

Higgs Recoil Mass Analysis with Full Simulation and Reconstruction

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ILC-ECFA and GDE Joint Meeting -
Valencia 2006

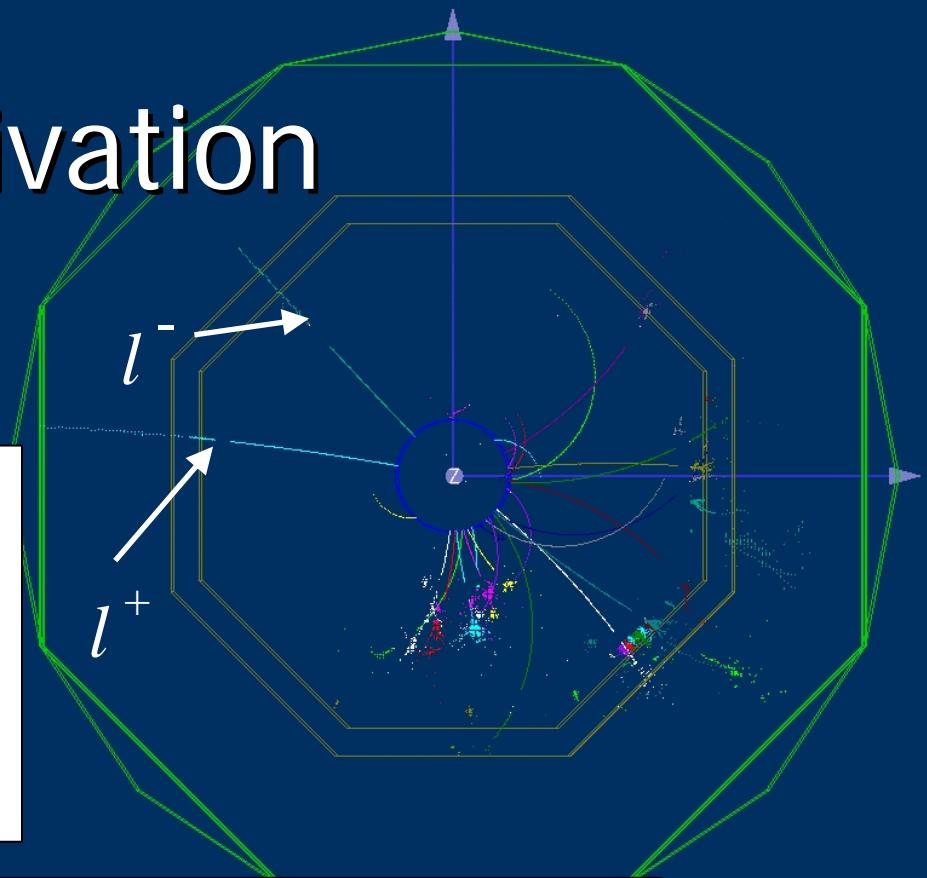
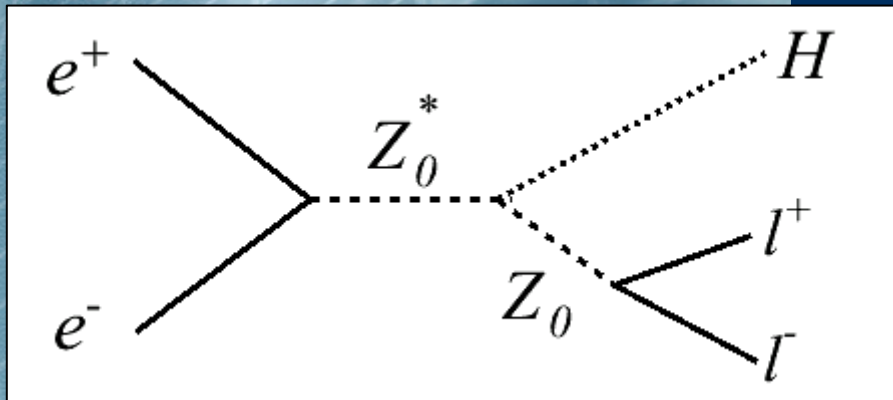
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Motivation

Higgs strahlungs process:



