

Status Update on $Z(4430)^{\mp}$ Analysis

PANDA Collaboration Meeting 22/2

May 30th, 2022



Umut Keskin¹ on behalf of Turkish-PANDA Group[‡]

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² Department of EEE, Giresun University, Turkey

³ Istanbul Okan University, Turkey

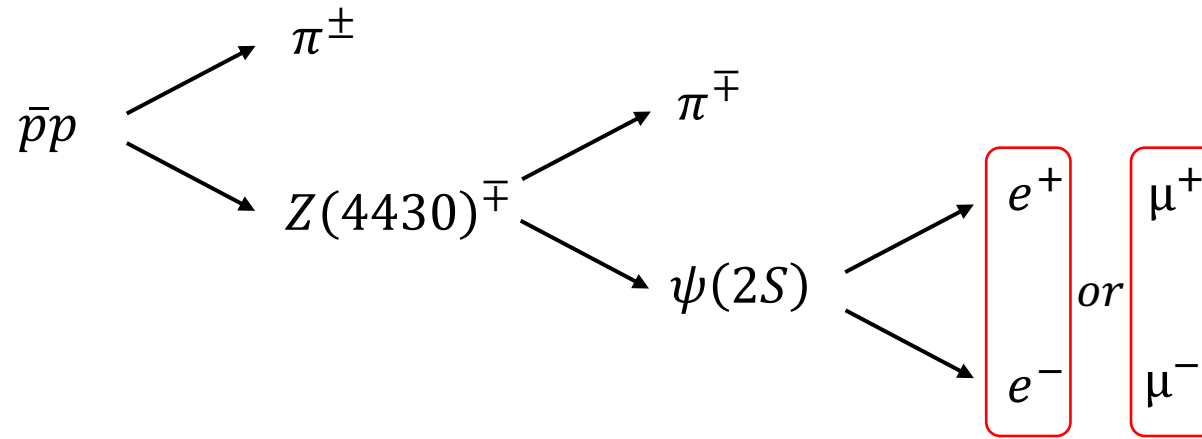
⁴ Department of Physics, Istanbul Dogus University, Turkey

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119F094



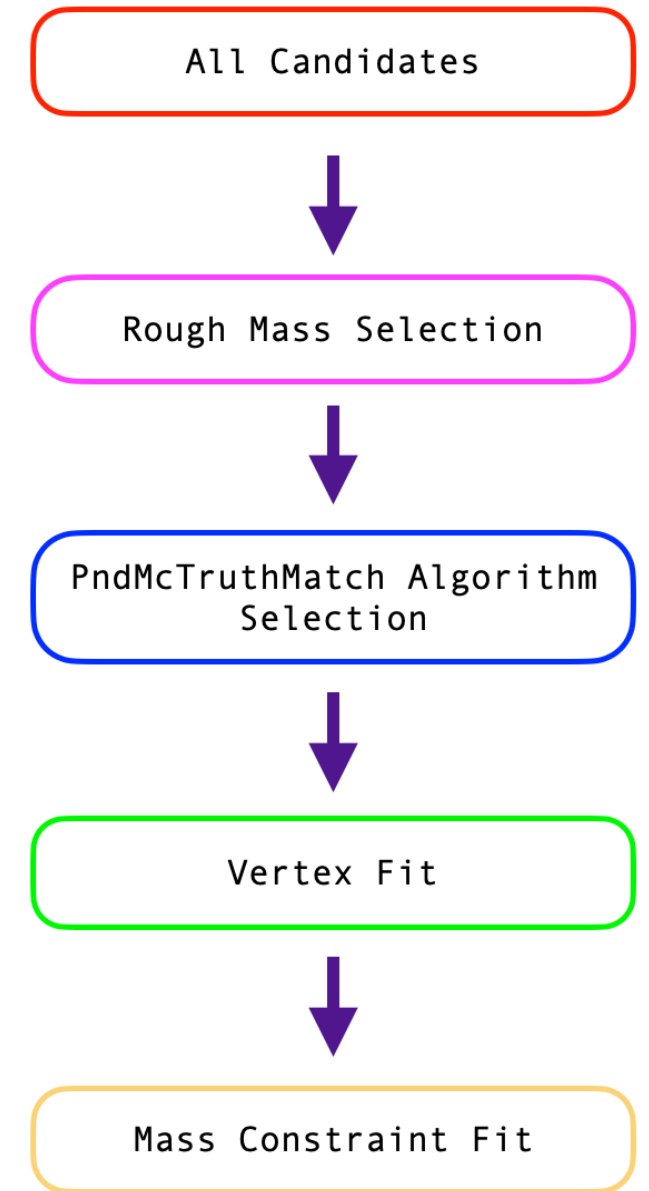
Monte Carlo Simulation



- Two intermediate resonances ($Z(4430)^-$ and $\psi(2S)$),
- Four final state particles : π^+, π^-, e^+ and e^- (or μ^+ and μ^-).

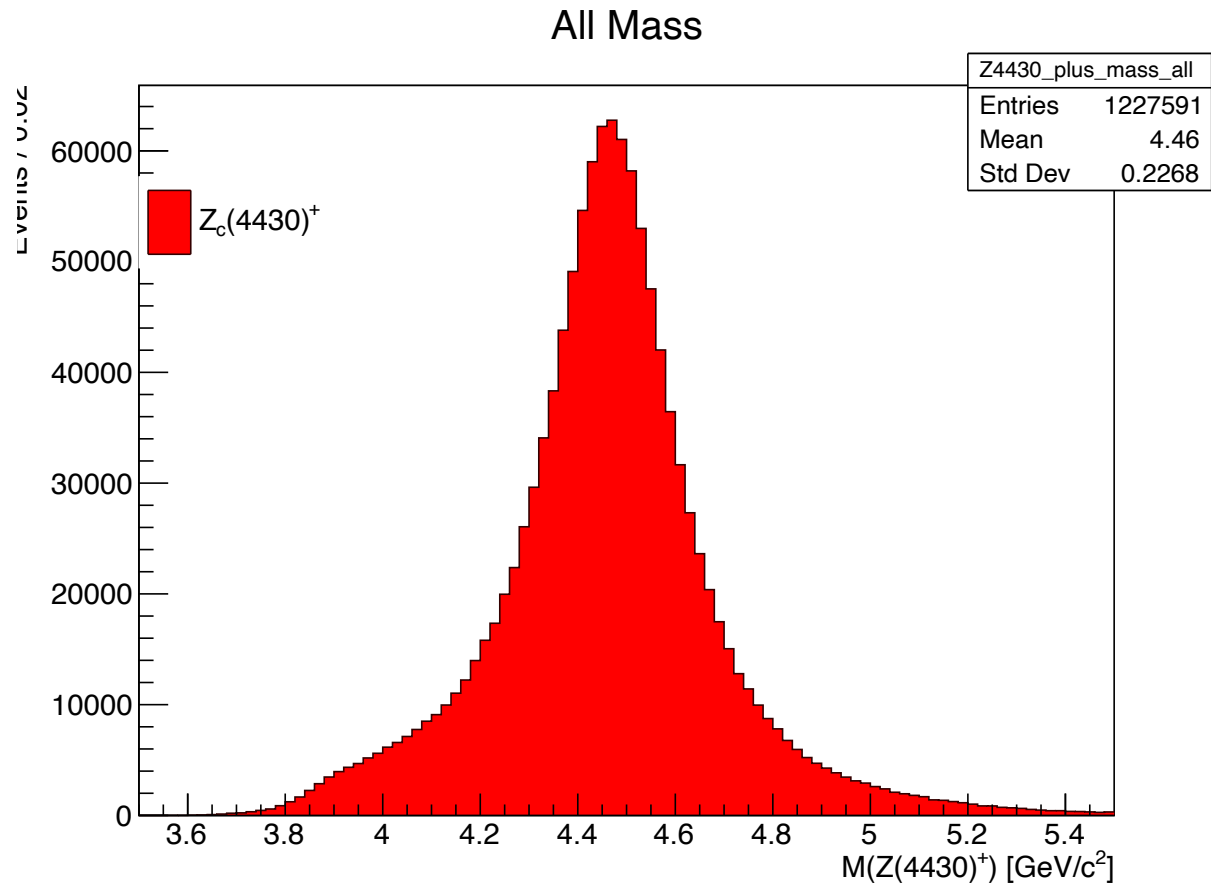
Reconstruction Algorithm & Strategy

- For particle reconstruction, we used an algorithm to select particles like in this scheme. After each cut/selection algorithm, reconstructed mass was remaked.
- At first, no cuts and nothing applied, just all reconstructed mass for that particle.
- Secondly, we applied a Rough Mass Cut about ± 0.25 GeV with "RhoMassParticleSelector".
- After that, McTruthMatch algorithm to select particles were applied.
- Then, McTruthMatch filtered candidates were gathered and Vertex Fit ($p>0.01$) applied to them.
- Lastly, after all that selection algorithm filters, last survived particle candidates were also applied a Mass Constraint Fit which is also $p>0.01$.

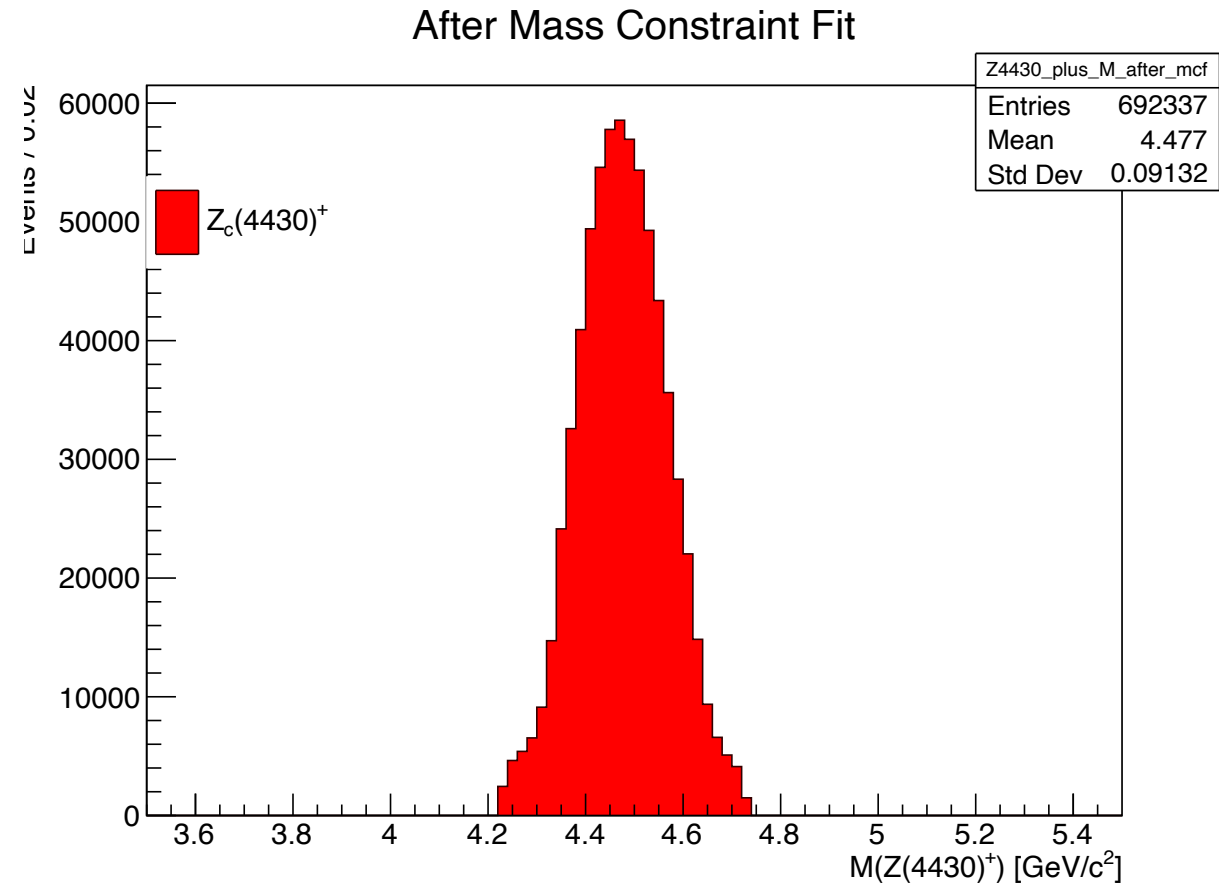


Analysis Update with Bigger Data (2M)
[Z(4430)⁺ @μ⁺μ⁻ channel]

2M events (no cuts)



