Nonlinearity correction study Update

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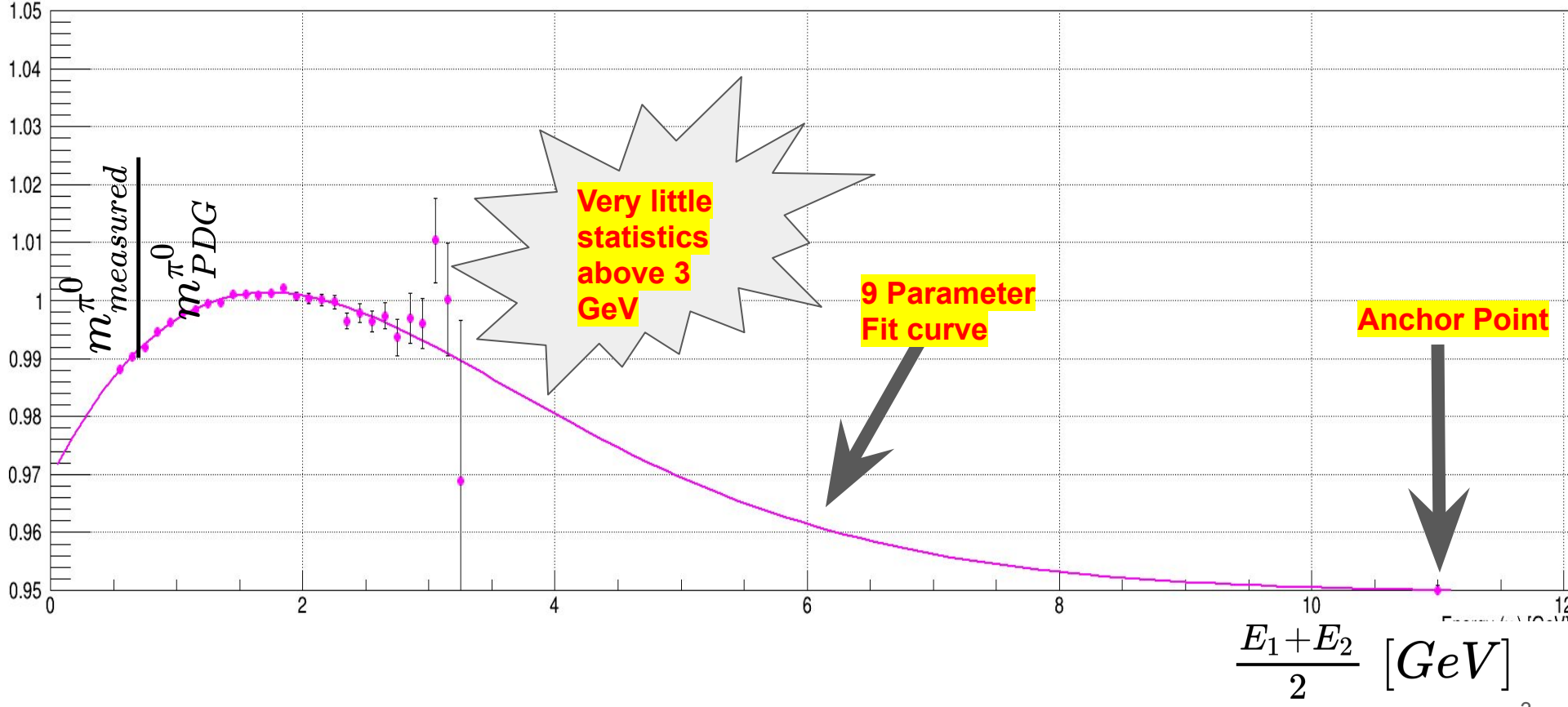
Nonlinear corrections (Current algorithm):

- After gain calibrations, select out $\pi^0 \rightarrow 2\gamma$ inclusive events with symmetric photon decays (|E1 - E2| < 0.1)
- Reconstruct the invariant mass of the events, and plot the Ratio of reconstructed invariant mass to PDG invariant mass (~0.135 GeV) as a function of E_{avg} = (E1 + E2)/2
- Put an anchor of 5 % offset at 11 GeV. This is to make the curve pass through 95% at 11 GeV. Follows from J/psi analysis
- Fit an empirical nonlinear function to fit the above distribution.

Nonlinear corrections



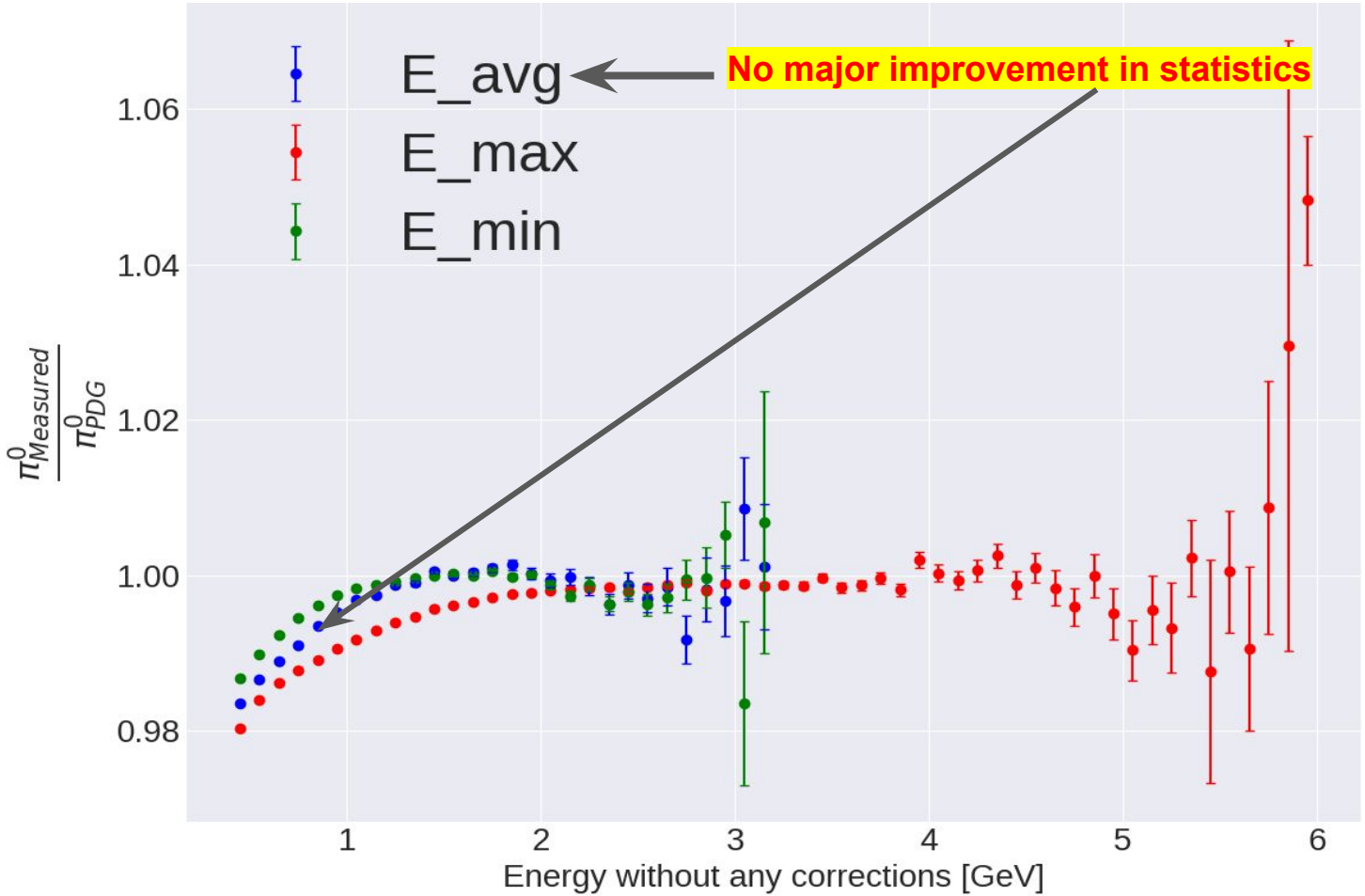
Nonlinearity correction (an alternative method)

