Measurement of D^0 Meson-Tagged Jet Generalized Angularities in Au+Au Collisions at $\sqrt{s_{NN}} = 200$ GeV at STAR

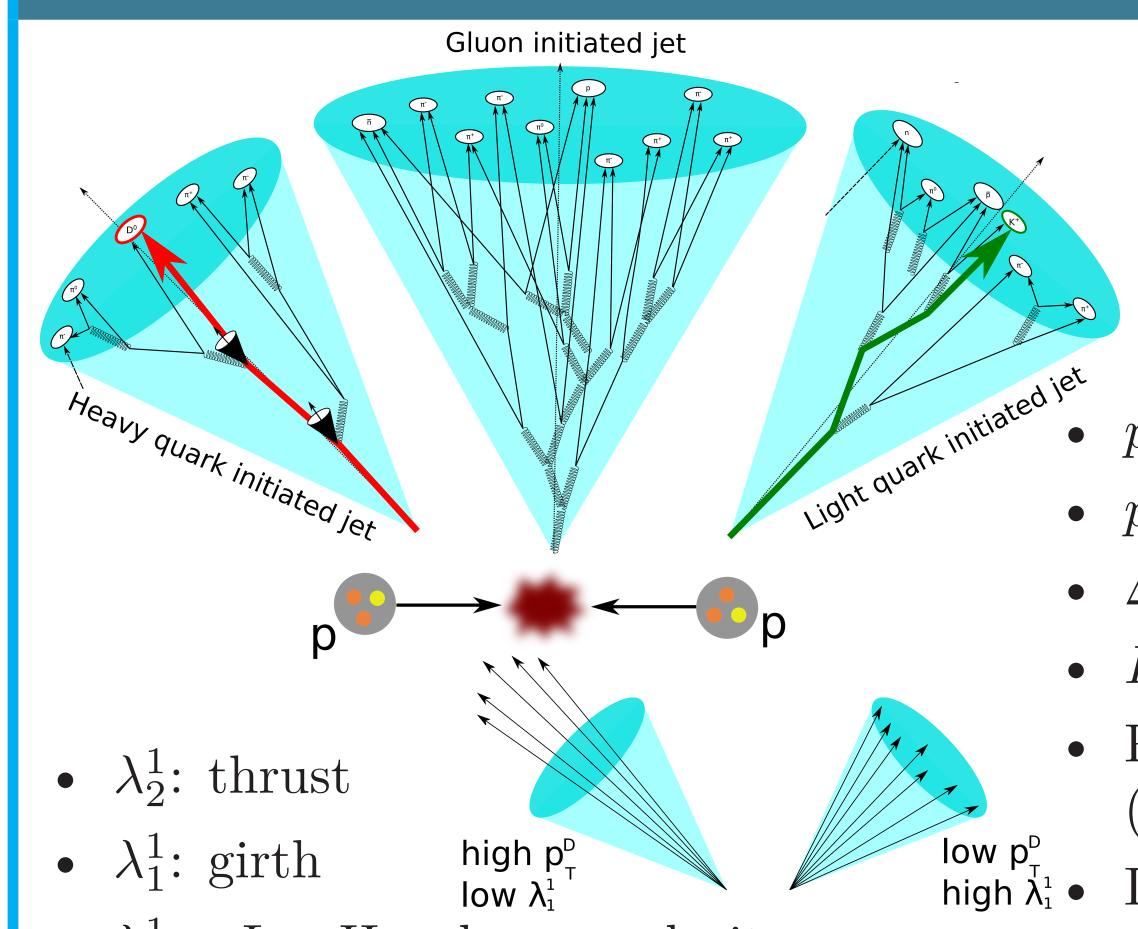
Ondřej Lomický (for the STAR collaboration)

Faculty of Nuclear Sciences and Physical Engineering
Czech Technical University in Prague

