sPHENIX Jet Calibration

Numerical Inversion method in pp + AA

Di-Jet MonteCarlo

- $10 < p_{\mathrm{T}}^{\mathrm{Jet}} < 75$ GeV/c
- $|\eta_{\mathrm{jet}}^{\mathrm{true}}| \leq 0.45$
- $\hat{p}_{\mathrm{T}}$ in bin of 2.5 GeV/c
- Anti-k_{T} R = 0.4
- No $\hat{p}_{\mathrm{T}}$ cross section scaling
- Simple Geometric Matching
  - Reconstructed jets are matched to true jets within $\Delta R < 0.2$

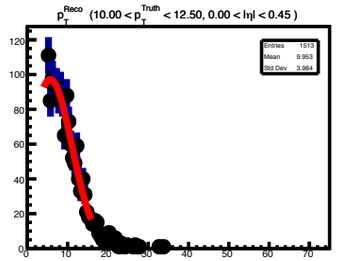
Numerical Inversion Method

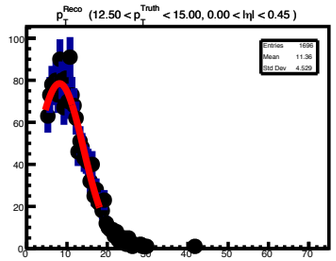
Goal: Correction factor as a function of $\langle p_{\mathrm{T}}^{\mathrm{Reco}} \rangle$

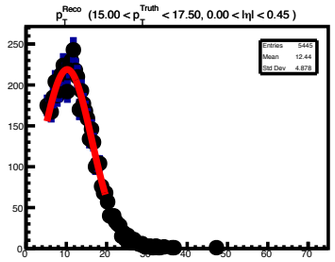
1. Obtain $\langle R \rangle$ as a function of $p_{\mathrm{T}}^{\mathrm{Truth}}$, $R = p_{\mathrm{T}}^{\mathrm{Reco}} / p_{\mathrm{T}}^{\mathrm{Truth}}$
2. Obtain $\langle p_{\mathrm{T}}^{\mathrm{Reco}} \rangle$ as a function of $p_{\mathrm{T}}^{\mathrm{Truth}}$
3. Plot $\langle R \rangle$ Vs. $\langle p_{\mathrm{T}}^{\mathrm{Reco}} \rangle$, then fit
4. $f(p_{\mathrm{T}}) = a + b \cdot \ln(\langle p_{\mathrm{T}}^{\mathrm{Reco}} \rangle) + c \cdot \ln(\langle p_{\mathrm{T}}^{\mathrm{Reco}} \rangle)^2$
5. Apply correction as $1/f(p_{\mathrm{T}})$

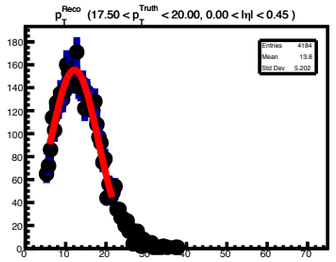
$\langle x \rangle$ Values are obtained from mean of gaussians fit in the range $\langle p_{\mathrm{T}}^{\mathrm{Reco}} / p_{\mathrm{T}}^{\mathrm{Truth}} \rangle \pm 1.5 \cdot \sigma(p_{\mathrm{T}}^{\mathrm{Reco}} / p_{\mathrm{T}}^{\mathrm{Truth}})$, where $\langle p_{\mathrm{T}}^{\mathrm{Reco}} / p_{\mathrm{T}}^{\mathrm{Truth}} \rangle$ is the numerical mean and σ is std. dev. of the distributions. There is a hard **cut at $p_{\mathrm{T}}^{\mathrm{Reco}}$ < 10 GeV/*c***

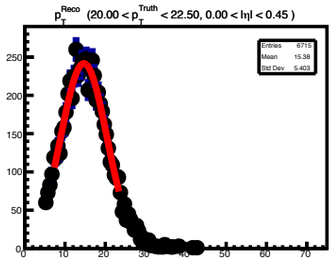
$p_{\mathrm{T}}^{\mathrm{Reco}}$ in "slices" of $p_{\mathrm{T}}^{\mathrm{Truth}}$ (2.5 GeV)

