Higgs to ZZ* at 1.4 TeV

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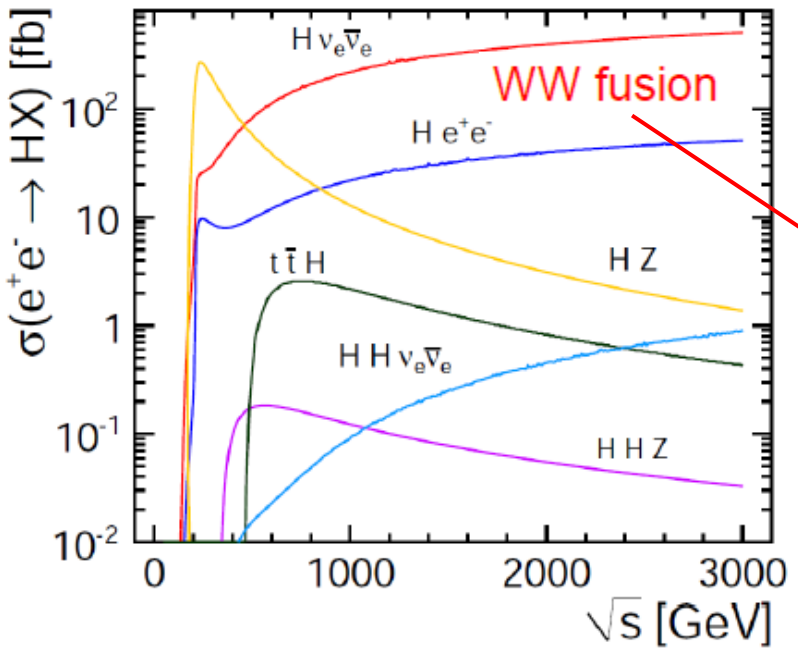
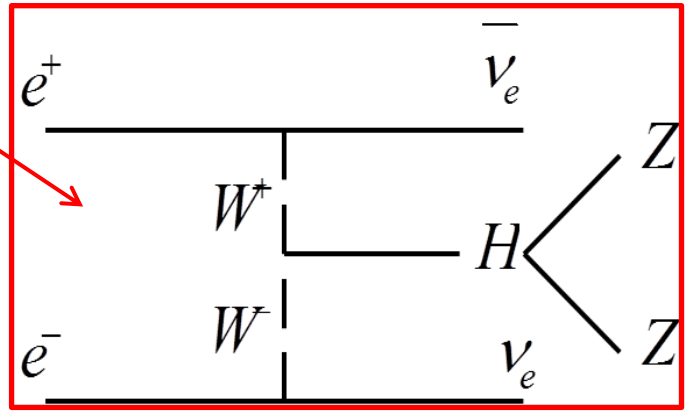
Overview

- Signal and background x-sec
- Analysis strategy
- MVA
- Final results
- Conclusions

