

$H \rightarrow bb, cc, gg$ branching ratio analysis with ZVTOP

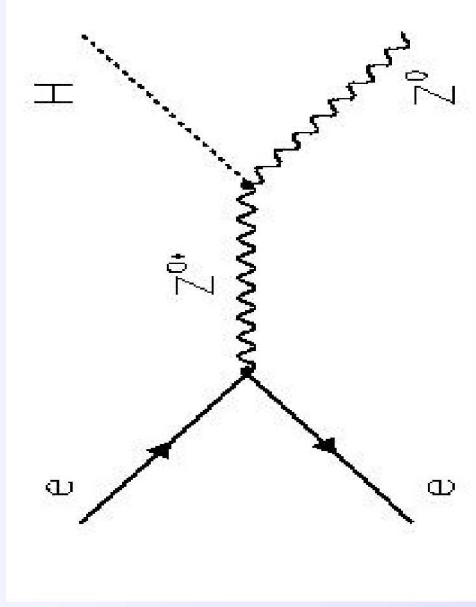
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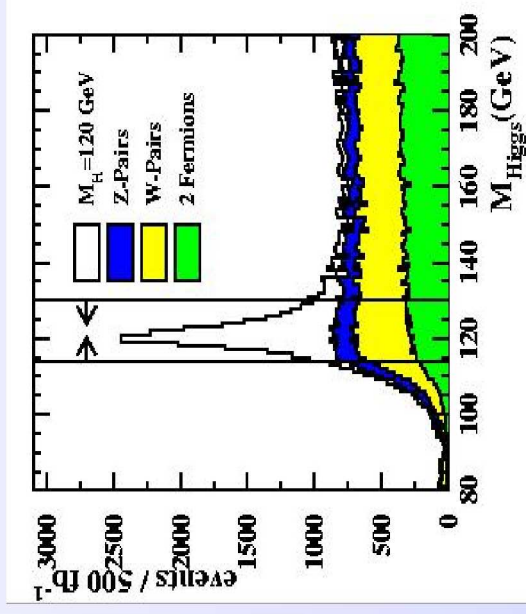
ECFA/DESY Workshop
Amsterdam 2003

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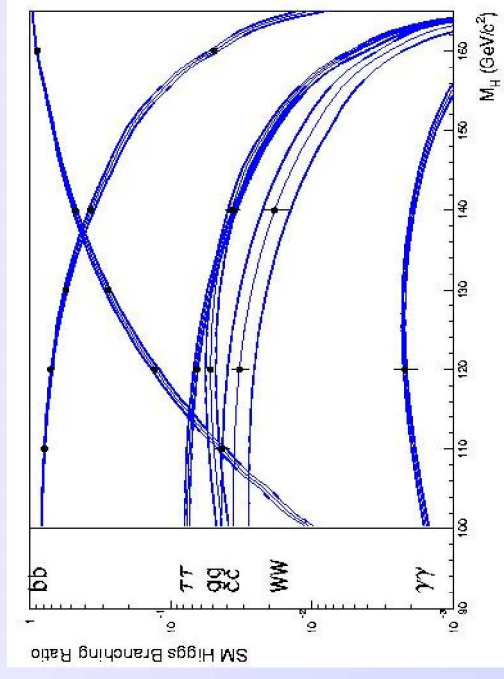
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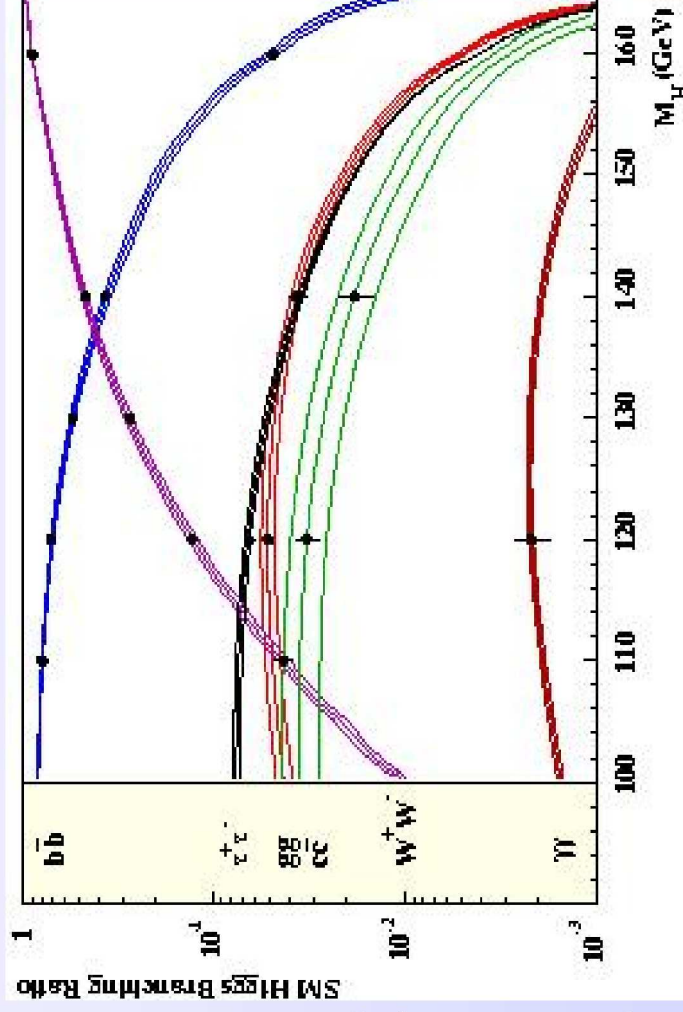
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- Event samples and simulation
- Kinematic selection
- ZVTOP: separation of charm and beauty (and other)
- Branching ratio analysis

