Introduction and the Data Sample

- The QCD Background is just Huge: $20 fb^{-1} \times 55 mb$
  $= 1.1 \times 10^{15}$ in $20\ fb^{-1}$ of data

- At relatively low Higgs mass, it is difficult to observe Higgs : $M_H = 150$ GeV
  $Br(H^0 \rightarrow ZZ^*) = 8.3\%$

- No Fully Simulated HLT QCD events officially produced is available.

Gen-Sim-Digi-Reco : .CMSSW_2_2_3 Fully Simulated

.M_H = 150GeV in Pythia

Signal Events($H^0 \rightarrow ZZ^* \rightarrow \mu\mu\mu\mu$, $\mu\mu ee$, $eeee$) : 15000 Events

QCD Dilepton HLT Events : .MSEL =1 and CKIN(3) = 25GeV

along with the appropriate QCD parameters in Pythia

. P_T (2Electrons) > 11.5 GeV or P_T (2 Muons) > 6.5 GeV

. Total 773174 Events are Produced with Full Simulation

$\Rightarrow \varepsilon_{Gen} = 1/1315765.75 = 7.6 \times 10^{-7}$

(Generator level, CKIN(3)=0GeV)

The Analysis Criteria

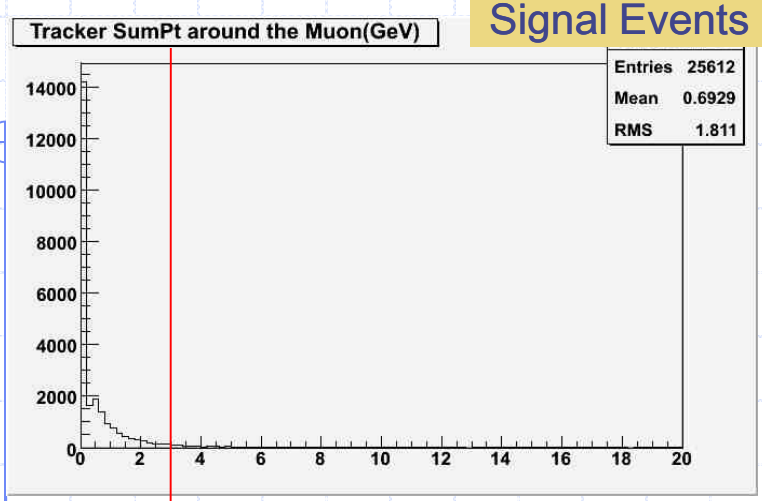
a. Lepton Isolation(All the leptons)

. Muons: tkDep.depositWithin(coneSize)>3. &&
(ecDep.depositWithin(coneSize)+
hcDep.depositWithin(coneSize))>5.
with coneSize = 0.3

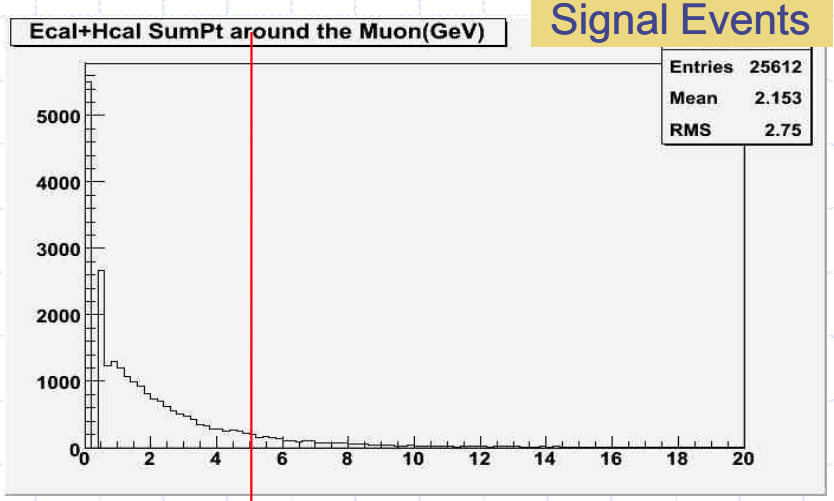
. Electrons: ecalIsolFromDepsMap[eleRef] > 7.

