Higgs Recoil Mass Study at 350 GeV

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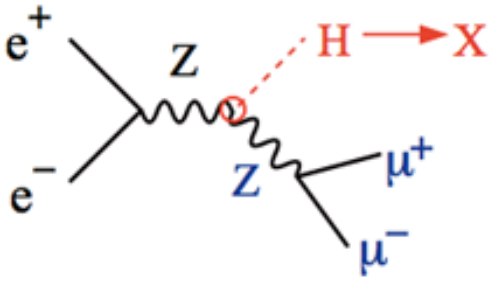
recoil mass study using e+e- → Zh → μ+μ-h

Ec.m.s. = 250 GeV, L = 250 fb-1

Ec.m.s. = 350 GeV, L = 333 fb-1

polarization:
(e−, e+) = (− 0.8, + 0.3)



Goal:

precise measurement of

- Higgs mass
- cross section σ_H

$$M_X^2 = \left(p_{CM} - (p_{\mu^+} + p_{\mu^-})\right)^2$$

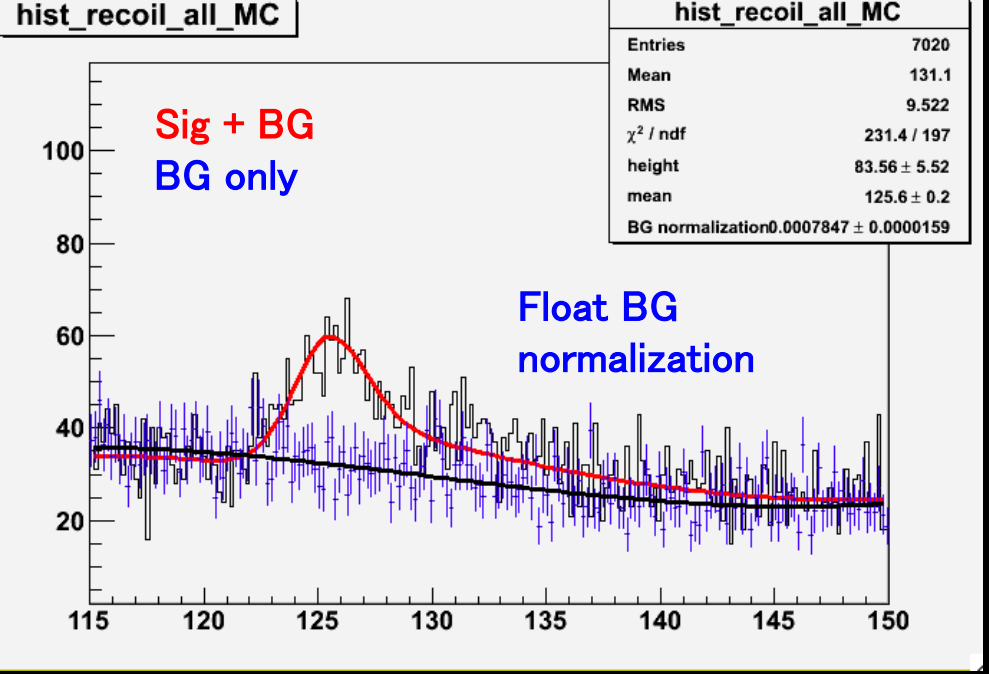
What's New This Week

- Toy MC
- Compare alternative polarization scenarios
- Summary & Plans

Float BG normalization or not ?

Answer is NO

Fitting in wide range **115-150 GeV**

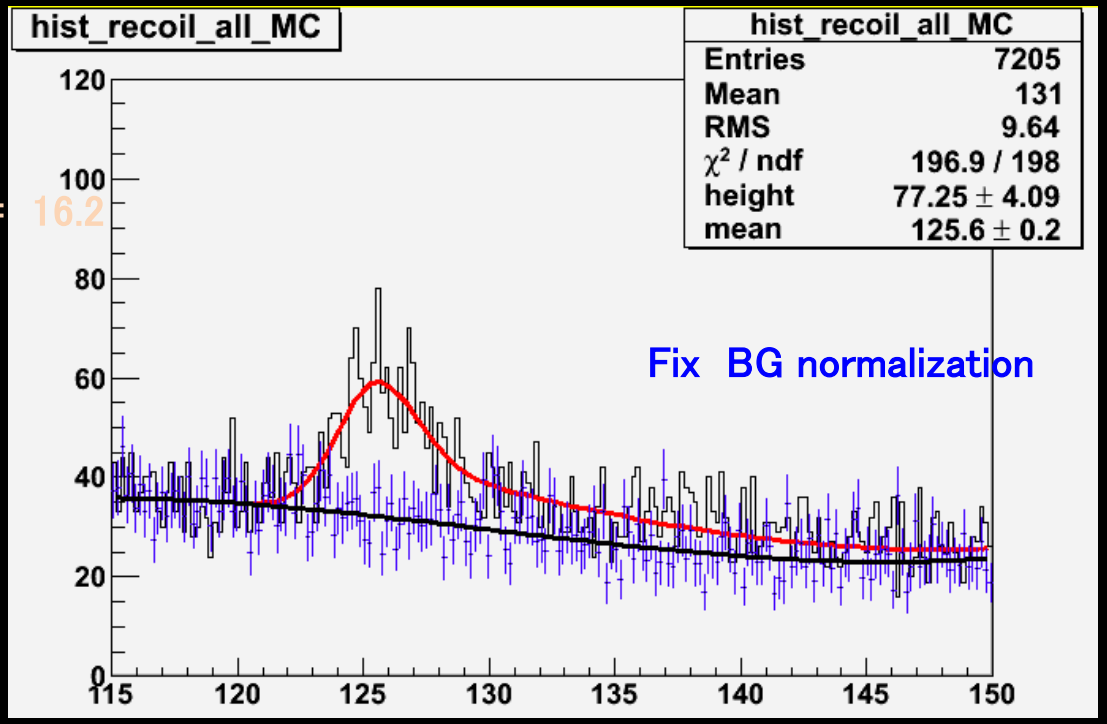


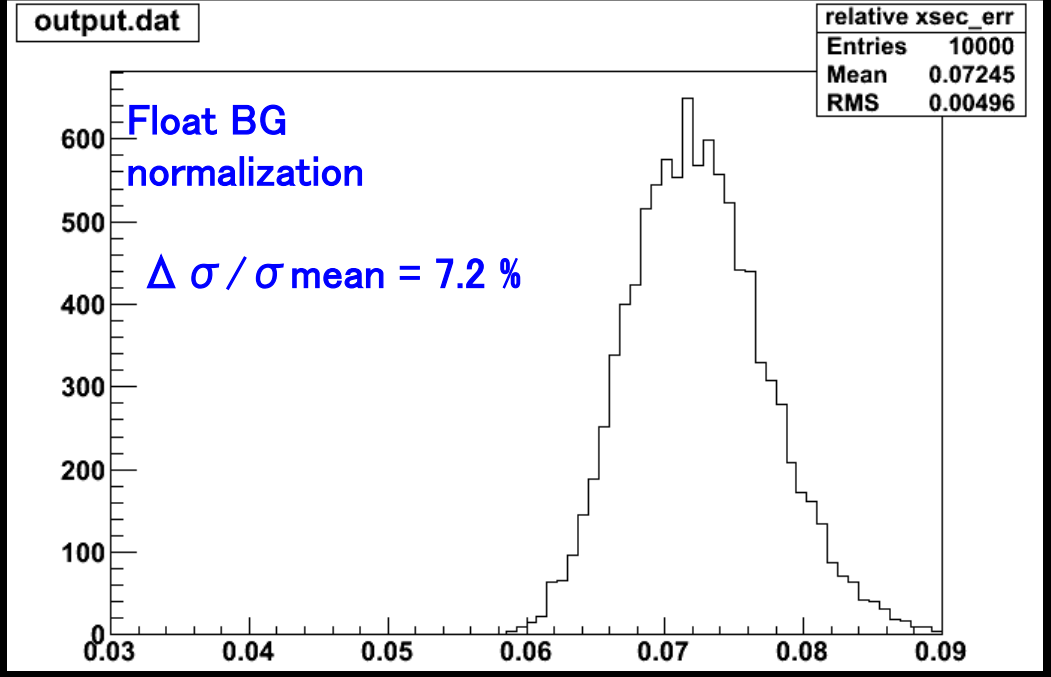
Integrated fitted func in (120 – 140 GeV)
to get Nsig

