A DATA-DRIVEN APPROACH TO DI-HADRON CORRELATIONS IN THE PRESENCE OF LARGE NUMBERS OF SECONDARY PARTICLES

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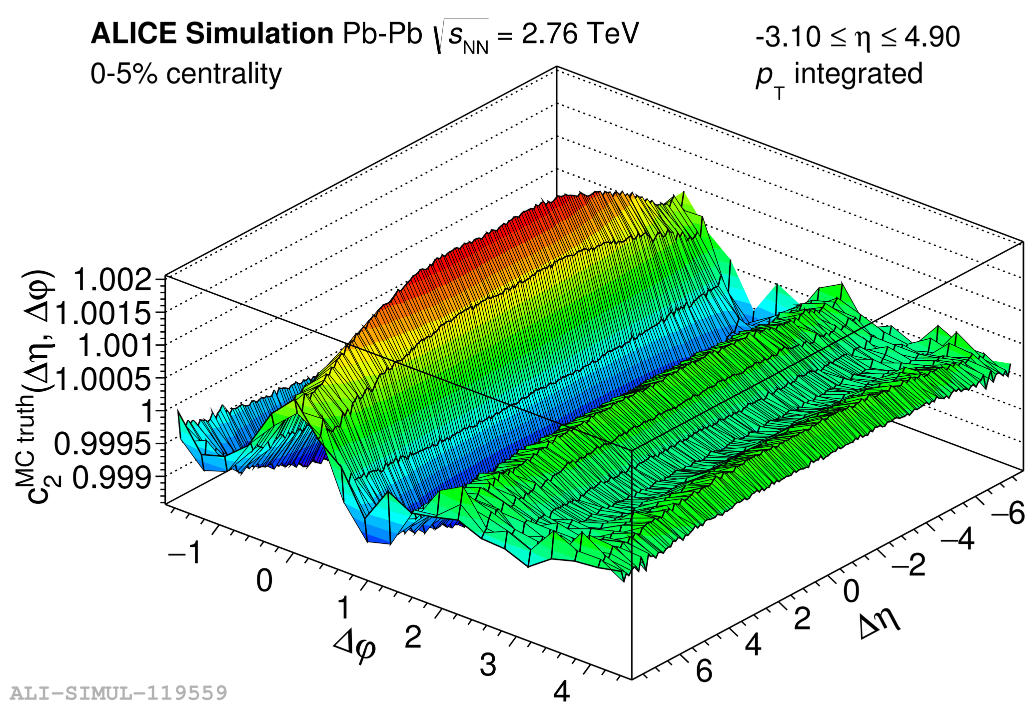
Abstract

The method presented here allows us to measure two-particle correlations and their Fourier coefficients over the **large pseudorapidity range** of up to $-3.4 \leqslant \eta \leqslant 5$. Furthermore, it enables us to calculate the Fourier components $V_{n\Delta}(\eta_1, \eta_2)$ as a function of both particle's η values which has been suggested as an observable of interest to better understand the initial conditions [1].



An analysis of the forward and backward region is often complicated by a **large number of secondary particles** produced by interactions with detector material. We correct for the effects caused by such secondary particles on the Fourier coefficients $V_{n\Delta}$ with a data-driven method.

Correlation function

$$c_2(\eta_1, \varphi_1, \eta_2, \varphi_2) = \frac{\langle n_1 n_2 \rangle}{\langle n_1 \rangle \langle n_2 \rangle}$$

- $\langle n_1 n_2 \rangle$ Average number of particle pairs
- $\langle n_i \rangle$ Average number of particles of type i
- Variable transformation yields $c_2(\eta_1, \eta_2, \Delta\varphi)$
- Robust against uncorrelated detector inefficiencies [2, 3]

The Fourier coefficients $V_{n\Delta}$ are found by

$$c_2(\eta_1, \eta_2, \Delta\varphi) \propto \frac{dN^{\text{pairs}}(\eta_1, \eta_2, \Delta\varphi)}{d\Delta\varphi} \propto P_\Delta(\eta_1, \eta_2, \Delta\varphi)$$

$$\propto 1 + \sum_{n=1}^{\infty} 2V_{n\Delta}(\eta_1, \eta_2)\cos(n\Delta\varphi)$$

$P_\Delta(\eta_1, \eta_2, \Delta\varphi)$ is the probability distribution of particle pairs.

