Thesis progress

Pietro Daniele

UNIVERSITÀ
DEGLI STUDI
DI MILANO

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GitHub

The whole code is available at this GitHib link

1° week

Uploading file .root

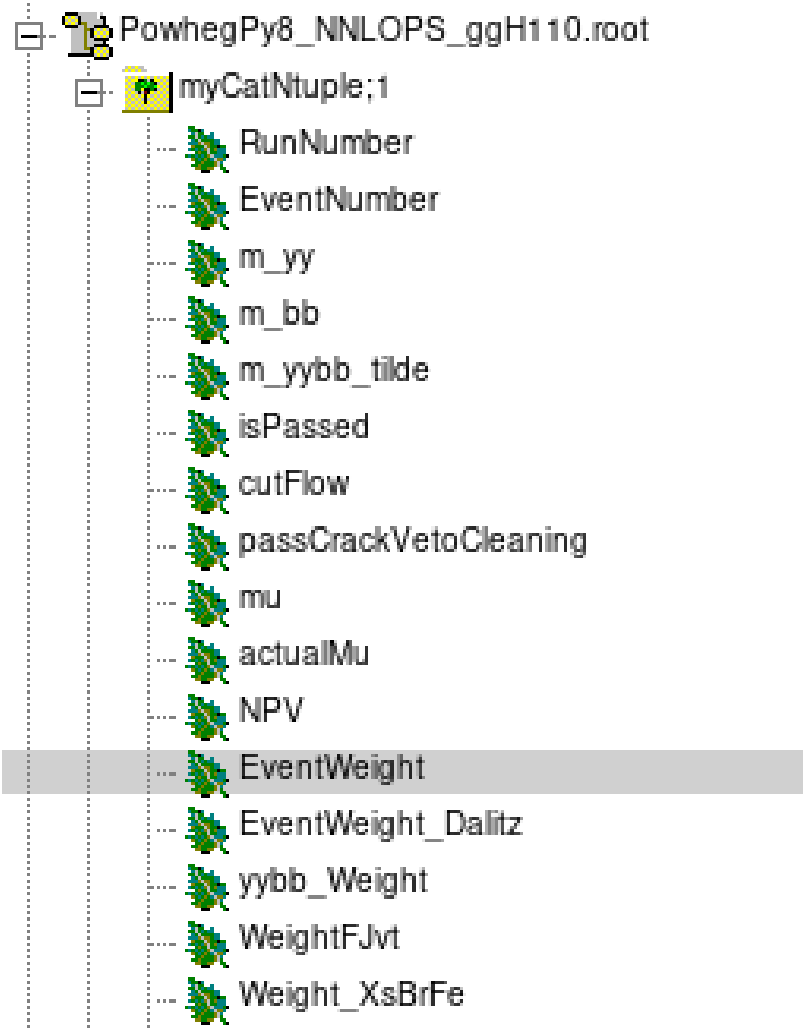
The file uploaded are:

- PowhegPy8_NNLOPS_ggH110.root;
- PowhegPy8_NNLOPS_ggH125.root;
- PowhegPy8_NNLOPS_ggH130.root;
- PowhegPy8_NNLOPS_ggH140.root;

Data

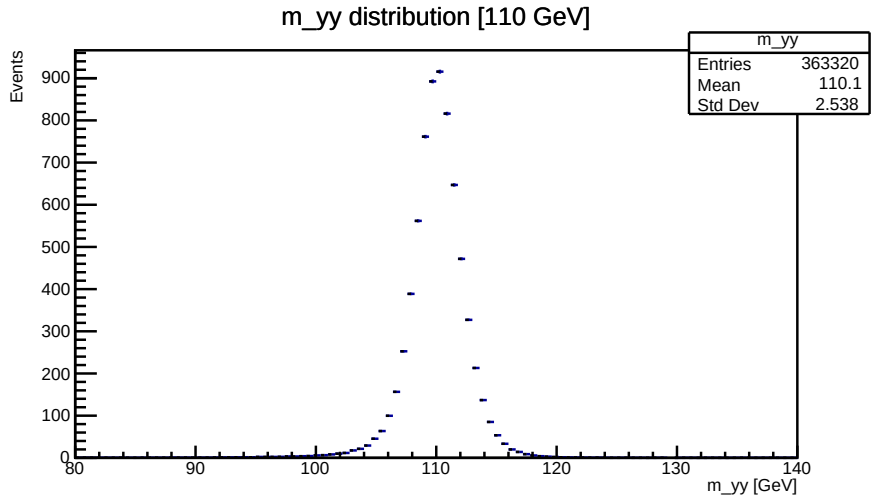
In each file, there is a `TTree myCatNtuple`, which contains all the variables. Only three of them were used:

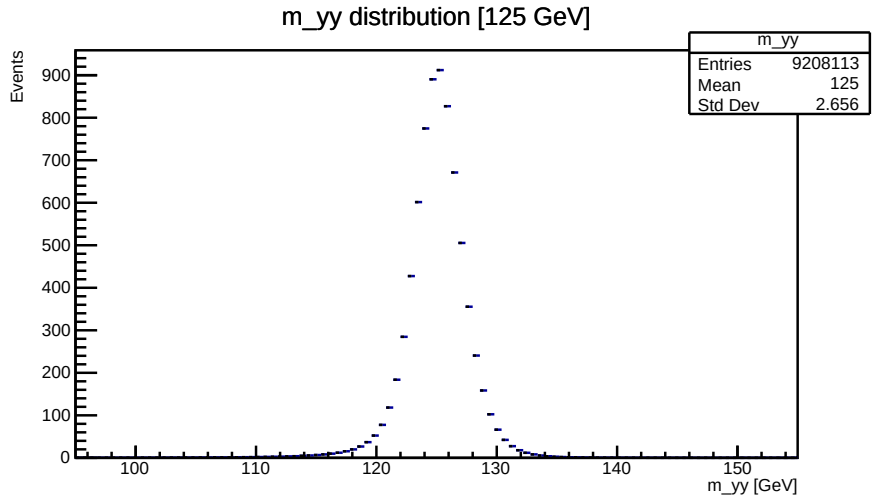
- **m_yy**: mass distribution;
- **EventWeight**: it contains all type of weights.
- **cutFlow**

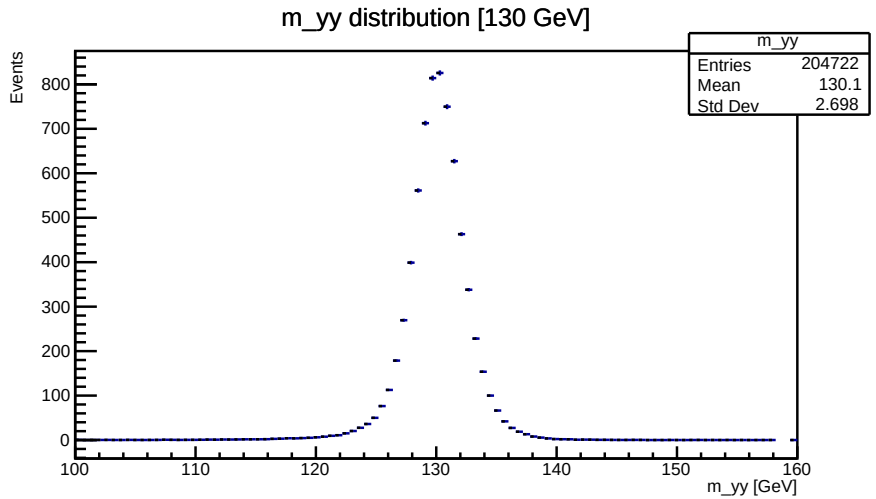


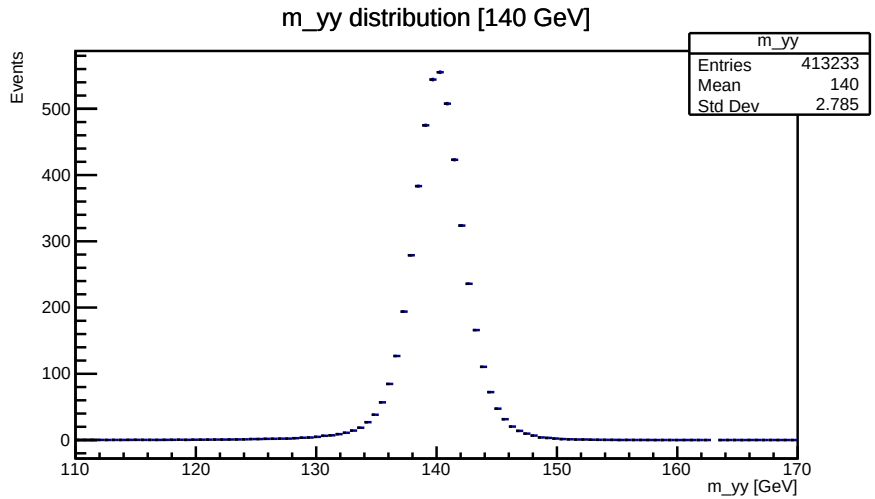
$m_{\gamma\gamma}$ distibution

Using all entries the distributions at different masses are:









Data analysis and fits

The distributions are fitted using two type of fit:

- **gaussian fit**: there are 2 parameters:
  - mean μ;
  - sigma σ;

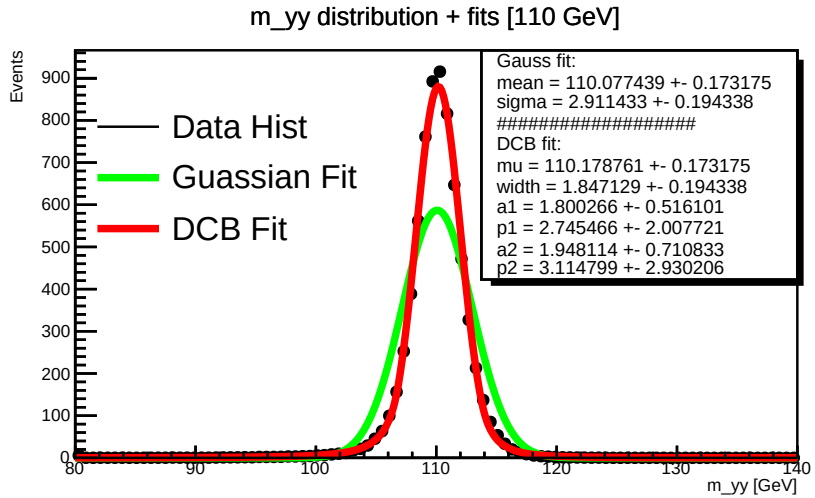
$$f(x, \mu, \sigma) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

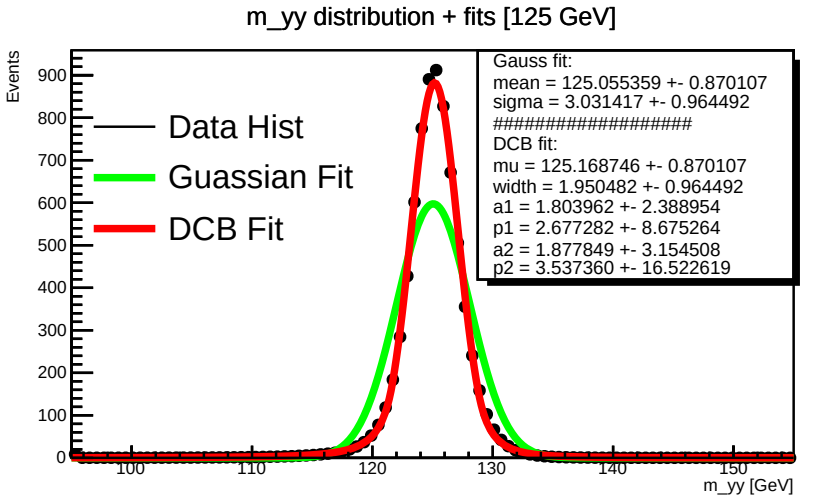
- **DCB fit**: there are six parameters:
  - mean μ;
  - sigma σ
  - a_1;
  - p_1;
  - a_2;
  - p_2;

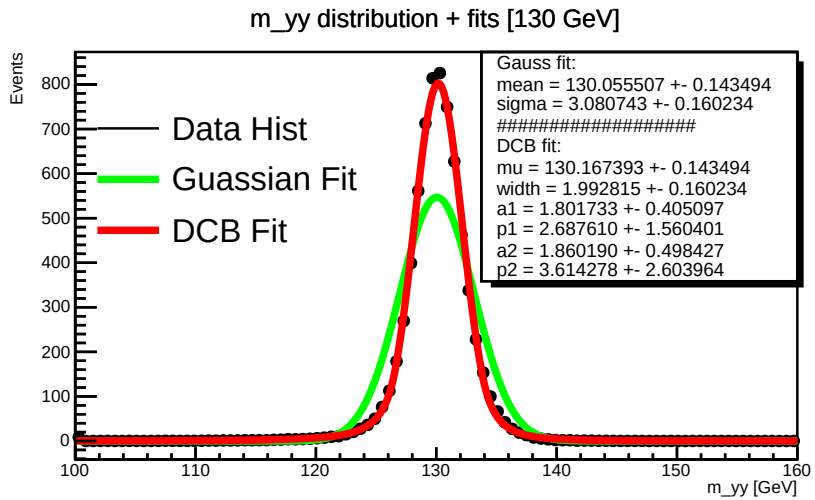
$$f(x, \mu, \sigma, a_1, p_1, a_2, p_2) = \cdots$$

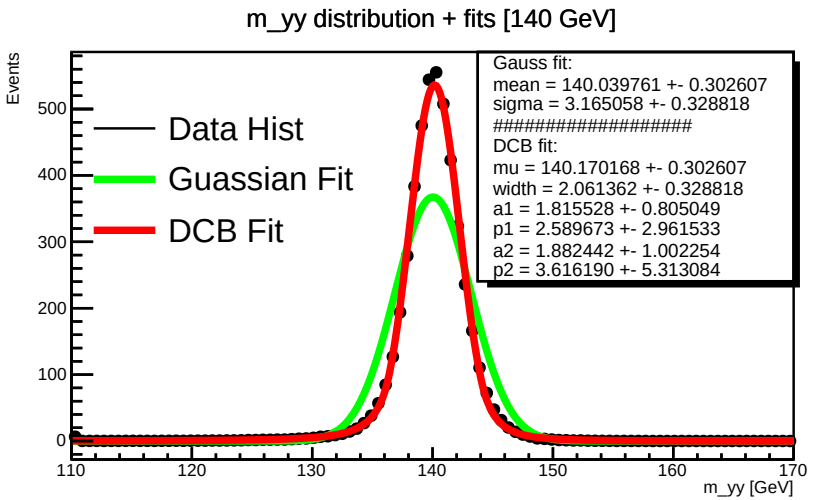
Gaussian and DCB fits

Applying the fits to all entries:









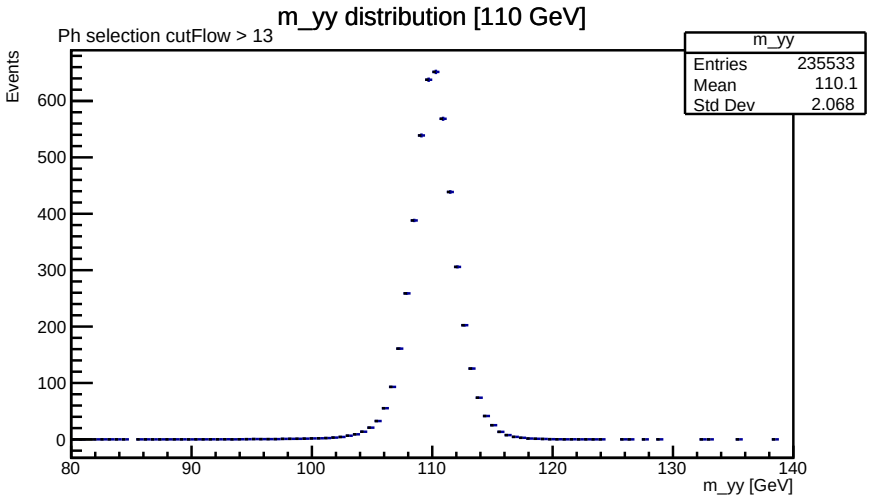
CutFlow

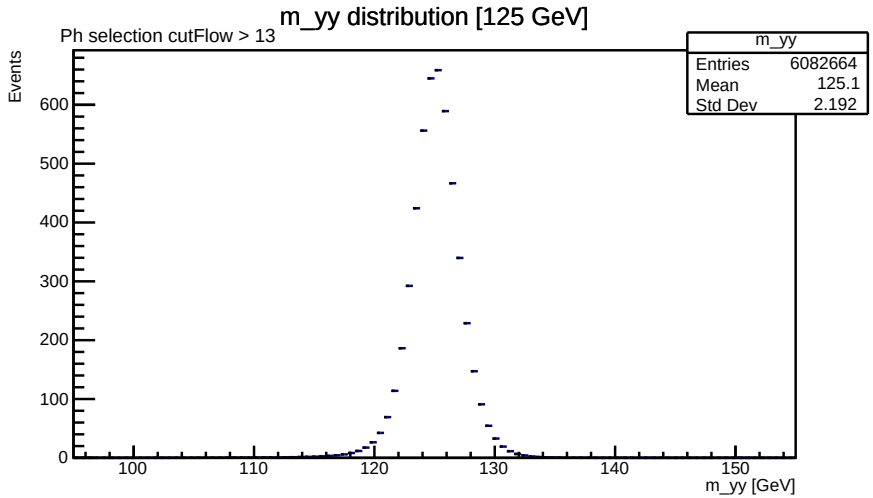
Events with at least two isolated γ with tight identification could be selected, where the transverse momentum of the leading photon is such that $p_T/m_{\gamma\gamma} > 0.35$, whereas that of the sub-leading photon is $p_T/m_{\gamma\gamma} > 0.25$. Then there are also other demands on the "quality" of data collection and triggers.

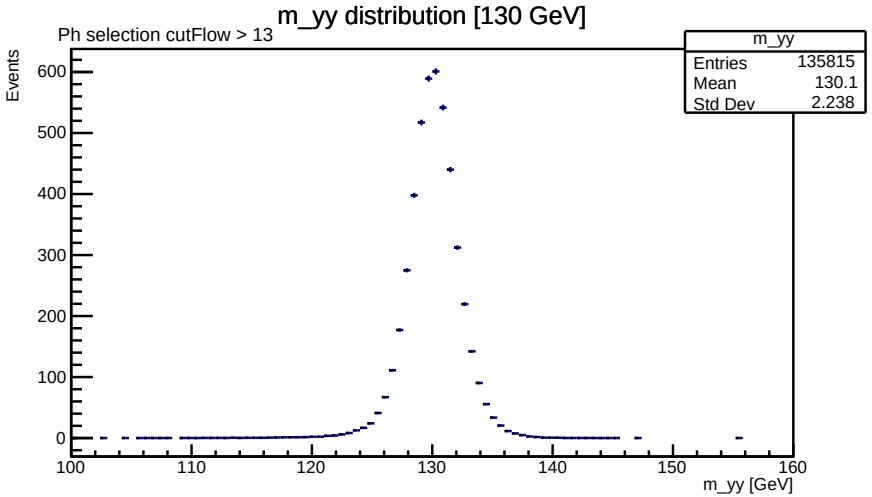
$\Longrightarrow$ Using the `cutFlow` greater than 13, the events are selected.

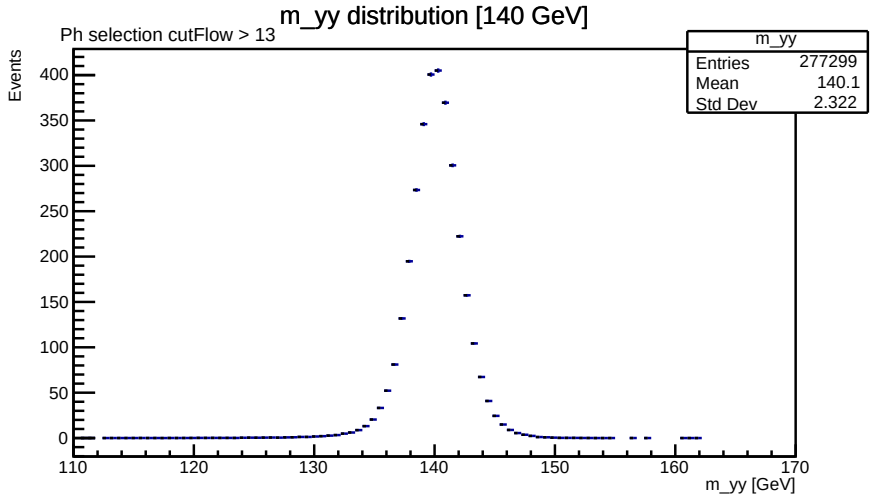
$m_{\gamma\gamma}$ distribution with cutFlow > 13

Using `cutFlow`>13 entries the distributions at different masses are:



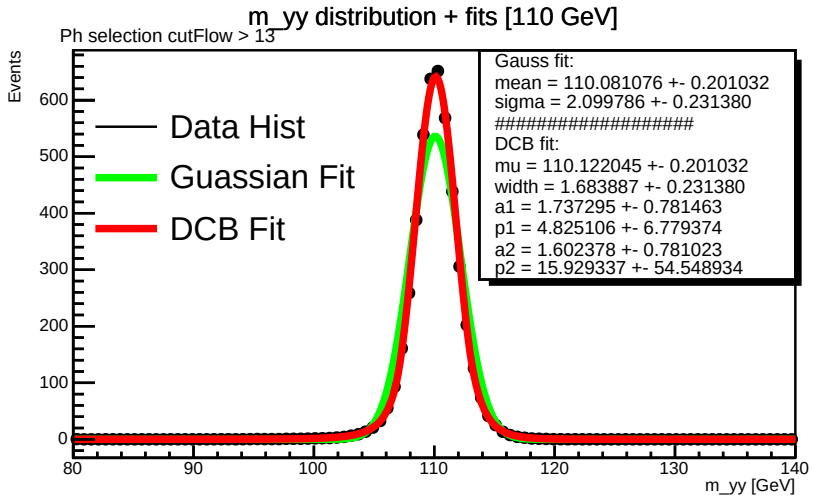


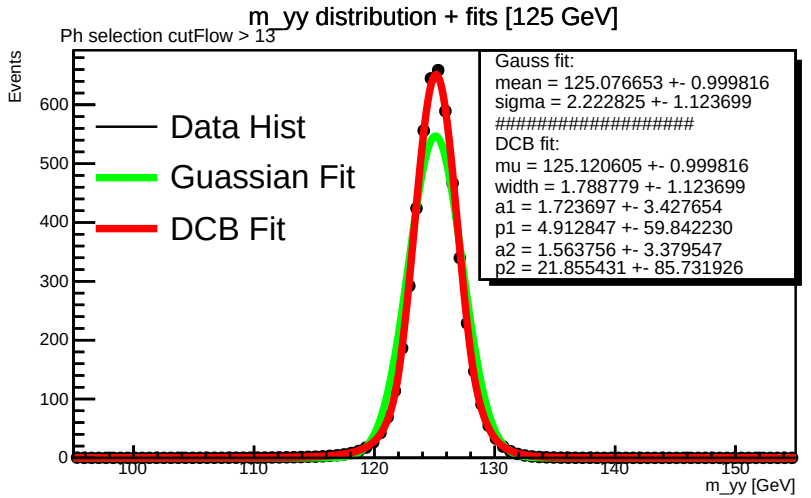


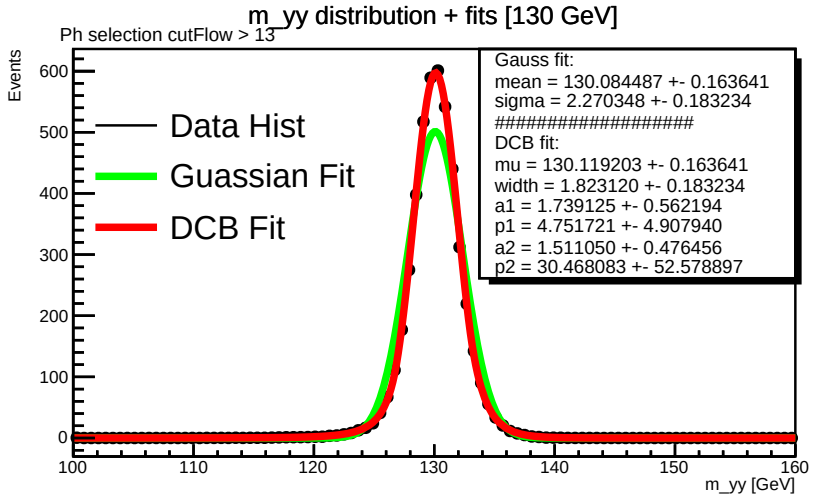


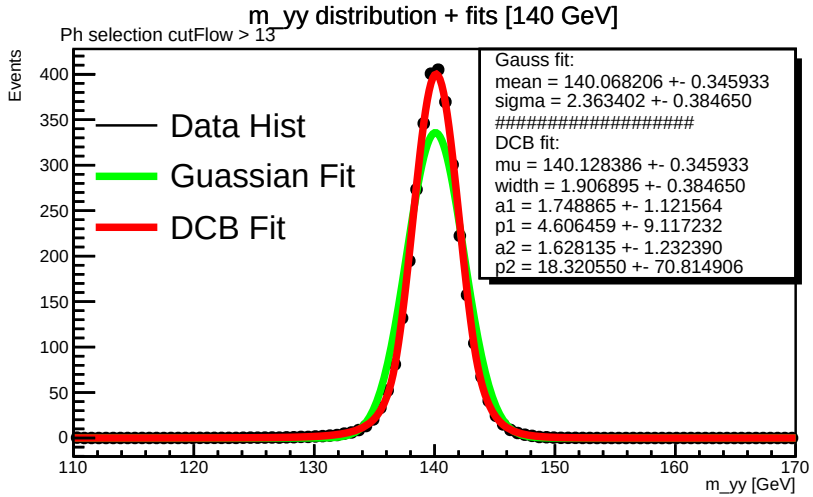
Gaussian and DCB fits with cutFlow > 13

Applying the fits to all entries:



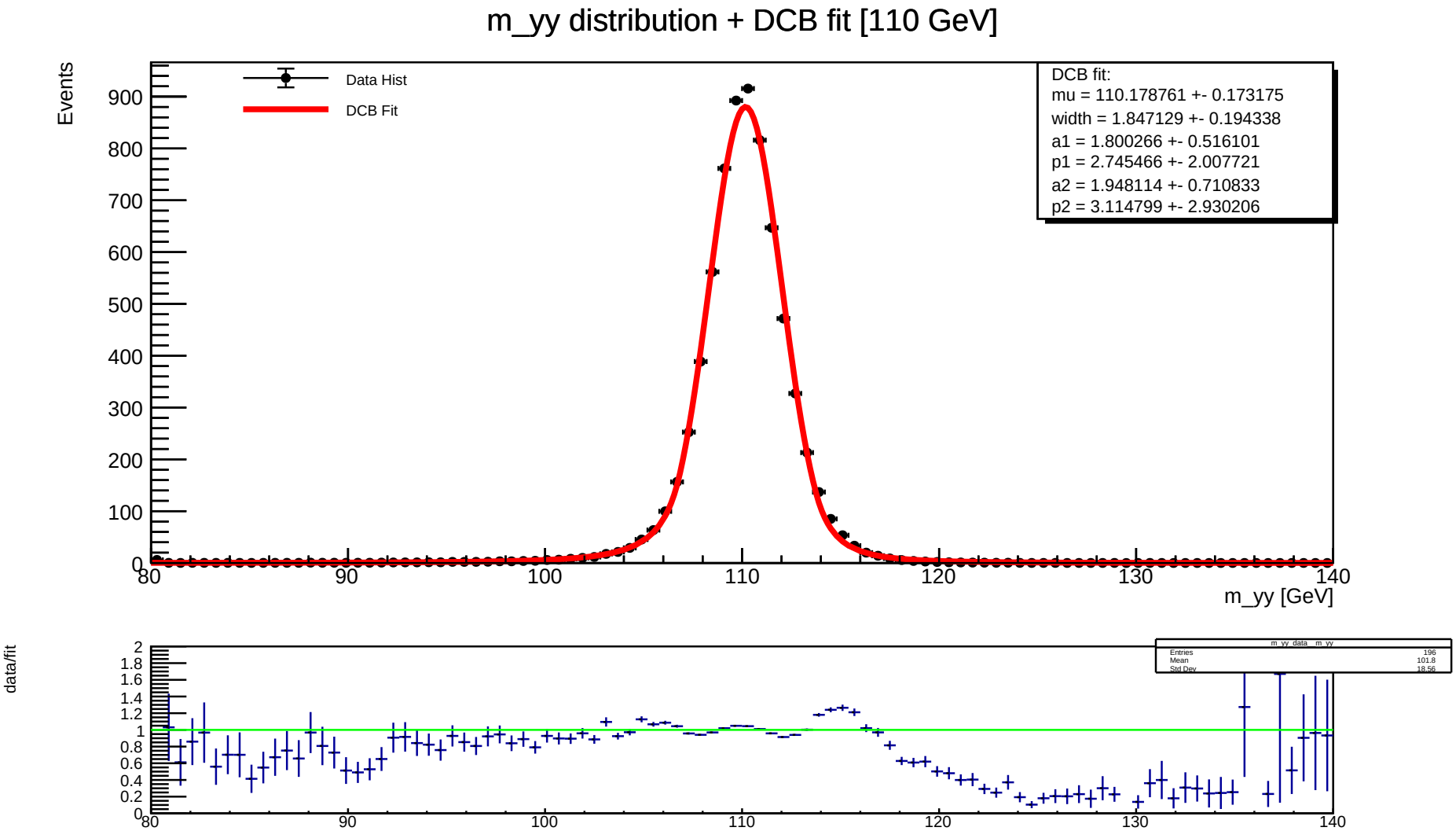






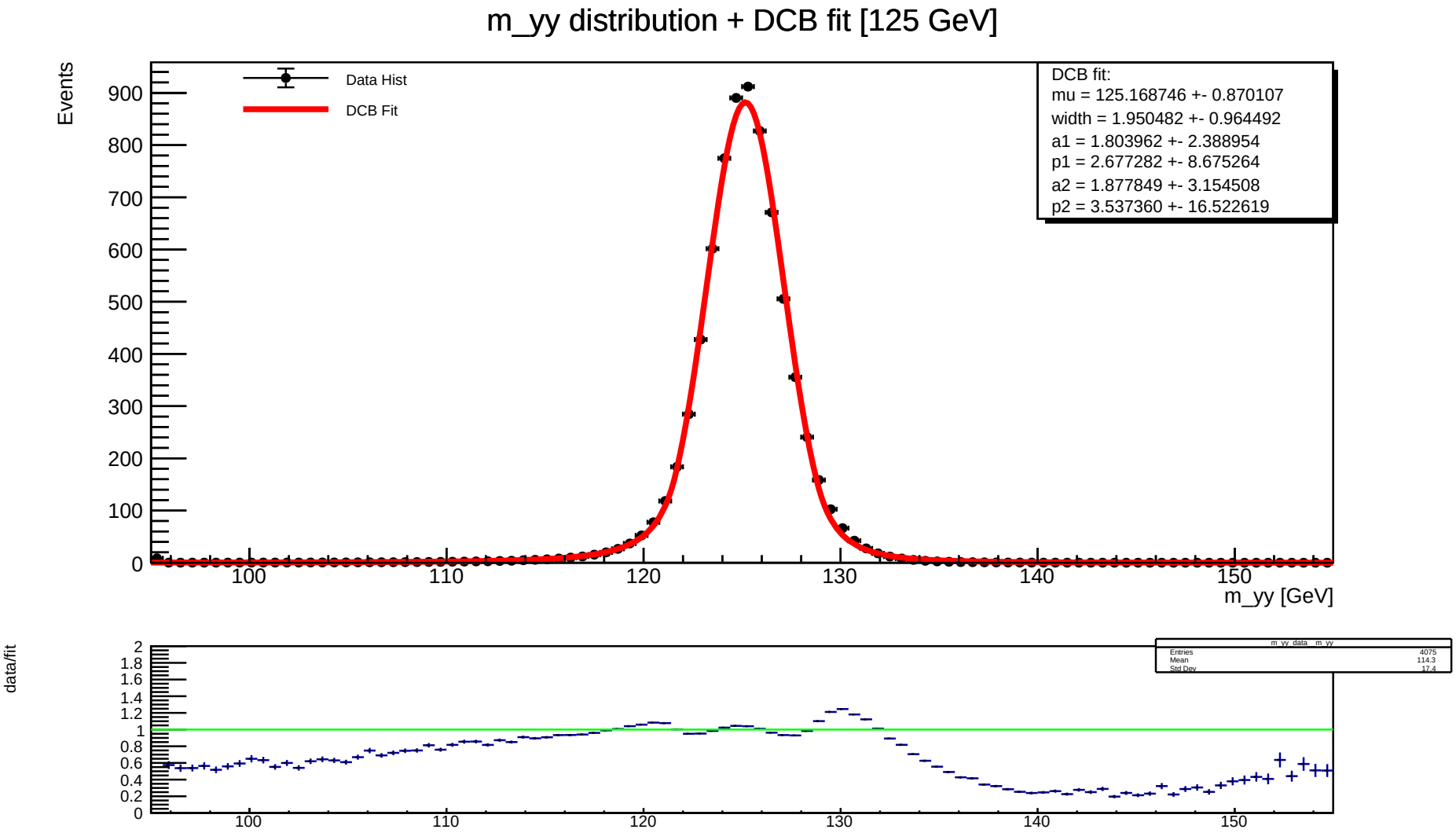
DCB fit and ratio plot [110 GeV]

The `ratio plot` between the fit and the distribution is added to each DCB fit.
Using the 110 GeV mass distribution:



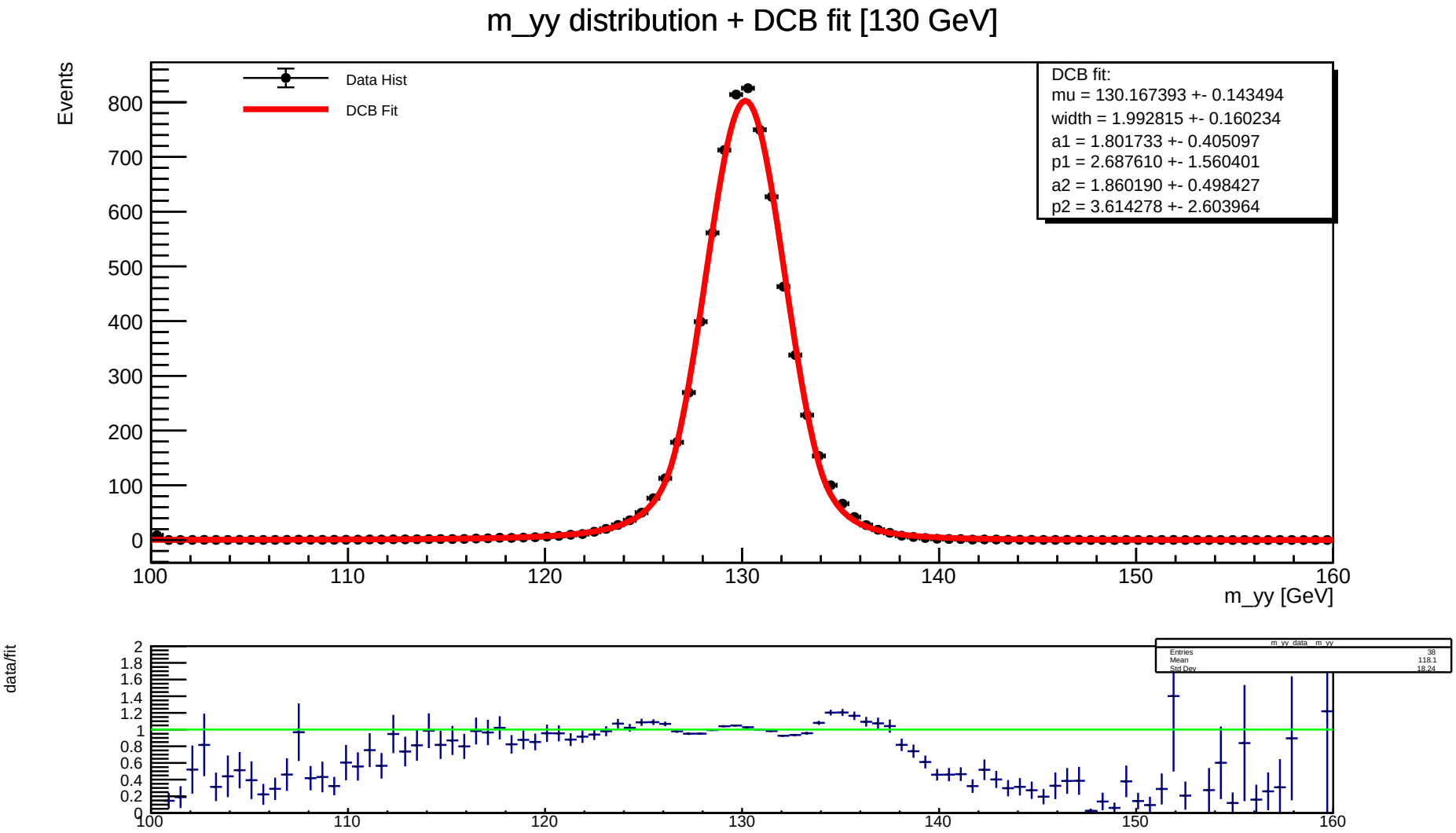
DCB fit and ratio plot [125 GeV]

The `ratio plot` between the fit and the distribution is added to each DCB fit.
Using the 125 GeV mass distribution:



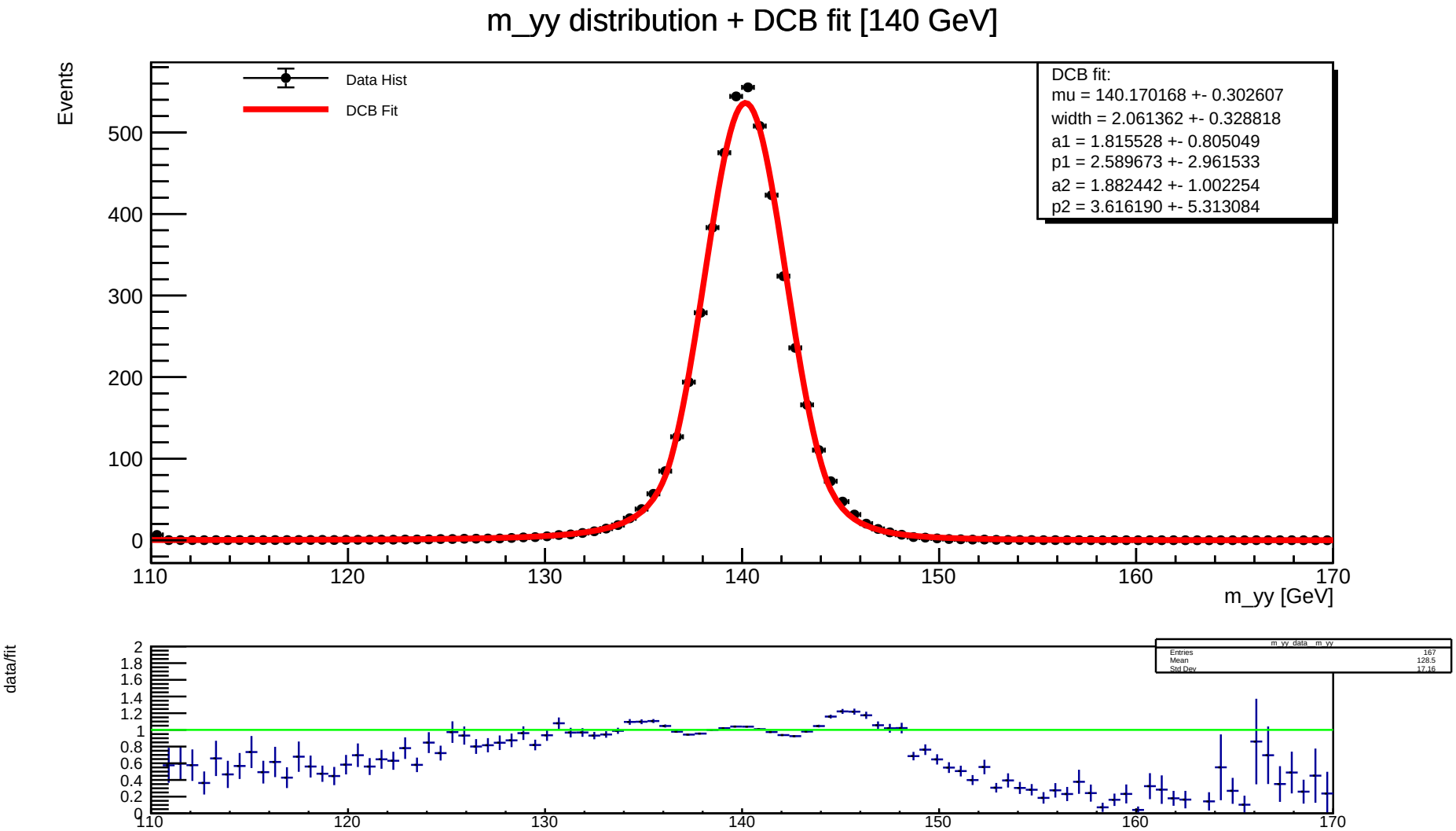
DCB fit and ratio plot [130 GeV]

The `ratio plot` between the fit and the distribution is added to each DCB fit.
Using the 130 GeV mass distribution:



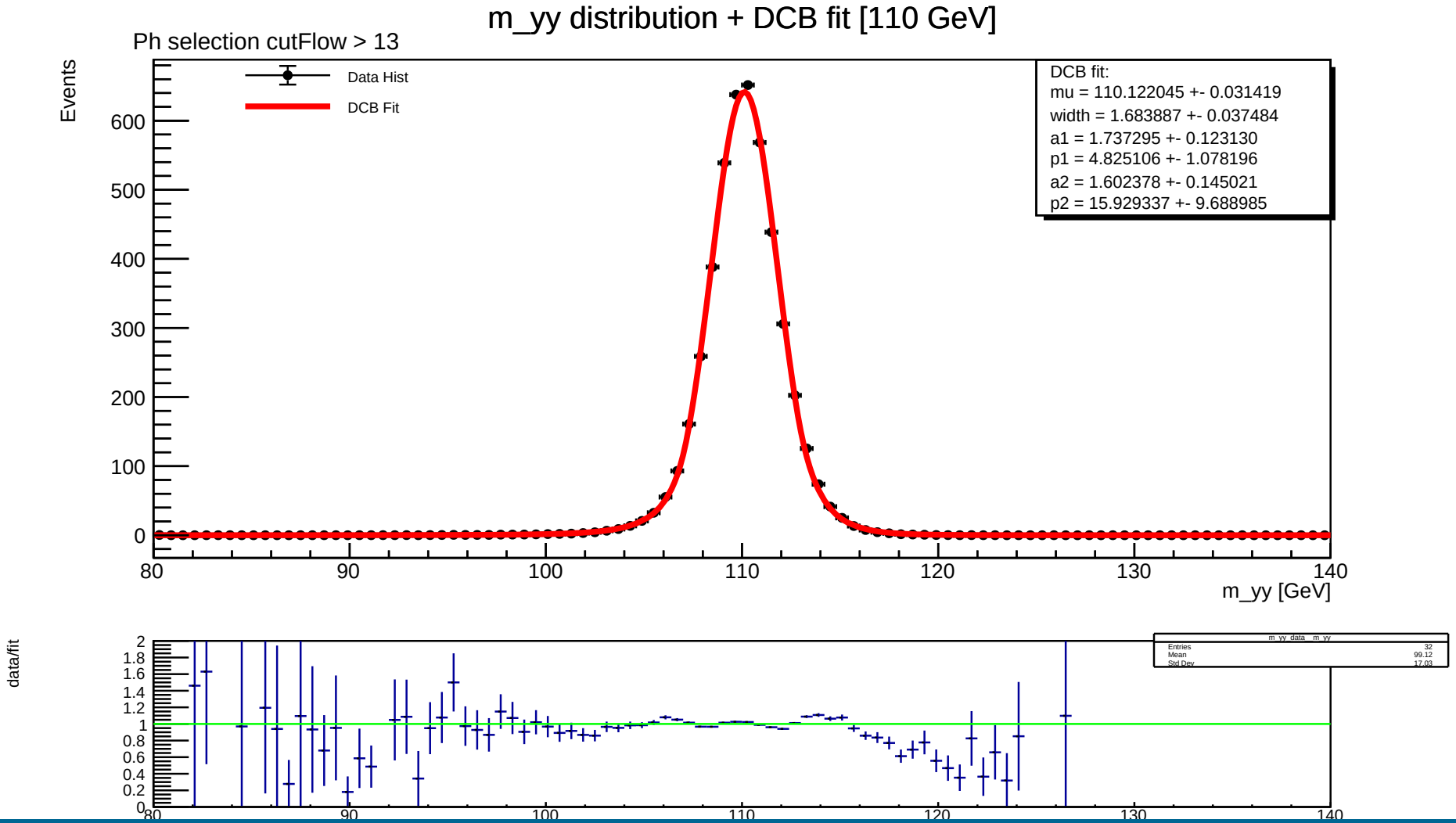
DCB fit and ratio plot [140 GeV]

The `ratio plot` between the fit and the distribution is added to each DCB fit.
Using the 140 GeV mass distribution:



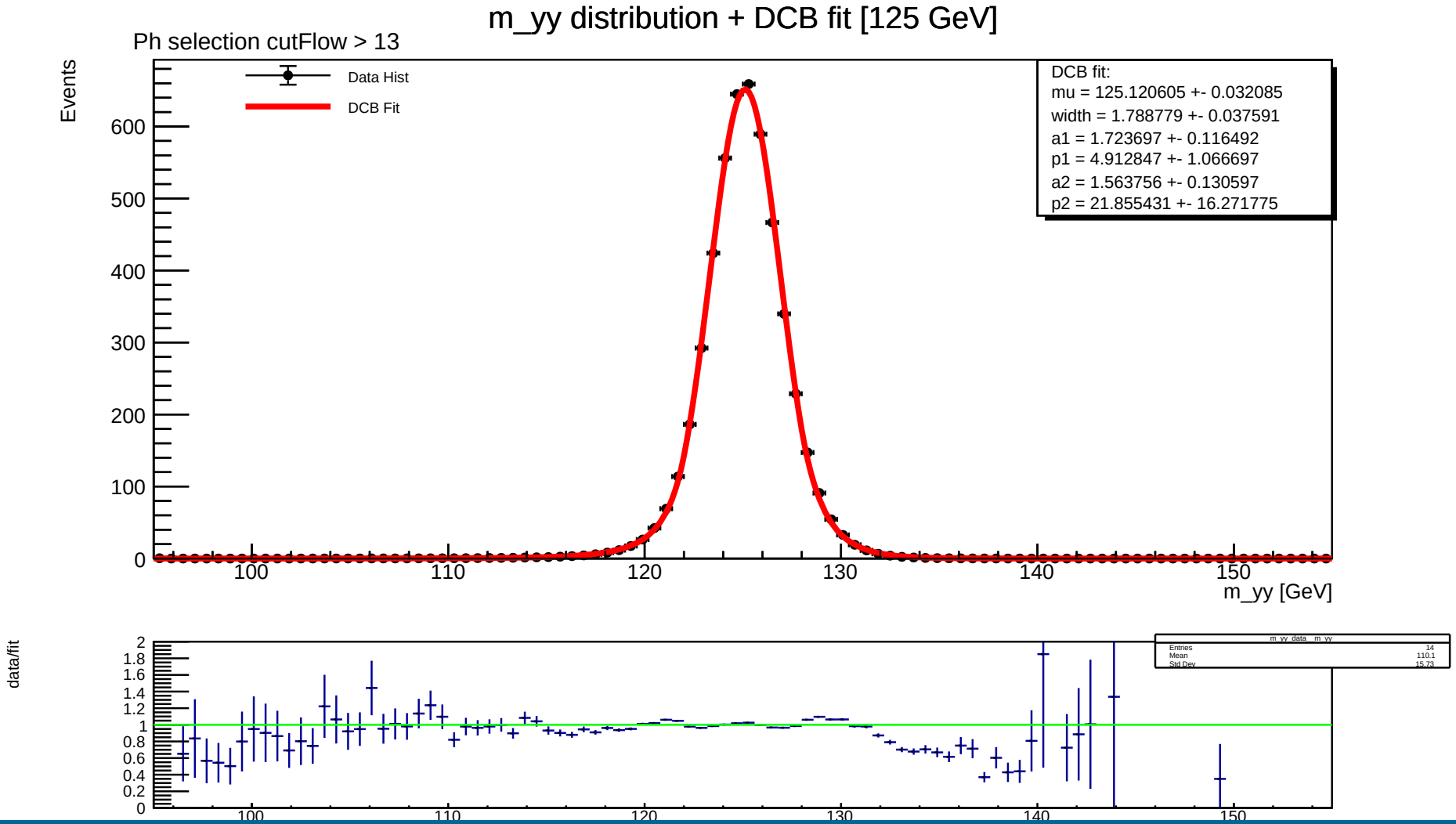
DCB fit+ratioplot [110 GeV] (cutFlow > 13)

The `ratio plot` between the fit and the distribution is added to each DCB fit. Using the 110 GeV mass distribution with `cutFlow` > 13:



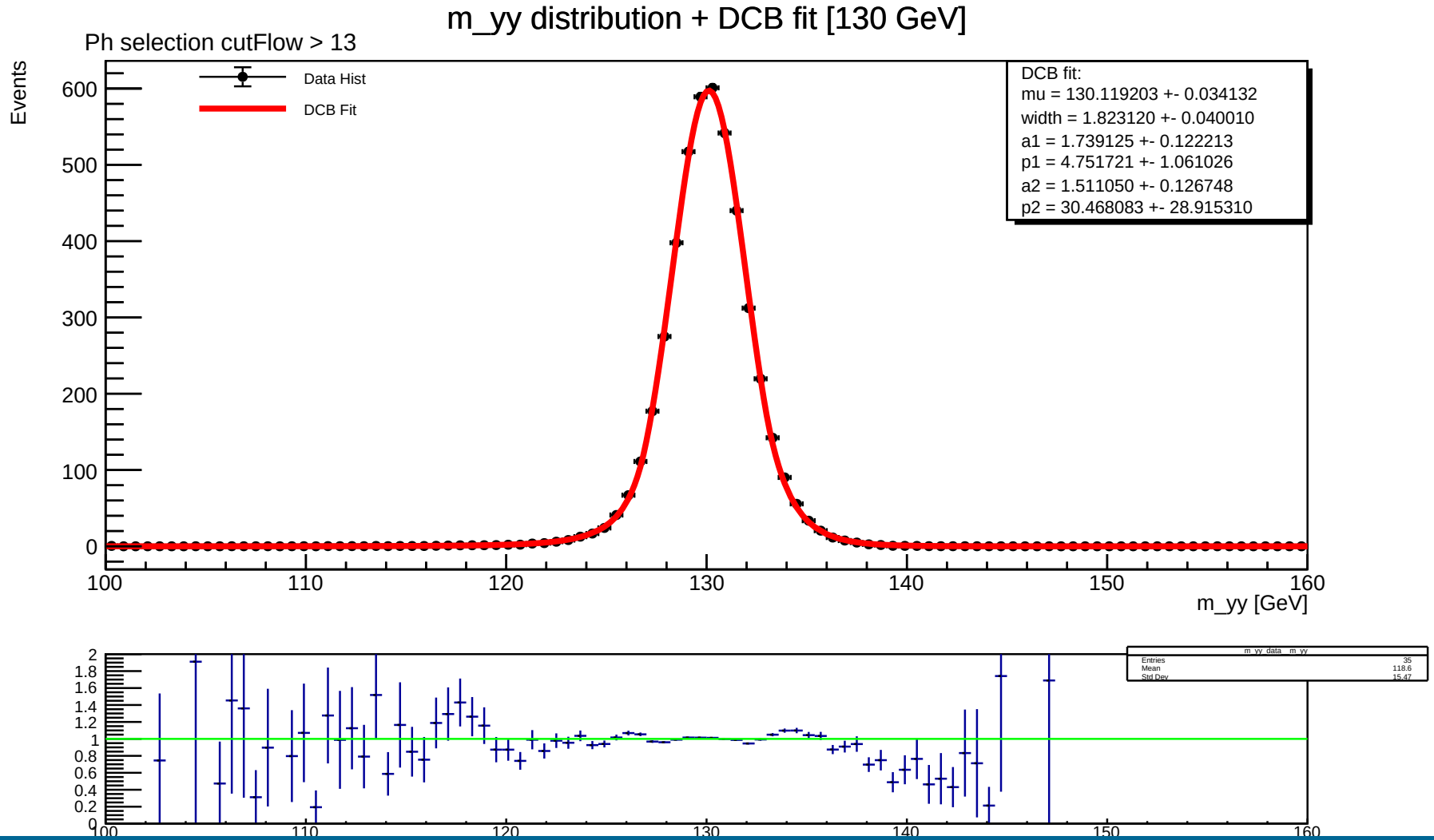
DCB fit+ratioplot [125 GeV] (cutFlow > 13)

The `ratio plot` between the fit and the distribution is added to each DCB fit. Using the 125 GeV mass distribution with `cutFlow` > 13:



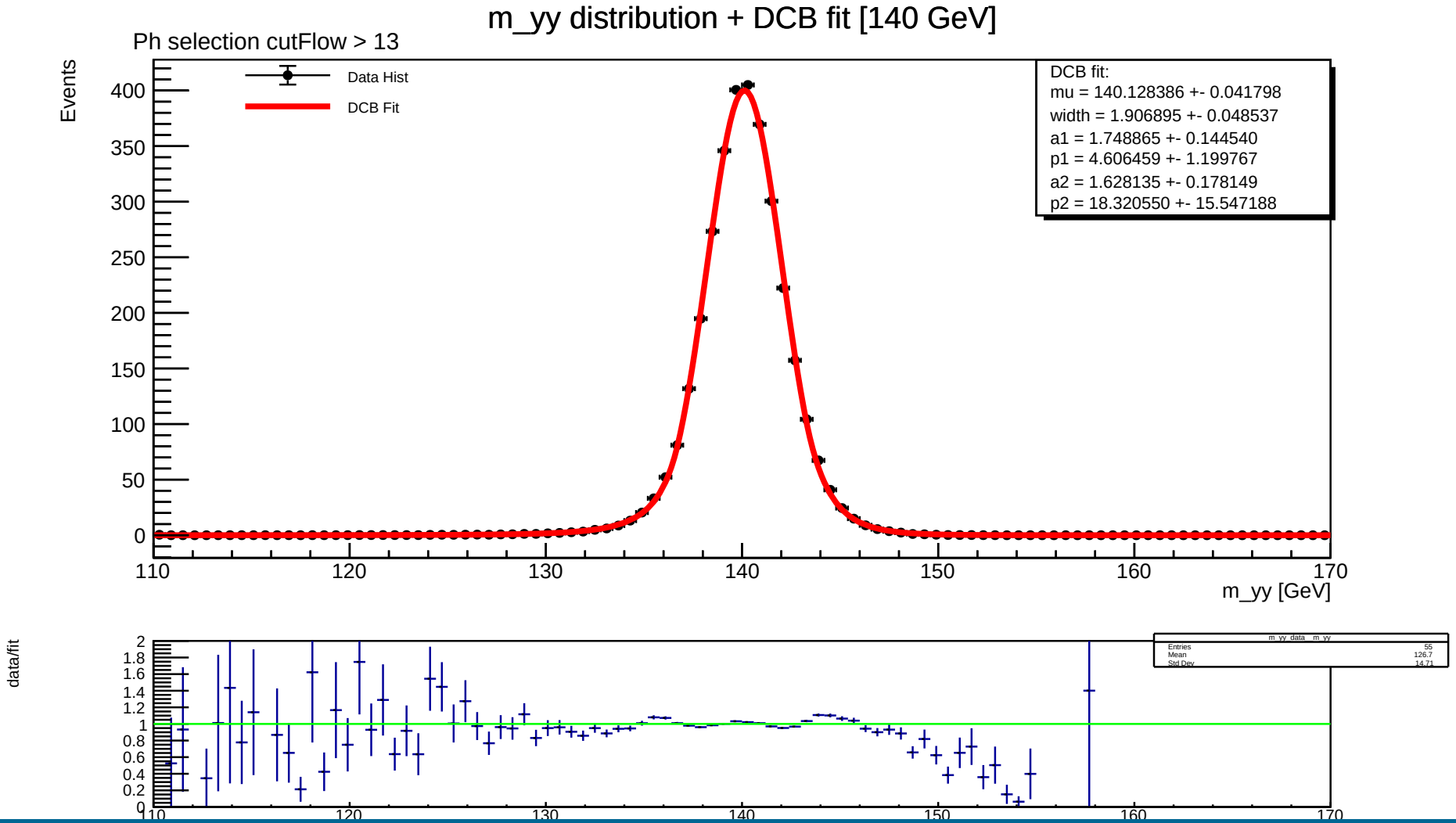
DCB fit+ratioplot [130 GeV] (cutFlow > 13)

The `ratio plot` between the fit and the distribution is added to each DCB fit. Using the 130 GeV mass distribution with `cutFlow` > 13:



DCB fit+ratioplot [140 GeV] (cutFlow > 13)

The `ratio plot` between the fit and the distribution is added to each DCB fit. Using the 140 GeV mass distribution with `cutFlow` $>$ 13:



2° week

DSCB(m_h)

The DSCD fit are studied with 3 different methods, in addiction to all free parameters fit:

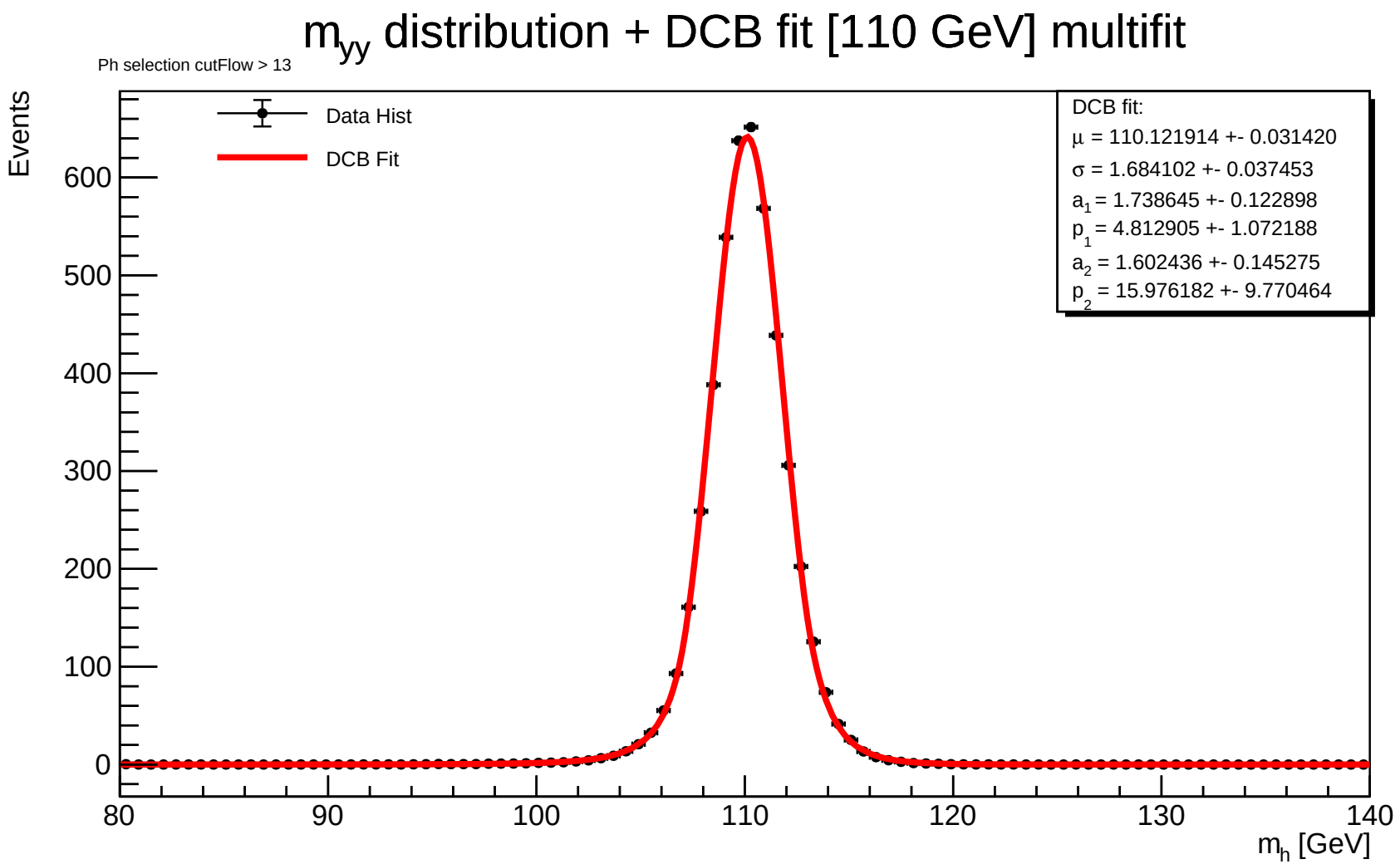
1. multi-fit;
2. μ and σ are functions of m_h;
3. all parameters are functions of m_h;

DSCB multifit

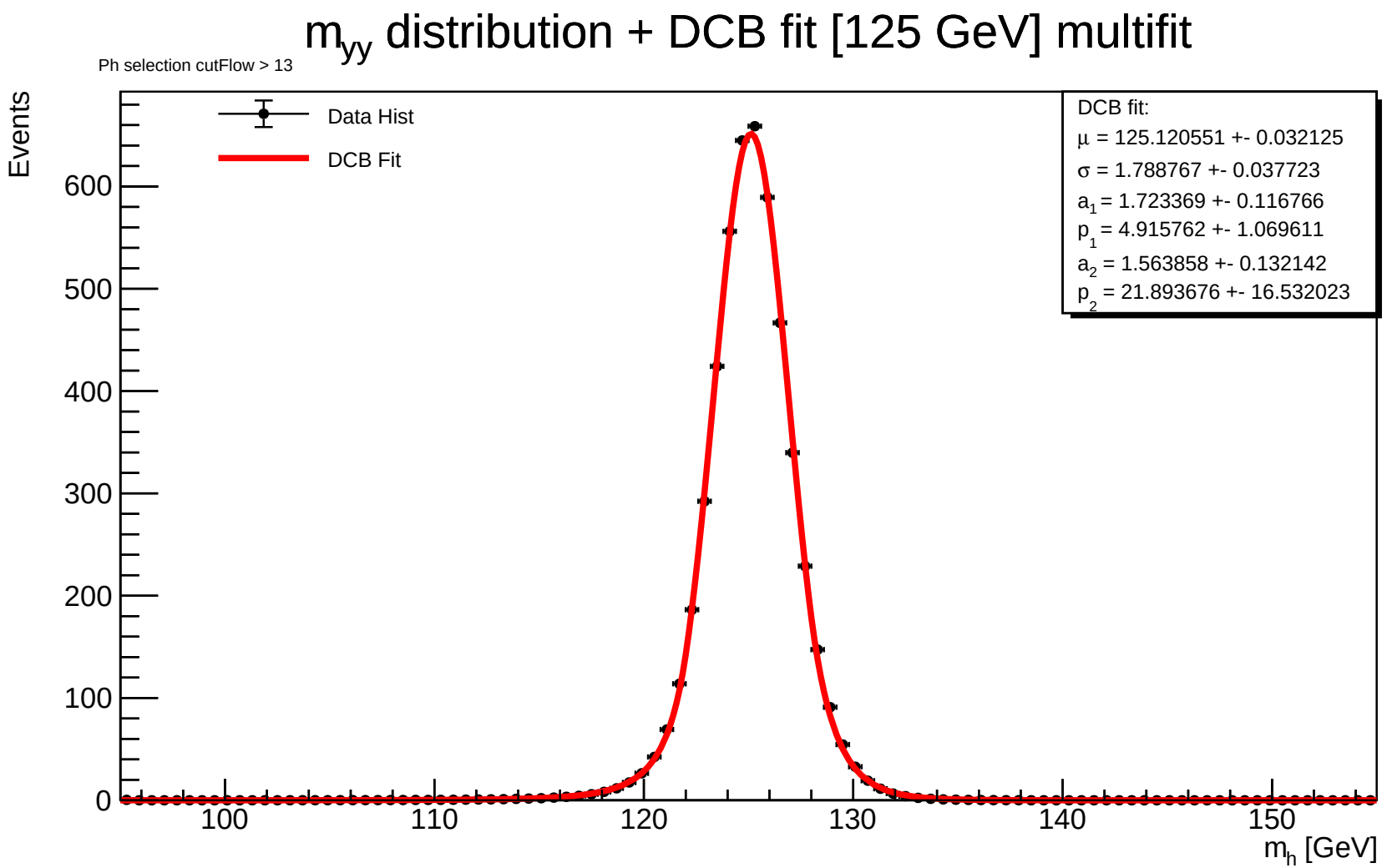
A DSCB multifit consists of a series of consecutive fits:

1. fit on μ and σ, tails params fixed;
2. fit on tails params, μ and σ fixed;
3. fit on all parameters;

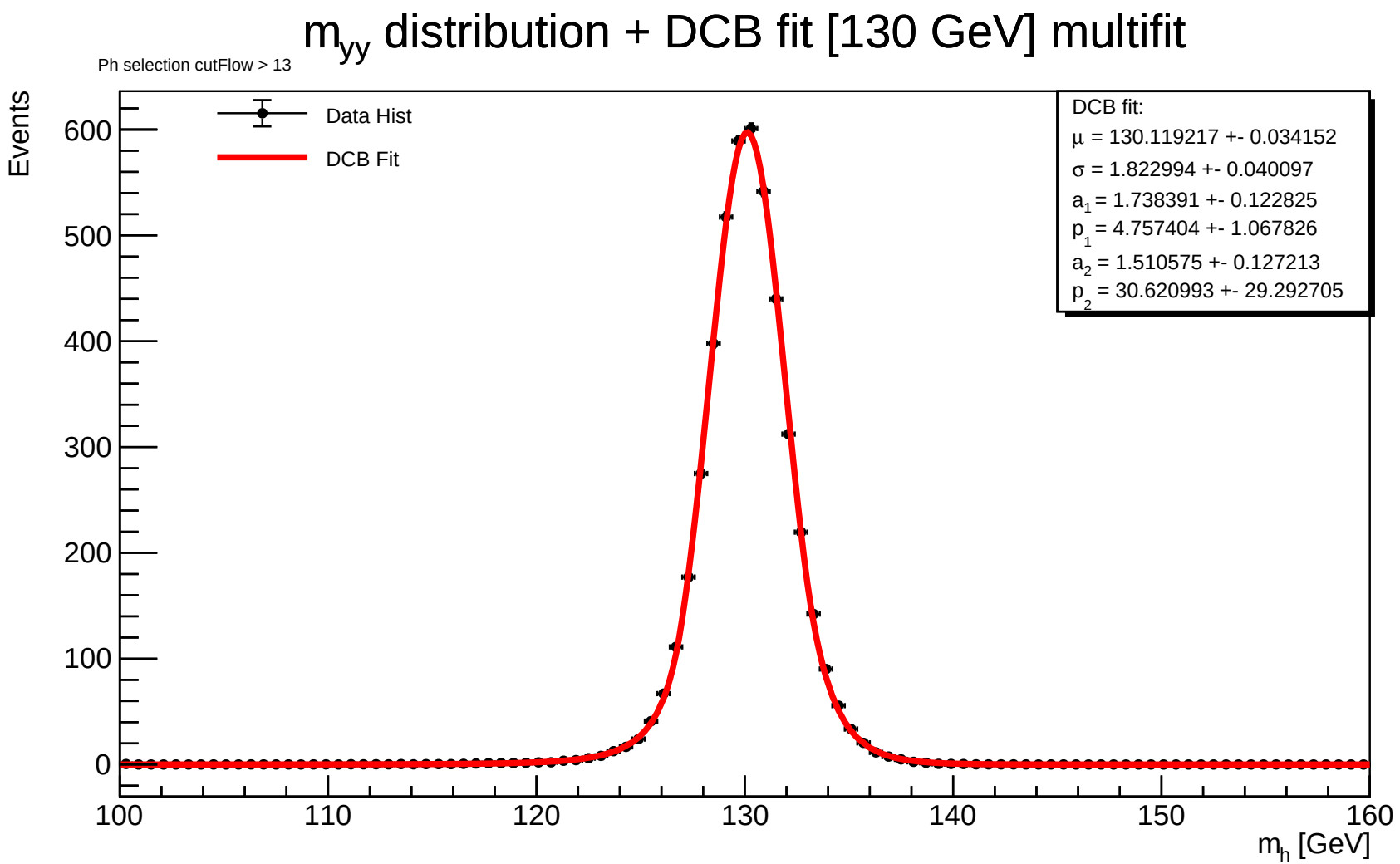
DSCB multifit [110 GeV]



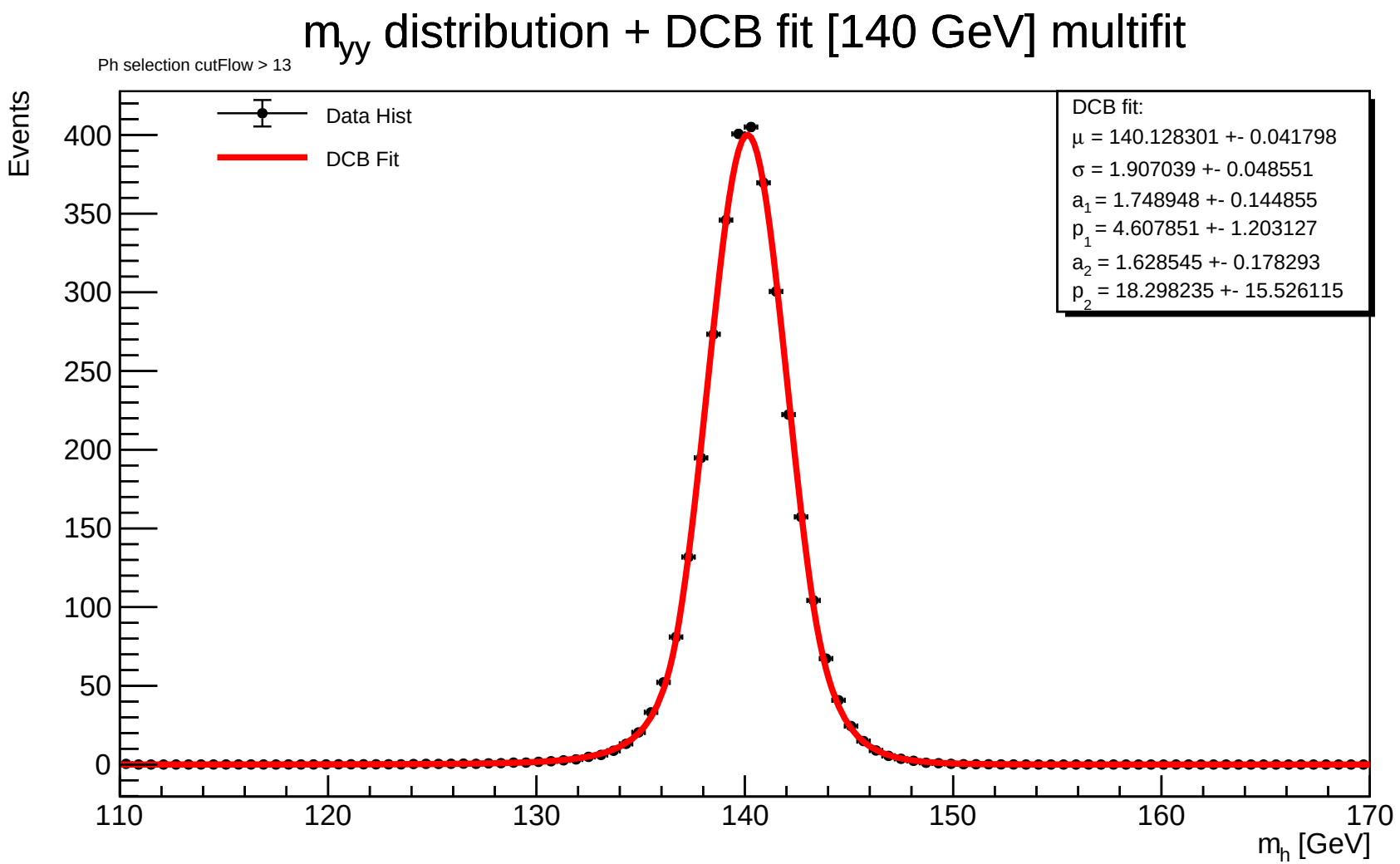
DSCB multifit [125 GeV]



DSCB multifit [130 GeV]



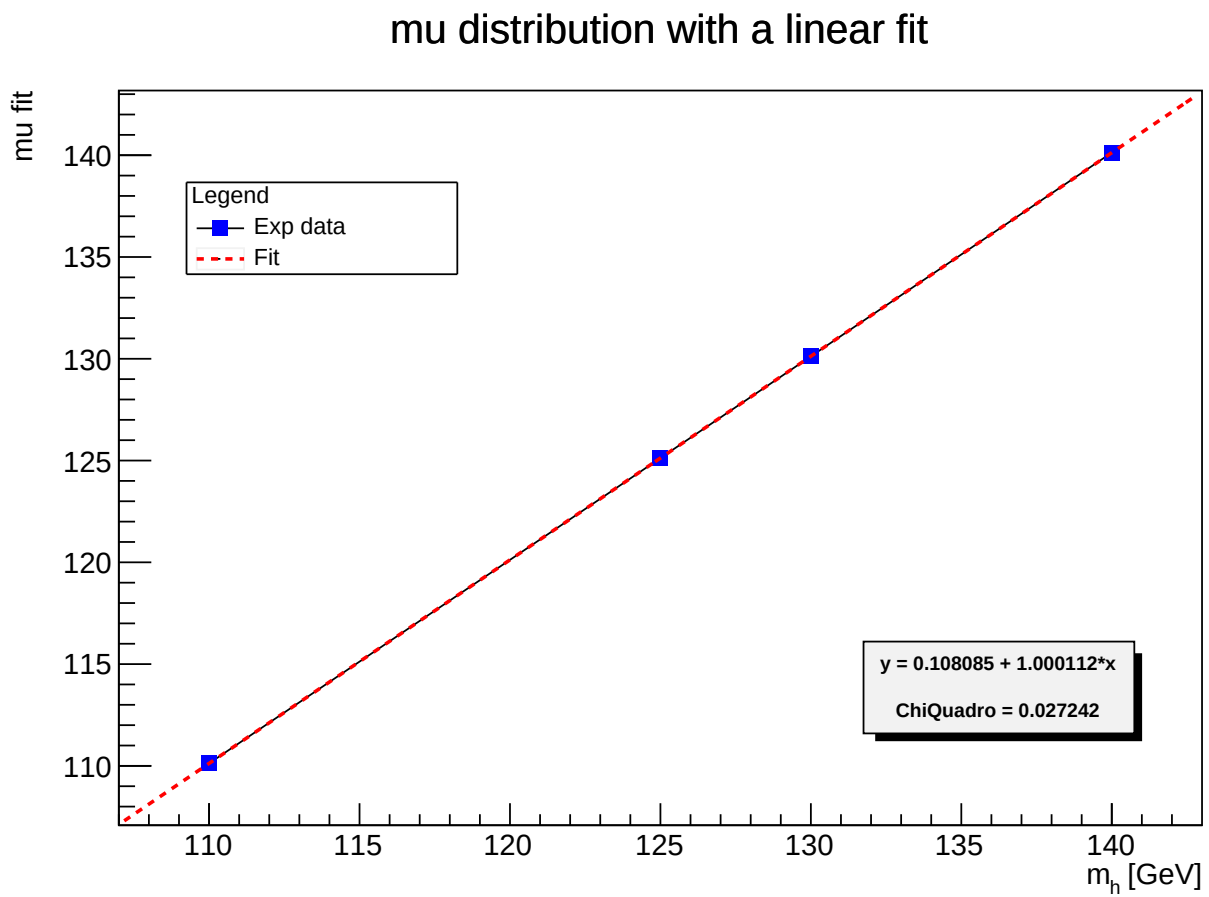
DSCB multifit [140 GeV]



$\mu(m_h)$

Fitting the μ values at different m_h with a linear fit:

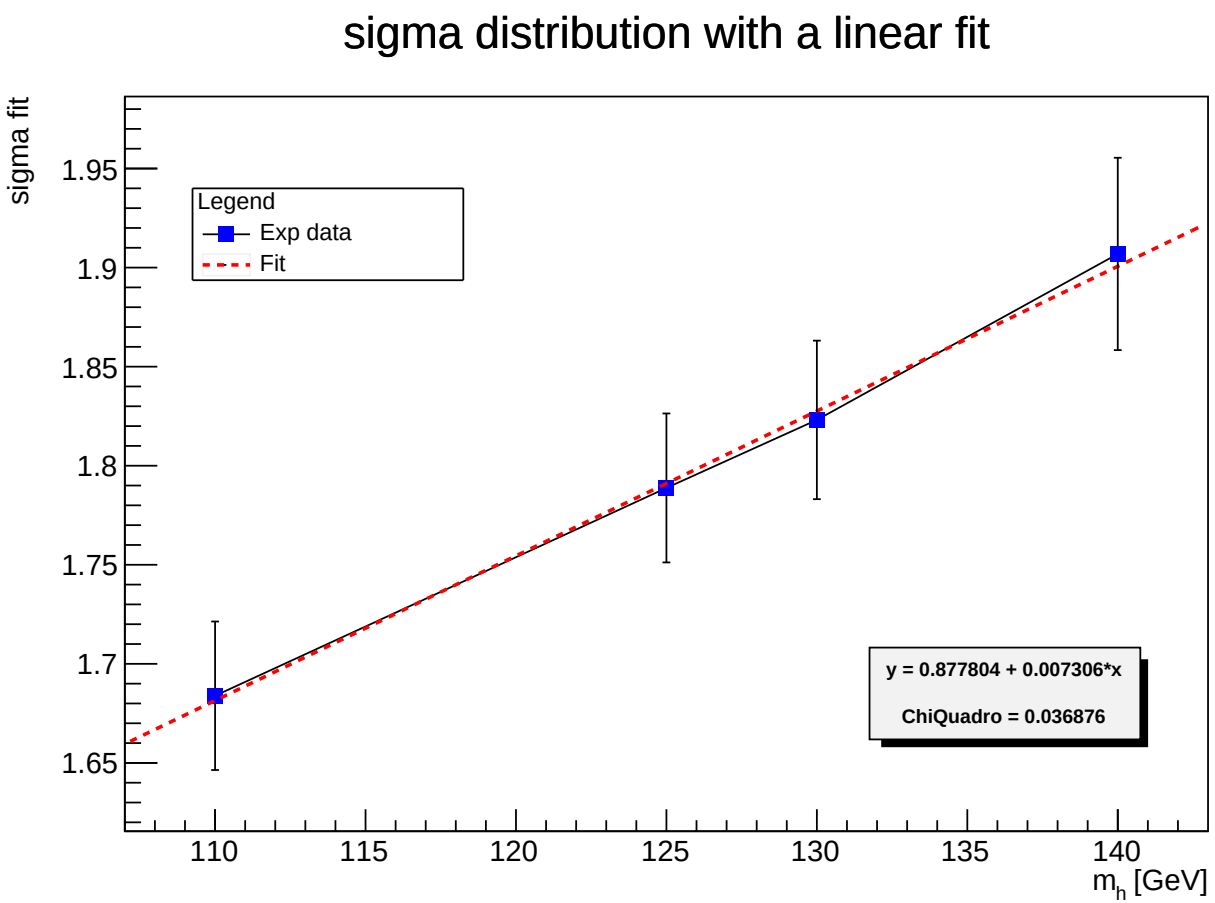
$$\mu(m_h) = A + B \cdot m_h$$



$\sigma(m_h)$

Fitting the σ values at different m_h with a linear fit:

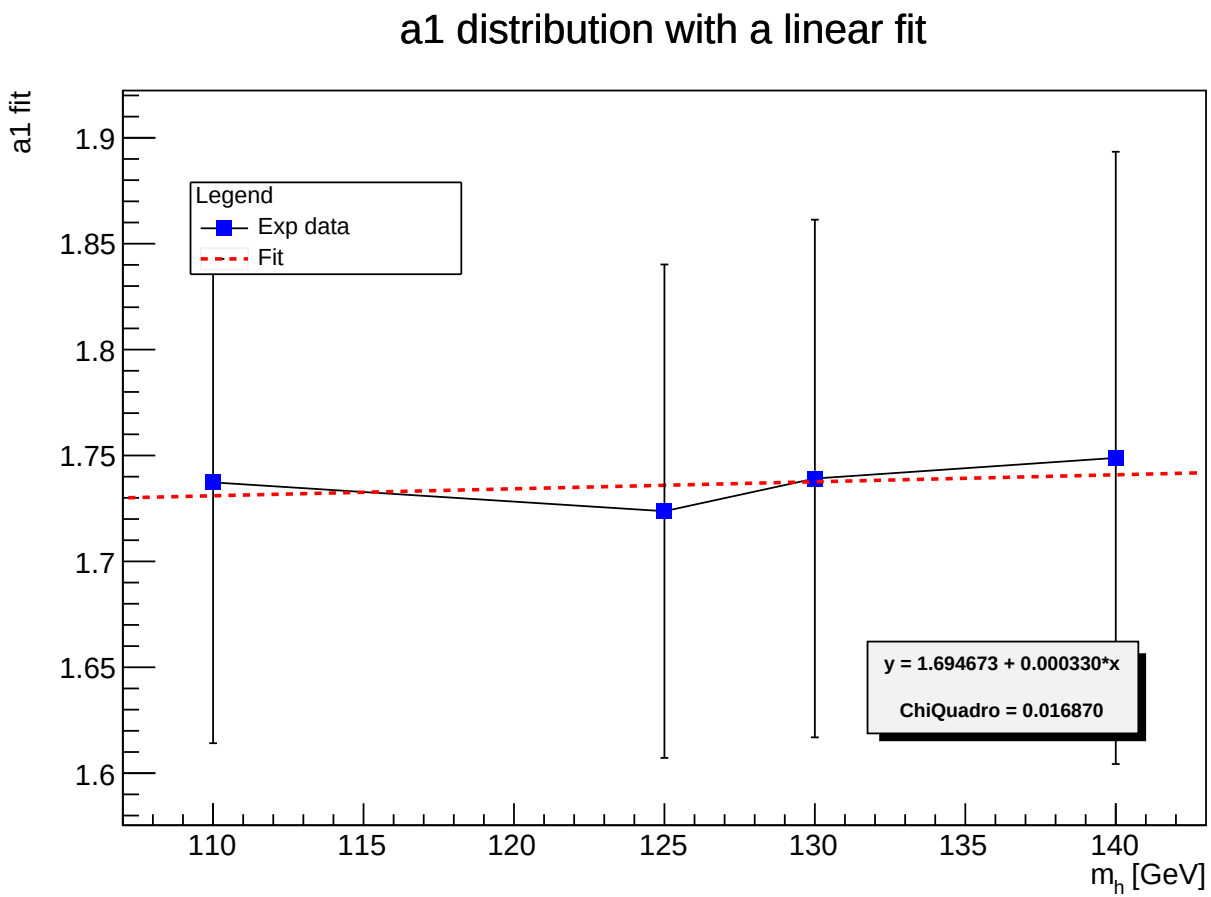
$$\sigma(m_h) = A + B \cdot m_h$$



$a_1(m_h)$

Fitting the a_1 values at different m_h with a linear fit:

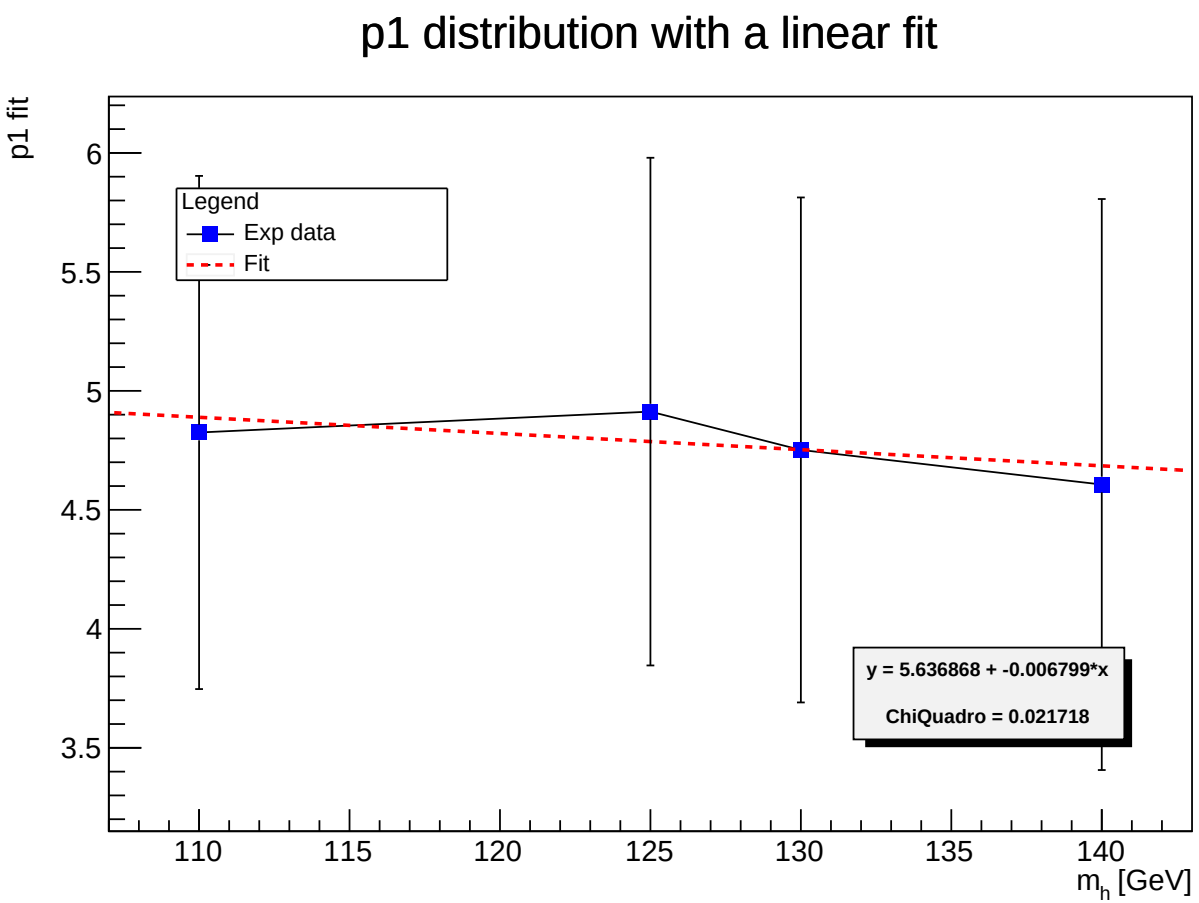
$$a_1(m_h) = A + B \cdot m_h$$



$p_1(m_h)$

Fitting the p_1 values at different m_h with a linear fit:

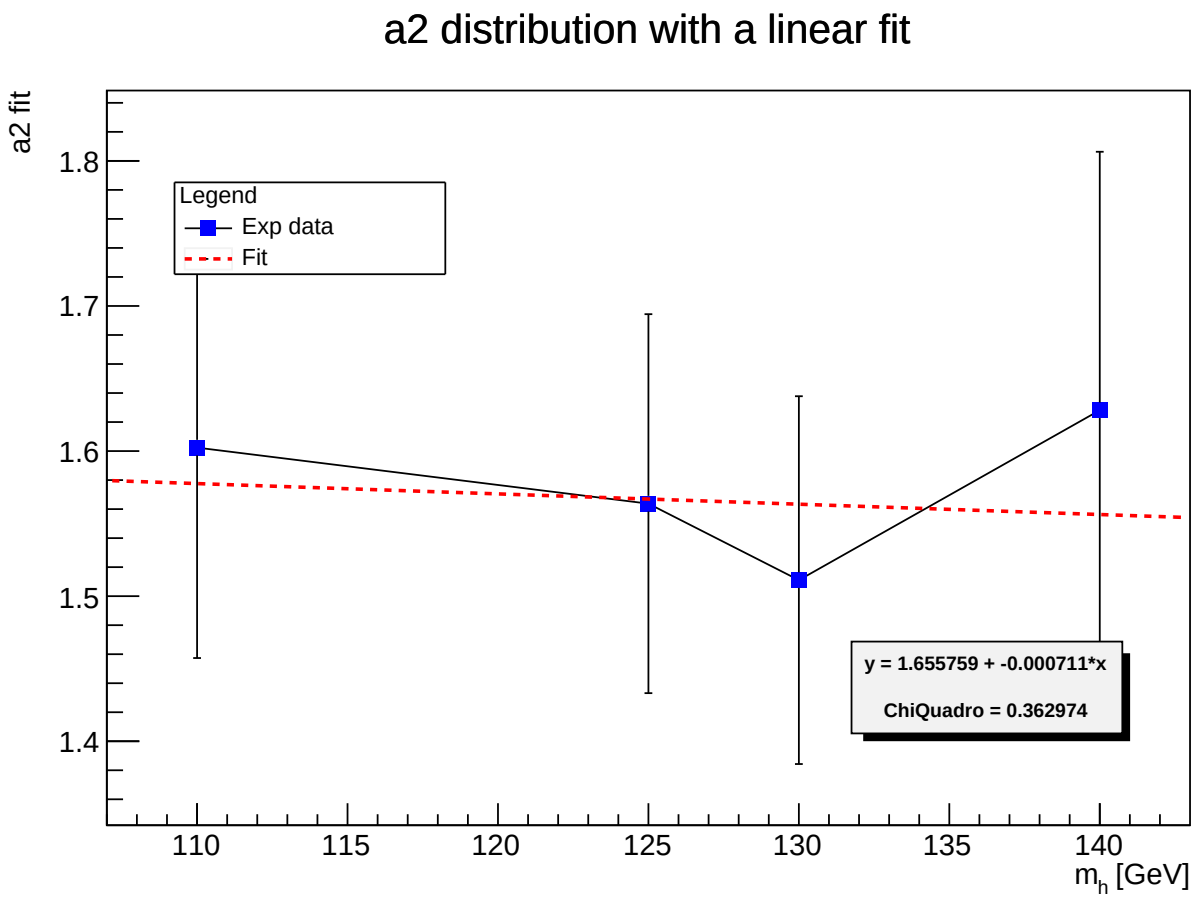
$$p_1(m_h) = A + B \cdot m_h$$



$a_2(m_h)$

Fitting the a_2 values at different m_h with a linear fit:

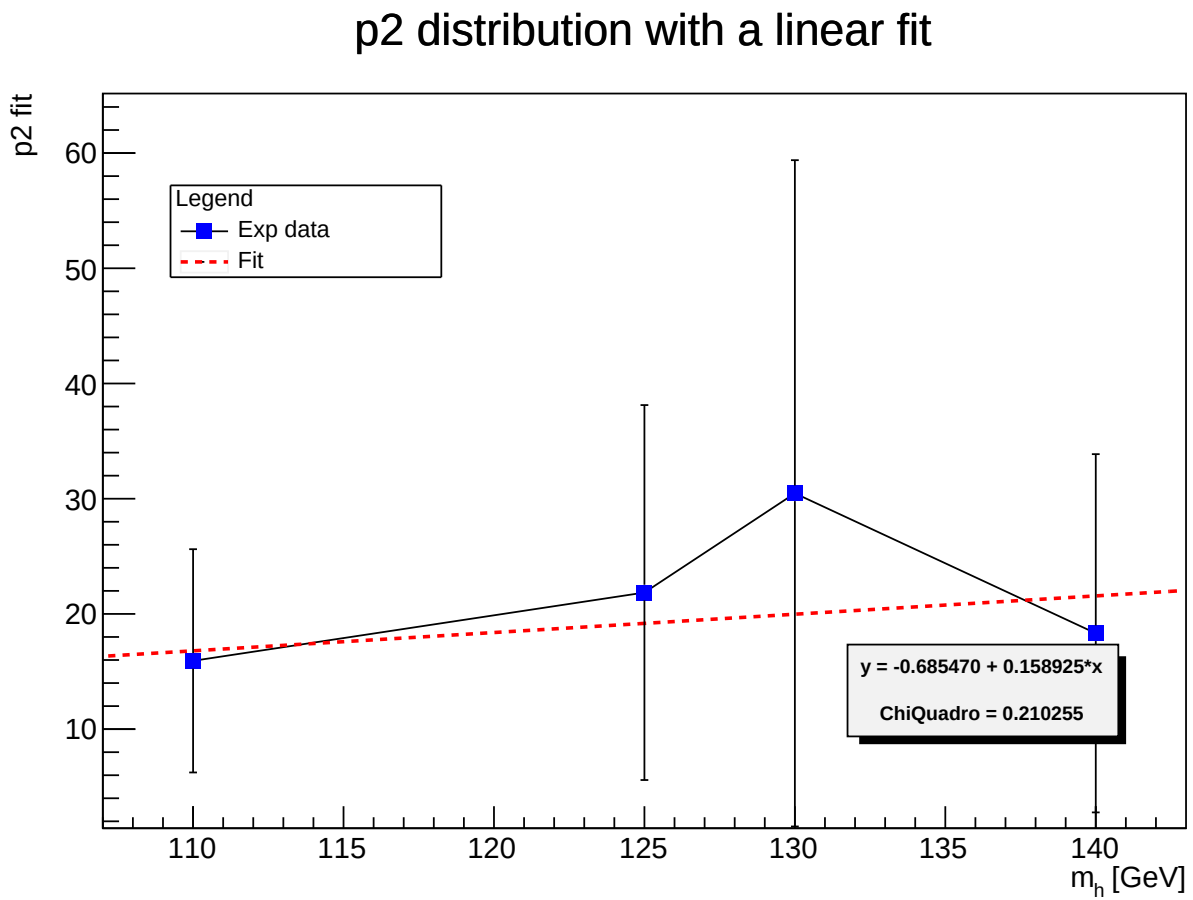
$$a_2(m_h) = A + B \cdot m_h$$



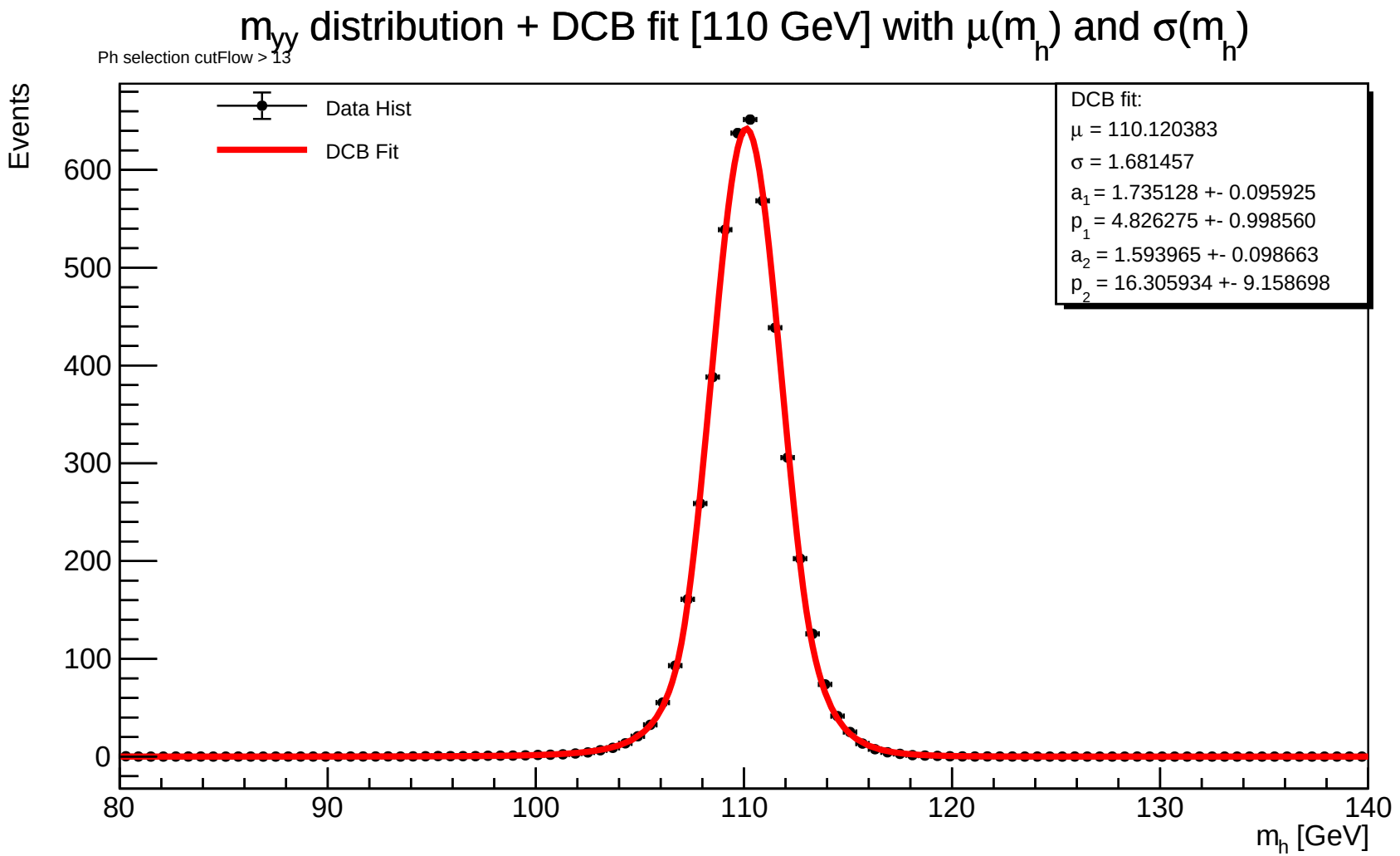
$p_2(m_h)$

Fitting the p_2 values at different m_h with a linear fit:

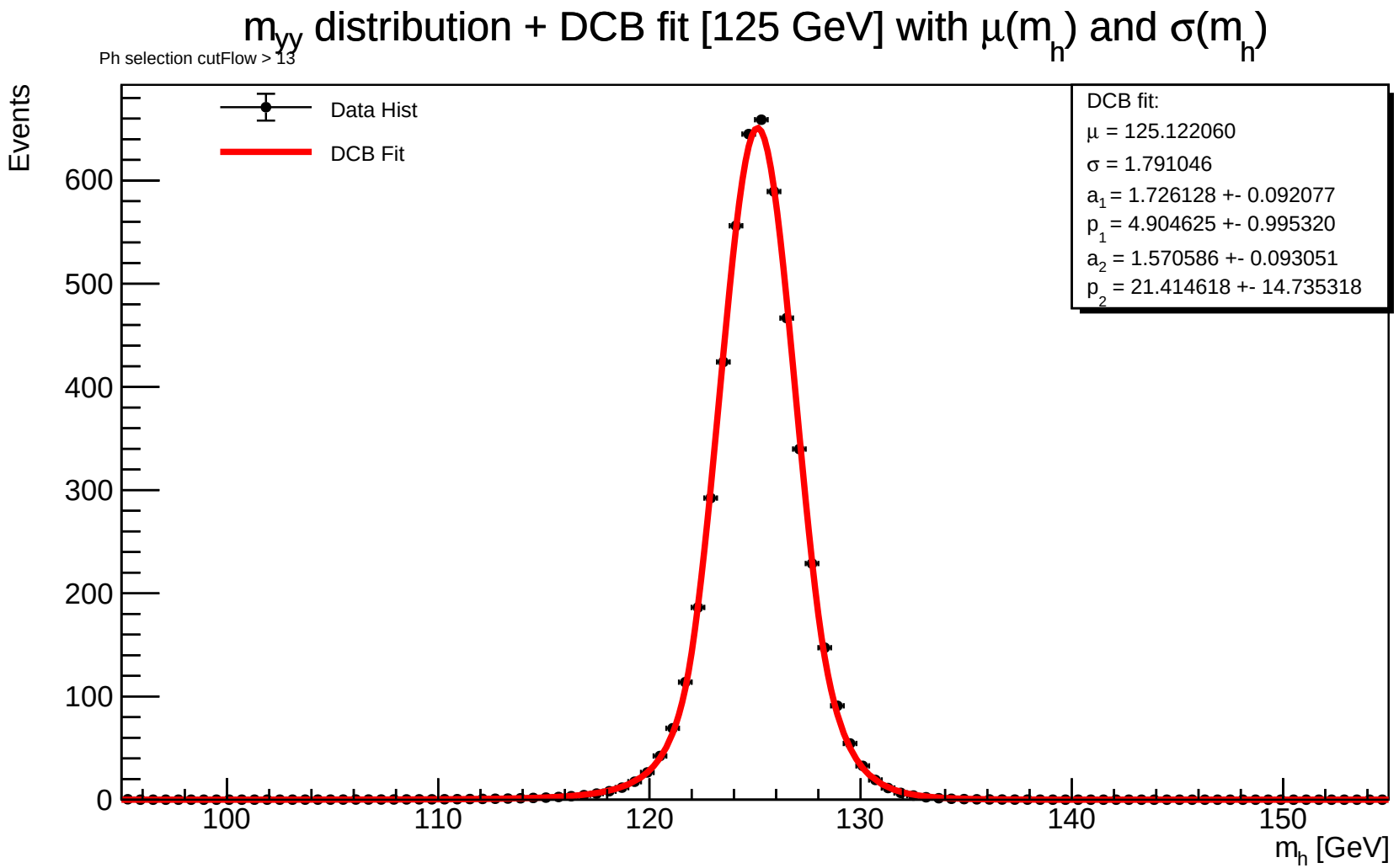
$$p_2(m_h) = A + B \cdot m_h$$



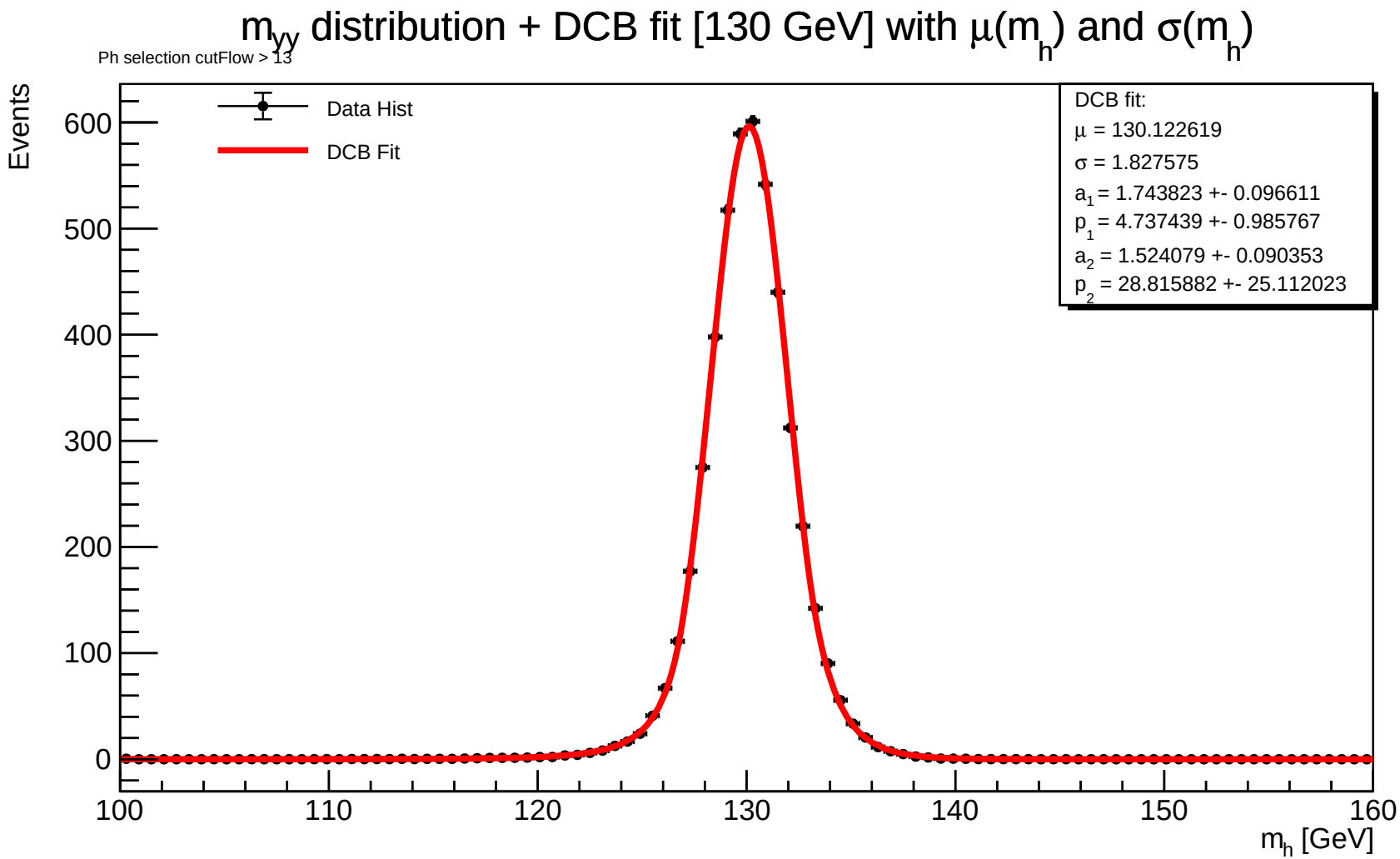
DSCB(m_h) with $\mu(m_h)$ and $\sigma(m_h)$ [110 GeV]



