JSSR for Run IIb1-2 data

(Jet Shifting, Smearing and Removing)

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D0-France, IPNL, 04/05/10

Outline

- JSSR: concept, status and method steps
- New oversmearing and shifting parameters

➔ comparison with the old results

- Closure tests
- Systematic uncertainties

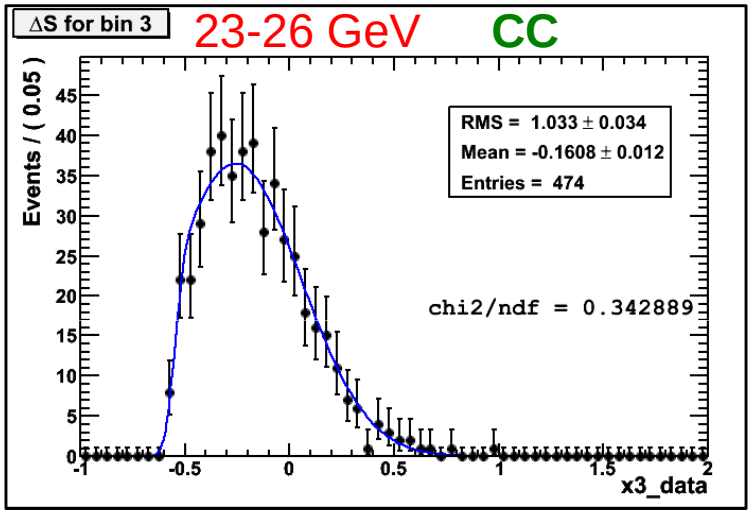
JSSR principle

- JSSR method purpose: correct data/MC differences for jet energy scale and resolution in a consistent way (on top of the respective JES)

- Method: use of the ΔS variable (relative transverse imbalance) in γ/Zee+jet events, with exactly 1 jet back-to-back to the γ/Z in Φ

$$\Delta S = \frac{p_T^{jet} - p_T^{\gamma/Z}}{p_T^{\gamma/Z}}$$

In Z pT bins: fit of the ΔS distributions by a gaussian×turn-on function



- Gaussian mean ➔ energy scale
- Gaussian width ➔ energy resolution
- turn-on ➔ reconstruction threshold

data/MC differences
➔ shifting and oversmearing factors to be applied to reconstructed MC jets

JSSR corrections for Run IIb

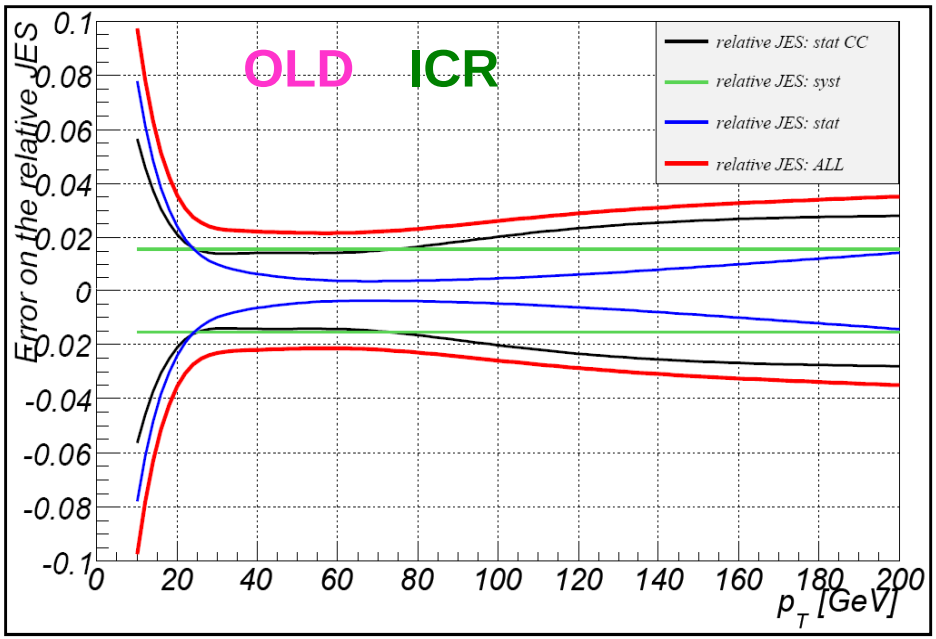
- Current corrections for run IIb (referred as "old" in the following):

➔ derived using ~1fb^{-1} of p20 data in 2 samples: γ+jet and Zee+jet

➔ the preliminary p20 JES was used

- Goal of the study:

➔ re-derive the JSSR parameters using 4.3 fb^{-1} (Run IIb1-2) of p20 data with the "final" p20 JES in the Zee+jet channel (MC reference =ALPGEN)



relative JES uncertainty completely dominated by:

- the Z+CC-jet statistics
- the extrapolation procedure

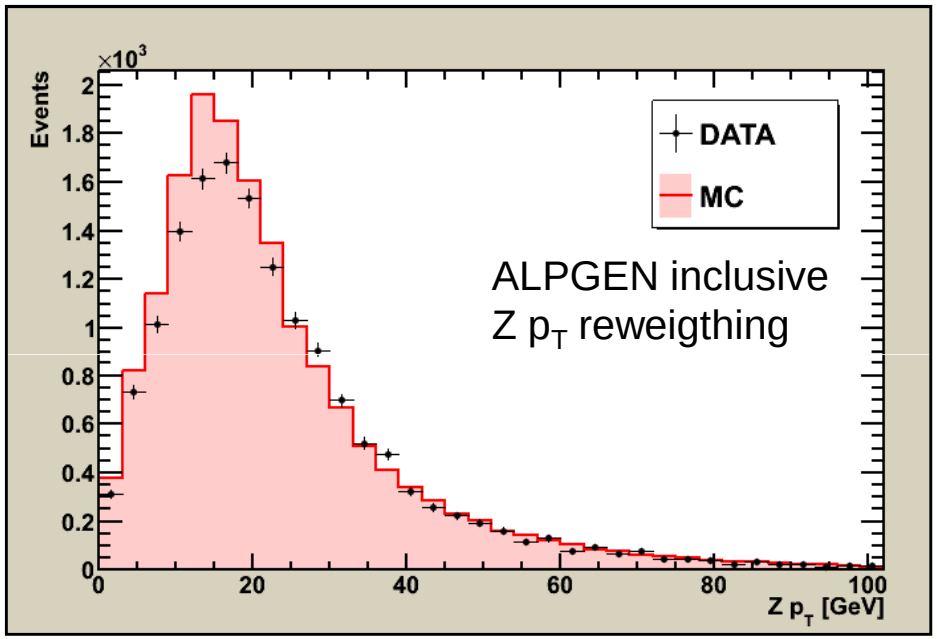
+ take into account the new luminosity profile

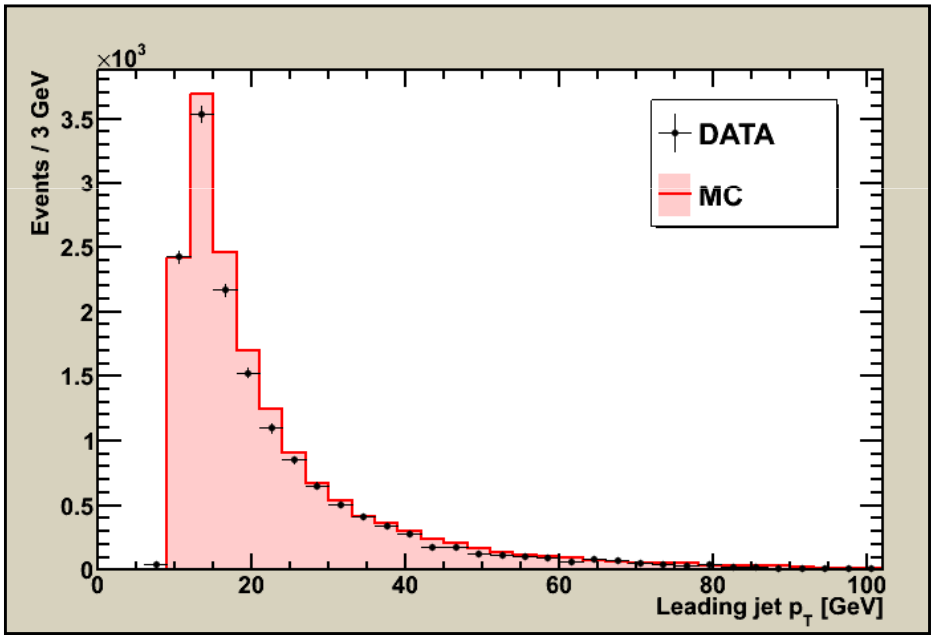
How do things look like before JSSR?

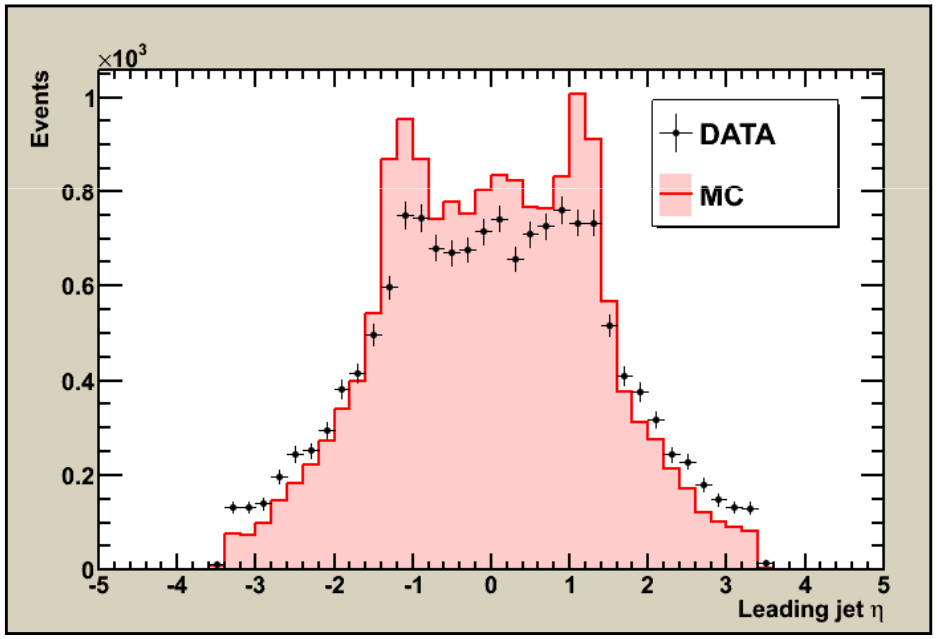
Final selection:

- 2 Top_tight electron p_T >15 GeV
- CC/CC or CC/EC pairs
- 80 < m_{Zee}< 102 GeV
- good JCCB jets (no p_T/η cuts)
- n(good jets) = 1
- n(bad jets) = 0
- ΔΦ(Z-jet)>2.8

See backup slides for more plots before JSSR







JSSR method (1/2)

- JSSR parameters derived in 4 η regions:
  - CC: |η| < 0.8
  - ICR: 0.8 < |η| < 1.6
  - EC: 1.6 < |η| < 2.4
  - VEC: 2.4 < |η| < 3.2

Jet region	DATA statistics
CC	**5576**
ICR	**5334**
EC	**2692**
VEC	**1698**

- For DATA and MC, in each η region:

ΔS distributions studied in Z p_T bins

➔ each 1-D histogram $h_i(\Delta S)$ adjusted by the function

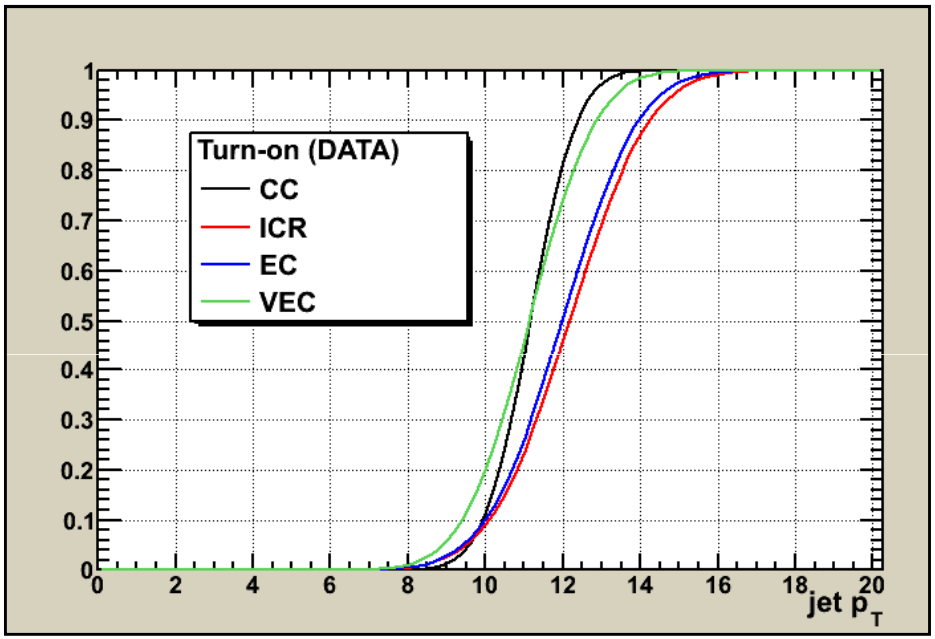
$$f_i(\Delta S) = N_i \exp\left(-\frac{(\Delta S - <\Delta S>_i)^2}{\sigma_i^2}\right) \times \left(1 + \mathrm{erf}\left(\frac{(\Delta S - \alpha_i)}{\sqrt{2}\beta_i}\right)\right)$$

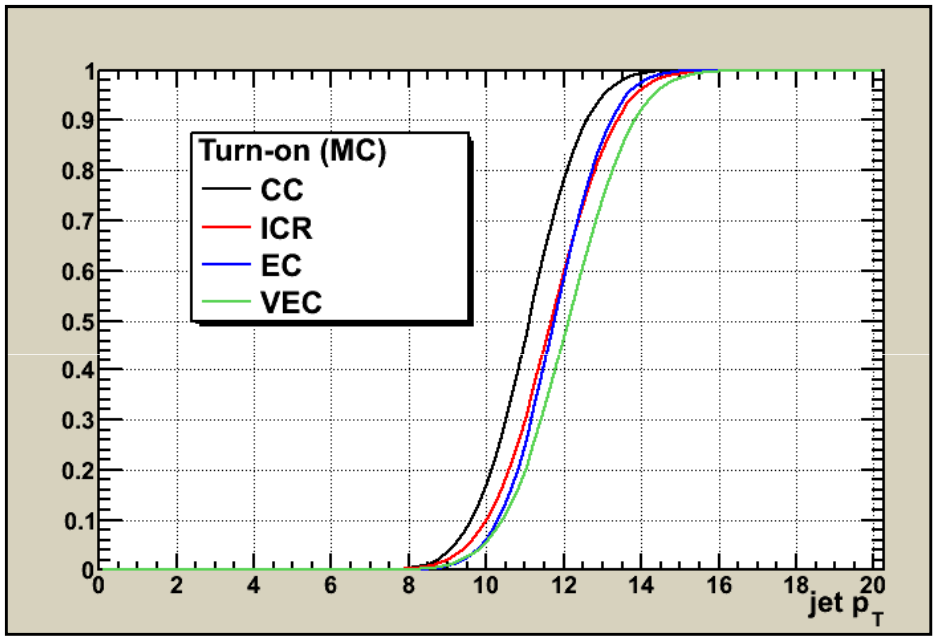
- Step 1: combined fit to extract the turn-on parameters

➔ using jet p_T turn-on: $1 + \mathrm{erf}\left(\frac{p_T^{jet} - \alpha'}{\sqrt{2}\beta'}\right)$

Assumption: the extracted turn-on curves versus p_T^{jet} are independent of the p_T^Z bin

JSSR method(2/2)





- Step 2: fit of the resolution points (turn-on fixed)

(parametrization used = standard sampling calorimeter resolution formula)

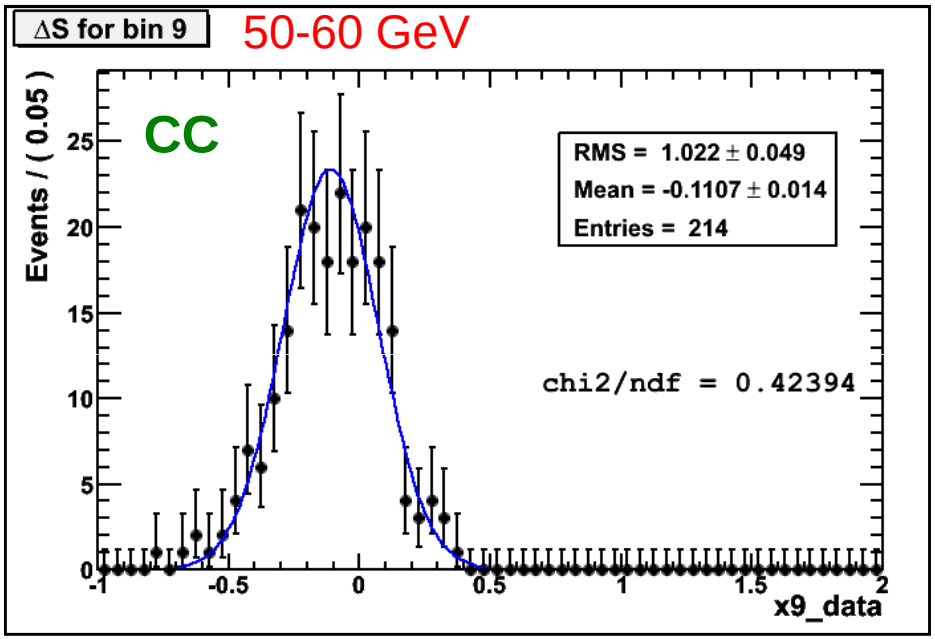
$$\sigma_{\Delta S} = \sqrt{\frac{a^2}{(p_T{}^Z)^2} + \frac{b^2}{p_T{}^Z} + c^2}$$

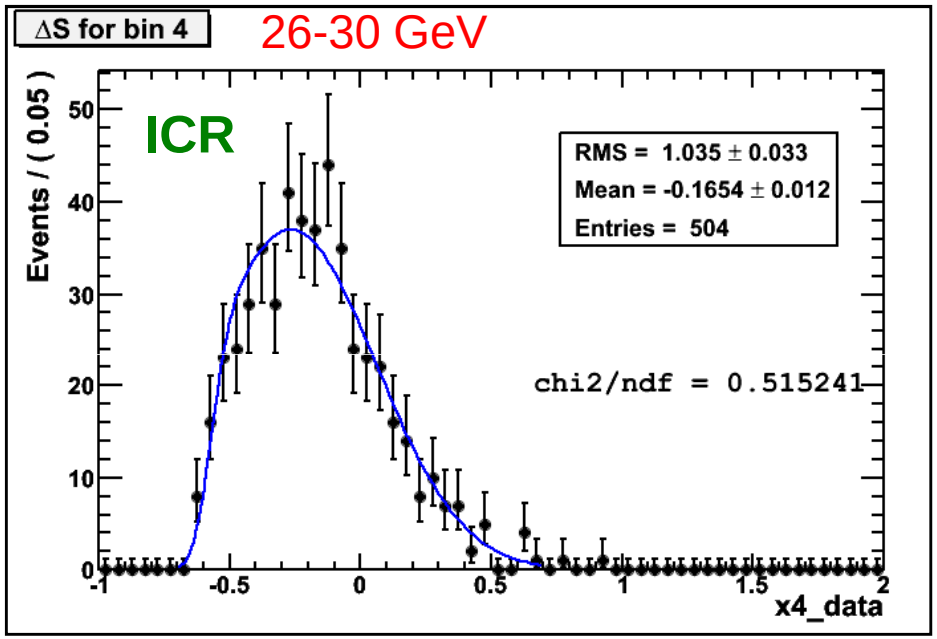
- Step 3: fit of the mean points (turn-on and resolution fixed)

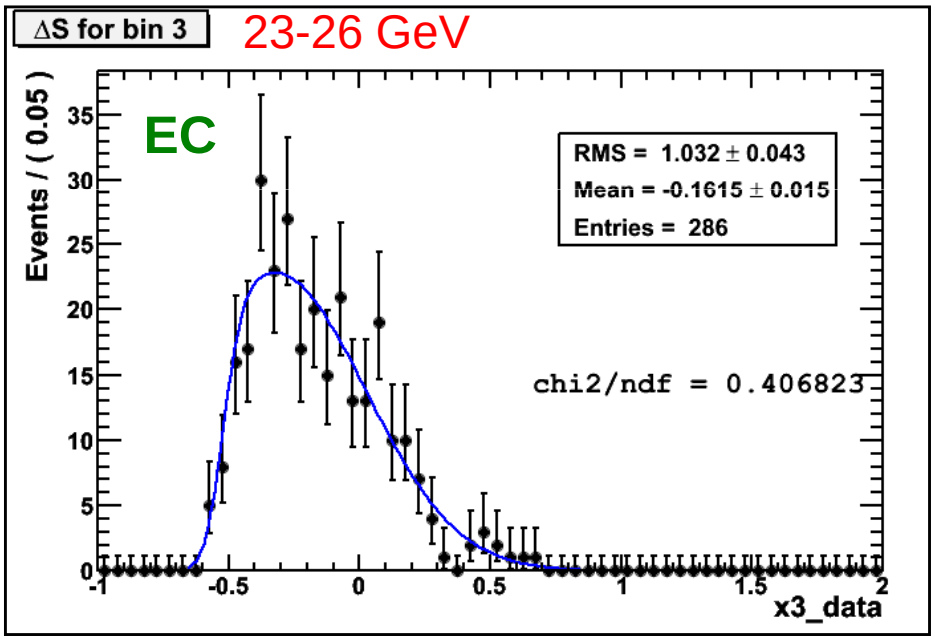
(parametrization: no particular form expected)

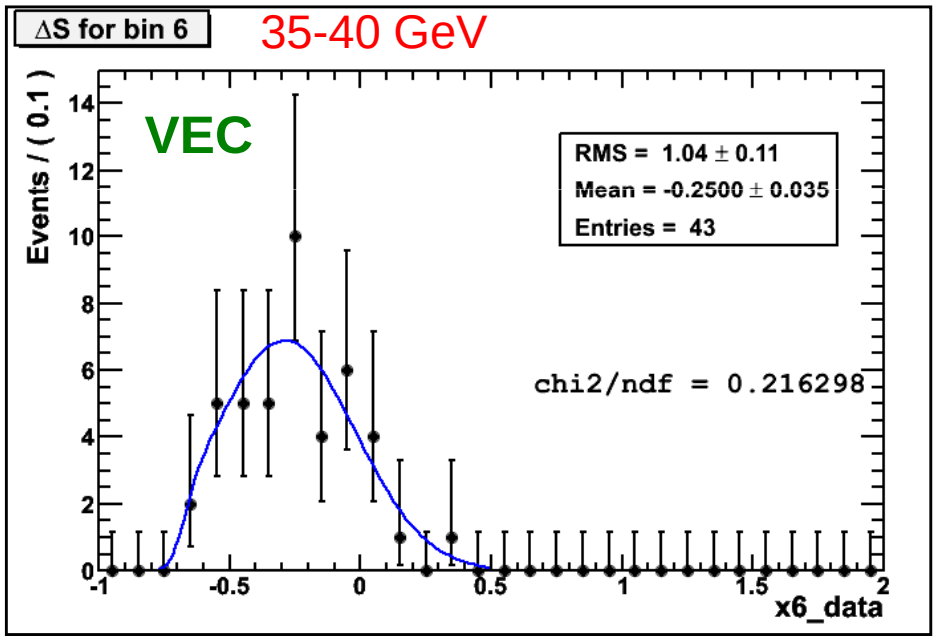
$$< \Delta S >= a + b\exp(-cp_T{}^Z) + d\exp(-ep_T{}^Z)$$

A few final fits for illustration (turn-on and resolution fixed)

