Pile-up

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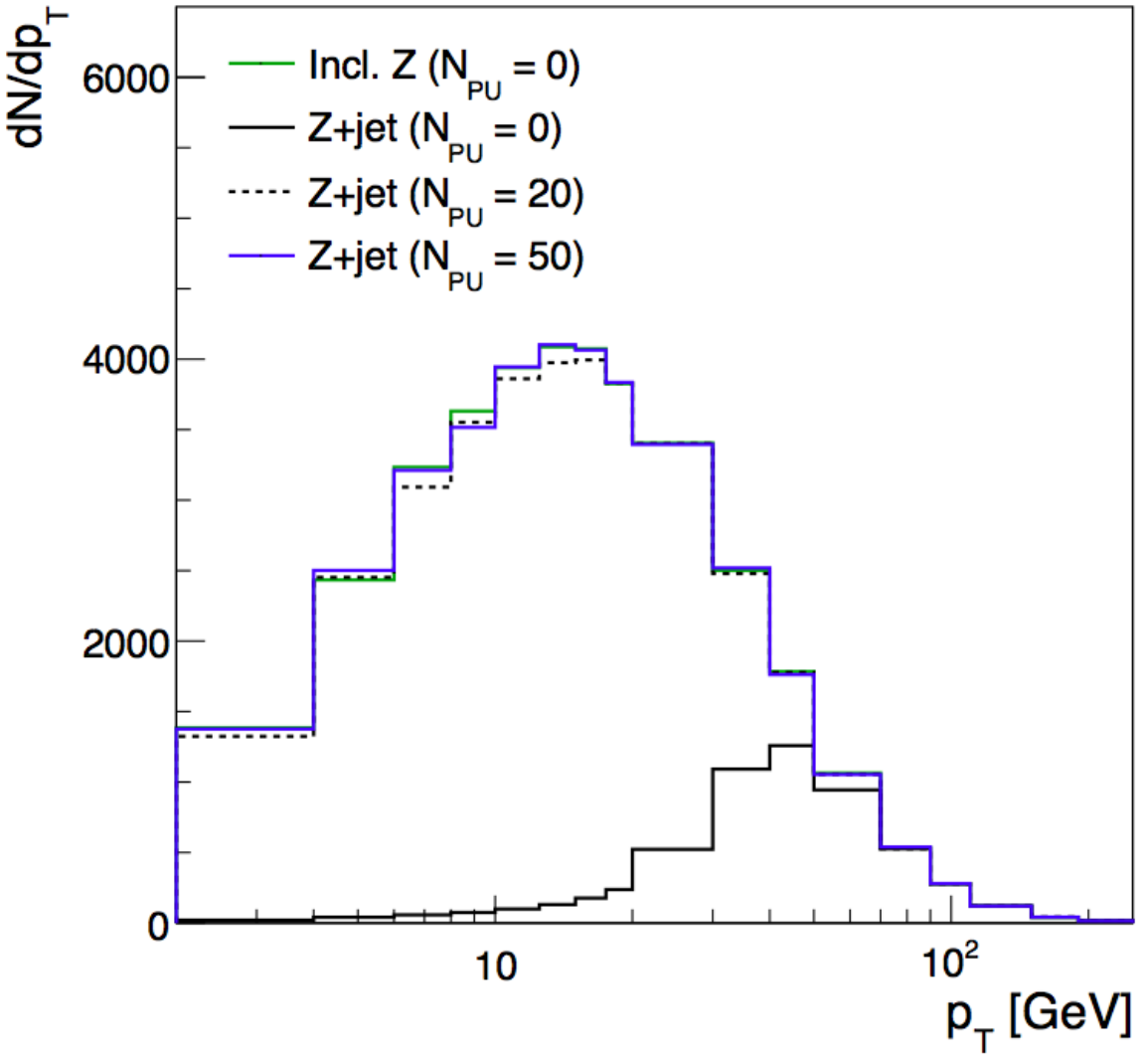
