Unused Energy and QF study

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Introduction

Invstigate the role of Unused energy in the event and the effect of the Shower Qualtiy Factor on the reconstructed final state.

Look at 3 different final states:

- $\gamma + p \rightarrow p + \eta \rightarrow p + \pi^0 + \pi^0 + \pi^0 \rightarrow p + 6\gamma$
- $\gamma + p \rightarrow p + \eta\prime + \pi^0 \rightarrow p + \pi^+ + \pi^- + \eta + \pi^0 \rightarrow p + \pi^+ + \pi^- + 4\gamma$
- $\gamma + p \rightarrow p + \eta + \pi^0 + \pi^0 \rightarrow p + \pi^+ + \pi^- + \pi^0 + \pi^0\pi^0 \rightarrow p + \pi^+ + \pi^- + 6\gamma$

Kinematic fit all masses (η, π^0) are NOT constrained!

All neutral final state

DATA: `RunPeriod-2018-08/analysis/ver05/tree_eta__eta_pi0pi0pi0__M17_M7_B4`

Final state $p + 6\gamma$; Look at events with exactly 6 γs and separately with more than 6γ

First Some Control plots:

All neutral final state

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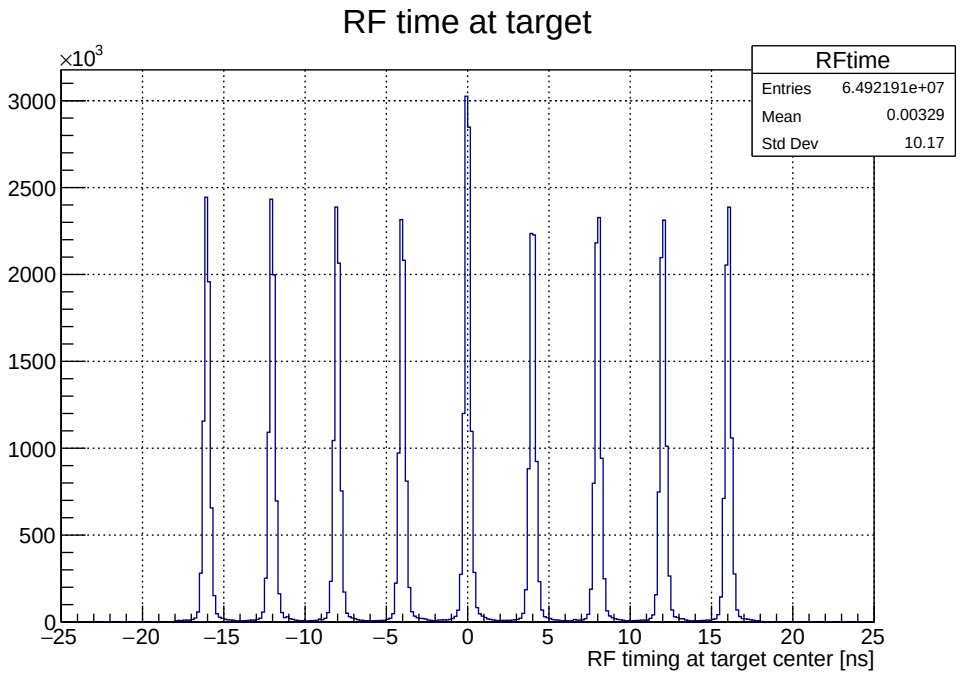
First Some Control plots:

1. Event RF time



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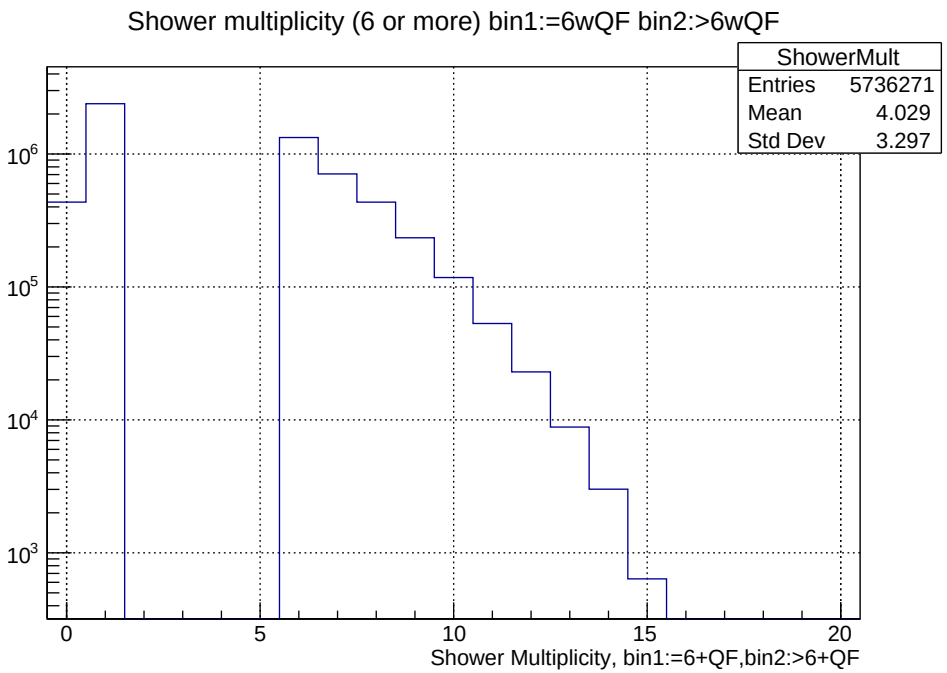
Final state $p + 6\gamma$; Look at events with exactly 6 γs and separately with more than 6γ

First Some Control plots:

1. Event RF time
2. Neutral Shower Multiplicity



All neutral final state

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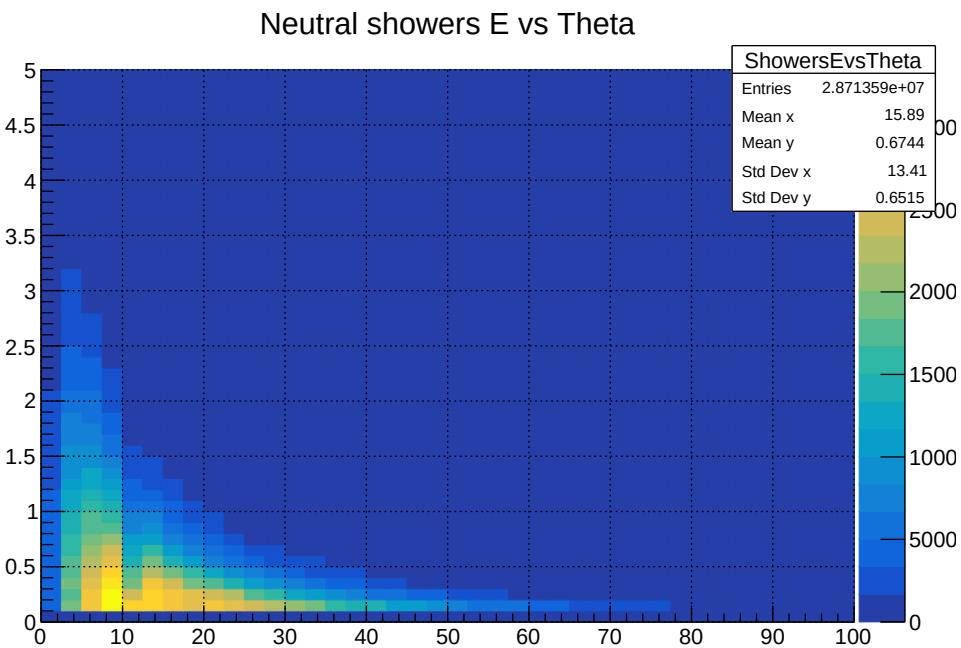
Final state $p + 6\gamma$; Look at events with exactly 6 γs and separately with more than 6γ

First Some Control plots:

1. Event RF time
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ



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First Some Control plots:

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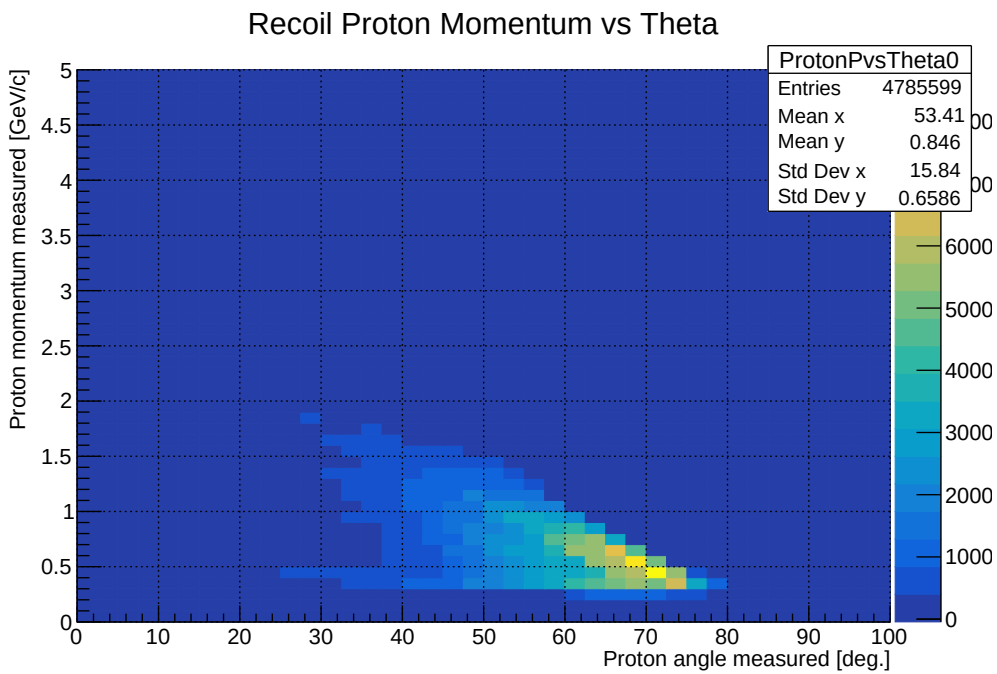
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ
4. Proton P vs θ



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3. Neutral Shower E vs θ
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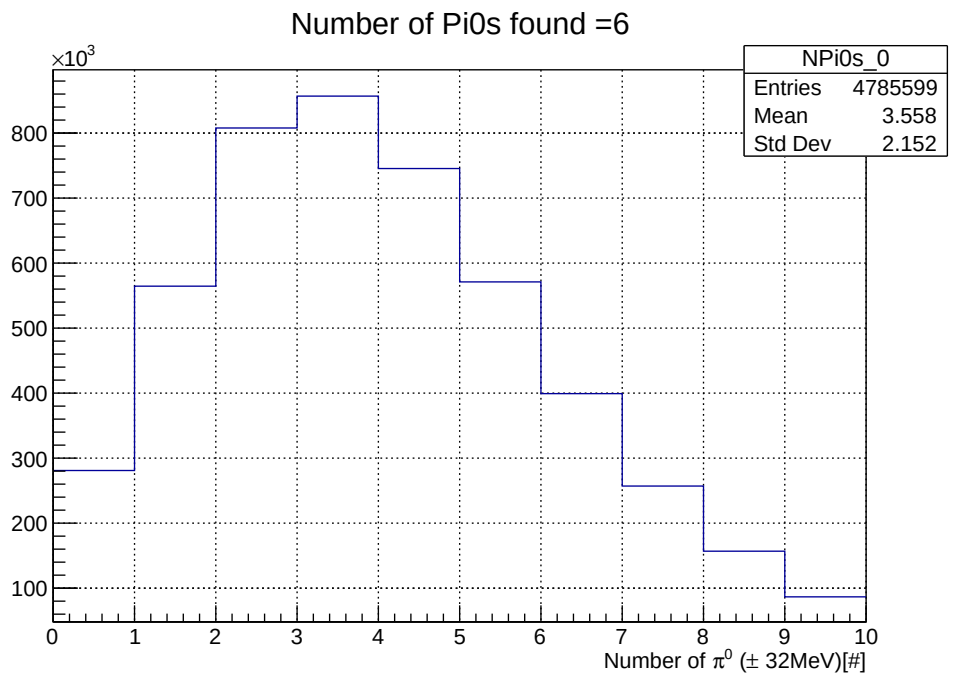
5. π^0 Multiplicity



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Final state $p + 6\gamma$; Look at events with exactly 6 γs and separately with more than 6γ

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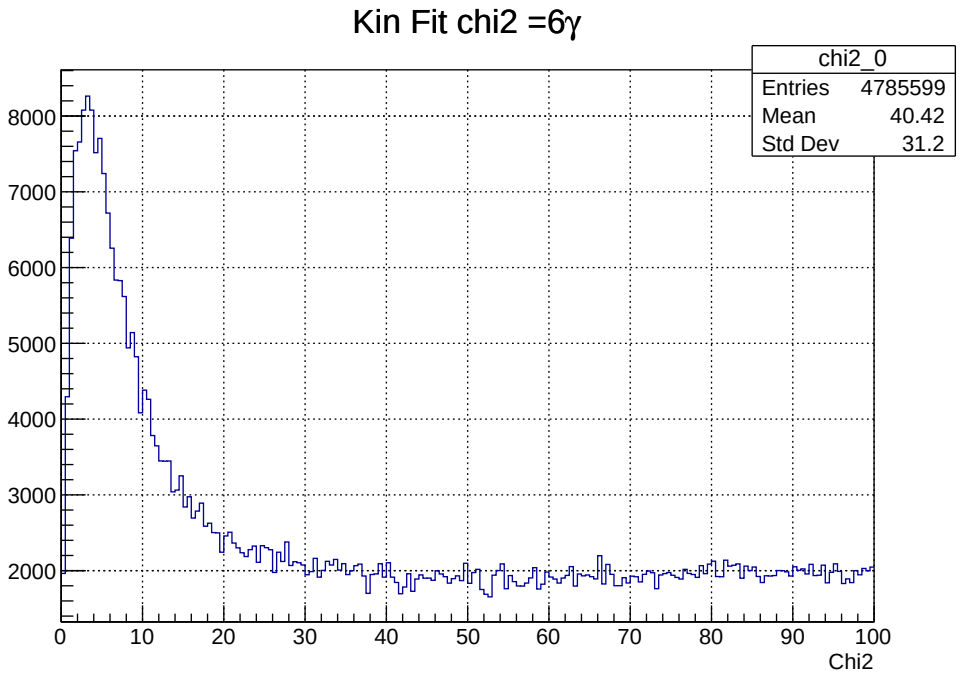
5. π^0 Multiplicity
6. Chi2 for 6γ events



