Measurement of H→ WW* fully hadronic in HZ at 350 GeV

Measurement of H to ZZ* at 1.4 TeV

status reports

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Common points

- We are measuring BF of H→VV (V=W,Z) to extract Higgs couplings

$$\frac{g^2_{HVV} \cdot g^2_{HV'V'}}{\Gamma_H}$$

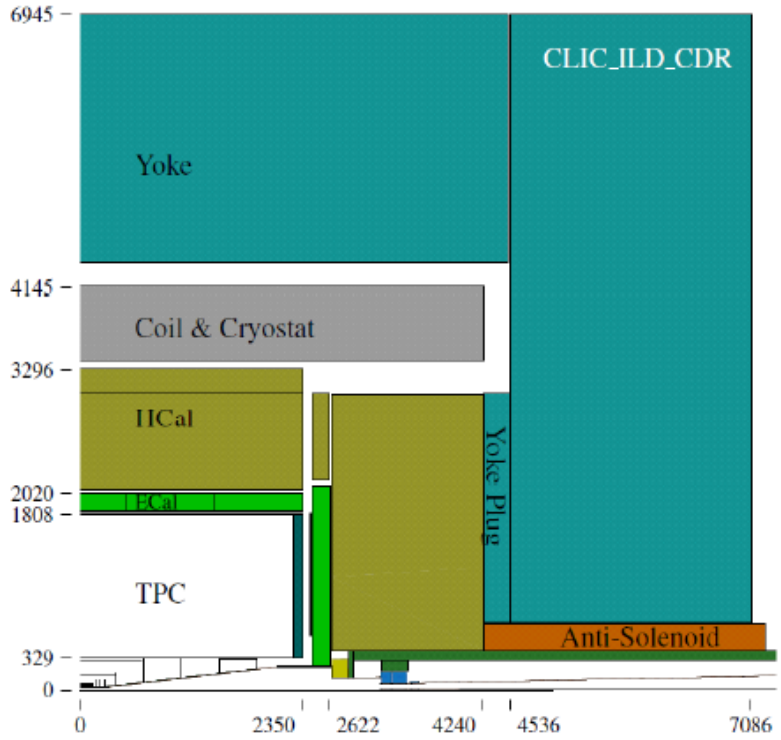
- Multijet final states
- Full analysis chain
- The status of both analysis after the preselection will be presented

Common points

Simulation and Reconstruction

Fully simulated events:

- » Event generation with WHIZARD v.1.95 including ISR and BS
- » Beamspectrum generated with GUINEAPIG
- » Hadronization with PYTHIA
- » Assuming m_H=126 GeV
- » CLIC_ILD detector
- » Particle reconstruction and identication using PandoraPFA



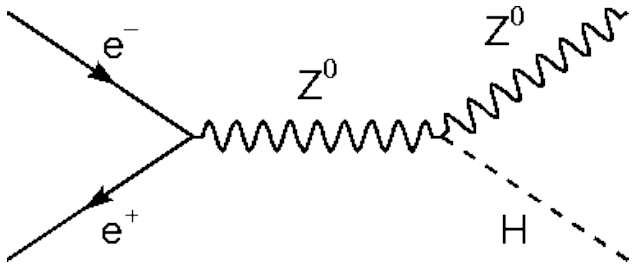
Measurement of H→ WW* fully hadronic in HZ at 350 GeV

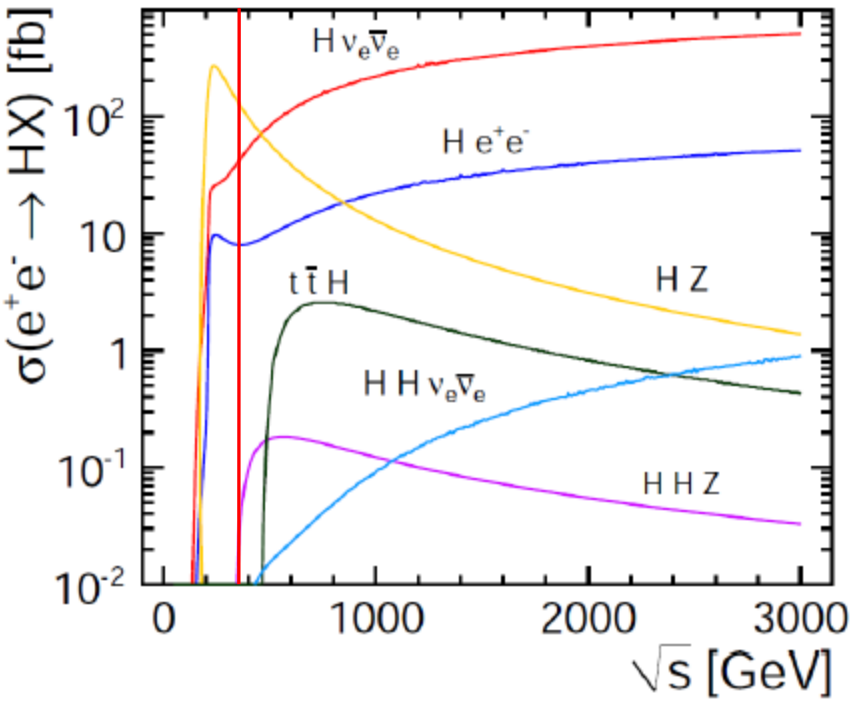
Mila Pandurović

Introduction

HZ @350GeV $\sigma(e^+e^- \to HZ) = 134$ fb

$H \to WW \to qqqq$, $Z \to ff$, $f = e, \mu, q$





Favourable BF:

BF(H→WW)~23%

BF(WW→qqqq)~45%

BF(Z→ll)~10%

BF(Z→qq)~70%

Signal and background processes

Signal HZ, H→WW→qqqq	σ [fb]
Z→ee	0.48
Z→μμ	0.48
Z→qq	9.7
Background	
HZ, other H decays, Z vis. d.	92.02
$e^+e^- \rightarrow qqqq$	5847
$e^+e^- \rightarrow qqll$	1704
$e^+e^- \rightarrow qql\nu$	5914
$e^+e^- \rightarrow qq\nu\nu$	324.6

Analysis chain

H→WW→qqqq , Z →ll

Semileptonic FS: H→WW→qqqq , Z →ll , l=e, μ

Isolated lepton finder !

FastJet Finder: Kt exclusive algorithm - 4 jet FS

Hadronic FS: H→WW→qqqq , Z →qq

FastJet Finder: Kt exclusive algorithm - 6 jet FS

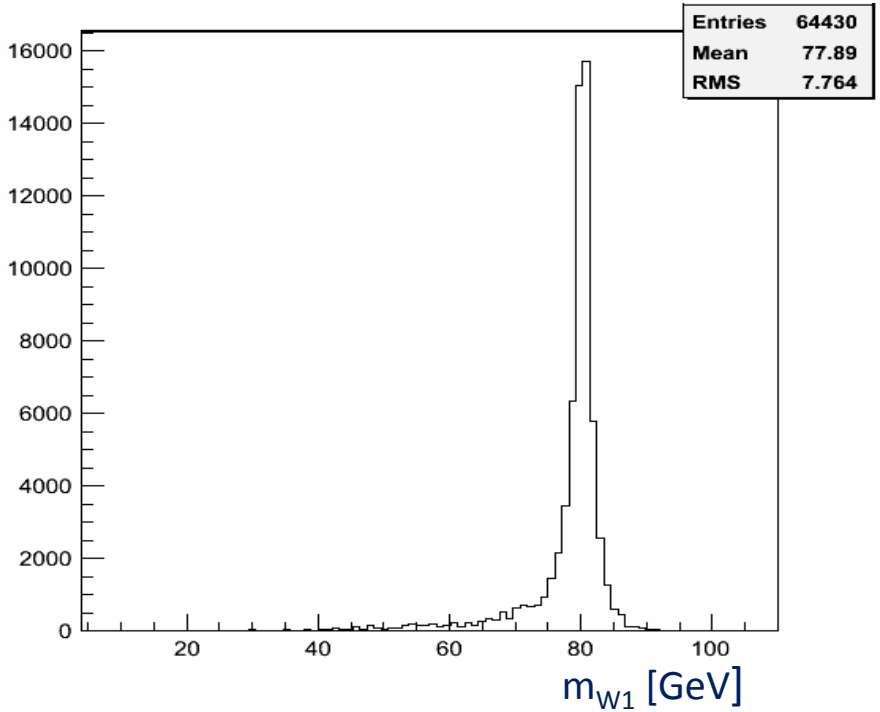
- ✓ **Lepton finding**
- ✓ **Jet Clustering**
- ✓ **Preselection** optimization
  - » mH , mW1, mW2, mZ, pT jet , Evis, jet transitions, (Θ_{el})