- The main drawback is there are no events beyond 3 GeV and there is no way to validate the fitted curve due to huge statistical fluctuations in the 3 GeV range
- As a first step the symmetric condition for photon showers are modified.

$$|E_1 - E_2| < 0.1 \rightarrow \frac{|E_1 - E_2|}{E_{avg}} < 0.1$$

- This amounts to variation between E1/E2 to about 84%
- This will give more statistics at higher energies
- Also explicitly sort E1 and E2 such that E1 > E2 (refer backups)

Nonlinearity with new symmetric conditions



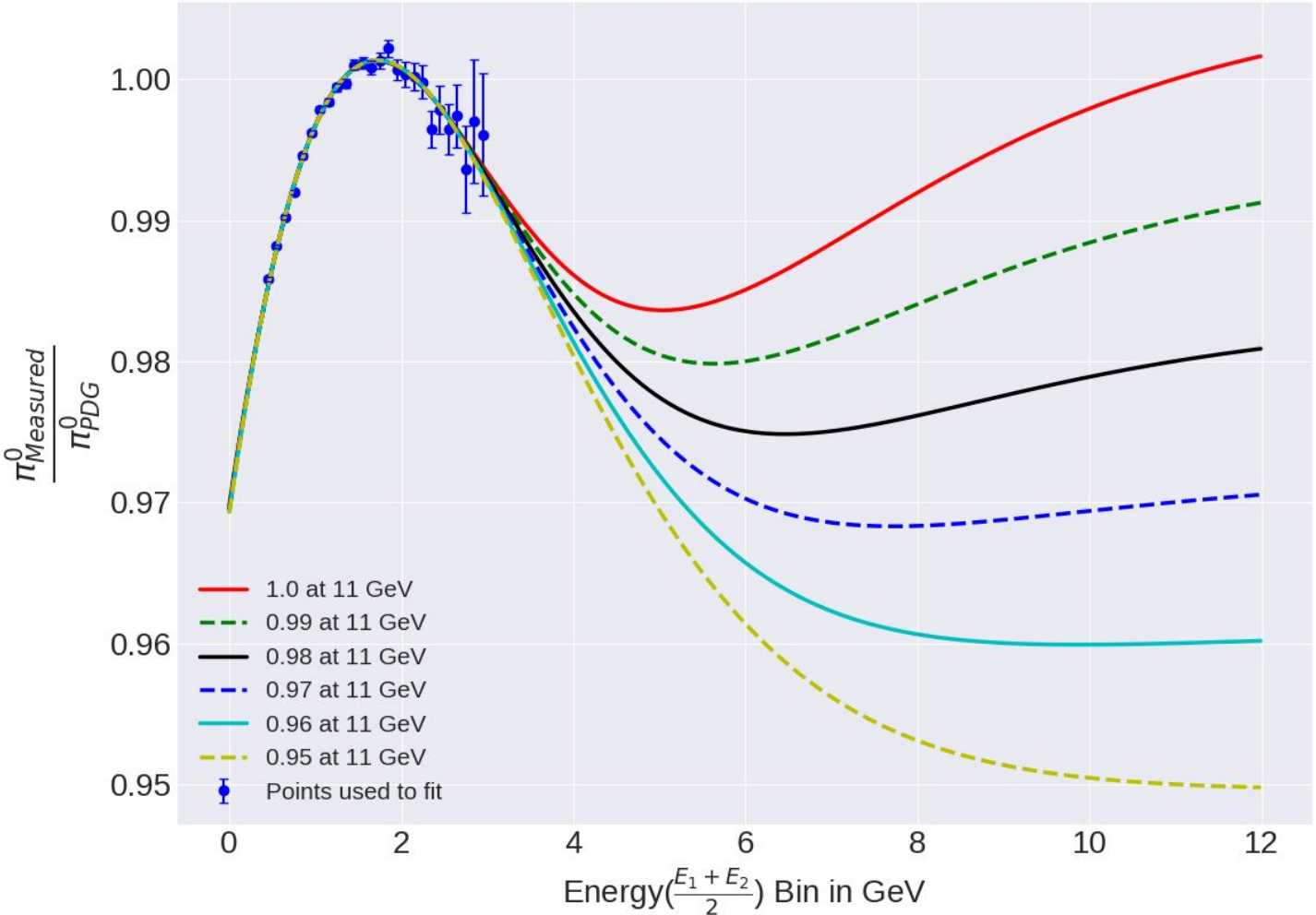
Nonlinearity Study

Fix anchor Point 0.95,0.96,0.97,0.98,0.99,1	fit Ratio_vs_E_avg and correct for nonlinearity	Look Ratio_vs_Emax (E1)	Fit for nonlinearity in Ratio_vs_Emax and apply nonlinearity	Look at Ratio_vs_Emax after correction
Fix an anchor point at 11 GeV to apply for nonlinear corrections	Use the new symmetric condition to produce ratio of measured π^0 mass to PDG value as a function E_avg energy. Fit the distribution along with the anchor point with a 9 parameter fit function. Apply the corrections using fit parameters	After correcting for nonlinearity plot ratio of measured π^0 mass to PDG value as a function Emax (E1) energy. Check for any nonlinearity in the plot (check for over-corrections)	If there exist a nonlinearity in the plot (Ratio_v_Emax), fit the distribution with a nonlinear function, and apply corrections.	Once again look at the plot of measured π^0 mass to PDG value as a function Emax energy with the new corrections applied from previous step. Check for any nonlinearity

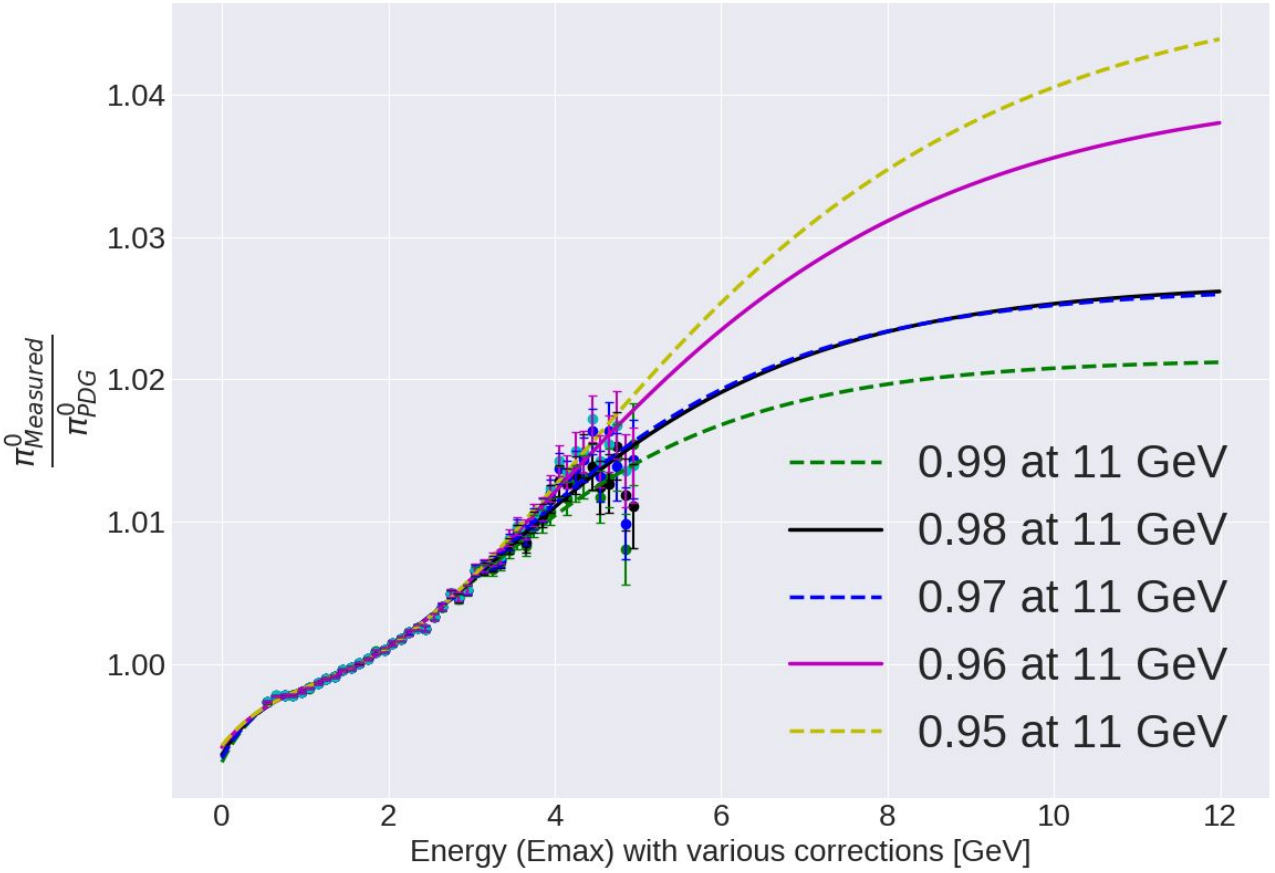
Nonlinearity correction (a systematic study on anchor point)