Signal process



Signal : 2 jets + 2 leptons (muons, electrons or taus) + missing energy

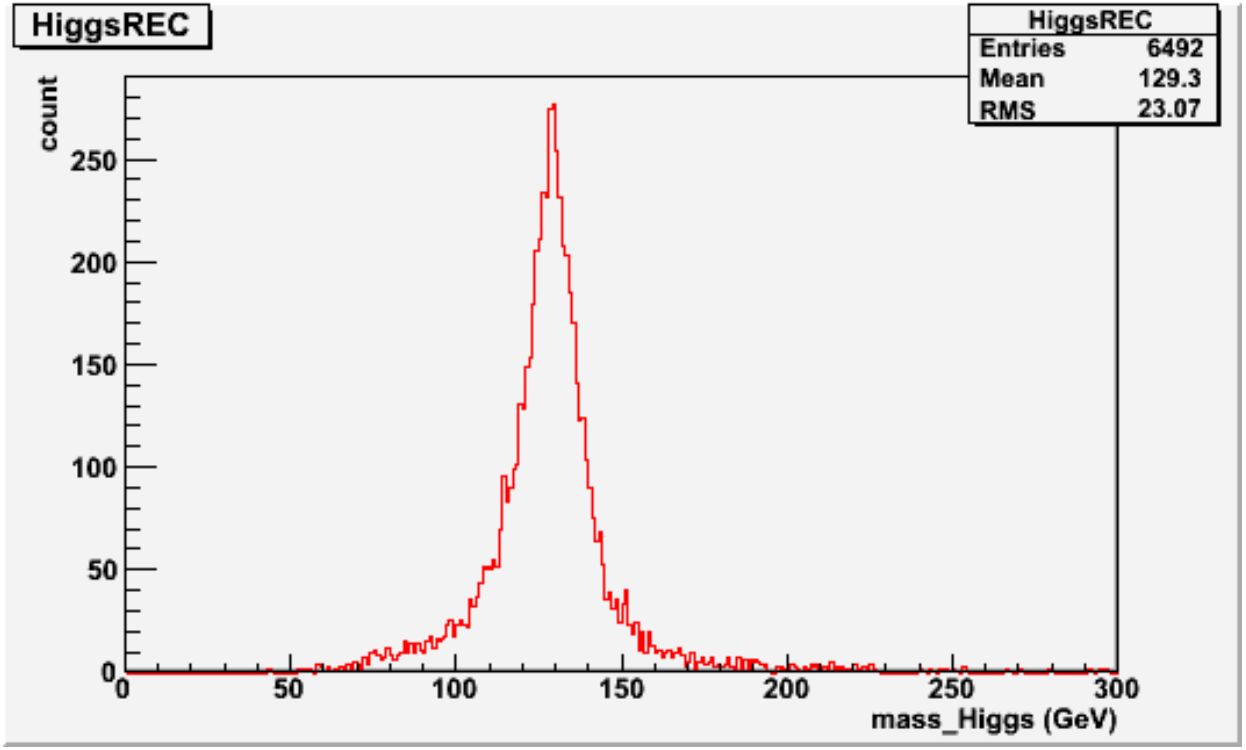


Higgs coupling: $\frac{g^2_{HWW} \cdot g^2_{HZZ}}{\Gamma_H}$

- BR(H→ZZ*) ≈ 2.89% ⇒ σ_{HWW} × BR ≈ 7.05 fb
- BR(Z→e+e−, Z→μ+μ−, Z →ττ) ≈ 10%
- N_s(ZZ*→qqe+e−, ZZ*→qqμ+μ−, ZZ*→ qq ττ) ≈ 1500/1.5 ab^{-1}

Signal

The reconstruction is based on the pair of jets or leptons (muons, electrons or taus) with the mass closest to the mass of real Z.

