Impact on Low p_T PID on SIDIS measurements

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(Marco Radici, Ralf Seidl, Charlotte Van Hulse, AV)

Some material collected in the document here:
https://docs.google.com/document/d/1fWhPF-c_1qiOM44CttbI3PQ8lKhZJ9qY1wPB4zT0uPk/edit?usp=sharing

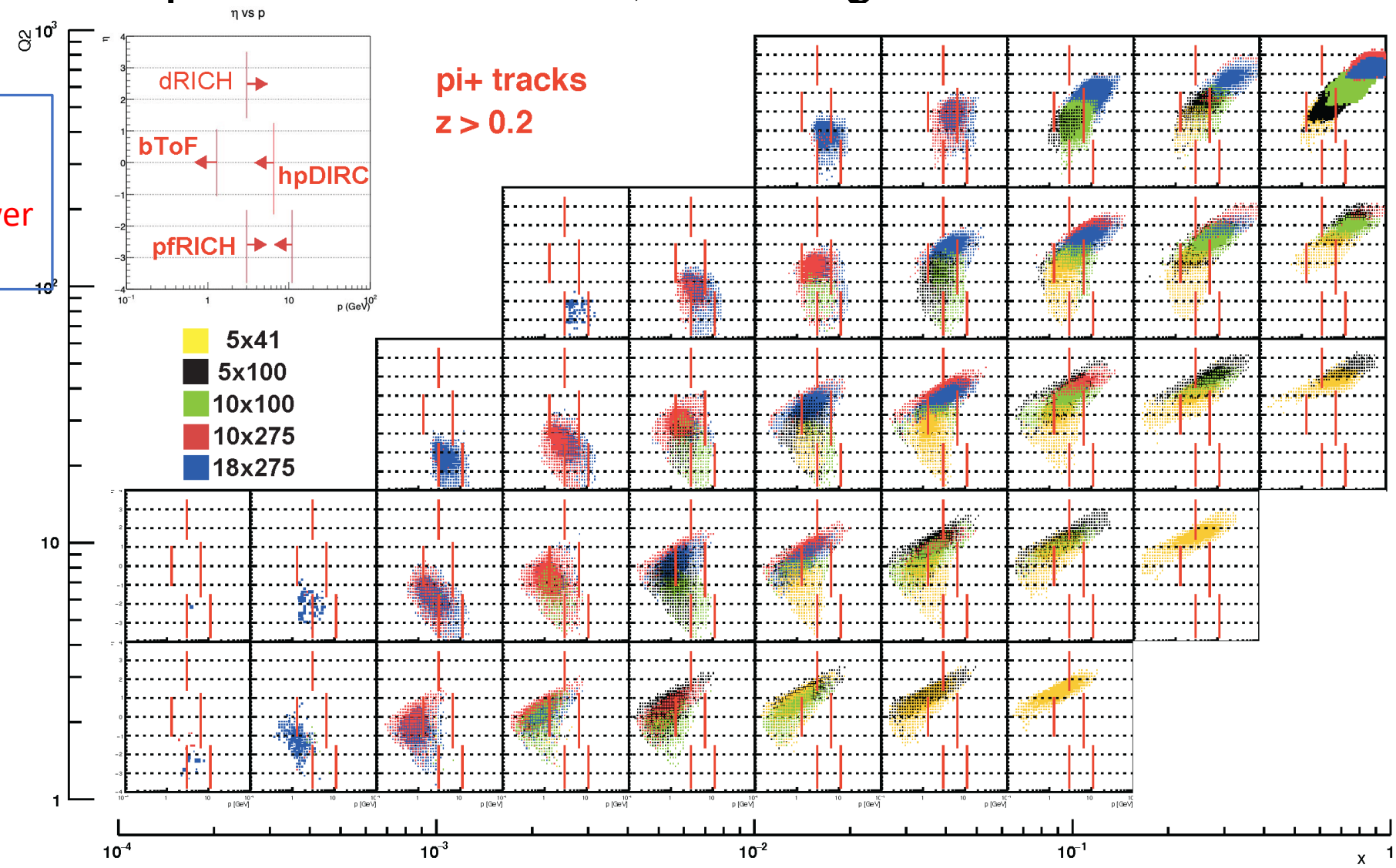
ePIC gGD/I meeting 9/19/2022

General picture: very few events at low p →some impact at low x, low Q^2

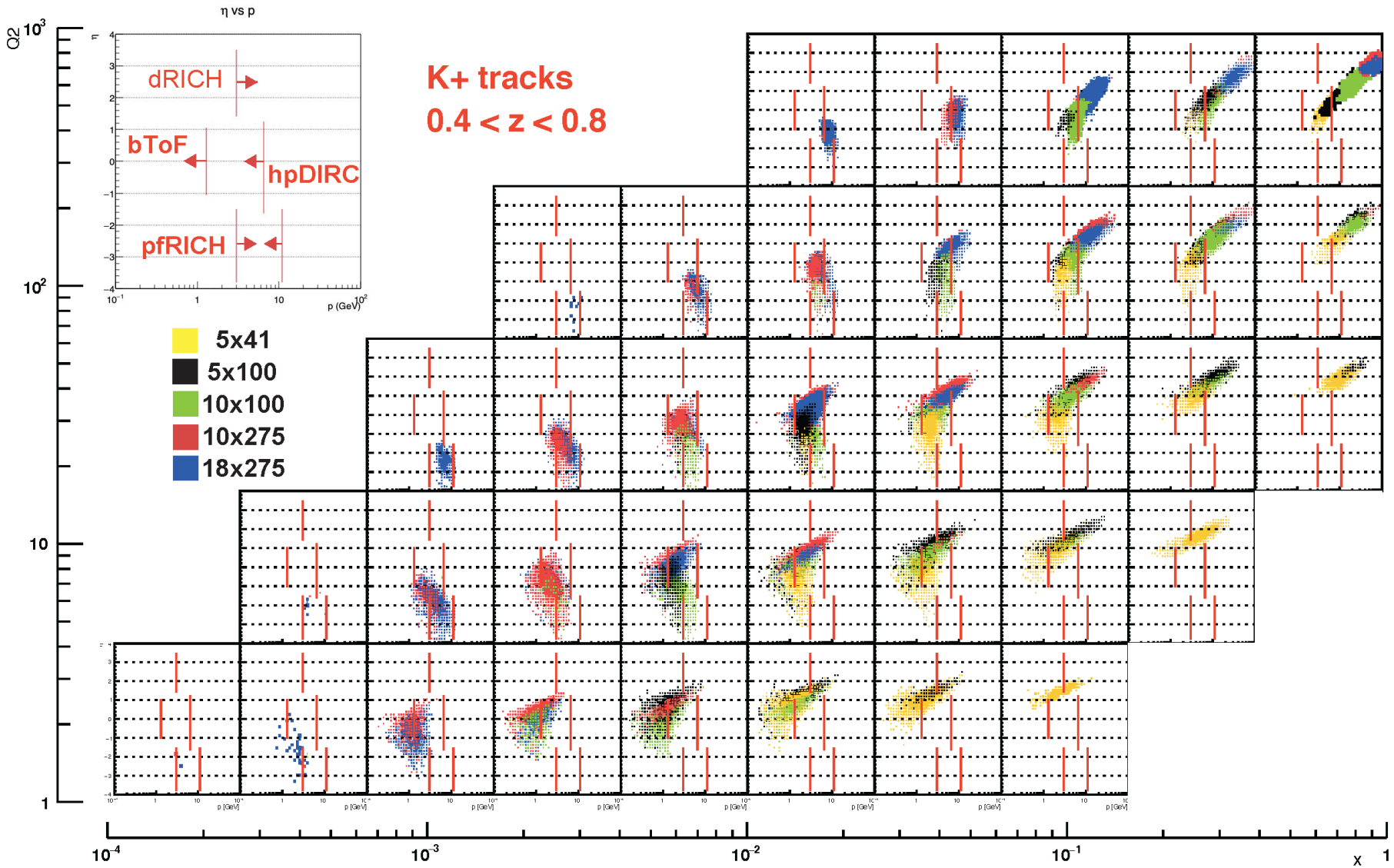
Note that a z cut is applied here
→low z will go to lower p_T