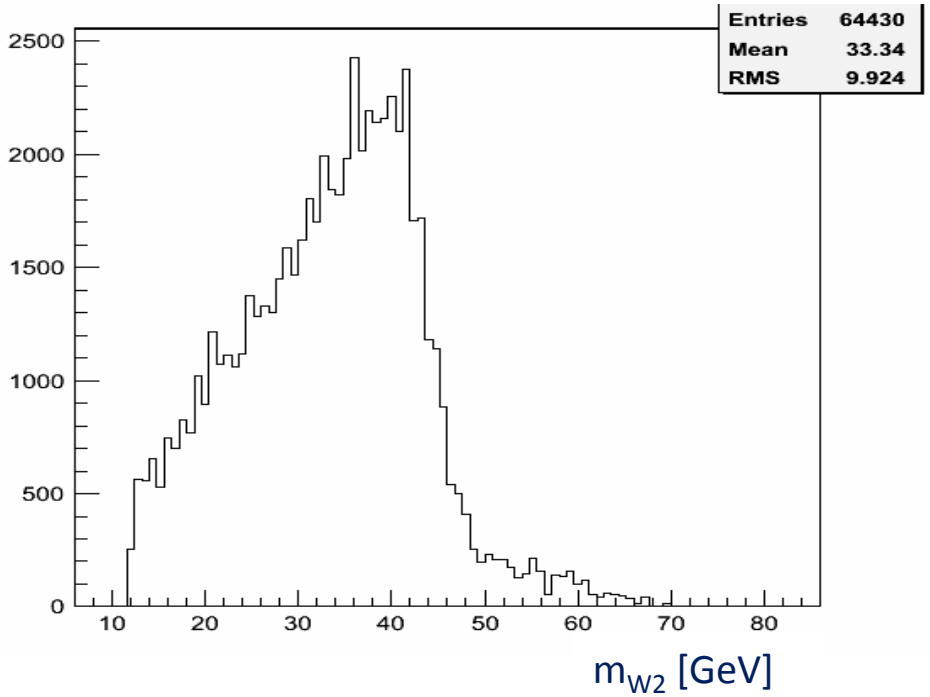
- × **Flavour tagging (b,c) LCFIPlus to reduce H->bb background**
- × **MVA analysis**

Signal Monte Carlo

$H \rightarrow WW \rightarrow qqqq$, $Z \rightarrow ll$

- WW decaying into four jets: real and off-shell W.
- The reconstruction is based on the pari of jets with the mass closest to the mass of real W.

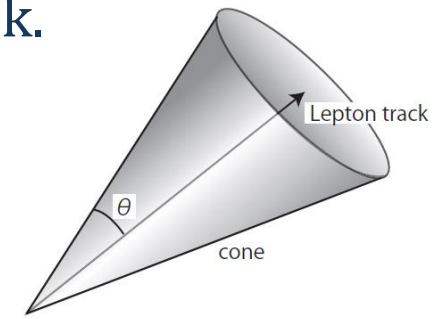




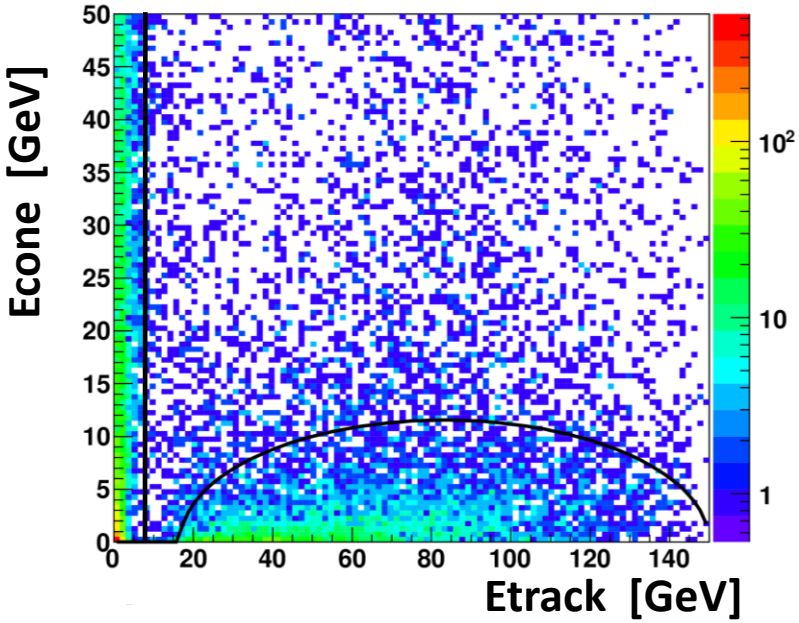
Isolation of lepton

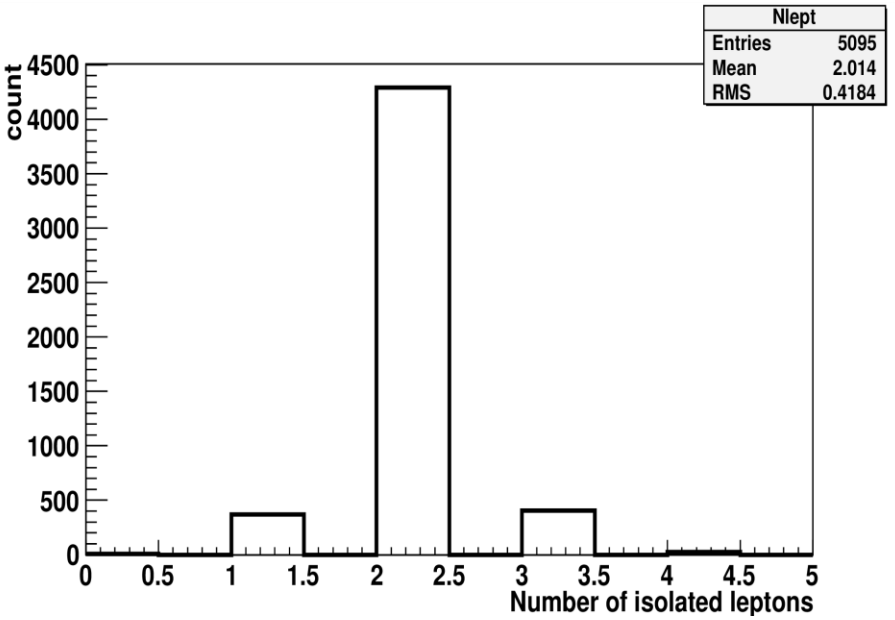
H→WW→qqqq , Z →ll

» Based on the track energy of a lepton candidate and calorimeter depositions within a cone of size cos θ=0.995 around lepton candidate track.