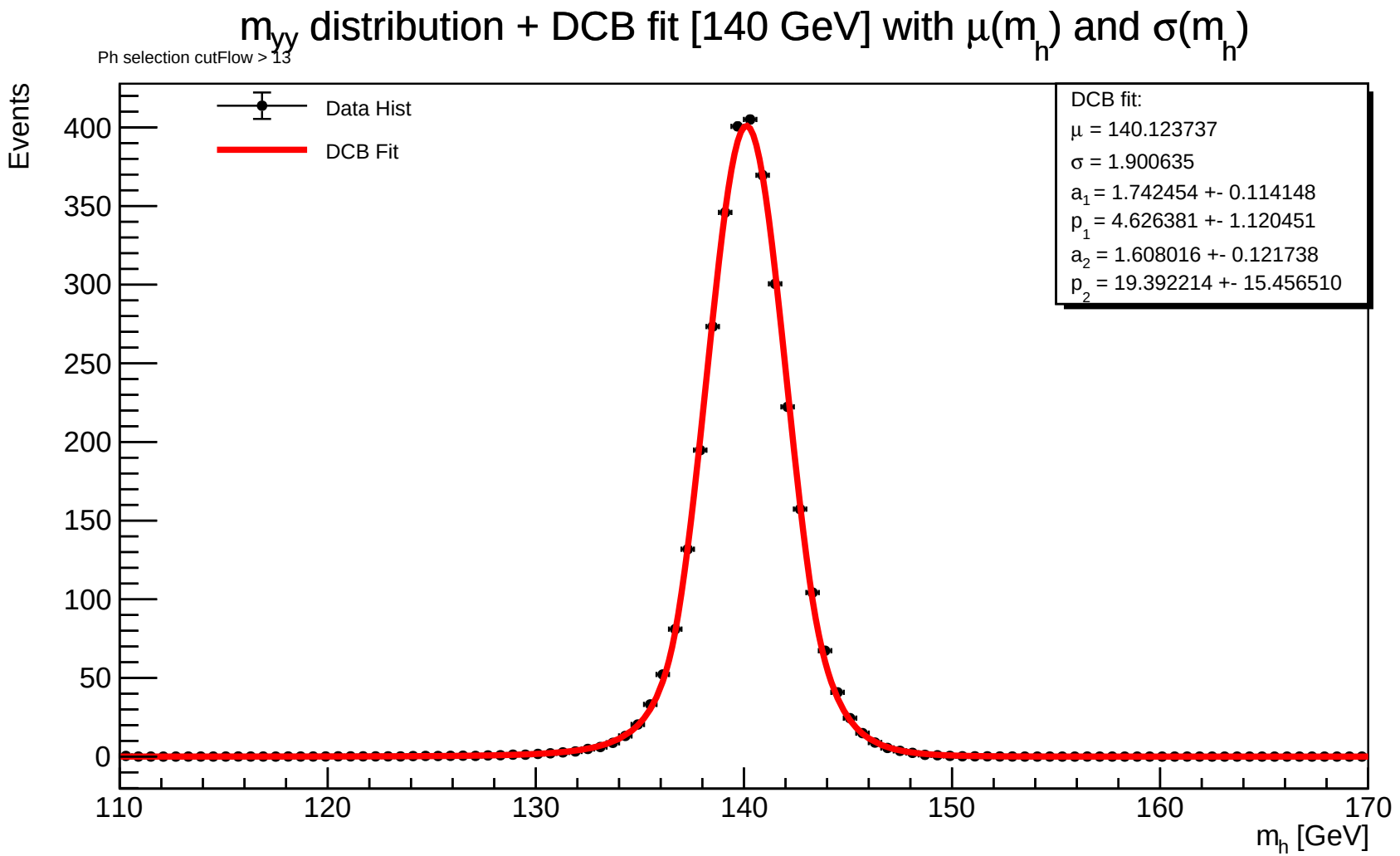
DSCB(m_h) with $\mu(m_h)$ and $\sigma(m_h)$ [125 GeV]



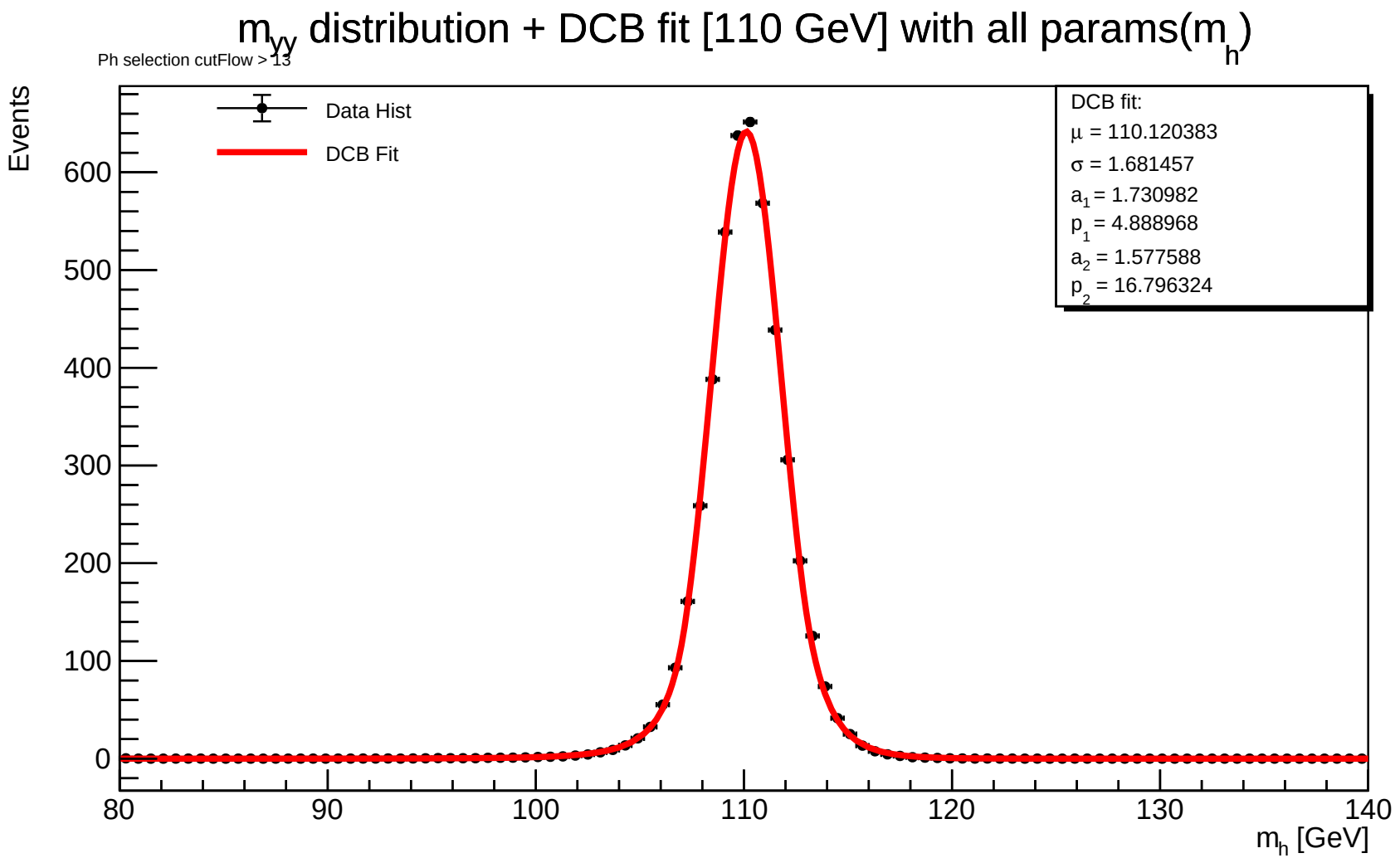
DSCB(m_h) with $\mu(m_h)$ and $\sigma(m_h)$ [130 GeV]



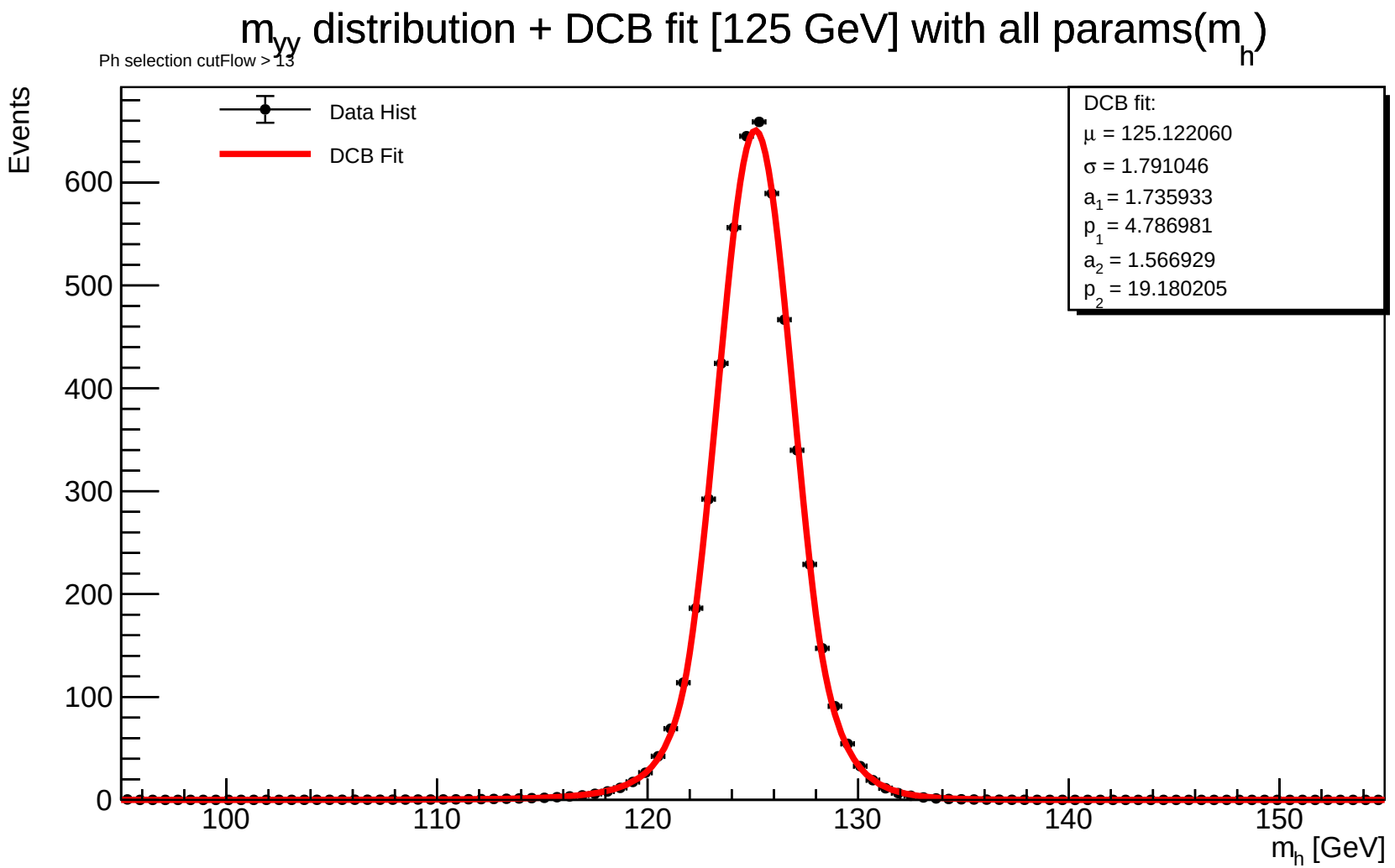
DSCB(m_h) with $\mu(m_h)$ and $\sigma(m_h)$ [140 GeV]



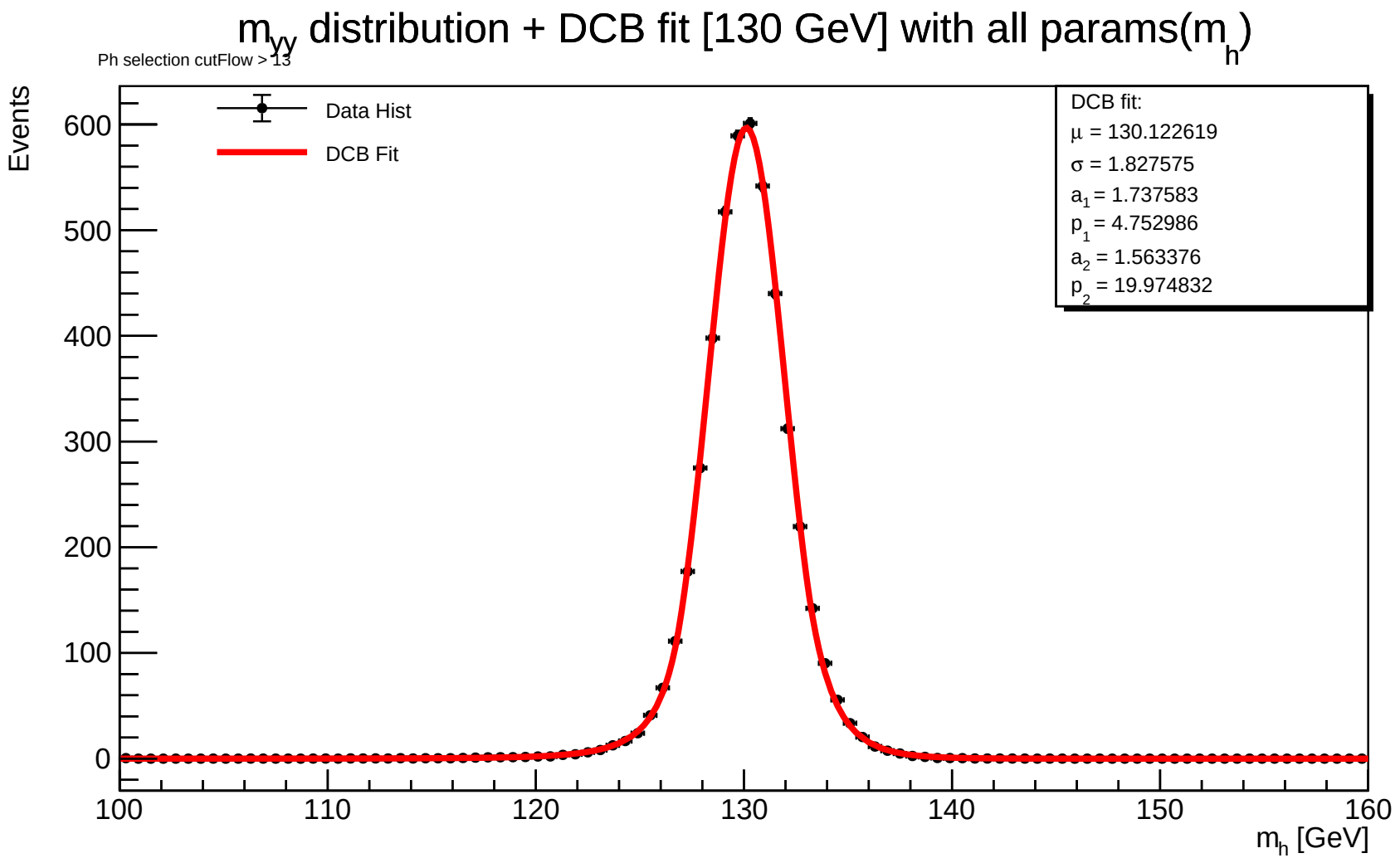
DSCB(m_h) with all params(m_h) [110 GeV]



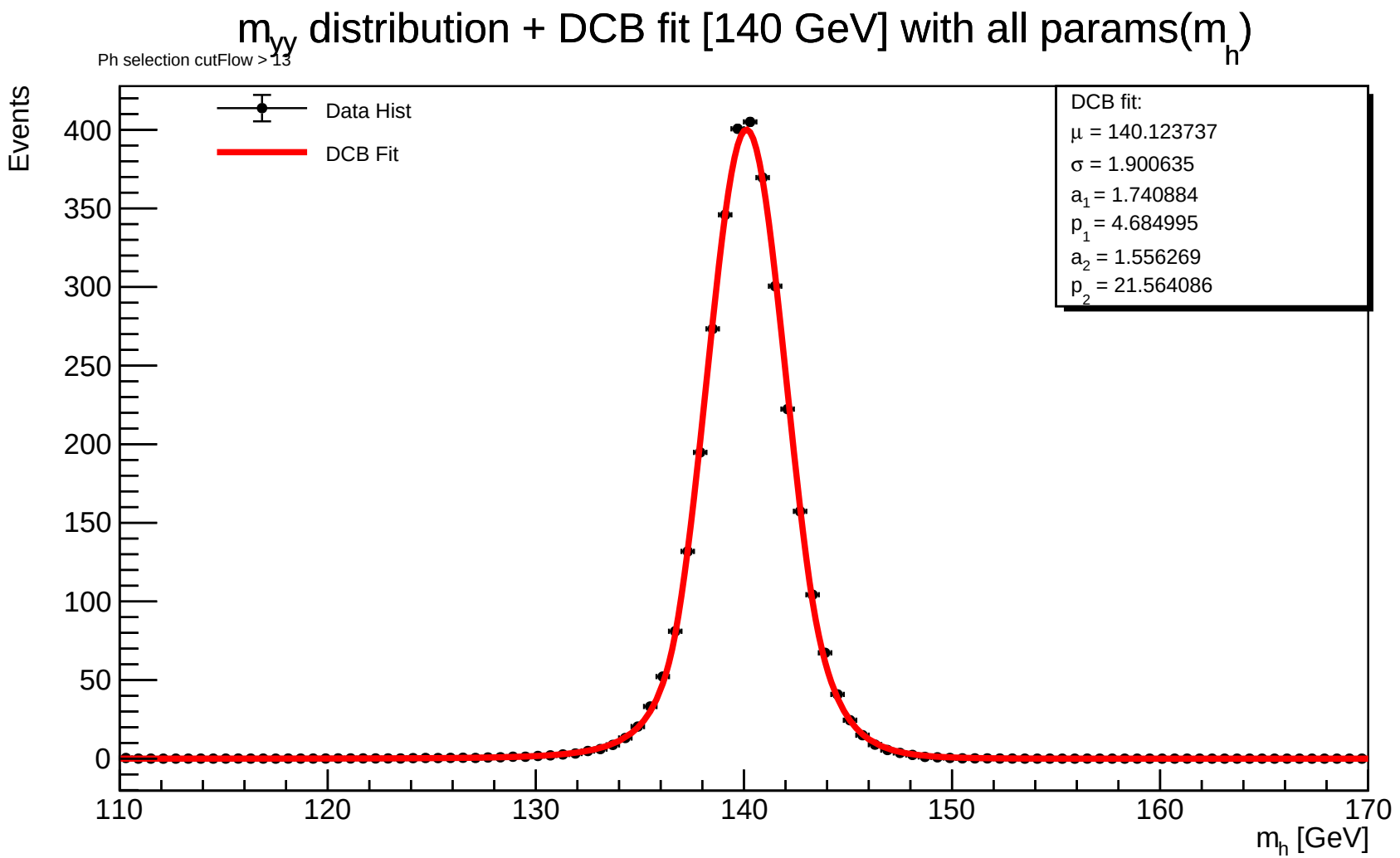
DSCB(m_h) with all params(m_h) [125 GeV]



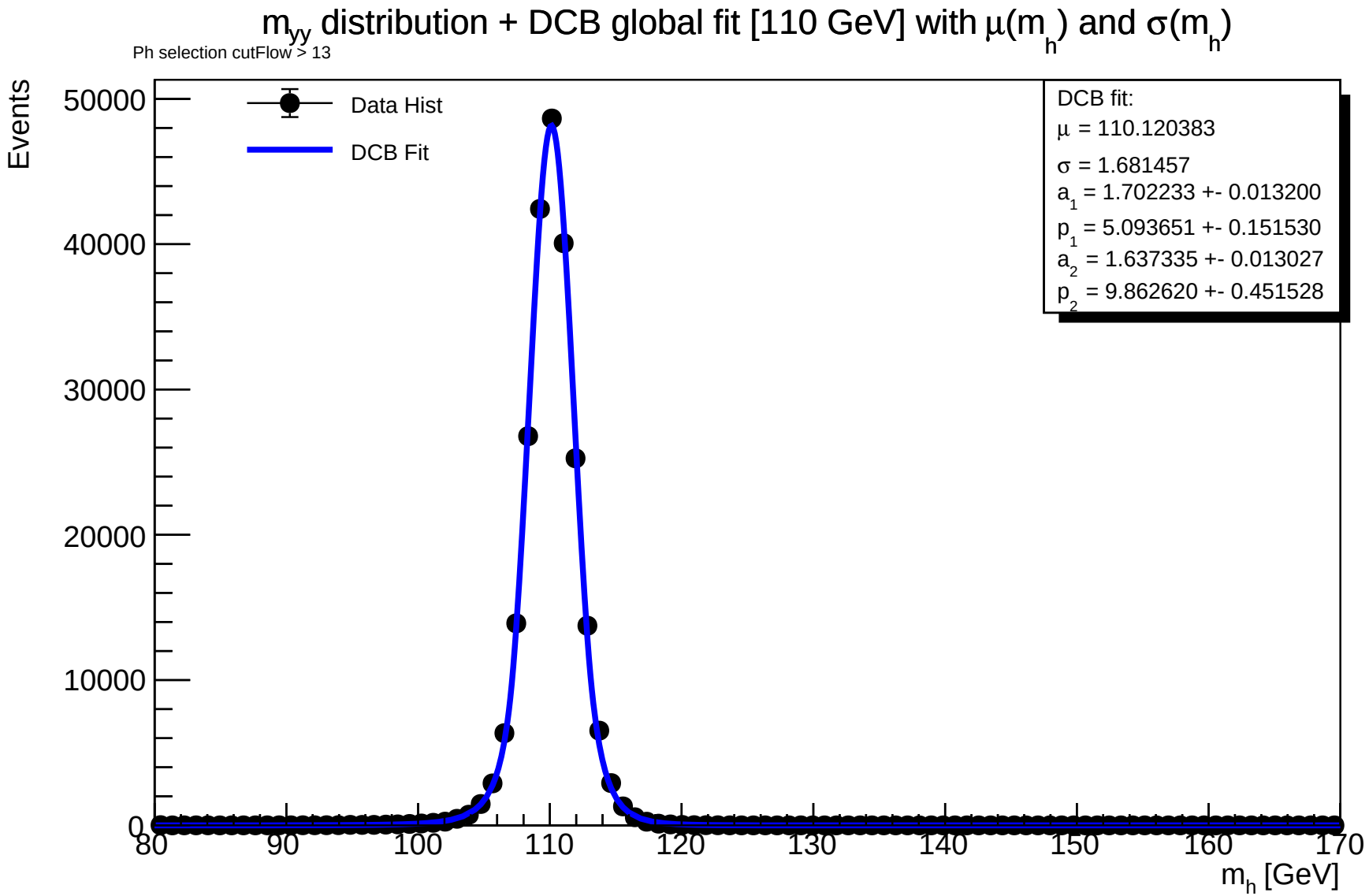
DSCB(m_h) with all params(m_h) [130 GeV]



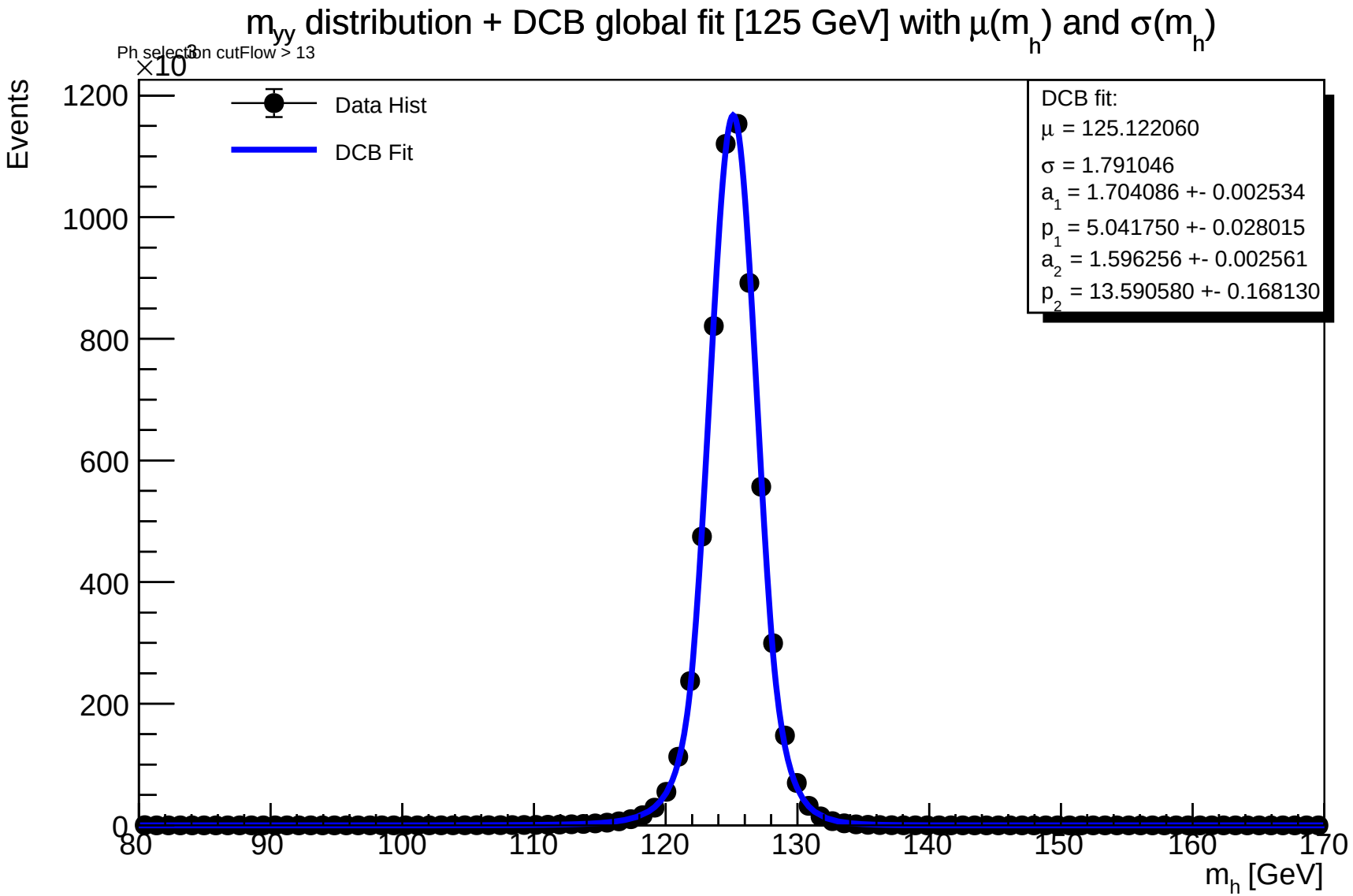
DSCB(m_h) with all params(m_h) [140 GeV]



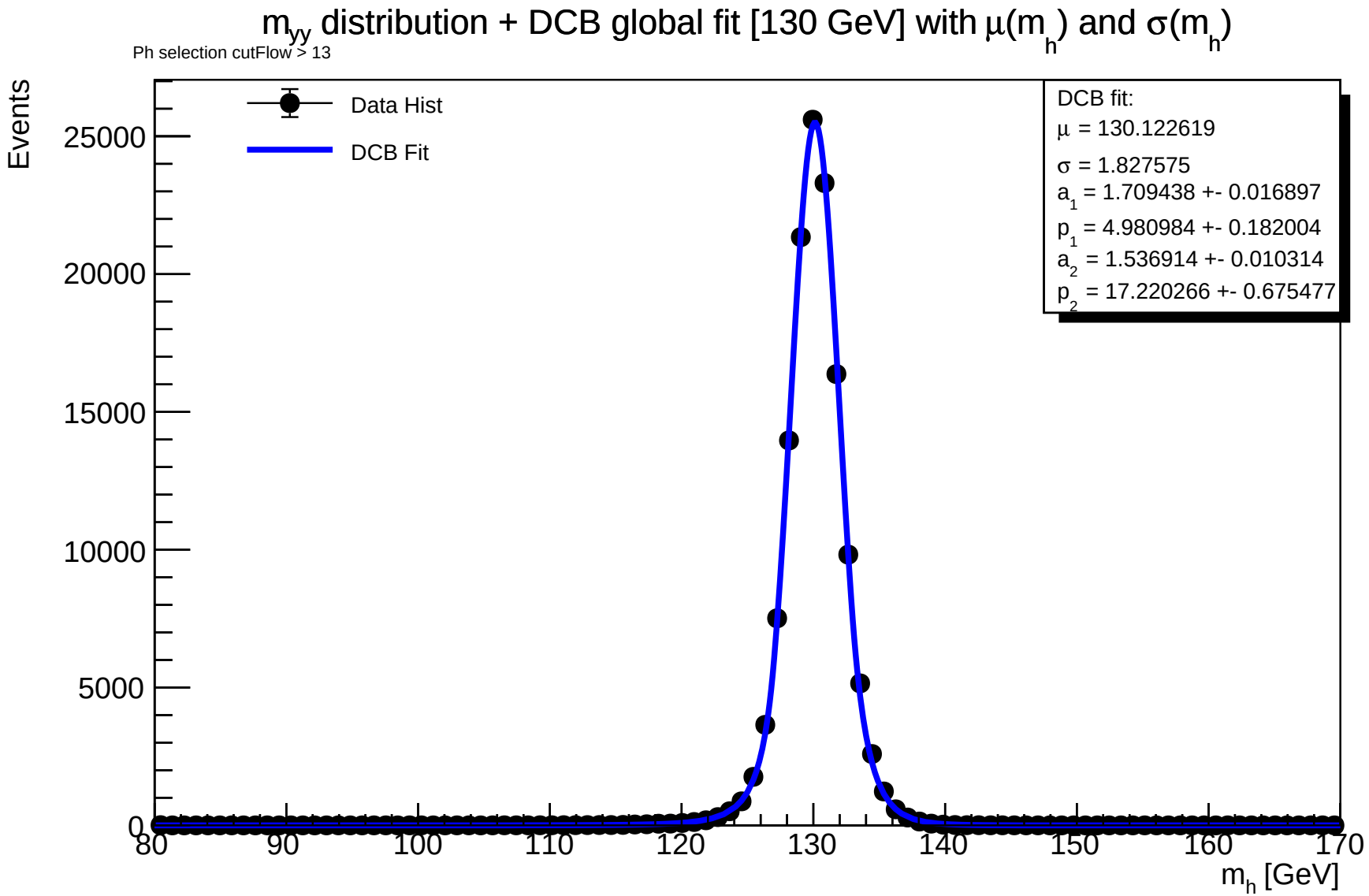
Global fit [110 GeV]



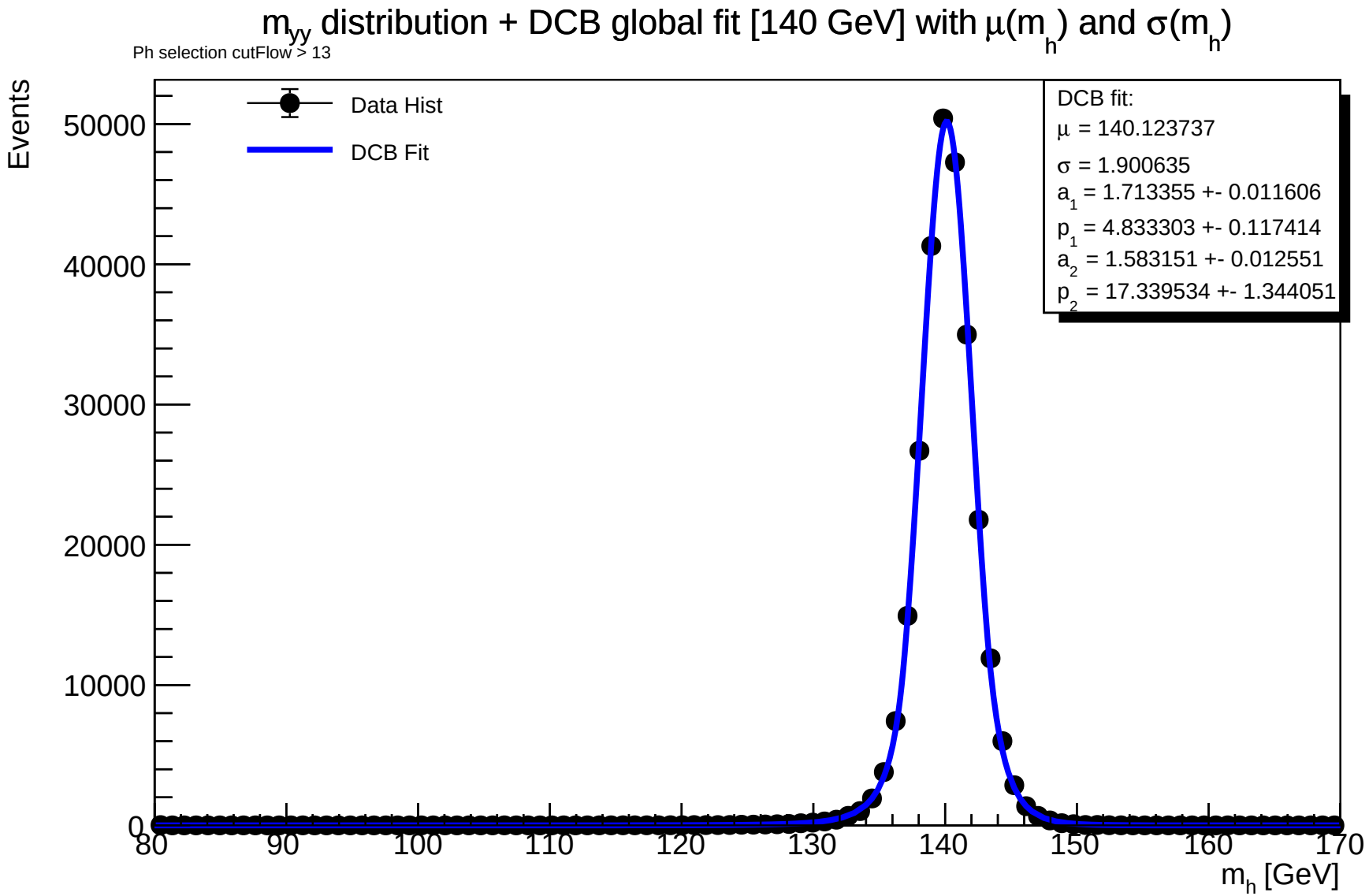
Global fit [125 GeV]



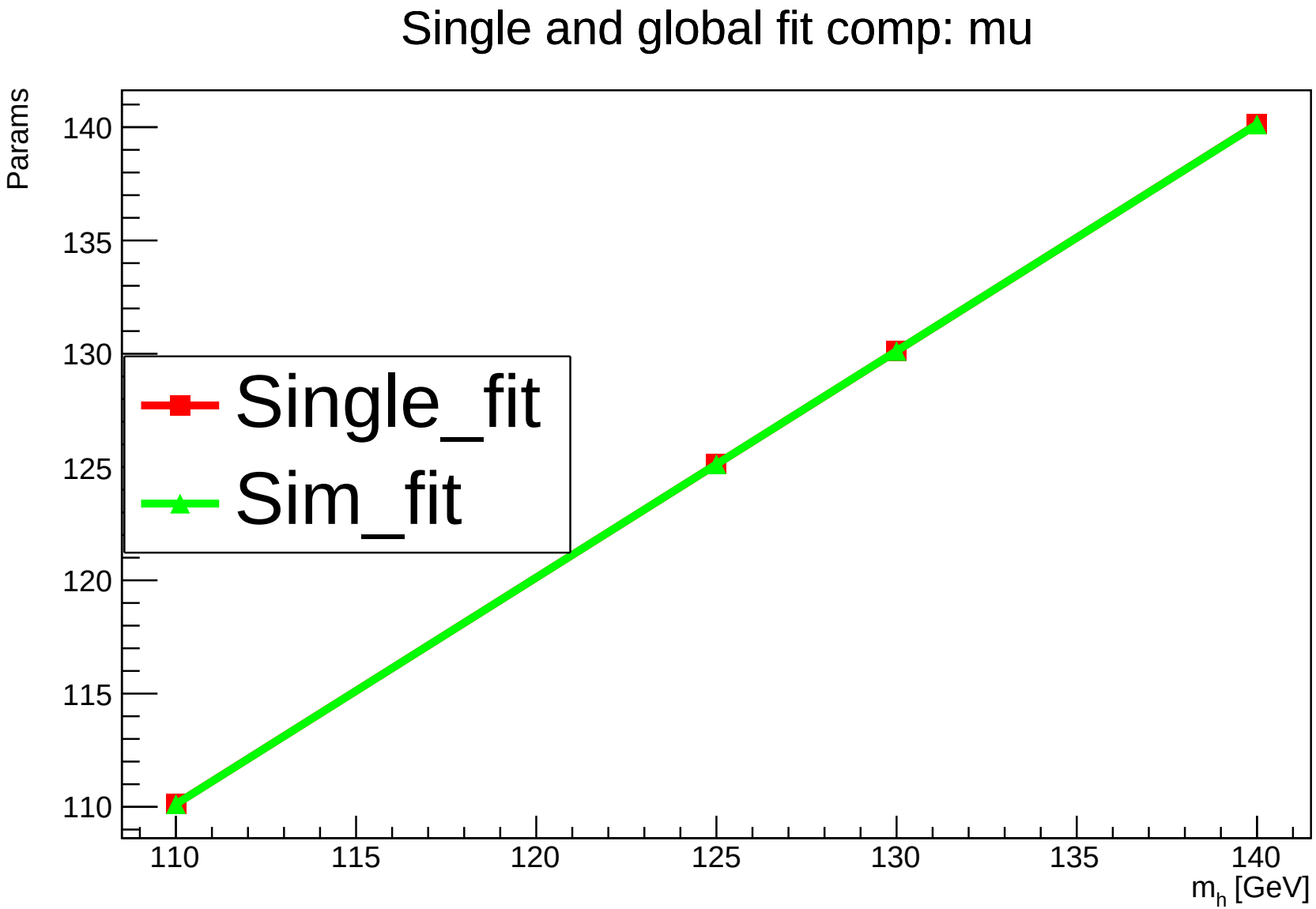
Global fit [130 GeV]



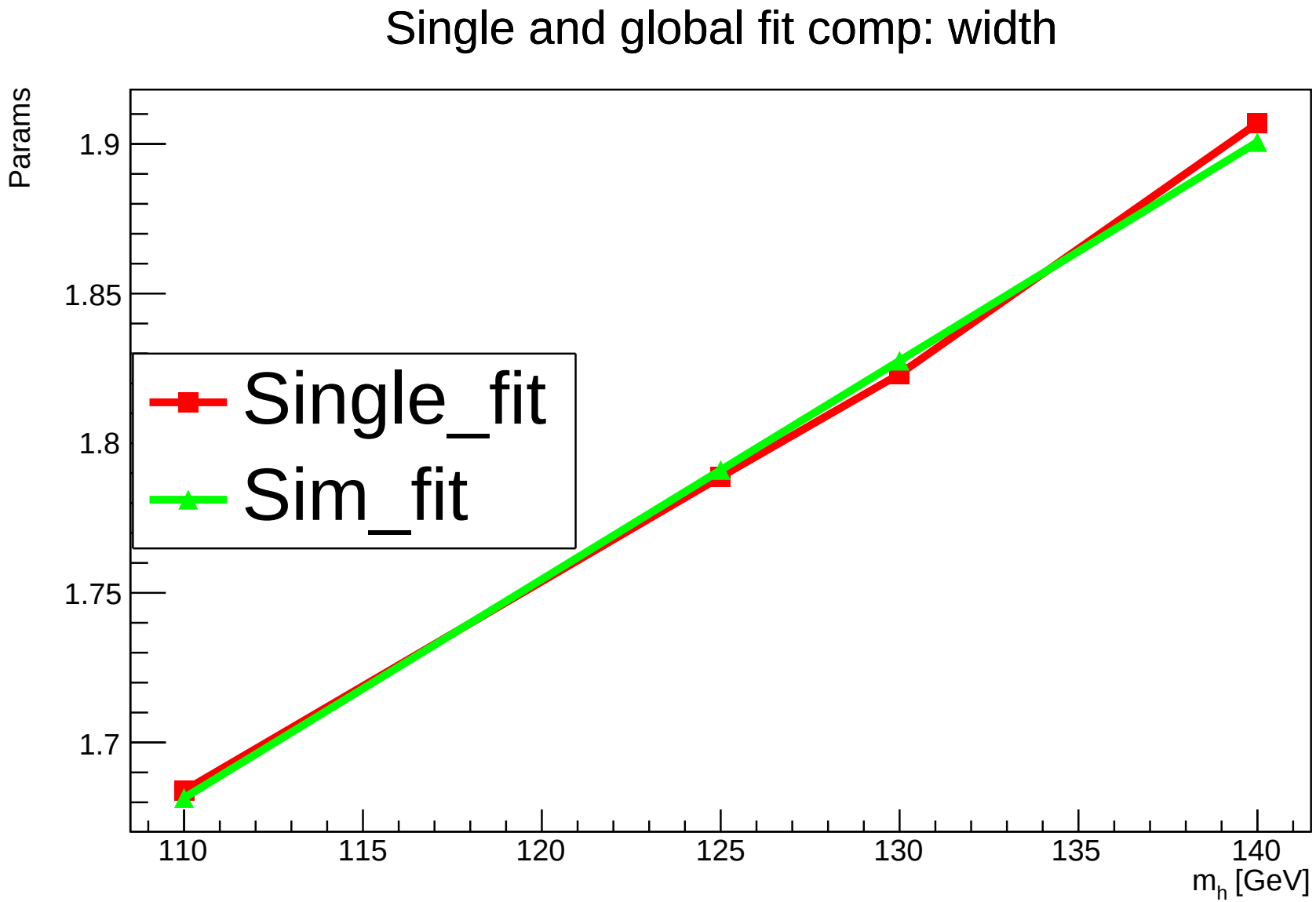
Global fit [140 GeV]



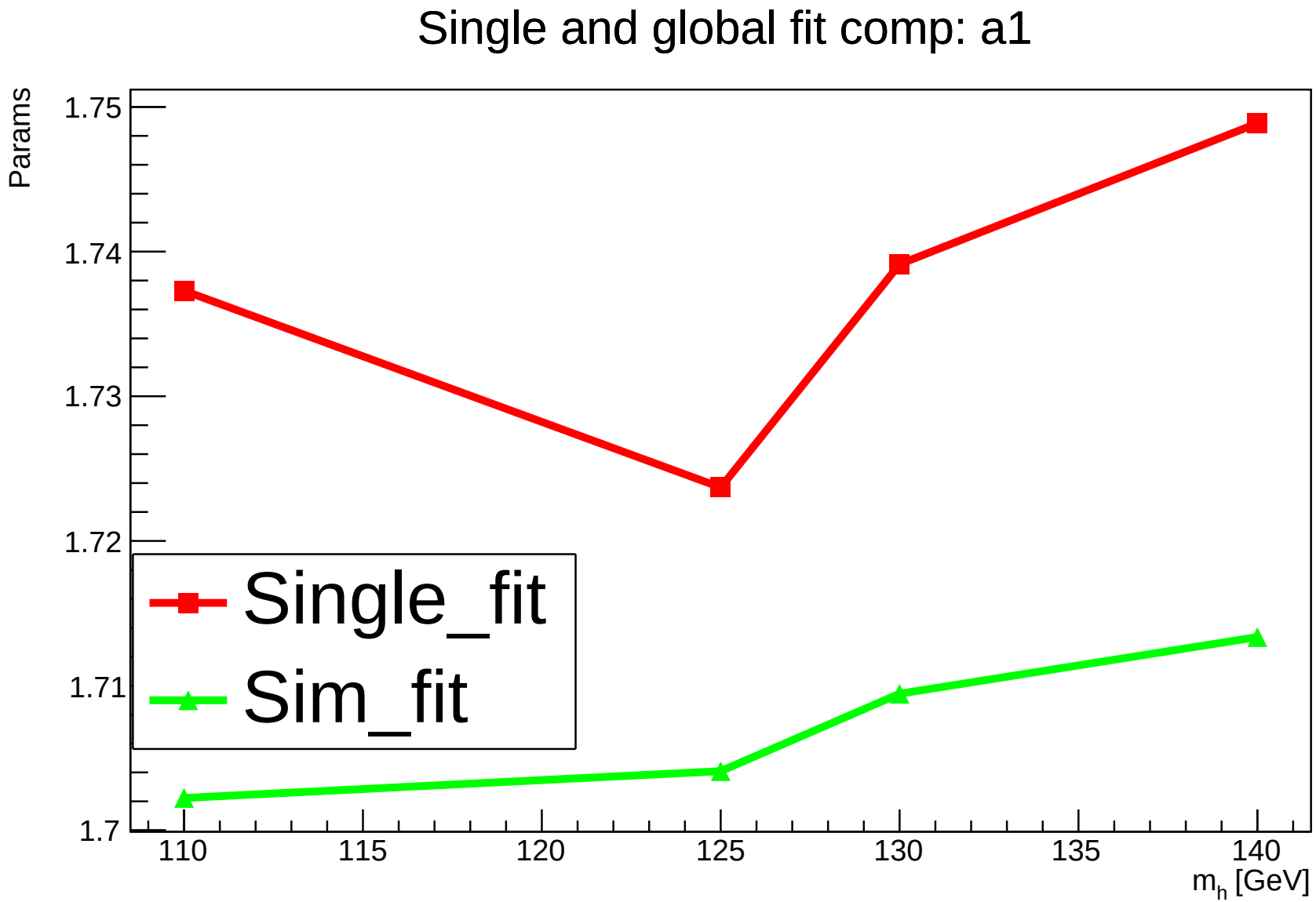
Single vs Global fit params: μ



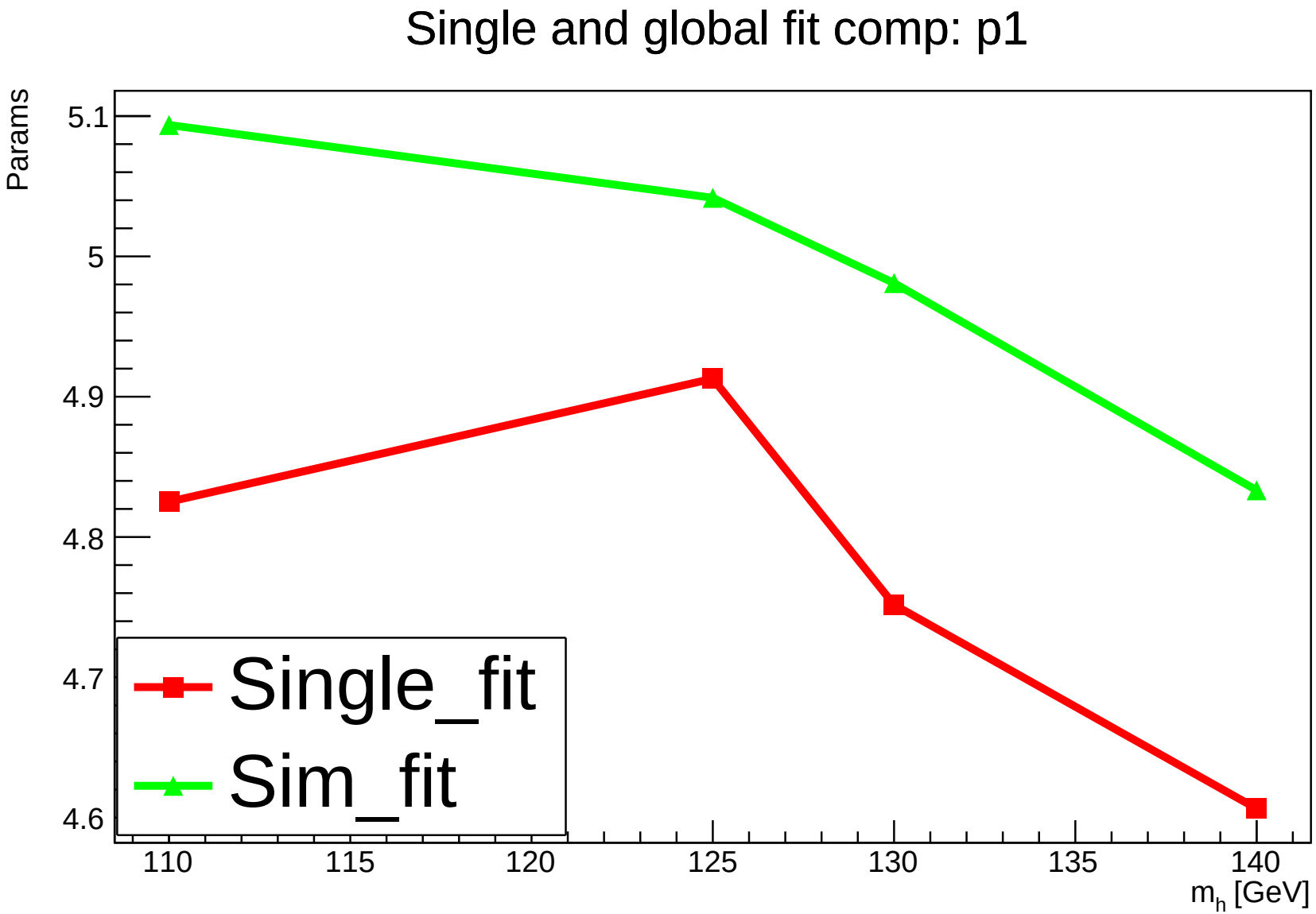
Single vs Global fit params: σ



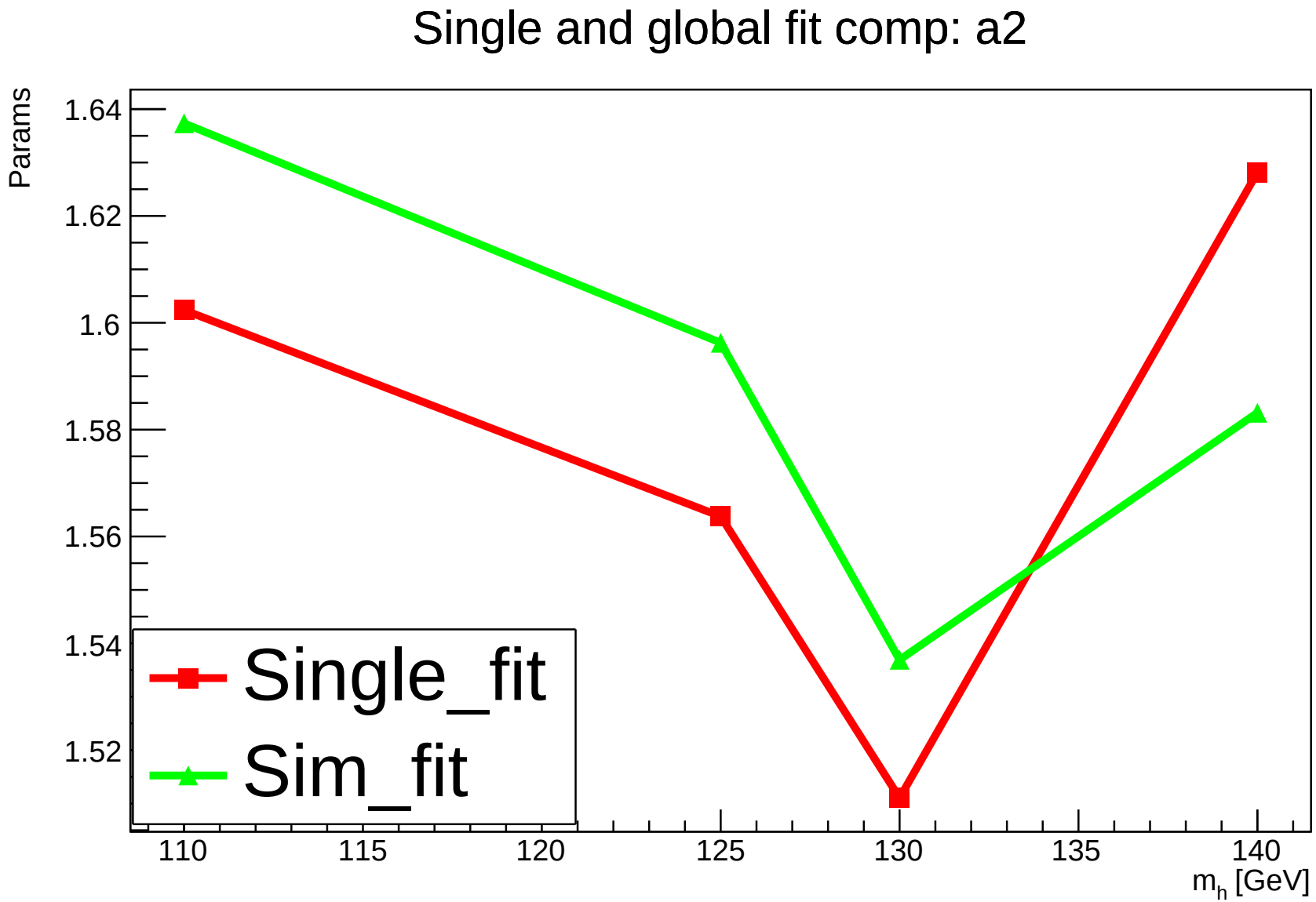
Single vs Global fit params: a_1



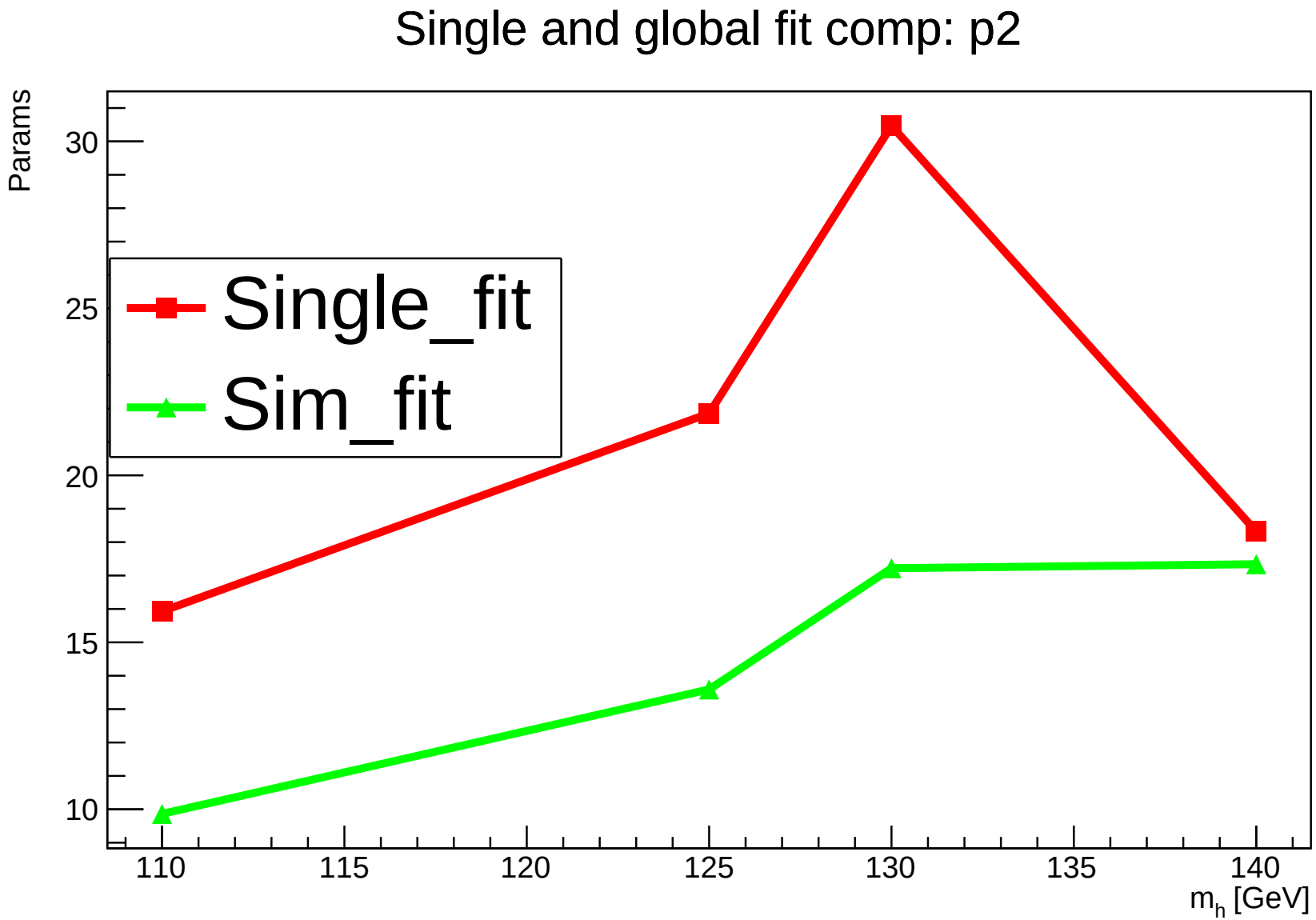
Single vs Global fit params: p_1



Single vs Global fit params: a_2

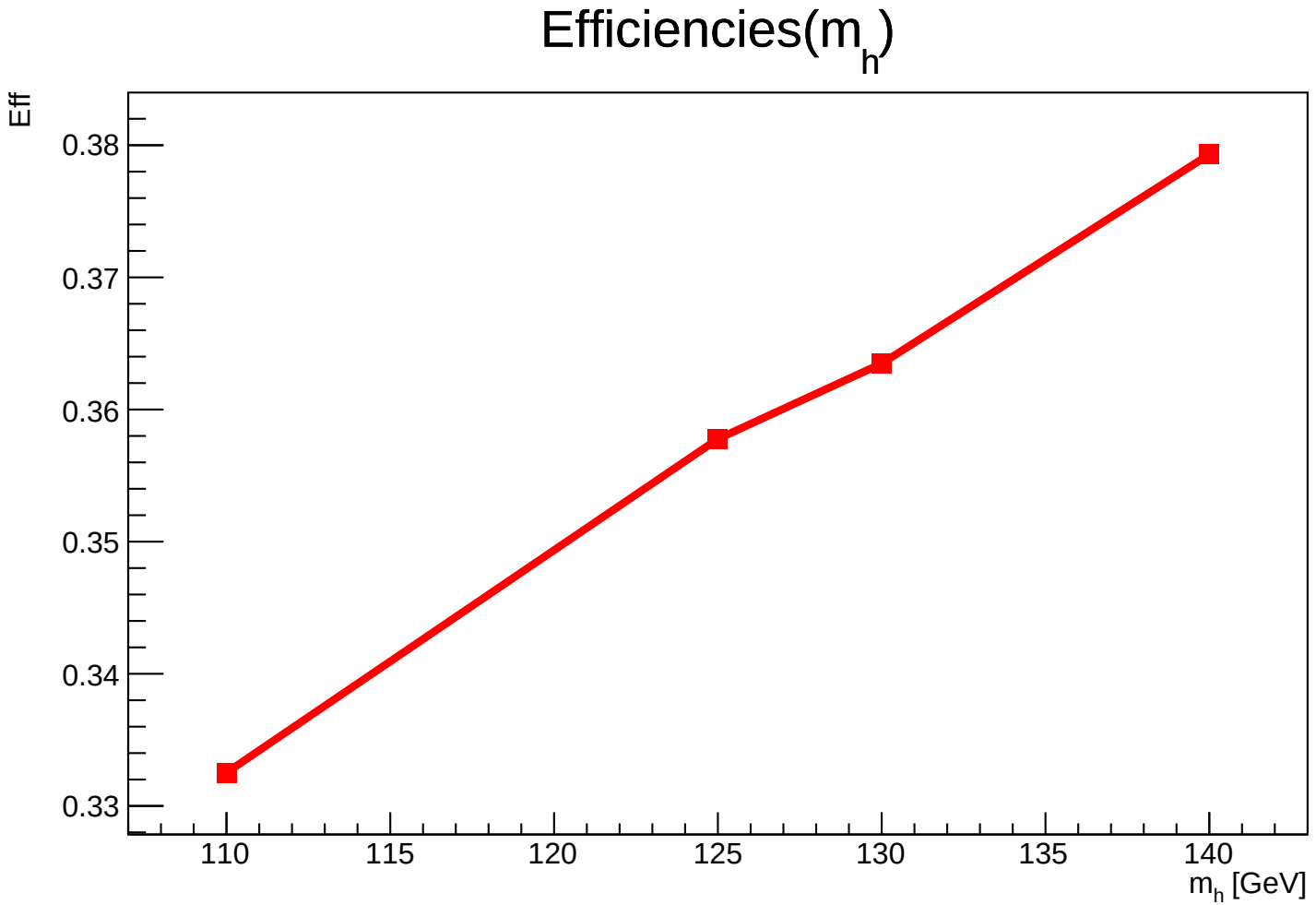


Single vs Global fit params: p_2



Efficiencies(m_h)

$$eff = \frac{\#\ of\ \ events\ \ with\ \ cutFlow>13}{\#\ \ of\ \ \ all\ \ \ events}$$

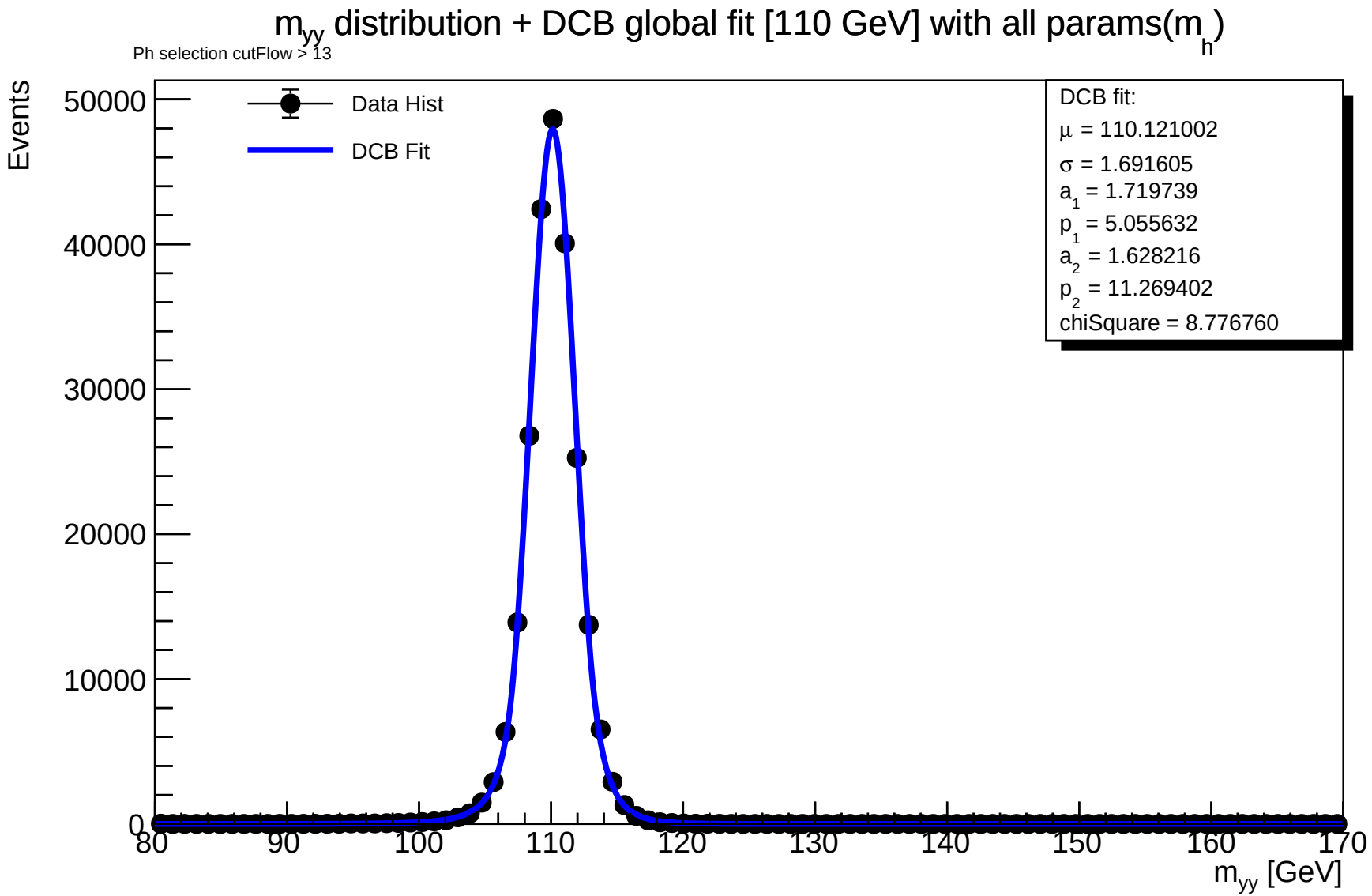


3° week

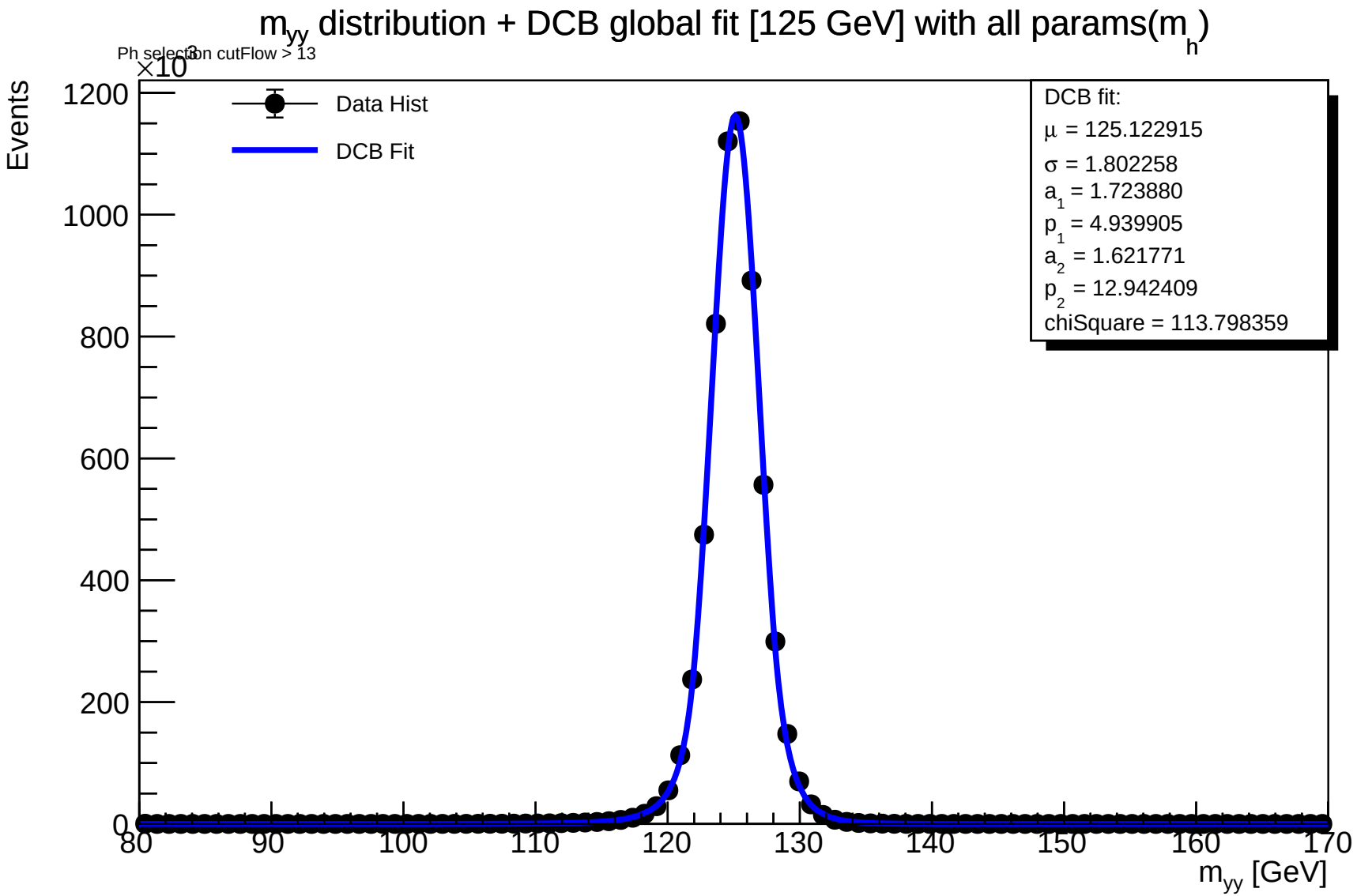
3° week assignments

- fix the X-axis:" m_{yy} $[GeV]$" to "m_h $[GeV]$";
- create a fit with all parameters as function of m_H;
- fit without a dataset:
  - the fit is build using 110, 130, 140 GeV datasets;
  - once the is created, it is applied to the 125 dataset.
- add errors bars;
- background MC:
  - plot the mass distribution;
  - apply a exp fit.
- build a p_0 scan on MC;

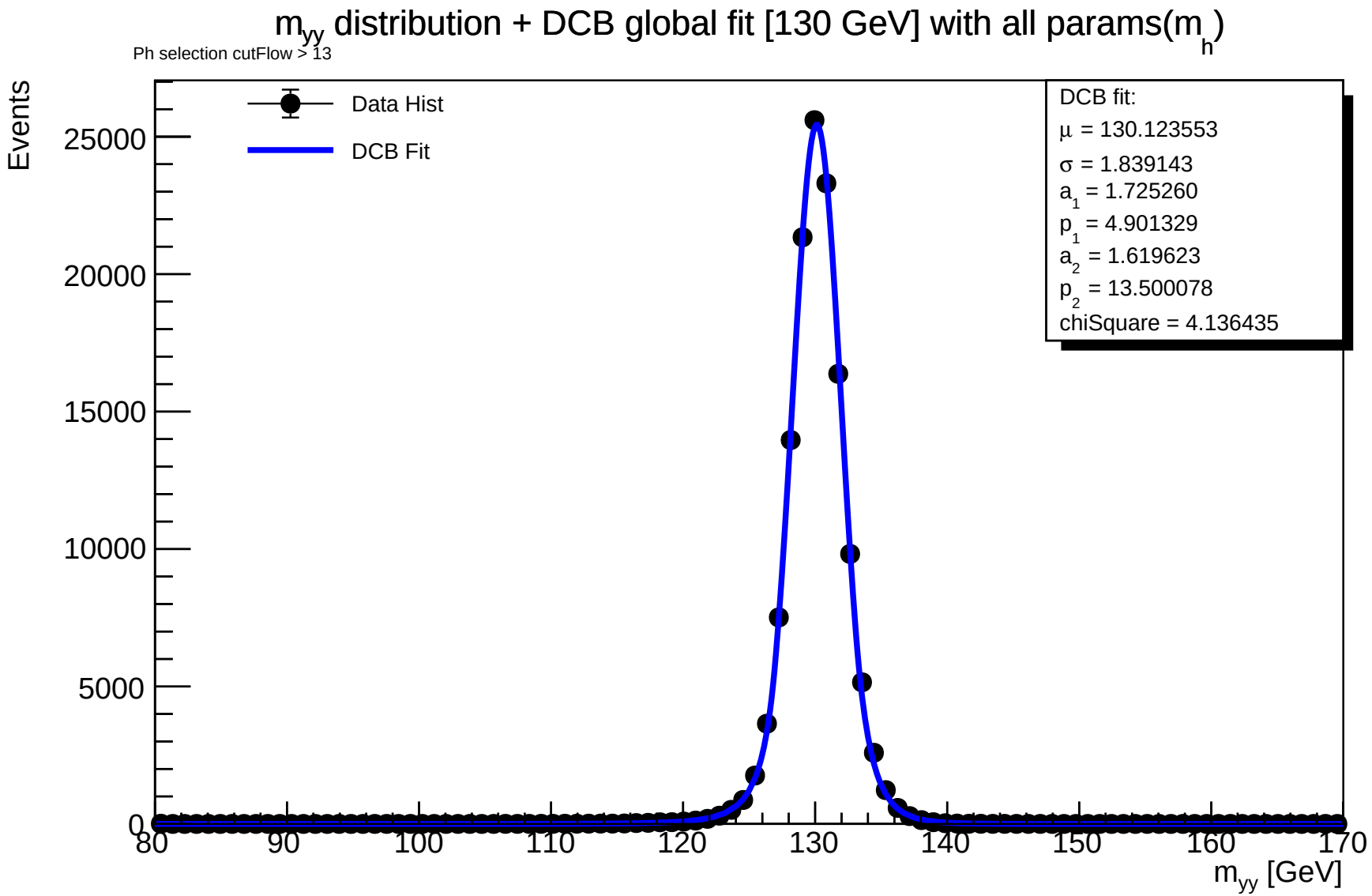
Global fit all params(m_H) [110 GeV]



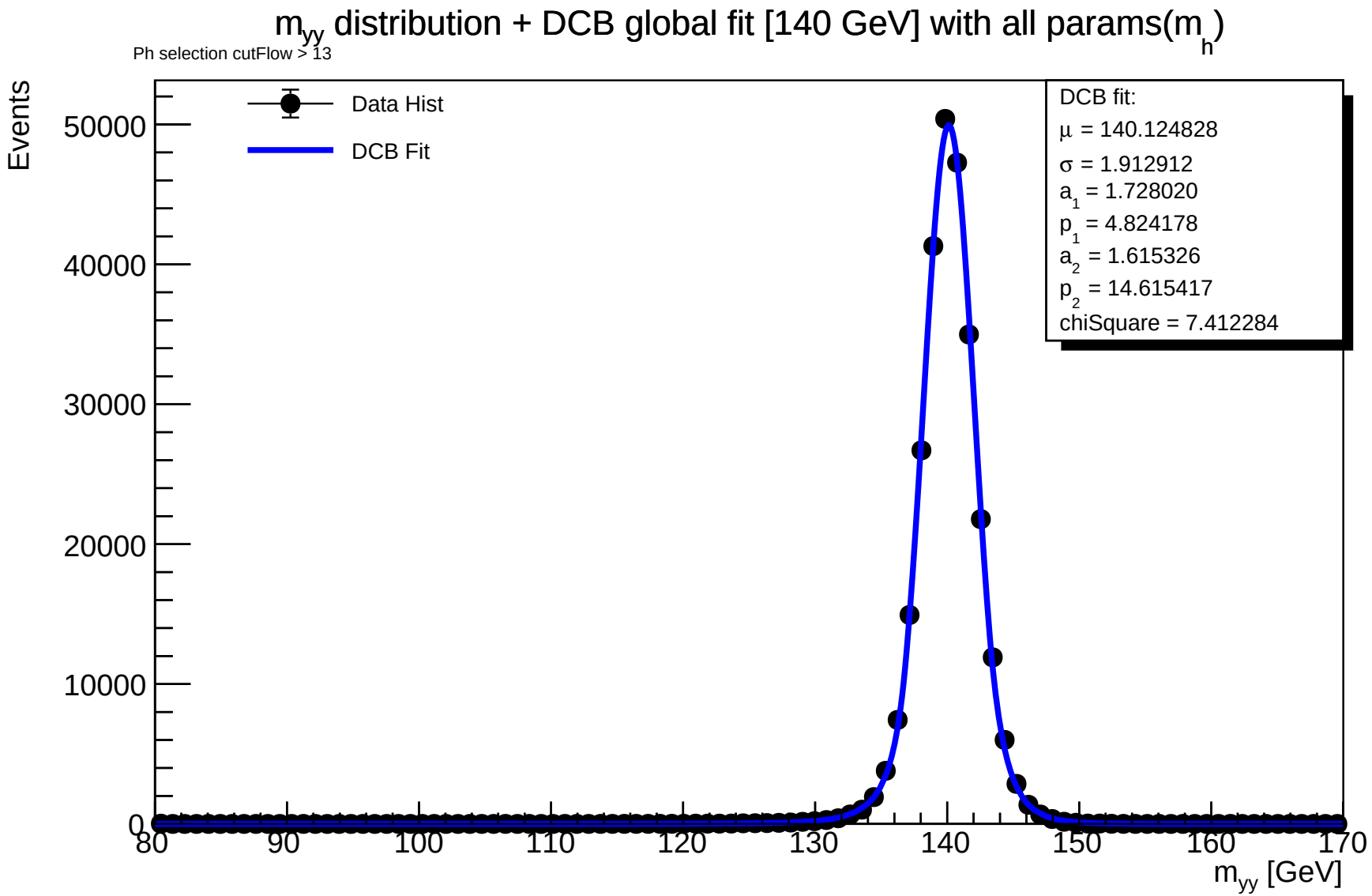
Global fit all params(m_H) [125 GeV]



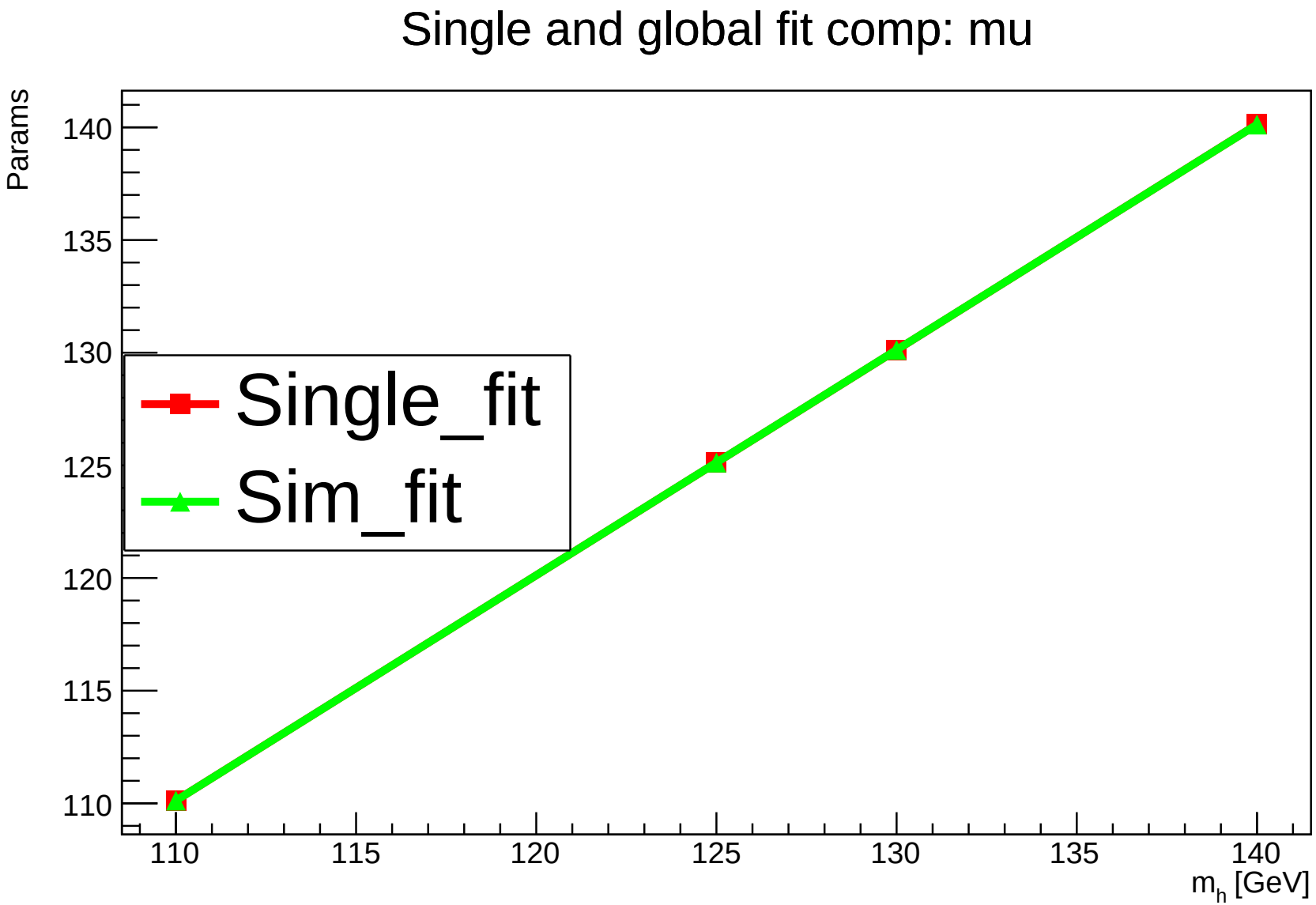
Global fit all params(m_H) [130 GeV]



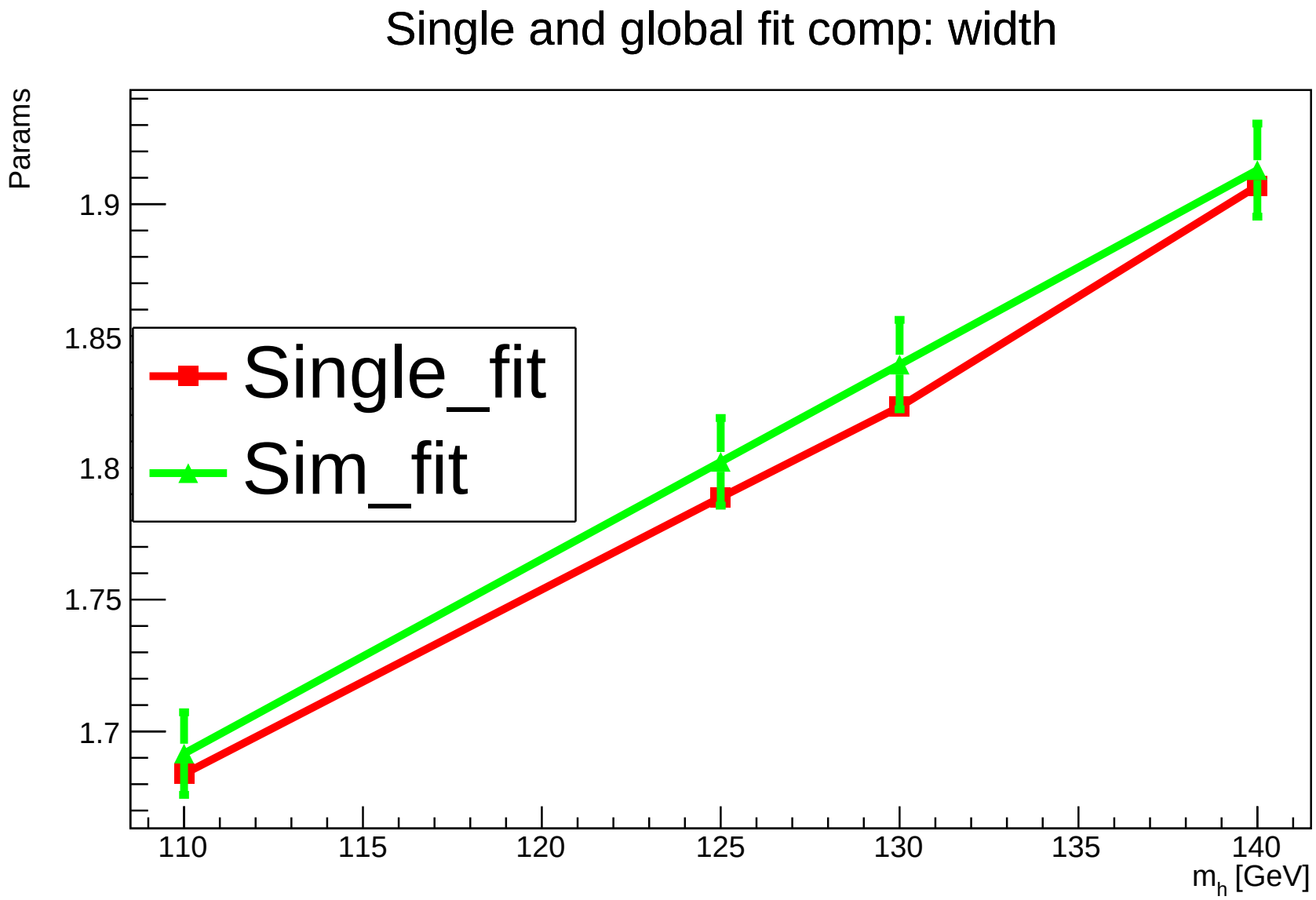
Global fit all params(m_H) [140 GeV]



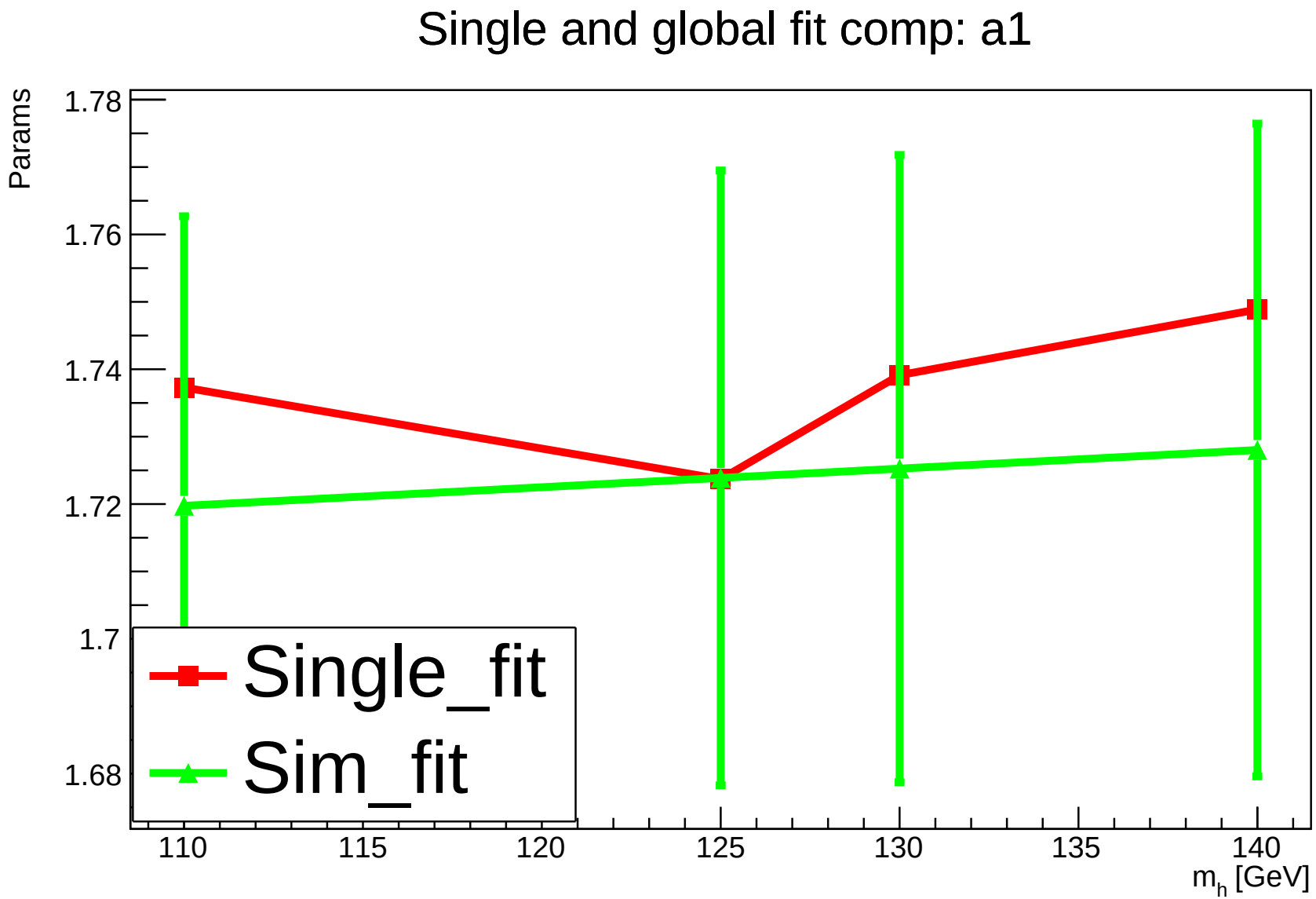
Single vs Global fit params: $\mu(m_h)$



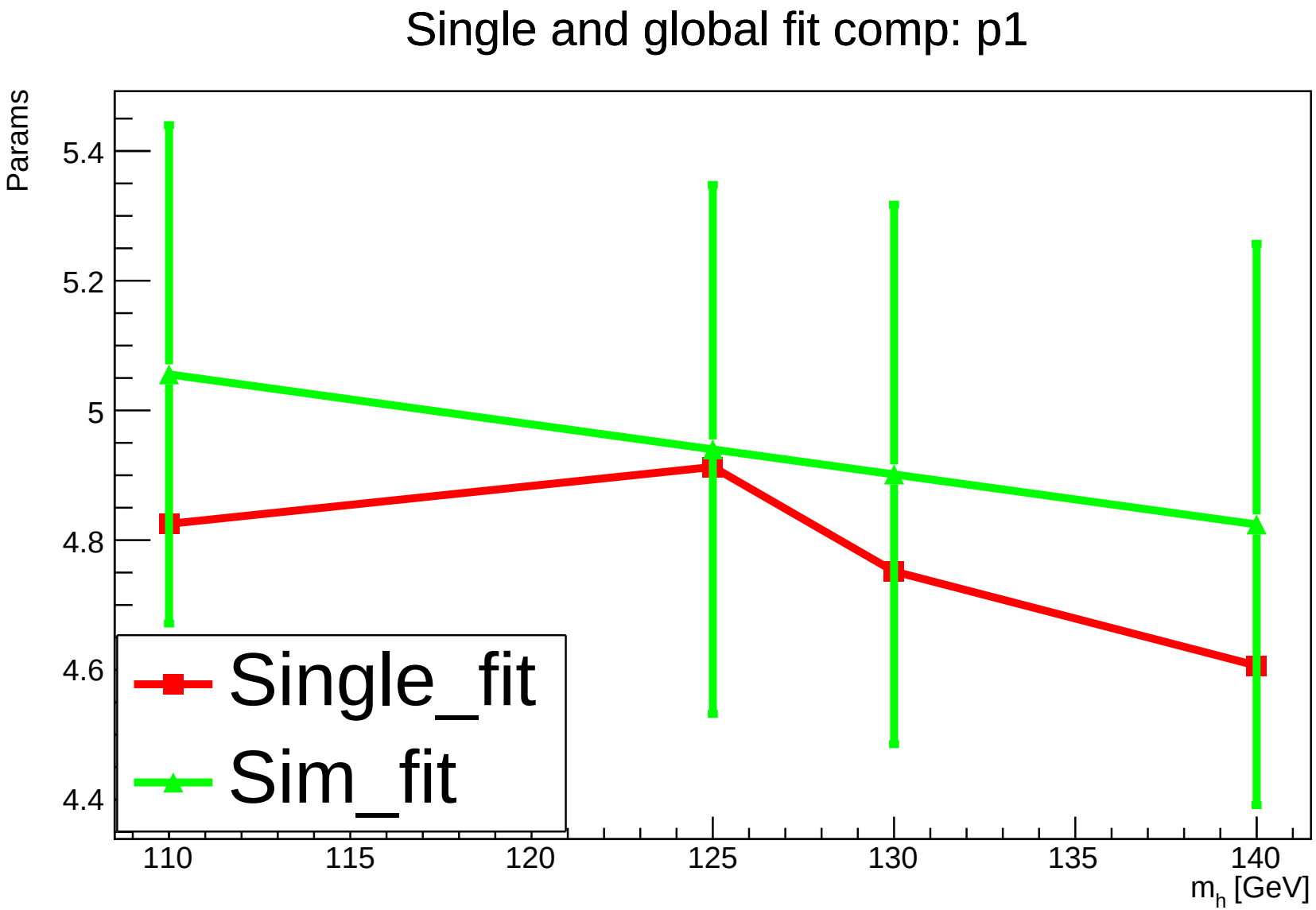
Single vs Global fit params: $\sigma(m_h)$



