$HZ \to WWZ \to 6f$ - Analyses

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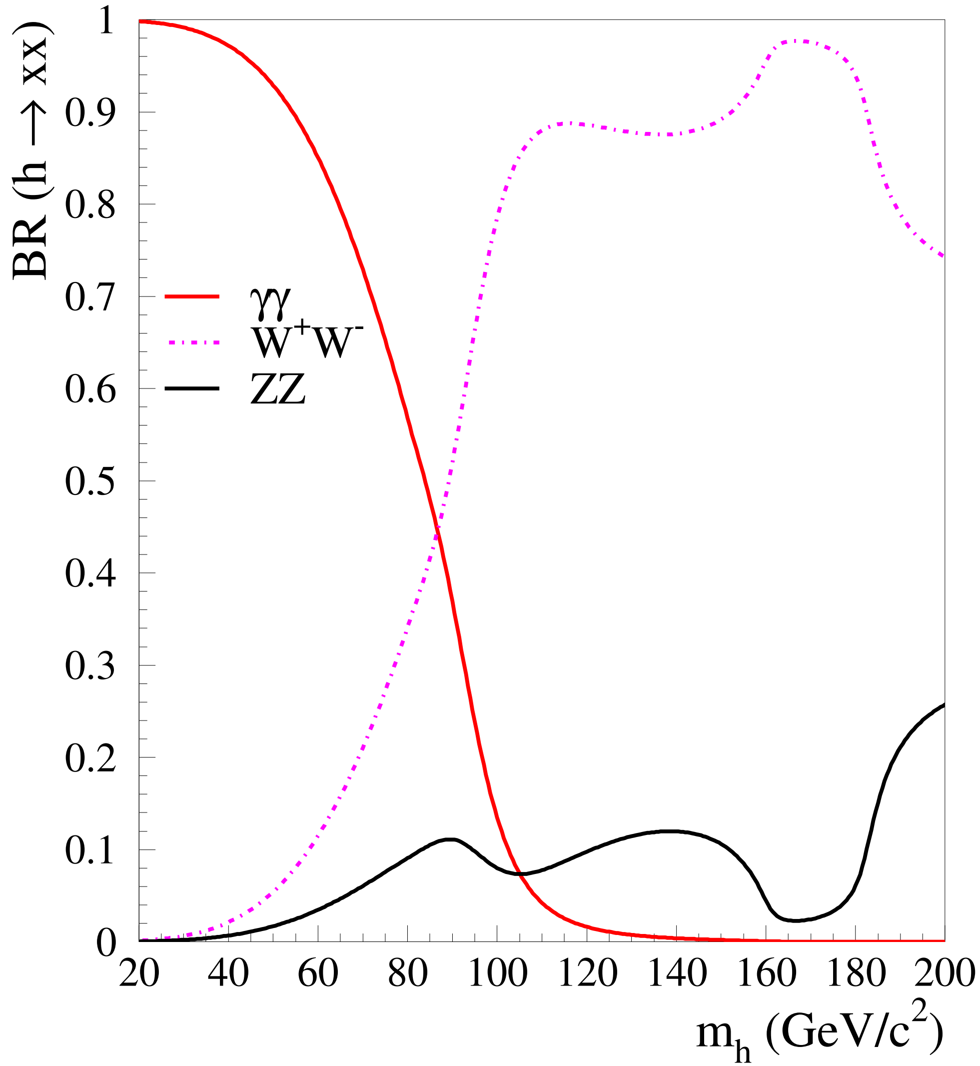
Outline

- Motivation
- The $qqq\nu\nu$ Channel (*J.Dalmau*)
- The $qql\nu qq$ Channel (*J.Rehn*)
- The $qqqqqq$ Channel (*M.Stanitzki*)
- Combined plots

Motivation

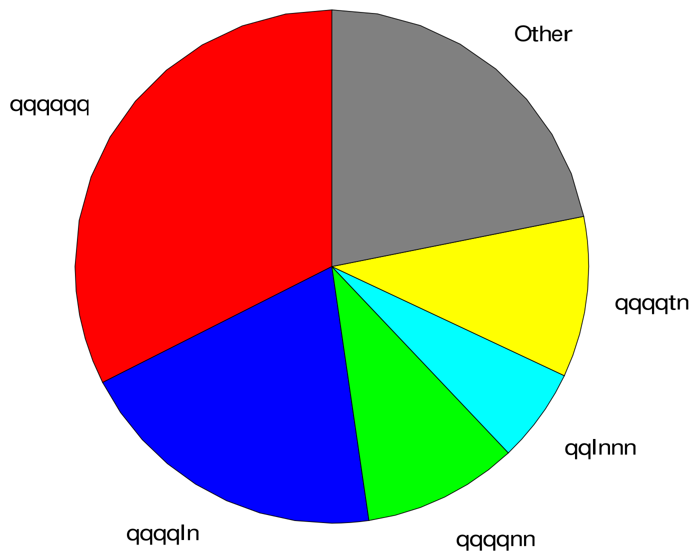
Why is this interesting ?