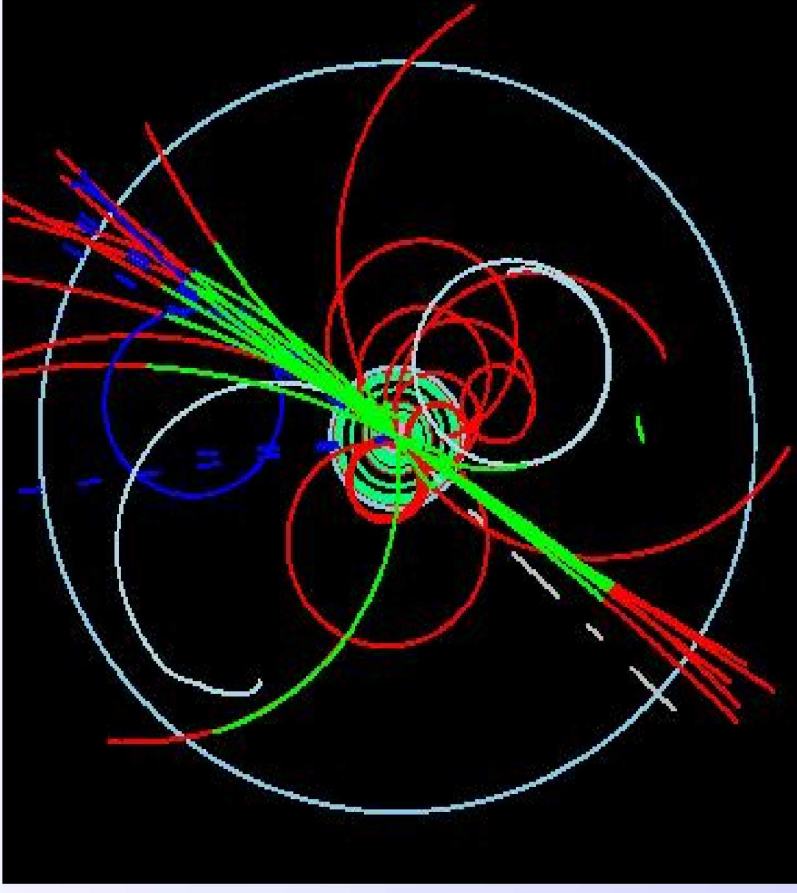
Introduction and Motivation

- Higgs branching ratio analysis: TDR benchmark
- Flavour separation: parametrisation ---> trackwise tag
- Discrepancy for cc to NLC analysis
- Simdet --> Brahms comparisons (job can cover both)



Simulation

- Event simulation: PHYTIA with CIRCE for beamstrahlung and initial state radiation
- Higgs branching ratios: HDECAY
- Detector: SIMDET4.0x with some fixes concerning track parameter calculation for tracks from secondary vertices --> talk this afternoon