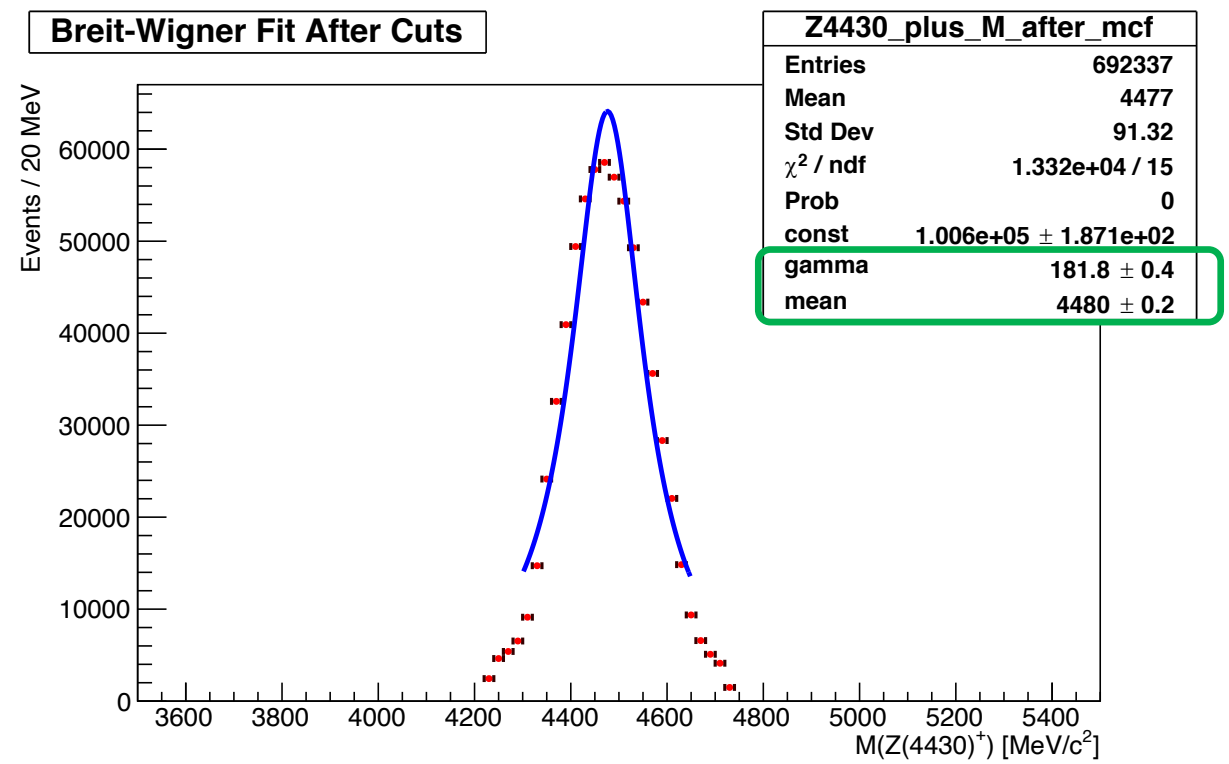
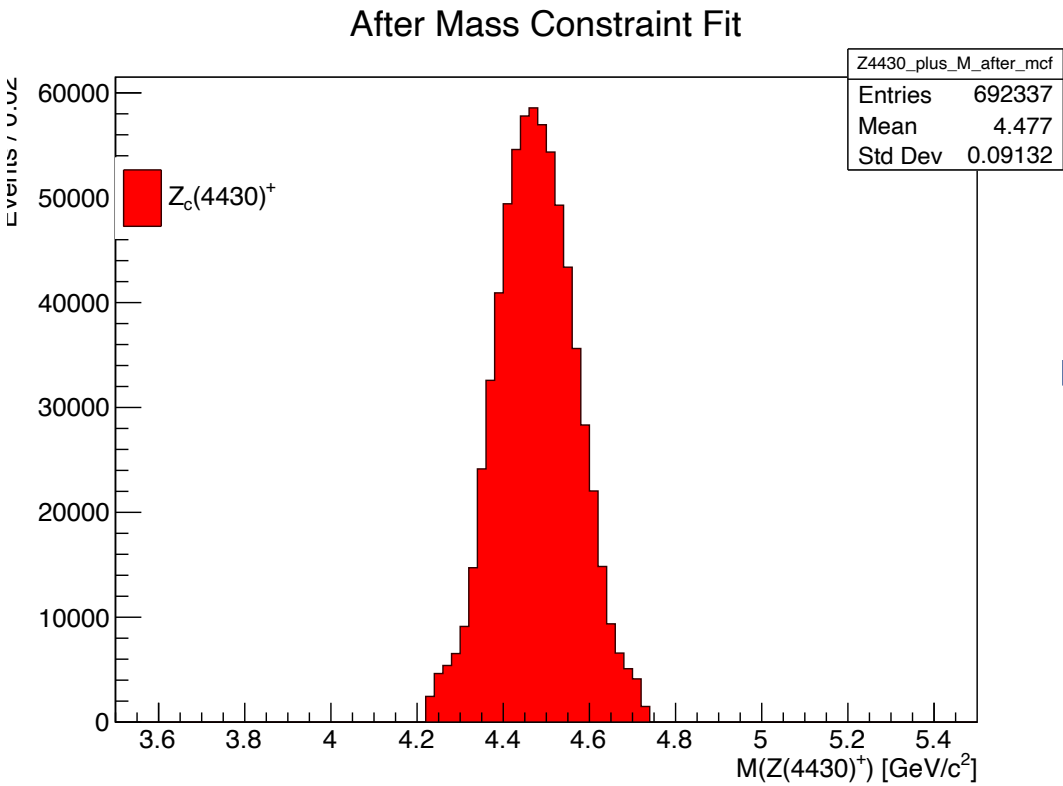
2M Events (after Mass selection, FTM, Vertex fit and mass constraint fit cuts)



Analysis Update with Bigger Data (2M)

[Z(4430)⁺ @ μ⁺ μ⁻ channel]

2M Events (Breit-Wigner fit after cuts)



```
1 *
2 * 21.04.2020 Updated by K. Goetzen. The format and convention are based on the current evt.pdl and PDG 2019
3 * - Updated particle data from http://pdg.lbl.gov/2019/mcd/mcd and http://pdglive.lbl.gov
4 * - Ordering according to http://pdg.lbl.gov/2008/reviews/montecarlo/rpp.pdf
5 *
6 *
7 * [basic]      name      id      mass/GeV      width/GeV      max_Dm/GeV      3*charge 2*spin lifetime*c/mm  PythiaId
8 add p Particle Z_c(4430)- -99210443  4.4780000e+00  1.8100000e-01  1.8100000e+00  -3      2  0.0000000e+00  -99210443
```

Z(4430) Mass : 4478⁺¹⁵₋₁₈ MeV
Z(4430) Width : 181 ± 31 MeV

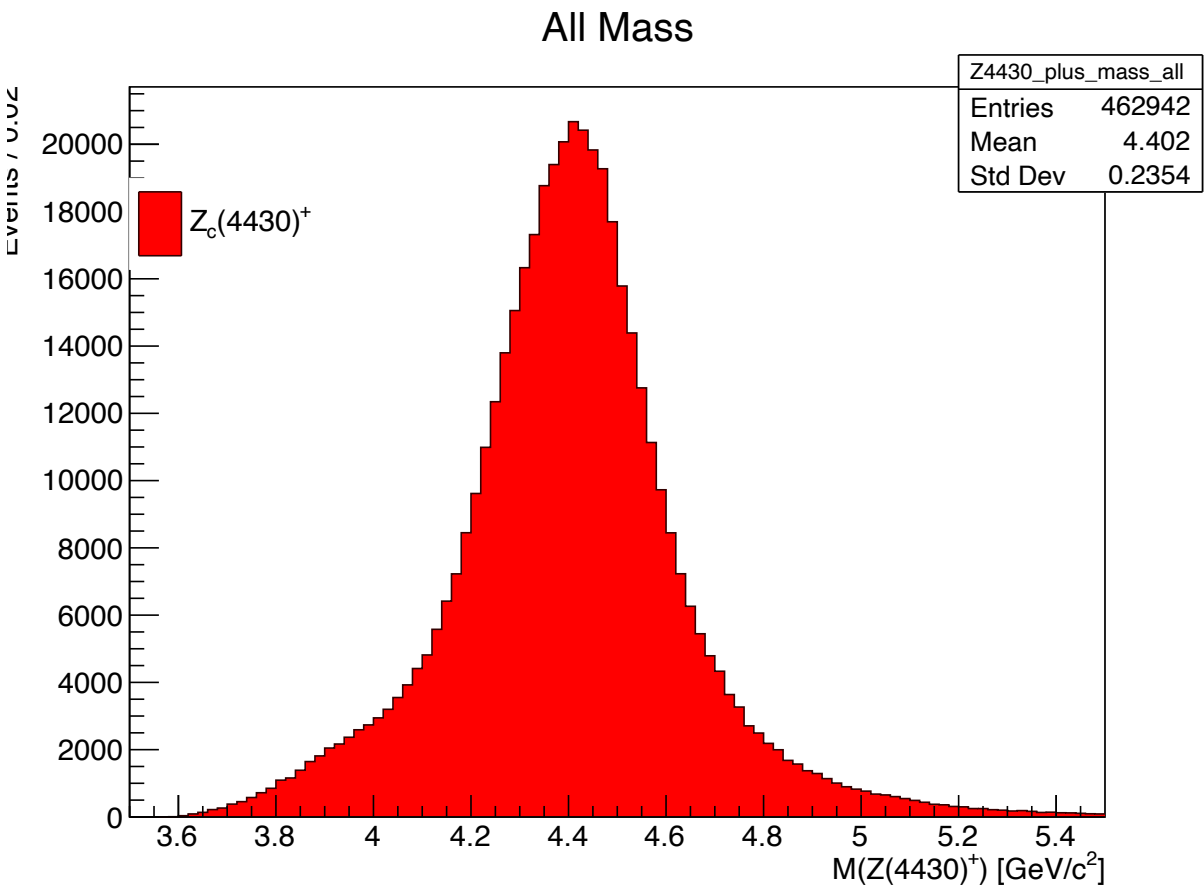
Z(4430) Mass : 4480 ± 0.2 MeV
Z(4430) Width : 181.8 ± 0.4 MeV

Z(4430) Mass → 99.96% accuracy
Z(4430) Width → 99.56% accuracy

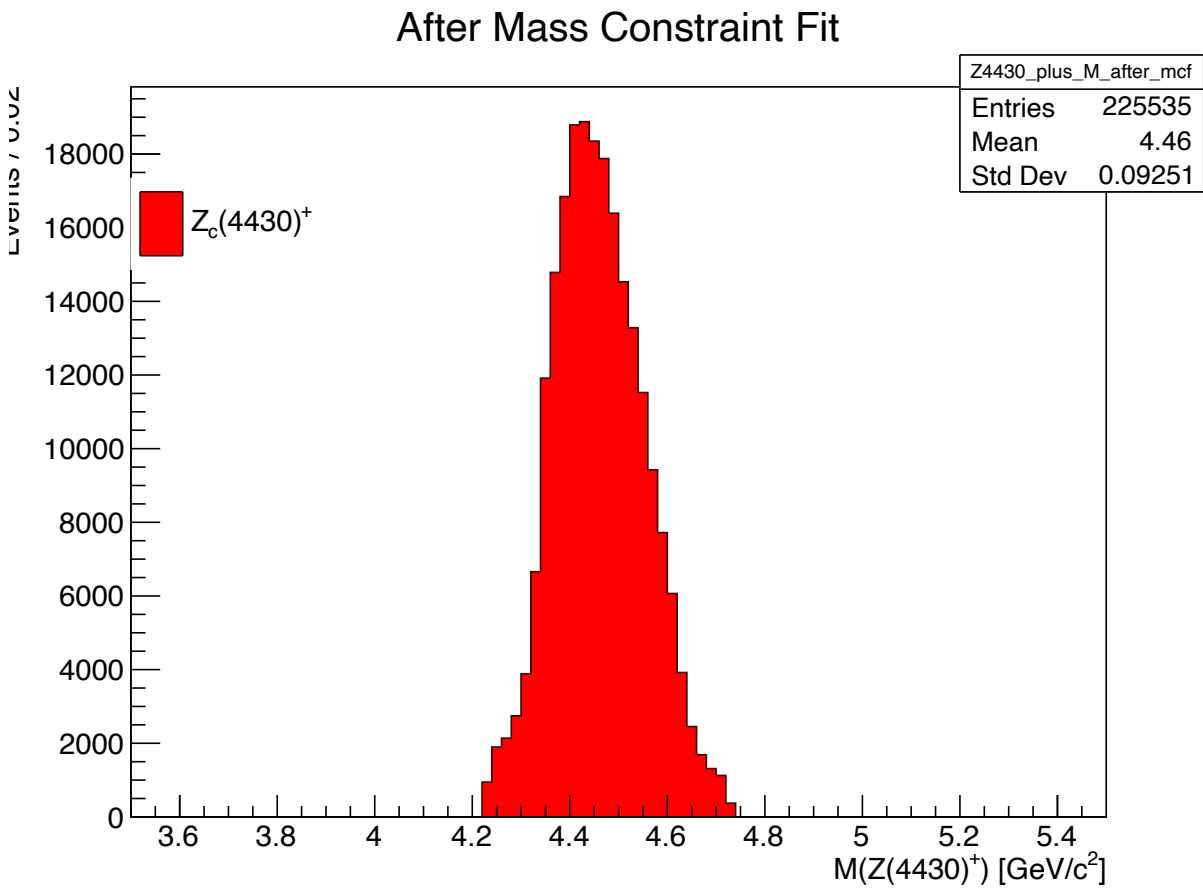
Analysis Update with Bigger Data (2M)

[Z(4430)⁺ @e⁺e⁻ channel]

2M events (no cuts)



2M Events (after Mass selection, FTM, Vertex fit and mass constraint fit cuts)

