

Inclusive Jet and Dijet Production in Polarized Proton-Proton Collisions at 200 GeV at RHIC

Measurement of Inclusive Jet Cross Section

MIT

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for the STAR collaboration

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- ➔ STAR and Jet measurement
- ➔ Data - MC comparison
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Introduction

- ❖ Jet cross sections in hadron collisions are fundamental test of QCD factorization and pQCD.

$$\sigma = \sum_{i,j} \int dx_1 \int dx_2 f_i(x_1, Q^2) f_j(x_2, Q^2) \hat{\sigma}(\cos \theta^*)$$

- ❖ Jet cross sections provide us with a theoretical interpretation of the spin asymmetry in polarized proton collisions,

$$\mathcal{A}_{LL} = \frac{\sigma^{++} - \sigma^{+-}}{\sigma^{++} + \sigma^{+-}} = \frac{\sum_{i,j} \int dx_1 \int dx_2 \Delta f_i(x_1, Q^2) \Delta f_j(x_2, Q^2) \hat{a}_{LL} \hat{\sigma}(\cos \theta^*)}{\sum_{i,j} \int dx_1 \int dx_2 f_i(x_1, Q^2) f_j(x_2, Q^2) \hat{\sigma}(\cos \theta^*)}$$

- ❖ allowing us to extract polarized gluon distribution from \mathcal{A}_{LL} .

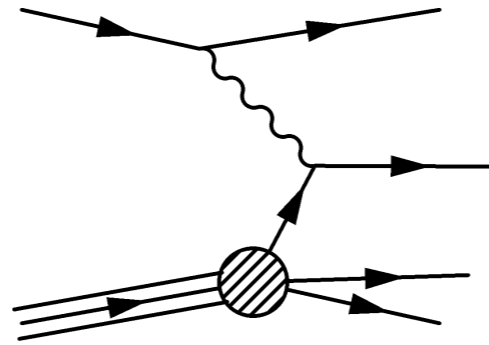
$$\Delta g(x, Q^2) = g^+(x, Q^2) - g^-(x, Q^2)$$

- ❖ Polarized gluon distribution can address the "*spin puzzle*."

$$\Delta G = \int_0^1 \Delta g(x) dx \qquad \frac{1}{2} = \frac{1}{2} \Sigma + \Delta G + L_q + L_g$$