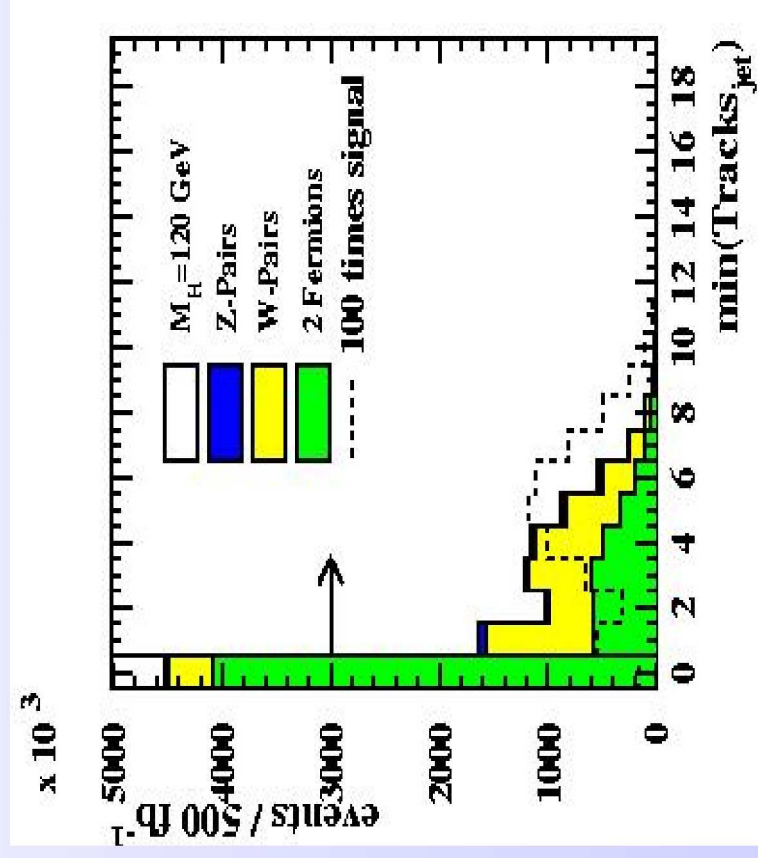
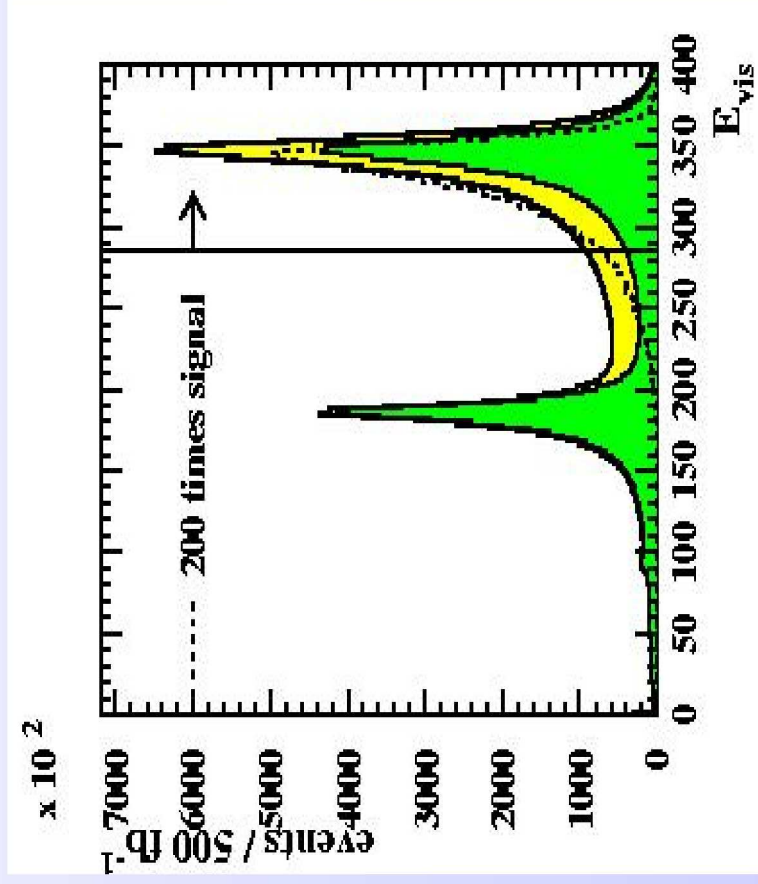


Event samples and analysis strategy

- To compare with Marco Battaglias analysis:
ECM=350 GeV; Luminosity: 500fb^{-1}
- Events generated (full background statistics):
 - 2 Fermions qq: 13.9 Mio
 - 4 Fermions WW-->qqqq: 3.0 Mio
 - WW-->qqln : 3.0 Mio
 - ZZ-->qqqq : 0.4 Mio
 - ZZ-->qqll : 0.1 Mio
 - Signal: 100 000 per channel
- Analysis strategy:
 - One selection for qqqq and qqll final state
 - Hard kinematic “preselection”
 - Separate qqqq and qqll
 - Calculate max. likelihood for BR