Nbg= 3467
S/BG = 0.32
significance = 16.2

Toy MC
10000 seeds

Input #of events according to
Poisson distr (mean = real # of input)



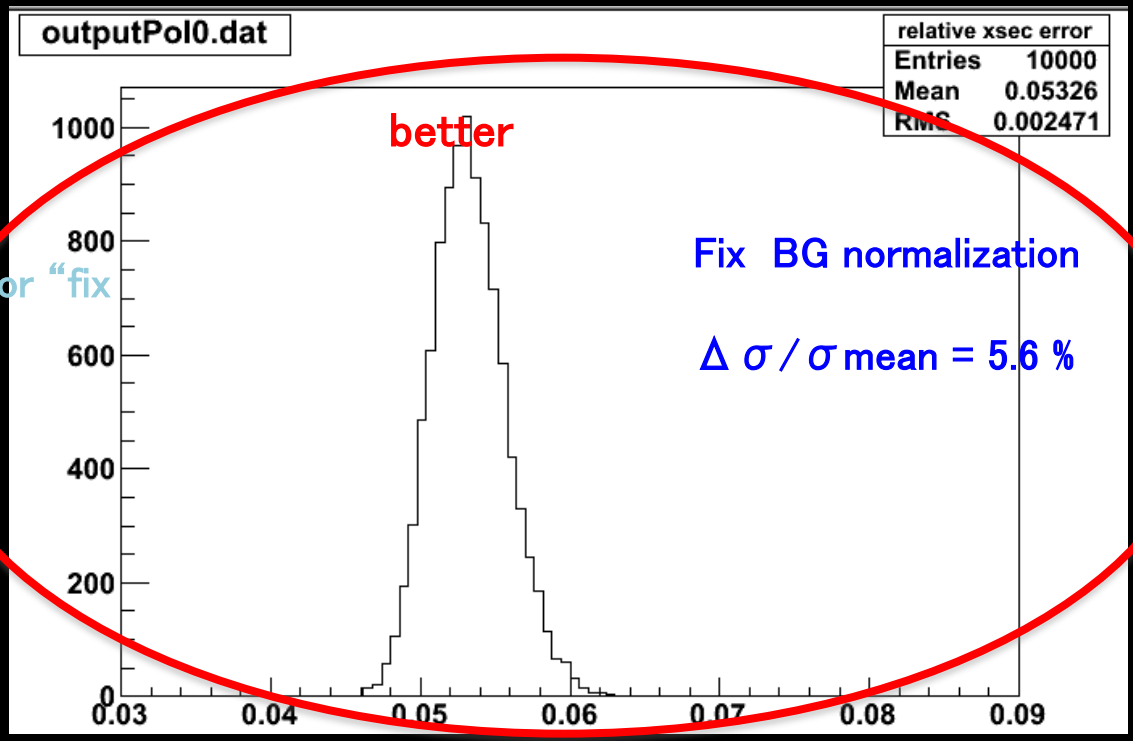


Relative Cross section error

Toy MC
10000 seeds

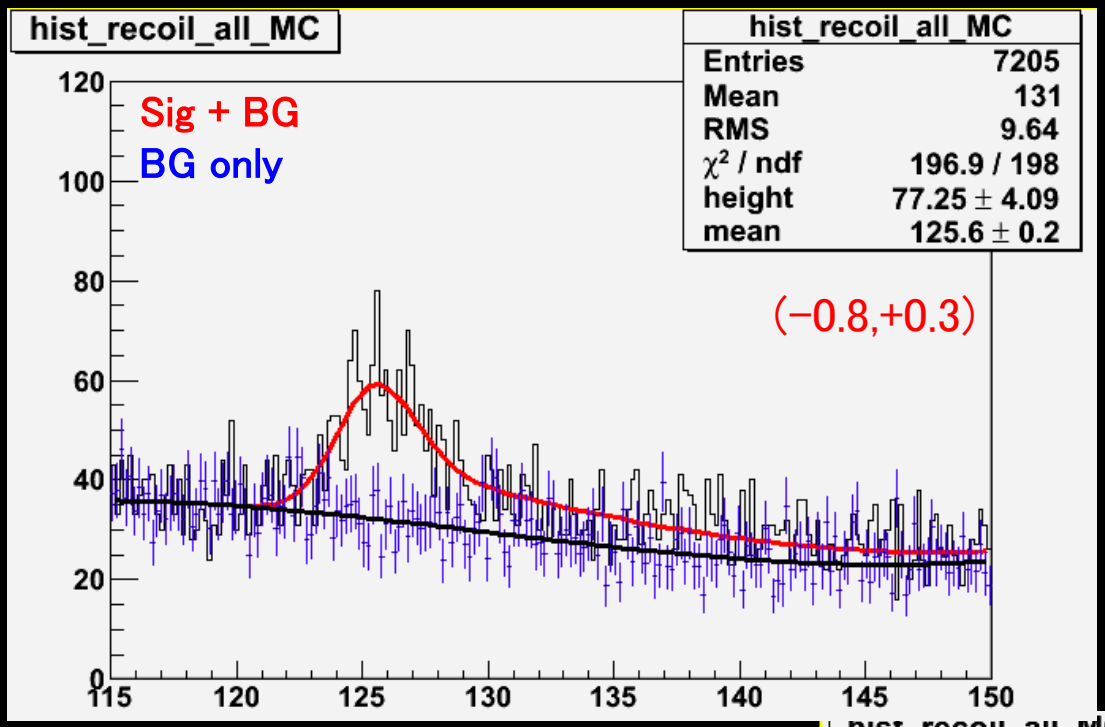
Xsec statistical fluctuation is smaller for "fix BG case"

however mean of xsec is biased



Compare Alternative Polarization Scenarios

(−0.8, +0.3) vs (+0.8, −0.3)