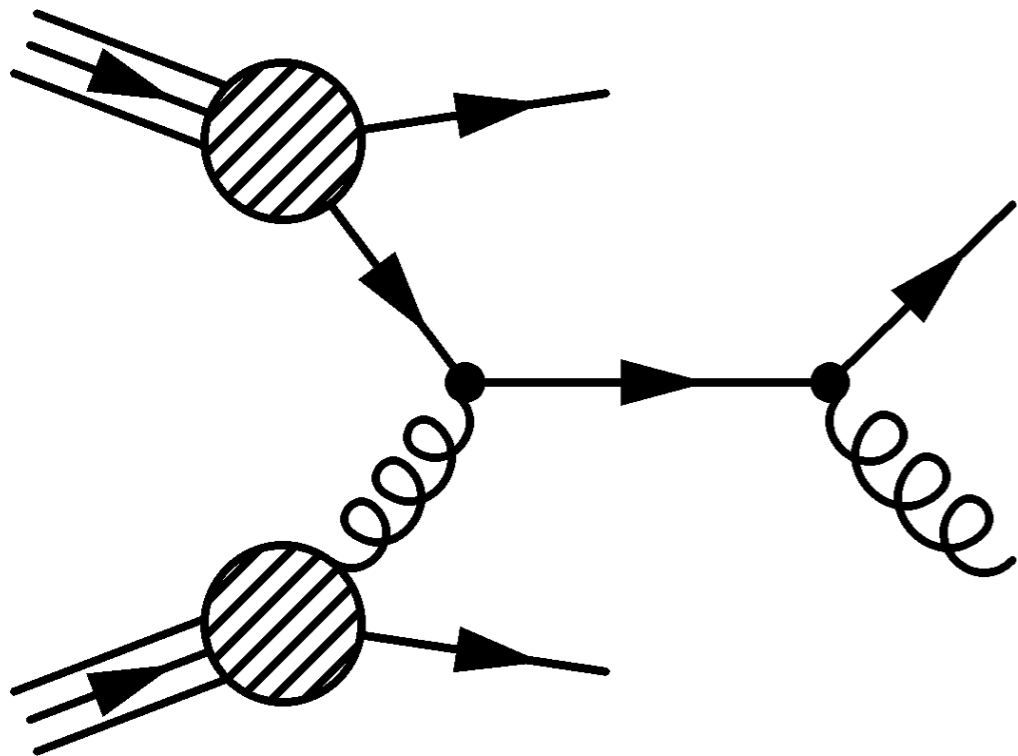
Introduction

In DIS, parton-level kinematics can be always determined



$$x = \frac{Q^2}{2M\nu}$$

In pp, not unless two outgoing partons are measured



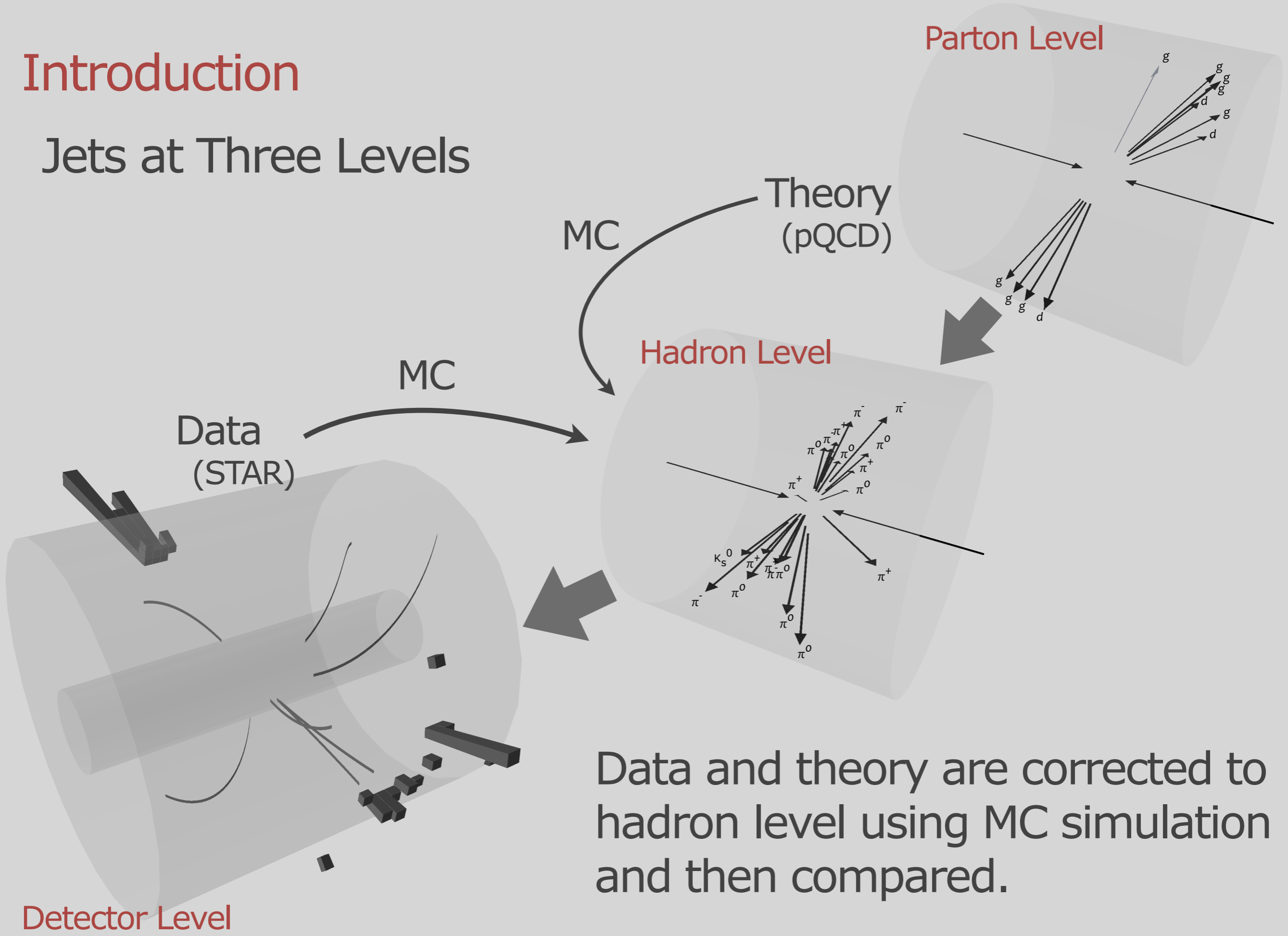
$$x_1 = \frac{p_T}{\sqrt{s}} (e^{\eta_3} + e^{\eta_4})$$

$$x_2 = \frac{p_T}{\sqrt{s}} (e^{-\eta_3} + e^{-\eta_4})$$

can be estimated from dijets

Introduction

Jets at Three Levels



Data and theory are corrected to hadron level using MC simulation and then compared.

