MC Study of $e^+e^- \rightarrow ZH(ZZ^*)$ process

Status report

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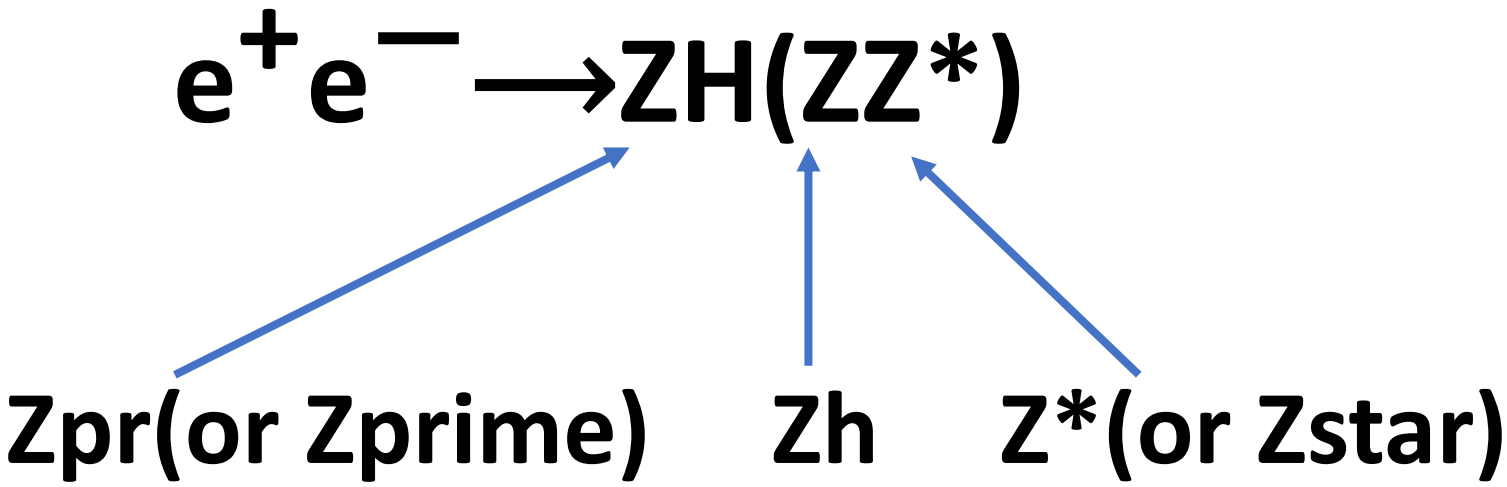
Descriptions

We use following notations for convenience:



Additional analysis. Jet finder

Quantiles: [0.05, 0.16, 0.5, 0.84, 0.95]
[QL, Q1, Qmid, Q3, QR]

$$diff = Mreco - Mmc$$

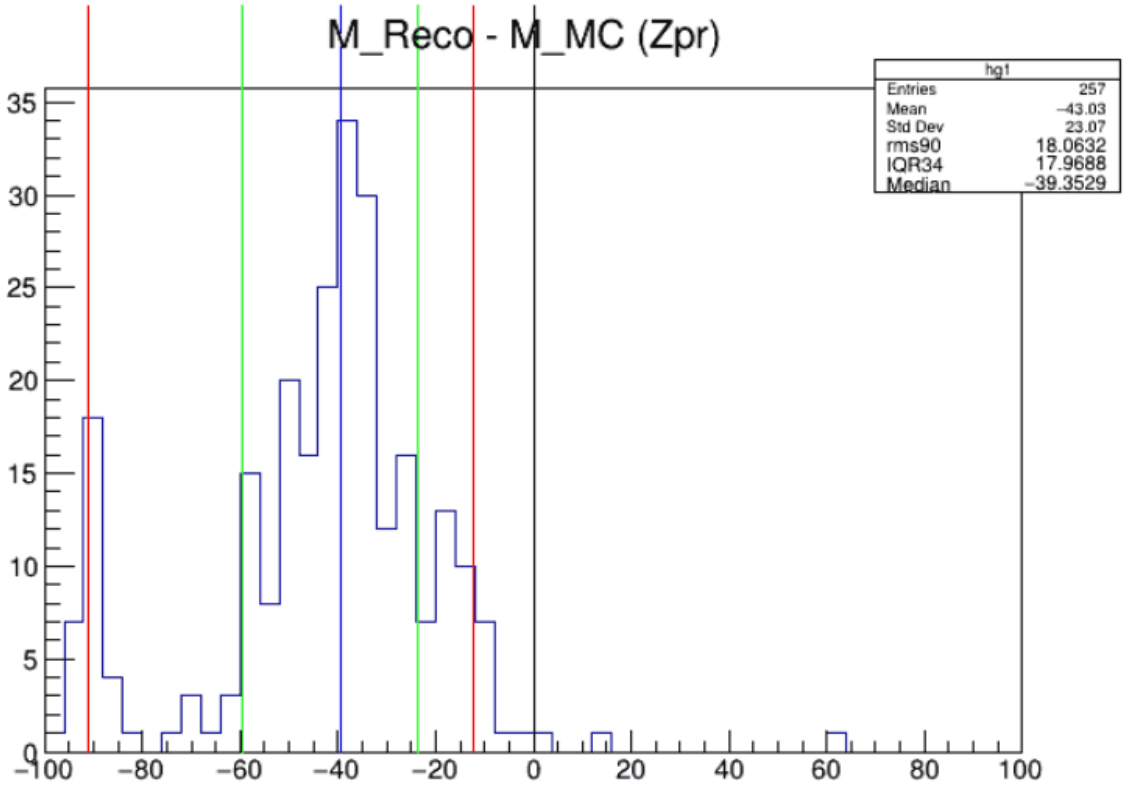
$$IQR34 = (Q3 - Q1)/2$$

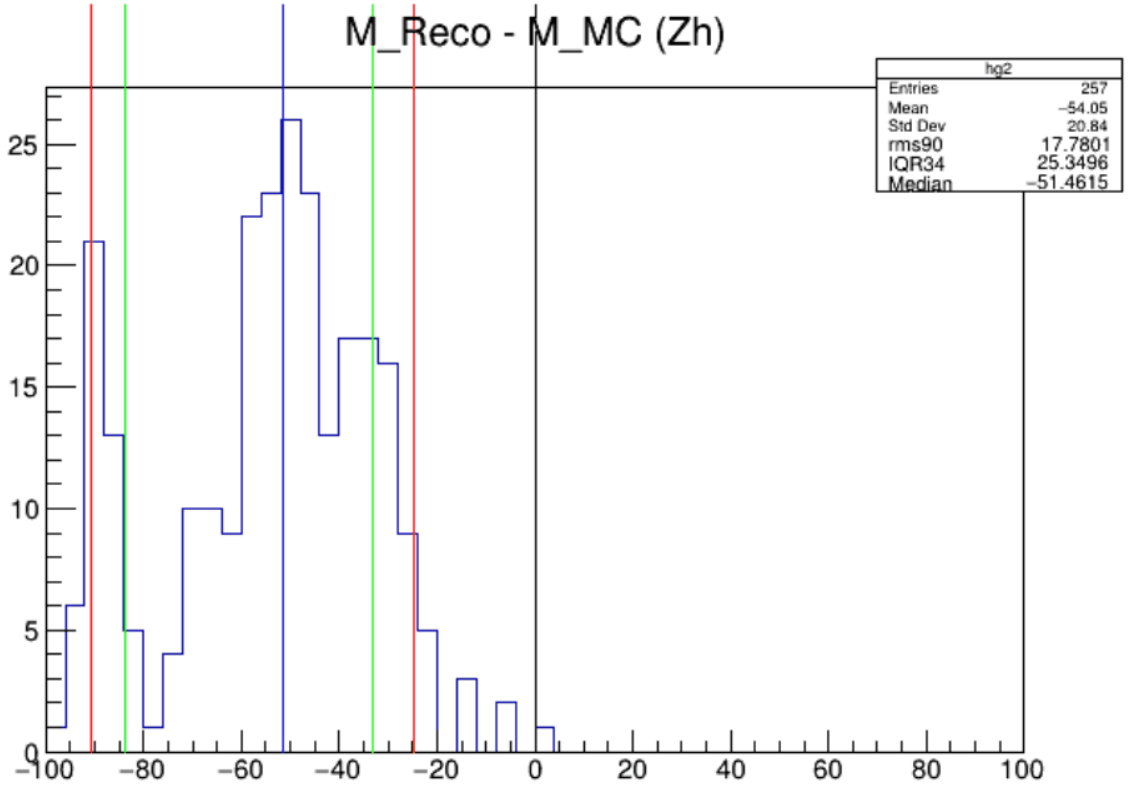
$$diff\ should\ be > QL\ and < QR, then$$

$$RMS90 = \sqrt{\left| \frac{(\sum diff)^2}{(Mentries)^2} - \left(\frac{\sum diff}{Mentries} \right)^2 \right|}$$

Need to choose the optimal set of parameters corresponding to minimum of the function for each reconstructed particle.

Z Mass differences. Zpr->qq, Z->qq, Z*->ll





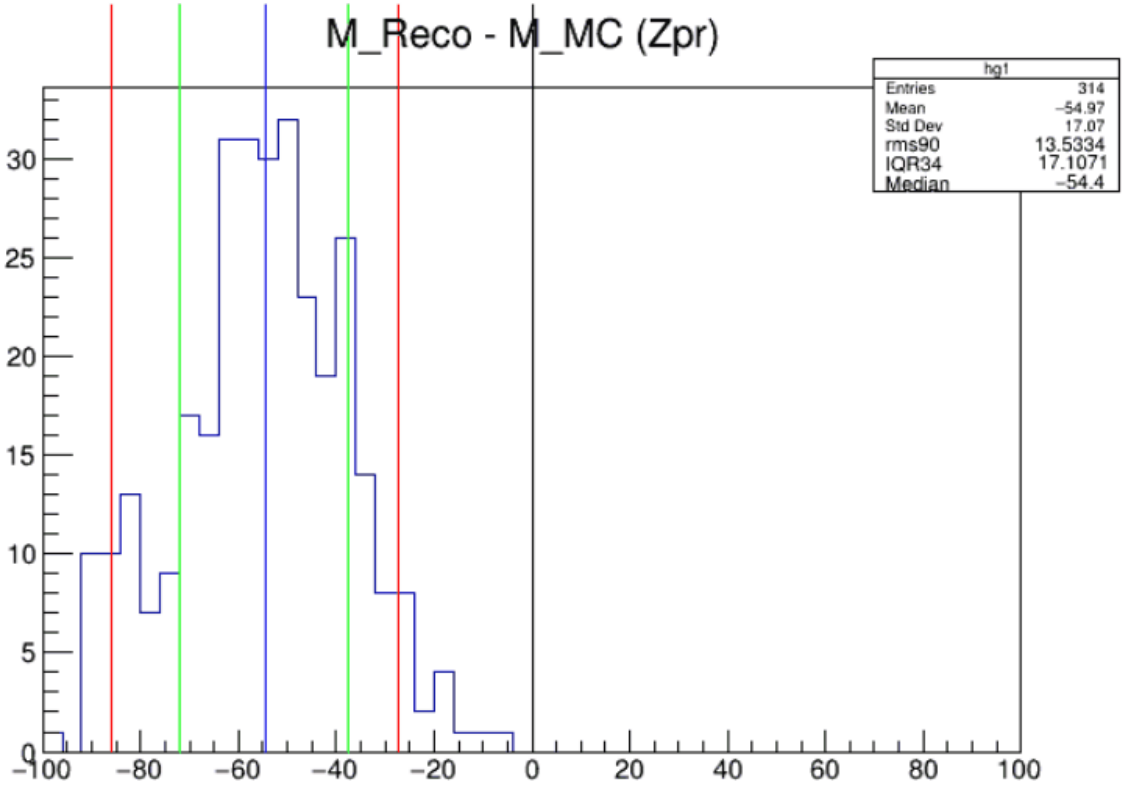
$M(Zpr) - M(Zpr\ MC)$

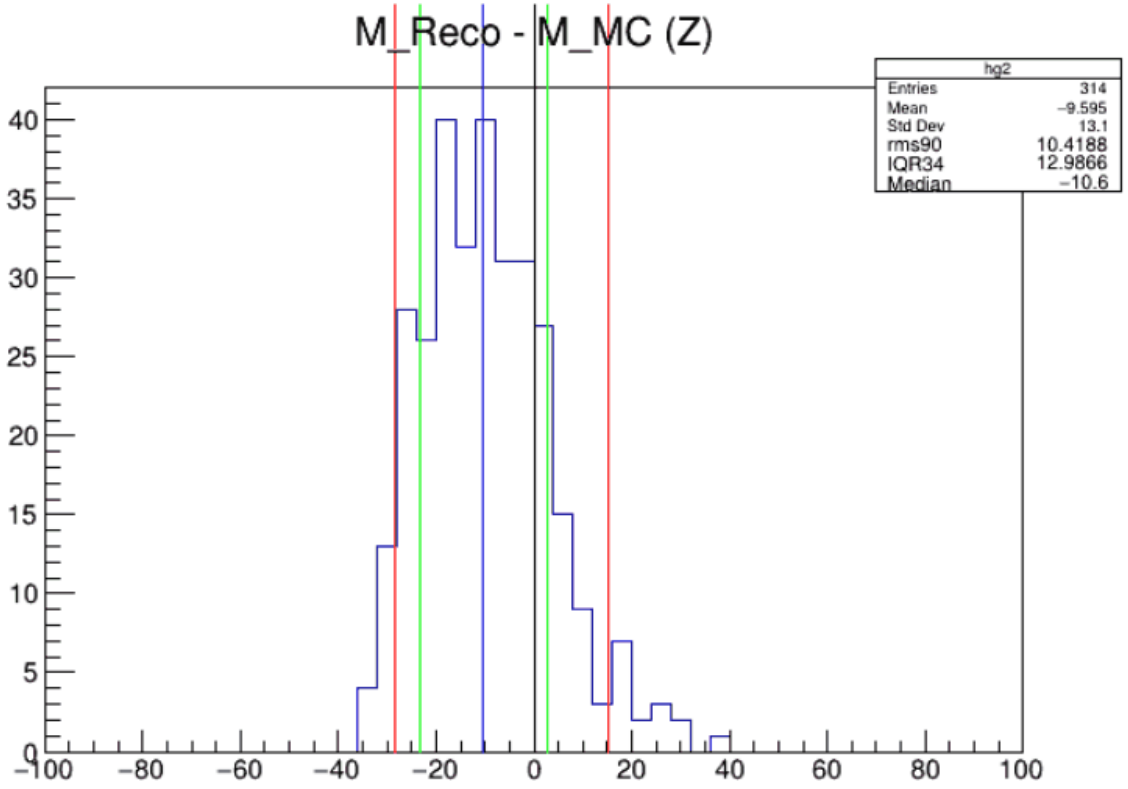
R = [0.1, 3.0]

