Status Report
TTbar resonances
Angular Distributions

NTUA

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Progress Report

- DCS
  - fwInstallationUtils:
    - Deploy the component
    - Changes in the database (create new tables etc)
    - Test that the tool works both when being operated with user credentials and when being operated without user credentials
    - Trying to Figure multiple scenarios that may go wrong
  - CMSfwInstallUtils
    - Conf DB checks tool
    - Why it takes so long to apply checks between project and db
    - Make the tool as generic as possible

- Analysis:
  - TTbar Angular distributions for several mass values of Z'
  - Hands on 2017 MC's.
    - Much more samples for the Zprime masses
  - Production of QCD and Mtt samples
    - Re-train and check outputs between 2016 and 2017
    - Waiting for the cross sections for the Mtt samples. The XsecDB does not include all the cross sections for the samples that I need
  - Deep AK8: Lisa sent an email, waiting for Working Points

Search for top-antitop resonances

- Numerous extensions of the SM predict the existence of new interactions with enhanced couplings to third generation quarks, especially the top quark
- The associated new particle → observation as a ttbar resonance
- Examples of such resonances:
    1. Massive Color-singlet Z like bosons (Z')
    2. Colorons
    3. Axigluons
    4. Heavier Higgs siblings
    5. Kaluza-Klein excitations of gluons
    6. Electroweak gauge bosons
    7. Gravitons in various extensions of the Randall-Sundrum model

- All of the above predict the existence of TeV-scale resonances with a cross section of a few pb's
- Resonant ttbar production would be observable in the reconstructed invariant mass of the ttbar system

- Most analyses search for peaks in the invariant ttbar mass

Variables

- We employ the dijet angular variable χ from the rapidities of the two leading jets
- Why χ?
  - The distributions associated with the final states produced via QCD interactions are relatively flat in comparison with the distributions of the BSM models or new particles, which typically peak at low values of x

- We can measure the variable χ in two ways

  1. By measuring the difference of the rapidities of the two leading jets such as the corresponding rapidity in the ZMF is:
  $$y^* = \frac{1}{2}(y_1 - y_2)$$

  X is defined as $\chi = e^{|y^*|} = e^{|y_1 - y_2|}$ (1) and can be measured by creating the TLorentzVector, boost it to the ZMF and find the rapidity difference of the two leading jets
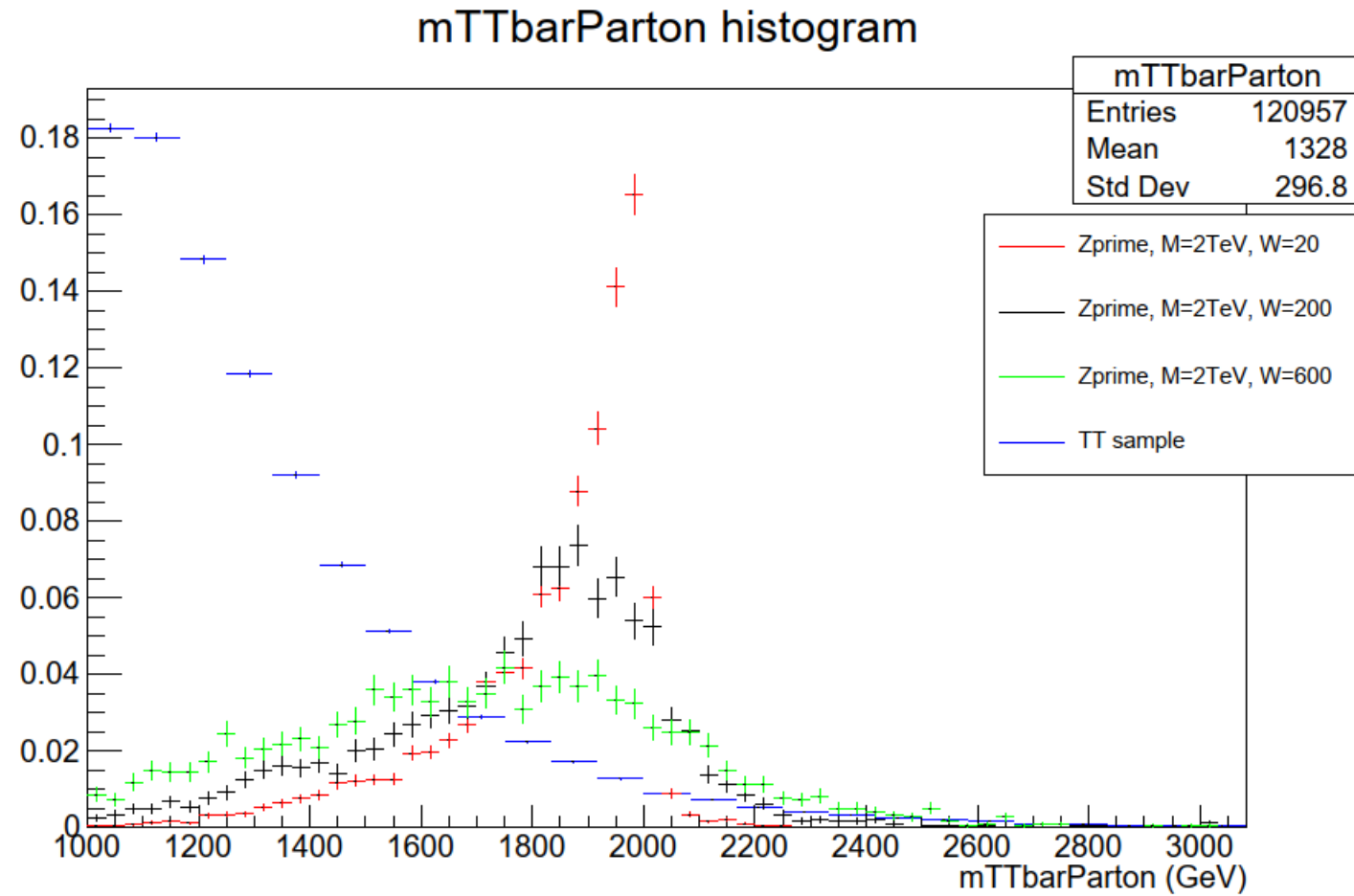
  2. By measuring the scattering angle θ* (angle between top quark and z-axis in the Zero Momentum Frame)
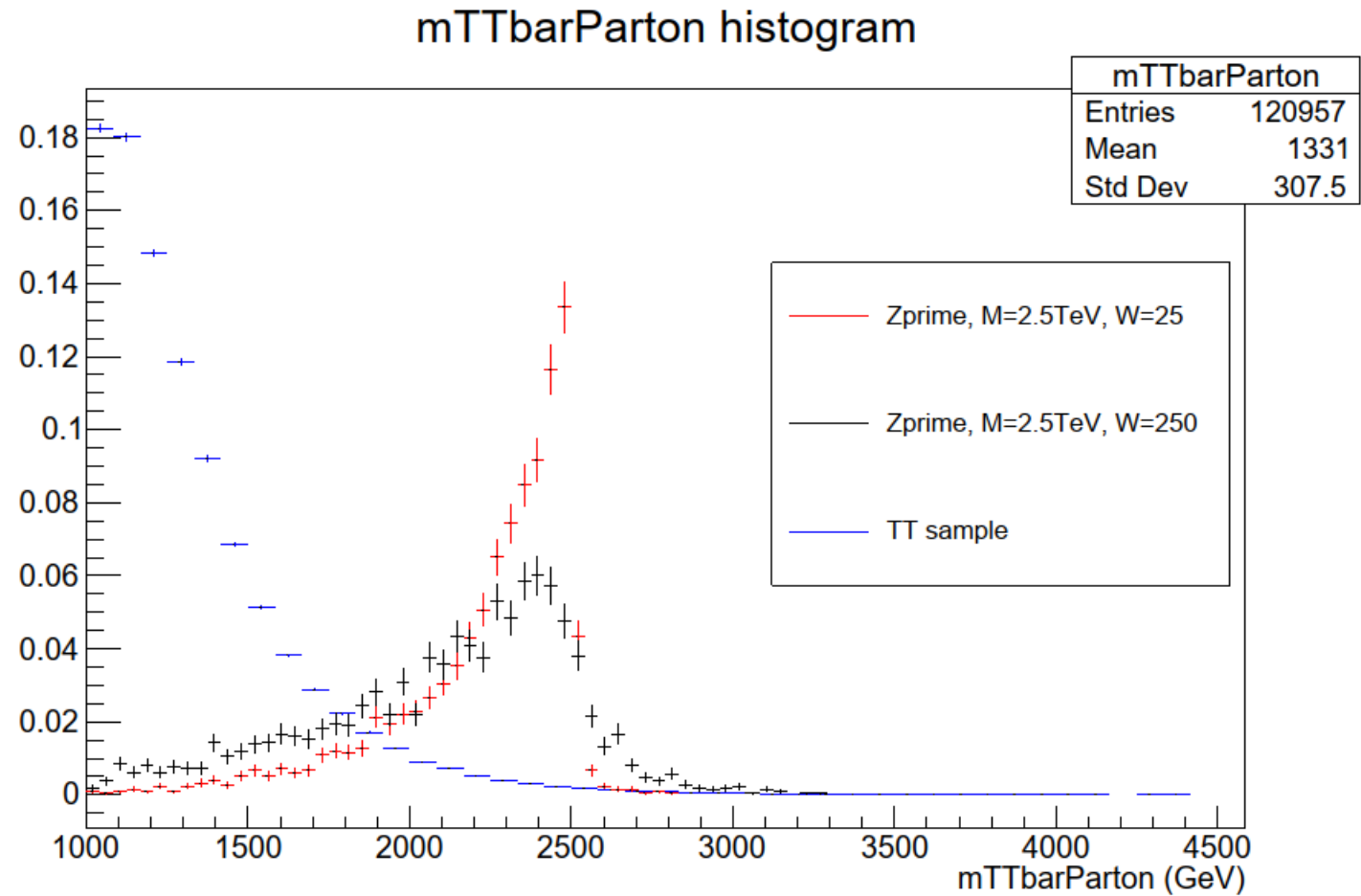 We define as $y^* = \frac{1}{2}\ln(\frac{1+|cos\theta^*|}{1-|cos\theta^*|})$ and from (1) we can find that:

  $$\chi = \frac{1 + |cos\theta^*|}{1 - |cos\theta^*|}$$

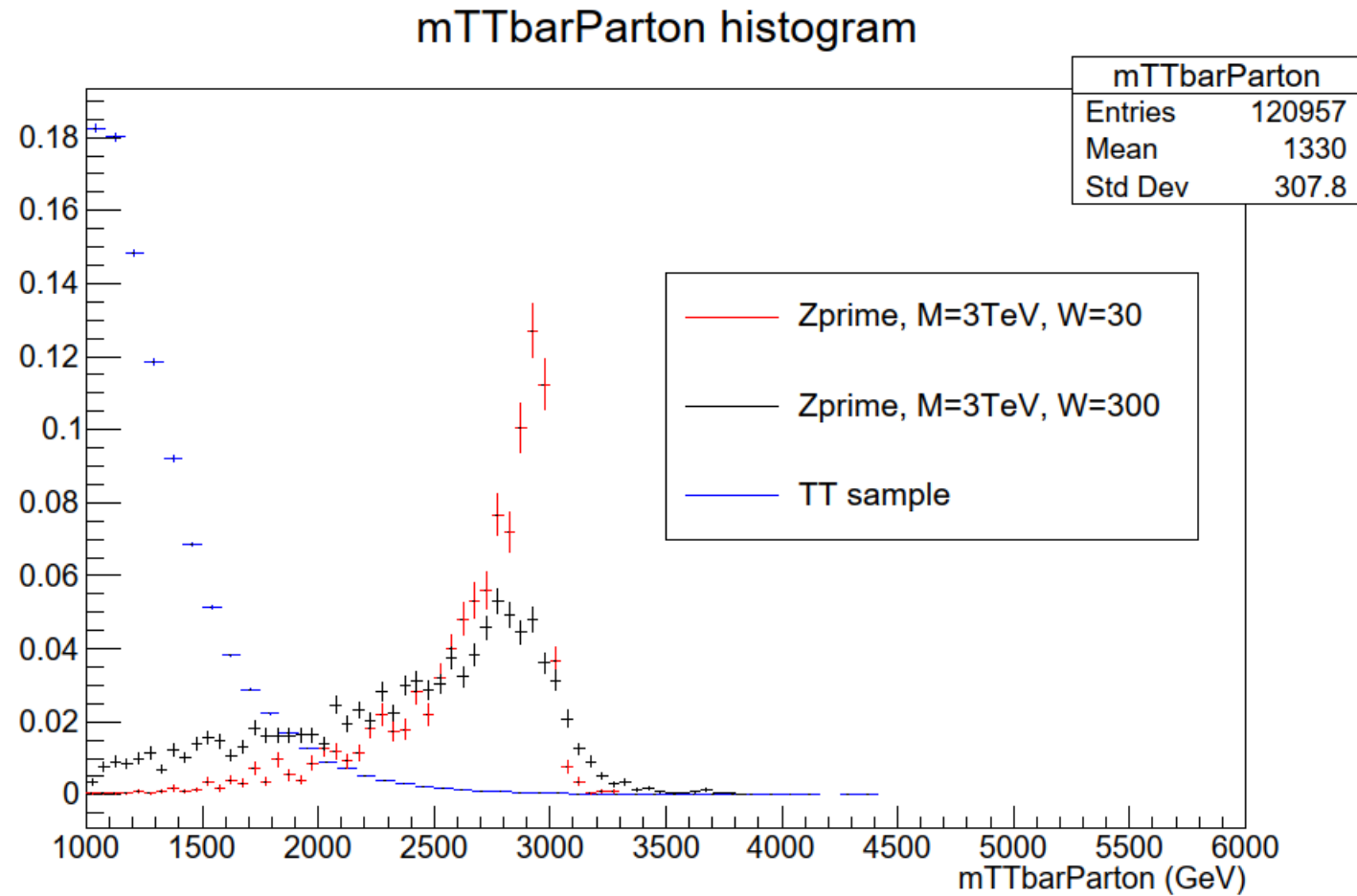 3. Distribution of the χ variable for specific Mtt ranges: [1000-2500]GeV, [2500-3500]GeV, [3500-5000]GeV