Muons

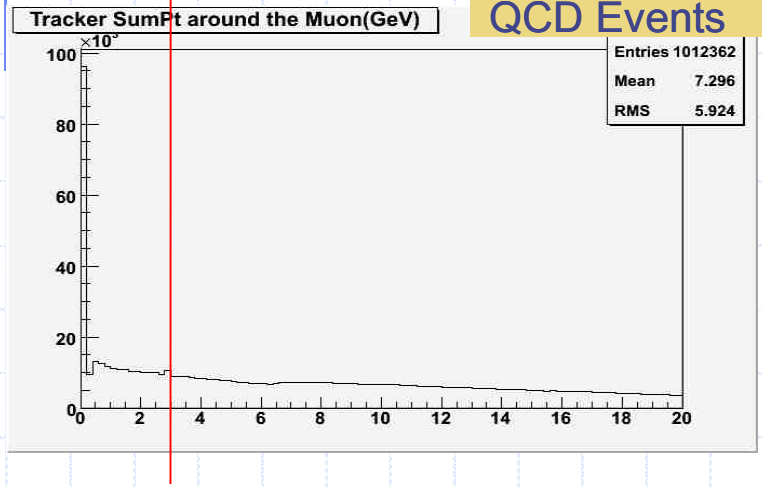
Signal Events



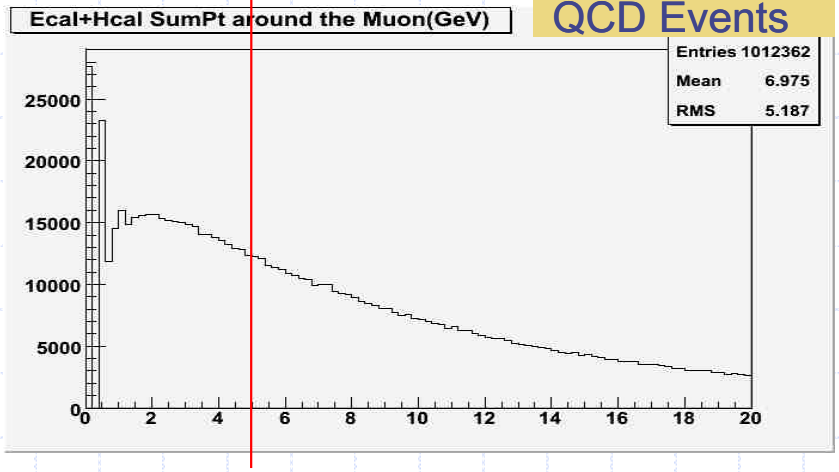
Signal Events



QCD Events

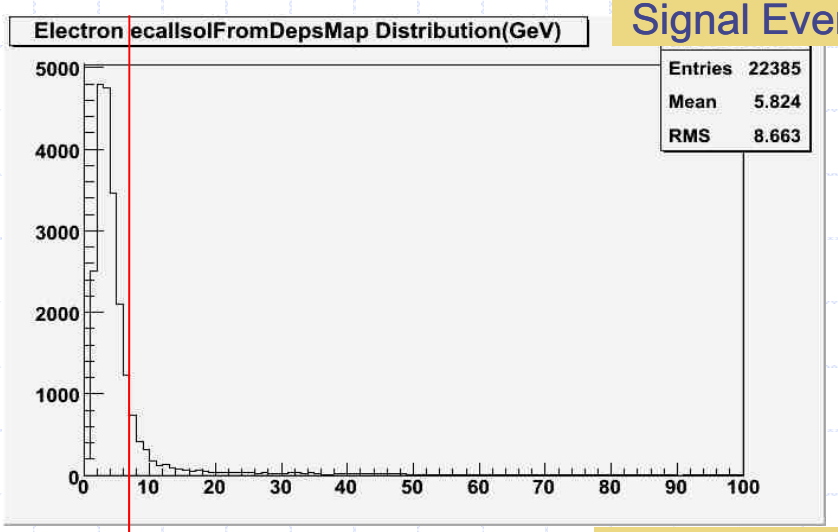


QCD Events

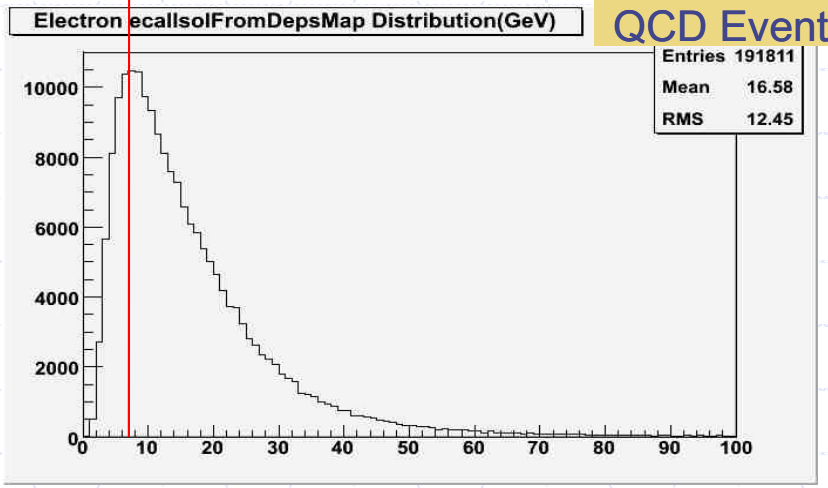


Electrons

