MC Study of $e^+e^- \rightarrow ZH(ZZ^*)$, $Z \rightarrow jj$, $Z^* \rightarrow l^+l^-$

Comparison new qqH_ZZ test samples with old higgs_ffh samples

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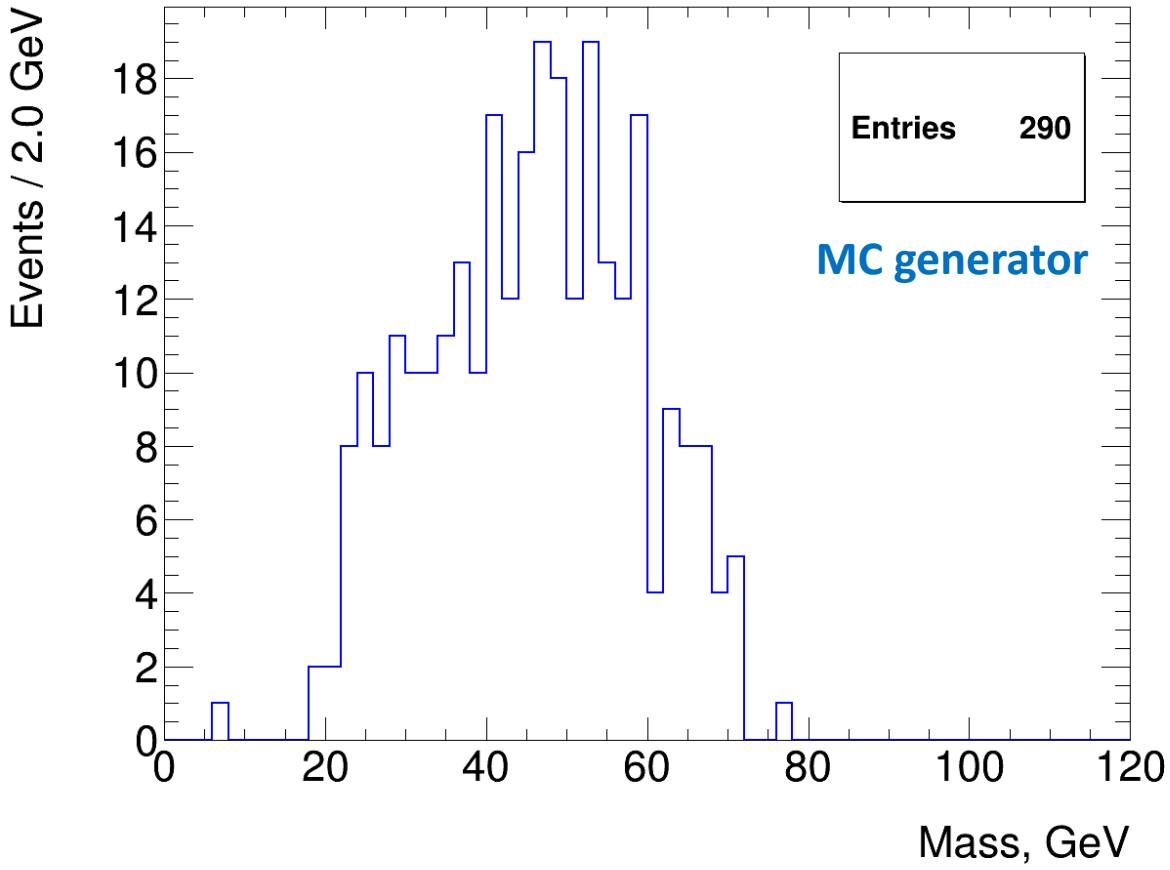
Event Selection

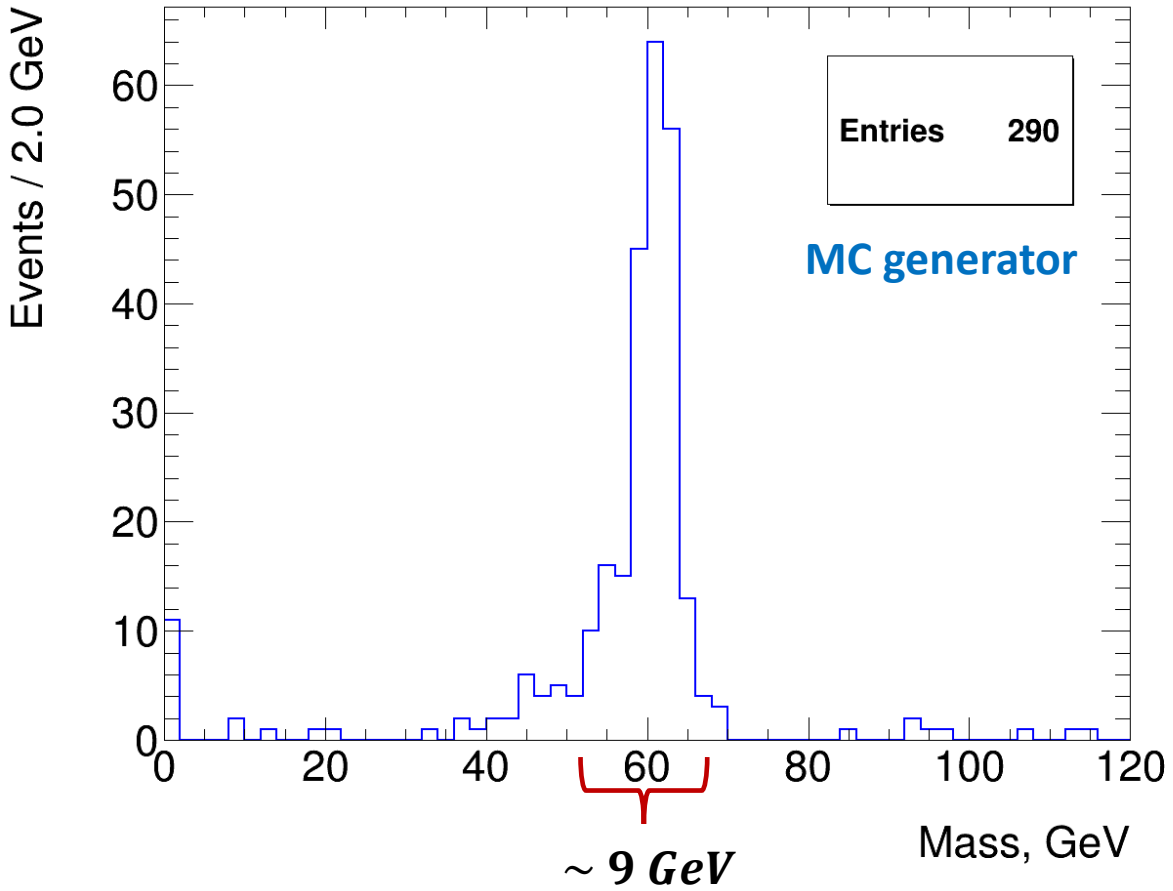
higgs_ffh_v01 − 16 − p10_250	**I401007.Pqqh_zz**
Initial: Z(qq)H events - 568797 evt ($2\ ab^{-1}$) Next: Selection of qqH_ZZ events - 14366 evt (2.5%) remain	Initial: qqH_ZZ events - 10000 evt
Next: Selection of qqH_Z(qq)Z*(ll) events: 628 evt (4.4%) remain.	Next: Selection of qqH_Z(qq)Z*(ll) events: 502 evt (5.0%) remain
IsoLepTag: 628 evt without Yoke	IsoLepTag: 502 evt without Yoke
IsoLepSelection (Selection of events with correct number of leptons): 435 evt (69.3%) remain	IsoLepSelection (Selection of events with correct number of leptons): 360 evt (72.7%) remain
JetClustering: 435 evt. 290 evt (67.7%) remained after cut for Zh mass [86, 94] to exclude Z*Z*	JetClustering: 360 evt. 233 evt (64.7%) remained after cut for Zh mass [86, 94] to exclude Z*Z*
Final number of events – 290 evt	Final number of events – 233 evt

Additional information

Comparison of Zh momentum with Zprime momentum (MC generator level)



