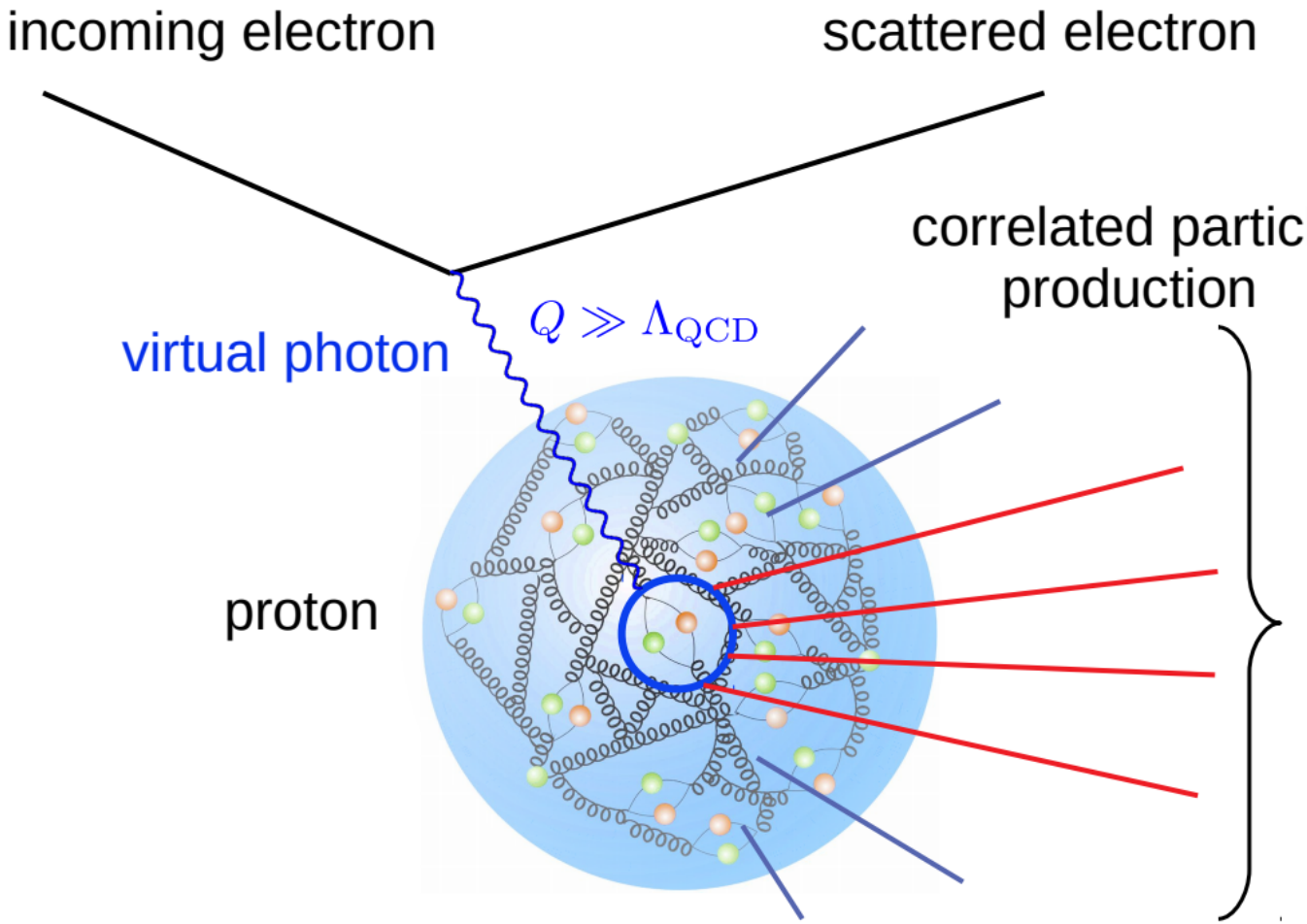
Two-particle azimuthal correlation analysis in photoproduction

- Analysis of two-particle correlations searching for collective behavior in DIS has been finished arXiv: 1912.07431.
- Positive referee responses from JHEP have been received on Jan 25th.
- The analysis can be extended to photoproduction and diffractive events.

Dhevan Gangadharan (Uni Heidelberg)
ZEUS collaboration meeting
Feb 18th-19th 2020

Deep inelastic scattering



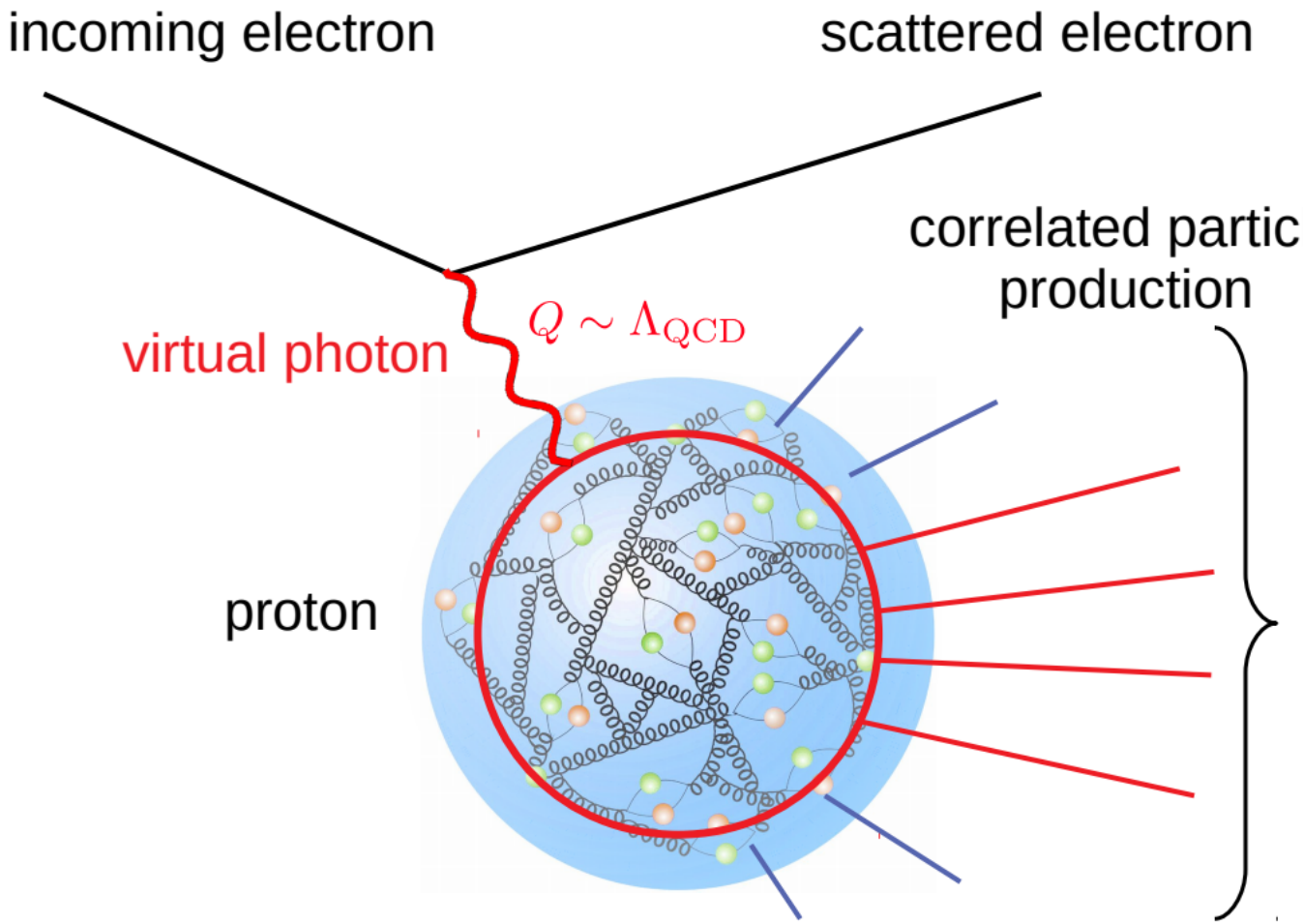
The average size of the interaction region (~1/Q) inside the proton is very small.