Etrack = 12 GeV



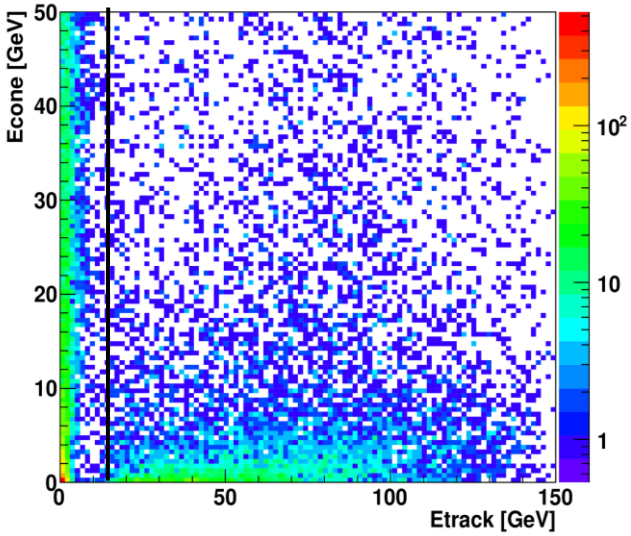


85% efficiency in reconstruction of the 'pure' lepton pair

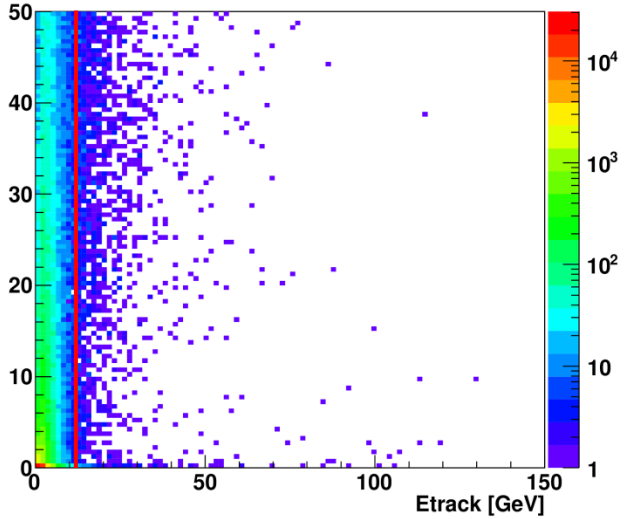
Lepton isolation

H→WW→qqqq , Z →ll

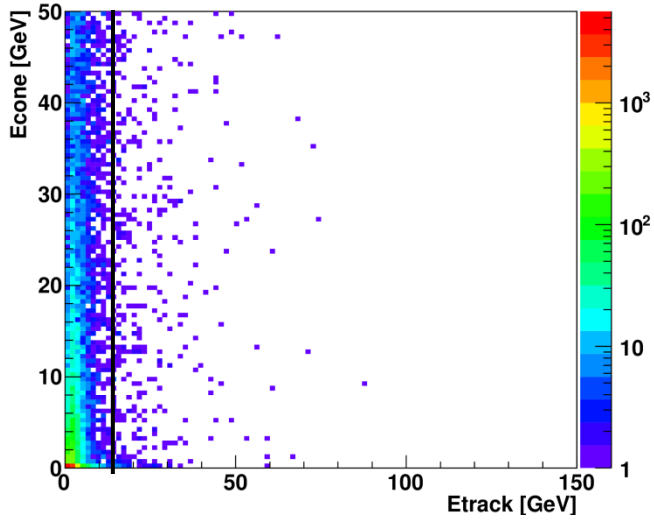
signal

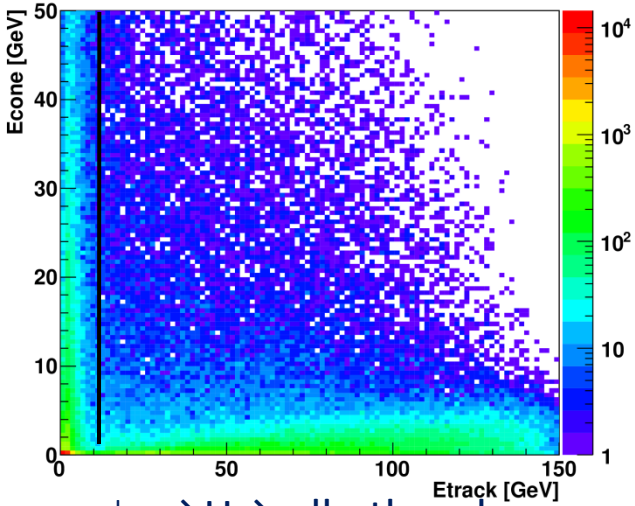


e^+e^-→qqqq

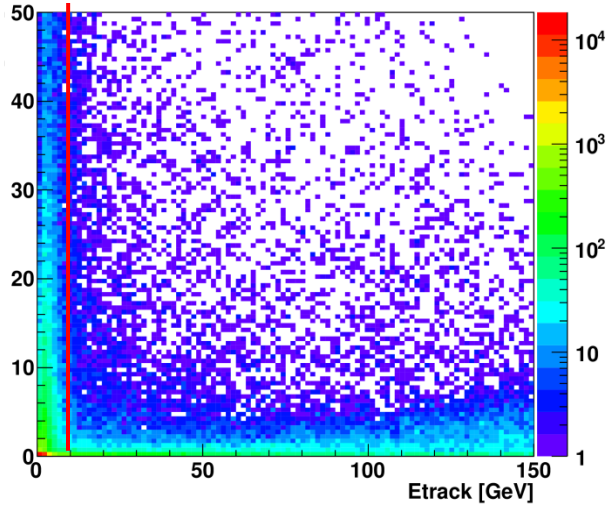


e^+e^-→qqvv

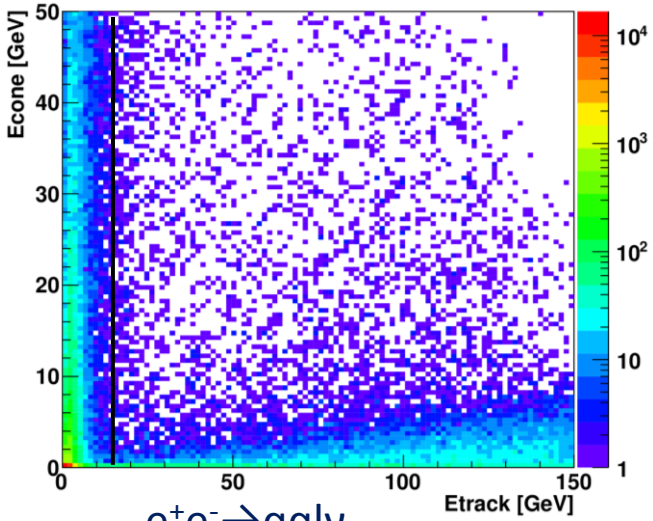




e^+e^-→H→ all other decays



e^+e^-→qqll

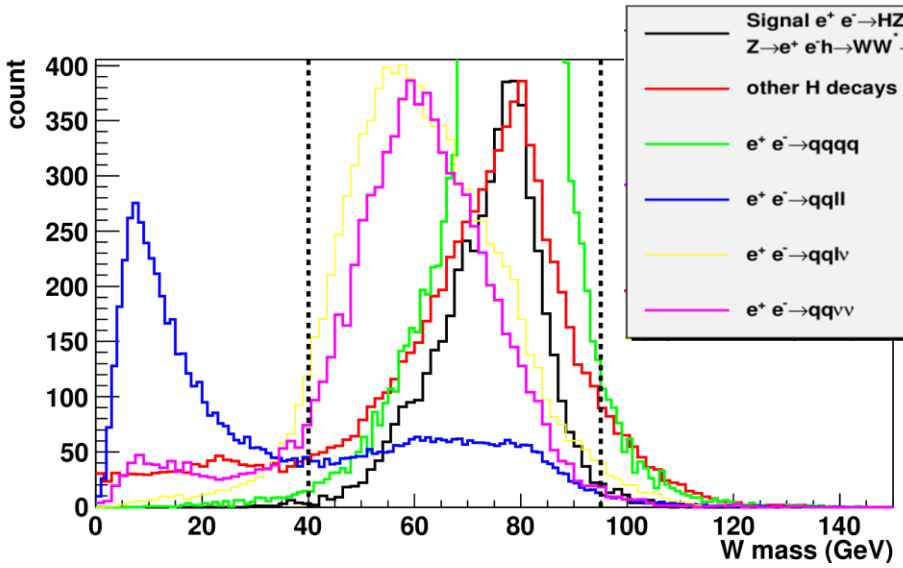