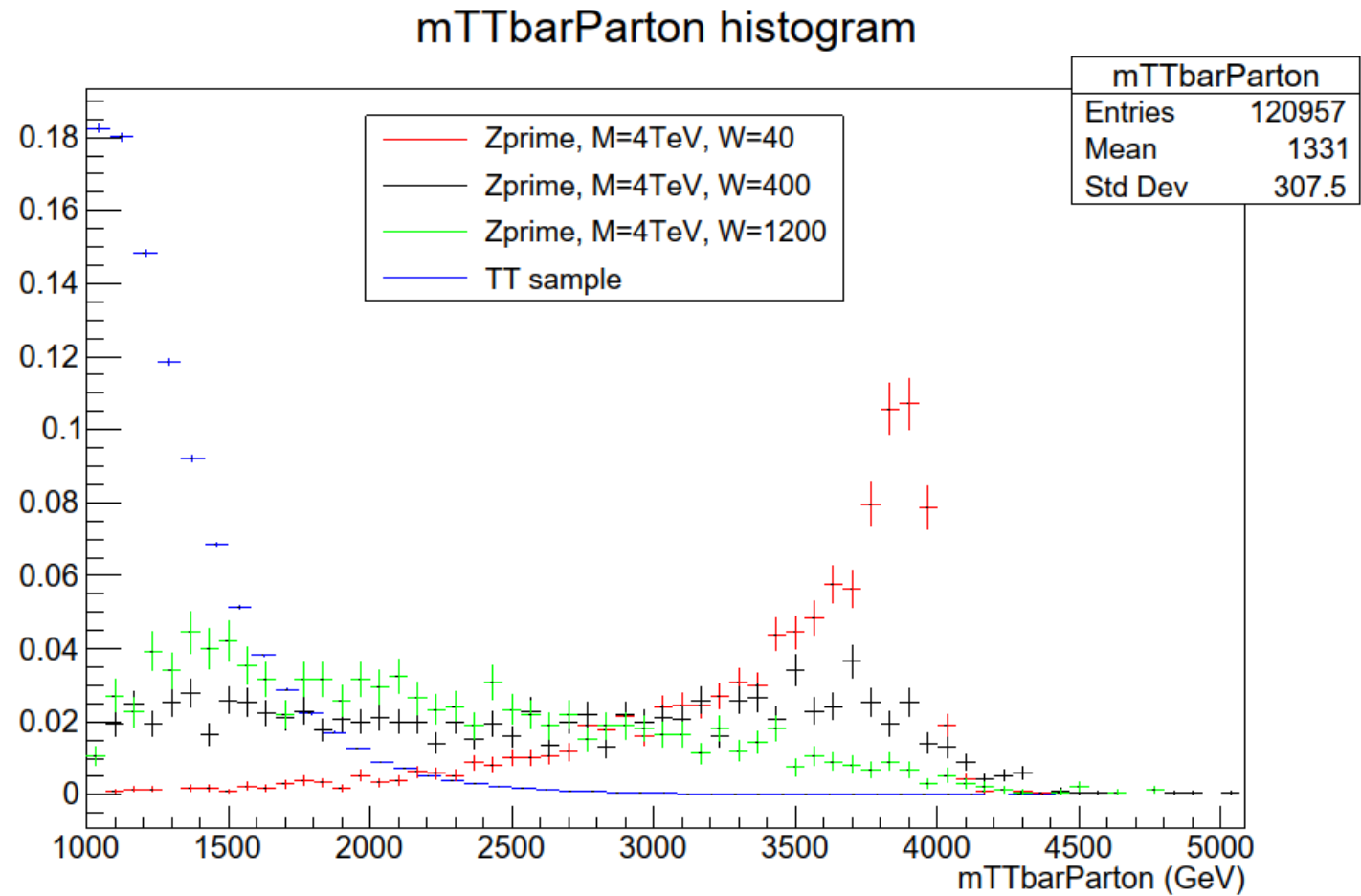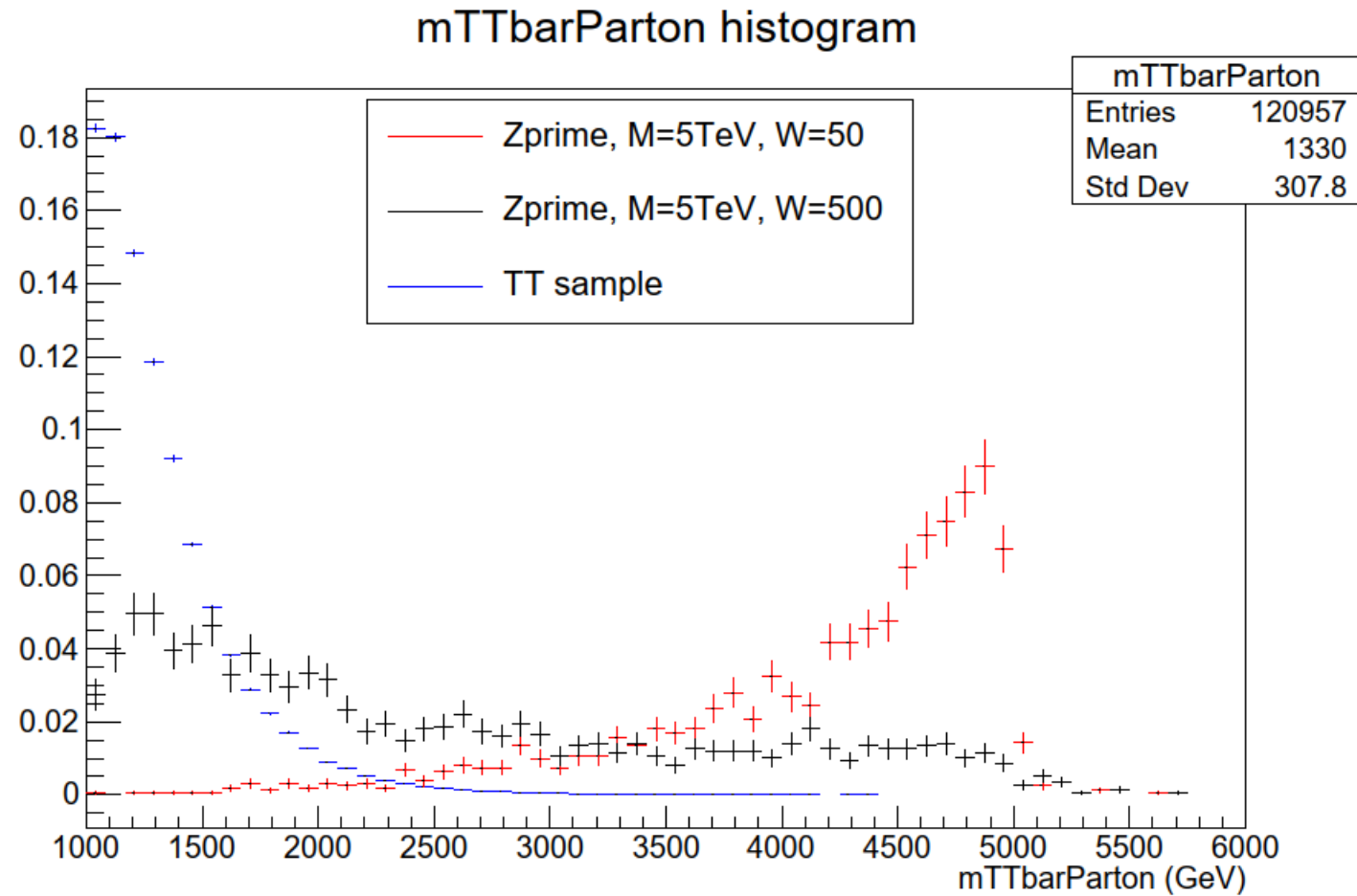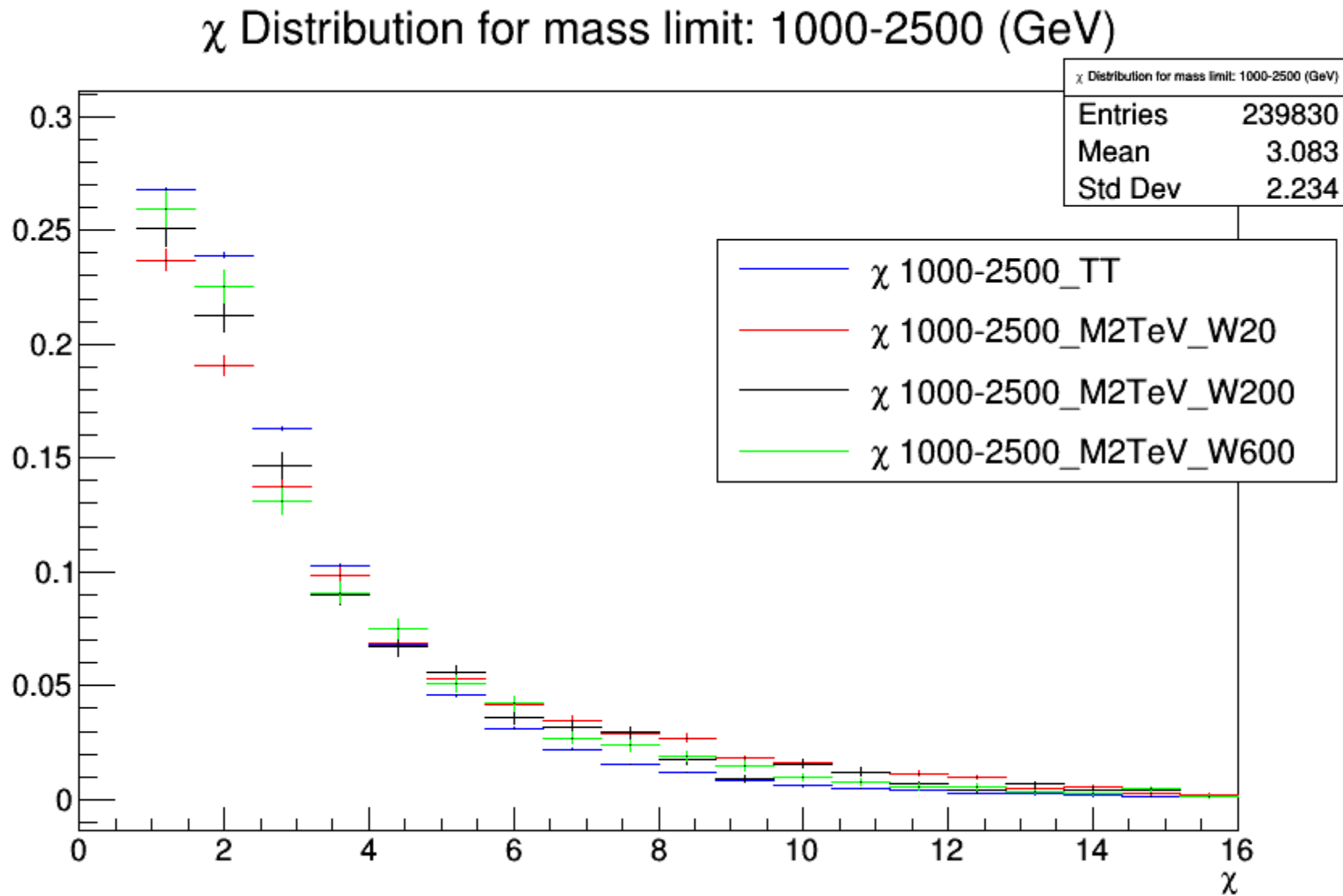# M$_{tt}$ distribution for Mtt sample (1000-Inf) and Zprime samples with M$_{Z'}$ = 2TeV and different widths

M$_{tt}$ distribution for Mtt sample (1000-Inf) and Zprime samples with M$_{z'}$ = 2.5TeV and different widths

M_{tt} distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{z'}$ = 3TeV and different widths

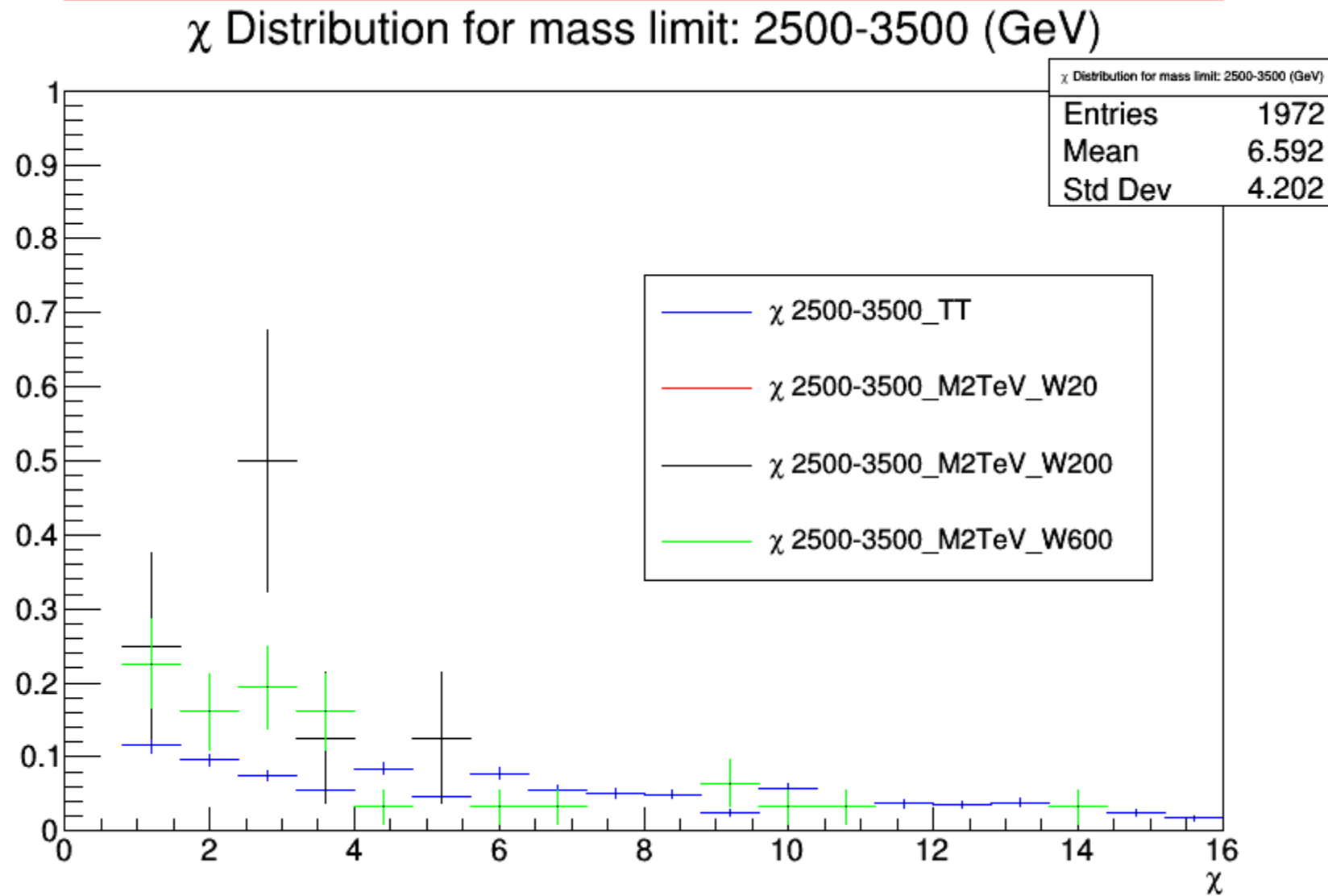M$_{tt}$ distribution for Mtt sample (1000-Inf) and Zprime samples with M$_{Z'}$ = 4TeV and different widths

M$_{tt}$ distribution for Mtt sample (1000-Inf) and Zprime samples with M$_{Z'}$ = 5TeV and different widths