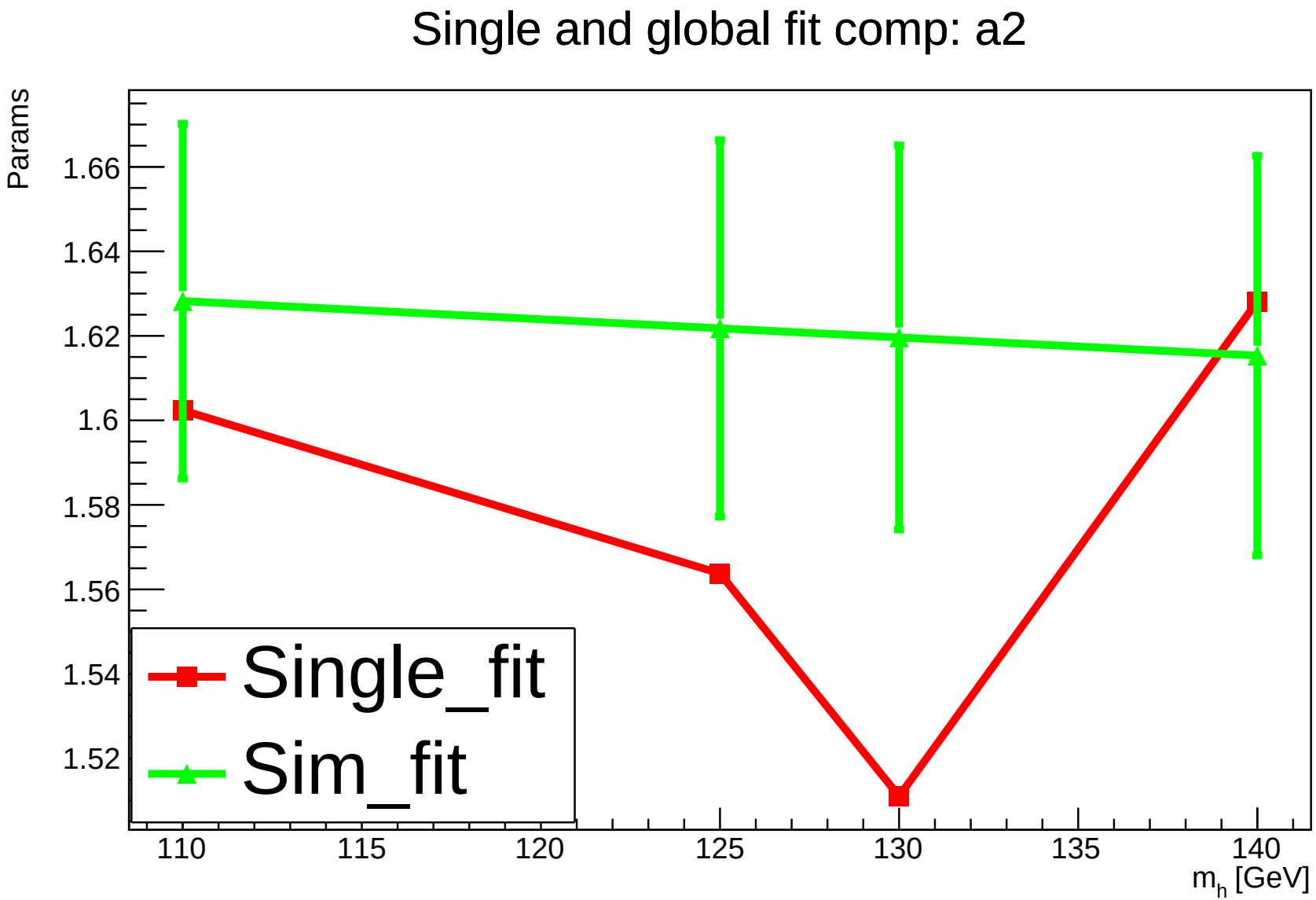
Single vs Global fit params: $a_1(m_h)$



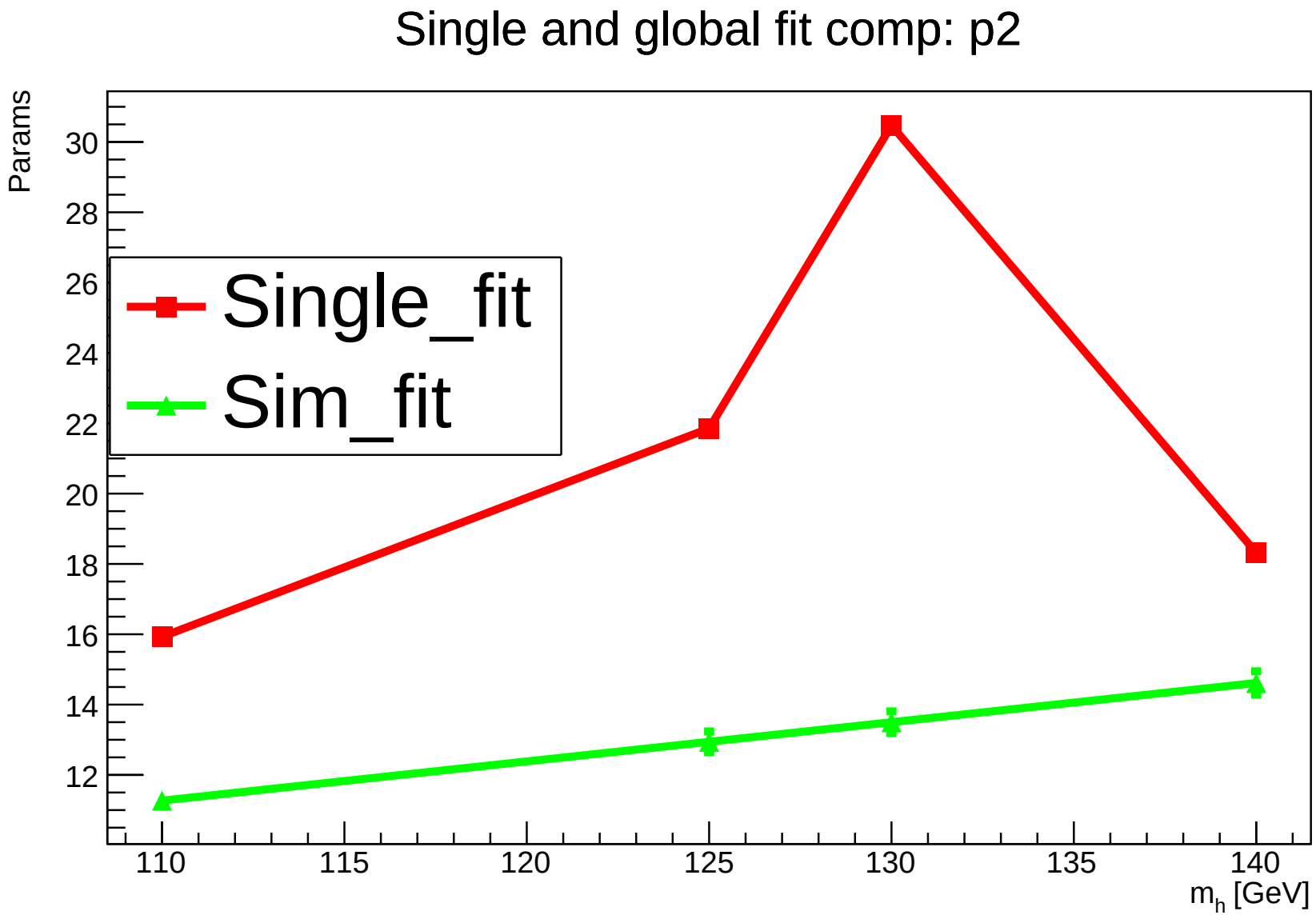
Single vs Global fit params: $p_1(m_h)$



Single vs Global fit params: $a_2(m_h)$

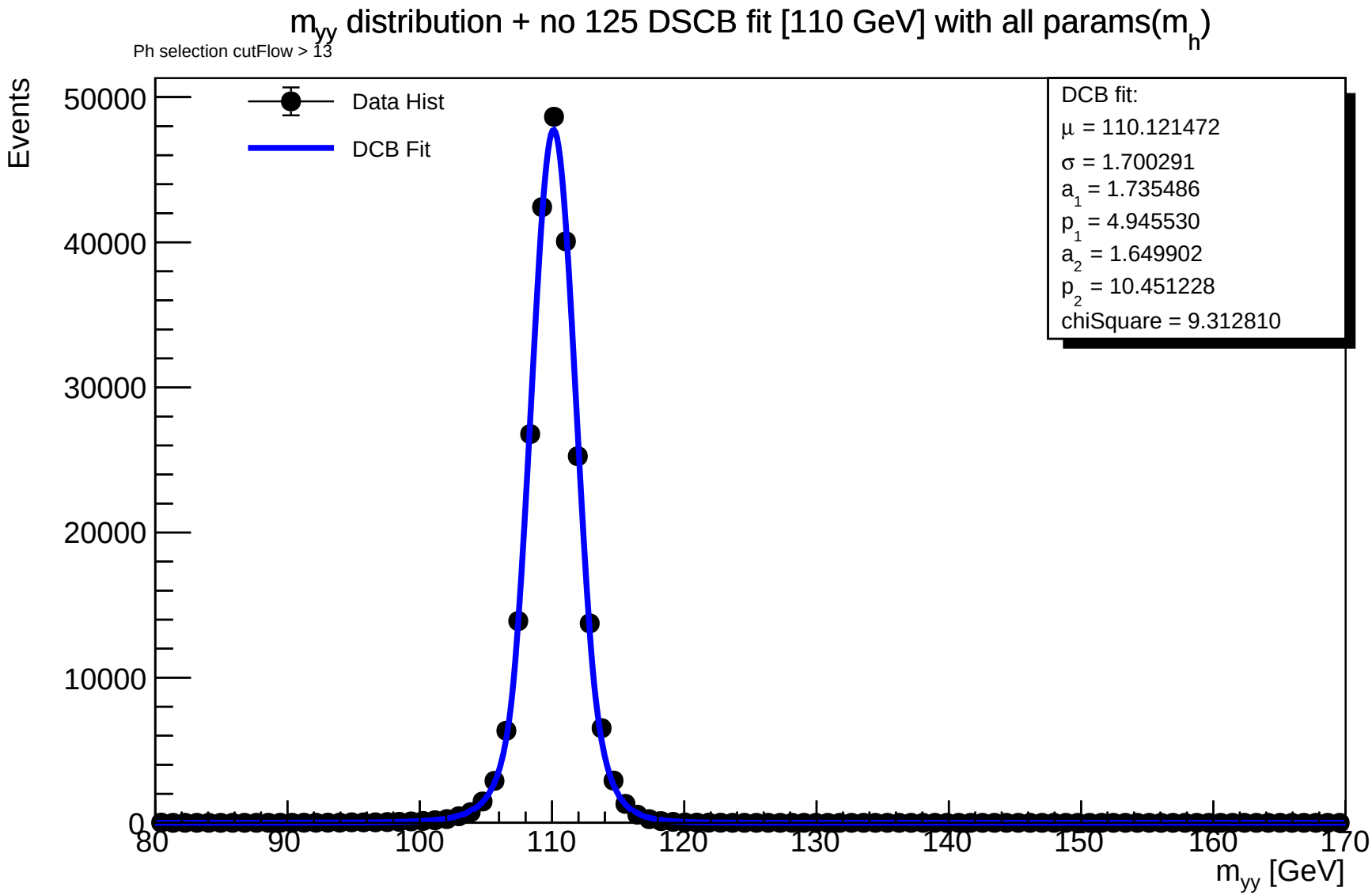


Single vs Global fit params: $p_2(m_h)$

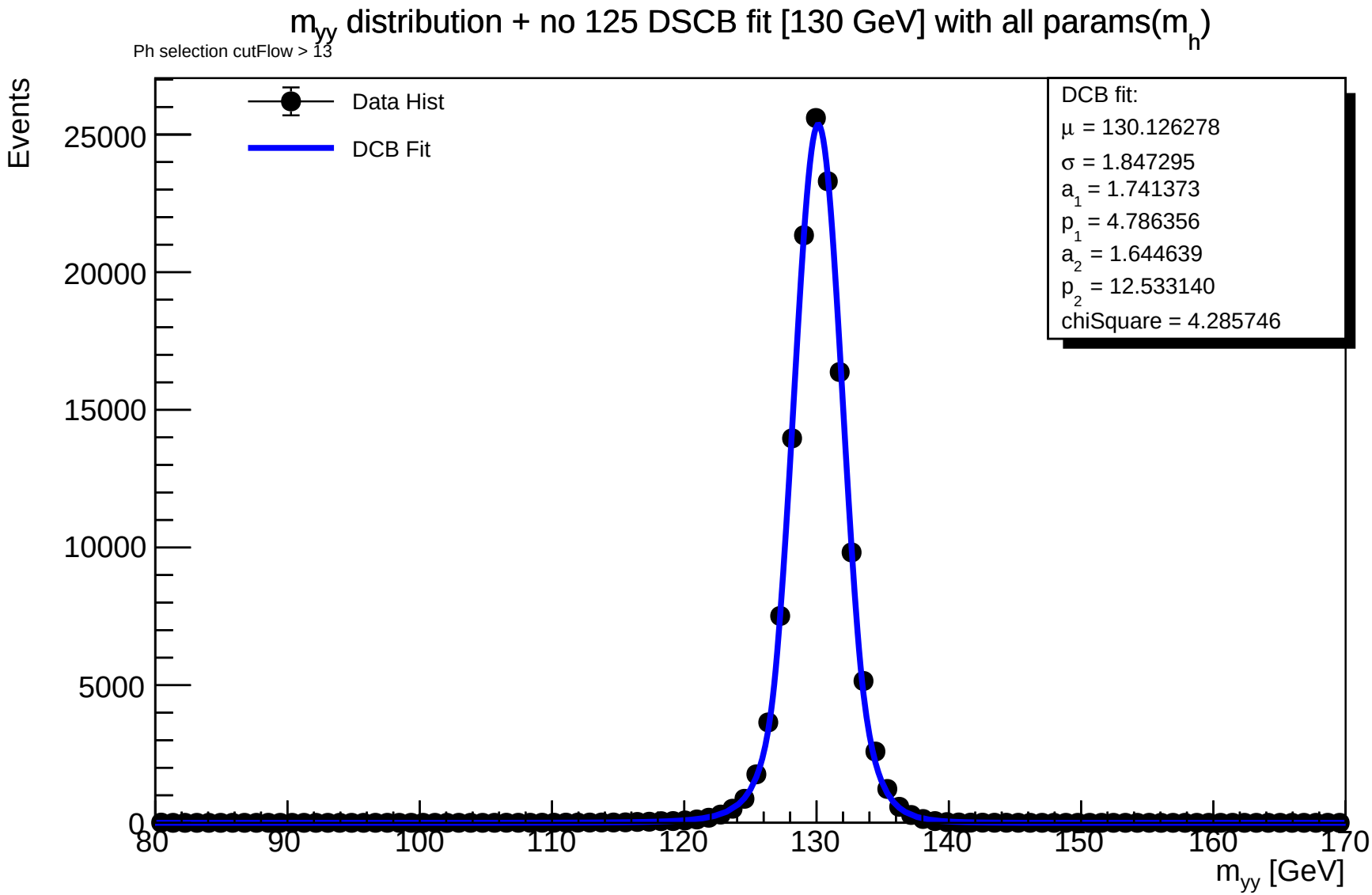


/Code

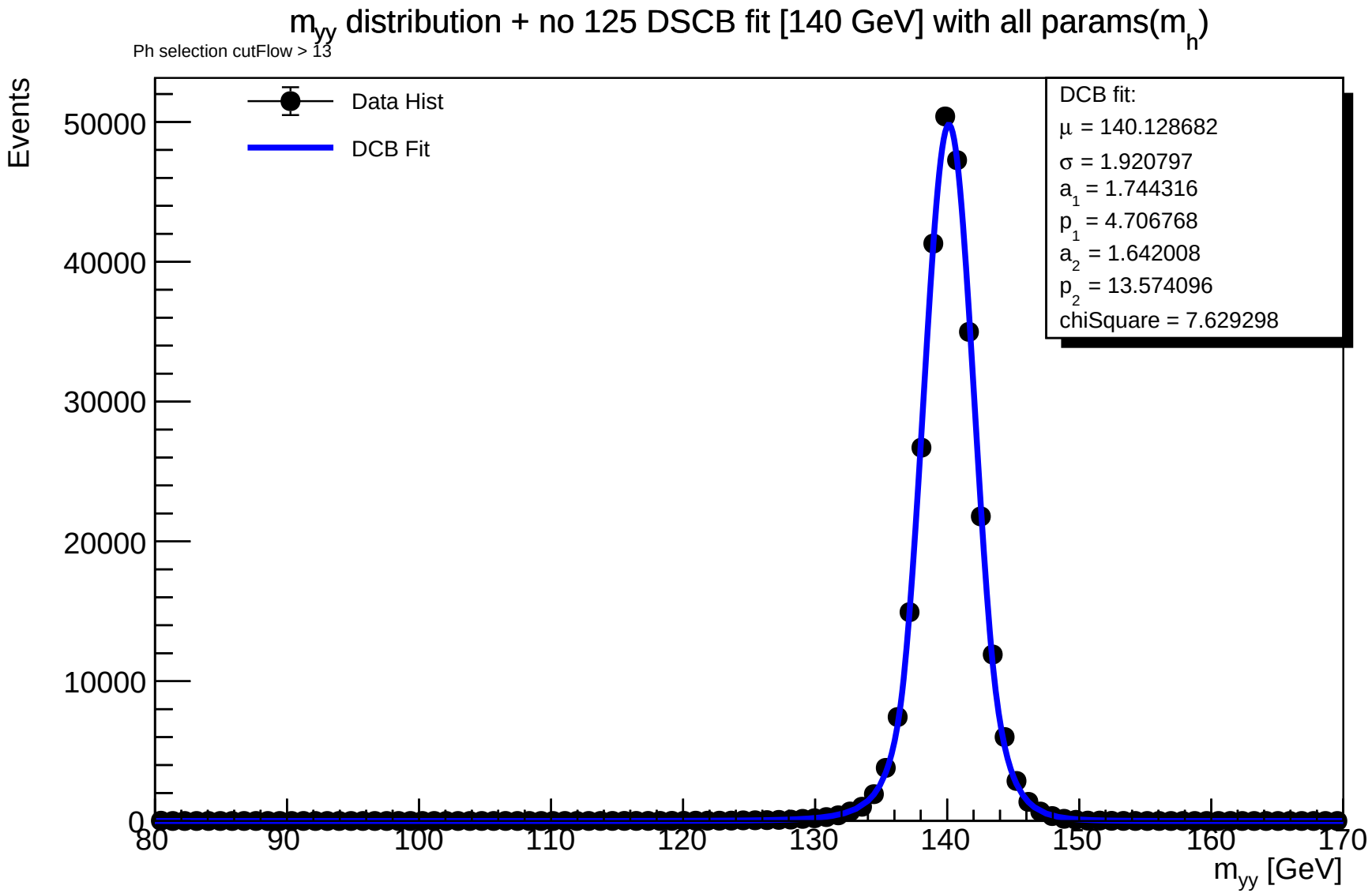
Global fit(m_H) (no 125) [110 GeV]



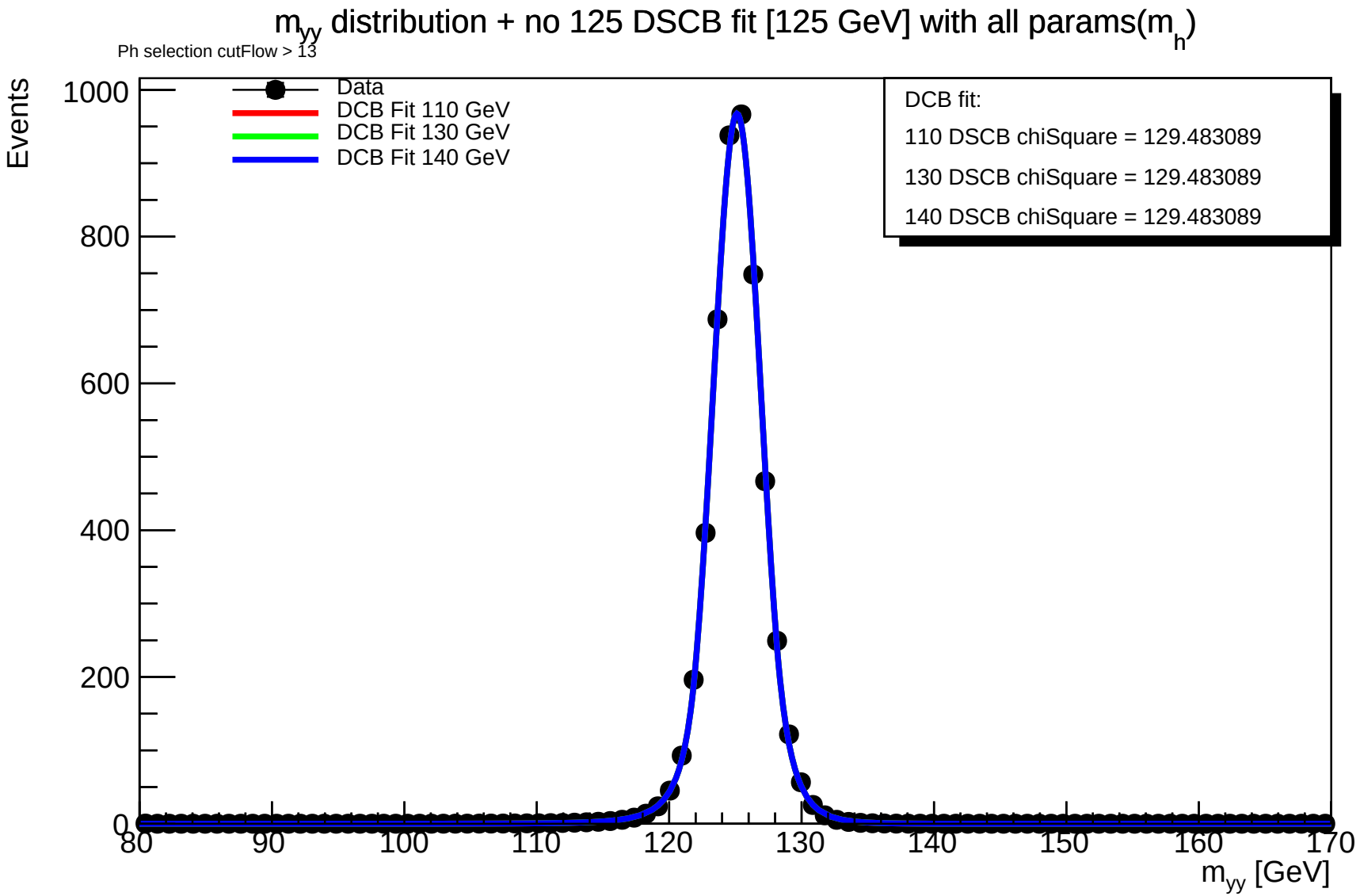
Global fit(m_H) (no 125) [130 GeV]



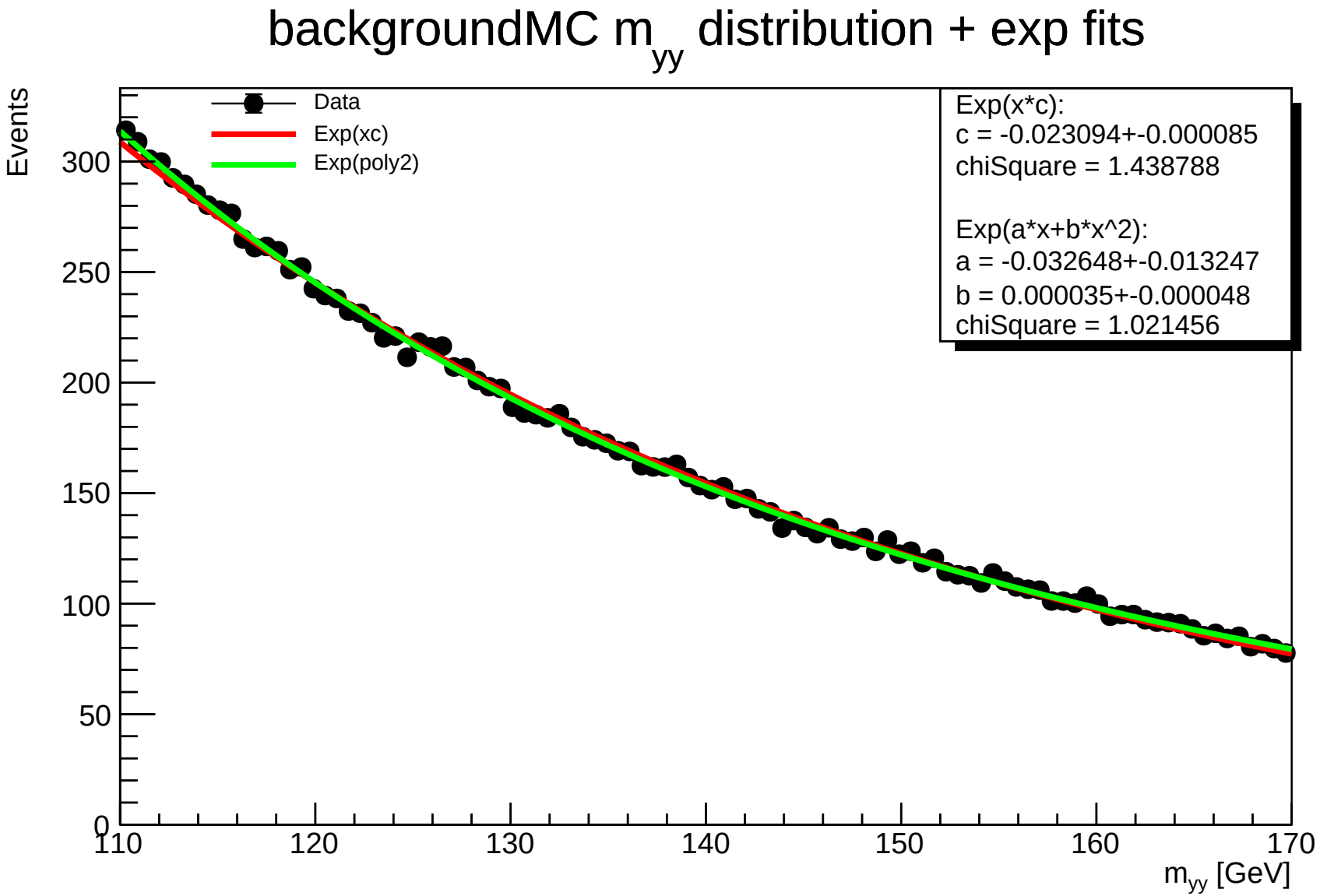
Global fit(m_H) (no 125) [140 GeV]



Fit without 125 GeV dataset

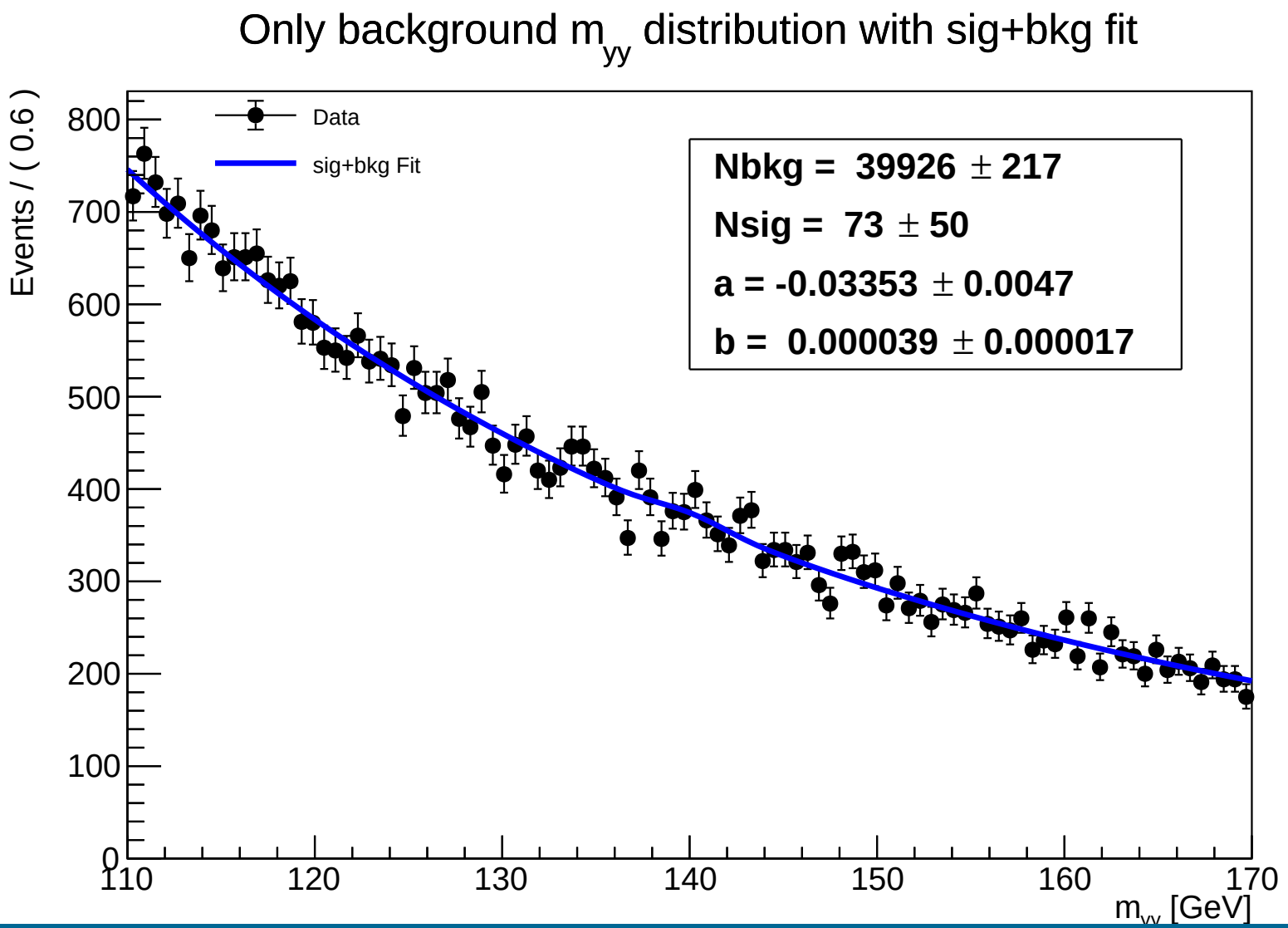


Background MC



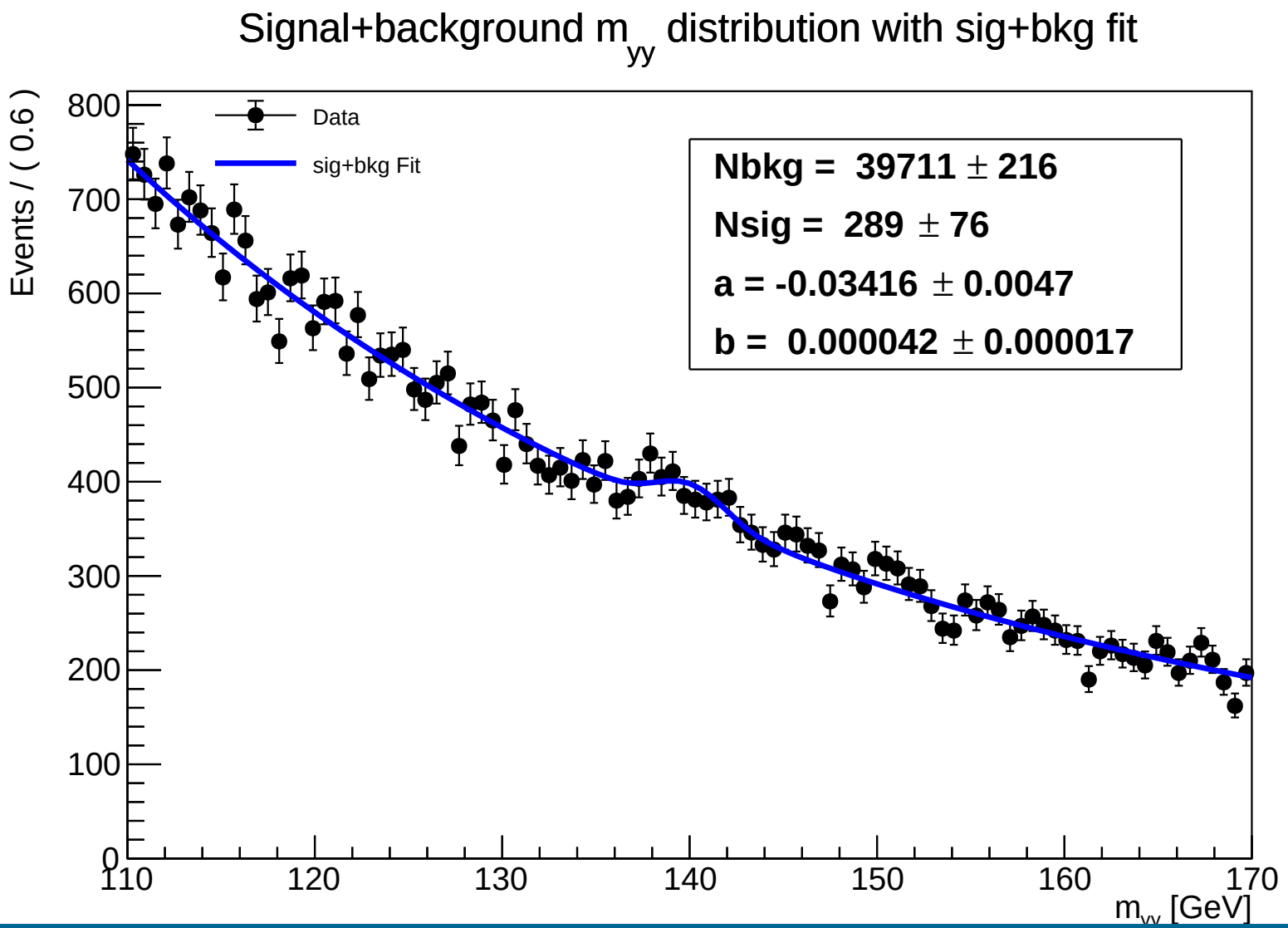
Only background workspace

Simultaneous fit composed by 4 DSCB (signal) + exp fit (background). Only background dataset.



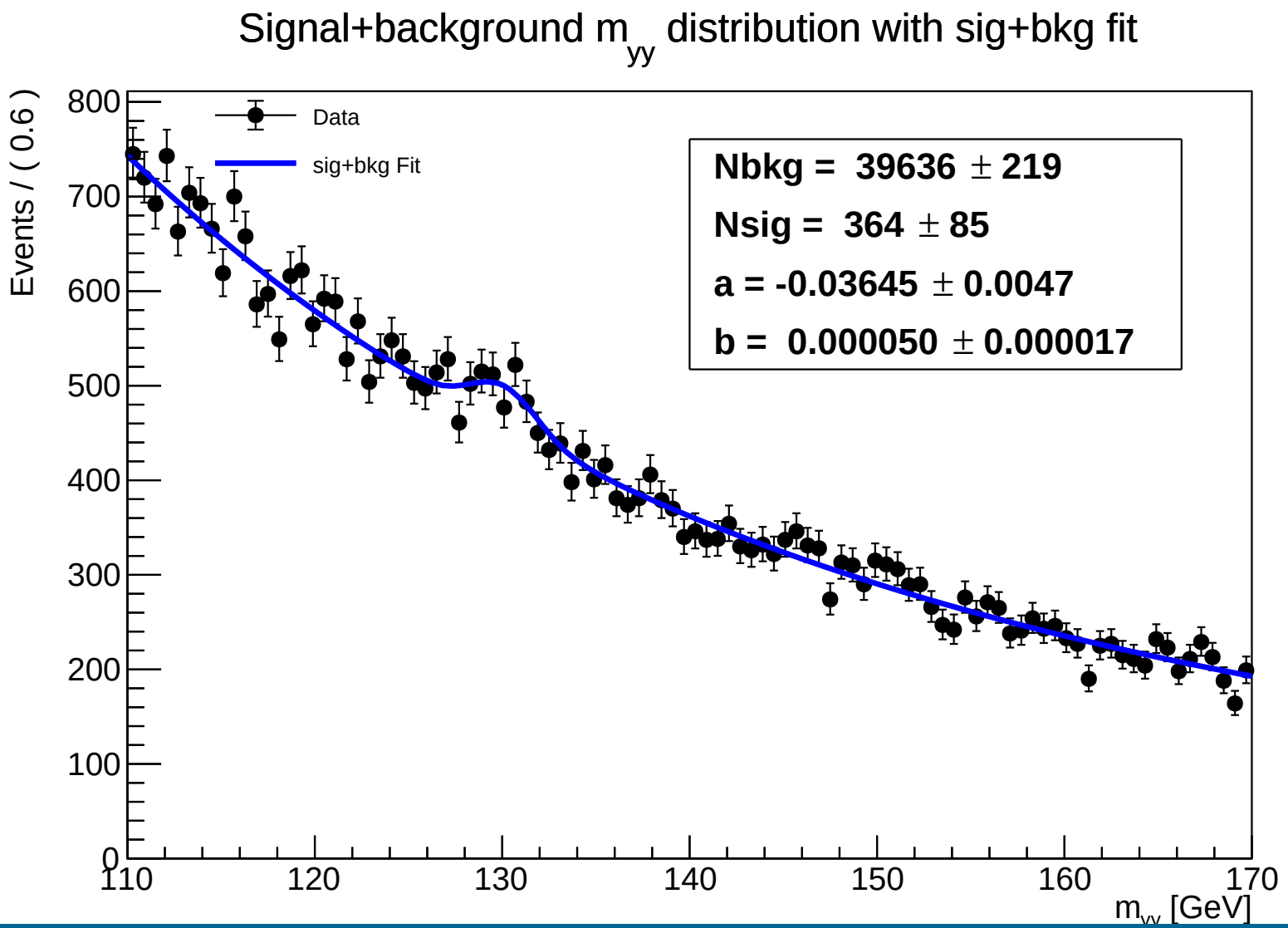
Signal+background workspace [140 GeV]

Simultaneous fit composed by 4 DSCB (signal) + exp fit (background).
Signal+background dataset.



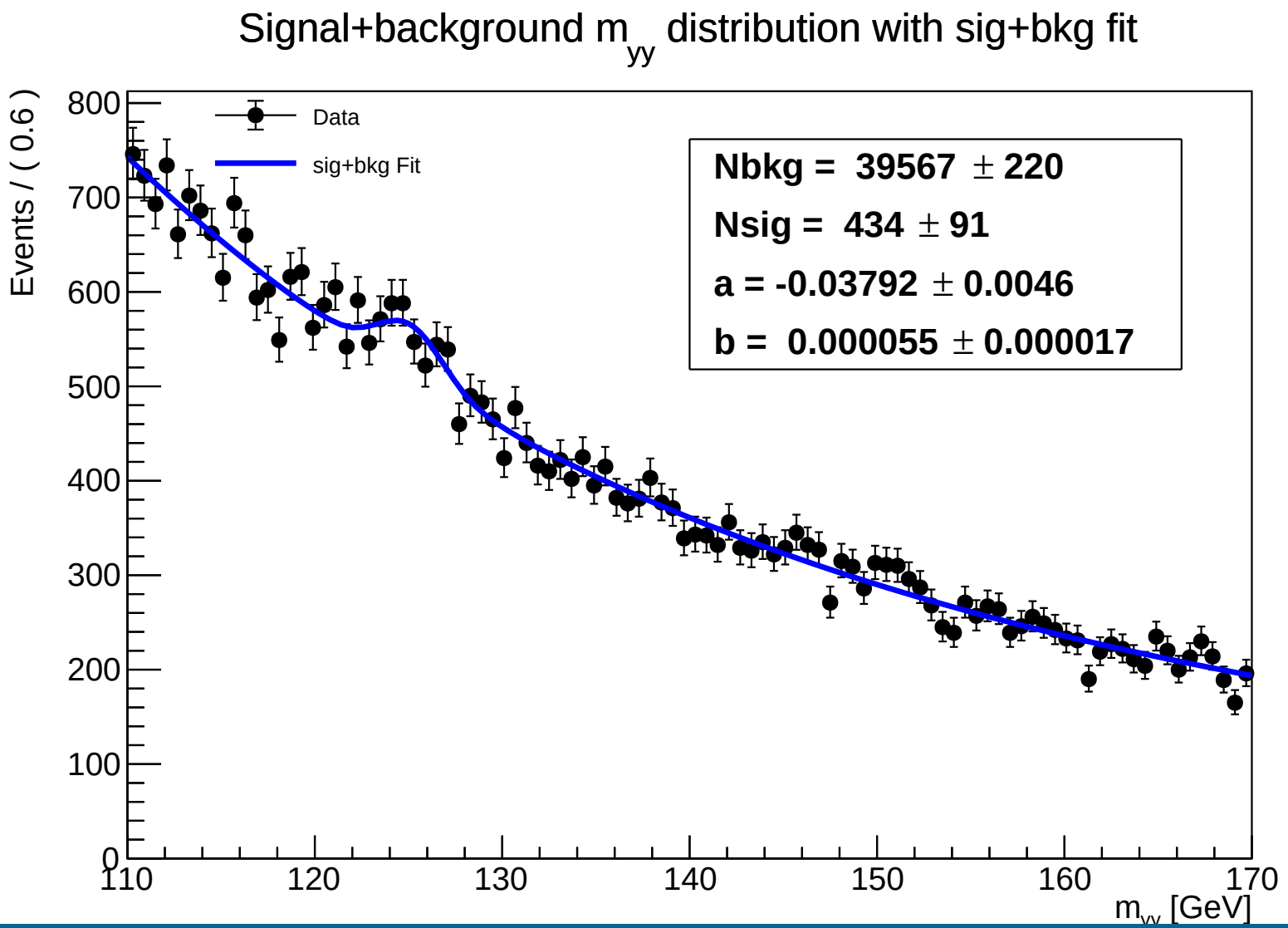
Signal+background workspace [130 GeV]

Simultaneous fit composed by 4 DSCB (signal) + exp fit (background).
Signal+background dataset.



Signal+background workspace [125 GeV]

Simultaneous fit composed by 4 DSCB (signal) + exp fit (background).
Signal+background dataset.



4° week

4° week assignments

- chiSquare check;
- single and global fit comparison:
  - plot with chiSquare;
  - y-log plot with chiSquare;
- normalisation check;
- efficiency check;
- only bkg and sig+bkg models study:
  - $m_{\gamma\gamma}$ distribution analysis;
  - p_0 scan;
  - CLs limit analysis;

ChiSquare

```
frame->chiSquare("Fit","Data")
```

◆ chiSquare() [1/2]

```
Double_t RooPlot::chiSquare ( const char * curvename,
                              const char * histname,
                              int          nFitParam = 0
                            )              const
```

Calculate and return reduced chi-squared between a curve and a histogram.

Parameters

[in] **curvename** Name of the curve or nullptr for last curve

[in] **histname** Name of the histogram to compare to or nullptr for last added histogram

[in] **nFitParam** If non-zero, reduce the number of degrees of freedom by this number. This means that the curve was fitted to the data with nFitParam floating parameters, which needs to be reflected in the calculation of χ^2/ndf.

Returns

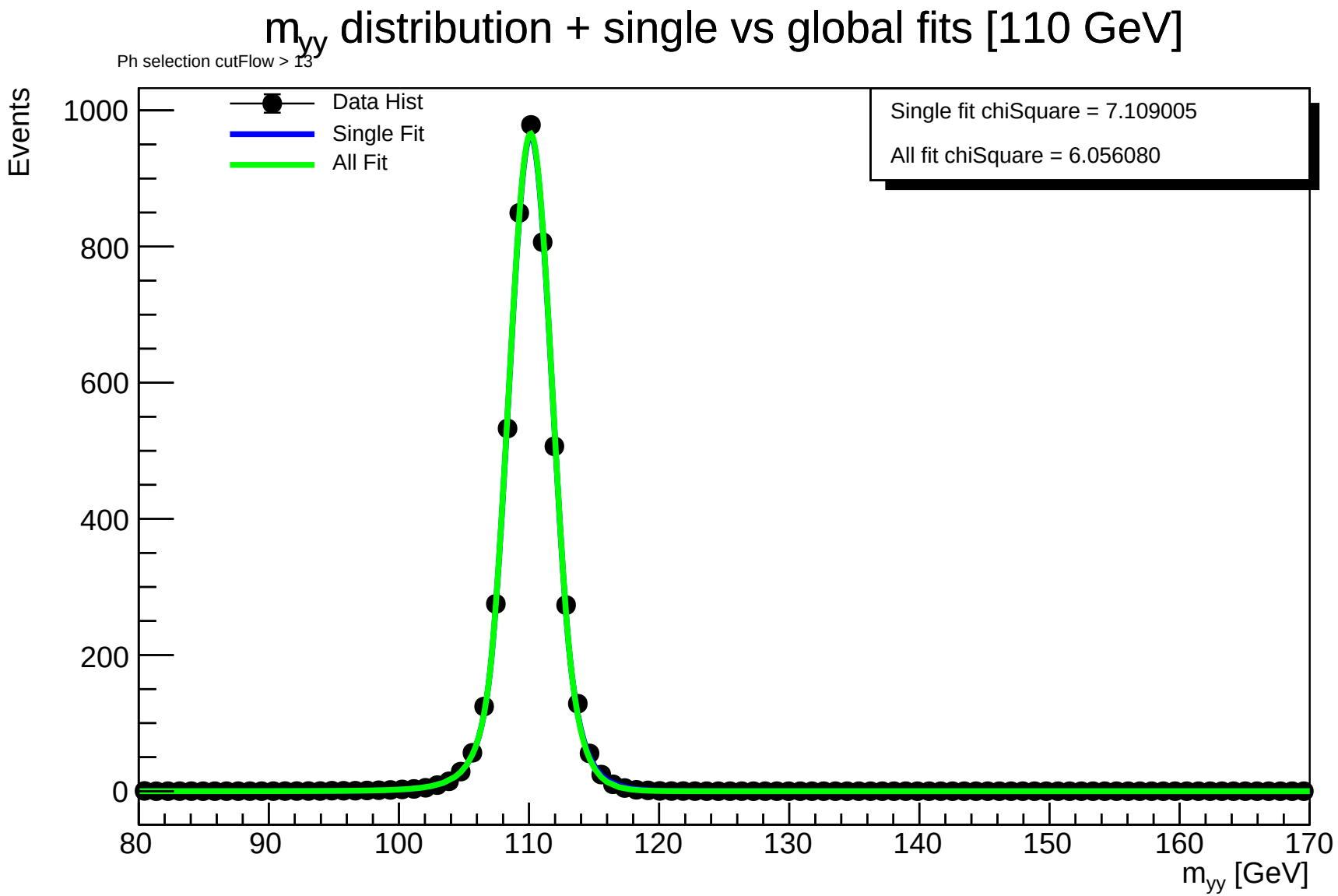
χ^2/ndf between the plotted curve and the data.

Note

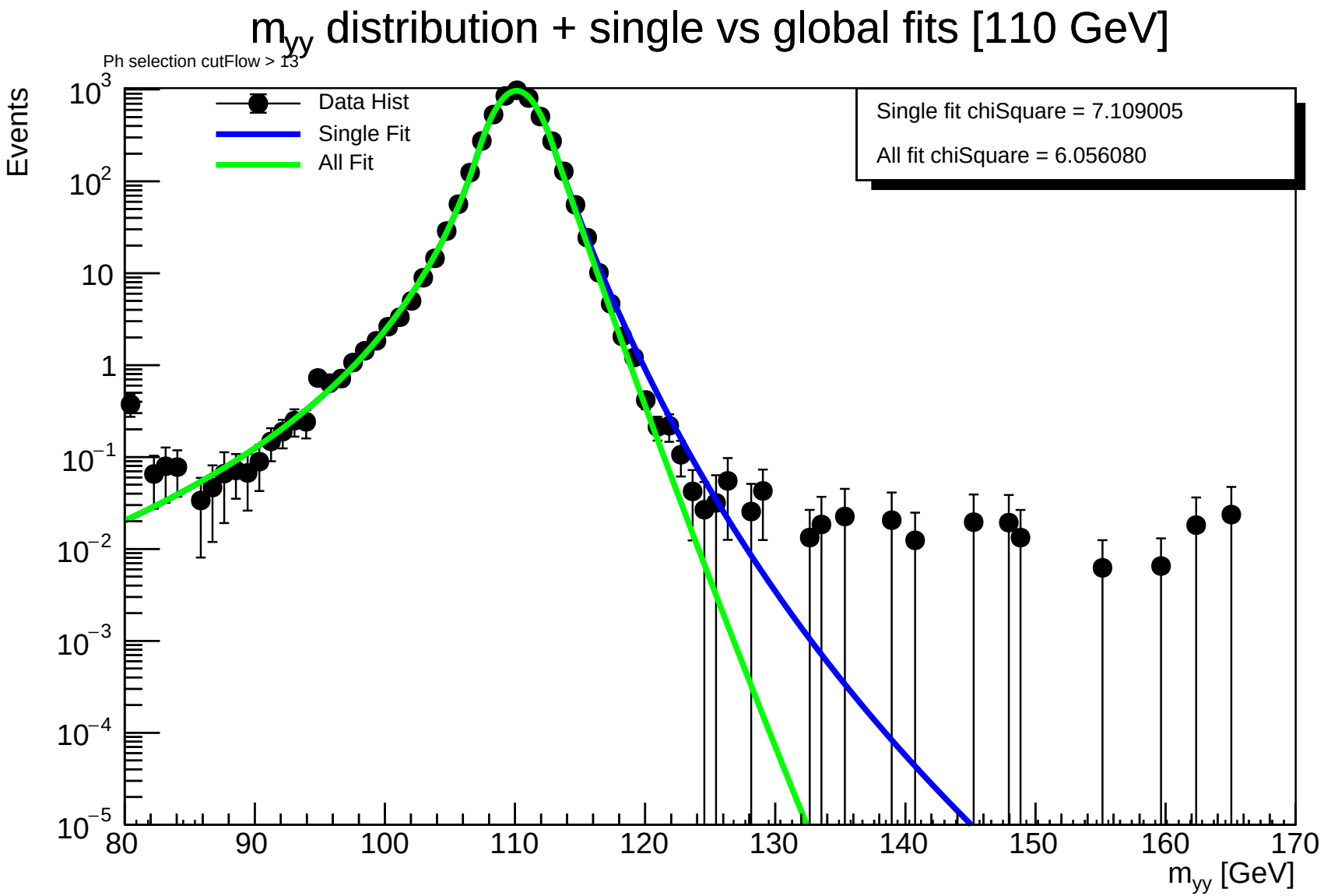
The χ^2 is calculated between a *plot of the original distribution* and the data. It therefore has more rounding errors than directly calculating the χ^2 from a PDF or function. To do this, use RooChi2Var.

Definition at line 1113 of file RooPlot.cxx.

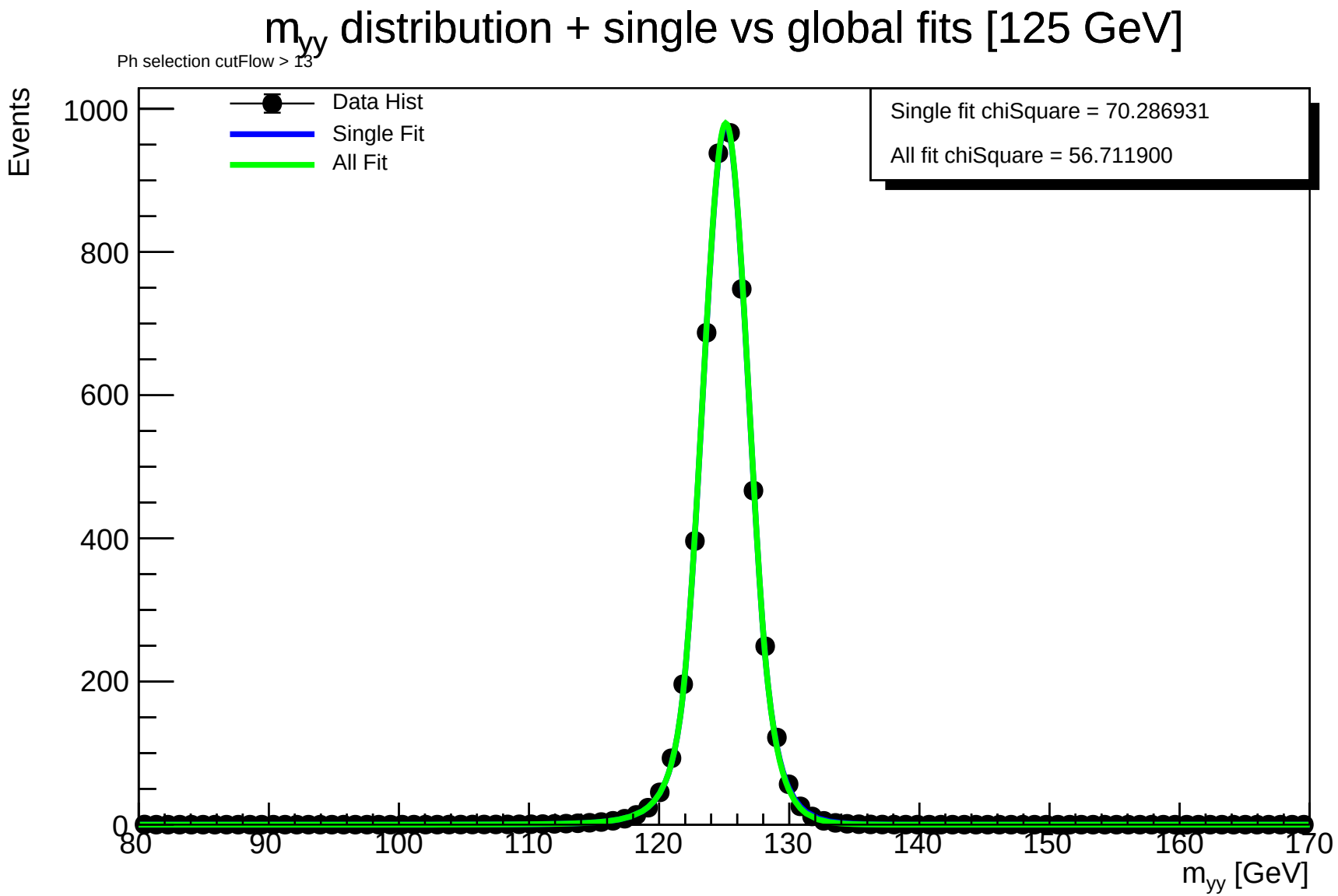
Single vs global fit comp. [110 Gev]



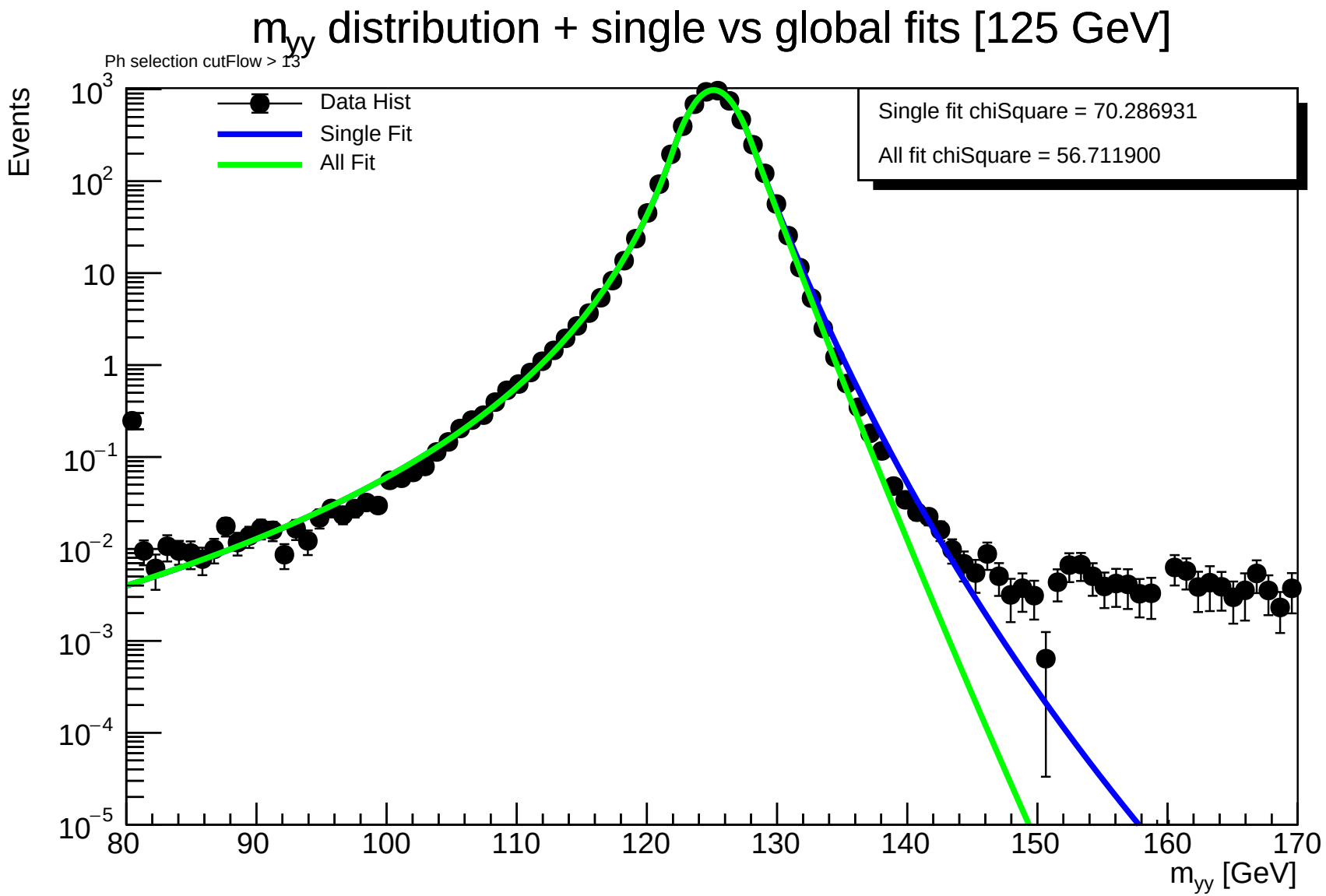
Single vs global fit comp. [110 Gev] (ylog)



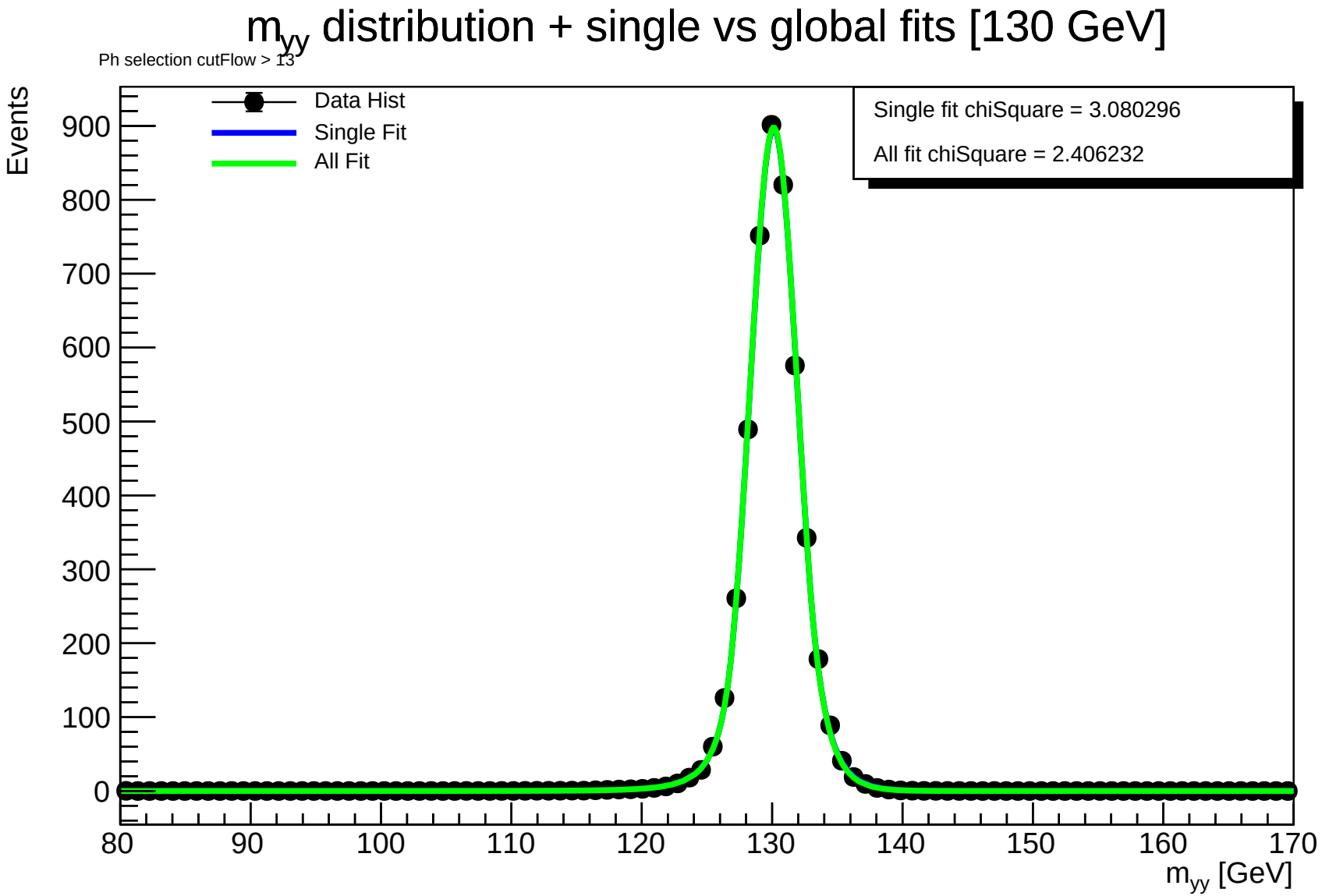
Single vs global fit comp. [125 Gev]



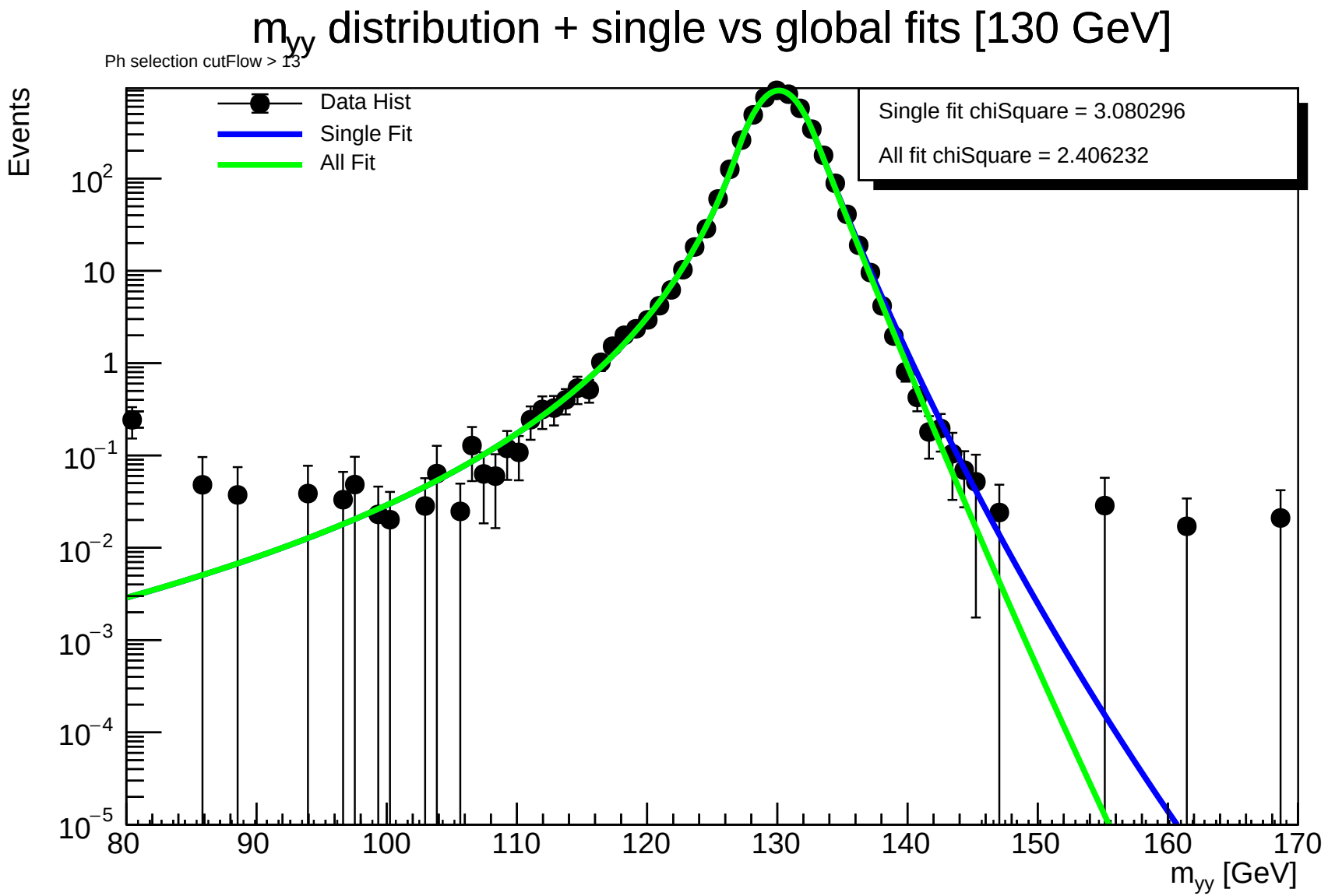
Single vs global fit comp. [125 Gev] (ylog)



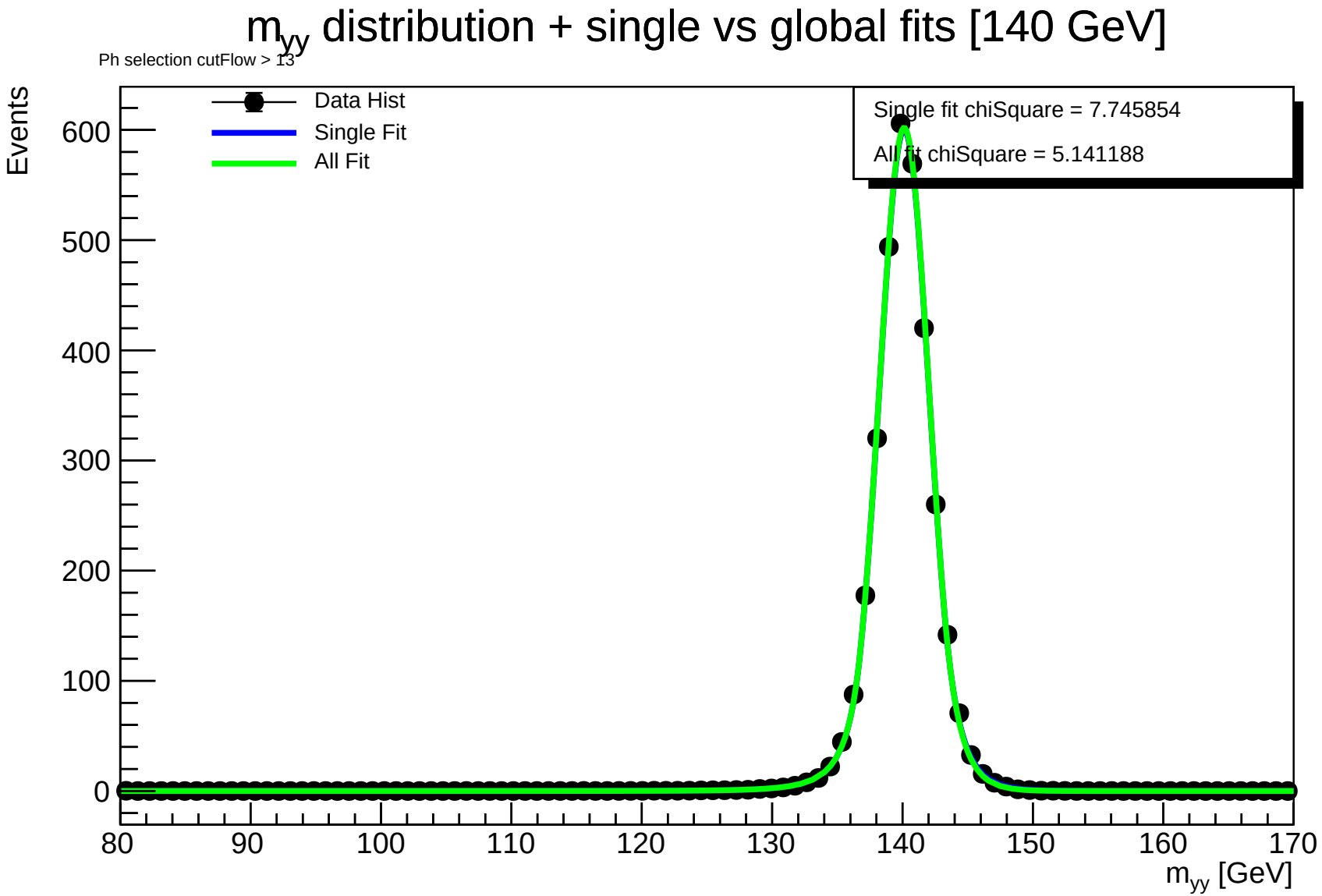
Single vs global fit comp. [130 Gev]



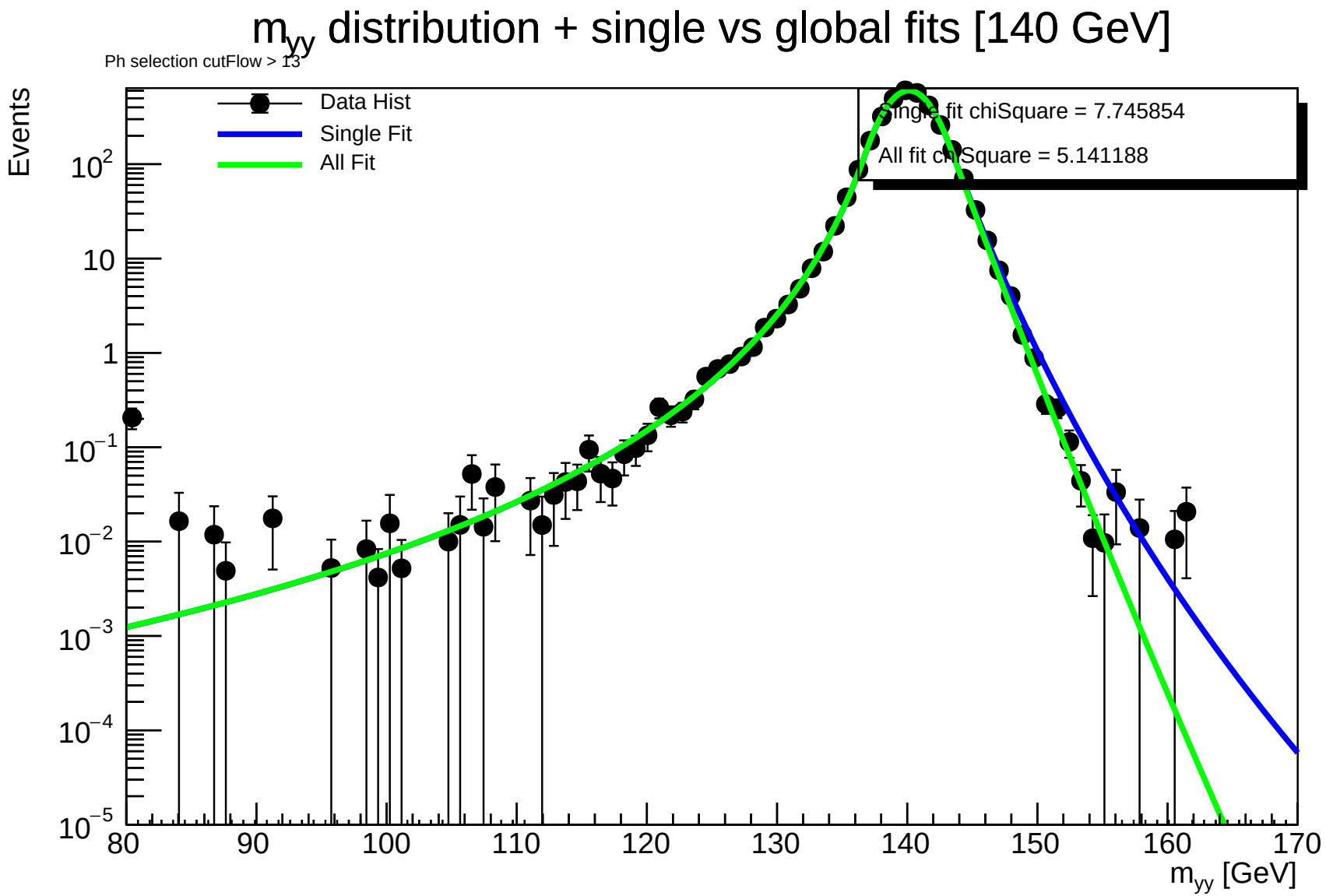
Single vs global fit comp. [130 Gev] (ylog)



Single vs global fit comp. [140 Gev]



Single vs global fit comp. [140 Gev] (ylog)

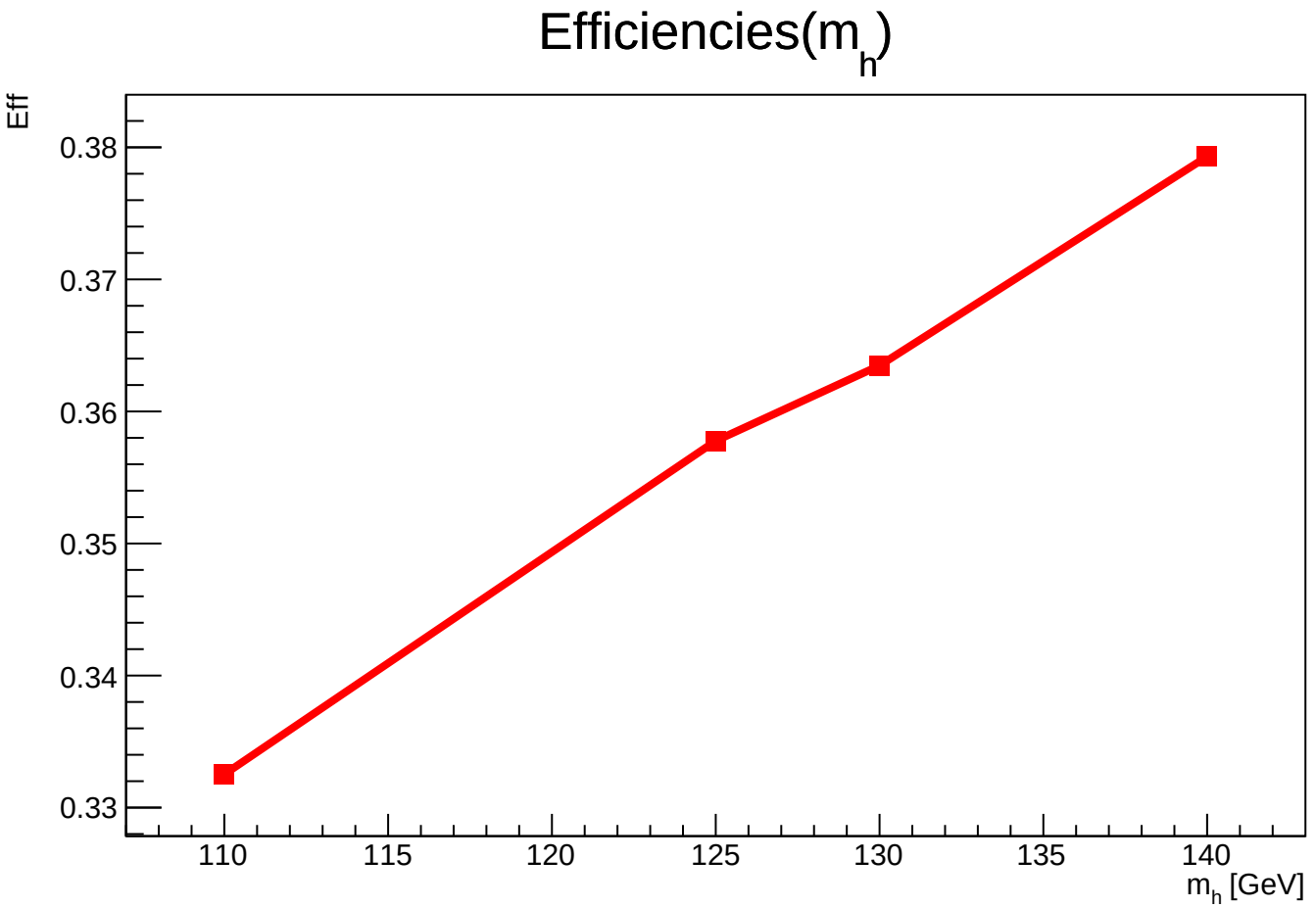


Check normalisations

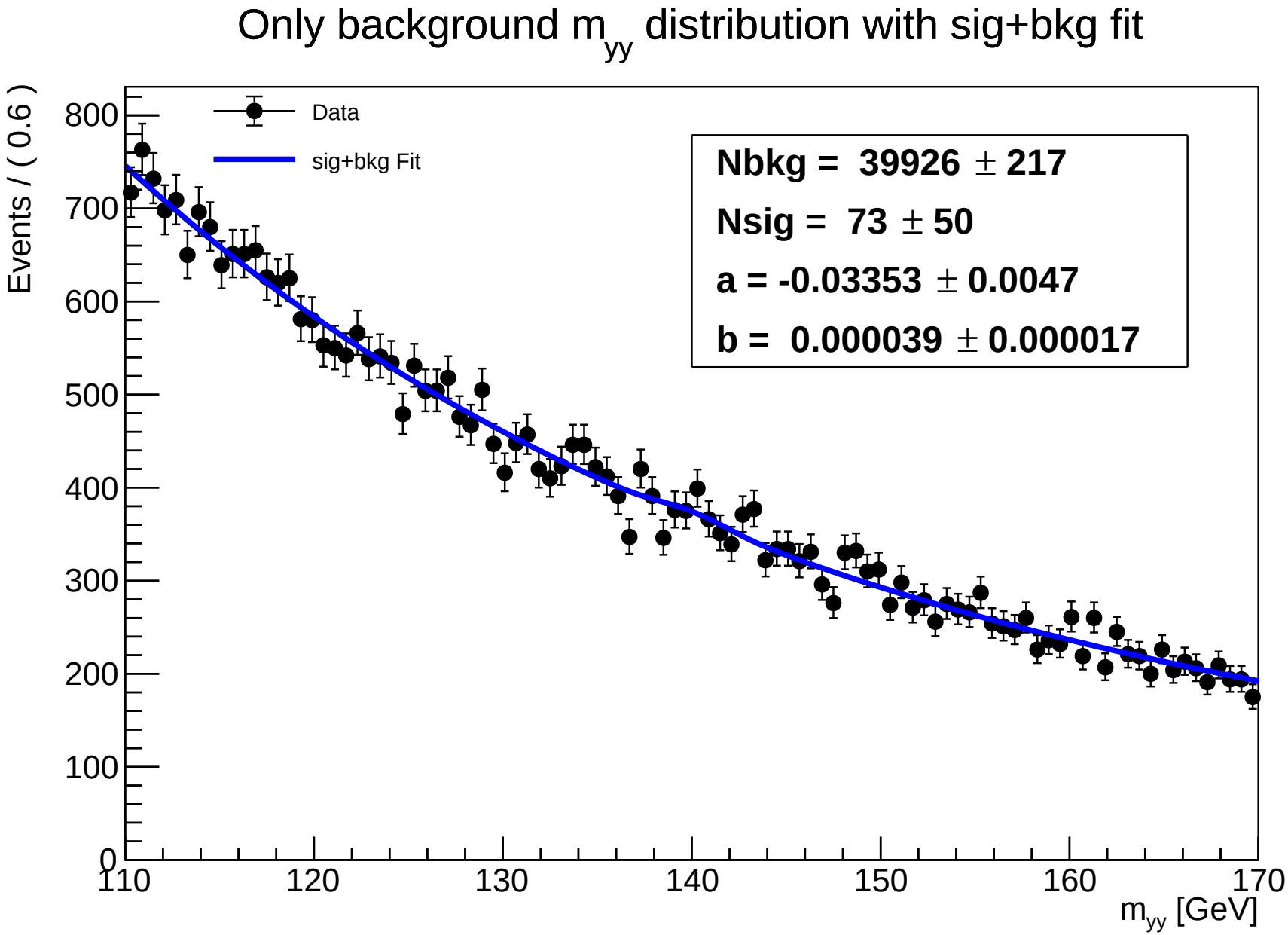
My and Elena's results are compared in: docs

Efficiencies(m_h)

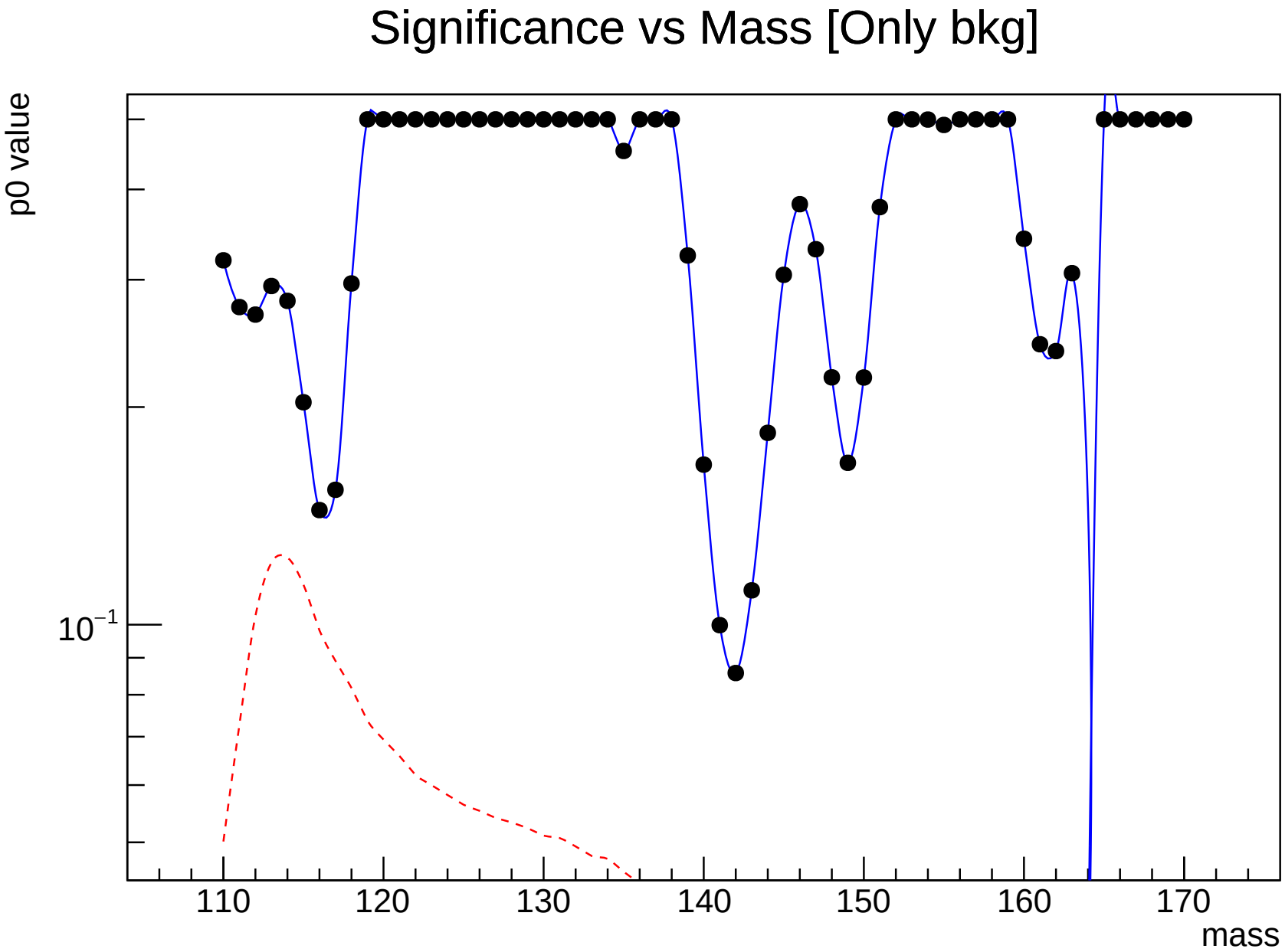
$$eff = \sum \frac{weight\ \ of\ \ event\ \ with\ \ cutFlow>13}{Weight_{XsBrFe}}$$



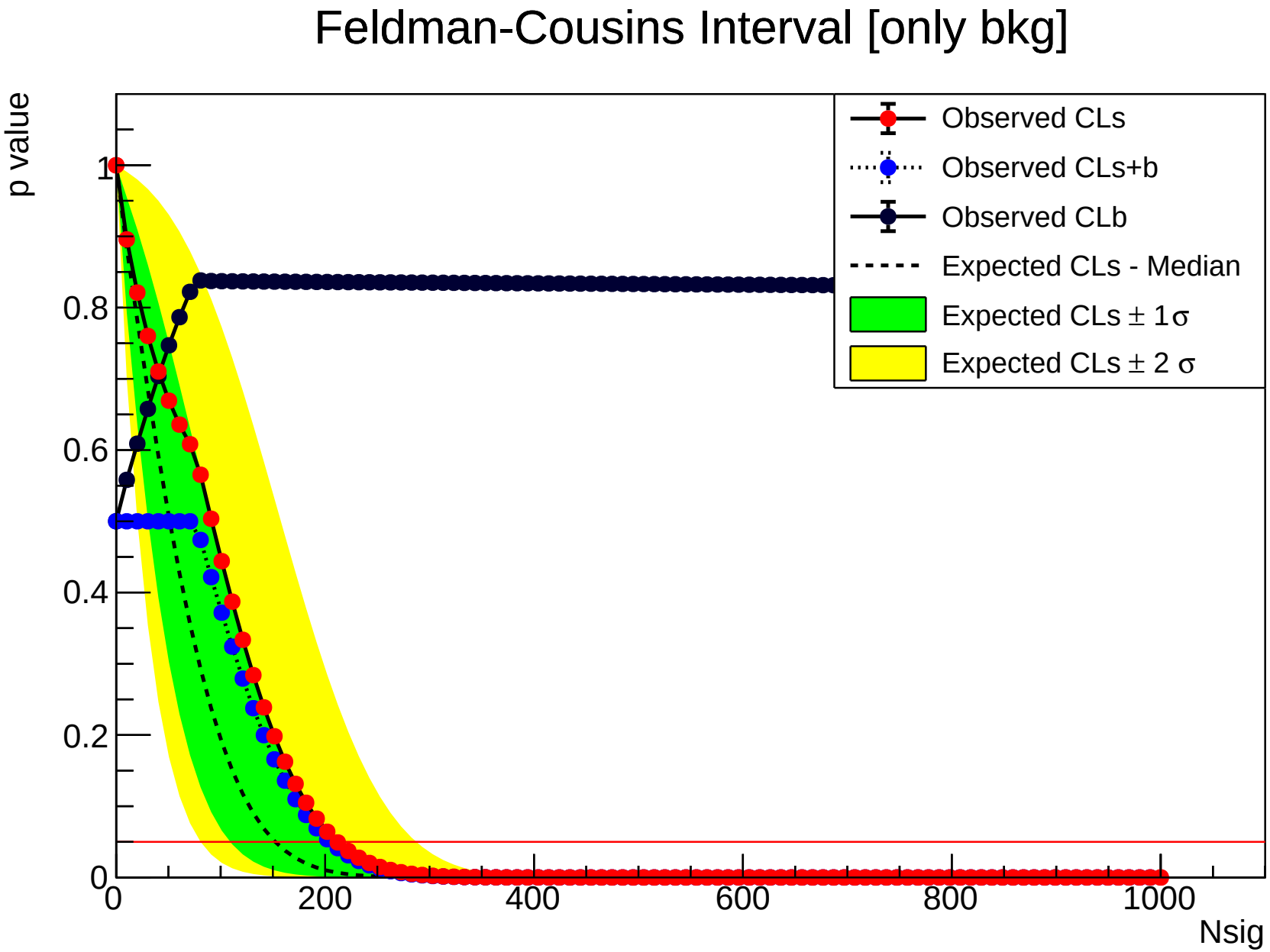
Only background



Only background p0 scan

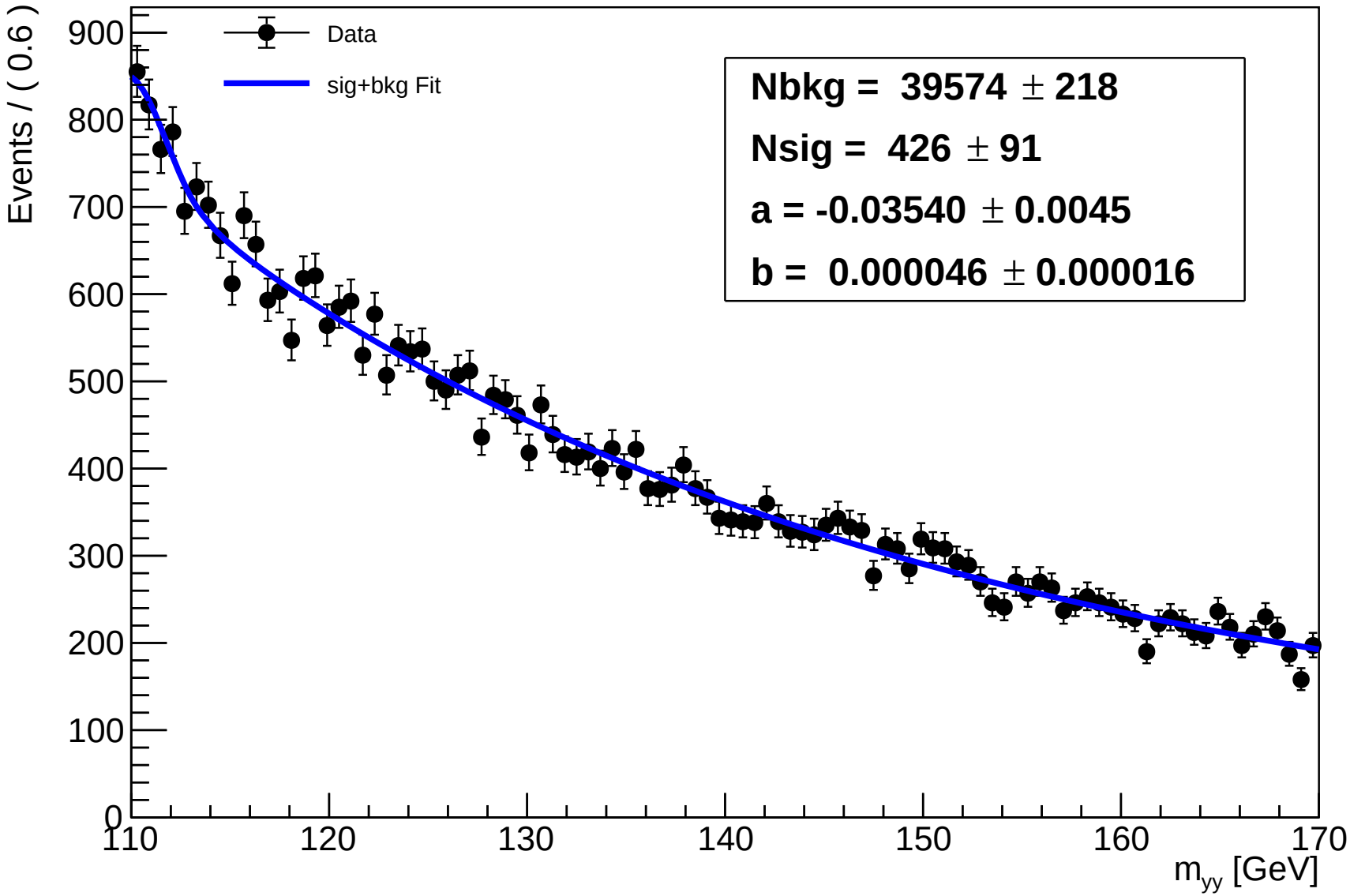


Only background limit

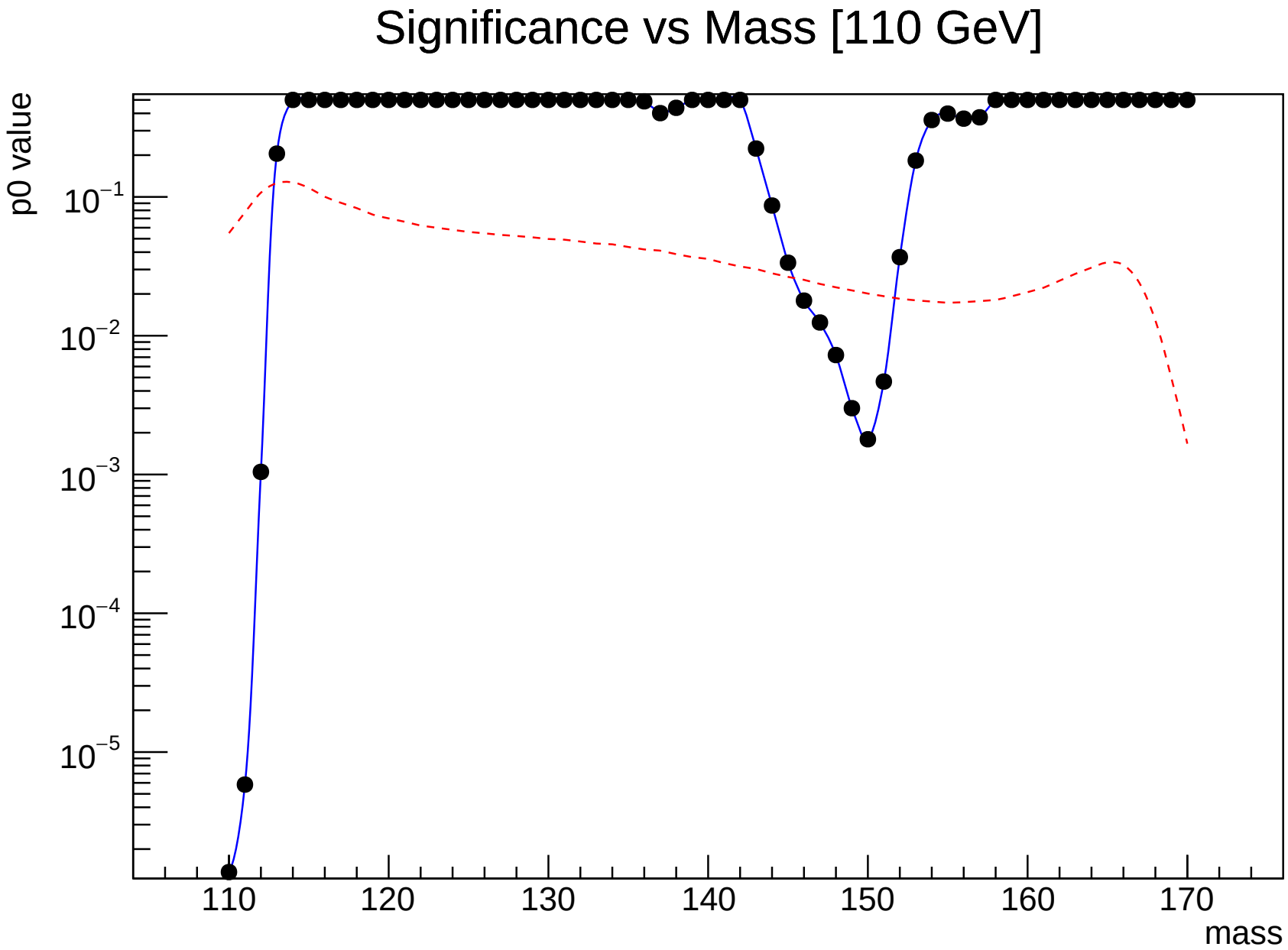


Sig+bkg [110 GeV]

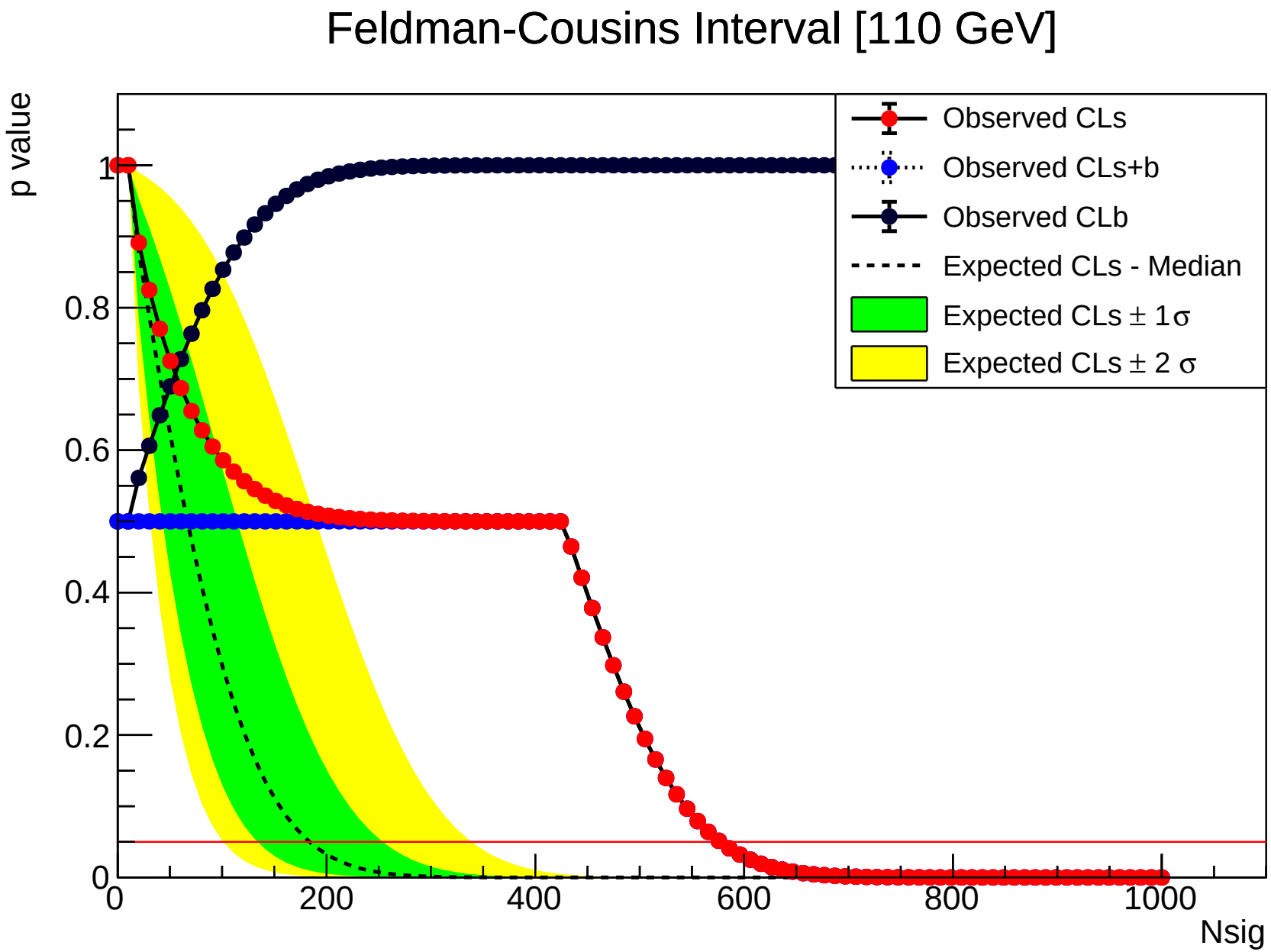
Signal+background m_{yy} distribution with sig+bkg fit



Sig+bkg p0 scan [110 GeV]

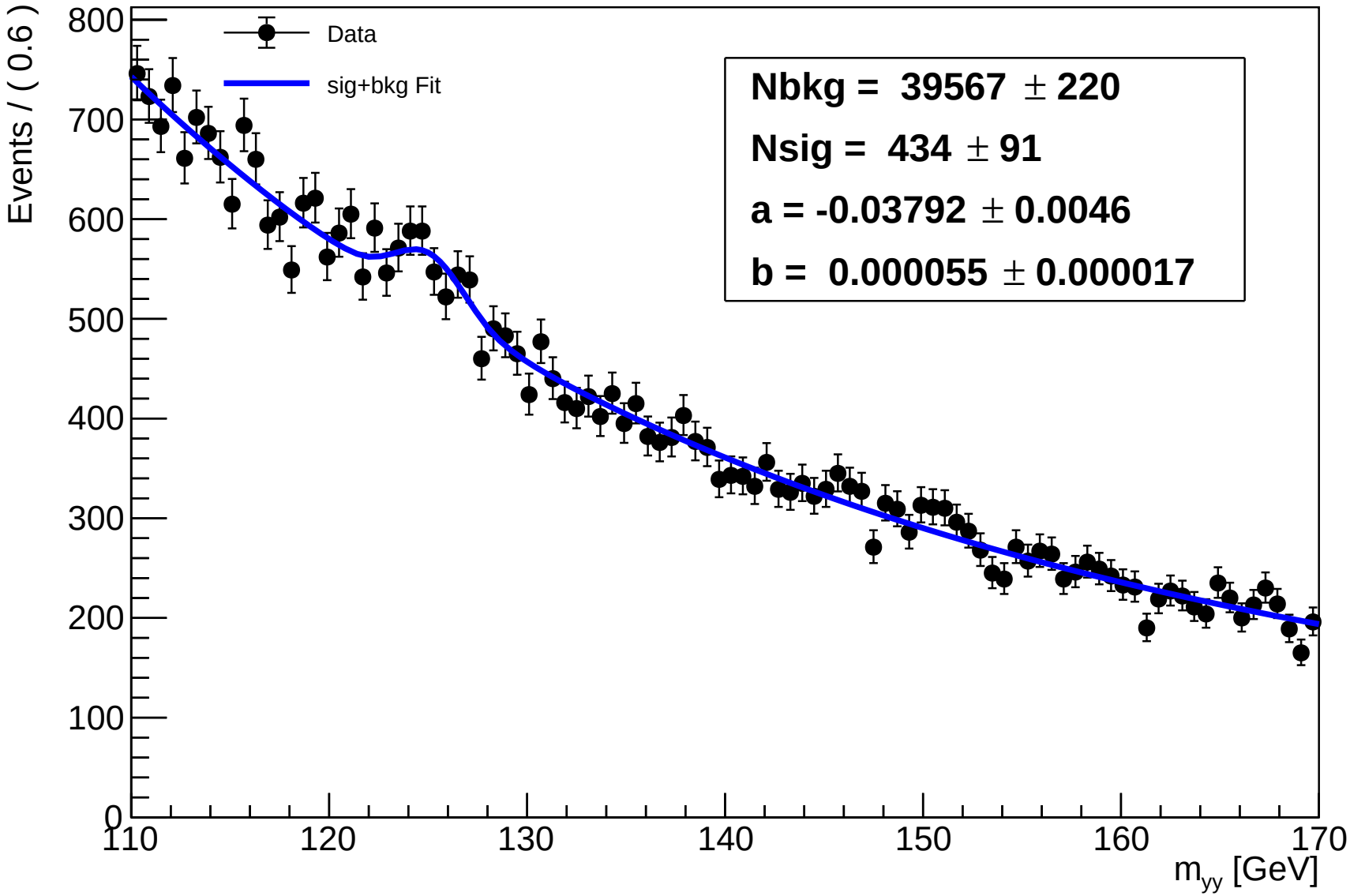


Sig+bkg limit [110 GeV]

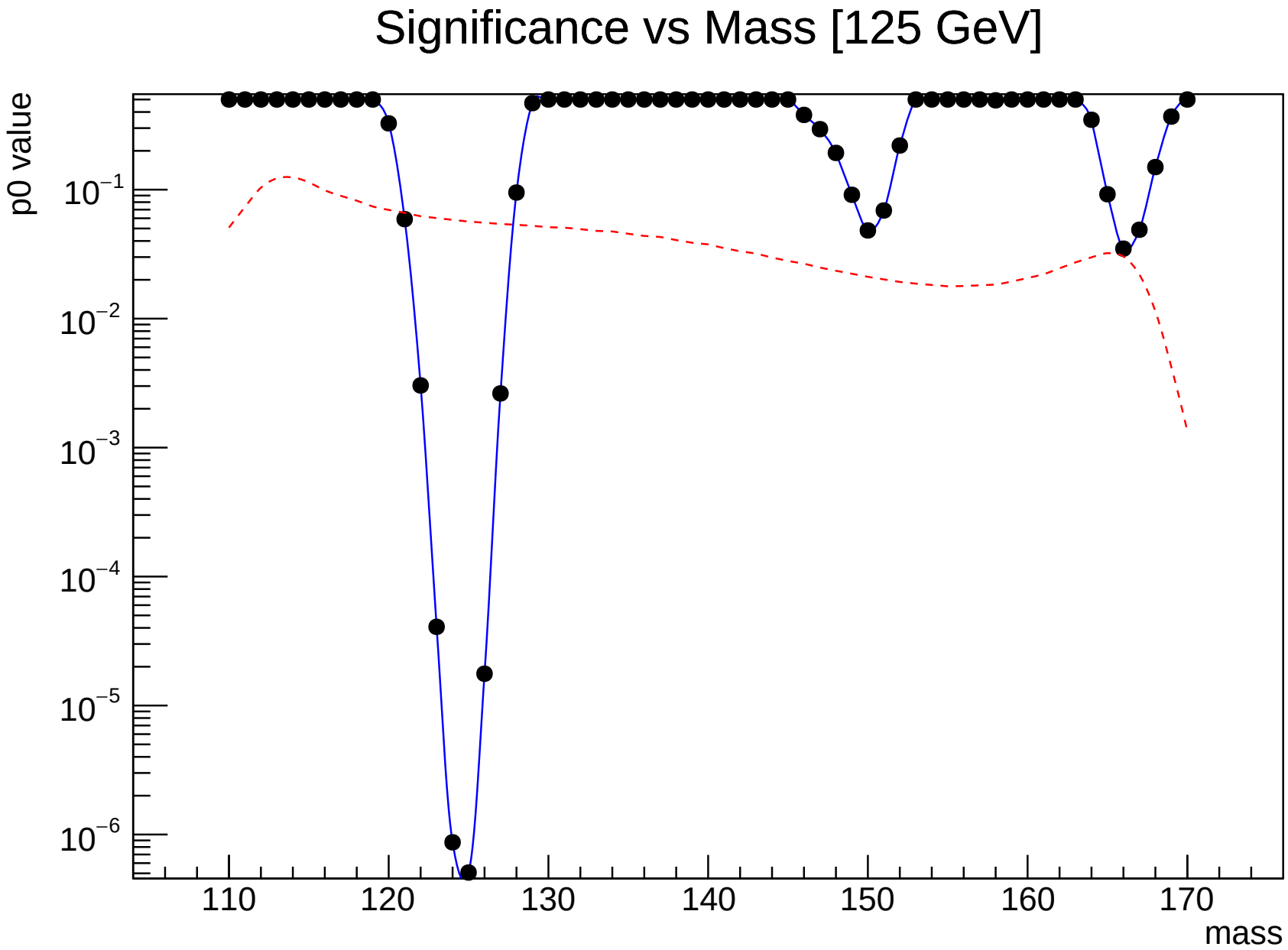


Sig+bkg [125 GeV]

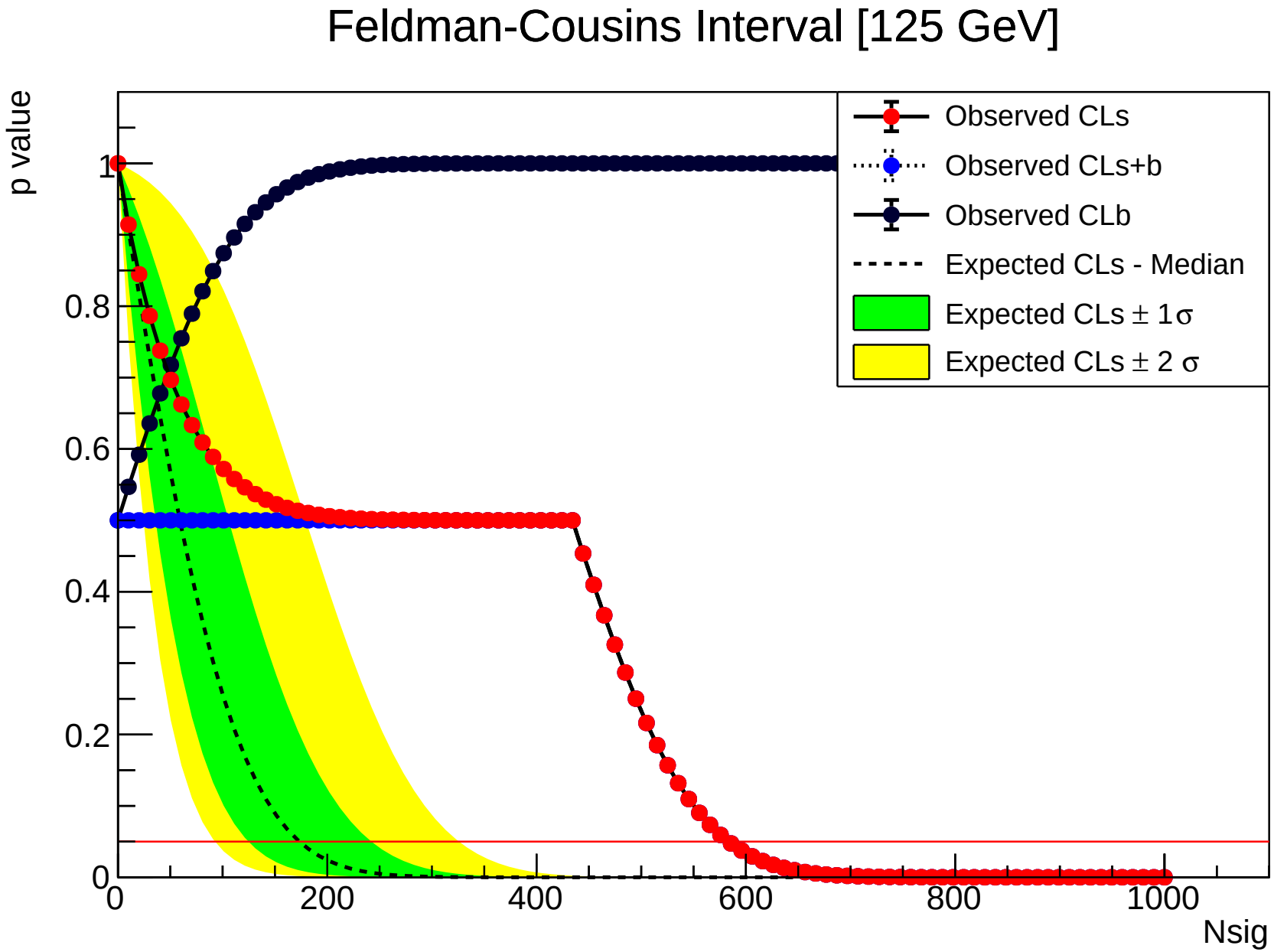
Signal+background m_{yy} distribution with sig+bkg fit