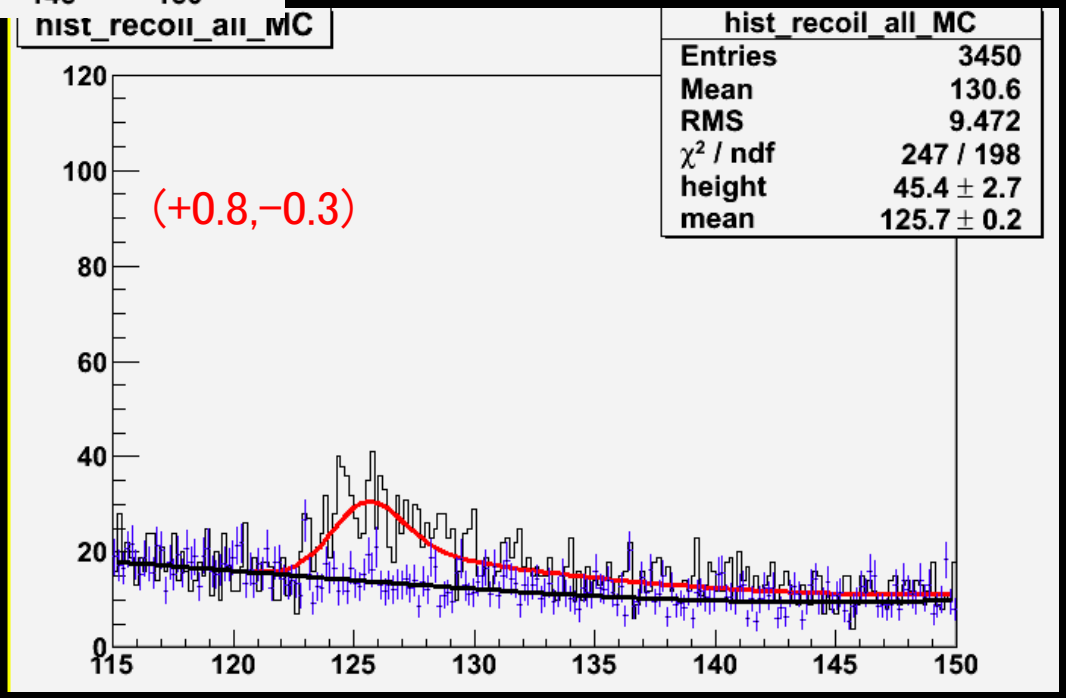


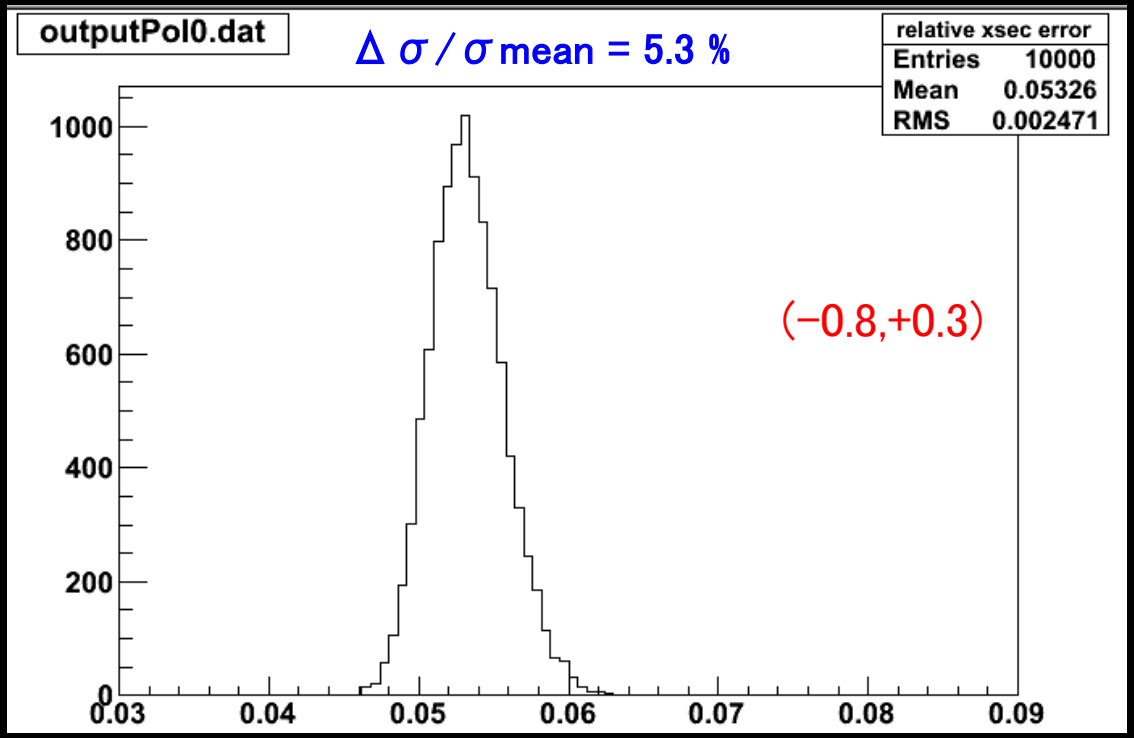
Fitting in wide range **115-150 GeV**

Integrated fitted func in (120 – 140 GeV) to get Nsig

Toy MC
10000 seeds

Input #of events according to Poisson distr (mean = real # of input)





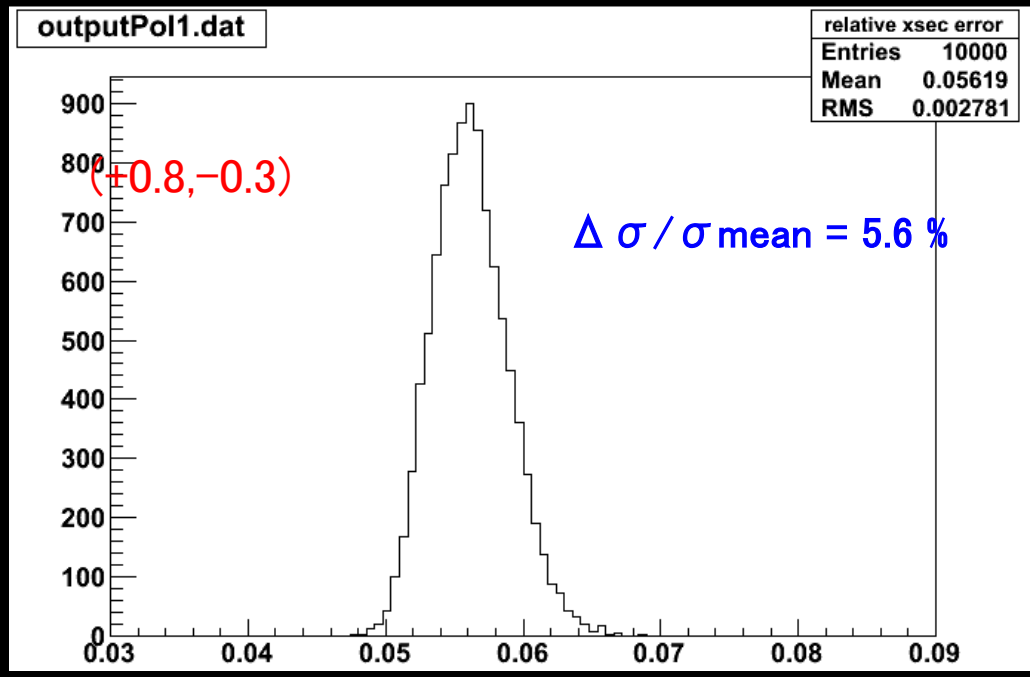
Relative Cross section error

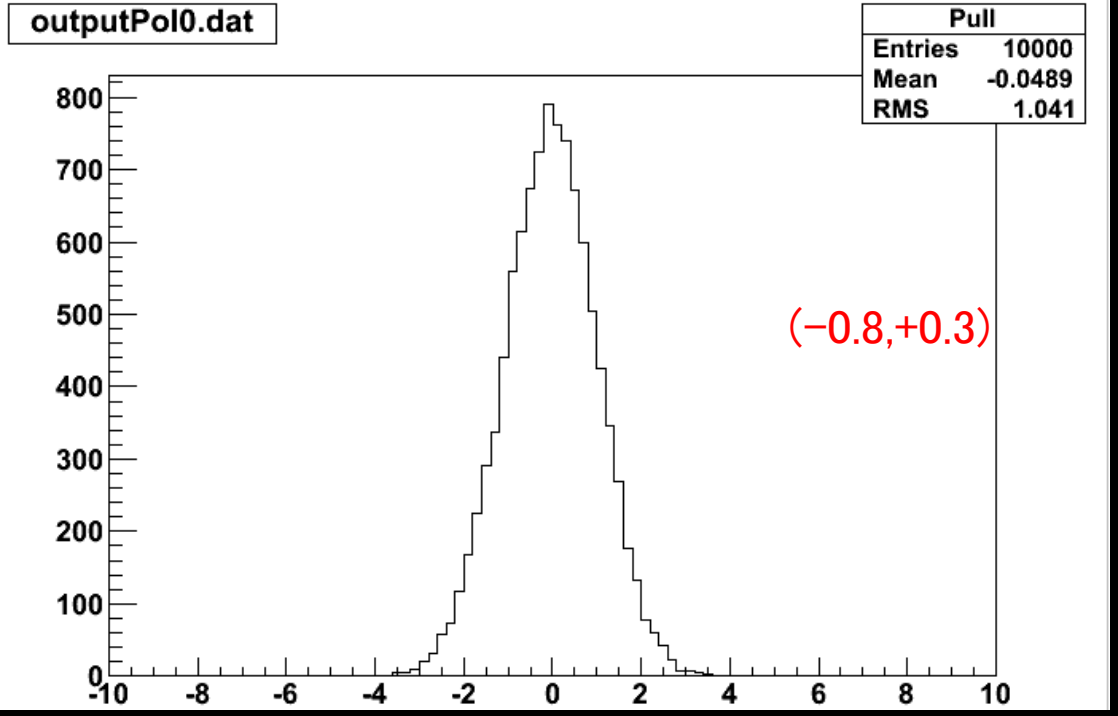
Toy MC
10000 seeds

Almost same

Xsec statistical fluctuation is smaller for “fix BG case”

