# Unfolding for Detector Effects in Presence of New Physics

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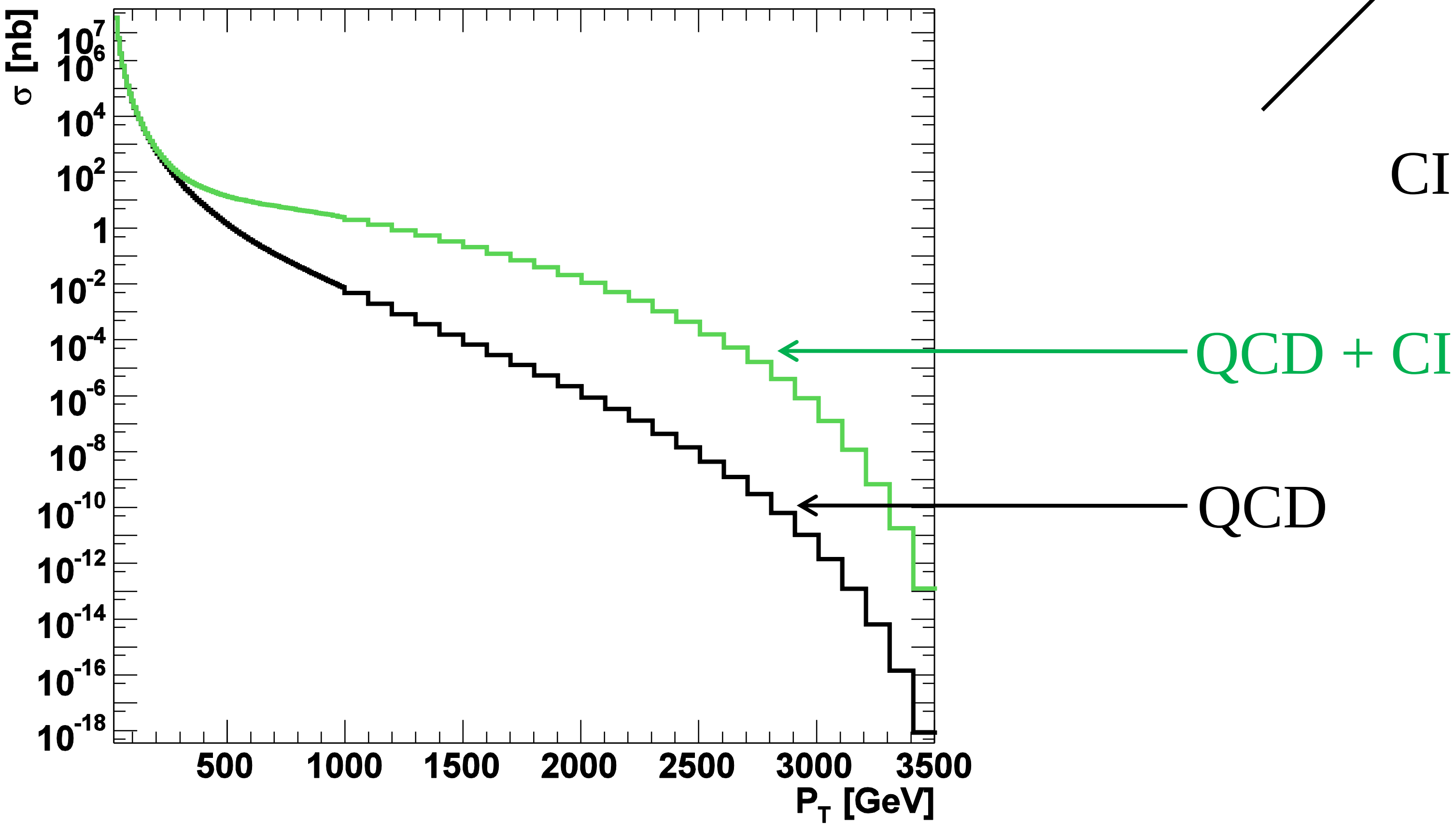
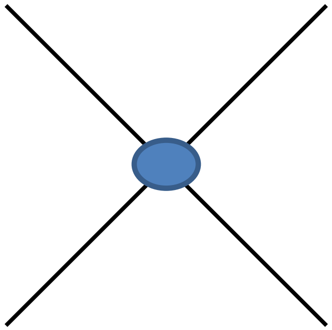
# One example: QCD & Contact Interaction (CI)