Signal Events

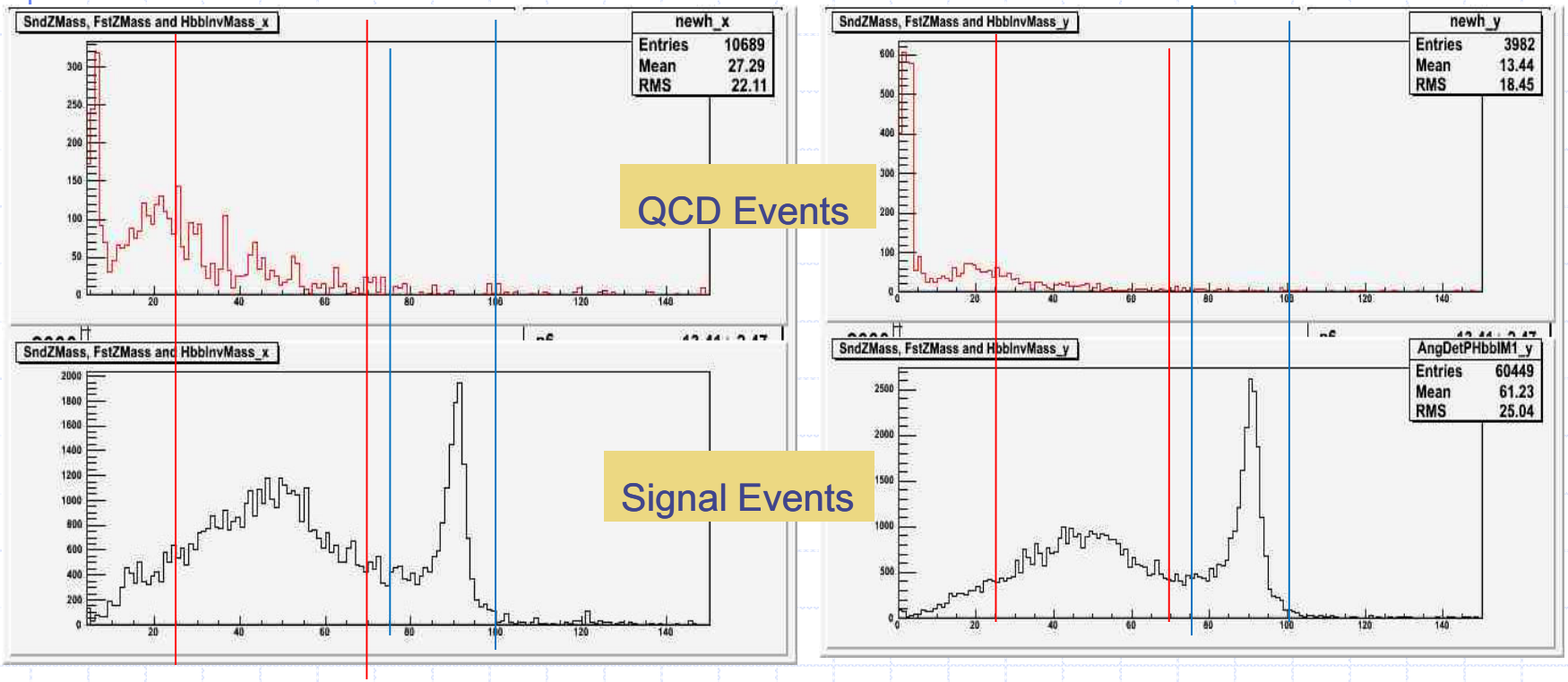


QCD Events

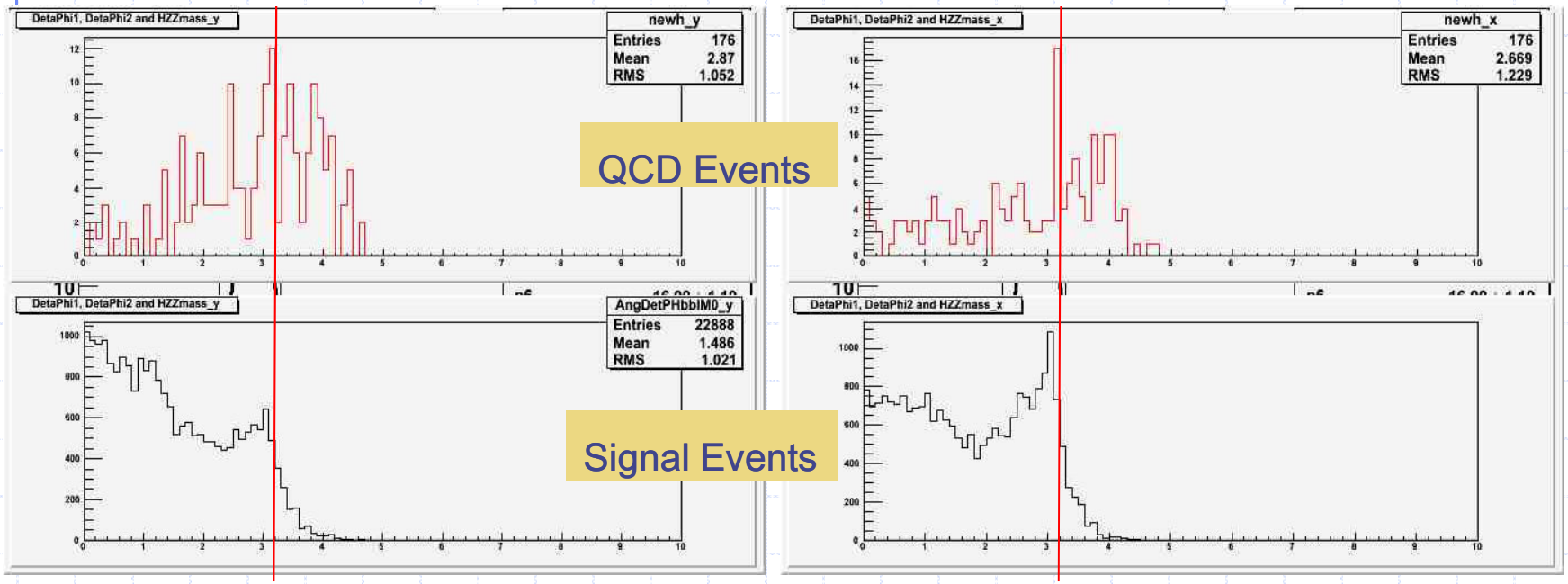


All the leptons with
P_T (Electrons) > 12 GeV
P_T (Muons) > 7 GeV

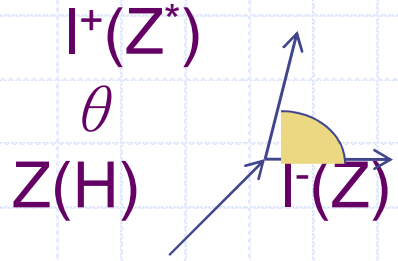
b. Z Mass