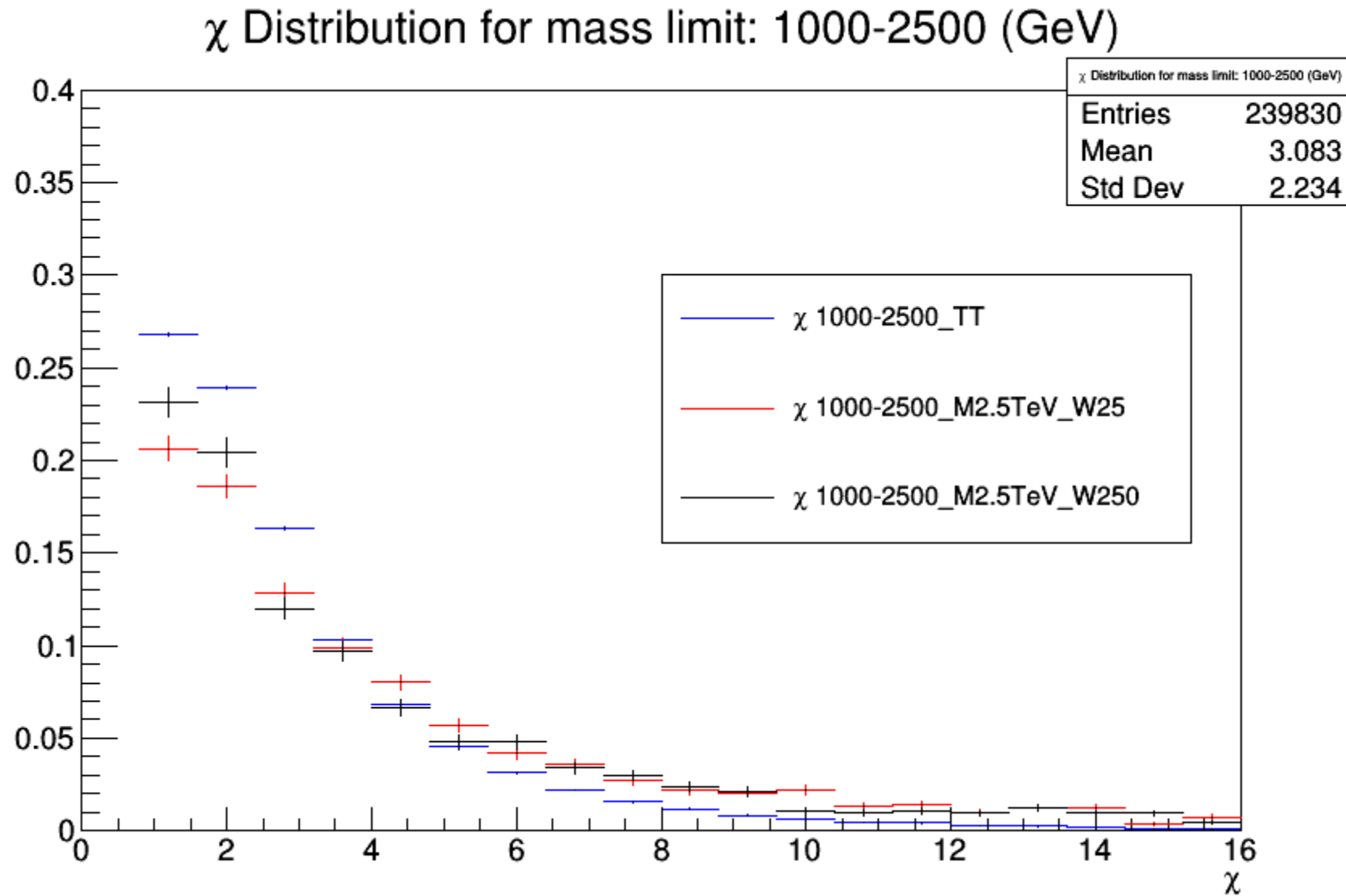χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2TeV and different widths
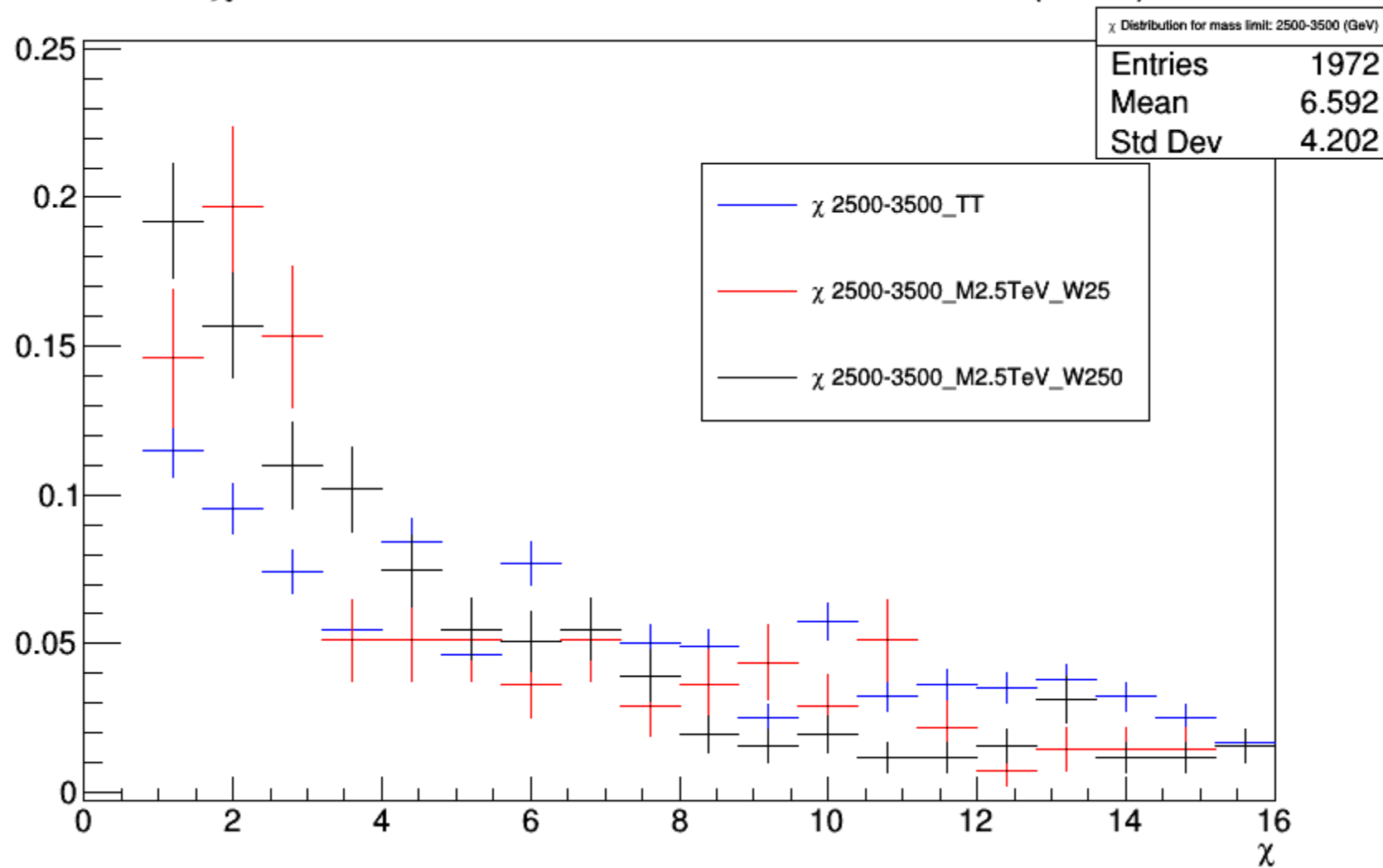
χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2TeV and different widths

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2.5TeV and different widths

χ Distribution for mass limit: 1000-2500 (GeV)

χ Distribution for mass limit: 1000-2500 (GeV)	
Entries	239830
Mean	3.083
Std Dev	2.234

χ 1000-2500_TT

χ 1000-2500_M2.5TeV_W25

χ 1000-2500_M2.5TeV_W250
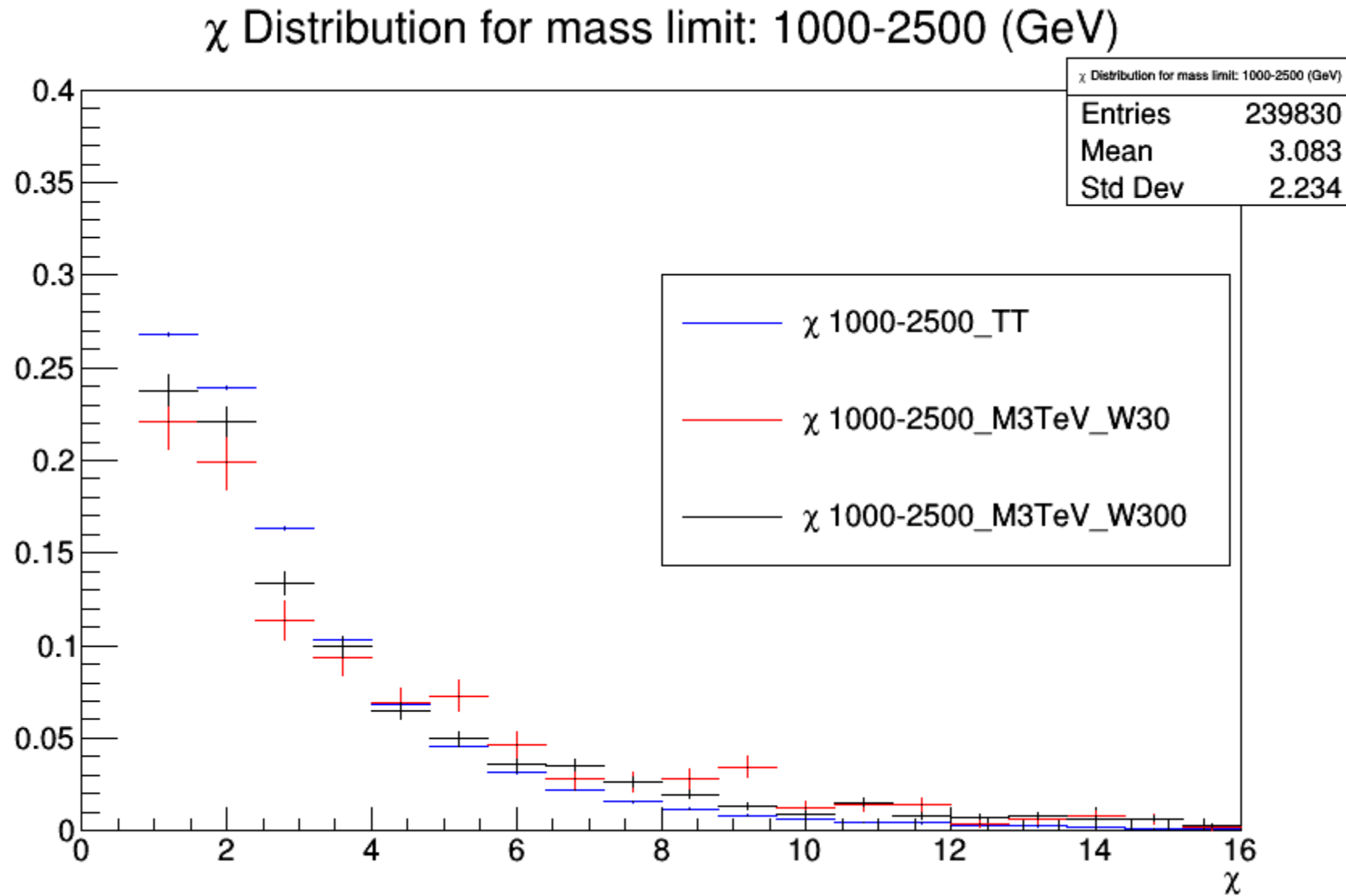
χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2.5TeV and different widths

χ Distribution for mass limit: 2500-3500 (GeV)

χ Distribution for mass limit: 2500-3500 (GeV)	
Entries	1972
Mean	6.592
Std Dev	4.202