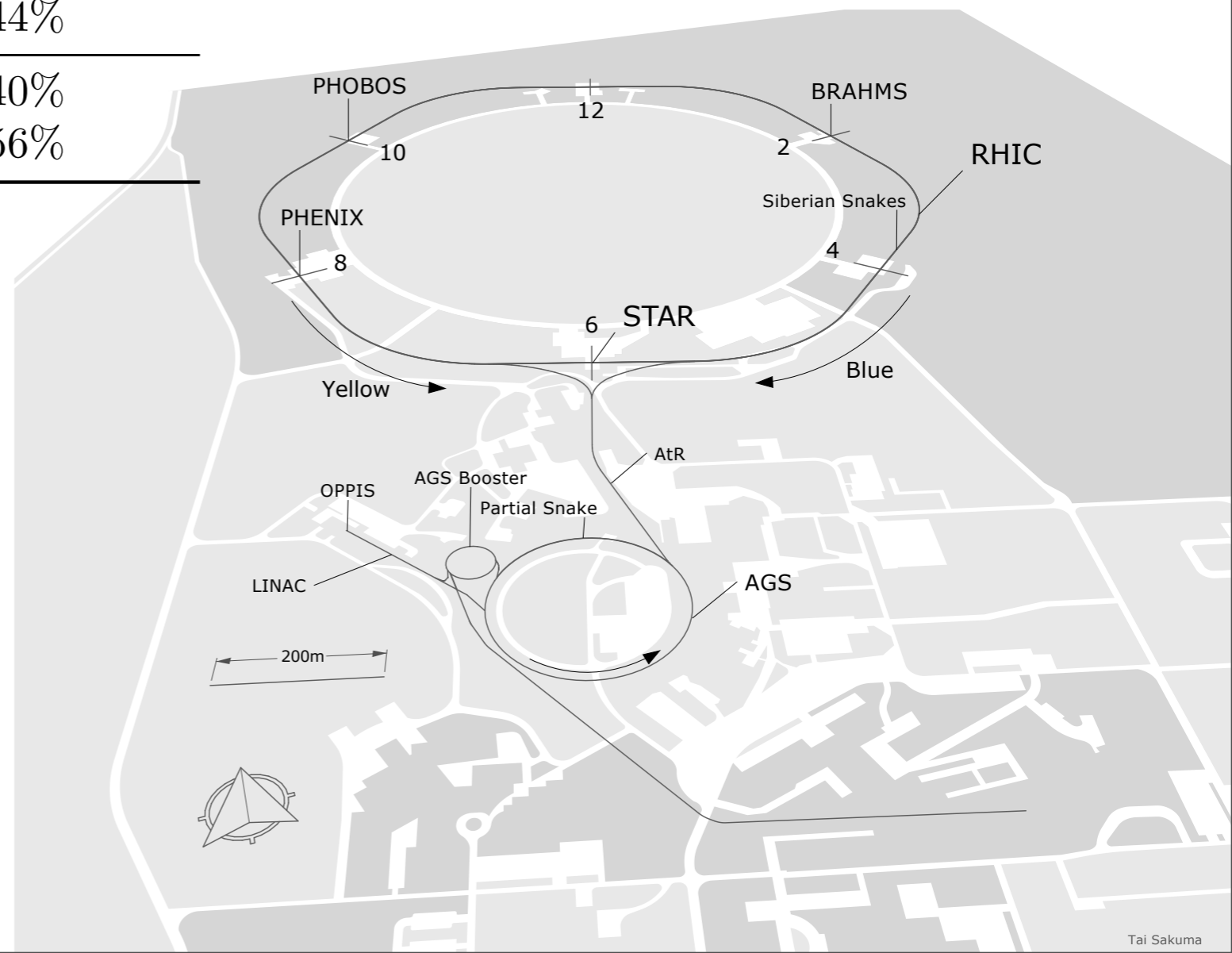
Detector Level

RHIC as a polarized proton-proton collider

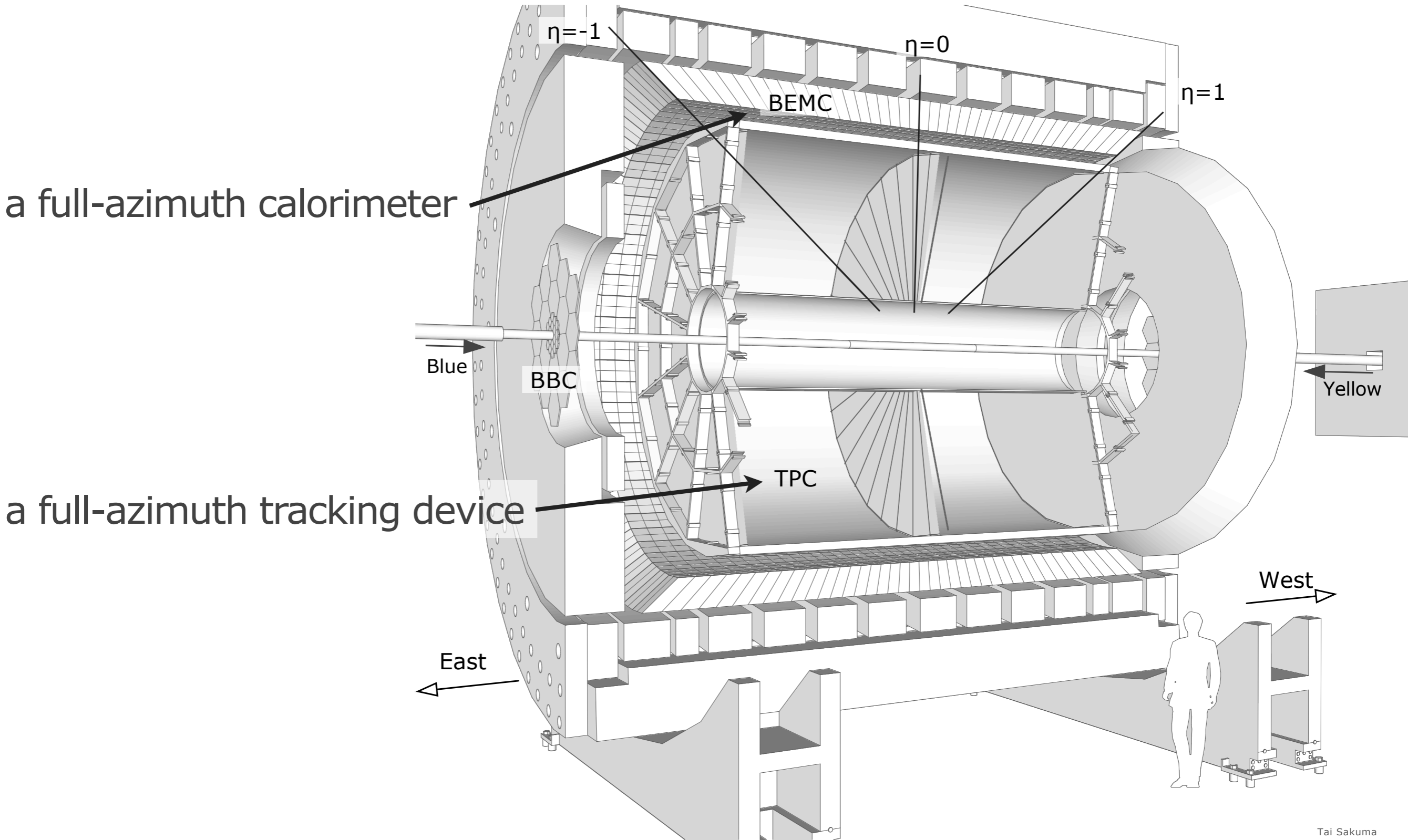
Run	\sqrt{s} [GeV]	$\int \mathcal{L} dt [\text{pb}^{-1}]^a$	Polarization ^b
Run-2	200	0.47	14%
Run-3	200	2.5	34%
Run-4	200	3.2	46%
Run-5	200	12.7	46%
Run-6	200	44.9	58%
	62	0.325	50%
Run-8	200	19.2	44%
Run-9	500	52.6	40%
	200	53.5	56%

^a Delivered luminosity at STAR

^b Average polarization



STAR Detector



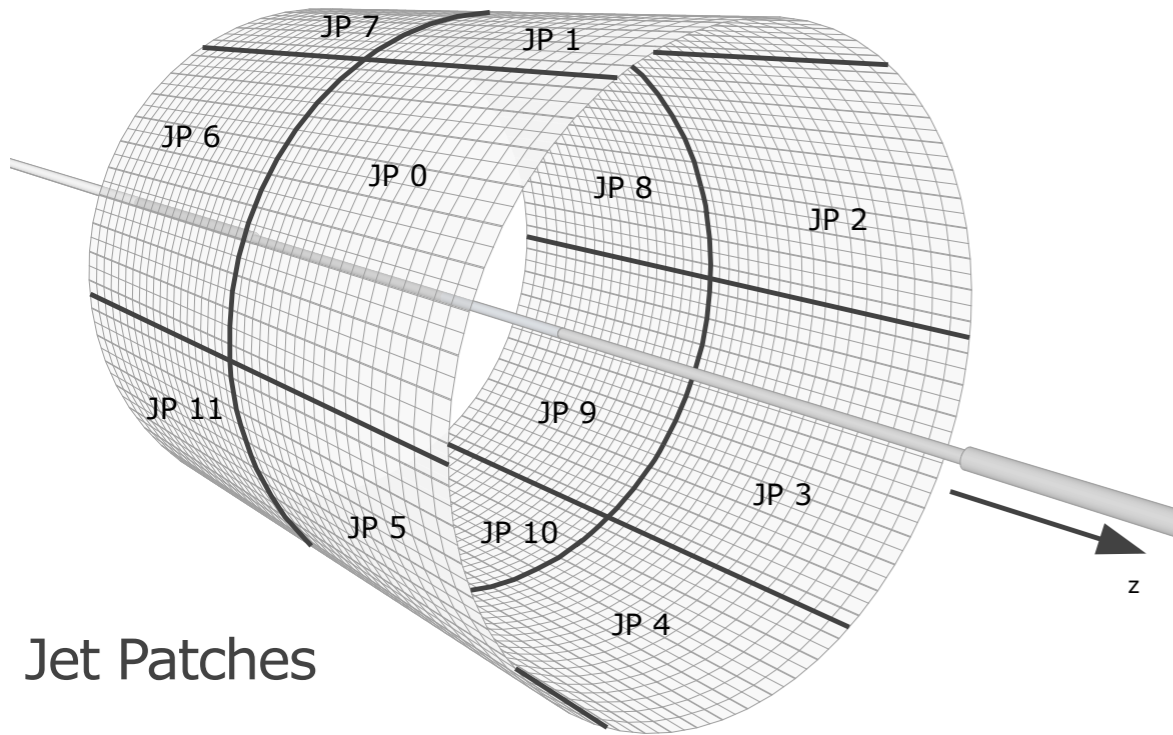
a full-azimuth calorimeter

a full-azimuth tracking device

well suited for jet measurement

Parameters of the Analysis

- ❖ 5.4 pb⁻¹, pp 200 GeV, RHIC Run-6
- ❖ BJP1 Trigger (8.3 GeV < E_T in Δη × Δφ=1×1)