▣ Higgs Recoil Mass

$$m_H^2 = s + m_Z^2 - 2E_Z \sqrt{s}$$

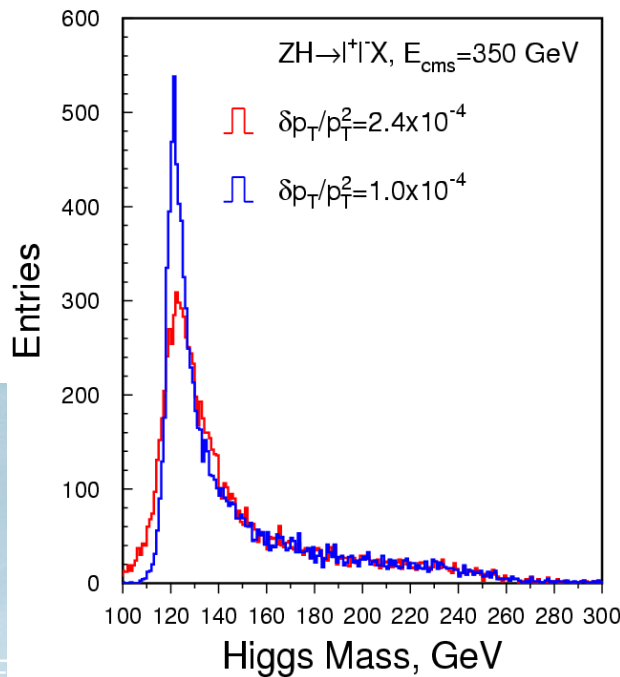
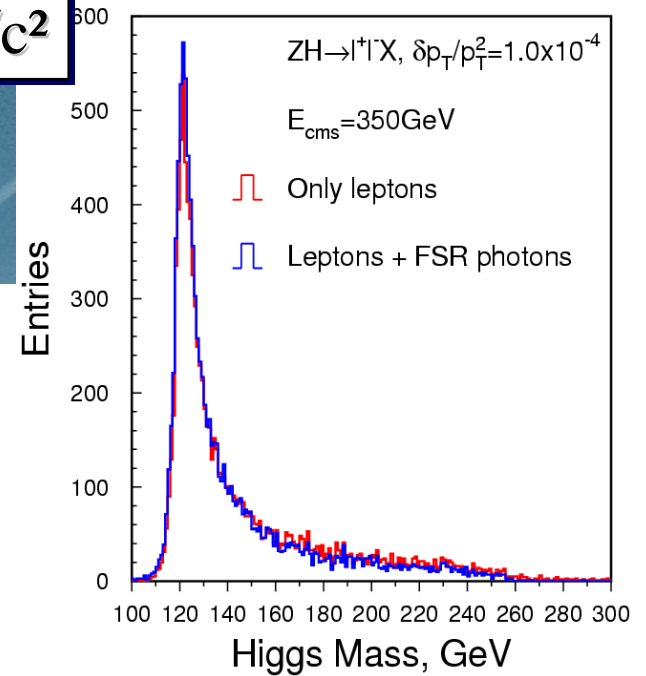
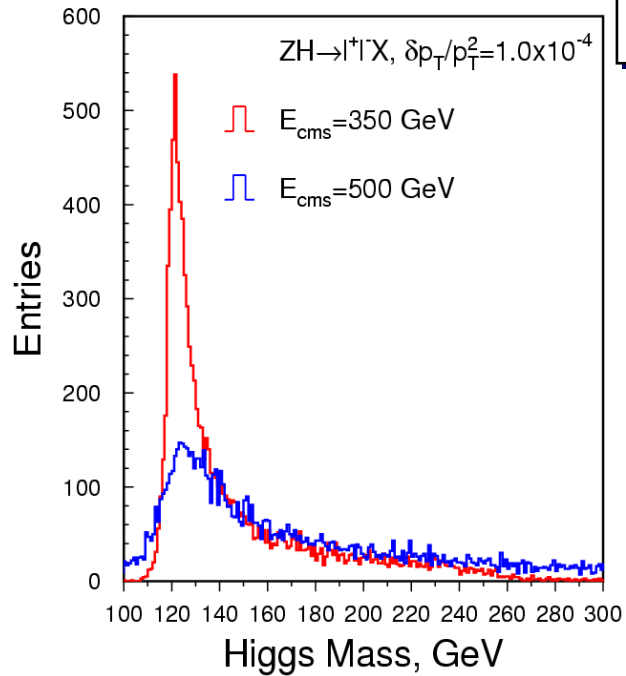
▣ Coupling Strength
(model independent)