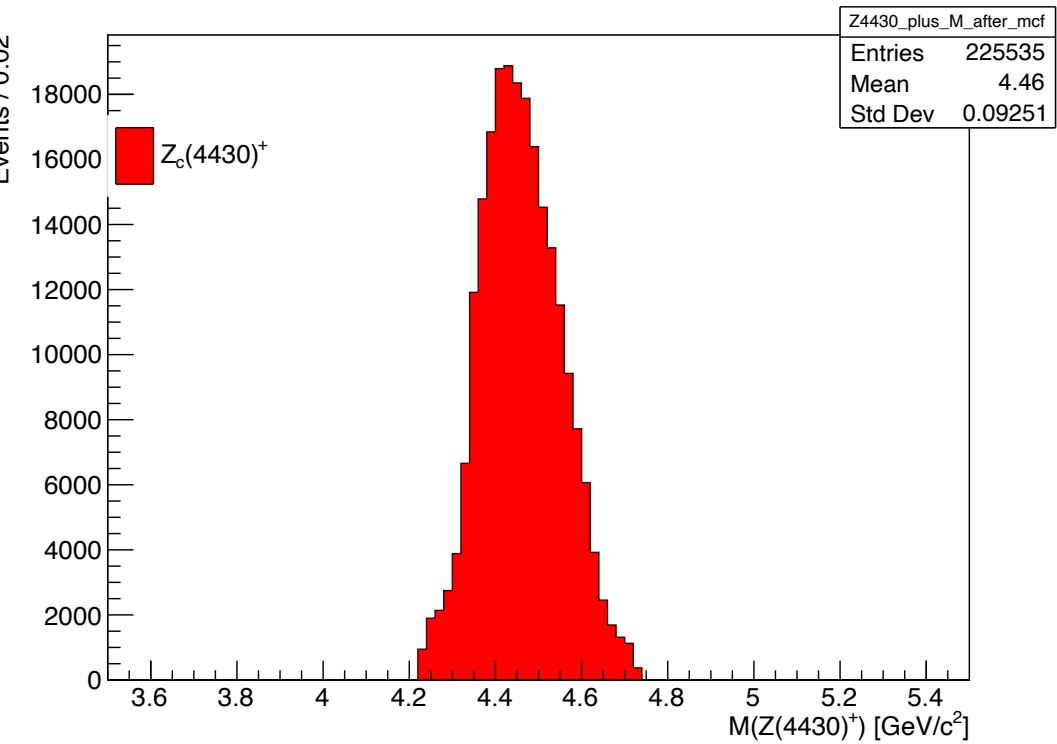


Analysis Update with Bigger Data (2M)

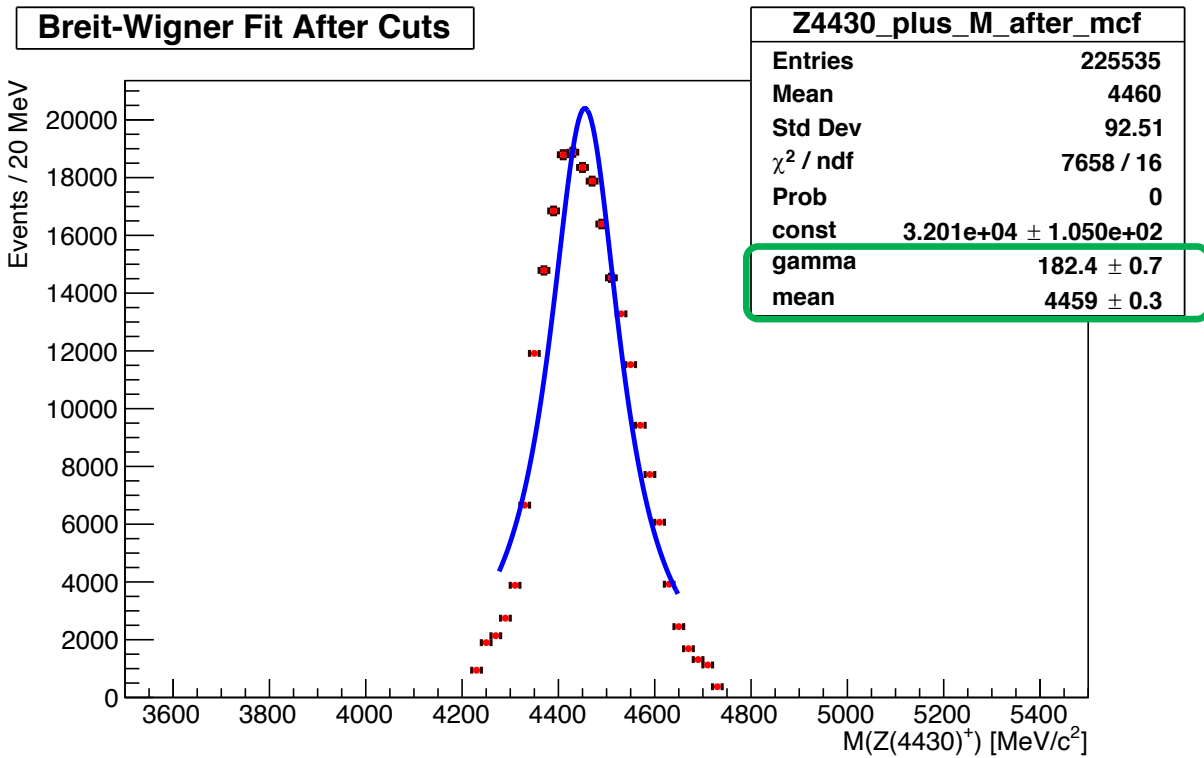
[Z(4430)⁺ @ e⁺ e⁻ channel]

2M Events (Breit-Wigner fit after cuts)

After Mass Constraint Fit



Breit-Wigner Fit After Cuts



```
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3 * - Updated particle data from http://pdg.lbl.gov/2019/mcd/mcdata/mass_width_2019.mcd and http://pdglive.lbl.gov
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5 *-----*
6 *
7 * [basic]      name                id      mass/GeV  width/GeV  max_Dm/GeV  3*charge  2*spin  lifetime*c/mm  PythiaId
8 add p Particle Z_c(4430)-         -99210443  4.4780000e+00  1.8100000e-01  1.8100000e+00  -3      2      0.0000000e+00  -99210443
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Z(4430) Mass : 4478⁺¹⁵₋₁₈ MeV
Z(4430) Width : 181 ± 31 MeV

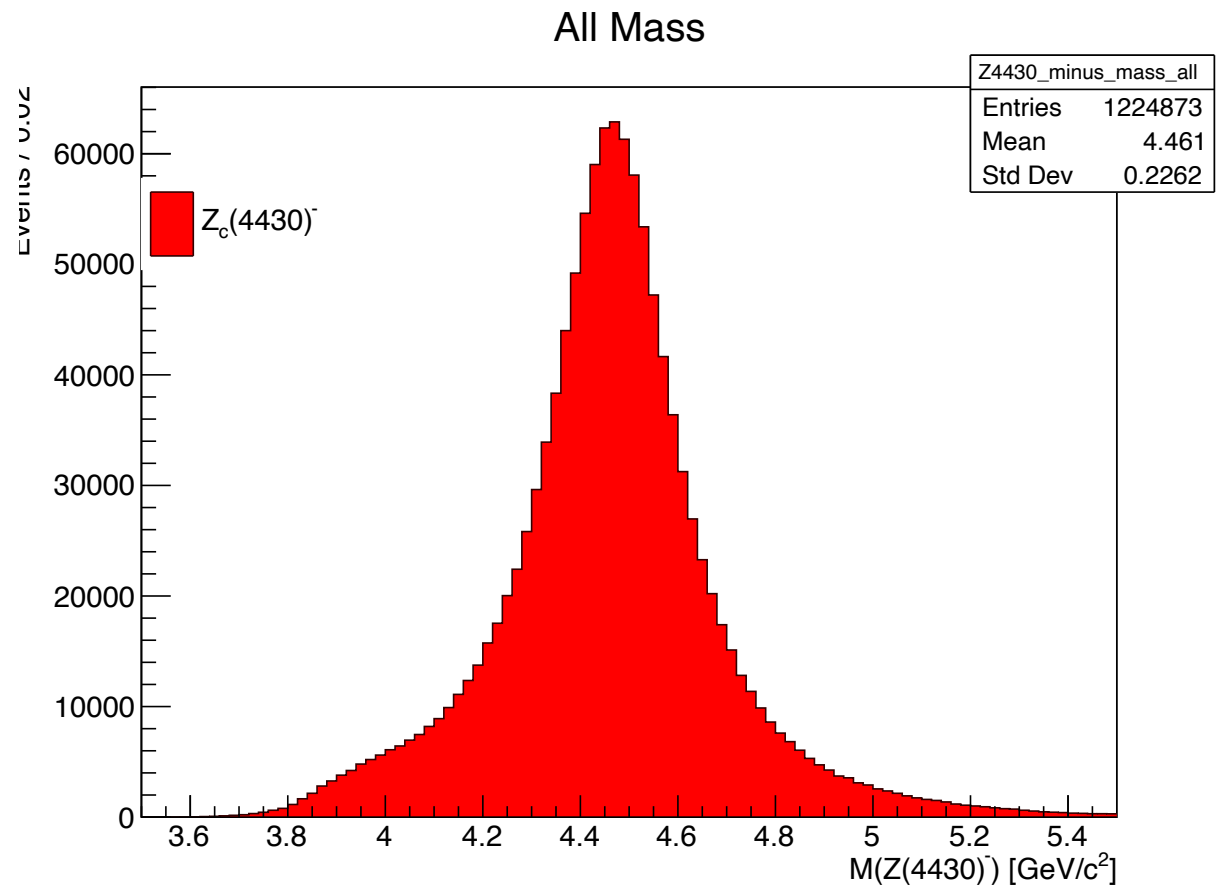
Z(4430) Mass : 4459 ± 0.3 MeV
Z(4430) Width : 182.4 ± 0.3 MeV

Z(4430) Mass → 99.58% accuracy
Z(4430) Width → 99.23% accuracy

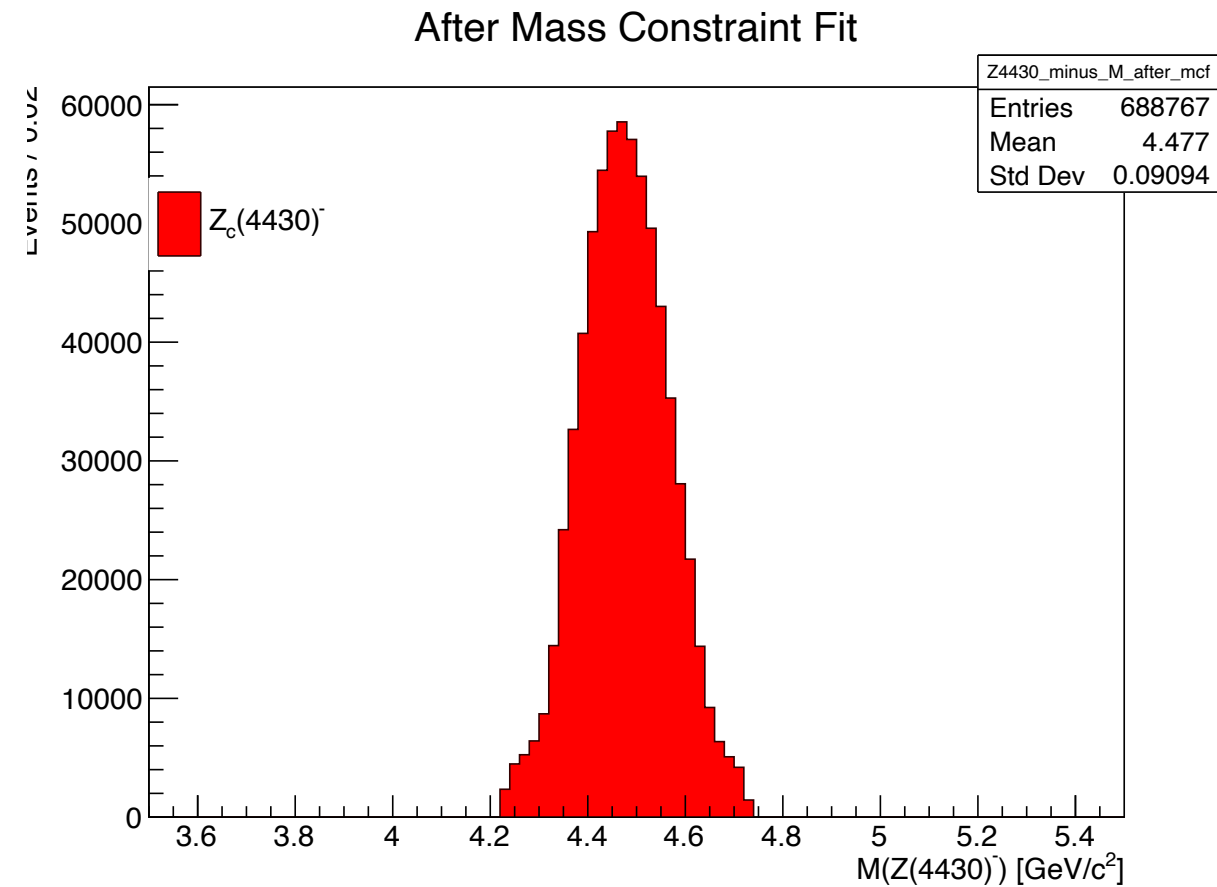
Analysis Update with Bigger Data (2M)

[Z(4430)⁻ @ $\mu^+\mu^-$ channel]

2M events (no cuts)



2M Events (after Mass selection, FTM, Vertex fit and mass constraint fit cuts)

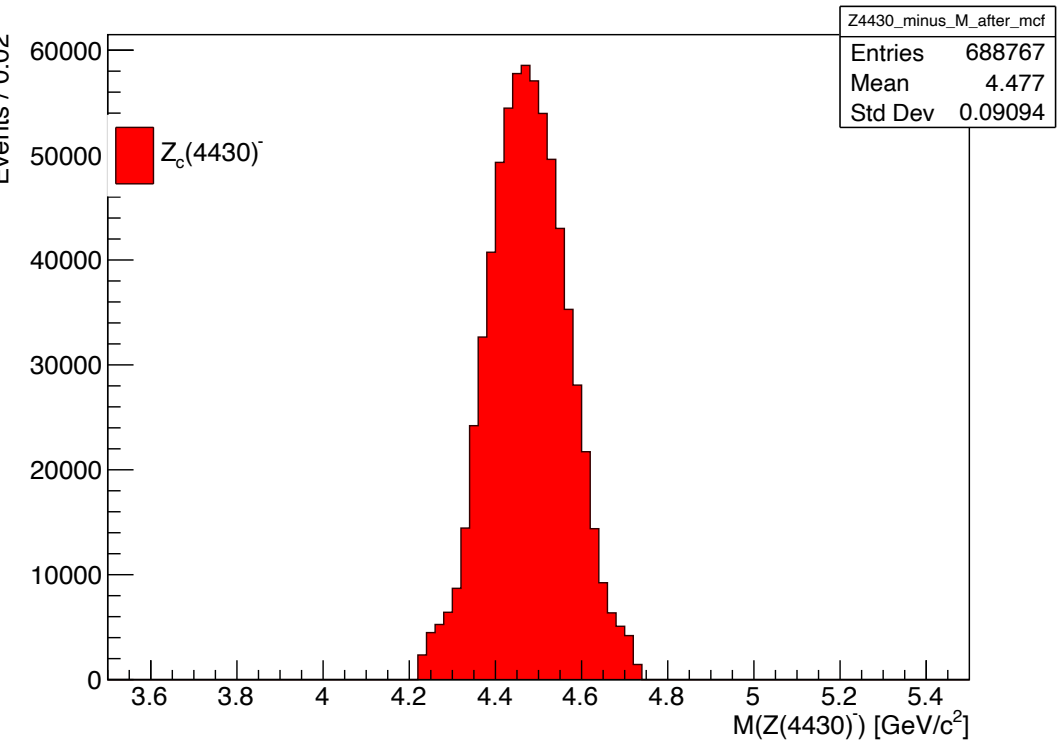


Analysis Update with Bigger Data (2M)

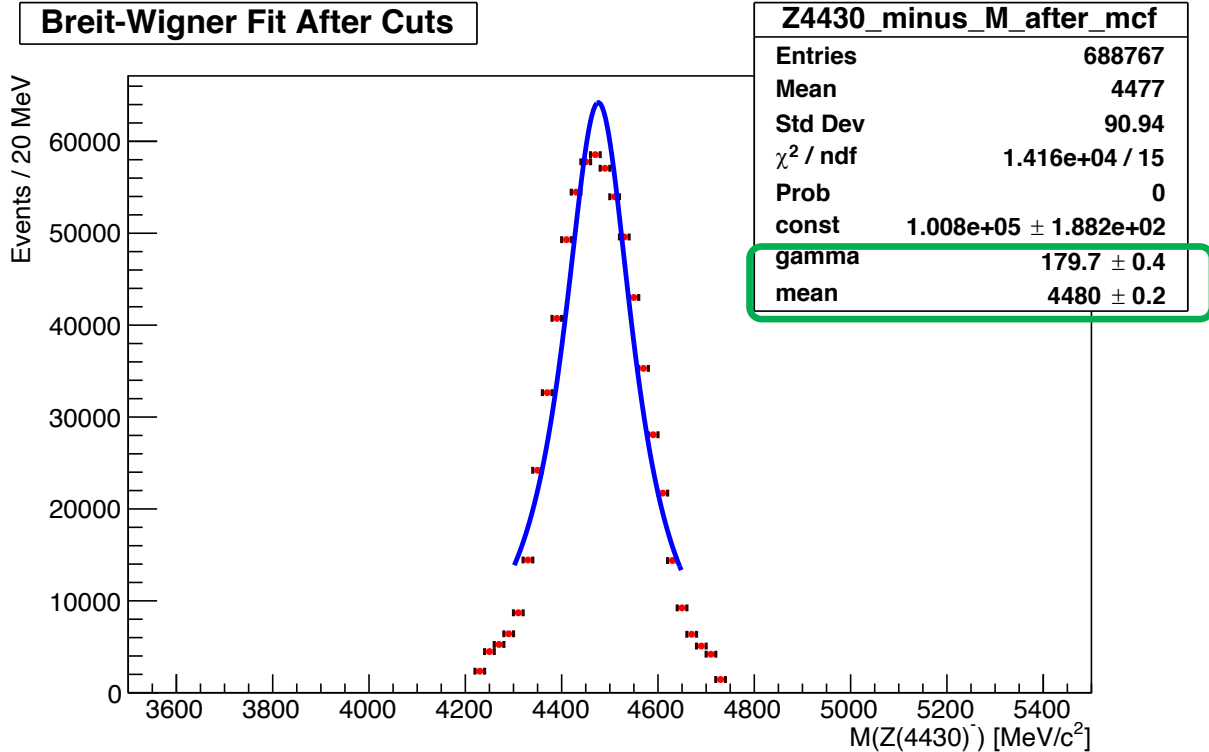
[Z(4430)⁻ @ μ⁺ μ⁻ channel]

2M Events (Breit-Wigner fit after cuts)

After Mass Constraint Fit



Breit-Wigner Fit After Cuts



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8 add p Particle Z_c(4430)- -99210443 4.4780000e+00 1.8100000e-01 1.8100000e+00 -3 2 0.0000000e+00 -99210443
```



