

# Thesis progress

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UNIVERSITÀ  
DEGLI STUDI  
DI MILANO

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# GitHub

The whole code is available at this GitHub [link](#)

1° week

# Uploading file .root

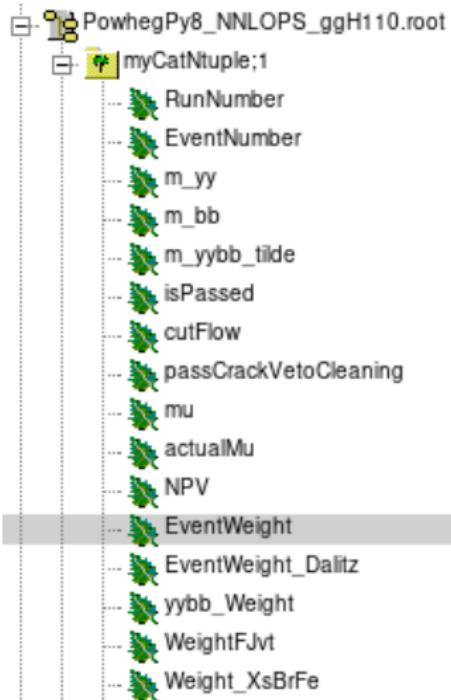
The file uploaded are:

- PowhegPy8\_NNLOPS\_ggH110.root;
- PowhegPy8\_NNLOPS\_ggH125.root;
- PowhegPy8\_NNLOPS\_ggH130.root;
- PowhegPy8\_NNLOPS\_ggH140.root;

# Data

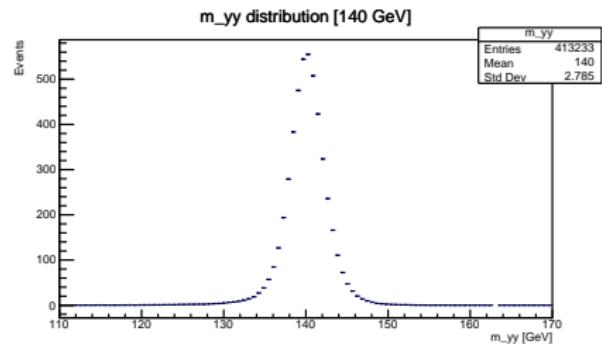
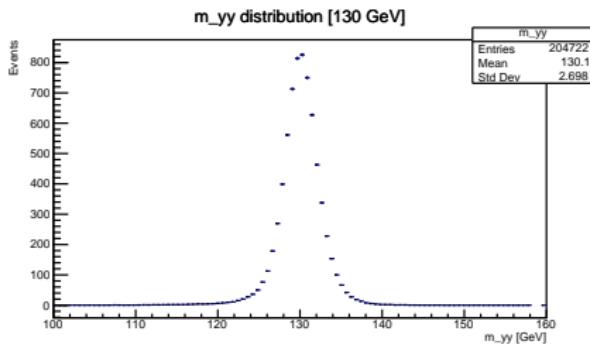
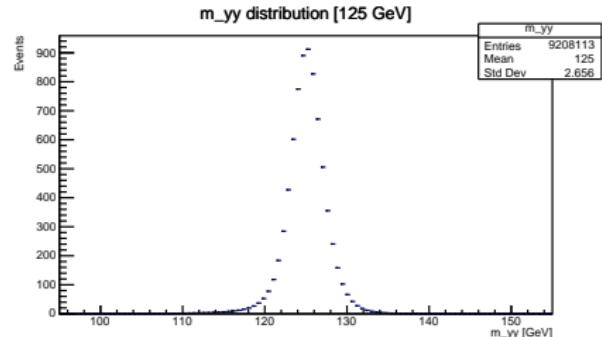
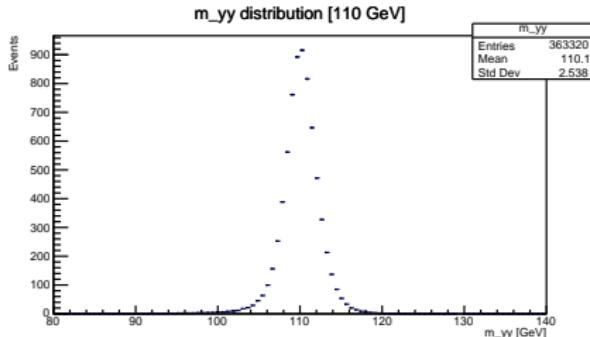
In each file, there is a TTree `myCatNtuple`, which contains all the variables. Only three of them were used:

- **m\_yy**: mass distribution;
- **EventWeight**: it contains all type of weights.
- **cutFlow**



# $m_{\gamma\gamma}$ distribution

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  $\mu$ ;
- sigma  $\sigma$ ;

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

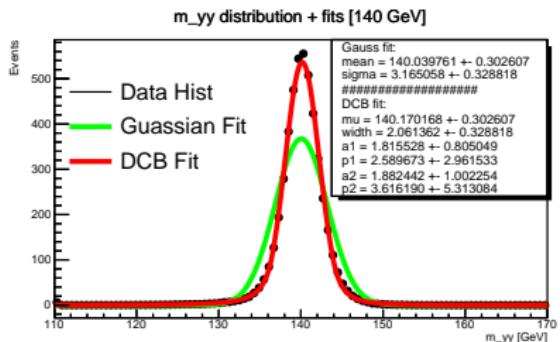
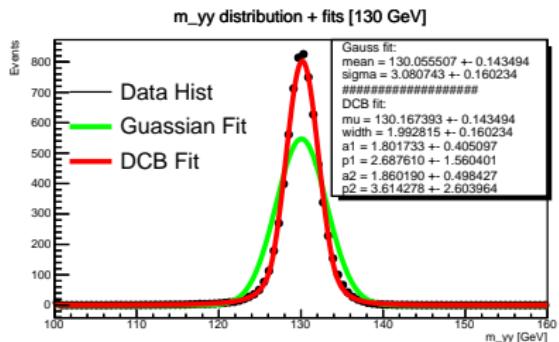
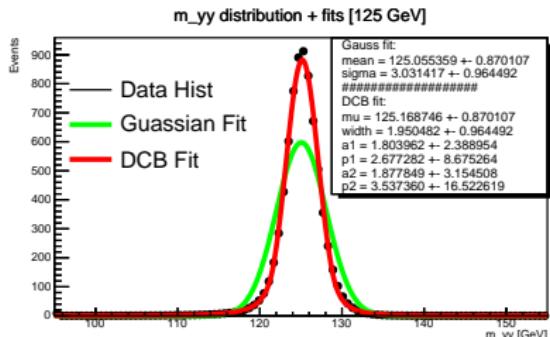
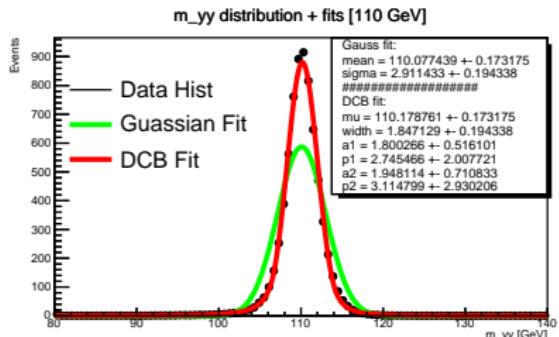
- **DCB fit**: there are six parameters:

- mean  $\mu$ ;
- sigma  $\sigma$
- $a_1$ ;
- $p_1$ ;
- $a_2$ ;
- $p_2$ ;

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

# Gaussian and DCB fits

Applying the fits to all entries:



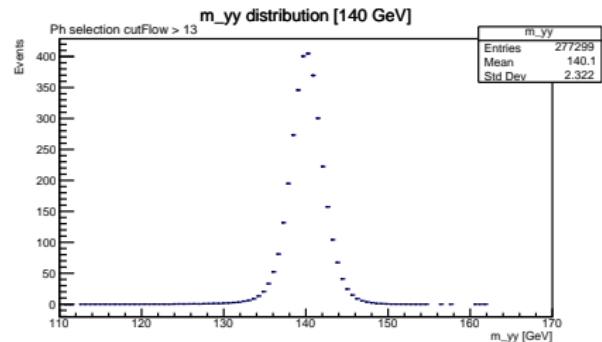
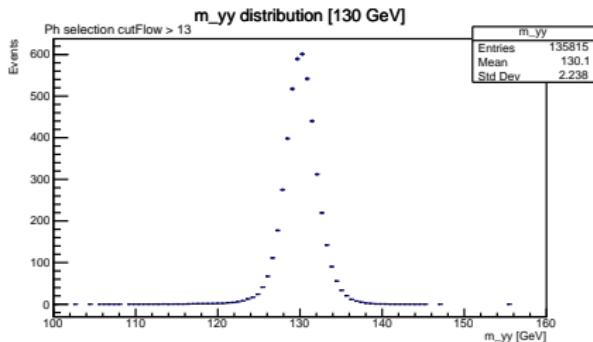
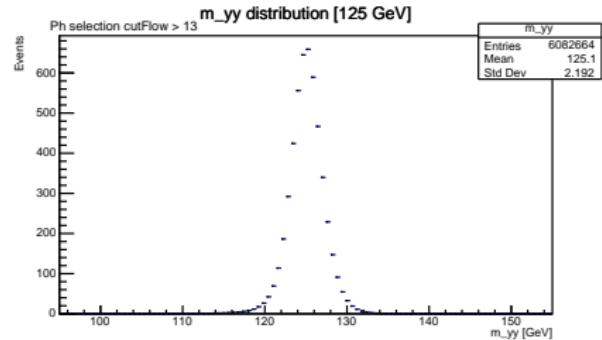
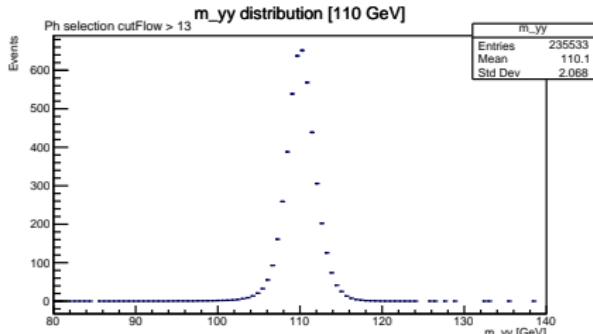
# CutFlow

Events with at least two isolated  $\gamma$  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.

⇒ Using the cutFlow greater than 13, the events are selected.

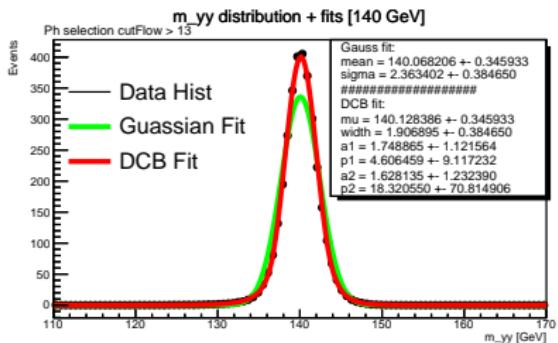
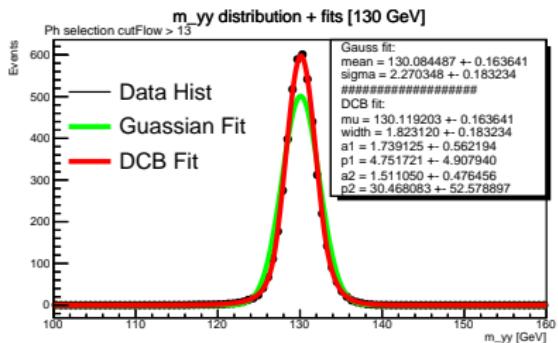
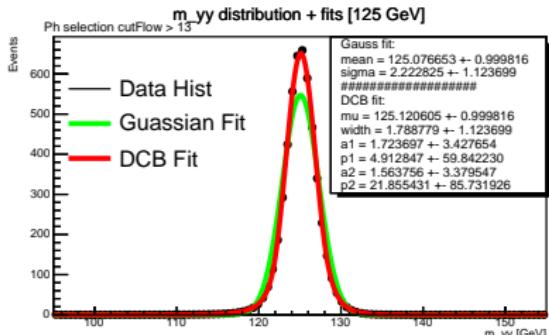
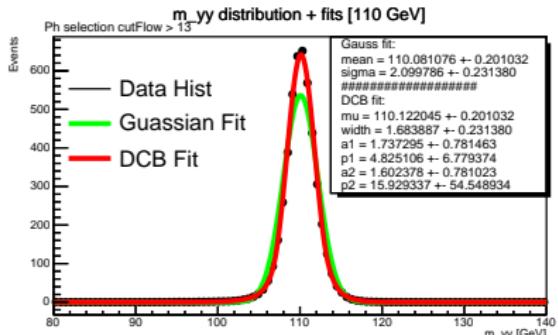
# $m_{\gamma\gamma}$ distribution with cutFlow > 13

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



# Gaussian and DCB fits with cutFlow > 13

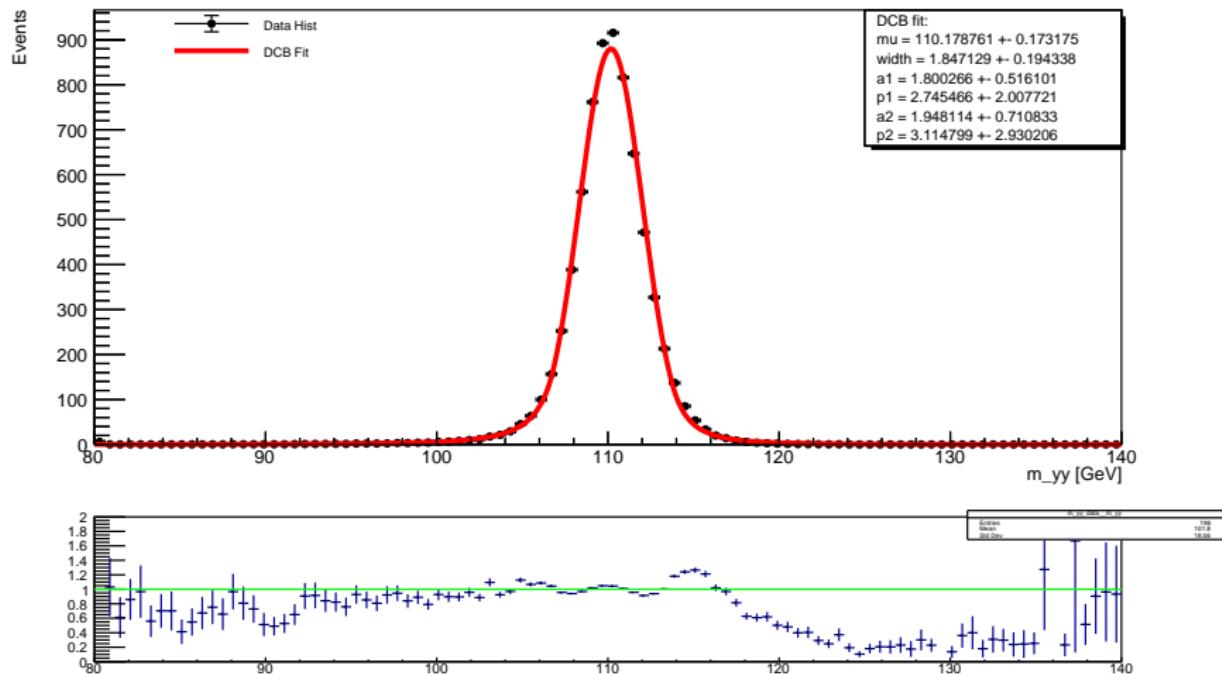
Applying the fits to all entries:



# 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:

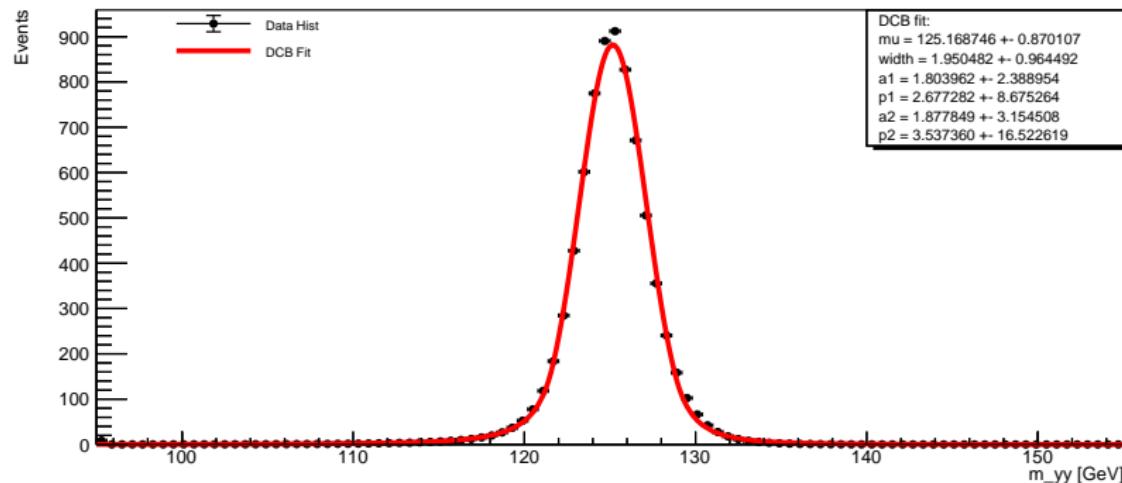
m\_yy distribution + DCB fit [110 GeV]



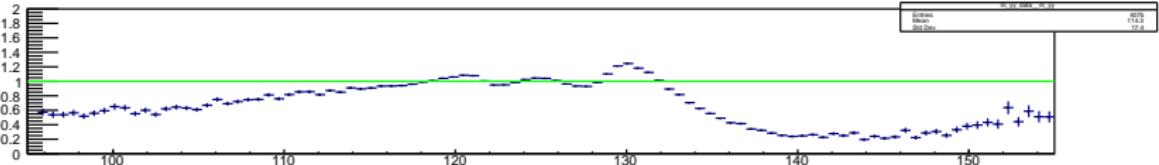
# DCB fit and ratio plot [125 GeV]

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

m\_yy distribution + DCB fit [125 GeV]



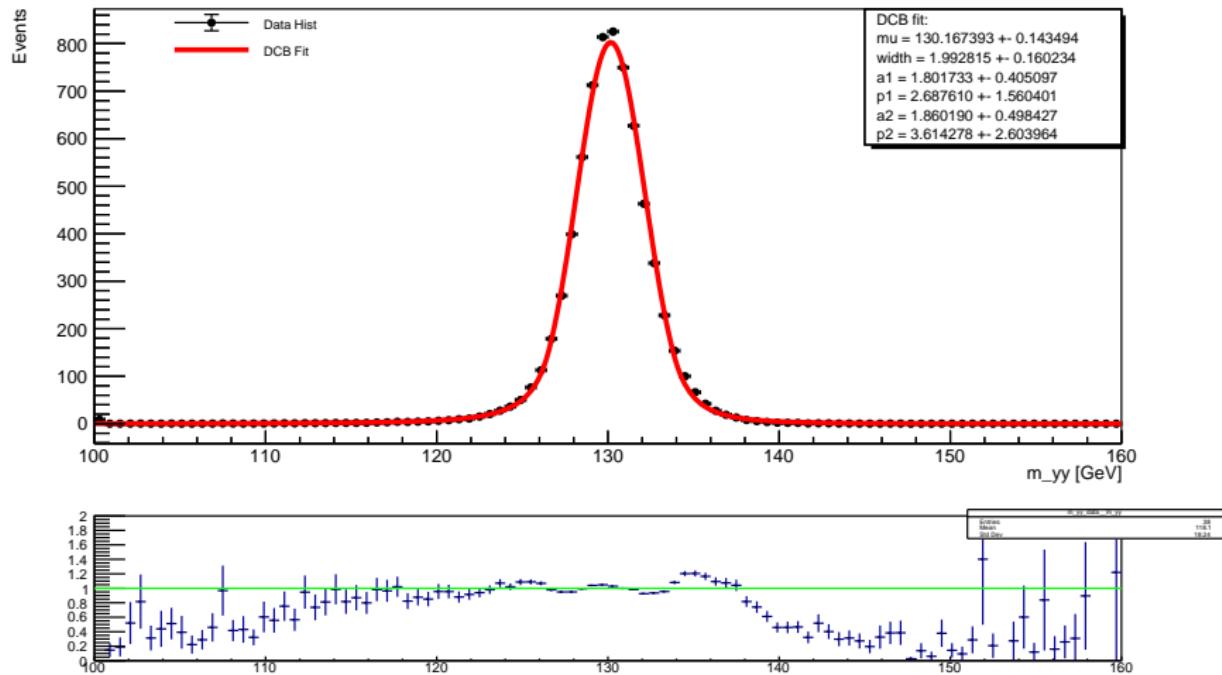
data/fit



# 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:

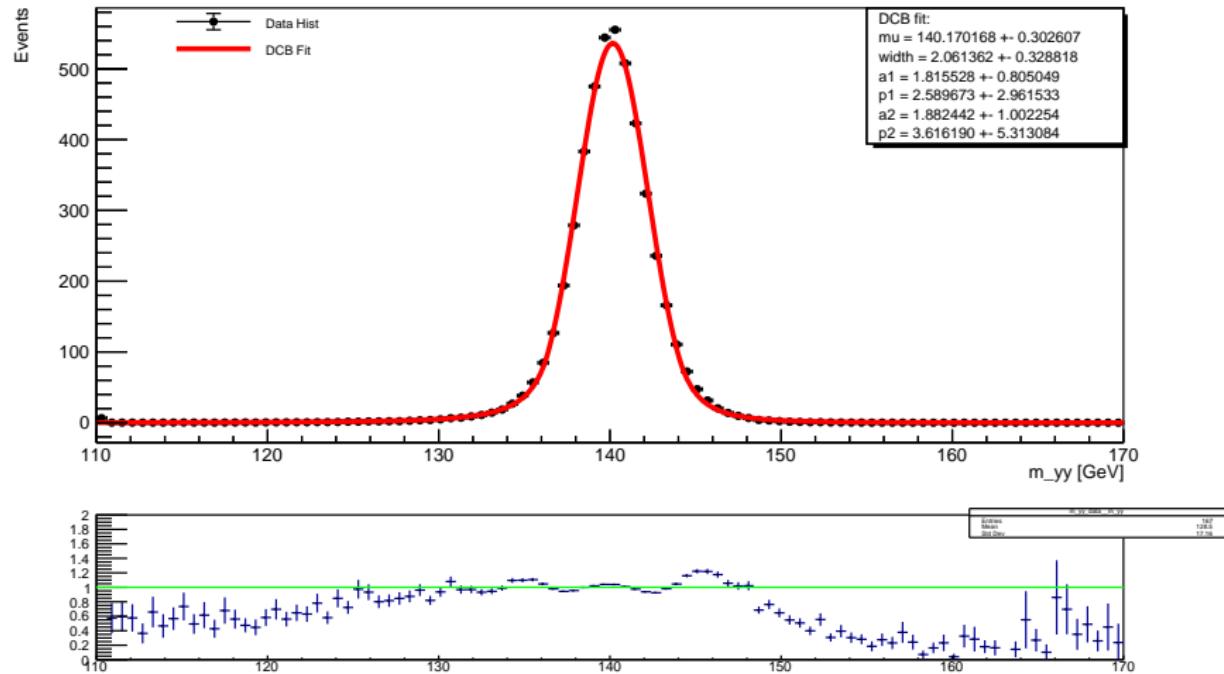
m\_yy distribution + DCB fit [130 GeV]



# DCB fit and ratio plot [140 GeV]

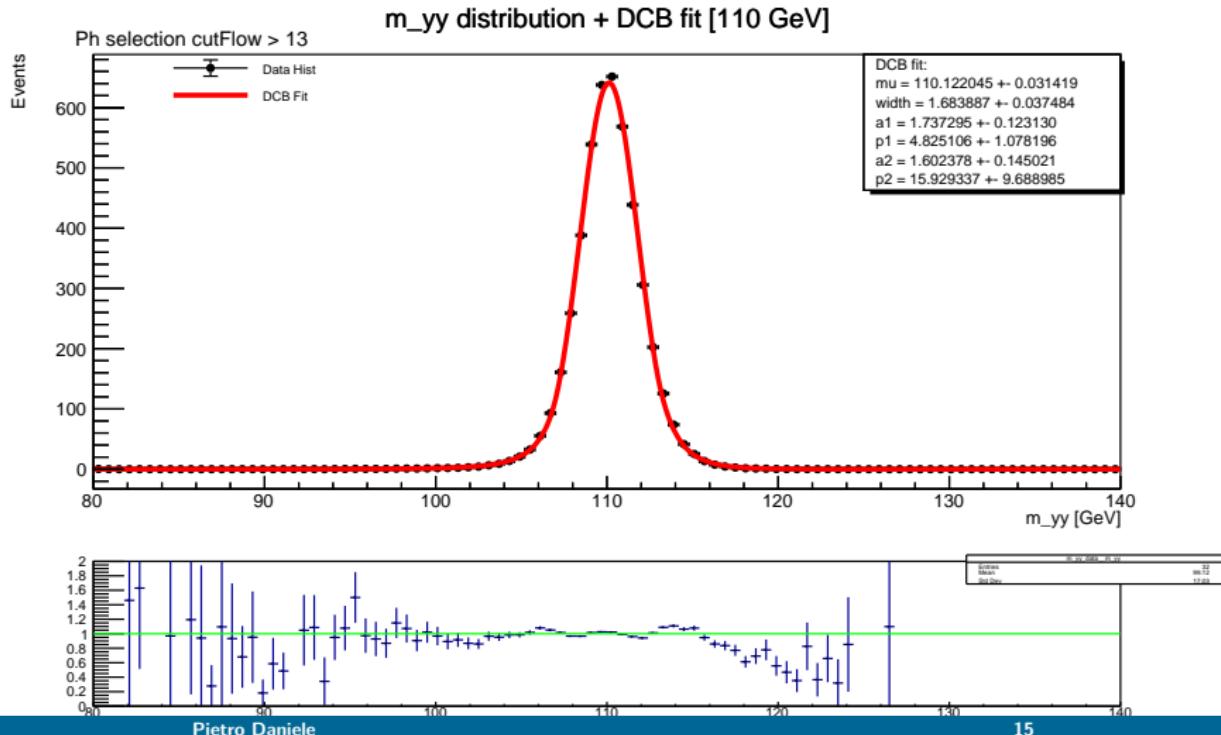
The ratio plot between the fit and the distribution is added to each DCB fit.  
Using the 140 GeV mass distribution:

m\_yy distribution + DCB fit [140 GeV]



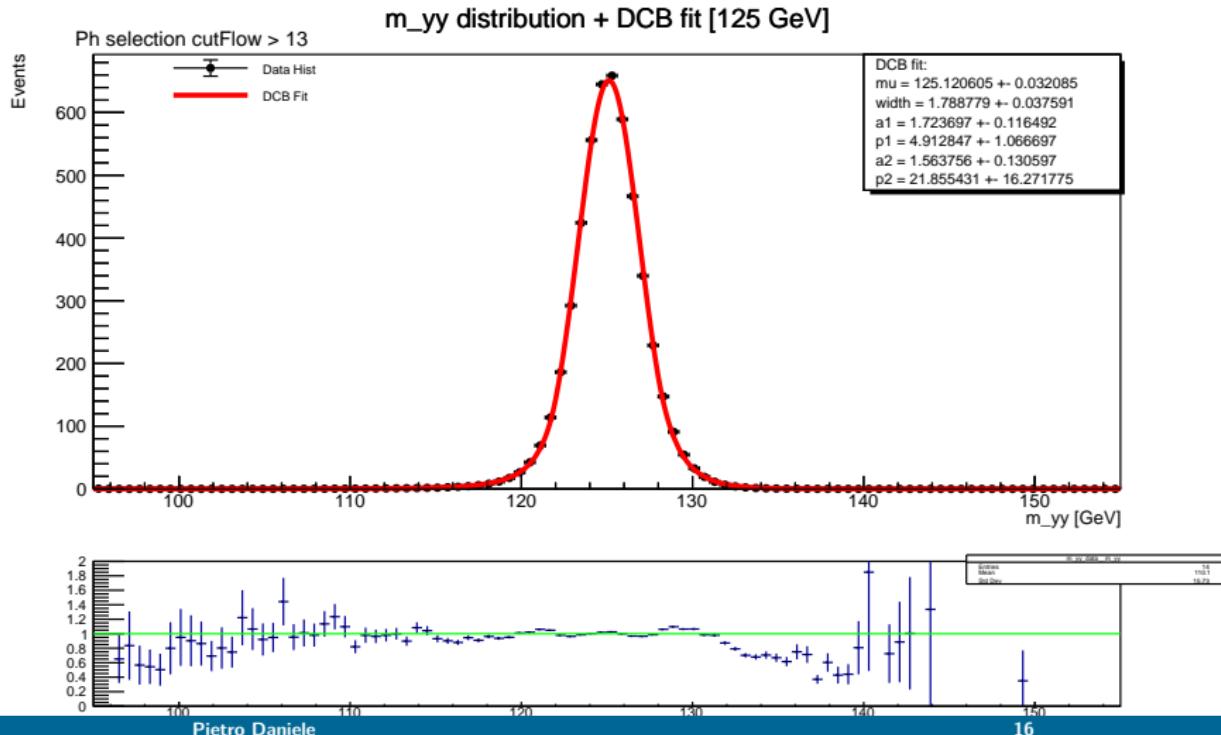
# DCB fit+ratioplot [110 GeV] (cutFlow > 13)

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



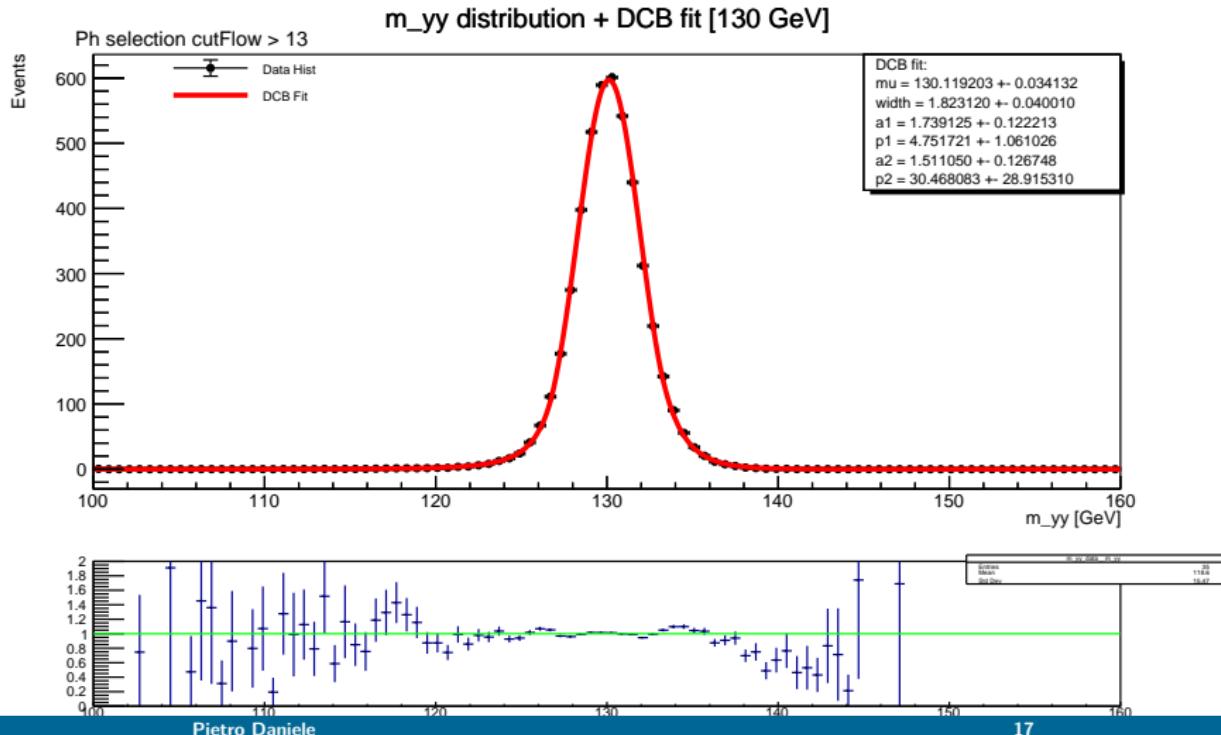
# DCB fit+ratioplot [125 GeV] (cutFlow > 13)

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



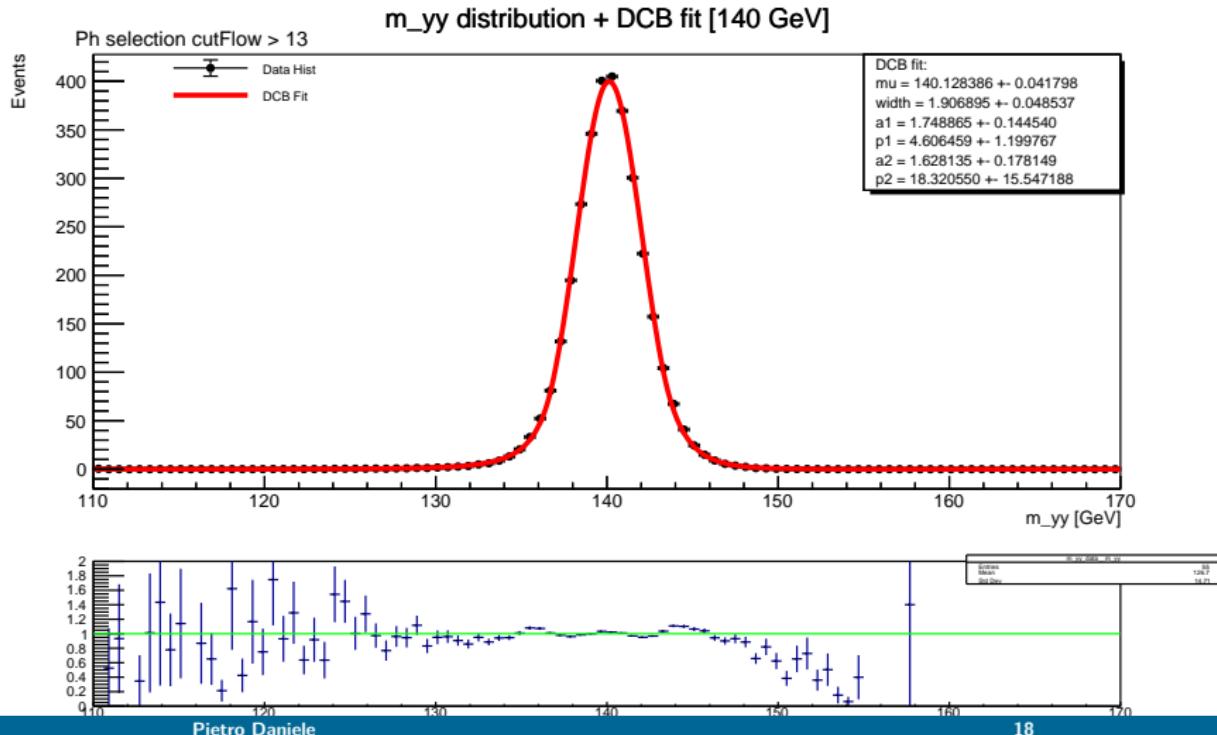
# DCB fit+ratioplot [130 GeV] (cutFlow > 13)

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  $\mu$  and  $\sigma$  are functions of  $m_h$ ;
- 3 all parameters are functions of  $m_h$ ;

# DSCB multifit

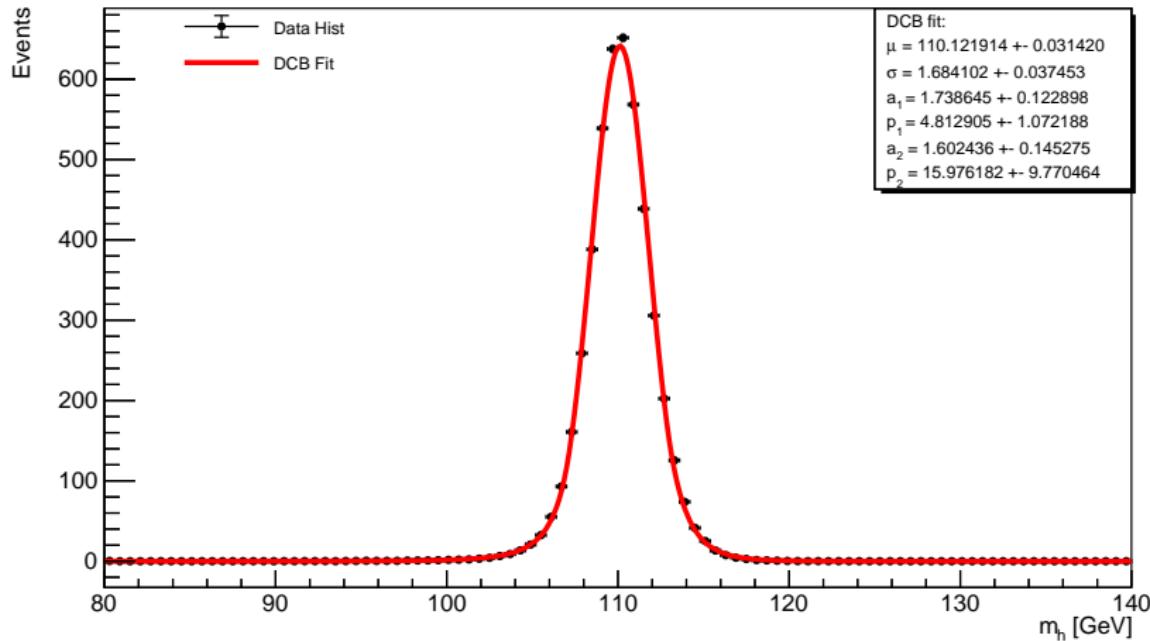
A DSCB multifit consists of a series of consecutive fits:

- 1 fit on  $\mu$  and  $\sigma$ , tails params fixed;
- 2 fit on tails params,  $\mu$  and  $\sigma$  fixed;
- 3 fit on all parameters;

# DSCB multifit [110 GeV]

$m_{yy}$  distribution + DCB fit [110 GeV] multifit

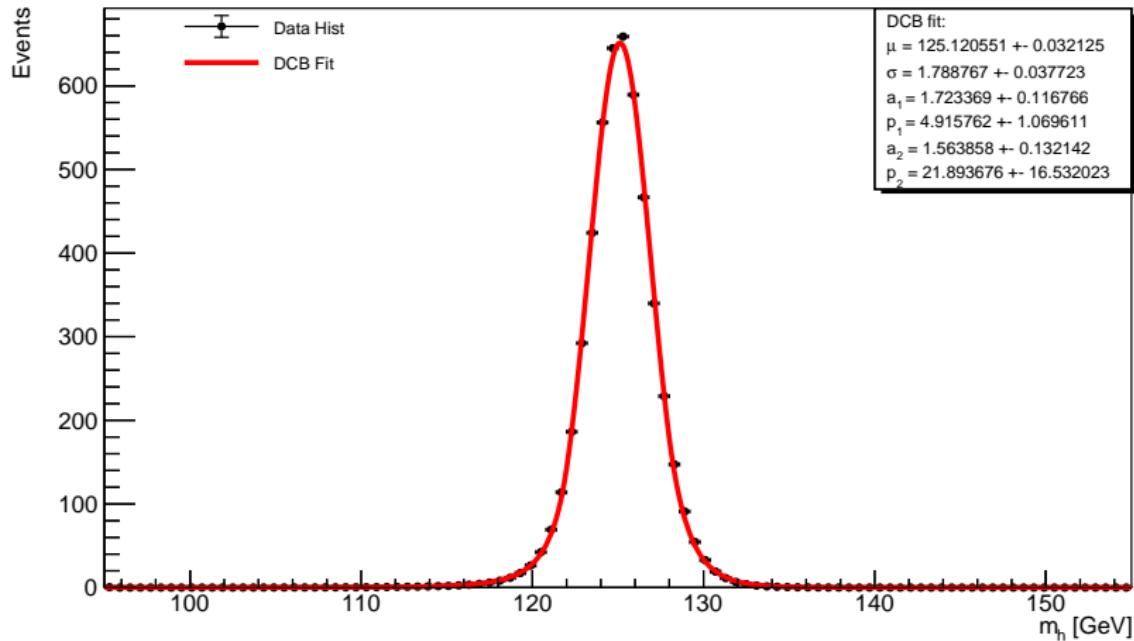
Ph selection cutFlow > 13



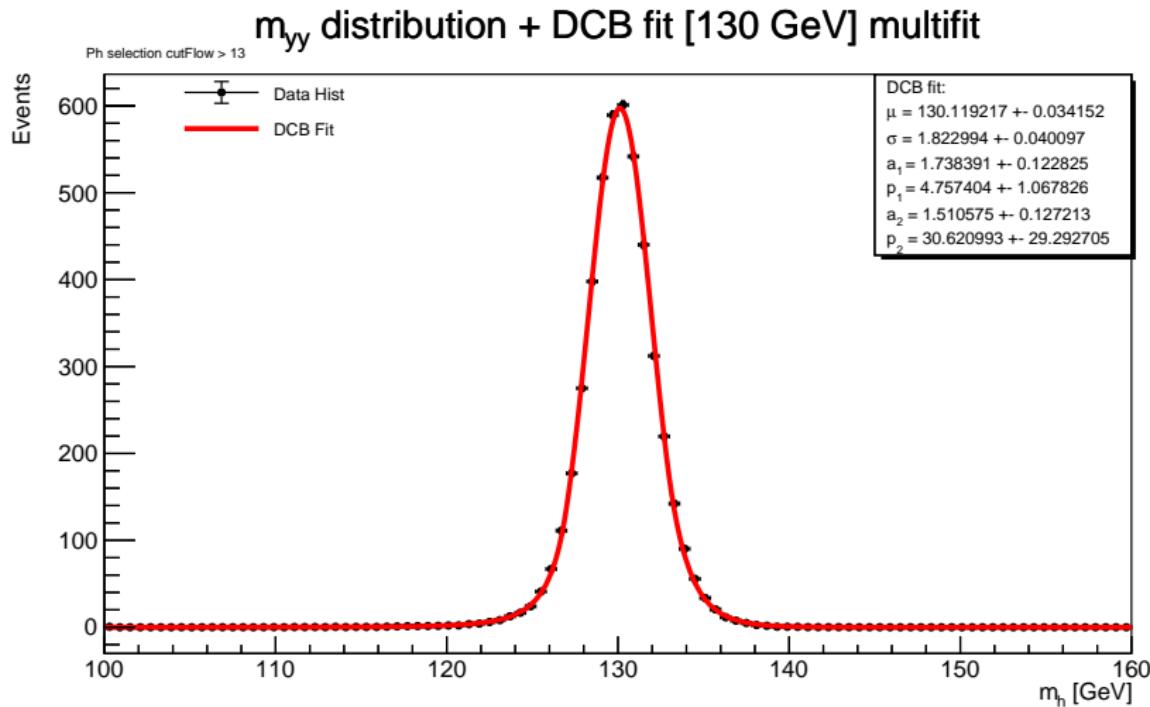
# DSCB multifit [125 GeV]

$m_{yy}$  distribution + DCB fit [125 GeV] multifit

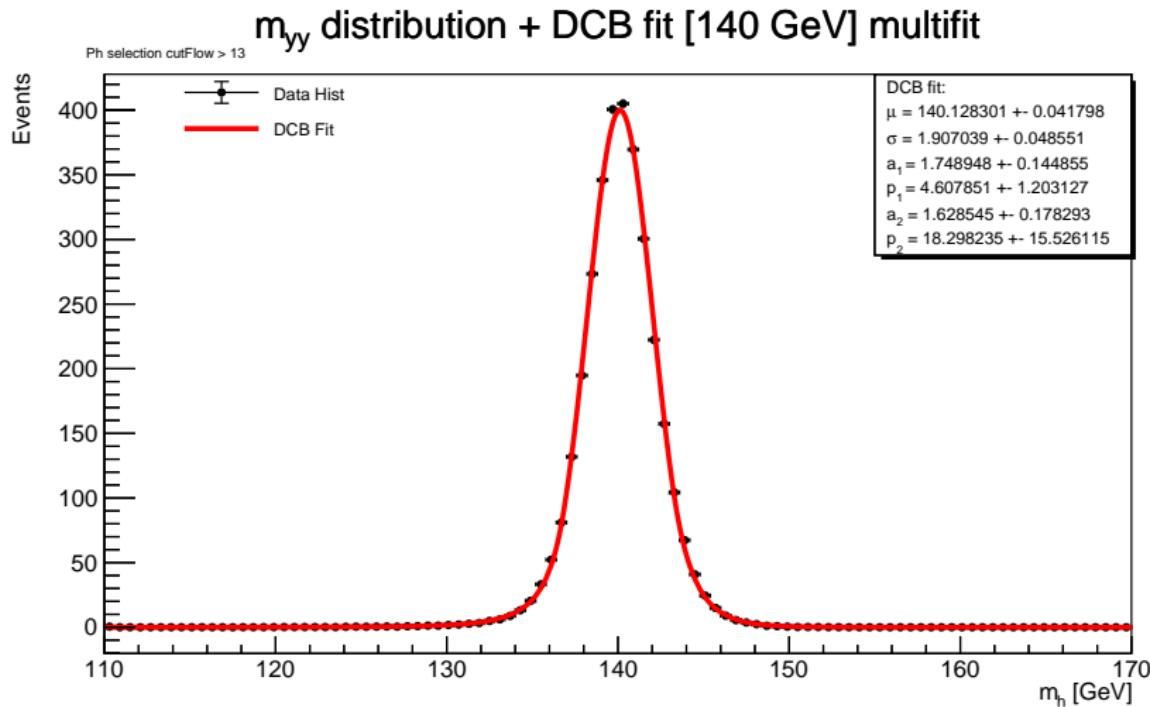
Ph selection cutFlow > 13



# DSCB multifit [130 GeV]



# DSCB multifit [140 GeV]

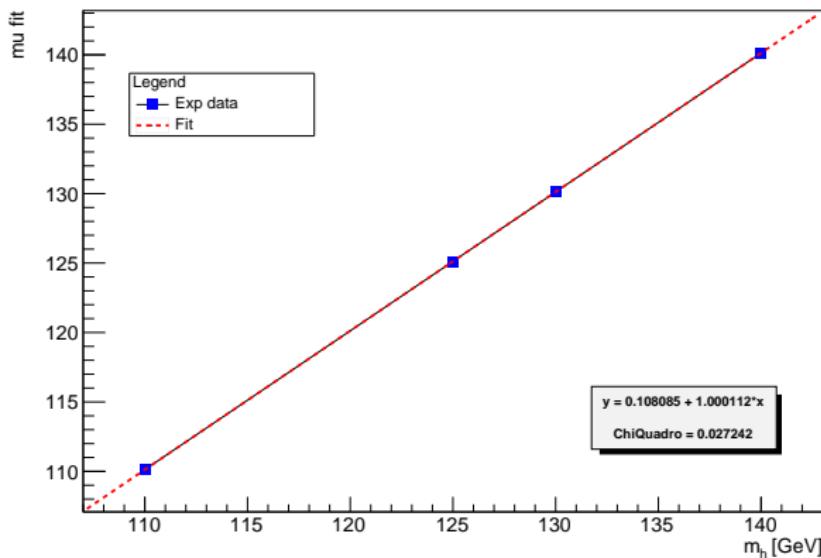


$$\mu(m_h)$$

Fitting the  $\mu$  values at different  $m_h$  with a linear fit:

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

mu distribution with a linear fit

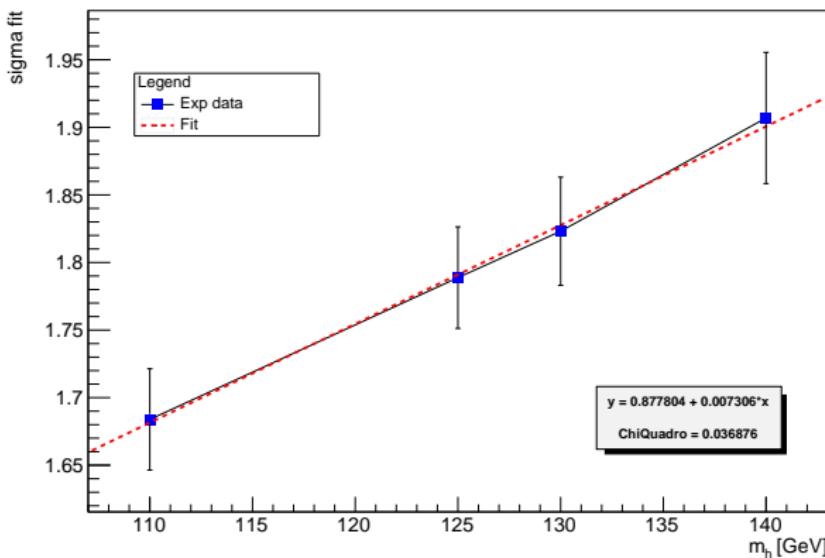


$$\sigma(m_h)$$

Fitting the  $\sigma$  values at different  $m_h$  with a linear fit:

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

sigma distribution with a linear fit

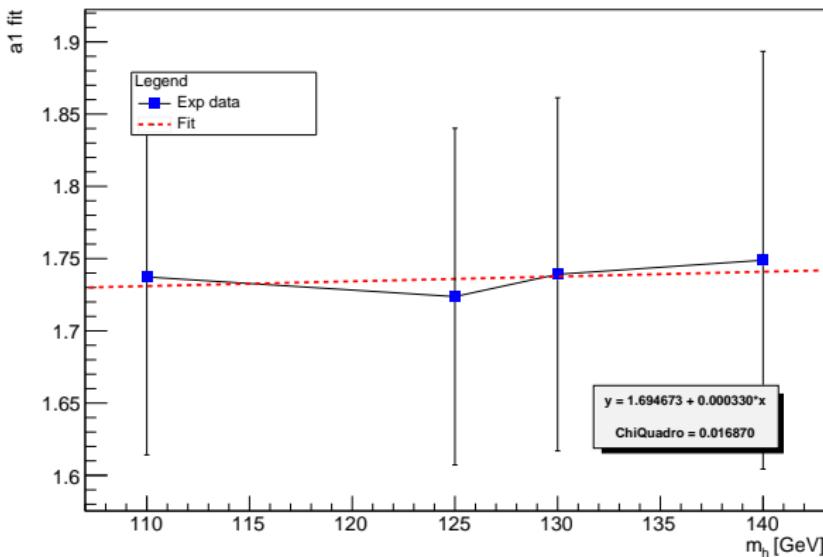


# $a_1(m_h)$

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

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

a1 distribution with a linear fit

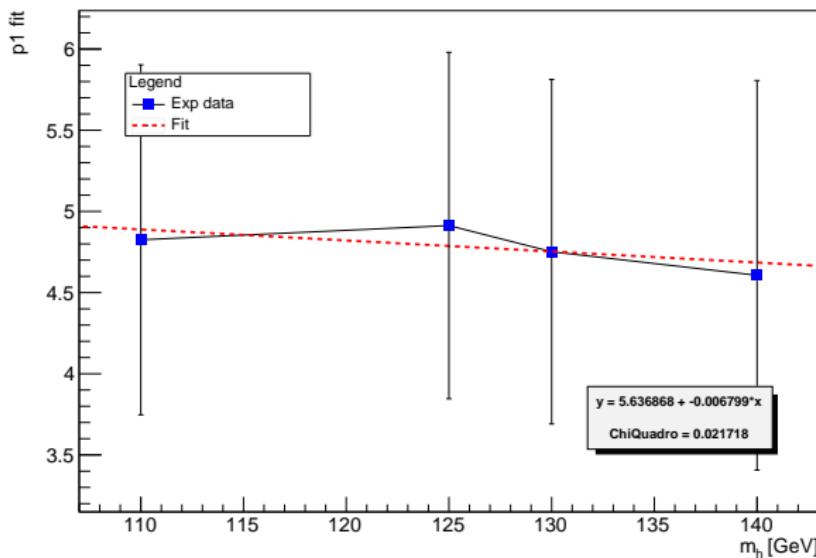


$$p_1(m_h)$$

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

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

p1 distribution with a linear fit

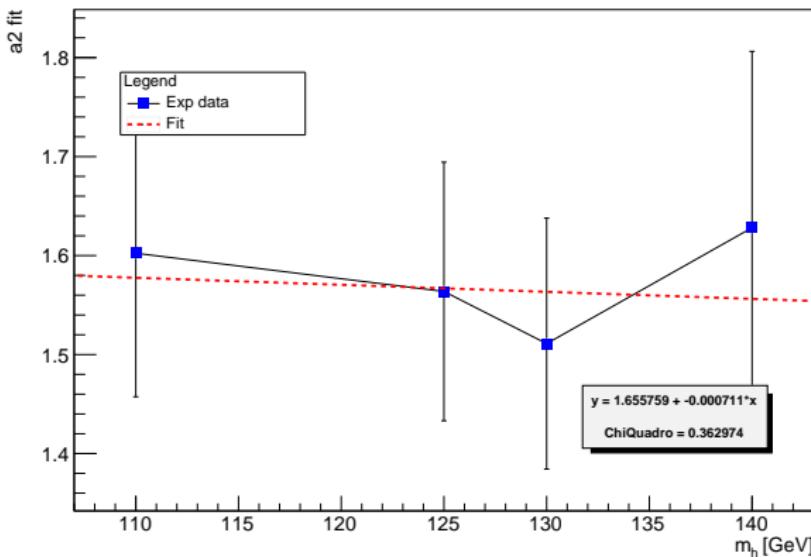


# $a_2(m_h)$

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

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

a2 distribution with a linear fit

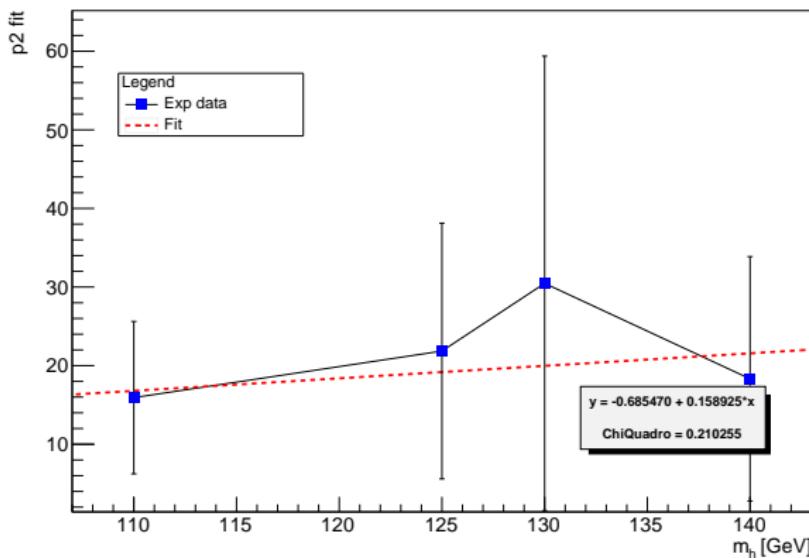


$$p_2(m_h)$$

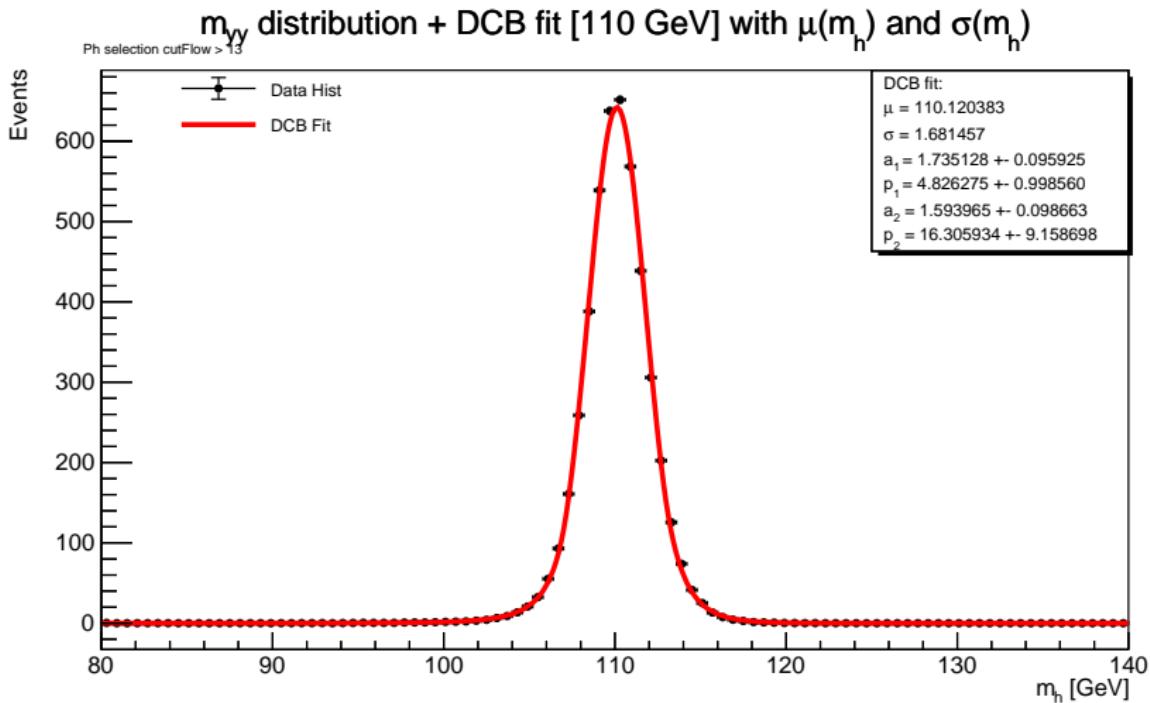
Fitting the  $p_2$  values at different  $m_h$  with a linear fit:

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

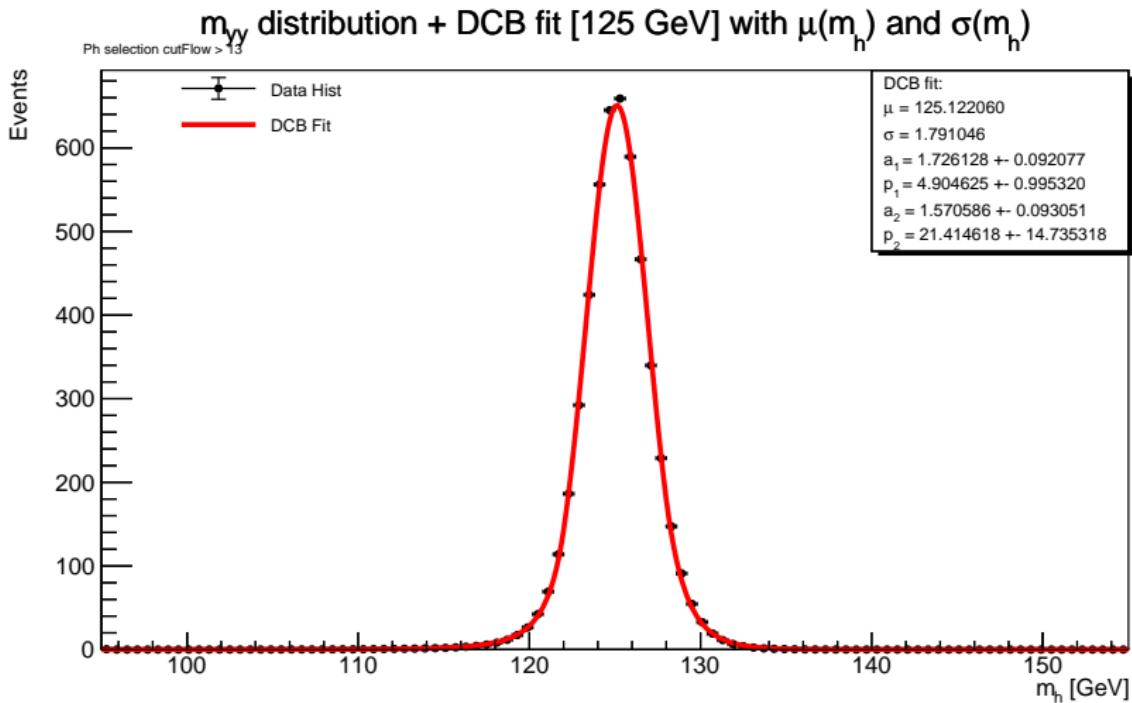
p2 distribution with a linear fit



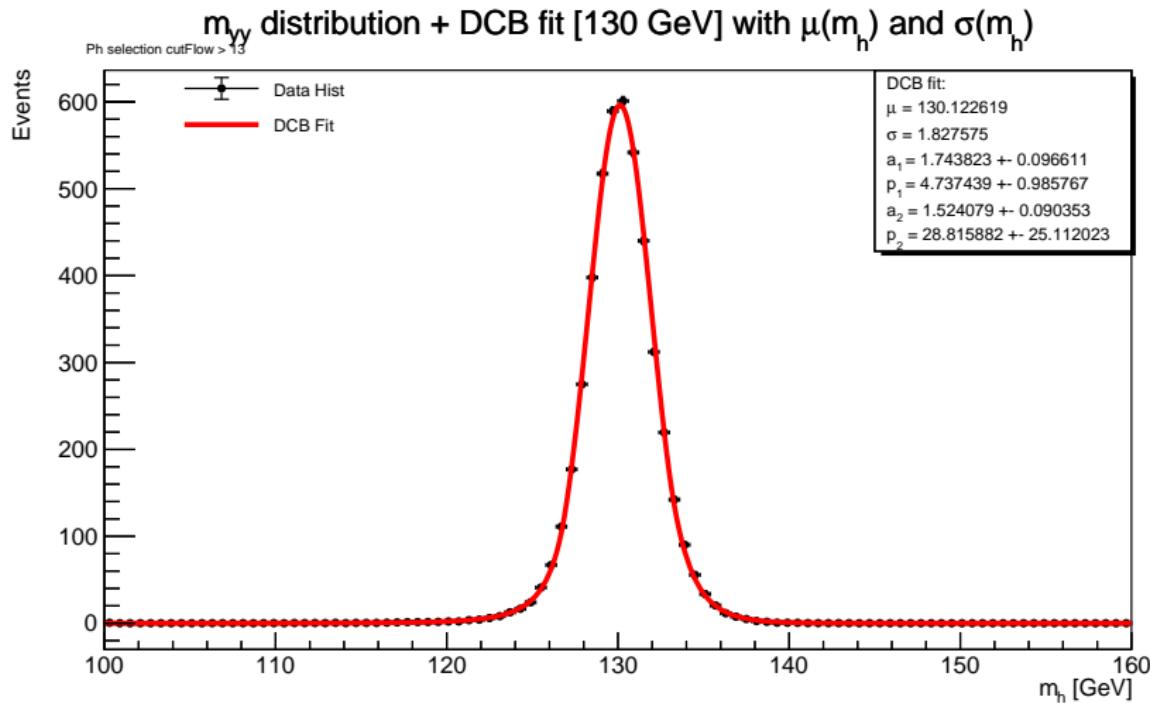
# DSCB( $m_h$ ) with $\mu(m_h)$ and $\sigma(m_h)$ [110 GeV]



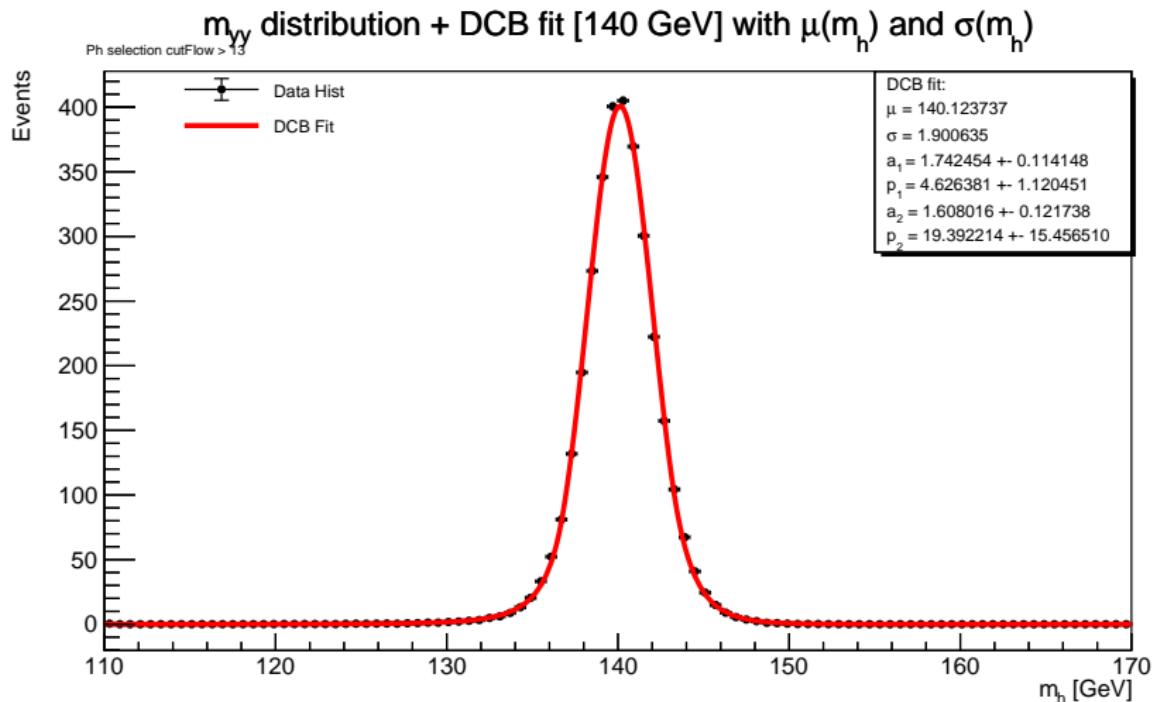
# DSCB( $m_h$ ) with $\mu(m_h)$ and $\sigma(m_h)$ [125 GeV]



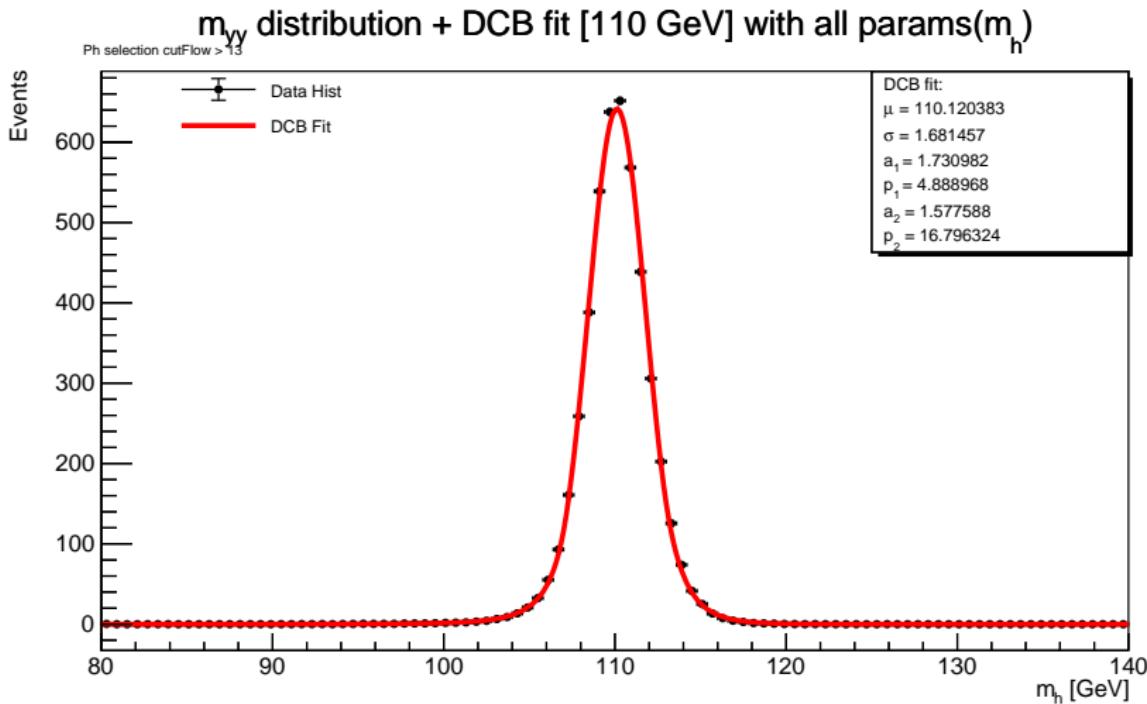
# DSCB( $m_h$ ) with $\mu(m_h)$ and $\sigma(m_h)$ [130 GeV]



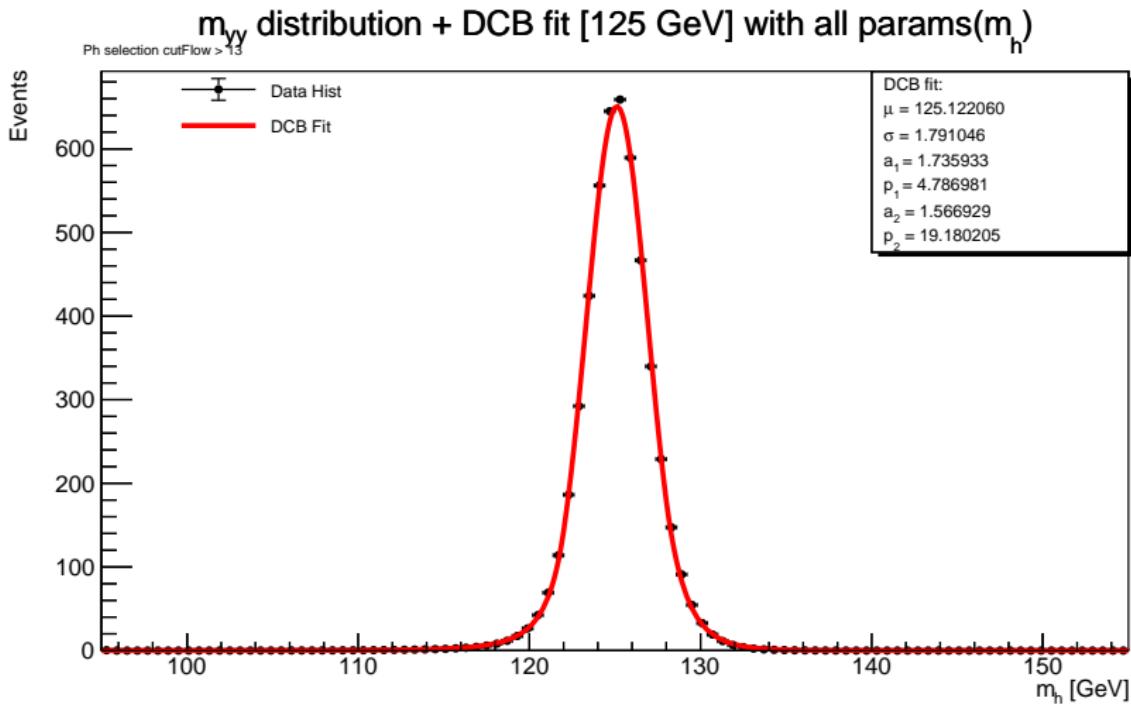
# DSCB( $m_h$ ) with $\mu(m_h)$ and $\sigma(m_h)$ [140 GeV]



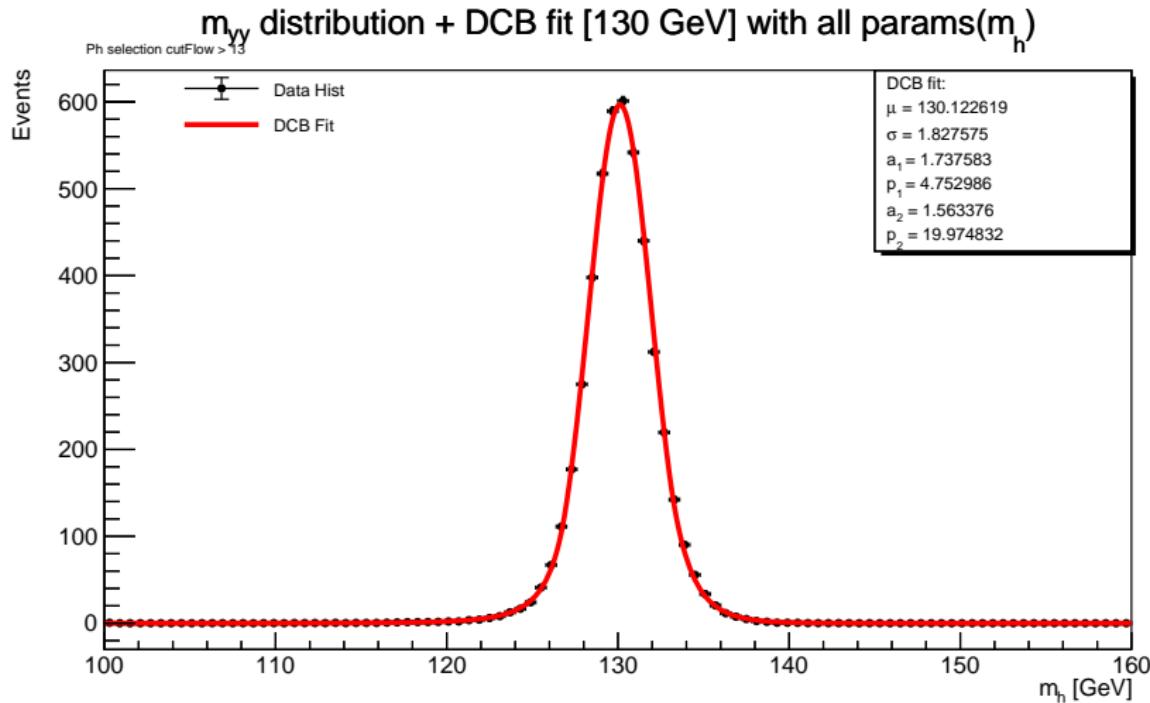
# DSCB( $m_h$ ) with all params( $m_h$ ) [110 GeV]



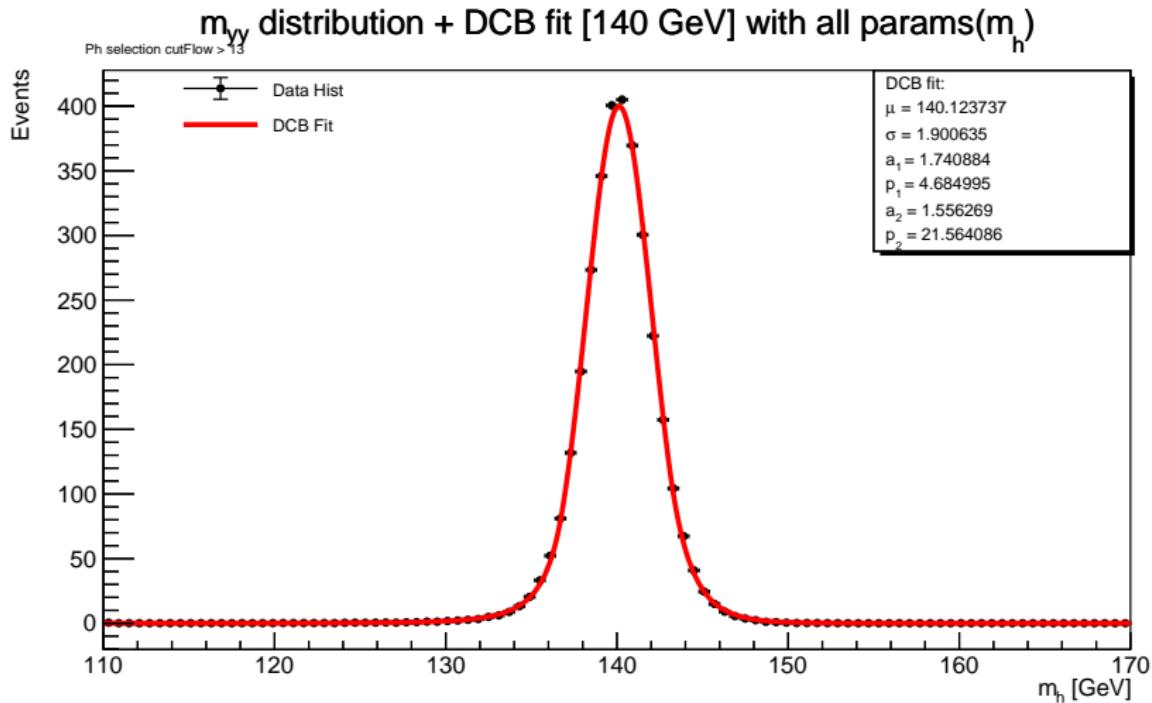
# DSCB( $m_h$ ) with all params( $m_h$ ) [125 GeV]



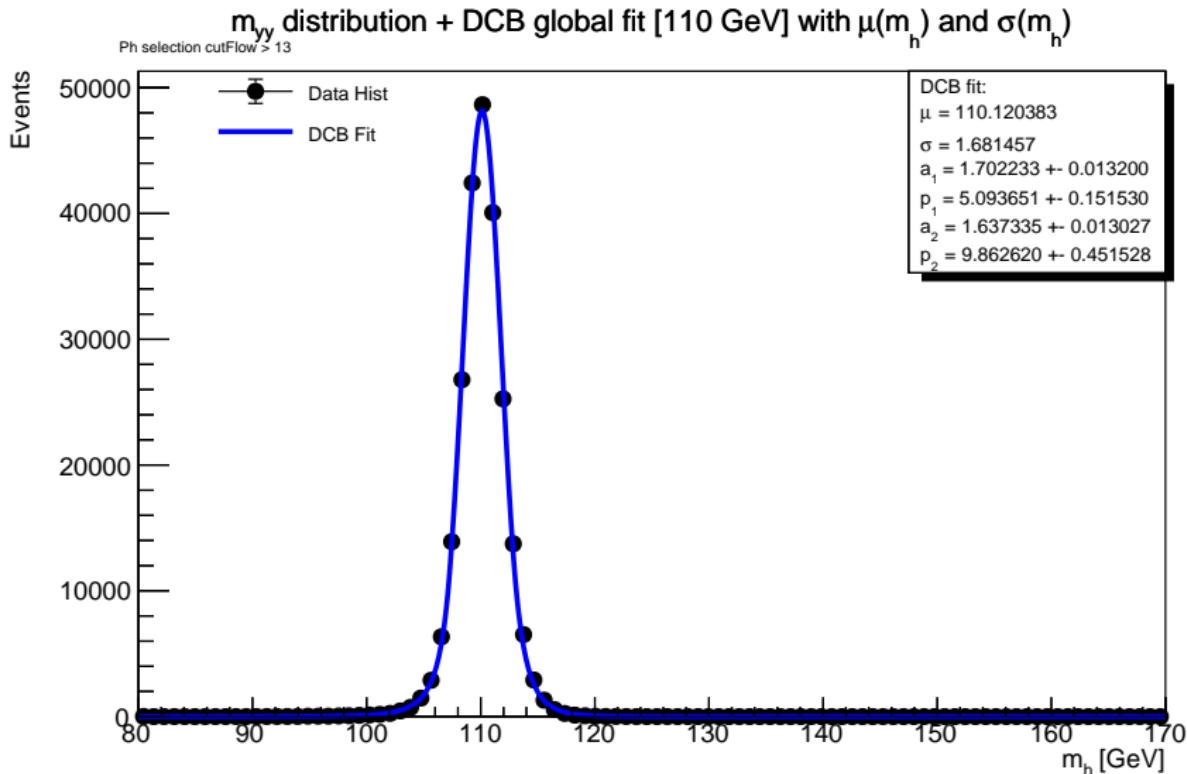
# DSCB( $m_h$ ) with all params( $m_h$ ) [130 GeV]



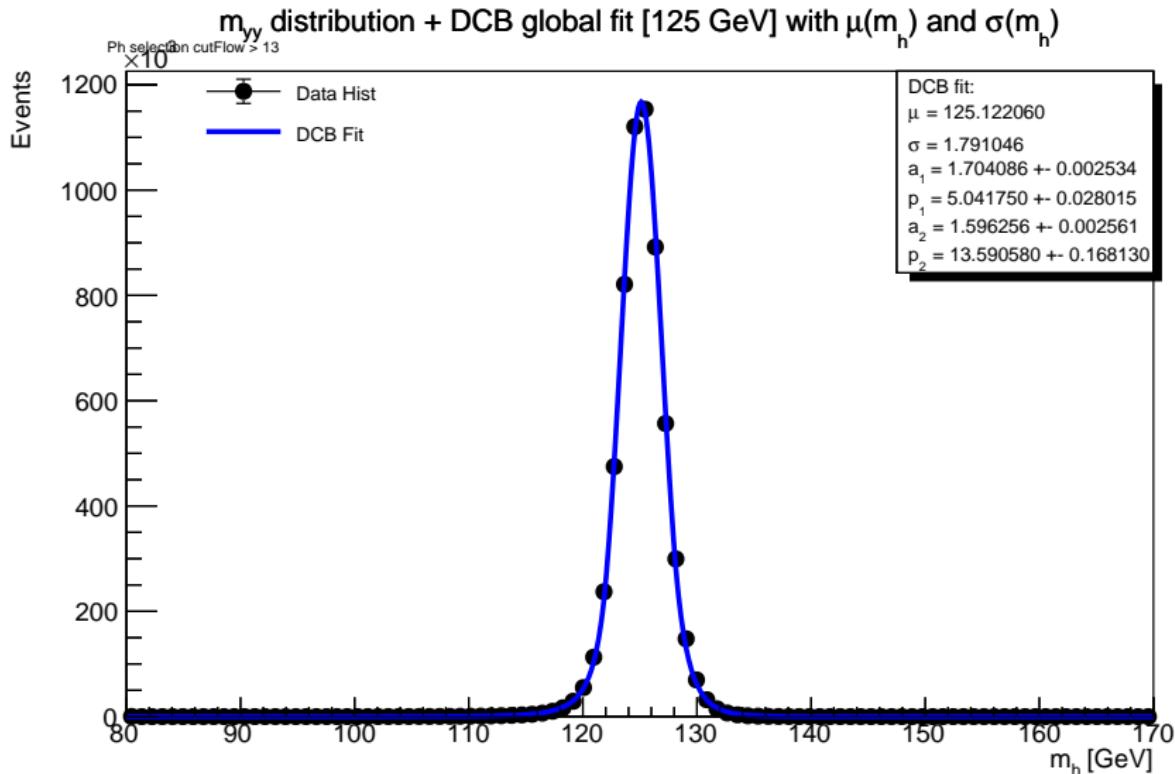
# DSCB( $m_h$ ) with all params( $m_h$ ) [140 GeV]