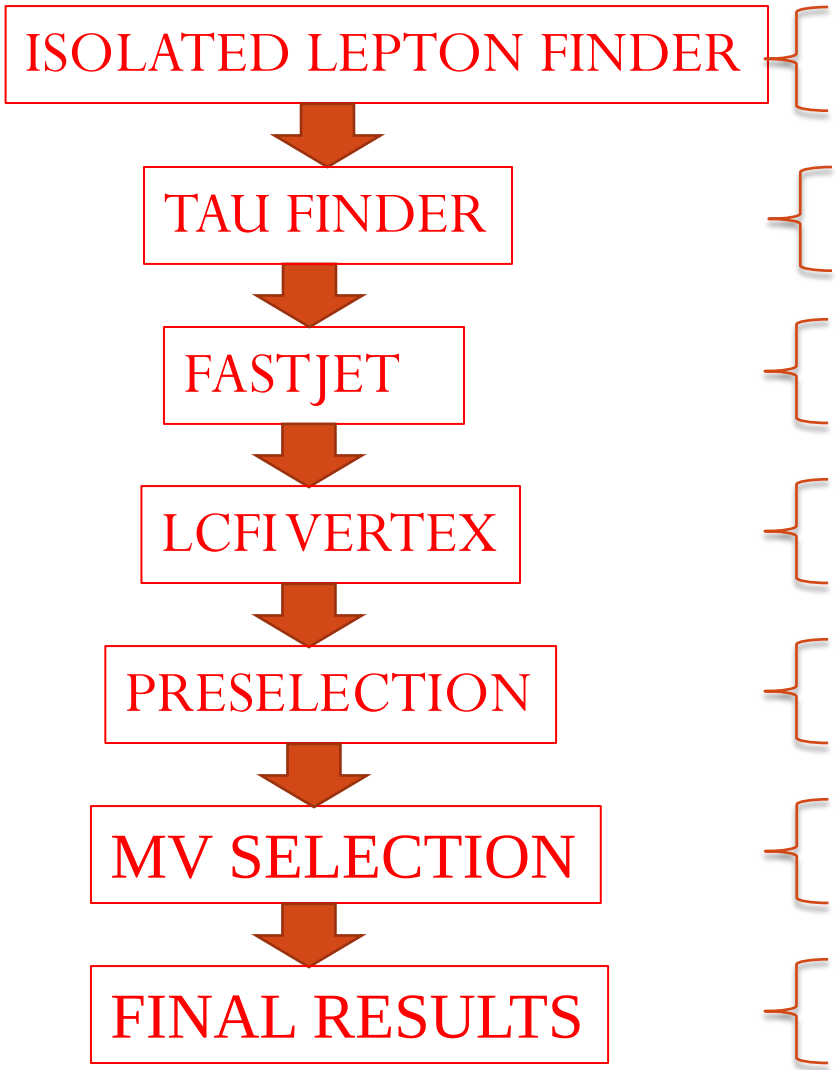


Higgs mass

Signal and bck x-sec

Process	$\sigma[fb]$
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to ZZ- > qqll$	0.995
$e^+e^- \to qq\nu_e\overline{\nu}_e$	788
$e^+e^- \to qqqq\nu_e\overline{\nu}_e$	24.7
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to WW$	56.4
$e^+e^- \to qq$	4009.5
$e^+e^- \to qqqq$	1245.1
$e^+e^- \to qqqqll$	71.7
$e^+e^- \to qqqql\nu$	115.3
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to bb$	136.94
$e^+e^- \to qqll$	2725.8
$e^+e^- \to H\nu_e\overline{\nu}_e, H \to ZZ- > qqqq/llll$	3.51
$e\gamma \to qq\nu$	29873.5
$e\gamma \to qqe$	16898.9
$\gamma\gamma \to qq$	76782.8
$\gamma\gamma \to qqll$	13829.7

