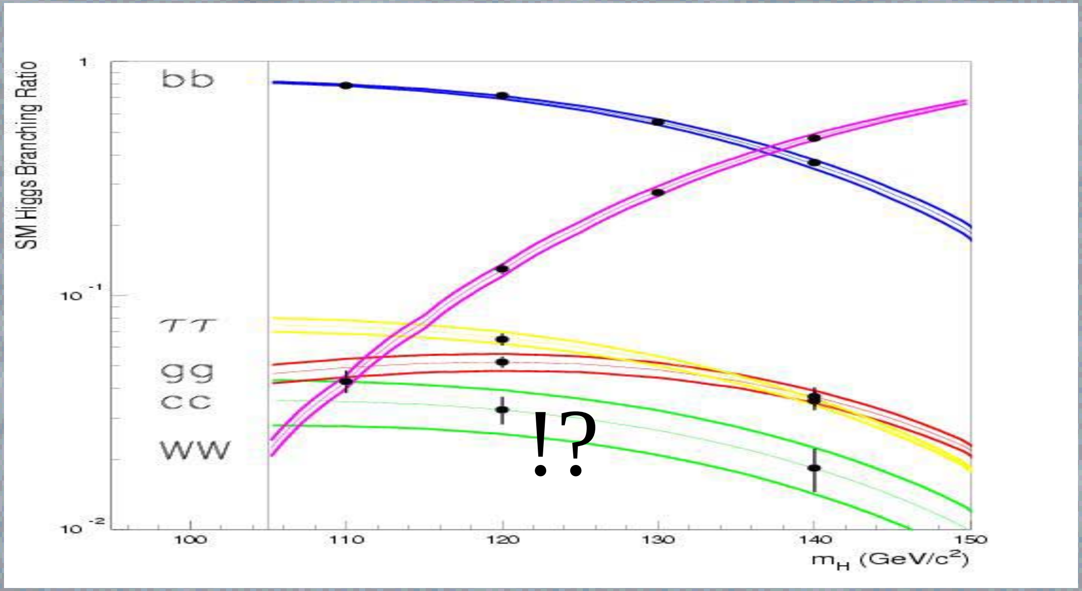
Heavy Quark Discrimination for SM Higgs BR Measurements



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SM Higgs branching ratios with errors vs Higgs mass (M. Battaglia, hep-ph/9910271, October 1999)

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Outline of Presentation

- Assumptions and Tools
- Heavy Quark Discrimination Parameters
- Relative Higgs BR Error Results
- Comparison to Other Studies
- Factors Which Determine the Charm BR
- The Charm Measurement: Effect of Factors
- Developments at Snowmass
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- Will the Ghost Track Algorithm Help?
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Assumptions and Tools

- 500 GeV linear collider with 500/fb
- Pandora generator with ISR and beamstrahlung
- Higgstrahlung production mode only (no WW-fusion)
- NLD Large detector w/ Fast Sim. (LCD Root Tools)
- ZVTOP with neural network (LCD Root Tools)

Heavy Quark Discrimination Parameters

In each event, leptonic Z decays were tagged and the recoiling Higgs mass calculated. Z and recoil mass cuts were then applied. The signal was scaled up by a factor of 4 to include hadronic Z decays.

- **Number of vertic**es found by ZVTOP in each jet
- Pt corrected mass found by ZVTOP in each jet
- Number of tracks with 3D impact parameter significance larger than 3

These parameters , along with ten others selected to identify h->gg, h->WW*, and h->tau+ tau-, were used as inputs to a neural network (NN). The NN output cuts were then optimized for BR error.

Relative Higgs BR Error Results

Mode	115 GeV	120 GeV	140 GeV	160 GeV	180 GeV	200 GeV
h->WW*	0.16	0.1	0.03	0.02	0.03	0.04
h->bb	0.03	0.03	0.04	0.13	0.59	-
h->tau+tau-	0.07	0.08	0.1	0.36	-	-
h->cc	0.31	0.39	0.44	-	-	-
h->gg	0.16	0.18	0.23	-	-	-
h->cc+gg	0.15	0.16	0.2		-	-

Results of the Oregon Higgs study for six SM Higgs masses. See "Standard Model Higgs Boson Branching Ratio Measurements at a Linear Collider," C.T. Potter, J.E. Brau, and M. Iwasaki in the Snowmass 2001 Proceedings for a full account of this study.

