Higgs to Dimuons: FEWZ Studies

Brendan Regnery, Dimitri Bourilkov, Darin Acosta
Department of Physics, P.O. Box 118440, Gainesville, FL 32611-8440

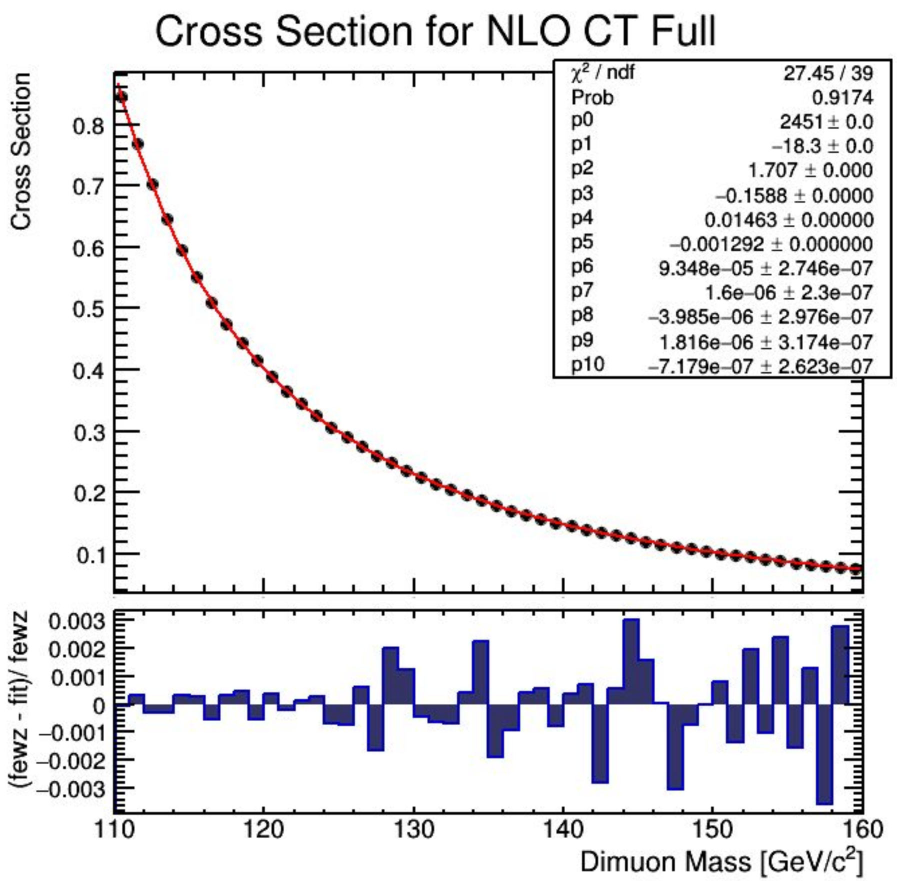
Objectives

- Make FEWZ NLO and NNLO histograms for dimuon mass
- Find the function that best describes these histograms
- The FEWZ NLO output histograms are located here: https://github.com/bregnery/FEWZforHiggs2mumu/tree/master/FEWZ/FEWZ_3.1.b2/bin/NLOresults
- The github repository for this fitting program is located here: https://github.com/bregnery/PythonModulesForCMSfits

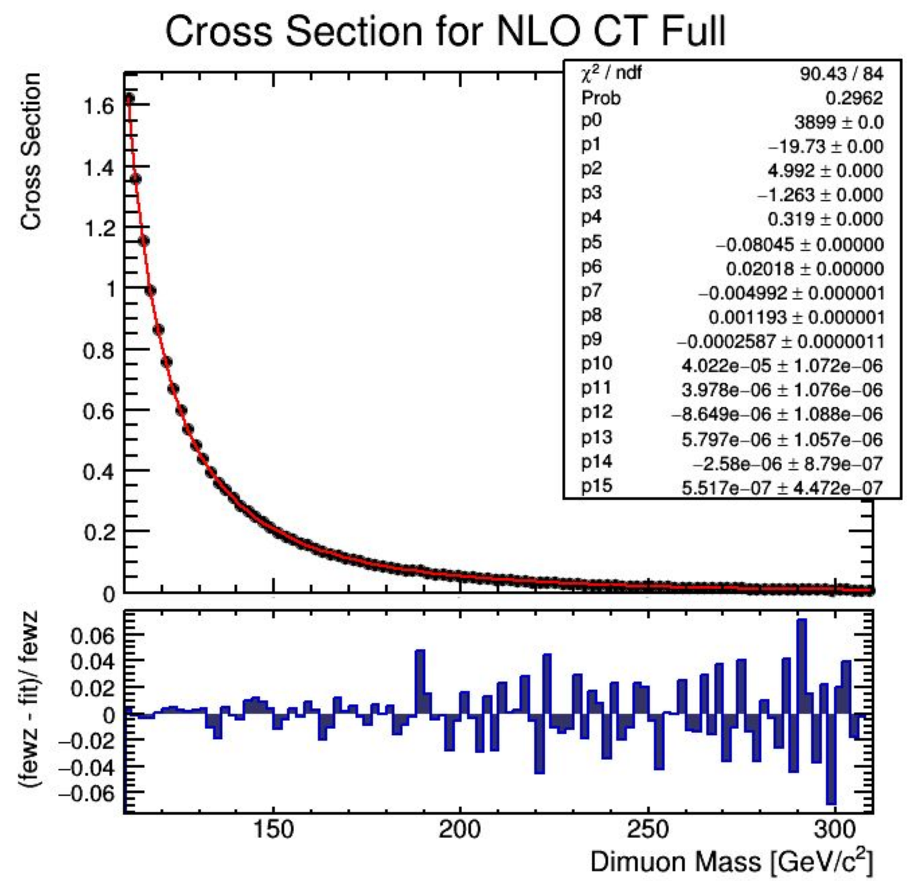
Leading Muon pT > 26 GeV, NLO Full Category

Chebyshev Polynomial Fit

Low Mass



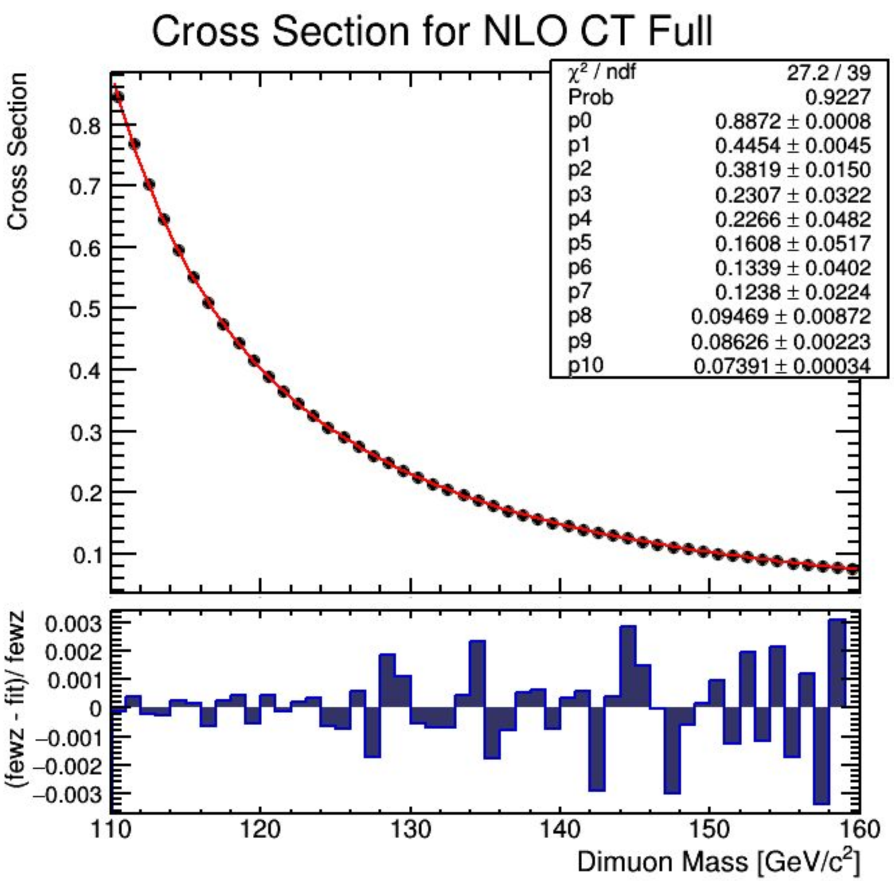
High Mass



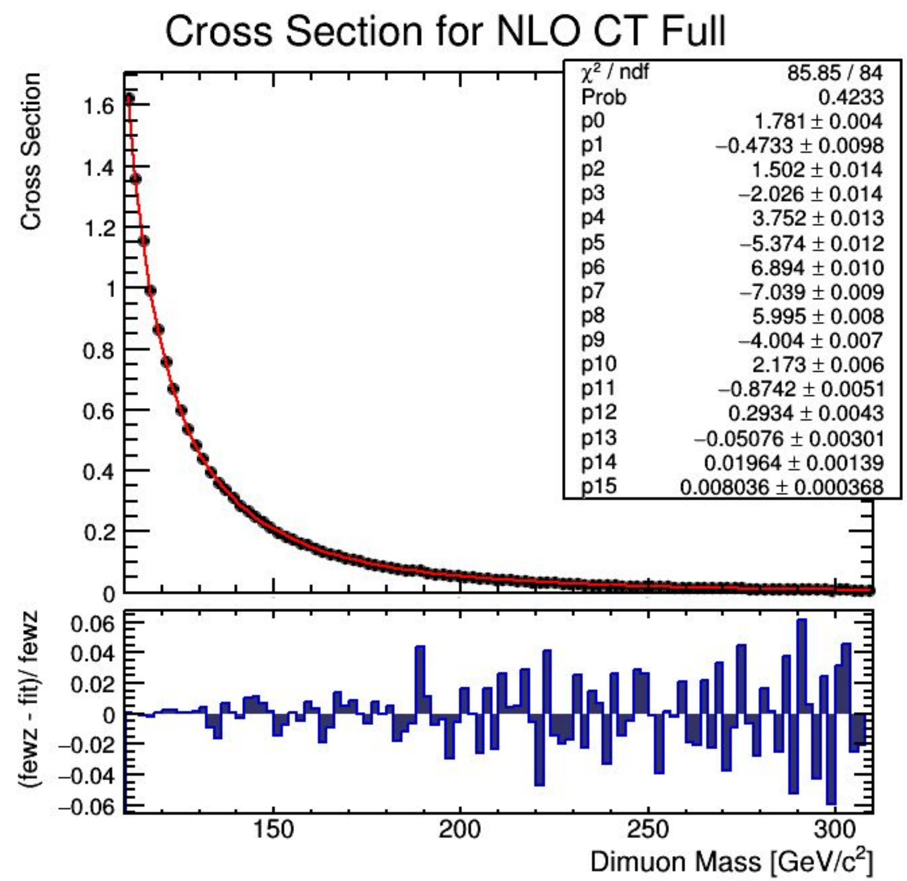
pN are the coefficients of the polynomials

Bernstein Polynomial Fit

Low Mass



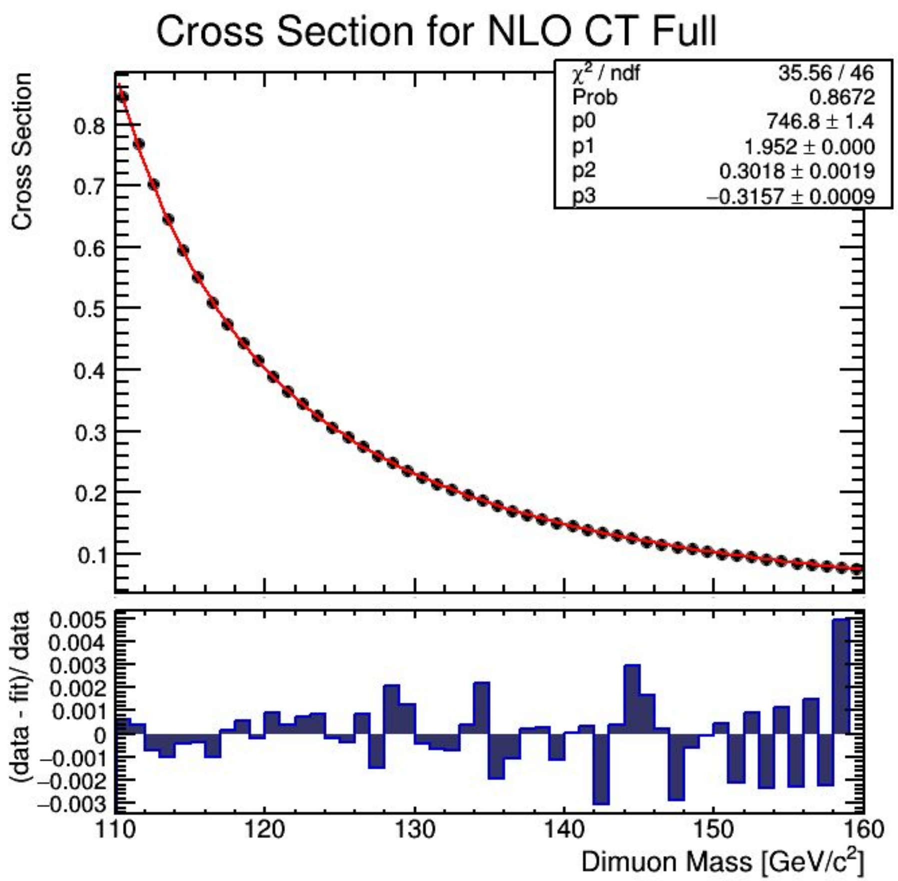
High Mass



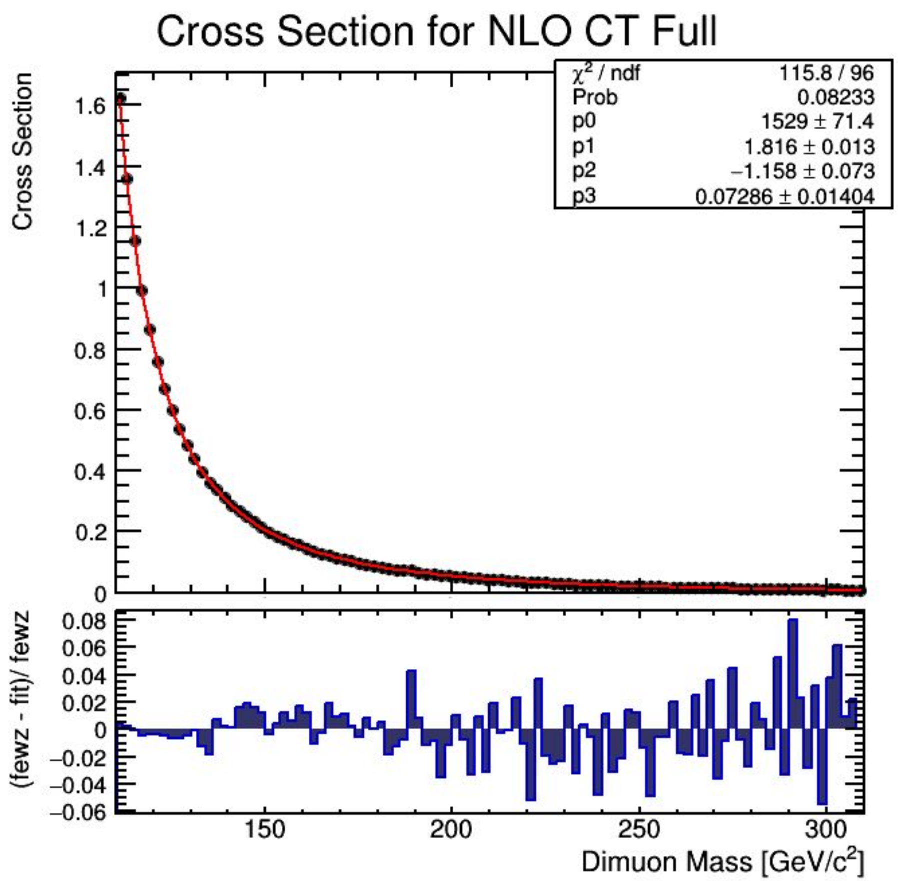
pN are the coefficients of the polynomials

Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner

Low Mass



High Mass

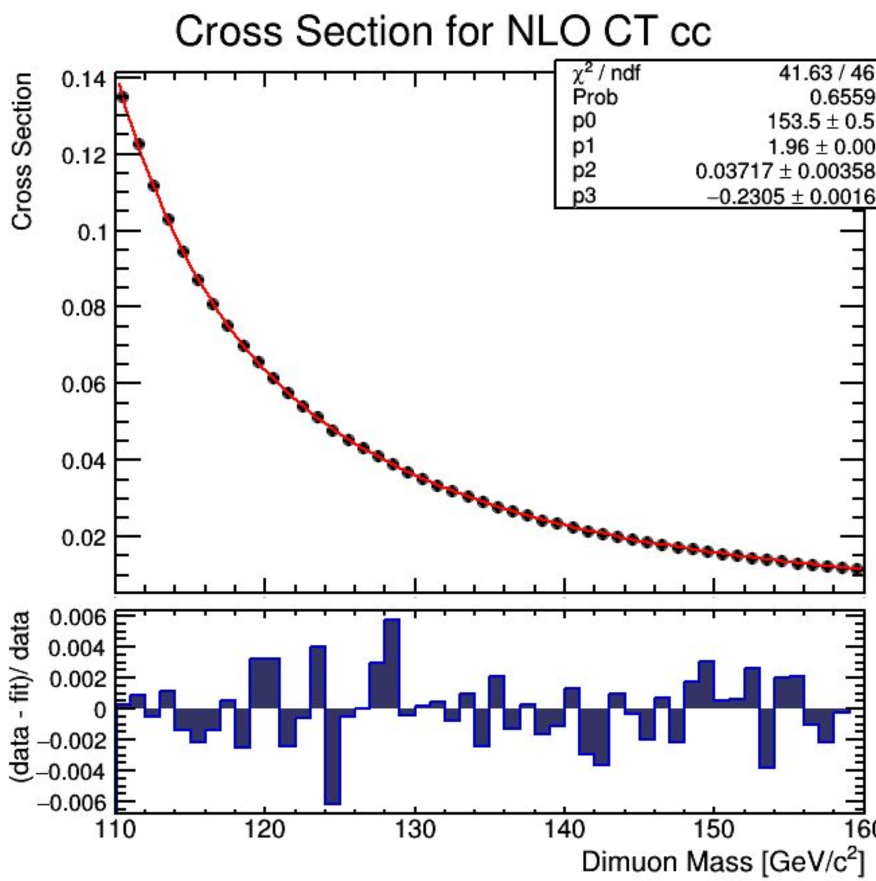


p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

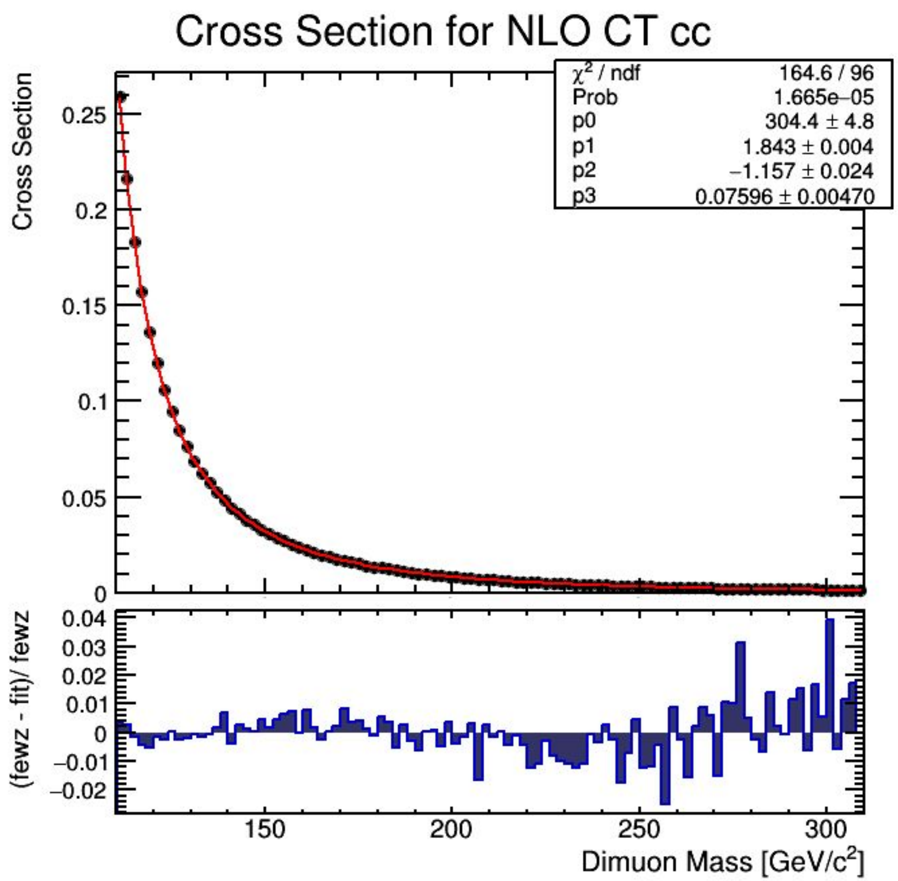
Leading Muon pT > 26 GeV, NLO Central Central (CC) Category

Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner

Low Mass



High Mass

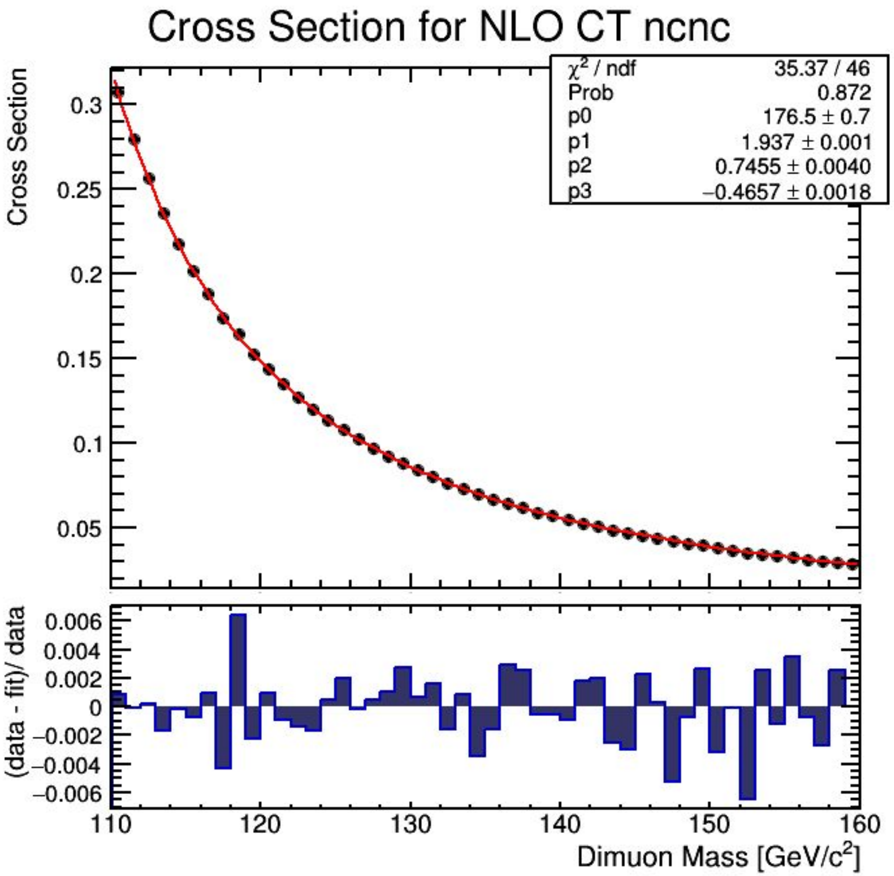


p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

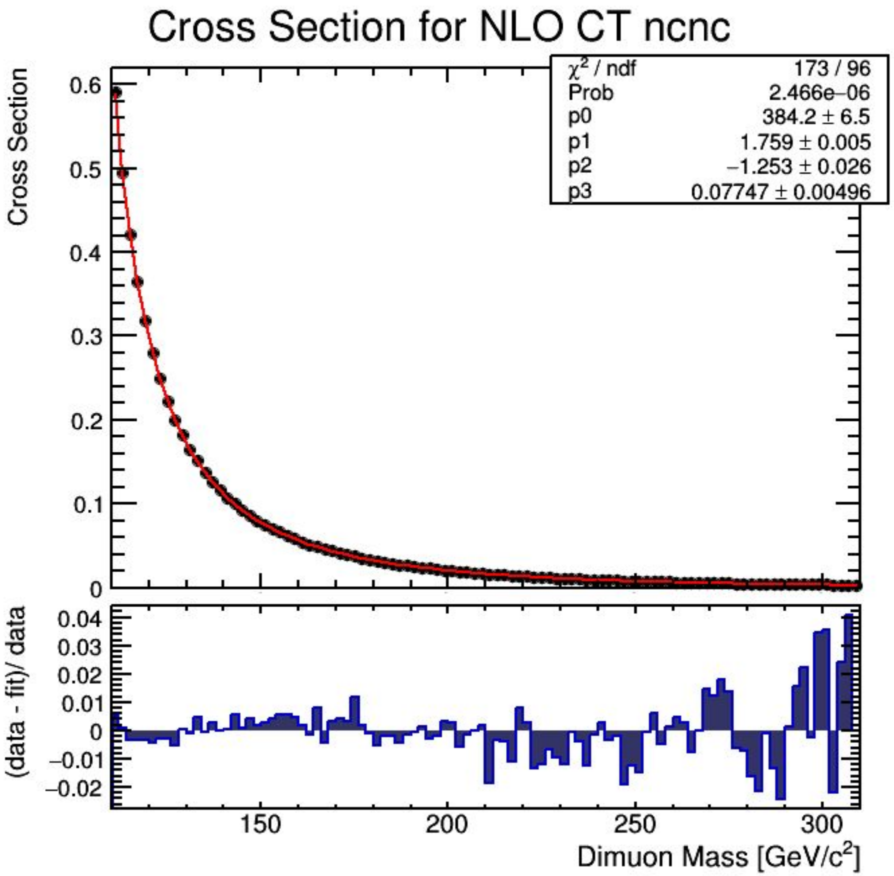
Leading Muon pT > 26 GeV, NLO Non-central Non-central (NCNC) Category

Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner

Low Mass



High Mass

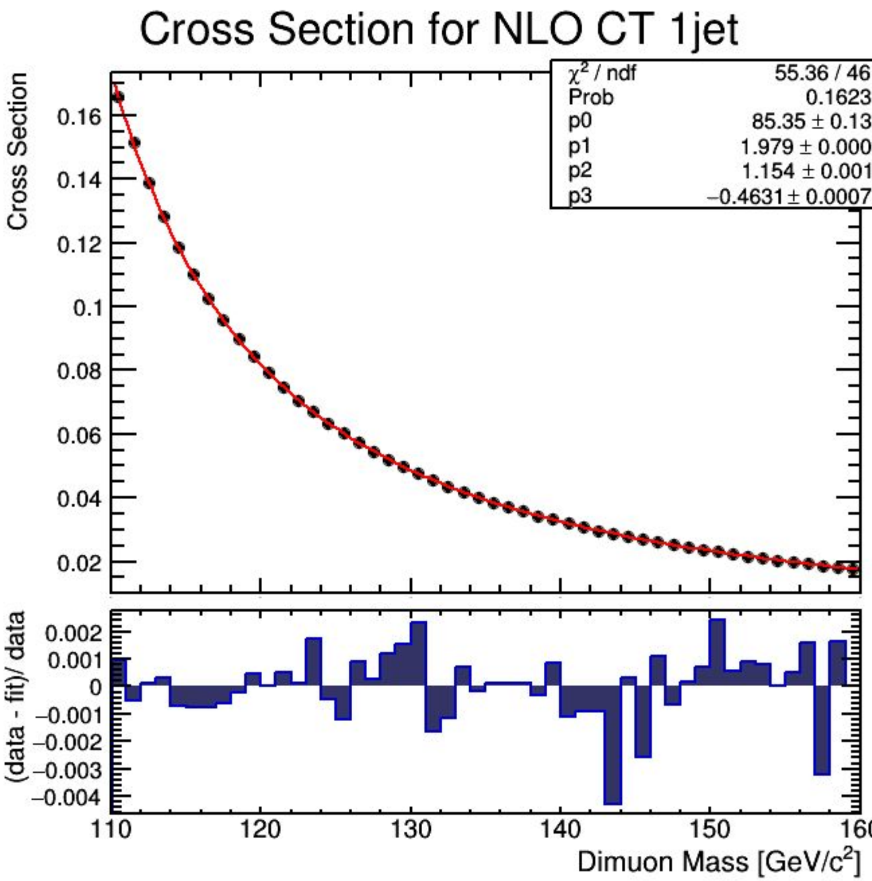


p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

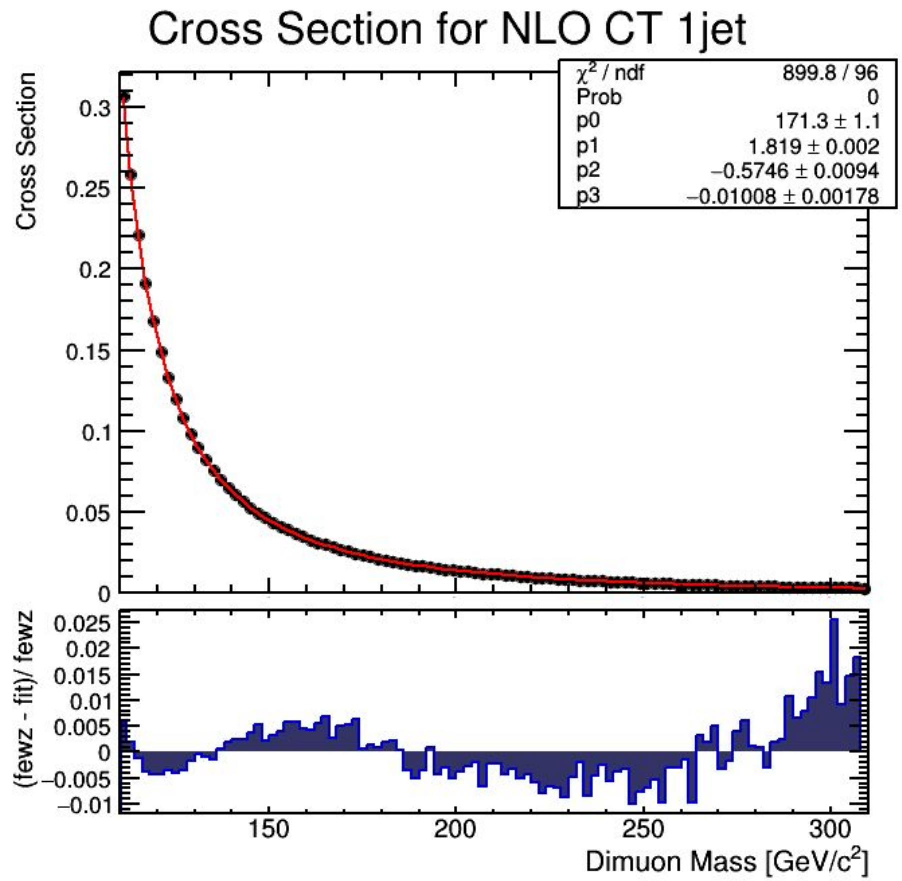
Leading Muon pT > 26 GeV, NLO 1 Jet (1jet) Category, 110 to 160 GeV/c^2

Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner

Low Mass



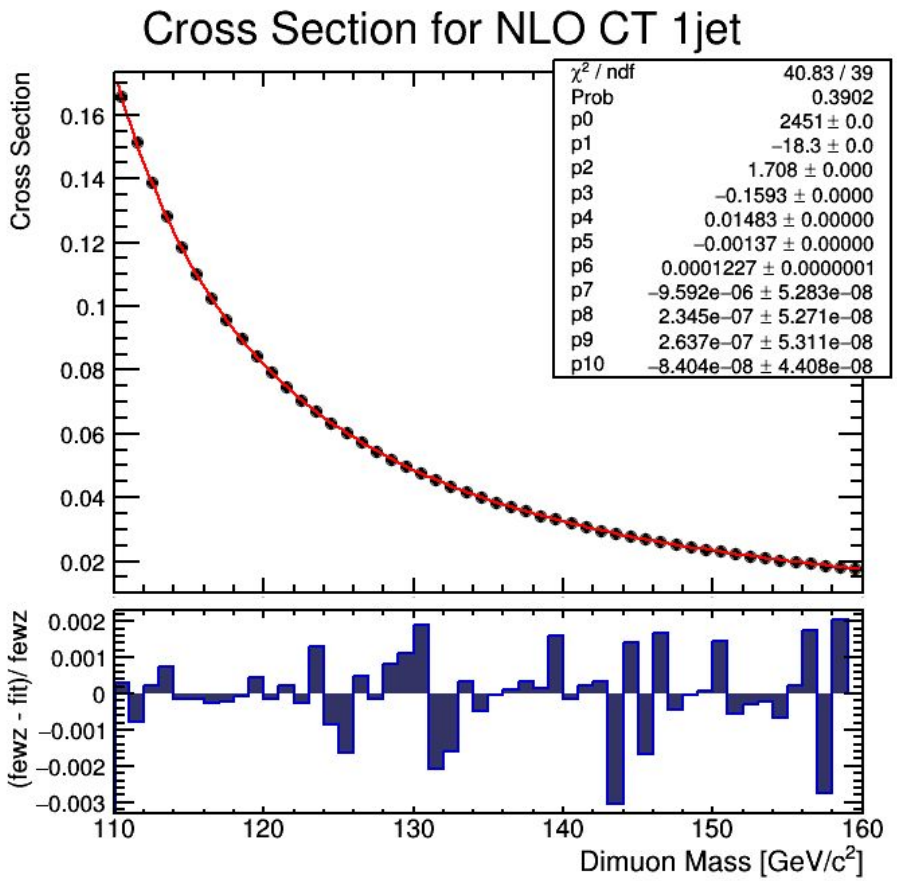
High Mass



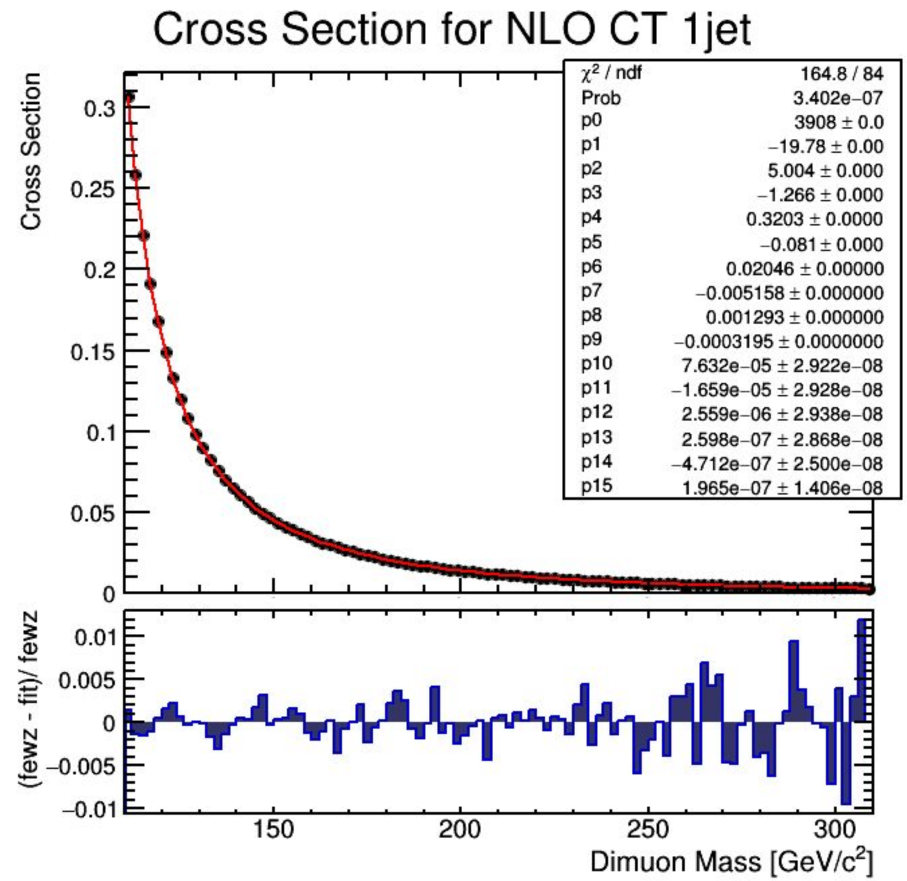
p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

