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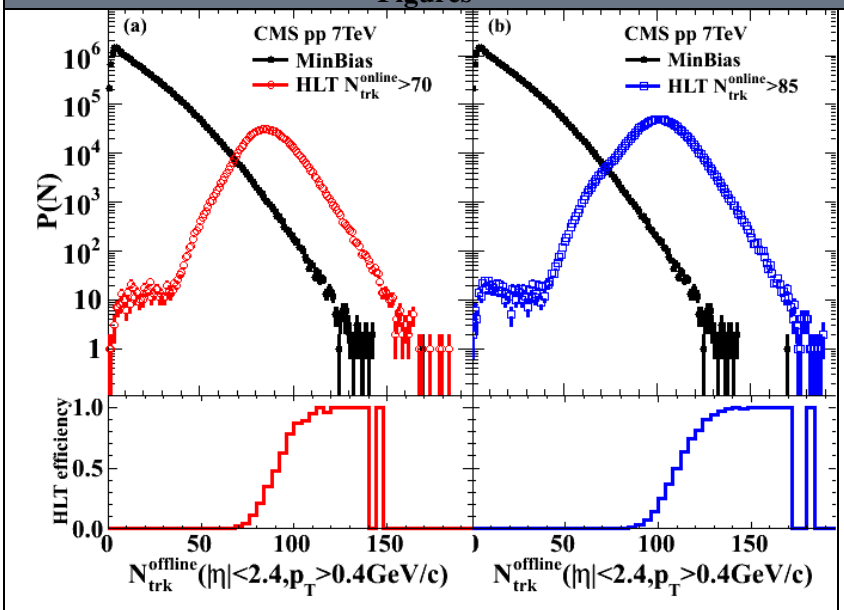
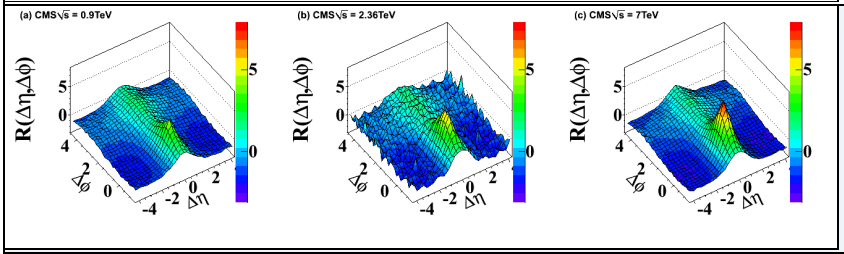
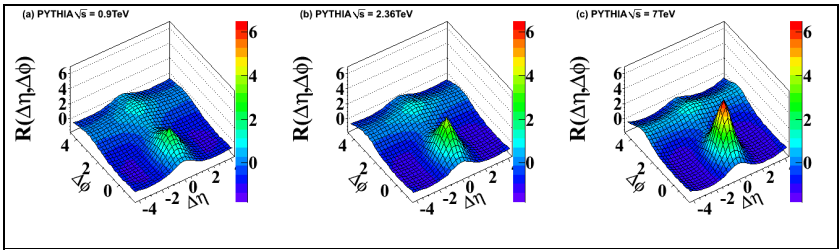
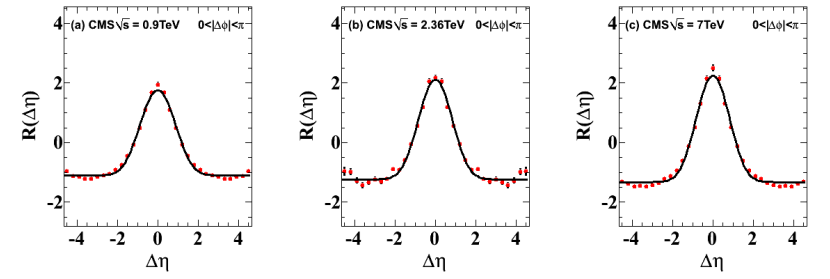
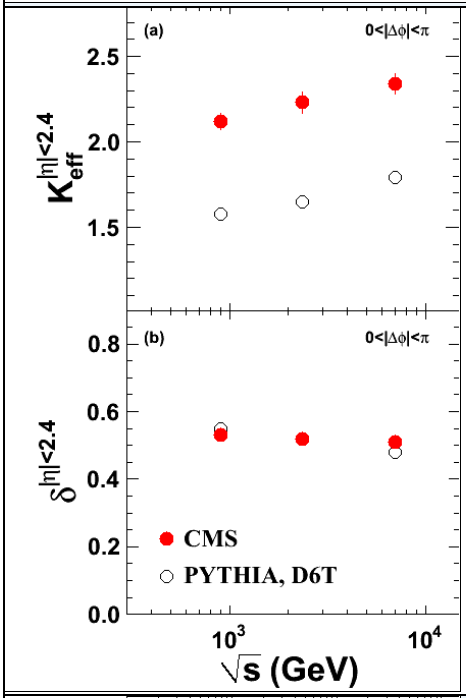
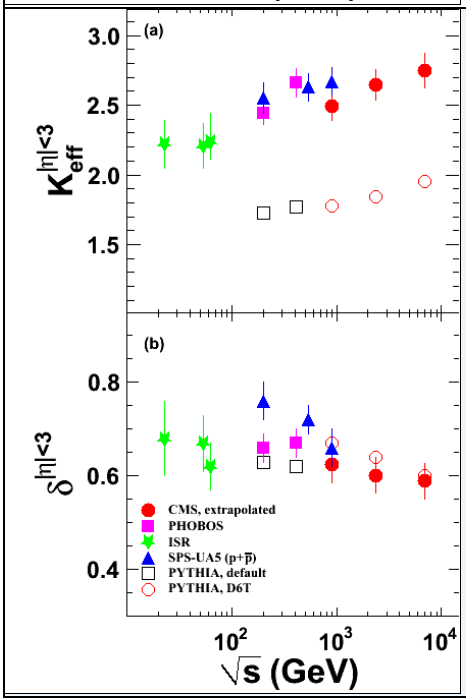
Observation of Long-Range, Near-Side Angular Correlations in Proton-Proton Collisions at the LHC

