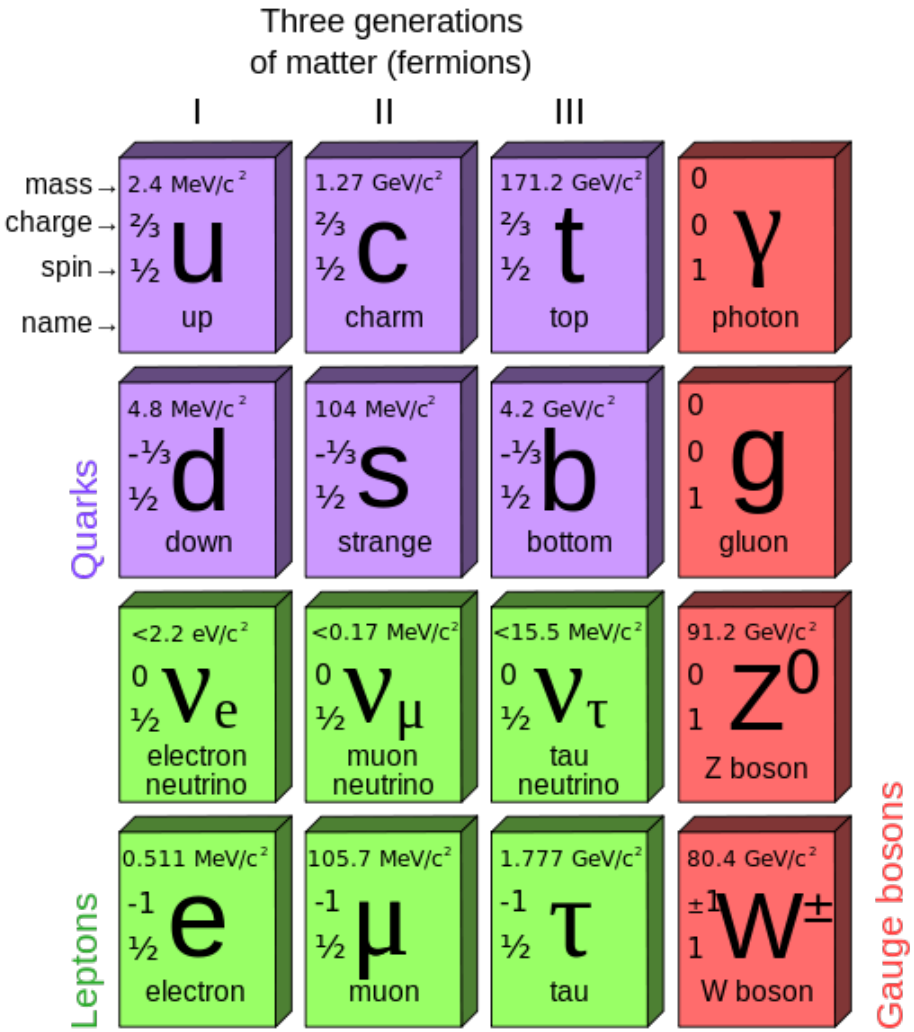
Untersuchung der Produktion von Z-Bosonen mit dem ATLAS Experiment am LHC

01. - 11.10.2018

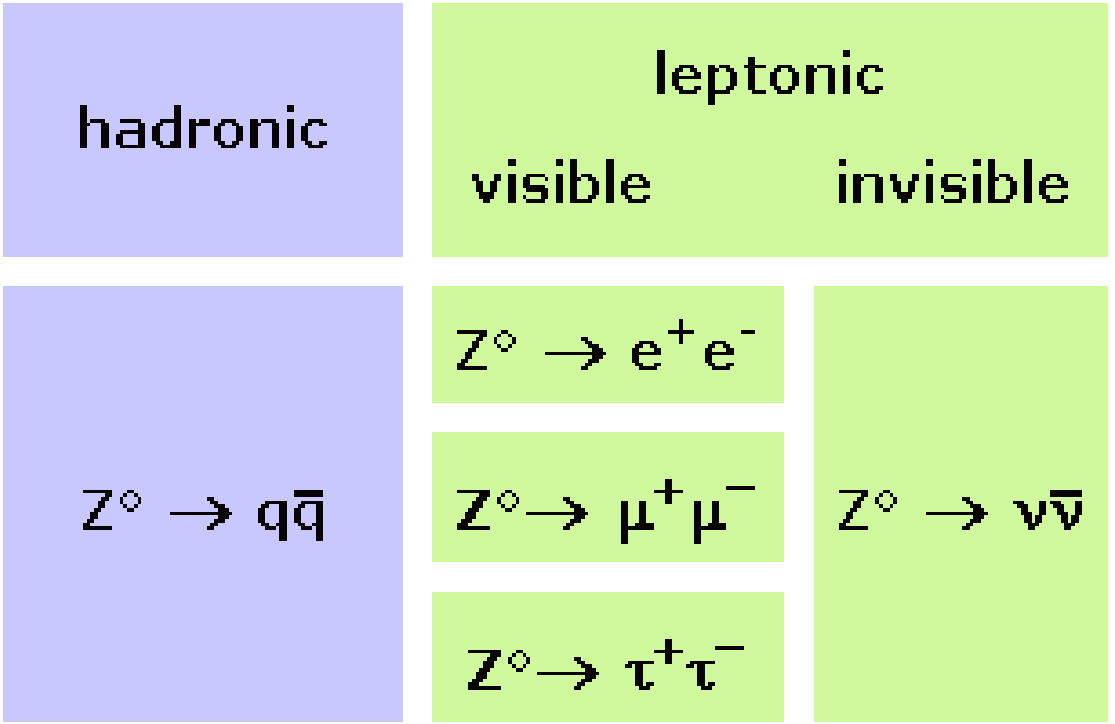
Phillip Schuster

Z - Boson



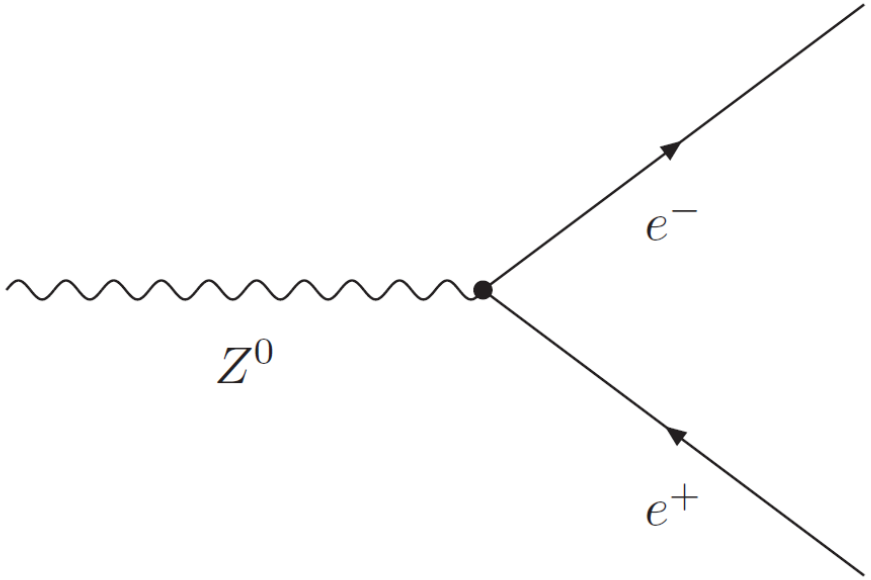
Quelle:http://2.bp.blogspot.com/-IqWBHHeASCc/URTIQK2W3eI/AAAAAAAAAC4/DwGsgBY4rSI/s1600/Standard_Model_of_Elementary_Particles.png