Z(4430) Mass : 4478^{+15}_{-18} MeV
Z(4430) Width : 181 ± 31 MeV

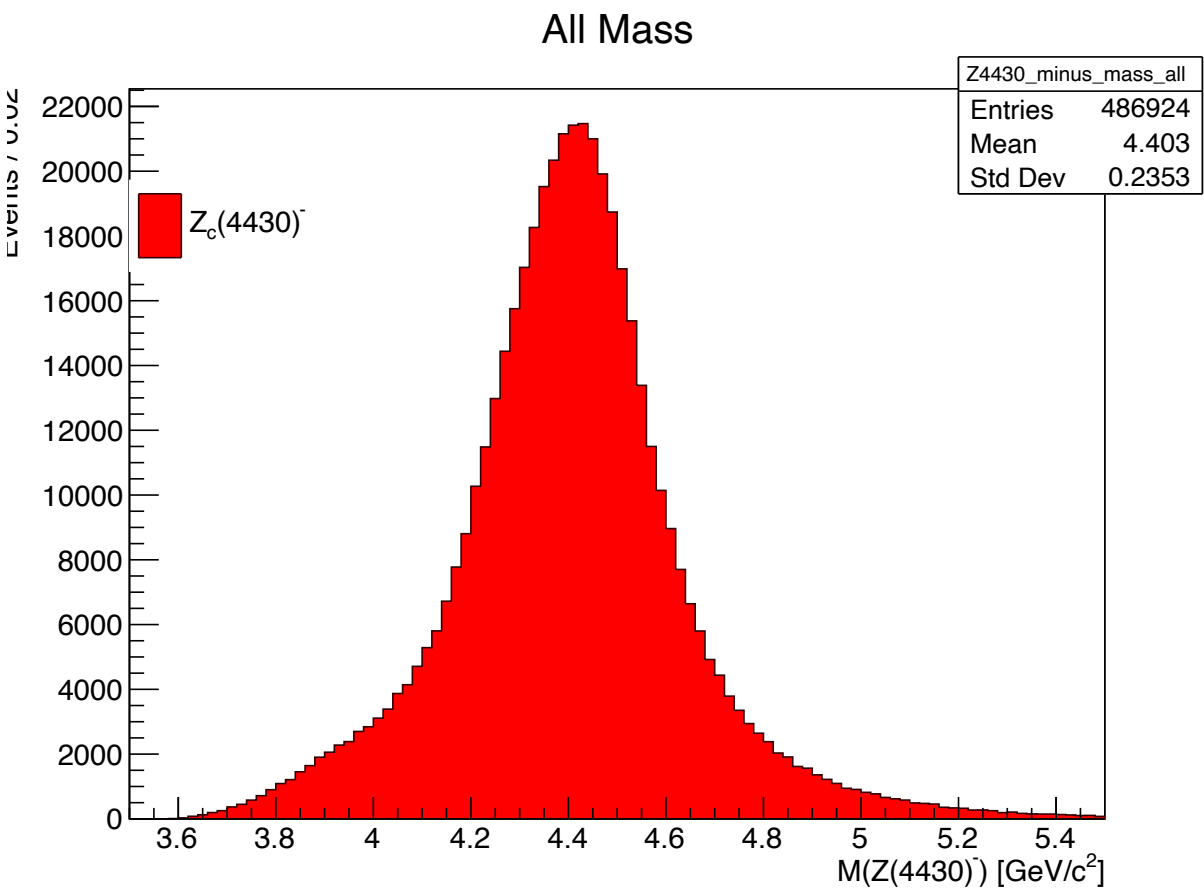
Z(4430) Mass : 4480 ± 0.2 MeV
Z(4430) Width : 179.7 ± 0.4 MeV

Z(4430) Mass → 99.96% accuracy
Z(4430) Width → 99.28% accuracy

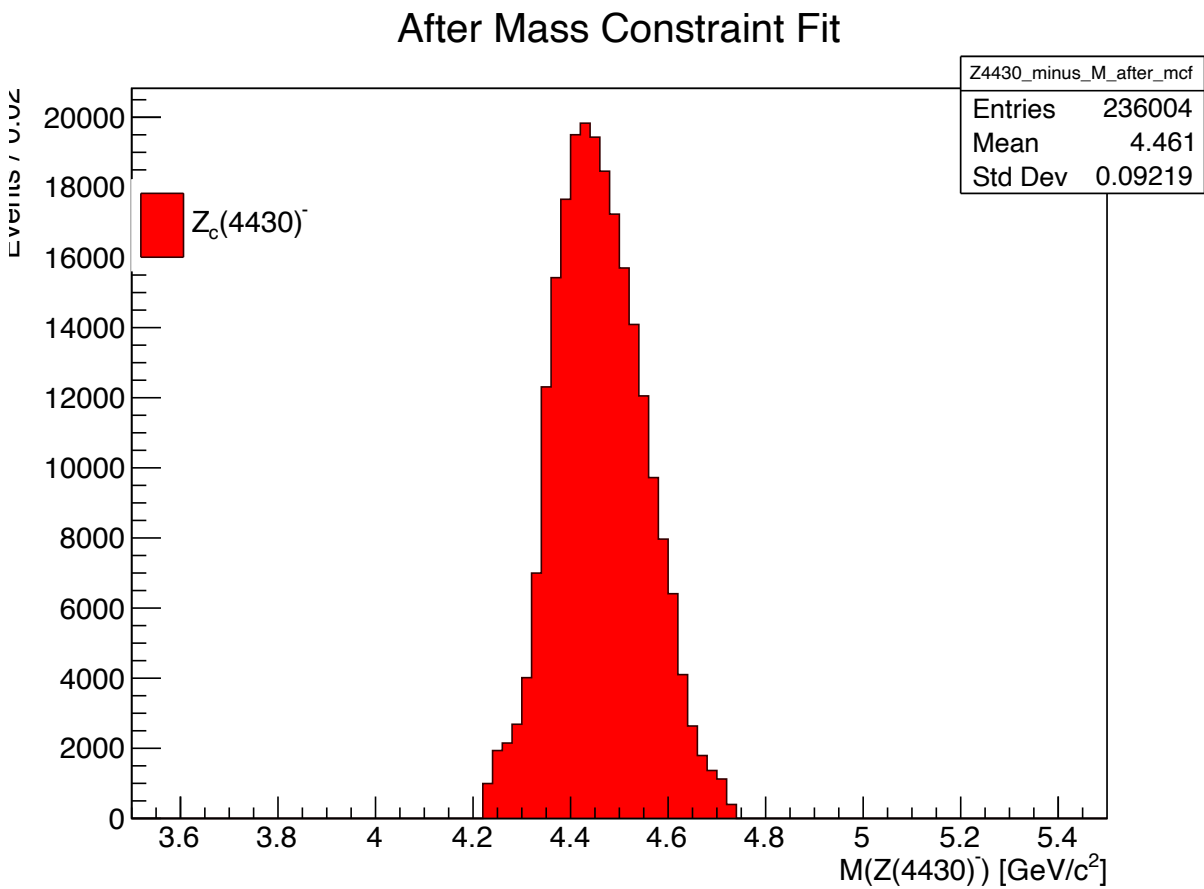
Analysis Update with Bigger Data (2M)

[Z(4430)⁻ @e⁺e⁻ channel]

2M events (no cuts)



2M Events (after Mass selection, FTM, Vertex fit and mass constraint fit cuts)

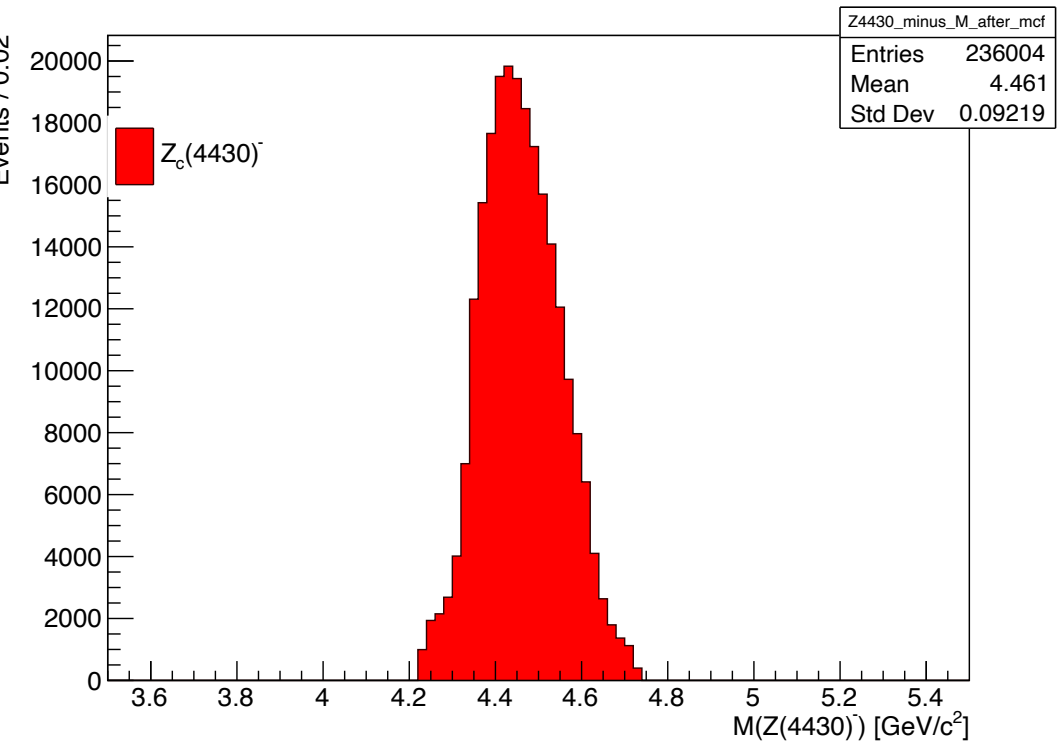


Analysis Update with Bigger Data (2M)