Relative Higgs BR Errors for a 120 GeV SM Higgs: Three Studies

Study	h->bb	h->cc	h->gg	**h->tau+tau-**	h->WW*
TESLA*	0.05	0.17	0.11	0.1	0.1
ACFA**	0.02	0.27	0.13	-	0.16
Oregon	0.03	0.39	0.18	0.08	0.1

* TESLA TDR study assumed a 350 GeV LC with both WW-fusion and Higgstrahlung production modes. The TESLA results have been scaled to the assumptions of the Oregon study.

** ACFA study assumed the same parameters as the Oregon study.

Factors Which Determine the Oregon 120 GeV Higgs Charm BR Measurement

- The initial e+e- -> Zh consistency mass cut. We get 31% efficiency and 56% purity. Battaglia ('99) gets 25% and 76% respectively for both production modes.

- Background from h->bb. See table below.

- Background from e+e- -> ZZ(*). See table below.

Mode	Charm Tag
h->WW*	3
h->bb	60
h->cc	30
h->gg	3
e+e- ->ZZ(*)	39

The Charm Measurement for a 120 GeV Higgs: Effects of Factors

Results when we optimize the charm tag after neglecting i) h->bb, ii) e+e-->ZZ(*), iii) mass cuts and e+e ->ZZ(*), and iv) mass cuts, h->bb and e+e-->ZZ(*) are at below.

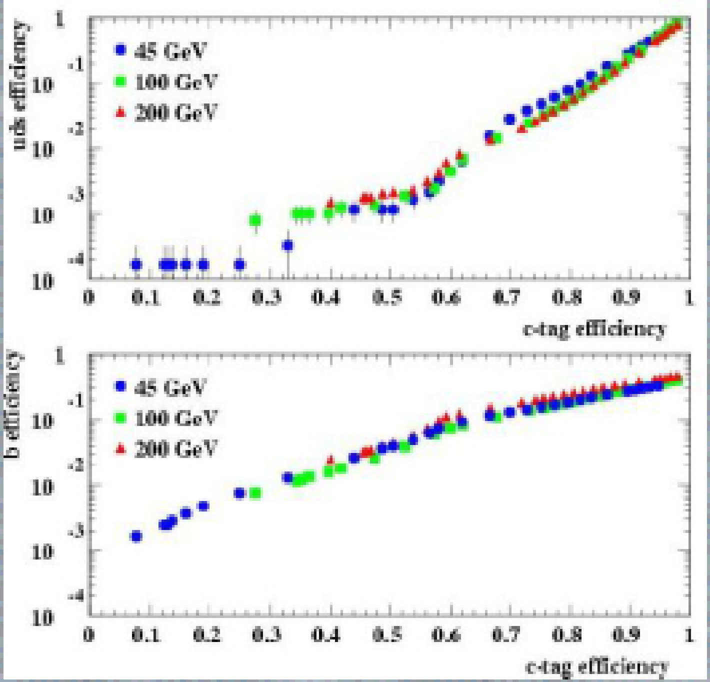
Study	**h->cc BR Err.**
Oregon	0.39
i) no bb	0.32
ii) no ZZ(*)	0.28
Iii) no Mcuts, no ZZ(*	0.16
iv) no Mcuts, bb, ZZ(*)	0.09
ACFA	0.27
TESLA	0.17