- In order to understand the effect of the anchor point on corrected energies, we perform a systematic study by varying the anchoring at 11 GeV with 0.95,0.96,0.97,0.98,0.99,1.0
- Therefore, we do fit a nonlinear exponential to the blue distribution shown in previous slide, but anchor it at various anchor points at 11 GeV

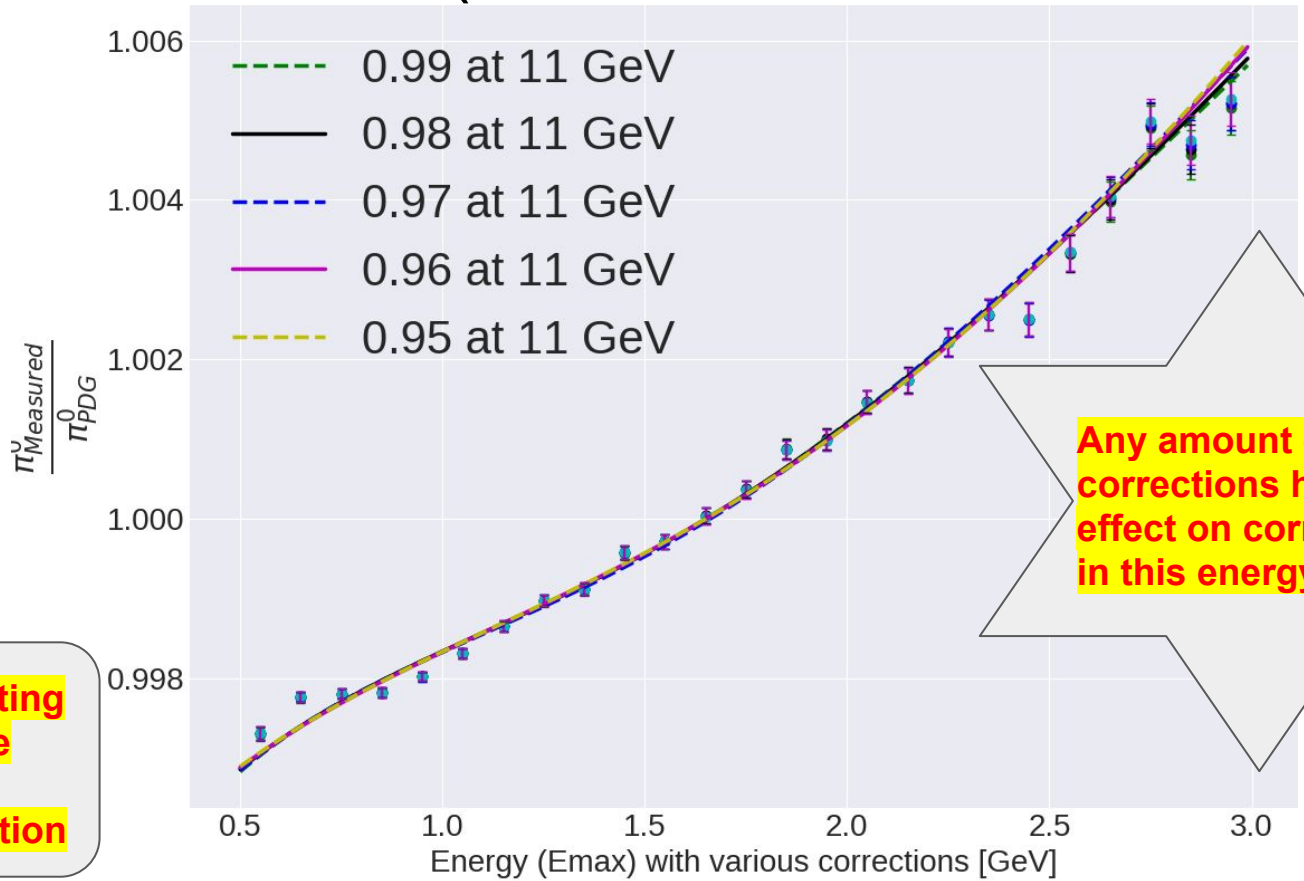
Anchor point study (Fixing the anchor point)



Ratio as a function of E1 (Emax) [GeV] with varying correction functions (Fitting the Emax plots)



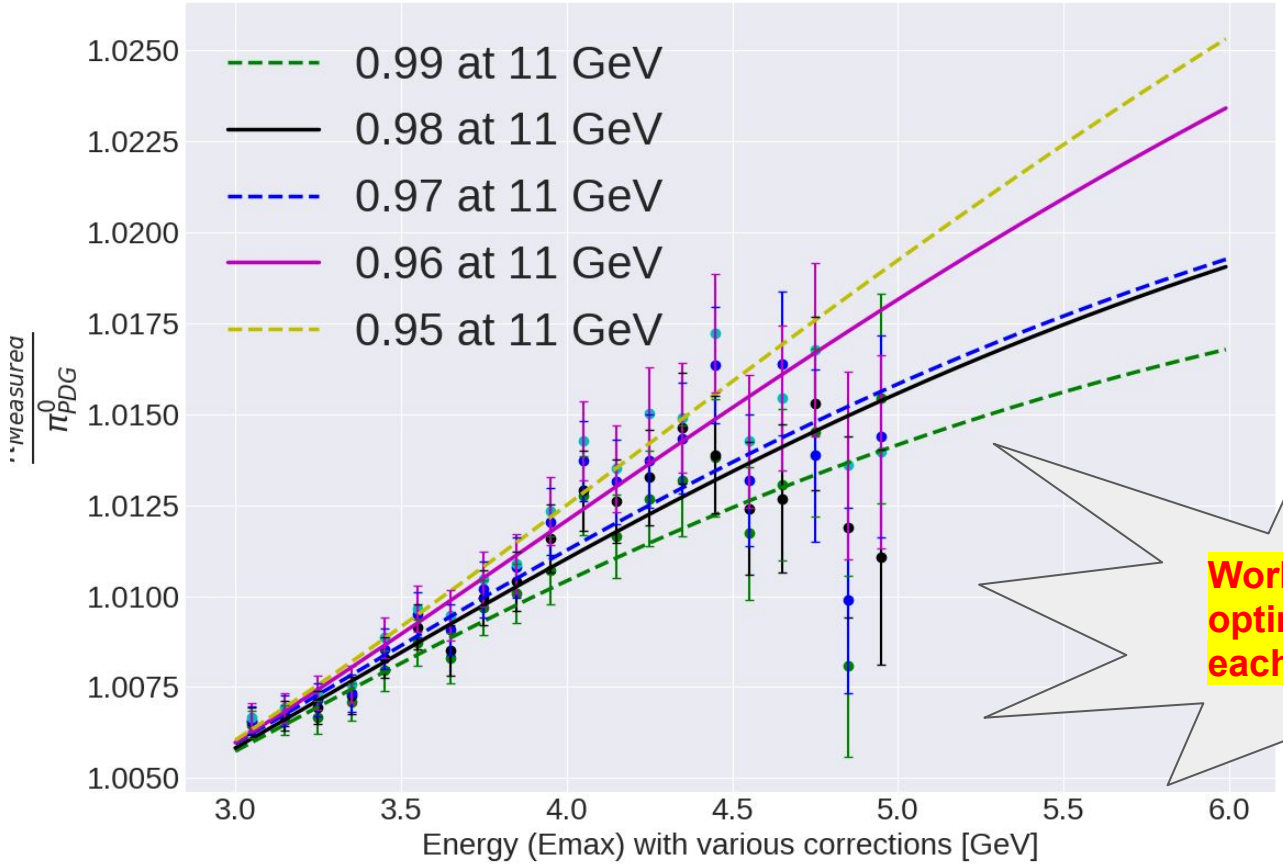
Ratio as a function of E1 (Emax) [GeV] with varying correction functions (zoomed between 0-3 GeV)