$M(Zh) - M(Zh\ MC)$

R = [0.1, 3.0]

Z Mass differences. Zpr->qq, Z->ll, Z*->qq





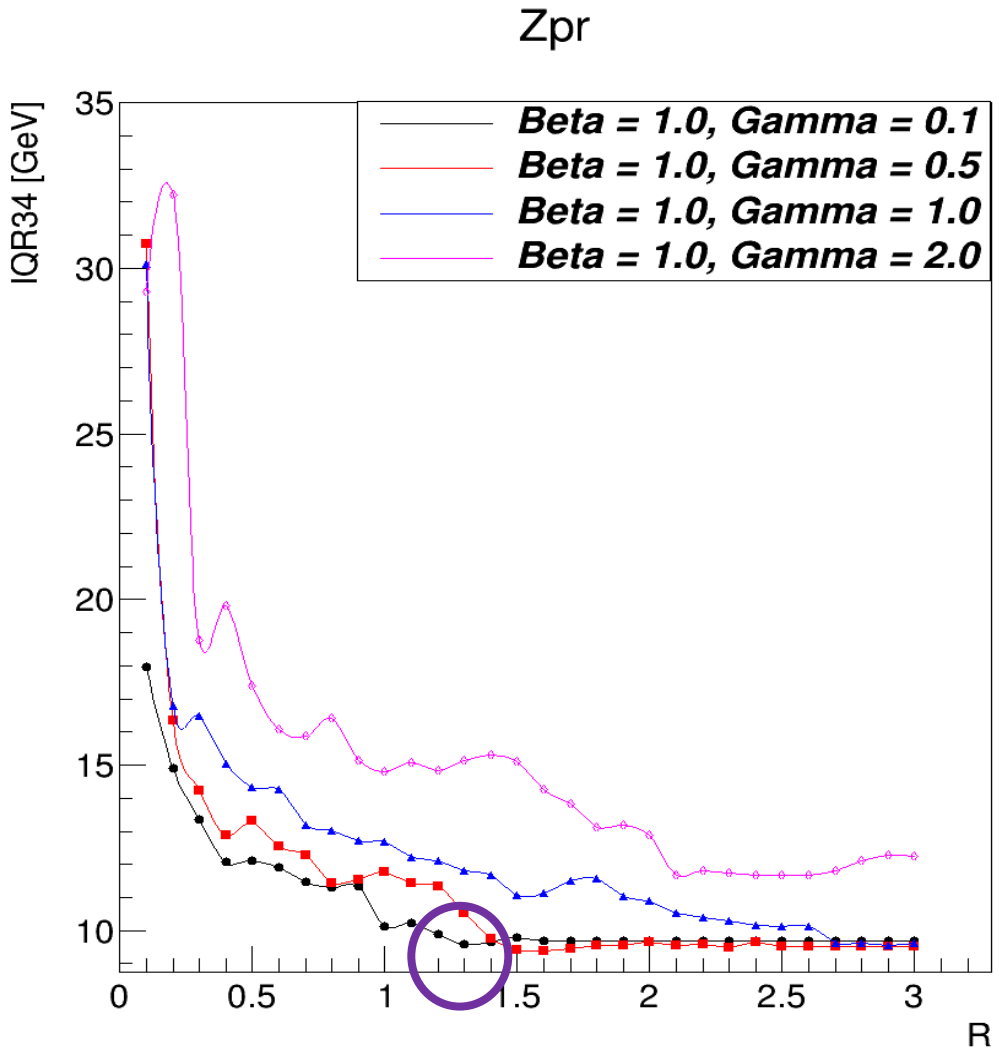
$M(Z_{pr}) - M(Z_{pr}MC)$

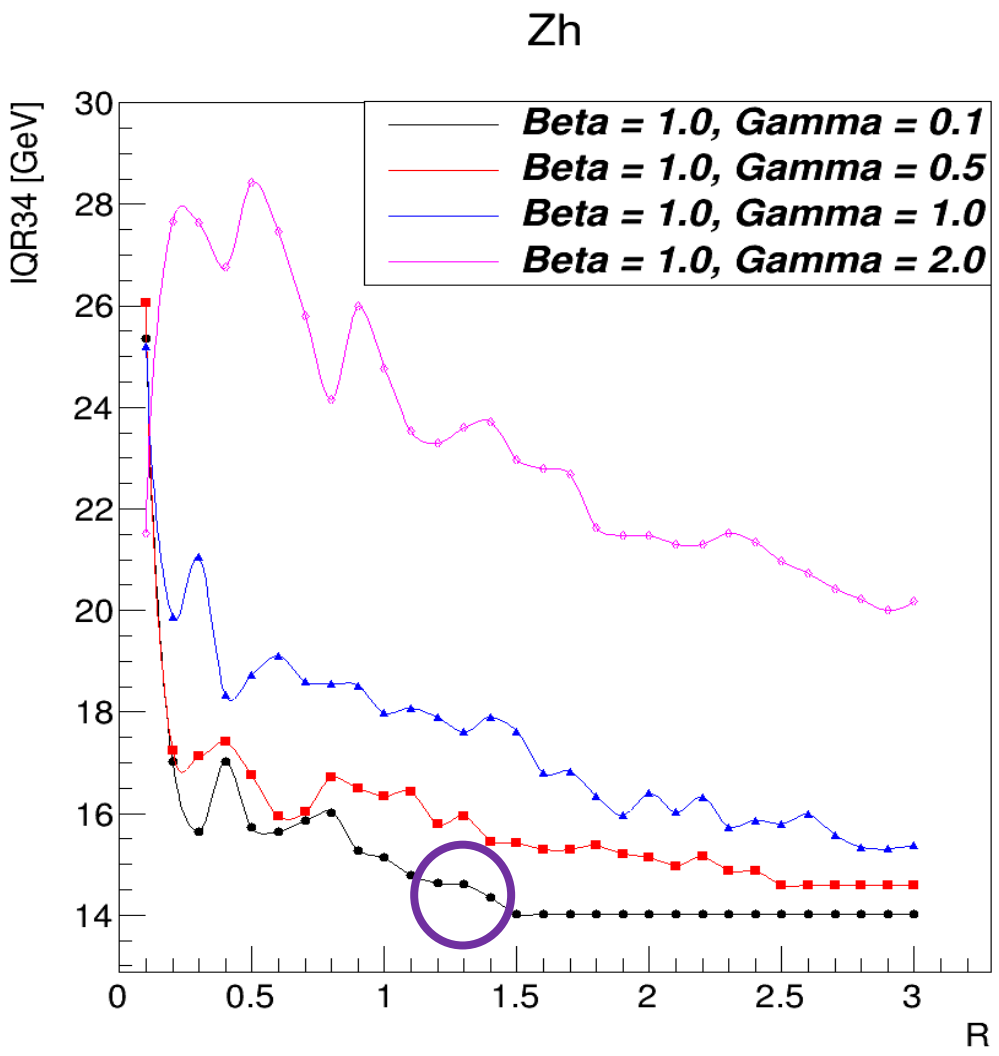
R = [0.1, 3.0]

$M(Z^*) - M(Z^*MC)$

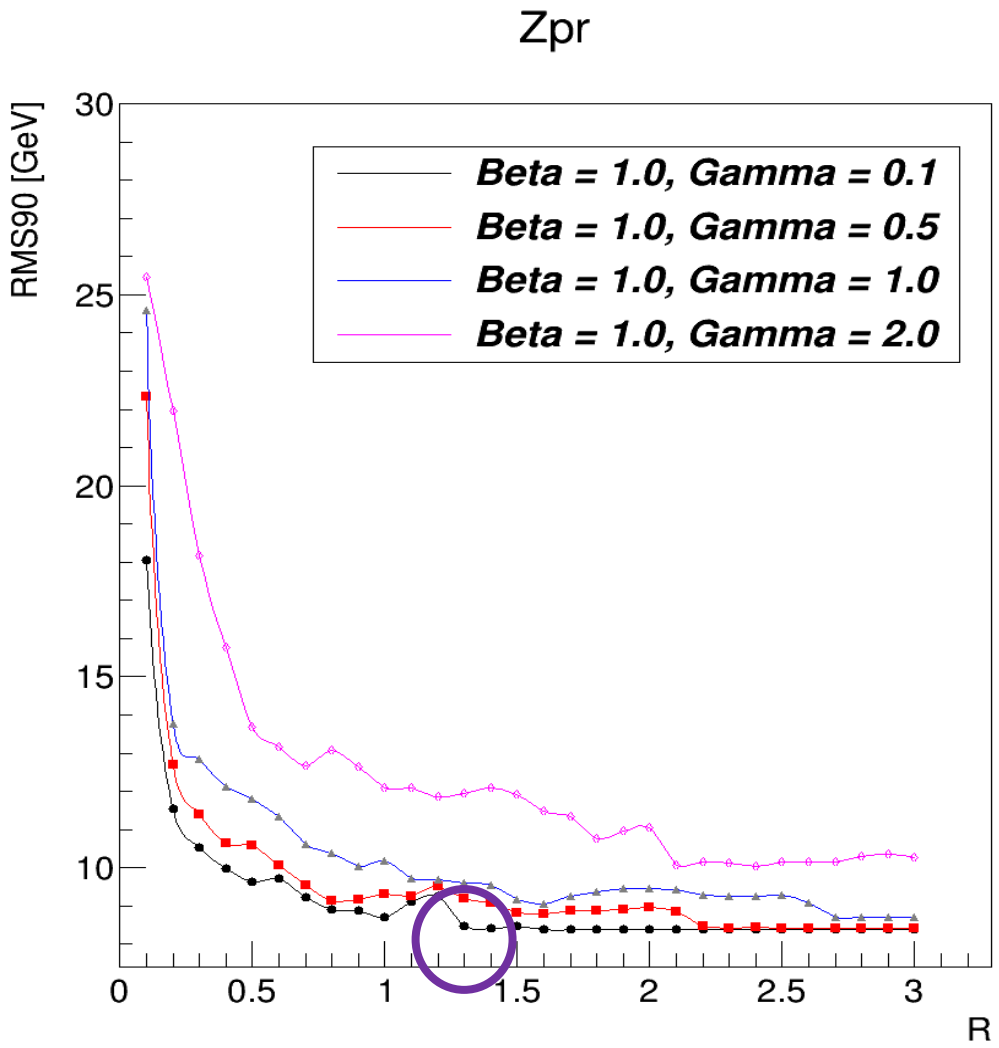
R = [0.1, 3.0]