however mean of xsec is biased





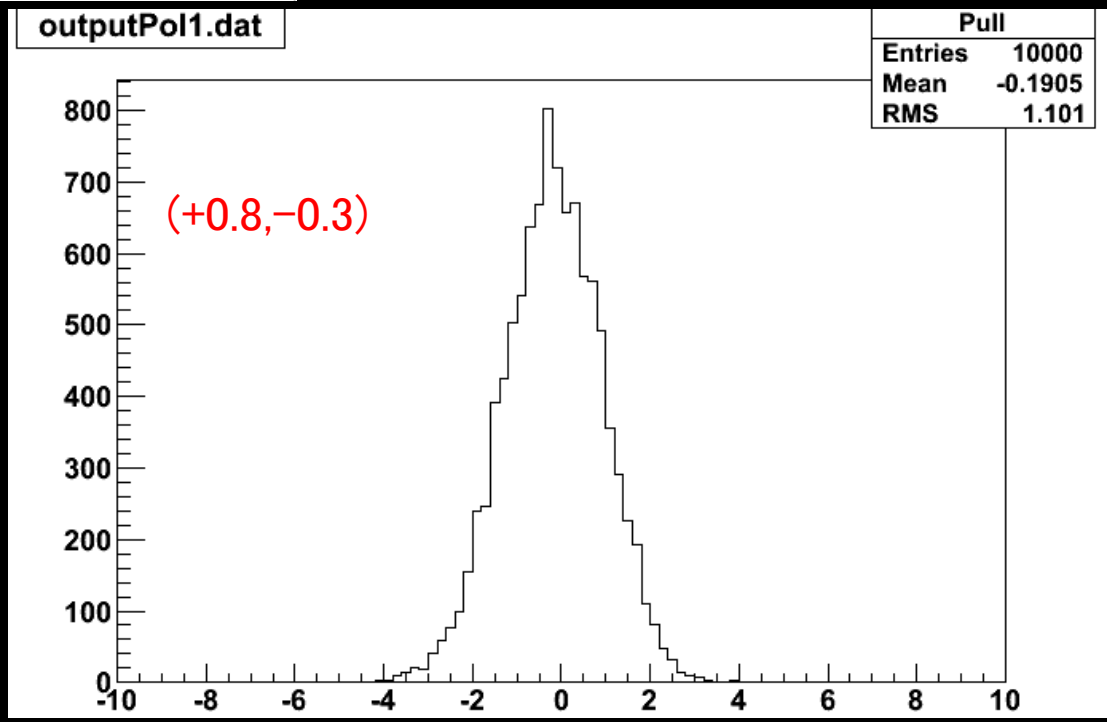
Pull plot

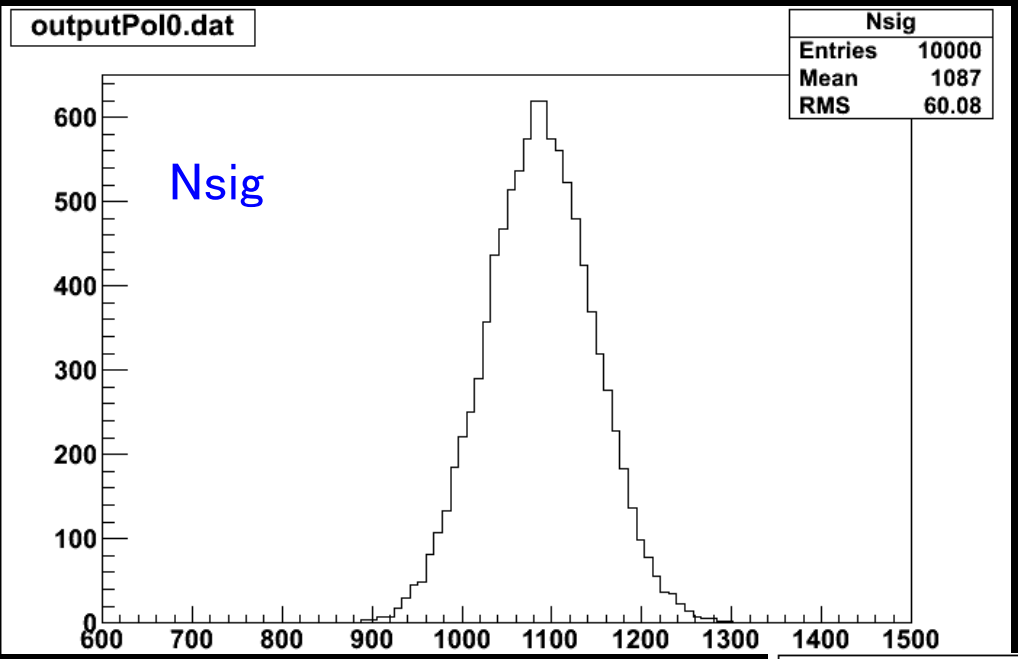
Toy MC
10000 seeds

Fix BG normalization

rms close to 1

Mean is close to 0 for (−0.8,+0.3)





(−0.8,+0.3)

