

Event-shape-dependent analysis of charm-anticharm correlations in simulations

Anikó Horváth^{1,2} together with Eszter Frajna¹, Róbert Vértesi¹
 Zimányi School Winter Workshop on Heavy Ion Physics, 2022.



1 Wigner Research Centre for Physics, MTA Centre of Excellence
 2 Eötvös Loránd University

The research was supported by NKFI-OKTA FK131979 and K135515, and 019-2.1.11-TÉT- 2019-00078, 2019-2.1.6-NEMZ KI-2019-00011 projects, and the Wigner Intern Programme

Event-shape-dependent analysis of charm-anticharm correlations in simulations



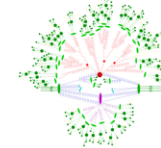
Zimányi School Winter Workshop on Heavy Ion Physics, 2022.

Anikó Horváth^{1,2} in collaboration with Eszter Frajna¹, Róbert Vértesi¹



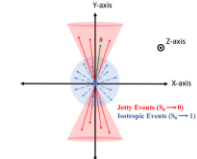
1. Motivations and goals

- Heavy quarks (e. g. charm) have a longer lifetime and are created in the early stages of the collision, can be used to track the strongly interacting substance in heavy ion collisions
- Smaller colliding systems provide an interesting probe (collectivity)
- Effect of the different creation processes on the correlation: FLC (flavor creation), FLX (flavor excitation), GSP (gluon splitting)
- How the different parton level processes change the correlation: MPI (multiparton interaction), ISR (initial state radiation), FSR (final state radiation)



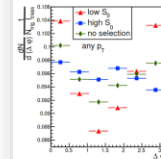
2. Methods of analysis

- 1 observed 2 particle c-c̄ azimuthal correlations with respect to event descriptor (N_{ch} , S_0 , ρ) cuts
- ρ - flatnecity [1]: $\rho = \frac{\sigma_{\text{PT}}^{\text{all}}}{(p_{\text{T}}^{\text{all}})^2}$. The distribution of p_{T} over the φ - η plane, separates isotropic and jetty events
- S_0 - sphericity: $S_0 = \frac{\pi^2}{4} \left(\frac{\sum_i |\vec{p}_{\text{T}i} \times \vec{n}|}{\sum_i p_{\text{T}i}} \right)^2$. Separates „pencil-like“ vs. spherical events
- N_{ch} - charged hadron multiplicity
- Simulated proton-proton collisions with PYTHIA8 at $\sqrt{s} = 13$ TeV

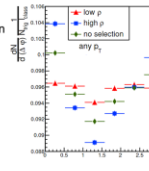


3. Correlation observations

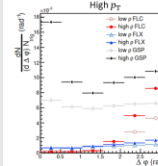
- Normalised with the integral of the given event descriptor range, used any p_{T} interval
- The ρ cut geometrically highlights the correlation peaks



- More jetty (low S_0) events give stronger correlation, more spherical (high S_0) events select more random correlation



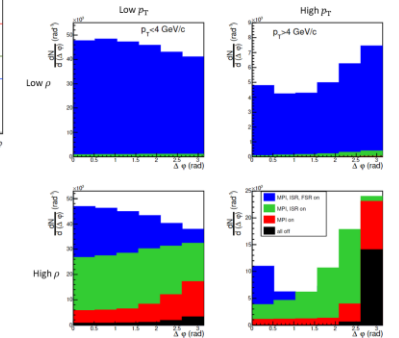
- Low N_{ch} cut gives sharper away-side peak, less background means more back-to-back correlations



- Sorted events by the trigger (c quark) creation processes: FLC, FLX, GSP
- Used the high p_{T} interval
- Sharp away-side peak from FLC, and FLX also adds to the away-side peak
- The flatnecity cut separates GSP from random correlation (low ρ)

4. Parton level processes

- Turned on and off the MPI, ISR and FSR
- MPI, ISR adds to the away-side peak and random correlations
- The near-side peak comes from FSR
- Flatnecity cut isolates FSR from ISR and MPI almost perfectly



5. Conclusion, future plans

- Flatnecity can provide a good insight into the behaviour of pp collisions, could be used to separate processes coming from final state radiation
- The next step can be analysing the correlation of D mesons (for example through D^0 - \bar{D}^0 correlations) [2]
- ALICE3 experiment provides an opportunity to compare simulations of D meson correlations with experimental data [3]