Chebyshev Polynomial Fit

Low Mass



High Mass



pN are the coefficients of the polynomials

Conclusions

- The polynomials fit each category well however the require a large number of parameters to reach this sensitivity
- The relativistic and non-relativistic versions of the perturbed exponential times a Breit Wigner describe the low mass region almost equally well
- The perturbed exponential times a relativistic Breit Wigner describes the high mass region better than the non-relativistic case
- For the perturbed exponential times the Breit Wigner, making the power in the denominator be a parameter (with limits [1.5, 2.5]) is essential for improving the goodness of fit
- Only the polynomials seem to be good at fitting the high mass 1 jet category

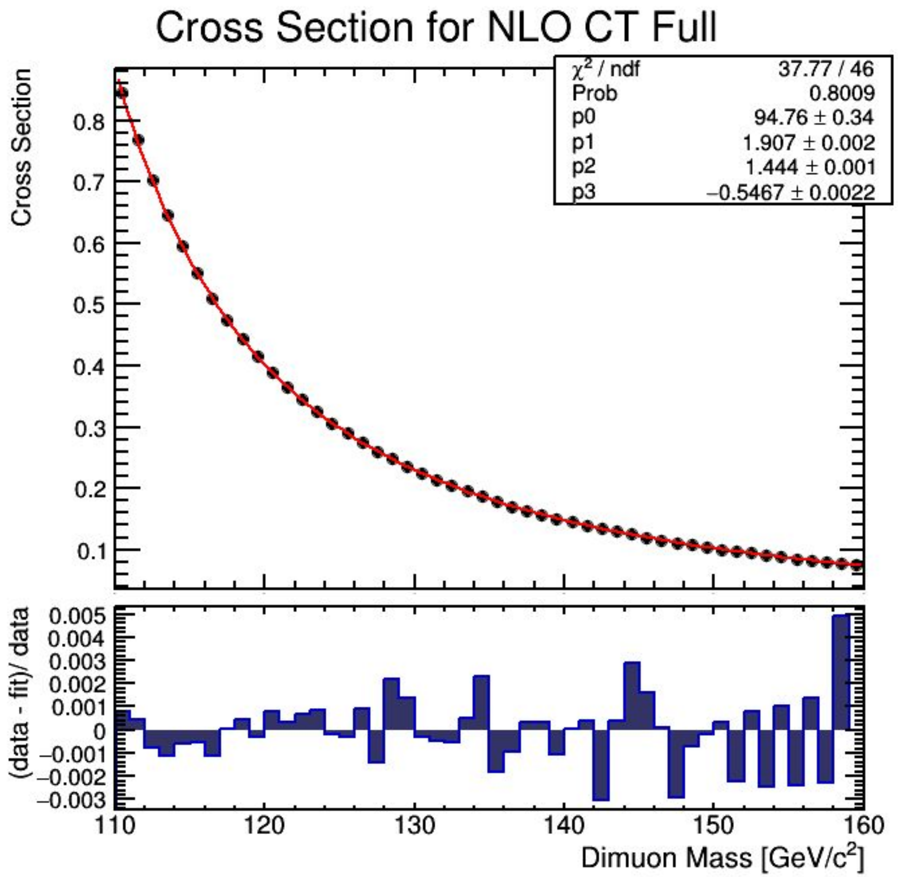
$$\frac{p0 * x^2 * \mathrm{Exp}[p2 * (x/100) + p3 * (x/100)^2]}{(x^2 - 91.2^2)^{p1} + (x^2 * 2.5/91.2\ )^{p1}}$$

Where p1 $\in$ [1.5, 2.5]

Back-Up

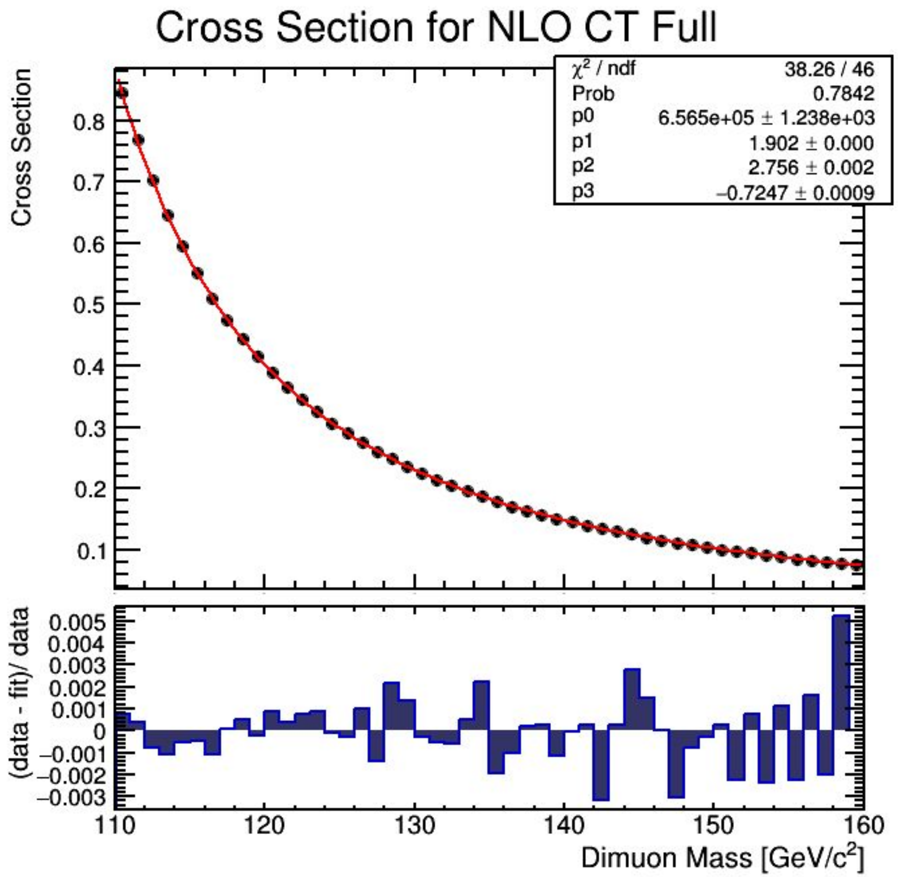
Leading Muon pT > 26 GeV, NLO Full Category, 110 to 160 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



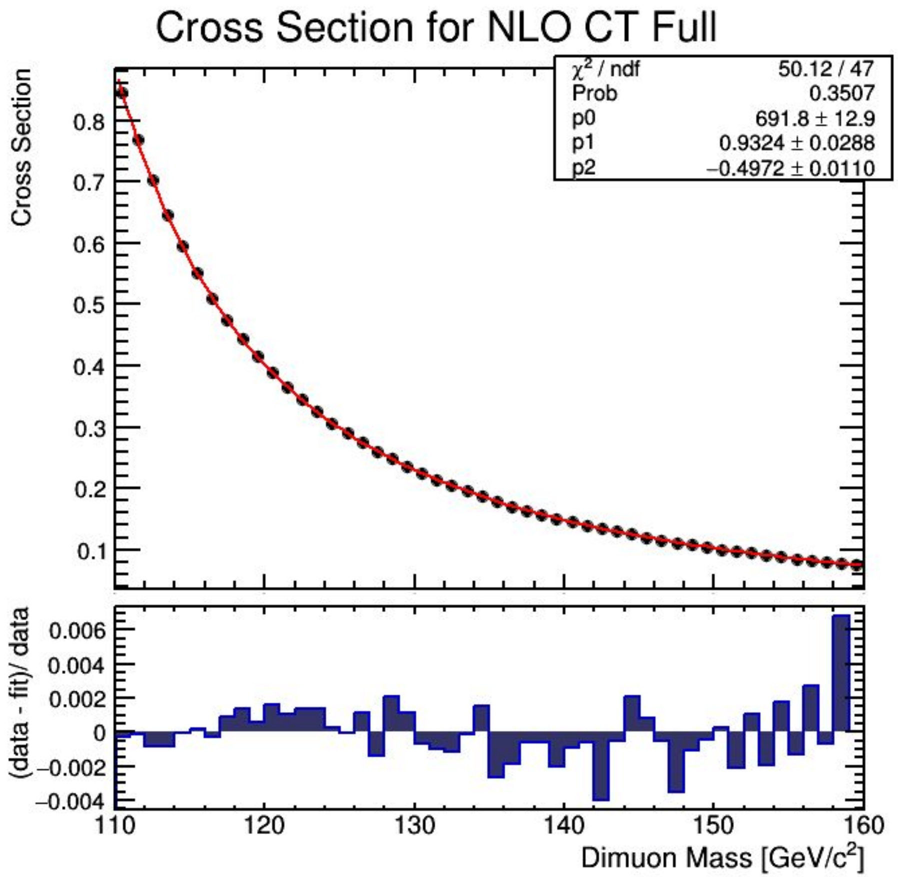
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

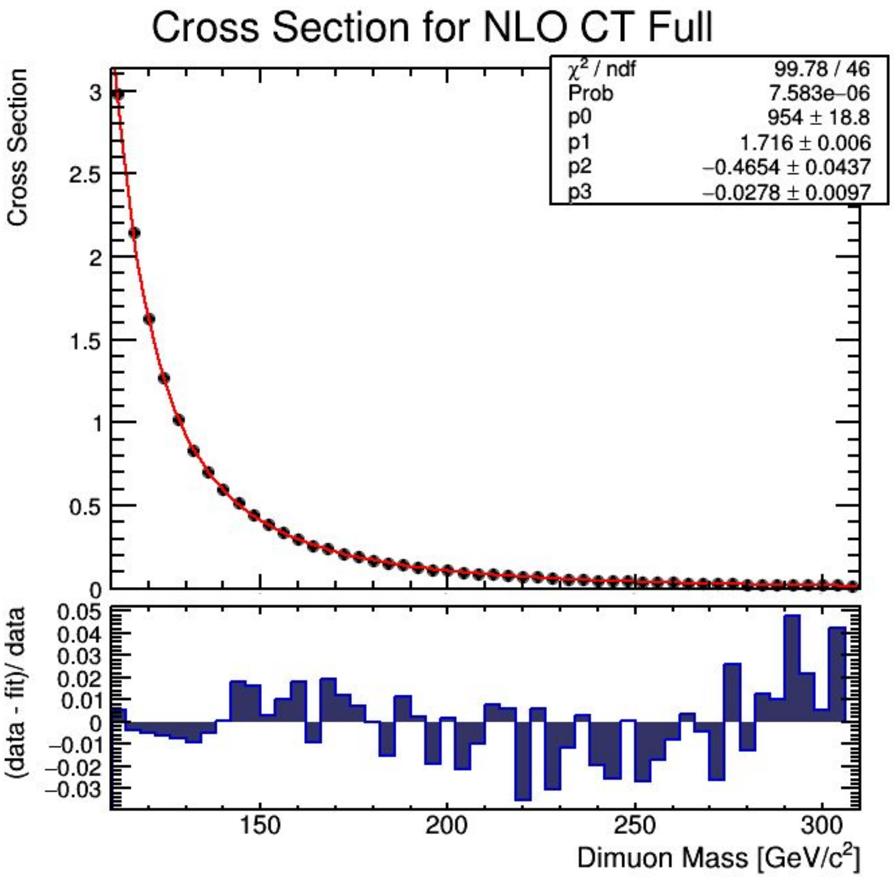
Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

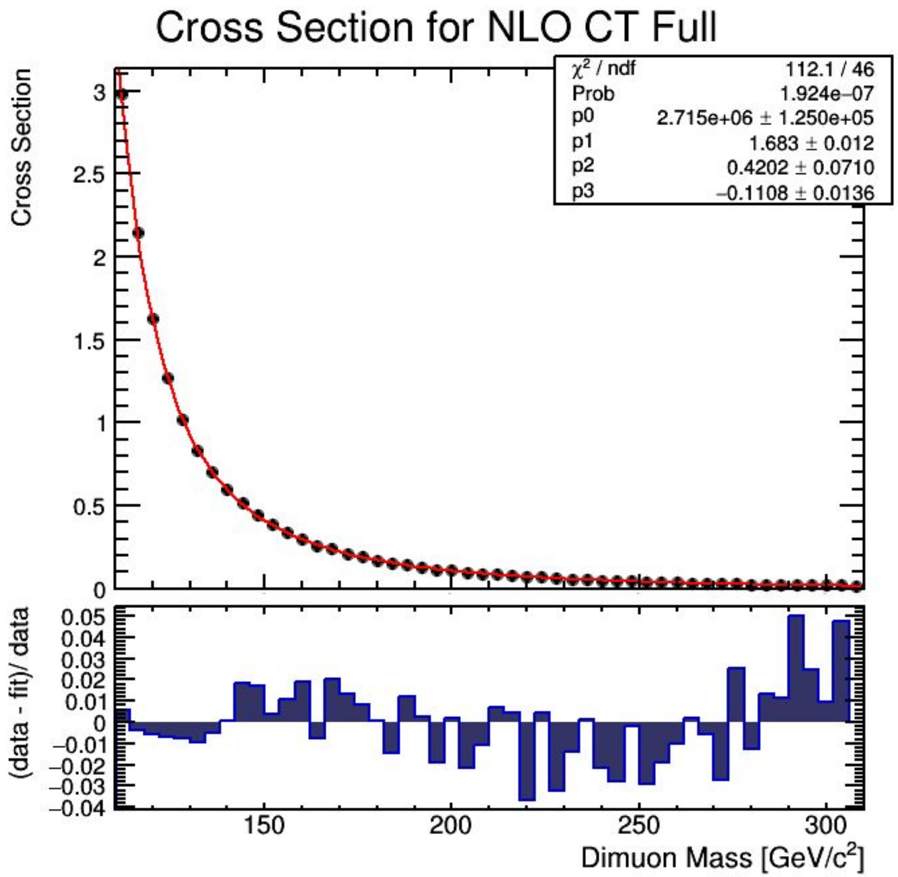
Leading Muon pT > 26 GeV, NLO Full Category 110 to 310 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



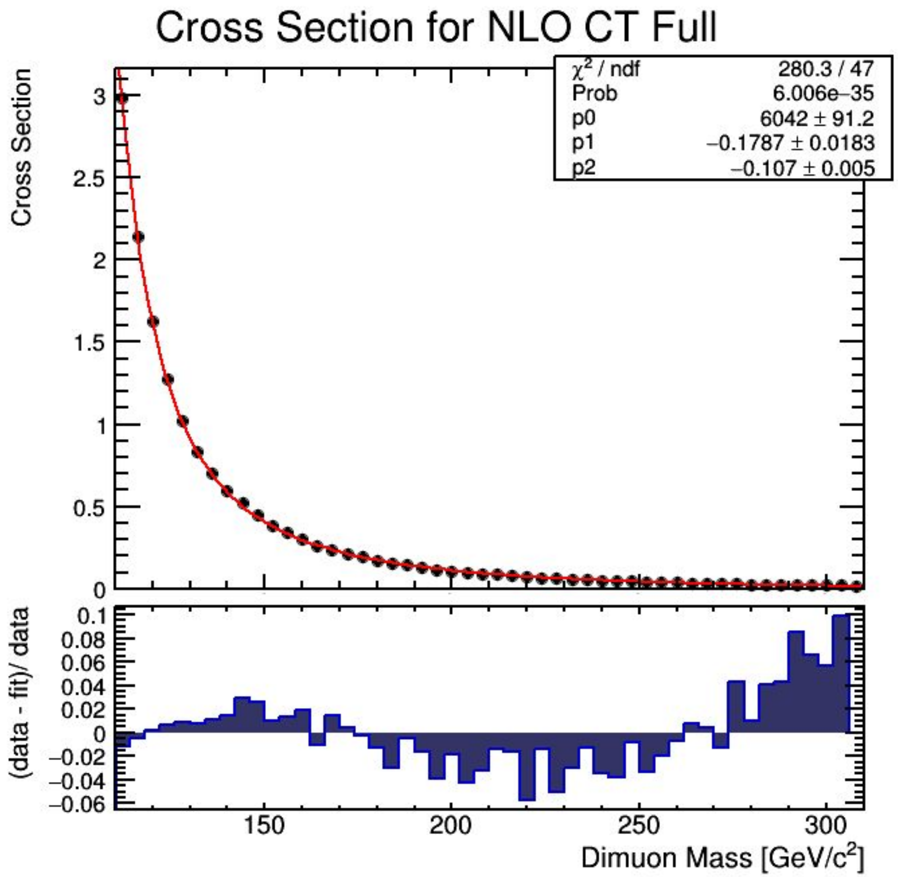
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