- ❖ Jet Definition
 - Charged tracks in TPC
 - Energy deposits in BEMC towers
 - Mid-point cone (R=0.7)
- ❖ Dijet Definition
 - Two-leading p_T jets

❖ Phase Space

- Inclusive Jets $\overline{-0.8 < \eta < 0.8}$
- Dijets $\overline{\begin{aligned} \max(p_T) > 10.0 \text{ GeV} \\ \min(p_T) > 7.0 \text{ GeV} \\ -0.8 < \eta < 0.8 \\ |\eta_3 - \eta_4| < 1.0 \\ |\Delta\varphi| > 2.0 \end{aligned}}$

❖ Cross Sections

- Inclusive Jets

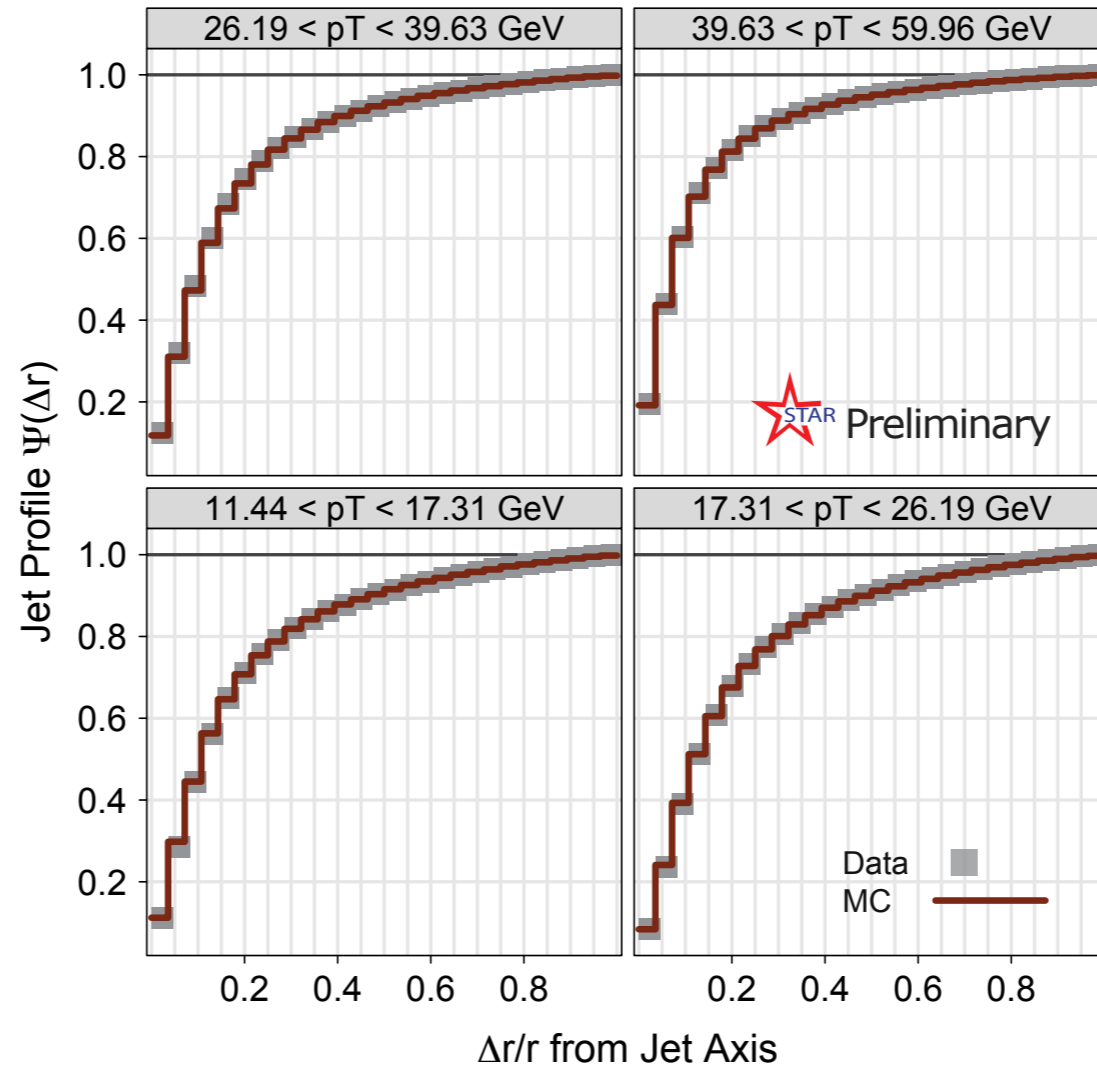
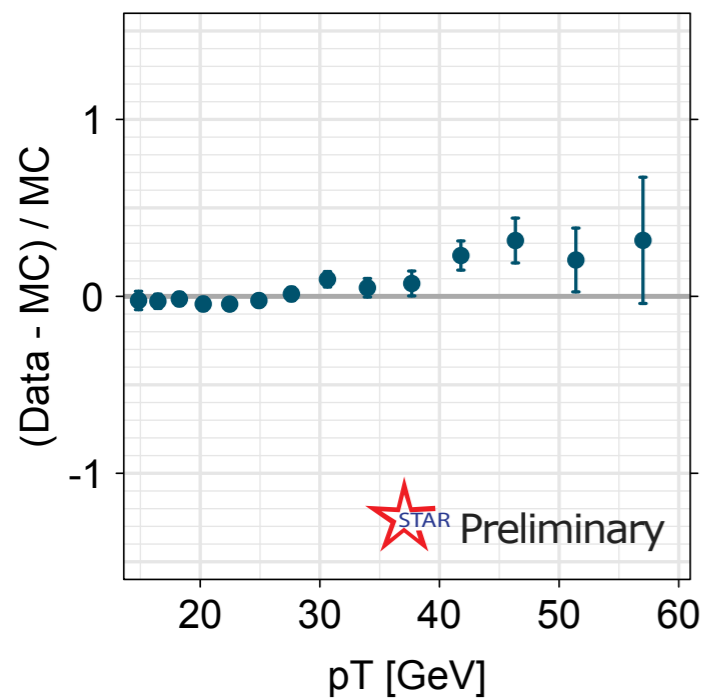
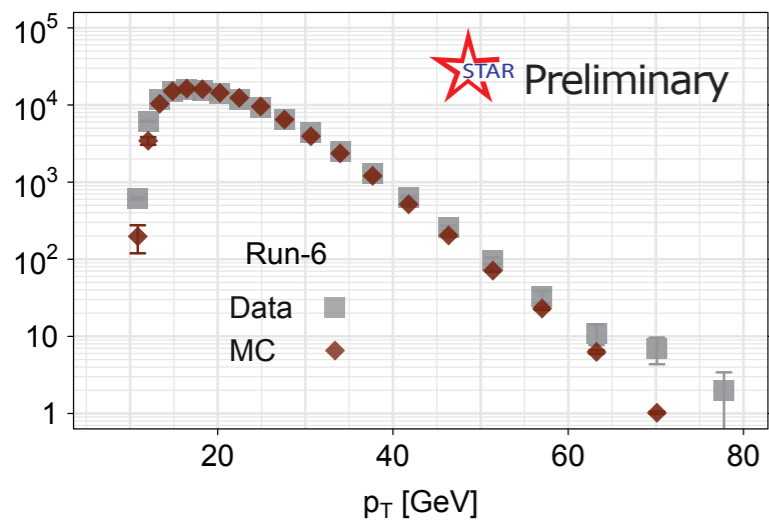
$$\frac{d^2\sigma}{2\pi dp_T d\eta} = \frac{1}{\int \mathcal{L} dt} \cdot \frac{1}{2\pi \Delta p_T \Delta \eta} \cdot \frac{1}{C} \cdot J$$