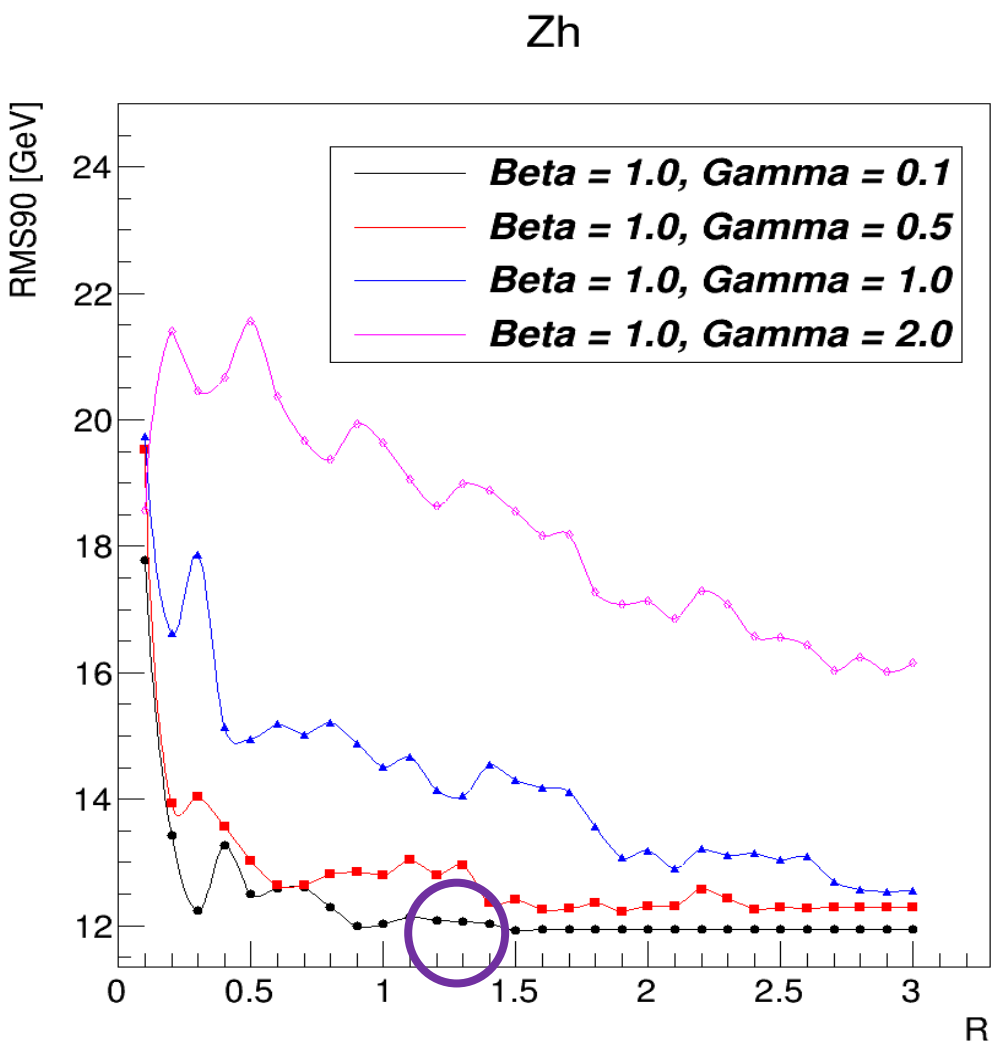
IQR34. Zpr->qq, Z->qq, Z*->ll



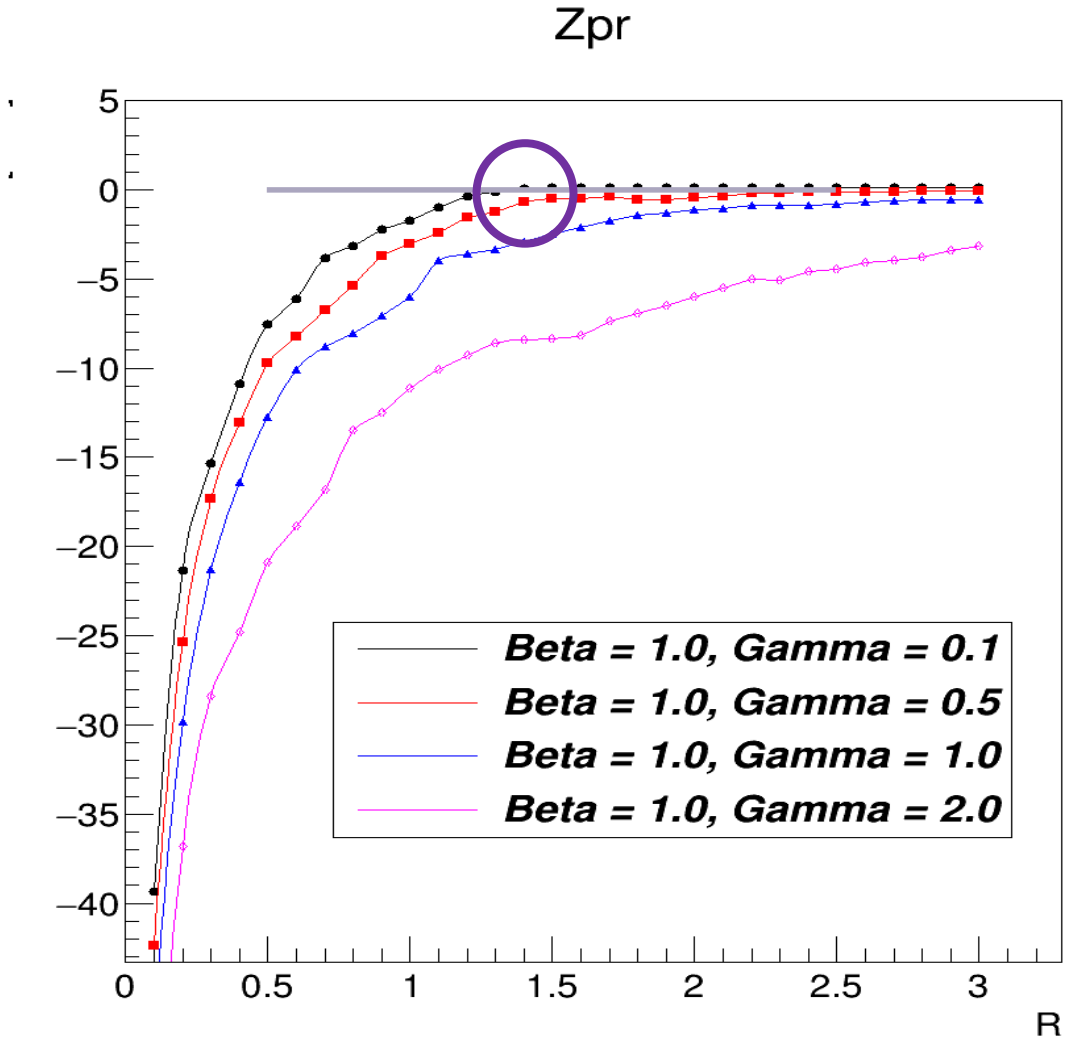


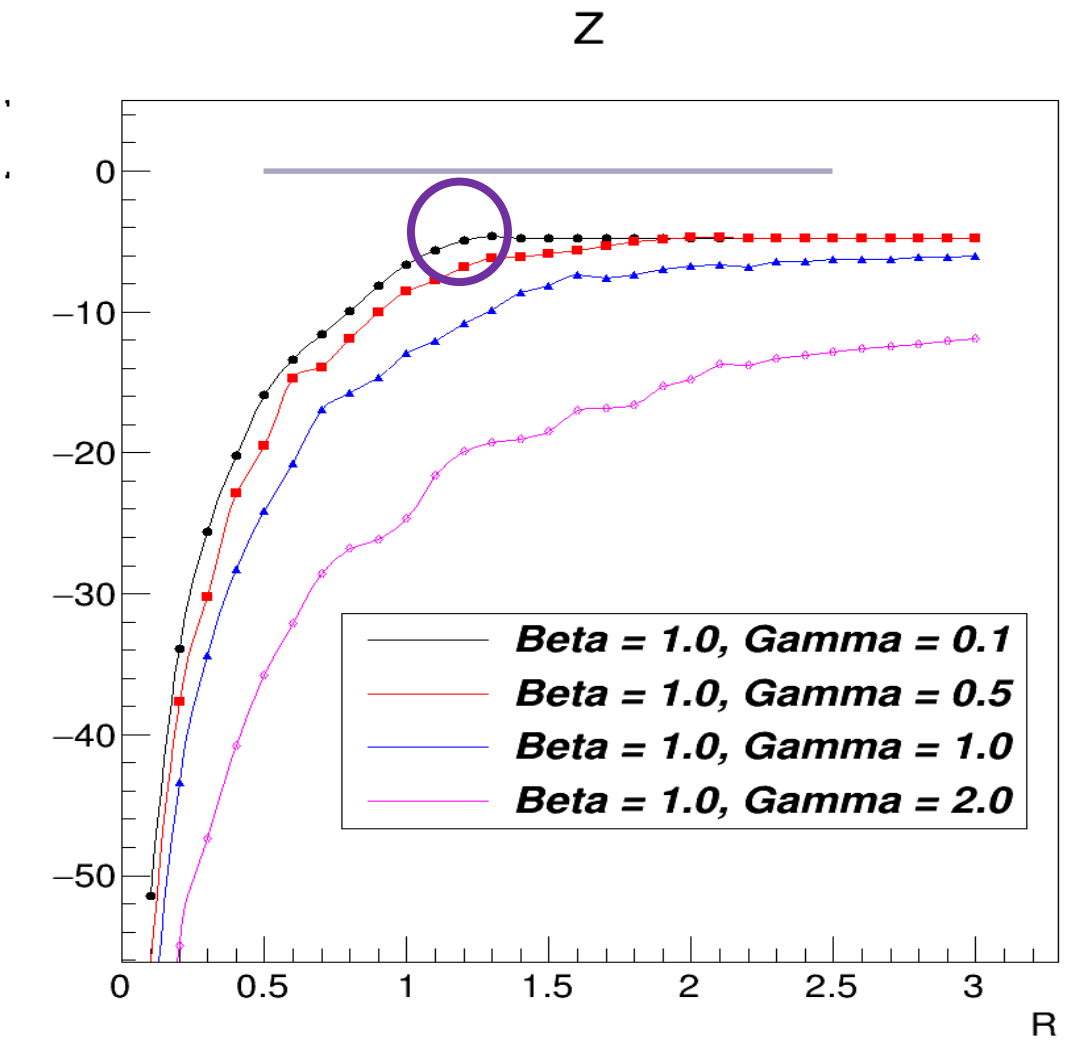
RMS90. Zpr->qq, Z->qq, Z*->ll





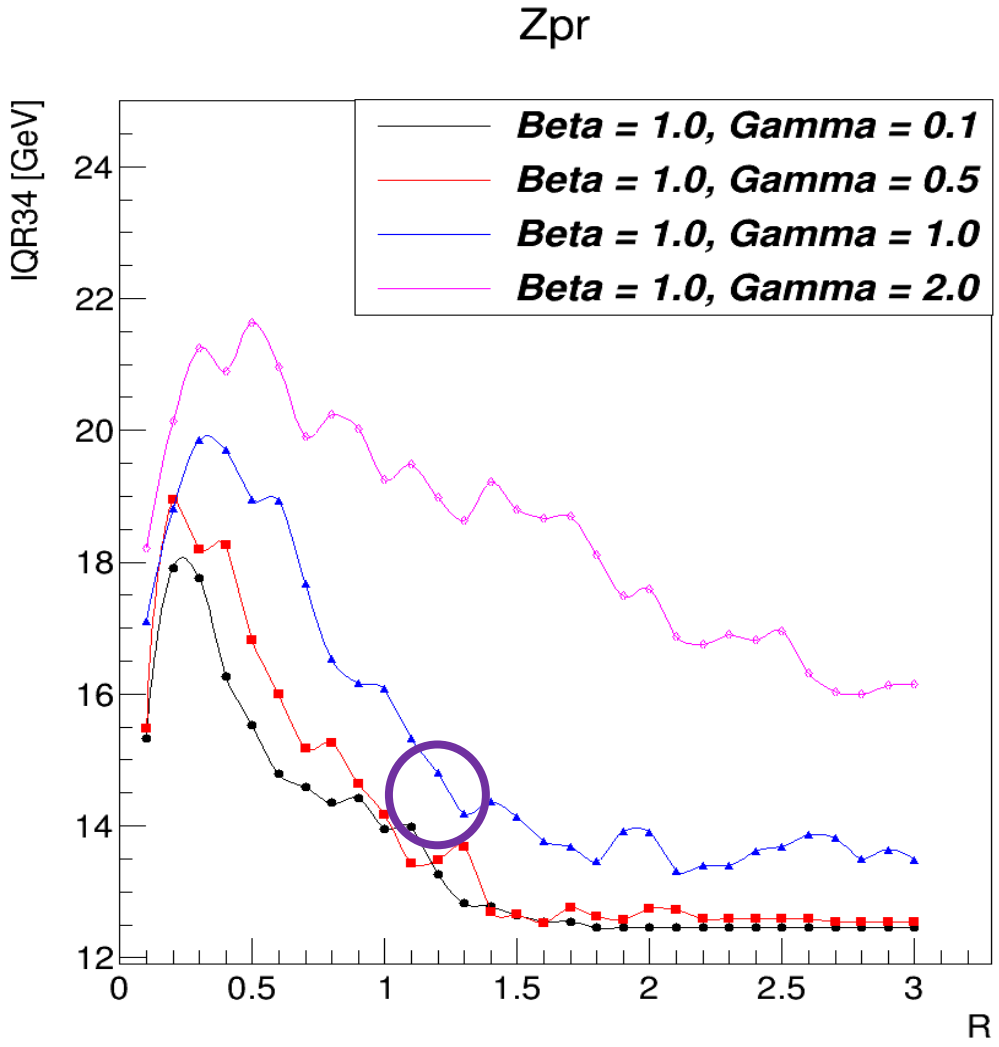
Median. Zpr->qq, Z->qq, Z*->ll

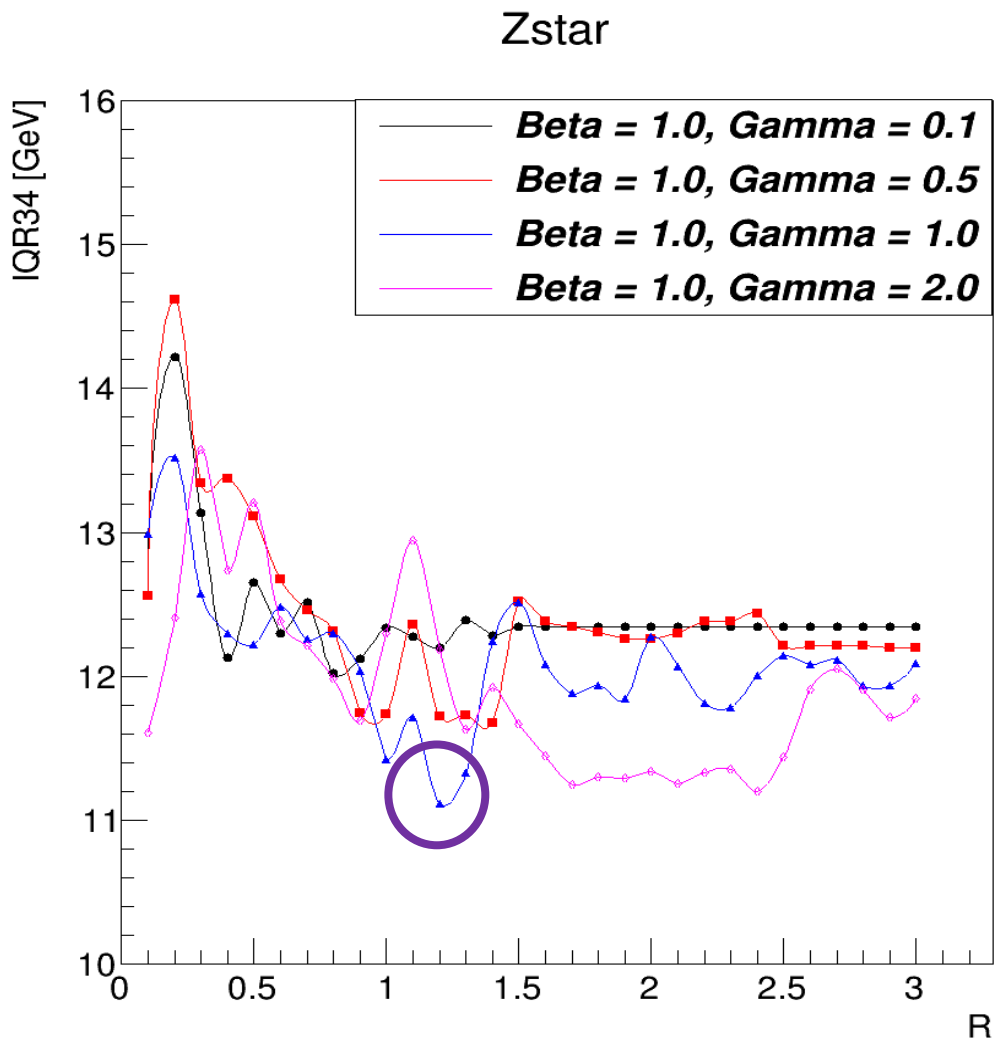




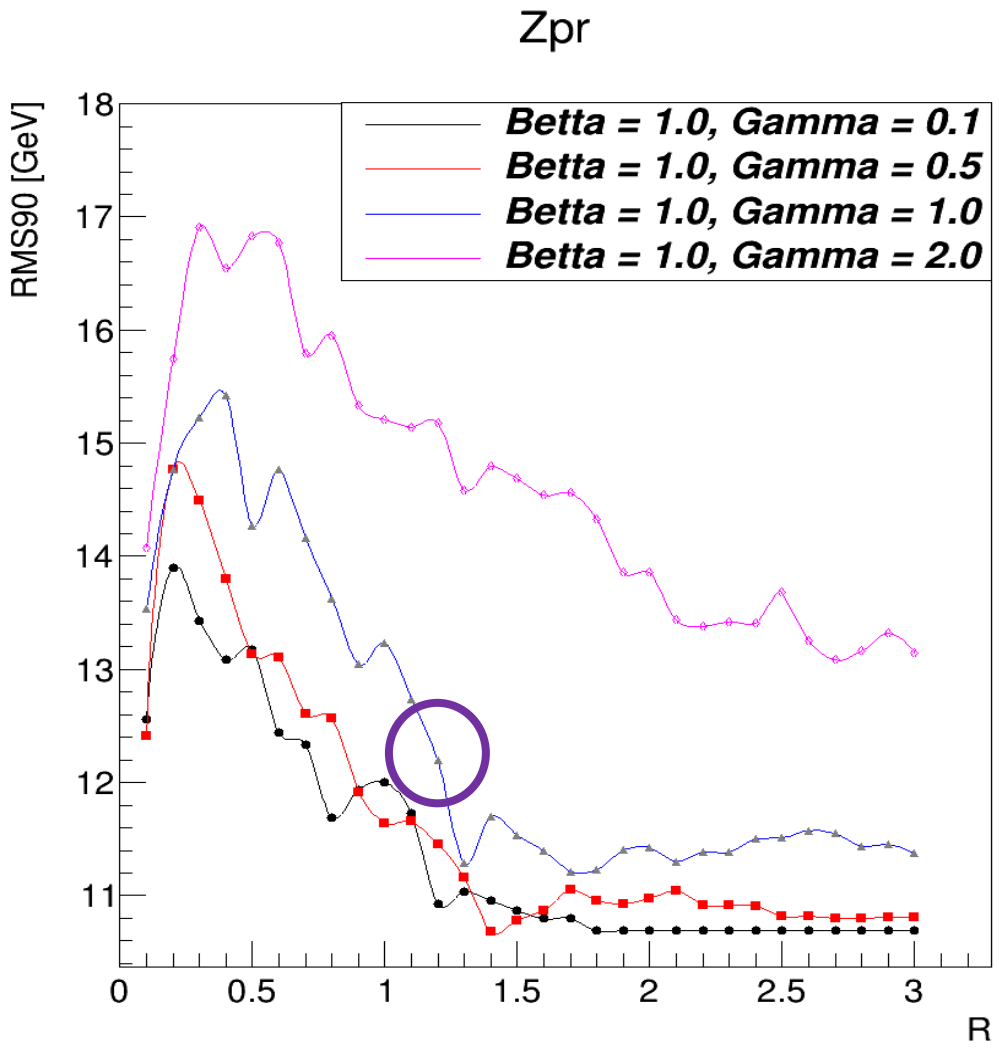
Finally we took this parameters: R=1.3, Beta=1.0, Gamma=0.1 for signal and WWg background