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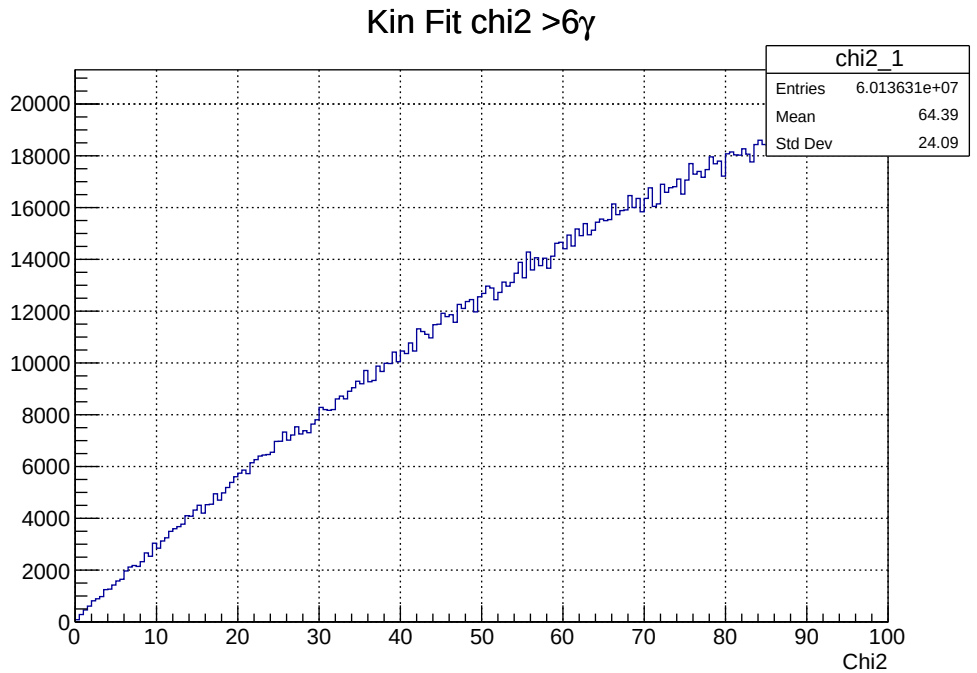
7. Chi2 for $>$ 6γ events



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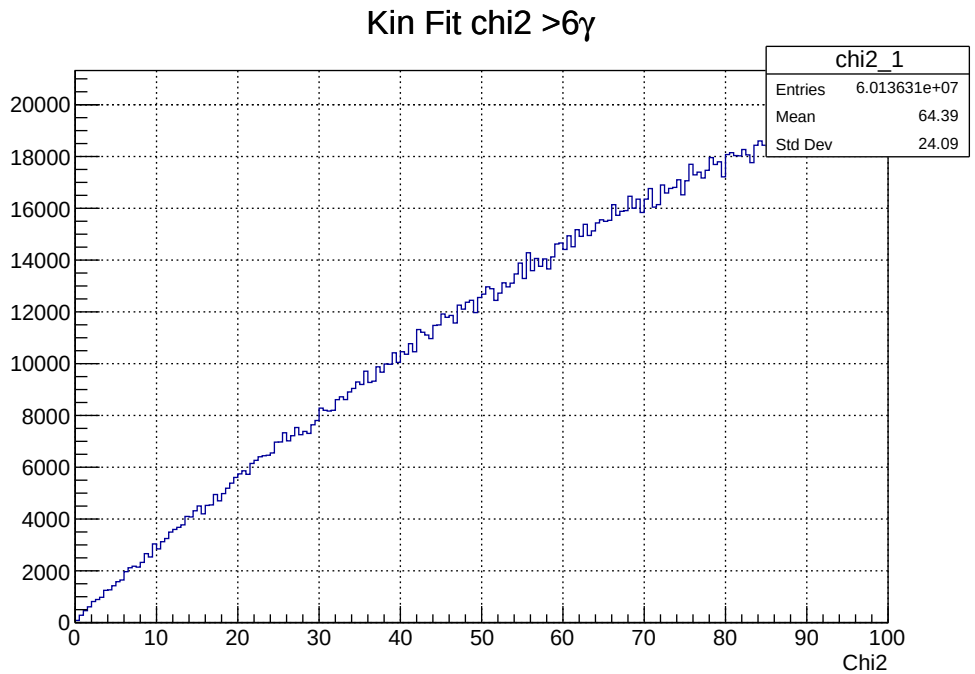

Chi2 distribution for events with more than 6 neutrals looks HORRIBLE!

All Neutral Final State Cont.

Reconstructed η Mass, look at effects of additional neutral showers and Shower Quality Cut. All plots do have a Chi2 cut applied and accidentals are subtracted.

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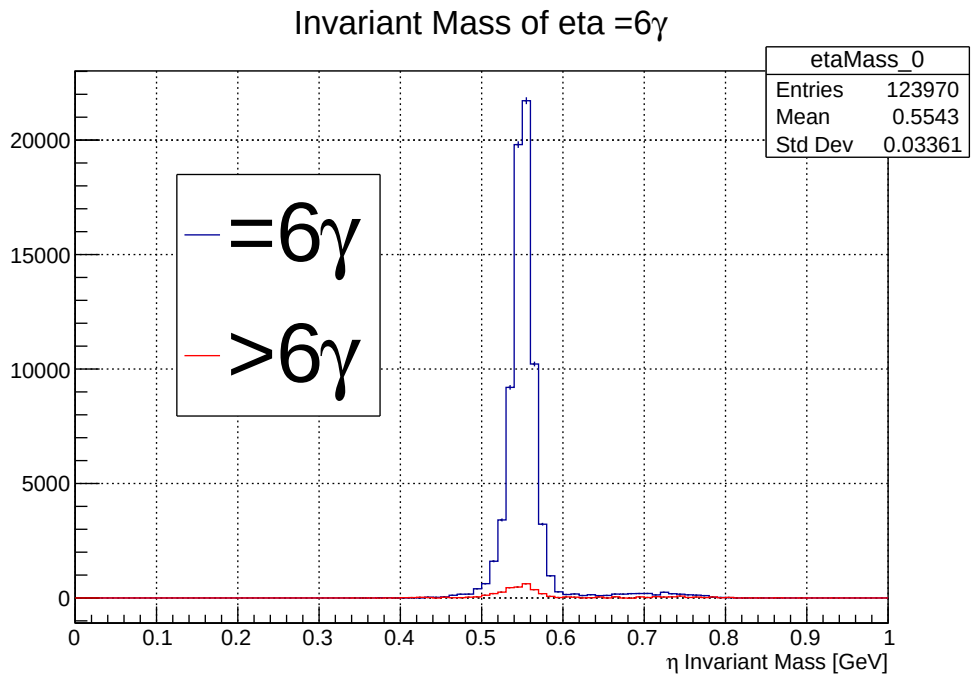
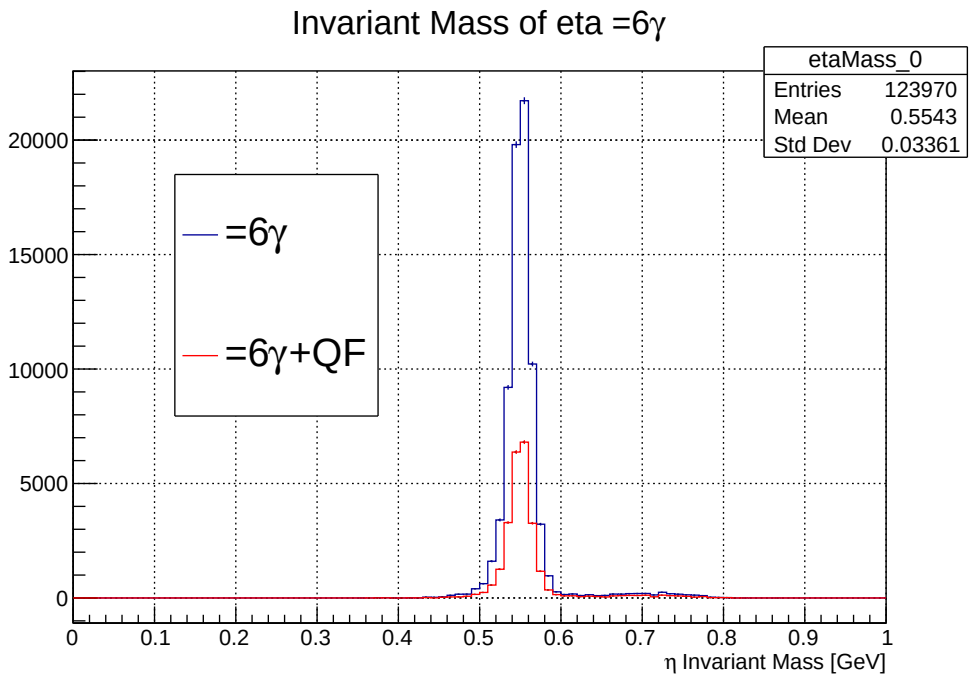
1. η (=6 and >6)



All Neutral Final State Cont.

Reconstructed η Mass, look at effects of additional neutral showers and Shower Quality Cut. All plots do have a Chi2 cut applied and accidentals are subtracted.

1. η (=6 and >6)
2. η (=6 and =6 plus QF)



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Reconstructed η Mass, look at effects of additional neutral showers and Shower Quality Cut. All plots do have a Chi2 cut applied and accidentals are subtracted.

1. η (=6 and >6)
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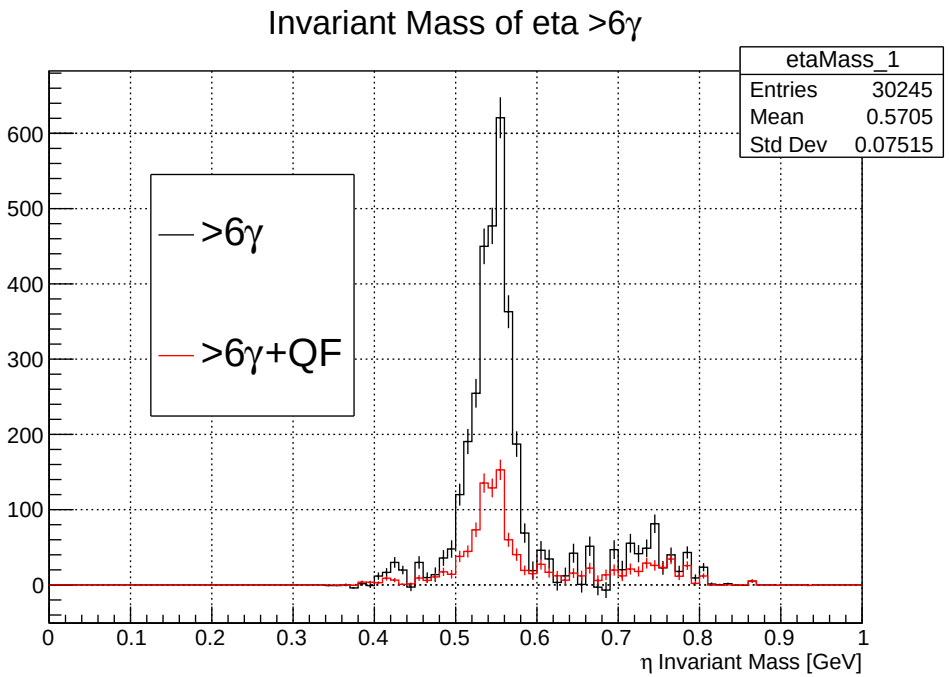
3. η (>6 and >6 plus QF)



All Neutral Final State Cont.

Reconstructed η Mass, look at effects of additional neutral showers and Shower Quality Cut. All plots do have a Chi2 cut applied and accidentals are subtracted.