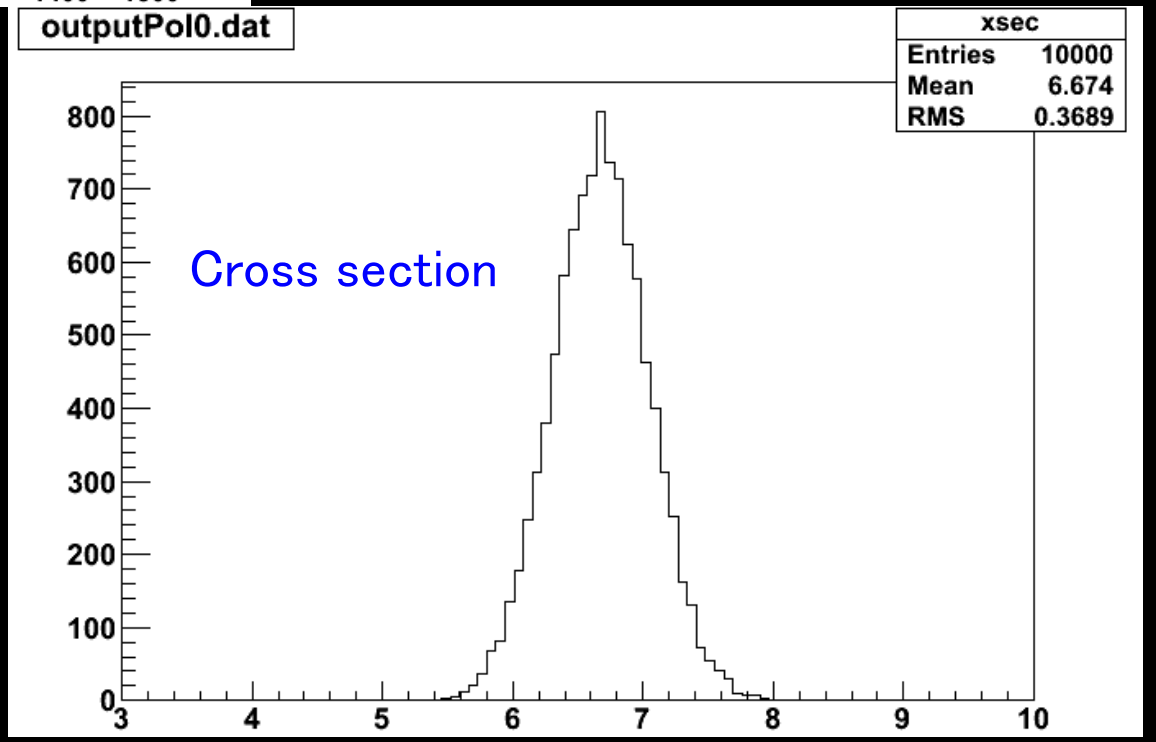
Toy MC
10000 seeds

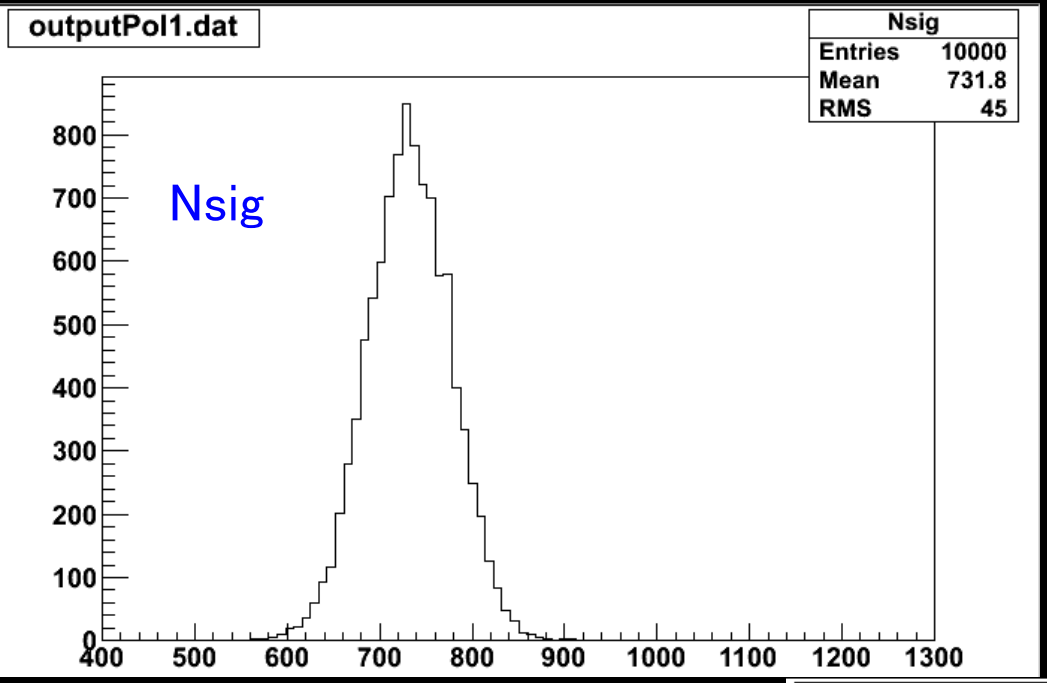
Fix BG normalization

“real xsec = 6.688”

“ real Nsig = 1089”

Consistent within error ranges





(+0.8,− 0.3)

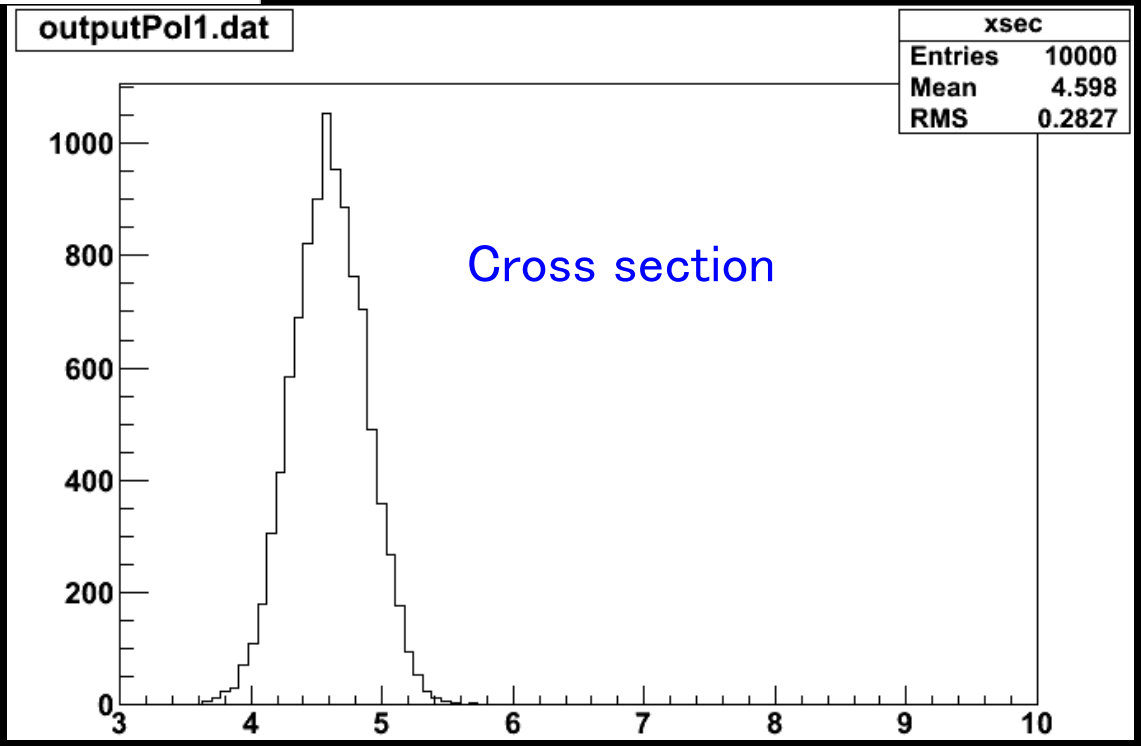
Toy MC
10000 seeds

Fix BG normalization

"real xsec = 4.643"

" real Nsig = 739"

Consistent within error ranges



Summary

Toy MC for Higgs recoil mass study using **e+e- → Zh → μ+μ-h** @ **Ec.m.s =350 GeV,** **L = 333 fb-1**

- **observed Δσ/σ, xsec, Nsig, ect…..**
- **no benefit from floating BG normalization**
- Pull plot look about reasonable (?)

- **Δσ/σ = 5.3%**
- **Almost no difference for (+0.8,-0.3), but higher S/N**
- **Δσ/σ not too bad, but should improve S/N further**

next

- compare with @ **Ec.m.s. = 250 GeV, L = 250 fb-1**
- But first add dPtbal cut (if time allows)

- **350 GeV:** **ε_sig = 48,9 +/-0.5 %,** S/B ∼ 0.31, **significance ∼16.1**

250 GeV: **ε_sig = 69.9 +/-0.5 %,** S/B ∼ 0.26, **significance ∼19**

BACKUP

Signal sample:

Pe2e2h_.eL.pR & Pe2e2h._eR.pL

relevant BG process for Zmumu

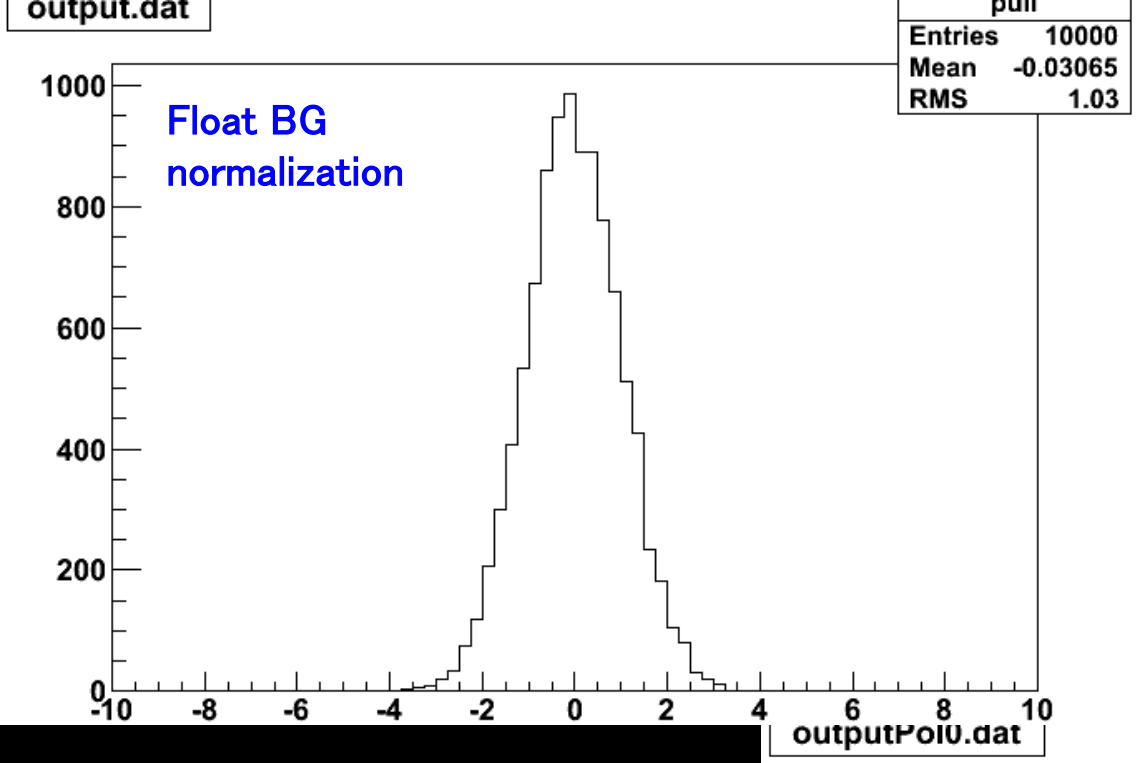
- 4f_ZZ_leptonic
- 4f_ZZ_semileptonic
- 2f_Z_leptonic
- 4f_WW_leptonic
- 4f_WW_semileptonic
- 4fSingleZee_leptonic
- 4fSingleZnunu_leptonic
- 4f_ZZWWMix_leptonic
- 6f backgrounds (sqrt(s)=350 GeV)

