HEP GROUP VINCA

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H->ZZ*->qqll at 1.4 TeV CLIC

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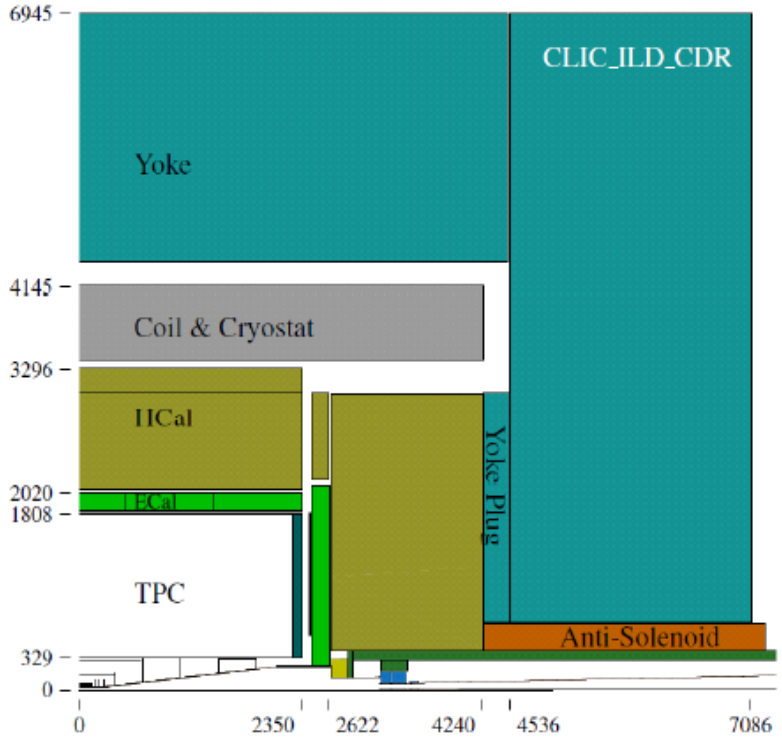
Overview

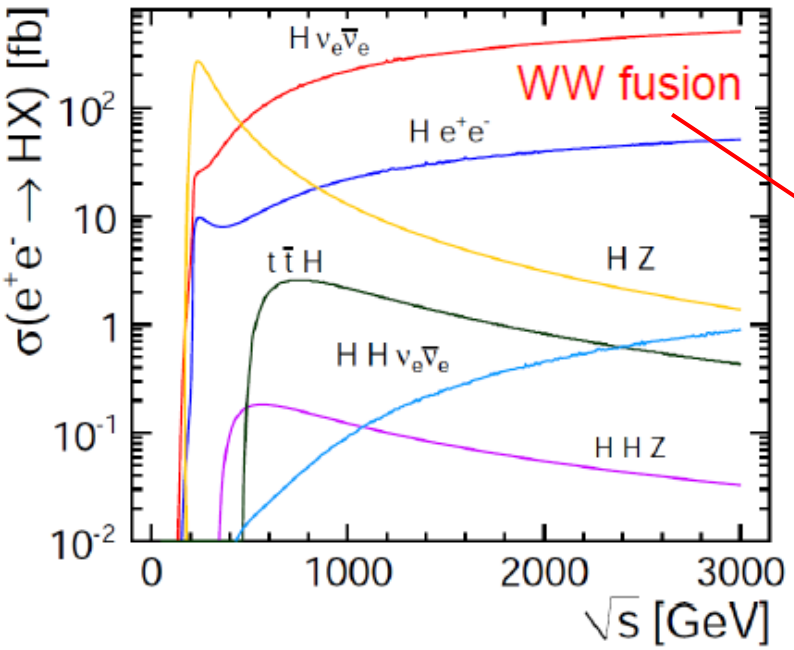
- Simulation and reconstruction
- Signal and background x-sec calculation and event samples
- Analysis strategy
- Preselection
- MVA results
- Next steps
- Conclusions