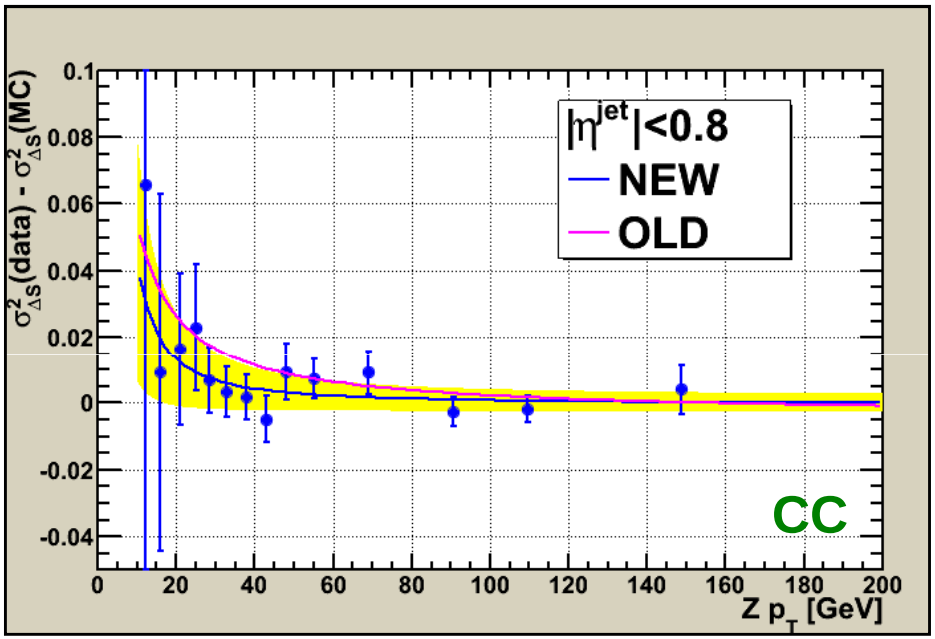


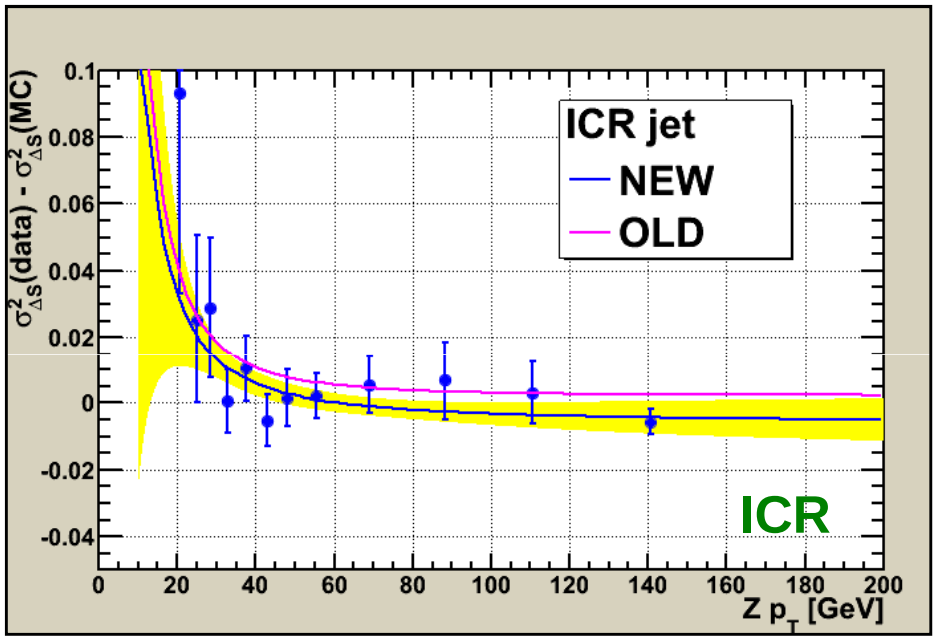


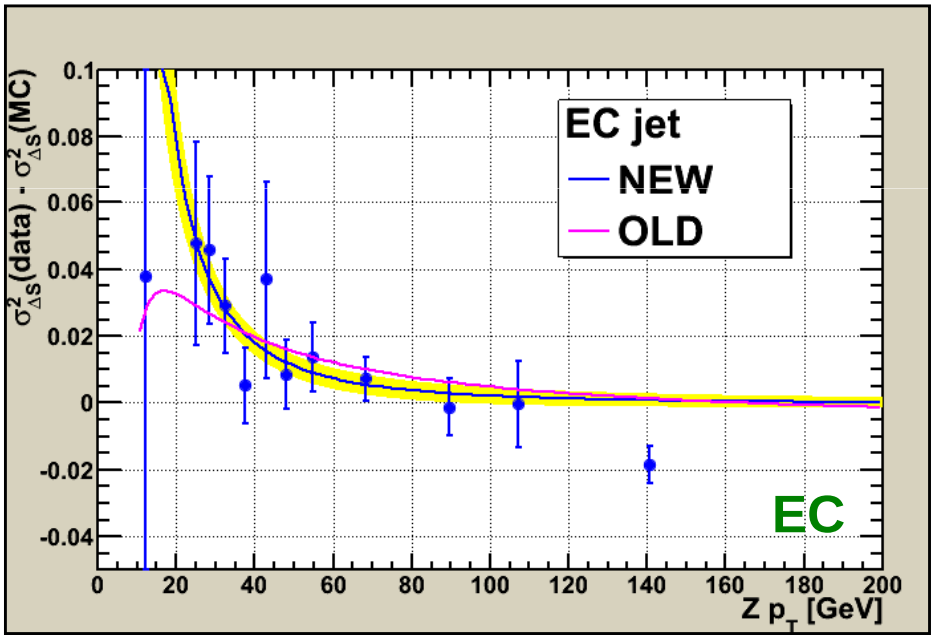


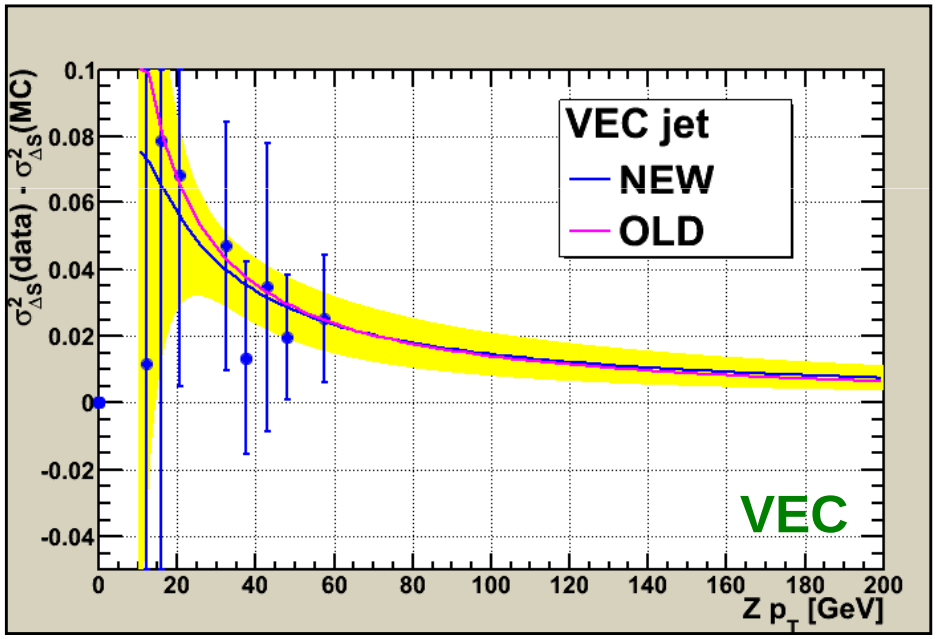


Oversmearing results

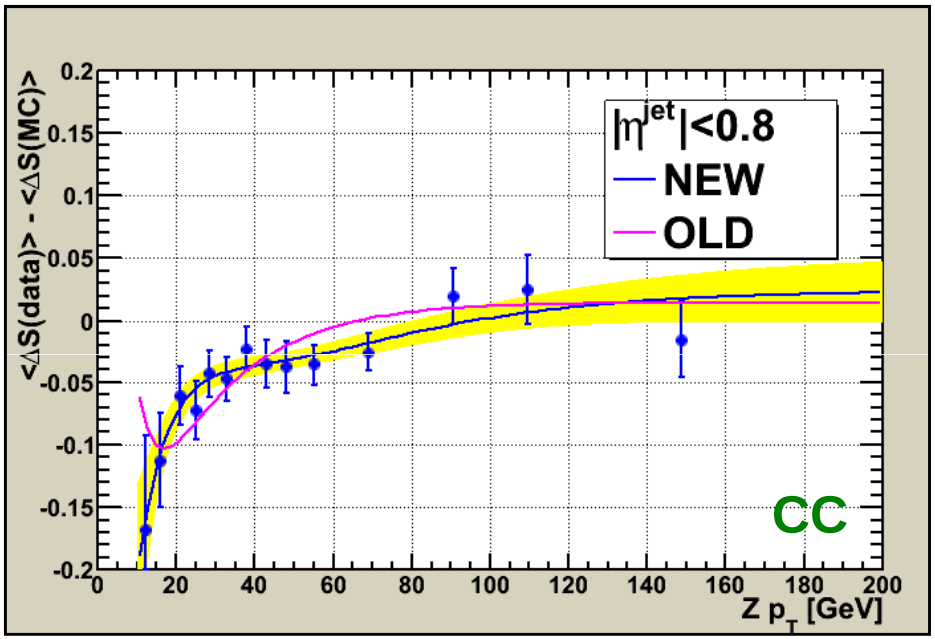


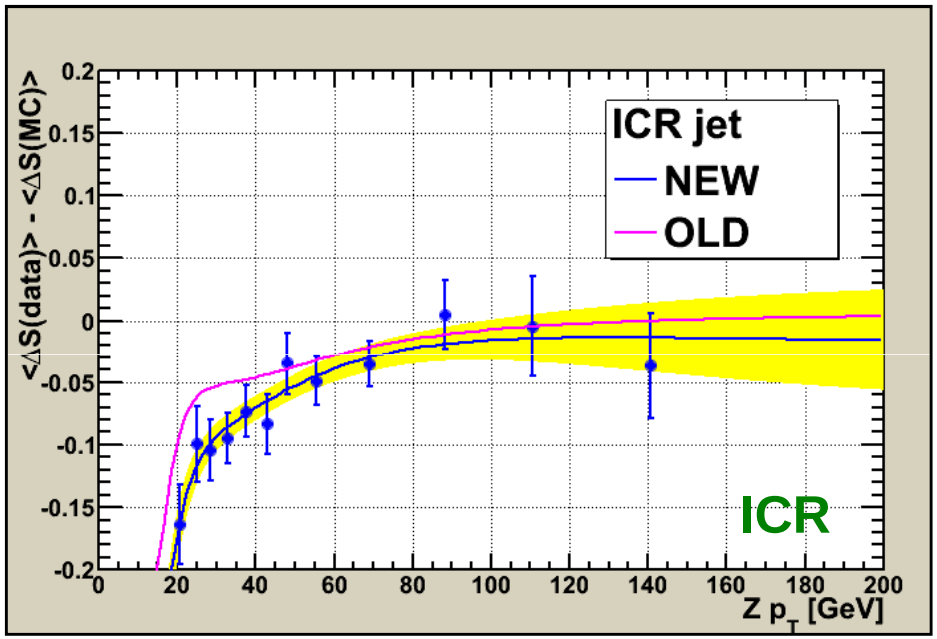


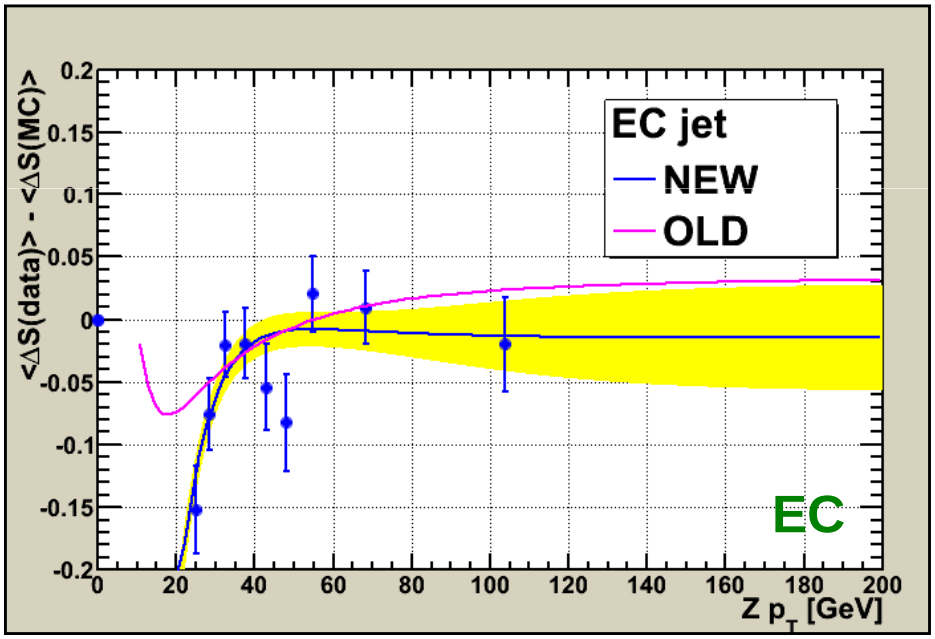


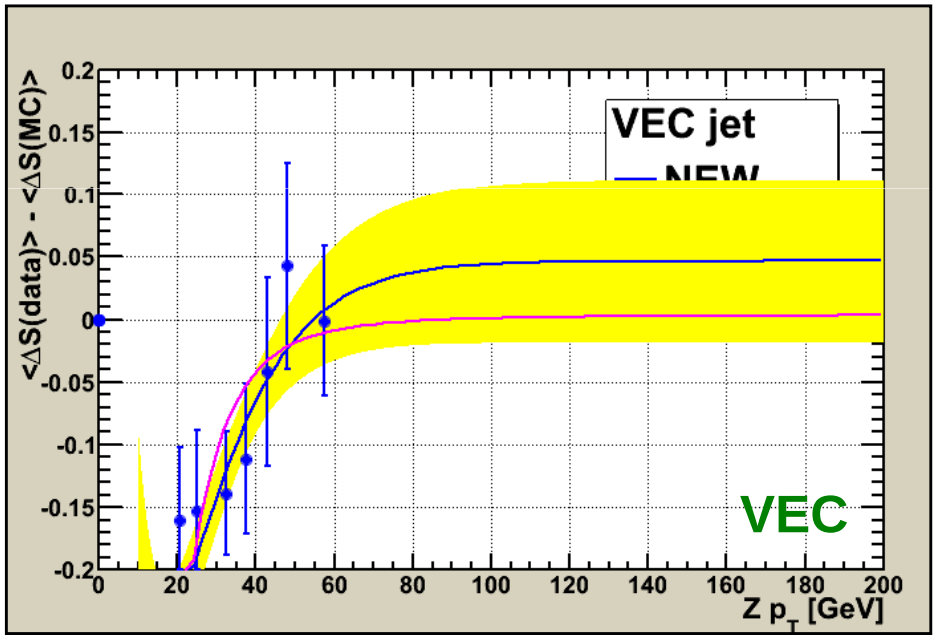


Shifting results



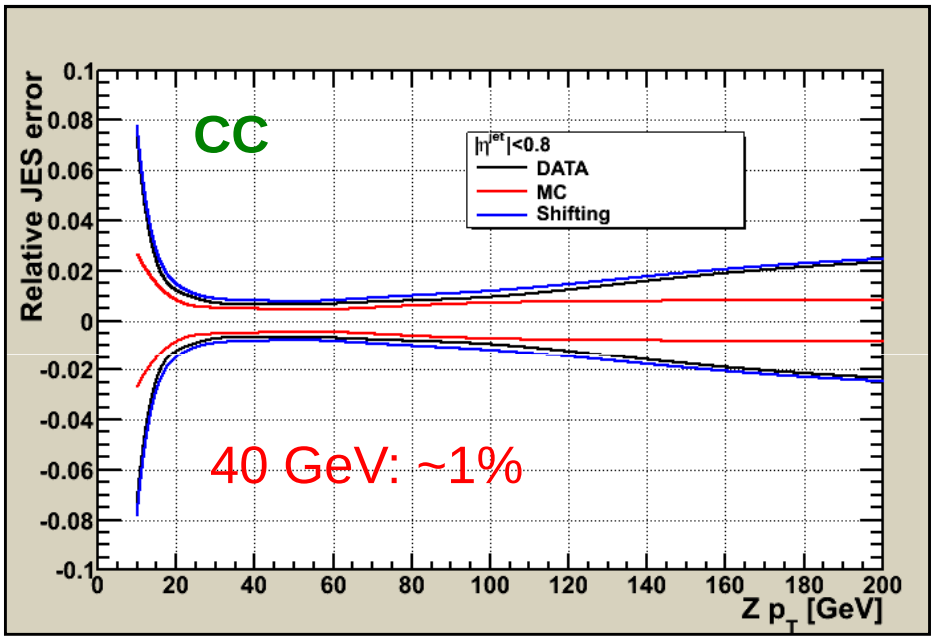


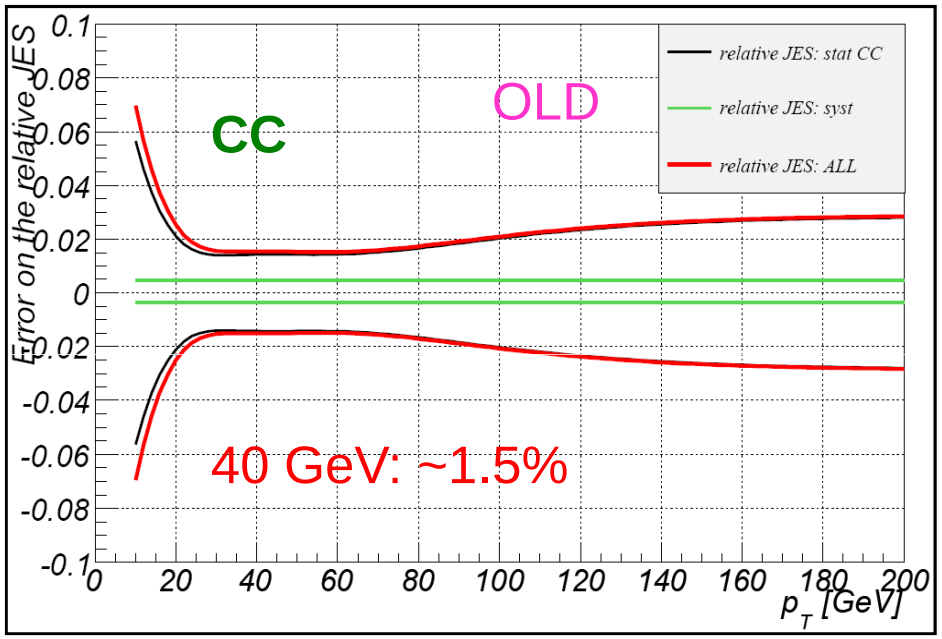


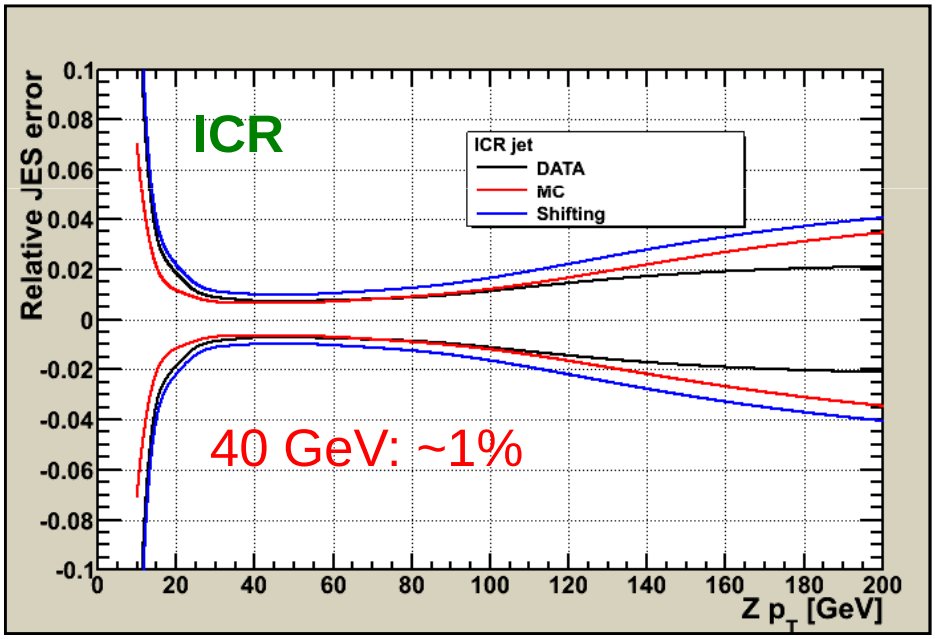


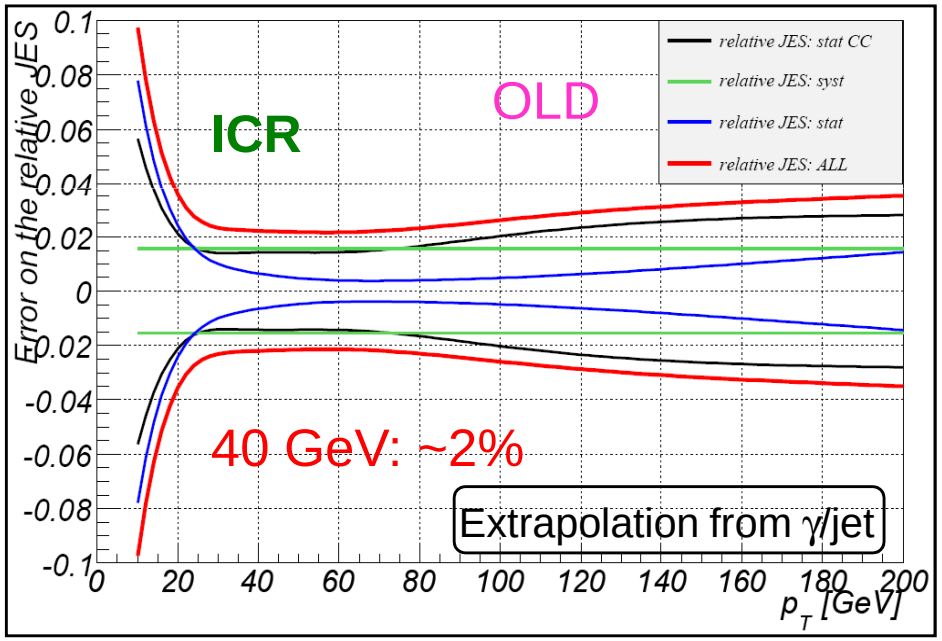
Shifting statistical uncertainties

EC and VEC in back-up





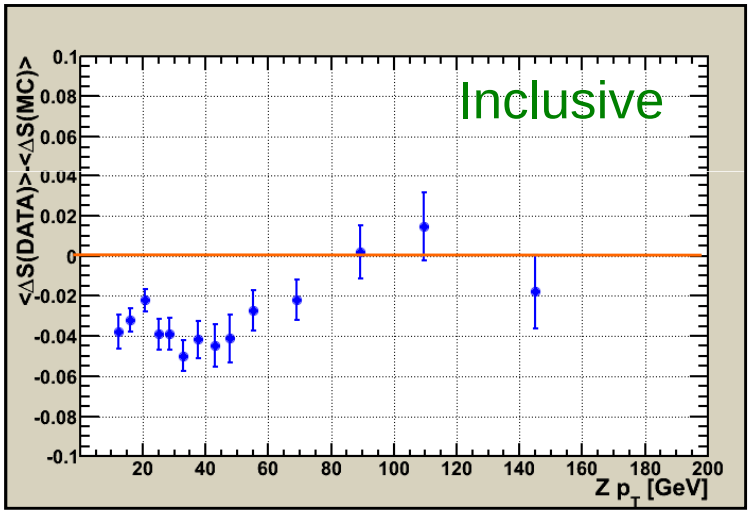


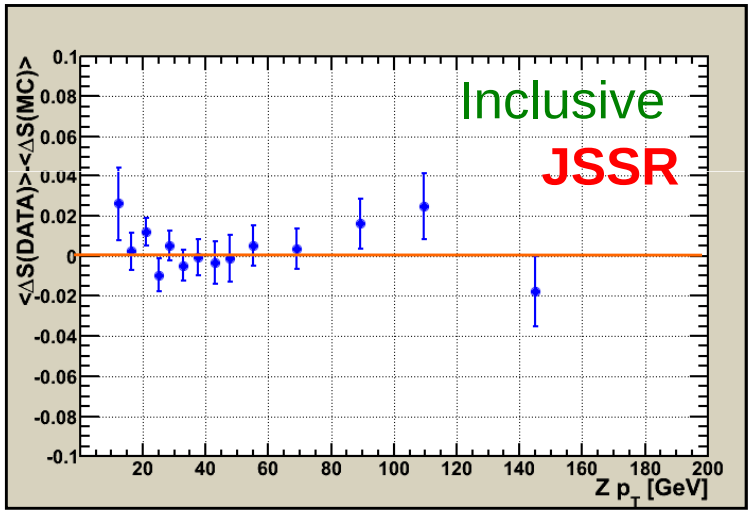


Closure tests

- Comparison before and after (the new) JSSR of:

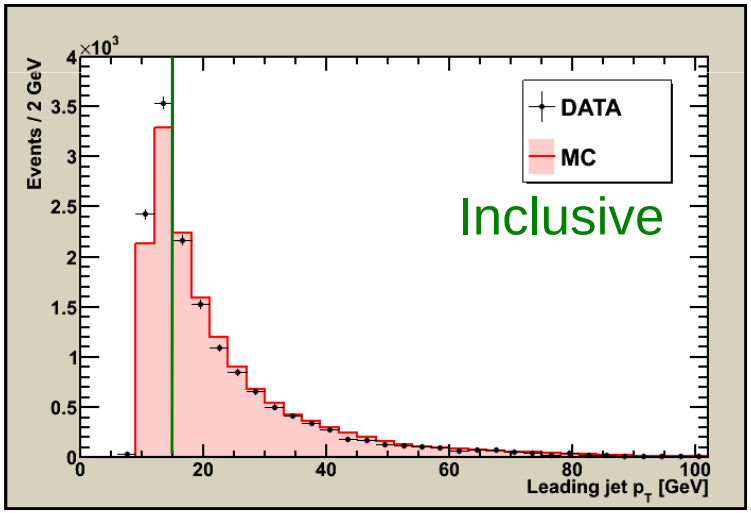
• the arithmetic means of the ΔS distribution ➔ variable <ΔS(DATA)>-<ΔS(MC)>

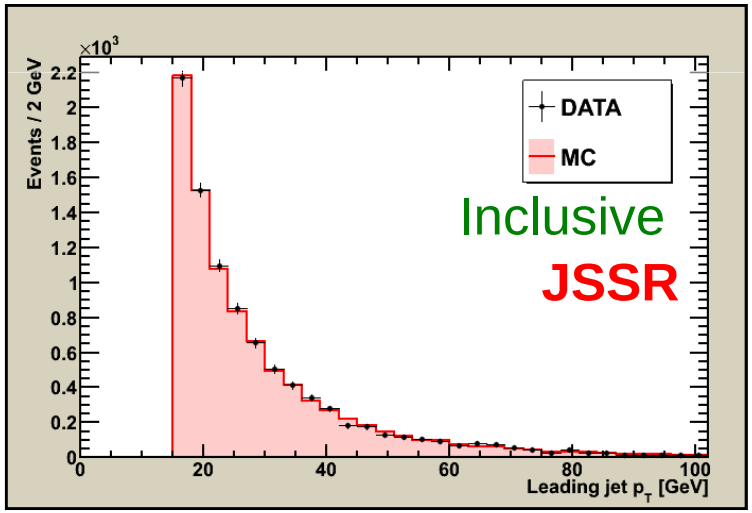




• the jet p_T spectra

See backup slides for results per region





Systematics: sources and estimation method

- Smearing: no systematic uncertainty considered

➔ much smaller effects than the statistical uncertainty

- Shifting: 4 sources

• EM energy scale: **±0.2%**

• $\Delta\Phi$ cut: **+0.2/-0.0%**

• 2^{nd} good jet veto: **±0.2%**

• luminosity ➔ see next slide

See backup slides for the corresponding plots

+ check impact of the jet vertex confirmation criterion

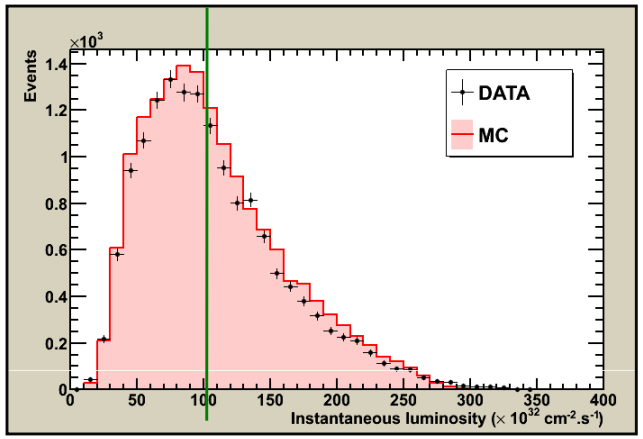
Method:

• select events with a non-nominal (1 different criterion) selection but apply the nominal JSSR parameters

• look at the variable:

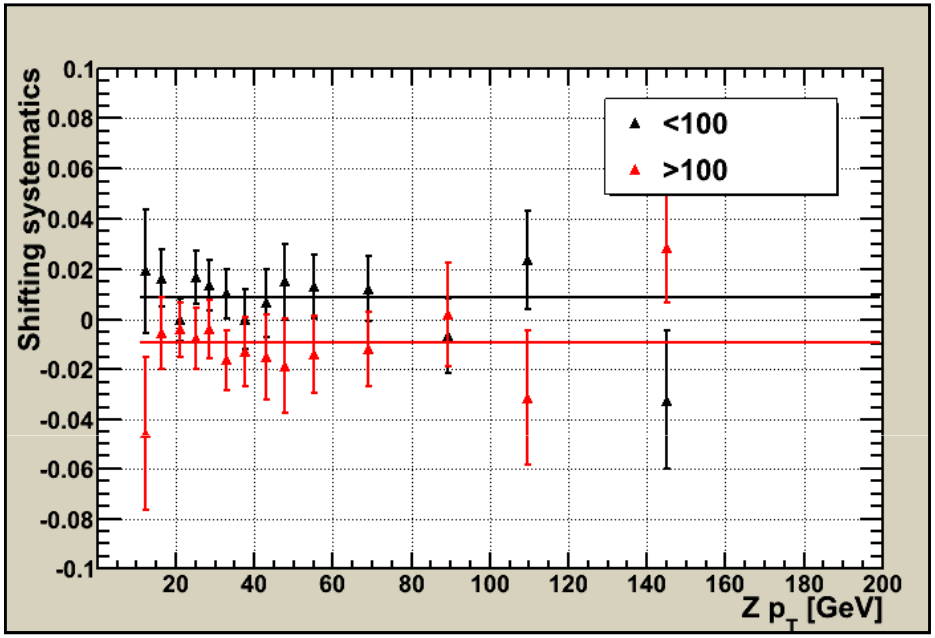
$$(\text{shifting})^{\text{non-nominal}} - (\text{shifting})^{\text{nominal}}$$

Shifting systematics: luminosity

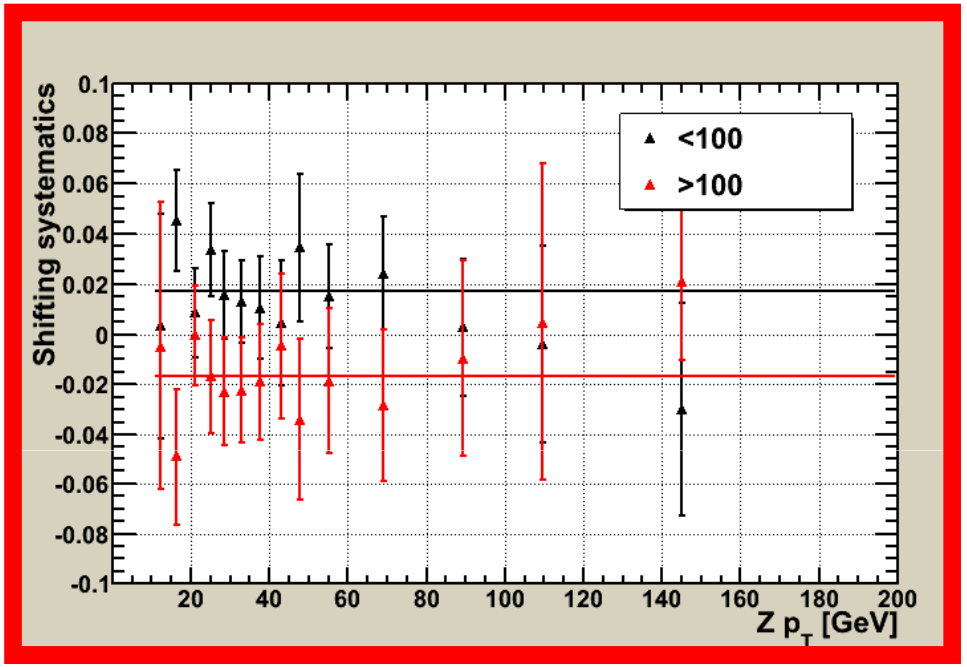


Two luminosity regions defined:

- low luminosity: < 100 10^{32} $cm^{-2}.s^{-1}$
- high luminosity: > 100 10^{32} $cm^{-2}.s^{-1}$



Significant effect: ~2%



Most important effect in the ICR: ~4%

Luminosity = main systematics source
➔ but effect corrected globally if the same data range is used

Conclusion

- A full set of JSSR parameters for 4.3 fb^{-1} of Run IIb has been derived

• smearing and shifting statistical errors significantly reduced

• shifting systematics reduced for non-central regions

• main systematics source: luminosity

➔ but effect corrected globally if the same data range is used

- CAFe informations

➔ new caf_mc_util tag: JSSR parameters with Run IIb1-2 data for MC p20.09 (presented results)

Timeline: these days (code ready, some closure test problems)

- Updates: under discussion…

New p20 JES, MC p20.15, new EM energy corrections, quark/gluon corrections, luminosity,…

Backup slides

Before JSSR

- Data: Runs IIb1+IIb2

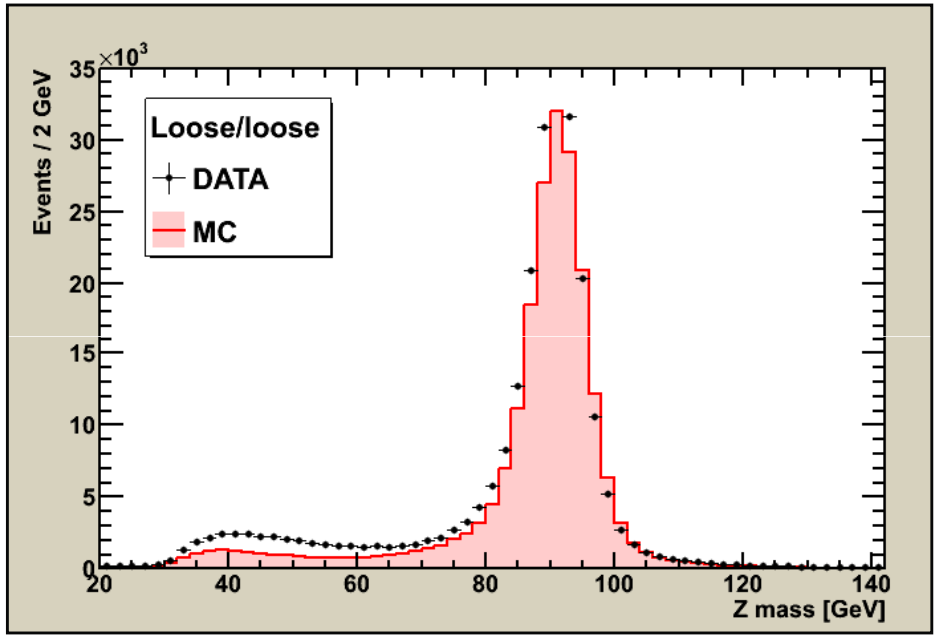
- Normalization = “vjets standard”

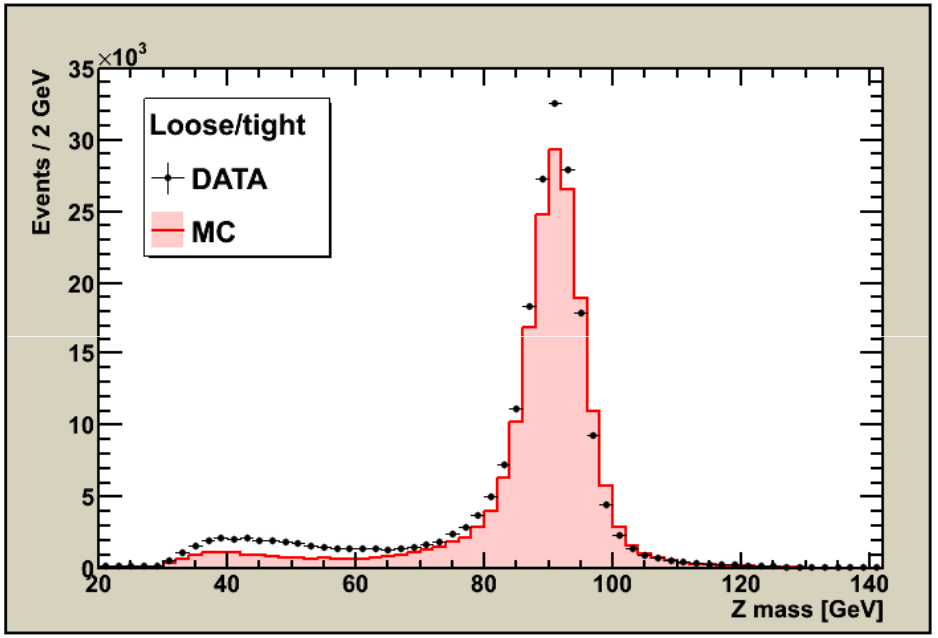
- <u>Selection:</u>

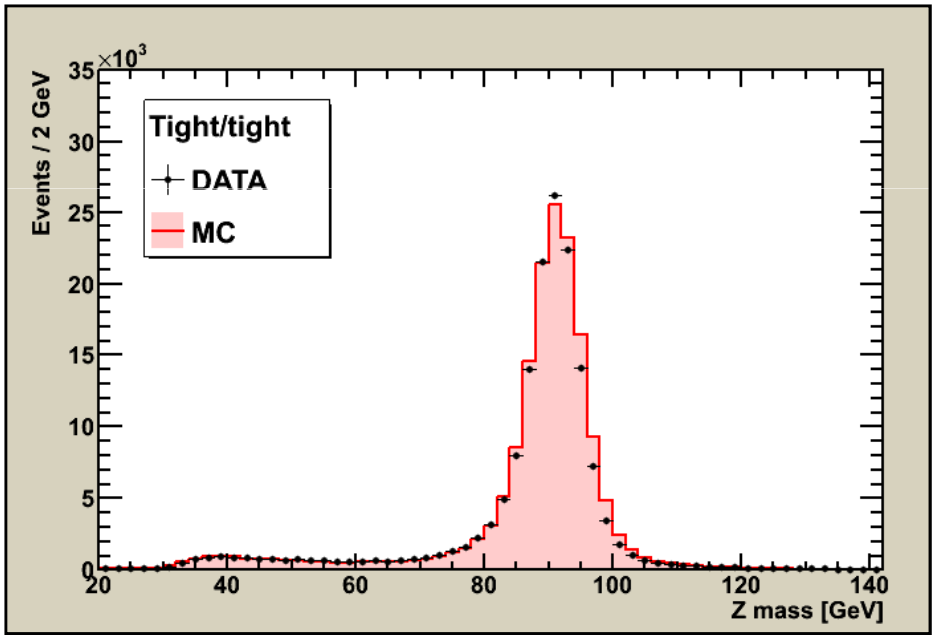
- 2 Top_loose electron candidates p_T >15 GeV

