Superiteration for unfolding

(Following J/Psi Analysis)

Flowchart:

- Start with a flat prior in fragmentation function (Z)
- Unfold the 2D jet pT vs Z distribution with flat prior assumption
- Use the unfolded Z distribution as a prior in next step

x repeat n times -----> Calling this "**SUPERITERATION**"

- Terminate at a reasonable chi-square value

Example:

1. Choose number of iterations for each unfolding → Usual value is 4 (I vary it from 3 to 20)
2. Start with a flat Z distribution and unfold the 2D jet pT vs Z detector level distribution
3. The unfolded Z distribution is used as a prior in the next step.
4. Unfold the original 2D jet pT vs Z detector level distribution with the new response matrix

Steps 2 and 3 are called a **SUPERITERATION**

Chi-Square (summed over all bins):

$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

For self closure, this is straight-forward, because we know the expected value (PYTHIA Truth)

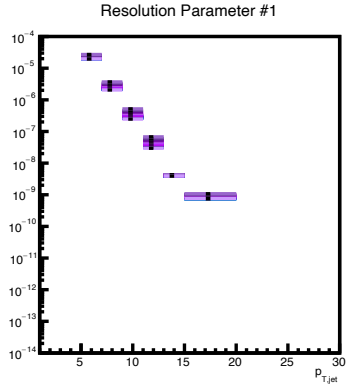
For data, I use the PYTHIA truth as the expected value.

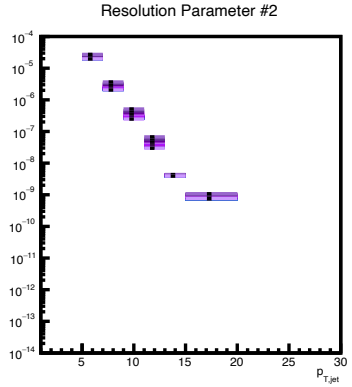
Self-Closure

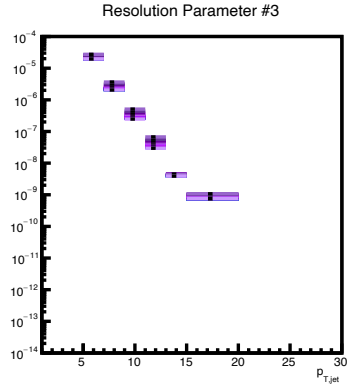
Unfolded Jet pT Spectra as a function of resolution parameter and superiterations

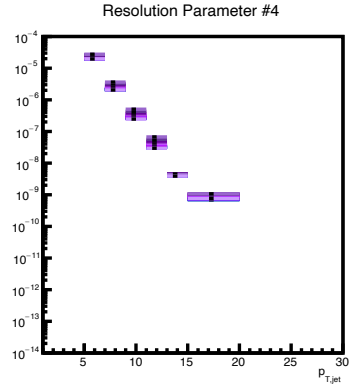
Central

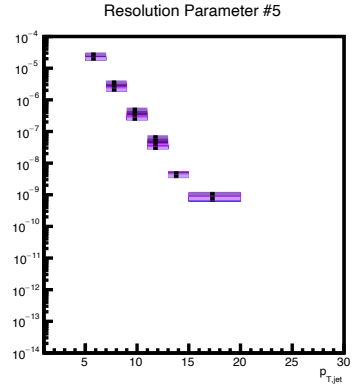
The jet pT spectra is recovered in most cases, which is clear in the ratio plots in the next slide