- Some impact of lower threshold in forward direction

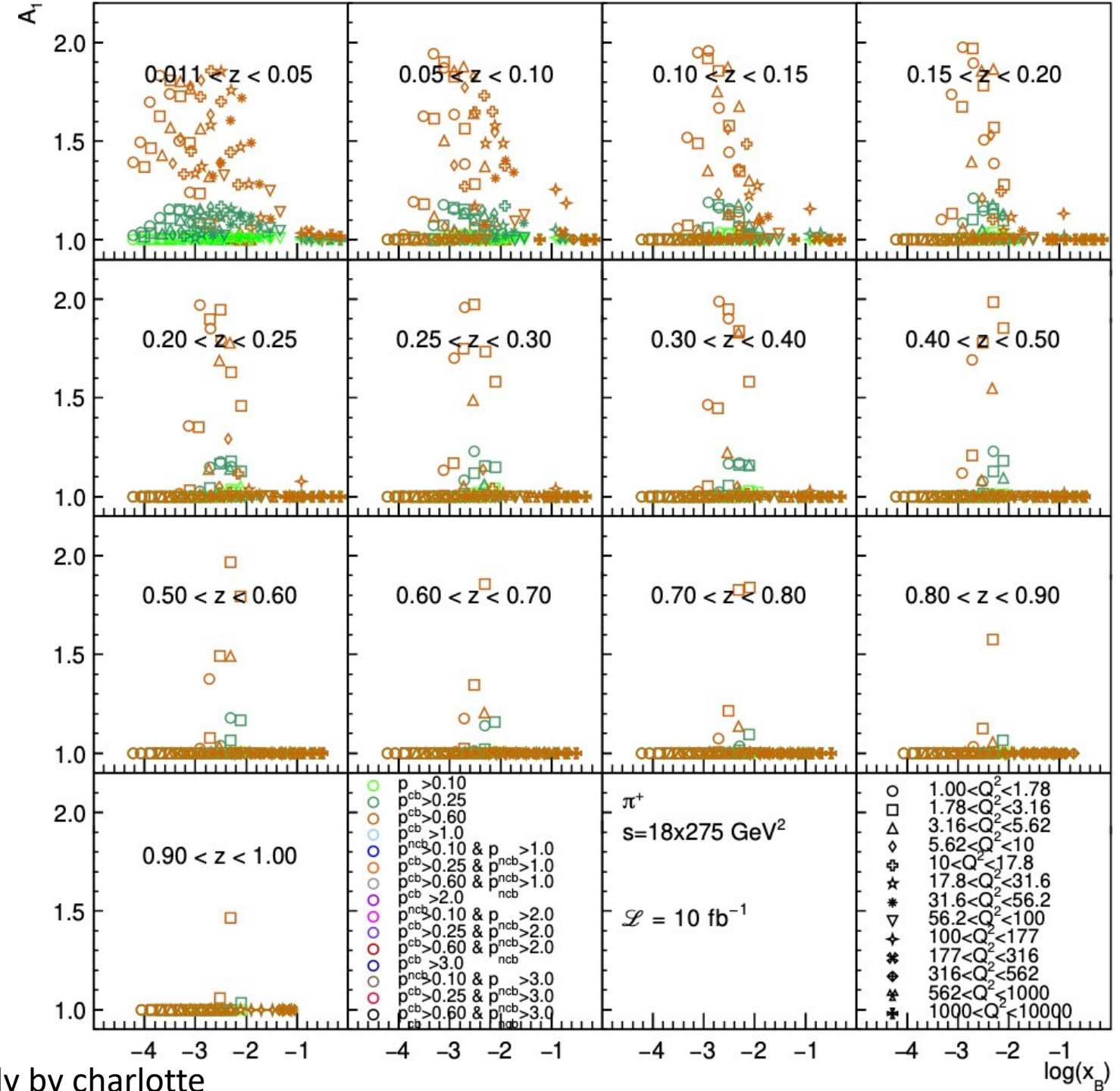
→important not to have gaps!!



Acceptance vs p, η from Athena, see https://wiki.bnl.gov/athena/index.php/SIDIS_Supplemental_Material

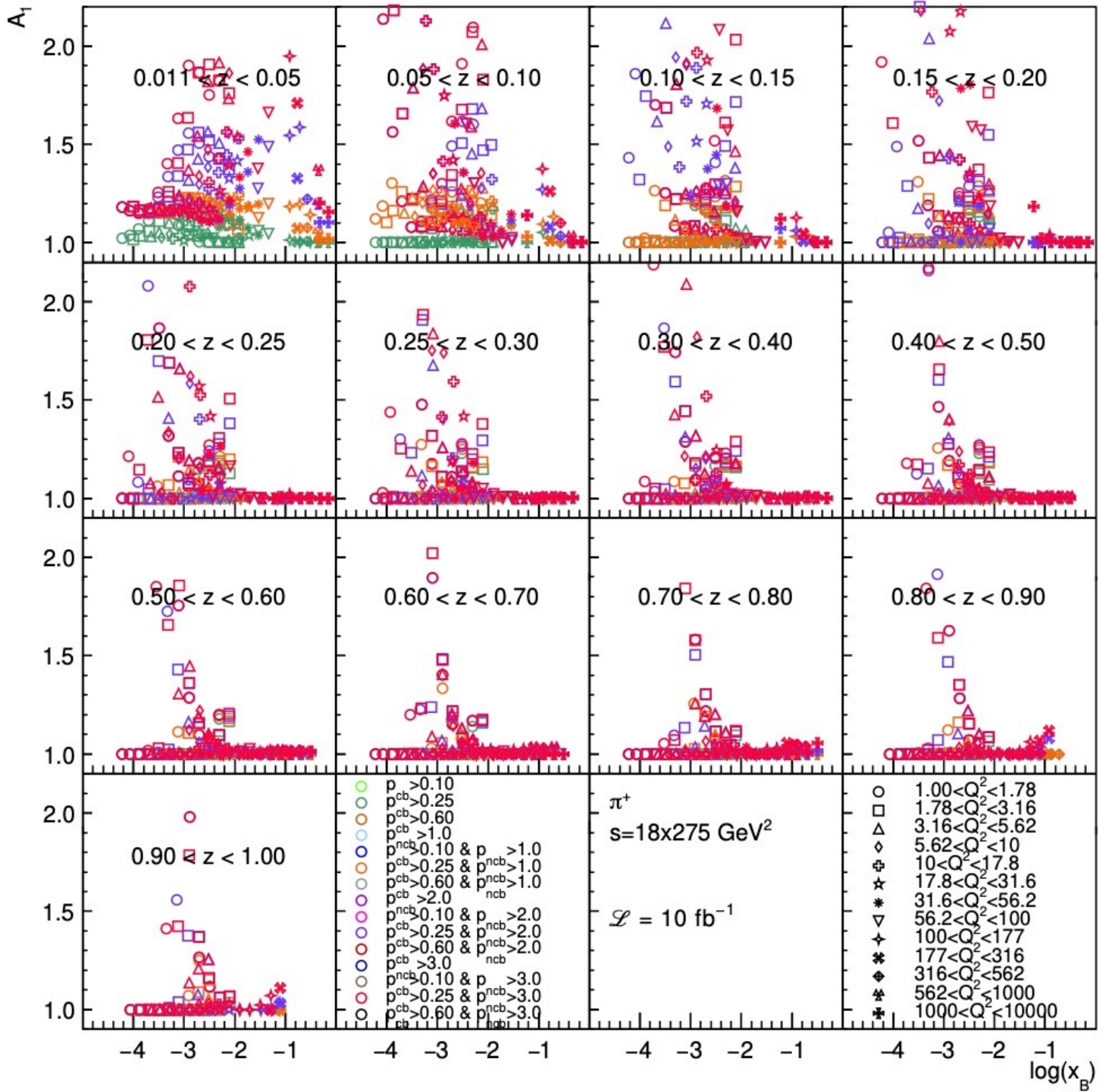

η vs p
dRICH
bToF
hpDIRC
pfRICH
p (GeV)
K+ tracks
0.4 < z < 0.8
5x41
5x100
10x100
10x275
18x275
Q2
10^3
10^2
10
1
10^{-4}
10^{-3}
10^{-2}
10^{-1}
x
1

