A Pythia8 tune of Ttbar observables

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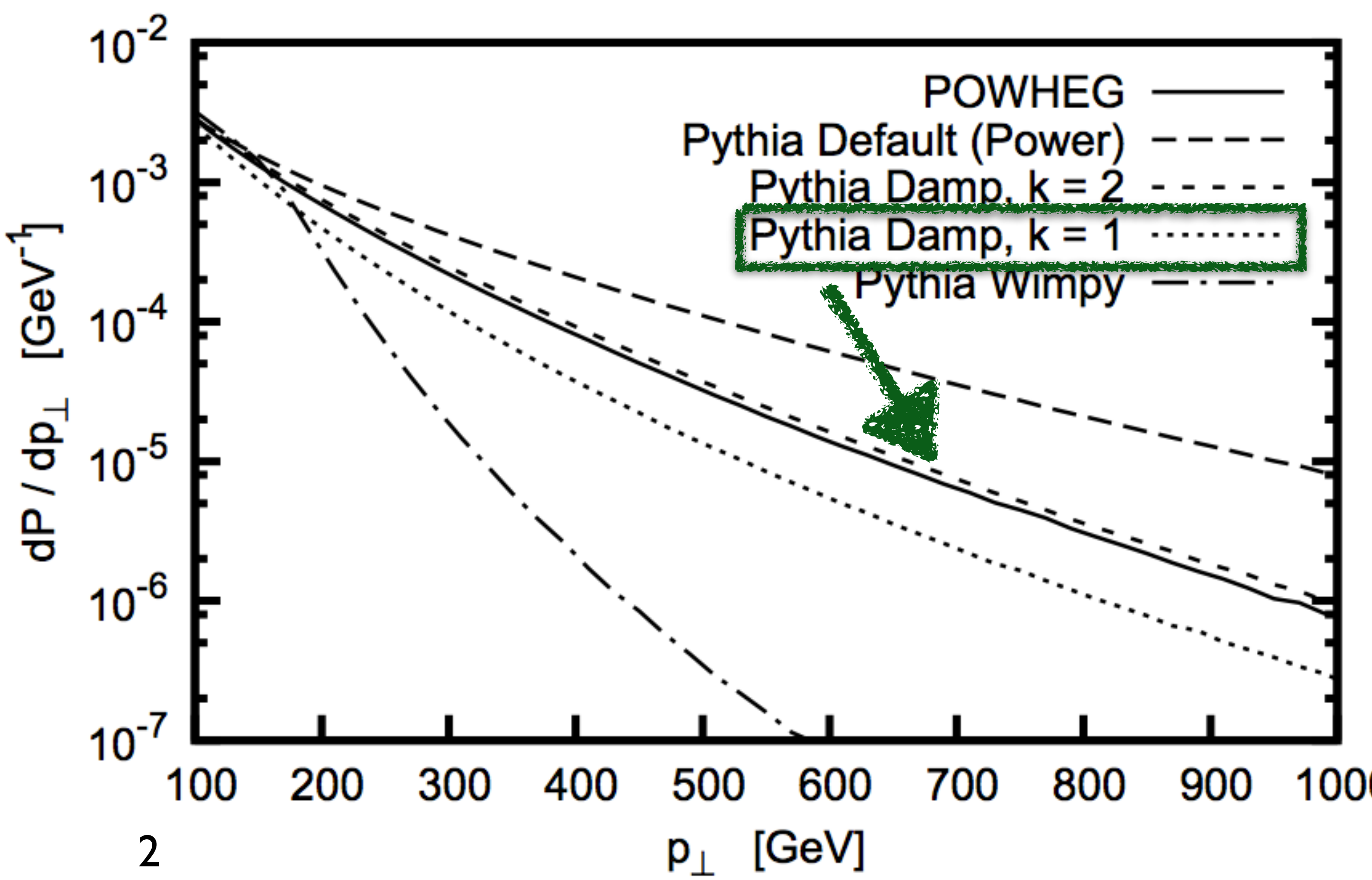
Motivation

- Inspired by (hep-ph:1003.2384):
  "Improved parton showers at large transverse momenta"
  - Neither power or wimpy showers are found to describe the high-p_T tail of ttbar events:
    - **Wimpy shower** ($1/p_T^2$ up to fac. scale, 0 after) underestimate data
    - **Power shower** ($1/p_T^2$ over all p_T range)
  - A new correction is introduced to get the first emission right
    - $1/p_T^2$ up to fac. scale, then gradually shifting to $1/p_T^4$

ren. or fac. scale (only coloured states play a role)

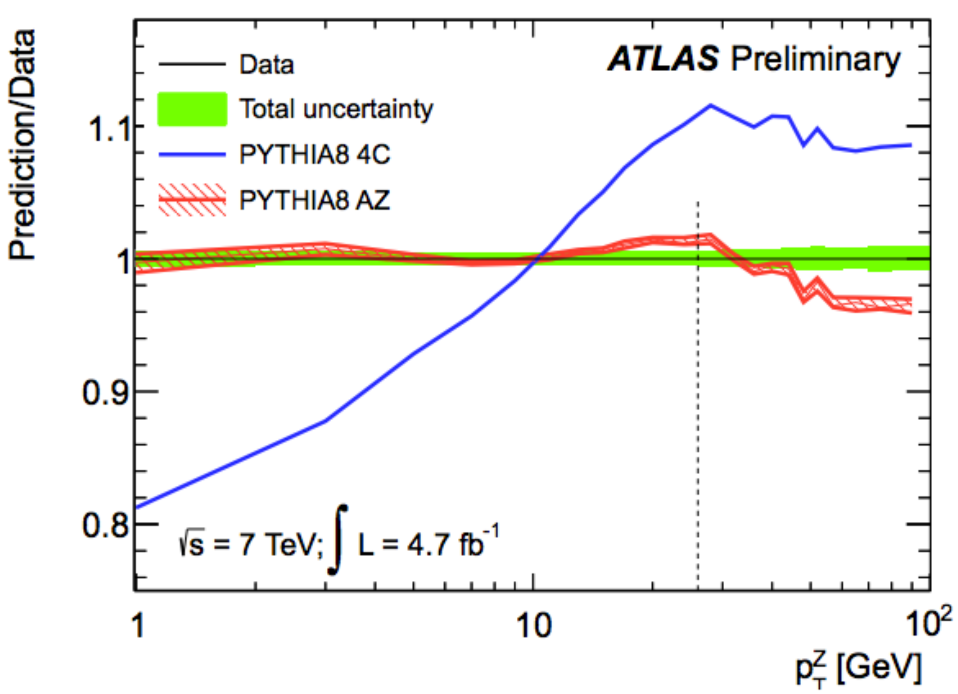
$$\frac{\mathrm{d}\mathcal{P}_{\mathrm{ISR}}}{\mathrm{d}p_\perp^2} \propto \frac{1}{p_\perp^2}\frac{k^2M^2}{k^2M^2+p_\perp^2}$$

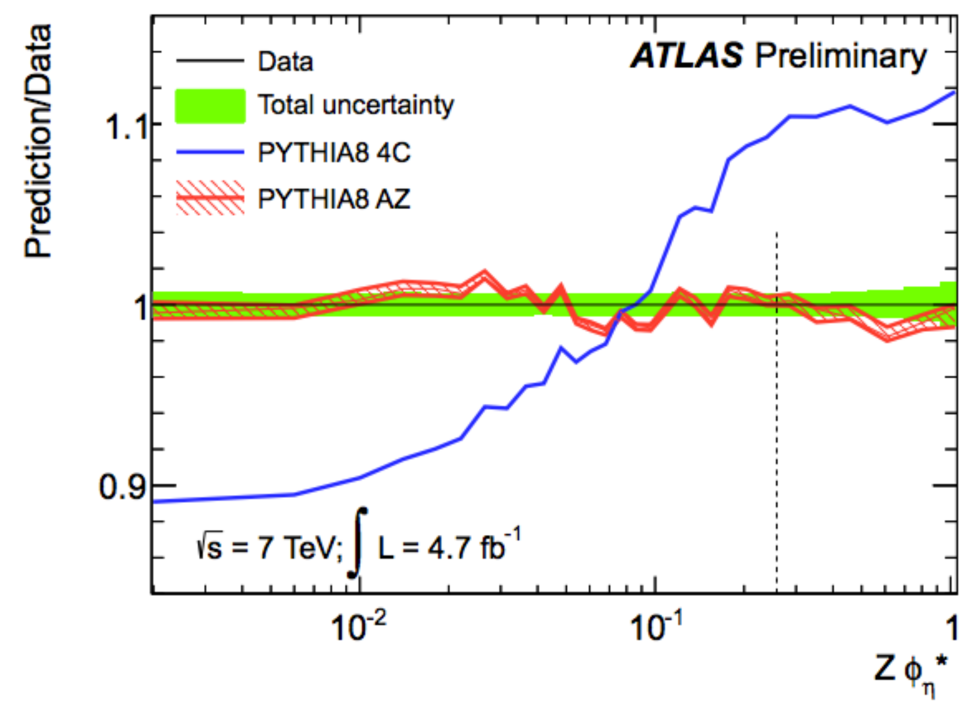
fudge factor of order unity



Motivation

- Test consistency between the **AZ tune** (**α_S^{ISR}**=0.1237+-0.0002, **primordial K_T**=1.71+-0.03, **pT0Ref** = 0.59+-0.08) to Z p_T and the ISR radiation in ttbar observables
  - Different initial states (**qq** vs **gg**) provide a strong test of PS model



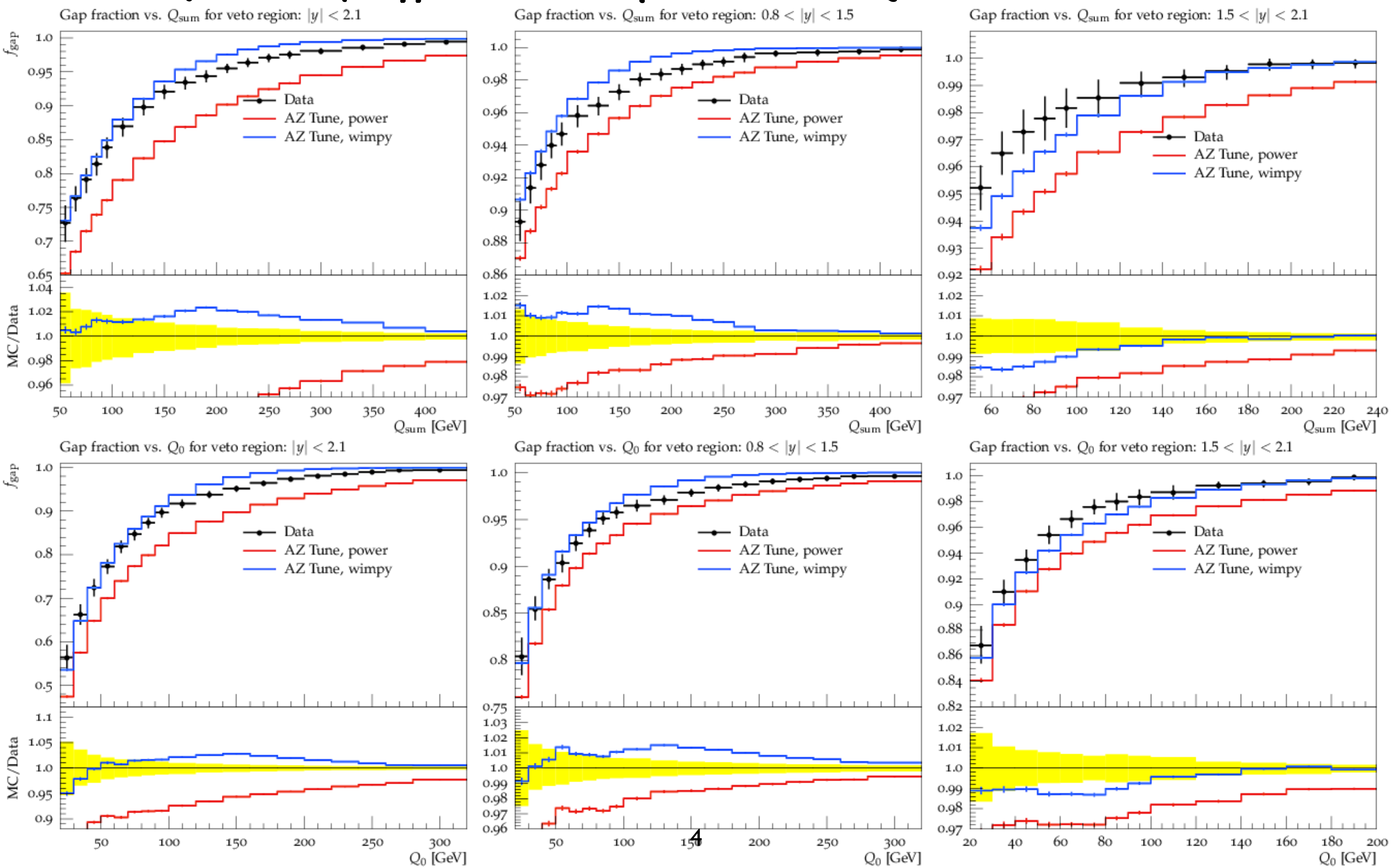


- A **Pythia8** tune of ISR on coloured final states would have direct applications for SUSY and BSM processes, for which ME corrections to the first radiation are not available in Pythia