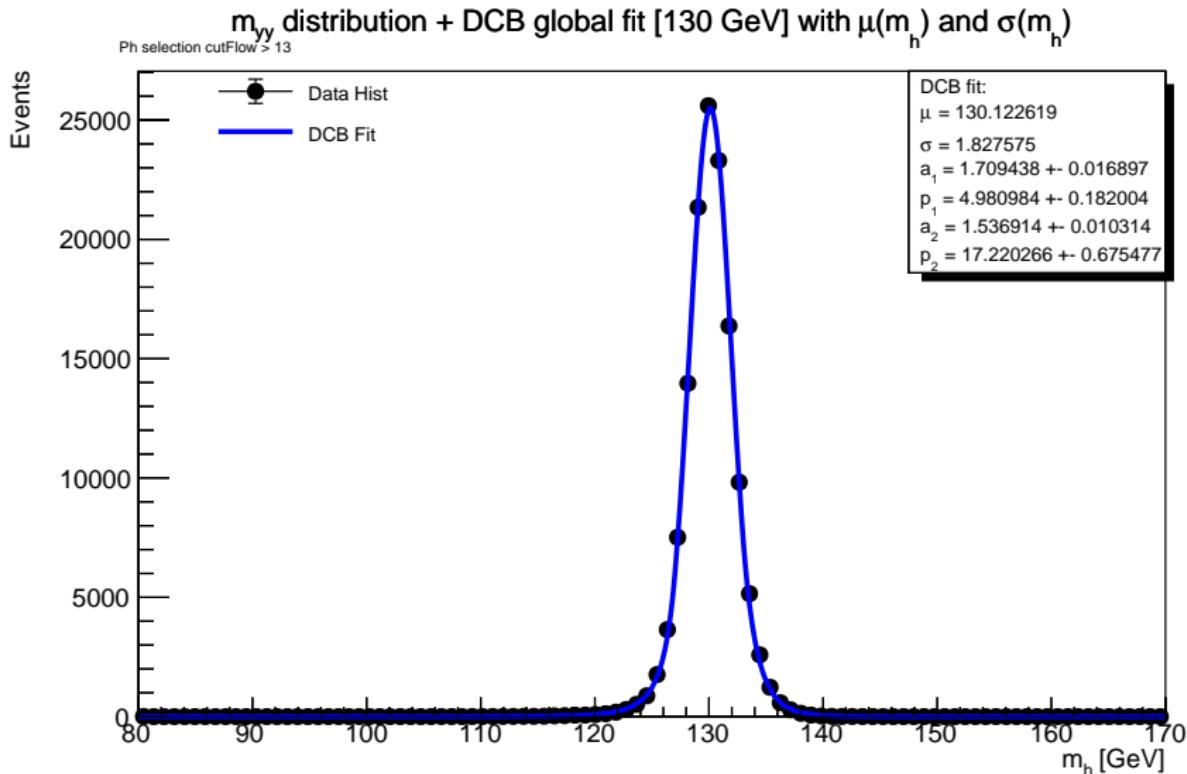
# Global fit [110 GeV]



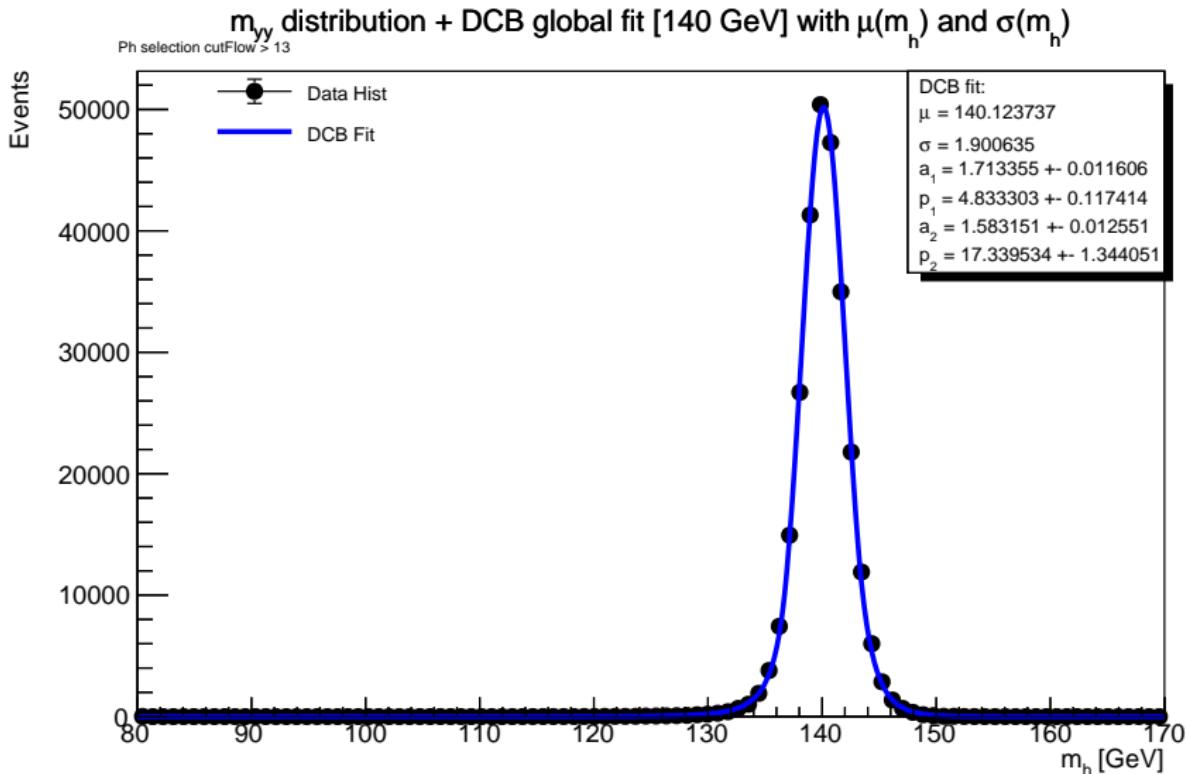
# Global fit [125 GeV]



# Global fit [130 GeV]

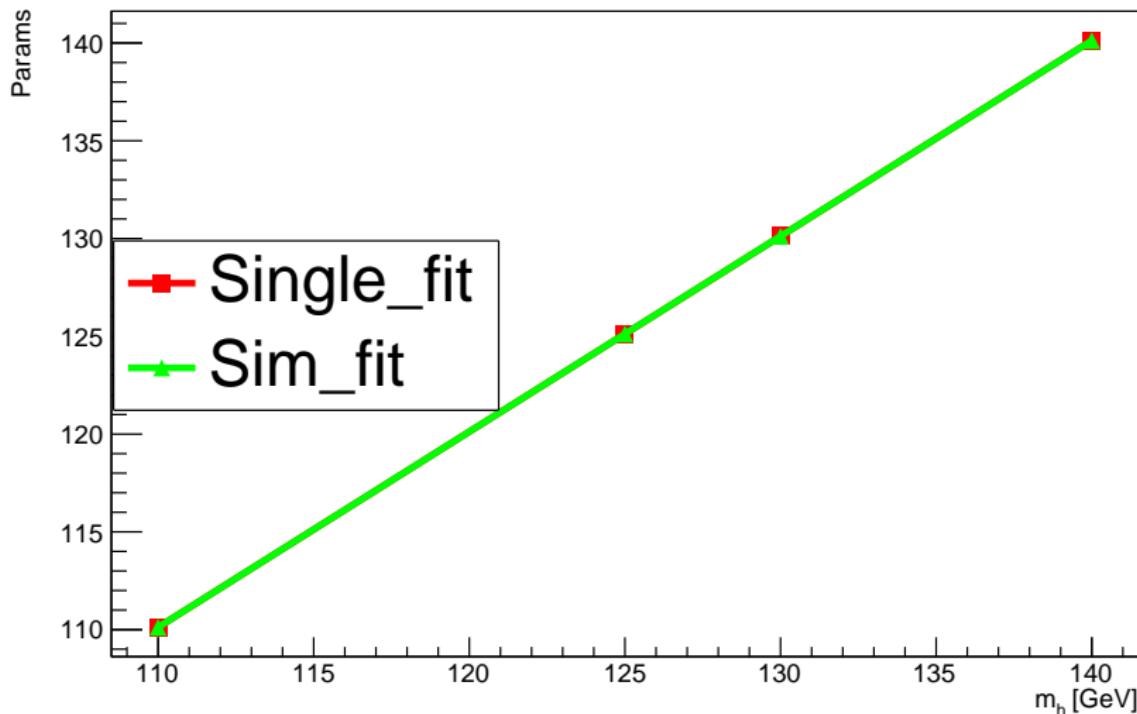


# Global fit [140 GeV]



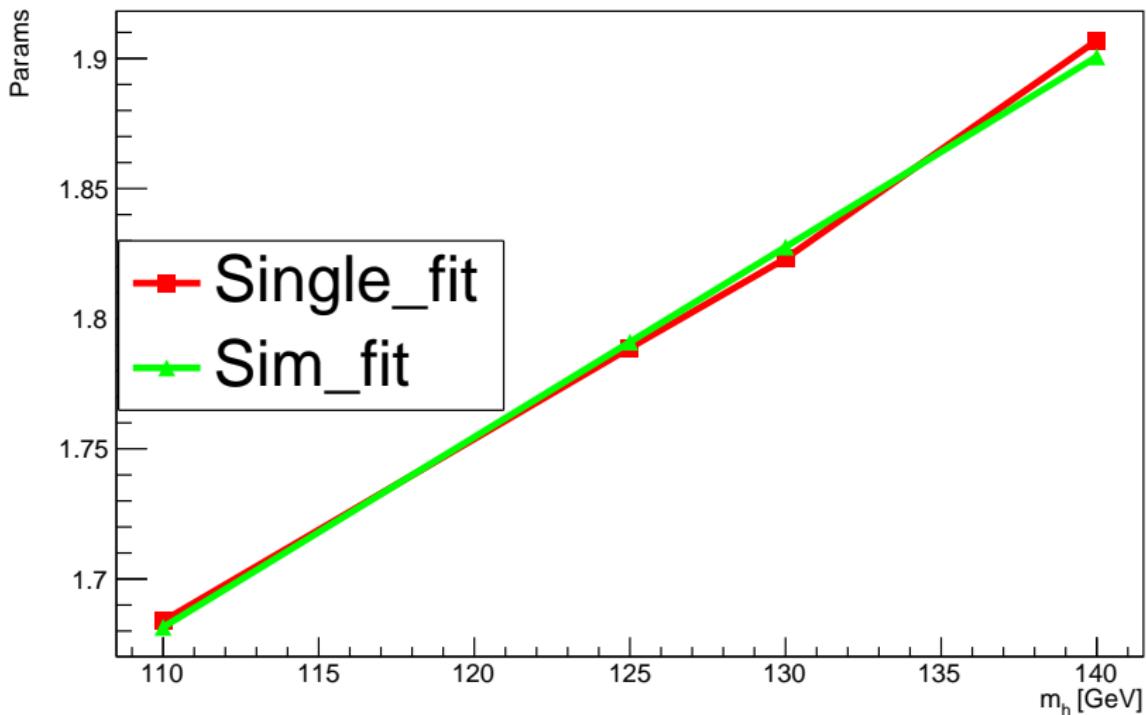
# Single vs Global fit params: $\mu$

Single and global fit comp: mu



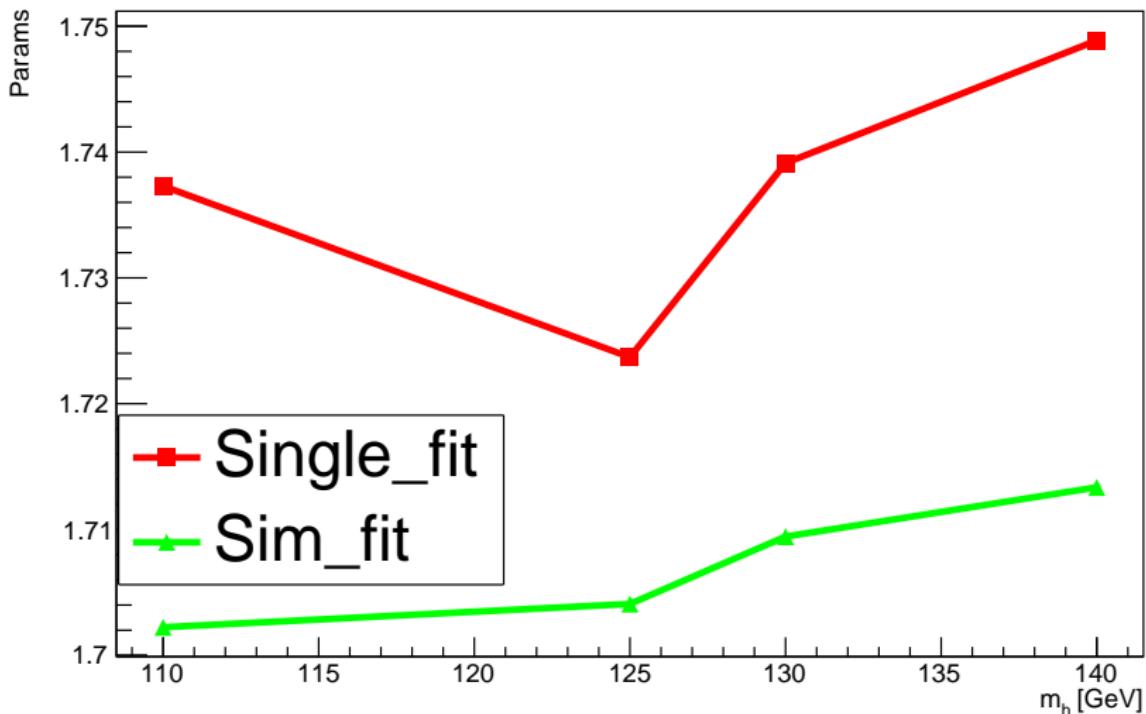
# Single vs Global fit params: $\sigma$

Single and global fit comp: width



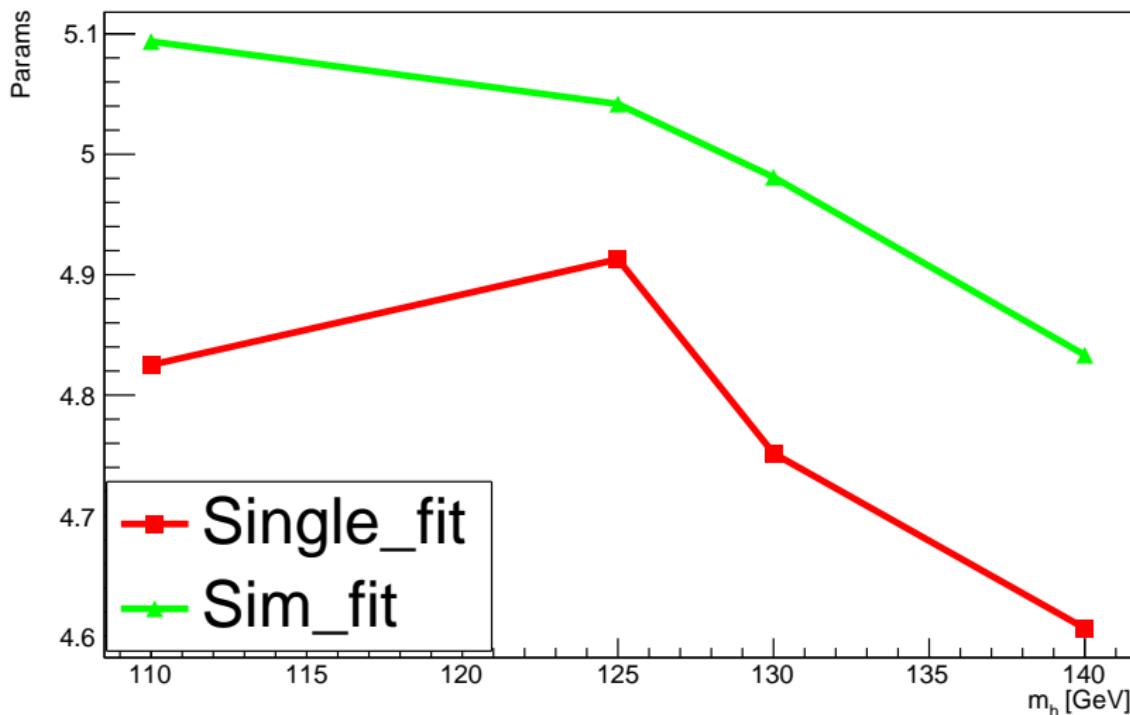
# Single vs Global fit params: $a_1$

Single and global fit comp: a1



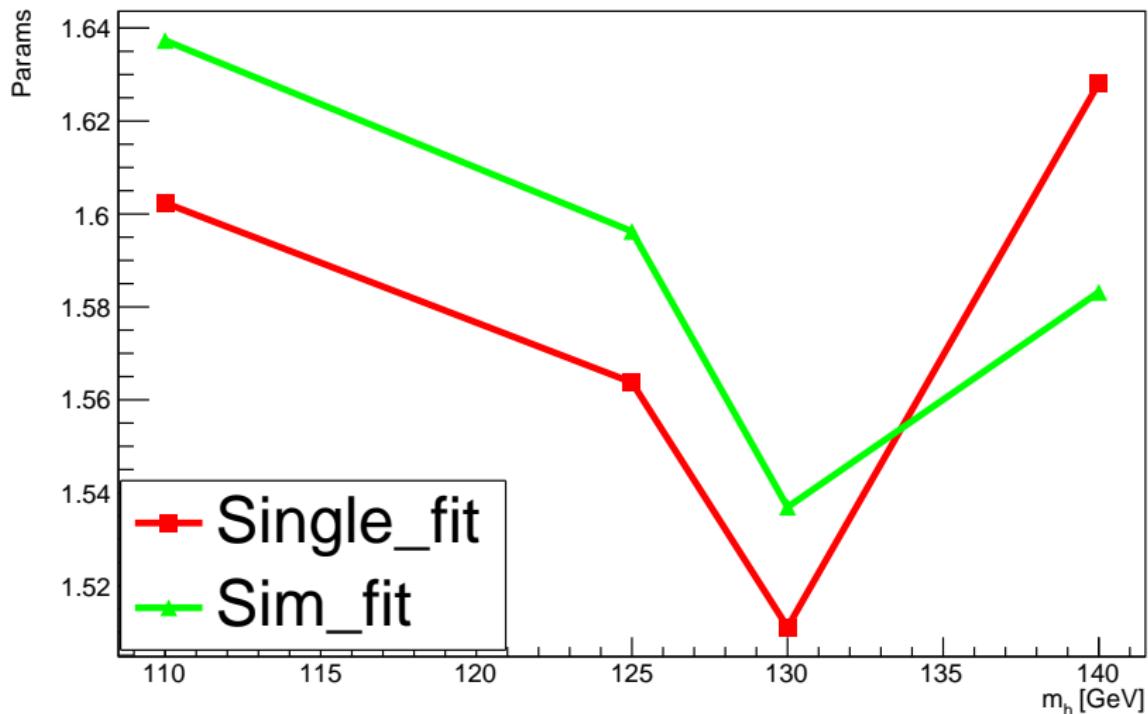
# Single vs Global fit params: $p_1$

Single and global fit comp: p1



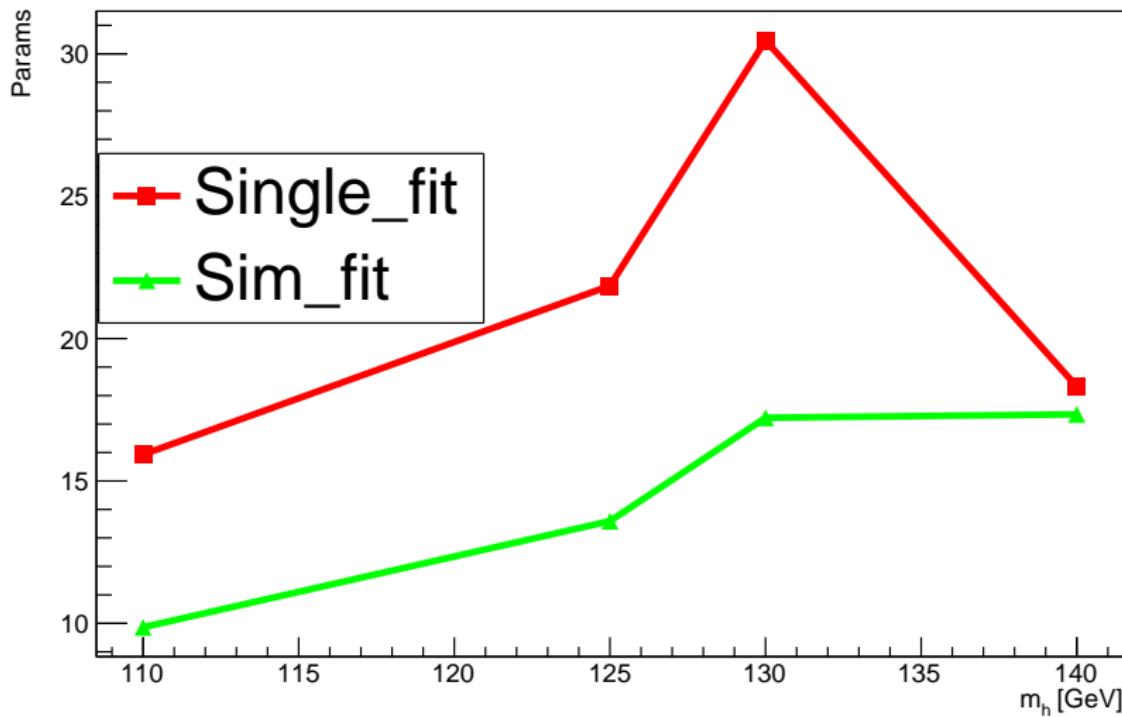
# Single vs Global fit params: $a_2$

Single and global fit comp: a2



# Single vs Global fit params: $p_2$

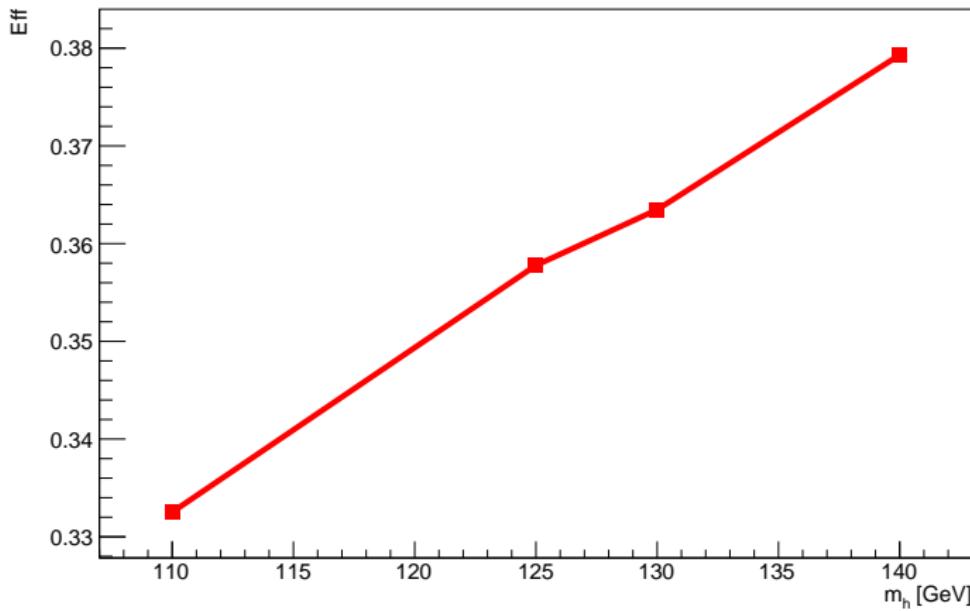
Single and global fit comp: p2



# Efficiencies( $m_h$ )

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

Efficiencies( $m_h$ )

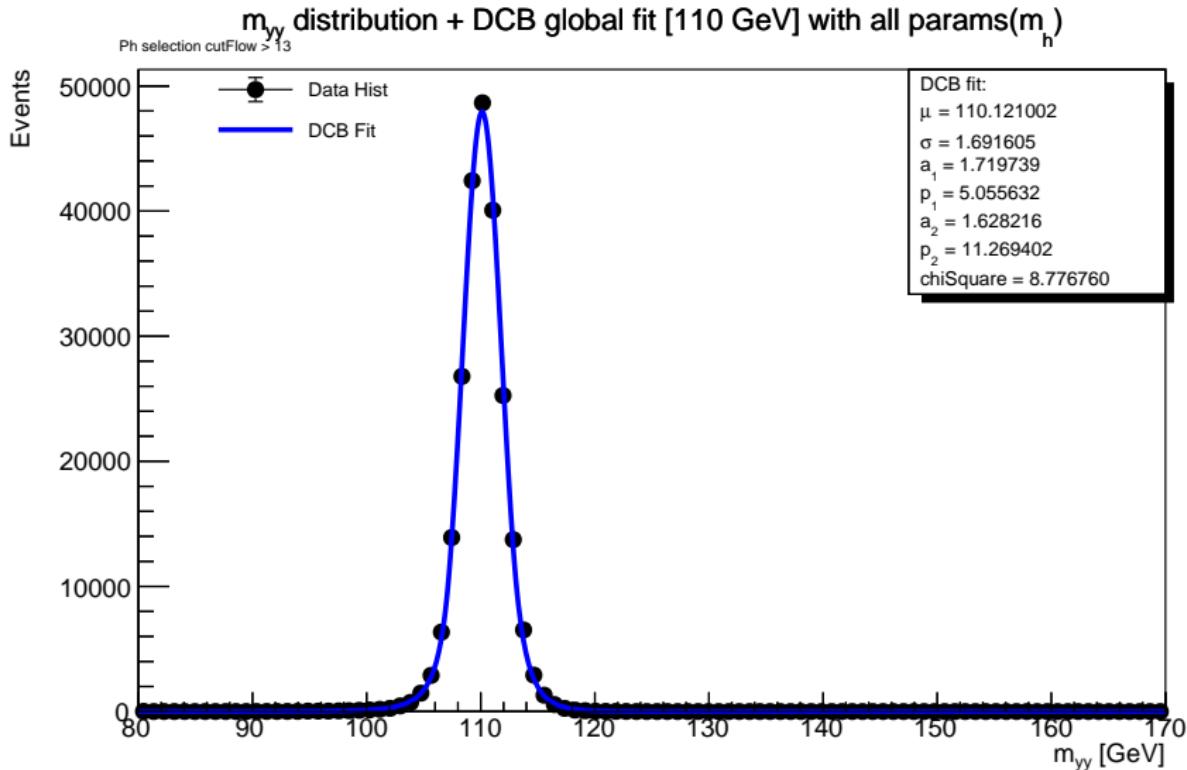


3° week

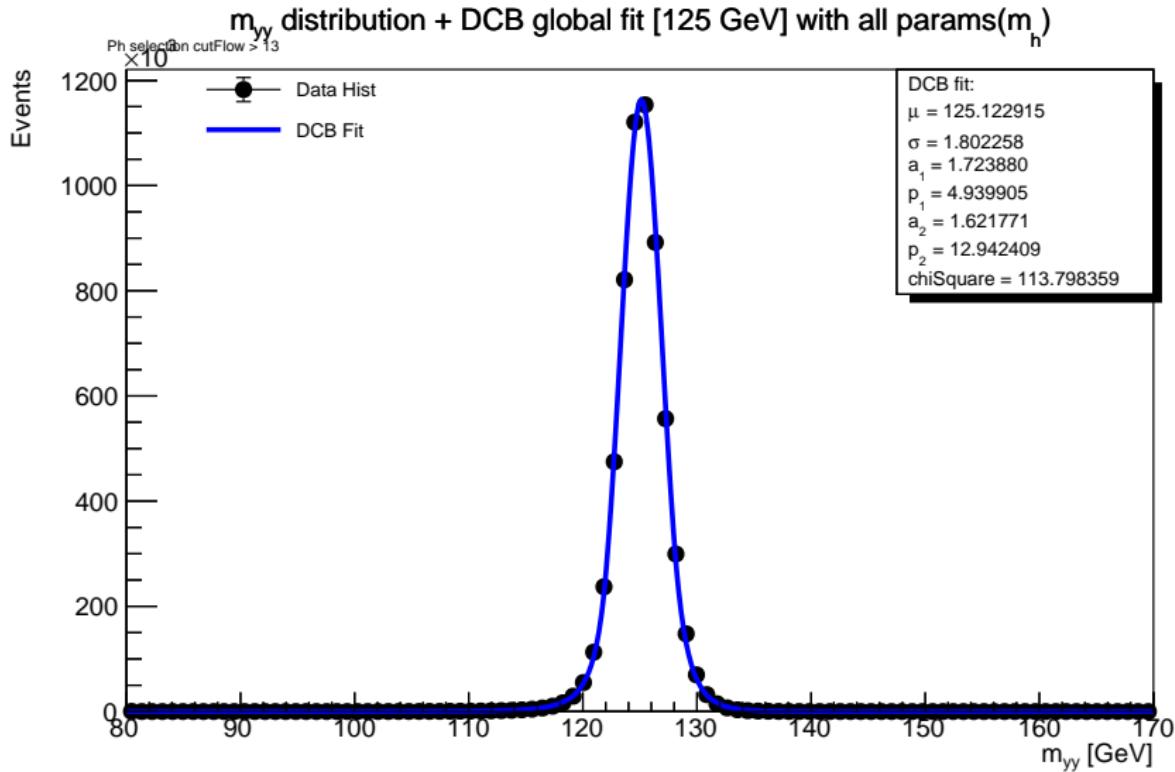
# 3° week assignments

- 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;

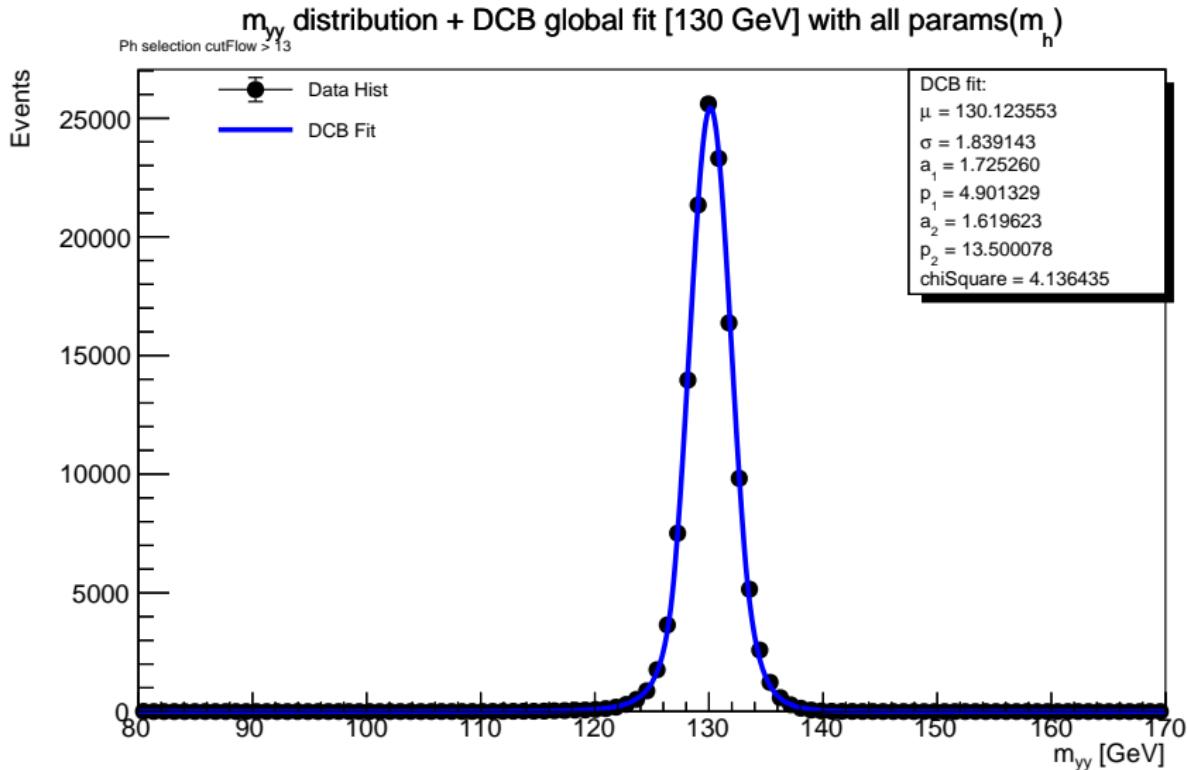
# Global fit all params( $m_H$ ) [110 GeV]



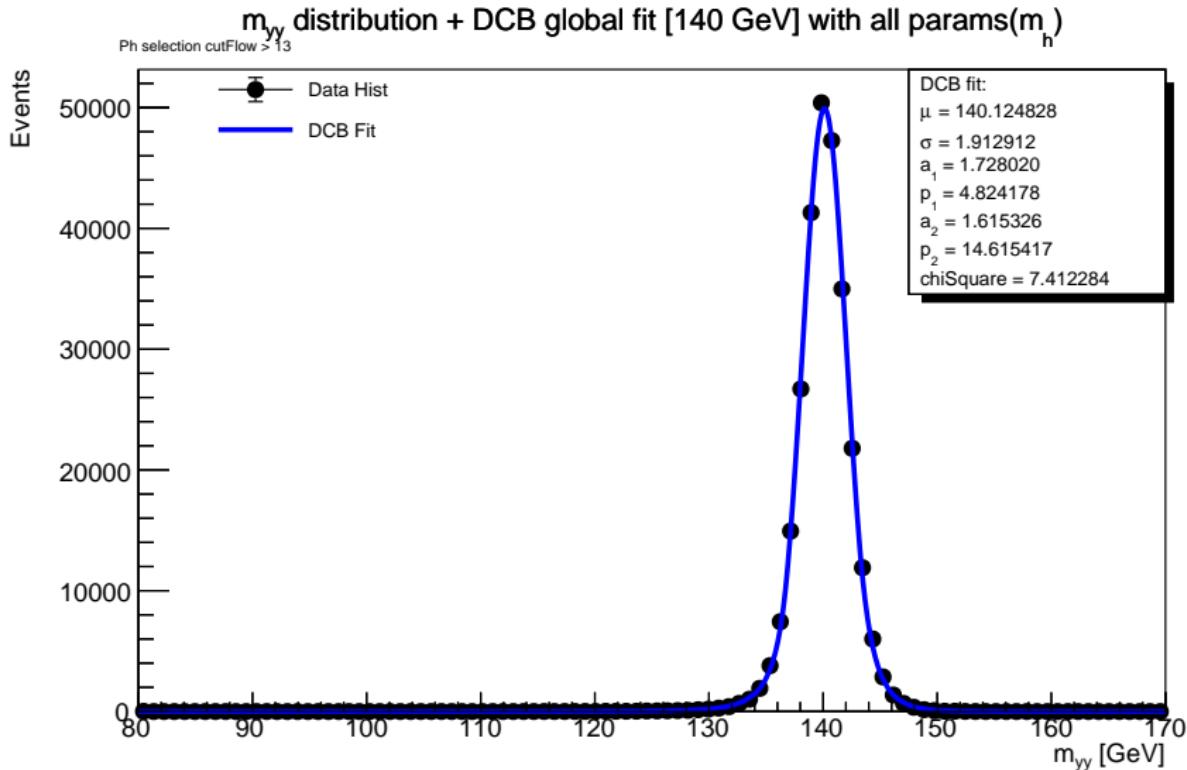
# Global fit all params( $m_H$ ) [125 GeV]



# Global fit all params( $m_H$ ) [130 GeV]

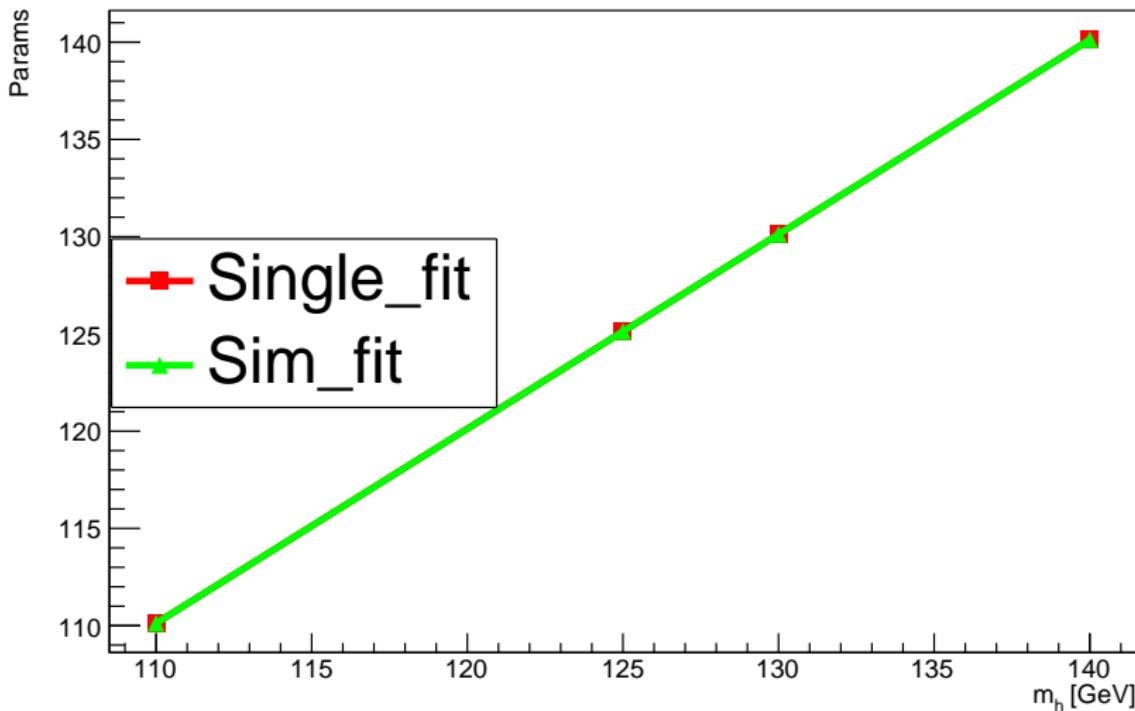


# Global fit all params( $m_H$ ) [140 GeV]



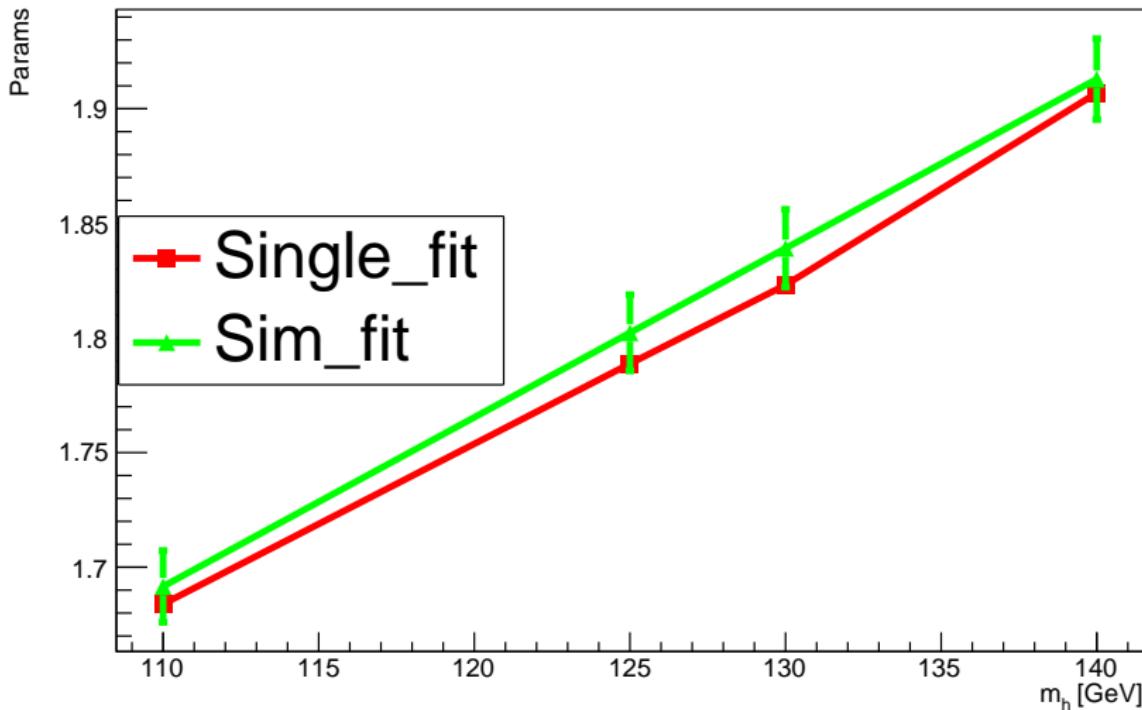
# Single vs Global fit params: $\mu(m_h)$

Single and global fit comp: mu



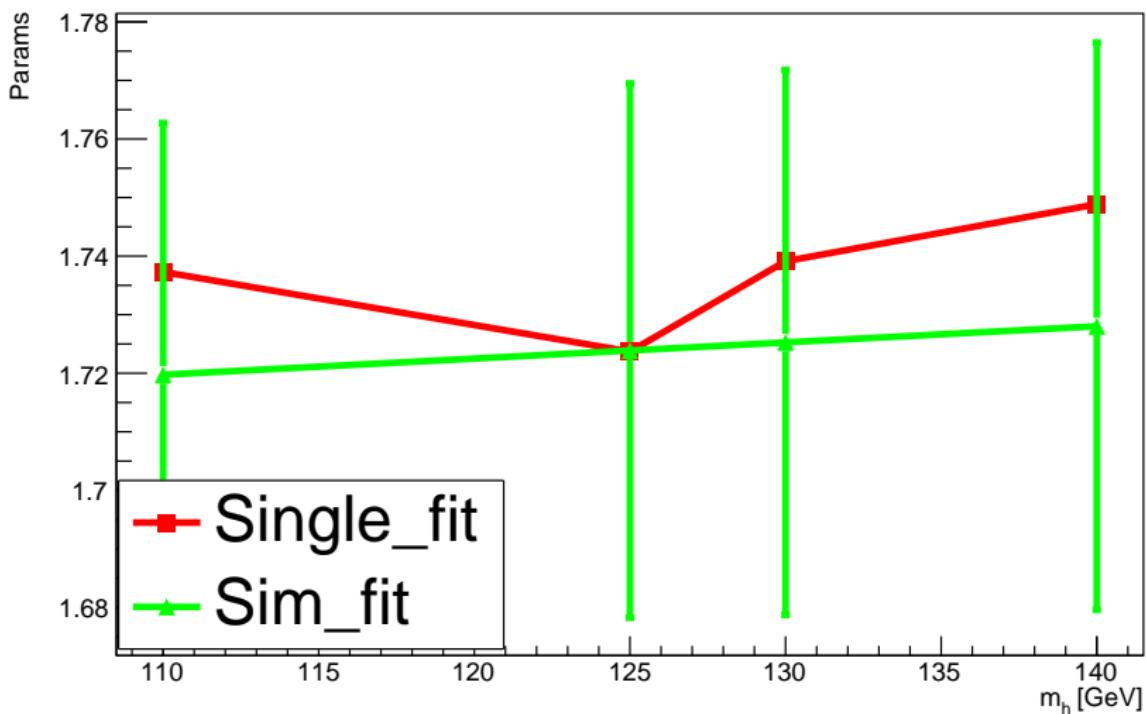
# Single vs Global fit params: $\sigma(m_h)$

Single and global fit comp: width



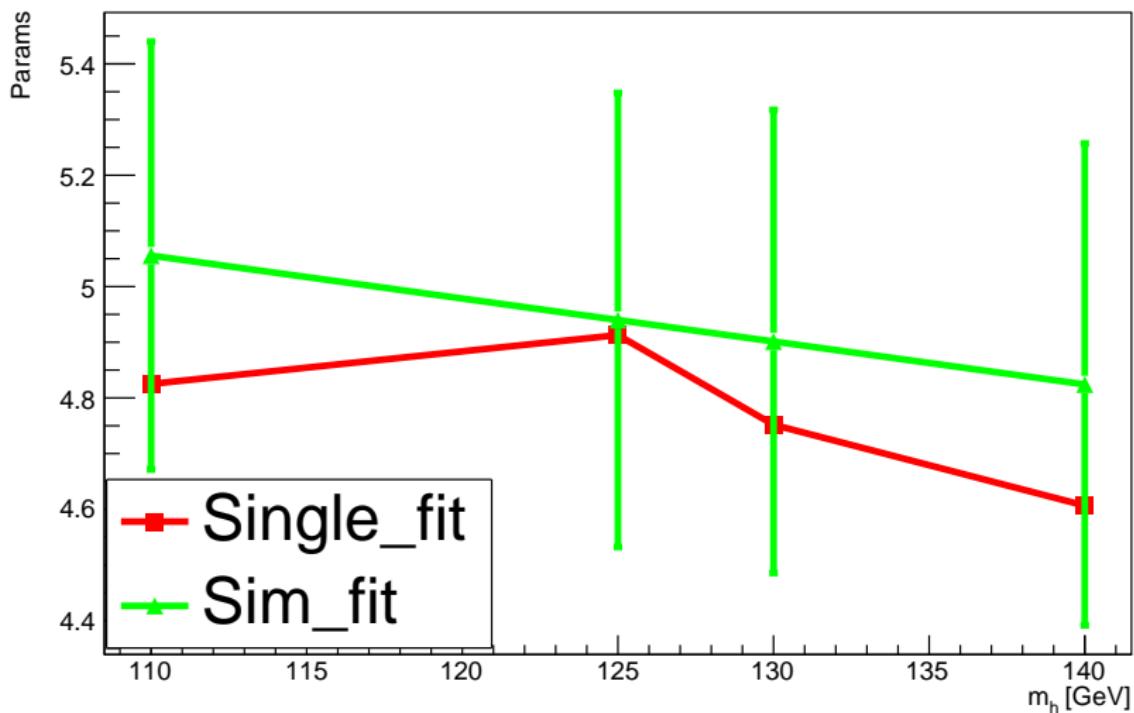
# Single vs Global fit params: $a_1(m_h)$

Single and global fit comp: a1



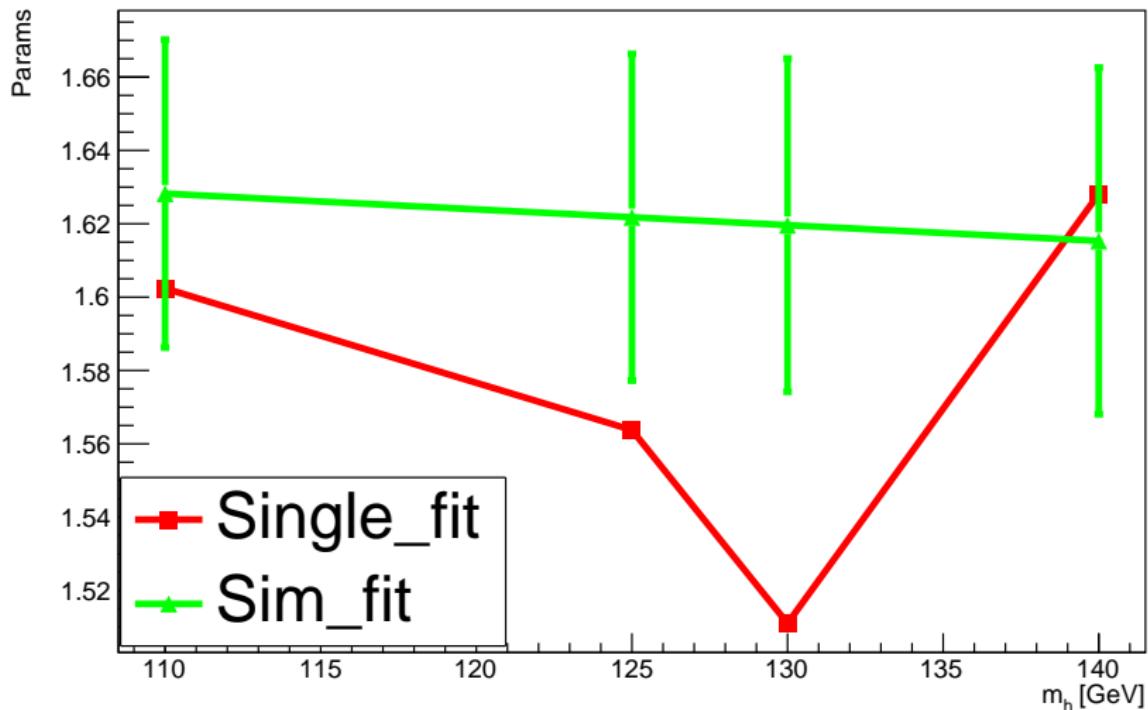
# Single vs Global fit params: $p_1(m_h)$

Single and global fit comp: p1



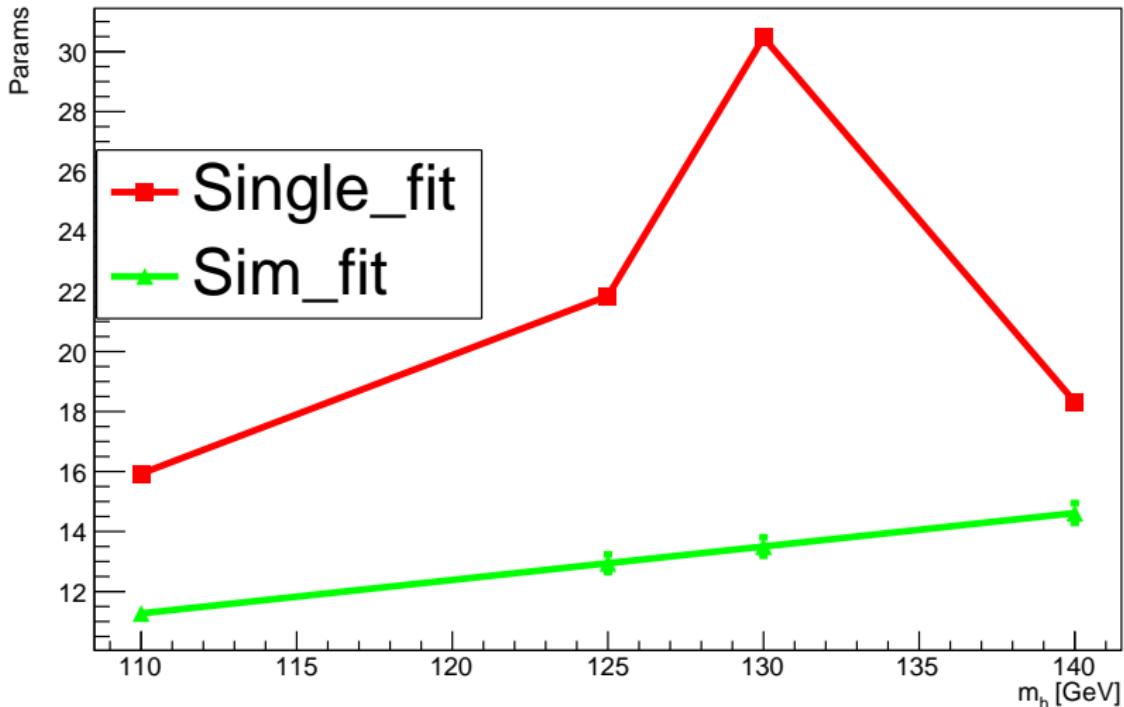
# Single vs Global fit params: $a_2(m_h)$

Single and global fit comp: a2



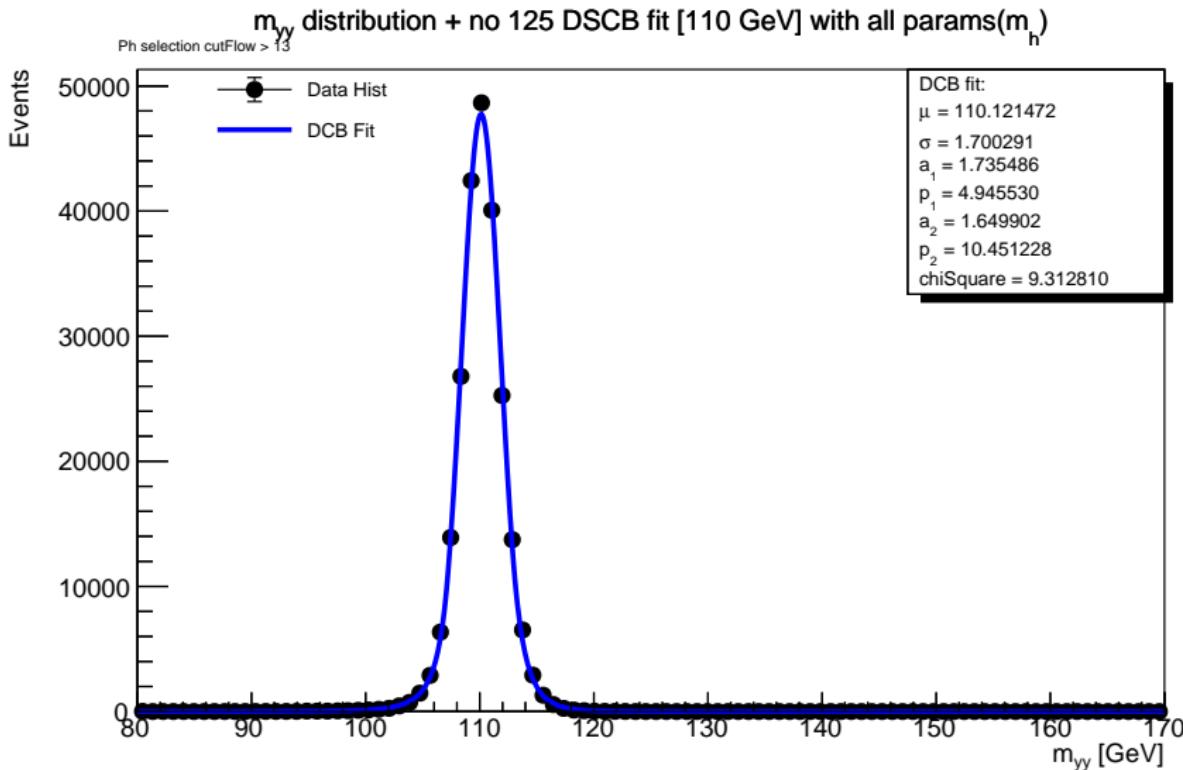
# Single vs Global fit params: $p_2(m_h)$

Single and global fit comp: p2

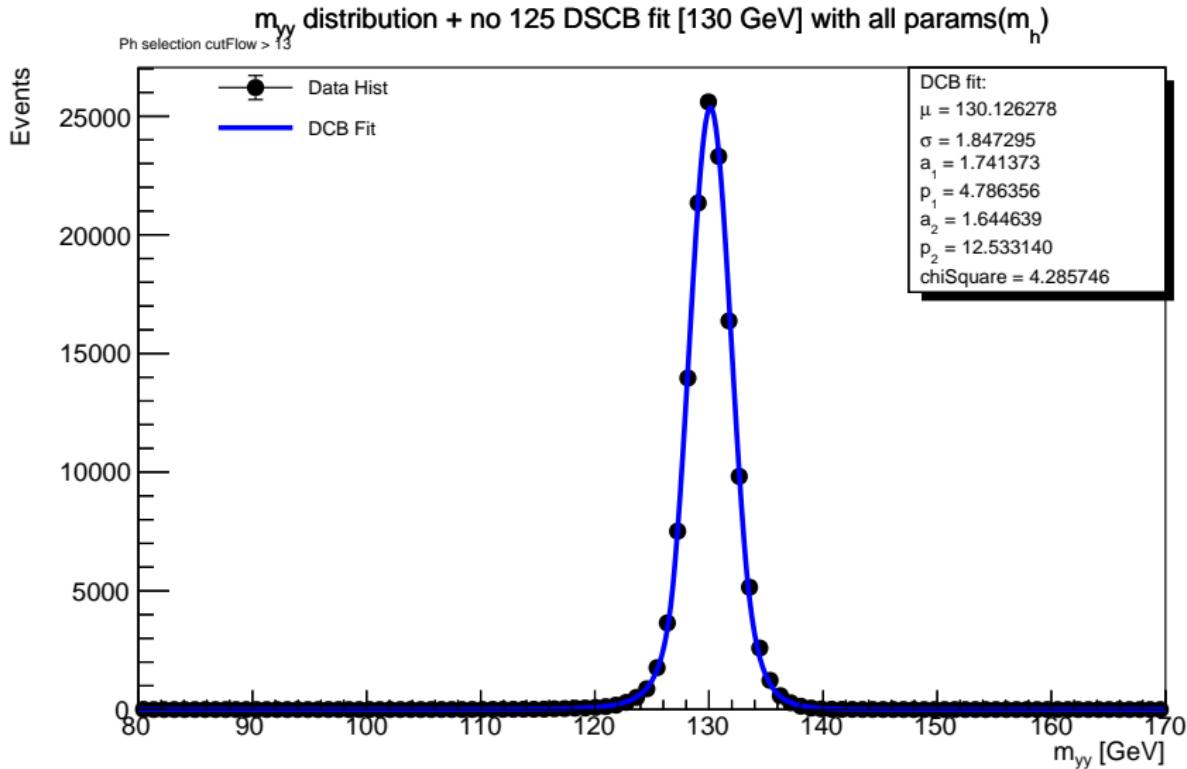


/Code

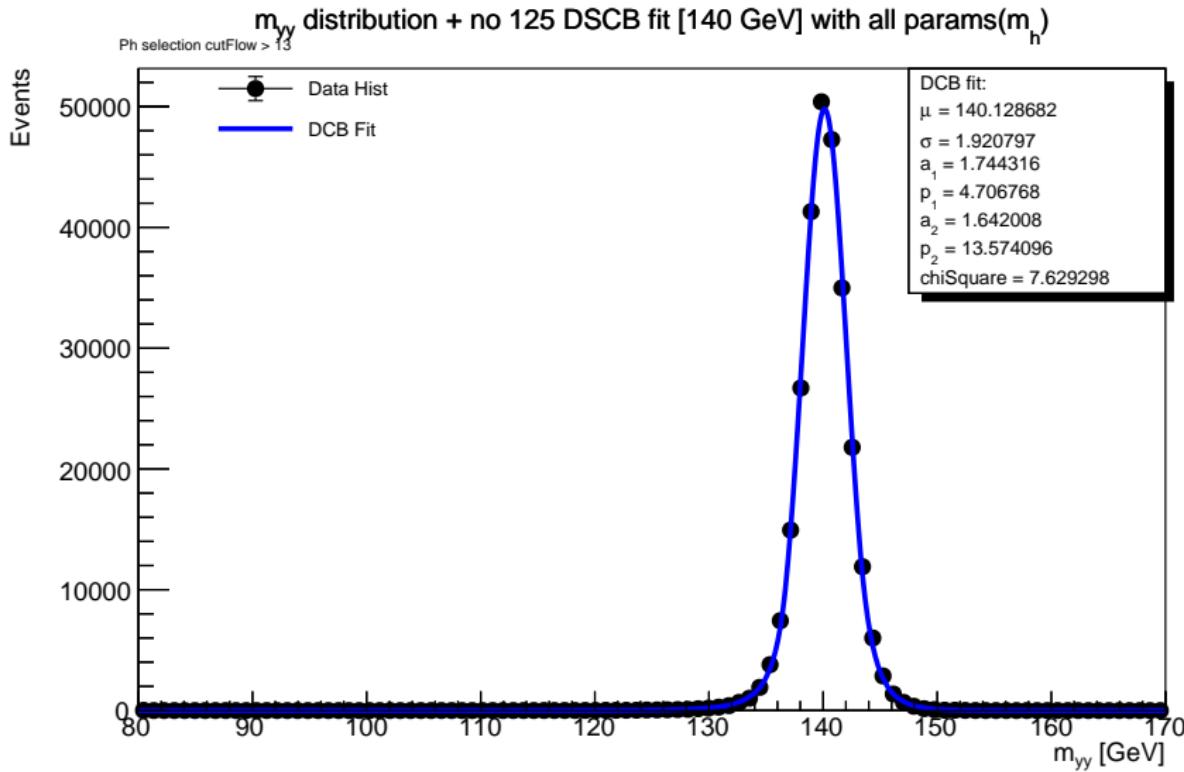
# Global fit( $m_H$ ) (no 125) [110 GeV]



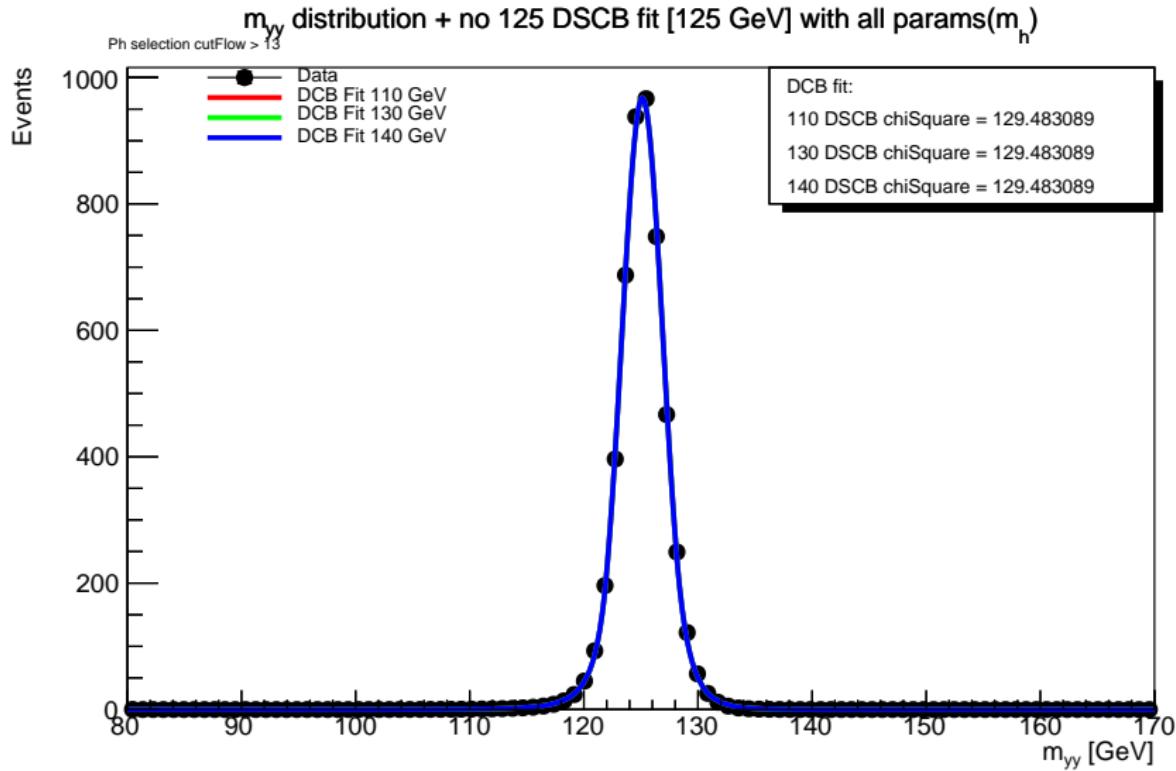
# Global fit( $m_H$ ) (no 125) [130 GeV]



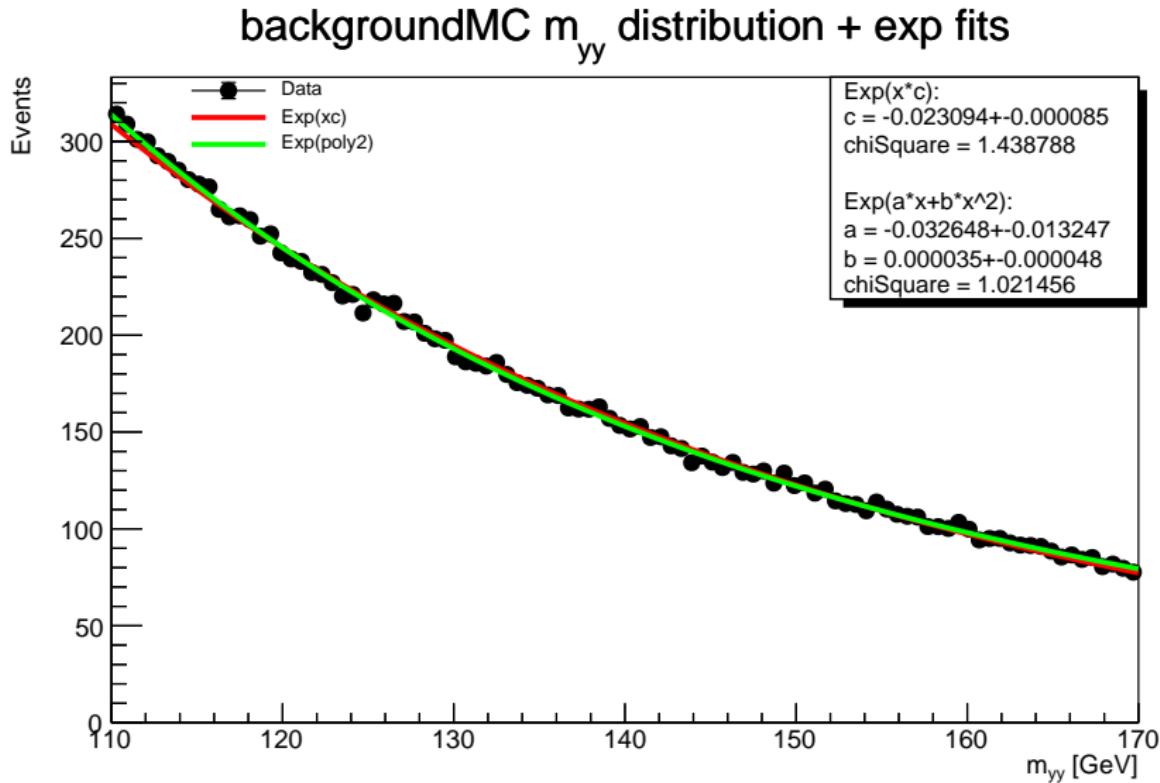
# Global fit( $m_H$ ) (no 125) [140 GeV]



# Fit without 125 GeV dataset

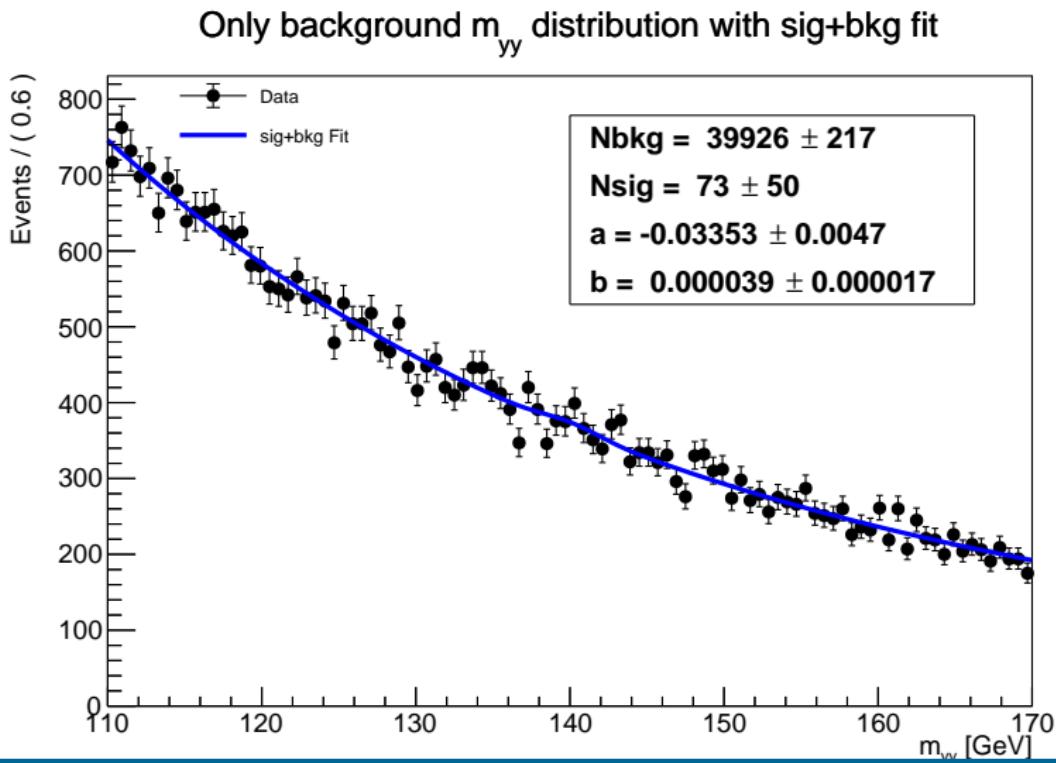


# Background MC



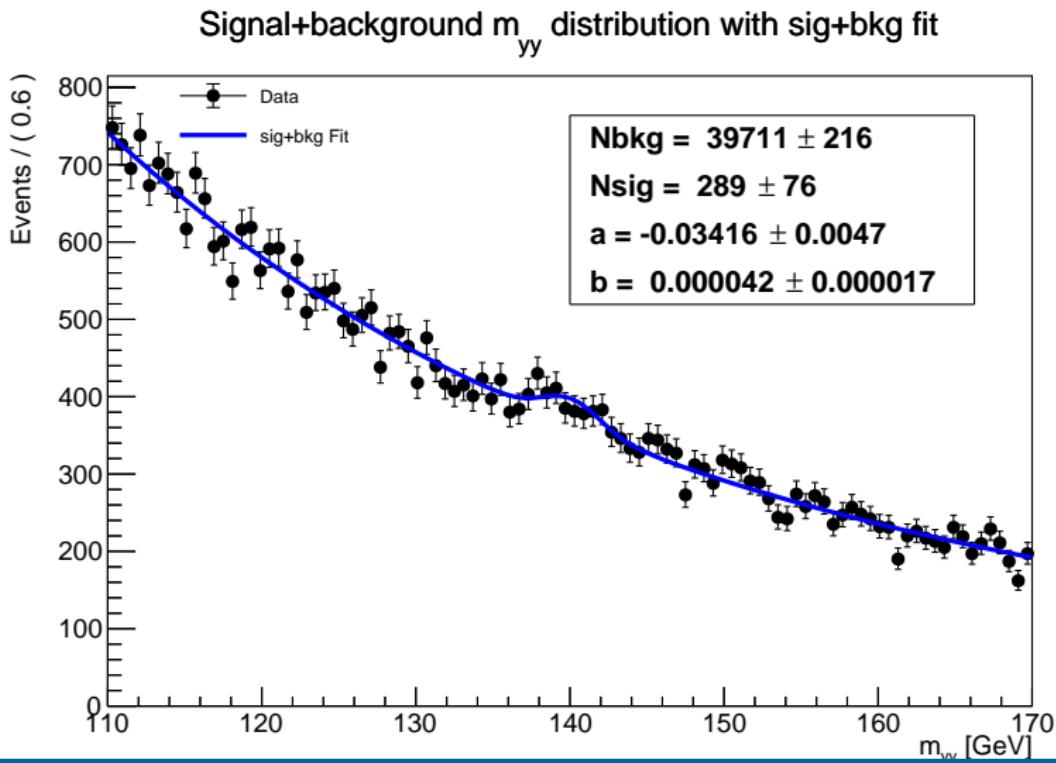
# Only background workspace

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



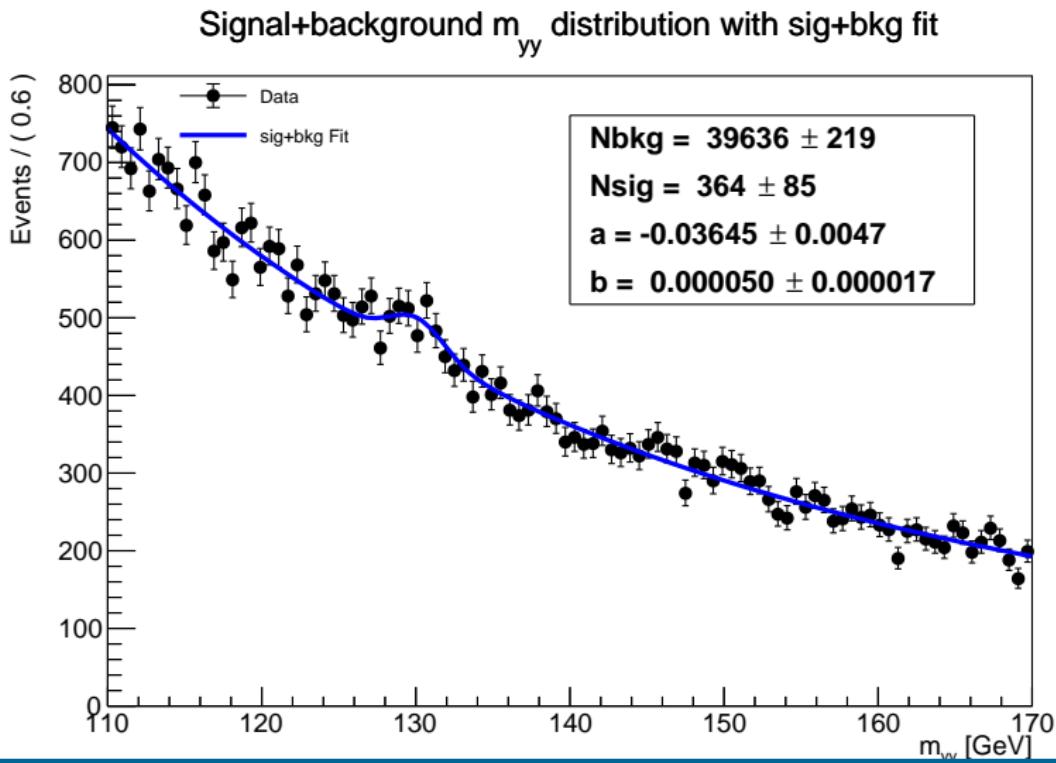
# Signal+background workspace [140 GeV]

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



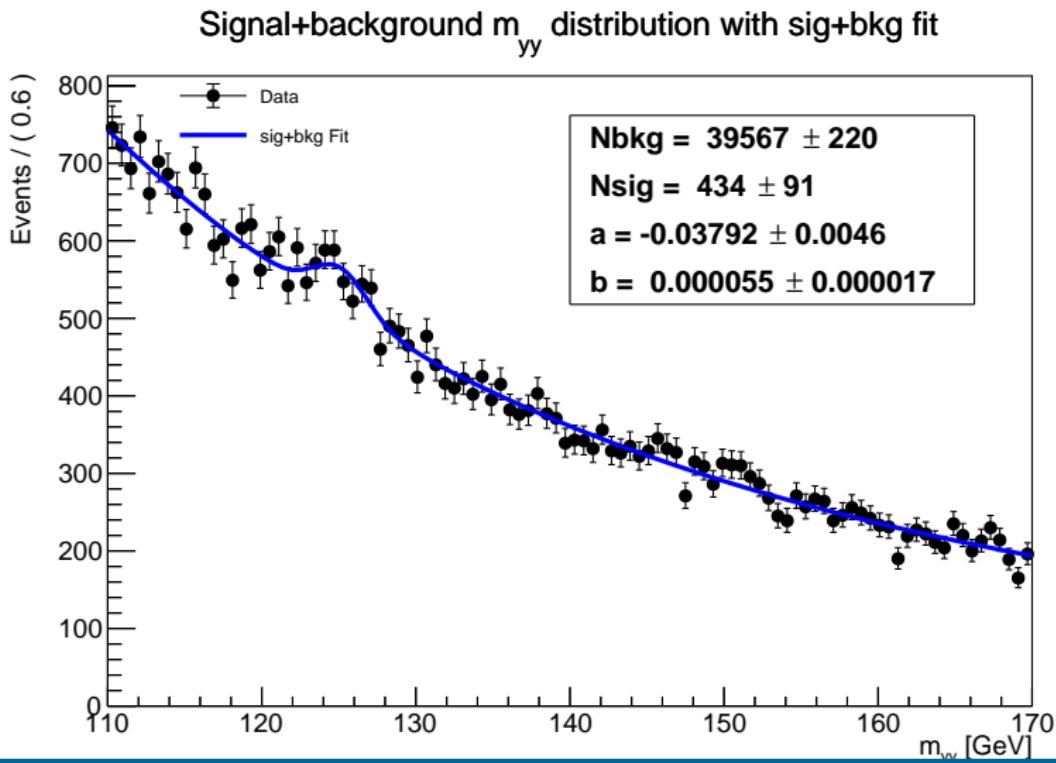
# Signal+background workspace [130 GeV]

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  $\chi^2/\text{ndf}$ .

### Returns

$\chi^2/\text{ndf}$  between the plotted curve and the data.

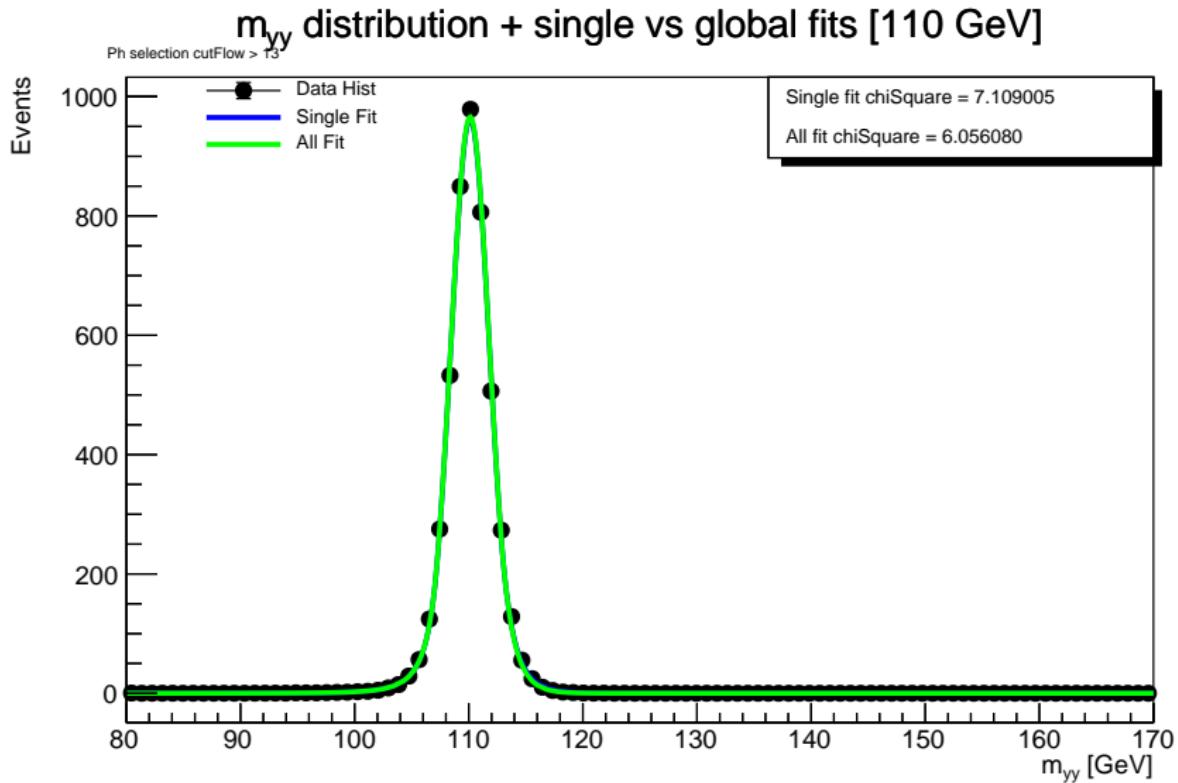
### Note

The  $\chi^2$  is calculated between a *plot of the original distribution* and the data. It therefore has more rounding errors than directly calculating the  $\chi^2$  from a PDF or function.