Chances and Challenges in the forward region

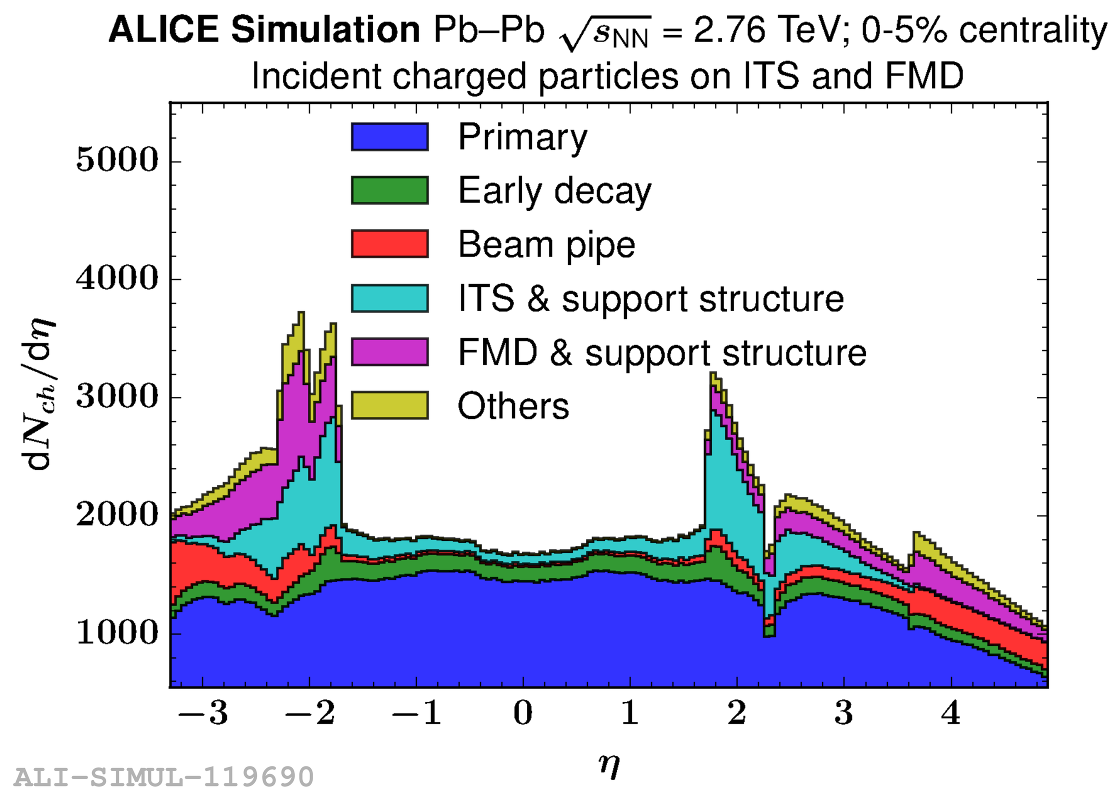
Combining ALICE's inner tracking system with the Forward Multiplicity Detector (FMD):

Advantages

- Large combined coverage: $-3.4 \leqslant \eta \leqslant 5$
- Full azimuthal acceptance

Challenges

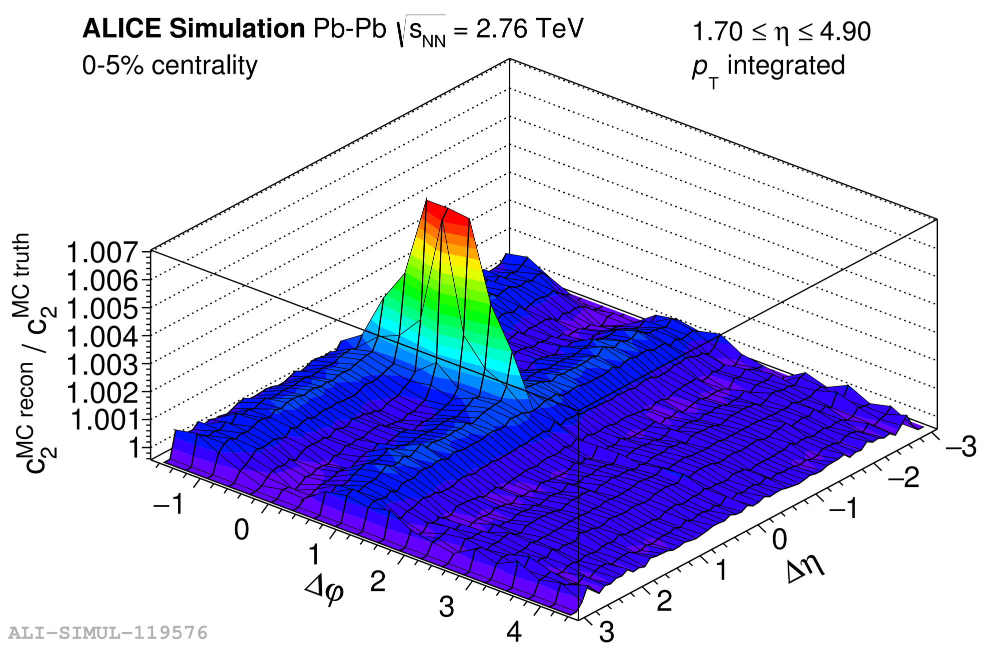
- FMD is hit based detector without tracking
- Many secondary particles from detector material