Simulation and reconstruction

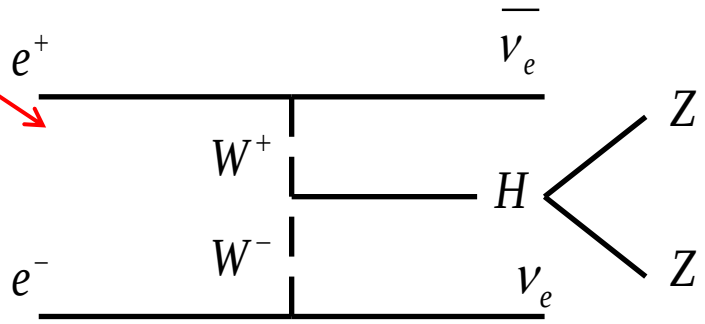
- Fully simulated events:
  Event generation with WHIZARD v.1.95
  including ISR and BS
- Beamspectrum generated with
  GUINEAPIG
- Hadronization with PYTHIA
- Assuming m_H=126 GeV
- CLIC_ILD detector
- Particle reconstruction
  and identification using
  PandoraPFA



Signal



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



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

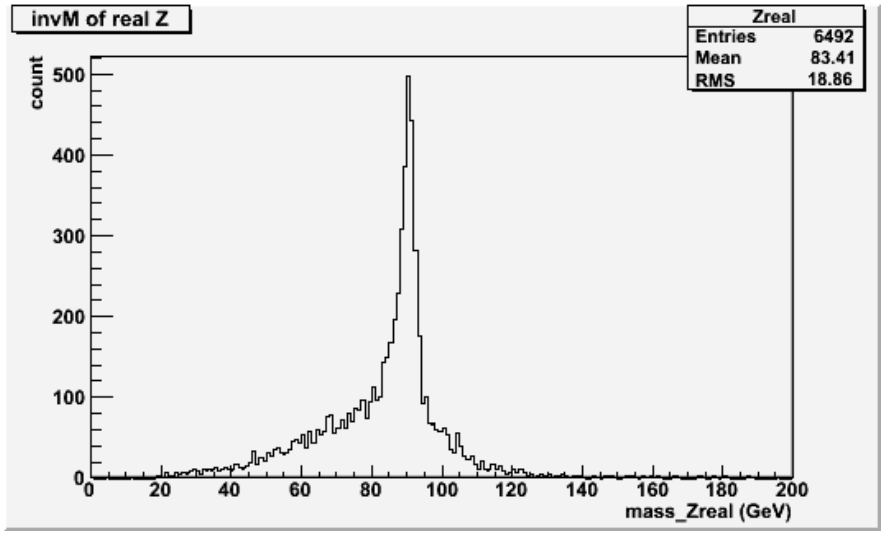
Two possible Z decay topologies:

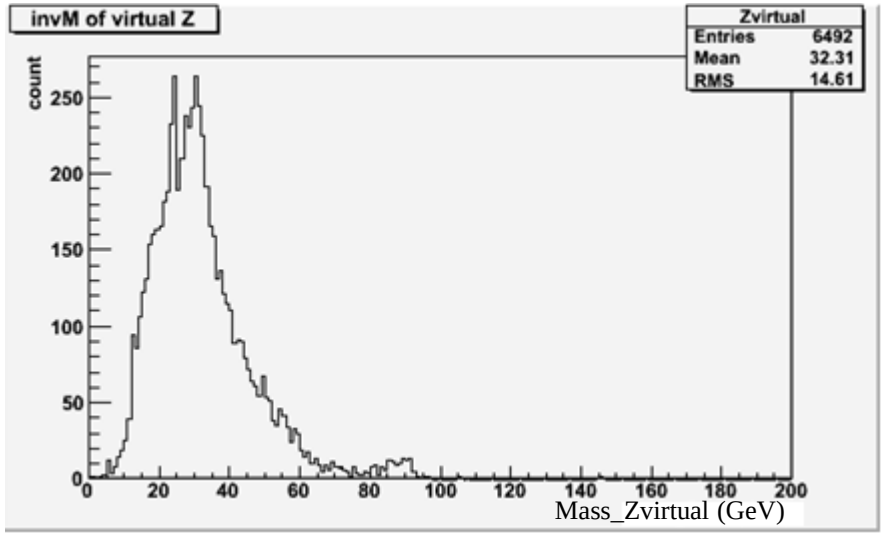
- qq~70%
- ll~10%

→ ZZ->qqll~14% (in this analysis l=electron or muon → 8.4%)