- Ratio of $\sigma_{A_{LL}}$ with and w/o p cut is shown
- A cut higher than $250\ MeV$ will have a significant impact at low Q^2
- (more details in backup)



Study by charlotte

- Impact of forward PID



A_{LL} summary

- Central region:
  - $p > 0.1$ GeV/c: ideal
  - $p > 0.25$ GeV/c: ~40% increase in statistical uncertainty at low z ($z < 0.1$)
  - $p > 0.6$ GeV/c: ~ up to double the statistical uncertainty for z<0.5.
  - for kaons smaller increase in statistical uncertainty (rather 1.5 times).
  - Forward region:
  - $p > 1.0$ GeV/c: ~10-20% increase in statistical uncertainty at low z ($z < 0.1$).
  - $p > 2.0$ GeV/c: ~1.5 times statistical uncertainty (more pronounced at low z).
  - $p > 3.0$ GeV/c: ~ up to double the statistical uncertainty (more pronounced at low z)

Di-Hadrons

- From Yellow Report:

→low momentum cutoff needed for PW decomposition

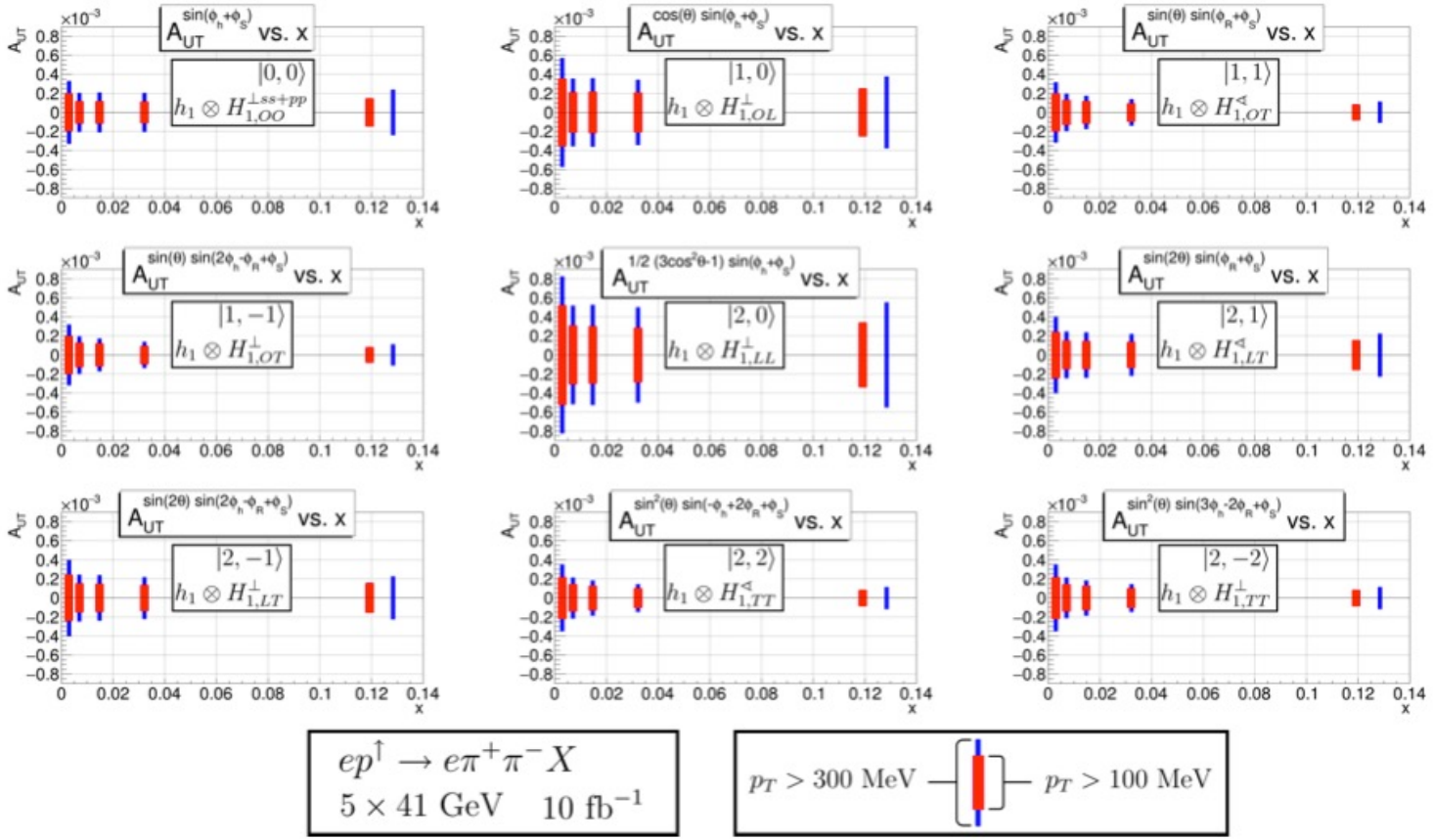
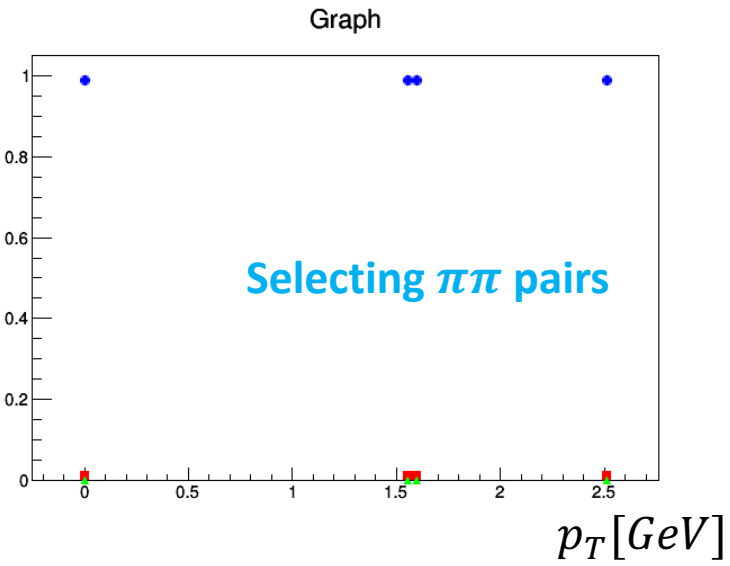
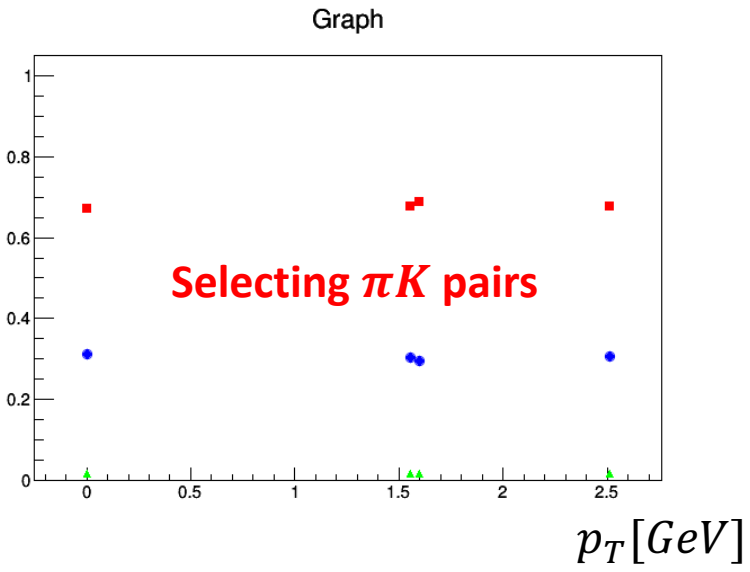
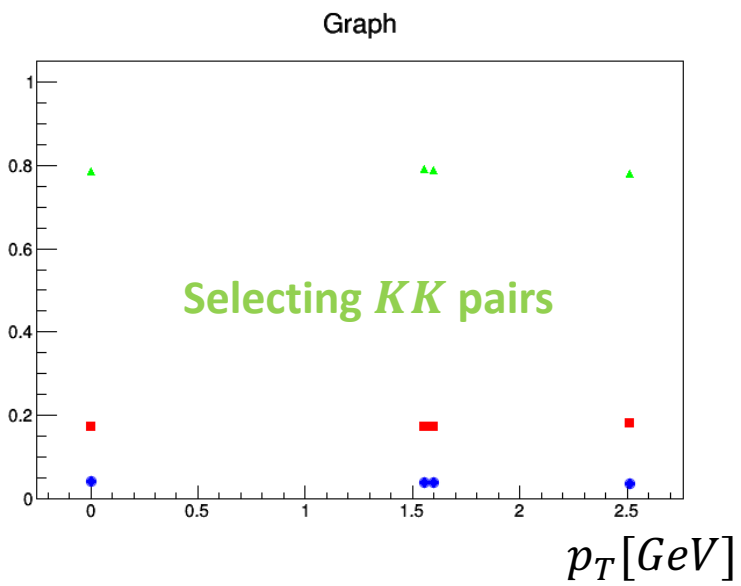