Any amount of corrections has little effect on corrections in this energy range

There exist Fitting issues in these graphs. See Questions section

Ratio as a function of E1 (Emax) [GeV] with varying correction functions (zoomed between 3-6 GeV)



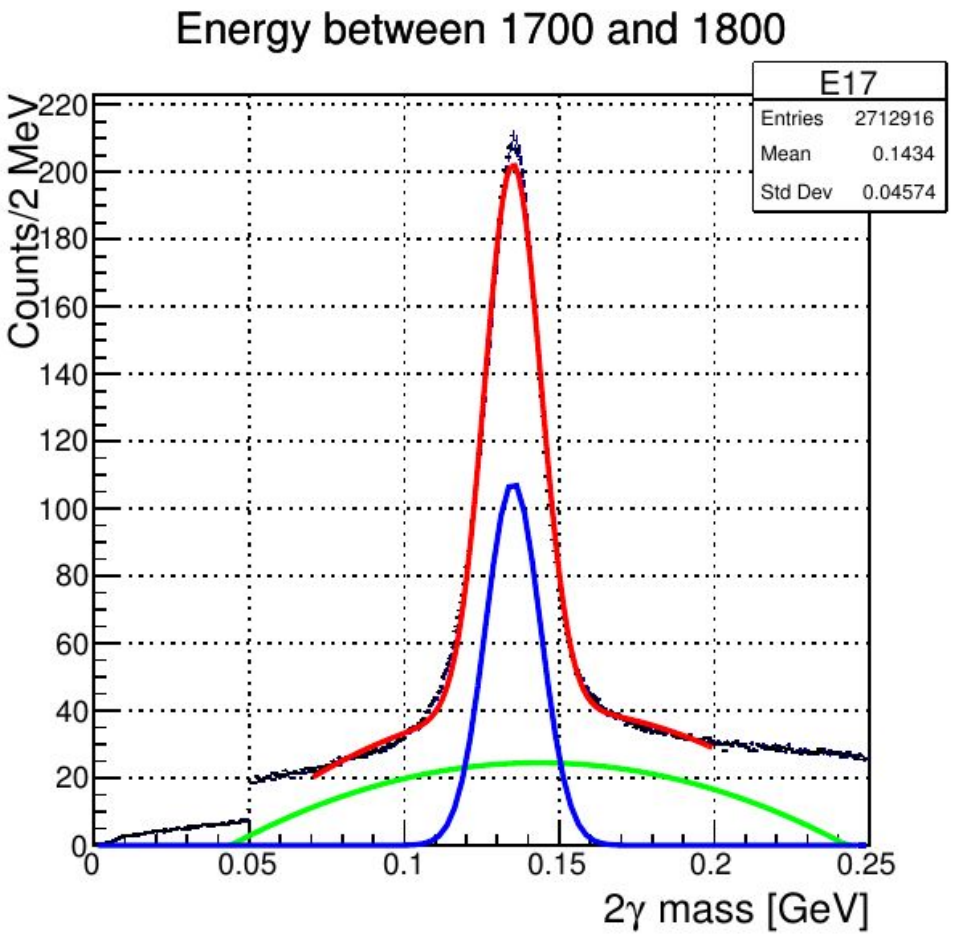
Working on finding the optimal fit parameters for each fitting functions

To do now

- Once the optimal fit parameters are estimated, apply the correction from various fit function once again to data and look in to Ratio of measured pi0 mass to PDG value as a function of Emax.
- However, there will be very little effects on Emax.