Sig+bkg p0 scan [125 GeV]

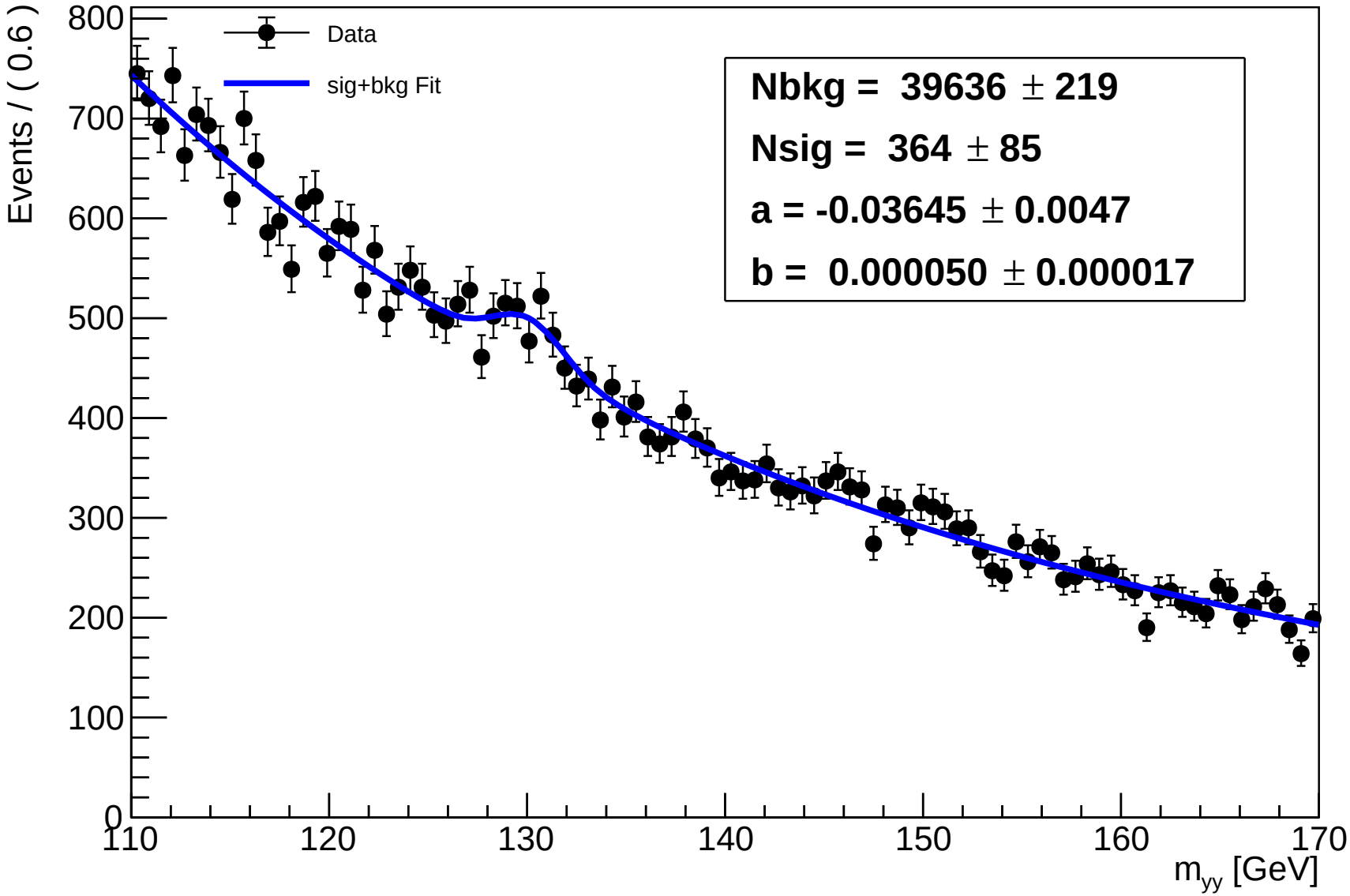


Sig+bkg limit scan [125 GeV]

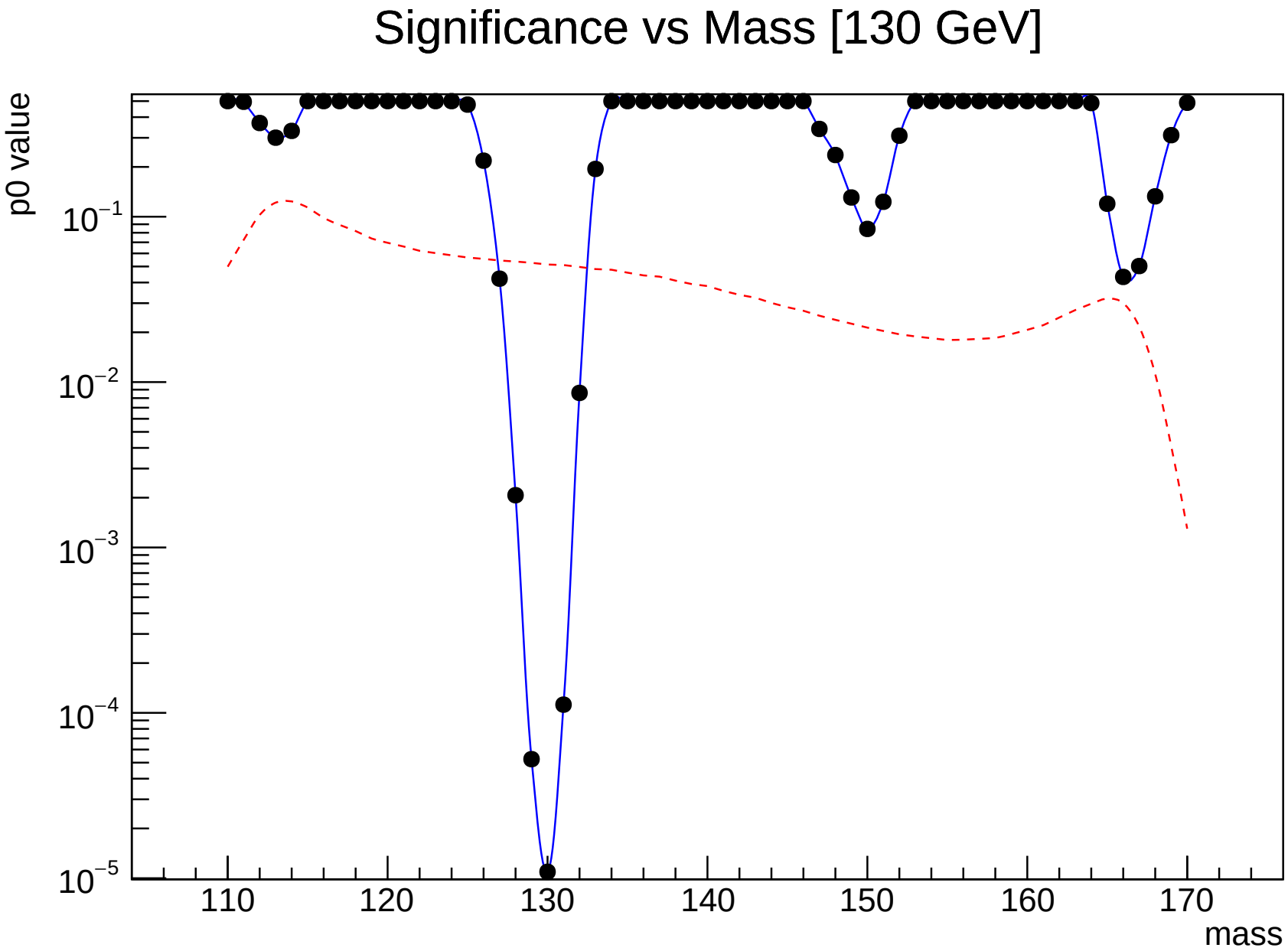


Sig+bkg [130 GeV]

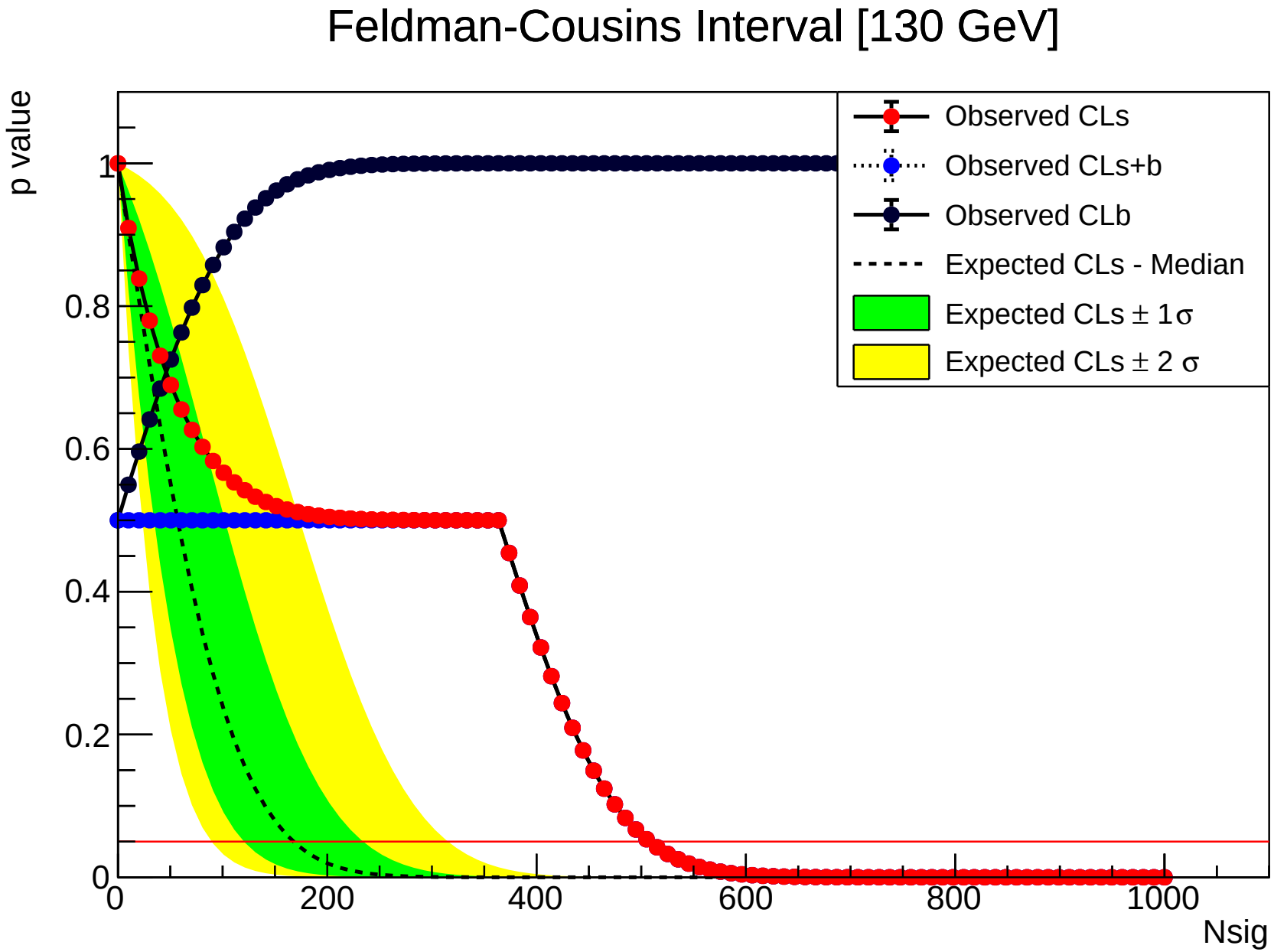
Signal+background m_{yy} distribution with sig+bkg fit



Sig+bkg p0 scan [130 GeV]

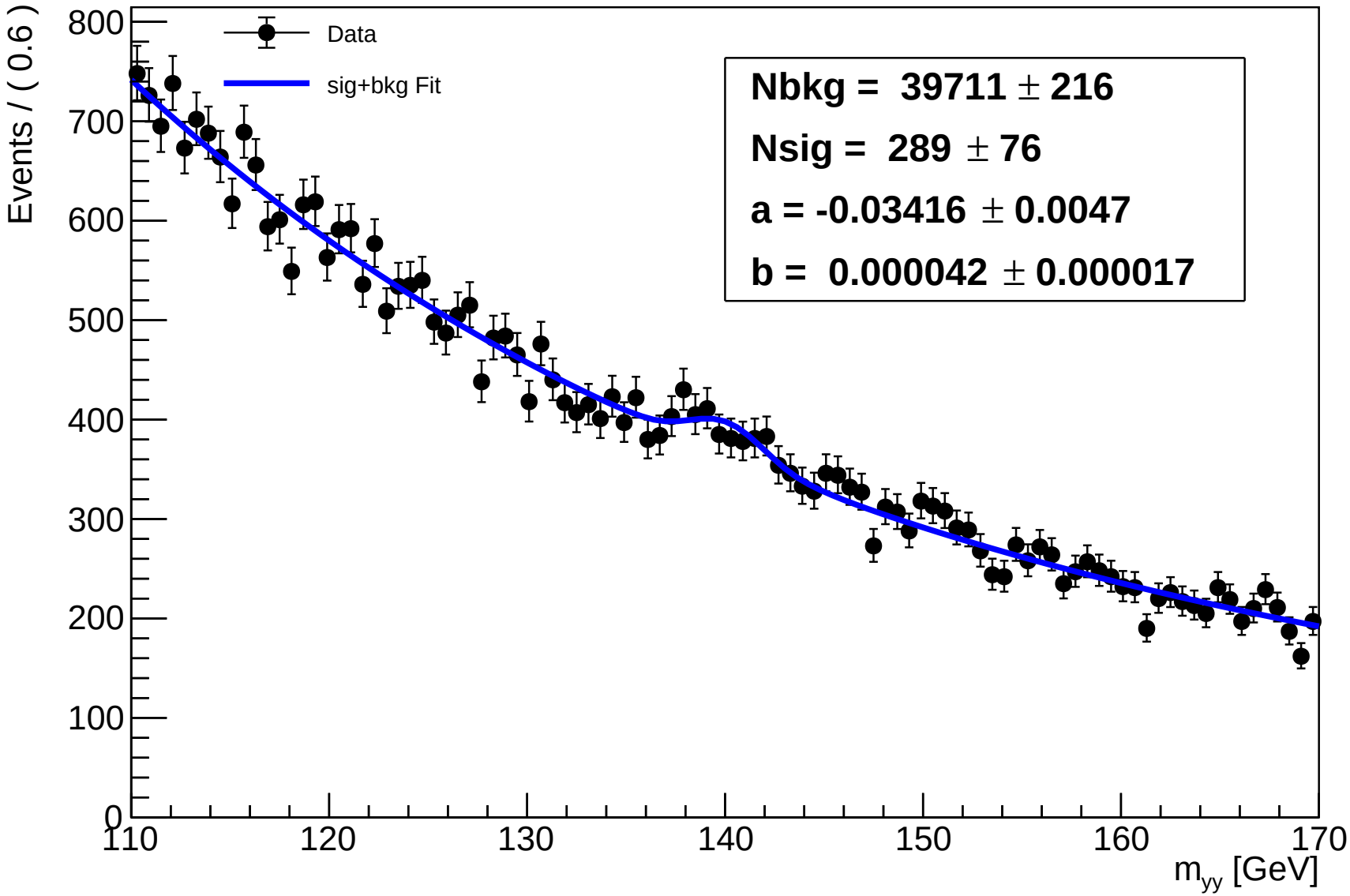


Sig+bkg limit scan [130 GeV]

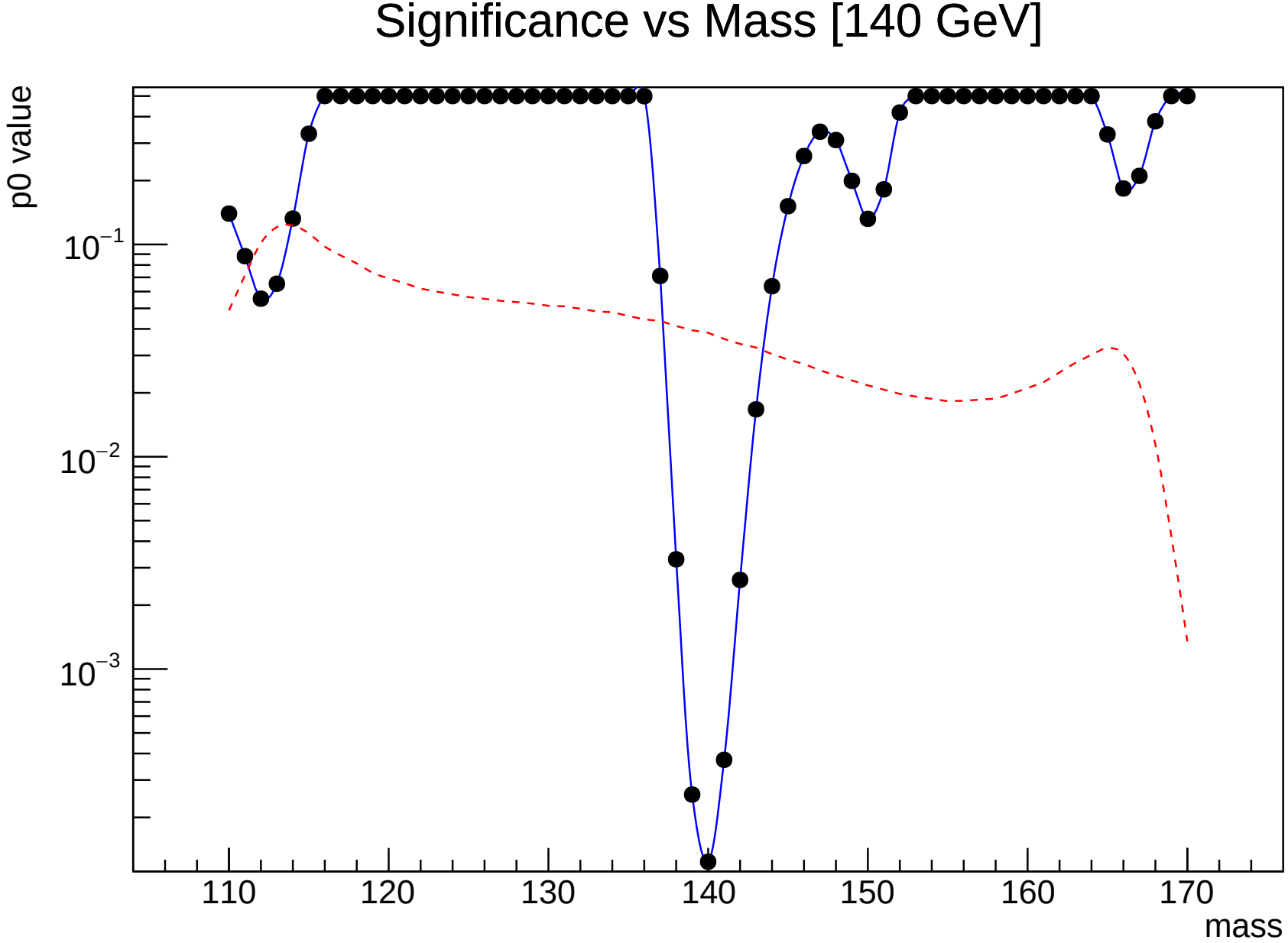


Sig+bkg [140 GeV]

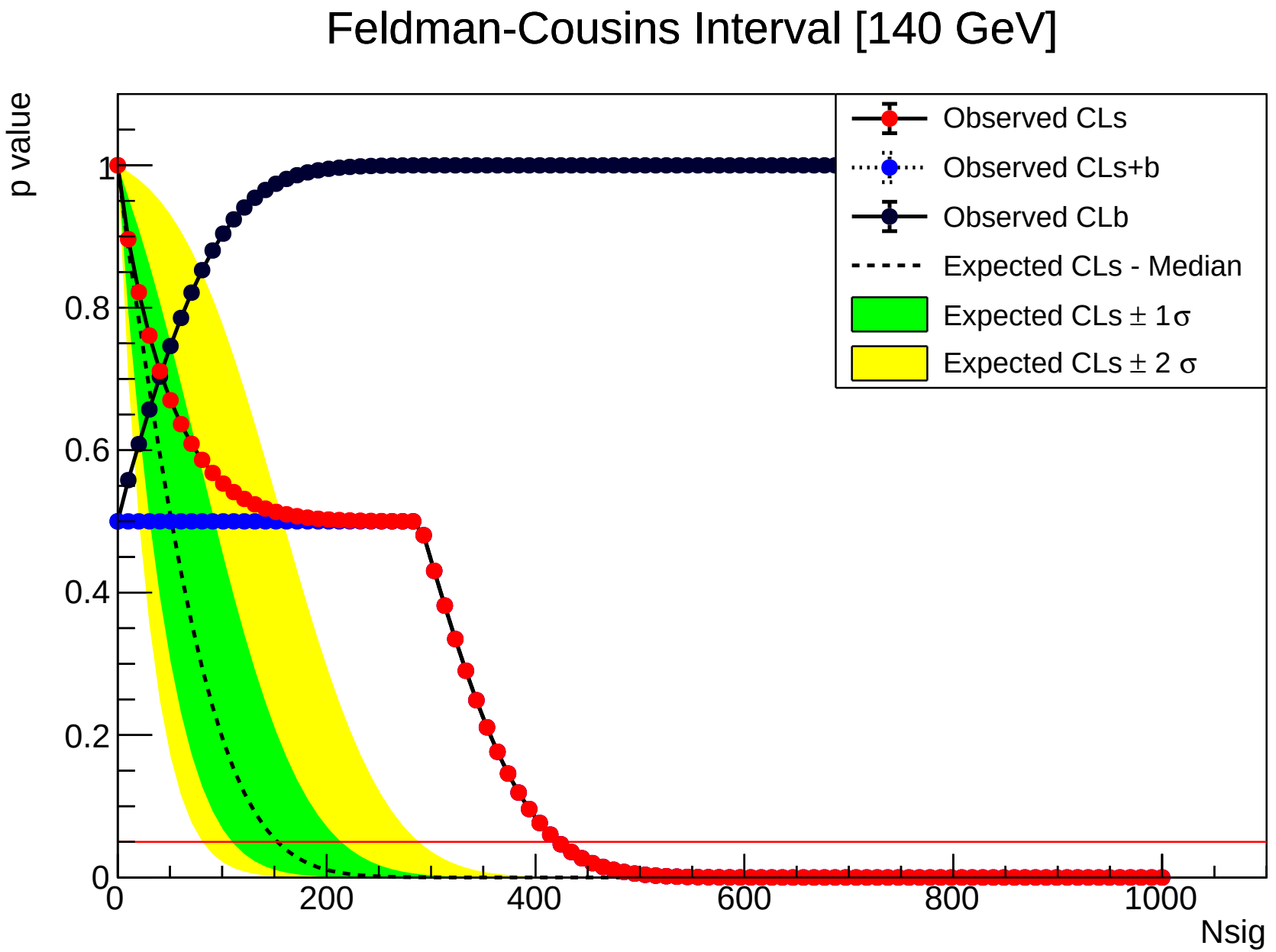
Signal+background m_{yy} distribution with sig+bkg fit



Sig+bkg p0 scan [140 GeV]

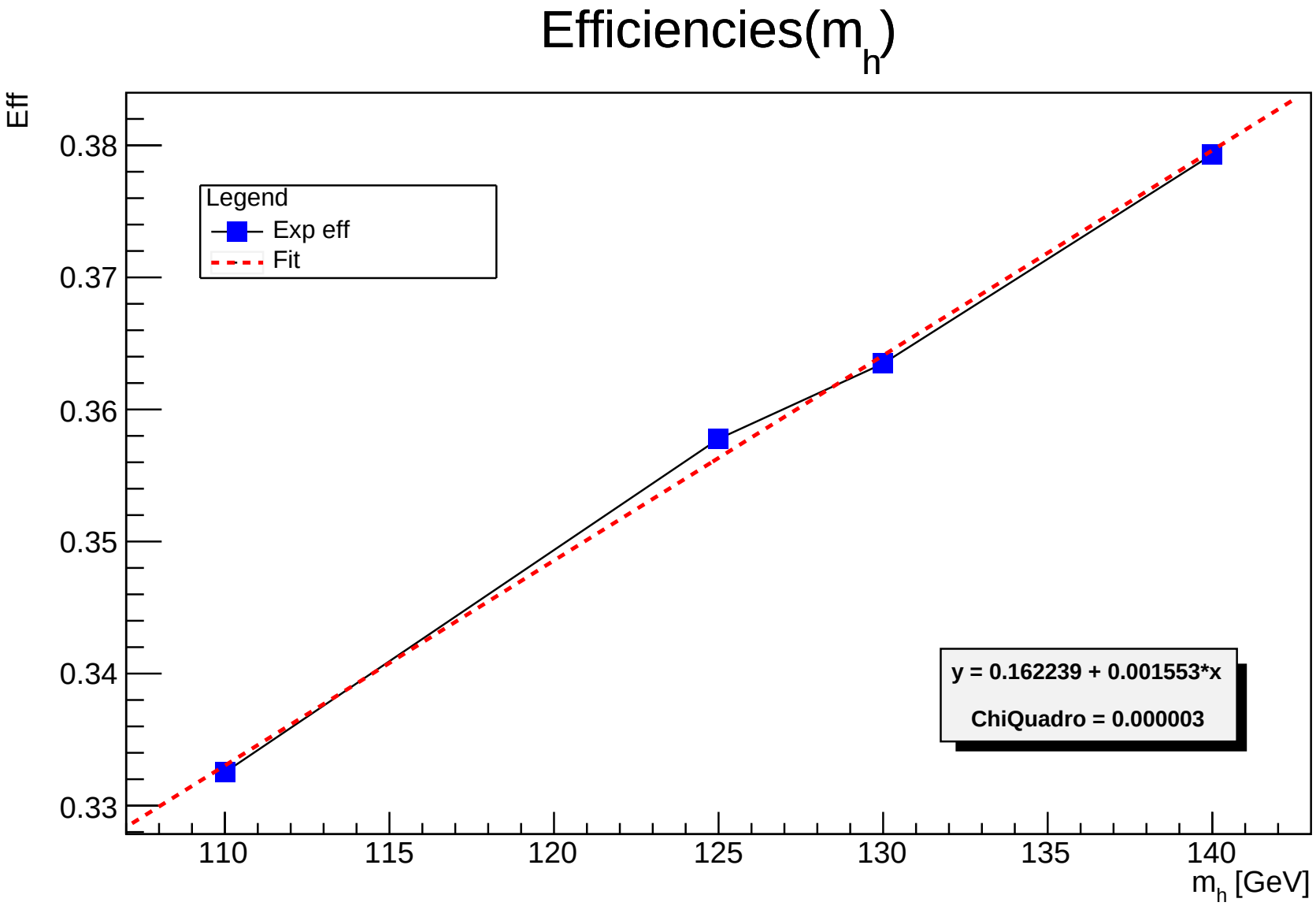


Sig+bkg limit scan [140 GeV]

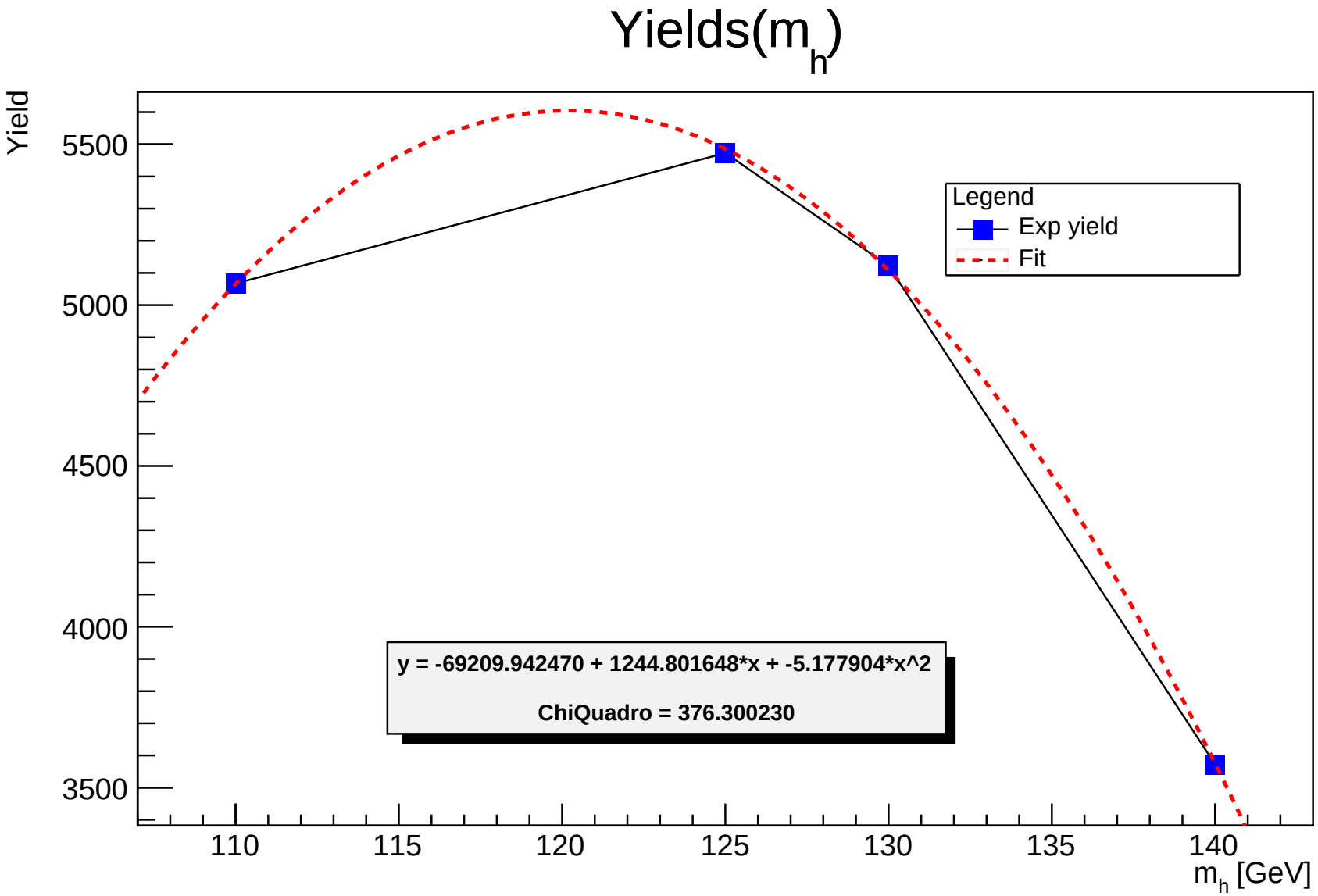


5° week

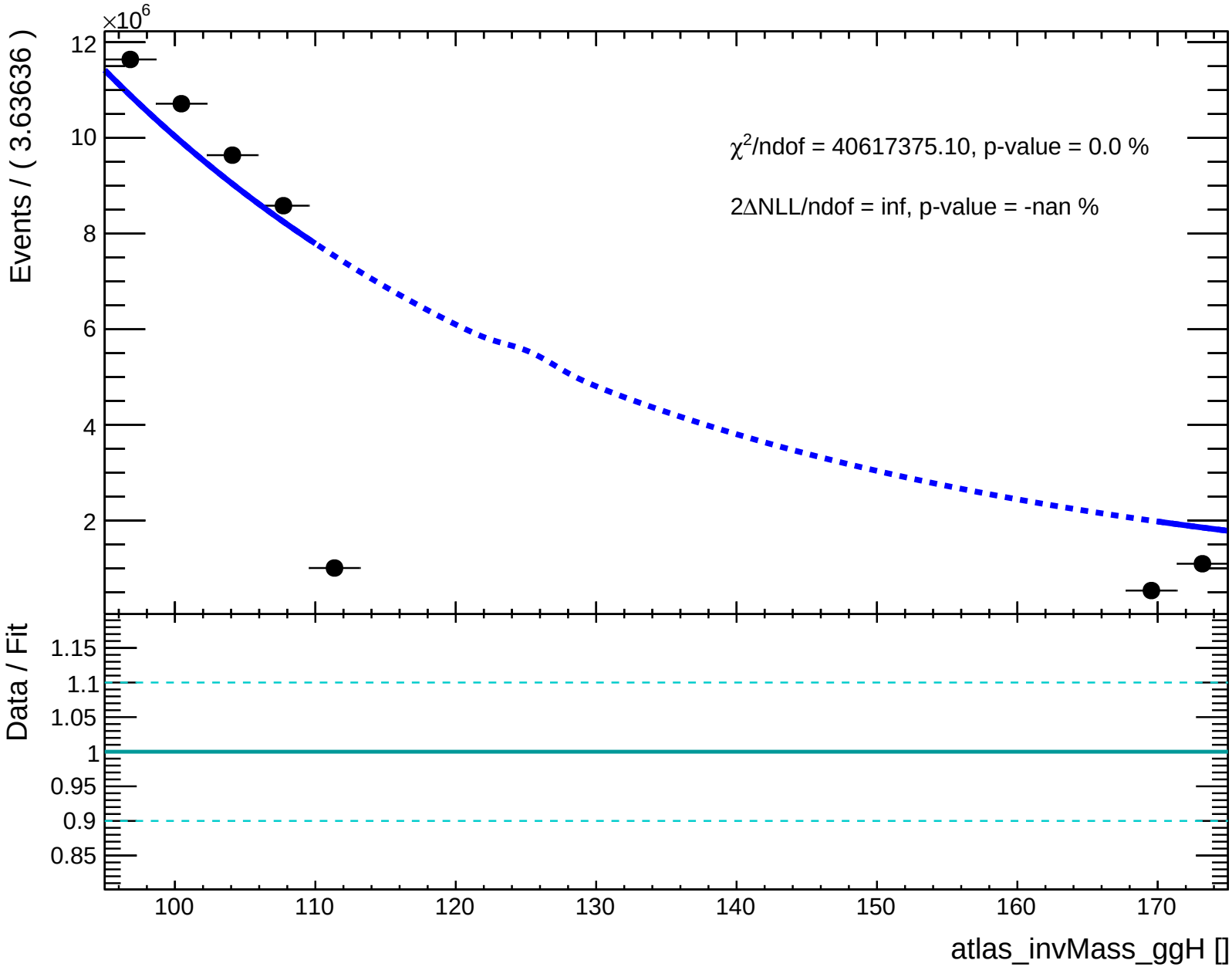
Efficiencies(m_H) fit



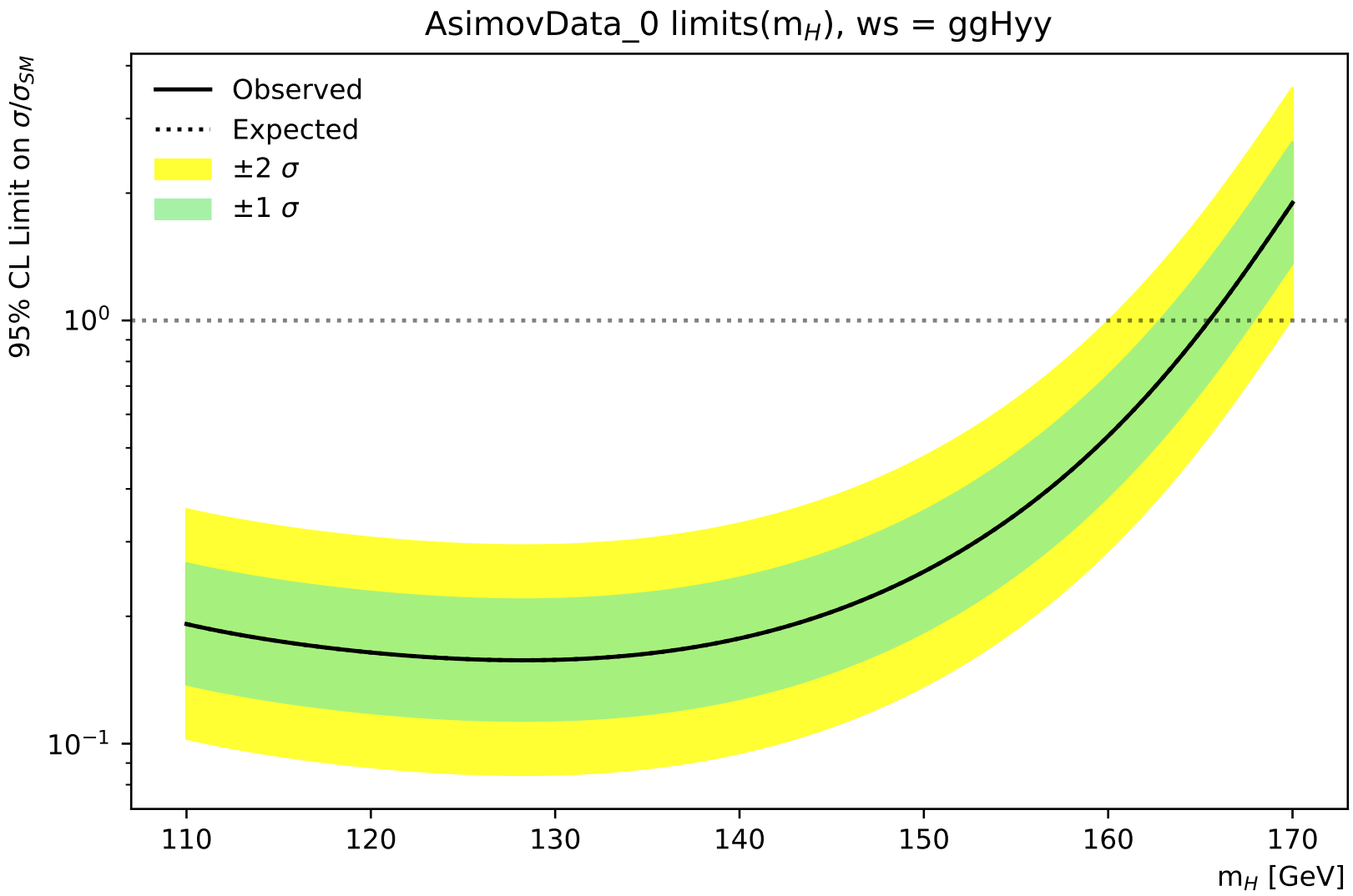
Yields(m_H) fit



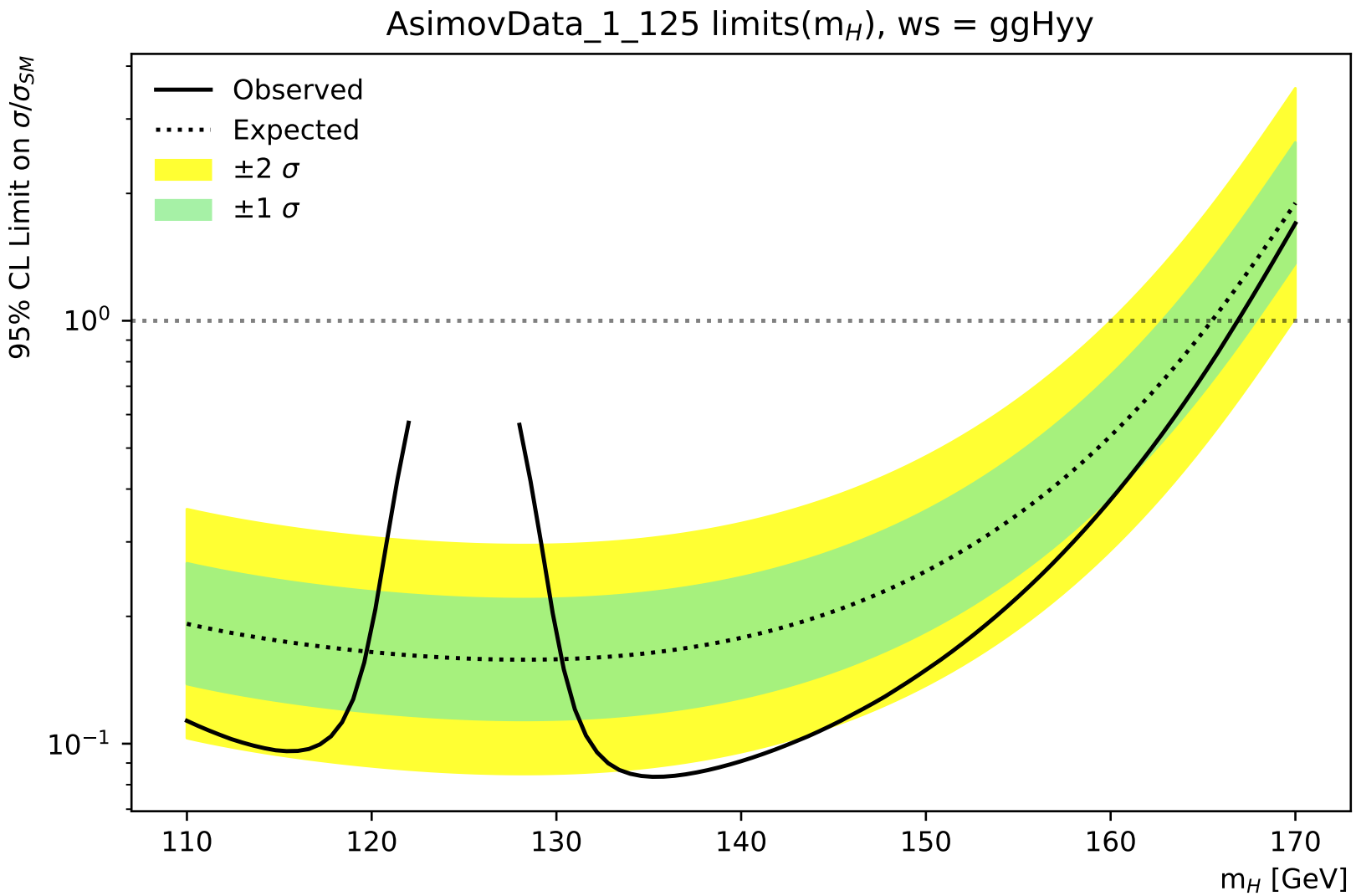
Workspace


×10^6
Events / (3.63636)
12
10
8
6
4
2
χ²/ndof = 40617375.10, p-value = 0.0 %
2ΔNLL/ndof = inf, p-value = -nan %
Data / Fit
1.15
1.1
1.05
1
0.95
0.9
0.85
100
110
120
130
140
150
160
170
atlas_invMass_ggH []

AsimovDataset $\mu = 0$

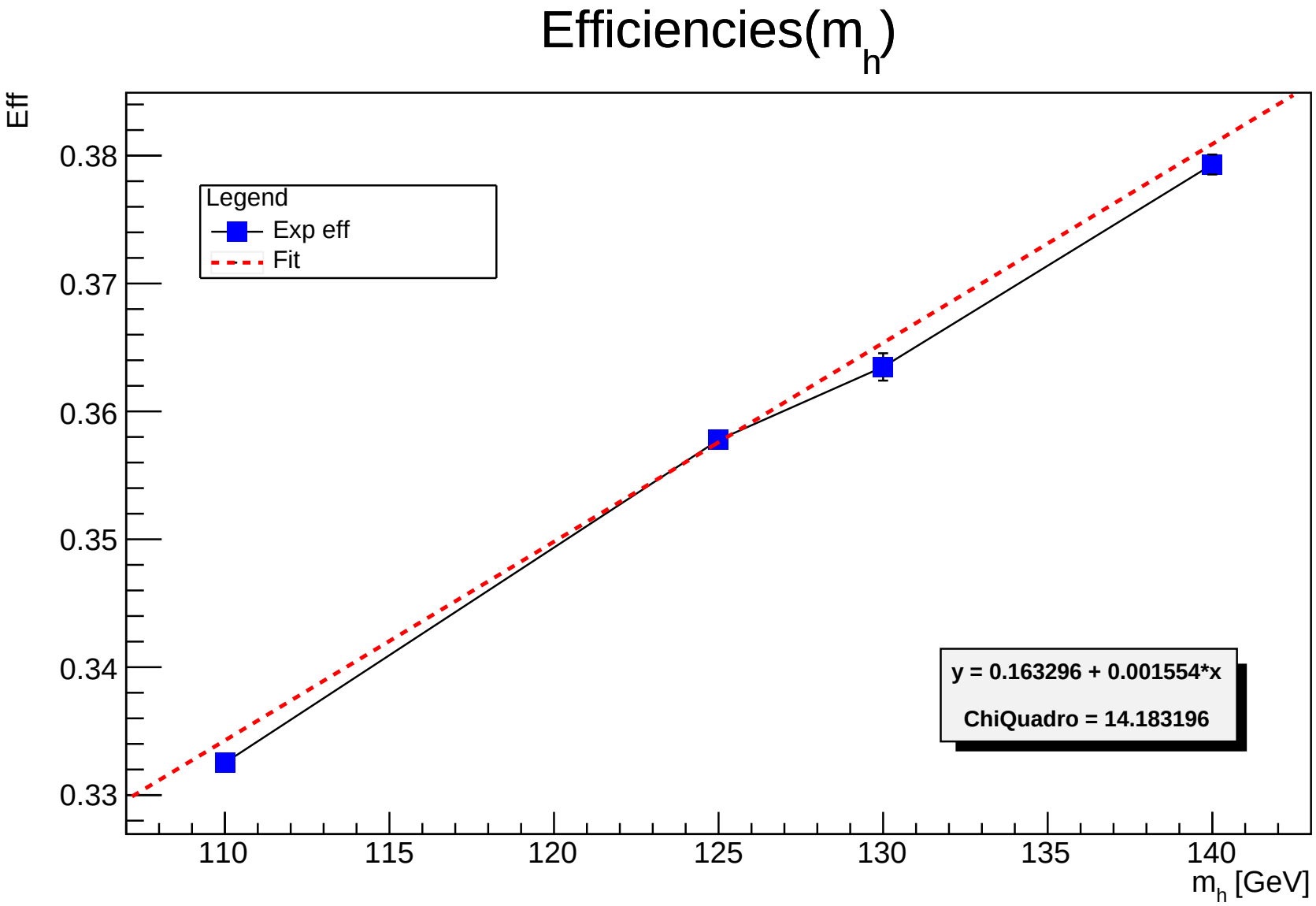


AsimovDataset $\mu = 1$ and $m_H = 125$



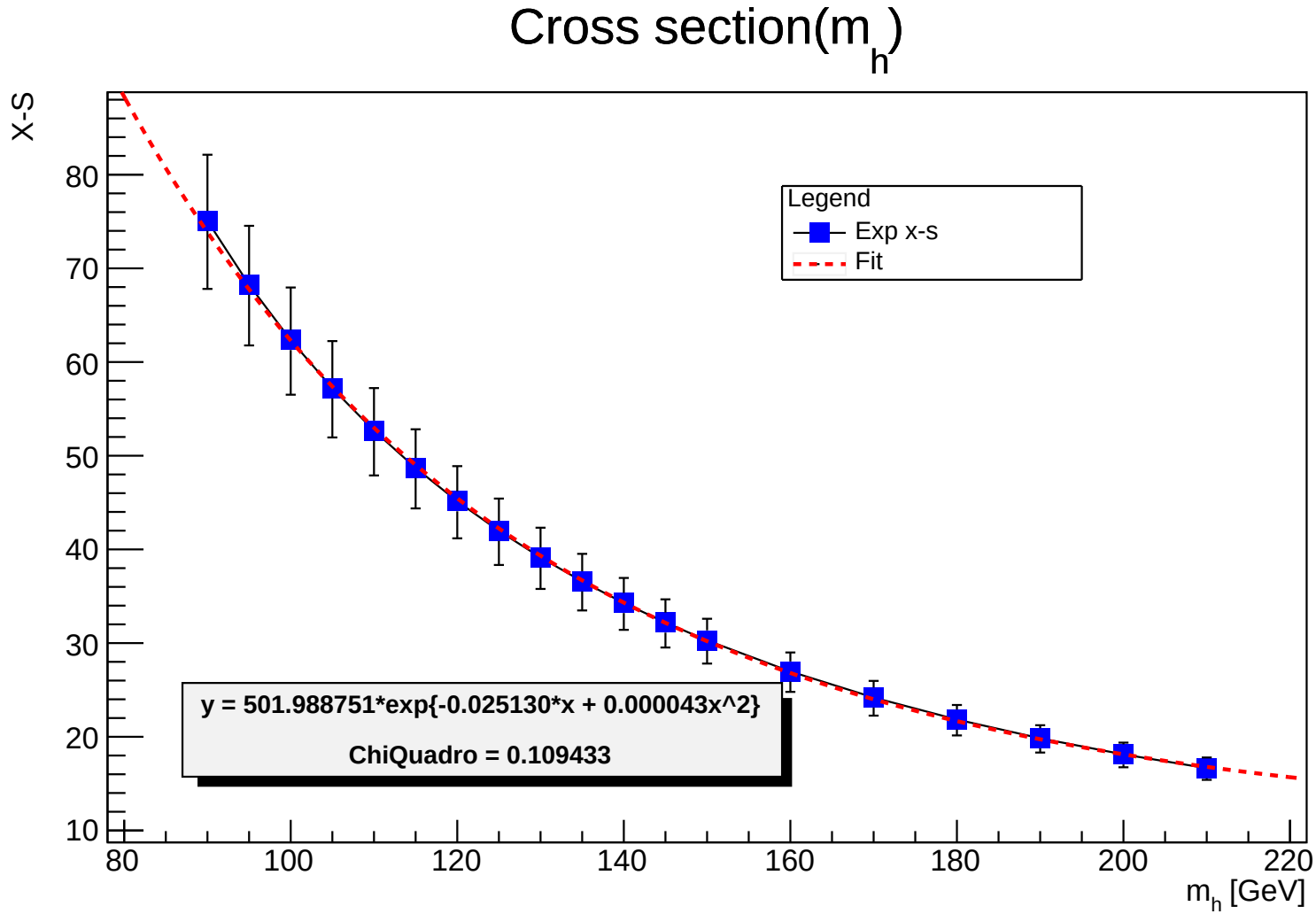
6° week

Efficiencies(m_H) fit



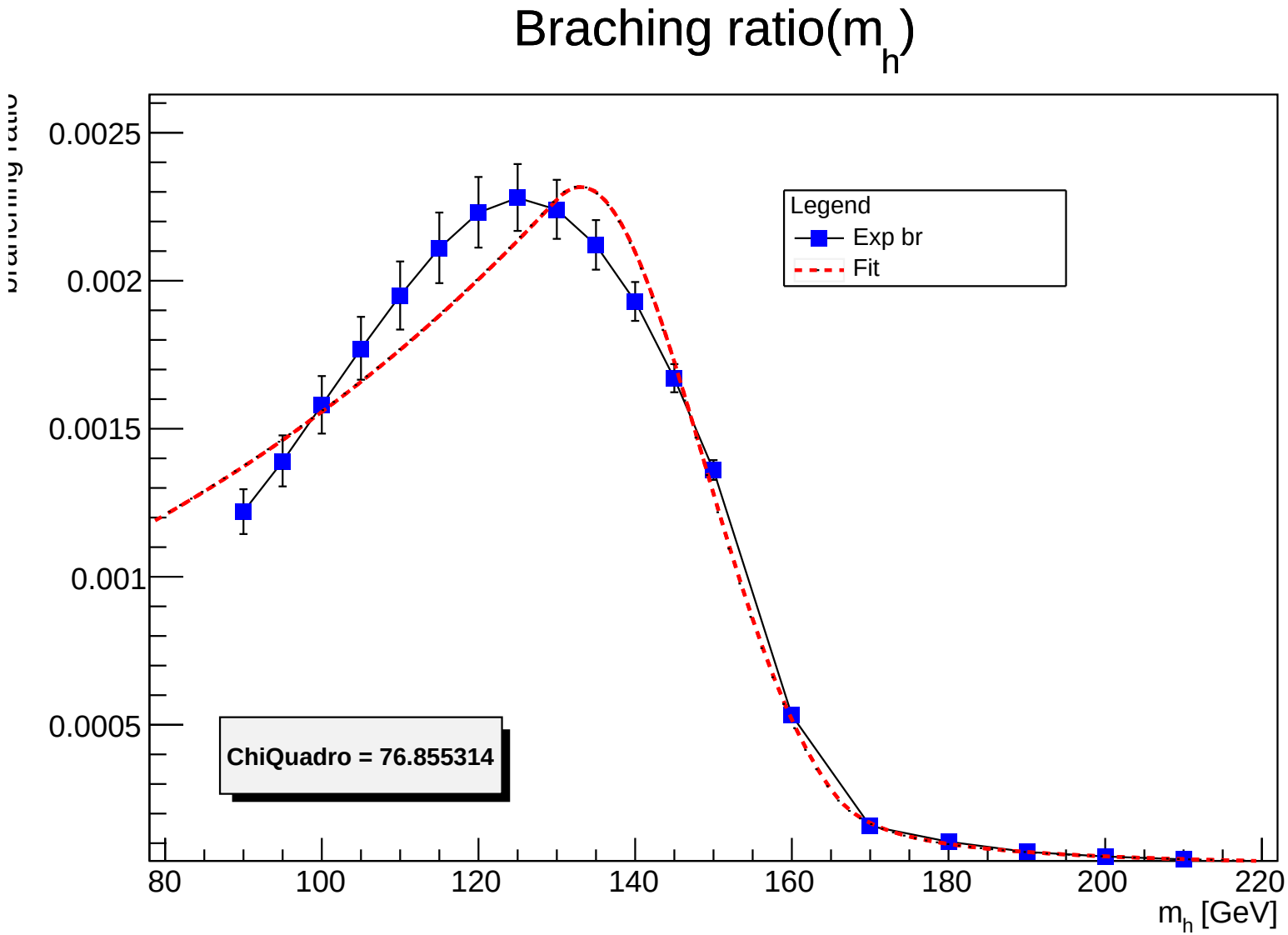
X-Section(mH)

x-section values –> link. Errors are evaluated using QCD and (Pdf+α) % errors (Quadratic sum).

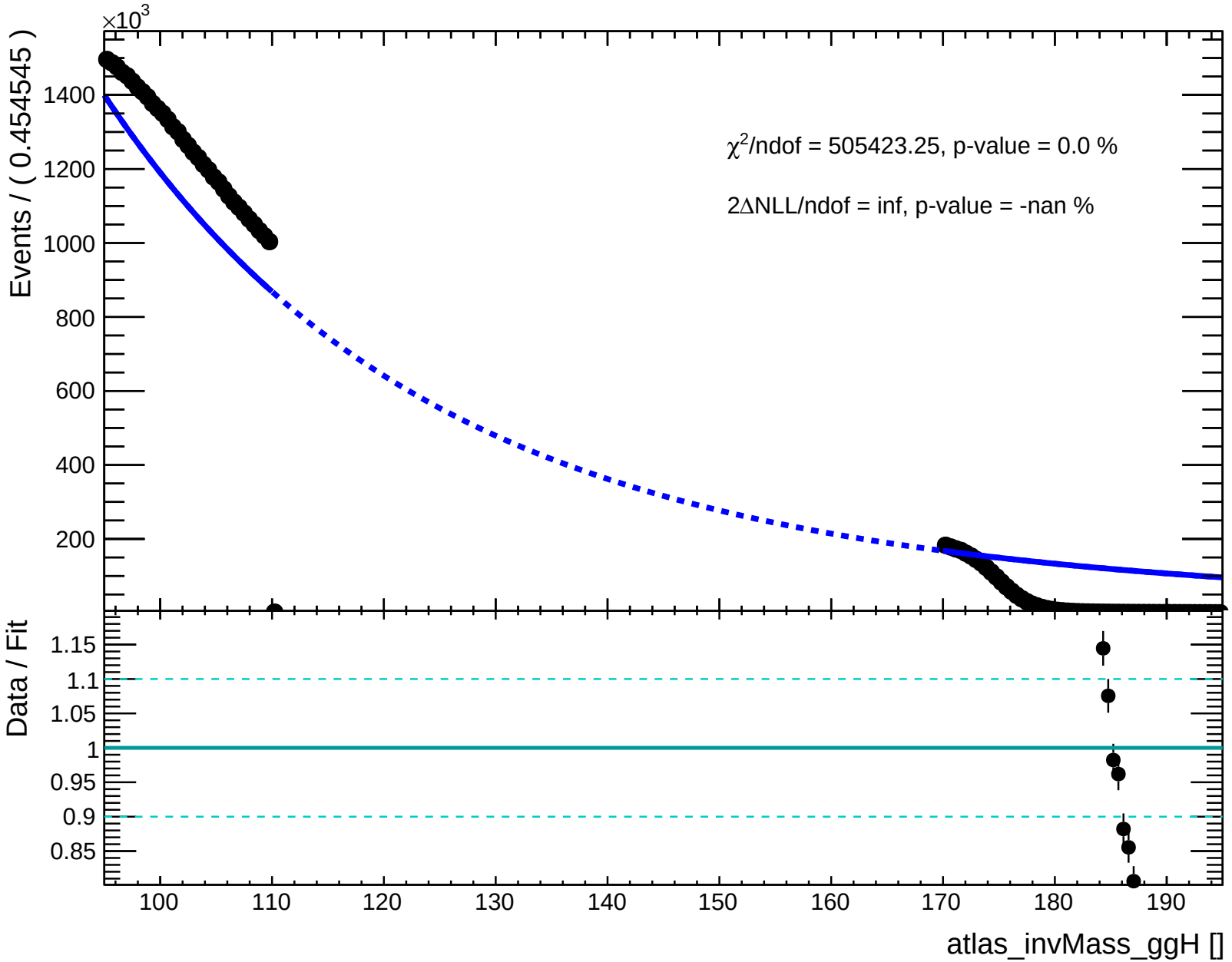


Branching Fraction(mH)

br values –> link.

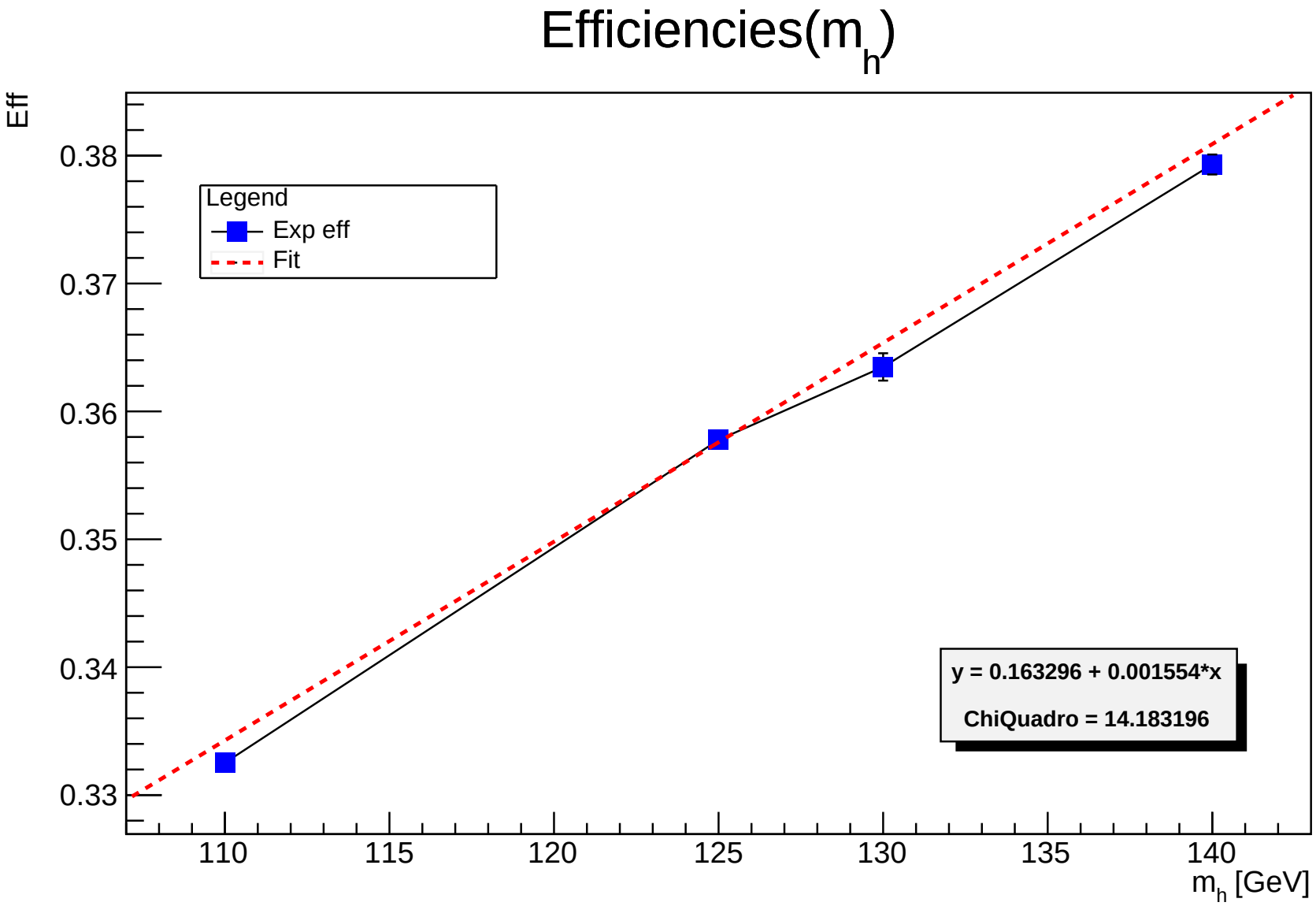


Workspace


×10^3
Events / (0.454545)
1400
1200
1000
800
600
400
200
χ²/ndof = 505423.25, p-value = 0.0 %
2ΔNLL/ndof = inf, p-value = -nan %
Data / Fit
1.15
1.1
1.05
1
0.95
0.9
0.85
100
110
120
130
140
150
160
170
180
190
atlas_invMass_ggH []

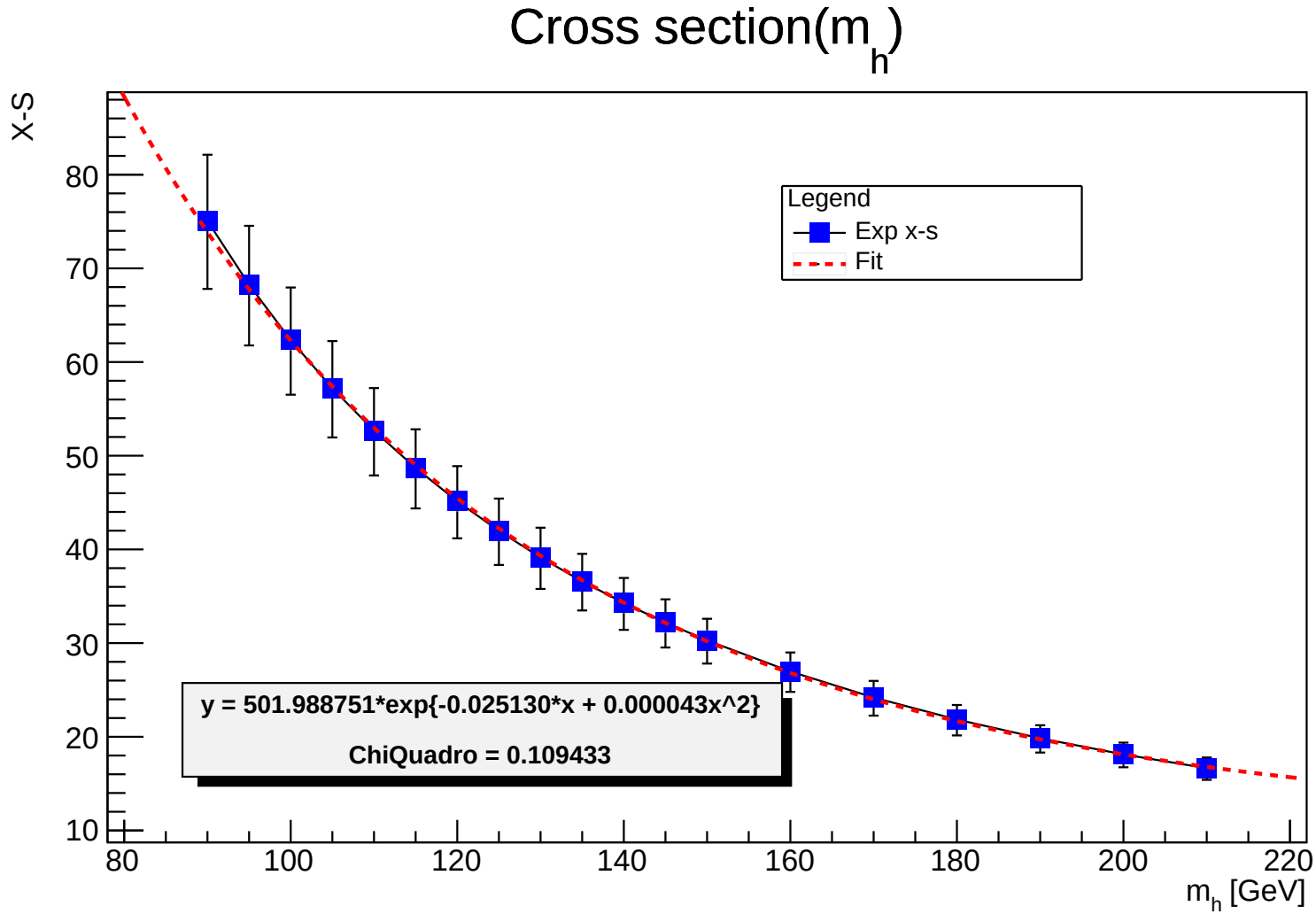
7° week

Efficiencies(m_H) fit



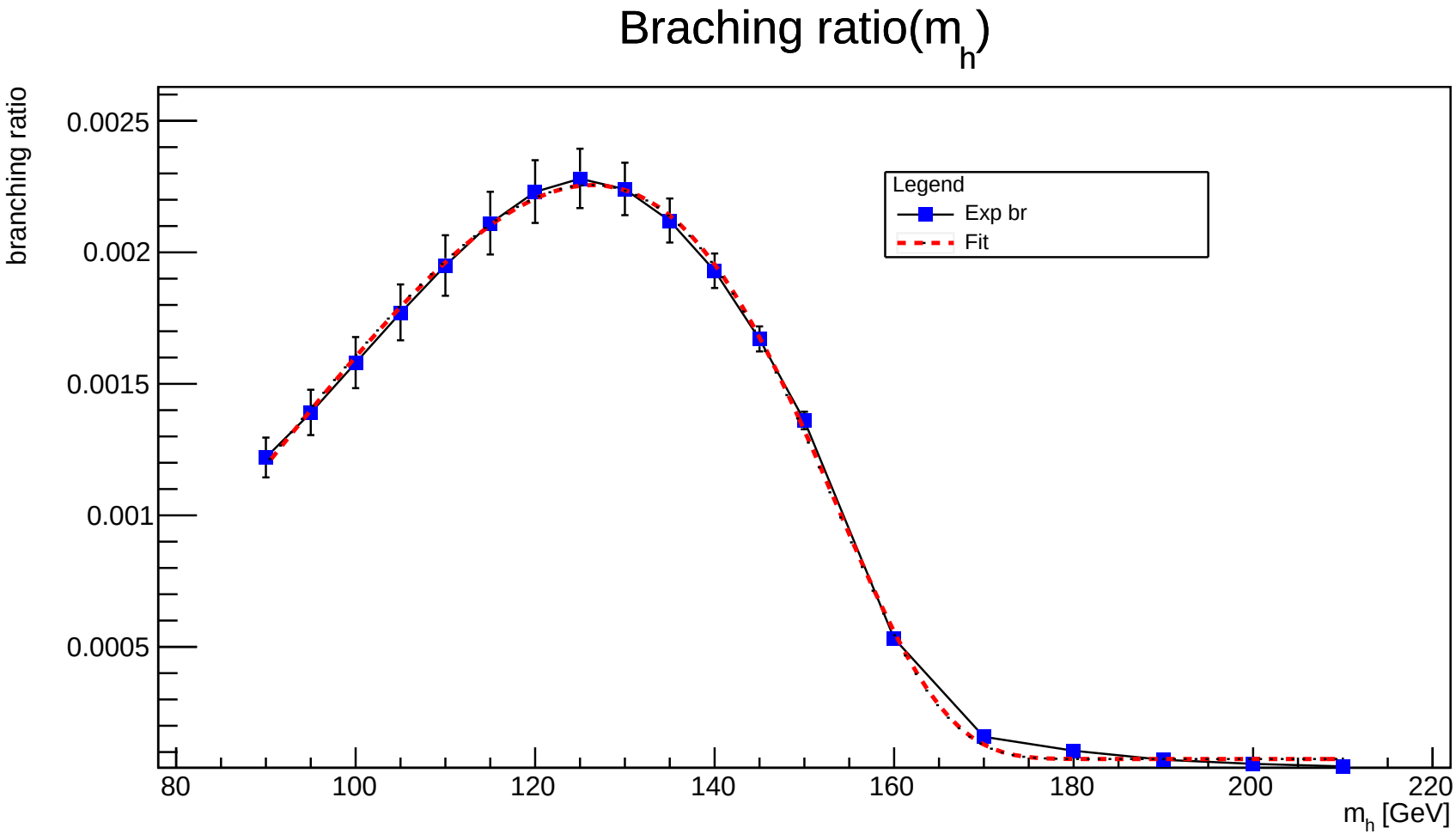
X-Section(mH)

x-section values –> link. Errors are evaluated using QCD and (Pdf+α) % errors (Quadratic sum).



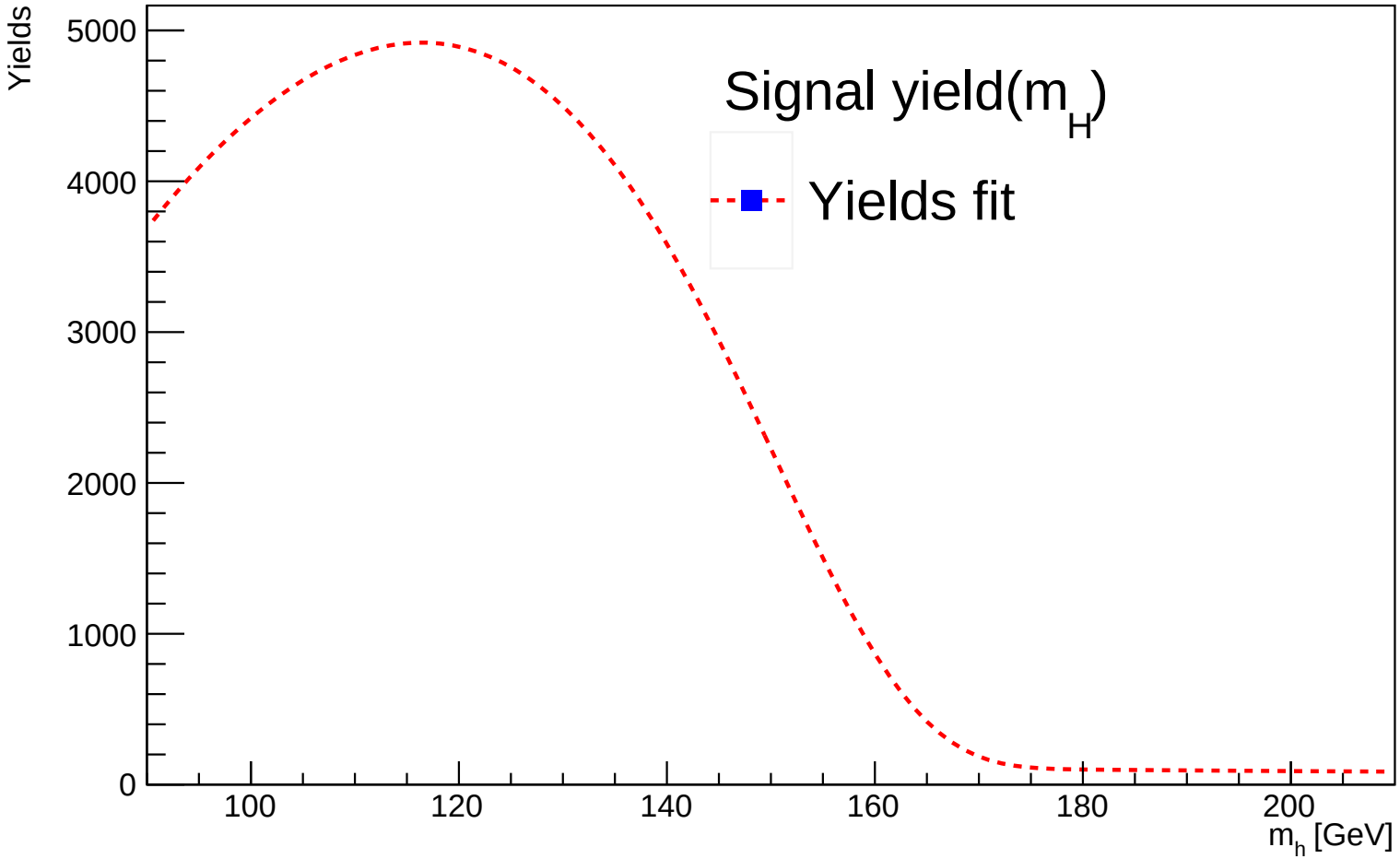
Branching Fraction(mH)

br values –> link.

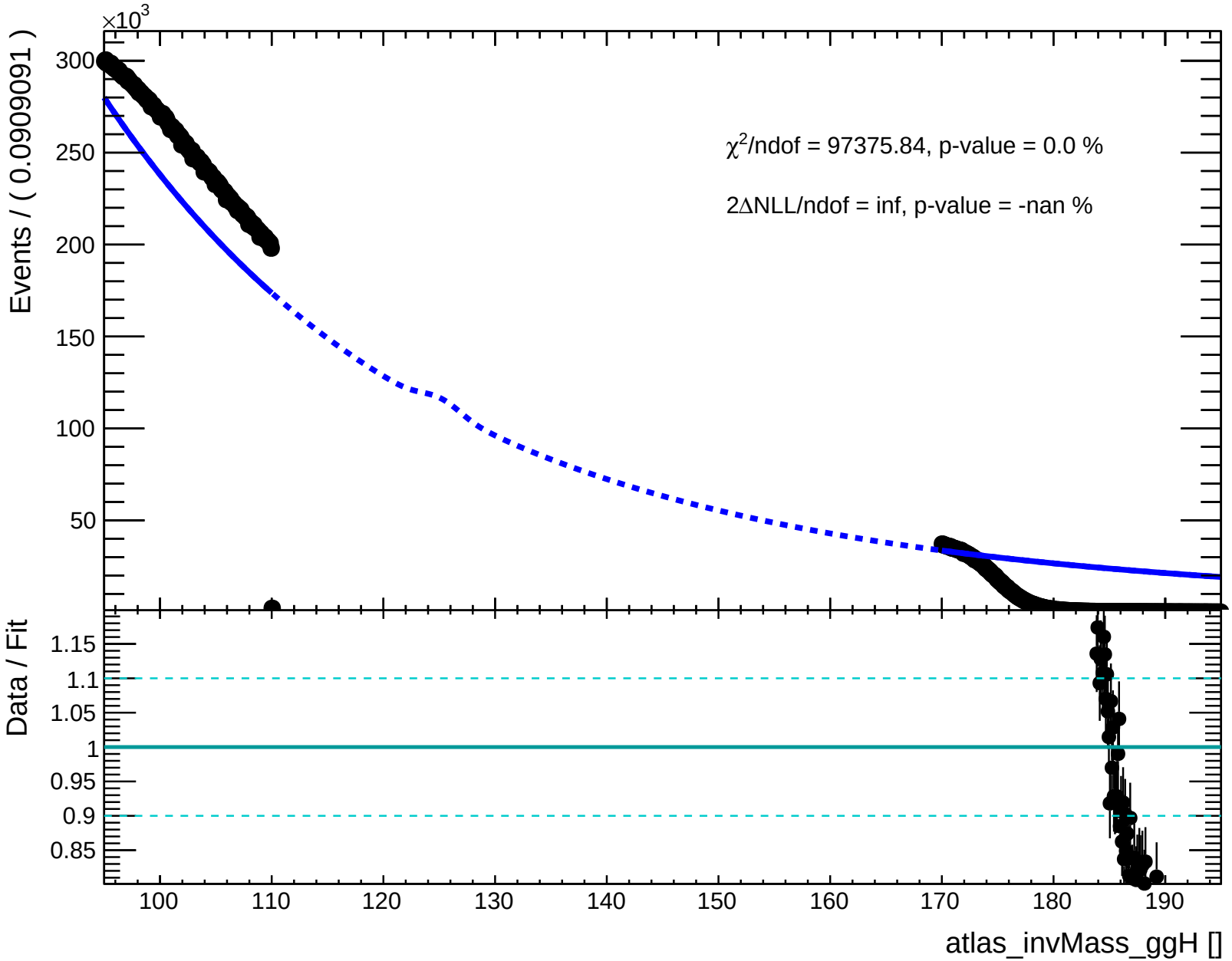


Check yields(mH)

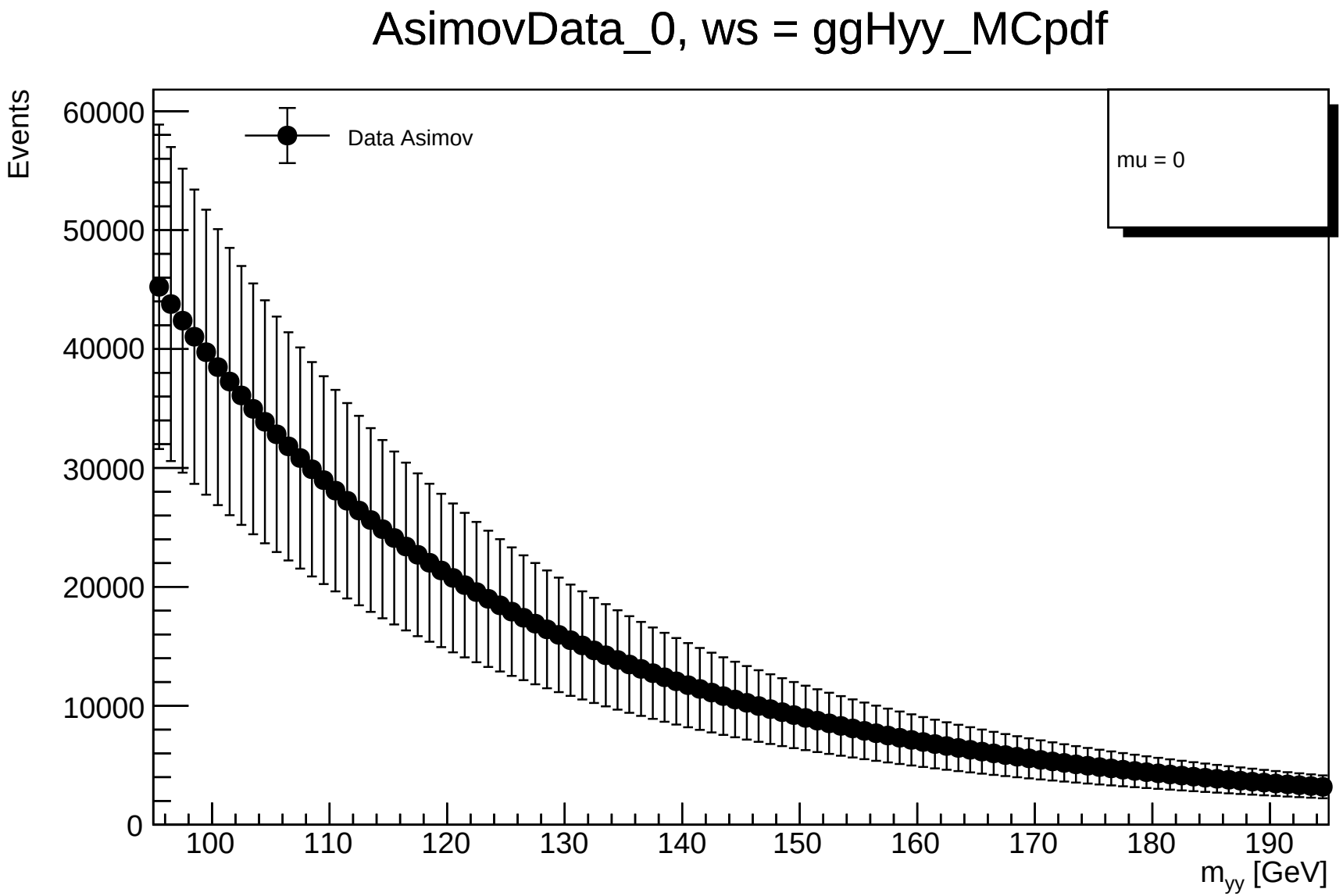
$$yield(mH) = xs(mH) \cdot eff(mH) \cdot br(mH) \cdot LumiRun2$$



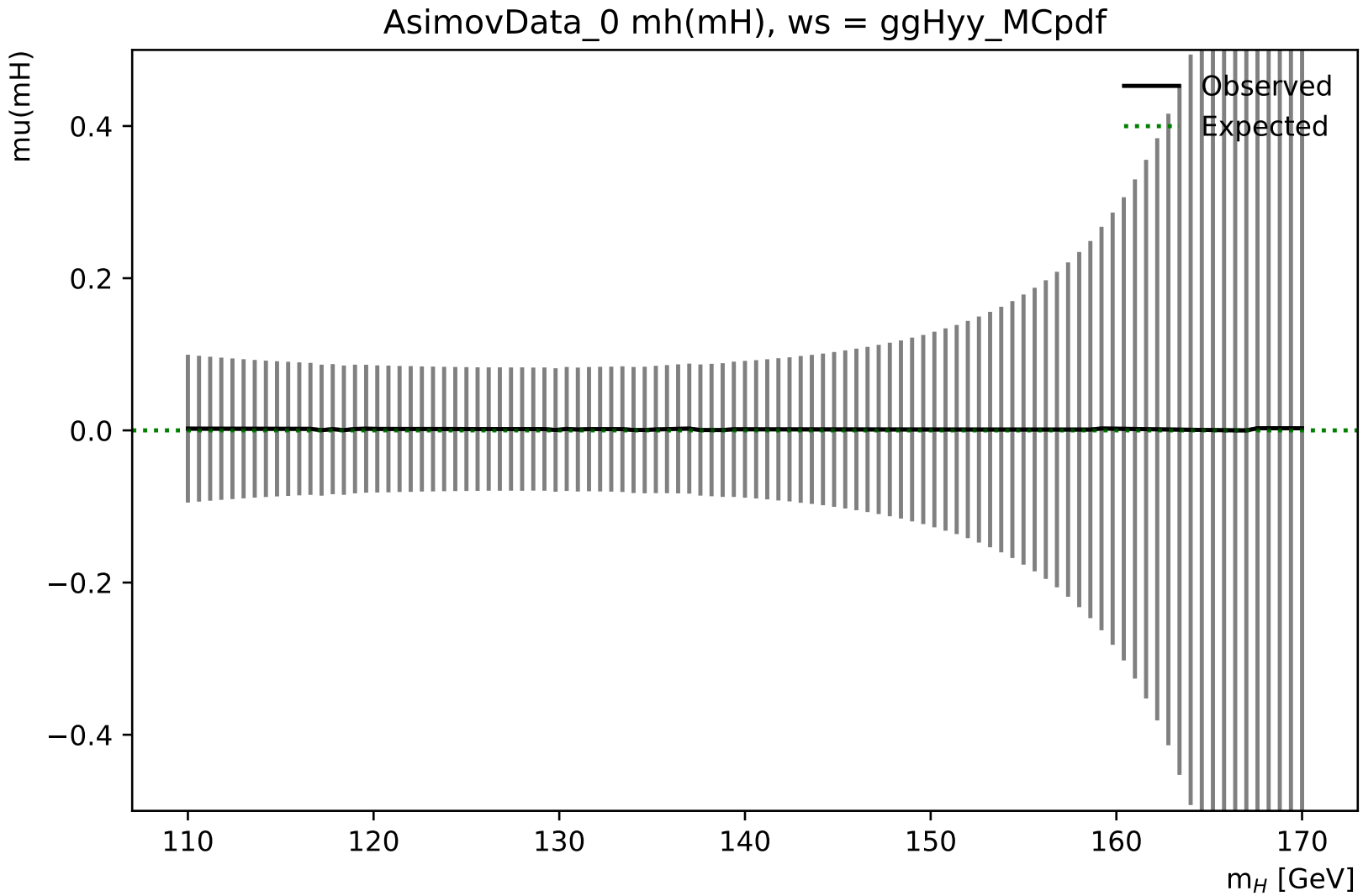
Workspace ggHyy_MCpdf



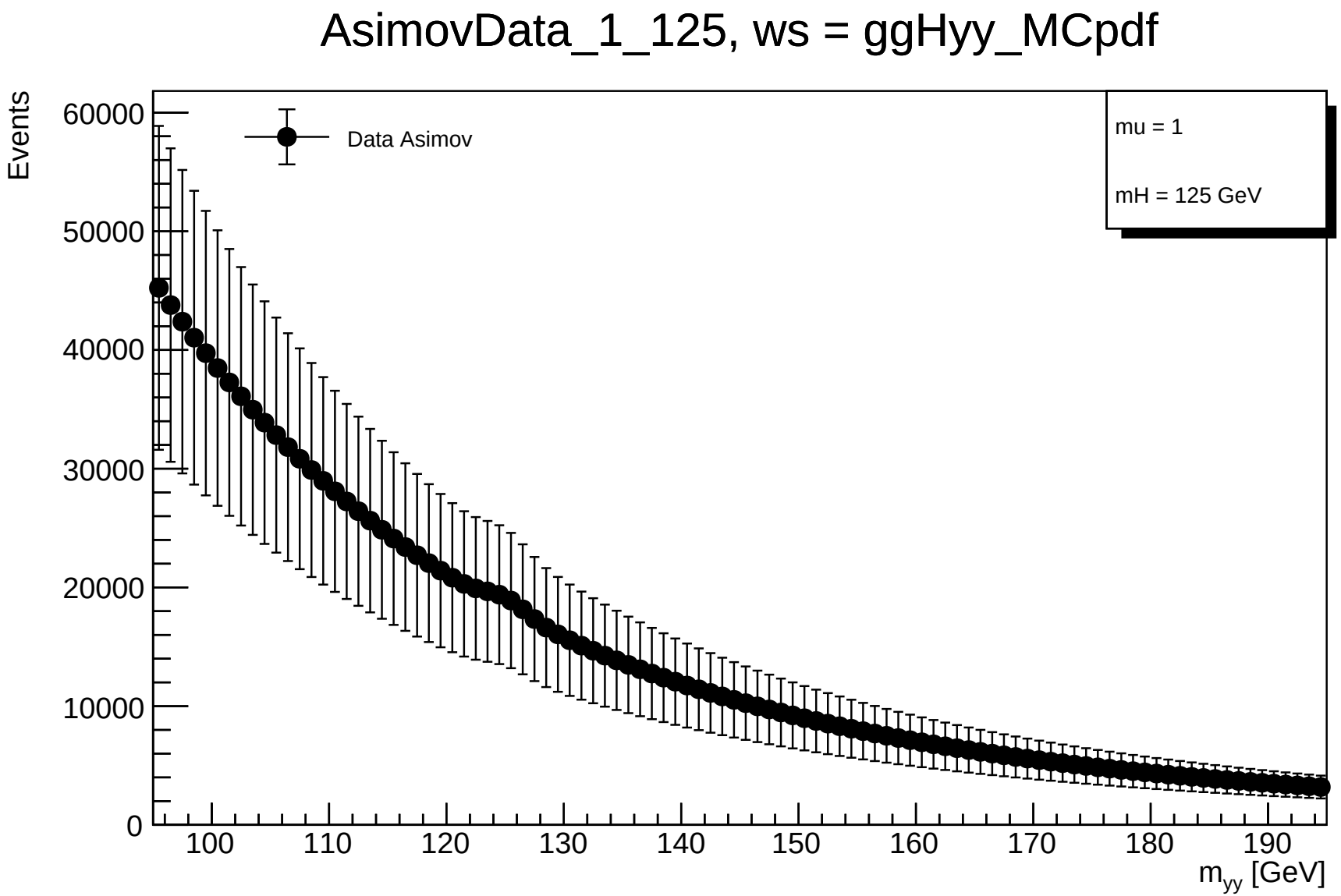
AsimovData μ=0, ggHyy_MCpdf



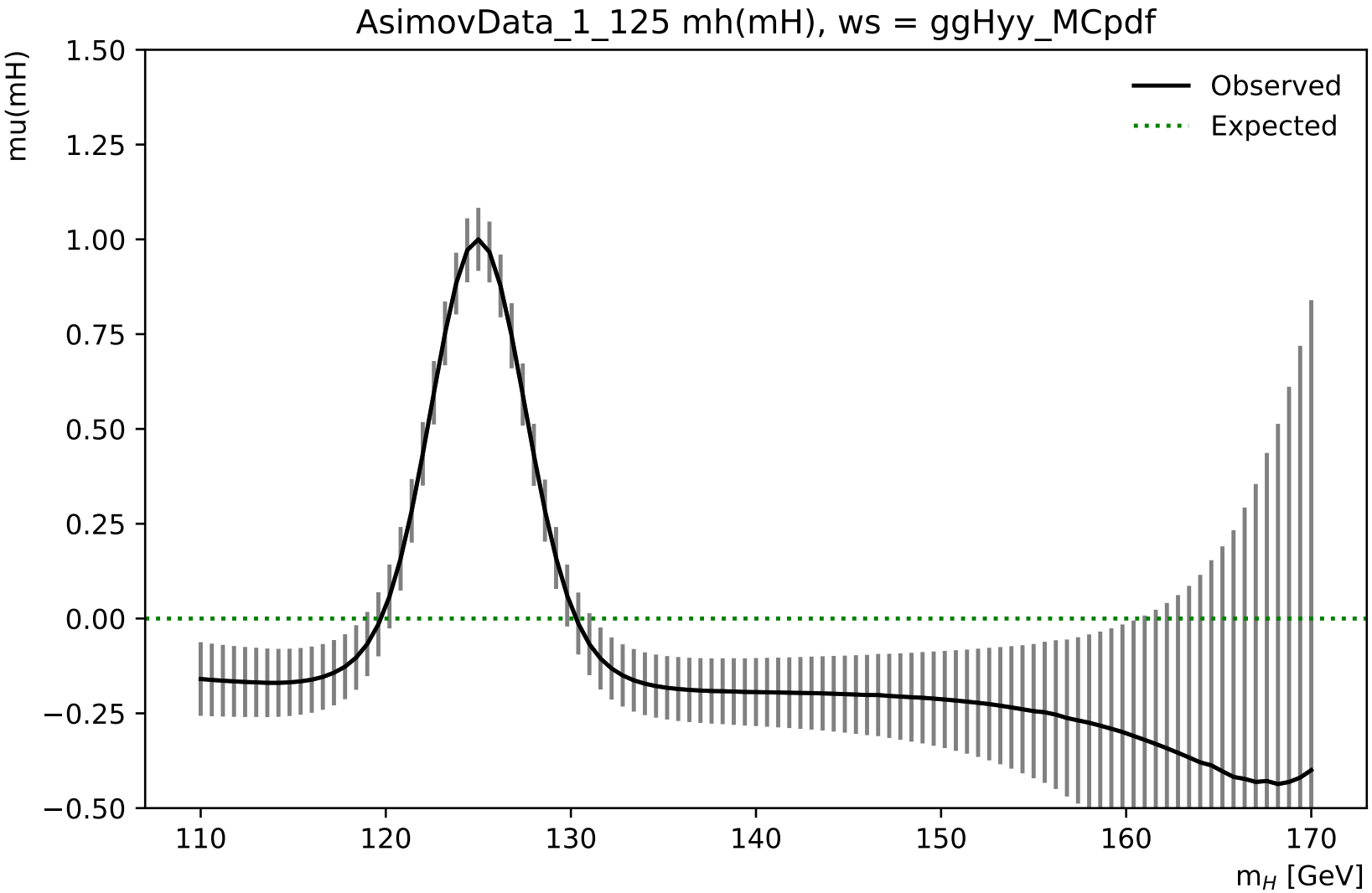
AsimovData $\mu(m_H)$, ggHyy_MCpdf



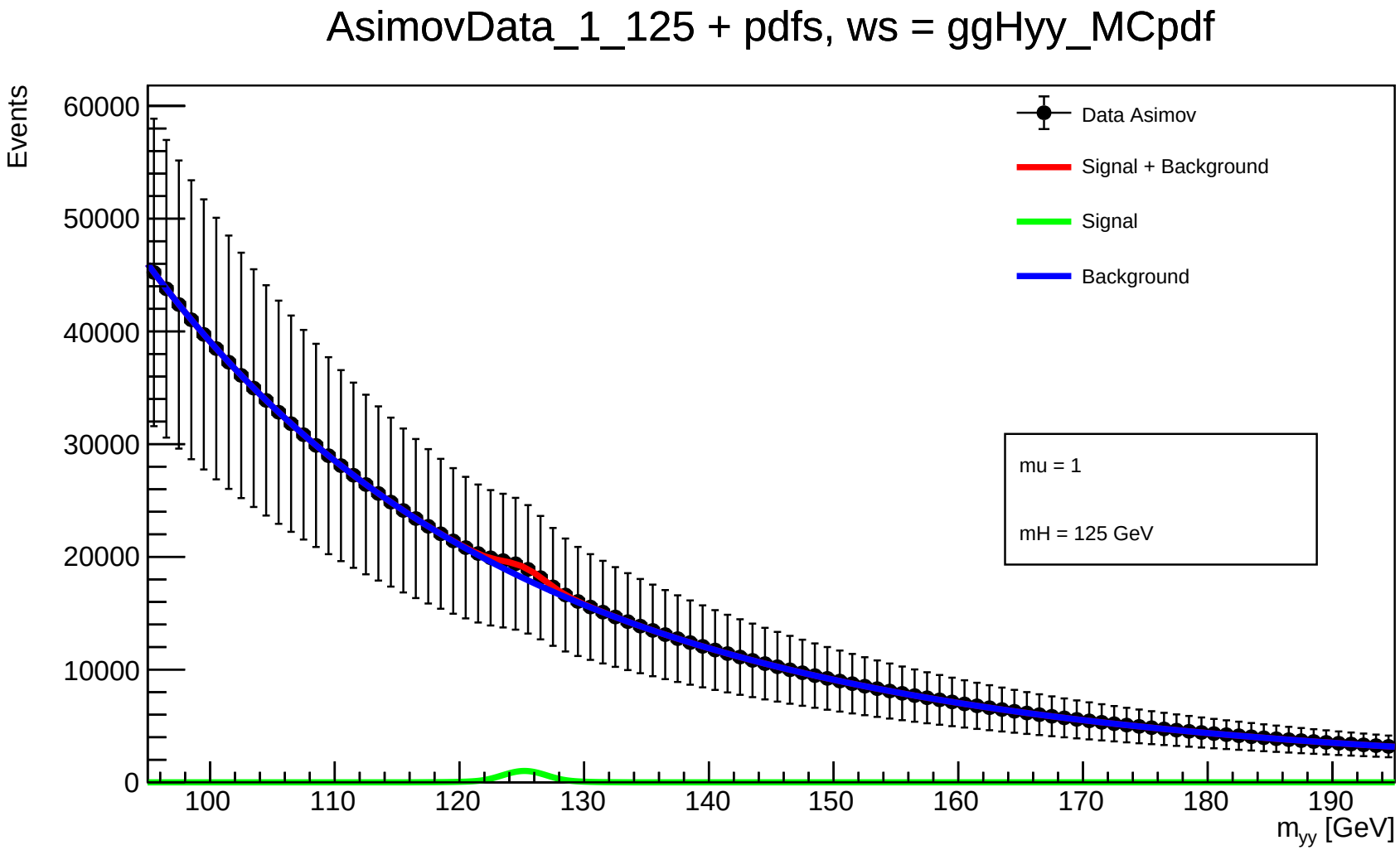
AsimovData μ=1, m_H=125, ggHyy_MCpdf



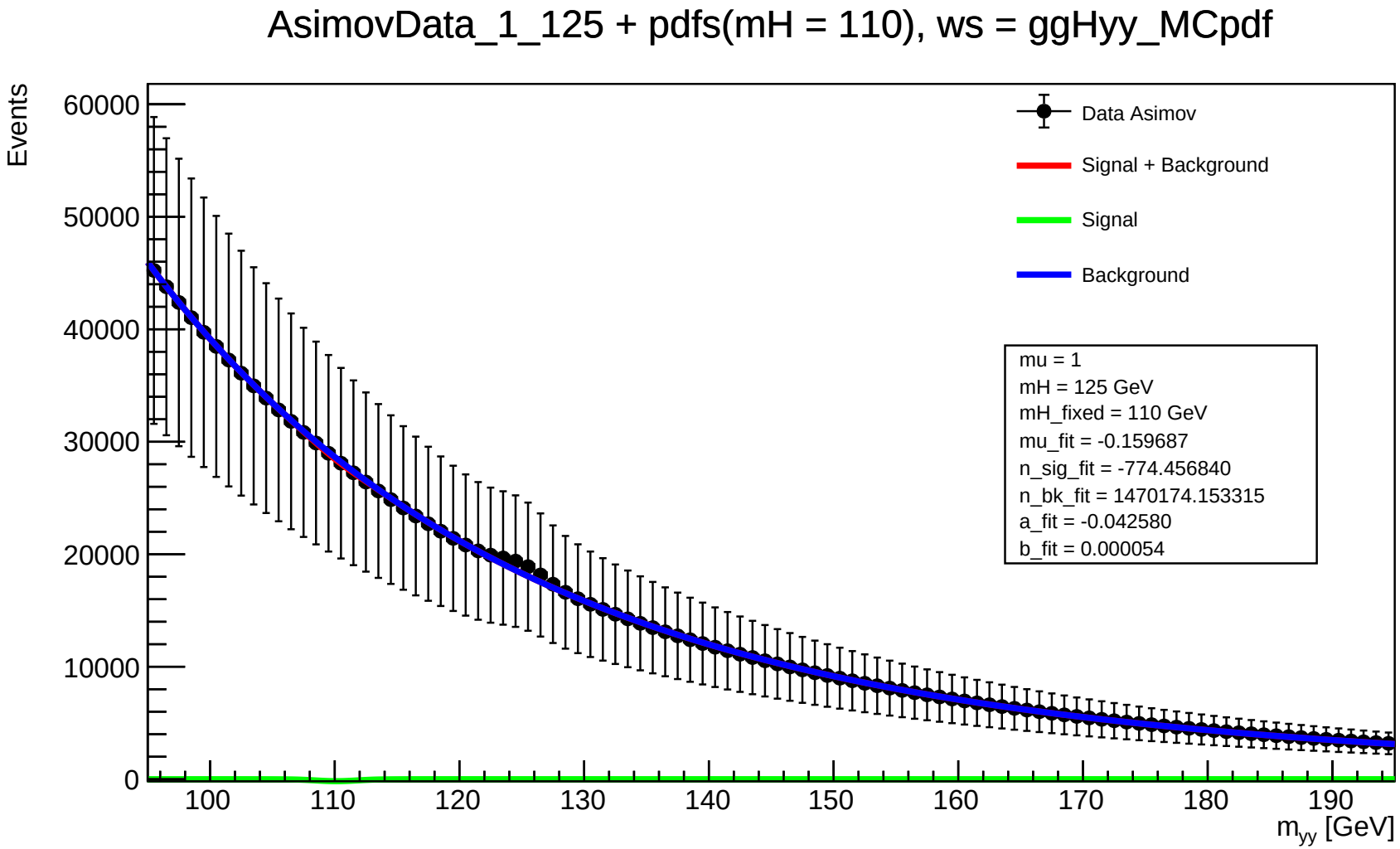
AsimovData $\mu(m_H)$, ggHyy_MCpdf



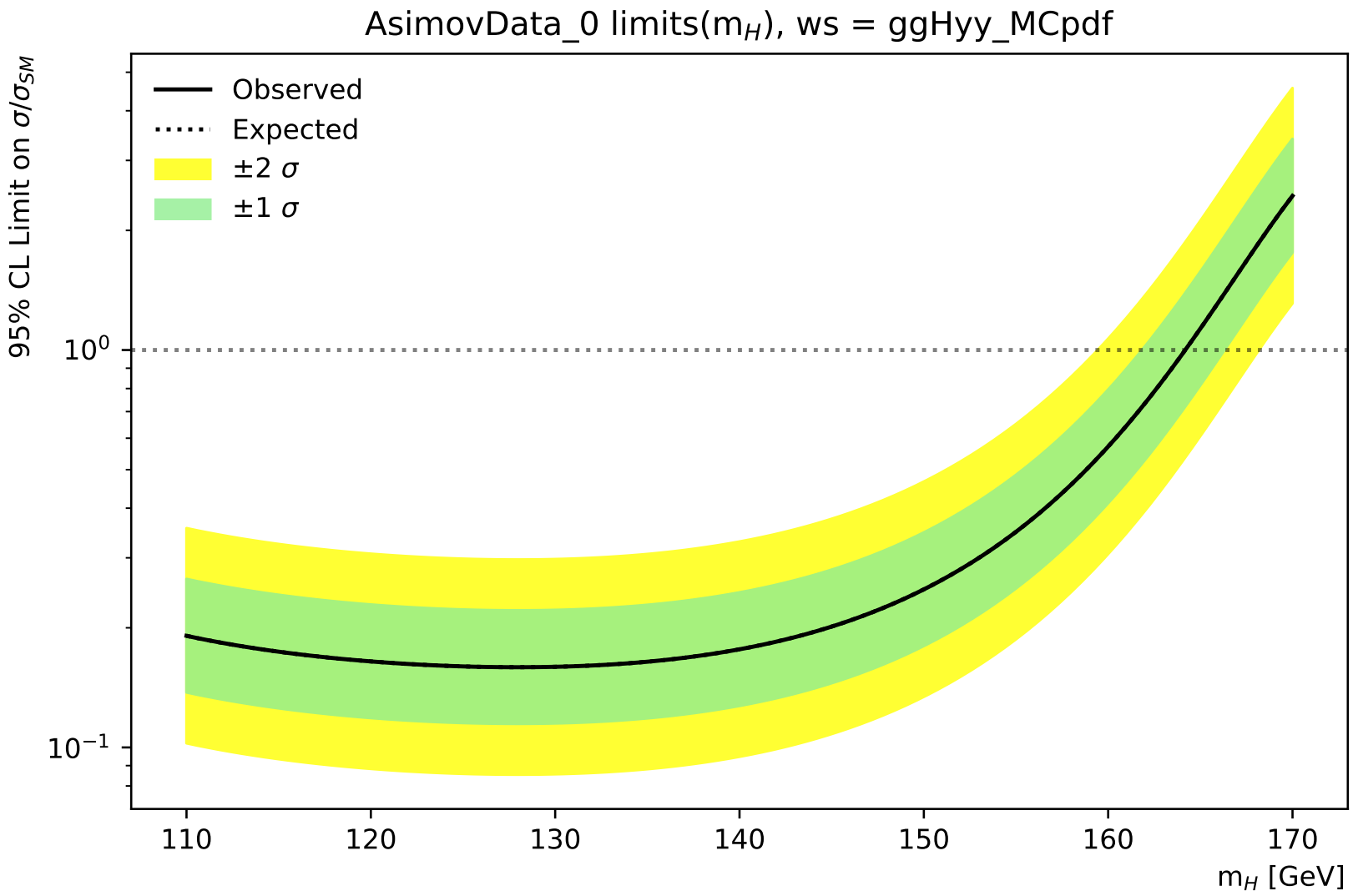
AsimovData μ=1, m_H=125 + fit, ggHyy_MCpdf