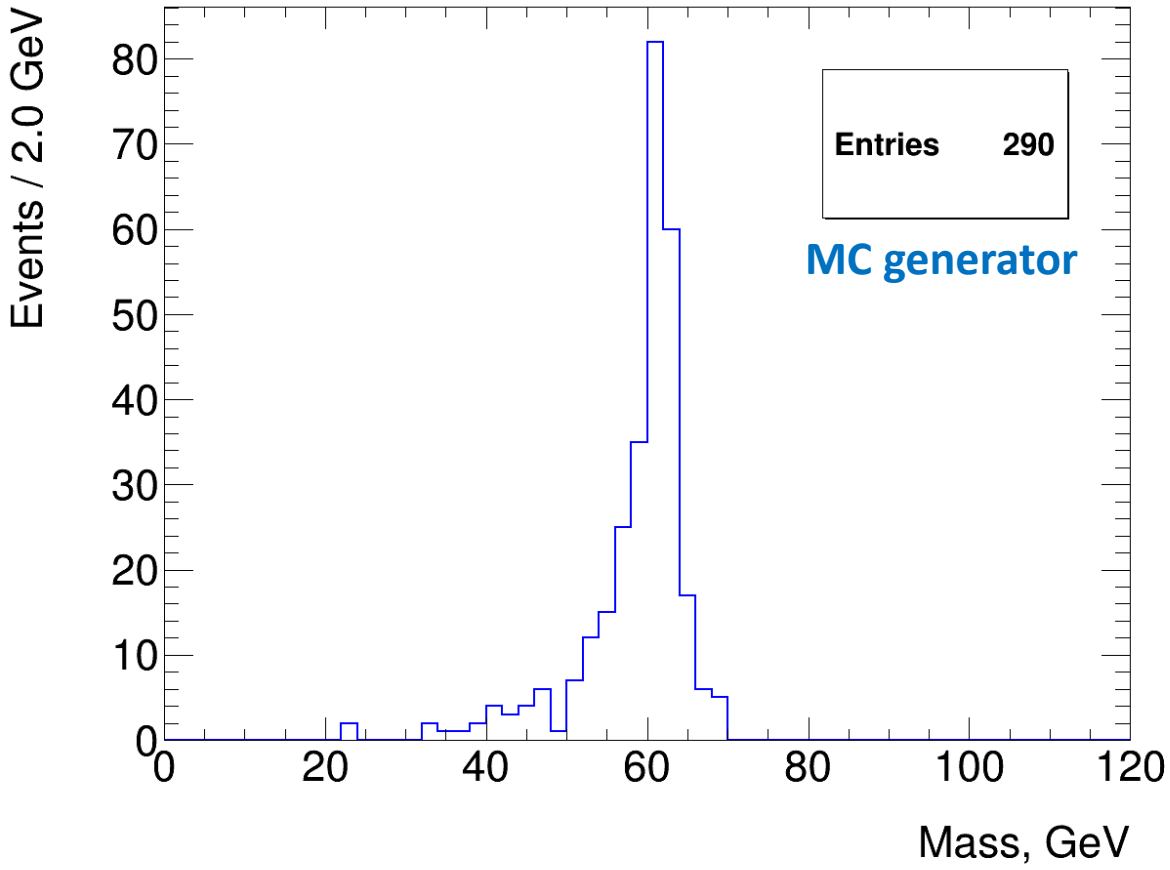
higgs_ffh_v01 – 16 – p10_250



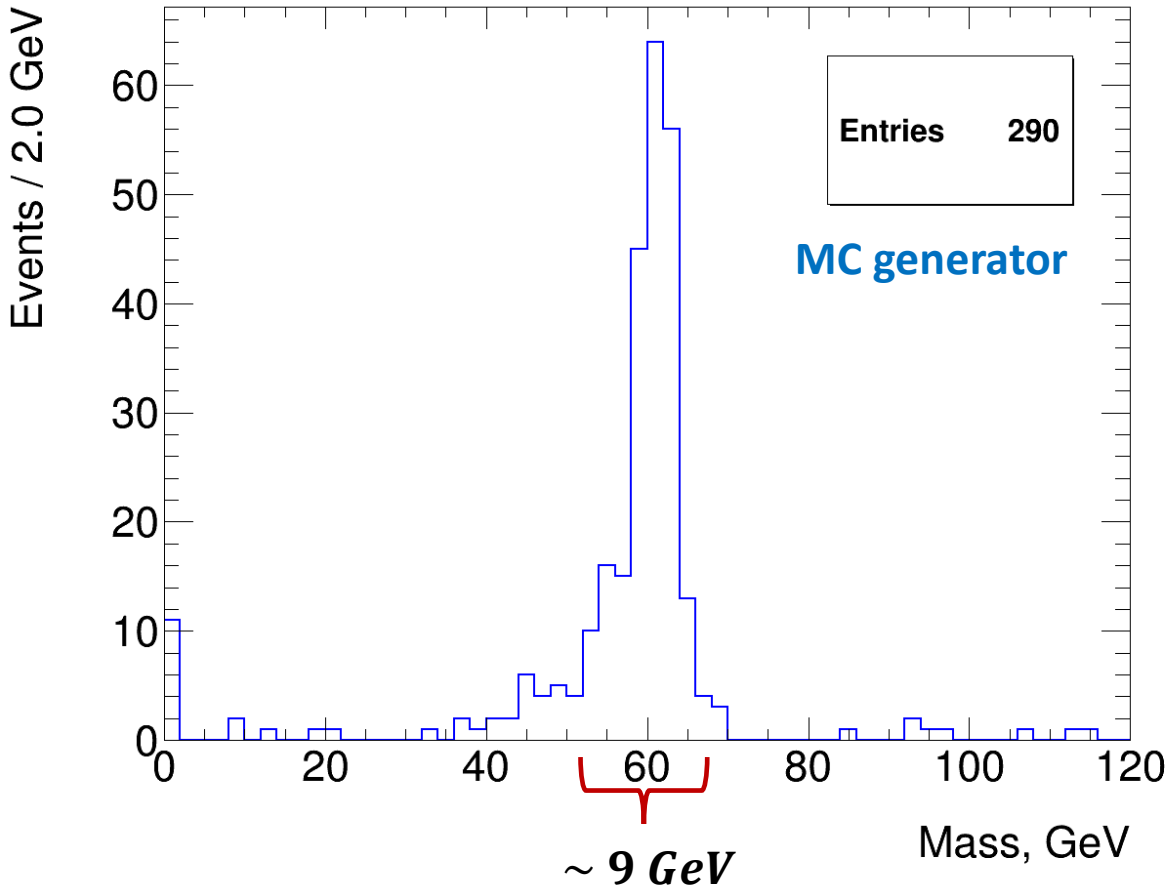
higgs_ffh_v01 – 16 – p10_250

Additional information

Comparison of Zh+Z* momentum with Zprime momentum (MC generator level)



higgs_ffh_v01 – 16 – p10_250



higgs_ffh_v01 – 16 – p10_250

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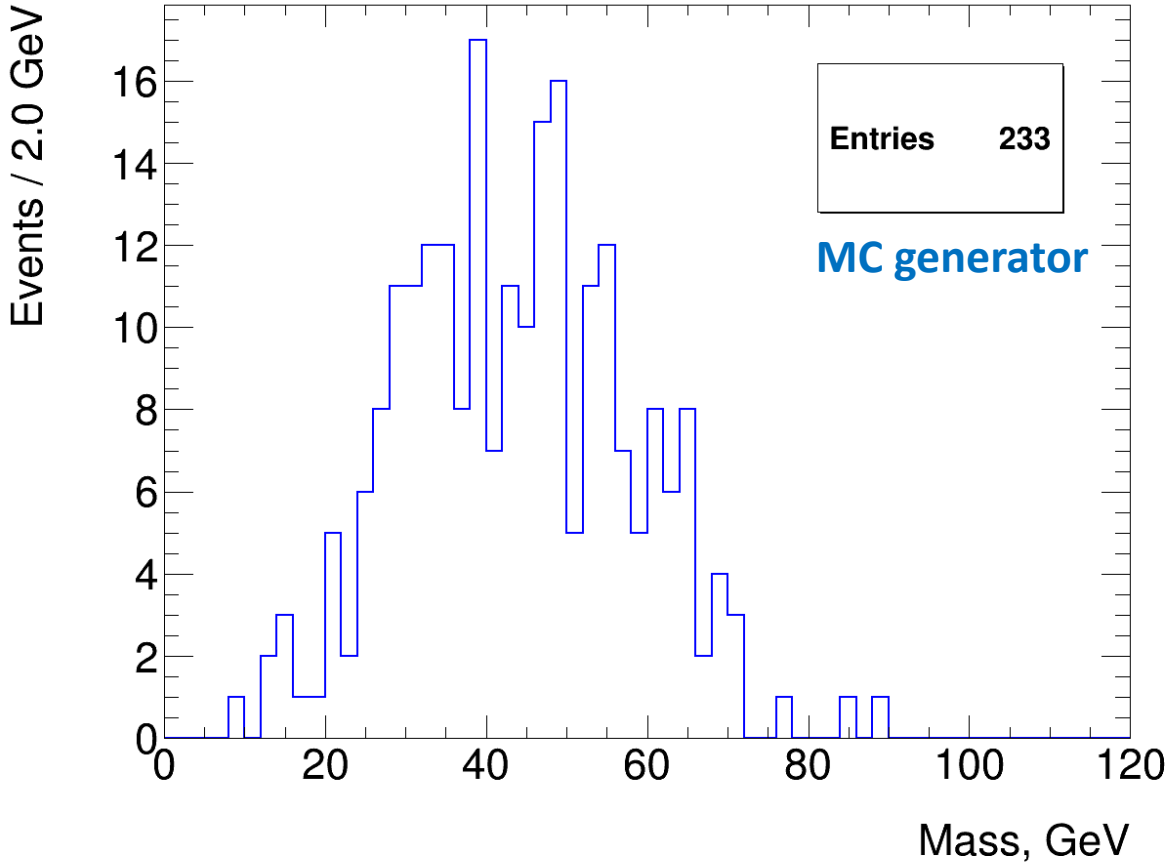