The **energy deposition** can be quite large since $Q^2 >> 1$.

In heavy-ion collisions, where collective behavior is observed, the energy deposition is also quite large.

This made DIS an interesting regime to look for collective behavior.

Photoproduction



In PHP **larger interaction regions** are created since $Q^2 << 1$.

In heavy-ion collisions, where collective behavior is observed, large interaction regions are produced.

This makes PHP an interesting regime to look for collective behavior.

Photoproduction event selection

- There is no dedicated PHP trigger.
- However, we could utilize jet triggers to obtain a PHP dominated sample.
  Single jet and dijet triggers:
  HFL05, HPP02, HPP09, HPP11, HPP14, HPP29, HPP30.
- First step, as suggested by Achim, is to rerun the DIS analysis with these triggers added on top.
- Determine if the deviations of the ZEUS data from the MC are at a comparable level to the just published DIS analysis.
- If this is satisfied, then our conclusion of jets being mainly responsible for the observed two-particle correlations in DIS remains intact.

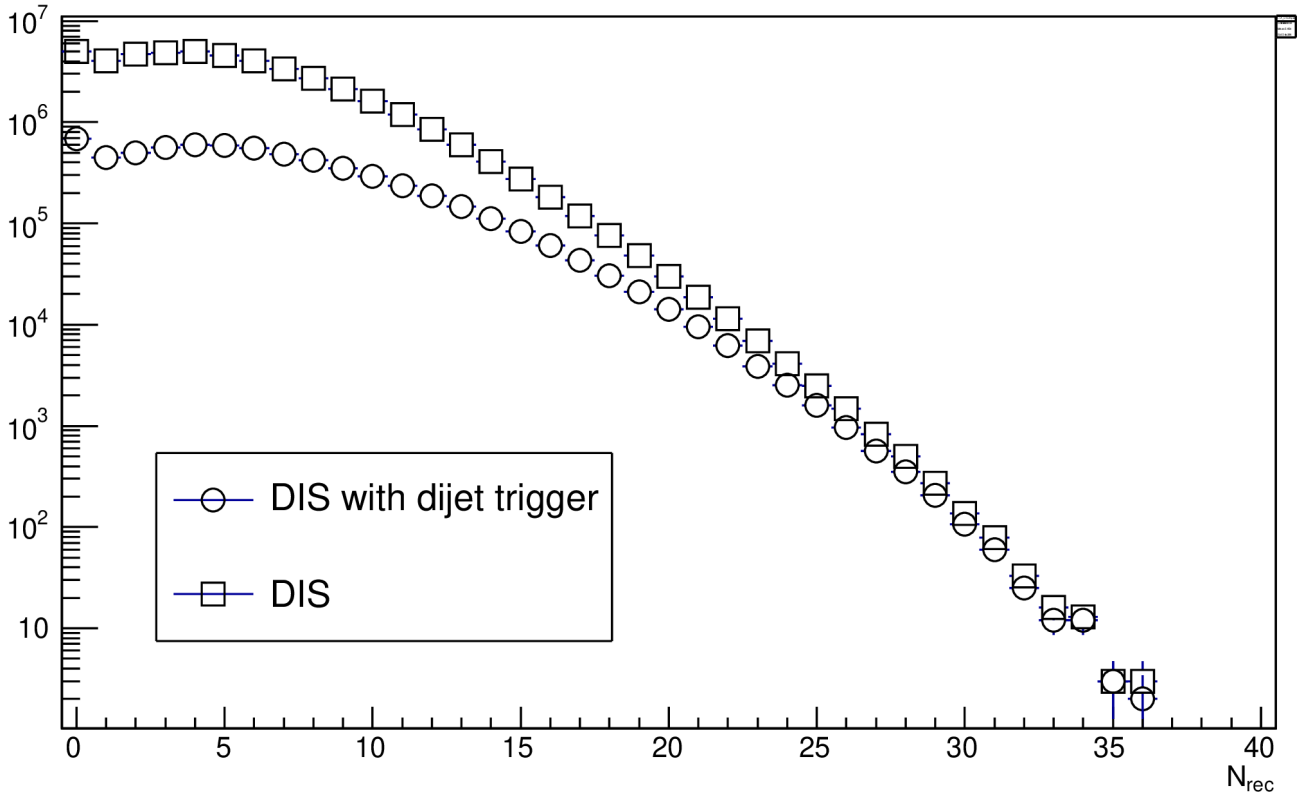
Two-particle correlation observable

$$c_n\{2\} = \langle\langle \cos n(\varphi_1 - \varphi_2)\rangle\rangle$$

Projected against

N_{rec} $\qquad$ $|\Delta\eta| = |\eta_1 - \eta_2|$ $\qquad$ $\langle p_T\rangle = (p_{T,1} + p_{T,2})/2$

N_{rec} distributions

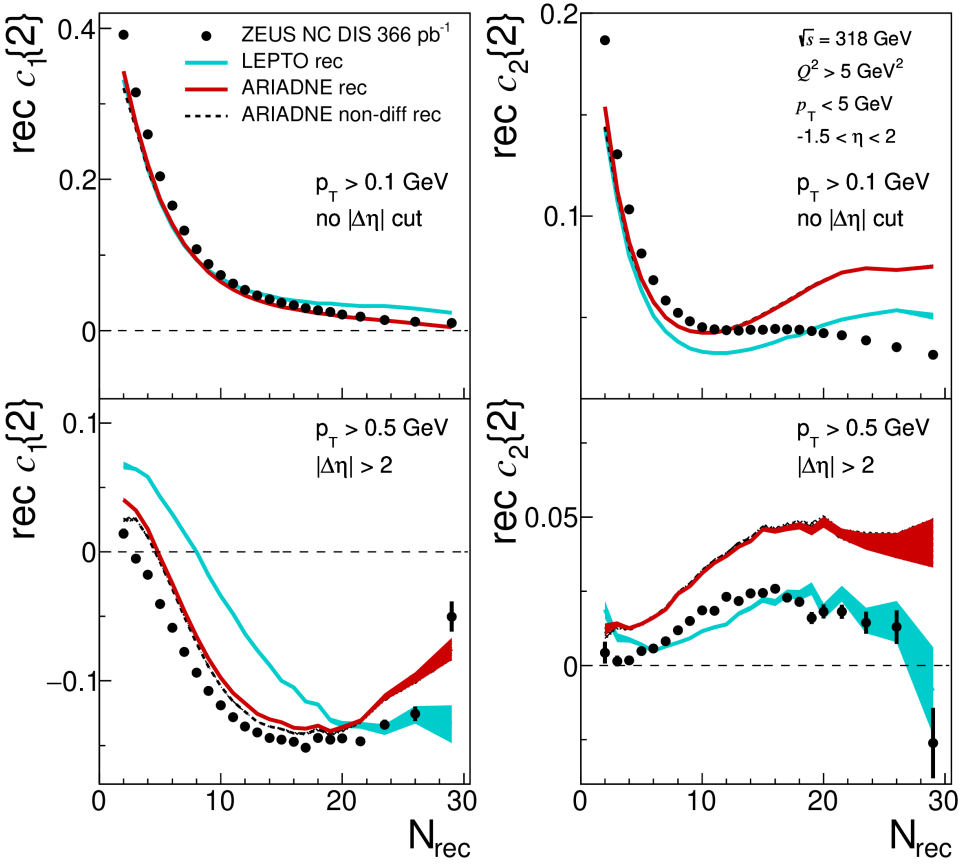


- Jet triggered DIS events represent a small subset of the full DIS sample.