Jet-production cross sections



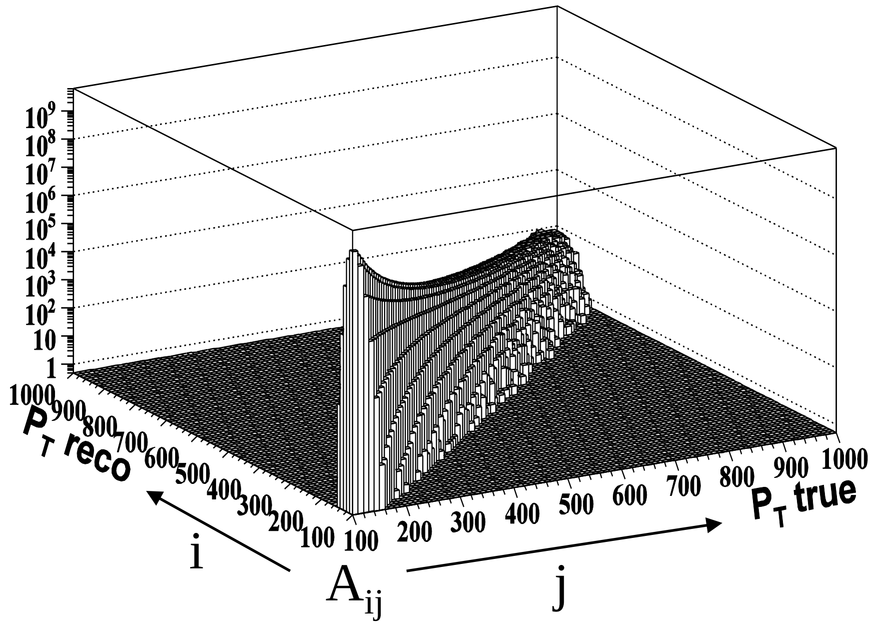



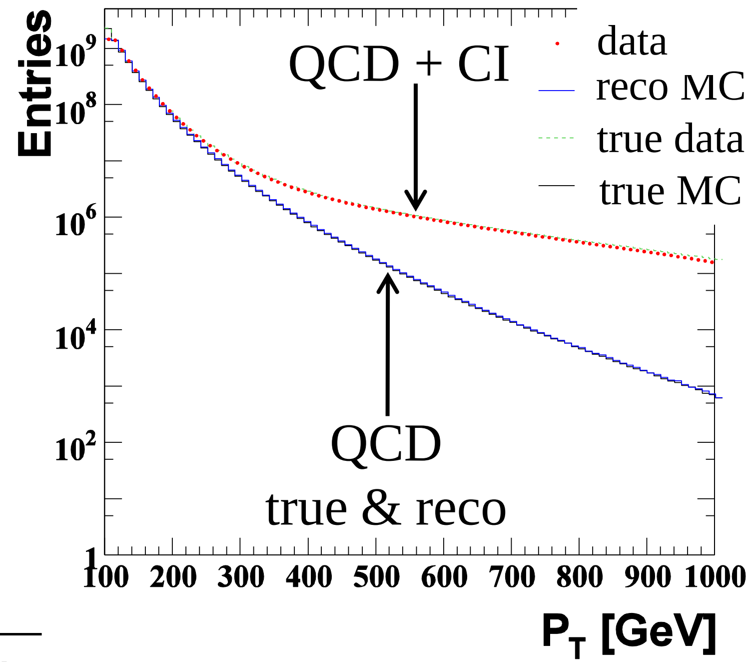
CI

Example with large variation of shape of $P_T$ distribution in presence of new physics

# Building the model

- Generating the true QCD and QCD+CI spectra, corresponding to $L = 10\ fb^{-1}$
- Smearing of the true spectra using a resolution function
- Obtain the reconstructed QCD+CI spectrum ("data" to be unfolded) and the MC transfer matrix (from QCD spectrum)




- Folding: $P \cdot true\ spectrum = data;\ P_{ij} = \frac{A_{ij}}{\sum_{k=1}^{NBins} A_{kj}}$
- Unfolding of detector effects in background-subtracted spectra (acceptance corrected afterwards)
- Unfolding is not a simple numerical problem: must use a <u>regularization method</u>.