Nachweis des Z -Bosons

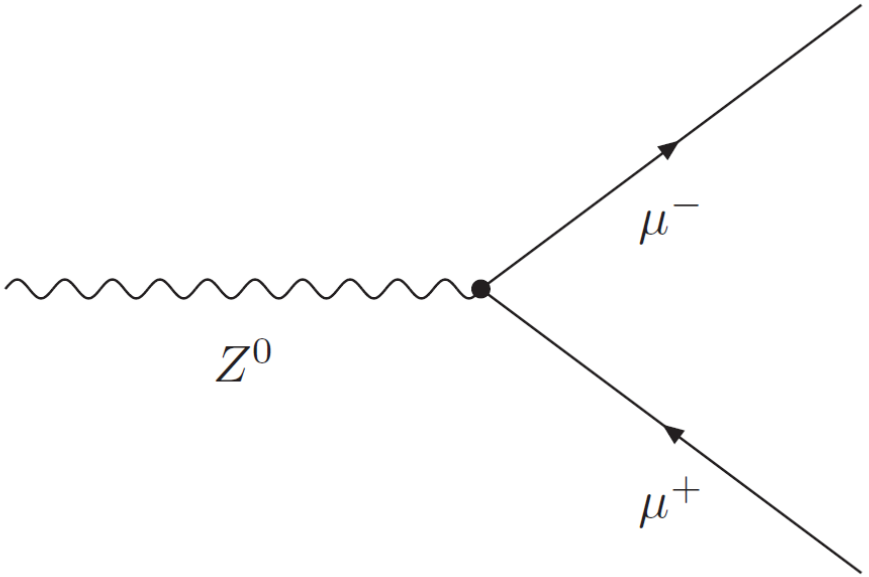


Quelle:
https://www.i2u2.org/elab/cosmic/users/AY2010/MN/Arden_Hills/Mounds_View_High_School/Michael_Cartwright/HUS/cosmic/plots/uploadedimage-HUS-2015.0226.181852.0123.gif

Nachweis des Z -Bosons

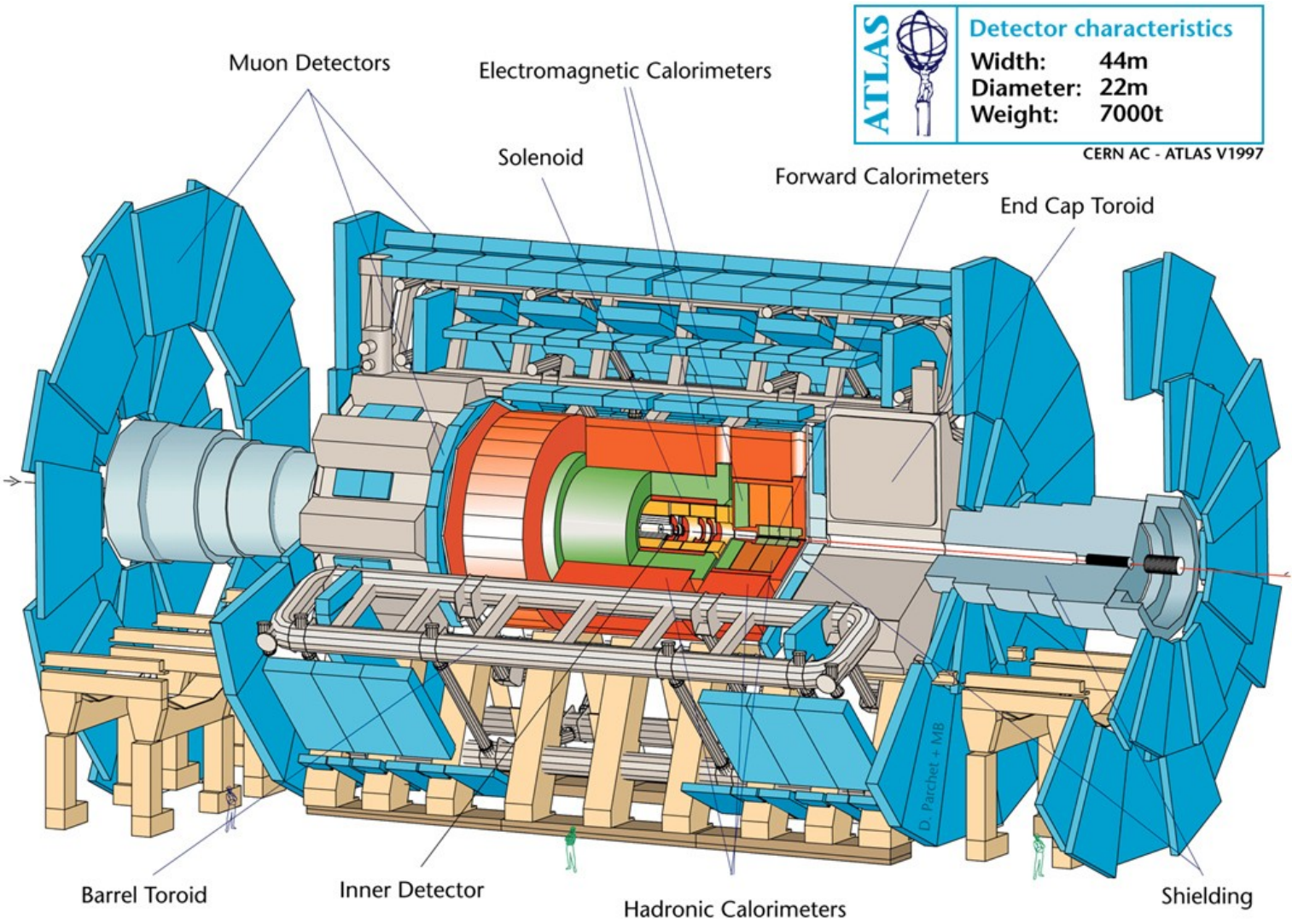


Quelle:
http://atlas.physicsmasterclasses.org/zpath_files/img/highslide/feynman/Z_ElectronPositron.png



Quelle:
http://atlas.physicsmasterclasses.org/zpath_files/img/highslide/feynman/Z_MyonAntimyon.png

ATLAS-Detektor



Quelle: https://cds.cern.ch/record/841458/files/lhc-pho-1998-304.jpg

Grundlagen

- Experiment fuer Studenten
- Daten:

  *Run 1

  *√s=8 TeV

  * $\int$ L=1fb^-1

Invariante Masse

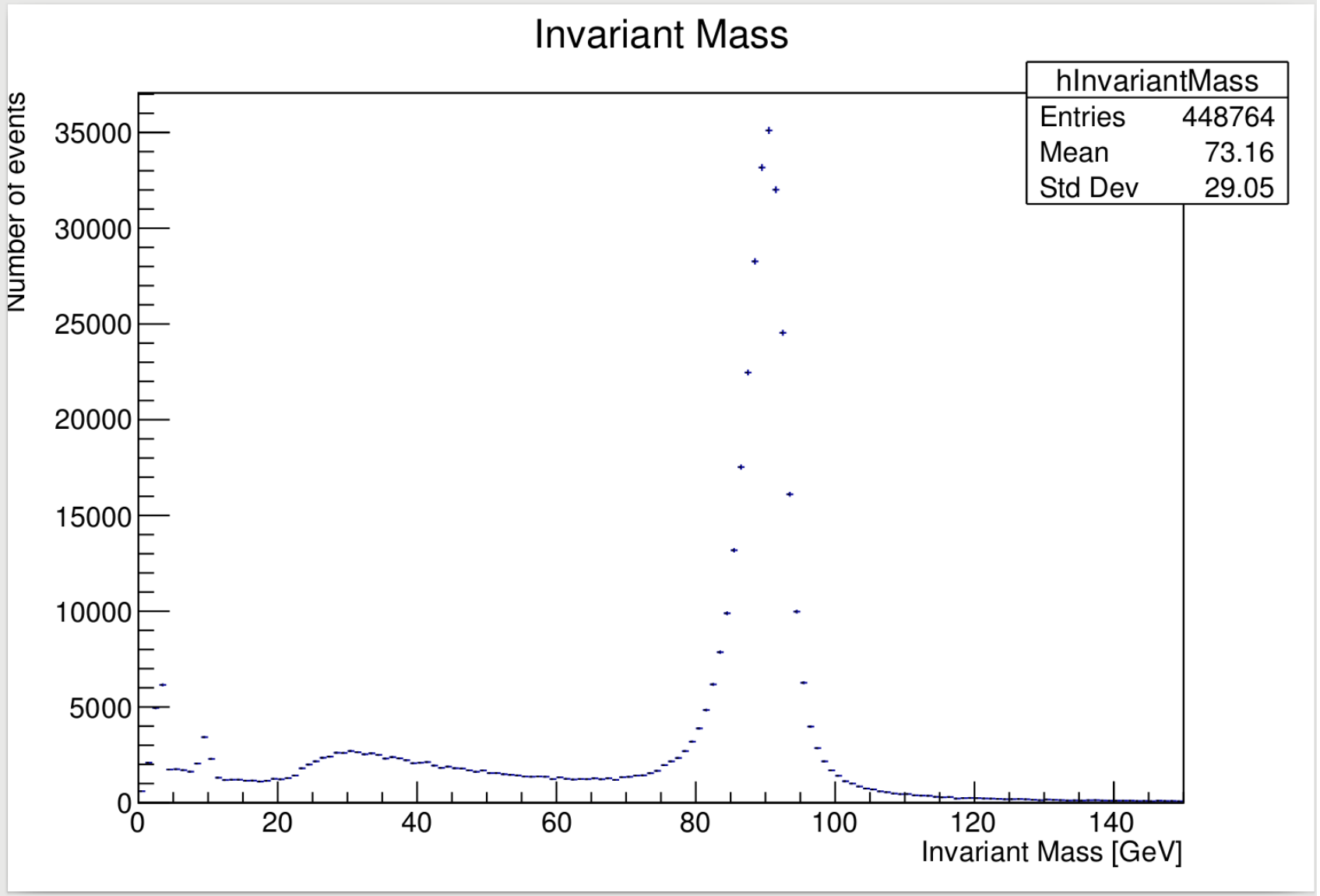
```
    if(nLeptons > 1):
     v1 = ROOT.TLorentzVector(0.,0.,0.,0.)
     v2 = ROOT.TLorentzVector(0.,0.,0.,0.)

     v1[0] = firstLeptPt*math.cos(firstLeptPhi)
     v1[1] = firstLeptPt*math.sin(firstLeptPhi)
     v1[2] = firstLeptPt*math.sinh(firstLeptEta)
     v1[3] = firstLeptE

     v2[0] = secondLeptPt*math.cos(secondLeptPhi)
     v2[1] = secondLeptPt*math.sin(secondLeptPhi)
     v2[2] = secondLeptPt*math.sinh(secondLeptEta)
     v2[3] = secondLeptE

     E = (firstLeptE + secondLeptE)*(firstLeptE + secondLeptE)
     Pa = (math.cosh(firstLeptEta)*firstLeptPt)*(math.cosh(firstLeptEta)*firstLeptPt)
     Pb = (math.cosh(secondLeptEta)*secondLeptPt)*(math.cosh(secondLeptEta)*secondLeptPt)
     Pc = 2*firstLeptPt*secondLeptPt*(math.cos(firstLeptPhi)*math.cos(secondLeptPhi) + math.sin(firstLeptPhi)*math.sin(secondLeptPhi) + math.sinh(firstLeptEta)*math.sinh
(secondLeptEta))
     P = (Pa + Pb + Pc)
```