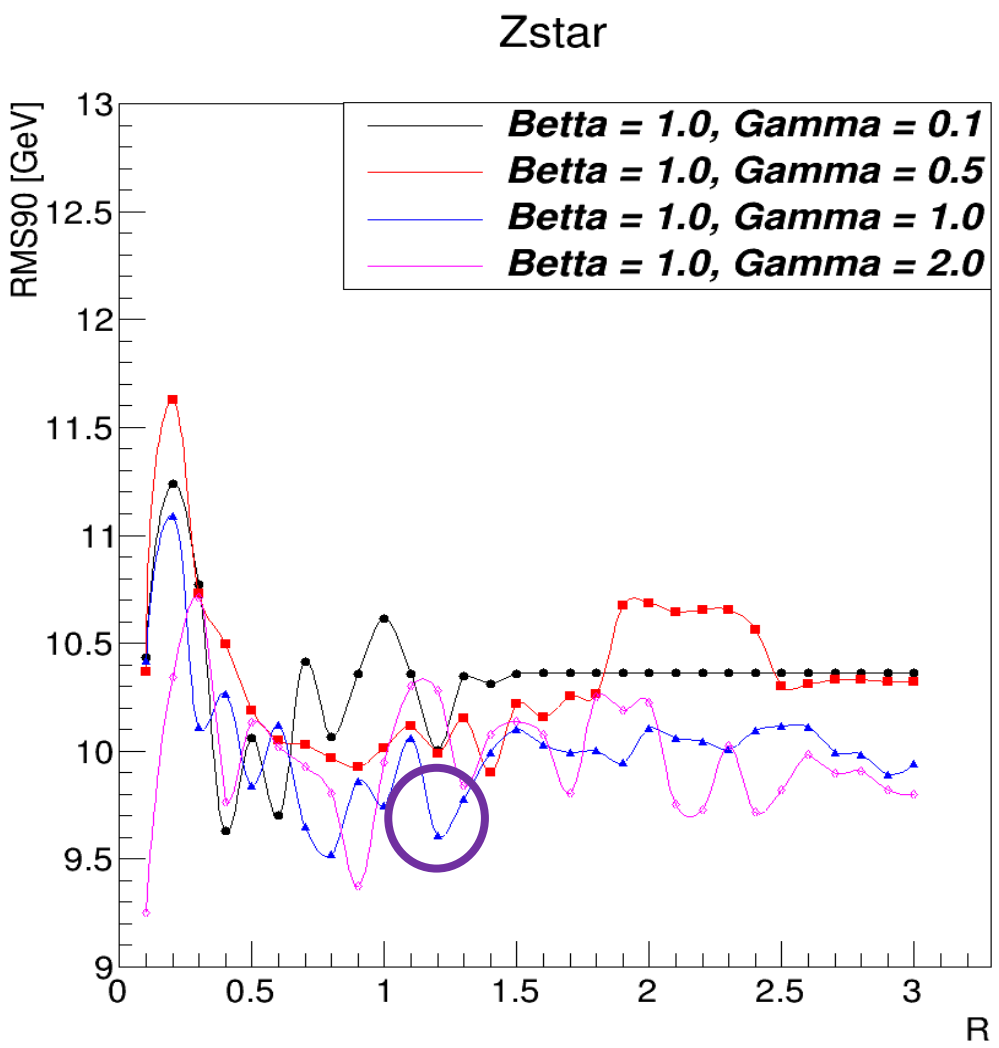
IQR34. Zpr->qq, Z->ll, Z*->qq



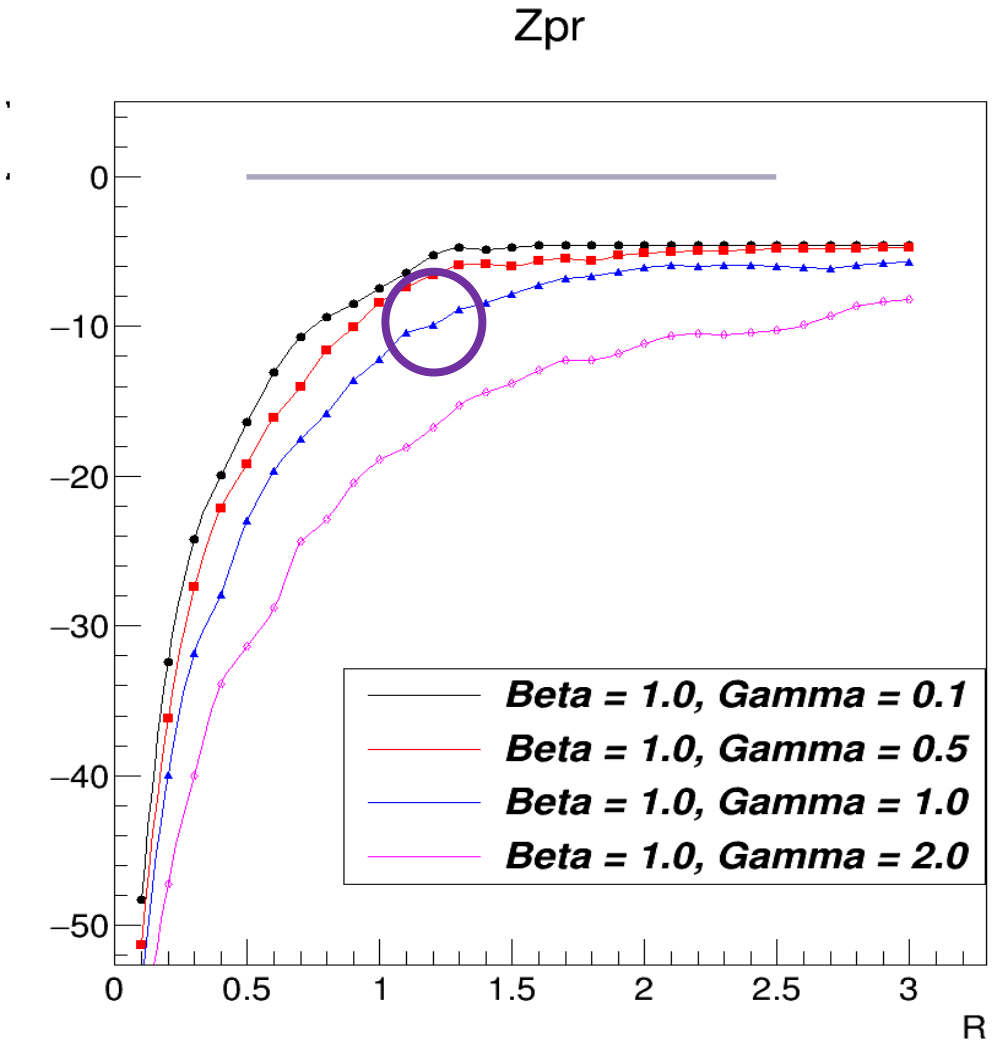


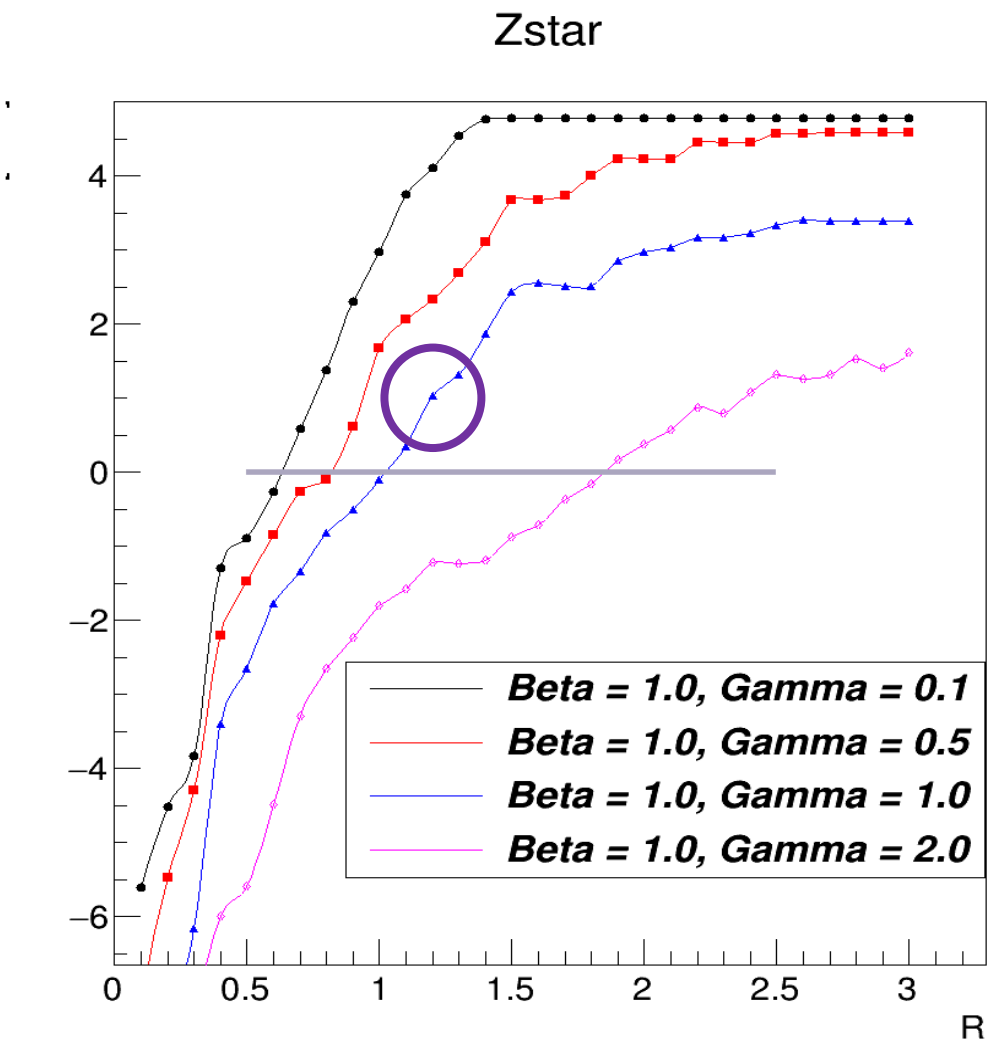
RMS90. Zpr->qq, Z->ll, Z*->qq





Median. Zpr->qq, Z->ll, Z*->qq





Finally we took this parameters: R=1.2, Beta=1.0, Gamma=1.0

Signal: Event selection for Zpr->qq, Z->qq, Z*->ll

I401007.Pqqh_zz

Initial: qqH_ZZ events - 10000 evt

Next: Selection of qqH_Z(qq)Z*(ll) events: 502 evt (5.0%) remain
IsoLepTag: 502 evt without Yoke

IsoLepSelection (Selection of events with correct number of leptons): 360 evt (72.7%) remain

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Cuts: 222 evt (61.7%) remained after cuts and weight:
Exclude Z*Z* MC level (M Z* < 45 GeV, M Zh > 82 GeV): -103
M Zh mass >70 GeV: -51
Total 360-103-51 = 206 evt
Pol [-0.8, 0.3] = Nint(1.08x206) = 222 evt

Final number of events – 222 evt

Background: Event selection for $W^+W^-\gamma$

I401009.6f_llxyyx

Initial: Z(mumu)H events - 20000 evt

IsoLepTag: 20000 evt without Yoke
IsoLepSelection (Selection of events with correct number of leptons): 2749 evt (13.7%) remain

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Cuts: 237 evt (8.6%) remained after cuts and weight:
M Z* mass > 10 GeV and < 45 GeV: -1318
M Zh mass >70 GeV: -386
Total 2749 - 1318 - 386 = 1045 evt
Pol [-0.8, 0.3] = Nint(0.227x1045) = 237 evt

Final number of events – 237 evt

Additional information

Zpr->qq, Z->qq, Z*->ll

Minimum chi square calculation

We used 6 combinations of minimum chi square with the most energetic jet.