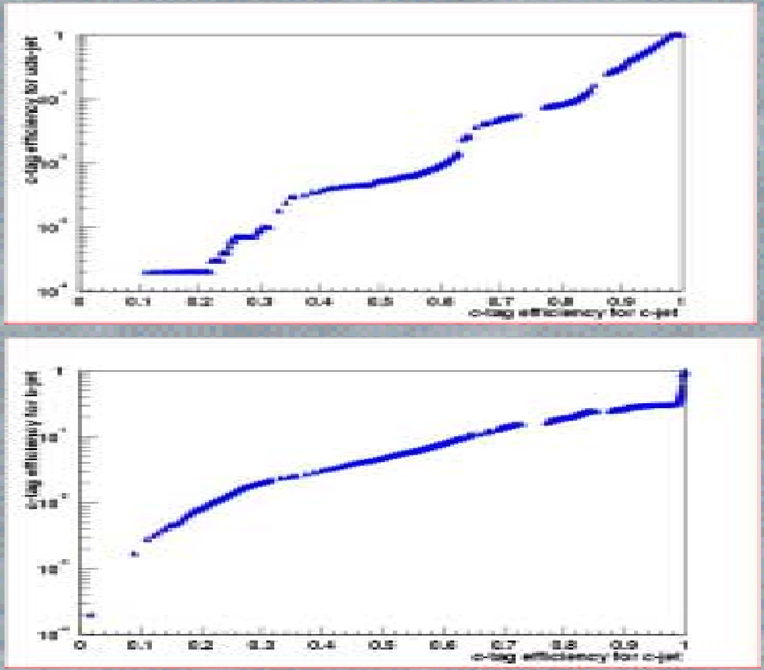
Developments at Snowmass

- We met with M. Battaglia and K. Desch.
- Battaglia planned to prepare a tag/mistag table.
- It appeared that the e+e-->ZZ* background may have been underestimated in the TESLA study.
- We were referred to the b/c/uds jet tagging efficiency plots for monojets in the TESLA TDR generated by Xella-Hansen et. al.

b/c/uds Tagging Efficiency Plots

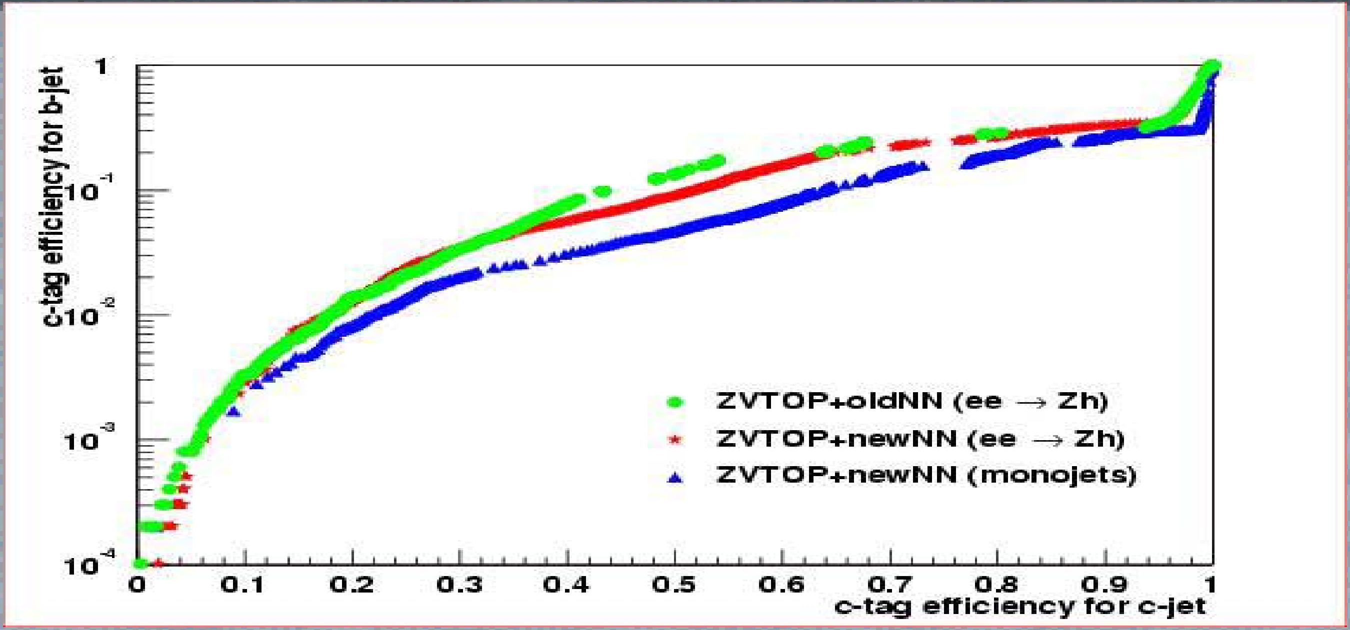
Are our jet tagging tools deficient? We added two changes to our neural network:
i) include the largest 3D impact parameter significance in each jet and ii) include the number of tracks with 3D impact parameter significance larger than 3 in each jet.