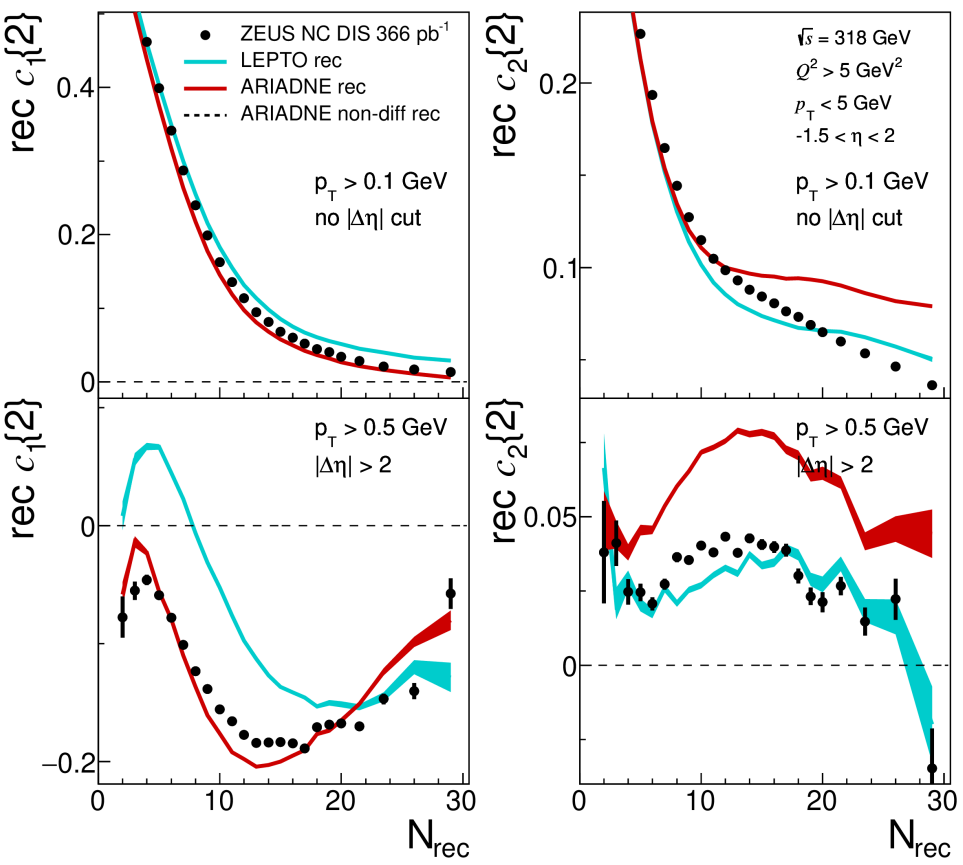
Control plot figure 3

DIS analysis
from the paper

ZEUS



DIS analysis
+ jet triggers

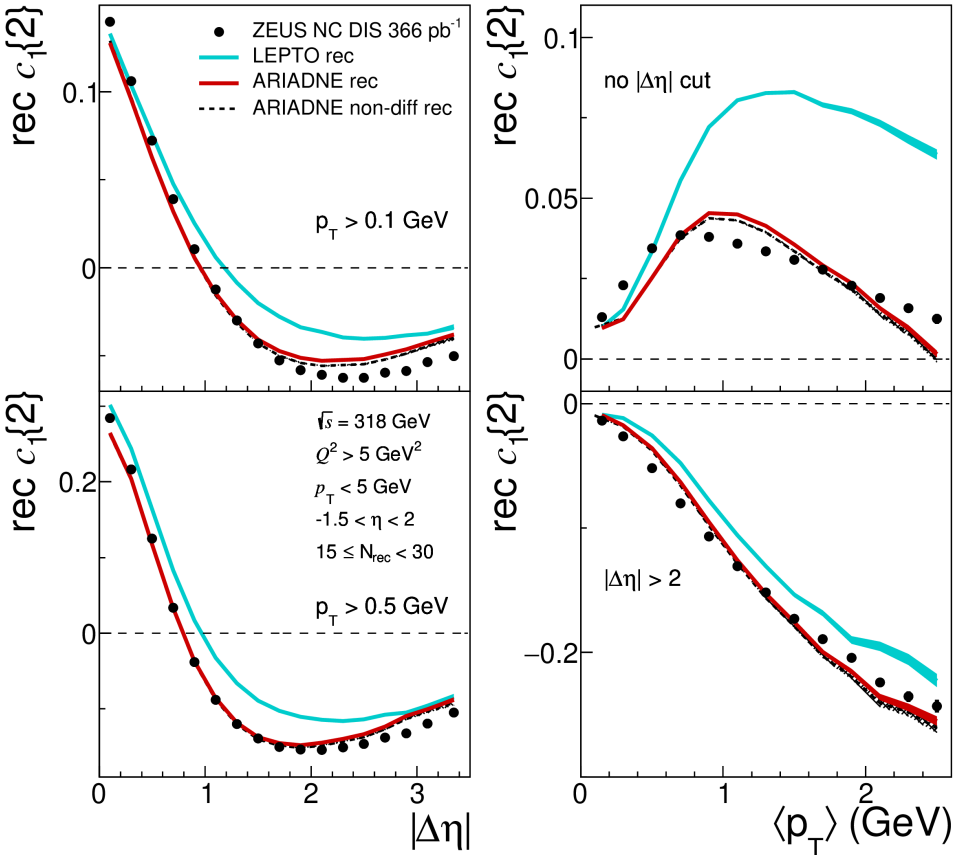


- Neither model simultaneously describes both c_1 and c_2.
- Ariadne describes c_1 reasonably well, while Lepto works better for c_2.
- The deviations from MC are basically at the same level with the jet triggers.