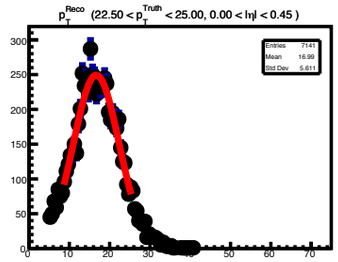


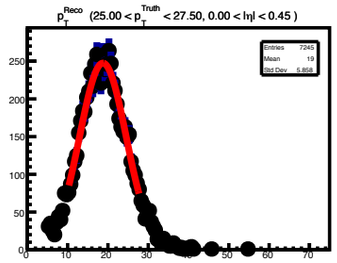


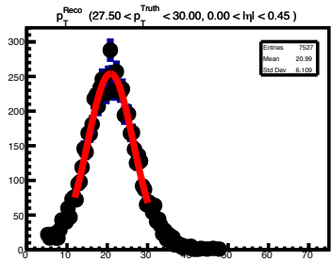


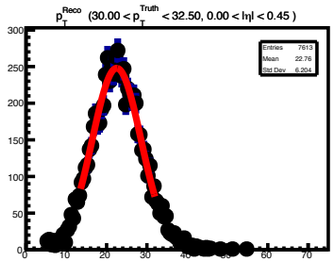


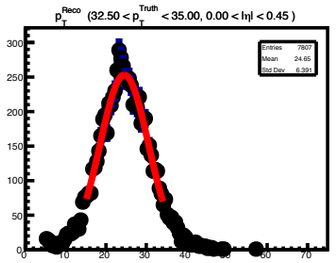


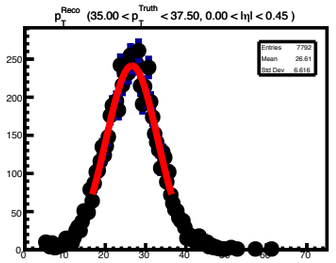


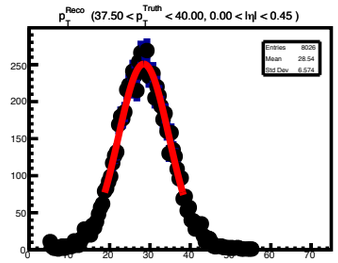


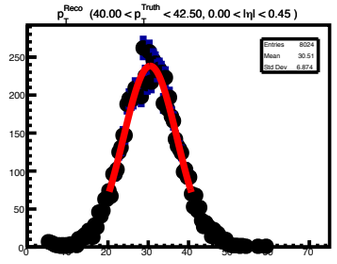


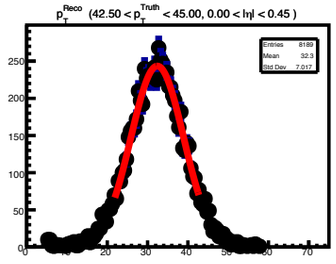


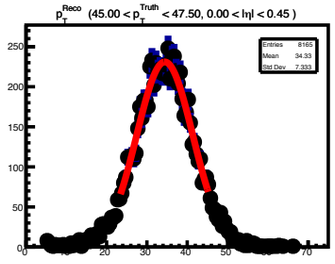


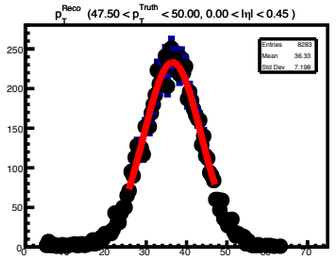


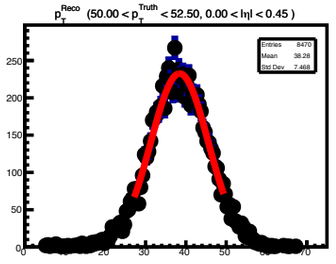


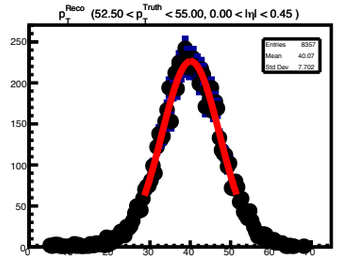


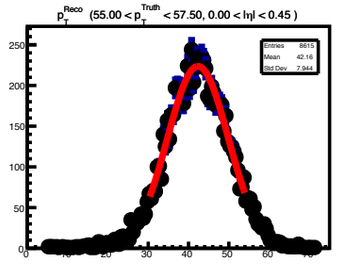


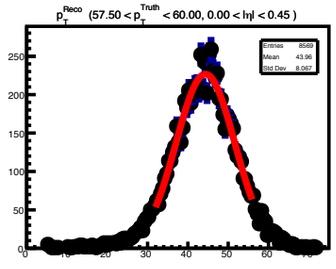


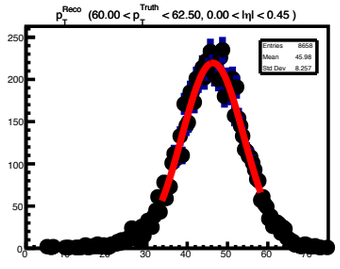


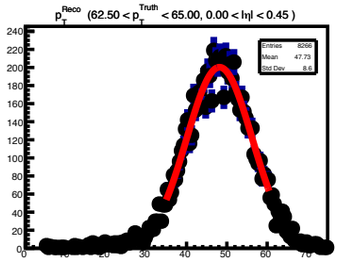


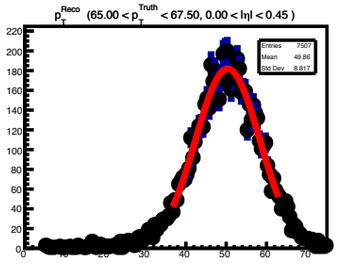


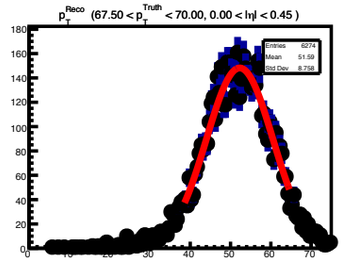






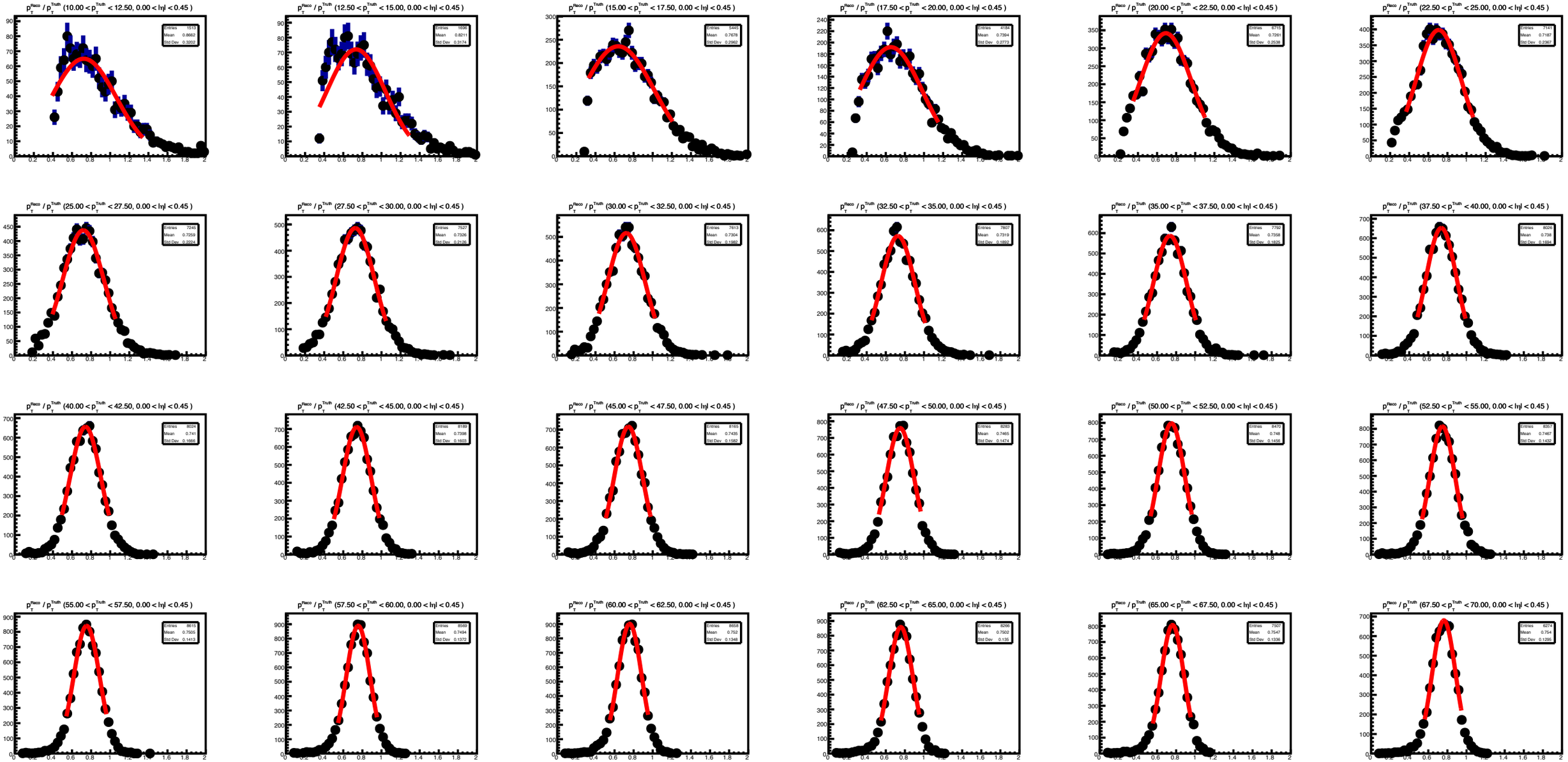






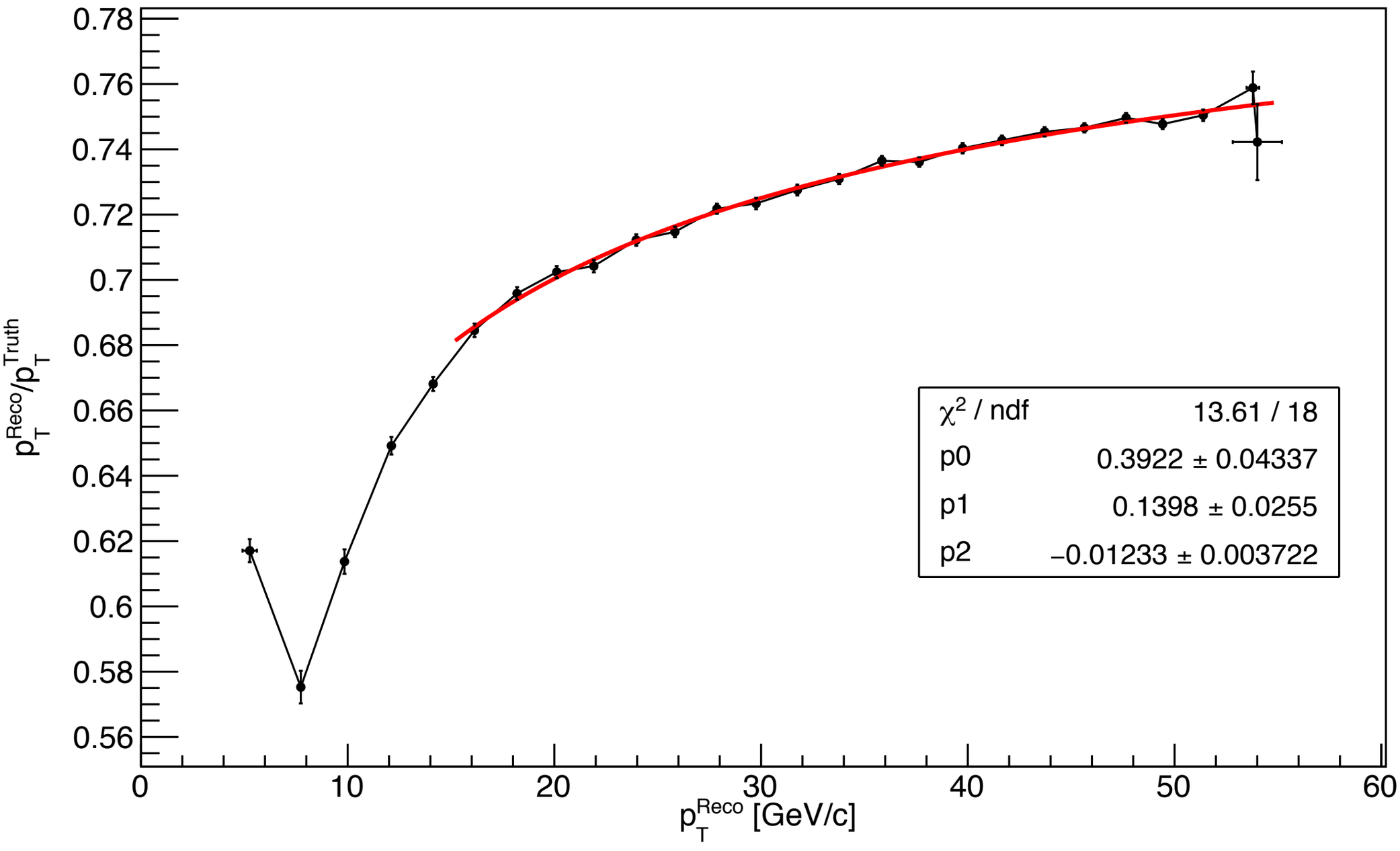
- Good fits with gaussian away from edges of MC production (10 & 75 GeV)
- The mean from each gaussian is taken as $\langle p_{\mathrm{T}}^{\mathrm{Reco}} \rangle$ in each $p_{\mathrm{T}}^{\mathrm{Truth}}$ bin

R in "slices" of $p_{\mathrm{T}}^{\mathrm{Truth}}$ (2.5 GeV)



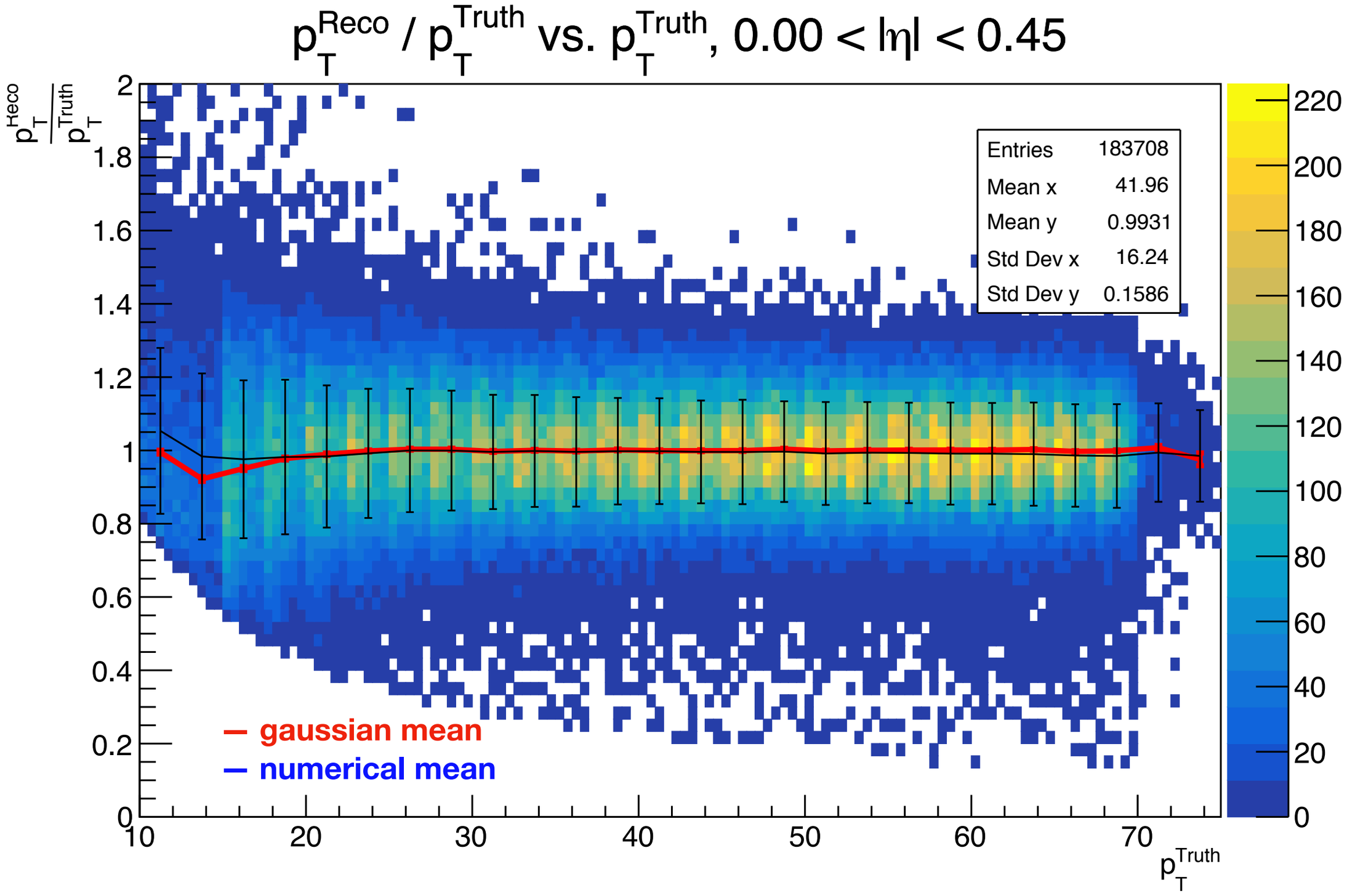
- Good fits with gaussian away from kinematic edges (10-75 GeV)
- The mean from each gaussian is taken as $\langle R \rangle$ in each $p_{\mathrm{T}}^{\mathrm{Truth}}$ bin

S



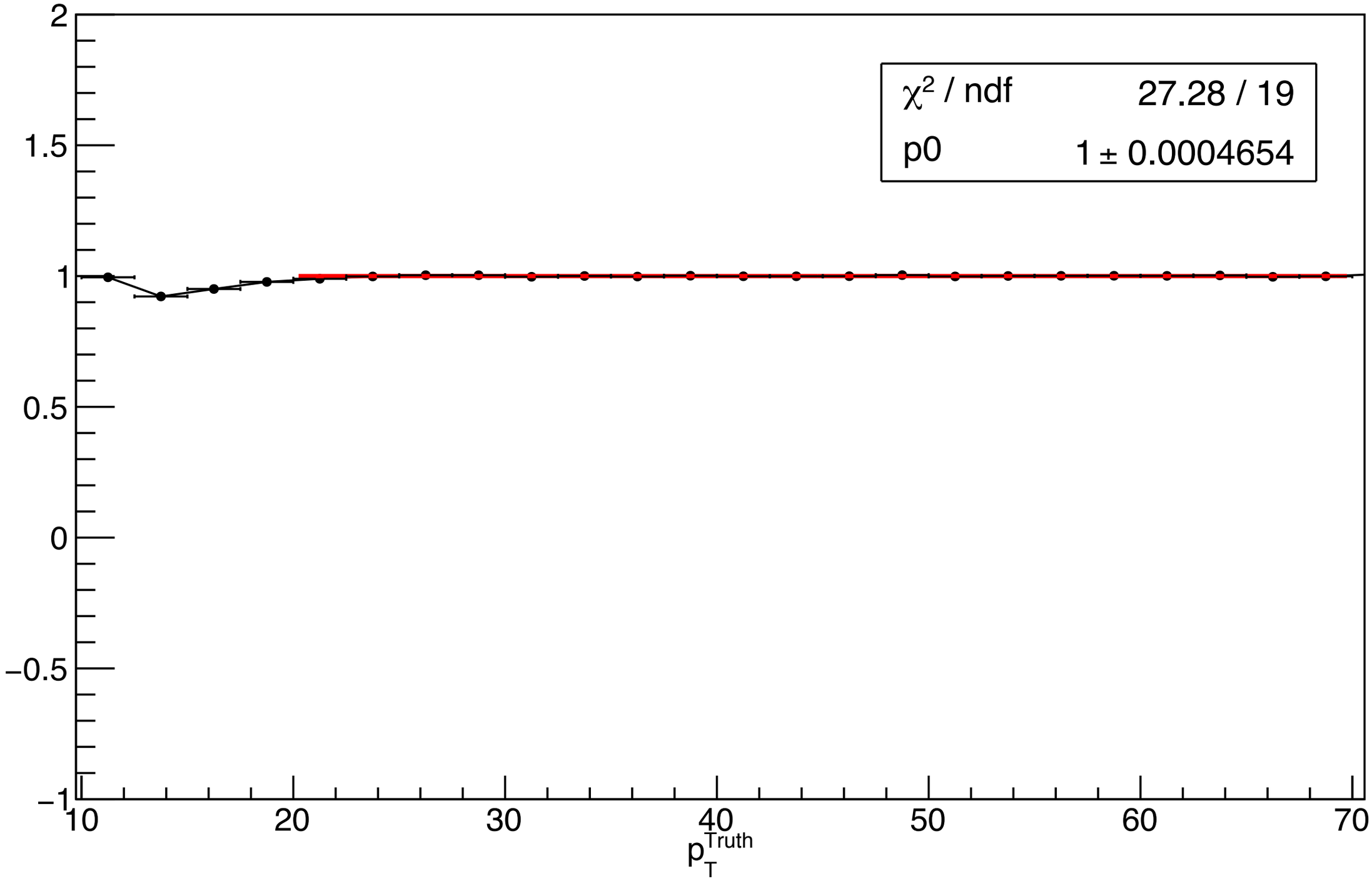
- Limited Fit range to 15-55 GeV/*c*
- Limited to range where gaussian fits are reasonable

