Introduction to the Jet Energy Scale Session

Hadronic Calibration Workshop

Ariel Schwartzman (SLAC)
Esteban Fullana Torregosa (ANL)
Mario Martinez-Perez (IFAE)

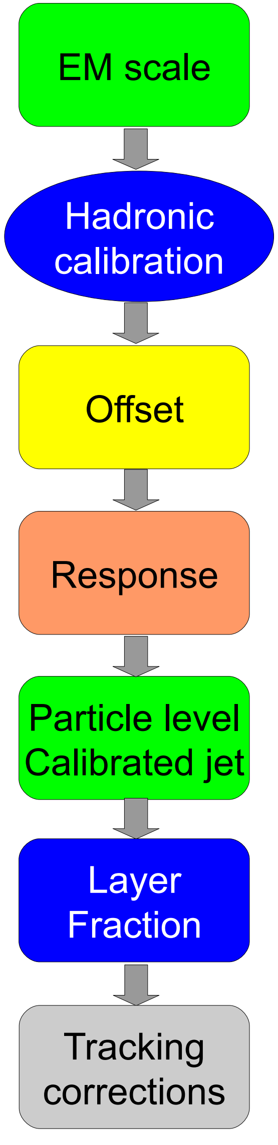
June 25, 2009

Outline

- Overview of the status of the the jet calibration task force:
  - Factorized jet energy scale corrections.
- Organization of the JES session
  - Topics, main issues to be discussed, and questions to be addressed.

Overview of the Jet Energy Scale (I)

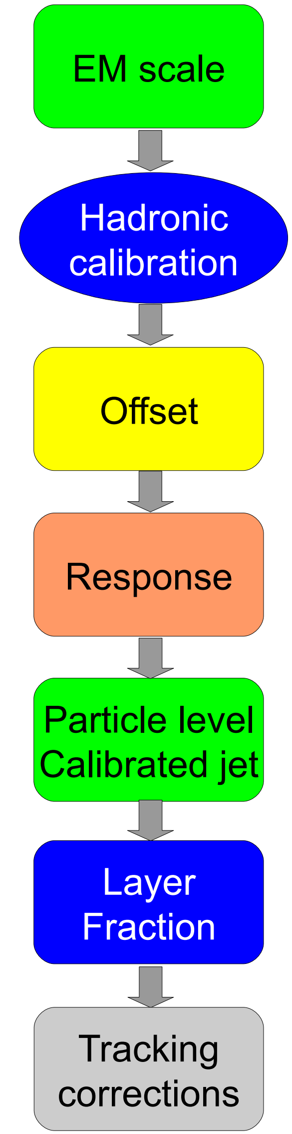
- Factorized, multi-step approach, combining Monte Carlo and data-driven corrections:
  - Flexibility to understand corrections individually, and use different techniques as they become validated with data, within a same framework.
  - General: Multiple calibration *schemes* are possible. Many approaches being pursued:
    - Monte Carlo (MC), Data-driven (DD), and combination of MC and DD corrections:
    - Example:
      - Local Hadron (MC) + Offset (DD) + Eta-dependent (DD) + Response (MC)
  - Data-driven and MC corrections are not competing approaches, but complementary methods.



Overview of the Jet Energy Scale (II)

- Hadronic calibration:
  - Cell energy density weighing.
  - Local calibration (particle/cluster level)
- Jet energy scale:
  - Offset (pile-up)
  - Absolute energy response:
    - MC: pT-Eta, jet properties, layer weighting
    - DD: Eta-dependent, g/Z+jets, MPF.
  - Corrections to improve resolution after calibration:
    - Tracks, vertices, jet properties.