- Coupling HWW is very fundamental
- Fermiophobic models always include $H \to WW^*$



Branching Ratios

	Z			
WW^*	$q\bar{q}$	$\nu\bar{\nu}$	l^+l^-	$\tau^+\tau^-$
$qq'qq'$	**32.4 %**	**9.9 %**	3.1 %	1.5 %
$qq'l\nu$	**19.9 %**	6.0 %	1.9 %	0.9 %
$l\nu l\nu$	3.0 %	0.9 %	0.3 %	0.1 %
$\tau\nu\tau\nu$	0.8 %	0.2 %	0.1 %	0.0 %
$qq'\tau\nu$	9.9 %	3.0 %	0.9 %	0.5 %
$l\nu\tau\nu$	3.0 %	0.9 %	0.3 %	0.1 %



24 final states, but 60% of BR goes into 3 channels !!

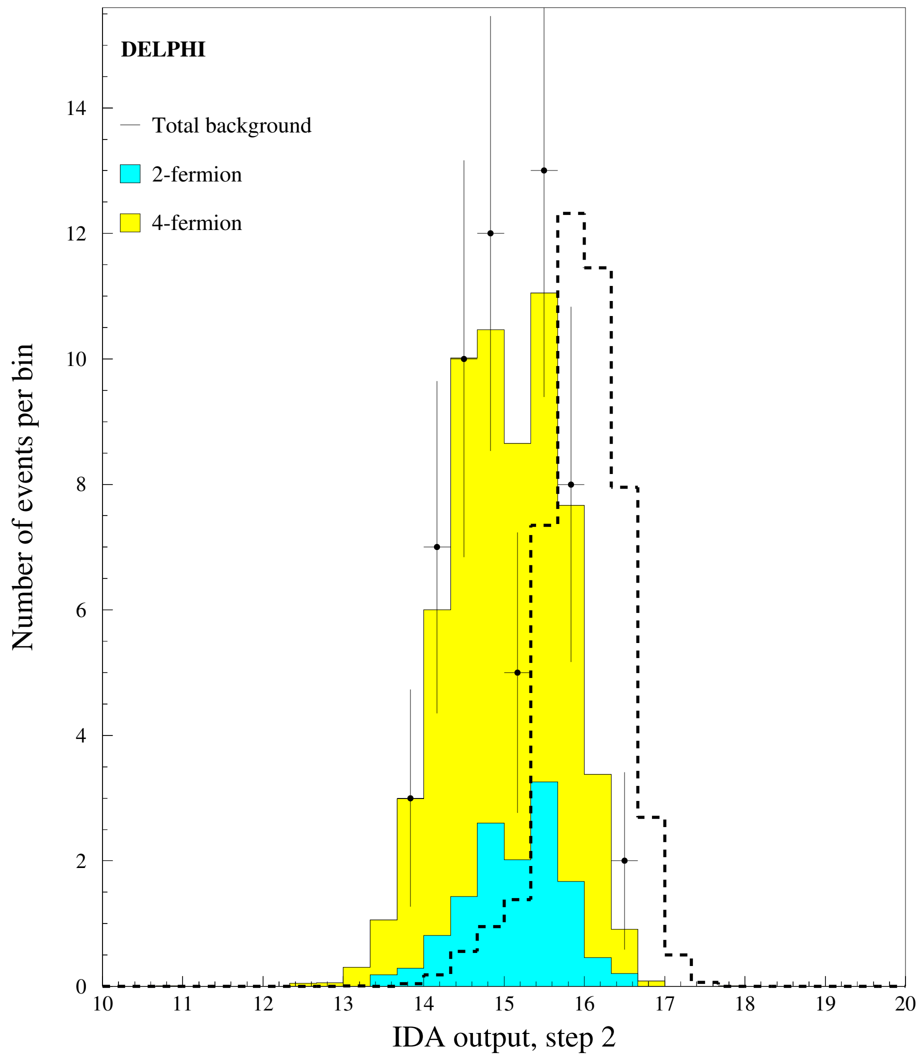
$qqqq\nu\nu$ Channel: Analysis

- IDA $H\nu\nu$ analysis preselection was used
- The IDA variables were not changed yet
- Just a retraining with the new samples was done
- There is still room for improvements

$qqq\nu\nu$ Channel: Results

$\sqrt{s}$	$\mathcal{L}$	Data	MC	2f	WW	ZZ	m_H=105 GeV	Eff
196	75.0	7	5.82	1.85	2.31	1.66	0.15	40.5%
200	82.2	4	5.09	1.55	2.33	1.22	0.52	41.5%
202	40.4	3	2.60	0.63	1.27	0.70	0.32	42.1%
205	75.7	2	3.28	0.52	1.73	1.02	0.70	40.3%
207	82.6	3	3.47	0.24	1.91	1.32	0.84	41.6%
u1	58.0	5	3.40	1.01	1.41	0.98	0.57	40.4%
Total	413.9	24	23.65	5.80	10.96	6.88	3.10	41.1%

$qqq\nu\nu$ Channel: IDA2 distribution



$qql\nu qq$ Channel: Signal topologies

analysis split up in two parts:

$W \to qq\ W^* \to l\nu$ $W \to l\nu\ W^* \to qq$

- seperate signal samples have been produced using MC information:
  - $W \to l\nu$: 60 GeV $< m_W <$ 100 GeV
  - $W^* \to l\nu$: $m_W <$ 60 GeV
- definition of leptonic final states: only electrons and muons have been studied (no taus !)