Signal

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

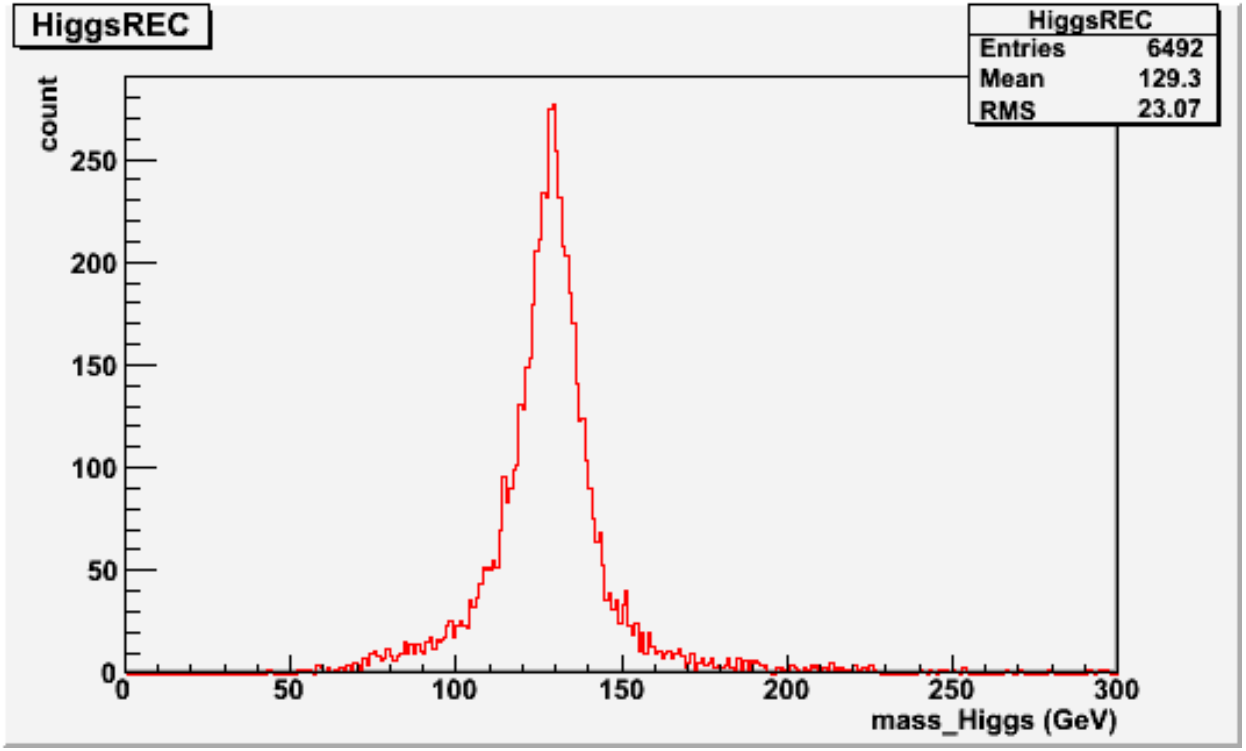




“real” Z

“virtual” Z

Signal



Higgs mass

Signal and bck x-sec calculation

Process	$\sigma[fb]$
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to ZZ -> qqll$	0.6
$e^+e^- \to qq\nu_e\bar{\nu}_e$	788
$e^+e^- \to qqqq\nu_e\bar{\nu}_e$	24.7
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to WW$	56.38
$e^+e^- \to qq$	4009.5
$e^+e^- \to qqq$	1328.1
$e^+e^- \to qqqql$	71.7
$e^+e^- \to qqqql\nu$	115.3
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to bb$	136.94
$e^+e^- \to qqll$	2725.8
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to ZZ -> qqqq/llll$	3.48

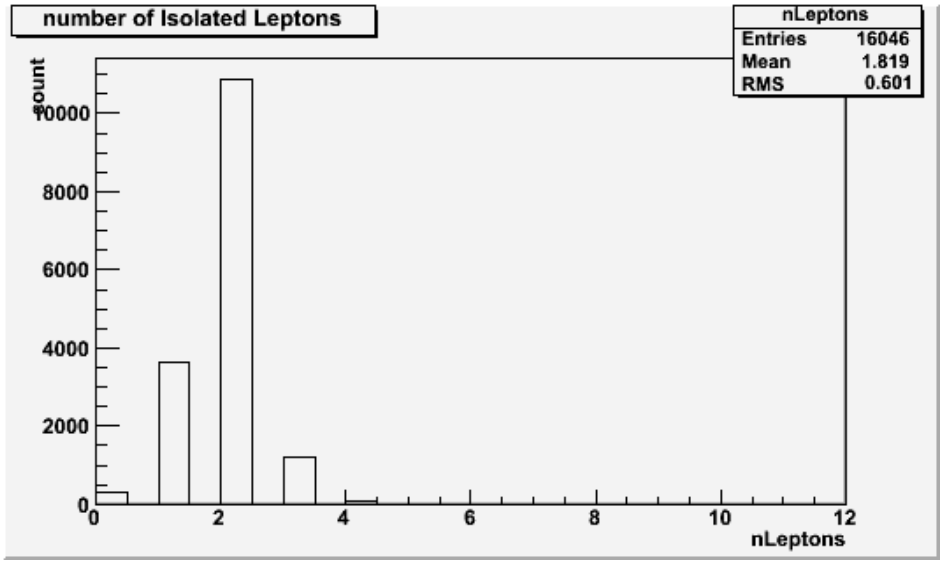
$\gamma\gamma \to hadrons$ backgound has been overlaid before the digitization phase.

Analysis strategy

- ISOLATED LEPTON FINDER
- FASTJET: Force events into 2 jets, k_T exclusive, SELECTEDPFOs, R=1.0
- b-TAGGING (helps to reduce $e^+e^- \to H\nu_e\overline{\nu_e}, H \to bb$)
- PRESELECTION
- MVA selection

Isolated Lepton Finder

- Etrack = 7 GeV
- cos θ=0.995
- Imact parameters: D0<0.2, Z0<0.2, R0<0.2
- 0.025<Muon Ecal to Hcal fraction<0.35
- Electron Ecal to Hcal fraction>0.94