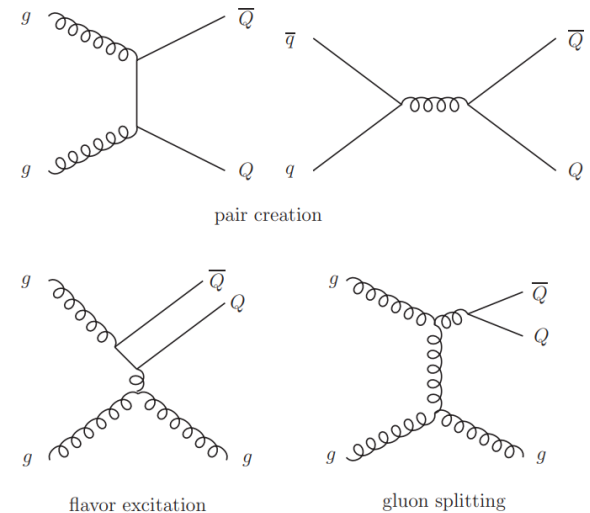
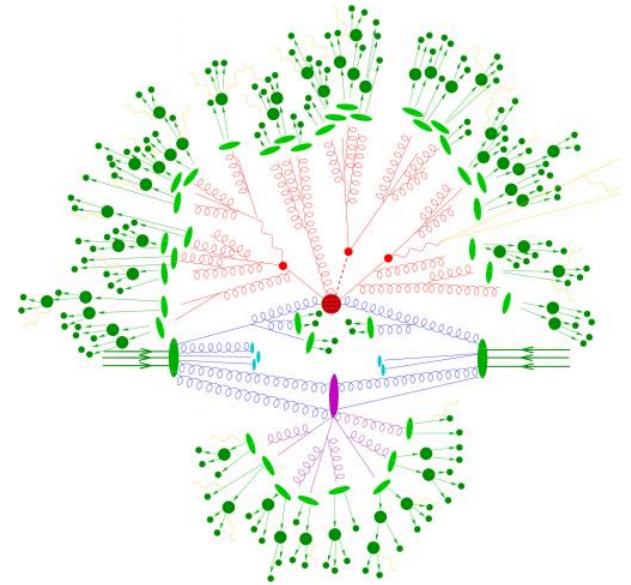
Acknowledgement: The research was supported by NKFI-OKTA FK131979 and K135515, 019-2.1.11-TÉT- 2019-00078, 2019-2.1.6-NEMZ KI-2019-00011 projects, and the Wigner Internship Programme

1: Wigner Research Centre for Physics, MTA Centre of Excellence 2: Eötvös Loránd University 3: Budapest University of Technology and Economics

[1] A. Ortiz, G. Paic, A look into the “tedgehog” events in pp collisions using a new event shape – flatnecity arXiv (2022) [2] S. Acharya et al. Azimuthal correlations of prompt D mesons with charged particles in pp and p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV EPIC 80 (2020) 979 [3] Alice Collaboration, Letter of intent for ALICE 3: A next-generation heavy-ion experiment at the LHC (2022)

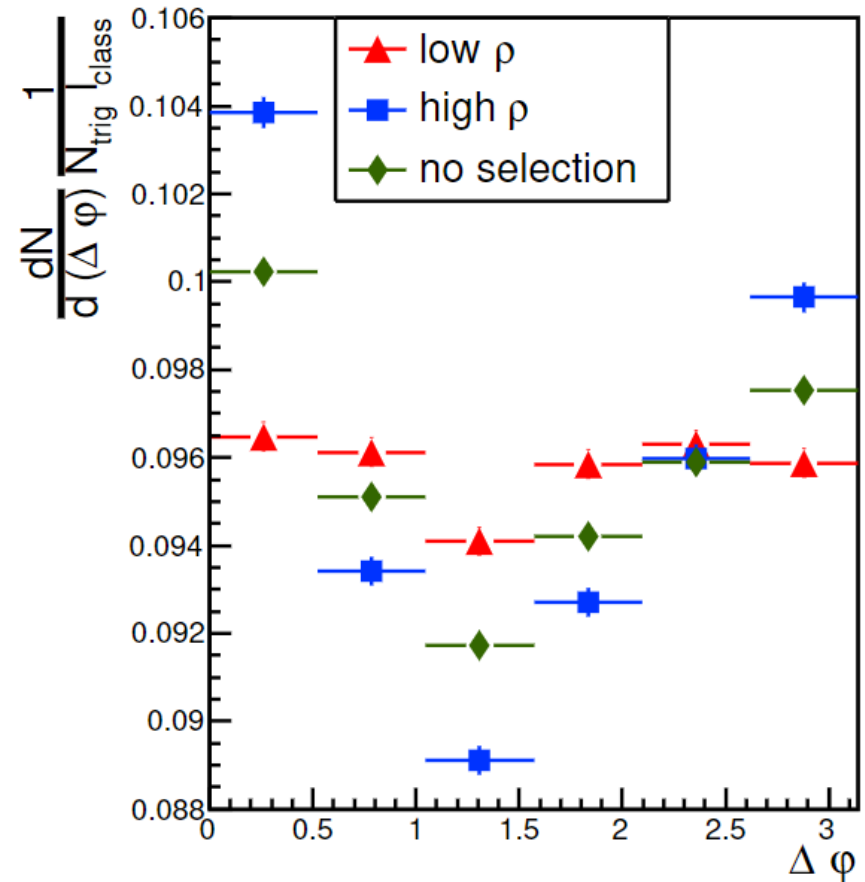
Motivation

- In heavy ion collisions, heavy quarks (charm) can be used to track the behaviour of the collision (long lifetime)
- Smaller collision systems provide an interesting probe (collectivity)
- Effects of parton level processes (multiparton interaction (MPI), initial (ISR) and final state radiation (FSR))
- Effect of quark creation process on the correlation: flavor creation, flavor excitation, gluonsplitting



Methods

- I used 2 particle c - \bar{c} azimuthal correlations with respect to event descriptors (N_{ch} , S_0 , ρ)
- Flatnecity: the distribution of p_T in the φ - η plane
- ρ highlights the correlation peaks
- Simulated pp (proton-proton) collisions with PYTHIA8 ($\sqrt{s} = 13$ TeV)



$$\rho = \frac{\sigma_{p_T}^{\text{cell}}}{\langle p_T^{\text{cell}} \rangle}$$

Parton level processes

- Low: $p_T < 4$ GeV/c,
High: $p_T > 4$ GeV/c
- Hard process, MPI, ISR:
away-side peak, random
correlations
- FSR: near-side peak
- **Flatnecity cut isolates
FSR from ISR and MPI
both at low and high p_T**

