r_c studies in pp collisions (2017)

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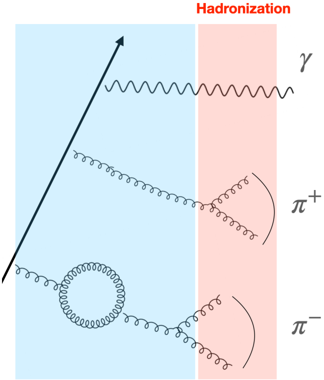
Internal jet structure

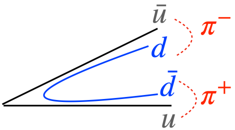
- Access the **dynamics of hadronization**;
- Charge-energy **correlation for Leading (L) and Next-to-Leading particles (NL)**.



Parton shower evolution + non-perturbative gluon splitting

Charge-energy correlation

- Compare the number of same-charge particles $(h_1 h_2)$ to opposite-charge particles $(h_1 \overline{h}_2)$
- **Access to the "string-like hadronization"**.



Observable:

$$r_c(X) = \frac{\mathrm{d}\sigma_{h_1 h_2}/\mathrm{d}X - \mathrm{d}\sigma_{h_1 \overline{h_2}}/\mathrm{d}X}{\mathrm{d}\sigma_{h_1 h_2}/\mathrm{d}X + \mathrm{d}\sigma_{h_1 \overline{h_2}}/\mathrm{d}X}$$

where h1 (L) ,h2 (NL) $\in (\pi^{\pm}, K^{\pm}, p)$

Reference

- [Y-T. Chien *et al.*, Phys Rev D.105.L051502]

STAR data analysis

- **pp collisions** at $\sqrt{s} = 500$ GeV;
- **Analyzed pico data in 2017**;
- **Using FastJet library**:
  - Anti-$k_{\perp}$ algorithm;
  - $R^{\text{Jets}} = 0.4$;
  - $p_{\perp}^{\text{Jet}} > 10$ GeV.

Cuts

Events

- $-90 < V_z < 90$ cm

Tracks and towers

- $-1 < \eta^{\text{track}} < 1$
- $2 < p_{\perp}^{\text{track}} < 30$ GeV
- NHitsFracMin $= 0.51$
- DcaMax $= 1$
- NHitsMin $= 15$
- $2 < E_{\perp}^{\text{tower}} < 30$ GeV

Relevant kinematic variables

Formation time

$$t_f = \frac{2z(1-z)P}{k_\perp^2}$$

- P: total momentum of L and NL particles;
- $k_\perp$: relative transverse momentum between L and NL particles;
- z: momentum fraction of NL particle.

Goals

- **Charge-energy correlation with** t_f for pions, kaons and protons;
- Probe **the flavor dependence of the hadronization process** inside a jet.

PYTHIA simulation

PYTHIA tunning

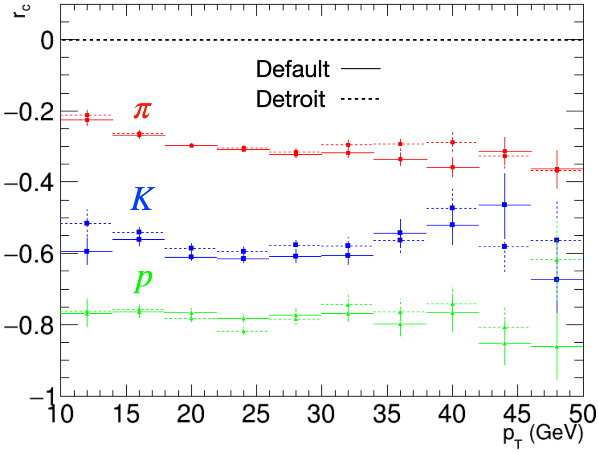
- Detroit tunning from [2110.09447]

Tuning Parameter	Default	Detroit
MultipartonInteractions:pT0Ref	2.28 GeV	1.40 GeV
MultipartonInteractions:ecmPow	0.215	0.135
MultipartonInteractions:coreRadius	0.4	0.56
MultipartonInteractions:coreFraction	0.5	0.78
ColourReconnection:range	1.8	5.4
PDF:pSet	13	17
MultipartonInteractions:ecmRef	7 TeV	200 GeV
MultipartonInteractions:bprofile	3	2

- Impact on the r_c calculation?