- CC/CC or CC/EC pairs

Z mass: loose/tight selections

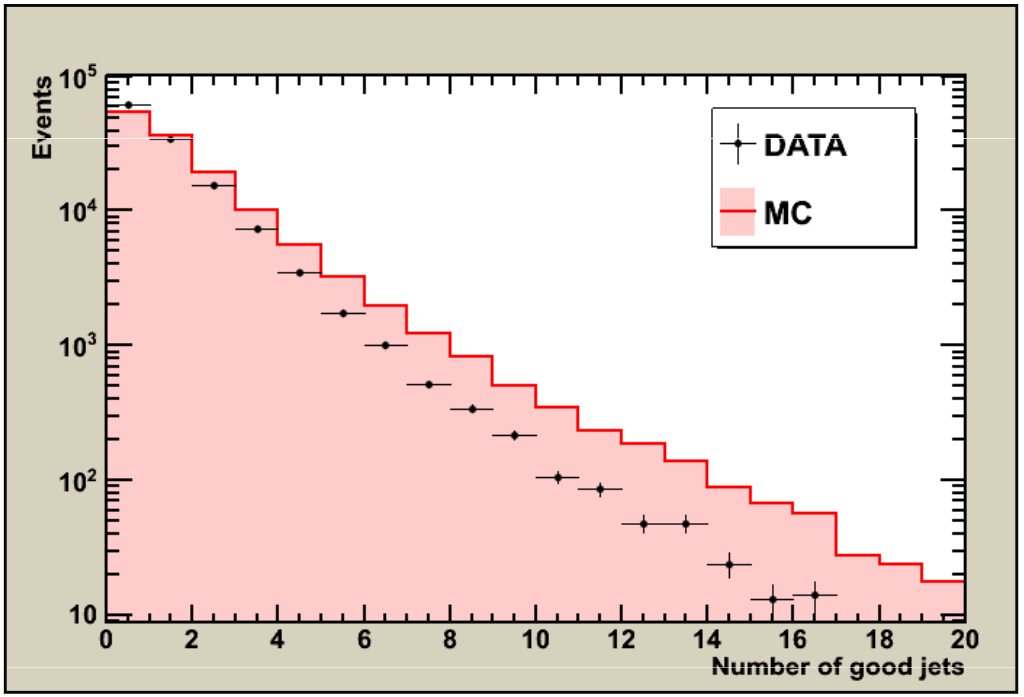




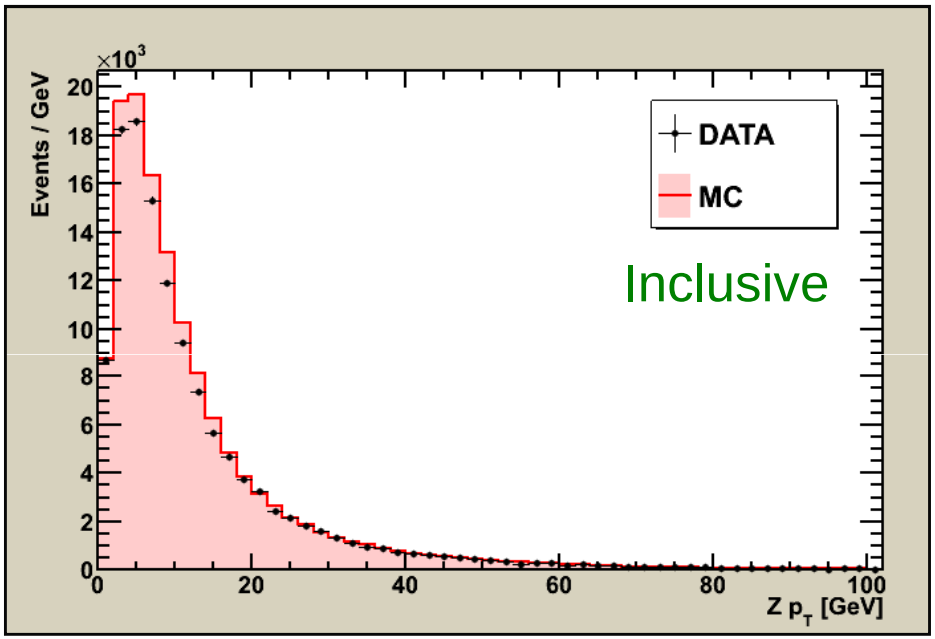


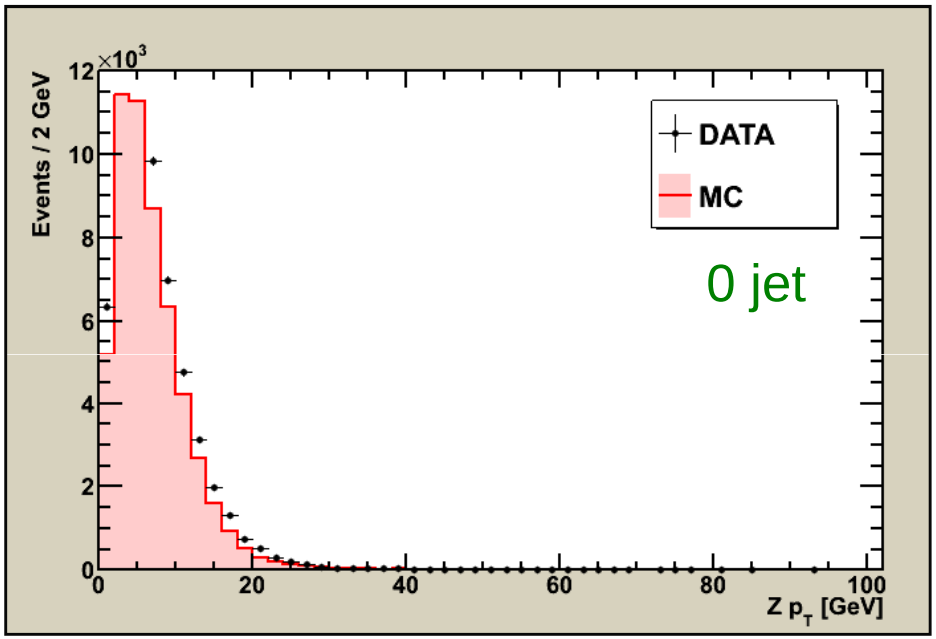
- Selection:
- 2 Top_tight electron candidates p_T >15 GeV
- CC/CC or CC/EC pairs
- 80 < m_{Zee}< 102 GeV
- select good JCCB jets without p_T and η cuts

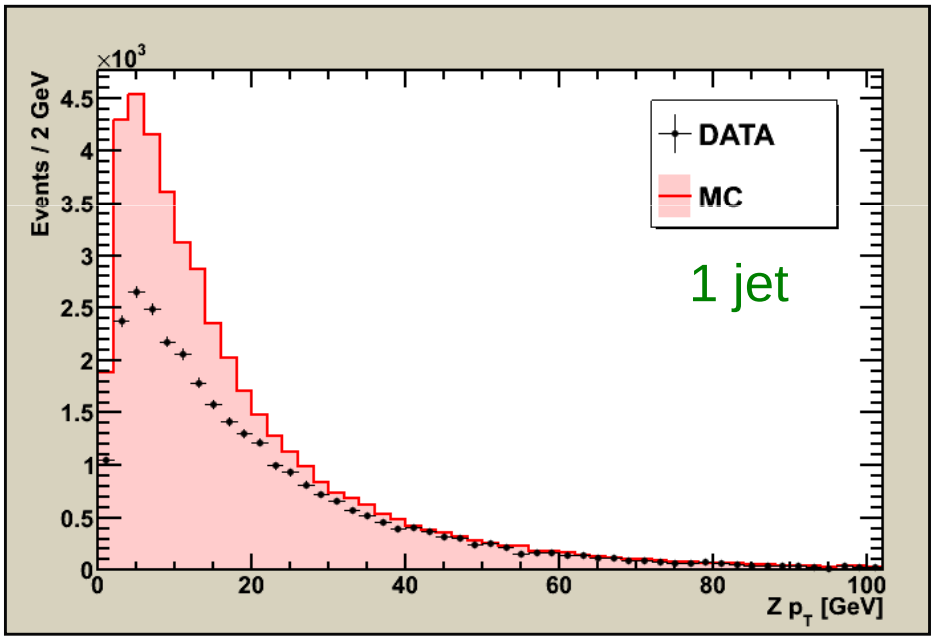
Good jets multiplicity

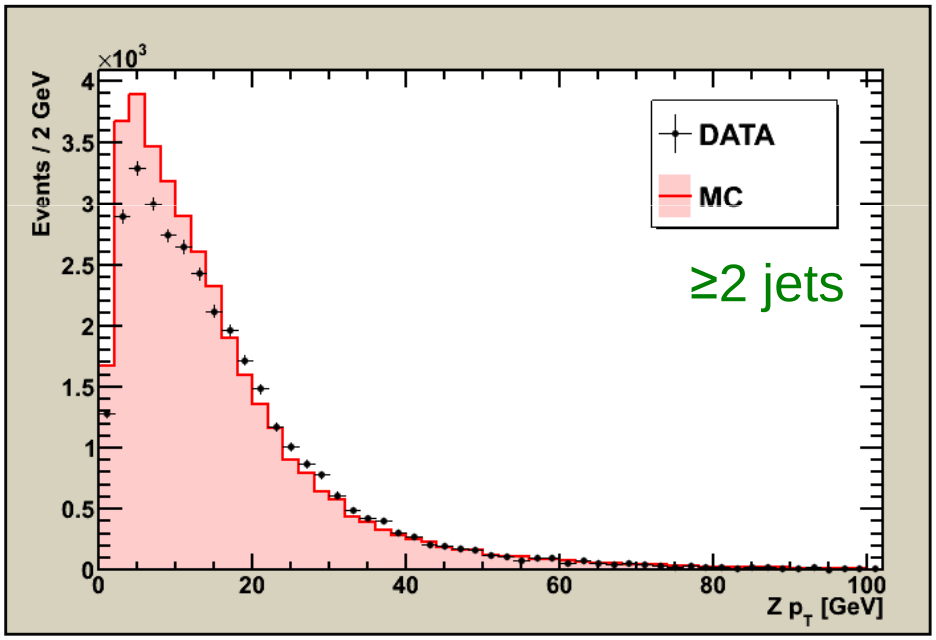


Z p_T


×10³
Events / GeV
DATA
MC
Inclusive
Z p_T [GeV]


×10³
Events / 2 GeV
DATA
MC
0 jet
Z p_T [GeV]

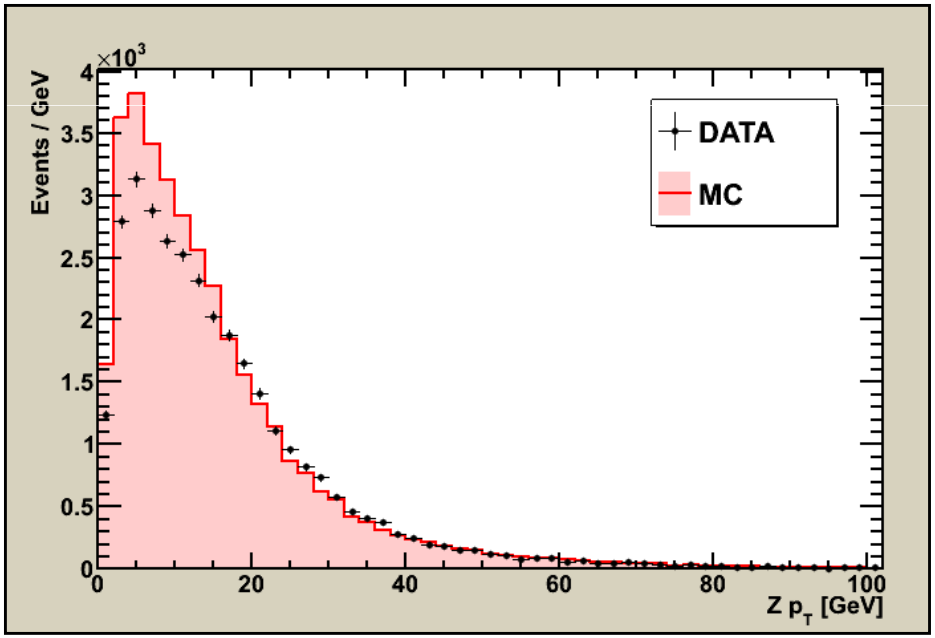

×10³
Events / 2 GeV
DATA
MC
1 jet
Z p_T [GeV]

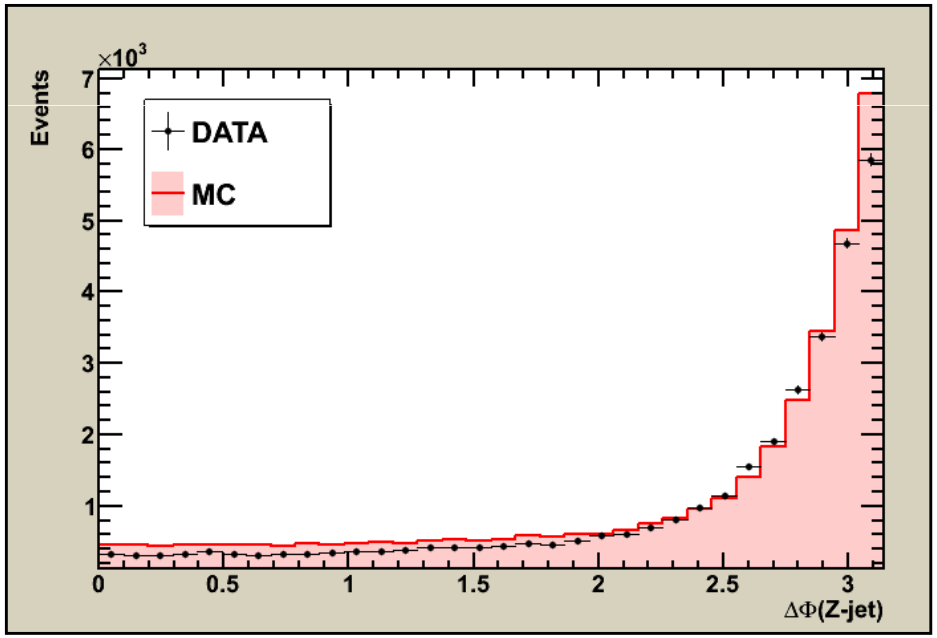

×10³
Events / 2 GeV
DATA
MC
≥2 jets
Z p_T [GeV]

• Selection:

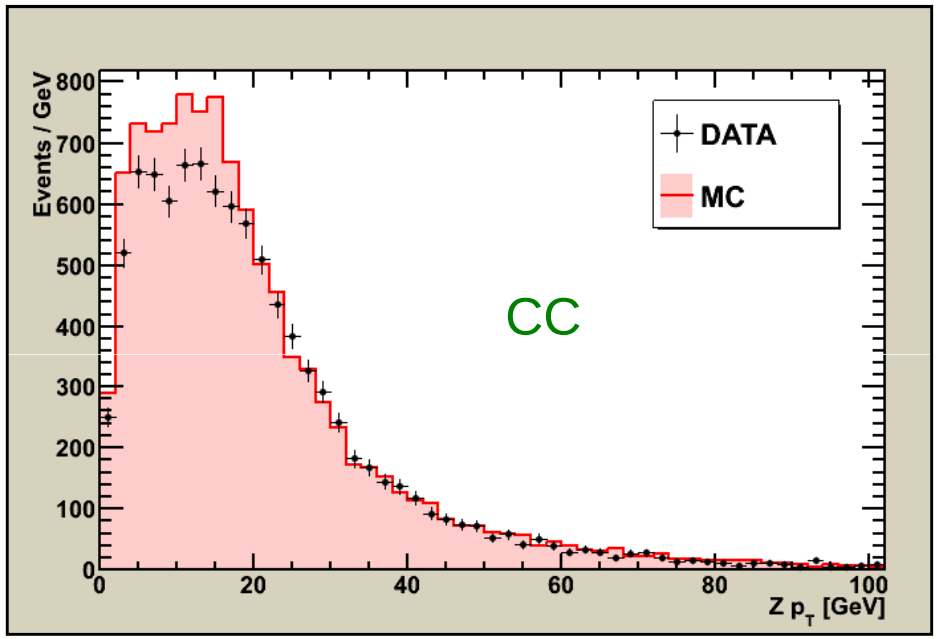
- 2 Top_tight electron candidates p_T >15 GeV
- CC/CC or CC/EC pairs
- 80 < m_{Zee}< 102 GeV
- n(good jets) = 1
- n(bad jets) = 0

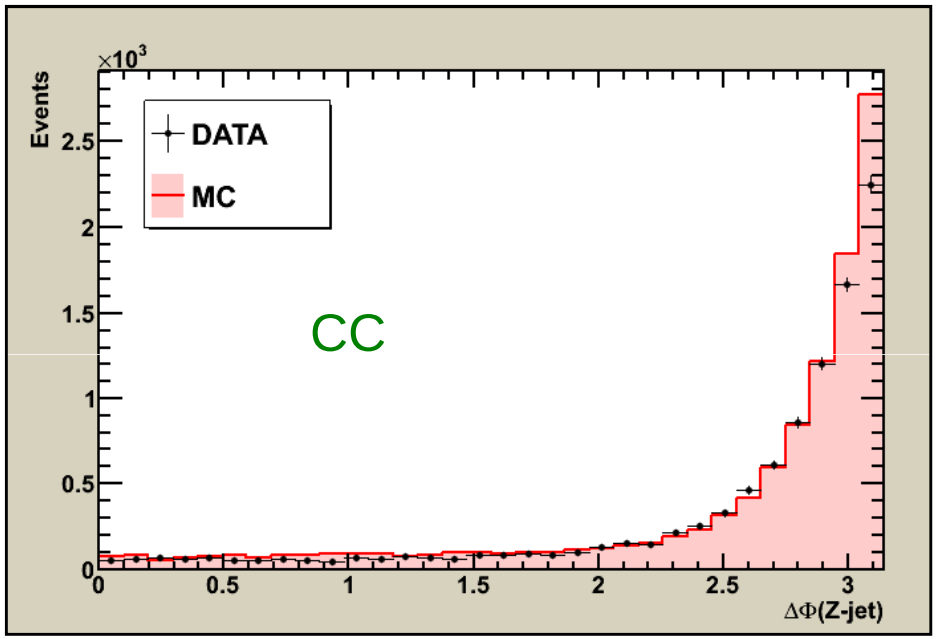
Z p_T and $\Delta\Phi$: inclusive

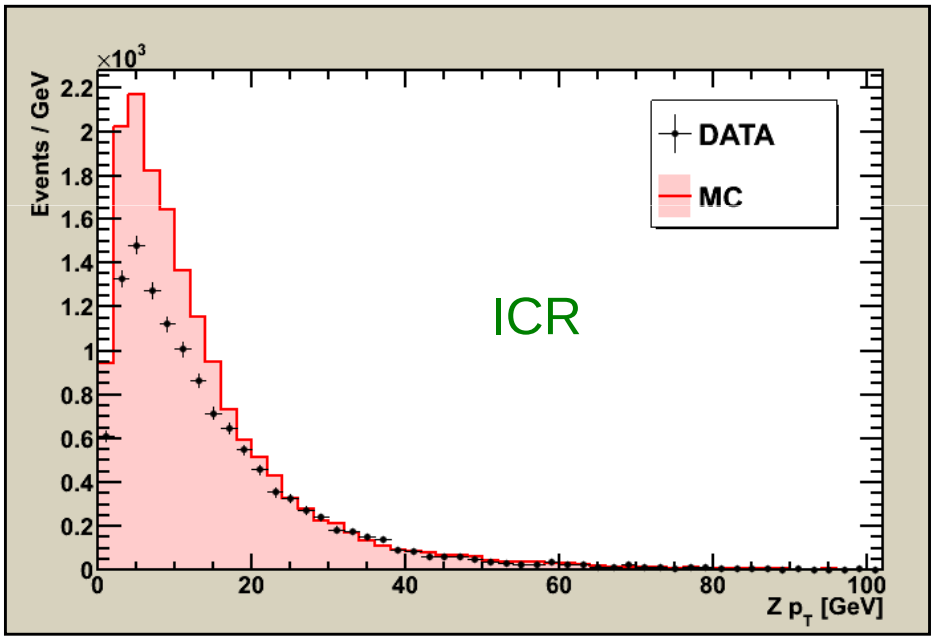


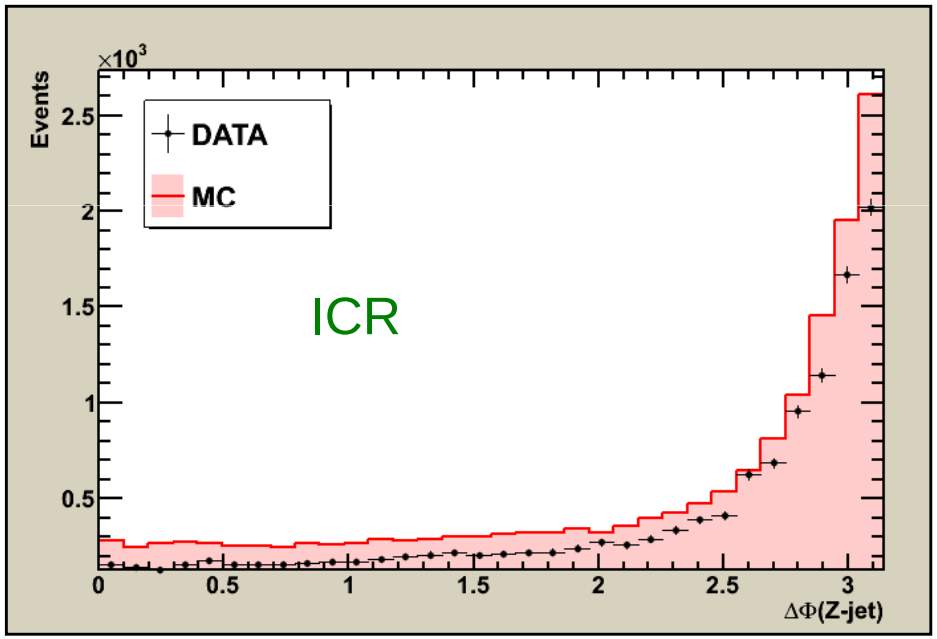


Z p_T and $\Delta\Phi$: CC and ICR

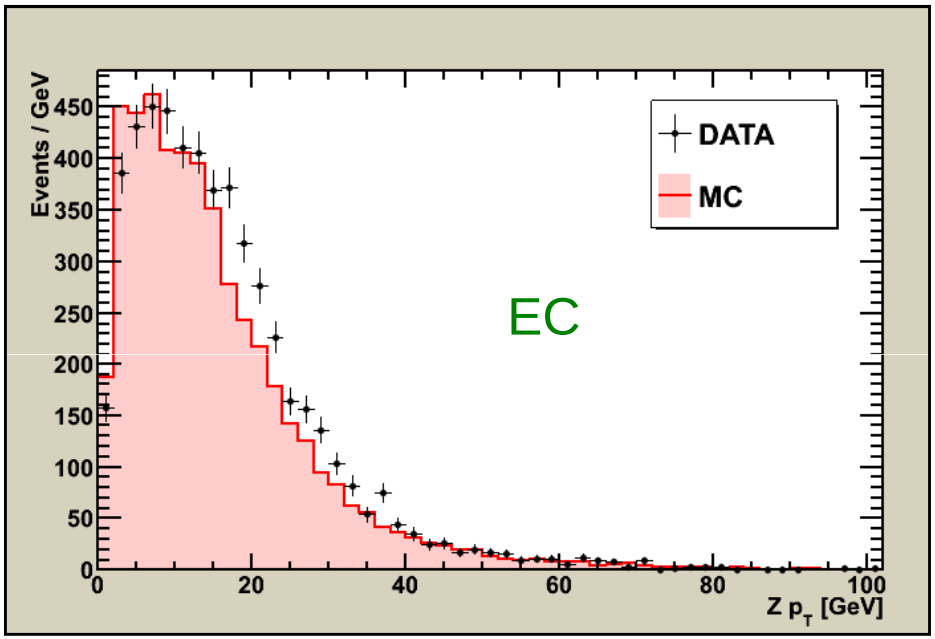


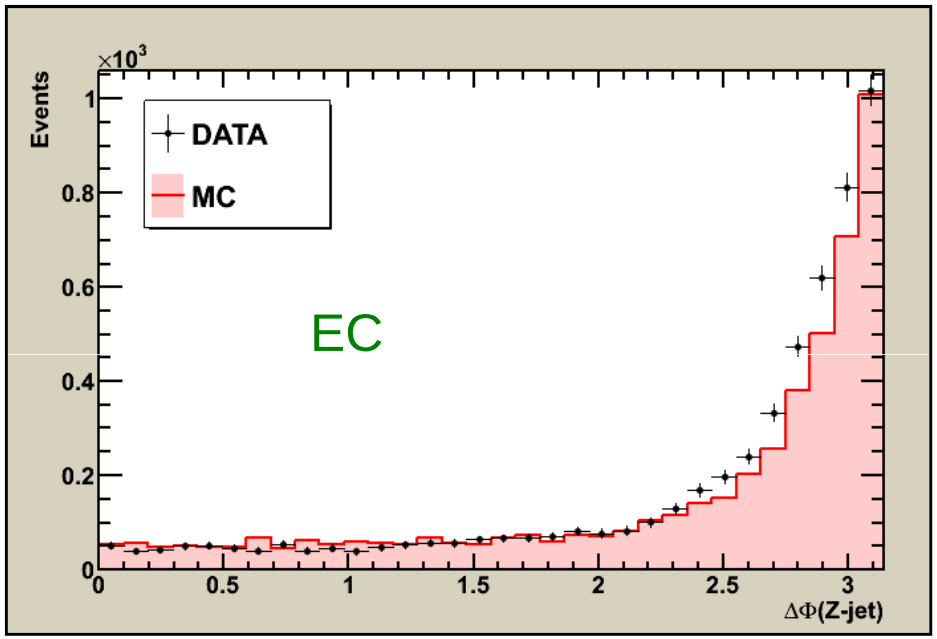


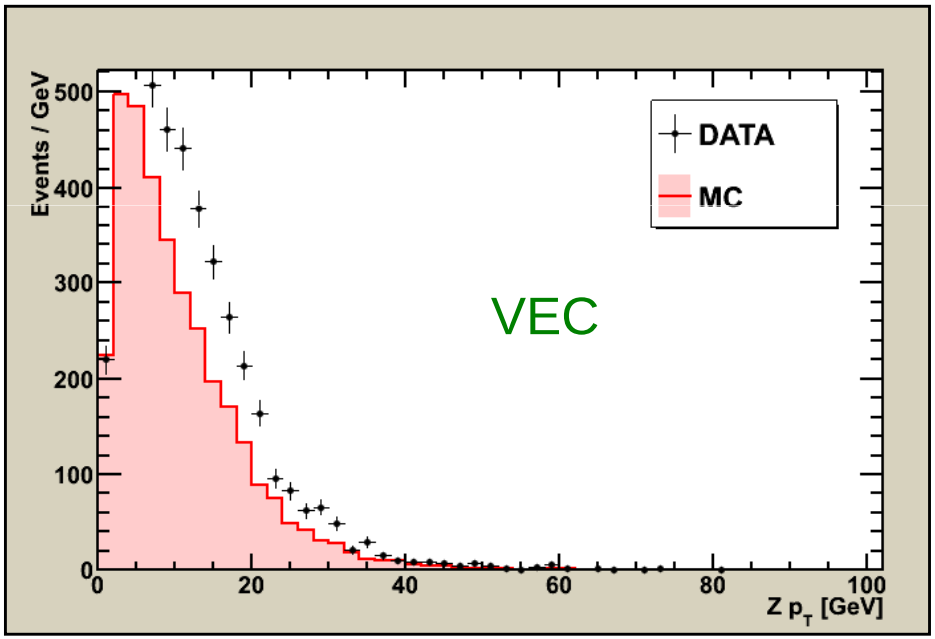


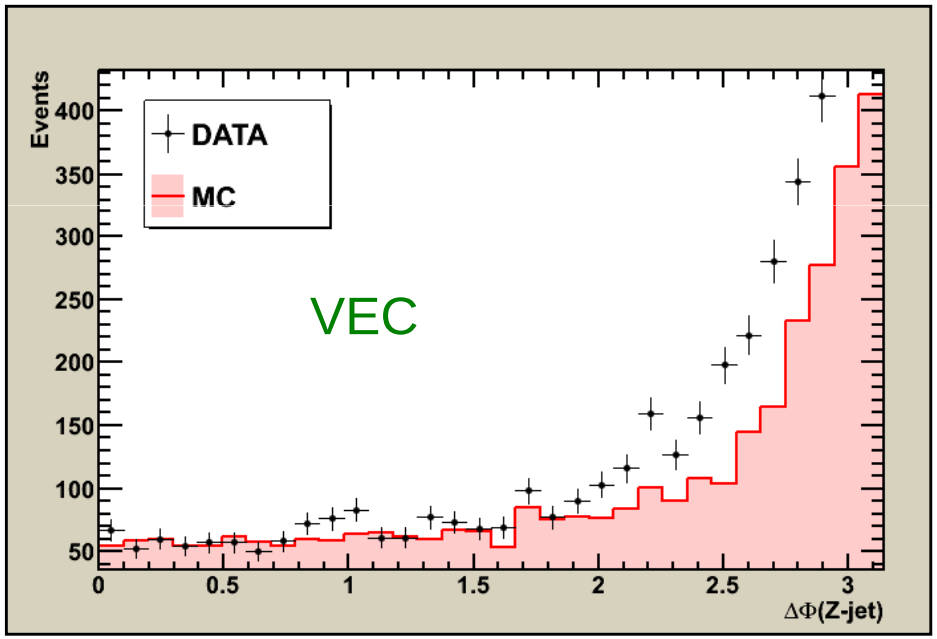


Z p_T and $\Delta\Phi$: EC and VEC









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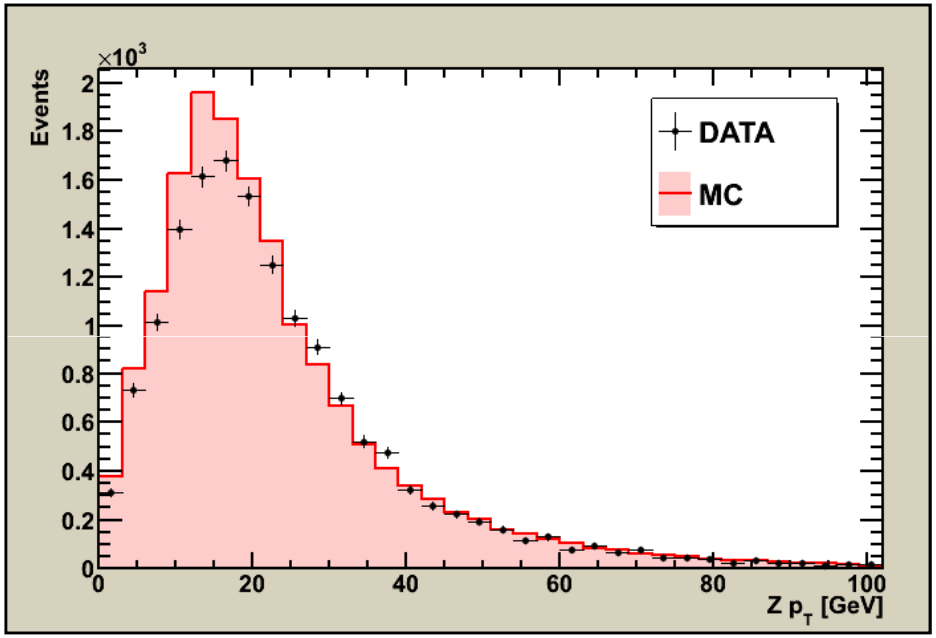
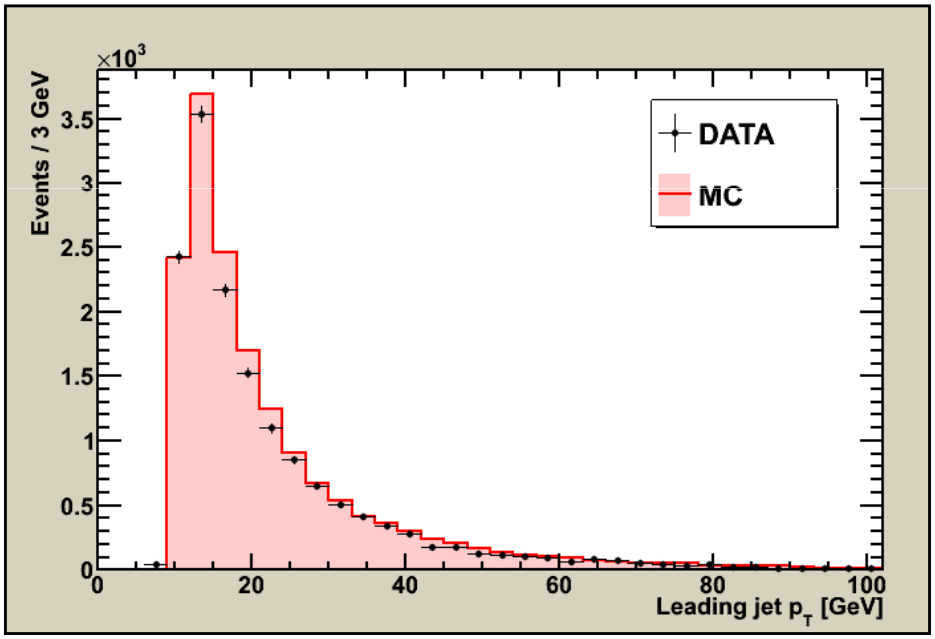
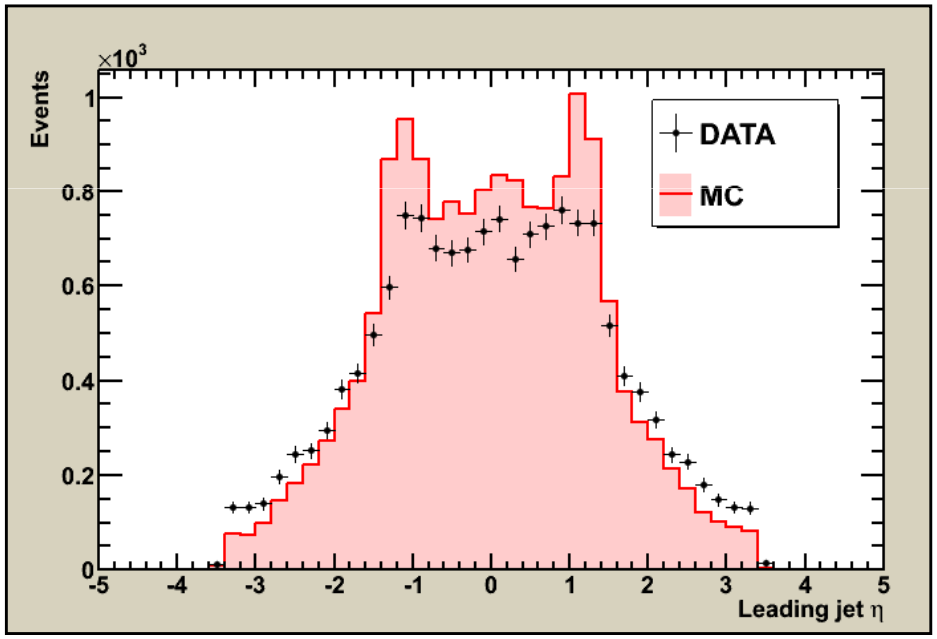
- select good JCCB jets without p_T and η cuts
- n(good jets) = 1
- n(bad jets) = 0
- $\Delta\Phi$(Z-jet)>2.8