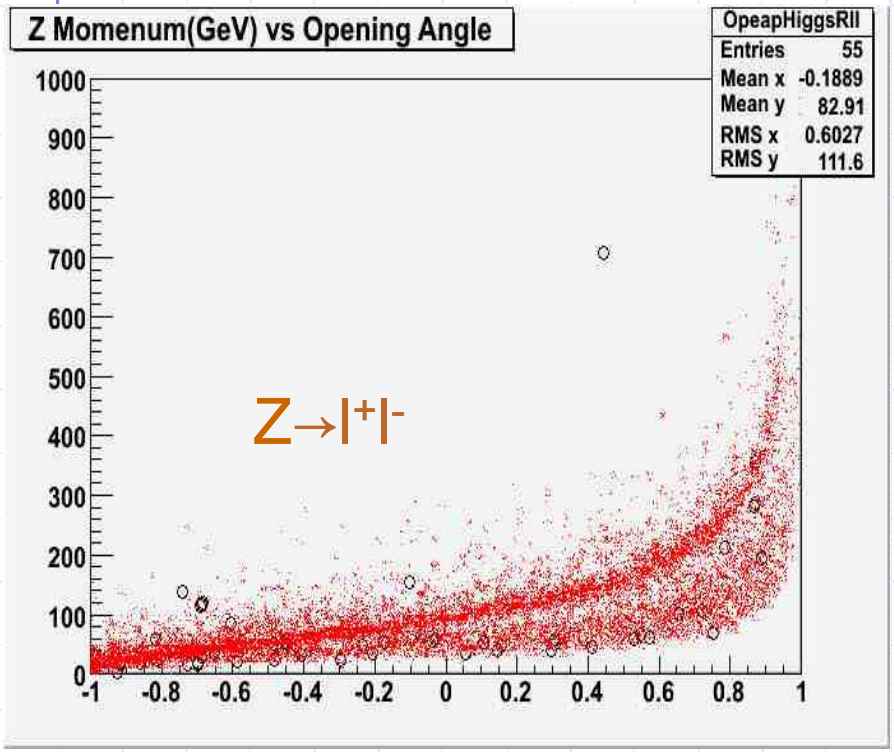

SndZMass, FstZMass and HbbInvMass_x
newh_x
Entries 10689
Mean 27.29
RMS 22.11
SndZMass, FstZMass and HbbInvMass_y
newh_y
Entries 3982
Mean 13.44
RMS 18.45
QCD Events
SndZMass, FstZMass and HbbInvMass_x