Figure 8.33: Statistical uncertainties estimated for the PW decomposition up to L=2 for $H_1^{\sphericalangle}$ for 10 fb^{-1} at 5 $GeV\times$ 41 GeV. Narrow blue bands correspond to a requirement of p_T >300 MeV and wide, red bands to a requirement of p_T >100 MeV on the pion tracks. The labels on the figure indicate the m, l state and which PDF and FF the PW is sensitive to.

Need for large separation for di-hadron measurements (generalizes for other jet correlation measurements)
→Using 2 σ separation

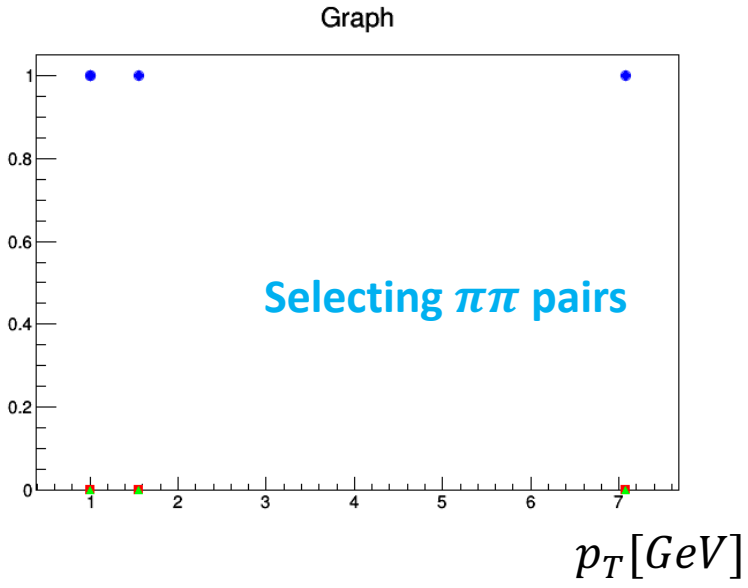


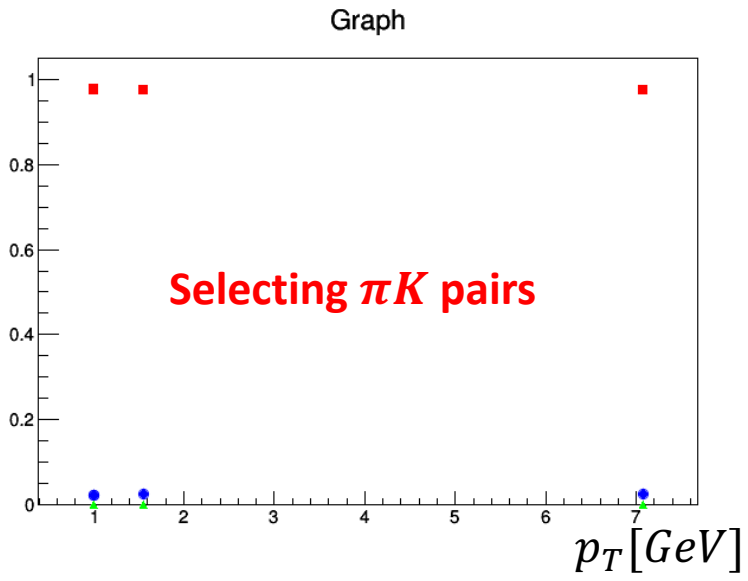


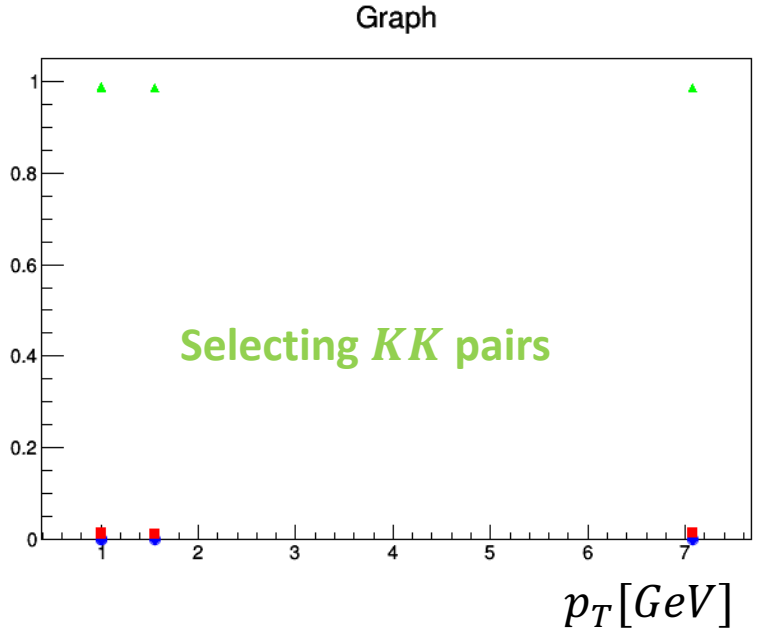


- **Fraction of reconstructed $\pi\pi$ pairs**
- **Fraction of reconstructed πK pairs**
- **Fraction of reconstructed KK pairs**