3 for Z prime:

$$\chi^2_{min} = \frac{(M_{inv\,Zpr} - M_{Z\,nominal})^2}{\sigma^2_{Z\,nominal}} + \frac{(M_{inv\,Zh} - M_{Z\,nominal})^2}{\sigma^2_{Z\,nominal}} + \frac{(P_{Zpr} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}} + \frac{(P_{Zh+Z*} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}};$$

3 for Zh:

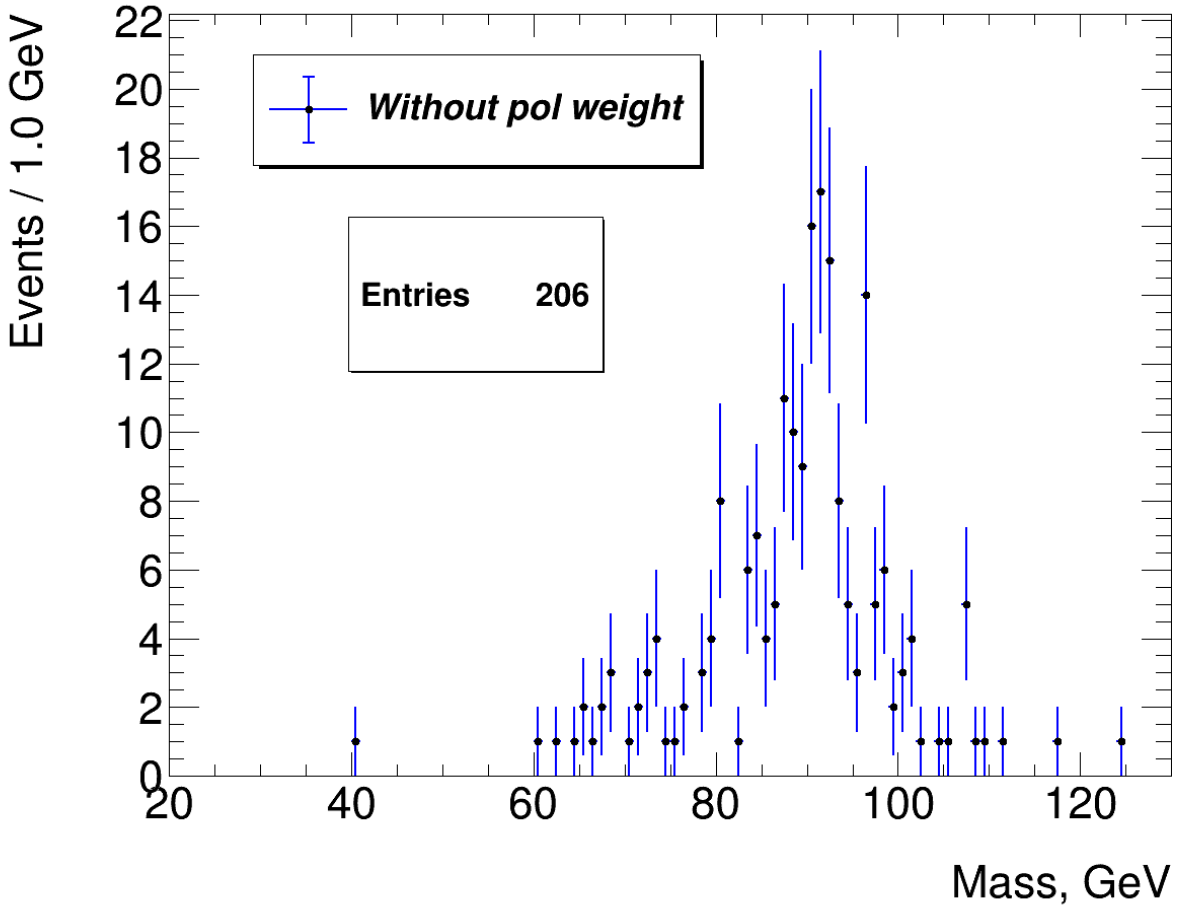
$$\chi^2_{min} = \frac{(M_{inv\,Zpr} - M_{Z\,nominal})^2}{\sigma^2_{Z\,nominal}} + \frac{(M_{inv\,Zh} - M_{Z\,nominal})^2}{\sigma^2_{Z\,nominal}} + \frac{(P_{Zh} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}} + \frac{(P_{Zpr+Z*} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}};$$