$$g^2 \propto \sigma = N / L \mathcal{E}$$

Results / MC toy studies

Higgs mass = 120 GeV/c²

momentum resolution



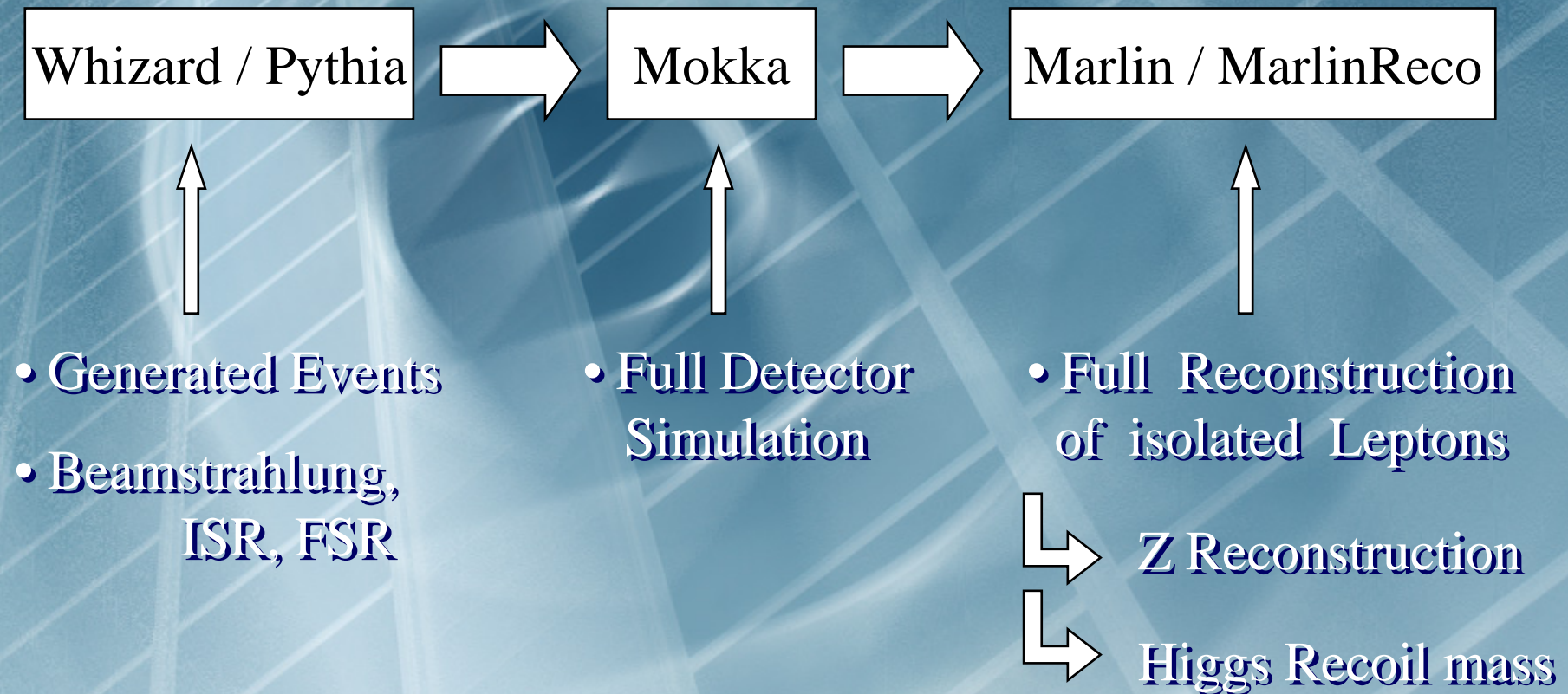
cms energy
350 GeV vs 500 GeV

Signal only!

no FSR vs FSR

Method – whole procedure

So far: Track reco with TPC only!



Method – Particle Identification

simple approach ...

	$\frac{E(\text{ECAL})}{E(\text{total})} > \text{Threshold}$	$\frac{E(\text{ECAL})}{E(\text{total})} < \text{Threshold}$
with Track	electron/positron	charged hadron, muon
without Track	photon	neutral hadron

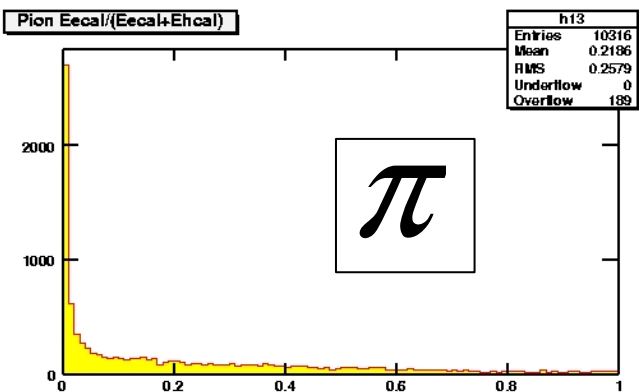
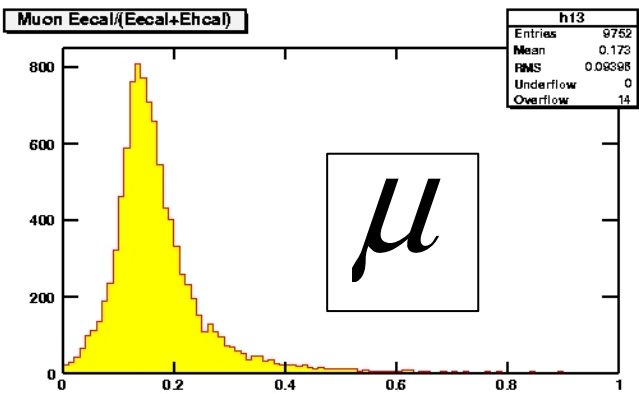
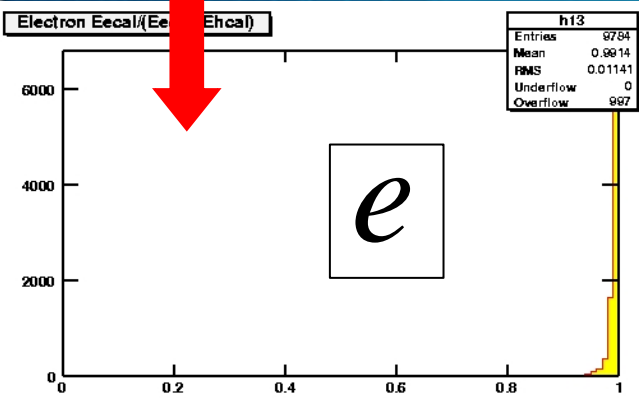
improved approach ...

Without Track: unchanged

With Track: Likelihood method (electron, muon, pion)

$$\frac{E_{ECAL}}{E_{ECAL} + E_{HCAL}}$$

Likelihood Method (1)