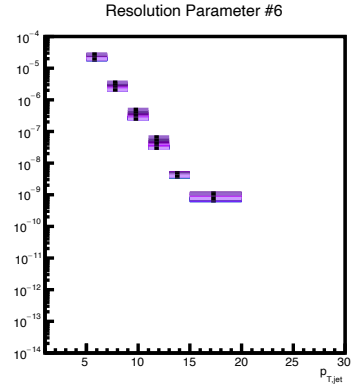


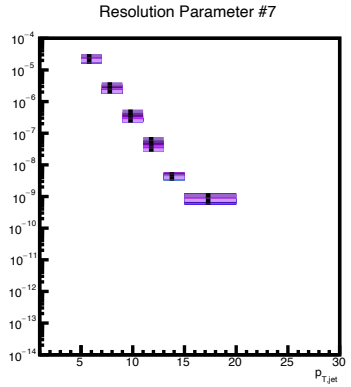


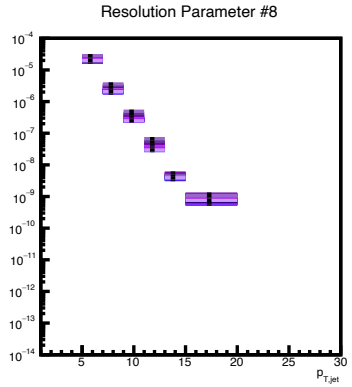


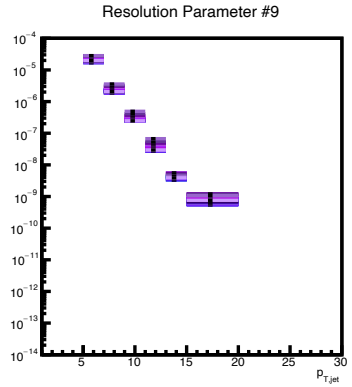


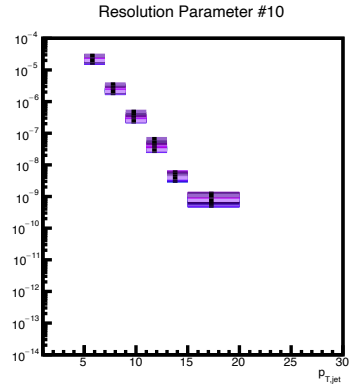


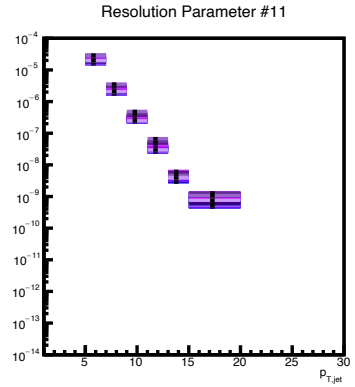


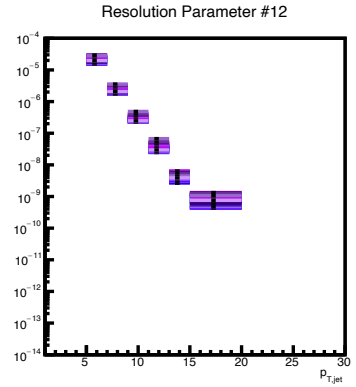


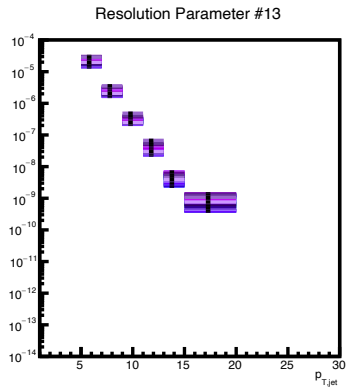


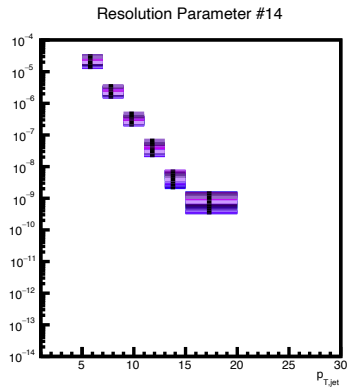