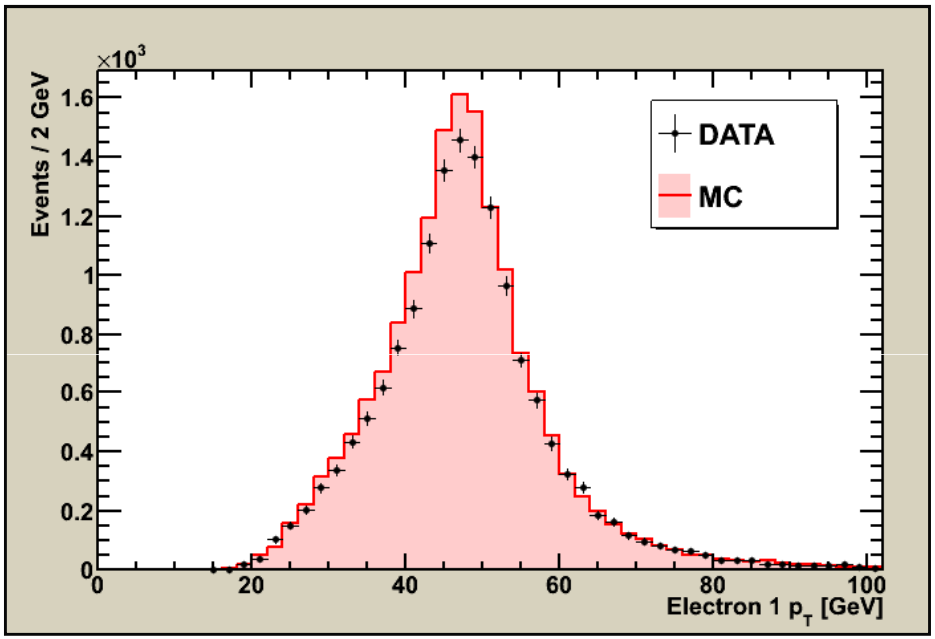
Z pt and jet p_T/η

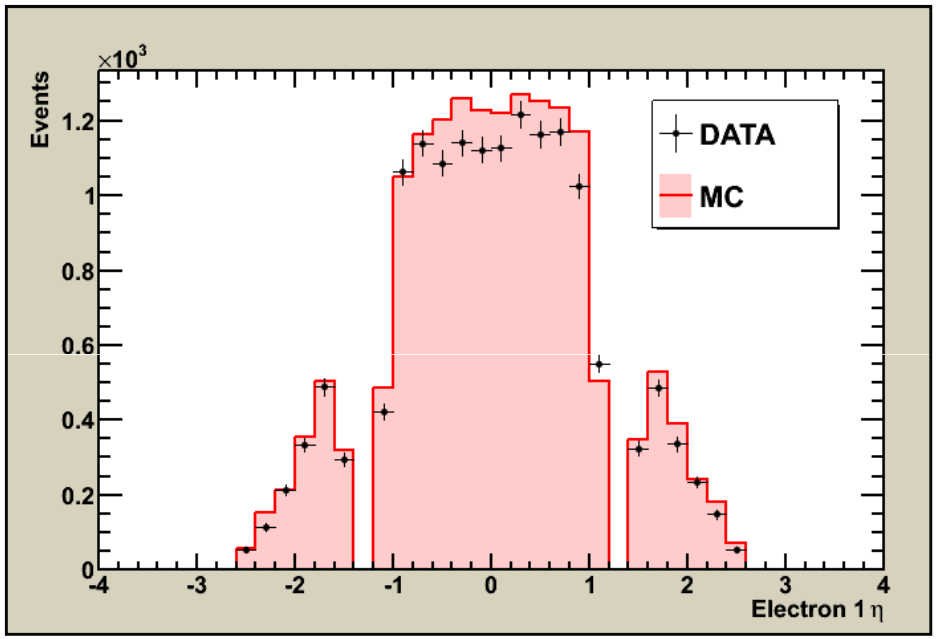


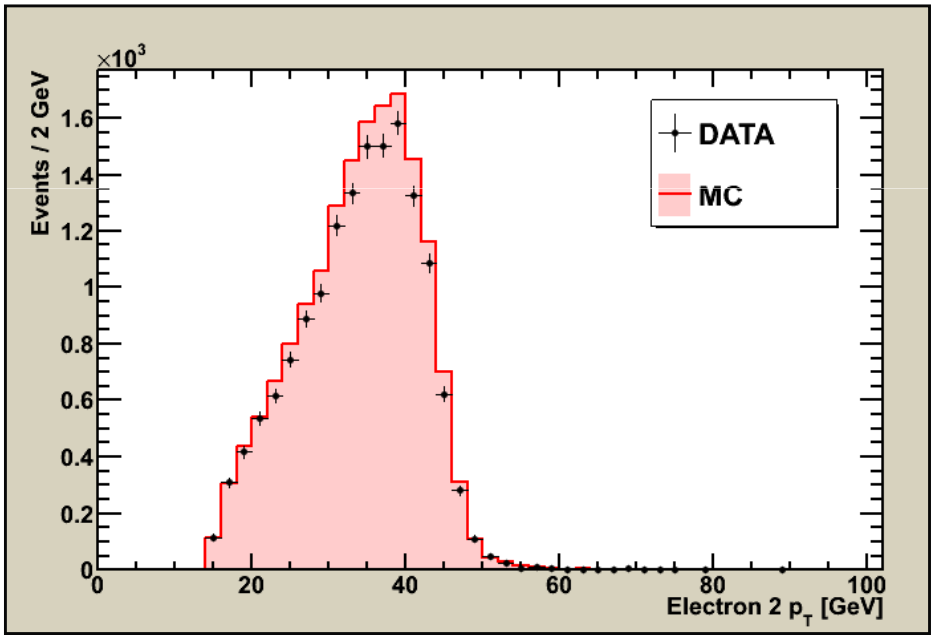


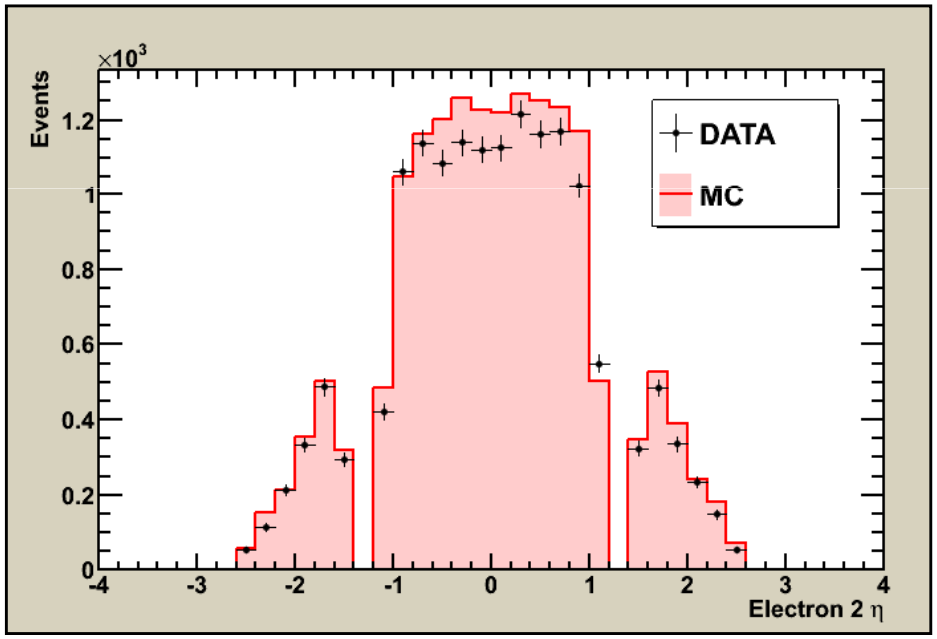


Electron kinematics

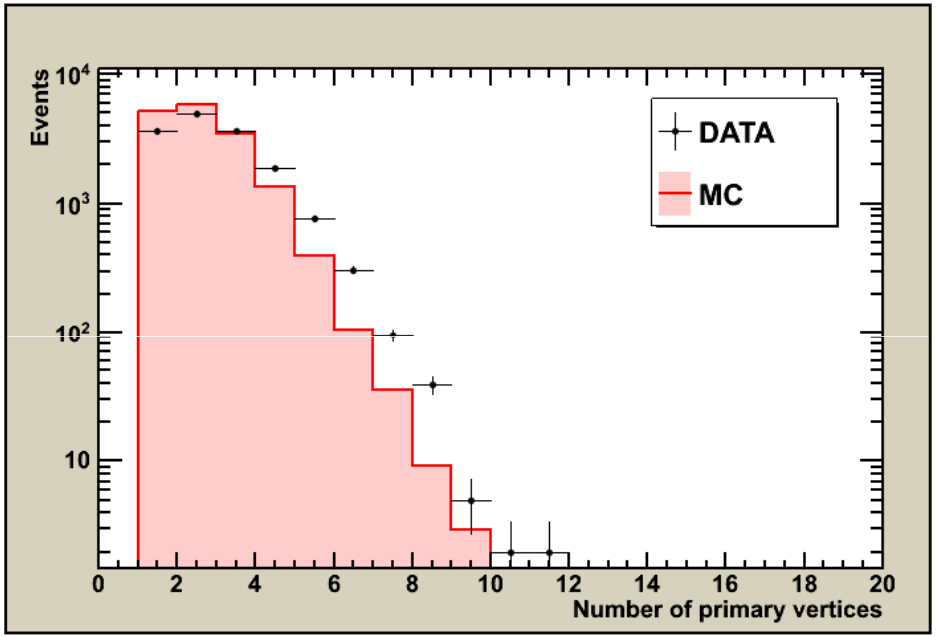


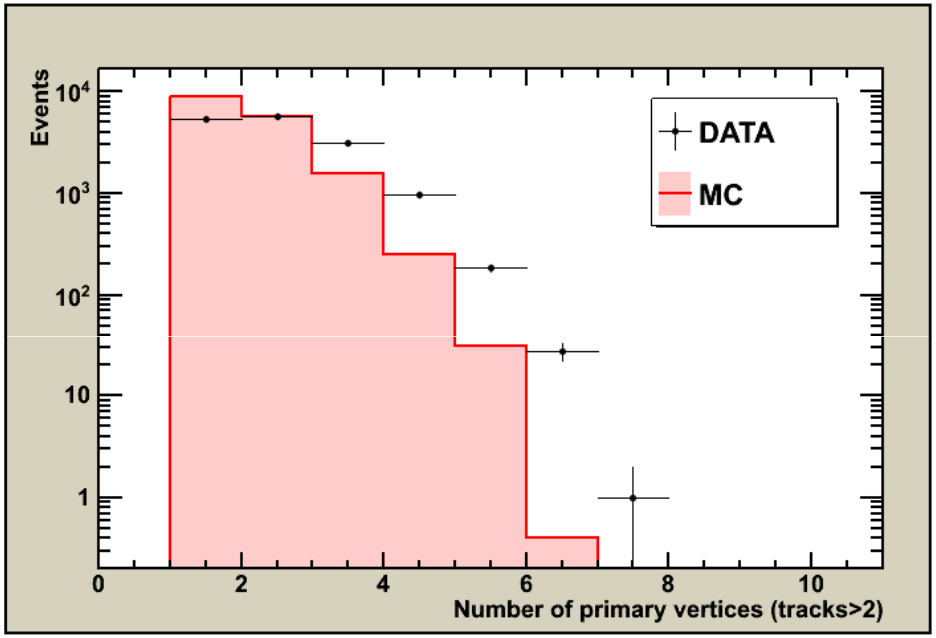


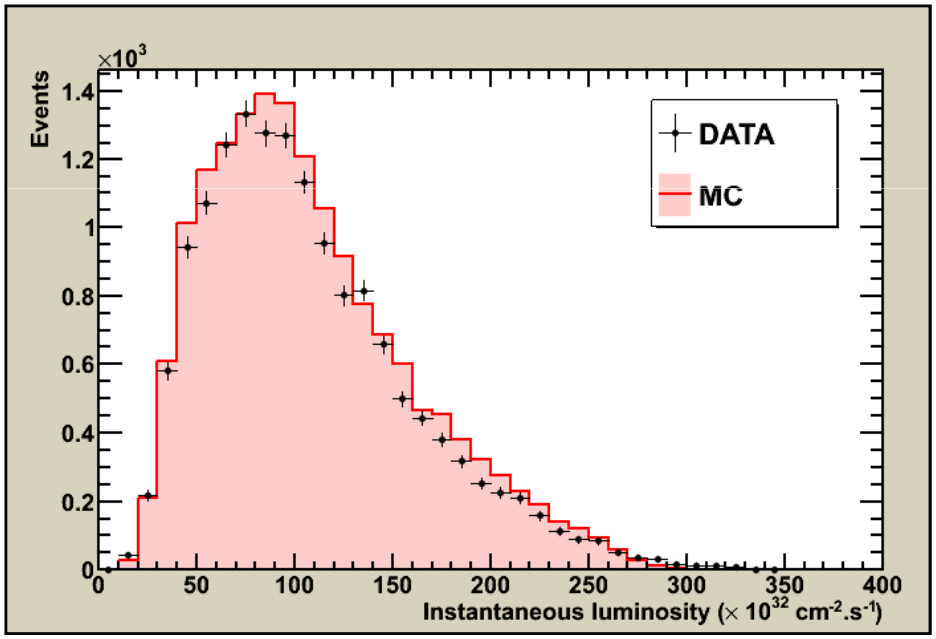




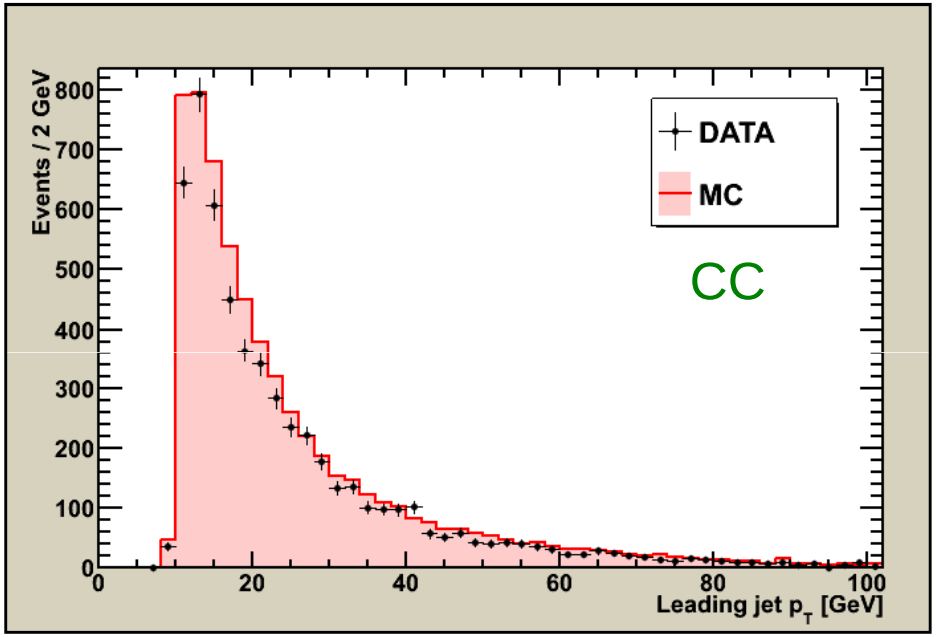
Vertices and luminosity

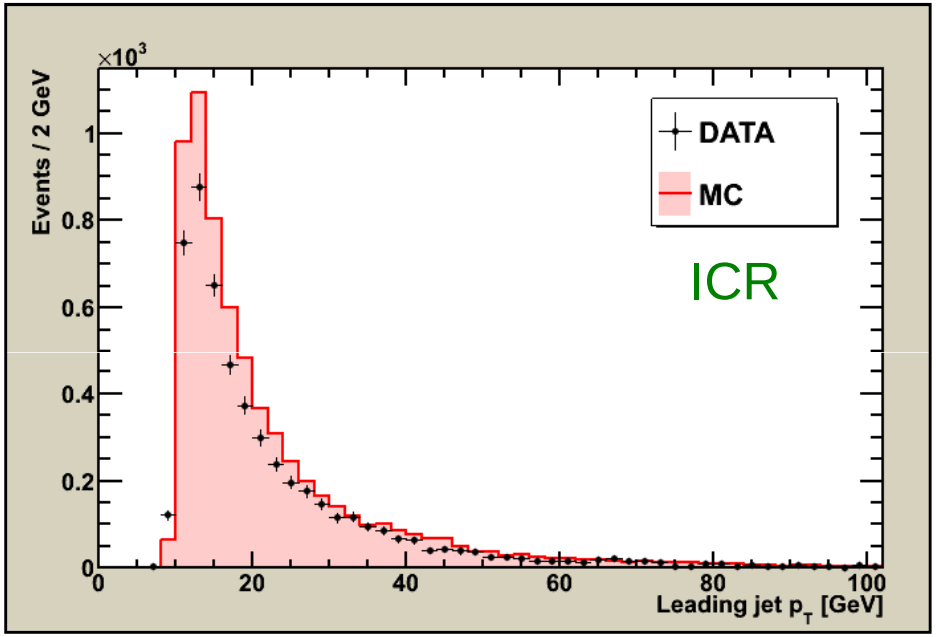


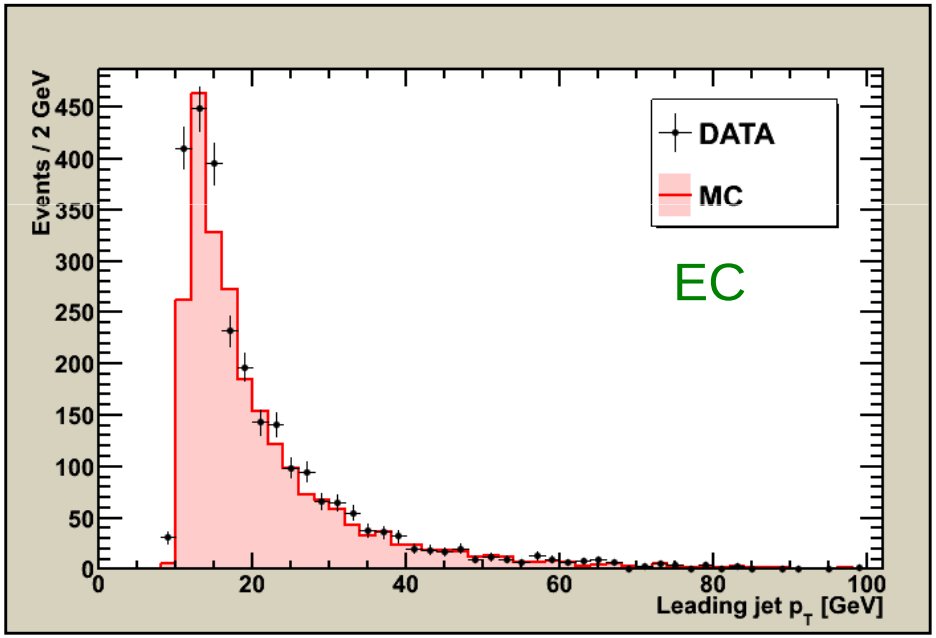


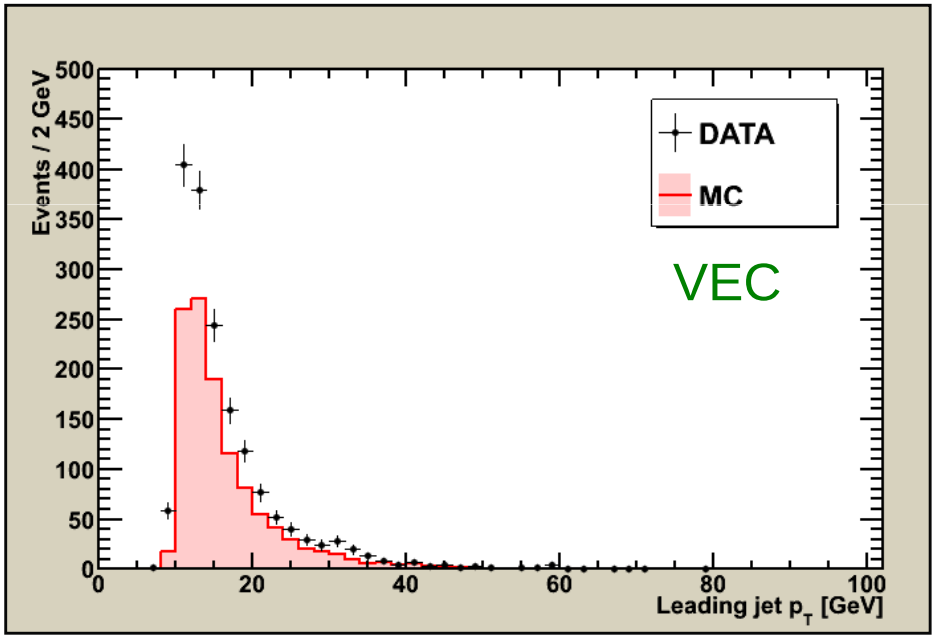


jet p_T

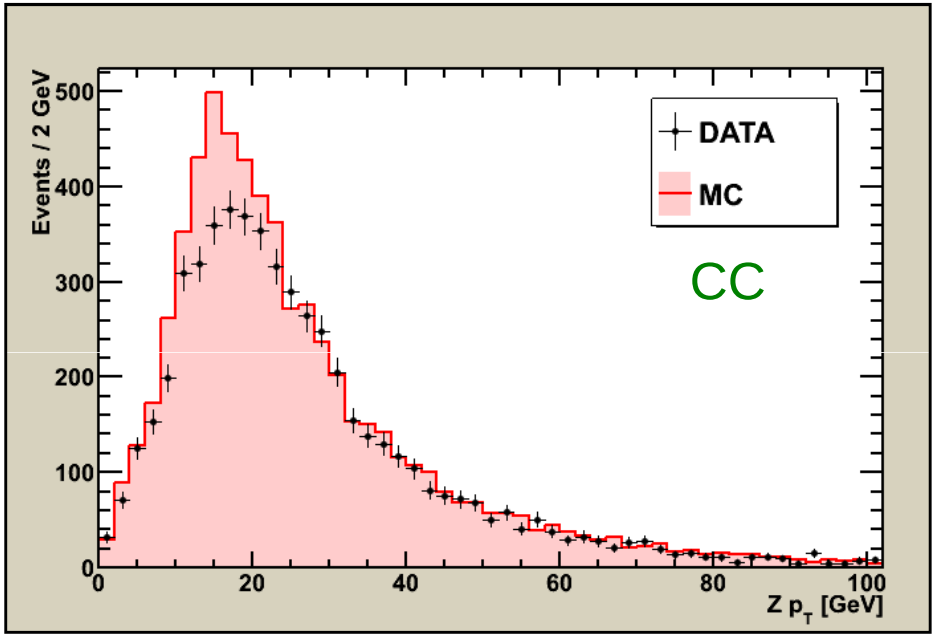

Events / 2 GeV
DATA
MC
CC
Leading jet p_T [GeV]

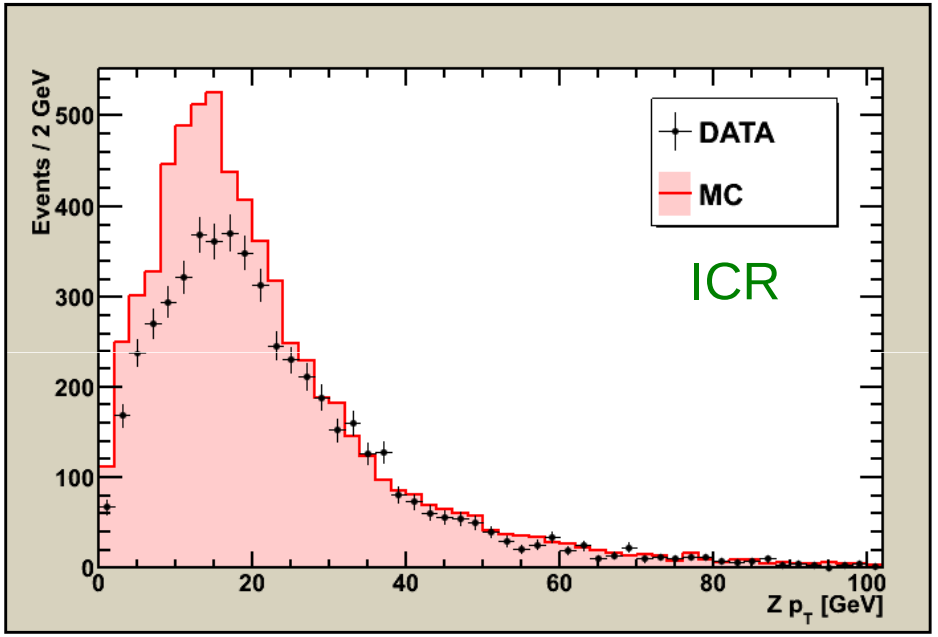

$\times 10^3$
Events / 2 GeV
DATA
MC
ICR
Leading jet p_T [GeV]

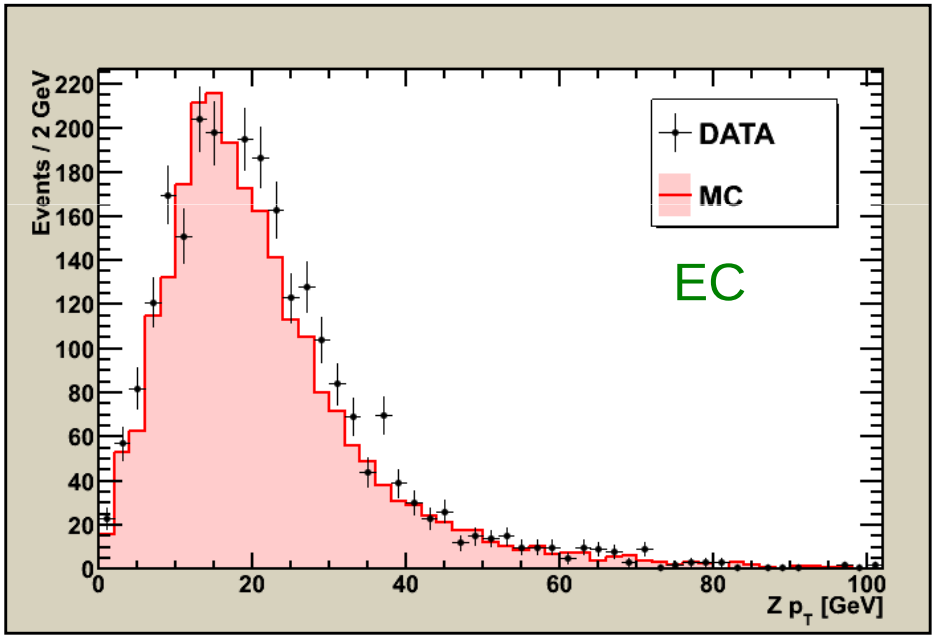

Events / 2 GeV
DATA
MC
EC
Leading jet p_T [GeV]

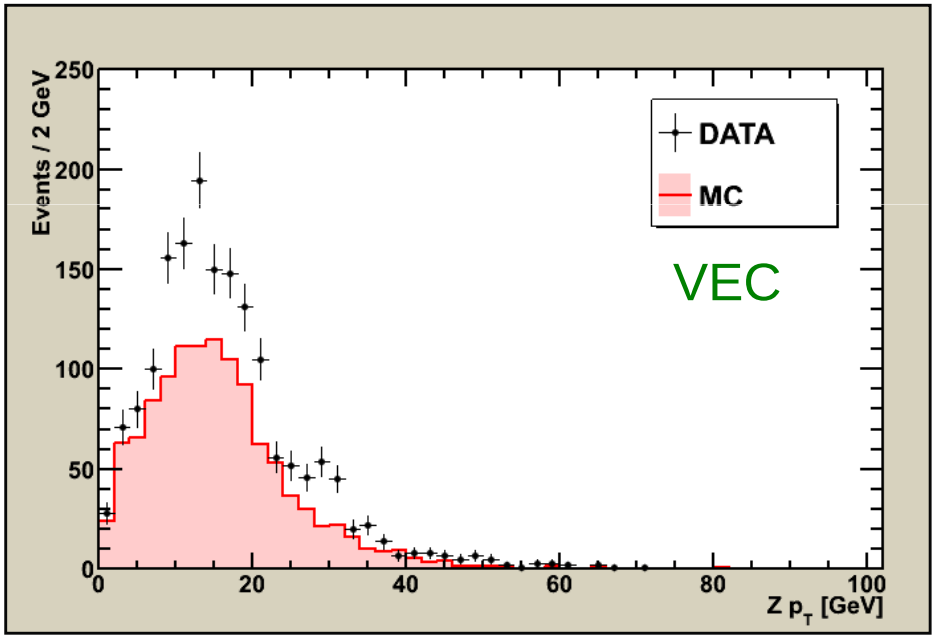

Events / 2 GeV
DATA
MC
VEC
Leading jet p_T [GeV]

Z p_T


Events / 2 GeV
DATA
MC
CC
Z p_T [GeV]


Events / 2 GeV
DATA
MC
ICR
Z p_T [GeV]

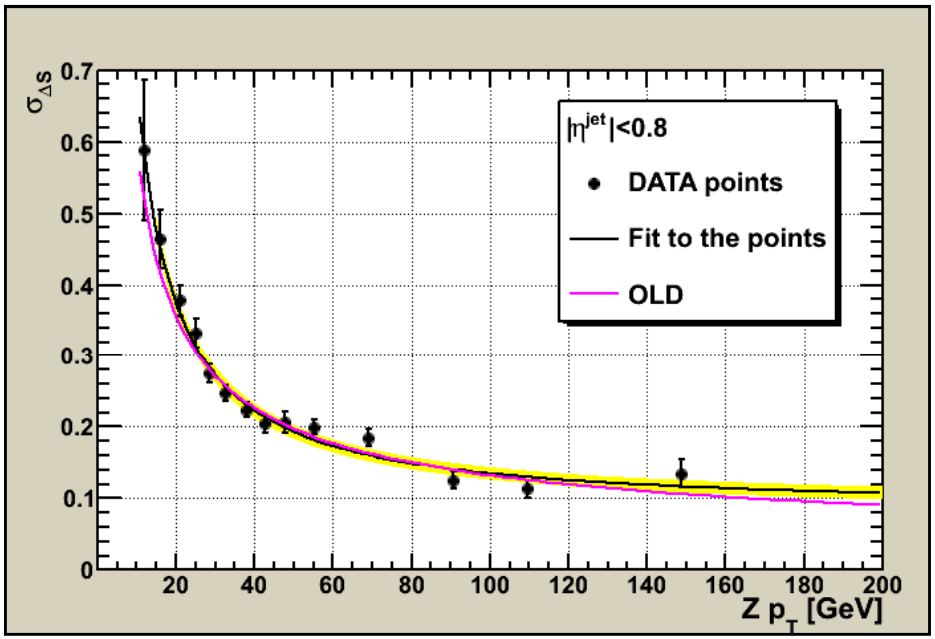

Events / 2 GeV
DATA
MC
EC
Z p_T [GeV]

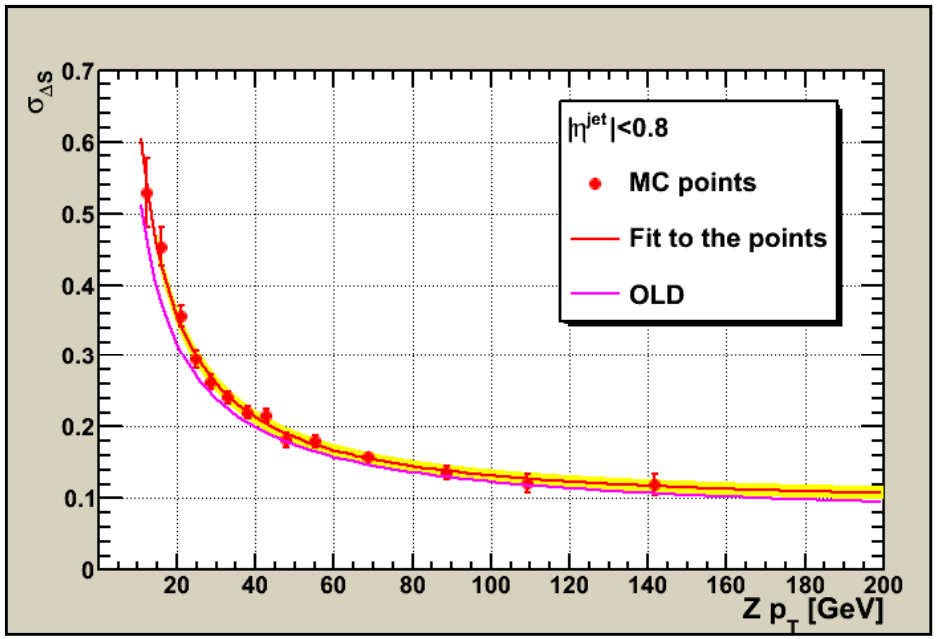

Events / 2 GeV
DATA
MC
VEC
Z p_T [GeV]