- Test case for the new features in Professor allowing handling of uncertainties correlations in the χ^2 computation

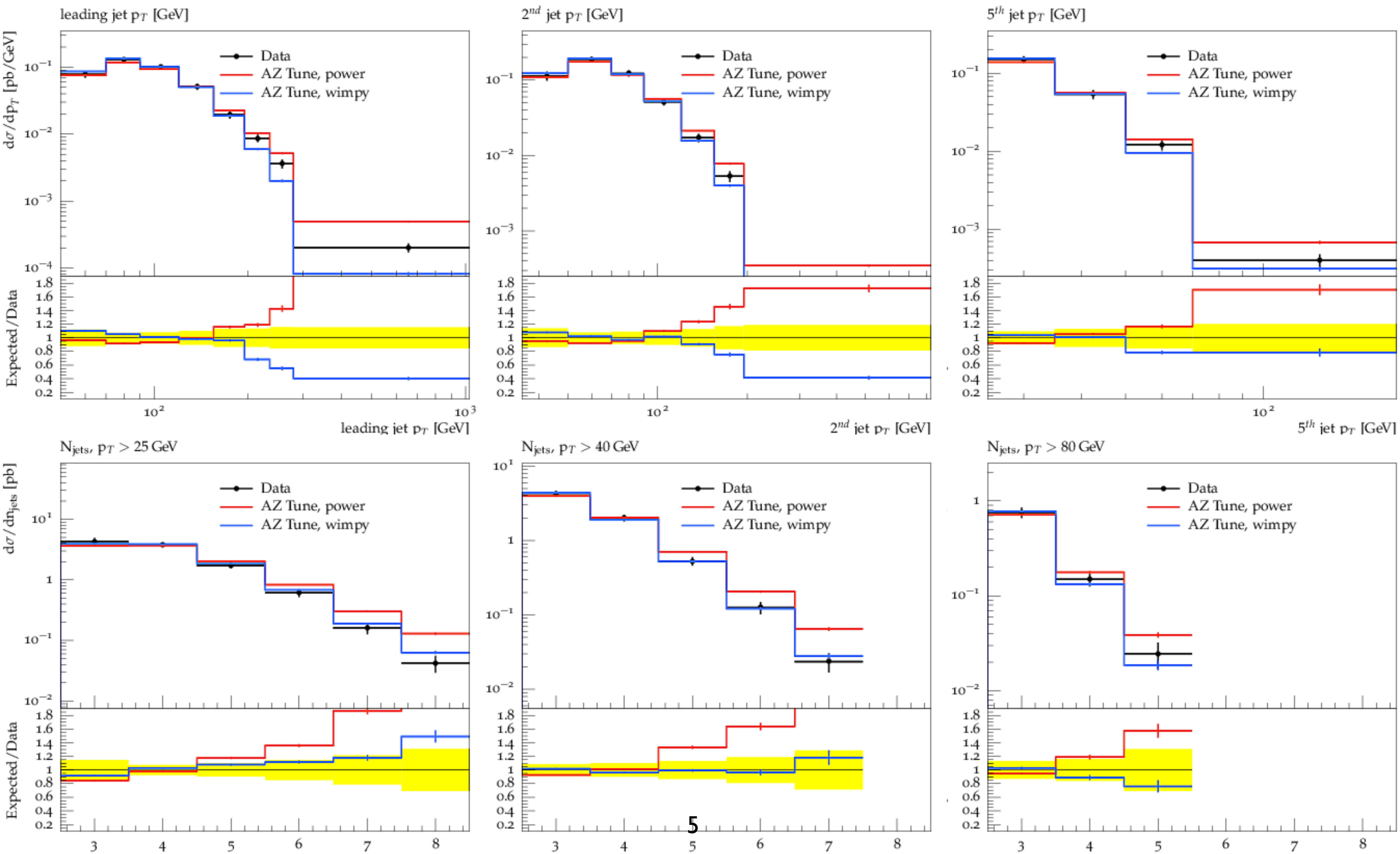
GapFraction

- "Measurement of ttbar production with a veto on additional central jet activity in pp collisions at sqrt(s) = 7 TeV using the ATLAS detector"



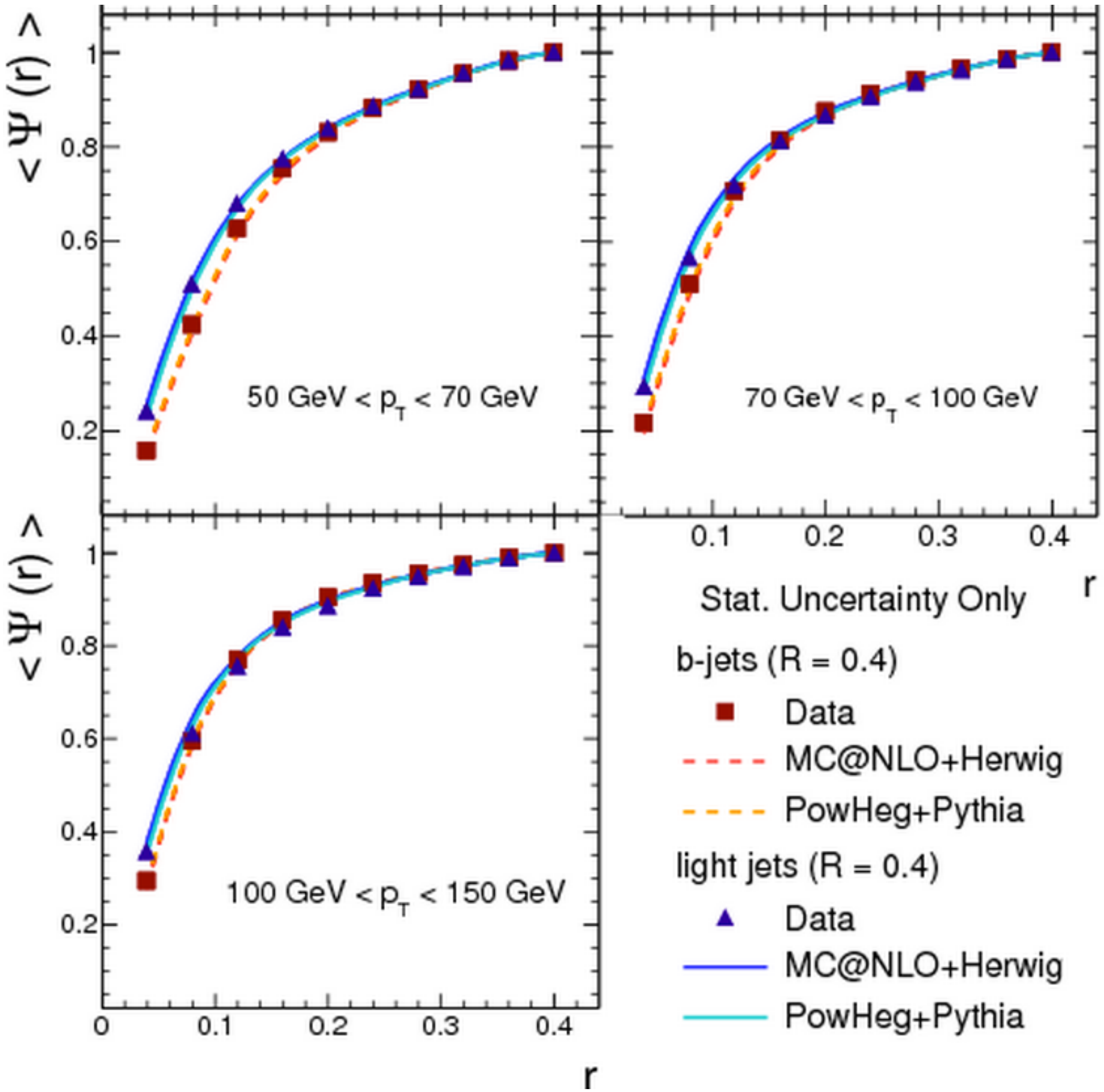
Ttbar+jets

- "Measurement of the ttbar production cross-section as a function of jet multiplicity and jet transverse momentum in 7 TeV proton-proton collisions with the ATLAS detector"



Ttbar+jets

- **Measurement of jet shapes in top-quark pair events at √s = 7 TeV using the ATLAS detector**