_after all cuts, dominant BG are:

sqrt(s) = 250 GeV : #1) 2f_Z_l #2) 4f_ZZ_sl #3) 4f_ZZWWMix_l

sqrt(s) = 350 GeV : #1) 4f_ZZ_sl #2) 2f_Z_l #3) 4f_WW_sl

no ttbar BG left after data selection

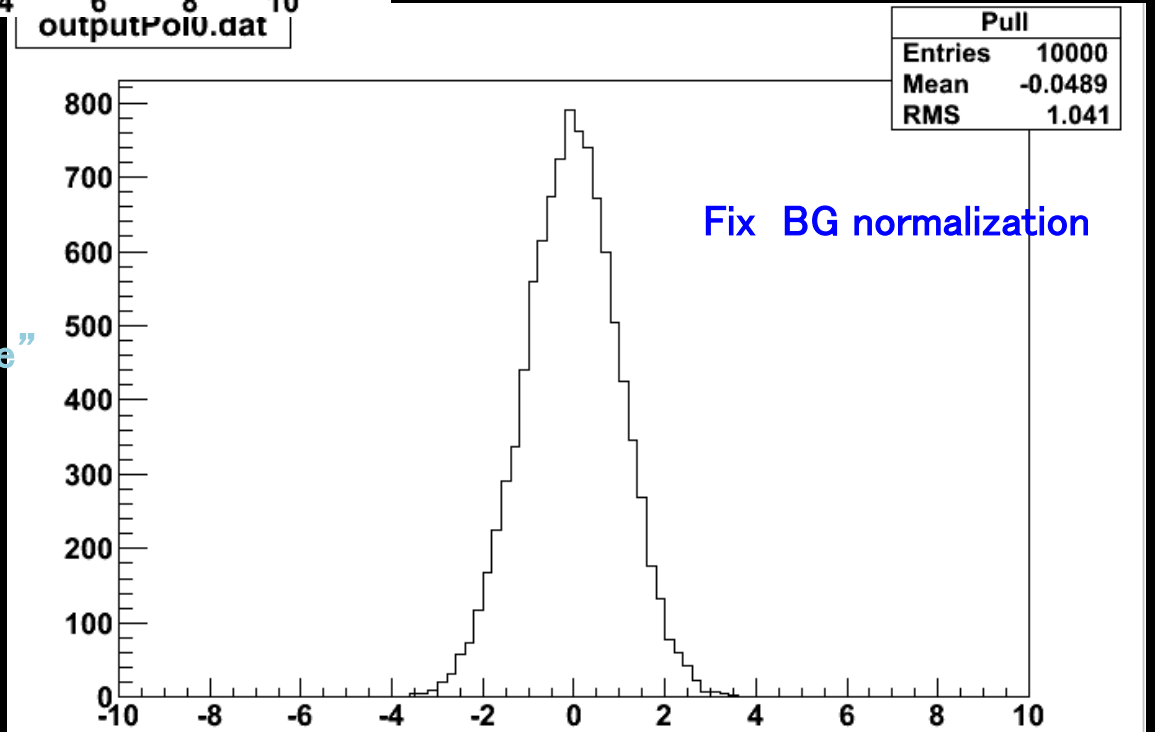


Pull plot

Toy MC
10000 seeds

rms close to 1

mean is more biased for “fix BG case”



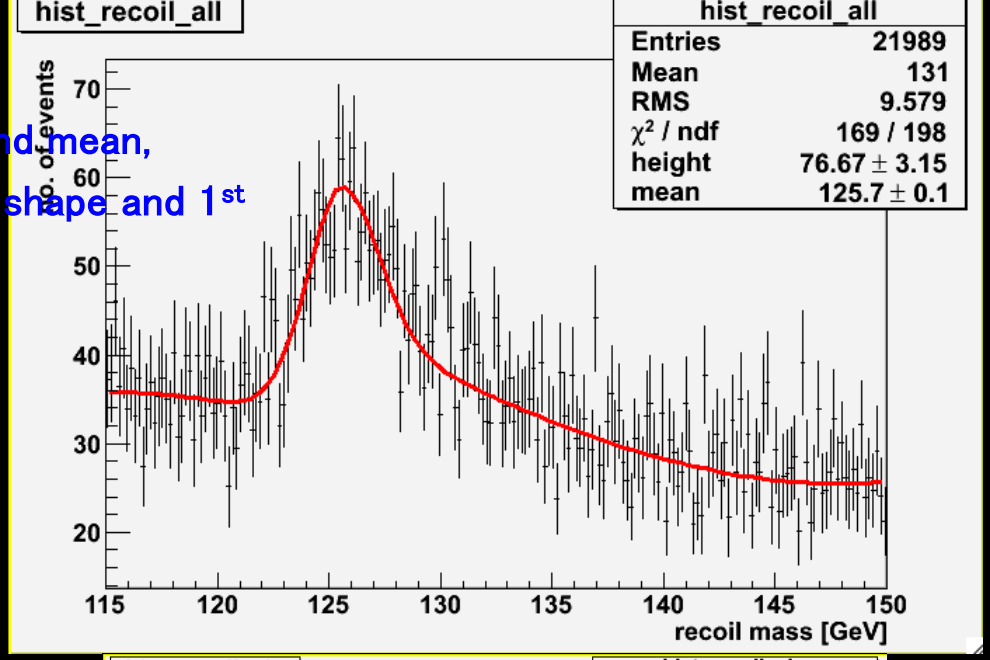
recoil mass

$\Delta\sigma/\sigma \sim 4.1\ \%$

Final fitting:

float only height and mean,

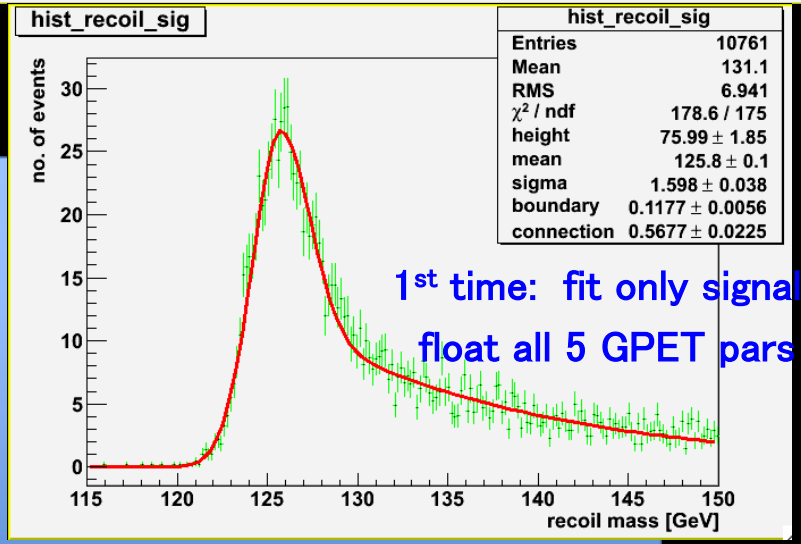
fix others from BG shape and 1st time fitting



fitted recoil mass :

Mh =125.7 GeV +/− 144 MeV

calculated recoil mass with correction for 14 mrad beam crossing angle



- BG: 3rd order polynomial
- signal : GPET: 5 parameters :