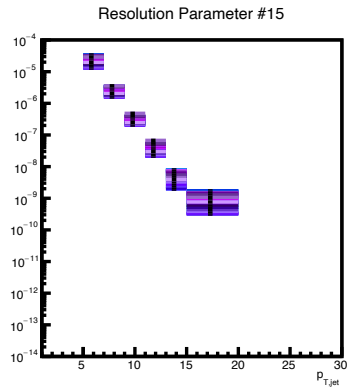


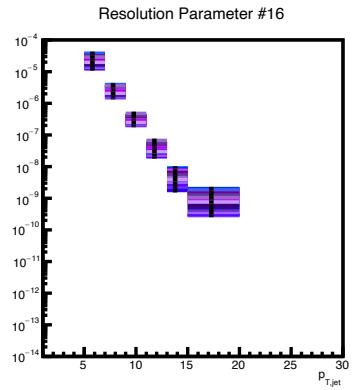


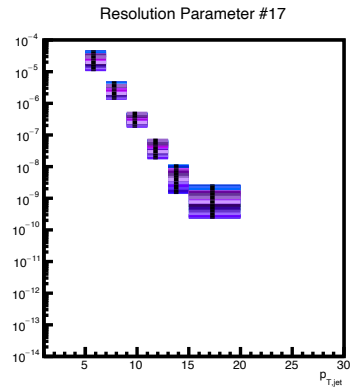


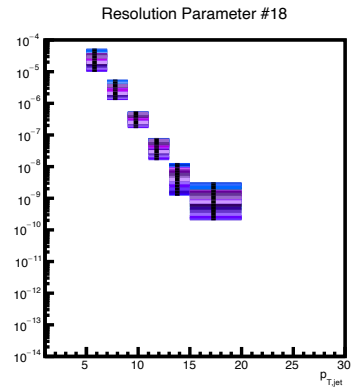








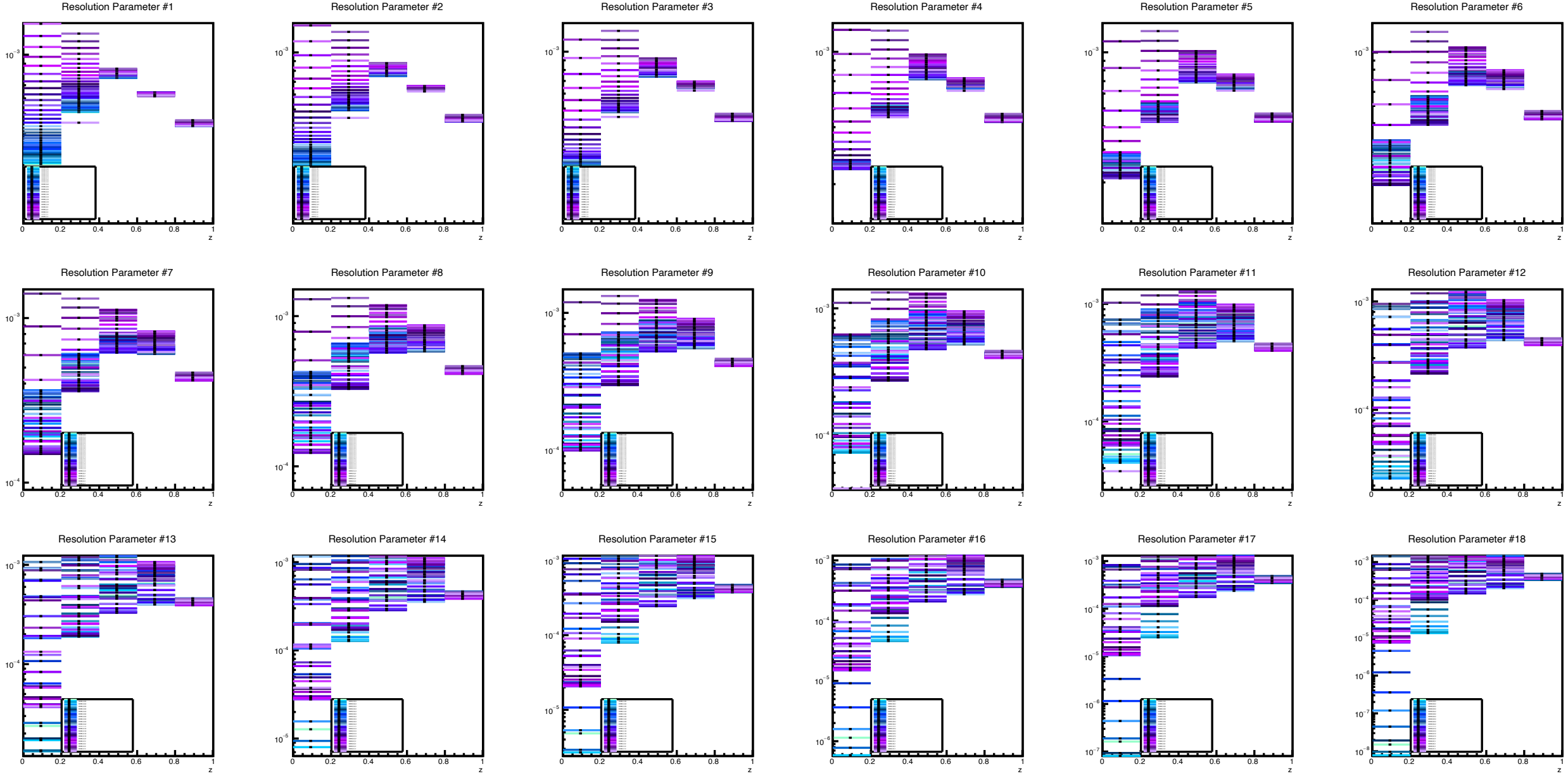




Number of superiterations on the x-axis

Self-Closure ***Unfolded Jet Z Spectra as a function of resolution parameter and superiterations*** Central