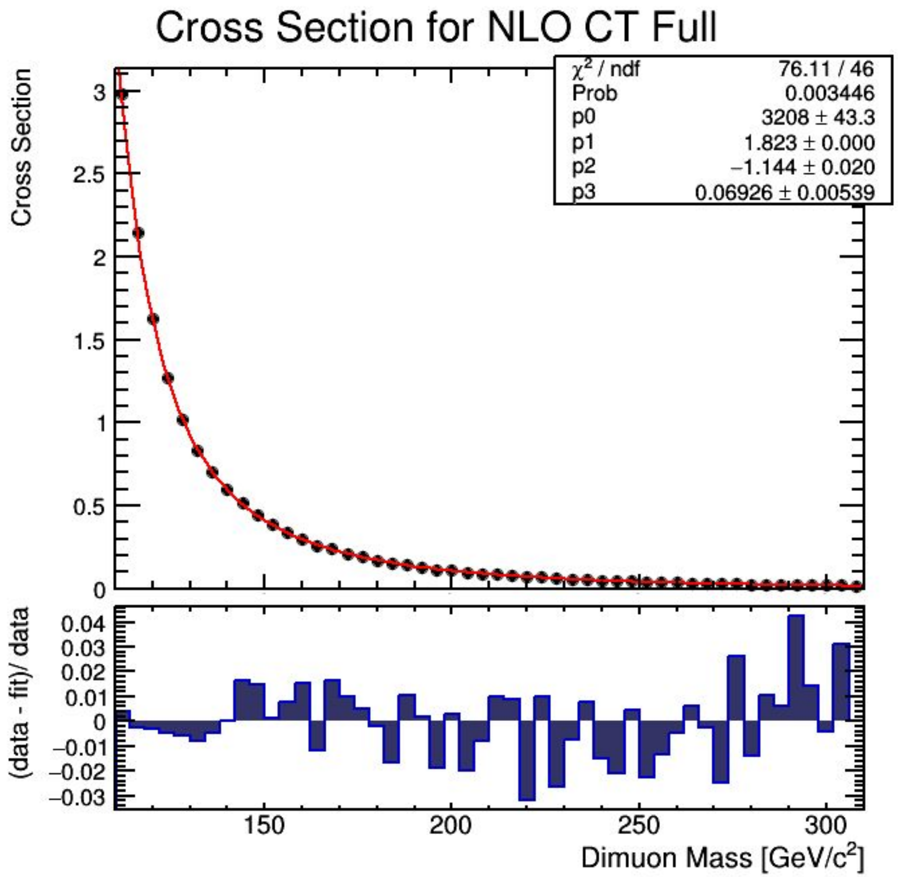
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

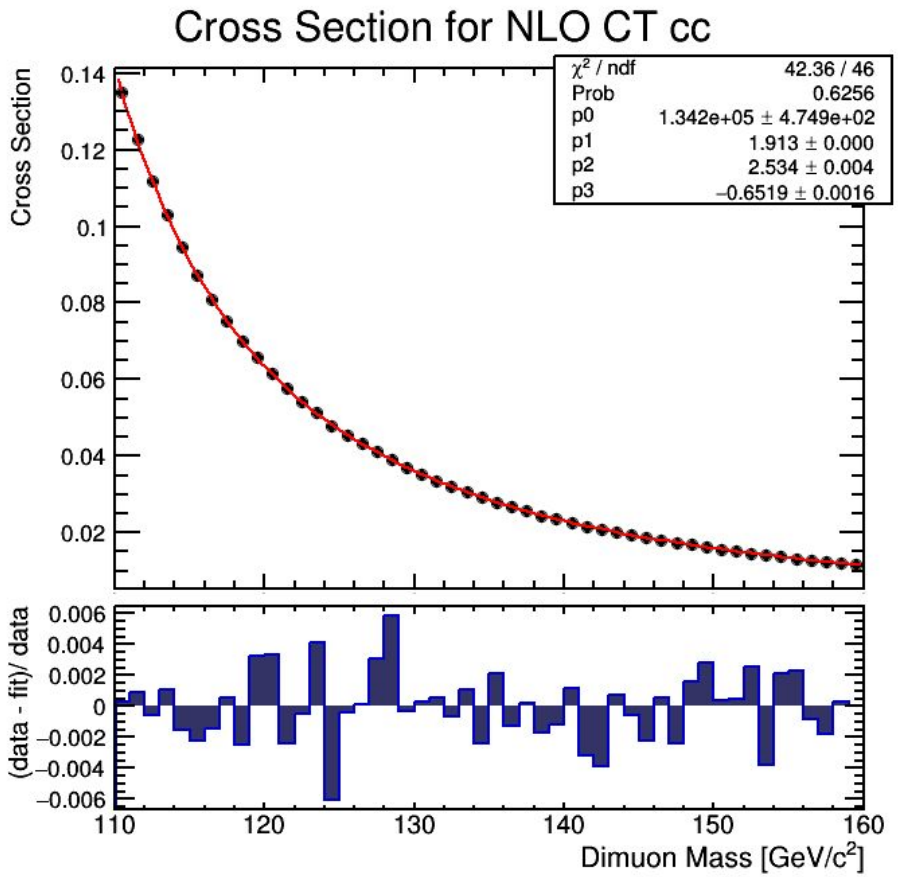
Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

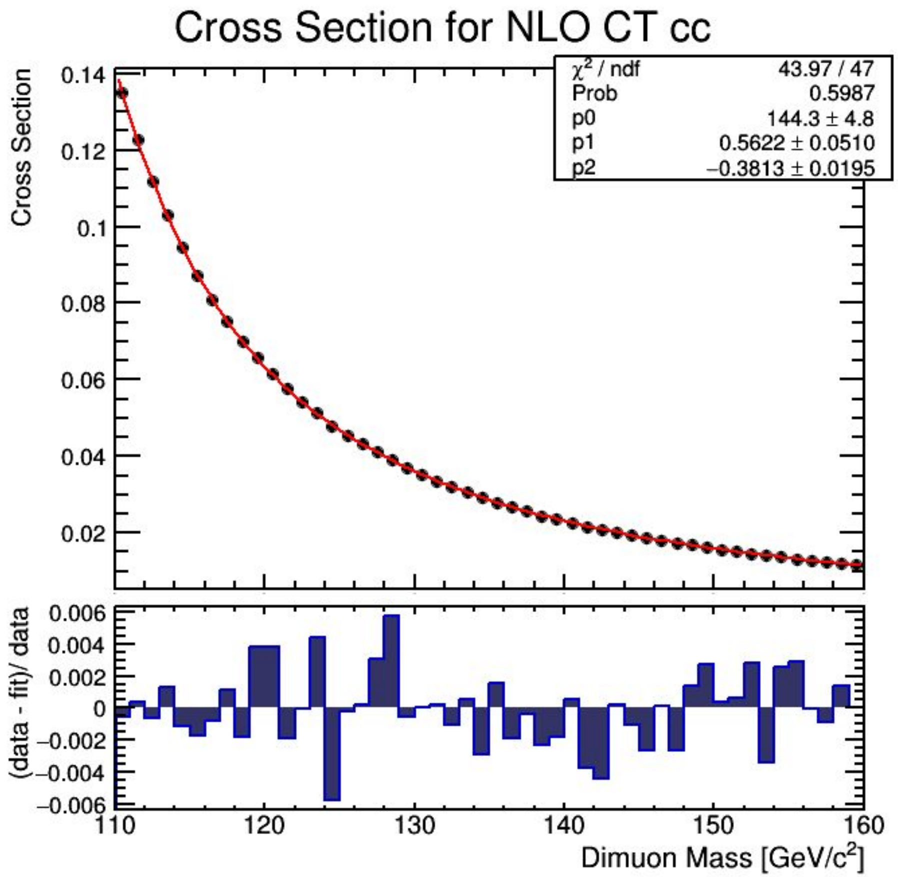
Leading Muon pT > 26 GeV, NLO Central Central (CC) Category, 110 to 160 GeV/c^2

Fit with Perturbed Exponential times Relativistic Breit Wigner



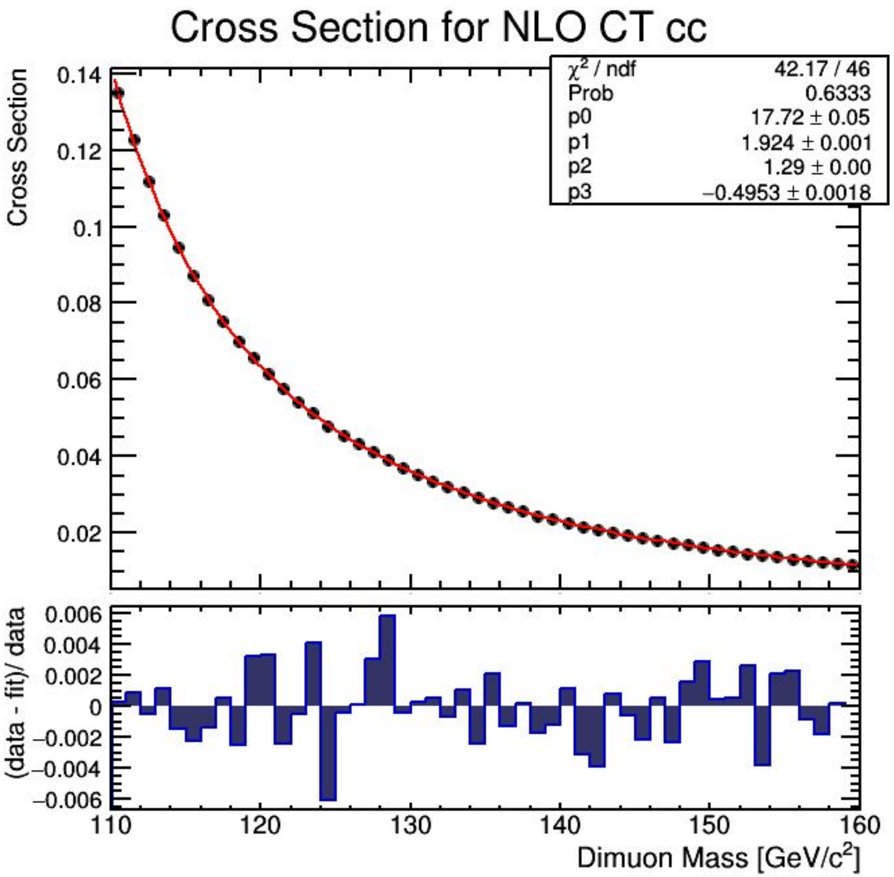
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

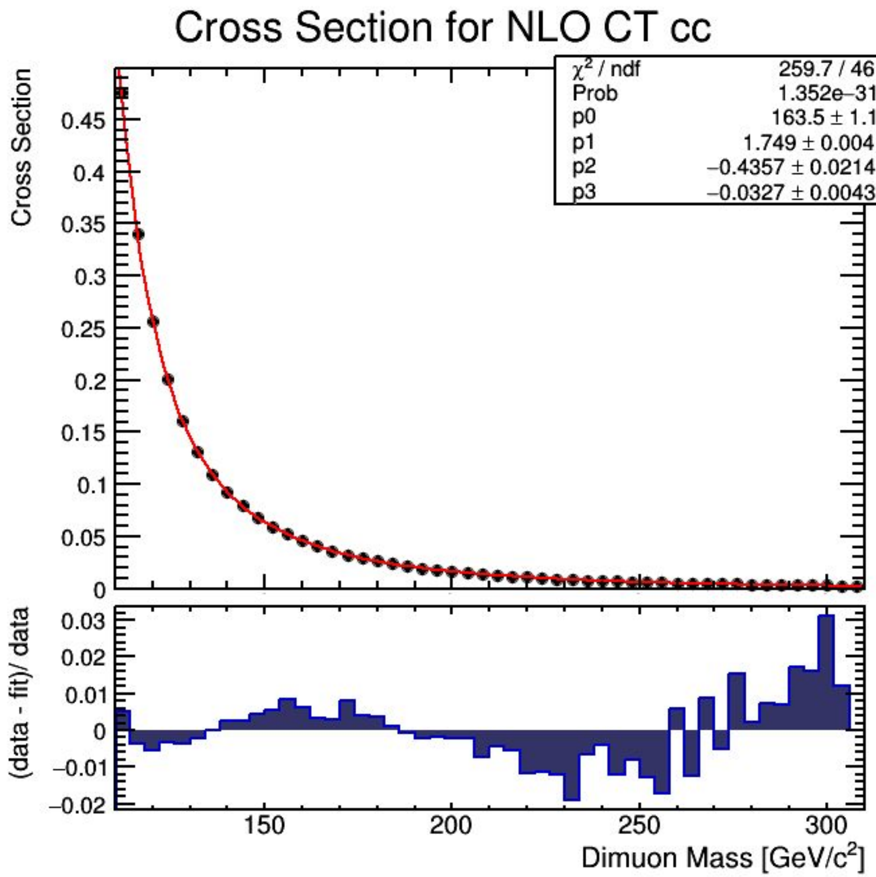
Fit with Perturbed Exponential times Breit Wigner



p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

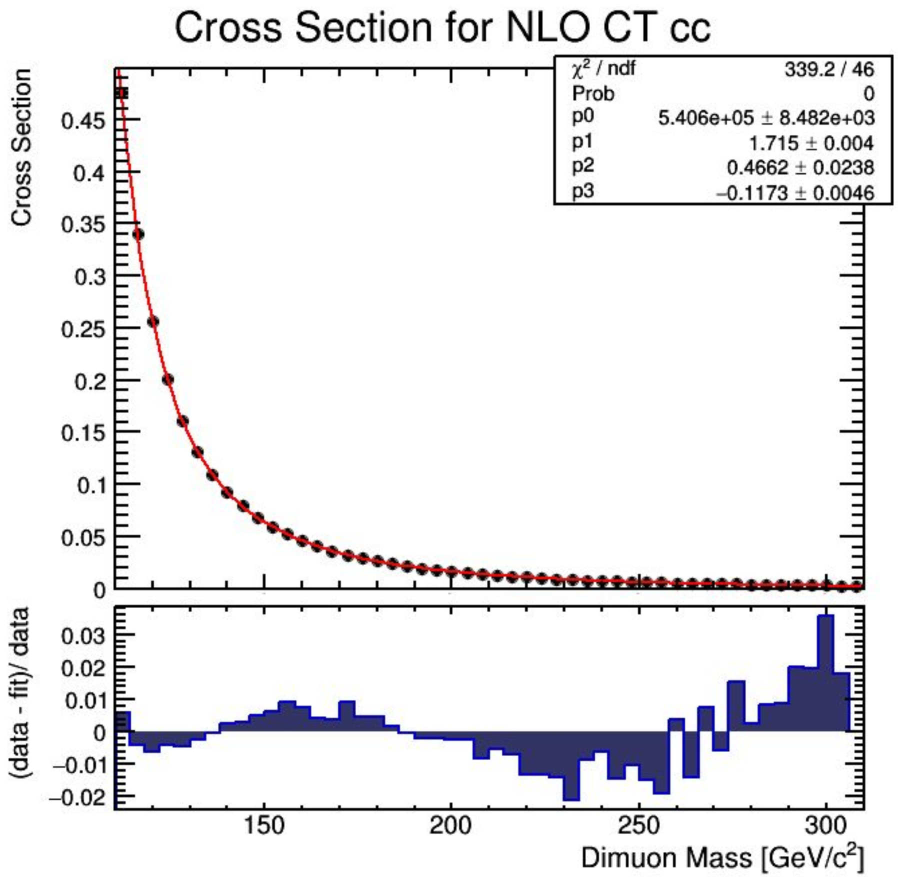
Leading Muon pT > 26 GeV, NLO Central Central (CC) Category, 110 to 310 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



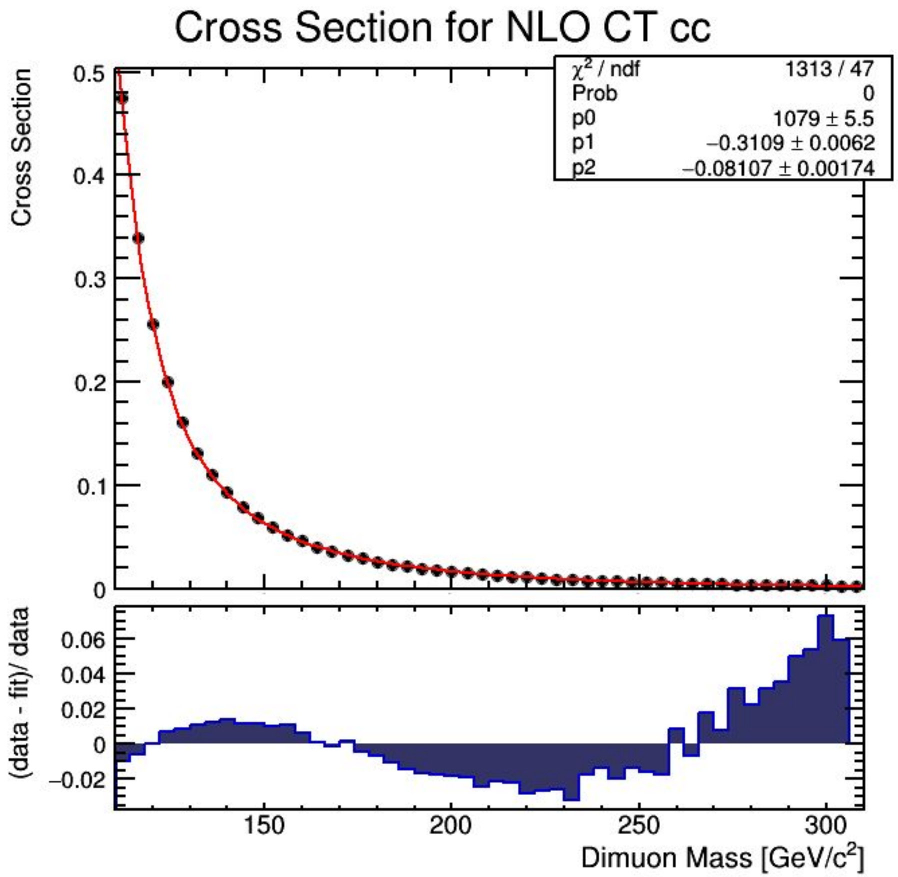
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