- Dijets

$$\frac{d^3\sigma}{dM_{jj} d\eta_3 d\eta_4} = \frac{1}{\int \mathcal{L} dt} \cdot \frac{1}{\Delta M_{jj} \Delta \eta_3 \Delta \eta_4} \cdot \frac{1}{C} \cdot J$$

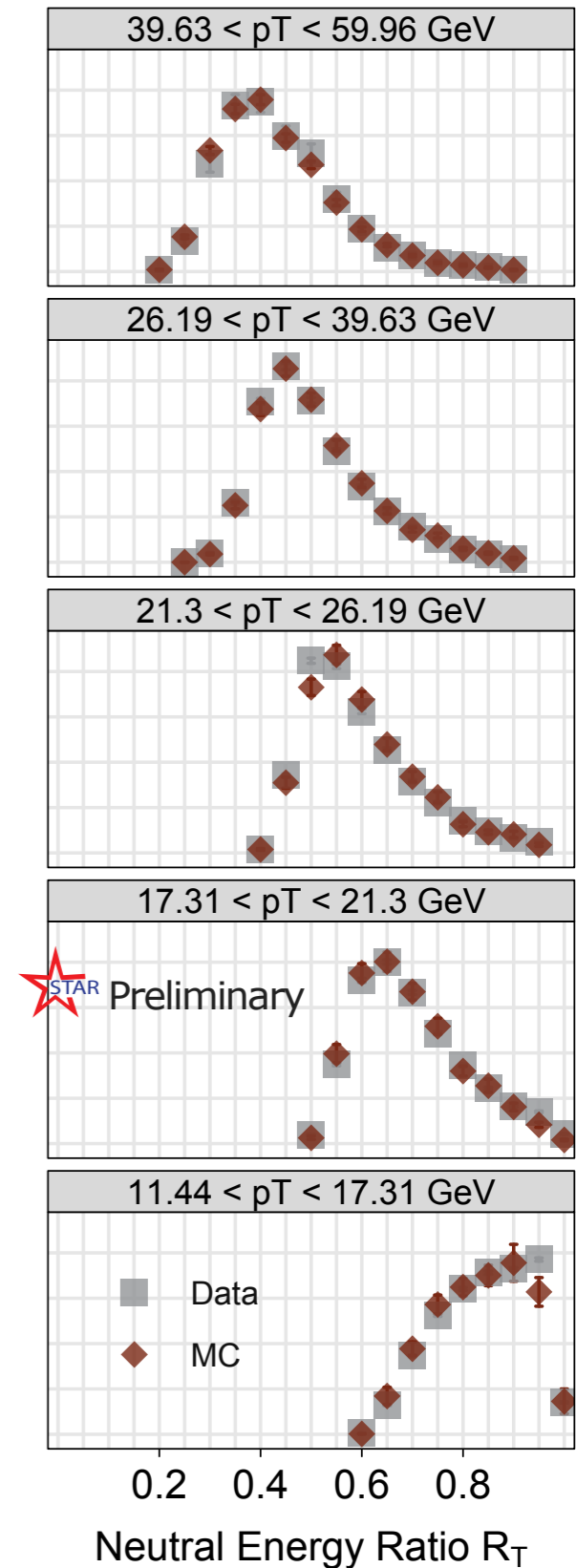
Data - MC Comparison of Inclusive Jets

Correction factors are determined with MC samples which well reproduce data.