$$p_T^{calib} = [p_T^{jet} - Offset(\eta, n_{PV}, L)]C_1(\eta).C_2(p_T)$$

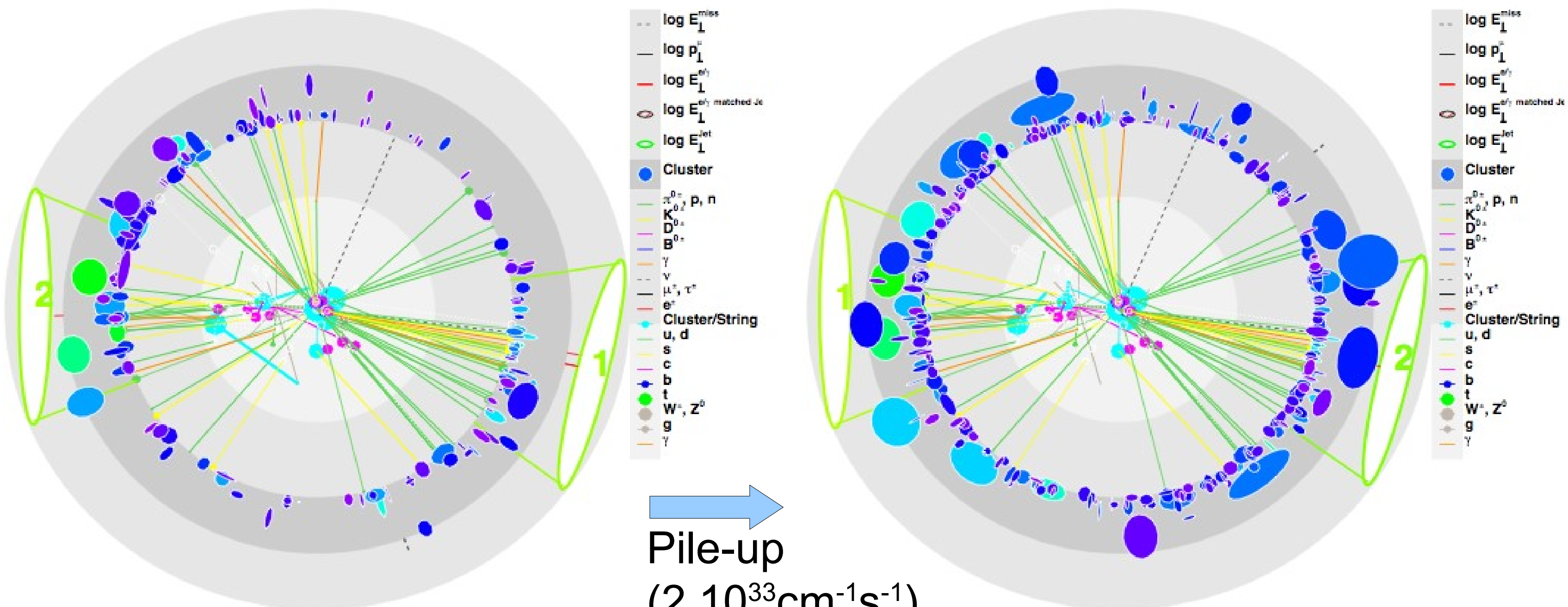


Organization of the JES Session

- Part I:
  - Inputs to jet reconstruction.
  - Pile-up offset corrections.
- Part II:
  - Absolute energy scale corrections.
- Part III:
  - Topology and flavor dependence of the jet energy scale. In-situ tests of the jet energy scale and resolution.
- Part IV:
  - Corrections to improve resolution after calibration.
  - Systematic uncertainties.

Part I

Inputs to jet reconstruction and pile-up corrections



Effect of input constituents on jet reconstruction and calibration: response, energy resolution, angular resolution, sensitivity to pile-up:

- Different cluster topology, increase in average energy and fluctuations.
  - Performance of clusters, towers, towers with noise suppression.
  - Offset pile-up energy corrections.

Part II: Setting the Absolute Scale

- Monte Carlo based methods:
  - MC Simple pt-eta correction (numerical inversion)
  - MC corrections based on cluster properties (moments)

Issues:

- E/P validation.
- Sensitivity to aspects not properly/fully simulated:
  - non-gaussian tile noise, bunch structure, pile-up...
- How much MC/Data agreement is required? For example, what if the jet response is not well described by the MC in one particular eta region? How can we apply a data-driven eta correction to jets and still use a cluster-based calibration? Cluster splitting in data and MC?