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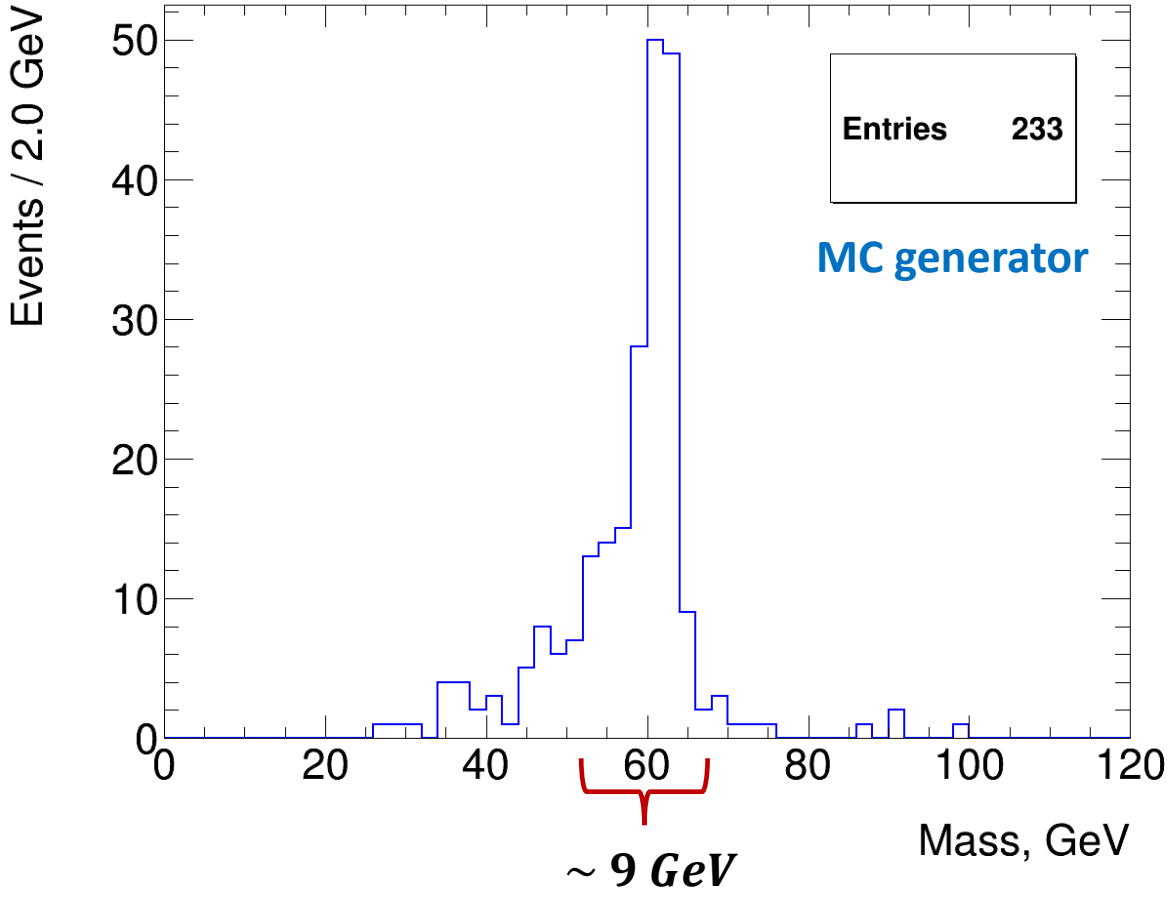

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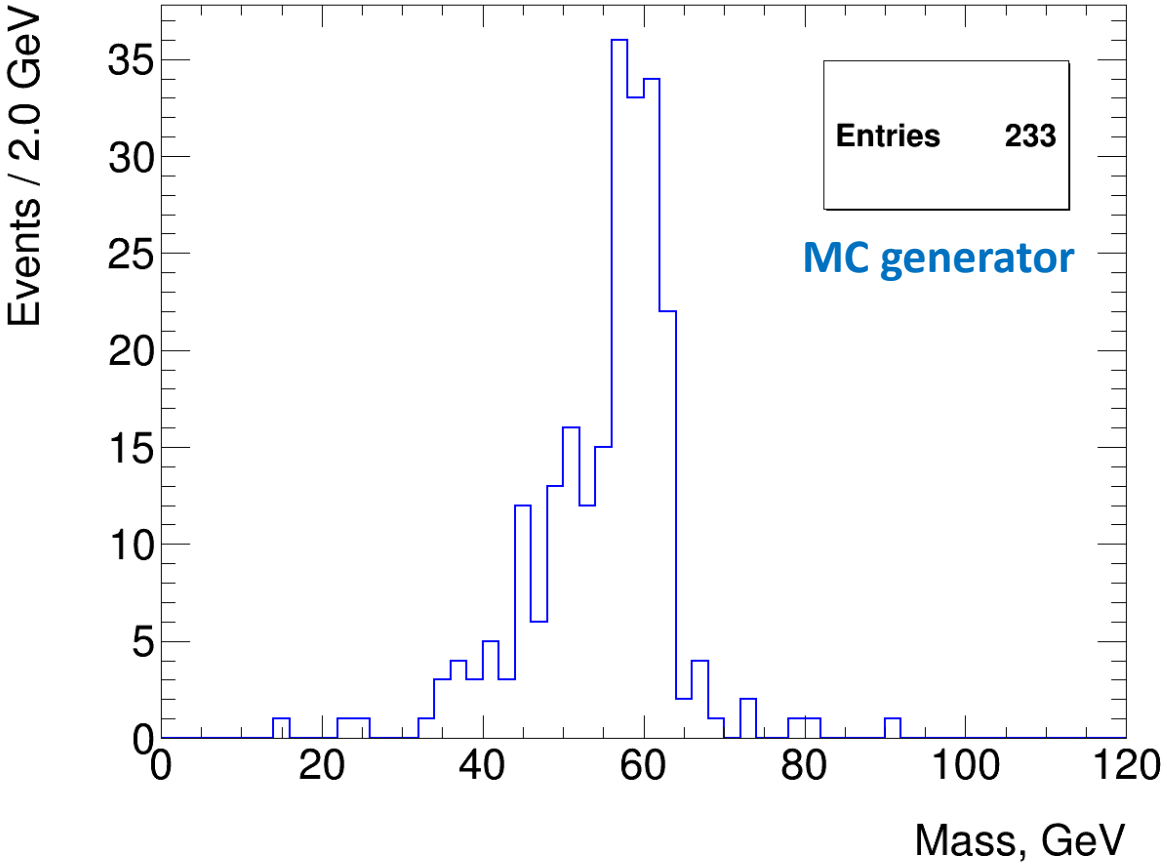
Additional information

Comparison of Zh+Z* momentum with Zprime momentum (MC generator level)