Monojets generated with Pythia (|cos(theta)|<0.9) are analyzed. TESLA plots are at left, the Oregon plots (45 GeV) at right.

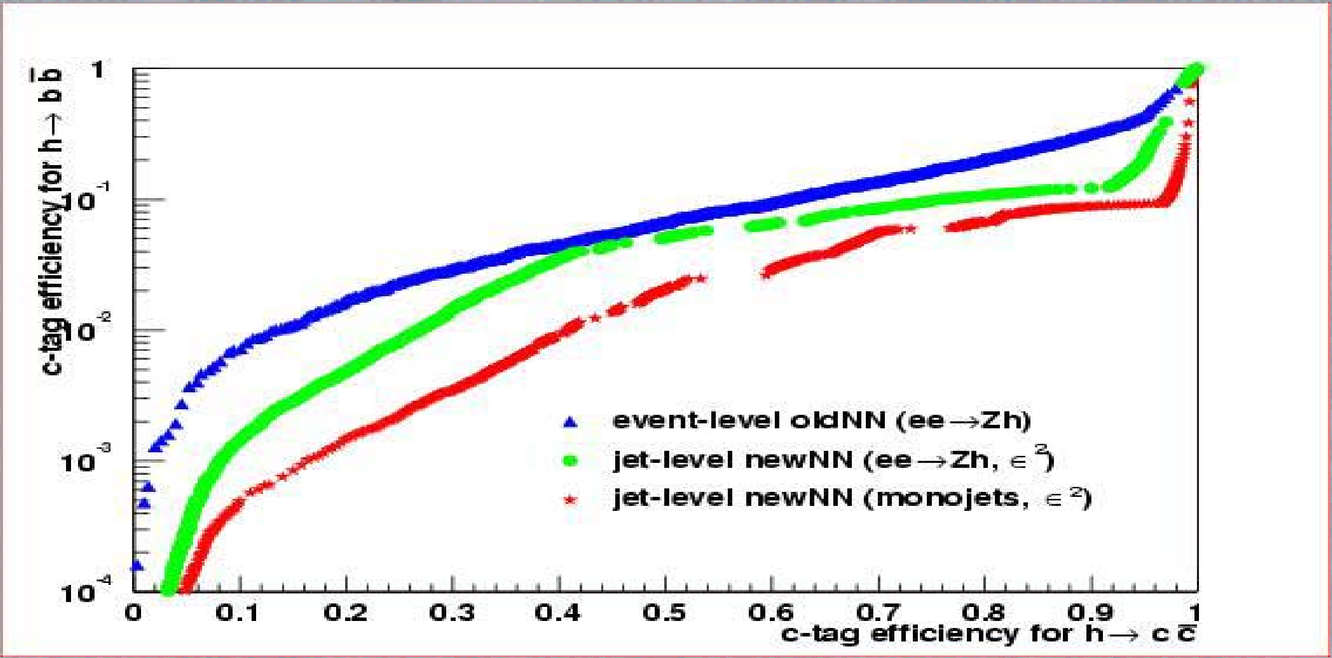
Impact of NN Changes on Higgs Tagging Performance



Jet level efficiencies for Higgs decays to jets in e+e- ->Zh, Oregon study.