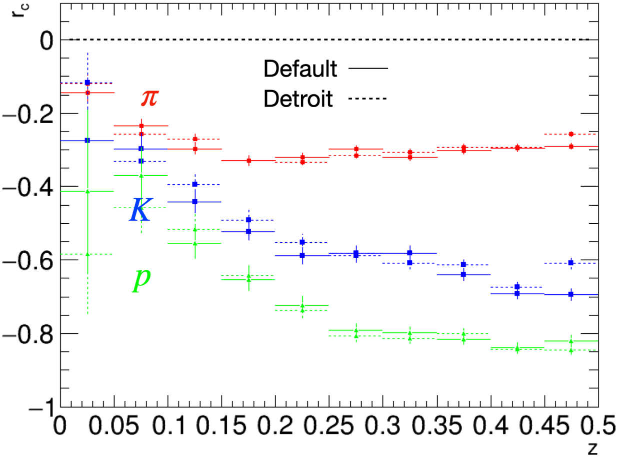
PYTHIA: $p_\perp$ jet dependence

pp collisions at $\sqrt{s}$ = 500 GeV



PYTHIA: z dependence

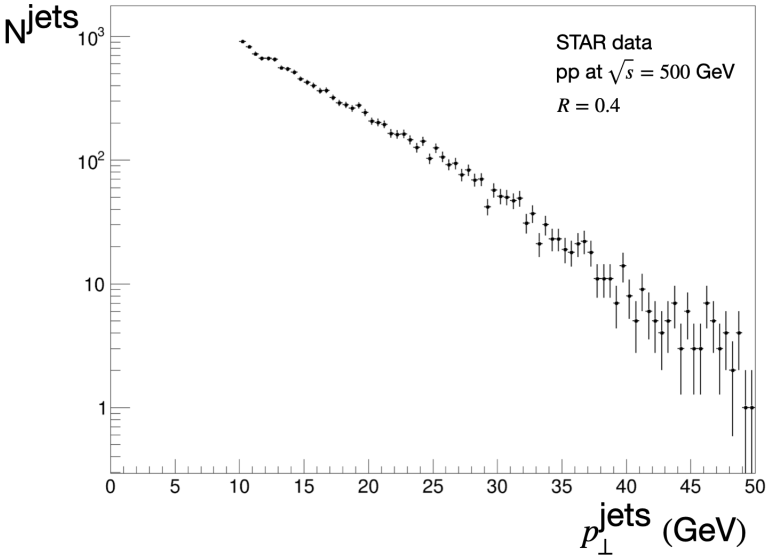
pp collisions at $\sqrt{s} = 500$ GeV



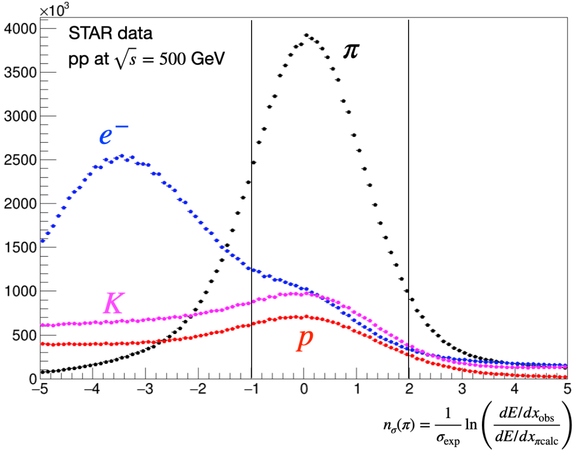
- **No impact of the tunning** on the r_c observable.