χ 2500-3500_TT

χ 2500-3500_M2.5TeV_W25

χ 2500-3500_M2.5TeV_W250

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 3TeV and different widths

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 3TeV and different widths

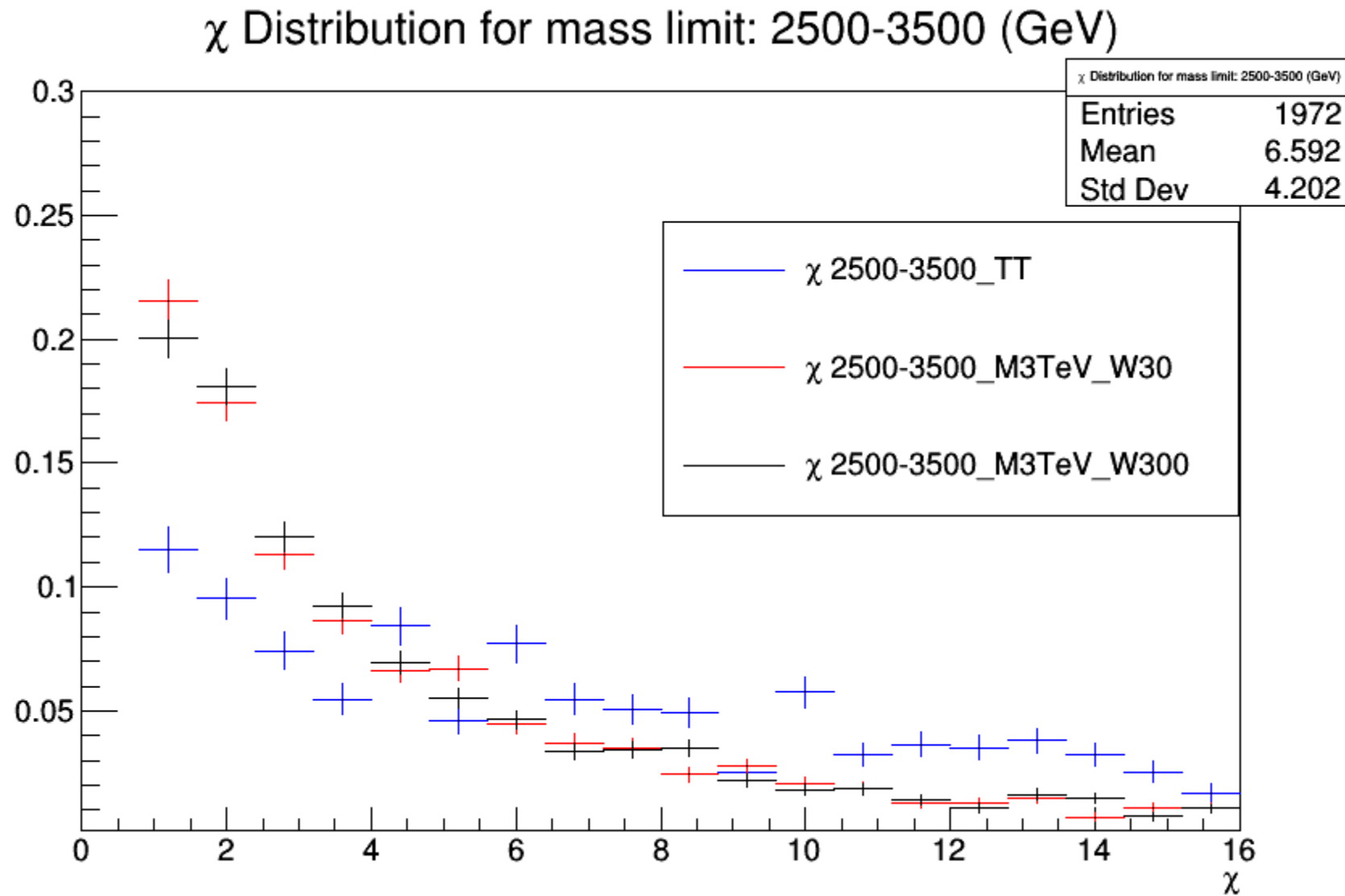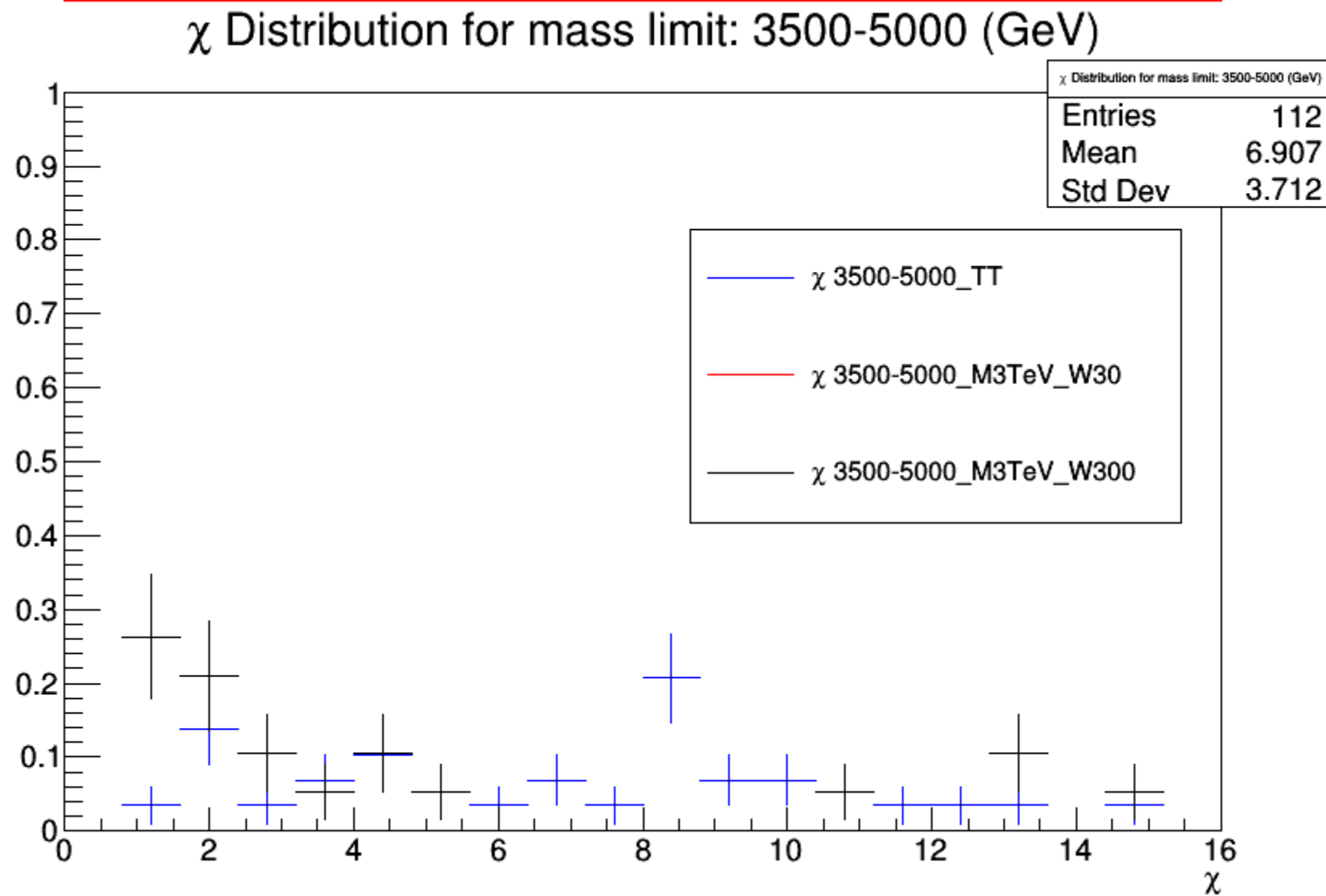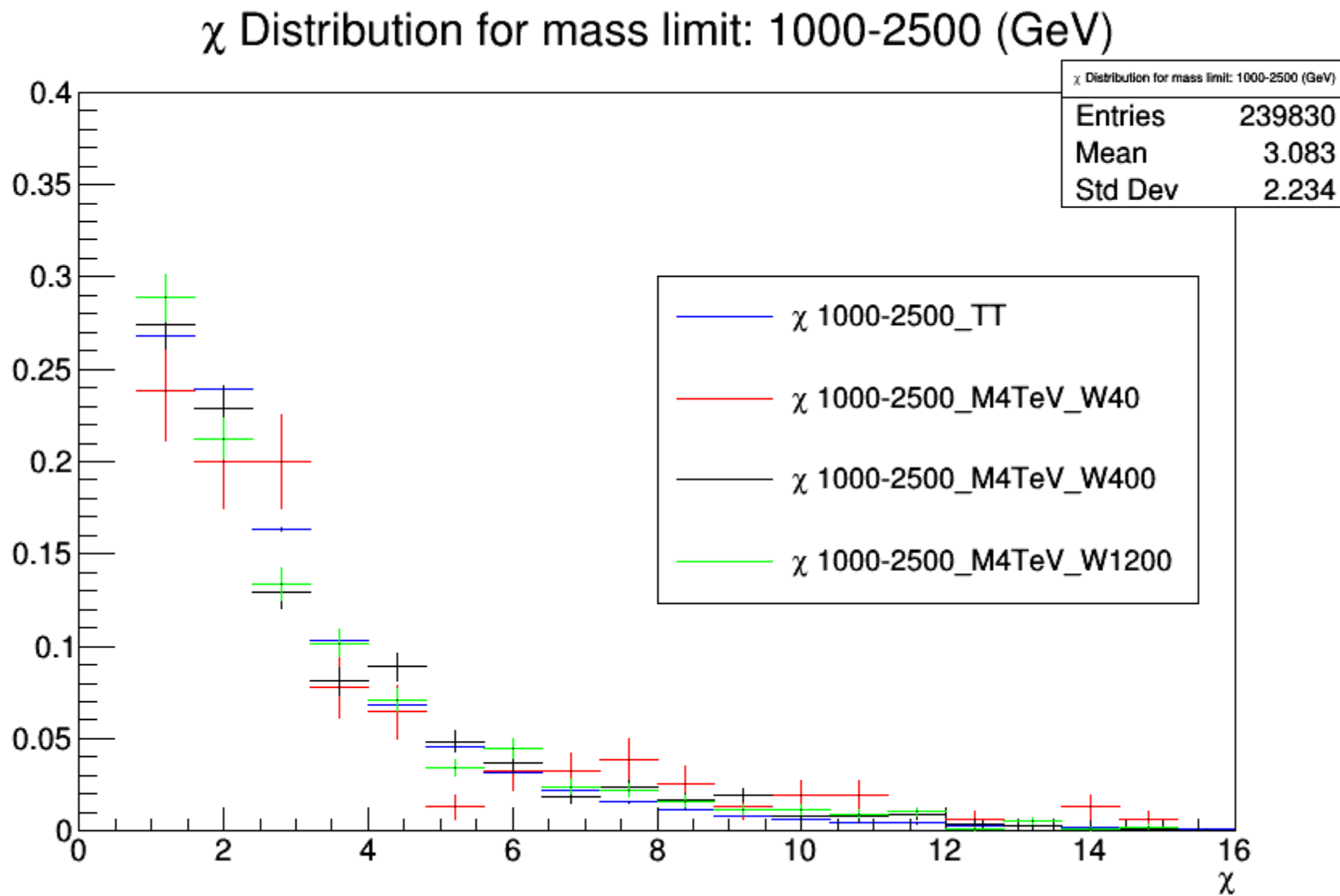χ Distribution for mass limit: 2500-3500 (GeV)

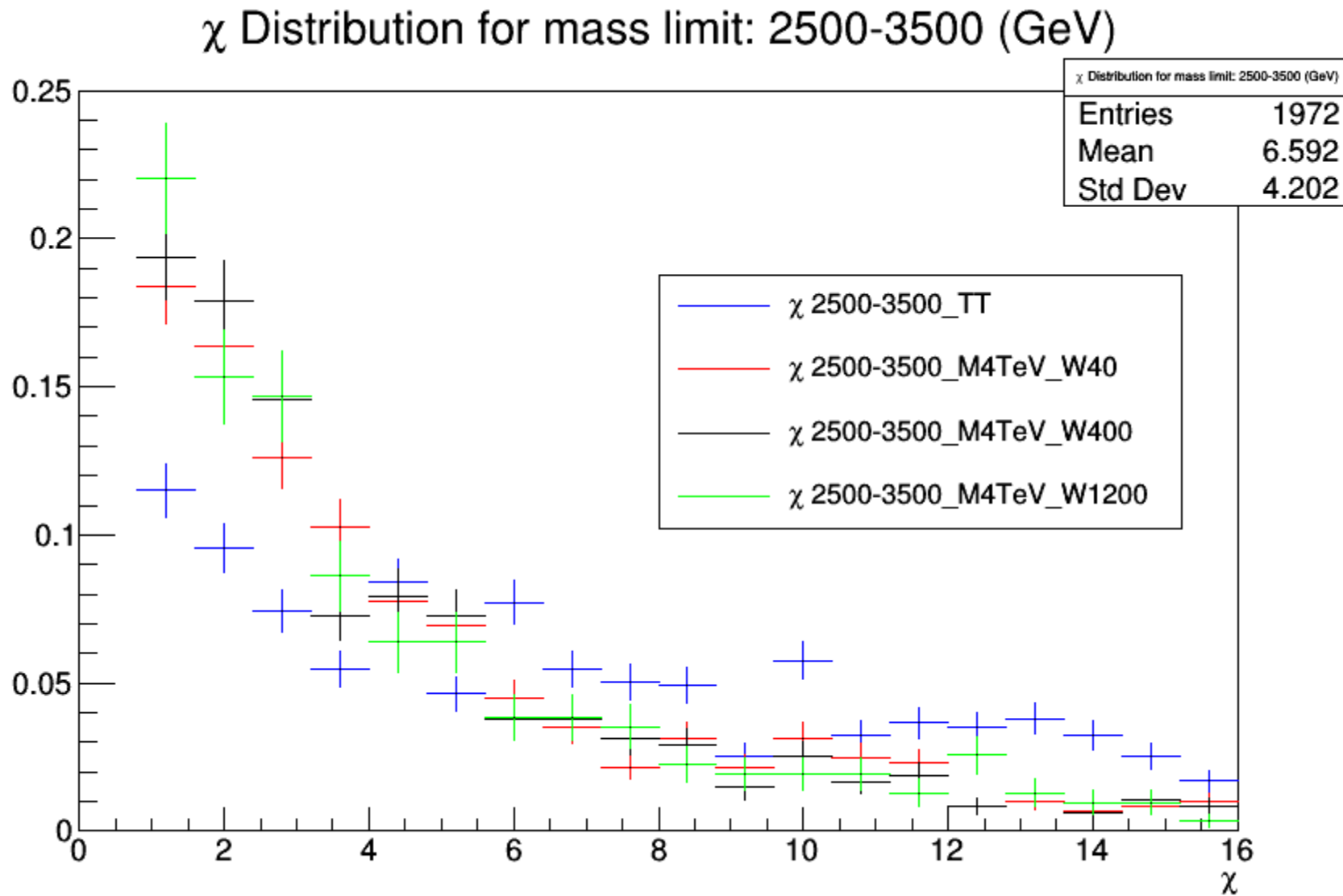| χ Distribution for mass limit: 2500-3500 (GeV)	
Entries	1972
Mean	6.592
Std Dev	4.202

χ 2500-3500_TT

χ 2500-3500_M3TeV_W30

χ 2500-3500_M3TeV_W300
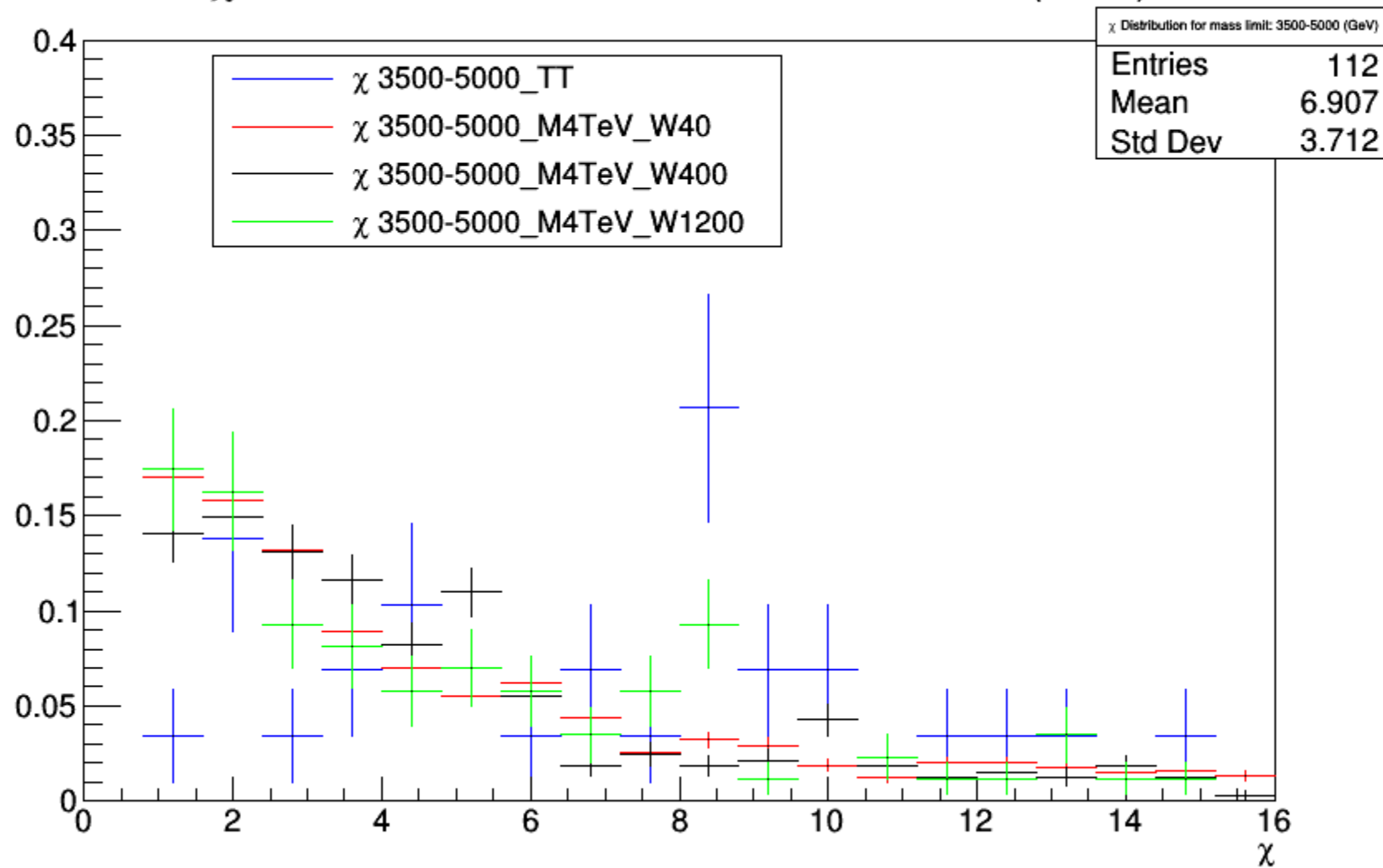
χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 3TeV and different widths