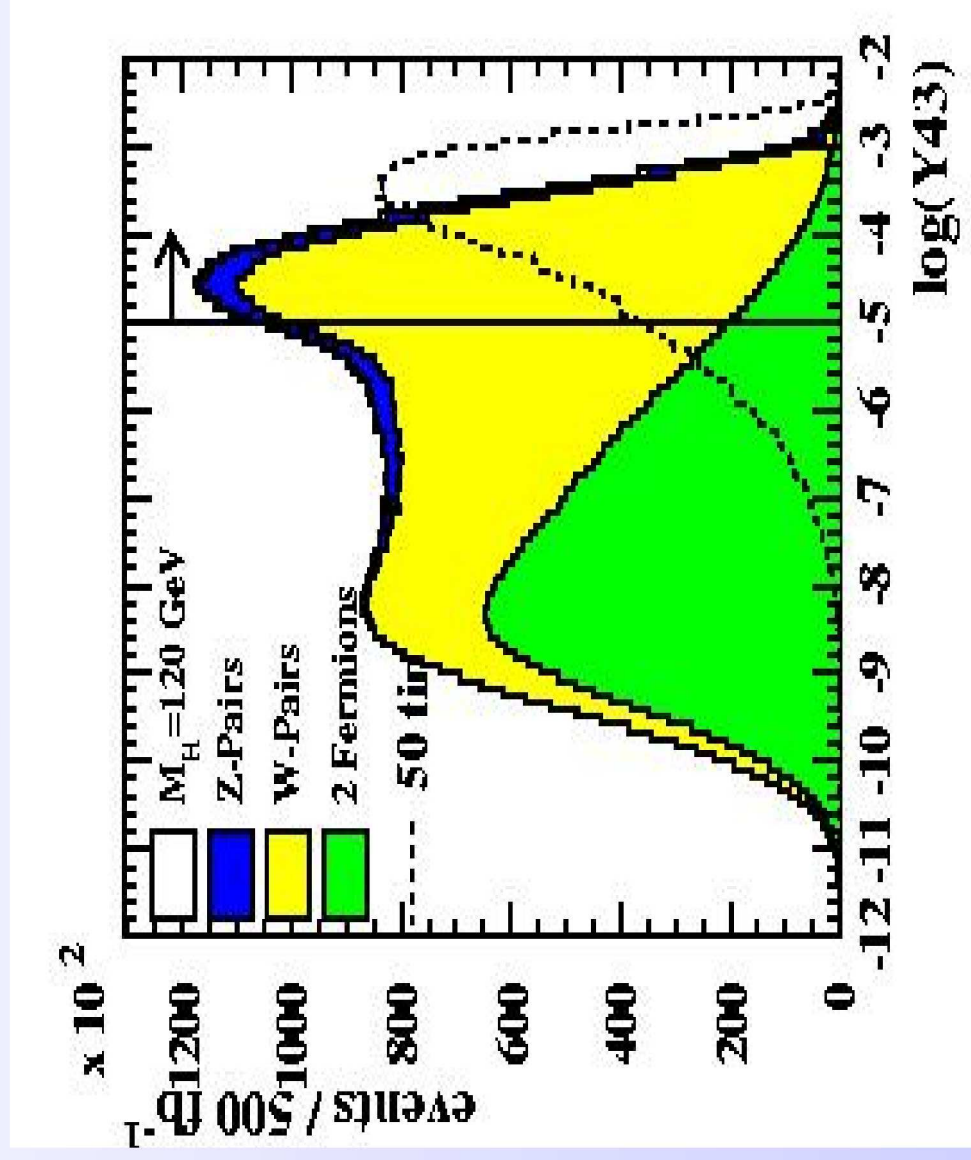
Kinematic cuts (I)

- Starting with 50 000 signal and 20 Mio background events
- Remove events with initial state radiation and missing energy
- Visible Energy
 - At least 1 track per jet



Kinematic cuts (II)

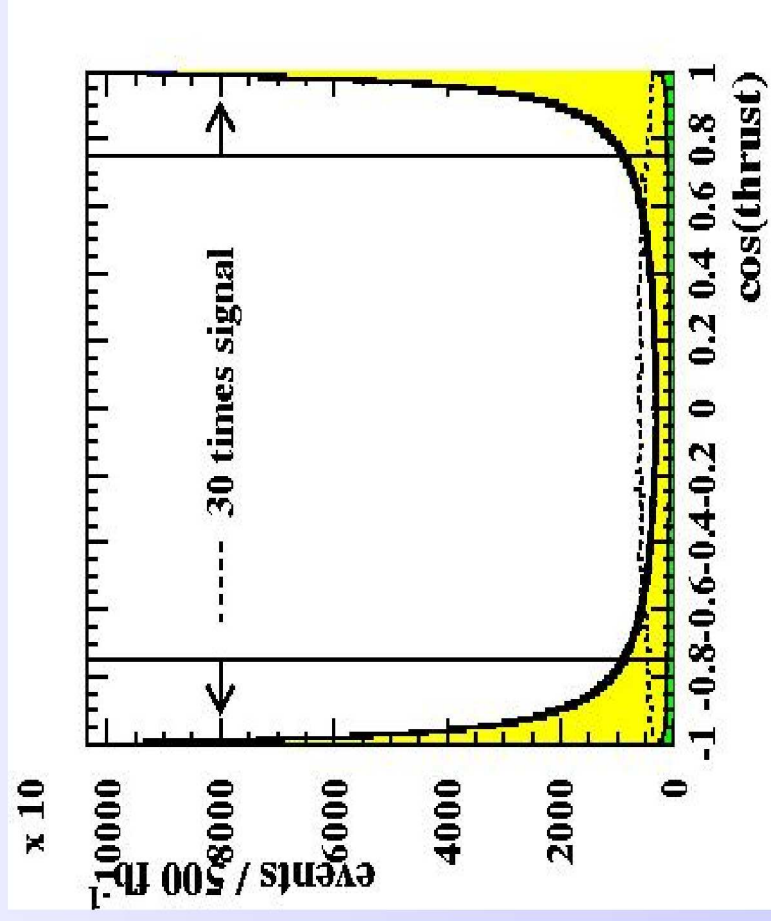
- Against 2 fermion background: ask for nice 4 jet events