2017 data analysis

Transverse momentum jets distribution

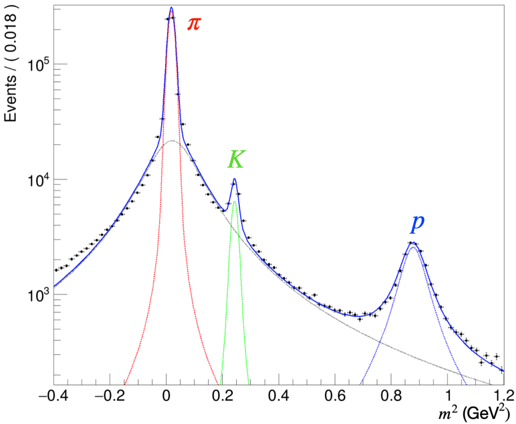


Hadrons separation I



- **Cut: mainly pions** for -1 $< n_\sigma <$ 2;
- $m^2 = p^2\left(\beta^{-2} - 1\right)$ from TOF but $p_\perp > 2$ GeV large errors;
- Most $p_\perp^{\text{Jets}} > 10$ GeV have $p_\perp^{\text{track}} > 2$ GeV.

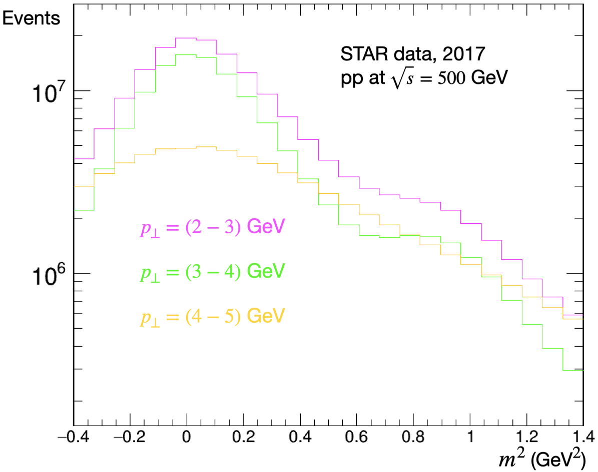
All $p_\perp^{\text{track}}$:



- **Fit using a multi-Voigt profile**;
- But for $p_\perp^{\text{Jets}} > 10$ GeV, $p_\perp^{\text{track}} > 2$ GeV.

Hadrons separation III

$p_\perp^{\text{track}} \geqq 2$ GeV:



- The resolution is very bad: how seperate hadrons?

Analysis method

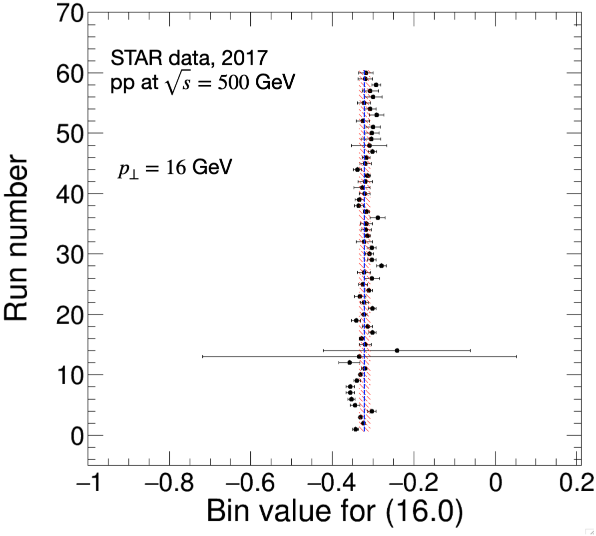
Data access

- pp 500 GeV, 2017 data;
- 94 repositories;
- Each repository contains a list of runs (2896 in total);
- **Simultaneous analysis of 94 repositories.**

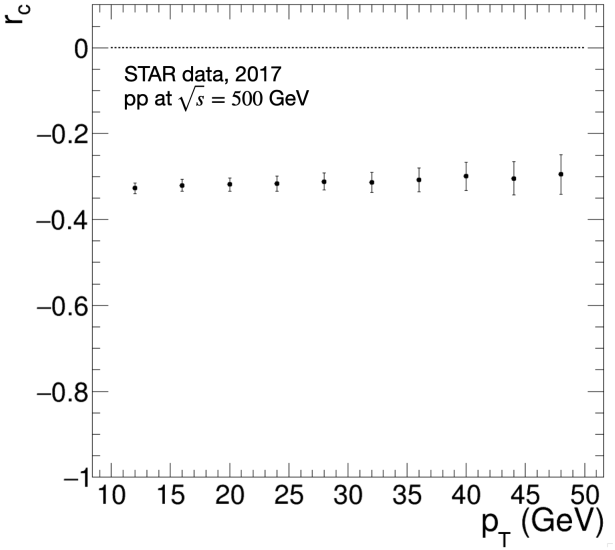
Data processing

- For each bin, extract the value for each repository;
- Calculation of the mean value for each bin;
- Calculation of the error band (normalized by $1/\sigma_i$);
- **Plot the mean distribution with the error band.**