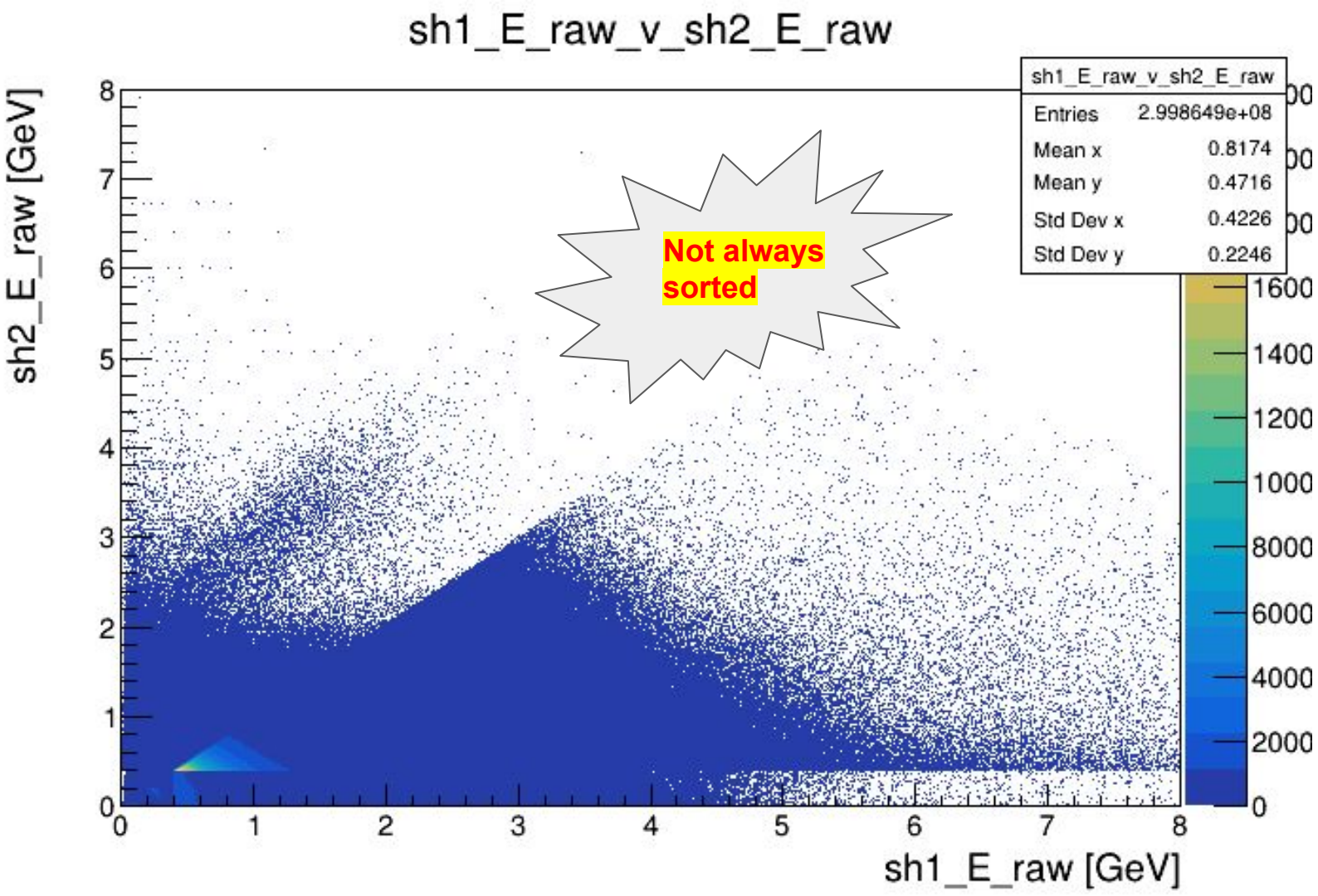
Questions and further checks

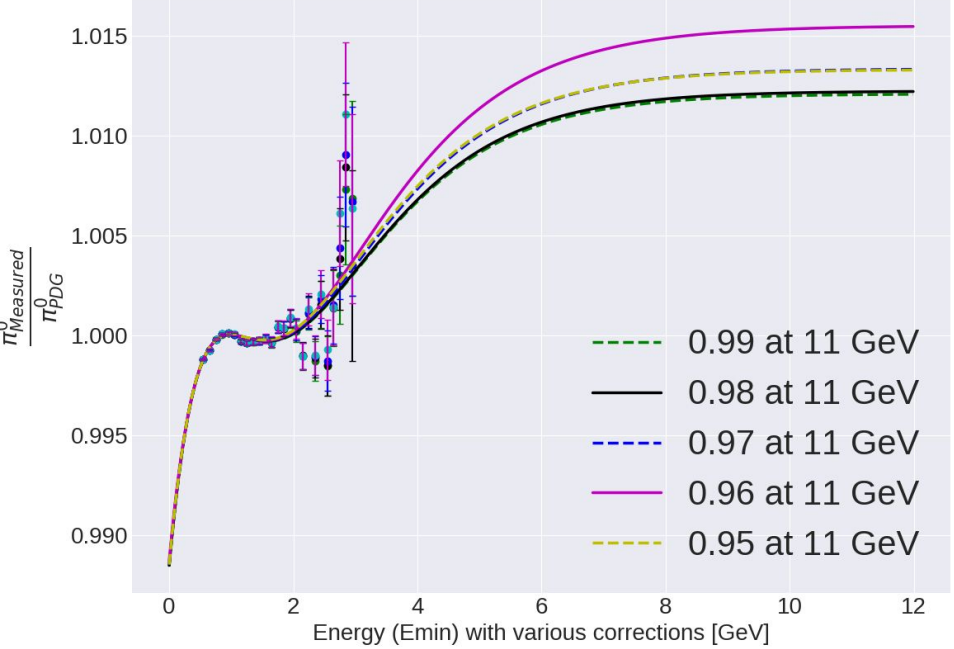
The Fitting Problem

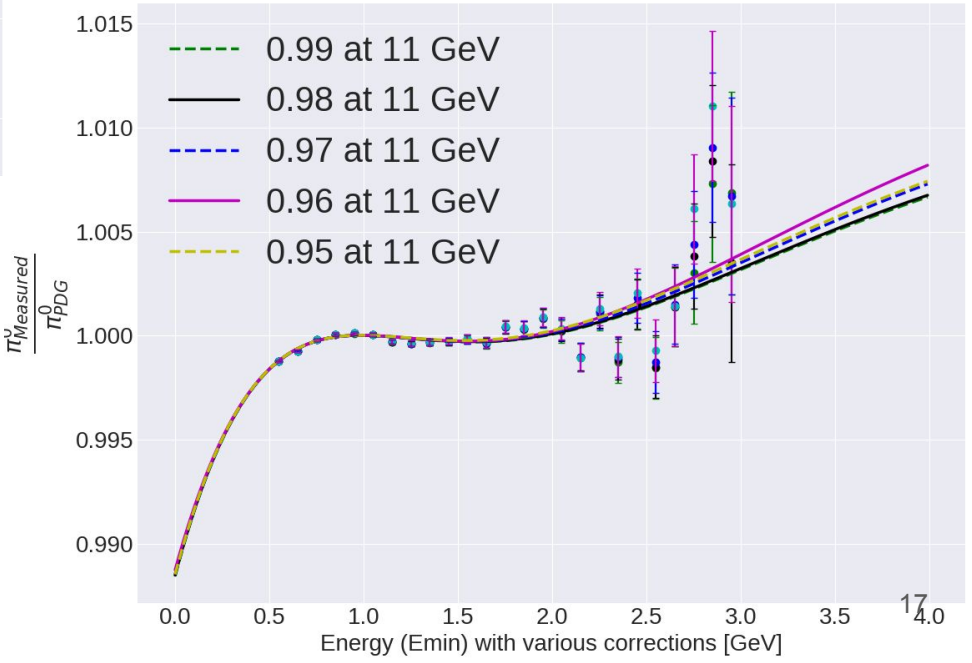


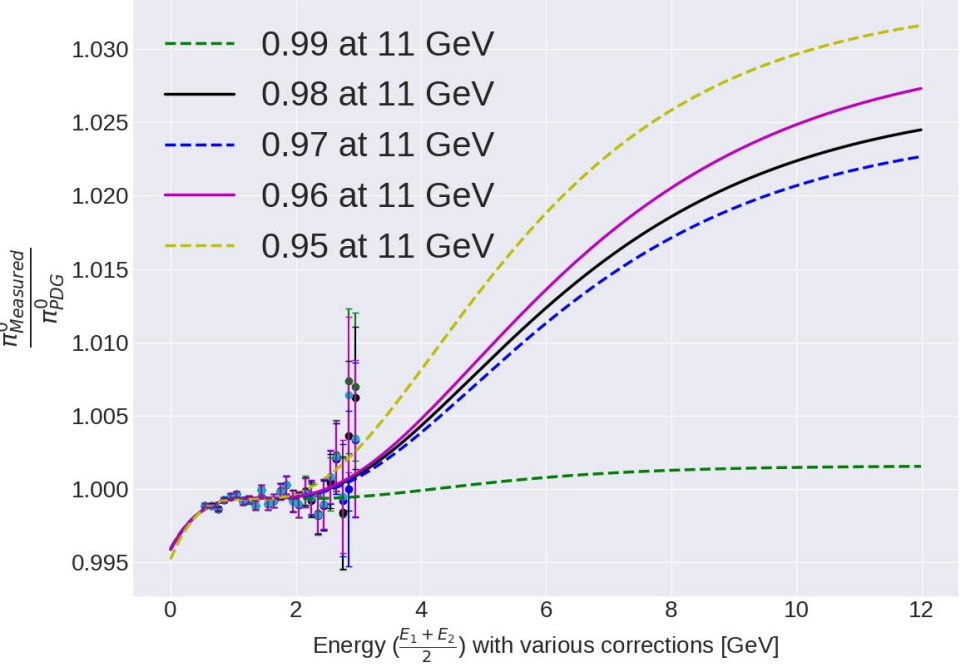
- Modelling the background impacts while fitting the distributions to extract the pi0 means.
- Chi2/NDF = 7.22854 , Probability = 1.1763e-08. This is caused due to
- Tried
  - Gaussian with 2nd order polynomial
  - Double gaussian with 2nd order polynomial
  - Gaussian with sigmoid and p2nd order polynomial
  - Gaussian with sigmoid
- Can we reduce the fitting range ?
- Can we cut down on number of showers in an Event ?