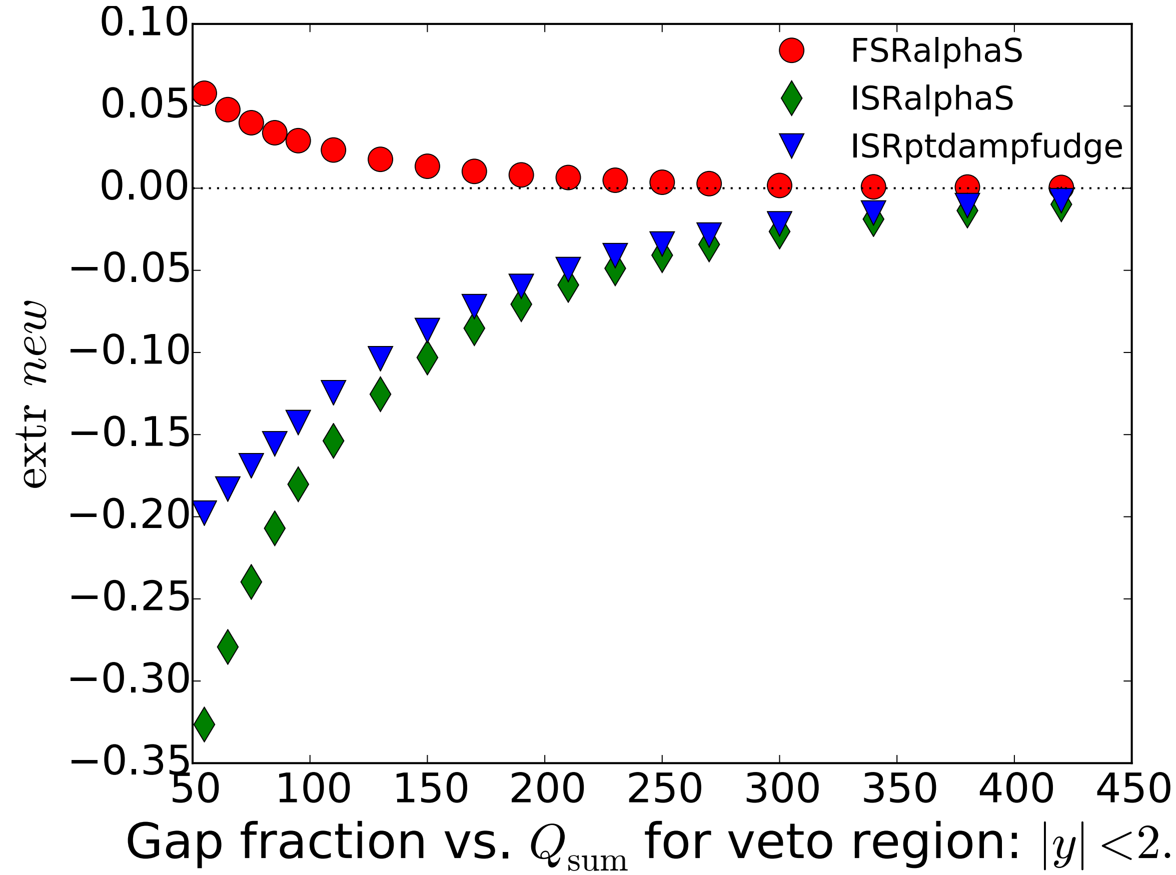


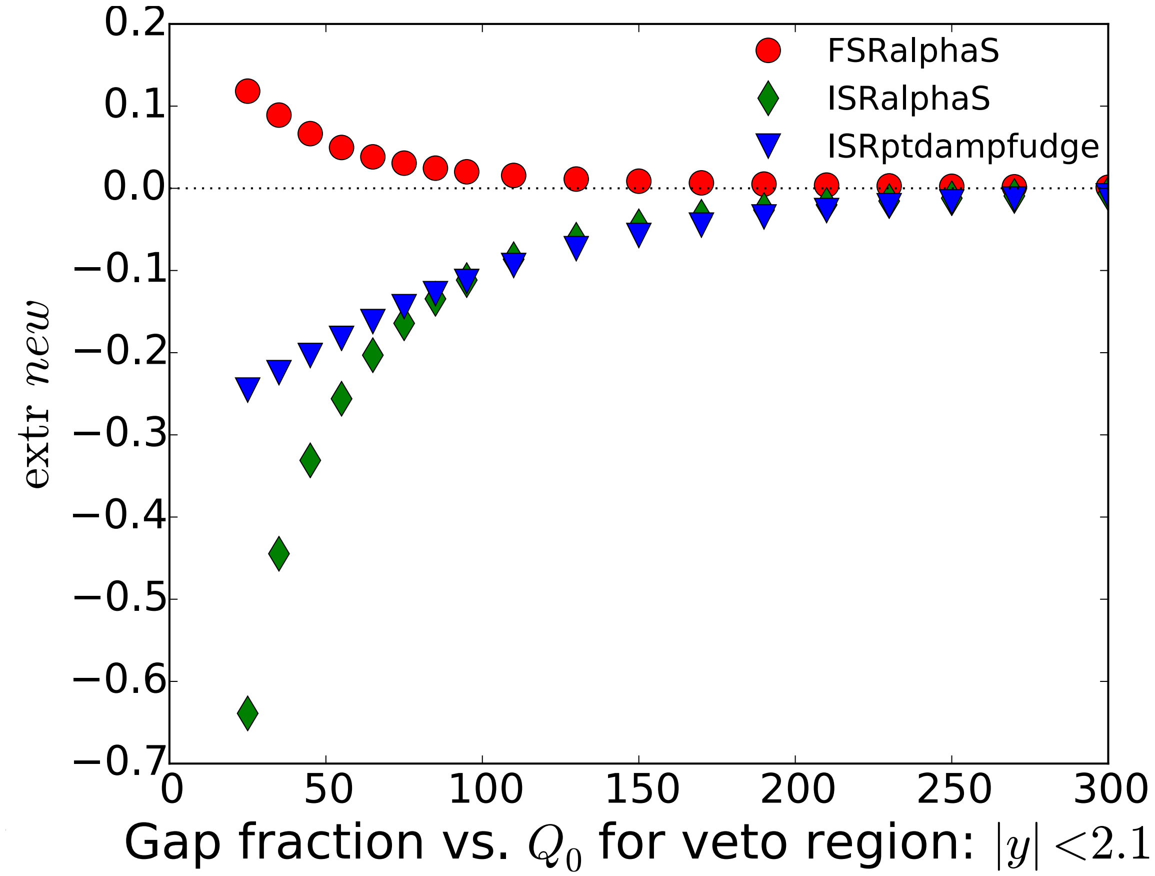
Setup

- The tunes are performed with the *Professor* framework
- As tuning parameters we are considering two cases:
  - α_S^{ISR} and the ISR fudge factor *$p_T$dampfudge*
  - α_S^{ISR} , *$p_T$dampfudge* and α_S^{FSR}
- Tune4C (with ISR pTdampMatch = 1) is used as baseline, Monash as a cross-check (and to check the impact of PDFs)
- Considered 2/300 (for 2/3 parameters) anchor points with random parameters sampled within the ranges:
  - *$p_T$dampfudge* = [0.6, 2]
  - α_S^{ISR} = [0.10, 0.14]
  - α^{FSR} = [0.10, 0.2]
- 20M events are generated per point; for the gap fraction analysis we force the Ws to decay leptonically, both to enhance statistics and because of some issues with the Rivet routine
- For each point the observables for the ttbar+jets analysis have been rescaled to the reference data, to account for the LO Pythia8 cross-section