Corrected JES Plot



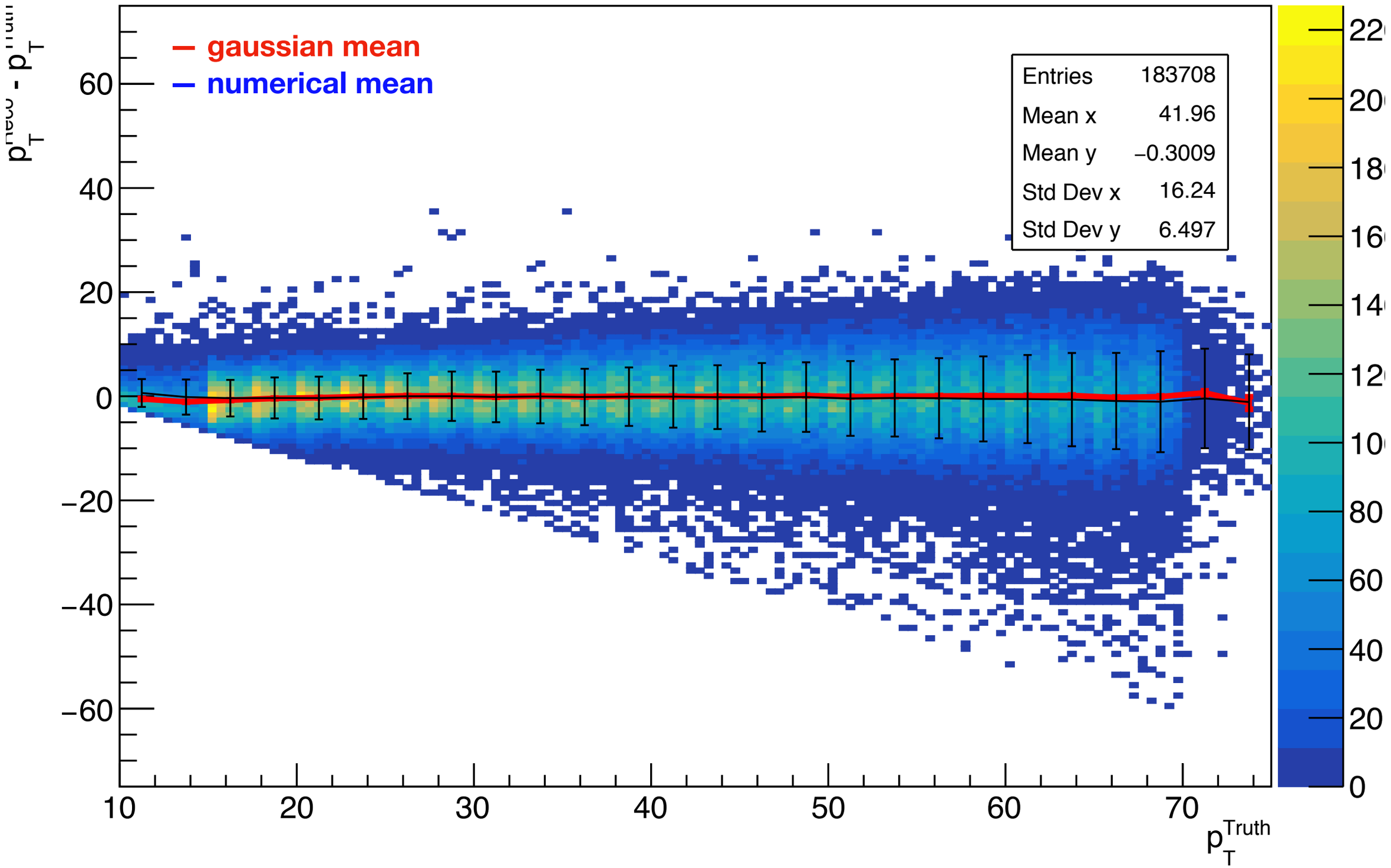
- Ratio at Unity with low pT deviations

Ratio Closure Test



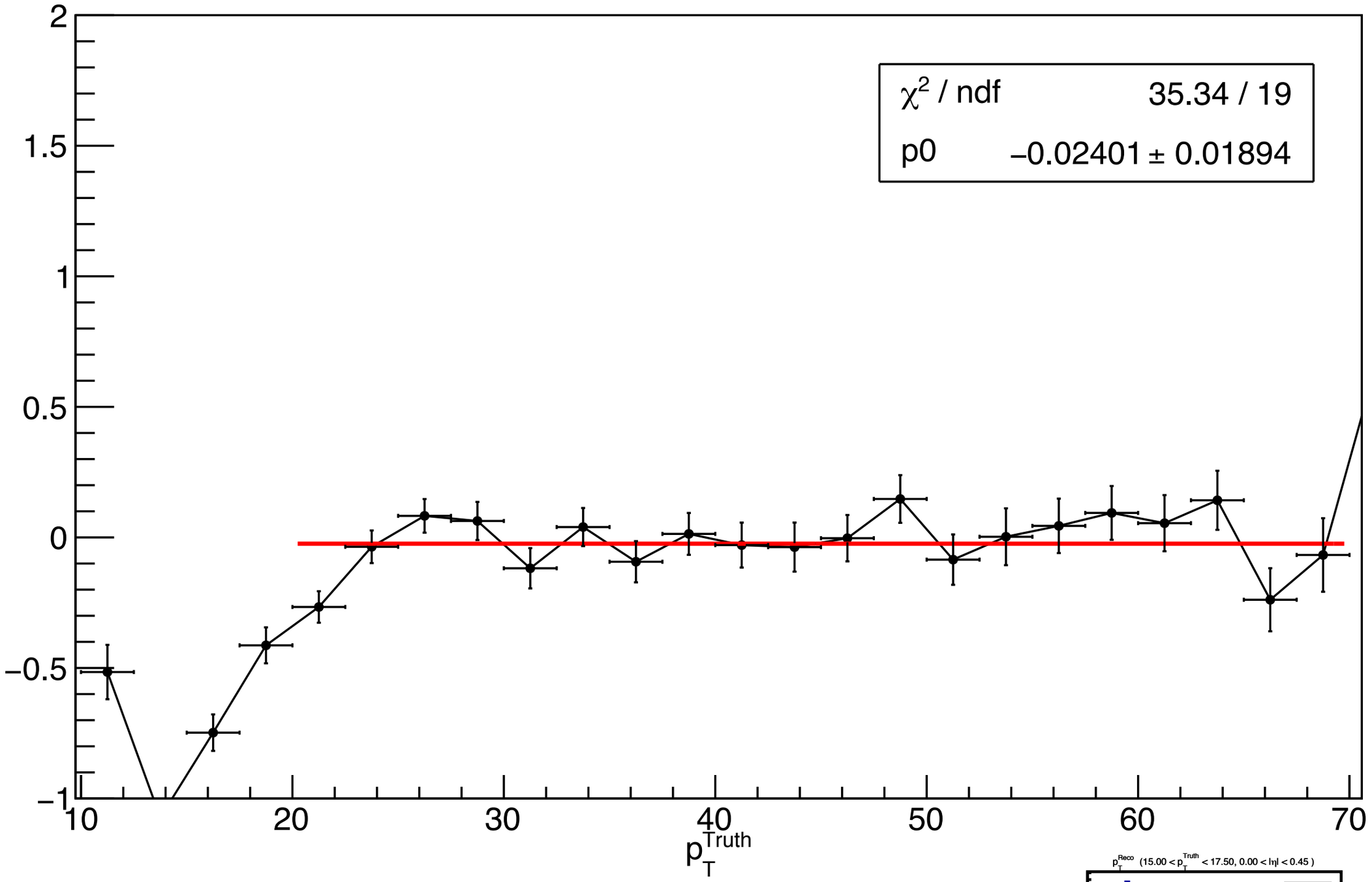
- Constant fit to ratio consistent with unity,
- High pT unaffected

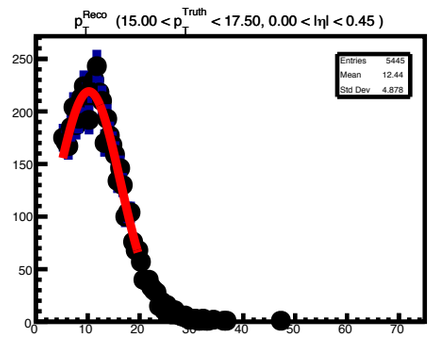
$p_T^{Reco} - p_T^{Truth}$ vs. p_T^{Truth}, $0.00 < |\eta| < 0.45$



- pT Difference centered at 0

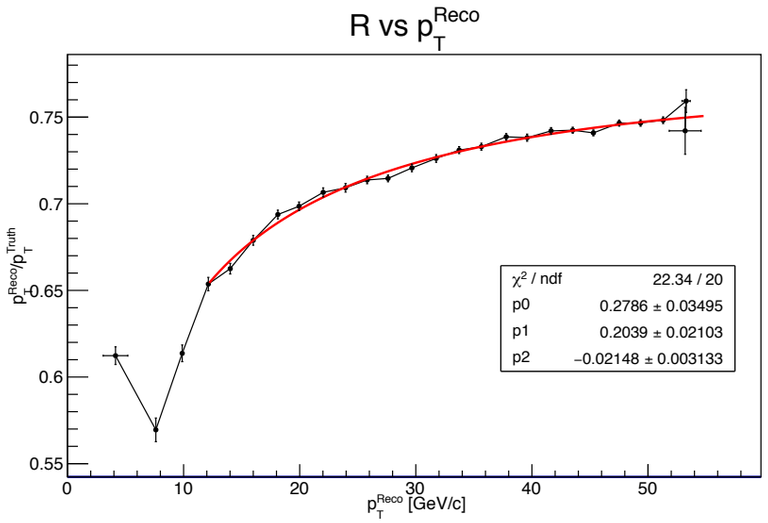
Difference Closure Test





- Constant fit consistent with 0
- Deviations at low pT

η dependance of JES fit



$$f = a + b \cdot \ln(p_{\mathrm{T}}^{\mathrm{Reco}}) + c \cdot \ln(p_{\mathrm{T}}^{\mathrm{Reco}})^2$$