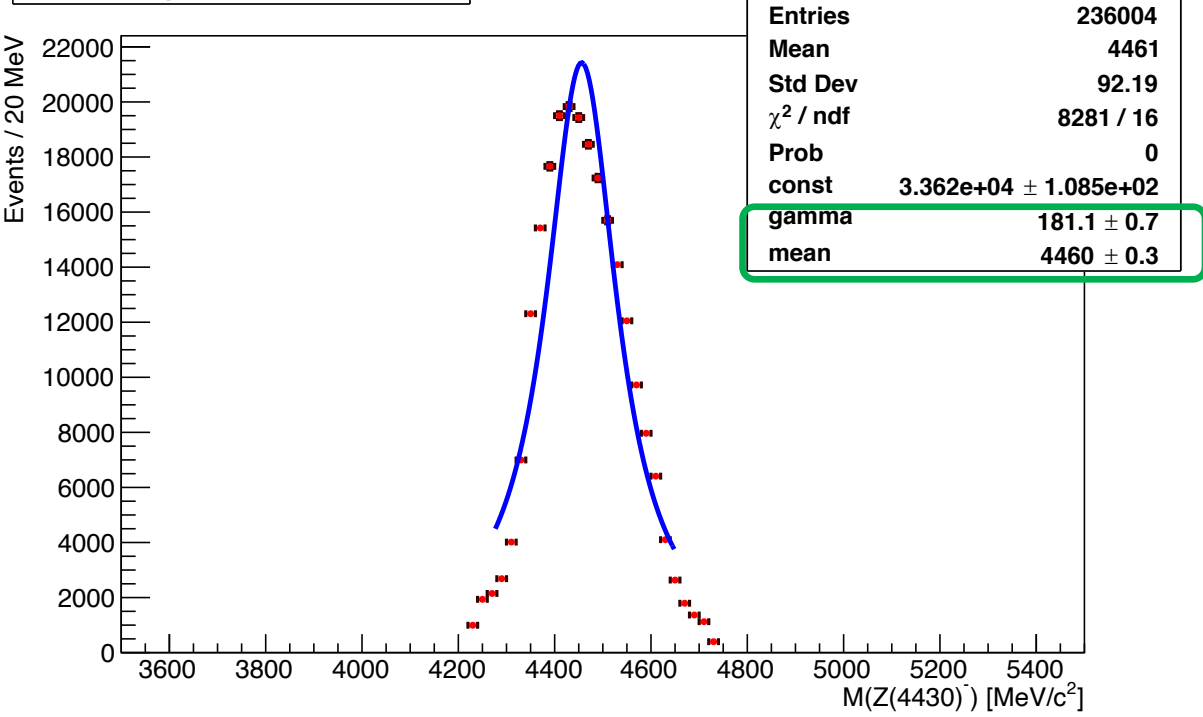
[Z(4430)⁻ @e⁺e⁻ channel]

2M Events (Breit-Wigner fit after cuts)