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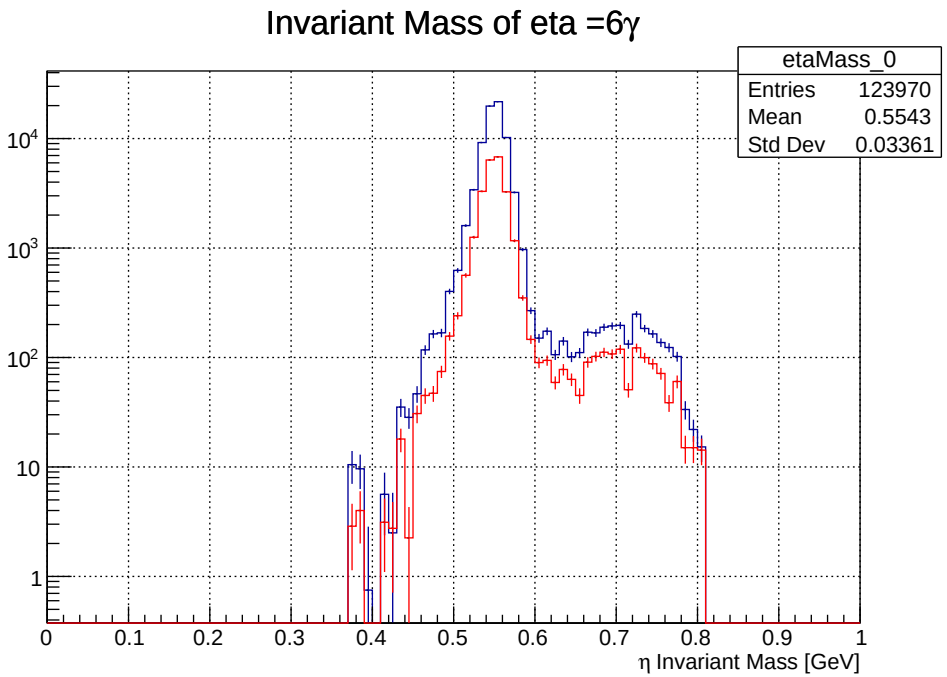
4. η (=6 log plot)



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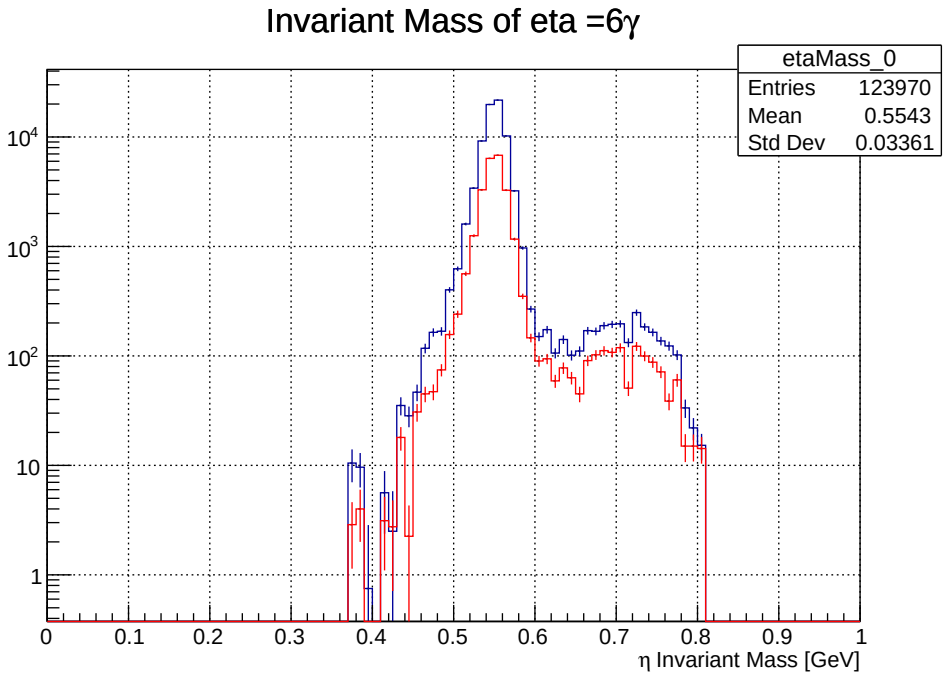

a) DO NOT USE EVENTS WITH MORE THAN 6 PHOTONS!
b) DO NOT USE SHOWER QUALITY CUT
THESE CONCLUSIONS ONLY APPLY TO THIS FINAL STATE!

$\pi^+\pi^-4\gamma$ Final State

`RunPeriod-2017-01/analysis/ver36/tree_pi0etapr__B4_M35_M7_M17`

Mixed charged and neutral final state with a $\pi^0 \to \gamma\gamma$ and an $\eta \to \gamma\gamma$

Question: How do the additional charged tracks change the behavior of events with additional neutral showers (Unused Energy) and the shower quality cut?

Some Control plots first:

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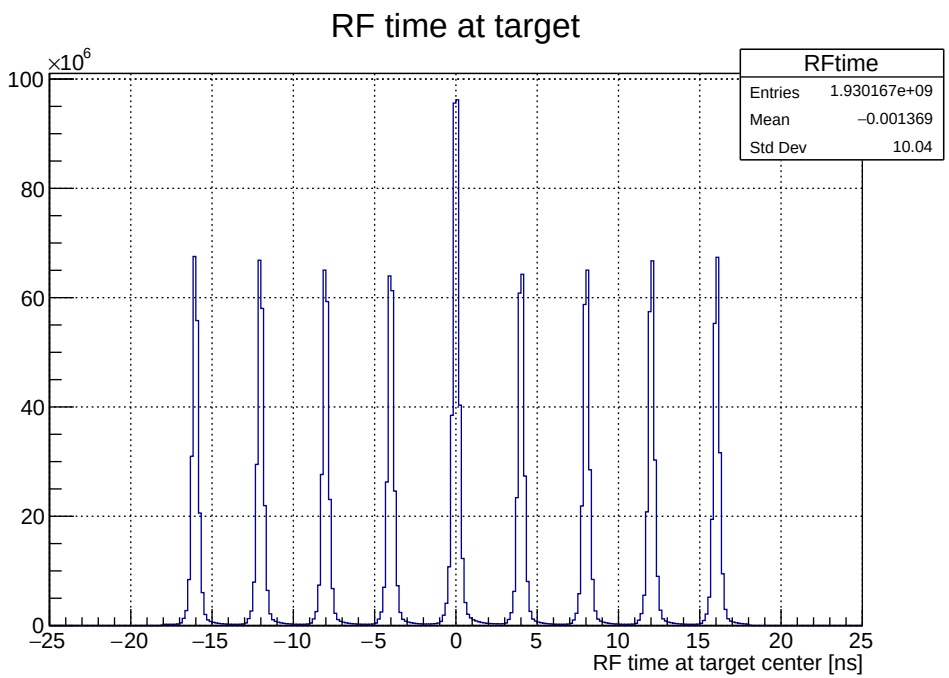

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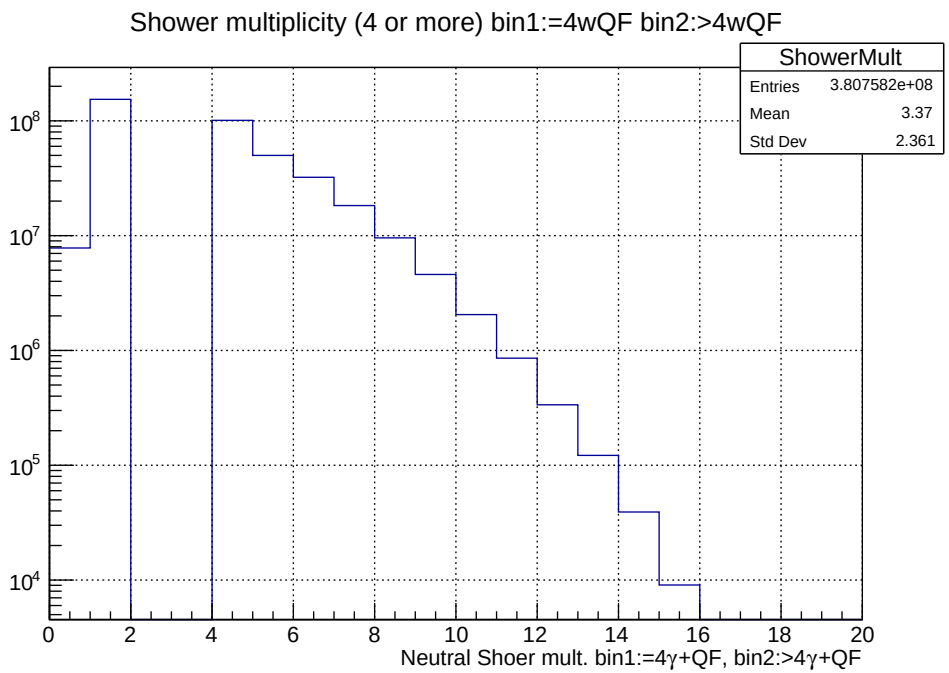

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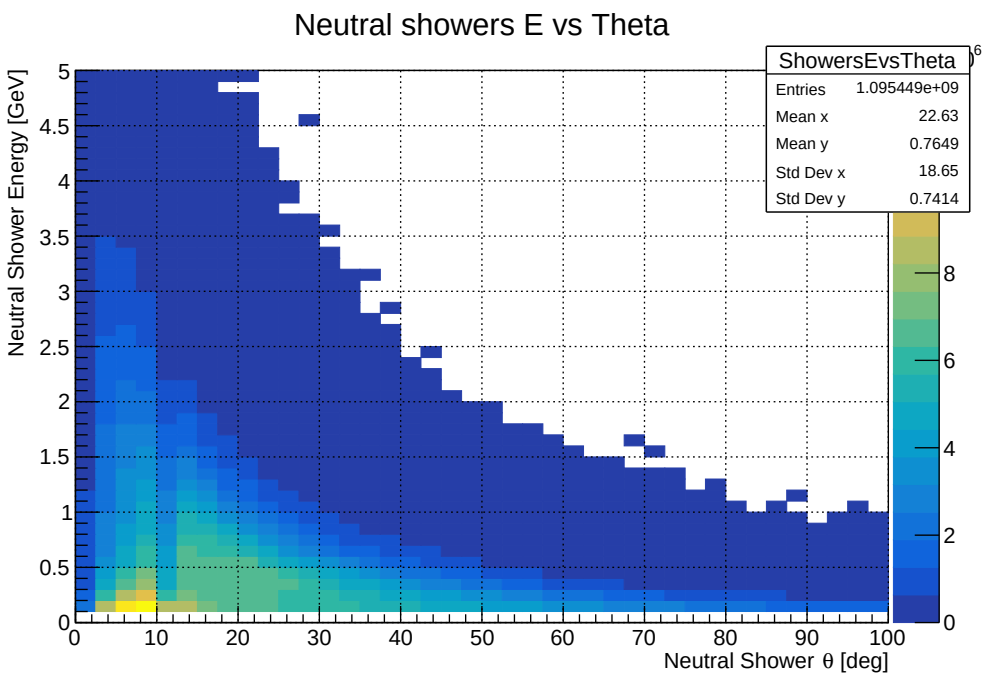

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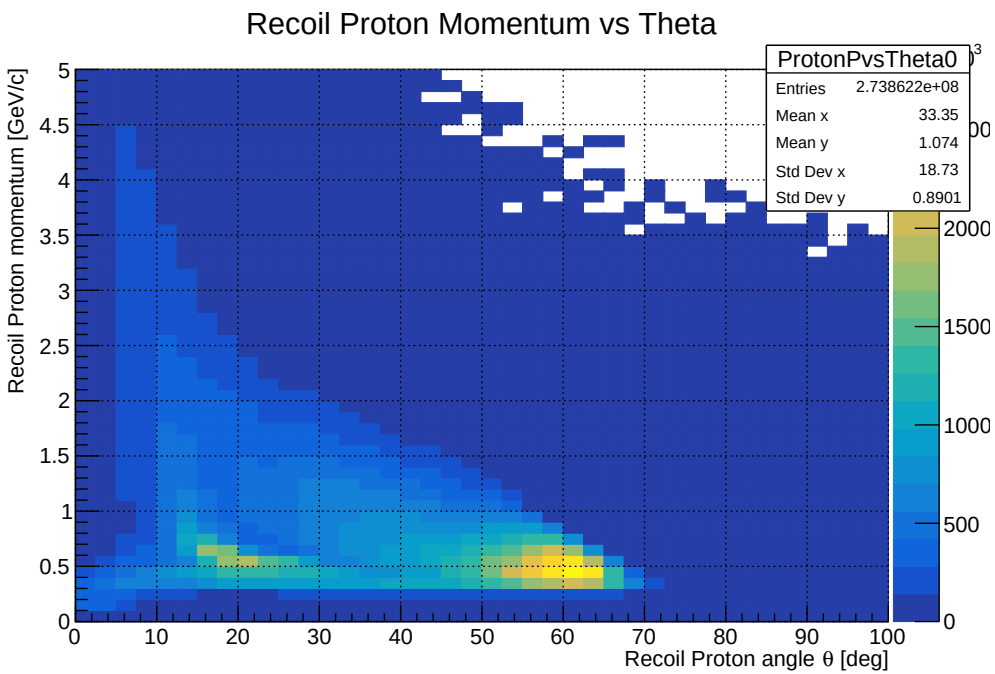

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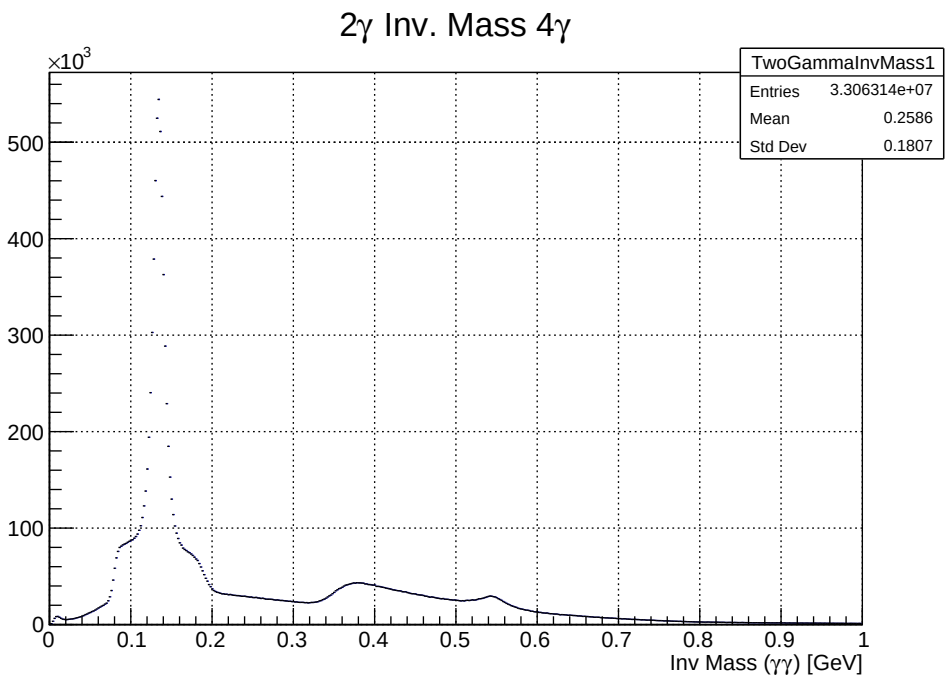
3. Neutral Shower E vs θ
4. Proton P vs θ
5. 2γ invariant mass