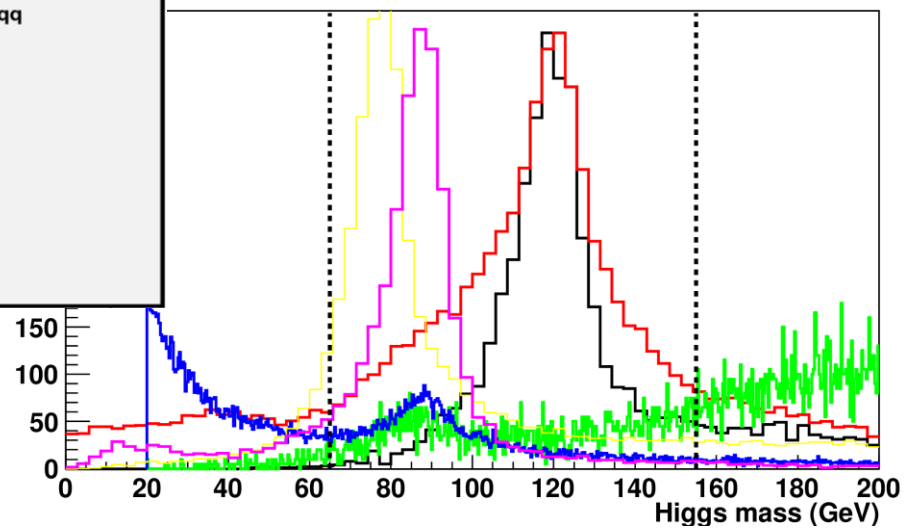
e^+e^-→qqlv

Preselection variables

H→WW→qqqq , Z →ll

» reconstruction focuses on a real W: jet pair with the mass closest to the W mass is chosen as a W candidate





45 GeV < m_W < 95 GeV

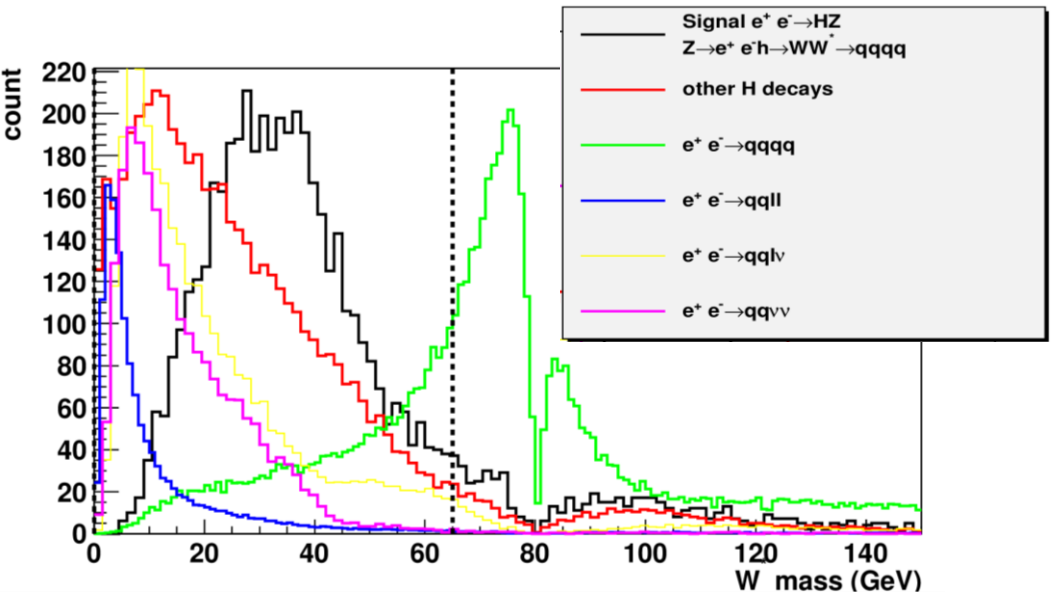
65GeV < m_H < 155 GeV

Preselection variables

$H \rightarrow WW \rightarrow qqqq$, $Z \rightarrow ll$

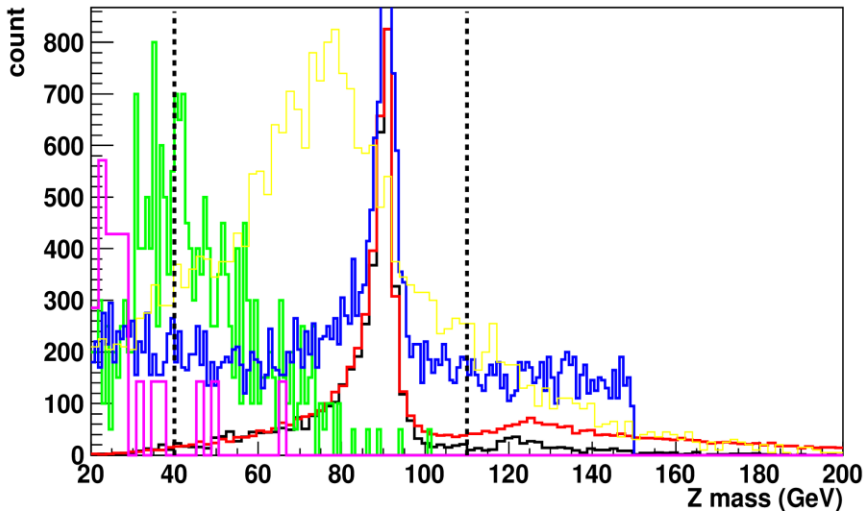
» Invariant masses of jet pair and lepton pair to reconstruct