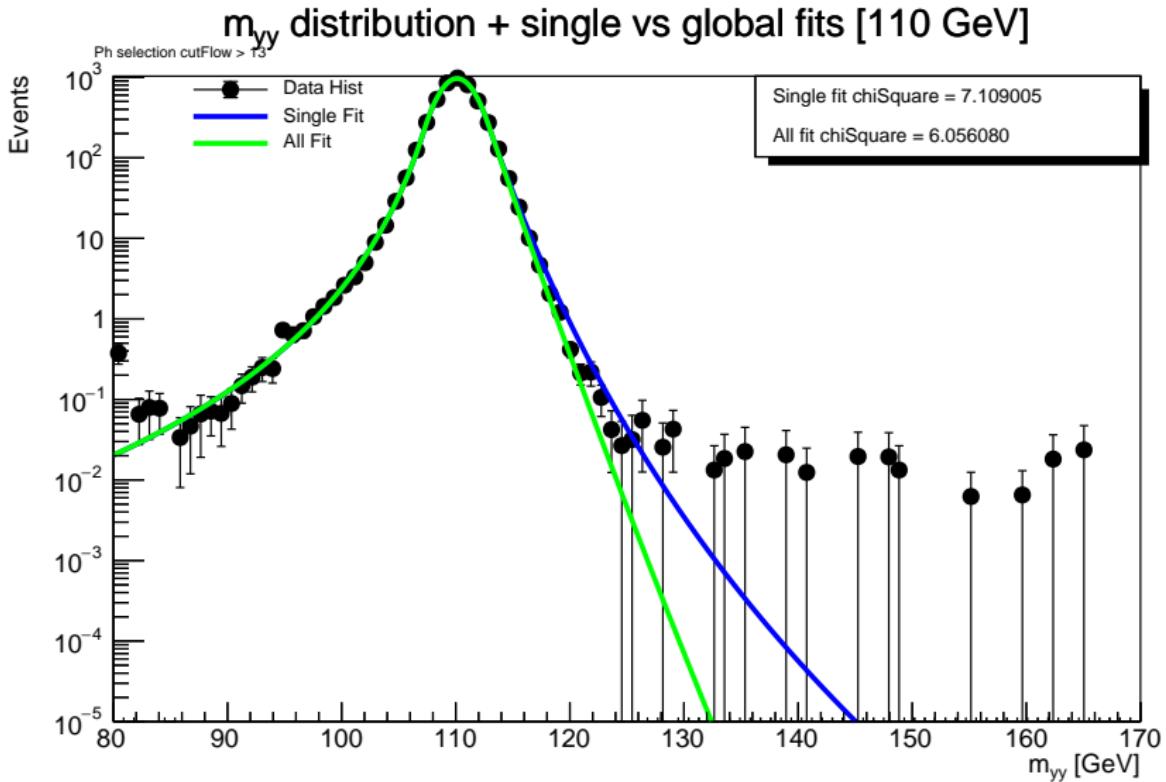
To do this, use `RooChi2Var`.

Definition at line 1113 of file `RooPlot.cxx`.

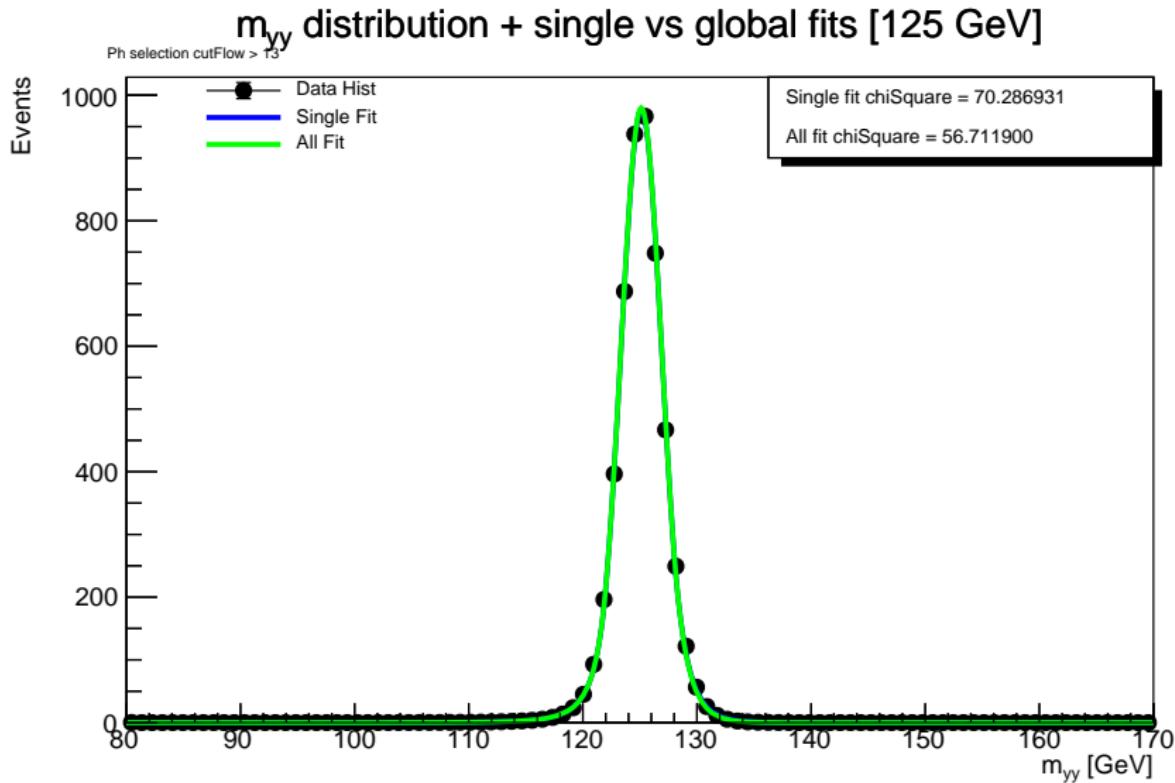
# Single vs global fit comp. [110 Gev]



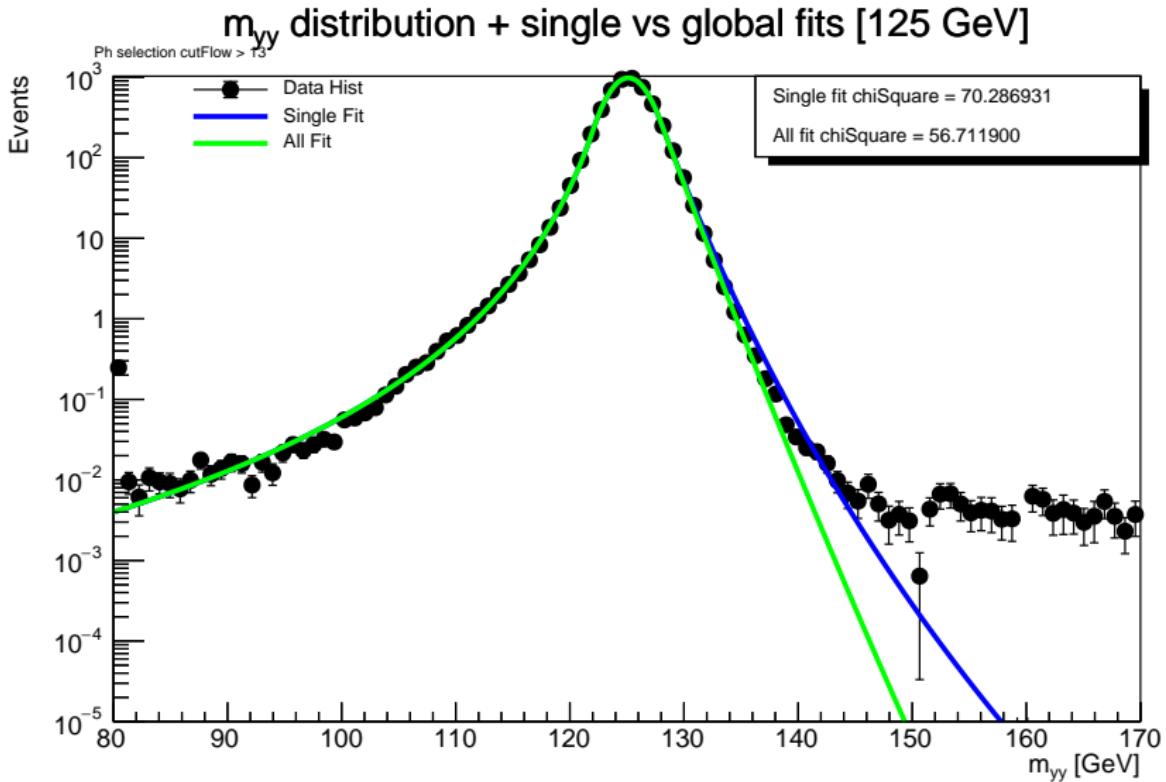
# Single vs global fit comp. [110 Gev] (ylog)



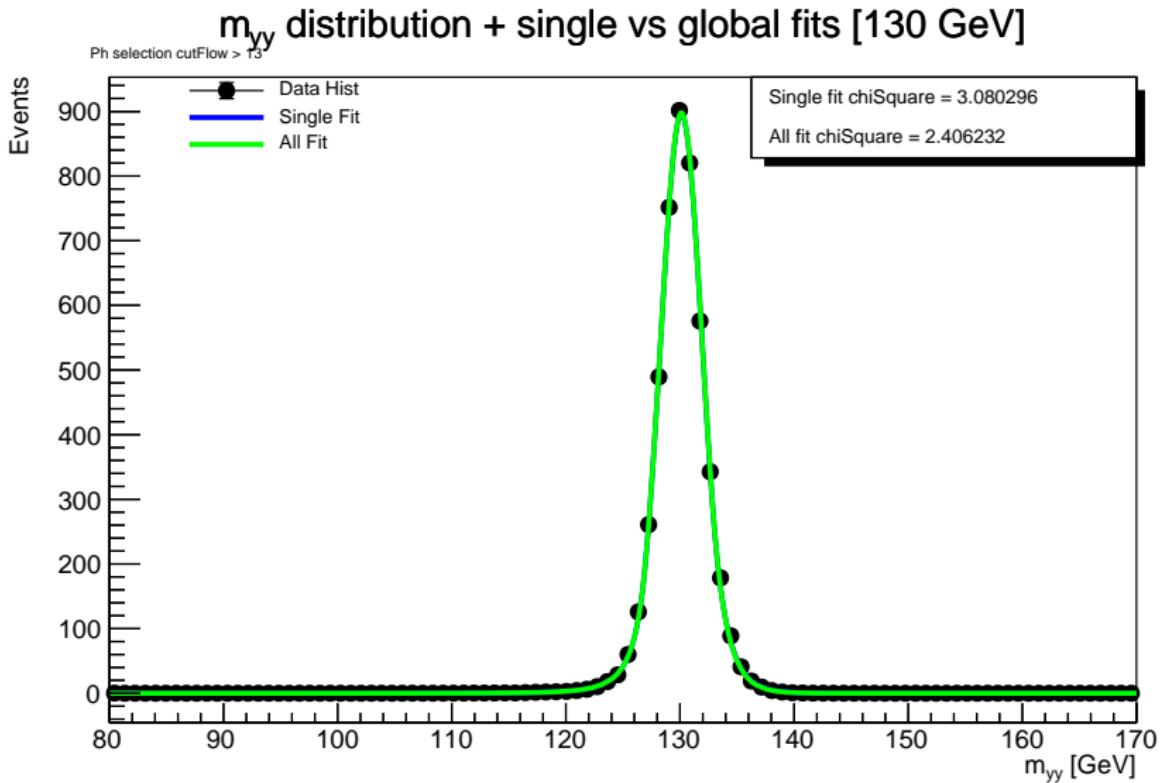
# Single vs global fit comp. [125 Gev]



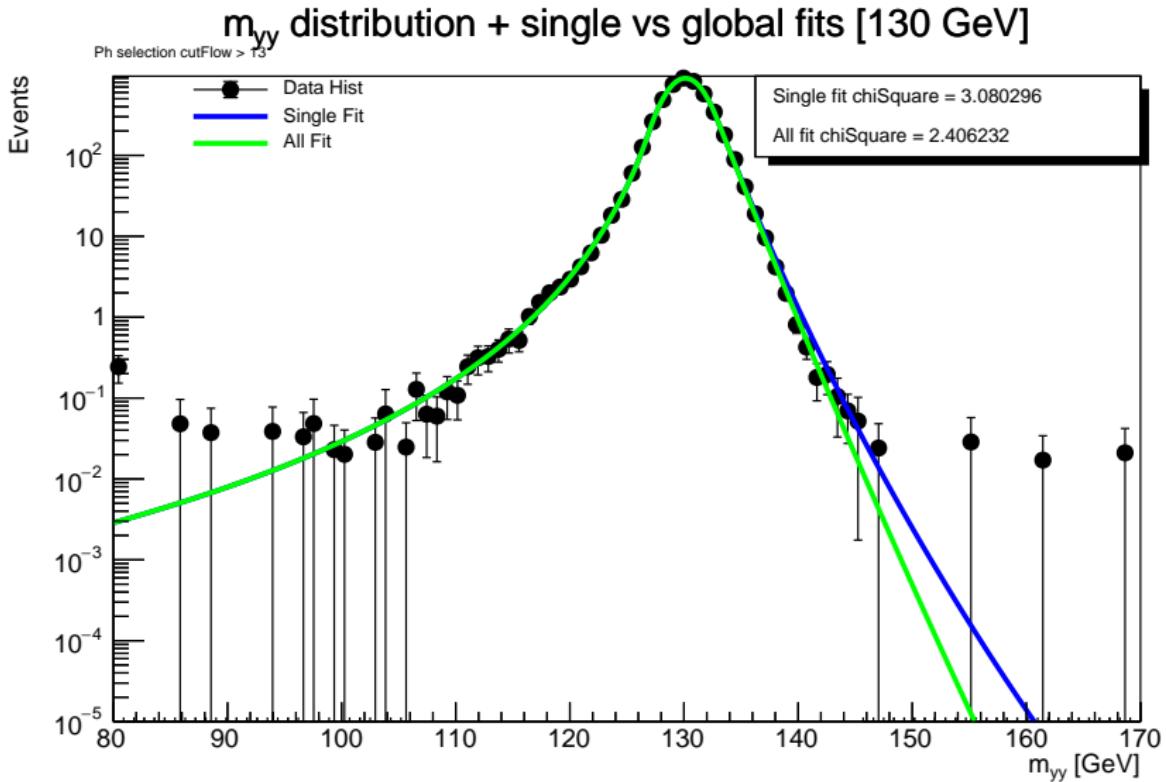
# Single vs global fit comp. [125 Gev] (ylog)



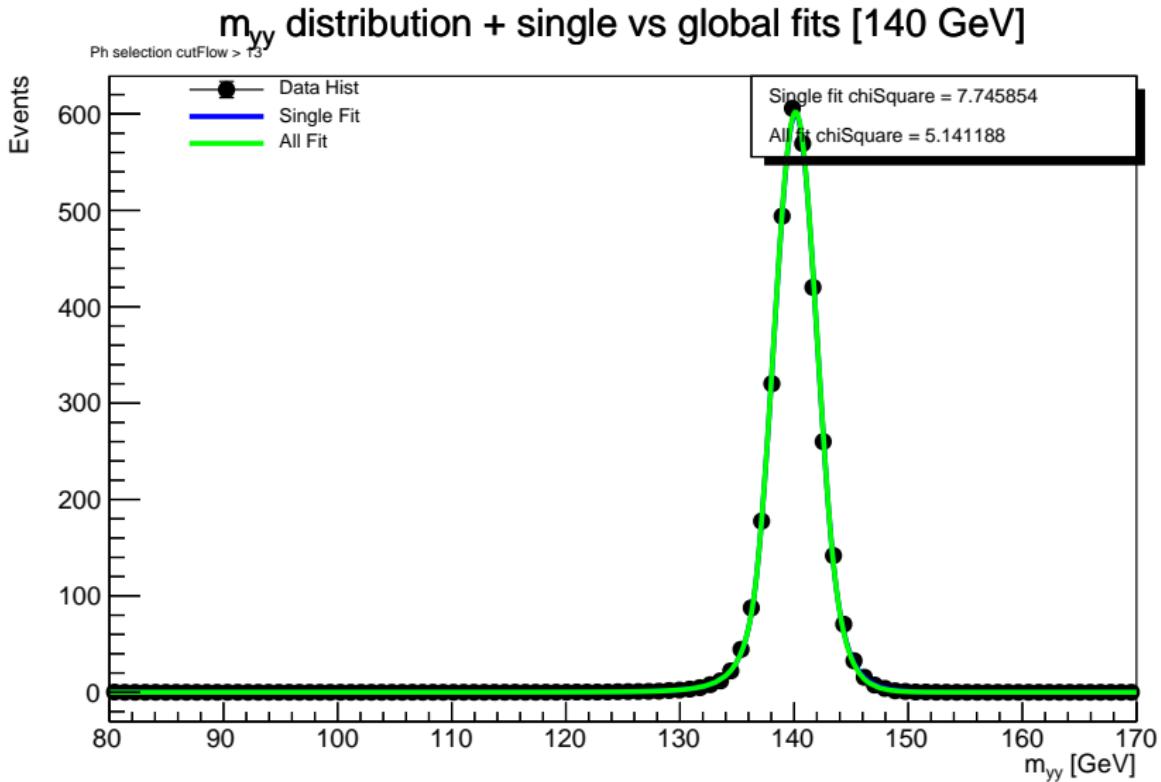
# Single vs global fit comp. [130 Gev]



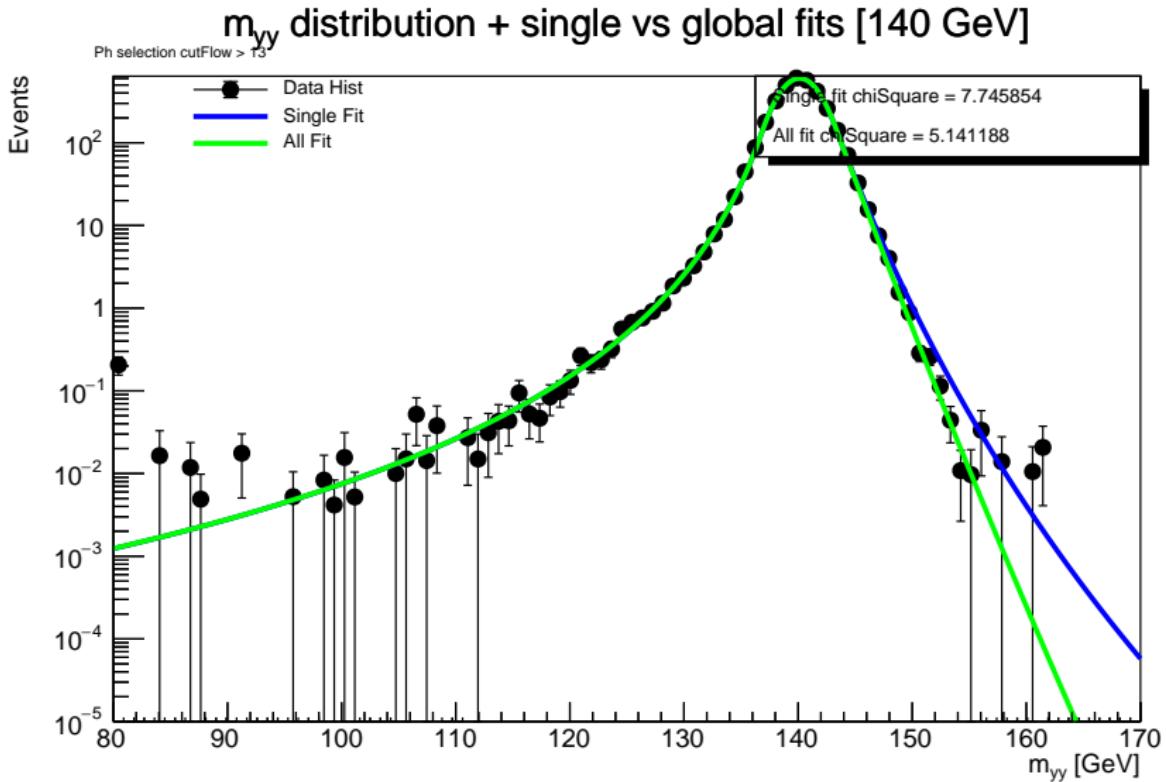
# Single vs global fit comp. [130 Gev] (ylog)



# Single vs global fit comp. [140 Gev]



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

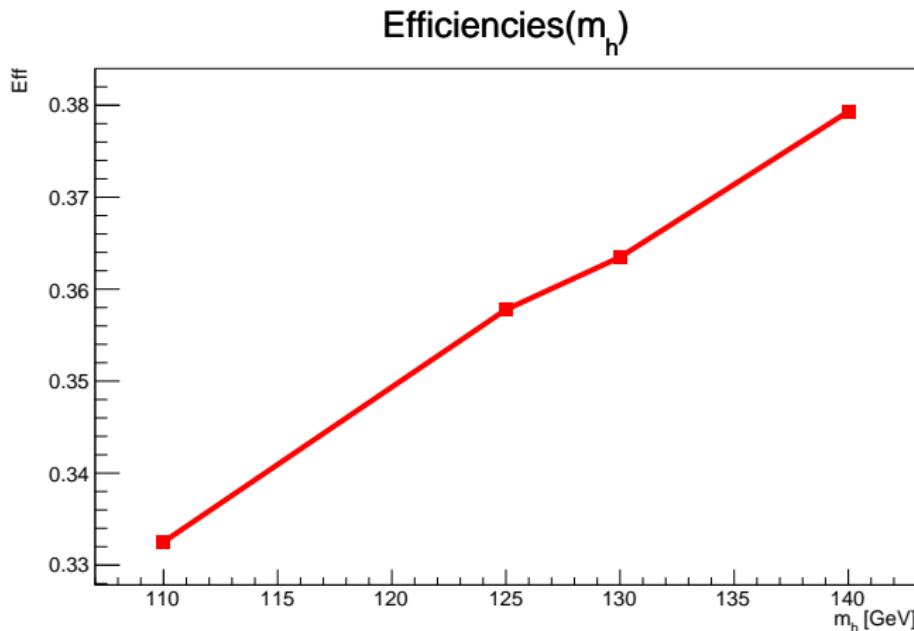


# Check normalisations

My and Elena's results are compared in: [docs](#)

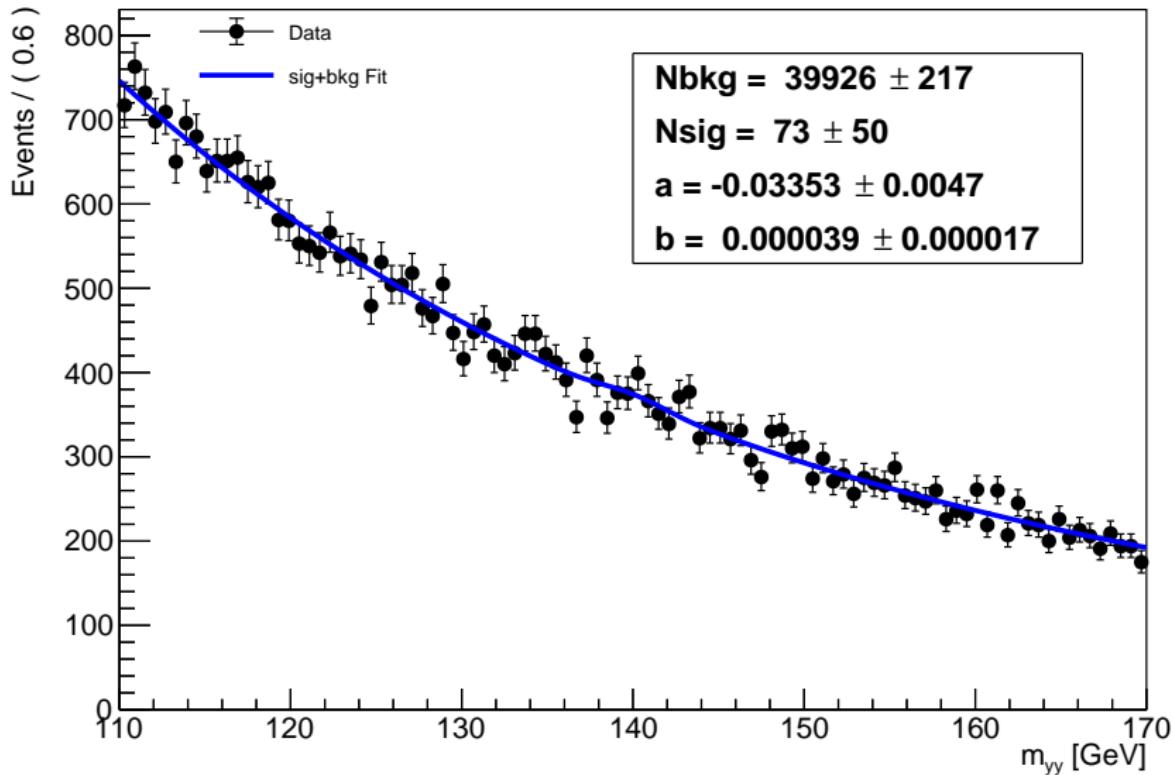
# Efficiencies( $m_h$ )

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



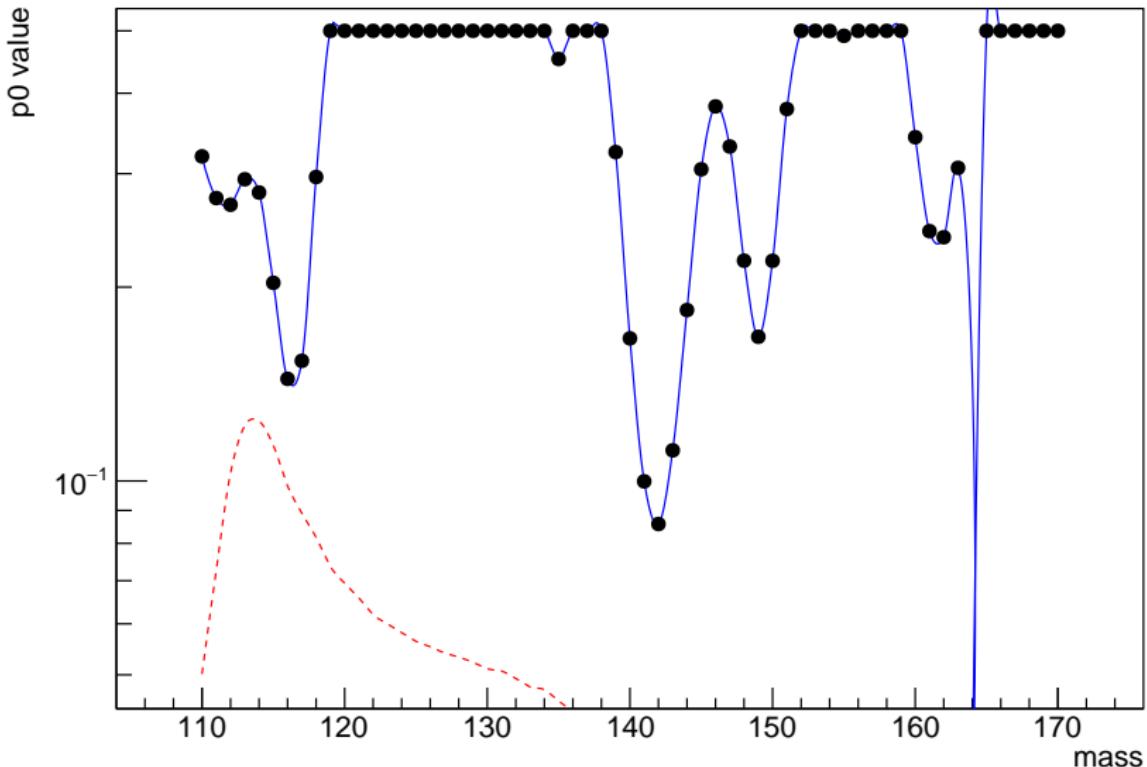
# Only background

Only background  $m_{yy}$  distribution with sig+bkg fit



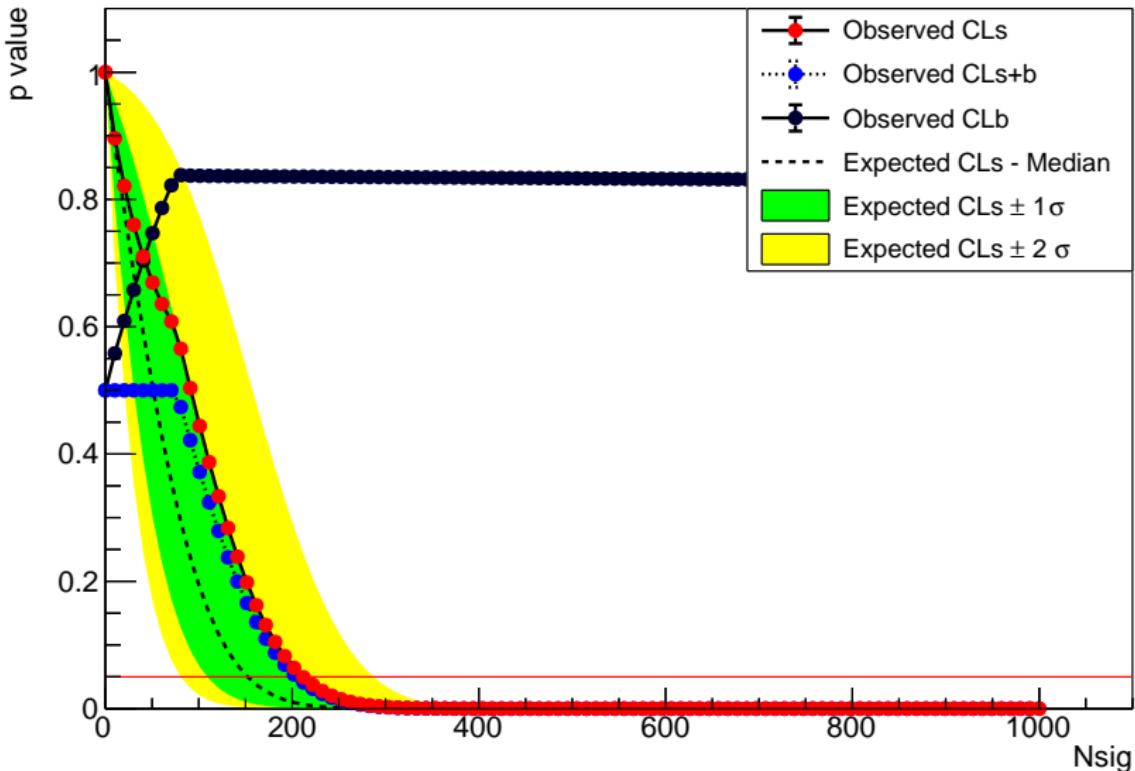
# Only background p0 scan

Significance vs Mass [Only bkg]



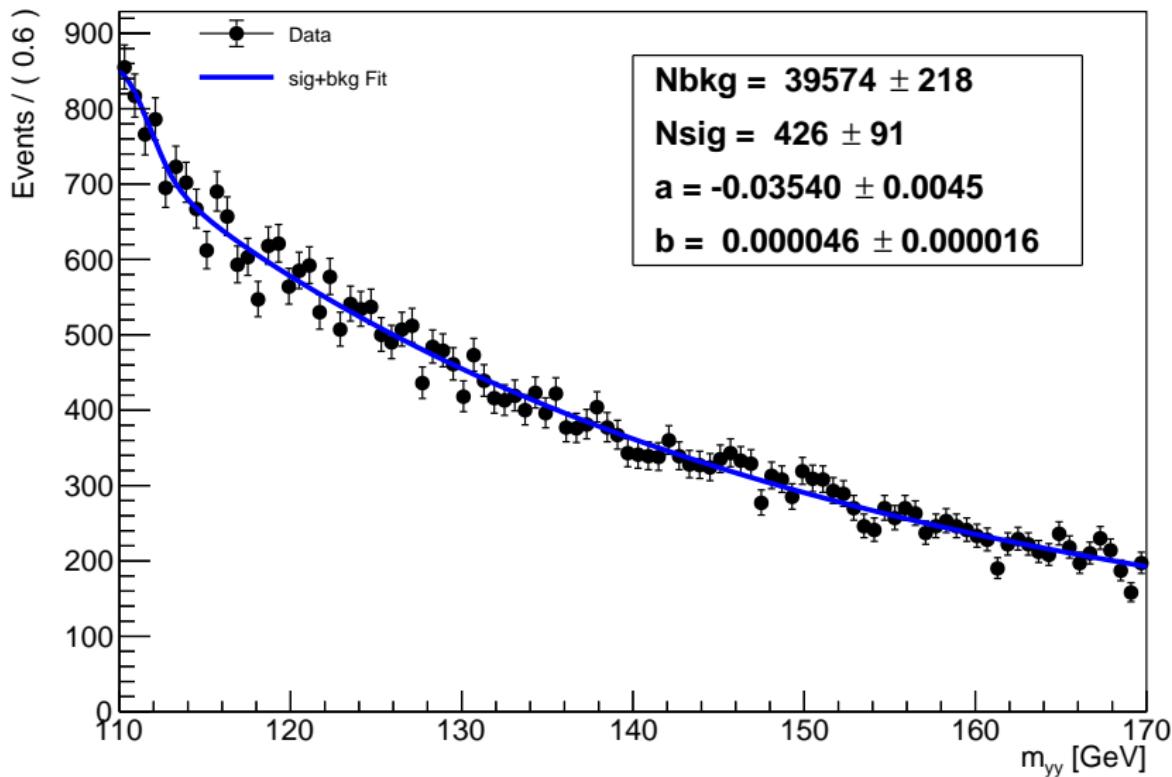
# Only background limit

## Feldman-Cousins Interval [only bkg]



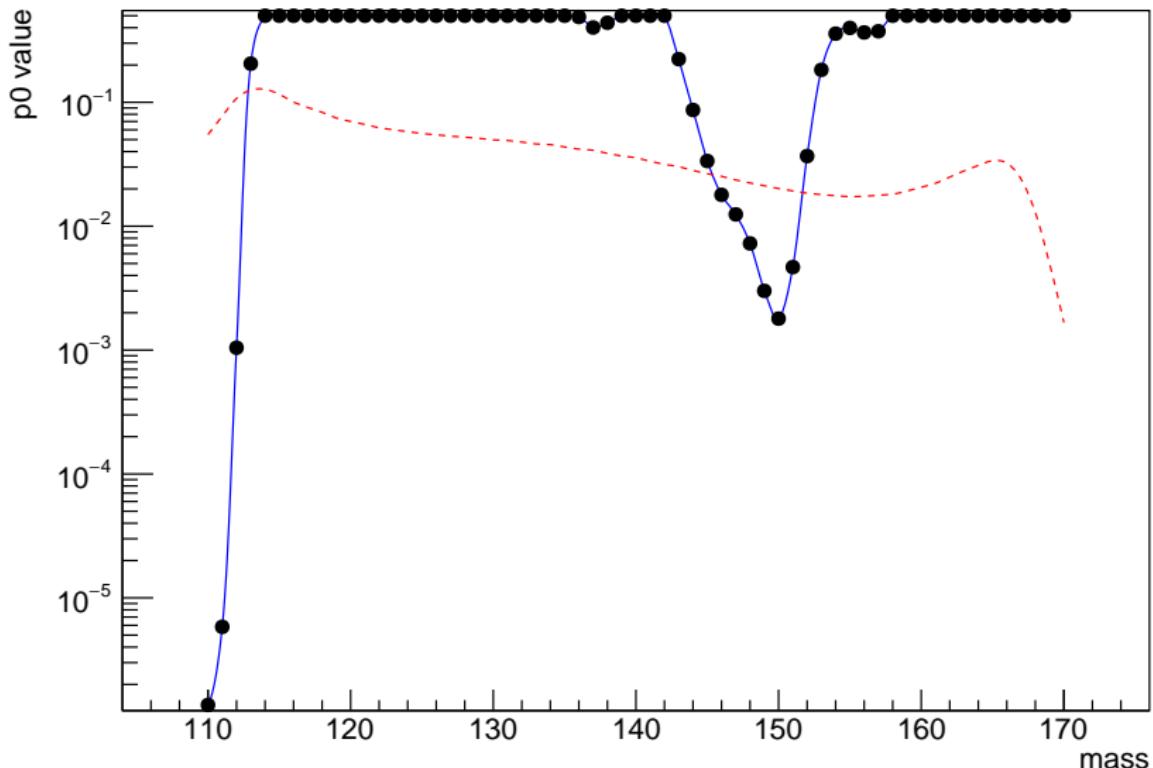
# Sig+bkg [110 GeV]

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



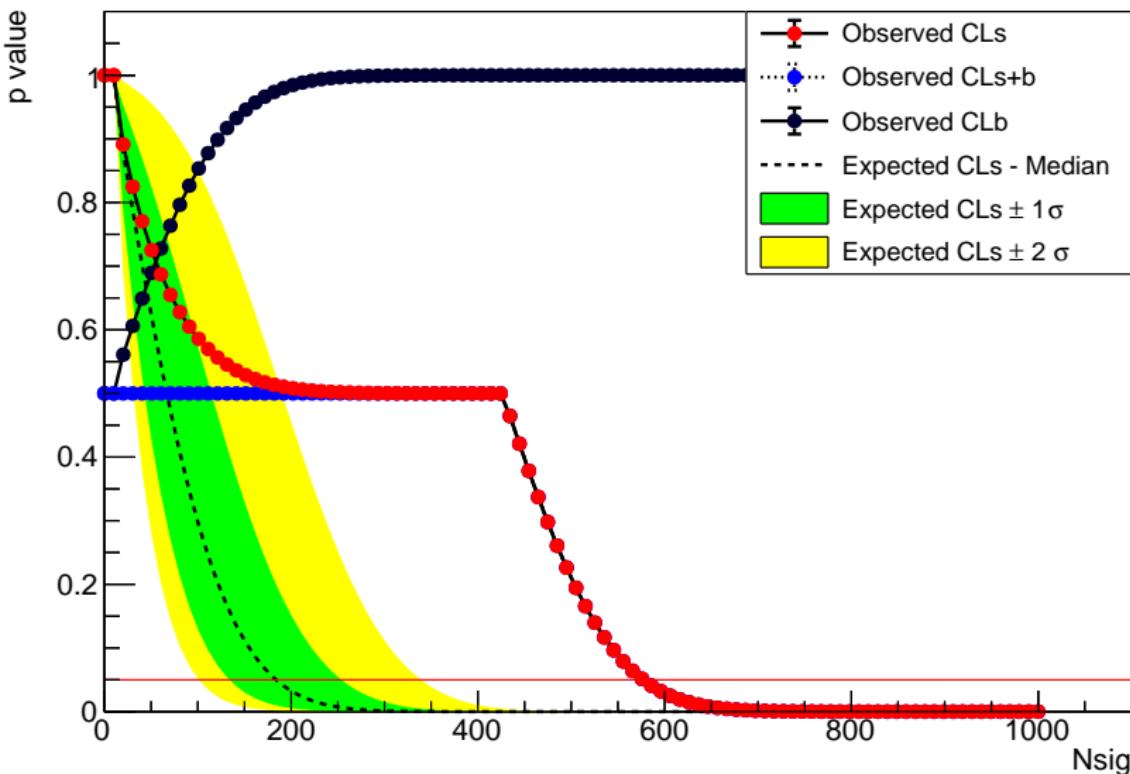
# Sig+bkg p0 scan [110 GeV]

Significance vs Mass [110 GeV]



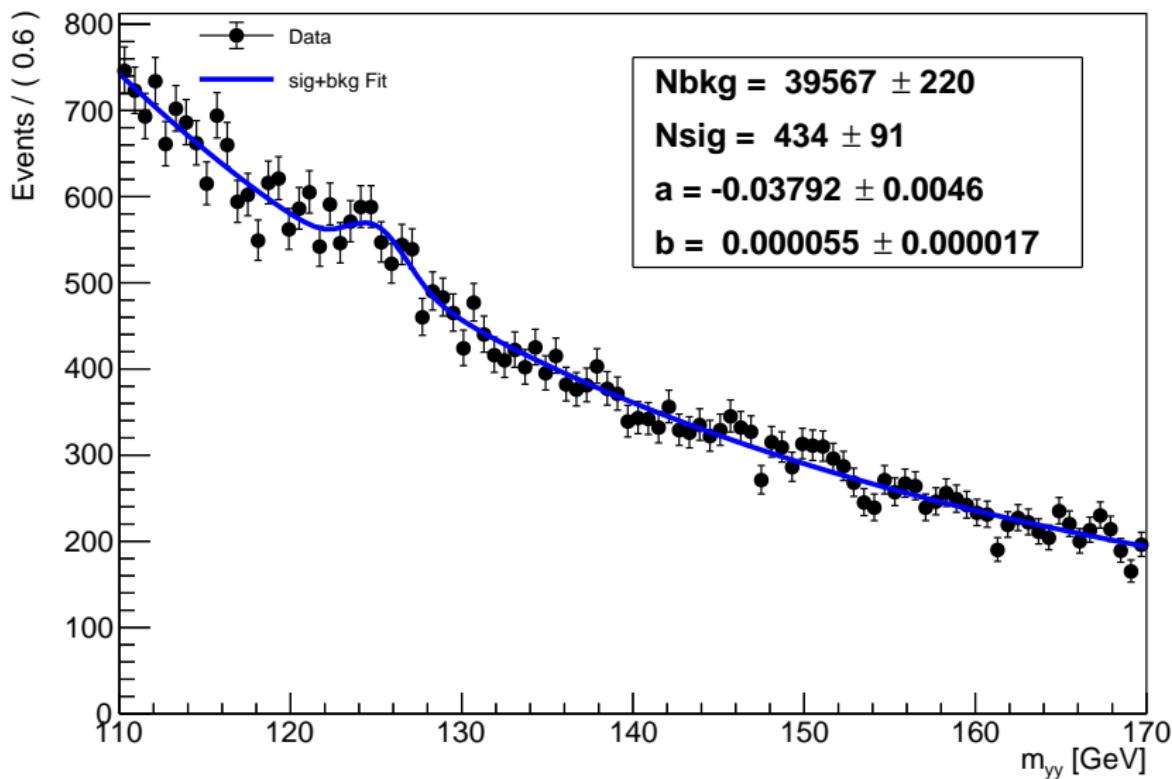
# Sig+bkg limit [110 GeV]

## Feldman-Cousins Interval [110 GeV]



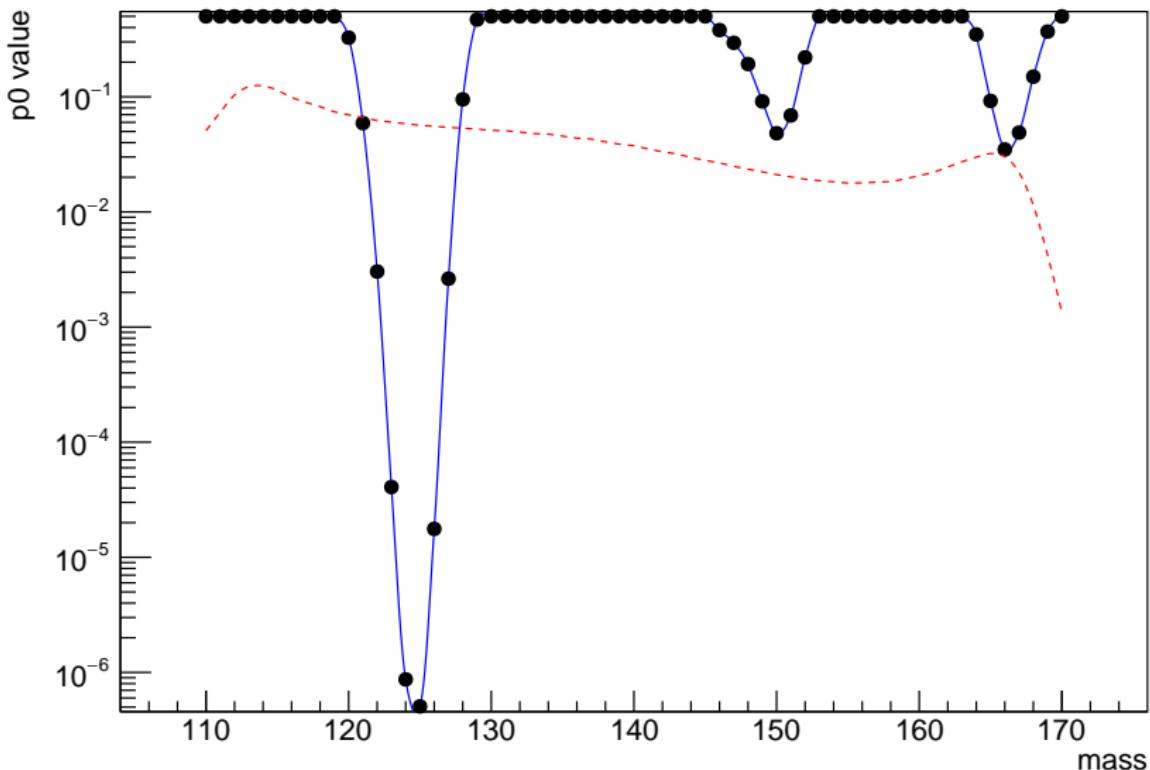
# Sig+bkg [125 GeV]

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



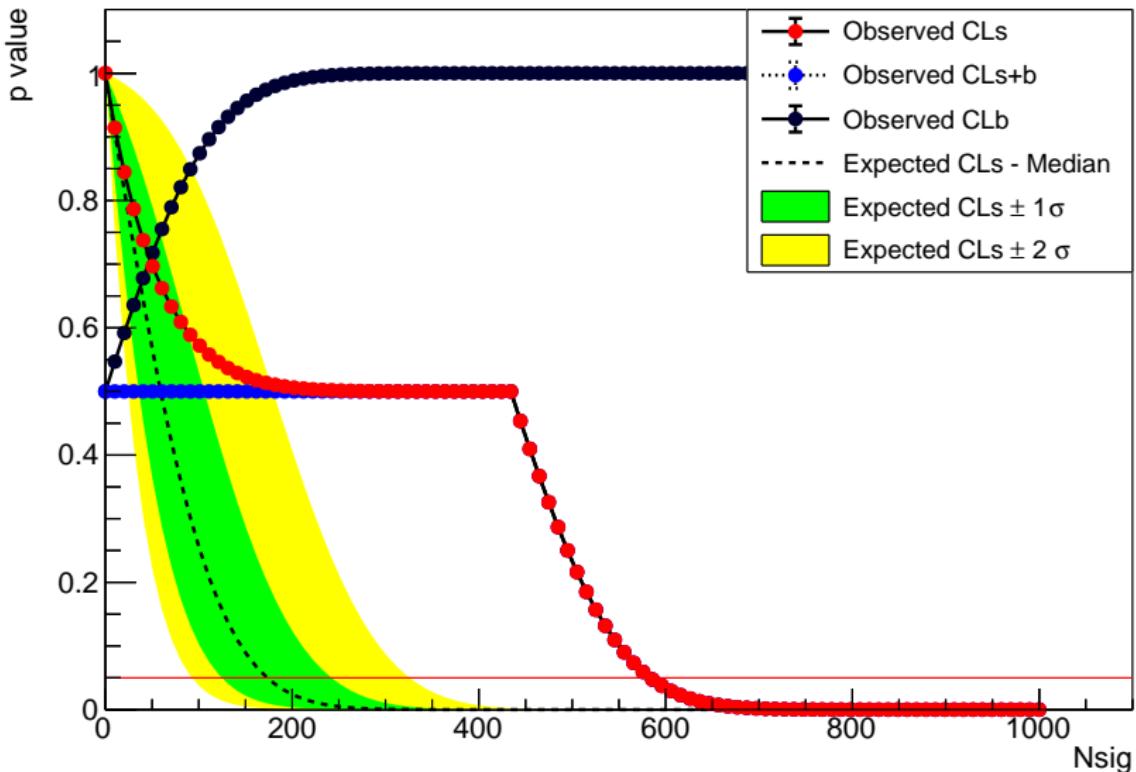
# Sig+bkg p0 scan [125 GeV]

Significance vs Mass [125 GeV]



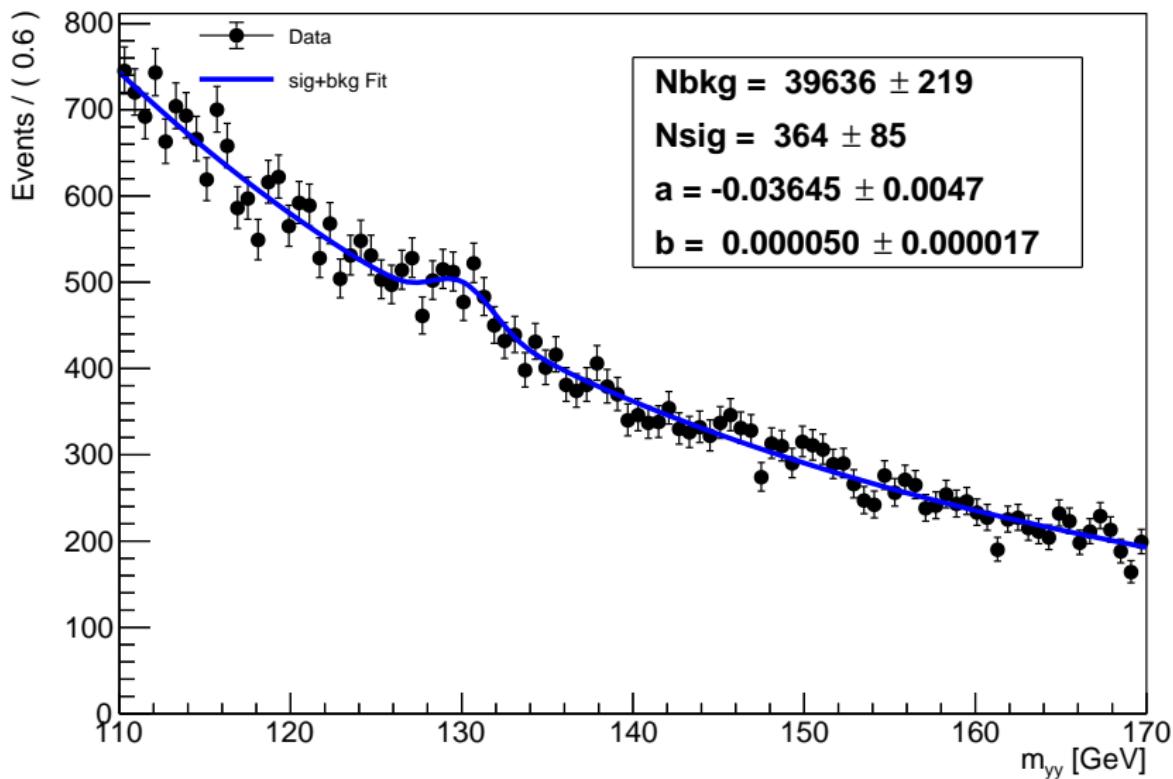
# Sig+bkg limit scan [125 GeV]

Feldman-Cousins Interval [125 GeV]



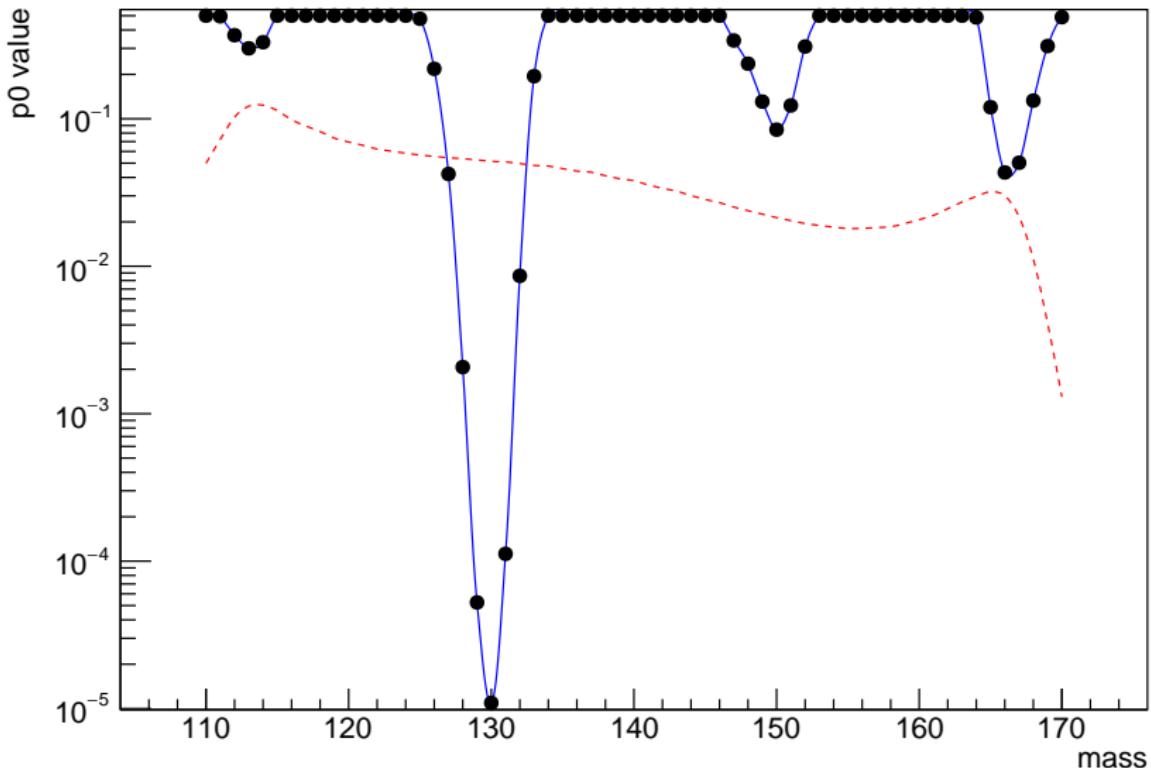
# Sig+bkg [130 GeV]

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



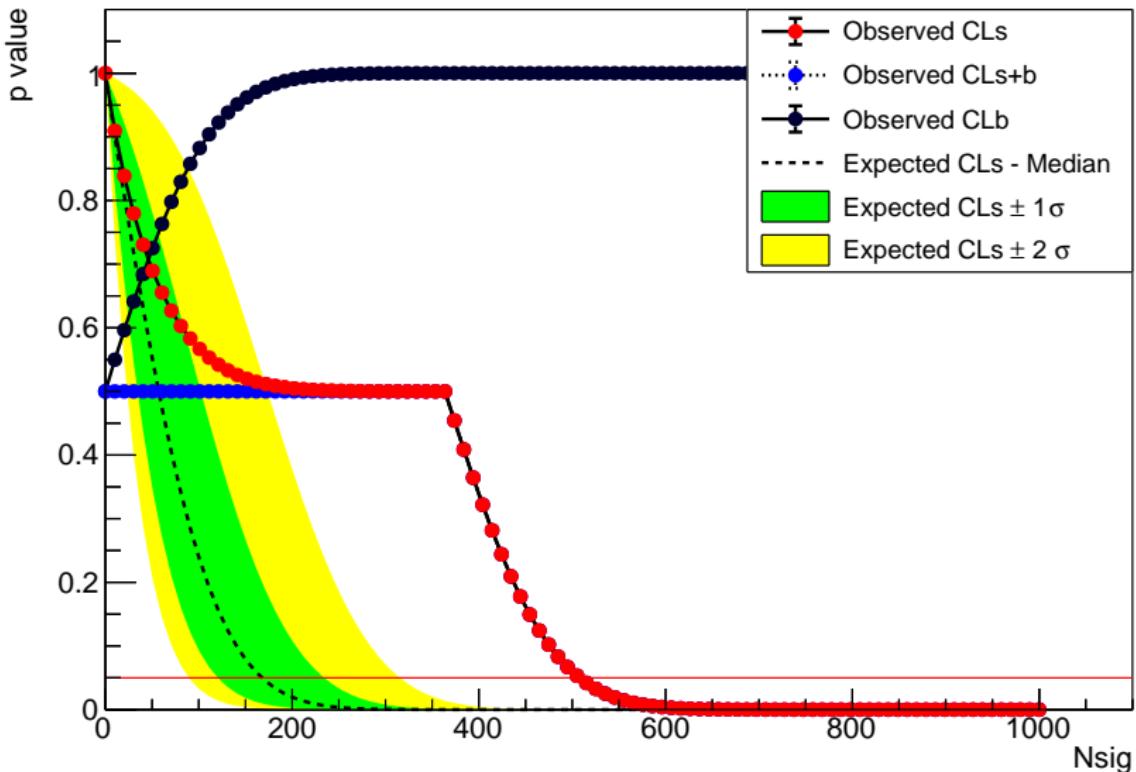
# Sig+bkg p0 scan [130 GeV]

Significance vs Mass [130 GeV]



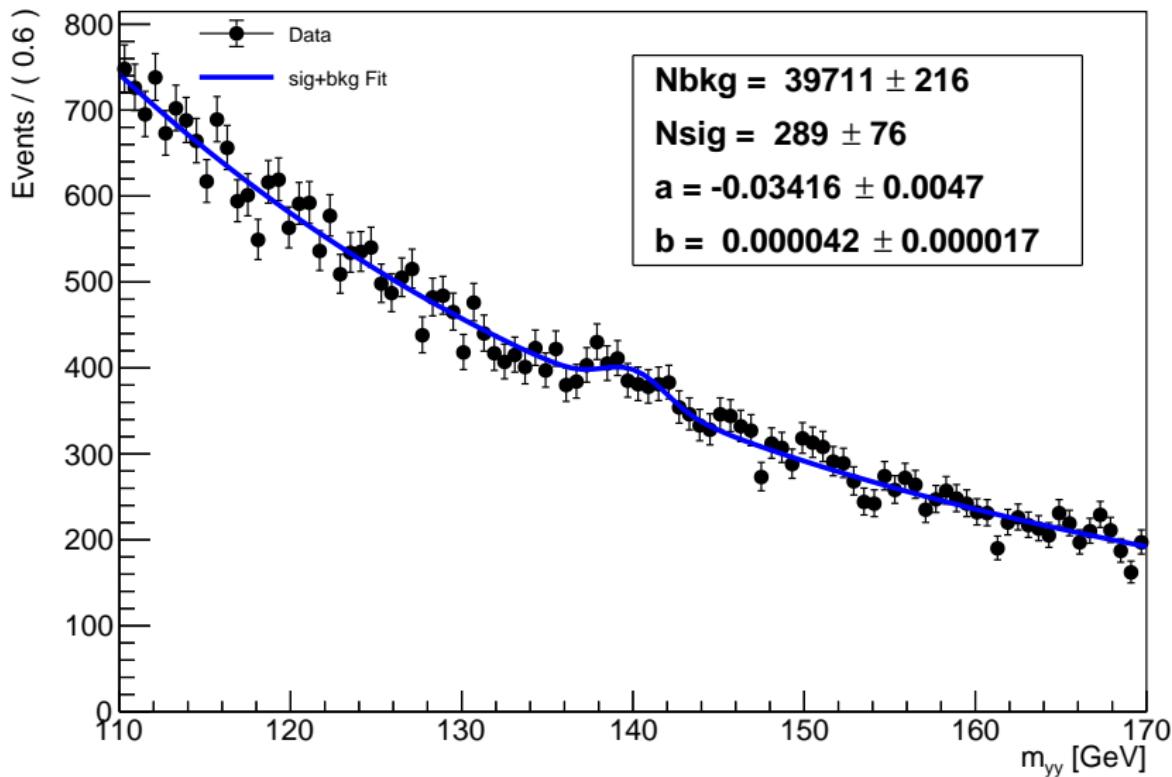
# Sig+bkg limit scan [130 GeV]

Feldman-Cousins Interval [130 GeV]



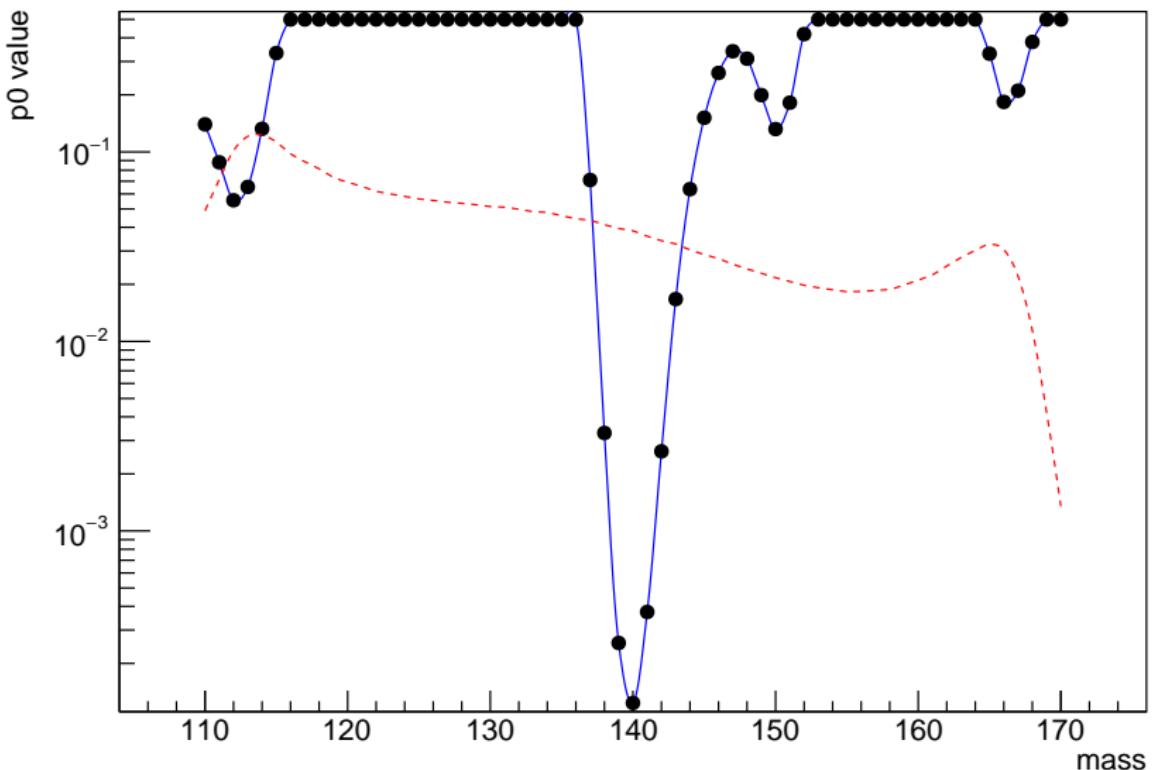
# Sig+bkg [140 GeV]

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



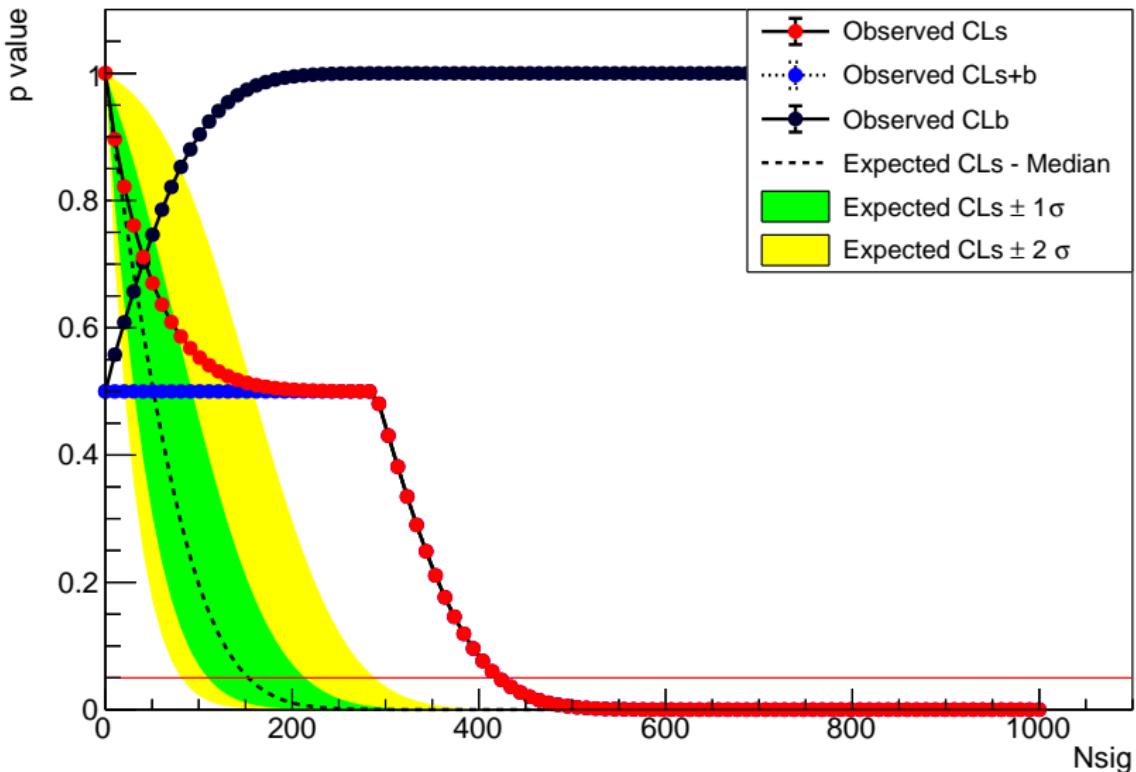
# Sig+bkg p0 scan [140 GeV]

Significance vs Mass [140 GeV]



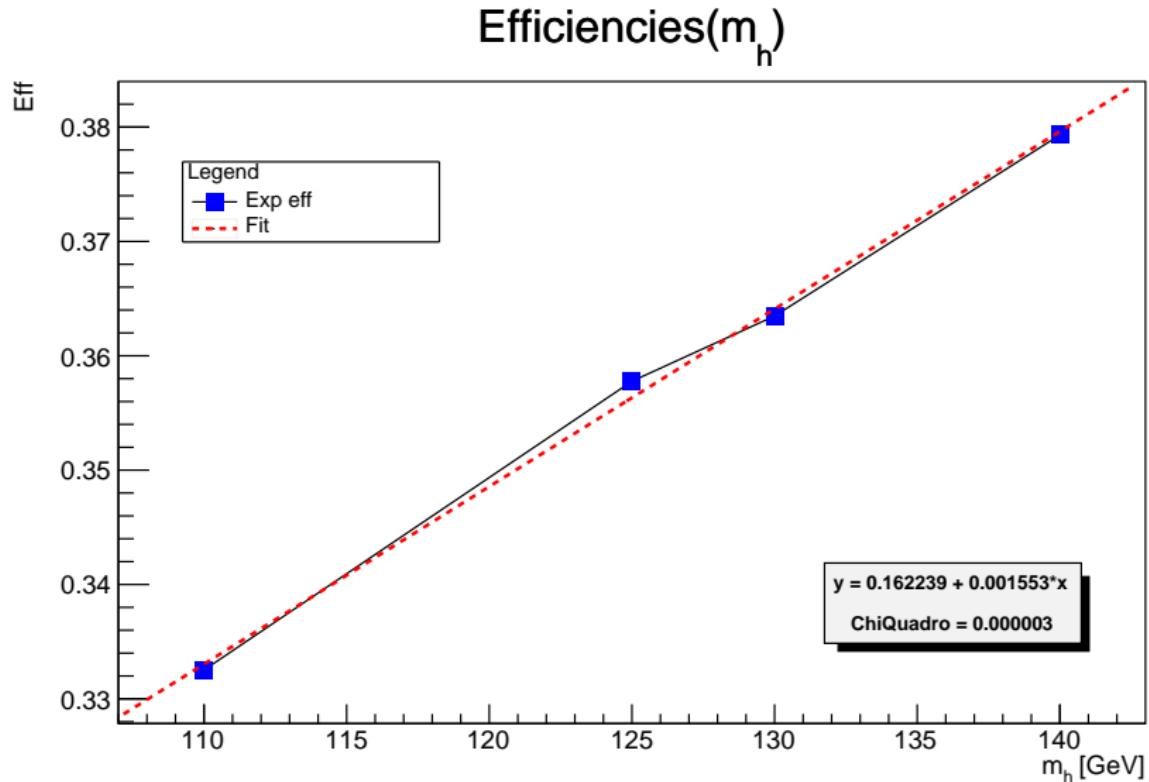
# Sig+bkg limit scan [140 GeV]

Feldman-Cousins Interval [140 GeV]

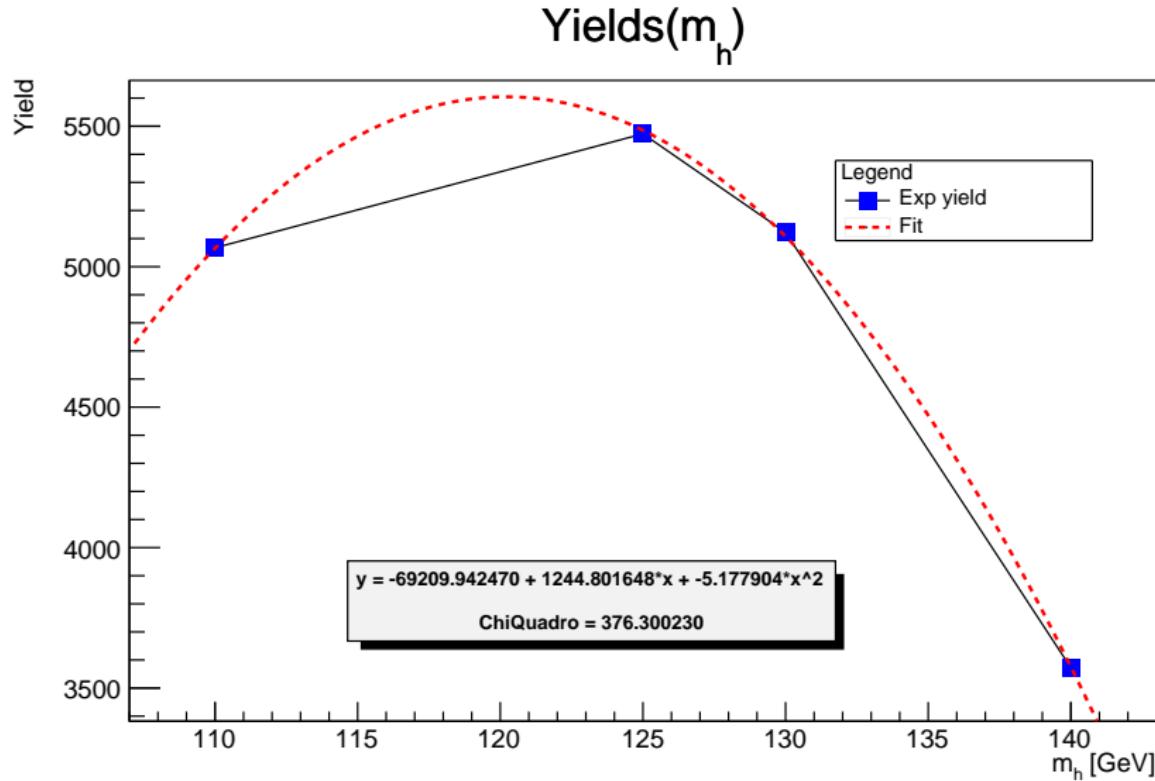


5° week

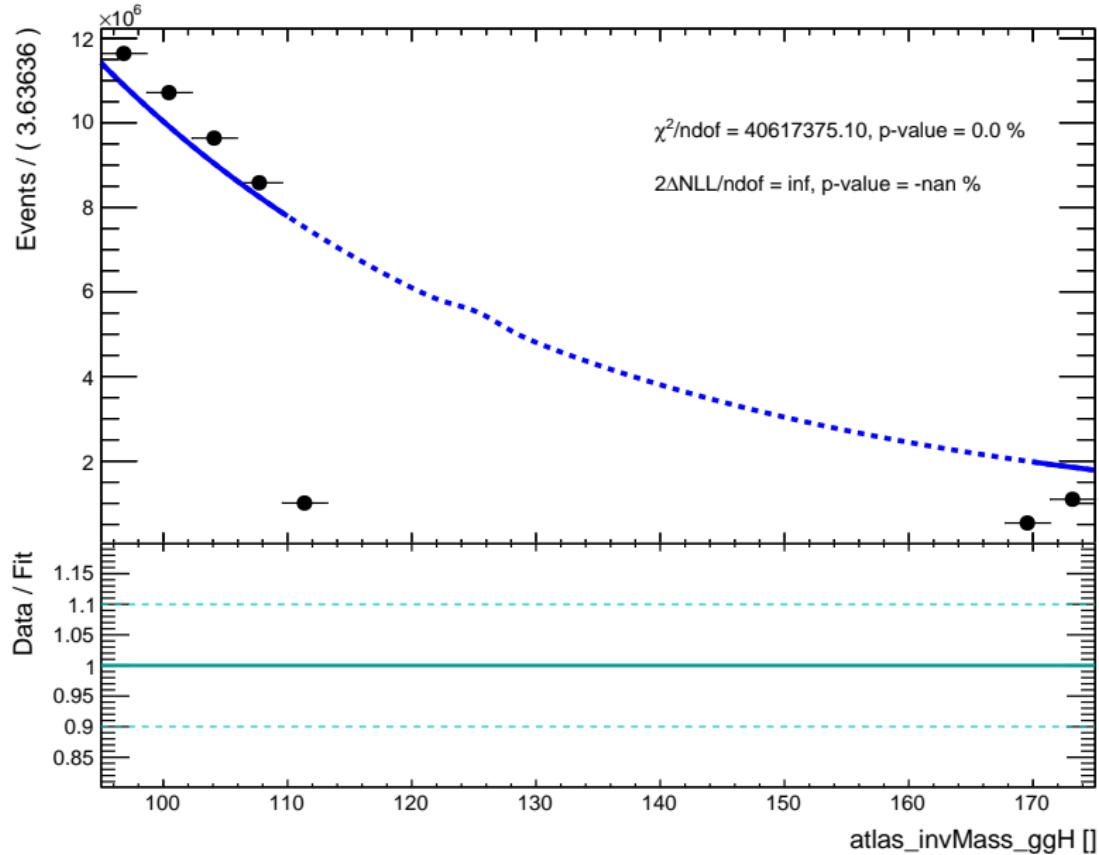
# Efficiencies( $m_H$ ) fit



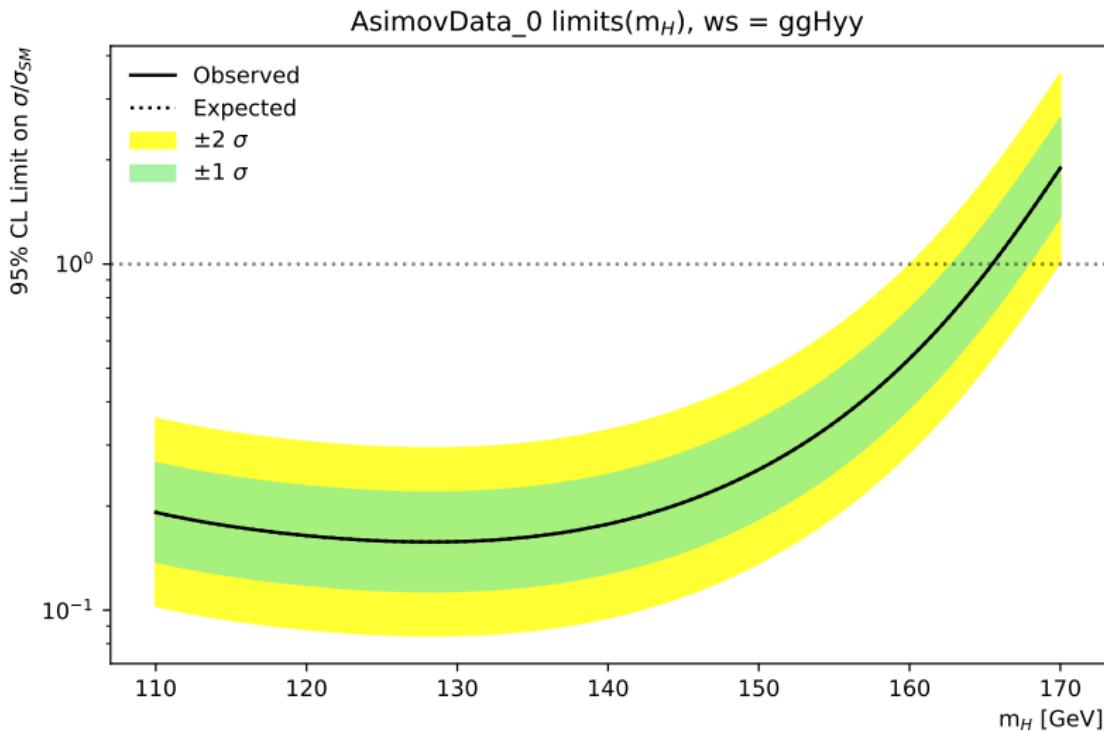
# Yields( $m_H$ ) fit



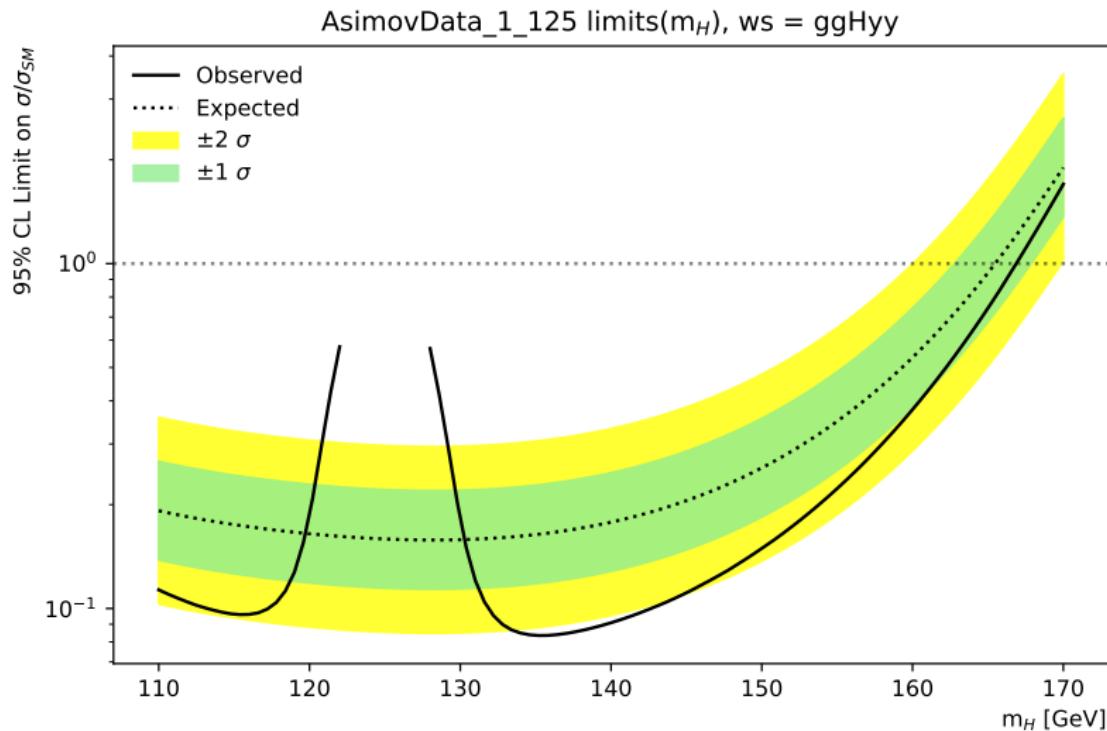
# Workspace



# AsimovDataset $\mu = 0$



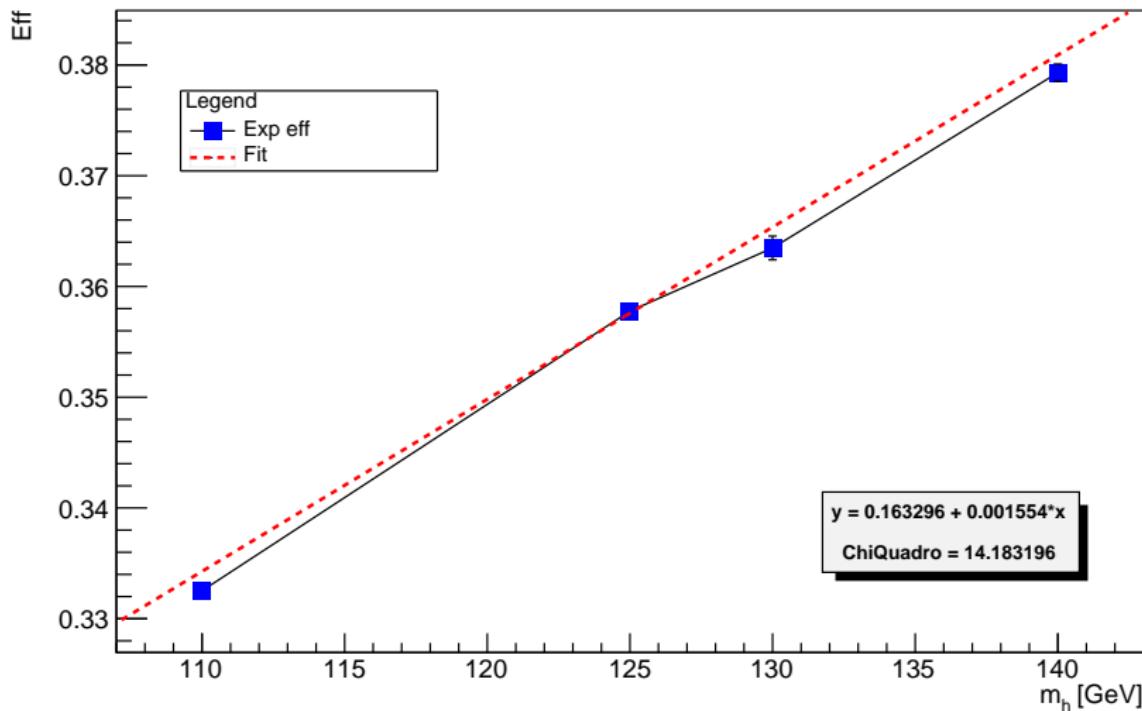
# AsimovDataset $\mu = 1$ and $m_H = 125$



6° week

# Efficiencies( $m_H$ ) fit

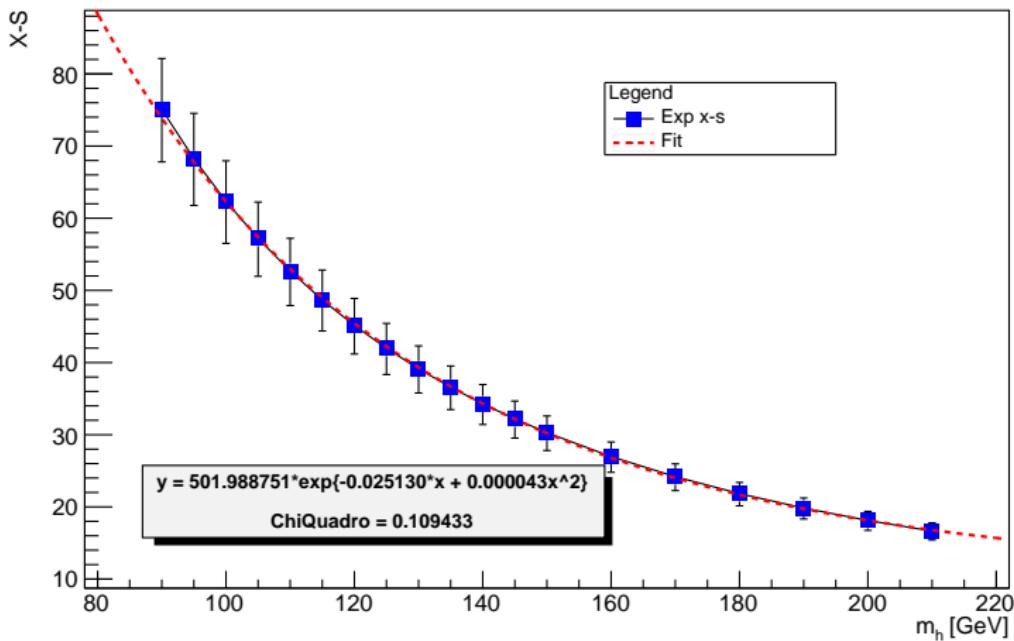
Efficiencies( $m_h$ )



# X-Section(mH)

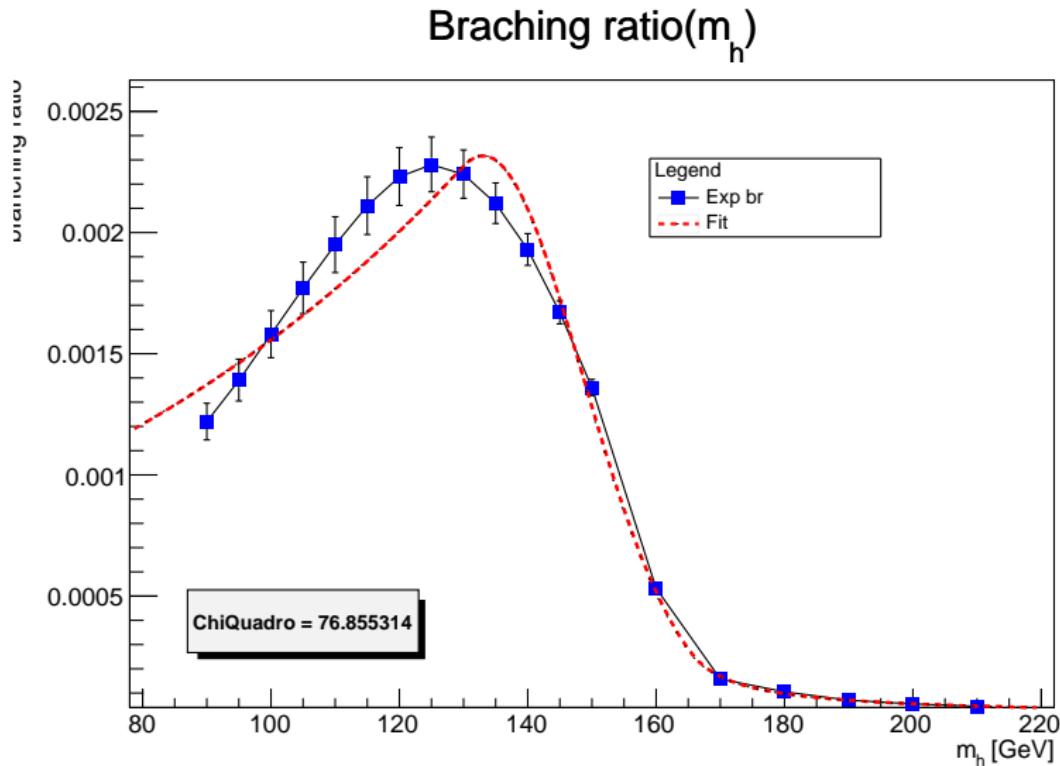
x-section values → [link](#). Errors are evaluated using QCD and (Pdf+ $\alpha$ ) % errors (Quadratic sum).