Introduction

The Quark-Gluon Plasma (QGP) produced in Heavy-Ion (HI) collisions can be studied using hard probes, such as D^0 meson-tagged jets created at early stage of the collision. The jet yield and its substructure are modified by interactions with the medium, compared to vacuum propagation. This phenomenon is known as jet quenching. The generalized angularities λ_α^κ characterize the jet substructure. In this contribution, we report the measurement of D^0 meson-tagged jets in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV by the STAR experiment at RHIC. We present for the first time distributions of different angularities, such as girth λ_1^1, thrust λ_2^1, momentum dispersion $\sqrt{\lambda_0^2}$, or Les Houches angularity $\lambda_{0.5}^1$. These results could help distinguish between different models of jet quenching and in-medium energy loss of heavy flavor quarks.

Generalized angularities



- λ_2^1: thrust
- λ_1^1: girth
- $\lambda_{0.5}^1$: Les Houches angularity
- $\lambda_0^2 = (p_T^D)^2$: momentum dispersion

$$\lambda_\alpha^\kappa = \sum_{i\in\mathrm{Jet}} \overbrace{\left(\frac{p_{\mathrm{T},i}}{p_{\mathrm{T,Jet}}}\right)^\kappa}^{\text{soft/hard}} \overbrace{\left(\frac{\Delta R_{\mathrm{Jet},i}}{R}\right)^\alpha}^{\text{collinearity sensitive}}$$

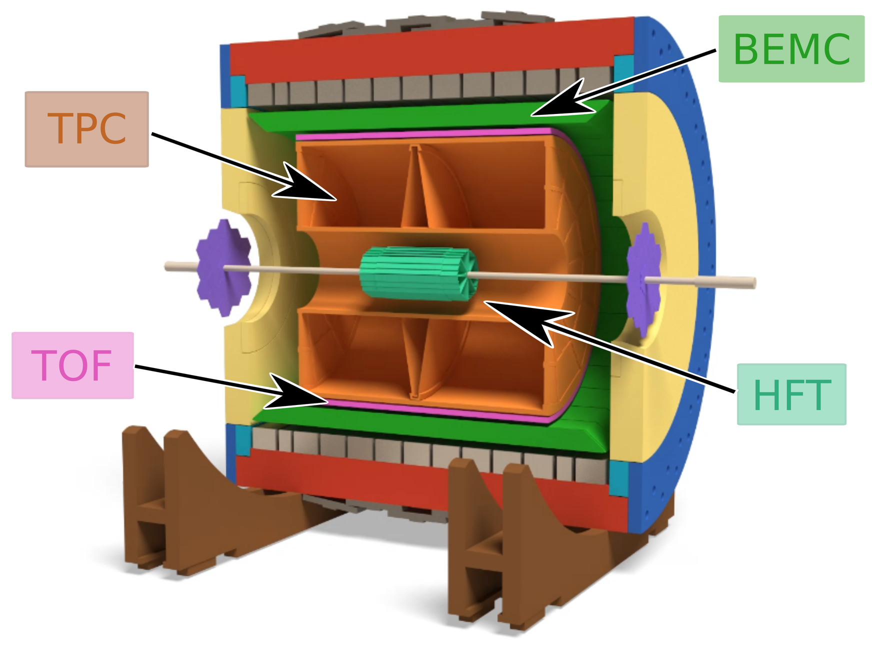
- $p_{\mathrm{T},i}$: transverse momentum of i-th jet constituent
- $p_{\mathrm{T,Jet}}$: inclusive jet transverse momentum
- $\Delta R_{\mathrm{Jet},i}$: distance of i-th constituent to the jet axis
- R: jet resolution parameter
- Parameters α and κ tune angularity sensitivity (mass vs Casimir color effects)
- IRC safe observable for parameters $\kappa = 1$, $\alpha > 0$
- Study of **modification of generalized angularities of heavy-flavor jets in HI collisions**

STAR experiment

Run 14: Au+Au $\sqrt{s_{\mathrm{NN}}} = 200$ GeV, 900M events

Time Projection Chamber: tracking and PID ($\mathrm{d}E/\mathrm{d}x$, $\vec{p}$)