- take M quantities

$$x_j; j = 1, \dots, M$$

- normalize histograms for N particle types

$$f_i(x_j); i = 1, \dots, N$$

- create probability density functions

$$p_i(x_j) = \frac{f_i(x_j)}{\sum_{k=1}^N f_k(x_j)}$$

- Likelihood function for a certain particle type

$$L_i = \frac{\prod_{j=1}^M p_i(x_j)}{\sum_{k=1}^N \prod_{l=1}^M p_k(x_l)}$$

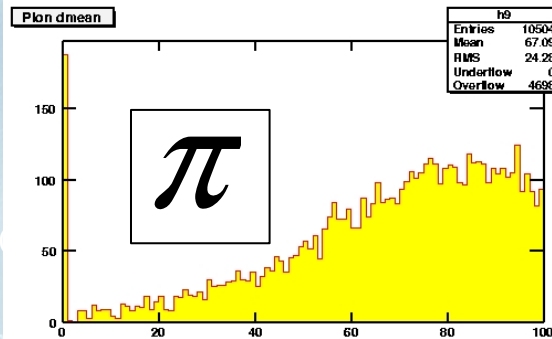
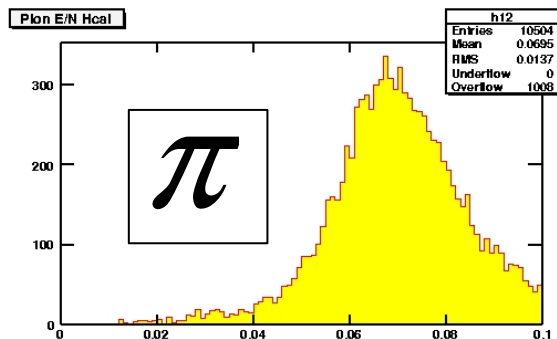
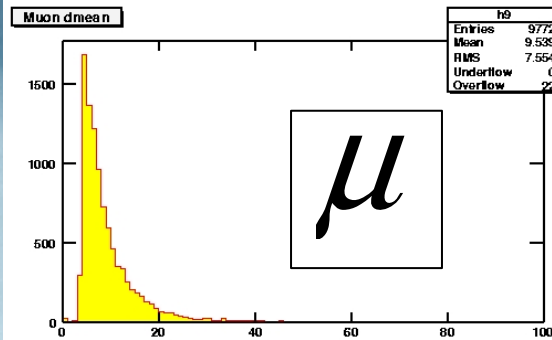
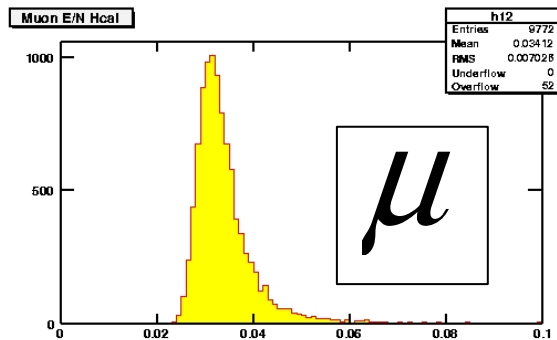
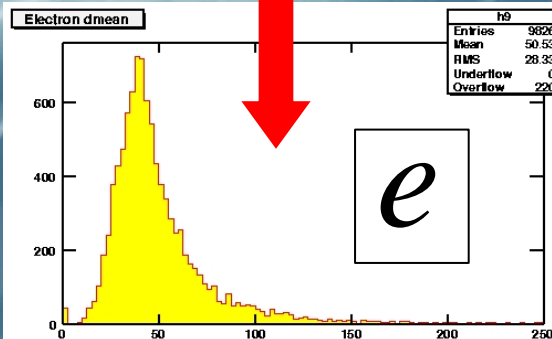
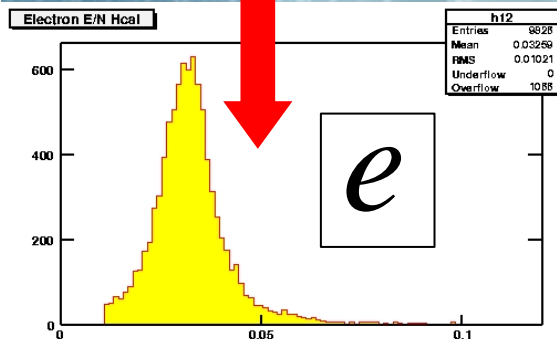
Further Variables ...

$$\frac{E_{HCAL}}{N_{HCAL}}$$

mean distance of hits from cluster center line (helix)

and

$$\frac{E_{ECAL}}{N_{ECAL}}$$

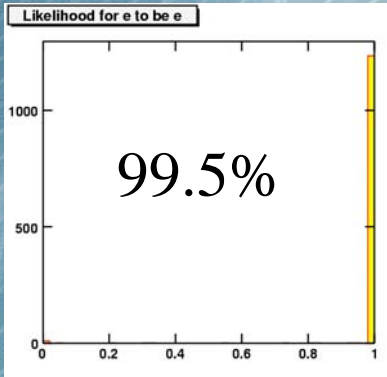


layer indices of last 3 most distant HCAL hits

excentricity of calorimeter cluster

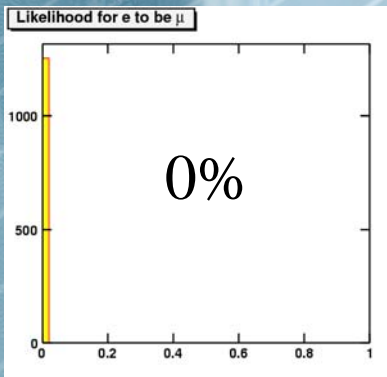
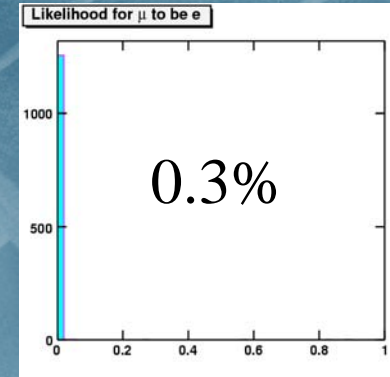
Likelihood - Particle ID