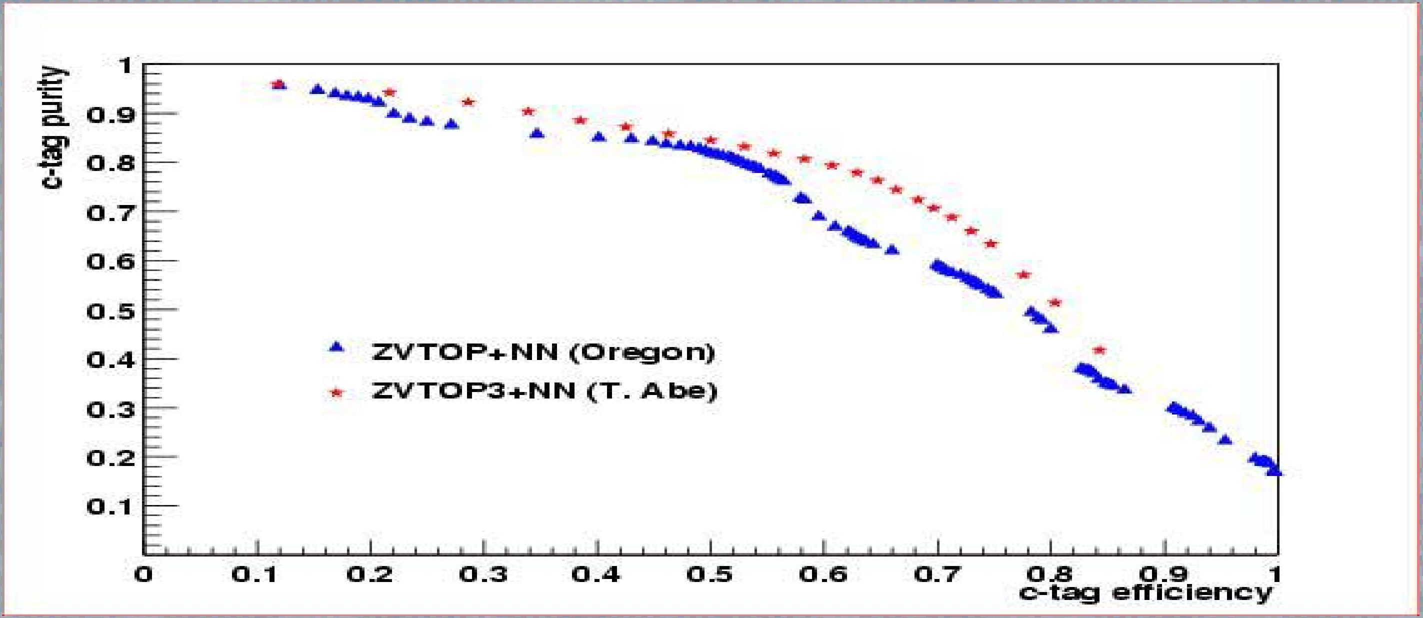
- **At intermediate efficiencies there is modest improvement when the NN includes i)the largest 3D impact parameter significance in each jet and ii) the number of tracks with 3D impact parameter significance larger than 3 in each jet.**
- **Monojets underestimate the flavor confusion in measuring h->cc.**

Monojet Efficiencies vs Event Level Efficiencies.



Event level efficiencies for Higgs decays to jets in e+e- ->Zh (oldNN), Oregon study. The idealized monojet efficiencies (newNN) are squared on this plot, as are the Zh single jet efficiencies (newNN).

Will the Ghost Track Algorithm Improve the Tagging?



Event level c-tag purity vs efficiency for Z decays to quark jets, Oregon study and SLAC study by T. Abe. ZVTOP3 includes the ghost track algorithm.

Conclusions

The tagging performance of LCD Root Tools agrees with that of the TESLA tools.

A new analysis with a NN which matches the TESLA monojet performance does not significantly decrease h->bb contamination in the h->cc sample.

Extrapolation from simple monojets underestimates flavor confusion in the h->cc BR measurement.

While the Ghost Track Algorithm may improve the h->cc measurement, it is unlikely to improve it dramatically.