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 4TeV and different widths

χ Distribution for mass limit: 1000-2500 (GeV)

χ Distribution for mass limit: 1000-2500 (GeV)	
Entries	239830
Mean	3.083
Std Dev	2.234

χ 1000-2500_TT

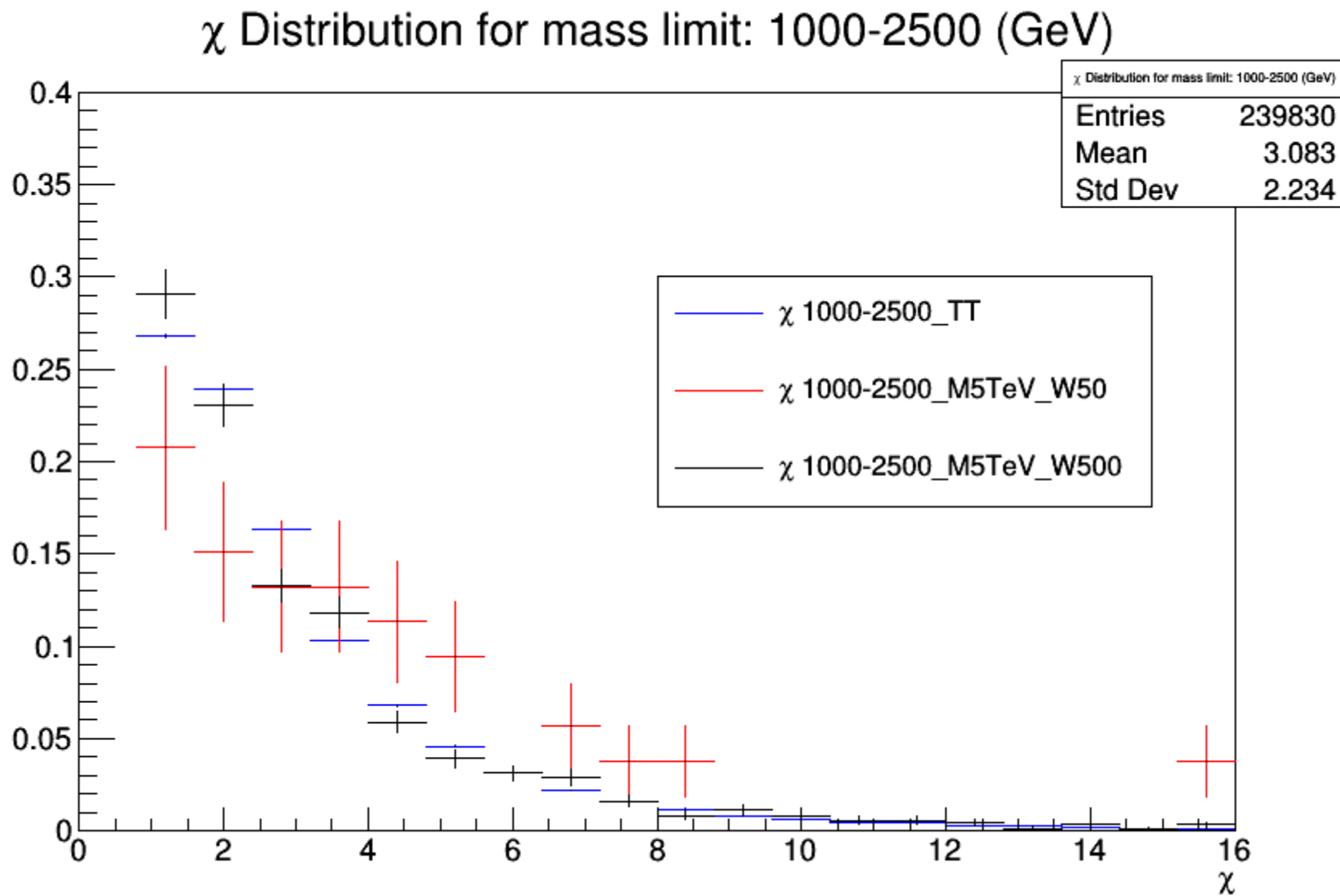χ 1000-2500_M4TeV_W40

χ 1000-2500_M4TeV_W400

χ 1000-2500_M4TeV_W1200

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 4TeV and different widths

χ Distribution for mass limit: 2500-3500 (GeV)

χ Distribution for mass limit: 2500-3500 (GeV)	
Entries	1972
Mean	6.592
Std Dev	4.202

χ 2500-3500_TT
χ 2500-3500_M4TeV_W40
χ 2500-3500_M4TeV_W400
χ 2500-3500_M4TeV_W1200

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 4TeV and different widths

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 5TeV and different widths

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 5TeV and different widths

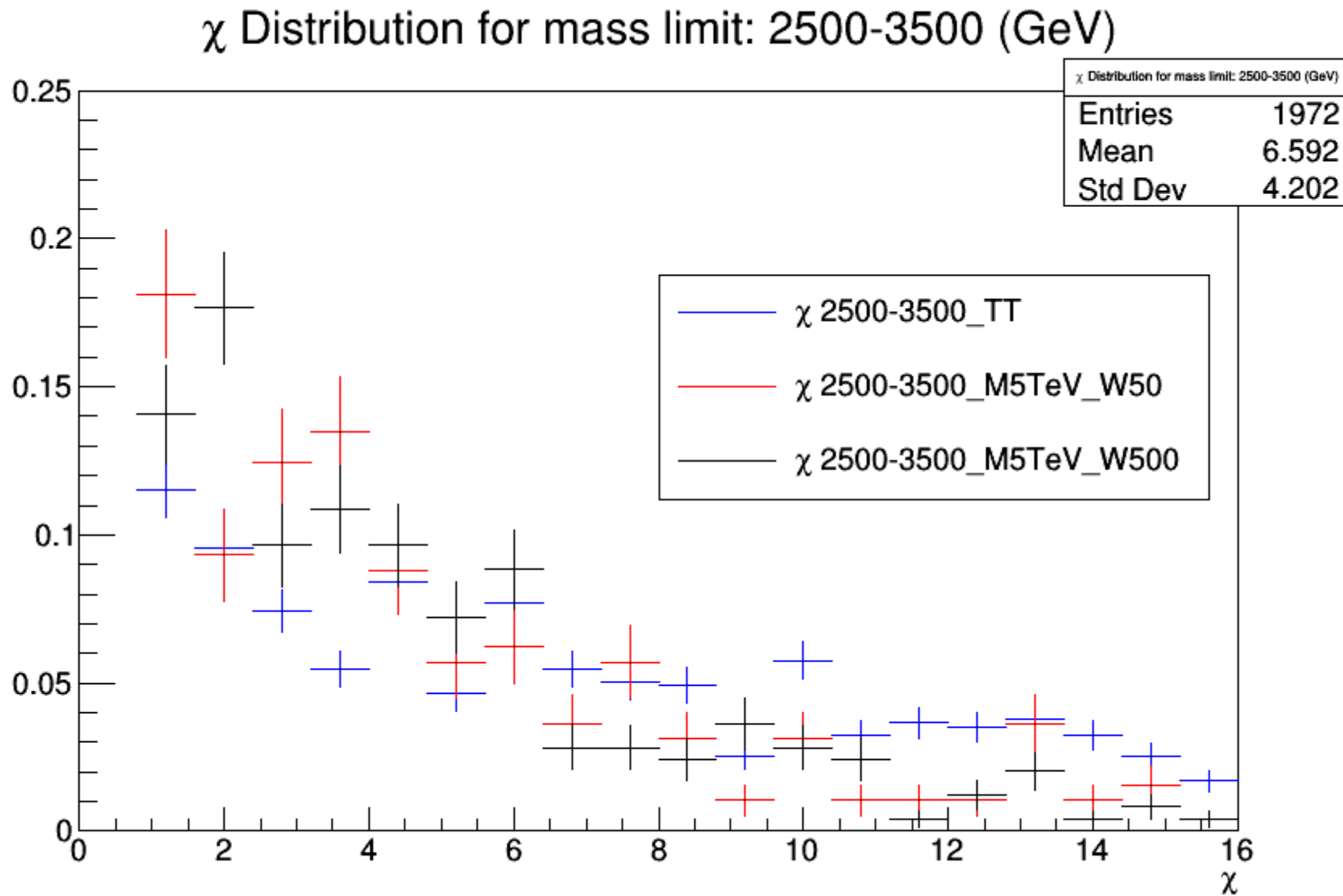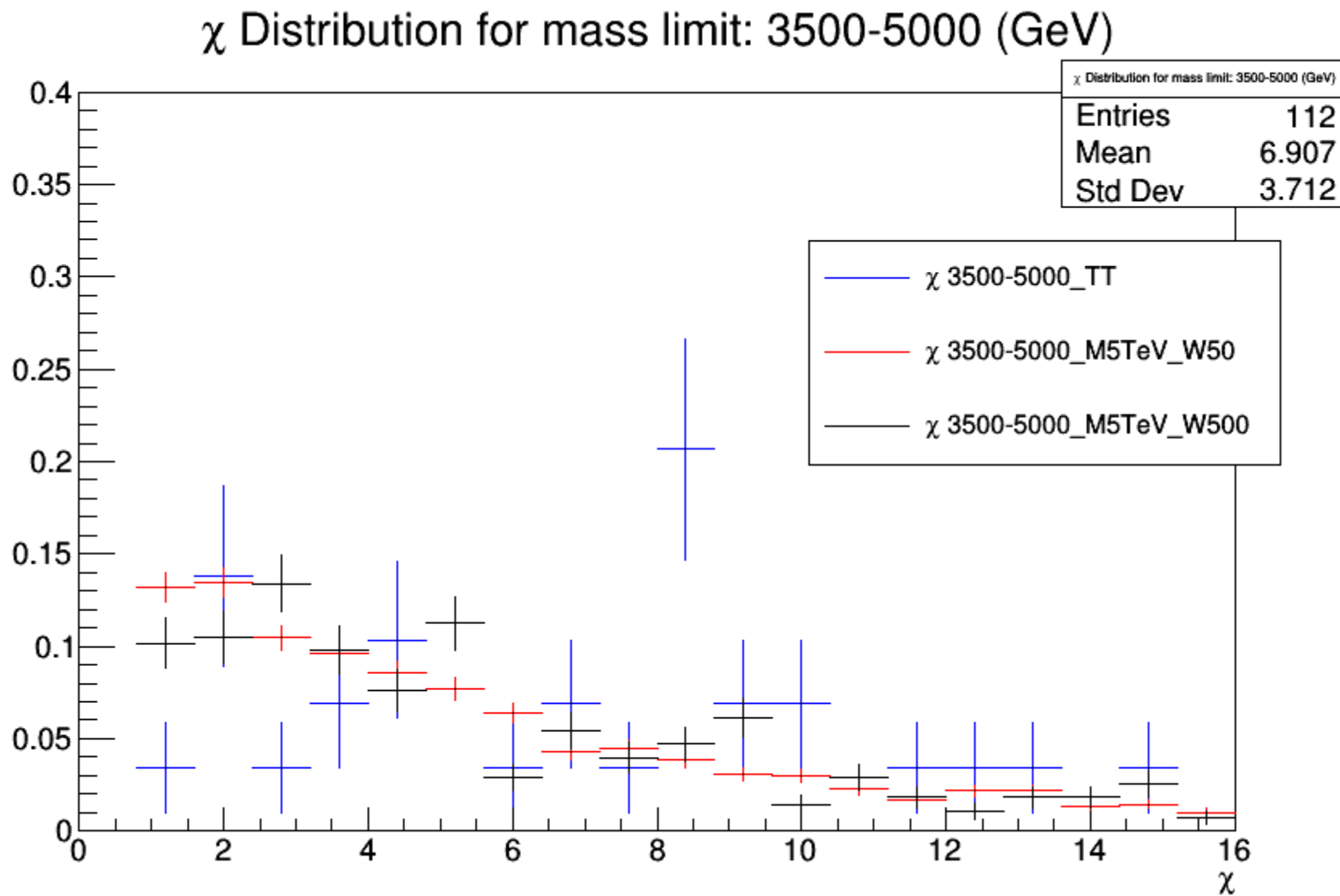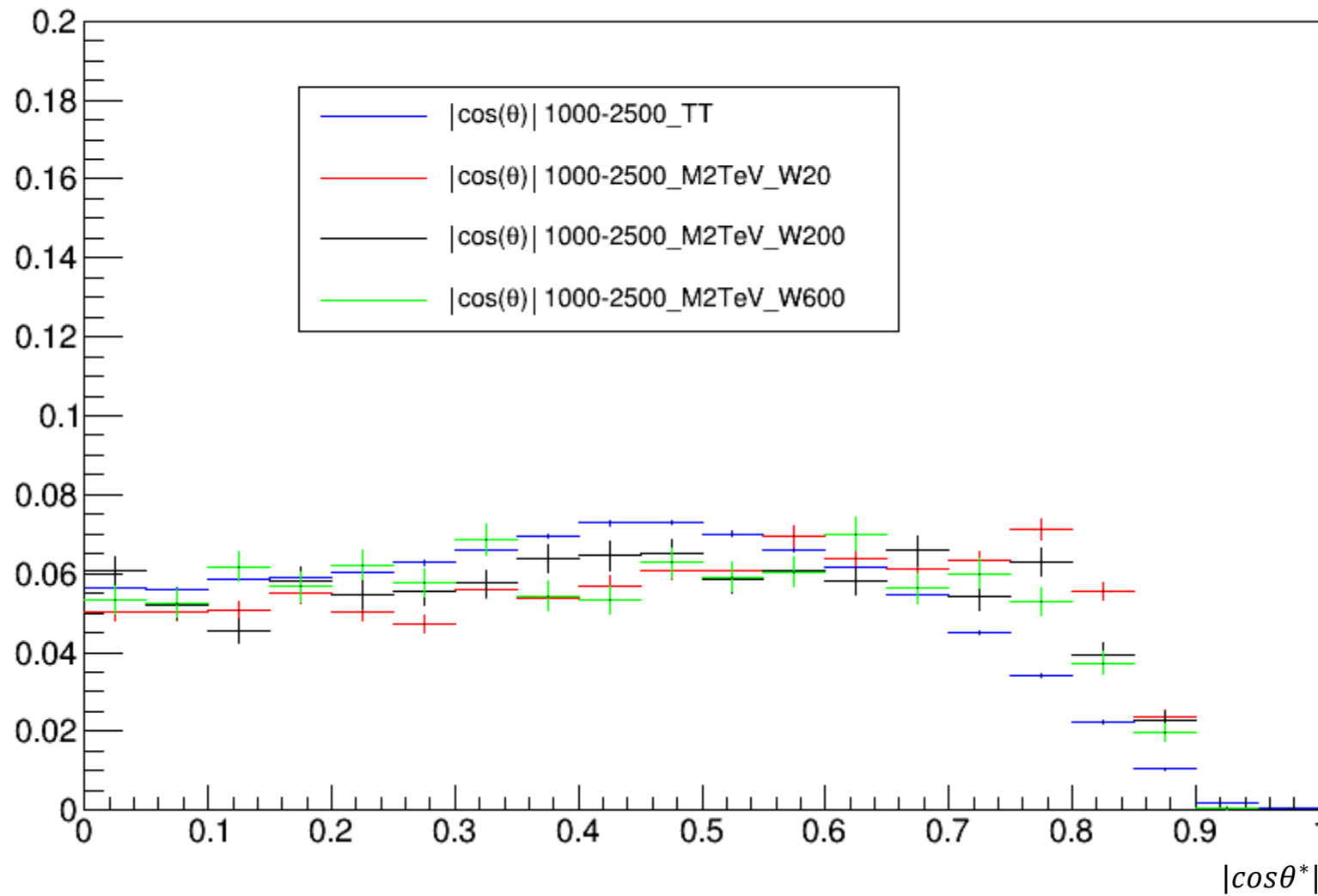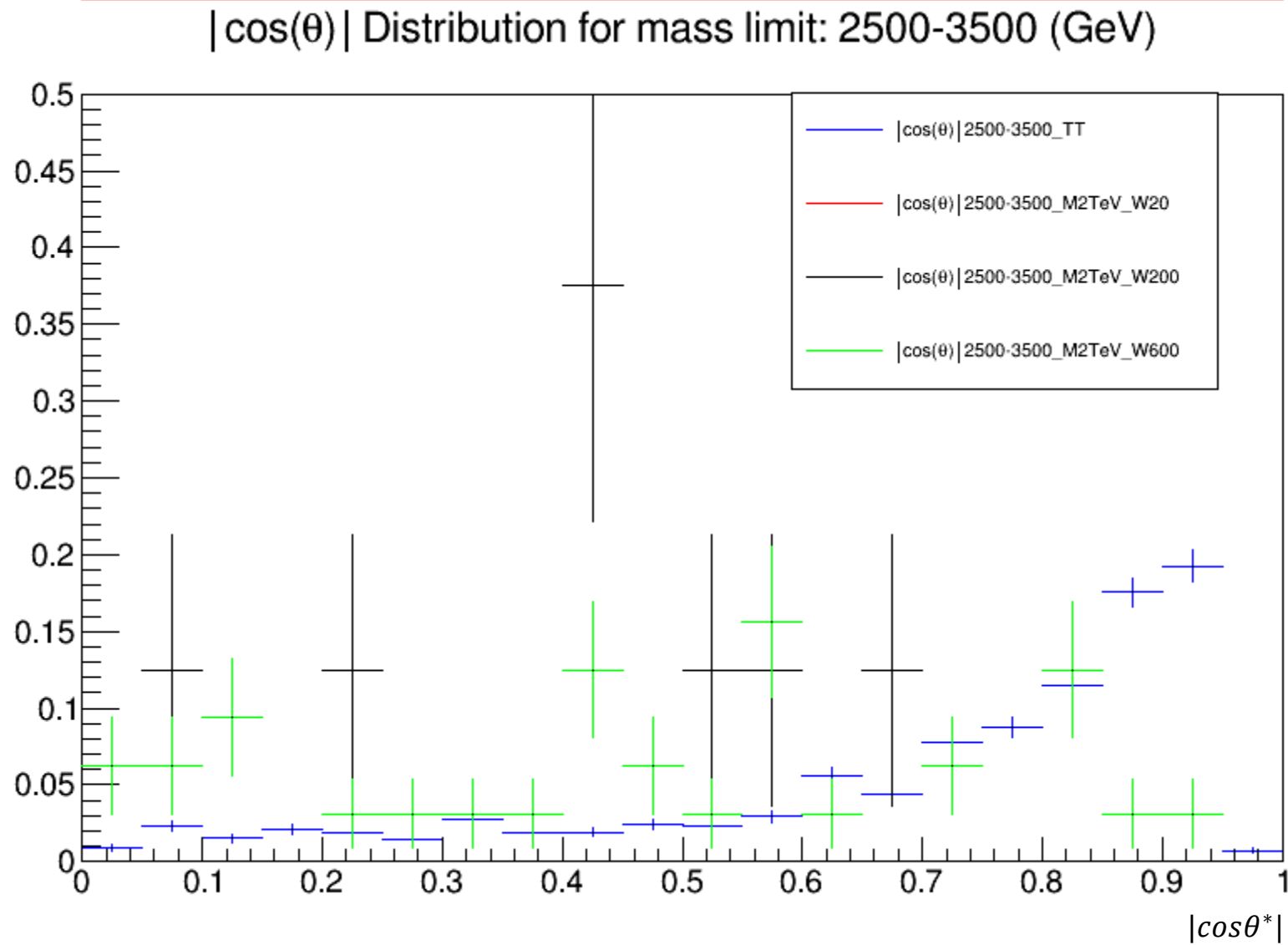χ Distribution for mass limit: 2500-3500 (GeV)