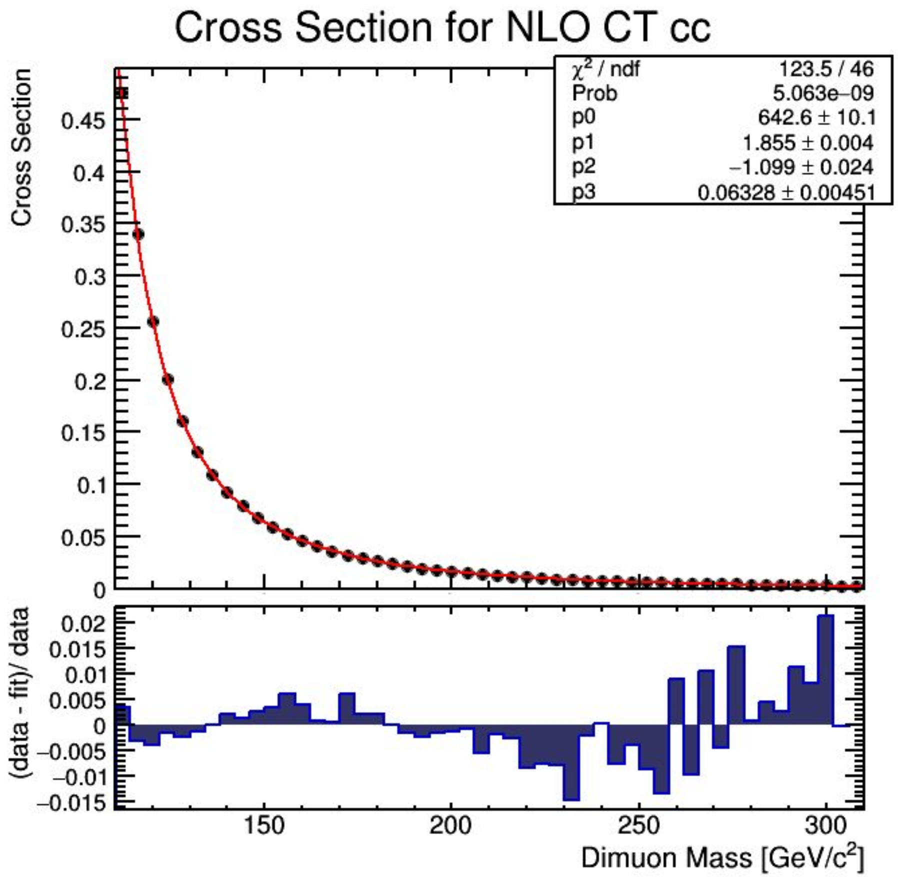
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

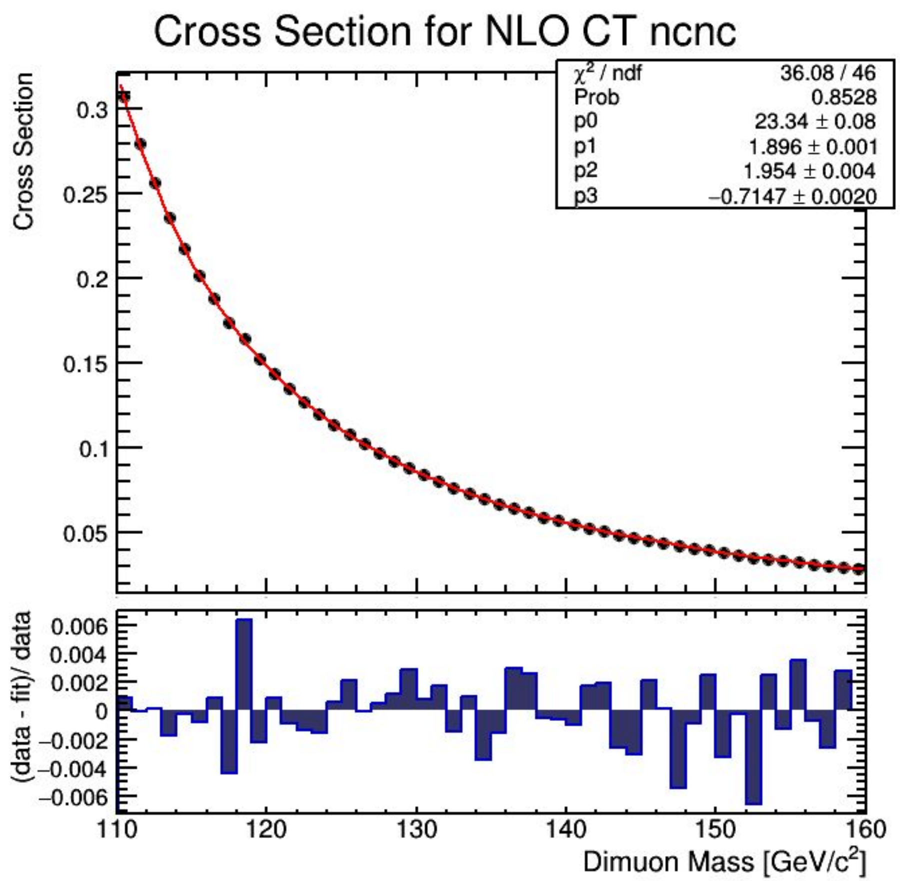
Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

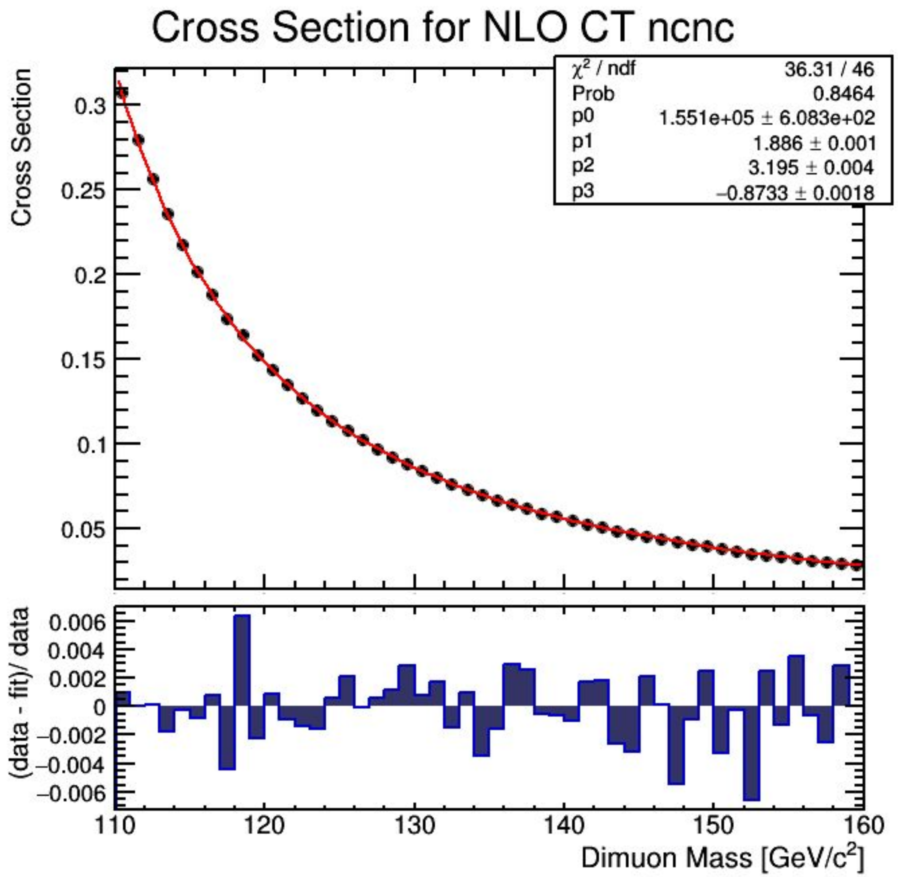
Leading Muon pT > 26 GeV, NLO Non-central Non-central (NCNC) Category, 110 to 160 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



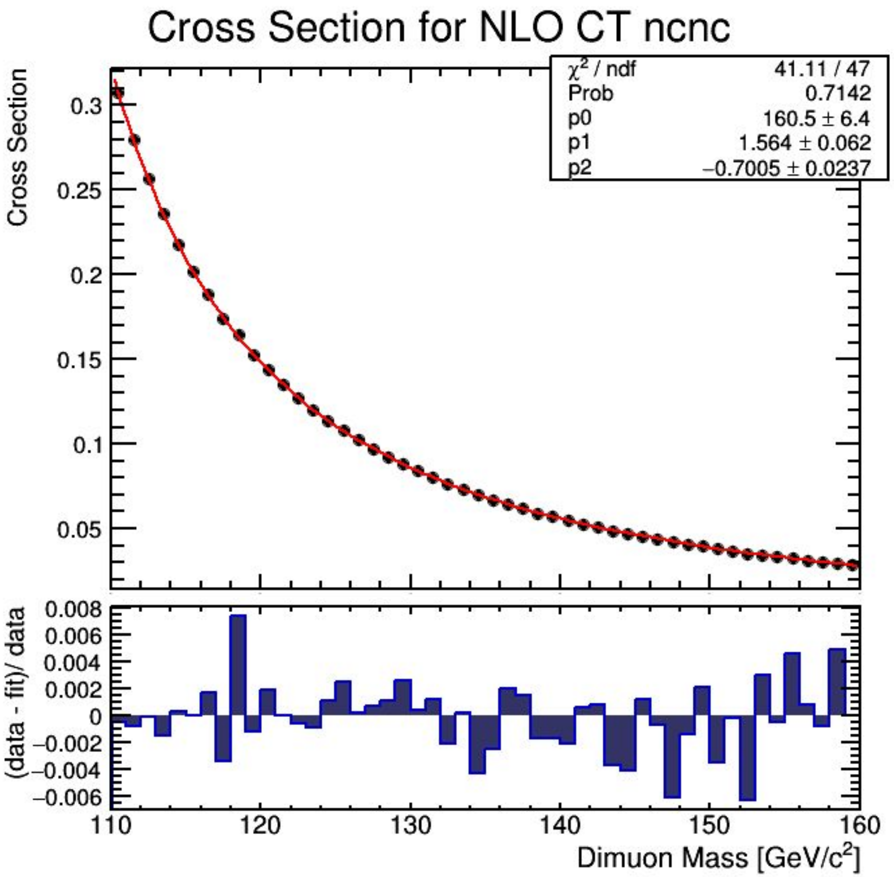
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

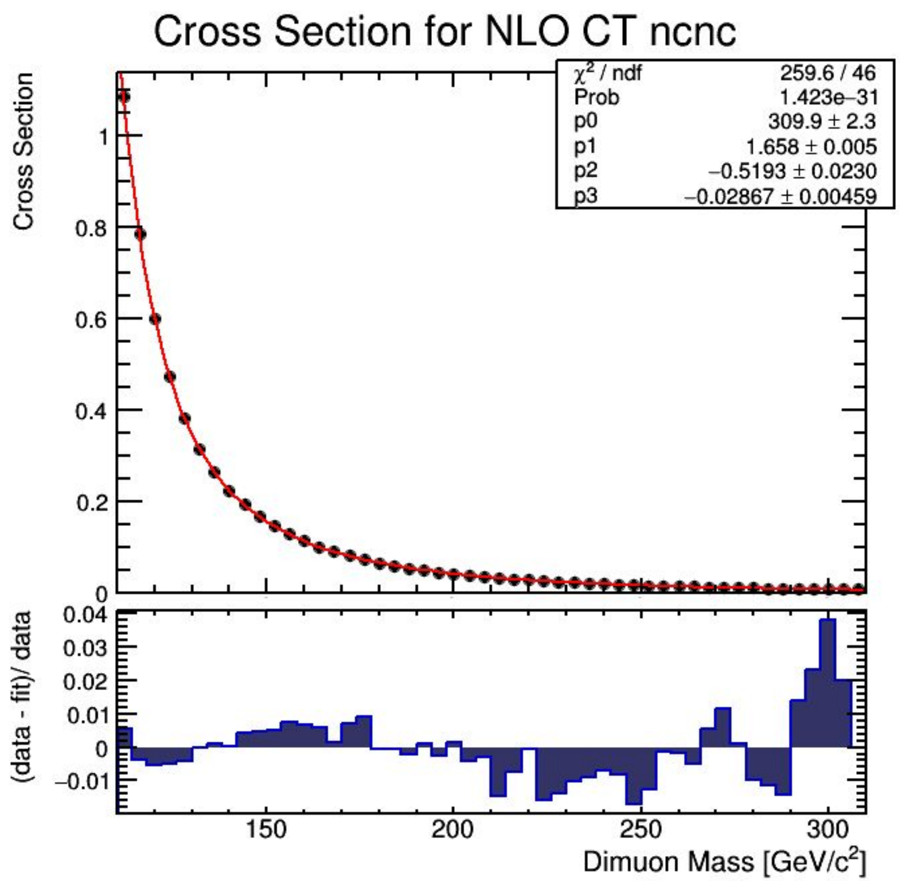
Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

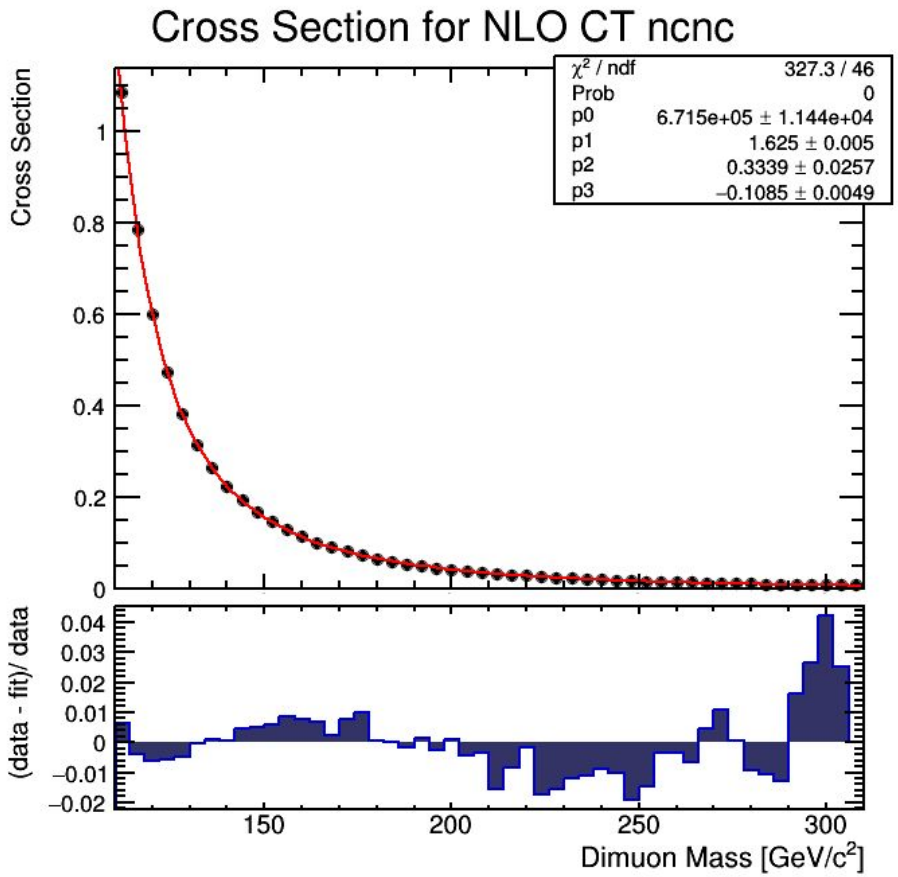
Leading Muon pT > 26 GeV, NLO Non-central Non-central (NCNC) Category, 110 to 310 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



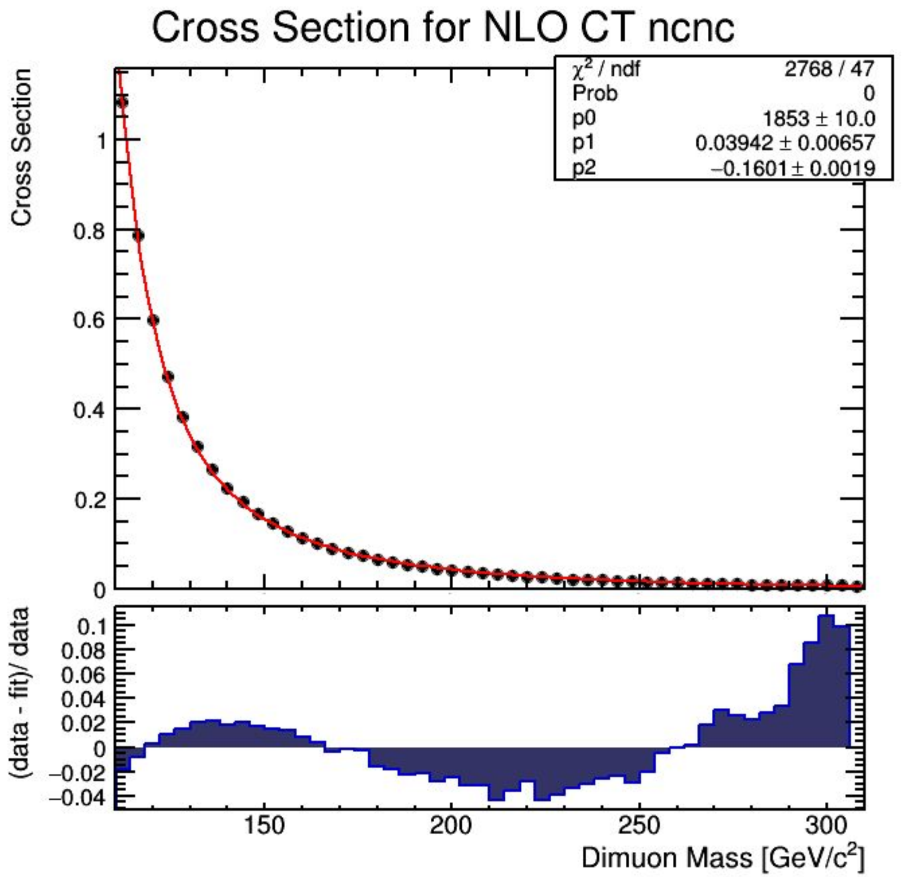
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