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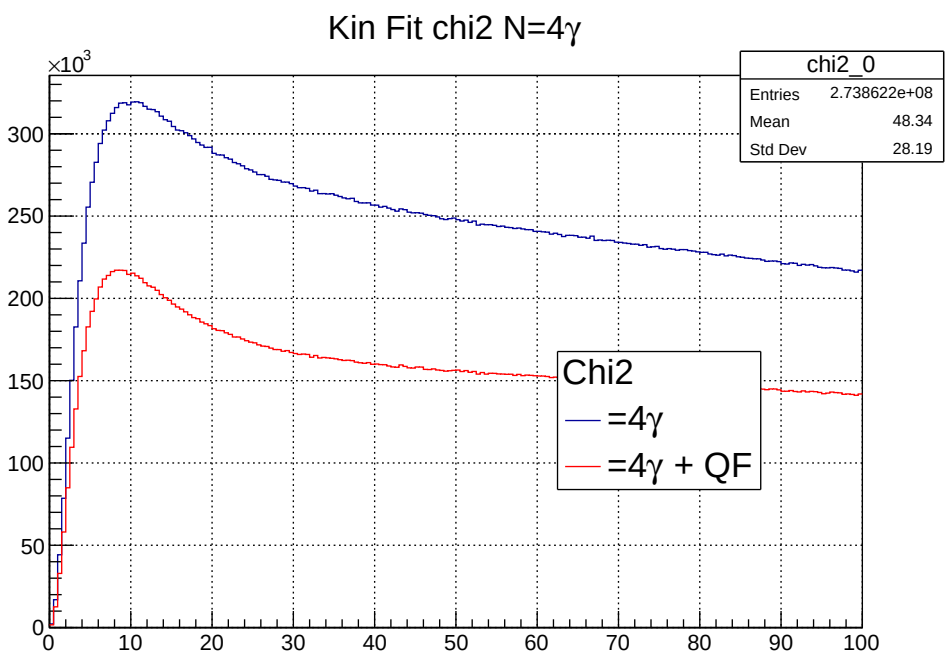

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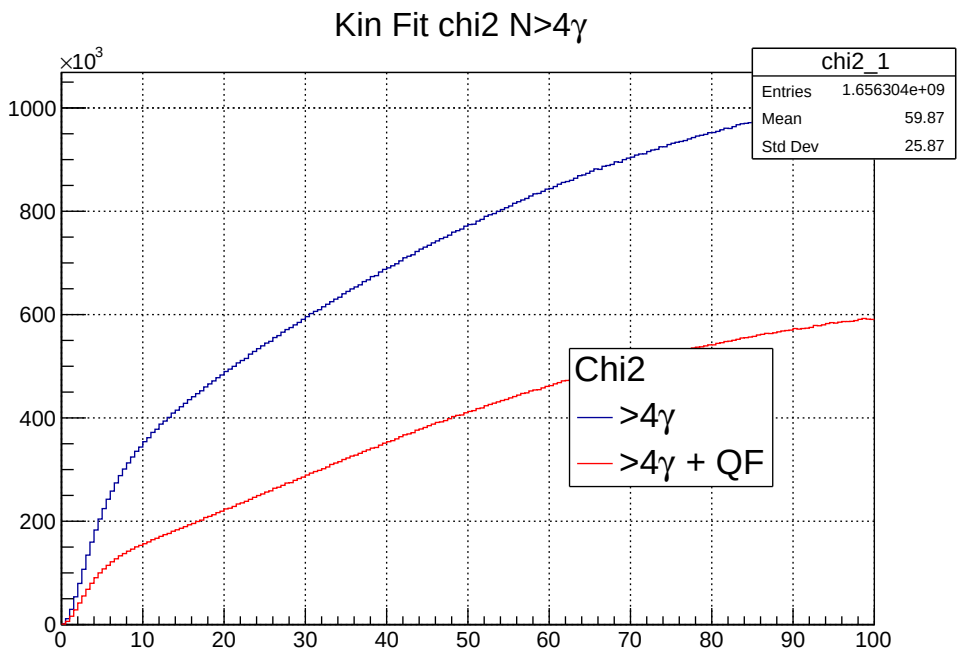

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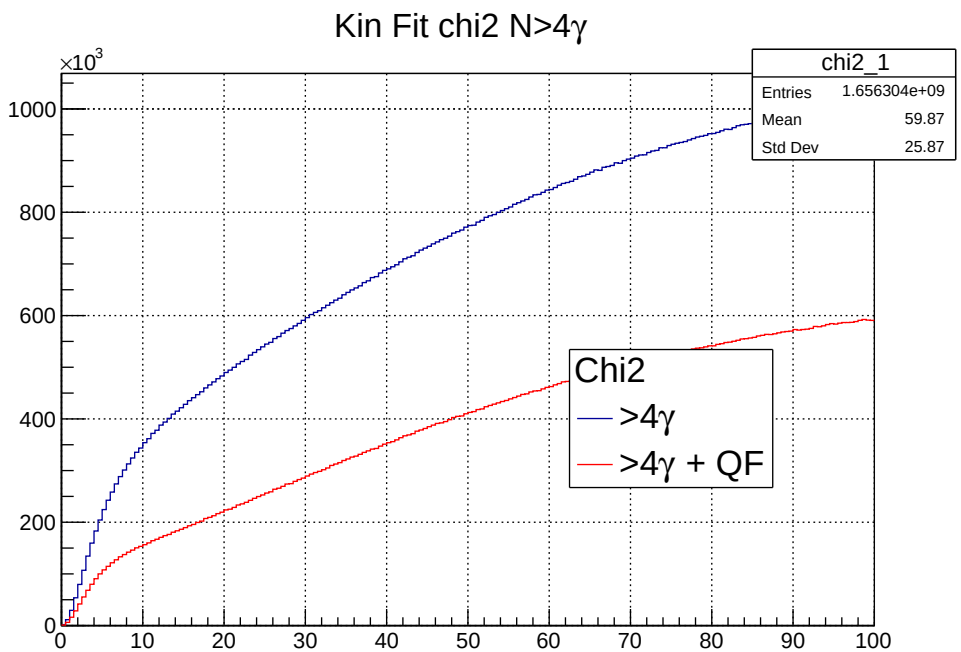

Chi2 distributions for events with more than 4 neutrals do not look great!

$\pi^+\pi^-4\gamma$ Final State

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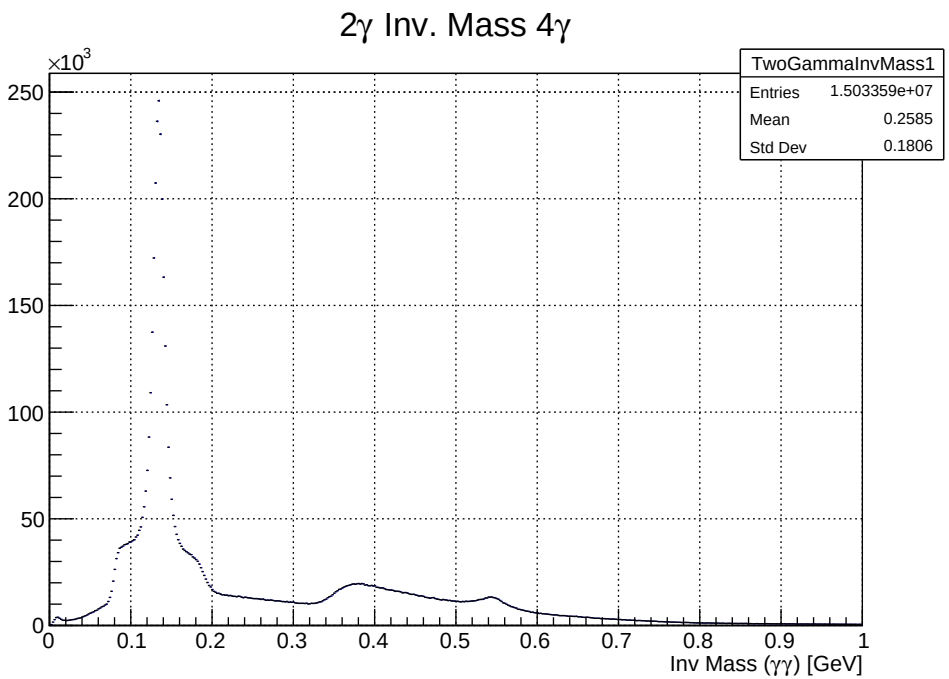

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More Control plots:

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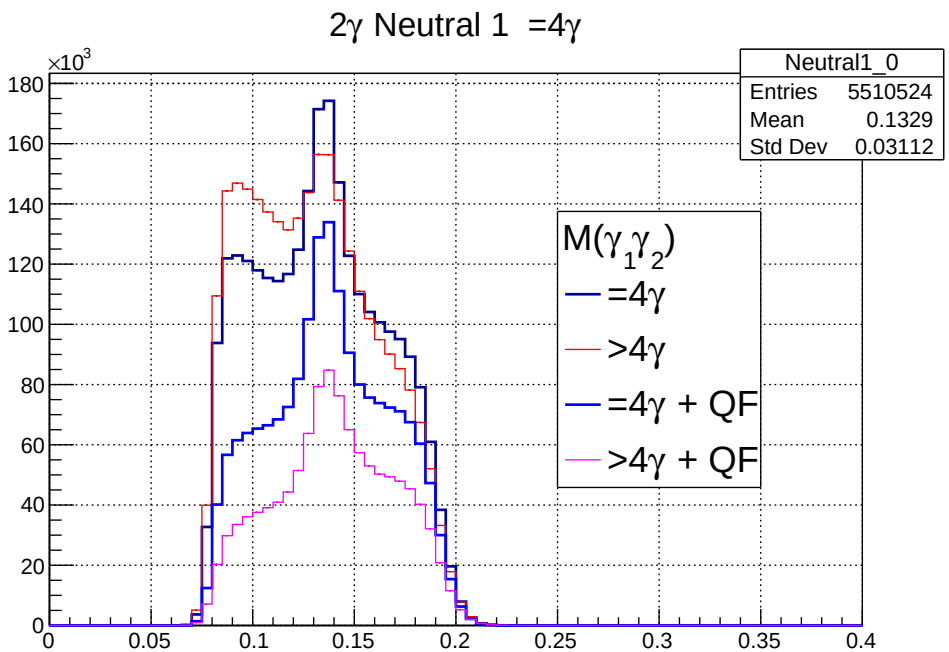
2. Inv, Mass M($\gamma_1\gamma_2$)



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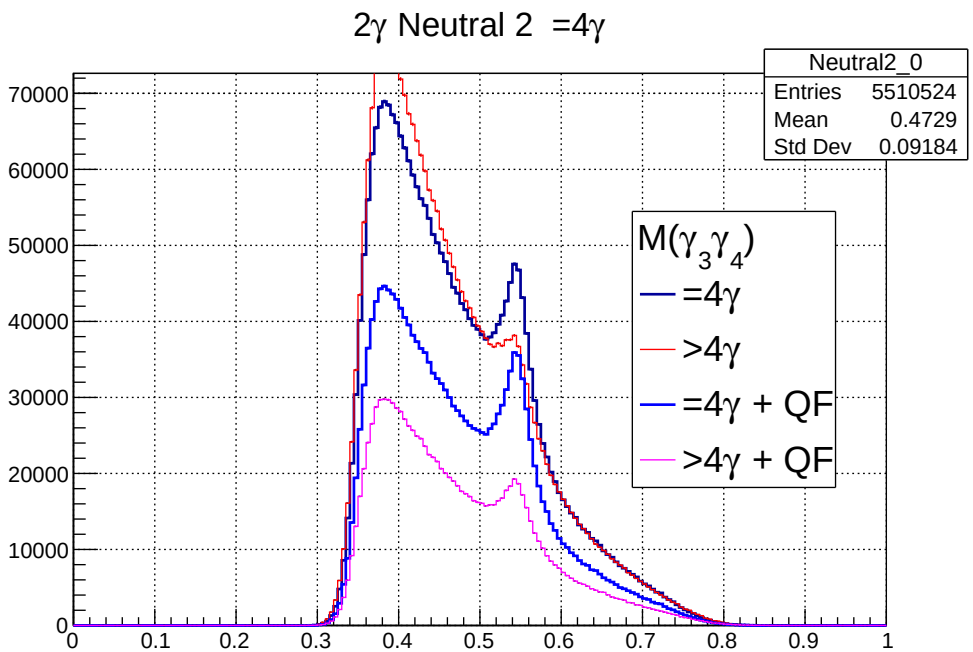
More Control plots:

1. 2γ invariant mass
2. Inv, Mass M($\gamma_1\gamma_2$)
3. Inv, Mass M($\gamma_3\gamma_4$)
   - large background for $> 4\gamma$ events
   - large background for η
   - QF seems to help