Gaus (left−side) , Gaus + expo (right side)

$$\frac{N}{\sqrt{ps}}\exp\left[-\frac{1}{2}\left(\frac{x-x_{mean}}{s}\right)^2\right] \qquad \frac{x-x_{mean}}{s} \pounds k$$

$$\frac{N}{\sqrt{ps}}\left[b\times\exp\left[-\frac{1}{2}\left(\frac{x-x_{mean}}{s}\right)^2\right]+(1-b)\exp\left[-k\left(\frac{x-x_{mean}}{s}-\frac{k}{2}\right)\right]\right] \qquad \frac{x-x_{mean}}{s} > k$$

Muon Selection

calculate recoil mass with correction for 14 mrad beam crossing angle

- reject neutrals
- Ptot > 5 GeV
- small E_cluster / P_total < 0.5
- opposite charge

■ **Best track selection :** cos(track angle) < 0.98 & |D0/δD0| < 5

Best Z Candidate Selection

2 mu candidates with **opposite charge**

choose pair **with invariant mass closest to Z mass**

Evaluate performance in recoil mass range of 120– 140 GeV

Final Selection for 350 GeV

- 84 GeV < M_mumu < 98 GeV
- 10 GeV < pT_mumu < 140 GeV
- coplanarity < 3
- |cos(θ_Zpro)| < 0.91
  (Z production angle)
- 120 GeV < Mrecoil < 140 GeV

	ε	$\Delta\sigma/\sigma$	Nsig	S/N	significance
350 GeV					
(−0.8,+0.3)	48.9+/−0.5%	4.10%	1089+/−45	0.31	16.1
(−0.8,0)	47.6+/−0.5%	4.00%	865+/−34	0.32	14.4
(0,0)	47.7+/−0.5%	3.10%	737+/−23	0.37	14.1
(+0.8,−0.3)	47.8+/−0.5%	3.70%	738+/−27	0.48	15.4
250 GeV					
(−0.8,+0.3)	69.9+/−0.5%	4.10%	1752+/−72	0.26	19
(−0.8,0)	67.2+/−0.5%	4.00%	1390+/−56	0.26	17
(0,0)	66.9+/−0.5%	3.20%	1183+/−38	0.3	16.6

Comparisons

(0,0) seems best for both $\Delta\sigma/\sigma$

(+0.8, −0.3) yields best S/N , $\Delta\sigma/\sigma$ not bad either

WW BGs significantly suppressed (< 1/10 of (−0.8, *0.3))

other major BGs less also (esp for eLpR) (< ½ of (−0.8, +0.3)

even though statistics is lower, some BG process is suppressed ?

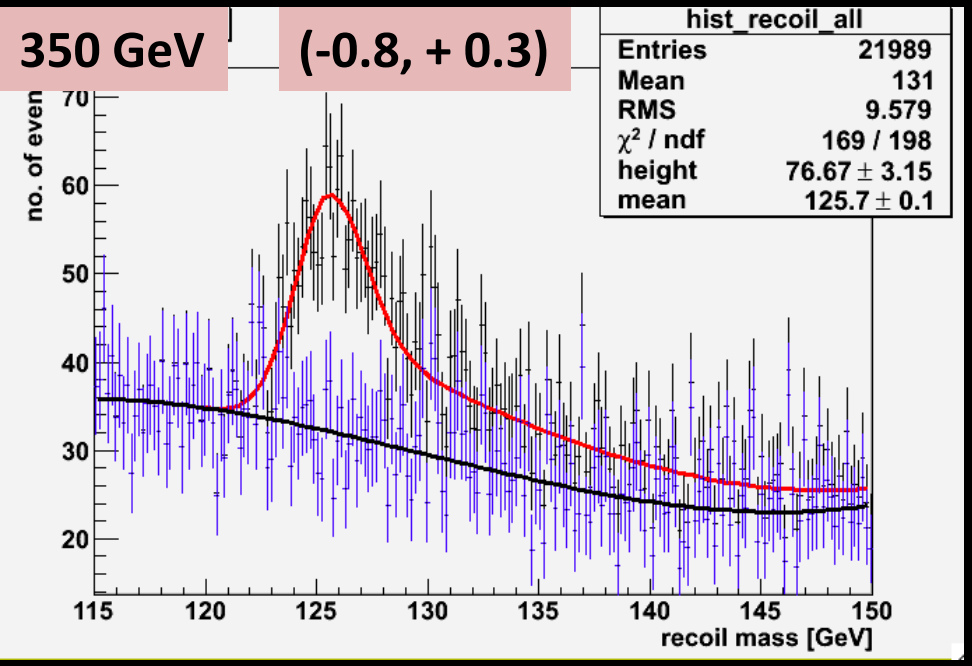
no big difference between (−0.8, + 0.3) and (−0.8, 0)

no big difference in cut efficiency for each individual BG process

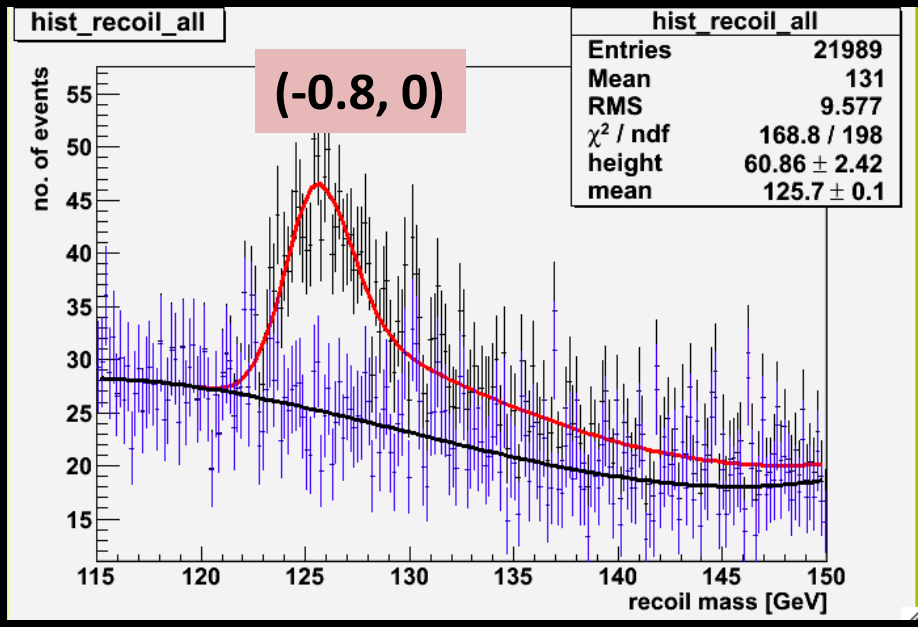
→ is e+ polarization really necessary (practical)? Re-consider for 250 GeV (accelerator issues)

350 GeV

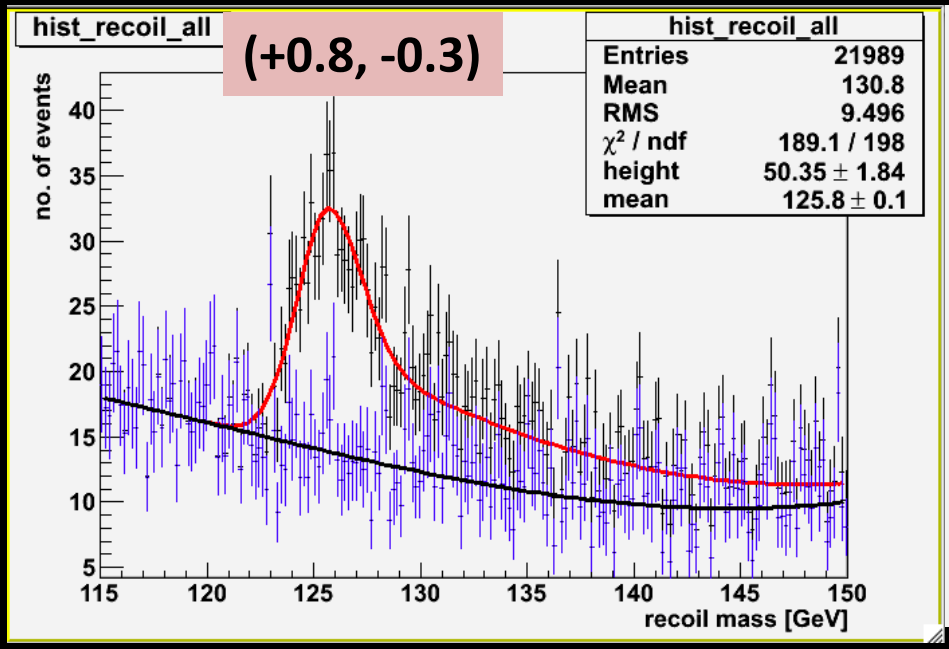
(-0.8, + 0.3)