74% efficiency in reconstruction of the lepton pair

Preselection

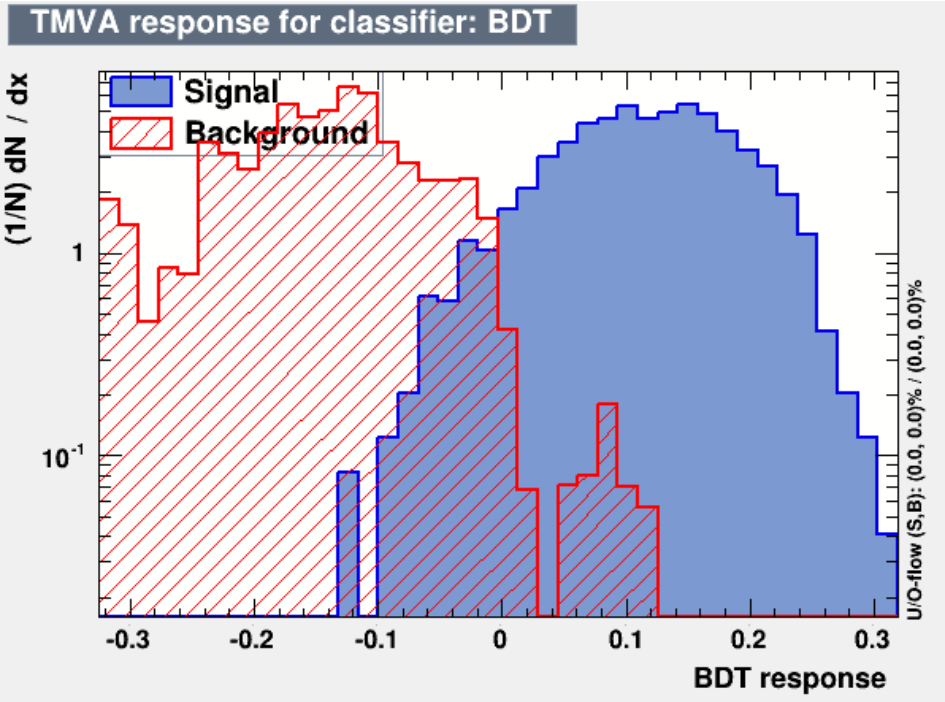
- Two isolated electrons or muons
- 50GeV<InvMassZ1<110GeV
- 10<InvMassZ2<60GeV
- 80GeV<InvMassHiggs<160GeV
- 150GeV<Evis<650GeV
- 20GeV<(Evis-HiggsEnergy)<210GeV
- missing_Pt<350GeV
- 50<Number_of_PFOs<150

Results after preselection

Process	$\sigma[fb]$	ε (%)
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to ZZ -> qqll$	0.32	54
$e^+e^- \to qq\nu_e\bar{\nu}_e$	0.63	0.08
$e^+e^- \to qqqq\nu_e\bar{\nu}_e$	0.01	0.05
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to WW$	0.51	0.9
$e^+e^- \to qq$	1.2	0.03
$e^+e^- \to qqqq$	0.13	0.01
$e^+e^- \to qqqql$	0.03	0.04
$e^+e^- \to qqqql\nu$	0.03	0.03
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to bb$	0.4	0.3
$e^+e^- \to qqll$	5.45	0.2
$e^+e^- \to H\nu_e\bar{\nu}_e, H \to ZZ -> qqqq/llll$	0.003	0.1