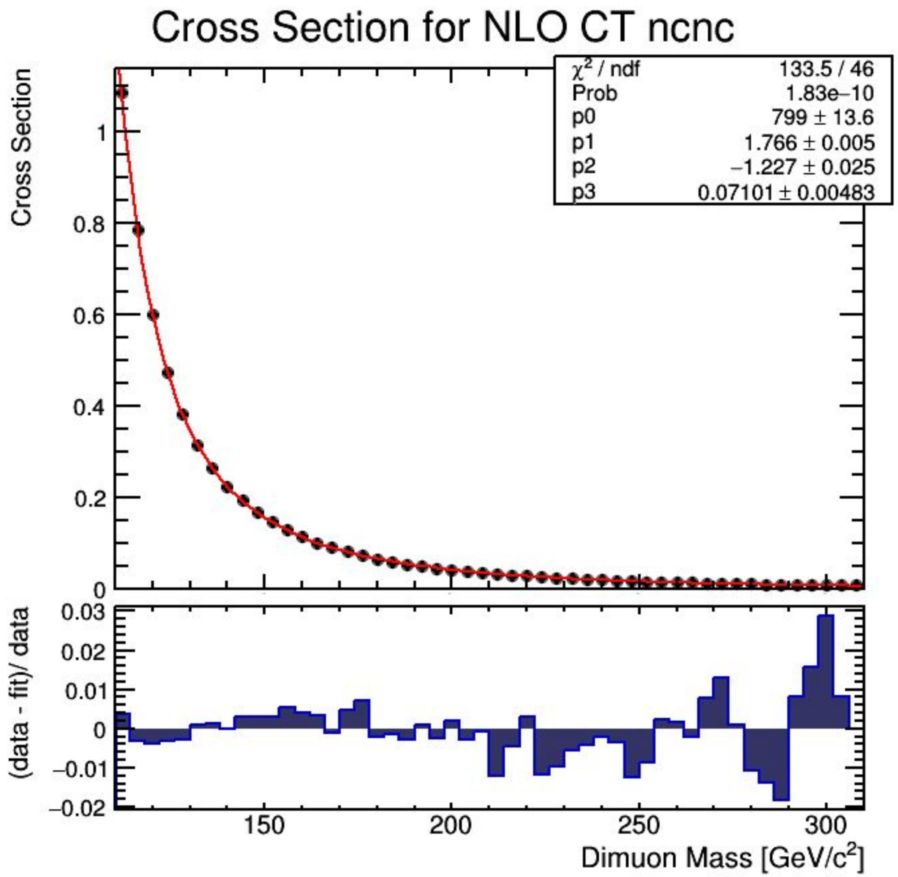
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

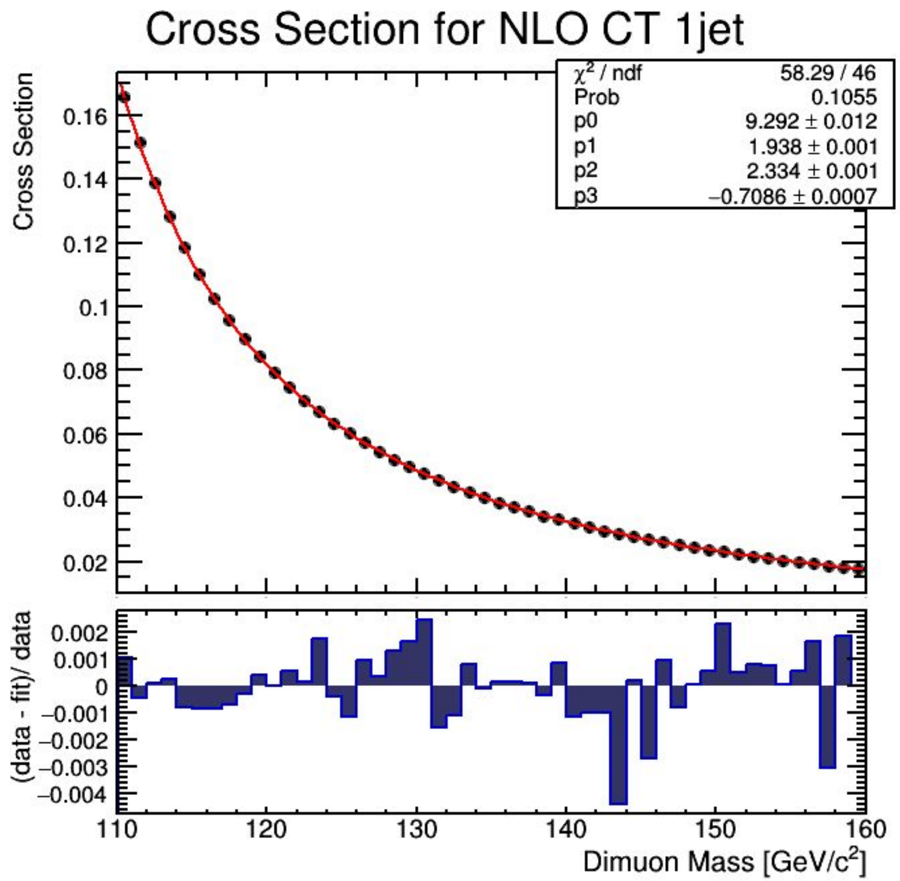
Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

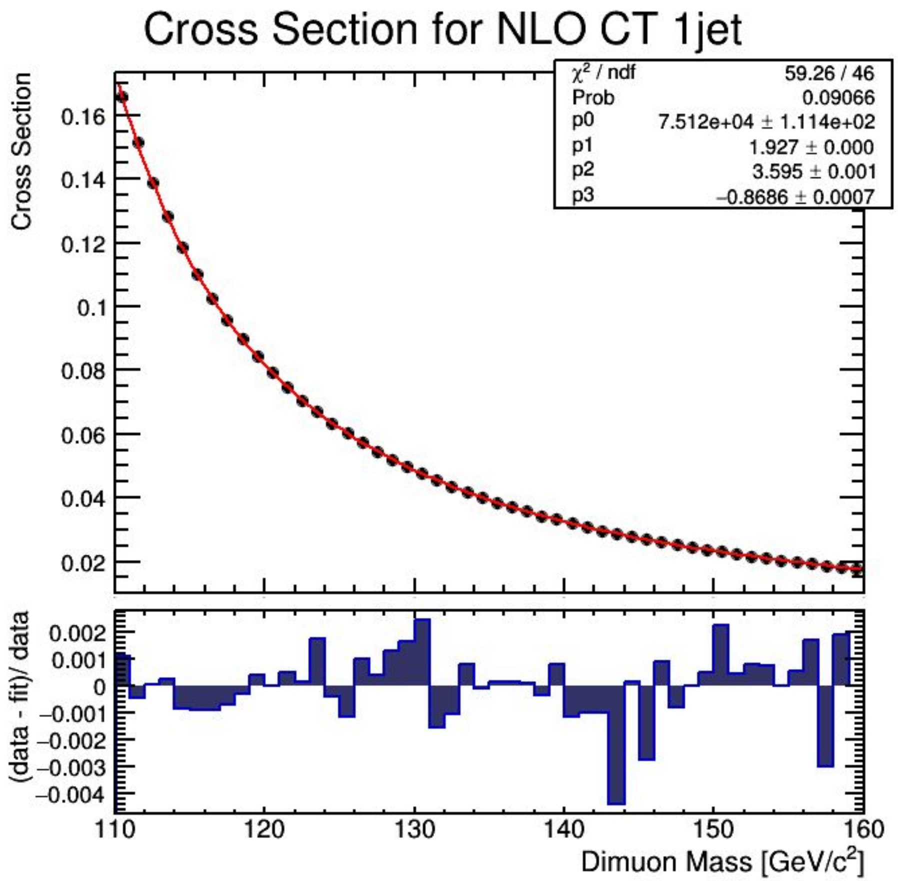
Leading Muon pT > 26 GeV, NLO 1 Jet (1jet) Category, 110 to 160 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



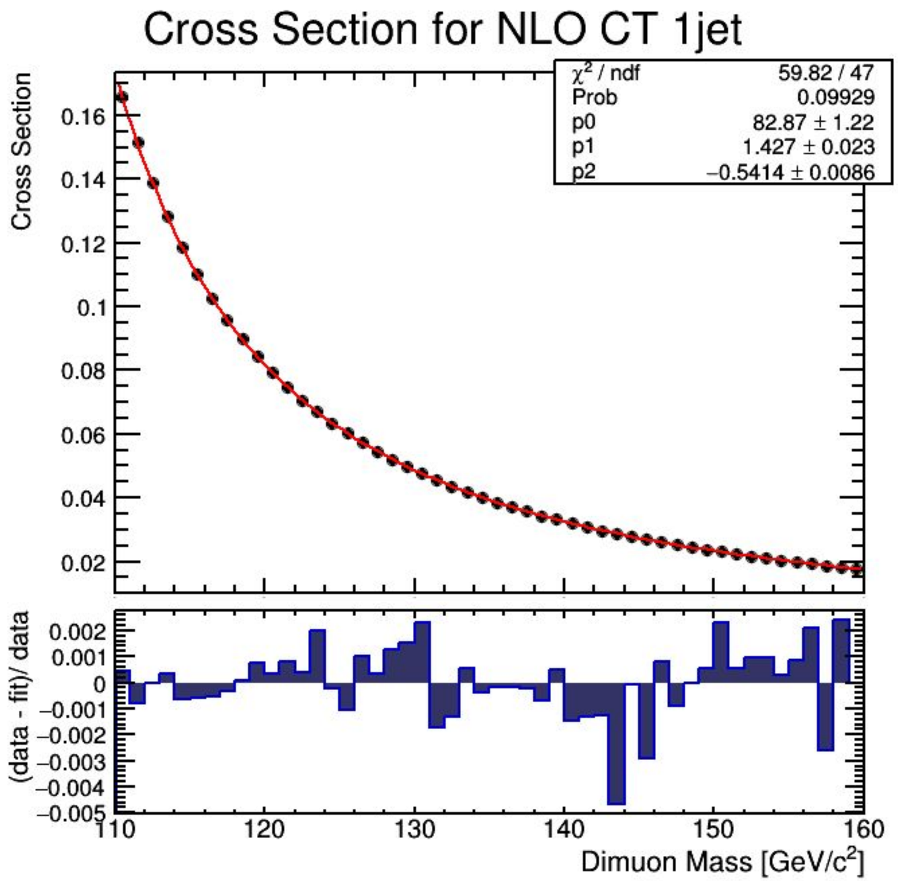
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

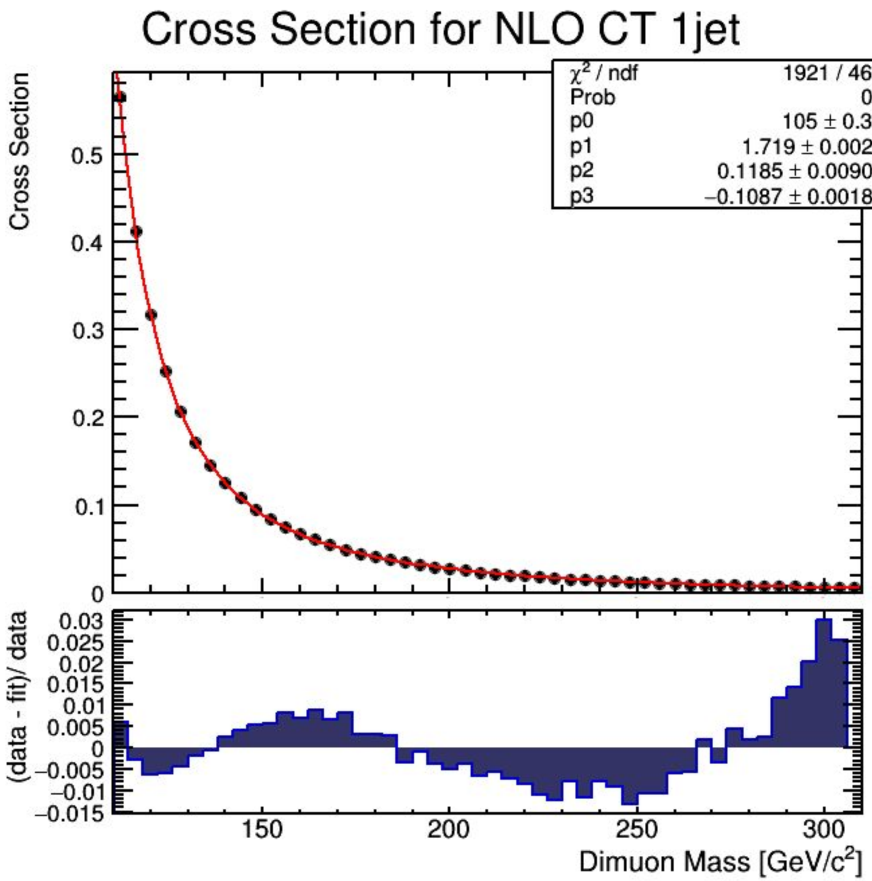
Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

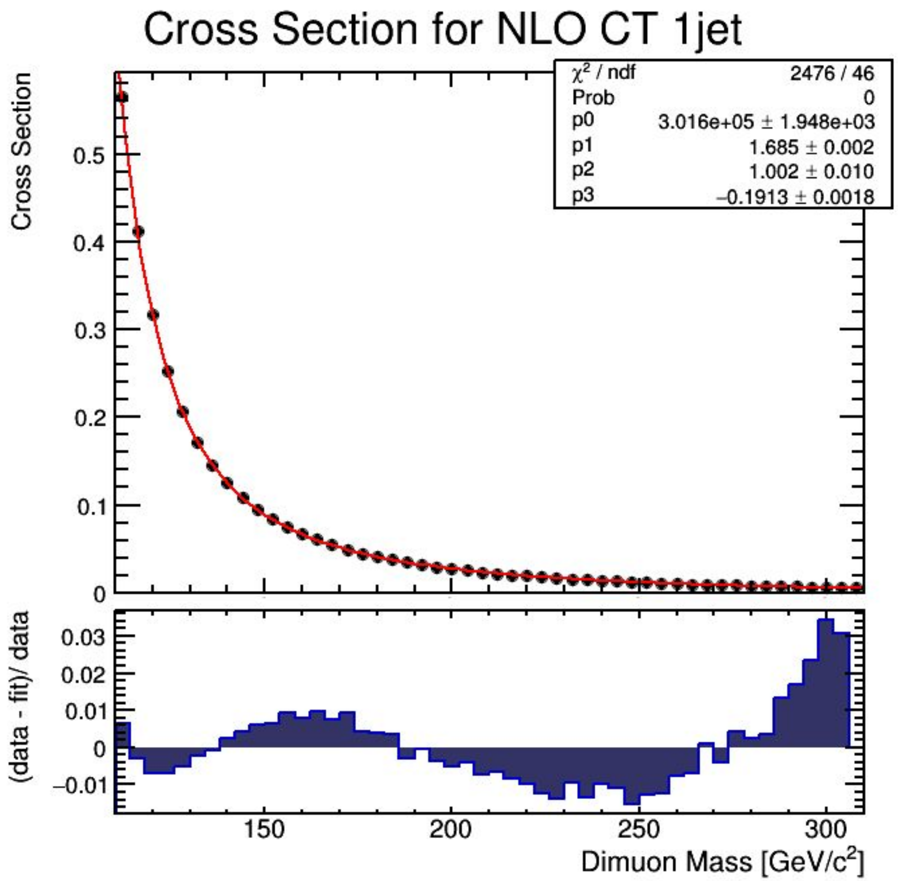
Leading Muon pT > 26 GeV, NLO 1 Jet (1jet) Category, 110 to 310 GeV/c^2

Fit with Perturbed Exponential times Breit Wigner



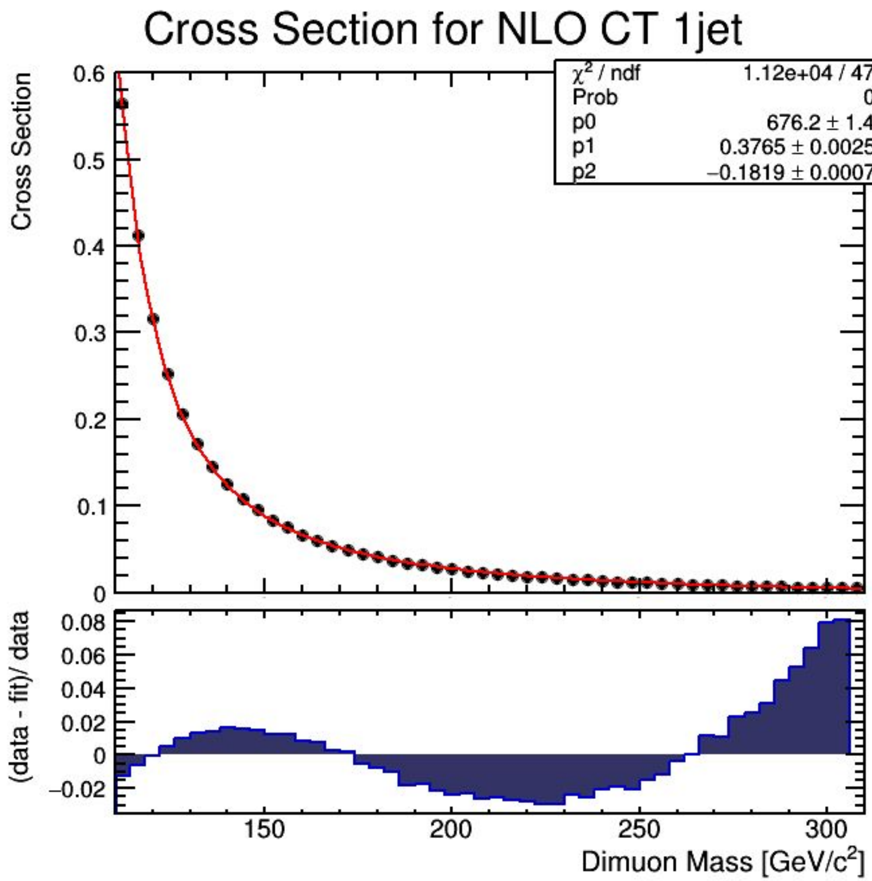
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