Test sample: Higgs strahlungs events



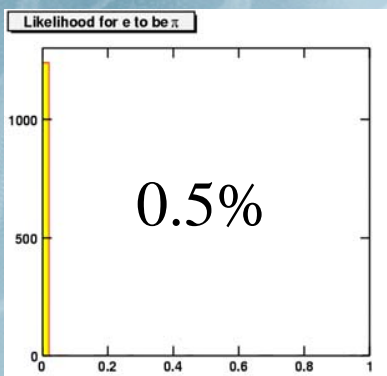
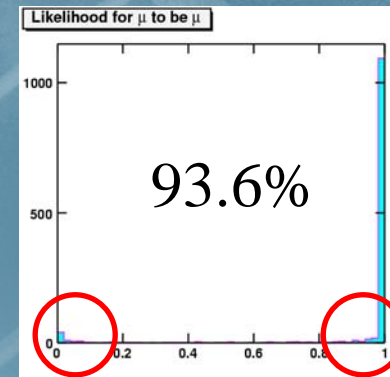
← electron = electron

muon = electron →



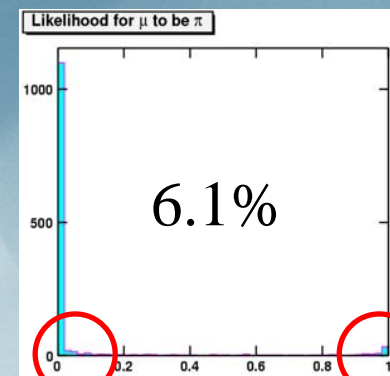
← electron = muon

muon = muon →



← electron = pion

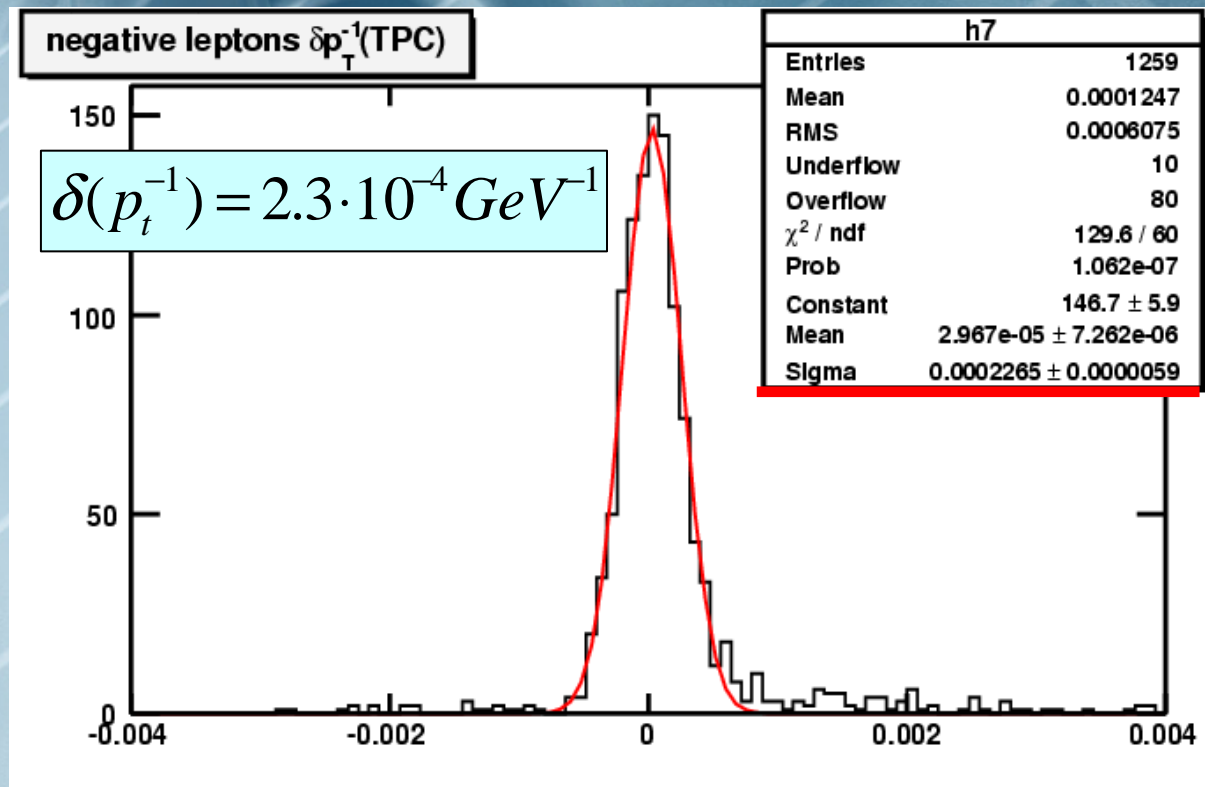
muon = pion →



Results / Resolution @ 500 GeV

- Tesla TDR – resolution for TPC

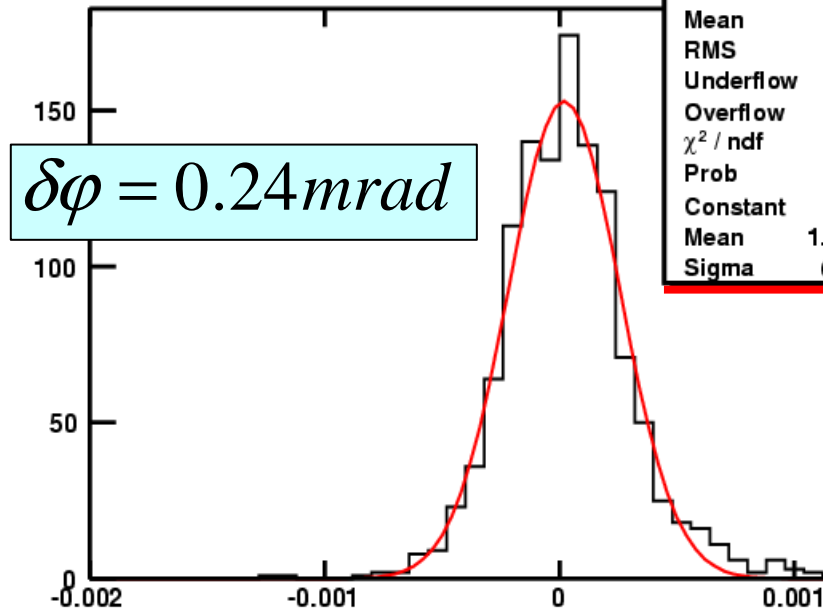
$$\delta\left(\frac{1}{p_t}\right) < 2 \cdot 10^{-4} \text{ GeV}^{-1}$$



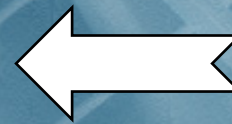
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Results / Resolution @ 500 GeV