Using 3 σ separation



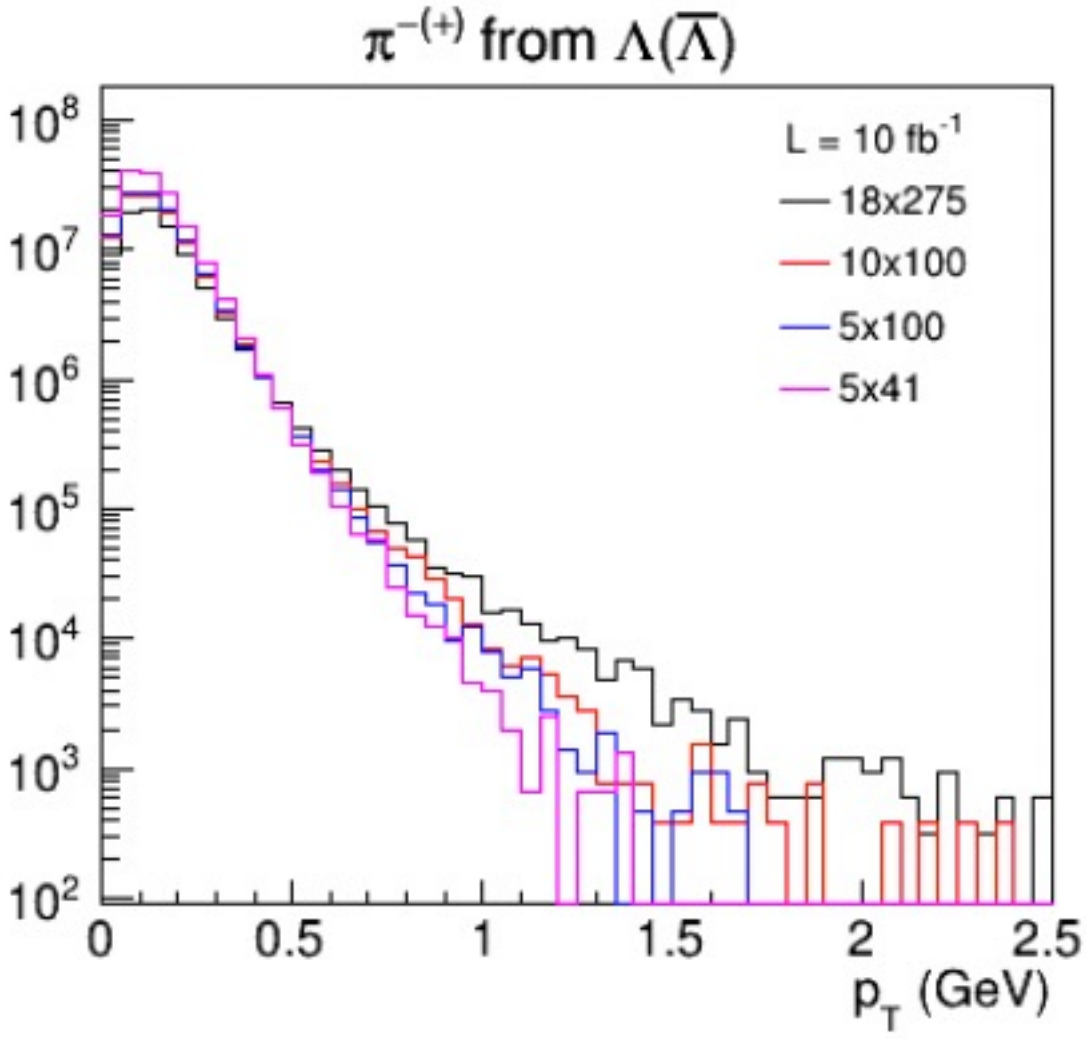




- Fraction of reconstructed $\pi\pi$ pairs
- Fraction of reconstructed πK pairs
- Fraction of reconstructed KK pairs

Lambda

- Pion from Λ decay very soft
- Need excellent tracking efficiency for displaced tracks at low momenta(not studied in detail yet)
- PID would be helpful, but likely not a dealbreaker as the proton id and displaced vertex should



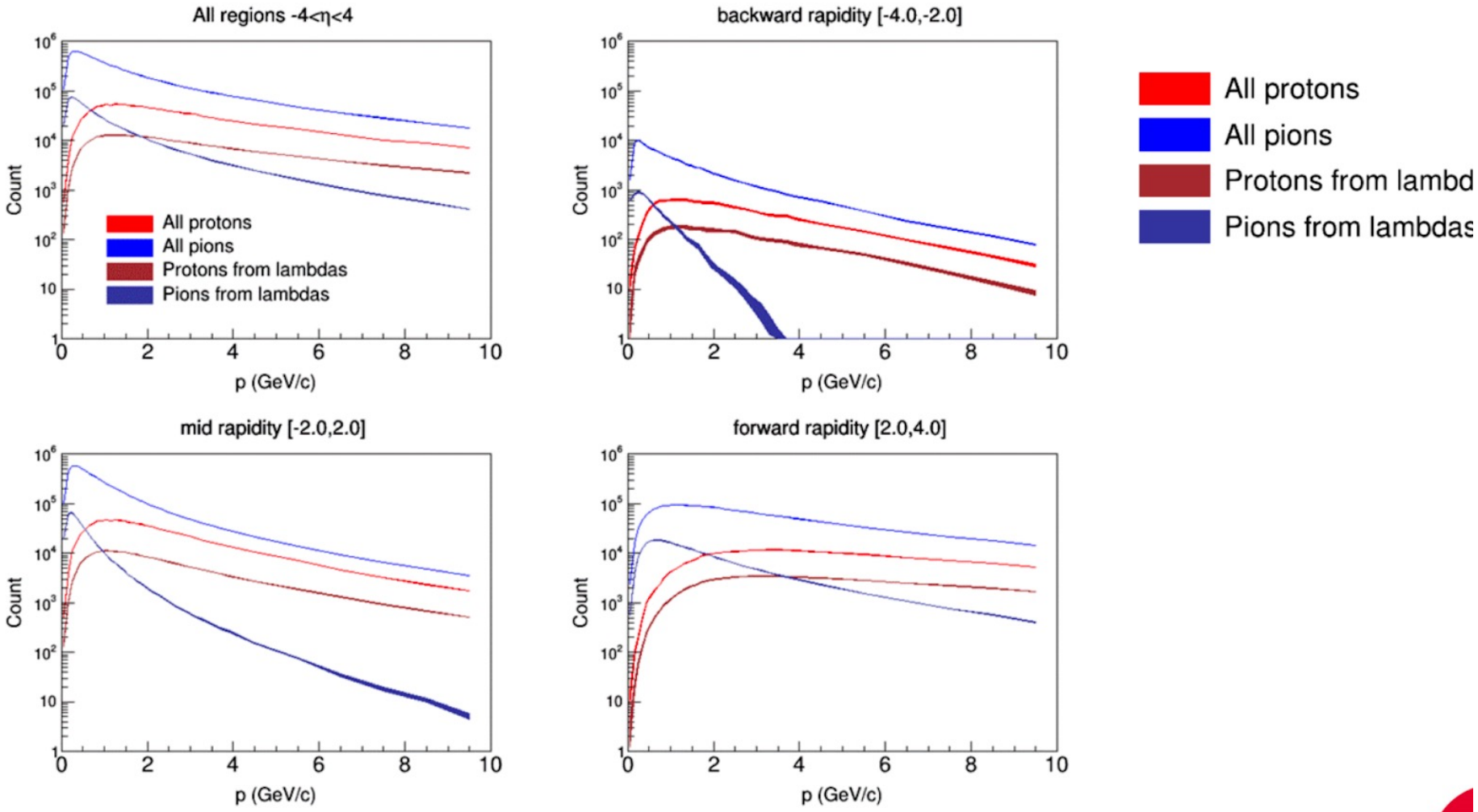
From YR

Summary

- Low momentum tracking and PID have impact on some SIDIS measurements
- Ideally $p > 100$ MeV, but $p > 250$ MeV seems still acceptable in the central region
- Similarly, forward going down to $1\ GeV$ would be ideal

- Note of caution: In particular for di-hadrons, a good separation ($3\ \sigma$) is also needed. Just positive π id might not be enough for kaon measurements (needs to be studied in more detail)

