Balancing Multi-Jet Events: Preliminary Studies on Truth

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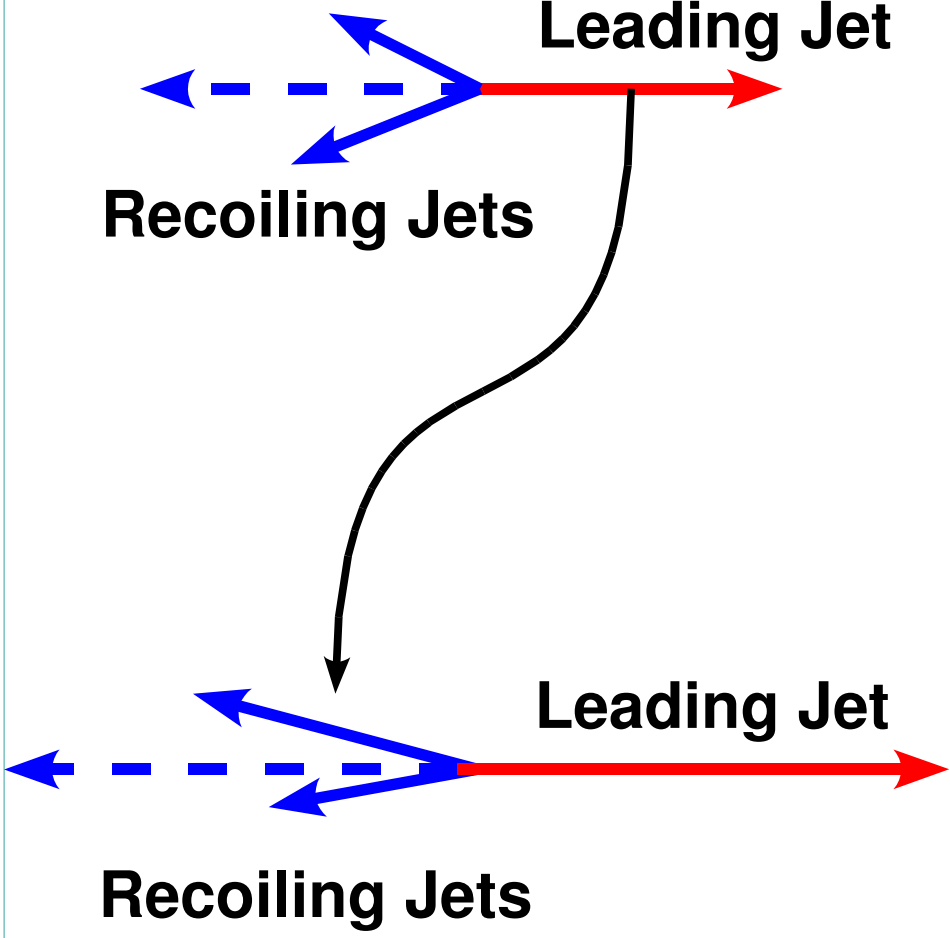
Outline

- Introduction to the Multi-Jet Balance Method
- Some results on Truth Jets
- Soft Radiation
- Conclusion

Multi-Jets Balance

- ***In-situ*** calibrations using **γ/Z+jets Balance** suffer from **small statistics at high P_T** (up to **250 GeV** with an error of **2%** with **10 pb^{-1}**).

- The **Multi-Jet Balance Approach**:
  - Utilizes the QCD jet production (**High statistics**).
  - Utilizes events with **one high P_T** jet recoiling **against several low P_T jets** (checked/calibrated).
  - Needs a **low P_T region checked**/calibrated with other methods.
  - **Iterative Method** - Bootstrap.



The aim of this talk

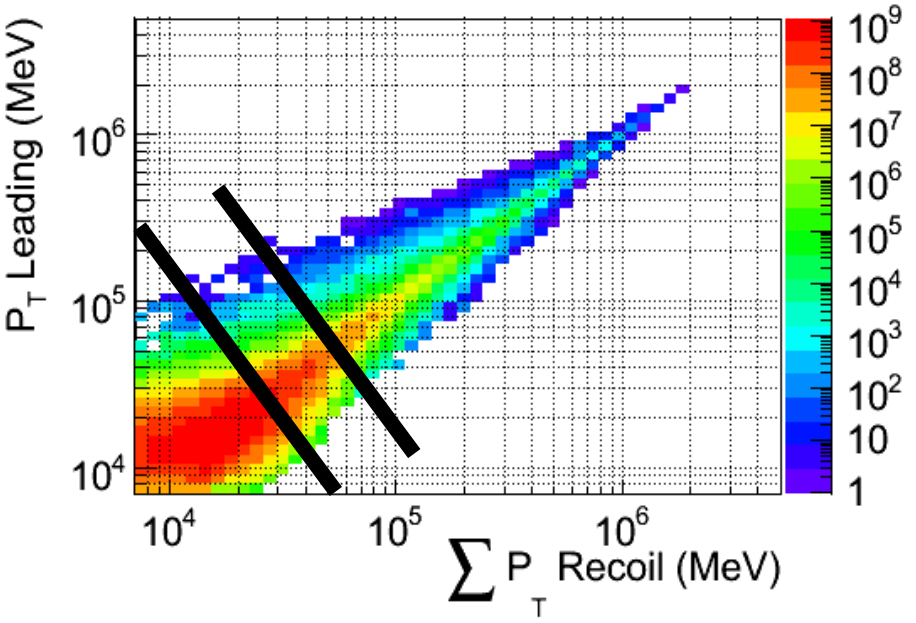
At present we are analysing the **biases/unbalance** in the truth in the Multi-Jet Balance.
The truth allow us to **evaluate the statistics** we can use in the first period.