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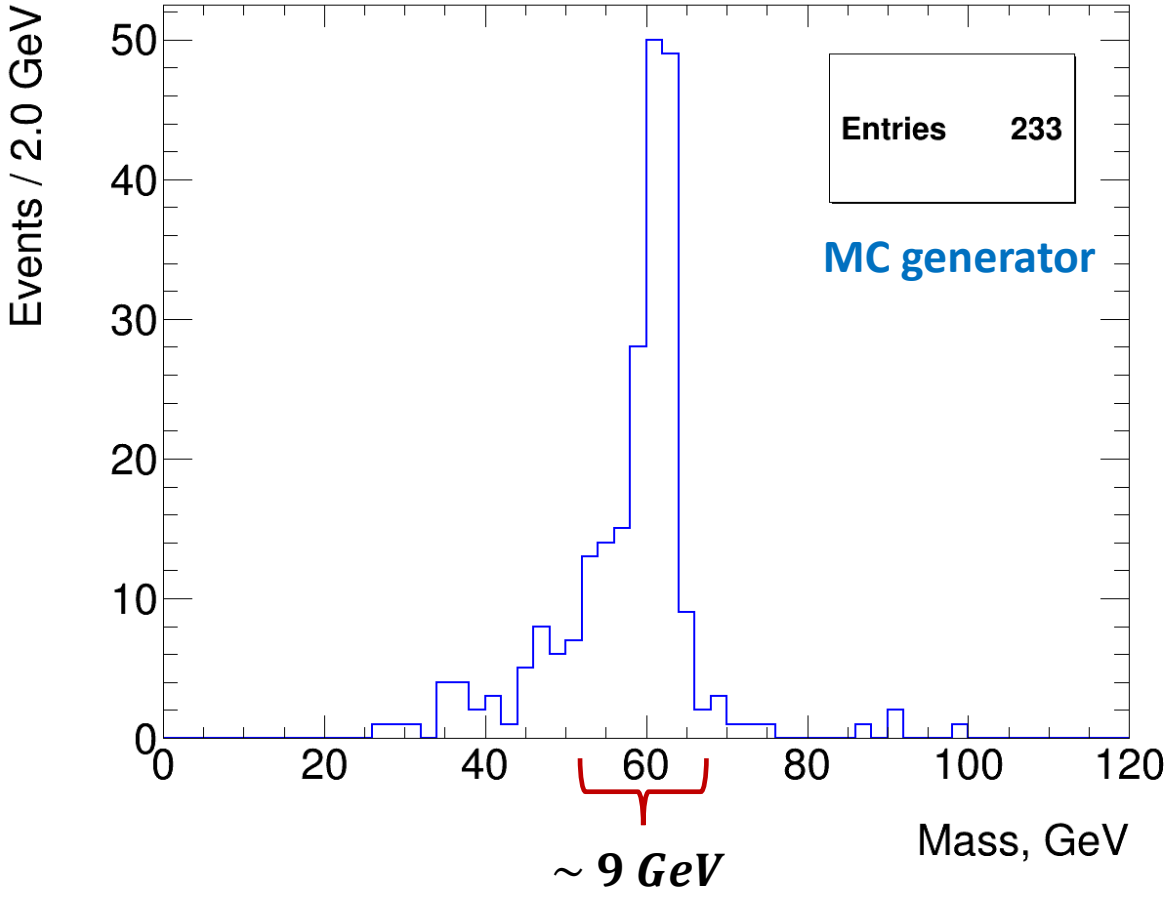

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Additional information

Minimum chi square calculation

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

3 for Z prime:

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

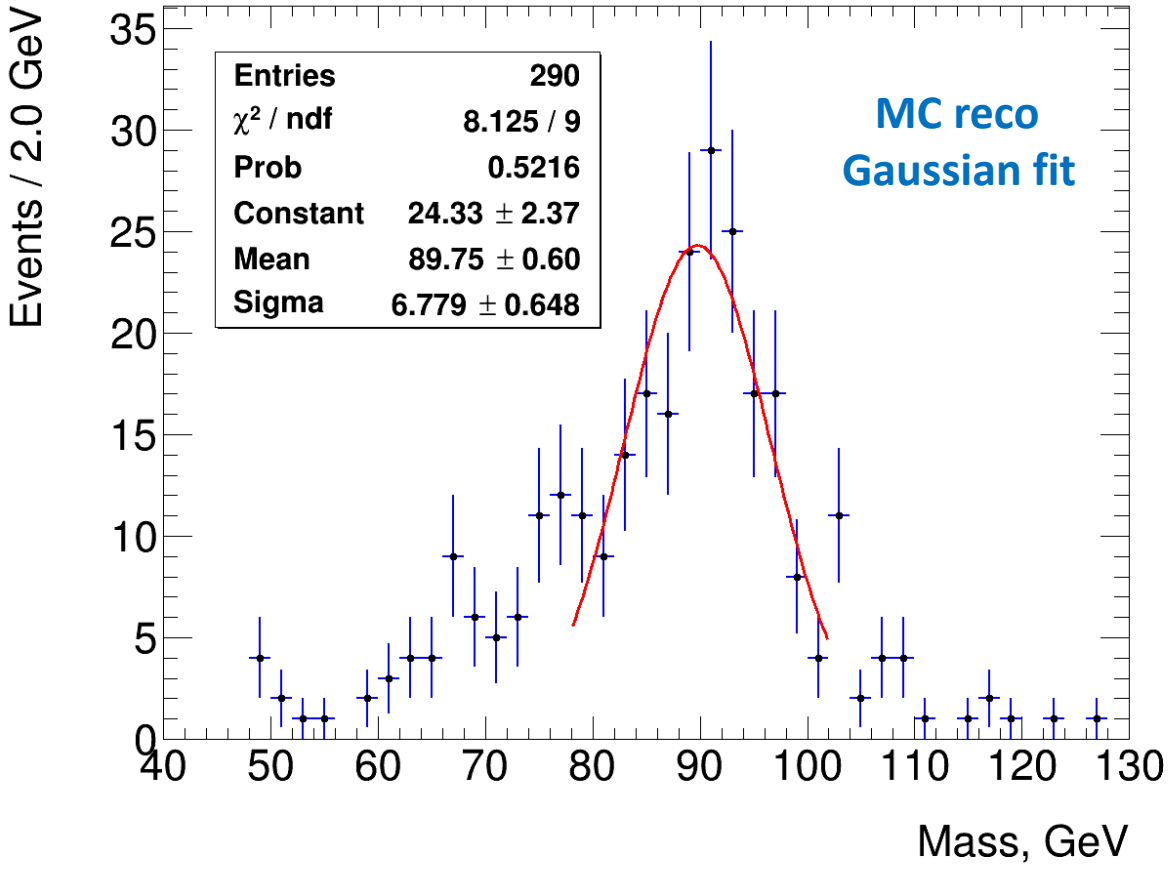
3 for Zh:

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

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

Comparison Old and New Samples

$M(jj)$ reconstruction (primary Z)



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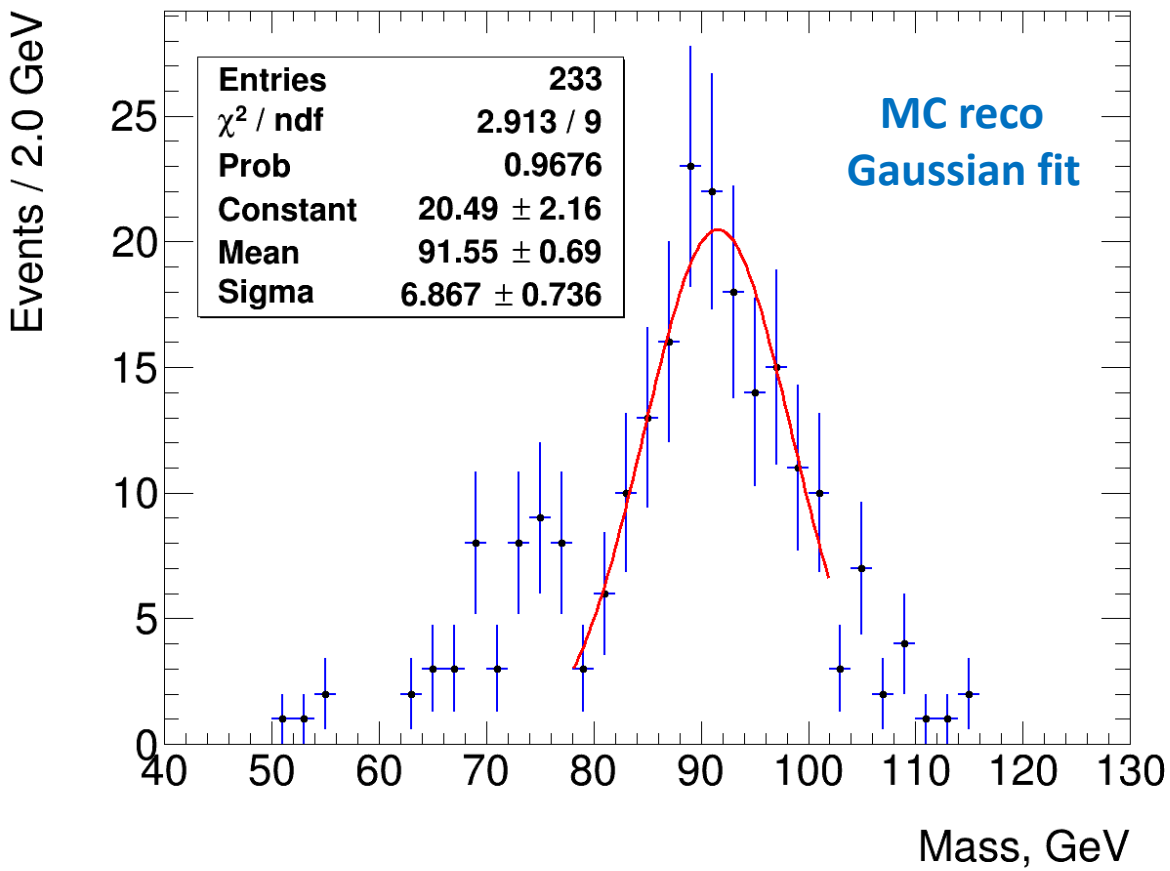