Short range effects of secondaries

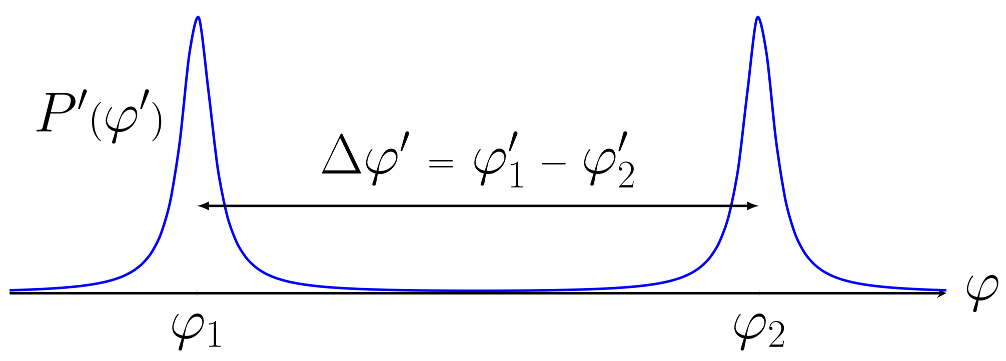
MC closure test reveals two effects of secondary particles

- Correlations between secondary particles dominant at $\Delta\eta \approx 0$
- Long range effect is present depending on anisotropic flow



Distribution of secondary particles

- Relative angular distribution of particle pairs $P_\Delta(\Delta\varphi)$ is quantity of interest
- Not directly accessible due to secondary particles from material interactions
- Distribution of secondary particles $P(\varphi')$ can be described in terms of a smearing function f and primary particle distribution $P(\varphi)$
- The problem can be formulated in terms of convolutions