A bin example

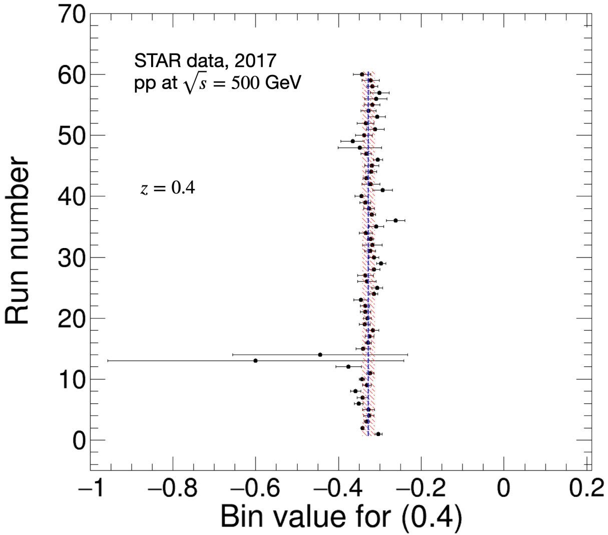


Mean value for all runs



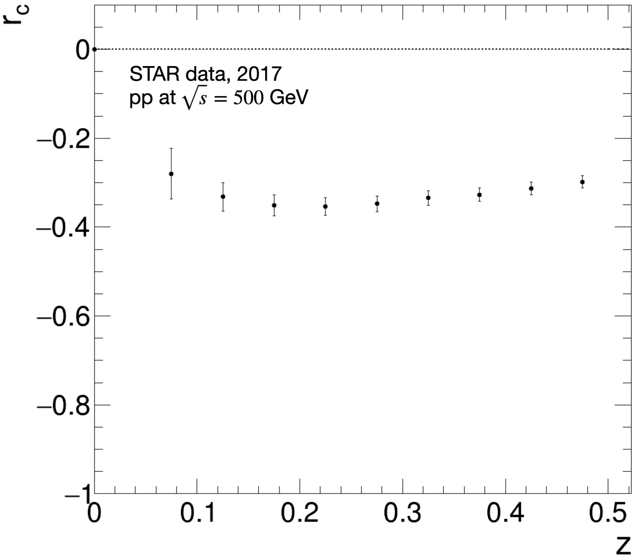
z dependence - run by run

A bin example



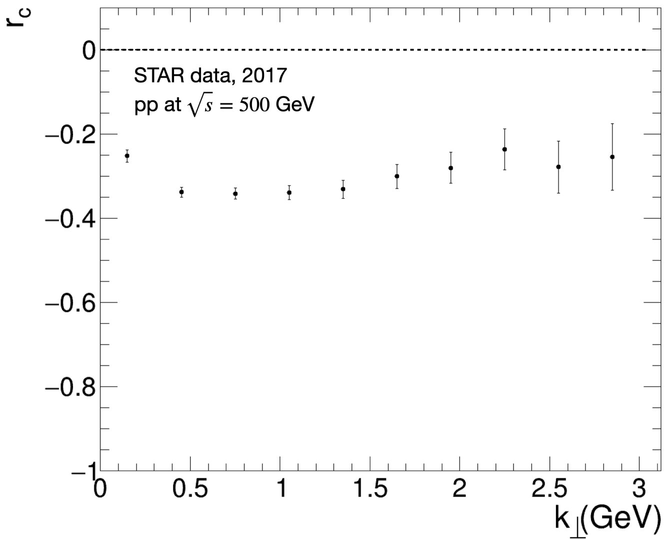
z dependence - all runs

Mean value for all runs

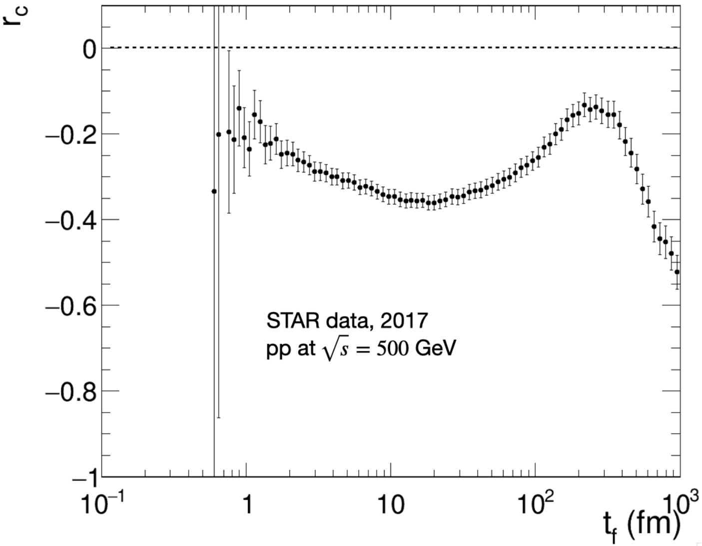


$k_\perp$ dependence - all runs

Mean value for all runs