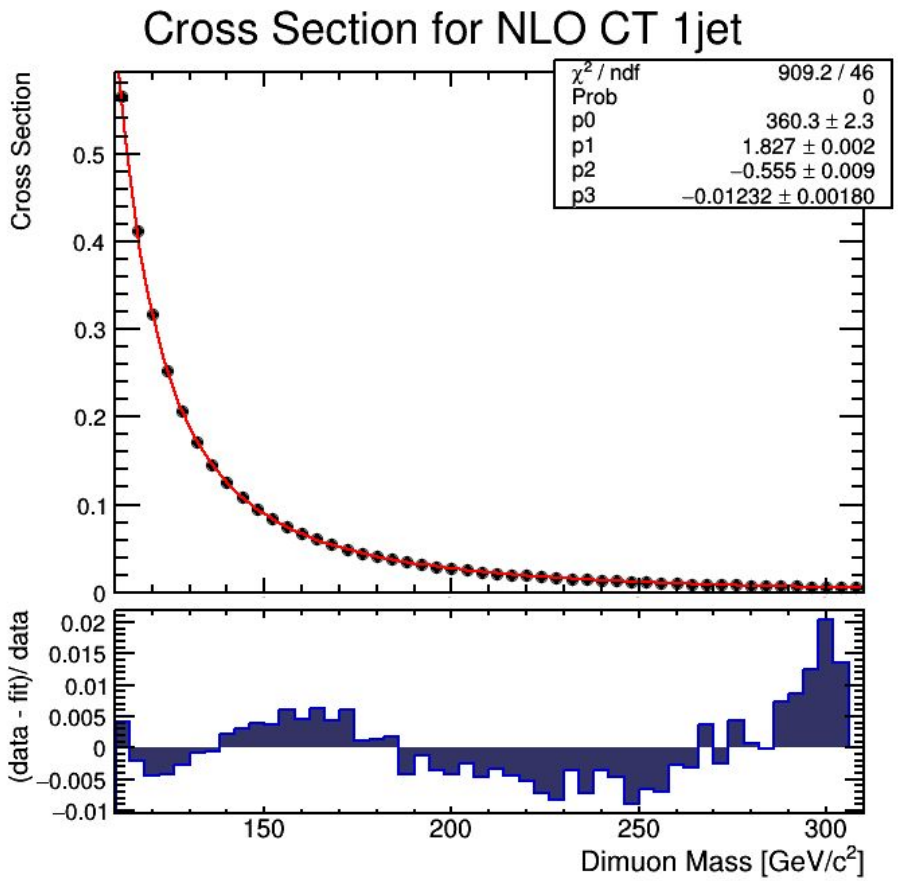
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

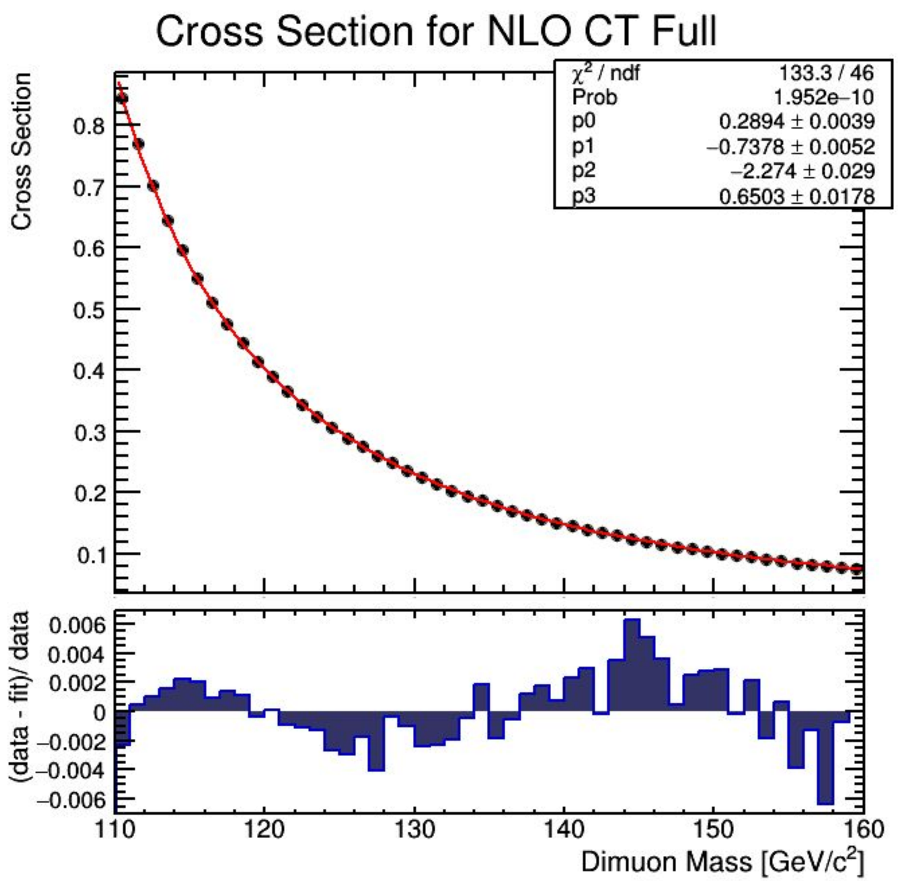
Fit with Modified Version of Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]

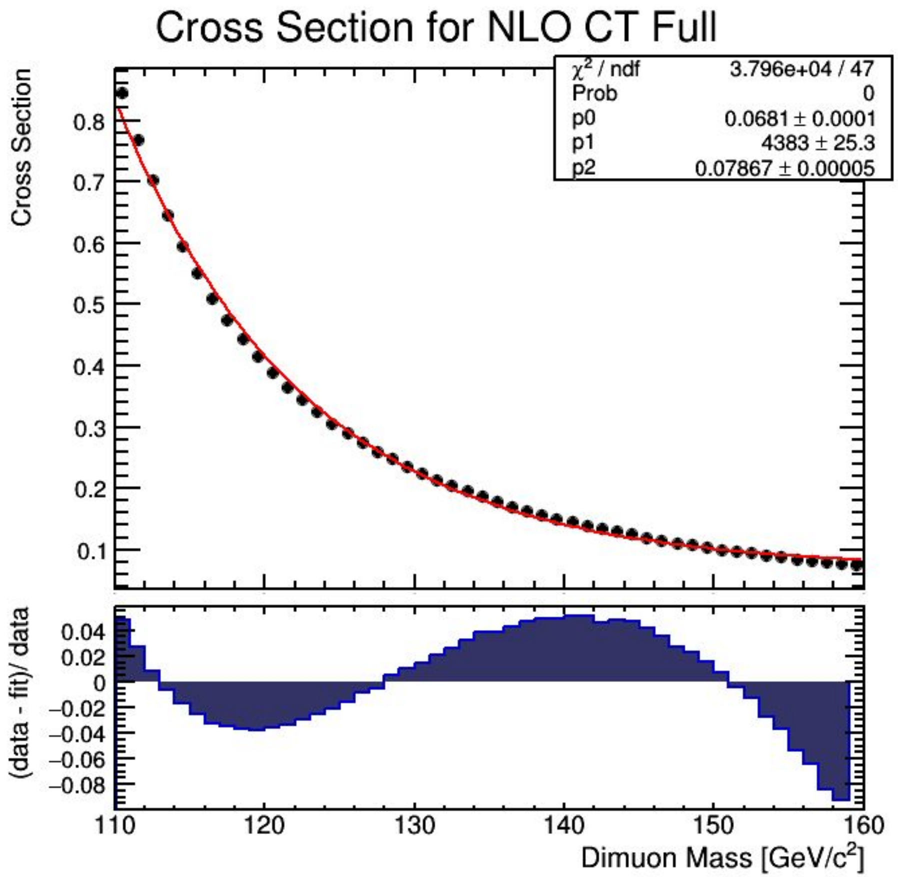
Leading Muon pT > 26 GeV with No FSR, NLO Full Category

Fit with Dimitri's PDF



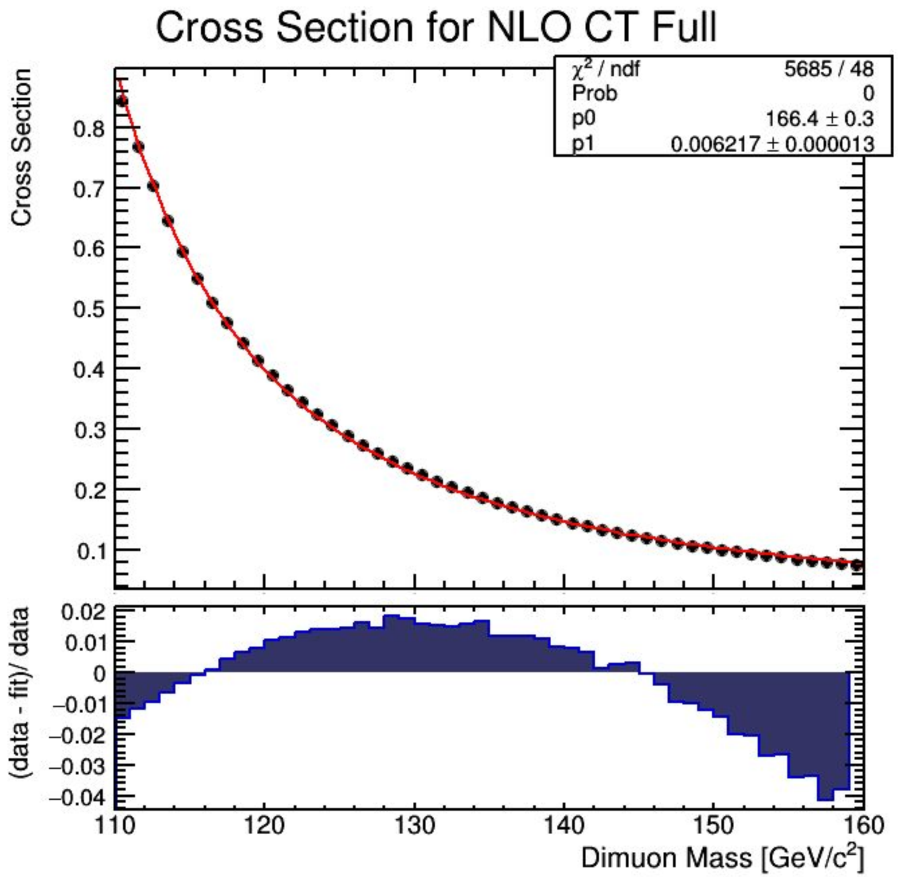
p0 * ((x-100)/70)^(p1) * e^(p2*(x-100)/70 + p3*((x-100)/70)^2)

Fit with Exponential



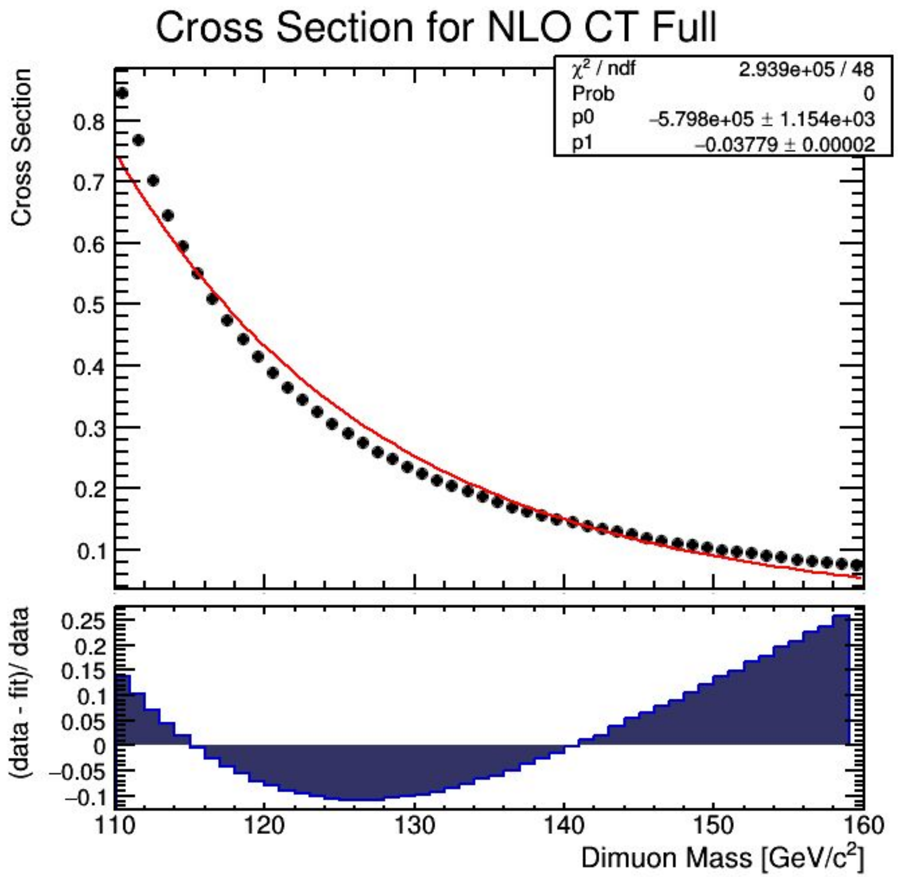
p0 + p1 * e^(p2 * x)

Fit with Breit Wigner scaled by Falling Exponential



[p0*exp(p1*x)]/[(x-91.2)^2 + (2.5/2)^2] + [(1-p0)*exp(p1*x)]/[x^2]

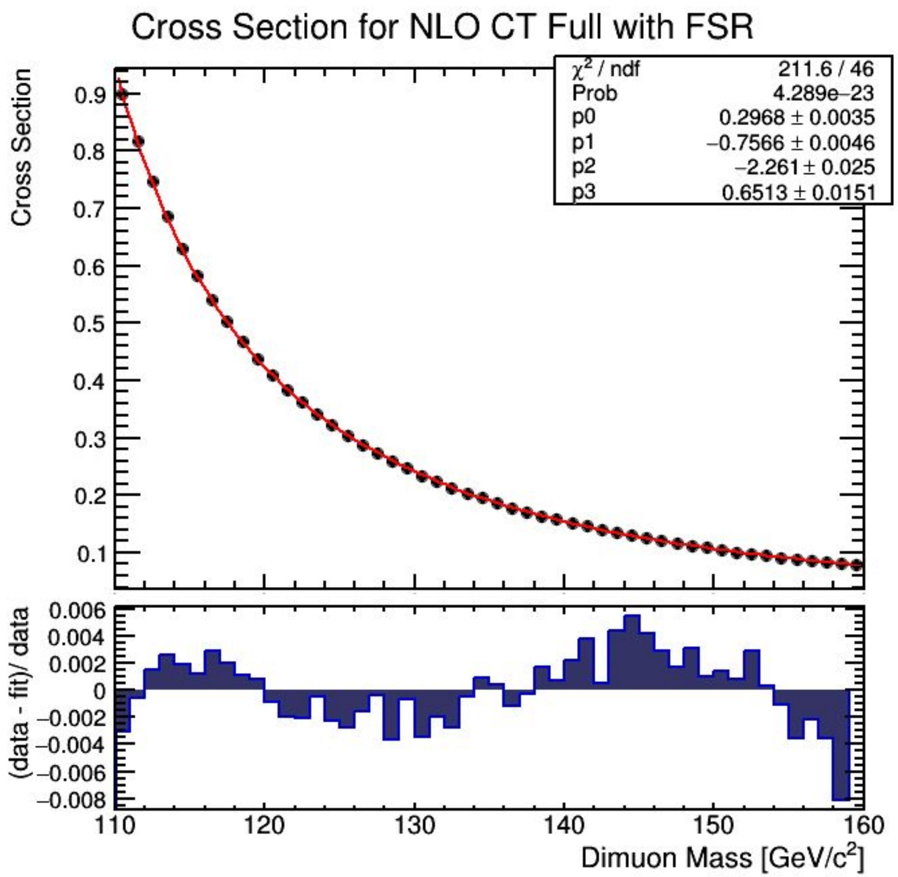
Fit with Relativistic Breit Wigner scaled by Falling Exponential



[p0*exp(p1*x)]/[(x^2 - 91.2^2)^2 + (91.2*2.5/2)^2] + [(1-p0)*exp(p1*x)]/[x^2]

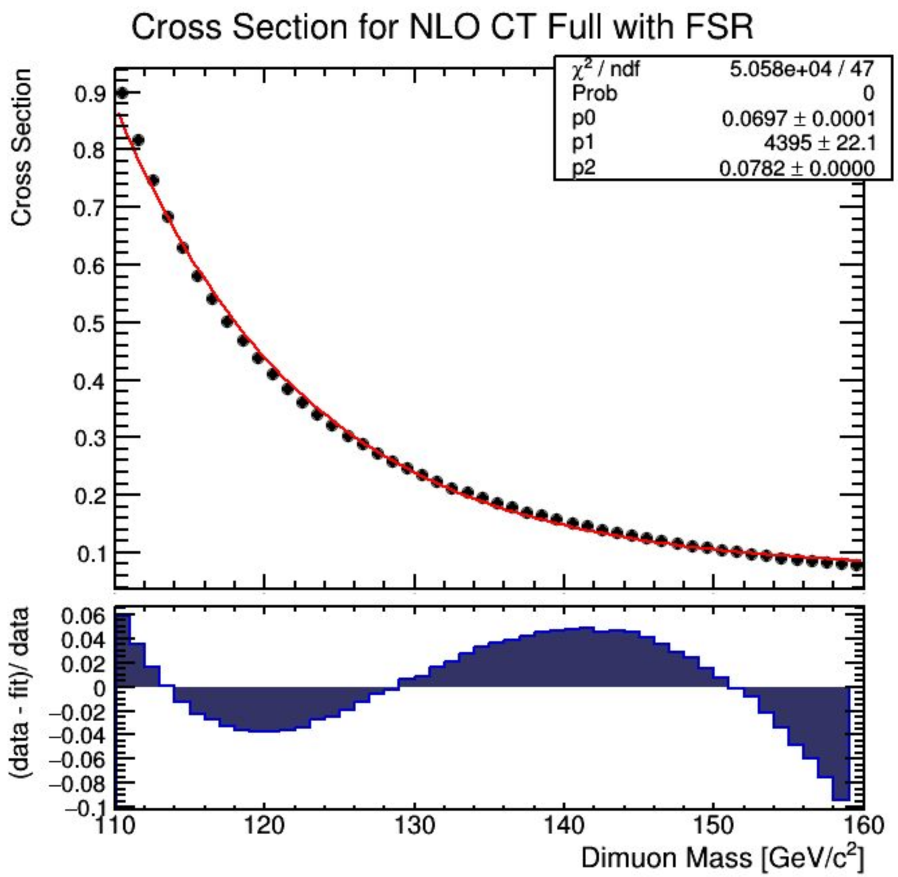
Leading Muon pT > 26 GeV with FSR, NLO Full Category