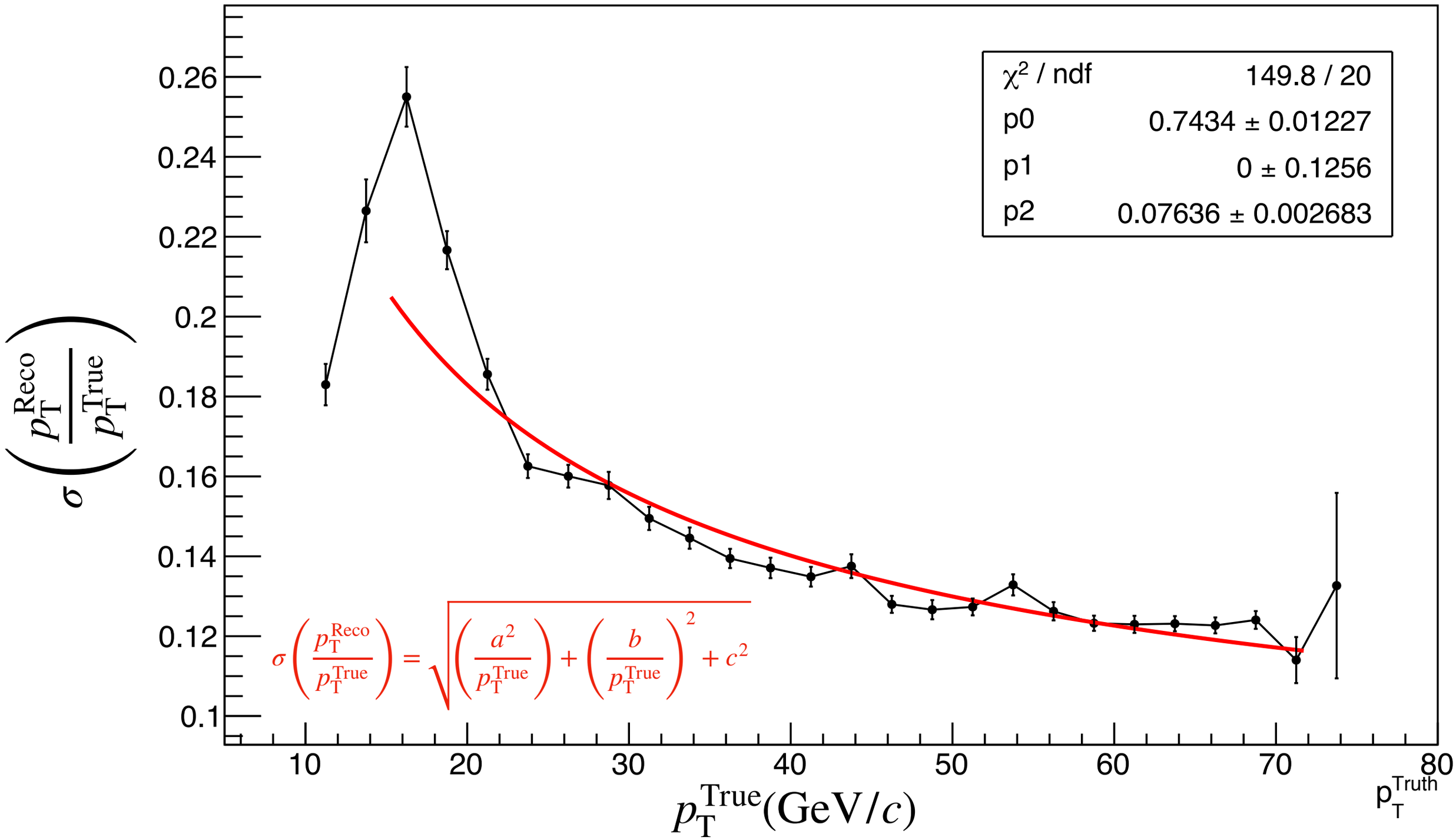
	a	B	C	$\chi^2_{\mathrm{red.}}$
$0 < \lvert\eta\rvert < 0.1125$	0.3043	0.1878	-0.01901	10.7/17
$0.1125 < \lvert\eta\rvert < 0.225$	0.4227	0.1228	-0.01001	11.51/17
$0.225 < \lvert\eta\rvert < 0.375$	0.4817	0.08797	-0.00477	15.58/17
$0.375 < \lvert\eta\rvert < 0.45$	0.347	0.1659	-0.01587	10.83/17

JER Parametrization

Goal: Understand performance in pp, and see what can be applied to AA

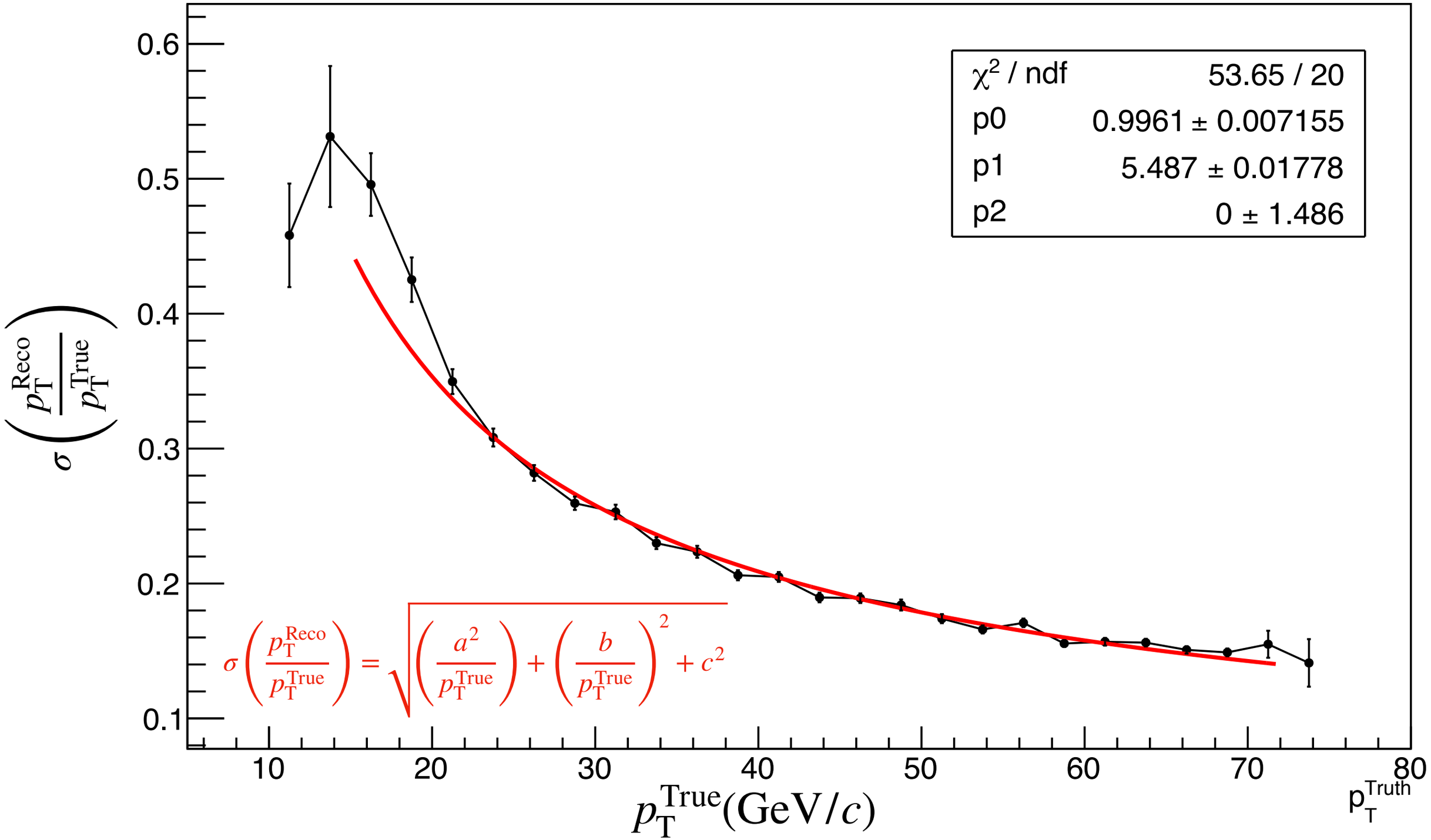
Based on: https://arxiv.org/pdf/1210.6210.pdf (ATLAS)

JER in pp (R=0.4)



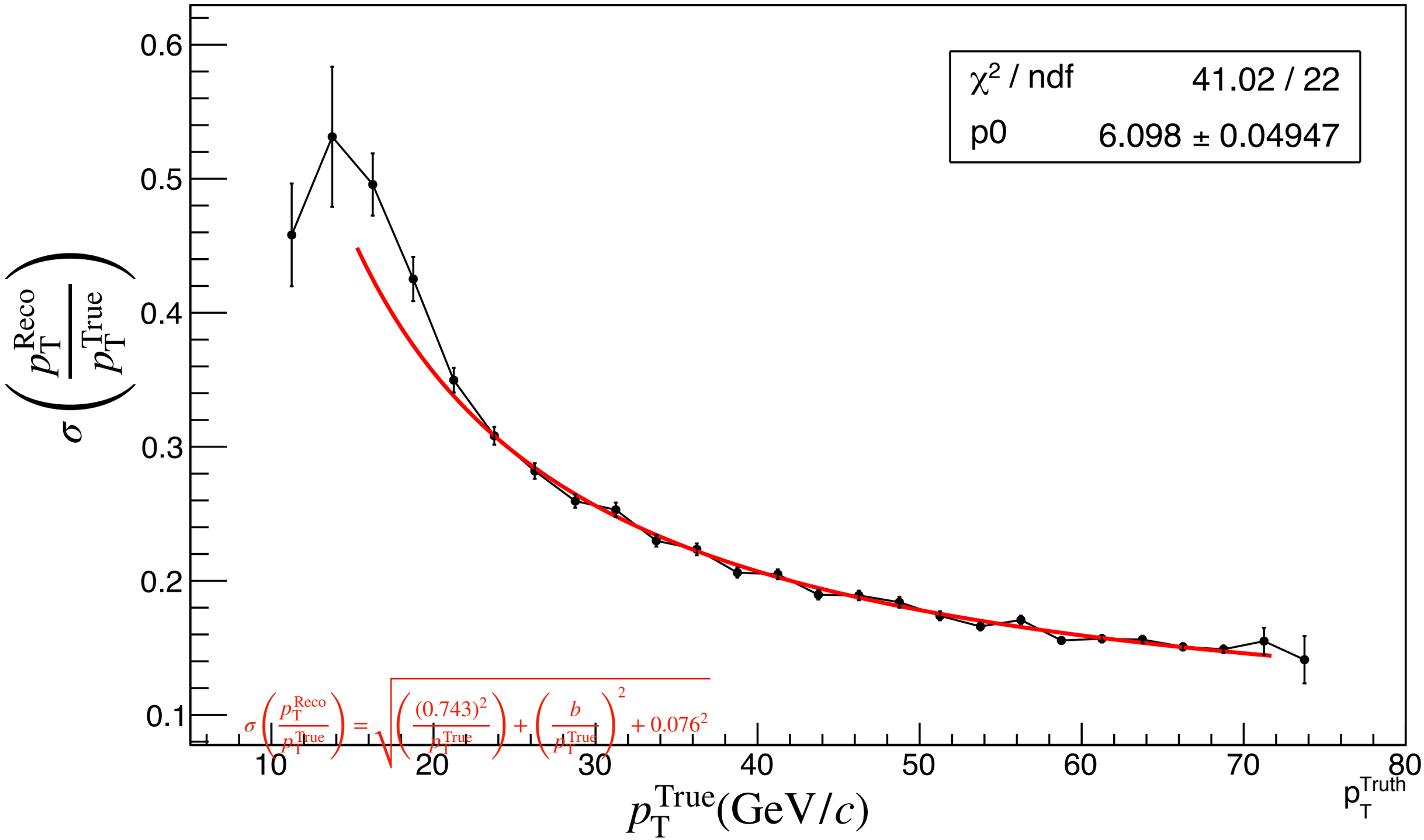
- Reasonable fit after ~20 GeV/*c*
- χ^2 driven by first few points

JER in AA (R=0.4)