SndZMass, FstZMass and HbbInvMass_y
AngDetPHbbIM1_y
Entries 60449
Mean 61.23
RMS 25.04
Signal Events
First Z
Second Z

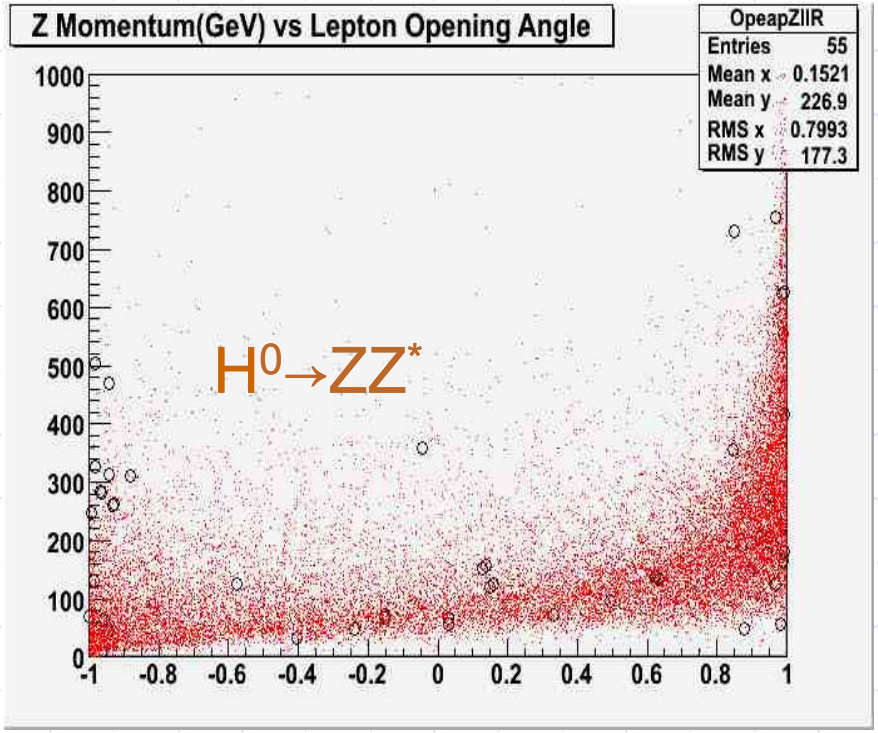
c. η φ Separation in Z decays to leptons



d. Momentum vs Cosine of Opening Angle(θ)