$$\sigma_{Z\,nominal} = 5\ GeV, \sigma_{P_Z\,nominal} = 9\ GeV$$

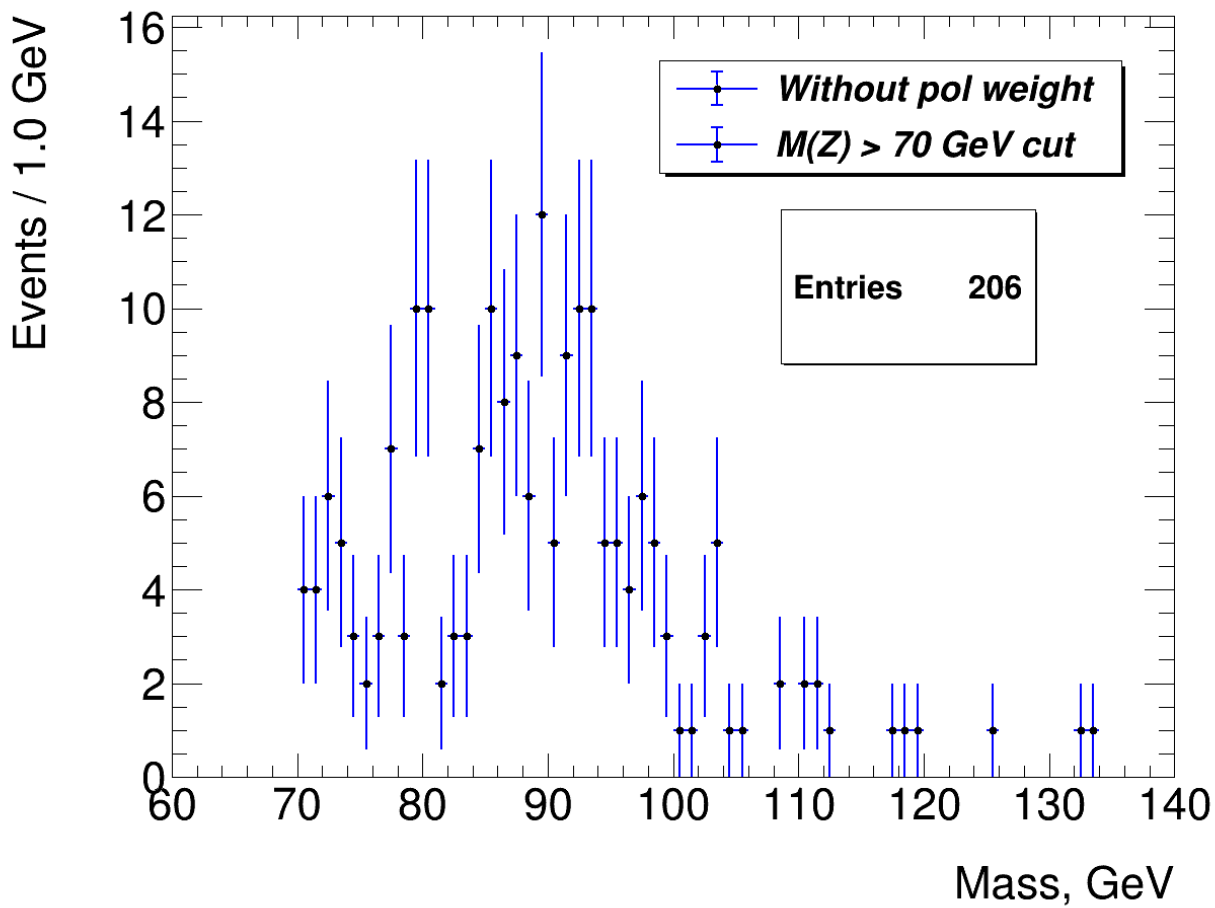
Zprime and Zh mass distributions

Zpr->qq, Z->qq, Z*->ll

I401007.Pqqh_zz signal



$MZpr, Zpr \rightarrow jj$

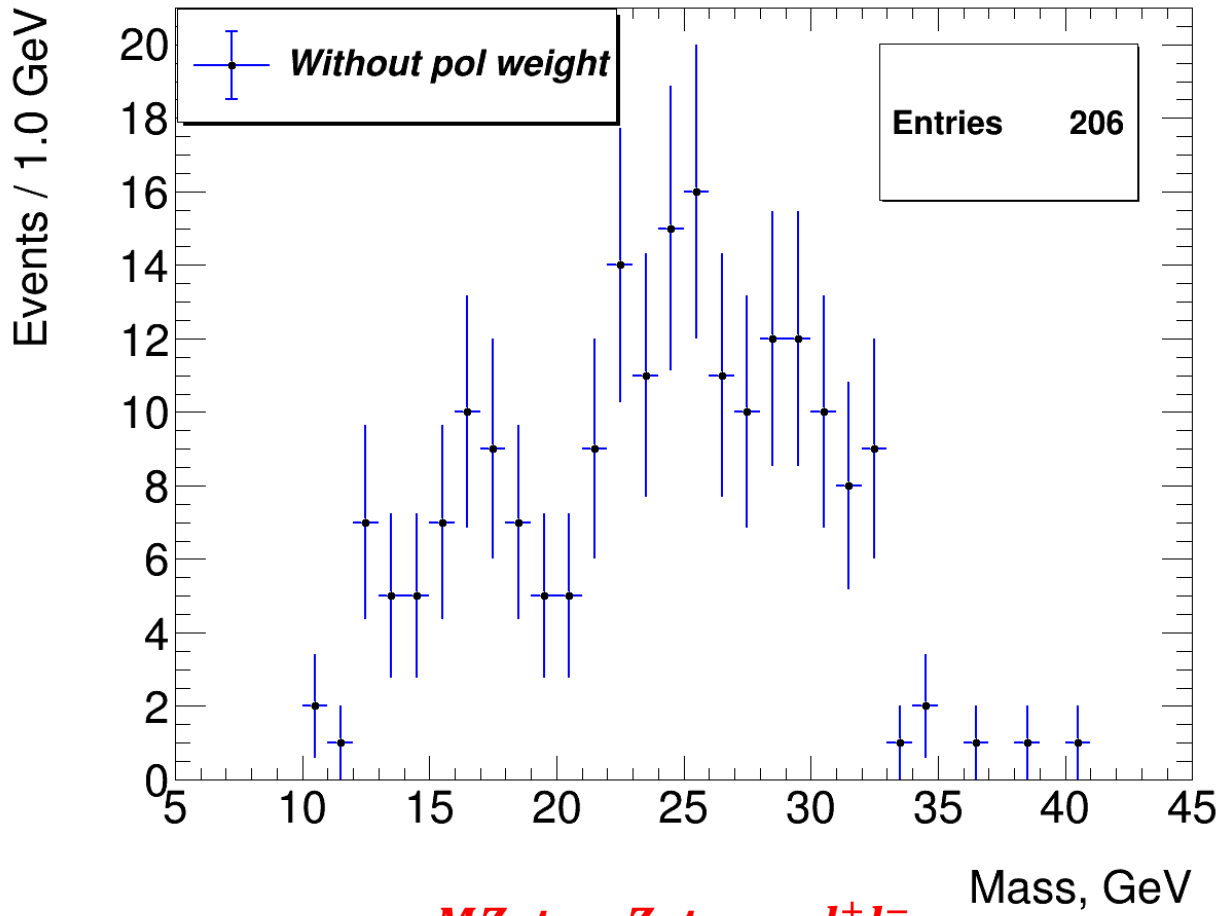


$MZh, Zh \rightarrow jj$

Zstar mass distribution

Zpr->qq, Z->qq, Z*->ll

I401007.Pqqh_zz signal

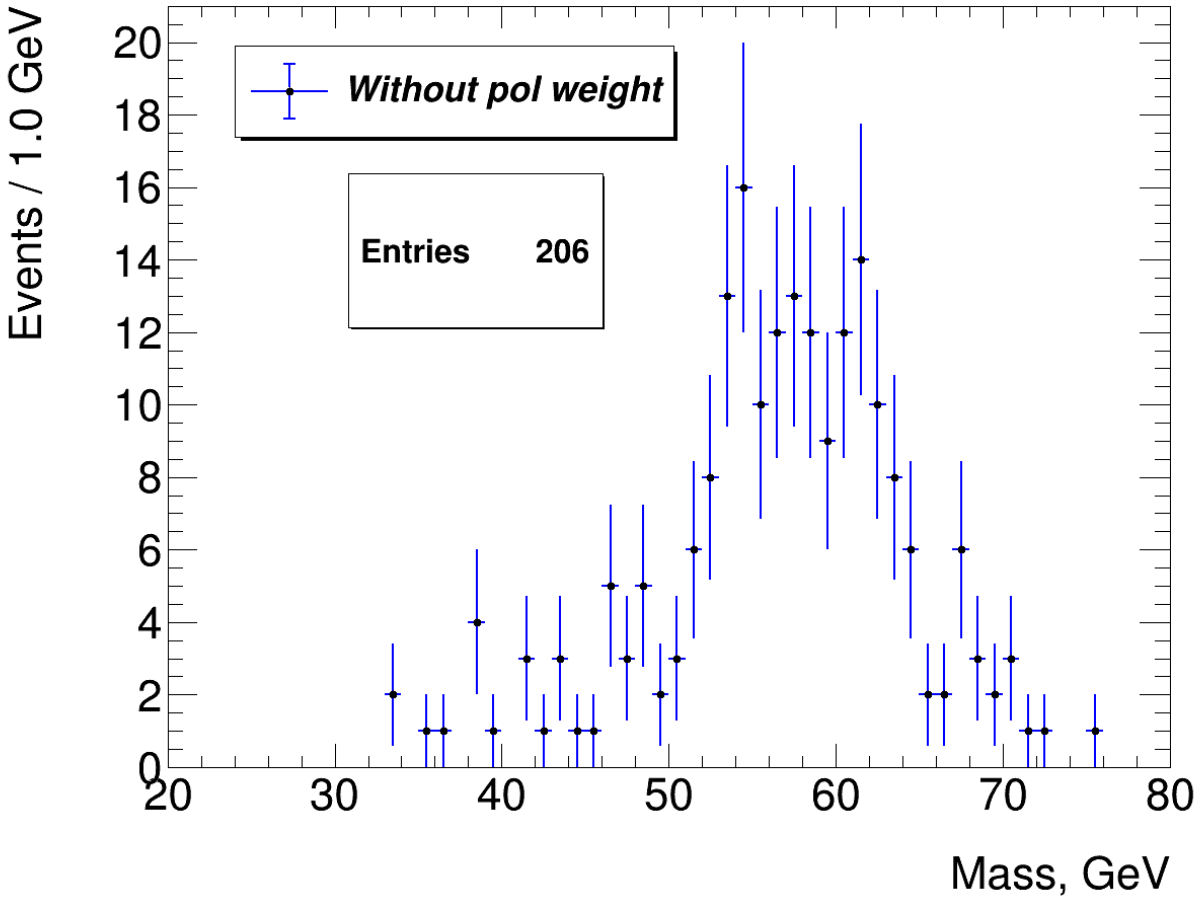


$MZstar, Zstar \rightarrow l^+l^-$

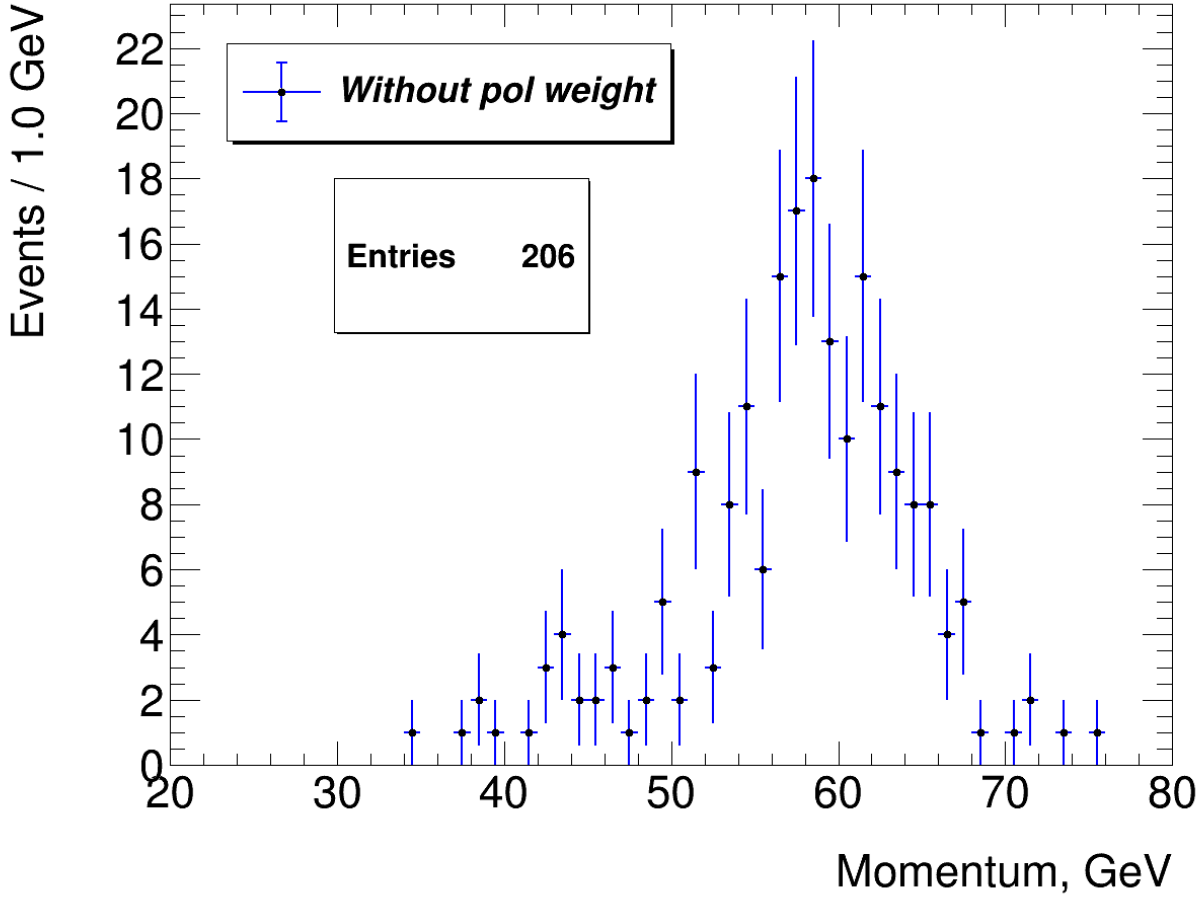
Zprime and Zh+Zstar momentums distributions

Zpr->qq, Z->qq, Z*->ll

I401007.Pqqh_zz signal



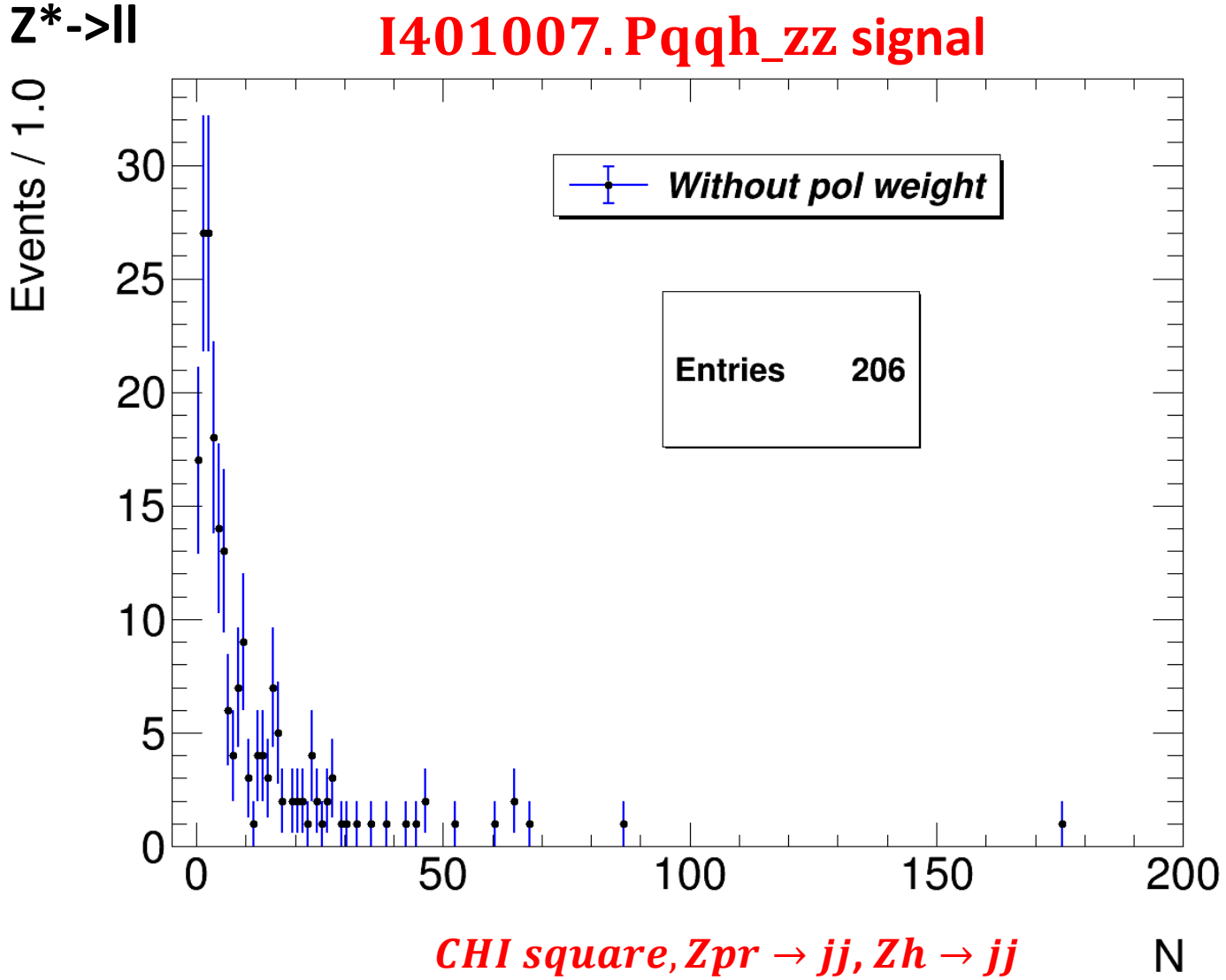
PZpr, Zpr → jj



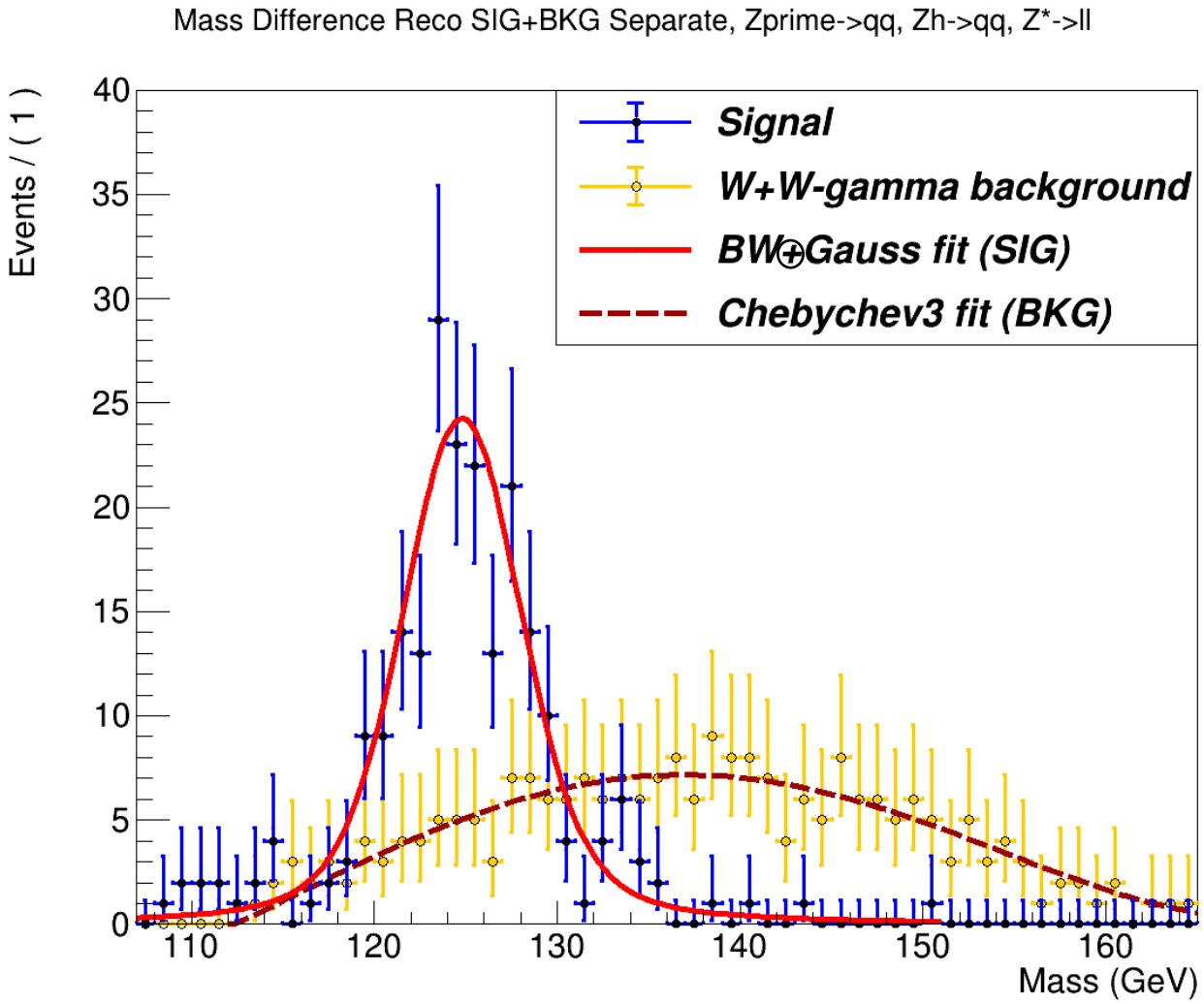
PZhZstar, Zh → jj, Zstar → l^+l^-

CHI square distribution

Zpr->qq, Z->qq, Z*->ll



Mass difference distribution $\Delta M = M(jjll) - M(jj) + M(Z\ nominal)$

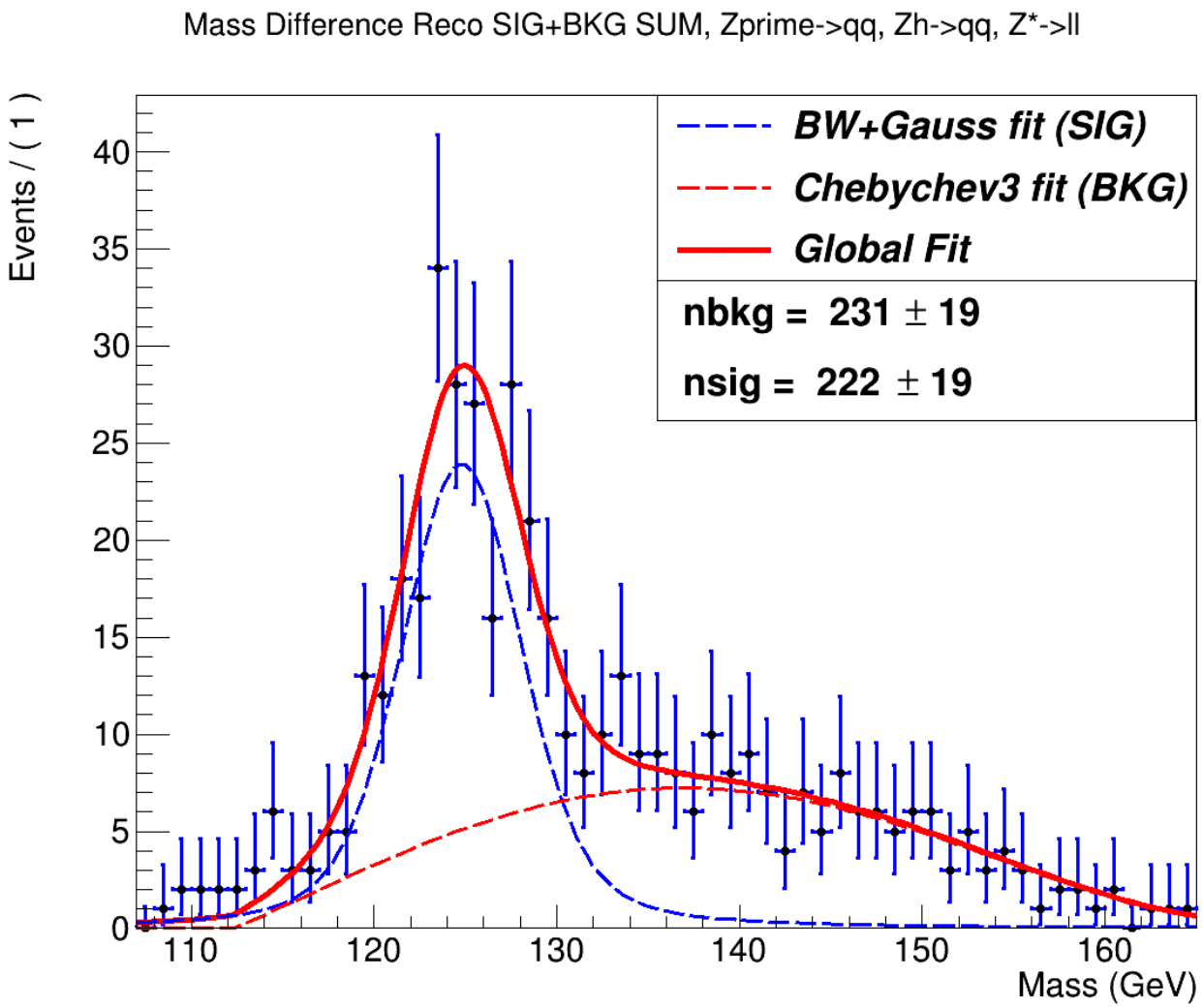


I401007. Pqqh_zz signal

I401009. 6f_llxyyx background

Separate

Mass difference distribution $\Delta M = M(jjll) - M(jj) + M(Z\ nominal)$



I401007. Pqqh_zz signal

I401009. 6f_llxyyx background

SUM

Need to optimize procedure

Significance of this channel ~8.5%

Signal: Event selection for Zpr->qq, Z->ll, Z*->qq

I401007.Pqqh_zz

Initial: qqH_ZZ events - 10000 evt

Next: Selection of qqH_Z(qq)Z*(ll) events: 439 evt (4.4%) remain
IsoLepTag: 439 evt without Yoke

IsoLepSelection (Selection of events with correct number of leptons): 408 evt (92.9%) remain

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Cuts: 337 evt (82.6%) remained after cuts and weight:
Exclude Z*Z* MC level (M Z* < 45 GeV, M Zh > 82 GeV): -92
Total 408-92 = 316 evt
Pol [-0.8, 0.3] = Nint(1.08x316) = 337 evt

Final number of events – 337 evt

Additional information

Zpr->qq, Z->ll, Z*->qq

Minimum chi square calculation

We used 6 combinations of minimum chi square with the most energetic jet.