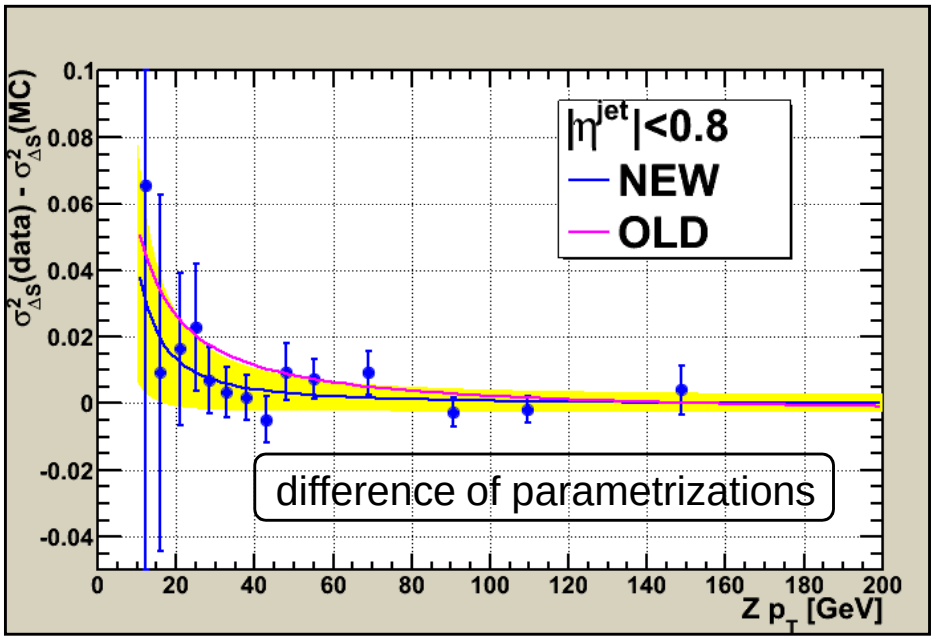
Smearing results

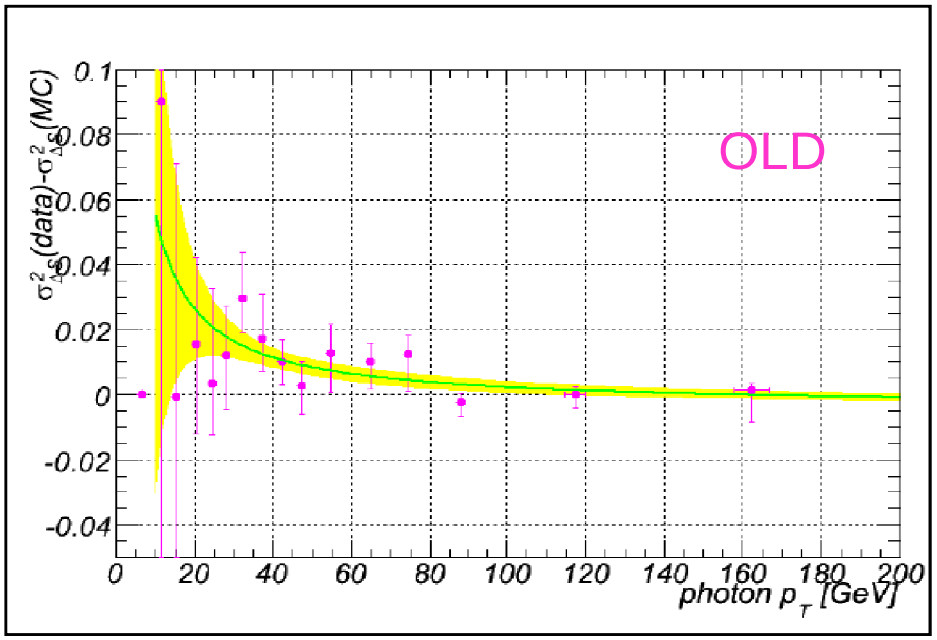
In the following:
yellow band = statistical uncertainty on the parametrization using the covariance matrix