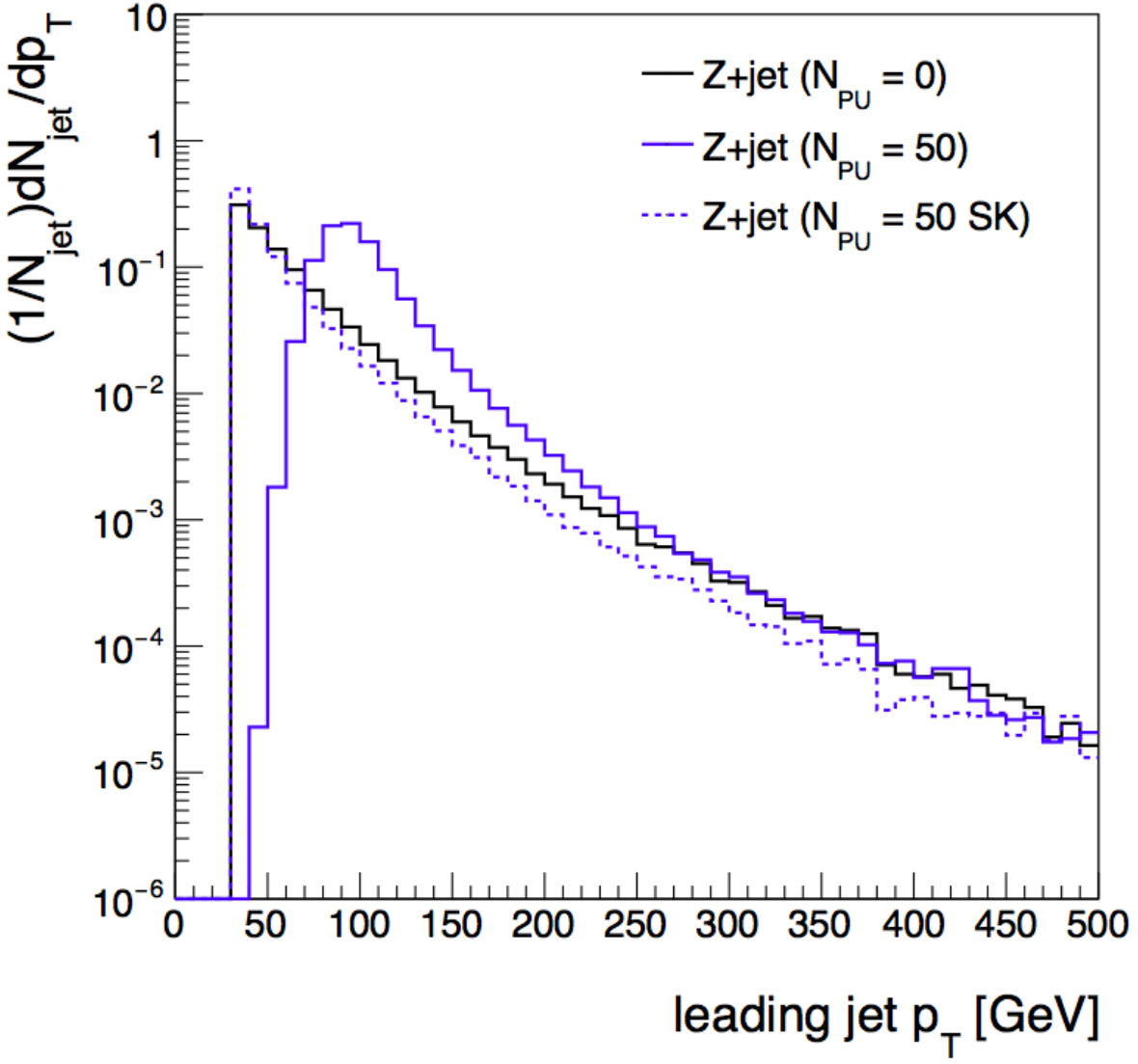
Z + jets at high pile-up as a case study