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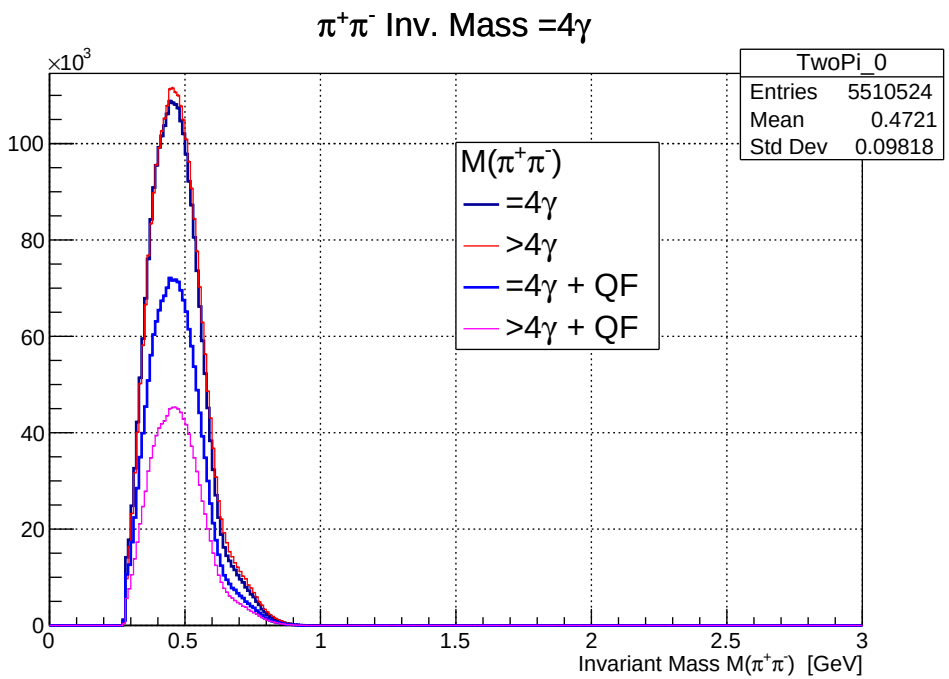

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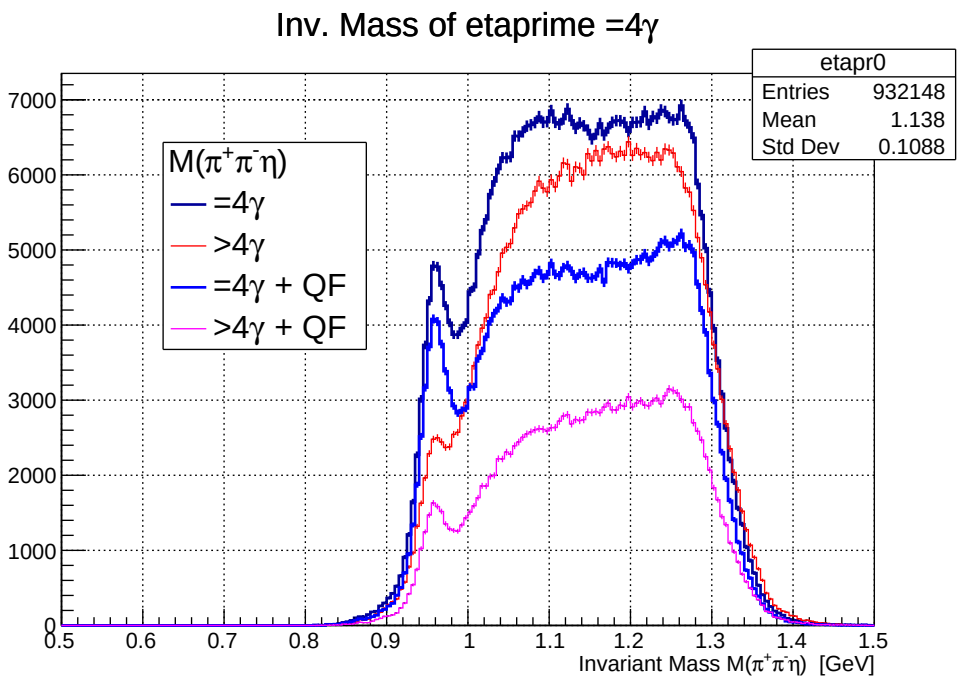

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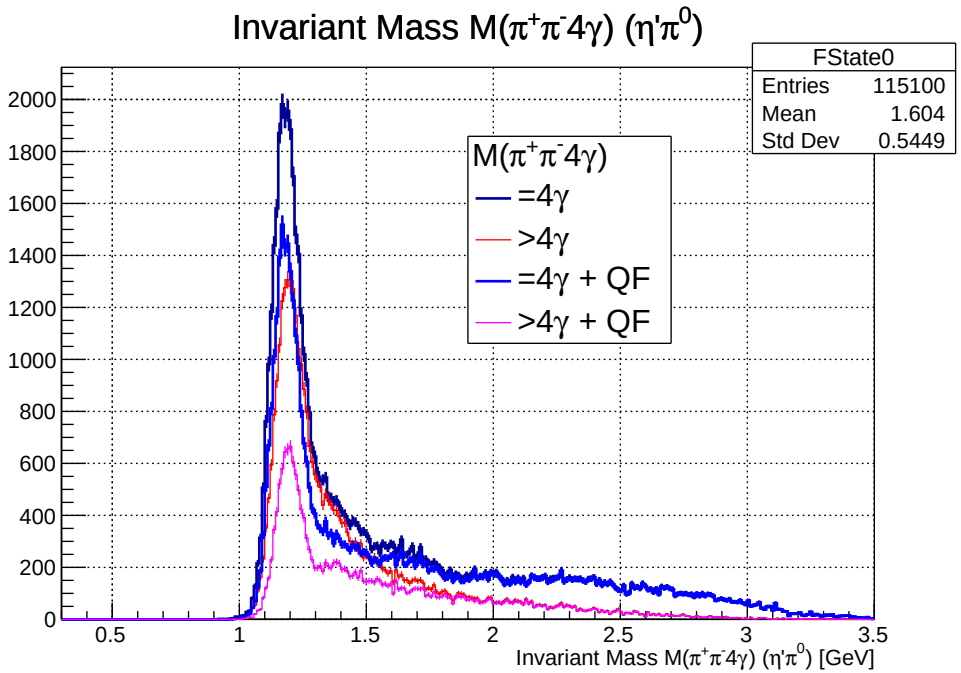

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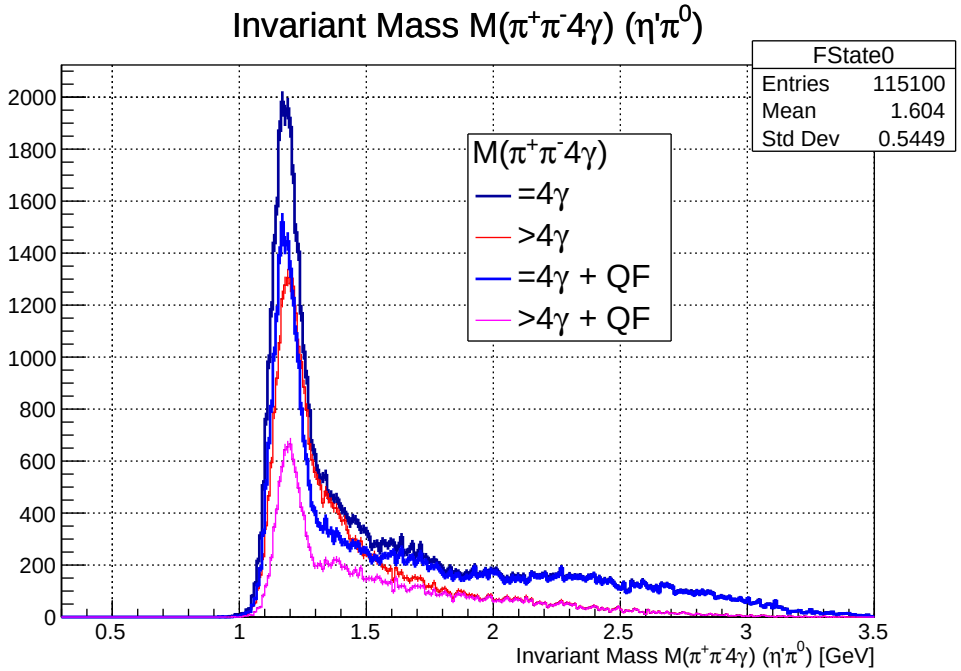

Conclusion:

a) QF cut seems to improves S/B ratio.

b) Unused energy still not that useful, contributes more BG

Intermezzo

Zack showed invariant mass distributions of $\pi^+\pi^-\eta$ and $\eta\prime\pi^0$, with both π^0 and η mass constrained.

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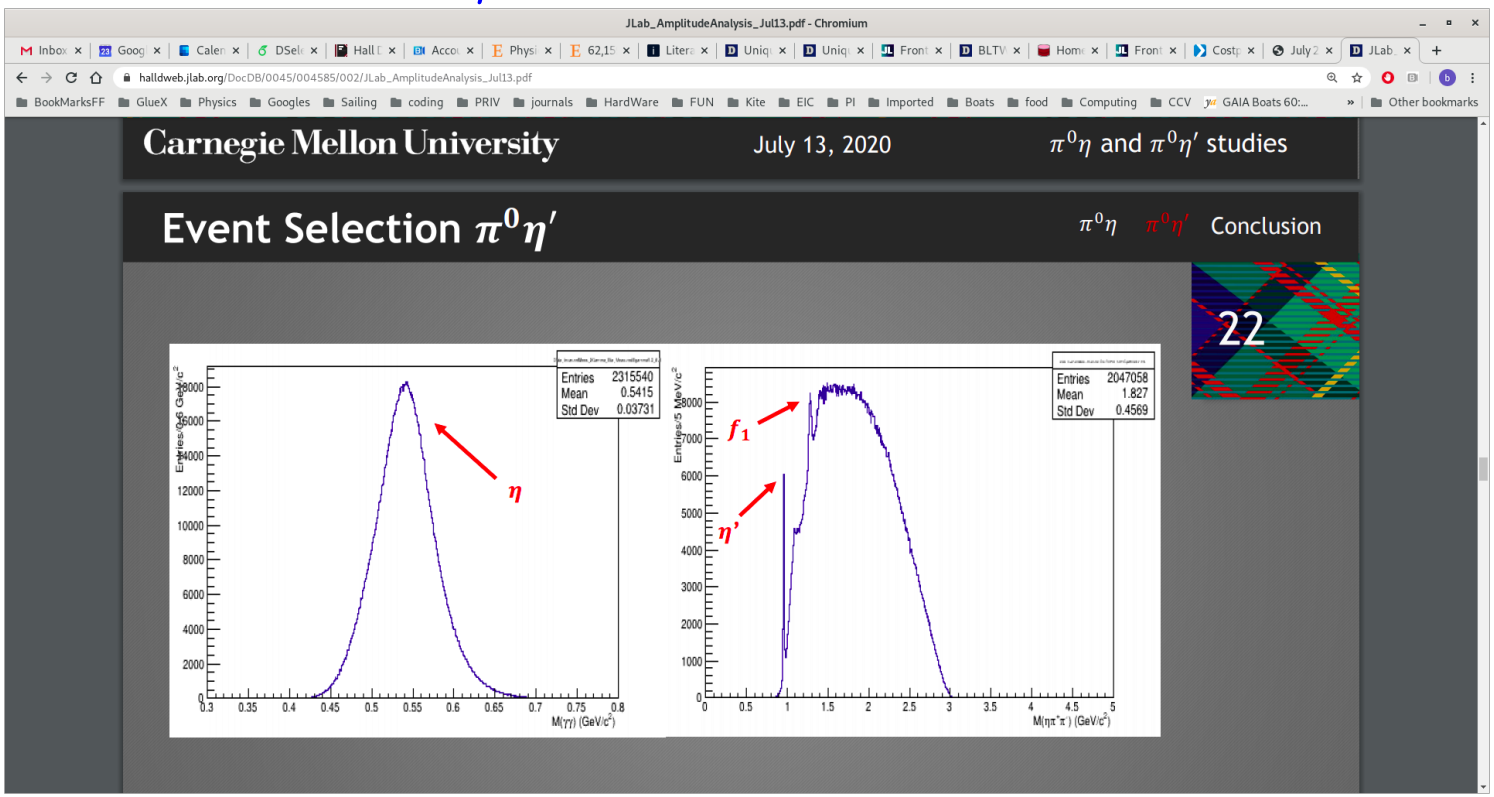