Analysis strategy



Find 2 isolated electrons or muons

Find 2 isolated taus

Force events into 2 jets, k_T exclusive, SELECTEDPFOs, R=1.0

helps to reduce $e^+e^- \rightarrow H\nu_e\overline{\nu}_e, H \rightarrow bb$

helps to reduce large x-sec background

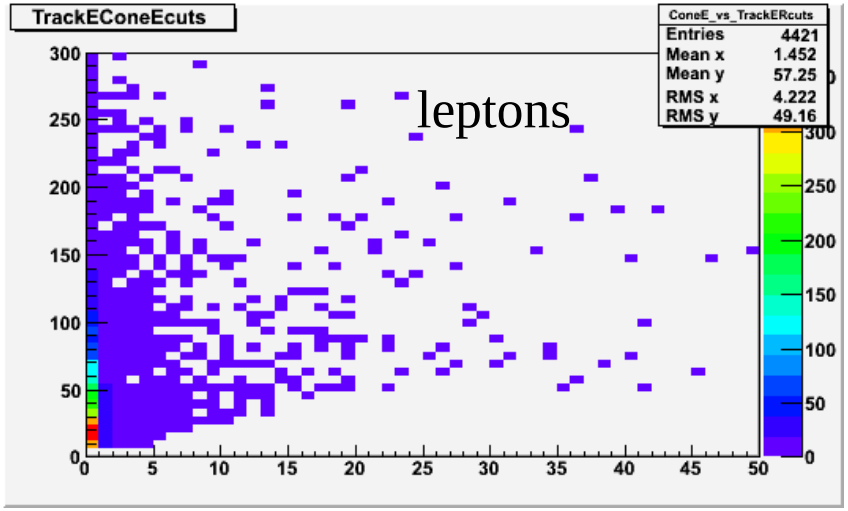
Multivariate BDT analysis

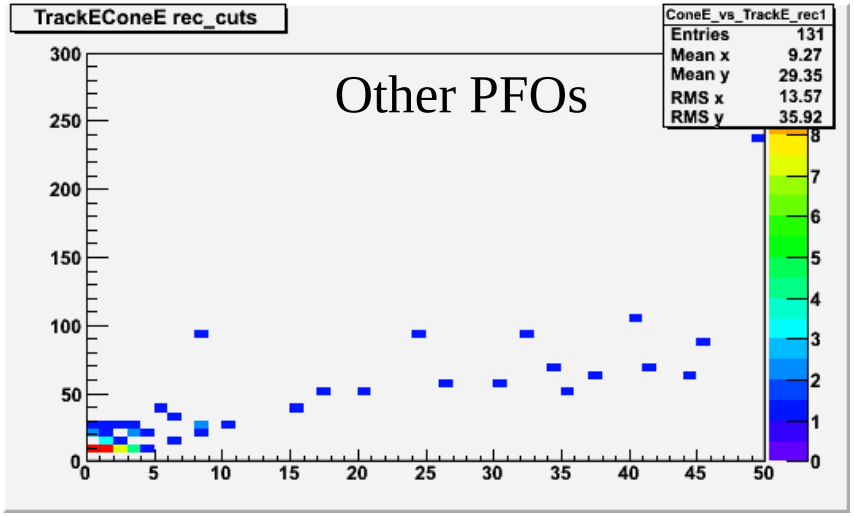
$\frac{\sqrt{S+B}}{S} * 100\%$

Isolated Lepton Finder

Lepton identification:

- Remove all tracks with E < 6 GeV
- Energy contained in a cone around the track (cos θ <0.995)
- Cut at IP < 0.02mm
- Ratio of track energy deposition in ECAL and HCAL (0.02< μ ECAL to HCAL fraction<0.3, e^- ECAL to HCAL fraction>0.94)
- Apply isolation criteria





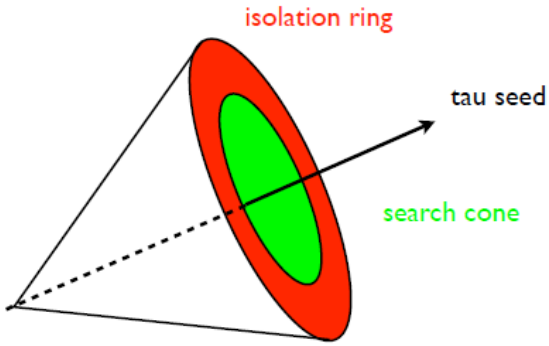
87% efficiency in reconstruction of the lepton pair

Tau Finder

Steps to reconstruct a tau:

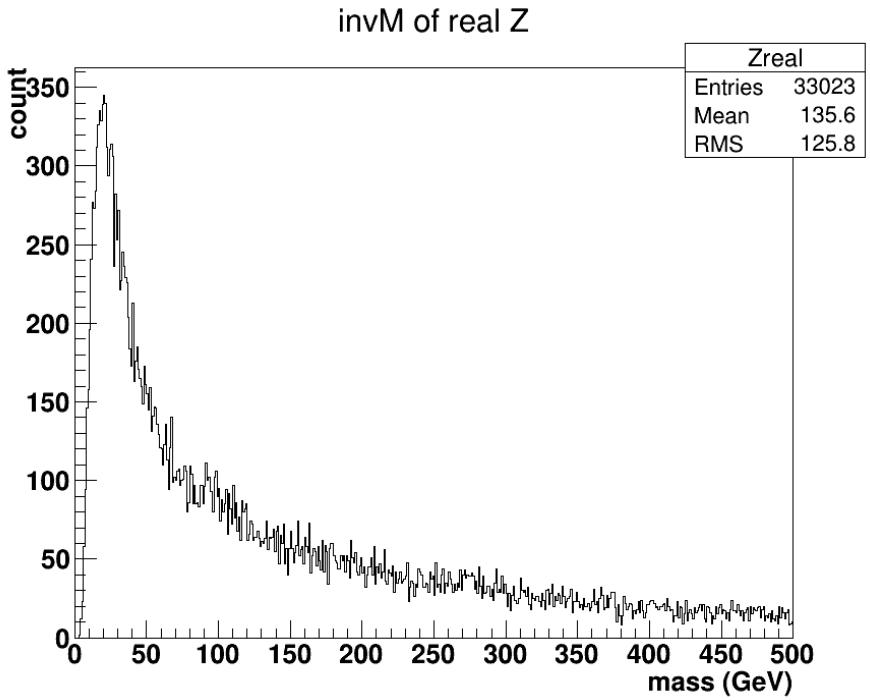
- 1. Look for tau 'seed' (a high energy, charged track)
- 2. Add all particles within search cone to seed
- 3. Check number of charged tracks, isolation, tau mass