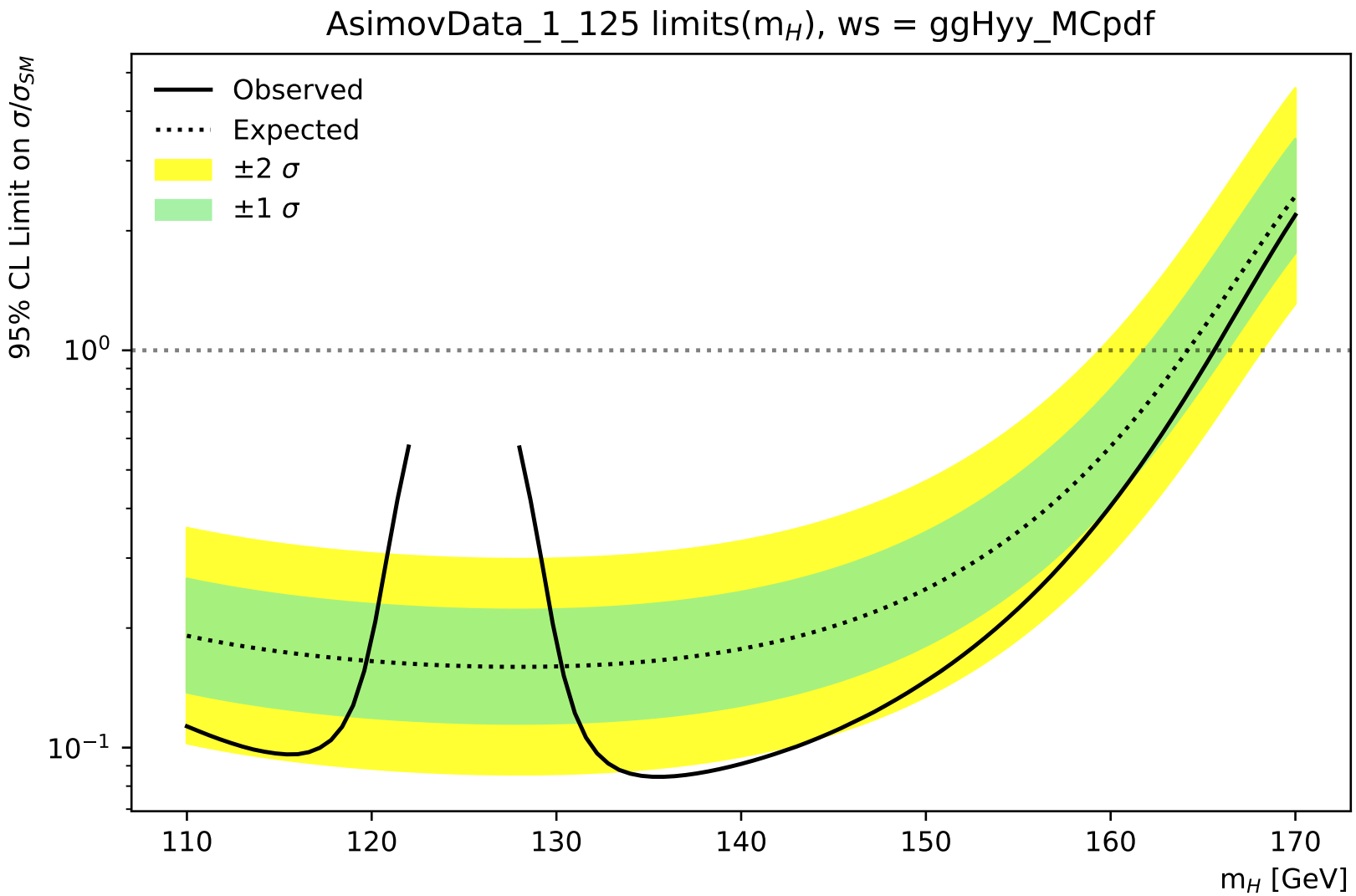
AsimovData μ=1, m_H=125 + fit(mH=110), ggHyy_MCpdf



AsimovData μ=0 limits



AsimovData μ=1, m_H=125 limits



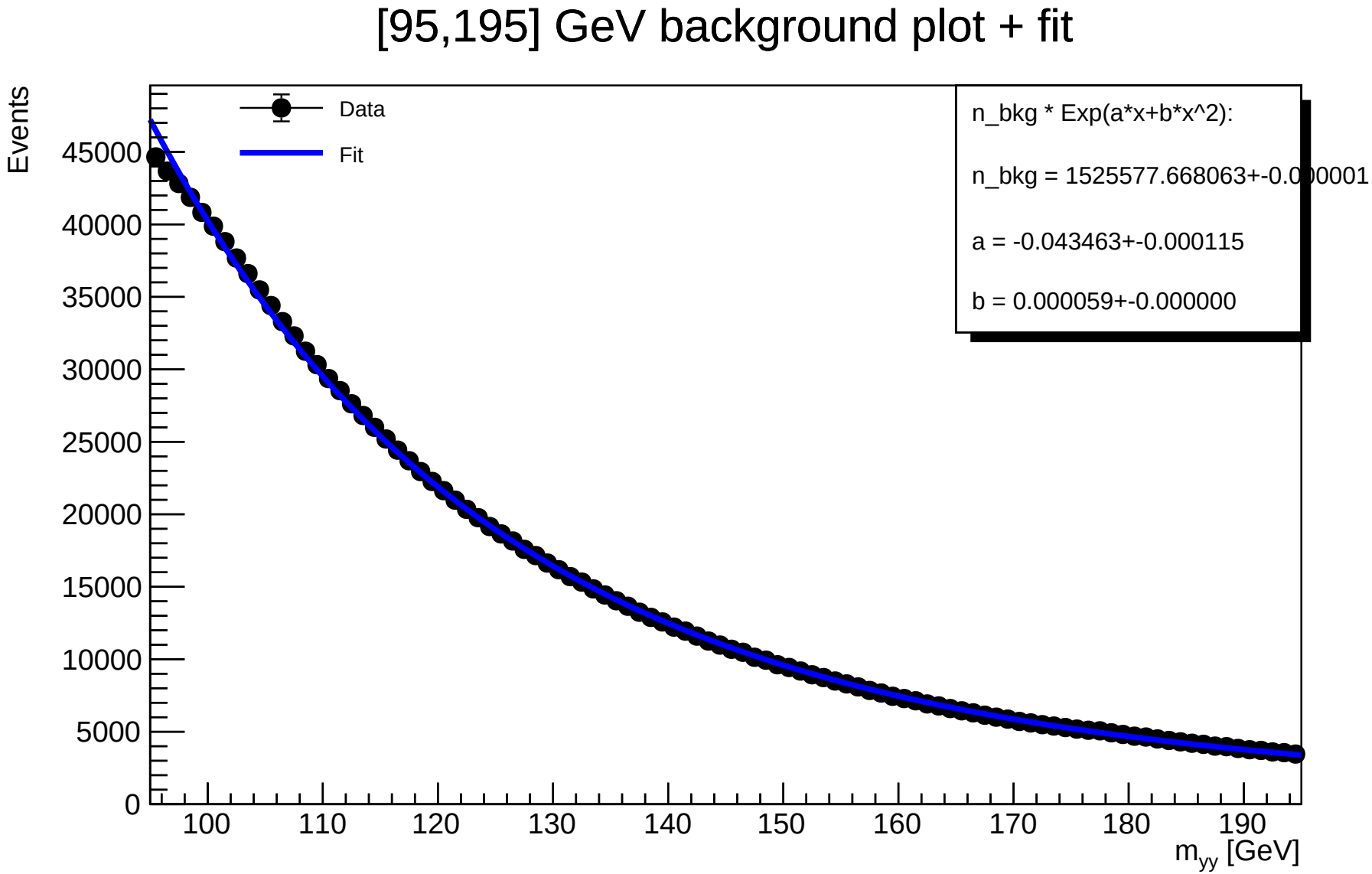
8° week

Background [95,195] GeV

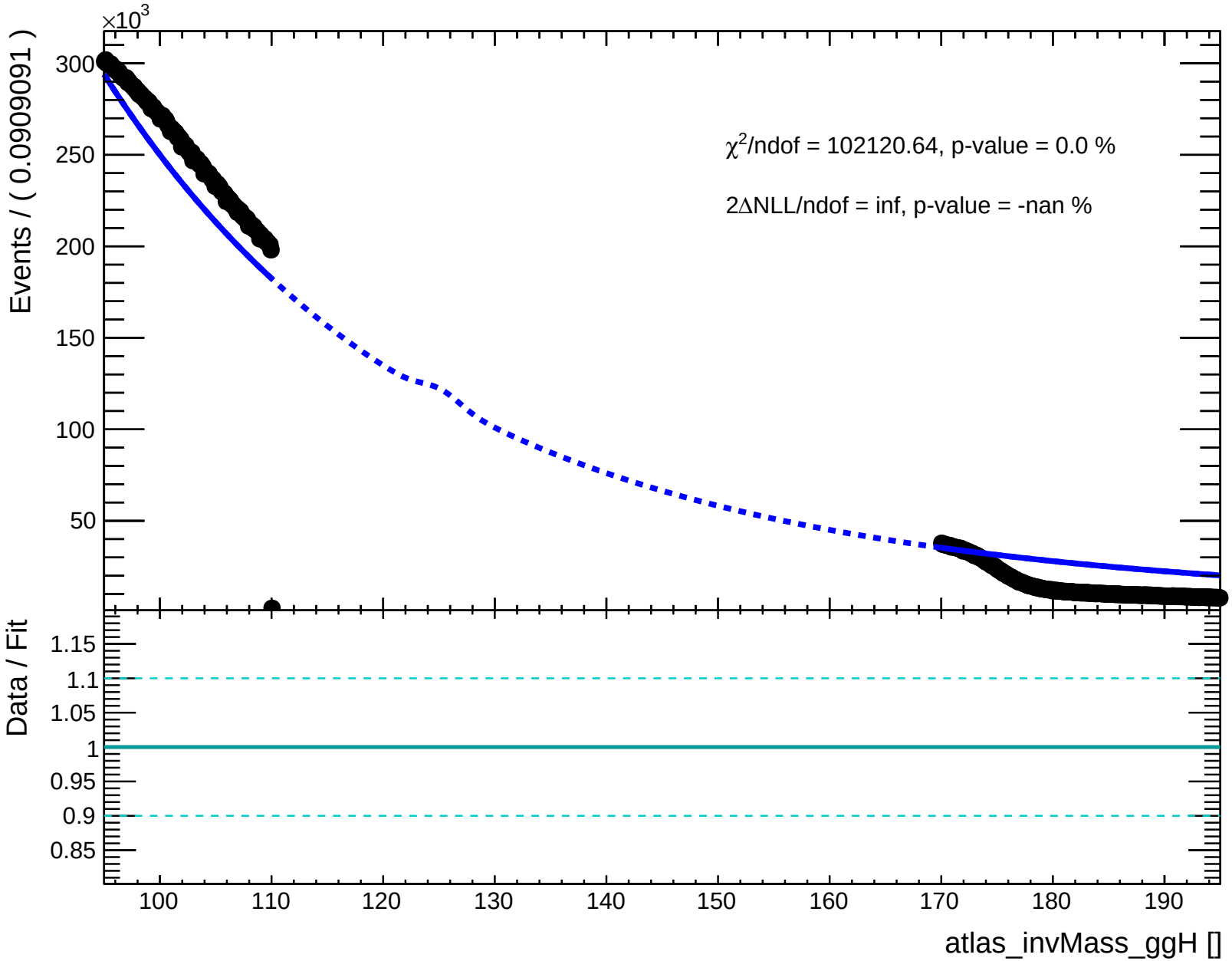
I have merged 3 MC ntuple samples in [95,195] GeV:

- Sherpa2_myy_50_90.root;
- Sherpa2_myy_90_175.root;
- Sherpa2_myy_175_2000.root;

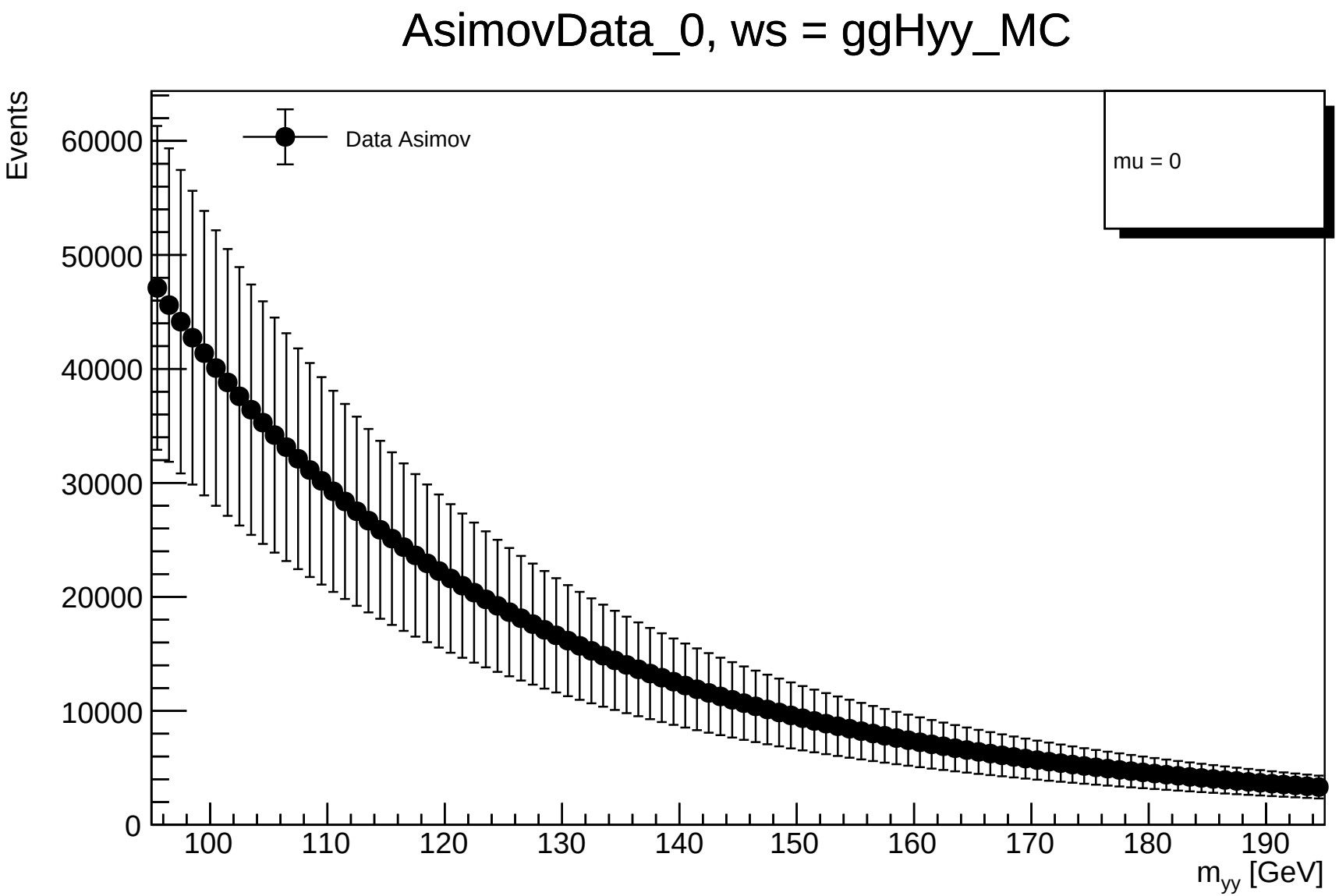
Background [95,195] GeV plot + bkg_fit



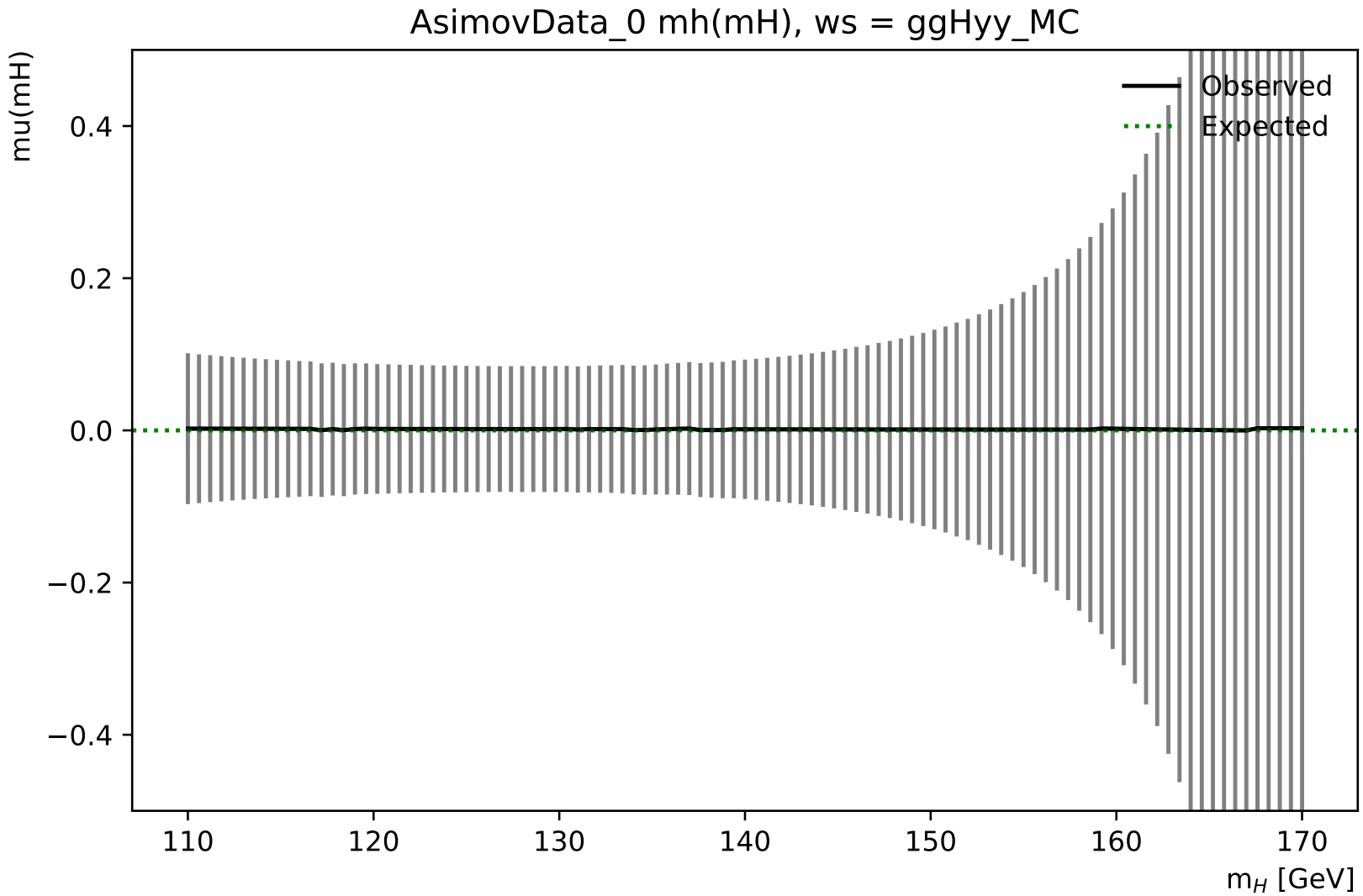
Workspace ggHyy_MC



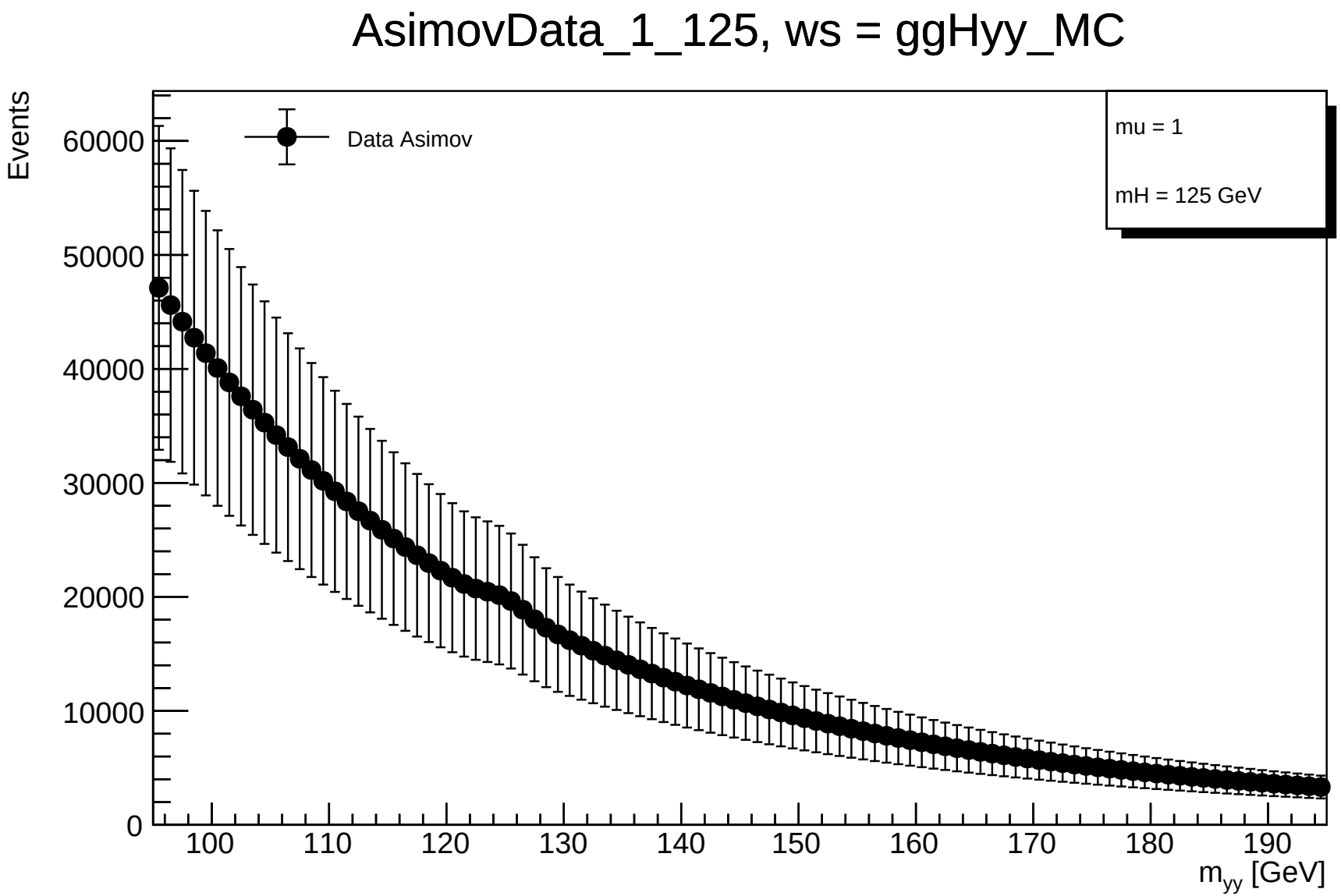
AsimovData μ=0, ggHyy_MC



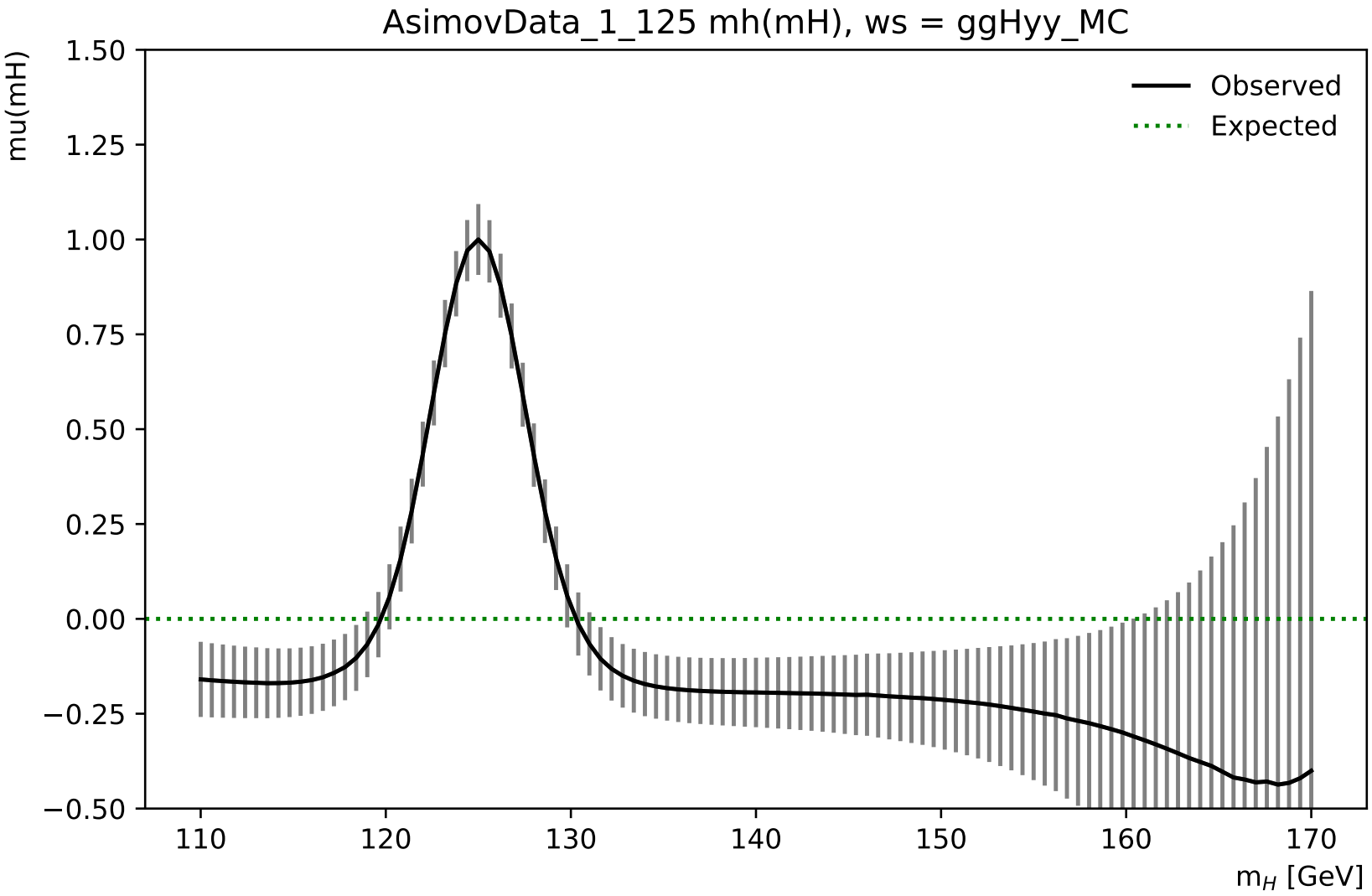
AsimovData $\mu(m_H)$, ggHyy_MC



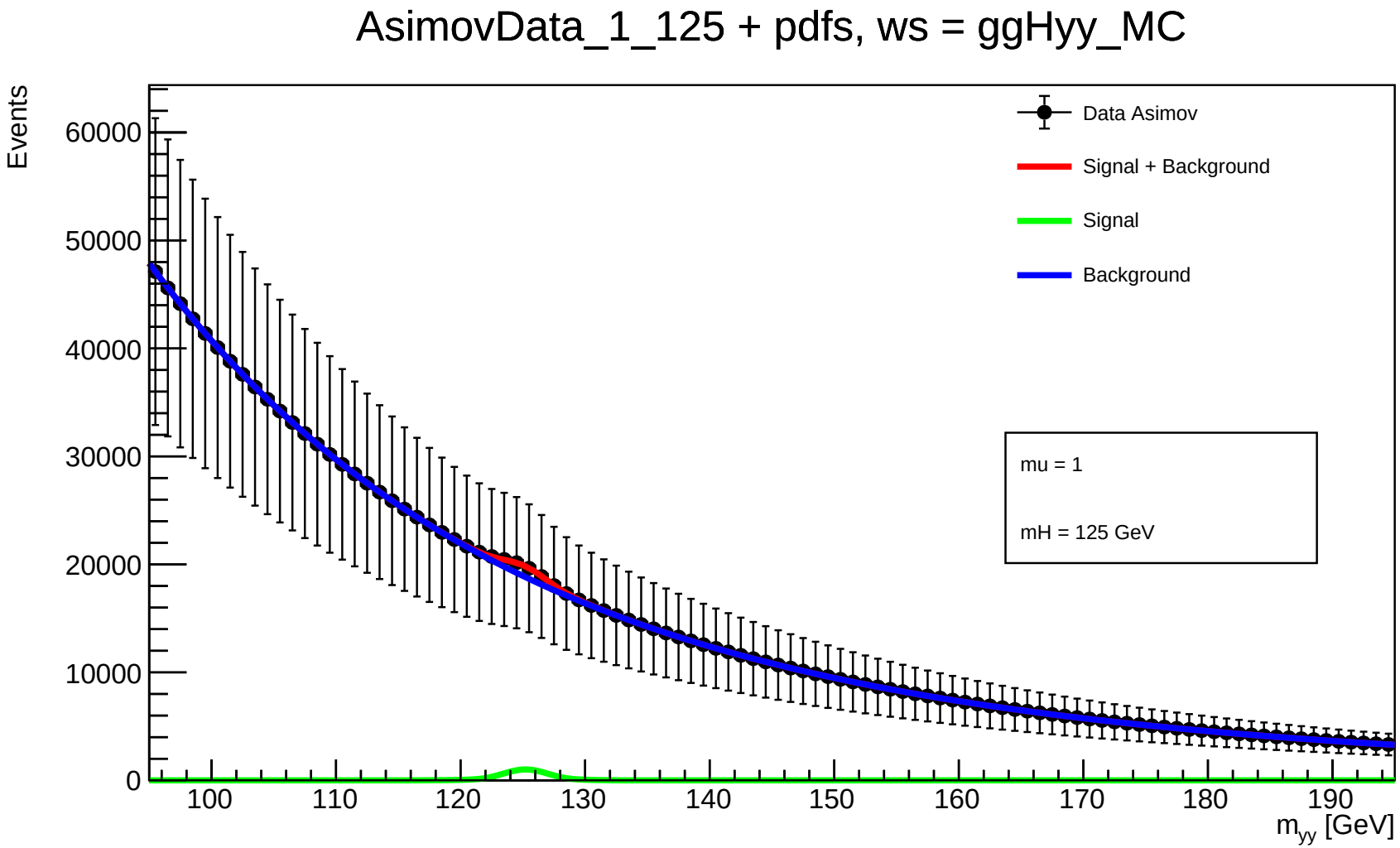
AsimovData μ=1, m_H=125, ggHyy_MC



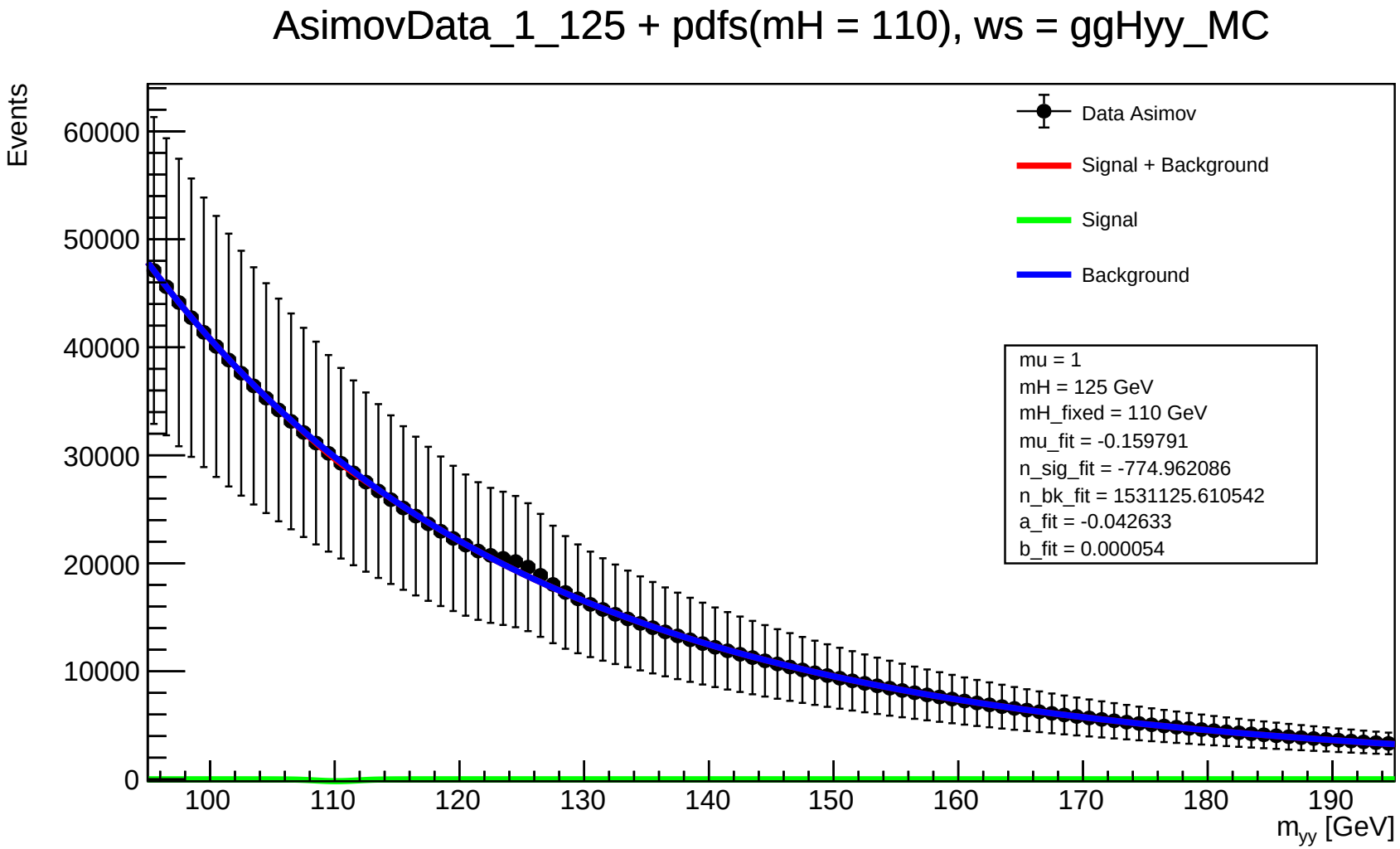
AsimovData $\mu(m_H)$, ggHyy_MC



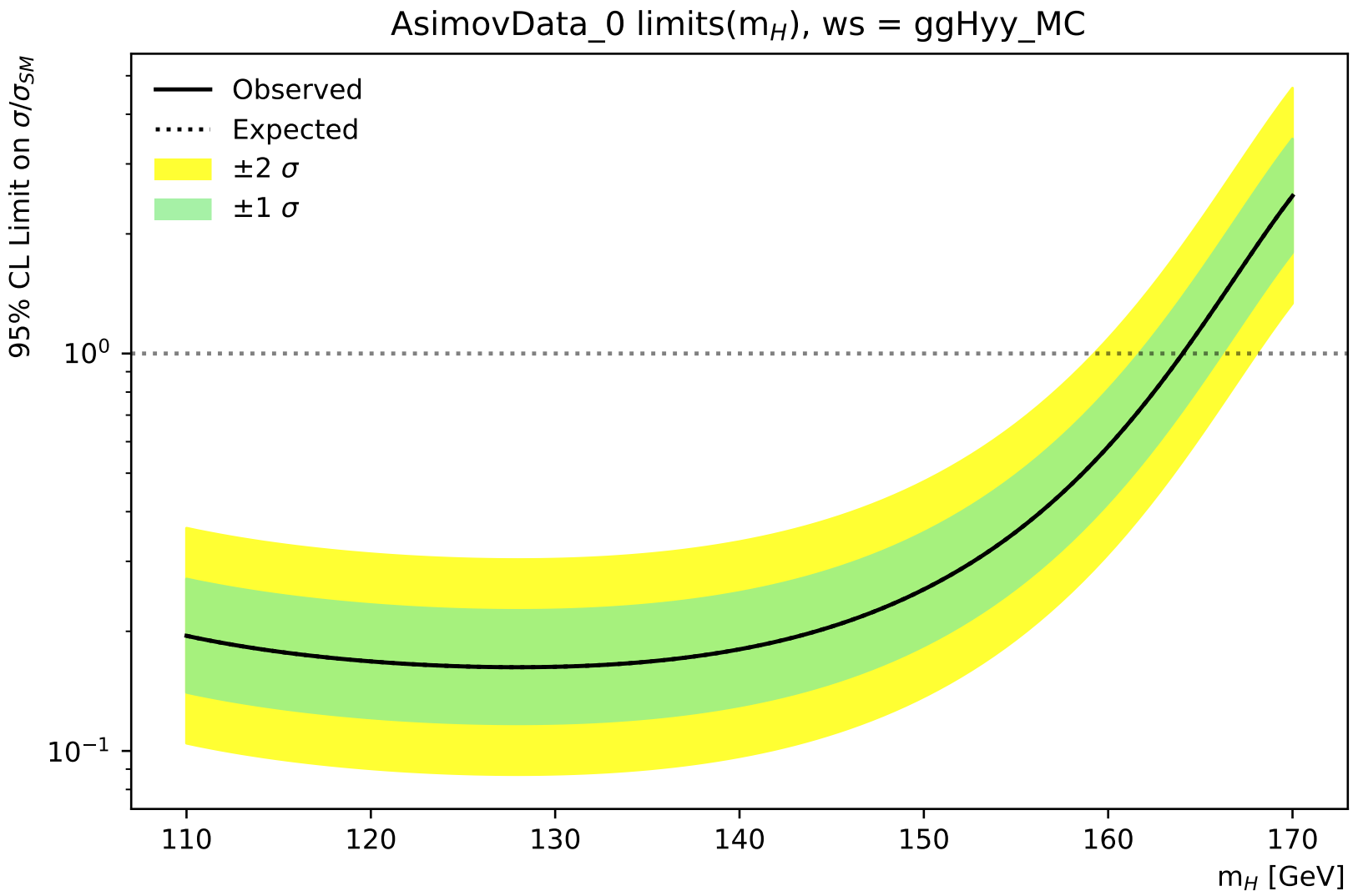
AsimovData μ=1, m_H=125 + fit, ggHyy_MC



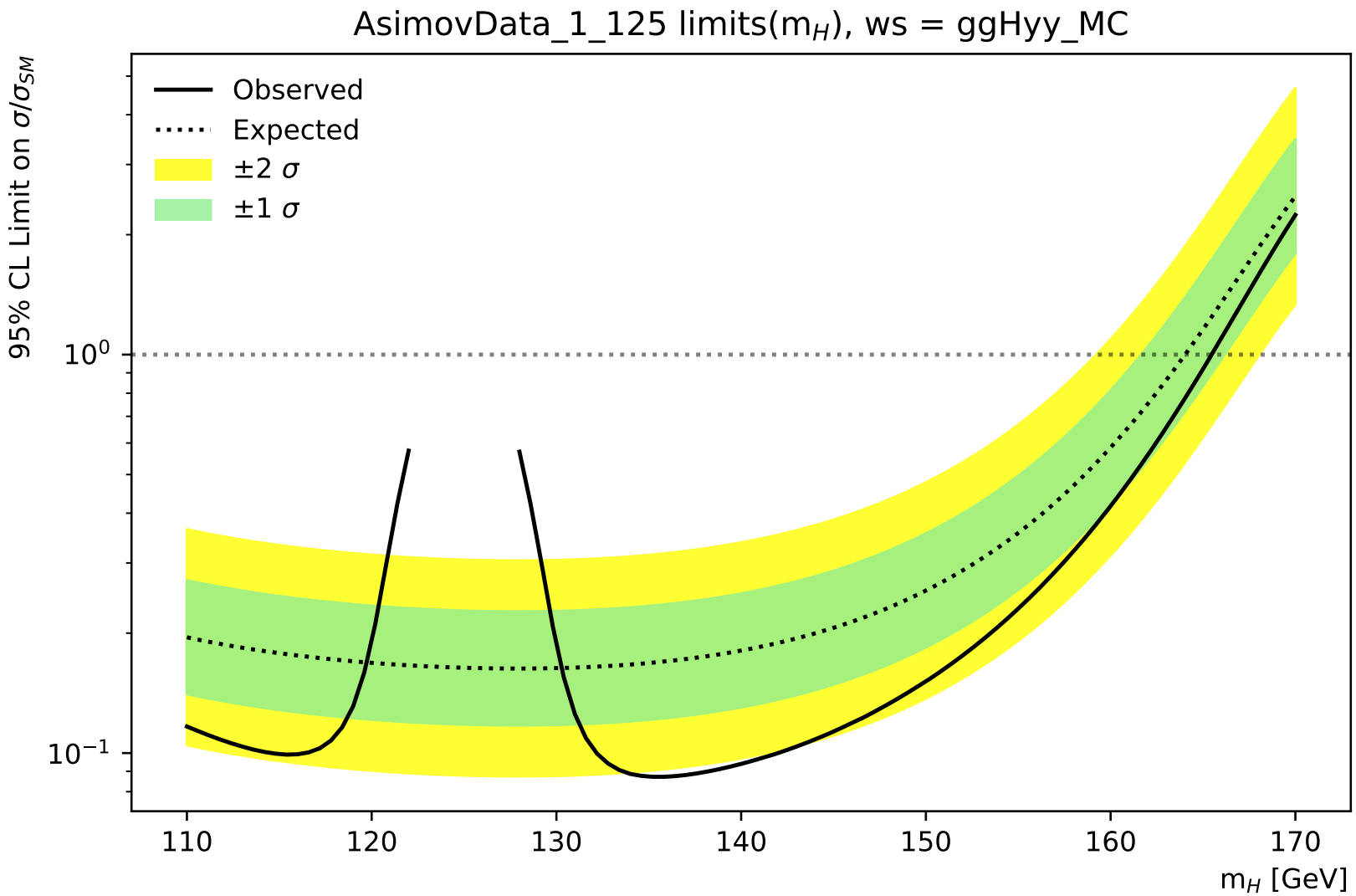
AsimovData μ=1, m_H=125 + fit(mH=110), ggHyy_MC



AsimovData μ=0 limits

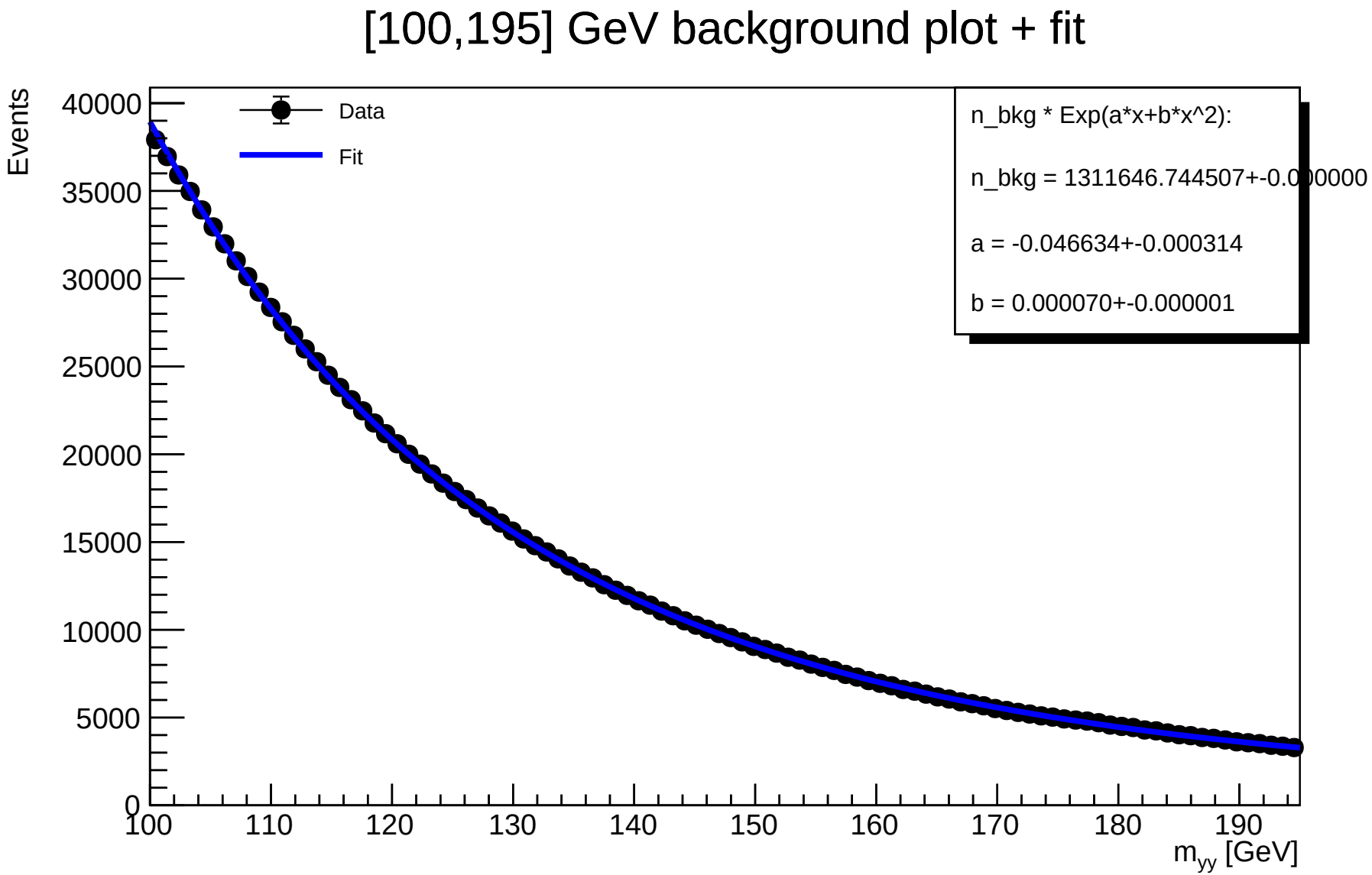


AsimovData μ=1, m_H=125 limits



9° week

Background [100,195] GeV plot + bkg_fit



Categories

- **unconv**: 2 unconv photons (ph*_Rconv ϵ]0,800[mm)
- **1_conv**: only 1 conv photon (ph*_Rconv ϵ (0,800) mm)
- **eta_1**: 2 phs in the inner eta region (|ph*_eta|<0.75)
- **eta_2**: at least 1 ph in the trans eta region (1.3<|ph*_eta|<1.37, 1.52<|ph*_eta|<1.75)
- **eta_3**: 2 phs in ext eta region (|ph*_eta|>1.75)

Categories

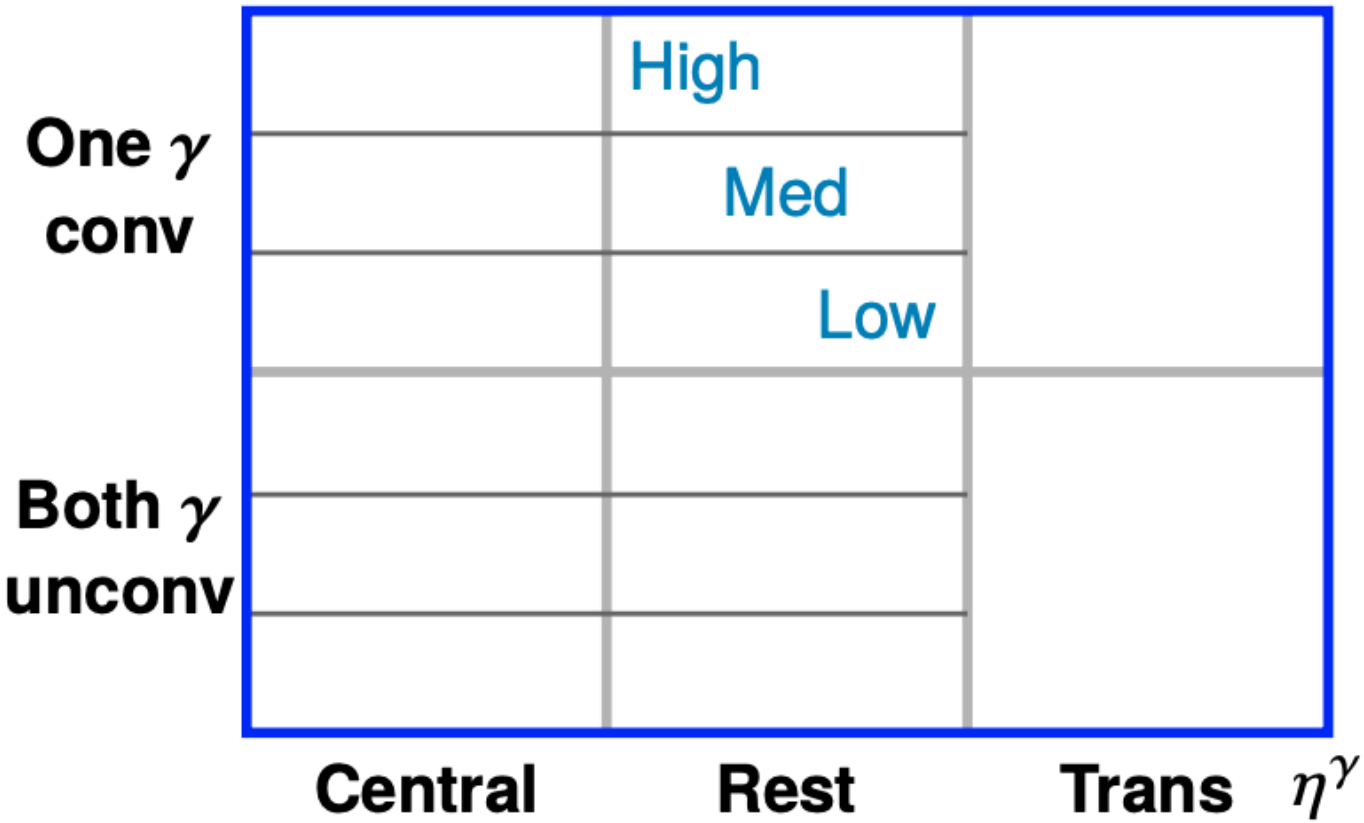
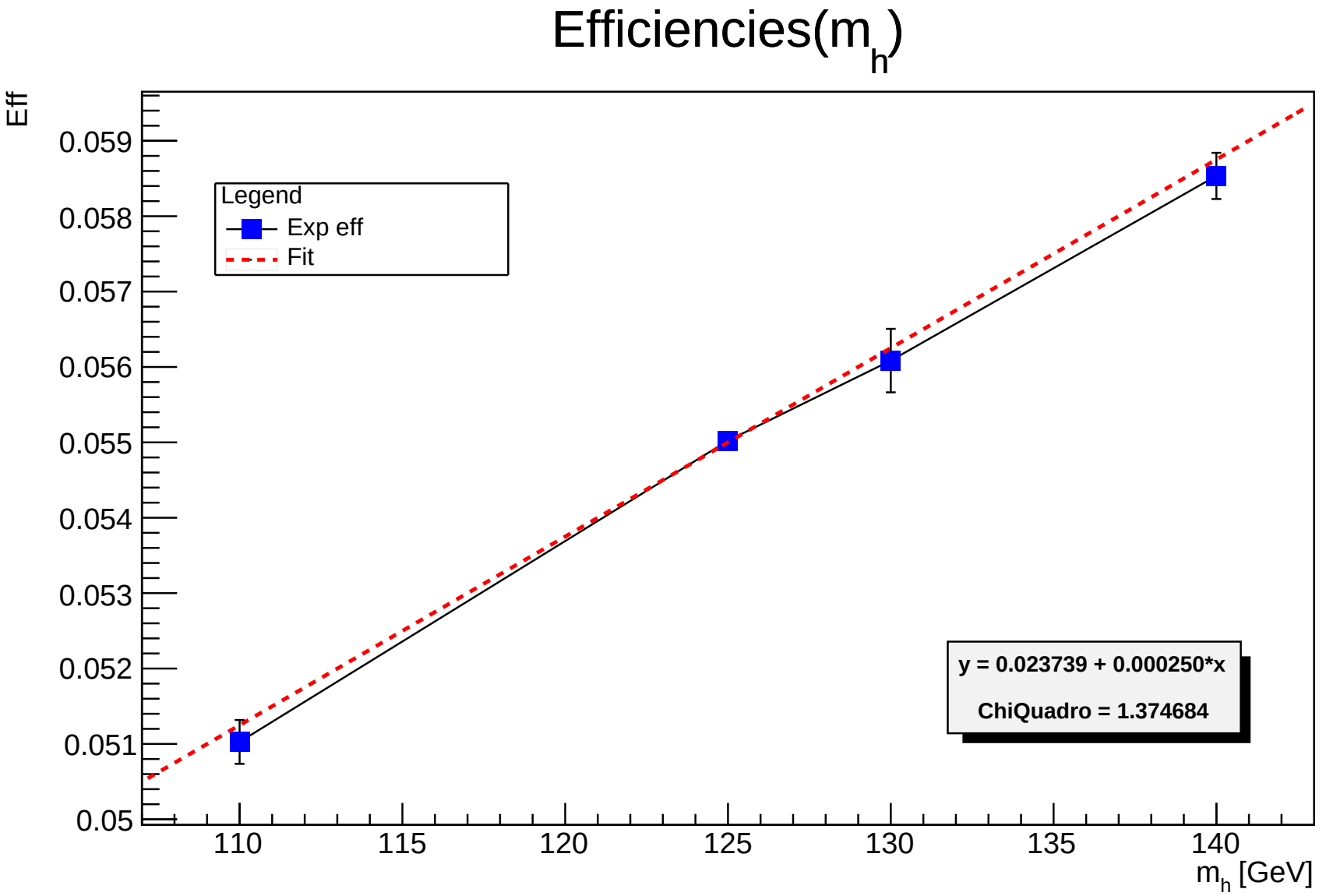
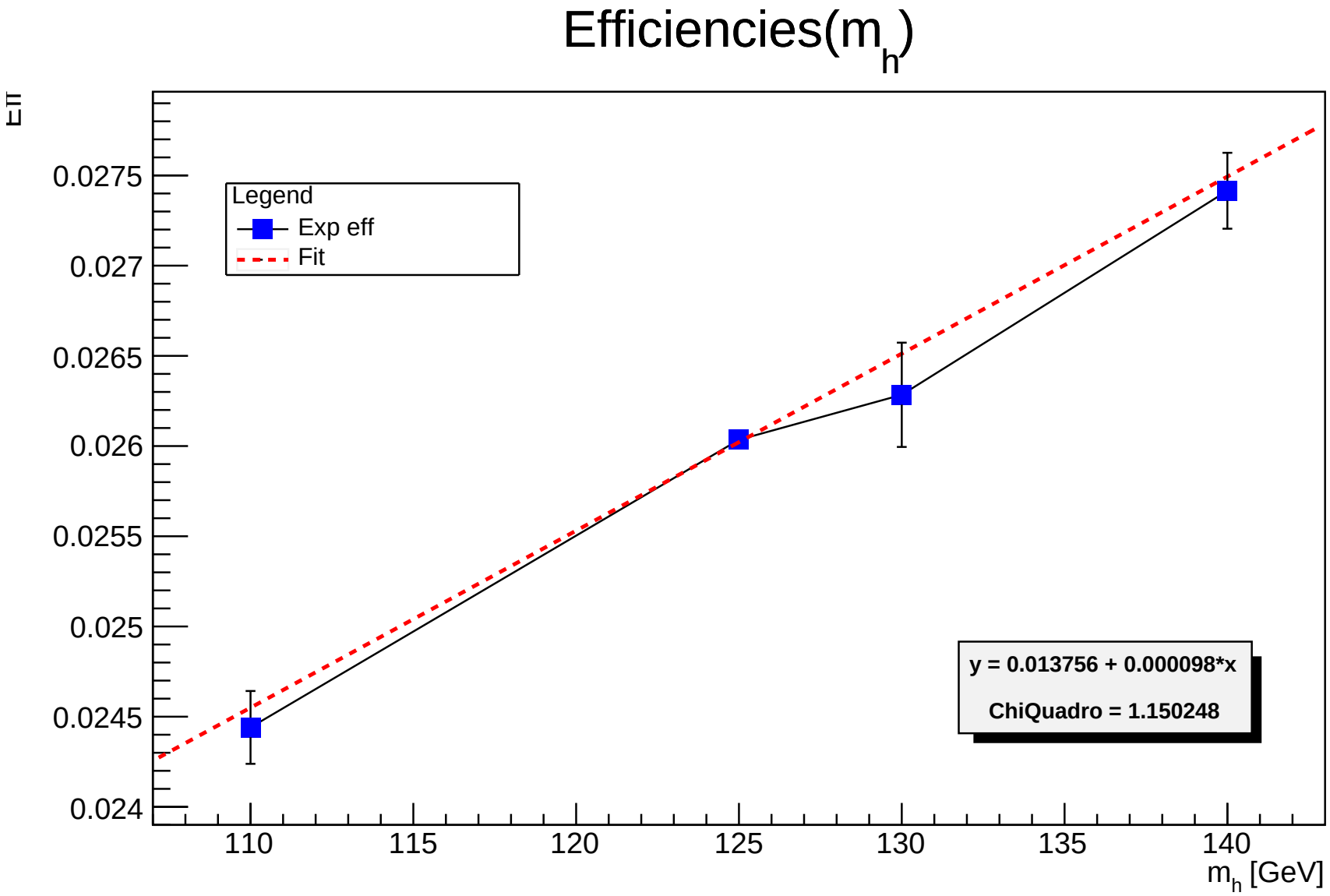


Figure 2: Simple sketch showing the mass analysis categories.

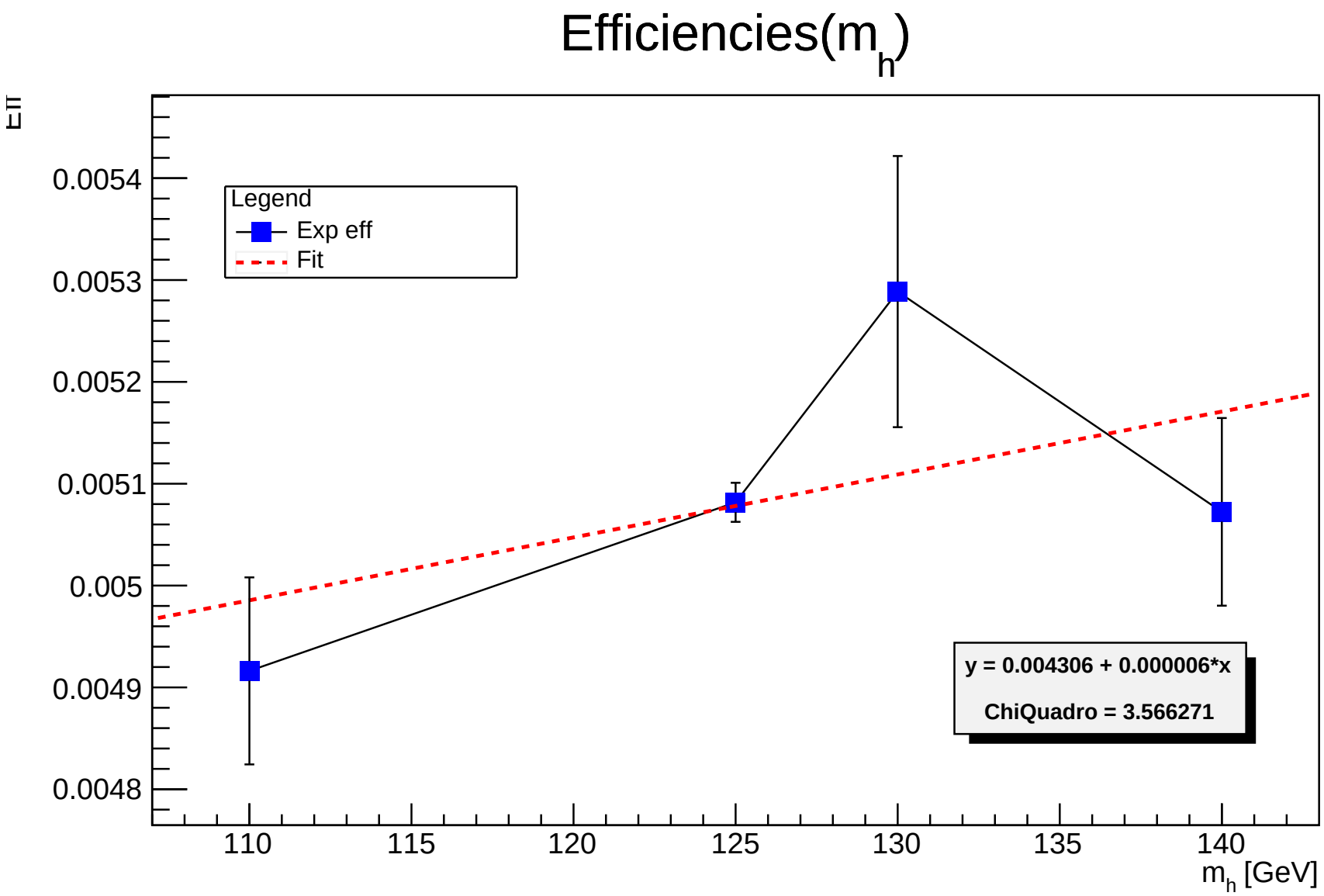
Eff unconv eta_1



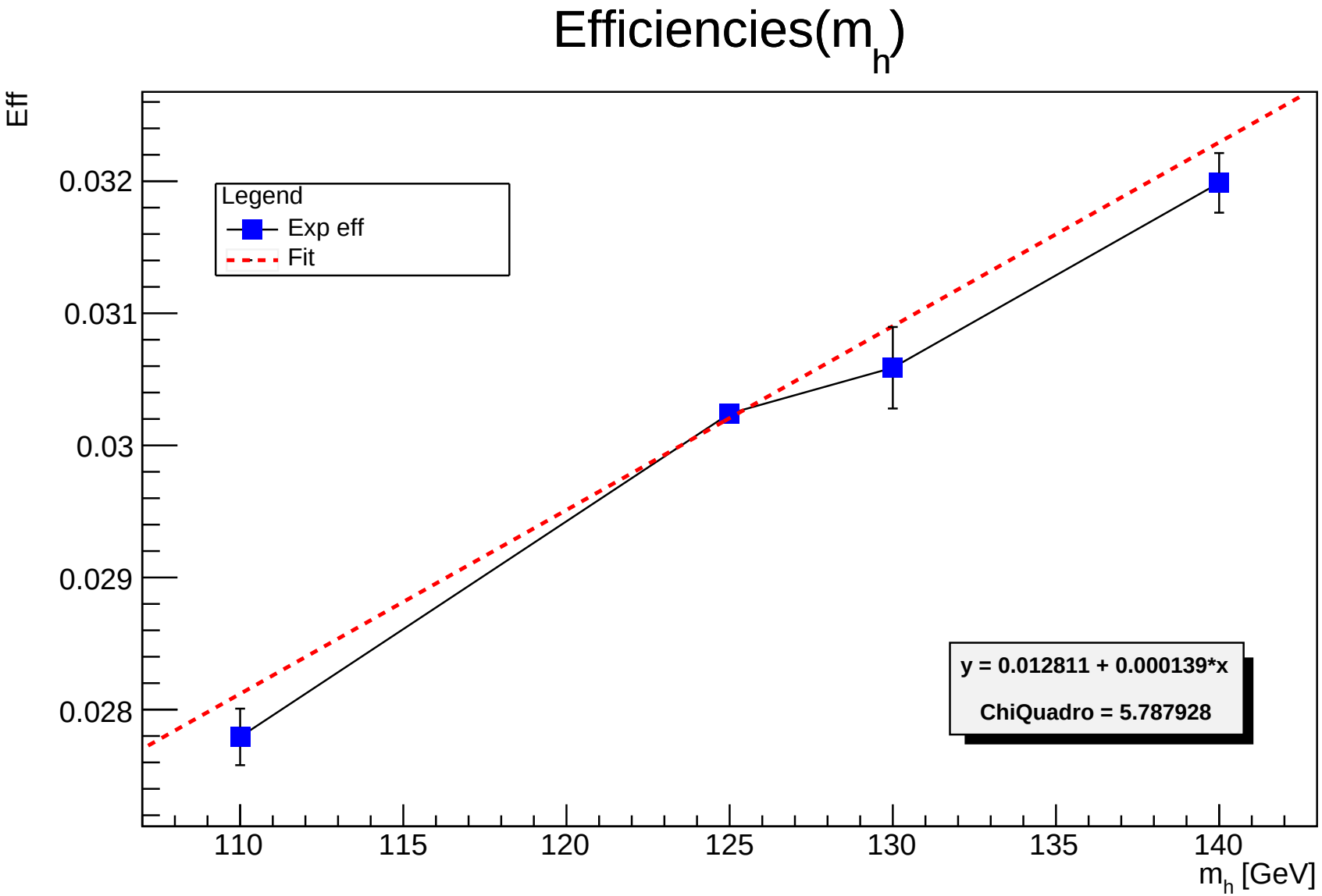
Eff unconv eta_2



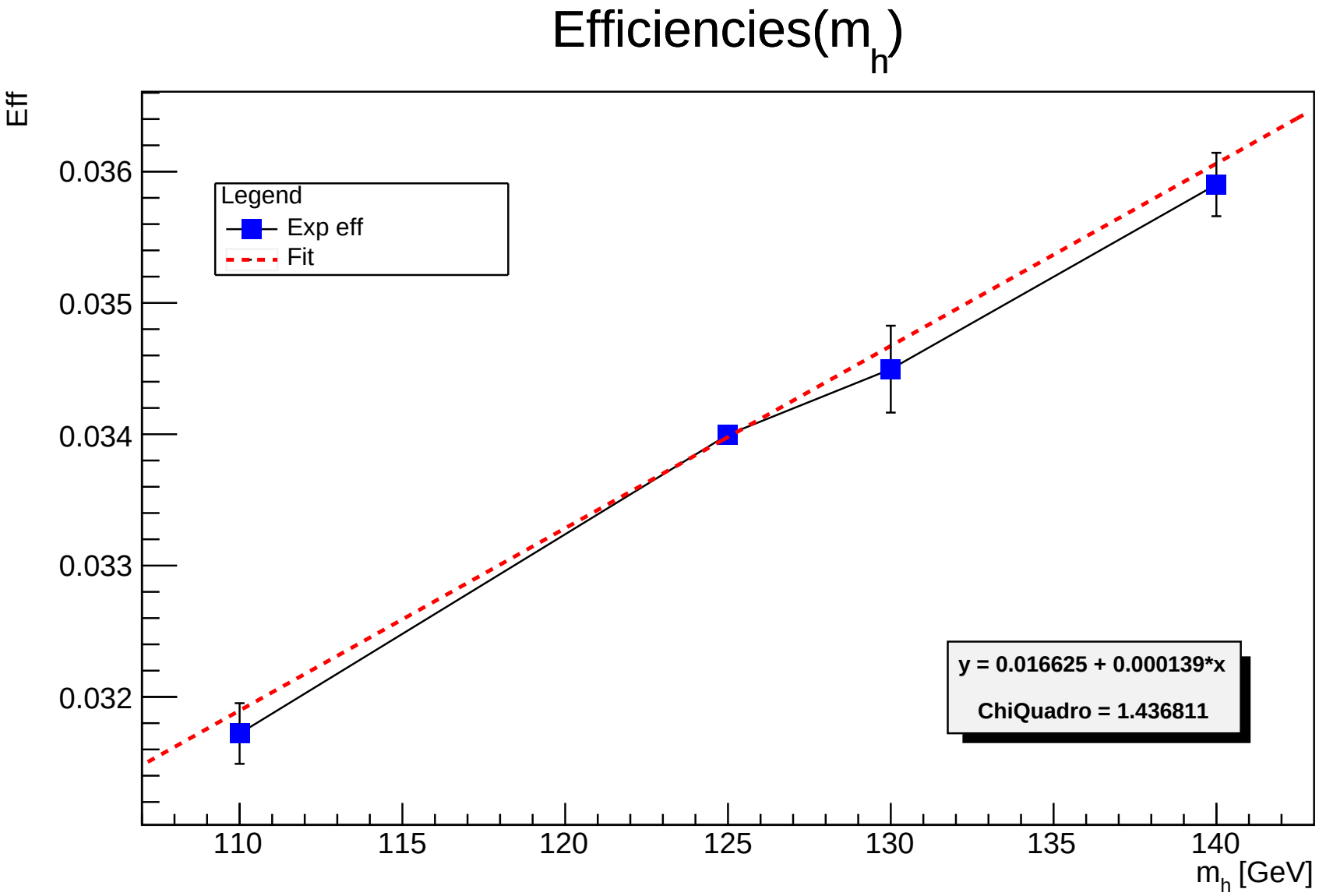
Eff unconv eta_3



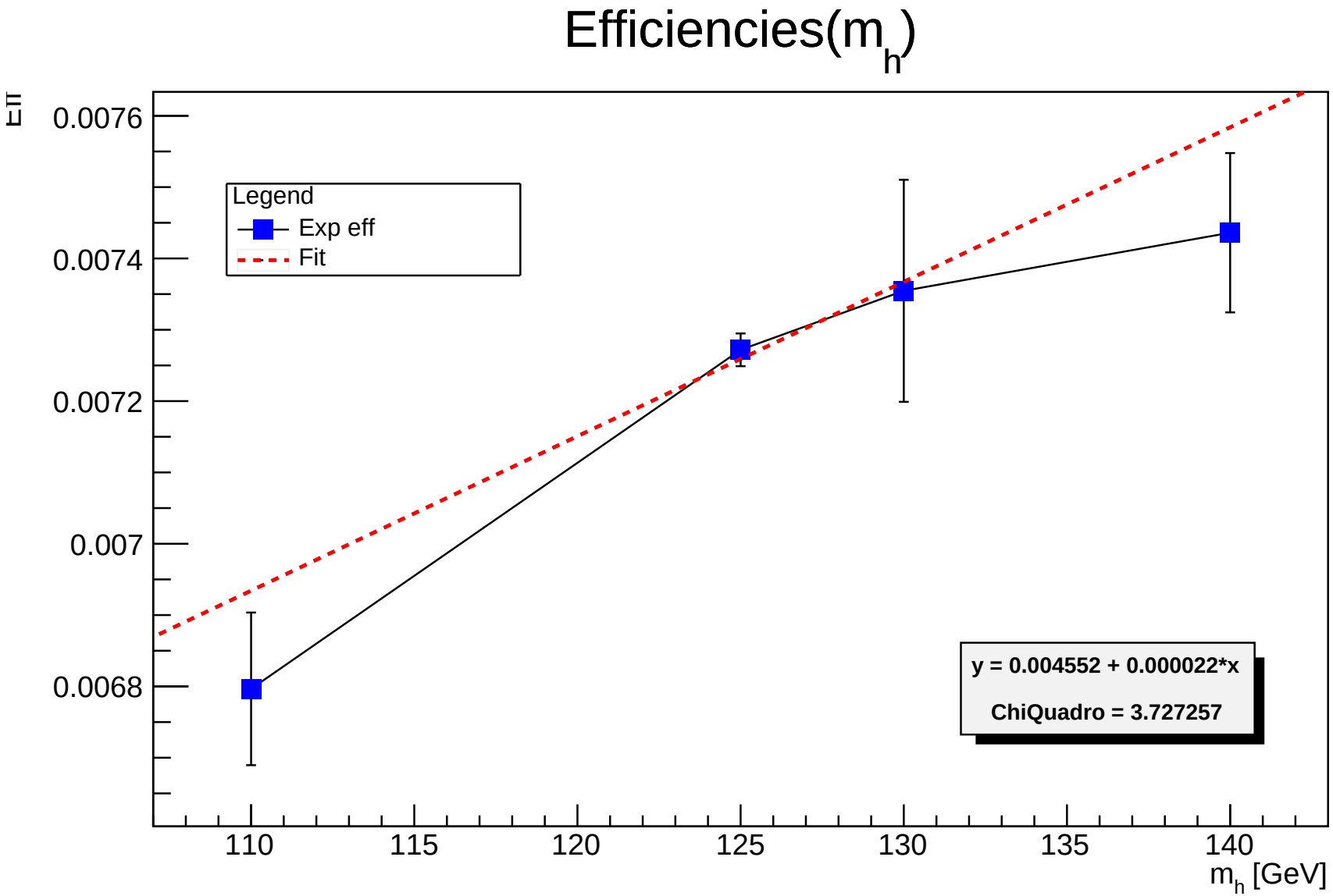
Eff 1_conv eta_1



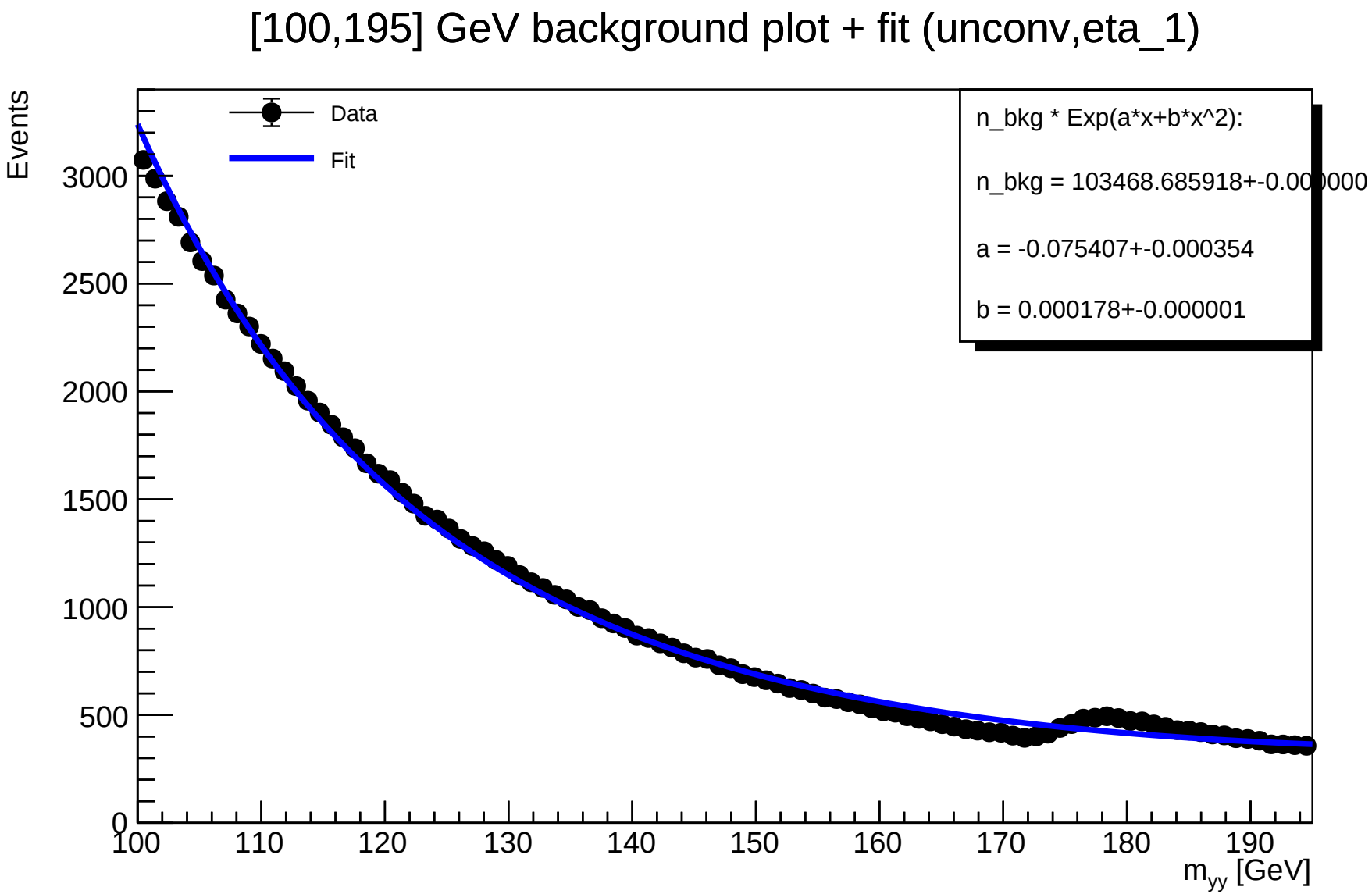
Eff 1_conv eta_2



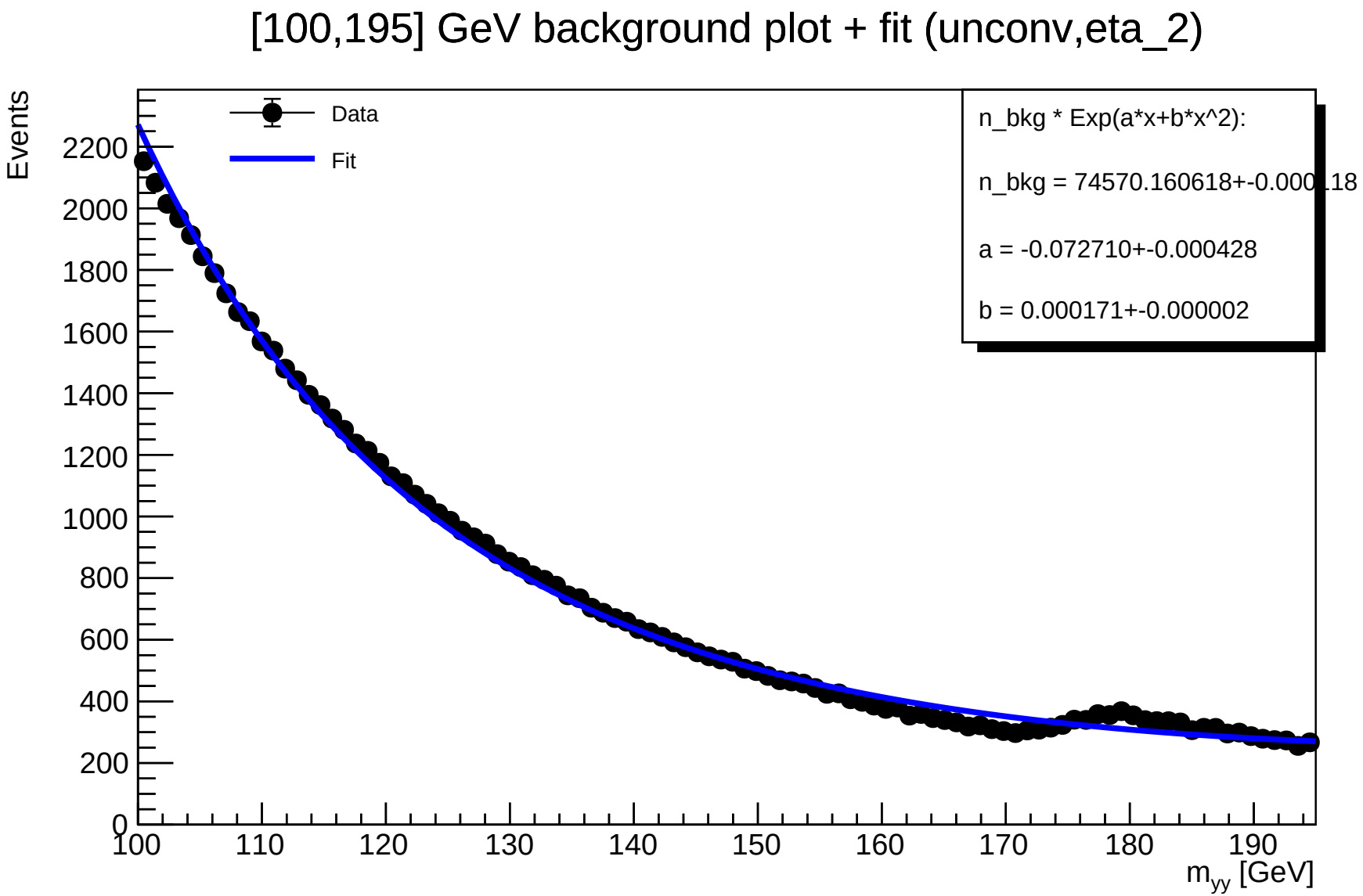
Eff 1_conv eta_3



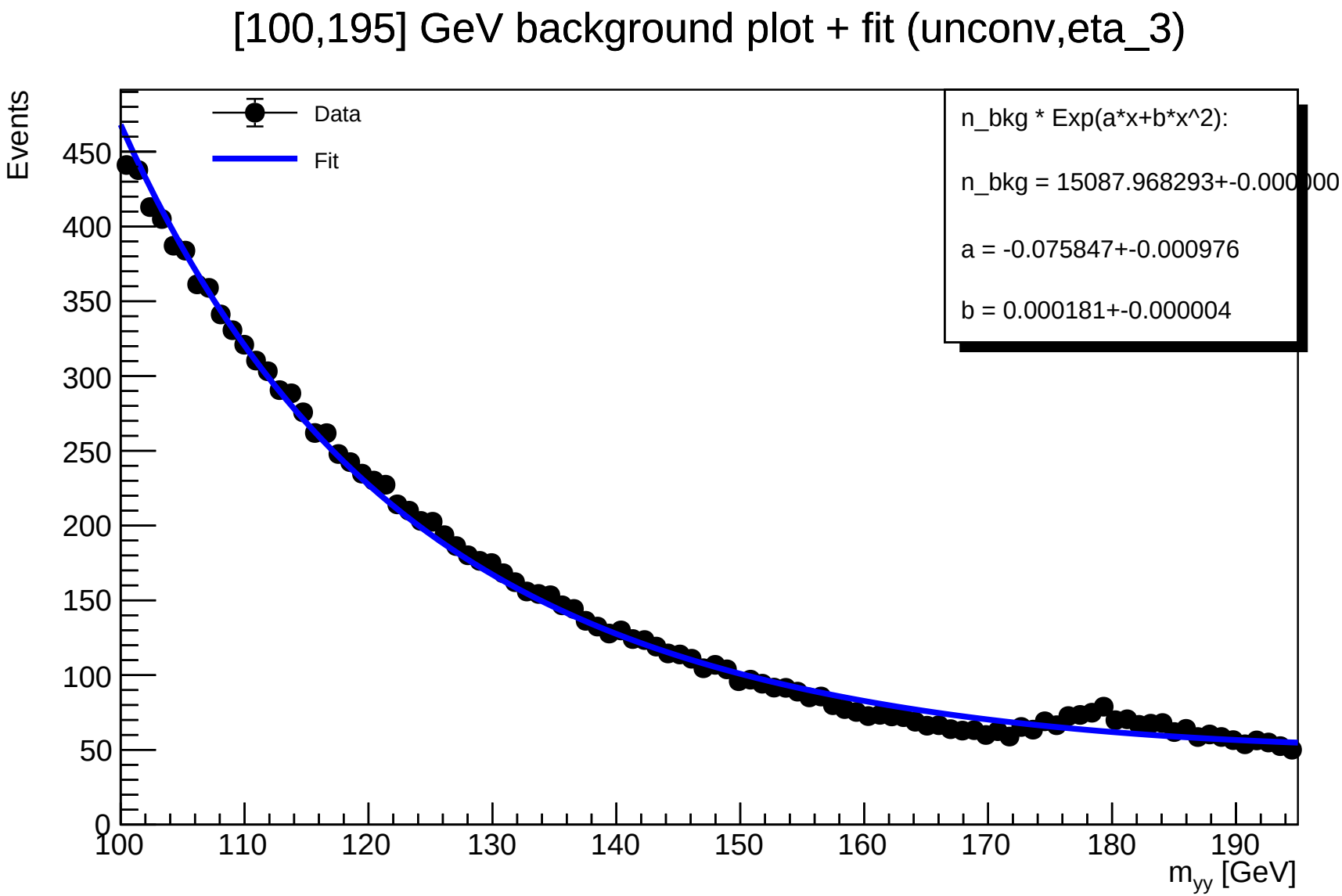
Bkg unconv eta_1



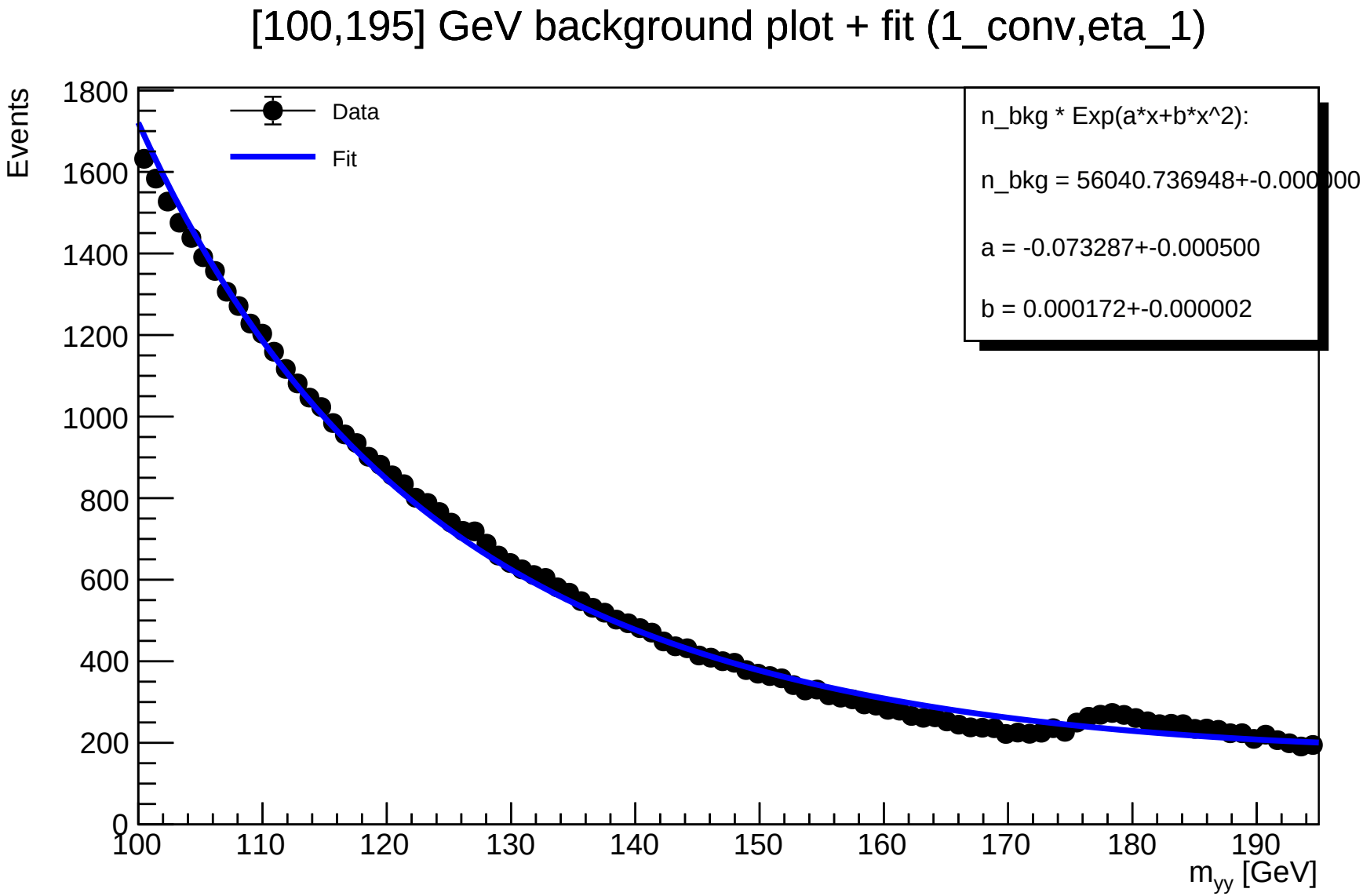
Bkg unconv eta_2



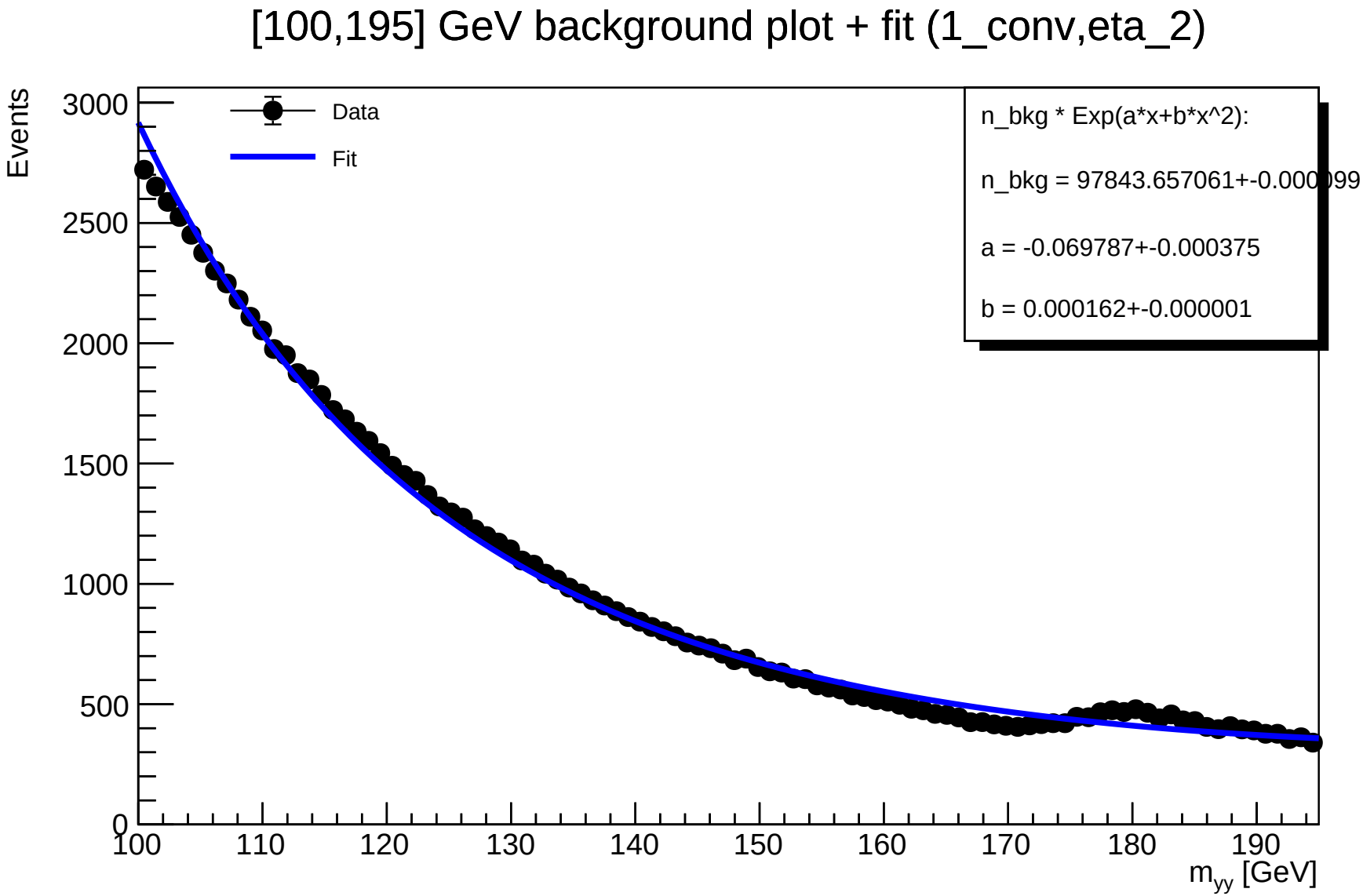
Bkg unconv eta_3



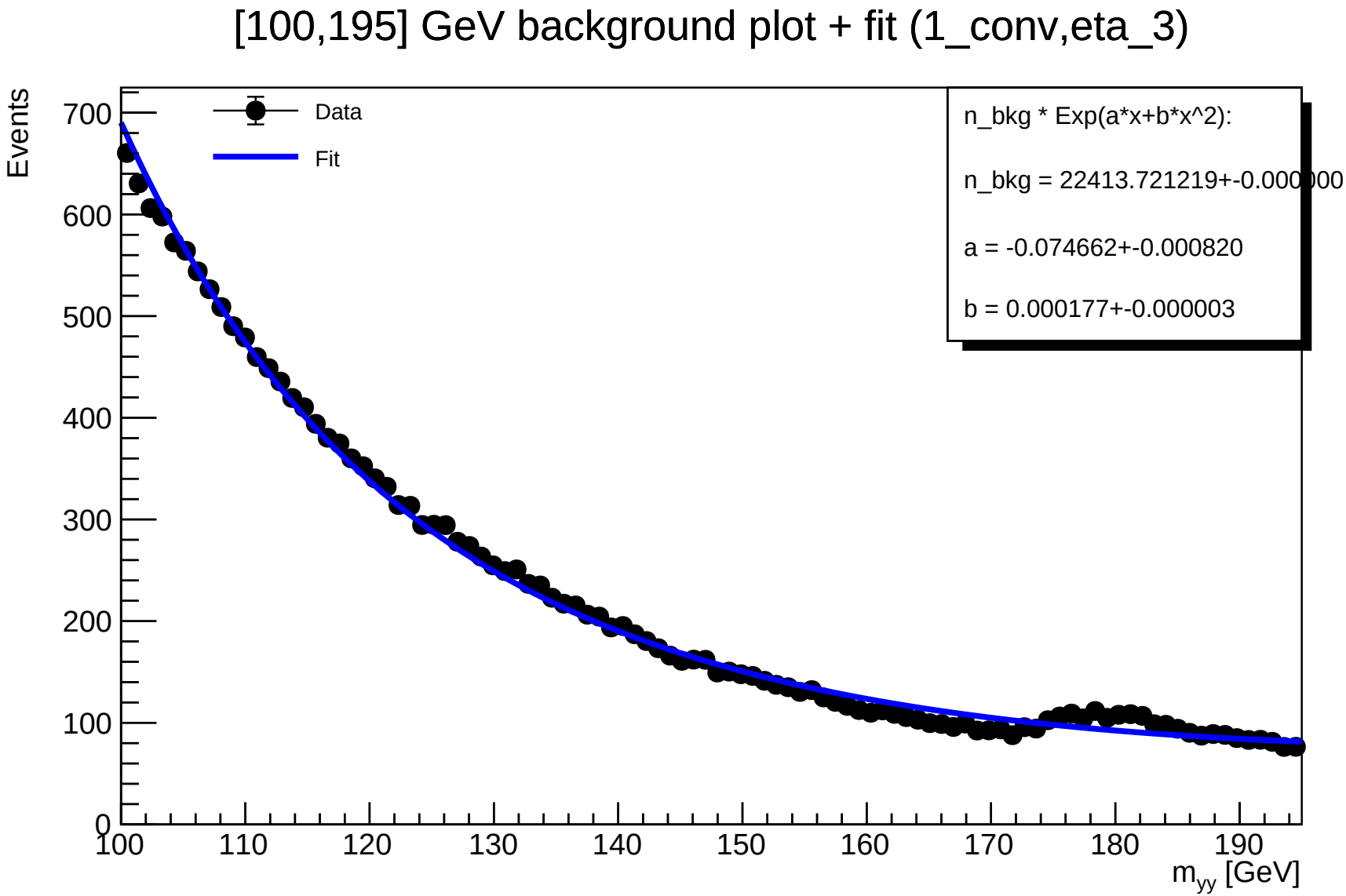
Bkg 1_conv eta_1



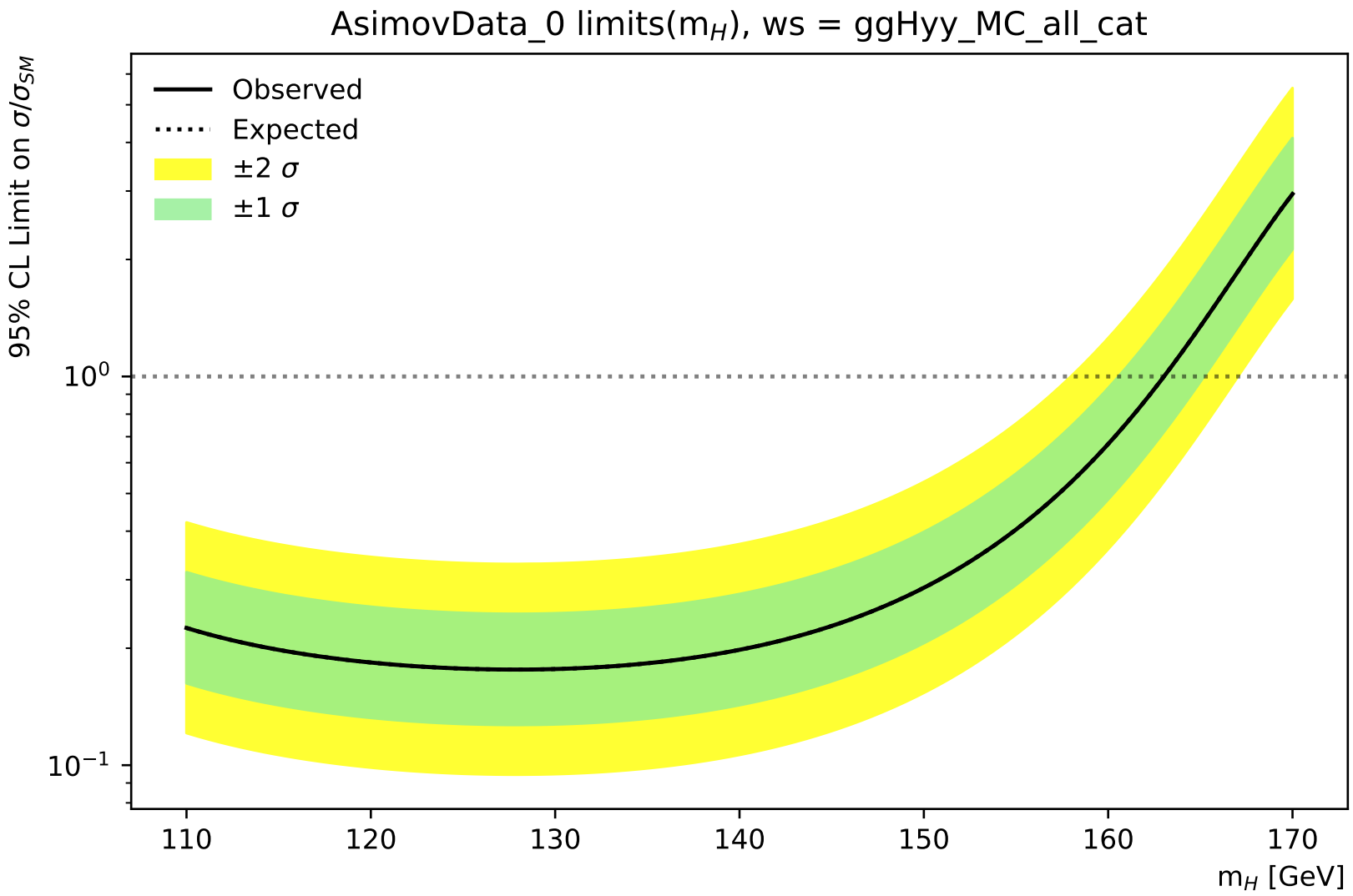
Bkg 1_conv eta_2



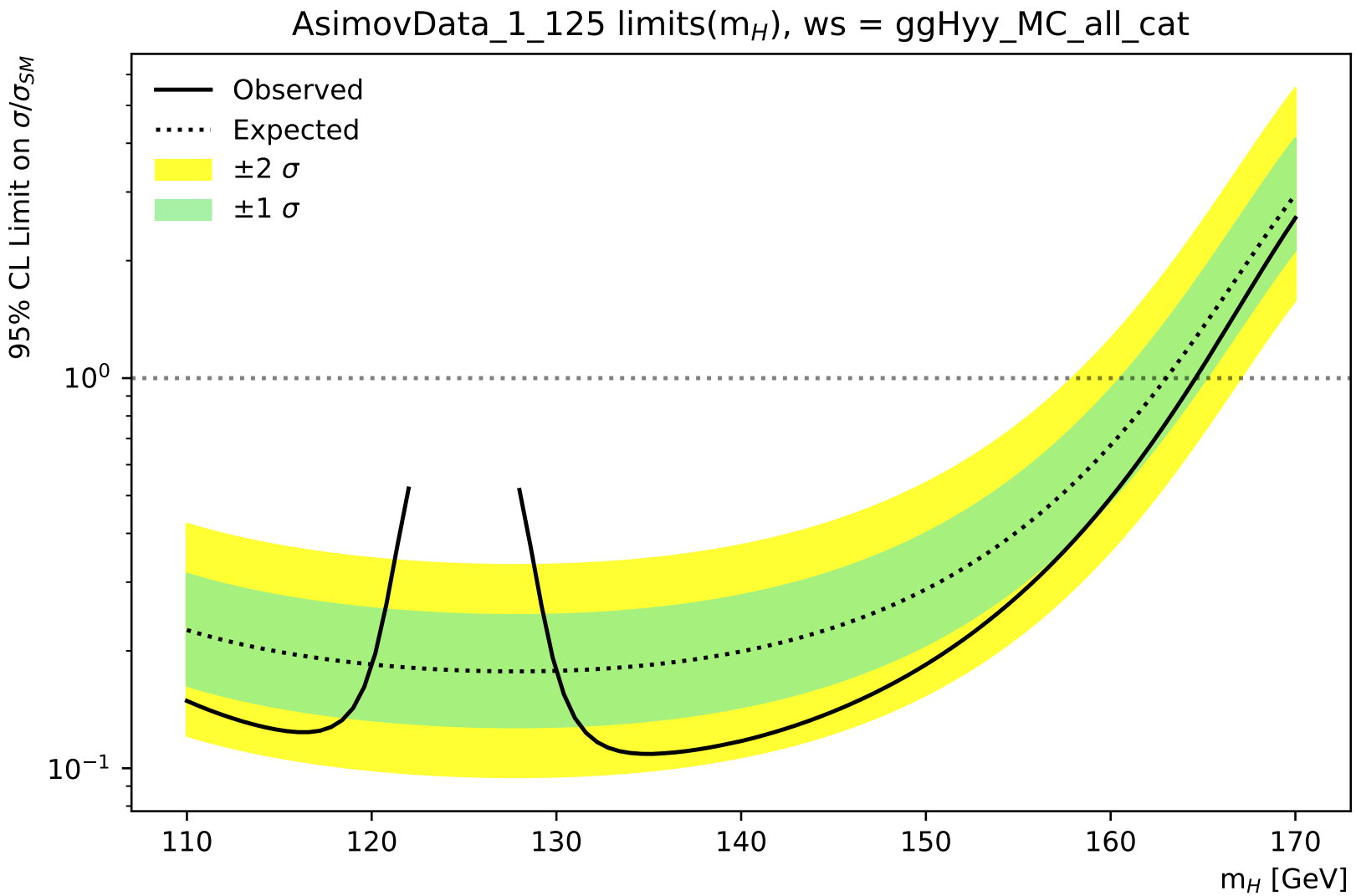
Bkg 1_conv eta_3



AsimovData μ=0 limits

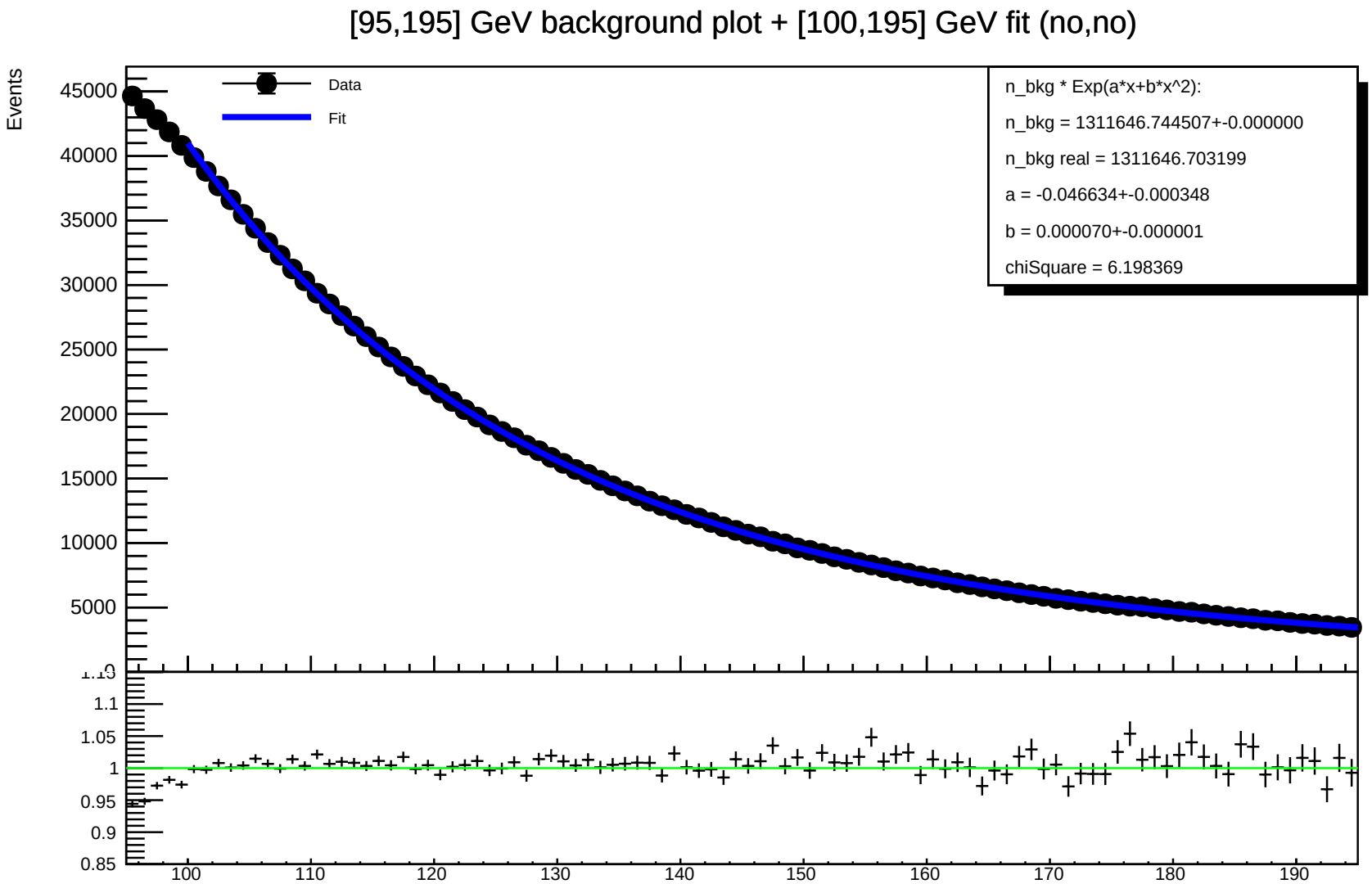


AsimovData μ=1, m_H=125 limits

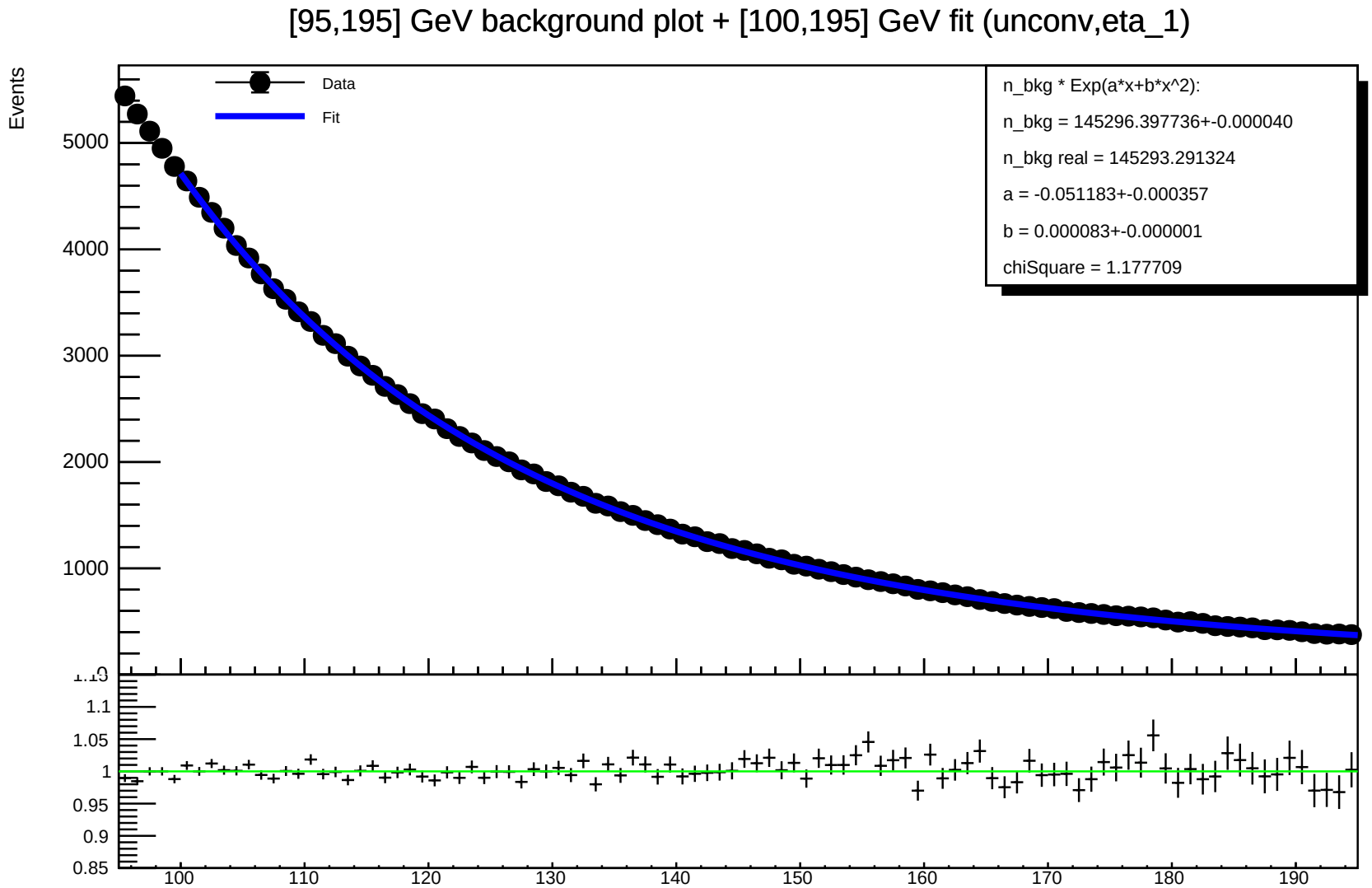


10^{th} week

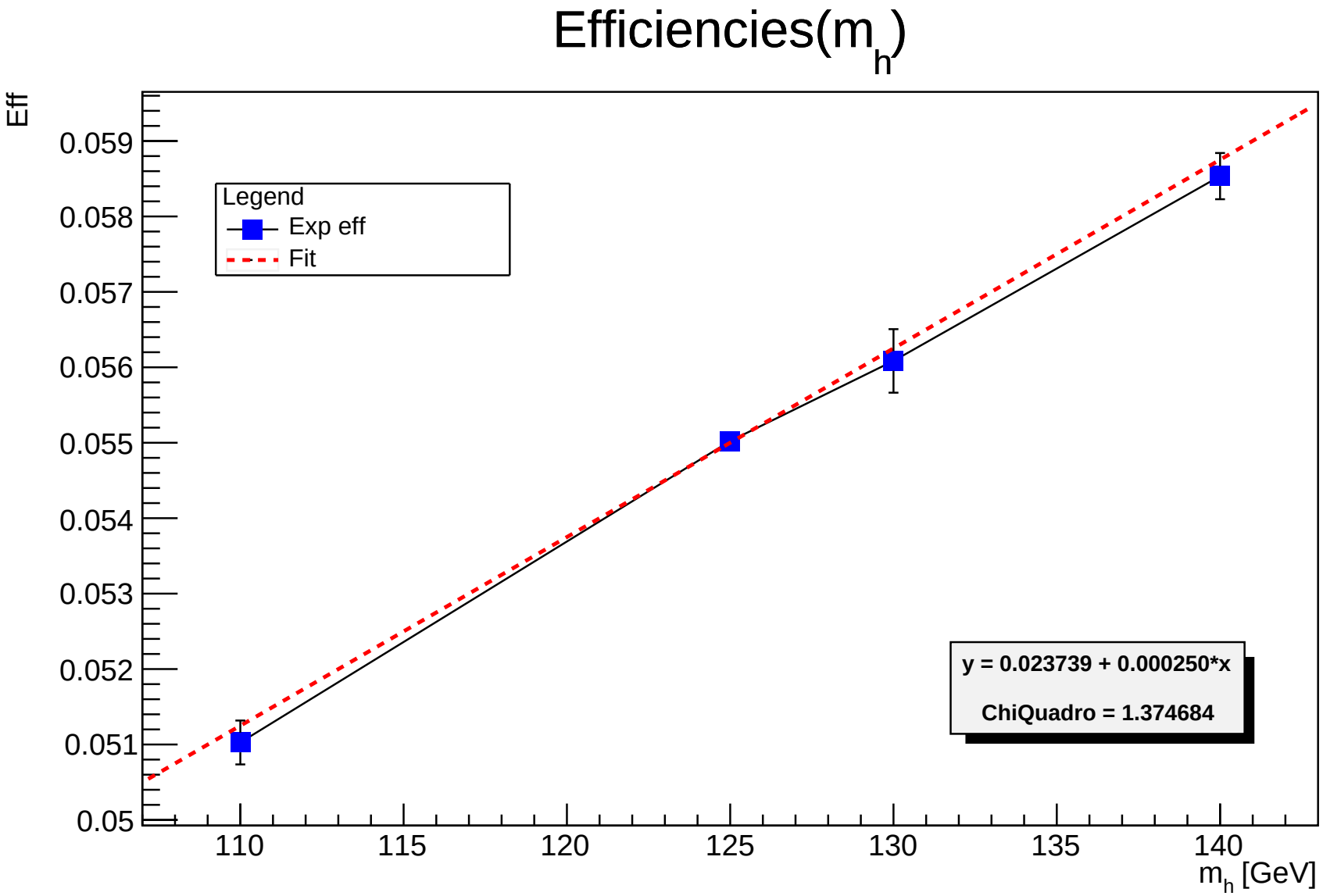
All bkg


[95,195] GeV background plot + [100,195] GeV fit (no,no)
Events
Data
Fit
n_bkg * Exp(a*x+b*x^2):
n_bkg = 1311646.744507+-0.000000
n_bkg real = 1311646.703199
a = -0.046634+-0.000348
b = 0.000070+-0.000001
chiSquare = 6.198369
45000
40000
35000
30000
25000
20000
15000
10000
5000
1.1
1.05
1
0.95
0.9
0.85
100
110
120
130
140
150
160
170
180
190

