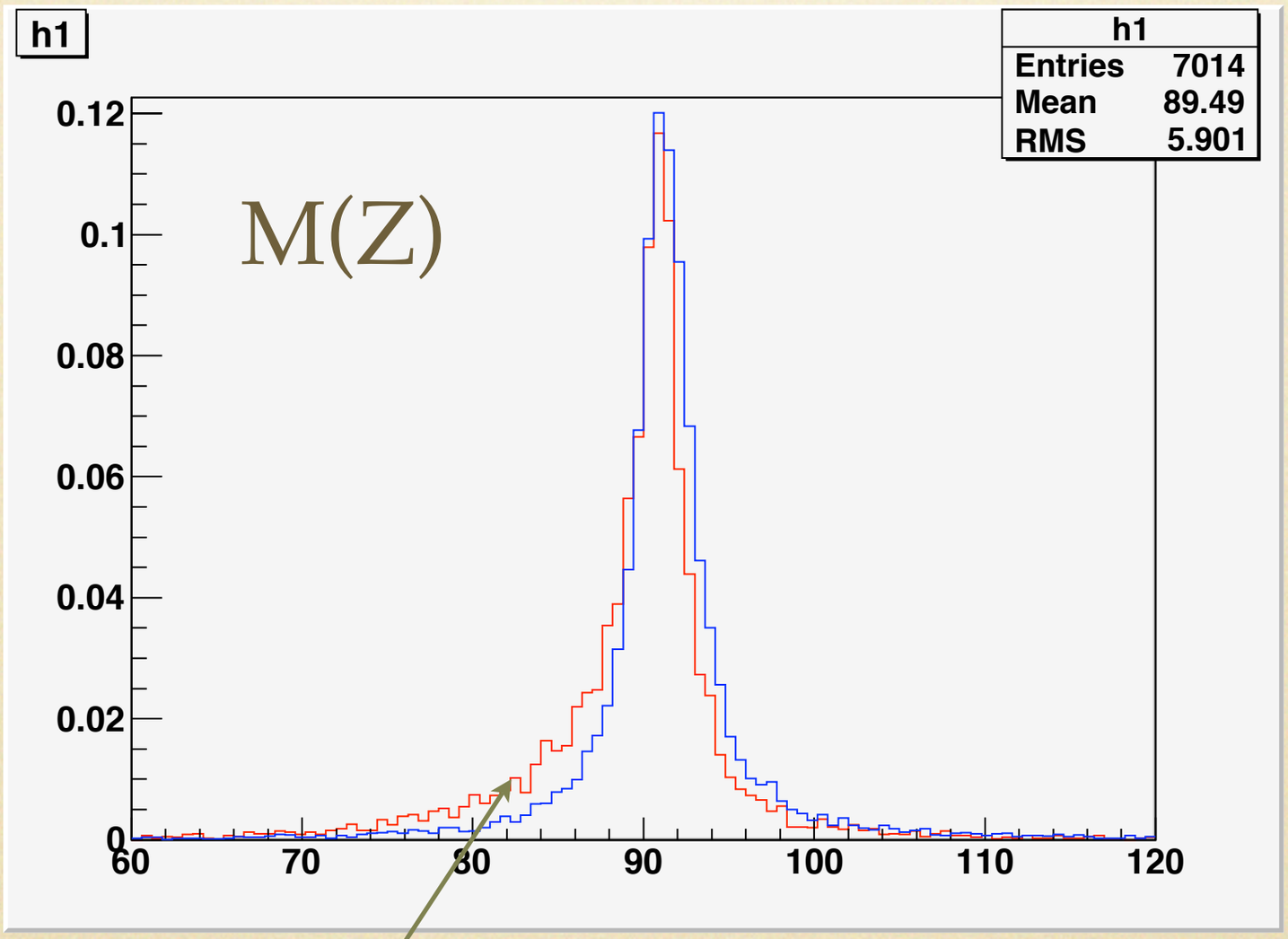
flavor tagging

- I don't know how to use the LCFIVTX algrithm in this case. I would like to use a jet composed of PFOs as input, but the PIDHander seems need LCCollection as input.