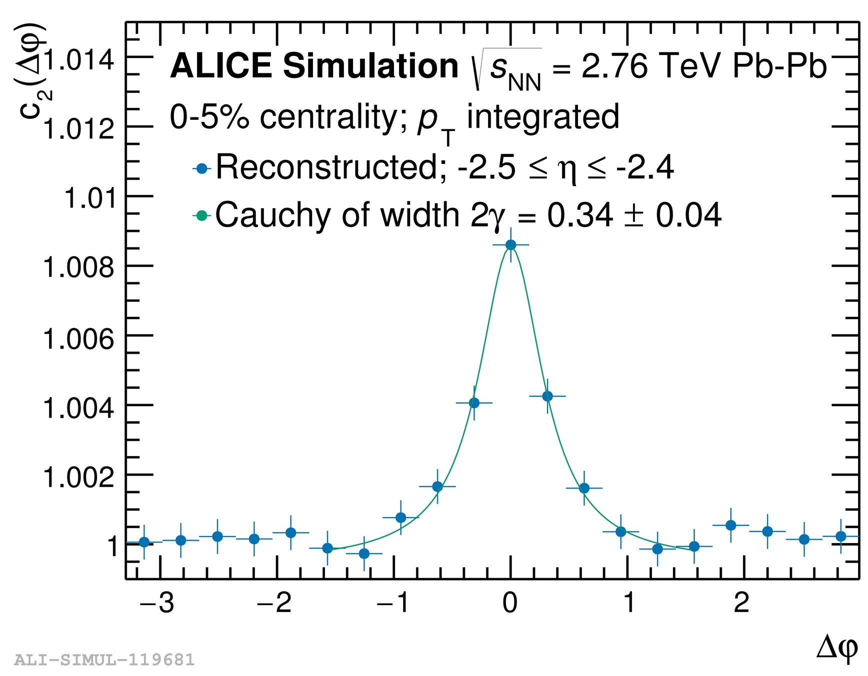


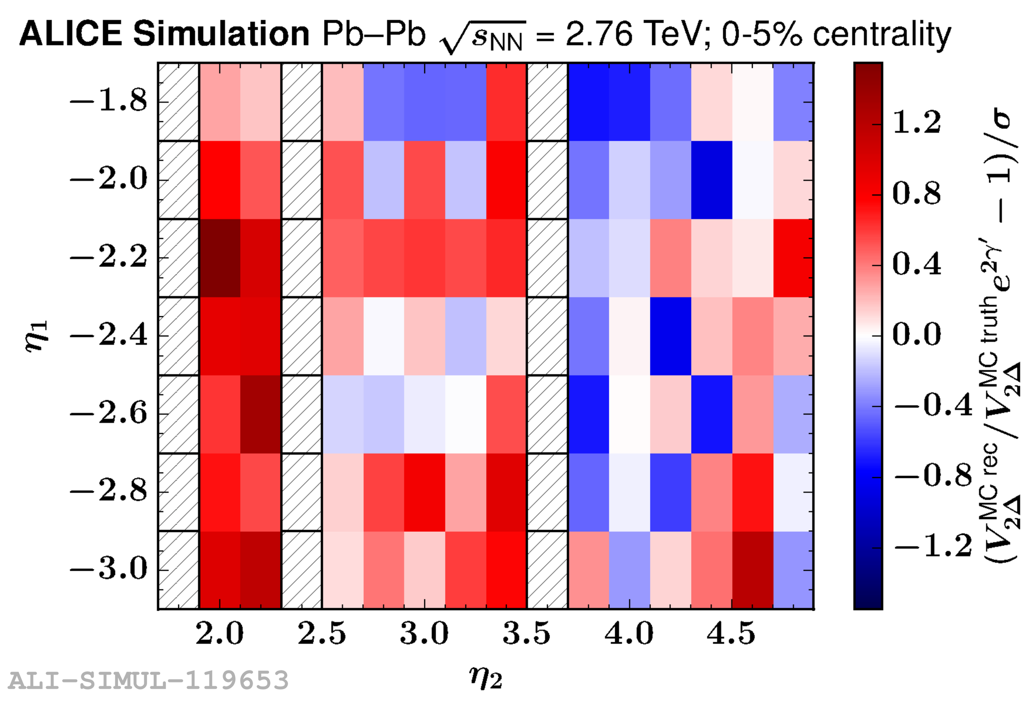
$$P_\Delta(\Delta\varphi) = P(\varphi) \circ P(\varphi)$$
$$P'(\varphi') = f(\varphi) \circ P(\varphi)$$
$$P'_\Delta(\Delta\varphi') = f(\varphi) \circ f(\varphi) \circ P_\Delta(\Delta\varphi)$$

If f is known, $P_\Delta(\Delta\varphi)$ can be retrieved.

Data driven correction

- $f \circ f$ can be extracted from short range correlations at $\Delta\eta \approx 0$
- f found to be Lorentzian with width $\gamma(\eta)$
- Correction factor $e^{n(\gamma_1+\gamma_2)}$ (Fourier transform of $f_{\eta_1} \circ f_{\eta_2}$) yields **MC closure** for $V_{n\Delta}(\eta_1, \eta_2)$





Deviation from $V_{2\Delta}^{\text{MC truth}}$ in units of std. deviation σ after correction

Summary and references

- Forward detectors offer a large pseudorapidity acceptance at the expense of tracking capabilities and large numbers of secondary particles from interactions in material
- Secondary particles cause enhanced short range correlations and decrease measured anisotropic flow
- **Effects can be corrected in a data driven way**

References

[1] J.-Y. Ollitrault and F. G. Gardim. In: *Nuclear Physics A* 904-905 (May 2013), pp. 75c–82c.
[2] S. Ravan et al. In: 89.2, 024906 (Feb. 2014), p. 024906. arXiv: 1311.3915 [nucl-ex].
[3] V. Vechernin. In: *Nuclear Physics A* 939 (2015), pp. 21–45.