Part II: Setting the Absolute Scale

- Monte Carlo based methods (cont.):

<u>Issues</u>:

- Sensitivity to flavor and jet topology:
  - simple pt scaling cannot account for differences in jet fragmentation.
  - Sample dependences, larger fluctuations (resolution)
    - Could be very small if applied after cell energy density weighting, local calibration, or layer weighting.

Part II: Setting the Absolute Scale

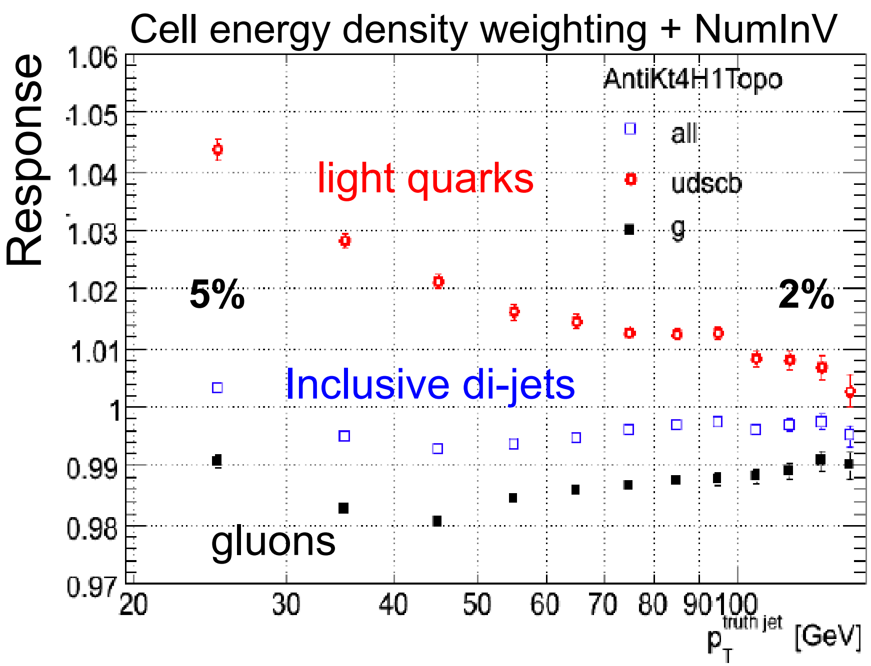
- Data-driven based methods:
  - Eta-dependent correction (di-jet balance)
  - g/Z+jet balance
  - MPF (g+jets)

Issues:

  - Backgrounds, event selection, trigger, jet resolution biases.
  - Out-of-cone showering (parton/particle level)
  - Missing ET:
    - Consistent definition for each calibration scheme.
    - Requirement on resolution?
  - Sample/flavor dependence.
  - Binning (photon pt, average pt, reco jet pt, ...)

Part III

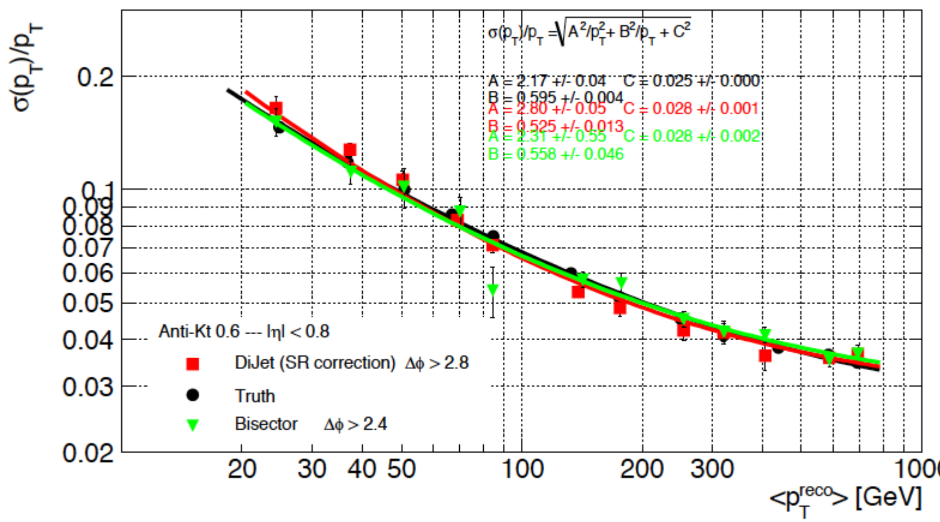
Flavor and topology dependence of the energy scale:



- Systematic uncertainty? flavor dependent correction?

Tests of the energy scale:

- In-situ validation of the full chain of corrections in different data samples.
- In-situ measurement of jet energy resolution, efficiency, and jet shapes.

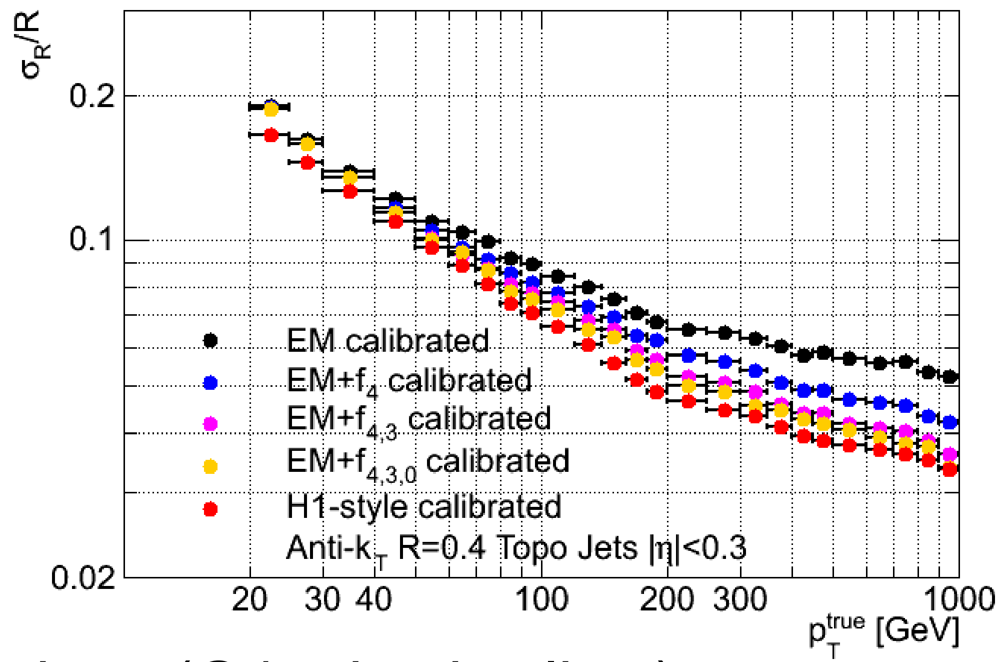


- Configurations of <u>close-by jets</u>: lower response for non-isolated jets: definition of isolation, possible strategies, uncertainties.

Part IV

Corrections to improve the jet energy resolution <u>after</u> calibration:

- Combining tracking and calorimeter information.
- Use of jet properties, longitudinal segmentation:



Systematic uncertainties:

- Hadronic calibration and MC based response corrections (G4, physics lists)
- Data-driven corrections:
  - Backgrounds, event selection, sample dependences, ...

Links to Documentation

- Jet calibration task force twiki:
  - Links to individual techniques and notes.

  https://twiki.cern.ch/twiki/bin/view/AtlasProtected/JetCalibrationTaskForce

- Jet calibration note:

  https://twiki.cern.ch/twiki/bin/view/AtlasSandboxProtected/JetCalibrationNote