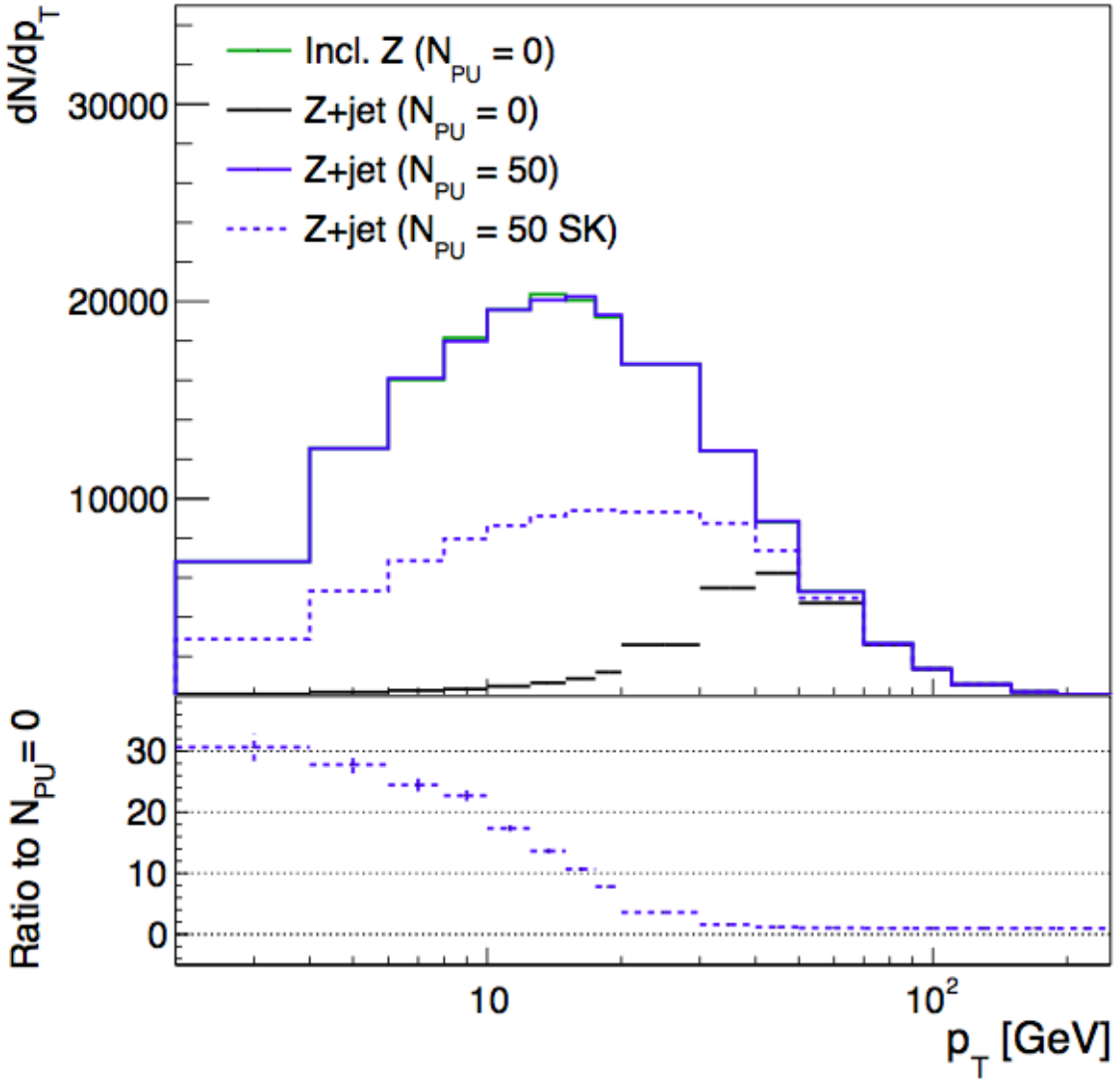
Effect of pile-up on the Z-boson transverse momentum pT in Z + jet production

Two main effects: i) jet pT pedestal and ...