Cross section(m<sub>h</sub>)

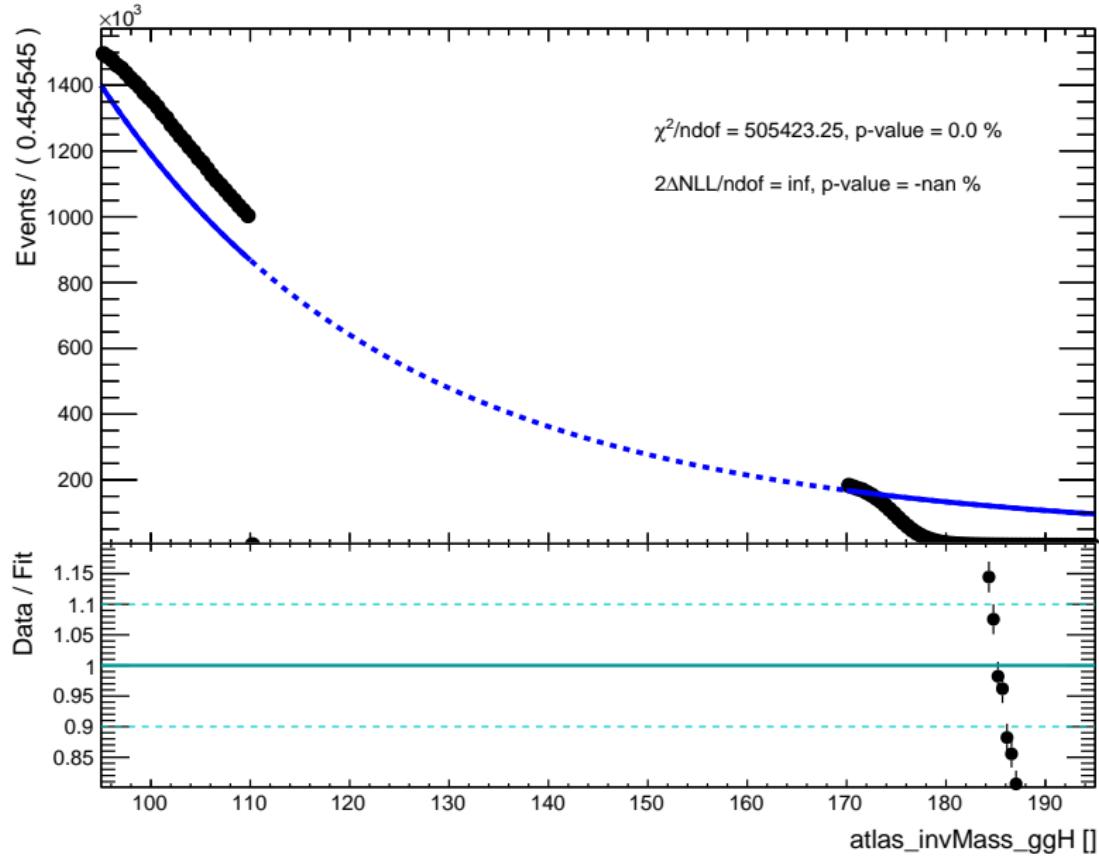


# Branching Fraction(mH)

br values -> [link](#).



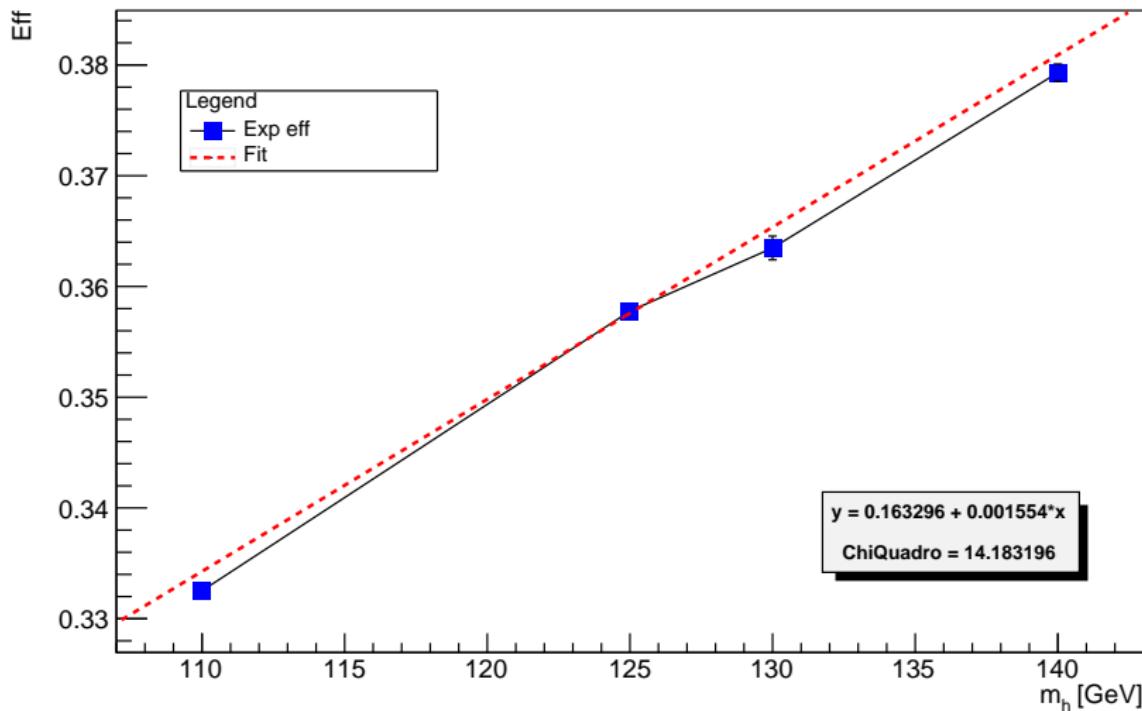
# Workspace



7° week

# Efficiencies( $m_H$ ) fit

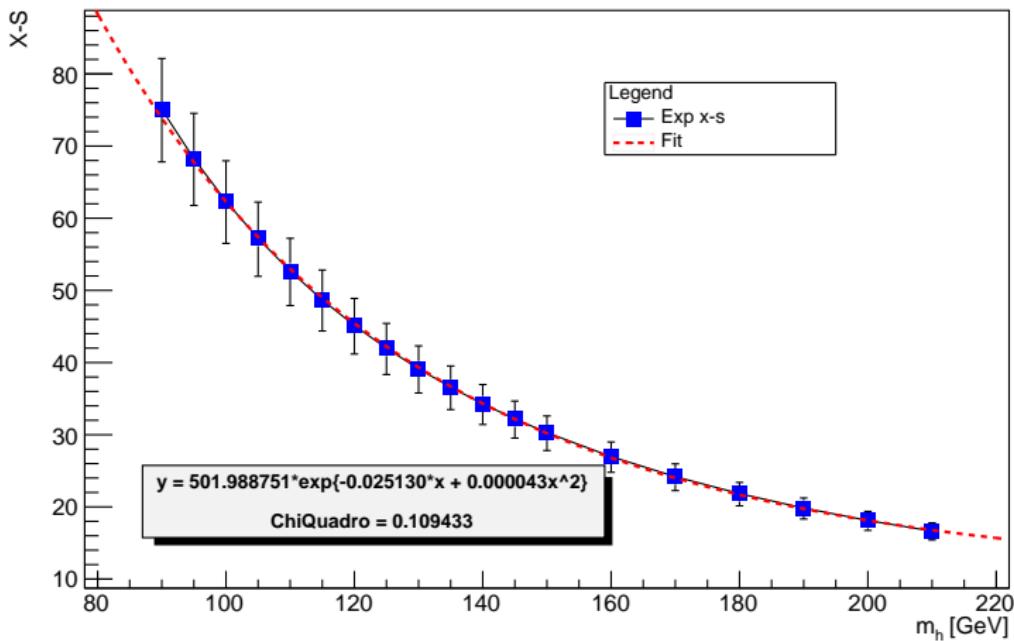
Efficiencies( $m_h$ )



# X-Section(mH)

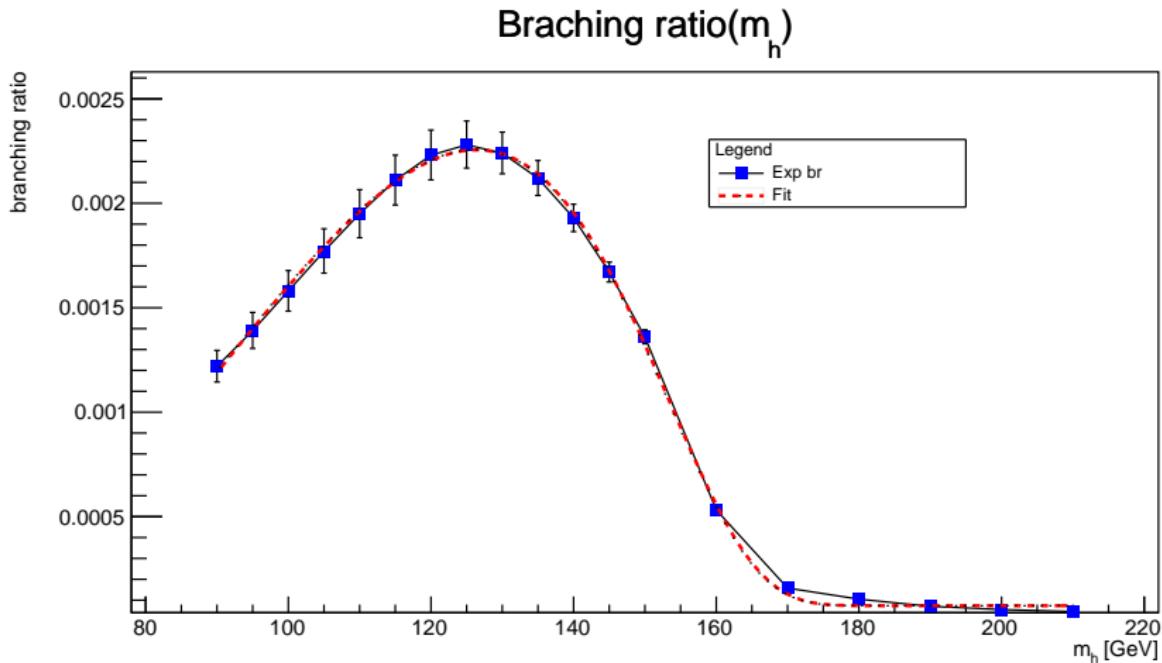
x-section values → [link](#). Errors are evaluated using QCD and (Pdf+ $\alpha$ ) % errors (Quadratic sum).

Cross section(m<sub>h</sub>)



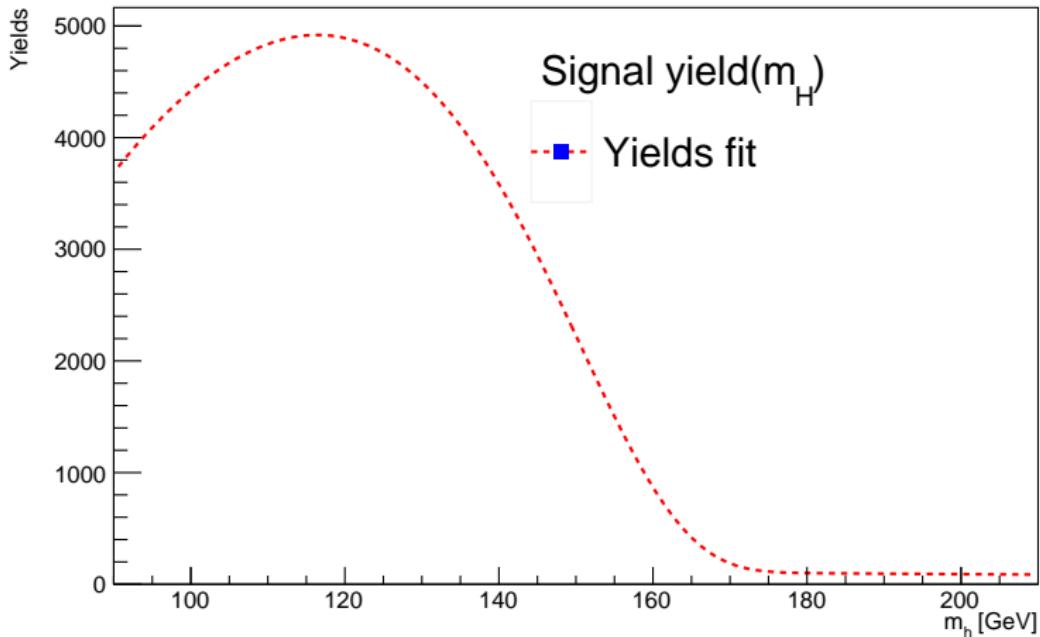
# Branching Fraction(mH)

br values -> [link](#).

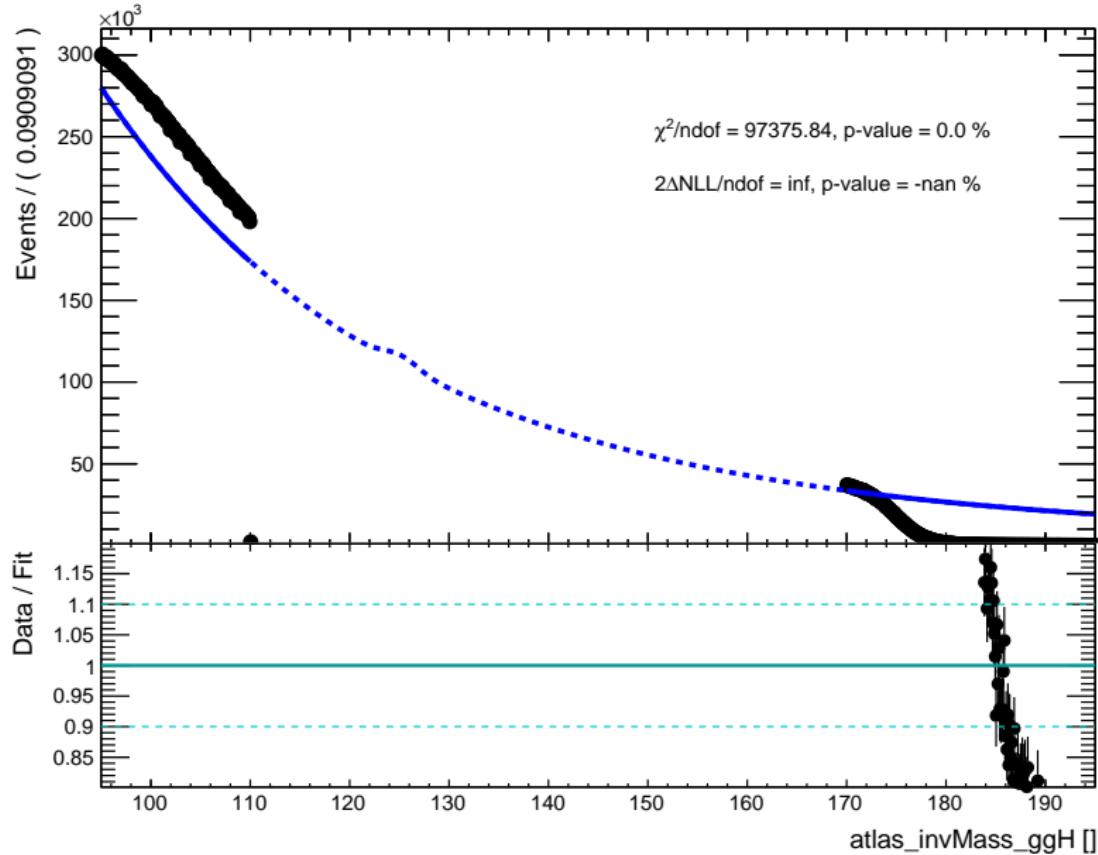


# Check yields( $mH$ )

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

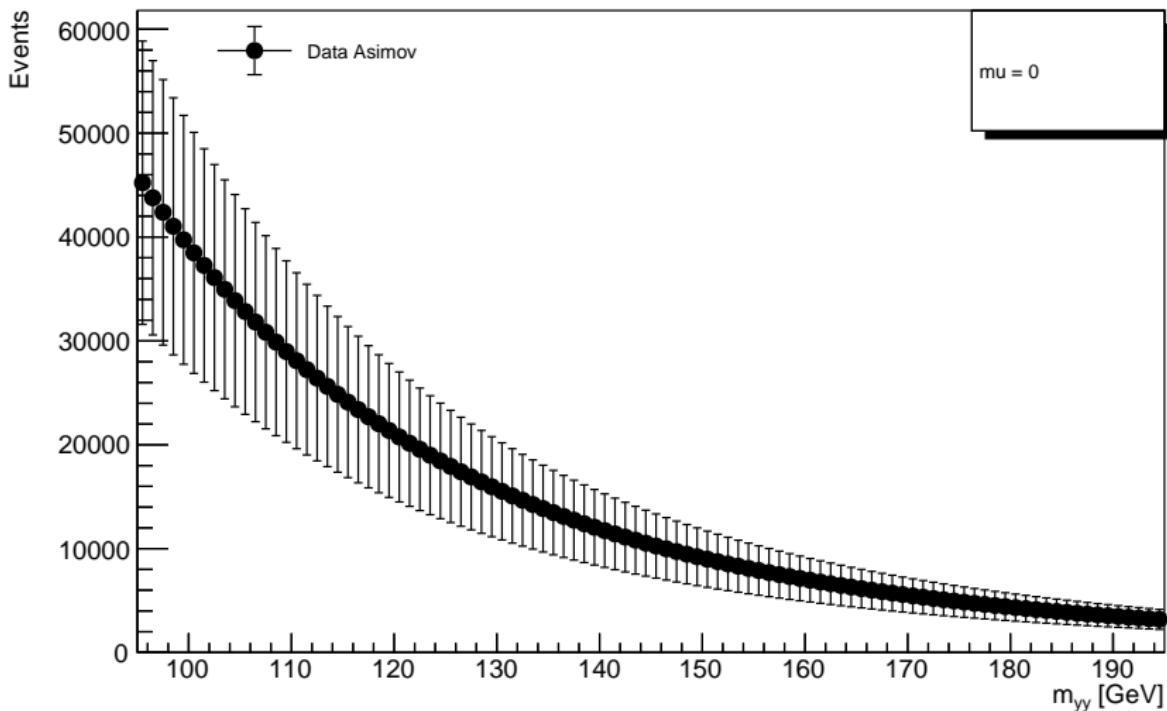


# Workspace ggHyy\_MCpdf

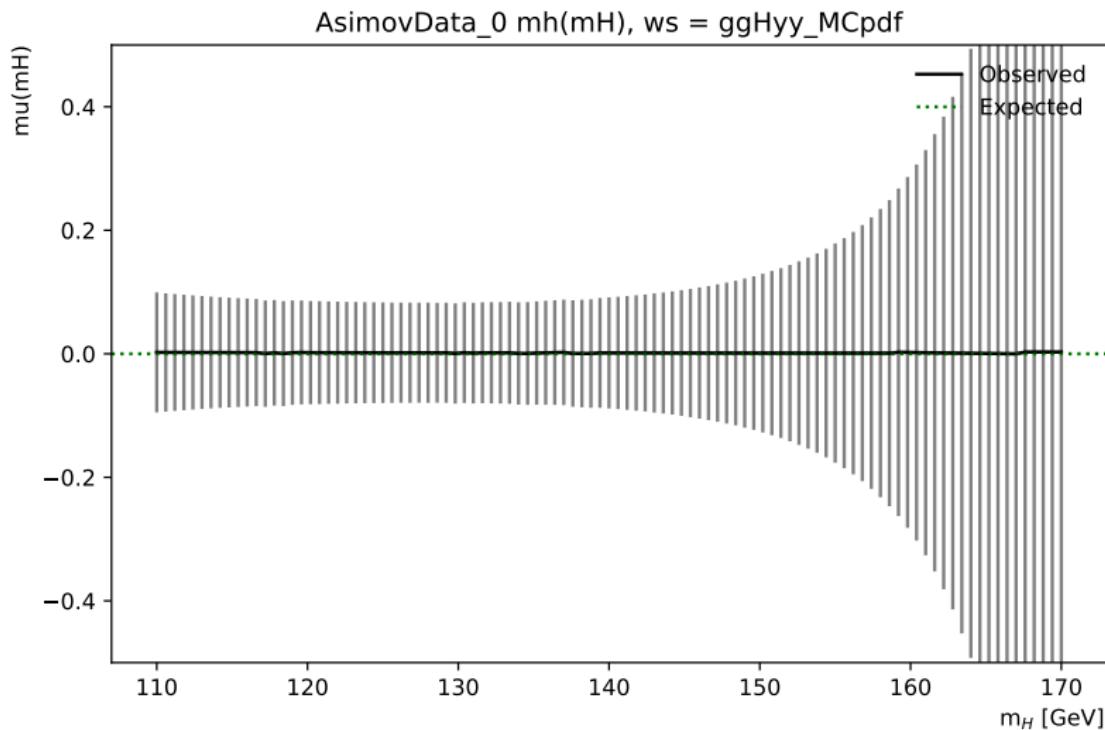


# AsimovData $\mu=0$ , ggHyy\_MCpdf

AsimovData\_0, ws = ggHyy\_MCpdf

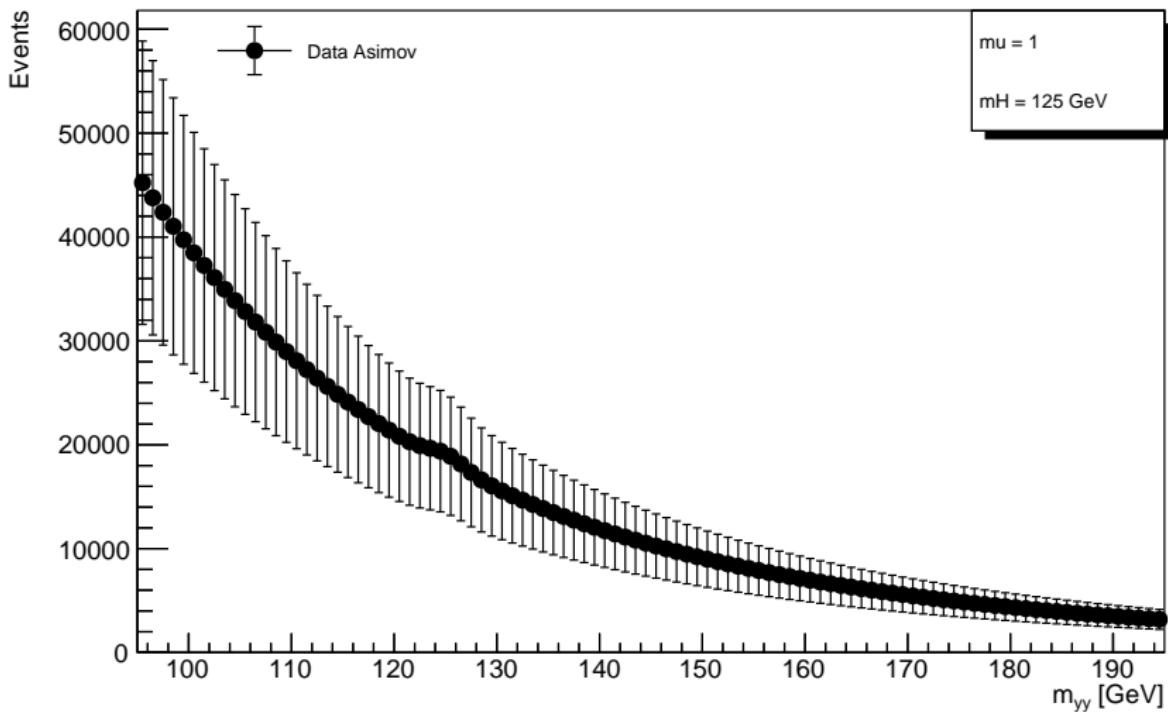


# AsimovData $\mu(m_H)$ , ggHyy\_MCpdf

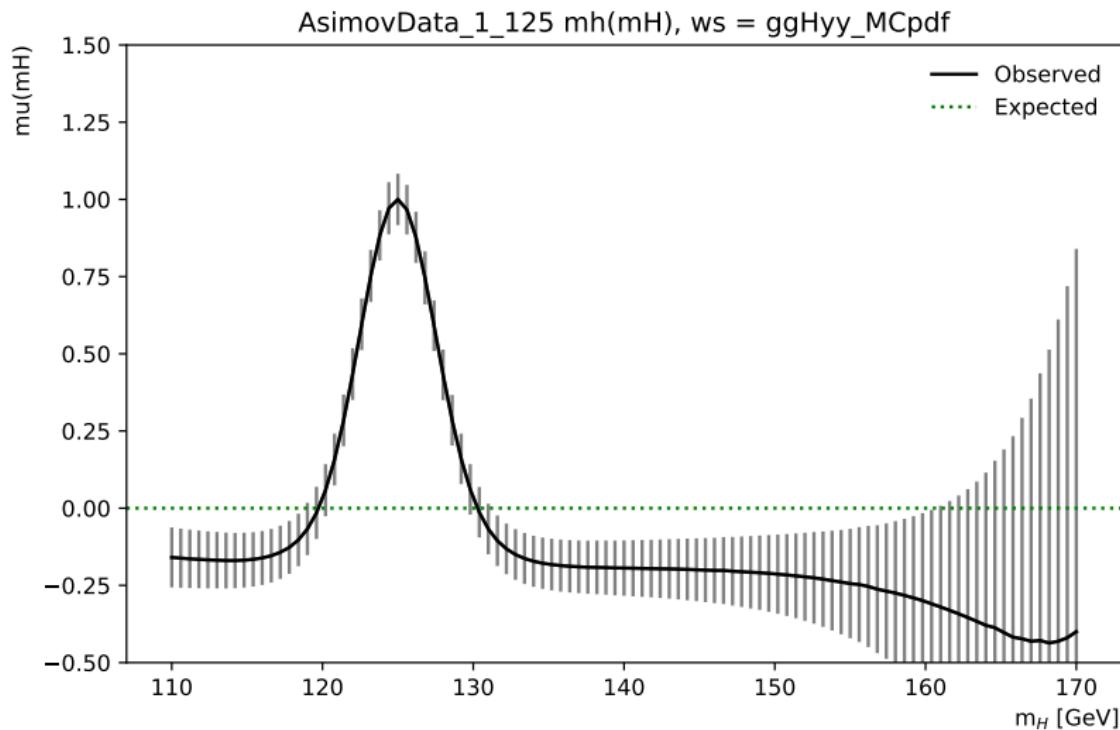


# AsimovData $\mu=1$ , $m_H=125$ , ggHyy\_MCpdf

AsimovData\_1\_125, ws = ggHyy\_MCpdf

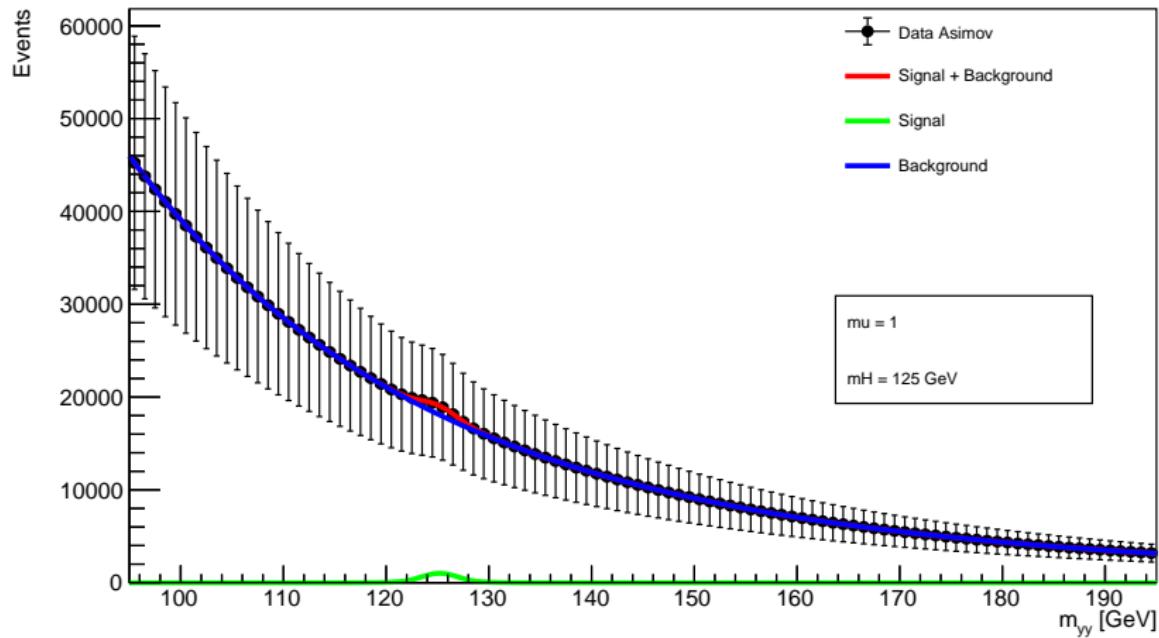


# AsimovData $\mu(m_H)$ , ggHyy\_MCpdf



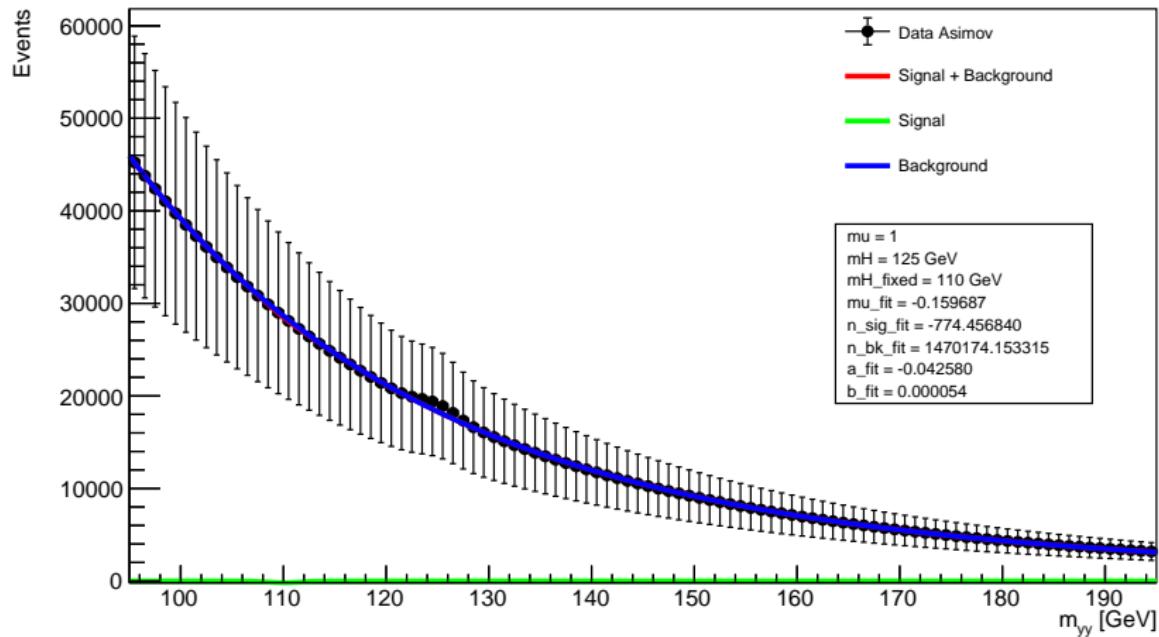
# AsimovData $\mu=1$ , $m_H=125$ + fit, ggHyy\_MCpdf

AsimovData\_1\_125 + pdfs, ws = ggHyy\_MCpdf

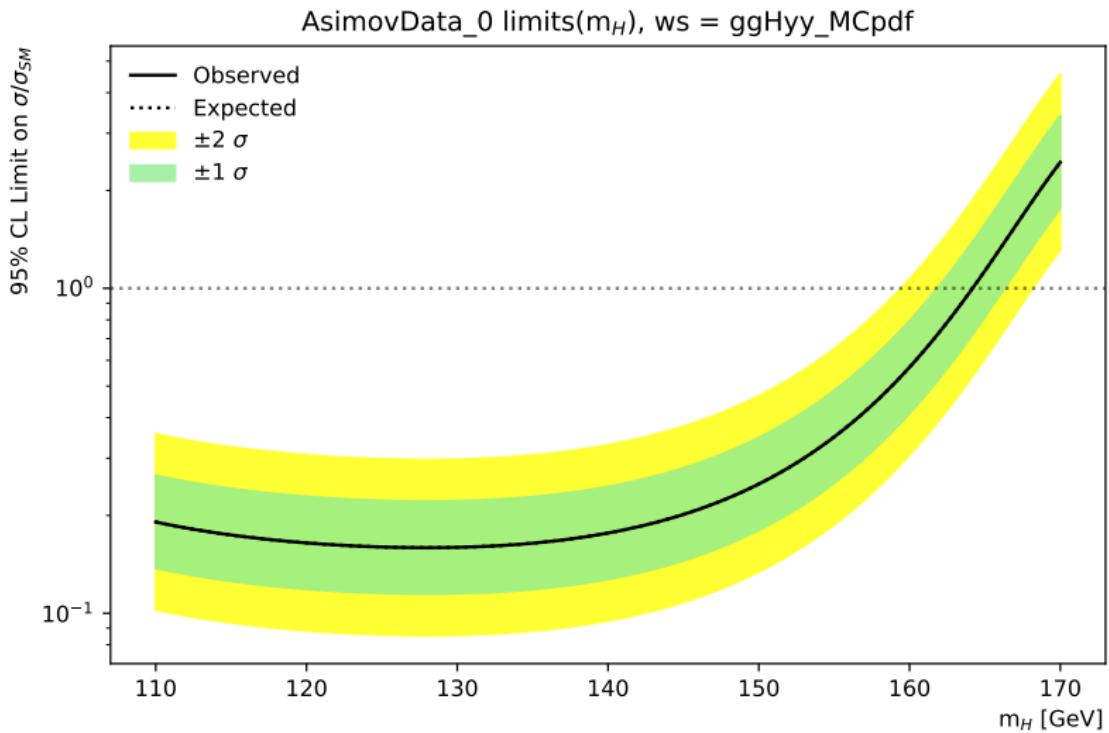


# AsimovData $\mu=1$ , $m_H=125$ + fit( $mH=110$ ), ggHyy\_MCpdf

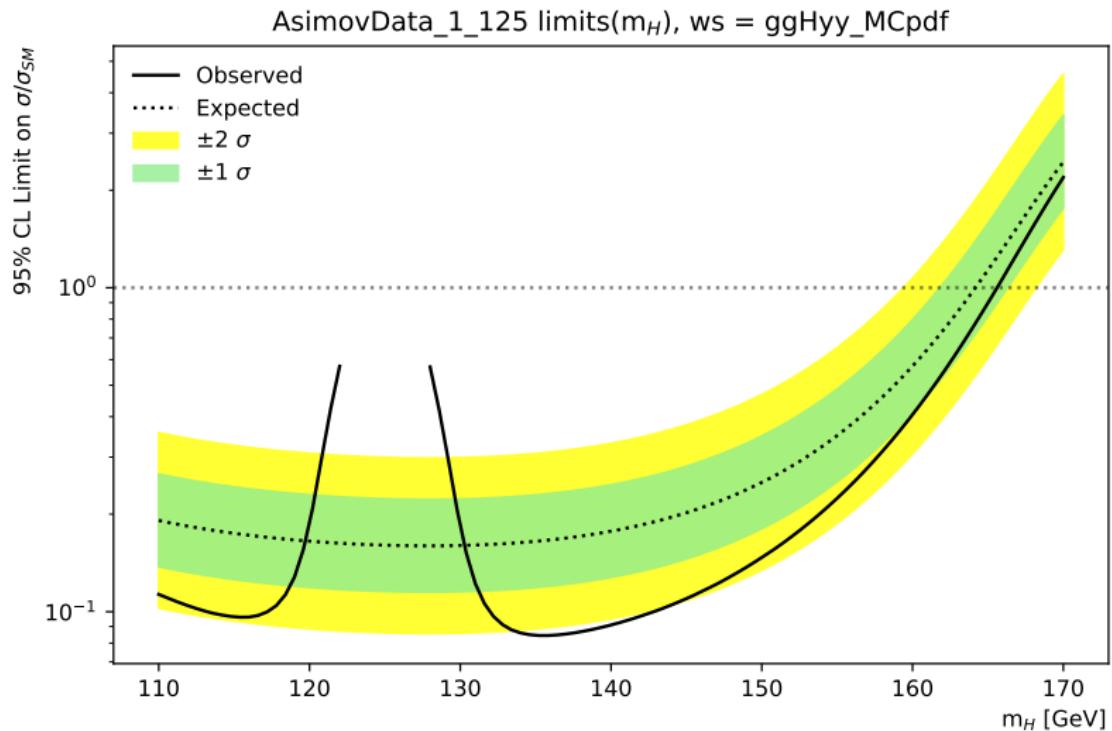
AsimovData\_1\_125 + pdfs( $mH = 110$ ), ws = ggHyy\_MCpdf



# AsimovData $\mu=0$ limits



# AsimovData $\mu=1$ , $m_H=125$ limits



8° week

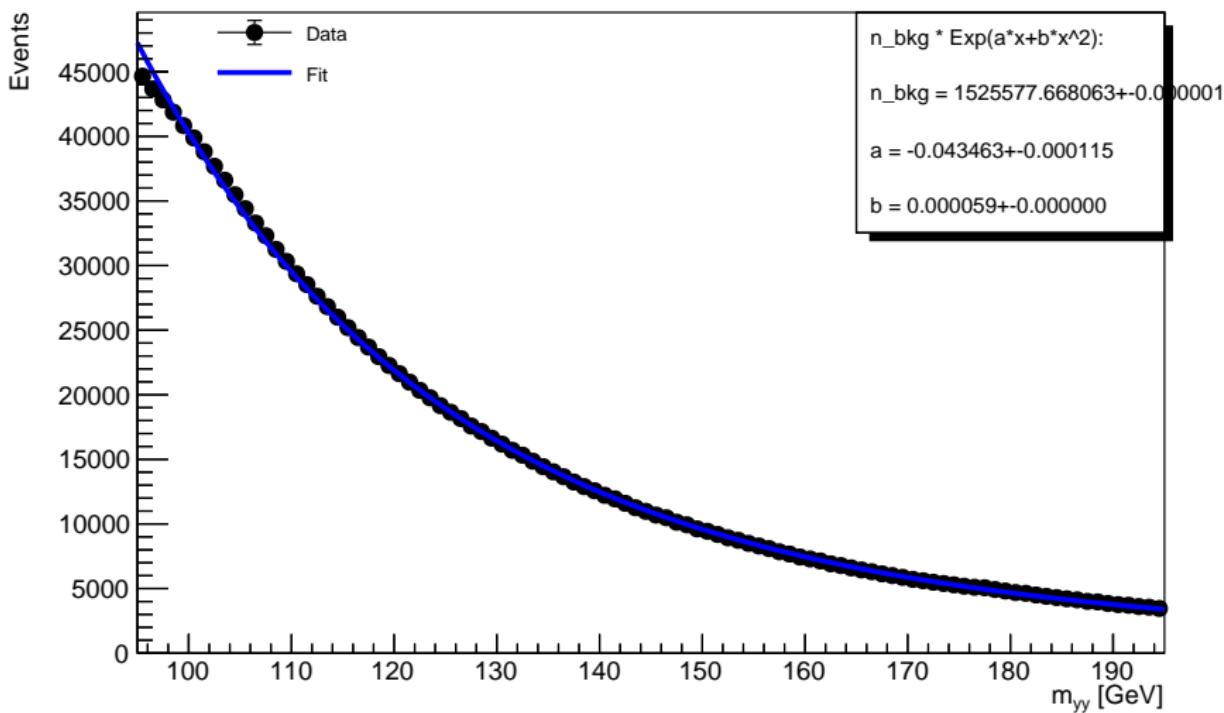
# Background [95,195] GeV

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

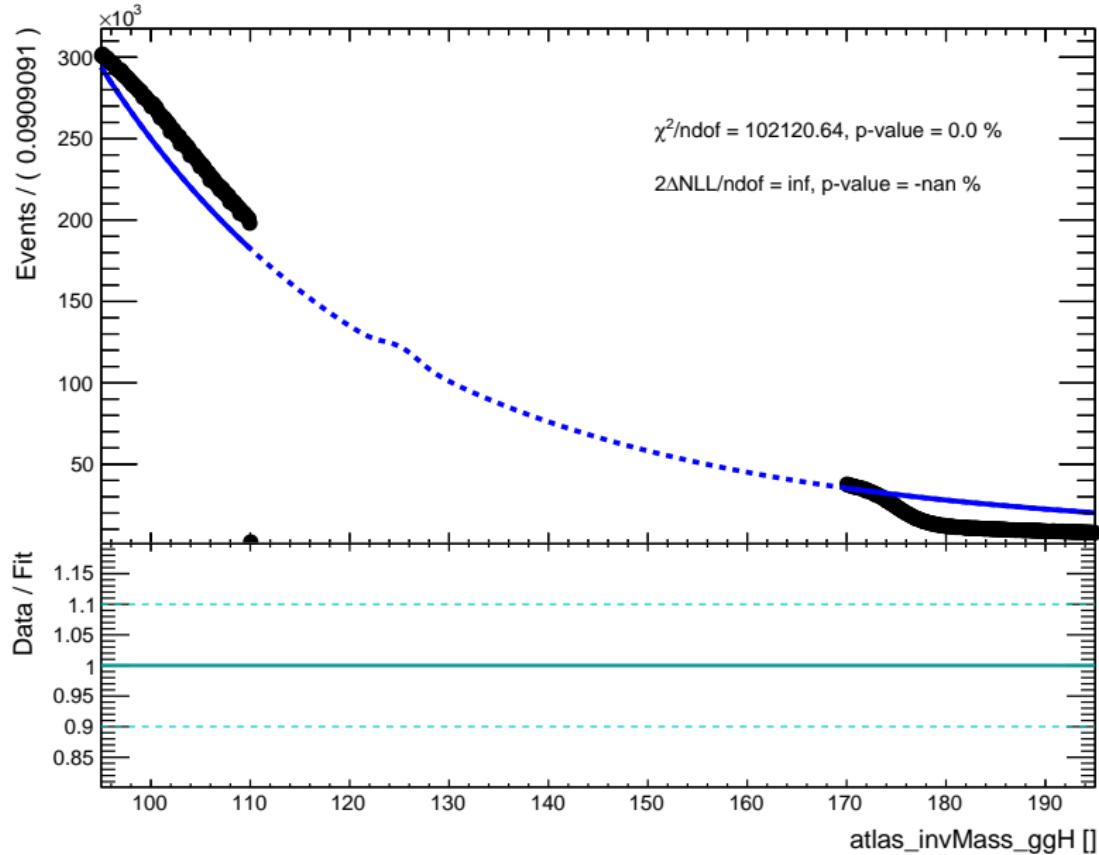
- Sherpa2\_myy\_50\_90.root;
- Sherpa2\_myy\_90\_175.root;
- Sherpa2\_myy\_175\_2000.root;

# Background [95,195] GeV plot + bkg\_fit

[95,195] GeV background plot + fit

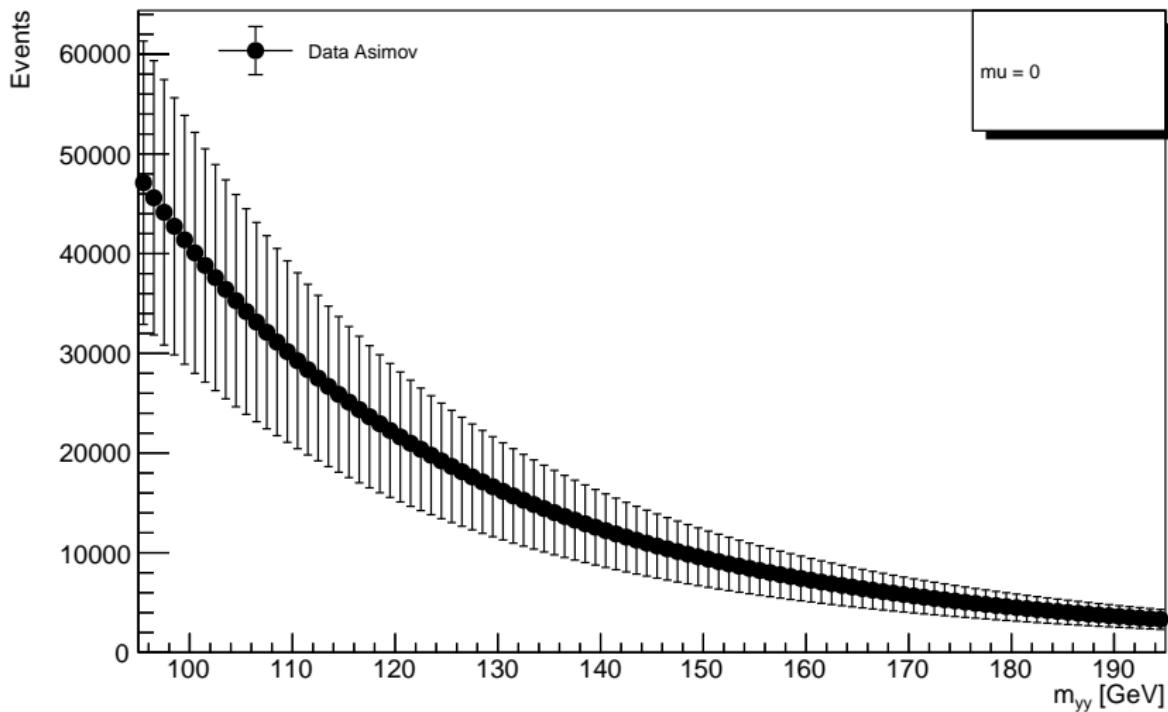


# Workspace ggHyy\_MC

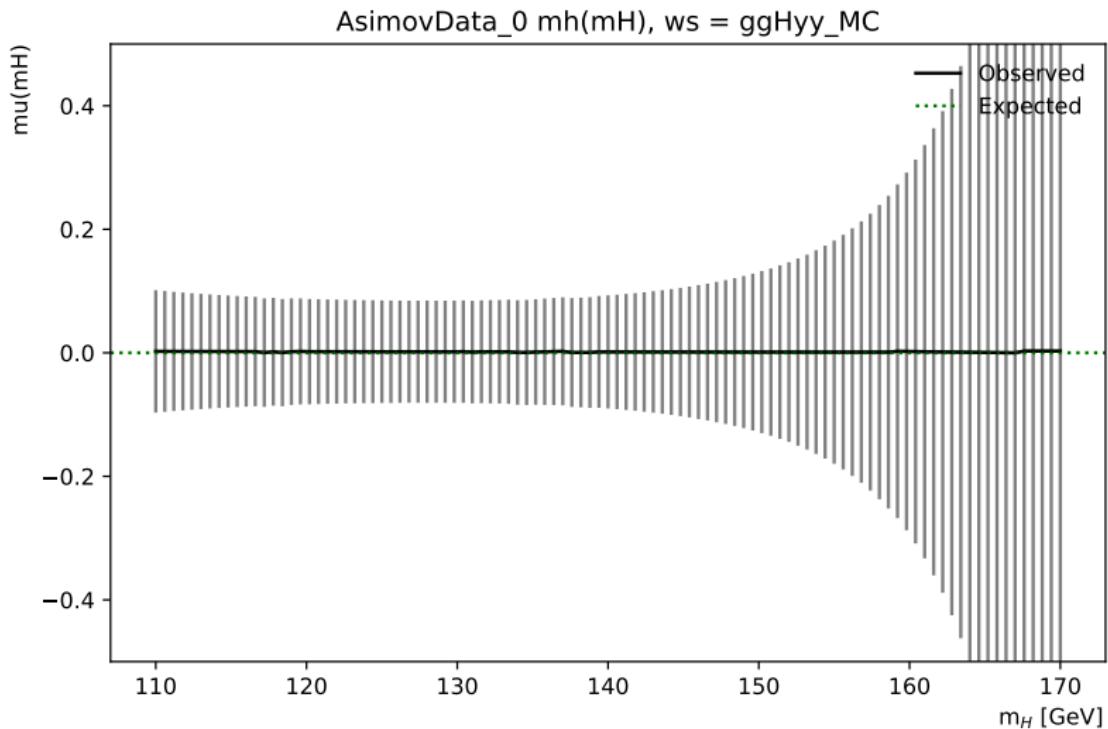


# AsimovData $\mu=0$ , ggHyy\_MC

AsimovData\_0, ws = ggHyy\_MC

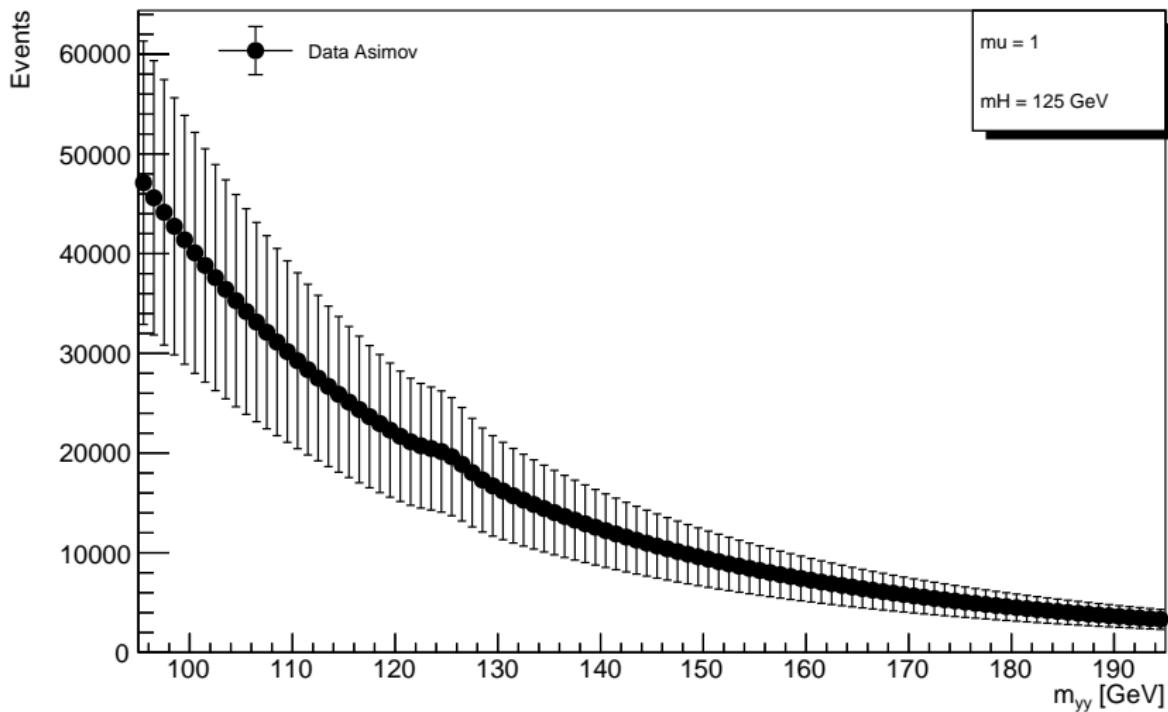


# AsimovData $\mu(m_H)$ , ggHyy\_MC

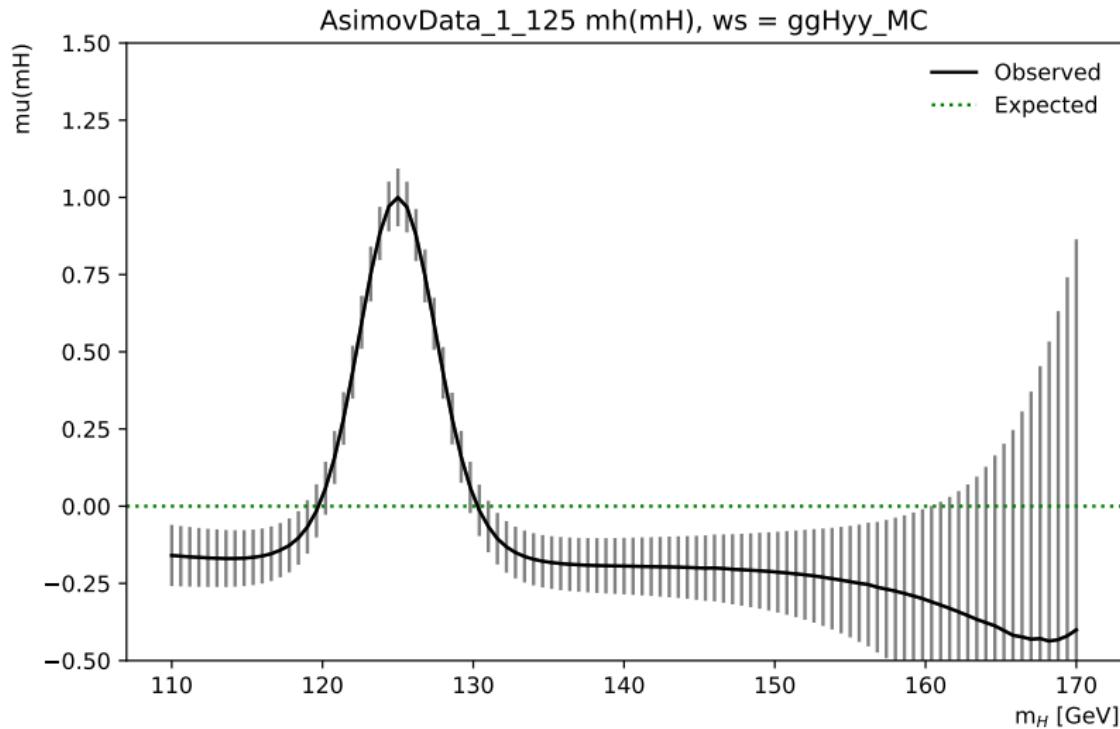


# AsimovData $\mu=1$ , $m_H=125$ , ggHyy\_MC

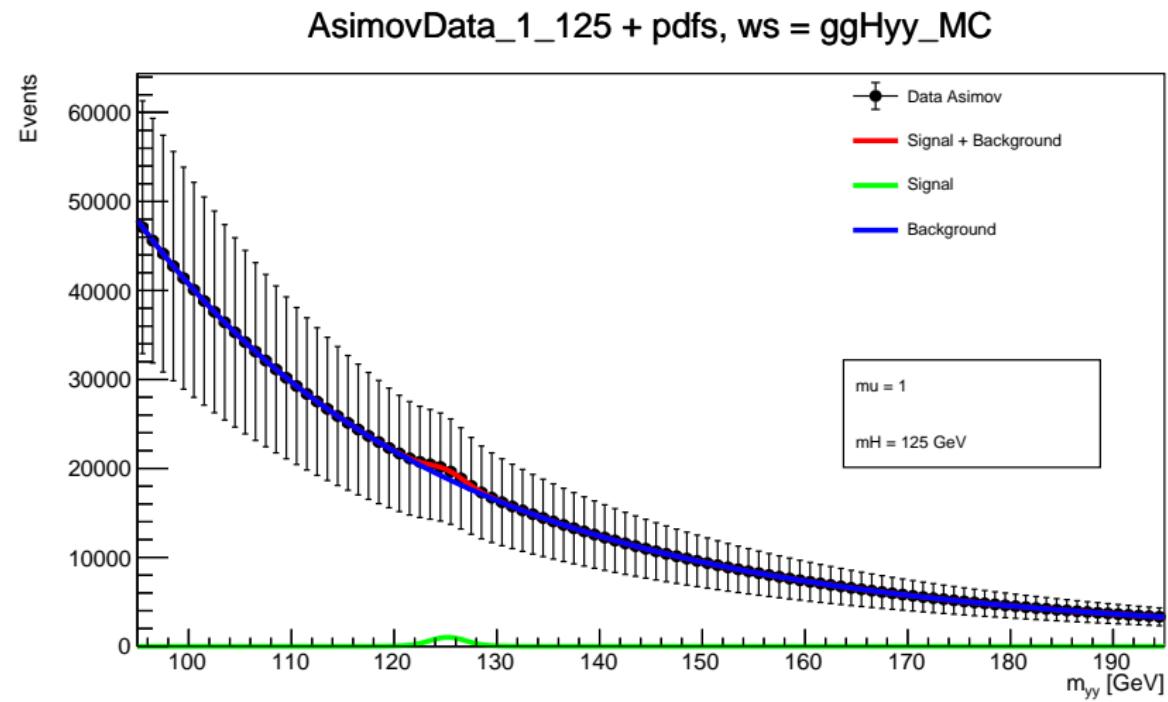
AsimovData\_1\_125, ws = ggHyy\_MC



# AsimovData $\mu(m_H)$ , ggHyy\_MC

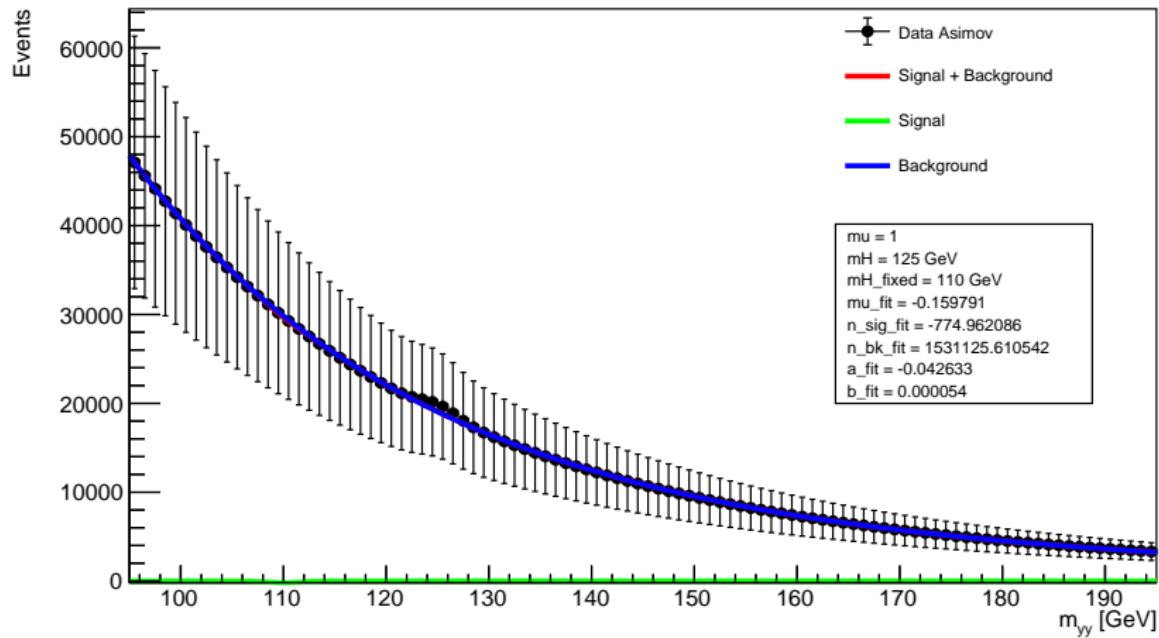


# AsimovData $\mu=1$ , $m_H=125$ + fit, ggHyy\_MC

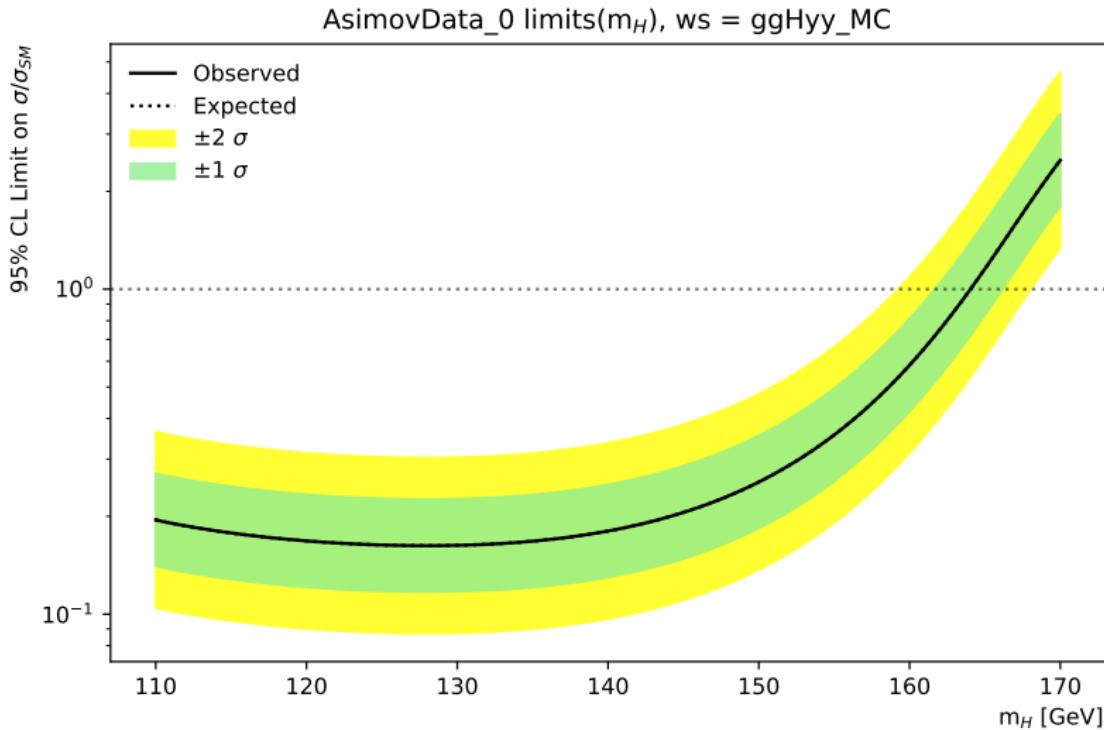


# AsimovData $\mu=1$ , $m_H=125$ + fit( $mH=110$ ), ggHy\_MC

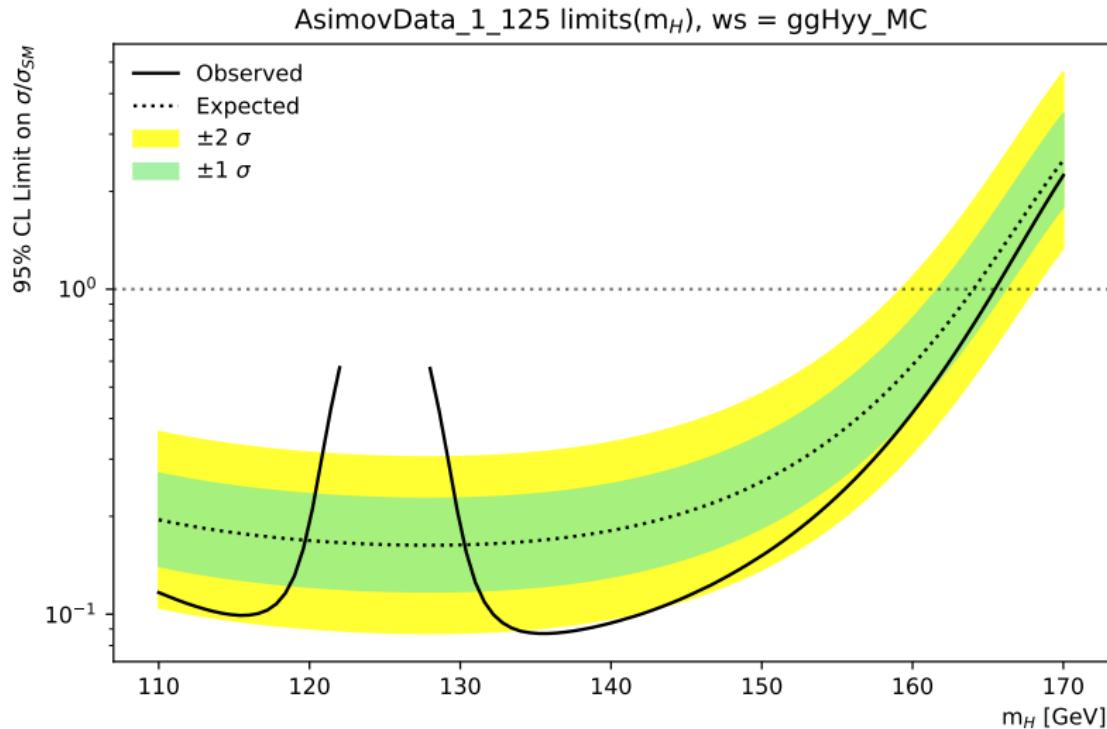
AsimovData\_1\_125 + pdfs( $mH = 110$ ), ws = ggHy\_MC



# AsimovData $\mu=0$ limits



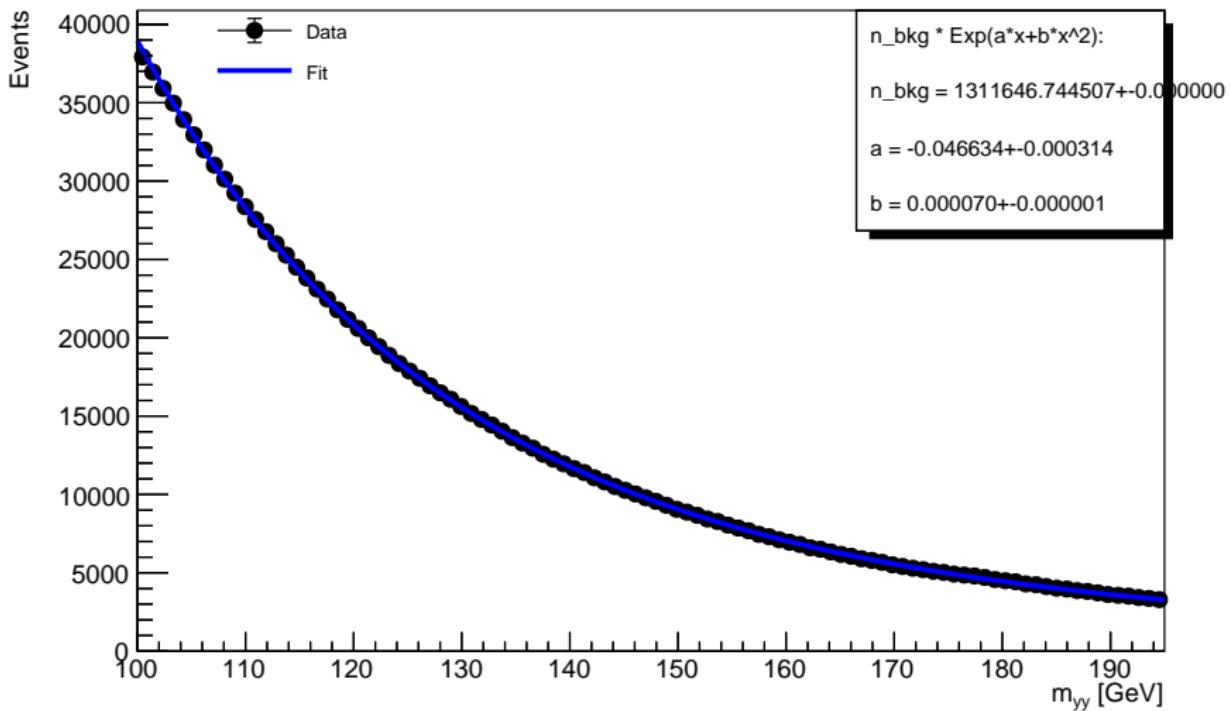
# AsimovData $\mu=1$ , $m_H=125$ limits



9° week

# Background [100,195] GeV plot + bkg\_fit

[100,195] GeV background plot + fit



# Categories

- **unconv**: 2 unconv photons ( $\text{ph*}_\text{Rconv} \in ]0, 800[\text{ mm}$ )
- **1\_conv**: only 1 conv photon ( $\text{ph*}_\text{Rconv} \in (0, 800)\text{ mm}$ )
- **eta\_1**: 2 phs in the inner eta region ( $|\text{ph*}_\text{eta}| < 0.75$ )
- **eta\_2**: at least 1 ph in the trans eta region ( $1.3 < |\text{ph*}_\text{eta}| < 1.37$ ,  
 $1.52 < |\text{ph*}_\text{eta}| < 1.75$ )
- **eta\_3**: 2 phs in ext eta region ( $|\text{ph*}_\text{eta}| > 1.75$ )

# Categories

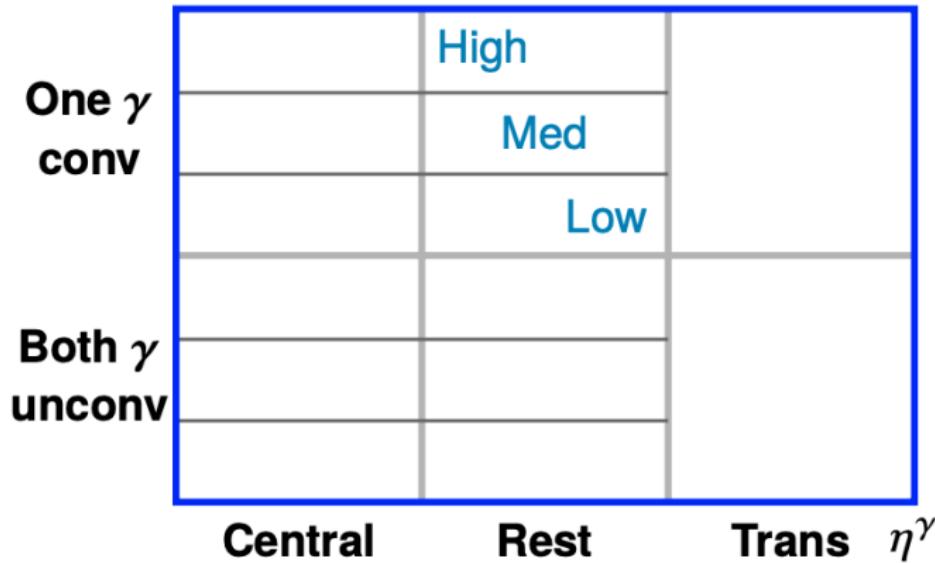
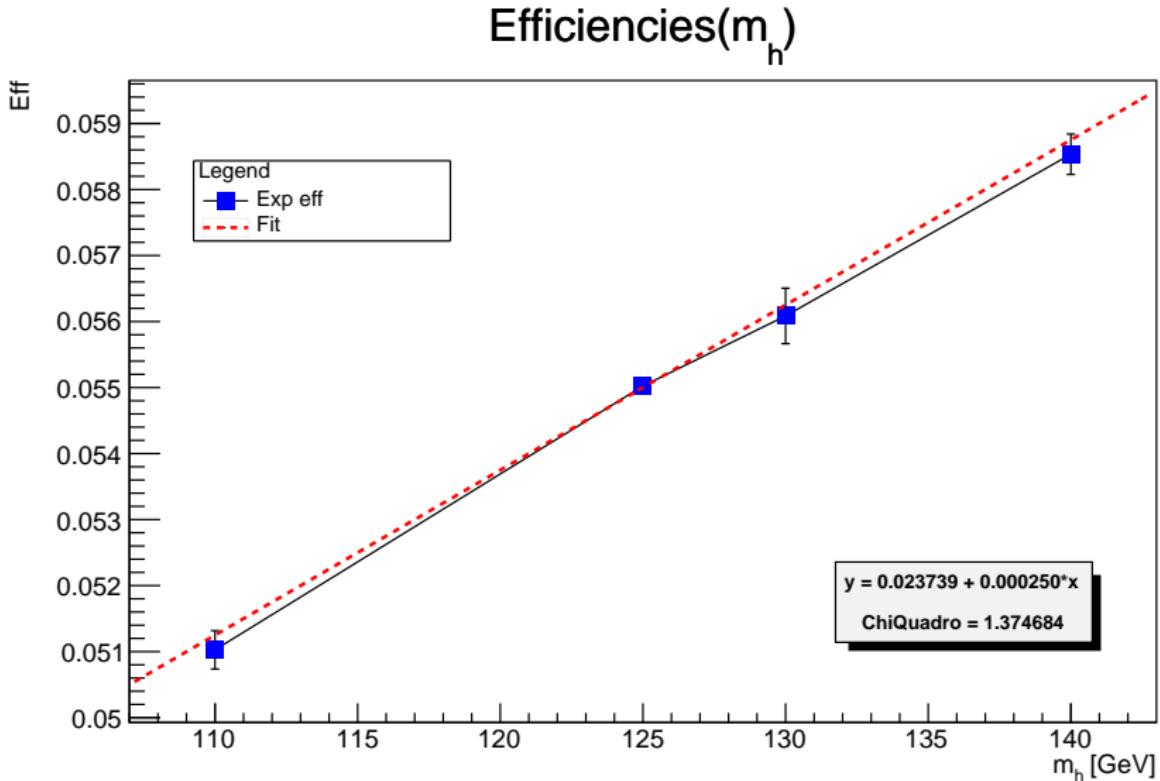
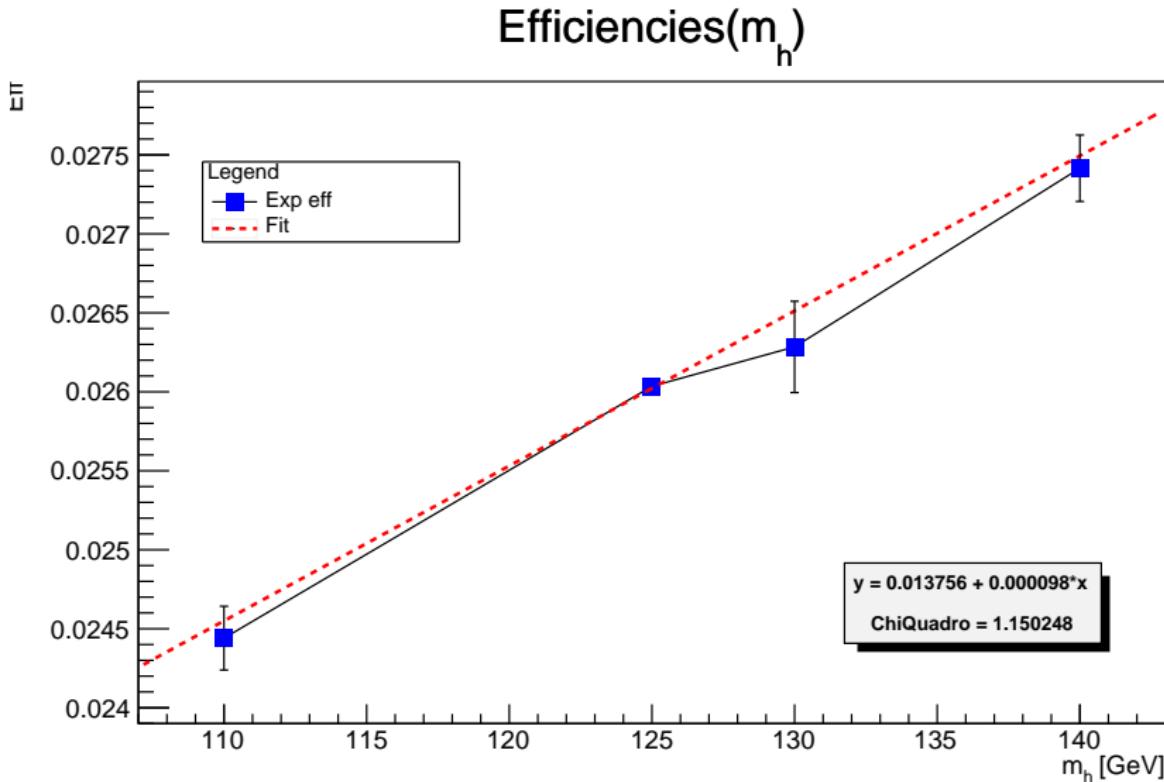


Figure 2: Simple sketch showing the mass analysis categories.