After Mass Constraint Fit



Breit-Wigner Fit After Cuts



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2 * 21.04.2020 Updated by K. Goetzen. The format and convention are based on the current evt.pdl and PDG 2019
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5 *
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7 * [basic]      name      id      mass/GeV      width/GeV      max_Dm/GeV      3*charge 2*spin lifetime*c/mm  PythiaId
8 add p Particle Z_c(4430)-      -99210443      4.4780000e+00      1.8100000e-01      1.8100000e+00      -3      2      0.0000000e+00      -99210443
```



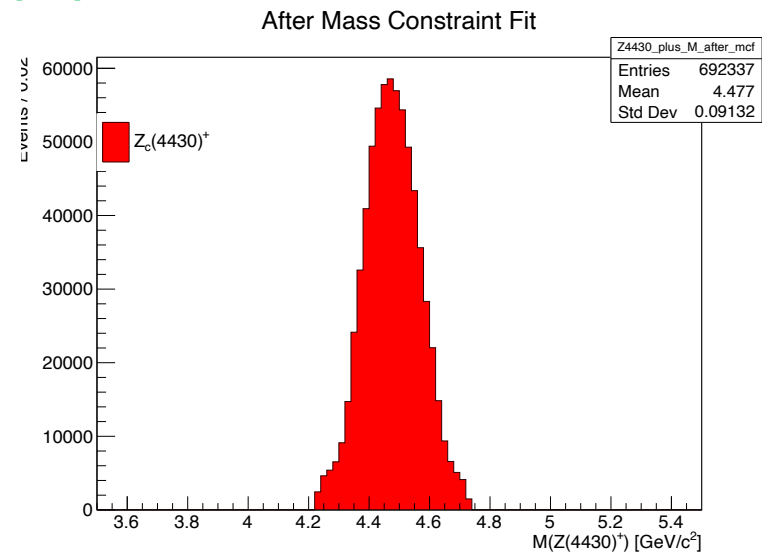
Z(4430) Mass : 4478^{+15}_{-18} MeV
Z(4430) Width : 181 ± 31 MeV

Z(4430) Mass : 4460 ± 0.3 MeV
Z(4430) Width : 181.1 ± 0.7 MeV

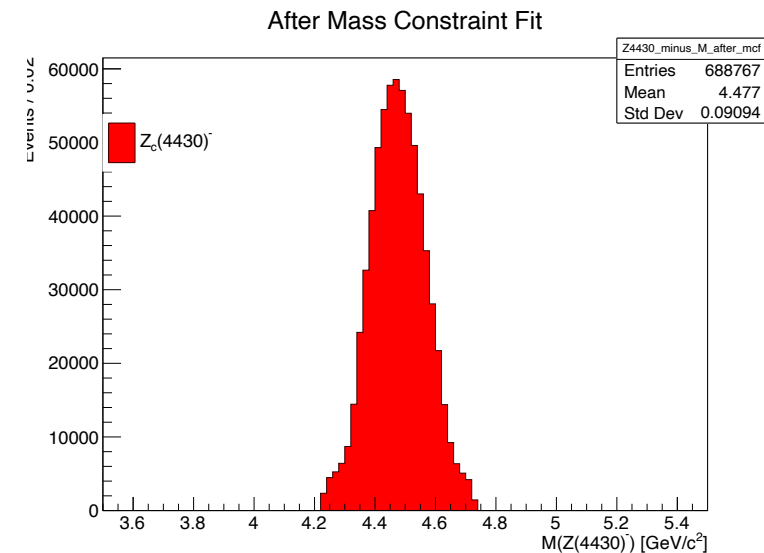
Z(4430) Mass → 99.60% accuracy
Z(4430) Width → 99.94% accuracy

Analysis Update with Bigger Data (2M)

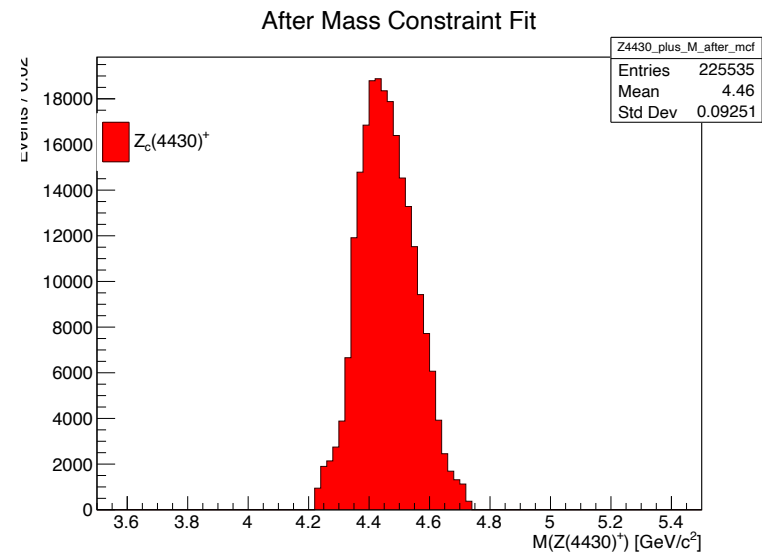
[Z(4430)⁺ @μ⁺μ⁻ channel]



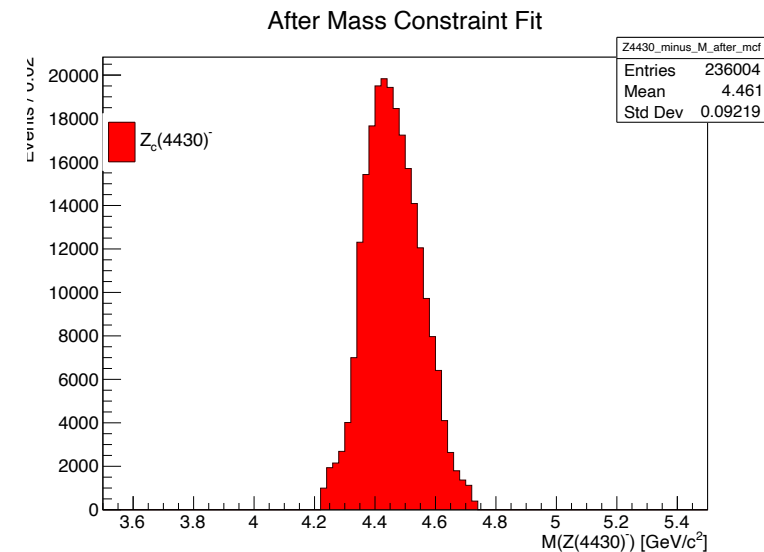
[Z(4430)⁻ @μ⁺μ⁻ channel]



[Z(4430)⁺ @e⁺e⁻ channel]

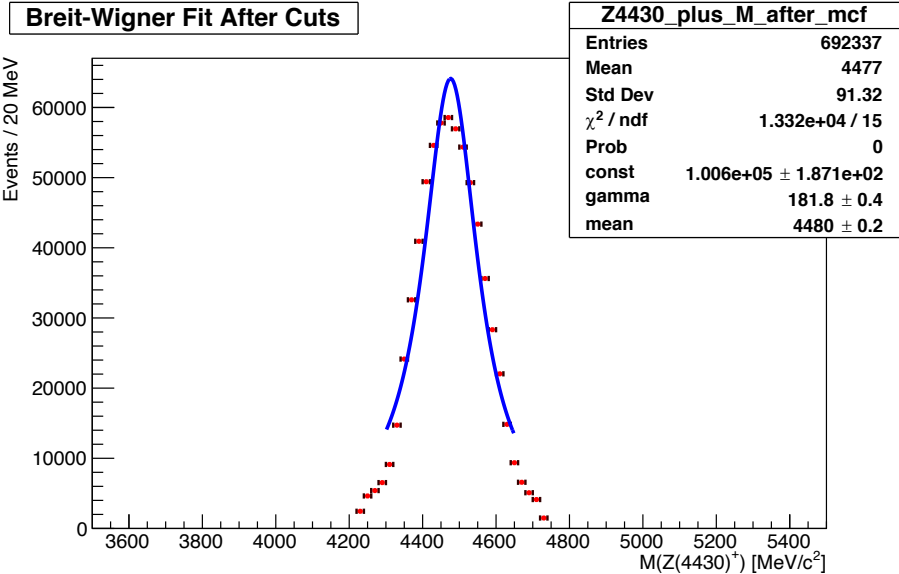


[Z(4430)⁻ @e⁺e⁻ channel]

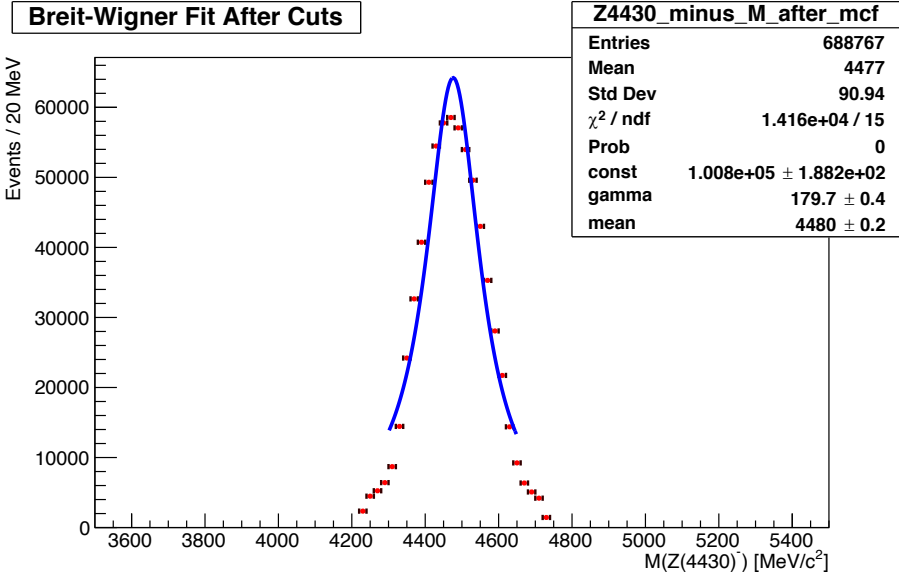


Analysis Update with Bigger Data (2M)

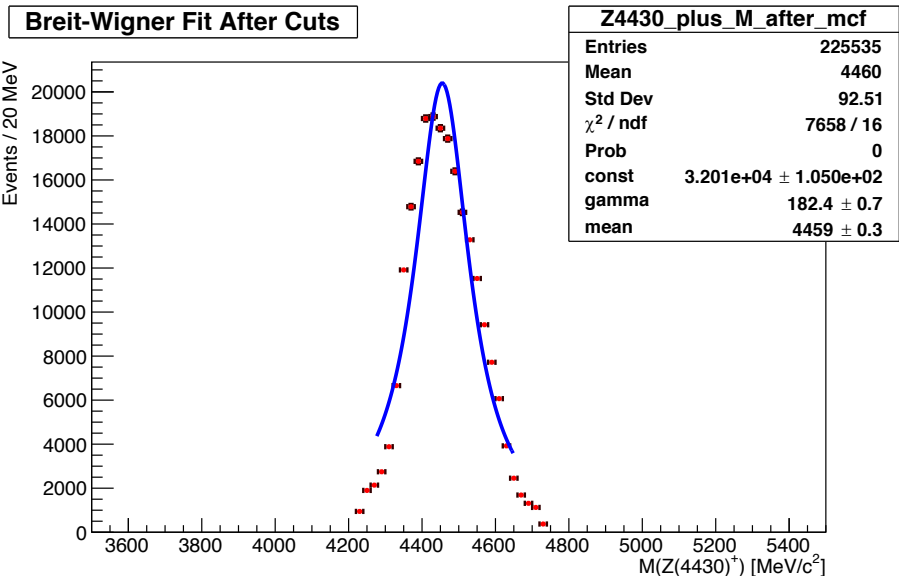