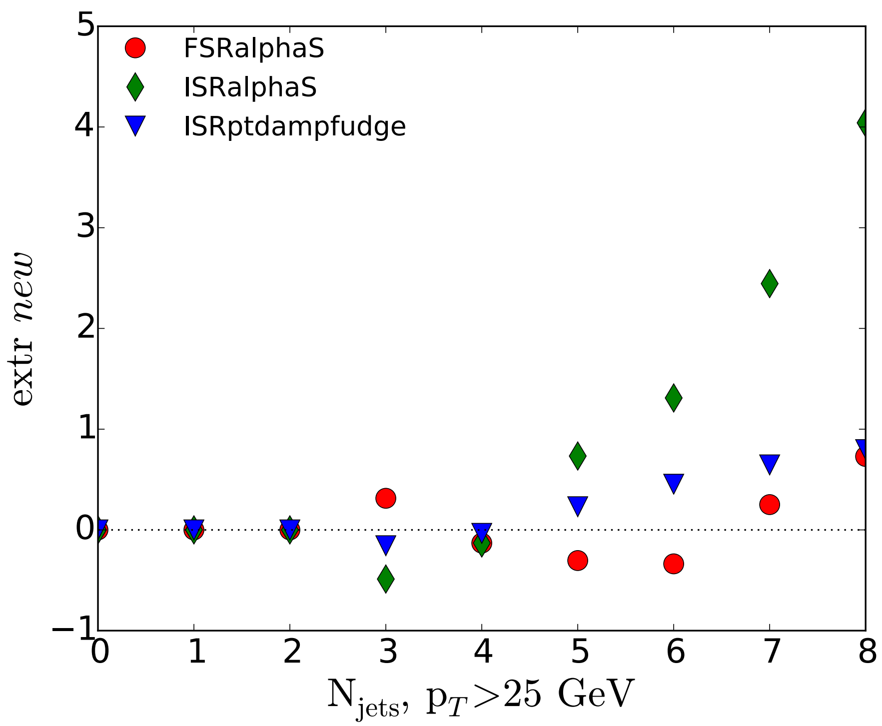
Sensitivities

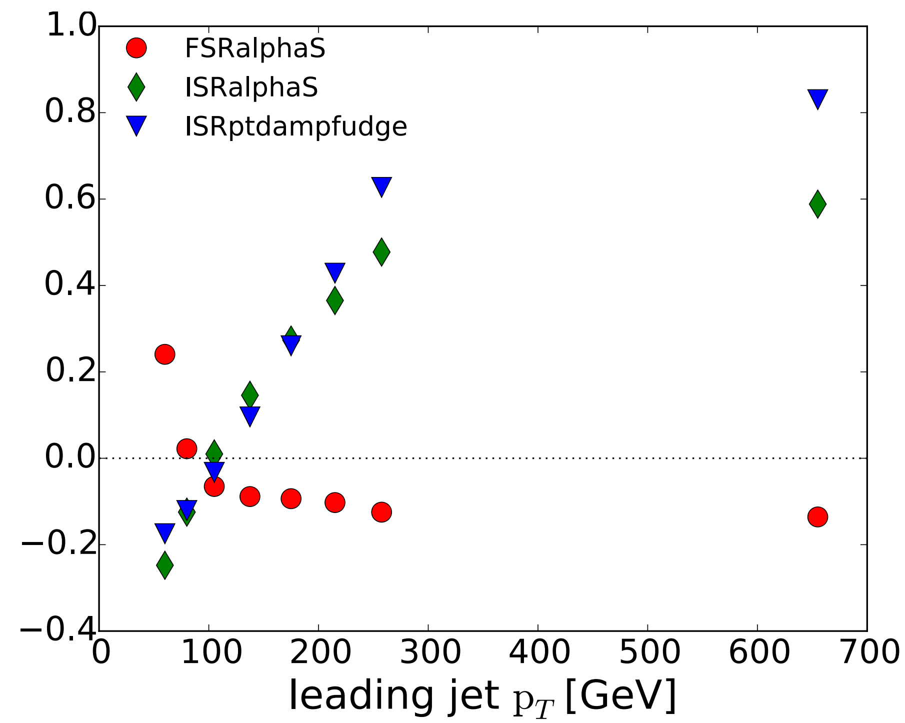
gap fraction

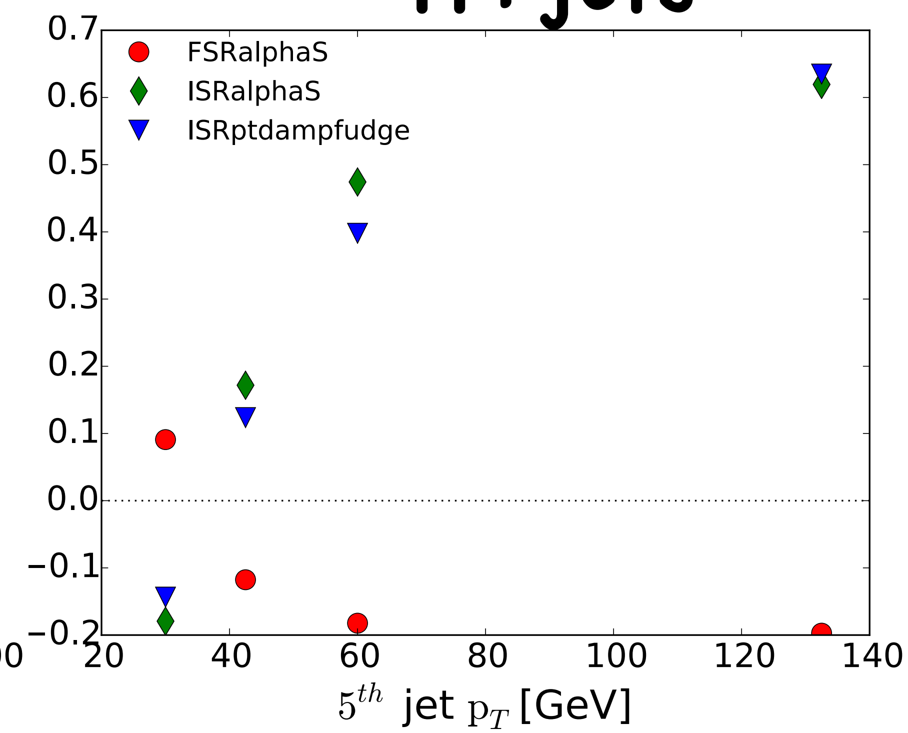




tt+jets







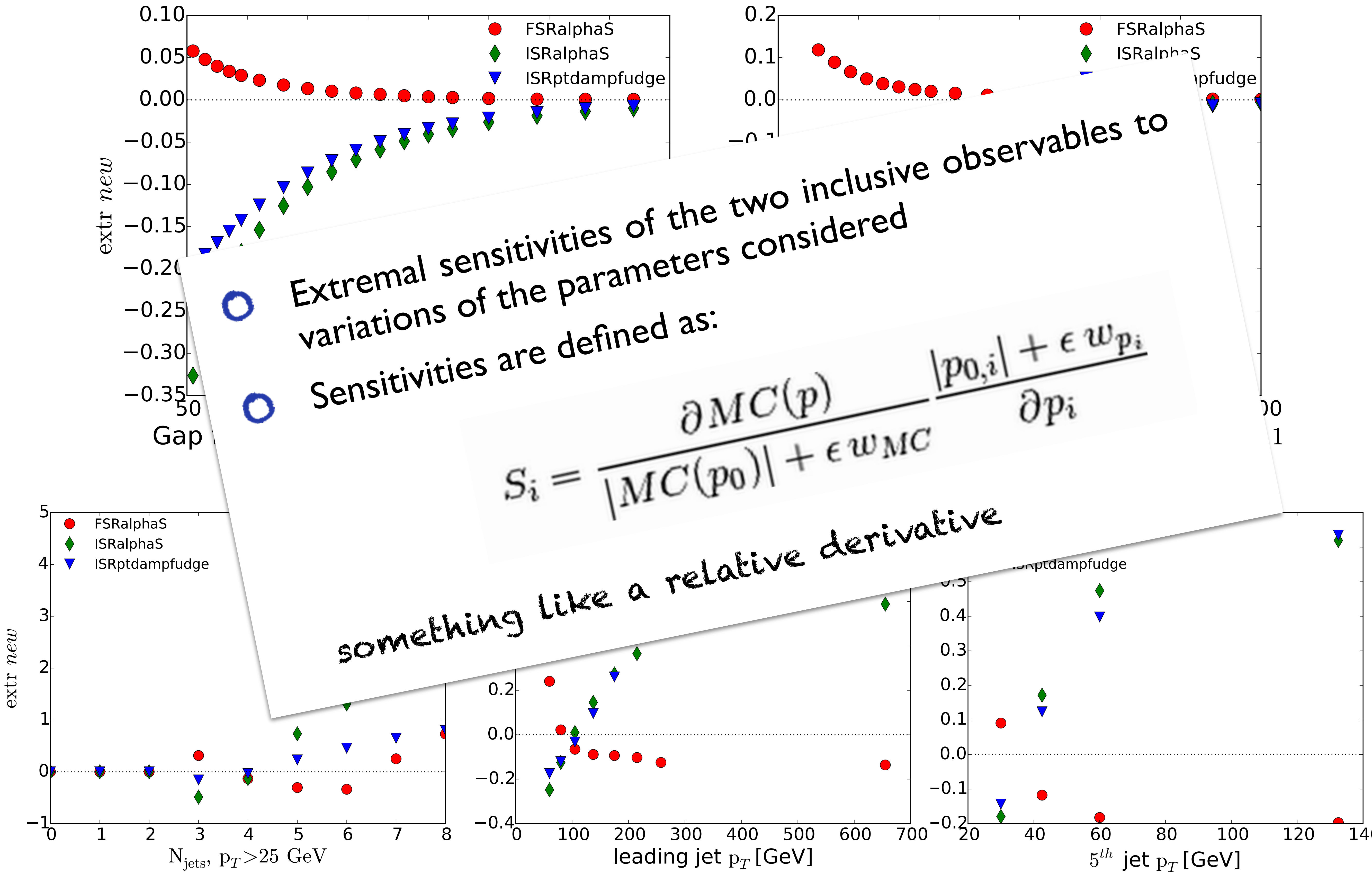
Sensitivities

gap fraction

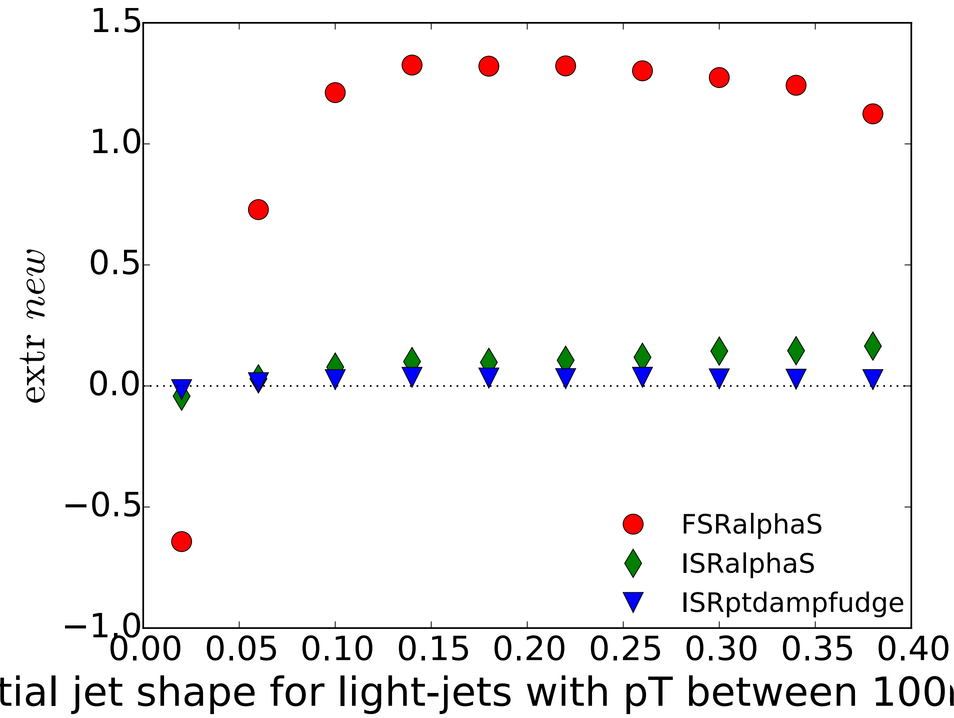
- Extremal sensitivities of the two inclusive observables to variations of the parameters considered
- Sensitivities are defined as:

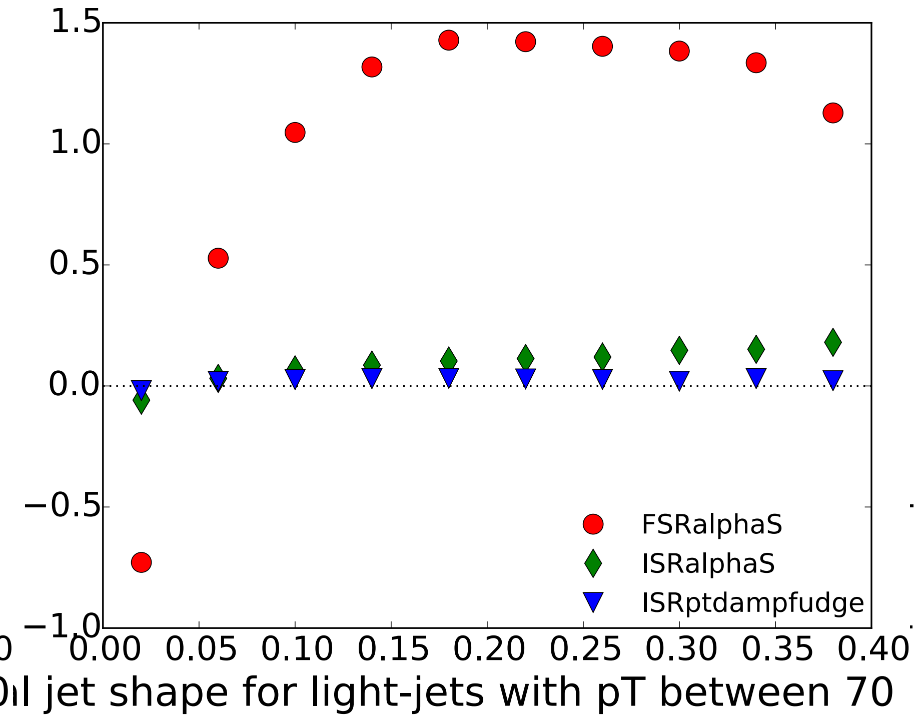
$$S_i = \frac{\partial MC(p)}{|MC(p_0)| + \epsilon\, w_{MC}} \frac{|p_{0,i}| + \epsilon\, w_{p_i}}{\partial p_i}$$