Invariante Masse



Cuts

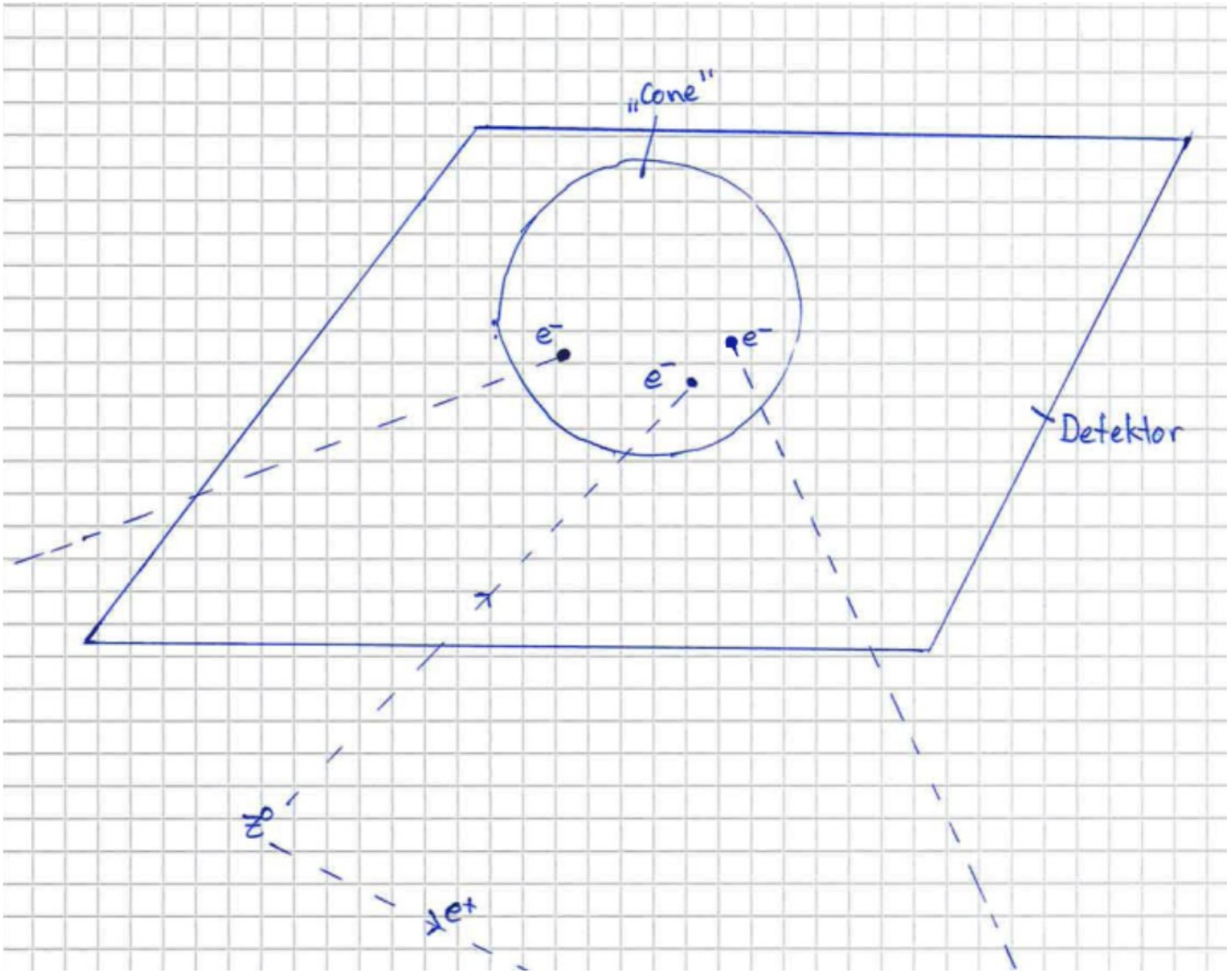
Cuts

```
if(myChain.lep_n > 1):
```

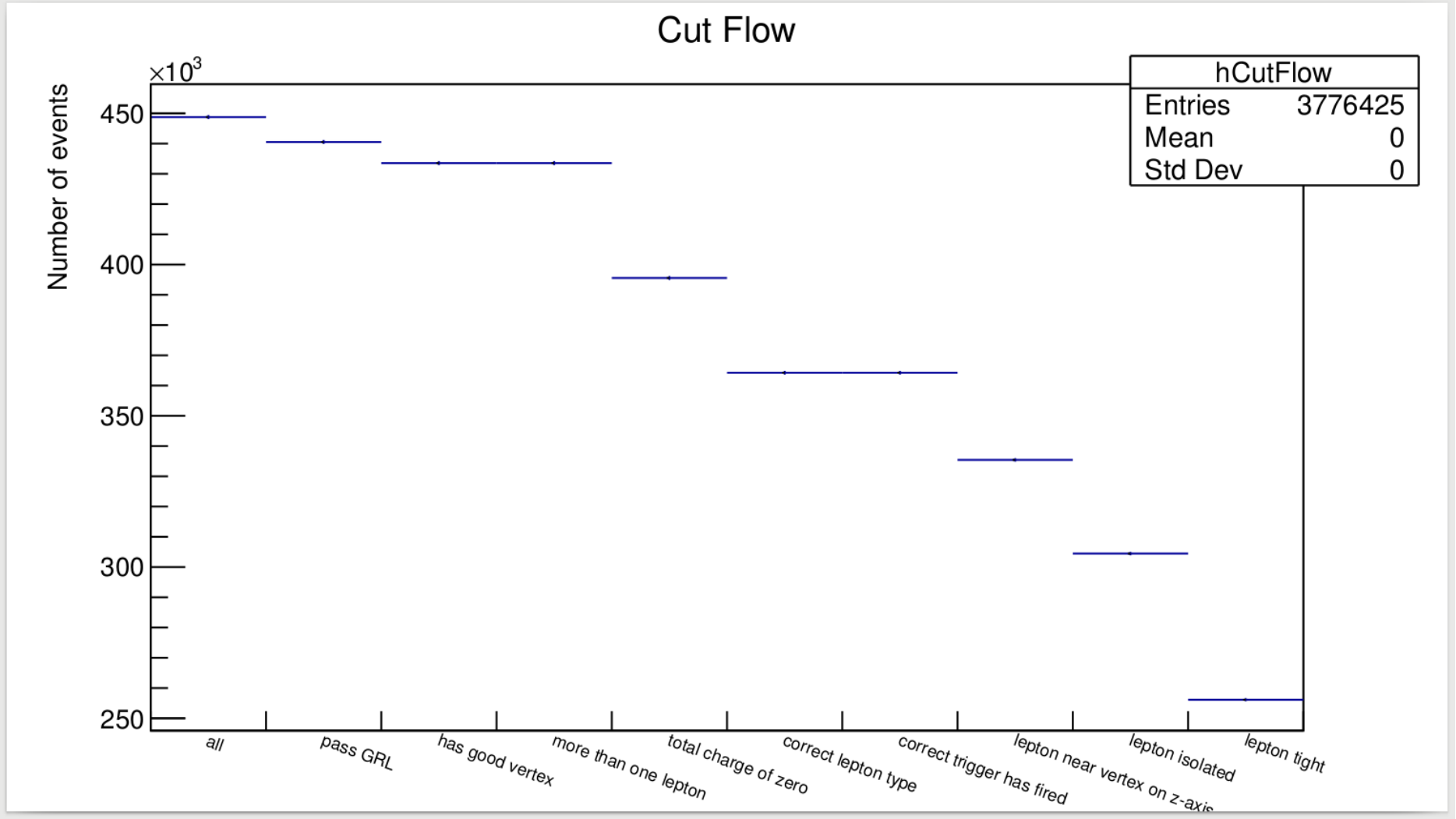
```
if((firstLeptCharge + secondLeptCharge) == 0):
```

```
if((firstLeptPtCone30/firstLeptPt) < 0.2 and (secondLeptPtCone30/secondLeptPt) < 0.2):
```