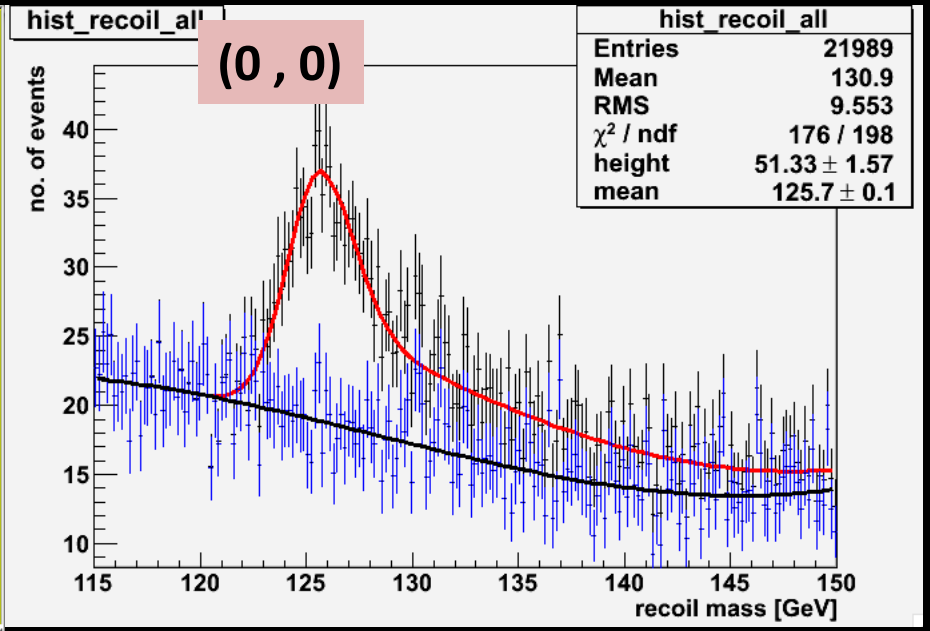
(-0.8, 0)



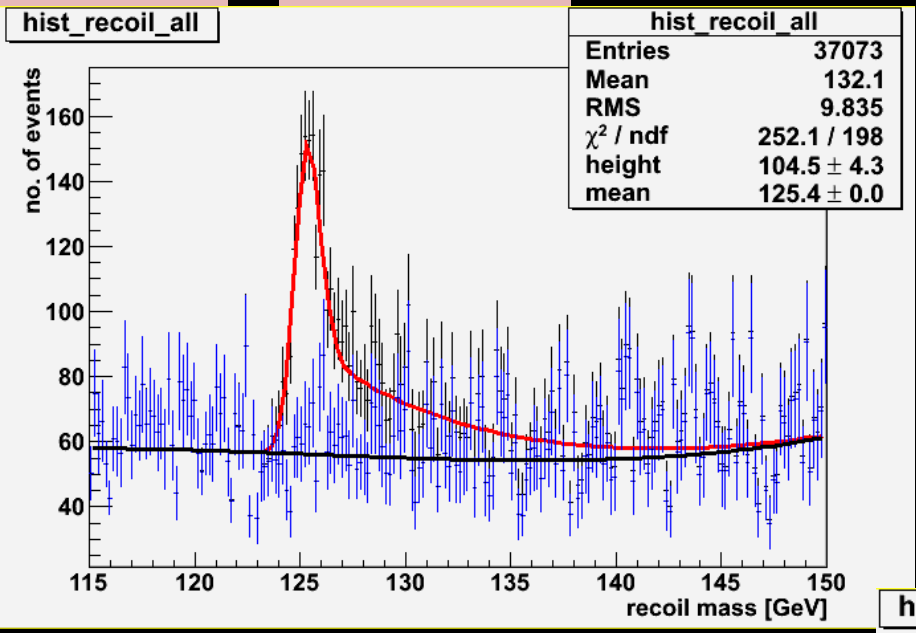
(+0.8, -0.3)



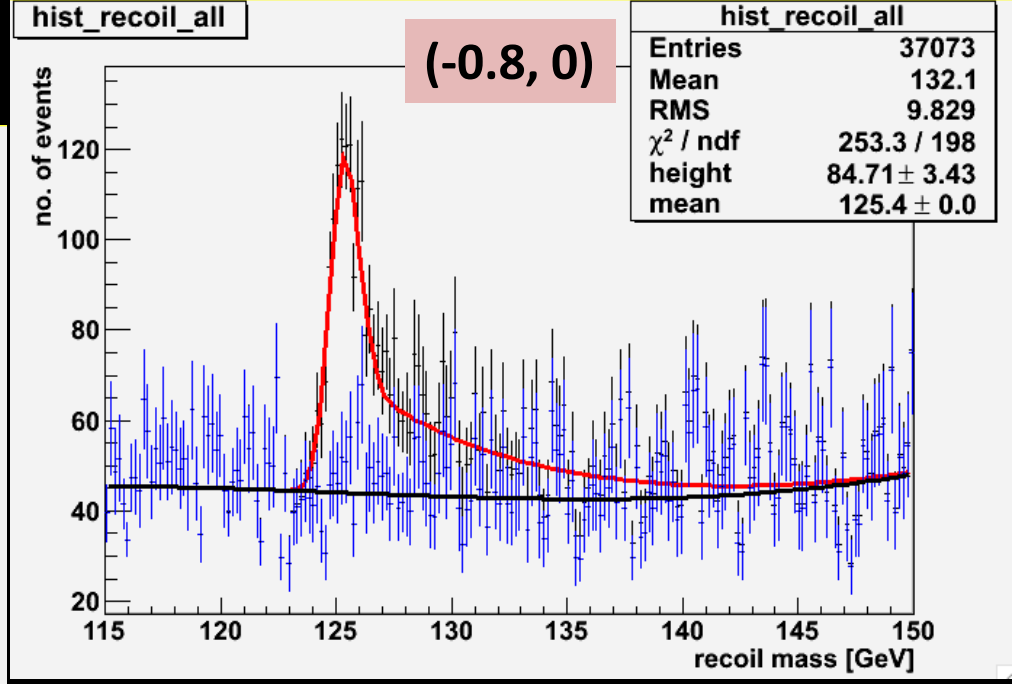
(0 , 0)

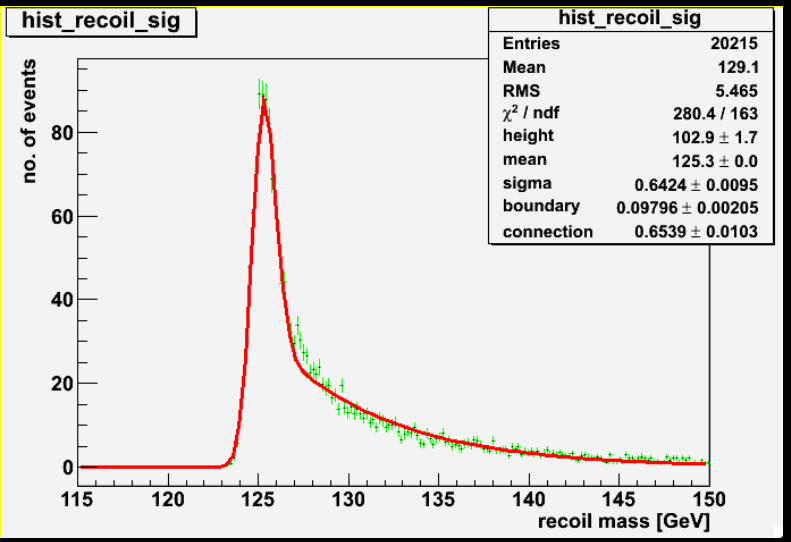


250 GeV **(-0.8, + 0.3)**



(-0.8, 0)





(0, 0)