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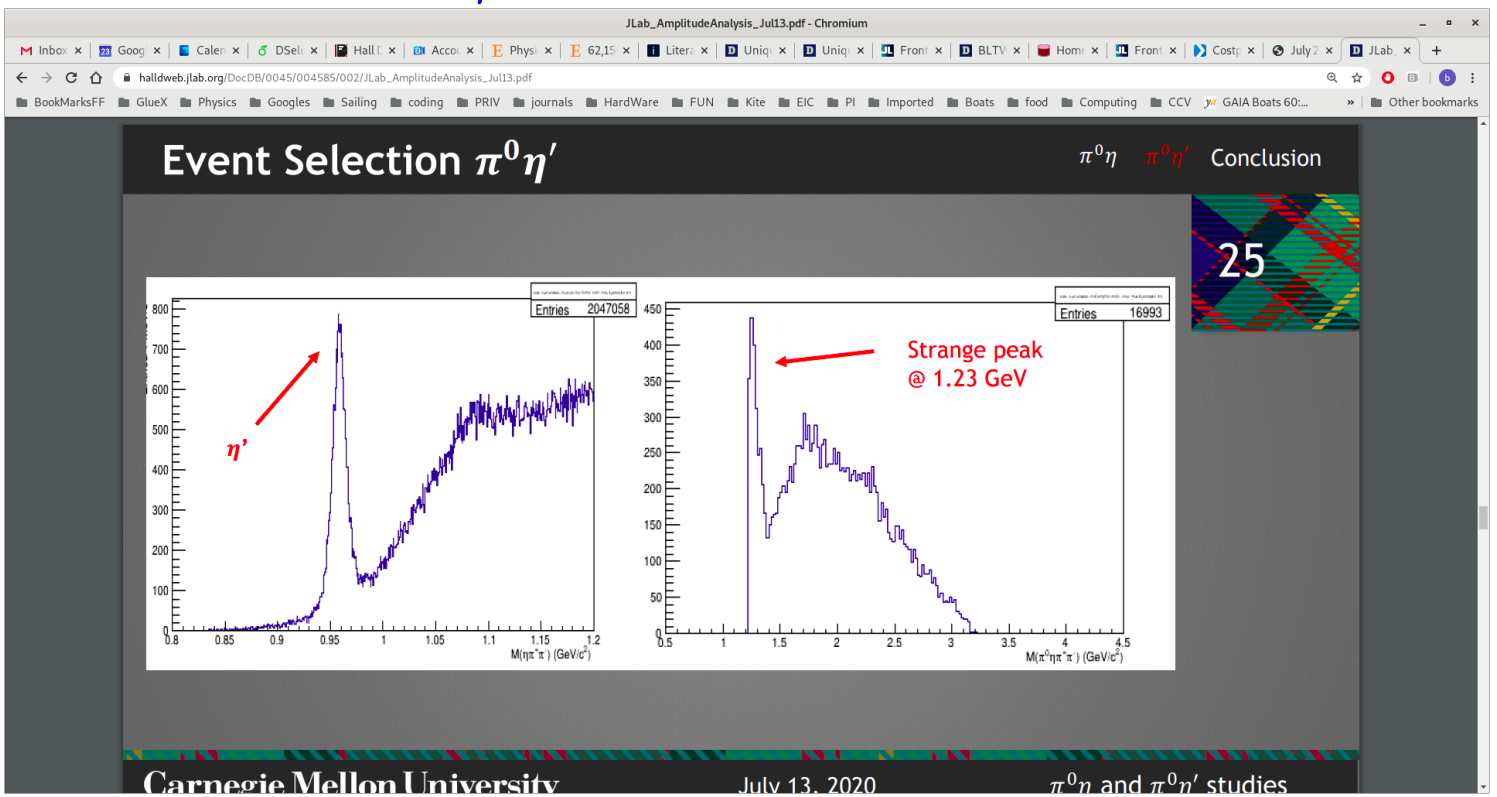

Intermezzo

Zack showed invariant mass distributions of $\pi^+\pi^-\eta$ and $\eta\prime\pi^0$, with both π^0 and η mass constrained.
Conclusion: Mass constraints can potentially introduce sharp cuts in mass spectrum!

$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

Mixed charged and neutral final state with a 3 $\pi^0 \to \gamma\gamma$.

Question: How do the additional charged tracks change the behavior of events with additional neutral showers (Unused Energy) and the shower quality cut?

Some Control plots first:

$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

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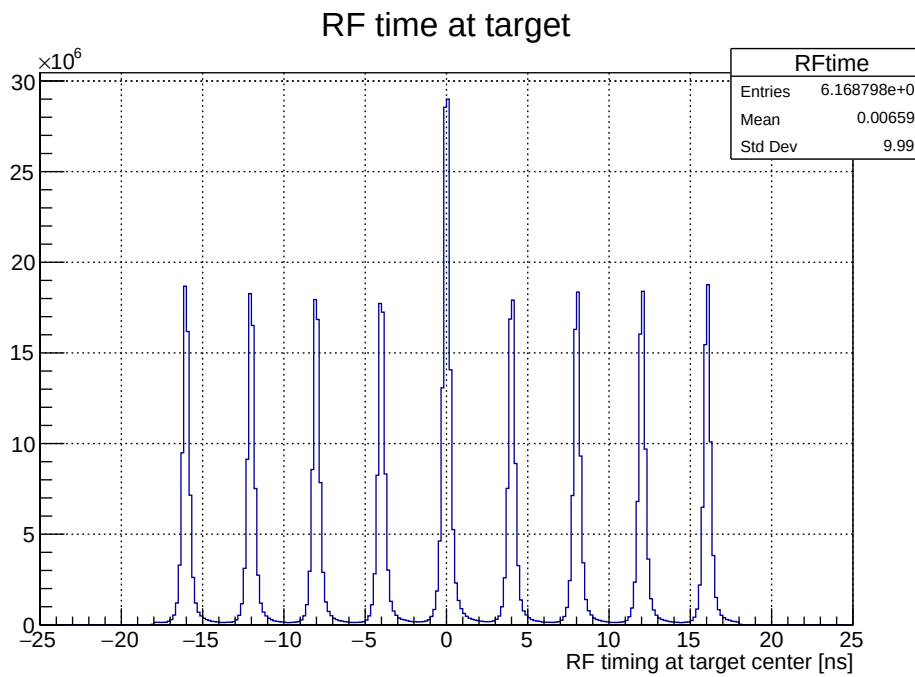
Question: How do the additional charged tracks change the behavior of events with additional neutral showers (Unused Energy) and the shower quality cut?

Some Control plots first:

1. Event RF time



$\pi^+\pi^-6\gamma$ Final State

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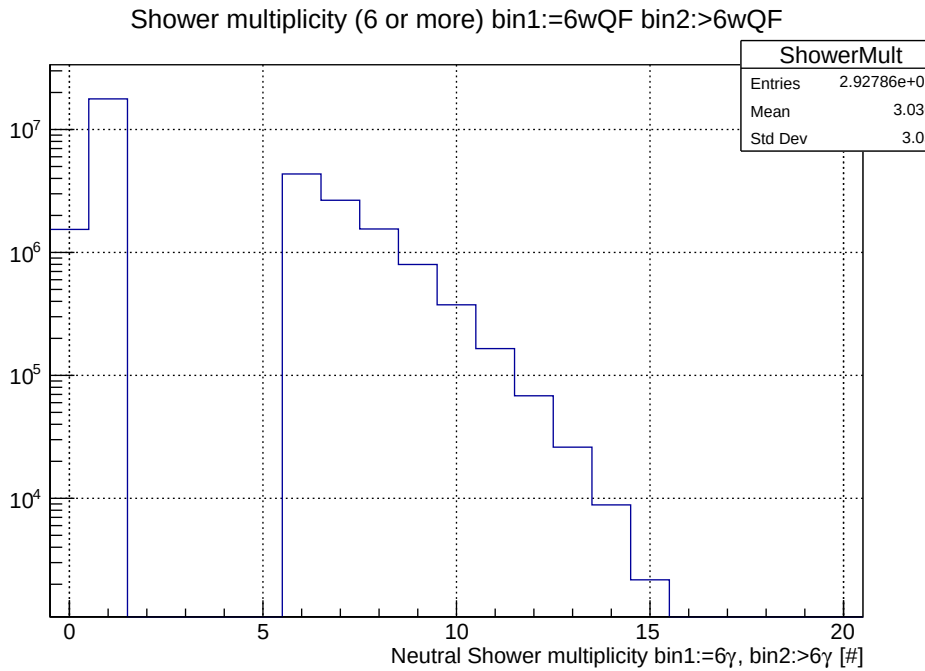
Question: How do the additional charged tracks change the behavior of events with additional neutral showers (Unused Energy) and the shower quality cut?

Some Control plots first:

1. Event RF time
2. Neutral Shower Multiplicity



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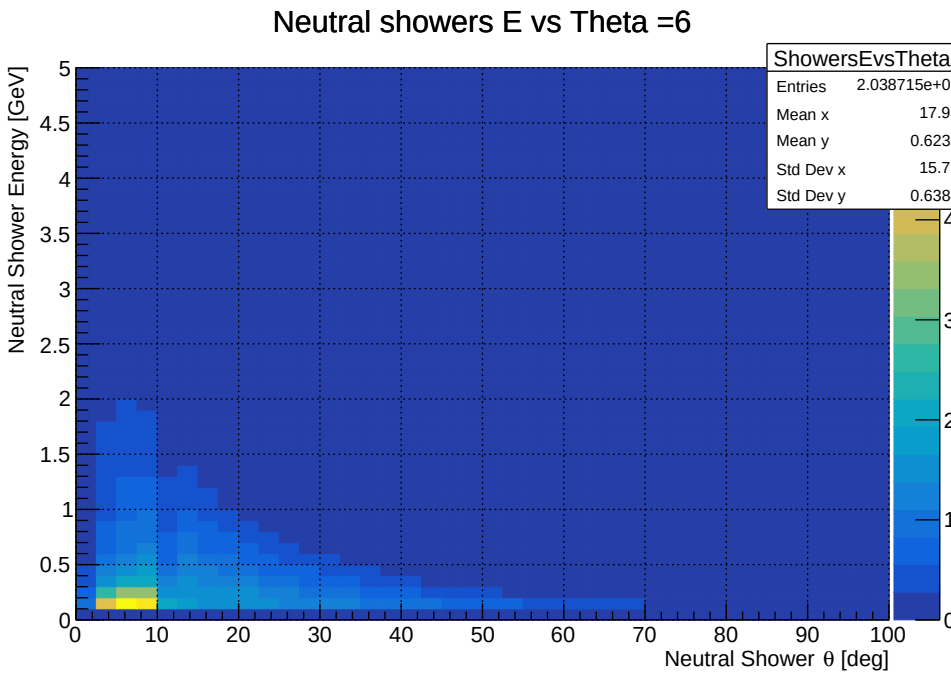
Question: How do the additional charged tracks change the behavior of events with additional neutral showers (Unused Energy) and the shower quality cut?

Some Control plots first:

1. Event RF time
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ



$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

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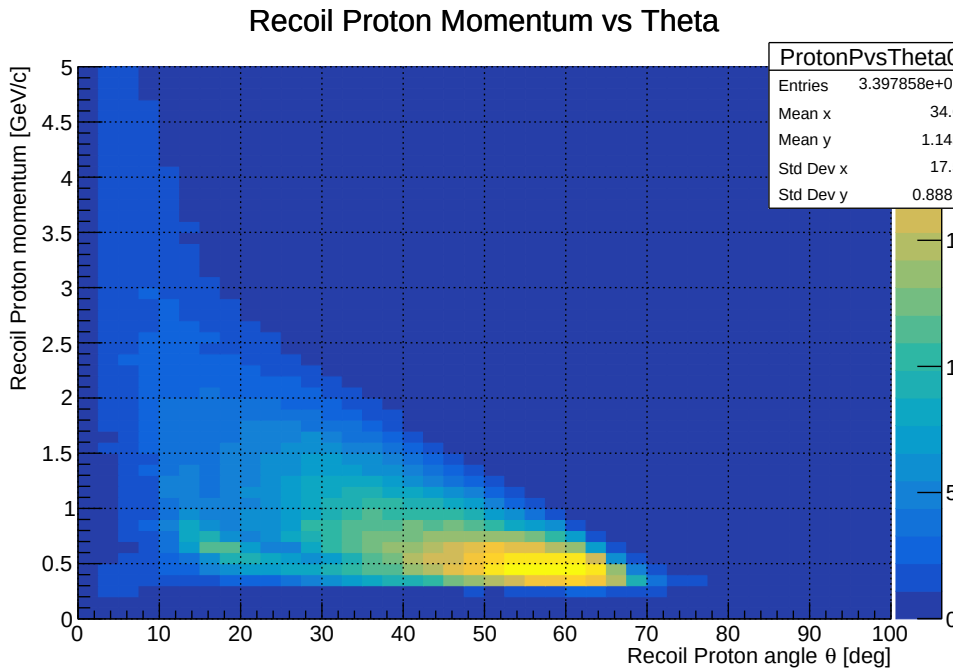
Question: How do the additional charged tracks change the behavior of events with additional neutral showers (Unused Energy) and the shower quality cut?