The jet Z spectra drastically changes with superiterations



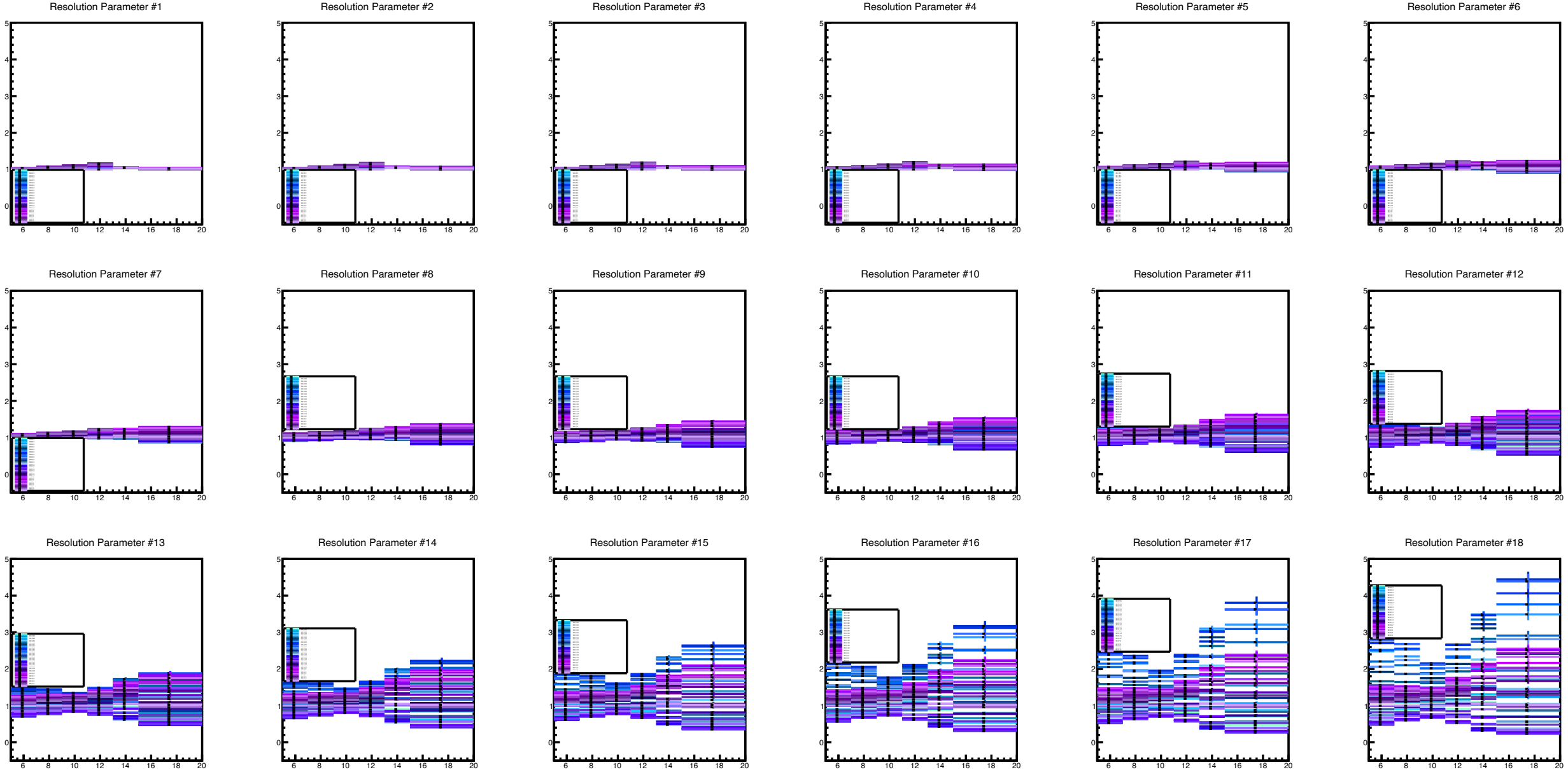
Number of superiterations on the x-axis

Self-Closure

Ratio of Unfolded Jet pT Spectra and Pythia Jet pT Spectra

Central

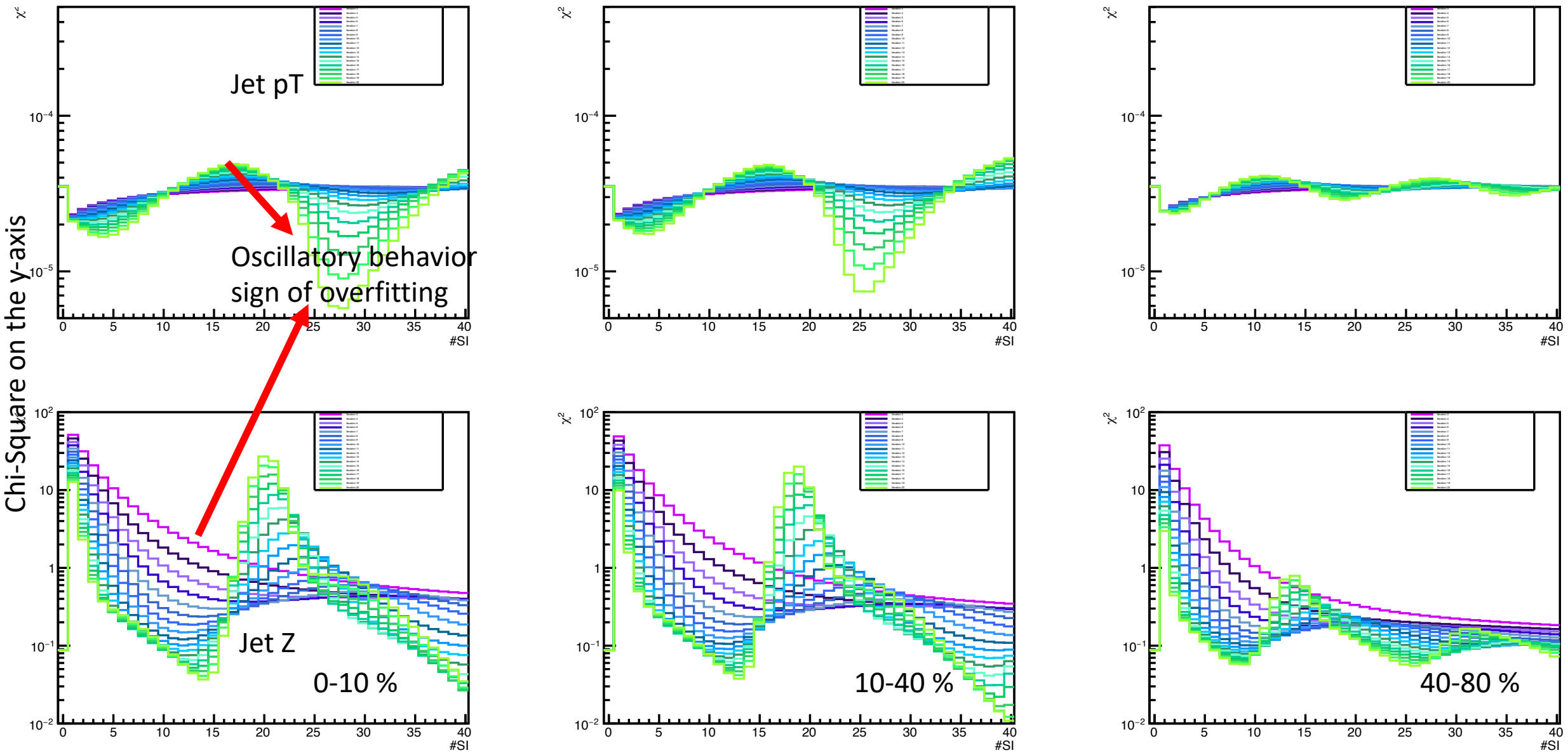
The method can get back the PYTHIA jet pT spectra for reasonable values of the resolution parameter and superiterations



Number of superiterations on the x-axis

Self-Closure

Chi-square as a function of number of superiterations for different regularization parameters



Steps for unfolding data:

For Each Centrality Bin

1. Make 4D response matrix (pT vs Z) from 0-3 and 3-inf pthatbins, and combine them with cross-section weights
2. Reweight fragmentation function distribution
   - **Hist1**: Normalise the uncorrected z-distribution from data to have integral 1.
   - **Hist2**: Normalise the detector side PYTHIA z-distribution to have integral 1.
   - Weight -> Hist2/Hist1
3. Repeat Steps 1 and 2 → **Superiteration** (SI)
4. After unfolding, scale pT distribution by T_{AA}