χ Distribution for mass limit: 2500-3500 (GeV)	
Entries	1972
Mean	6.592
Std Dev	4.202

χ 2500-3500_TT
χ 2500-3500_M5TeV_W50
χ 2500-3500_M5TeV_W500

χ distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 5TeV and different widths

χ Distribution for mass limit: 3500-5000 (GeV)

χ Distribution for mass limit: 3500-5000 (GeV)	
Entries	112
Mean	6.907
Std Dev	3.712

χ 3500-5000_TT

χ 3500-5000_M5TeV_W50

χ 3500-5000_M5TeV_W500

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2TeV and different widths
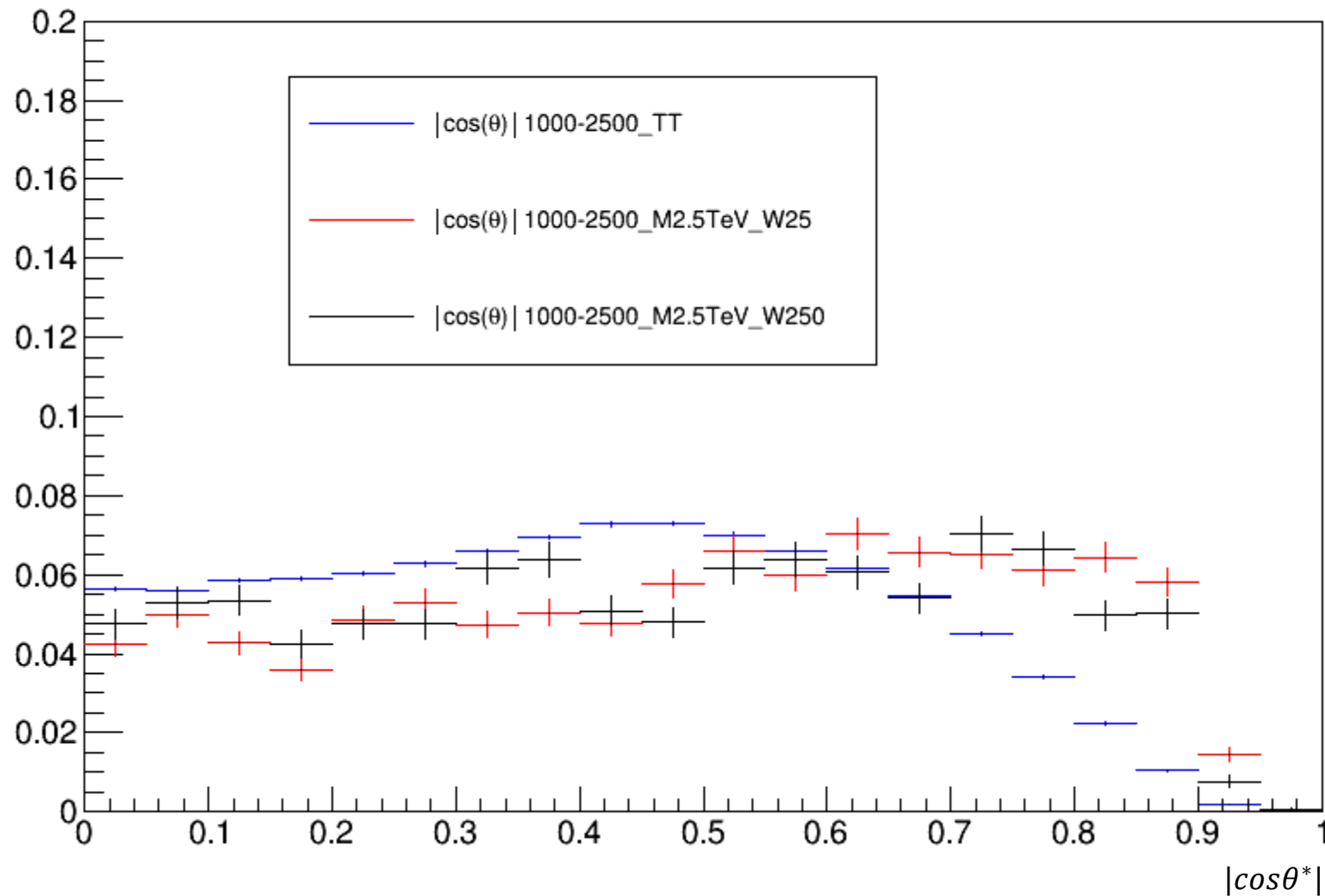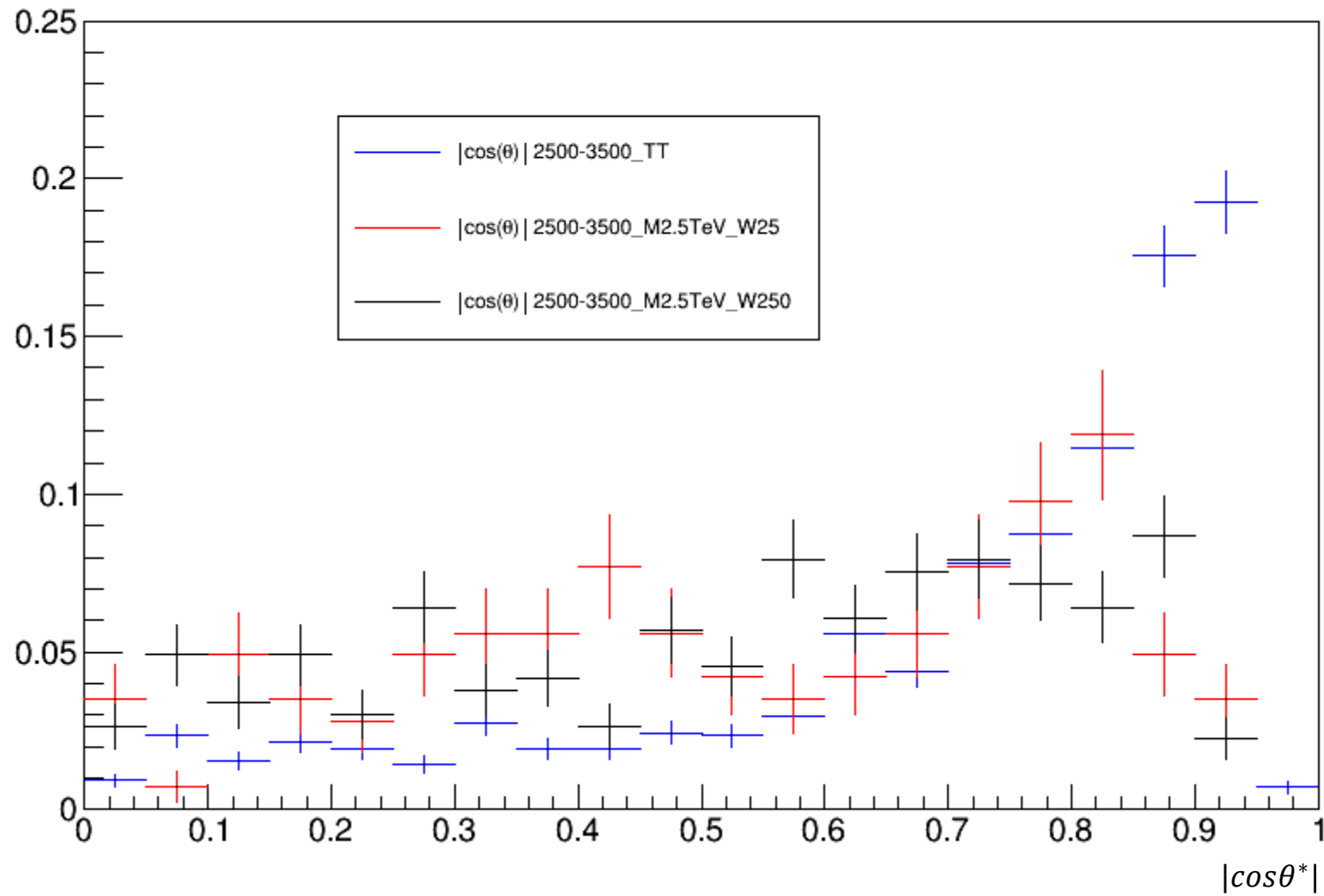

|cos(θ)| Distribution for mass limit: 1000-2500 (GeV)

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2TeV and different widths

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2.5TeV and different widths

|cos(θ)| Distribution for mass limit: 1000-2500 (GeV)