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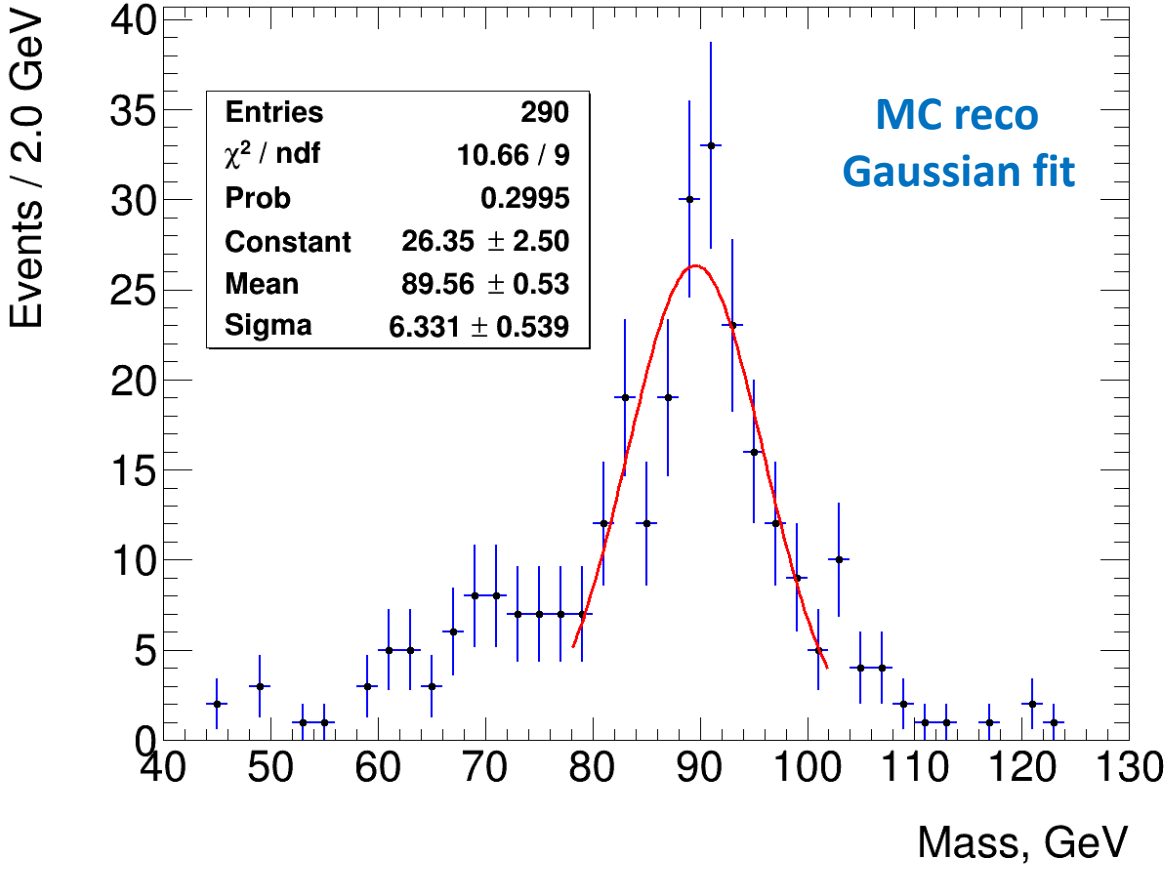
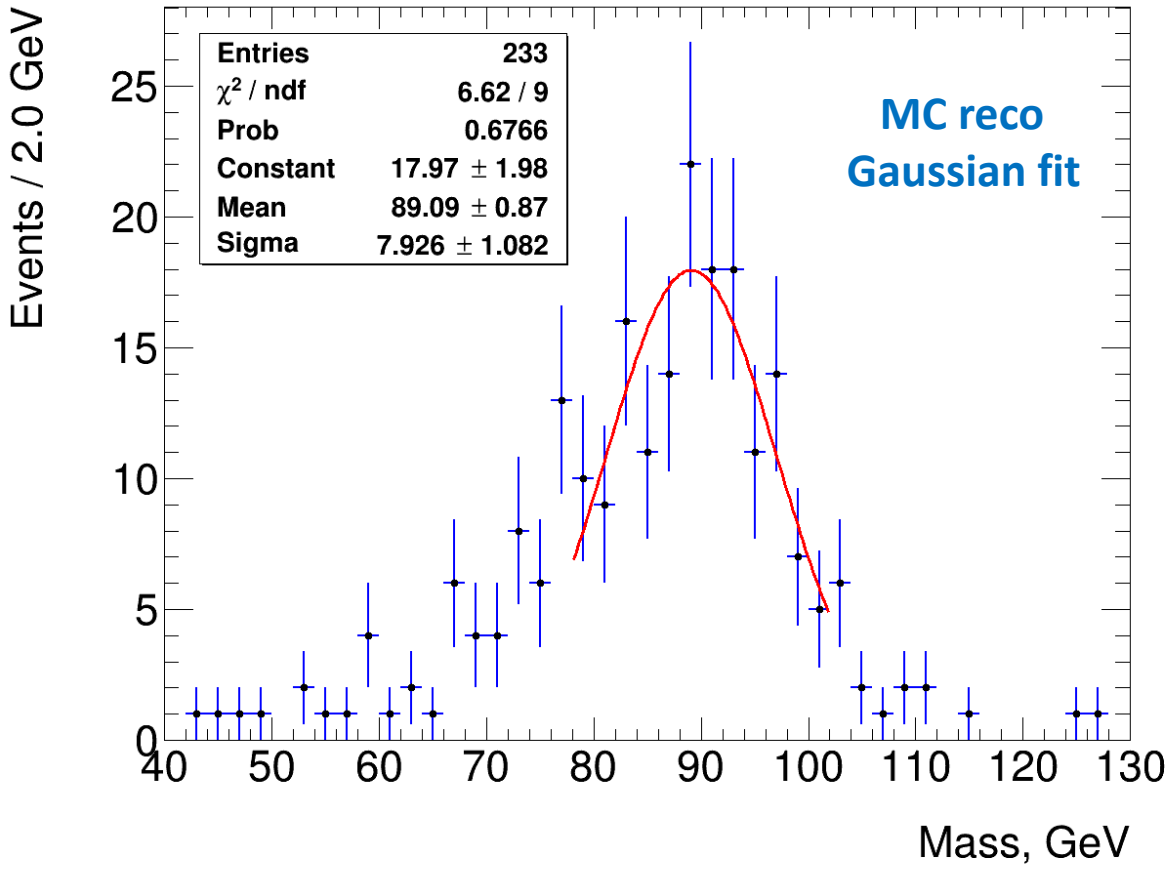
Comparison Old and New Samples

$M(jj)$ reconstruction (Z from Higgs boson)