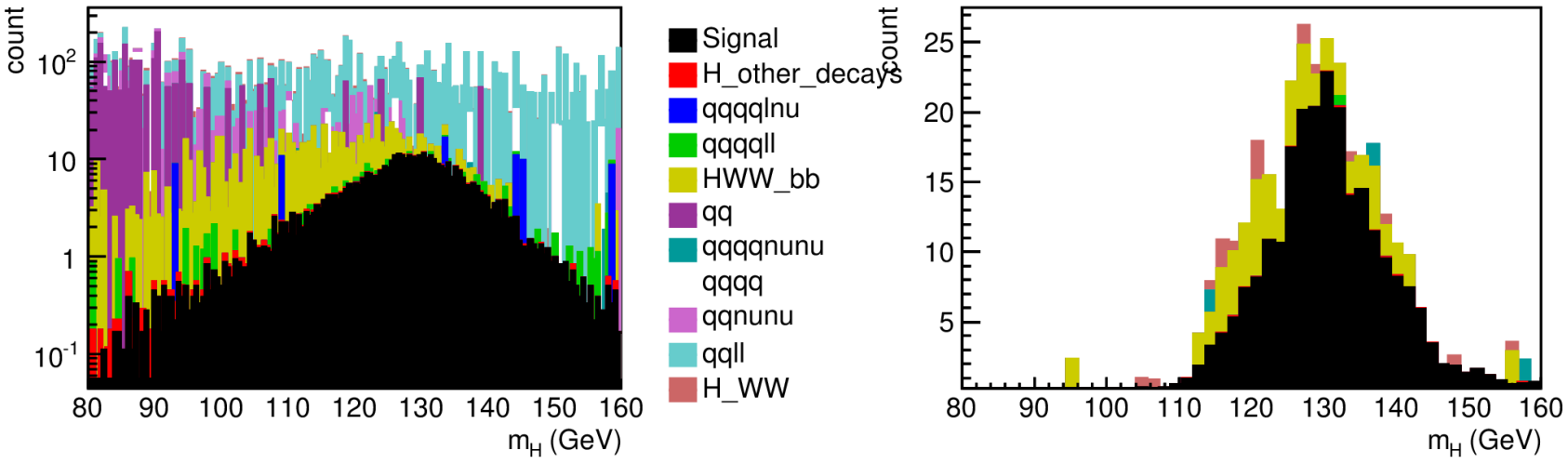
MVA analysis

- TMVA trained with 12 variables ($m_{Z1,}$ -log (y_{34}), -log(y_{23}), -log(y_{12}), $P(b)^{jet1}$, $P(b)^{jet2}$, $P(c)^{jet1}$, $P(c)^{jet2}$, Evis, missing_Pt, Higgs_angle, m_H) on total background