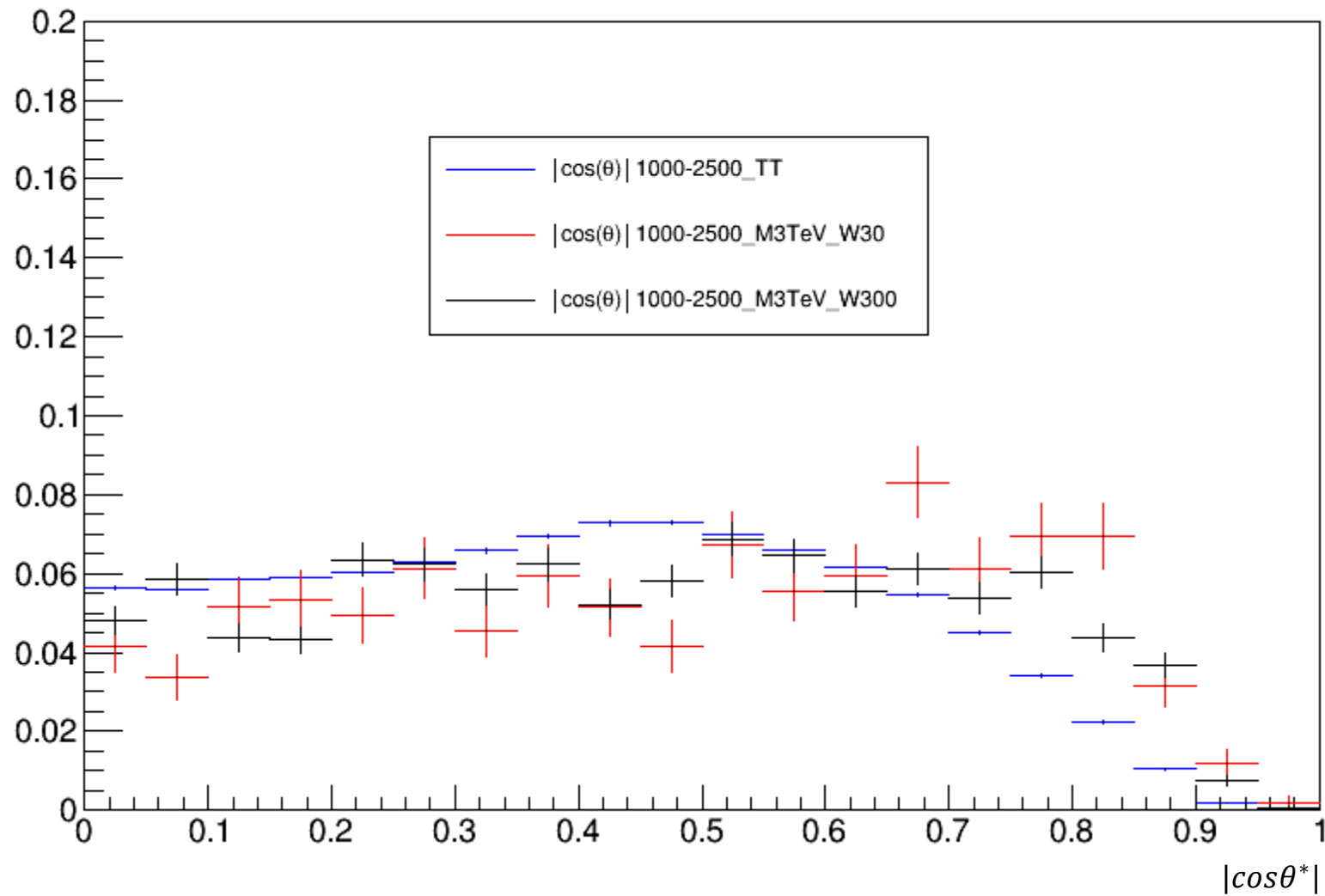|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 2.5TeV and different widths
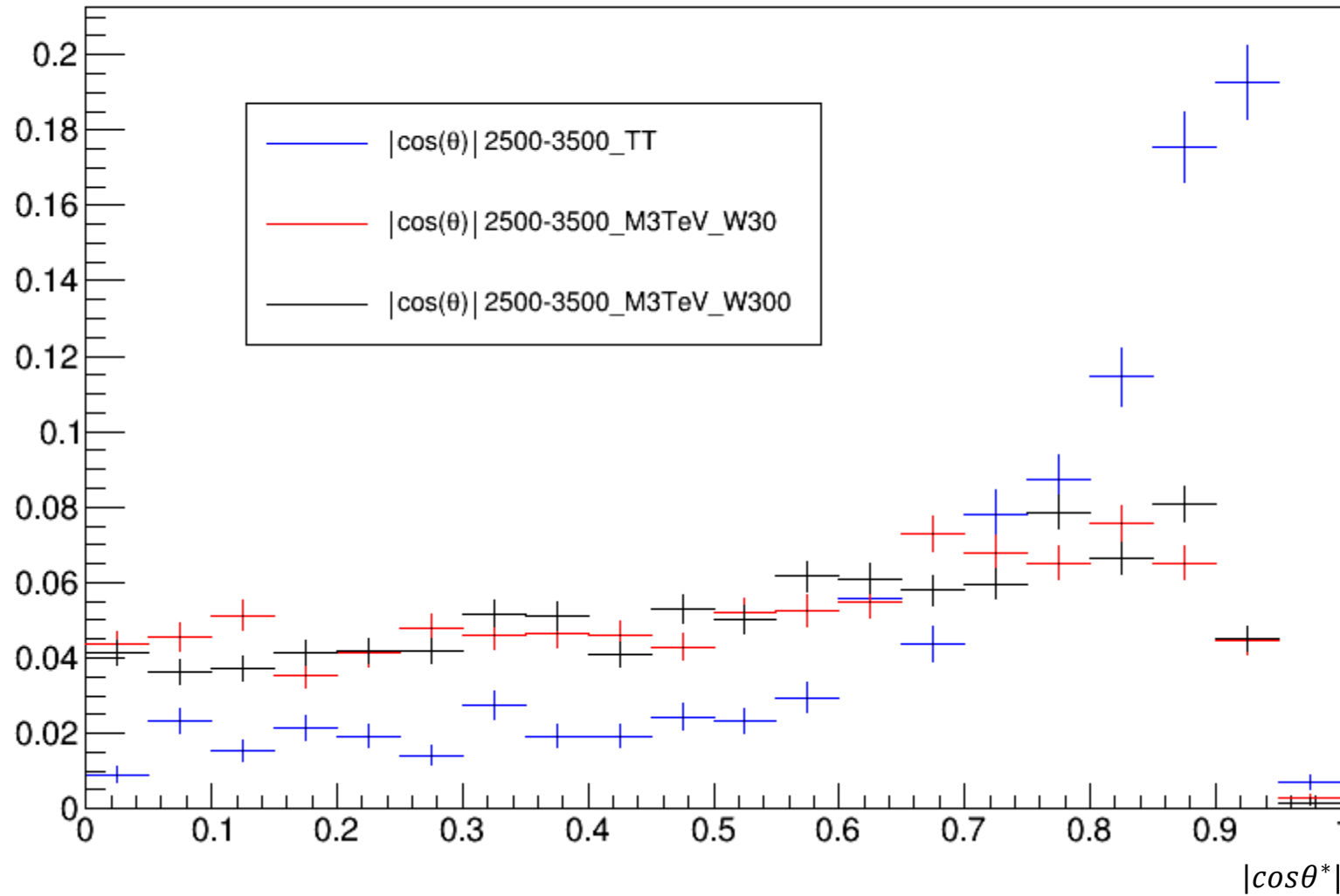

|cos(θ)| Distribution for mass limit: 2500-3500 (GeV)

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 3TeV and different widths

|cos(θ)| Distribution for mass limit: 1000-2500 (GeV)

Legend:
- |cos(θ)| 1000-2500_TT (blue)
- |cos(θ)| 1000-2500_M3TeV_W30 (red)
- |cos(θ)| 1000-2500_M3TeV_W300 (black)

$|cos\theta^*|$

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 3TeV and different widths
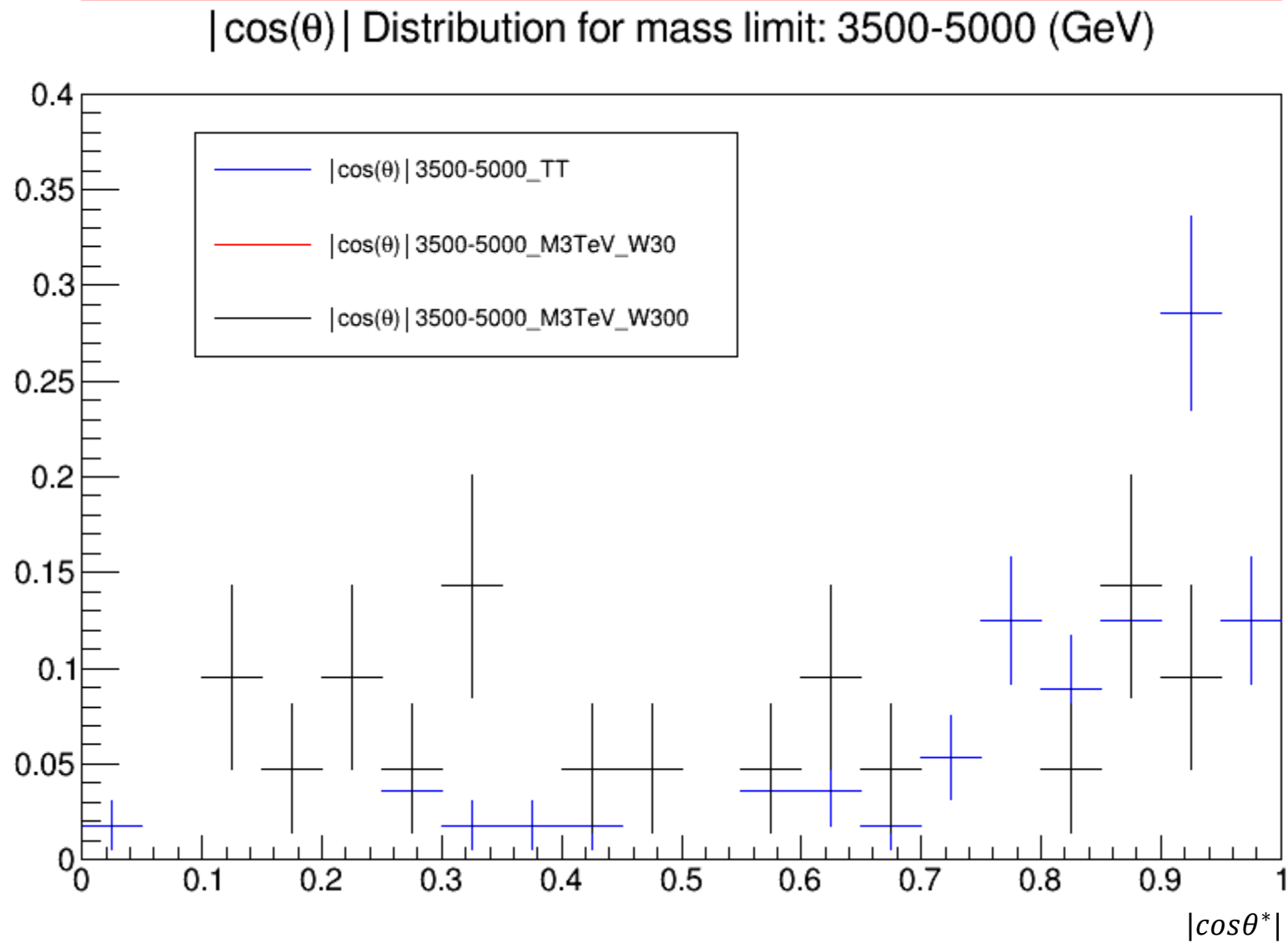

|cos(θ)| Distribution for mass limit: 2500-3500 (GeV)

Legend:
- |cos(θ)| 2500-3500_TT
- |cos(θ)| 2500-3500_M3TeV_W30
- |cos(θ)| 2500-3500_M3TeV_W300

$|cos\theta^*|$

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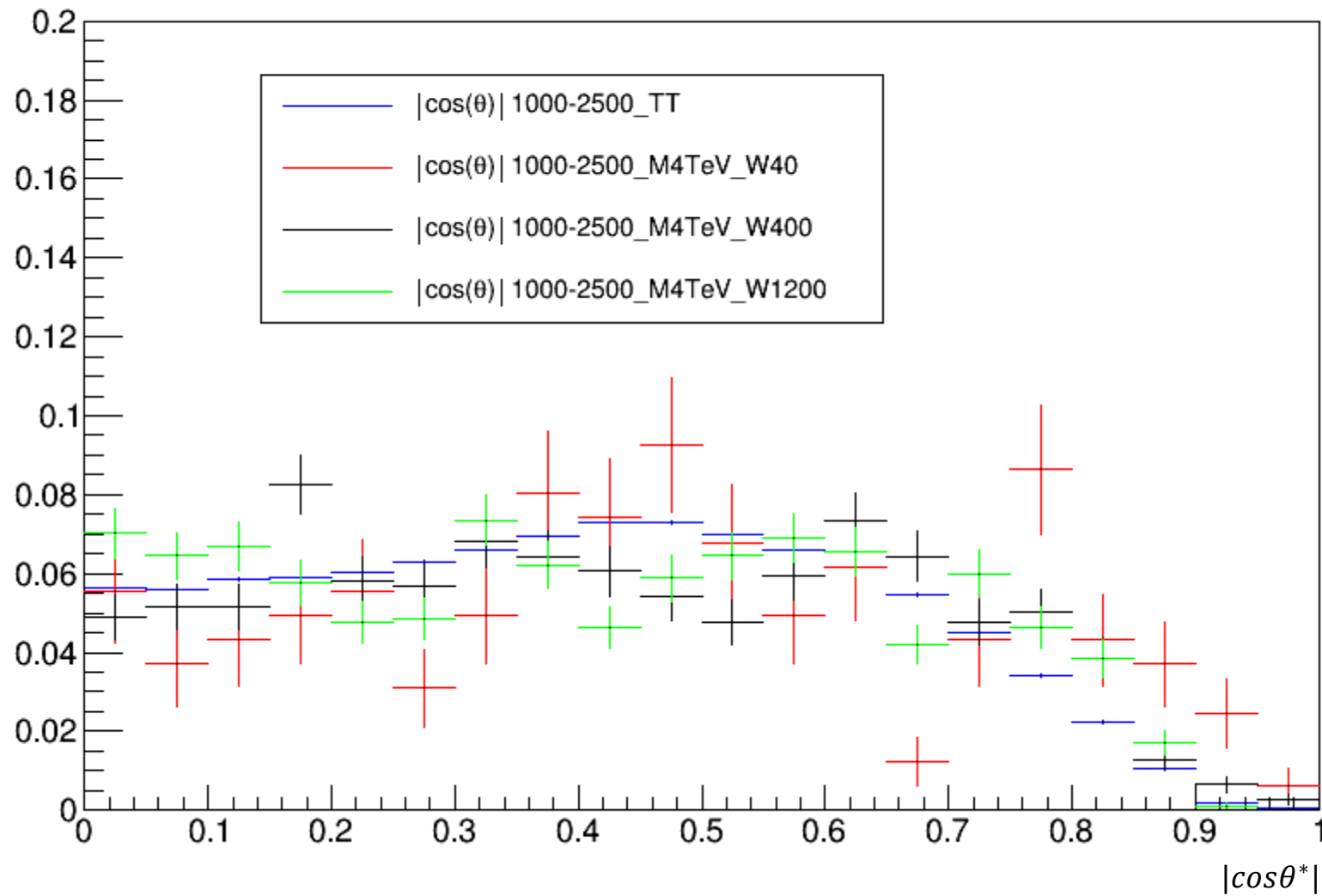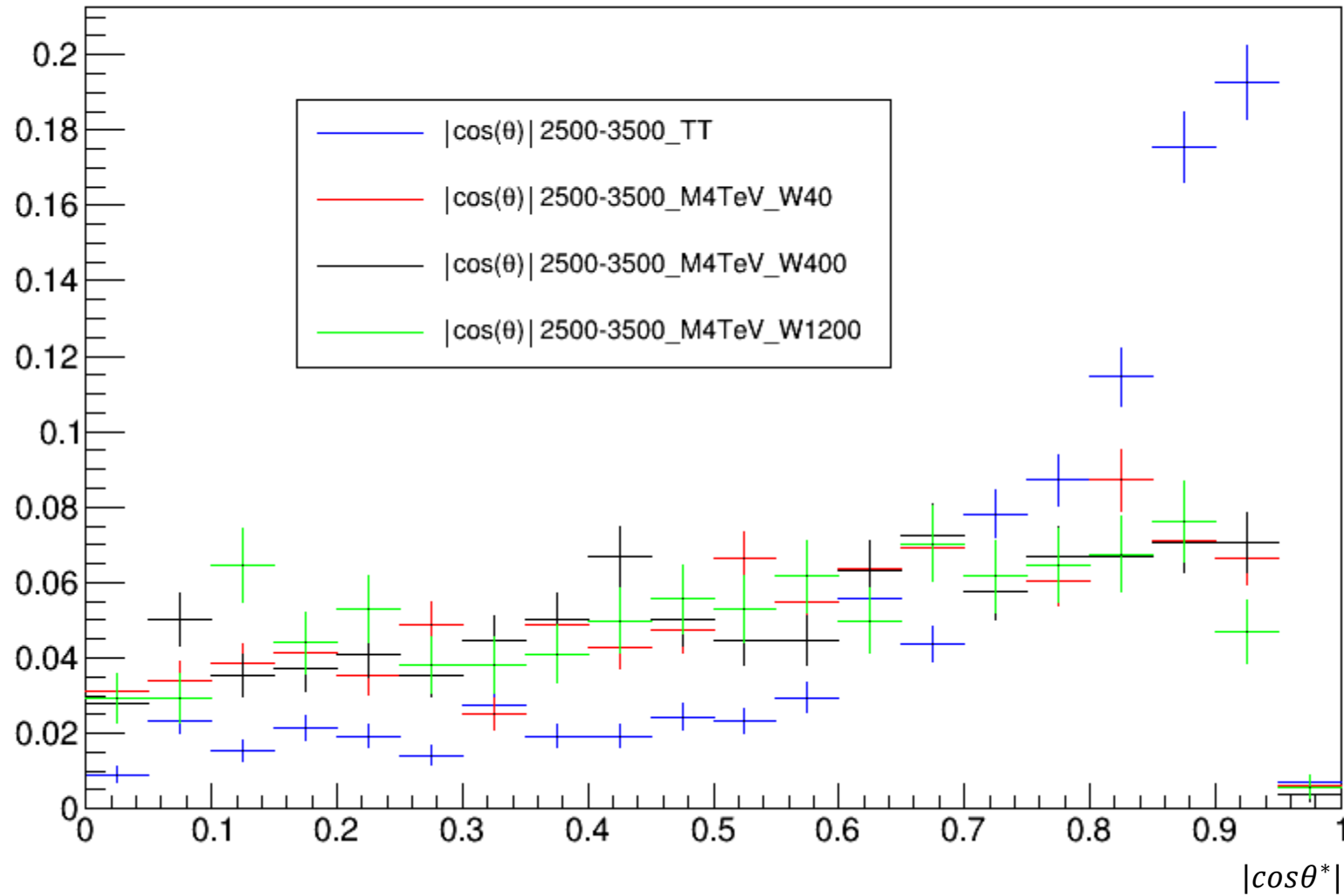