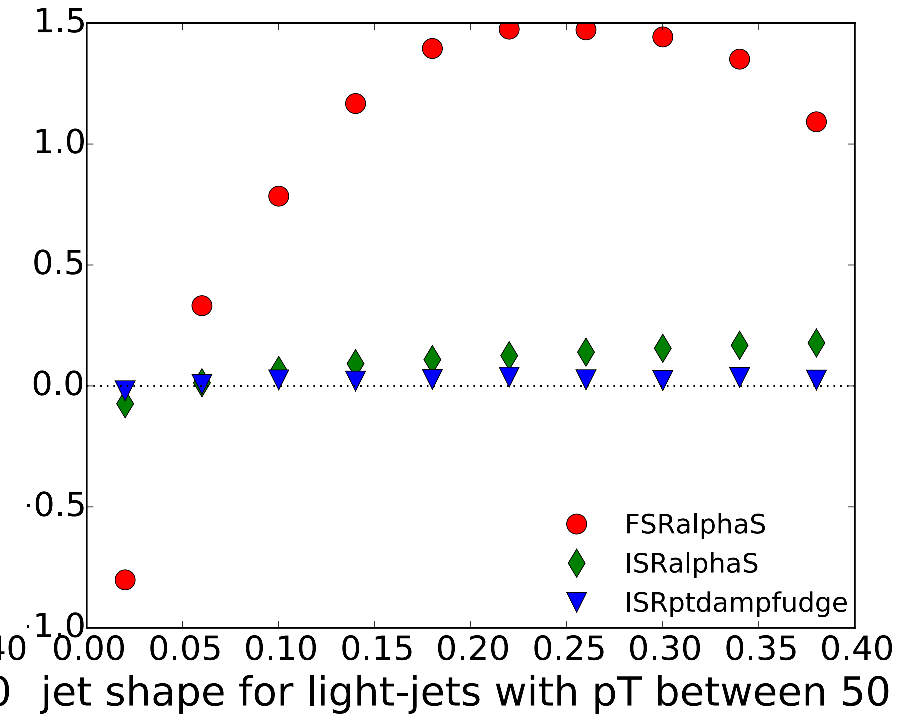
something like a relative derivative



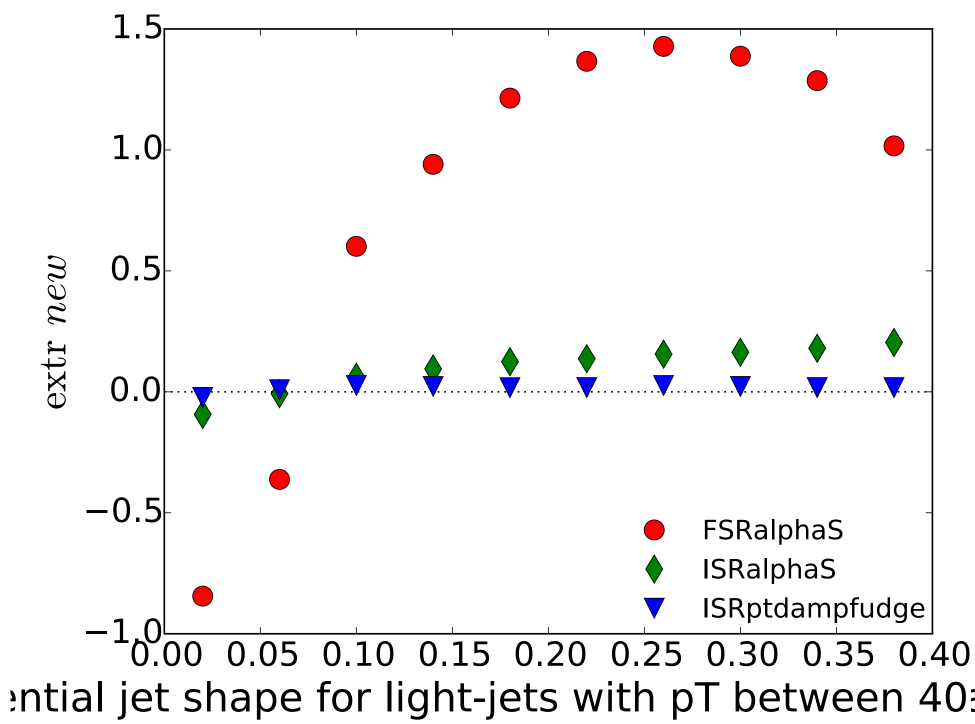
Sensitivities

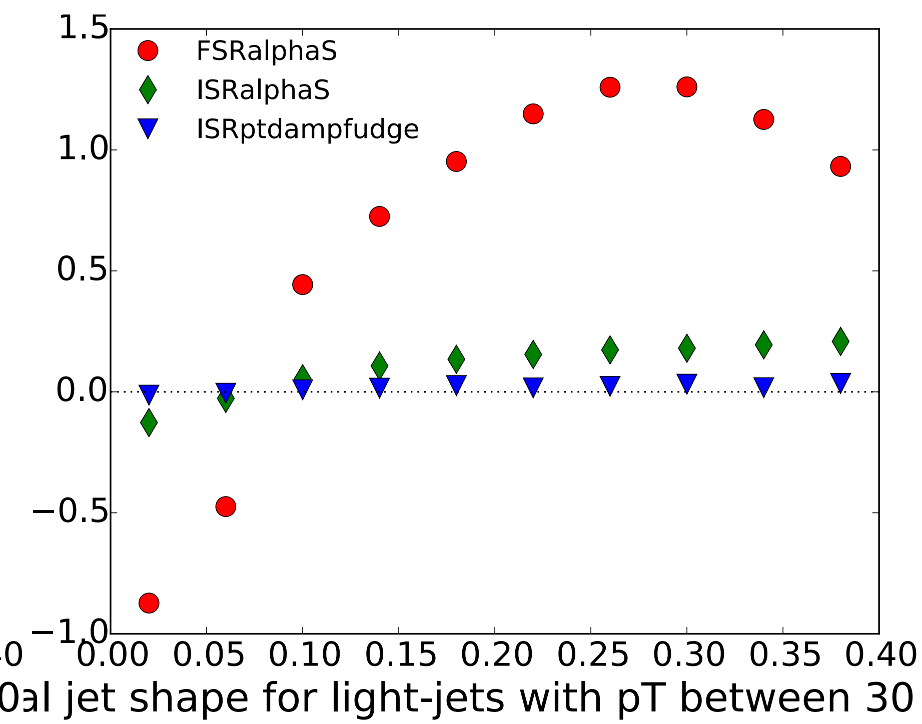




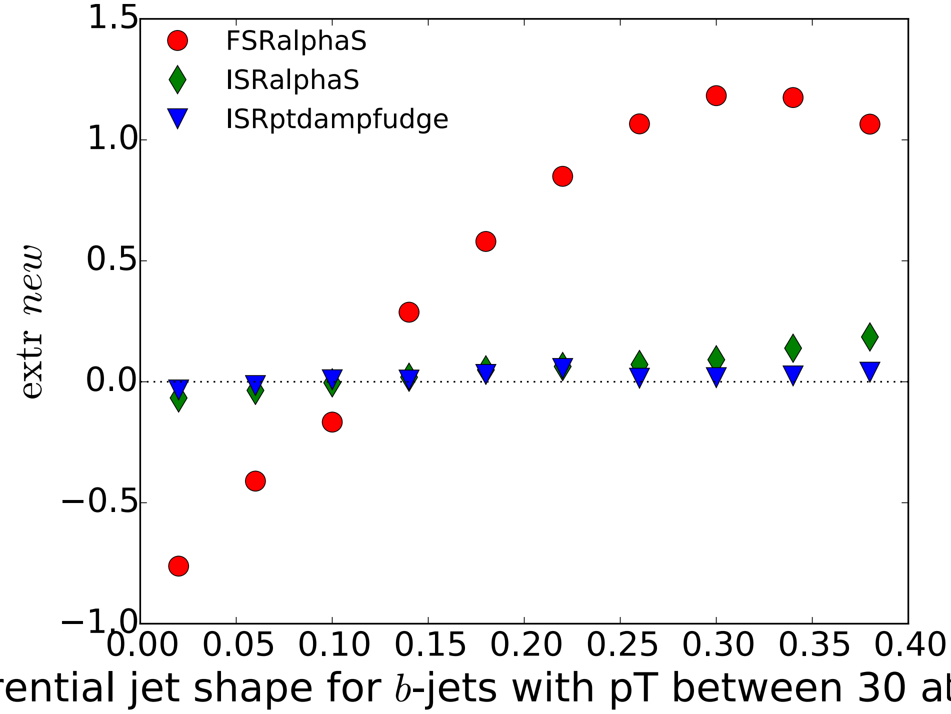


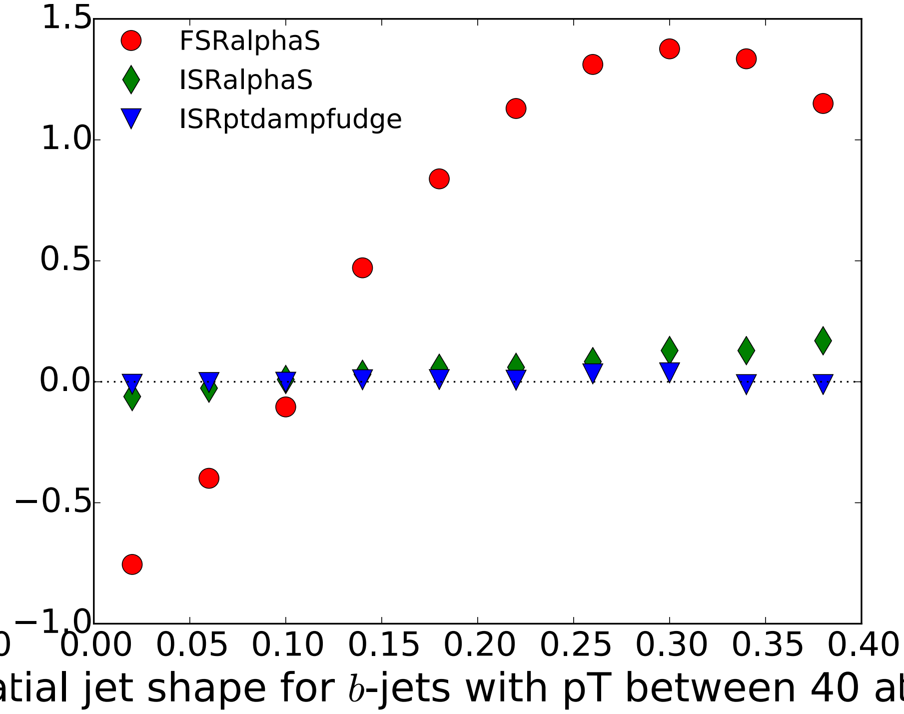
jet shapes
for light jets

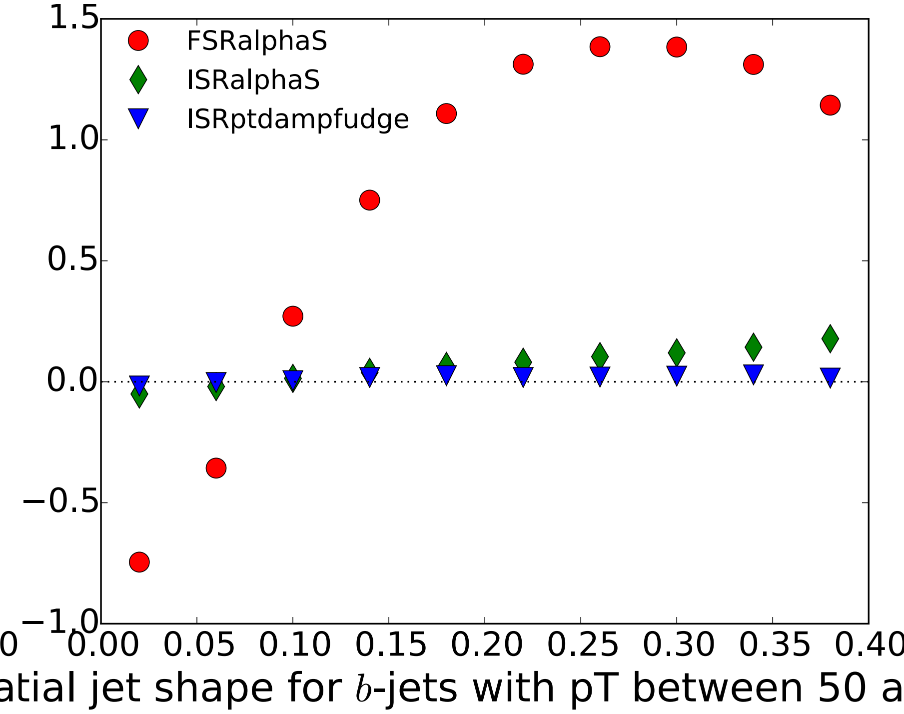




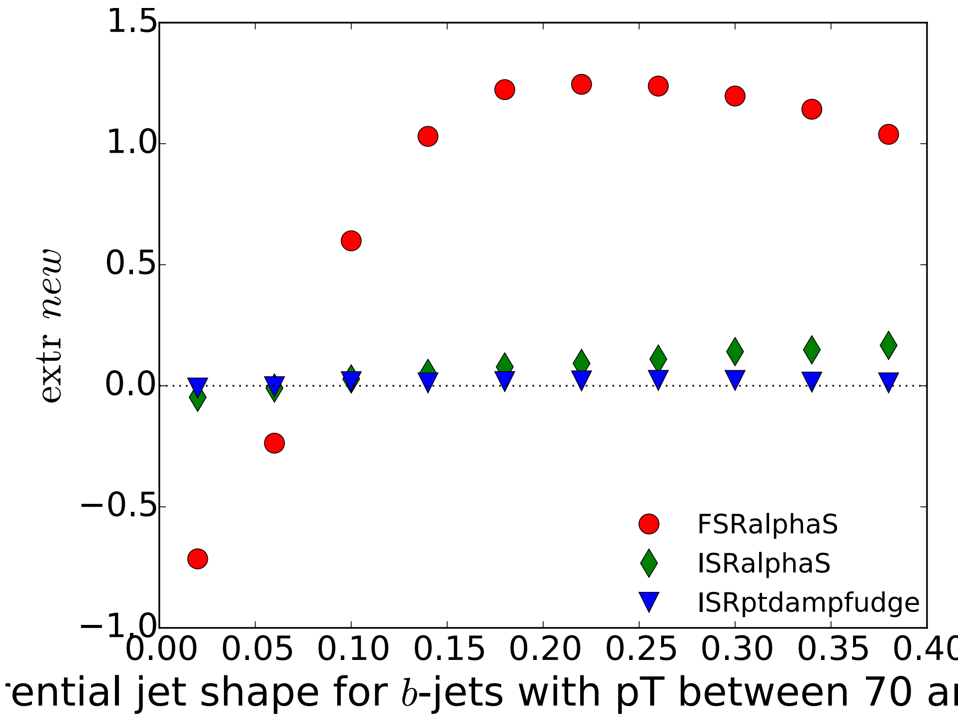
Sensitivities

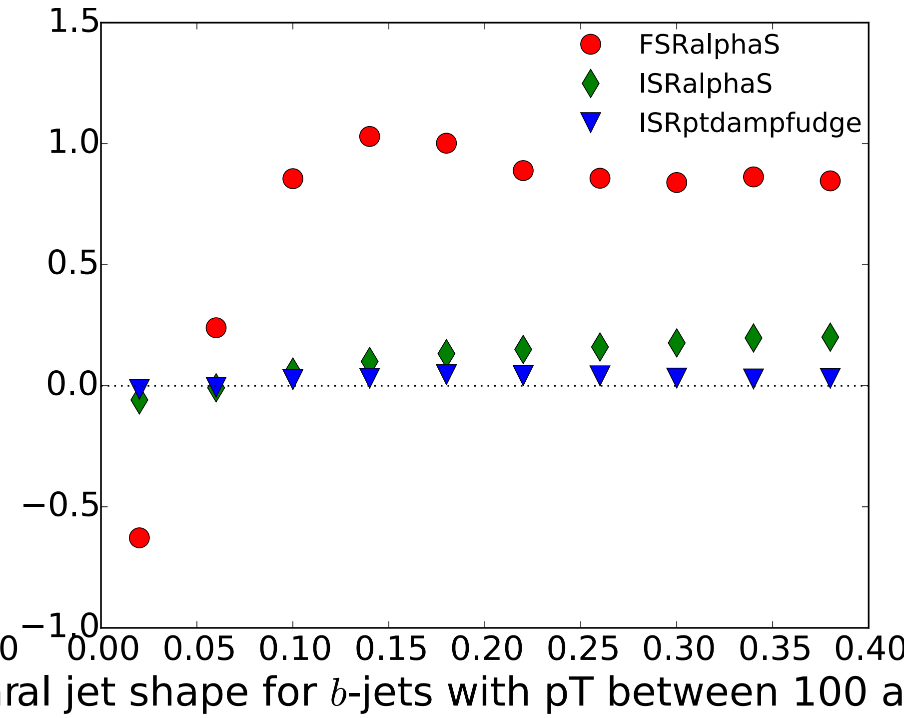






jet shapes for b-jets





2 PARAMETERS TUNE

- Tune of the ISR parameters only, using the gap fraction and tt+jets separately and using as baseline 4C with rapidityOrder=Off

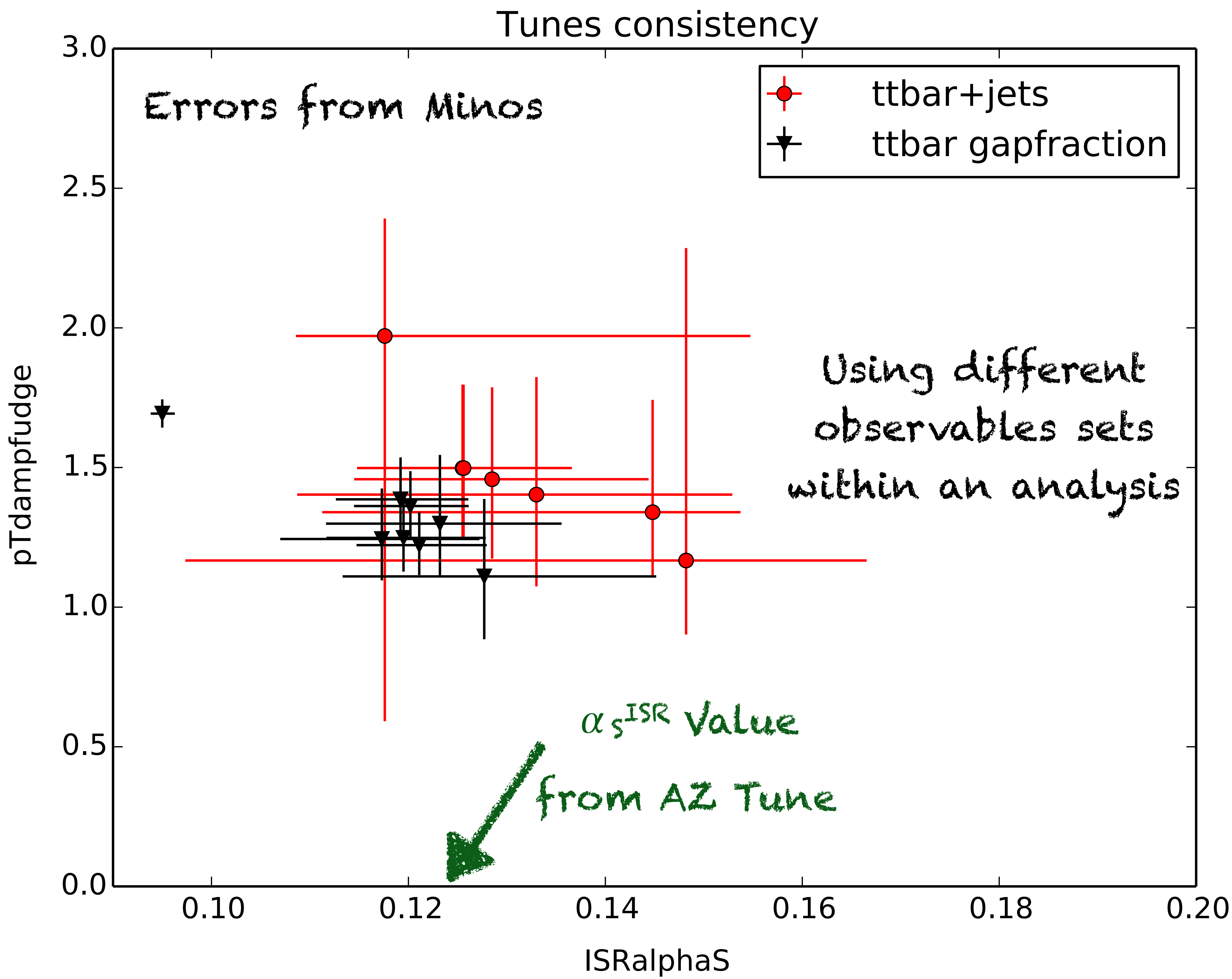
- For the first tune we have used the inclusive gap fractions Q0 and Qsum