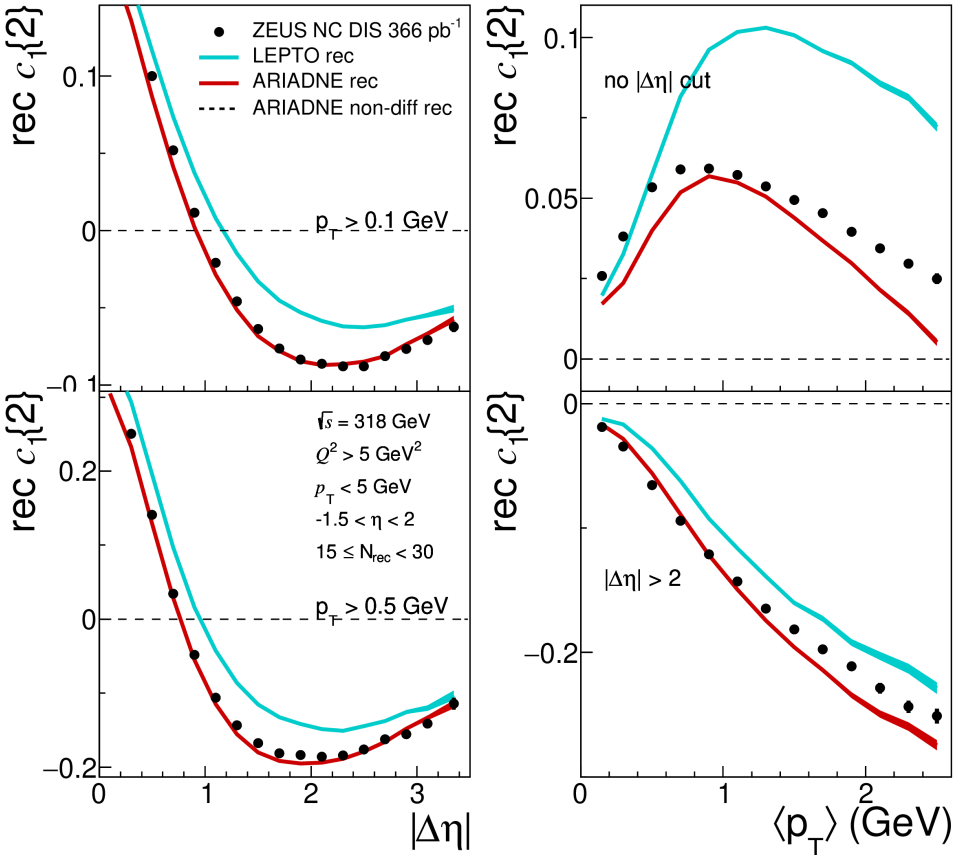
Control plot figure 4

DIS analysis
from the paper

ZEUS



DIS analysis
+ jet triggers

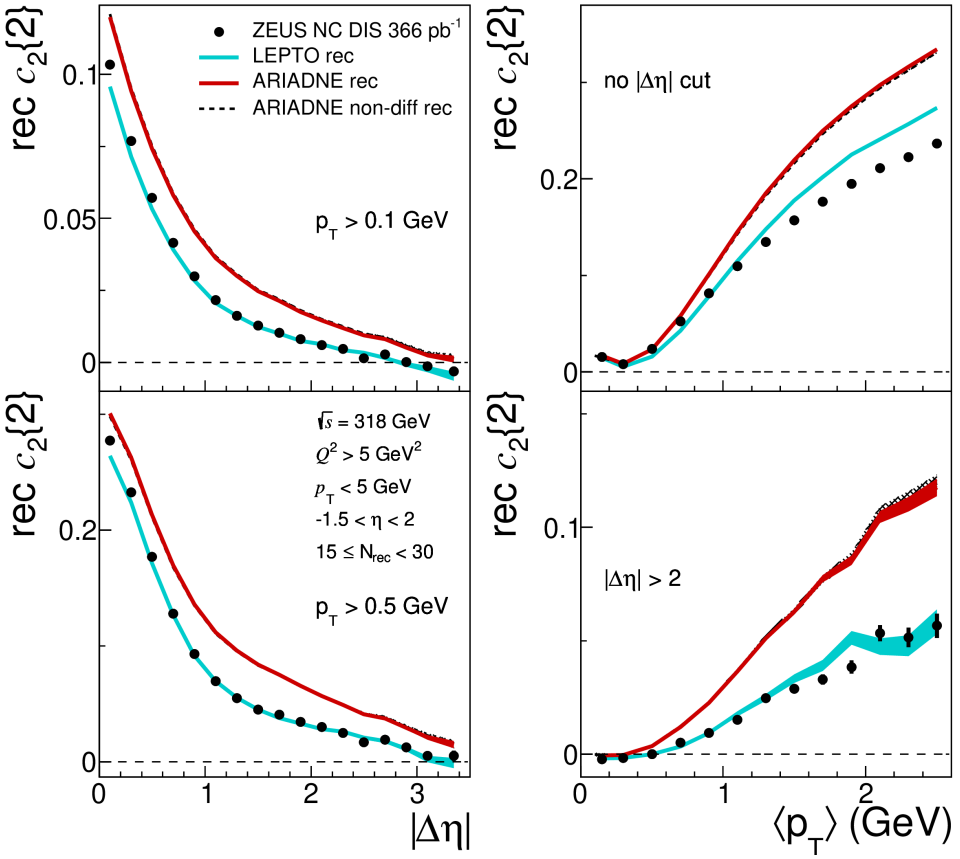


- Neither model simultaneously describes both c_1 and c_2.
- Ariadne describes c_1 reasonably well, while Lepto works better for c_2.
- The deviations from MC are basically at the same level with the jet triggers.

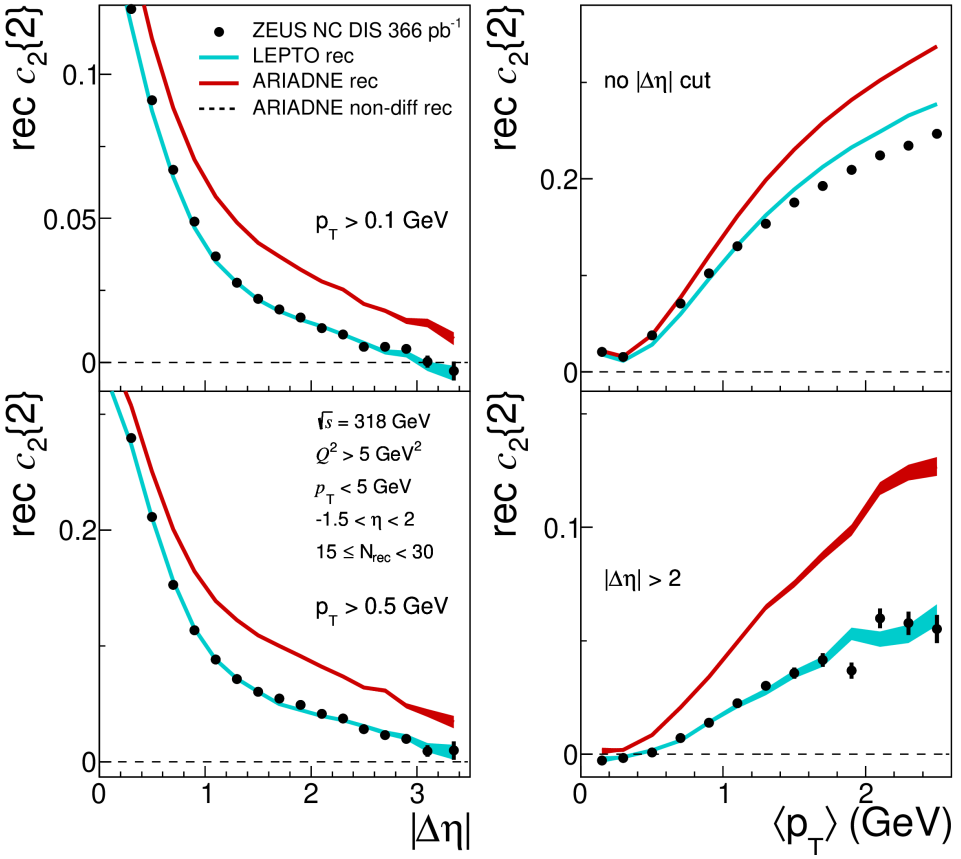
Control plot figure 5

DIS analysis
from the paper

ZEUS



DIS analysis
+ jet triggers



- Neither model simultaneously describes both c_1 and c_2.
- Ariadne describes c_1 reasonably well, while Lepto works better for c_2.
- The deviations from MC are basically at the same level with the jet triggers.

Outlook and next steps

- Although jet triggers will be used to obtain an enriched PHP data sample, the correlations within jets produce strong “unwanted” contributions to two-particle correlation functions.

- We are looking for hints of multiparticle correlations indicative of the hydrodynamic collective behavior seen in heavy-ion collisions. If they are present in *ep*, they will likely be small.

- Investigate further PHP event selection techniques within the jet-triggered event sample. E-Pz, offline jet energy thresholds, other offline quantities…

- Perhaps a special set of event selection techniques can reduce the strength of jet correlations while still providing a rich PHP data sample.