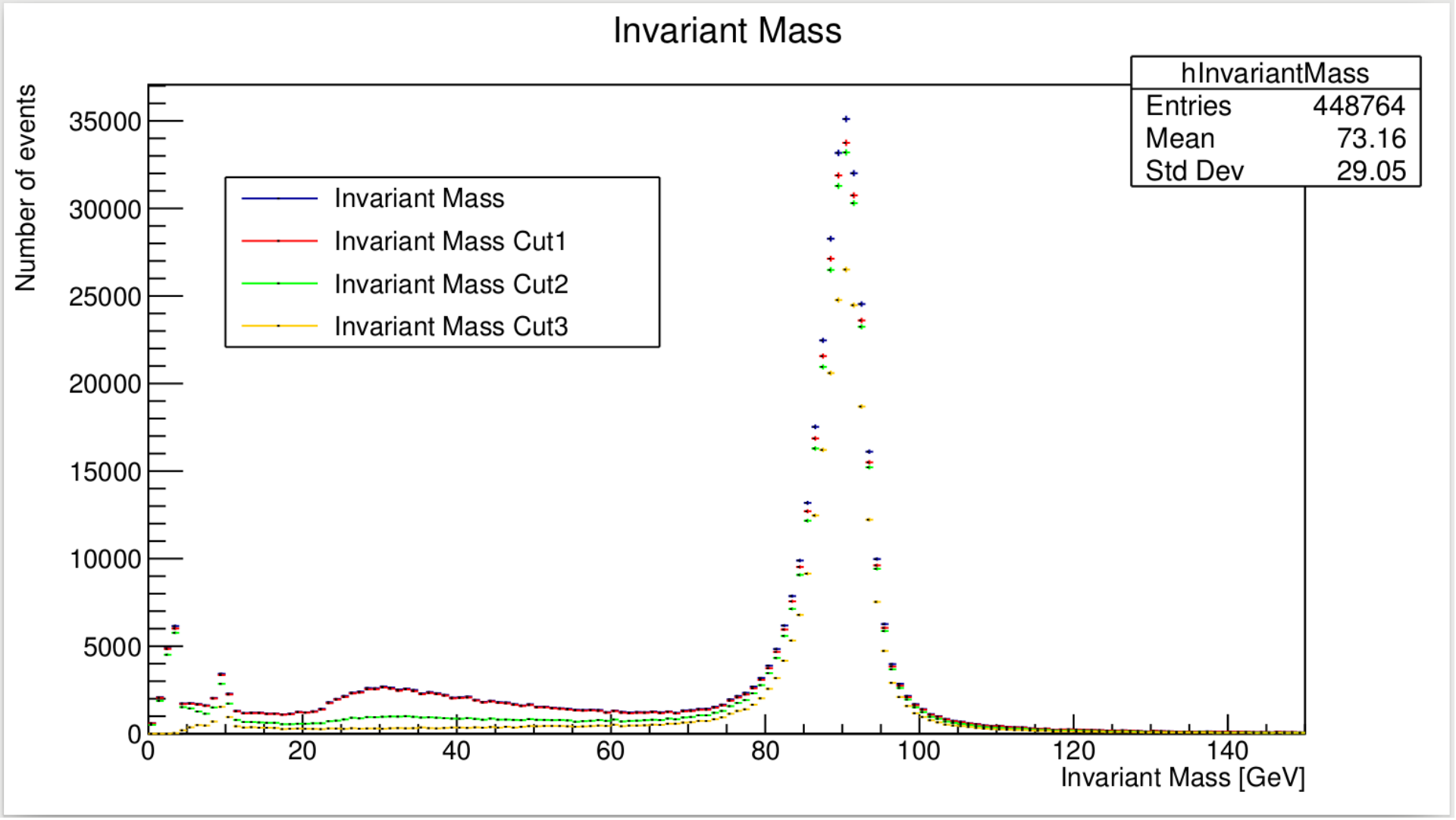
Cuts



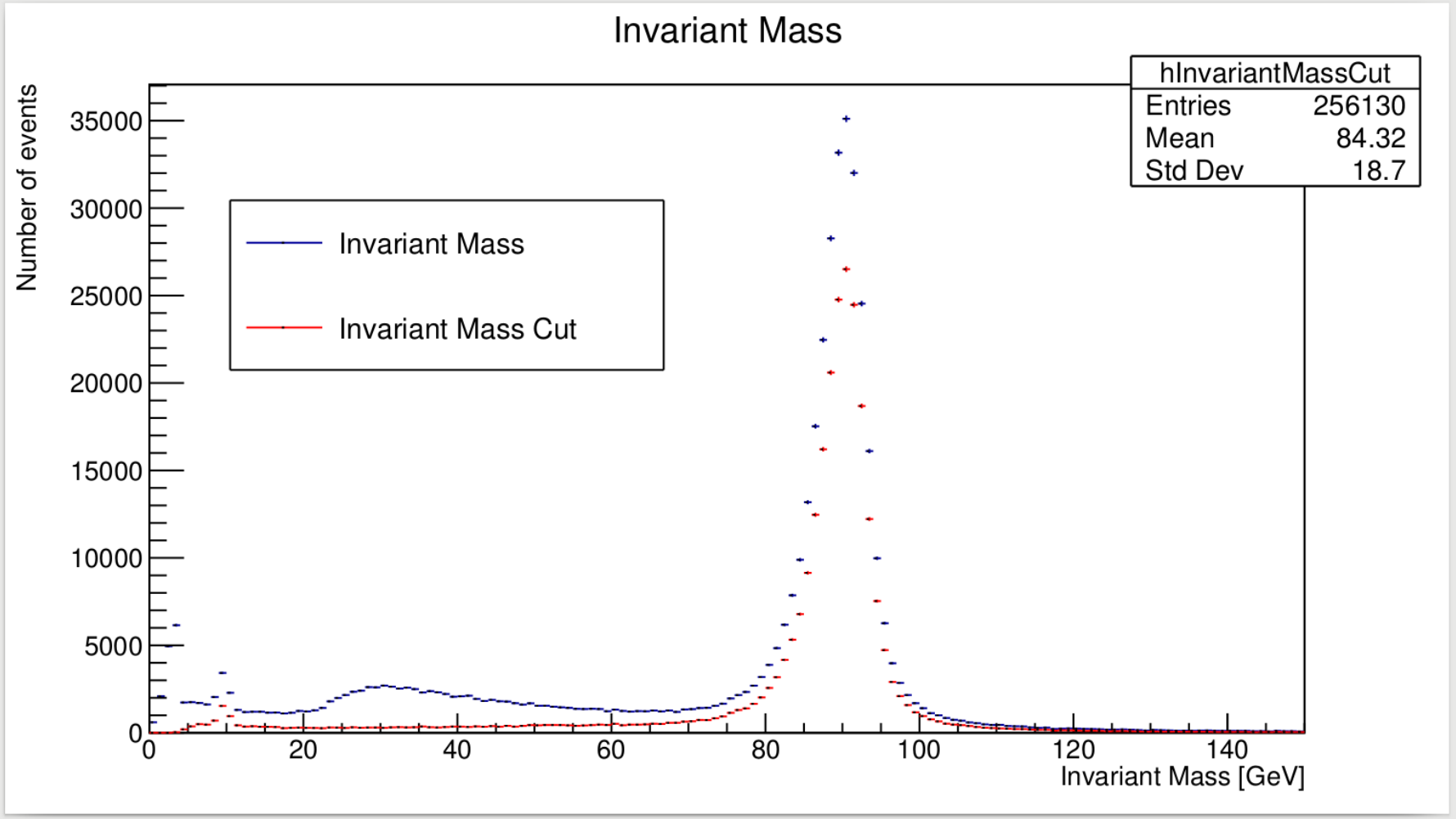
Cuts


Cut Flow
hCutFlow
Entries 3776425
Mean 0
Std Dev 0
Number of events
×10^3
450
400
350
300
250
all
pass GRL
has good vertex
more than one lepton
total charge of zero
correct lepton type
correct trigger has fired
lepton near vertex on z-axis
lepton isolated
lepton tight

Cuts


Invariant Mass
hInvariantMass
Entries 448764
Mean 73.16
Std Dev 29.05
Invariant Mass
Invariant Mass Cut1
Invariant Mass Cut2
Invariant Mass Cut3
Number of events
0
5000
10000
15000
20000
25000
30000
35000
0
20
40
60
80
100
120
140
Invariant Mass [GeV]

Cuts


Invariant Mass
hInvariantMassCut
Entries 256130
Mean 84.32
Std Dev 18.7
Invariant Mass
Invariant Mass Cut
Number of events
35000
30000
25000
20000
15000
10000
5000
0
0
20
40
60
80
100
120
140
Invariant Mass [GeV]

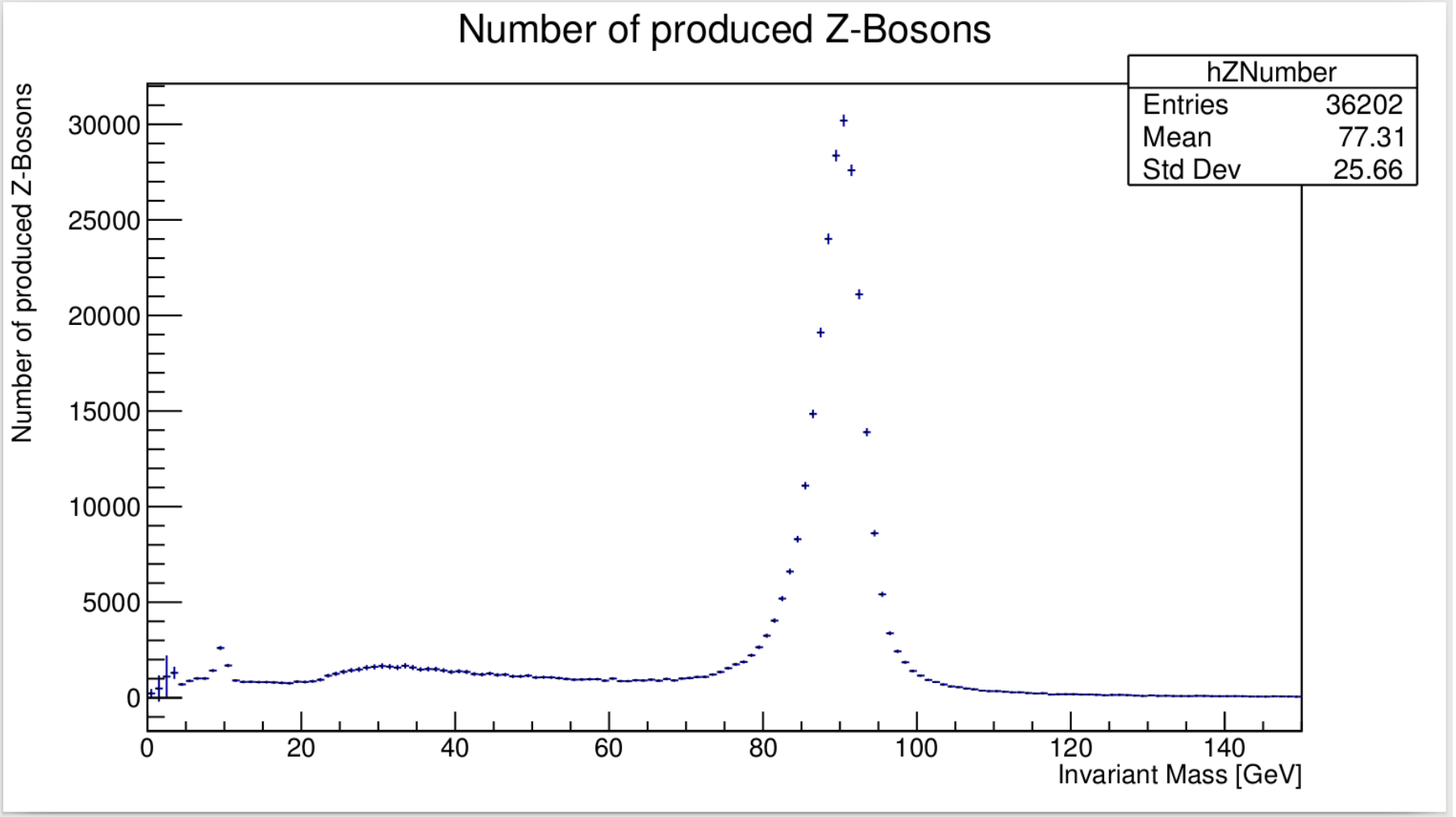
Effizienz

$$\text{Effizienz} = \frac{\textit{Anzahl selektierter Elektronen}}{\textit{Anzahl aller Elektronen}}$$