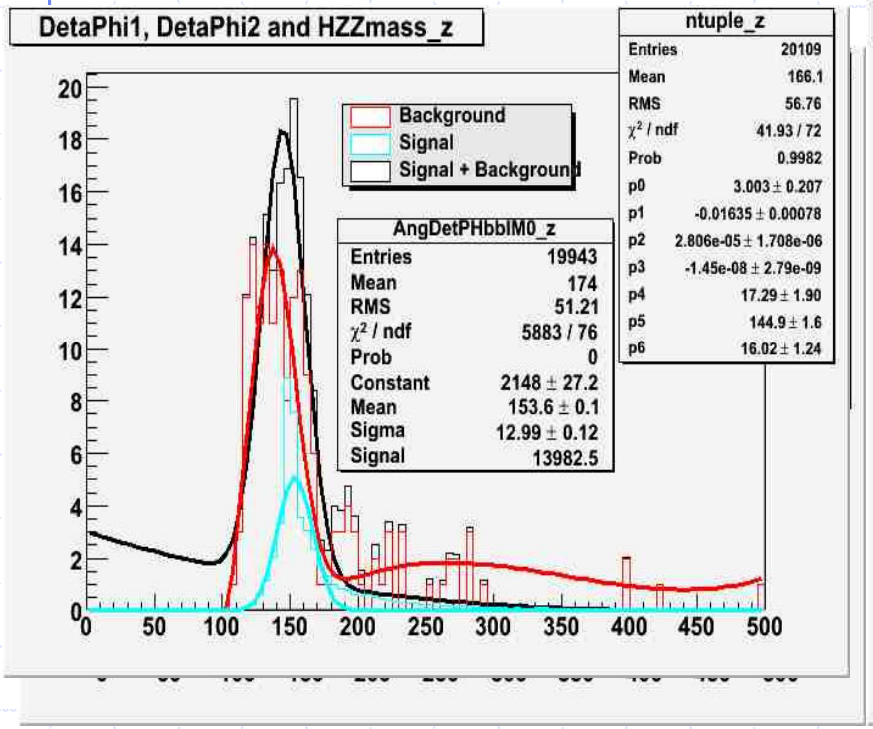


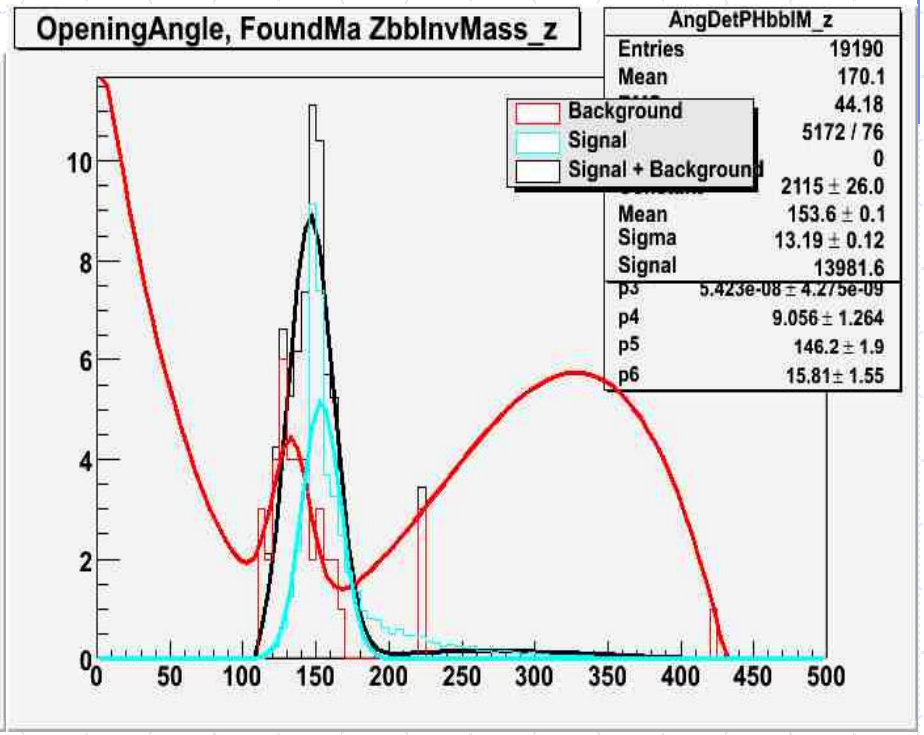
- Signal

o QCD Background

The Result

Before and After the η φ Separation Cut





Only the Signal is sacled to the expected number of events

Summary Table ($20fb^{-1}$)

Steps		Criteria	ε	Remaining Events
Beginning	Signal		$\sigma \times L = 25pb \times 20fb^{-1} = 500000$	
	QCD			1.1×10^{15}
Generator Level	Signal			46.9 [1]
	QCD	$P_T(ee>11.5, \mu\mu>6.5)$	7.6×10^{-7}	83600000
Reco. Level 1	Signal	$P_T(ee>12GeV, \mu\mu>7GeV)$, Lepton Iso., Zmass	0.93	43.6
	QCD		1.6×10^{-4}	13376
Reco. Level 2	Signal	$\eta\varphi$ Separation	0.93	43.6
	QCD		5.2×10^{-5}	4347

[1] $Br(H0 \rightarrow ZZ^{*}) \times 2Br(Z \rightarrow ll) = 0.083 \times 0.03363 \times 0.03363 \times 500000$

Discussion and Conclusion

. Used CKIN(3) = 25GeV instead of CKIN(3) =0GeV:
Will have some effect

. The Remaining QCD Events are still large Compared to the Signal Events:
S/B($\sqrt{B}$) = 43.6/4347(66)

. QCD Events are always troublesome!!!