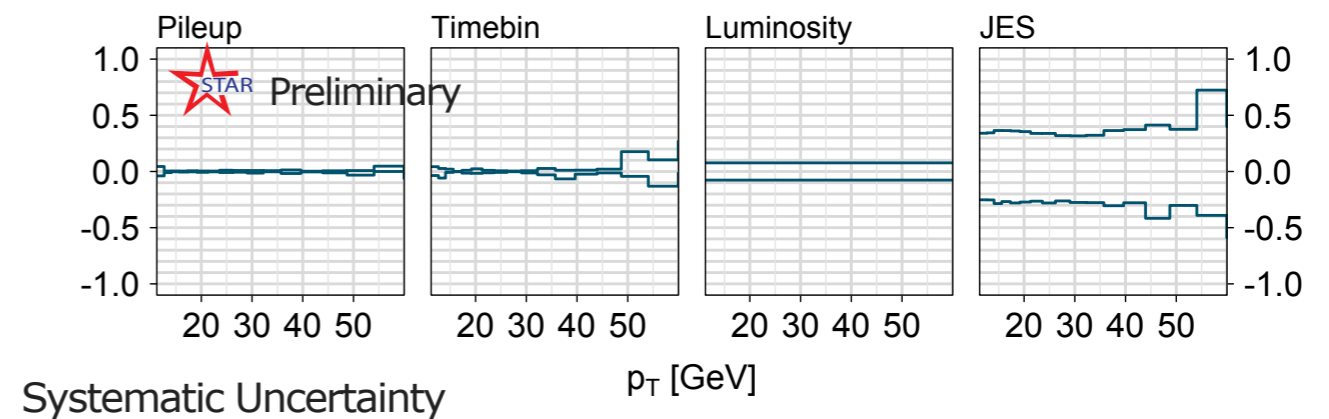
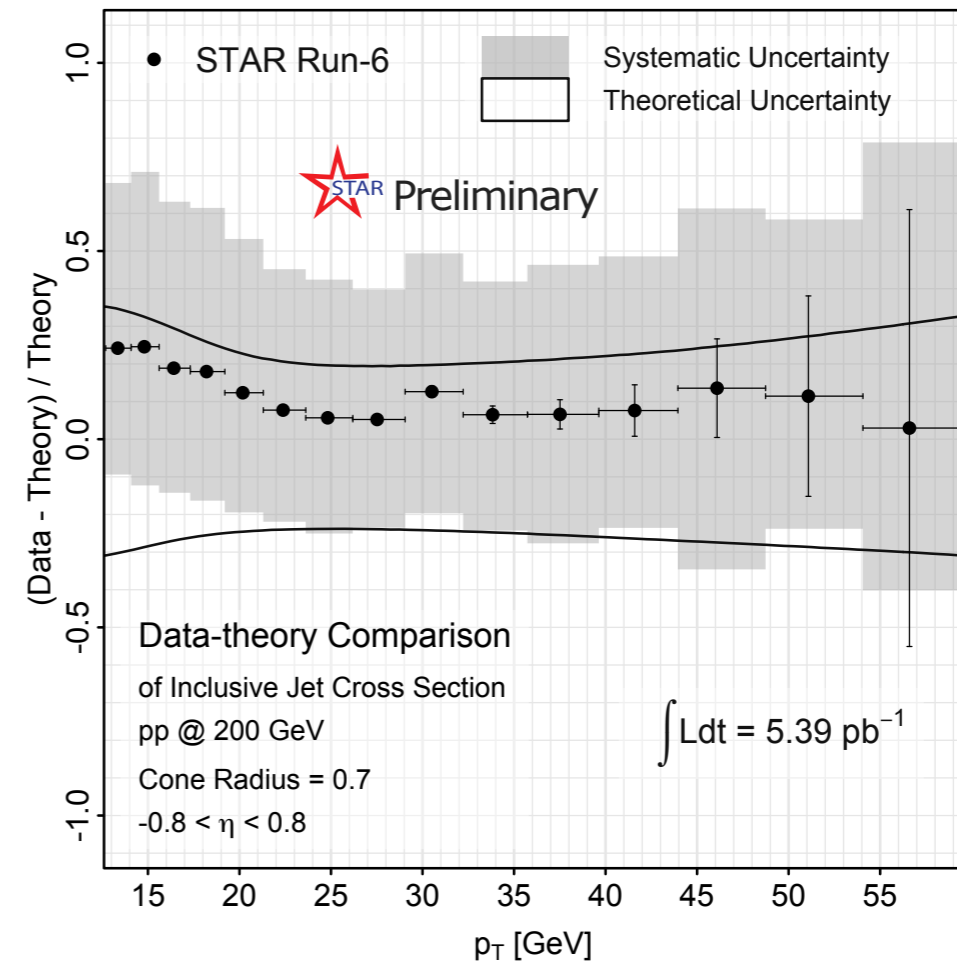
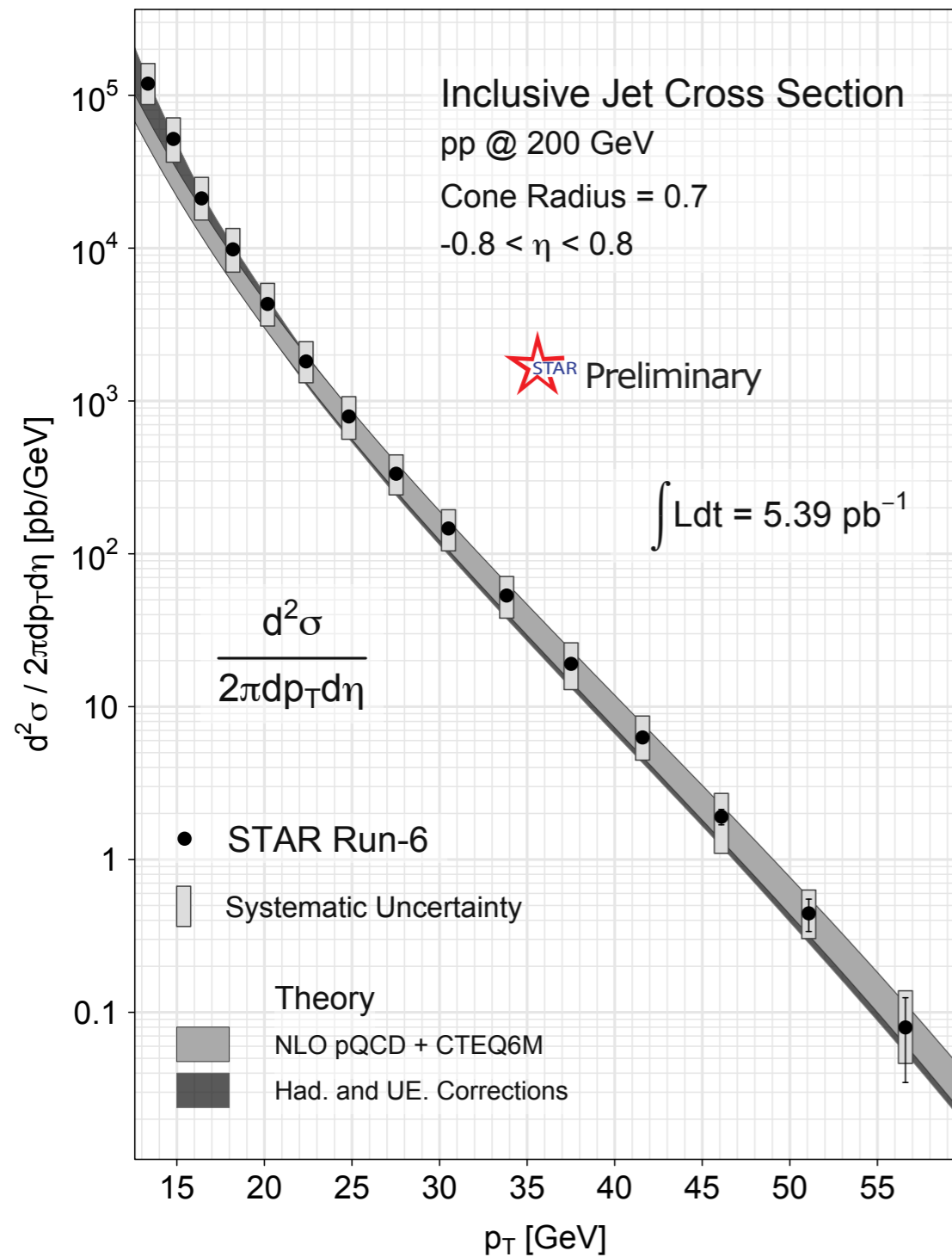