Starting studying the method on **Truth** Jets **Cone 0.7.**
Simulation: ~ 500 kEvt per Jx sample (**PYTHIA** - Private production)

Some consideration on variables:

- Balance on P_T and **not on** E_T
  (Difference of ~2GeV for J3)
- Bins in $\langle P_T \rangle = (P_T^{Leading} + \Sigma P_T^{Recoils})/2$

to avoid an unbalance due to the **correlation** between $P_T^{Leading}$ **and** $\Sigma P_T^{Recoils}$



Bootstrap

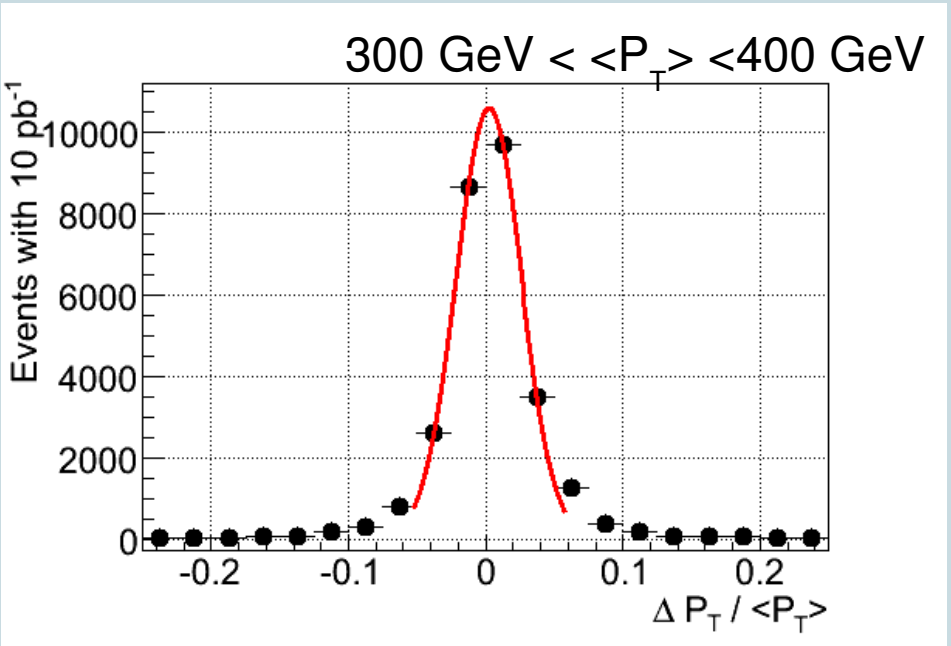
The Iterative Method:

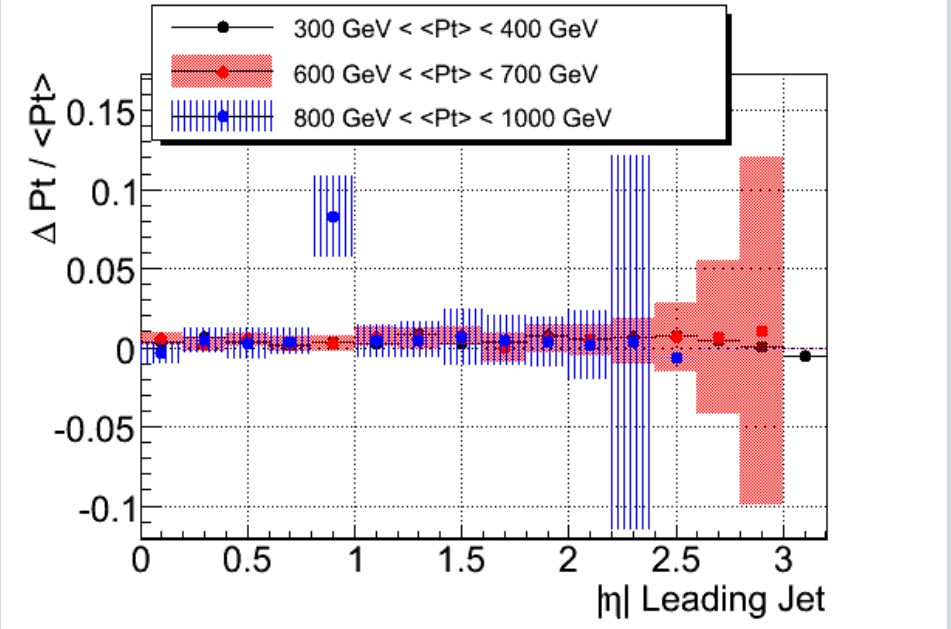
- **Starting point:** Assuming the **Jet Energy Scale correct** up to **100 GeV** in $|\eta|<3.2$;
- Calculating $\Delta P_T = P_T^{Leading} - \Sigma P_T^{Recoils}$; $\langle P_T \rangle = (P_T^{Leading} + \Sigma P_T^{Recoils})/2$
- **$\langle P_T \rangle$ in [150 – 200 GeV];** **max $P_T^{Recoils}$ <100 GeV.**
- **For Recontructed Jets : Checking** and **Calibrating** the JES using the ratio $\Delta P_T / \langle P_T \rangle$
- The **Jet Energy Scale** is correct up to **175 GeV.**
- Iterate to the **next bin in $\langle P_T \rangle$** assuming the JES correct up to 175 GeV.
- Starting from 100 GeV we reach ~ 1 TeV with 10 pb^{-1}