Update on the QCD Background for Higgs to 4 Lepton Channel

http://indico.cern.ch/conferenceDisplay.py?confId=55773

CMSSW_2_2_9 is used for the analysis

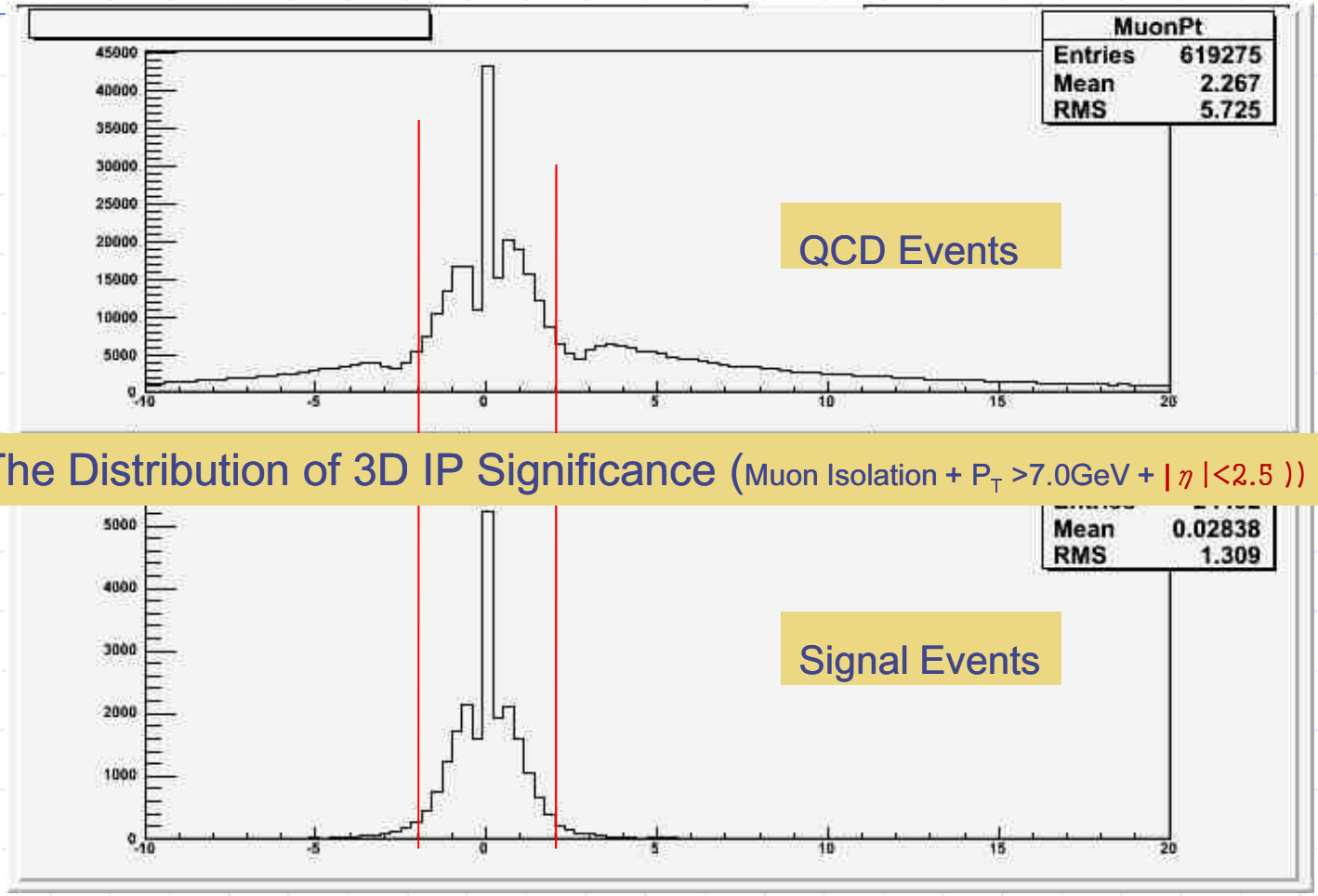
3D IP Significance requirement (for all the leptons)

. Muons: abs(data.ip3d.significance()) < 2.

. Electrons: -3.<data.ip3d.significance()<5.