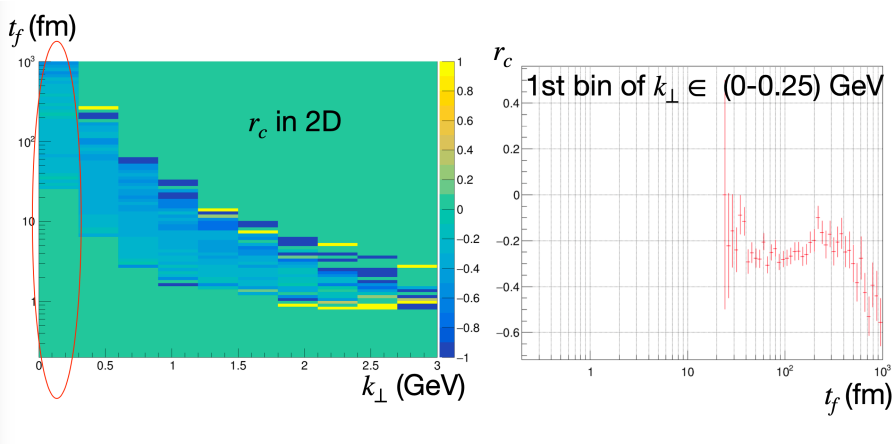


Mean value for all runs



$(k_\perp, t_f)$ dependence

Just few runs to check the peak at large t_f

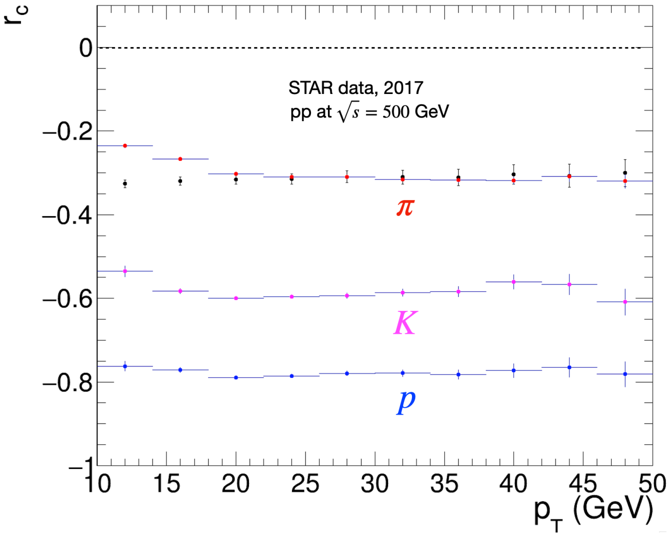


- Peak arround $t_f \sim (100 - 1000)$ fm, related to small $k_\perp \lesssim 0.5$ GeV;
- **Investigation still ongoing: checking of small angles.**