Checking the Balance

For every bin the ratio $\Delta P_T/\langle P_T\rangle$ is studied:

- $\Delta P_T/\langle P_T\rangle$ **distribution**
- $\Delta P_T/\langle P_T\rangle$ **VS.** $|\eta^{\text{Leading}}|$
- $\Delta P_T/\langle P_T\rangle$ **VS.** $\langle P_T\rangle$ **in the bin**
- $\Delta P_T/\langle P_T\rangle$ **VS.** $\phi^{\text{Leading}} - \phi^{\Sigma\text{Recoils}}$





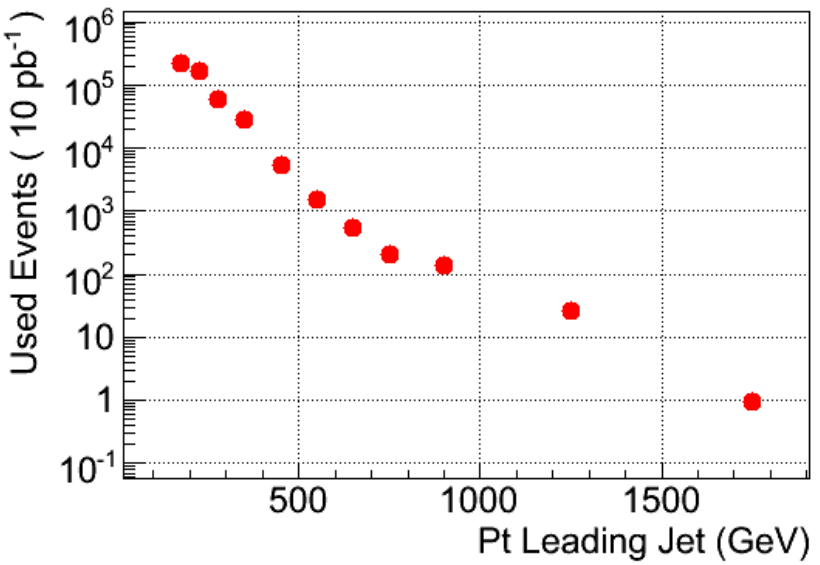
Using the **ratio** $\Delta P_T/\langle P_T\rangle$ we can **check/ calibrate** the **JES** in the bin under control.
Than we can go to the next step

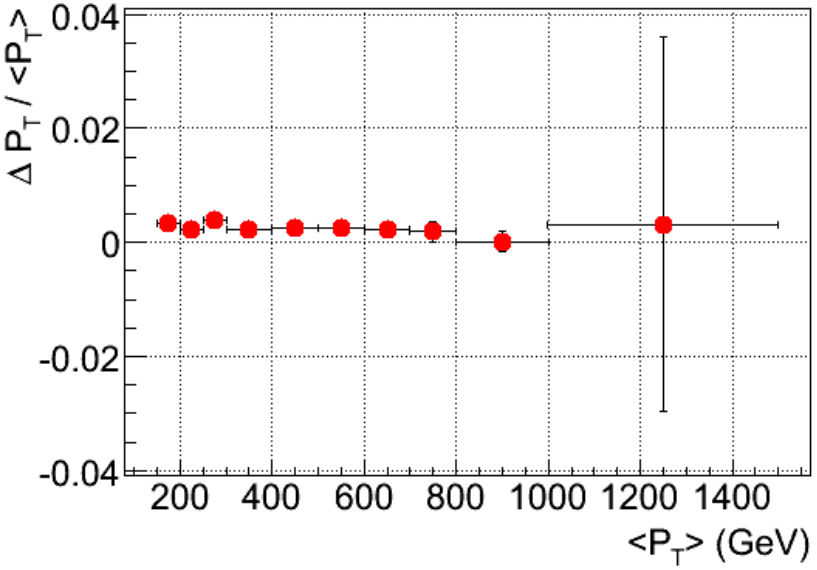
Statistics with 10 pb^{-1}

What can we do with the first data?

This is the limit of the method:

- No Trigger effects
- Probably we need cuts to select events
- Evaluated for 14 TeV