Chi-Square (summed over all bins):

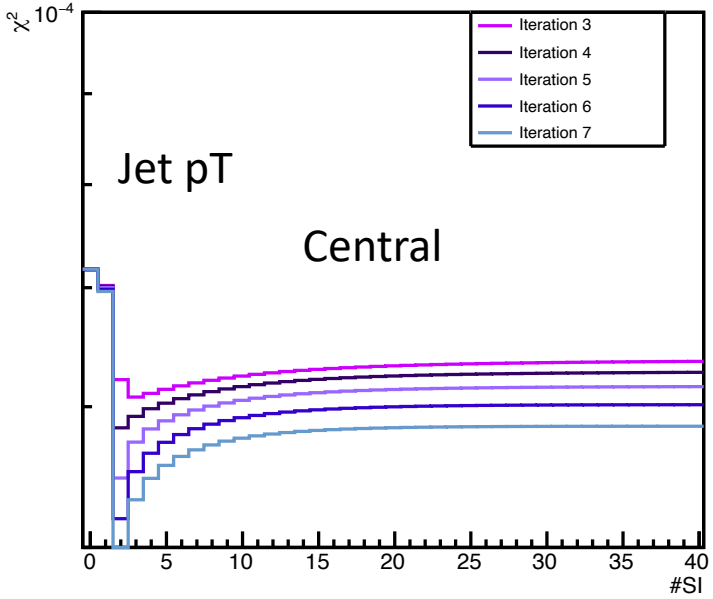
$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

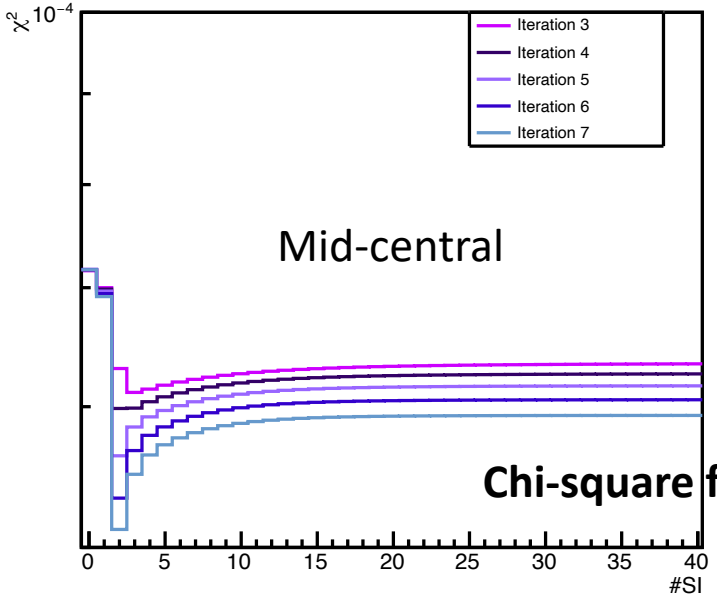
For data, I use the PYTHIA truth as the expected value.

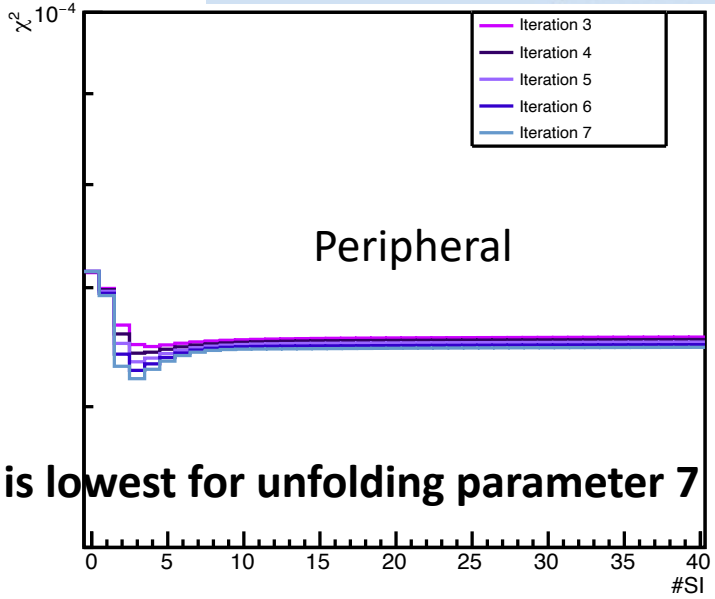
Chi-Square after superiterations:

Chi-Square (summed over all bins):

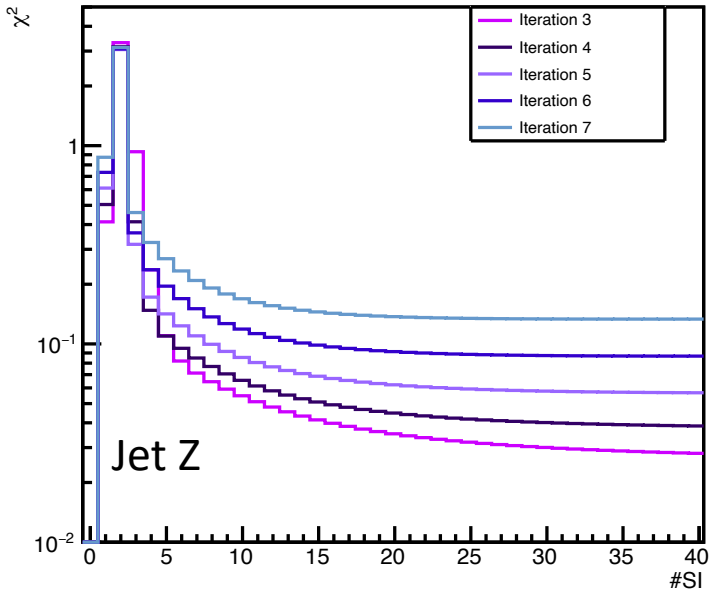
$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