Fit with Dimitri's PDF



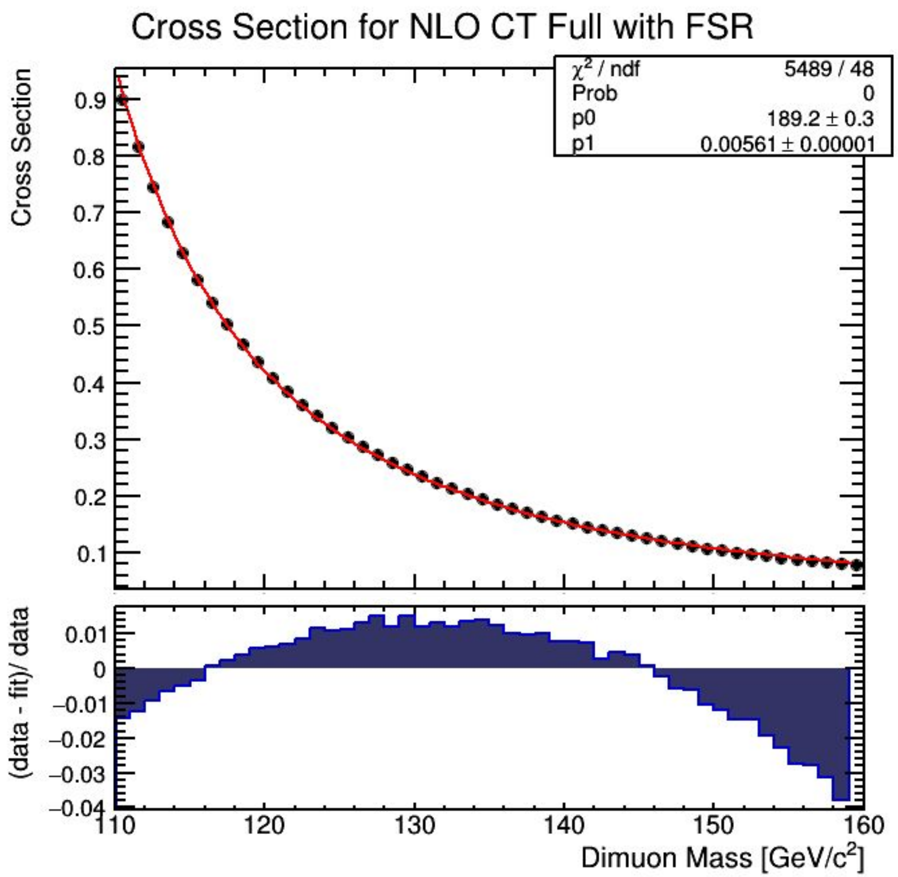
p0 * ((x-100)/70)^(p1) * e^(p2*(x-100)/70 + p3*((x-100)/70)^2)

Fit with Exponential



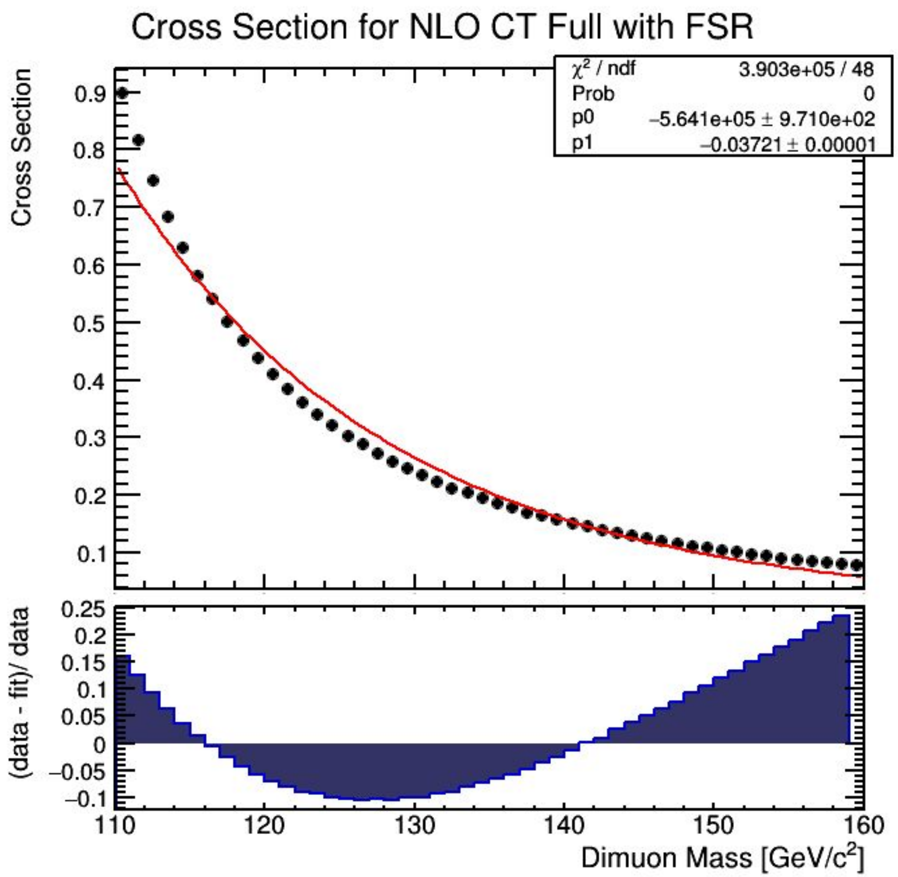
p0 + p1 * e^(p2 * x)

Fit with Breit Wigner scaled by Falling Exponential



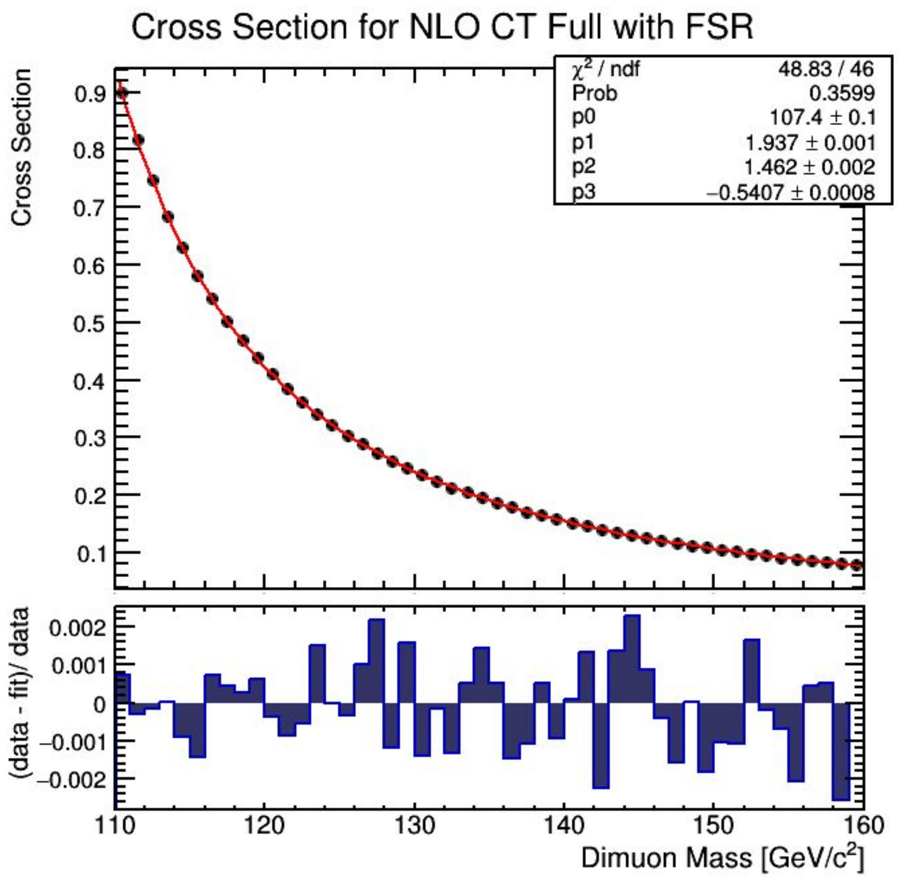
[p0*exp(p1*x)]/[(x-91.2)^2 + (2.5/2)^2] + [(1-p0)*exp(p1*x)]/[x^2]

Fit with Relativistic Breit Wigner scaled by Falling Exponential



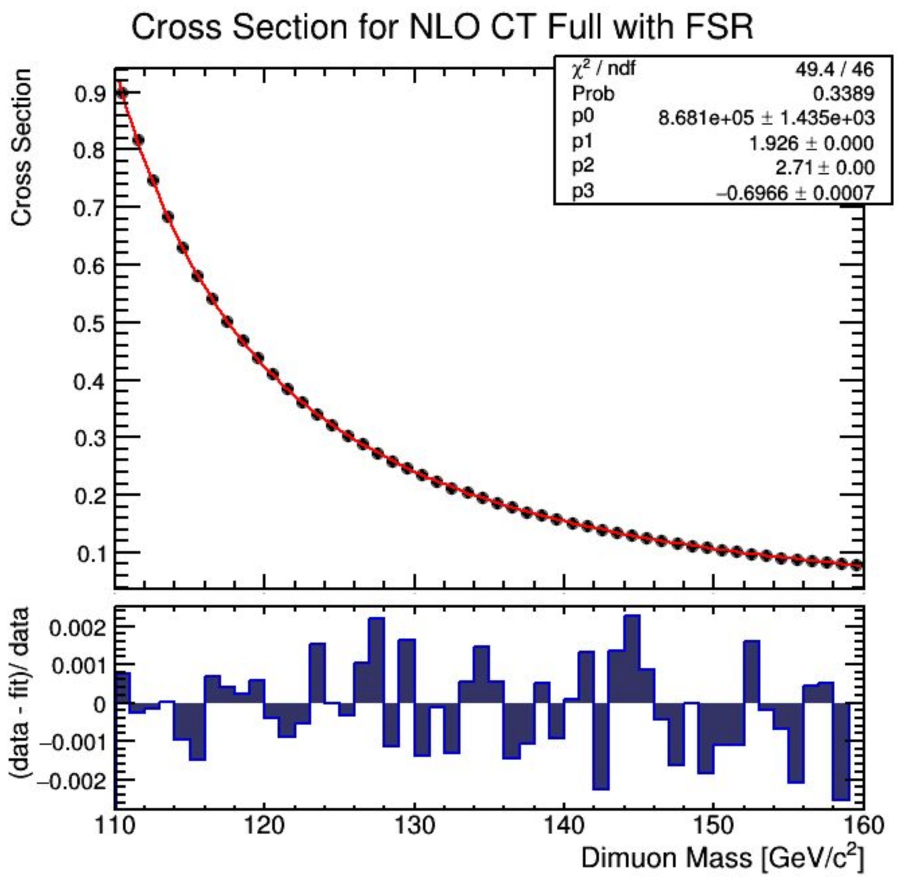
[p0*exp(p1*x)]/[(x^2 - 91.2^2)^2 + (91.2*2.5)^2] + [(1-p0)*exp(p1*x)]/[x^2]

Fit with Perturbed Exponential times Breit Wigner



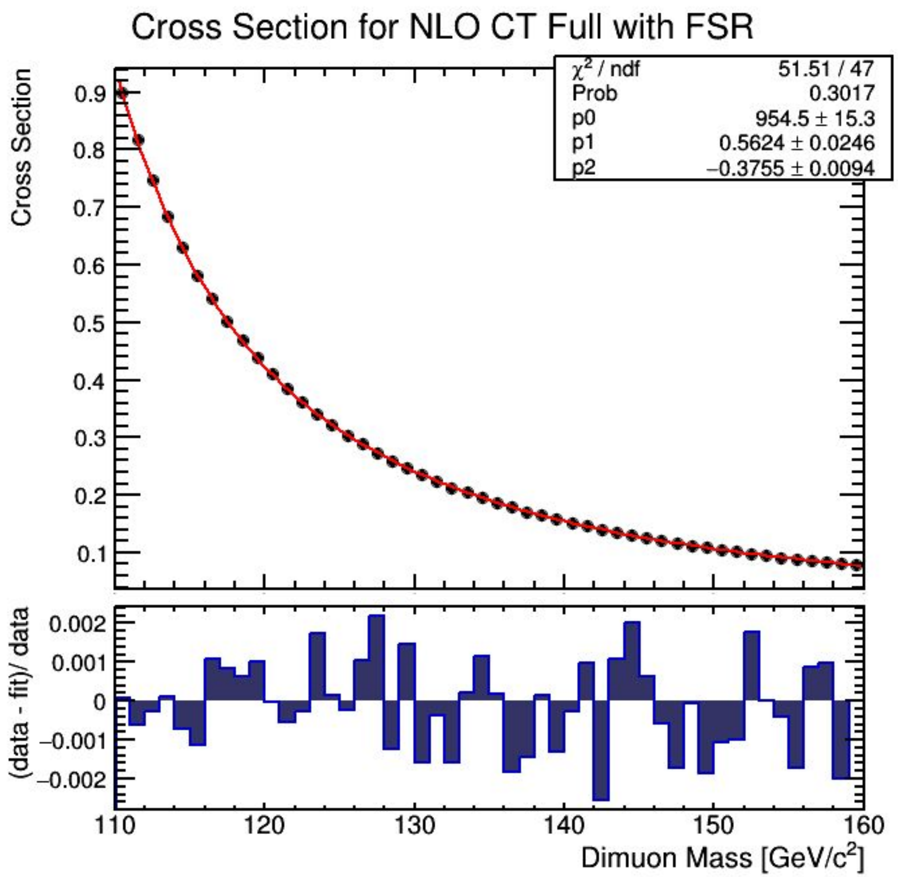
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x-91.2)^p1 + (2.5/2)^p1]

Fit with Perturbed Exponential times Relativistic Breit Wigner



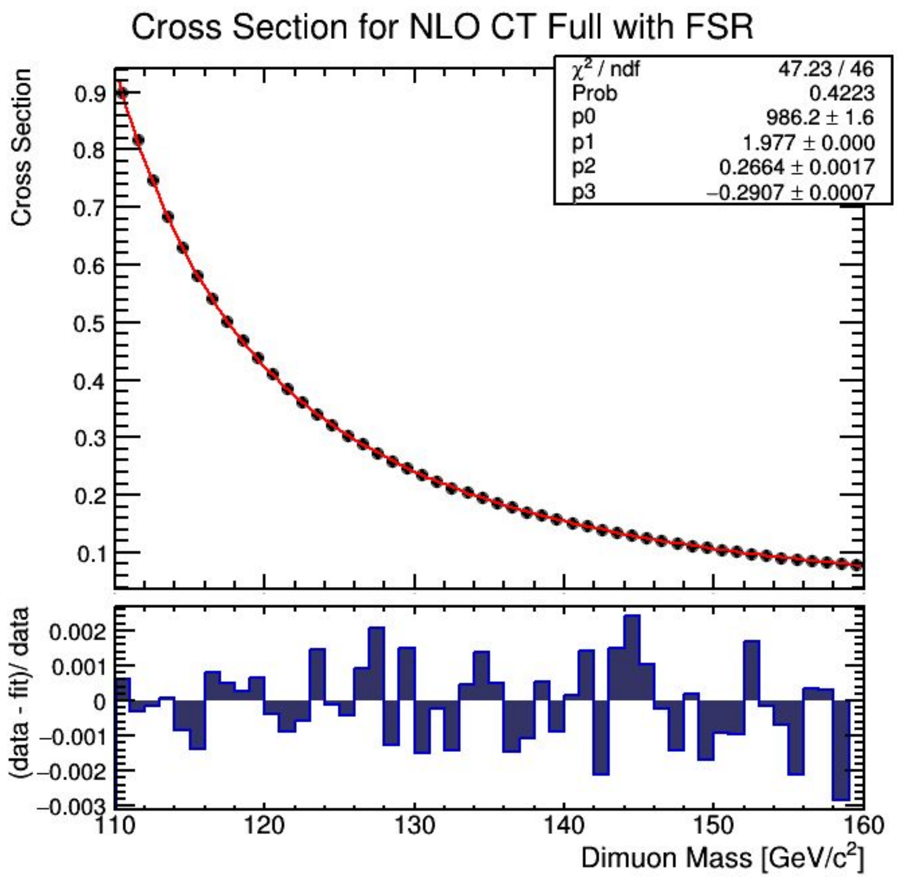
p0*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (91.2*2.5)^p1]

Fit with Dimitri's Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p1*(x/100) + p2*(x/100)^2] / [(x^2 - 91.2^2)^2 + (x^2*2.5/91.2)^2]

Fit with Modified Version of Dimitri’s Perturbed Exponential times Relativistic Breit Wigner



p0*x^2*Exp[p2*(x/100) + p3*(x/100)^2] / [(x^2 - 91.2^2)^p1 + (x^2*2.5/91.2)^p1]