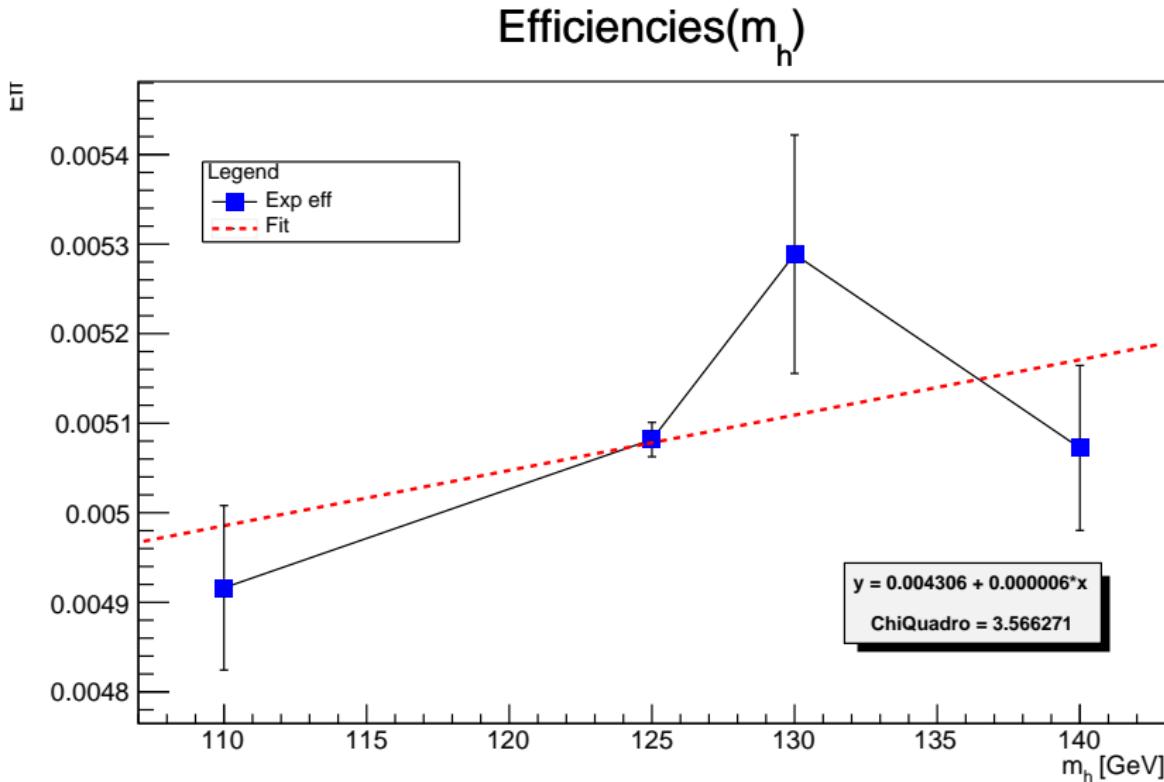
# Eff unconv eta\_1



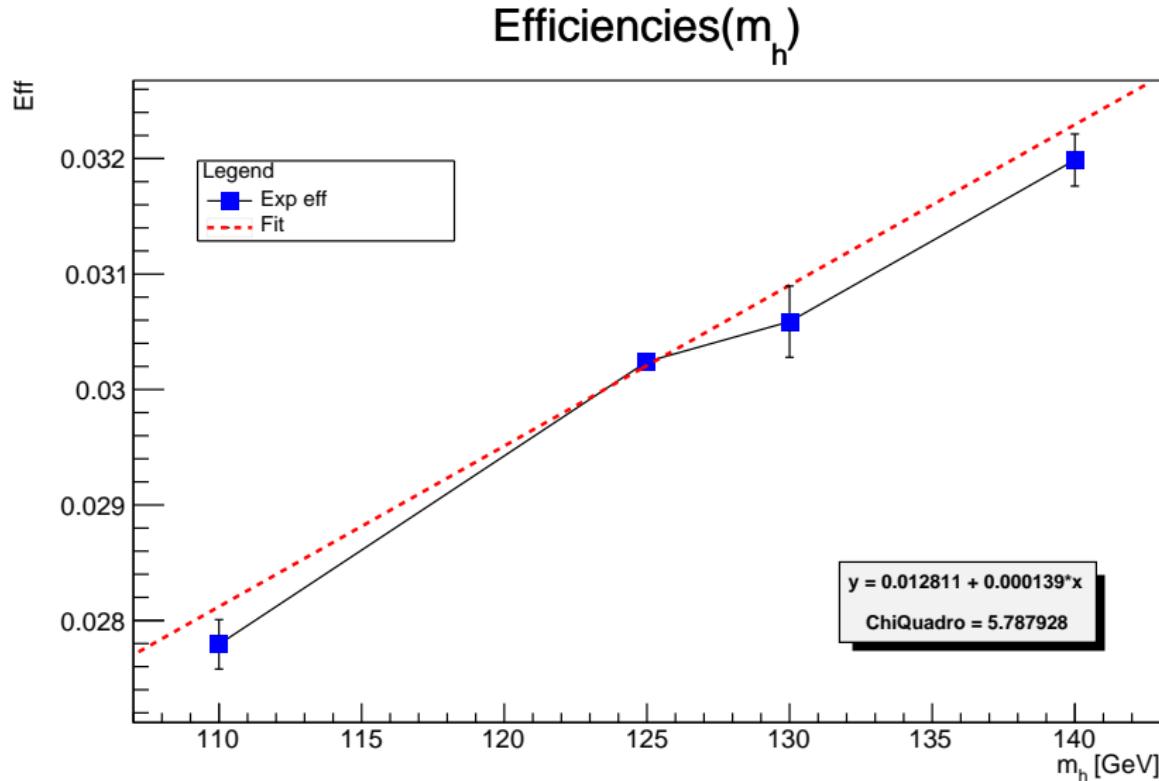
# Eff unconv eta\_2



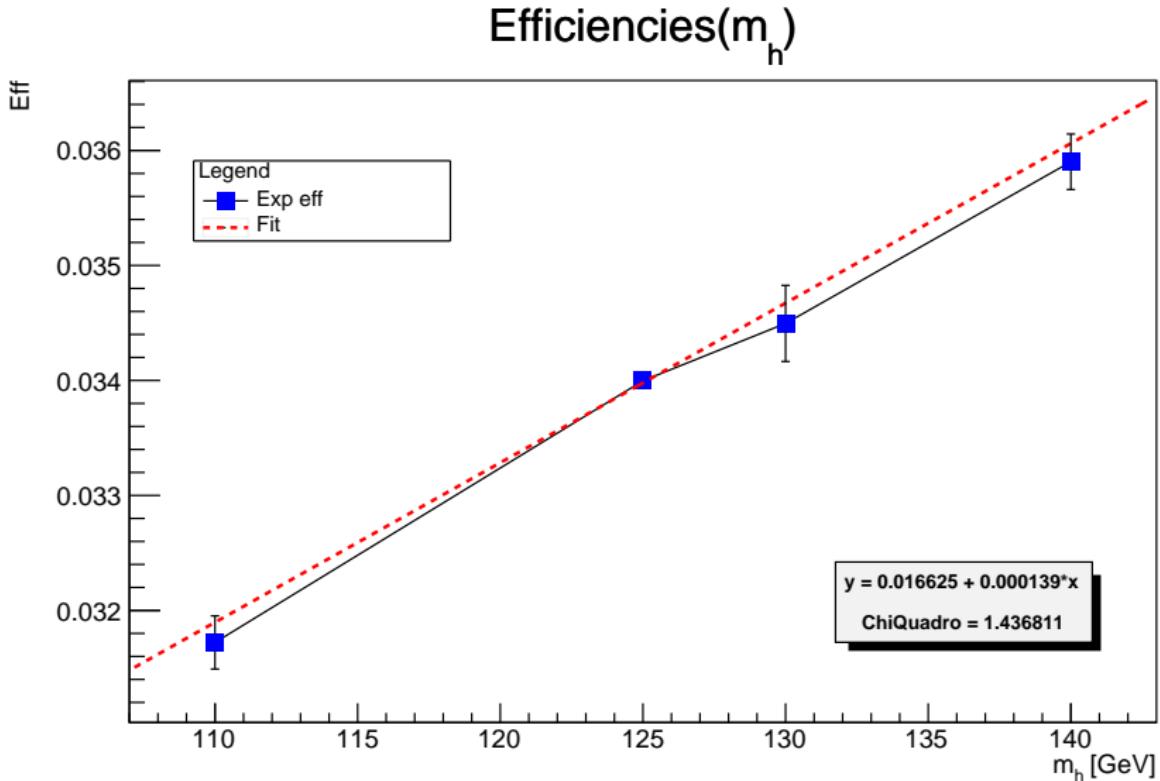
# Eff unconv eta\_3



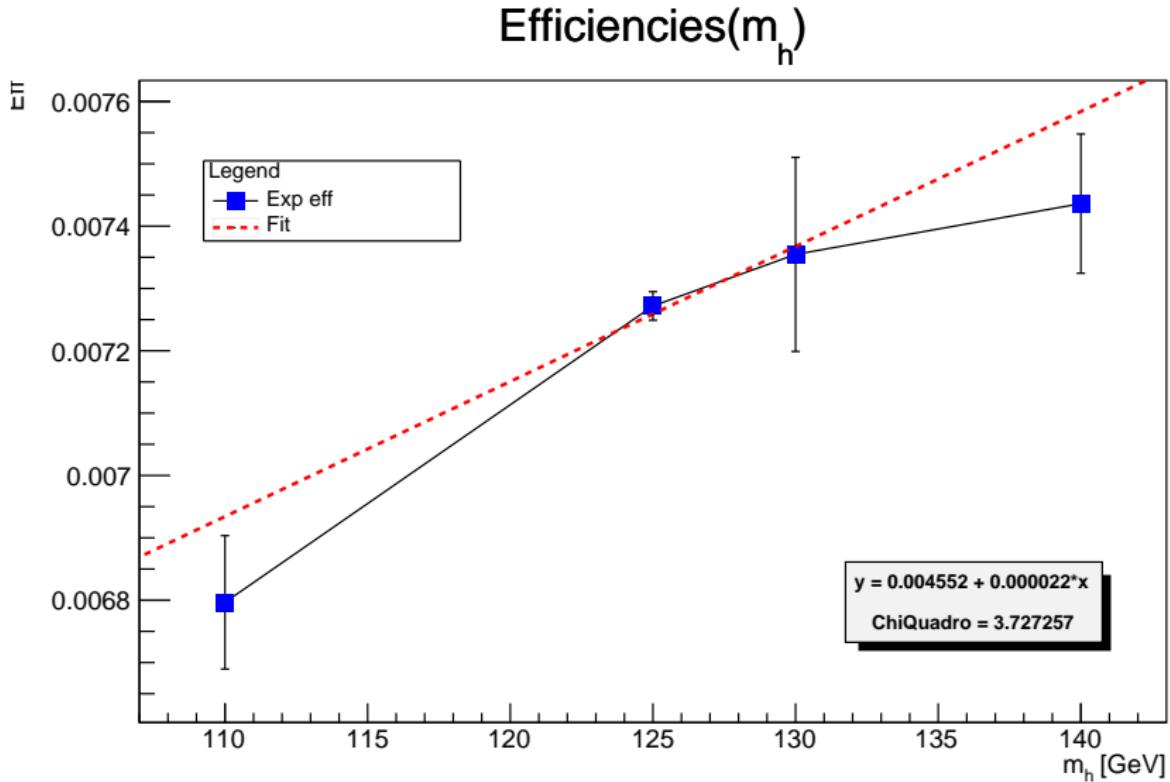
# Eff 1\_conv eta\_1



# Eff 1\_conv eta\_2

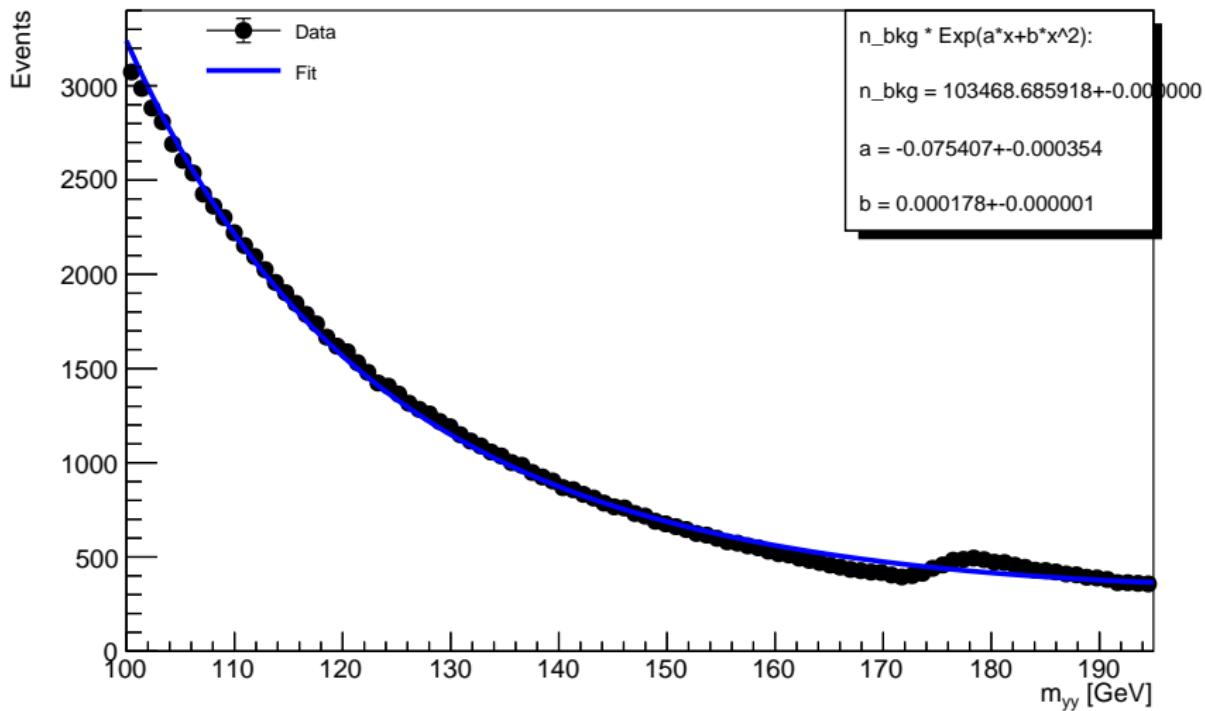


# Eff 1\_conv eta\_3



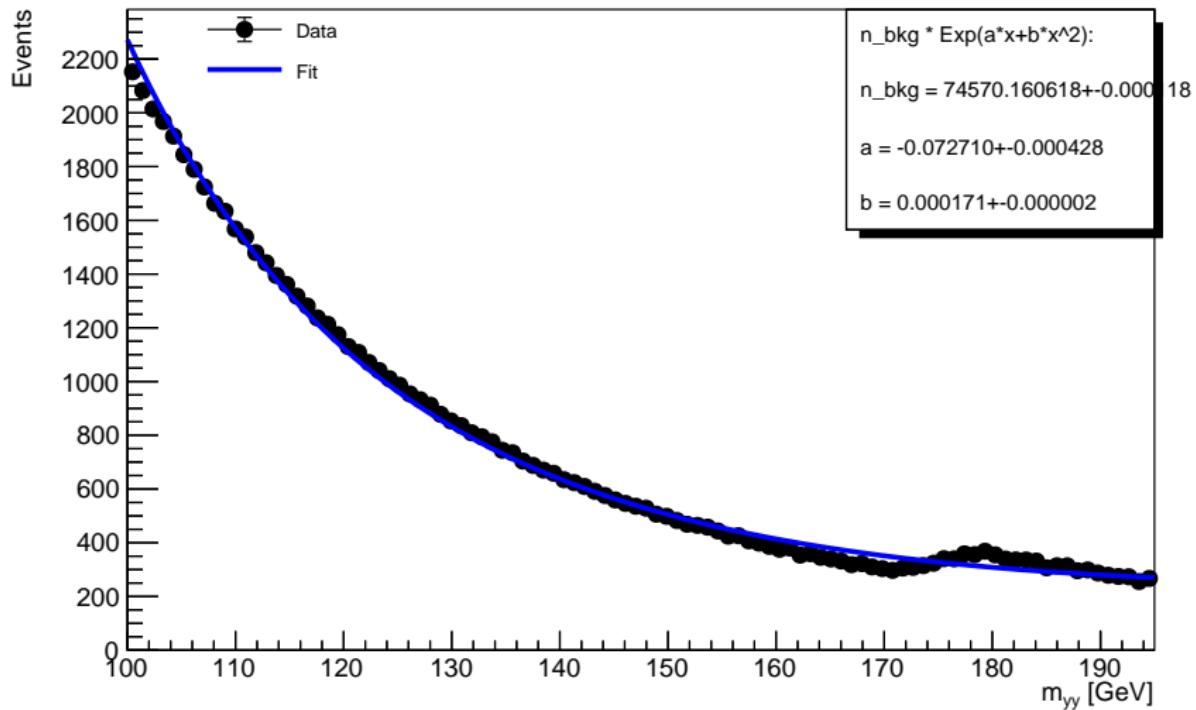
# Bkg unconv eta\_1

[100,195] GeV background plot + fit (unconv,eta\_1)



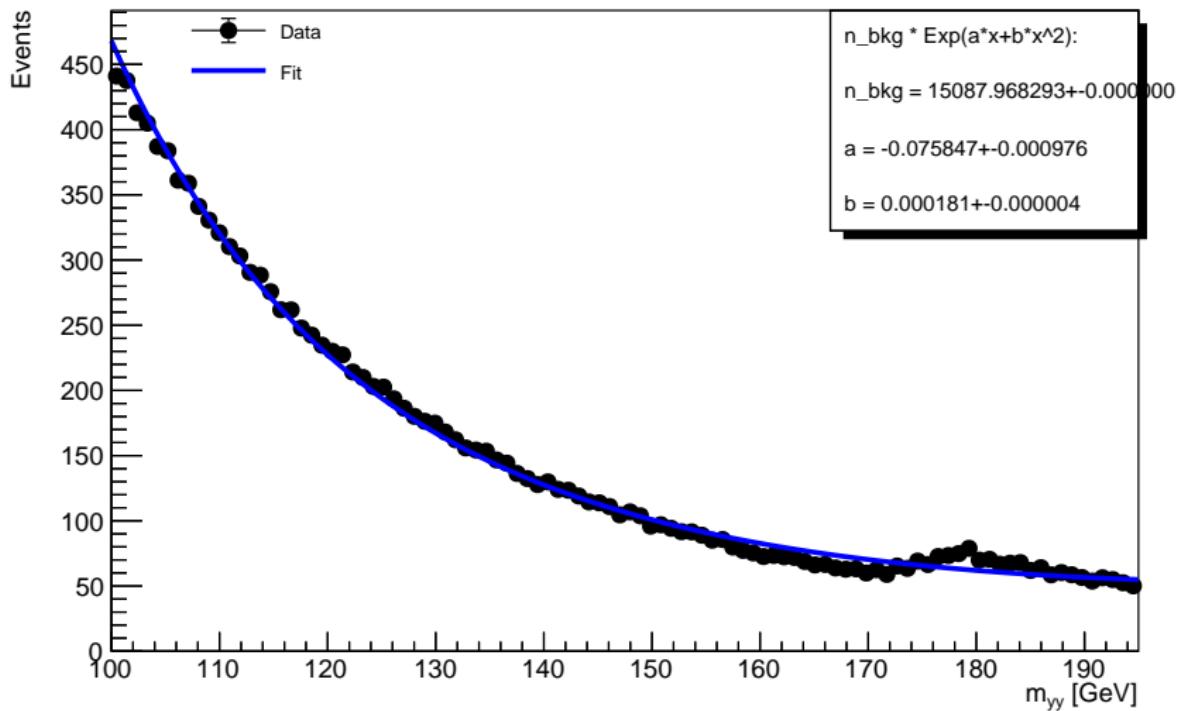
# Bkg unconv eta\_2

[100,195] GeV background plot + fit (unconv,eta\_2)



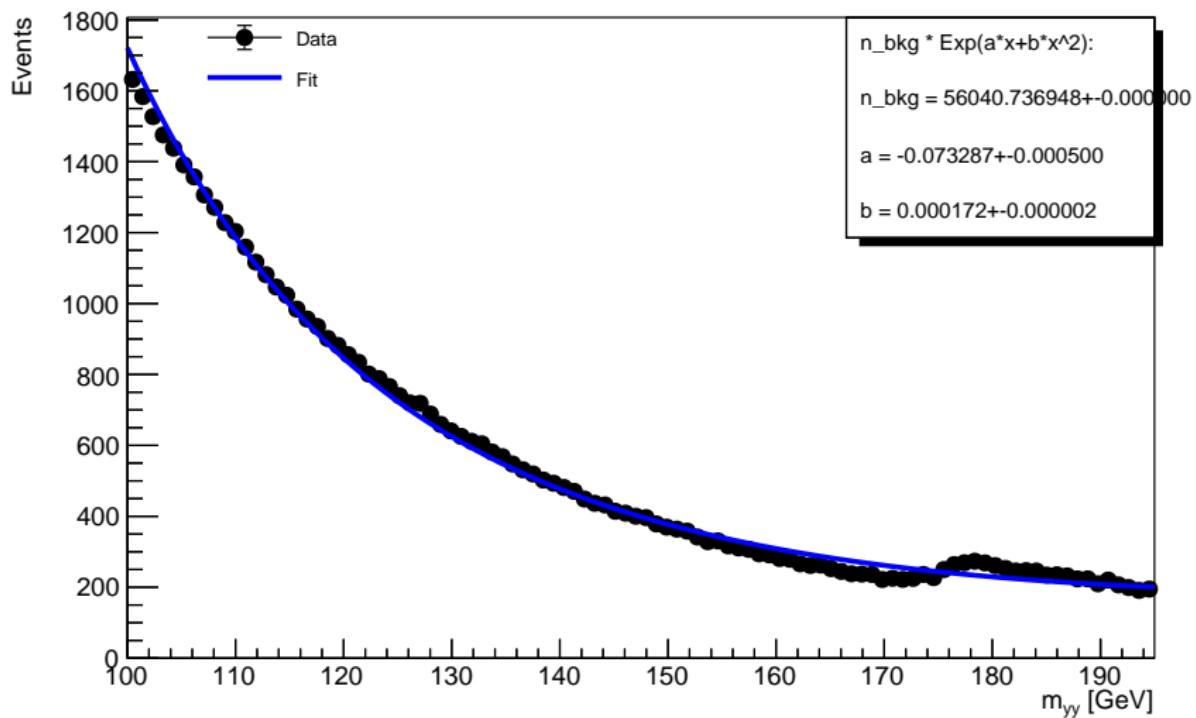
# Bkg unconv eta\_3

[100,195] GeV background plot + fit (unconv,eta\_3)



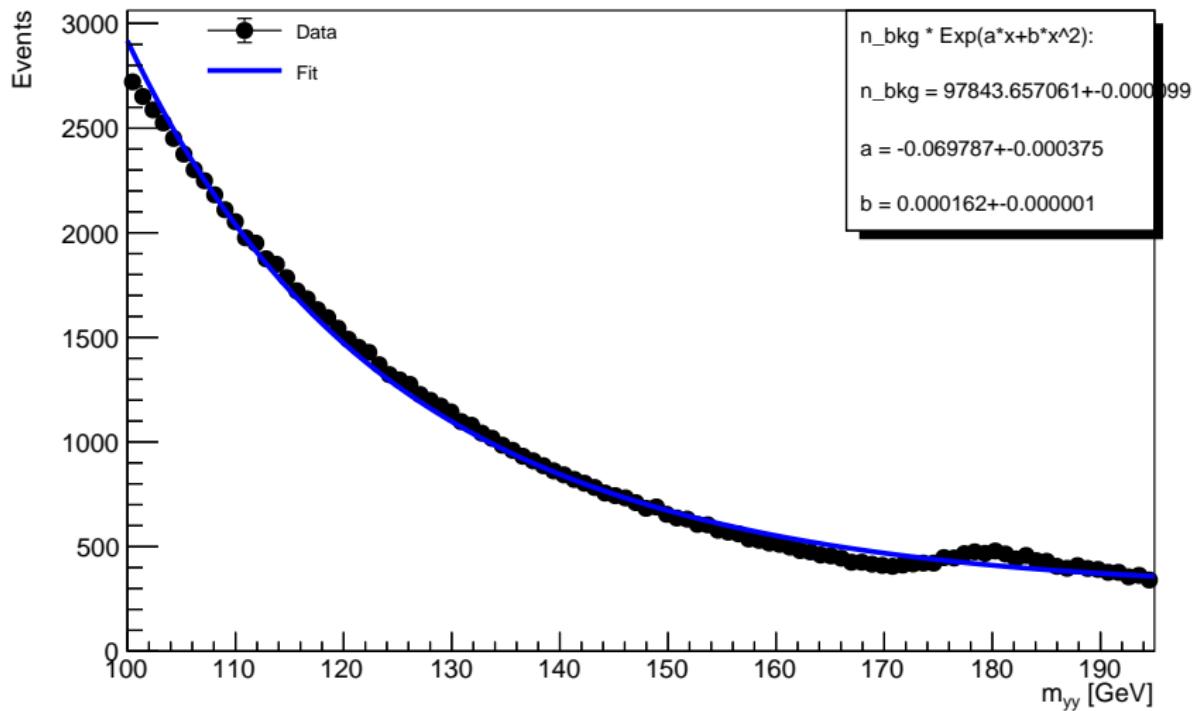
# Bkg 1\_conv eta\_1

[100,195] GeV background plot + fit (1\_conv,eta\_1)



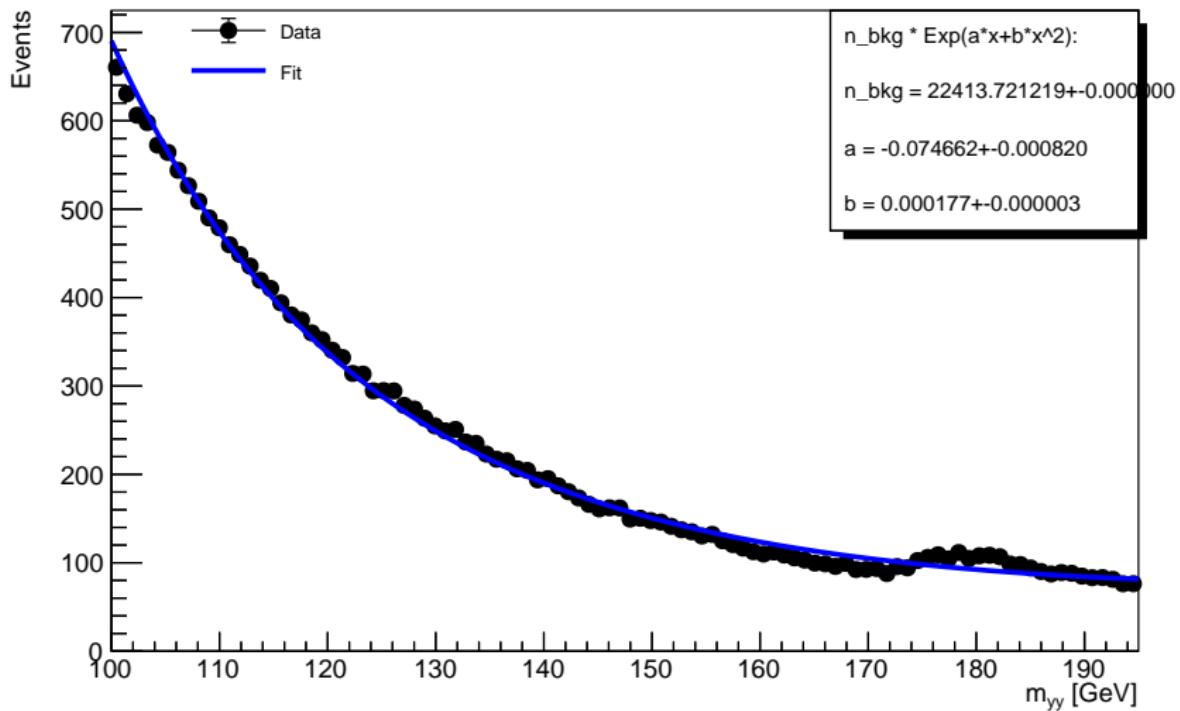
# Bkg 1\_conv eta\_2

[100,195] GeV background plot + fit (1\_conv,eta\_2)

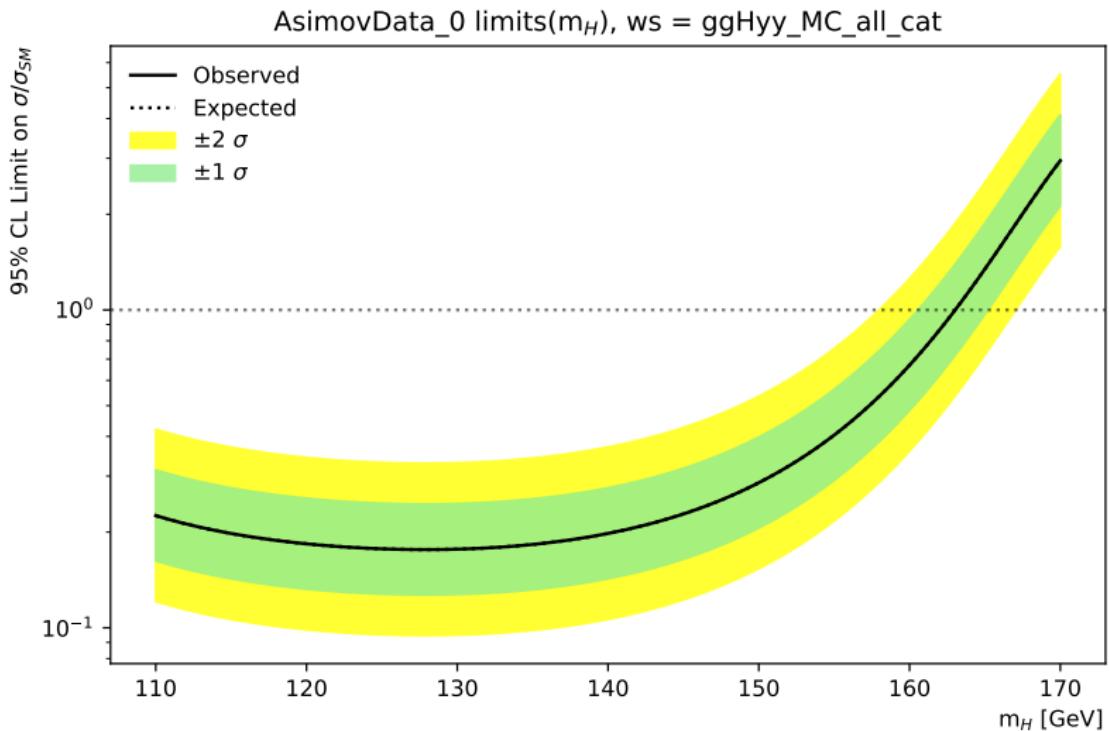


# Bkg 1\_conv eta\_3

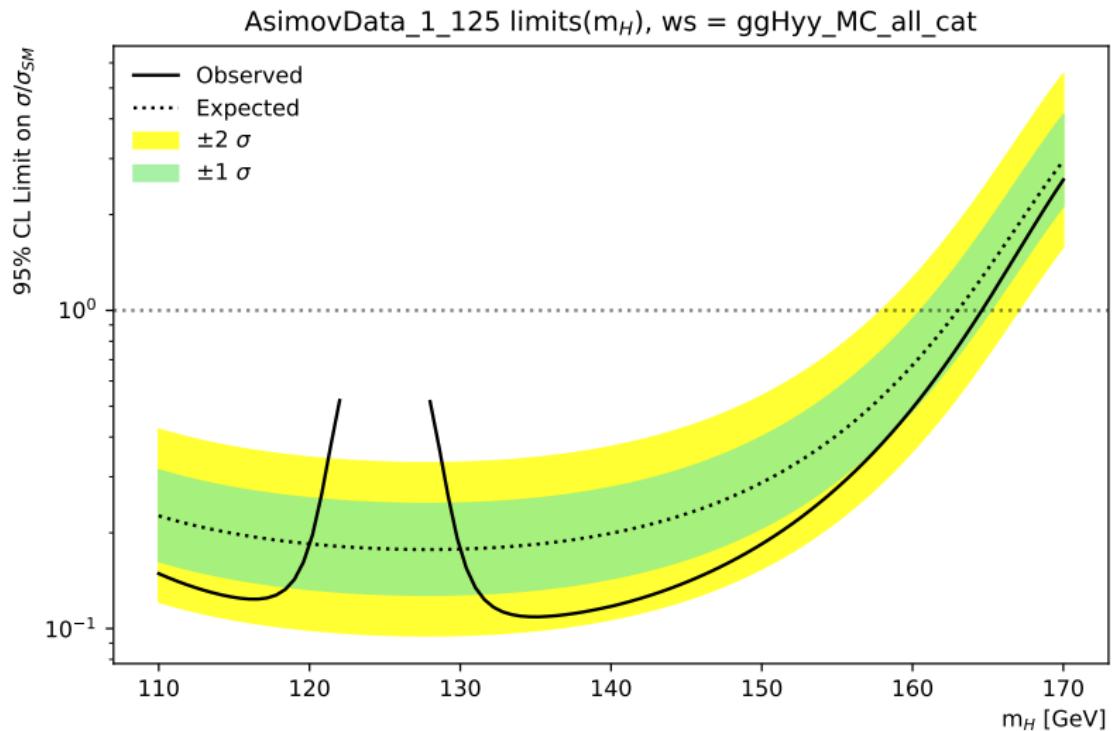
[100,195] GeV background plot + fit (1\_conv,eta\_3)



# AsimovData $\mu=0$ limits



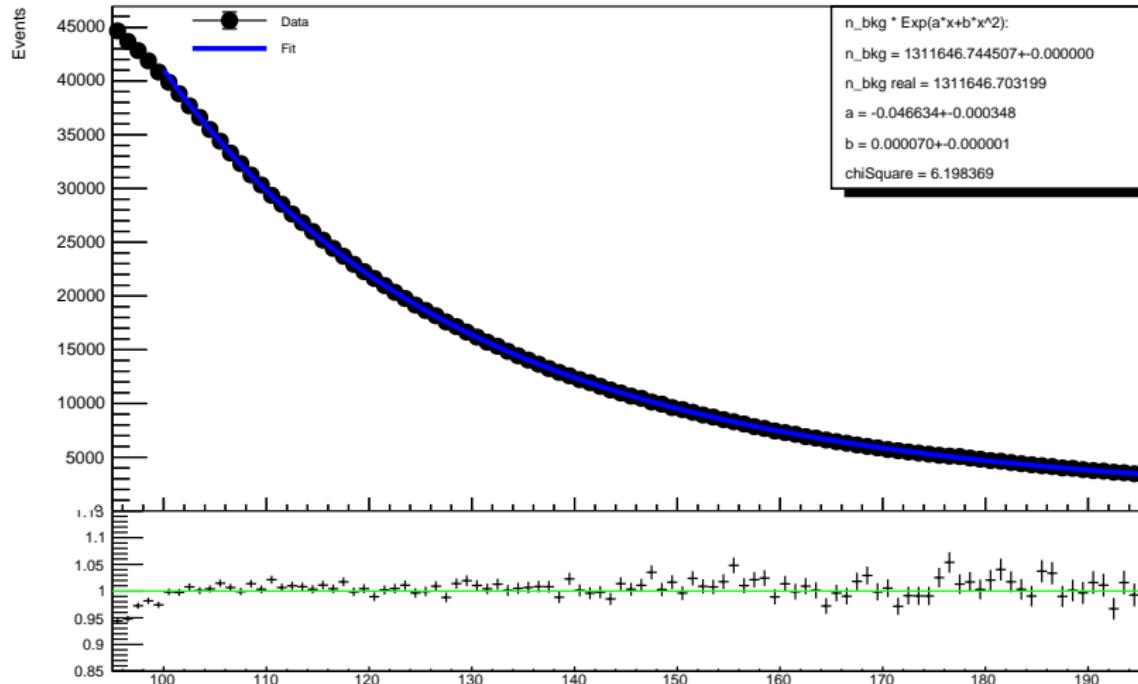
# AsimovData $\mu=1$ , $m_H=125$ limits



**10<sup>th</sup> week**

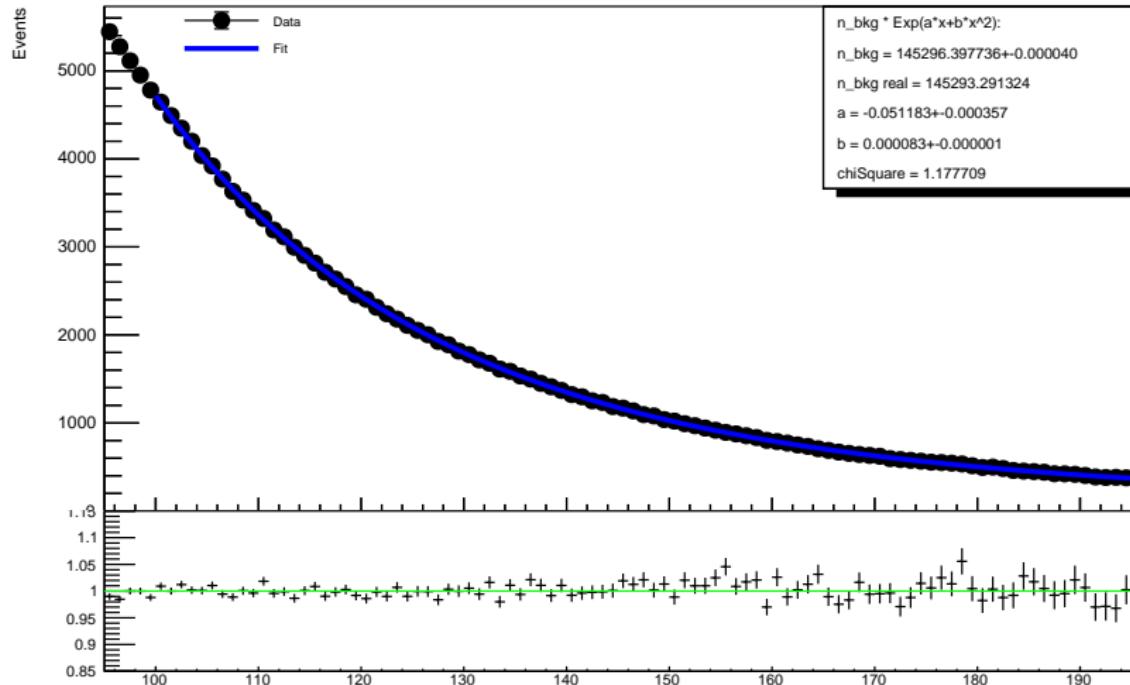
# All bkg

[95,195] GeV background plot + [100,195] GeV fit (no,no)

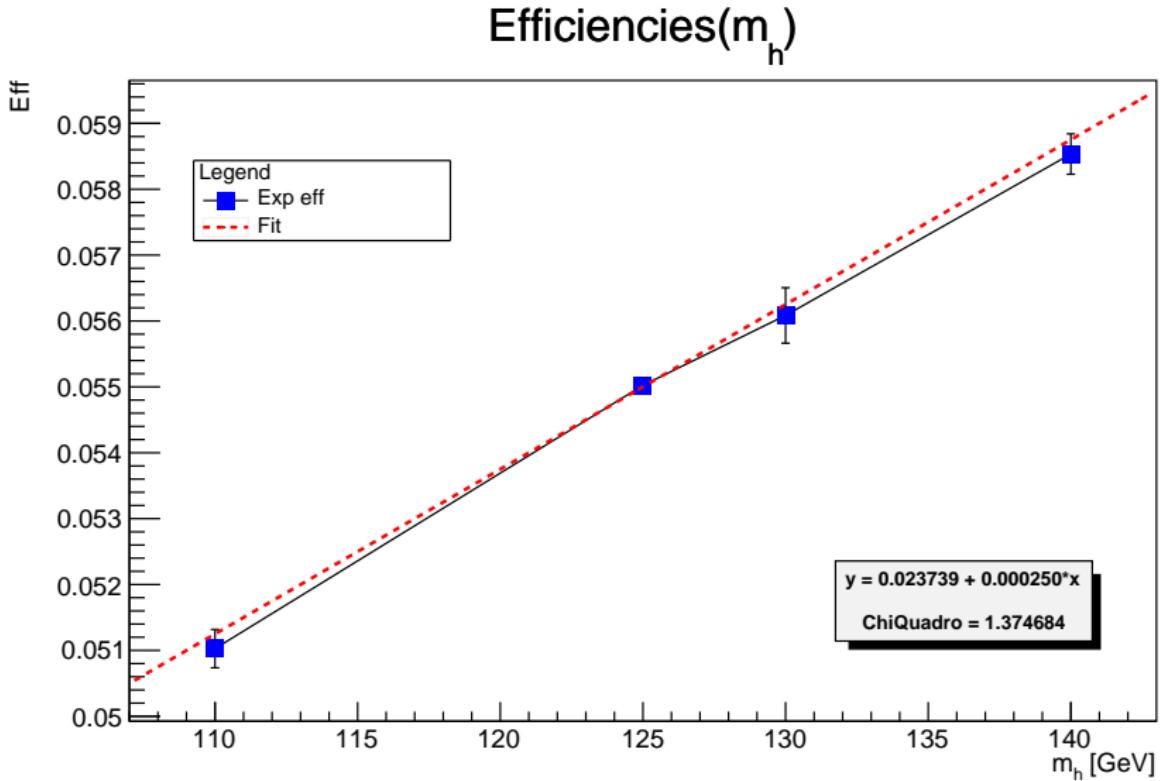


# Bkg unconv eta\_1

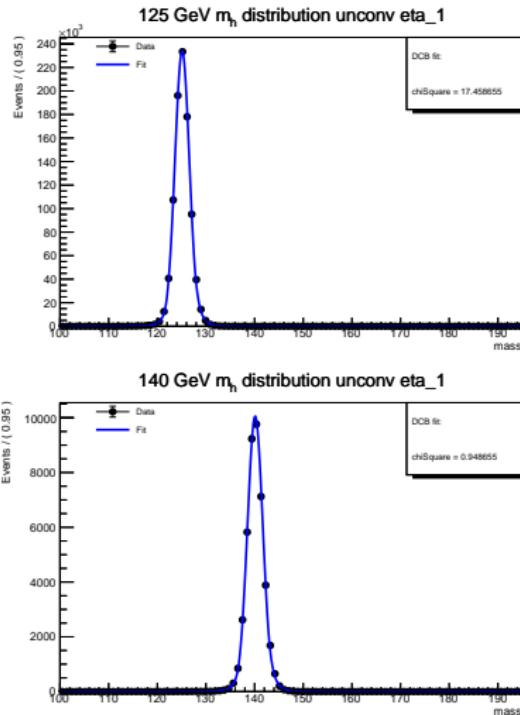
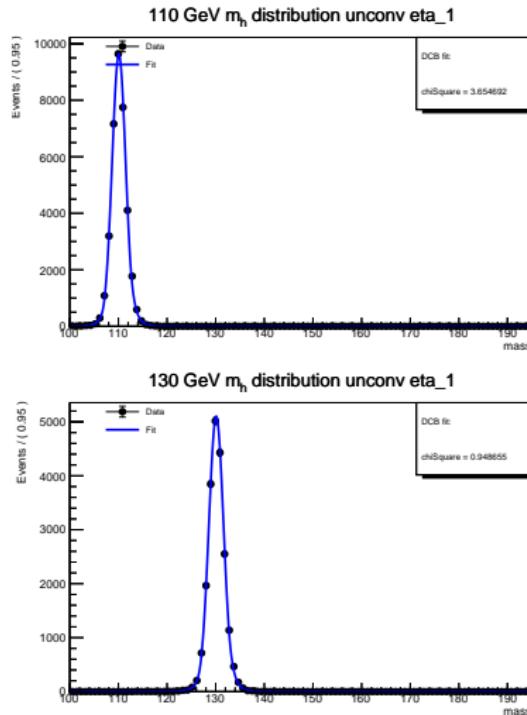
[95,195] GeV background plot + [100,195] GeV fit (unconv,eta\_1)



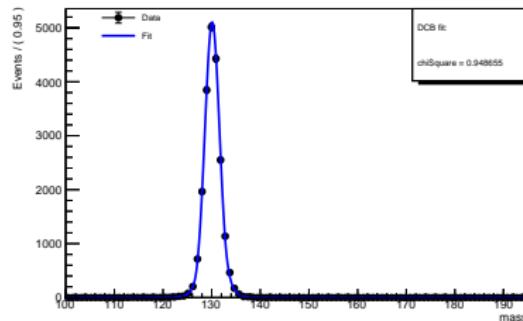
# Eff unconv eta\_1



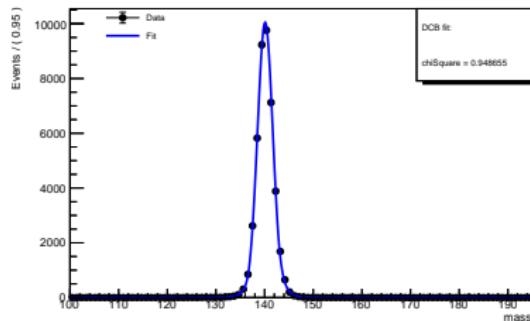
# Sig unconv eta\_1



130 GeV  $m_h$  distribution unconv eta\_1

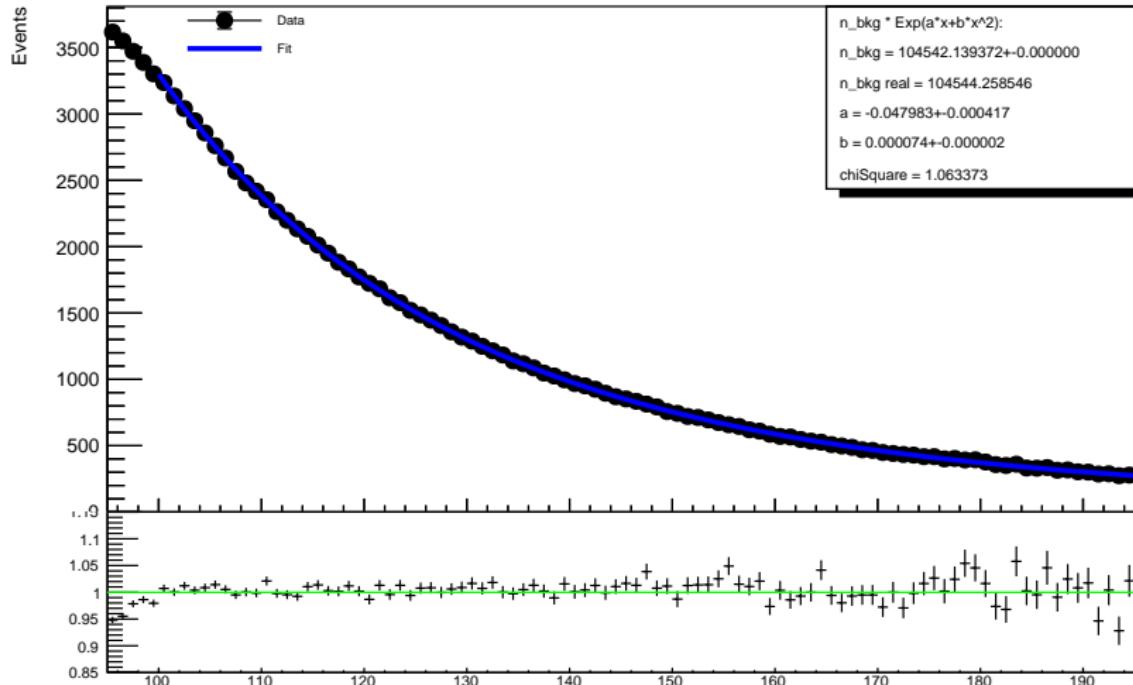


140 GeV  $m_h$  distribution unconv eta\_1

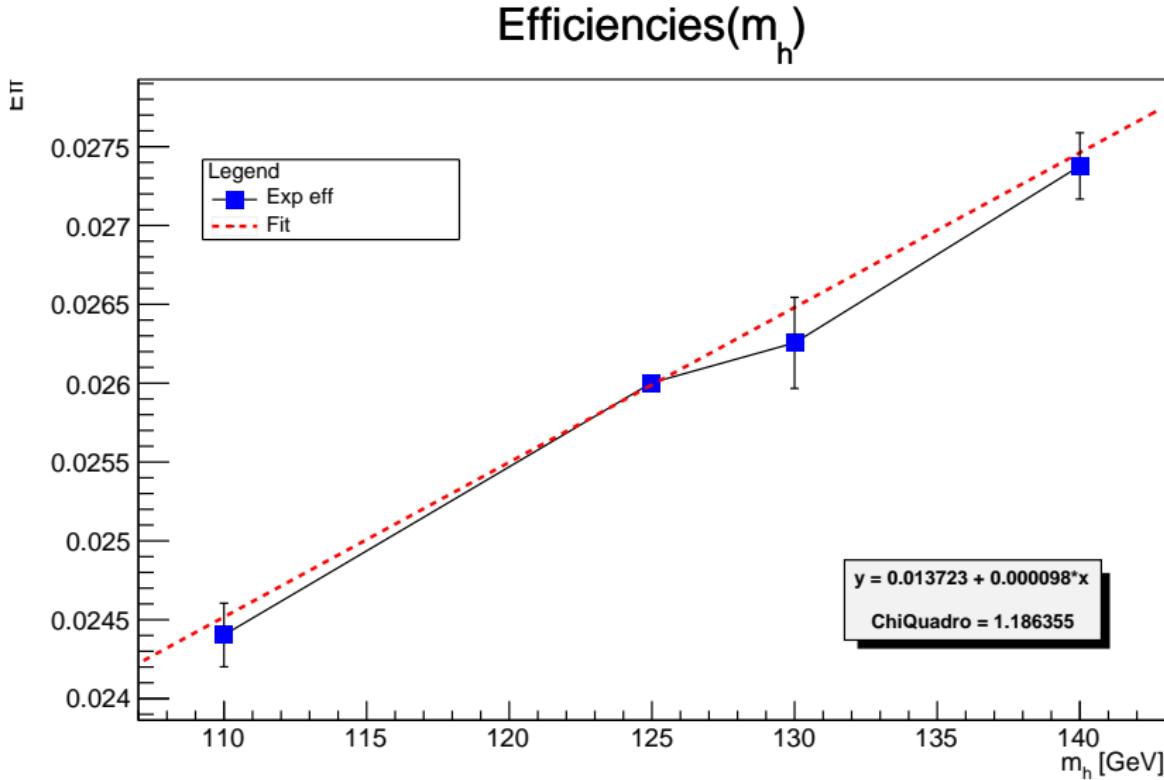


# Bkg unconv eta\_2

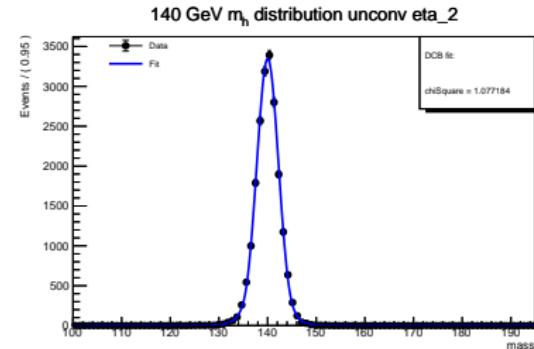
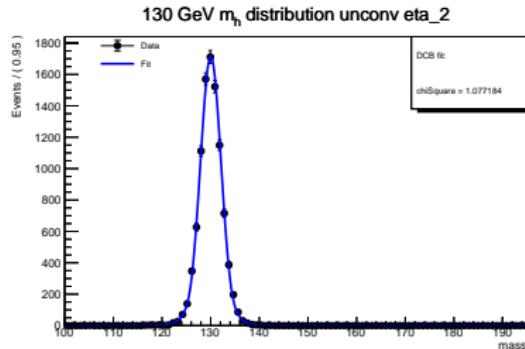
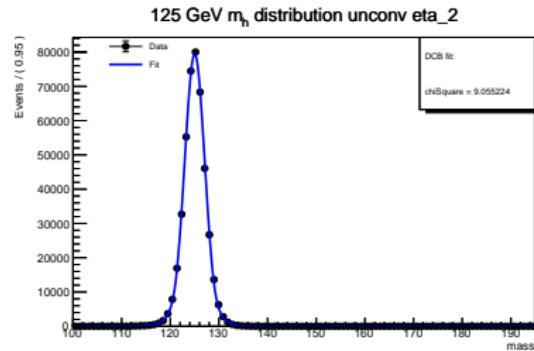
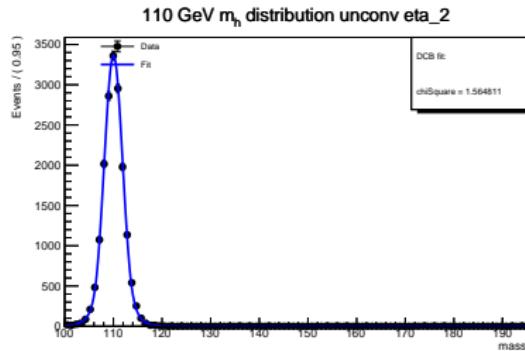
[95,195] GeV background plot + [100,195] GeV fit (unconv,eta\_2)



# Eff unconv eta\_2

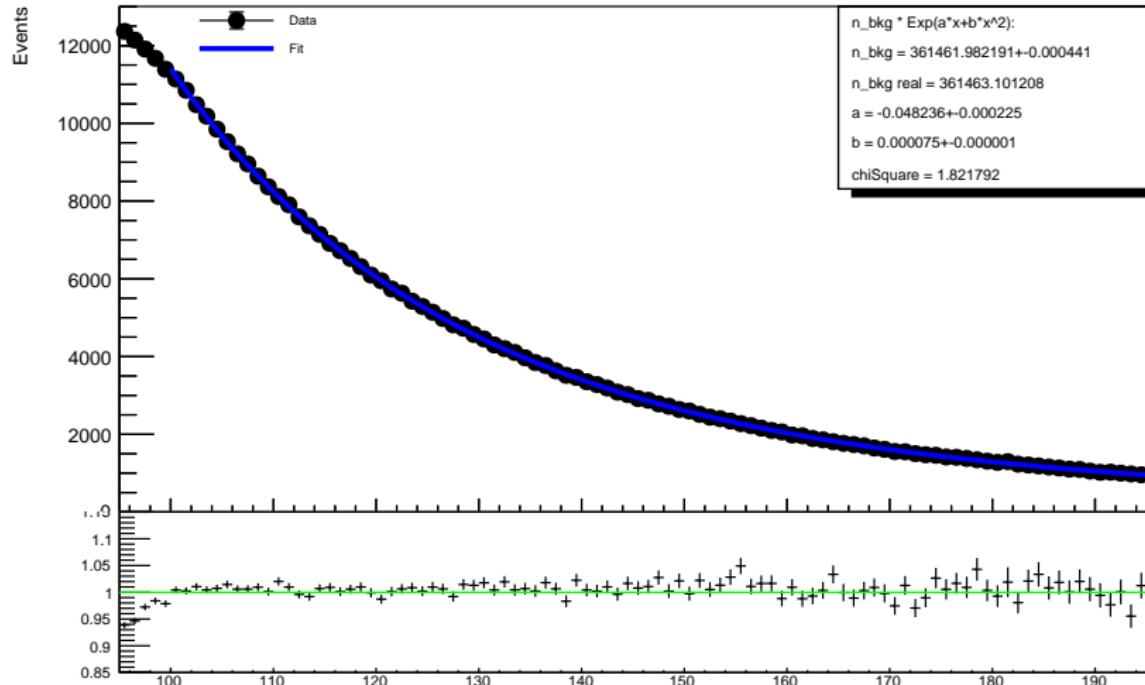


# Sig unconv eta\_2



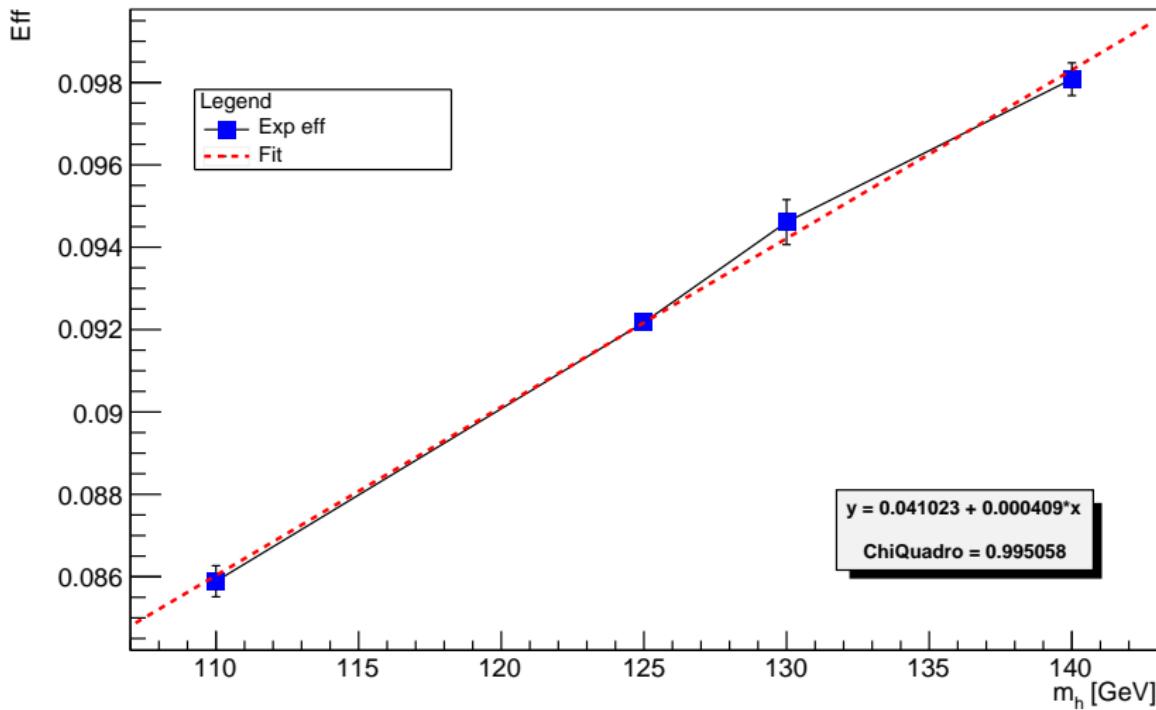
# Bkg unconv eta\_3

[95,195] GeV background plot + [100,195] GeV fit (unconv,eta\_3)

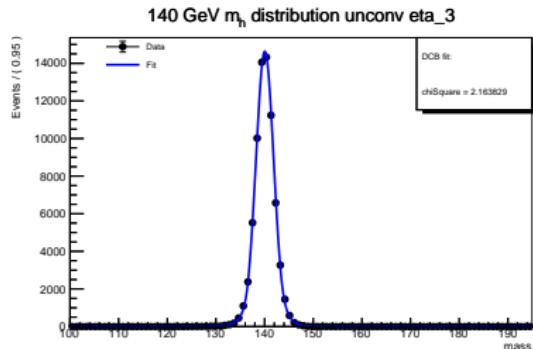
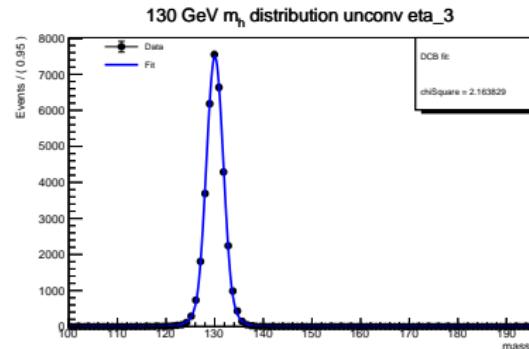
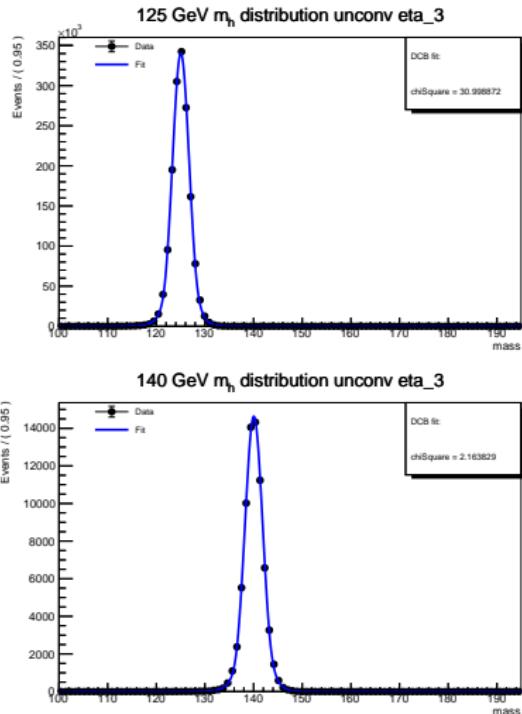
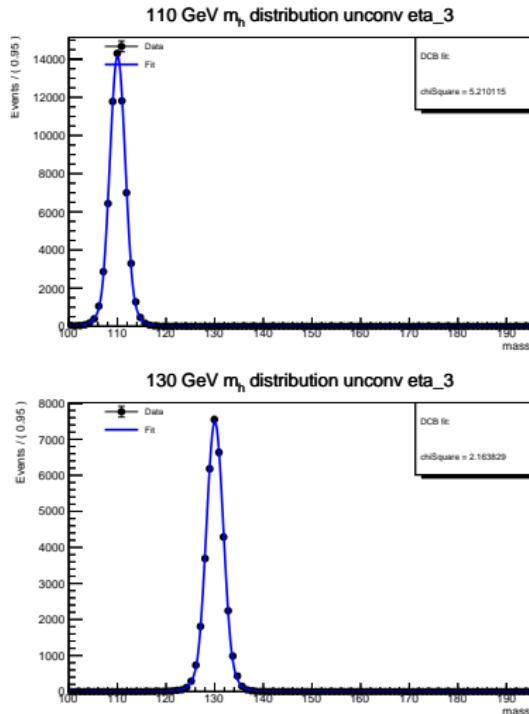


# Eff unconv eta\_3

Efficiencies( $m_h$ )

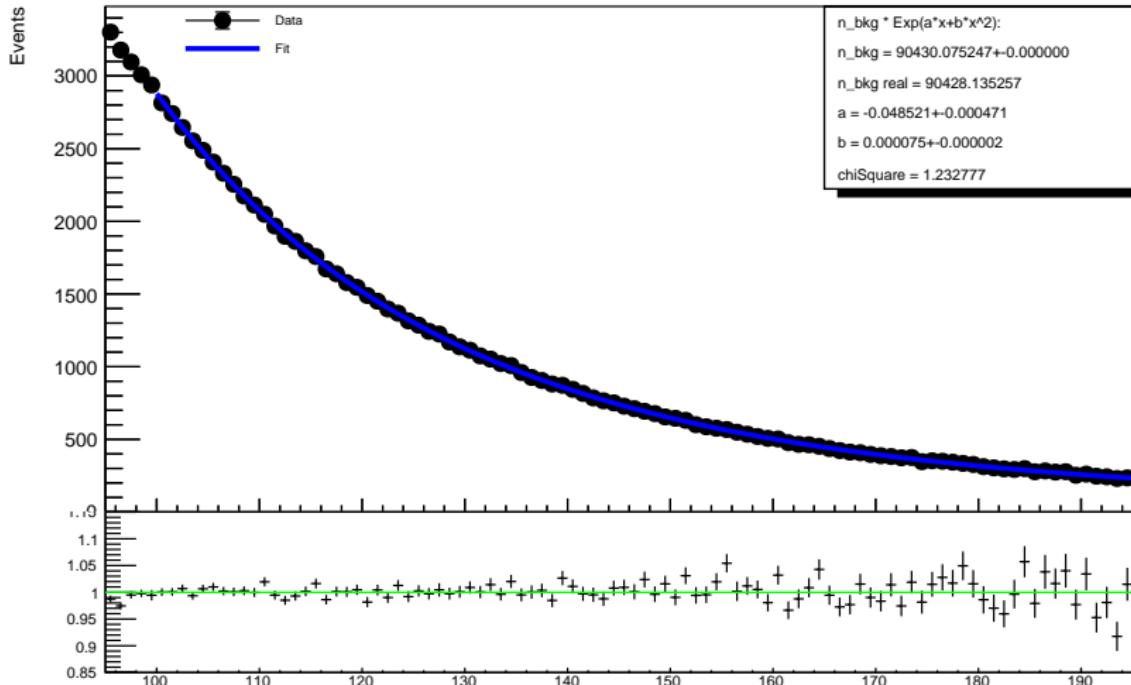


# Sig unconv eta\_3

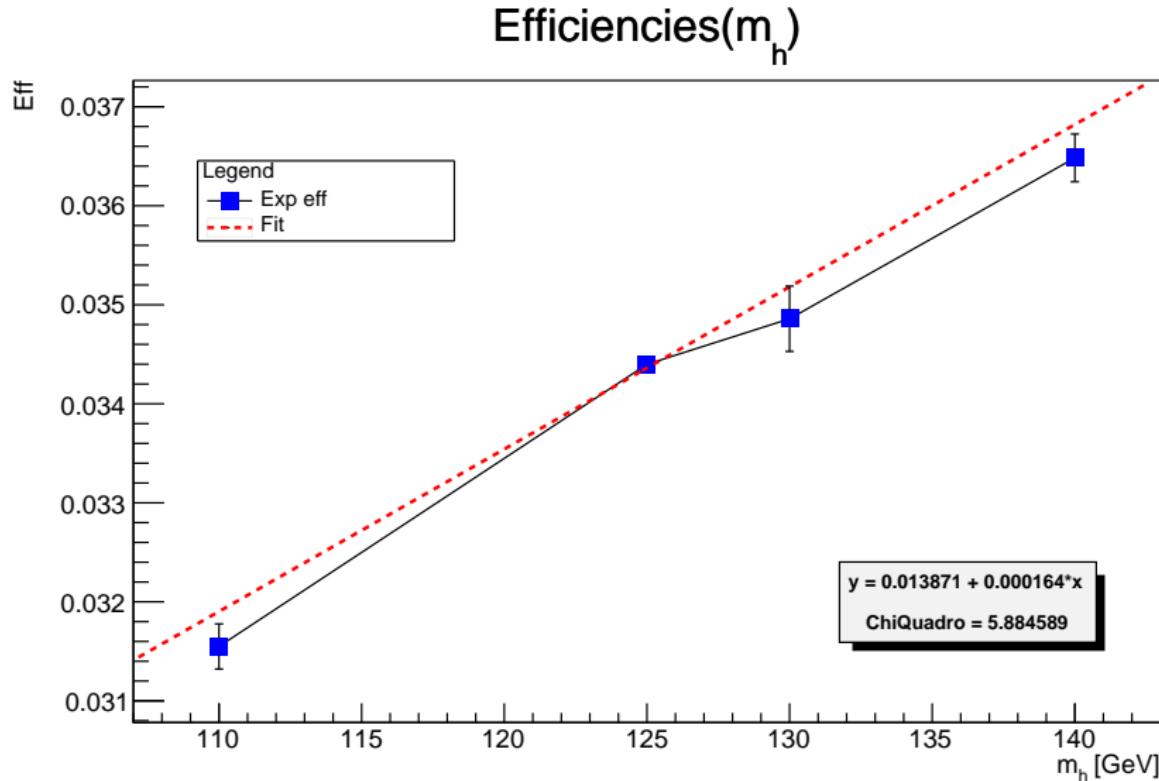


# Bkg 1\_conv eta\_1

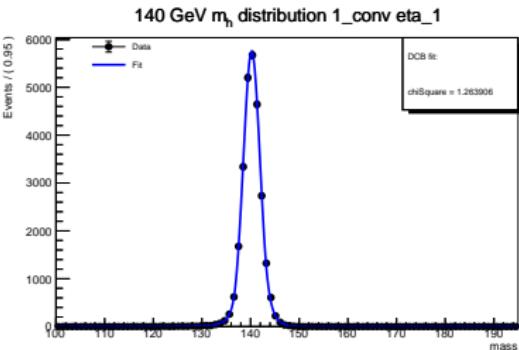
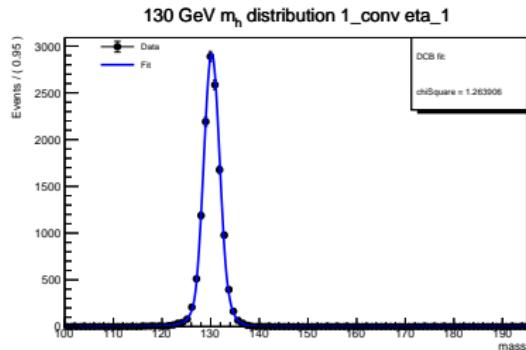
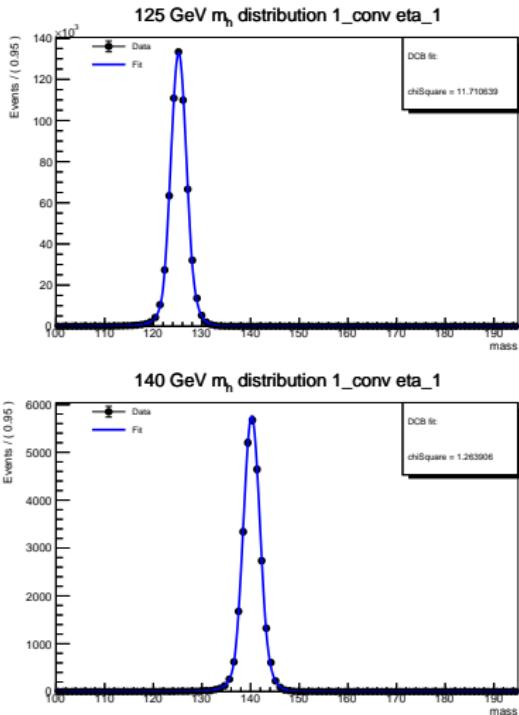
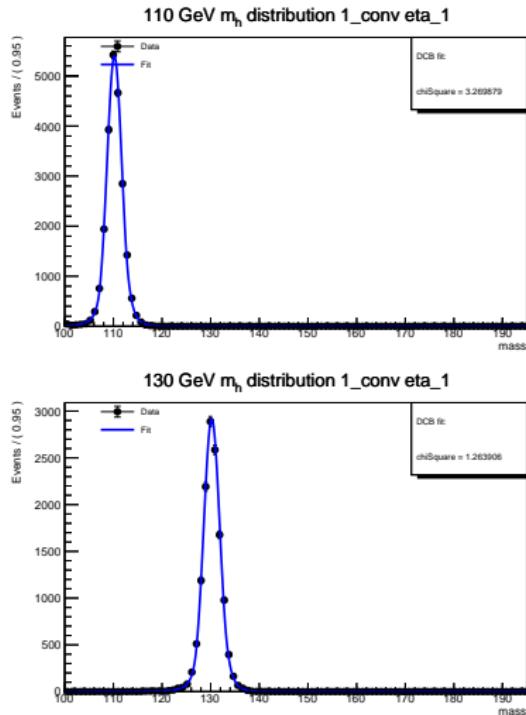
[95,195] GeV background plot + [100,195] GeV fit (1\_conv,eta\_1)



# Eff 1\_conv eta\_1

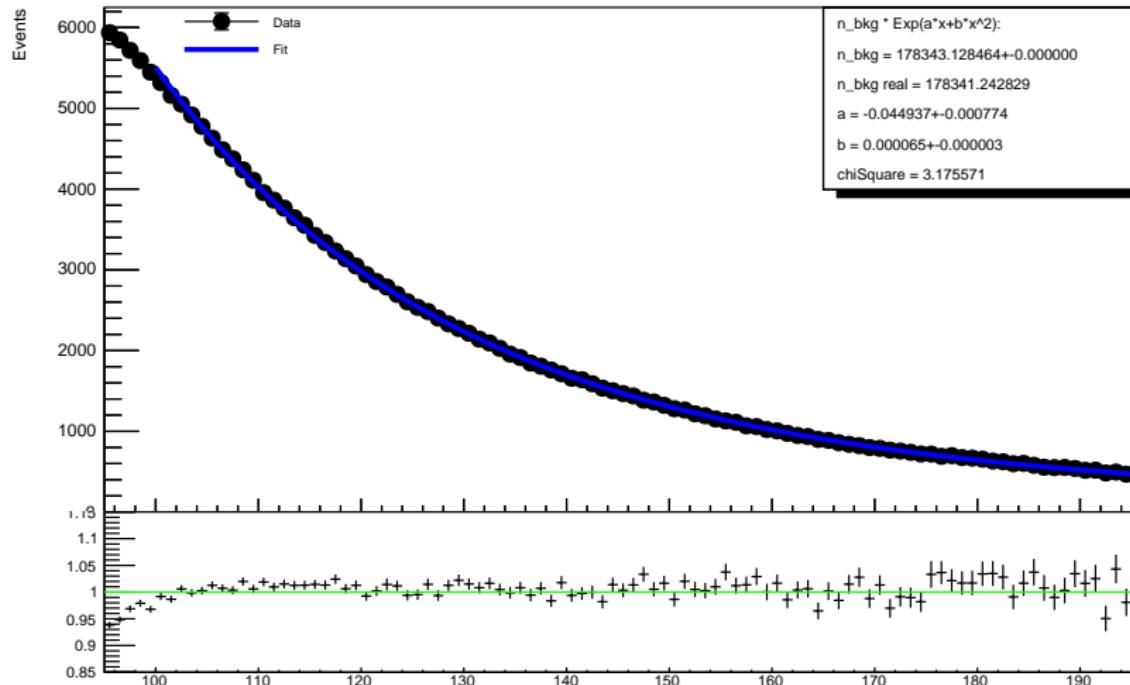


# Sig 1\_conv eta\_1



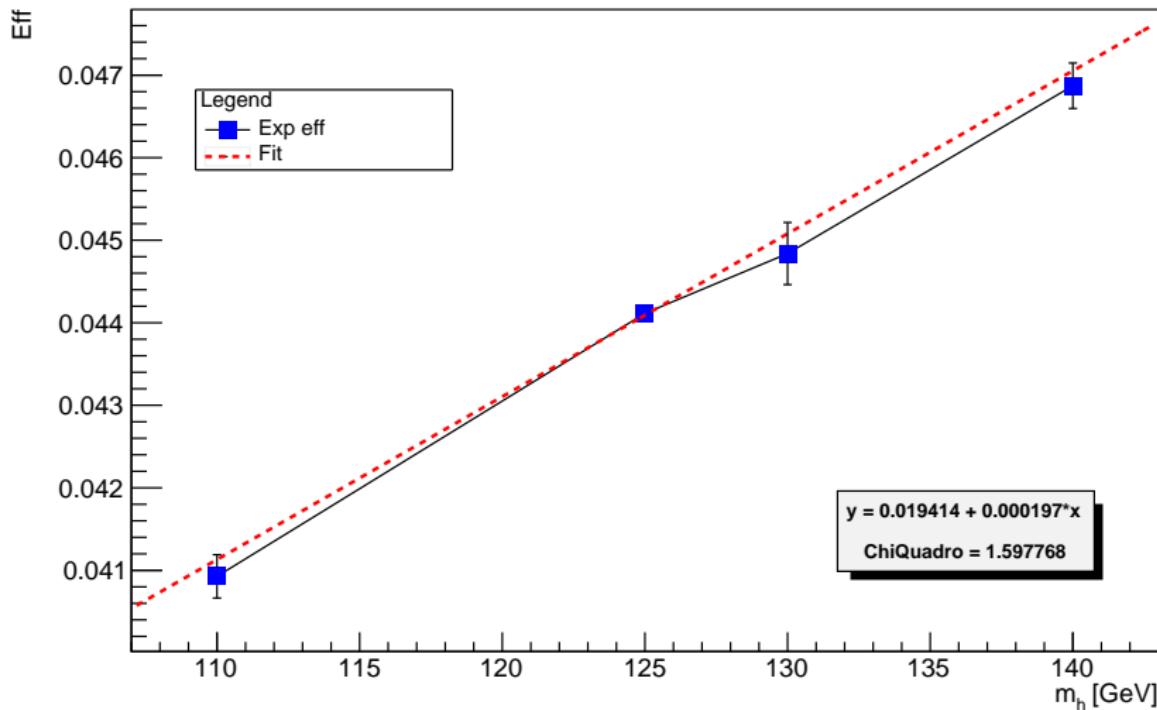
# Bkg 1\_conv eta\_2

[95,195] GeV background plot + [100,195] GeV fit (1\_conv,eta\_2)

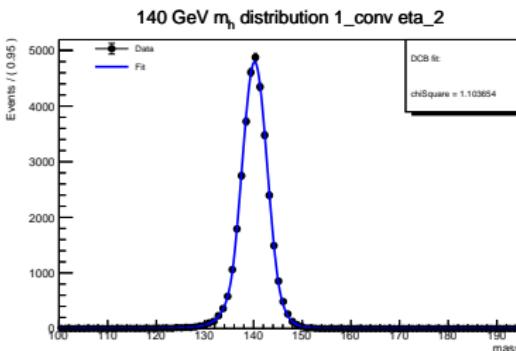
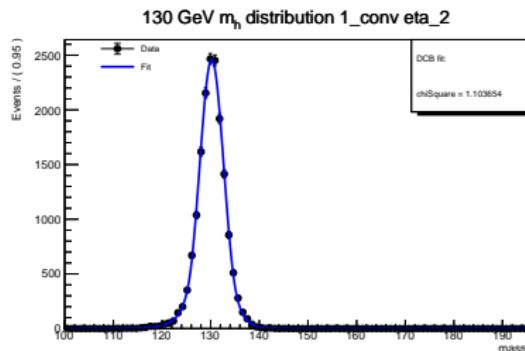
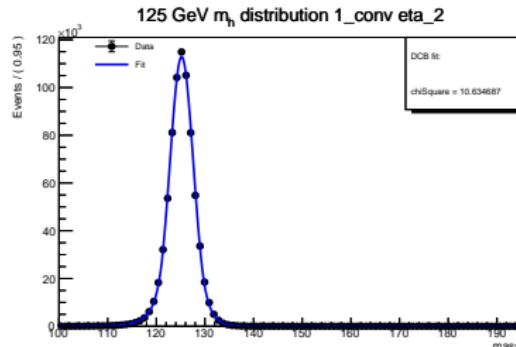
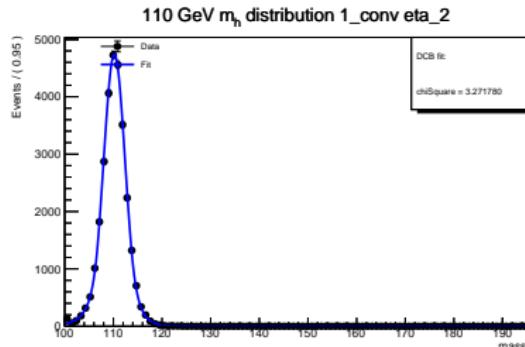


# Eff 1\_conv eta\_2

Efficiencies( $m_h$ )

