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

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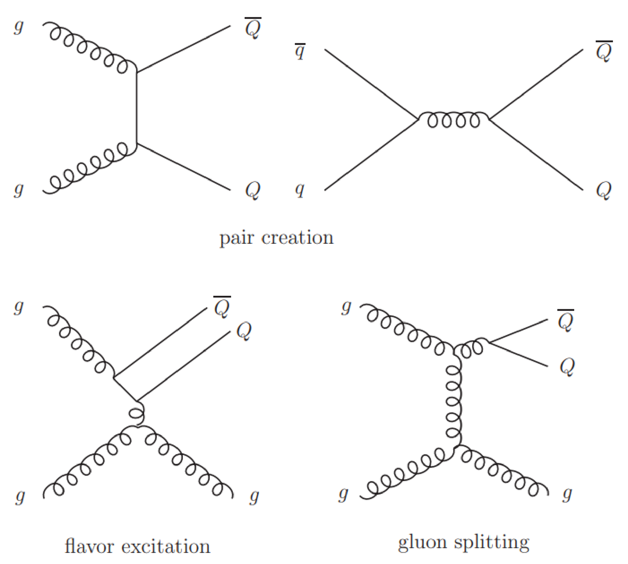
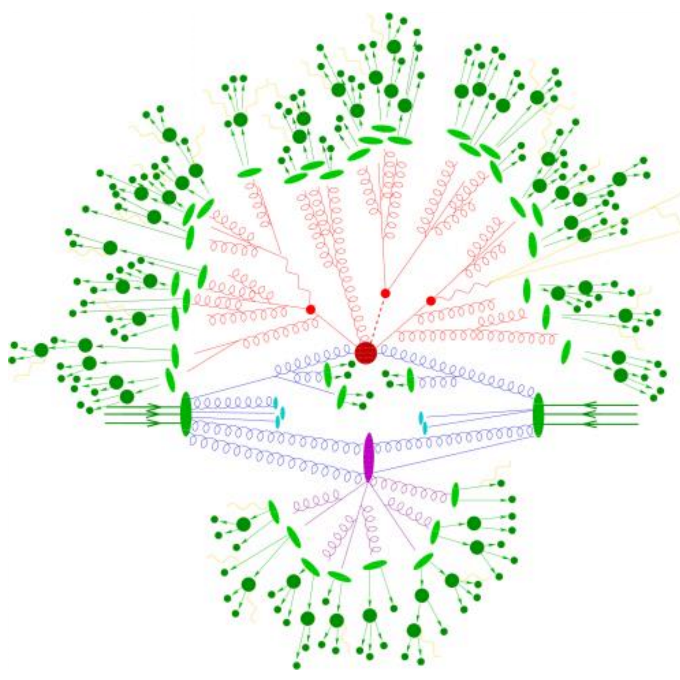
1. Motivations and goals

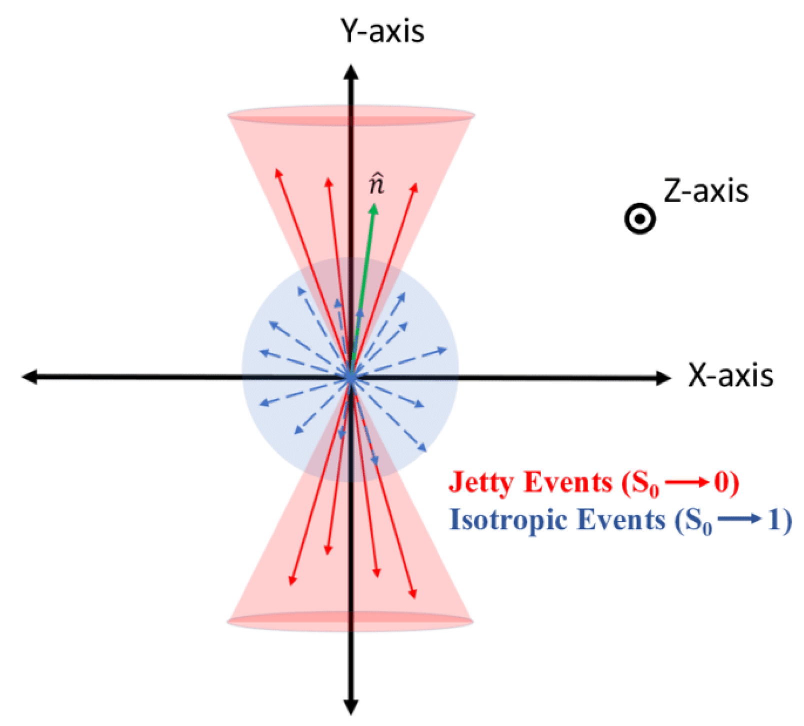
- Heavy quarks (e. g. charm) have a longer lifetime and are created in the early stages of the collision, can be used to track the strongly interacting substance in heavy ion collisions
- Smaller colliding systems provide an interesting probe (collectivity)
- Effect of the different creation processes 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)