Smearing: CC jet

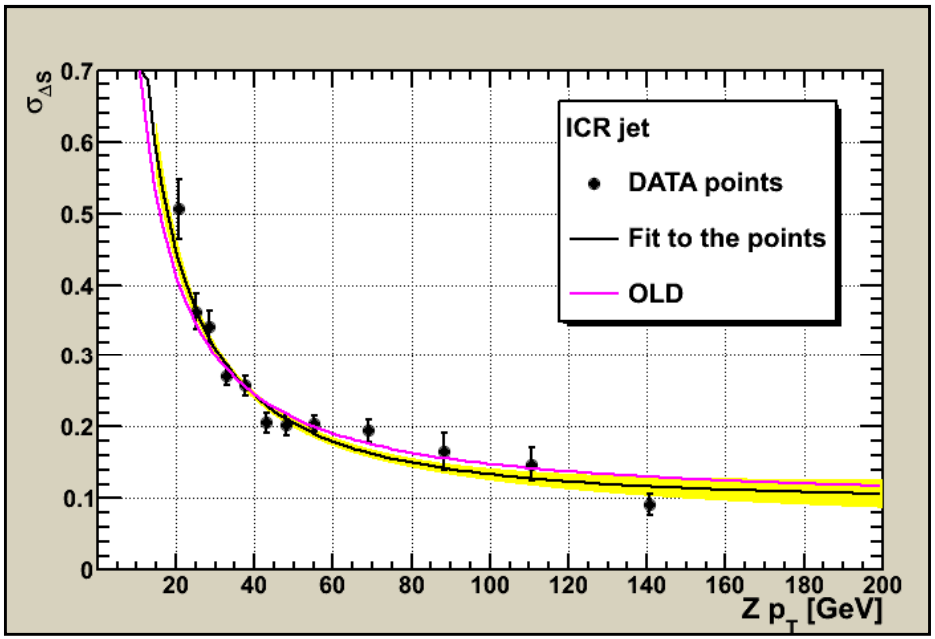


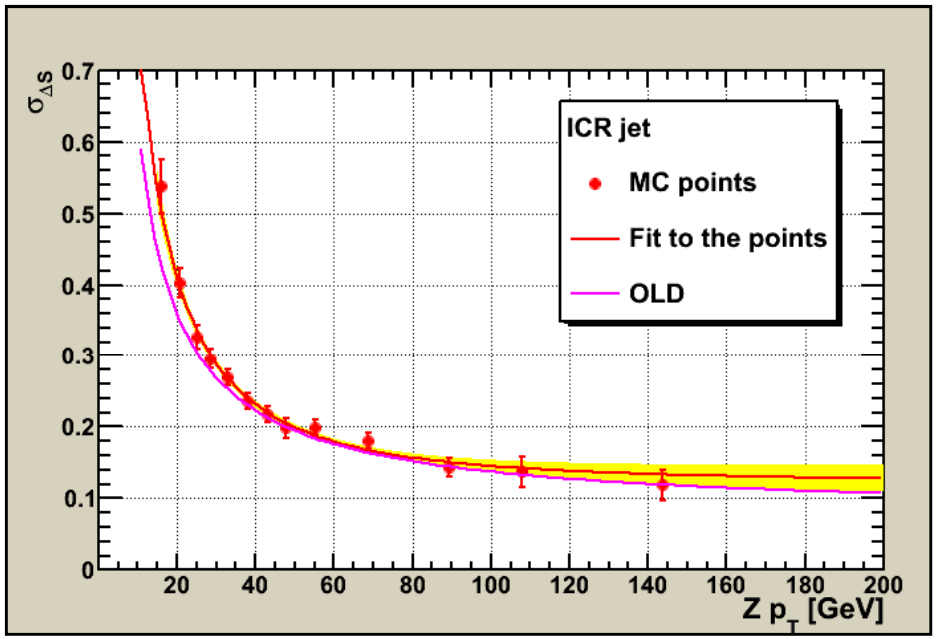


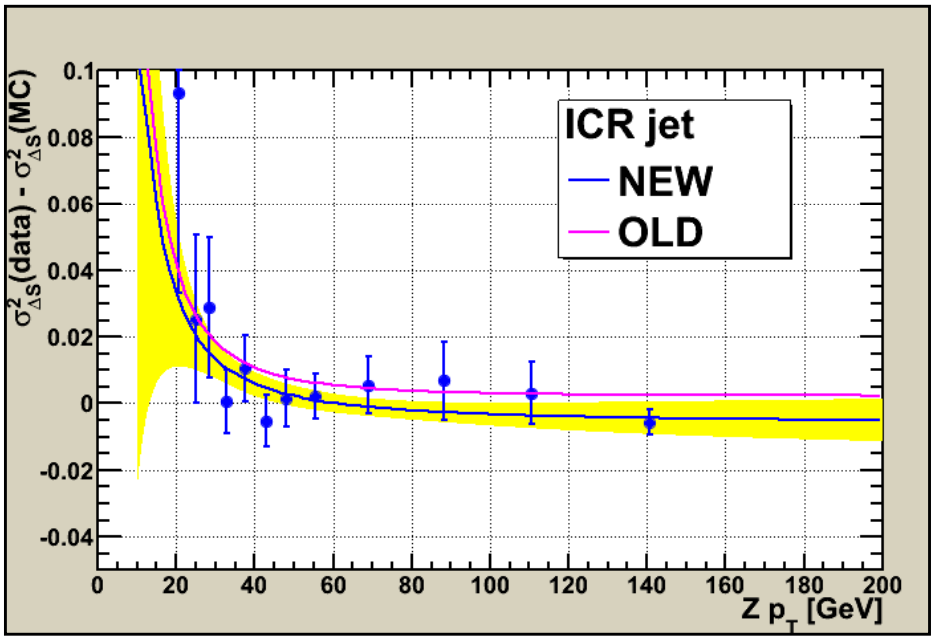


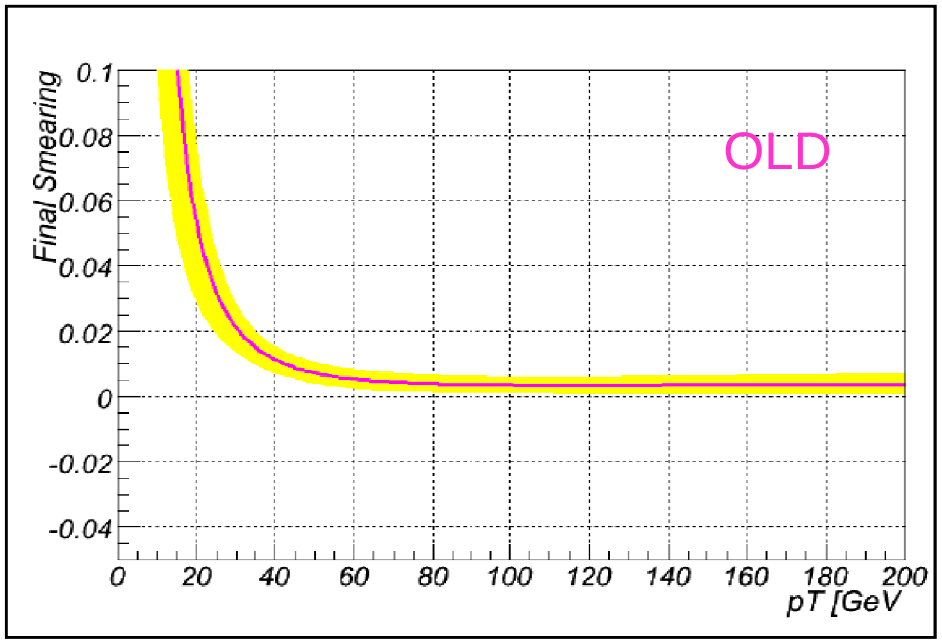


Smearing: ICR jet

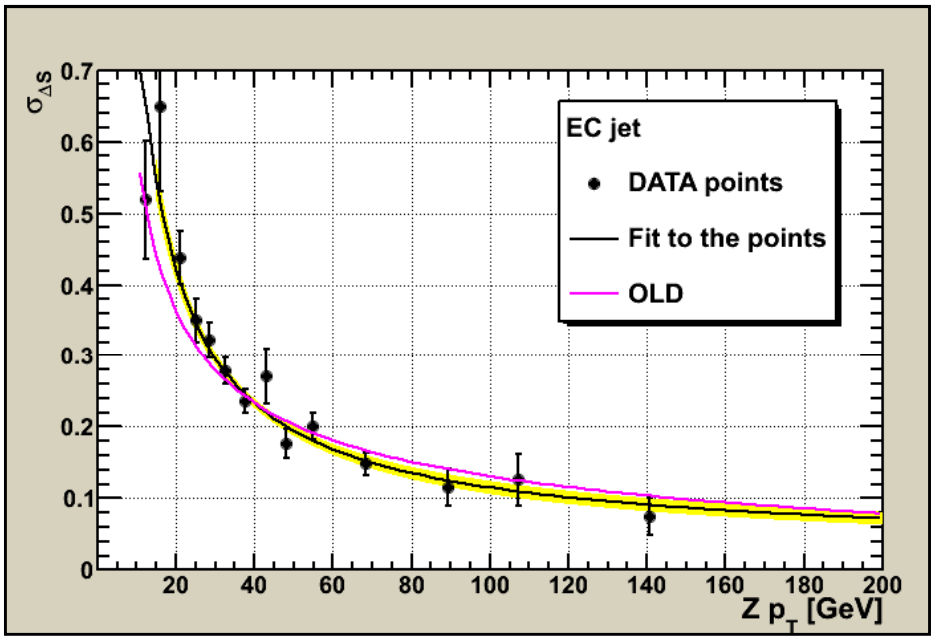


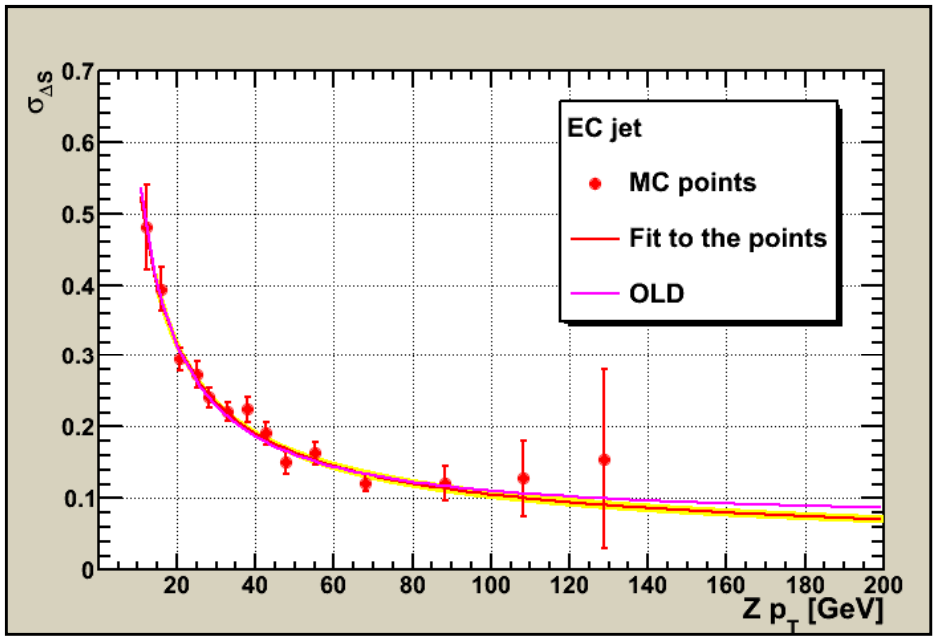


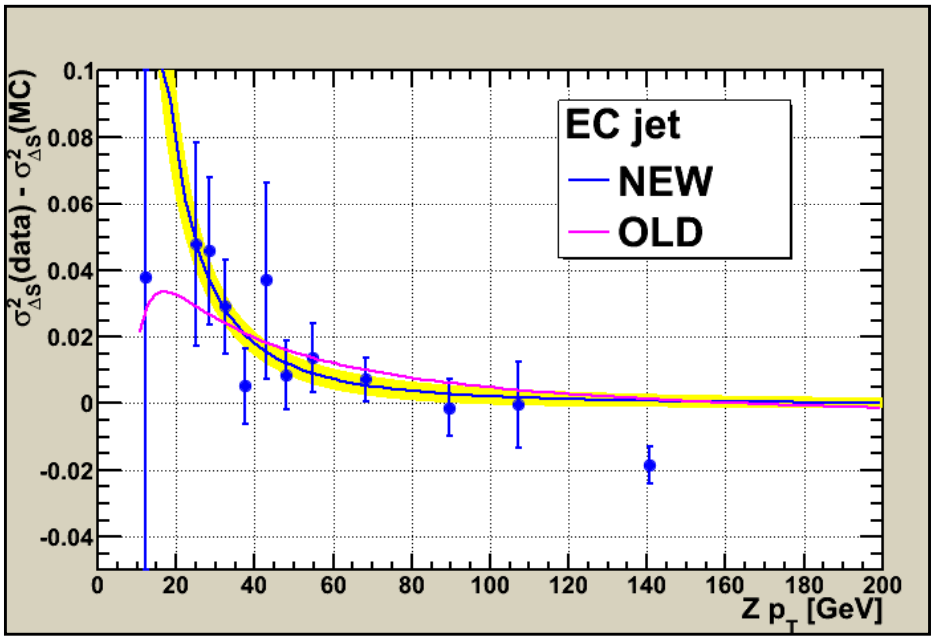


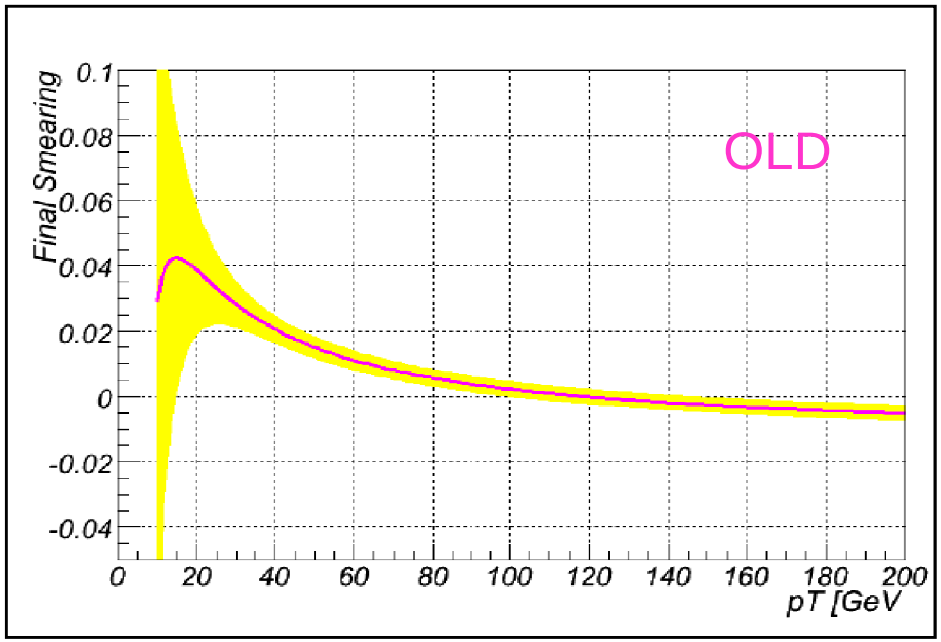


Smearing: EC jet

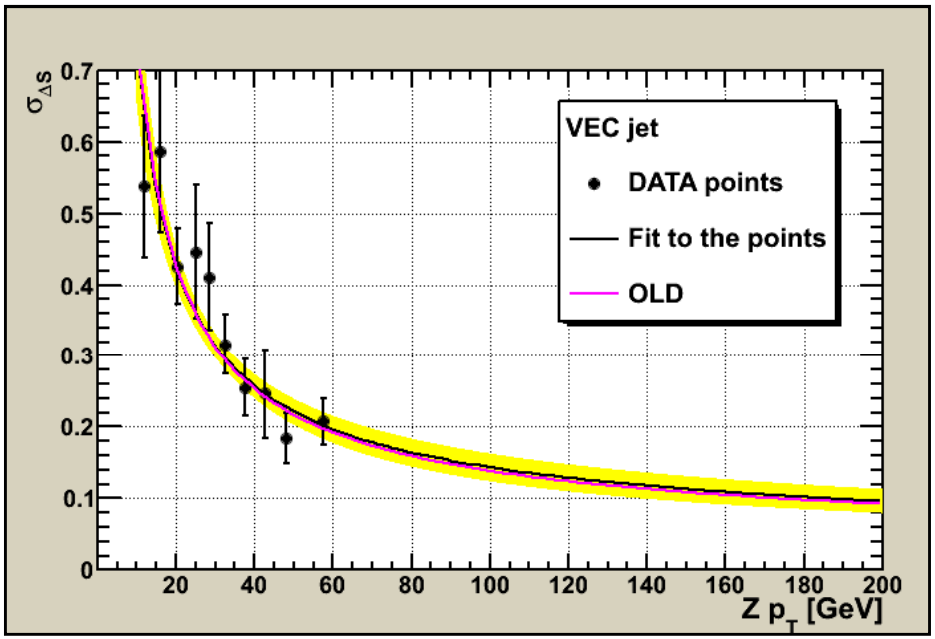


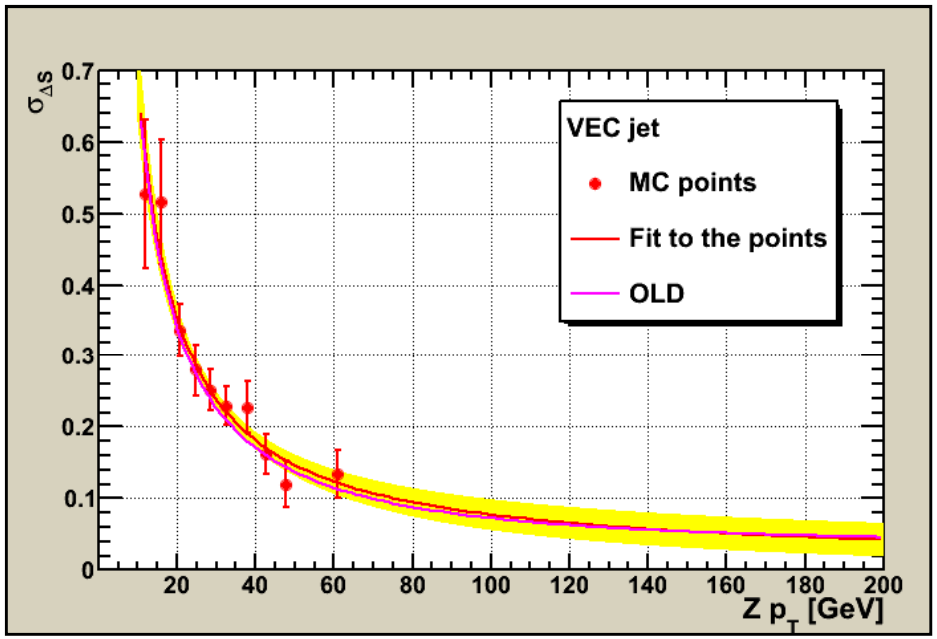


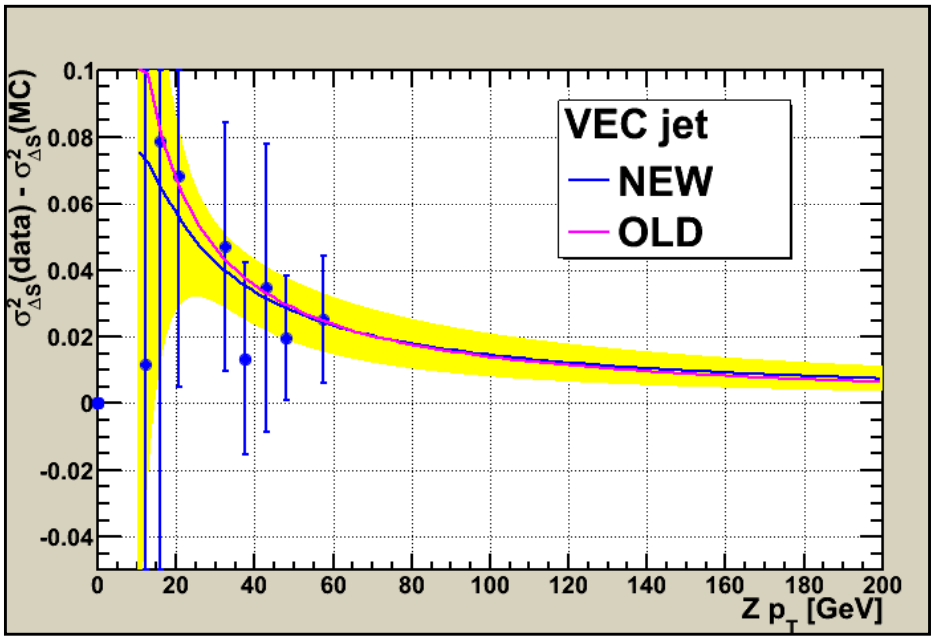


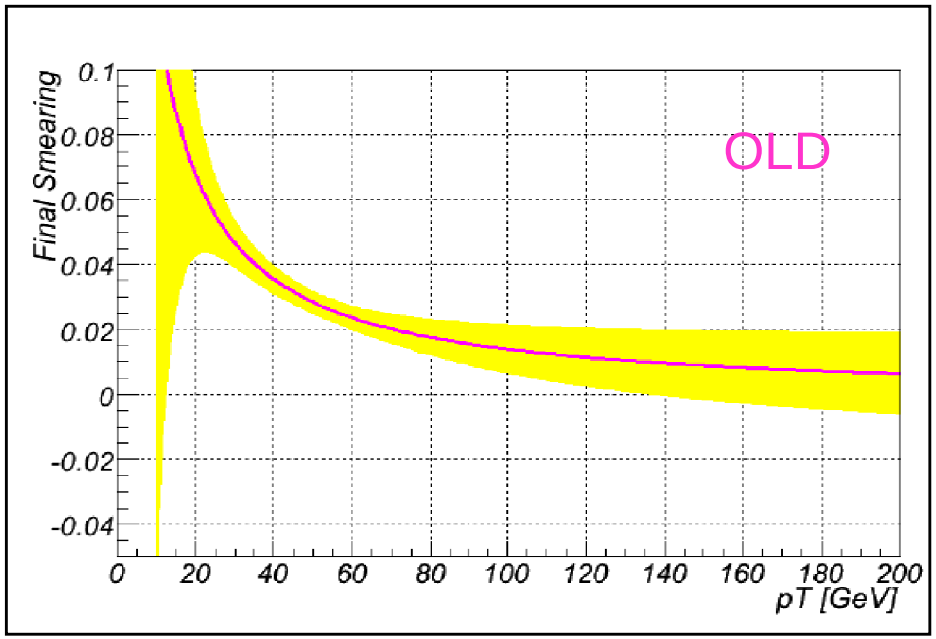


Smearing: VEC jet



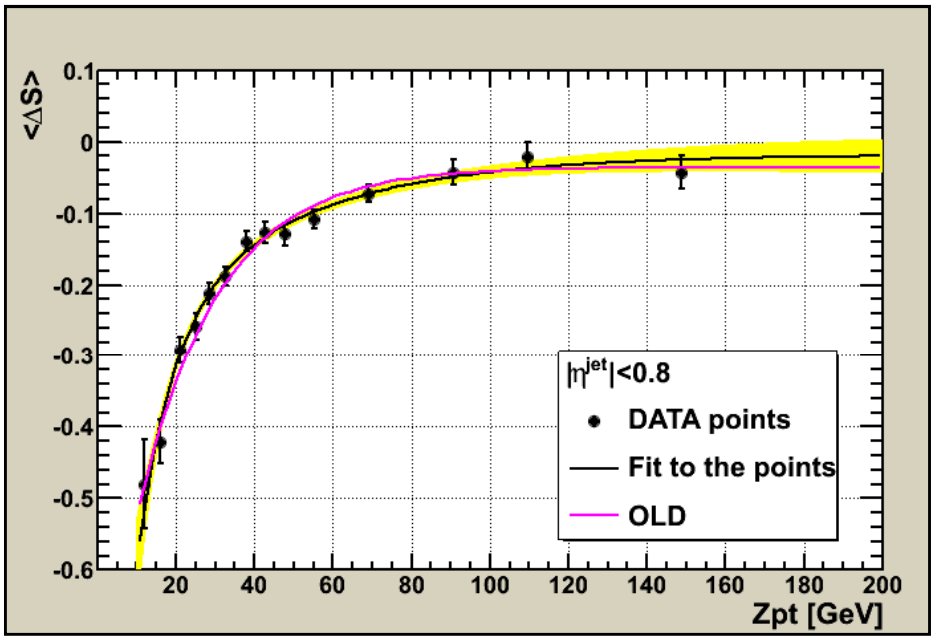


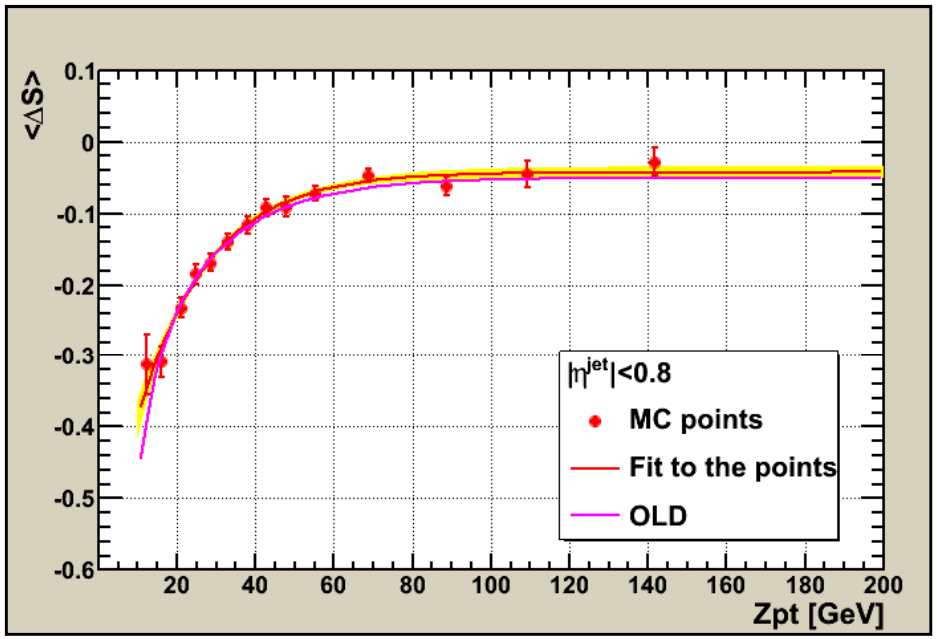


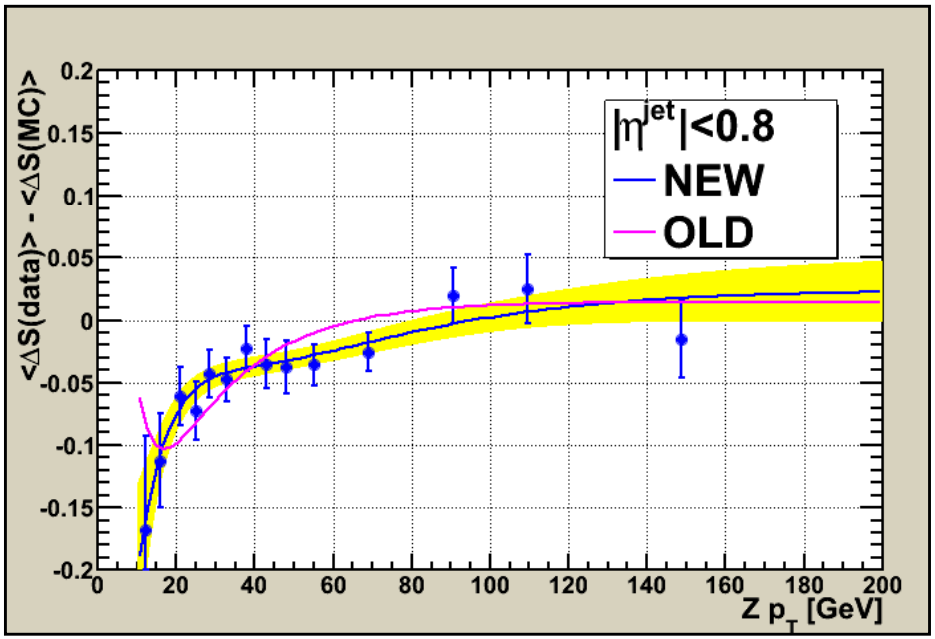


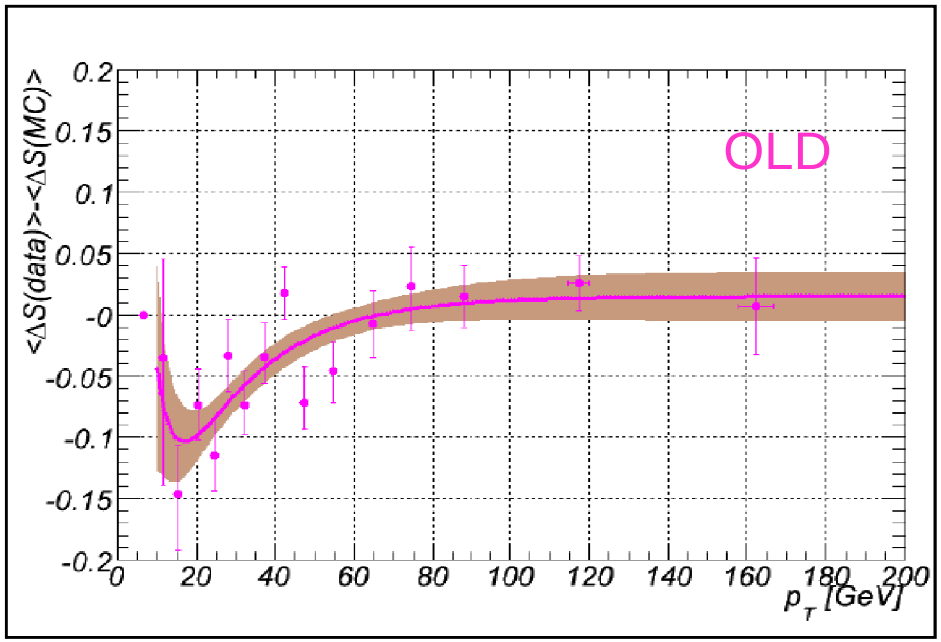
Shifting results

Shifting: CC jet

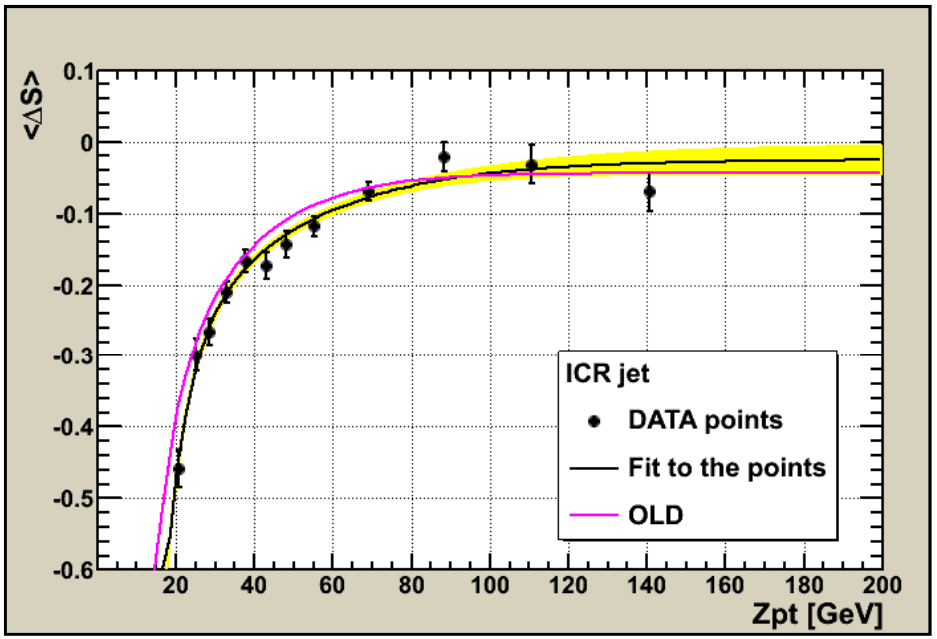


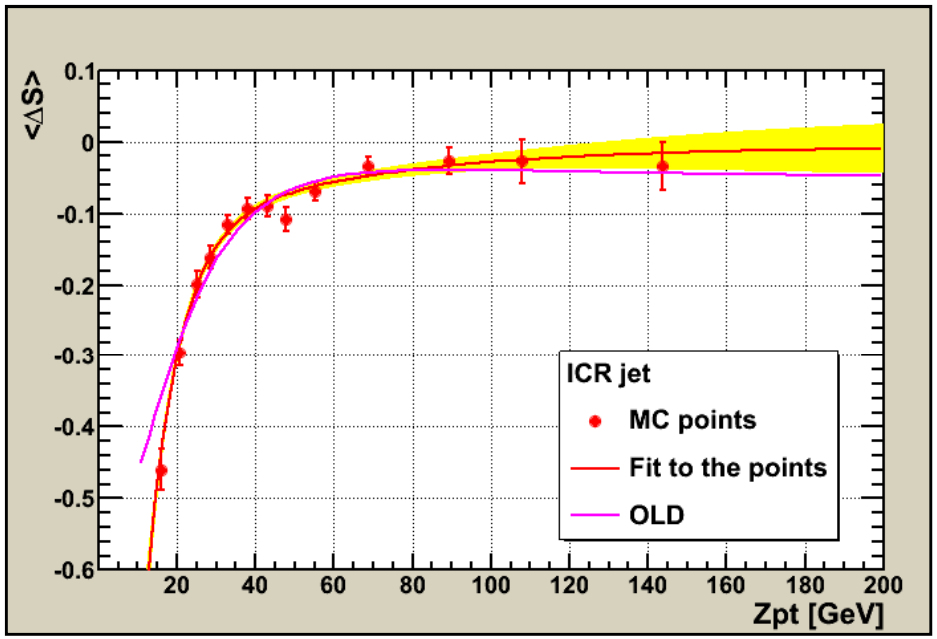


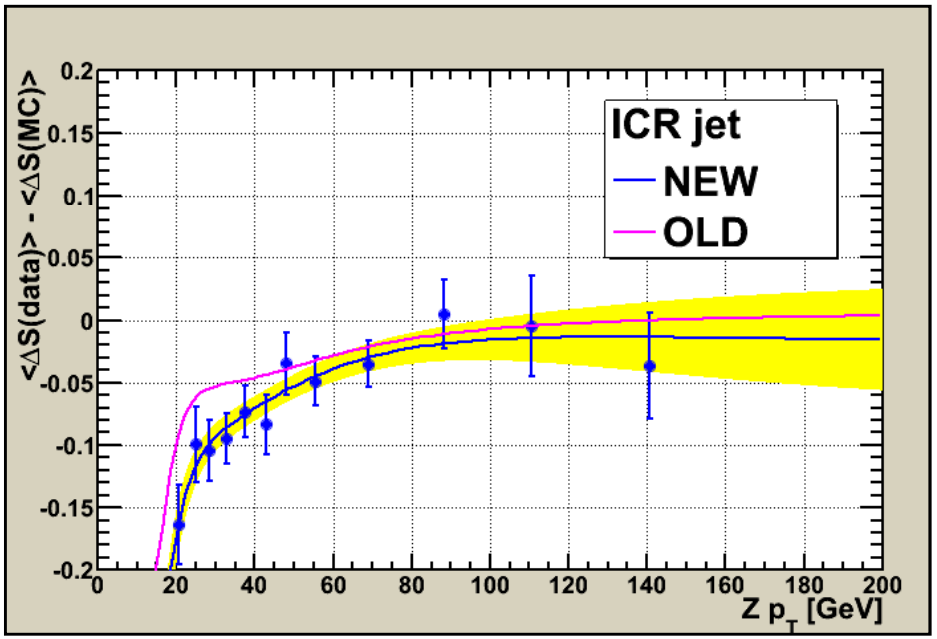


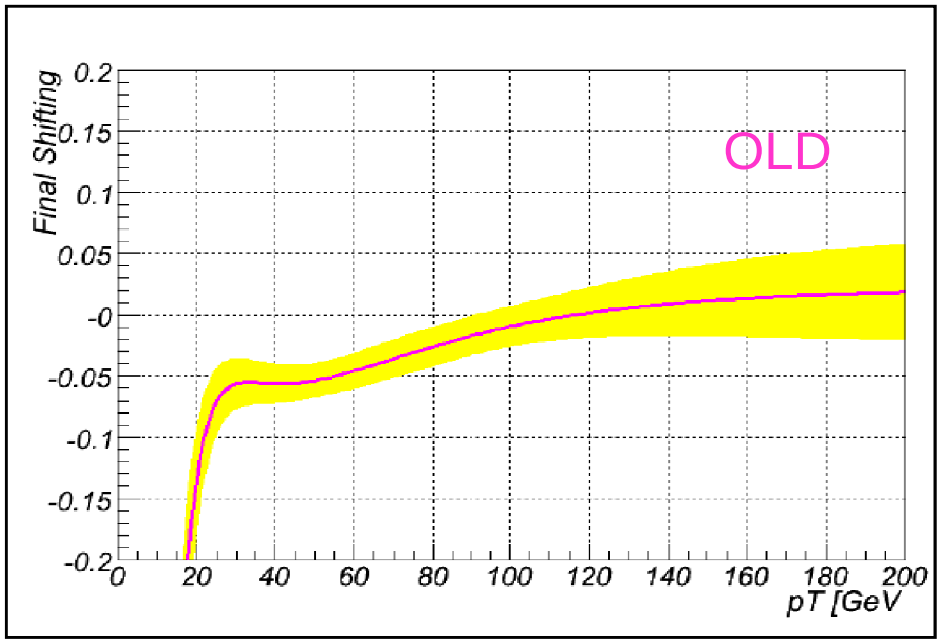


Shifting: ICR jet

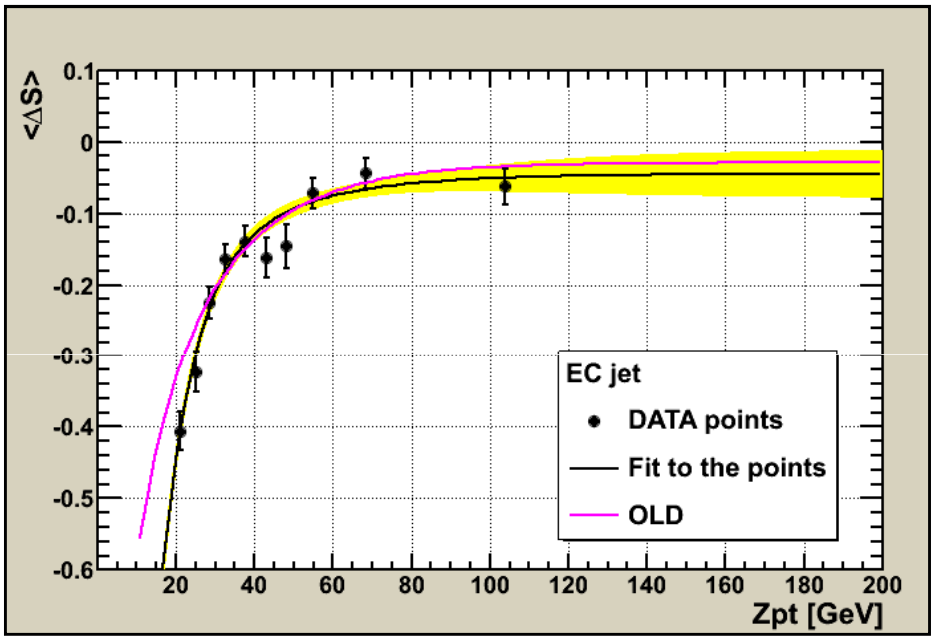


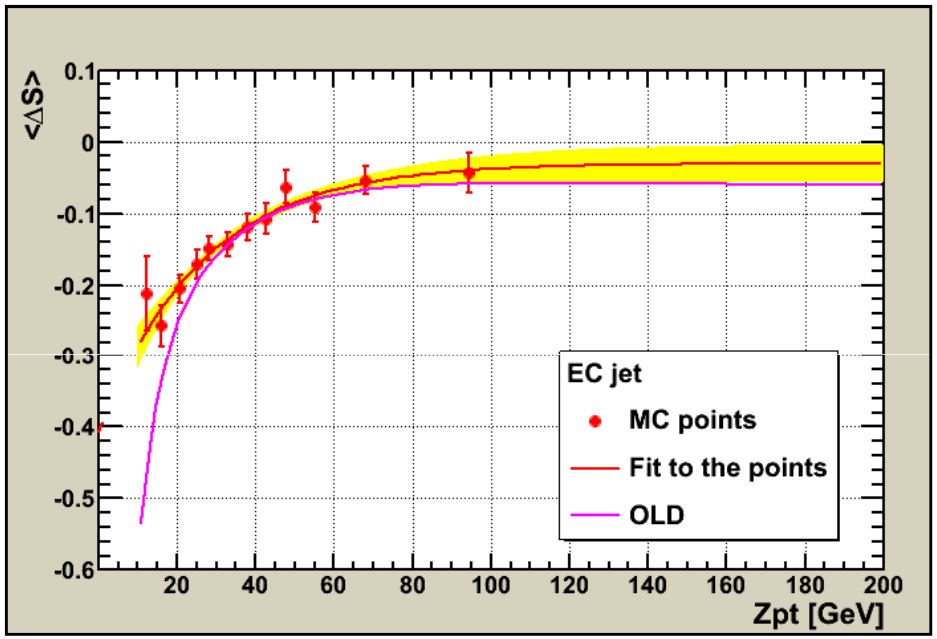


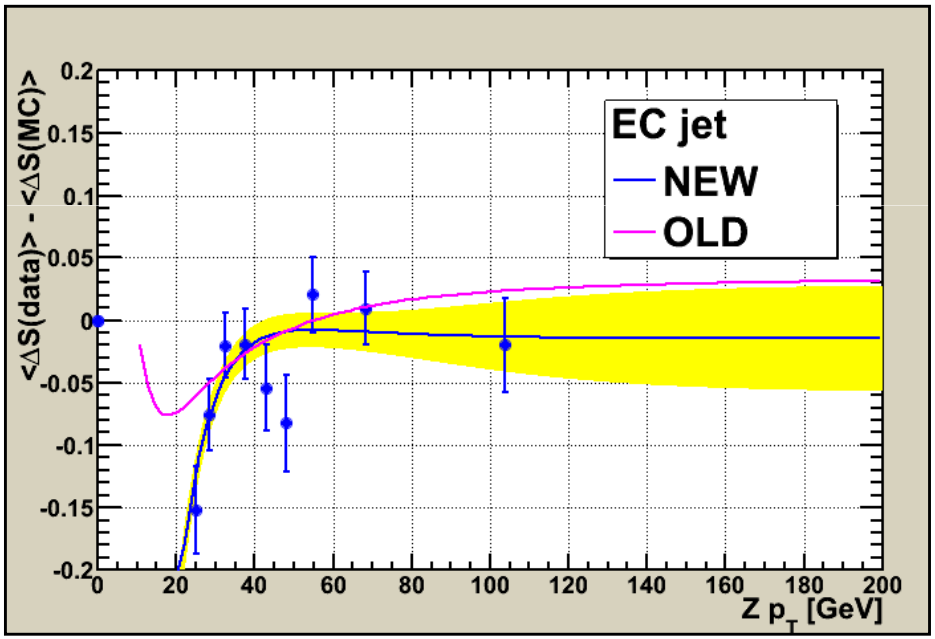




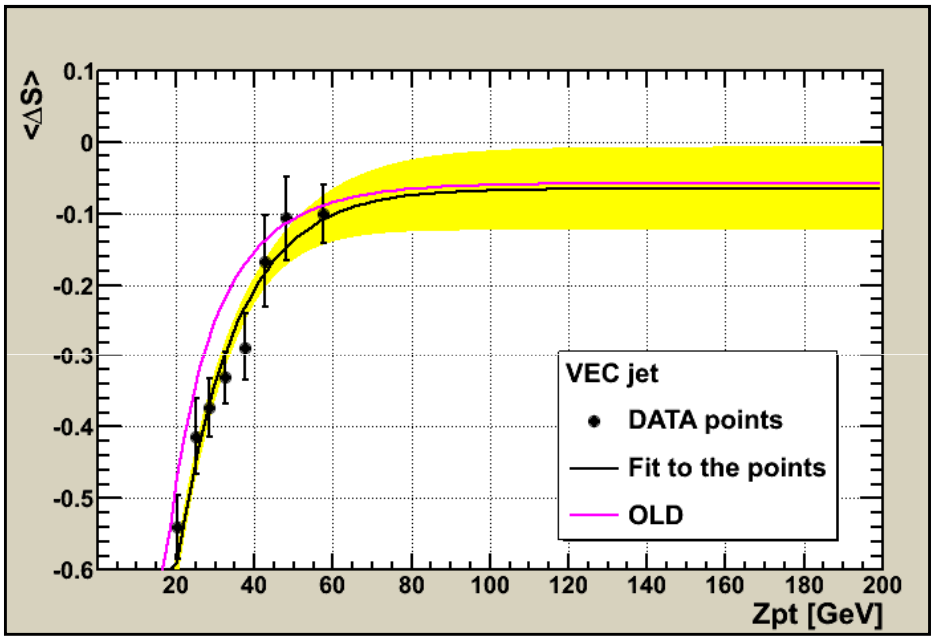
Shifting: EC jet

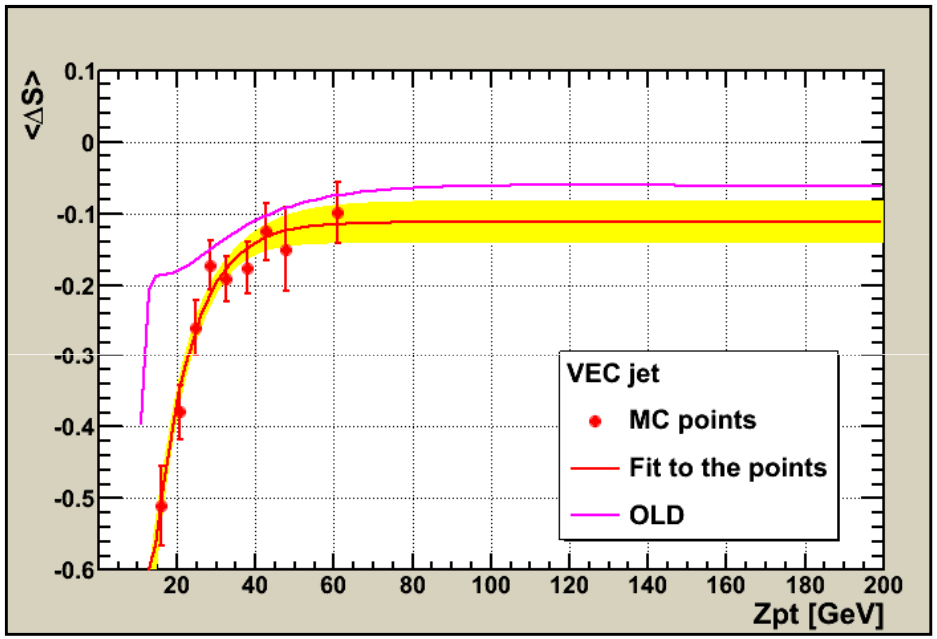


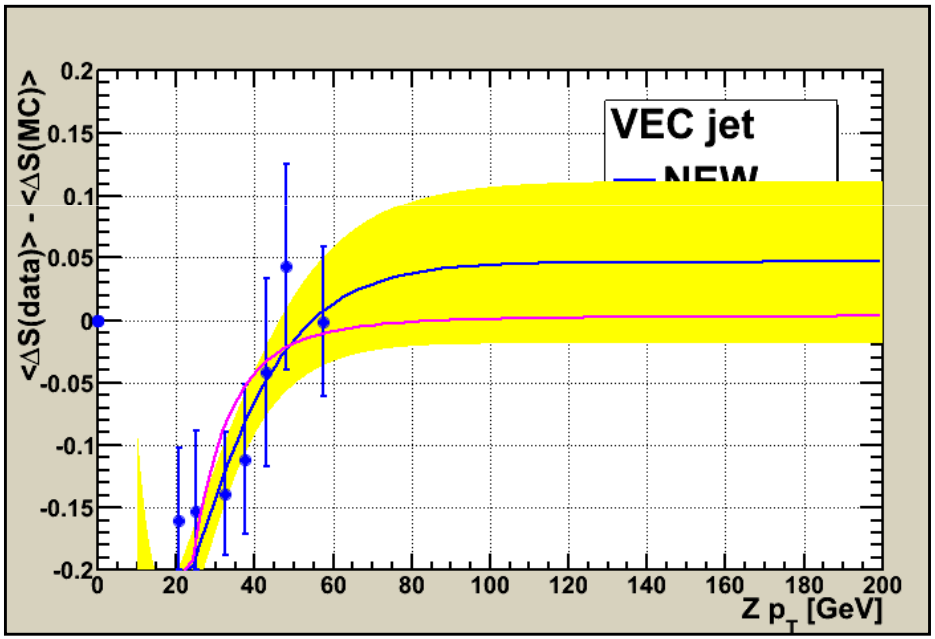




Shifting: VEC jet

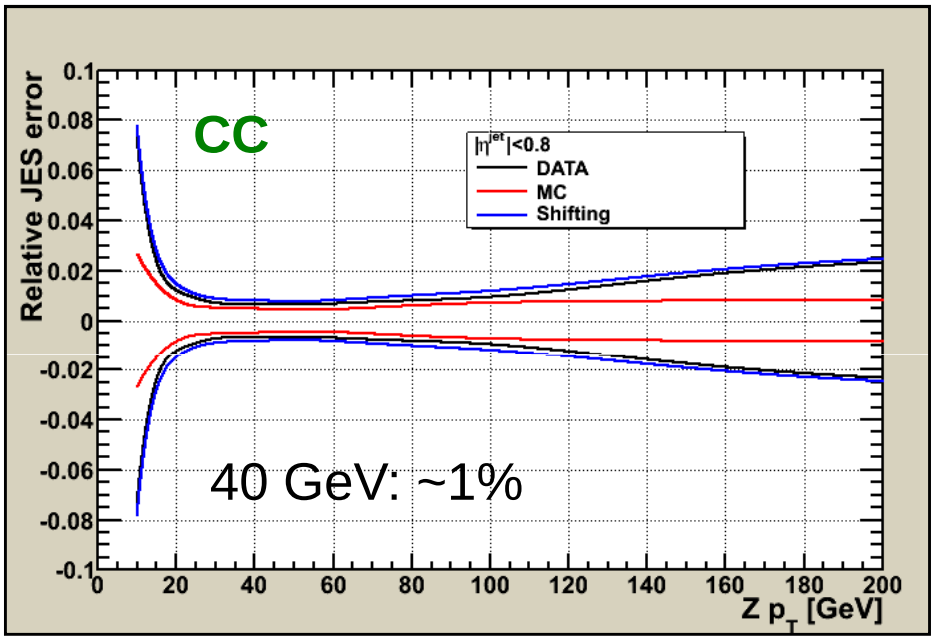


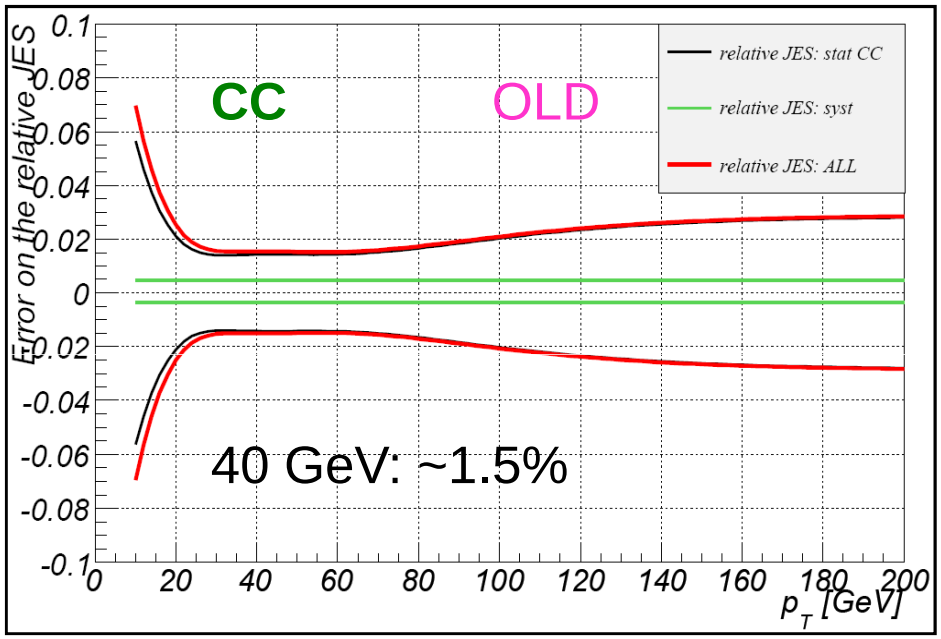


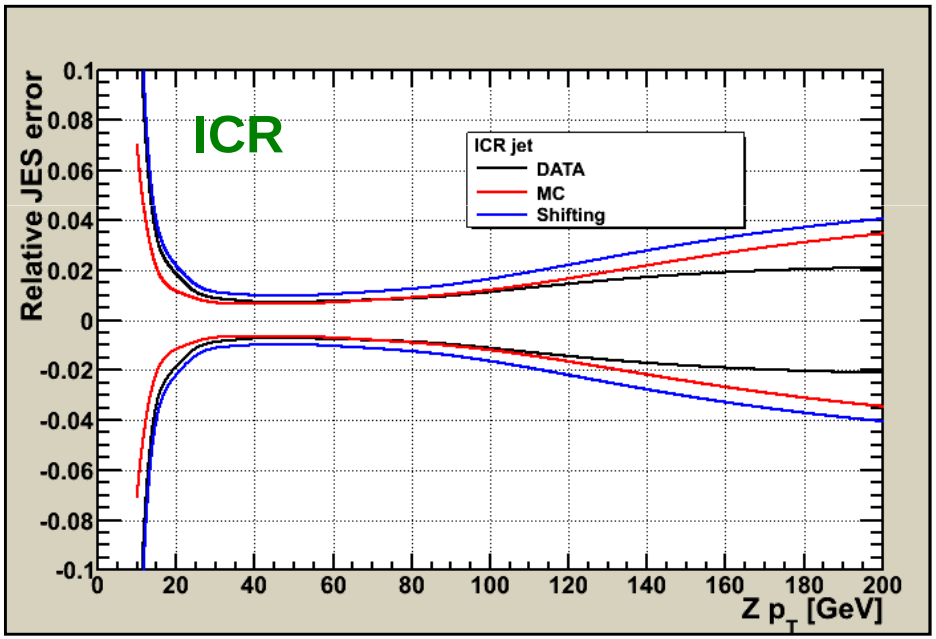


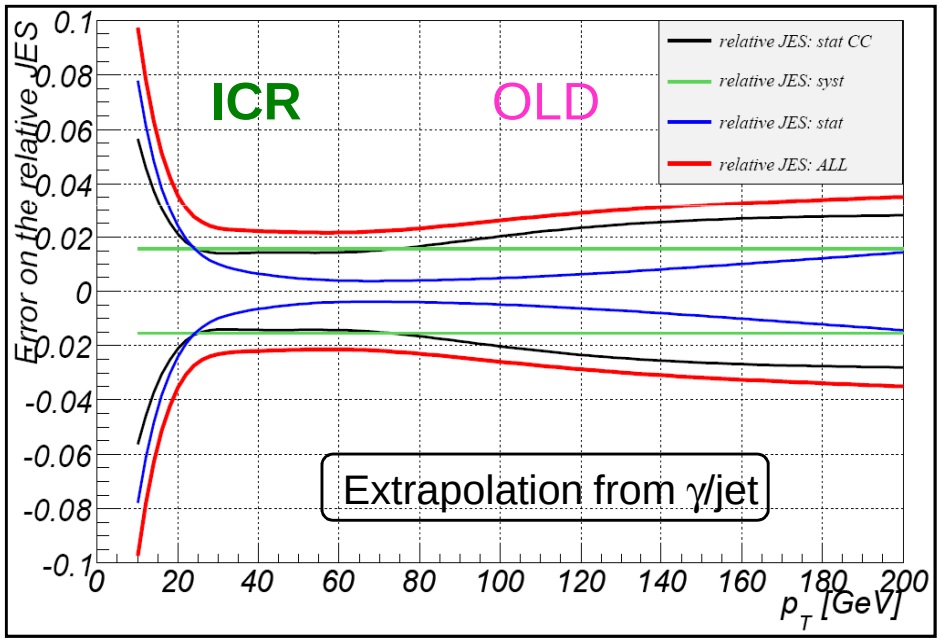
- EC turn-on's used
- simple exponential parametrization used