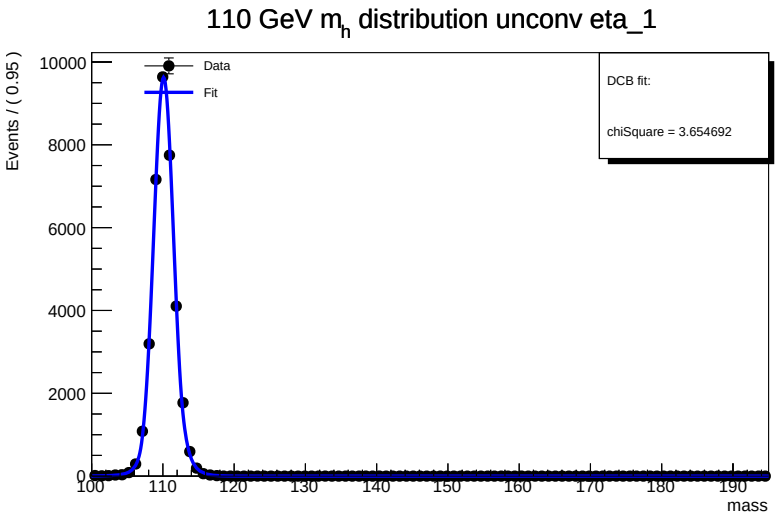
Bkg unconv eta_1

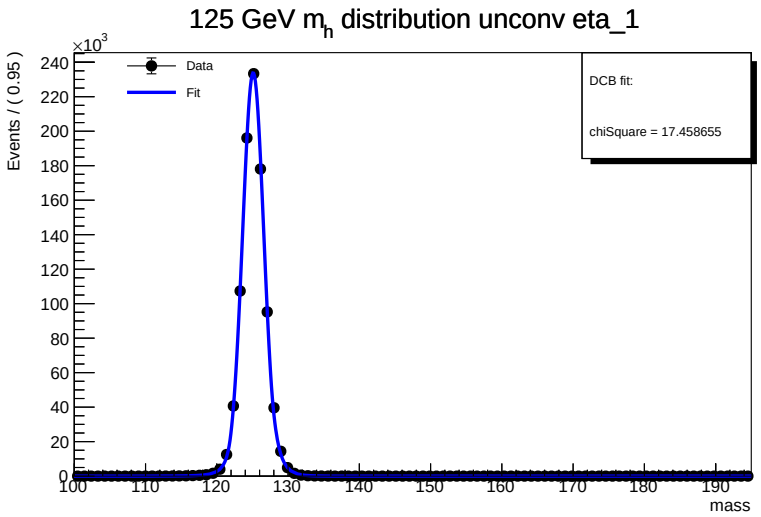


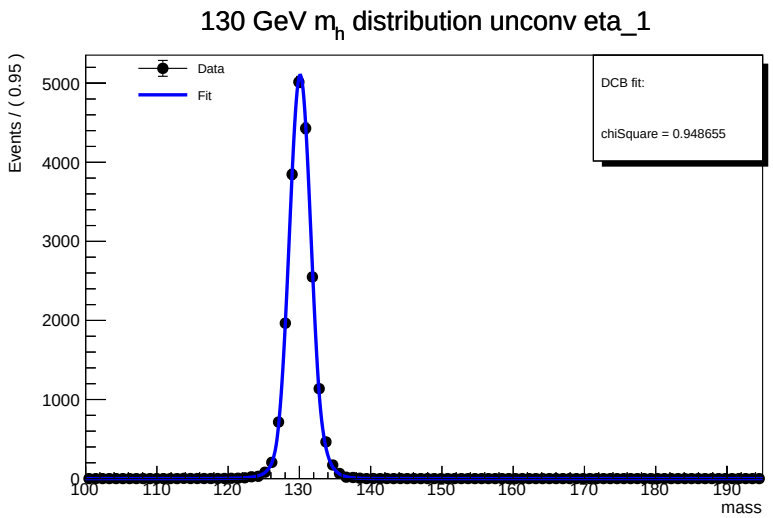
Eff unconv eta_1

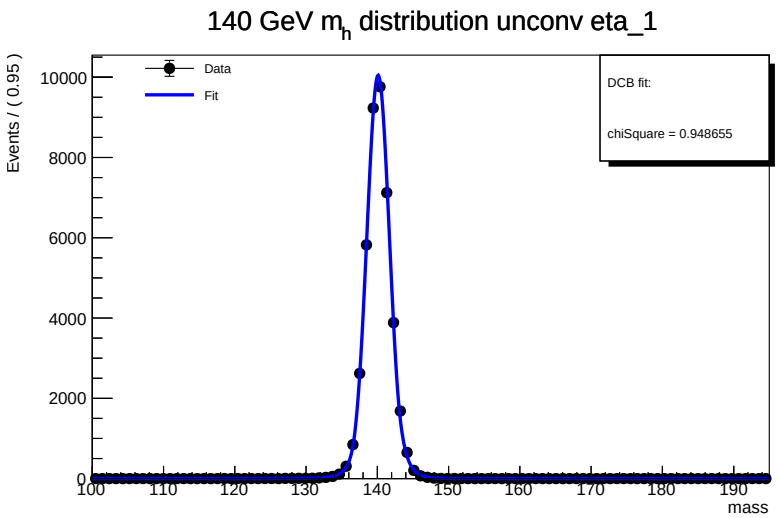


Sig unconv eta_1

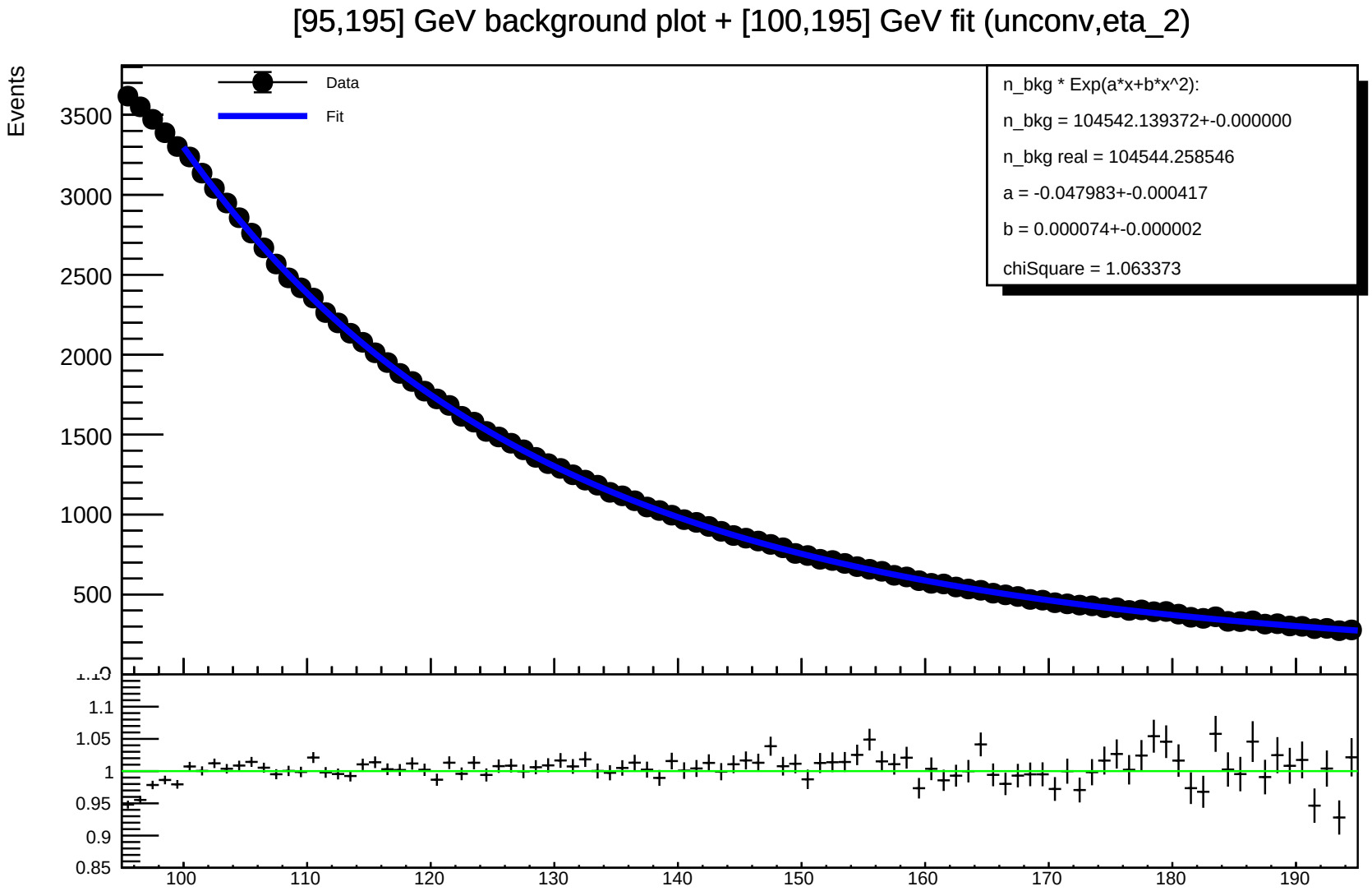




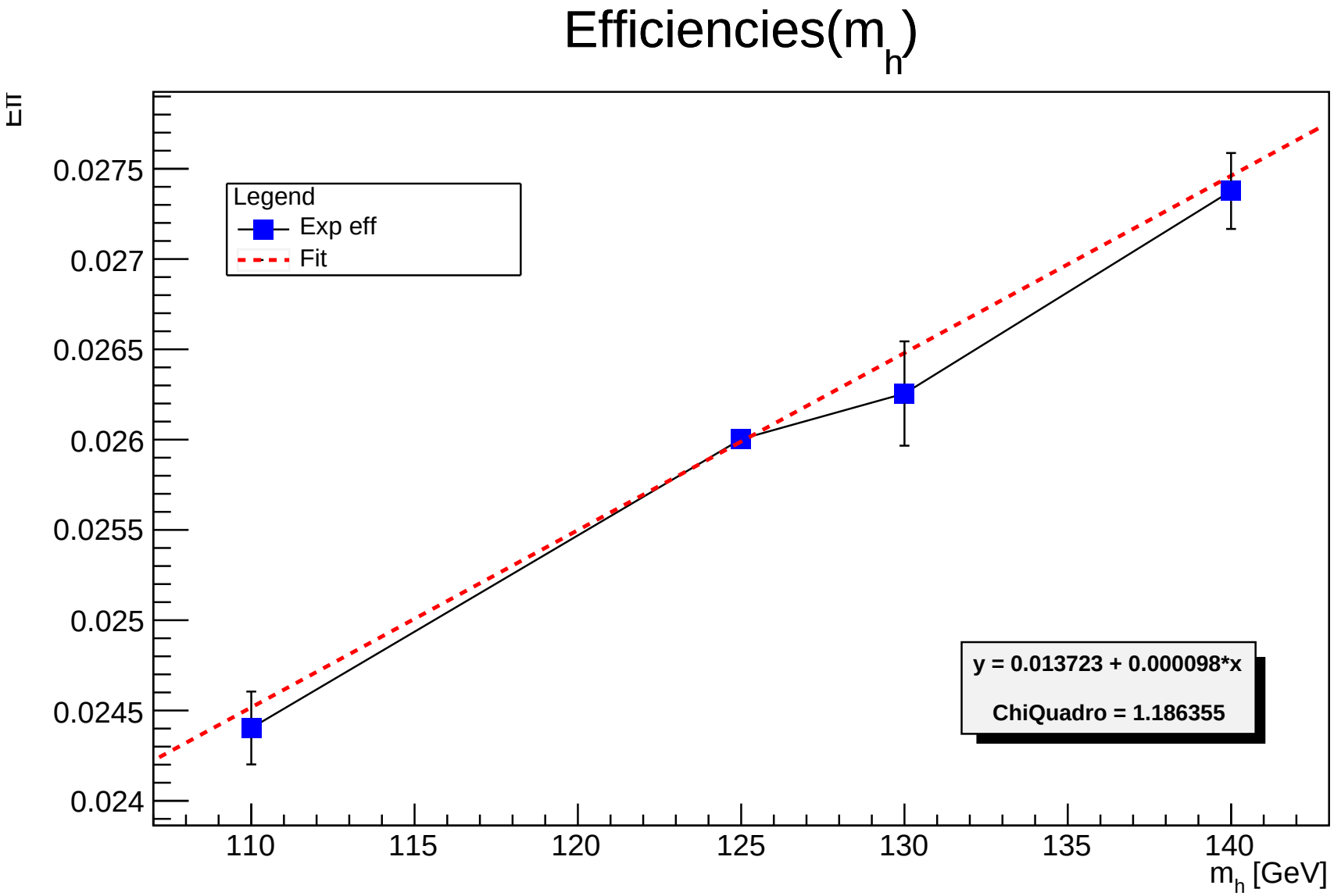




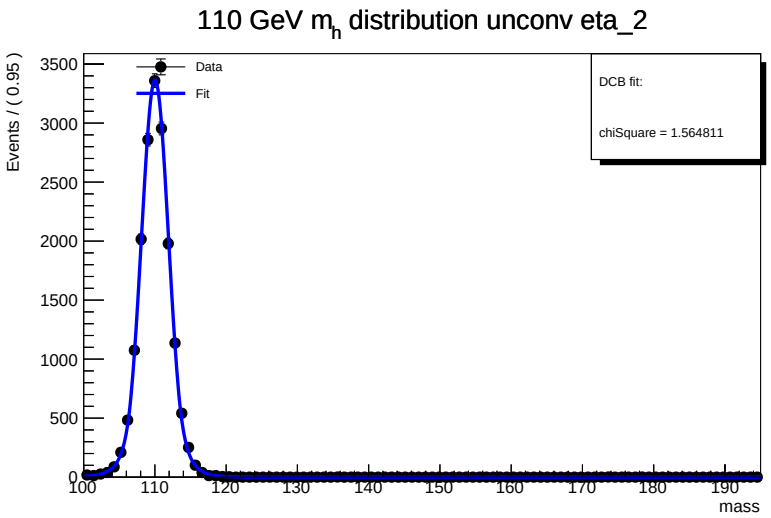
Bkg unconv eta_2

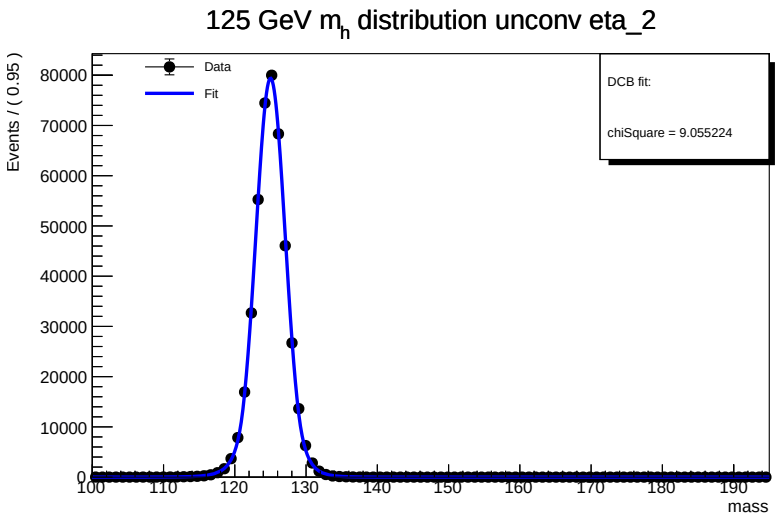


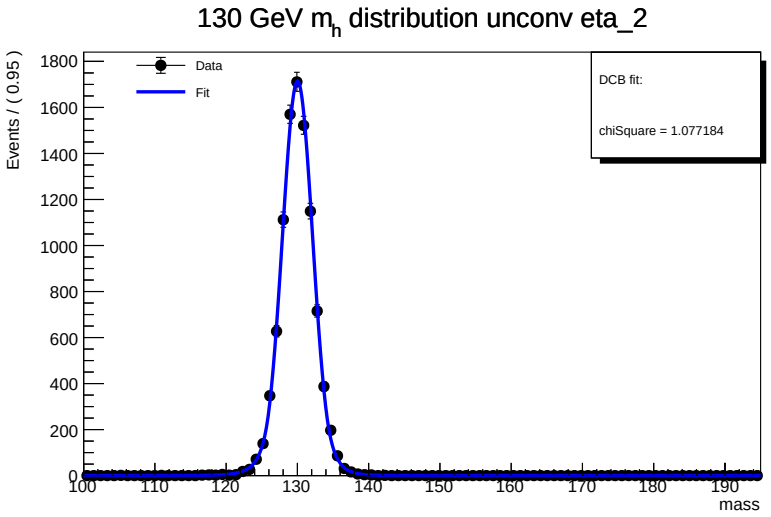
Eff unconv eta_2

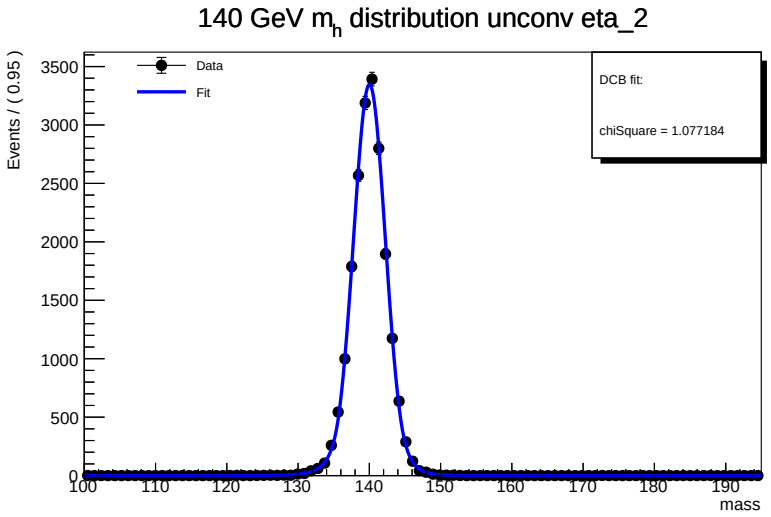


Sig unconv eta_2

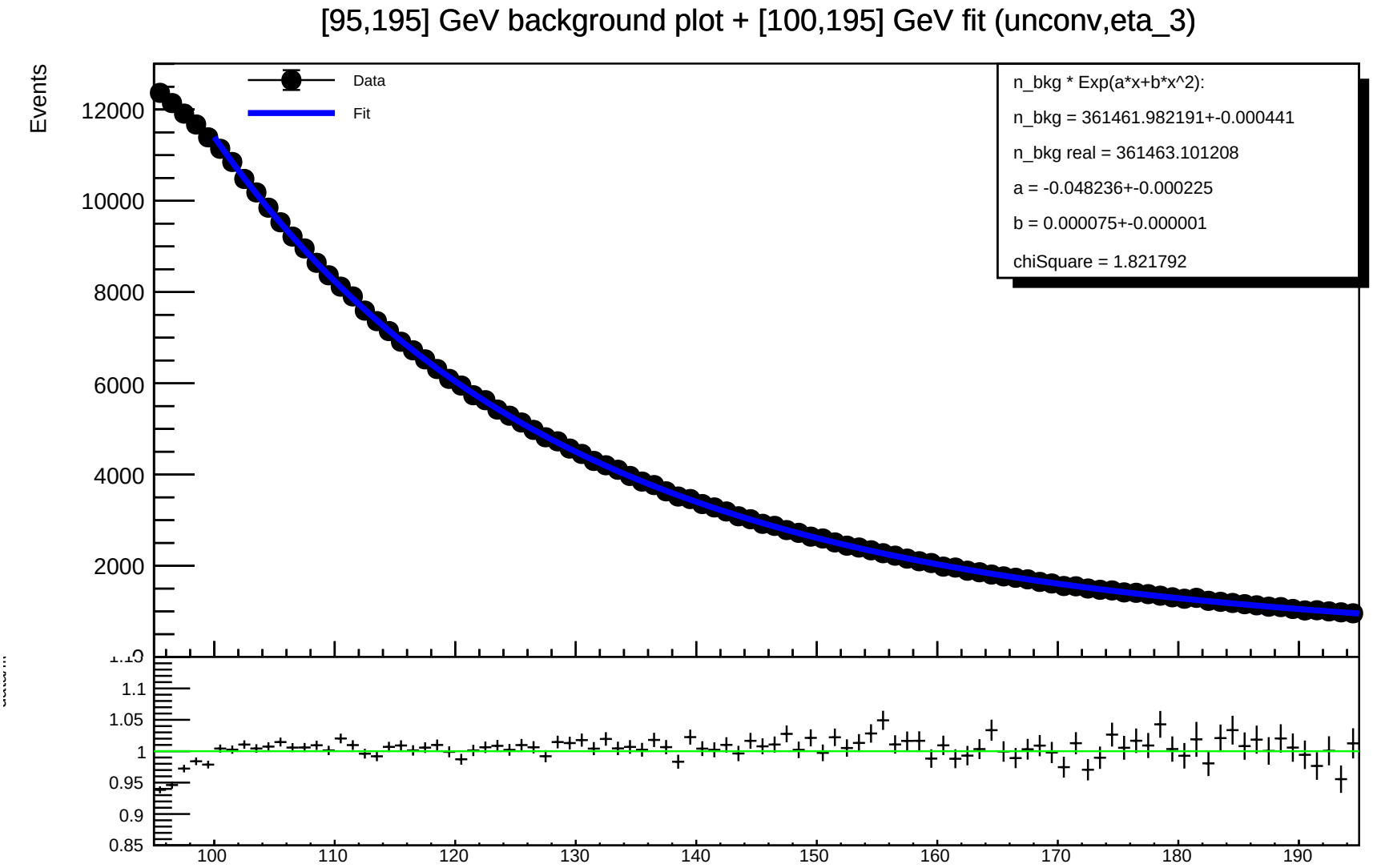




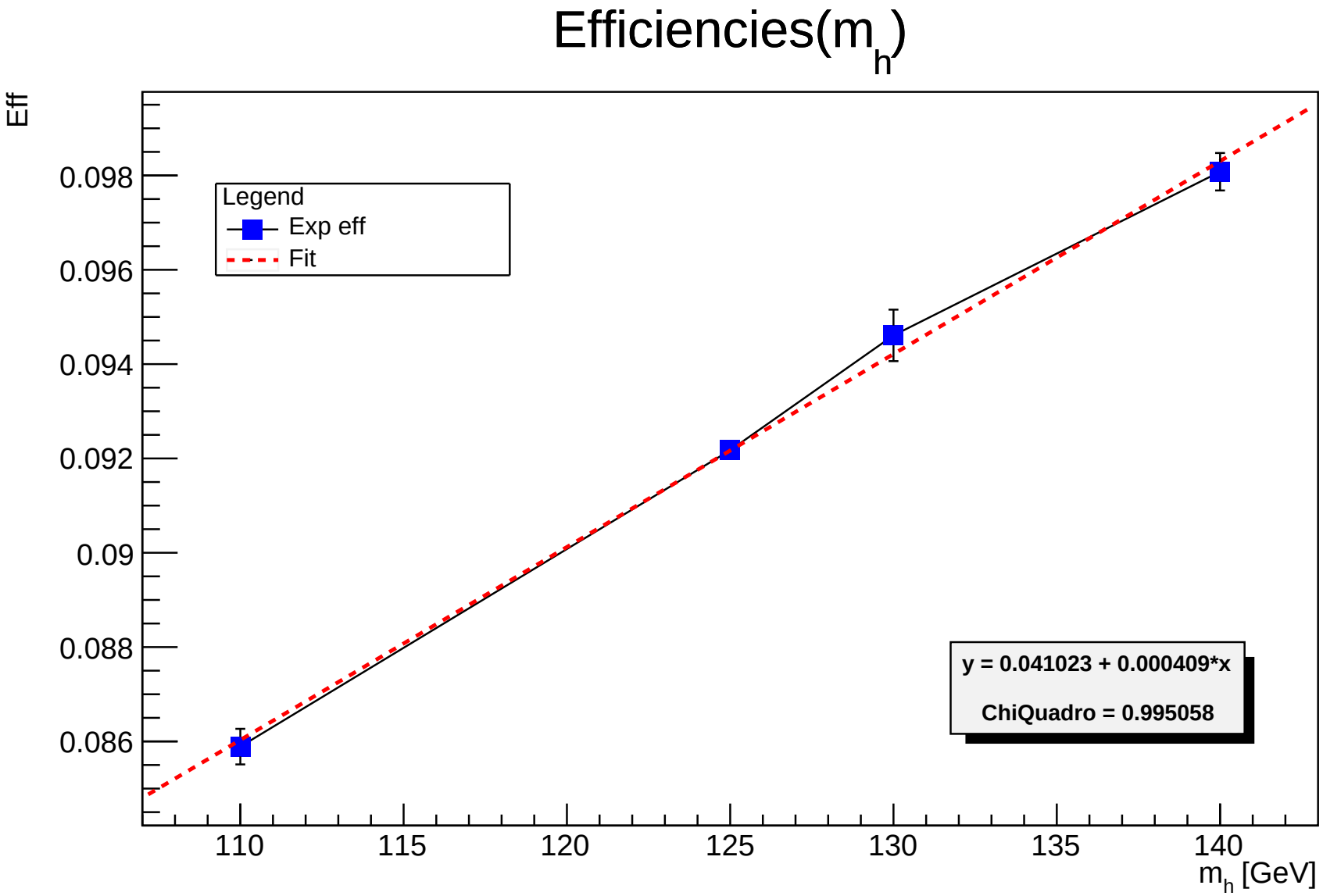




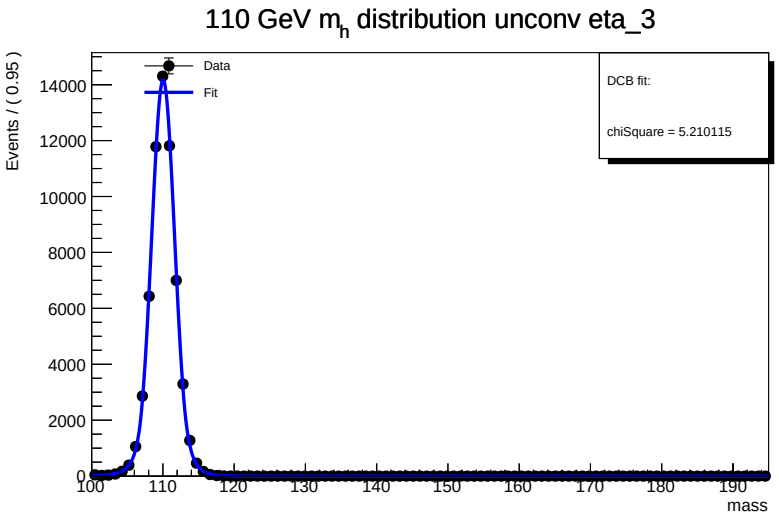
Bkg unconv eta_3

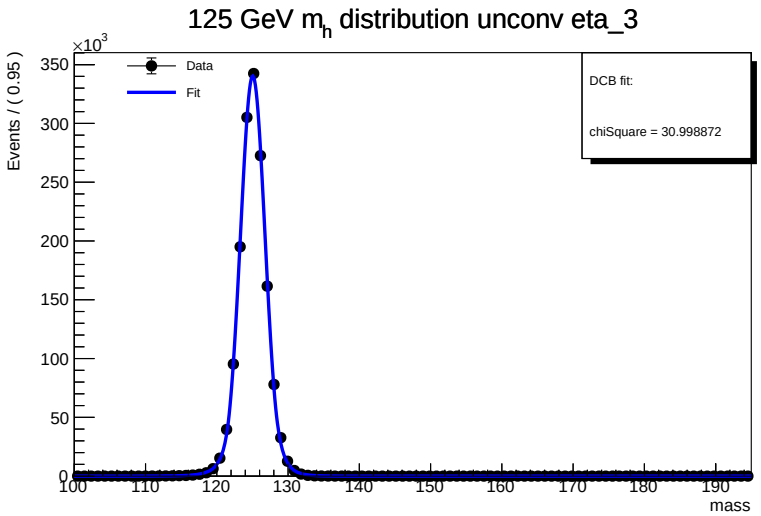


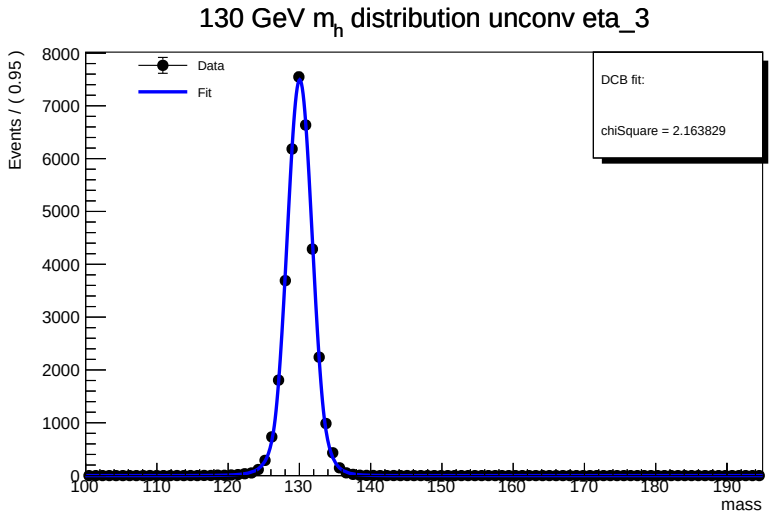
Eff unconv eta_3

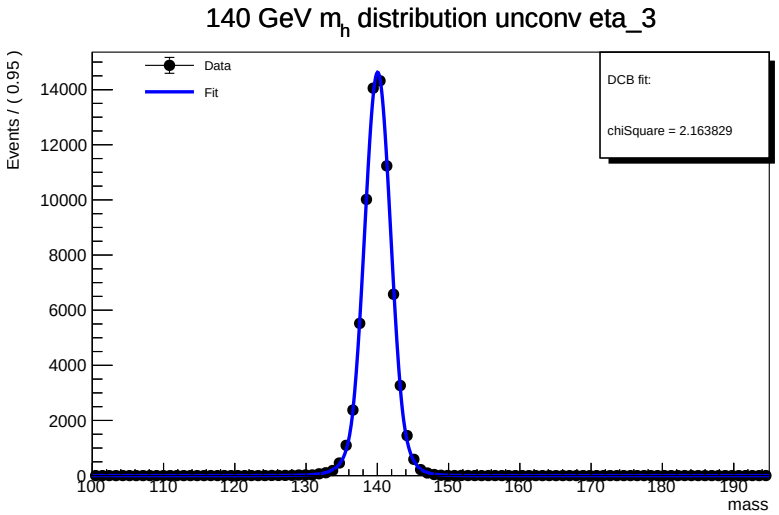


Sig unconv eta_3

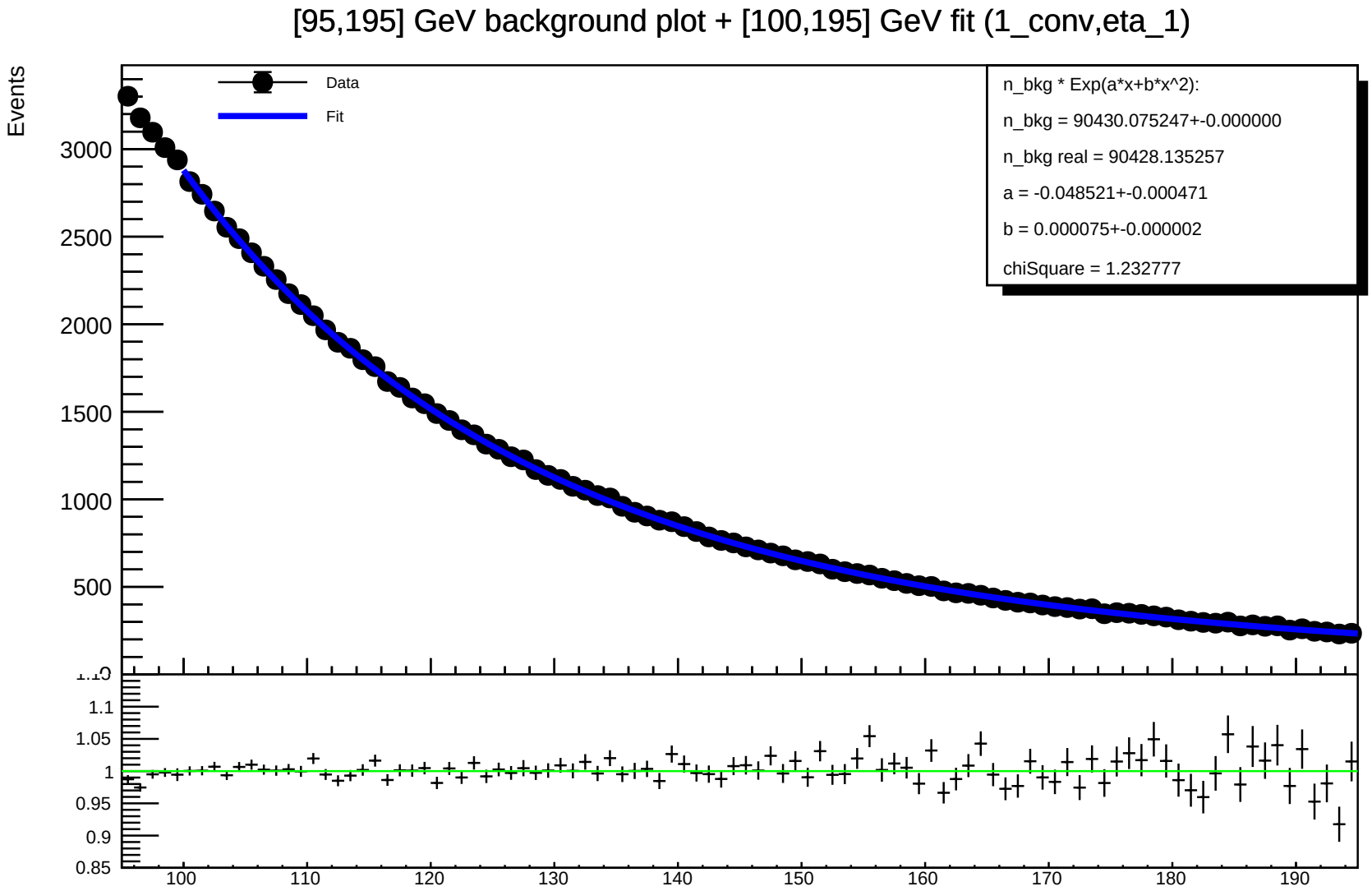




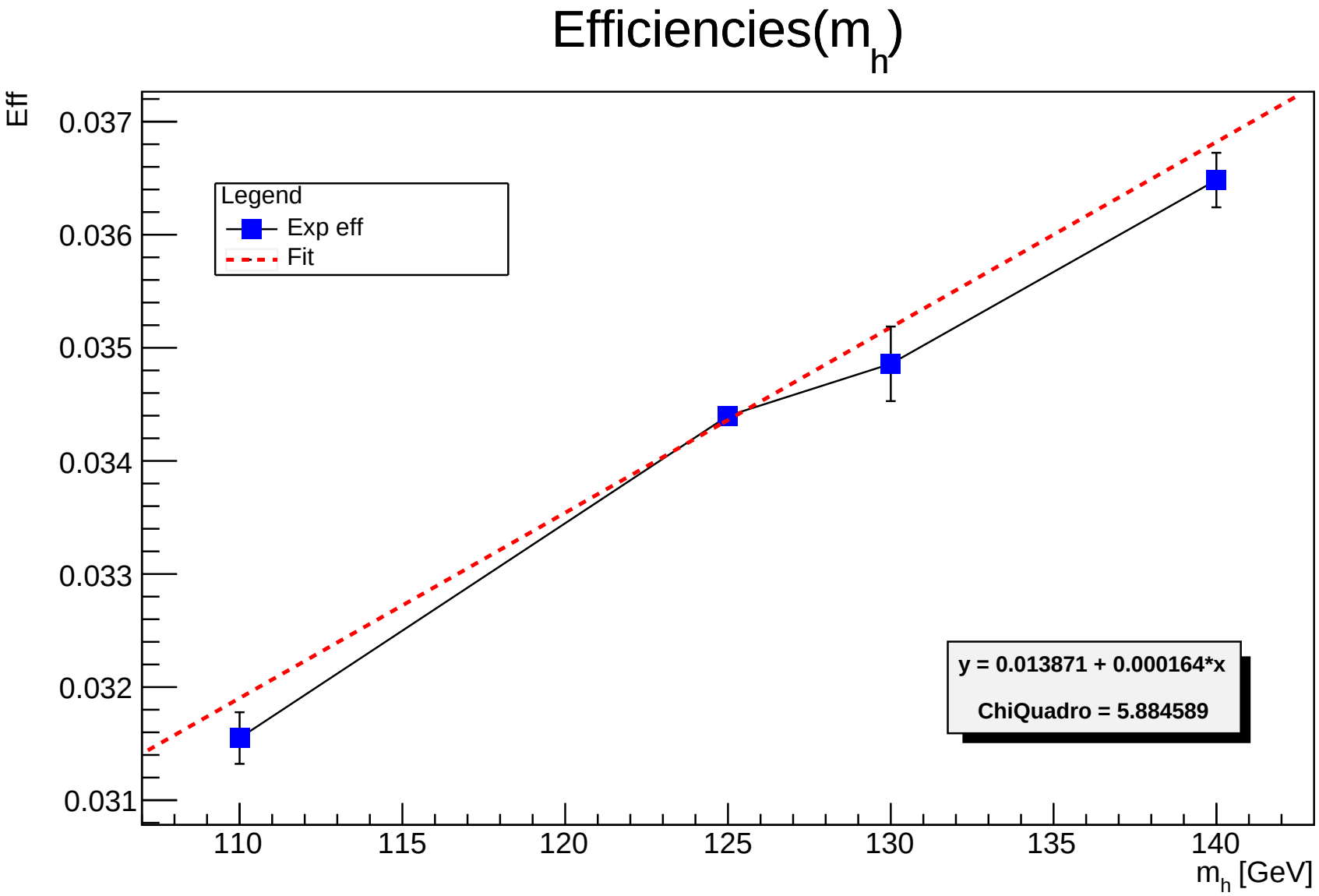




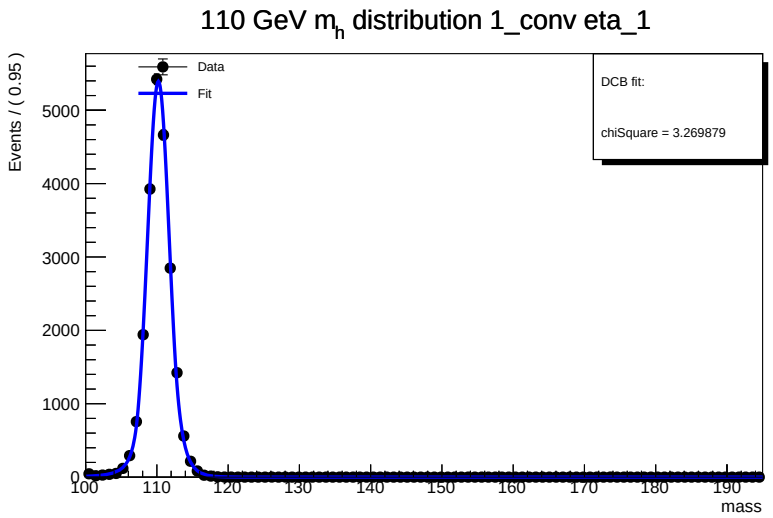
Bkg 1_conv eta_1

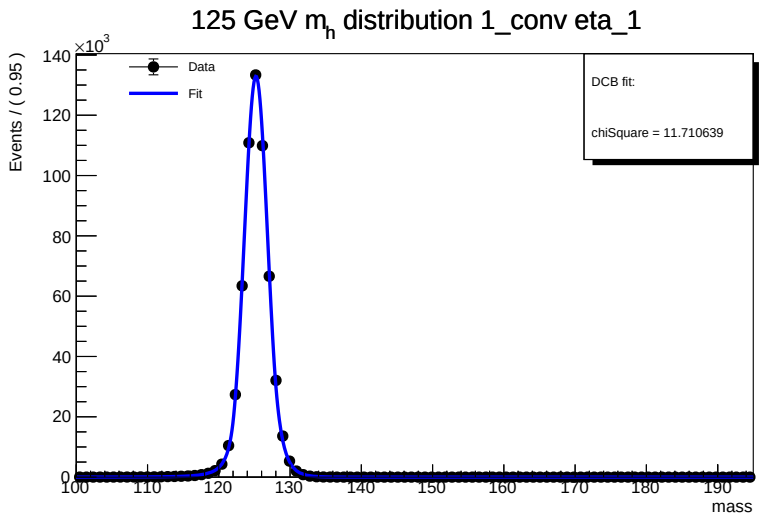


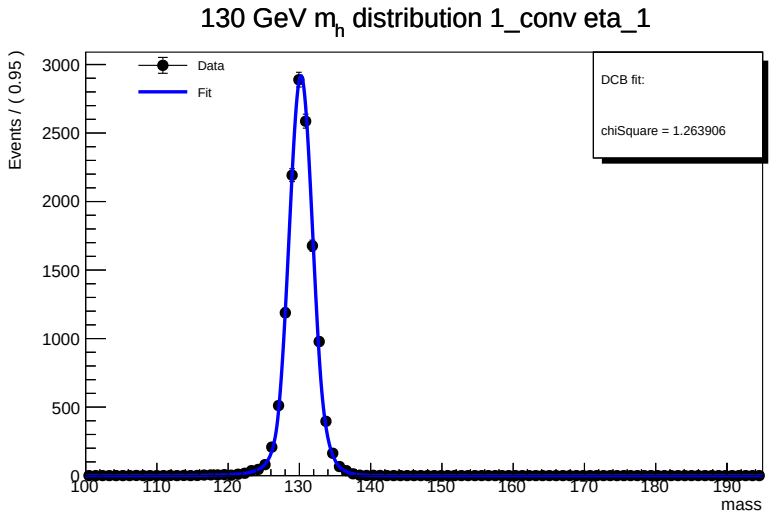
Eff 1_conv eta_1

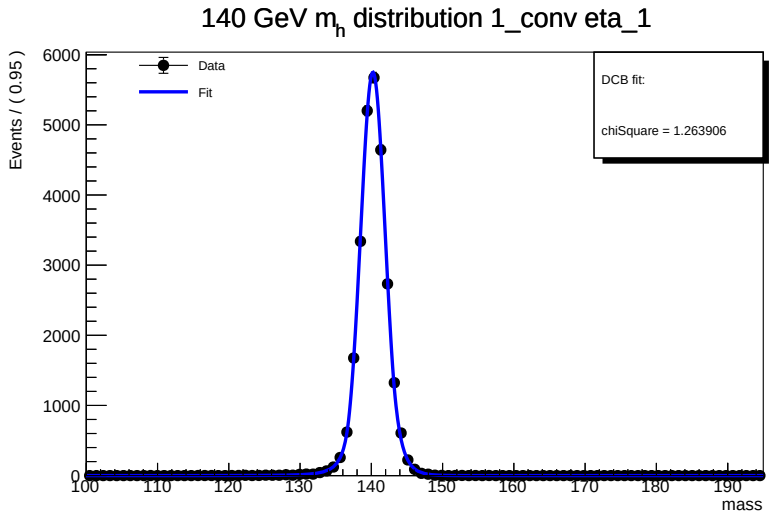


Sig 1_conv eta_1

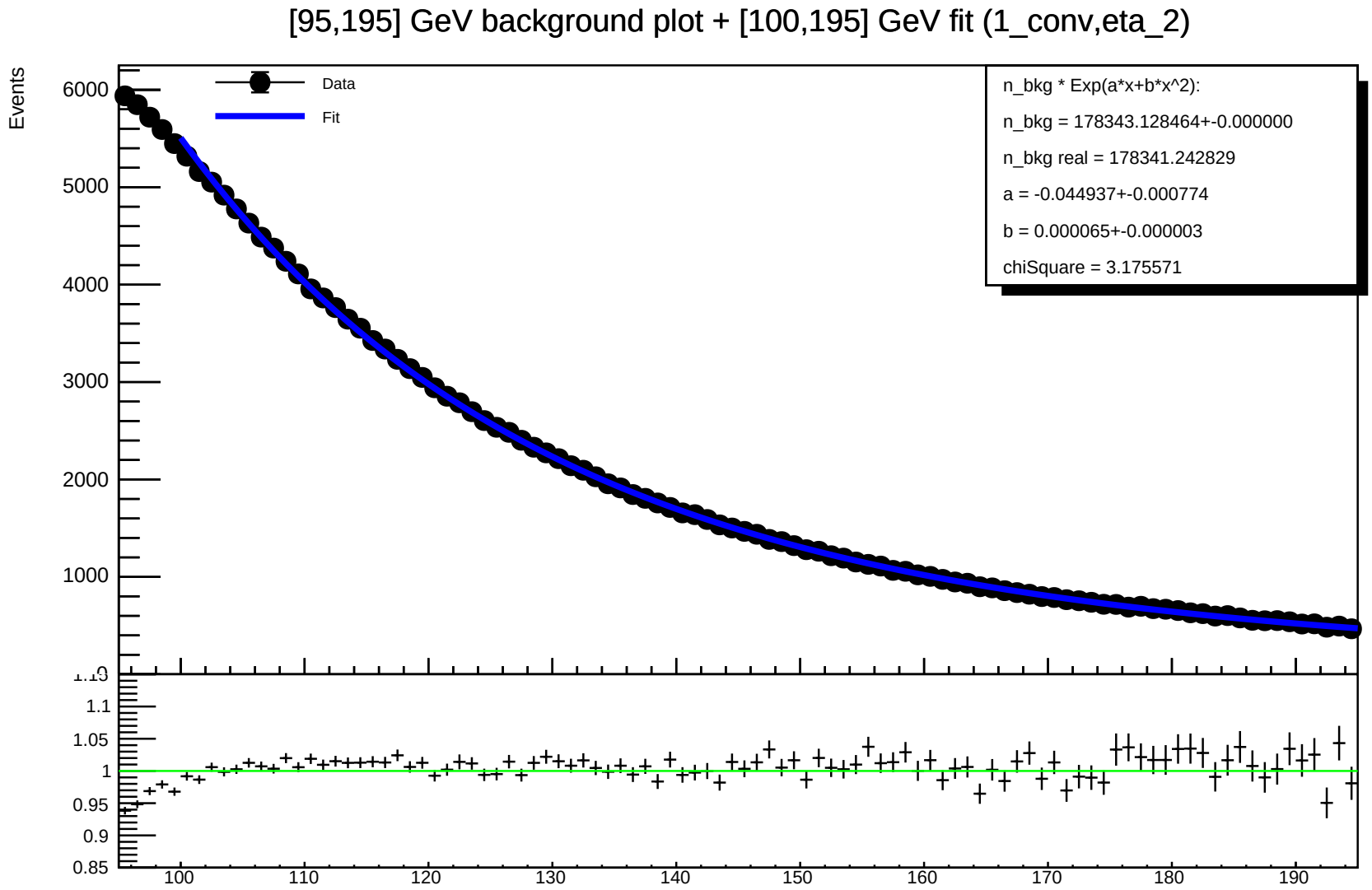




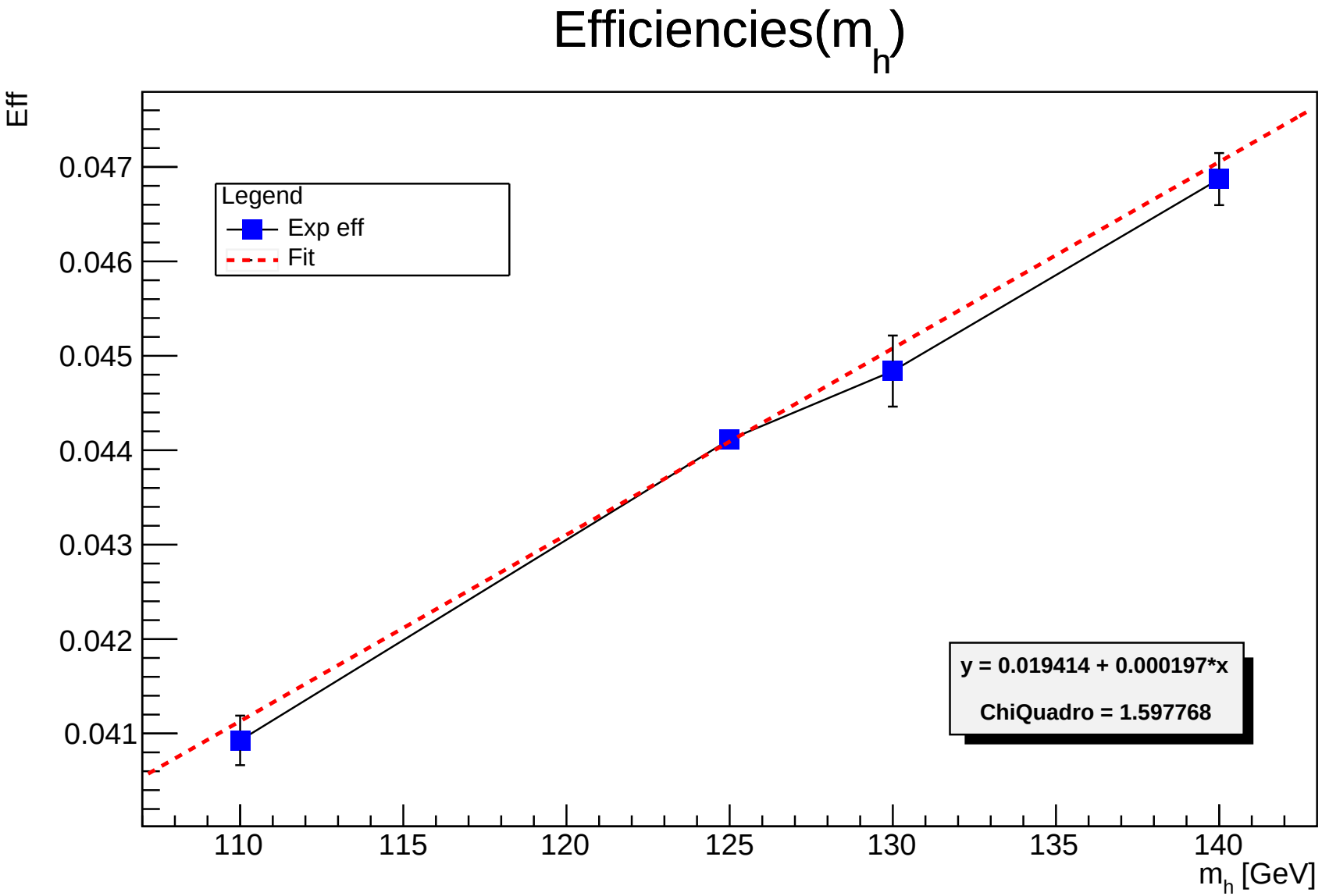




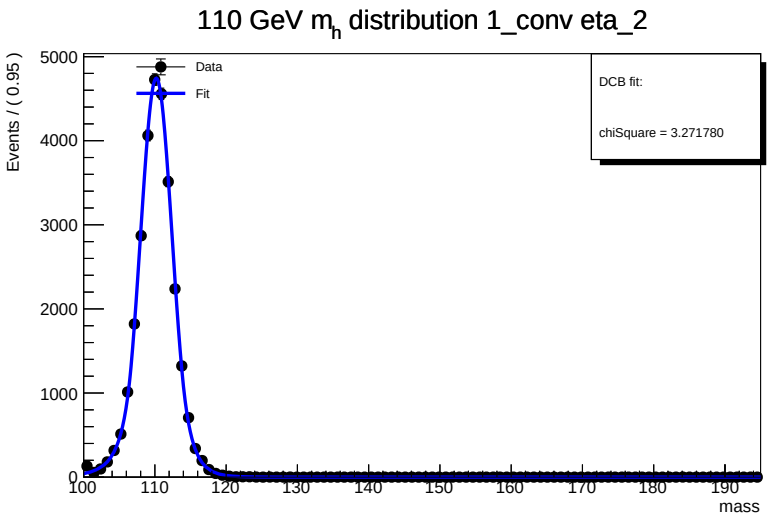
Bkg 1_conv eta_2

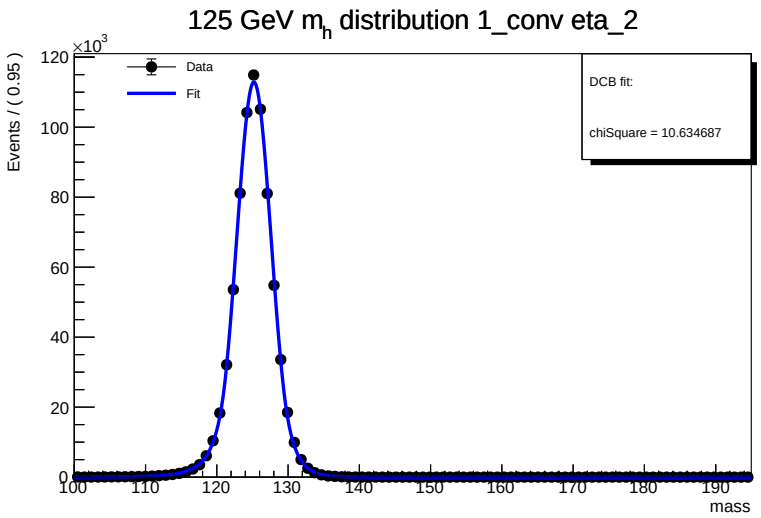


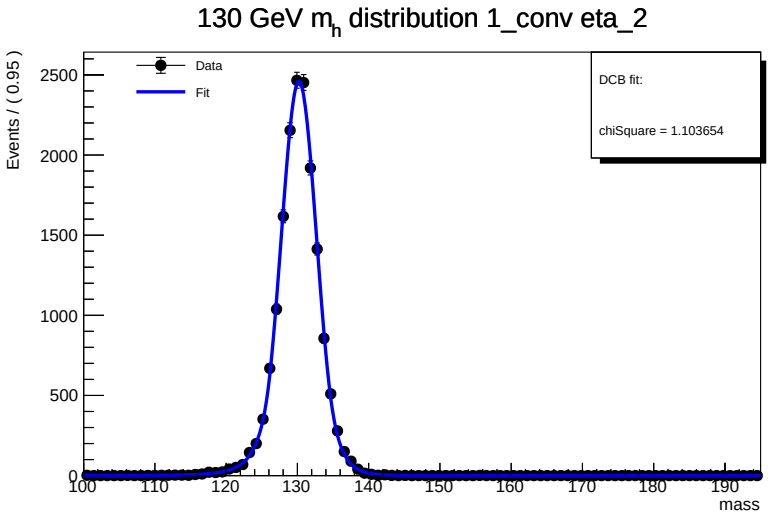
Eff 1_conv eta_2

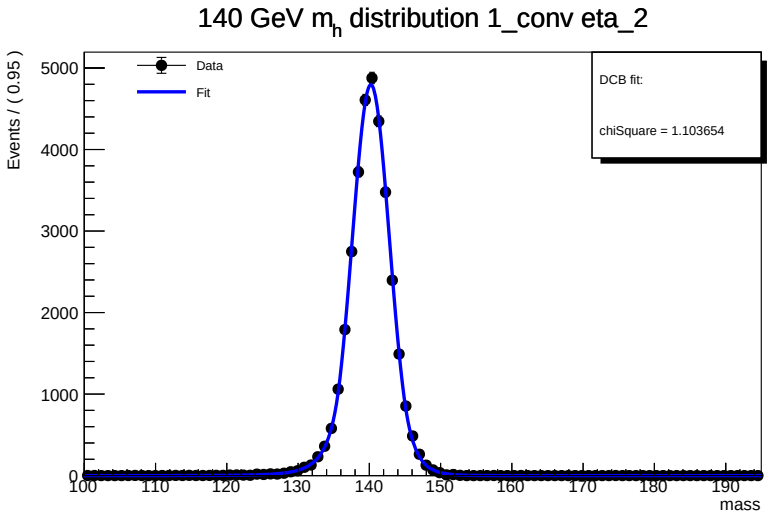


Sig 1_conv eta_2

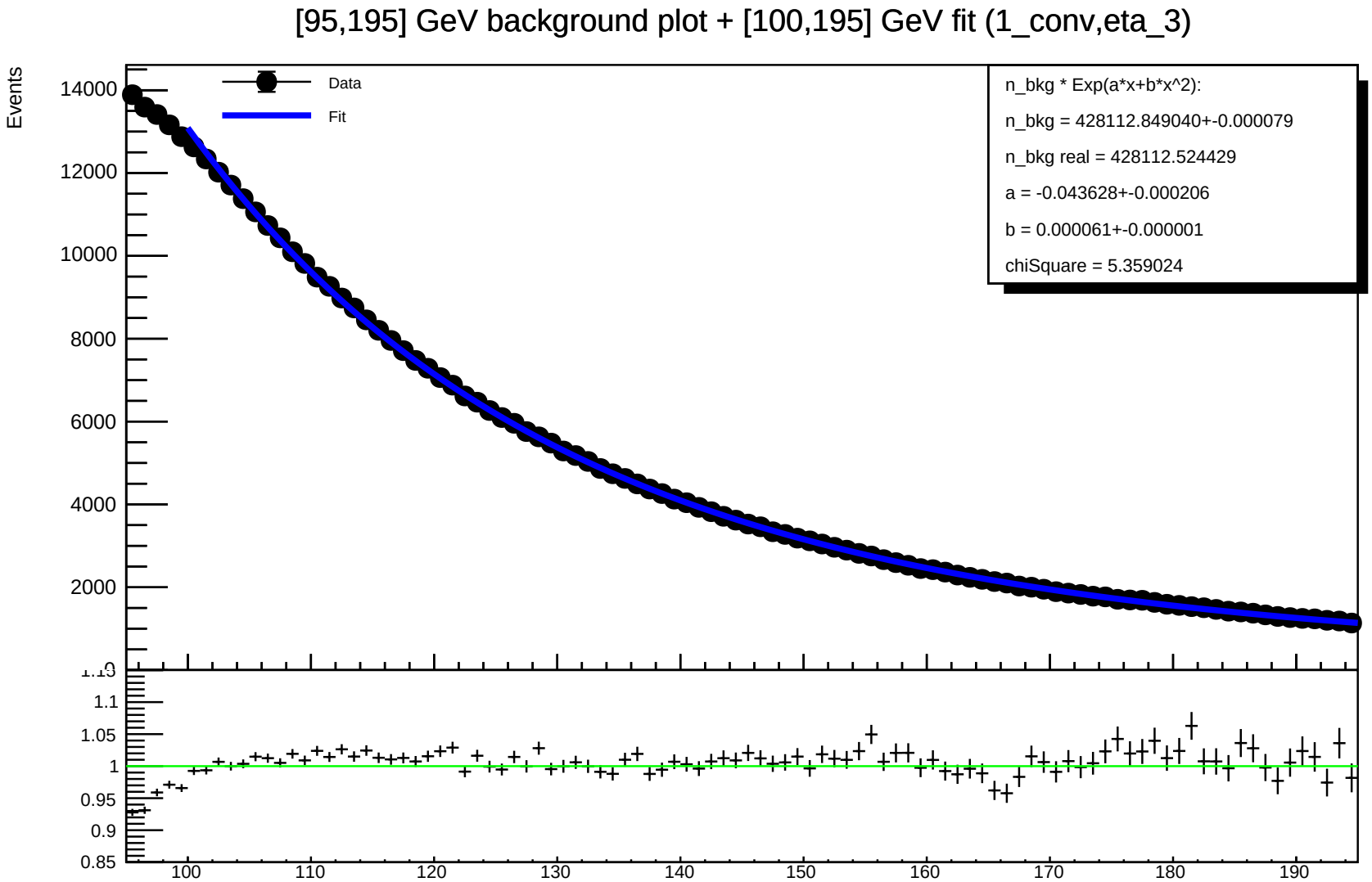




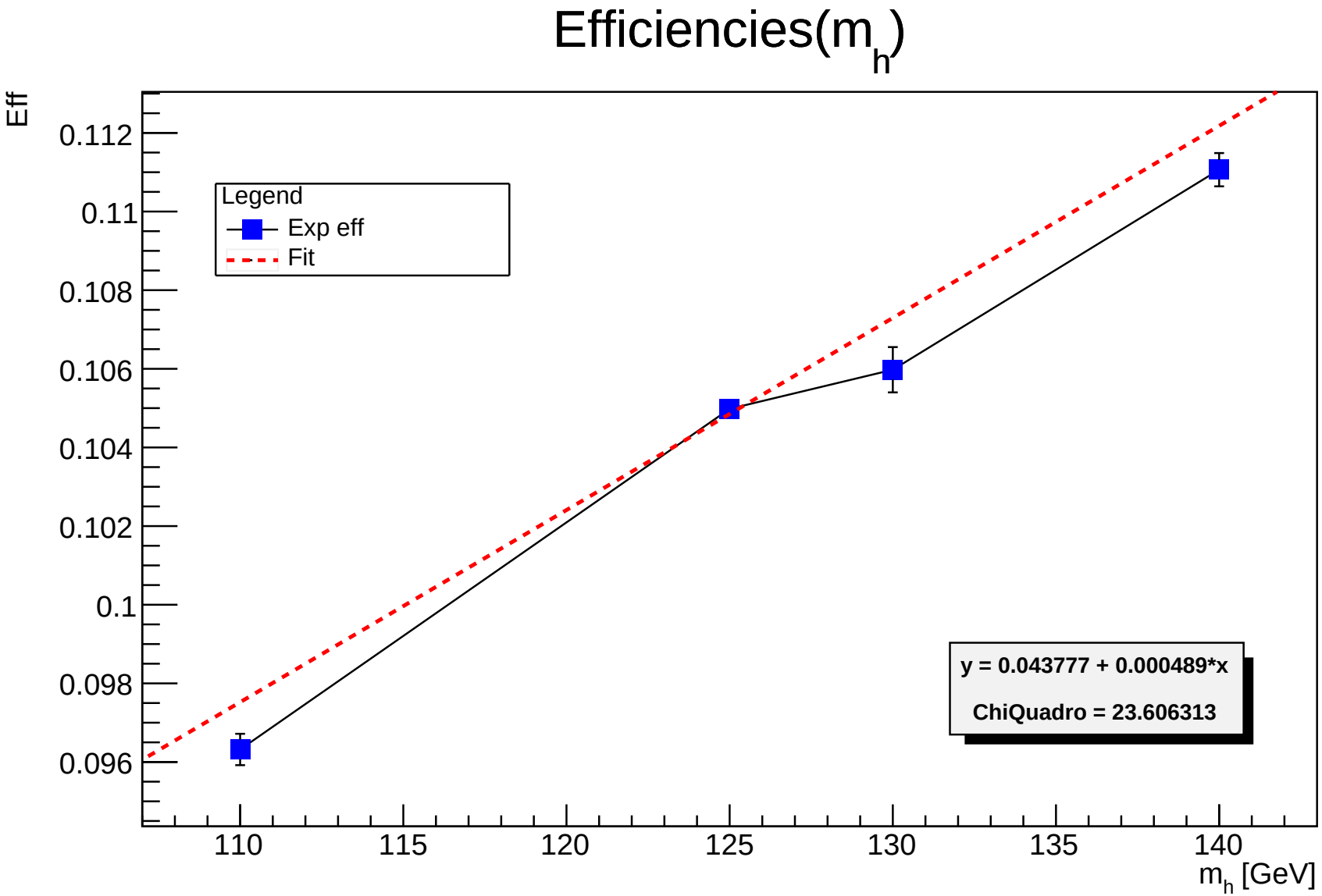




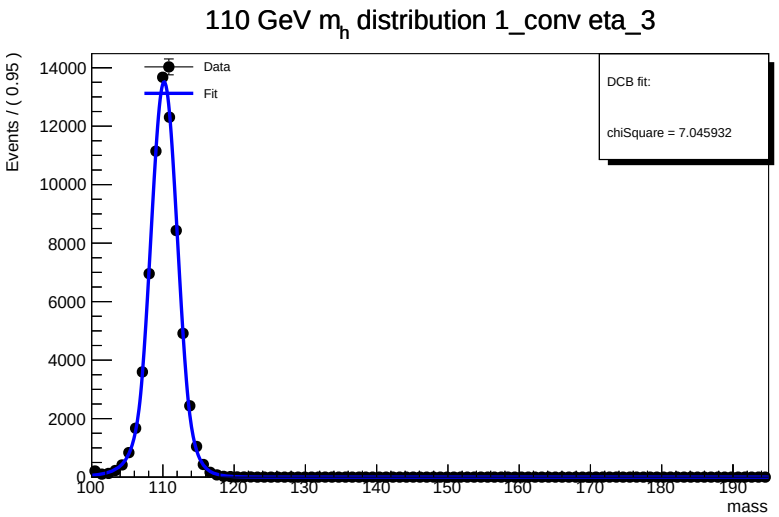
Bkg 1_conv eta_3

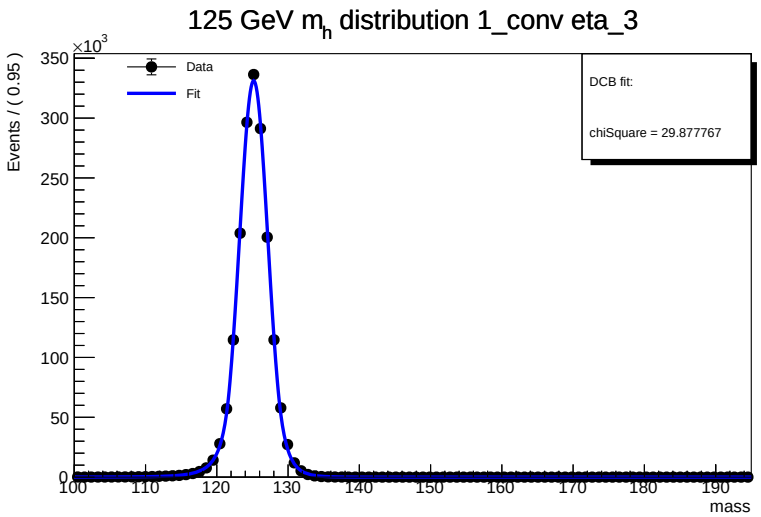


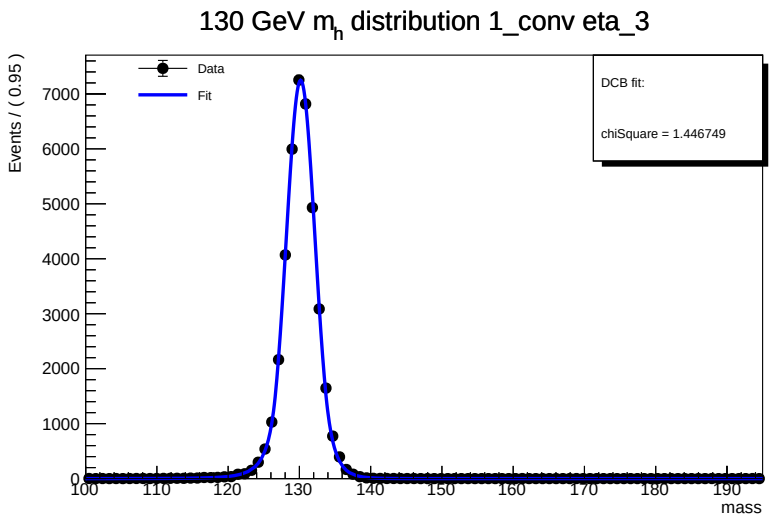
Eff 1_conv eta_3

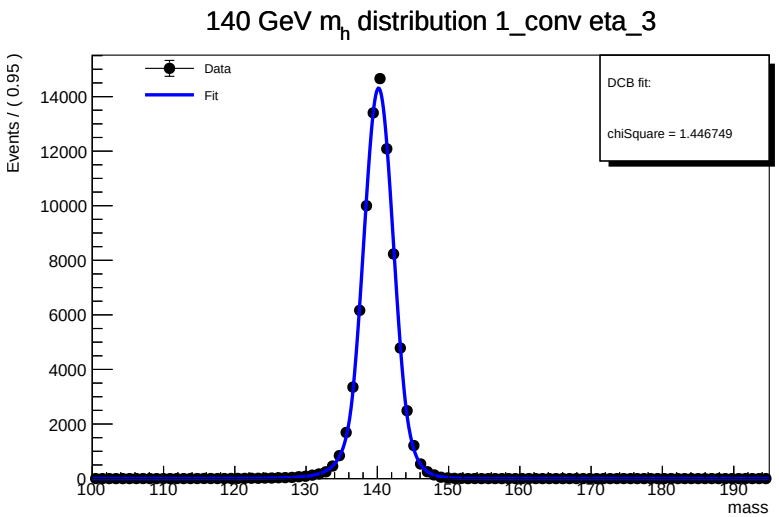


Sig 1_conv eta_3









σ comp

σ	110 GeV	125 GeV	130 GeV	140 GeV
no cat	1.6815	1.7914	1.8280	1.9013
unconv eta1	1.3850	1.4767	1.5073	1.5684
unconv eta2	1.8905	2.0592	2.1154	2.2279
unconv eta3	1.6011	1.7101	1.7464	1.8191
1conv eta1	1.5162	1.6136	1.6461	1.7110
1conv eta2	2.2108	2.4057	2.4707	2.6006
1conv eta3	1.8623	1.9712	2.0075	2.0801

Table: DSCB global fit σ

Sig/Bkg comp

S/B	110 GeV	125 GeV	130 GeV	140 GeV
no cat	0.016654	0.028482	0.030459	0.027733
unconv eta1	0.022935	0.039959	0.043401	0.040293
unconv eta2	0.015188	0.025486	0.027365	0.025094
unconv eta3	0.015641	0.026629	0.029040	0.026555
1conv eta1	0.022731	0.039530	0.042438	0.039615
1conv eta2	0.014479	0.024191	0.025957	0.023770
1conv eta3	0.014678	0.024909	0.026536	0.024405

Table: Number of signal and bkg events ratio in [peak-5,peak+5] GeV intervall

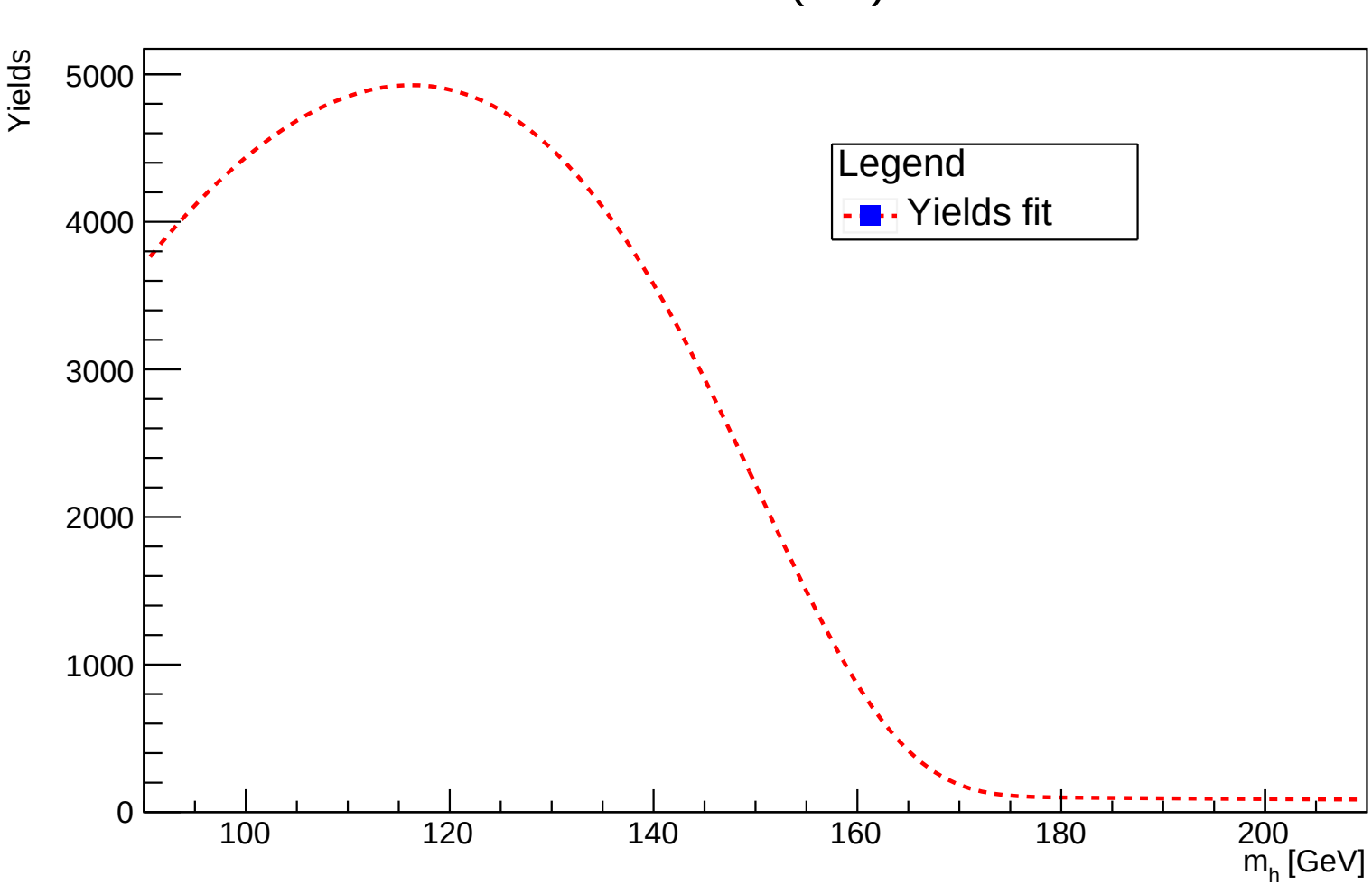
Signal events

Signal	110 GeV	125 GeV	130 GeV	140 GeV
no cat	5043.55	5470.73	5121.93	3572.26
unconv eta1	777.589	842.152	790.323	551.257
unconv eta2	371.877	397.986	369.978	257.827
unconv eta3	1308.86	1410.78	1333.2	923.673
1conv eta1	480.782	526.501	491.21	343.588
1conv eta2	623.682	675.171	631.844	441.421
1conv eta3	1467.8	1606.79	1493.38	1045.96

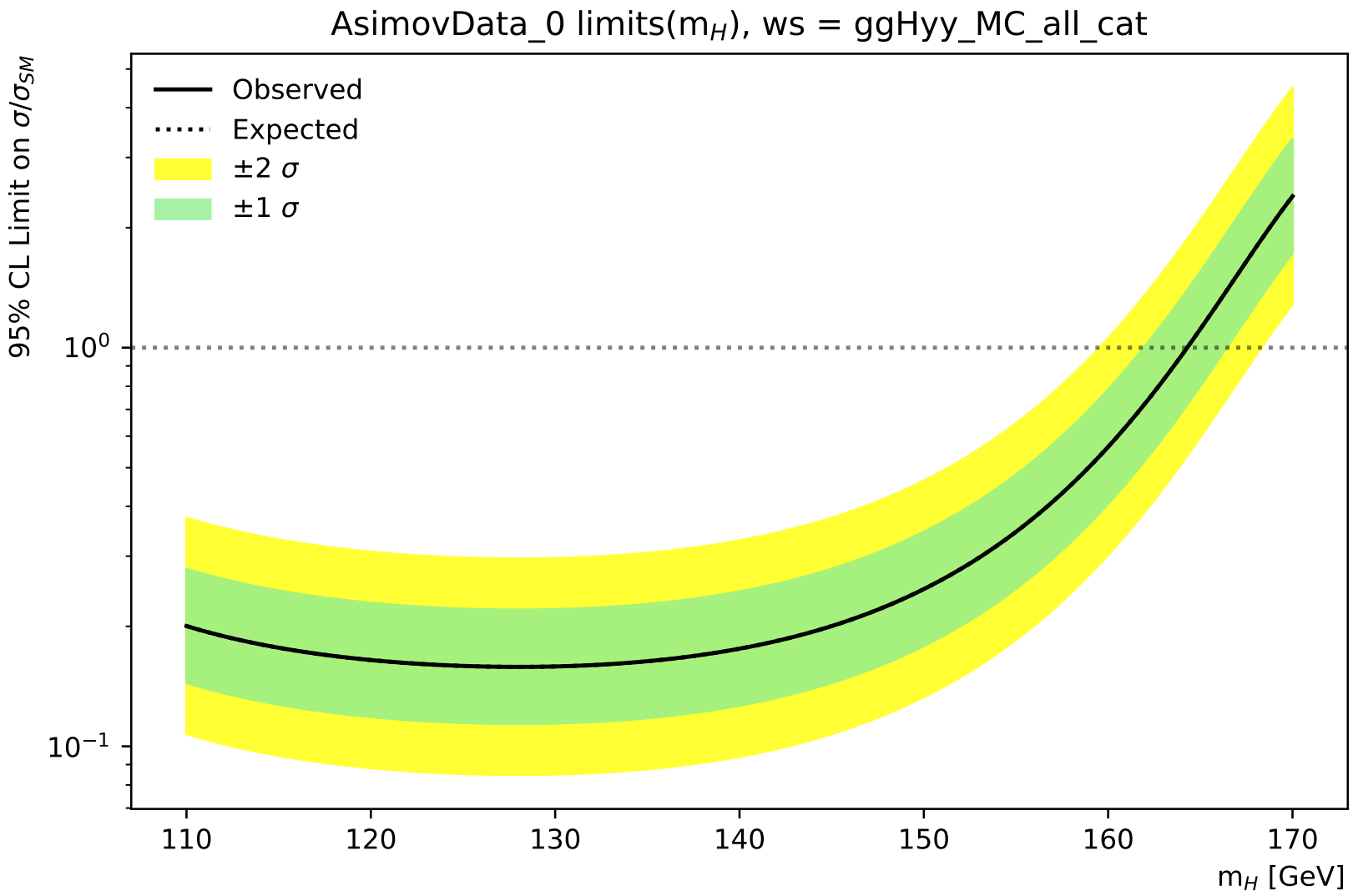
Table: Number of signal events in [-∞,+∞] GeV intervall

Check yields(mH)

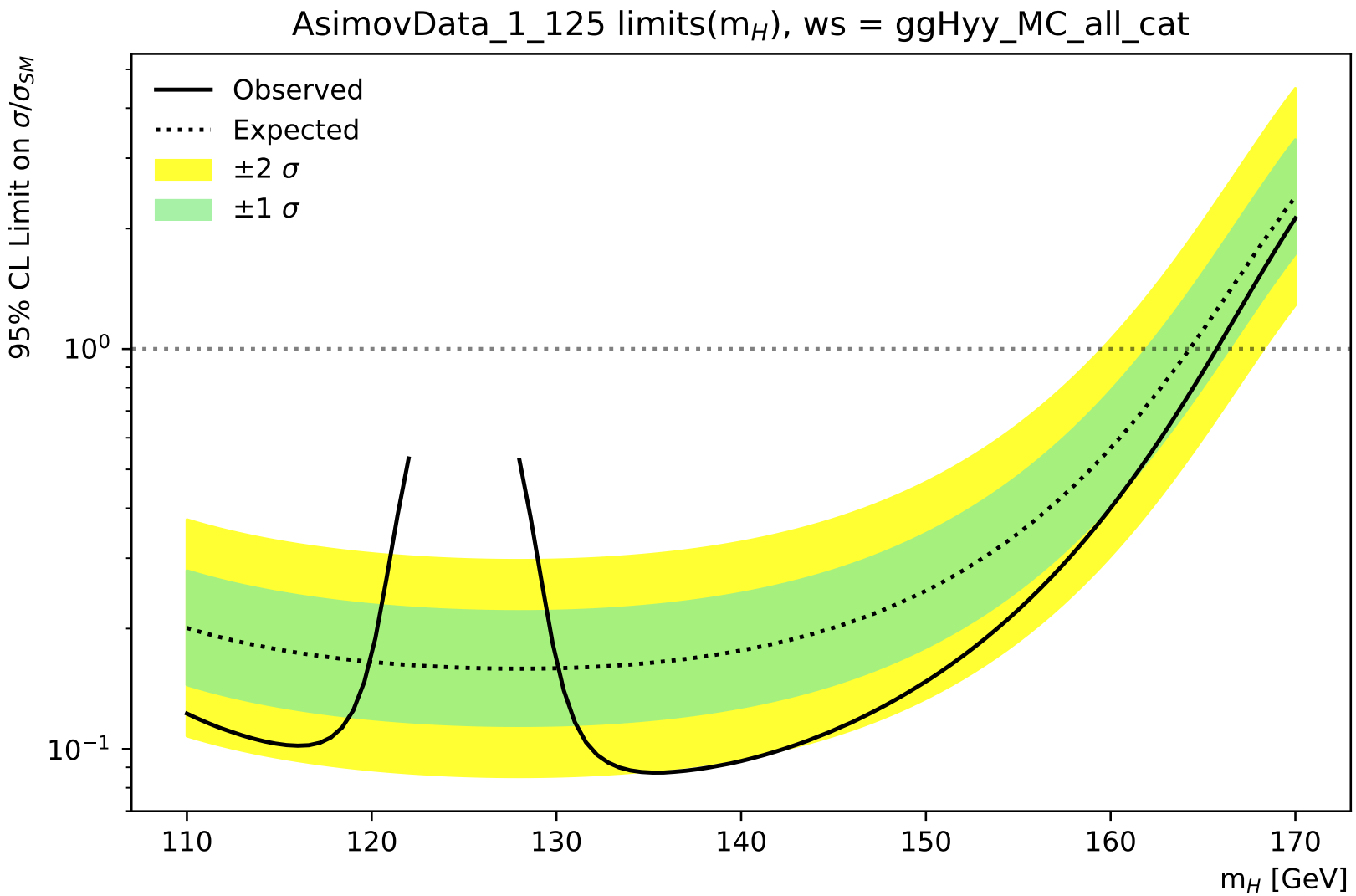
$$yield(mH) = xs(mH) \cdot eff(mH) \cdot br(mH) \cdot LumiRun2$$



AsimovData μ=0 limits

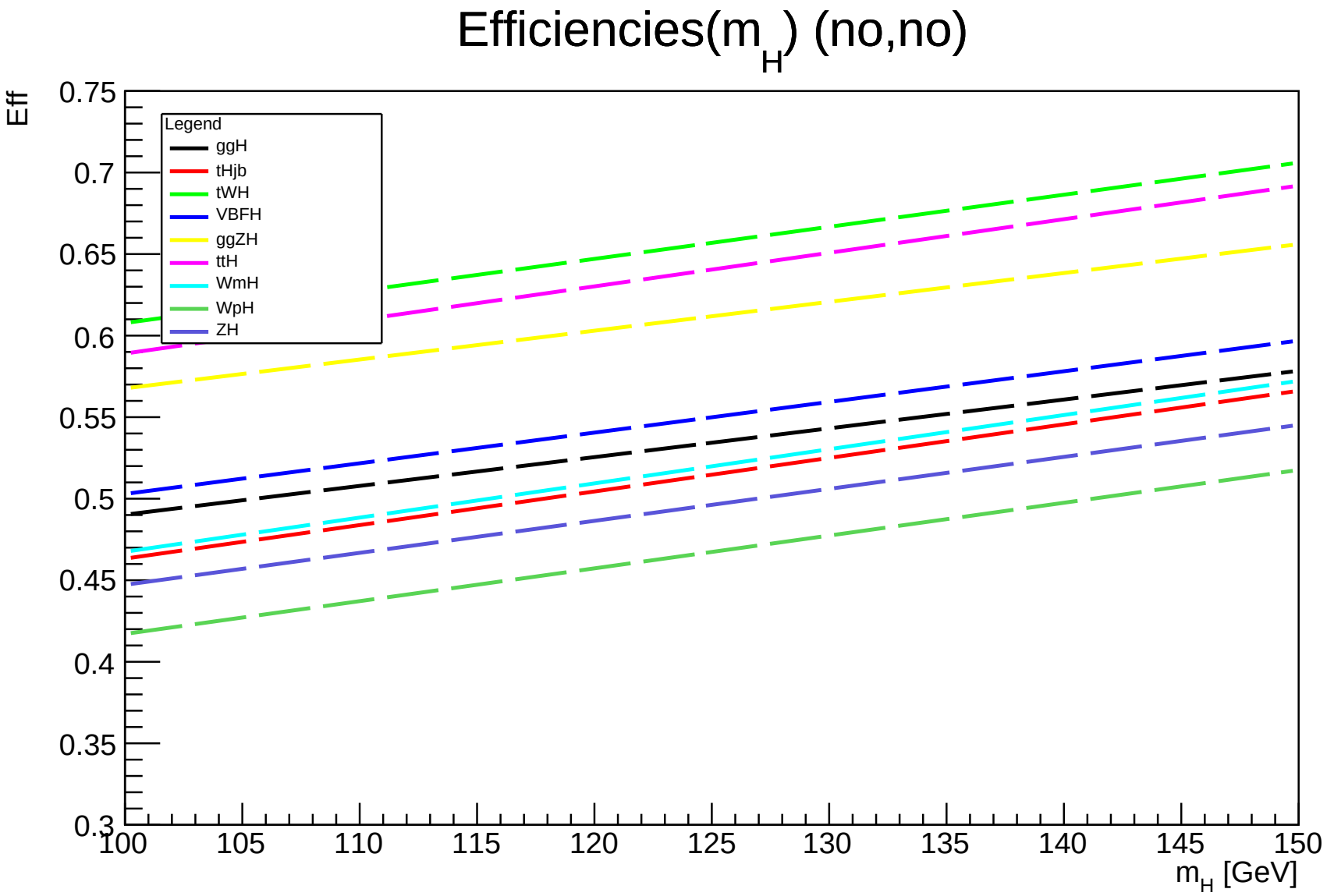


AsimovData μ=1, m_H=125 limits

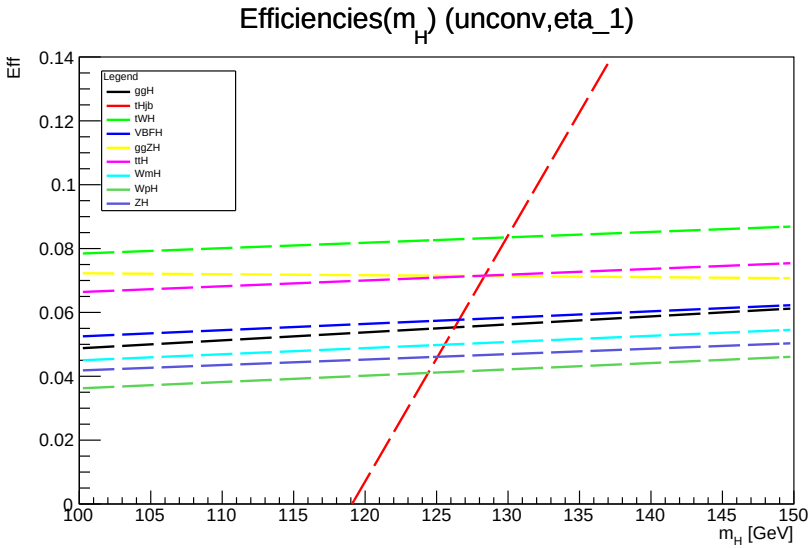


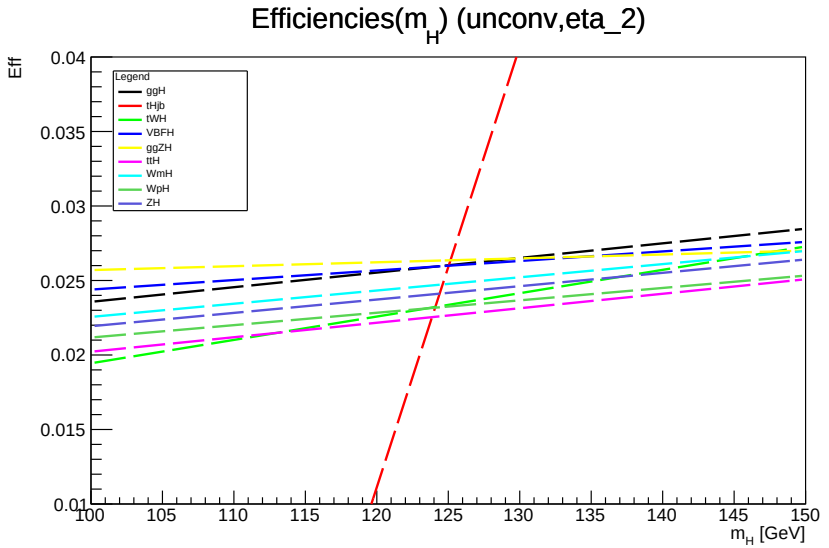
11^{th} week

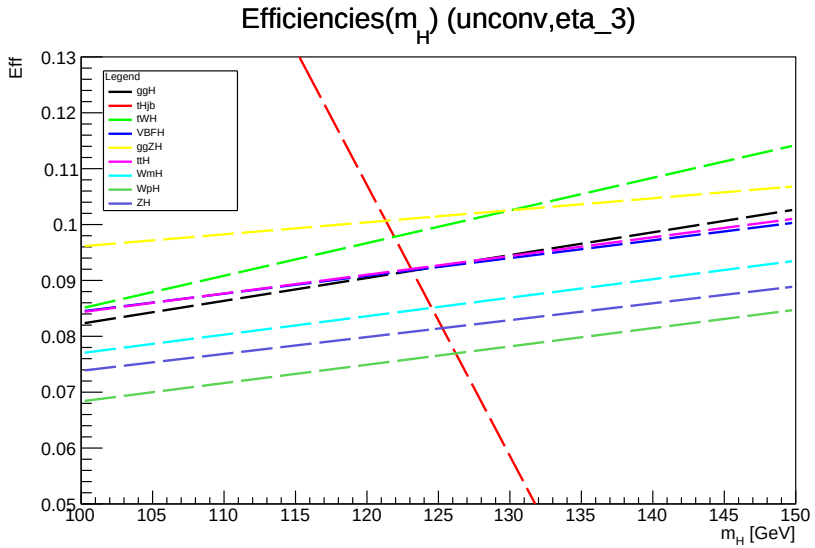
Production mods



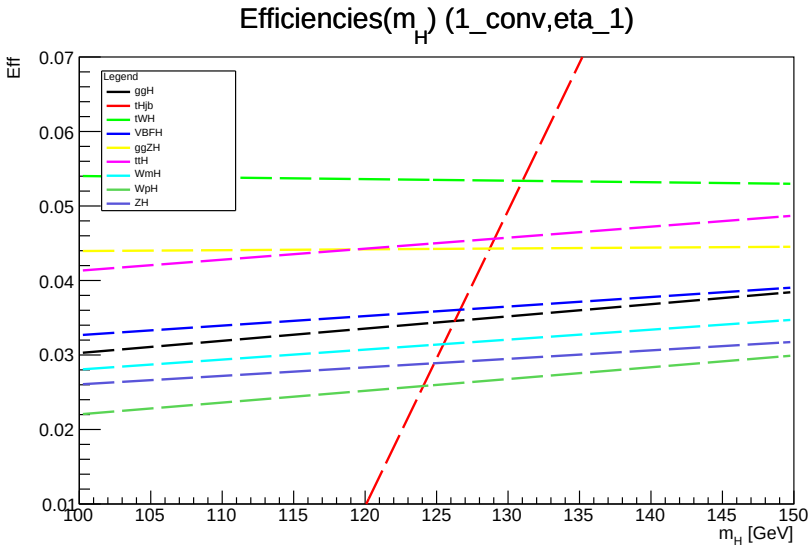
Production mods cat unconv

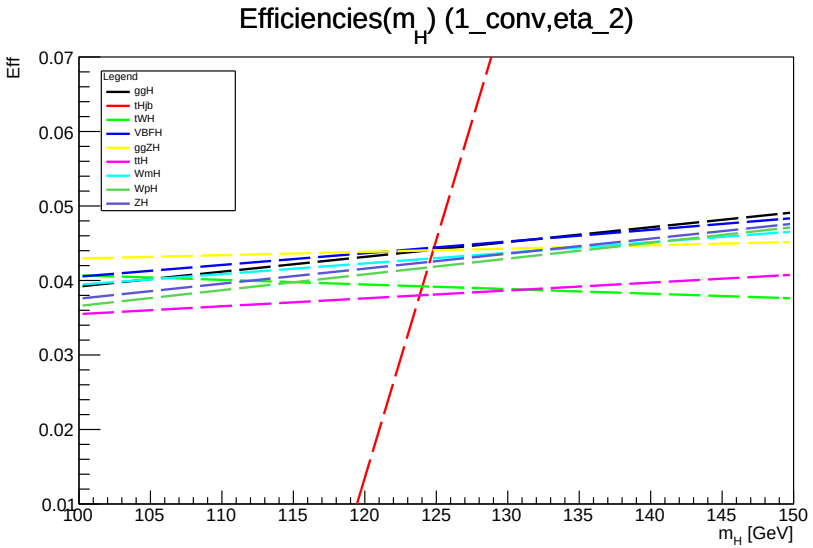


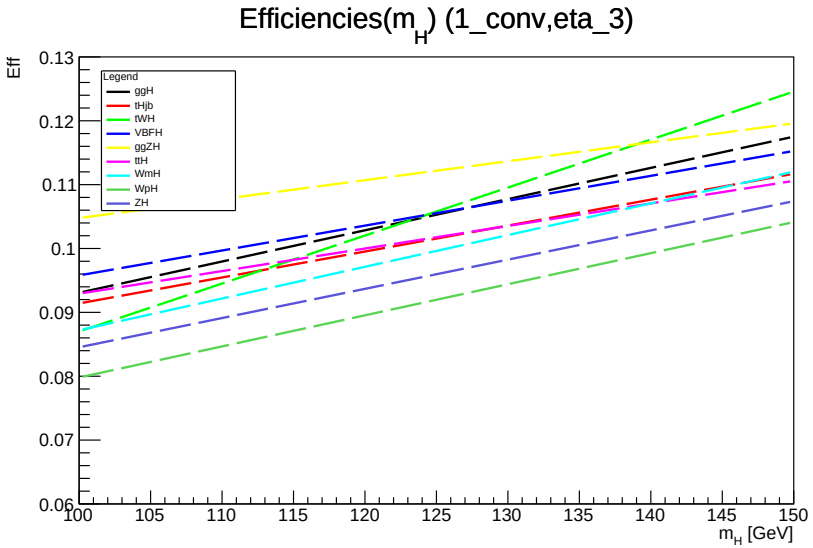




Production mods cat 1_conv







Production mods inc

	unc eta1	unc eta2	unc eta3	1con eta1	1con eta2	1con eta3
tHjb	4.92168	4.21999	2.22058	3.98446	5.2605	0.0585493
tWH	0.563279	0.144088	0.135479	0.686898	0.315391	0.0967323
VBFH	0.0621418	0.0514518	0.0374365	0.0639847	0.0299703	0.0331766
ggZH	0.404182	0.0955298	0.137776	0.381332	0.132958	0.0997581
ttH	0.330438	0.136784	0.027963	0.341308	0.192605	0.0756582
WmH	0.117803	0.0551875	0.0968894	0.103596	0.0696044	0.0591053
WpH	0.254666	0.113125	0.17659	0.259891	0.0602127	0.135705
ZH	0.188264	0.0734086	0.143477	0.184275	0.0390125	0.0903738