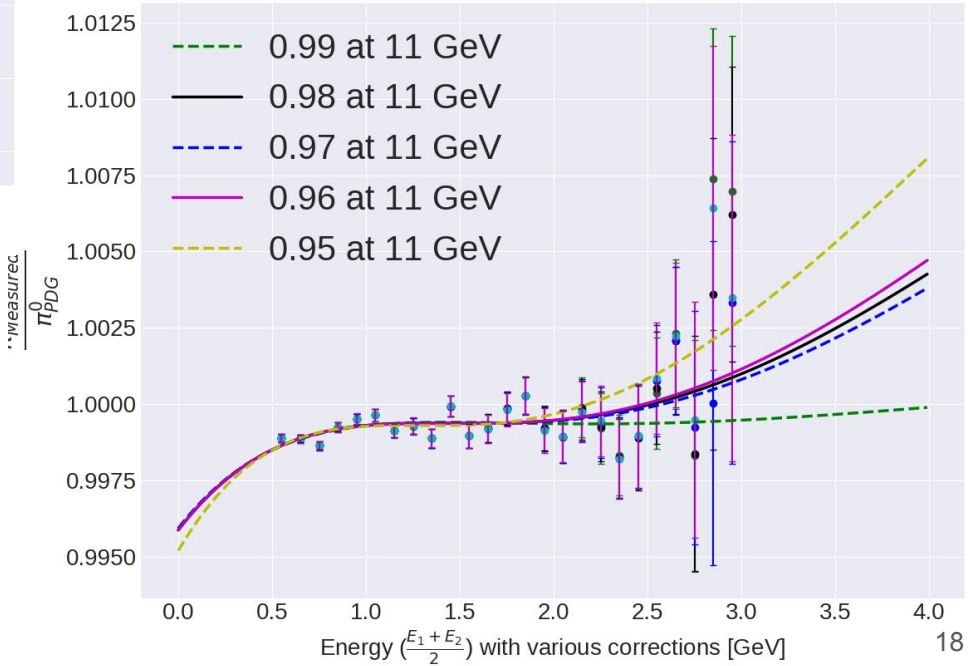
BACKUPS

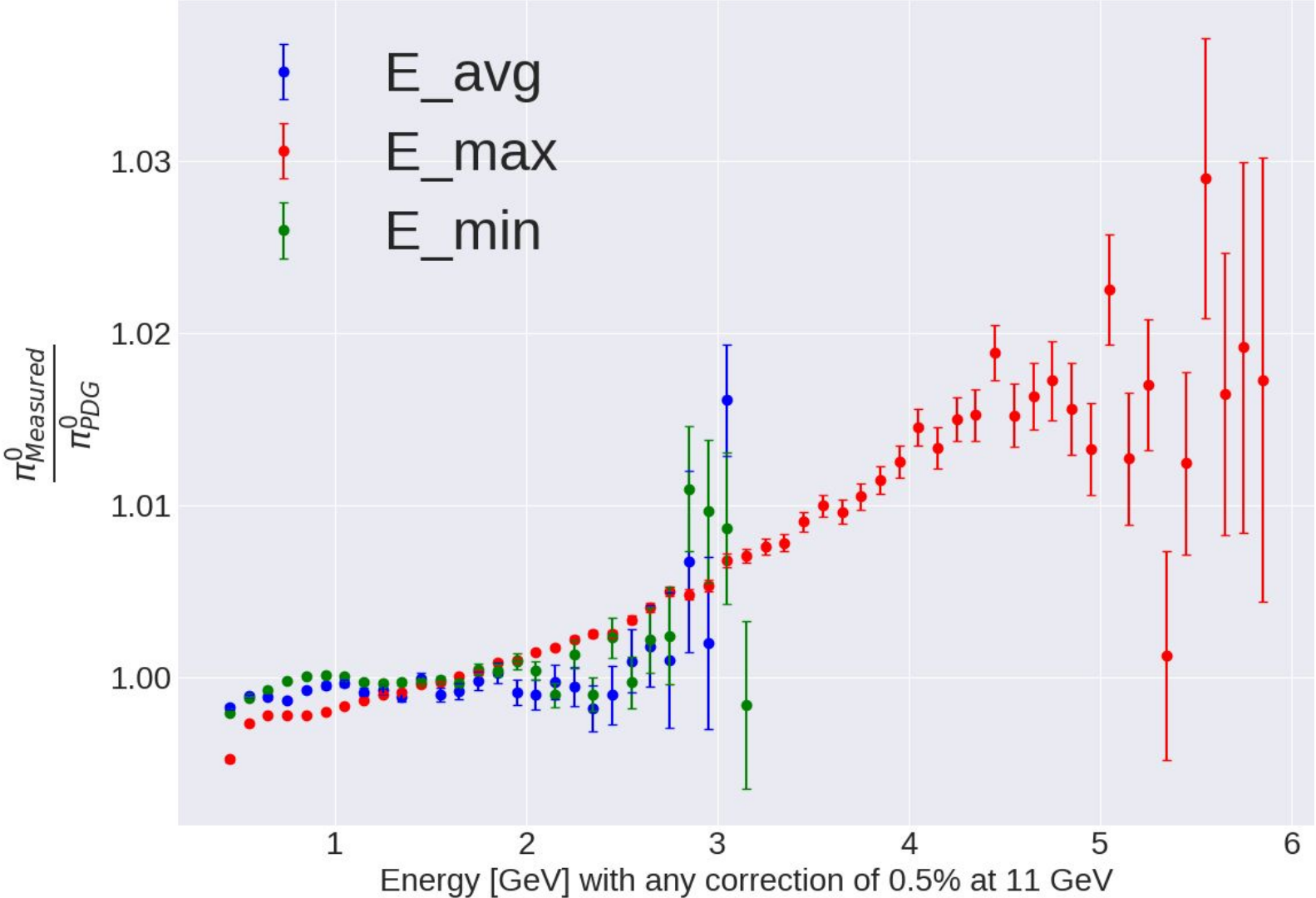

sh1_E_raw_v_sh2_E_raw
sh1_E_raw_v_sh2_E_raw
Entries 2.998649e+08
Mean x 0.8174
Mean y 0.4716
Std Dev x 0.4226
Std Dev y 0.2246
Not always sorted
sh2_E_raw [GeV]
sh1_E_raw [GeV]
0
1
2
3
4
5
6
7
8
1600
1400
1200
1000
8000
6000
4000
2000