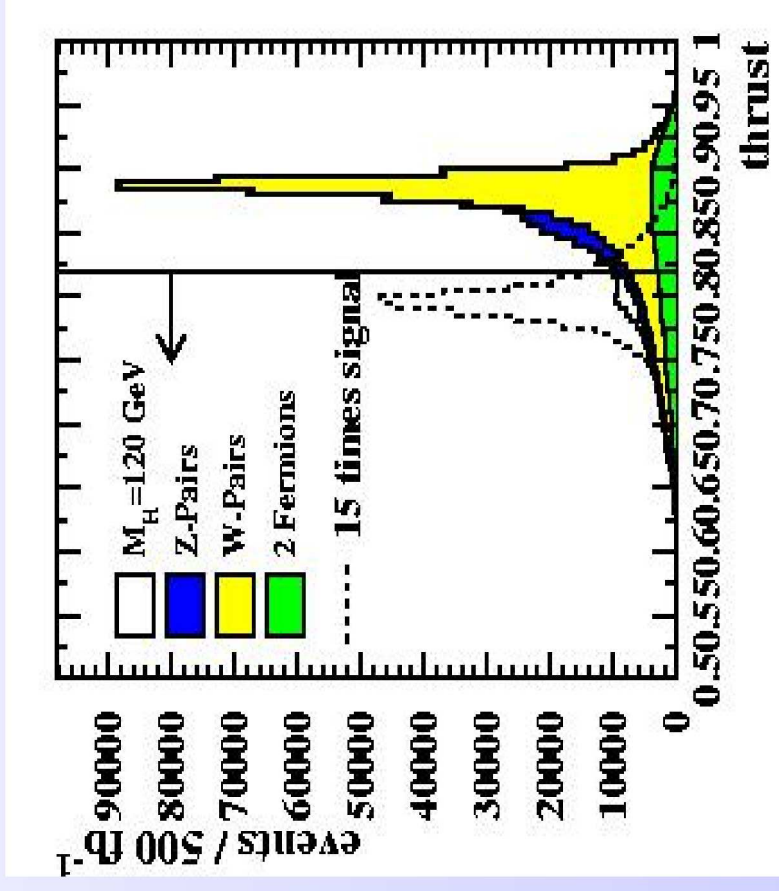
Kinematic cuts (III)

- And now attack the 4 fermion background (WW,ZZ)
 ----> different angular distributions and more boost

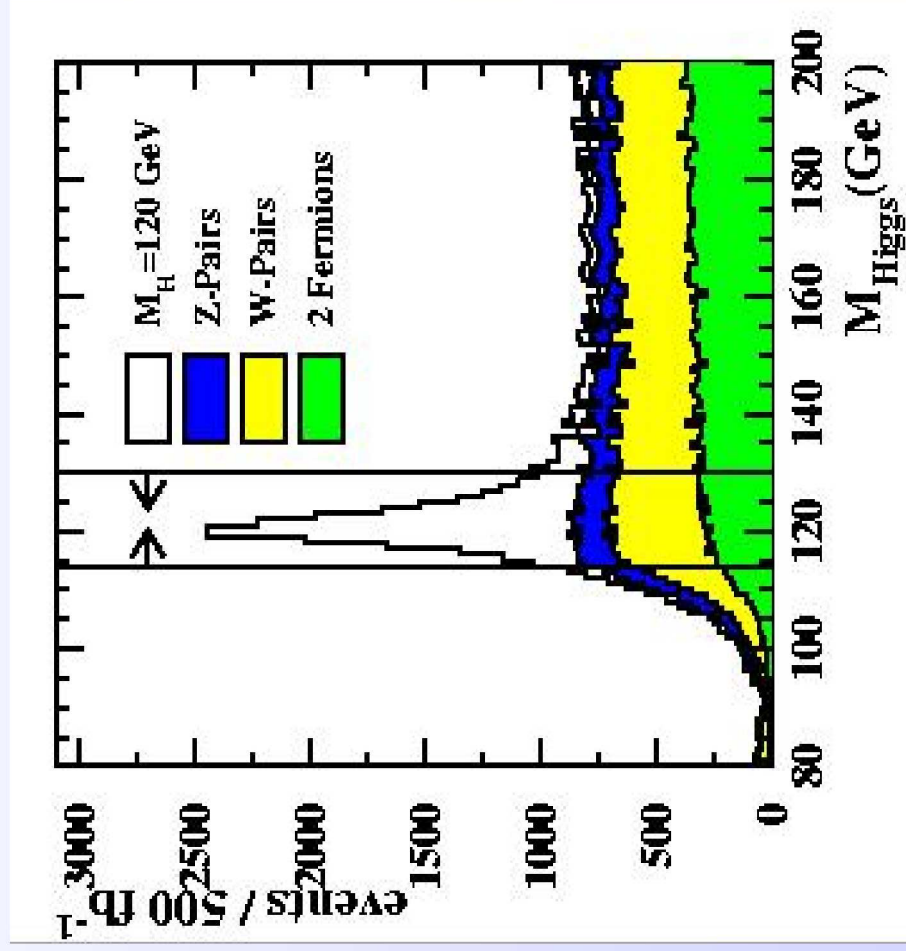
• Cos(thrust)