Backup

Figure 1

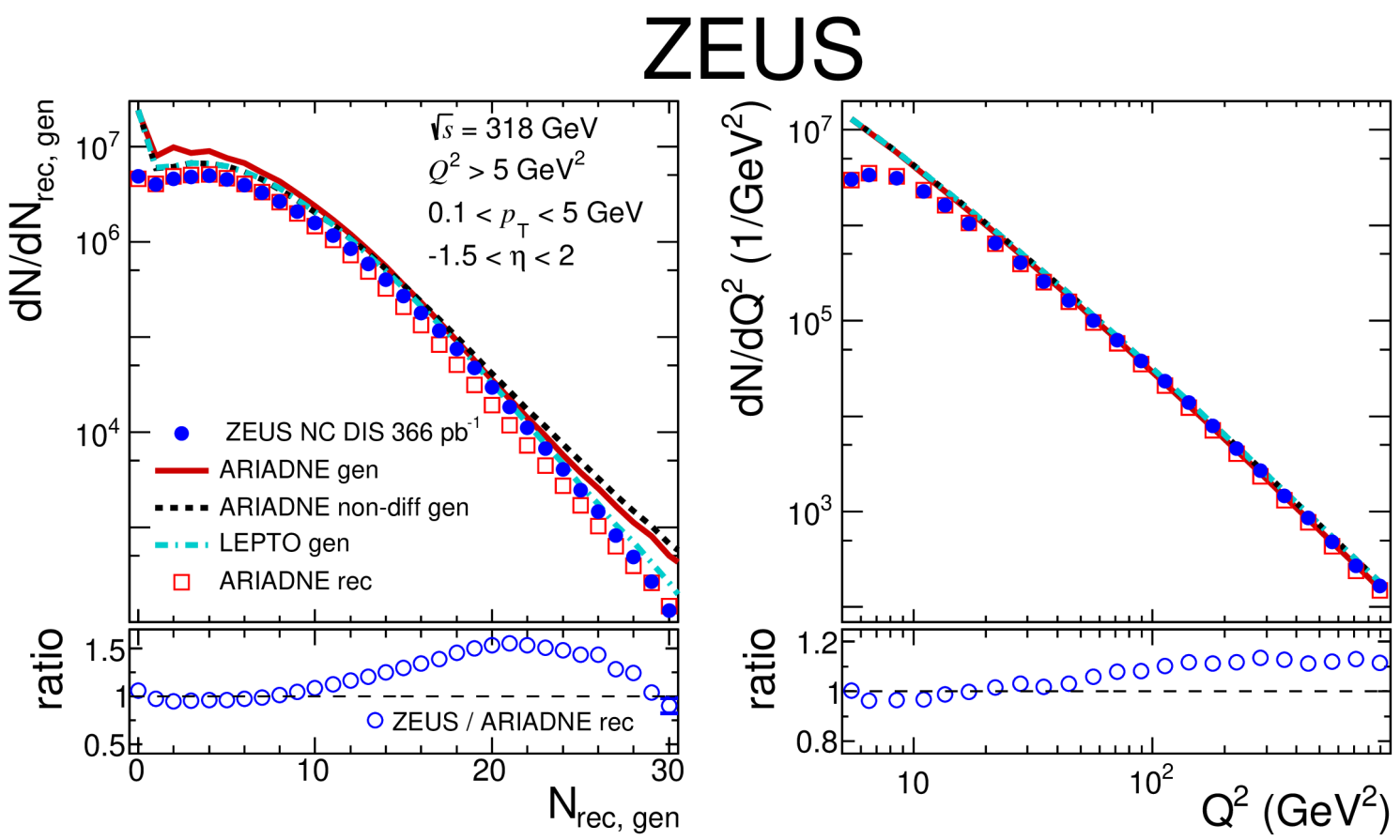

ZEUS
√s = 318 GeV
Q² > 5 GeV²
0.1 < p_T < 5 GeV
-1.5 < η < 2
ZEUS NC DIS 366 pb⁻¹
ARIADNE gen
ARIADNE non-diff gen
LEPTO gen
ARIADNE rec
dN/dN_rec, gen
ratio
ZEUS / ARIADNE rec
N_rec, gen
dN/dQ² (1/GeV²)
Q² (GeV²)

Figure 2

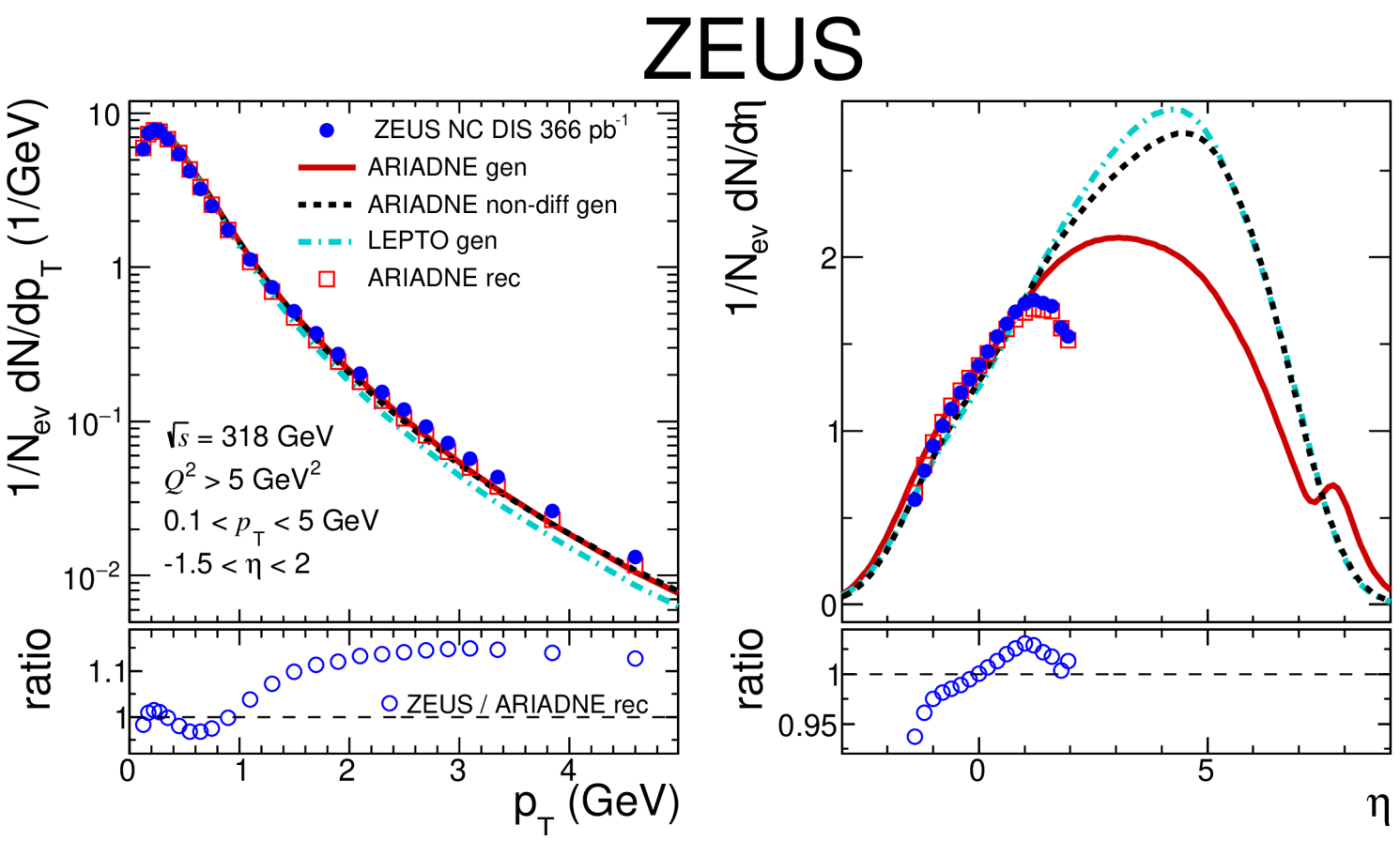

ZEUS
ZEUS NC DIS 366 pb-1
ARIADNE gen
ARIADNE non-diff gen
LEPTO gen
ARIADNE rec
√s = 318 GeV
Q2 > 5 GeV2
0.1 < pT < 5 GeV
-1.5 < η < 2
1/Nev dN/dpT (1/GeV)
ratio
ZEUS / ARIADNE rec
pT (GeV)
1/Nev dN/dη
η