$qql\nu qq$ Channel: Loose preselection

- common data quality cuts
- at least one identified electron or muon required
- common $H\nu\nu$ team $\gamma\gamma$ cuts
- loose anti 2–fermion (QCD) cuts:
  - $\sqrt{s'} > 0.6\sqrt{s}$
  - charged multiplicity > 22
  - $E_t > 0.35\sqrt{s}$
  - $y34 > -5.0$
- selection cut for $W \to l\nu$ $W^* \to qq$: $E_{m.\,energ.\,lept.} > 0.1\sqrt{s}$
- selection cut for $W^* \to l\nu$ $W \to qq$: $E_{m.\,energ.\,lept.} < 0.1\sqrt{s}$

$qql\nu qq$ Channel: Some numbers at different cut levels

combination of 196 GeV - 207 GeV for $W \to l\nu\ W^* \to qq$

cut level	$Z\gamma$	4f CC	4f NC	tot. MC	data	signal
$\gamma\gamma$ cuts	8345.7	3485.1	383.7	12214.5	11866	5.1
QCD cuts	92.3	382.3	49.0	523.6	513	3.8
NN @40%	2.8	94.4	8.9	106.1	102	2.6

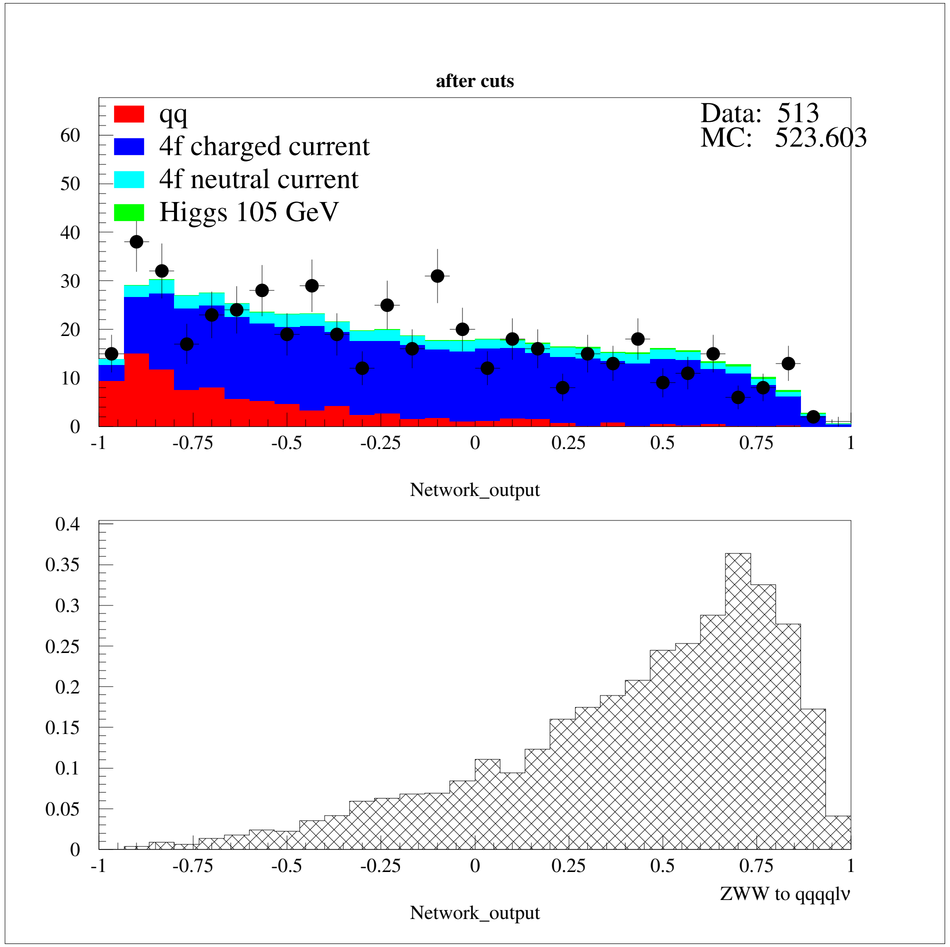
combination of 196 GeV - 207 GeV for $W^* \to l\nu\ W \to qq$

cut level	$Z\gamma$	4f CC	4f NC	tot. MC	data	signal
$\gamma\gamma$ cuts	8345.7	3485.1	383.7	12214.5	11866	6.3
QCD cuts	1392.3	1477.1	36.6	2905.9	2739	5.6
NN @40%	15.8	76.9	2.4	95.2	106	3.0