Shifting statistical uncertainties: CC and ICR

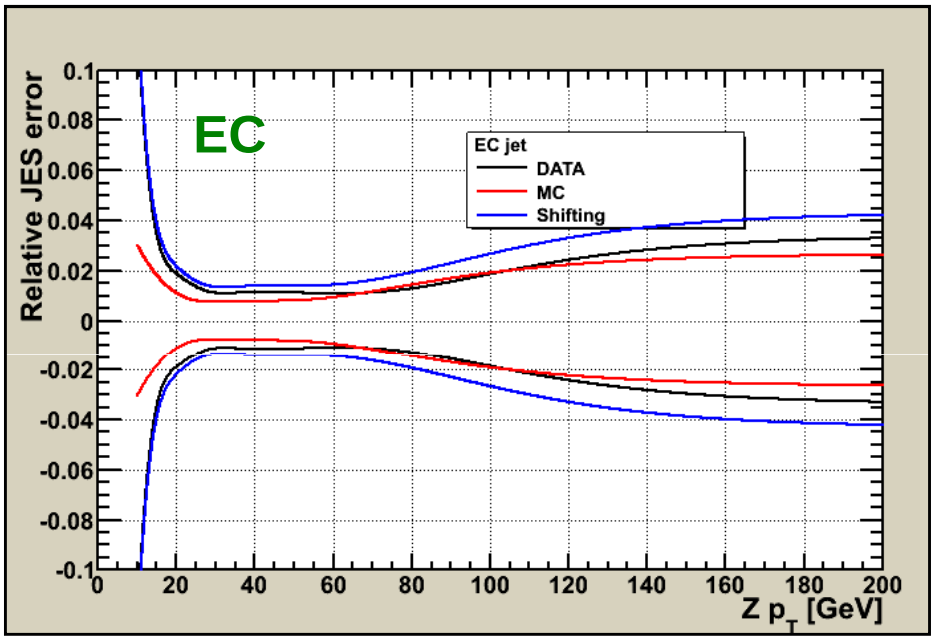


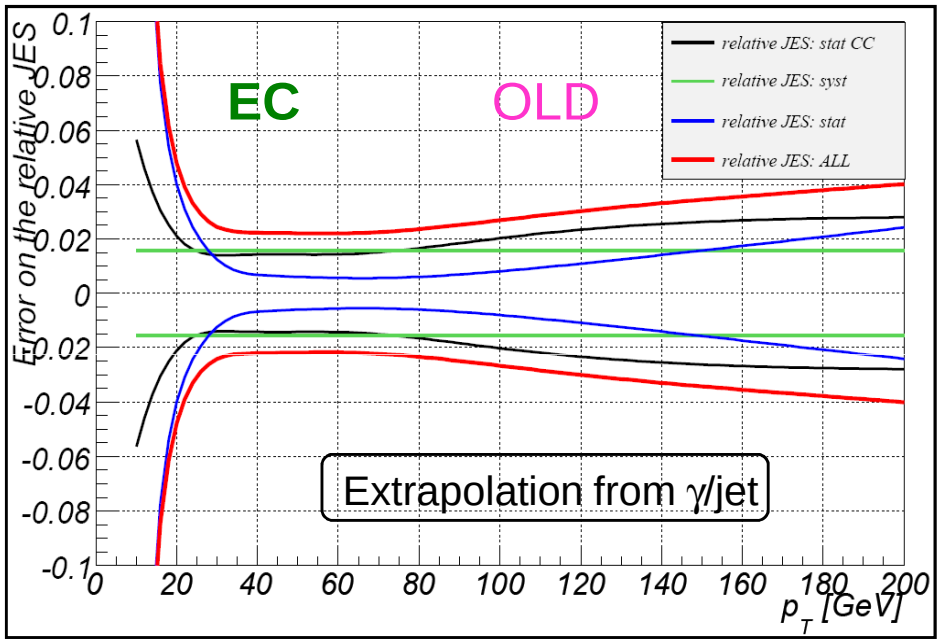


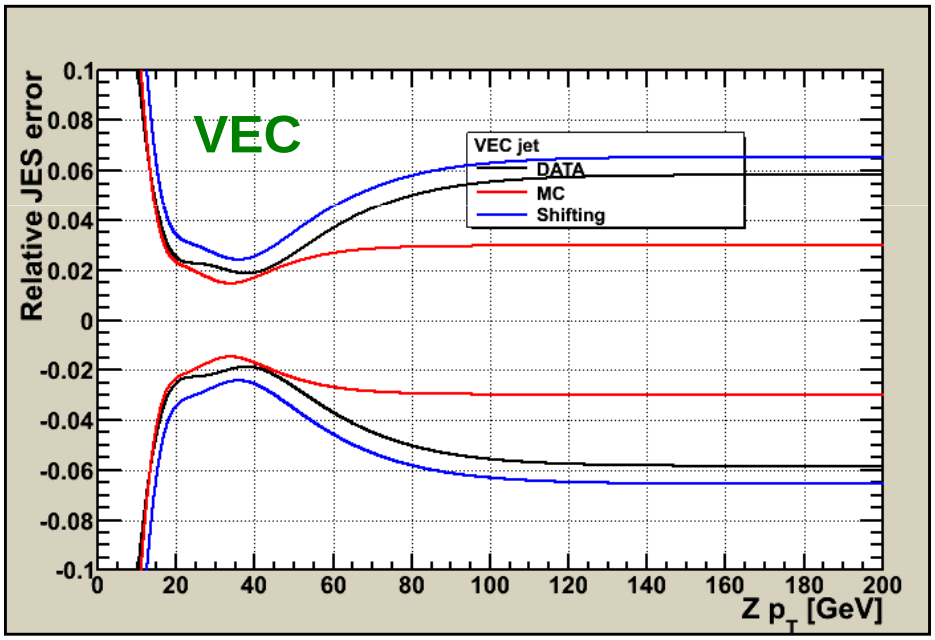


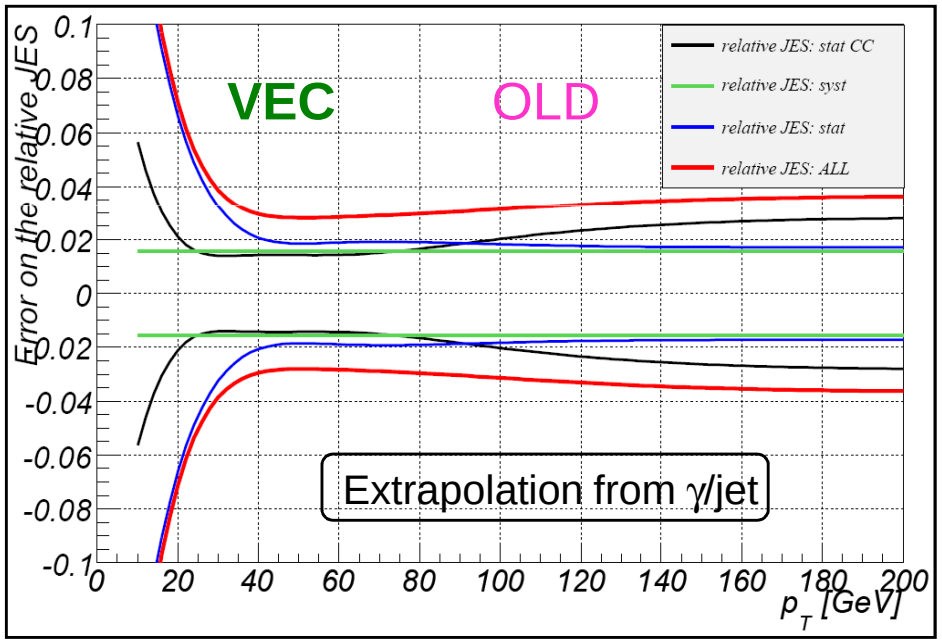


Shifting statistical uncertainties: EC and VEC



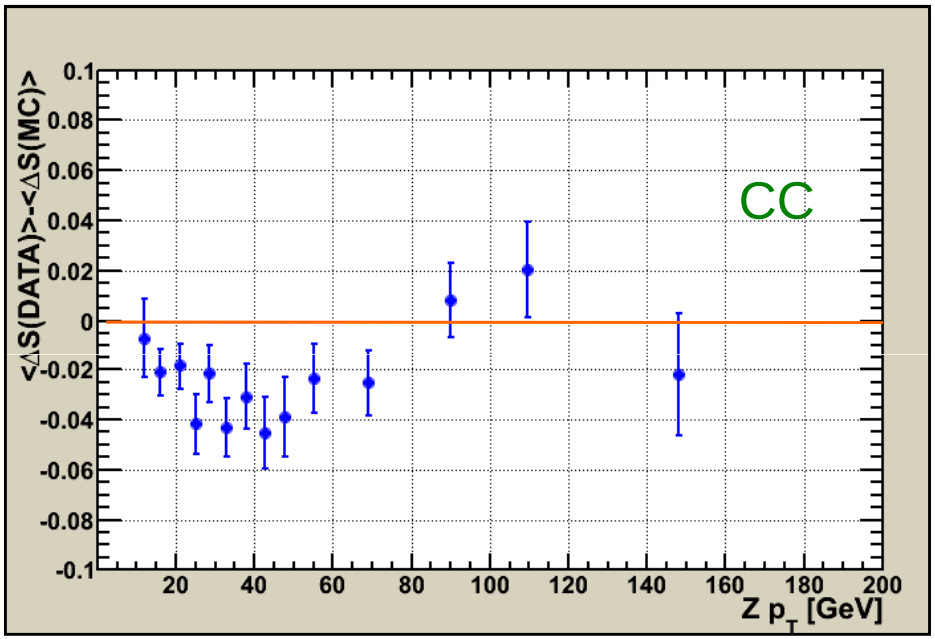


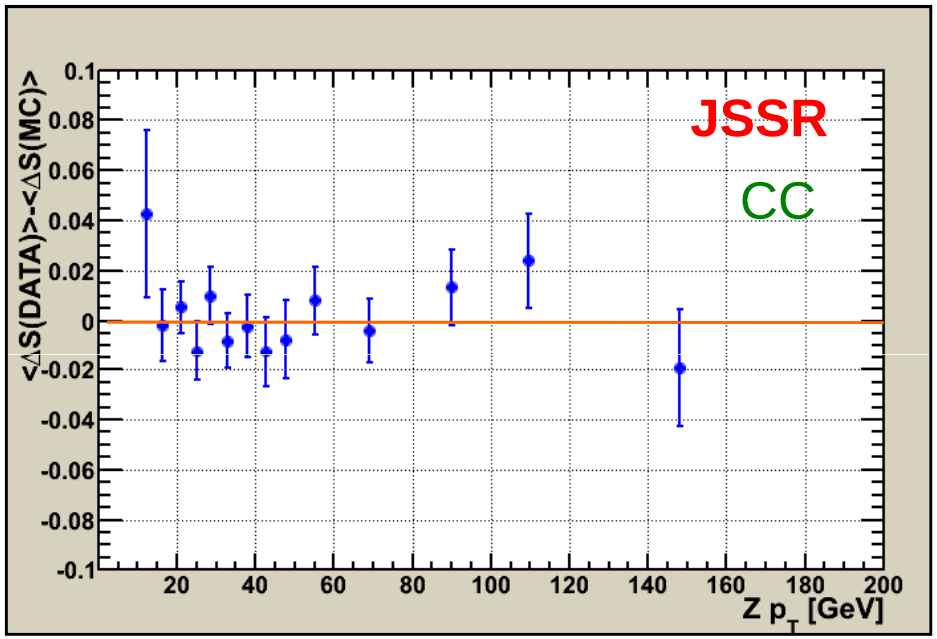


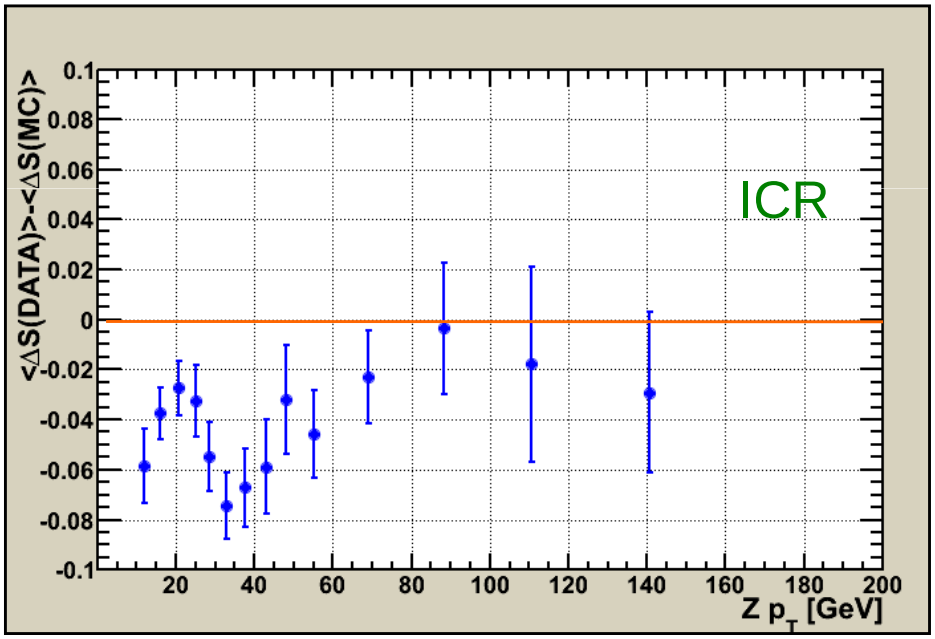


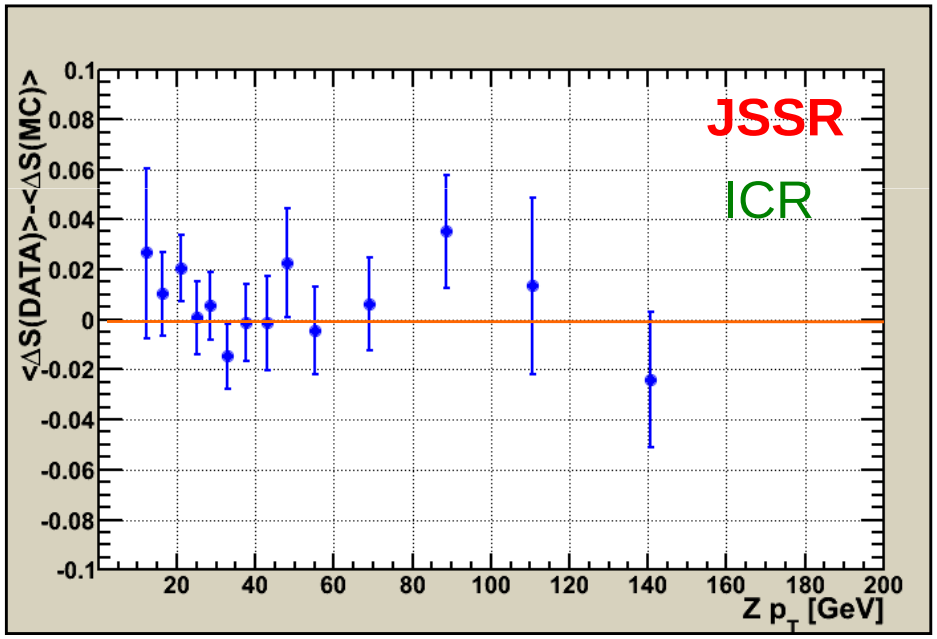
Closure tests

$\langle \Delta S^{DATA} \rangle - \langle \Delta S^{MC} \rangle$ arithmetic, CC and ICR

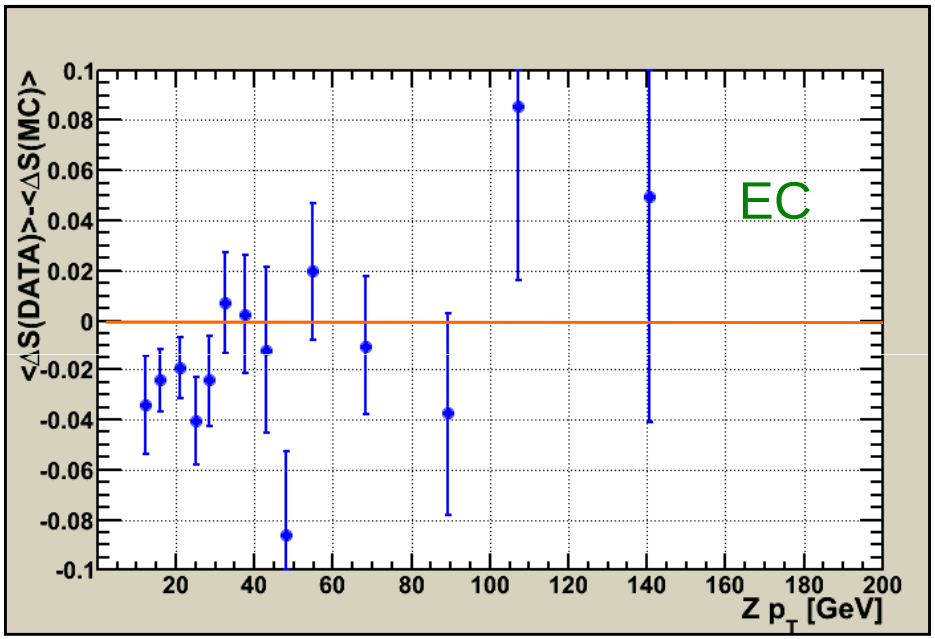


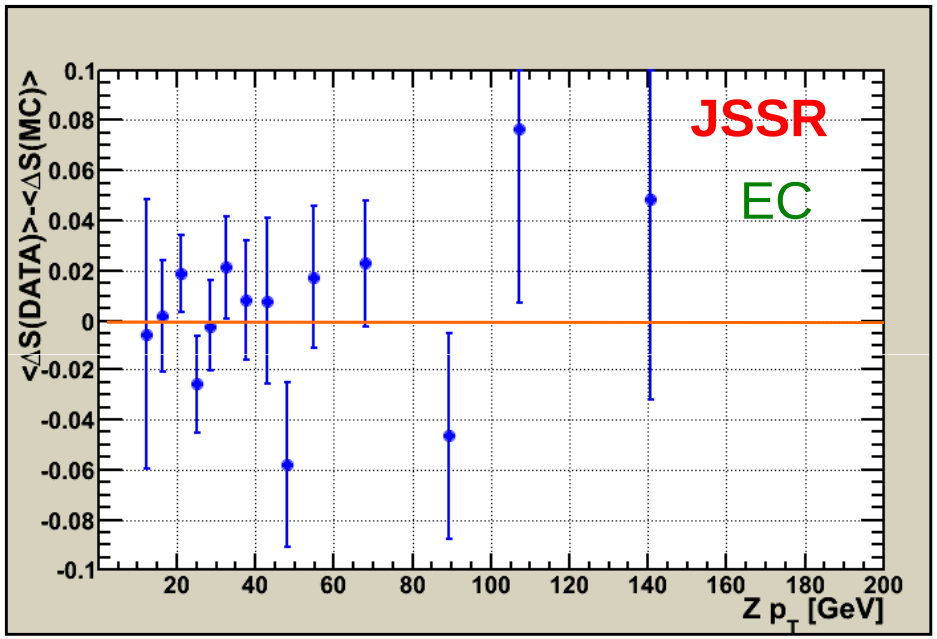


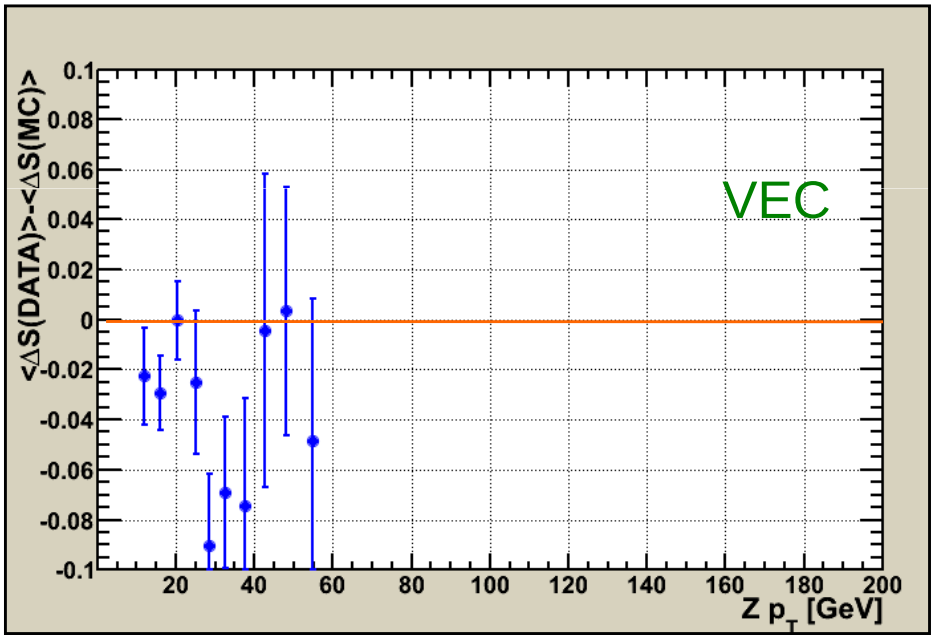


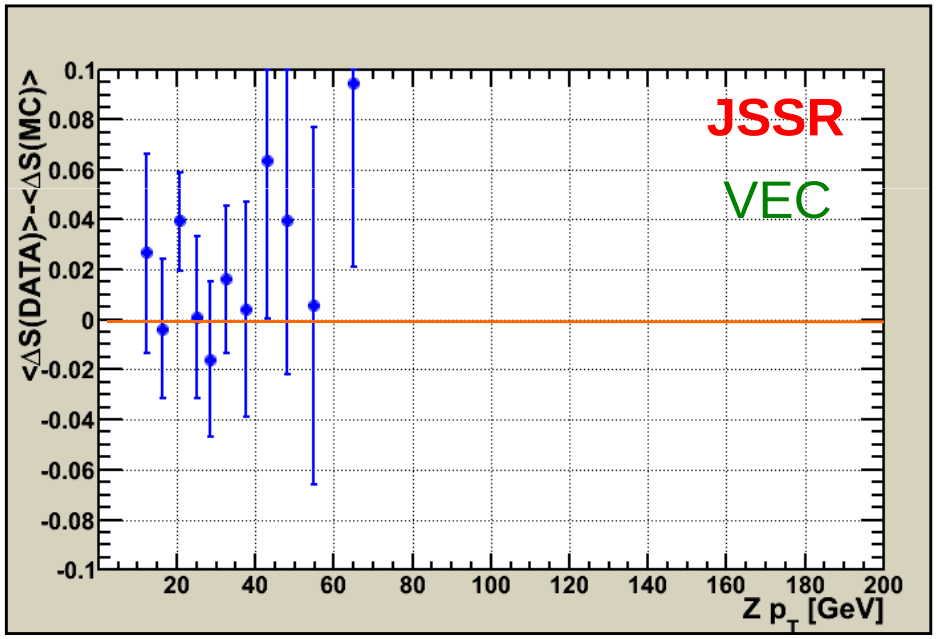


$\langle \Delta S^{DATA} \rangle - \langle \Delta S^{MC} \rangle$ arithmetic, EC and VEC