[Z(4430)⁺ @μ⁺μ⁻ channel]



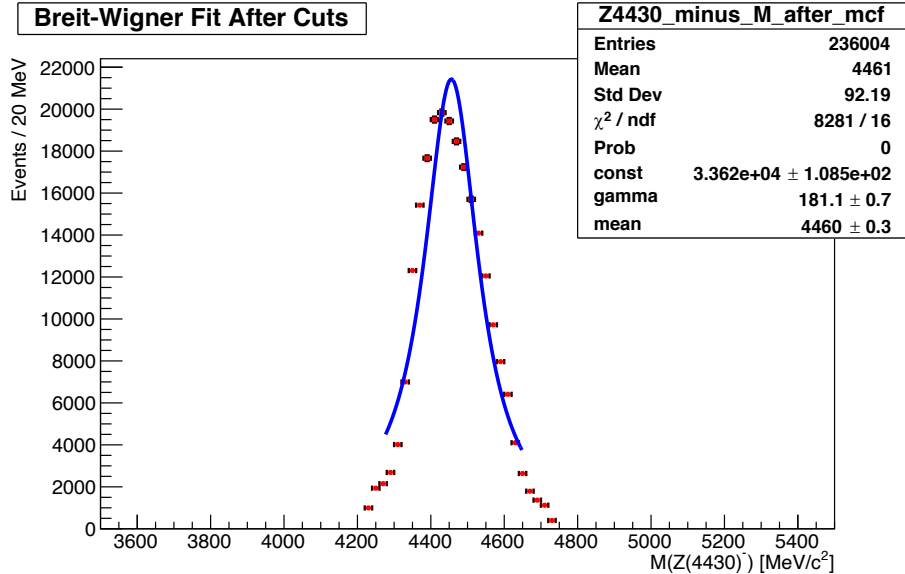
[Z(4430)⁻ @μ⁺μ⁻ channel]



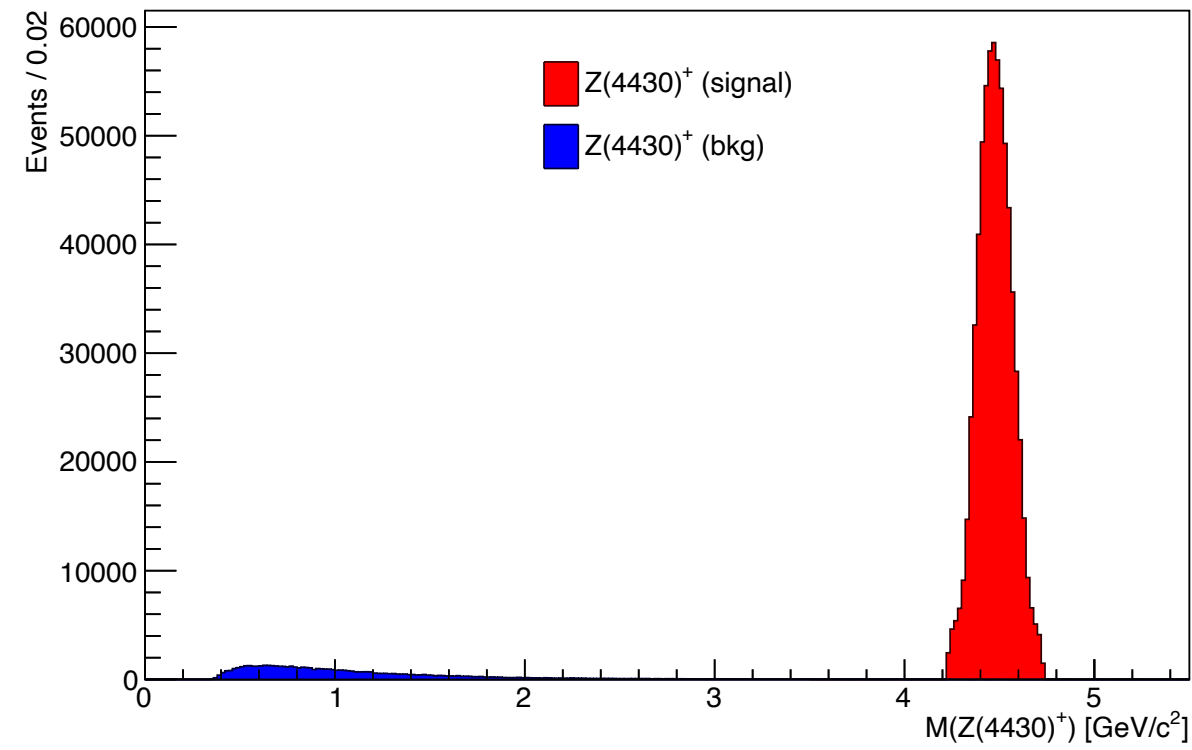
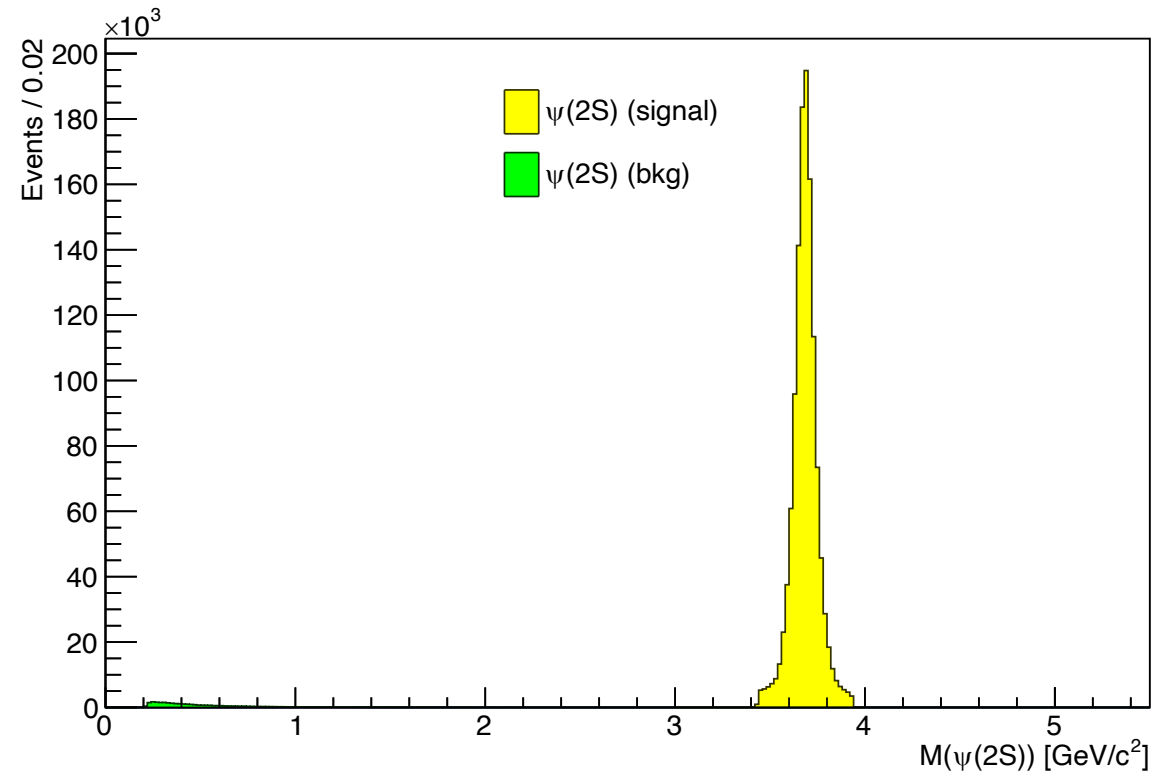
[Z(4430)⁺ @e⁺e⁻ channel]



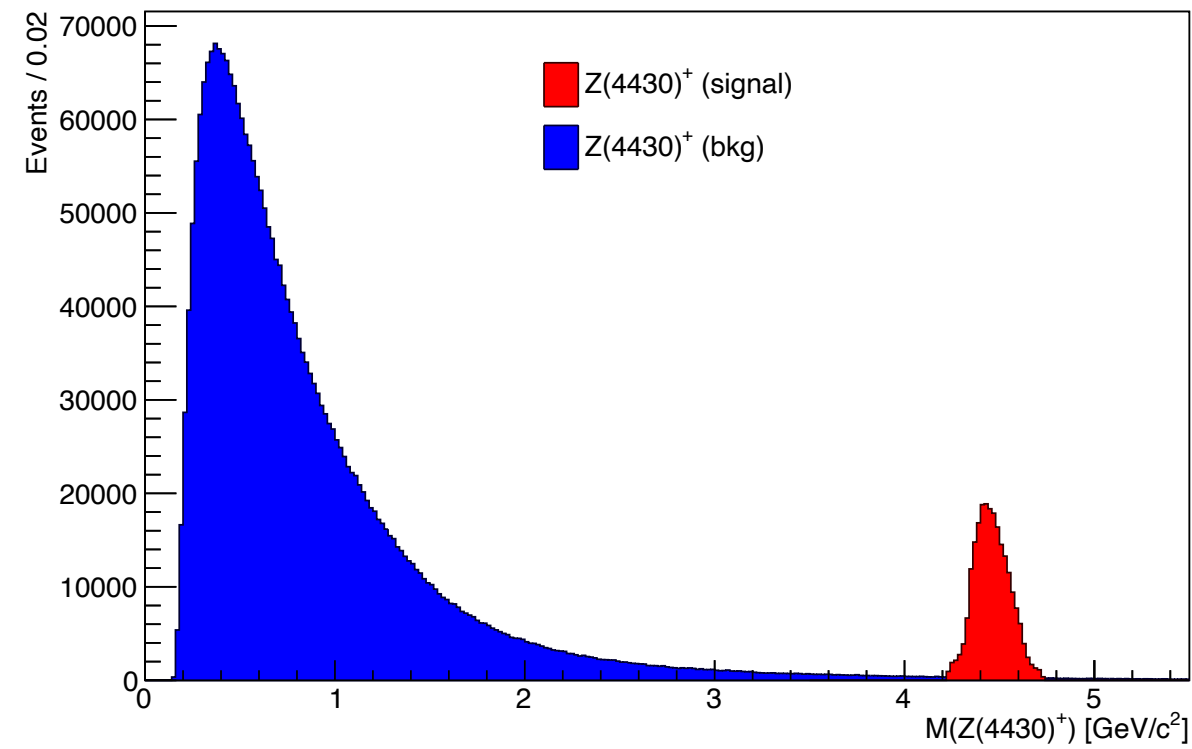
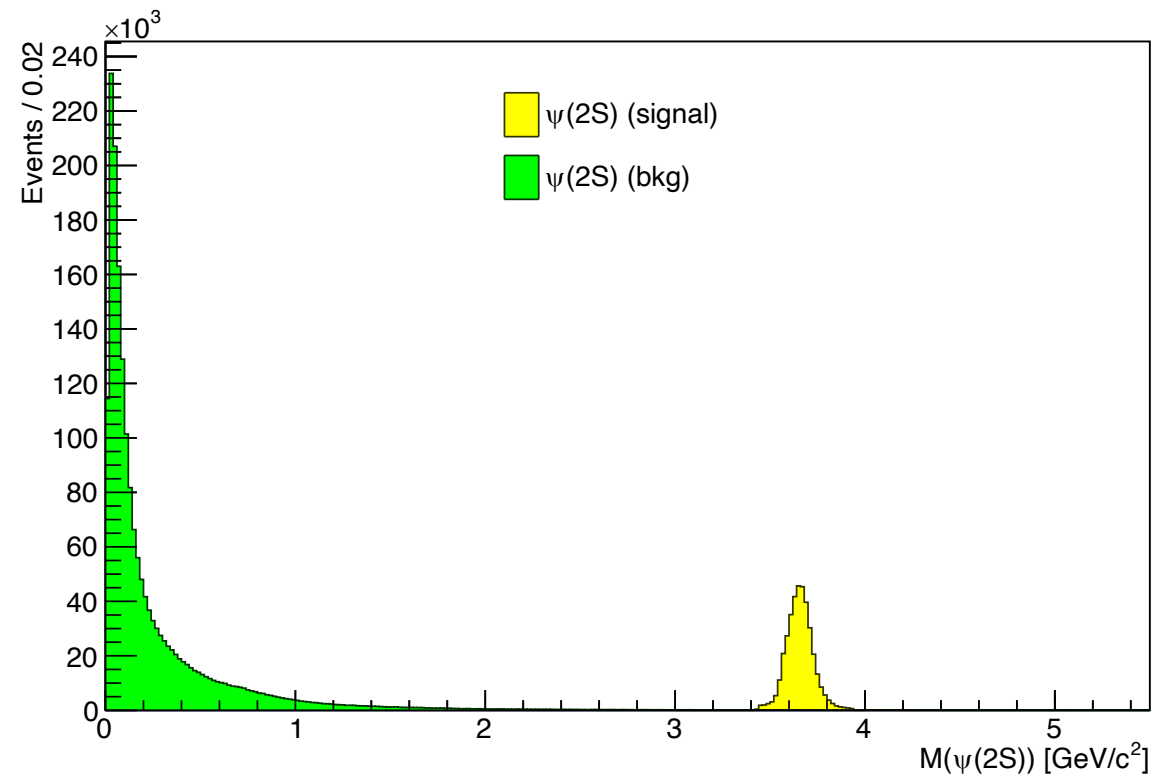
[Z(4430)⁻ @e⁺e⁻ channel]



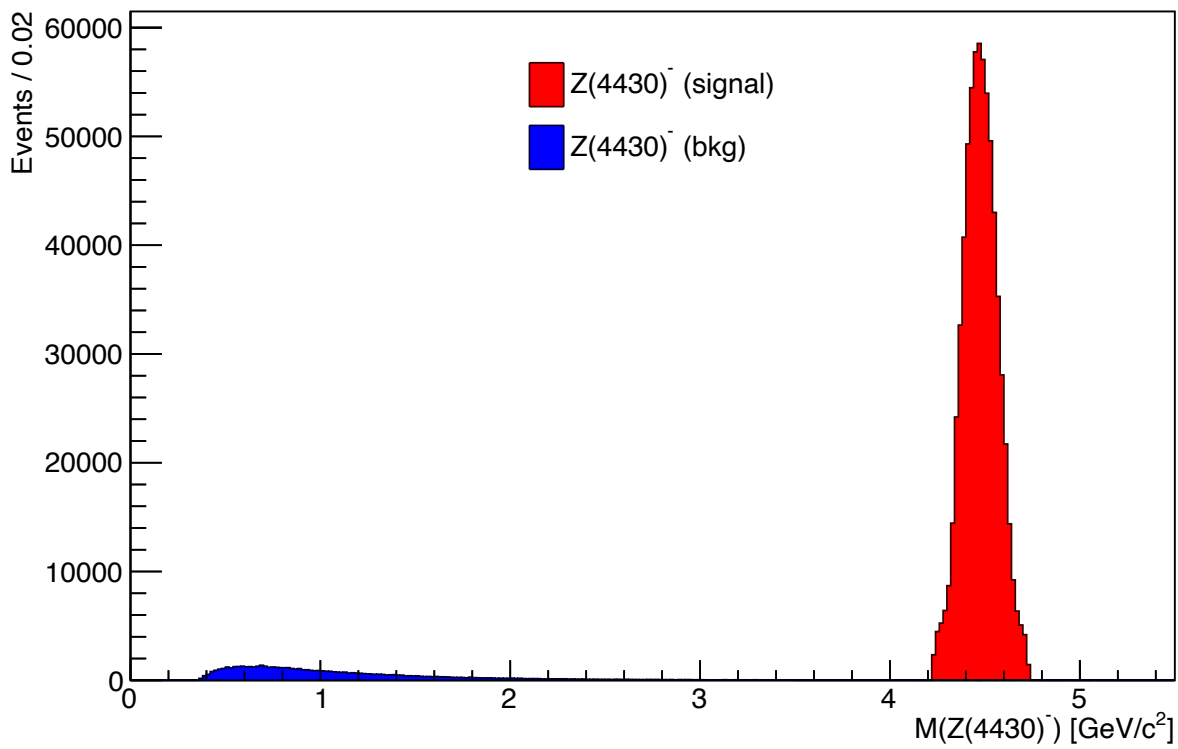
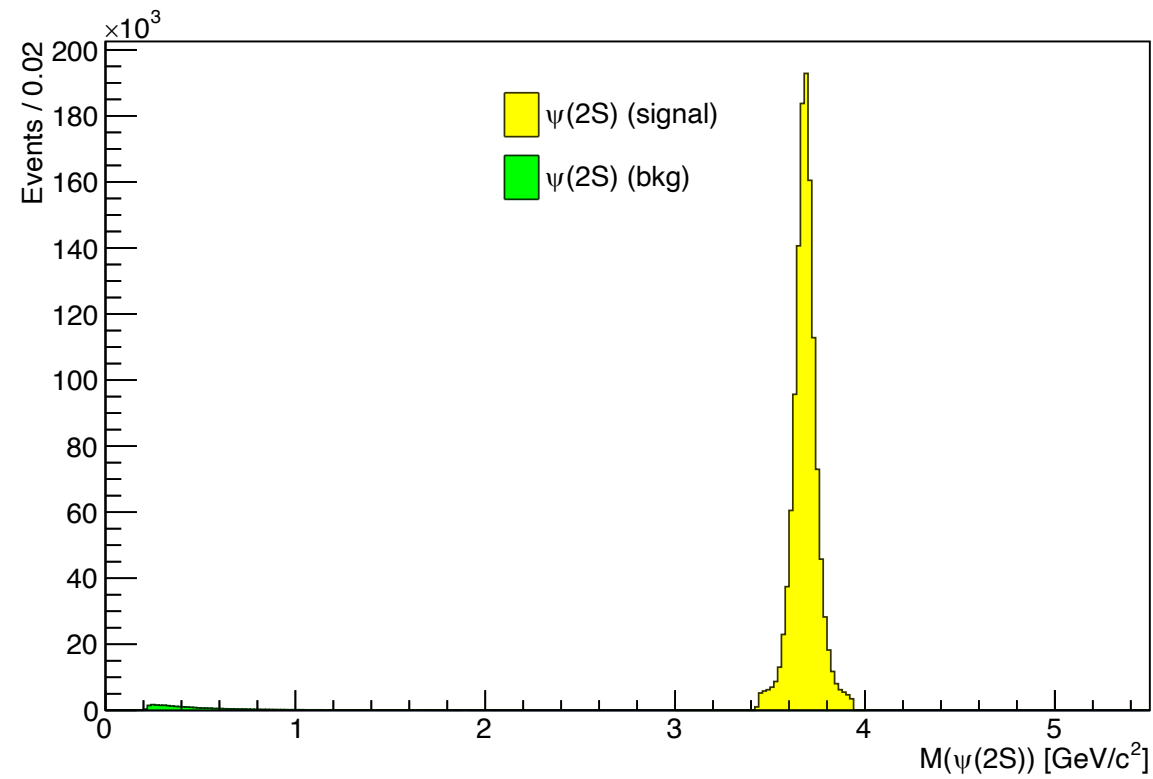
DPM analysis (7M Filtered Events)
[Z(4430)⁺ @ $\mu^+\mu^-$ channel]



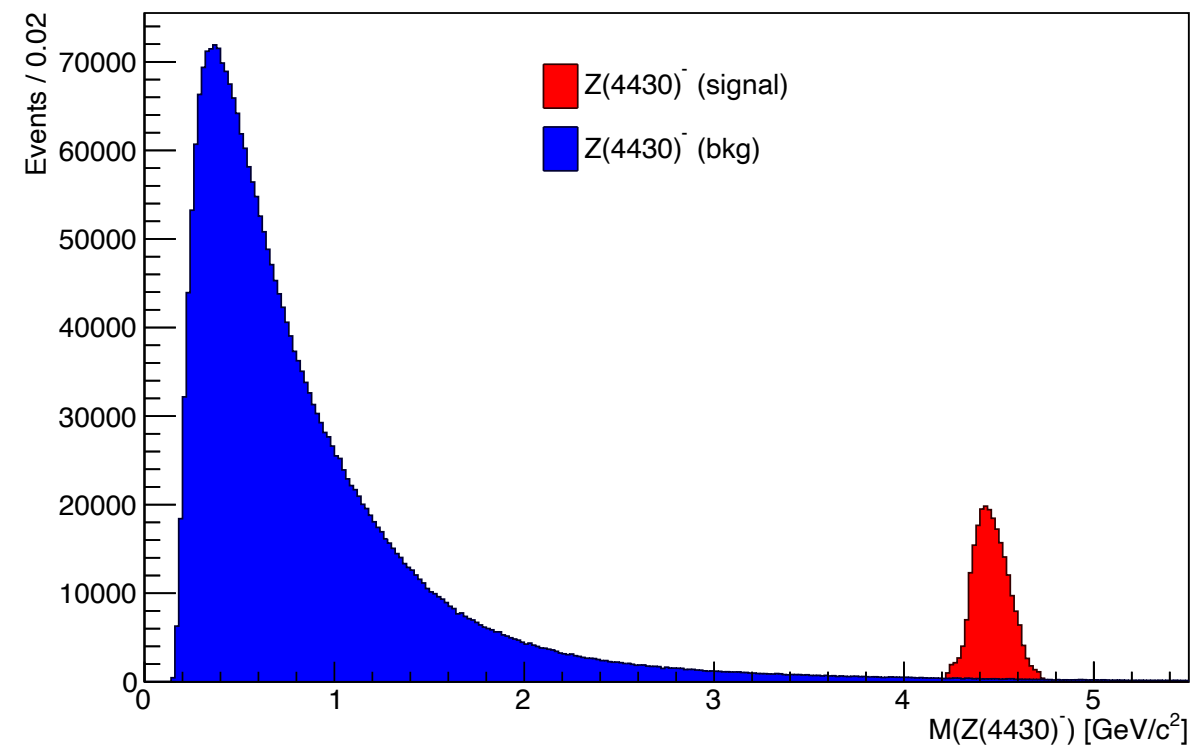
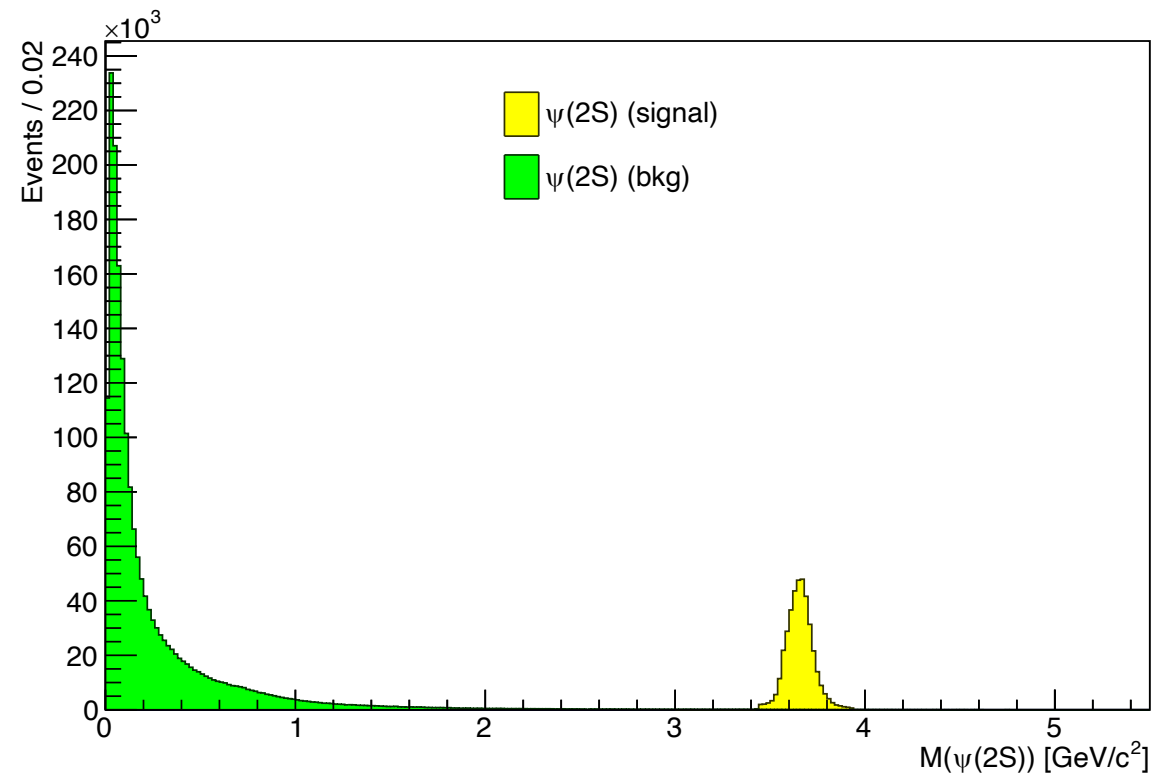
DPM analysis (7M Filtered Events)
[Z(4430)⁺ @ e⁺ e⁻ channel]



DPM analysis (7M Filtered Events)
[Z(4430)⁻ @ μ⁺ μ⁻ channel]



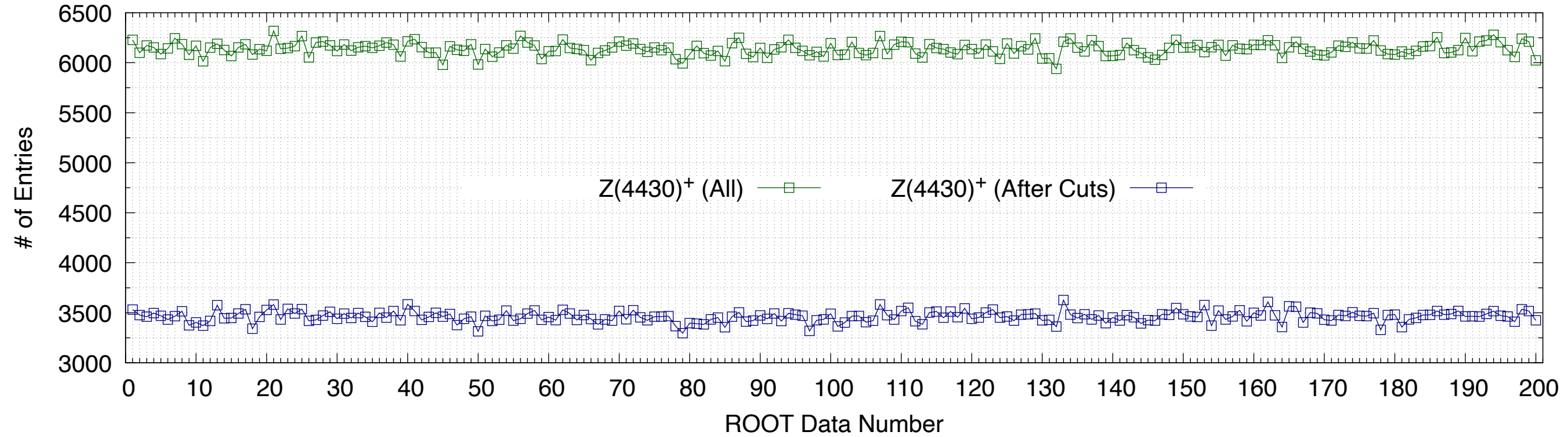
DPM analysis (7M Filtered Events)
[Z(4430)⁻ @ e⁺e⁻ channel]



Analysis Update with Bigger Data (2M)

[Z(4430)⁺ @ $\mu^+\mu^-$ channel]

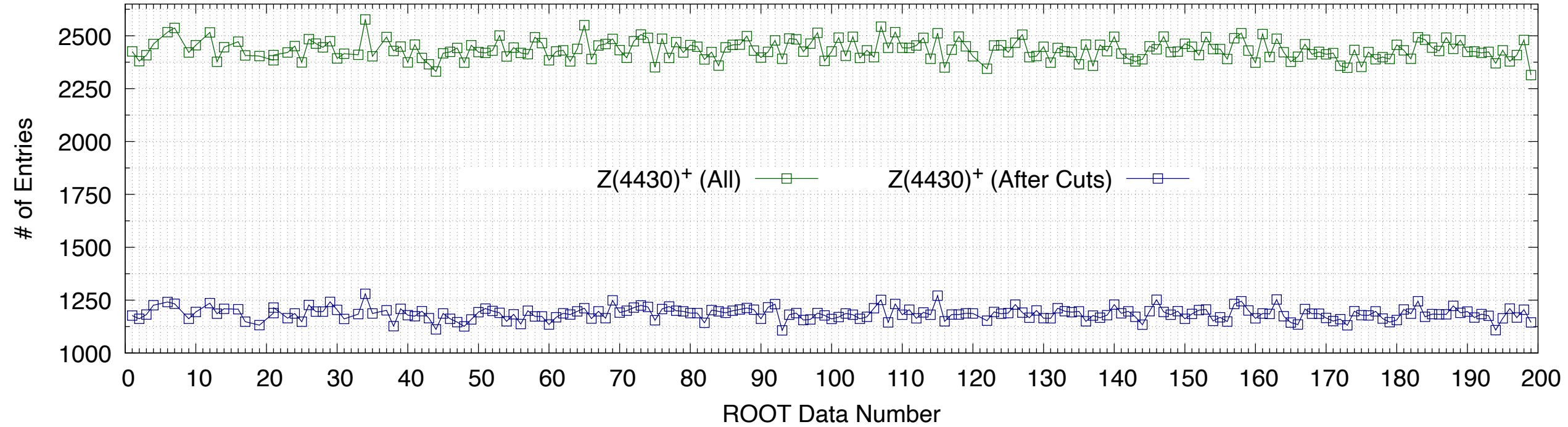
of Reconstructed Z(4430)⁺ Candidates (200 x 10.000 Events of Data)



Analysis Update with Bigger Data (2M)

[Z(4430)⁺ @e⁺e⁻ channel]

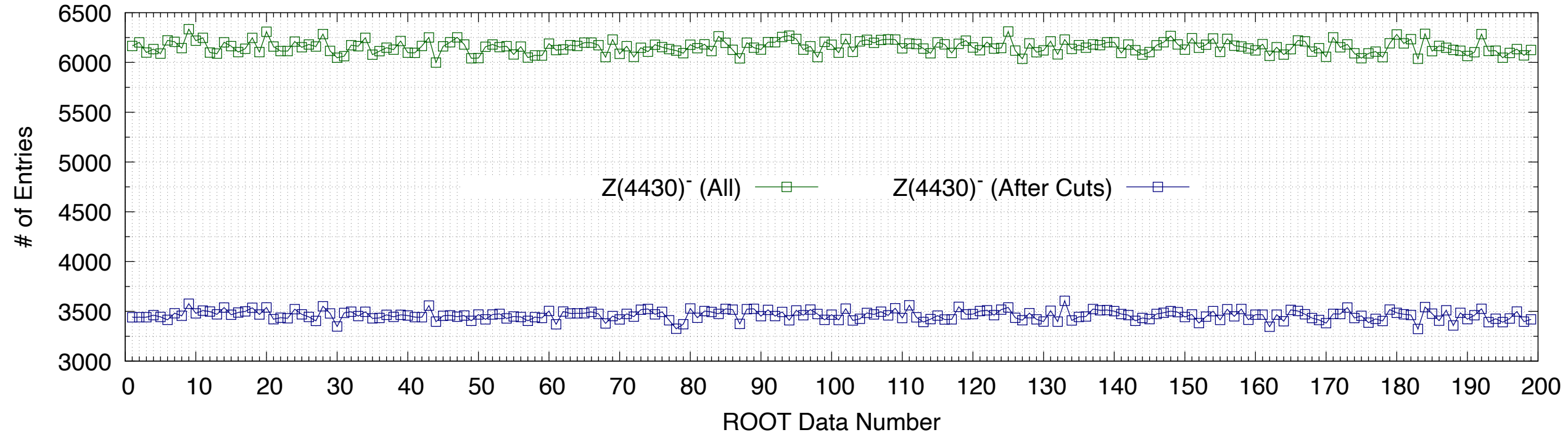
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Analysis Update with Bigger Data (2M)

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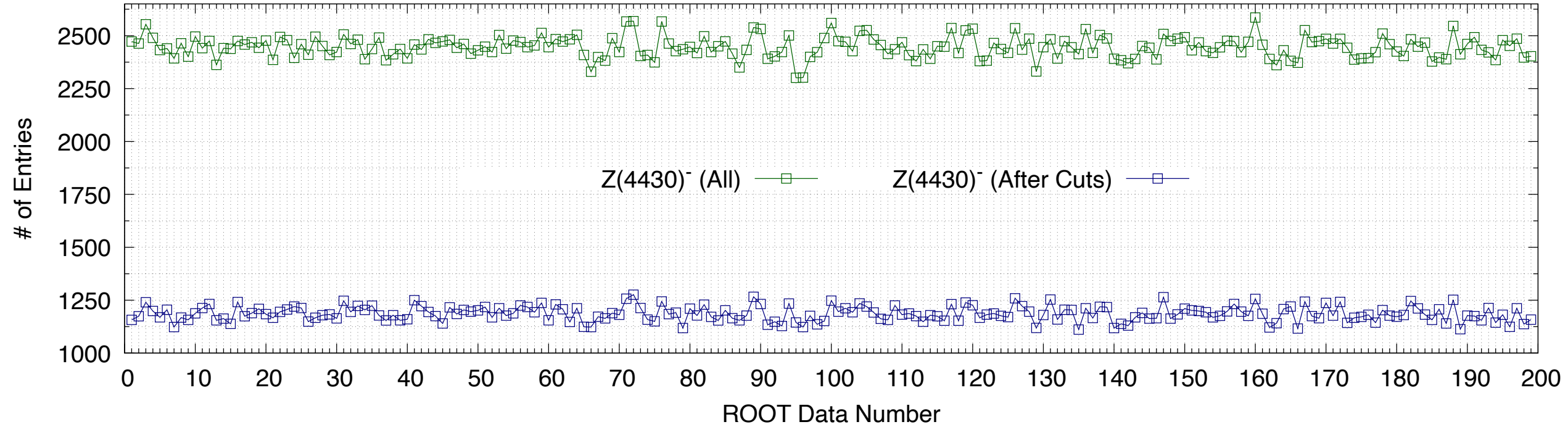
of Reconstructed Z(4430)⁻ Candidates (200 x 10.000 Events of Data)