W* candidate



$m_{W^*} < 65$ GeV

Z candidate

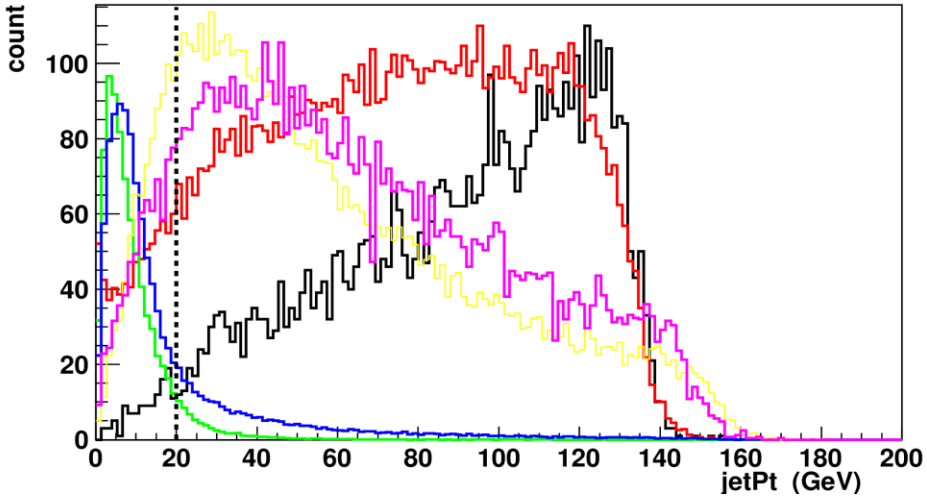


$40 \text{ GeV} < m_z < 110 \text{ GeV}$

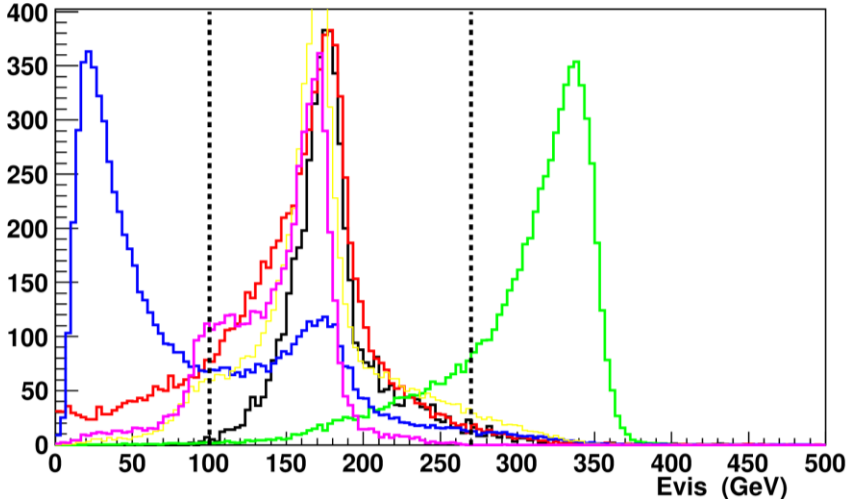
Preselection variables

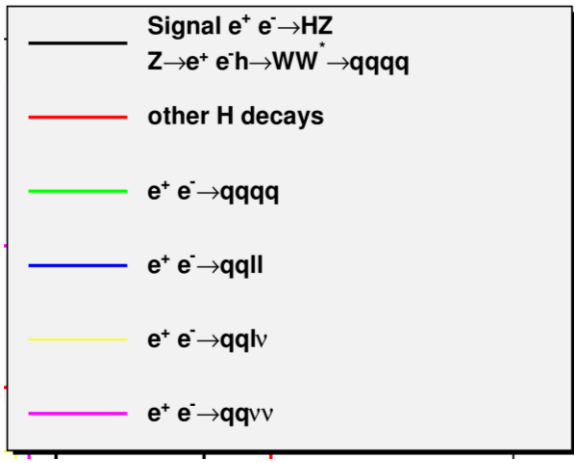
H→WW→qqqq , Z →ll

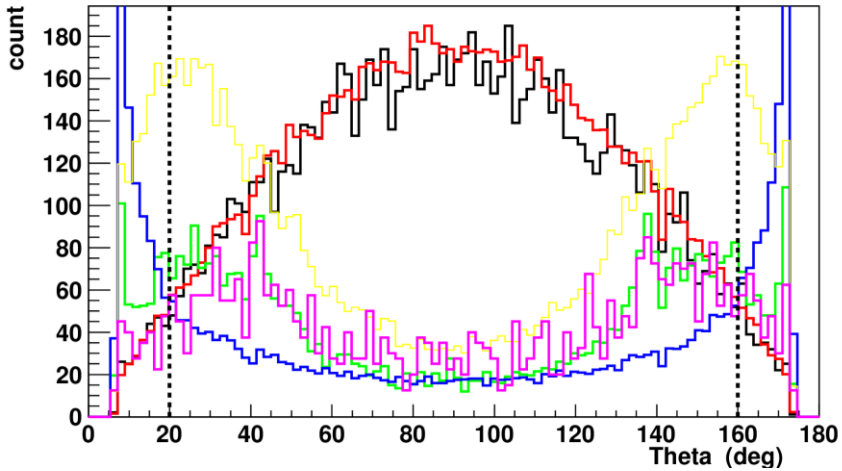
JetPt >20 GeV



100 GeV<Evis <300 GeV





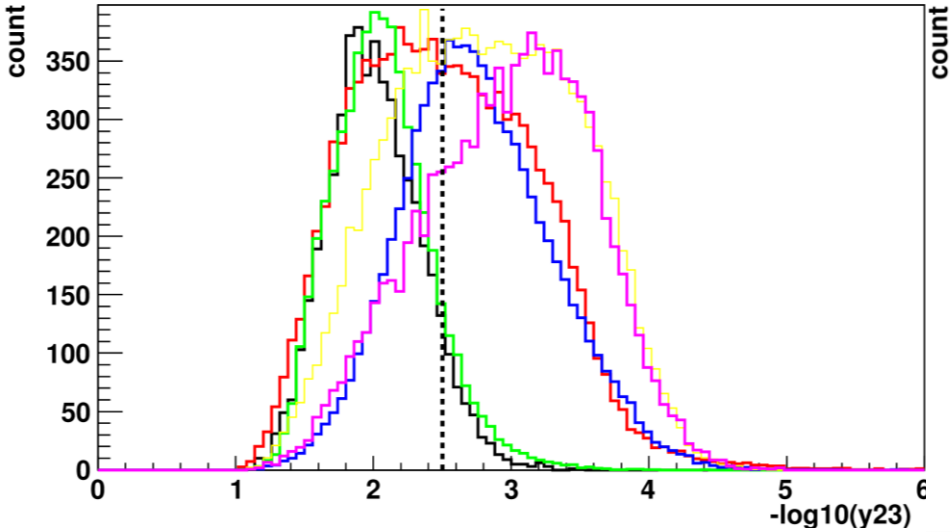


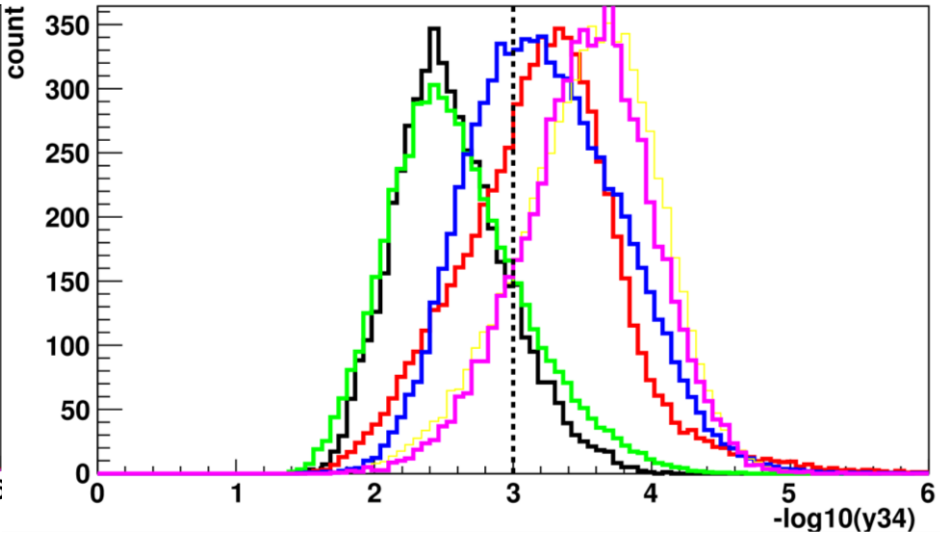
$20^0 < \theta_{el} < 160^0$

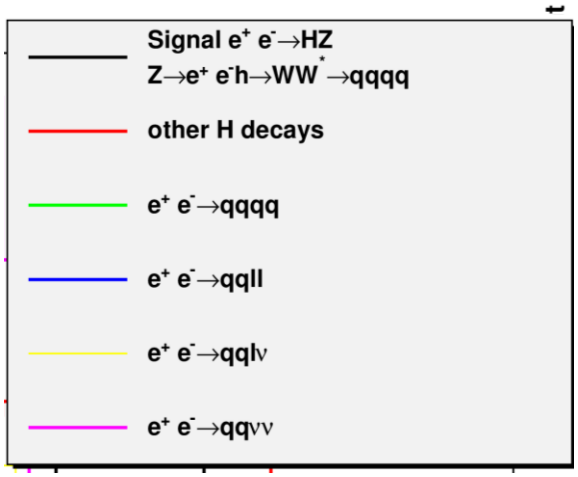
Preselection variables

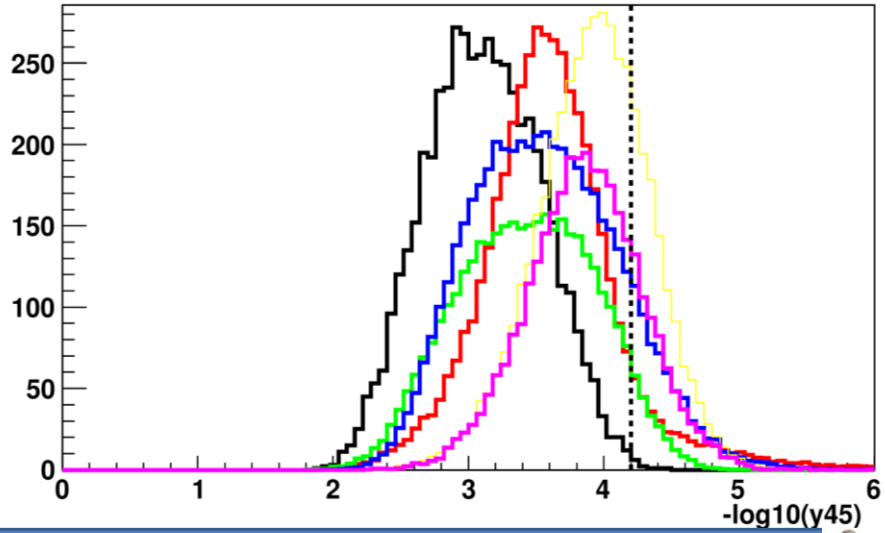
H→WW→qqqq , Z →ll

Jet transitions









Preselection

$H \rightarrow WW \rightarrow qqqq$, $Z \rightarrow ll$

	m_Z	m_H	Jet transitions	**Total preselection**	**σ[fb]**	**σ[fb] after pres.**
Signal eff.	84.2%	76.6%	63.3%	52.0%	0.48	0.25
Background eff.						
Other H decays from HZ→ee	45.5%	30%	81.2%	8.0%	4. 14	0.33
qqqq	0.0053%	3.5%	32.3%	0.005%	5847	0.29
qqll	5.5%	26.8%	12.9%	**0.22%**	1704	**3.78**
qqlν	4.5%	69.0%	4.4%	**0.08%**	5914	**4.73**
qqνν	0.4 %	83.0%	5.8%	0.02%	324.6	0.06

Summary

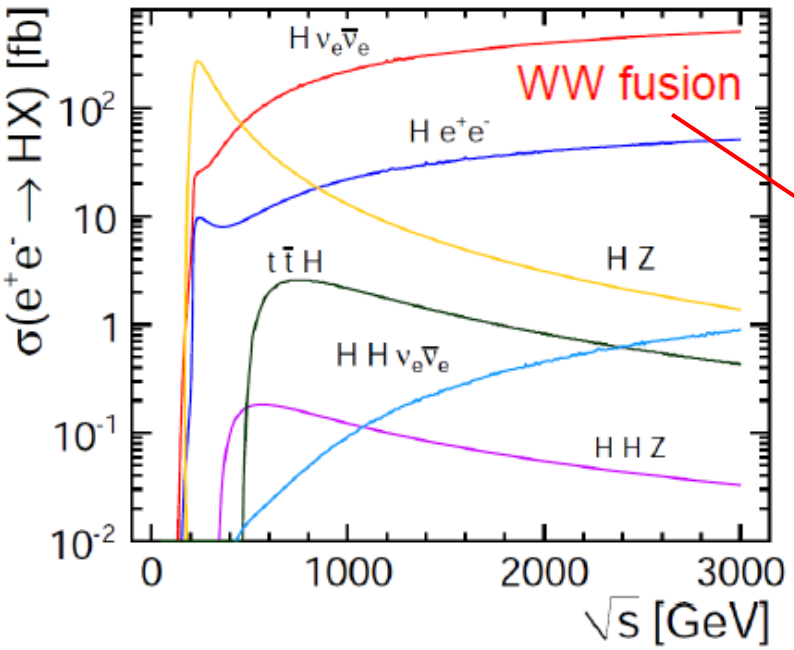
H→WW→qqqq , Z →ll

- The status of the H→WW→qqqq , Z →ll at 350 GeV is being presented
- Preselection cuts are being optimized to maximize background suppresion and preserve signal efficiency
- After preselecion S/B is ~ 3/100 (not final)