Figure 6

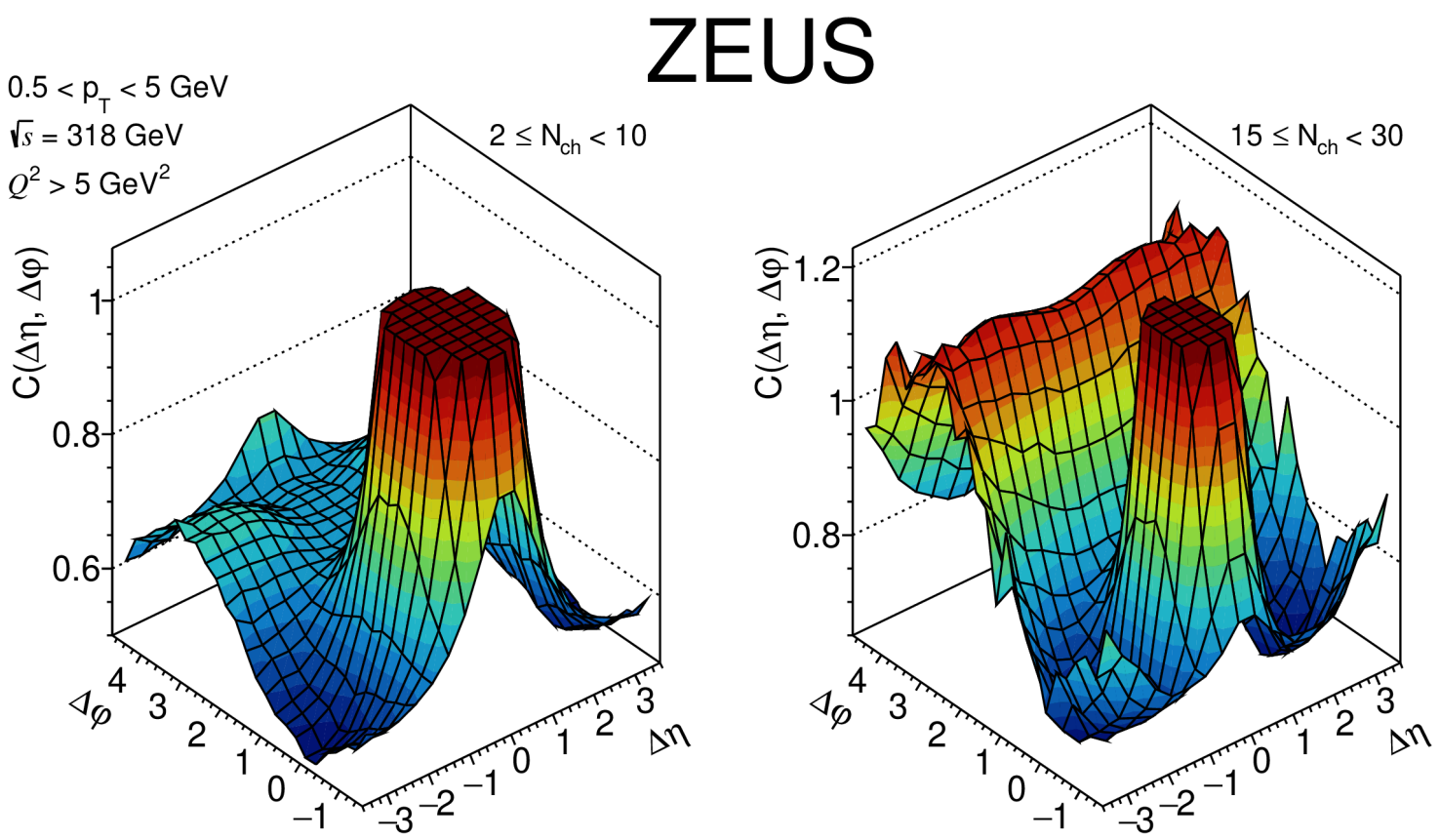


Figure 7

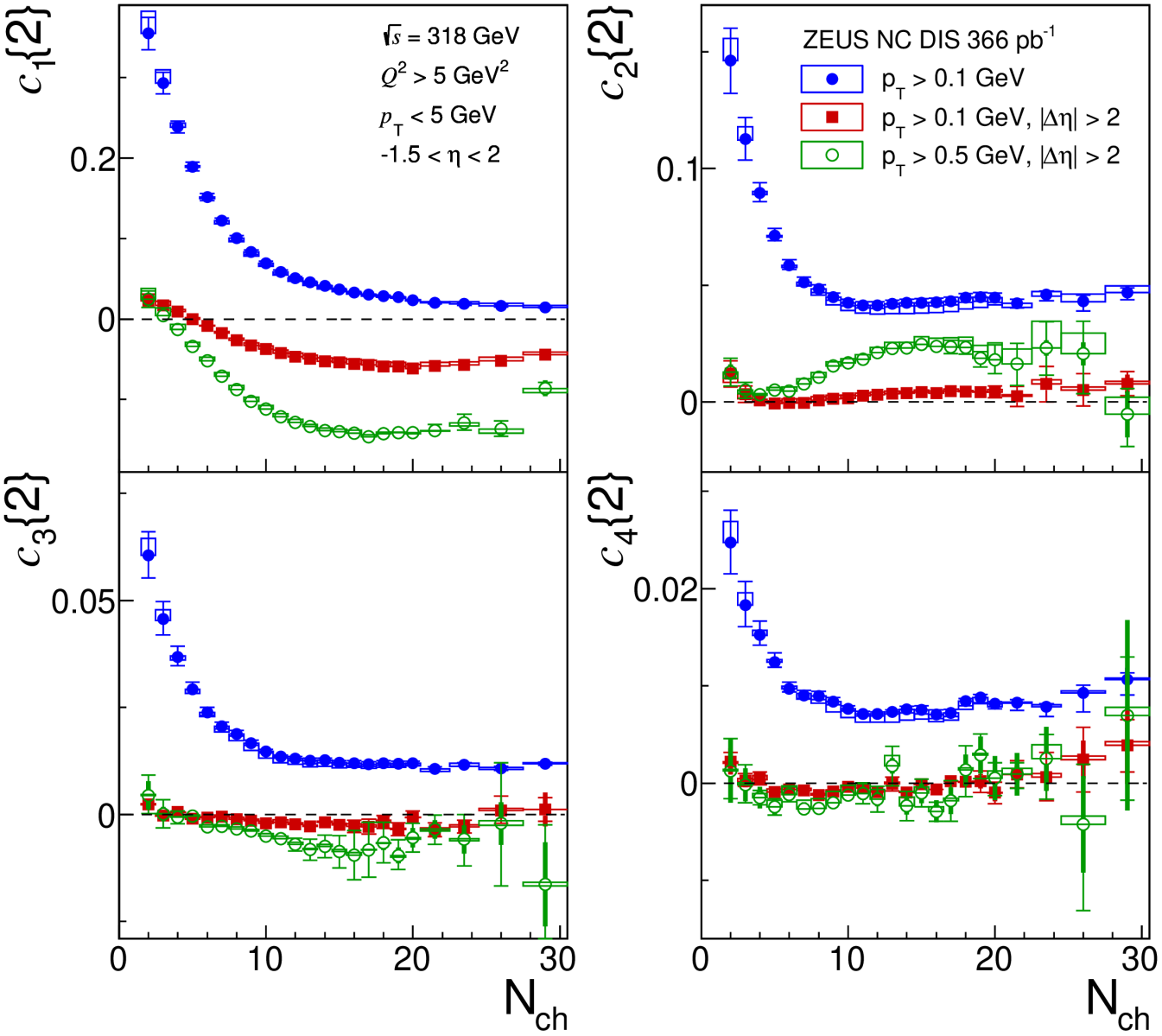

ZEUS
$\sqrt{s}$ = 318 GeV
Q^2 > 5 GeV^2
p_T < 5 GeV
-1.5 < η < 2
ZEUS NC DIS 366 pb^{-1}
p_T > 0.1 GeV
p_T > 0.1 GeV, |Δη| > 2
p_T > 0.5 GeV, |Δη| > 2
$c_1\{2\}$
$c_2\{2\}$
$c_3\{2\}$
$c_4\{2\}$
0.2
0
0.1
0
0.05
0
0.02
0
0
10
20
30
N_{ch}
N_{ch}