Barrel Elmag. Calorimeter: neutral particle energy



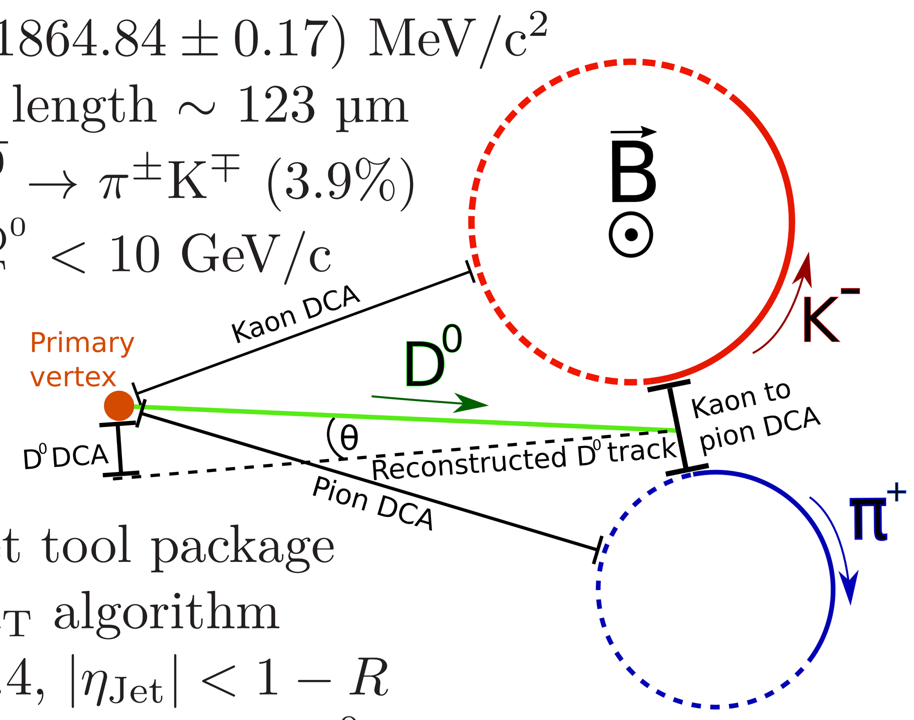
Time-of-Flight Detector: PID ($1/\beta$)