3 for Z prime:

$$\chi^2_{min} = \frac{(M_{inv\,Zpr} - M_{Z\,nominal})^2}{\sigma^2_{Z\,nominal}} + \frac{(P_{Zpr} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}} + \frac{(P_{Zh+Z*} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}};$$

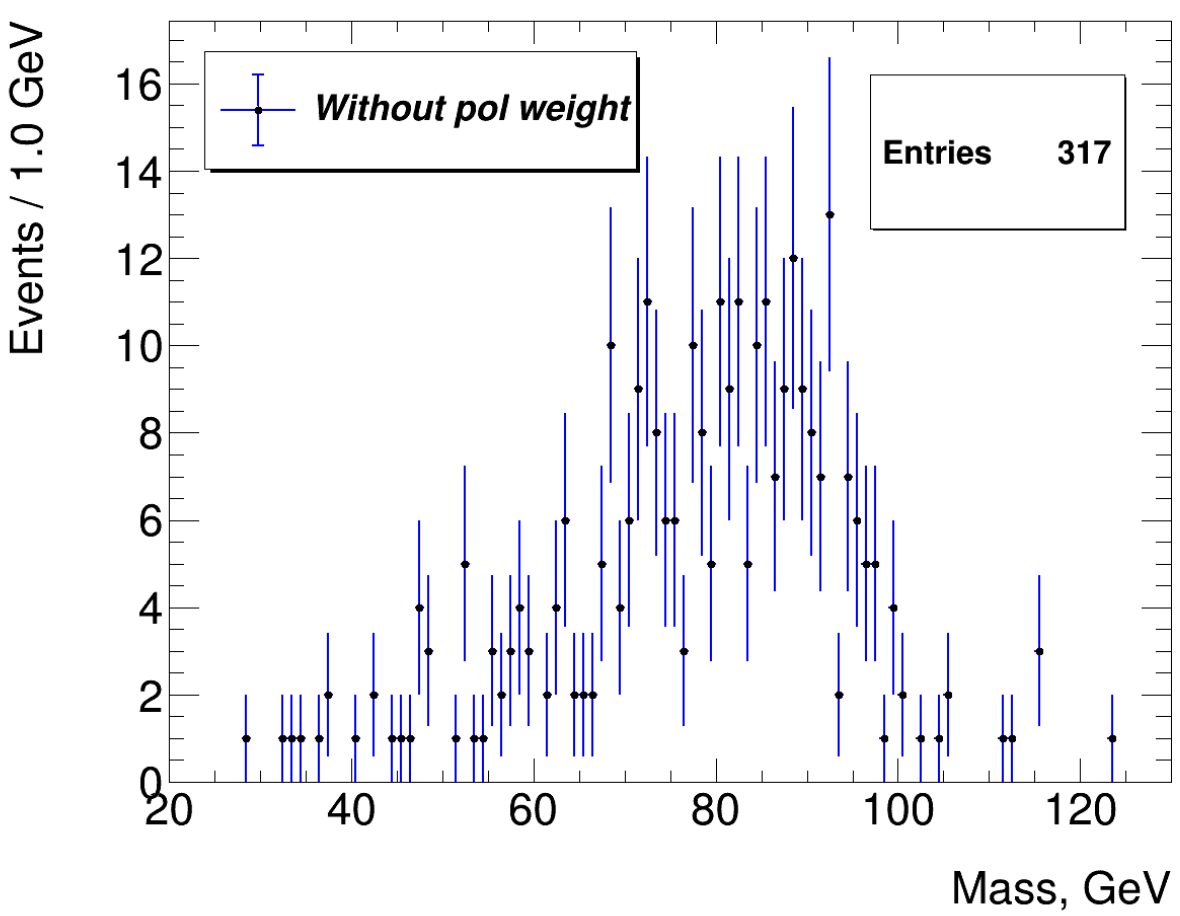
3 for Zstar:

$$\chi^2_{min} = \frac{(M_{inv\,Zpr} - M_{Z\,nominal})^2}{\sigma^2_{Z\,nominal}} + \frac{(P_{Z*} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}} + \frac{(P_{Zpr+Zh} - P_{Z\,nominal})^2}{\sigma^2_{P_Z\,nominal}};$$