• Thrust

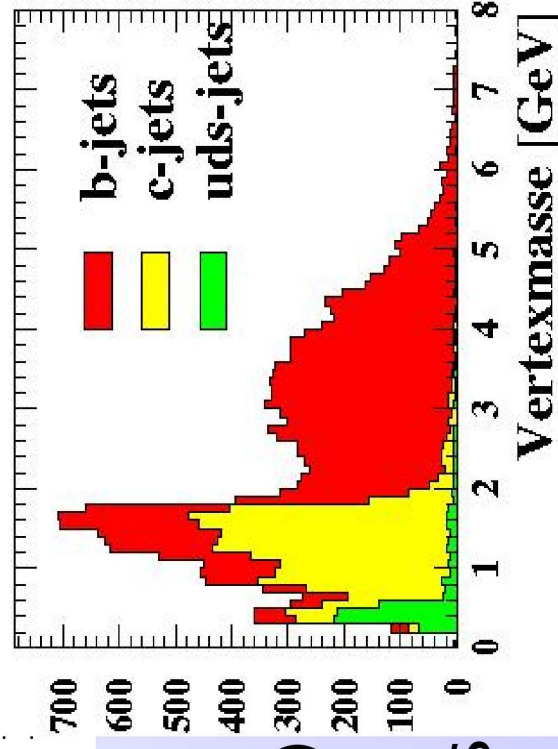
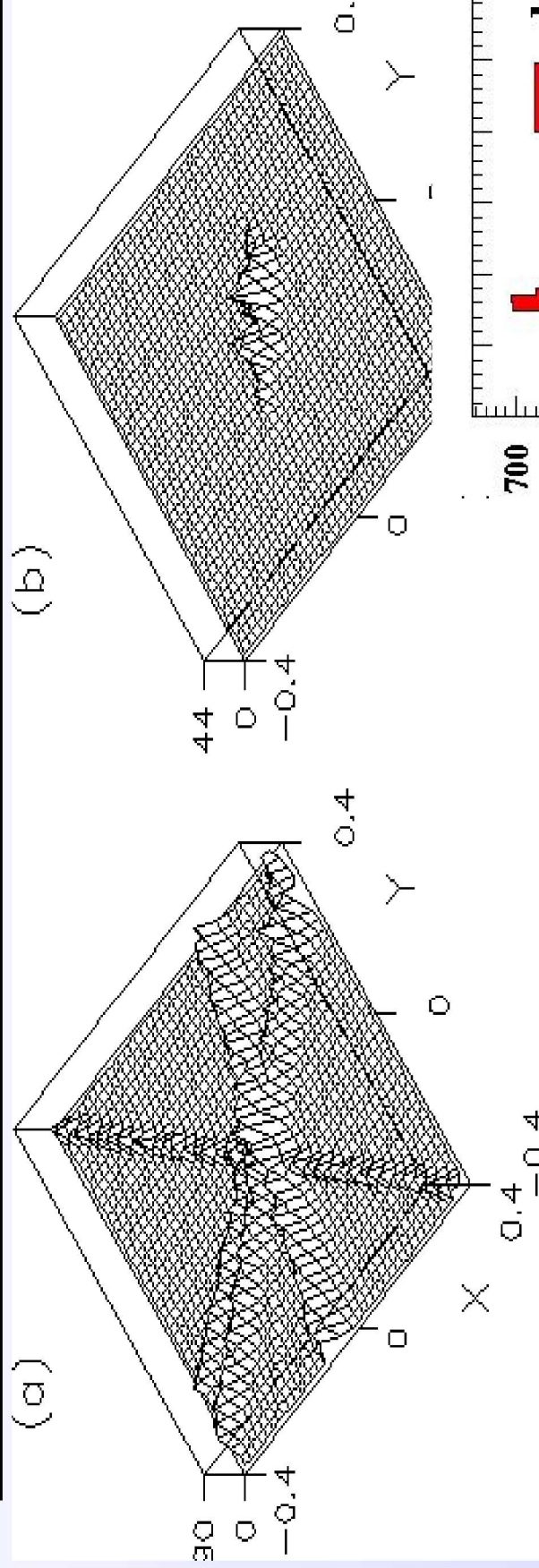


Mass distribution and cut flow



Cut	Signal	Total BG
All	51439	20108400
$E_{\text{vis}} > 285.$	45487	11334800
$N_{\text{track}}^{\text{jet}} > 0$	43909	6802700
$\log(y_{43}) > -5.$	34598	2024540
$ \cos_{\text{thrust}} < 0.75$	27715	703286
$\text{Thrust}_{\text{val}} > 0.82$	22882	127407
N_{track} Selection	22138	116877
M_{higgs}	11778	13406
Xxqq	10534	12680
Xxll	1244	726