- Similar story in AA
- Better fit overal

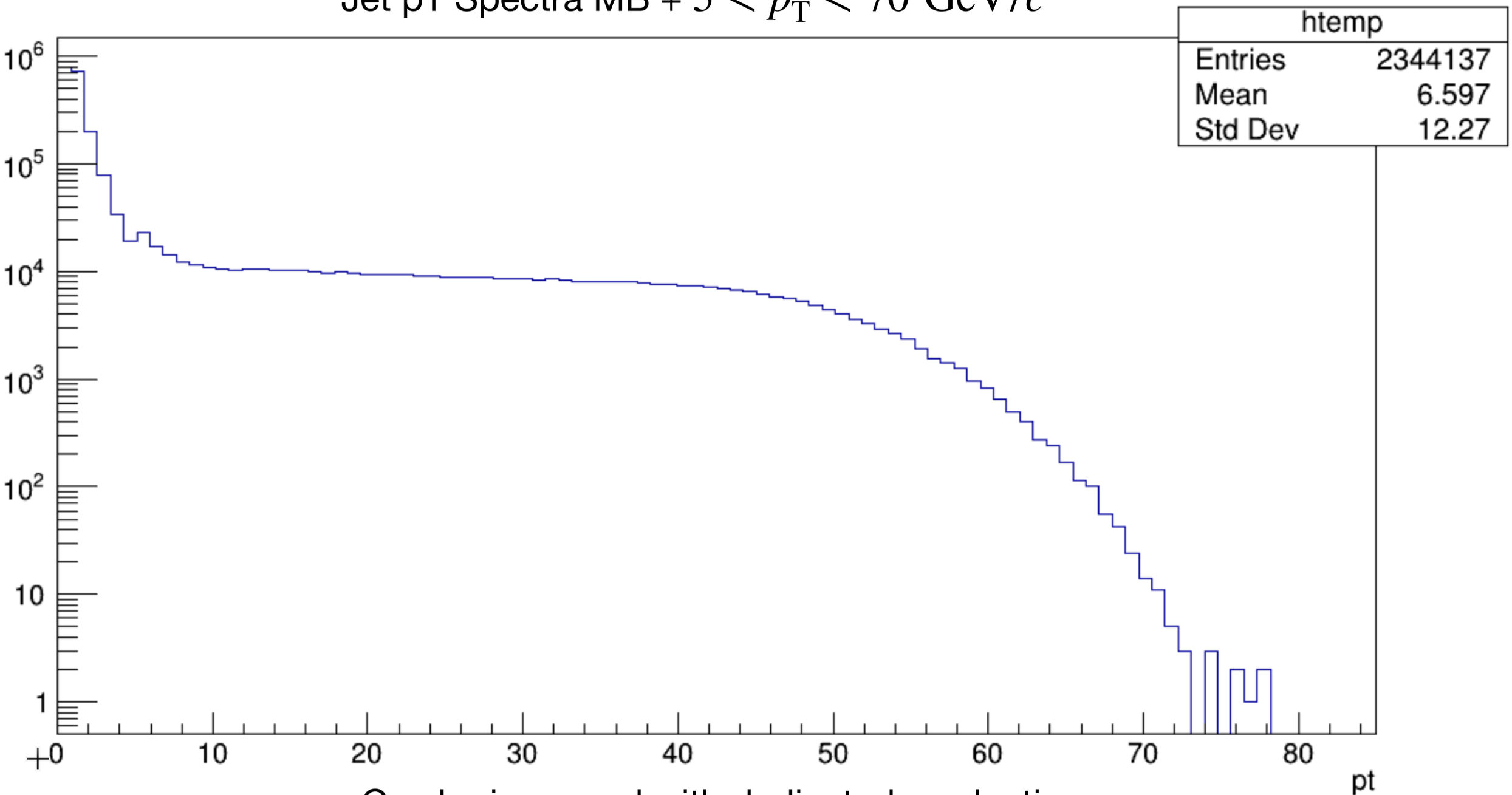
JER in AA w/ Parameters from pp



Parameters ***a*** and ***c*** taken from pp JER
Improved fit with forced parameters

MB for Low pT Jets

Jet pT Spectra MB + $5 < \hat{p}_{\mathrm{T}} < 70$ GeV/c

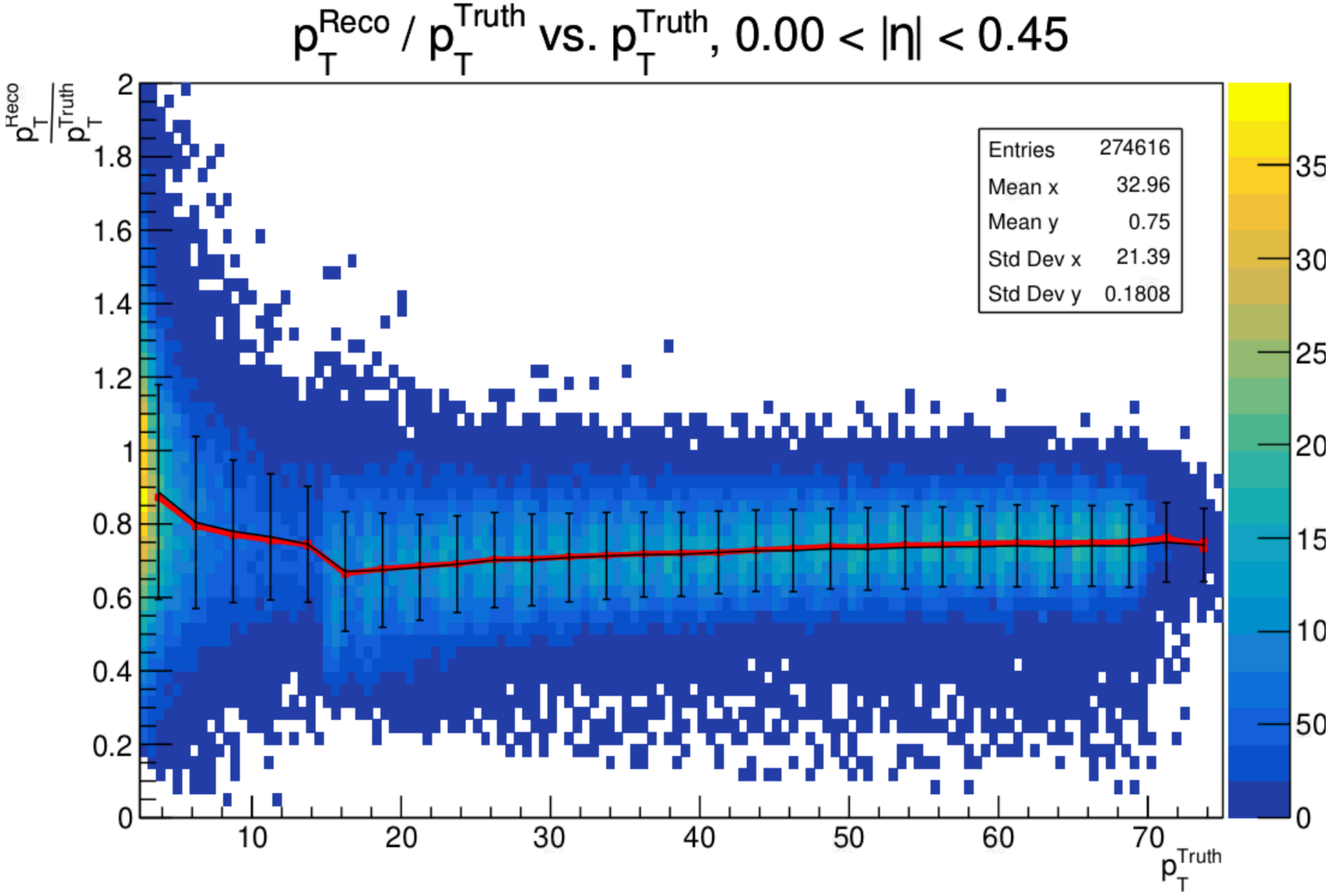


Can be improved with dedicated production

Suggest PhaseSpace:bias2SelectionPow

Goal: MC for high pT jets (without $\hat{p}_{\mathrm{T}}$ binning)

MB For Low pT Jets



- Crossover from MB to $\hat{p}_T$ production needs work

About the Code

- Builds with latest Version of Fun4All
  - Uses TTrees created from myjetanalysis in sPHENIX/tutorials
  - Works inside Singularity containers (can upload container if easier for others)
- Analysis is on github for others to pick up:
  - Additional dependencies can be added easily (z-vertex, for example)
  - Two version of analysis. One works with myjetanalysis, the other with TreeMaker (from Dennis).
- **Github Link: https://github.com/ftoralesacosta/macros.git**

Next Steps

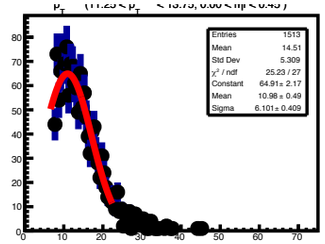
- Further Explore Low Jet pT
  - Have some minbias MC for low pT in back up. Easy to pick up from there
- Flat Jet pT Spectra for further studies
  - See my phpythia8.cfg
  - Suggestion: PhaseSpace:bias2SelectionPow
- Add TEnv or config file for binning and cuts
  - Changes must be recompiled in .cc file right now
  - Fun4All doesn’t need to be rebuilt each time

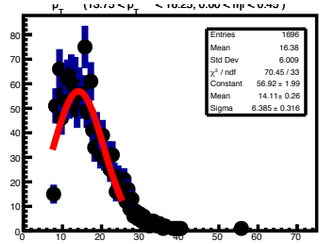
Backup

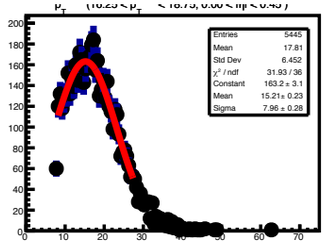
Summary

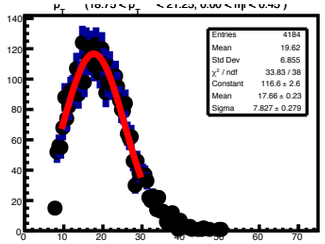
- JES/JER Explored in pp and AA
  - Works well for jets pT: 10 < pT <70
  - No strong eta dependance (backup)
- Code works with latest version of Fun4All
  - Hopefully easy for others to use