Effizienz

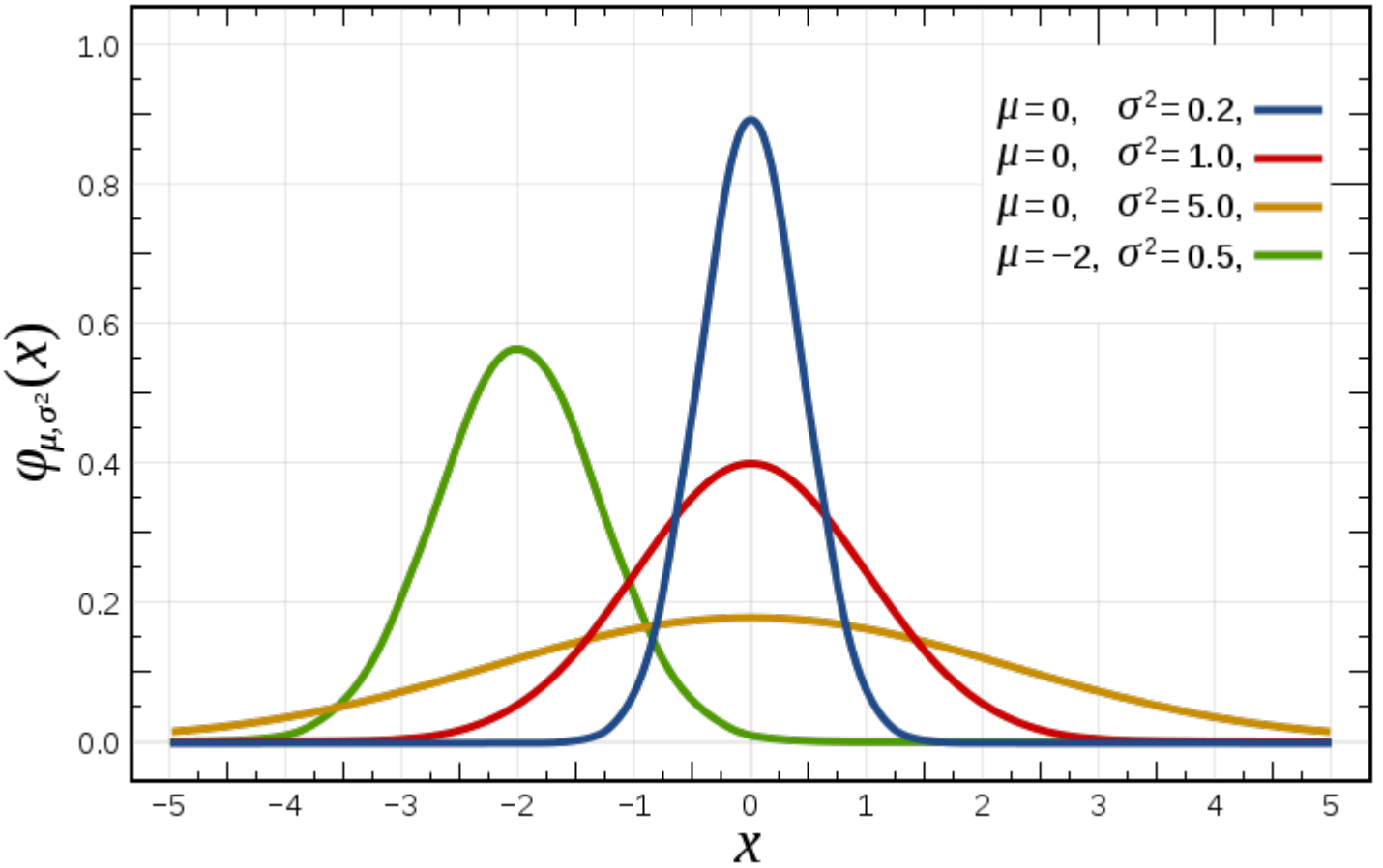
Anzahl produzierter Z-Bosonen = $\frac{Anzahl\ gemessener\ Z-Bosonen}{Effizienz}$

Effizienz


Number of produced Z-Bosons
hZNumber
Entries 36202
Mean 77.31
Std Dev 25.66
Number of produced Z-Bosons
30000
25000
20000
15000
10000
5000
0
0
20
40
60
80
100
120
140
Invariant Mass [GeV]