|cos(θ)| Distribution for mass limit: 3500-5000 (GeV)

Legend:
- |cos(θ)| 3500-5000_TT
- |cos(θ)| 3500-5000_M3TeV_W30
- |cos(θ)| 3500-5000_M3TeV_W300

$|cos\theta^*|$

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 4TeV and different widths
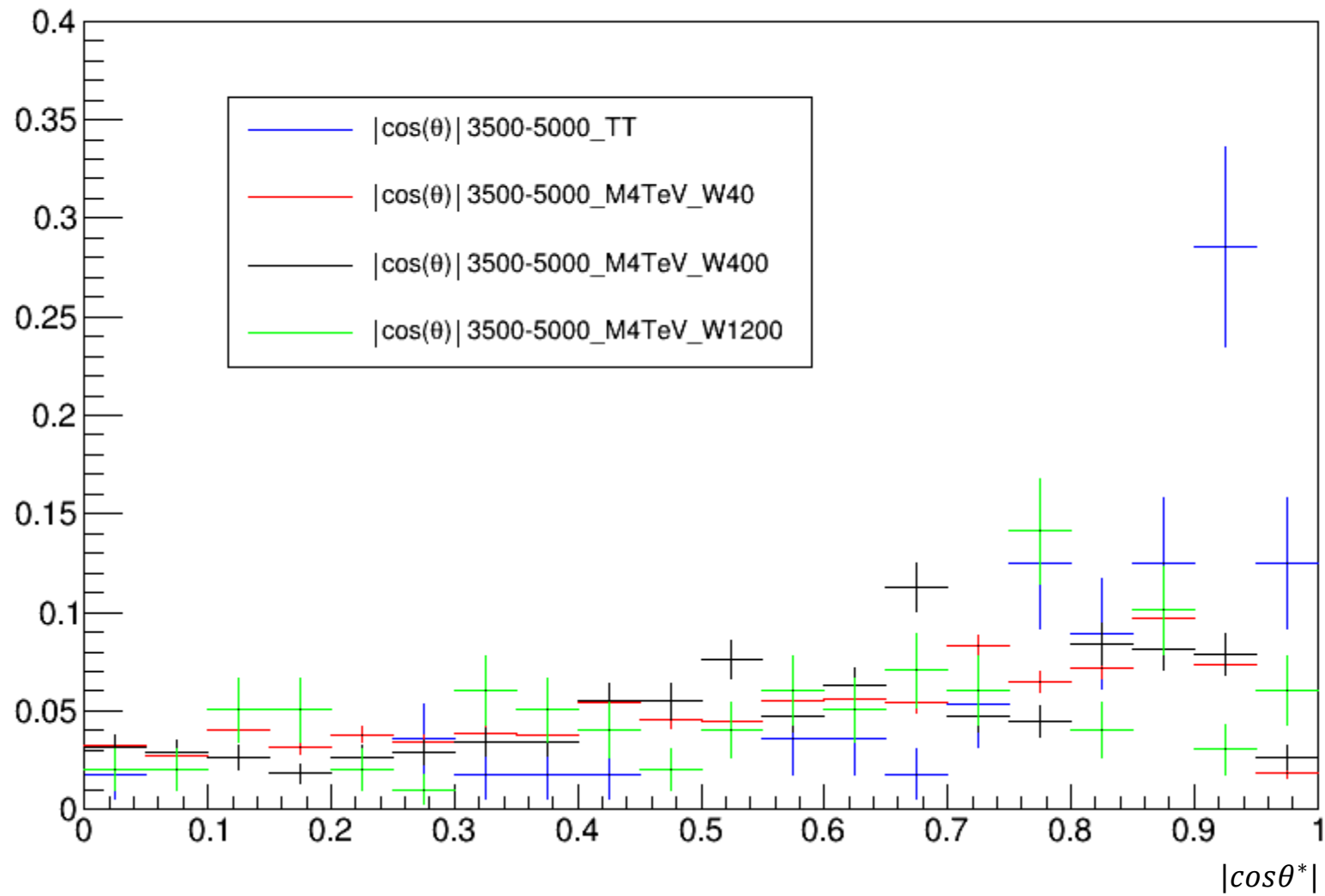

|cos(θ)| Distribution for mass limit: 1000-2500 (GeV)

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 4TeV and different widths

|cos(θ)| Distribution for mass limit: 2500-3500 (GeV)

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 4TeV and different widths

|cos(θ)| Distribution for mass limit: 3500-5000 (GeV)

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 5TeV and different widths

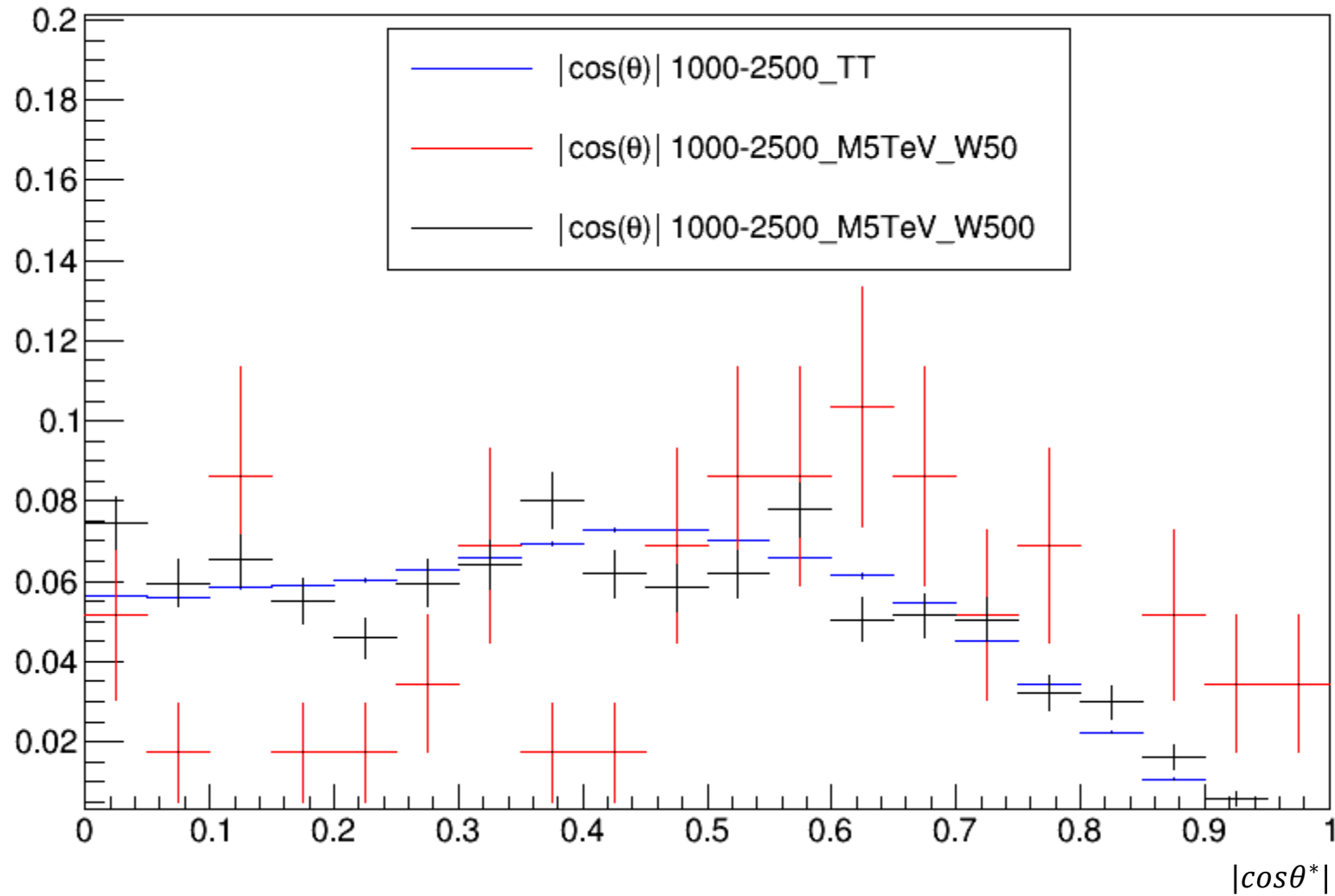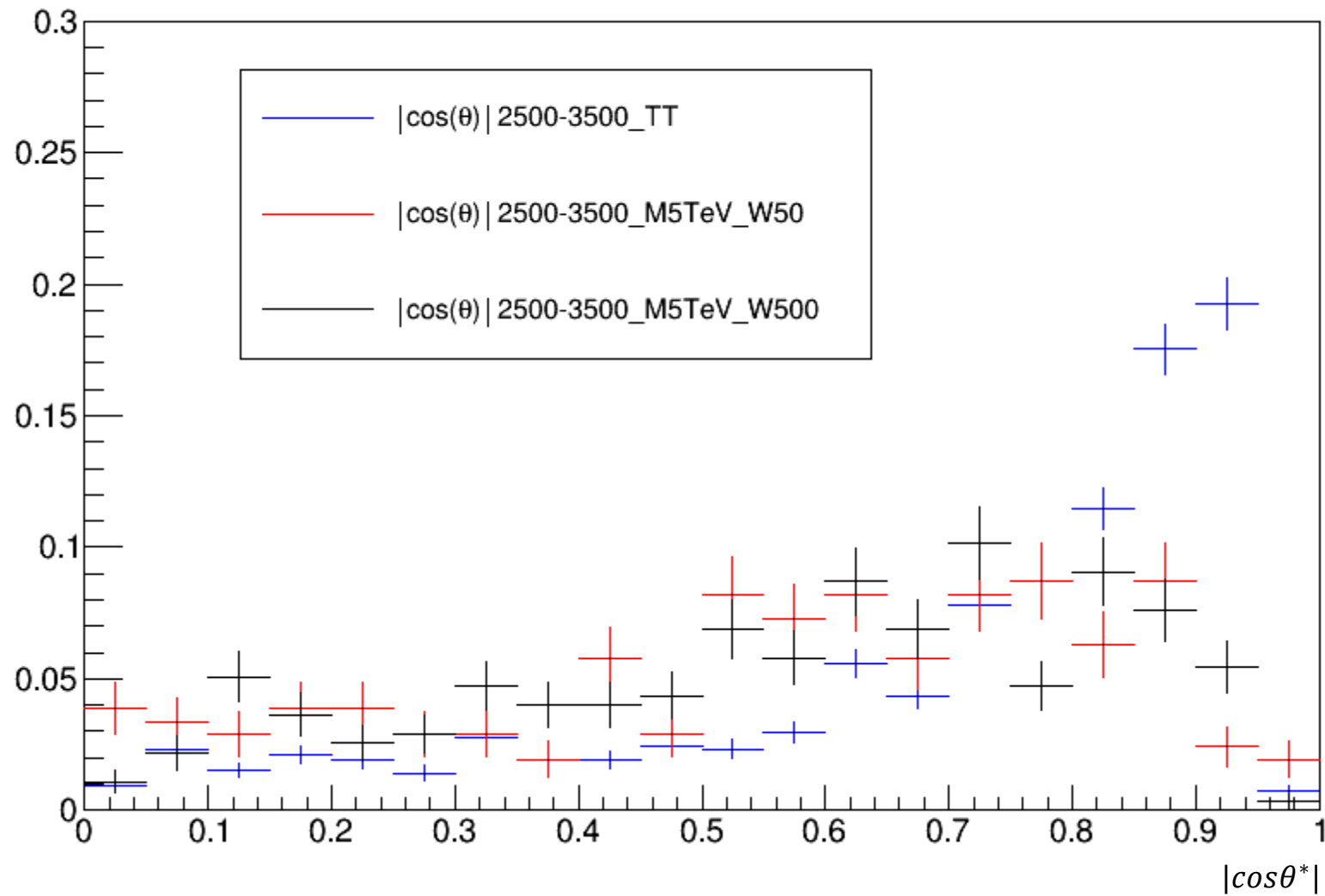$|\cos(\theta)|$ Distribution for mass limit: 1000-2500 (GeV)

|cosθ*| distribution for Mtt sample (1000-Inf) and Zprime samples with $M_{Z'}$ = 5TeV and different widths

|cos(θ)| Distribution for mass limit: 2500-3500 (GeV)

Legend:
- |cos(θ)| 2500-3500_TT
- |cos(θ)| 2500-3500_M5TeV_W50
- |cos(θ)| 2500-3500_M5TeV_W500

$|cos\theta^*|$

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|cos(θ)| Distribution for mass limit: 3500-5000 (GeV)