Application of SoftKiller [Cacciari, Salam, Soyez, EPJC 75 (2015) 59] to Z + jet production: a) the leading jet pT spectrum

… and ii) pile-up jet misidentification



Application of SoftKiller [Cacciari, Salam, Soyez, EPJC 75 (2015) 59] to Z + jet production: b) the Z-boson pT spectrum

Treating effects beyond the jet pT pedestal

- Event mixing techniques using uncorrelated event samples

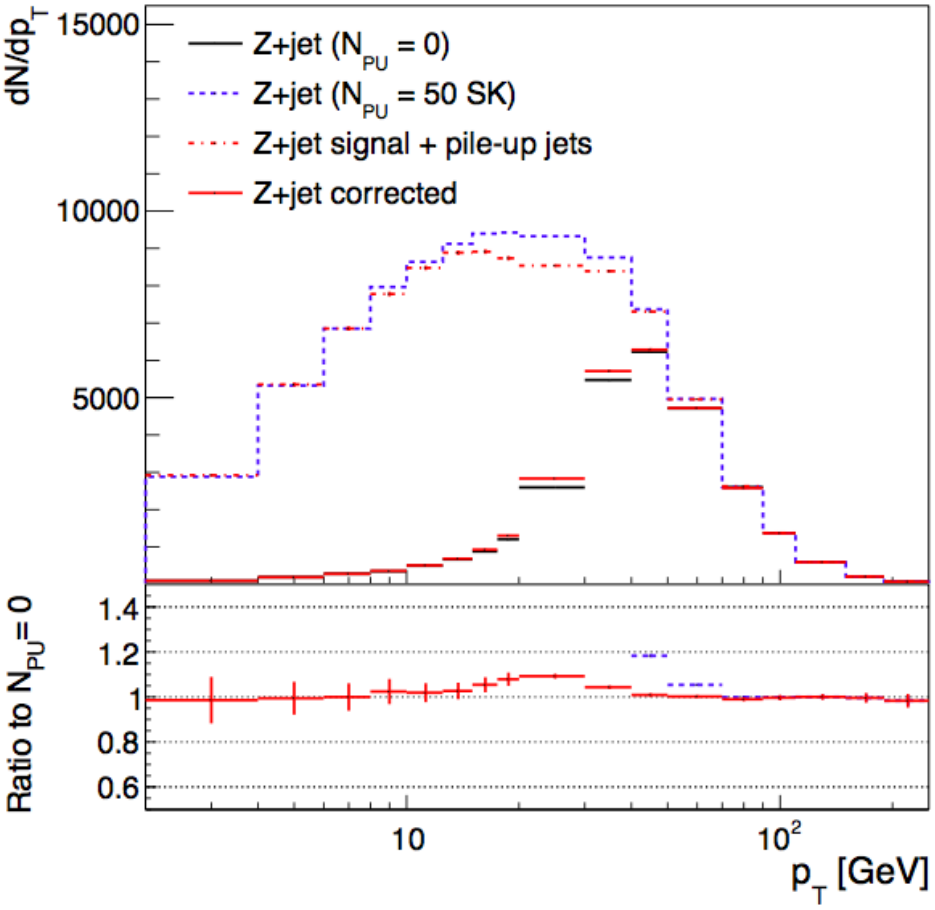
$$\mathcal{M} \otimes T = \mathcal{D}$$

mixing matrix — "true" — data

To identify contribution of high-pT jets from independent pile-up events, construct signal + pile-up scenario In a data-driven manner.