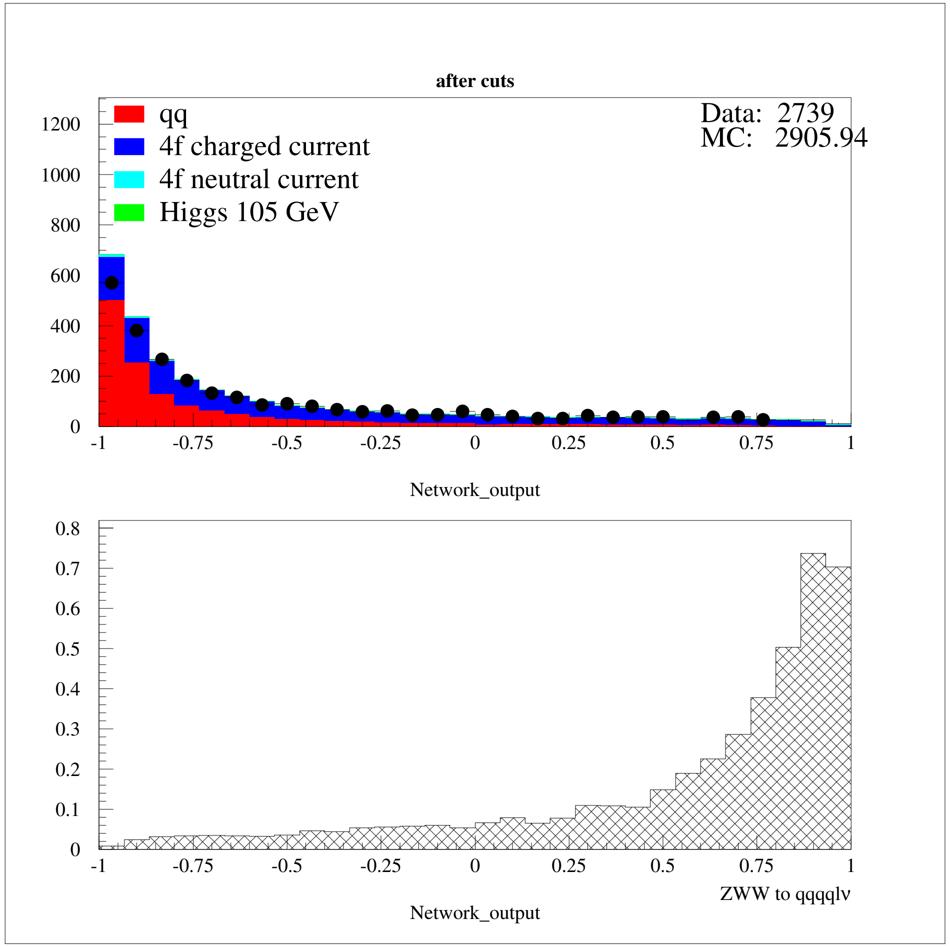
$qql\nu qq$ Channel: NN output after QCD cuts

distributions using all energies: 196 - 207 GeV

$W \to l\nu \; W^* \to qq$



$W^* \to l\nu \; W \to qq$



$qql\nu qq$ Channel: Higgs mass reconstruction

$$W \to l\nu \; W^* \to qq$$

- 5 constraints assuming 4 jets, 1 lepton and a neutrino
- choosing pairing with lowest χ^2