preliminary results
and compare with fast simulation

red: full simulation

blue: fast simulation

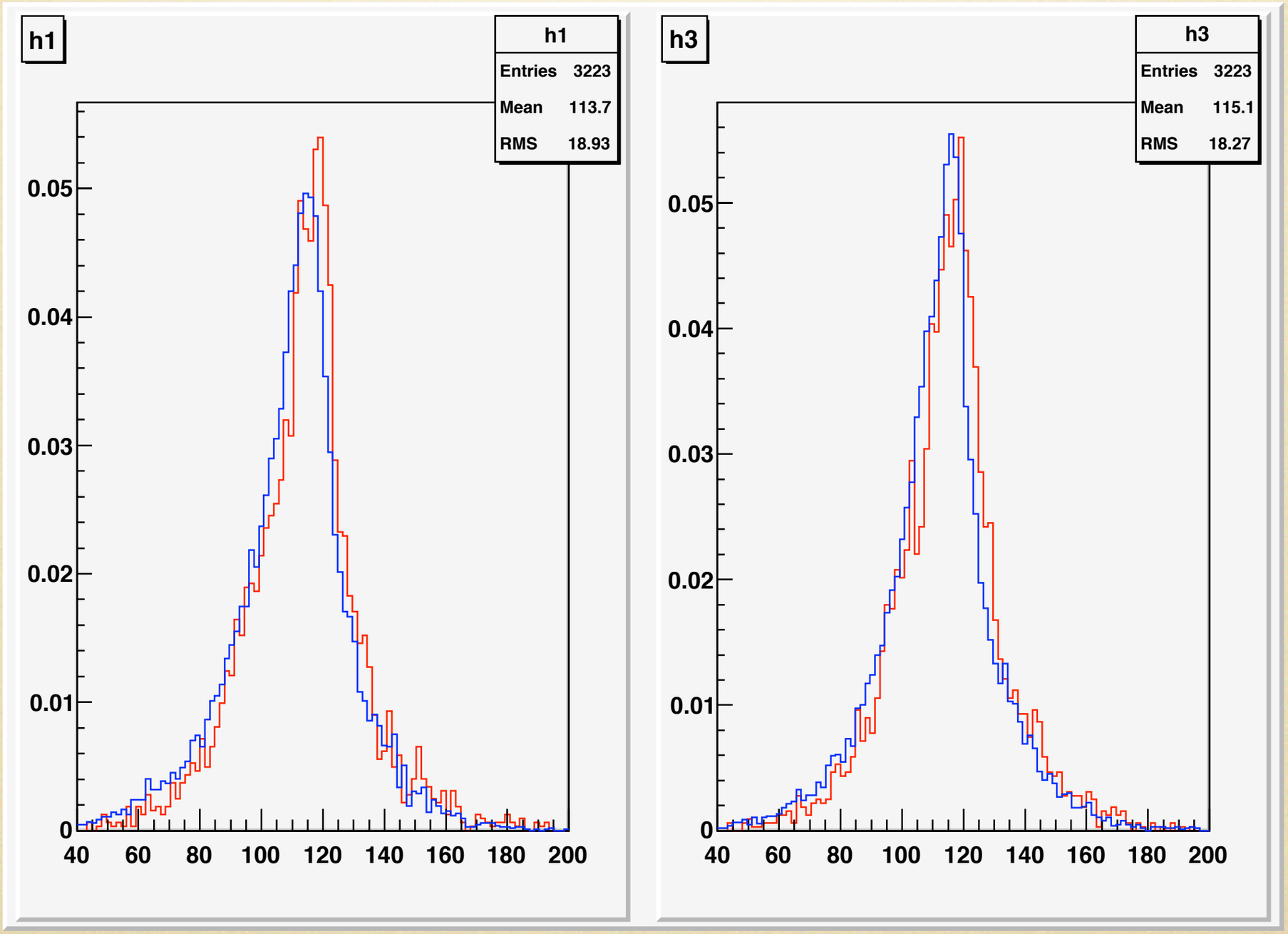


bremsstrahlung

Higgs masses

red: full simulation

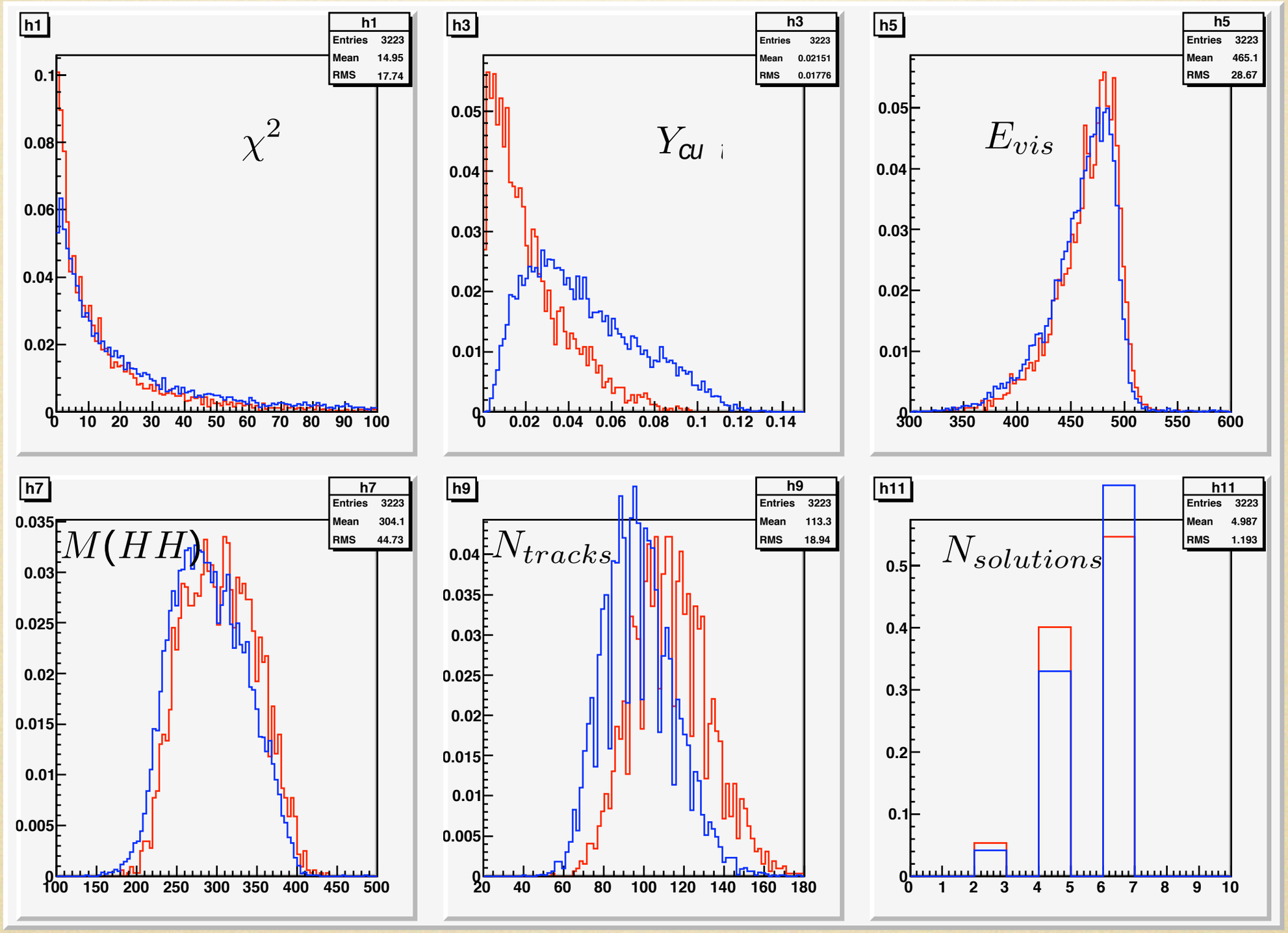
blue: fast simulation



others...

red: full simulation

blue: fast simulation



difference of Ycut is due to different ANLJetFinder:

JadeE in fast simulation, Durham in full simulation

Standard Model backgrounds (preliminary)

250 fb^{-1} ?

not normalized!

	llHH	tt-bar	bbbbbb&bbcsdu	bbHH&ccHH	llffff
generated	9791	39960	39998	16000	681
pre-seletion	7014	231	4	91	112
70<M(Z)<110	6842	123	0	38	94
ycut>0.005	5770	34	0	31	59
chi2<40	4811	12	0	21	36
80<M(H1)<140	4475	12	0	18	31
80<M(H2)<140	4134	12	0	15	30
evis>400	3850	7	0	12	30

without b tagging...

next to do

- try to include b tagging
- optimize the lepton selection
- prepare more ZZZ, tt-bar backgrounds for neural-net analysis