Some Control plots first:

1. Event RF time
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ
4. Proton P vs θ



$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

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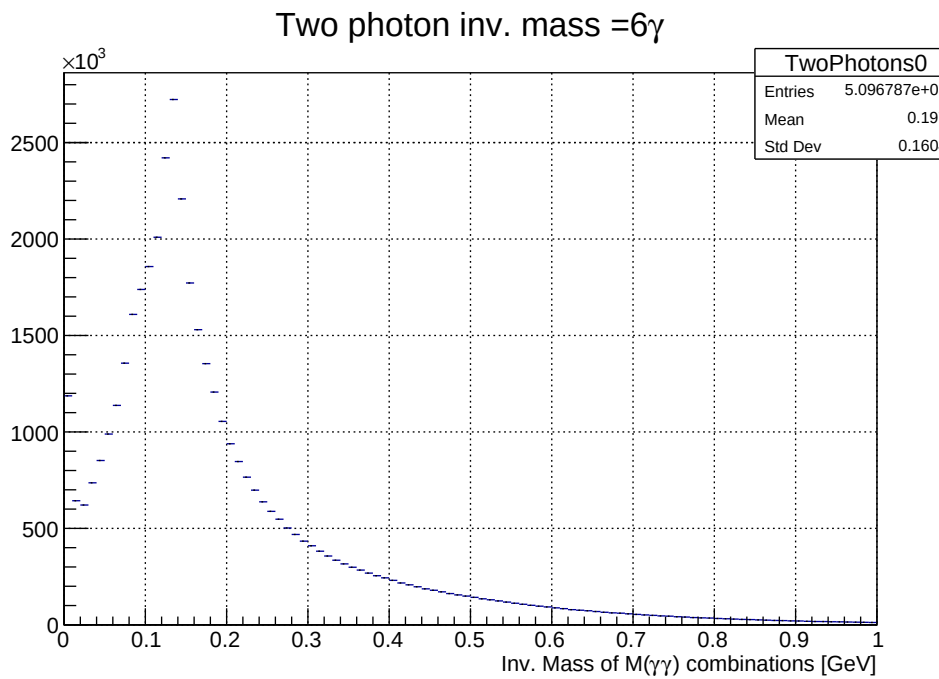
Some Control plots first:

1. Event RF time
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ
4. Proton P vs θ
5. 2γ invariant mass



$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

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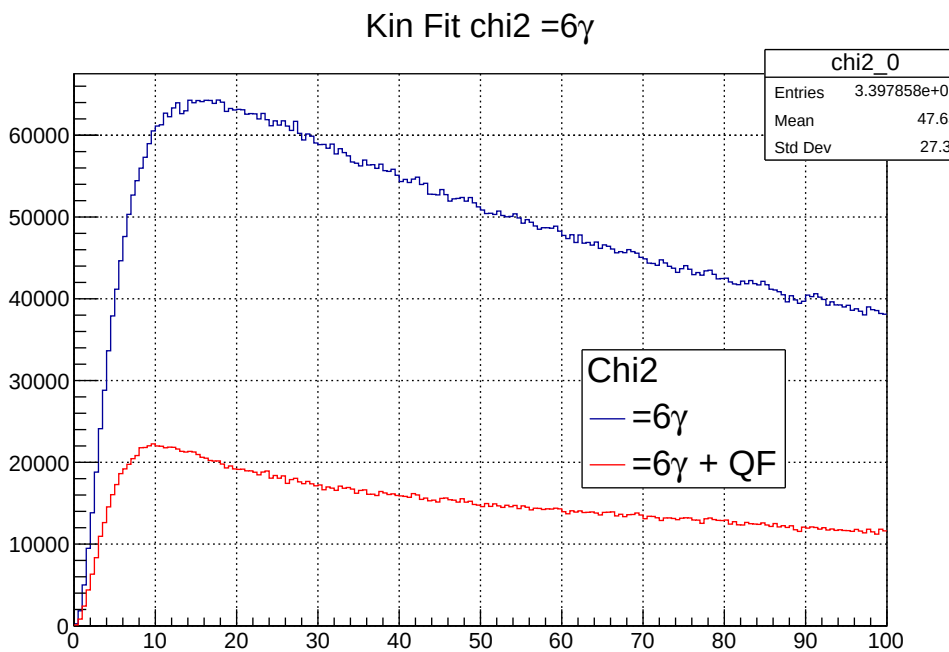
Some Control plots first:

1. Event RF time
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ
4. Proton P vs θ
5. 2γ invariant mass
6. Chi2 for 6γ events



$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

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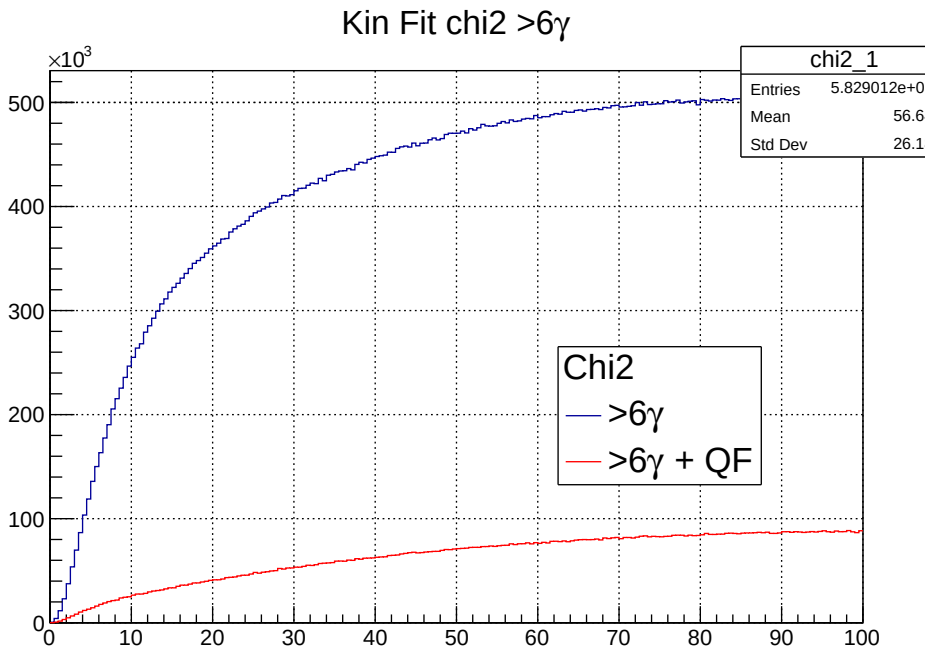
2. Neutral Shower Multiplicity
3. Neutral Shower E vs θ
4. Proton P vs θ
5. 2γ invariant mass
6. Chi2 for 6γ events
7. Chi2 for $>$ 6γ events



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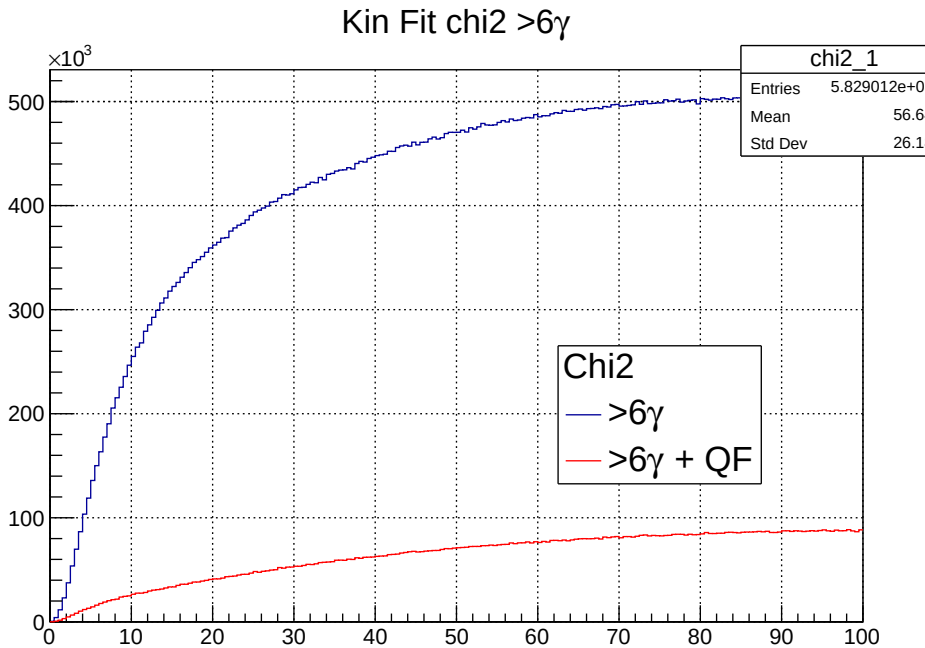
3. Neutral Shower E vs θ
4. Proton P vs θ
5. 2γ invariant mass
6. Chi2 for 6γ events
7. Chi2 for $>$ 6γ events



Chi2 distributions for events with more than 6 neutrals do not look great!

$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

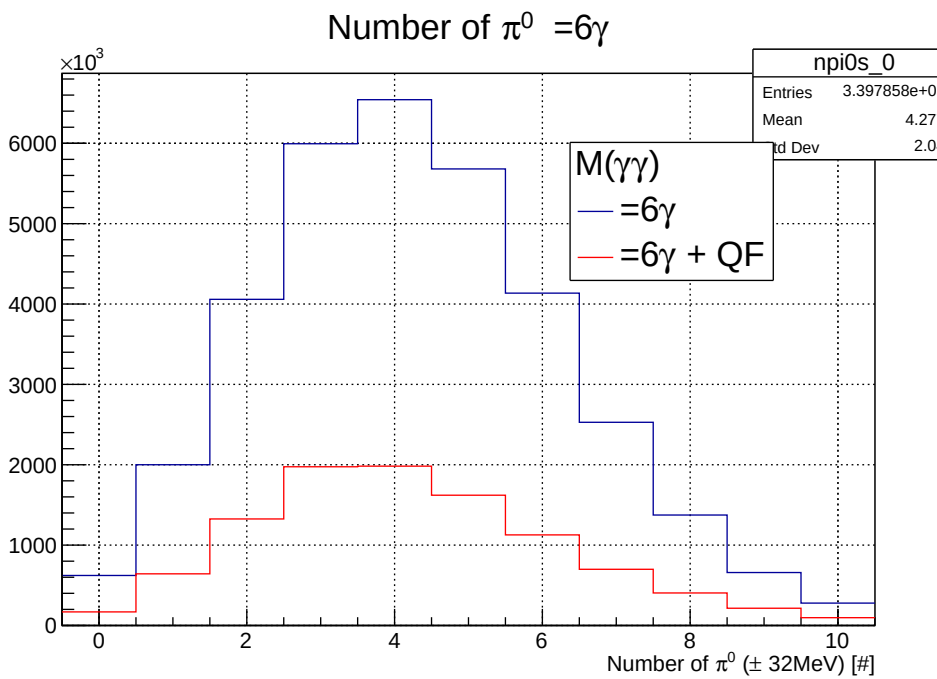
More Control plots:

$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

More Control plots:

1. pi^0 multiplicity =6γ

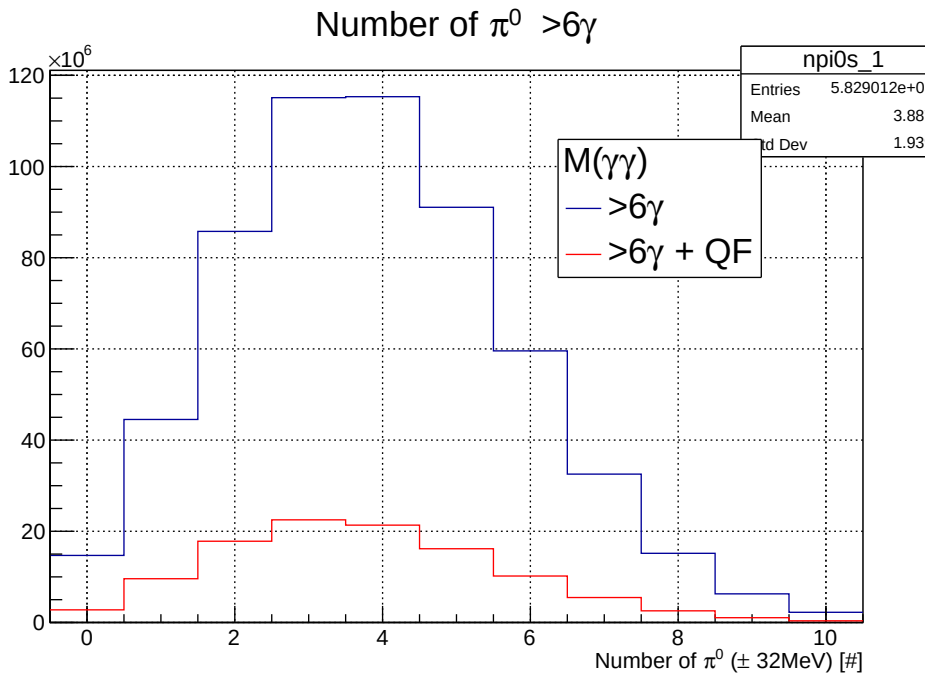


$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

More Control plots:

1. pi^0 multiplicity $=6\gamma$
2. pi^0 multiplicity $>6\gamma$

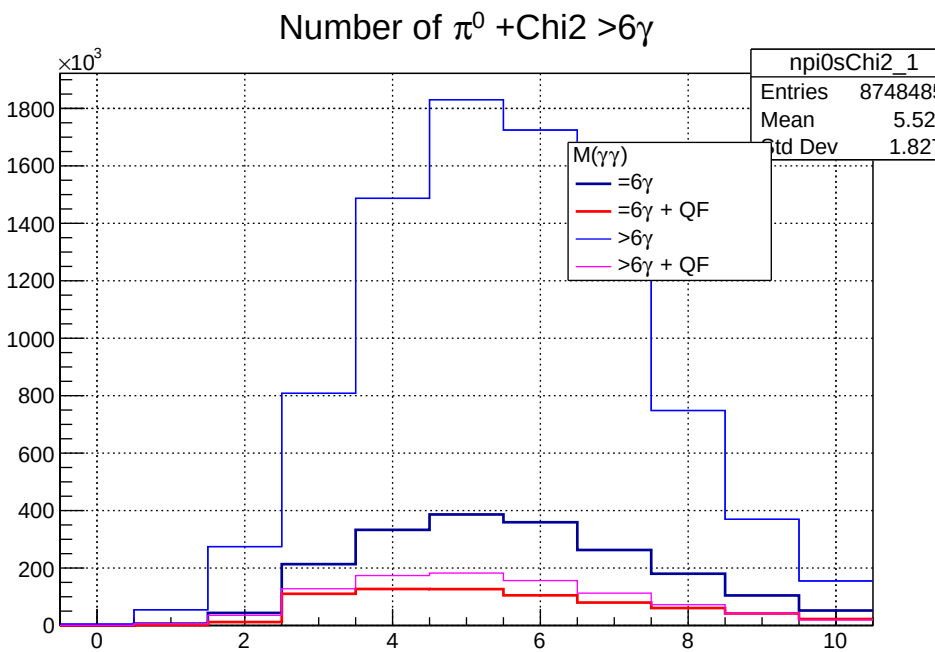


$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut

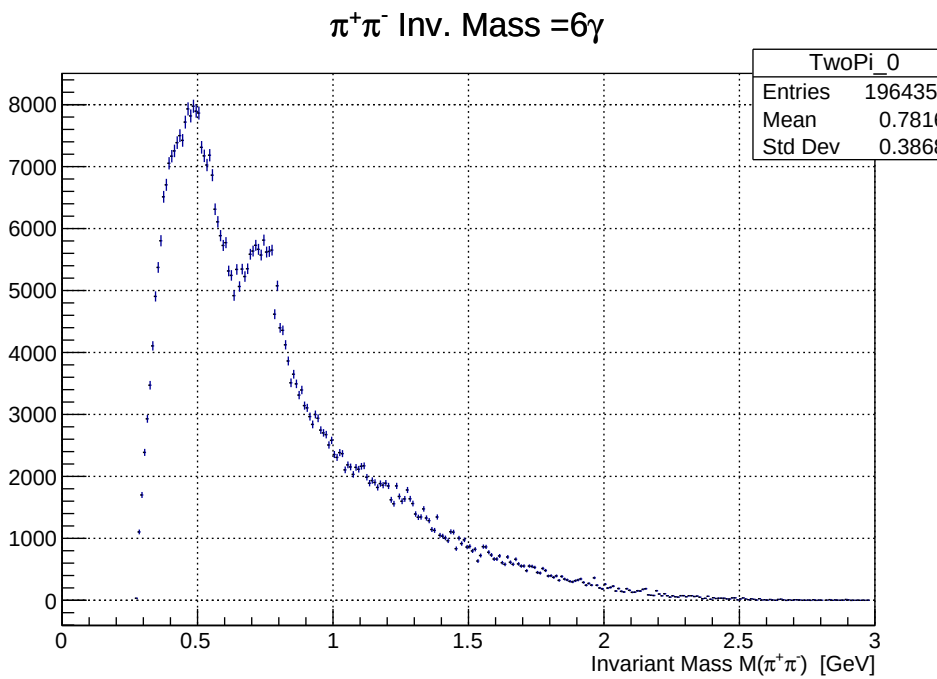


$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut
4. Inv. Mass $\pi^+\pi^-$: some ρ