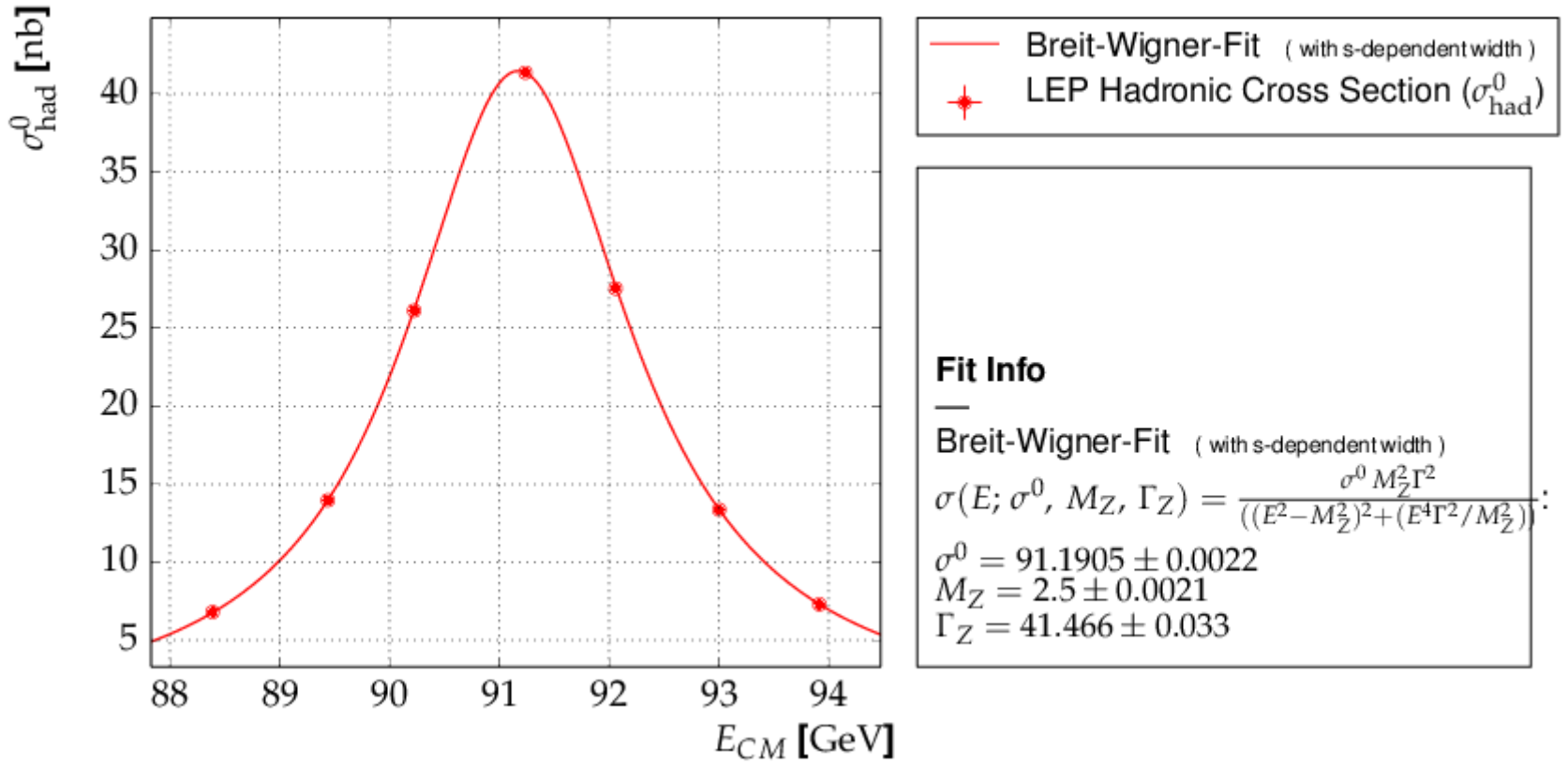
Fitting

Fitting - Gauss



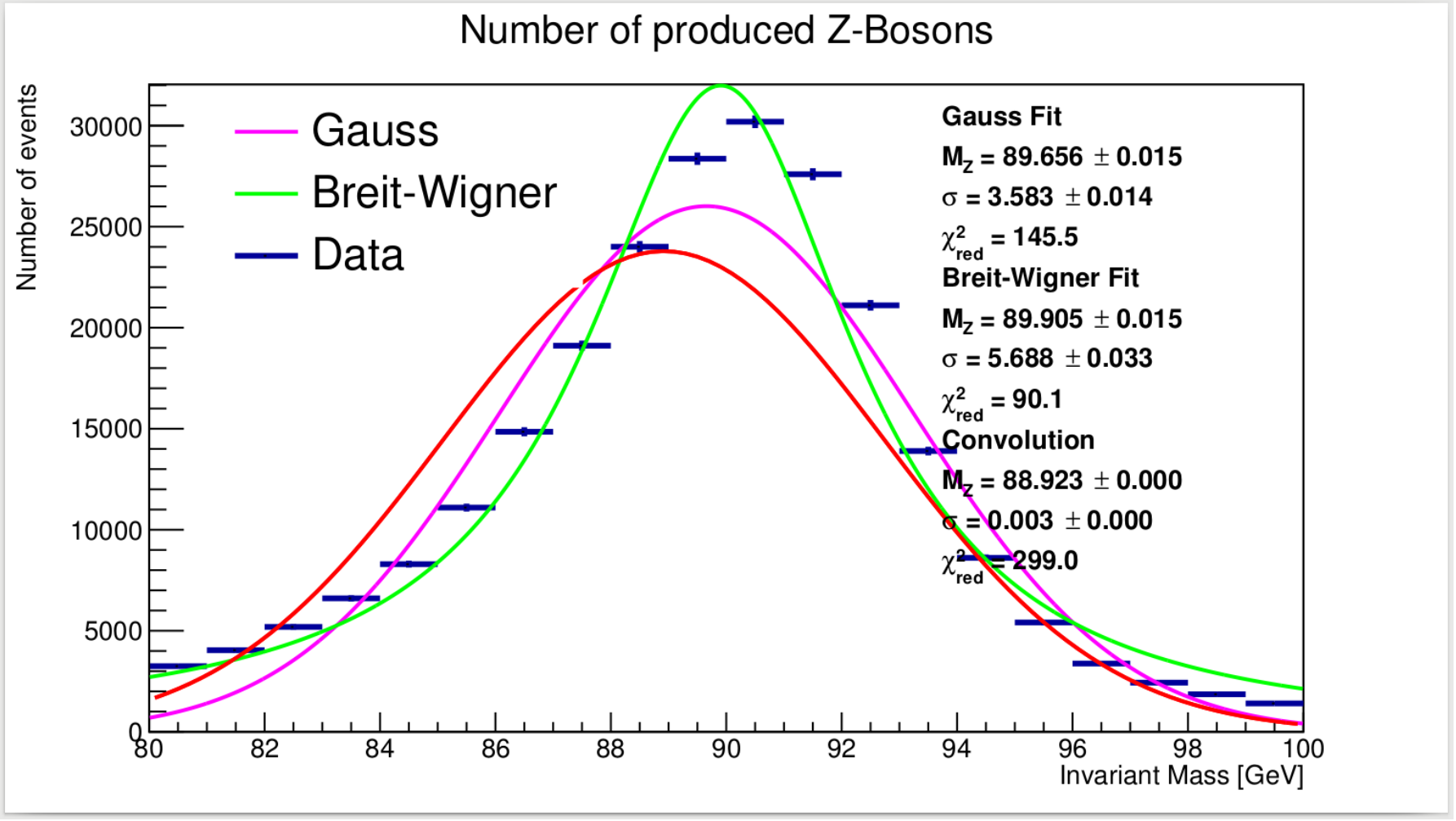
Quelle: https://en.wikipedia.org/wiki/Gaussian_function#/media/File:Normal_Distribution_PDF.svg

Fitting - Breit-Wigner



Quelle: https://kafe.readthedocs.io/en/latest/_images/kafe_BreitWignerFit.png

Fitting


Number of produced Z-Bosons
Number of events
Invariant Mass [GeV]
Gauss
Breit-Wigner
Data
Gauss Fit
M_Z = 89.656 ± 0.015
σ = 3.583 ± 0.014
χ^2_{red} = 145.5
Breit-Wigner Fit
M_Z = 89.905 ± 0.015
σ = 5.688 ± 0.033
χ^2_{red} = 90.1
Convolution
M_Z = 88.923 ± 0.000
σ = 0.003 ± 0.000
χ^2_{red} = 299.0
0
5000
10000
15000
20000
25000
30000
80
82
84
86
88
90
92
94
96
98
100