ZVTOP: Search for charm and beauty

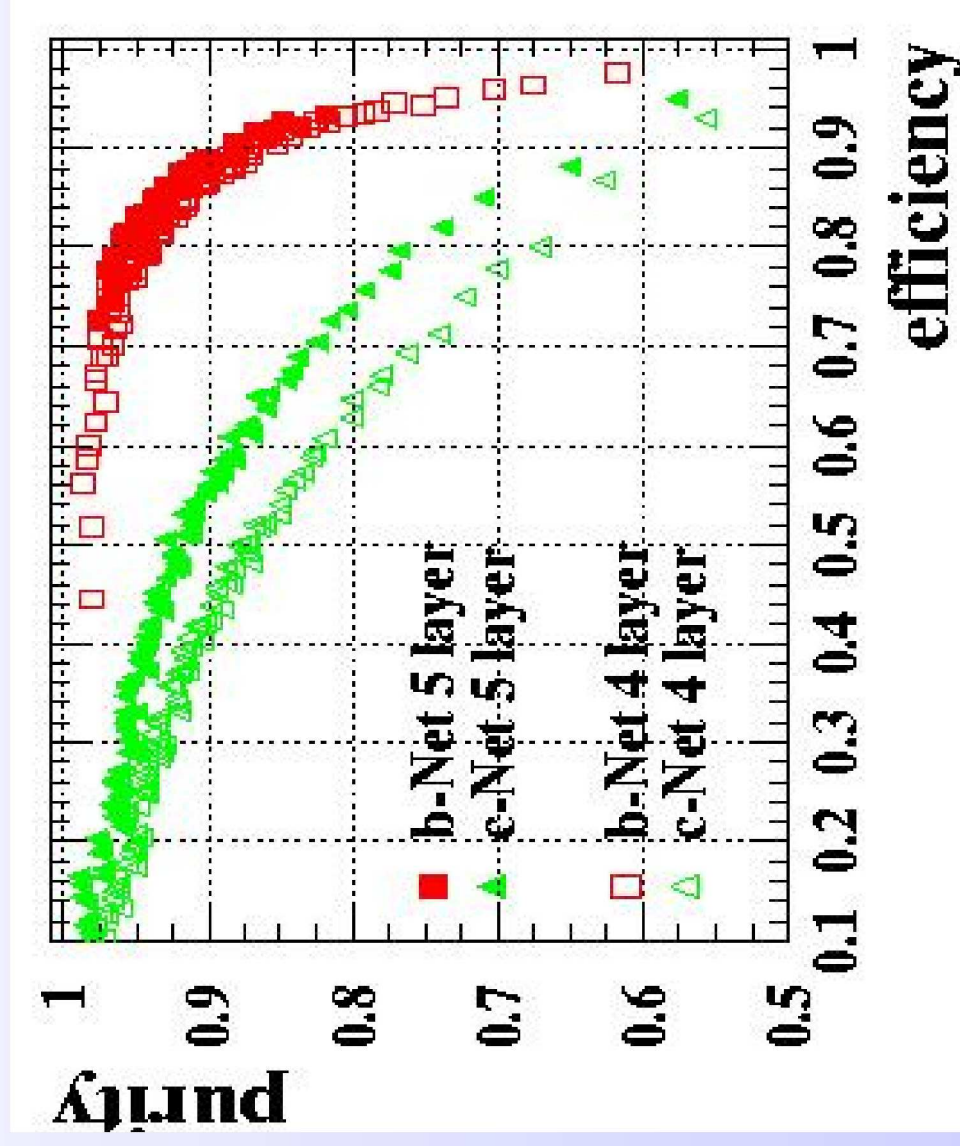


- Topological vertex finder
(from SLD, see talk this afternoon)
- Vertices: high track density regions
- Most important variable: Vertex mass
- High efficient neural net selection

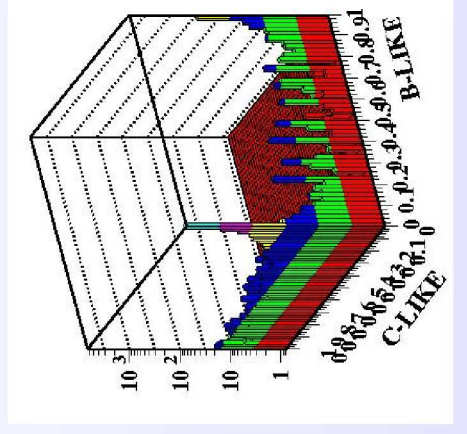
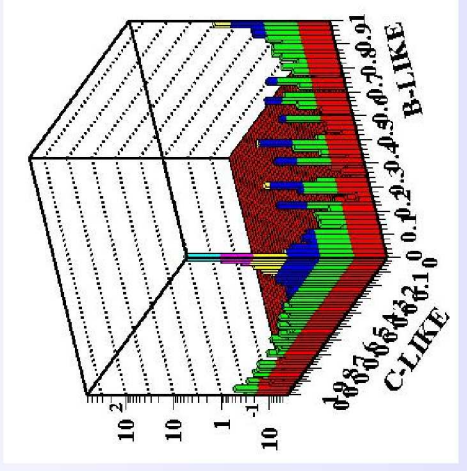
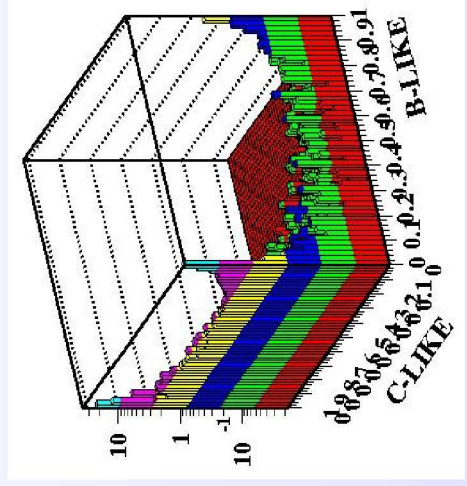
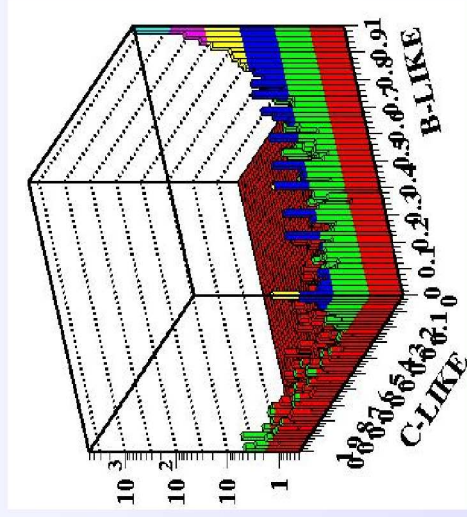
Neural Net Performance