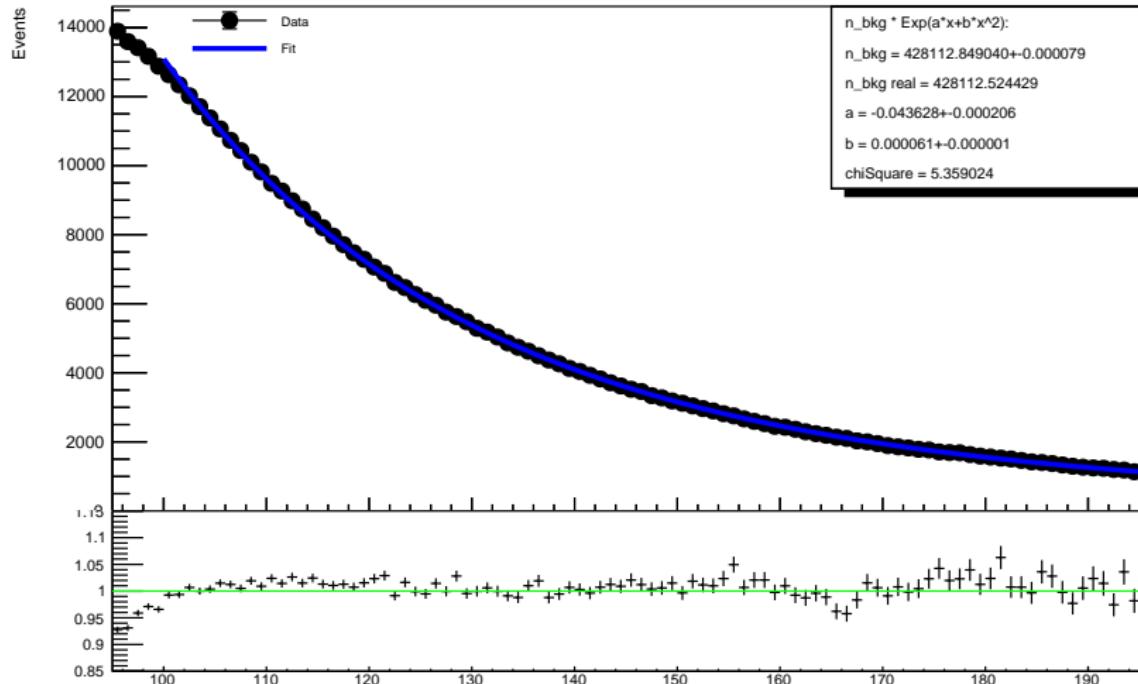


# Sig 1\_conv eta\_2

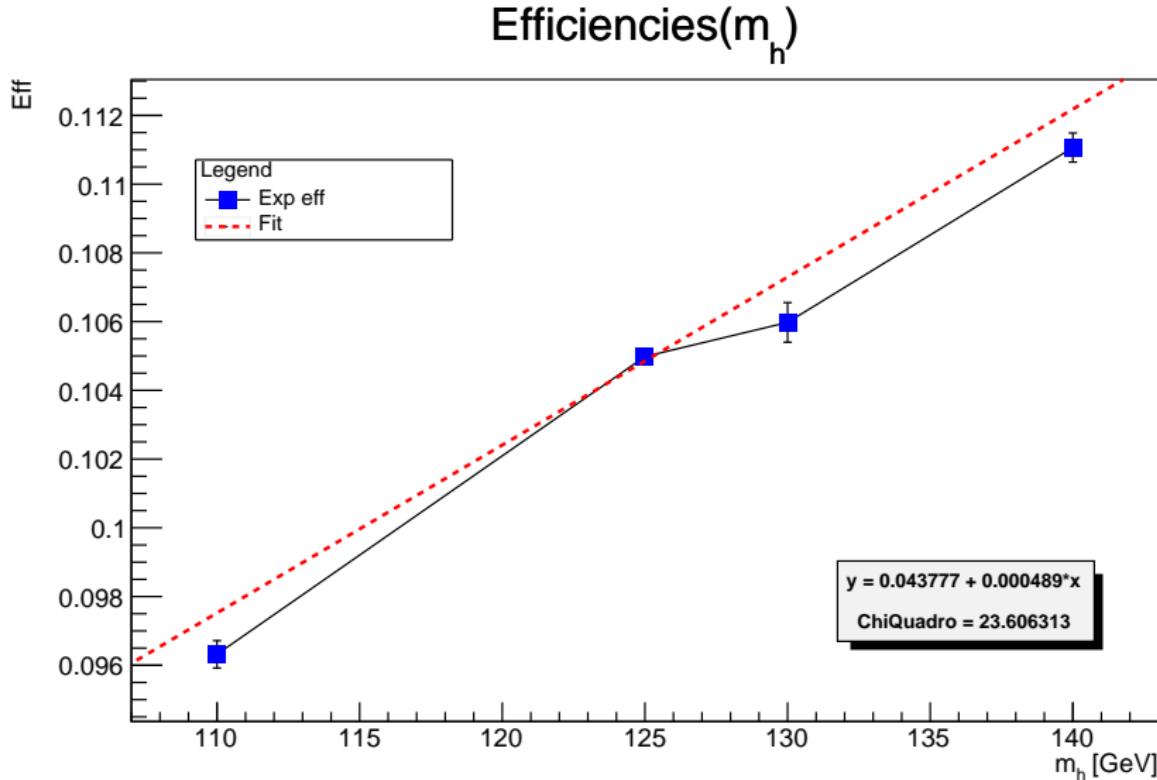


# Bkg 1\_conv eta\_3

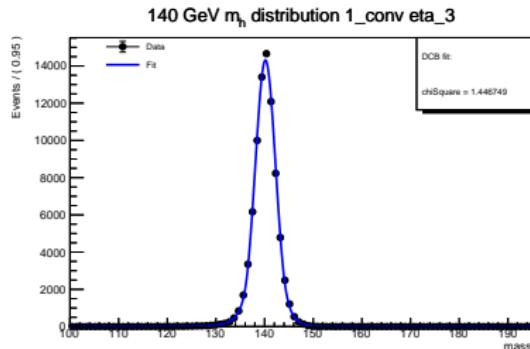
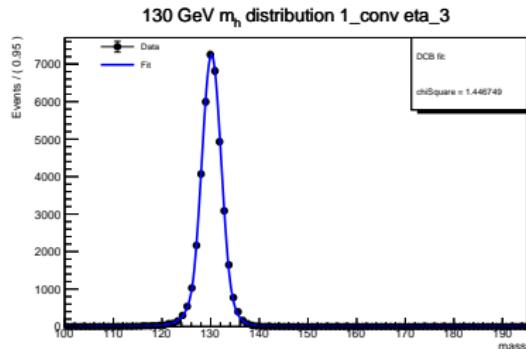
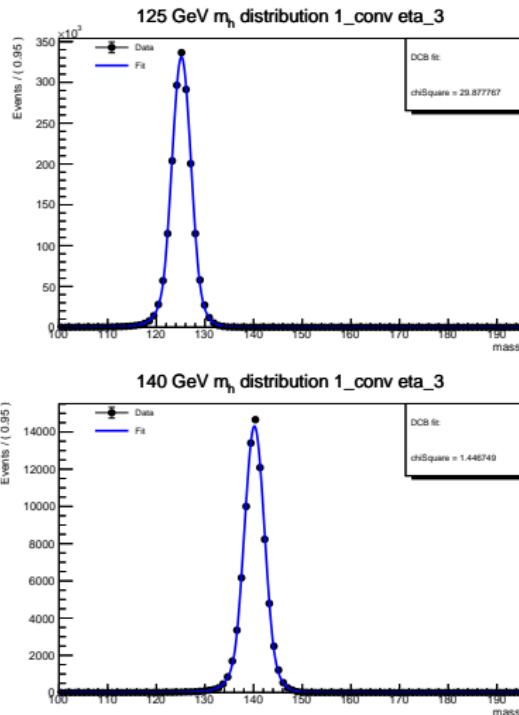
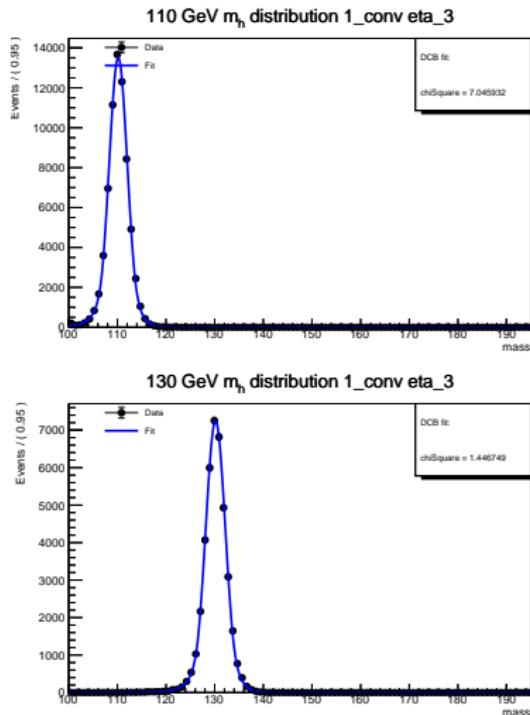
[95,195] GeV background plot + [100,195] GeV fit (1\_conv,eta\_3)



# Eff 1\_conv eta\_3



# Sig 1\_conv eta\_3



# $\sigma$ comp

$\sigma$	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  $\sigma$

# 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

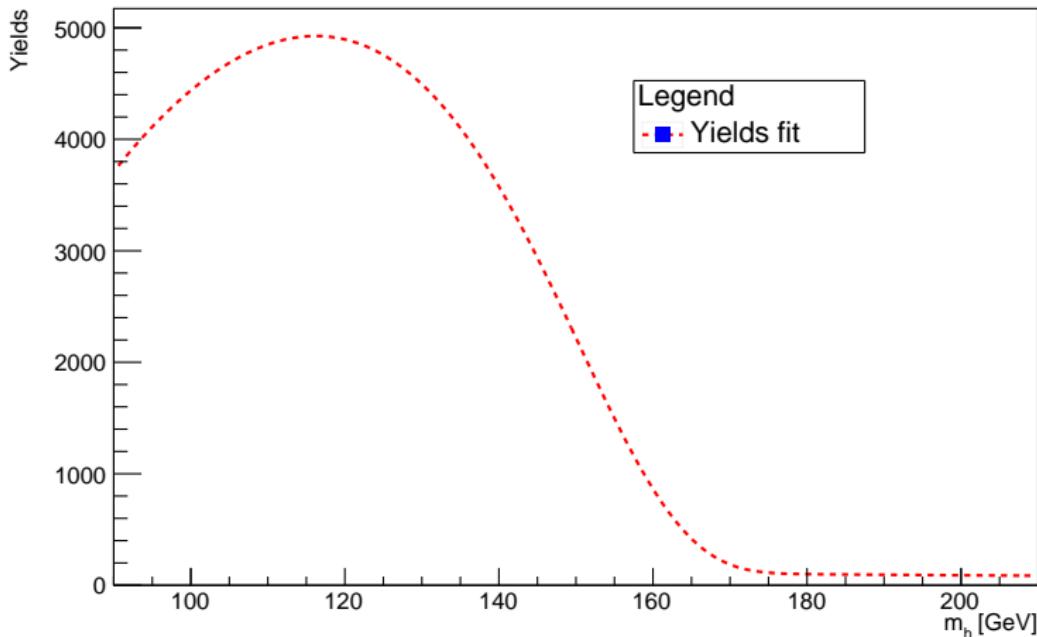
Signal	110 GeV	125 GeV	130 GeV	140 GeV
no cat	5043.55	5470.73	5121.93	3572.26
unconv eta1	777.589	842.152	790.323	551.257
unconv eta2	371.877	397.986	369.978	257.827
unconv eta3	1308.86	1410.78	1333.2	923.673
1conv eta1	480.782	526.501	491.21	343.588
1conv eta2	623.682	675.171	631.844	441.421
1conv eta3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

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

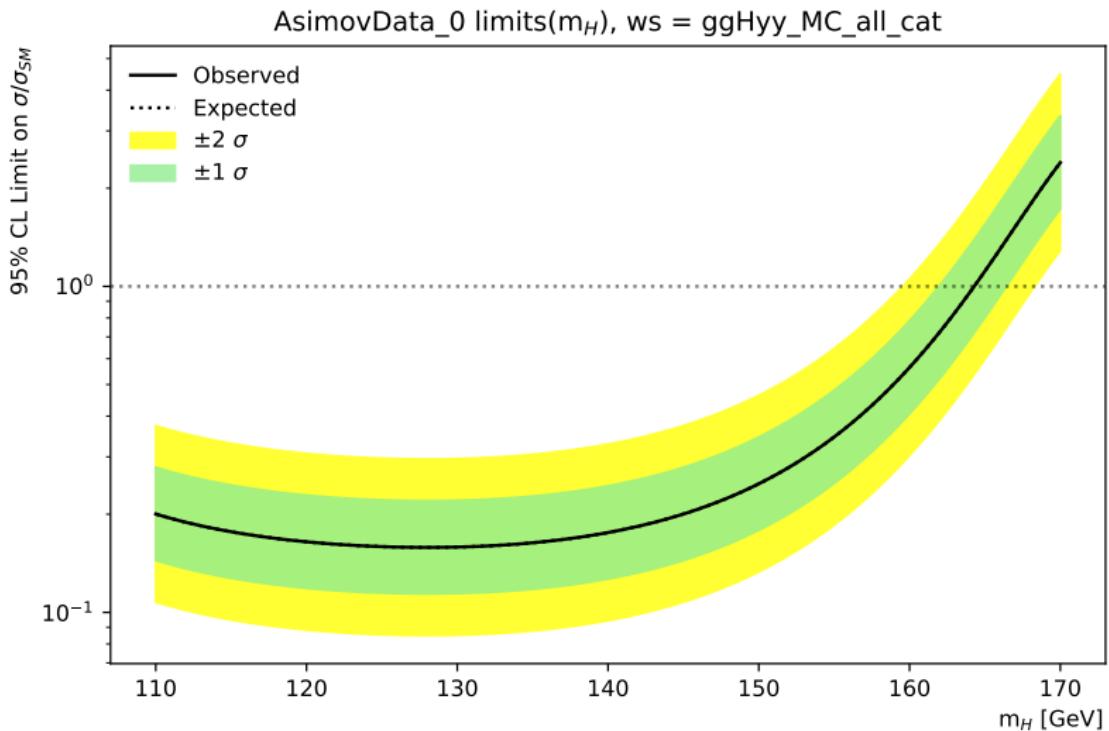
# Check yields( $mH$ )

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

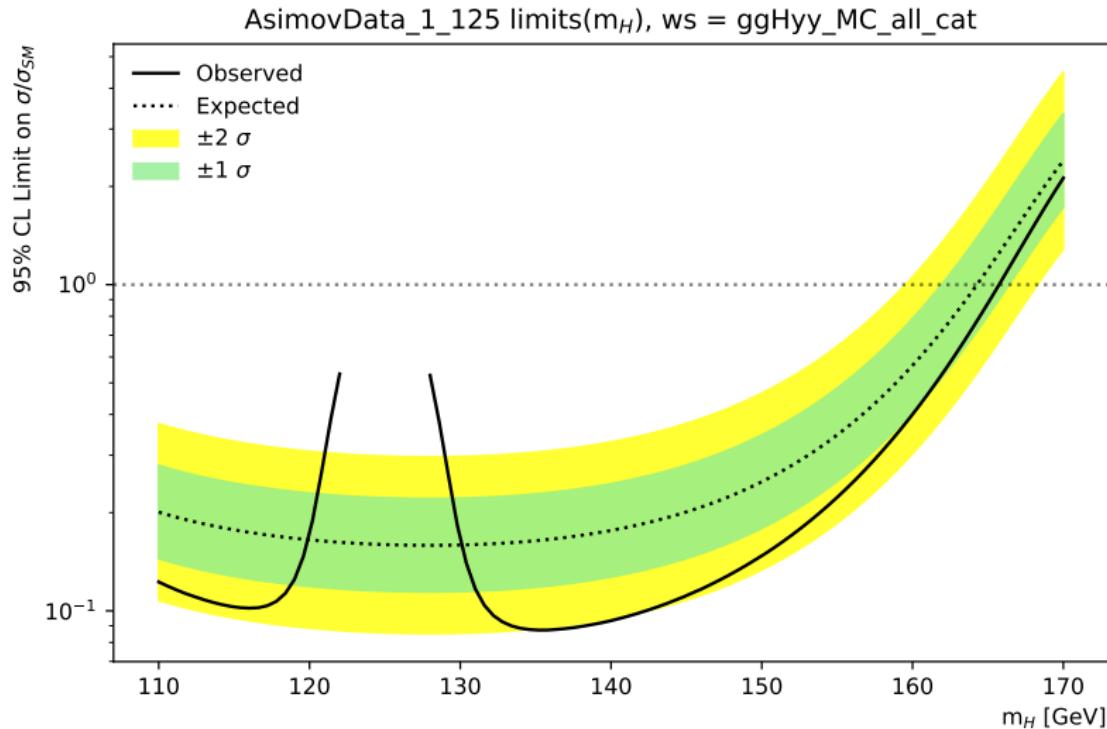
Yields fit( $mH$ )



# AsimovData $\mu=0$ limits



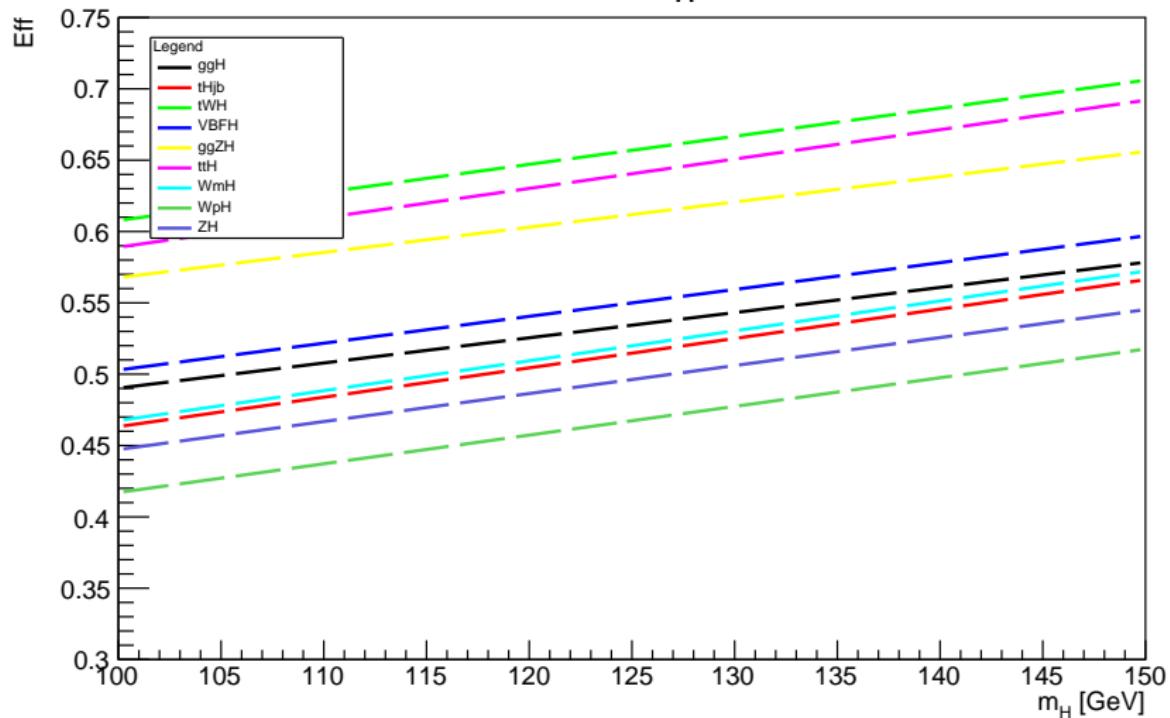
# AsimovData $\mu=1$ , $m_H=125$ limits



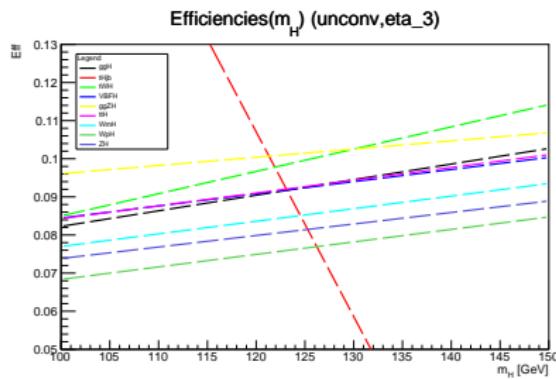
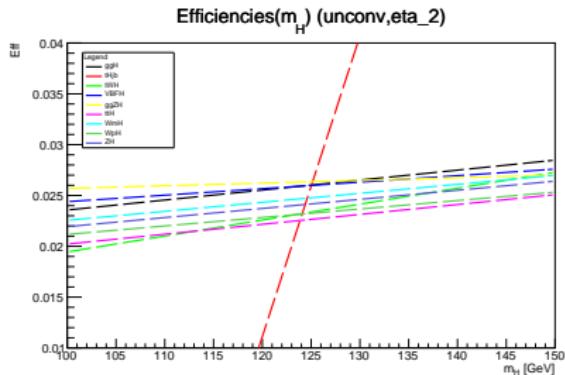
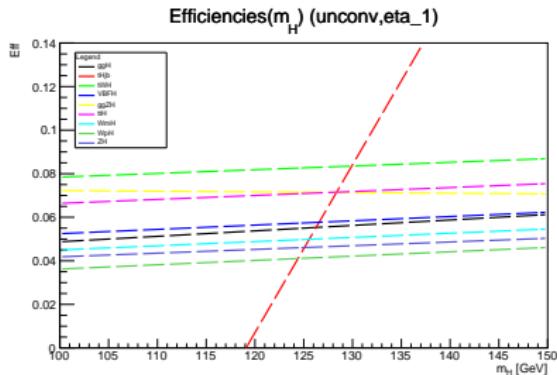
*11<sup>th</sup>* week

# Production mods

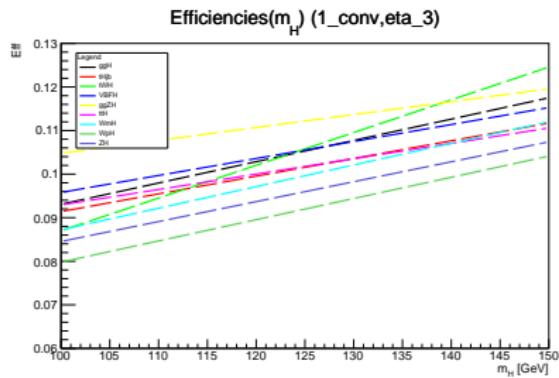
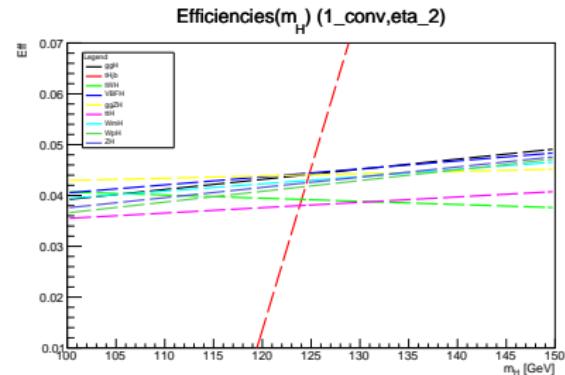
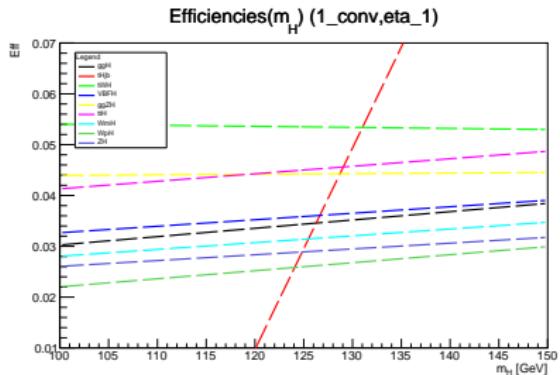
Efficiencies( $m_H$ ) (no,no)



# 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:  $(\text{eff}_{\text{prod}} - \text{eff}_{\text{gg}H}) / \text{eff}_{\text{gg}H}$

*12<sup>th</sup>* week

# Categories

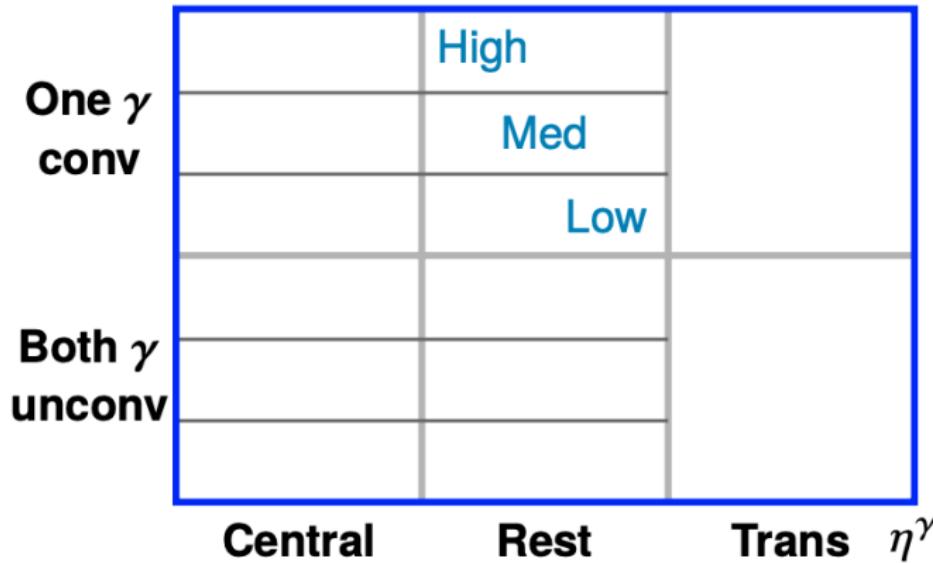


Figure 2: Simple sketch showing the mass analysis categories.

# catMass\_Run1

## ■ 2 phs unconv:

- $|\eta_{s2}| < 0.75$ :
  - $pTt_{yy} < 70 \text{ GeV} \rightarrow 1$ ;
  - $pTt_{yy} > 70 \text{ GeV} \rightarrow 2$ ;
- $|\eta_{s2}|$  no central and trans regions:
  - $pTt_{yy} < 70 \text{ GeV} \rightarrow 3$ ;
  - $pTt_{yy} > 70 \text{ GeV} \rightarrow 4$ ;
- at least one  $|\eta_{s2}| \in [1.3, 1.75] \rightarrow 5$ ;

## ■ at least 1 ph conv:

- $|\eta_{s2}| < 0.75$ :
  - $pTt_{yy} < 70 \text{ GeV} \rightarrow 6$ ;
  - $pTt_{yy} > 70 \text{ GeV} \rightarrow 7$ ;
- $|\eta_{s2}|$  no central and trans regions:
  - $pTt_{yy} < 70 \text{ GeV} \rightarrow 8$ ;
  - $pTt_{yy} > 70 \text{ GeV} \rightarrow 9$ ;
- at least one  $|\eta_{s2}| \in [1.3, 1.75] \rightarrow 10$ ;

# $\sigma$ comp

$\sigma$	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  $\sigma$

# 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

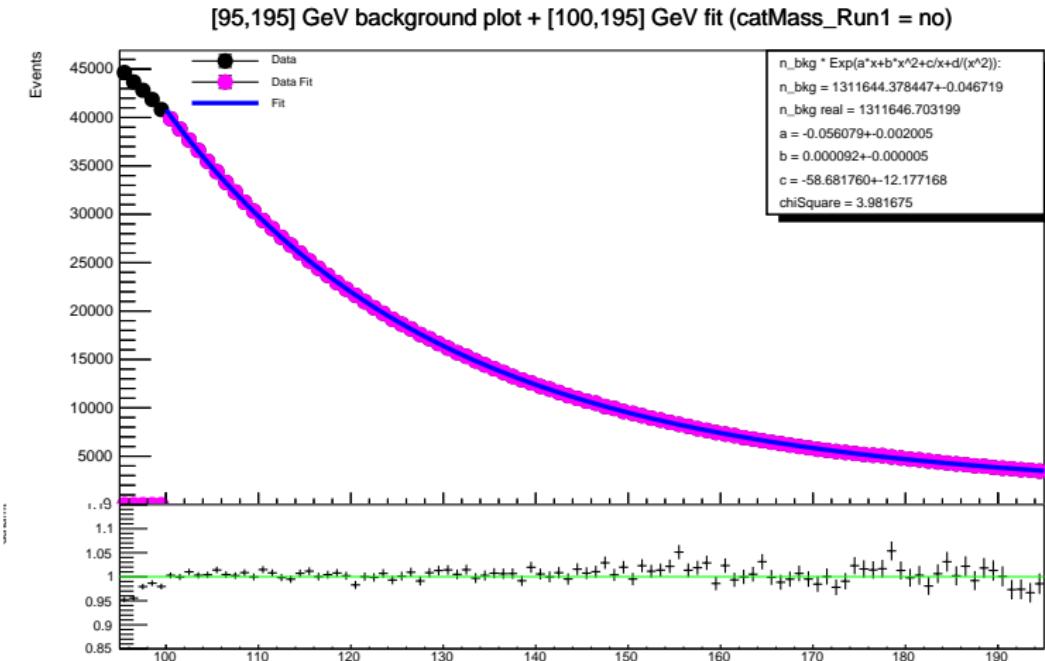
Table: Number of signal events in  $[-\infty, +\infty]$  GeV intervall

# Background events

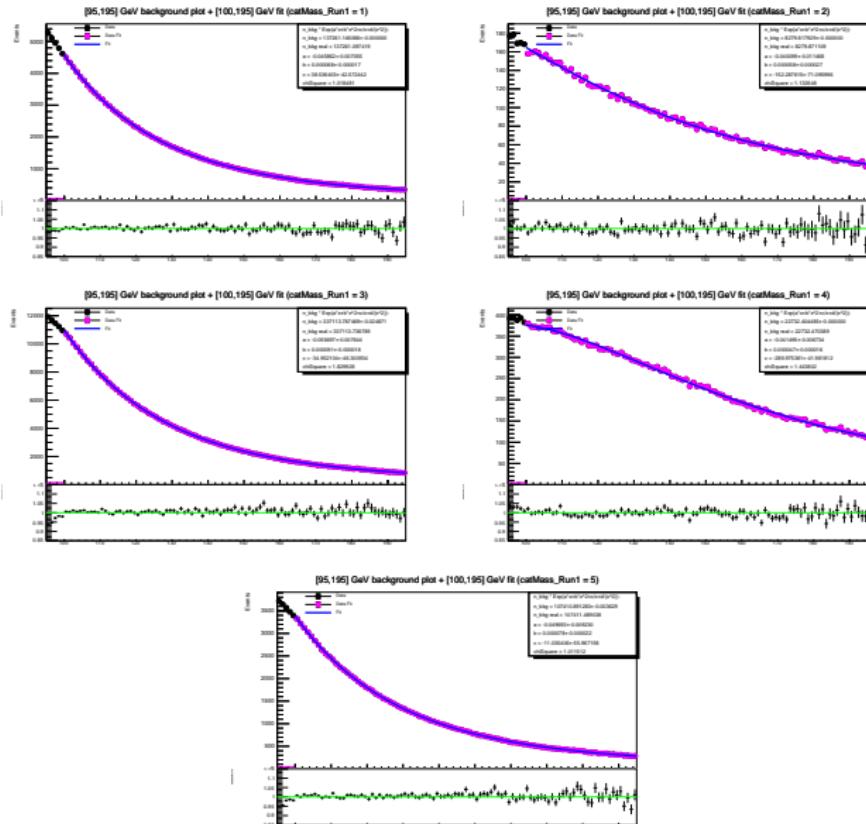
Bkg	WS	MC
no	1311644.378	1311646.703
1	137260.990	137261.097
2	8279.818	8279.871
3	337113.787	337113.739
4	22732.404	22732.471
5	107410.891	107411.489
6	85384.539	85384.483
7	5258.930	5258.815
8	398641.906	398641.875
9	27564.471	27564.465
10	181998.098	181998.398

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

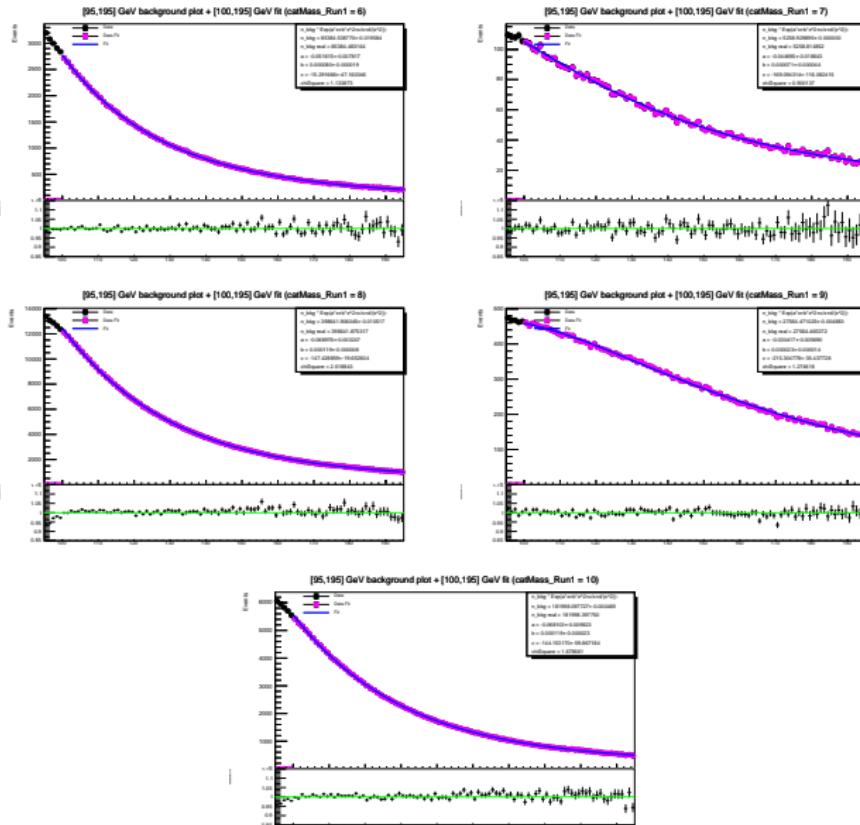
# Bkg fit, catMass\_Run1 = no



# Bkg fit, catMass\_Run1 → unconv



# $\pm 1\sigma$ var sys, catMass\_Run1 → 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

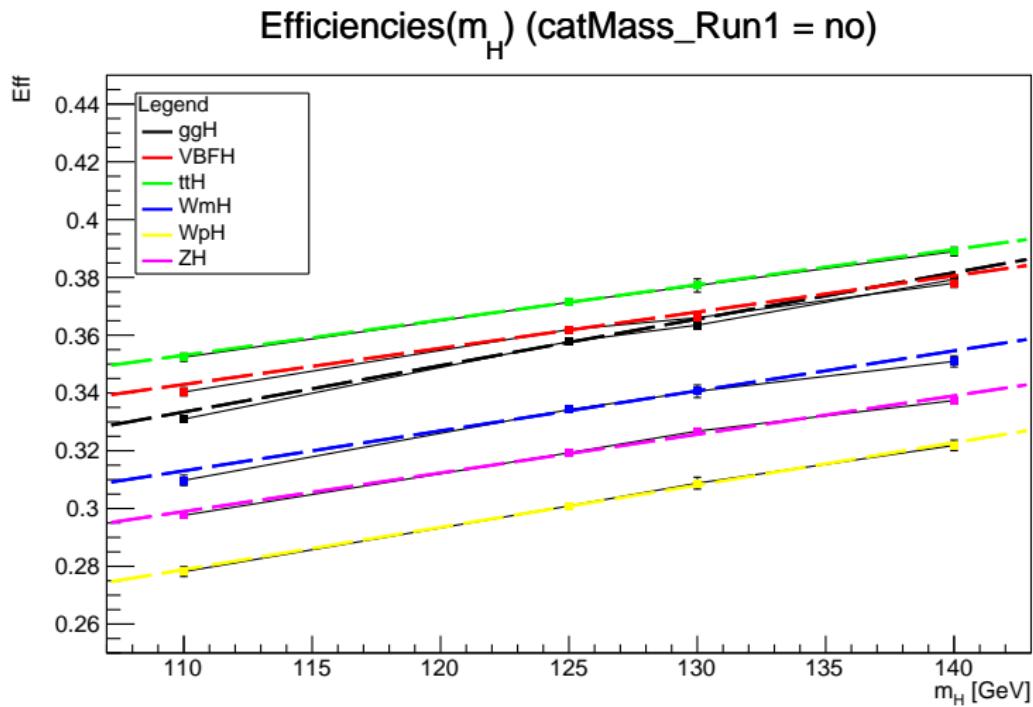
**Table:** Number of signal and  $\sqrt{bkg}$  events ratio in [peak-5,peak+5] GeV intervall

# Production mods inc

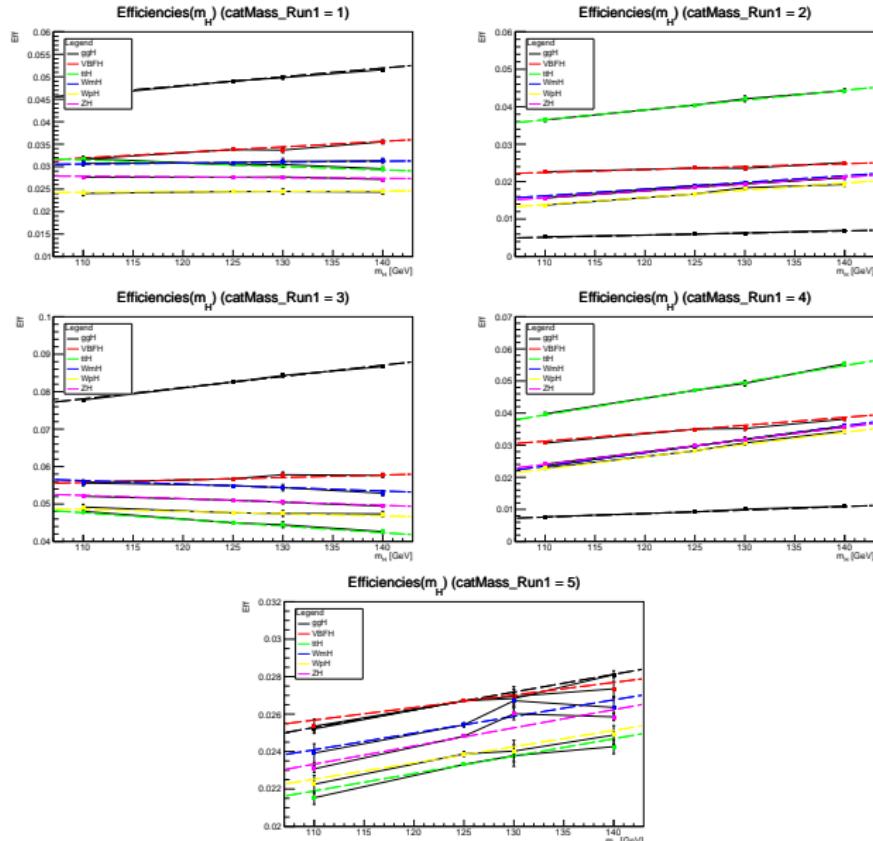
	110 GeV	125 GeV	130 GeV	140 GeV
no	0.163719	0.158653	0.157113	0.154228
1	0.473474	0.501648	0.510308	0.526655
2	6.10882	5.75791	5.66206	5.49417
3	0.389534	0.454923	0.475167	0.513567
4	4.19079	4.09942	4.07578	4.03563
5	0.134046	0.127847	0.125924	0.122273
6	0.483679	0.49864	0.503204	0.511778
7	5.89377	5.83035	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:  $\text{abs}(\text{eff}_{\text{prod}} - \text{eff}_{\text{ggH}}) / \text{eff}_{\text{ggH}}$

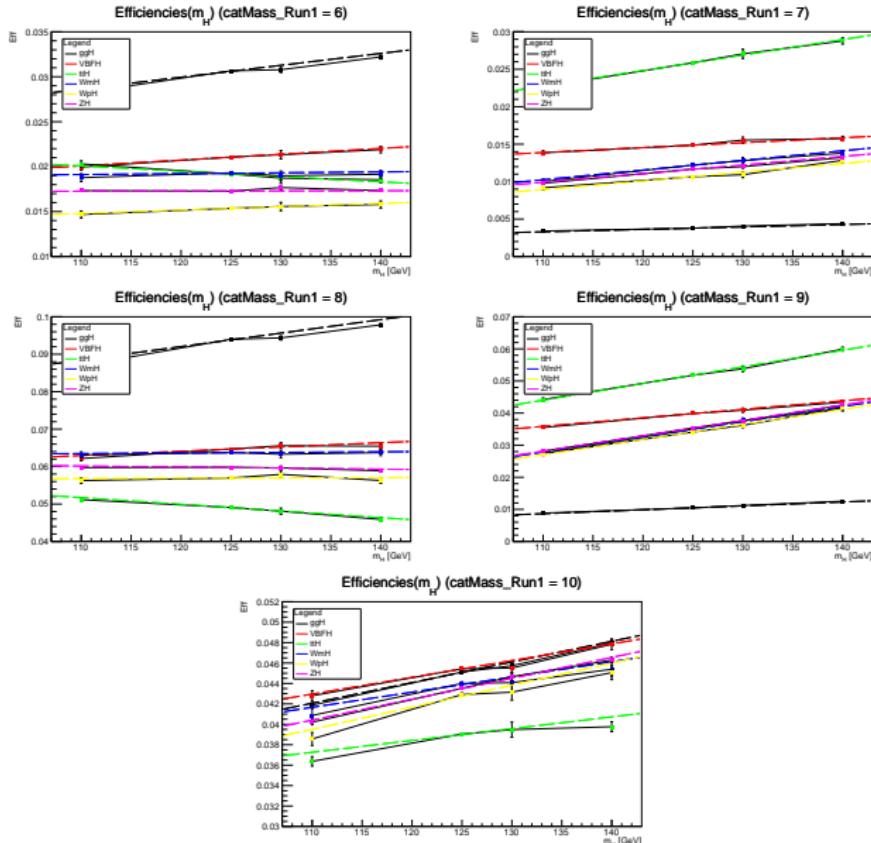
# Production mods



# Production mods cat unconv



# Production mods cat 1\_conv



# $\pm 1\sigma$ var sys

Signal	no		1		2		3		4		5	
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$
_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	0.00018235	0.00483447	-0.0046946	-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	0.0131866	-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

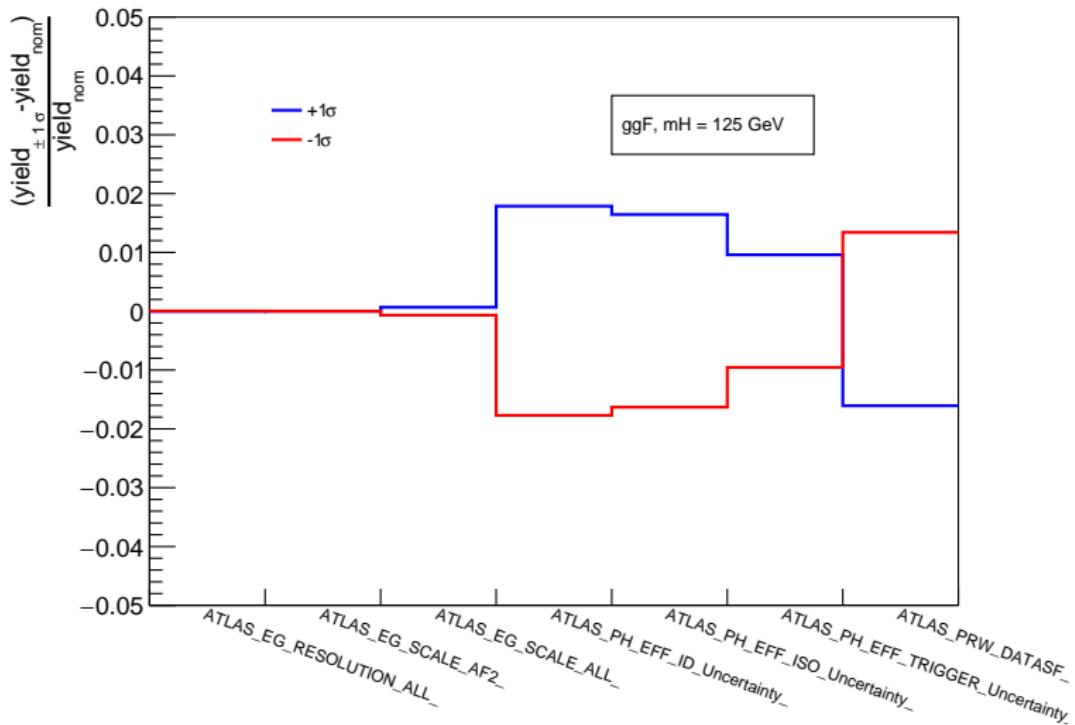
  

Signal	6		7		8		9		10		
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	
_EG_RESOLUTION_ALL_	1.5645e-05	-4.38881e-05	-0.000141157	0.000706633	-5.81966e-05	3.8653e-05	9.66237e-05	0.000141198	-2.45463e-05	5.04156e-05	
_EG_SCALE_AF2_	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	

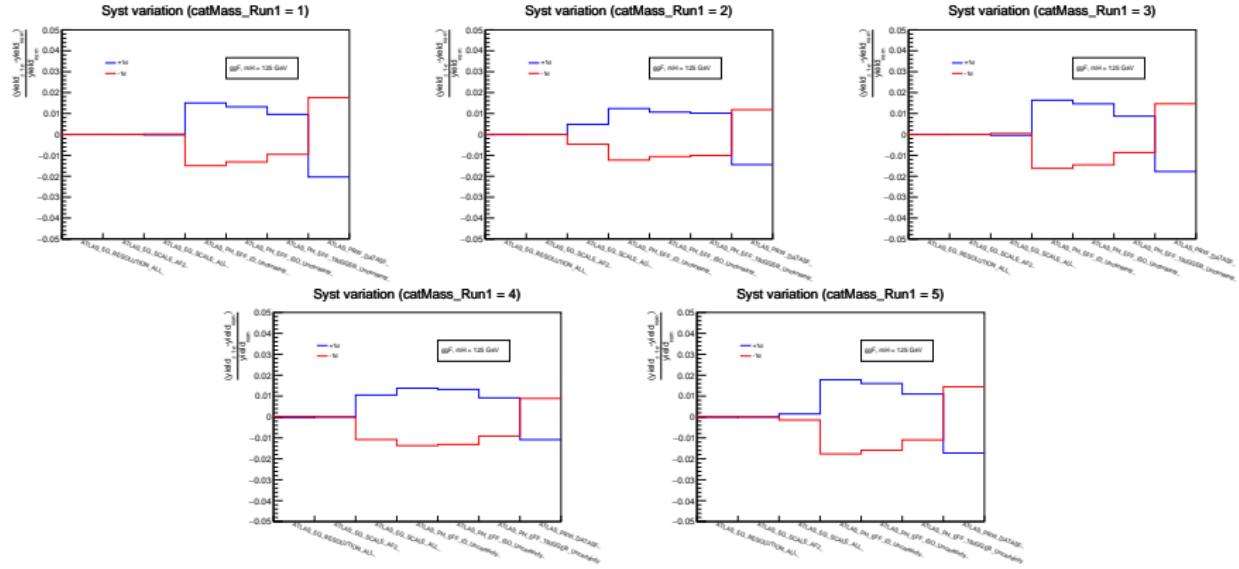
Table:  $\pm 1\sigma$  var sys for each category

$\pm 1\sigma$  var sys, catMass\_Run1 = no

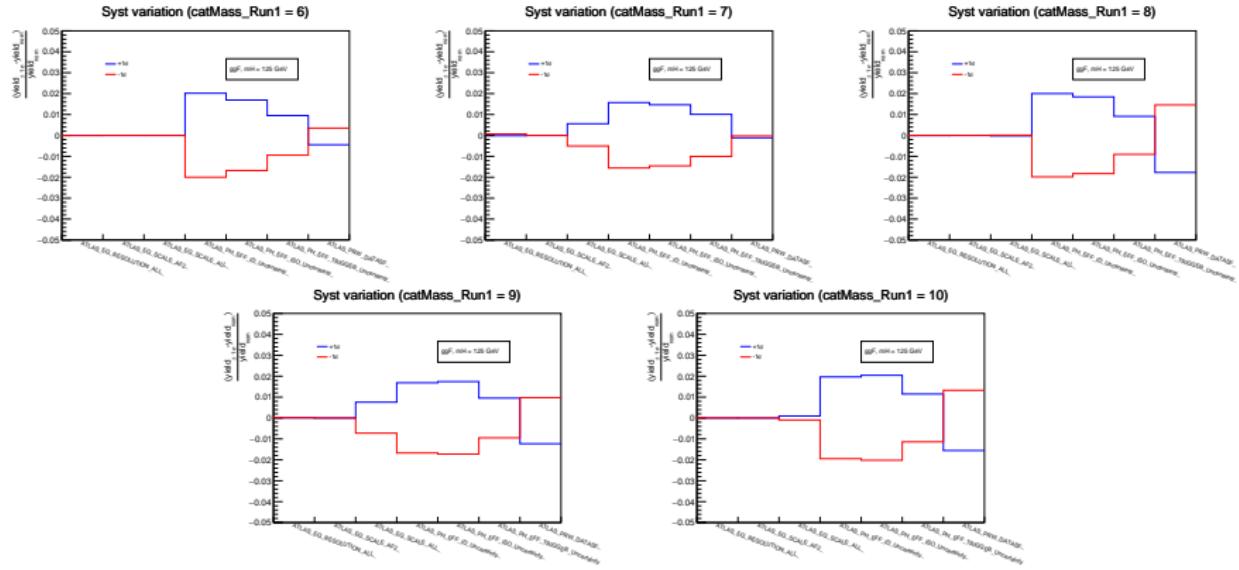
Syst variation (catMass\_Run1 = no)



# $\pm 1\sigma$ var sys, catMass\_Run1 → unconv



# $\pm 1\sigma$ var sys, catMass\_Run1 $\rightarrow$ 1\_conv



13<sup>th</sup> 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
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
Sum cat	28.3845	37.8069	37.9791	30.2578

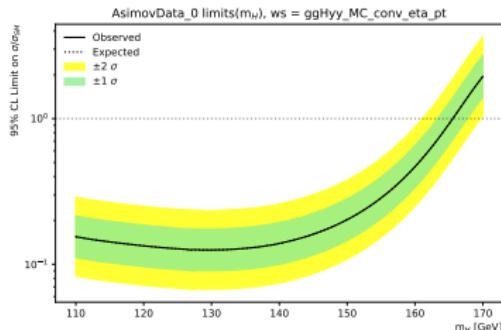
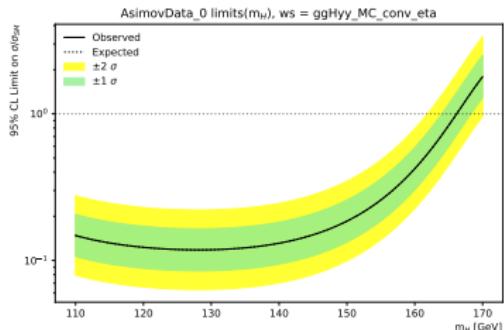
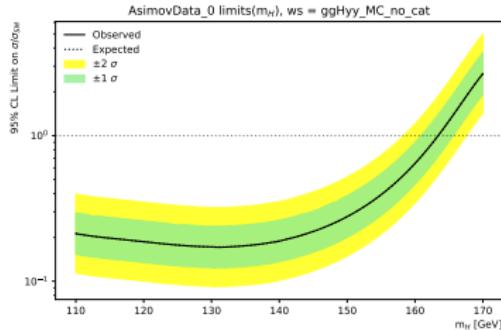
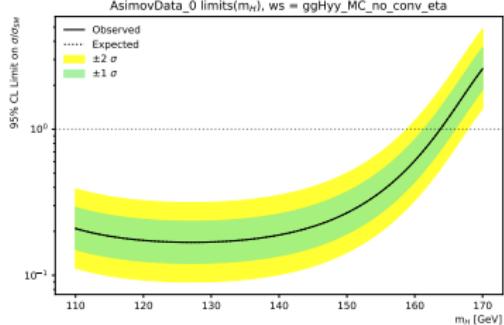
Table: Number of signal and  $\sqrt{bkg}$  events ratio in [peak-5,peak+5] GeV intervall

# Xs·Br check

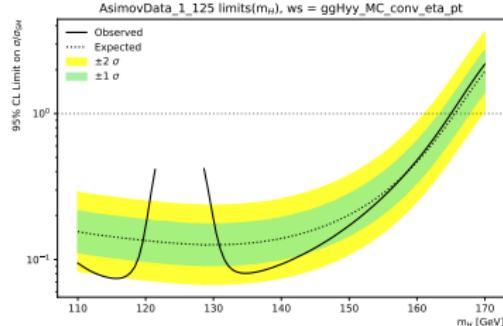
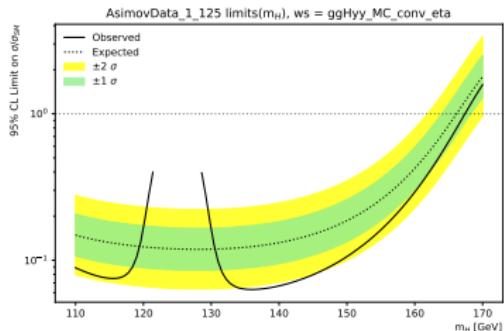
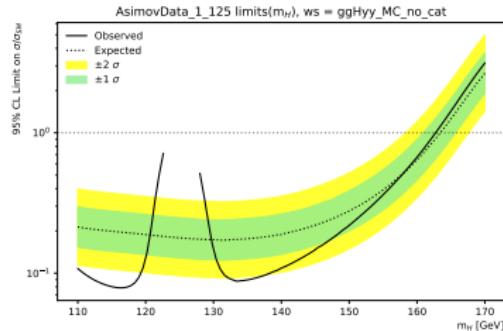
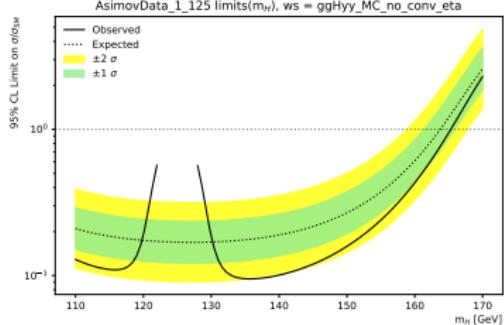
Xs·Br	Hgamma	Weight_XsBrFe	Fit
125	0.1101404	0.11014	0.0957348
110	0.10966	0.10966	0.104417
130	0.1014038	0.101404	0.0885264
140	0.06777	0.06777	0.0675757

Table: Xs and Br comparison

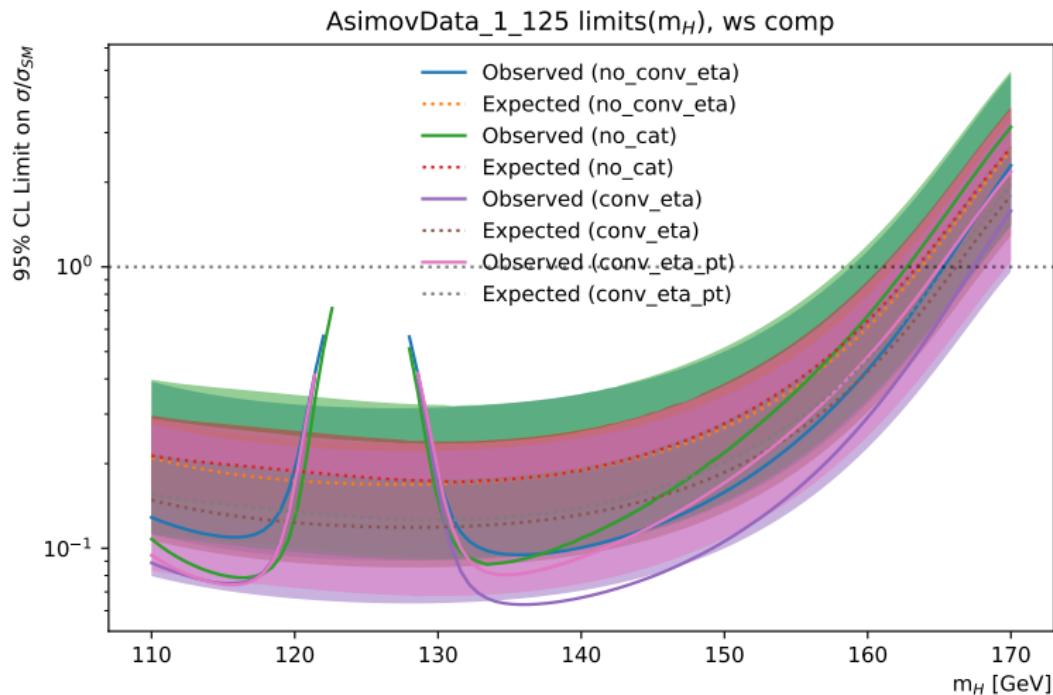
# AsimovData $\mu=0$ limits



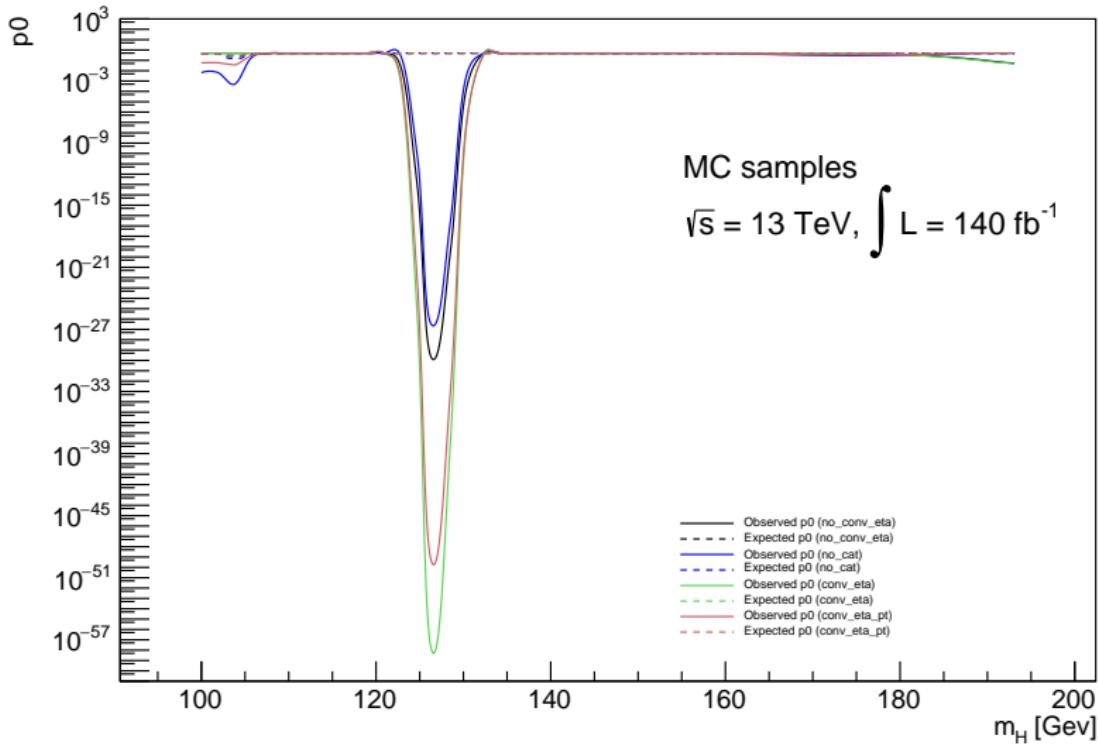
# AsimovData $\mu=1$ mH=125 limits



# AsimovData $\mu=1$ mH=125 comp



# p0 scan comparison



# $\pm 1\sigma$ yield sys

Signal	no		1		2		3		4		5	
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$
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	-0.00423294	0.00482657	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	0.0146609

Signal	6		7		8		9		10	
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$
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

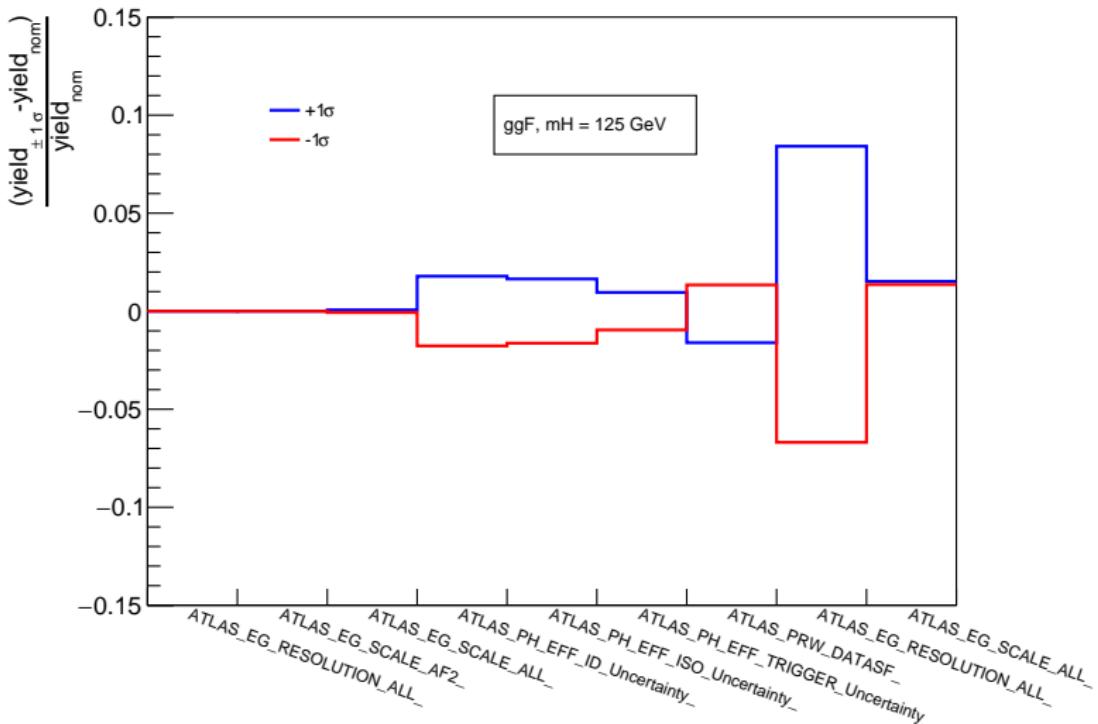
Signal	no		1		2		3		4		5	
	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$
ATLAS_EG_RESOLUTION_ALL_	0.0841314	-0.0668985	0.0878635	-0.0483741	0.144179	-0.0783765	0.0847722	-0.0719211	0.130348	-0.106281	0.118665	-0.116413
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	
	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$	$+1\sigma$	$-1\sigma$
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

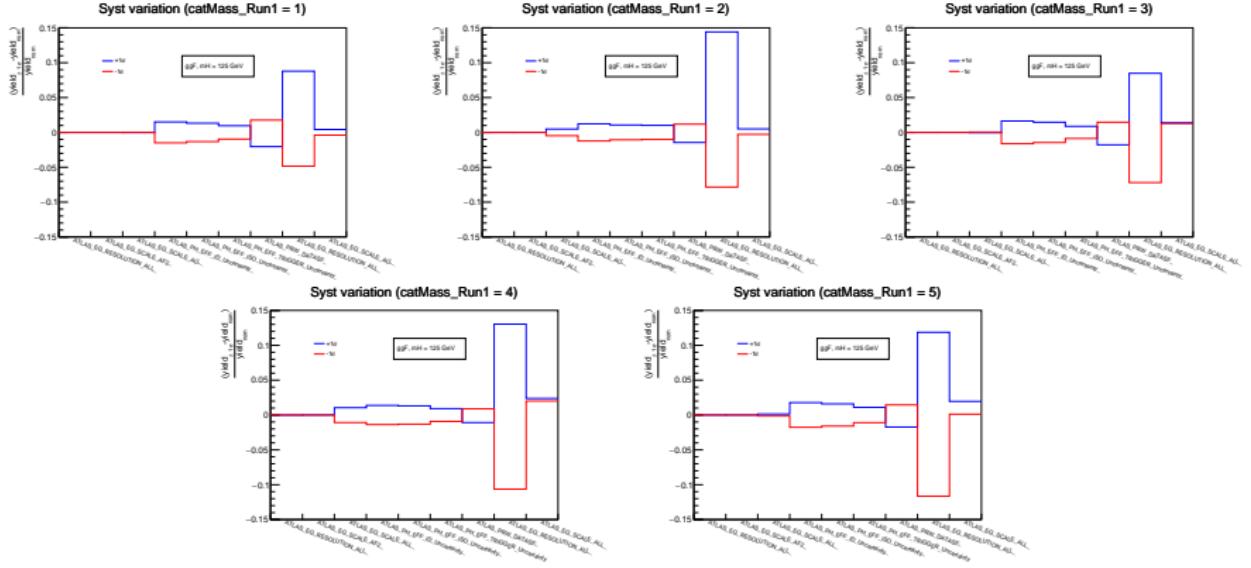
Table:  $\pm 1\sigma$  shape sys for each category

# $\pm 1\sigma$ yield and shape sys, catMass\_Run1 = no

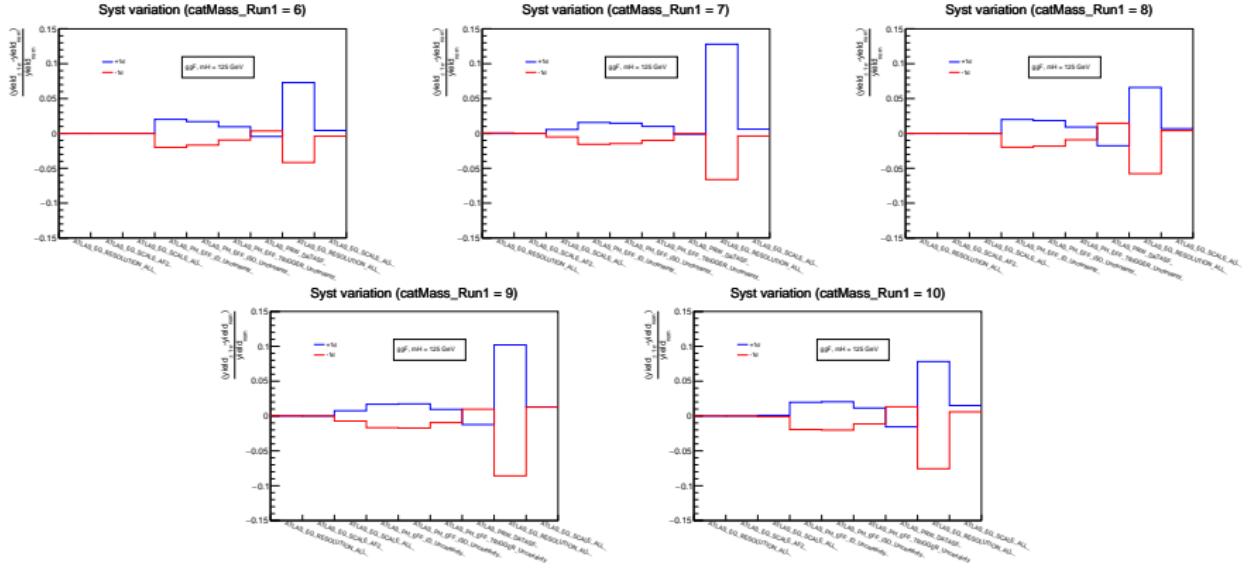
Syst variation (catMass\_Run1 = no)



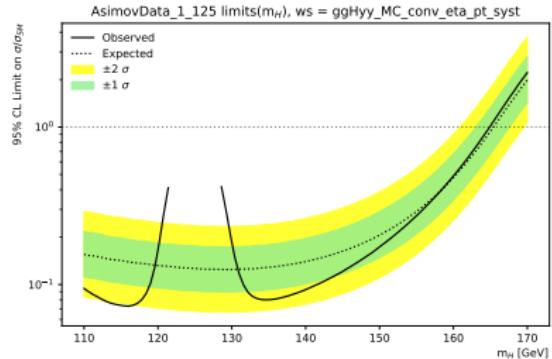
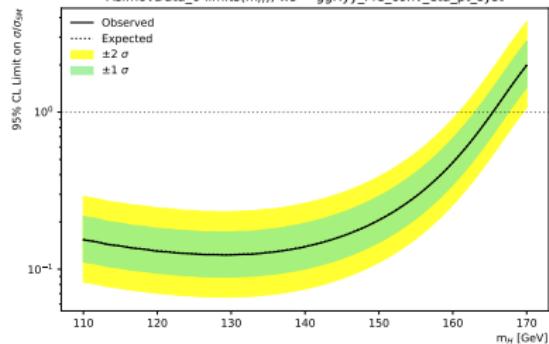
# $\pm 1\sigma$ yield and shape sys, unconv



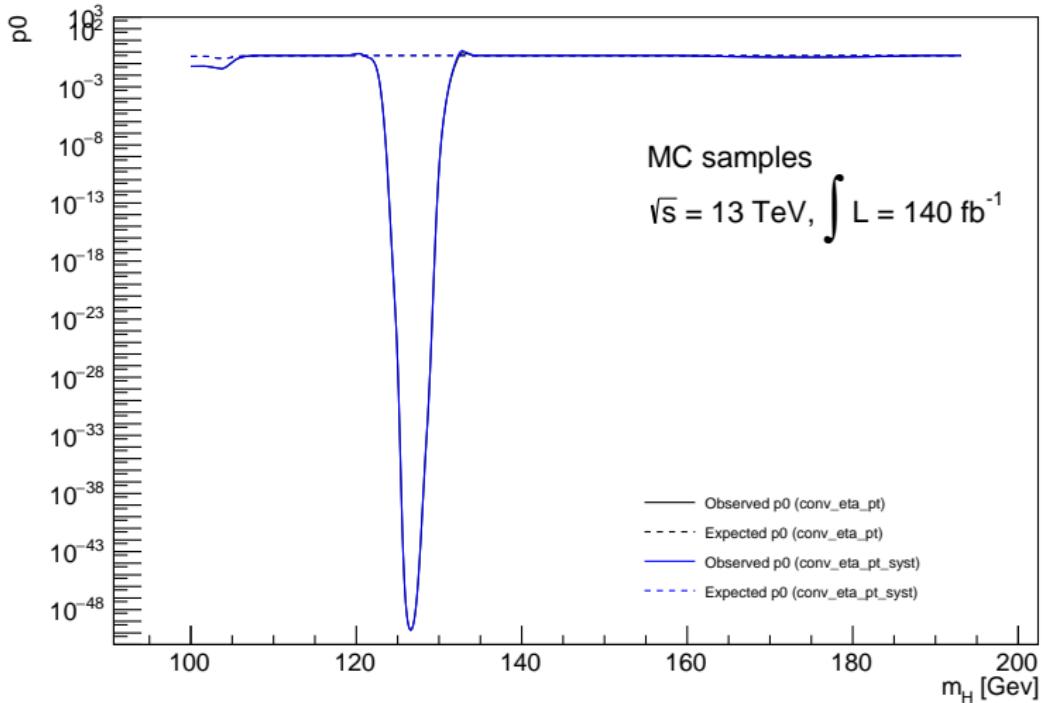
# $\pm 1\sigma$ yield and shape sys, 1\_conv



# Limits ws conv\_eta\_pt with syst



# p0 scan sys comparison



*14<sup>th</sup>* week

# Ntuples update

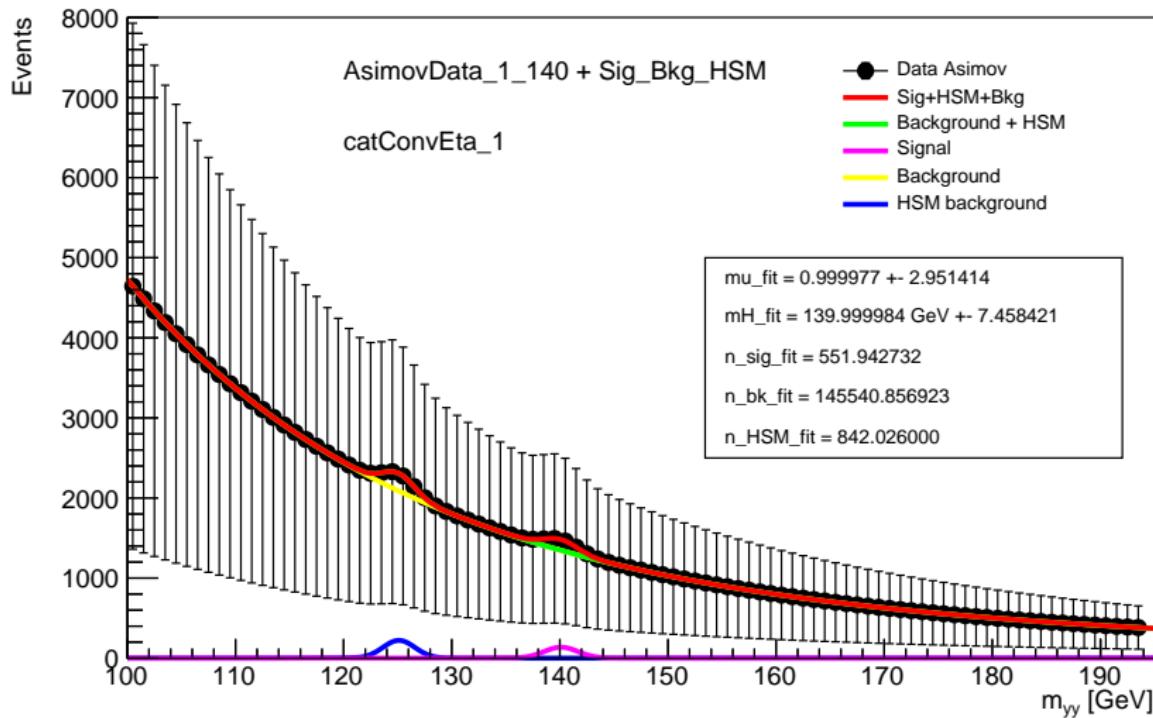
- added the `isFiducialLowMyy` and `isFiducialHighMyy` for fiducial x-s parameterisation of the limits;
- started h026 → h027 update.