higgs_ffh_v01 – 16 – p10_250



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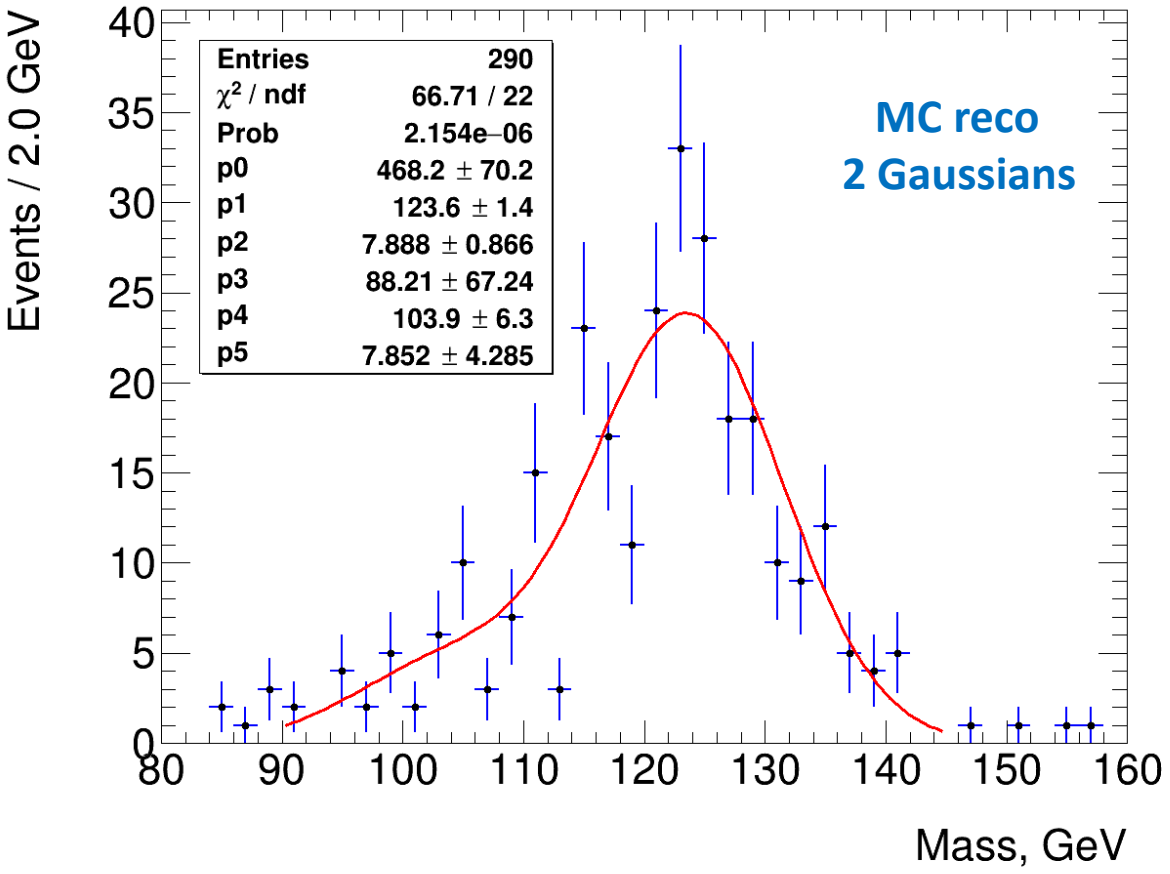
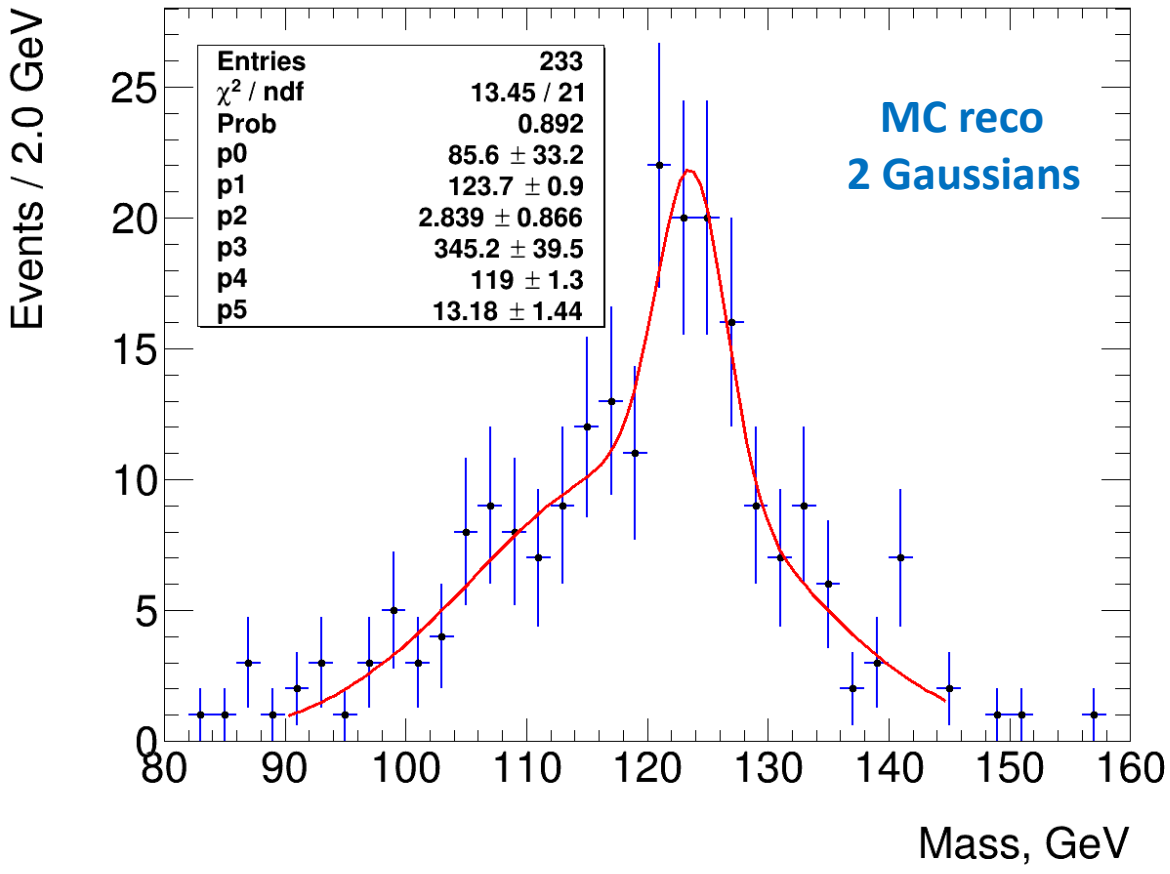
Comparison old and new Samples

$M(jjll)$ reconstruction (Higgs boson)



higgs_ffh_v01 – 16 – p10_250



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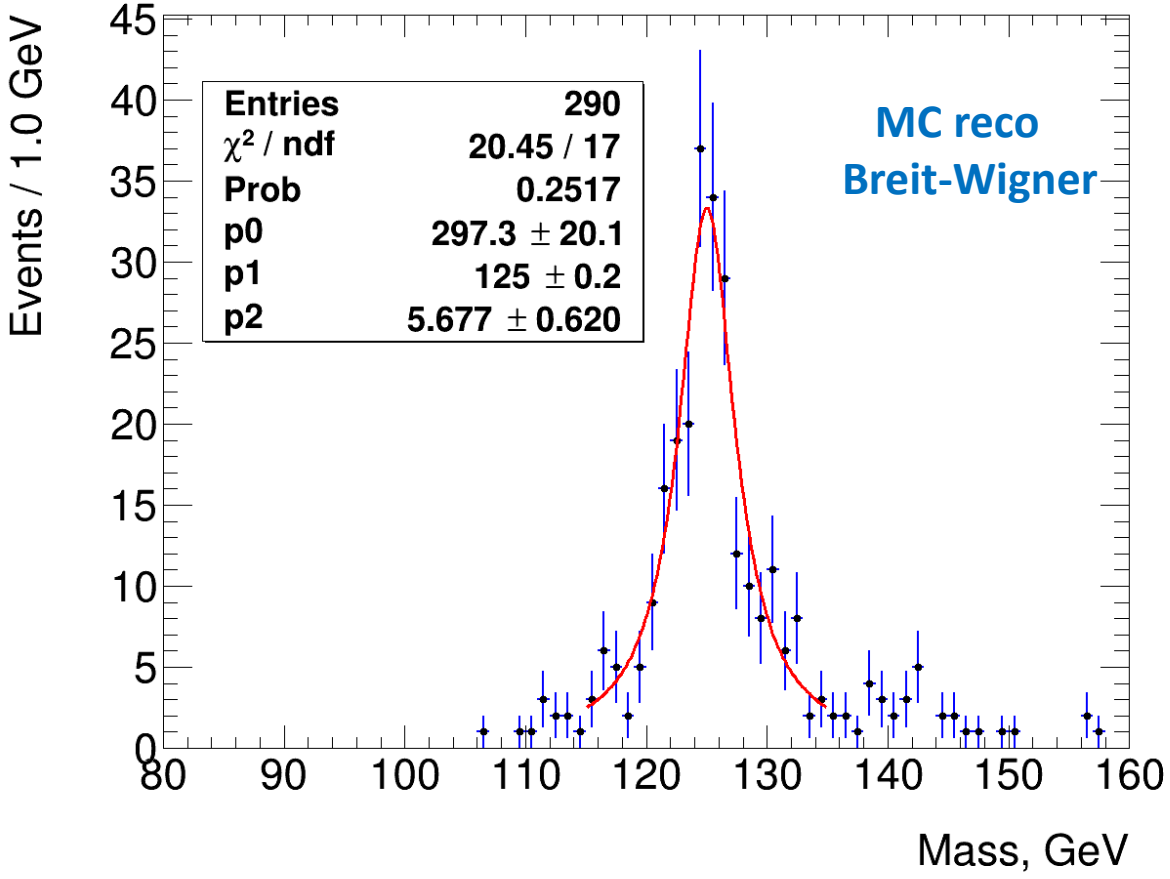
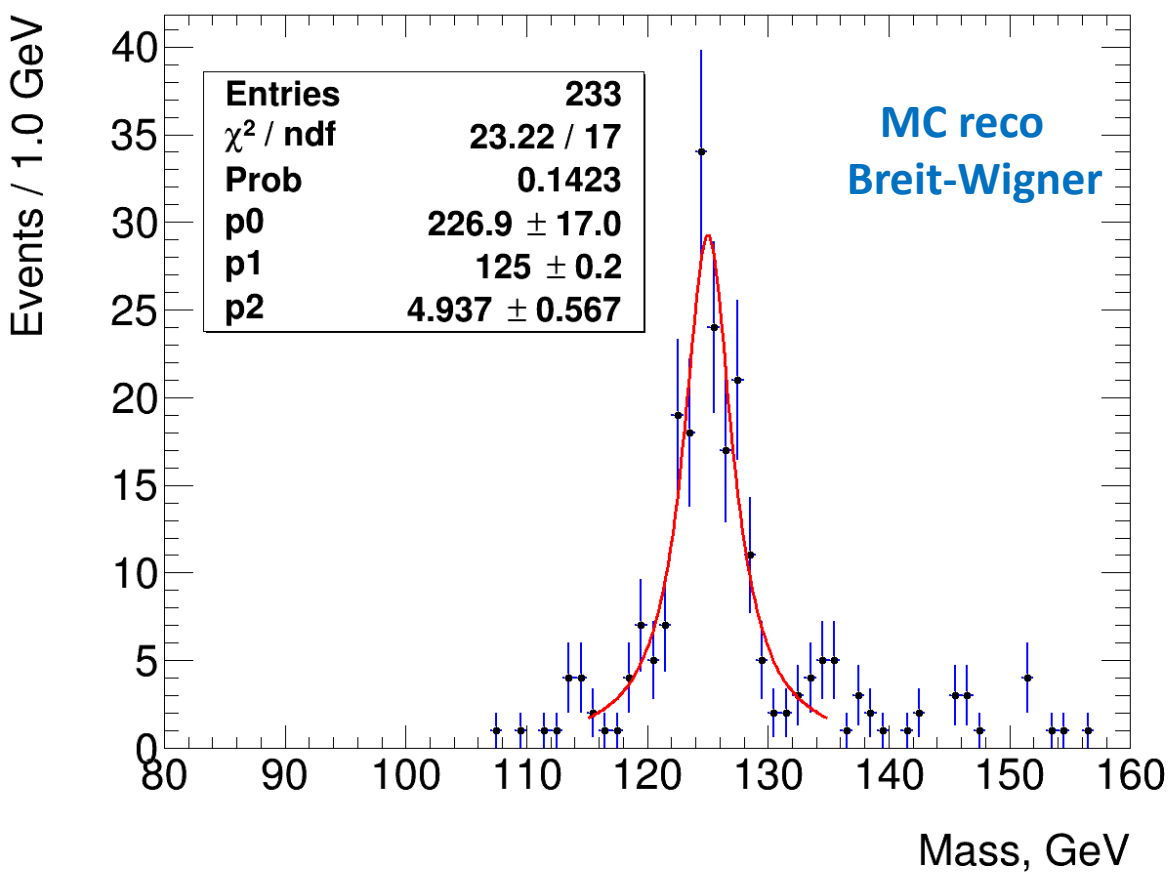
Comparison old and new Samples