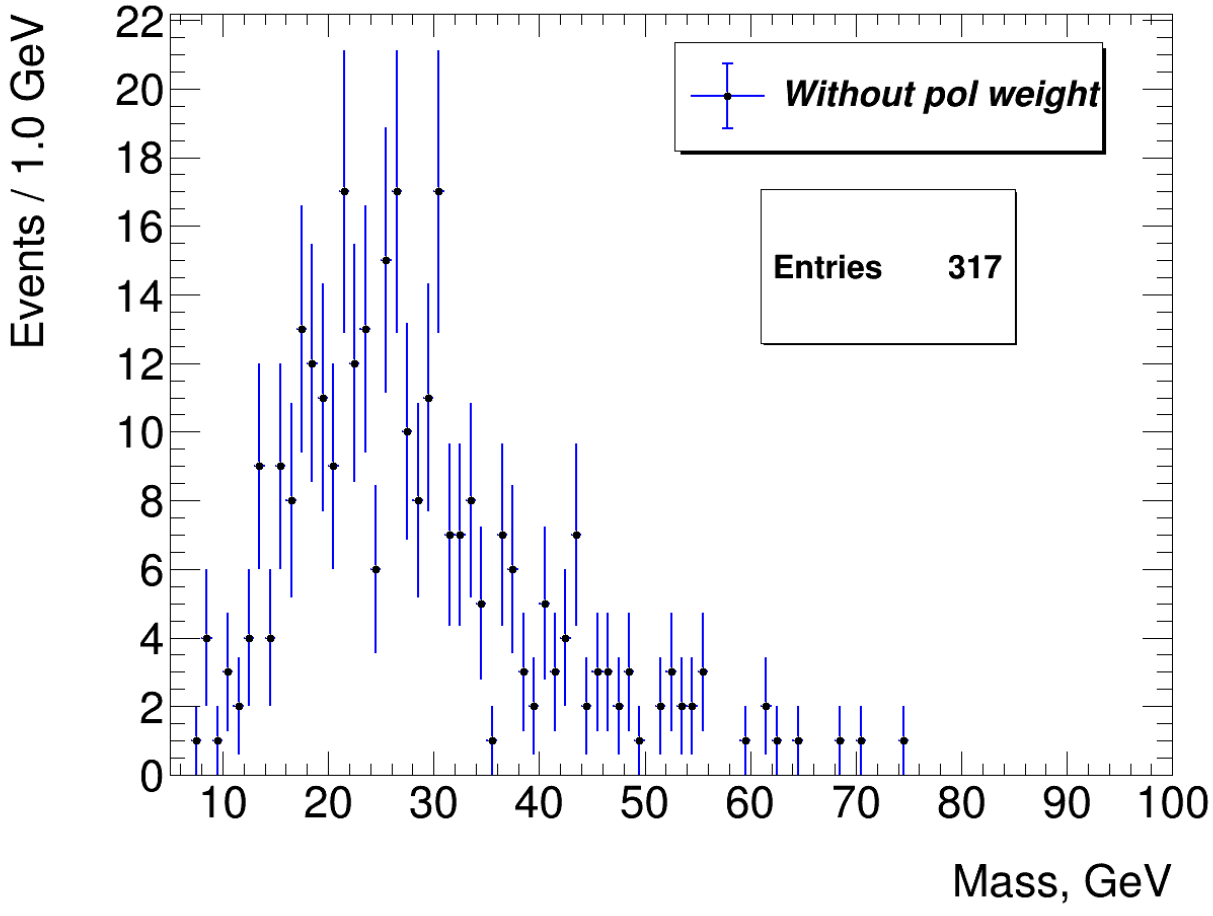
Zprime and Zstar mass distributions

Zpr->qq, Z->ll, Z*->qq

I401007.Pqqh_zz signal



$MZpr, Zpr \rightarrow jj$

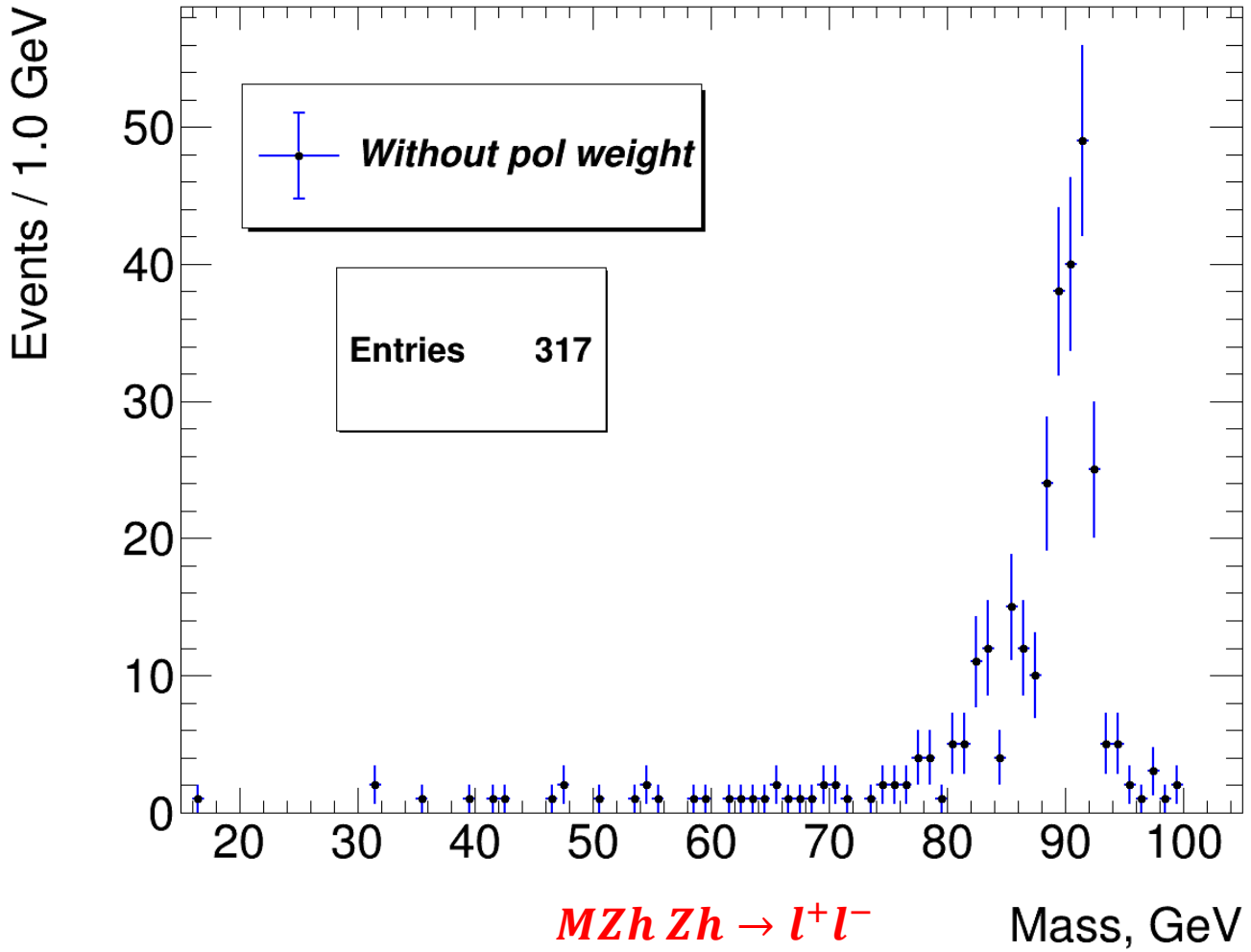


$MZstar, Zstar \rightarrow jj$

Zh mass distribution

Zpr->qq, Z->ll, Z*->qq

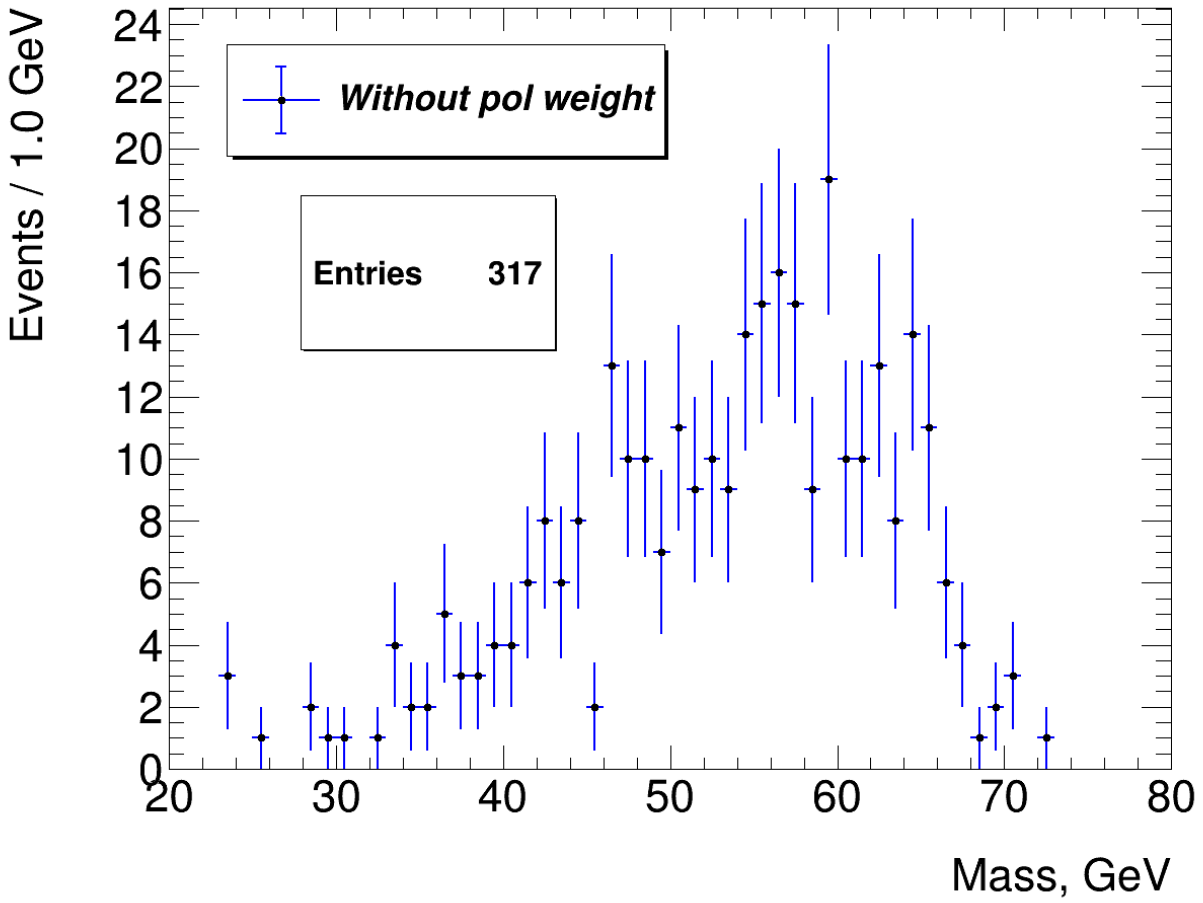
I401007.Pqqh_zz signal



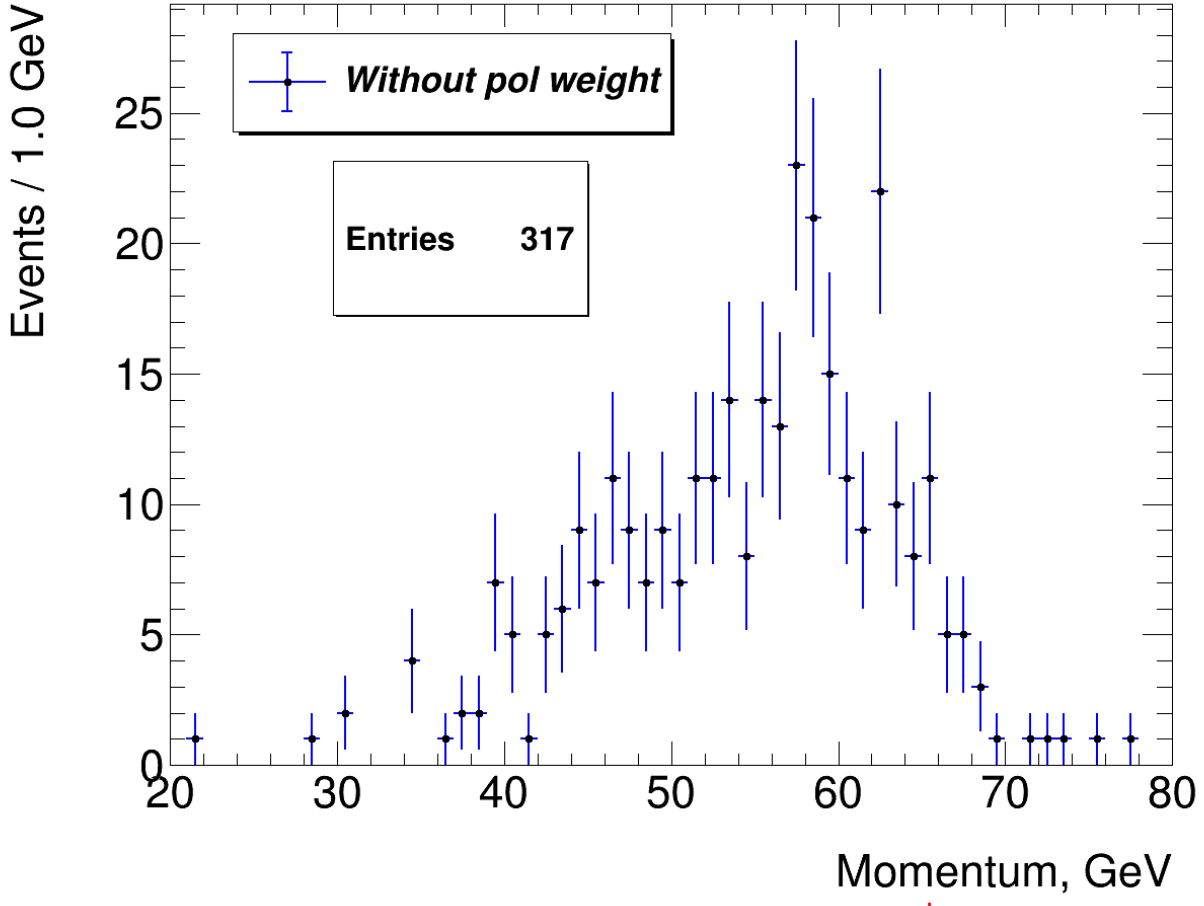
Zprime and Zh+Zstar momentums distributions

Zpr->qq, Z->ll, Z*->qq

I401007.Pqqh_zz signal



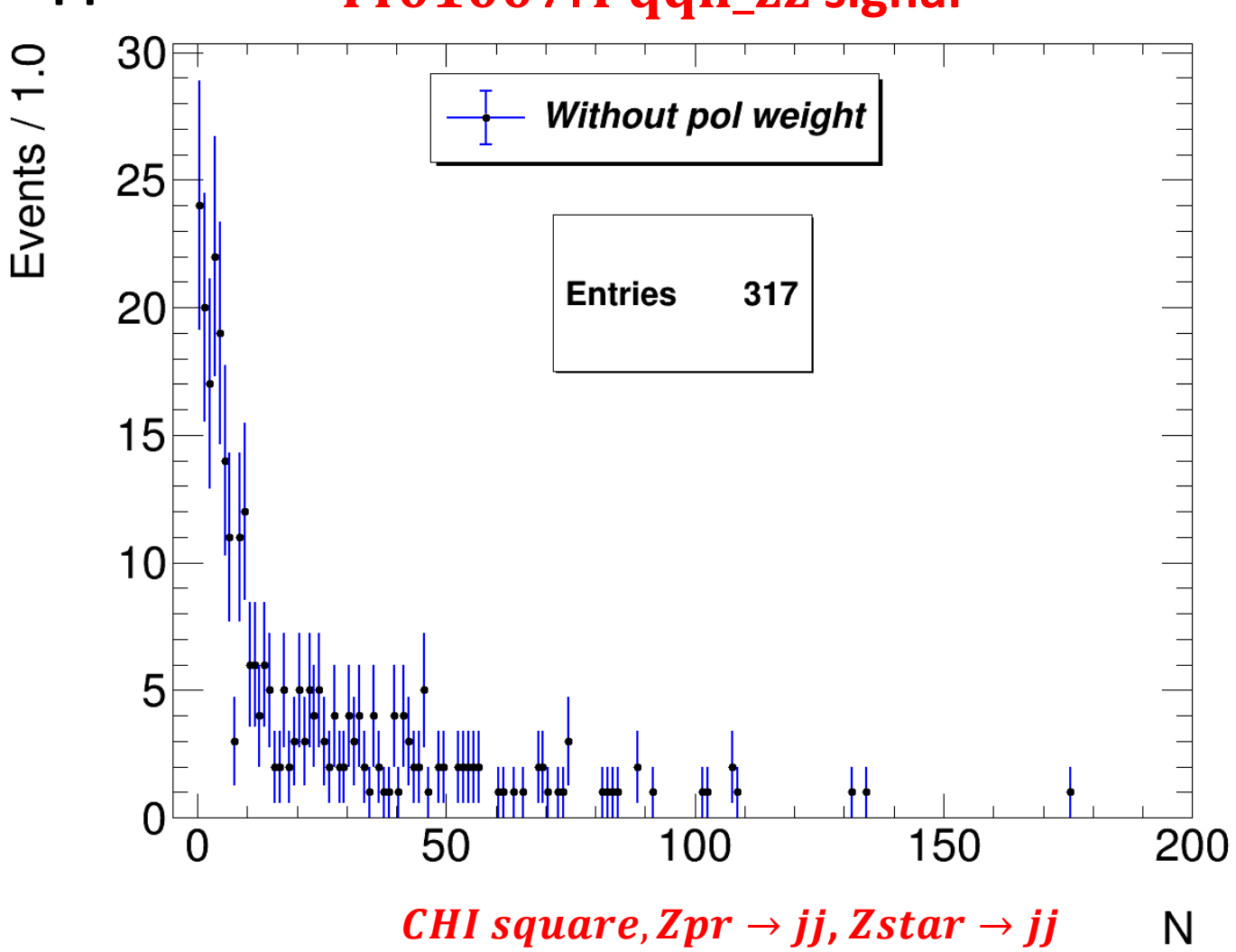
PZpr, Zpr → jj



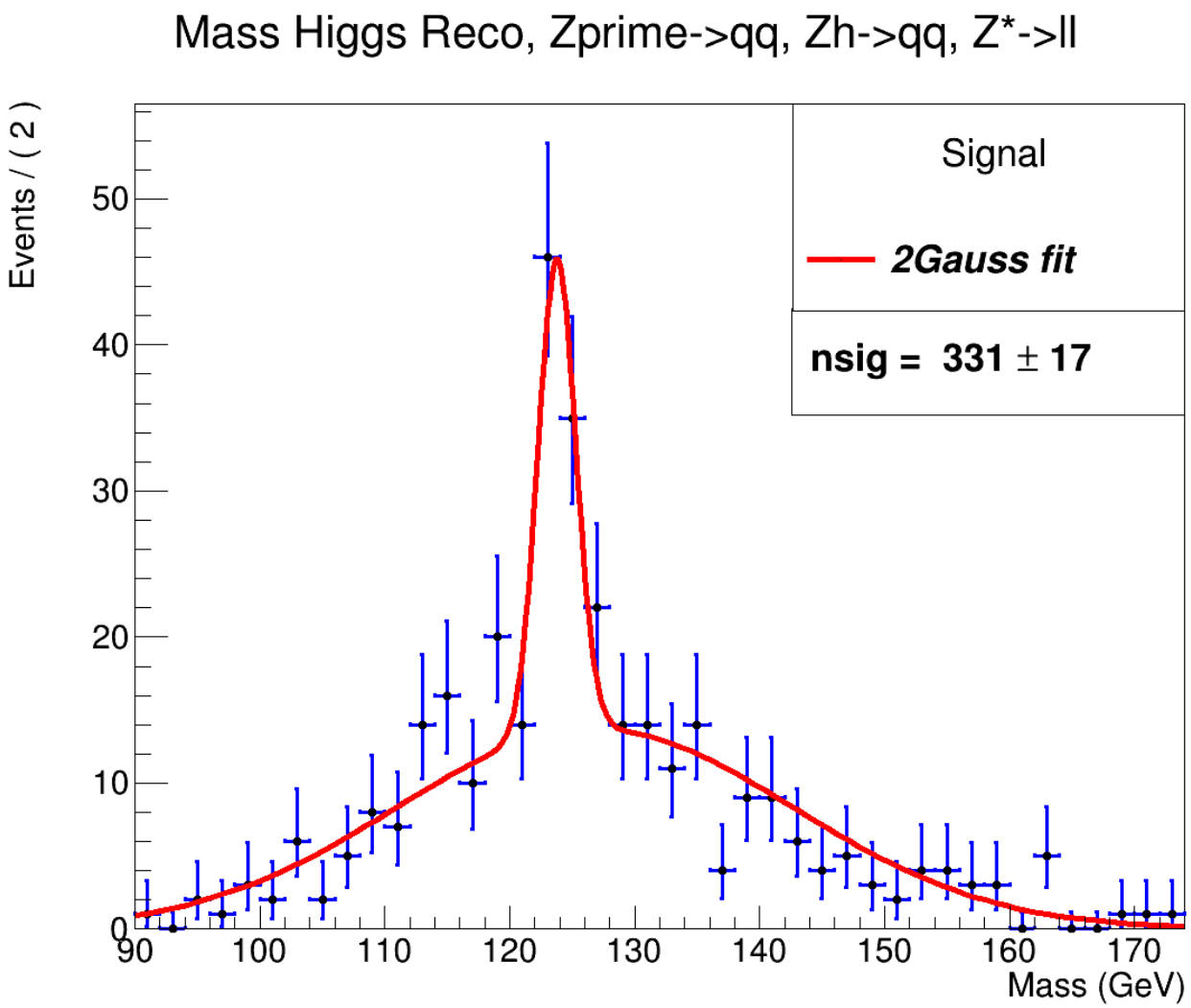
PZhZstar, Zstar → jj, Zh → l^+l^-

CHI square distribution

Zpr->qq, Z->ll, Z*->qq



Higgs boson mass distribution



I401007. Pqqh_zz signal

Need to optimize procedure

CHI square firstly

Signal and background channels. Significance of method

Signal:

1. $Z_{prime}H(ZZ^*), Z_{prime} \to jj$
2. $Z_{prime}H(ZZ^*), Z_{prime} \to e^+e^-/\mu^+\mu^-$
3. $Z_{prime}H(ZZ^*), Z_{prime} \to \nu\bar{\nu}$

$Z \to jj, Z^* \to e^+e^-/\mu^+\mu^-$

$Z \to e^+e^-/\mu^+\mu^-, Z^* \to jj$

In total we have 6 channels

Background:

$ZZ\gamma(ll)$ and $WW\gamma(ll)$ - background for channel 1

$b\bar{b} \to jj\, l^+l^-\nu\bar{\nu}$ - background for channel 3

Significance of method:

$$\frac{1}{Sign} = \sqrt{\left(\sum \left(\frac{1}{\sigma_1^2}\right) + \left(\frac{1}{\sigma_2^2}\right) + \cdots\right)}, \quad where\ \sigma = \frac{\sigma_{distribution}}{N_{evt}},$$

$Sign_{expected} \sim 5\%$

Thank you for attention