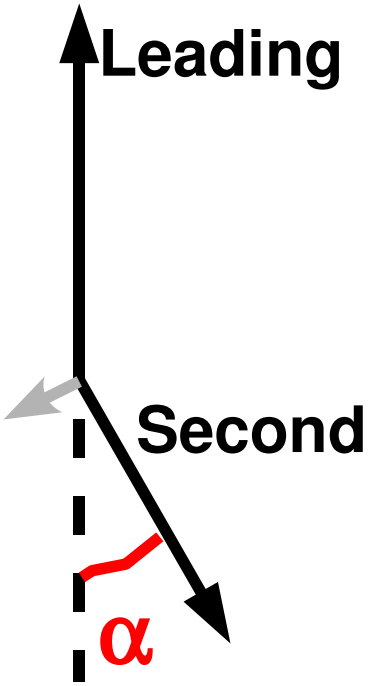
We could set the scale up to ~ 1 TeV

Unbalance in the Truth – some effects

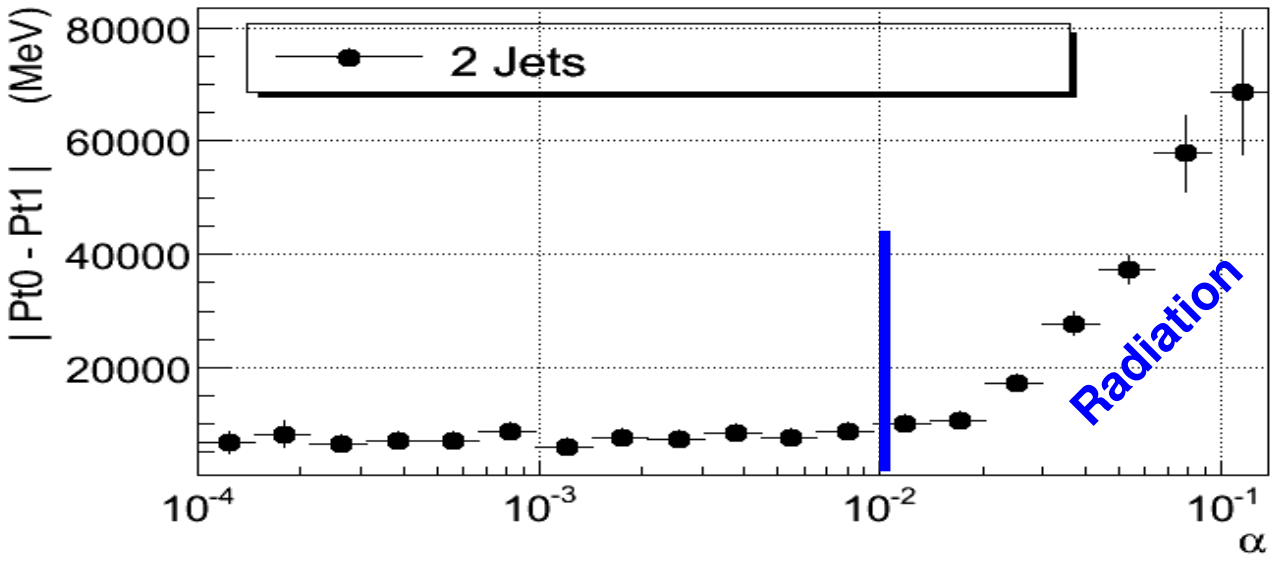
Truth Jets (Cone 0.7) - NO Reconstruction Effects

- **Not perfectly balanced**:
  - **Soft Radiation** – below the seed for the jet reconstruction.
  - **Underlying Event.**
  - **Out-Of-Cone** (not so important for Cone0.7).

Soft Radiation: an example in Di-Jet Events (J6)



| Pt[0]-Pt[1] | VS. **|α|** – Missing the grey jet



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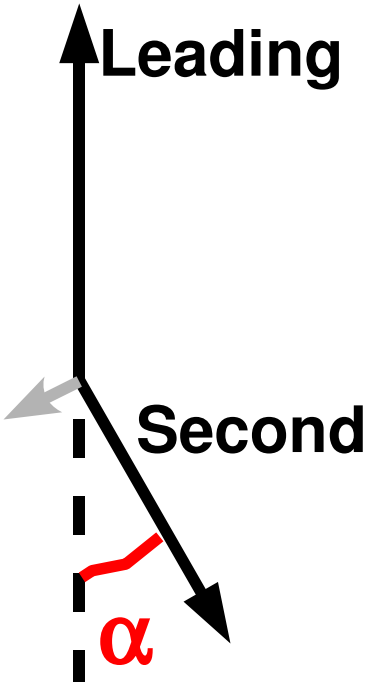