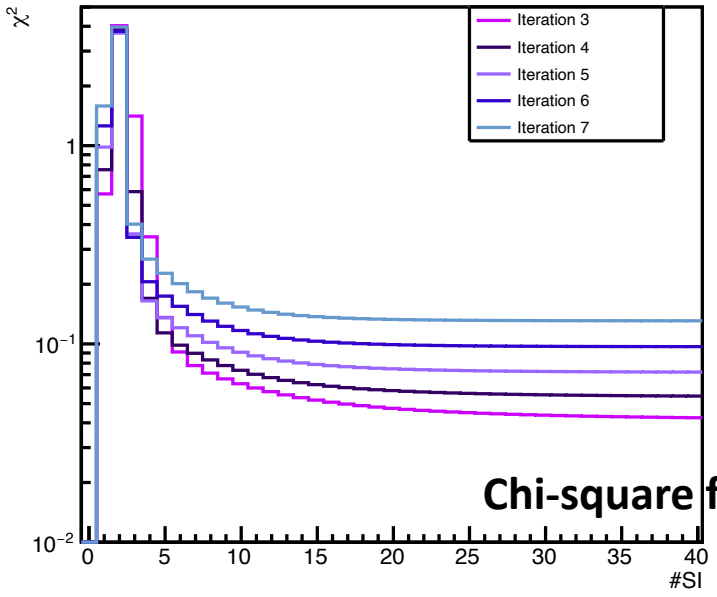


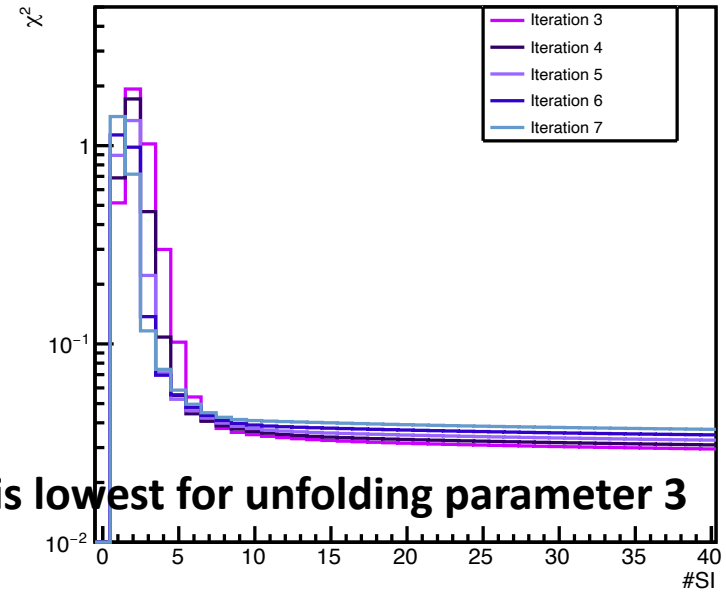




Chi-square for p_T is lowest for unfolding parameter 7

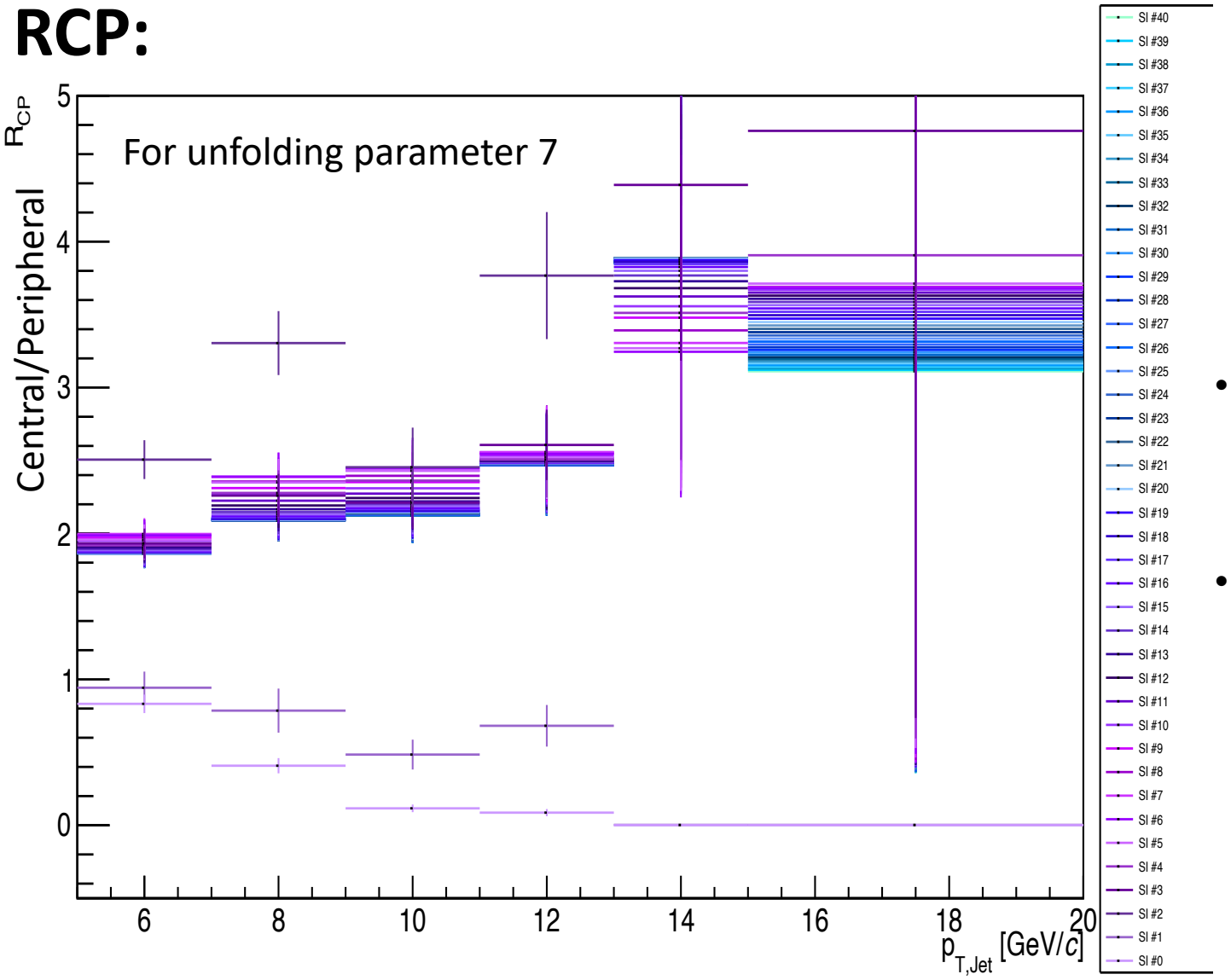






Chi-square for z is lowest for unfolding parameter 3

RCP:



- RCP stabilizes to values after ~10 Superiterations, same as chi2
- **The RCP shows the correct trend for superiterations ~5 and above, but it's greater than 2.**

- **I checked all the normalisations we were doing earlier, and I am applying them correctly.**
- **It still seems like I am missing some normalization, and I am stuck on what test I can run to figure this out.**
- **I checked RCP for self-similar and test-train samples with this method, and they are around 1 with some fluctuations (~20%).**