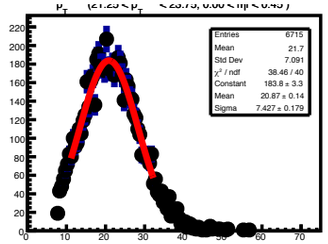
Corrected Gaussian Fits

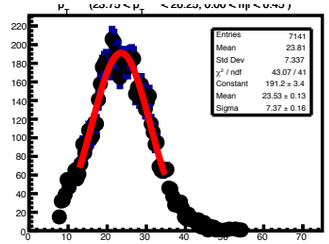


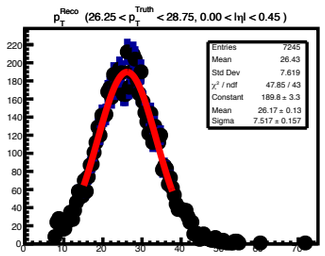


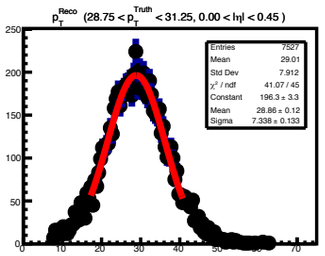


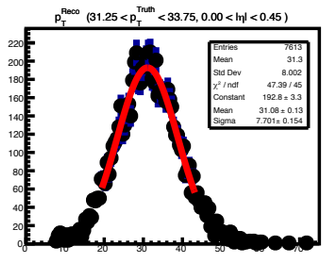


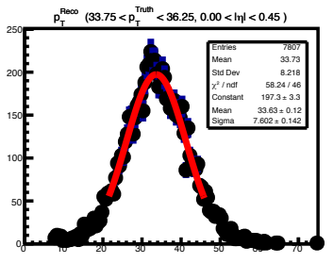


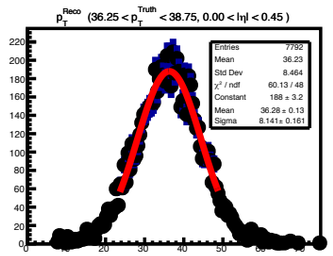


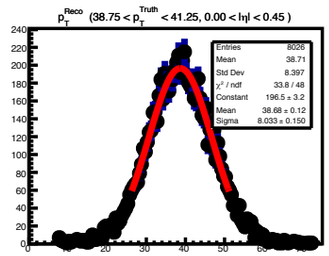


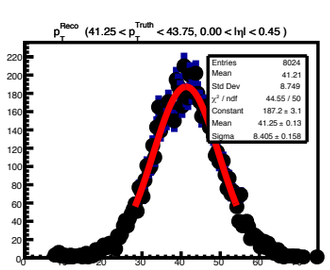


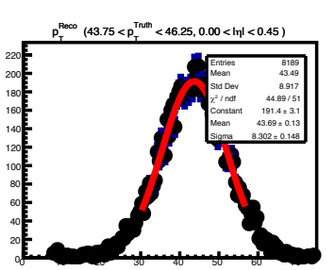


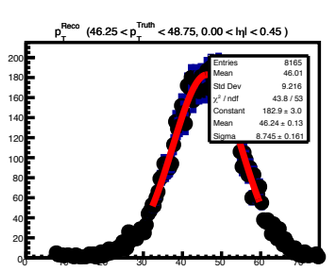


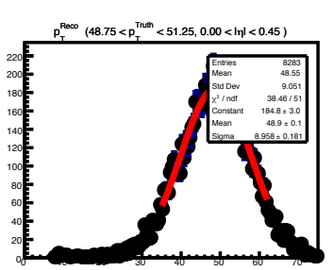


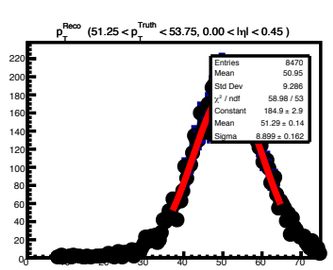


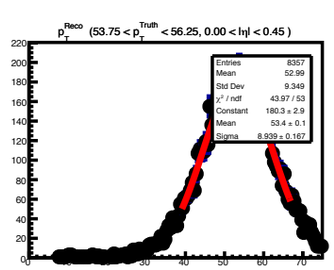


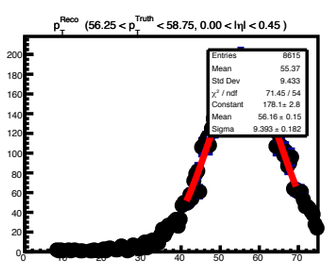


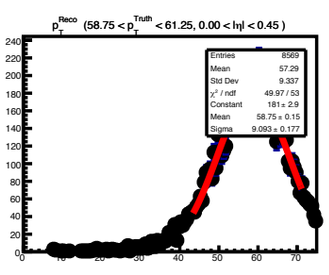


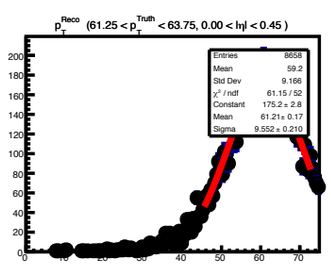


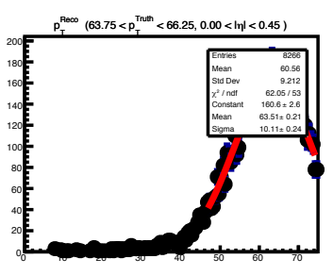


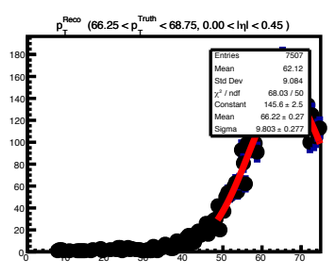


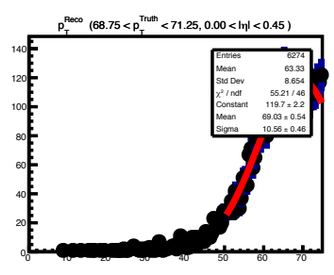






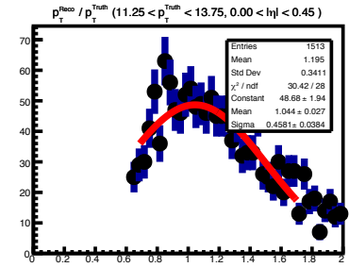


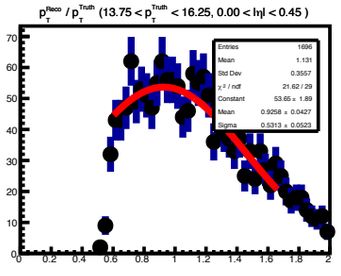


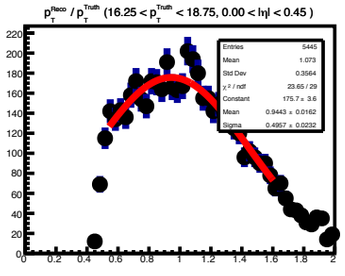


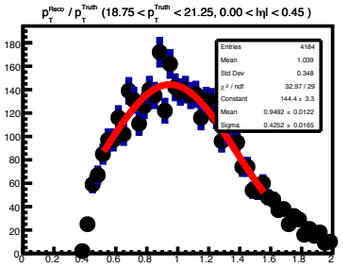
- Corrected gaussians are wider as a result of JES Correction
- Division by mean yields slightly smaller JER

