Generic framework for anisotropic flow analyses with multi-particle azimuthal correlations (arXiv:1312.3572)

A. Bilandzic[1], C. H. Christensen[1], K. Gulbrandsen[1], A. Hansen[1] and Y. Zhou[2,3]
[1]Niels Bohr Institute, Univ. Copenhagen, [2]Nikhef, Amsterdam, [3]Utrecht Univ.

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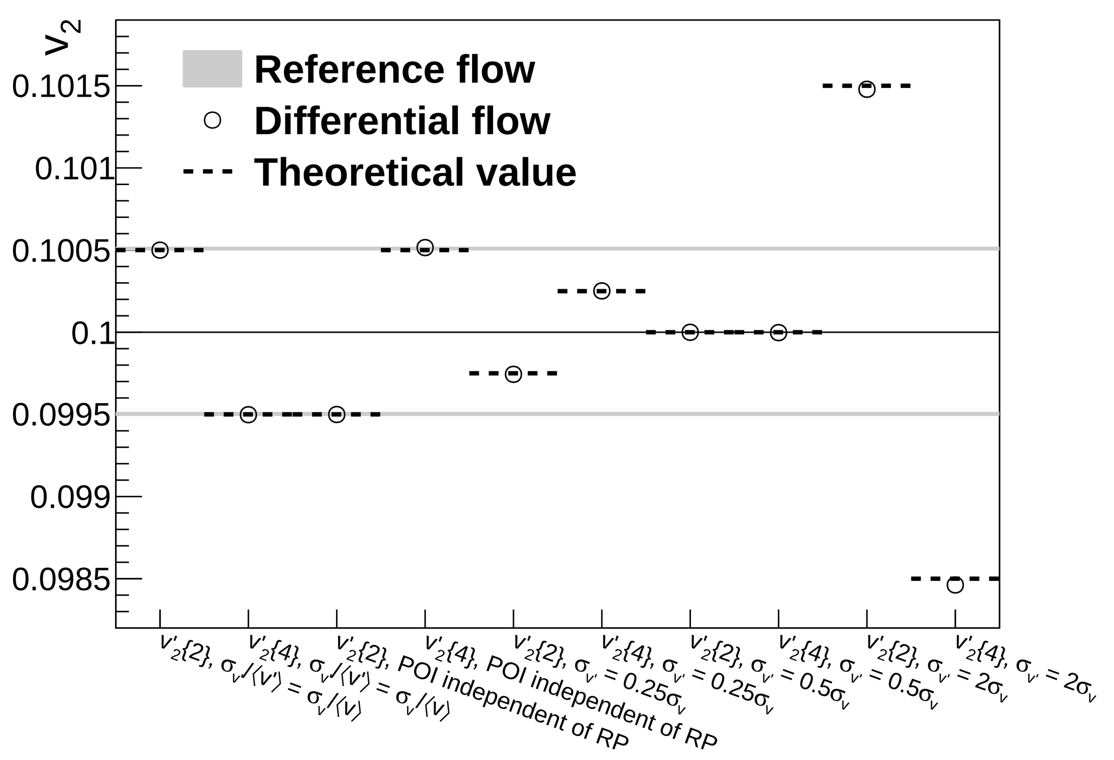
Generic framework