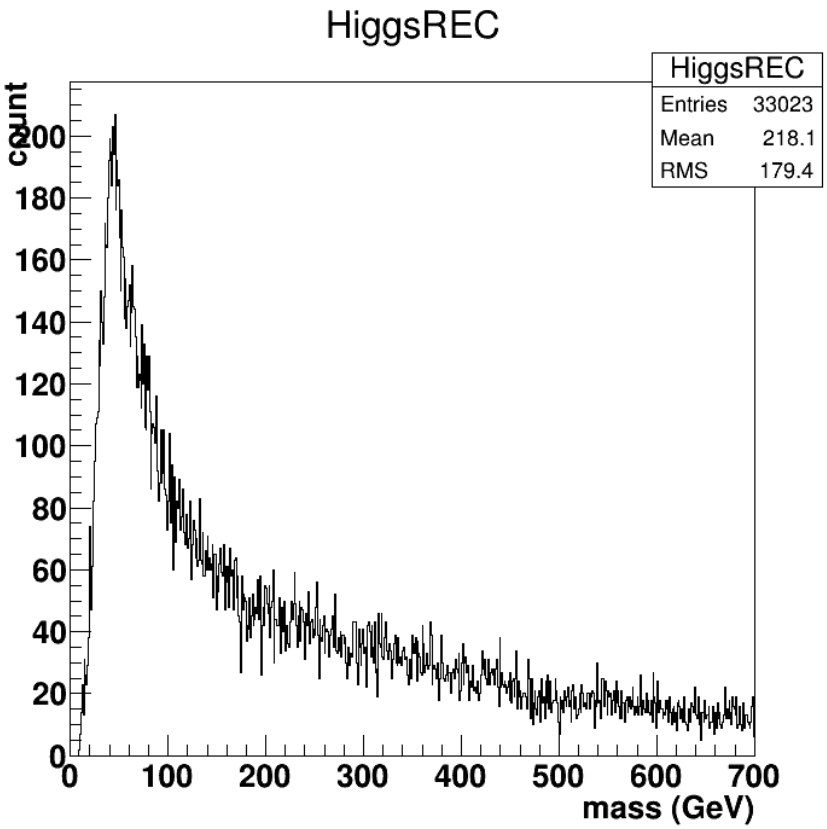
Initial pT cut for all tracks > 4 GeV
pT cut for seed > 10 GeV
Impact parameter R_0: 0.01 - 0.5
Search cone angle < 0.15 rad
Isolation energy < 3 GeV
Ring particles < 5
Invariant mass < 2. GeV/c^2