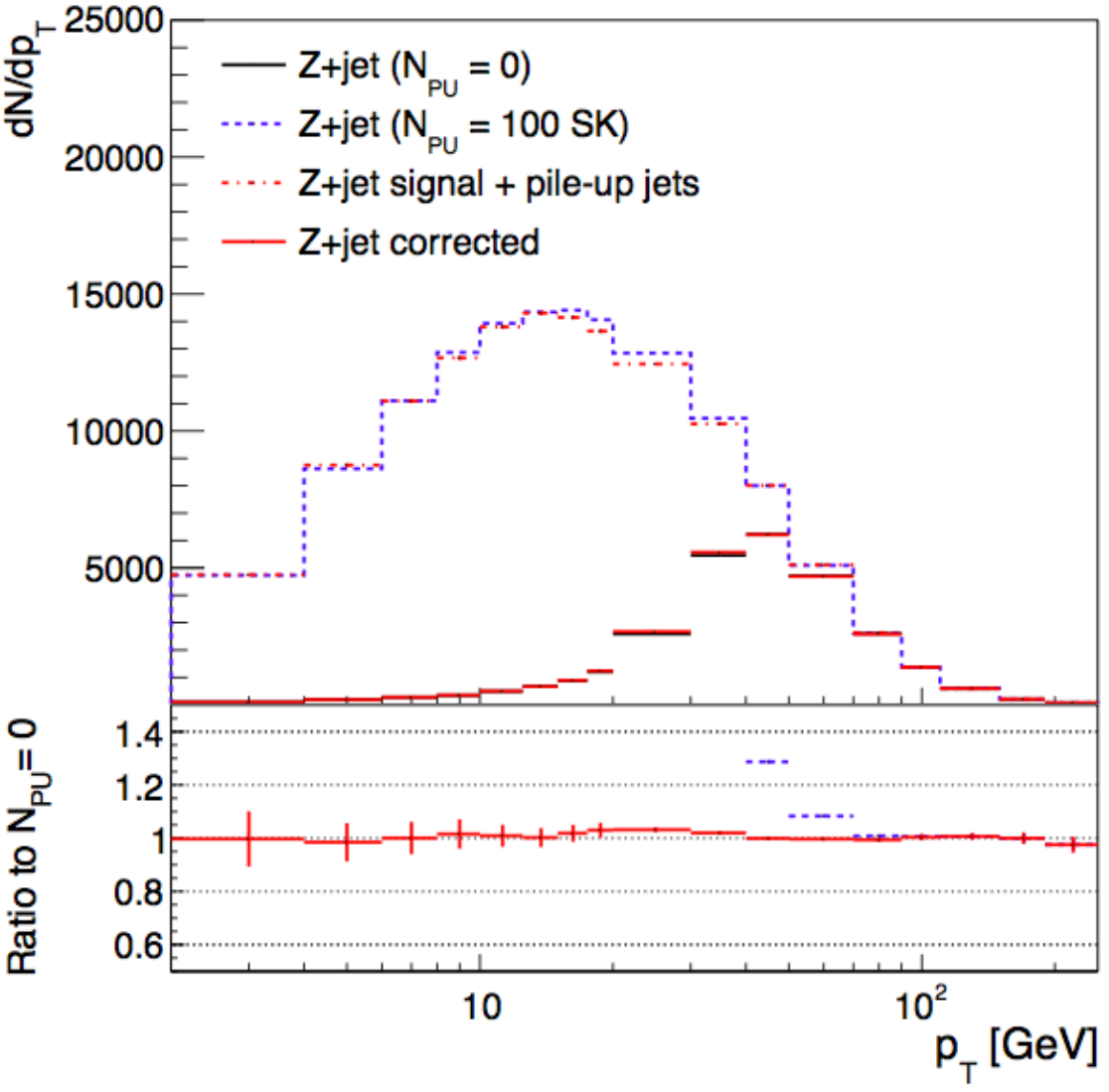
Valid for high pile-up:

$$(N_{\mathrm{PU}} + 1)/N_{\mathrm{PU}} \approx 1$$

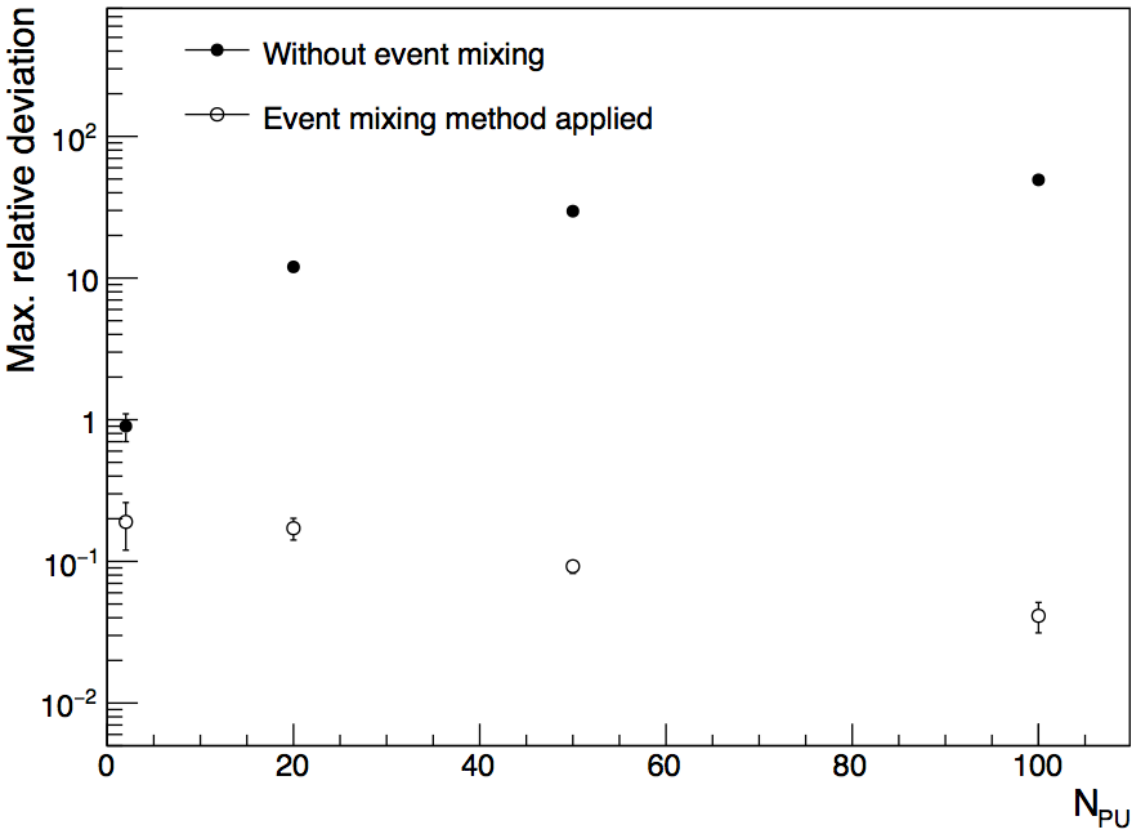


Without appealing to any Monte Carlo method, true signal extracted nearly perfectly from mixed sample

Treating effects beyond the jet pT pedestal: high pile-up N_PU = 100



Maximal relative deviation between pile-up corrected signal and true signal as a function of the number of pile-up collisions



black dots: SoftKiller corrected result, without event mixing
open dots: event mixing method applied