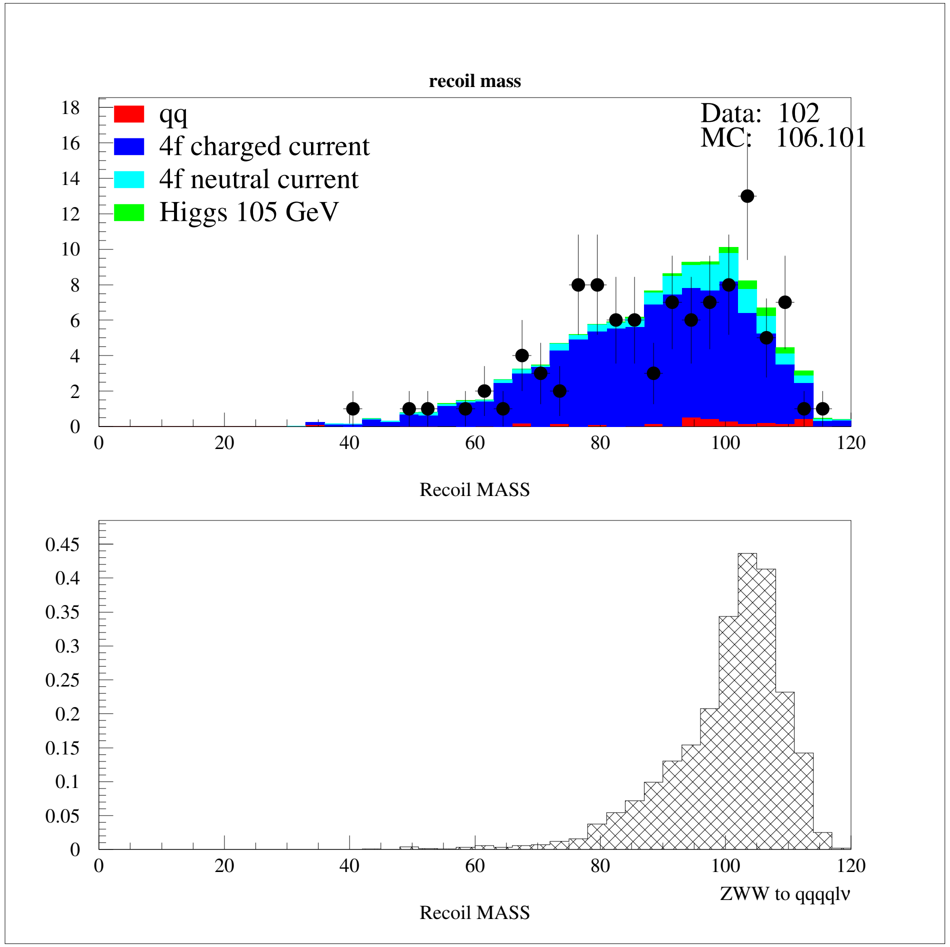
$$W^* \to l\nu \; W \to qq$$

- 5 constraints assuming 5 jets and a neutrino
- choosing pairing with lowest χ^2

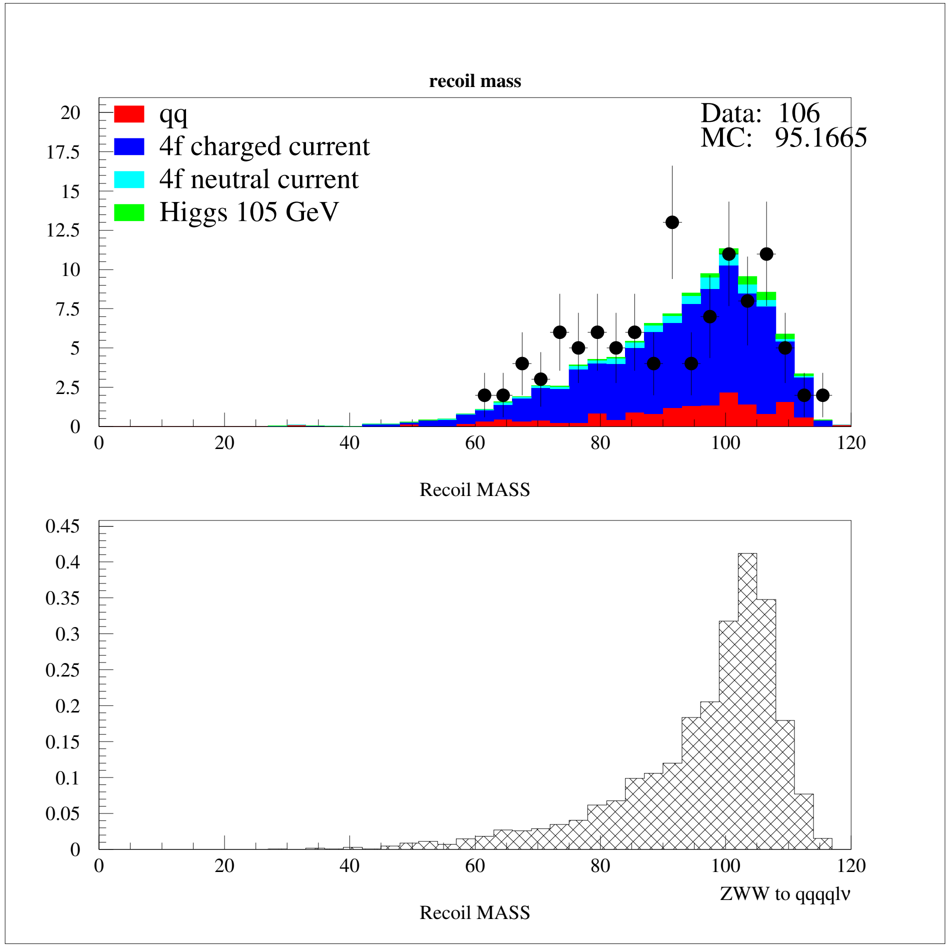
$qql\nu qq$ Channel: Reconstructed Higgs mass