negative leptons $\delta\varphi$ (TPC)



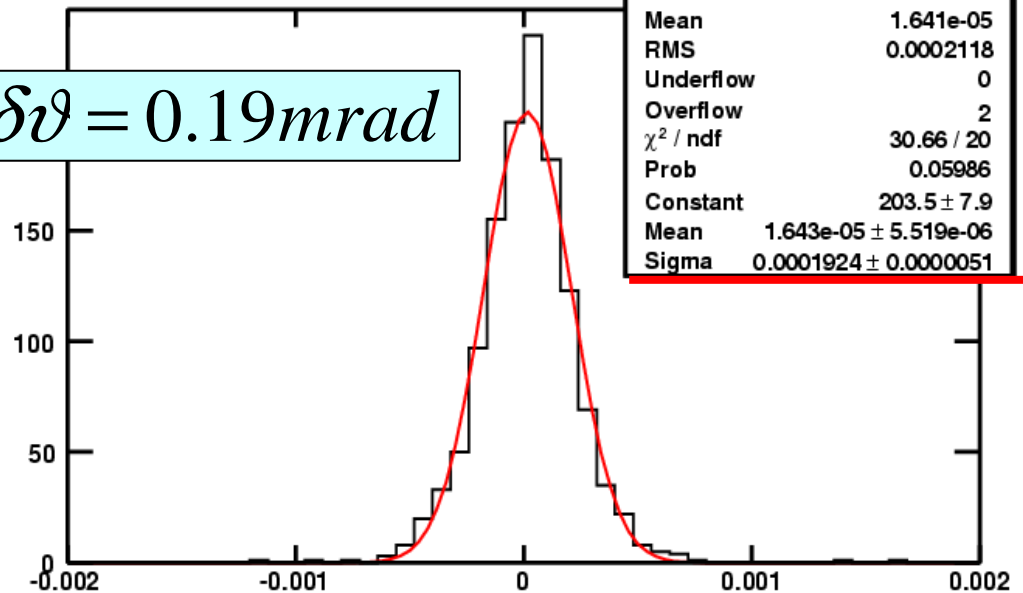
h15	
Entries	1259
Mean	5.192e-05
RMS	0.0003173
Underflow	8
Overflow	55
χ^2 / ndf	59.71 / 33
Prob	0.002979
Constant	153 ± 6.0
Mean	1.941e-05 ± 7.126e-06
Sigma	0.000237 ± 0.000006



$\delta\varphi$

negative leptons $\delta\vartheta$ (TPC)

$\delta\vartheta = 0.19 \text{ mrad}$



h11	
Entries	1259
Mean	1.641e-05
RMS	0.0002118
Underflow	0
Overflow	2
χ^2 / ndf	30.66 / 20
Prob	0.05986
Constant	203.5 ± 7.9
Mean	1.643e-05 ± 5.519e-06
Sigma	0.0001924 ± 0.0000051