Wirkungsquerschnitt

$$N = L * \sigma$$

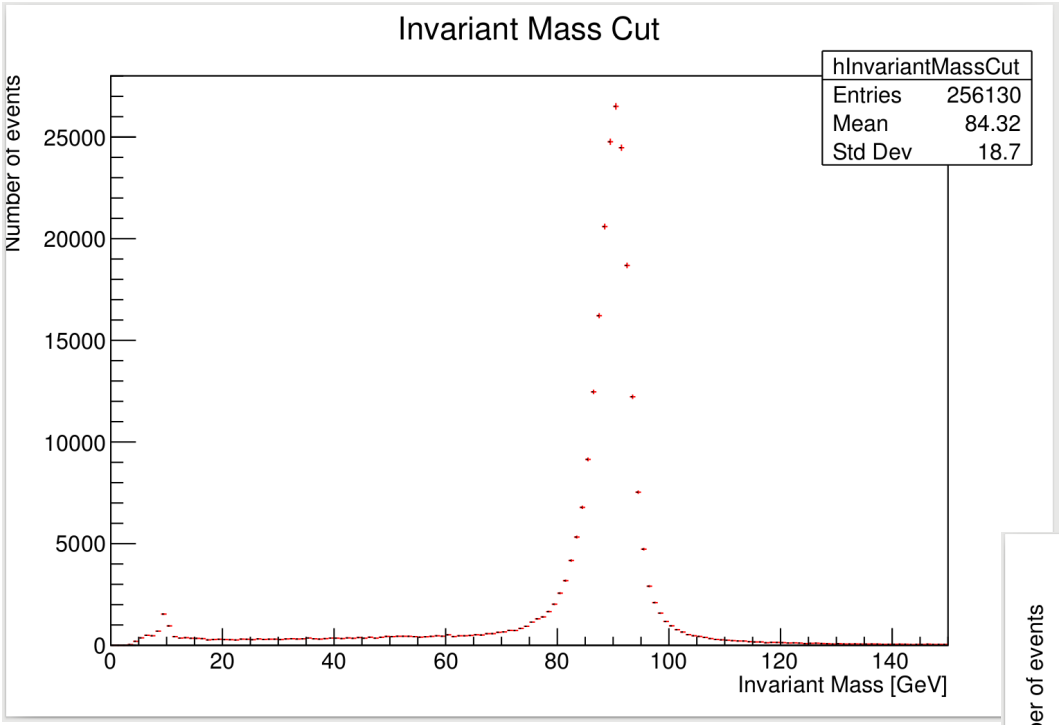
$$\Rightarrow \sigma = \frac{N}{L}$$

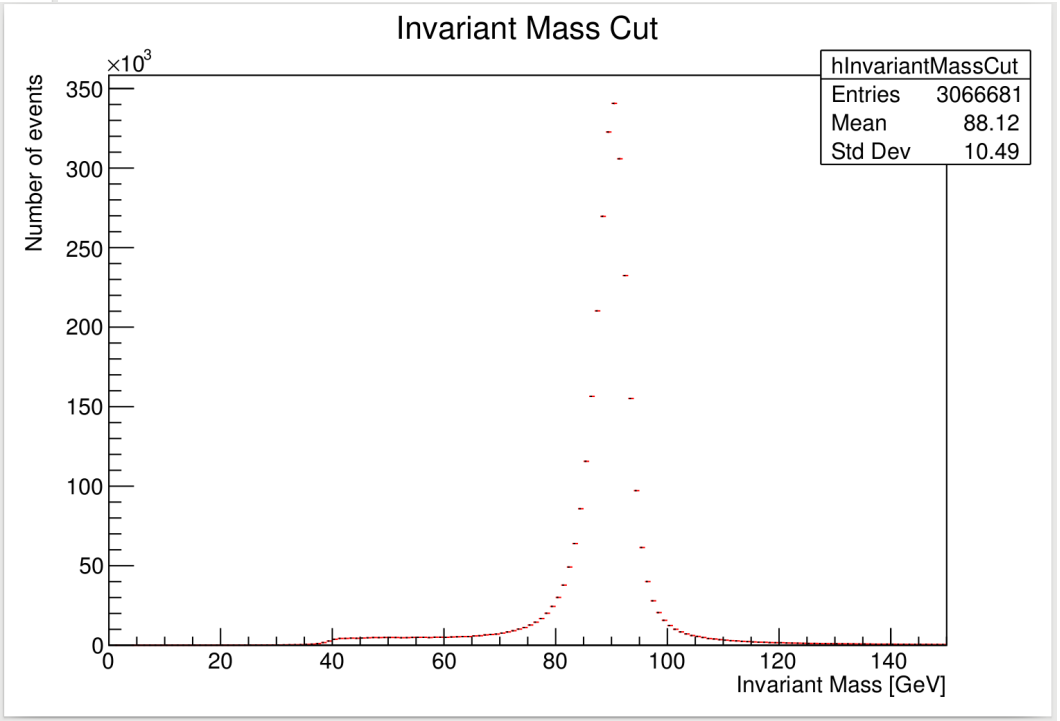
Wirkungsquerschnitt

$\sigma = 217809.767947$ fb

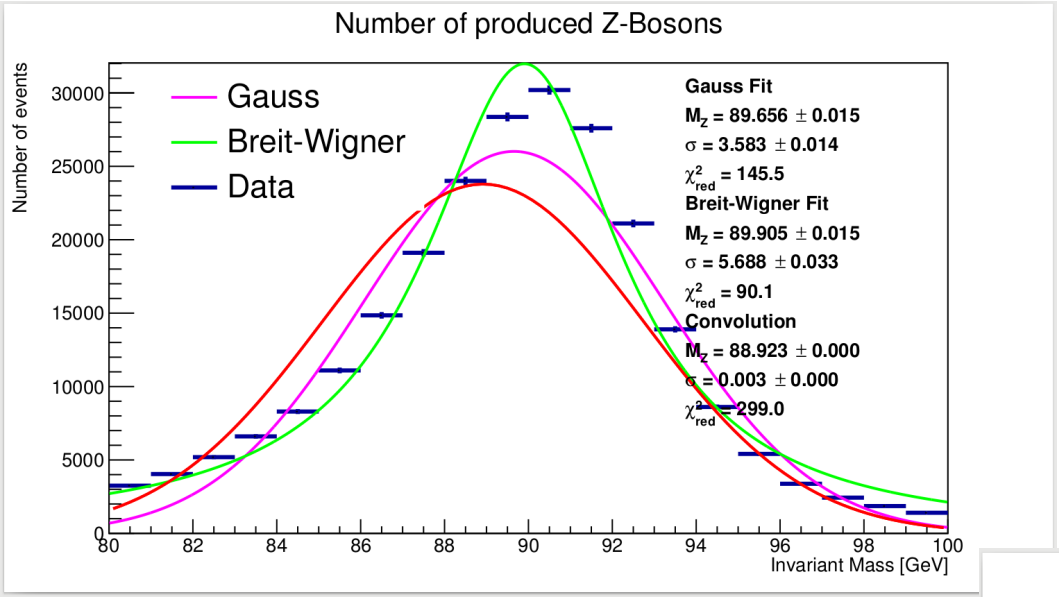
Monte-Carlo Simulationen

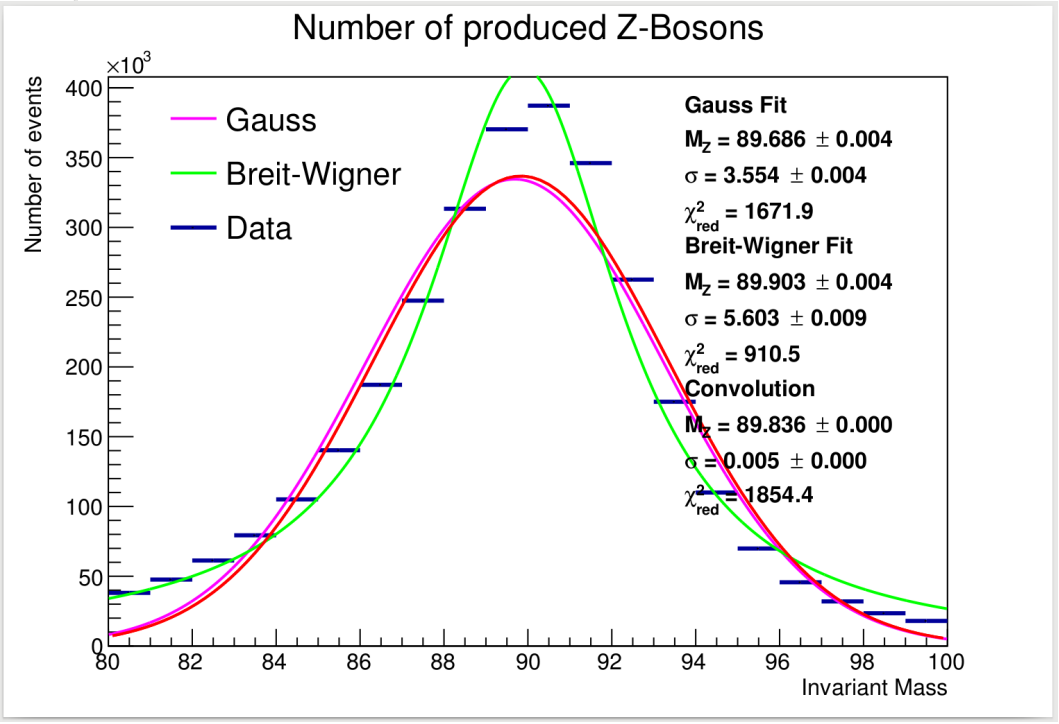
Monte-Carlo Simulationen





Monte-Carlo Simulationen





Monte-Carlo Simulationen

MC : σ = 2803711.60422 fb

Daten: σ = 217809.767947 fb

Ausblick

- Akzeptanz
- Fehler
- Myon-Daten