PYTHIA simulations vs data

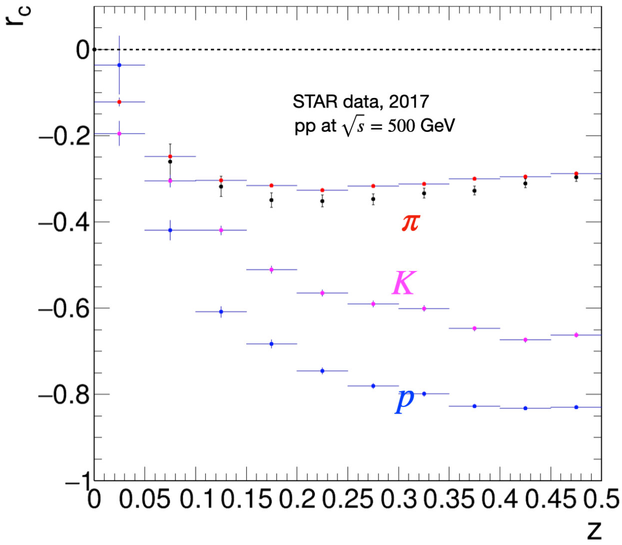
$p_\perp$ dependence - data vs PYTHIA

PYTHIA: Detroit tunning



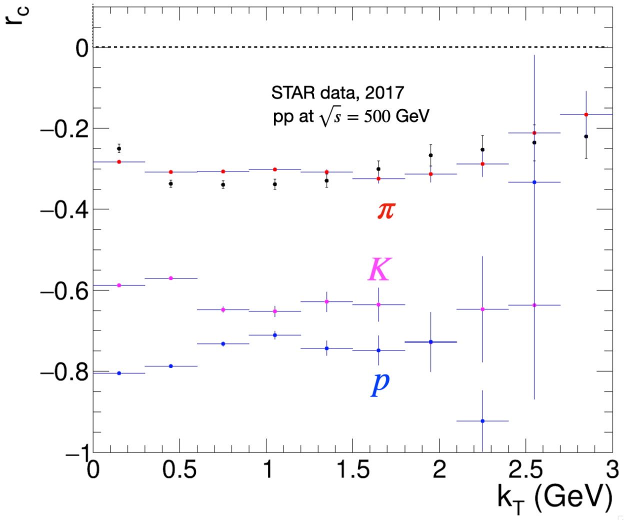
z dependence - data vs PYTHIA

PYTHIA: Detroit tunning

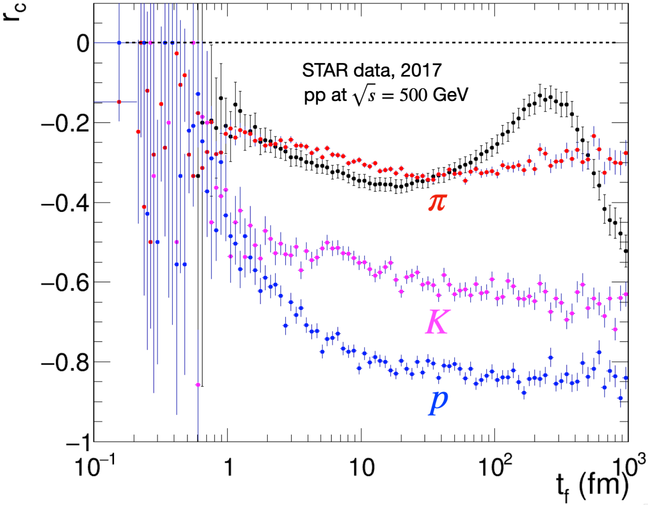


k_T dependence - data vs PYTHIA

PYTHIA: Detroit tunning



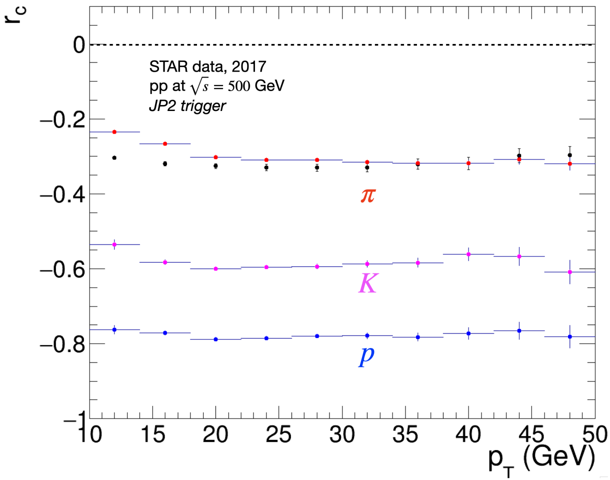
PYTHIA: Detroit tunning



PYTHIA simulations vs data (+ JP2 trigger)