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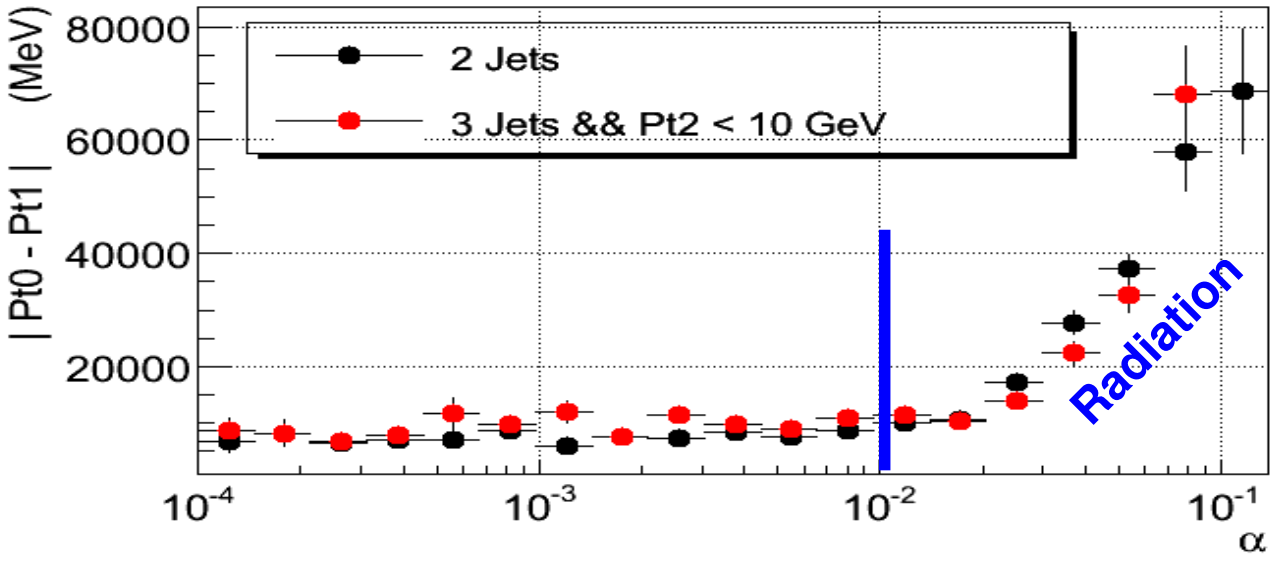
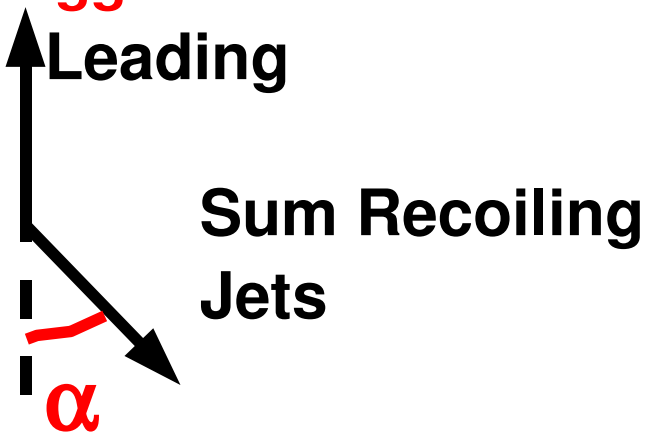
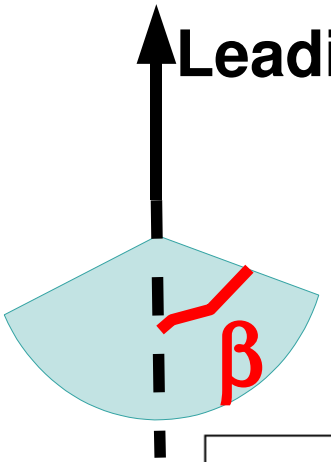
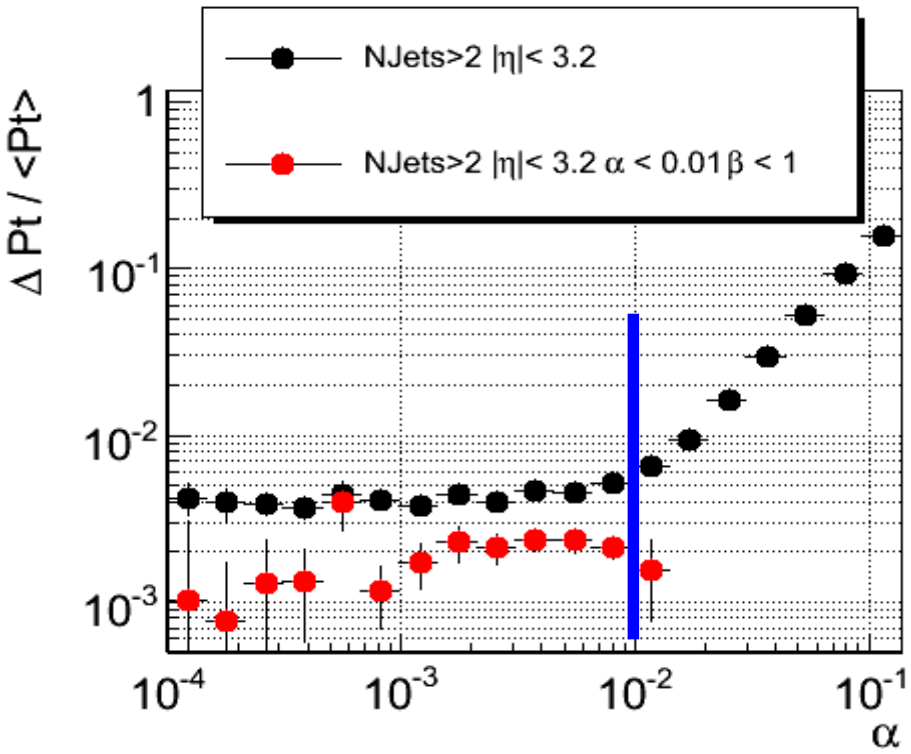