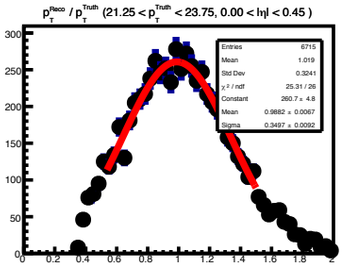
Corrected Ratio Fits

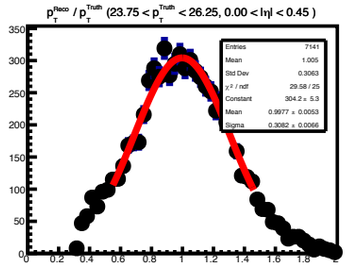


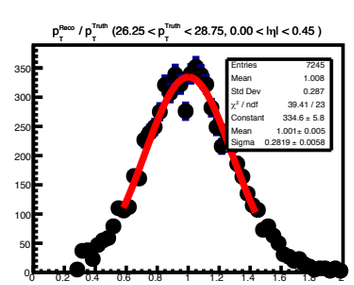


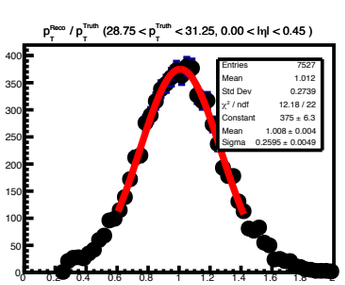


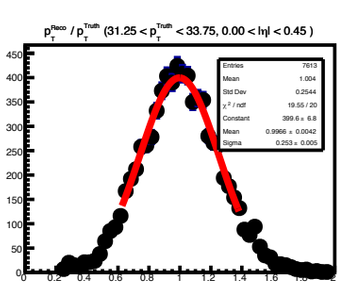


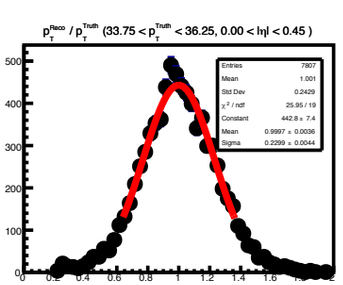


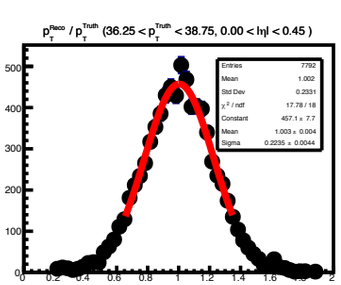


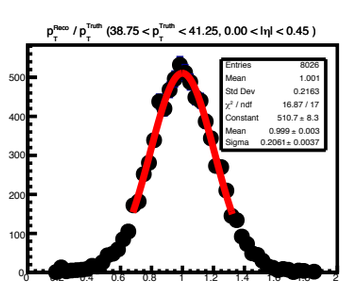


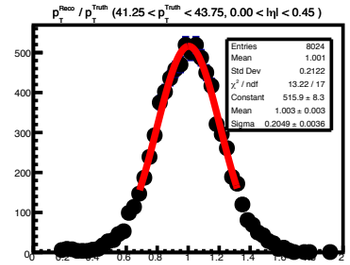


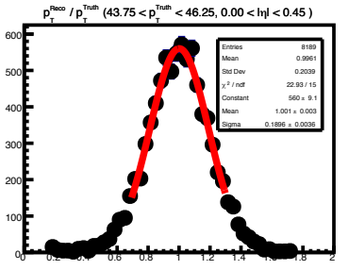


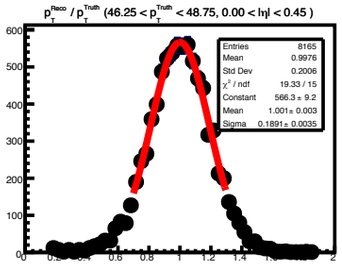


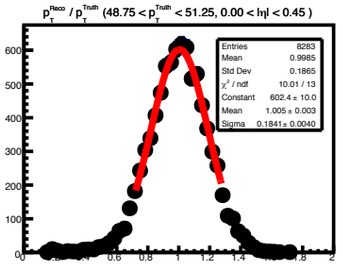


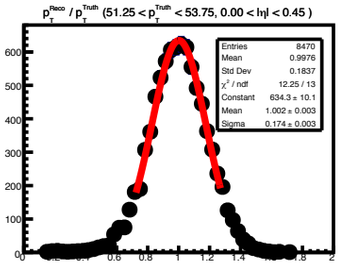


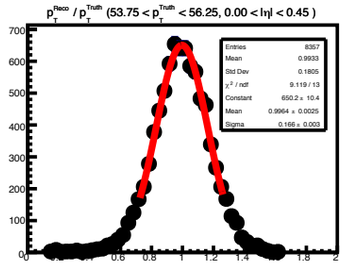


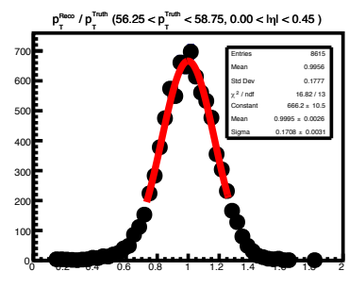


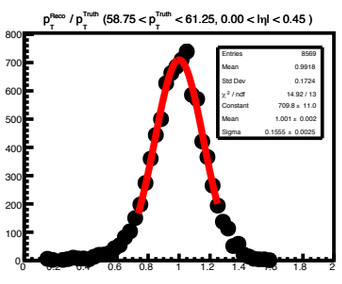


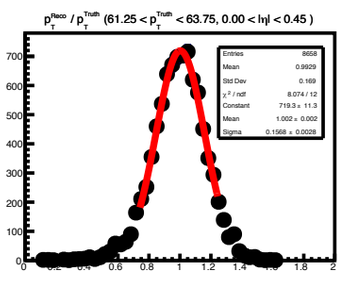


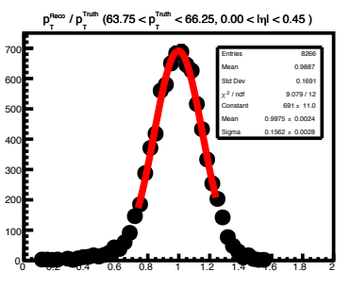


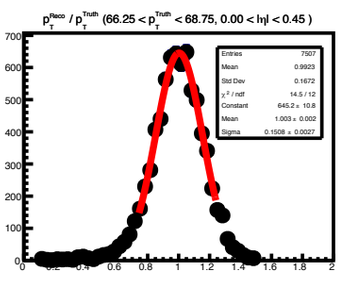


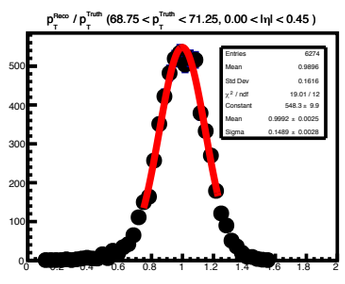








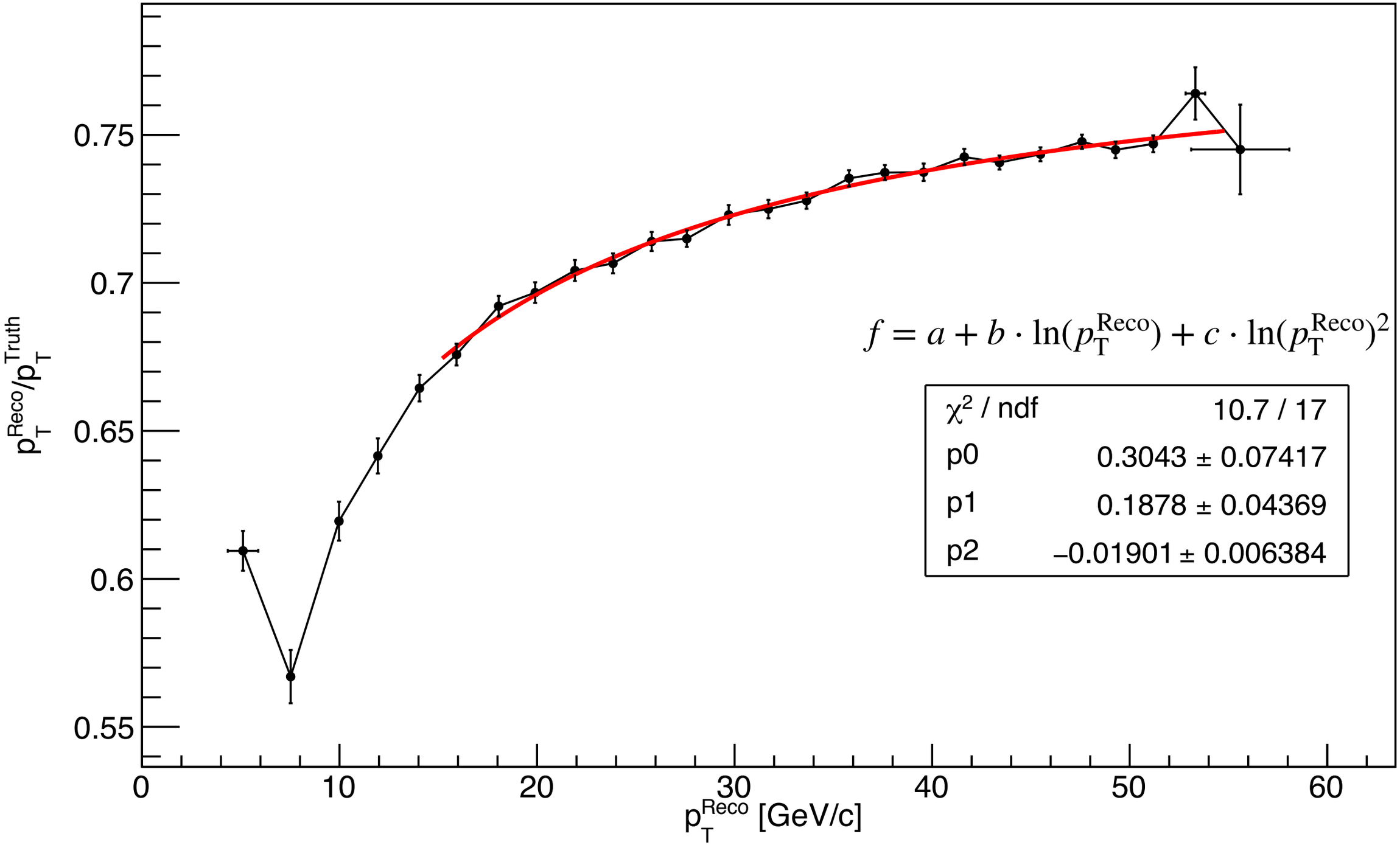




More narrow widths
Means centered ~3/4

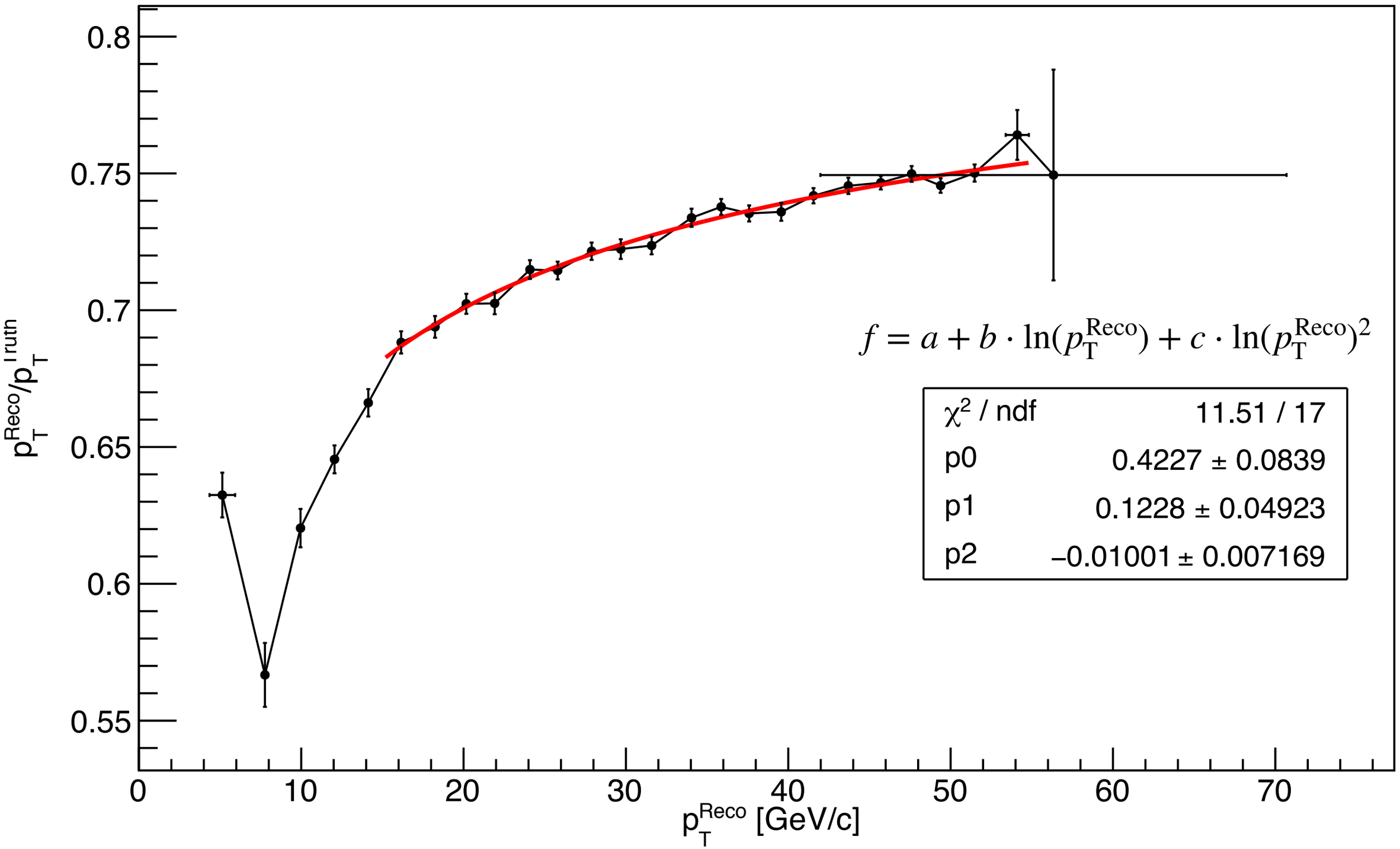
η Dependance

$0 < |\eta| < 0.1125$



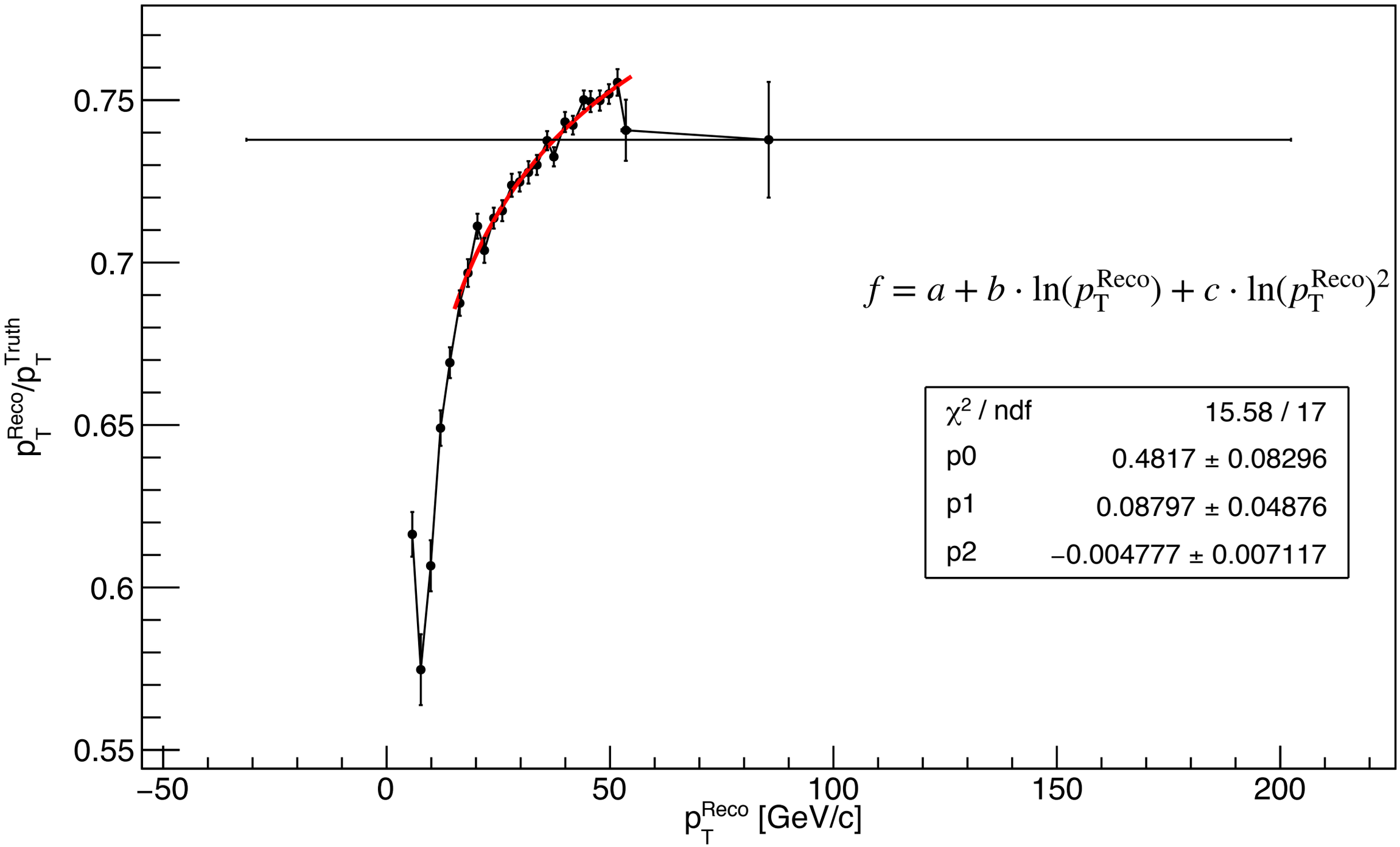
- Limited Fit range to 12-55 GeV/*c*
- Very reasonable fit in given range

$0.1125 < |\eta| < 0.225$



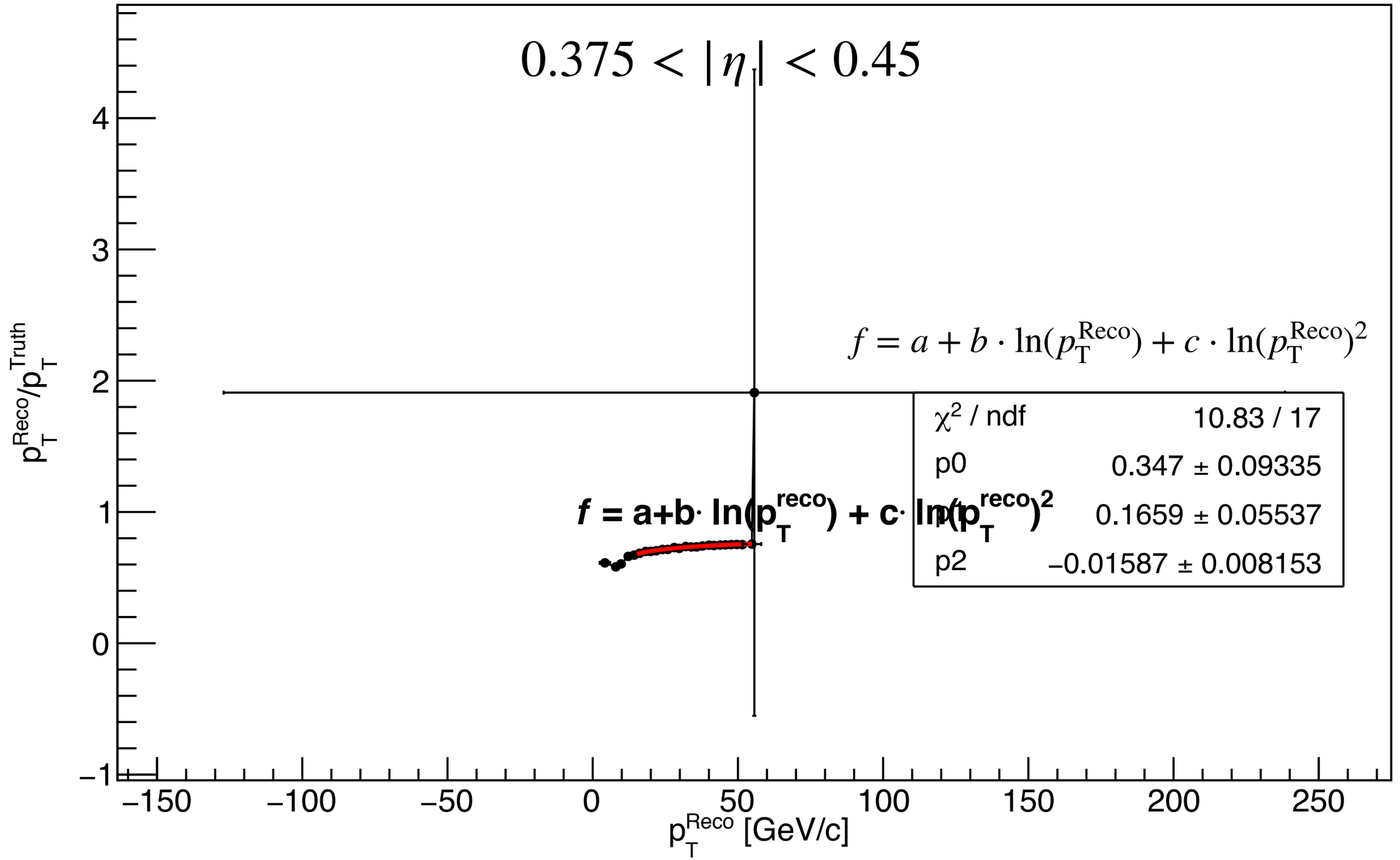
- Limited Fit range to 15-55 GeV/*c*
- Very reasonable fit in given range