Table: $(\text{eff}_{prod} - \text{eff}_{ggH})/\ \text{eff}_{ggH}$

12^{th} week

Categories

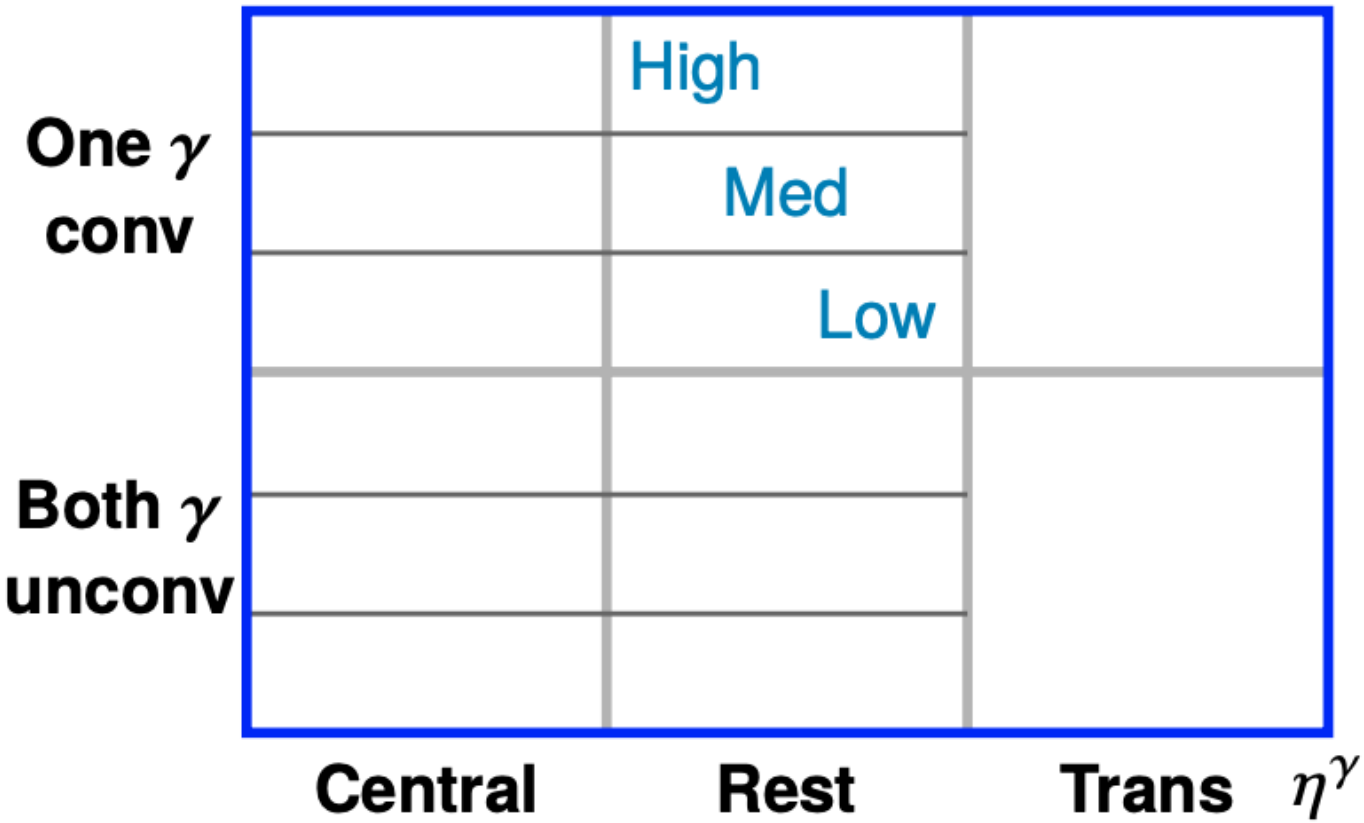


Figure 2: Simple sketch showing the mass analysis categories.

catMass_Run1

- **2 phs unconv**:
  - $|\eta_{s2}| < 0.75$:
    - pTt_yy < 70 GeV $\rightarrow$ 1;
    - pTt_yy > 70 GeV $\rightarrow$ 2;
  - $|\eta_{s2}|$ no central and trans regions:
    - pTt_yy < 70 GeV $\rightarrow$ 3;
    - pTt_yy > 70 GeV $\rightarrow$ 4;
  - at least one $|\eta_{s2}|$ ϵ $[1.3, 1.75] \rightarrow$ 5;
- **at least 1 ph conv**:
  - $|\eta_{s2}| < 0.75$:
    - pTt_yy < 70 GeV $\rightarrow$ 6;
    - pTt_yy > 70 GeV $\rightarrow$ 7;
  - $|\eta_{s2}|$ no central and trans regions:
    - pTt_yy < 70 GeV $\rightarrow$ 8;
    - pTt_yy > 70 GeV $\rightarrow$ 9;
  - at least one $|\eta_{s2}|$ ϵ $[1.3, 1.75] \rightarrow$ 10;

σ comp

σ	110 GeV	125 GeV	130 GeV	140 GeV
no	1.68147	1.79136	1.828	1.90126
1	1.42129	1.51595	1.54751	1.61062
2	1.14771	1.26317	1.30165	1.37862
3	1.65019	1.75329	1.78766	1.85639
4	1.32691	1.45938	1.50353	1.59184
5	1.88956	2.06138	2.11865	2.23319
6	1.5664	1.66296	1.69514	1.75952
7	1.28357	1.37509	1.4056	1.46661
8	1.92092	2.01923	2.052	2.11754
9	1.54226	1.6871	1.73538	1.83195
10	2.20815	2.40964	2.4768	2.61112

Table: DSCB global fit σ

Signal events

Signal	110 GeV		125 GeV		130 GeV		140 GeV	
	MC	**WS**	**MC**	**WS**	**MC**	**WS**	**MC**	**WS**
no	5043.55	4837.93	5470.73	4756.55	5121.93	4497.31	3572.26	3583.96
1	696.742	668.743	750.602	651.967	701.603	614.845	485.561	487.606
2	80.2544	74.5349	91.4242	79.6312	88.3154	77.1165	66.0322	64.1805
3	1185.1	1133	1264.18	1098.53	1188.59	1034.23	816.253	817.579
4	117.456	110.204	141.154	122.893	142.137	120.375	103.457	102.17
5	384.184	366.879	408.89	355.256	378.034	334.327	264.688	264.09
6	429.612	415.381	469.261	407.259	433.78	384.737	303.301	306.115
7	51.9456	47.9023	57.7754	50.3729	57.3162	48.5692	41.333	40.1116
8	1325.41	1283.29	1438.63	1248.44	1329.64	1176.58	921.605	931.941
9	134.748	125.694	160.193	139.503	158.066	136.477	118.131	115.594
10	638.087	610.39	690.553	599.942	644.483	567.192	451.832	451.925

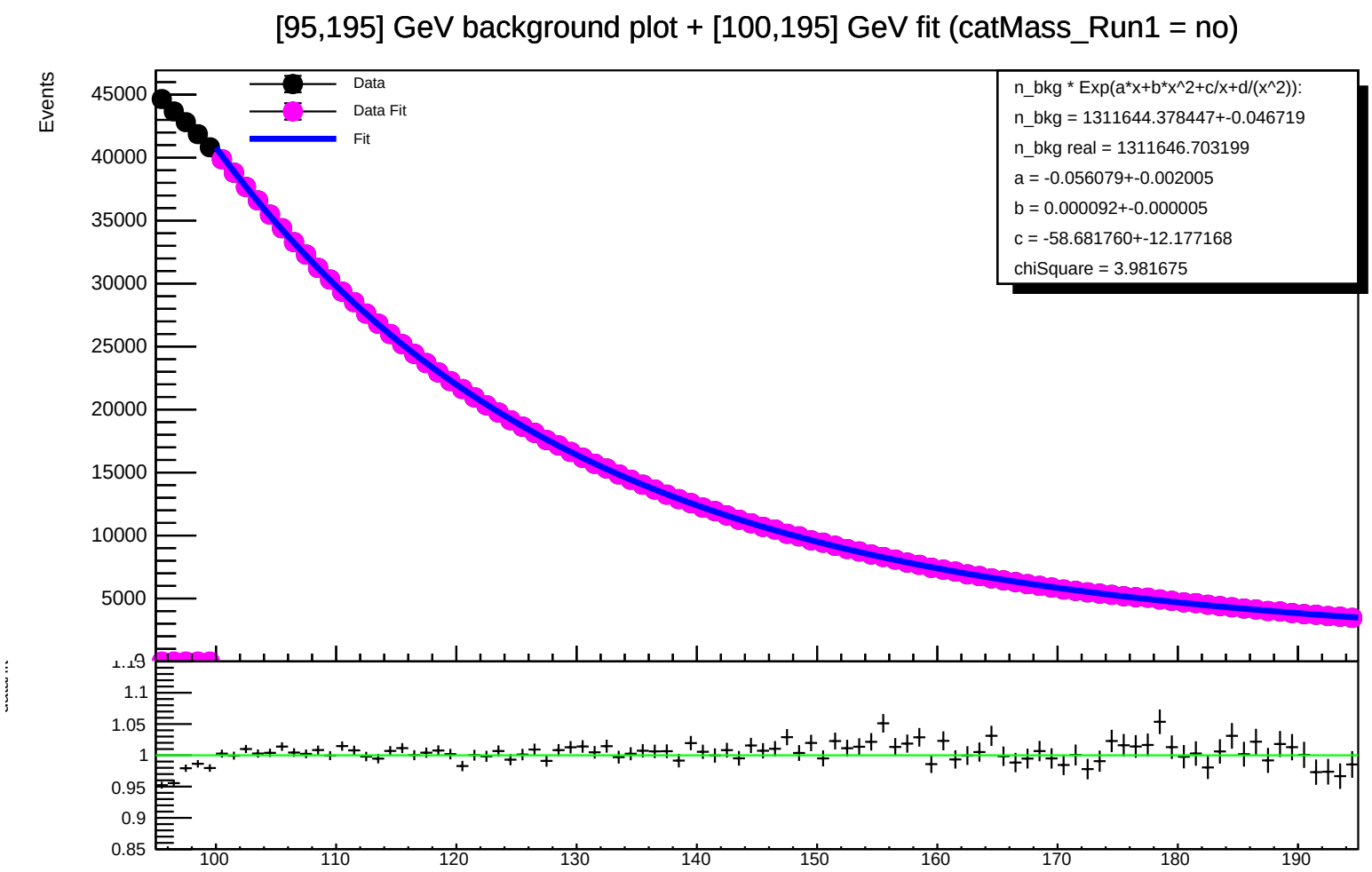
Table: Number of signal events in $[-\infty,+\infty]$ GeV intervall

Background events

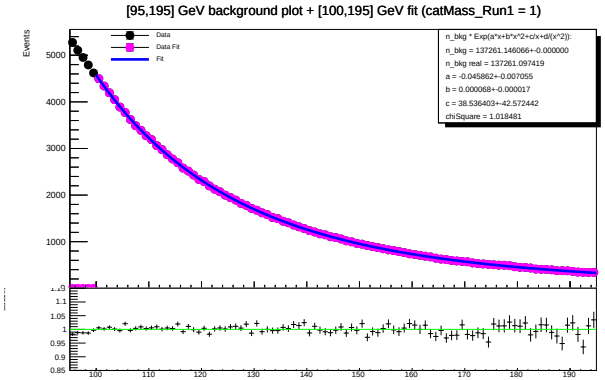
Bkg	**WS**	**MC**
no	1311644.378	1311646.703
1	137260.990	137261.097
2	8279.818	8279.871
3	337113.787	337113.739
4	22732.404	22732.471
5	107410.891	107411.489
6	85384.539	85384.483
7	5258.930	5258.815
8	398641.906	398641.875
9	27564.471	27564.465
10	181998.098	181998.398

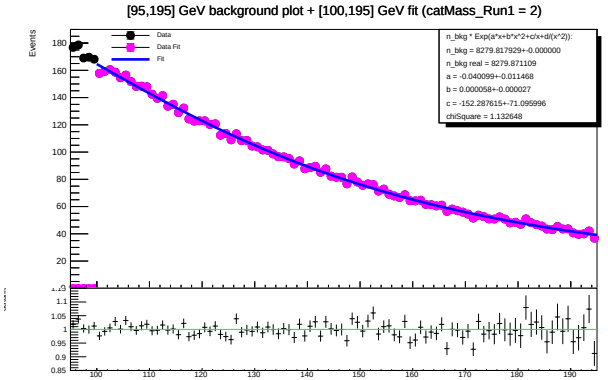
Table: Number of bkg events in [-∞,+∞] GeV intervall

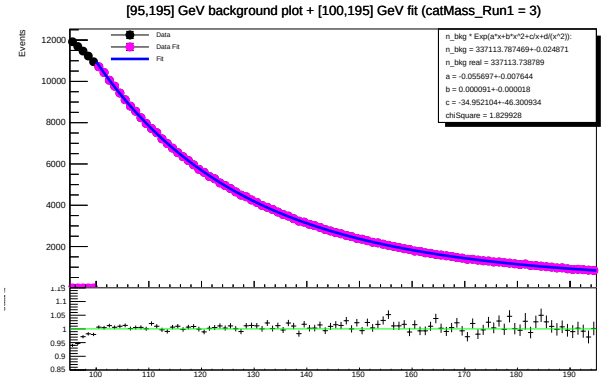
Bkg fit, catMass_Run1 = no

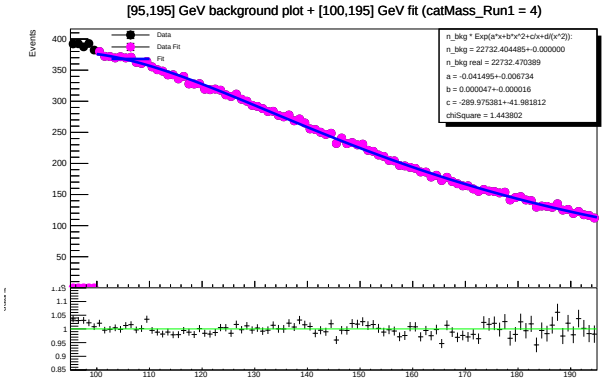


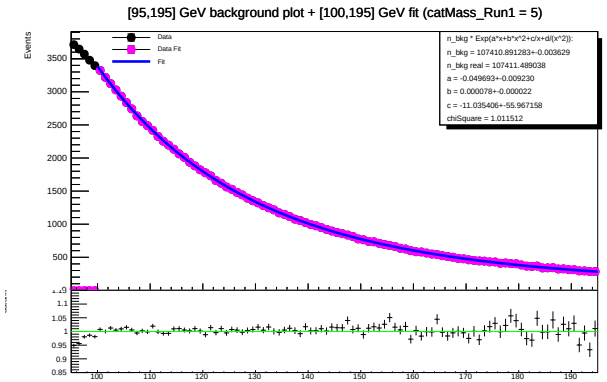
Bkg fit, catMass_Run1 → unconv



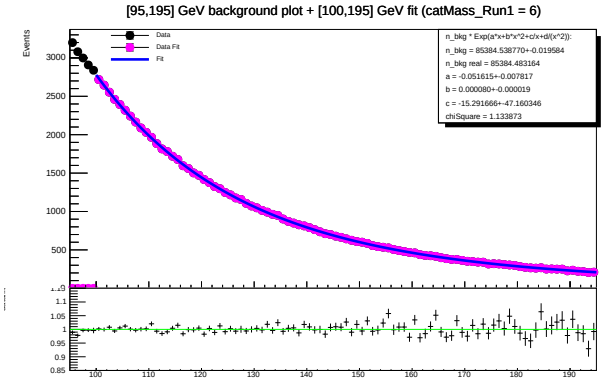


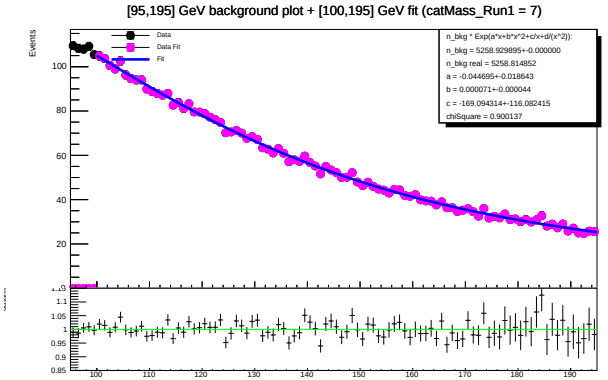


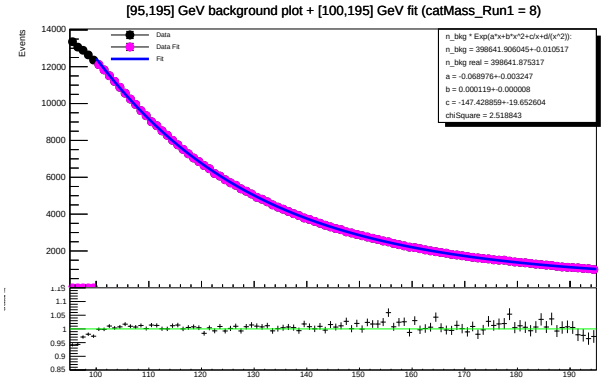


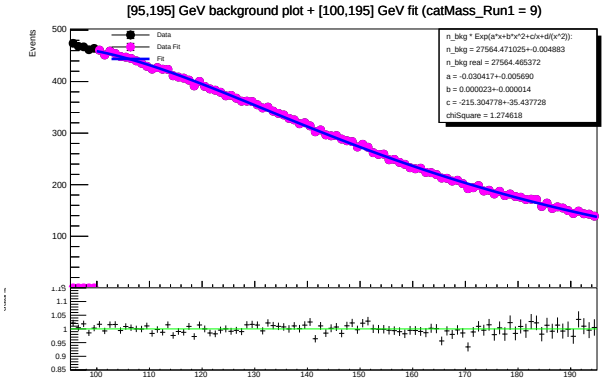


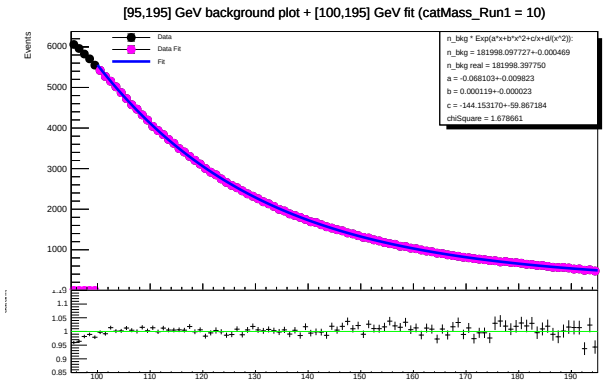
$\pm 1\sigma$ var sys, catMass_Run1 $\rightarrow$ 1_conv











Sig/Bkg comp

S/B	110 GeV	125 GeV	130 GeV	140 GeV
no	0.0166529	0.0284823	0.0304603	0.0277326
1	0.021419	0.0375575	0.0407769	0.0379514
2	0.0554274	0.0803118	0.0841923	0.0730285
3	0.0148703	0.0254731	0.0277976	0.0255077
4	0.0328145	0.0452041	0.048022	0.0391807
5	0.0152553	0.0254699	0.0272165	0.0250637
6	0.0211346	0.0371674	0.0396436	0.0373148
7	0.0573909	0.078944	0.0853157	0.0721993
8	0.0139178	0.0237978	0.0253832	0.0233588
9	0.03087	0.0420136	0.0432393	0.0366214
10	0.0145092	0.0242335	0.0259188	0.0238128

Table: Number of signal and bkg events ratio in [peak-5,peak+5] GeV intervall

Sig/$\sqrt{Bkg}$ comp

$S/\sqrt{B}$	110 GeV	125 GeV	130 GeV	140 GeV
no	9.05469	12.2968	12.2887	9.77524
1	3.85122	5.28691	5.3209	4.27062
2	2.10398	2.70284	2.72112	2.187
3	4.17193	5.629	5.7006	4.5162
4	1.95799	2.51564	2.60207	2.00167
5	2.38983	3.17393	3.15318	2.52515
6	2.98634	4.13411	4.09718	3.32831
7	1.72307	2.12479	2.20016	1.71525
8	4.22538	5.73578	5.68458	4.53078
9	2.02405	2.56635	2.57861	2.05091
10	2.95071	3.93759	3.92067	3.1319

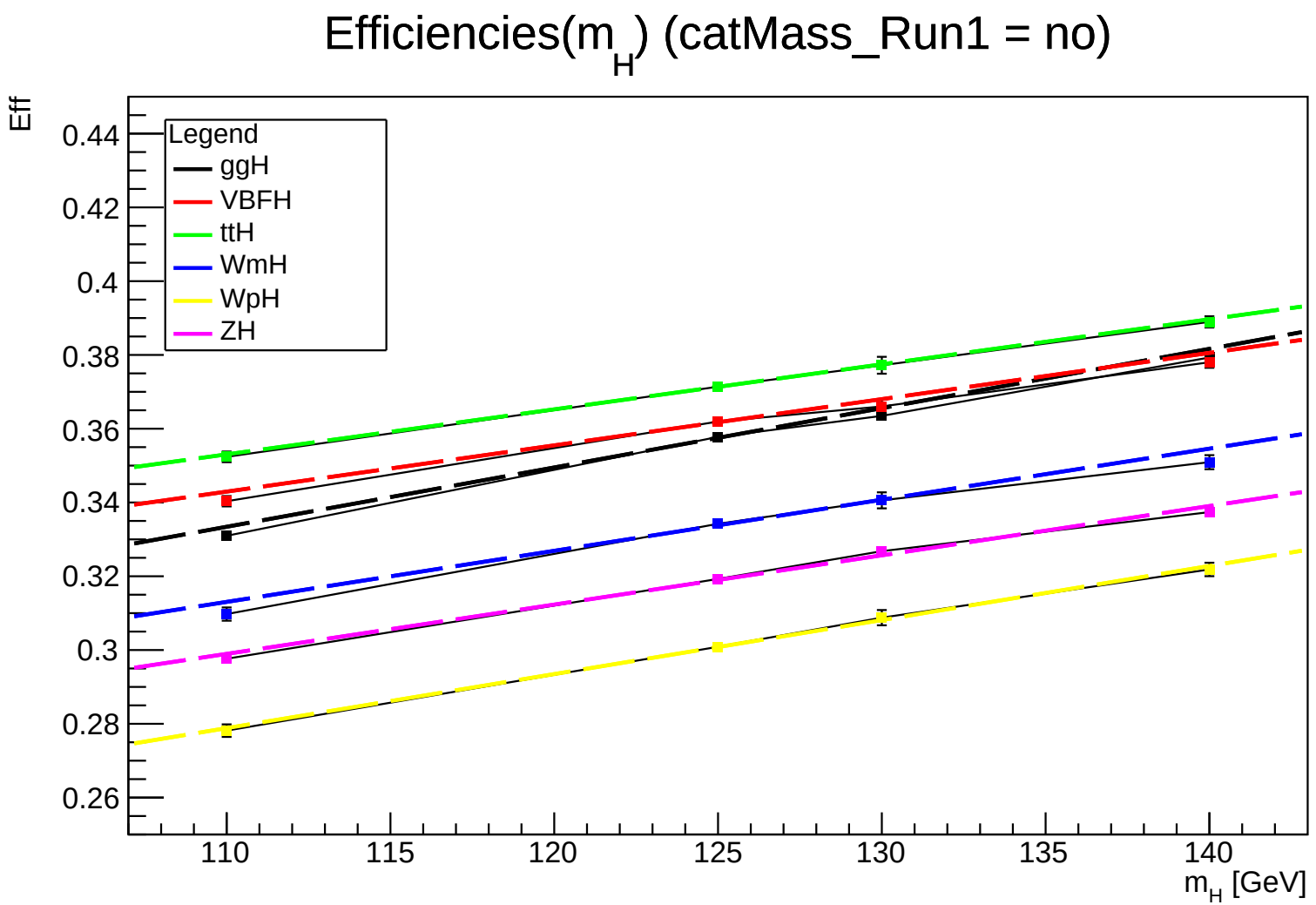
Table: Number of signal and $\sqrt{bkg}$ events ratio in [peak-5,peak+5] GeV intervall

Production mods inc

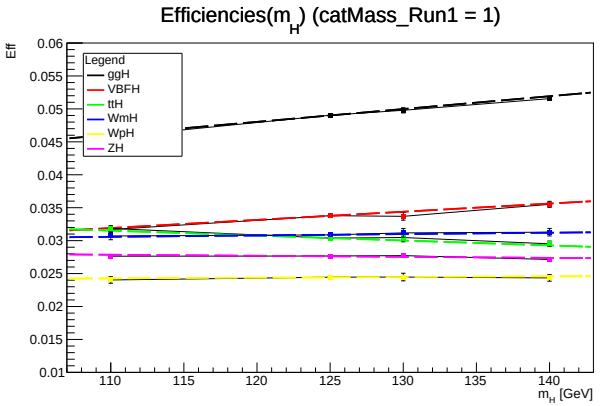
	110 GeV	125 GeV	130 GeV	140 GeV
no	0.163719	0.158653	0.157113	0.154228
1	0.473474	0.501648	0.510308	0.526655
2	6.10882	5.75791	5.66206	5.49417
3	0.389534	0.454923	0.475167	0.513567
4	4.19079	4.09942	4.07578	4.03563
5	0.134046	0.127847	0.125924	0.122273
6	0.483679	0.49864	0.503204	0.511778
7	5.89377	5.83035	5.81268	5.78134
8	0.415306	0.477397	0.496536	0.532731
9	4.08364	3.94033	3.90303	3.83948
10	0.114249	0.135306	0.14171	0.153712

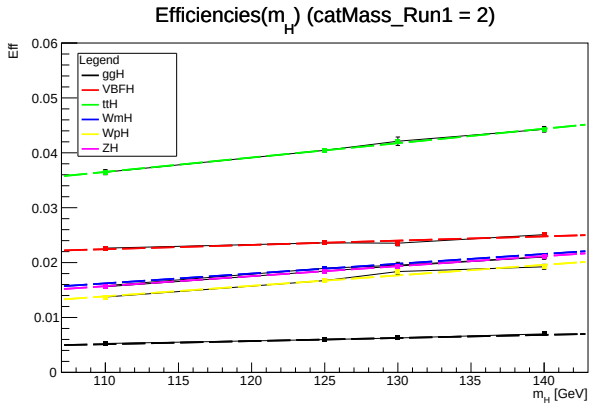
Table: abs(eff_{prod} - eff_{ggH})/ eff_{ggH}

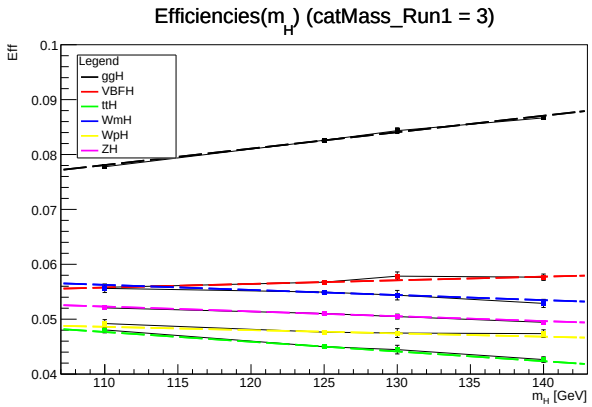
Production mods

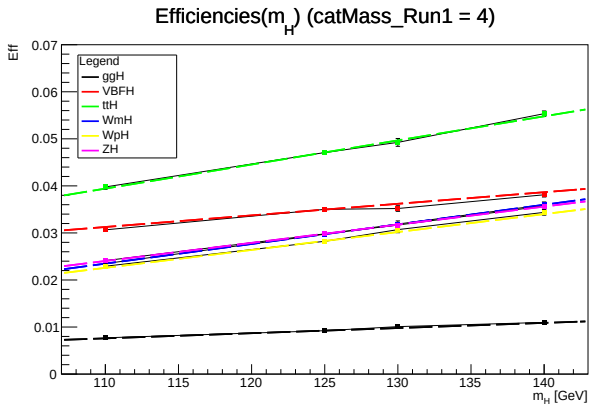


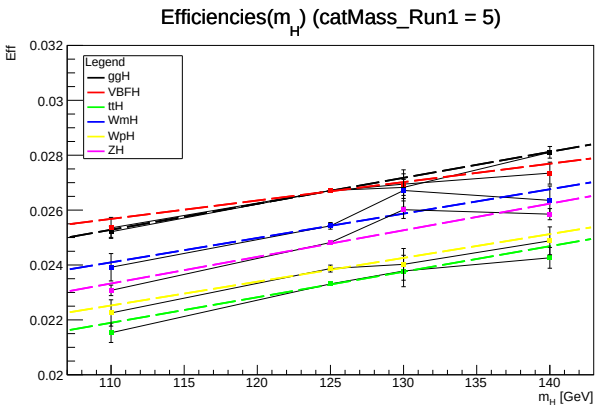
Production mods cat unconv



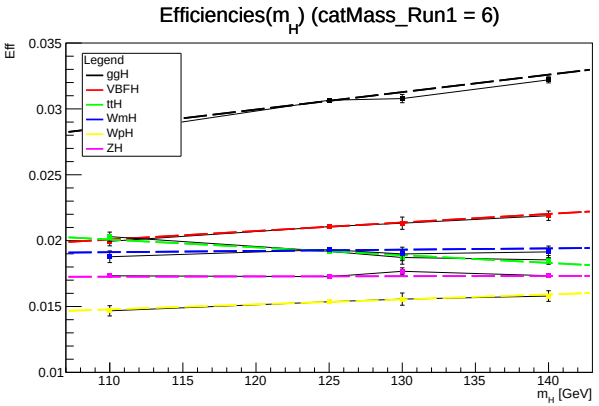


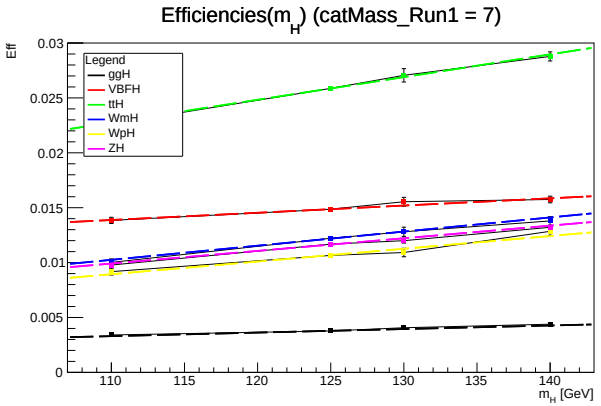


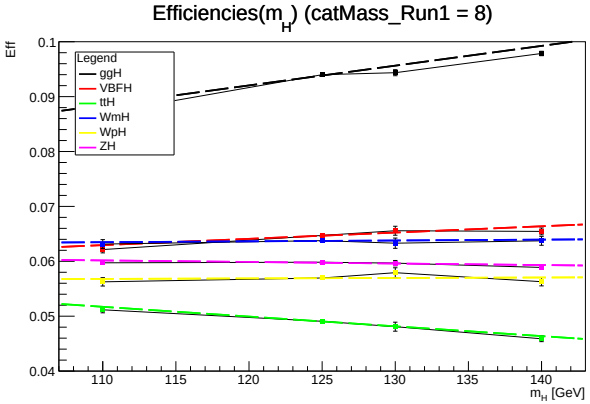


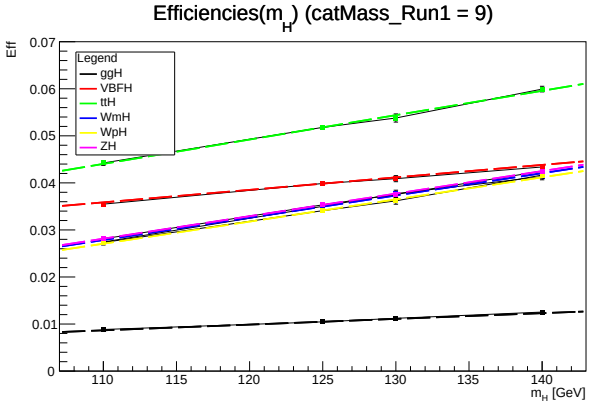


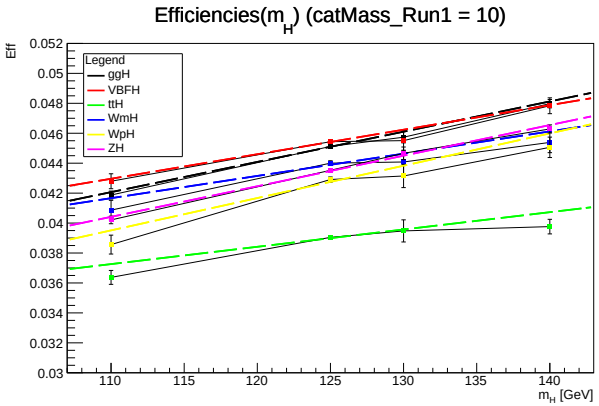
Production mods cat 1_conv











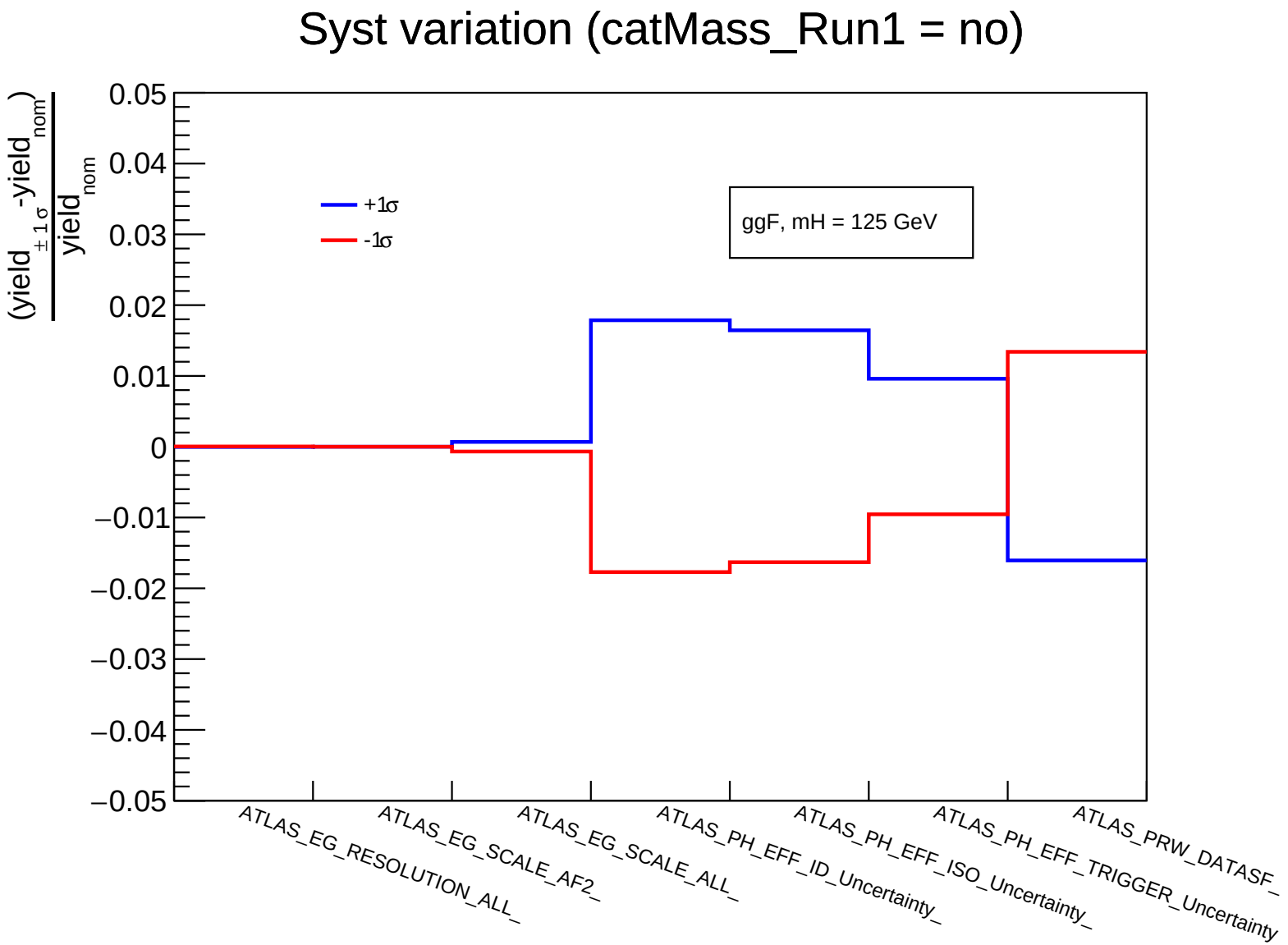
$\pm 1\sigma$ var sys

Signal	no		1		2		3		4		5	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
_EG_RESOLUTION_ALL_	-3.40462e-05	3.3878e-05	-6.11058e-06	-7.58219e-07	-9.1139e-05	8.79852e-05	6.57836e-06	-4.91537e-05	-0.000263193	0.000263654	-0.00014322	0.000170178
_EG_SCALE_AF2_	0	0	0	0	0	0	0	0	0	0	0	0
_EG_SCALE_ALL_	0.000678601	-0.000679522	-0.000232135	0.000188235	0.00483447	-0.0046946	-0.000428294	0.000482657	0.010503	-0.0107856	0.0014803	-0.00142847
_PH_EFF_ID_Uncertainty_	0.0178653	-0.0177085	0.015046	-0.0149364	0.0123724	-0.0122983	0.0163719	-0.0162403	0.013768	-0.0136748	0.0177965	-0.017642
_PH_EFF_ISO_Uncertainty_	0.0164459	-0.0163114	0.0132218	-0.0131345	0.0106729	-0.0106168	0.0146318	-0.0145239	0.0131856	-0.0130982	0.0160314	-0.0159049
_PH_EFF_TRIGGER_Uncertainty_	0.00959862	-0.00954776	0.00958805	-0.00954001	0.0101478	-0.0100931	0.00871426	-0.00867415	0.00916871	-0.00912181	0.0109943	-0.0109264
_PRW_DATASF_	-0.0160675	0.0134036	-0.0203614	0.0176278	-0.0144369	0.0118348	-0.0177415	0.0146681	-0.0108232	0.00886235	-0.0172345	0.0144609

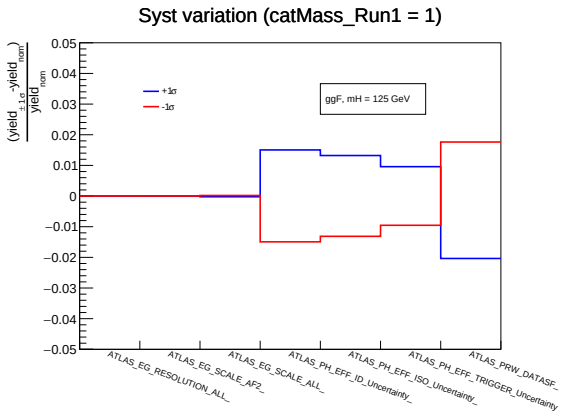
Signal	6		7		8		9		10	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
_EG_RESOLUTION_ALL_	1.5645e-05	-4.38881e-05	-0.000141157	0.000706633	-5.81966e-05	3.8653e-05	9.66237e-05	0.000141198	-2.45463e-05	5.04156e-05
_EG_SCALE_AF2_	0	0	0	0	0	0	0	0	0	0
_EG_SCALE_ALL_	1.11065e-05	-1.46545e-05	0.00558347	-0.00505572	-0.000217932	0.000124032	0.00756583	-0.00724876	0.000975332	-0.000945535
_PH_EFF_ID_Uncertainty_	0.0201687	-0.0199793	0.0157039	-0.015589	0.0200123	-0.0198184	0.0168557	-0.0167183	0.0196456	-0.0194573
_PH_EFF_ISO_Uncertainty_	0.0169114	-0.0167773	0.0146402	-0.0145404	0.01843	-0.0182663	0.0174182	-0.0172731	0.0204232	-0.0202244
_PH_EFF_TRIGGER_Uncertainty_	0.00950289	-0.00945582	0.0100839	-0.0100299	0.00911367	-0.00906769	0.00950835	-0.00945637	0.0114736	-0.0113976
_PRW_DATASF_	-0.00446197	0.00349614	-0.00114446	-0.000230635	-0.0177047	0.0145884	-0.0122896	0.00974719	-0.0155331	0.0132597

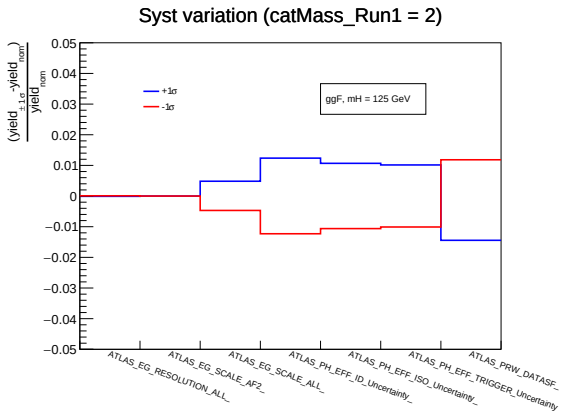
Table: $\pm 1\sigma$ var sys for each category

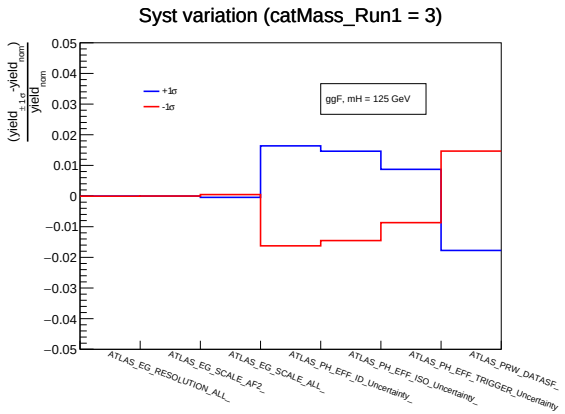
$\pm 1\sigma$ var sys, catMass_Run1 = no

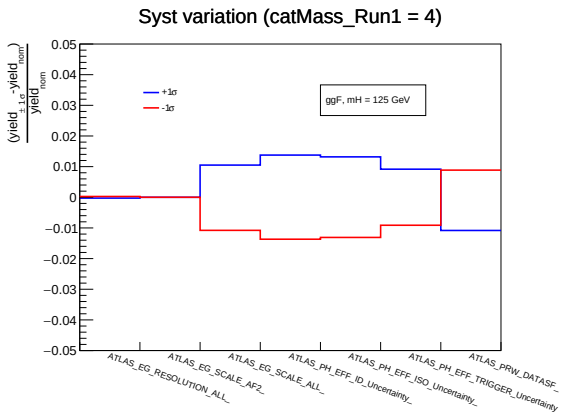


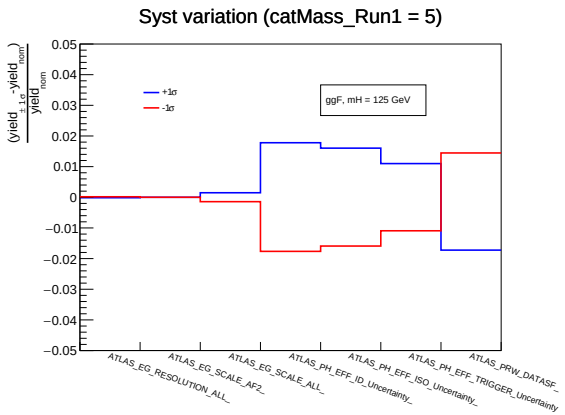
$\pm 1\sigma$ var sys, catMass_Run1 $\rightarrow$ unconv



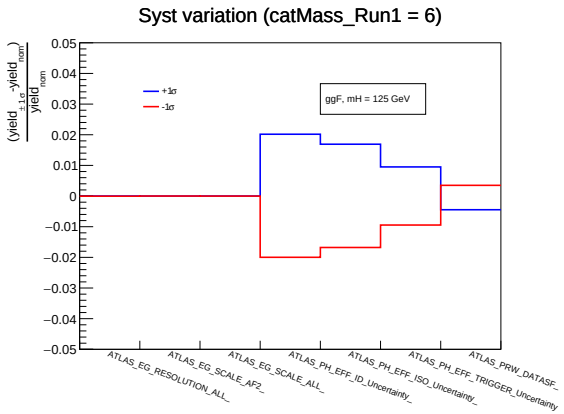


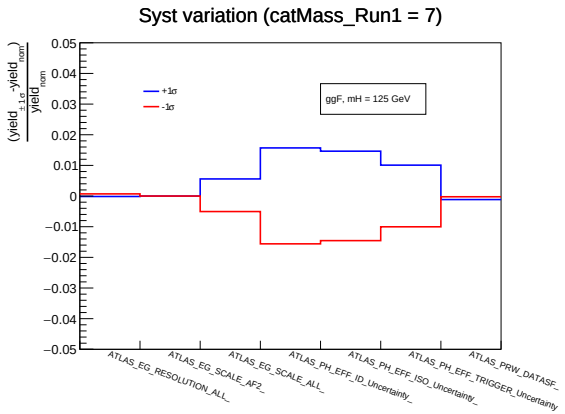


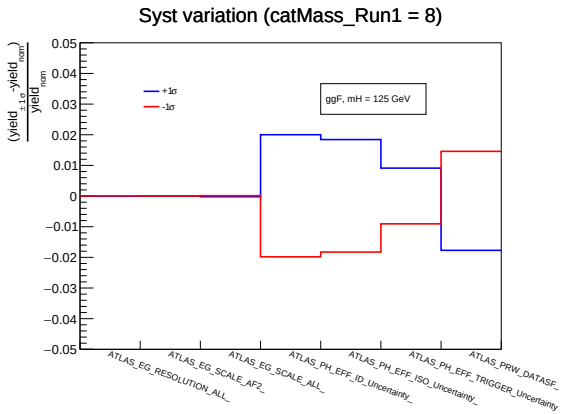


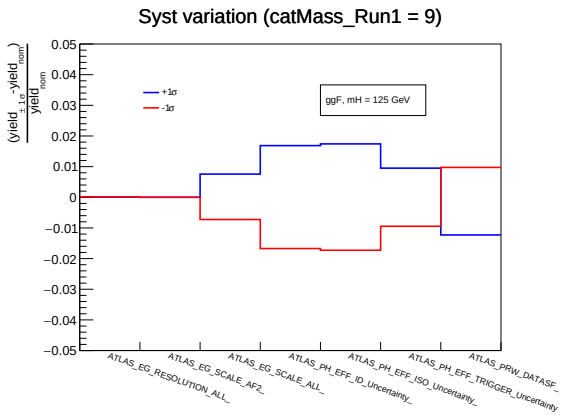


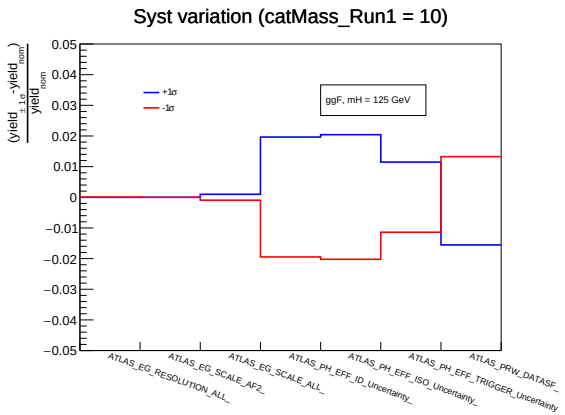
$\pm 1\sigma$ var sys, catMass_Run1 $\rightarrow$ 1_conv











13^{th} week

Entries check

Sherpa diph	50-90 GeV	90-175 GeV	175-2000 GeV
no	2.83802e+07	1.22994e+08	7.44365e+06
1	4.54425e+06	1.33151e+07	694794
2	116704	463813	71660
3	6.99888e+06	3.28154e+07	1.85895e+06
4	195258	1.19827e+06	202604
5	2.42628e+06	1.01237e+07	604662
6	2.53465e+06	8.31316e+06	441796
7	73668	295725	45623
8	7.37025e+06	3.82128e+07	2.24061e+06
9	240226	1.44858e+06	245288
10	3.88002e+06	1.68073e+07	1.03766e+06
sum cat	2.83802e+07	1.22994e+08	7.44365e+06

Table: Number of entries for each bkg MC sample

Sig/$\sqrt{Bkg}$ comp

S/$\sqrt{B}$	110 GeV	125 GeV	130 GeV	140 GeV
no	9.05469	12.2968	12.2887	9.77524
1	3.85122	5.28691	5.3209	4.27062
2	2.10398	2.70284	2.72112	2.187
3	4.17193	5.629	5.7006	4.5162
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5	2.38983	3.17393	3.15318	2.52515
6	2.98634	4.13411	4.09718	3.32831
7	1.72307	2.12479	2.20016	1.71525
8	4.22538	5.73578	5.68458	4.53078
9	2.02405	2.56635	2.57861	2.05091
10	2.95071	3.93759	3.92067	3.1319
Sum cat	28.3845	37.8069	37.9791	30.2578

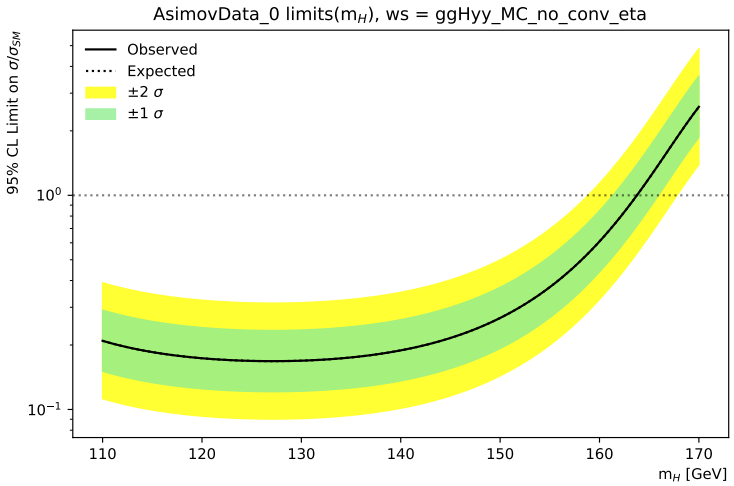
Table: Number of signal and $\sqrt{bkg}$ events ratio in [peak-5,peak+5] GeV intervall

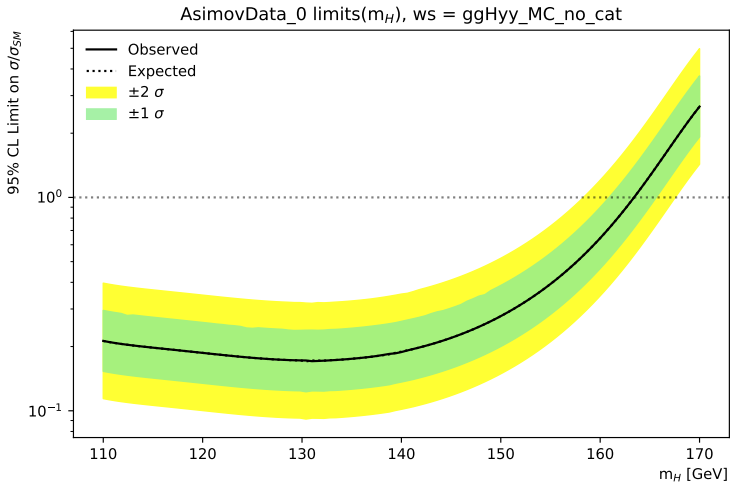
Xs·Br check

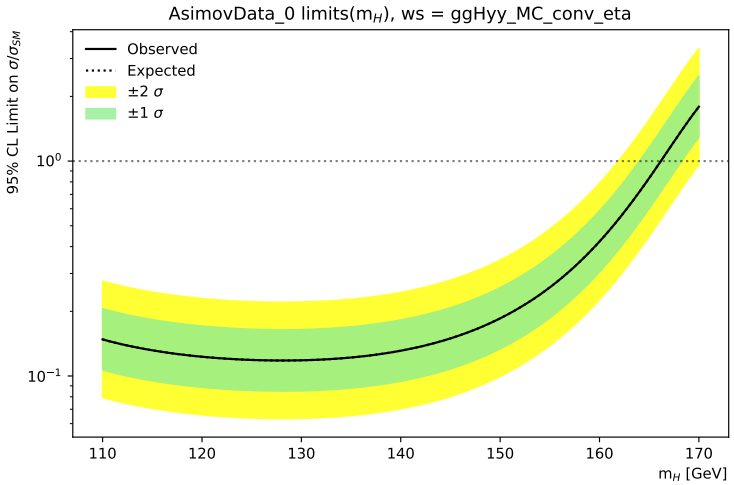
Xs·Br	Hgamma	Weight_XsBrFe	Fit
125	0.1101404	0.11014	0.0957348
110	0.10966	0.10966	0.104417
130	0.1014038	0.101404	0.0885264
140	0.06777	0.06777	0.0675757

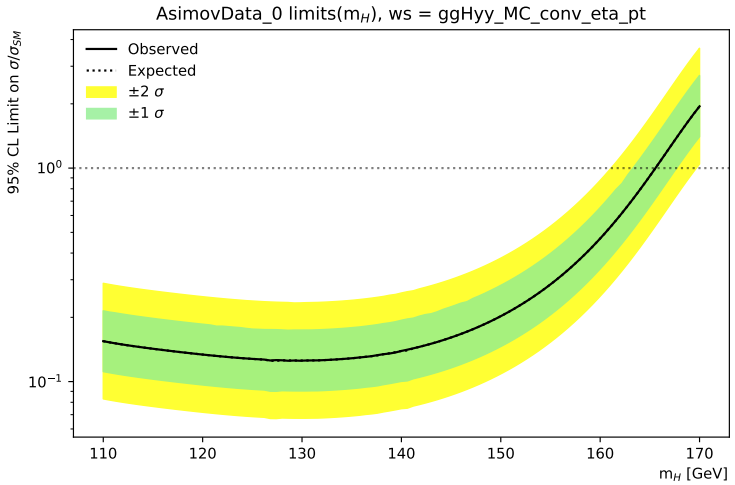
Table: Xs and Br comparison

AsimovData μ=0 limits

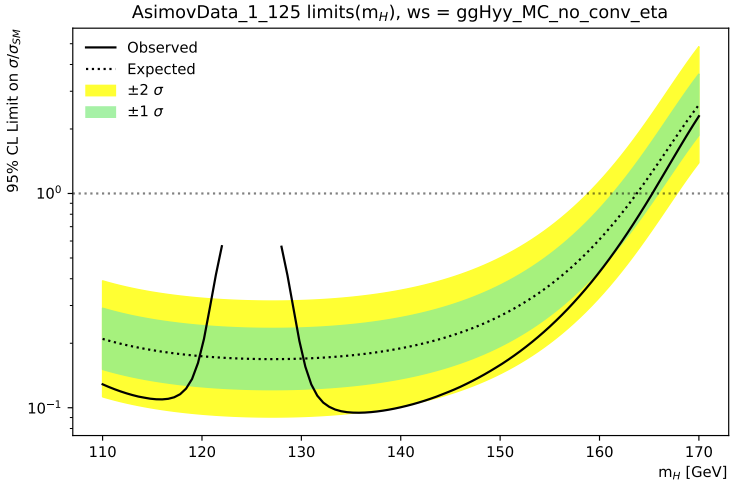


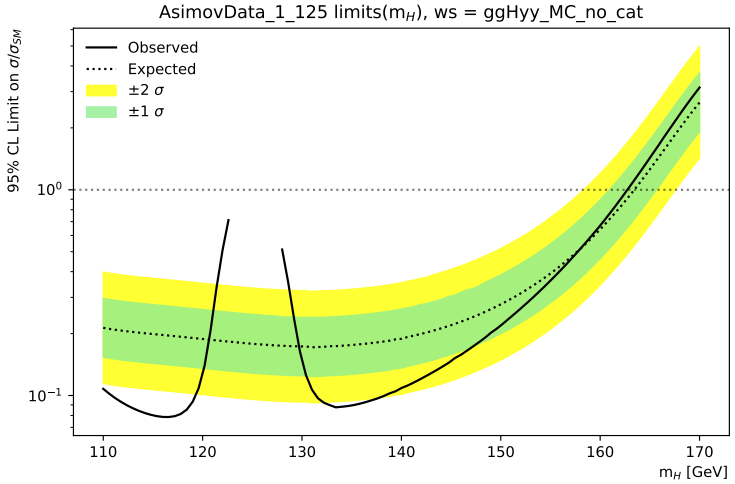


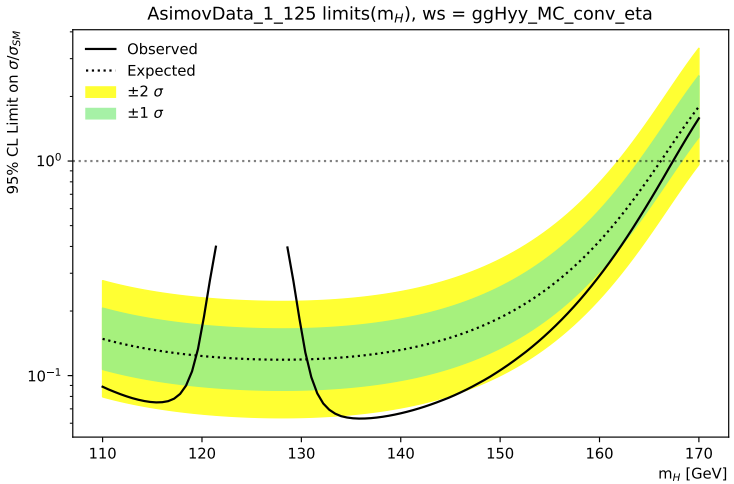


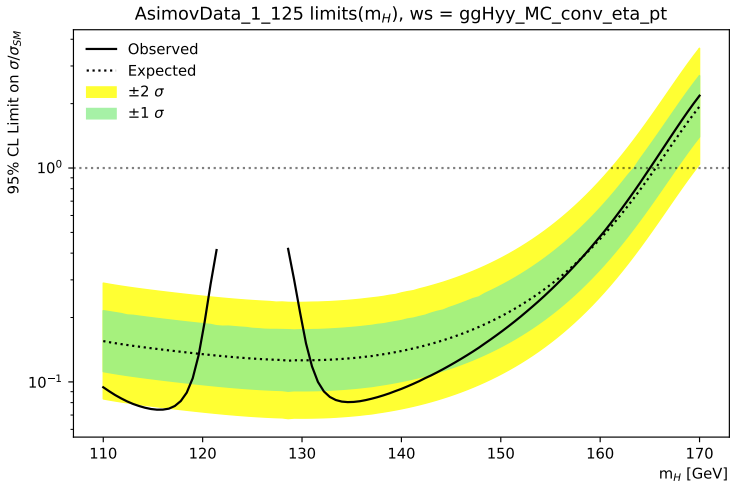


AsimovData μ=1 mH=125 limits

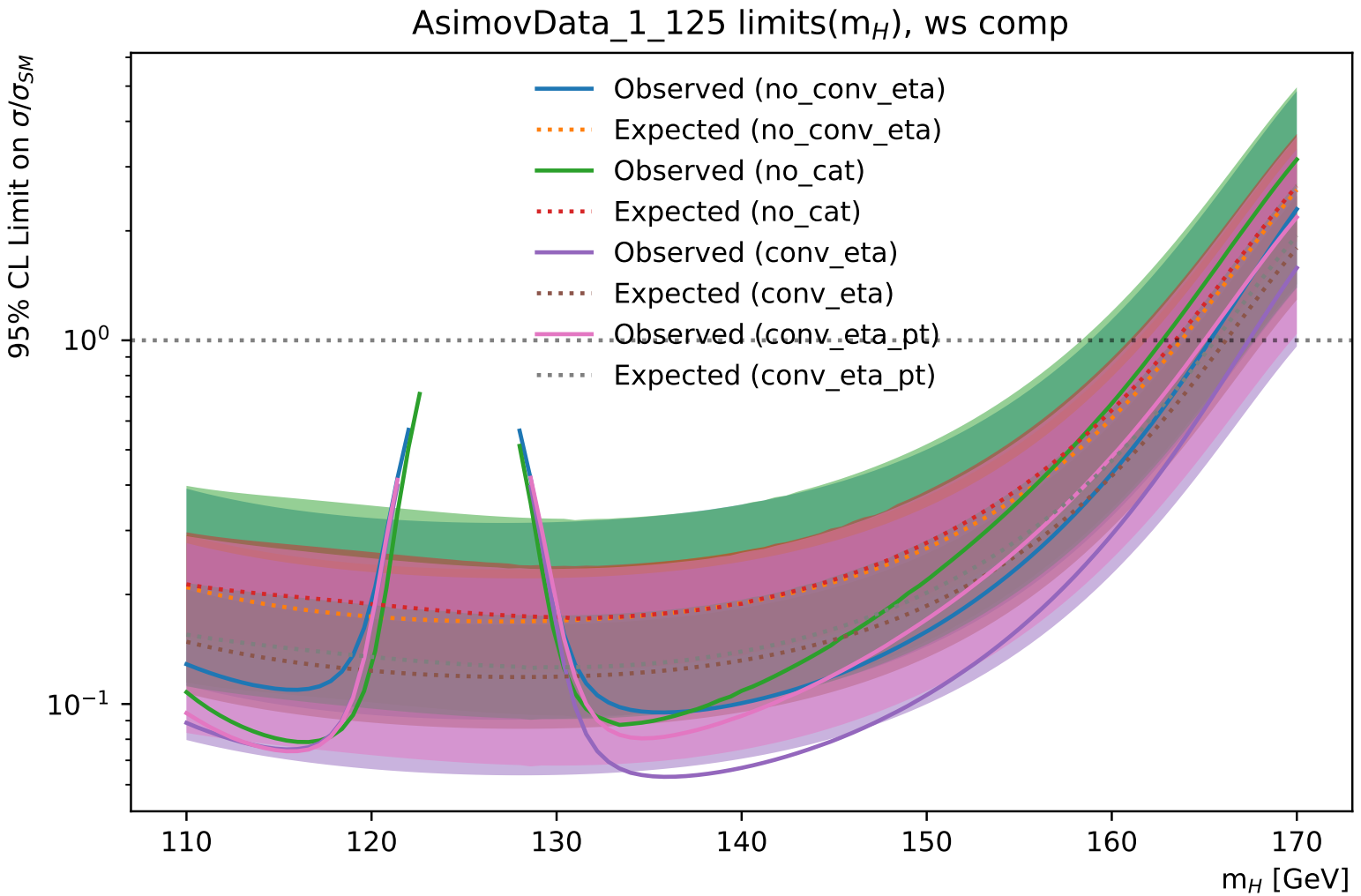




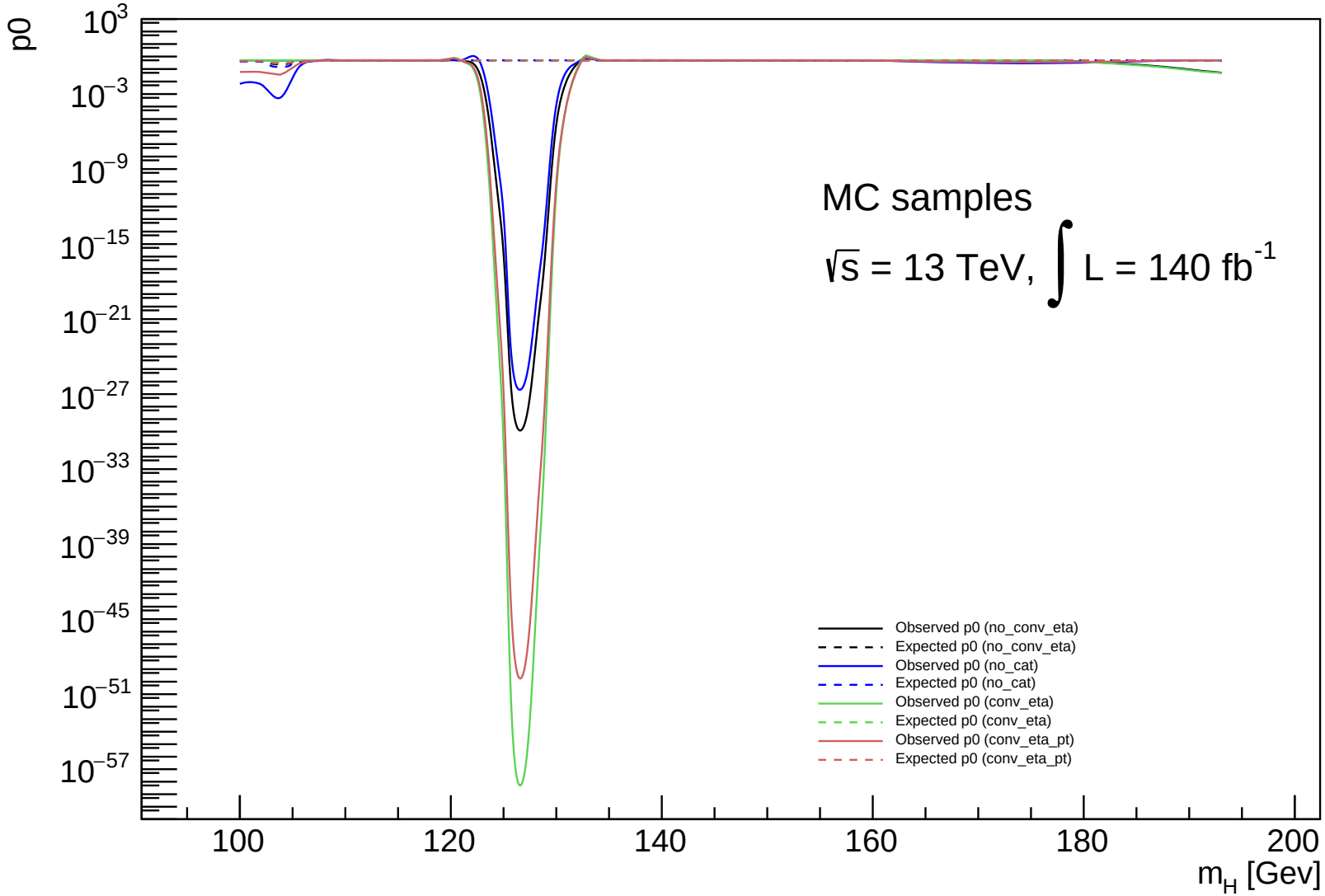




AsimovData μ=1 mH=125 comp



p0 scan comparison



$\pm 1\sigma$ yield sys

Signal	no		1		2		3		4		5	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	-3.40462e-05	3.3878e-05	-6.11058e-06	-7.58219e-07	-9.1139e-05	8.79852e-05	6.57836e-06	-4.91537e-05	-0.000263193	0.000263654	-0.00014322	0.000170178
ATLAS_EG_SCALE_AF2_	0	0	0	0	0	0	0	0	0	0	0	0
ATLAS_EG_SCALE_ALL_	0.000678601	-0.000679522	-0.000232135	0.000188235	0.00483447	-0.0046946	-0.000428294	0.000482657	0.010503	-0.0107856	0.0014803	-0.00142847
ATLAS_PH_EFF_ID_Uncertainty_	0.0178653	-0.0177085	0.015046	-0.0149364	0.0123724	-0.0122983	0.0163719	-0.0162403	0.013768	-0.0136748	0.0177965	-0.017642
ATLAS_PH_EFF_ISO_Uncertainty_	0.0164459	-0.0163114	0.0132218	-0.0131345	0.0106729	-0.0106168	0.0146318	-0.0145239	0.0131856	-0.0130982	0.0160314	-0.0159049
ATLAS_PH_EFF_TRIGGER_Uncertainty_	0.00959862	-0.00954776	0.00958805	-0.00954001	0.0101478	-0.0100931	0.00871426	-0.00867415	0.00916871	-0.00912181	0.0109943	-0.0109264
ATLAS_PRW_DATASF_	-0.0160675	0.0134036	-0.0203614	0.0176278	-0.0144369	0.0118348	-0.0177415	0.0146681	-0.0108232	0.00886235	-0.0172345	0.0144609

Signal	6		7		8		9		10	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	1.5645e-05	-4.38881e-05	-0.000141157	0.000706633	-5.81966e-05	3.8653e-05	9.66237e-05	0.000141198	-2.45463e-05	5.04156e-05
ATLAS_EG_SCALE_AF2_	0	0	0	0	0	0	0	0	0	0
ATLAS_EG_SCALE_ALL_	1.11065e-05	-1.46545e-05	0.00558347	-0.00505572	-0.000217932	0.000124032	0.00756583	-0.00724876	0.000975332	-0.000945535
ATLAS_PH_EFF_ID_Uncertainty_	0.0201687	-0.0199793	0.0157039	-0.015589	0.0200123	-0.0198184	0.0168557	-0.0167183	0.0196456	-0.0194573
ATLAS_PH_EFF_ISO_Uncertainty_	0.0169114	-0.0167773	0.0146402	-0.0145404	0.01843	-0.0182663	0.0174182	-0.0172731	0.0204232	-0.0202244
ATLAS_PH_EFF_TRIGGER_Uncertainty_	0.00950289	-0.00945582	0.0100839	-0.0100299	0.00911367	-0.00906769	0.00950835	-0.00945637	0.0114736	-0.0113976
ATLAS_PRW_DATASF_	-0.00446197	0.00349614	-0.00114446	-0.000230635	-0.0177047	0.0145884	-0.0122896	0.00974719	-0.0155331	0.0132597

Table: $\pm 1\sigma$ yield sys for each category

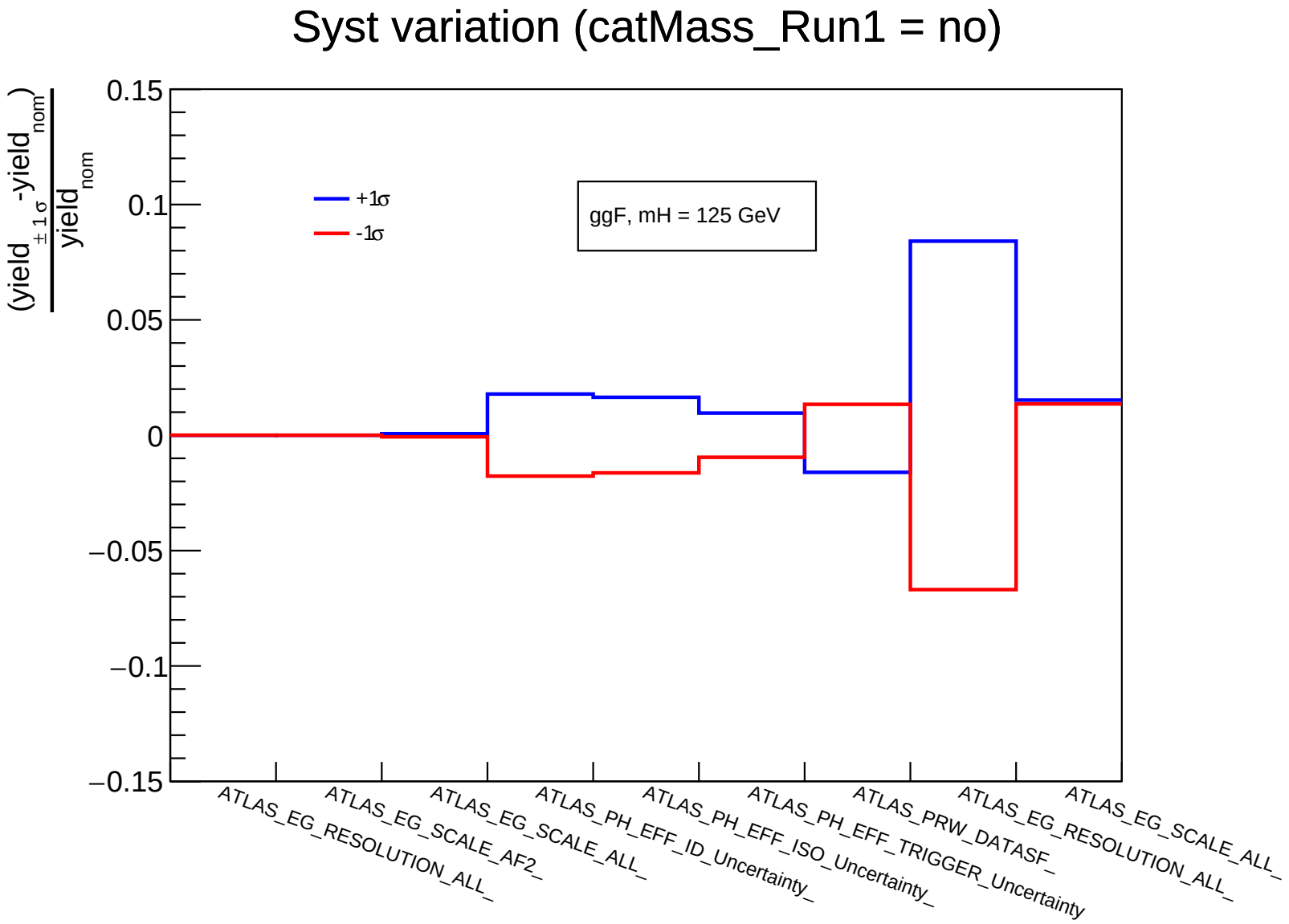
$\pm 1\sigma$ shape sys

Signal	no		1		2		3		4		5	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	0.0841314	-0.0668985	0.0878635	-0.0483741	0.144179	-0.0783765	0.0847722	-0.0719211	0.130348	-0.106281	0.118665	-0.116413
ATLAS_EG_SCALE_ALL_	0.0152297	0.0135799	0.00421576	-0.00388284	0.00505519	-0.00283272	0.0138049	0.0128029	0.0238145	0.0201192	0.019574	0.00121658

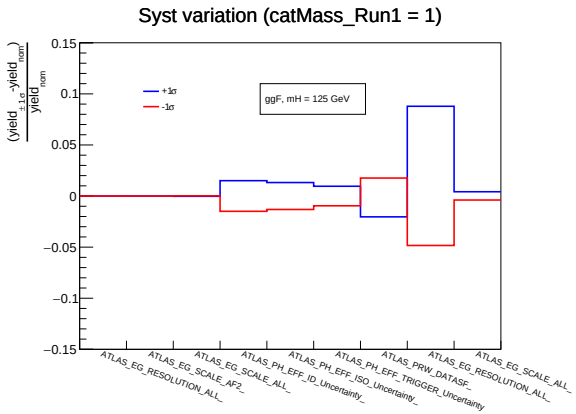
Signal	6		7		8		9		10	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	0.0728903	-0.0417185	0.127988	-0.0662111	0.065929	-0.0577203	0.102	-0.0858425	0.0780923	-0.075636
ATLAS_EG_SCALE_ALL_	0.00427387	-0.00398708	0.00602166	-0.00377303	0.0068512	0.00399626	0.0130627	0.0127248	0.0150755	0.00594704

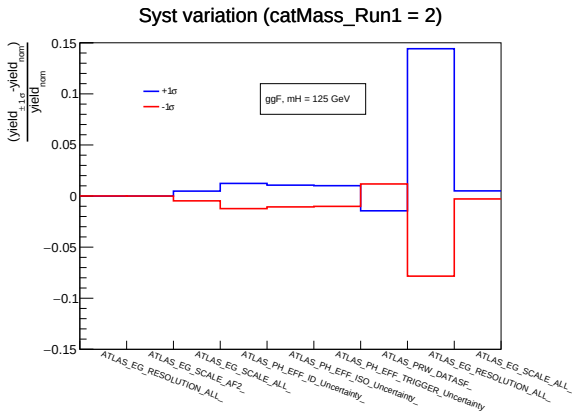
Table: $\pm 1\sigma$ shape sys for each category

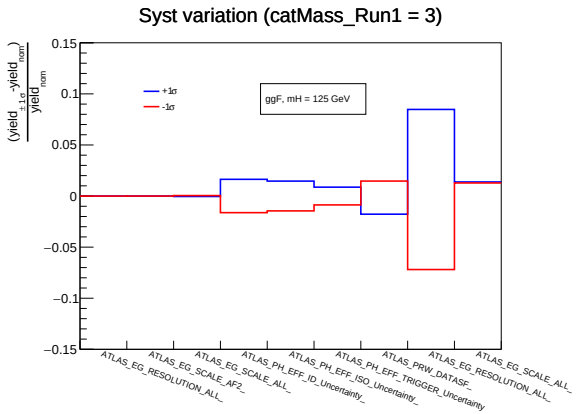
$\pm 1\sigma$ yield and shape sys, catMass_Run1 = no

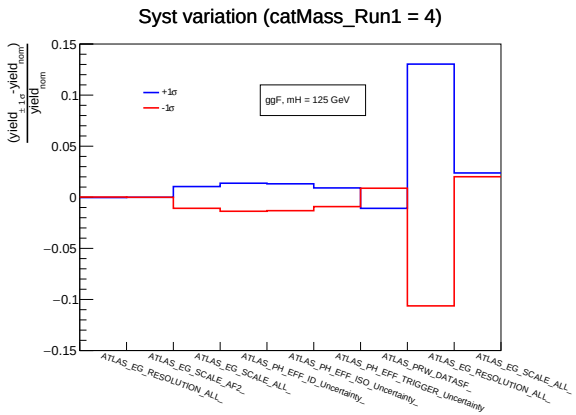


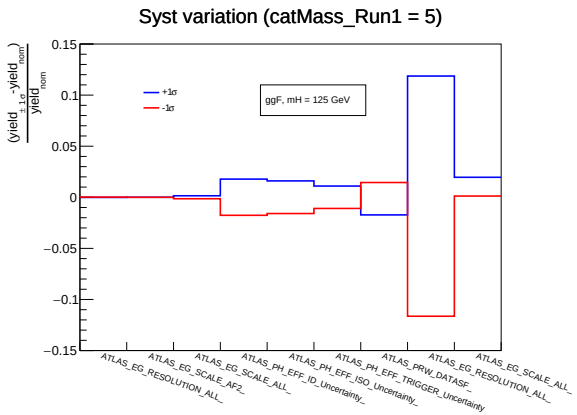
$\pm 1\sigma$ yield and shape sys, unconv



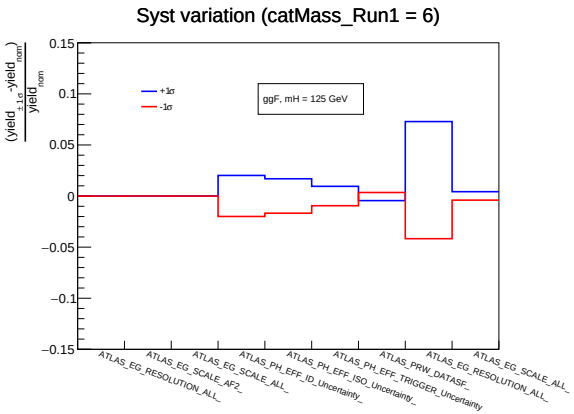


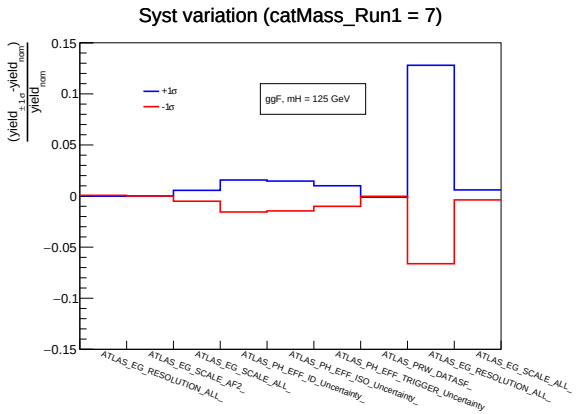


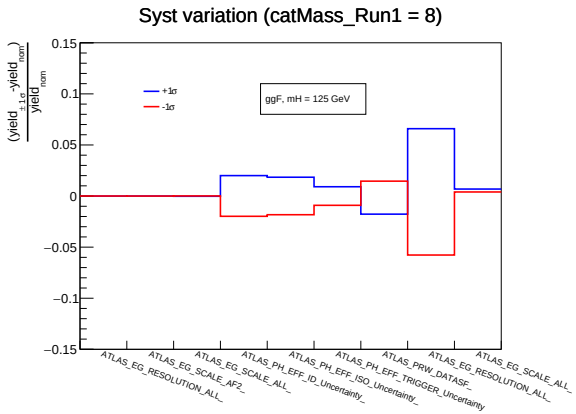


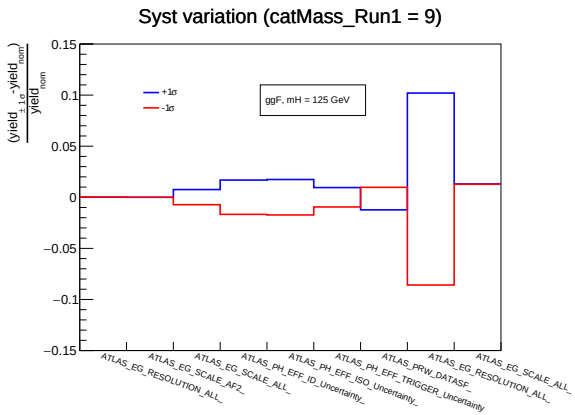


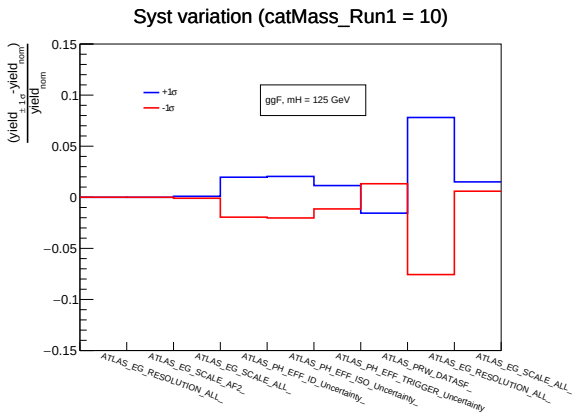
$\pm 1\sigma$ yield and shape sys, 1_conv



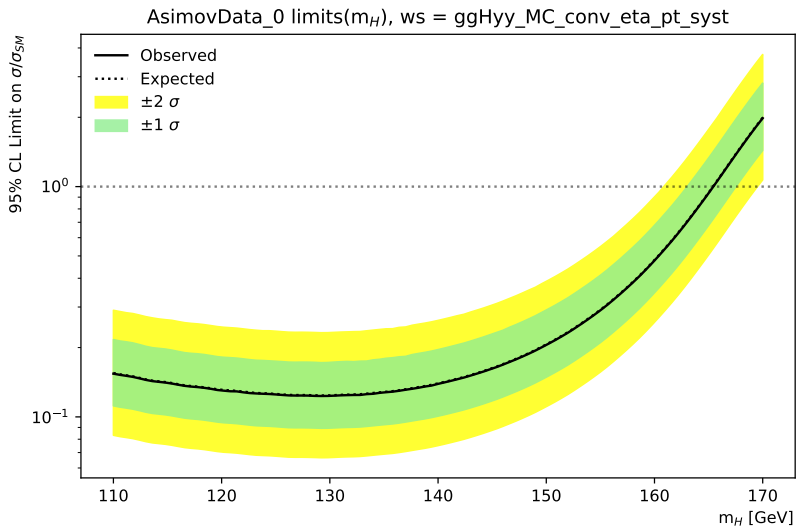


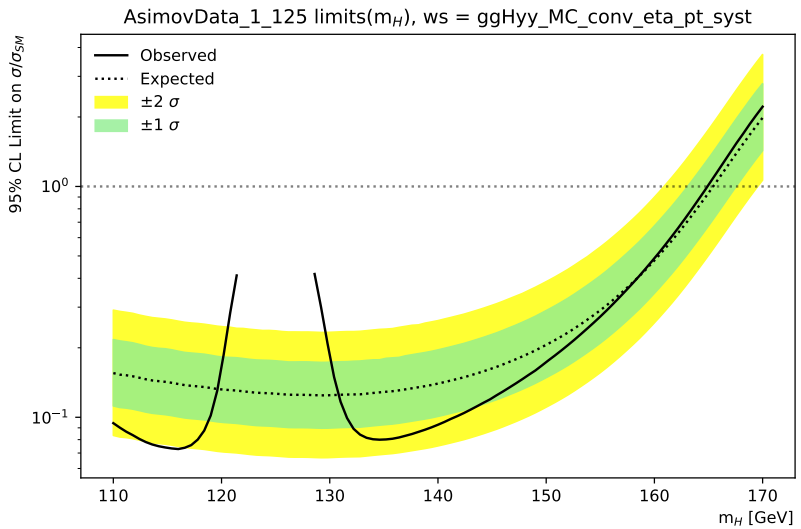




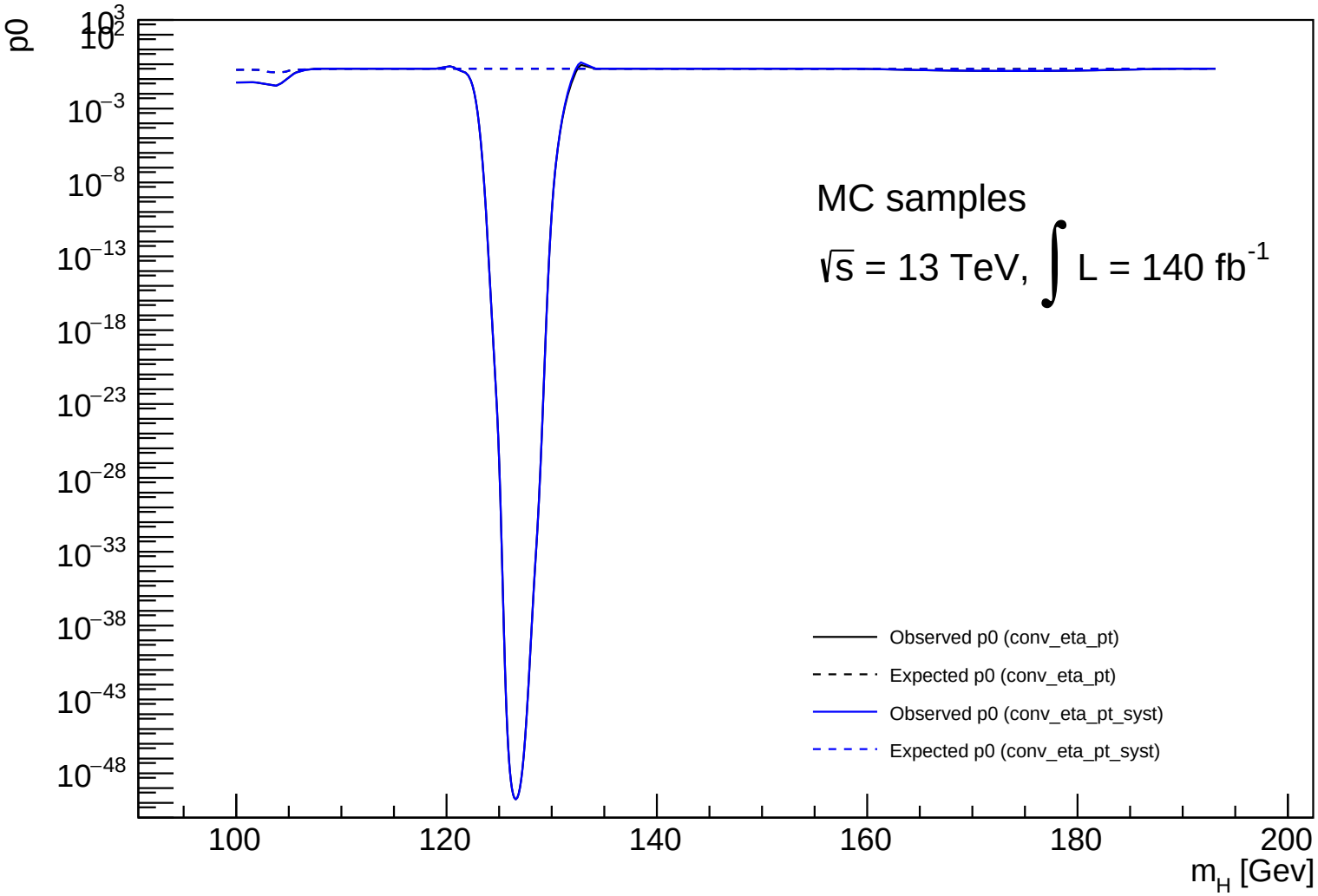


Limits ws conv_eta_pt with systs





p0 scan systs comparison



14^{th} week

Ntuples update

- added the `isFiducialLowMyy` and `isFiducialHighMyy` for fiducial x-s parameterisation of the limits;

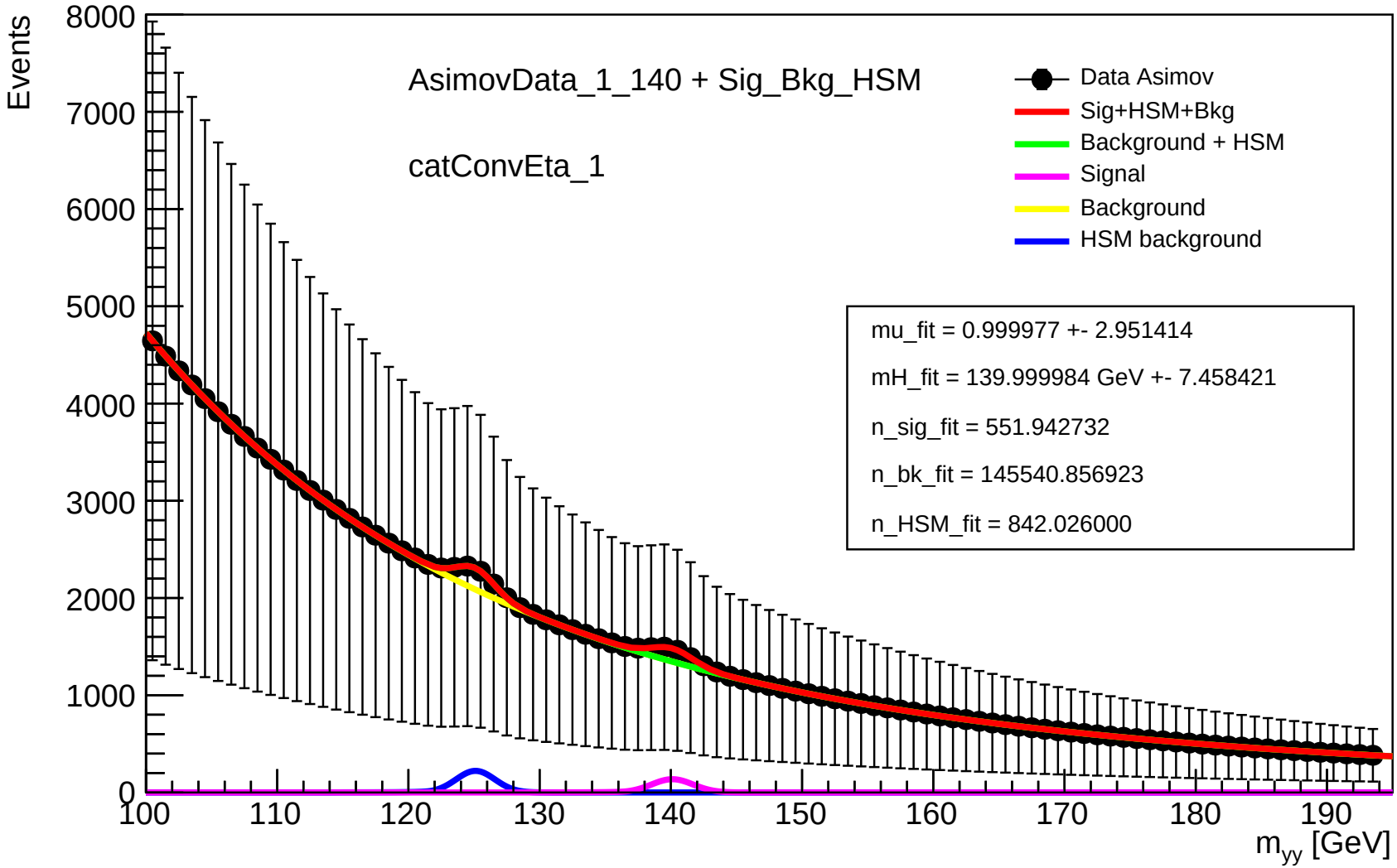
- started h026 $\rightarrow$ h027 update.