$\delta\vartheta$

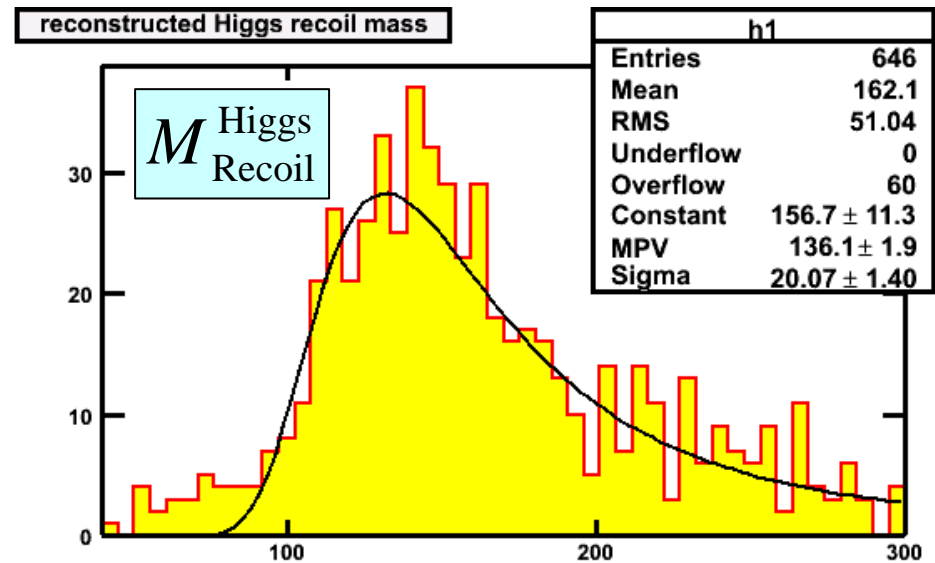
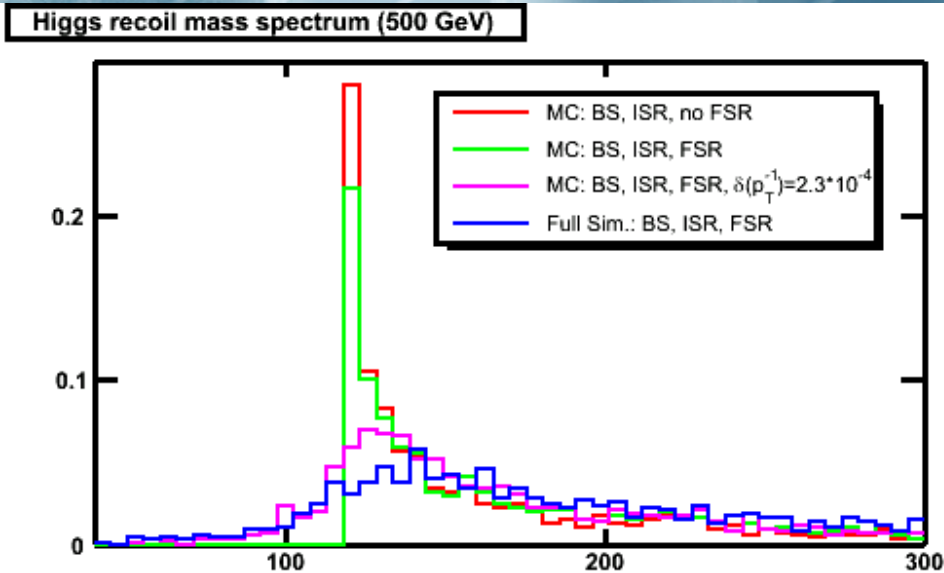
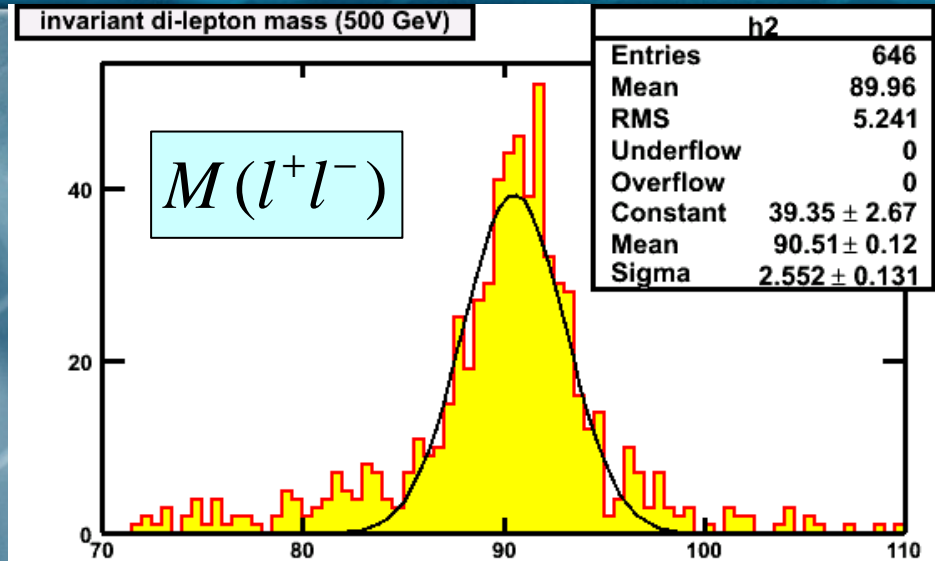