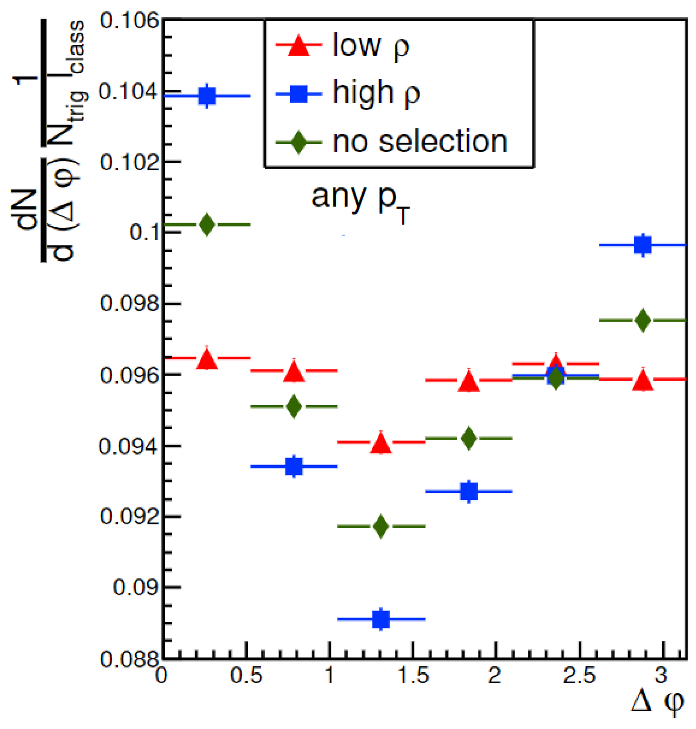
2. Methods of analysis

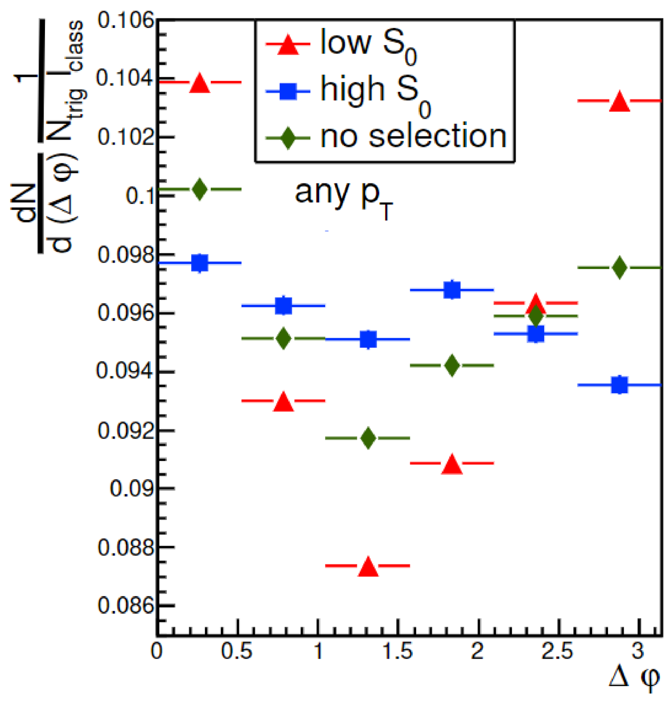
- I observed 2 particle c-$\bar{c}$ azimuthal correlations with respect to event descriptor (N_{ch}, S_0, ρ) cuts
- ρ – flatenicity [1] : $\rho = \frac{\sigma_{p_T}^{cell}}{\langle p_T^{cell} \rangle}$ The distribution of p_T over the φ-η plane, separates isotropic and jetty events
- S_0 - spherocity : $S_0 = \frac{\pi^2}{4}\left(\frac{\sum_i |\vec{p_{T_i}} \times \vec{n}|}{\sum_i \vec{p_{T_i}}}\right)^2$ Separates „pencil-like" vs. spherical events
- N_{ch} - charged hadron multiplicity
- Simulated proton-proton collisions with PYTHIA8 at $\sqrt{s} = 13$ TeV