HSM background

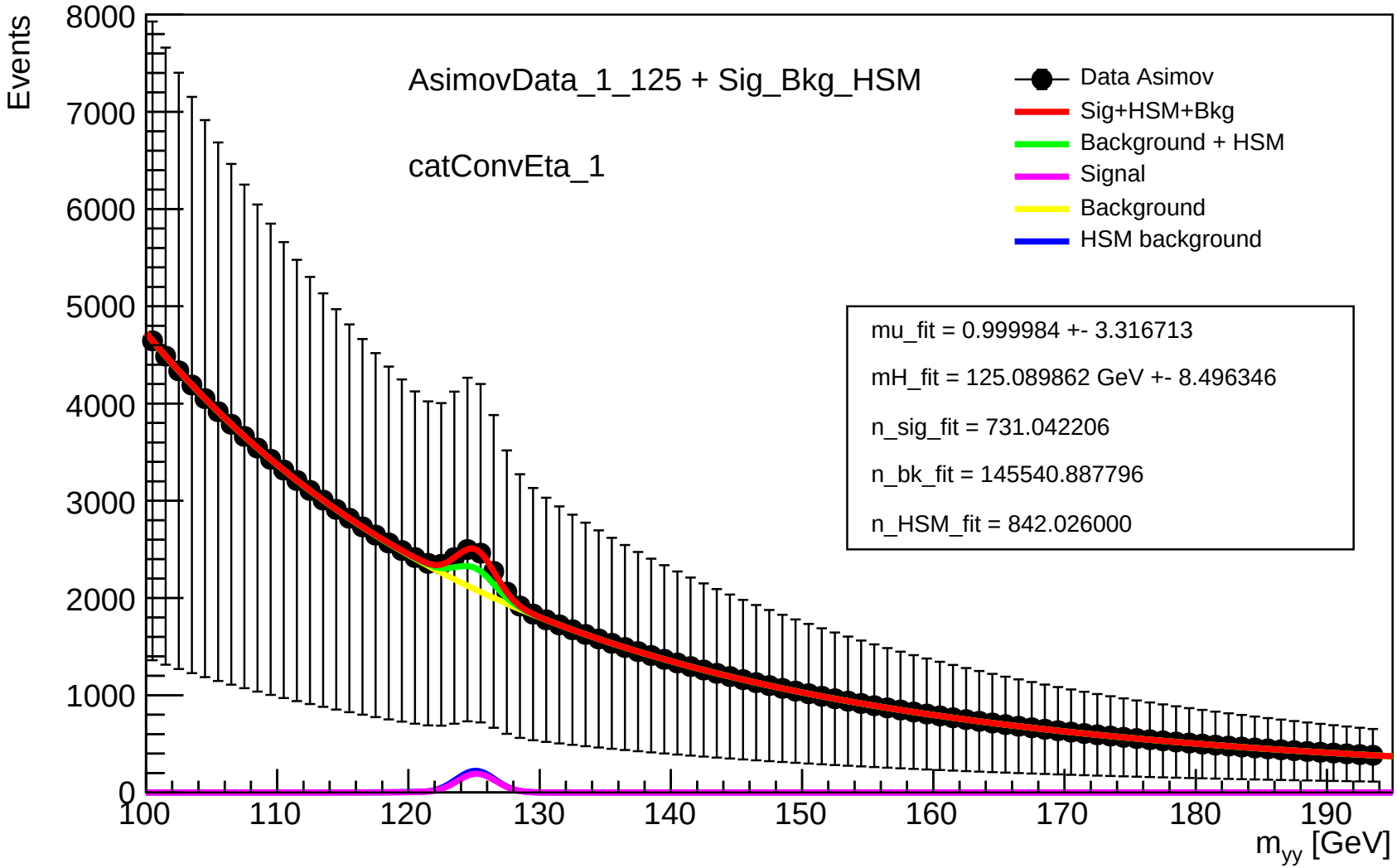
HSM background:

- DSCB fit performed only on the single $m_H = 125$ ggH MC sample;
- DSCB parameters fitted;
- the HSM background event number is obtained from MC and it is fixed;

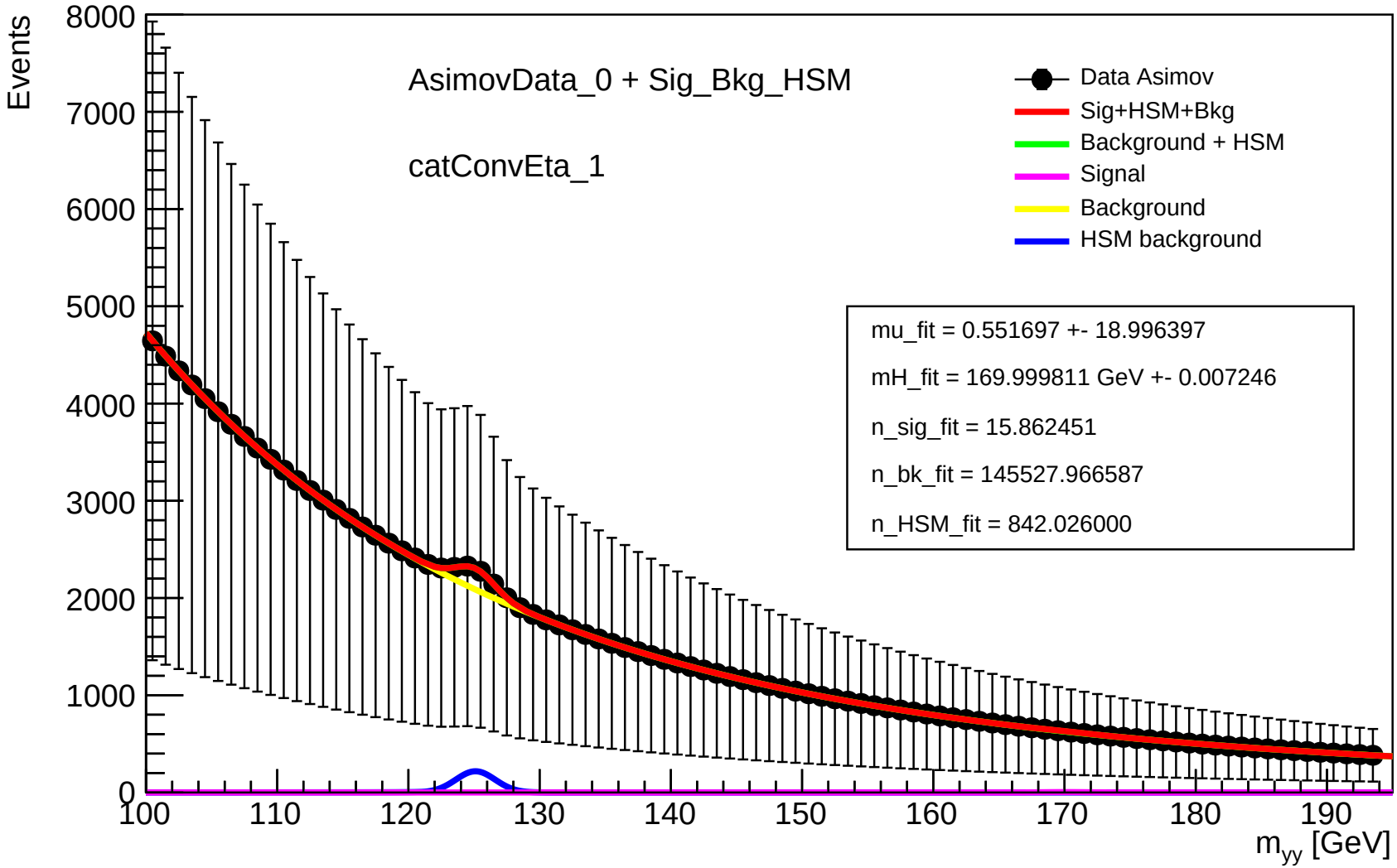
Asimov $\mu = 1$ $mH = 140$ + HSM



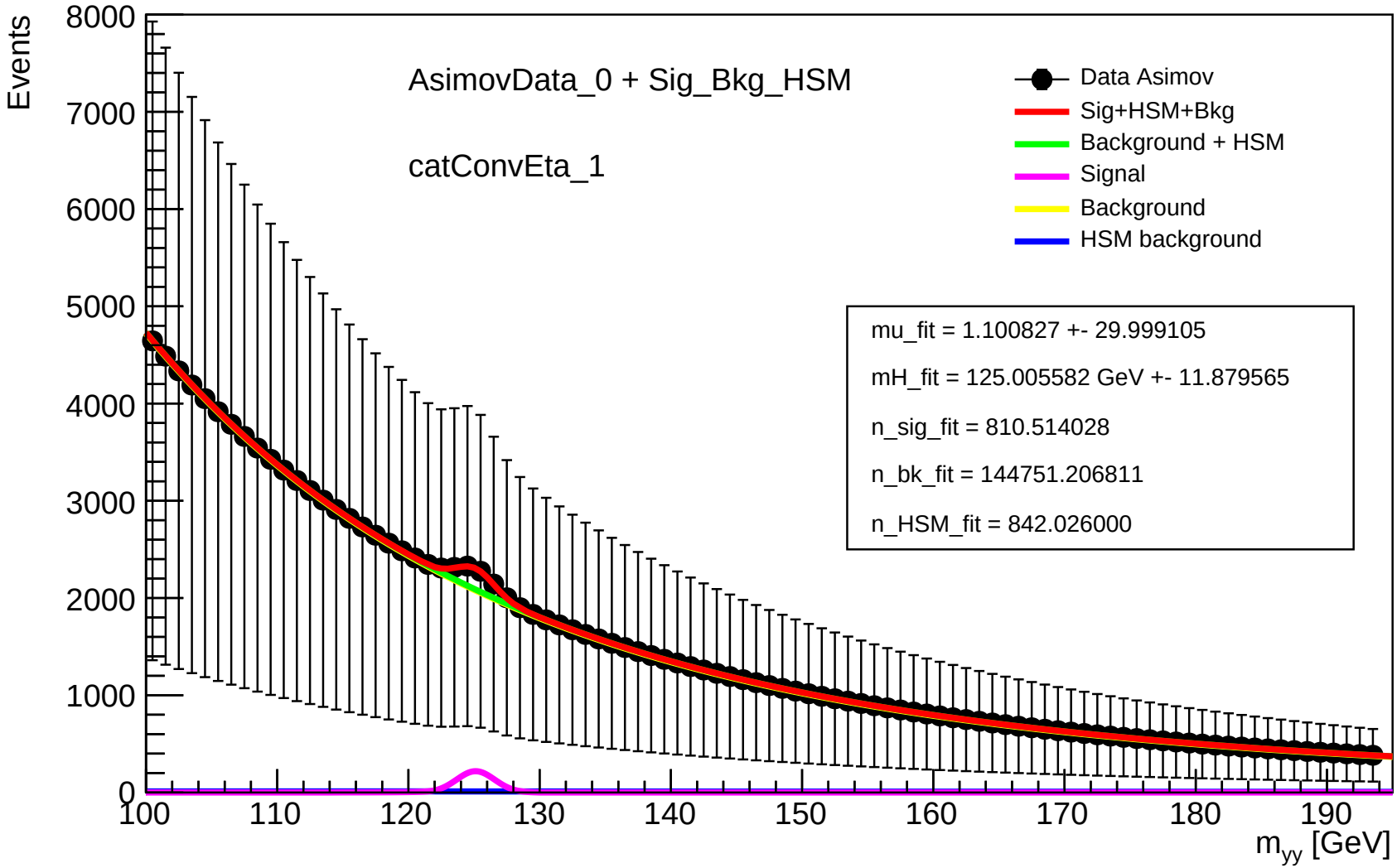
Asimov $\mu = 1$ $mH = 125$ + HSM



Asimov $\mu = 0$ + HSM



Asimov $\mu = 0$ + HSM



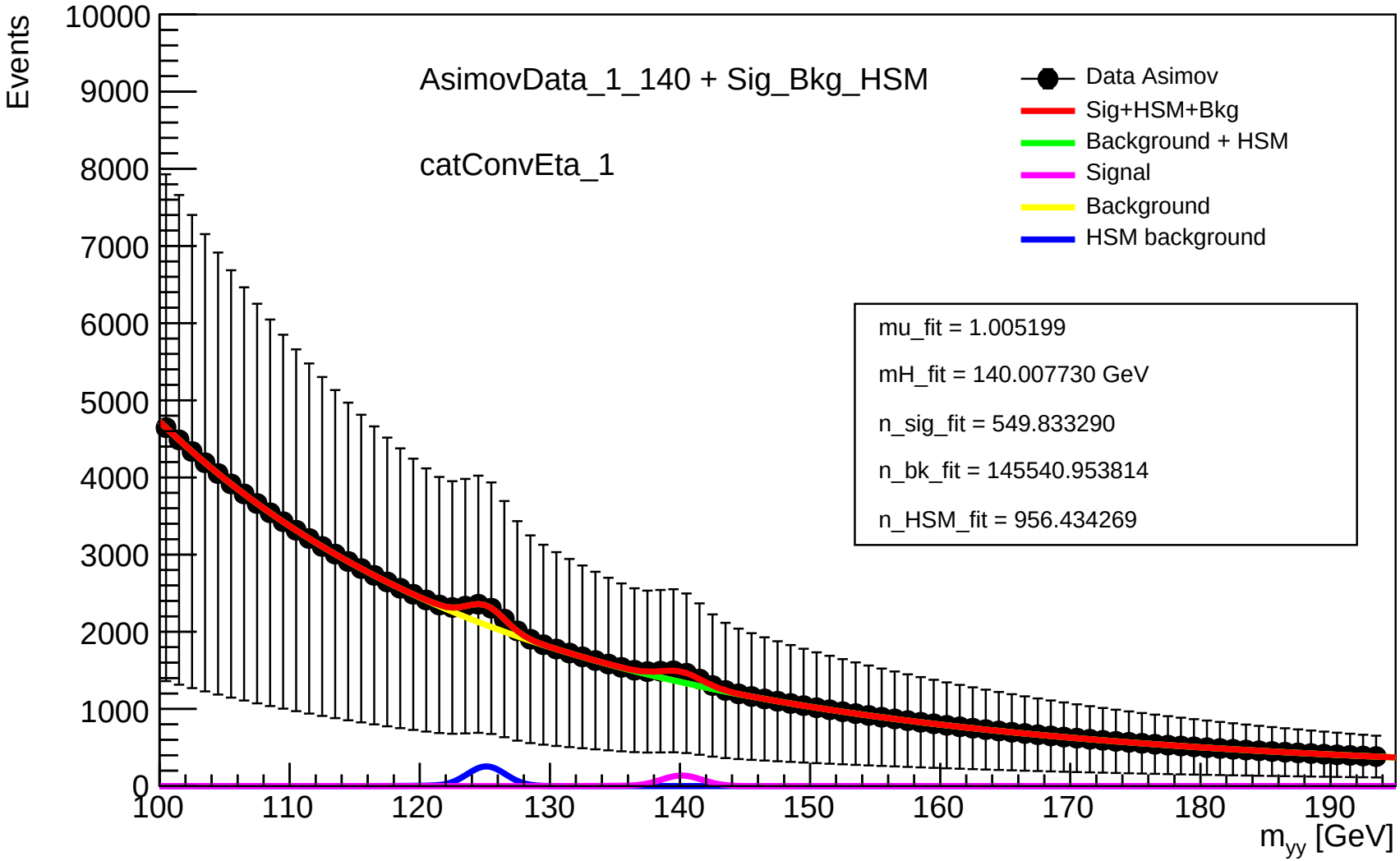
15^{th} week

HSM events

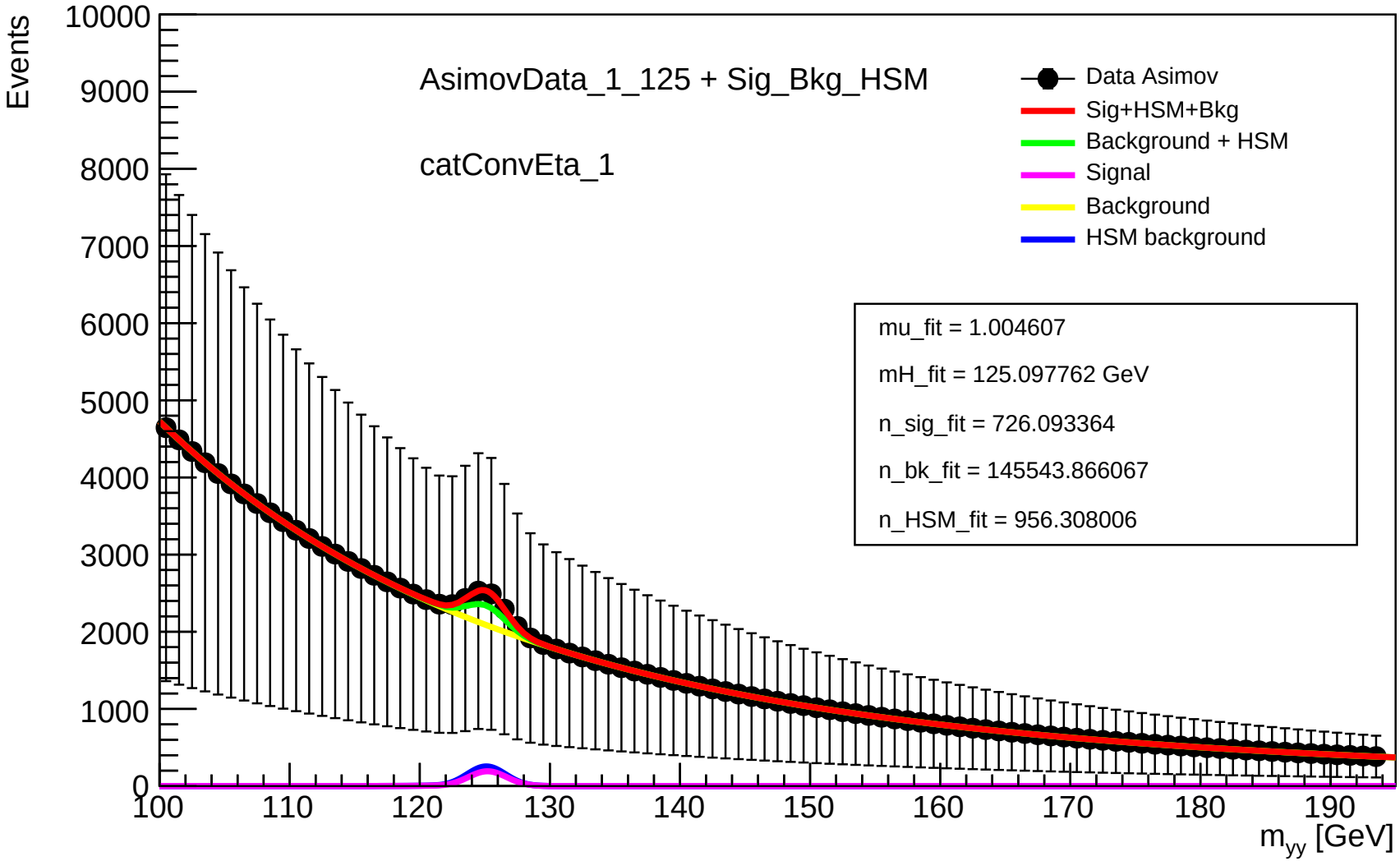
Category	# of HSM events
Inclusive	6198.8
1	956.294
2	1589.39
3	462.759
4	598.854
5	1810.2
6	783.151

Table: Number of Higgs SM events for each category

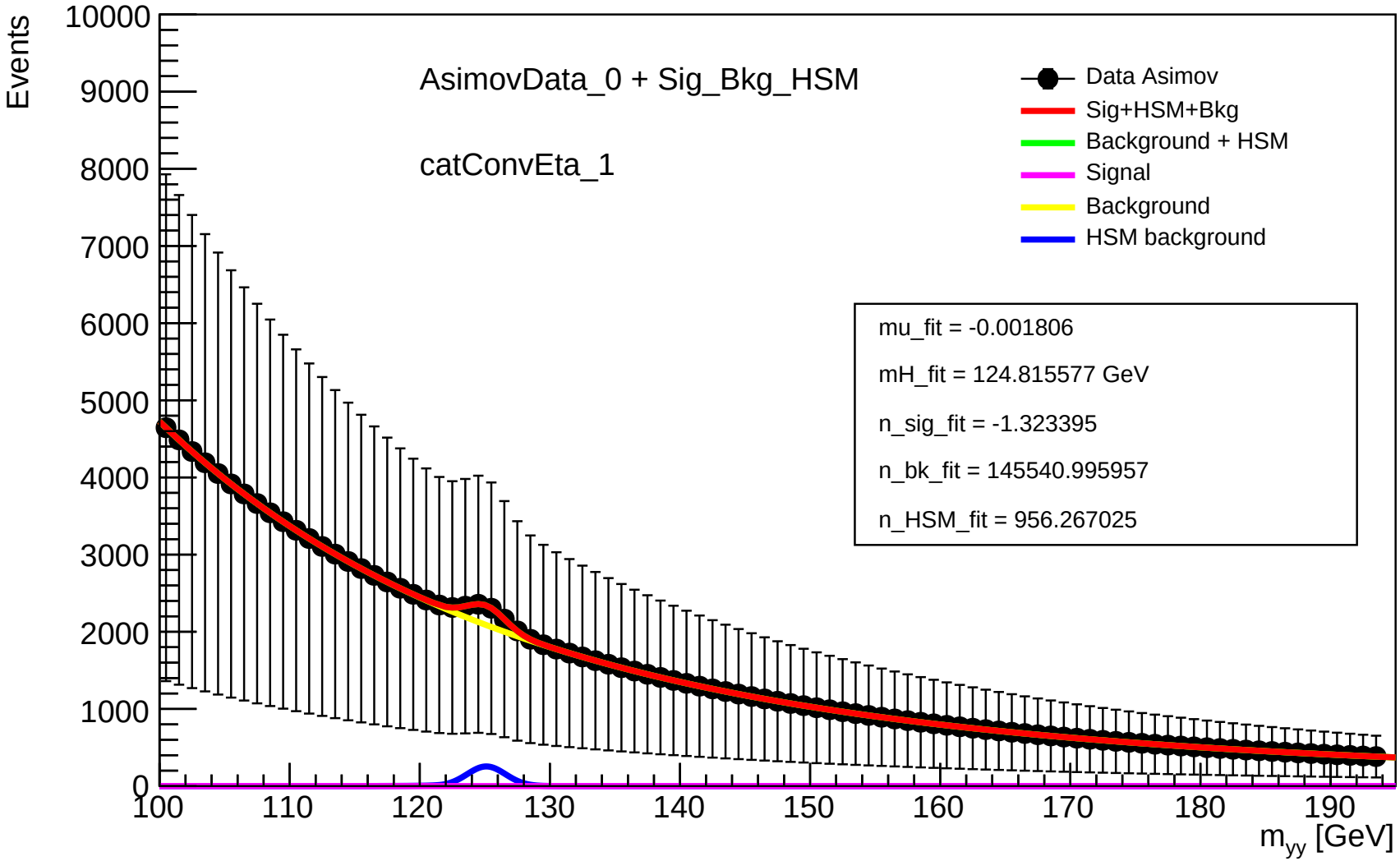
Asimov $\mu = 1$ $mH = 140$ + HSM



Asimov $\mu = 1$ $mH = 125$ + HSM



Asimov $\mu = 0$ + HSM



HSM yield systs

Signal	no		1		2		3		4		5		6	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	-3.68931e-05	3.33411e-05	-1.51854e-05	1.62804e-05	-2.20624e-05	-1.29236e-05	-0.000144017	0.000152033	-3.79369e-06	4.16123e-05	-4.77056e-05	3.91477e-05	-3.05133e-05	5.81898e-05
ATLAS_EG_SCALE_ALL_	0.000628386	-0.000632089	0.000293918	-0.000307453	0.000604343	-0.000581159	0.00139528	-0.00135319	0.000596184	-0.000547202	0.00051025	-0.000569145	0.000930154	-0.000916184
ATLAS_PH_EFF_ID_Uncertainty_	0.0177179	-0.0175637	0.0146459	-0.0145419	0.0159981	-0.0158722	0.0177029	-0.0175502	0.0194147	-0.0192381	0.019531	-0.019346	0.0194797	-0.0192947
ATLAS_PH_EFF_ISO_Uncertainty_	0.0163986	-0.0162649	0.0128009	-0.012719	0.0144306	-0.0143256	0.0159963	-0.0158704	0.0165834	-0.0164545	0.0183376	-0.0181758	0.0204007	-0.0202023
ATLAS_PH_EFF_TRIGGER_Uncertainty_	0.00962177	-0.00957059	0.00966958	-0.00962059	0.00878235	-0.00874122	0.0110135	-0.0109453	0.0095903	-0.00954221	0.00917878	-0.00913182	0.0114929	-0.0114165
ATLAS_PRW_DATASF_	-0.0158285	0.0132177	-0.0194486	0.0167841	-0.0167484	0.0138607	-0.0169866	0.0143085	-0.00392561	0.00298635	-0.01692	0.0139293	-0.0154345	0.0130912

Table: $\pm 1\sigma$ yield sys for each category

HSM shape systs

Signal	no		1		2		3		4		5		6	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	0.0866339	-0.0686718	0.0973955	-0.0523099	0.0924181	-0.0778125	0.121311	-0.118801	0.0825436	-0.0452907	0.0717434	-0.062416	0.0802543	-0.0776709
ATLAS_EG_SCALE_ALL_	0.00436999	-0.00437357	0.00271049	-0.00271016	0.00505455	-0.00505887	0.00941769	-0.00943935	0.00287867	-0.00287469	0.00347786	-0.00347915	0.00522825	-0.00524284

Table: $\pm 1\sigma$ shape sys for each category

cuFlow vs Fiducial

Parameter	Name	cutFlow > 13	`isFiducialHighMyy`	`isFiducialLowMyy`
η^{γ_1}	η cut	|||||||	< 2.37	< 2.37
η^{γ_2}	η cut	|||||||	< 2.37	< 2.37
$E_T^{cone40\ \gamma_1}/(p_T^{\gamma_1} + 120e3)$	High-mass Isolation cut	||||||	< 0.05	//
$E_T^{cone40\ \gamma_2}/(p_T^{\gamma_2} + 120e3)$	High-mass Isolation cut	||||||	< 0.05	//
$E_T^{cone20\ \gamma_1}/p_T^{\gamma_1}$	Low-mass Isolation cut	||||||	//	< 0.065
$E_T^{cone20\ \gamma_2}/p_T^{\gamma_2}$	Low-mass Isolation cut	||||||	//	< 0.065
$p_T^{\gamma_1}/m_{\gamma\gamma}^{Truth}$	Scalar relative p_T cut	> 0.35	> 0.3	//
$p_T^{\gamma_2}/m_{\gamma\gamma}^{Truth}$	Scalar relative p_T cut	> 0.25	> 0.25	//
$p_T^{\gamma_1}$	Low-mass p_T cut	> 25 GeV	//	> 22 GeV
$p_T^{\gamma_2}$	Low-mass p_T cut	> 25 GeV	//	> 22 GeV

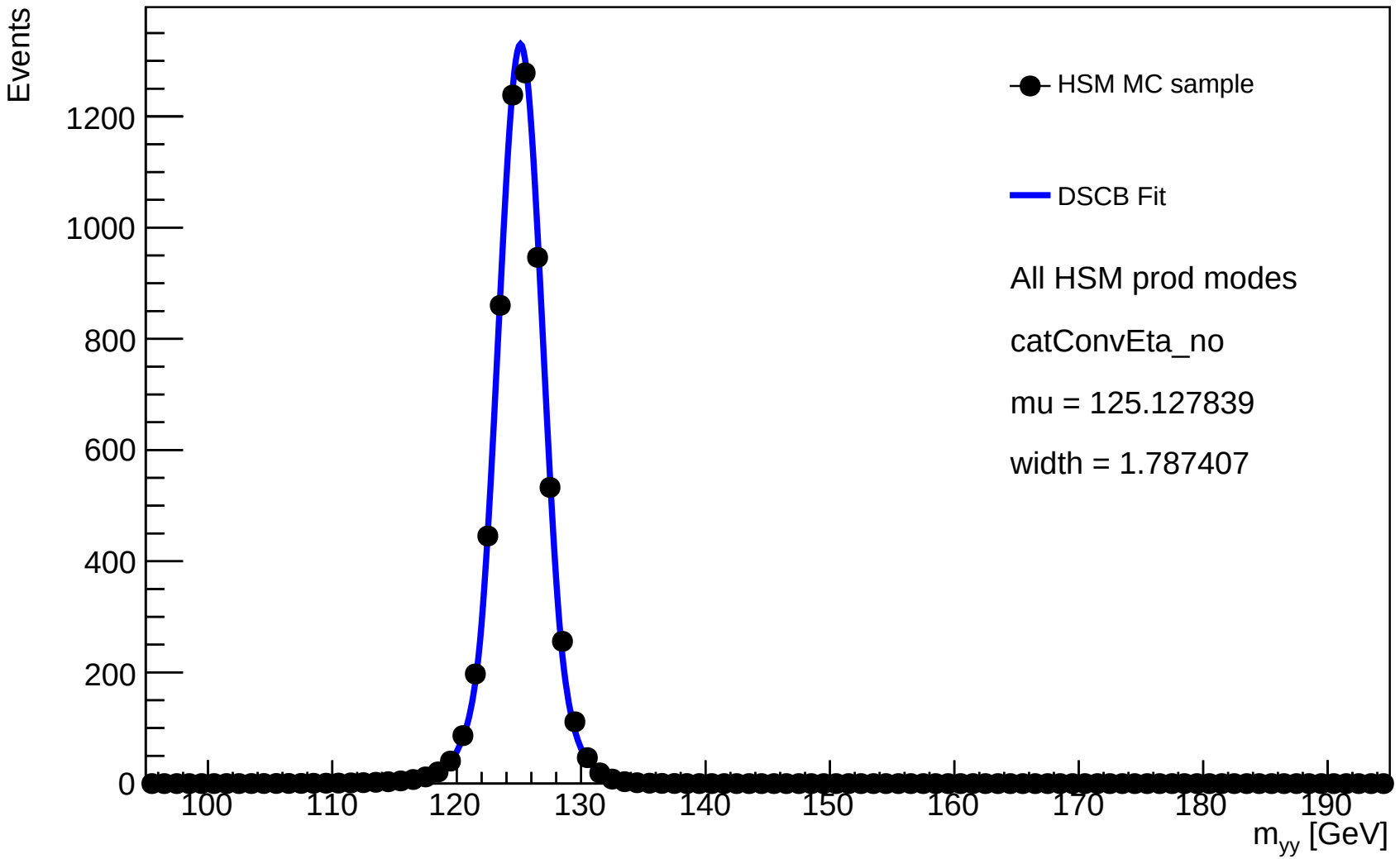
Table: Number of entries for each bkg MC sample

16^{th} week

Workspace

- **Signal**
  - Fit: DSCB, function of m_X.
  - Syst:
    - Yield
    - Shape
    - Production modes
- **Non-resonant background**
  - Fit: exp poly2.
  - Spurios signal: NO
- **HSM background**
  - Fit: DSCB fixed.
  - Syst:
    - Yield
    - Shape
    - ATLAS Higgs mass
- Theoretical syst

HSM DSCB fit


Events
1200
1000
800
600
400
200
0
100
110
120
130
140
150
160
170
180
190
m_{yy} [GeV]
HSM MC sample
DSCB Fit
All HSM prod modes
catConvEta_no
mu = 125.127839
width = 1.787407

HSM events

Category	# of HSM events
Inclusive	6198.8
1	956.294
2	1589.39
3	462.759
4	598.854
5	1810.2
6	783.151

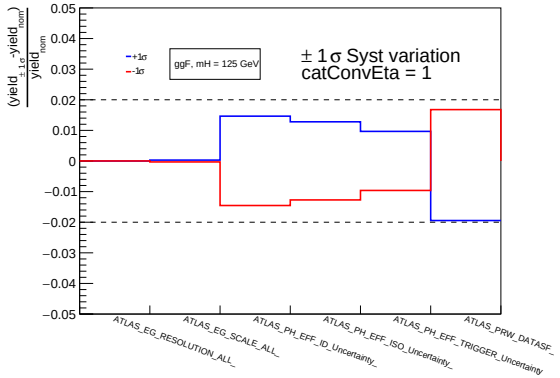
Table: Number of Higgs SM events for each category

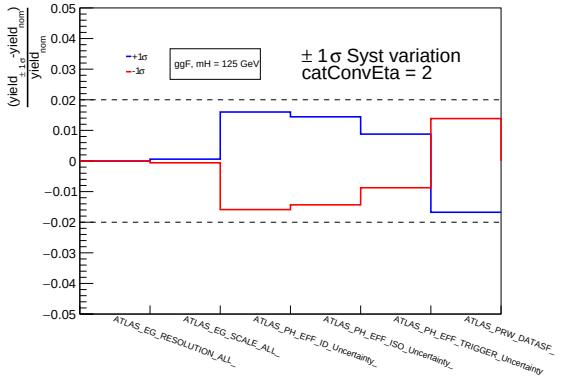
HSM yield systs

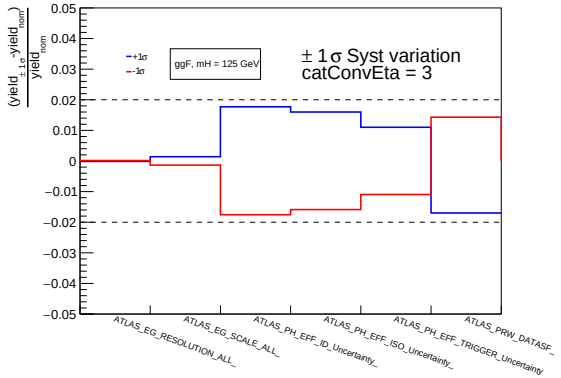
Signal	no		1		2		3		4		5		6	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	-3.68931e-05	3.33411e-05	-1.51854e-05	1.62804e-05	-2.20624e-05	-1.29236e-05	-0.000144017	0.000152033	-3.79369e-06	4.16123e-05	-4.77056e-05	3.91477e-05	-3.05133e-05	5.81898e-05
ATLAS_EG_SCALE_ALL_	0.000628386	-0.000632089	0.000293918	-0.000307453	0.000604343	-0.000581159	0.00139528	-0.00135319	0.000596184	-0.000547202	0.00051025	-0.000569145	0.000930154	-0.000916184
ATLAS_PH_EFF_ID_Uncertainty_	0.0177179	-0.0175637	0.0146459	-0.0145419	0.0159981	-0.0158722	0.0177029	-0.0175502	0.0194147	-0.0192381	0.019531	-0.019346	0.0194797	-0.0192947
ATLAS_PH_EFF_ISO_Uncertainty_	0.0163986	-0.0162649	0.0128009	-0.012719	0.0144306	-0.0143256	0.0159963	-0.0158704	0.0165834	-0.0164545	0.0183376	-0.0181758	0.0204007	-0.0202023
ATLAS_PH_EFF_TRIGGER_Uncertainty_	0.00962177	-0.00957059	0.00966958	-0.00962059	0.00878235	-0.00874122	0.0110135	-0.0109453	0.0095903	-0.00954221	0.00917878	-0.00913182	0.0114929	-0.0114165
ATLAS_PRW_DATASF_	-0.0158285	0.0132177	-0.0194486	0.0167841	-0.0167484	0.0138607	-0.0169866	0.0143085	-0.00392561	0.00298635	-0.01692	0.0139293	-0.0154345	0.0130912

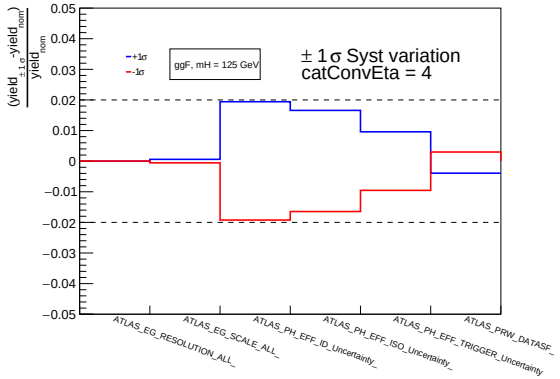
Table: $\pm 1\sigma$ yield sys for each category

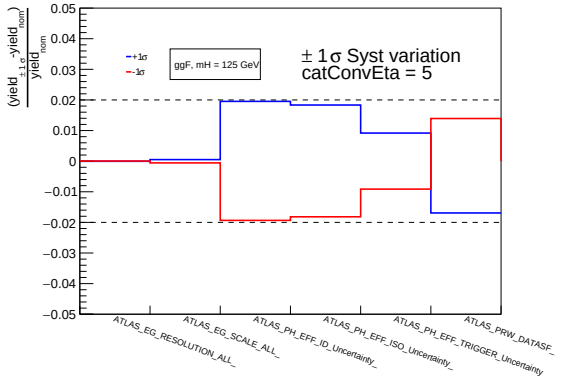
$\pm 1\sigma$ yield, catConvEta

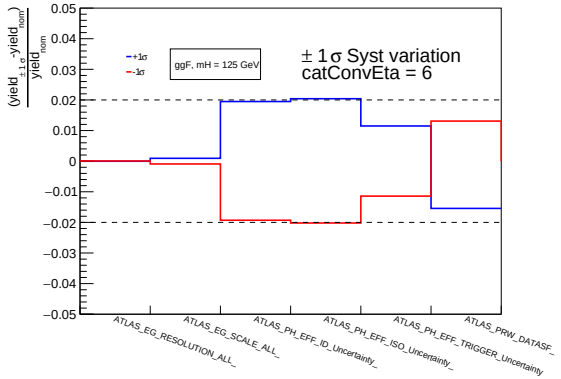










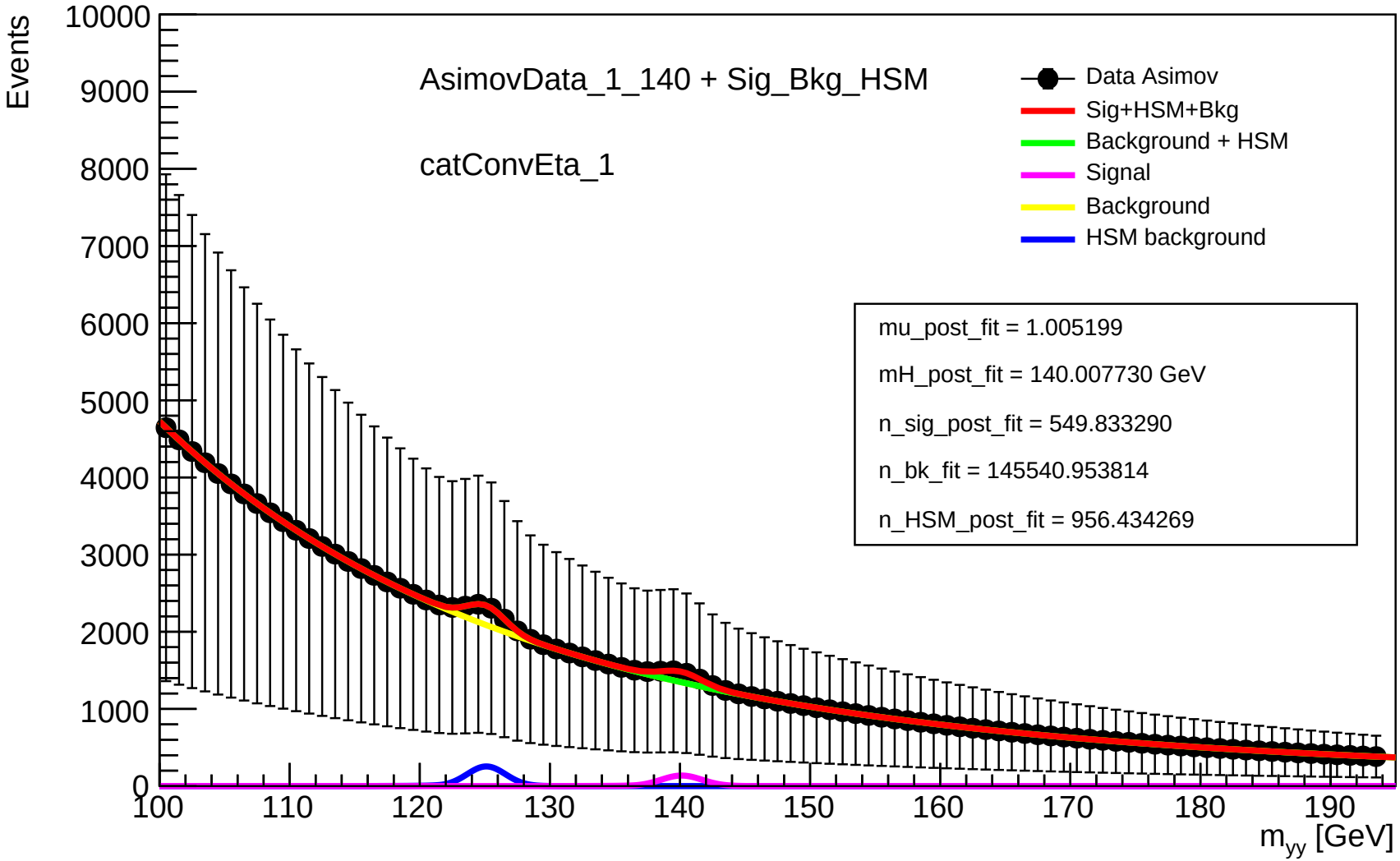


HSM shape systs

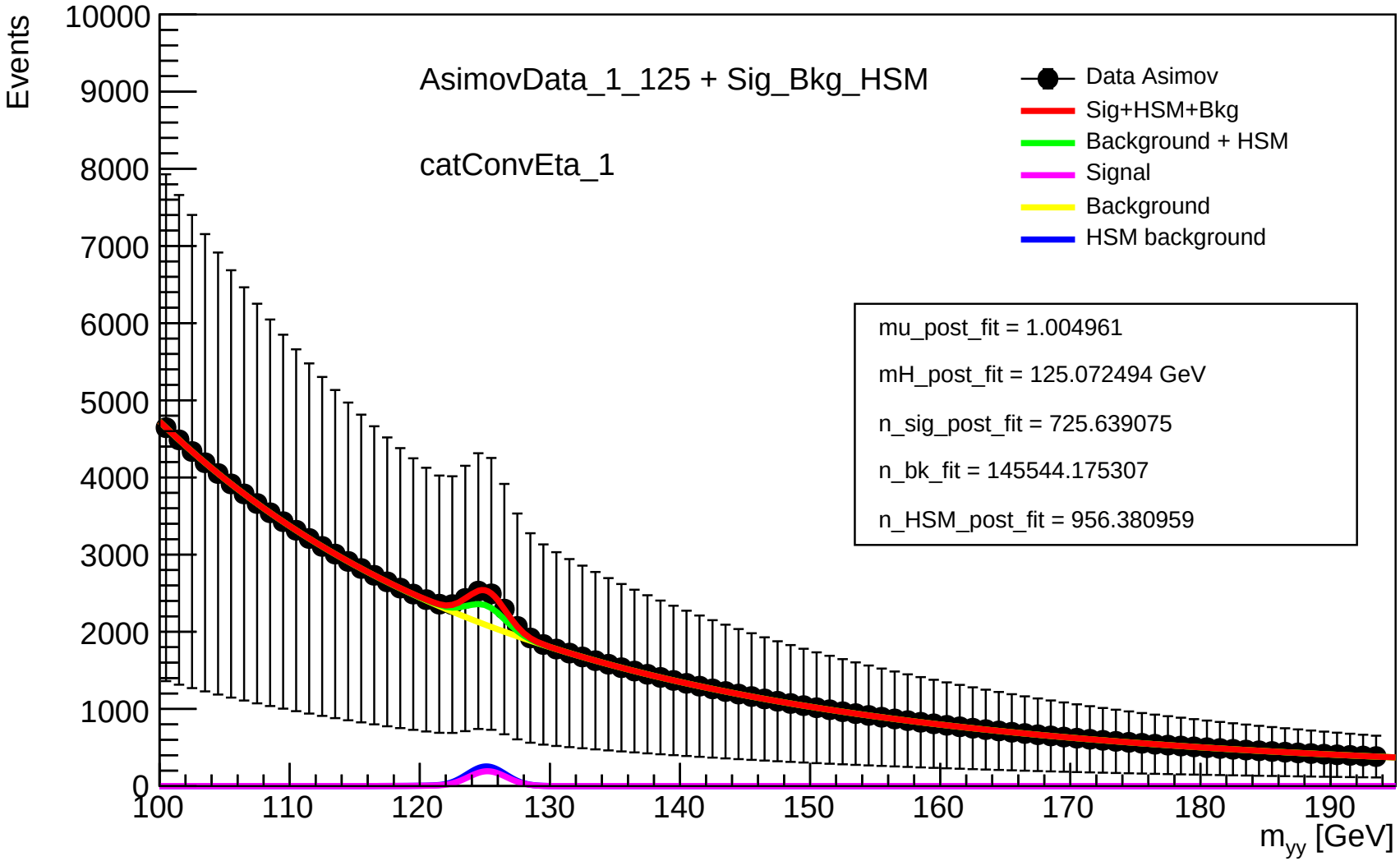
Signal	no		1		2		3		4		5		6	
	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ	$+1\sigma$	-1σ
ATLAS_EG_RESOLUTION_ALL_	0.0866339	-0.0686718	0.0973955	-0.0523099	0.0924181	-0.0778125	0.121311	-0.118801	0.0825436	-0.0452907	0.0717434	-0.062416	0.0802543	-0.0776709
ATLAS_EG_SCALE_ALL_	0.00436999	-0.00437357	0.00271049	-0.00271016	0.00505455	-0.00505887	0.00941769	-0.00943935	0.00287867	-0.00287469	0.00347786	-0.00347915	0.00522825	-0.00524284

Table: $\pm 1\sigma$ shape sys for each category

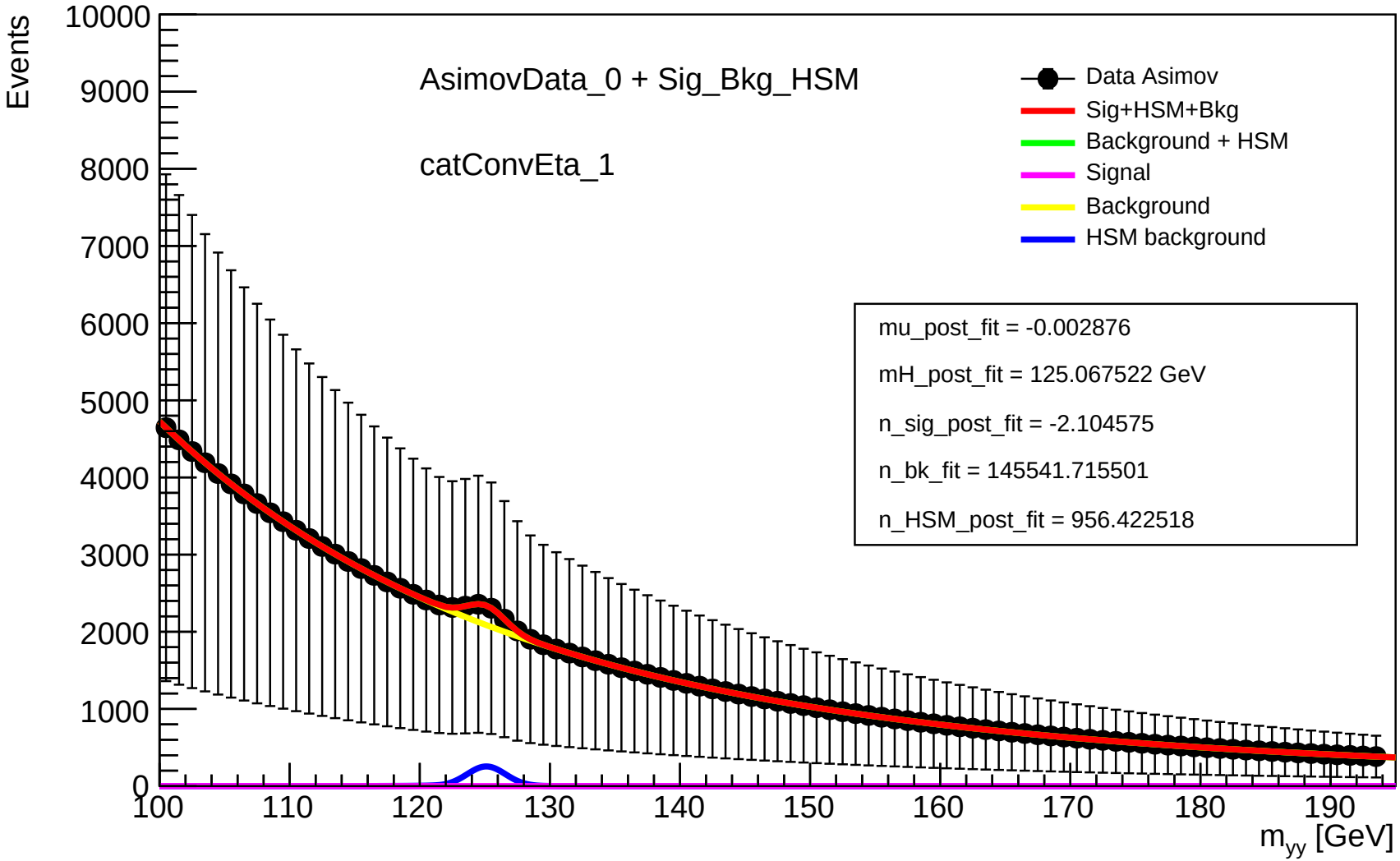
Asimov $\mu = 1$ $mH = 140$ + HSM



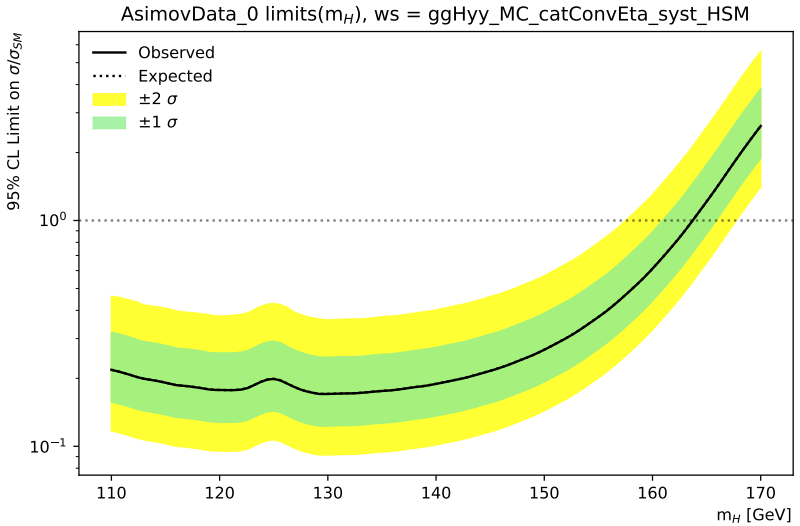
Asimov $\mu = 1$ $mH = 125$ + HSM

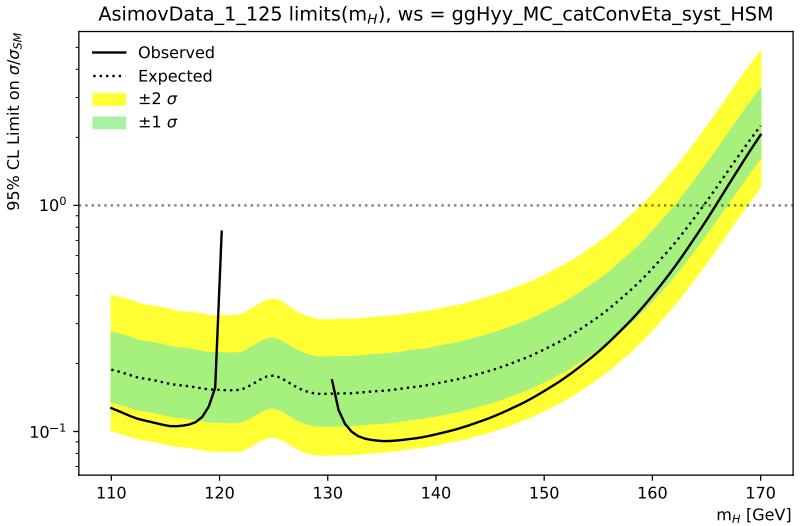


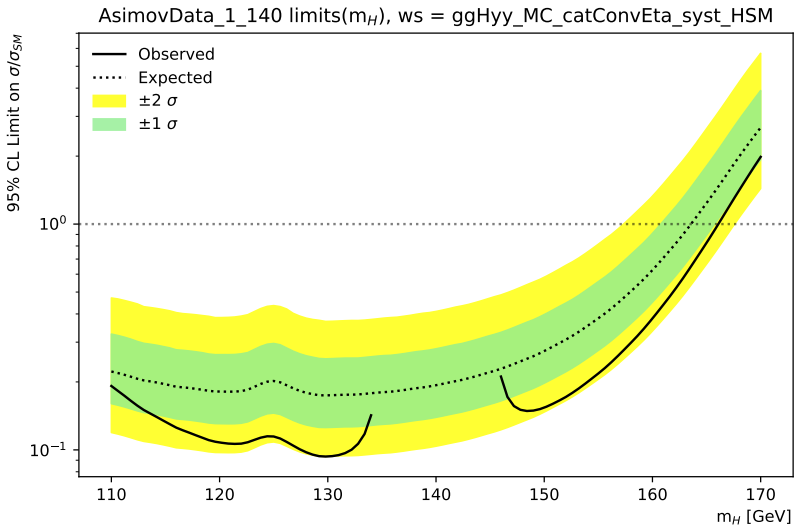
Asimov $\mu = 0$ + HSM



Limits ws catConvEta (systs and HSM bkg)







cutFlow vs Fiducial

Parameter	Name	cutFlow > 13	`isFiducialHighMyy`	`isFiducialLowMyy`
η^{γ_1}	η cut	$\|\|\|\|\|\|\|$	< 2.37	< 2.37
η^{γ_2}	η cut	$\|\|\|\|\|\|\|$	< 2.37	< 2.37
$p_T^{\gamma_1}/m_{\gamma\gamma}^{Truth}$	Scalar relative p_T cut	> 0.35	> 0.3	//
$p_T^{\gamma_2}/m_{\gamma\gamma}^{Truth}$	Scalar relative p_T cut	> 0.25	> 0.25	//
$p_T^{\gamma_1}$	Low-mass p_T cut	> 25 GeV	//	> 22 GeV
$p_T^{\gamma_2}$	Low-mass p_T cut	> 25 GeV	//	> 22 GeV
$E_T^{cone40\ \gamma_1}/(p_T^{\gamma_1} + 120e3)$	High-mass Isolation cut	$\|\|\|\|\|\|$	< 0.05	//
$E_T^{cone40\ \gamma_2}/(p_T^{\gamma_2} + 120e3)$	High-mass Isolation cut	$\|\|\|\|\|\|$	< 0.05	//
$E_T^{cone20\ \gamma_1}/p_T^{\gamma_1}$	Low-mass Isolation cut	$\|\|\|\|\|\|$	//	< 0.065
$E_T^{cone20\ \gamma_2}/p_T^{\gamma_2}$	Low-mass Isolation cut	$\|\|\|\|\|\|$	//	< 0.065

Table: CutFlow vs Fiducial selections

cutFlow steps

- CUT 0 : Remove duplicate events (only for data)
- CUT 1 : GRL
- CUT 2 : Require trigger
- CUT 3 : Detector quality
- CUT 4 : Require a vertex
- CUT 5 : Require two loose photons, p_T>25 GeV
- CUT 6 : Preselection $\rightarrow$ Require two loose photons that also pass e-gamma ambiguity
- CUT 7 : Require two loose photons to pass trigger matching
- CUT 8 : Require both photons to pass photon ID (isEM)
- CUT 9 : Require both photons to fulfill the isolation criteria
- CUT 10 : Relative pT cuts

17^{th} week

Workspace

- **Signal**
  - Fit: DSCB, function of m_X.
  - Syst:
    - Yield
    - Shape
    - Production modes
  - Fiducial events
- **Non-resonant background**
  - Fit: exp poly2.
  - Spurios signal: NO
- **HSM background**
  - Fit: DSCB fixed.
  - Syst:
    - Yield
    - Shape
    - ATLAS Higgs mass
- Theoretical syst

Fiducial: 110 GeV

Cat [110 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidLow	cut/fidLow	fidLow/all
no	15209.9	5043.55	6397.7	0.788339	0.419828	6882.38	0.732822	0.451632
1	⇑	776.993	⇑	0.121449	⇑	⇑	0.112896	⇑
2	⇑	1302.56	⇑	0.203598	⇑	⇑	0.18926	⇑
3	⇑	384.184	⇑	0.0600503	⇑	⇑	0.0558214	⇑
4	⇑	481.558	⇑	0.0752705	⇑	⇑	0.0699697	⇑
5	⇑	1460.16	⇑	0.228233	⇑	⇑	0.21216	⇑
6	⇑	638.087	⇑	0.0997371	⇑	⇑	0.0927132	⇑

Table: Number of events and efficiencies for `cutFlow>13`, `isFiducialHighMyy` and `isFiducialLowMyy` cuts. $m_X = 110$ GeV with `catConvEta` categorisation

Fiducial: 125 GeV

Cat [125 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidLow	cut/fidLow	fidLow/all
no	16807.8	5470.83	6622.02	0.826157	0.433171	7341.79	0.745164	0.48034
1	⇑	842.033	⇑	0.127156	⇑	⇑	0.11469	⇑
2	⇑	1405.32	⇑	0.212219	⇑	⇑	0.191414	⇑
3	⇑	408.892	⇑	0.0617472	⇑	⇑	0.0556937	⇑
4	⇑	527.038	⇑	0.0795886	⇑	⇑	0.071786	⇑
5	⇑	1598.8	⇑	0.241436	⇑	⇑	0.217767	⇑
6	⇑	690.55	⇑	0.104281	⇑	⇑	0.0940575	⇑

Table: Number of events and efficiencies for `cutFlow>13`, `isFiducialHighMyy` and `isFiducialLowMyy` cuts. $m_X = 125$ GeV with `catConvEta` categorisation

Fiducial: 130 GeV

Cat [130 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidLow	cut/fidLow	fidLow/all
no	14108.3	5121.93	6127.01	0.835958	0.434792	6850.87	0.747631	0.486163
1	⇑	789.917	⇑	0.128924	⇑	⇑	0.115302	⇑
2	⇑	1330.73	⇑	0.21719	⇑	⇑	0.194242	⇑
3	⇑	378.034	⇑	0.0616995	⇑	⇑	0.0551804	⇑
4	⇑	491.096	⇑	0.0801525	⇑	⇑	0.0716837	⇑
5	⇑	1487.7	⇑	0.24281	⇑	⇑	0.217155	⇑
6	⇑	644.483	⇑	0.105187	⇑	⇑	0.0940731	⇑

Table: Number of events and efficiencies for `cutFlow>13`, `isFiducialHighMyy` and `isFiducialLowMyy` cuts. $m_X = 130$ GeV with `catConvEta` categorisation

Fiducial: 140 GeV

Cat [140 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidLow	cut/fidLow	fidLow/all
no	9438.64	3572.26	4191.27	0.852309	0.445044	4738.85	0.753823	0.503182
1	⇑	551.591	⇑	0.131605	⇑	⇑	0.116398	⇑
2	⇑	919.714	⇑	0.219436	⇑	⇑	0.19408	⇑
3	⇑	264.688	⇑	0.0631522	⇑	⇑	0.0558549	⇑
4	⇑	344.633	⇑	0.0822265	⇑	⇑	0.072725	⇑
5	⇑	1039.73	⇑	0.248072	⇑	⇑	0.219407	⇑
6	⇑	451.832	⇑	0.107803	⇑	⇑	0.0953462	⇑

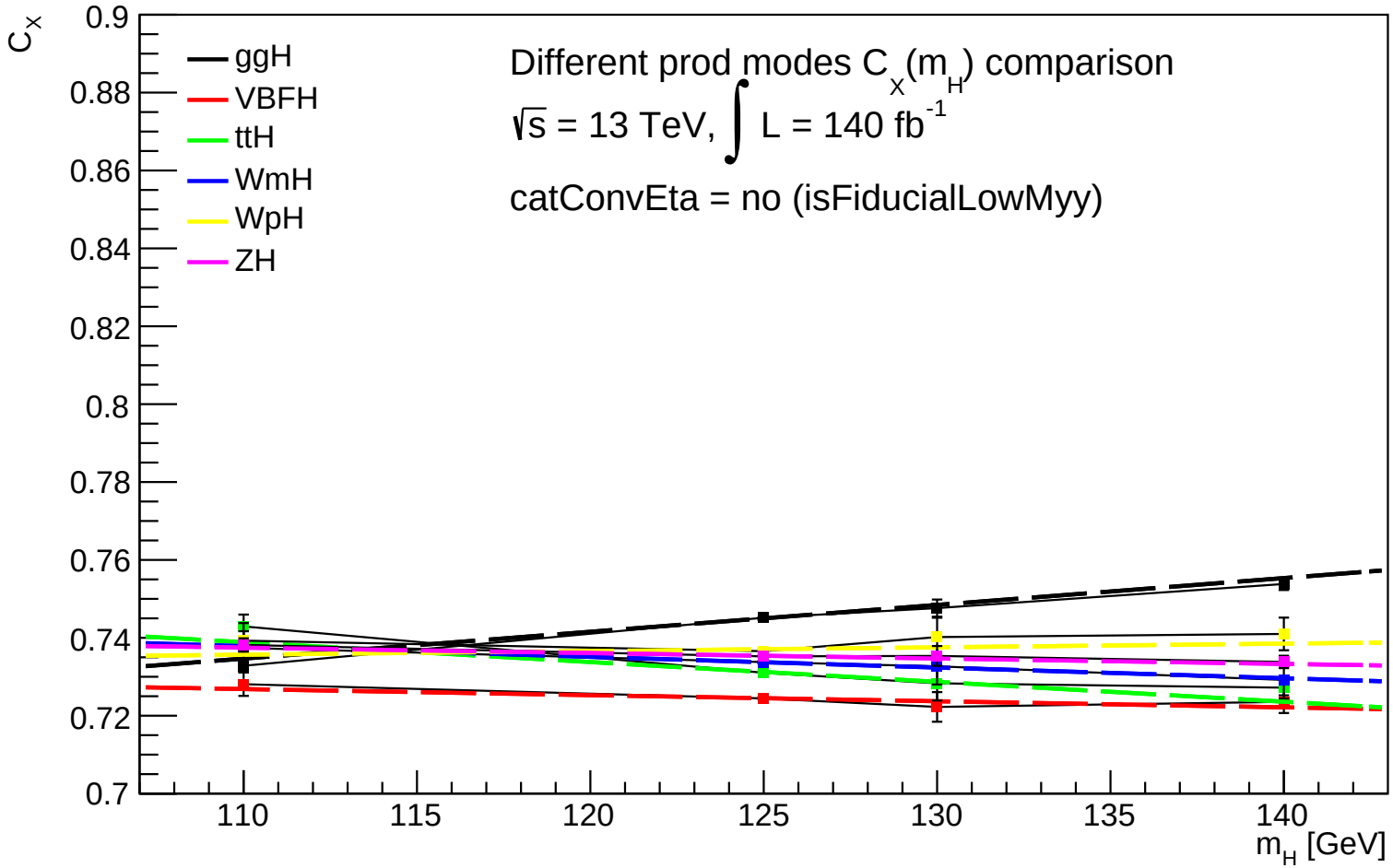
Table: Number of events and efficiencies for `cutFlow>13`, `isFiducialHighMyy` and `isFiducialLowMyy` cuts. $m_X = 140$ GeV with `catConvEta` categorisation

Production mods inc

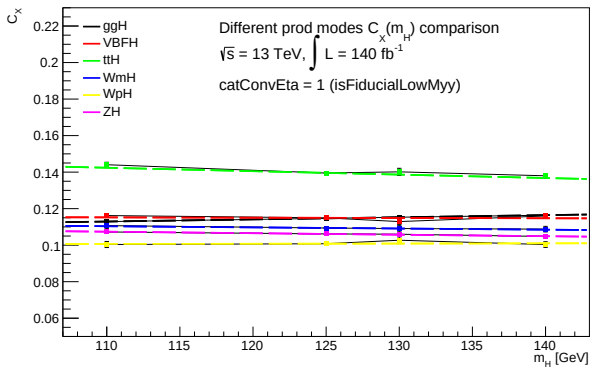
Cat	110 GeV		125 GeV		130 GeV		140 GeV	
	All	**Fid_Low**	**All**	**Fid_Low**	**All**	**Fid_Low**	**All**	**Fid_Low**
no	0.163719	0.0106515	0.158653	0.0275281	0.157113	0.03305	0.154228	0.0439428
1	0.329207	0.260816	0.28836	0.217073	0.275966	0.202788	0.252775	0.174647
2	0.168929	0.0348676	0.172123	0.0522419	0.173095	0.0579295	0.174916	0.069153
3	0.134046	0.175762	0.127847	0.176196	0.125924	0.17634	0.122273	0.176629
4	0.343184	0.274333	0.309866	0.237343	0.299803	0.225312	0.281032	0.201683
5	0.136881	0.0645004	0.12726	0.086883	0.124344	0.0941893	0.118891	0.108577
6	0.114249	0.158083	0.135306	0.183131	0.14171	0.19133s	0.153712	0.207507

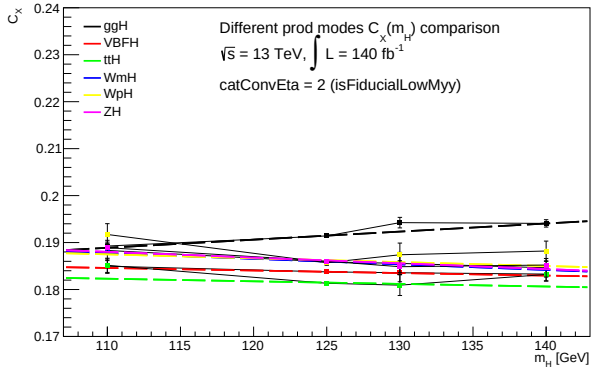
Table: abs(eff_{prod} - eff_{ggH})/ eff_{ggH} vs abs(cx_{prod} - cx_{ggH})/ cx_{ggH} other production modes systematic uncertainties

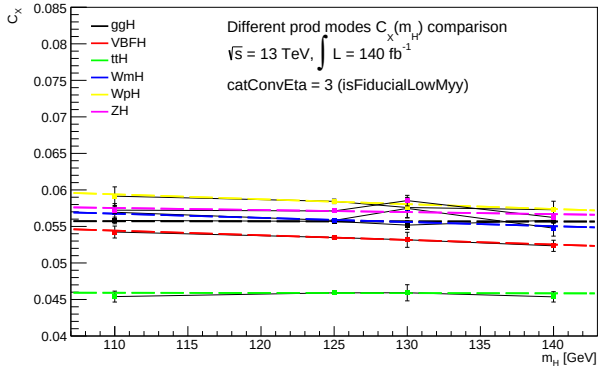
Production mods

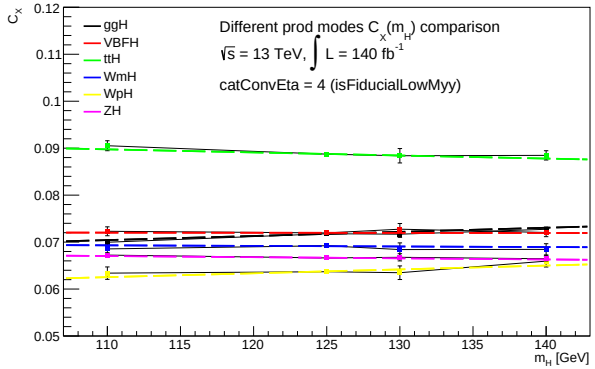


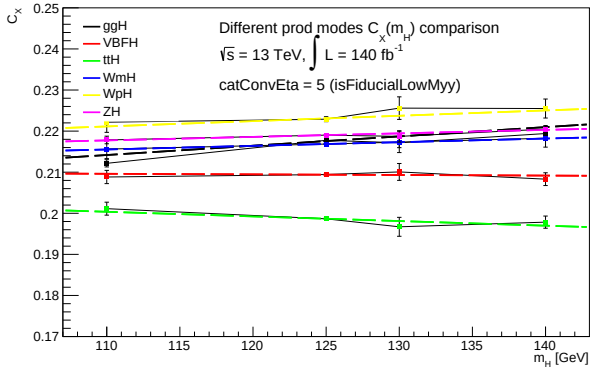
Production mods catConvEta

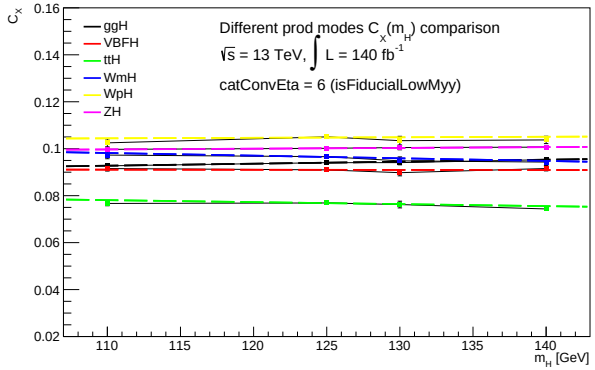




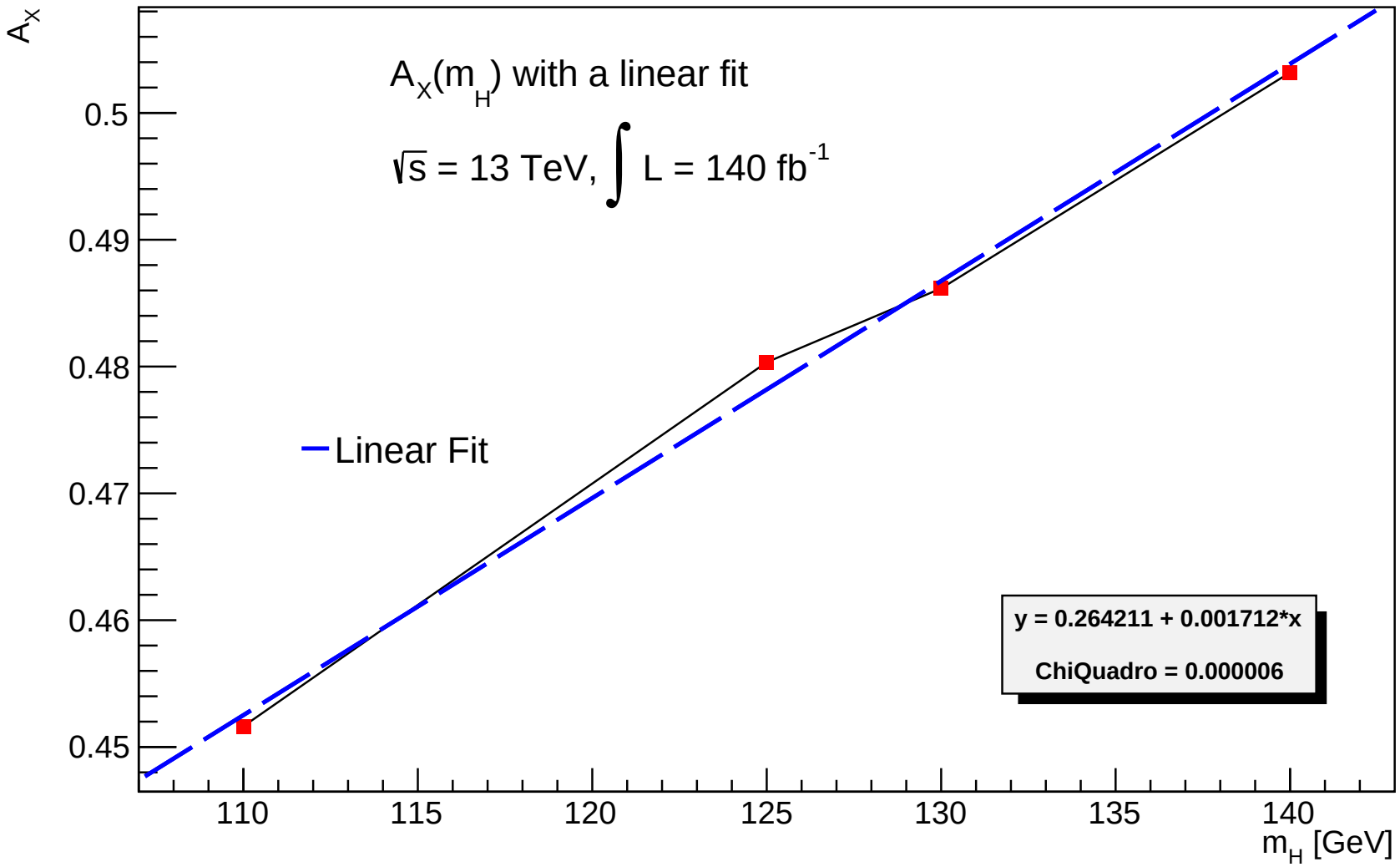




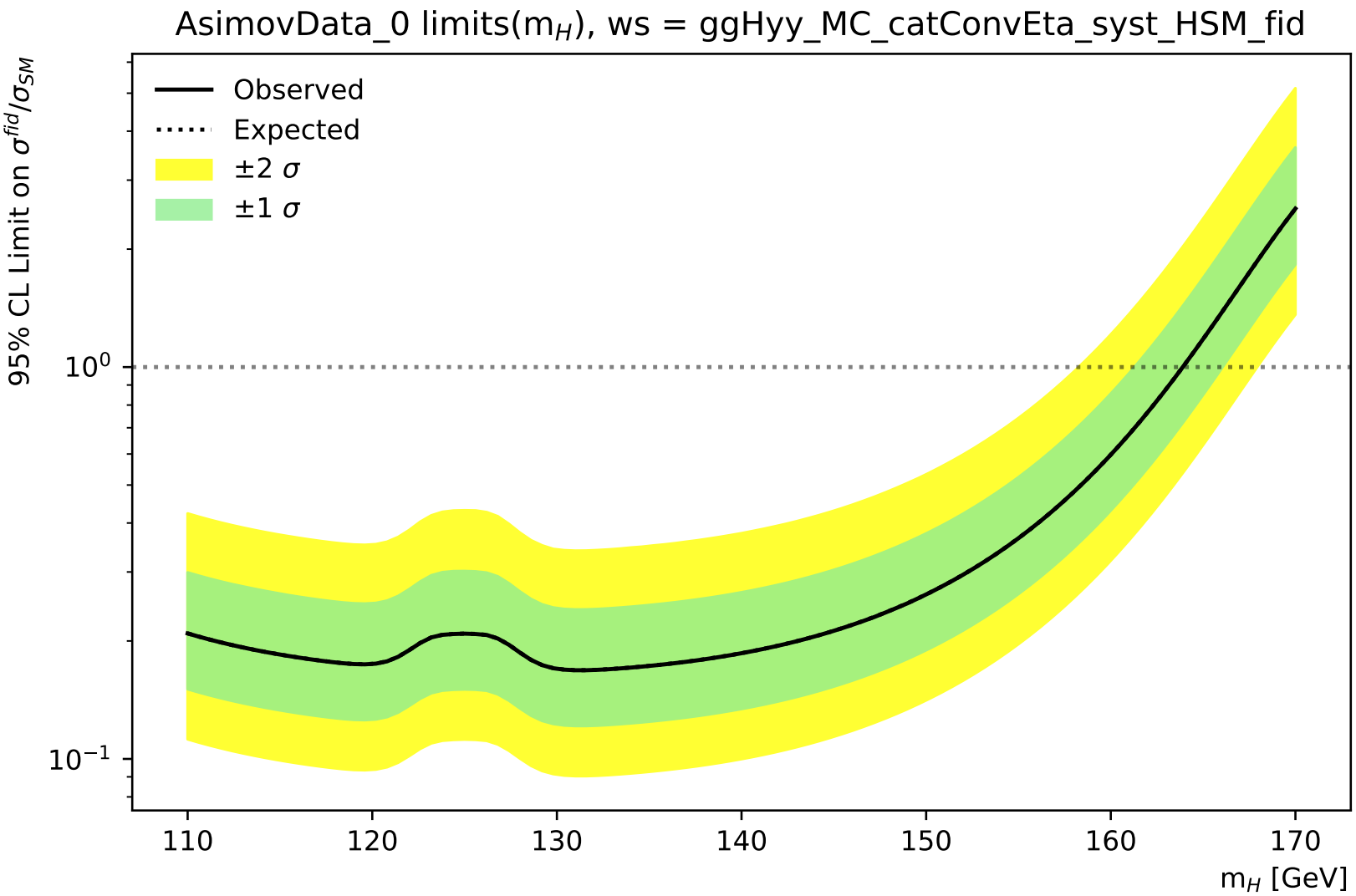




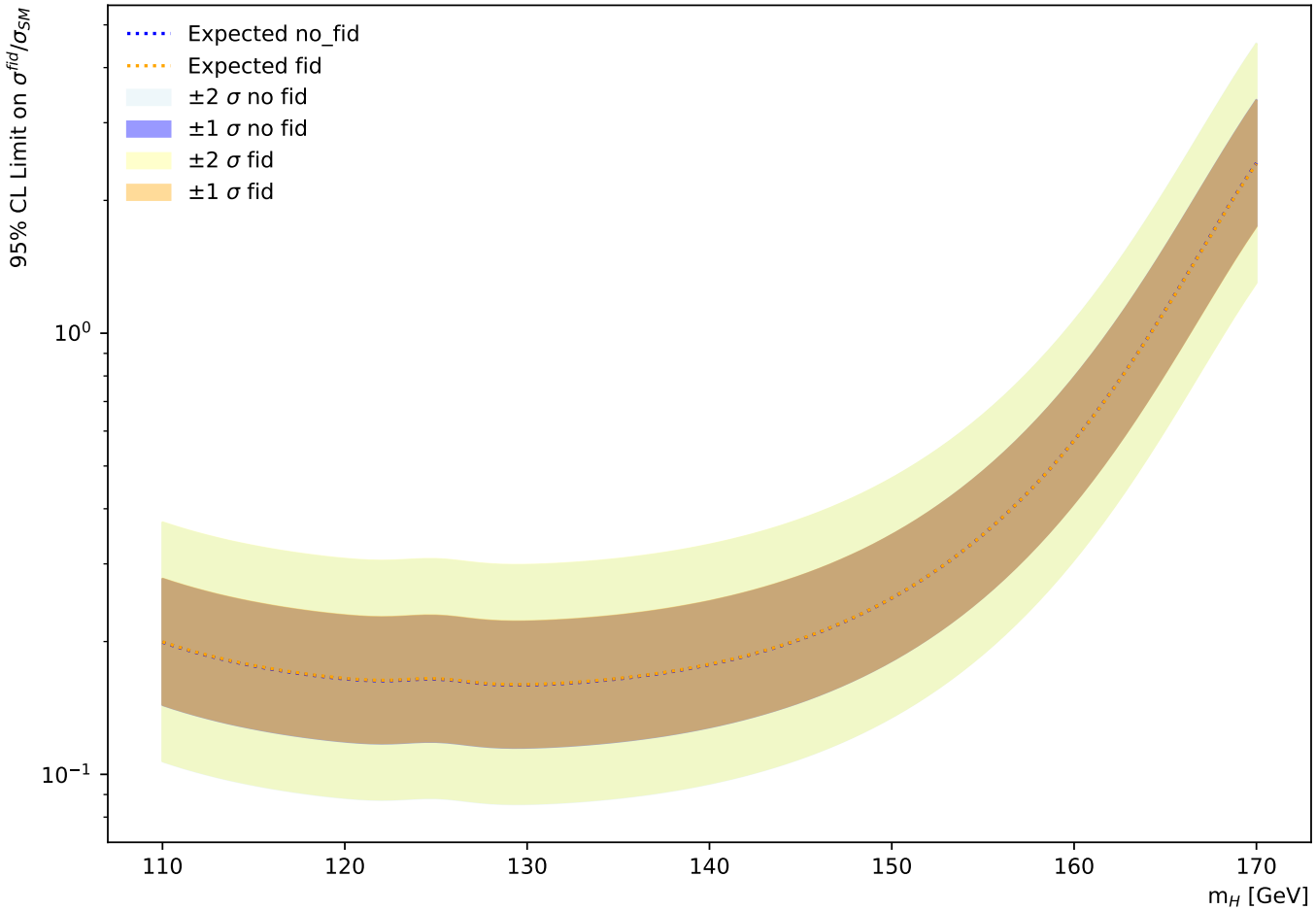
A_X linear fit



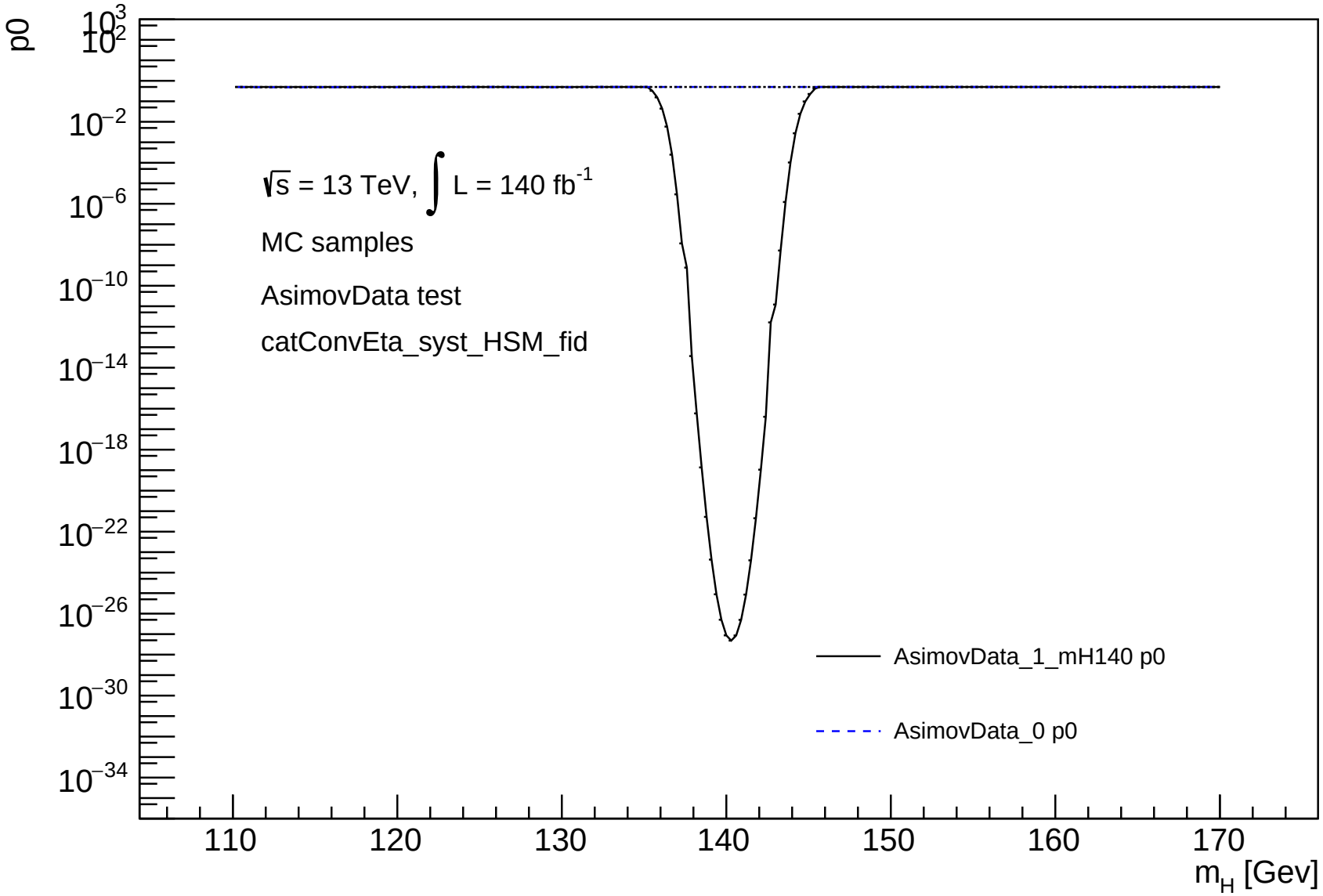
Limits with μ=0



No fid vs fid ws

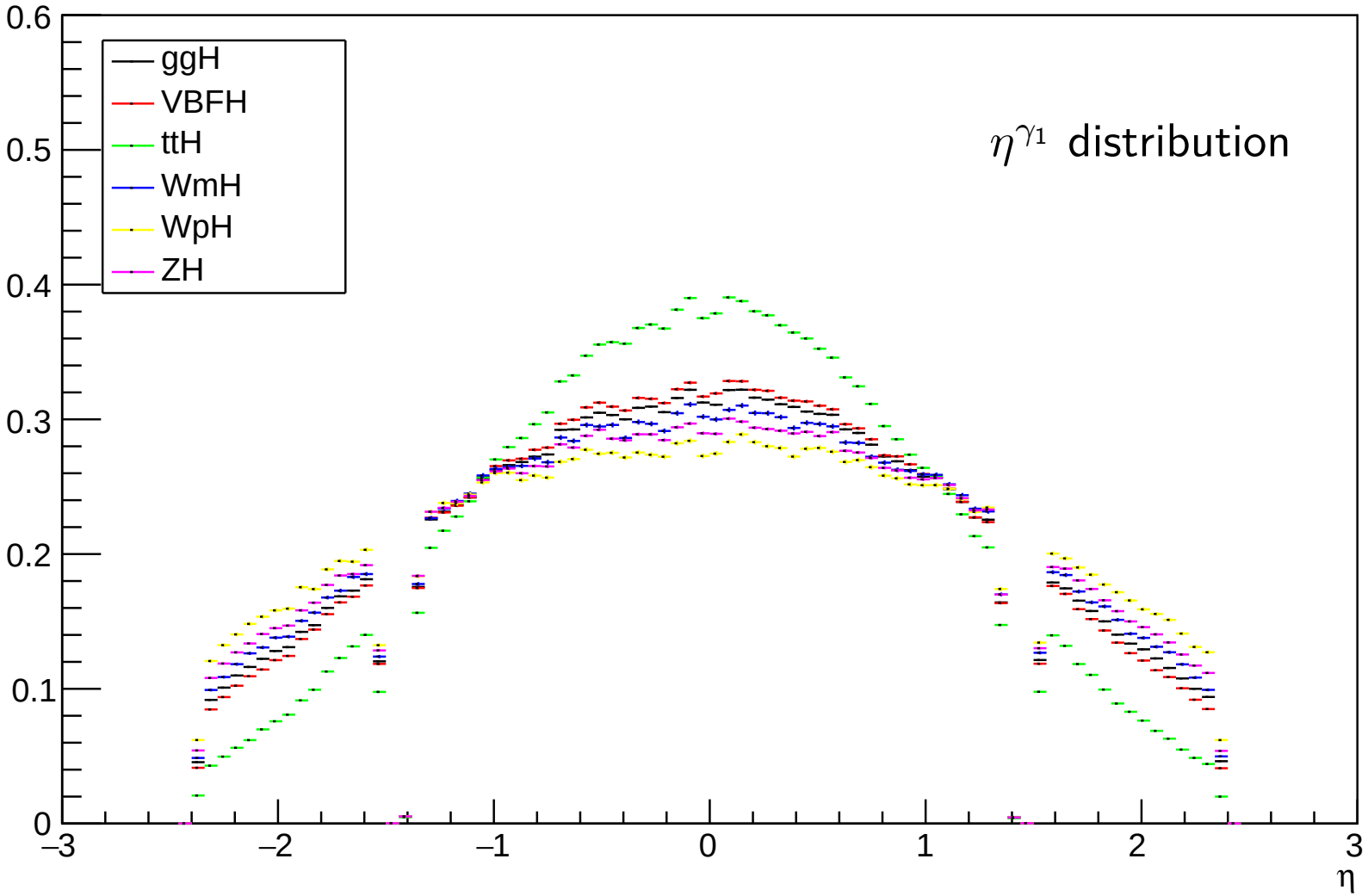


p0 scan

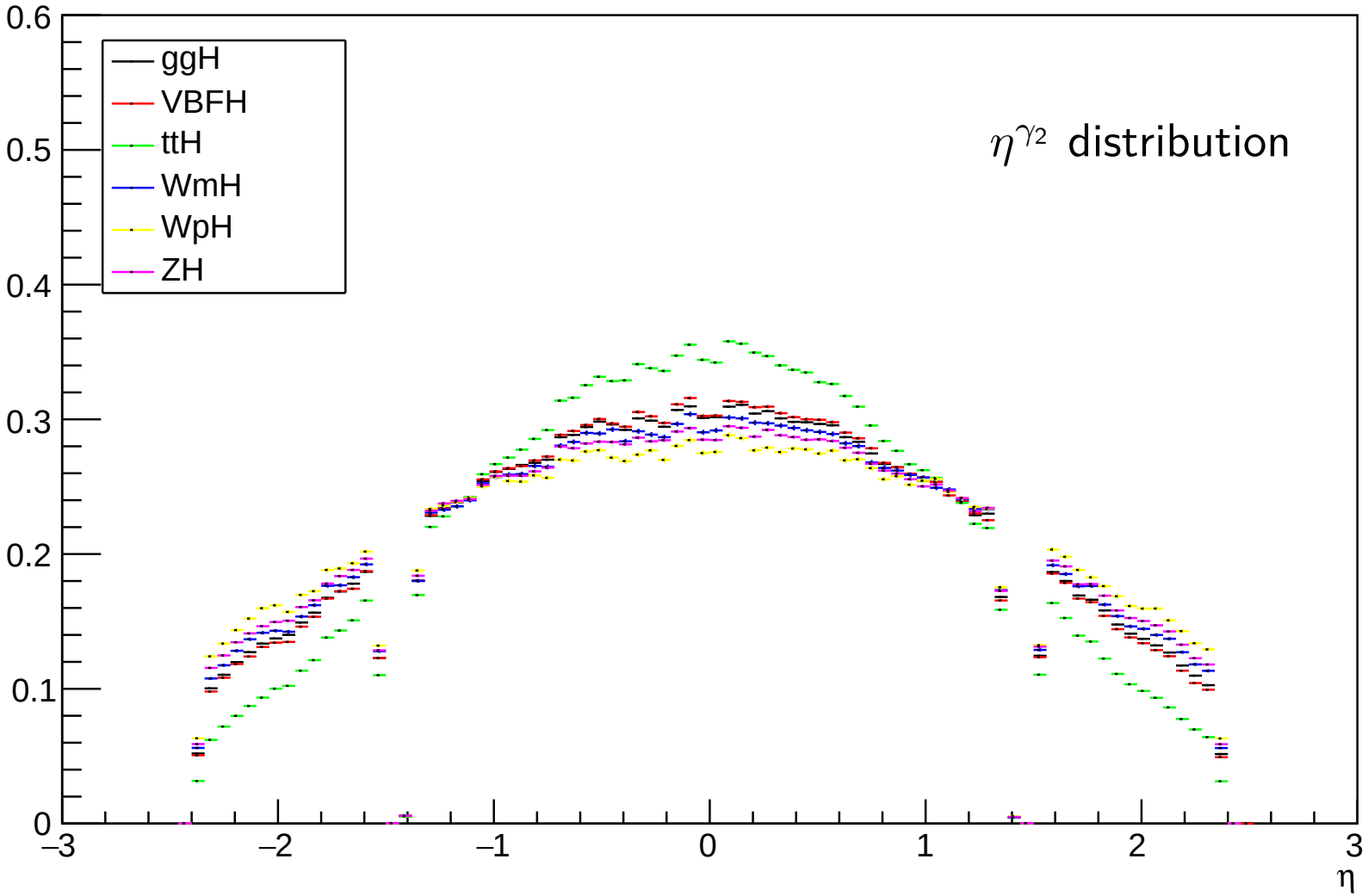

p0
10^{3}
10^{2}
10^{-2}
10^{-6}
10^{-10}
10^{-14}
10^{-18}
10^{-22}
10^{-26}
10^{-30}
10^{-34}
$\sqrt{s}$ = 13 TeV, $\int$ L = 140 fb^{-1}
MC samples
AsimovData test
catConvEta_syst_HSM_fid
AsimovData_1_mH140 p0
AsimovData_0 p0
110
120
130
140
150
160
170
m_H [Gev]

18^{th} week

$\eta^{\gamma 1}$ distribution



$\eta^{\gamma 2}$ distribution



Reco and Fiducial selections

ggH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	5063.64	2283.63
isFiducialLowMyy != true	105.844	269.335

Table: ggF Reco and Fiducial selections

VBFH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	402.074	193.321
isFiducialLowMyy != true	5.82568	19.4722

Table: VBFH Reco and Fiducial selections

ttH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	53.7432	27.4287
isFiducialLowMyy != true	2.25594	13.2096

Table: ttH Reco and Fiducial selections

Reco and Fiducial selections

WpH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	73.1771	34.8496
isFiducialLowMyy != true	1.96502	7.0056

Table: `WpH` Reco and Fiducial selections

ZH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	70.5388	33.7031
isFiducialLowMyy != true	1.80641	6.70319

Table: `ZH` Reco and Fiducial selections

WmH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	51.6014	24.7641
isFiducialLowMyy != true	1.33993	4.85144

Table: `WmH` Reco and Fiducial selections

19^{th} week

Reco and Fiducial selections

ggH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	5169.16	10301.5
isFiducialLowMyy != true	0	0

Table: ggF Reco and Fiducial selections

VBFH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	407.896	784.271
isFiducialLowMyy != true	0	0

Table: VBFH Reco and Fiducial selections

ttH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	55.9692	103.848
isFiducialLowMyy != true	0	0

Table: ttH Reco and Fiducial selections

Reco and Fiducial selections

WpH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	75.1665	189.317
isFiducialLowMyy != true	0	0

Table: `WpH` Reco and Fiducial selections

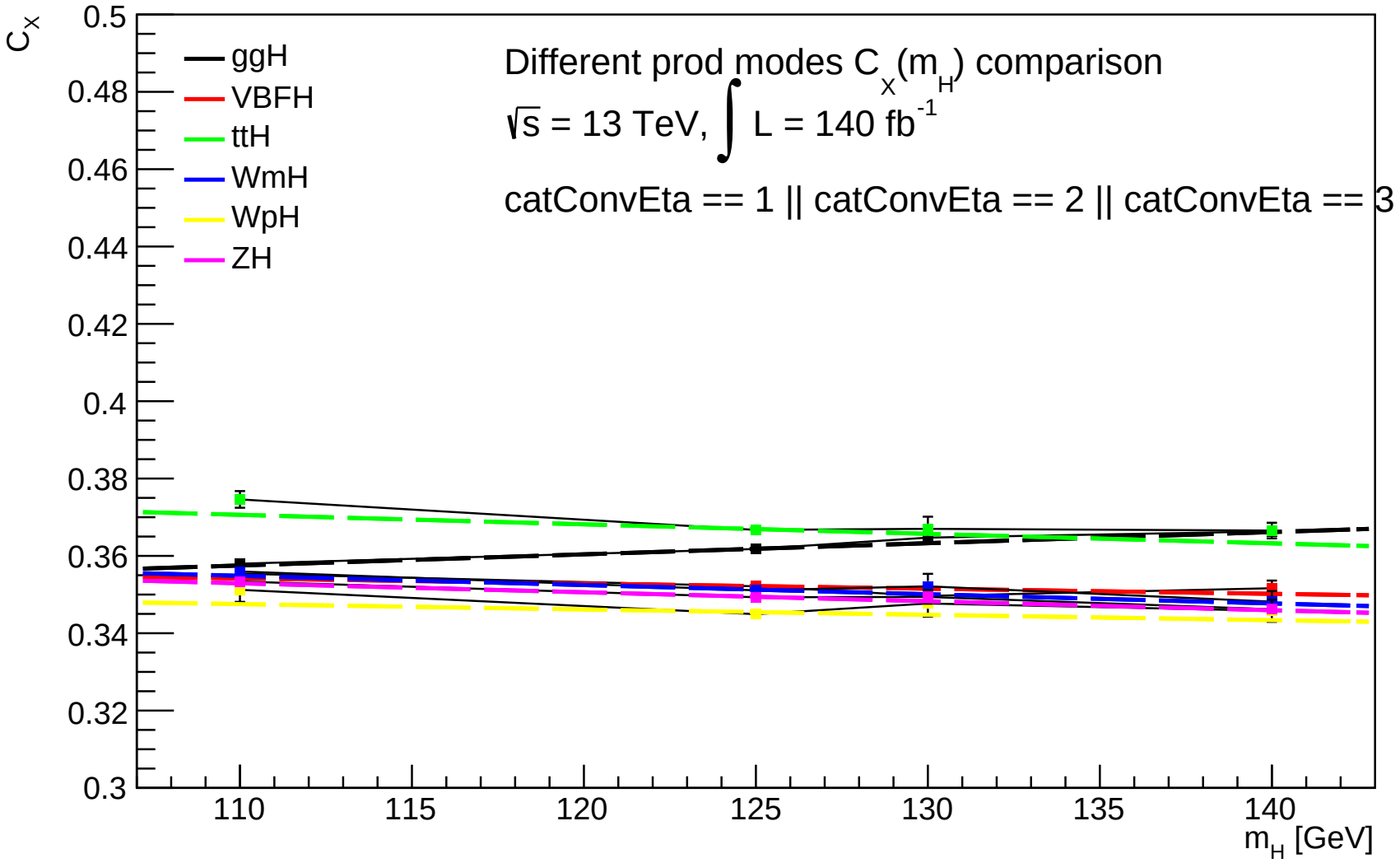
ZH	cutFlow > 13	cutFlow <= 13
sFiducialLowMyy == true	72.3131	167.481
isFiducialLowMyy != true	0	0

Table: `ZH` Reco and Fiducial selections

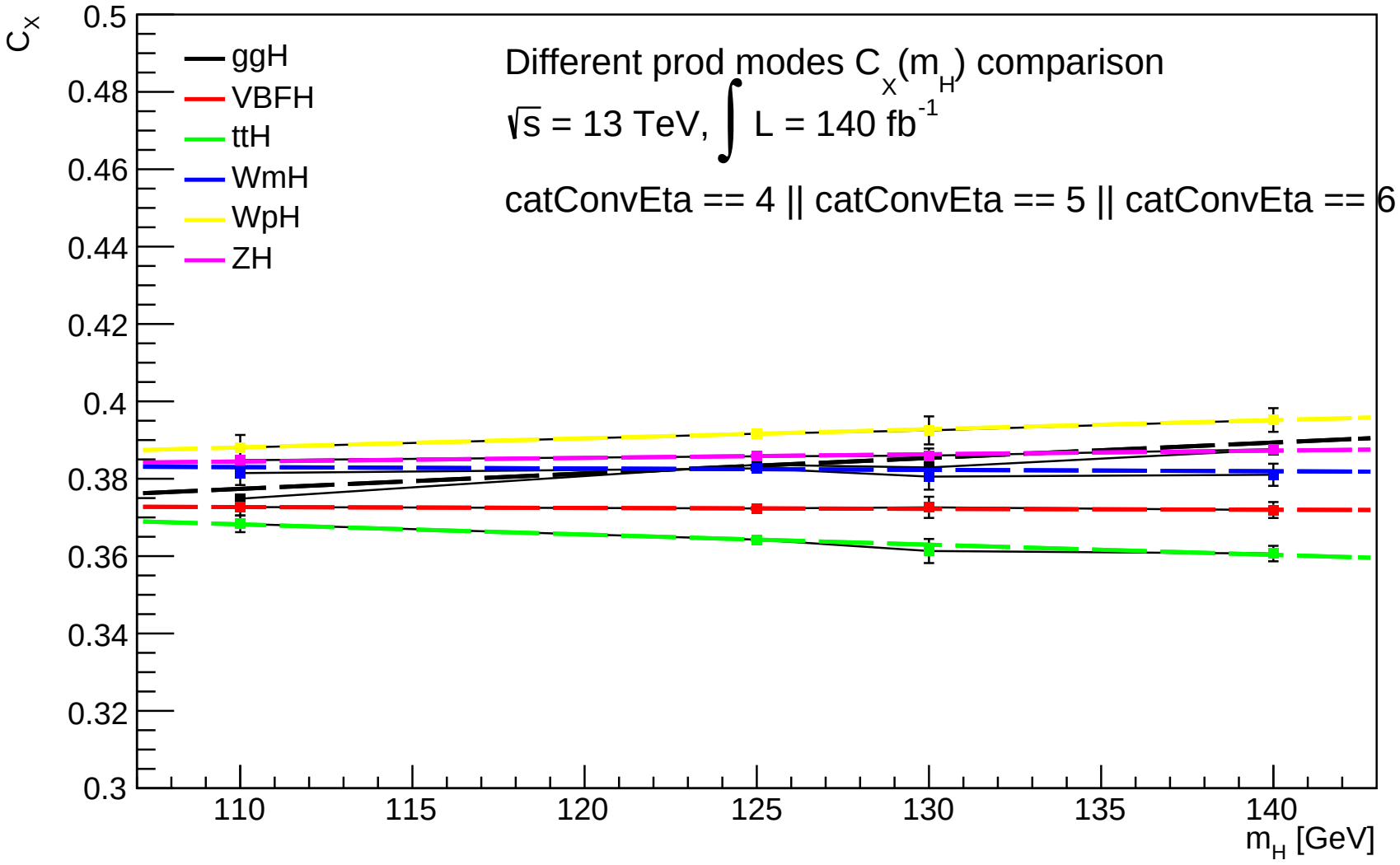
WmH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	52.9455	114.679
isFiducialLowMyy != true	0	0

Table: `WmH` Reco and Fiducial selections

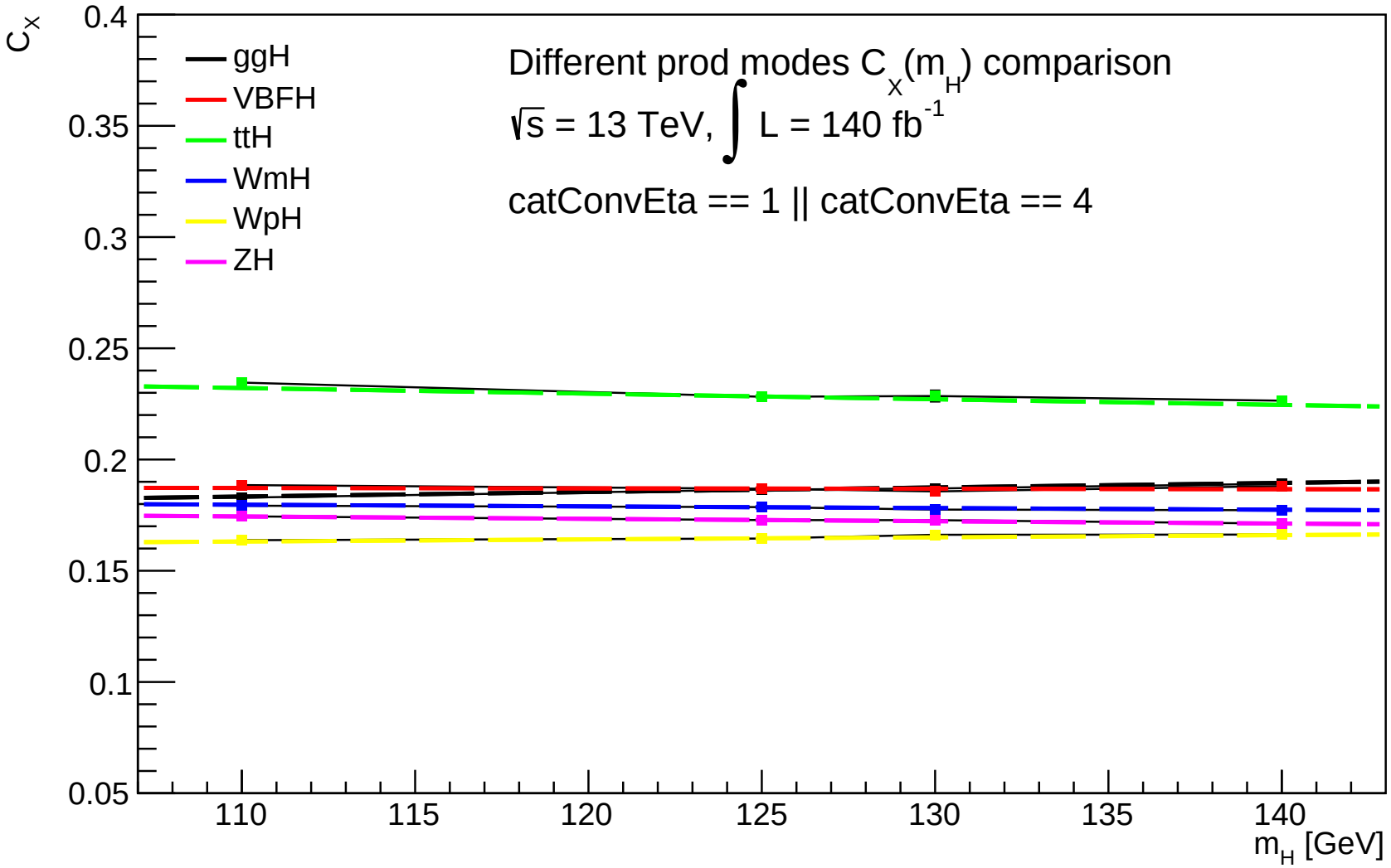
2 γ unconv



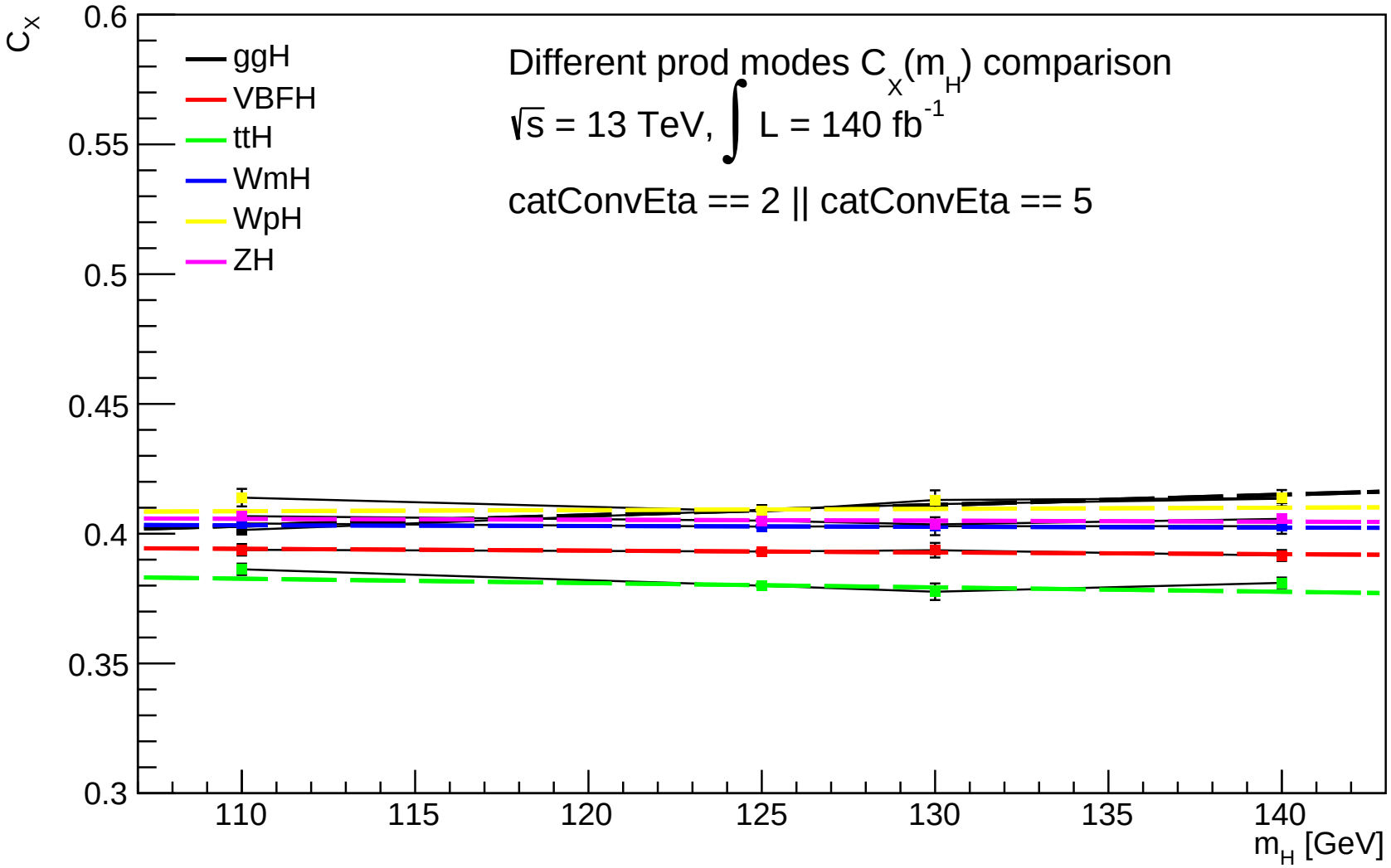
At least 1 γ conv



$|\eta_{s2}| < 0.75$


C_x
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
ggH
VBFH
ttH
WmH
WpH
ZH
Different prod modes C_X(m_H) comparison
√s = 13 TeV, ∫ L = 140 fb^-1
catConvEta == 1 || catConvEta == 4
110
115
120
125
130
135
140
m_H [GeV]

no central and no trans regions



$|\eta_{s2}| \in [1.3, 1.75]$