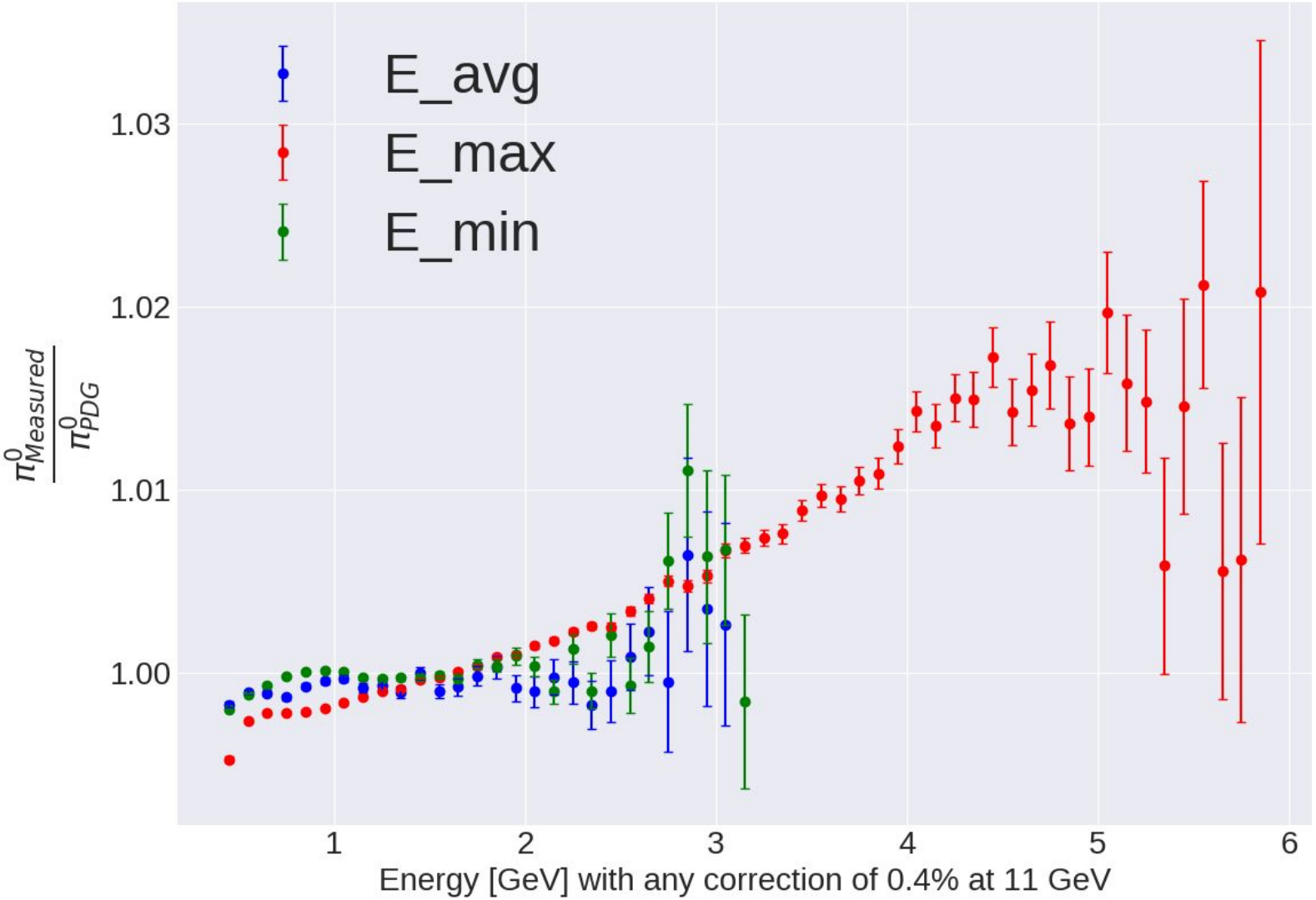

1.015
1.010
1.005
1.000
0.995
0.990
0
2
4
6
8
10
12
Energy (Emin) with various corrections [GeV]
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
0.99 at 11 GeV
0.98 at 11 GeV
0.97 at 11 GeV
0.96 at 11 GeV
0.95 at 11 GeV

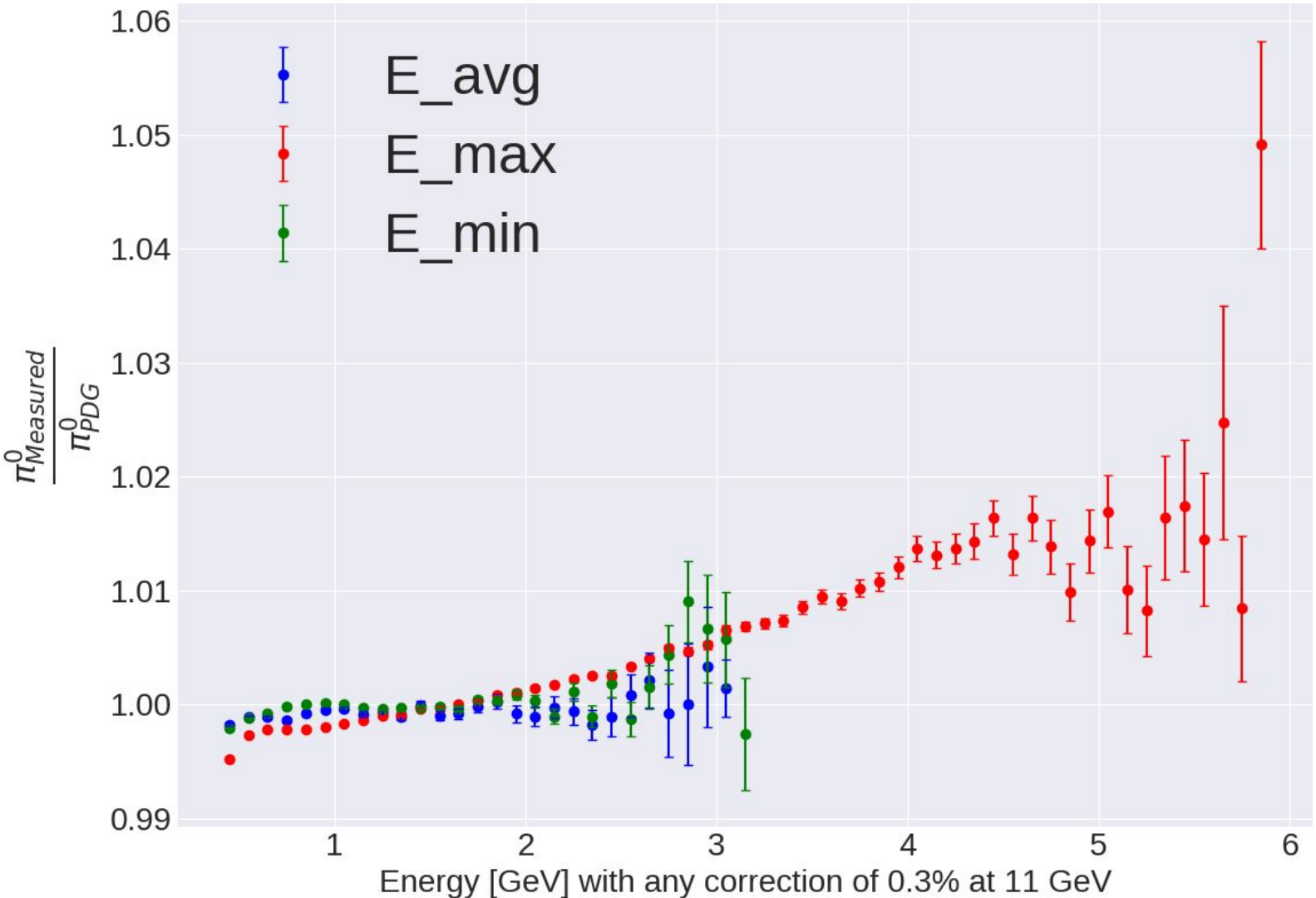

1.015
1.010
1.005
1.000
0.995
0.990
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Energy (Emin) with various corrections [GeV]
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
0.99 at 11 GeV
0.98 at 11 GeV
0.97 at 11 GeV
0.96 at 11 GeV
0.95 at 11 GeV