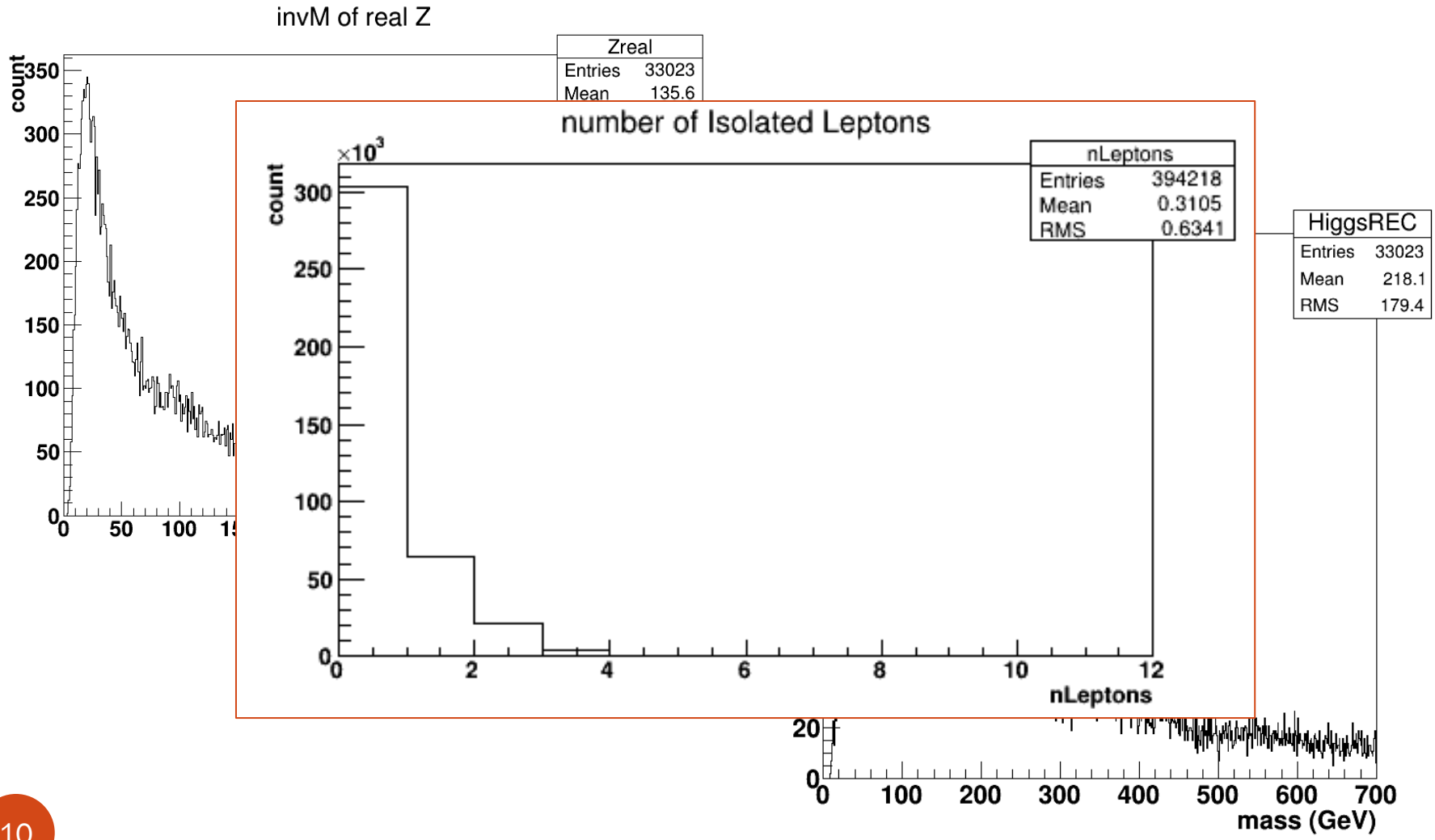
37% efficiency in reconstruction of tau pair