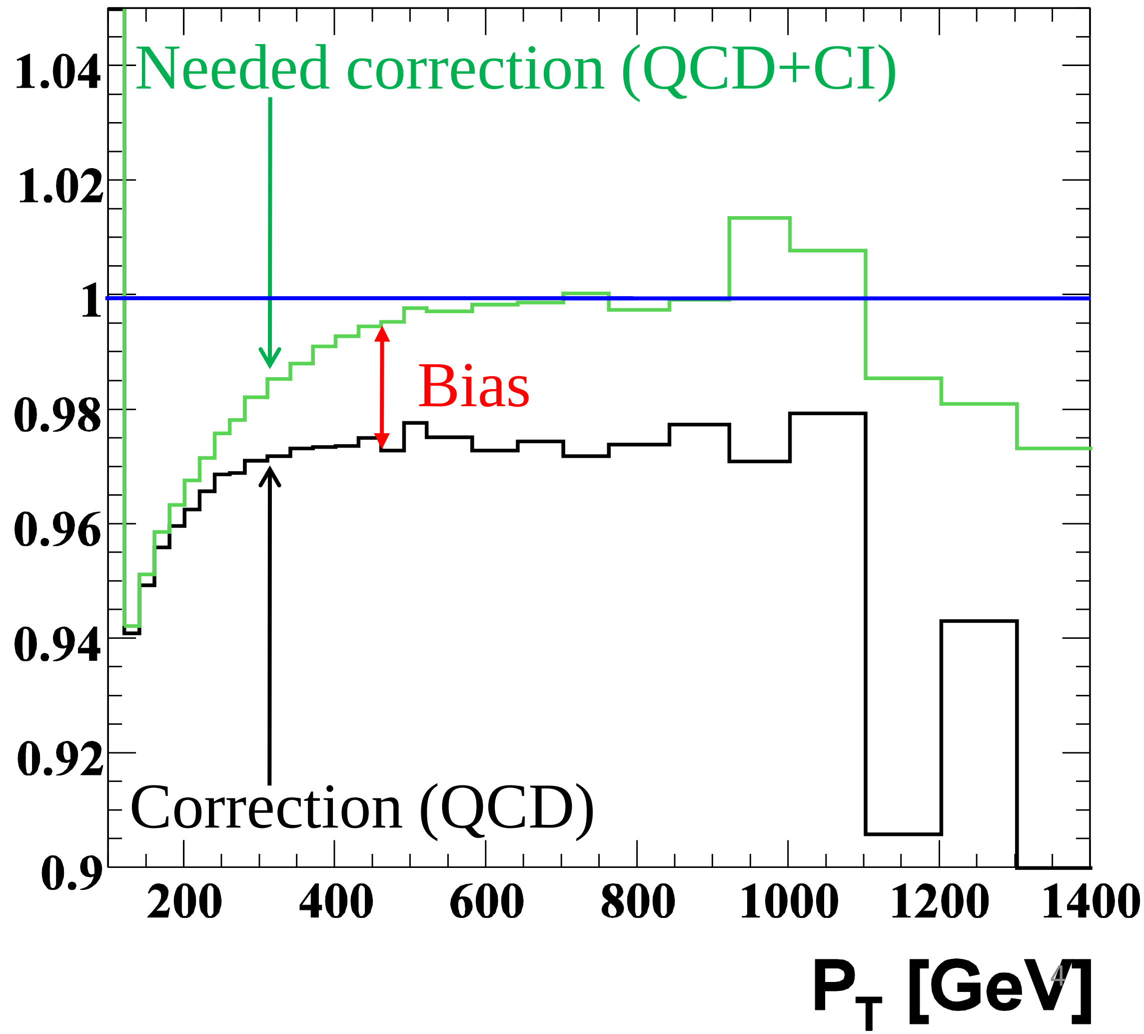
# Bin-to-bin correction & problems

$$\text{Corrected data}[i] = \text{data}[i] \cdot \frac{\text{MCtrue}[i]}{\text{MCreco}[i]}$$

Assumes that MC describes well the shape of the data spectrum!