MC: Pythia 6.4 + Geant 3

$$-0.8 < \eta < 0.8$$



Data - NLO pQCD comparison of Inclusive Jet Cross Section

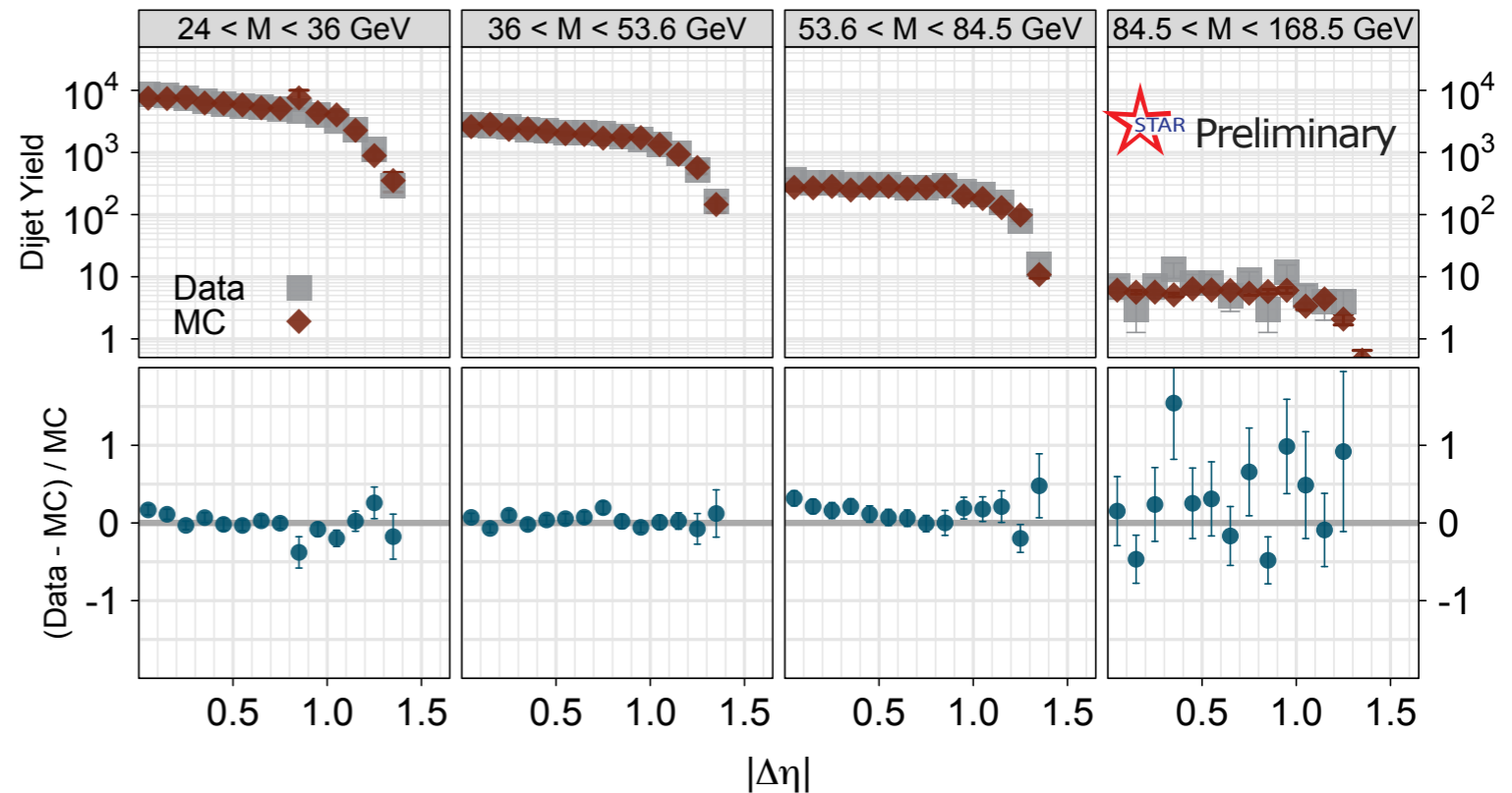
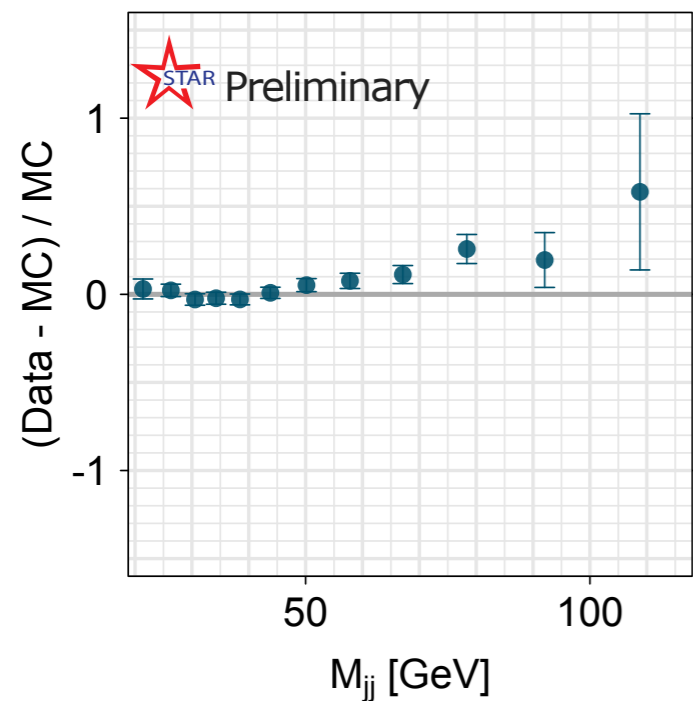
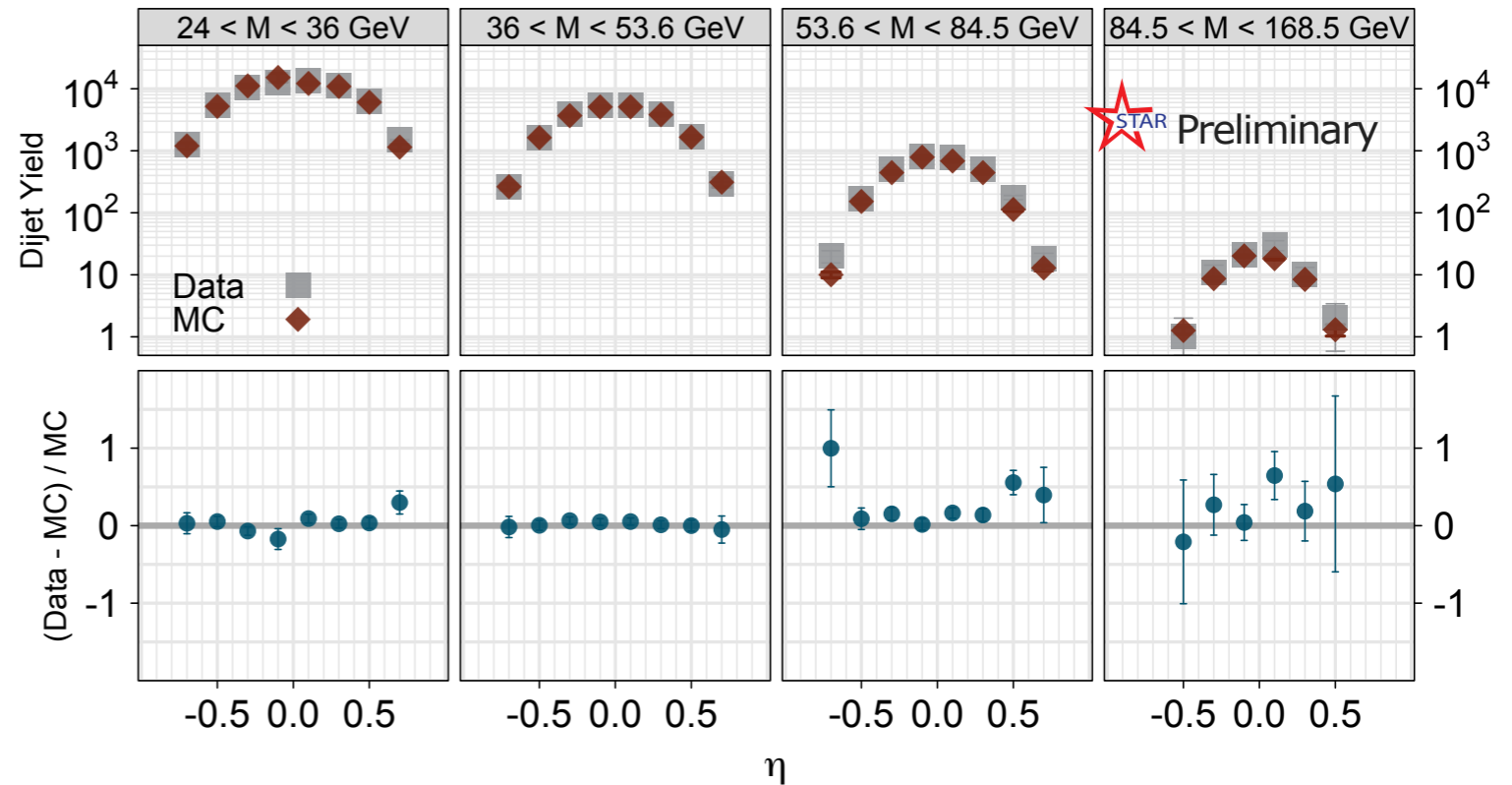
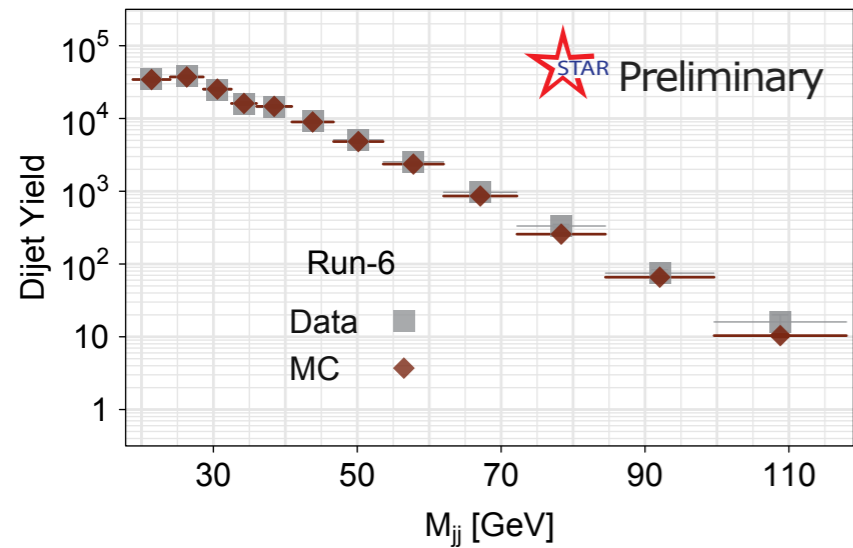


Data are well described by NLO pQCD plus hadronization and underlying event corrections.

Data - MC Comparison of Dijets

$\max(p_T) > 10.0 \text{ GeV}$
 $\min(p_T) > 7.0 \text{ GeV}$
 $-0.8 < \eta < 0.8$
 $|\eta_3 - \eta_4| < 1.0$
 $|\Delta\varphi| > 2.0$

Data are well described by MC



Summary

- ❖ Inclusive jet cross section in $pp@200$ GeV in the mid-rapidity region is measured with 5.4 pb^{-1} of RHIC Run-6 data collected with the STAR detector.
- ❖ The results are in agreement with NLO pQCD.
- ❖ The results are in consistent with our previous results with smaller acceptance and cone size.
- ❖ The results lend confidence that the inclusive jet \mathcal{A}_{LL} can be interpreted in the framework of the QCD factorization with NLO pQCD.
- ❖ The dijet production is well described by MC.
- ❖ The dijet cross section will facilitate an interpretation of dijet \mathcal{A}_{LL} .