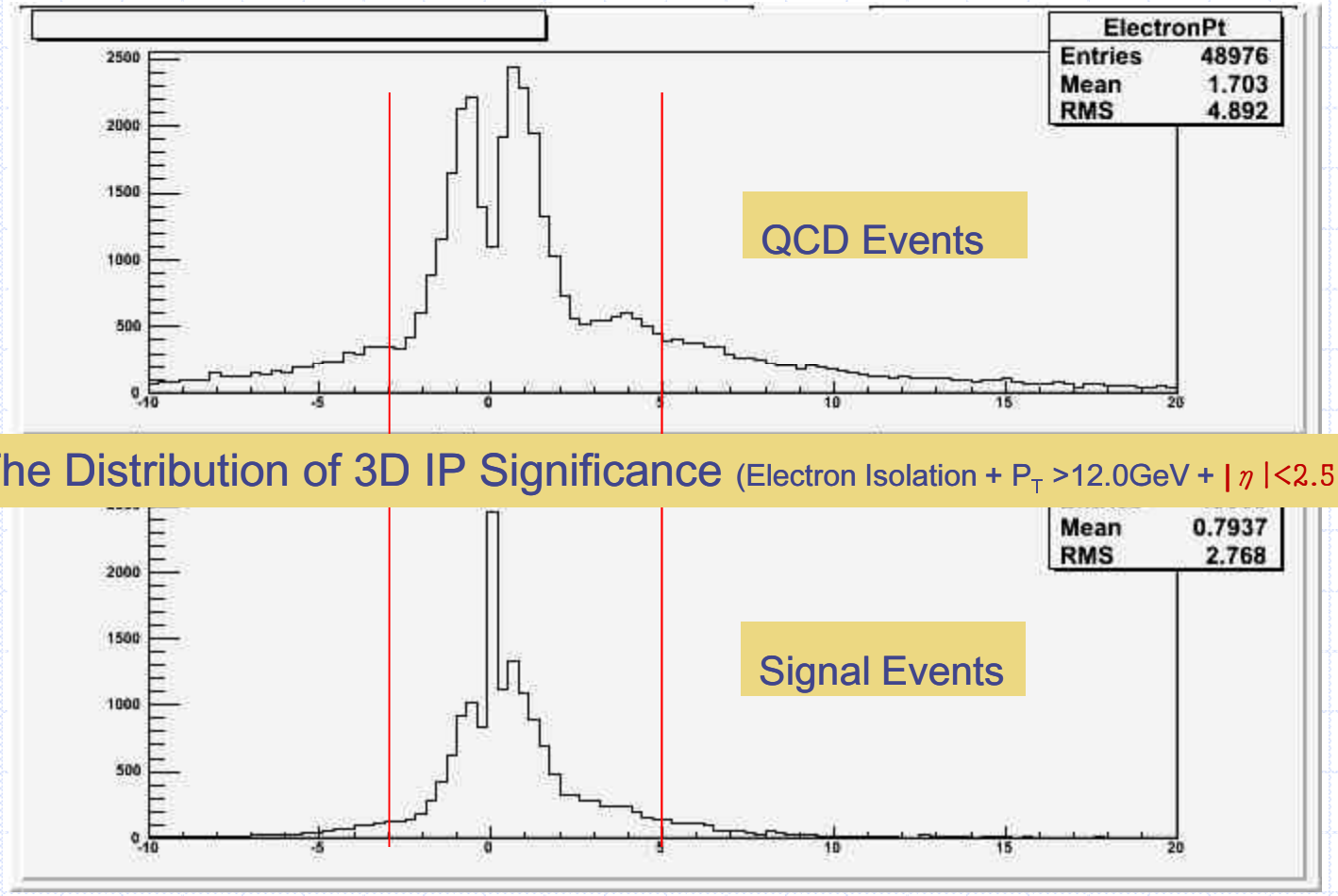
. Overlaps with Lepton Isolation.

Muons



The Distribution of 3D IP Significance (Muon Isolation + P_T >7.0GeV + $|\eta|$<2.5))

Electrons



The Distribution of 3D IP Significance (Electron Isolation + P_T >12.0GeV + $|\eta|$<2.5)

Summary Table ($20fb^{-1}$)

Steps		Criteria	ε	Remaining Events
Beginning	Signal		$\sigma \times L = 25pb \times 20fb^{-1}$	$= 500000$
	QCD			1.1×10^{15}
Generator Level	Signal			46.9 [1]
	QCD	$P_T(ee>11.5,\ \mu\mu>6.5)$	7.6×10^{-7}	83600000
Reco. Level 1	Signal	$\lvert\eta\rvert<2.5$, $P_T(ee>12GeV,\ \mu\mu>7GeV)$, Lepton Iso., Zmass, 3DIPSig	0.69	32.4
	QCD		1.4×10^{-5}	1170 (14 [2])
Reco. Level 2	Signal	$\eta - \varphi$ Separation	0.59	21.8
	QCD		10^{-6} [3]	83.6

[1] $Br(H0 \rightarrow ZZ^*) \times 2Br(Z \rightarrow 11) = 0.083 \times 0.03363 \times 0.03363 \times 500000$

[2] The remaining number of events in the signal region out of 1022901 fully simulated events.

[3] No events out of 1022901 are survived and assume 1 events survived out of 1 million events.