Backup

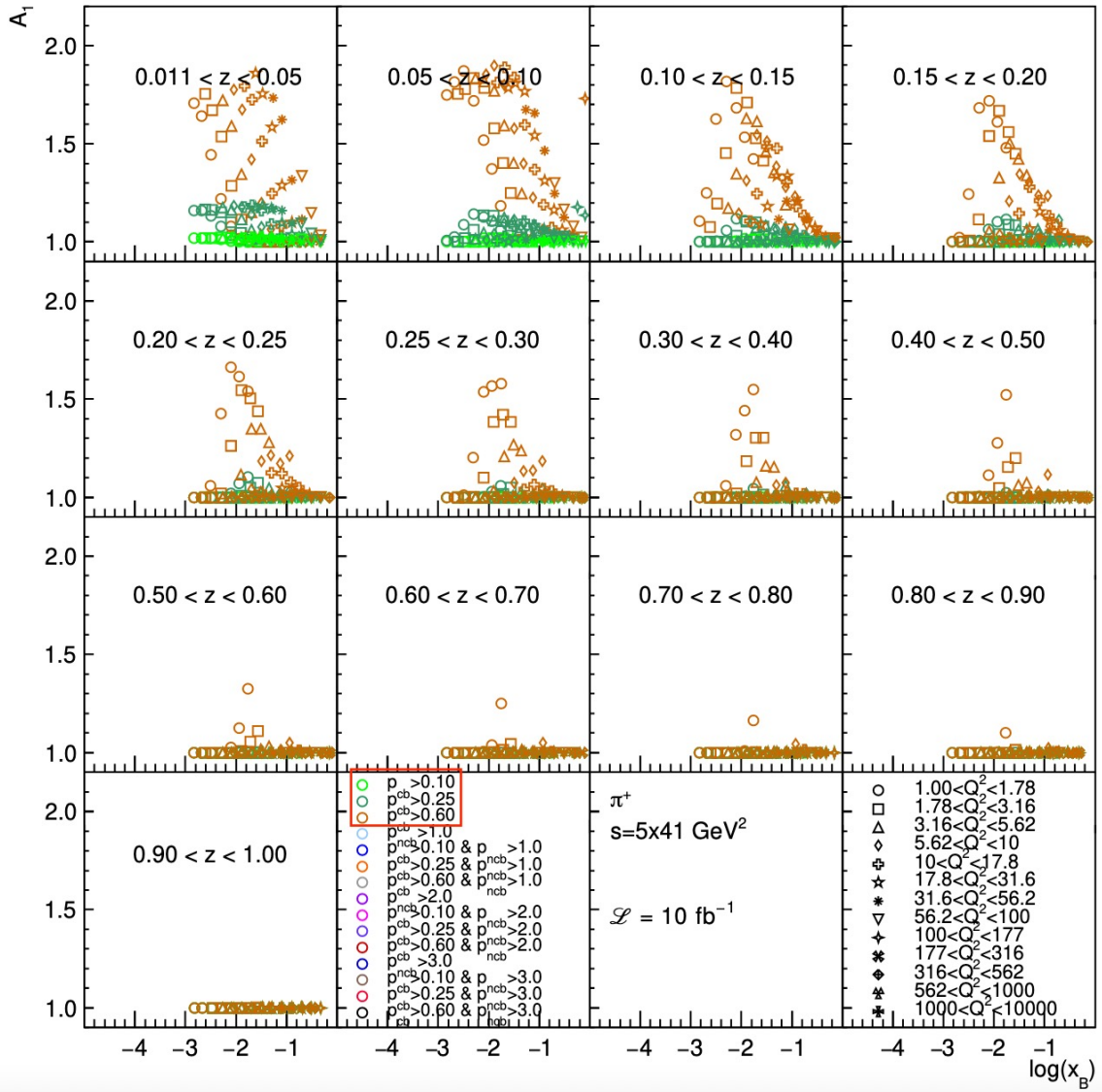


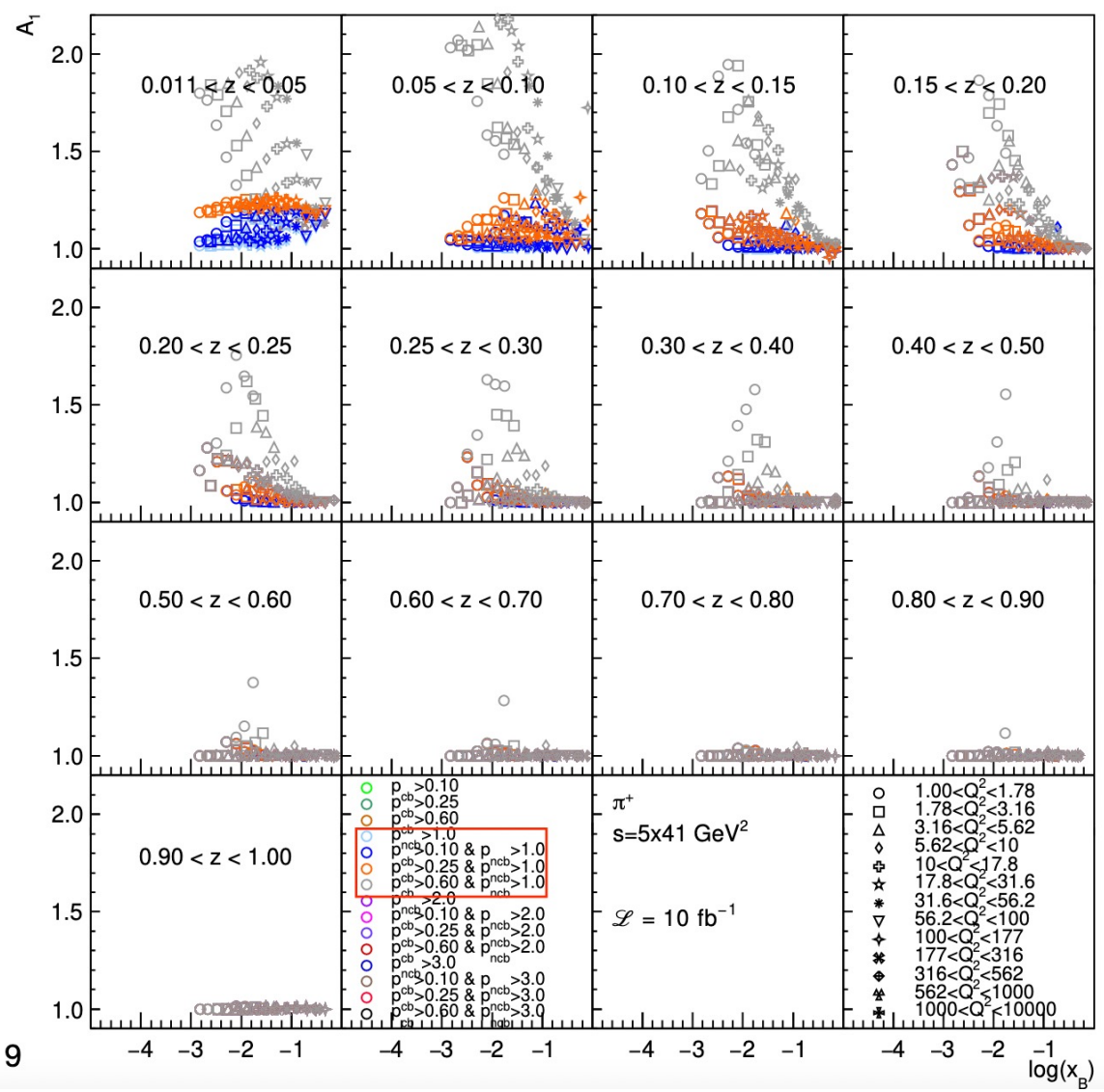
- Momentum distribution of Lambda daughters' vs all pions (and protons) distribution

Study by Enea Prifti (UIC)