→Induced bias

→Unstable under iterations



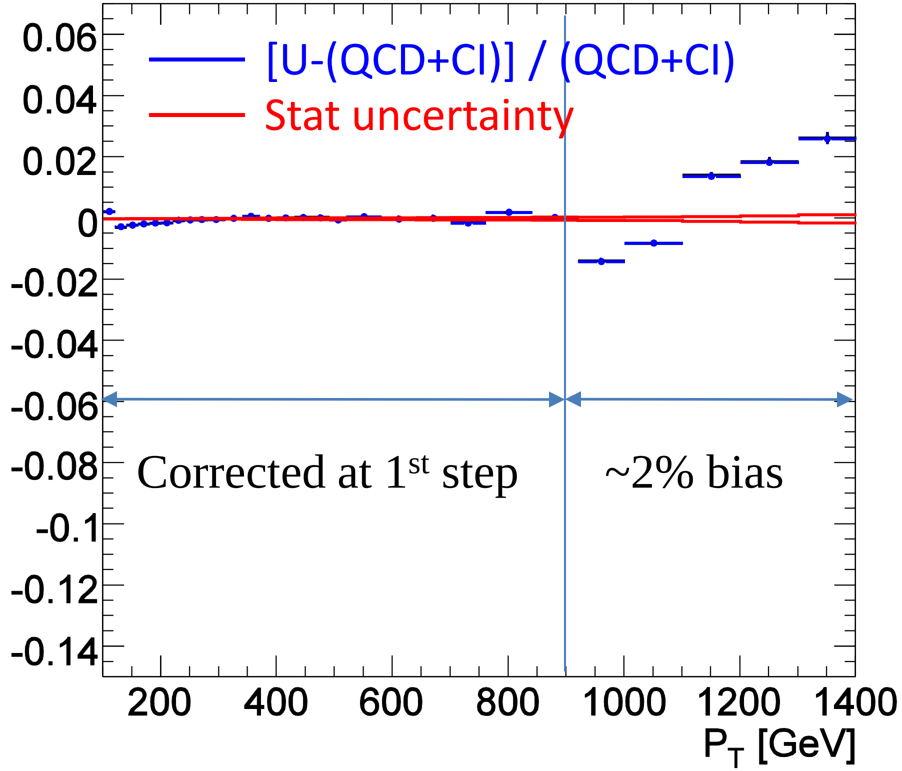
# Result with the IDS method

IDS: matrix based, iterative unfolding method (similar to the Bayesian method) with regularization:

→ provided by the use of the significance of data-MC differences at each step of the procedure

→ different treatment for significant structures and statistical fluctuations

IDS result (1 iteration)