- Dedicated net for ECM=350 GeV
- Trained with $ZH \rightarrow llxx$ $xx=(bb, cc, gg)$
- Use equal BR
- Checked already dependence on vertex detector
- Plot shows importance of best possible vertex detector for this analysis

Eventwise flavour likelihood:



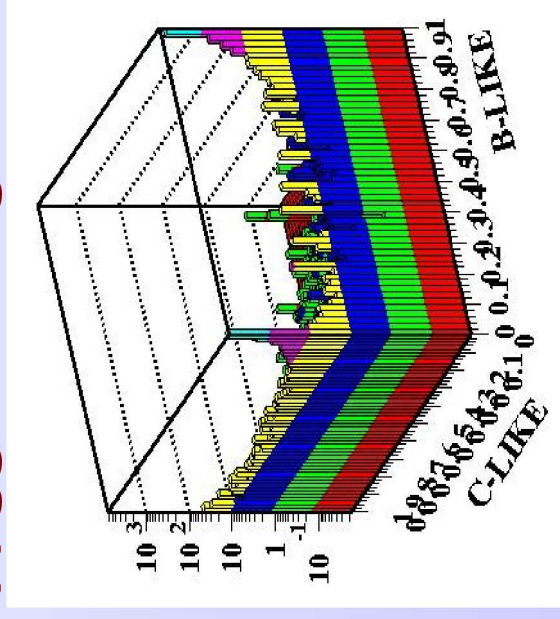
Branching Ratio Analysis: Strategy



$ZH \rightarrow ll(qq)bb + ZH \rightarrow ll(qq)cc + ZH \rightarrow ll(qq)gg + \text{background}$

- Binned maximum likelihood
- Fit qqxx and llxx in separated channels but simultaneously --> utilise different flavour composition of background

= all



Branching Ratio Analysis: Results

- Result of this analysis (without error for $H \rightarrow \text{hadrons}$):
 - $(BR(H \rightarrow b\bar{b})) = 1.1\%$
 - $(BR(H \rightarrow c\bar{c})) = 12.8\%$
 - $(BR(H \rightarrow g\bar{g})) = 11.3\%$
- Comparison with Marcos Battaglias TDR analysis:
 - $(BR(H \rightarrow b\bar{b})) = 2.3\%$
 - $(BR(H \rightarrow c\bar{c})) = 8.5\%$
 - $(BR(H \rightarrow g\bar{g})) = 5.5\%$
- Not that bad for 2 days of work
- Biggest difference should come from kinematic part ...

There is room for improvement...

- Including missing energy channel
factor 1.3 in statistic
- Kinematic selection --> likelihood selection
~ 30-50% less background (LEP experience)
- Search for leptons before jetfinding -->
signal efficiency for leptonic channels
- Search for photons before jetfinding -->
WW and qq background in hadronic channel
using effective ECM ---> 5c-fit efficiency
- Full 4 fermion MC: WIZARD
more background left ???
- Some additional fixes in tracking
only small changes but very important
(see talk in detector performance group meeting)

Lets play some games ...

- Without incorporation the error for $H \rightarrow \text{hadrons}$ (would shift error on $H \rightarrow b\bar{b}$ 1% $\rightarrow$ 2.x%)
- This analysis:
 $bb=1.1\%$, $cc=12.8\%$, $gg=11.3\%$
- Reducing background by 50%:
 $bb=1.0\%$, $cc=11.0\%$, $gg=8.5\%$
- Including factor for missing energy:
 $bb=0.9\%$, $cc=9.3\%$, $gg=7.2\%$
- 5 time lepton channel with 50% background (should be similar to the NLC neural net analysis)
 $bb=1.0\%$, $cc=13.5\%$, $gg=6.7\%$

Summary

- Redone Higgsstrahlung branching ratio analysis with topological flavour tagging (ZVTOP)
- Especially kinematic selection is very preliminary
- Results in the same order than Marcos one:
 - $(BR(H \rightarrow bb)) = 1.1\%$
 - $(BR(H \rightarrow cc)) = 12.8\%$
 - $(BR(H \rightarrow gg)) = 11.3\%$
- Discrepancy to the NLC analysis for cc still there
- The analysis should be redone with WHIZARD
- Brahms <--> Simdet comparison: interface to my analysis N-tuple should be ready very soon ---> repeat the analysis with exactly the same tools (and bugs :-)