Ratio of statistical uncertainty of A_{LL} for various p cuts

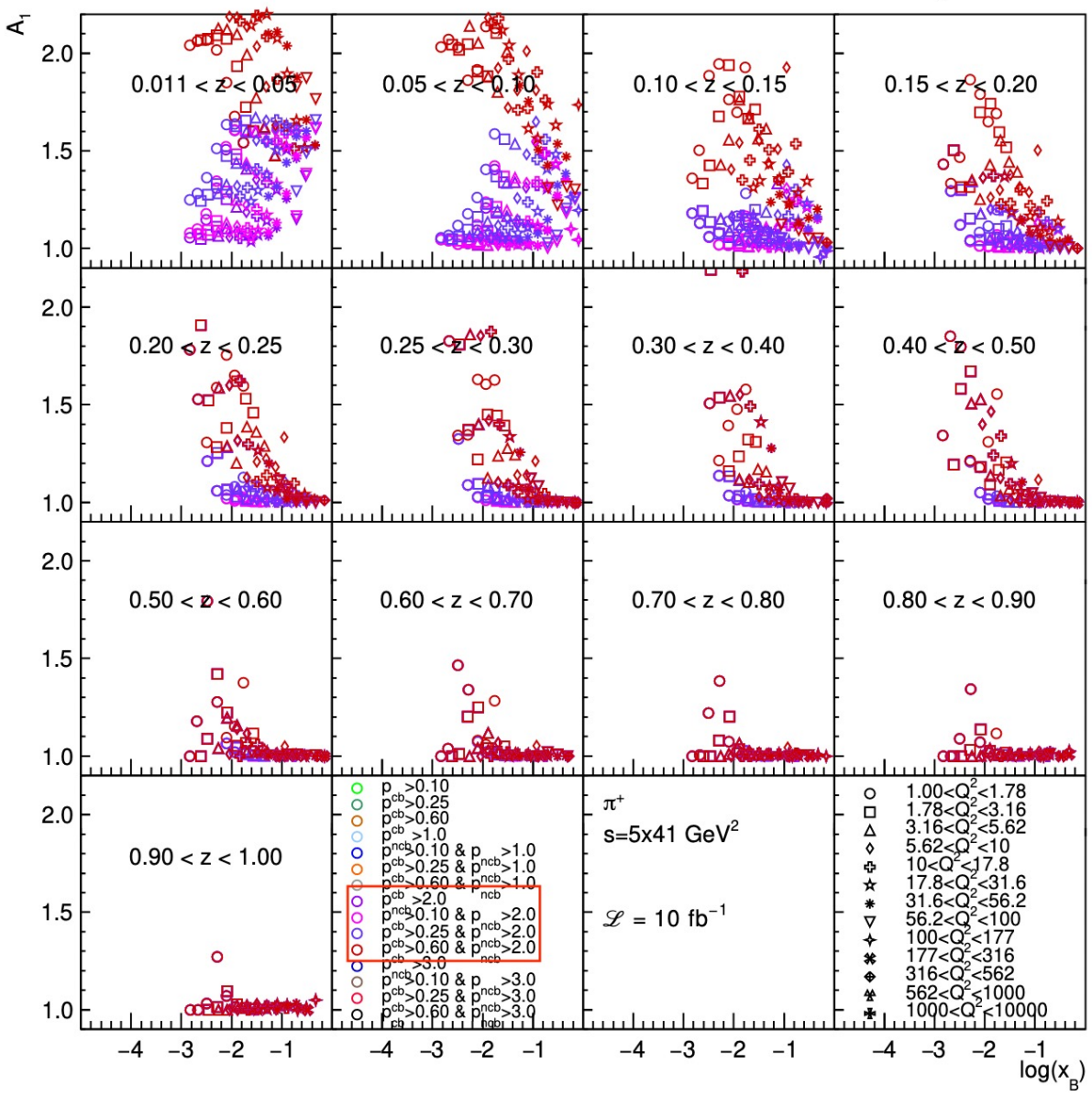
pions E=5x41 GeV^2

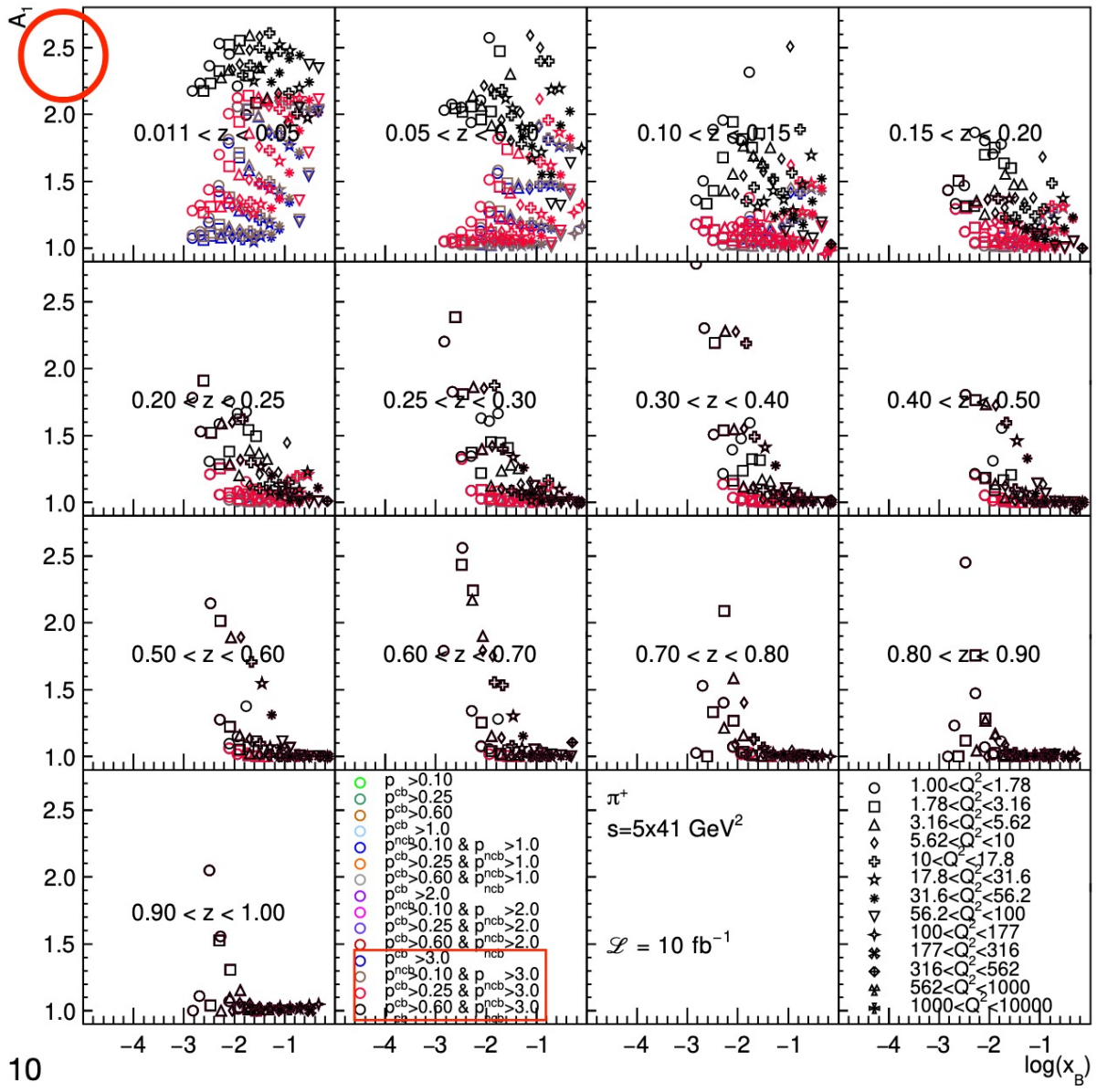


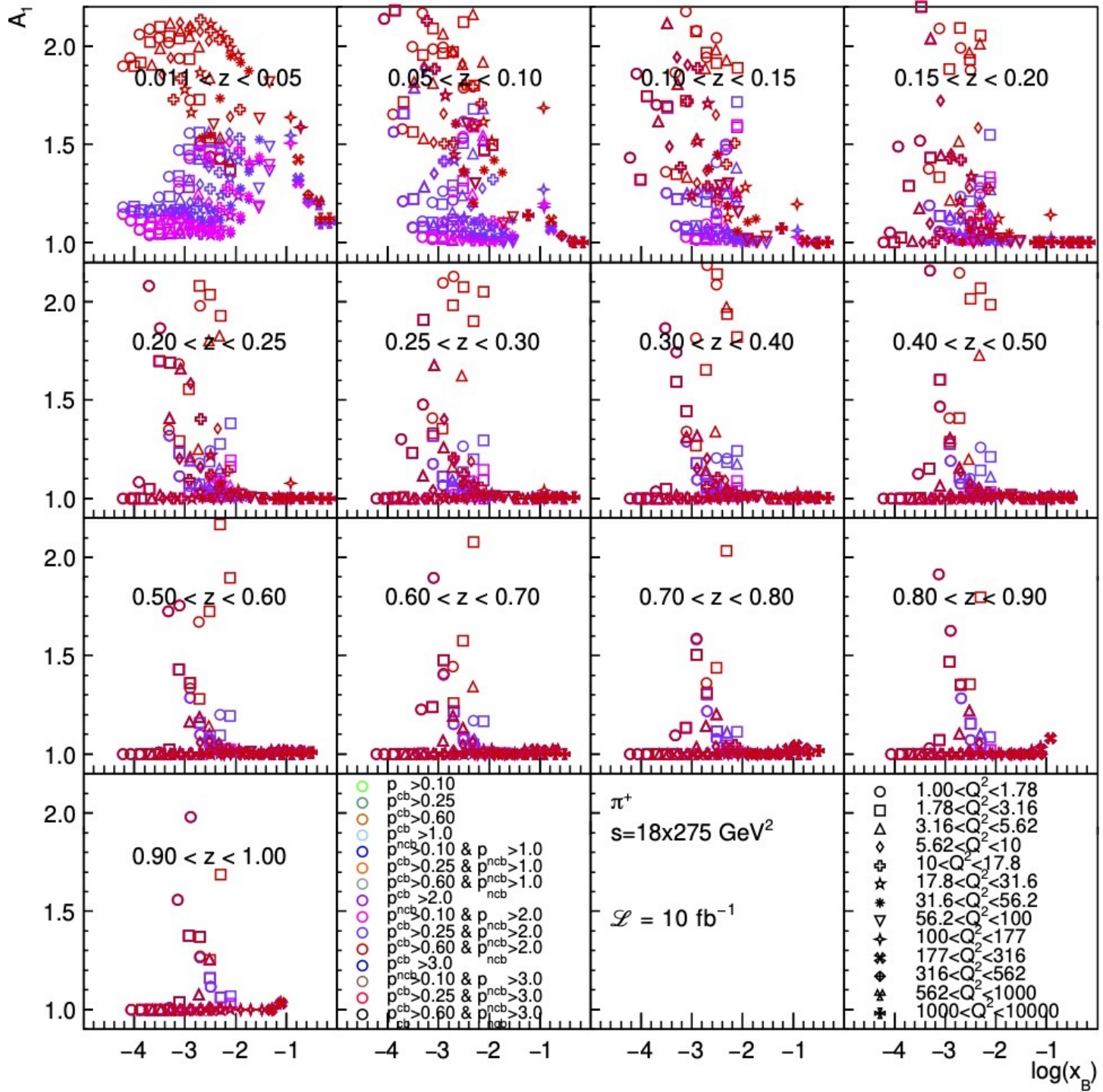


Ratio of statistical uncertainty of A_{LL} for various p cuts

pions E=5x41 GeV²

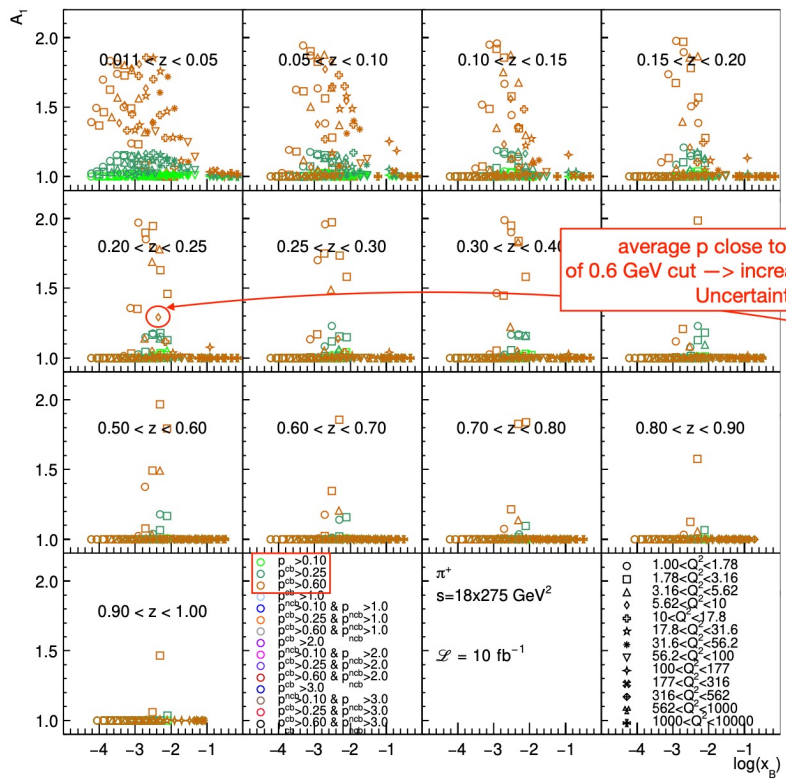





A1
0.01 < z < 0.05
0.05 < z < 0.10
0.10 < z < 0.15
0.15 < z < 0.20
0.20 < z < 0.25
0.25 < z < 0.30
0.30 < z < 0.40
0.40 < z < 0.50
0.50 < z < 0.60
0.60 < z < 0.70
0.70 < z < 0.80
0.80 < z < 0.90
0.90 < z < 1.00
p_T^cb>0.10
p_T^cb>0.25
p_T^cb>0.60
p_T^cb>1.0