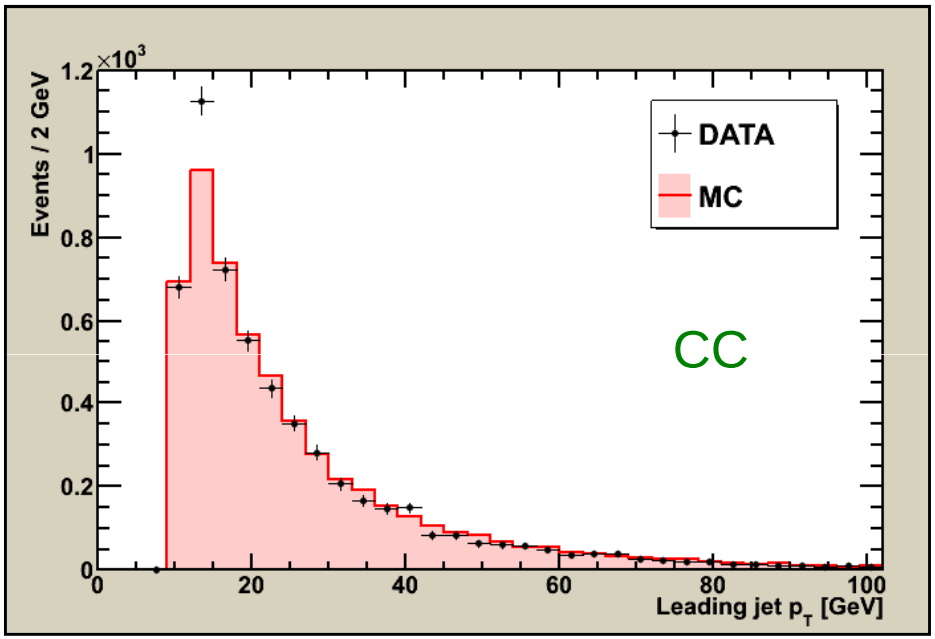


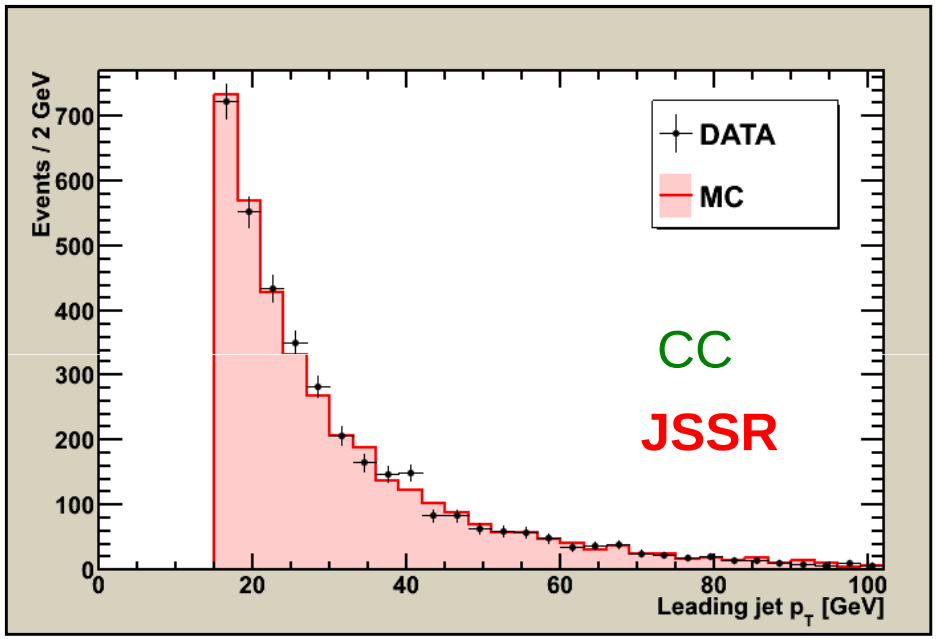


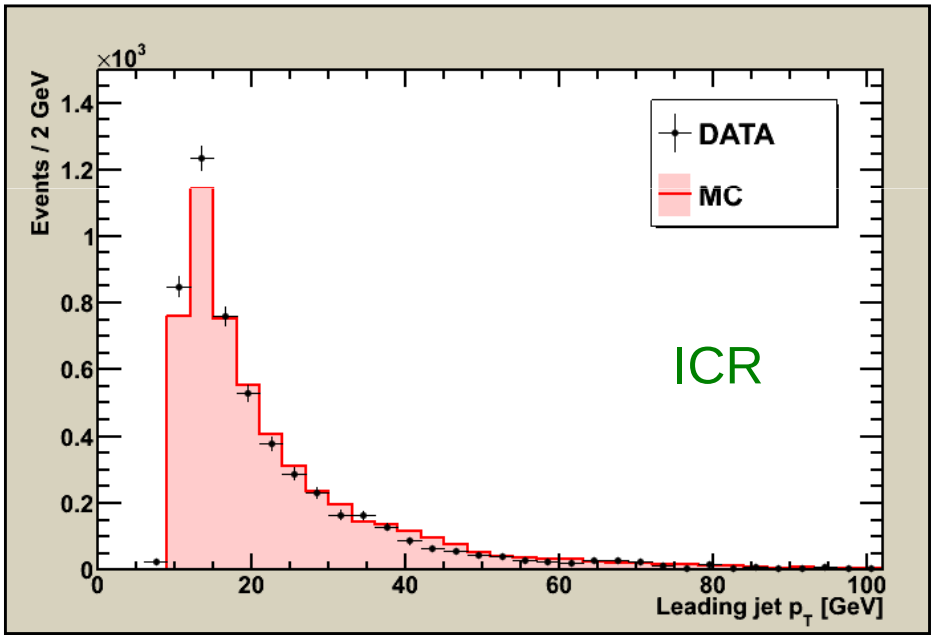


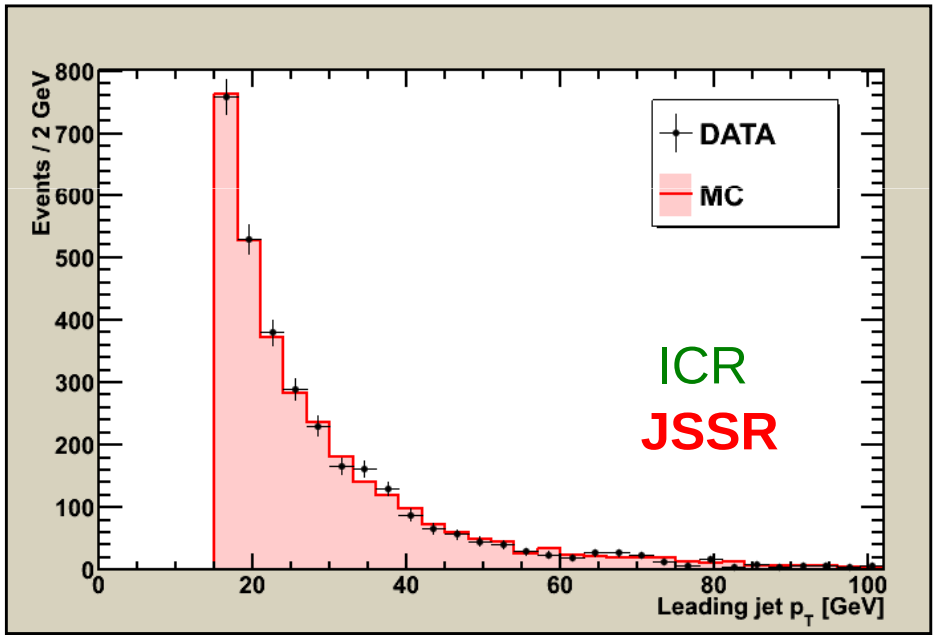


Jet p_T spectra, CC and ICR

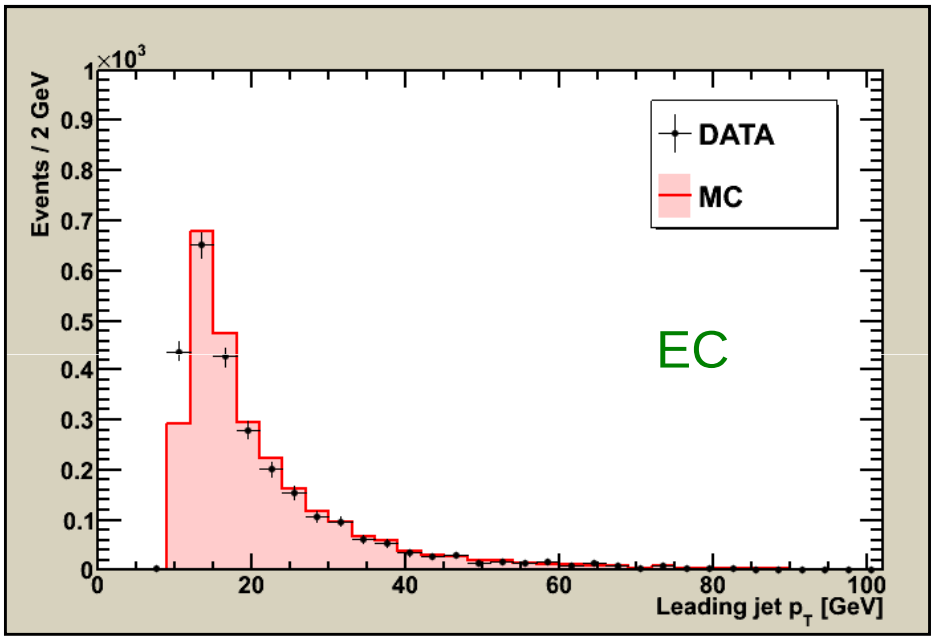


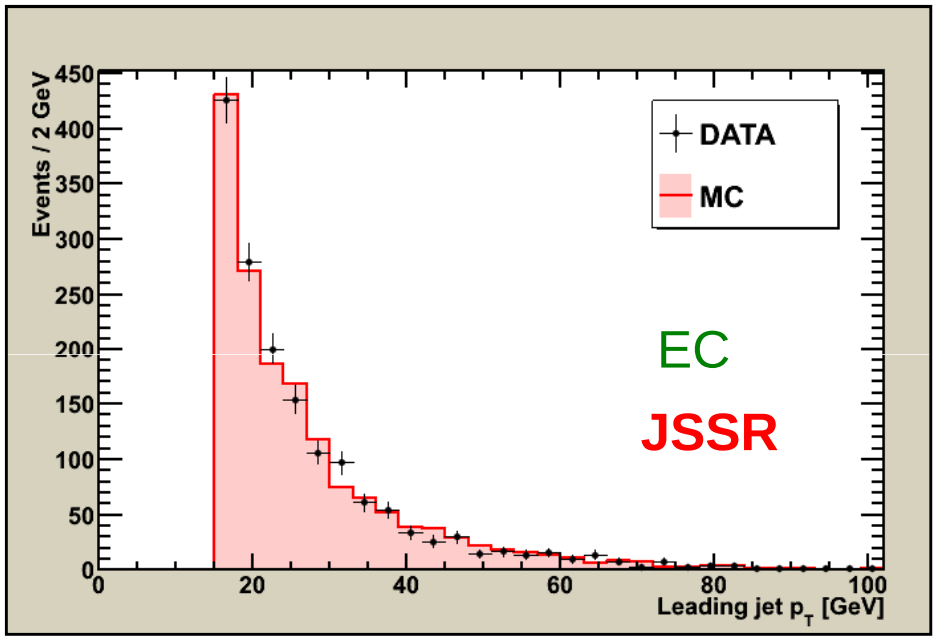


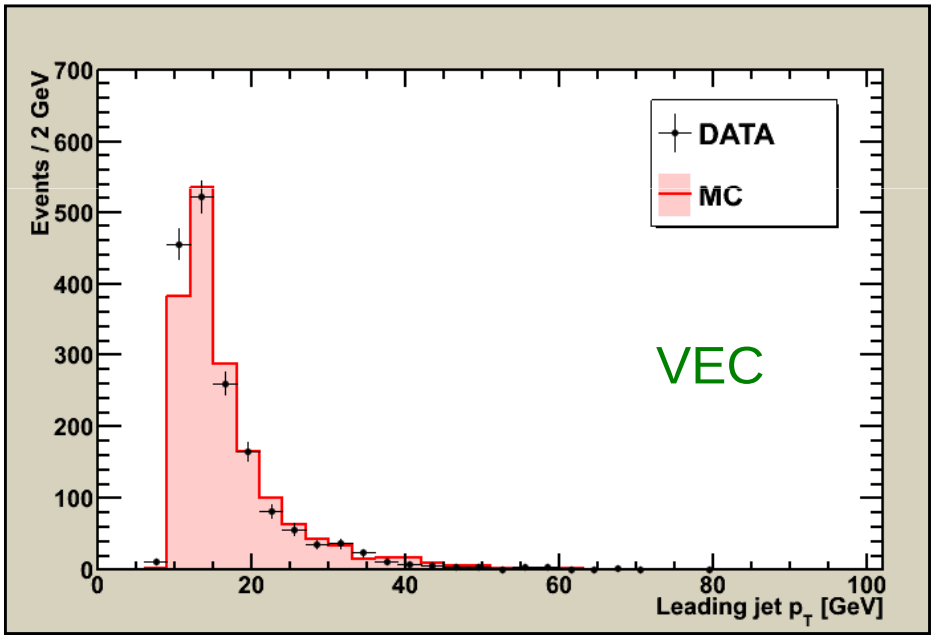


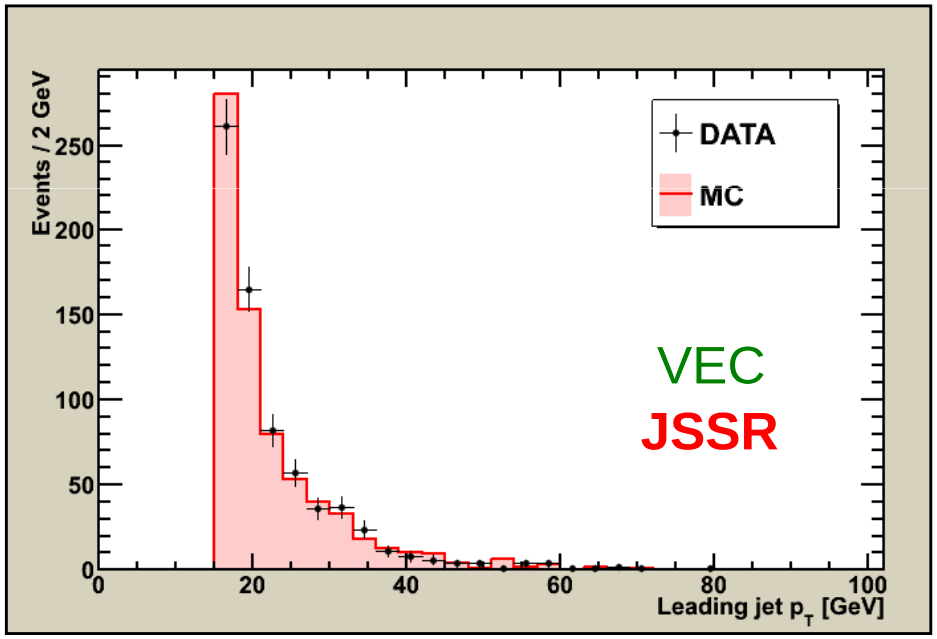


Jet p_T spectra, EC and VEC



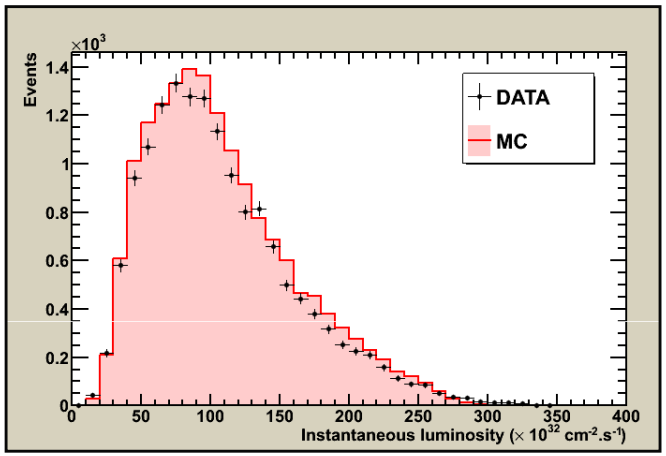


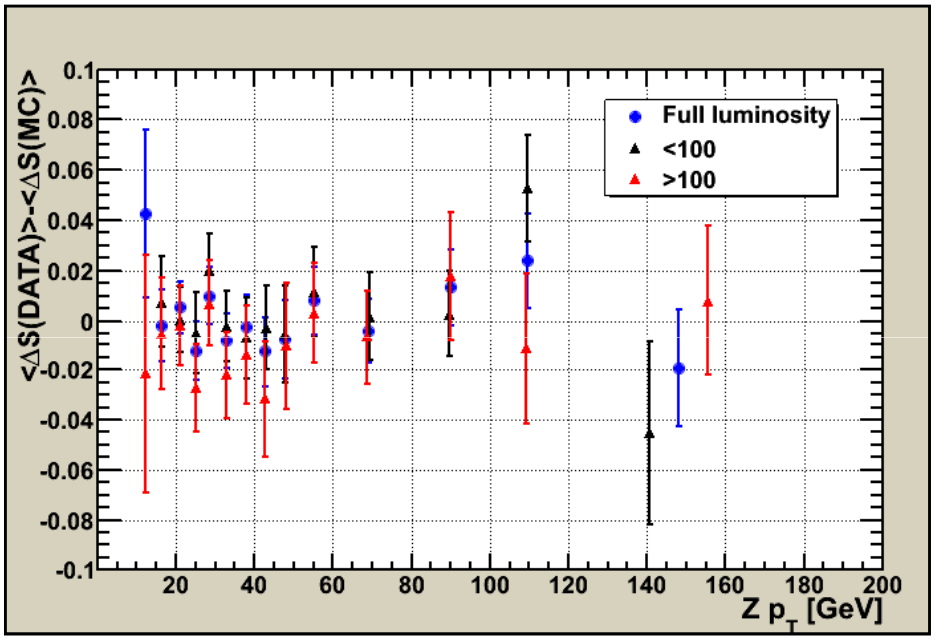


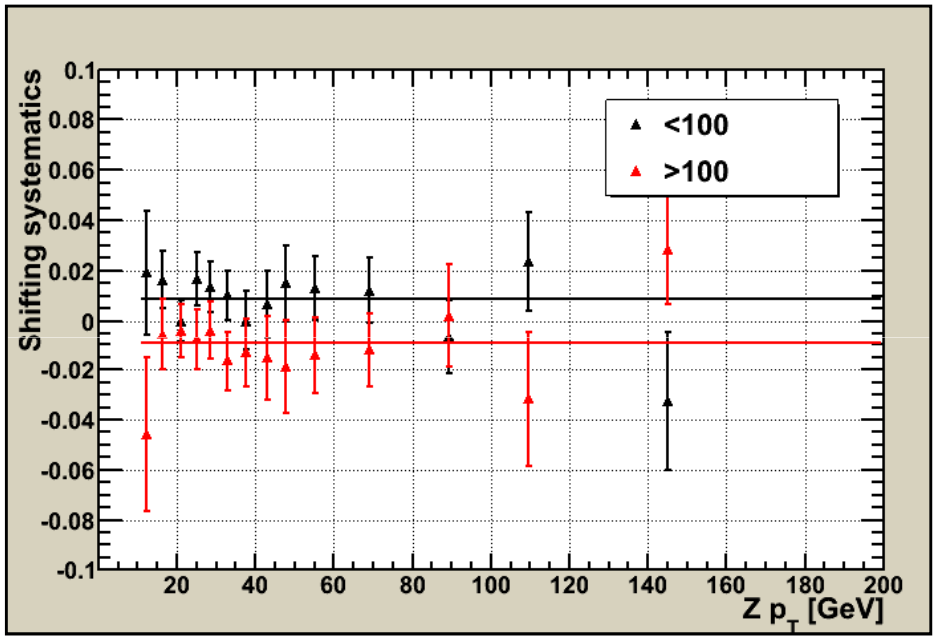


Systematic uncertainties

Shifting systematics: luminosity

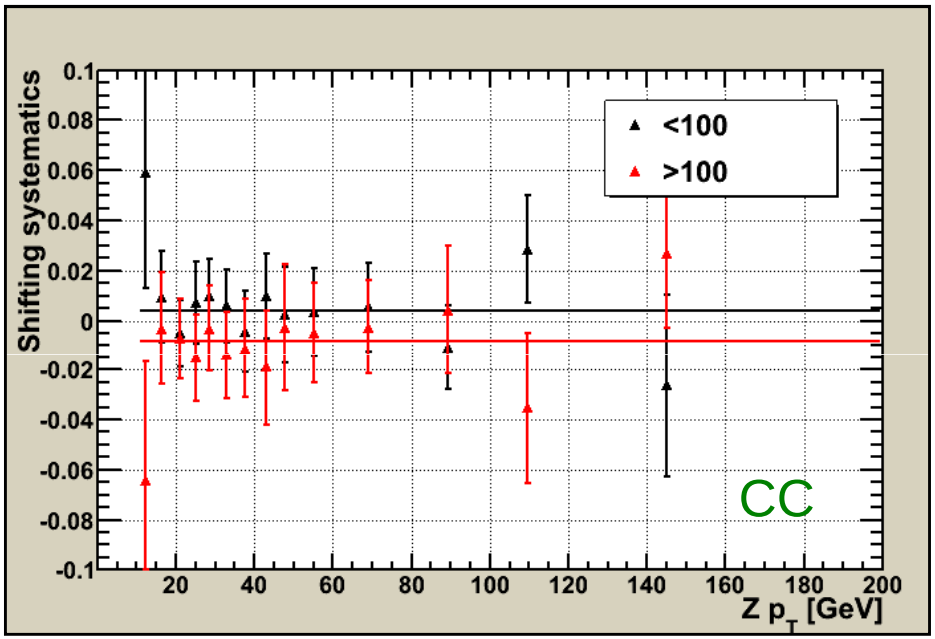


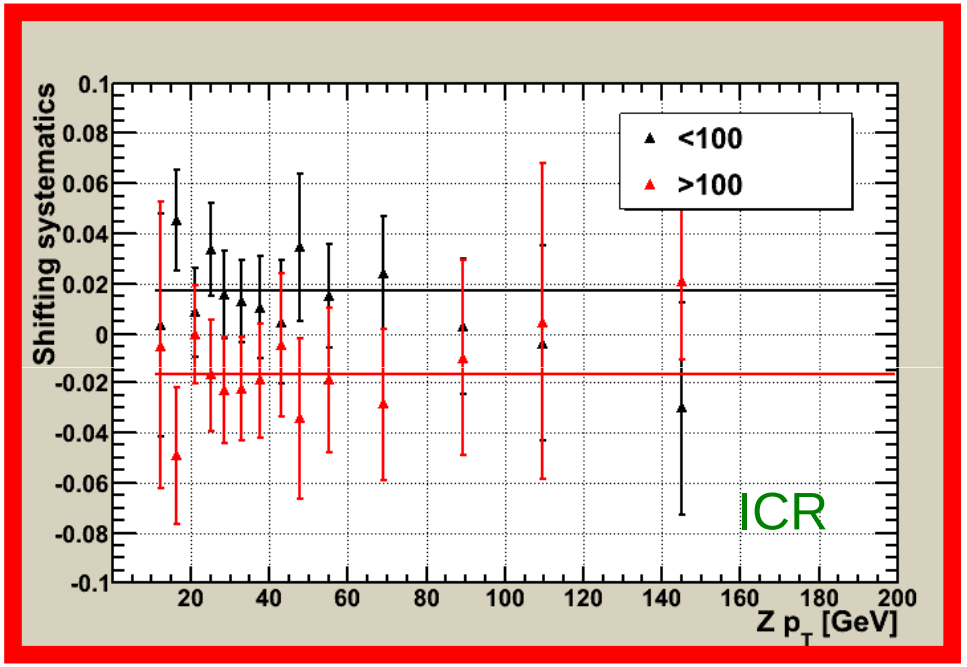


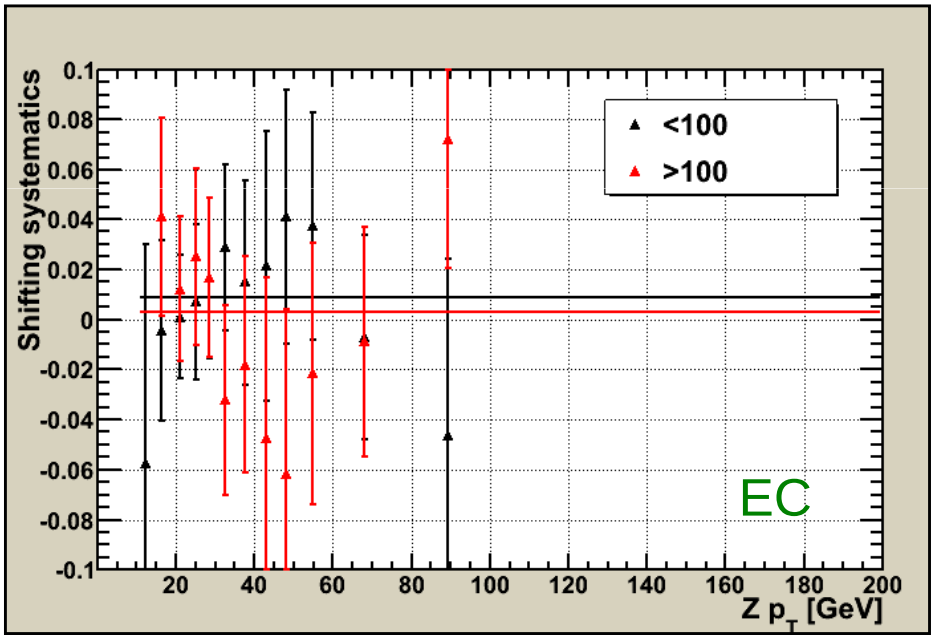


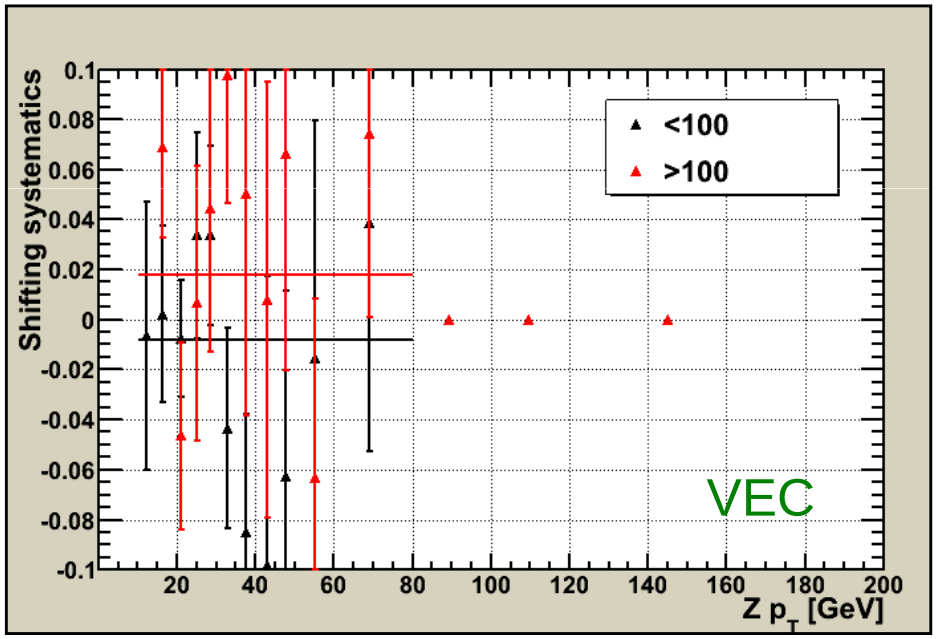
Much bigger effect: ~1%

Shifting systematics: luminosity per eta region



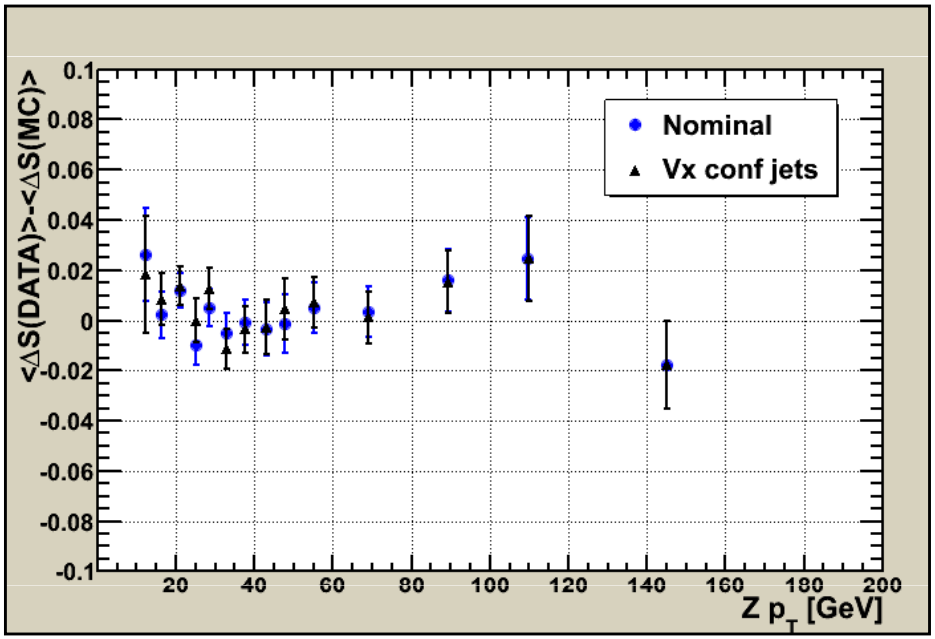


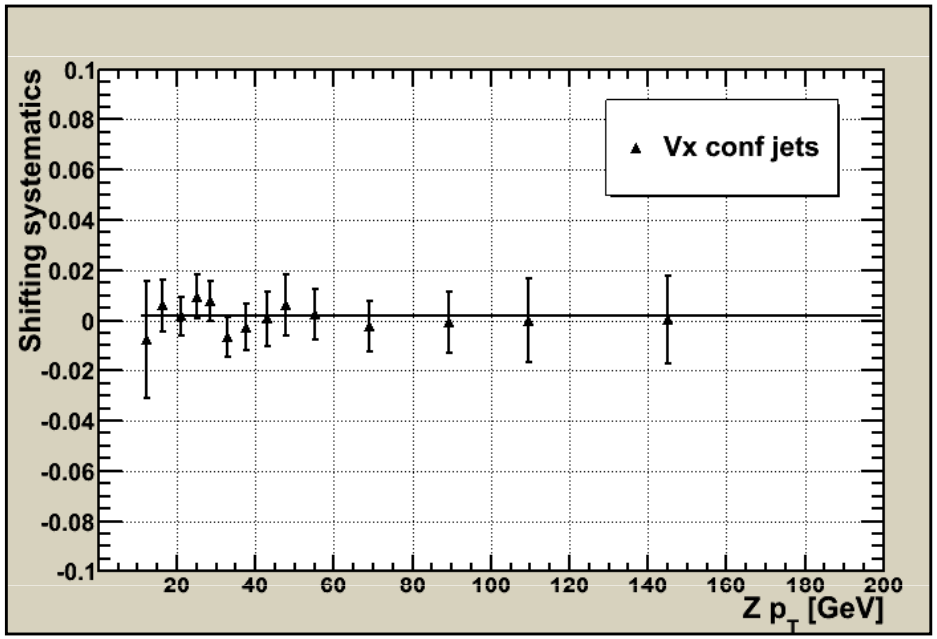




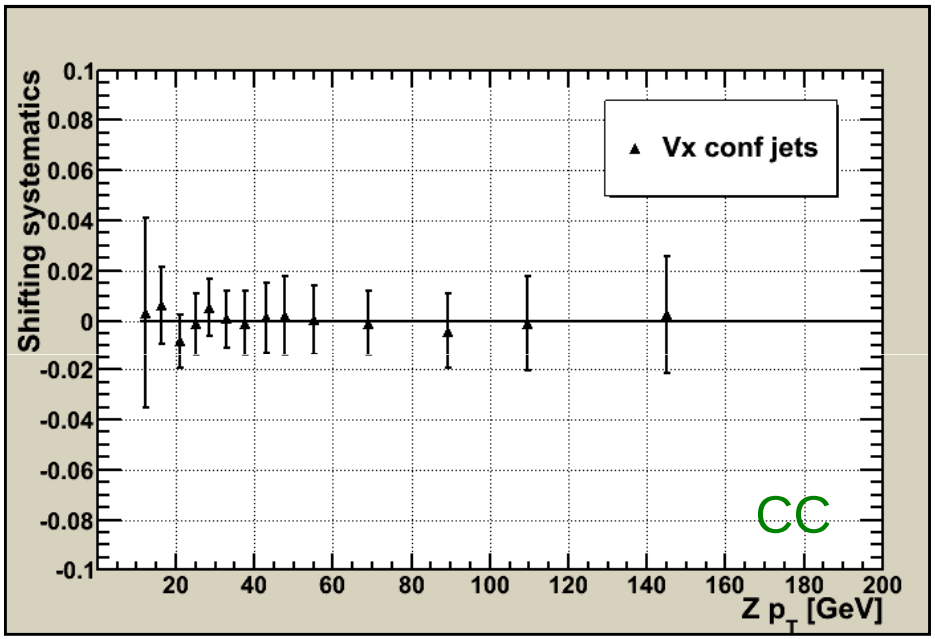
Shifting systematics: vertex confirmed jet

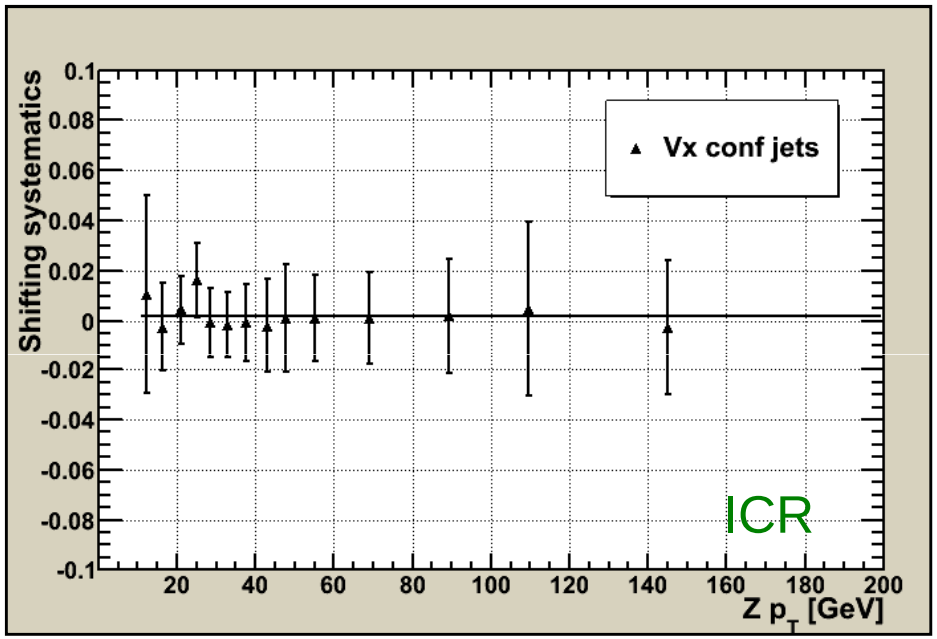
Vertex confirmation criterion used: number of tracks ≥ 2

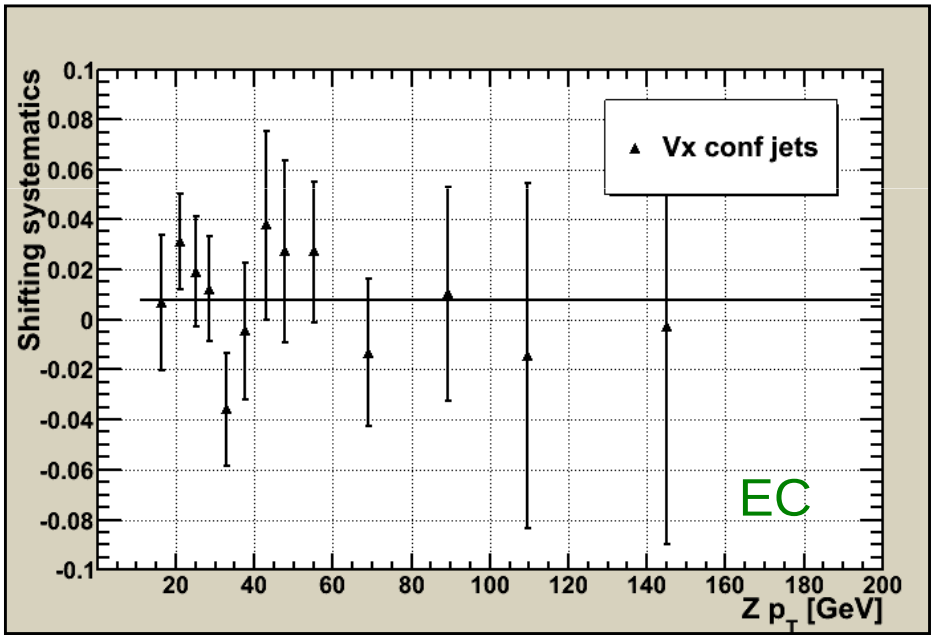


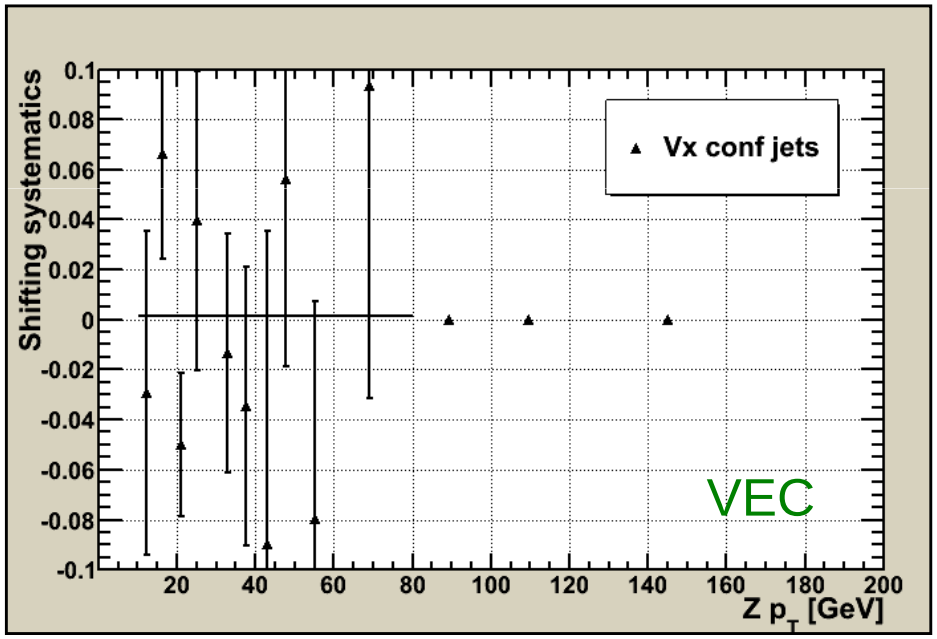


Shifting systematics: vertex confirmed jet per η region



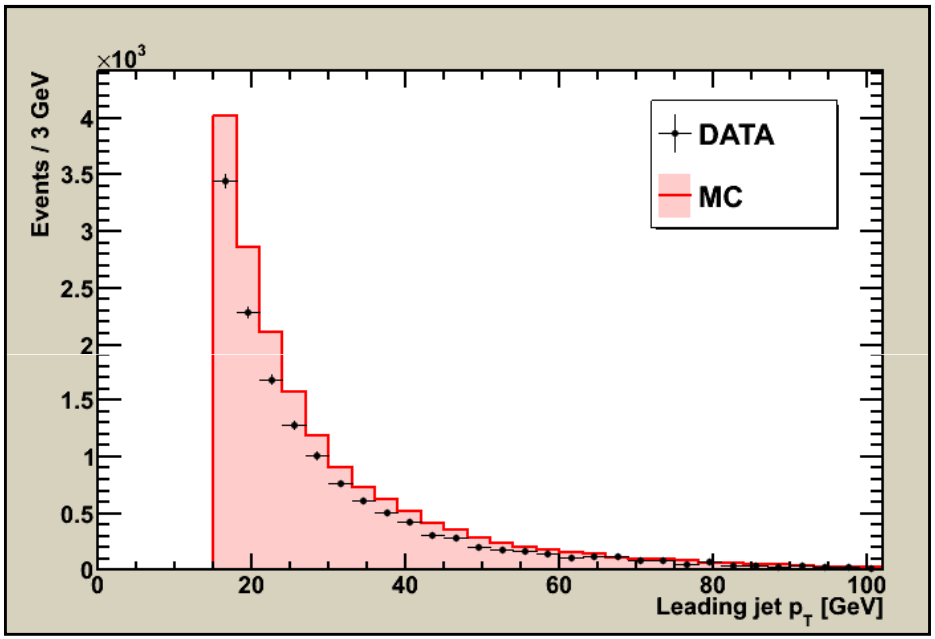


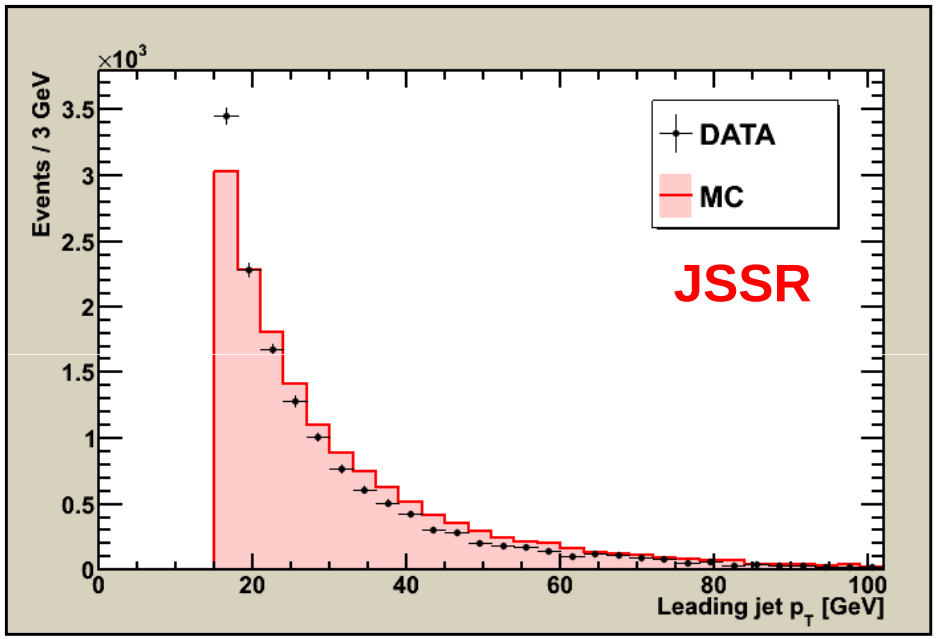


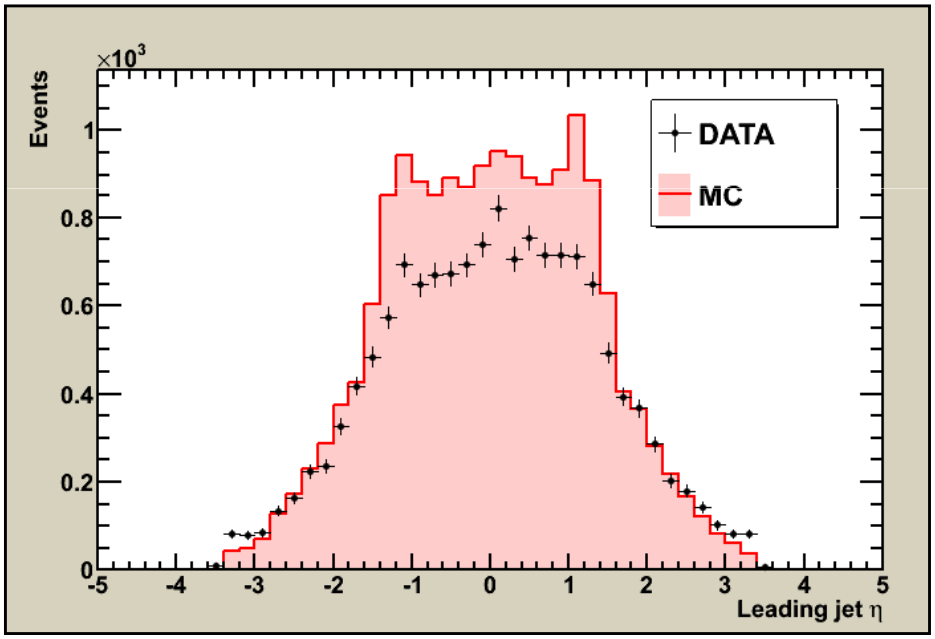


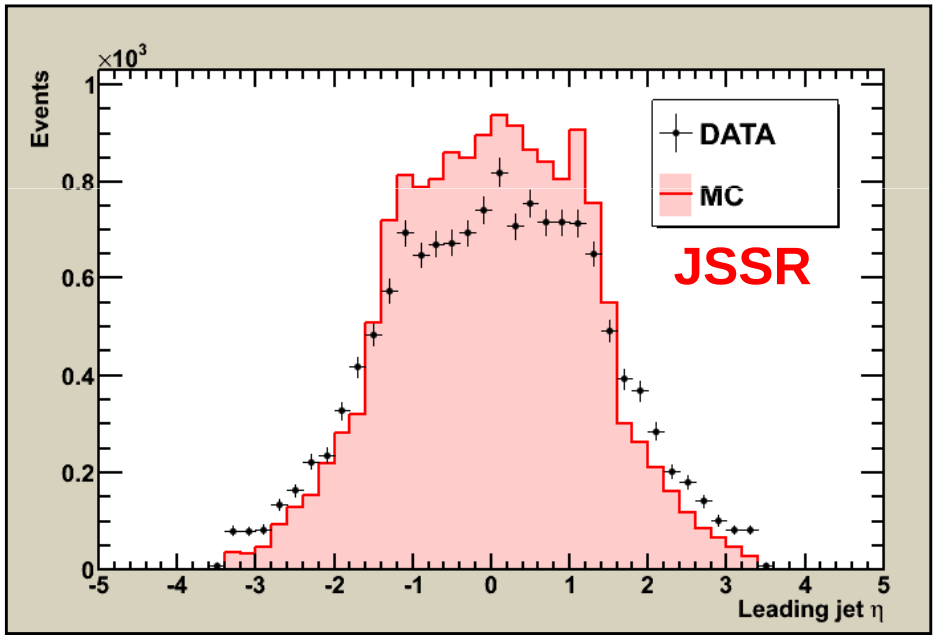
ICR horns after JSSR?

Jet pt/η


×10³
Events / 3 GeV
DATA
MC
Leading jet p_T [GeV]


×10³
Events / 3 GeV
DATA
MC
JSSR
Leading jet p_T [GeV]


×10³
Events
DATA
MC
Leading jet η


×10³
Events
DATA
MC
JSSR
Leading jet η