Control checks on jet resolution from applying event mixing method

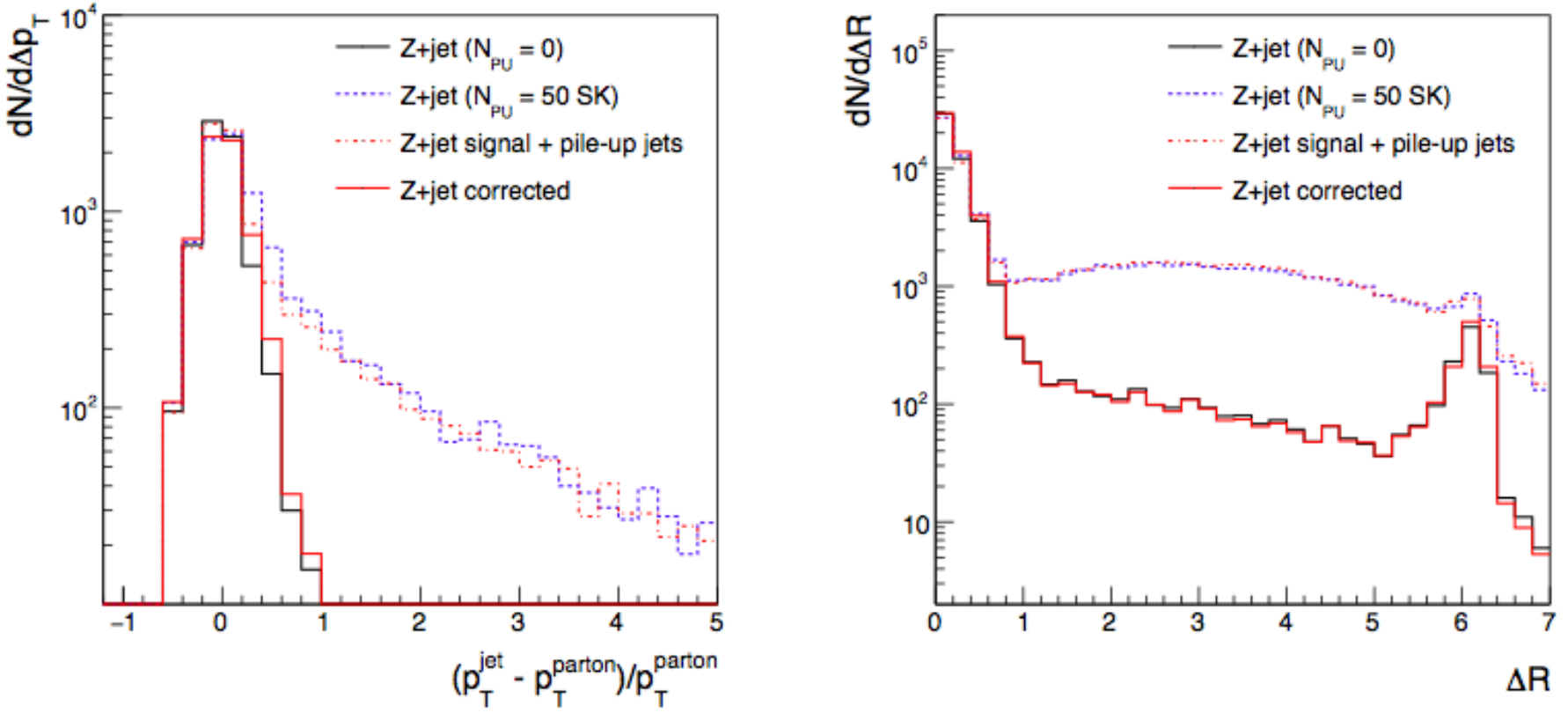
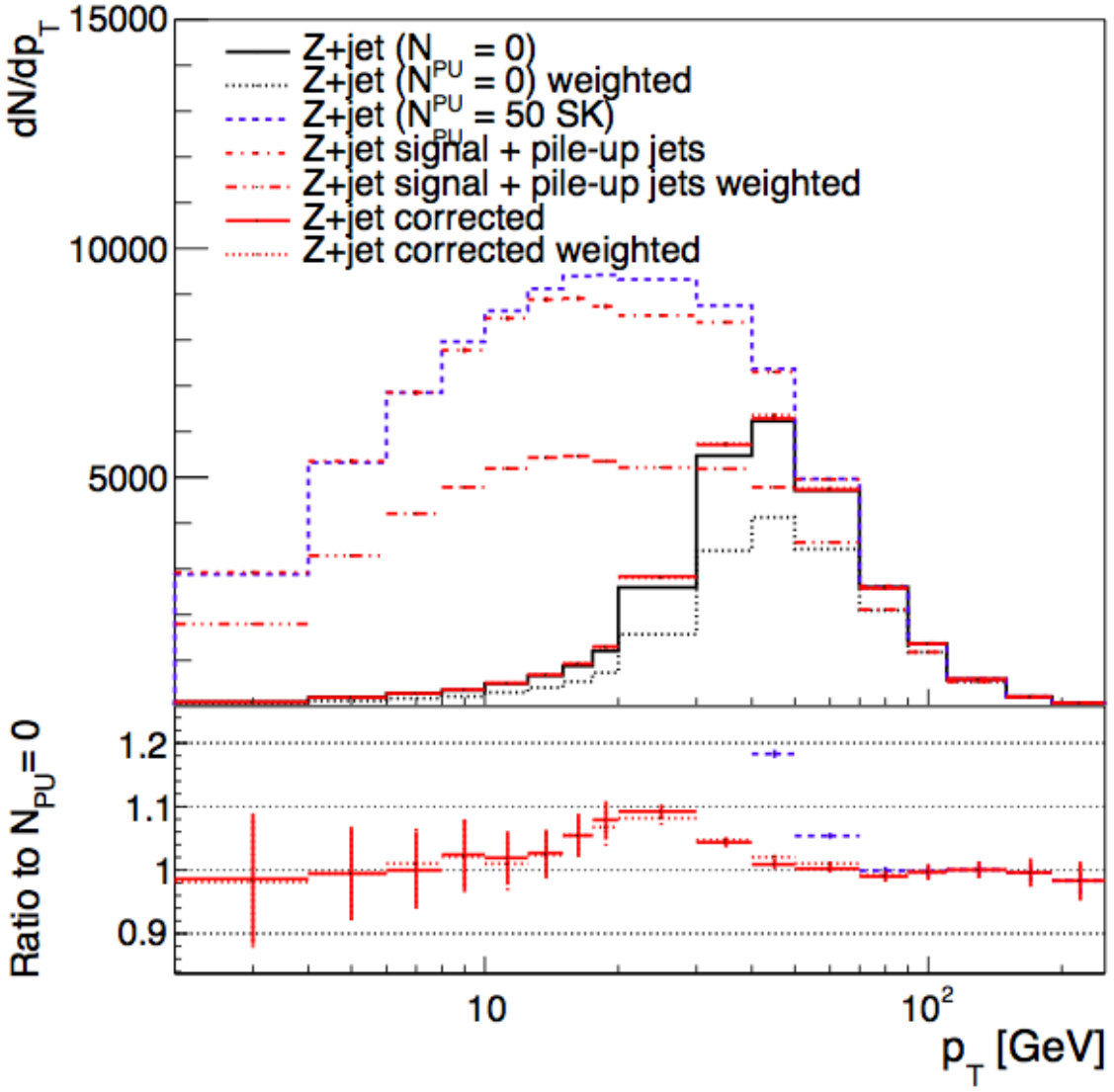


FIG. 5. *Effects on jet resolution: (left) the parton-jet p_T correlation; (right) the ΔR distribution.*

Comment on the unfolding: what if the mixing is done with the “wrong” ansatz for the signal?



mixed sample now far off pseudodata – but true signal still recovered from unfolding!

To sum up

- Effects of pile-up beyond the jet pT pedestal: mistagging of high-pT jets from independent pile-up events
- Treatment by data-driven methods, not dependent on Monte Carlo generators
- Relevant especially for regions outside tracker acceptances, where vertexing techniques cannot be relied on to identify pile-up jets. Example: Higgs by vector boson fusion
- No need for low pile-up runs – no loss in luminosity