- Precise lepton isolation important for good reconstruction of invariant Z mass which is the most effective preselection variable

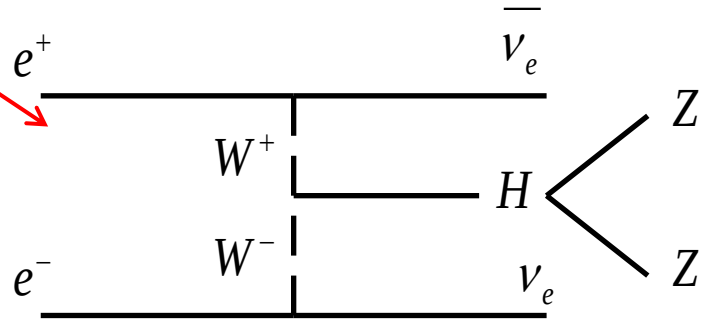
Current status of the H to ZZ* analysis at 1.4 TeV

G. Milutinović - Dumbelović

Signal



Signal : 4 jets + missing energy



Three possible ZZ decay topologies:

- qqqq~48%
- qqll~42%
- llll~10%

Only fully-hadronic final state considered

Signal and bck cross-sections

Process	$\sigma[fb]$
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to ZZ -> qqqq$	3.45
$e^+e^- \to qq\,\nu_e\overline{\nu}_e$	788
$e^+e^- \to qqqq\,\nu_e\overline{\nu}_e$	24.7
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to WW -> qqqq$	27.6
$e^+e^- \to qq$	4009.5
$e^+e^- \to qqqq$	1328.1
$e^+e^- \to qqqqll$	71.7
$e^+e^- \to qqqql\,\nu$	115.3
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to bb$	136.94
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to ZZ -> qqll\,/\,llll$	0.177

- The most dominant $e^+e^- \to qq$ and $e^+e^- \to qqqq$ backgrounds will be rejected by the E_{vis} based preselection.
- $\gamma\gamma \to hadrons$ backgound has been overlade before the digitization phase.

Preselection

- 40GeV<InvMassZ1<110GeV
- InvMassZ2<65GeV
- 80GeV<InvMassHiggs<180GeV
- $-\log_{10} y_{34} < 3.5$
- $-\log_{10} y_{23} < 3.0$

→ 2 jet topologies

- 150GeV<Evis<650GeV →

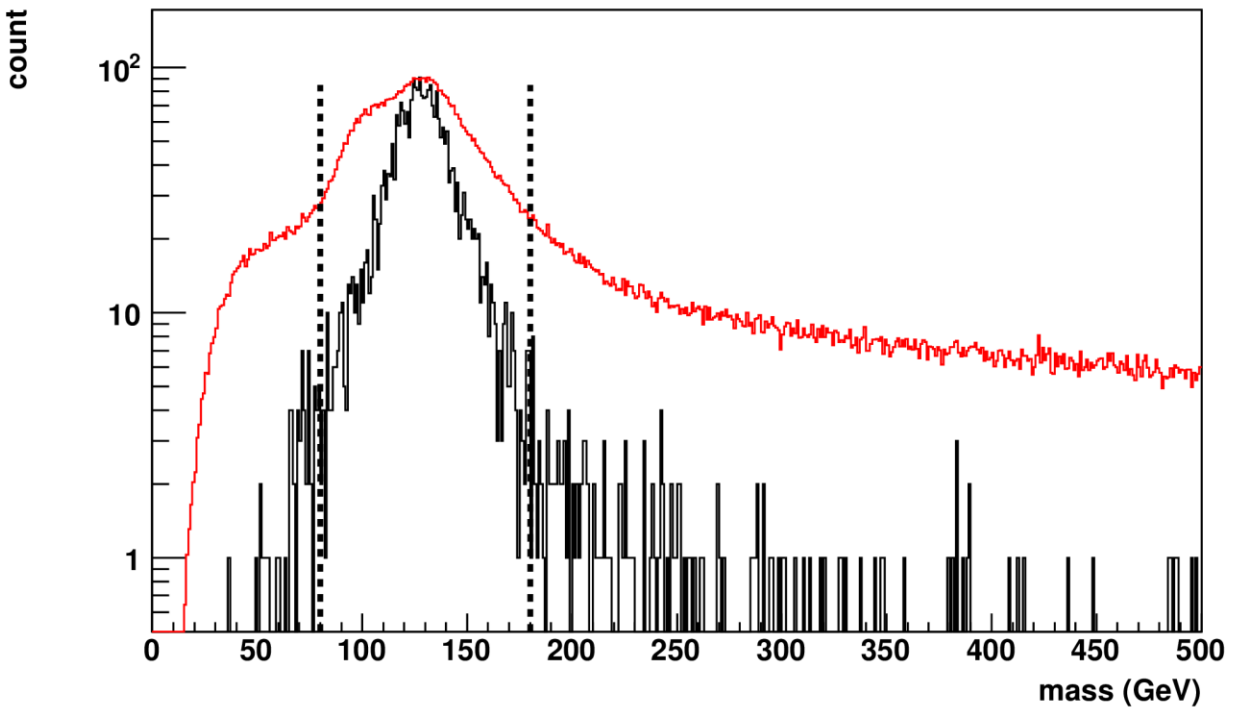
$e^+e^- \to qq$ $\quad$ $e^+e^- \to qqqq$