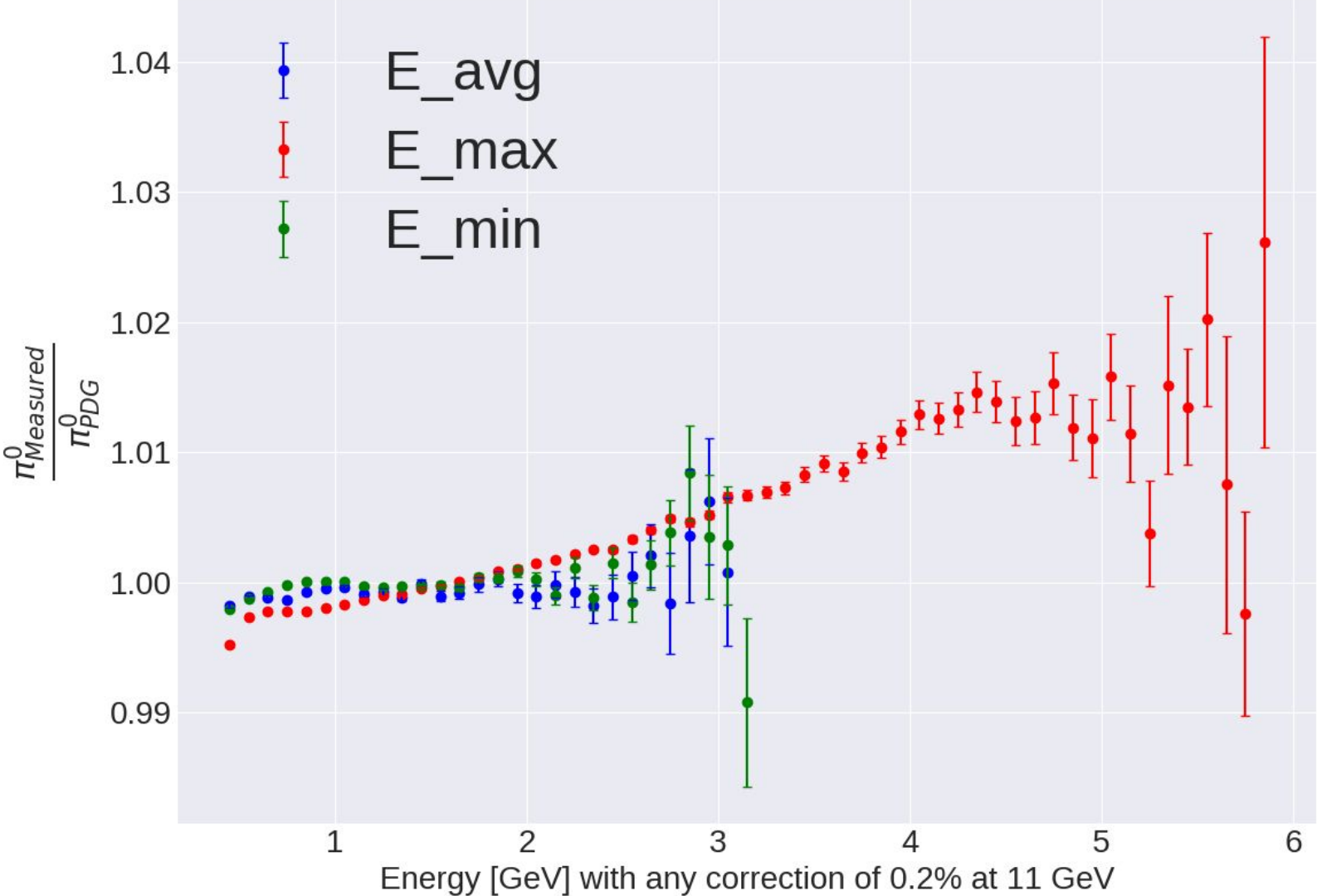

0.99 at 11 GeV
0.98 at 11 GeV
0.97 at 11 GeV
0.96 at 11 GeV
0.95 at 11 GeV
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
Energy ($\frac{E_1+E_2}{2}$) with various corrections [GeV]

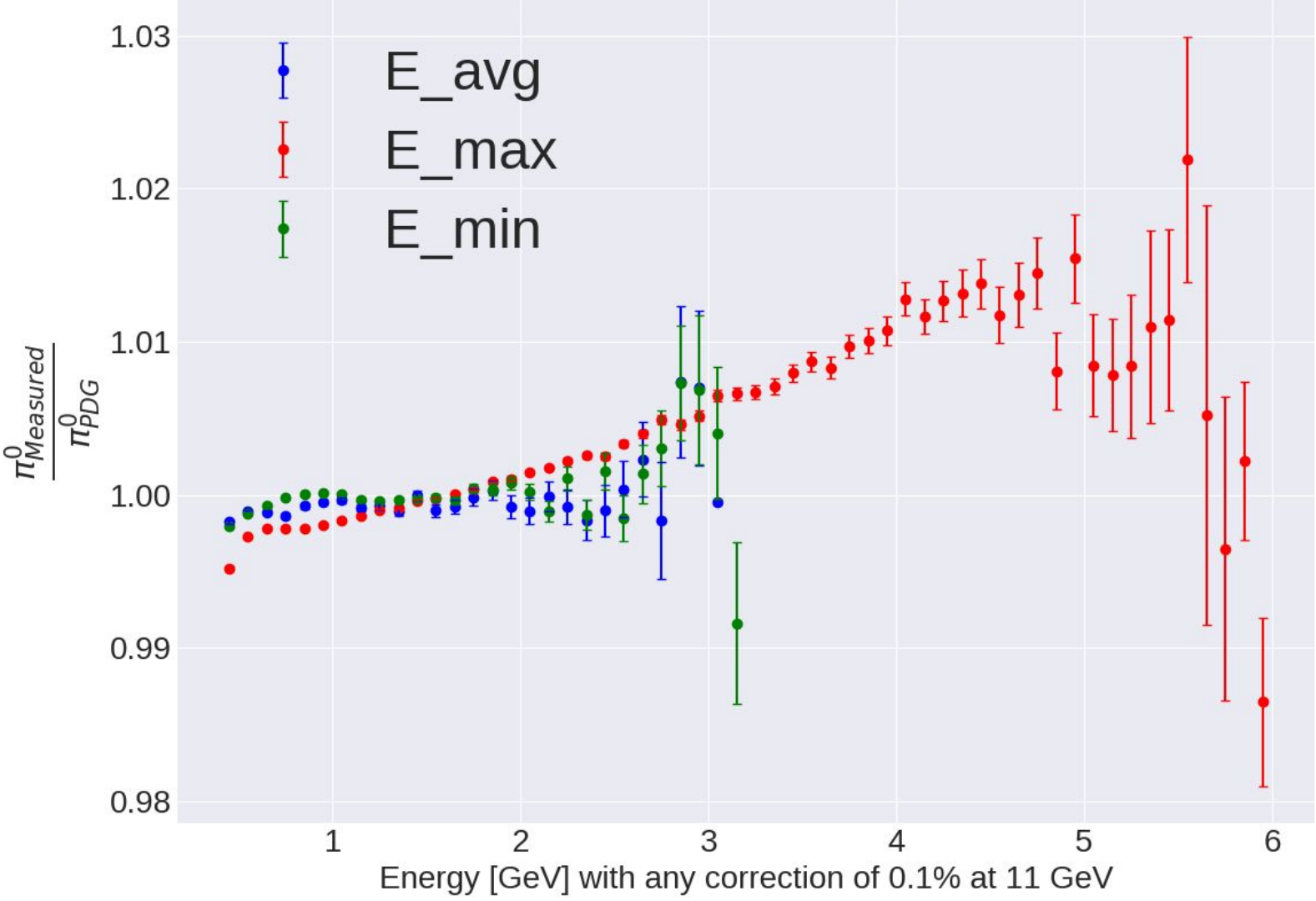

0.99 at 11 GeV
0.98 at 11 GeV
0.97 at 11 GeV
0.96 at 11 GeV
0.95 at 11 GeV
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
Energy ($\frac{E_1+E_2}{2}$) with various corrections [GeV]


E_avg
E_max
E_min
1.03
1.02
1.01
1.00
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
1
2
3
4
5
6
Energy [GeV] with any correction of 0.5% at 11 GeV


E_avg
E_max
E_min
1.03
1.02
1.01
1.00
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
1
2
3
4
5
6
Energy [GeV] with any correction of 0.4% at 11 GeV


E_avg
E_max
E_min
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
1.06
1.05
1.04
1.03
1.02
1.01
1.00
0.99
1
2
3
4
5
6
Energy [GeV] with any correction of 0.3% at 11 GeV


E_avg
E_max
E_min
1.04
1.03
1.02
1.01
1.00
0.99
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
1
2
3
4
5
6
Energy [GeV] with any correction of 0.2% at 11 GeV


E_avg
E_max
E_min
1.03
1.02
1.01
1.00
0.99
0.98
$\frac{\pi^0_{Measured}}{\pi^0_{PDG}}$
1
2
3
4
5
6
Energy [GeV] with any correction of 0.1% at 11 GeV