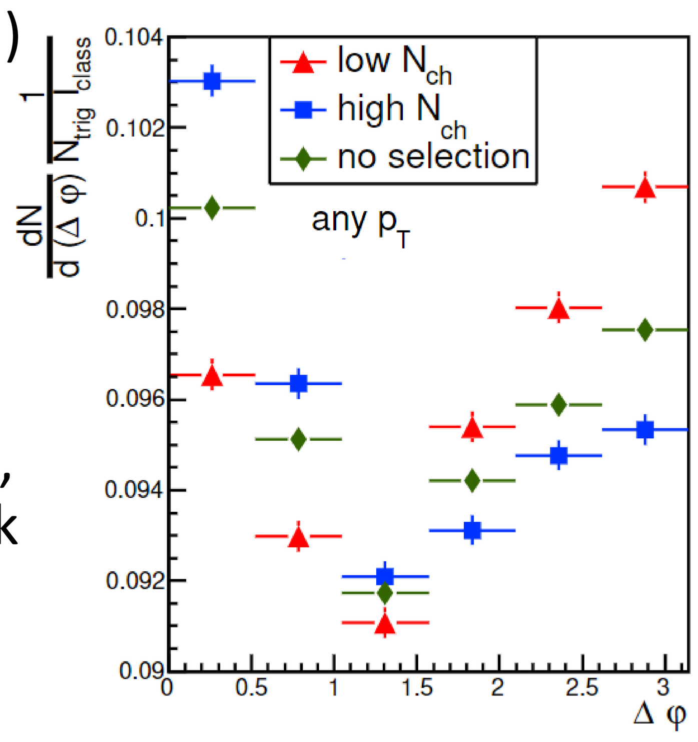
3. Correlation observations

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



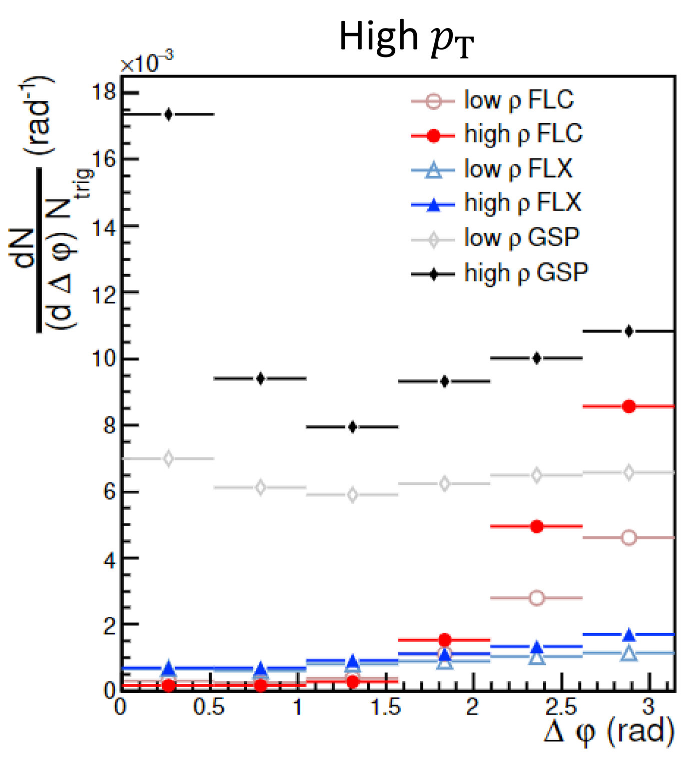


- More jetty (low S_0) events give stronger correlation, more shperical (high S_0) events select more random correlation