$$0.225 < |\eta| < 0.375$$



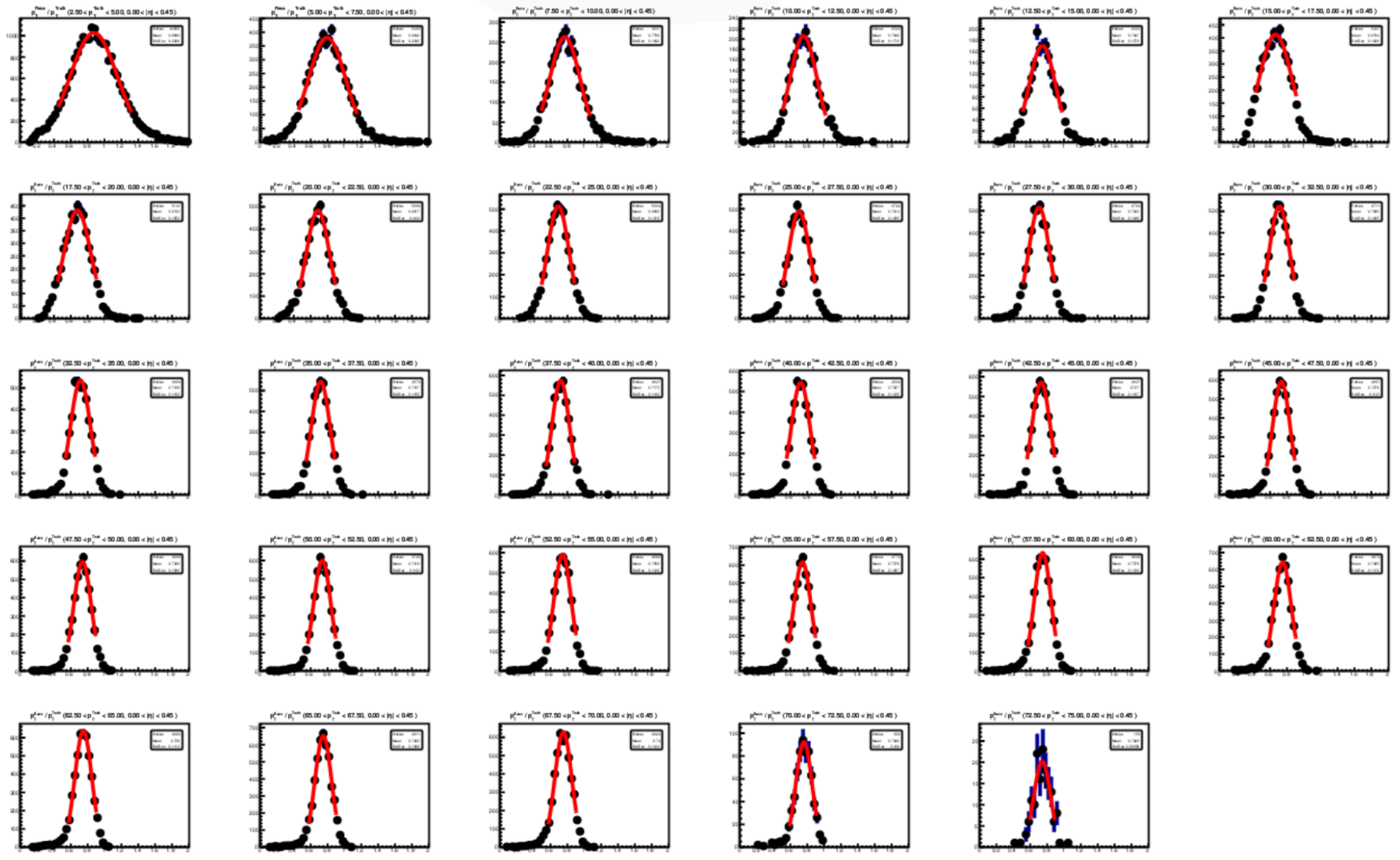
- Please excuse plotting range.
- Box is useful for fit errors

R vs p_T^{Reco} $0.34 < |\eta| < 0.45$



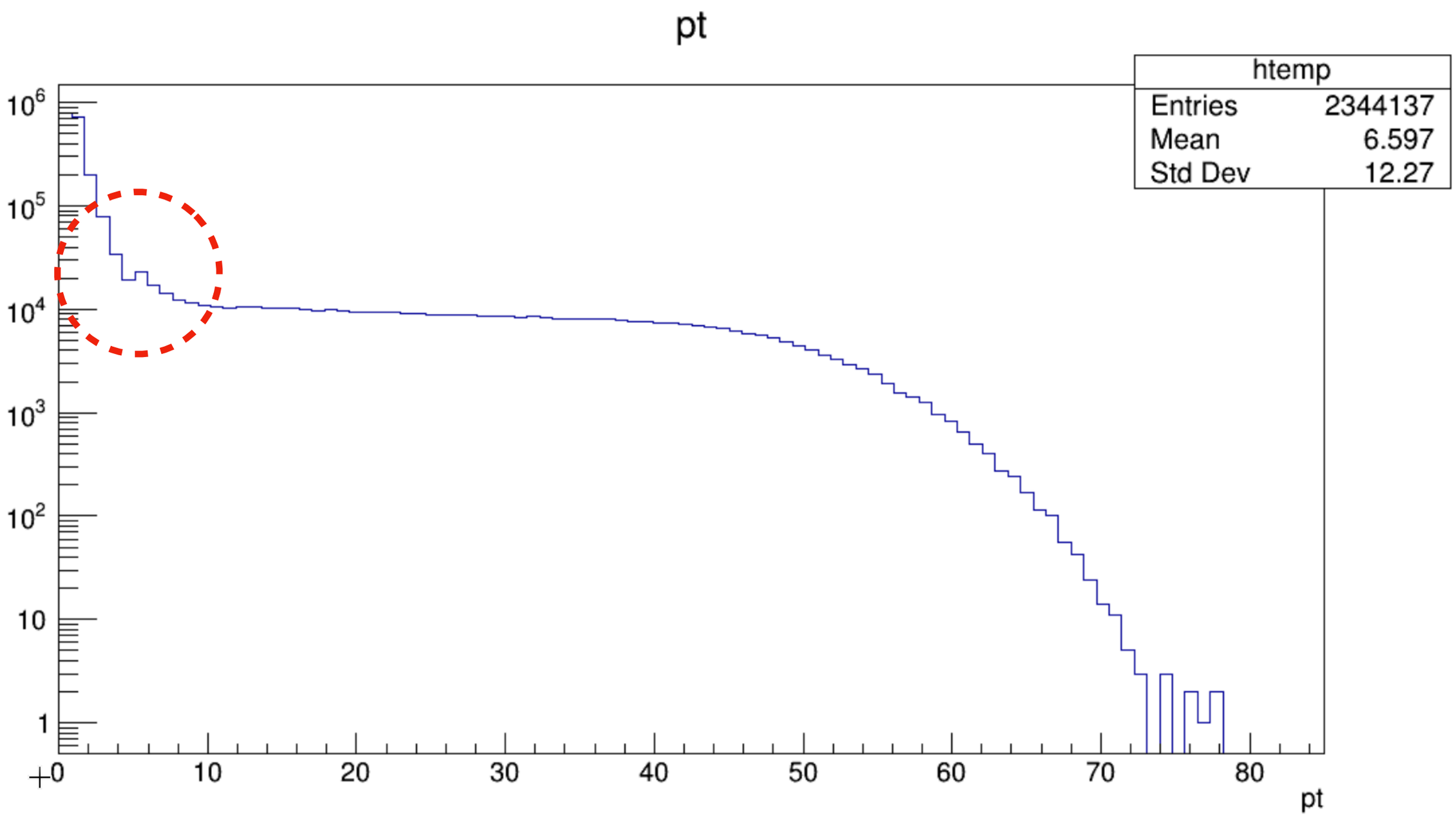
- Please excuse plotting range.
- Box is useful for fit errors

JES with MB Jets



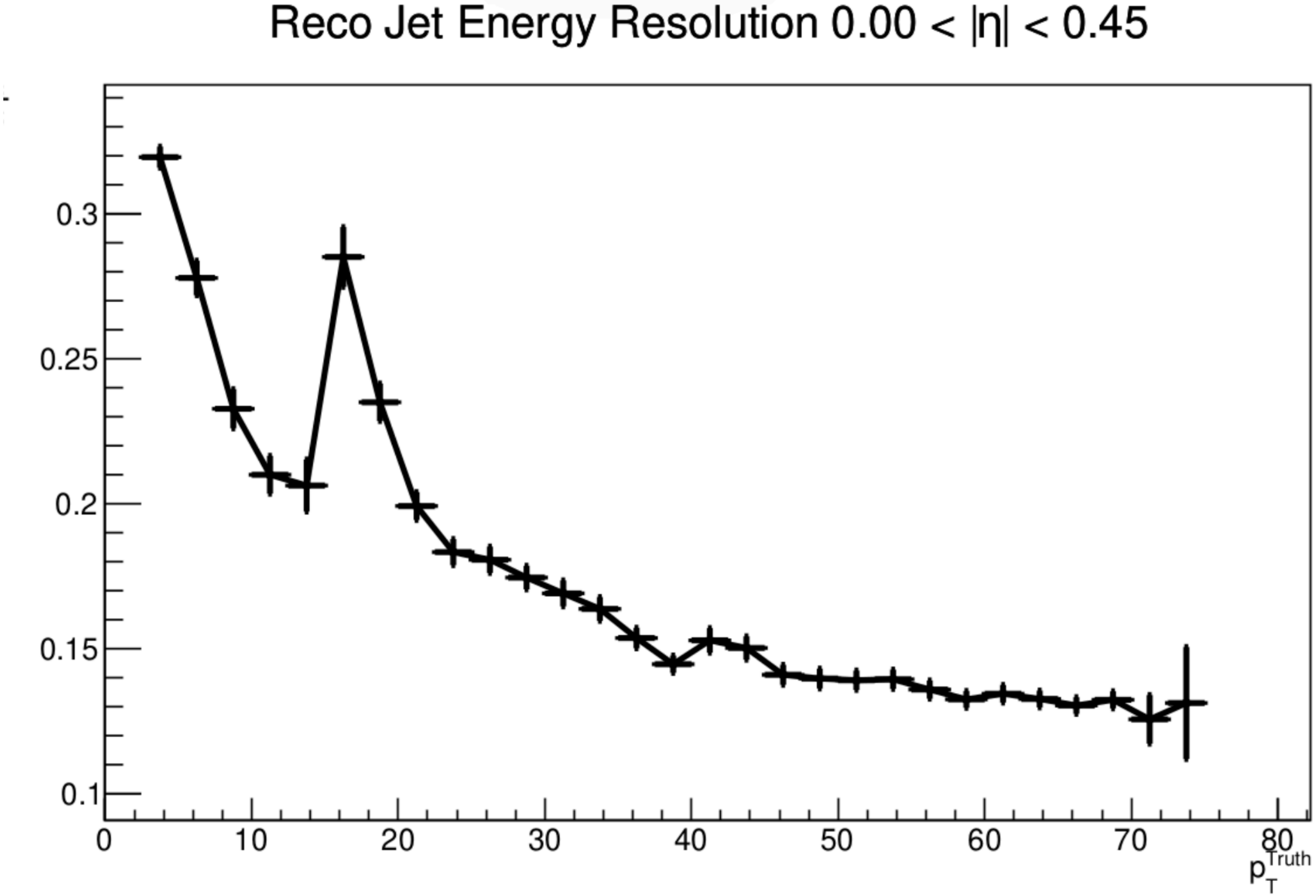
Good Gaussian Fits for full pT range
Difficulties with crossover from low pT MB to pT-hat MC production

pT Spectra (MB + 15 < $\hat{p}_T$ 70)



Difficulties with crossover from low pT MB to pT-hat MC production

MB Jets, JER



- Needs dedicated production

Older JER Plot