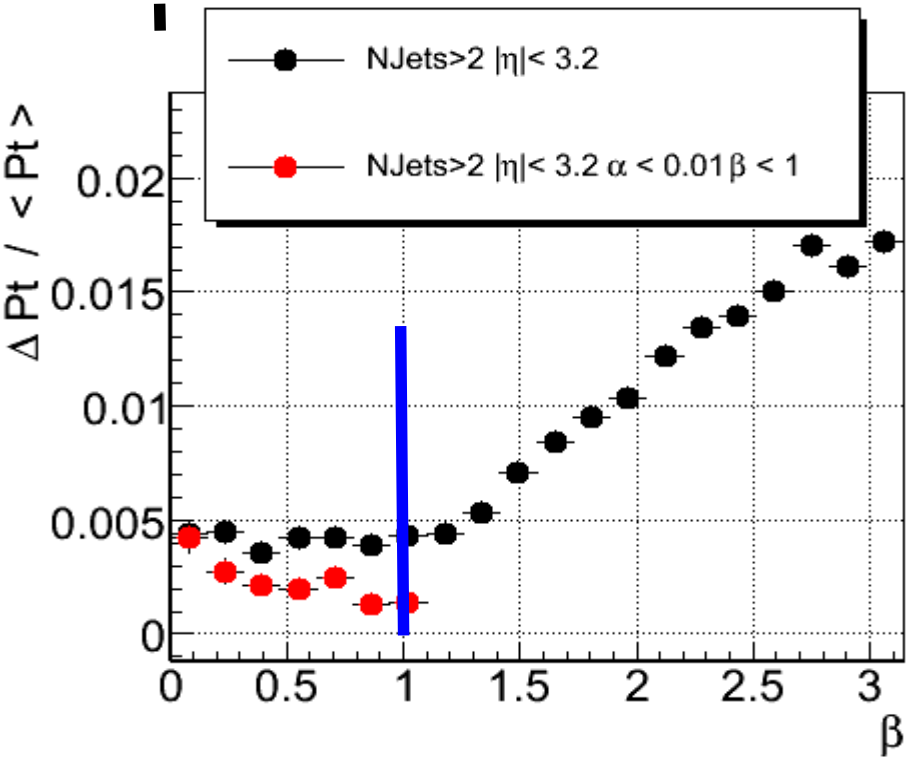
Multi-Jets Balance: Possible Selection

Suggestions on cuts to avoid the Unbalance due to the soft radiation









Conclusions

The calibration of the jet energy scale up to high P_T jets is important for QCD studies and for the search of new physics.

The JES can be verified/calibrated up to high P_T using Multi-Jet Balance

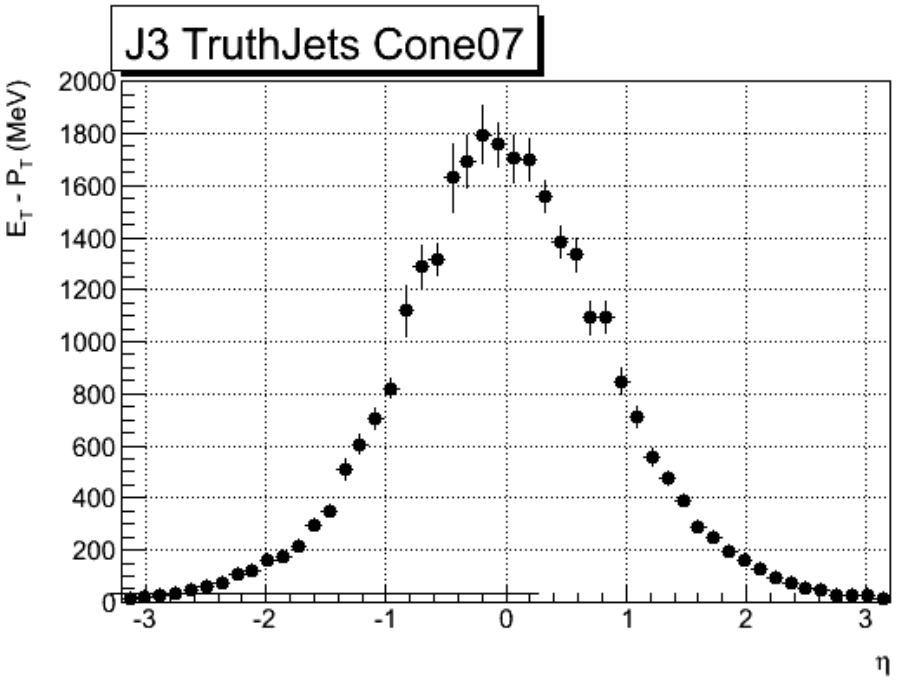
The bootstrap method need a starting point well verified (using **γ/Z+jets**)

Plans - Needed more studies on:

- Reconstruction Effects;
- Analysis cuts and evaluation of the systematic uncertainties;
- Capability to check the correctness of the JES;
- Integration with other methods (**γ/Z+jets , Di-Jet Balance, Tracks**)
- Improvement of the method with the statistics
- Write the software in a package.