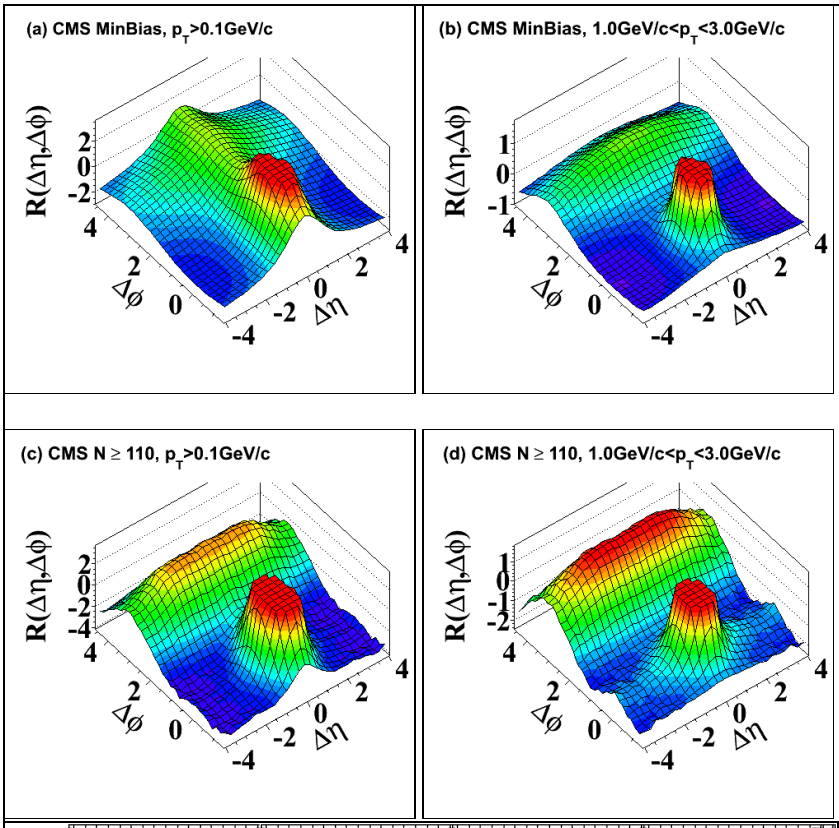
Abstract

Results on two-particle angular correlations for charged particles emitted in proton-proton collisions at center-of-mass energies of 0.9, 2.36, and 7 TeV are presented, using data collected with the CMS detector over a broad range of pseudorapidity(eta) and azimuthal angle (phi). Short-range correlations in Delta-eta, which are studied in minimum bias events, are characterized using a simple ``independent cluster'' parametrization in order to quantify their strength (cluster size) and their extent in eta (cluster decay width). Long-range azimuthal correlations are studied differentially as a function of charged particle multiplicity and particle transverse momentum using a 980 nb^{-1} data set at 7 TeV. In high multiplicity events, a pronounced structure emerges in the two-dimensional correlation function for particle pairs with intermediate p_T