$\Delta M = M(jjll) - M(jj) + M(Z\ nominal)$ reconstruction



higgs_ffh_v01 – 16 – p10_250



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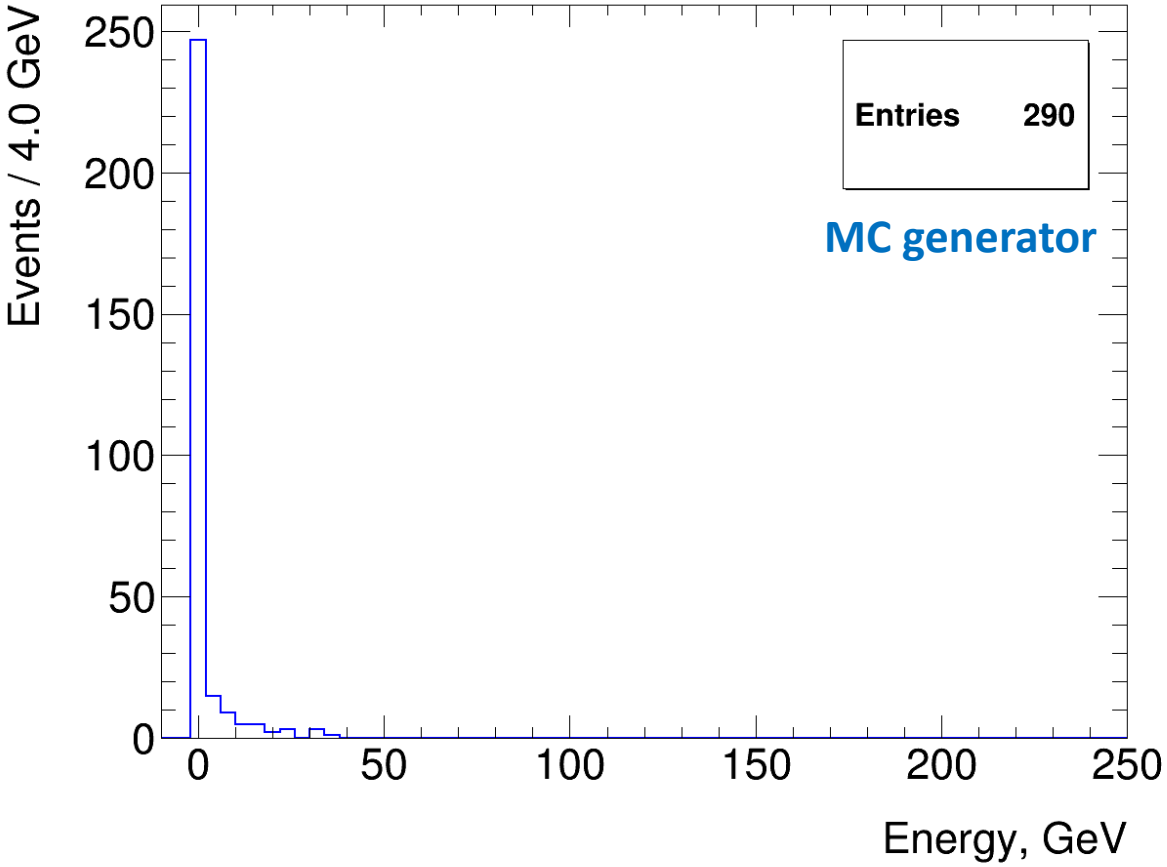
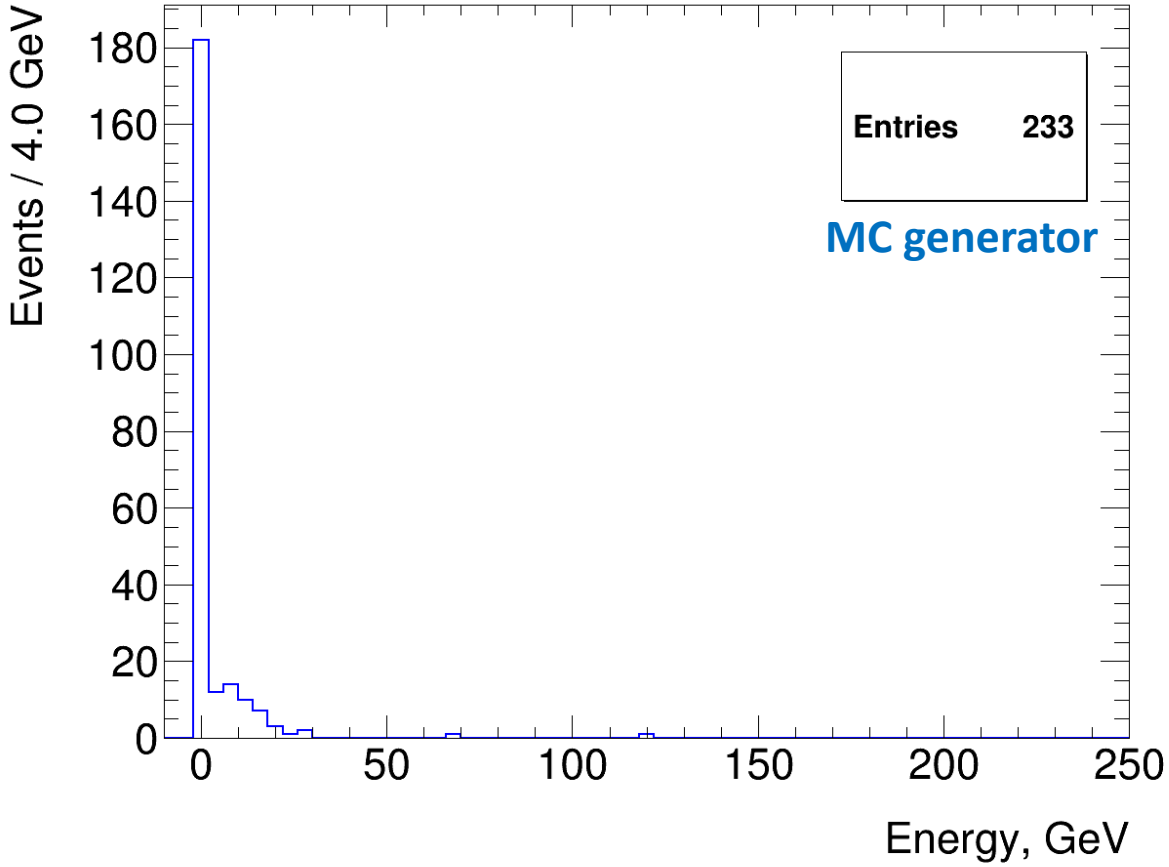
Comparison old and new Samples