$\gamma\gamma \rightarrow qq\ell\ell$ background





$\gamma\gamma \rightarrow qq\ell\ell$ background



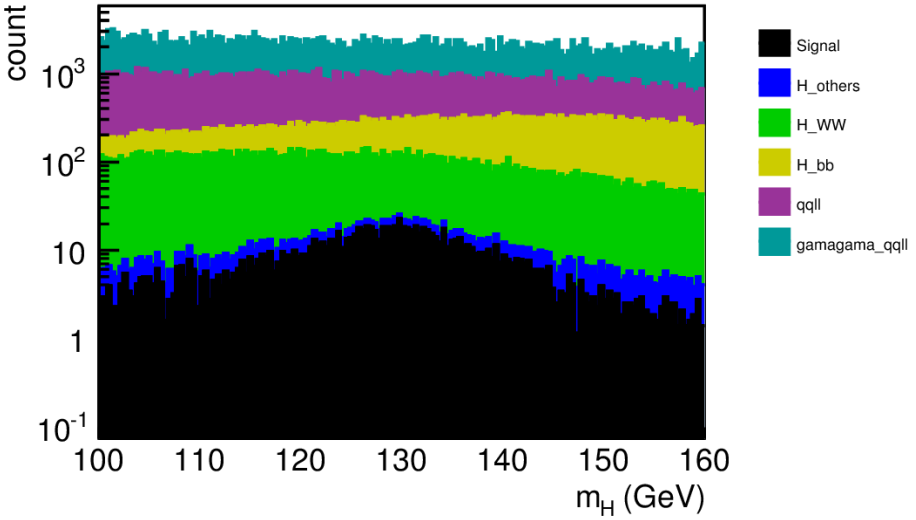
MVA analysis

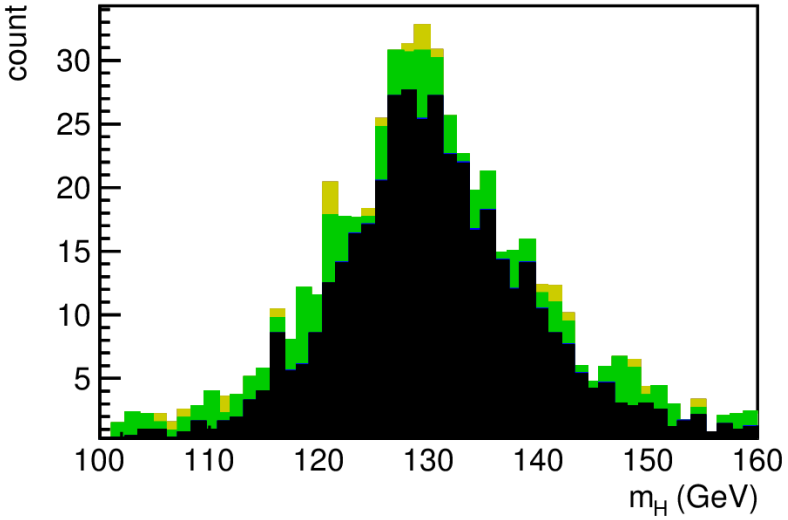
- TMVA trained with 17 variables on total background except $\gamma\gamma \rightarrow qqll$

List of variables for TMVA:

$m_{Z1,}$ $m_{Z2,}$ $-\log(y_{34})$, $-\log(y_{23})$, $-\log(y_{12})$, $P(b)^{jet1}$, $P(b)^{jet2}$, $P(c)^{jet1}$, $P(c)^{jet2}$, E_{vis}, p_{Tmiss}, θ_H, m_H, m_{ll}, m_{qq} , E_{vis1} , N_{PFOs}

MVA result





- Overall signal efficiency 30.4%
- $\gamma\gamma \rightarrow qqll$ background completely removed after MVA

$$\frac{\Delta\sigma}{\sigma} \sim 5.6\%$$

Result

ε_s	30%
$\sigma_{WWH} \times BR(\boldsymbol{H \rightarrow ZZ \rightarrow qqll})$	0.995 fb
$\delta(\sigma_{WWH} \times BR(\boldsymbol{H \rightarrow ZZ \rightarrow qqll}))$	5.6%

- Uncertainty of the measurement is dominated by the backgrounds with large x-sections and limited efficiency in tau pair reconstruction which reduces the overall gain in statistics.
- One should not that no polarization is included that can boost statistics by a factor 2.

Conclusion

- The status of the H→ZZ*→qqll analysis is being presented
- All relevant SM background processes are considered, and beam-induced background from gamma gamma->hadrons interactions is overlaid to the physics events.
- It has been shown that BR(H→ ZZ) can be measured with a statistical accuracy of 5.6%.
- Limited efficiency in tau pair reconstruction reduces the overall gain in statistics.