distributions using all energies: 196 - 207 GeV

$W \to l\nu \; W^* \to qq$



$W^* \to l\nu \; W \to qq$



$qqqqqq$ Channel: Preselection

Three steps are performed

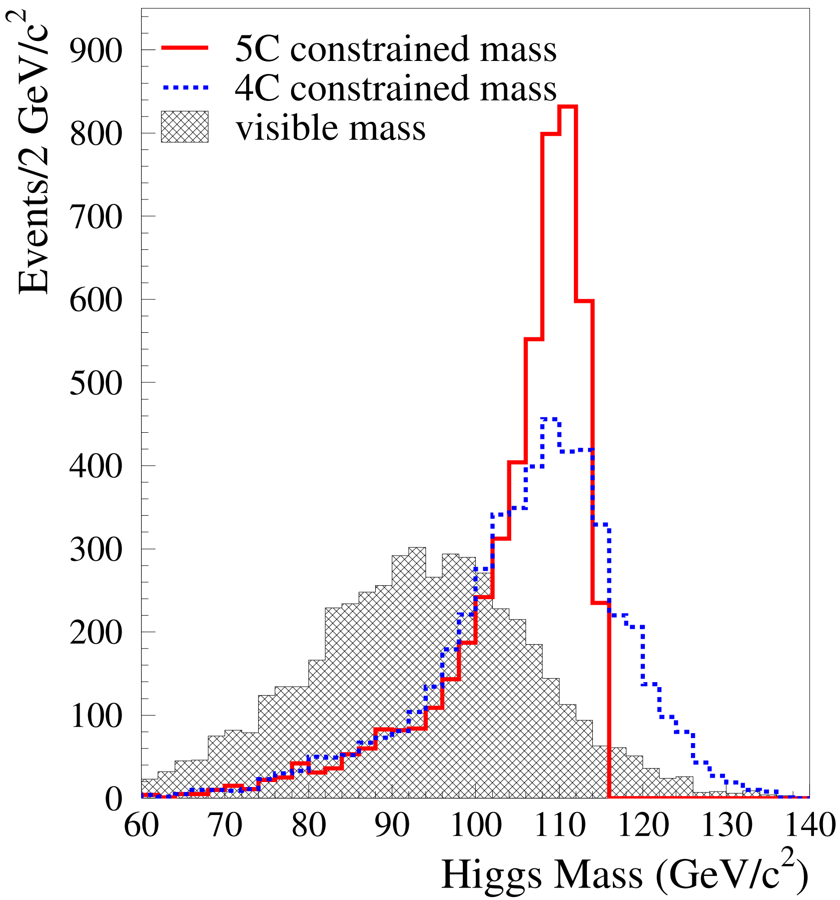
- Data quality veto of $H\nu\nu$ team
- General multi-jet selection to enrich events with ¿4 jets
- 6-jet selection (forcing the event into 6 jets)

$qqqqqq$ Channel: Data/MC after Preselection

$\sqrt{s}$	Fully hadronic selection		Six jet selection	
(Gev)	Data	MC	Data	MC
195.5	789	722.0	366	310.2
199.5	803	788.4	340	334.7
201.6	385	377.2	180	159.6
205.0	716	762.2	320	322.1
206.5	743	759.5	333	321.0
206.5U	472	506.9	217	215.8

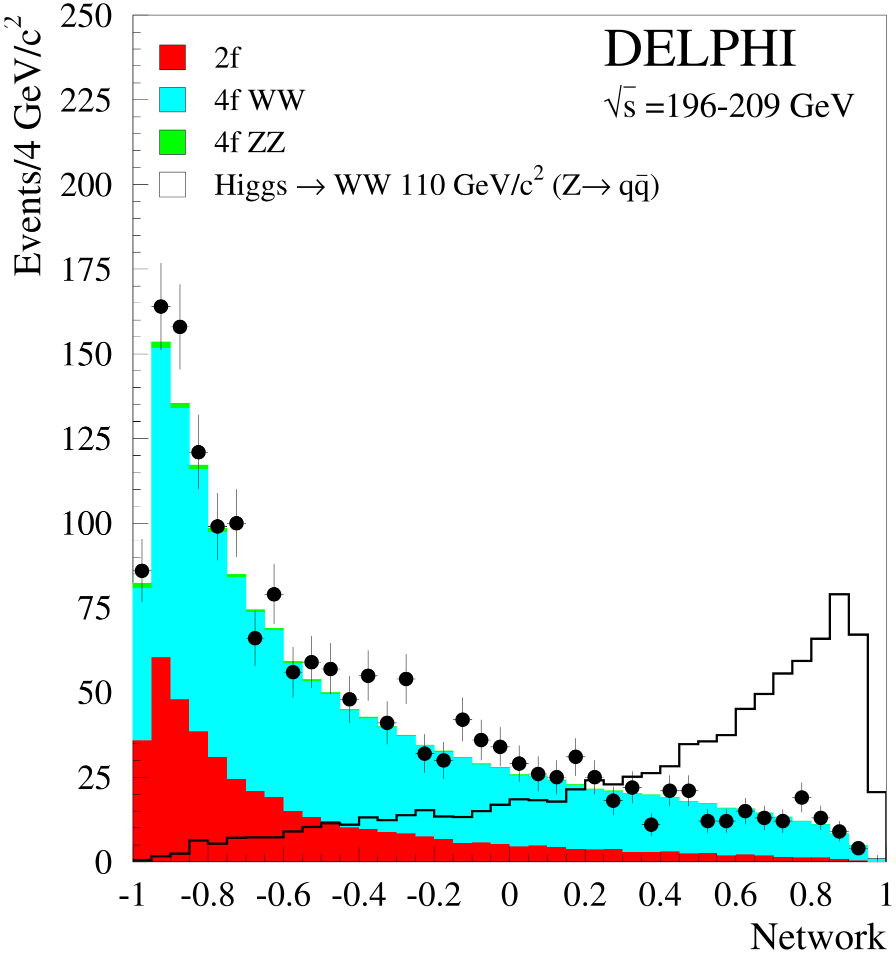
qqqqqq Channel: Mass reconstruction

- 4 Jet 5C Fit (energy, momentum + Z mass) 5 combinations
- 6 Jet 5C Fit (energy, momentum + Z mass) 15 combinations
- 6 Jet 6C Fit (energy, momentum + W mass +Z mass) 90 combinations
  $\rightarrow$ Many possible combinations