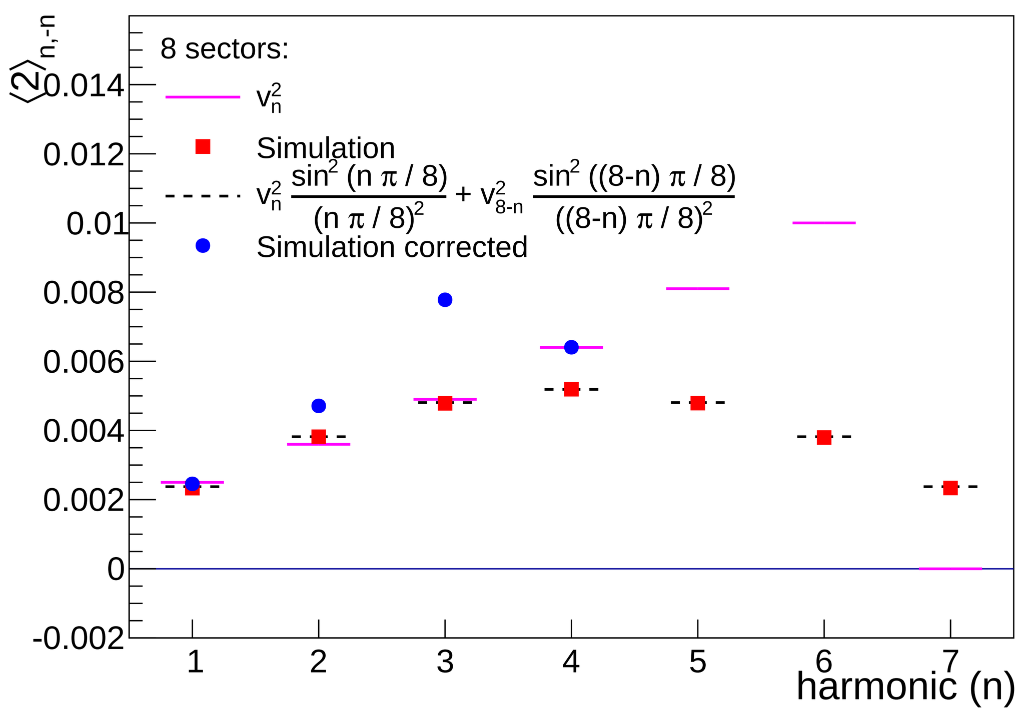
- Generic framework for multi-particle correlators.
- Exact and efficient evaluation.
- Requires only single pass over data.
- Includes acceptance and efficiency corrections.
- Recursive algorithms extend implementation to n-particle correlations.
- New observables proposed.

In depth analysis of biases

- Generic framework extended to differential flow.



- Possible biases from particle selection criteria in differential flow analyses.



- Biases due to finite detector granularity calculated.

The complex made simple

Average m-particle correlation in harmonics $n_1, n_2, \ldots, n_m$:

$$\langle m\rangle_{n_1,n_2,\ldots,n_m} \equiv \left\langle e^{i(n_1\varphi_{k_1}+n_2\varphi_{k_2}+\cdots+n_m\varphi_{k_m})}\right\rangle.$$

Factorization implies analytical mean value [1]:

$$\mu_{\langle m\rangle_{n_1,n_2,\ldots,n_m}} = v_{n_1}\cdots v_{n_m} e^{i(n_1\Psi_{n_1}+\cdots+n_m\Psi_{n_m})}.$$

Values estimated directly in single pass over data, using the weighted Q-vectors, $Q_{n,p} \equiv \sum_{k=1}^{M} w_k^p e^{in\varphi_k}$.
Equations given for the 2- to 4-particle correlators; Recursive algorithms for any $n-$particle correlators.
This establishes a wealth of new observables to probe non-linear effects of hydrodynamics, e.g,:

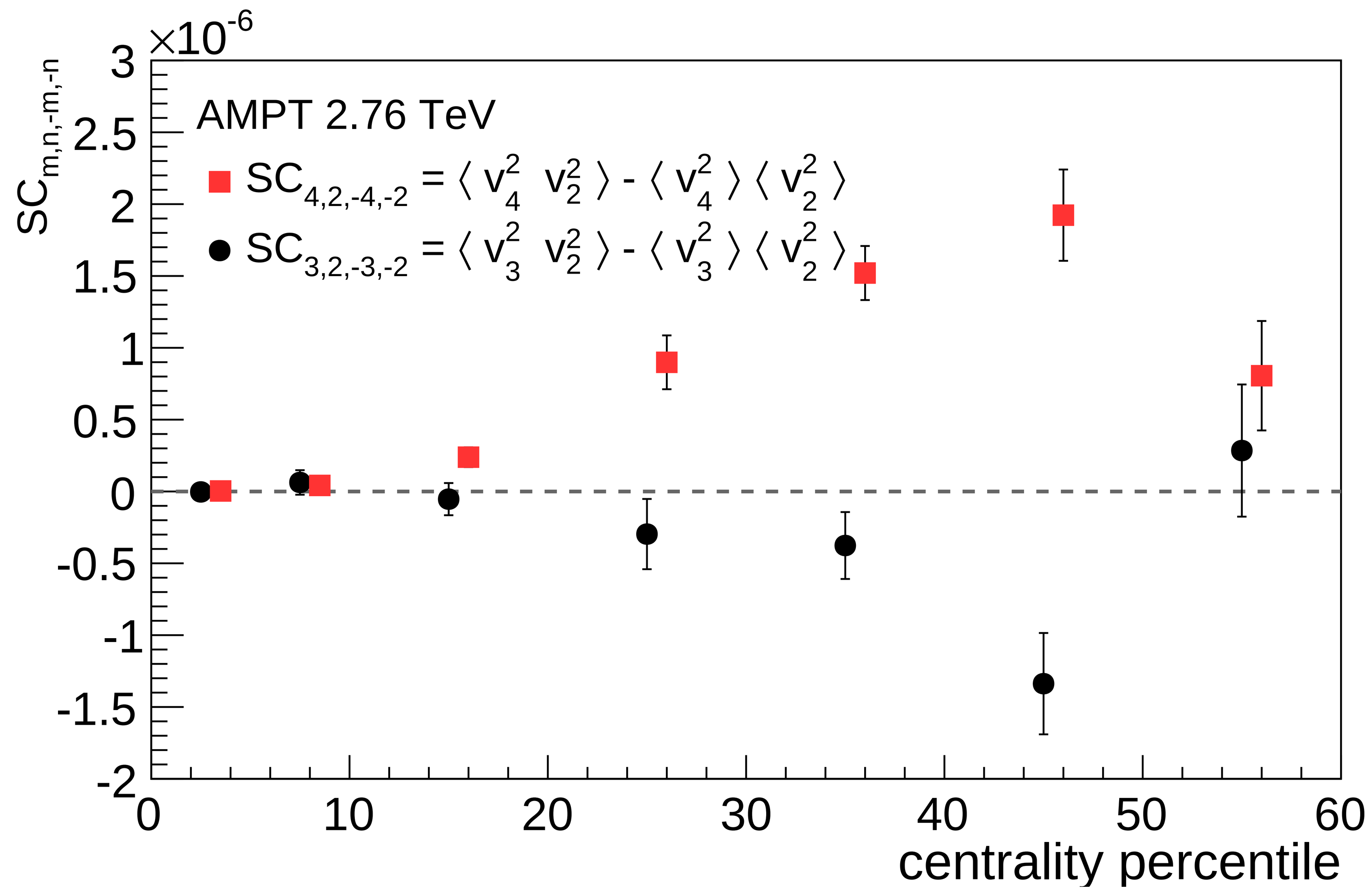
$$\langle\langle\cos(m\varphi_1 + n\varphi_2 - m\varphi_3 - n\varphi_4)\rangle\rangle,$$

which for $m \neq n$ has the isotropic parts of the 4-particle cumulant given by:

$$\langle\langle\cos(m\varphi_1 + n\varphi_2 - m\varphi_3 - n\varphi_4)\rangle\rangle_c = \langle v_m^2 v_n^2\rangle - \langle v_m^2\rangle\langle v_n^2\rangle \equiv \mathrm{SC}_{m,n,-m,-n}.$$