Figure 8

ZEUS

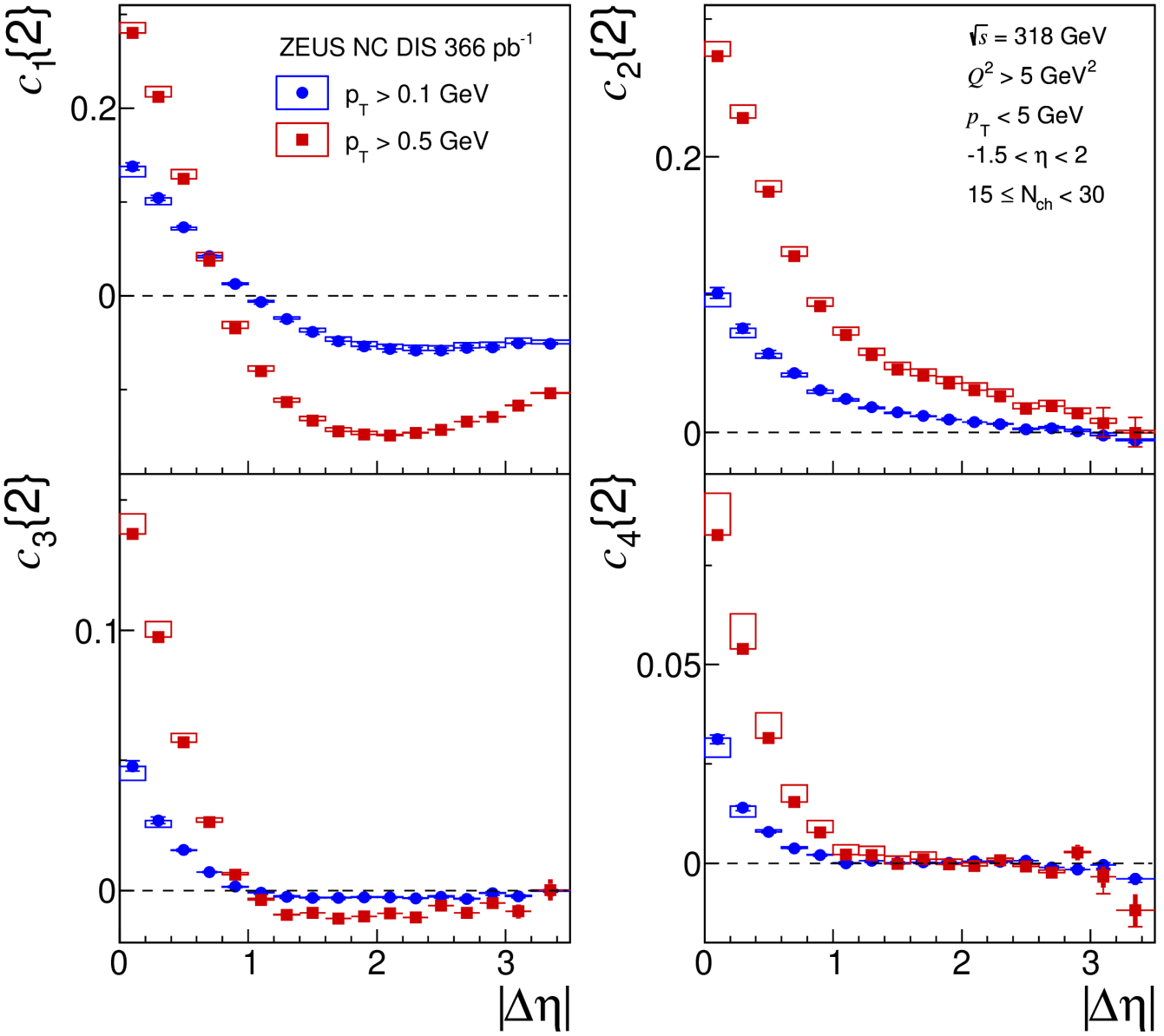


Figure 9

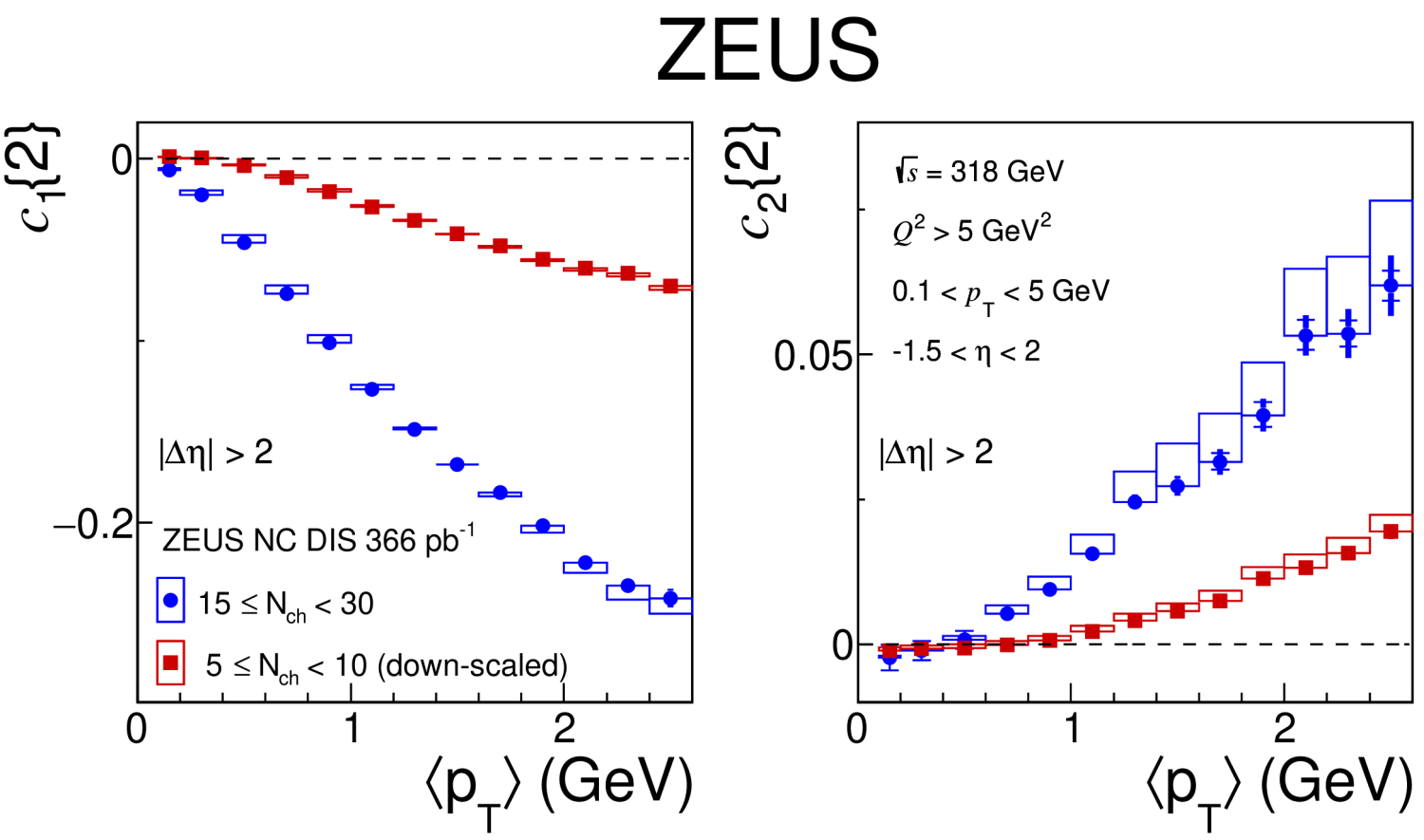

ZEUS
$c_1\{2\}$
0
−0.2
$|\Delta\eta| > 2$
ZEUS NC DIS 366 pb^{-1}
$15 \le N_{ch} < 30$
$5 \le N_{ch} < 10$ (down-scaled)
0
1
2
$\langle p_T \rangle$ (GeV)
$c_2\{2\}$
$\sqrt{s}$ = 318 GeV
$Q^2 > 5$ GeV^2
$0.1 < p_T < 5$ GeV
$-1.5 < \eta < 2$
$|\Delta\eta| > 2$
0.05
0
0
1
2
$\langle p_T \rangle$ (GeV)