Heavy-Flavor Tracker: topological rec. of HF hadrons

D^0 meson and jet reconstruction

D^0 meson

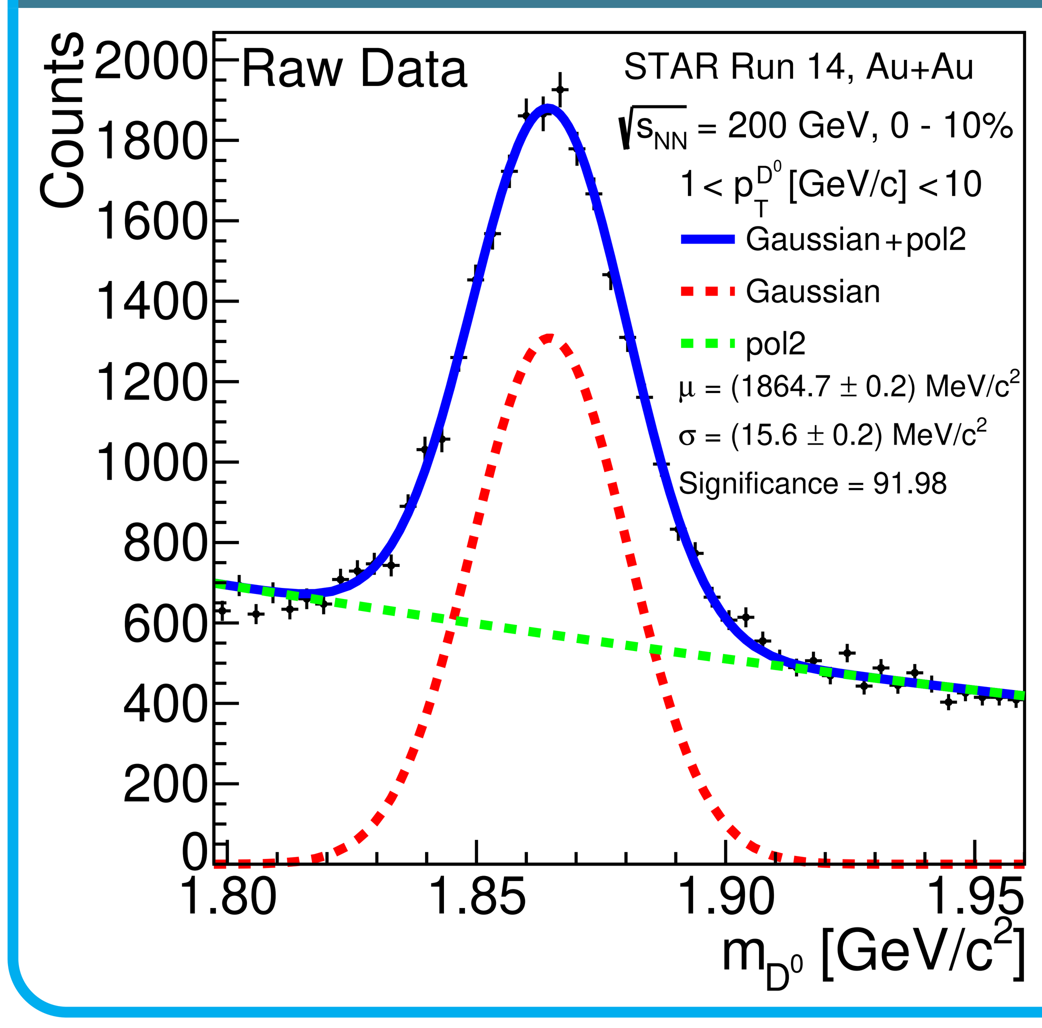
- $m = (1864.84 \pm 0.17)$ MeV/c^2
- Decay length ~ 123 μm
- $\mathrm{D}^0/\overline{\mathrm{D}^0} \to \pi^\pm \mathrm{K}^\mp$ (3.9%)
- $1 < p_\mathrm{T}^{\mathrm{D}^0} < 10$ GeV/c



D^0 jet

- FastJet tool package
- Anti-k_T algorithm
- $R = 0.4$, $|\eta_{\mathrm{Jet}}| < 1 - R$
- Inclusive jets with D^0 as constituent
- Iterative Constituent Subtraction (ICS) applied to soft background JHEP 08 (2019) 175