Analysis Update with Bigger Data (2M)

[Z(4430)⁻ @ e⁺e⁻ channel]

of Reconstructed Z(4430)⁻ Candidates (200 x 10.000 Events of Data)



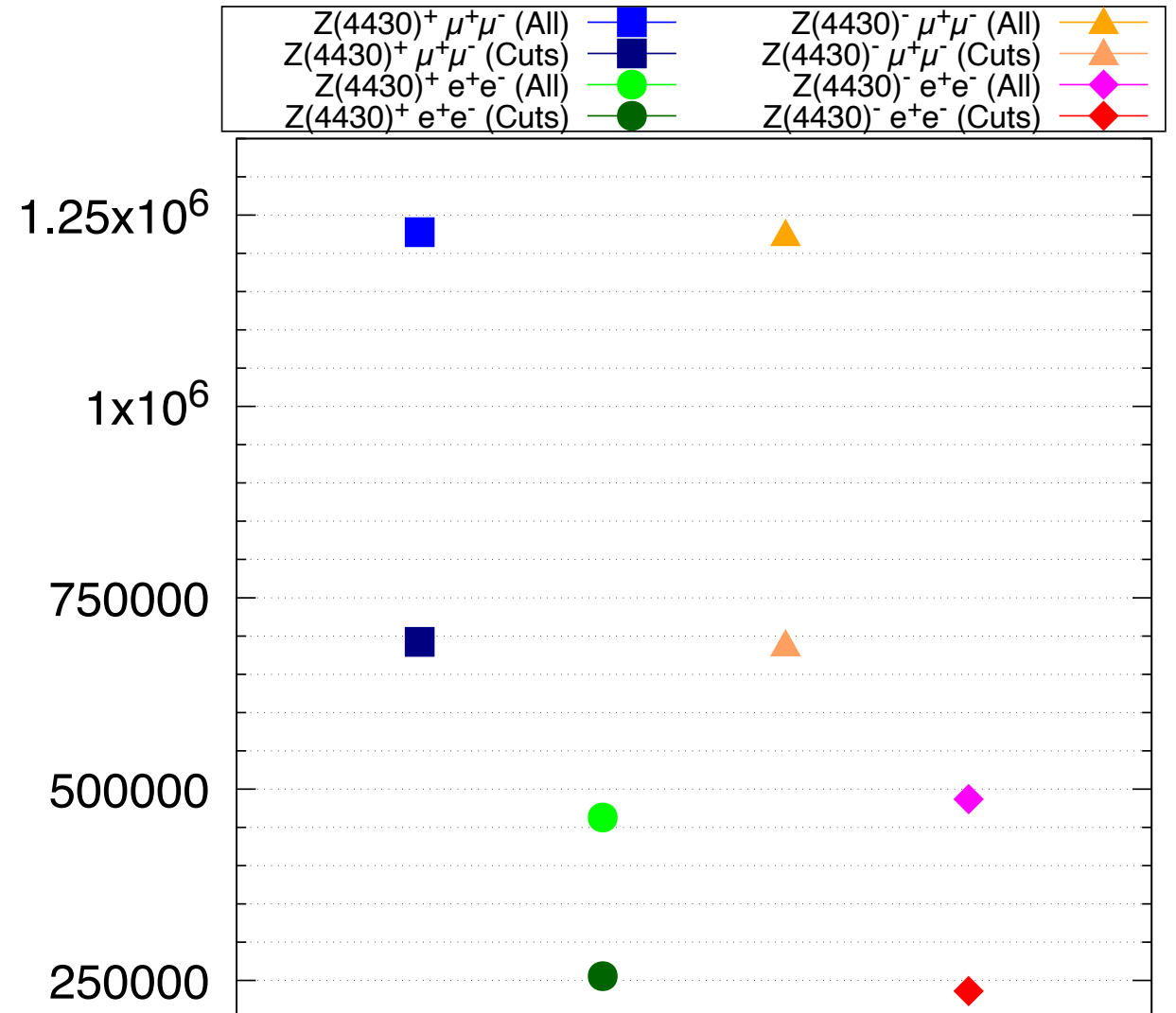
Analysis Update with Bigger Data (2M)

of Reconstructed $Z(4430)^{\mp}$ Candidates (200 x 10.000 Events of Data)

For 2M Events:

Channel	All Candidates	After Cuts	Reconstruction Efficiency
$Z(4430)^+ @ \mu^+ \mu^-$	1.227.591	692.337	34.62%
$Z(4430)^+ @ e^+ e^-$	462.942	255.535	12.78%
$Z(4430)^- @ \mu^+ \mu^-$	1.224.873	688.767	34.44%
$Z(4430)^- @ e^+ e^-$	486.924	236.004	11.80%

of Entries



Discussion & Outlook

- We produced and analyzed 2M signal events for each $Z(4430)^{\mp}$ channel separately as well as 7M filtered DPM events at maximum beam energy of 15 GeV.
- For these $Z(4430)^{\mp}$ analysis studies, we are aiming to find particle widths accurately by fitting the reconstructed candidate distributions via Breit-Wigner function.
- We found mass and width of $Z(4430)^{\mp}$ more accurately than previous studies for each channel with Breit-Wigner fit by using PANDA detector simulated data.
- Efficiency study for those channels were also done.
- We are aiming to do cross-section estimations for this analysis in further studies.

**THANK YOU FOR YOUR
ATTENTION!**