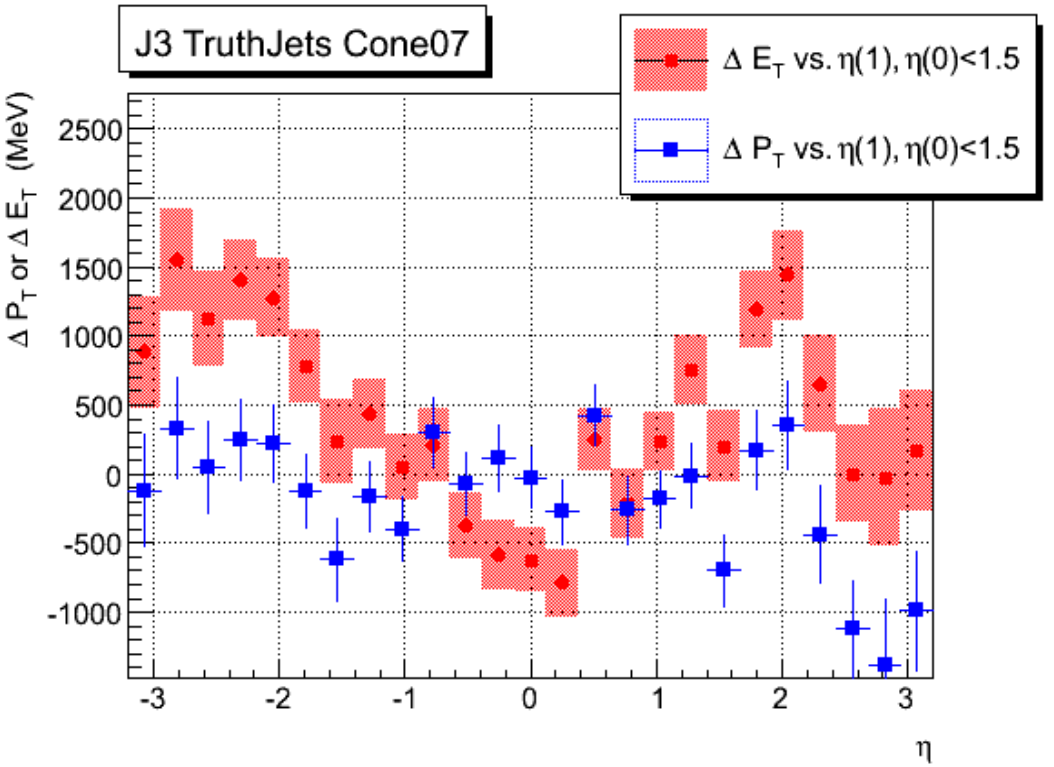
BACKUP

Using Pt or Et: Differences in η



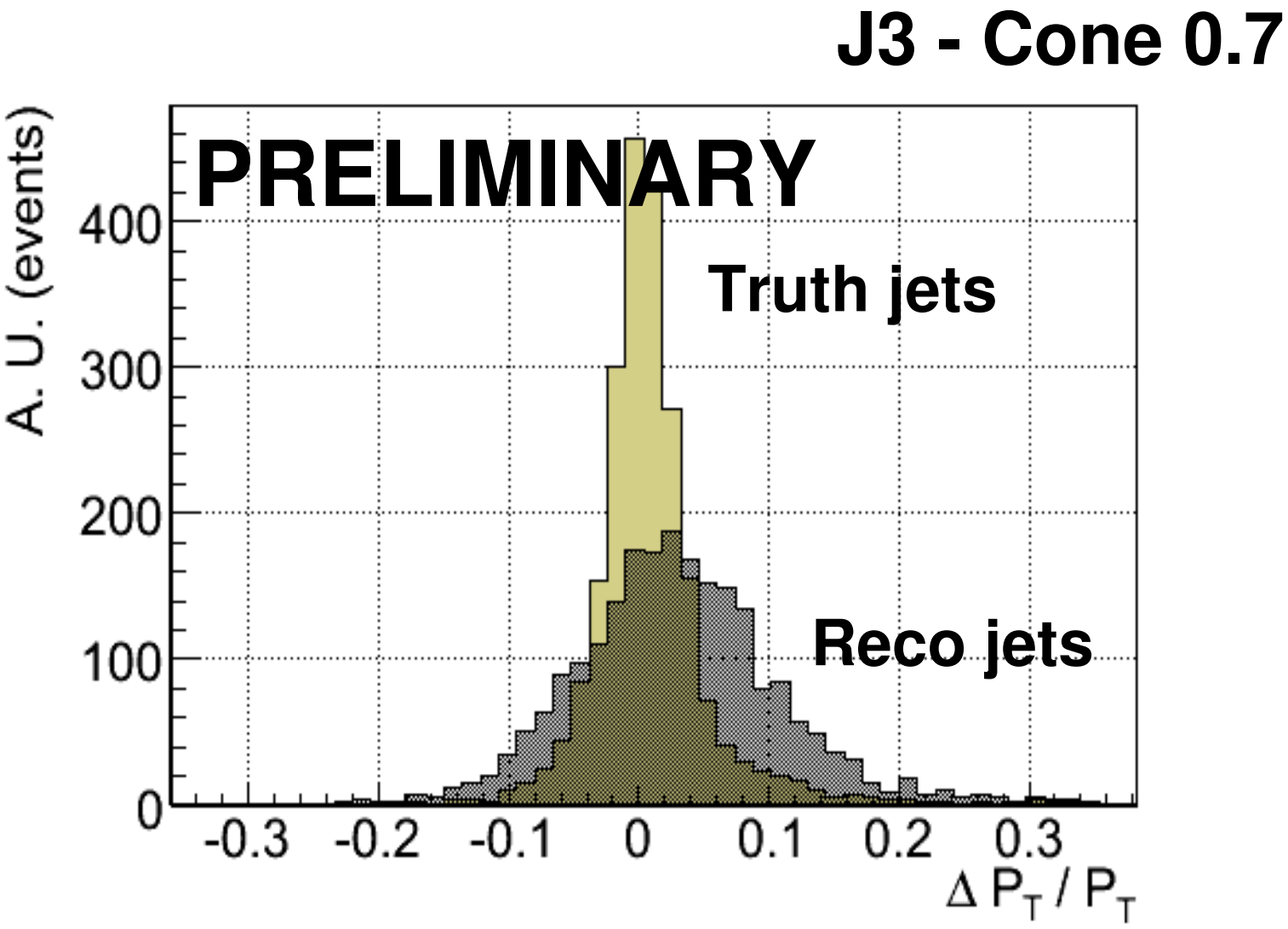
The difference between Et and Pt could be important in the Di-Jet Balance.