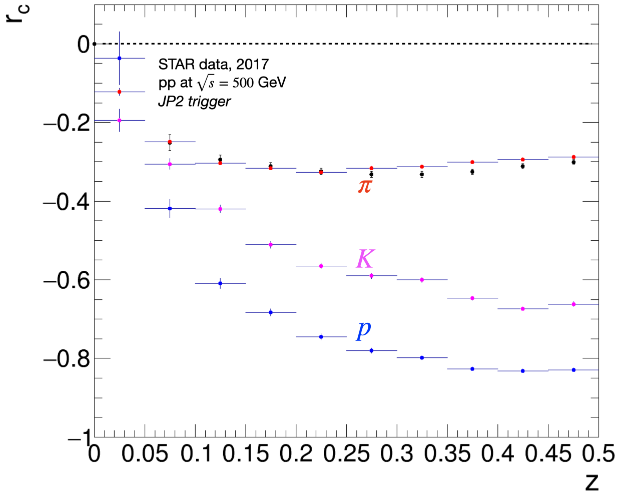
$p_\perp$ dependence - data vs PYTHIA

PYTHIA: Detroit tunning
STAR data: analysis cut + JP2 trigger



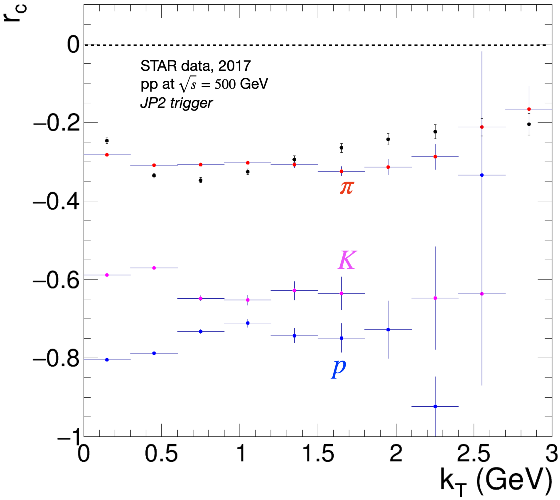
z dependence - data vs PYTHIA

PYTHIA: Detroit tunning
STAR data: analysis cut + JP2 trigger



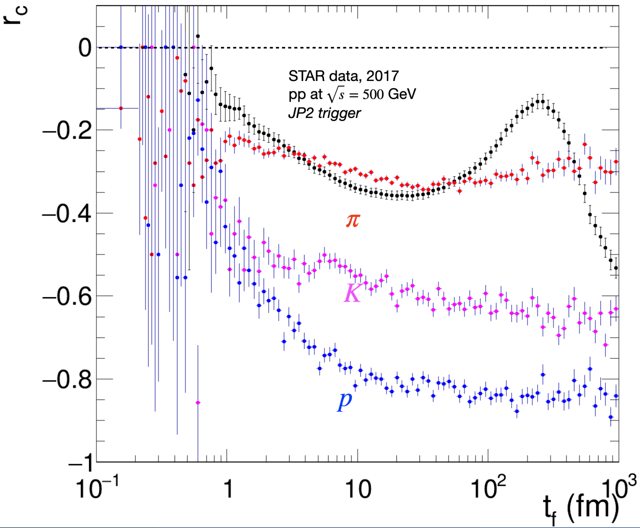
$k_\perp$ dependence - data vs PYTHIA

PYTHIA: Detroit tunning
STAR data: analysis cut + JP2 trigger



t_f dependence - data vs PYTHIA

PYTHIA: Detroit tunning
STAR data: analysis cut + JP2 trigger



Next steps

- Application of the bad run list;
- Ongoing research on hadron separation techniques, check the mass (from TOF) and n_σ vs $p_\perp^{\text{track}}$.