- P(b)jet$_1$<0.95
- P(b)jet$_2$<0.95

→ $H \to bb$

Higgs Invariant Mass

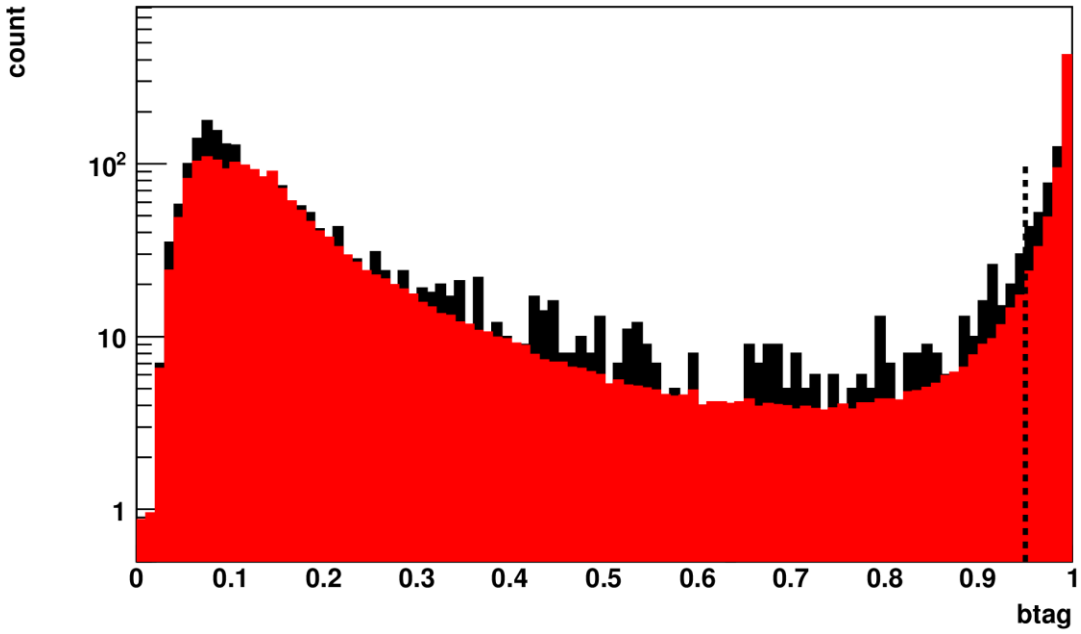
Background
Signal



80GeV < InvMassHiggs < 180GeV

P(b)jet$_1$

Background
Signal



P(b)jet$_1$<0.95

Signal and bck. after preselection

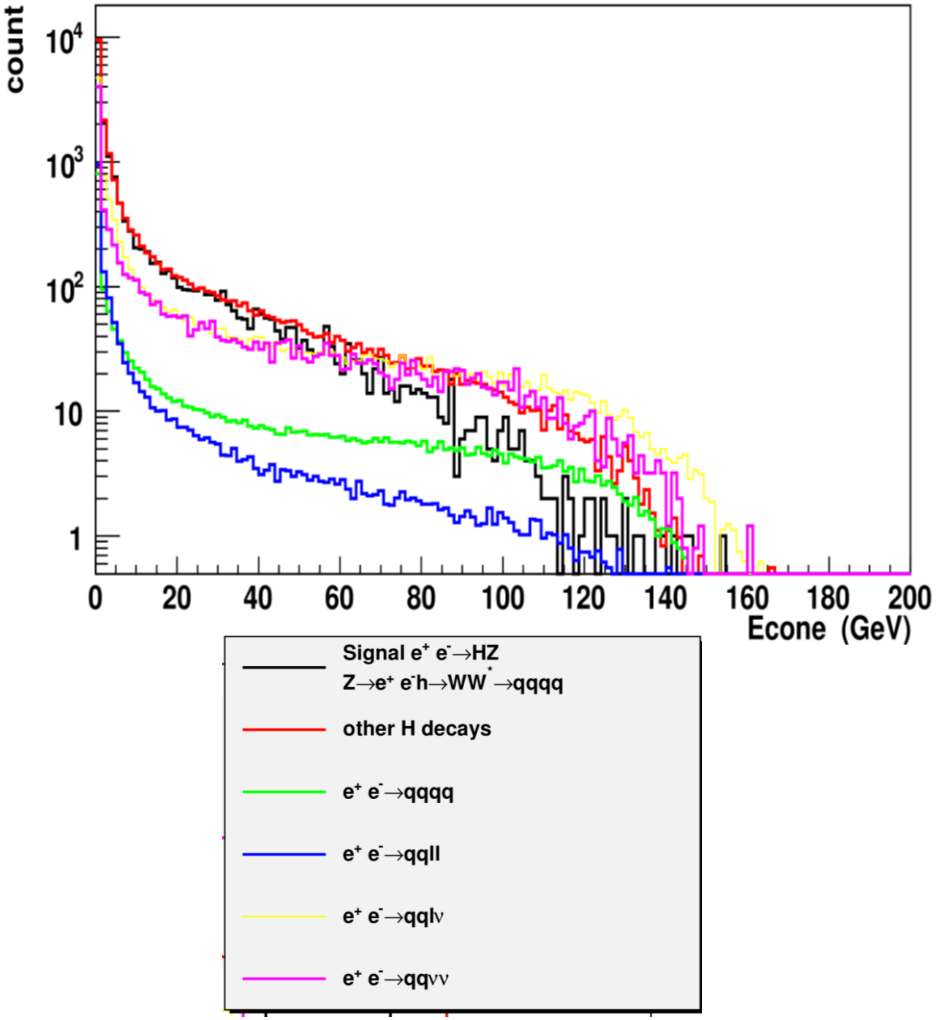
Process	$\sigma[fb]$	Efficiency(%)
$e^+e^- \to H\nu_e\overline{\nu_e}, H \to ZZ -> qqqq$	1.97	57
$e^+e^- \to qq\nu_e\overline{\nu_e}$	165.48	21
$e^+e^- \to qqqq\nu_e\overline{\nu_e}$	0.87	3.53
$e^+e^- \to H\nu_e\overline{\nu_e}, H \to WW -> qqqq$	19.87	72
$e^+e^- \to qq$	135.92	3.39
$e^+e^- \to qqqq$	48.47	3.65
$e^+e^- \to qqqqll$	1.84	2.57
$e^+e^- \to qqqql\nu$	0.51	0.44
$e^+e^- \to H\nu_e\overline{\nu_e}, H \to bb$	12.06	8.81
$e^+e^- \to H\nu_e\overline{\nu_e}, H \to ZZ -> qqll / llll$	0.05	31.5