of 1-3 GeV/c, 2.0<|Delta-eta|<4.8 and Delta-phi ~ 0. This is the first observation of such a long-range, near-side feature in two-particle correlation functions in pp or ppbar collisions.

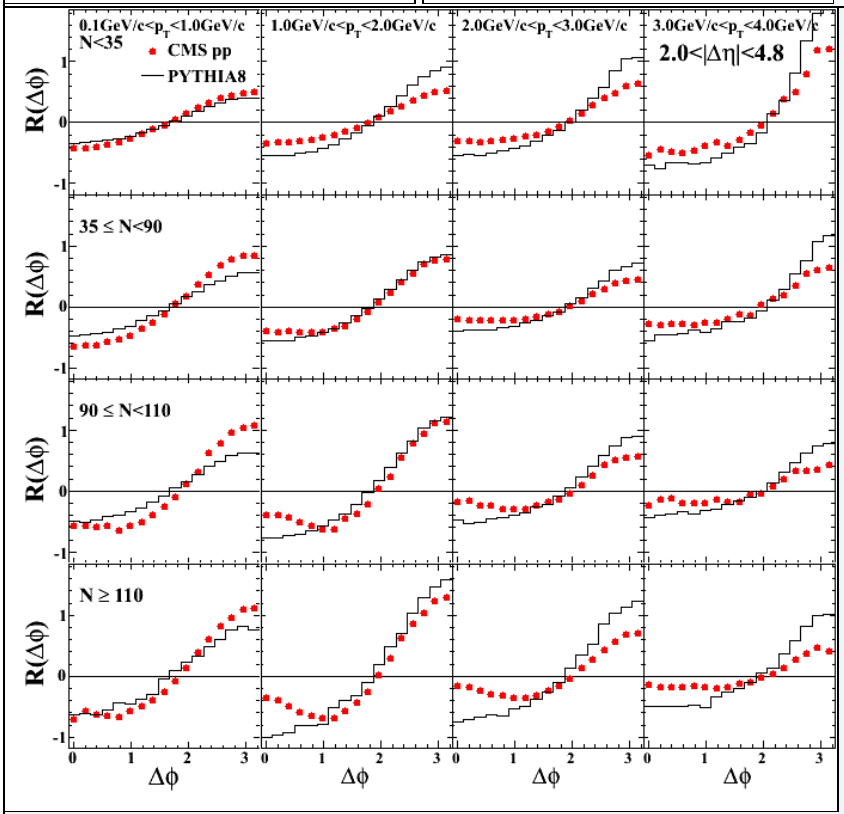
Approved Plots from QCD-10-002 (*click for pdf*)

Figures	Abbreviated Caption
	Distributions of the number of tracks reconstructed in offline analysis for minimum bias events, as well as high-multiplicity triggered events, both at 7 TeV, with online multiplicity greater than (a) 70 and (b) 85. The total integrated luminosity of the data set is 980 nb^{-1}. The minimum bias trigger was heavily prescaled during higher luminosity LHC running. The HLT efficiency turn-on curves for the two high multiplicity triggers are shown in the two panels at the bottom.
	Two-particle correlation functions versus Delta-eta and Delta-phi in pp collisions at (a) 0.9, (b) 2.36, and (c) 7 TeV.