BDT>0.1

MVA analysis



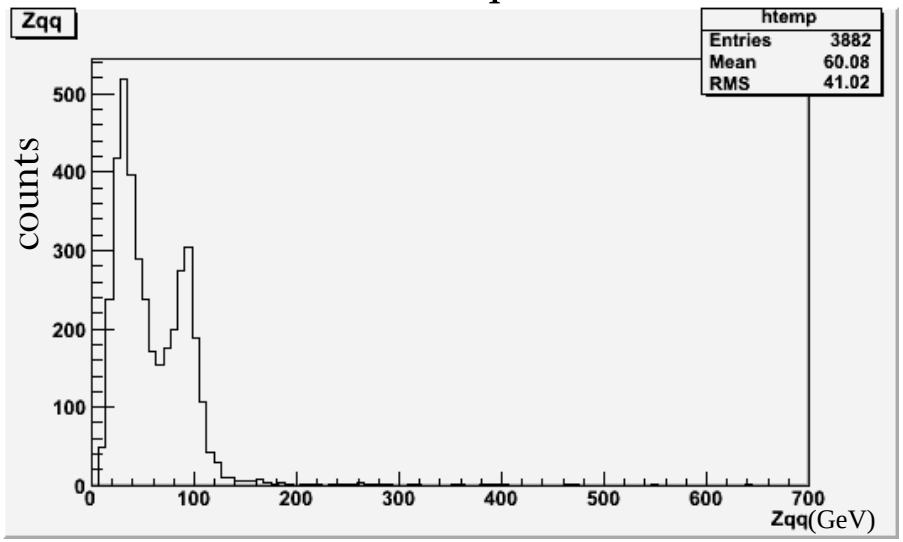
Preselection efficiency 54%

Overall signal efficiency 40%

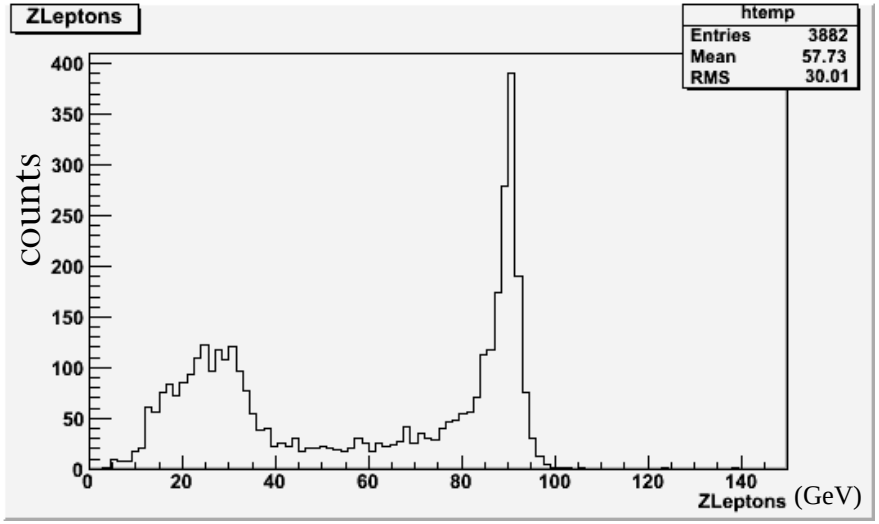
$$\frac{\Delta\sigma}{\sigma} = \frac{\sqrt{S+B}}{S} \sim 7.5\%$$

Next steps

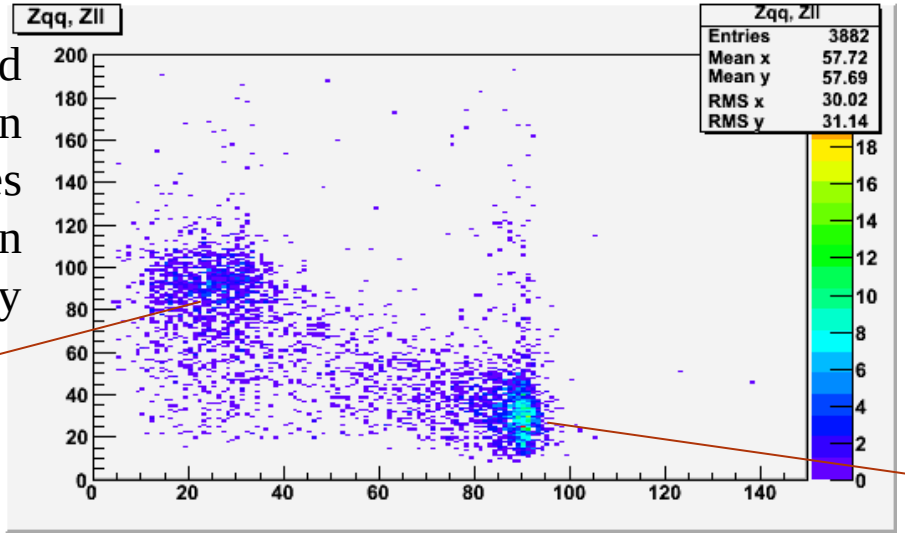
Z from two quakrs



Z from two leptons



So far we applied general selection on Z and final states independently on individual Z decay mode.



Region A

Now we will look into separate properties /phase space areas/ of Z decaying leptonicly and hadronicly.

Region B

Next steps

- Make categorisation:
  - muon type and region A
  - muon type and region B
  - electron type and region A
  - electron type and region B

Next steps

Include background processes:

Process
$e\gamma \rightarrow qqqqe$
$e\gamma \rightarrow qqqq\nu$
$e\gamma \rightarrow qq$
$e\gamma \rightarrow qqqq$
$e\gamma \rightarrow qq\nu$
$e\gamma \rightarrow qqe$

EPA approximation included.

Conclusion

- The status of the H→ZZ*→qqll analysis is being presented
- Reasonable preselection efficiency.
- TMVA preserves signal to a large extent.
- Background $e^+e^- \to qqll$ and $e^+e^- \to qq\nu_e\overline{\nu_e}$ reduced for an order of magnitude.
- An optimization of the MVA training will be done.
- Categorisation of leptons type in two regions of interest will be done.