# HSM background

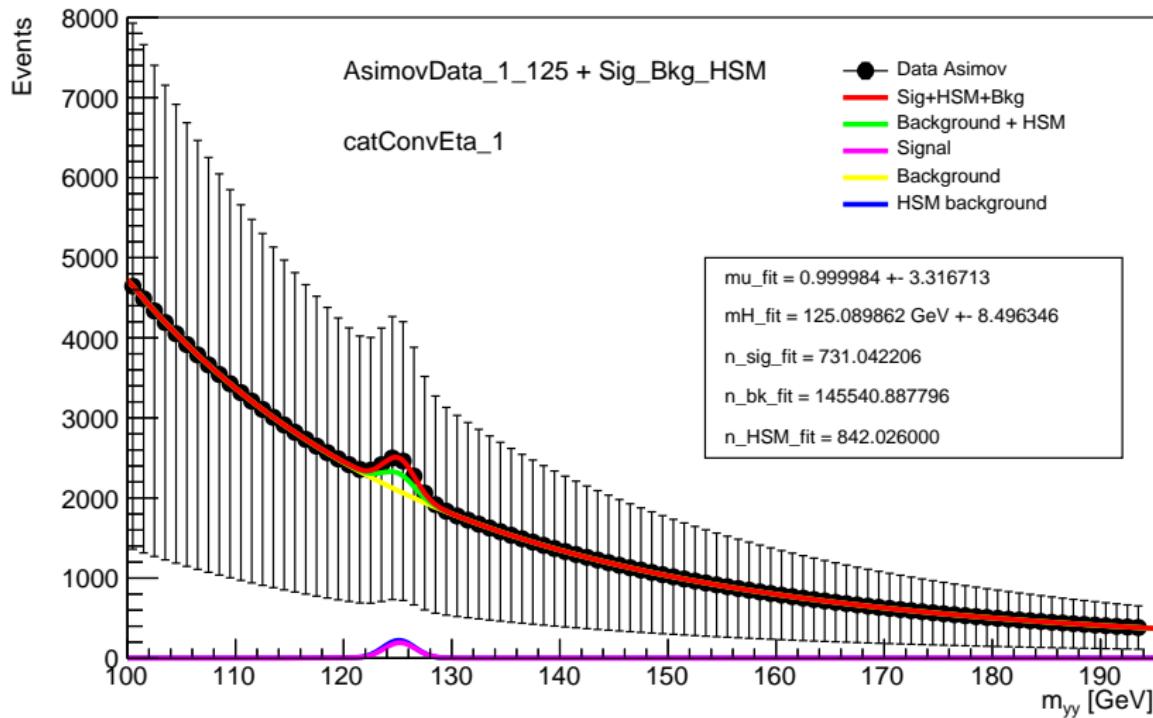
HSM background:

- 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;

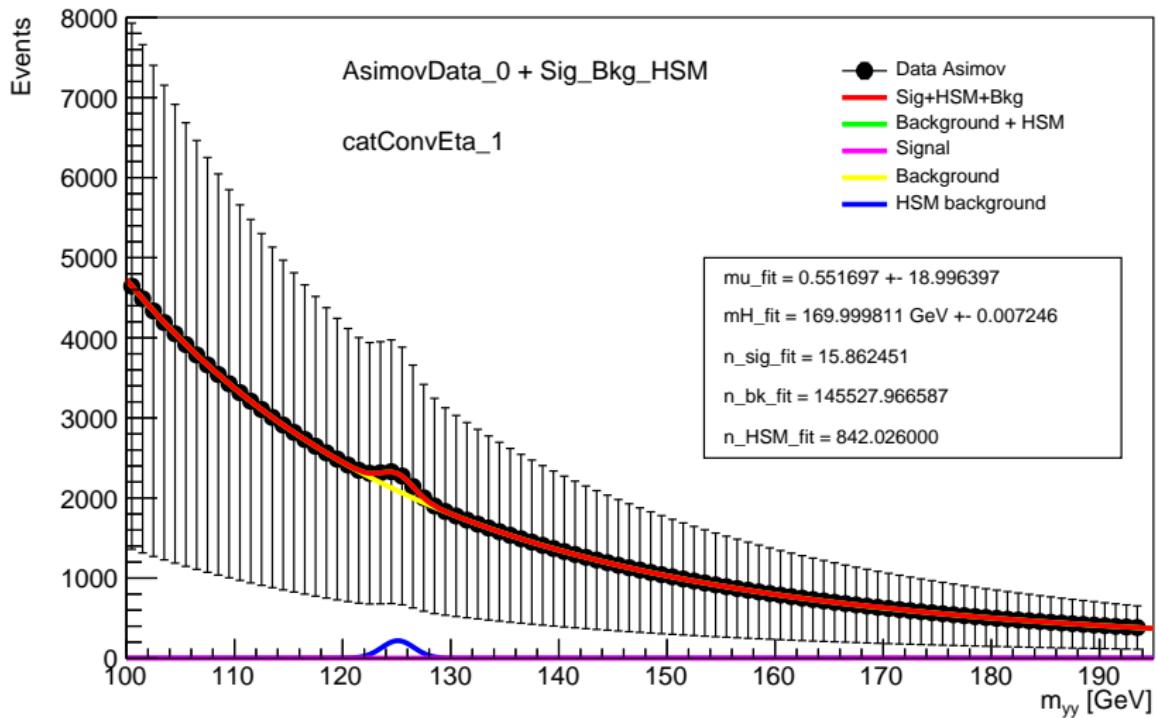
# Asimov $\mu = 1$ $mH = 140 + \text{HSM}$



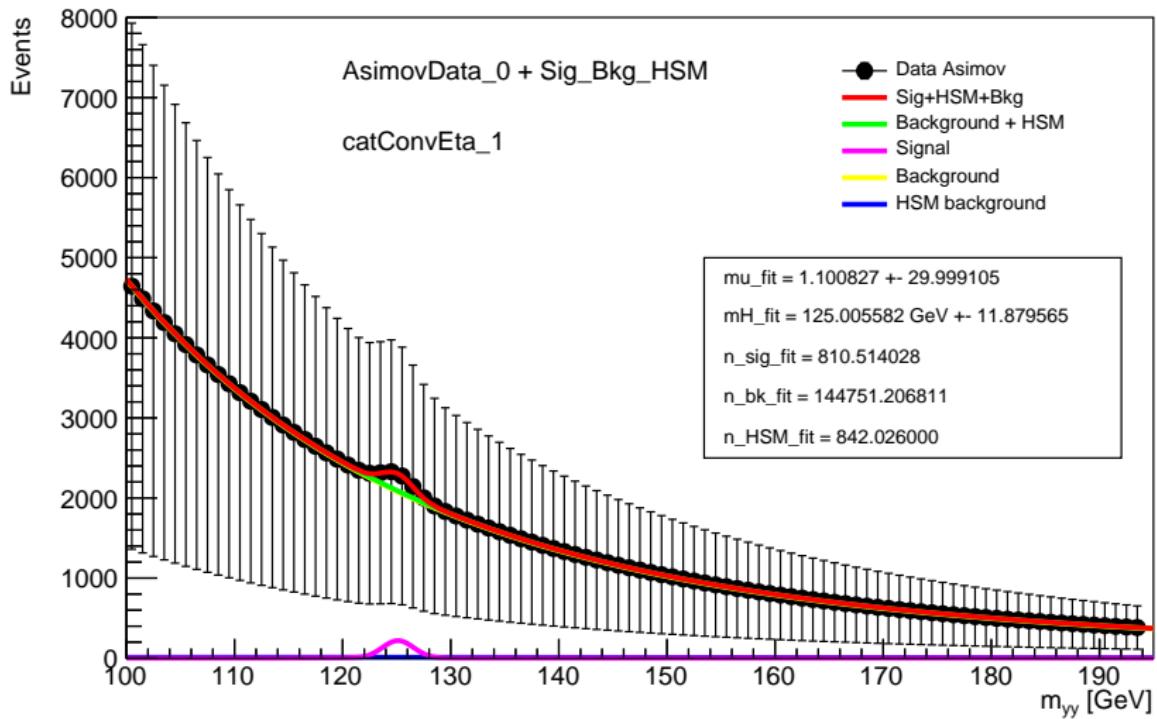
# Asimov $\mu = 1$ $mH = 125 + \text{HSM}$



# Asimov $\mu = 0 + \text{HSM}$



# Asimov $\mu = 0 + \text{HSM}$



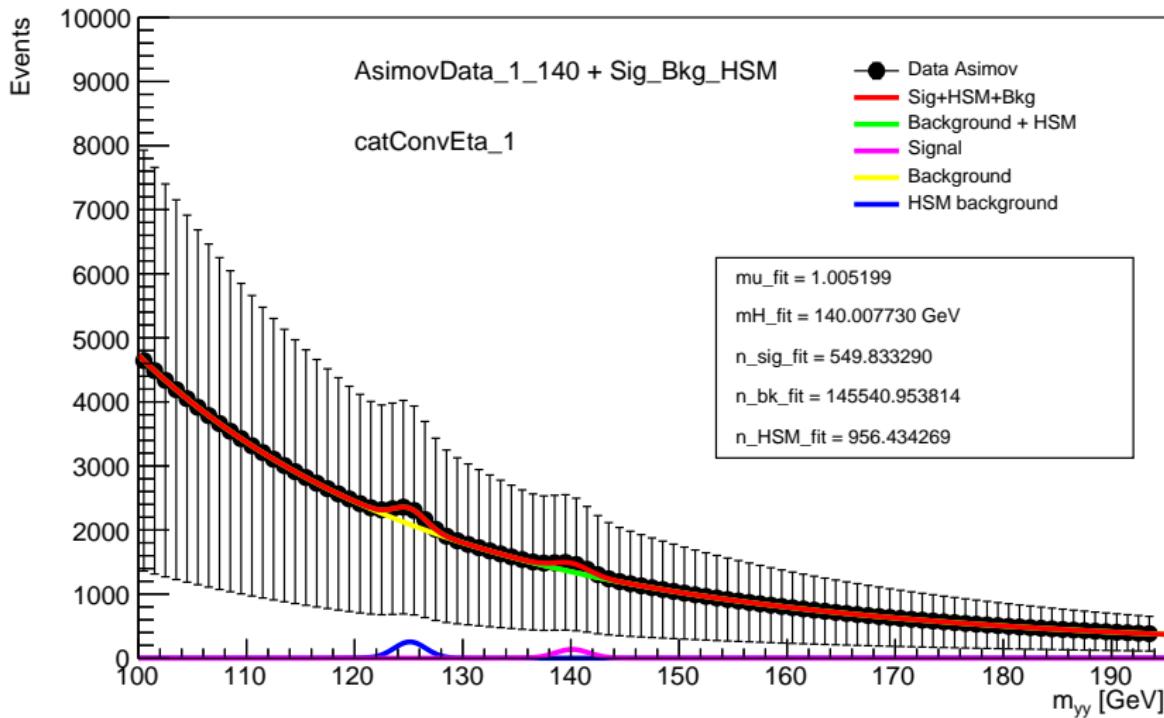
15<sup>th</sup> week

# HSM events

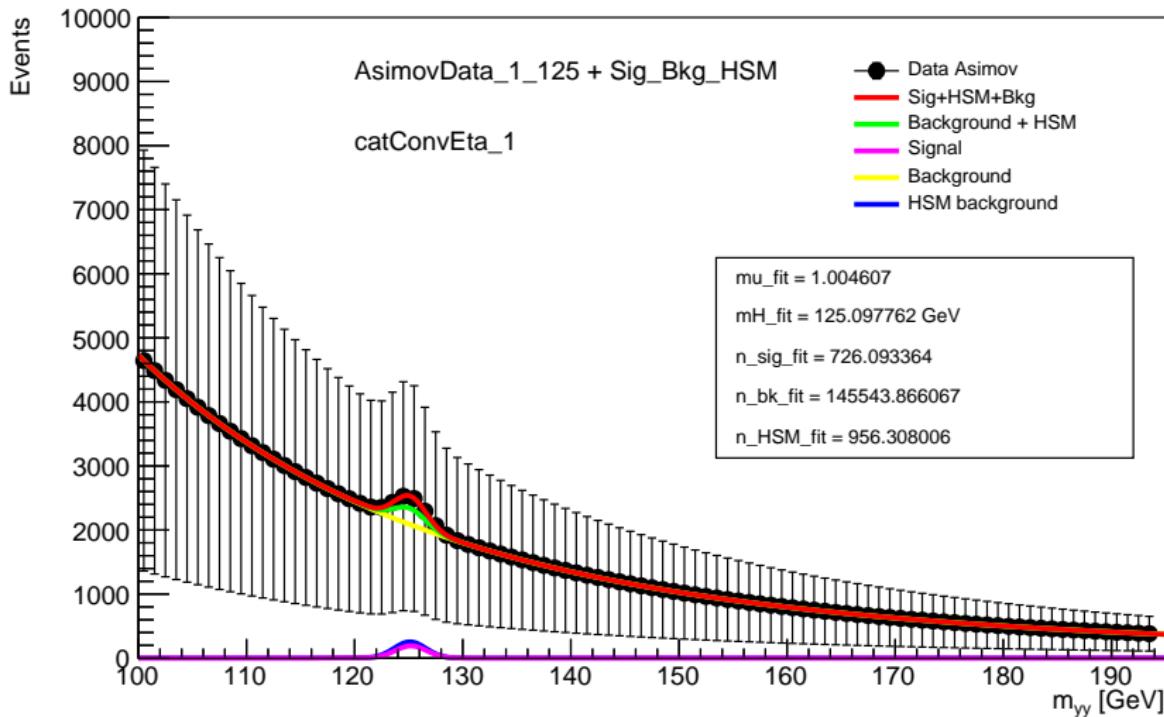
Category	# of HSM events
Inclusive	6198.8
1	956.294
2	1589.39
3	462.759
4	598.854
5	1810.2
6	783.151

**Table:** Number of Higgs SM events for each category

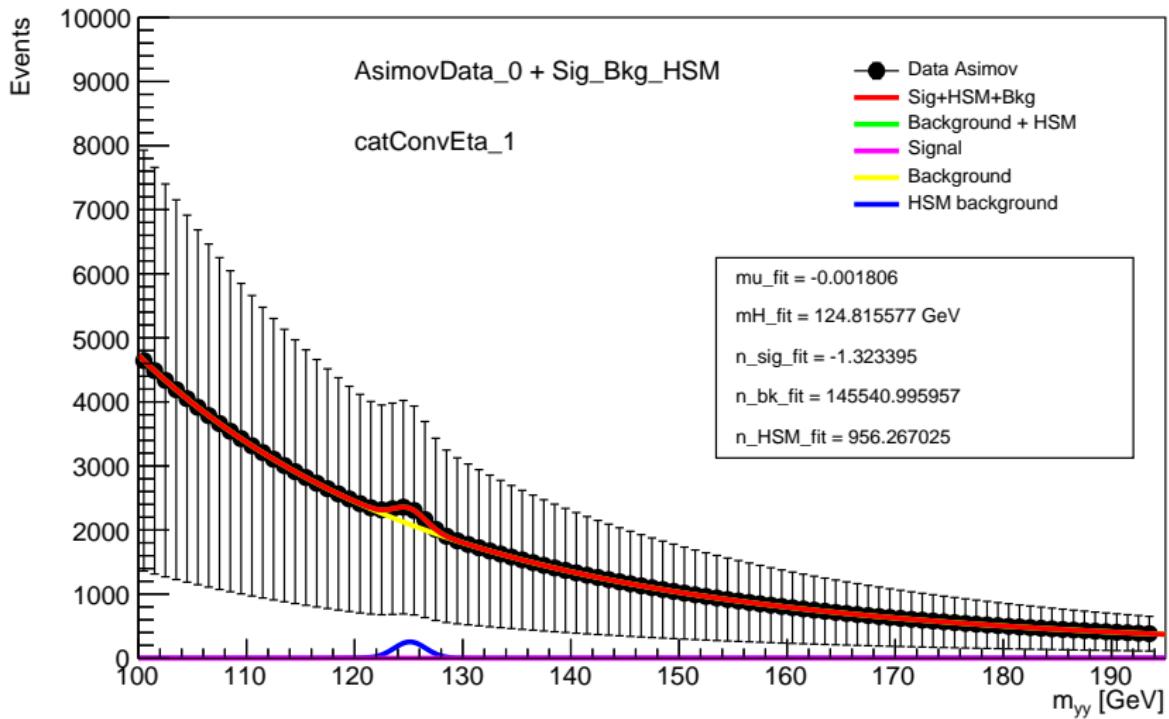
# Asimov $\mu = 1$ $mH = 140 + \text{HSM}$



# Asimov $\mu = 1$ $mH = 125 + \text{HSM}$



# Asimov $\mu = 0$ + HSM



# HSM yield sys

Signal	no	1	2	3	4	5	6					
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$
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
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
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
ATLAS_PH_EFF_ISO_Uncertainty_	0.0163986	-0.0162649	0.0128009	-0.0127179	0.0144306	-0.0143256	0.0159963	-0.0158704	0.0165834	-0.0164545	0.0183376	-0.0181758
ATLAS_PH_EFF_TRIGGER_Uncertainty_	0.00962177	-0.00957059	0.00966958	-0.00962059	0.00878235	-0.00874122	0.0110145	-0.0109453	0.0095903	-0.0095421	0.00917878	-0.00913182
ATLAS_PRW_DATASF_	-0.0156235	0.0132177	-0.0194486	0.0167841	-0.0167484	0.0138607	-0.0169866	0.0143085	-0.00392561	0.00296635	-0.01692	0.0139293

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

# HSM shape sys

Signal	no		1		2		3		4		5		6	
	+1 $\sigma$	-1 $\sigma$												
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	isFiducialHighMy	isFiducialLowMy
$\eta^{\gamma_1}$	$\eta$ cut		< 2.37	< 2.37
$\eta^{\gamma_2}$	$\eta$ cut		< 2.37	< 2.37
$E_T^{\text{cone}40} \gamma_1 / (p_T^{\gamma_1} + 120\text{e3})$	High-mass Isolation cut		< 0.05	//
$E_T^{\text{cone}40} \gamma_2 / (p_T^{\gamma_2} + 120\text{e3})$	High-mass Isolation cut		< 0.05	//
$E_T^{\text{cone}20} \gamma_1 / p_T^{\gamma_1}$	Low-mass Isolation cut		//	< 0.065
$E_T^{\text{cone}20} \gamma_2 / p_T^{\gamma_2}$	Low-mass Isolation cut		//	< 0.065
$p_T^{\gamma_1} / m_{\gamma\gamma}^{\text{Truth}}$	Scalar relative $p_T$ cut	> 0.35	> 0.3	//
$p_T^{\gamma_2} / m_{\gamma\gamma}^{\text{Truth}}$	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<sup>th</sup> week**

# Workspace

## ■ Signal

- Fit: DSCB, function of  $m_X$ .
- Syst:
  - Yield
  - Shape
  - Production modes

## ■ Non-resonant background

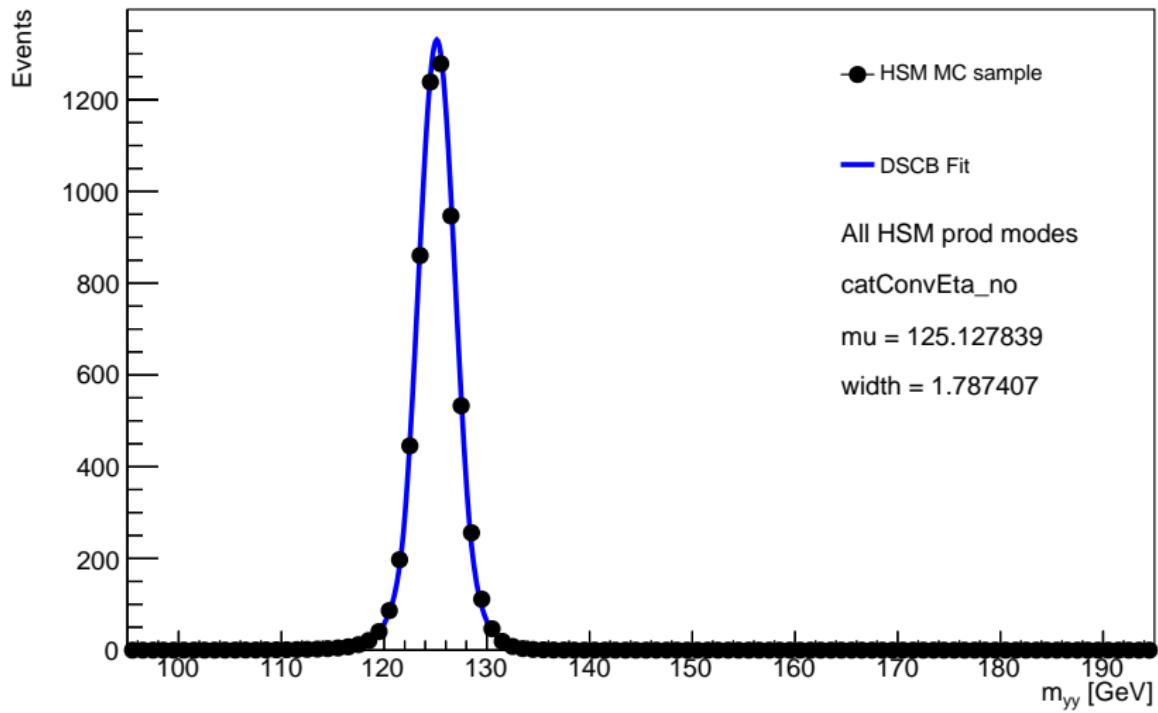
- Fit: exp poly2.
- Spurious signal: NO

## ■ HSM background

- Fit: DSCB fixed.
- Syst:
  - Yield
  - Shape
  - ATLAS Higgs mass

## ■ Theoretical syst

# HSM DSCB fit



# 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

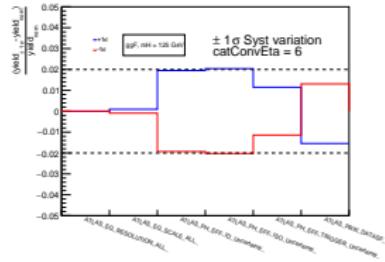
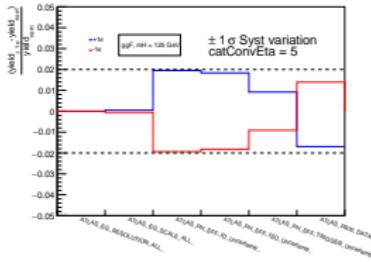
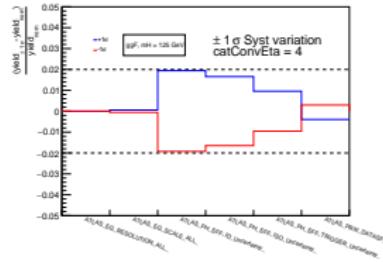
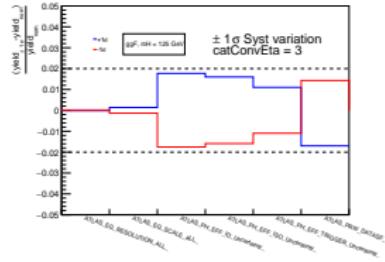
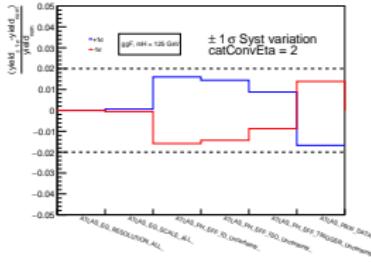
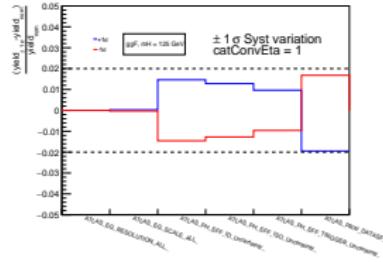
**Table:** Number of Higgs SM events for each category

# HSM yield sys

Signal	no	1	2	3	4	5	6					
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$	-1 $\sigma$
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
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
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
ATLAS_PH_EFF_ISO_Uncertainty_	0.0163986	-0.0162649	0.0128009	-0.0127179	0.0144306	-0.0143256	0.0159963	-0.0158704	0.0165834	-0.0164545	0.0183376	-0.0181758
ATLAS_PH_EFF_TRIGGER_Uncertainty_	0.00962177	-0.00957059	0.00966958	-0.00962059	0.00878235	-0.00874122	0.0110145	-0.0109453	0.0095903	-0.0095421	0.00917878	-0.00913182
ATLAS_PRW_DATASF_	-0.0156235	0.0132177	-0.0194486	0.0167841	-0.0167484	0.0138607	-0.0169866	0.0143085	-0.00392561	0.00296635	-0.01692	0.0139293

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

# $\pm 1\sigma$ yield, catConvEta

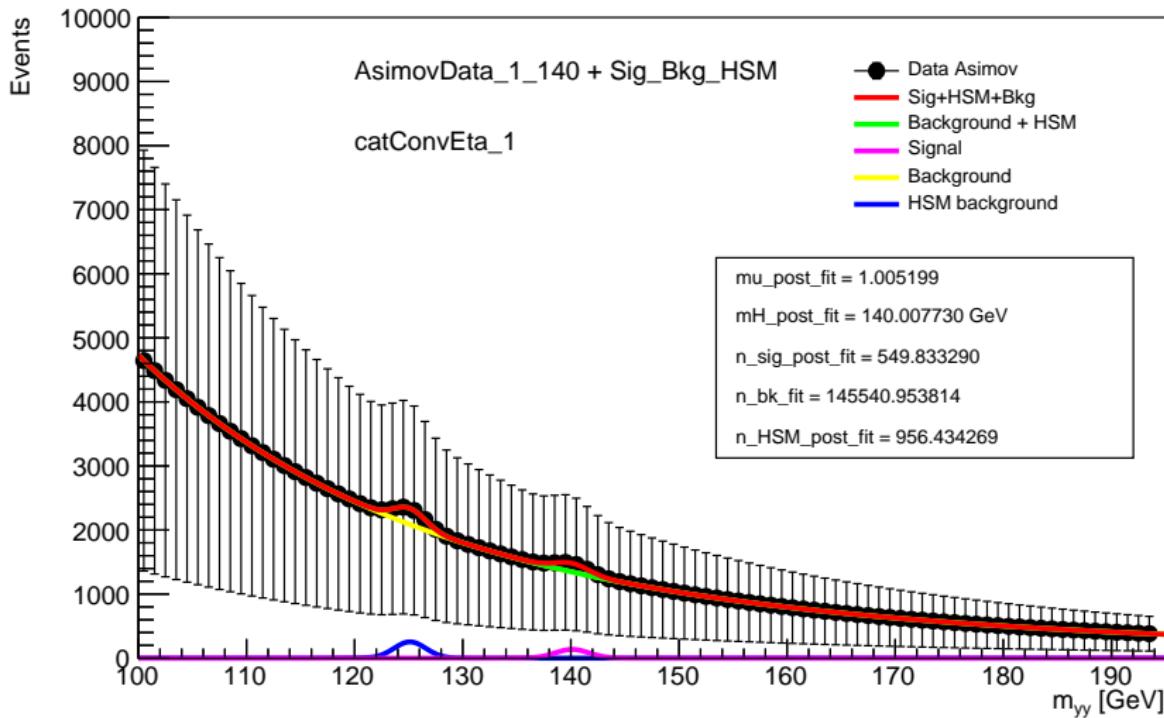


# HSM shape sys

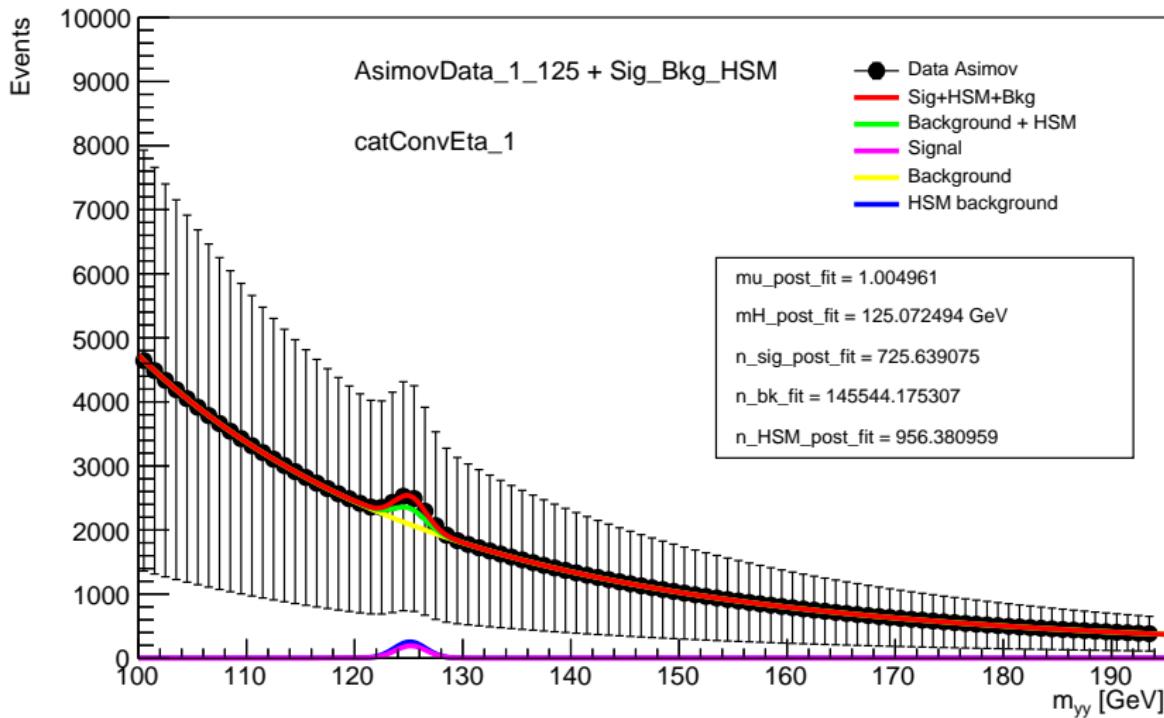
Signal	no		1		2		3		4		5		6	
	+1 $\sigma$	-1 $\sigma$												
ATLAS_EG_RESOLUTION_ALL_	0.0866339	-0.0686718	0.0973955	-0.0523099	0.0924181	-0.0778125	0.121311	-0.118801	0.0825436	-0.0452907	0.0717434	-0.062416	0.0802543	-0.0776709
ATLAS_EG_SCALE_ALL_	0.00436999	-0.00437357	0.00271049	-0.00271016	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

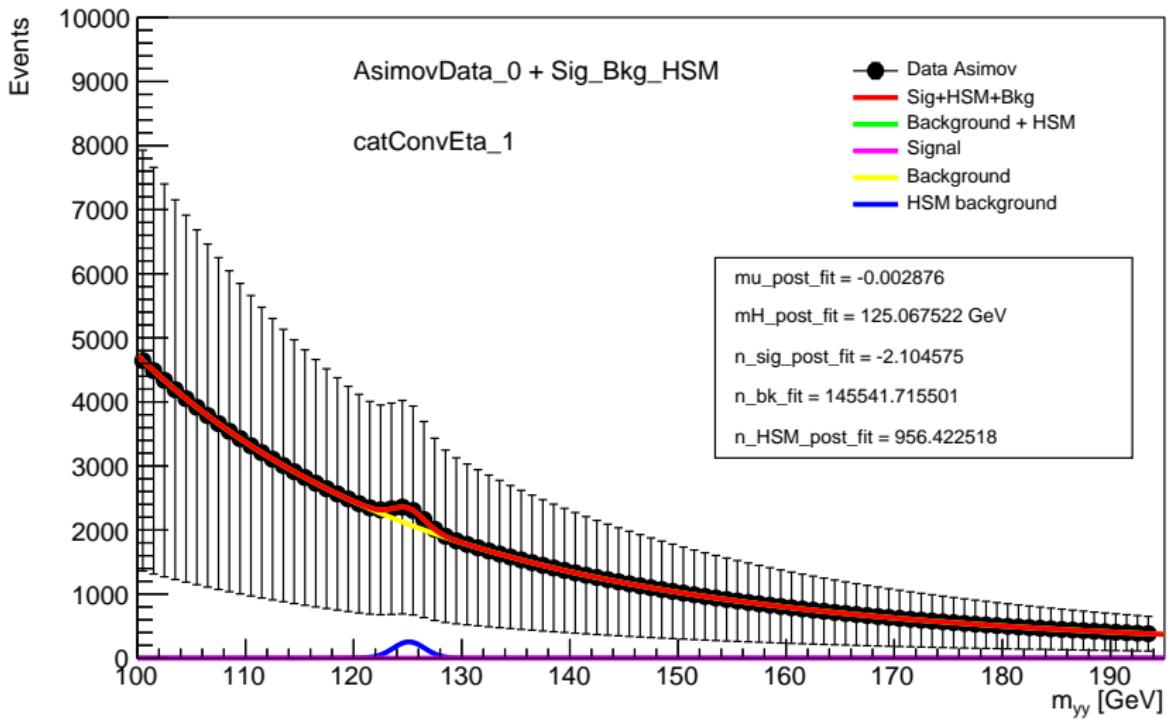
# Asimov $\mu = 1$ $mH = 140 + \text{HSM}$



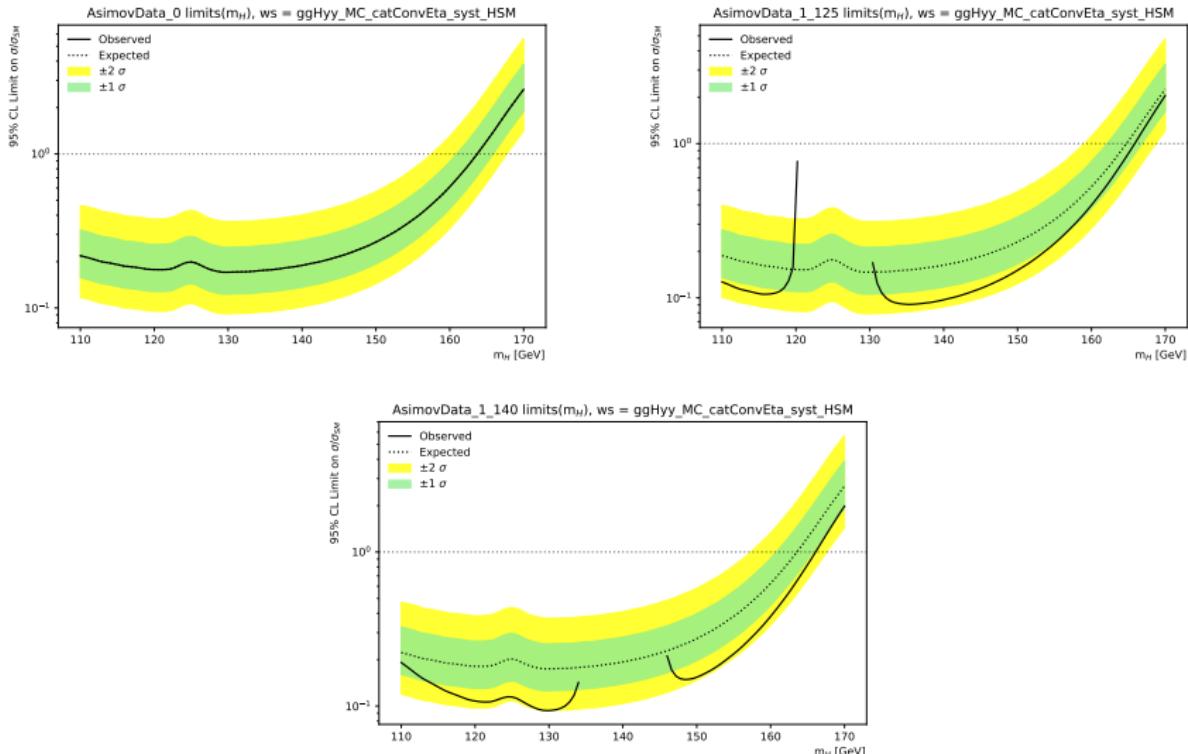
# Asimov $\mu = 1$ $mH = 125 + \text{HSM}$



# Asimov $\mu = 0$ + HSM



# Limits ws catConvEta (systs and HSM bkg)



# cutFlow vs Fiducial

Parameter	Name	cutFlow > 13	isFiducialHighMy	isFiducialLowMy
$\eta^{\gamma_1}$	$\eta$ cut		< 2.37	< 2.37
$\eta^{\gamma_2}$	$\eta$ 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 → 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<sup>th</sup> week

# Workspace

## ■ Signal

- Fit: DSCB, function of  $mx$ .
- Syst:
  - Yield
  - Shape
  - Production modes
- Fiducial events

## ■ Non-resonant background

- Fit: exp poly2.
- Spurious 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	↑

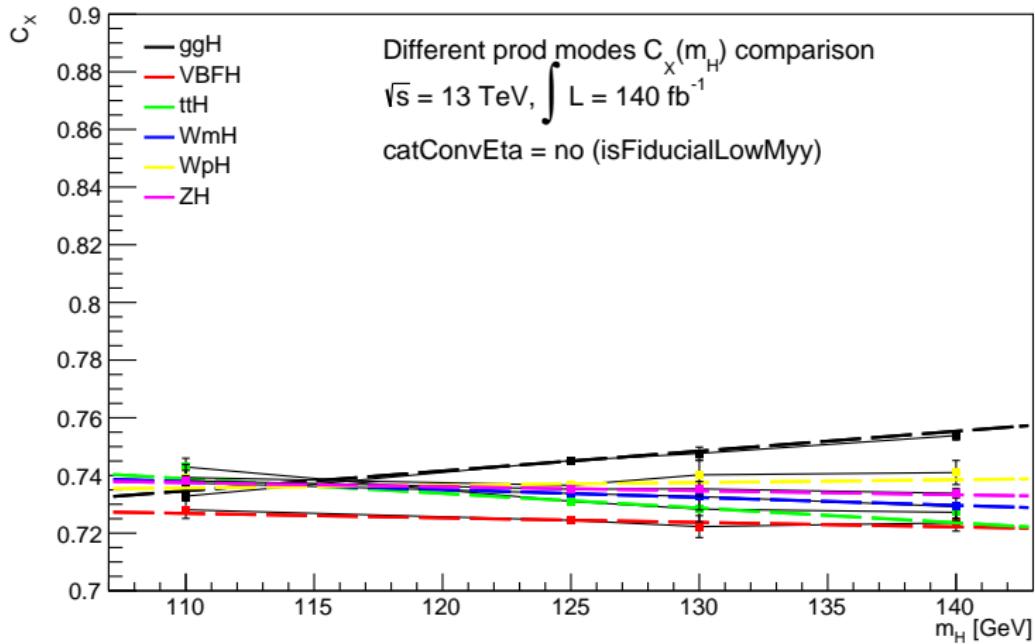
**Table:** Number of events and efficiencies for cutFlow>13, isFiducialHighMyy and isFiducialLowMyy cuts.  $m_X = 140$  GeV with catConvEta categorisation

# Production mods inc

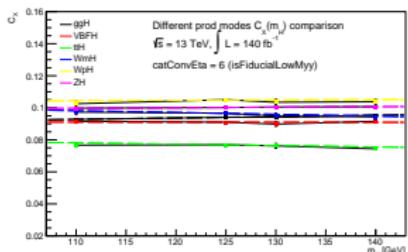
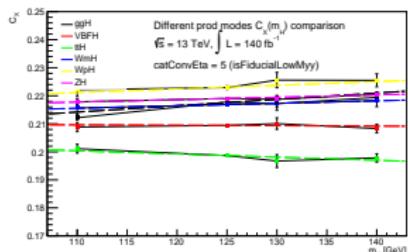
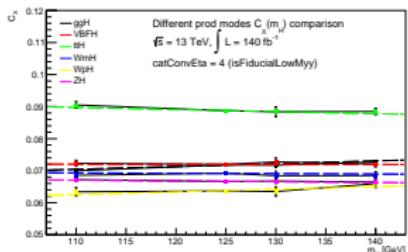
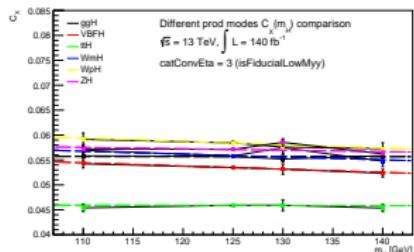
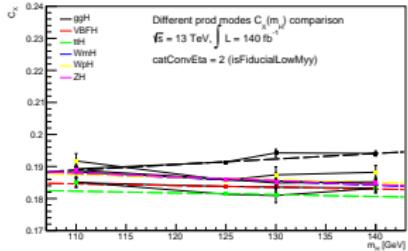
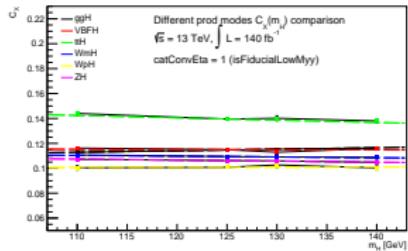
Cat	110 GeV		125 GeV		130 GeV		140 GeV	
	All	Fid_Low	All	Fid_Low	All	Fid_Low	All	Fid_Low
no	0.163719	0.0106515	0.158653	0.0275281	0.157113	0.03305	0.154228	0.0439428
1	0.329207	0.260816	0.28836	0.217073	0.275966	0.202788	0.252775	0.174647
2	0.168929	0.0348676	0.172123	0.0522419	0.173095	0.0579295	0.174916	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:  $\text{abs}(\text{eff}_{\text{prod}} - \text{eff}_{\text{ggH}}) / \text{eff}_{\text{ggH}}$  vs  $\text{abs}(\text{cx}_{\text{prod}} - \text{cx}_{\text{ggH}}) / \text{cx}_{\text{ggH}}$  other production modes systematic uncertainties

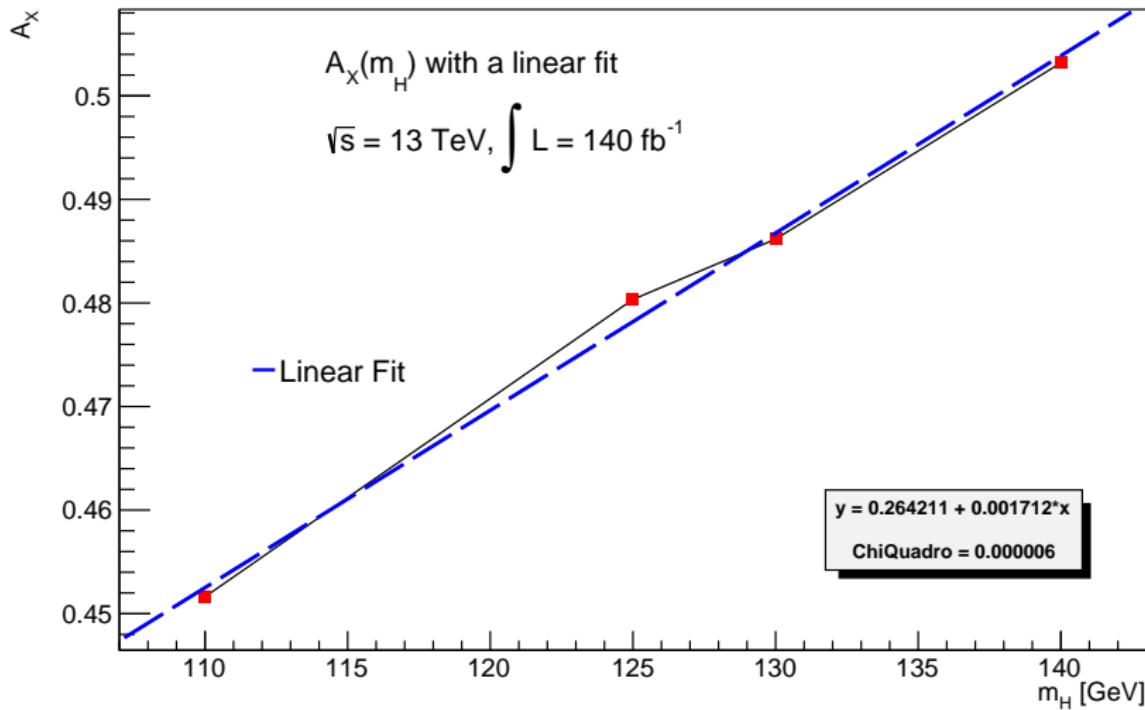
# Production mods



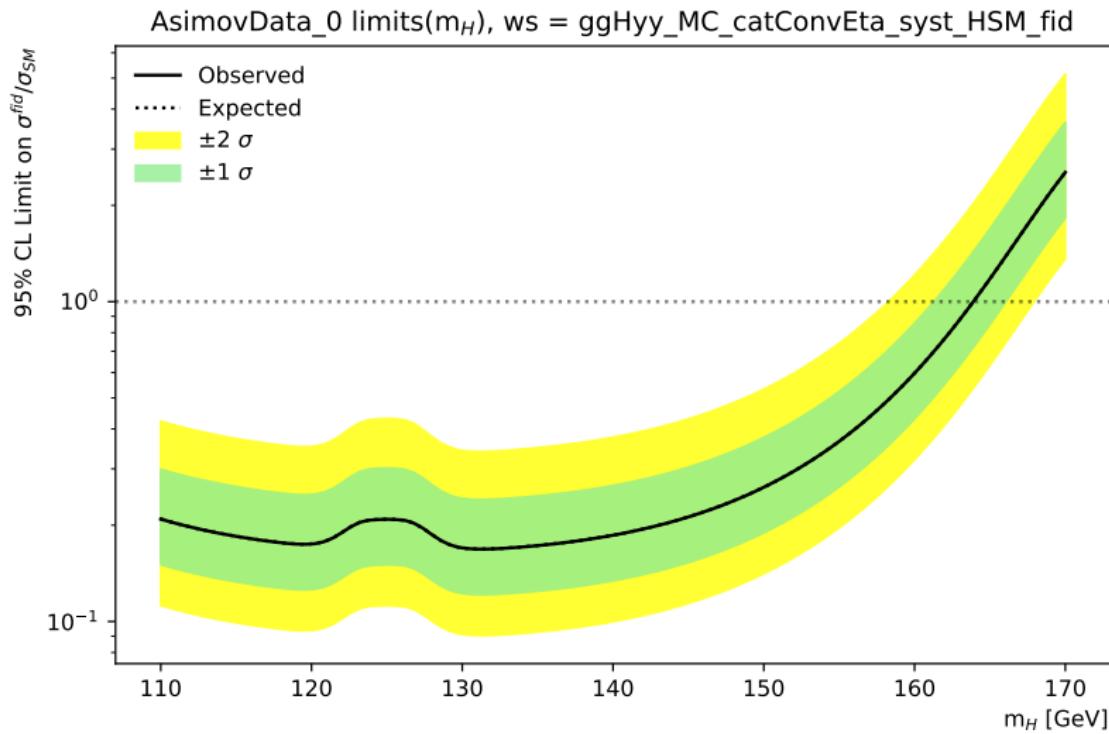
# Production mods catConvEta



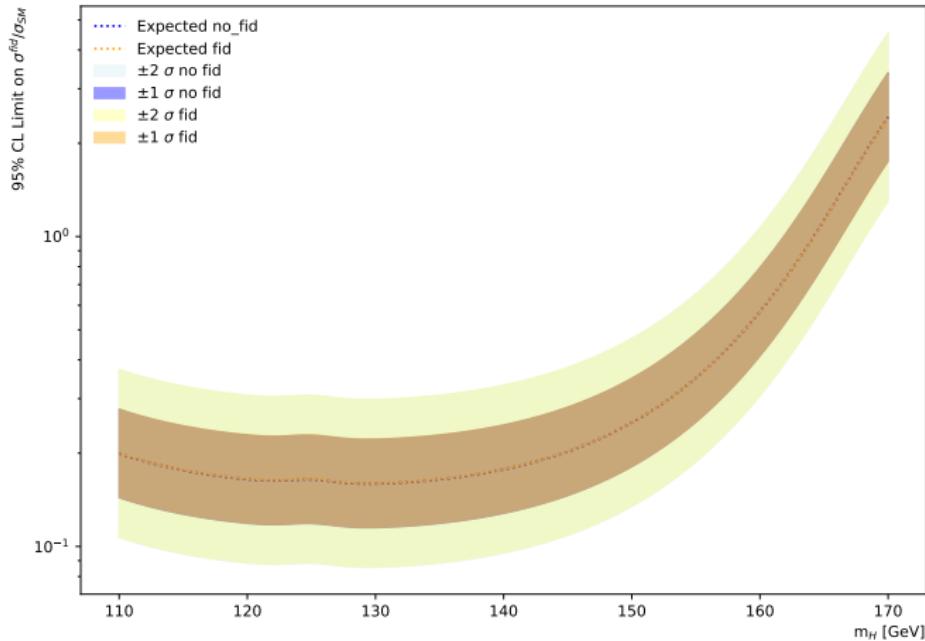
# $A_X$ linear fit



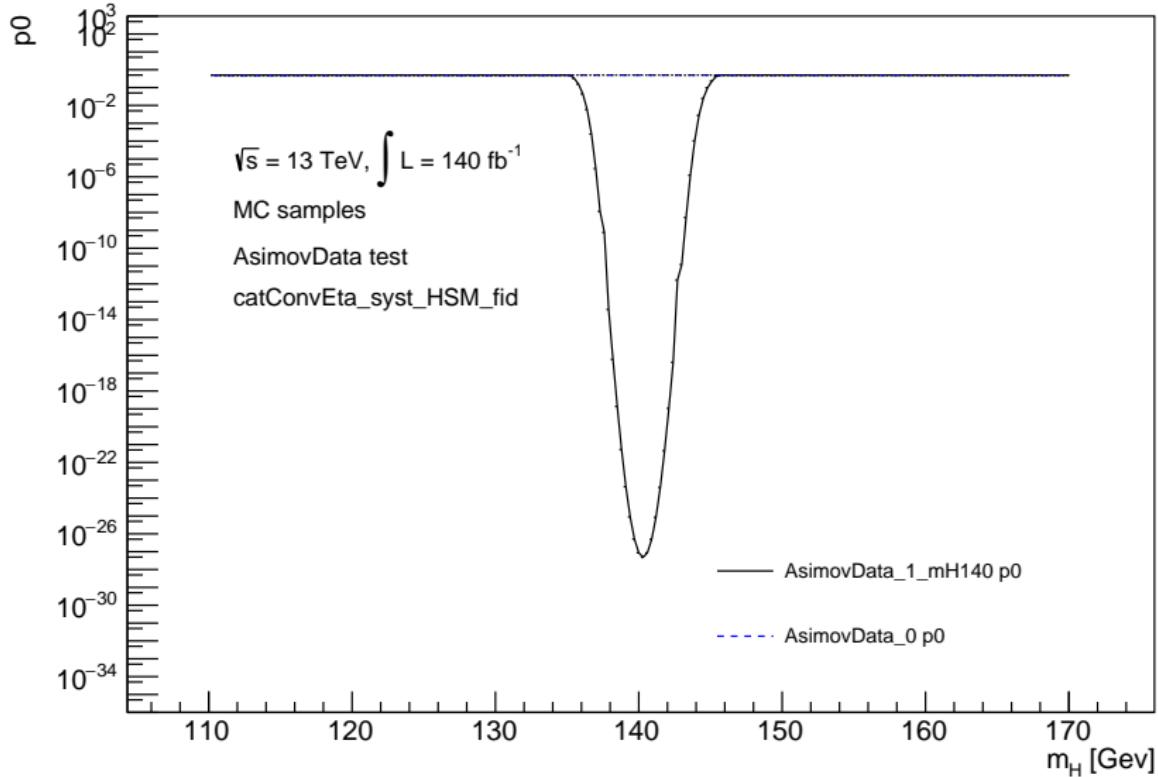
# Limits with $\mu=0$



# No fid vs fid ws

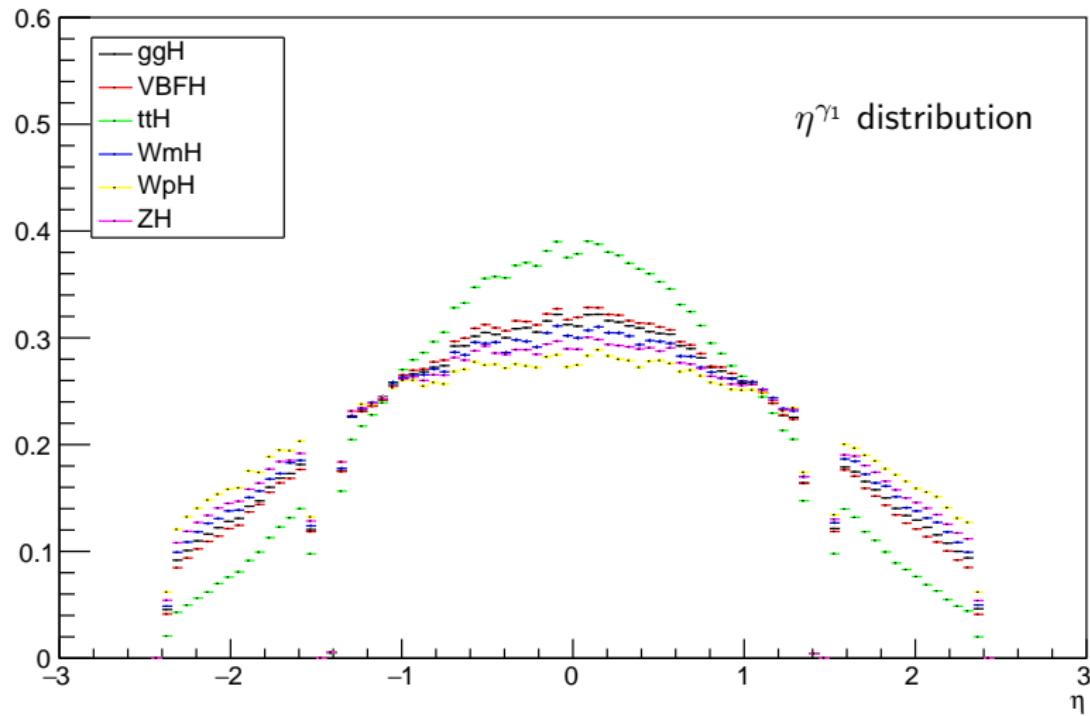


# $p_0$ scan

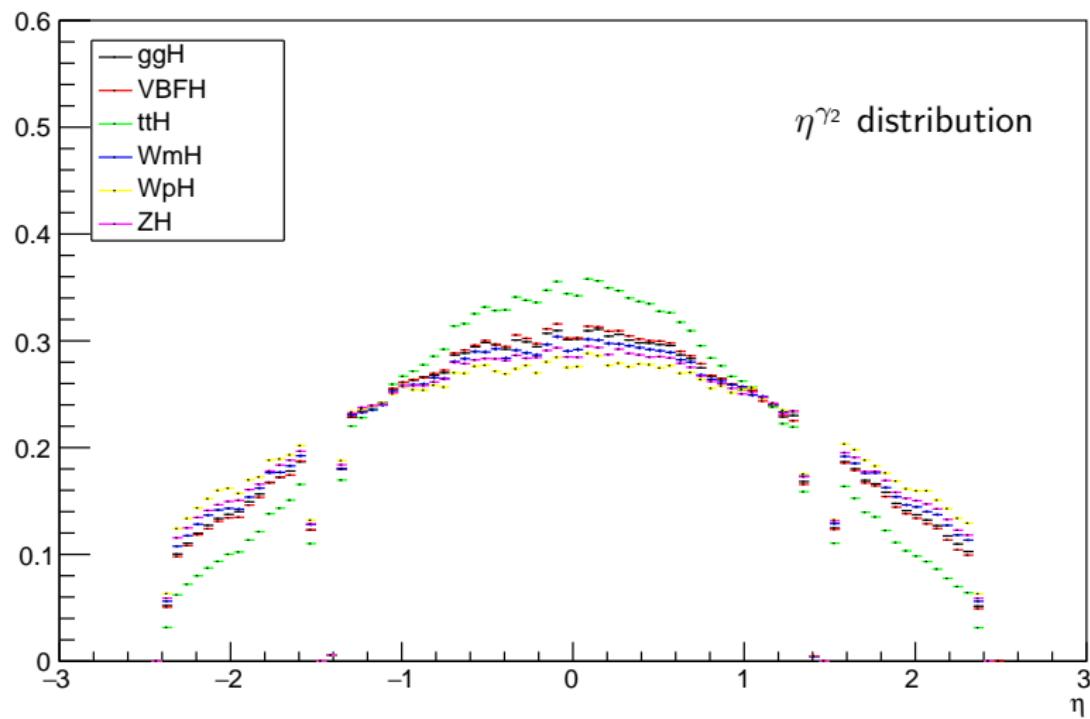


**18<sup>th</sup> week**

# $\eta^{\gamma_1}$ 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<sup>th</sup> 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

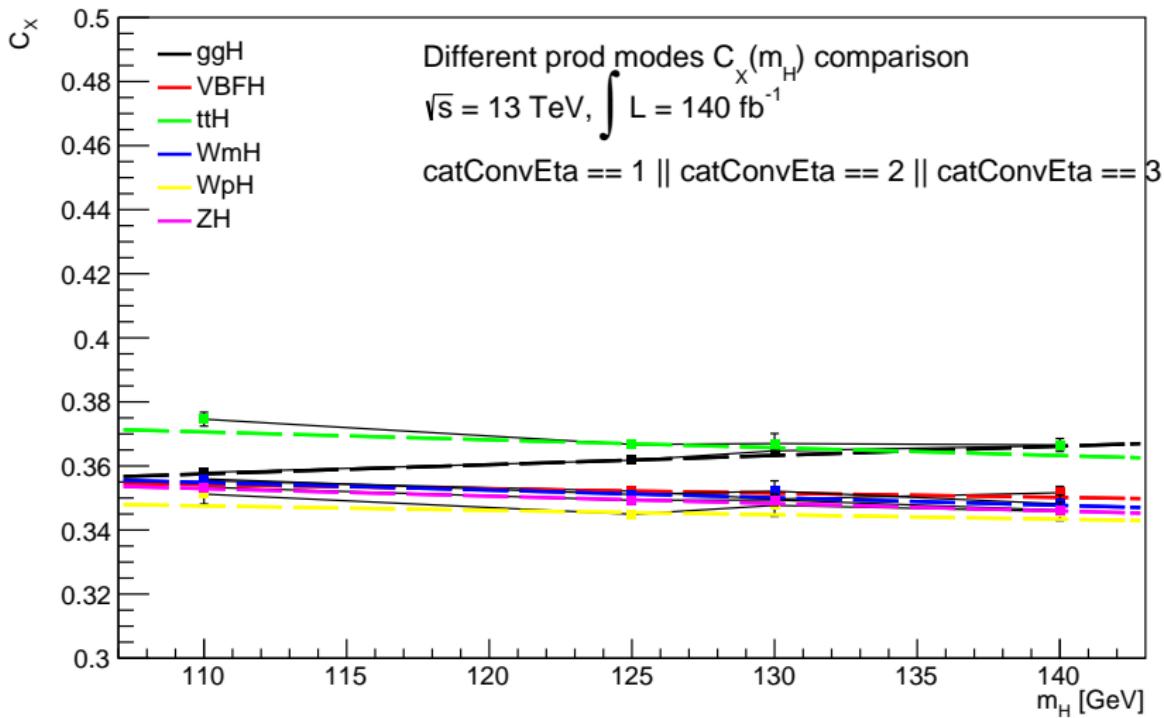
ZH	cutFlow > 13	cutFlow <= 13
sFiducialLowMyy == true	72.3131	167.481
isFiducialLowMyy != true	0	0

Table: ZH Reco and Fiducial selections

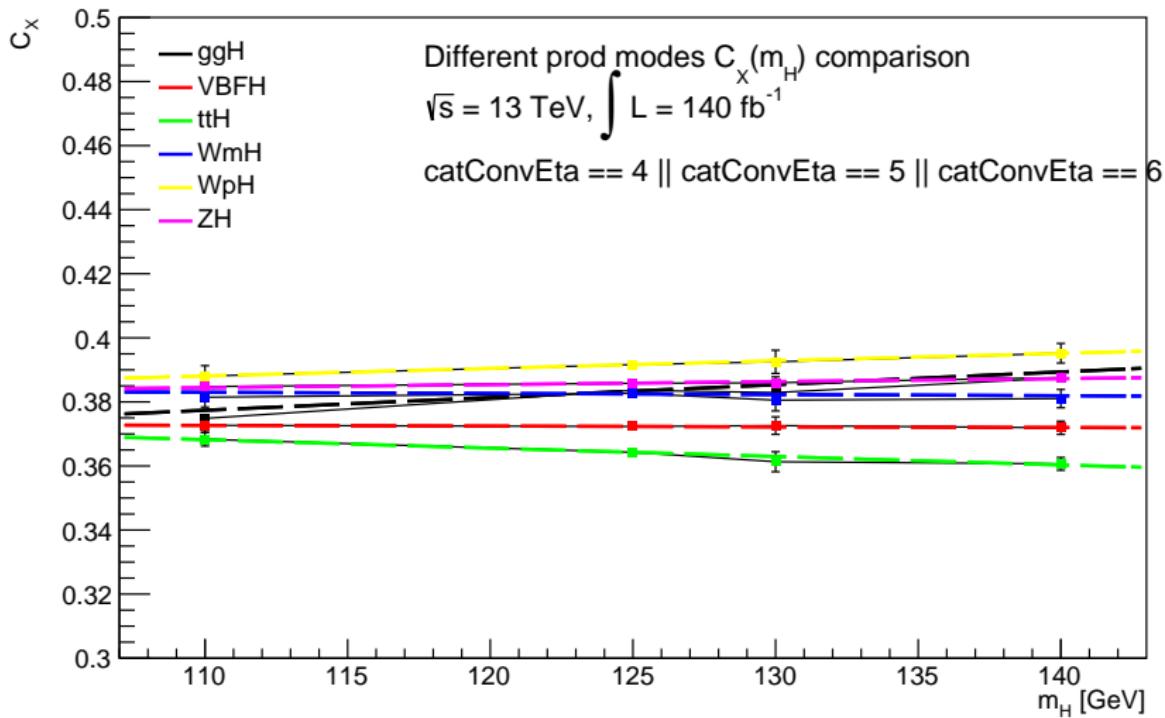
WmH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	52.9455	114.679
isFiducialLowMyy != true	0	0

Table: WmH Reco and Fiducial selections

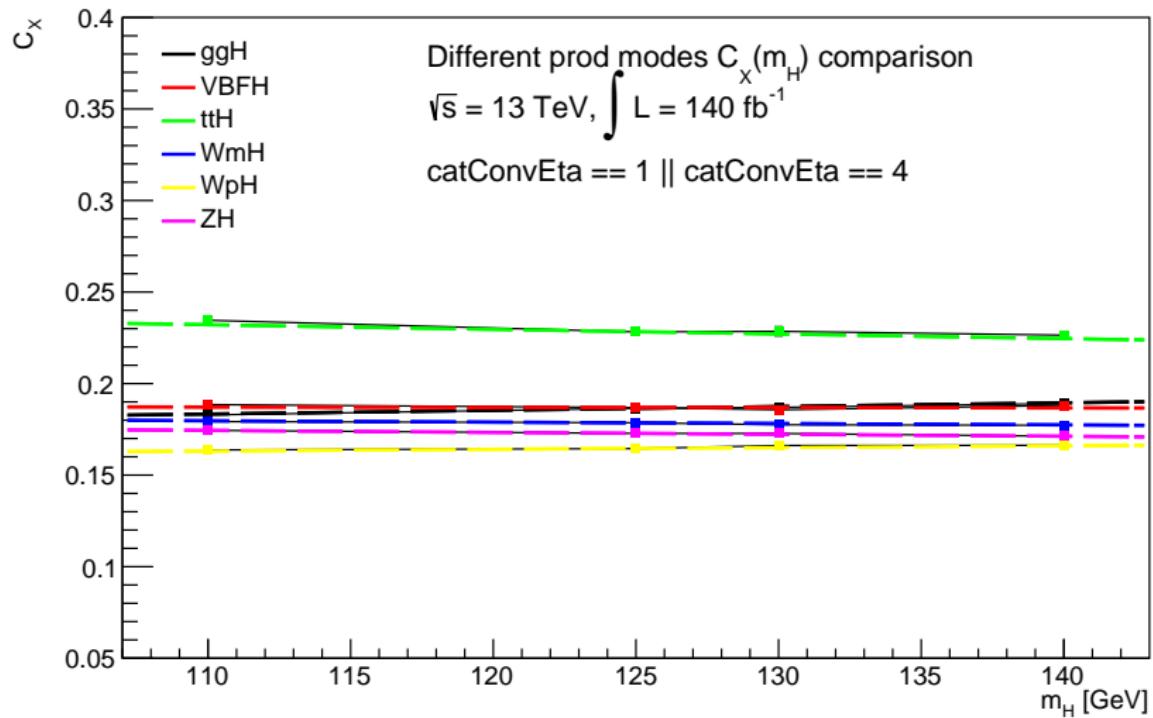
## 2 $\gamma$ unconv



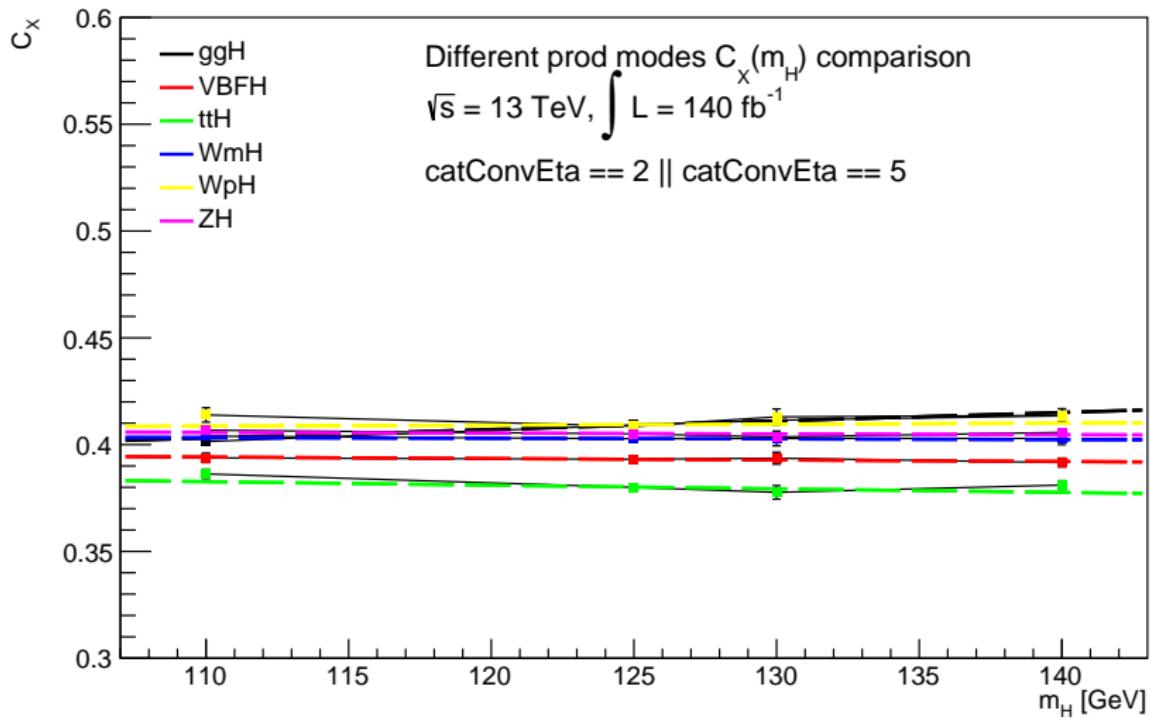
# At least 1 $\gamma$ conv



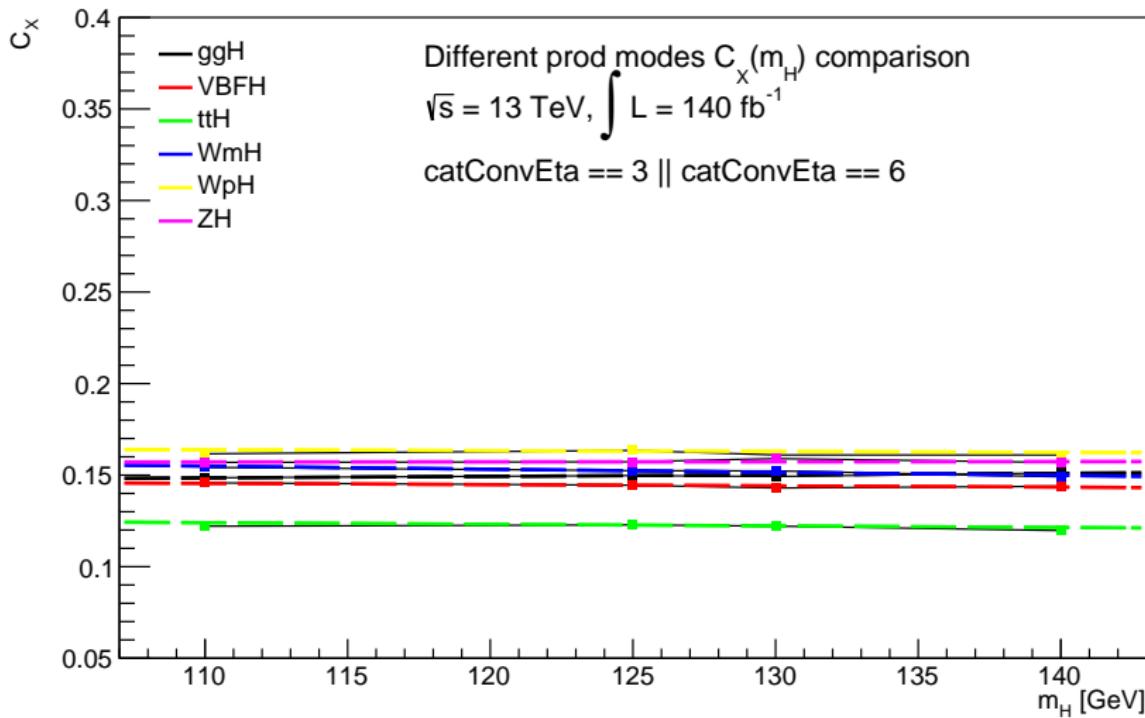
$|\eta_{s2}| < 0.75$



# no central and no trans regions



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



**20<sup>th</sup> week**

# Sig / $\sqrt{Bkg}$ comp

cat	110 GeV	125 GeV	130 GeV	140 GeV
inclusive	9.01248	11.9474	11.8646	9.277
1	4.58346	6.10034	6.08811	4.8166
2	4.57151	6.00597	6.05182	4.7138
3	2.26846	2.90857	2.85755	2.2402
4	3.4161	4.58158	4.53164	3.61815
5	4.35578	5.78831	5.72444	4.51258
6	2.66066	3.4511	3.41461	2.68389
Sum	9.2073	12.1717	12.1169	9.54441
1	6.68576	8.80468	8.82263	6.92144
2	6.04509	7.953	7.86681	6.21837
Sum	9.01346	11.8648	11.8206	9.30454

Table: Number of signal and  $\sqrt{bkg}$  events ratio in [peak- $3\sigma$ , peak+ $3\sigma$ ] GeV interval

# Fiducial: 110 GeV

Cat [110 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
inclusive	15209.9	5043.55	6397.7	0.788339	0.419828	6298.63	0.800738	0.413325	6882.38	0.732822	0.451632
1	15209.9	776.993	6397.7	0.121449	0.419828	6298.63	0.123359	0.413325	6882.38	0.112896	0.451632
2	15209.9	1302.56	6397.7	0.203598	0.419828	6298.63	0.2068	0.413325	6882.38	0.18926	0.451632
3	15209.9	384.184	6397.7	0.0600503	0.419828	6298.63	0.0609948	0.413325	6882.38	0.0558214	0.451632
4	15209.9	481.558	6397.7	0.0752705	0.419828	6298.63	0.0764543	0.413325	6882.38	0.0699697	0.451632
5	15209.9	1460.16	6397.7	0.228233	0.419828	6298.63	0.231822	0.413325	6882.38	0.21216	0.451632
6	15209.9	638.087	6397.7	0.0997371	0.419828	6298.63	0.101306	0.413325	6882.38	0.0927132	0.451632
1	15209.9	2463.72	6397.7	0.385095	0.419828	6298.63	0.391151	0.413325	6882.38	0.357975	0.451632
2	15209.9	2579.81	6397.7	0.40324	0.419828	6298.63	0.409582	0.413325	6882.38	0.374843	0.451632

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

# Fiducial: 125 GeV

Cat [125 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
no	16807.8	5470.72	6621.86	0.826161	0.433143	6551.52	0.835031	0.428574	7341.63	0.745164	0.480327
1	16807.8	842.02	6621.86	0.127158	0.433143	6551.52	0.128523	0.428574	7341.63	0.114691	0.480327
2	16807.8	1405.33	6621.86	0.212225	0.433143	6551.52	0.214504	0.428574	7341.63	0.191419	0.480327
3	16807.8	408.894	6621.86	0.0617492	0.433143	6551.52	0.0624122	0.428574	7341.63	0.0556953	0.480327
4	16807.8	527.041	6621.86	0.079591	0.433143	6551.52	0.0804455	0.428574	7341.63	0.0717879	0.480327
5	16807.8	1598.79	6621.86	0.241441	0.433143	6551.52	0.244033	0.428574	7341.63	0.21777	0.480327
6	16807.8	690.544	6621.86	0.104283	0.433143	6551.52	0.105402	0.428574	7341.63	0.0940587	0.480327
1	16807.8	2656.21	6621.86	0.401127	0.433143	6551.52	0.405434	0.428574	7341.63	0.361801	0.480327
2	16807.8	2816.46	6621.86	0.425328	0.433143	6551.52	0.429894	0.428574	7341.63	0.383628	0.480327

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

# Fiducial: 130 GeV

Cat [130 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
no	14108.3	5121.93	6127.01	0.835958	0.434792	6071.88	0.84355	0.430877	6850.87	0.747631	0.486163
1	14108.3	789.917	6127.01	0.128924	0.434792	6071.88	0.130094	0.430877	6850.87	0.115302	0.486163
2	14108.3	1330.73	6127.01	0.21719	0.434792	6071.88	0.219162	0.430877	6850.87	0.194242	0.486163
3	14108.3	378.034	6127.01	0.0616995	0.434792	6071.88	0.0622598	0.430877	6850.87	0.0551804	0.486163
4	14108.3	491.096	6127.01	0.0801525	0.434792	6071.88	0.0808804	0.430877	6850.87	0.0716837	0.486163
5	14108.3	1487.7	6127.01	0.24281	0.434792	6071.88	0.245015	0.430877	6850.87	0.217155	0.486163
6	14108.3	644.483	6127.01	0.105187	0.434792	6071.88	0.106142	0.430877	6850.87	0.0940731	0.486163
1	14108.3	2498.67	6127.01	0.407812	0.434792	6071.88	0.411516	0.430877	6850.87	0.364723	0.486163
2	14108.3	2623.29	6127.01	0.428152	0.434792	6071.88	0.43204	0.430877	6850.87	0.382914	0.486163

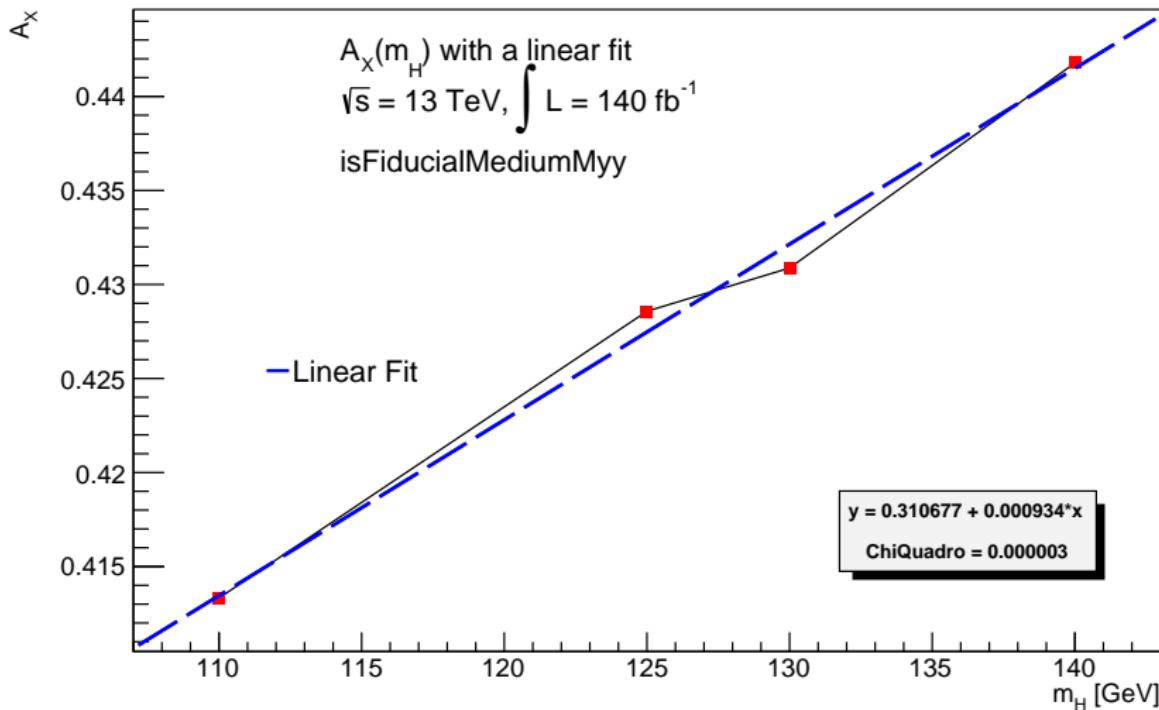
**Table:** Number of events and efficiencies for `cutFlow>13`, `isFiducialHighMyy` and `isFiducialLowMyy` cuts.  $m_X = 130$  GeV with `catConvEta` and `catConv` categorisation

# Fiducial: 140 GeV

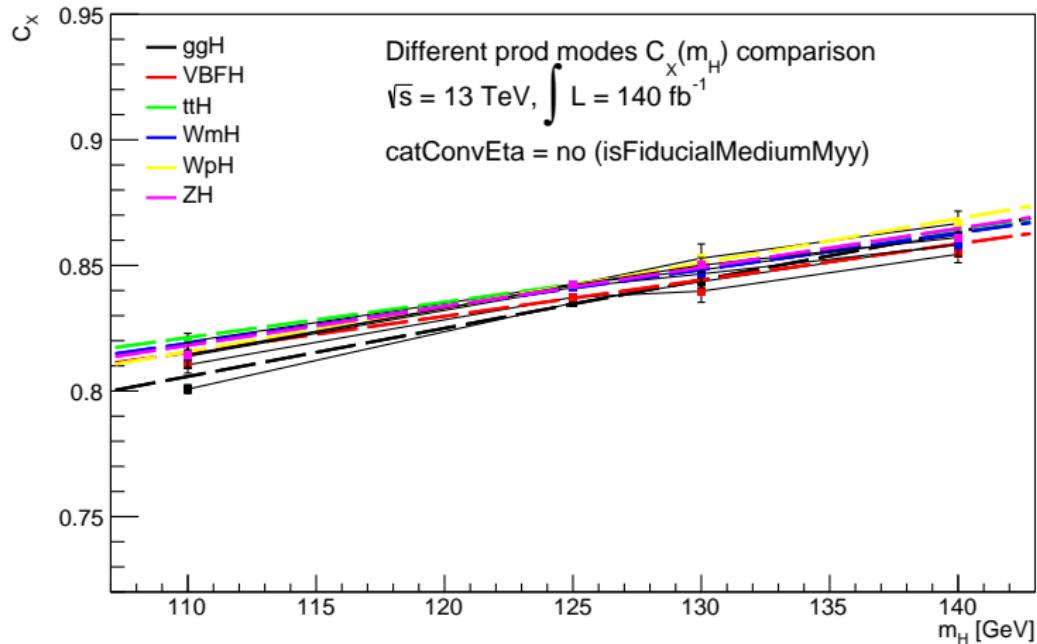
Cat [140 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
no	9438.64	3572.26	4191.27	0.852309	0.445044	4160.5	0.858612	0.441777	4738.85	0.753823	0.503182
1	9438.64	551.591	4191.27	0.131605	0.445044	4160.5	0.132578	0.441777	4738.85	0.116398	0.503182
2	9438.64	919.714	4191.27	0.219436	0.445044	4160.5	0.221059	0.441777	4738.85	0.19408	0.503182
3	9438.64	264.688	4191.27	0.0631522	0.445044	4160.5	0.0636193	0.441777	4738.85	0.0558549	0.503182
4	9438.64	344.633	4191.27	0.0822265	0.445044	4160.5	0.0828345	0.441777	4738.85	0.072725	0.503182
5	9438.64	1039.73	4191.27	0.248072	0.445044	4160.5	0.249906	0.441777	4738.85	0.219407	0.503182
6	9438.64	451.832	4191.27	0.107803	0.445044	4160.5	0.1086	0.441777	4738.85	0.0953462	0.503182
1	9438.64	1735.99	4191.27	0.414192	0.445044	4160.5	0.417255	0.441777	4738.85	0.366332	0.503182
2	9438.64	1836.17	4191.27	0.438095	0.445044	4160.5	0.441335	0.441777	4738.85	0.387472	0.503182

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

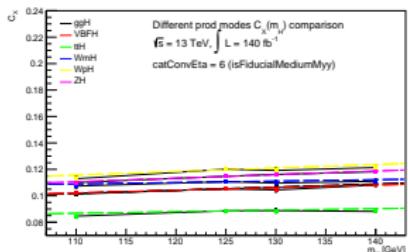
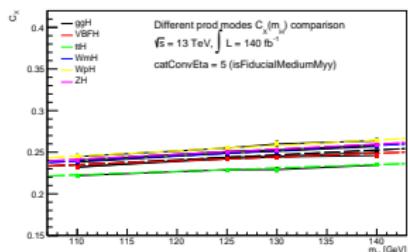
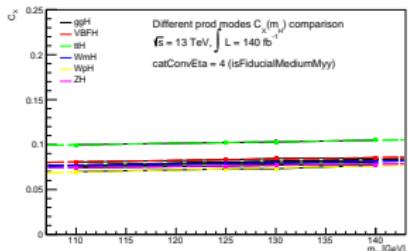
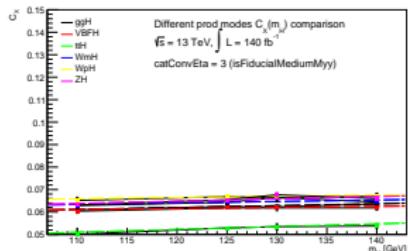
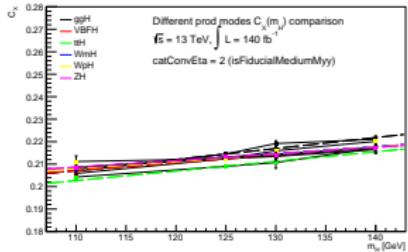
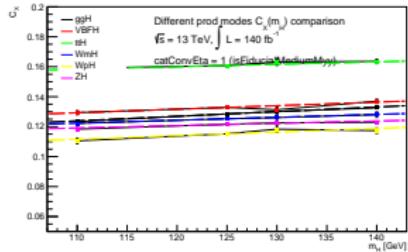
# $A_X$ linear fit



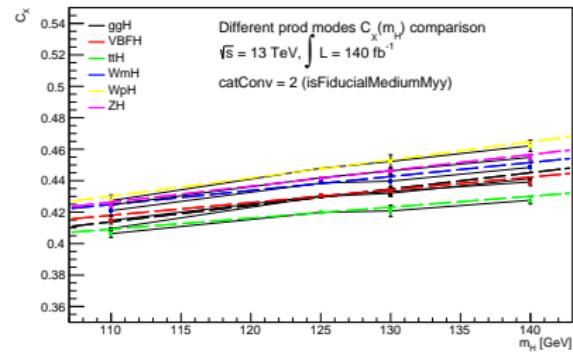
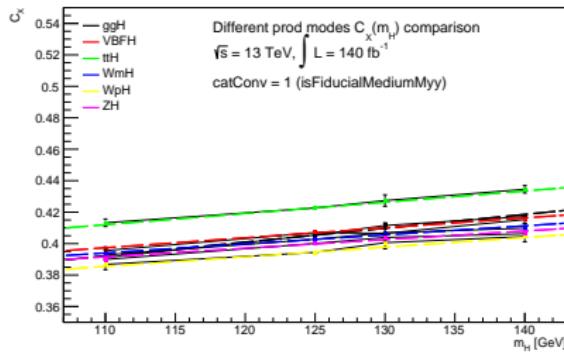
# Production mods



# Production mods catConvEta



# Production mods catConv

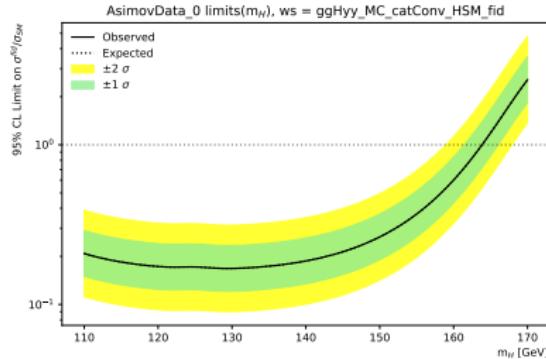
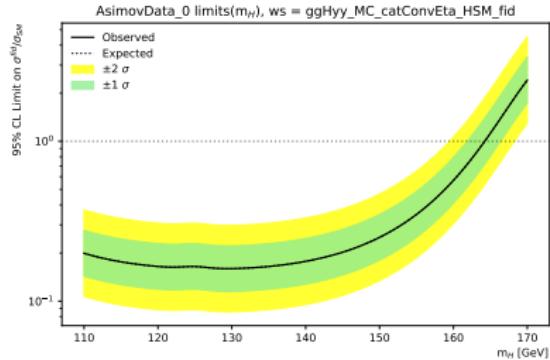
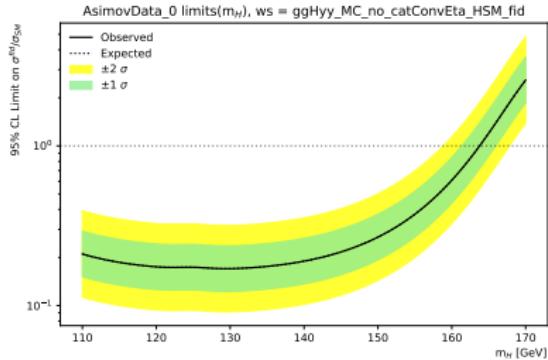


# Production mods inc

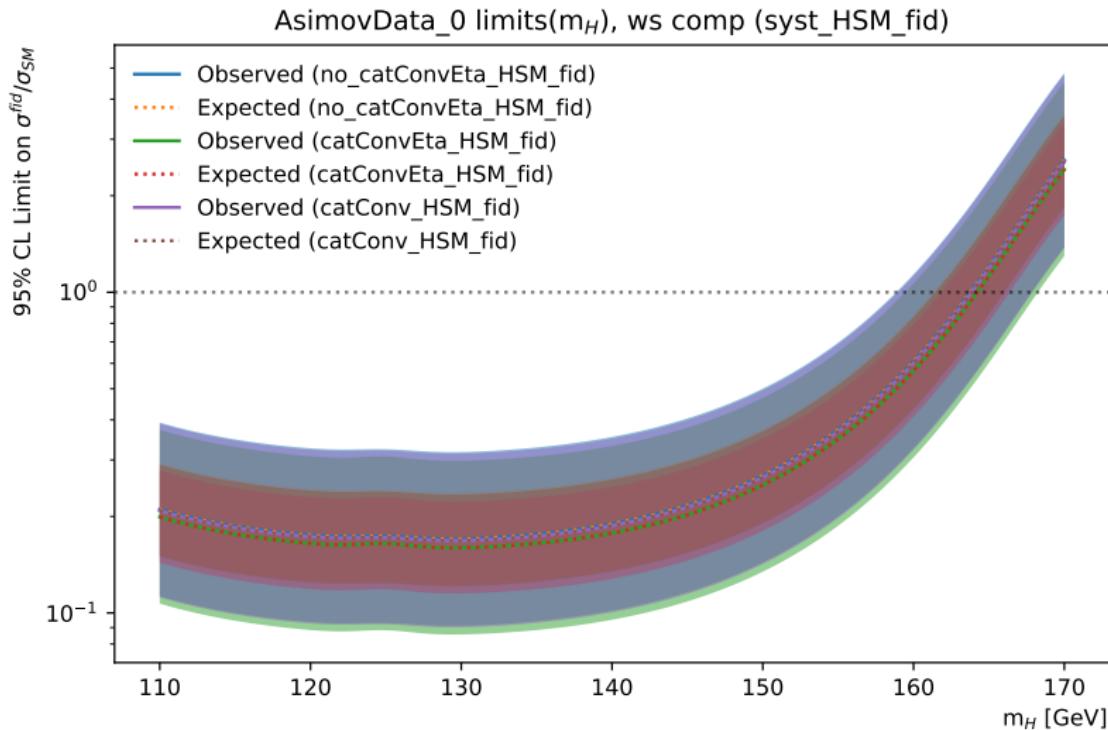
	110 GeV	125 GeV	130 GeV	140 GeV
no	0.0192556	0.00941578	0.00802174	0.00603007
1	0.278492	0.251661	0.243141	0.226689
2	0.0218422	0.0252903	0.0263881	0.0285113
3	0.1658	0.152775	0.14855	0.140266
4	0.291832	0.272469	0.266346	0.25456
5	0.05187	0.0609306	0.063806	0.0693548
6	0.14729	0.159938	0.163964	0.17175
1	0.0505814	0.0428436	0.040375	0.0355933
2	0.0393194	0.0418226	0.0426171	0.0441504

