# Autocorrelations in pPb Centrality

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## 1. Motivation

Any measure of centrality based on a particular η range will induce auto-correlations for measurements within that range. The wide CMS η range allows for studies of these effects, which are small in PbPb[1] but are noticeable in pPb.

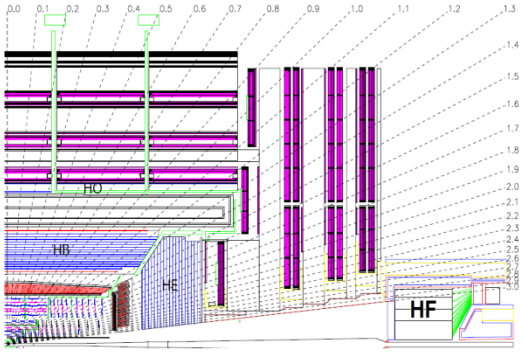


**Figure 1:** *Slice through ¼ of CMS with lines of constant η. The Hadronic Forward (HF) calorimeter covers 3 < |η| < 5. The pixel detector covers |η| < 2.4 and the ZDC (not shown) |η| > 8.6.*

## 2. Characterizing the autocorrelations

$$S_{PC} = E_T(\text{peripheral},\eta) / E_T(\text{central},\eta)$$

This ratio allows for the study of how autocorrelations may influence the η dependence of centrality measurements over the full η coverage of CMS while canceling out some of the systematic errors arising from acceptance effects.

## 3. Simulation

Figure 2 shows $S_{PC}$ for EPOS-LHC generator level Monte Carlo calculations[2]. For this simulation, the sum of $E_T$ for particles with -5 < η < -4 was used for the centrality definition. A break in the $S_{PC}$ behavior is clearly seen at η = -4.

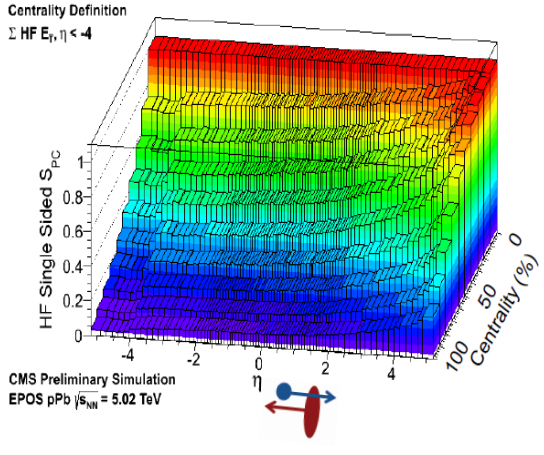


**Figure 2:** *$S_{PC}$ from EPOS-LHC at the generator level.*

## 4. Experimental pPb results

$S_{PC}$ is explored with several different centrality variables (see Table 1). Figure 3 displays $S_{PC}$ with the HF– centrality. A steady rise with η is seen except at the boundaries of detector subsystems and at η = -4 where an autocorrelation induced break is present. The centrality dependence of $S_{PC}$ depends strongly on η. Figure 4 compares $S_{PC}$ for the different centrality variables. A more regular behavior is seen when using a wider η range for defining centrality.

**Table 1: Centrality Variables**

| | |
|---|---|
| HF– | Σ $E_T$ (-5 < η < -4) |
| HF | Σ $E_T$ (-5 < \|η\| < -4) |
| $N_{trk}^{Offline}$ | # tracks in \|η\| < 2.4 |
| ZDC + pixel tracks | \|η\| < 2.4 and \|η\| > 8.6 |

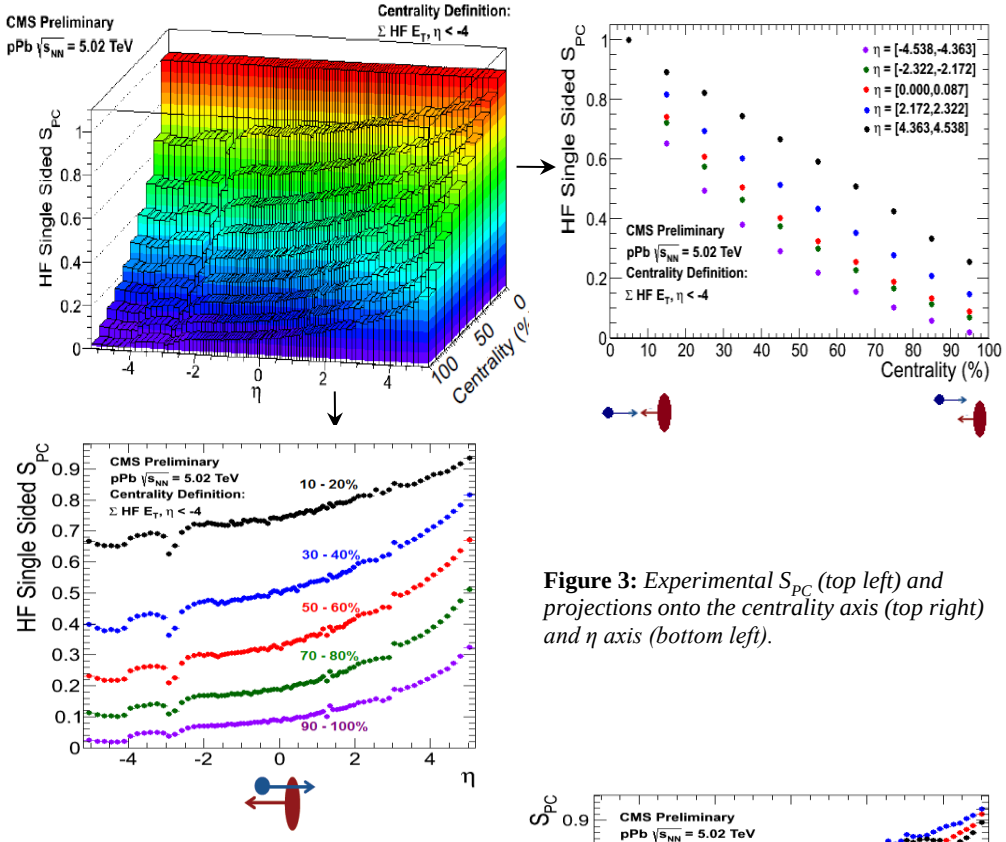


**Figure 3:** *Experimental $S_{PC}$ (top left) and projections onto the centrality axis (top right) and η axis (bottom left).*

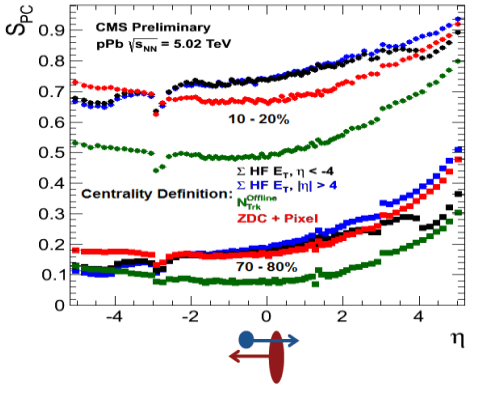


**Figure 4:** *Experimental $S_{PC}$ vs. η based on four different centrality definitions. Two centrality ranges are shown*

## 5. Conclusion

Autocorrelations must be considered when defining pPb centrality. $S_{PC}$ is sensitive to these autocorrelations and may provide guidance as to the most appropriate centrality definition for a given study.

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[1] PRL 109, 152303
[2] arXiv:1006.2967v1