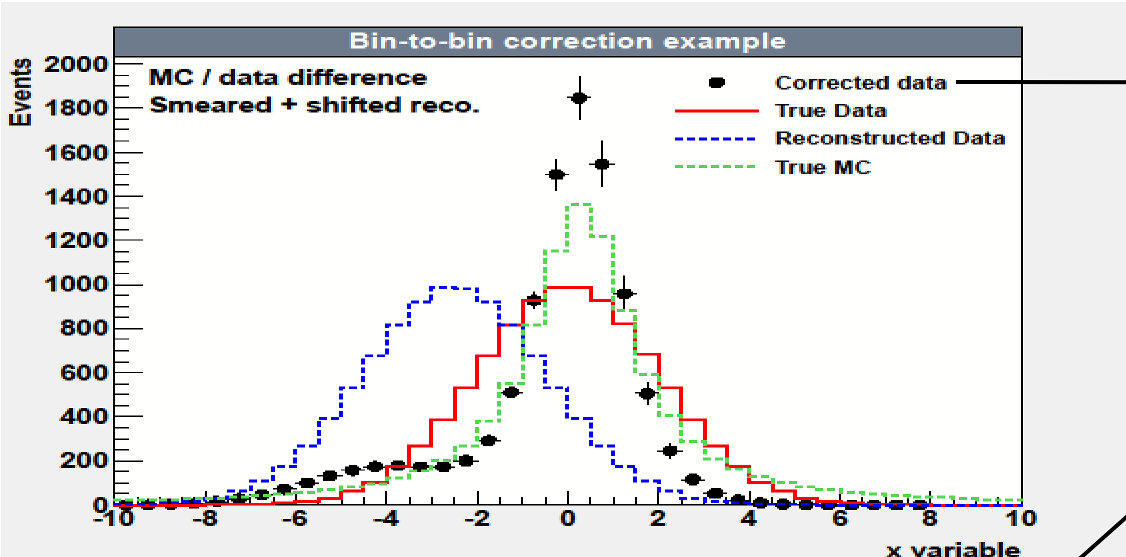

→ Very small bias after one iteration, up to 900 GeV

→ Possible improvements at high $p_T$, using more iterations

→ Statistical uncertainties propagated using pseudo-experiments

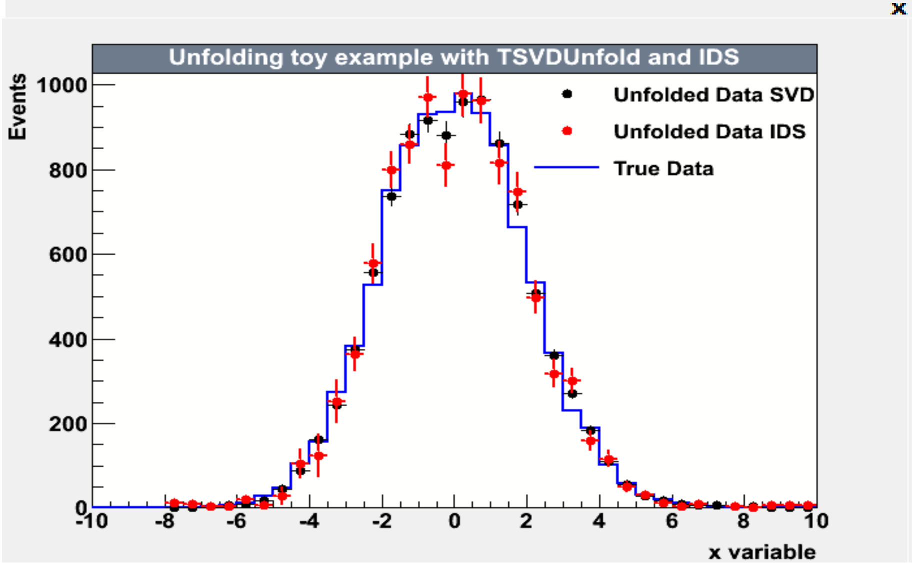
# A second example

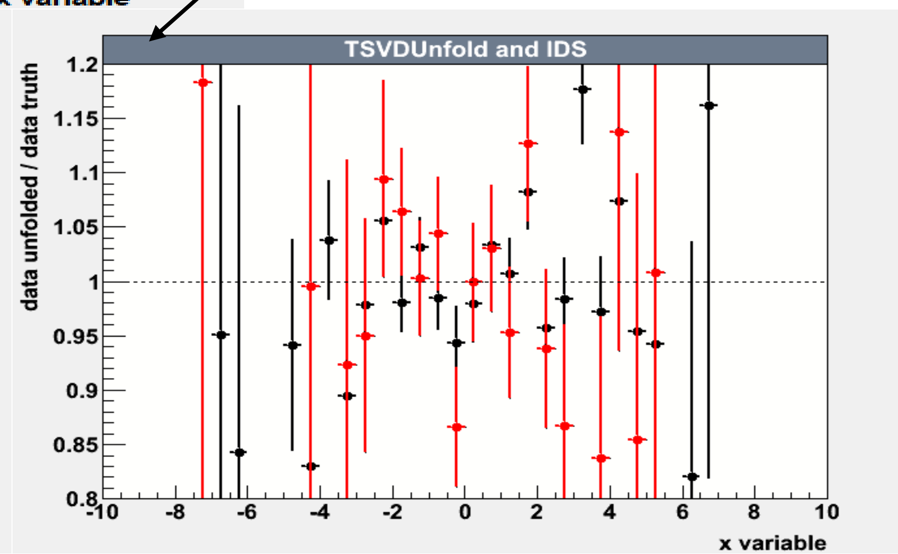
"New physics": different resonance width. Detector effect: resolution + systematic shift.




Large bias for the bin-by-bin correction

Good results obtained using IDS and SVD




Many thanks to Andreas HOECKER and Kerstin TACKMANN for providing this example, and the SVD result.

# Conclusions

- Several unfolding methods have been tested on toy models simulating the presence of new physics
- The bin-by-bin correction introduces biases and is unstable when trying to iterate
- Alternative methods can be used to unfold data even in presence of large new physics effects
- Full statistical information (uncertainties, distributions and correlation) can be propagated from the raw data to the unfolded spectrum → using pseudo-experiments etc.
- Unfolded spectra have the advantage to allow any theorist to test his model, without needing fast detector simulation