Figure 10

ZEUS

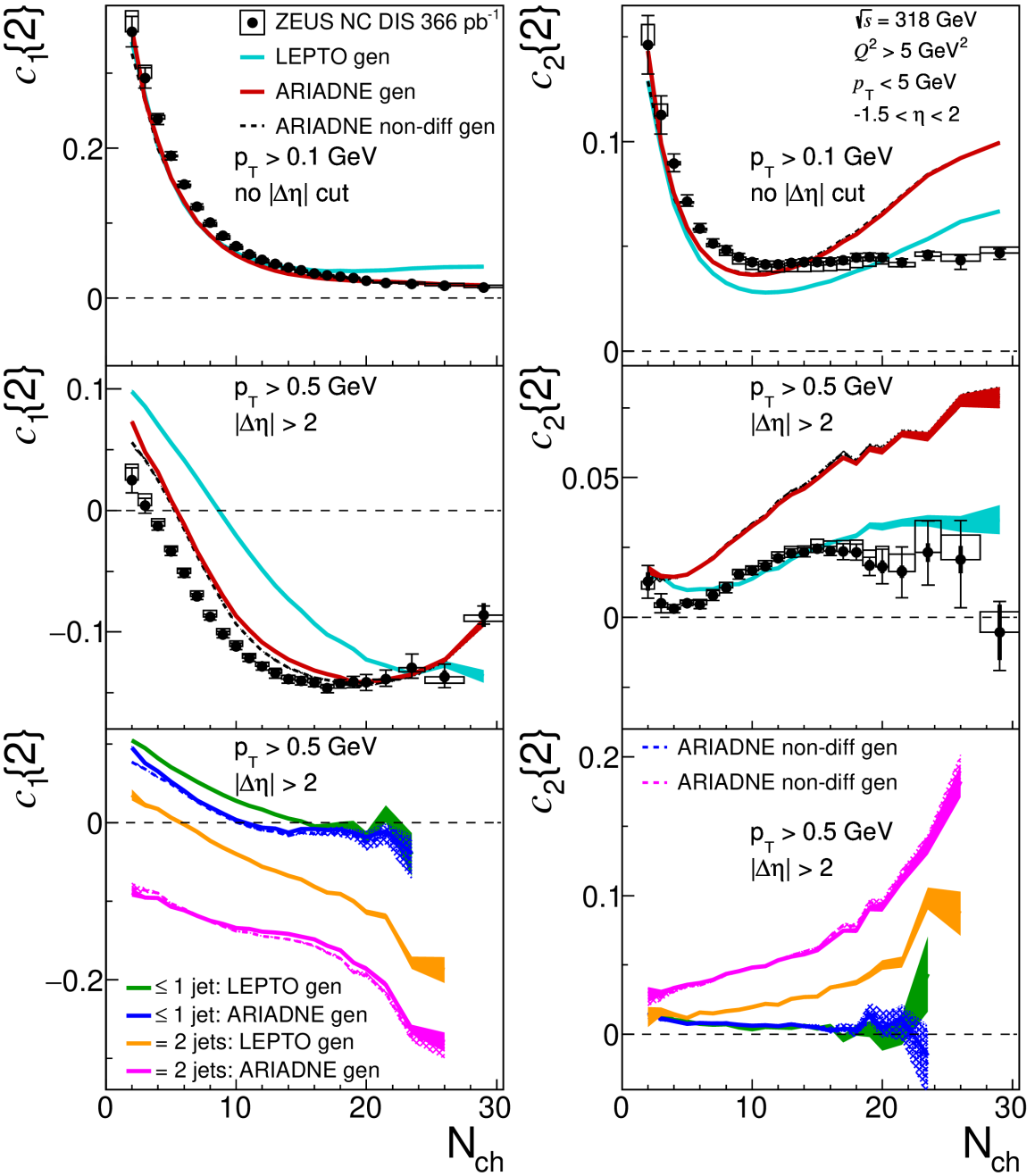


Figure 11

ZEUS

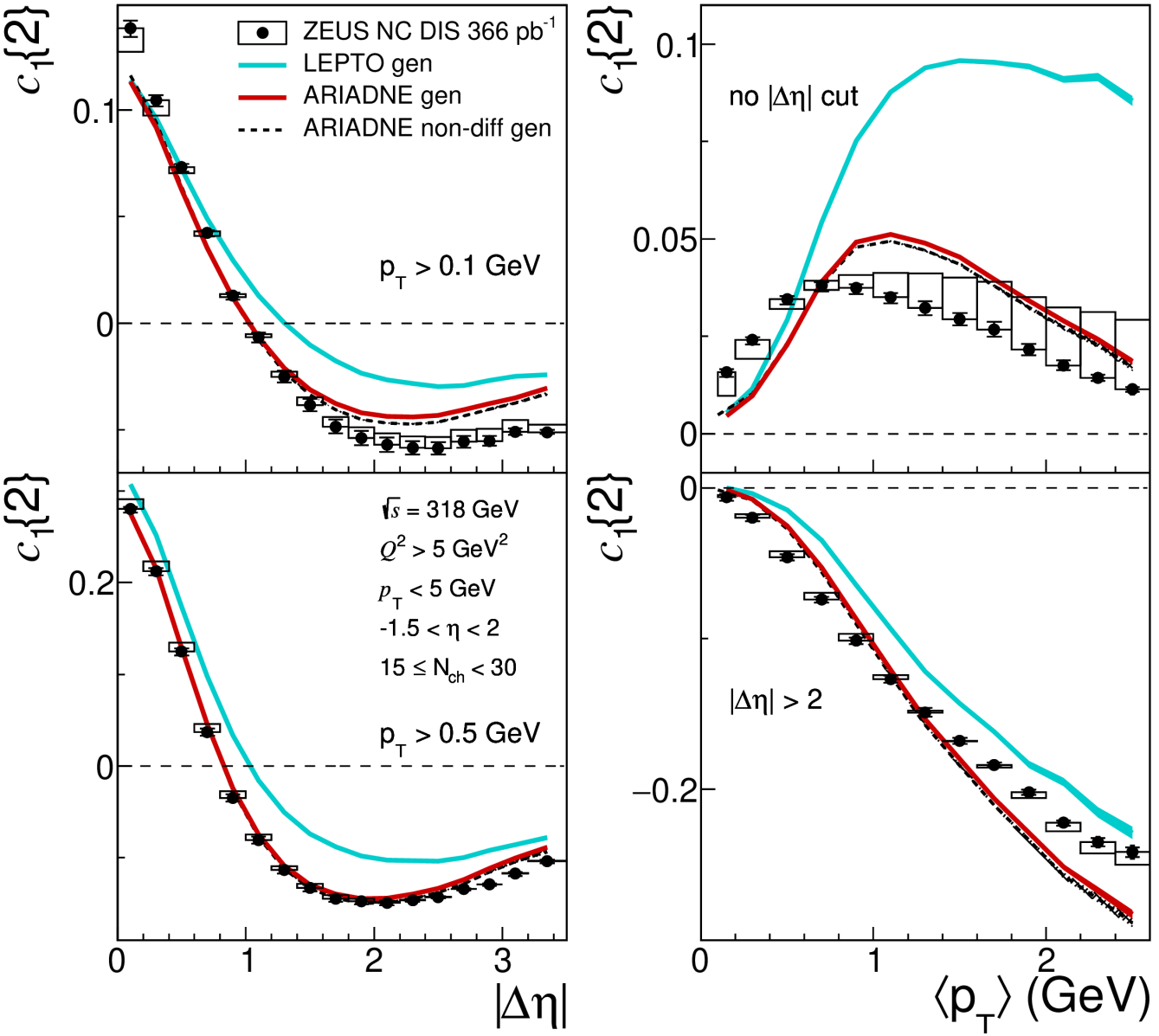


Figure 12

ZEUS