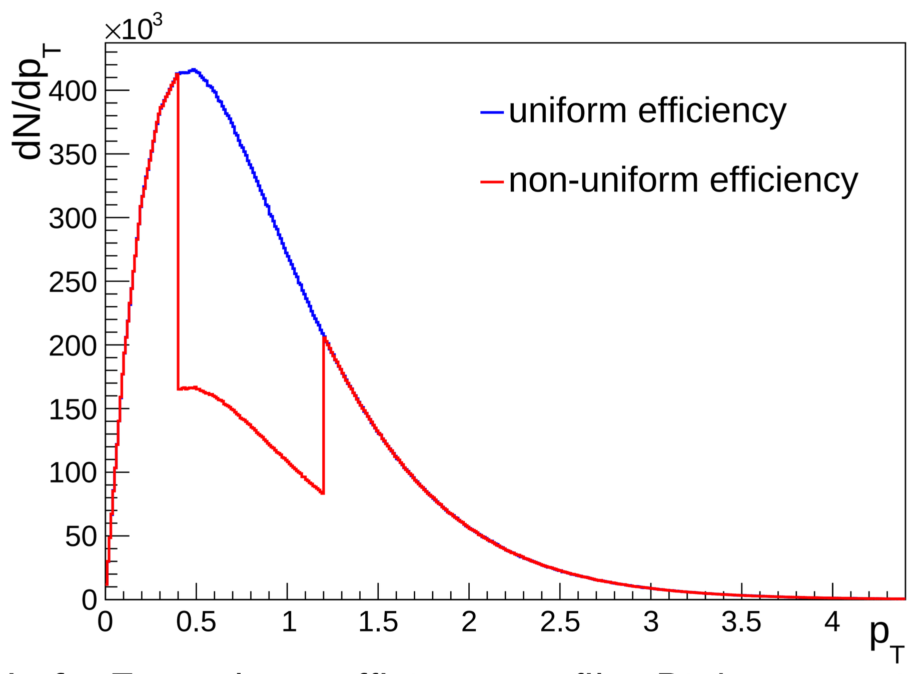
➠ C++ and Mathematica code at: `http://www.nbi.dk/~cholm/mcorrelations/`

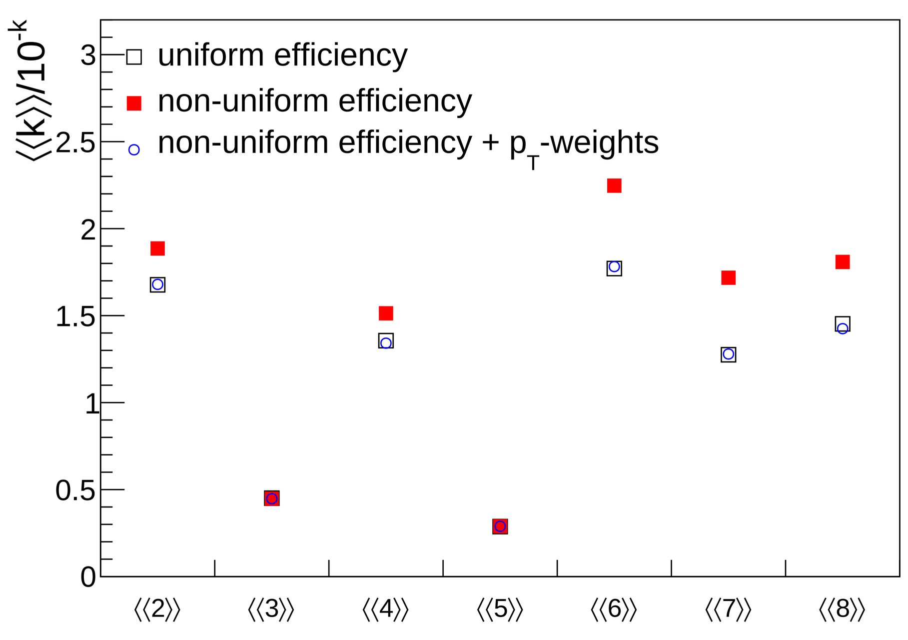
New observables - The Standard Candles



AMPT[2] with LHC tune[3] for new observables. AMPT predicts non-zero values for correlations of event-by-event fluctuations between v_2 and v_3 and between v_2 and v_4. New observables provide valuable information on non-linear hydrodynamic effects.

Using p_T-weights for efficiency and φ-weights for acceptance corrections





Left: Example p_T efficiency profile. Right: p_T-weights (blue circles) removes bias from efficiency (red squares), recovers input (black squares).

References and further information

References

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[2] Z. -W. Lin, C. M. Ko, B. -A. Li, B. Zhang and S. Pal, Phys. Rev. C **72** (2005) 064901 [nucl-th/0411110].

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