qqqqqq Channel: The neural network

- The Neurobayes NN package by M.Feindt has been used
- 11 input variables were used

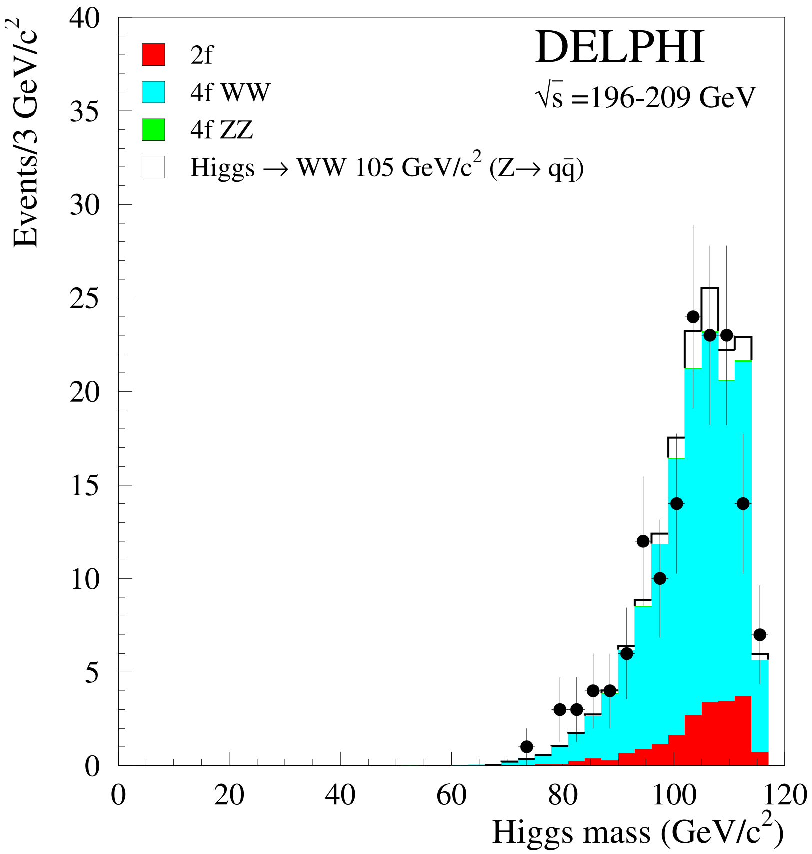


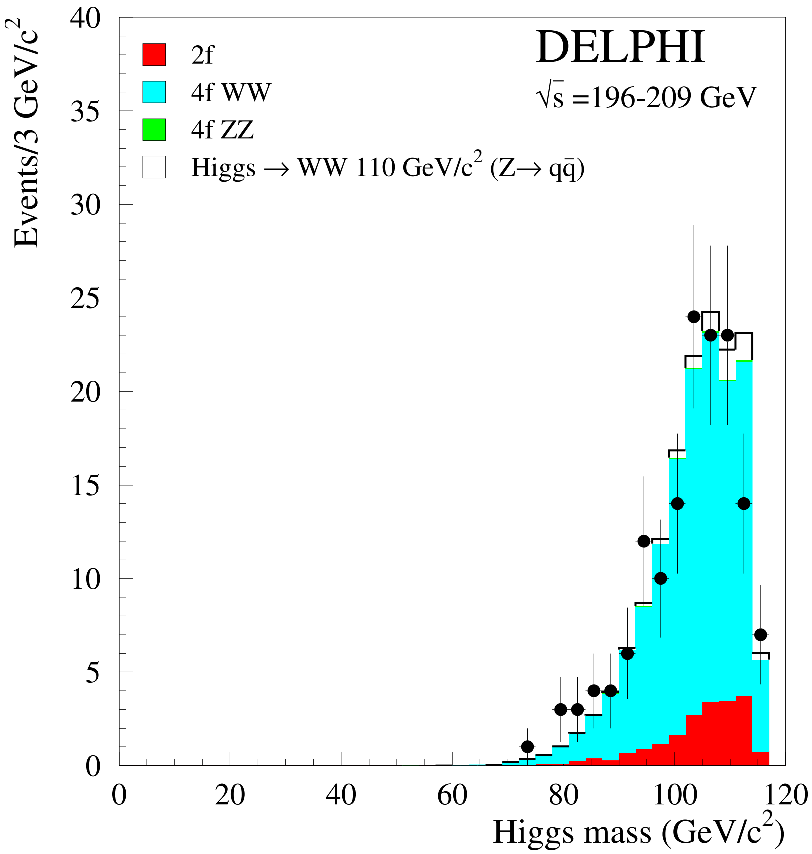
$qqqqqq$ Channel: Results

Cut at 40 % Efficiency for 105 GeV Higgs

$\sqrt{s}(GeV)$	Data	MC	105 GeV Higgs	110 GeV Higgs
195.5	25	24.5	0.5	0.1
199.5	27	26.7	1.6	0.3
201.6	22	13.5	1.0	0.4
205.0	21	26.2	2.2	1.6
206.5	30	31.3	2.7	2.1
206.5U	23	23.9	1.9	1.6
total	148	146.1	9.9	6.1

$qqqqqq$ Channel: Mass plots



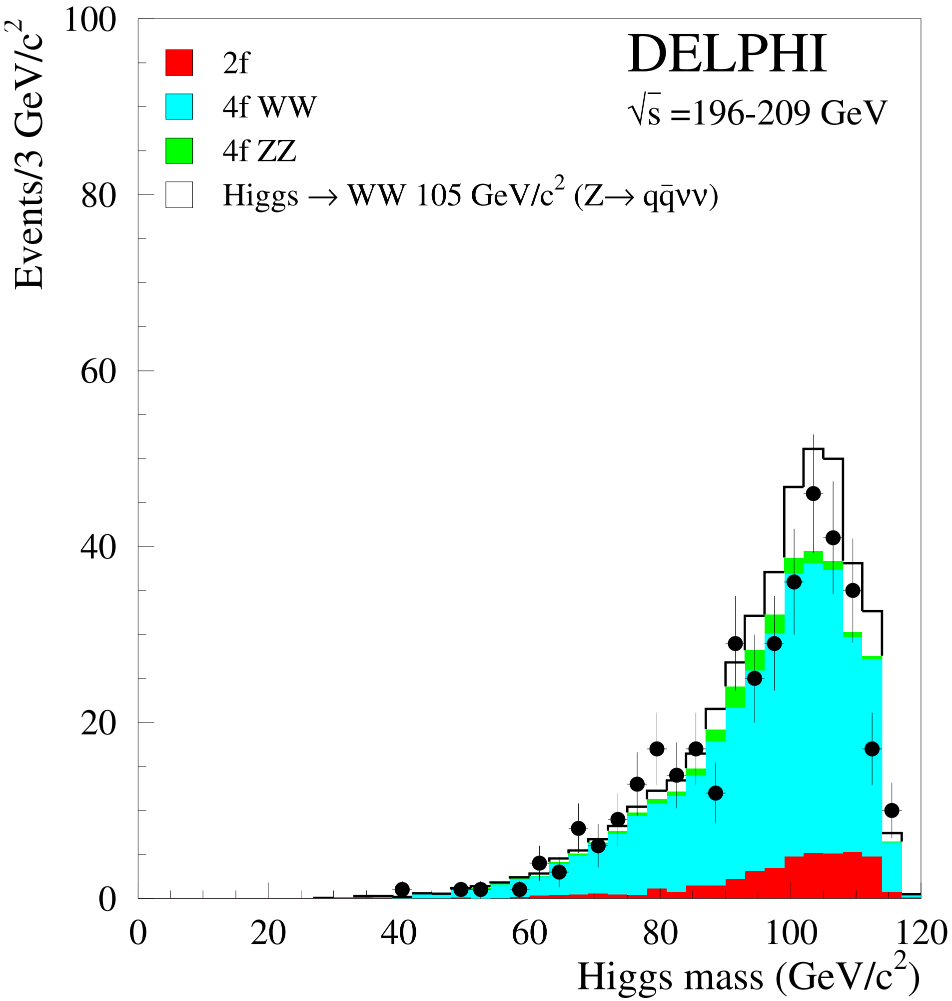


105 GeV Higgs 110 GeV Higgs

Combinations

Channel	Data	MC	105 GeV Higgs
$qqqqqq$	148	146.1	9.9
$qqqql\nu$	208	201.3	5.6
$qqqq\nu\nu$	24	23.65	3.1
total	380	371.1	18.6

Combined mass plot



Most significant events at 206 GeV

Run-No.	Event-No.	$\sqrt{s}$ (GeV)	Mass (GeV)	Channel
113410	179	206.6	94.8	$qqqq\nu\nu$
113381	197	206.7	85.0	$qqqq\nu\nu$
113763	2748	206.4	114.7	$qqqqqq$
112813	16086	206.7	106.8	$qqqqqq$
113945	4491	206.4	103.6	$qql\nu qq$ (on-shell)
113103	2613	208.0	78.6	$qql\nu qq$ (off-shell)

Conclusion

- $qqq\nu\nu$-Analysis will improve
- $ql\nu qq$ -Analysis is almost stable
- $qqqqqq$ -Analysis is almost stable
- Systematics have to be done
- ALRMC integration to be done