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Particle flow event reconstruction at CMS: Commissioning with December collisions, prospects for 7 TeV

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Summary. — The results of the commissioning of the Particle Flow on 900 GeV collisions recorded by CMS are shown. The Particle Flow is an event reconstruction technique which combines all CMS subdetectors into the creation of particle candidates, and improves jet and missing transverse-energy reconstruction performance.

PACS 07.05.Fb – Design of experiments.
PACS 07.05.Kf – Data analysis: algorithms and implementation; data management.
PACS 29.40.-n – Radiation detectors.
PACS 29.85.-c – Computer data analysis.

The Particle Flow [1] is an event reconstruction technique that has the aim of reconstructing and identifying all stable particles produced in a proton-proton collision, through the optimal combination of all CMS subdetectors. Charged tracks are reconstructed in the silicon tracker, calorimeter deposits are clustered in the electromagnetic and hadronic calorimeters, hits are collected in the muon spectrometers. These reconstructed objects are then linked, giving way to particle candidates: a track linked to a calorimeter deposit is a charged hadron candidate, an electromagnetic (hadronic) energy cluster not linked to tracks is a photon (neutral hadron) candidate, and so forth. The combination of tracks with calorimeter-based information requires an adequate calibration of the calorimeter energy measurement, in order to ensure that neutral particles produced close to charged particles do not go undetected. The track momentum and the (calibrated) calorimeter energy are compared, and if found compatible a charged hadron candidate is created. If a significant excess of energy is observed in the calorimeter, a photon and possibly a neutral hadron candidates are created. Figure 1 shows the calibrated calorimeter energy for isolated charged hadron candidates, as a function of their track momentum, both in 900 GeV data (red markers) and in the full-detector simulation (blue markers). The linear correlation between these two quantities is proof of an adequate calibration of the calorimeters. The figure also shows the expected trend by assuming a ±30% bias in the hadronic calorimeter calibration (green dotted line).

Once the reconstruction algorithm has created a list of reconstructed particle candidates, a clustering algorithm groups them to define Particle Flow jets. In this study, jets clustered with the anti-k_T [2] algorithm, with aperture parameter $R = 0.5$ are considered. Figure 2 (left) shows the average Particle Flow jet energy composition, as a function of

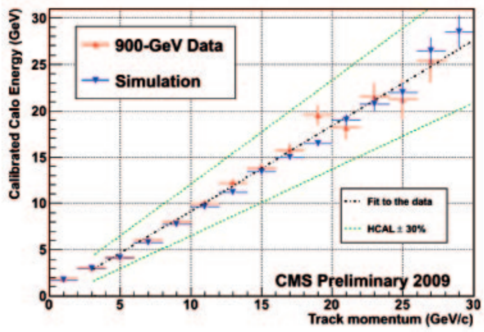

Fig. 1. – Calibrated calorimeter energy of isolated charged hadron candidates as a function of their track momentum.

pseudorapidity, for jets with transverse momentum greater than 5 GeV/c: in the central region, from bottom to top, $\sim 65\%$ of the jet energy is carried by charged hadrons (red), $\sim 15\%$ by photons (blue) and $\sim 20\%$ by neutral hadrons (green). The contribution of electron candidates, barely visible, is shown in cyan. The charged hadron component starts dropping at the end of the CMS tracker acceptance ($\eta = 2.5$), whereas the central calorimetry ends at $\eta = 3$. In the very forward region of the detector ($3 < \eta < 5$), particles are reconstructed only in the forward calorimeter and can be broadly classified into hadronic particles (pink) and electromagnetic particles (grey, on top).

The Particle Flow improves the CMS performance in jet and event missing transverse energy ($E_{\mathrm{T}}^{\mathrm{miss}}$) reconstruction. The latter can be studied as a function of the scalar sum of the transverse energies of all the reconstructed particle candidates in the event (ΣE_{T}). Figure 2 (right) shows the width of the $E_{\mathrm{T}}^{\mathrm{miss}}$ distribution along two orthogonal (x, y) directions in the transverse plane as a function of ΣE_{T}. The trend is fitted with the function $\mathrm{RMS}(E_{\mathrm{x,y}}^{\mathrm{miss}}) = \sqrt{a \oplus b \cdot \Sigma E_{\mathrm{T}}}$. The fit yields $a = 0.55$ GeV and $b = 45\%$.

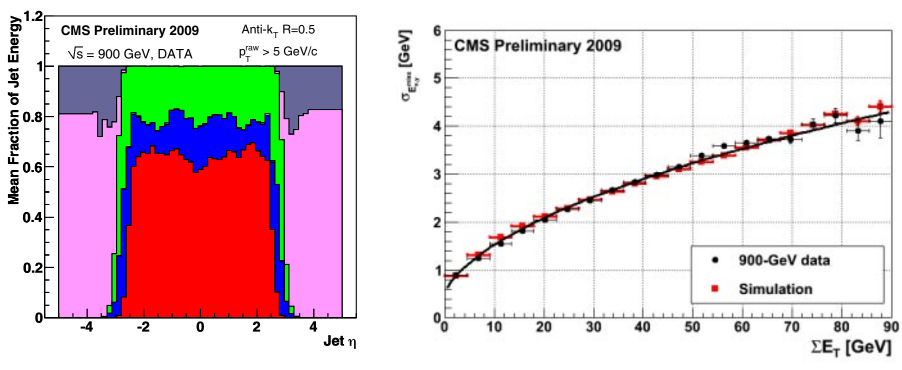

Fig. 2. – (Colour on-line) Left: average jet energy composition as a function of pseudorapidity. Different colours indicate different particle candidates (see text for details). Right: resolution of the particle-based $E_{\mathrm{T}}^{\mathrm{miss}}$ as a function of the event ΣE_{T}, in 900 GeV data (black markers) and simulation (red markers). The fit to the data is shown as a black line.

REFERENCES

[1] CMS Collaboration, *Particle-Flow Event Reconstruction in CMS and Performance for Jets, Taus and Missing* E_T, CMS PAS PFT-09-001.
[2] Cacciari M., Salam G. P. and Soyez G., *JHEP*, **0804** (2008) 063 (arXiv:0802.1189).