Signal-weighted distribution extraction



$_s\mathcal{P}lot$ method

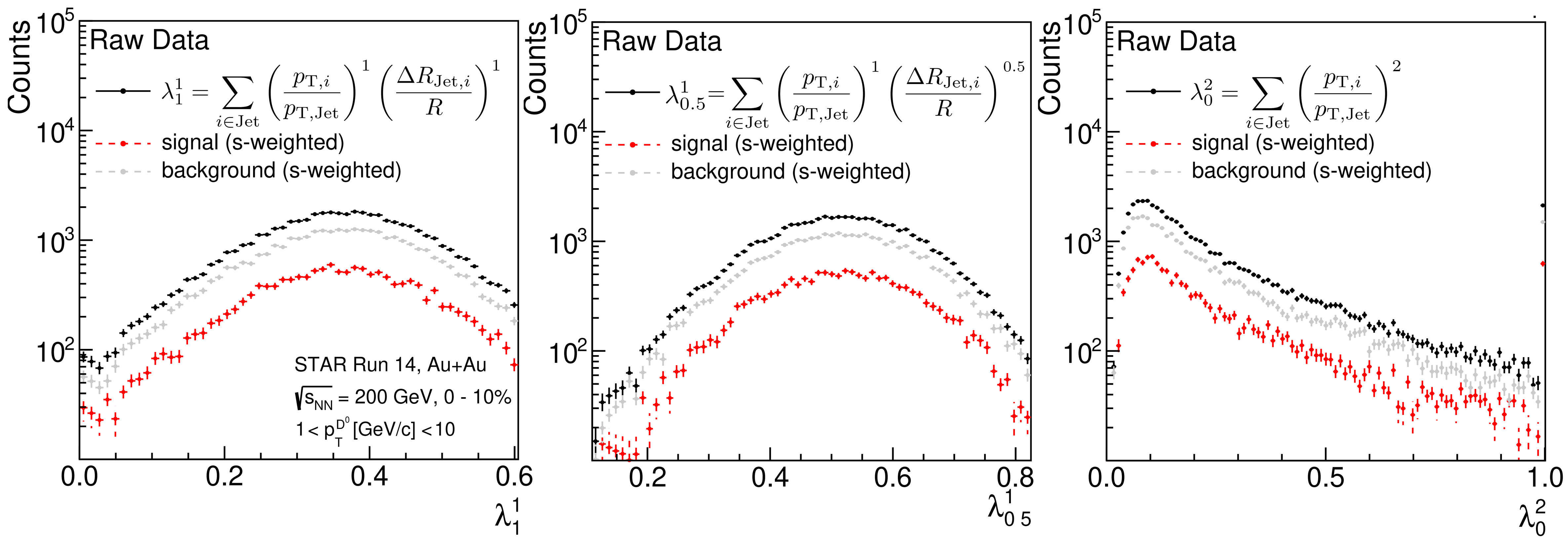
$$_s\mathcal{P}_n(m_{\mathrm{D}^0,i}) = \frac{\mathbb{V}_{n\mathrm{S}} f_\mathrm{S}(m_{\mathrm{D}^0,i}) + \mathbb{V}_{n\mathrm{B}} f_\mathrm{B}(m_{\mathrm{D}^0,i})}{N_\mathrm{S} f_\mathrm{S}(m_{\mathrm{D}^0,i}) + N_\mathrm{B} f_\mathrm{B}(m_{\mathrm{D}^0,i})}$$

- Discriminating variable: m_{D^0}, control variables: λ_α^κ
- n: signal (S) or background (B) weight component
- $f_{\mathrm{S/B}}(m_{\mathrm{D}^0})$: S/B contribution pdf
- $N_{\mathrm{S/B}}$: S/B yield, $\mathbb{V}_{n\mathrm{S/B}}$: covariance matrix
- $_s\mathcal{P}_n(m_{\mathrm{D}^0,i})$: s-weight for each jet
- Simple application of efficiency correction $\varepsilon(m_{\mathrm{D}^0,i})$

$$_s\mathcal{P}_n(m_{\mathrm{D}^0,i}) \to \frac{_s\mathcal{P}_n(m_{\mathrm{D}^0,i})}{\varepsilon(m_{\mathrm{D}^0,i})}$$

Results

- Raw λ_α^κ distributions of D^0 jets obtained after ICS and $_s\mathcal{P}lot$ method
- $_s\mathcal{P}_\mathrm{S}$ weights: D^0 signal contribution, $_s\mathcal{P}_\mathrm{B}$ weights: D^0 combinatorial background contribution



Conclusions and outlook

We presented the recent progress on generalized angularities of D^0 meson-tagged jets in Au+Au collisions at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV measured by the STAR experiment.

Ongoing and future steps:

- 2D Bayesian unfolding of jet p_T and λ_α^κ
- Nuclear modification factor R_{CP} as a function of generalized angularities of heavy-flavor jets in heavy-ion collisions
- Estimating systematic uncertainties

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CTU CZECH TECHNICAL UNIVERSITY IN PRAGUE

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