Table:  $\text{abs}(C_X^{\text{prod}} - C_X^{\text{gg}H}) / C_X^{\text{gg}H}$

# Limits with $\mu=0$

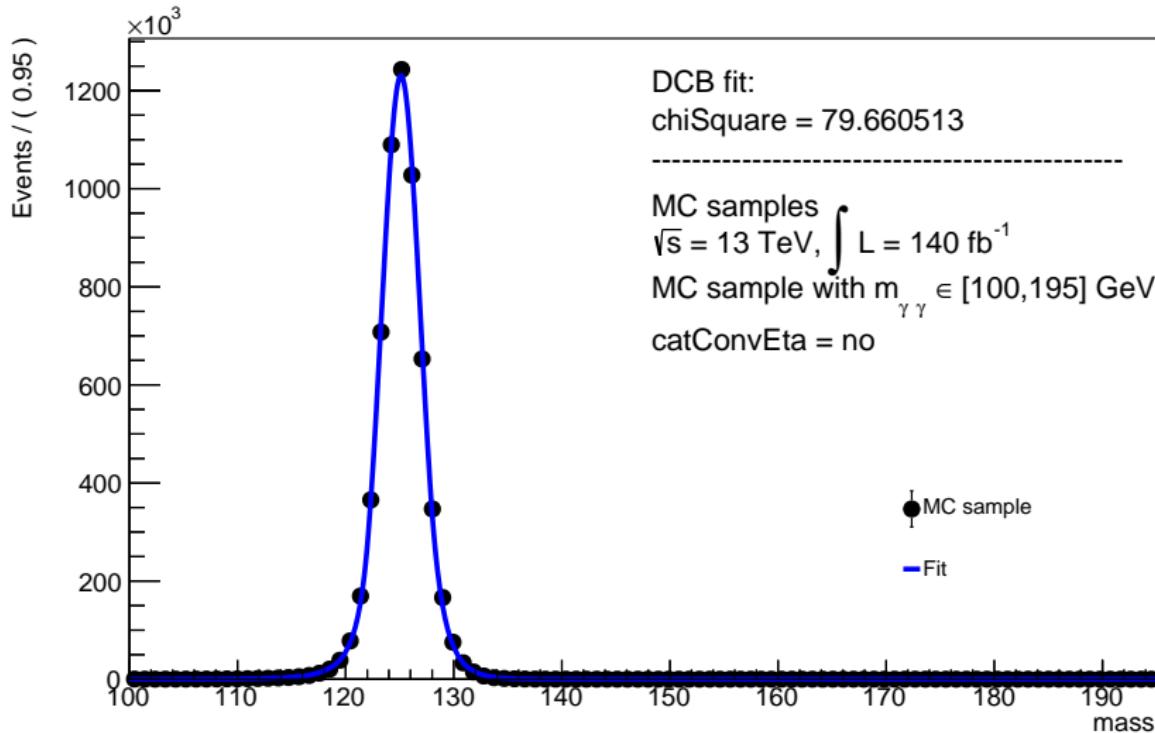


# Limits with $\mu=0$

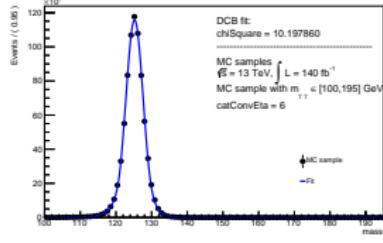
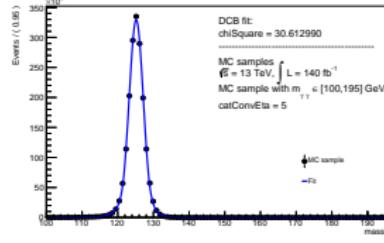
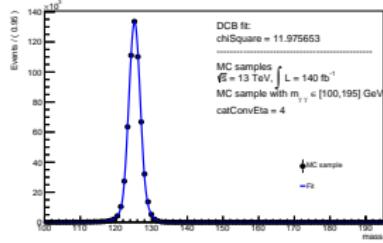
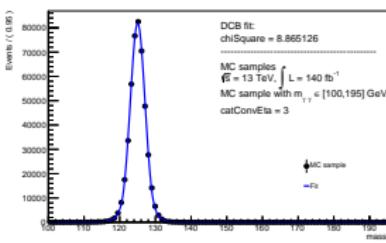
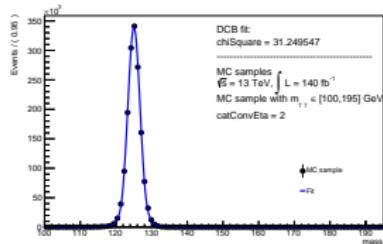
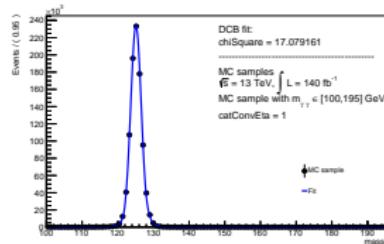


*21<sup>th</sup>* week

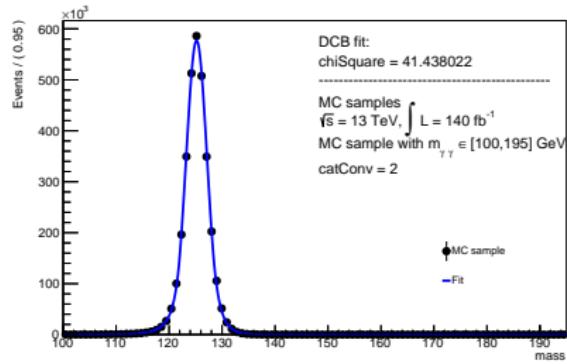
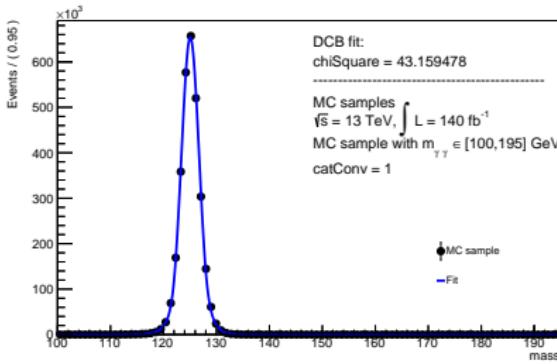
# Signal Fit (Inclusive)



# Signal Fit (catConvEta)



# Signal Fit (catConv)



## $\sigma$ comparison

	110 GeV	125 GeV	130 GeV	140 GeV
Inclusive	1.68132	1.79145	1.82816	1.90158
catConvEta_1	1.38117	1.47621	1.50789	1.57125
catConvEta_2	1.60006	1.7092	1.74558	1.81834
catConvEta_3	1.88921	2.06123	2.11857	2.23325
catConvEta_4	1.51839	1.61354	1.64526	1.7087
catConvEta_5	1.86642	1.97048	2.00516	2.07453
catConvEta_6	2.20572	2.40916	2.47697	2.61259
catConv_1	1.55868	1.66141	1.69565	1.76414
catConv_2	1.84453	1.95829	1.9962	2.07204

Table:  $\sigma_{DSCB}$  for each mass and category

# Reco and Fiducial selections

ggH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	5036.4	4145.27
isFiducialLowMyy != true	106.476	5979.15

Table: ggF Reco and Fiducial selections

VBFH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	399.502	340.719
isFiducialLowMyy != true	5.87971	443.619

Table: VBFH Reco and Fiducial selections

ttH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	53.5442	45.1398
isFiducialLowMyy != true	2.25248	58.927

Table: ttH Reco and Fiducial selections

# Reco and Fiducial selections

WpH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	73.1484	62.9383
isFiducialLowMyy != true	1.96482	127.06

Table: WpH Reco and Fiducial selections

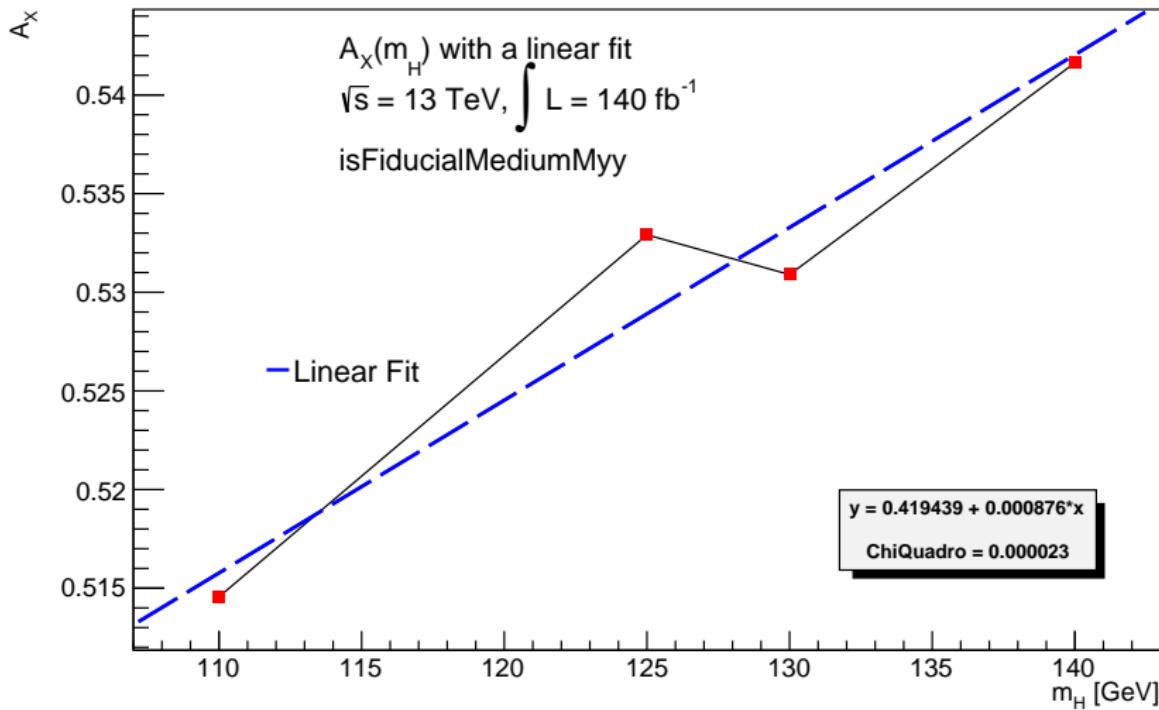
ZH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	70.4644	60.5945
isFiducialLowMyy != true	1.8212	107.84

Table: ZH Reco and Fiducial selections

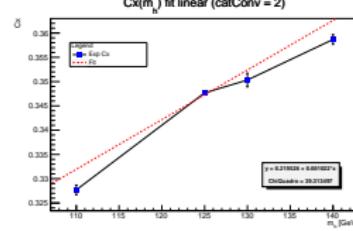
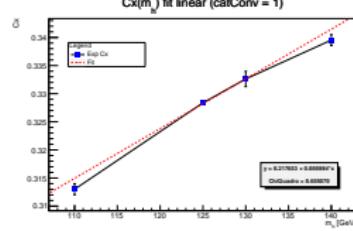
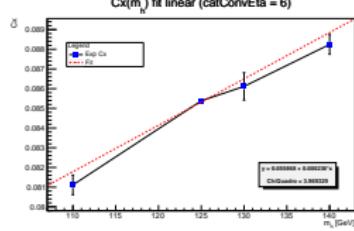
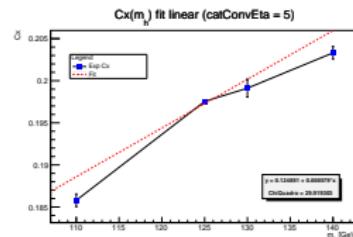
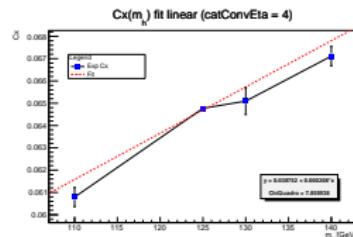
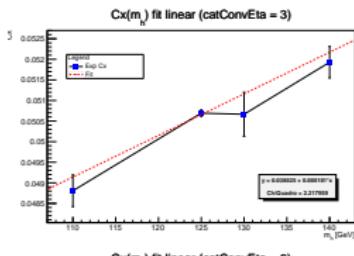
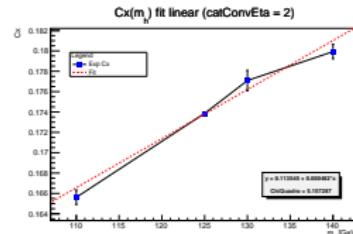
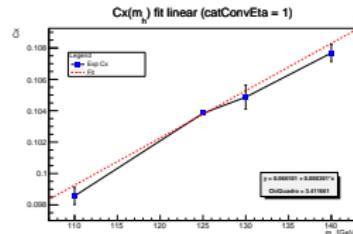
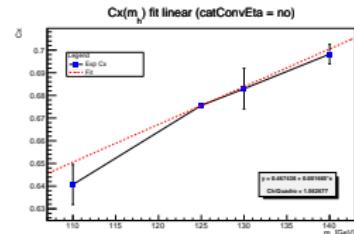
WmH	cutFlow > 13	cutFlow <= 13
isFiducialLowMyy == true	51.5652	44.0857
isFiducialLowMyy != true	1.33791	71.0324

Table: WmH Reco and Fiducial selections

# $A_X$ linear fit



# C<sub>X</sub> fit



# Fiducial: 110 GeV

Cat [110 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
Inclusive no	15238.9	5023.84	7980.77	0.629494	0.523713	7841.37	0.640685	0.514563	8693.85	0.577862	0.570504
catConvEta_1	15238.9	772.926	7980.77	0.0968486	0.523713	7841.37	0.0985703	0.514563	8693.85	0.0889049	0.570504
catConvEta_2	15238.9	1298.67	7980.77	0.162726	0.523713	7841.37	0.165618	0.514563	8693.85	0.149379	0.570504
catConvEta_3	15238.9	382.712	7980.77	0.0479542	0.523713	7841.37	0.0488067	0.514563	8693.85	0.044021	0.570504
catConvEta_4	15238.9	476.675	7980.77	0.059728	0.523713	7841.37	0.0607898	0.514563	8693.85	0.054829	0.570504
catConvEta_5	15238.9	1456.86	7980.77	0.182546	0.523713	7841.37	0.185792	0.514563	8693.85	0.167574	0.570504
catConvEta_6	15238.9	636.03	7980.77	0.0796954	0.523713	7841.37	0.0811122	0.514563	8693.85	0.0731587	0.570504
catConv_1	15238.9	2454.33	7980.77	0.30753	0.523713	7841.37	0.312997	0.514563	8693.85	0.282306	0.570504
catConv_2	15238.9	2569.59	7980.77	0.321973	0.523713	7841.37	0.327697	0.514563	8693.85	0.295565	0.570504

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

# Fiducial: 125 GeV

Cat [125 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
Inclusive	15305.7	5447.59	8166.48	0.667067	0.540262	8063.41	0.675594	0.532912	9265.09	0.587969	0.613821
catConveEta_1	15305.7	837.285	8166.48	0.102527	0.540262	8063.41	0.103838	0.532912	9265.09	0.0903698	0.613821
catConveEta_2	15305.7	1401.93	8166.48	0.171669	0.540262	8063.41	0.173863	0.532912	9265.09	0.151313	0.613821
catConveEta_3	15305.7	408.755	8166.48	0.0500528	0.540262	8063.41	0.0506926	0.532912	9265.09	0.0441178	0.613821
catConveEta_4	15305.7	522.279	8166.48	0.0639539	0.540262	8063.41	0.0647714	0.532912	9265.09	0.0563706	0.613821
catConveEta_5	15305.7	1592.84	8166.48	0.195047	0.540262	8063.41	0.19754	0.532912	9265.09	0.171919	0.613821
catConveEta_6	15305.7	688.484	8166.48	0.0843061	0.540262	8063.41	0.0853838	0.532912	9265.09	0.0743095	0.613821
catConv_1	15305.7	2647.84	8166.48	0.324233	0.540262	8063.41	0.328377	0.532912	9265.09	0.285787	0.613821
catConv_2	15305.7	2803.49	8166.48	0.343292	0.540262	8063.41	0.34768	0.532912	9265.09	0.302586	0.613821

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

# Fiducial: 130 GeV

Cat [130 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
Inclusive	14091.6	5109.32	7564.07	0.675472	0.536773	7481.25	0.68295	0.530897	8555.29	0.597212	0.607119
catConvEta_1	14091.6	784.534	7564.07	0.103719	0.536773	7481.25	0.104867	0.530897	8555.29	0.0917017	0.607119
catConvEta_2	14091.6	1324.84	7564.07	0.175149	0.536773	7481.25	0.177087	0.530897	8555.29	0.154856	0.607119
catConvEta_3	14091.6	379.041	7564.07	0.0501107	0.536773	7481.25	0.0506654	0.530897	8555.29	0.0443049	0.607119
catConvEta_4	14091.6	486.993	7564.07	0.0643824	0.536773	7481.25	0.0650952	0.530897	8555.29	0.0569231	0.607119
catConvEta_5	14091.6	1489.64	7564.07	0.196936	0.536773	7481.25	0.199116	0.530897	8555.29	0.174119	0.607119
catConvEta_6	14091.6	644.251	7564.07	0.0851725	0.536773	7481.25	0.0861154	0.530897	8555.29	0.0753044	0.607119
catConv_1	14091.6	2488.41	7564.07	0.328978	0.536773	7481.25	0.33262	0.530897	8555.29	0.290863	0.607119
catConv_2	14091.6	2620.88	7564.07	0.34649	0.536773	7481.25	0.350326	0.530897	8555.29	0.306346	0.607119

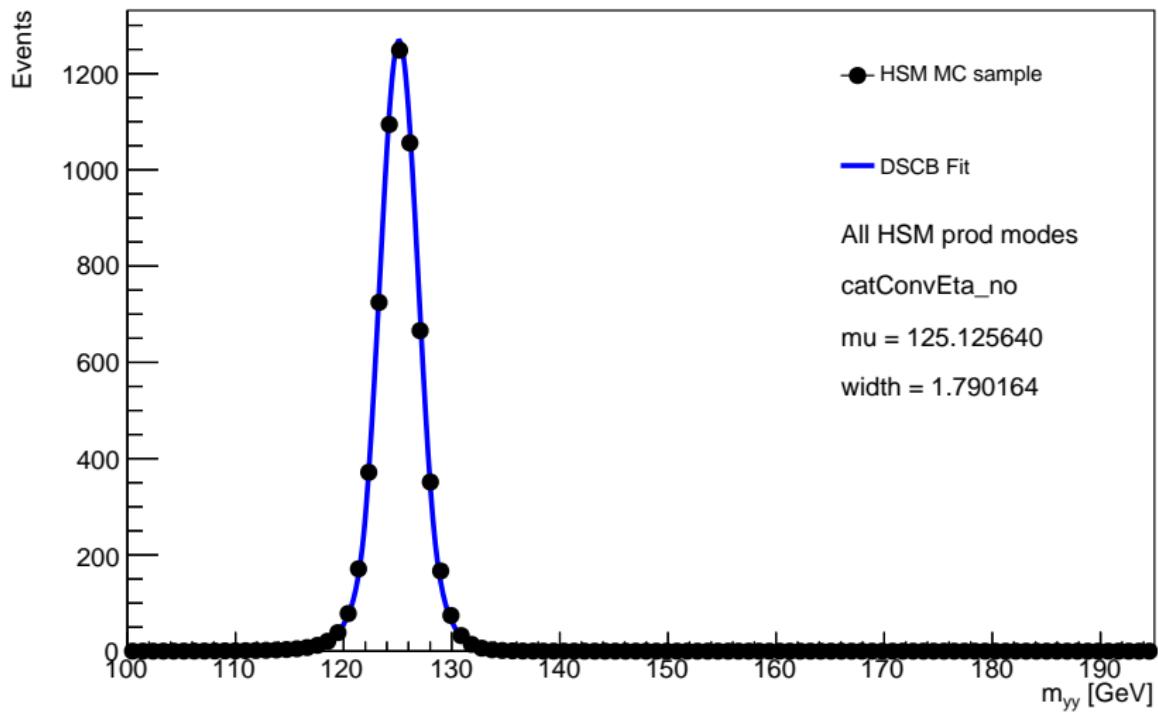
**Table:** Number of events and efficiencies for `cutFlow>13`, `isFiducialHighMyy`, `isFiducialMediumMyy` and `isFiducialLowMyy` cuts.  $m_X = 130$  GeV with `catConvEta` and `catConv` categorisation

# Fiducial: 140 GeV

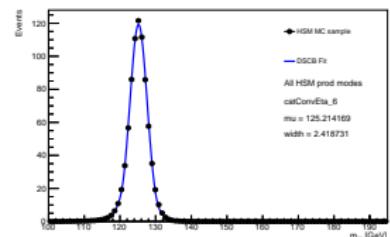
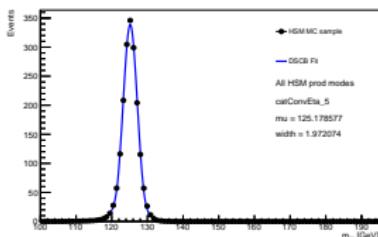
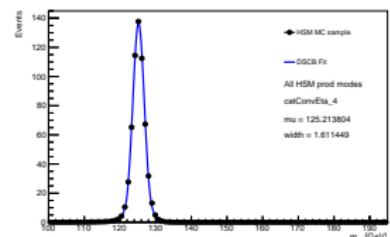
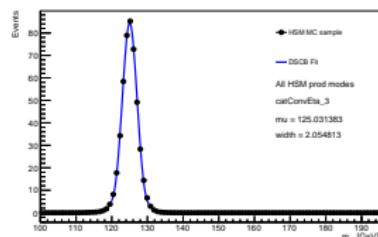
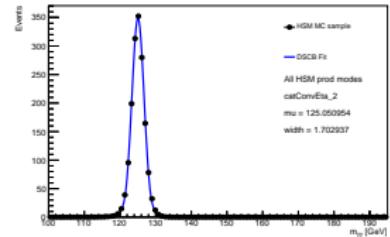
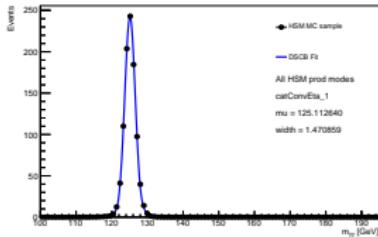
Cat [140 GeV]	n_all	n_cut13	n_fidHigh	cut/fidHigh	fidHigh/all	n_fidMedium	cut/fidMedium	fidHMedium/all	n_fidLow	cut/fidLow	fidLow/all
Inclusive	9417.65	3561.48	5145.09	0.692209	0.546321	5100.88	0.698209	0.541631	5880.7	0.605621	0.624429
catConvEta_1	9417.65	549.255	5145.09	0.106753	0.546321	5100.88	0.107679	0.541631	5880.7	0.0933996	0.624429
catConvEta_2	9417.65	917.788	5145.09	0.178381	0.546321	5100.88	0.179928	0.541631	5880.7	0.156068	0.624429
catConvEta_3	9417.65	264.884	5145.09	0.0514628	0.546321	5100.88	0.0519291	0.541631	5880.7	0.0450429	0.624429
catConvEta_4	9417.65	342.337	5145.09	0.0665366	0.546321	5100.88	0.0671133	0.541631	5880.7	0.0582136	0.624429
catConvEta_5	9417.65	1037.07	5145.09	0.201565	0.546321	5100.88	0.203312	0.541631	5880.7	0.176351	0.624429
catConvEta_6	9417.65	450.143	5145.09	0.0874898	0.546321	5100.88	0.0882482	0.541631	5880.7	0.0765458	0.624429
catConv_1	9417.65	1731.92	5145.09	0.336616	0.546321	5100.88	0.339534	0.541631	5880.7	0.294509	0.624429
catConv_2	9417.65	1829.55	5145.09	0.355592	0.546321	5100.88	0.358674	0.541631	5880.7	0.311111	0.624429

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

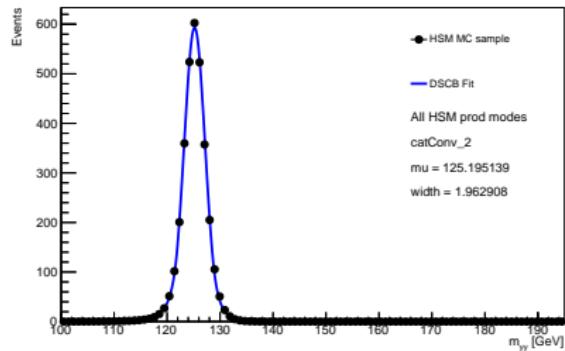
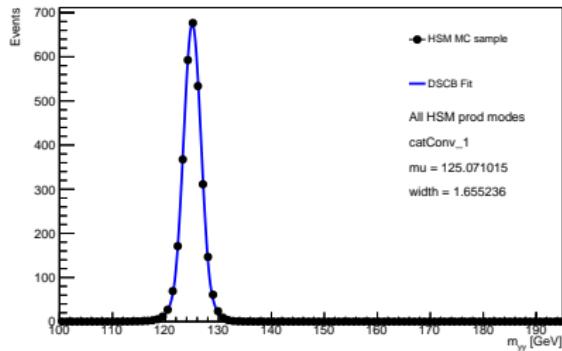
# HSM Fit (Inclusive)



# HSM Fit (catConvEta)



# HSM Fit (catConv)

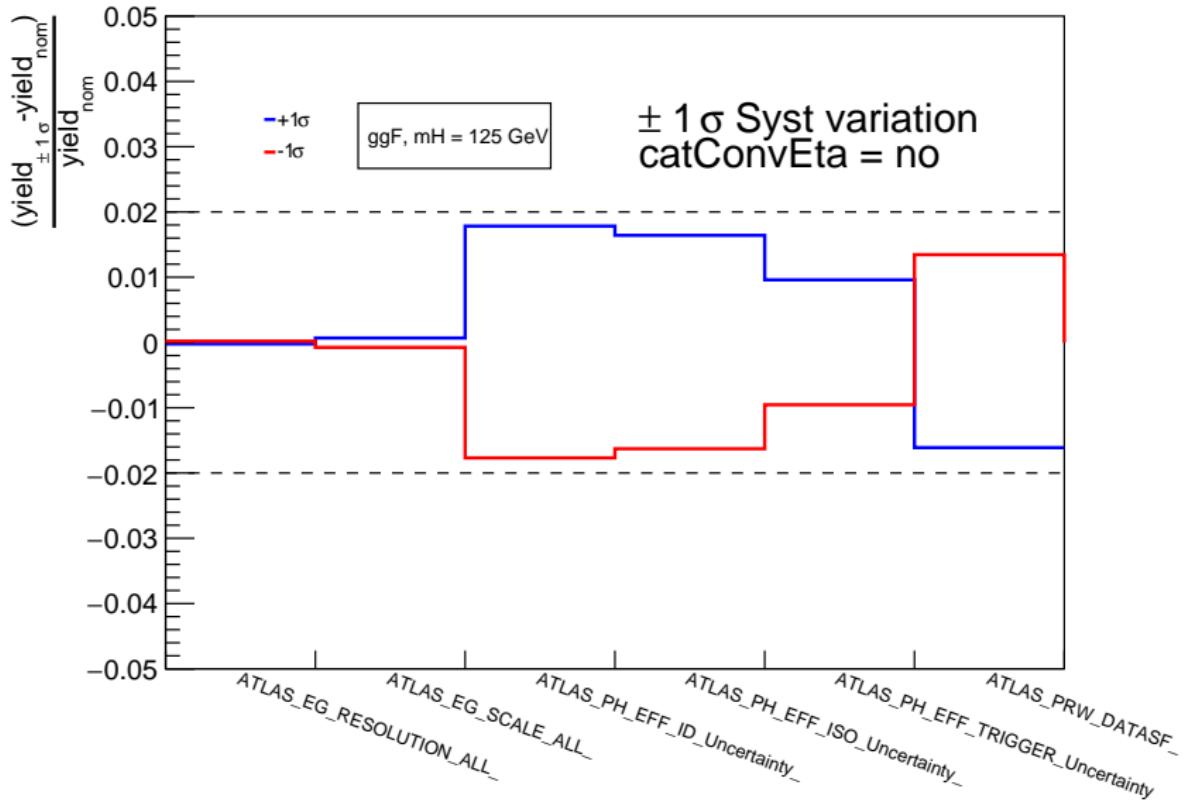


# HSM events

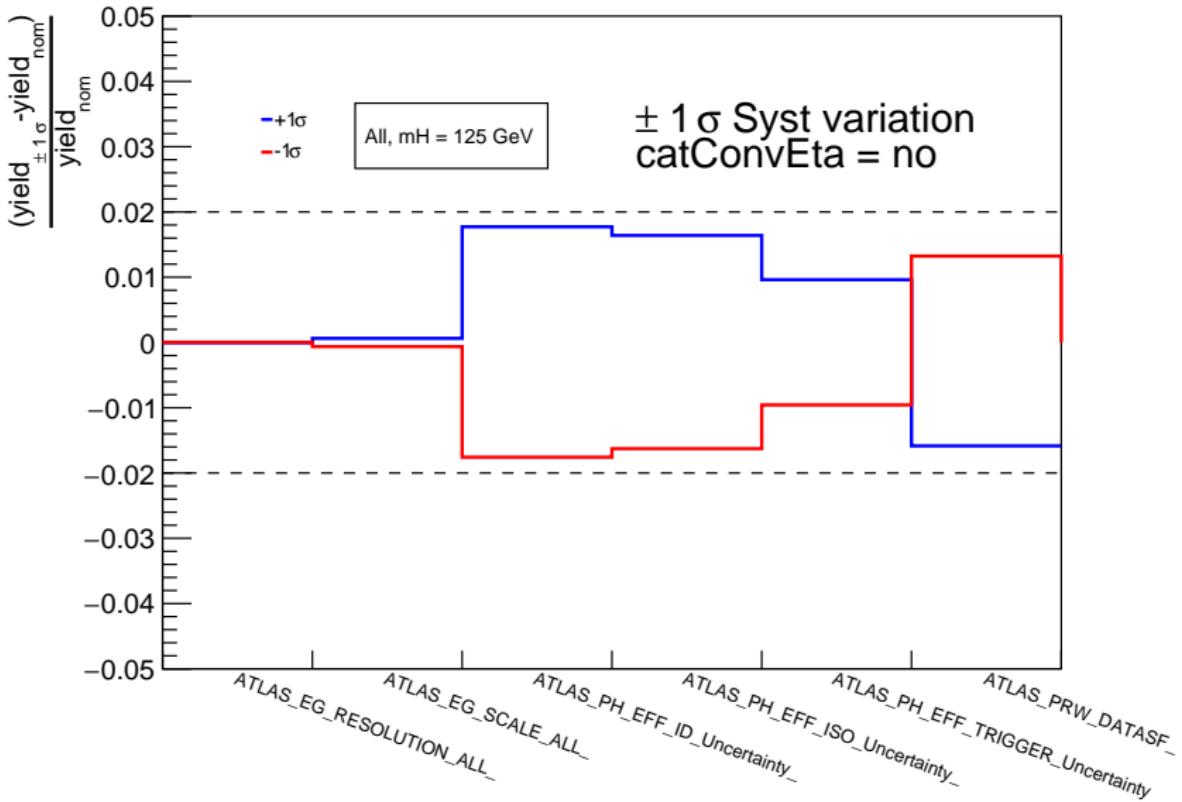
Cat	HSM_events
Inclusive	6232.25
catConvEta_1	960.525
catConvEta_2	1600.96
catConvEta_3	466.921
catConvEta_4	599.439
catConvEta_5	1820.56
catConvEta_6	787.967
catConv_1	3028.29
catConv_2	3207.86

**Table:** Number of HSM events for each category

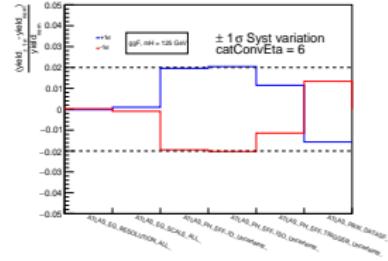
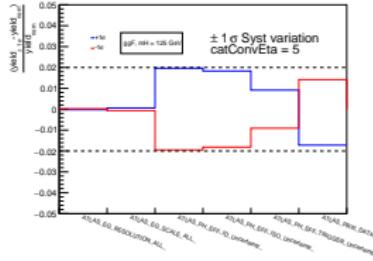
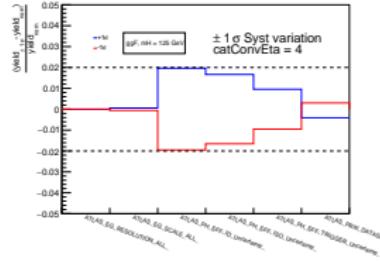
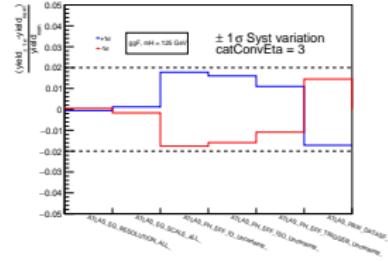
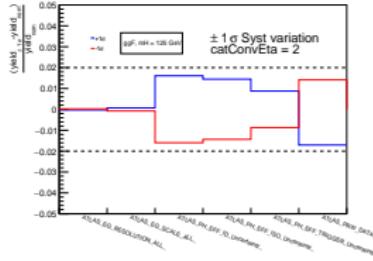
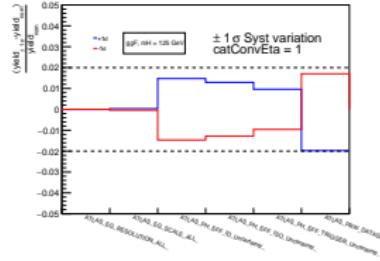
# $\pm 1\sigma$ yield, catConvEta, Sig



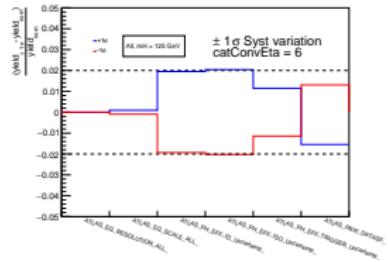
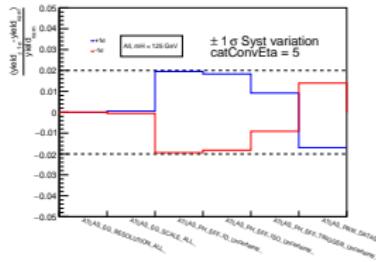
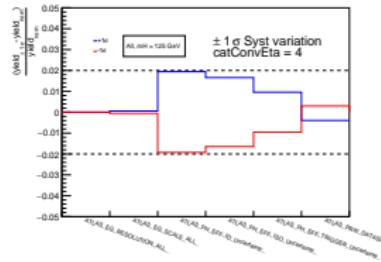
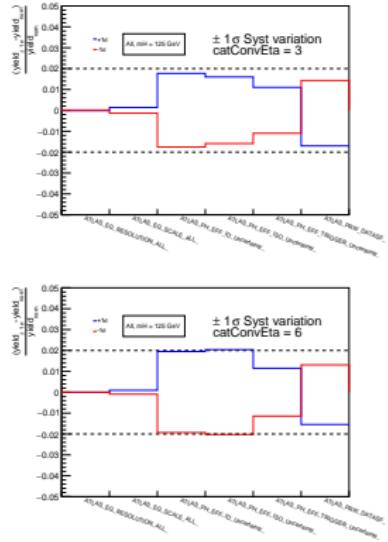
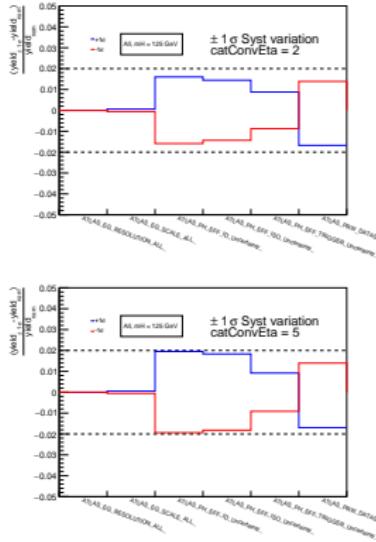
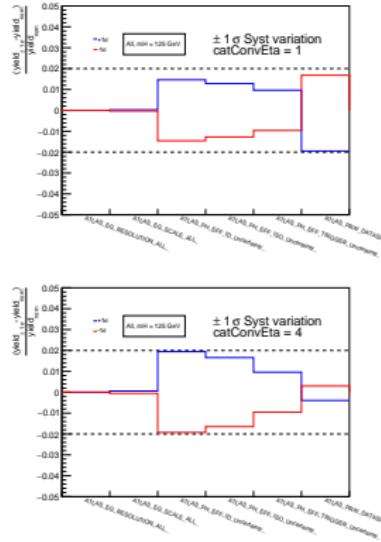
# $\pm 1\sigma$ yield, Inclusive, HSM



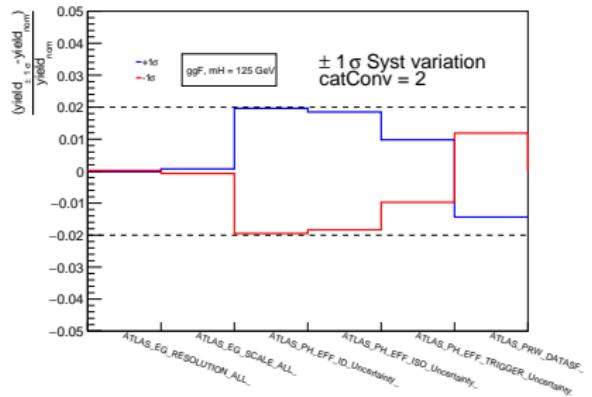
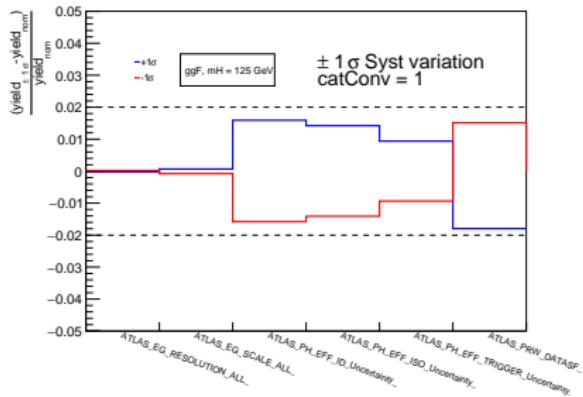
# $\pm 1\sigma$ yield, catConvEta, Sig



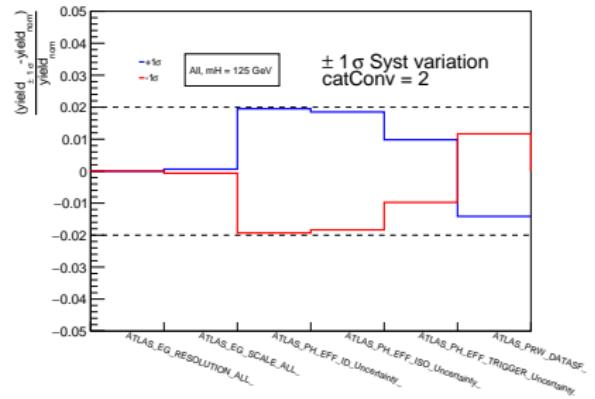
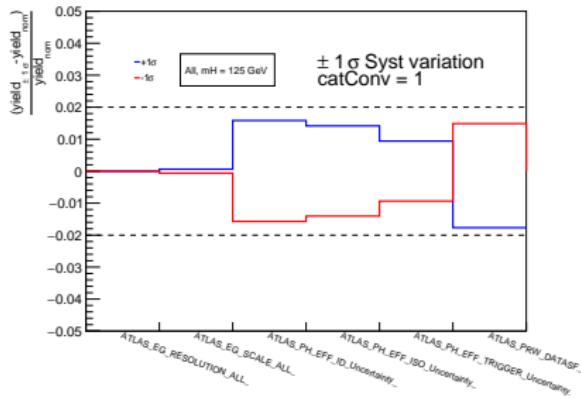
# $\pm 1\sigma$ yield, catConvEta, HSM



# $\pm 1\sigma$ yield, catConv, Sig



# $\pm 1\sigma$ yield, catConv, HSM



# Shape sys

Signal	no	1	2	3	4	5	6	1*	2*
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$						
ATLAS_EG_RESOLUTION_ALL_	0.096339	-0.0686718	0.0973955	-0.0523099	0.0924381	-0.0778125	0.121311	-0.118801	0.0825436
ATLAS_EG_SCALE_ALL_	0.00436999	-0.00437357	0.00271049	-0.00271016	0.00505455	-0.00505887	0.00941769	-0.00943935	0.00287867

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

Signal	no	1	2	3	4	5	6	1*	2*
	+1 $\sigma$	-1 $\sigma$	+1 $\sigma$						
ATLAS_EG_RESOLUTION_ALL_	0.0945234	-0.070541	0.107098	-0.059773	0.1000989	-0.0840764	0.132651	-0.12967	0.0944995
ATLAS_EG_SCALE_ALL_	0.00436966	-0.00437261	0.00270654	-0.00270694	0.00503926	-0.00504719	0.0094084	-0.00942786	0.00287889

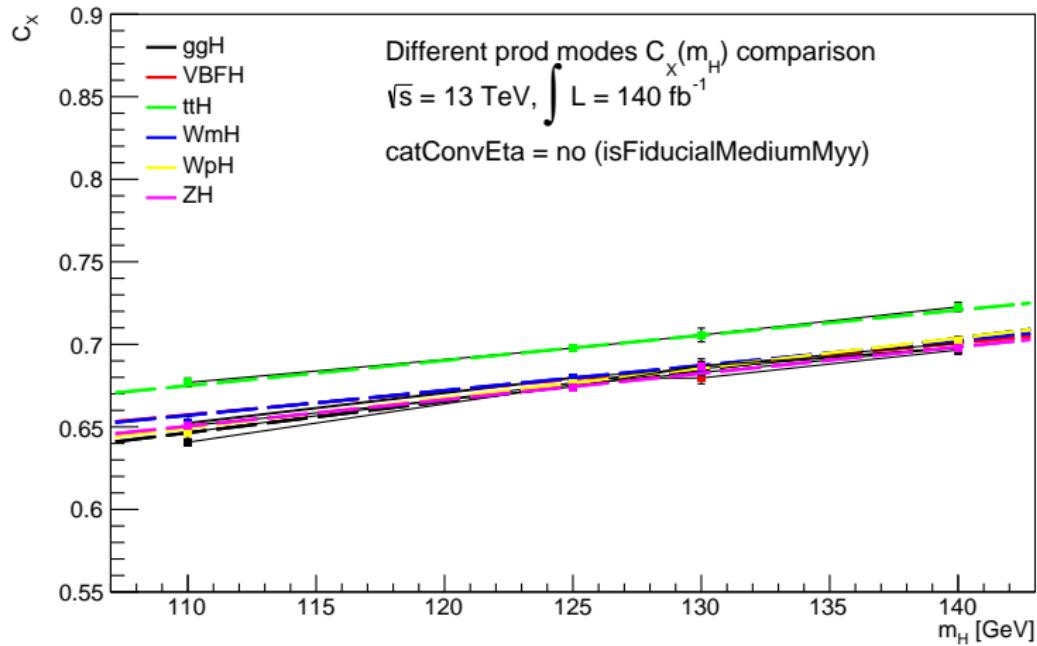
Table:  $\pm 1\sigma$  HSM shape sys for each category

*22<sup>th</sup>* week

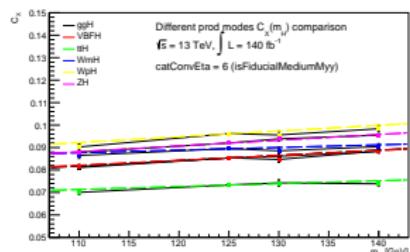
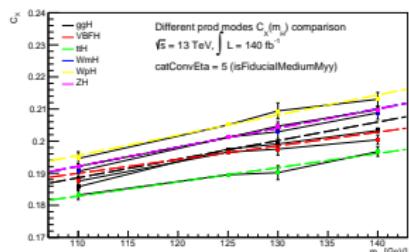
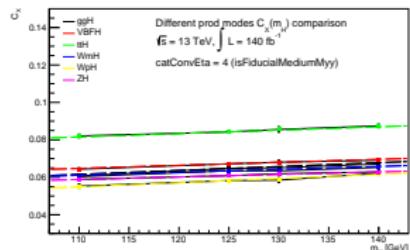
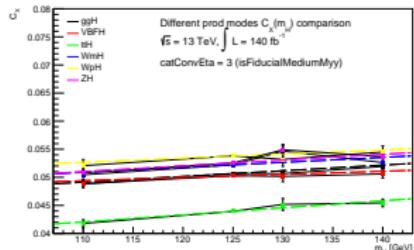
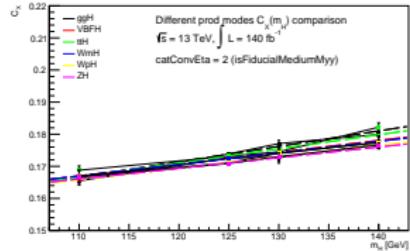
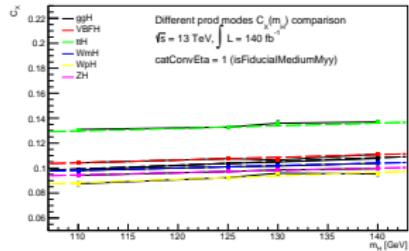
# WS and h02\* version

- Signal → h027
- Non resonant background → h026
- SM Higgs background → h027
- $A_X$  and  $C_X$  fit → h027
- Systematic uncertainties:
  - exp systs → h027 (mc16a)
  - prod modes syst → h027

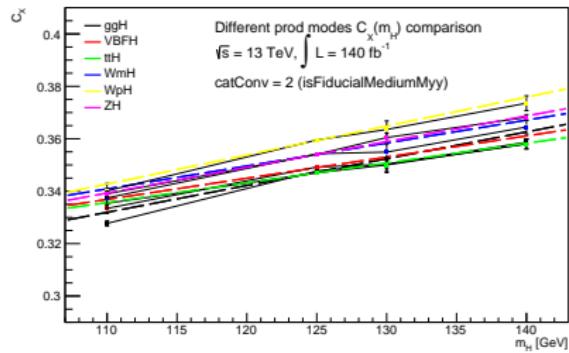
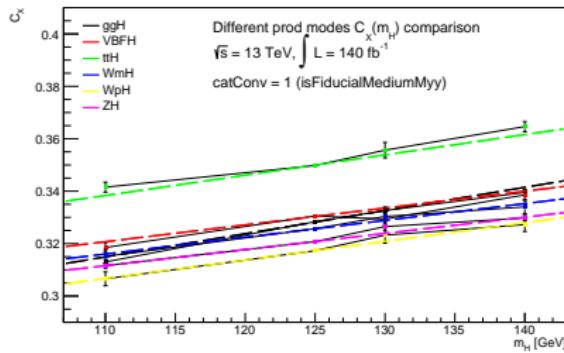
# Production mods



# Production mods catConvEta



# Production mods catConv

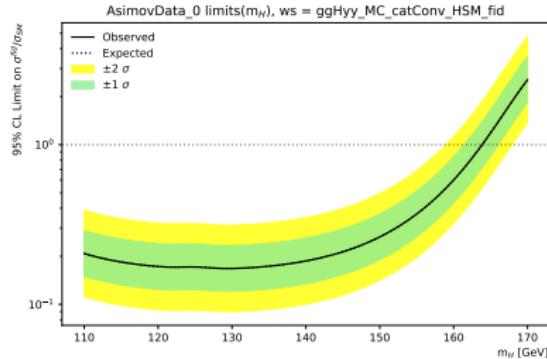
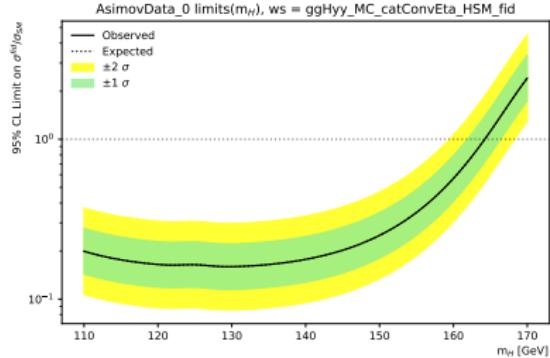
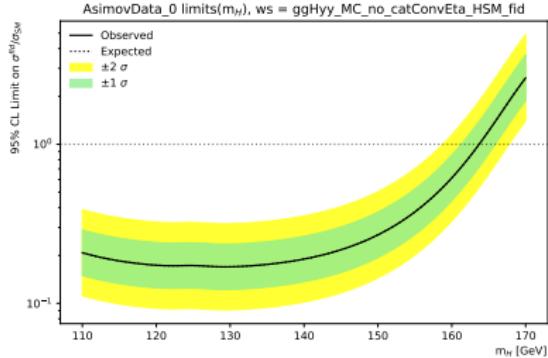


# Production mods inc

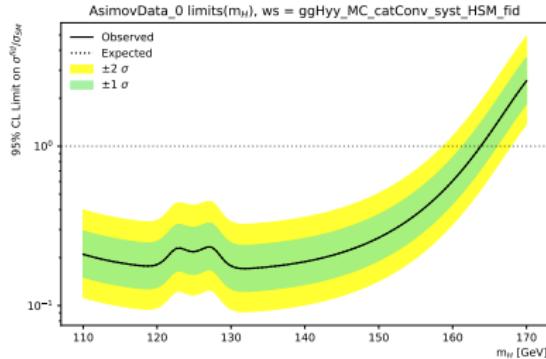
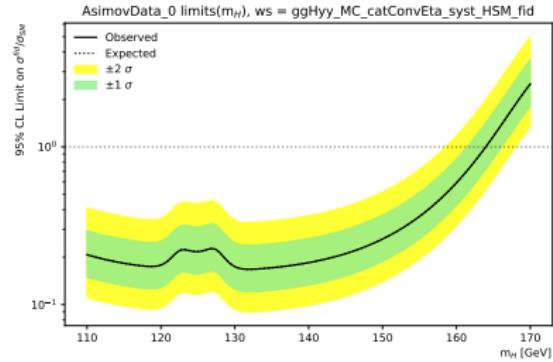
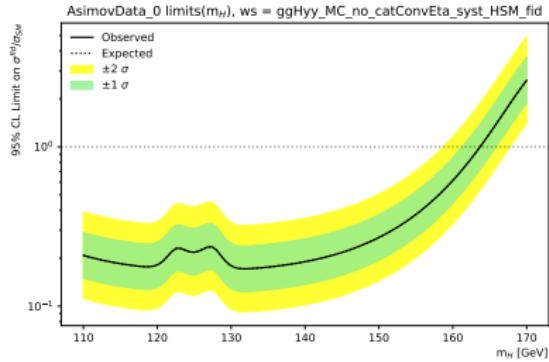
	110 GeV	125 GeV	130 GeV	140 GeV	$\sigma$
Inclusive	0.0441454	0.0337496	0.0304775	0.0241997	0.0441454
catConvEta_1	0.307372	0.280811	0.272465	0.256468	0.307372
catConvEta_2	0.00437714	0.0159262	0.0199841	0.0277759	0.0277759
catConvEta_3	0.144165	0.132688	0.129014	0.121879	0.144165
catConvEta_4	0.324436	0.302588	0.295765	0.282745	0.324436
catConvEta_5	0.0371224	0.0392882	0.0421254	0.0475605	0.0475605
catConvEta_6	0.127654	0.141083	0.145315	0.153443	0.153443
catConv_1	0.0743635	0.0663374	0.0638042	0.0589349	0.0743635
catConv_2	0.0324792	0.0346489	0.0353302	0.0366352	0.0366352

Table:  $\text{abs}(C_X^{\text{prod}} - C_X^{\text{gg}H})/C_X^{\text{gg}H}$

# Limits $\mu=0$ , no sys



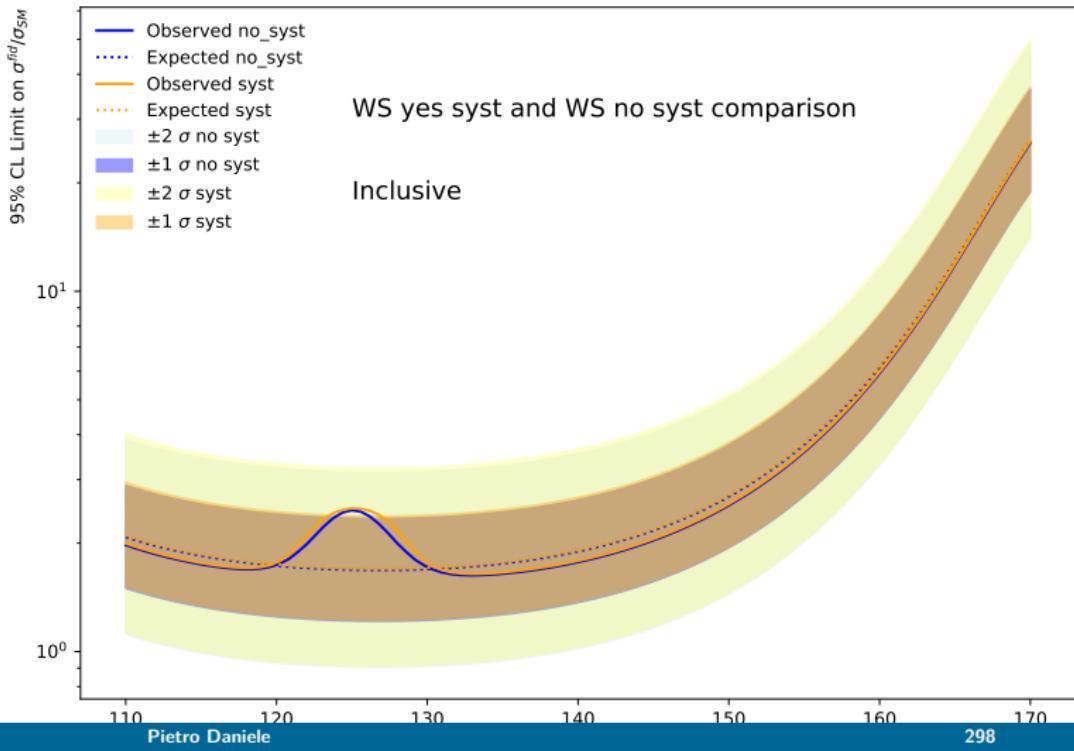
# Limits $\mu=0$ , sys



*23<sup>th</sup>* week

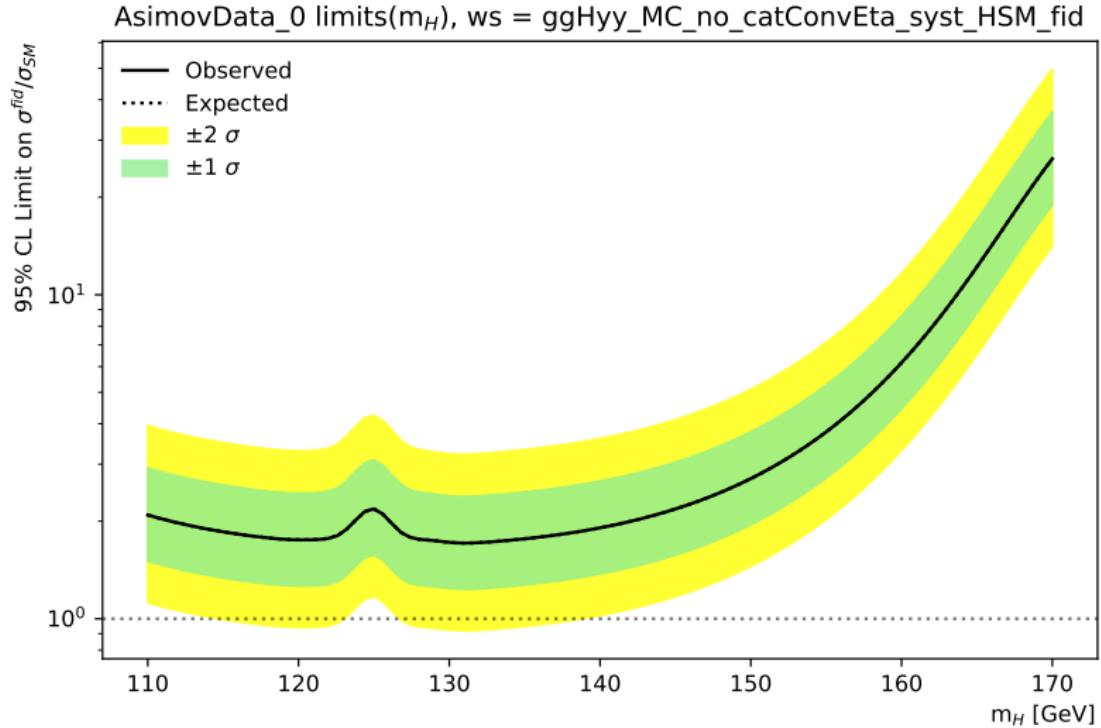
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL·2



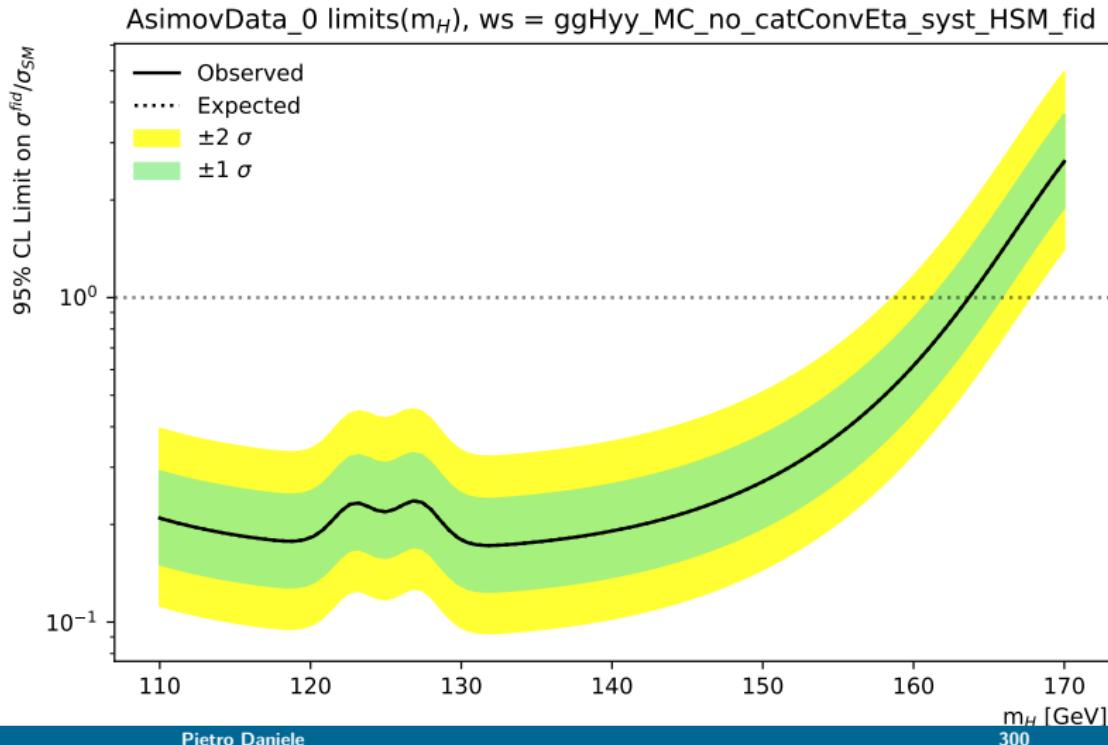
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL and ATLAS\_LHCmass



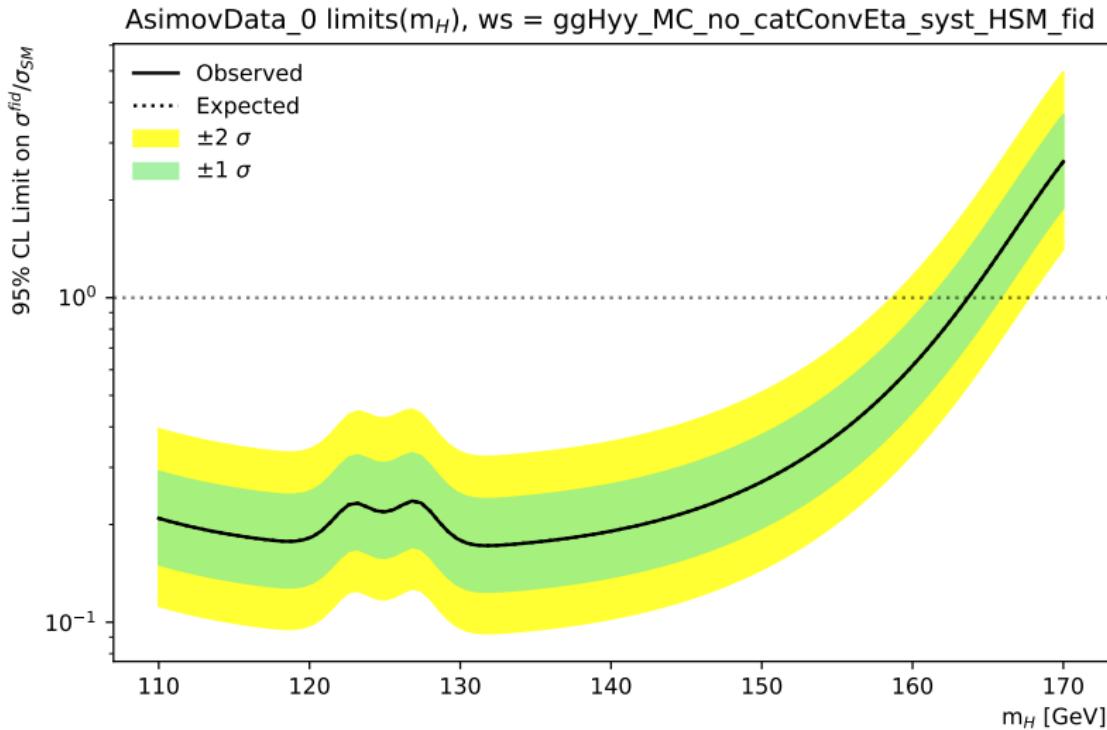
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL → ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE and  
ATLAS\_EG\_SCALE\_ALL\_HSM\_YIELD



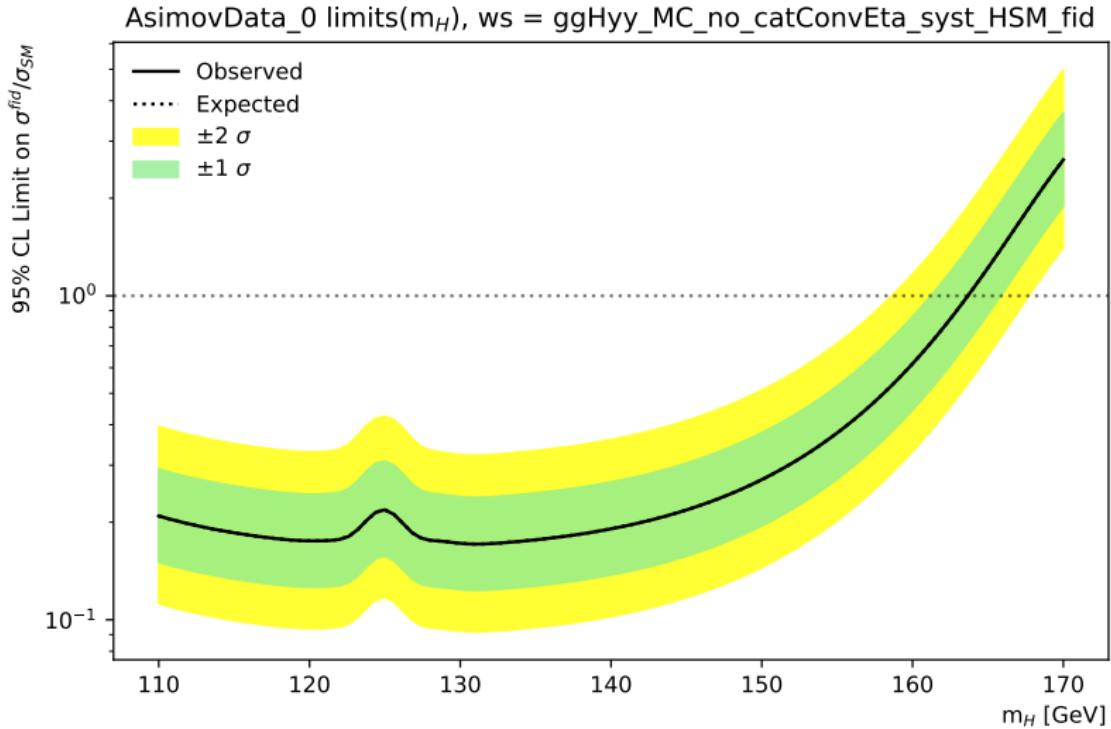
# Study limits $\mu=0$

Signal ATLAS\_EG\_SCALE\_ALL fixed



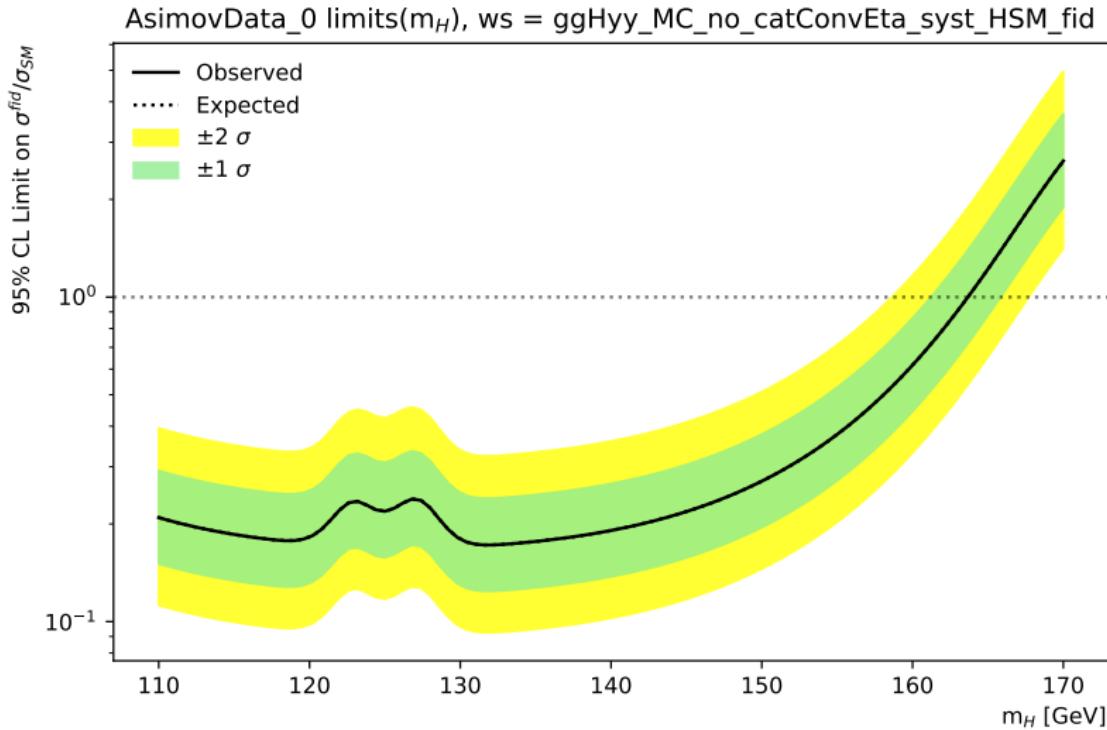
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE and ATLAS\_LHCmass



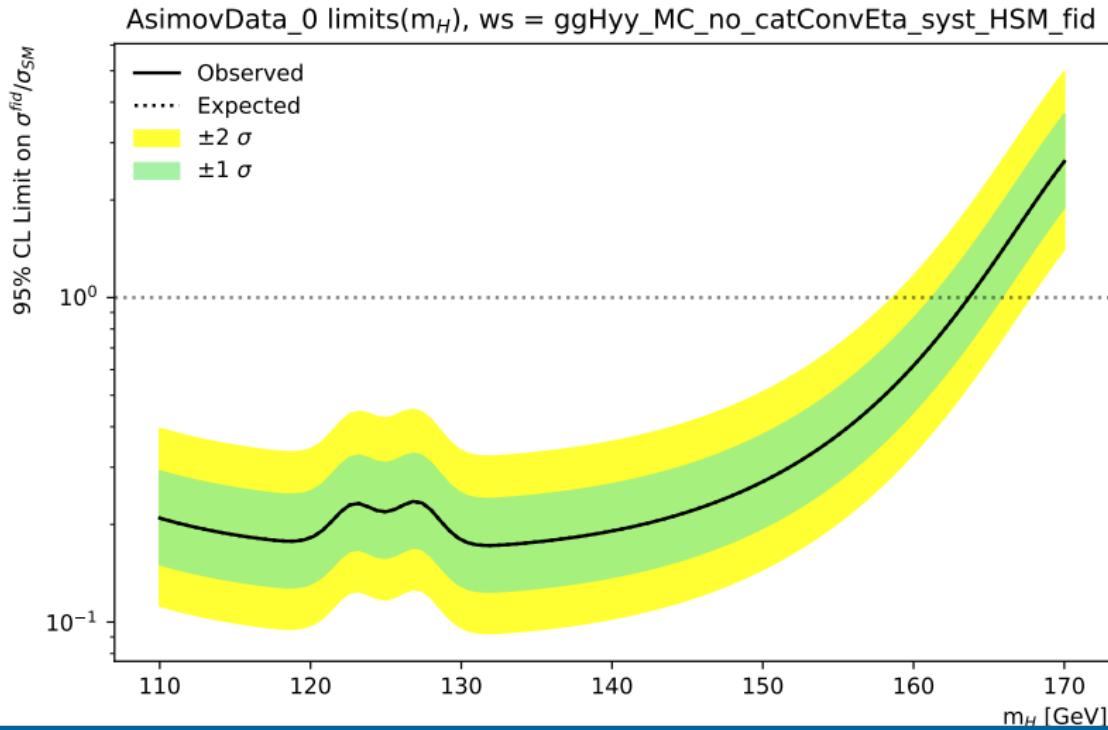
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE and ATLAS\_LHCmass correlated



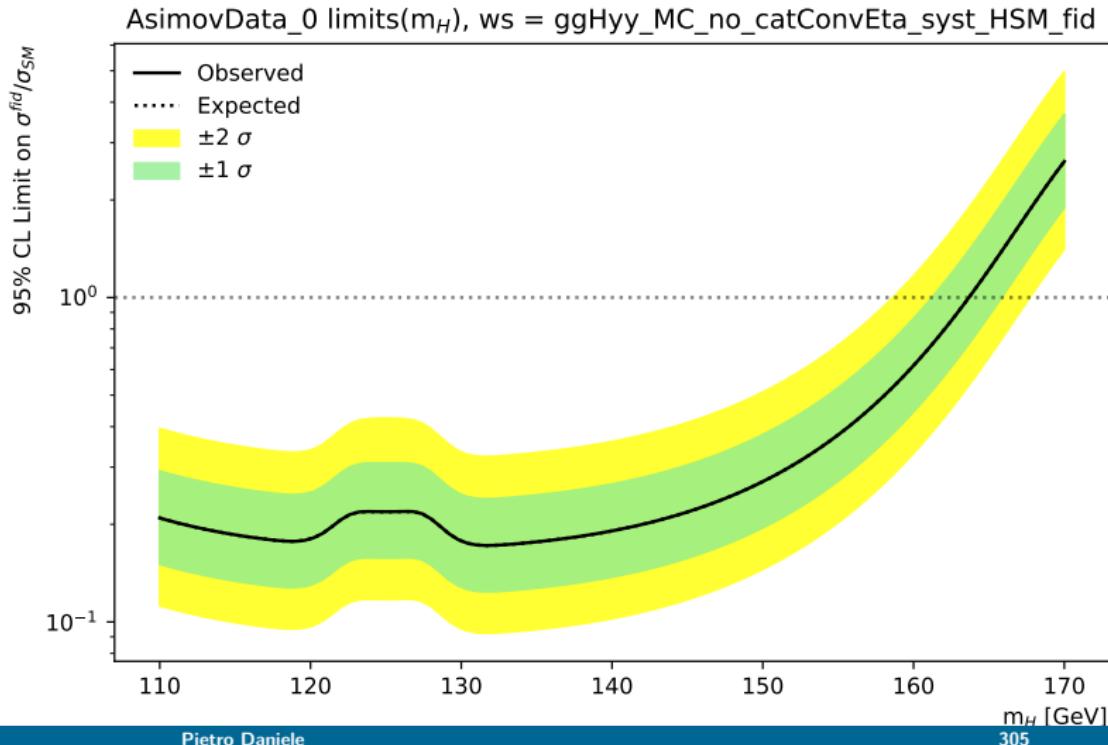
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE and ATLAS\_LHCmass correlated.  
ATLAS\_LHCmass fixed



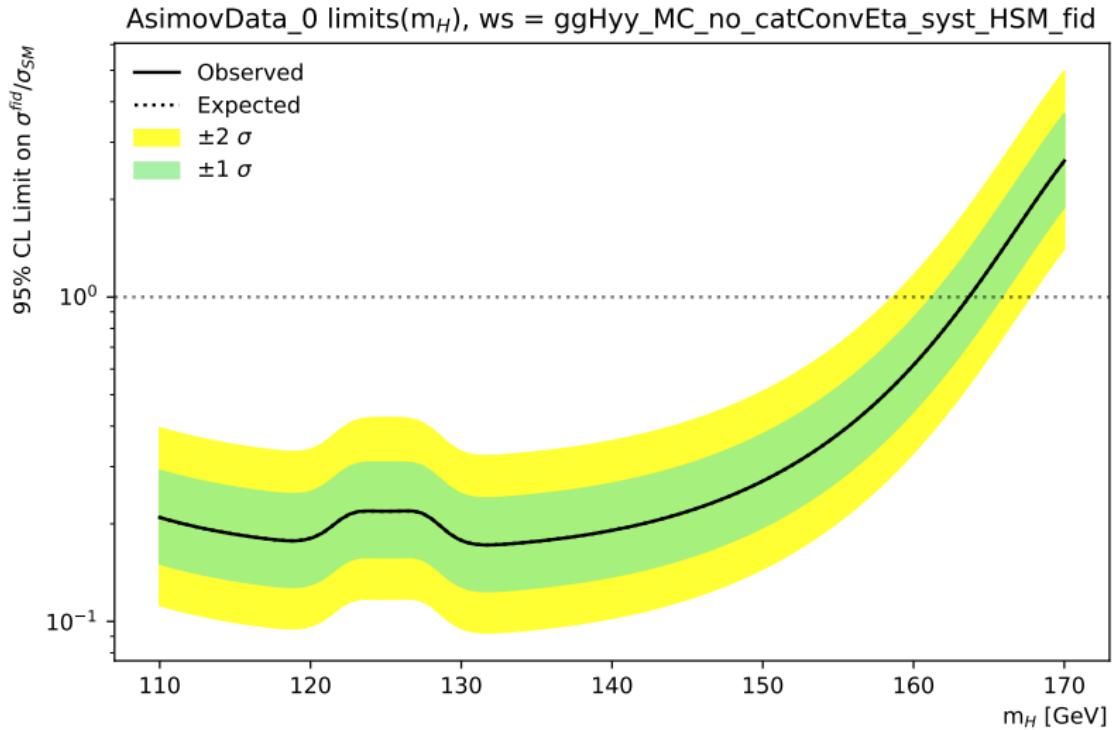
# Study limits $\mu=0$

ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE and ATLAS\_LHCmass correlated.  
ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE fixed

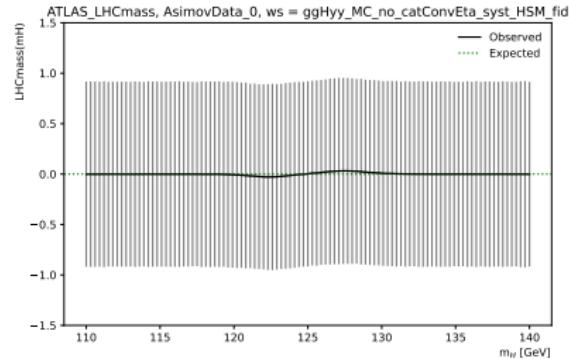
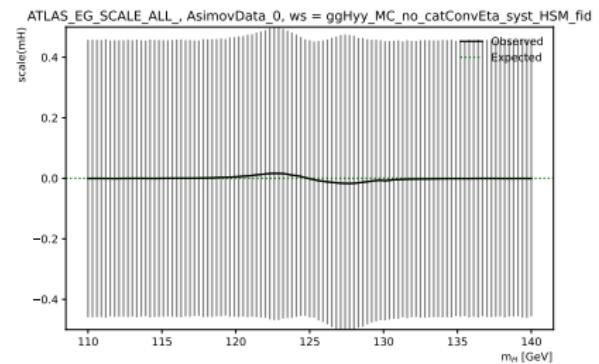
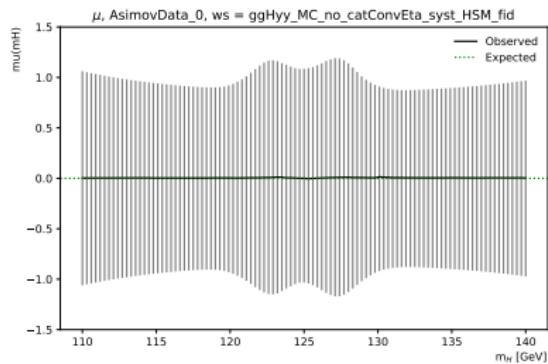


# Study limits $\mu=0$

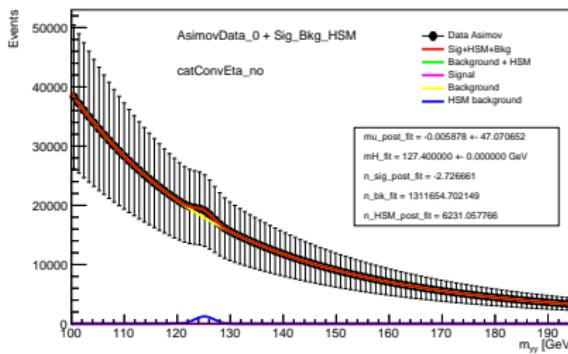
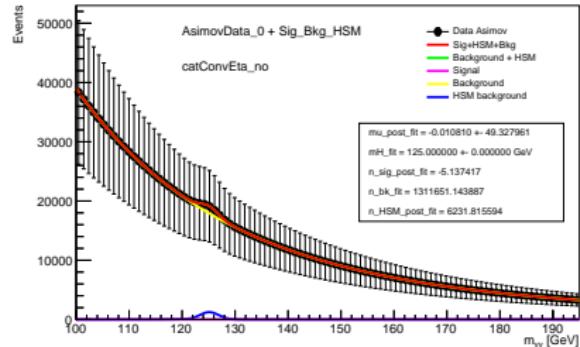
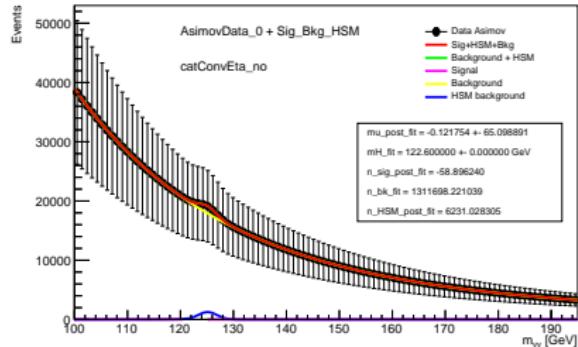
ATLAS\_EG\_SCALE\_ALL\_HSM\_SCALE fixed



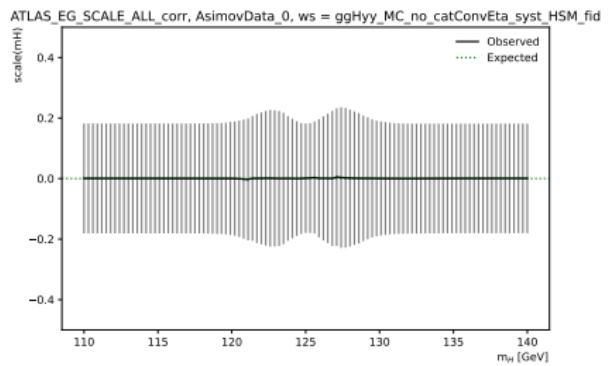
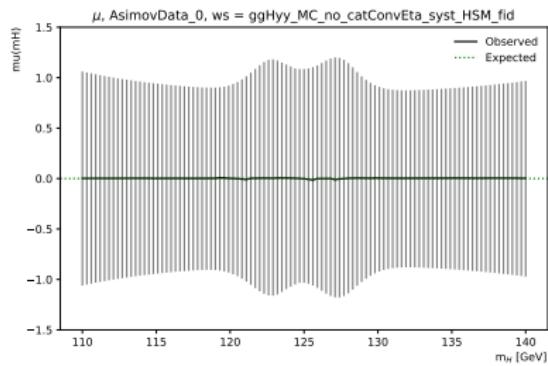
# Nominal ws



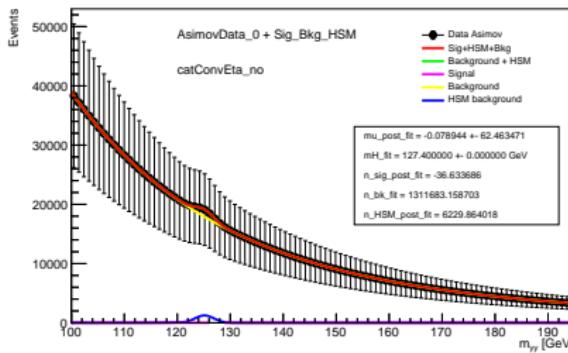
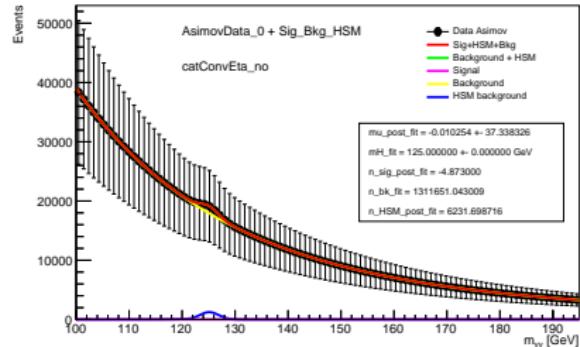
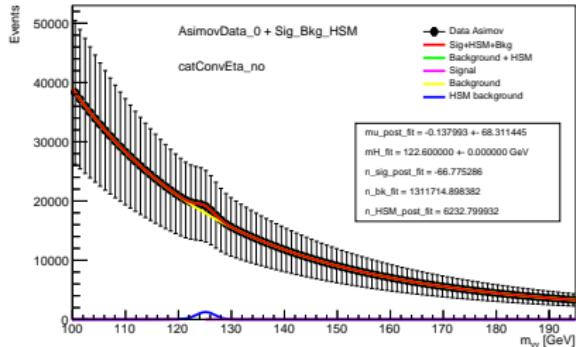
# Nominal ws



# All corr ws



# All corr ws



# Comp gobbe