$E_T - P_T (\eta=0) > E_T - P_T (\eta=2)$



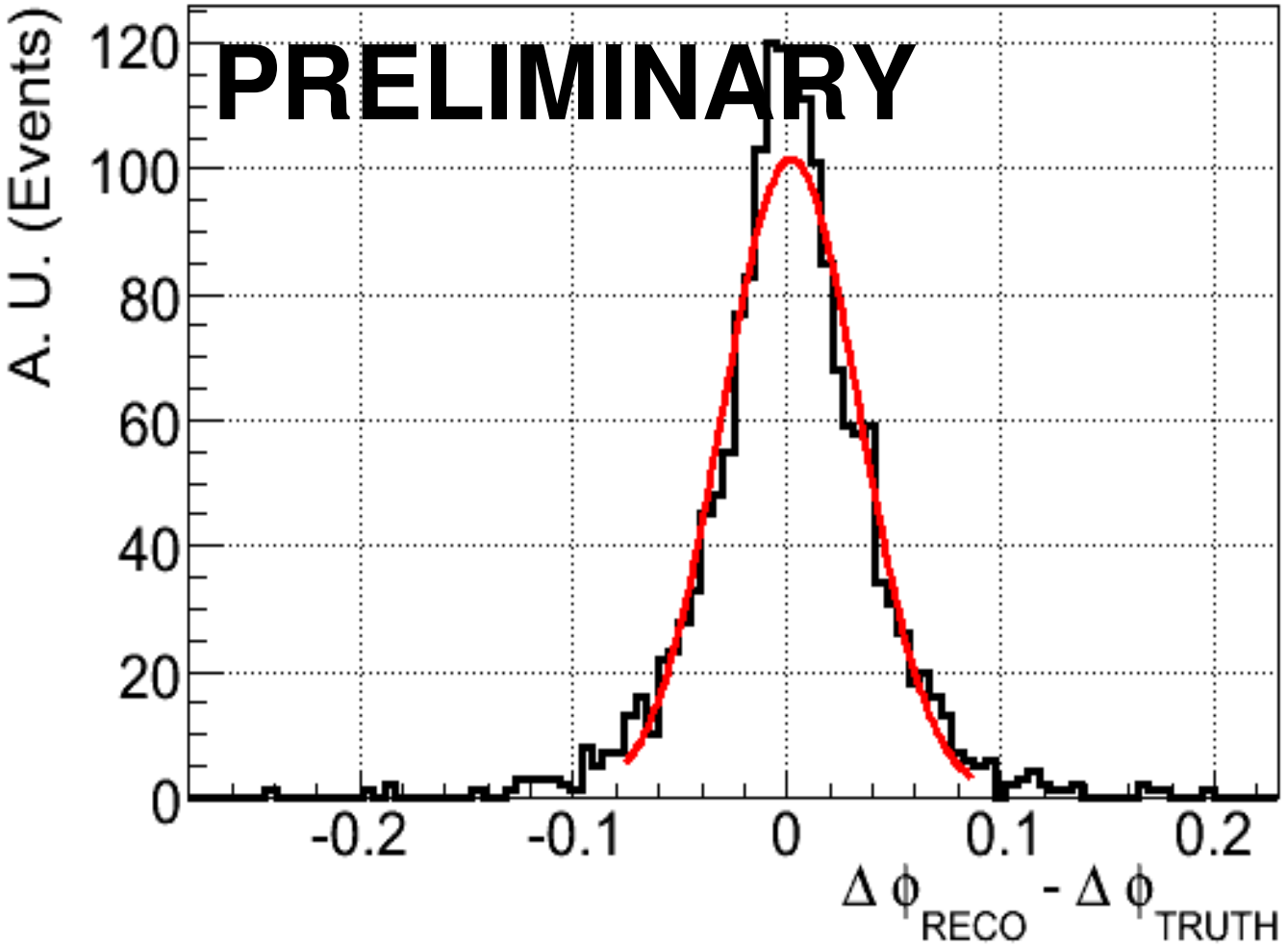
Balancing Jets in different η regions, we obtain differences using E_T

Reco Jets: A first Look



Resolution on α

J3 - Cone 0.7



$\sigma_{\alpha} = 0.032 \pm 0.001$ rad.

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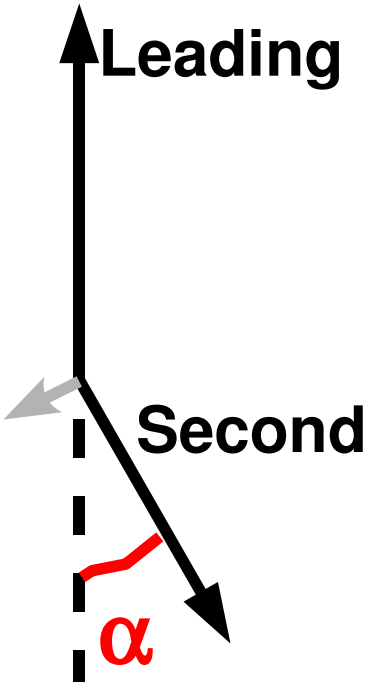

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