  - $p_T dampfudge$ = 1.2+-0.1
  - α_S^{ISR} = 0.121+-0.006

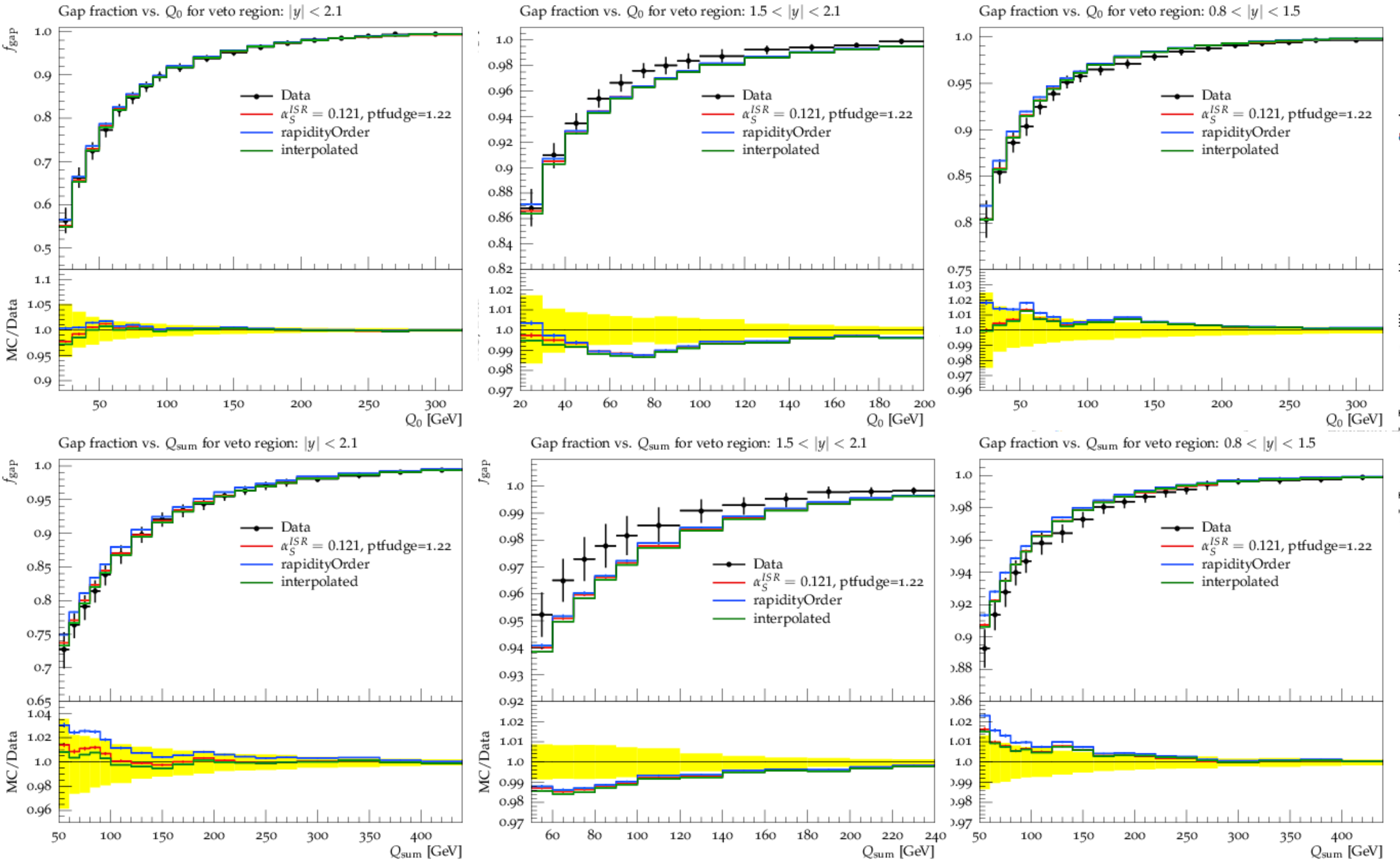
- The second tune uses the leading and 5th jet pT distributions, as well as the number of jets with pT>25GeV

  - $p_T dampfudge$ = 1.50+-0.25
  - α_S^{ISR} =0.125+-0.11

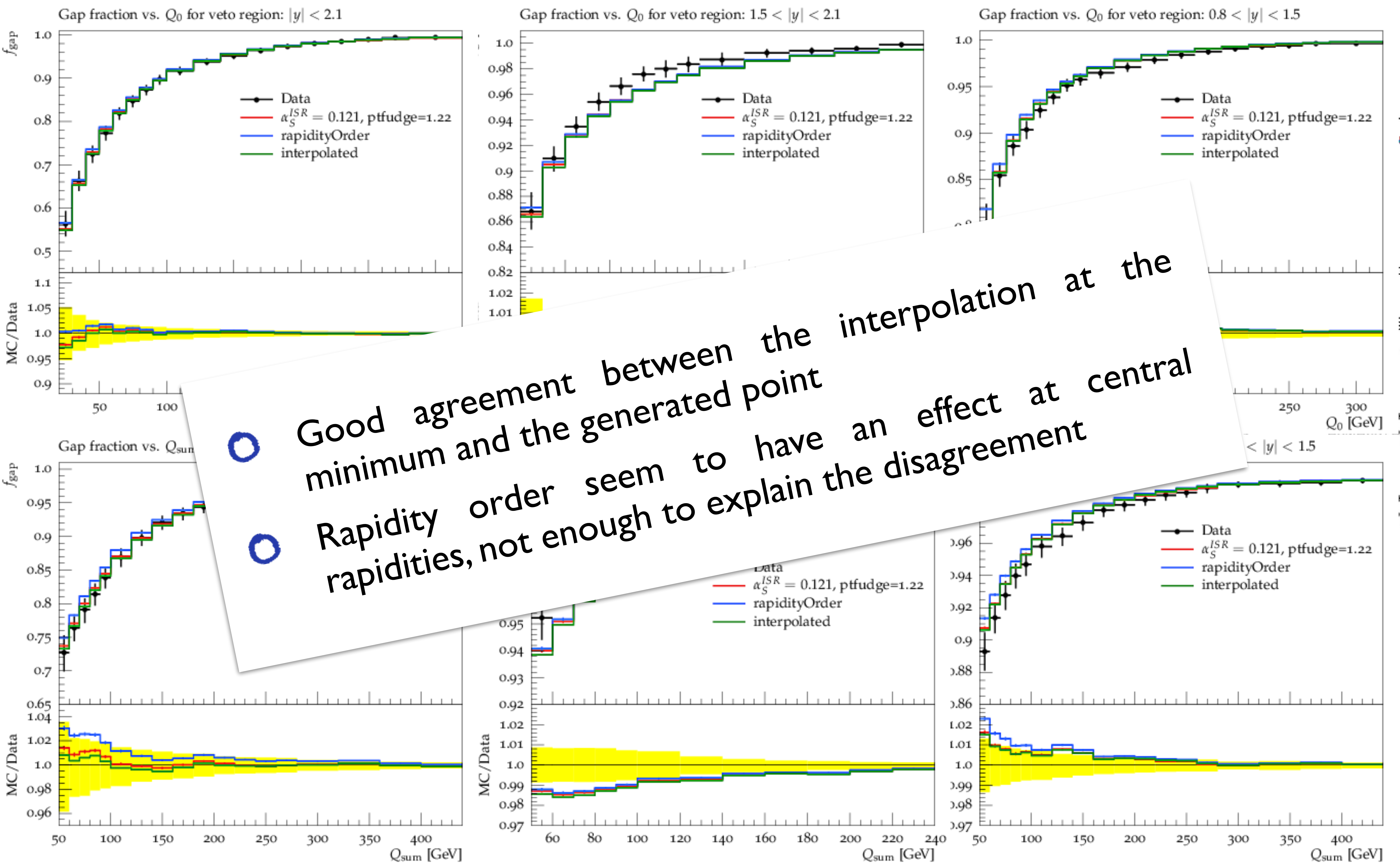
Tunes Consistency



Tuning - Inclusive Gap Fraction



Tuning - Inclusive Gap Fraction



- Good agreement between the interpolation at the minimum and the generated point
- Rapidity order seem to have an effect at central rapidities, not enough to explain the disagreement