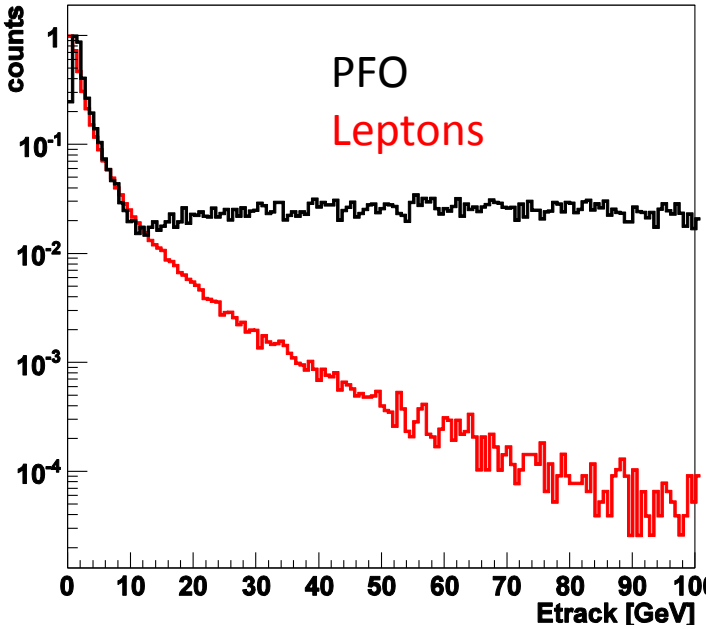
- Z is decaying more frequently to b quarks than W what results in enlarged selection efficiency.

Conclusion

- Preselection completed to reduce the most dominant backgrounds.
- Reasonably high rejection rate for bck. processes, except for WW fully hadronic decay.
- An attempt to optimize further preselection will be made before MVA analysis.

Backup

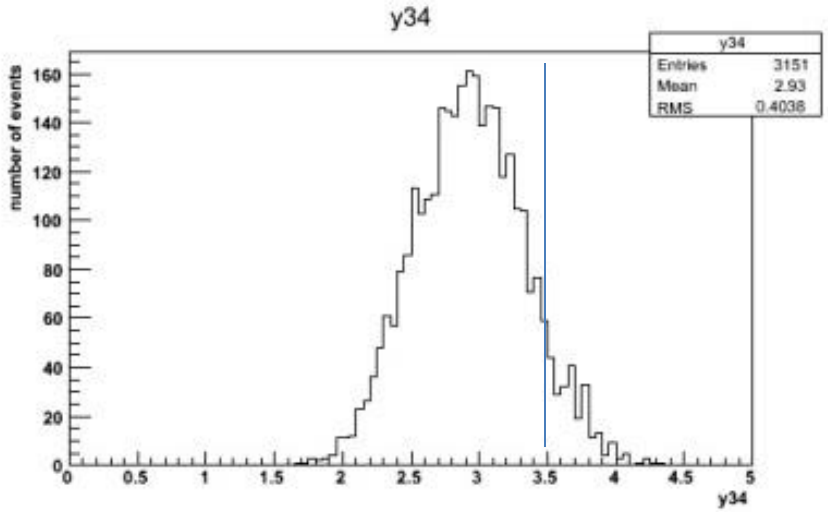

count
Econe (GeV)
Signal e+ e-→HZ
Z→e+ e-h→WW*→qqqq
other H decays
e+ e-→qqqq
e+ e-→qqll
e+ e-→qqlν
e+ e-→qqνν

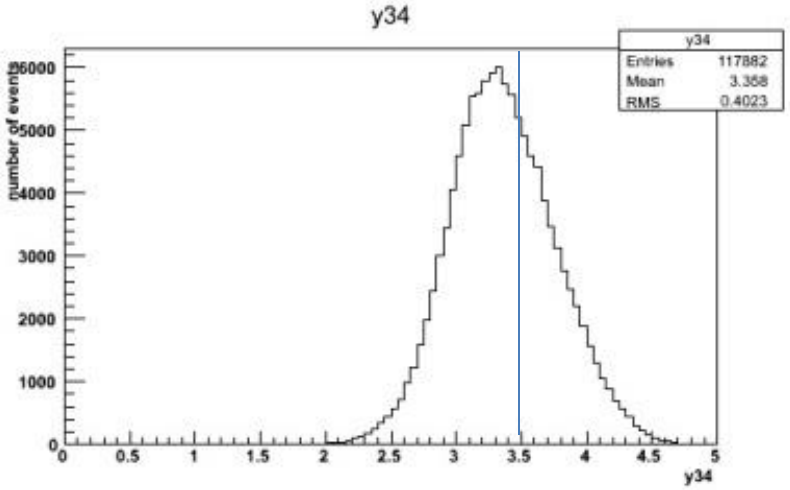

counts
PFO
Leptons
Etrack [GeV]

Jet transitions

Signal

$e^+e^- \to qq\nu_e\overline{\nu_e}$





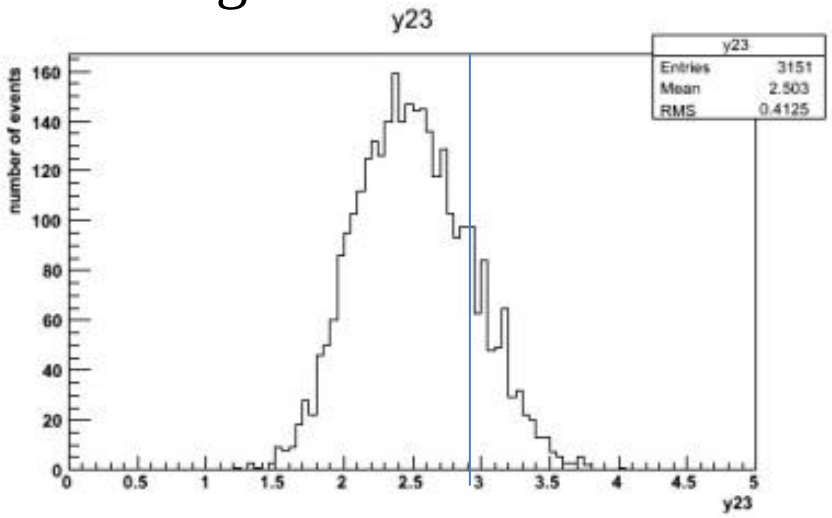
$-\log_{10}(y34) < 3.5$

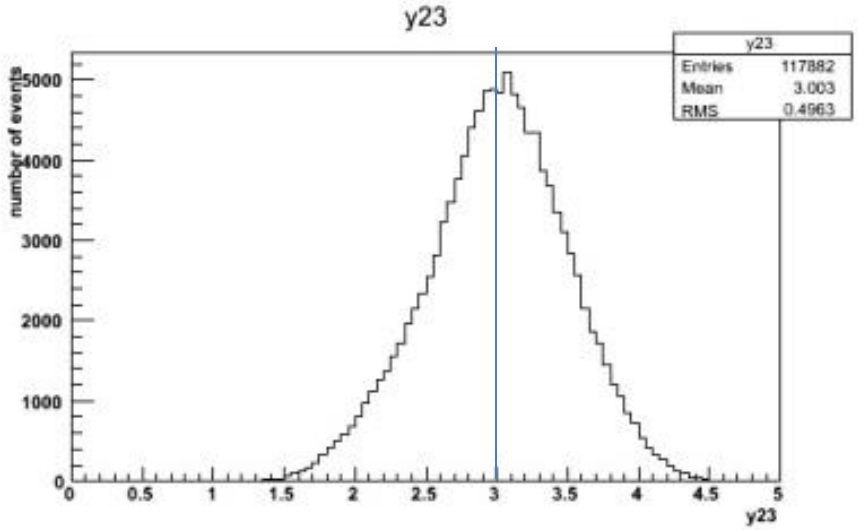
- Require event to be 4-jet like: use y_{34} (the k_T value at which the event transit from 3 jets to 4 jets)

Jet transitions

Signal

$e^+e^- \to qq\nu_e\overline{\nu_e}$





$-\log_{10}(y23) < 3.$