Results / Reconstruction @ 500 GeV

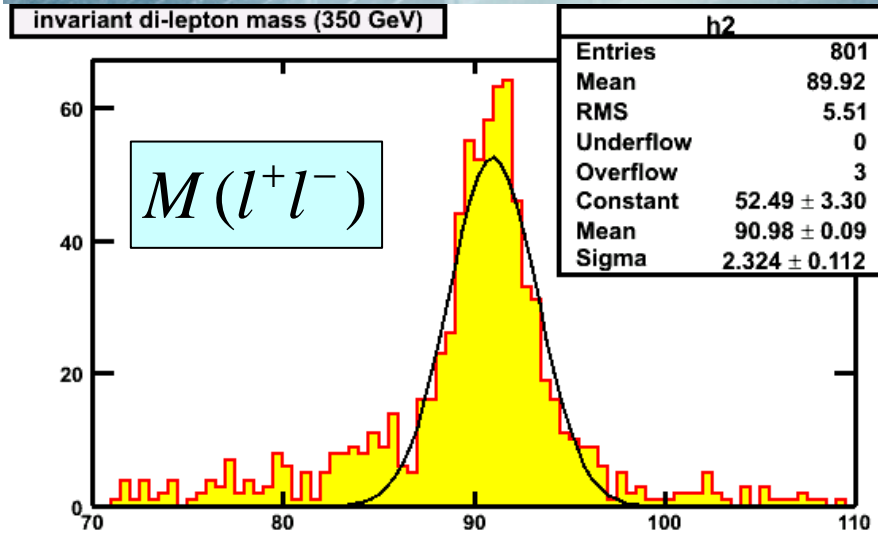
Higgs mass: 120 GeV/c²

Signal only!

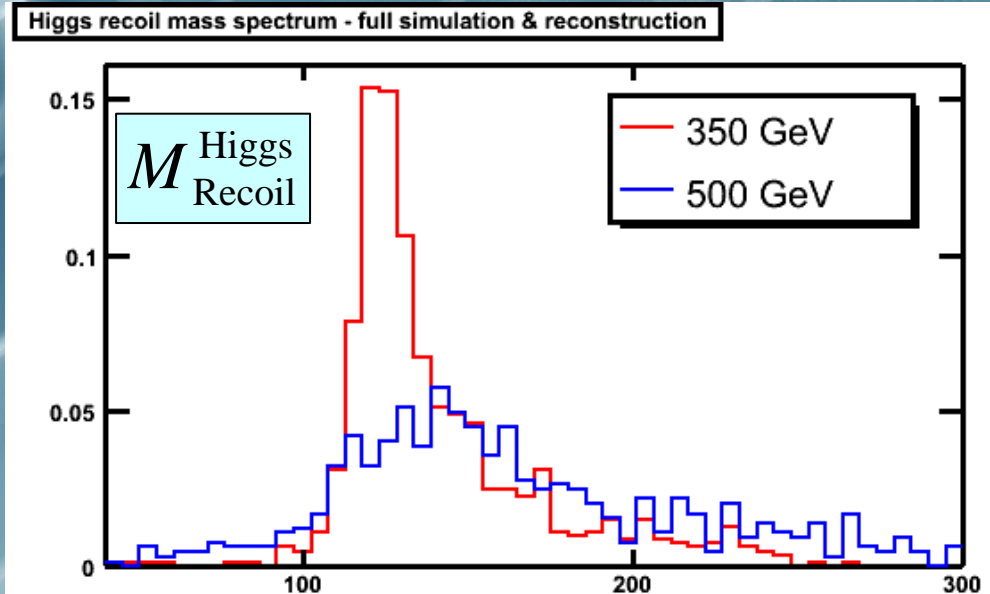
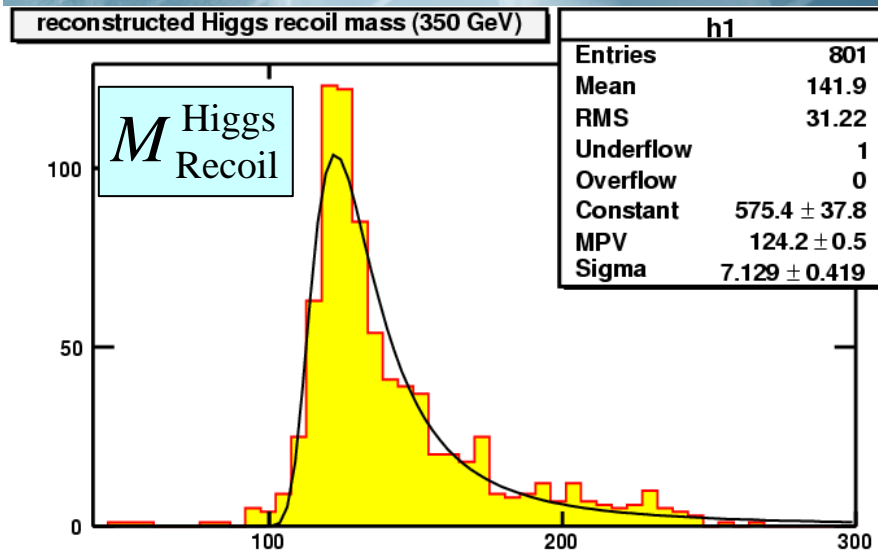
efficiency for Higgs-Reconstruction: 47.6%



Results / 350 GeV vs 500 GeV



efficiency for Higgs Reconstruction
@ 350 GeV: similar



Summary (1)

- Particle identification using Likelihood is working, electron-muon separation almost perfect, muon-pion separation very good
- Momentum and Angle Resolutions for reconstructed particles are as expected using only TPC

Summary (2)

- 350 GeV is more appropriate for Higgs-Reconstruction than 500 GeV; e.g. better momentum reconstruction
- FSR has small influence on Higgs recoil mass reconstruction

Outlook

- use VTX + SIT + FTD + TPC for track reconstruction → better momentum resolution ($\delta(p_t^{-1}) < 10^{-4}$)
- improvement of likelihood method (more particles, other/more variables, ...)
- test of Marlin processor for non Higgs strahlungs processes
- └ studies of SM background processes like WW, ZZ, qqbar production ...

Special Thanks To ...

A. Schaelicke, R. Schmidt and J. Mamuzic

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