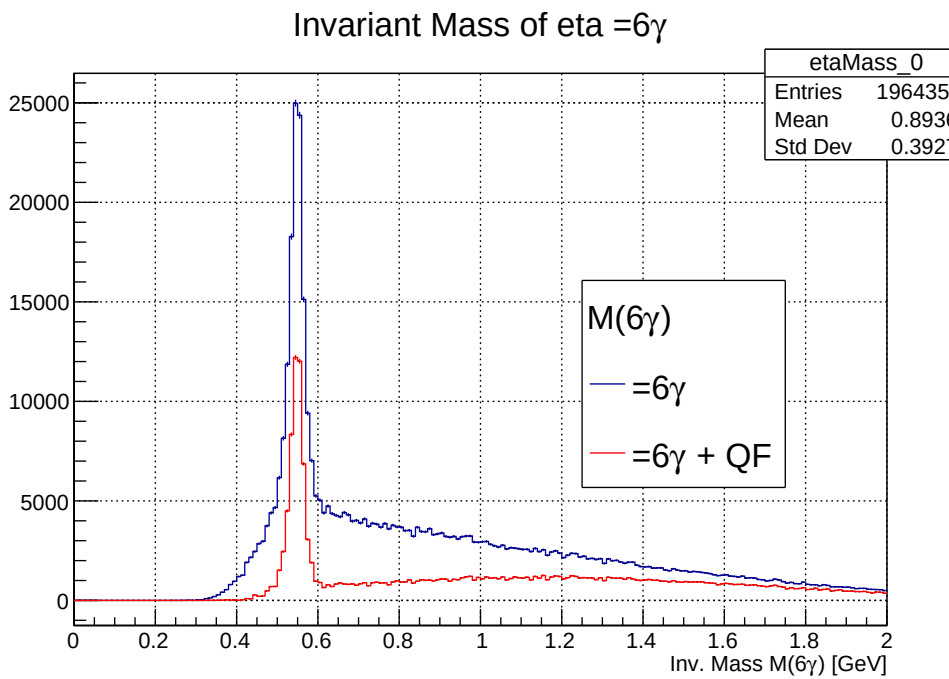


$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut
4. Inv. Mass $\pi^+\pi^-$: some ρ
5. Inv. Mass 6γ =6

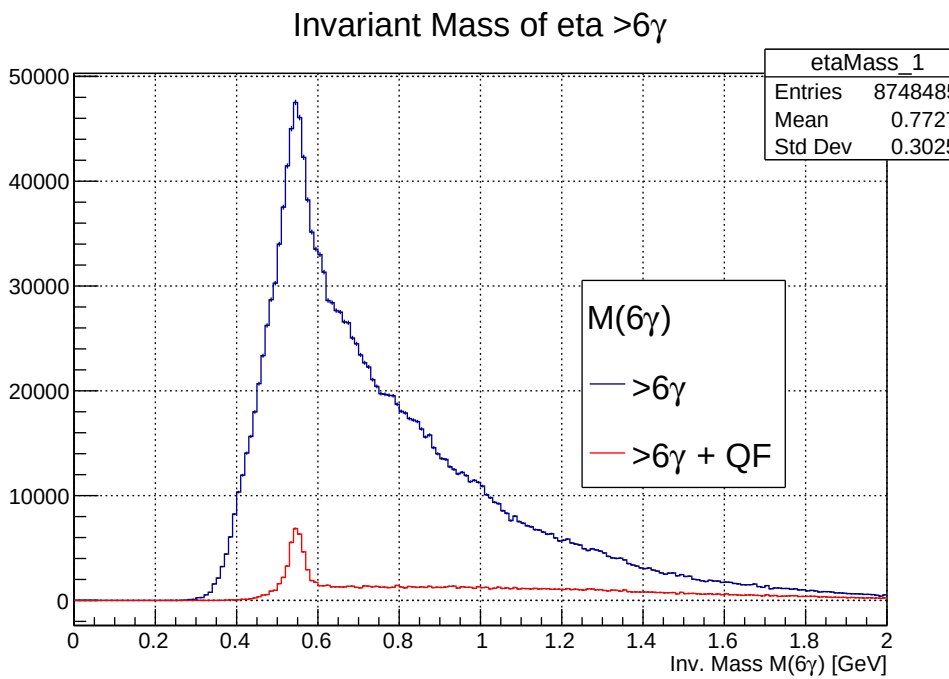


$\pi^+\pi^-6\gamma$ Final State

`RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7`

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut
4. Inv. Mass $\pi^+\pi^-$: some ρ
5. Inv. Mass 6γ =6
6. Inv. Mass 6γ >6

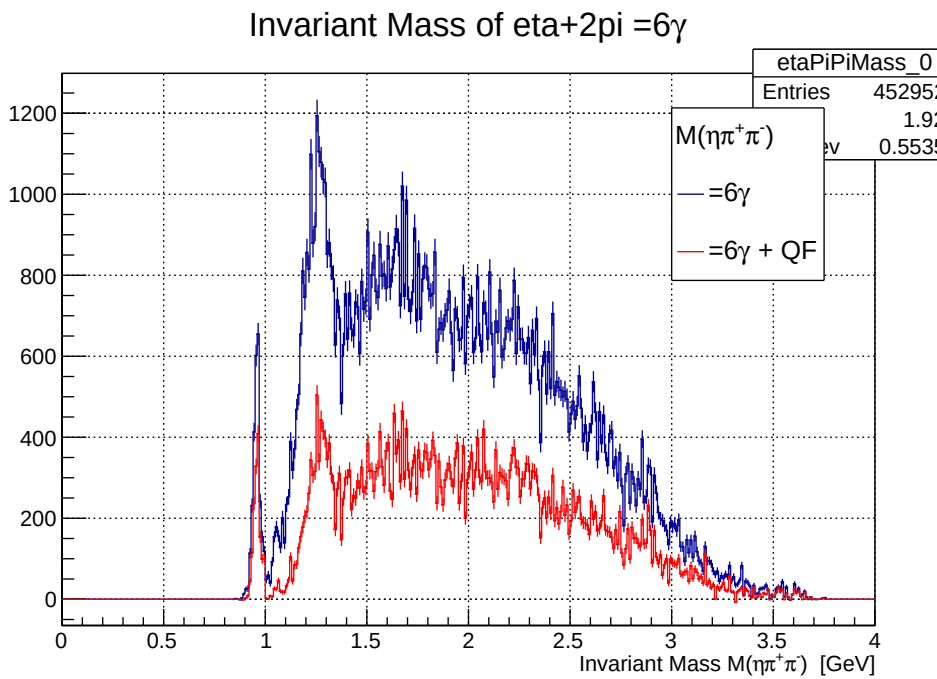


$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut
4. Inv. Mass $\pi^+\pi^-$: some ρ
5. Inv. Mass 6γ =6
6. Inv. Mass 6γ >6
7. Inv. Mass $\eta\pi^+\pi^-$ with =6γ

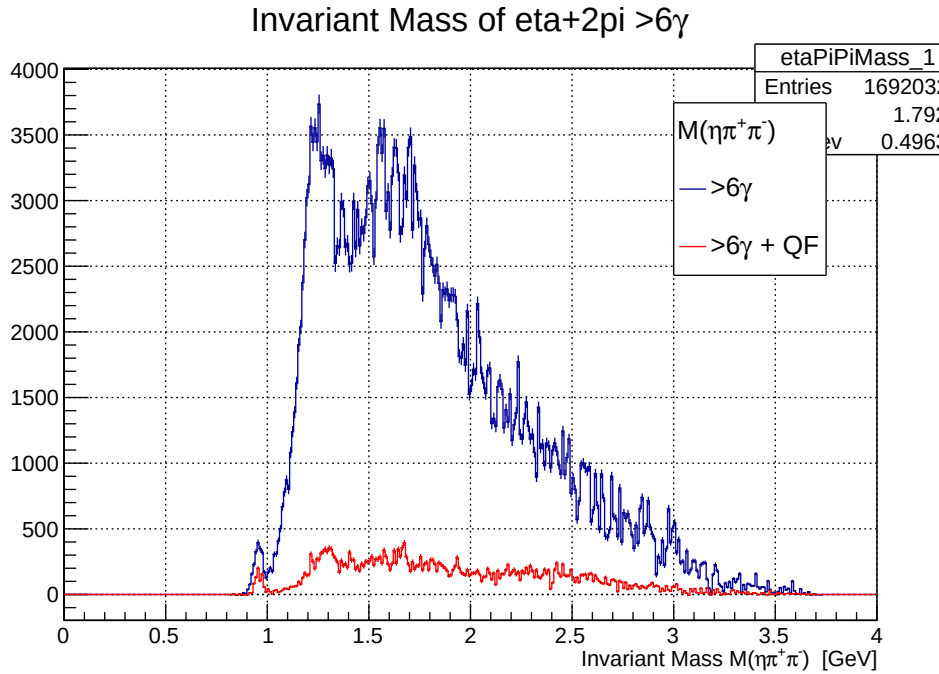


$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut
4. Inv. Mass $\pi^+\pi^-$: some ρ
5. Inv. Mass 6γ =6
6. Inv. Mass 6γ >6
7. Inv. Mass $\eta\pi^+\pi^-$ with =6γ
8. Inv. Mass $\eta\pi^+\pi^-$ with >6γ

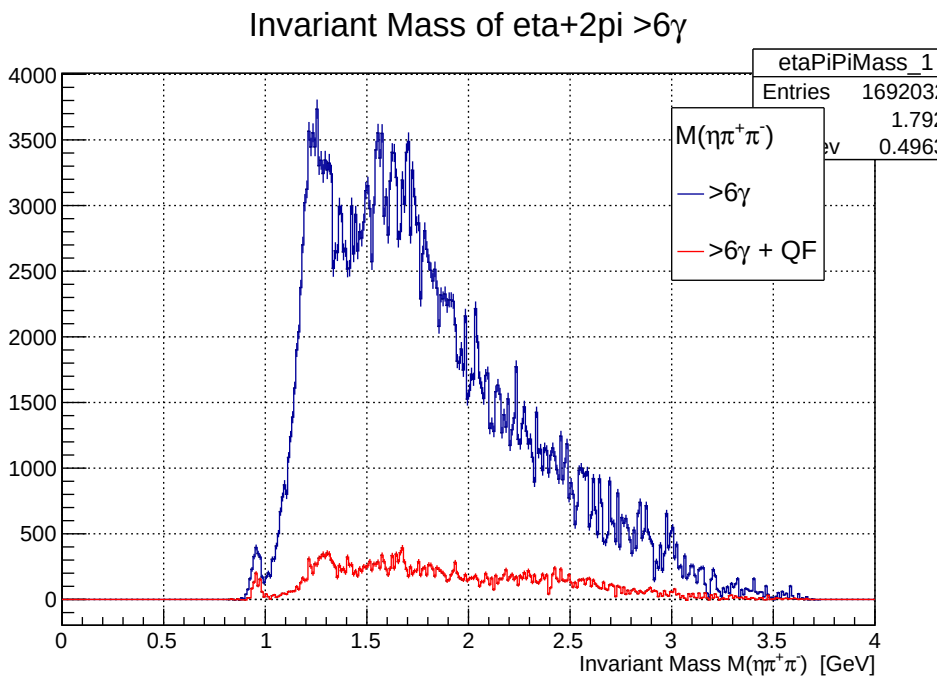


$\pi^+\pi^-6\gamma$ Final State

RunPeriod-2018-08/analysis/ver06/tree_pi0pi0pi0pippim__B4_M7

More Control plots:

1. pi^0 multiplicity =6γ
2. pi^0 multiplicity >6γ
3. pi^0 multiplicity With Chi2 cut
4. Inv. Mass $\pi^+\pi^-$: some ρ
5. Inv. Mass 6γ =6
6. Inv. Mass 6γ >6
7. Inv. Mass $\eta\pi^+\pi^-$ with =6γ
8. Inv. Mass $\eta\pi^+\pi^-$ with >6γ



Conclusion:

a) QF cut may help some in the case of $> 6\gamma$

b) Unused energ does not seem useful?