	Two-particle correlation functions versus Delta-eta and Delta-phi in PYTHIA D6T tune at (a) 0.9, (b) 2.36, and (c) 7 TeV.
	Two-particle pseudorapidity correlation function, obtained by averaging over the entire Delta-phi range from 0 to pi, in pp collisions at (a) 0.9, (b) 2.36, and (c) 7 TeV. The solid curves correspond to the fits by the cluster model. Error bars are smaller than the symbols.
	(a) K_{eff} and (b) delta as a function of energy, measured for p_T>0.1 GeV/c and eta<2.4 by CMS in solid circles. Open circles show the PYTHIA results with the D6T tune.
	(a) K_{eff} and (b) delta as a function of energy based on a model-dependent extrapolation of CMS data to p_T ~ 0 and eta<3 (solid circles), as well as data from PHOBOS (solid squares), UA5 (solid triangles) and ISR (solid stars) experiments for pp and ppbar collisions. Open circles and squares show the PYTHIA results for the D6T tune and default parameters, respectively.

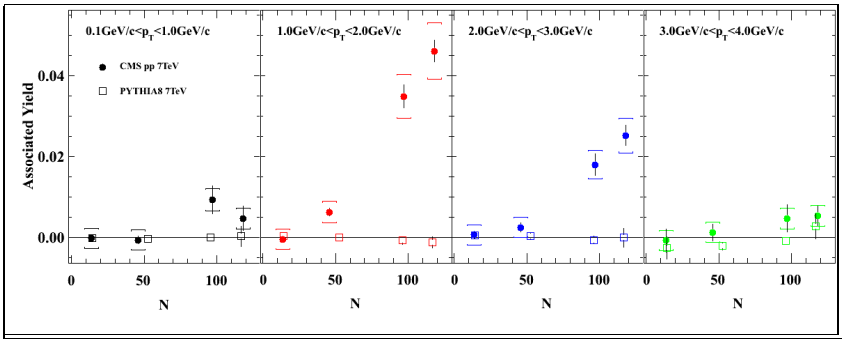
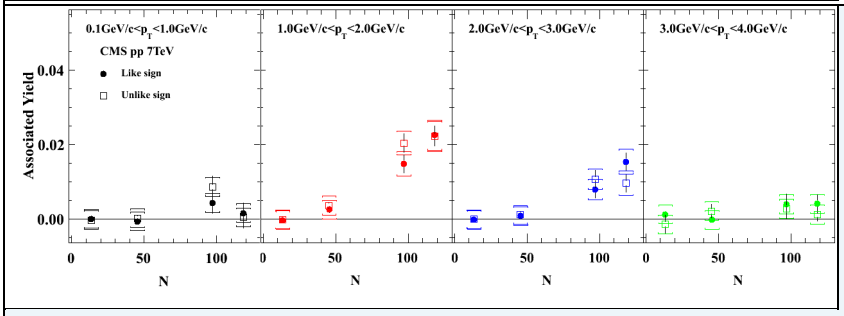


2-D two-particle correlation functions for 7 TeV pp (a) minimum bias events with p_T > 0.1 GeV/c , (b) minimum bias events with 1 < p_T < 3 GeV/c, (c) high multiplicity (N>110) events with p_T > 0.1 GeV/c and (d) high multiplicity (N>110) events with 1 < p_T < 3 GeV/c. The sharp near-side peak from jet correlations is cut off in order to better illustrate the structure outside that region.



Projections of 2-D correlation functions onto Delta-phi for 2.0<Delta-eta<4.8 in different p_T and multiplicity bins for fully corrected 7 TeV pp data and reconstructed PYTHIA8 simulations. Error bars are smaller than the symbols.

Associated yield for the near-side of the correlation function integrated over the region of 2.0<Delta-eta<4.8 as a function of event multiplicity in bins of p_T for 7 TeV pp collisions. The error bars correspond to statistical errors, while the brackets around the data points denote the

	systematic uncertainties. The open squares show results for PYTHIA8.
	Like-sign and unlike-sign associated yield for the near-side of the correlation function integrated over the region of 2.0<Delta-eta<4.8 as a function of event multiplicity in bins of p_T. The error bars correspond to statistical errors, while the brackets around the data points denote the systematic uncertainties.

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