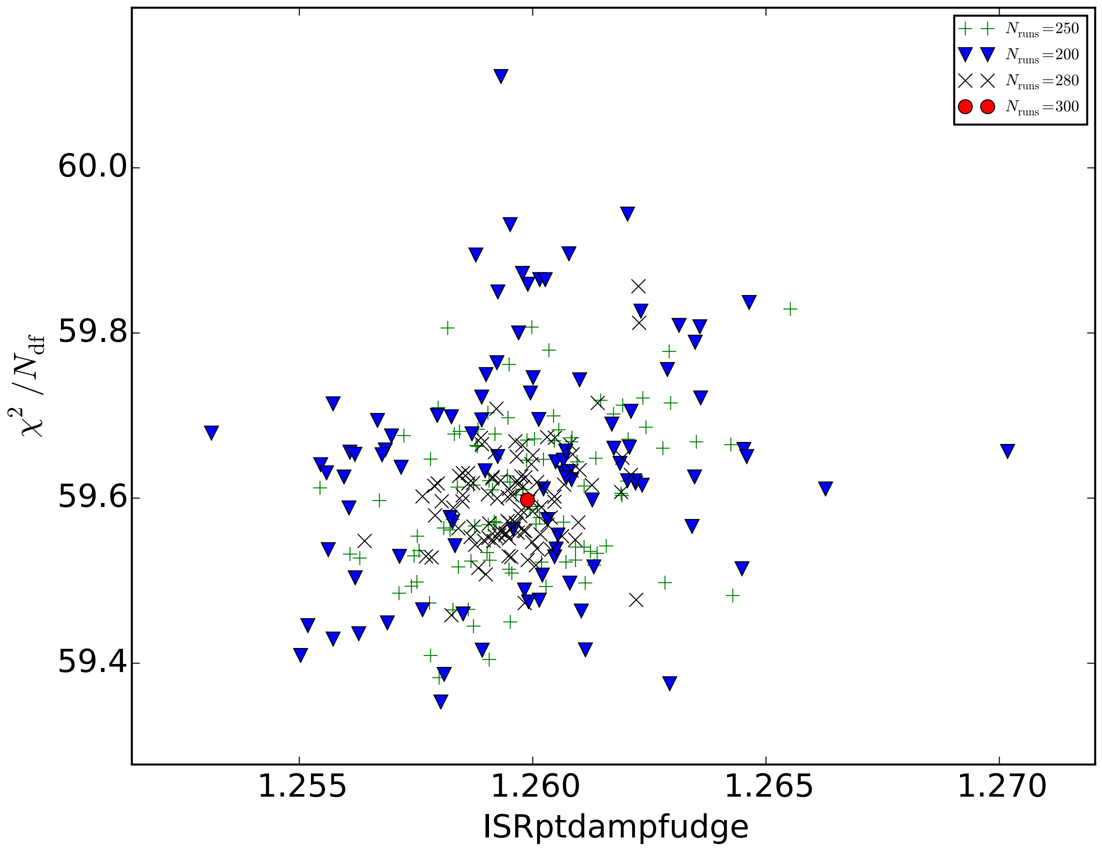
3 - PARAMETER TUNE

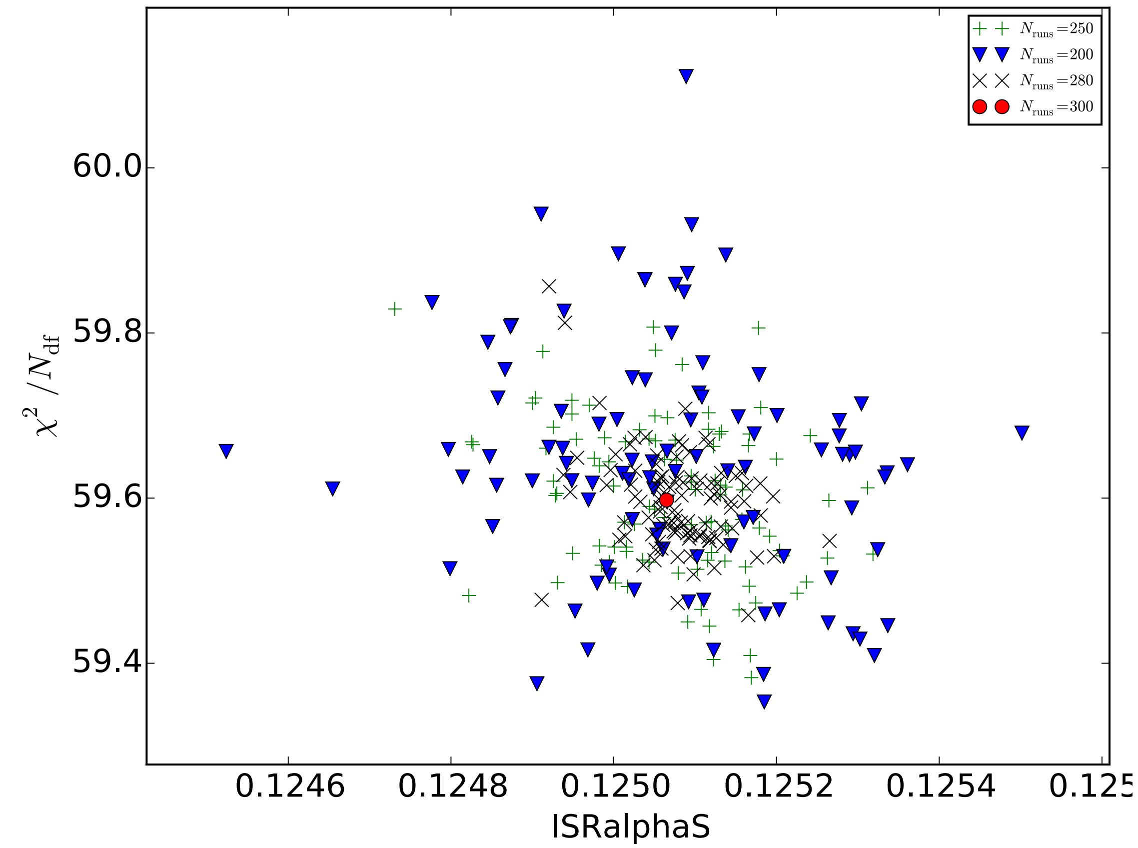
- Adding α_S^{FSR} the to the tune, as well as the jet shapes analysis
  - We tried to include *$p_T$dampfudge* on the FSR shower as well, but we found no sensitivity
- Using the inclusive gap fractions Q0 and Qsum the Njets pT>25GeV, Leading and 5th jet pT from the tt+jets , as well as the integrated jet shapes in tt events for light and b-jets between 30 and 100 GeVs

- α_S^{FSR} = 0.125+-0.001
- α_S^{ISR} = 0.125+-0.006

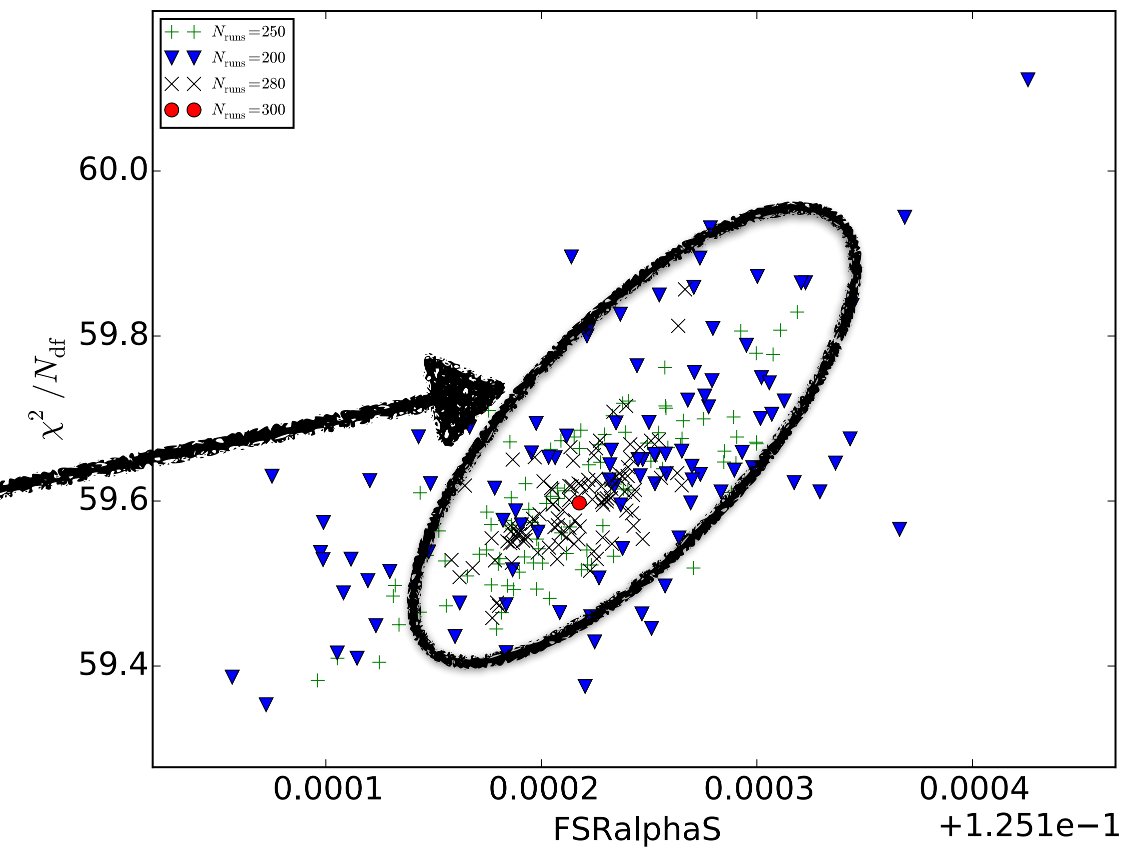
- *$p_T$dampfudge* = 1.3+-0.1

Interpolation Order





Hints of a bad interpolation



Summary

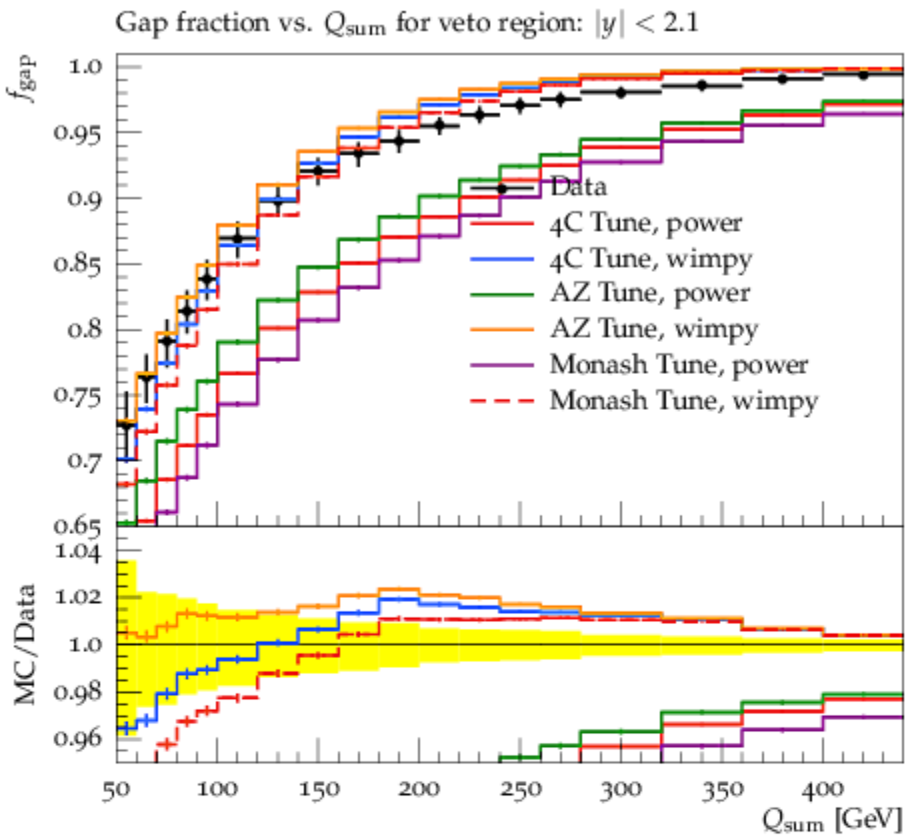
- Presented preliminary results of a **Pythia8** tune to high-p_T ttbar observables
- The tuned value of α_S^{ISR} is compatible with the Z p_T tune
- The standalone **Pythia8** can describe extra radiation in ttbar data by adding a damping factor to the ISR emission probability
- Some tensions between the values obtained with the various analyses, trying to understand what might be the origin
- The low value of α_S^{FSR} would be in conflict with LEP data, and will require more investigation

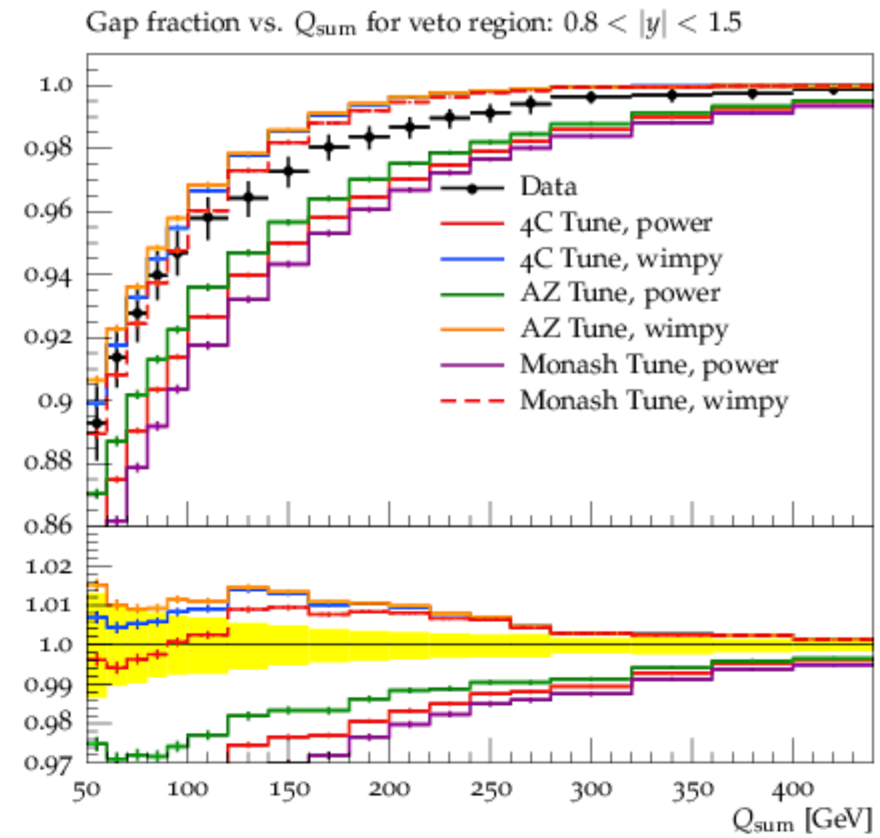
Next steps:

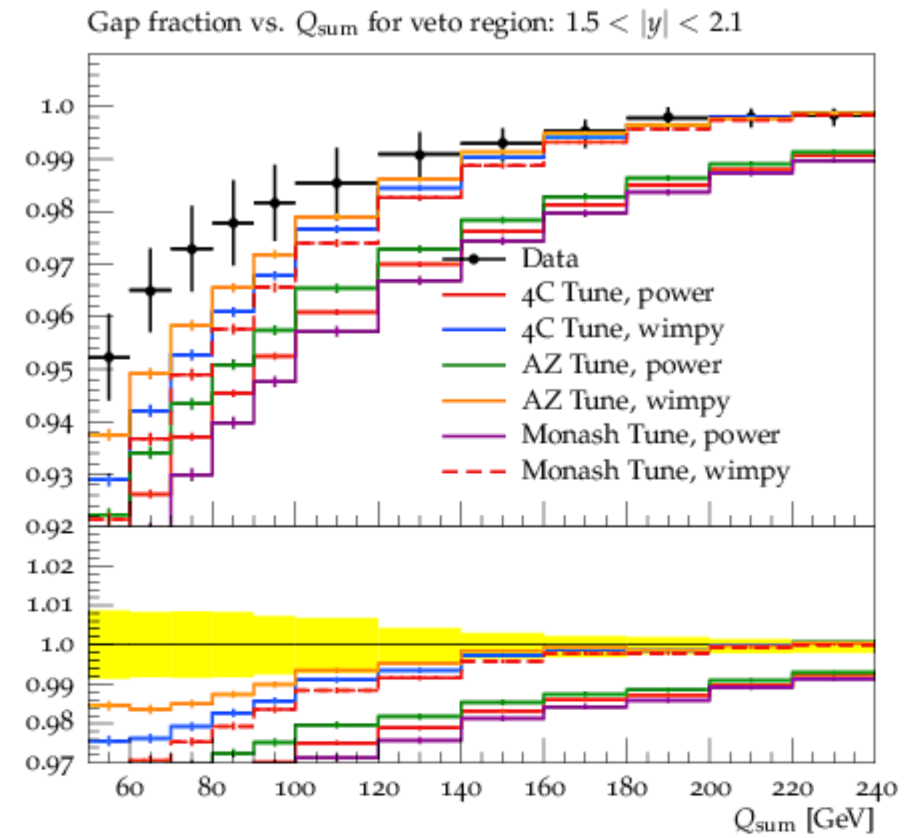
- Include the statistical and systematic correlations in the observables
- Document the results in a PUB note

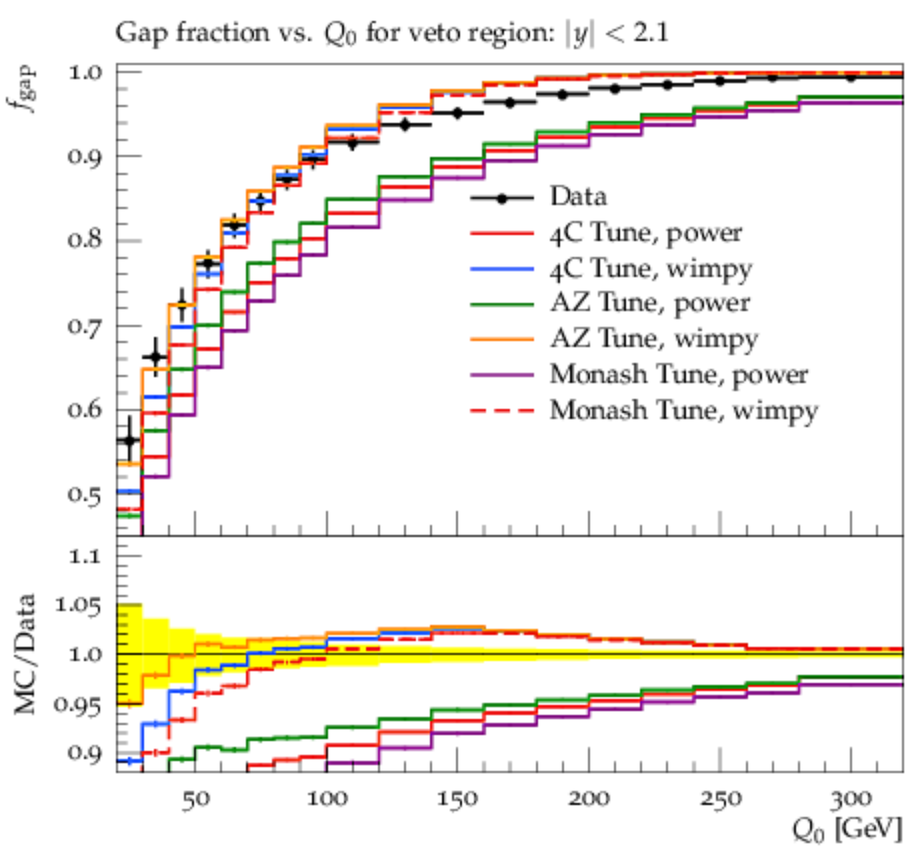
Backup

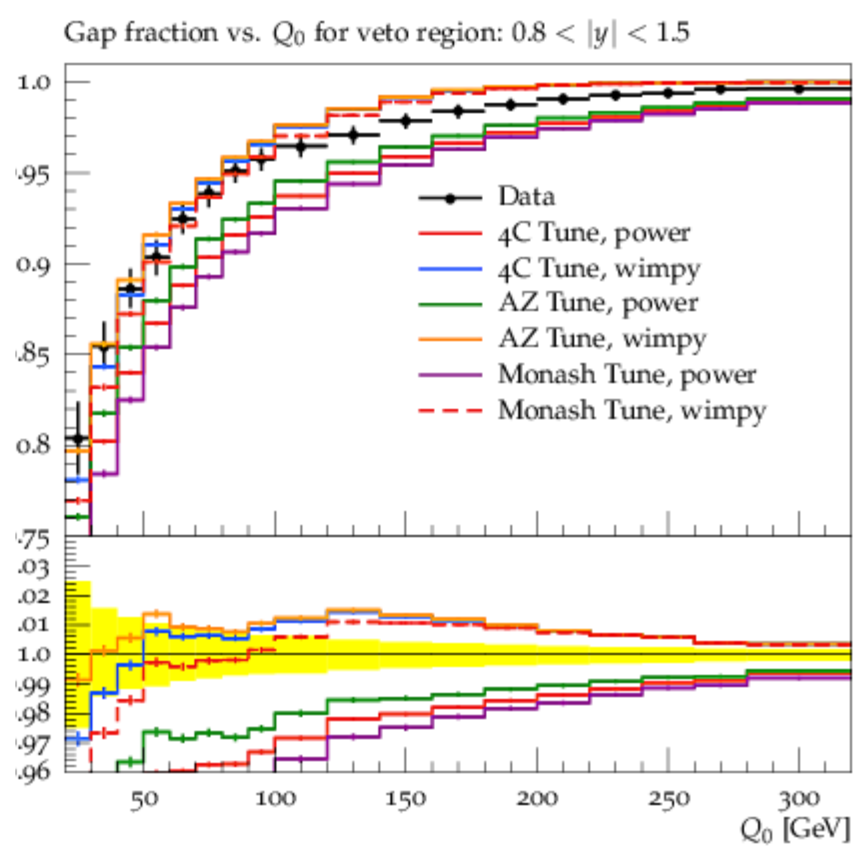
Gap Fraction

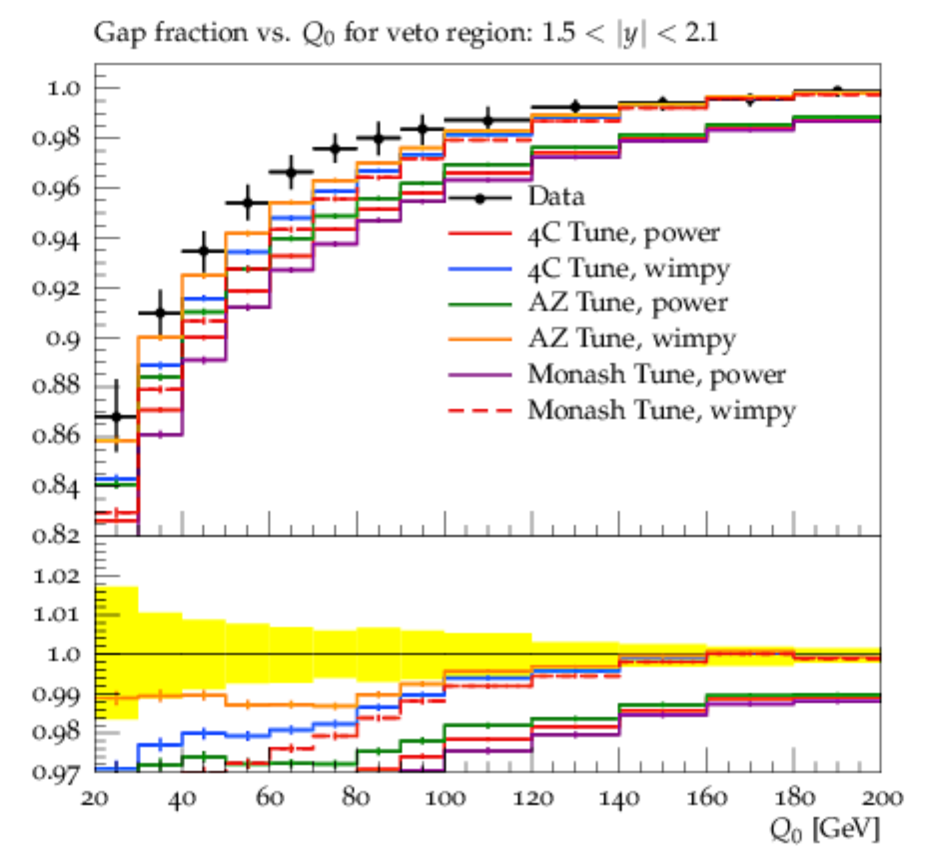




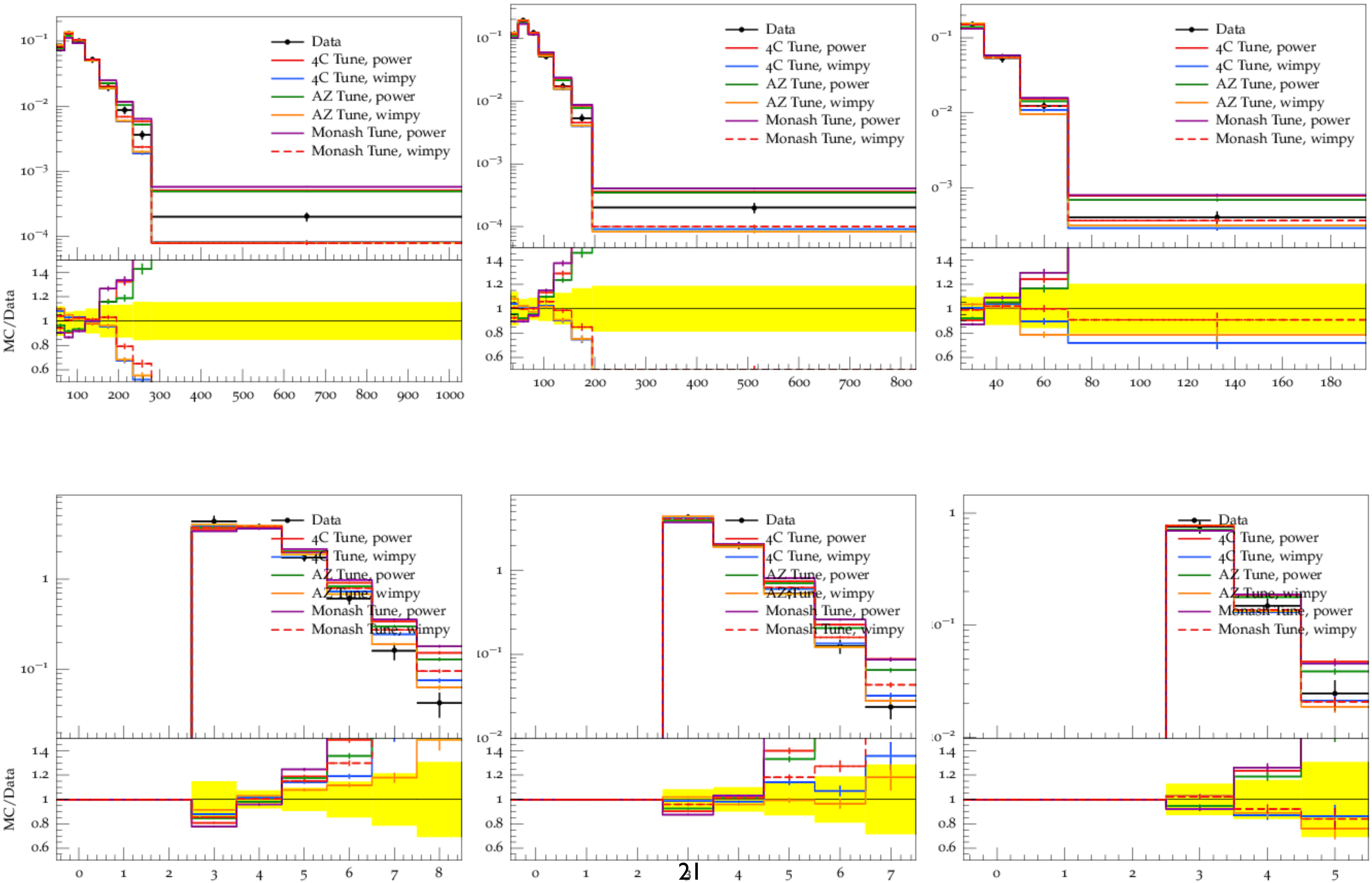








Ttbar+jets


Data
4C Tune, power
4C Tune, wimpy
AZ Tune, power
AZ Tune, wimpy
Monash Tune, power
Monash Tune, wimpy
MC/Data