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

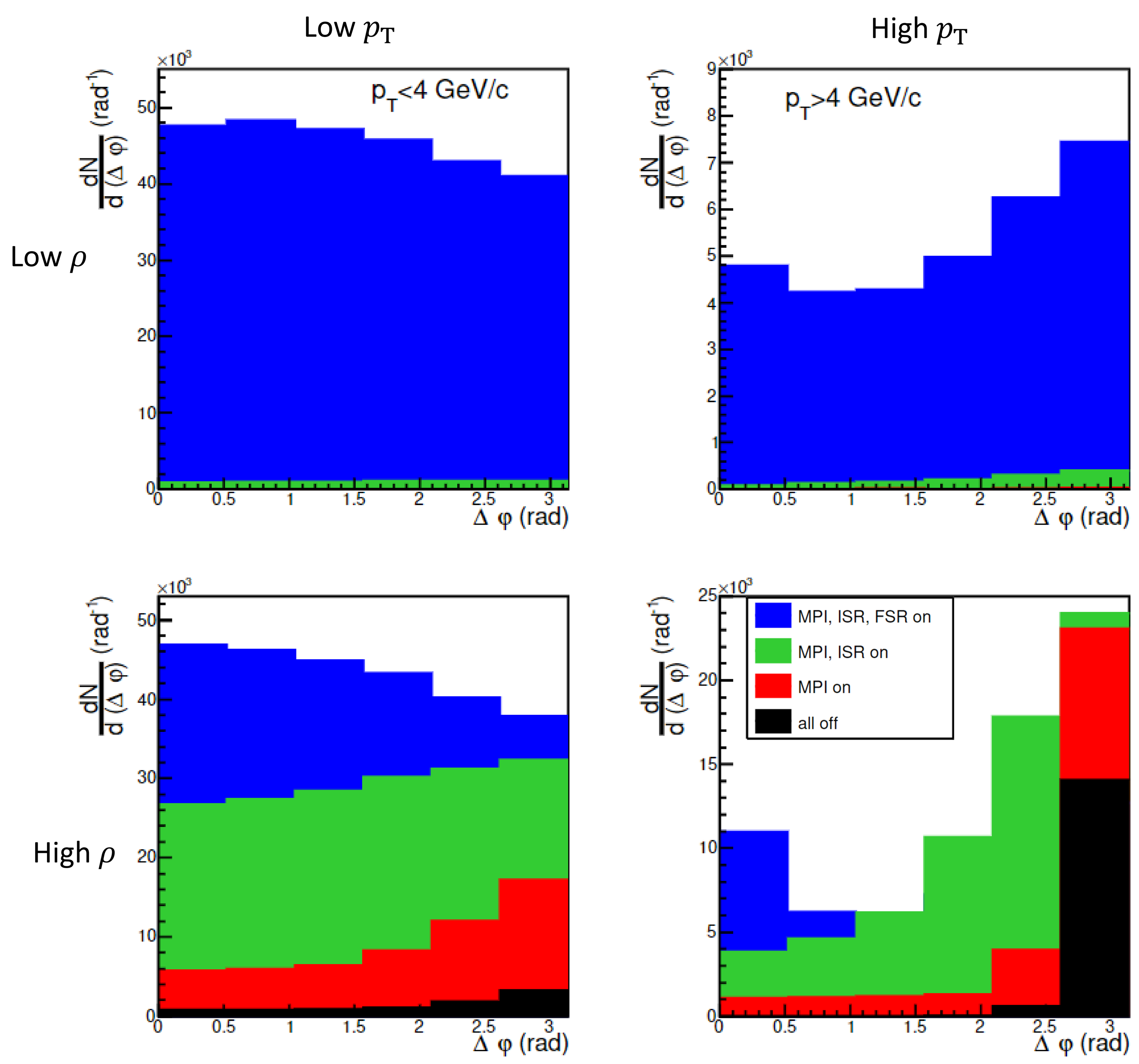
High p_T



- 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 flatenicity 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
- **Flatenicity cut isolates FSR from ISR and MPI** almost perfectly



5.Conclusion, future plans

- Flatenicity 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-$\overline{D^0}$ correlations) [2]
- ALICE3 experiment provides an opportunity to compare simulations of D meson correlations with experimental data [3]

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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 "hedgehog" events in pp collisions using a new event shape – flatenicity 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 EPJC 80 (2020) 979 [3] Alice Collaboration, Letter of intent for ALICE 3: A next-generation heavy-ion experiment at the LHC (2022)