ISR Energy



higgs_ffh_v01 – 16 – p10_250

More events with ISR energy > 0 GeV



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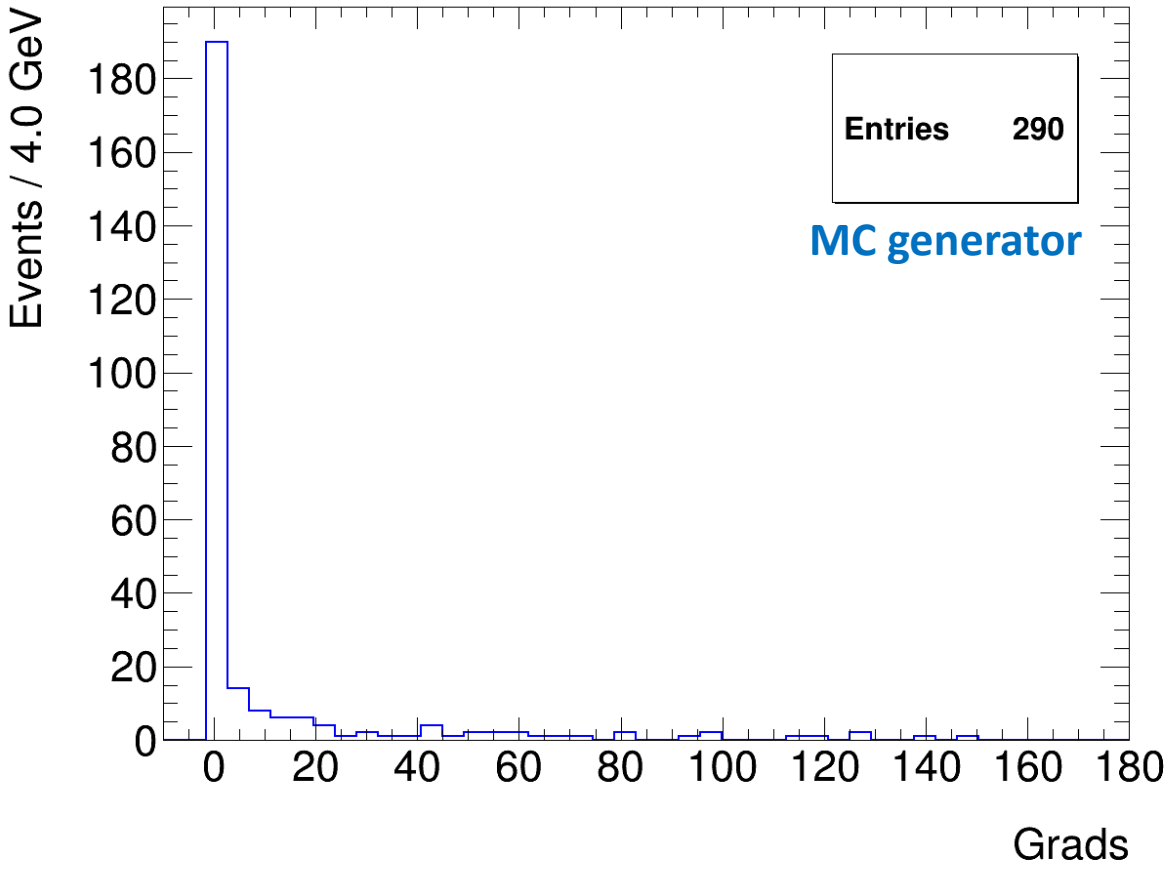
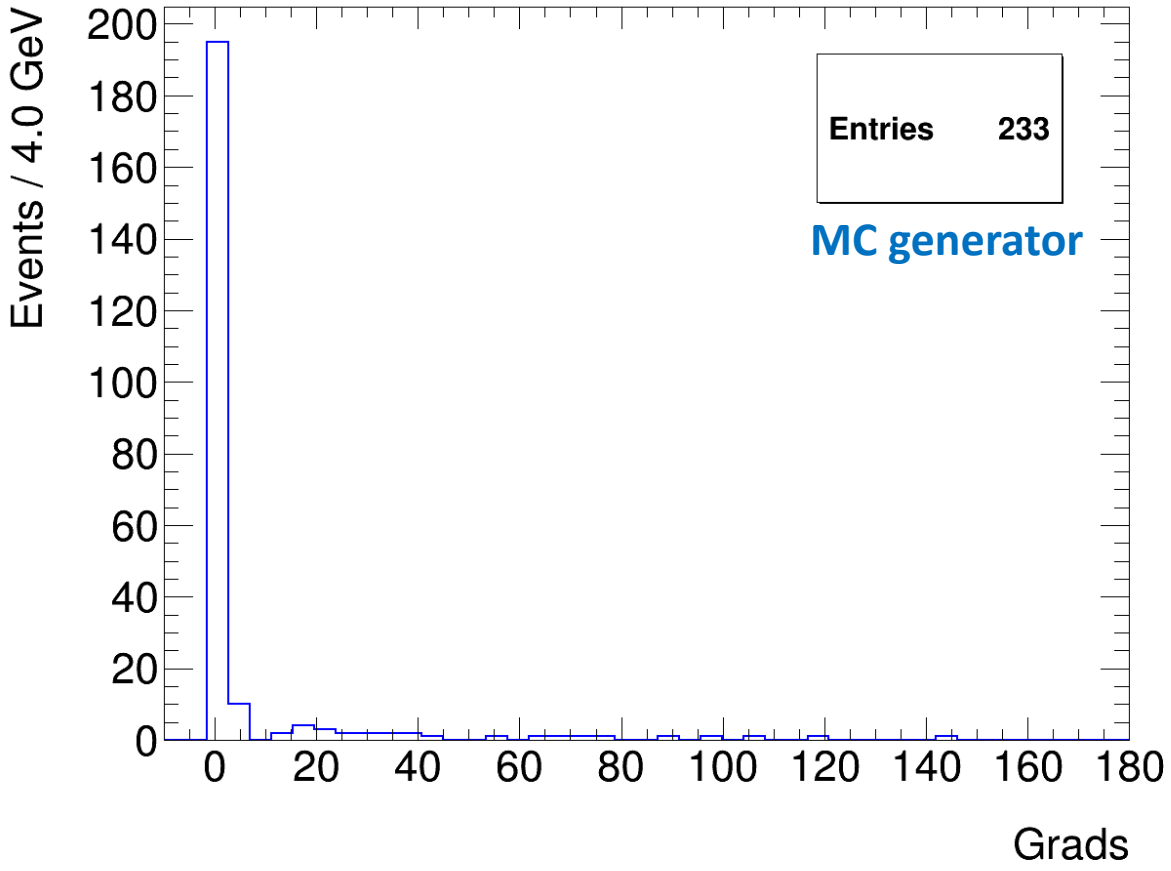
Comparison old and new Samples

Angle between ISR gamma and electron beam



higgs_ffh_v01 – 16 – p10_250

More events with zero beam deviation



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Conclusions

1. Comparison of the samples demonstrate roughly similar results.
2. Measurements of key variables for analysis converge within the margin of error:

   Zpime: 6.78±0.65 GeV (Old) vs 6.87±0.74 GeV (New)
   Zh: 6.33±0.54 GeV (Old) vs 7.93±1.08 GeV (New)
   ΔM: 5.68±0.62 GeV (Old) vs 4.94±0.57 GeV (New)

3. Selection of qqH_Z(qq)Z*(ll) events:
   large event rate in new samples:

   4.37±0.18 % (Old) vs 5.02±0.22 % (New)

   selection of leptons using ILT showed similar results:

   69.27±3.32 % (Old) vs 71.71±3.78 % (New)

Thank you for attention