p_T^ncb>0.10 & p_T^cb>1.0
p_T^cb>0.25 & p_T^ncb>1.0
p_T^cb>0.60 & p_T^ncb>1.0
p_T^cb>2.0
p_T^ncb>0.10 & p_T^cb>2.0
p_T^cb>0.25 & p_T^ncb>2.0
p_T^cb>0.60 & p_T^ncb>2.0
p_T^cb>3.0
p_T^ncb>0.10 & p_T^cb>3.0
p_T^cb>0.25 & p_T^ncb>3.0
p_T^cb>0.60 & p_T^ncb>3.0
π+
s=18x275 GeV2
ℒ = 10 fb−1
1.00<Q2<1.78
1.78<Q2<3.16
3.16<Q2<5.62
5.62<Q2<10
10<Q2<17.8
17.8<Q2<31.6
31.6<Q2<56.2
56.2<Q2<100
100<Q2<177
177<Q2<316
316<Q2<562
562<Q2<1000
1000<Q2<10000
log(xB)

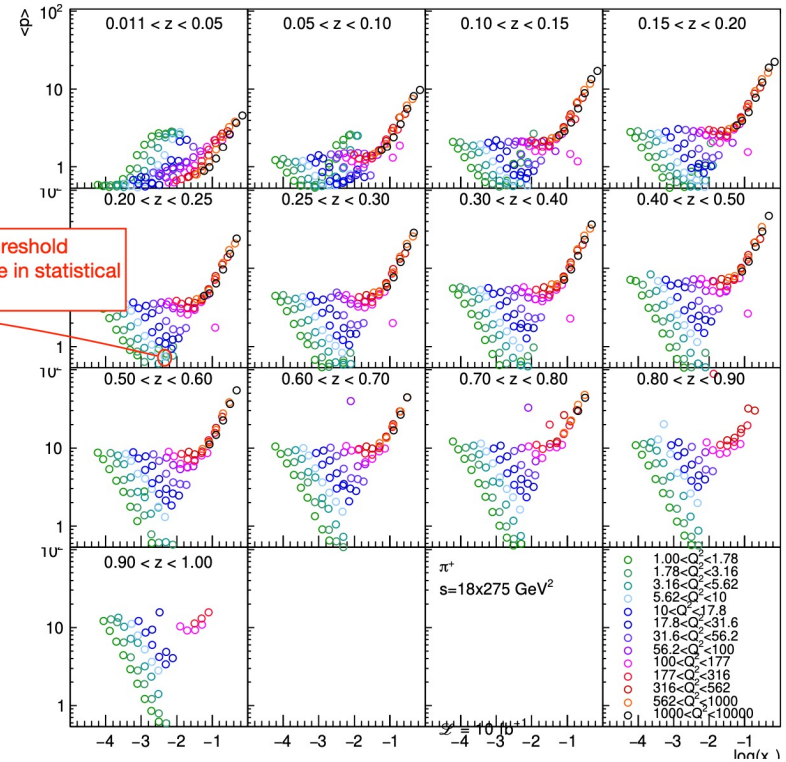
pions E=18x275 GeV²

Ratio of statistical uncertainty of A_{LL} for various p cuts

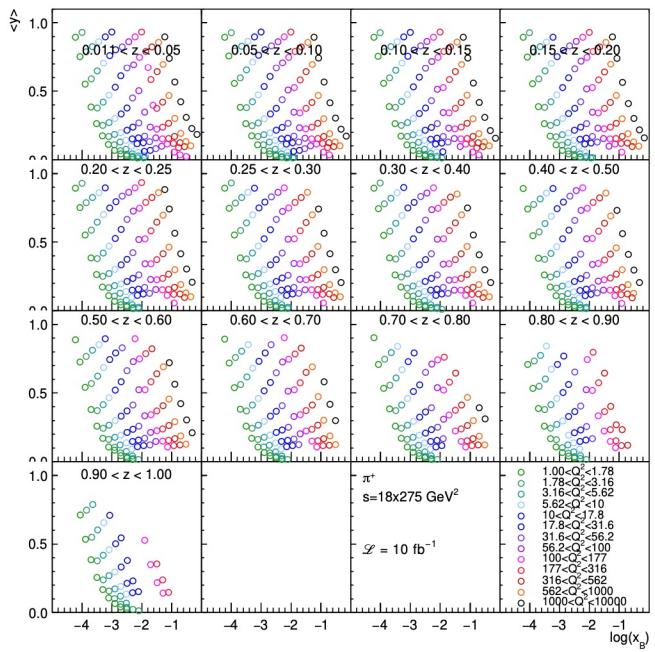


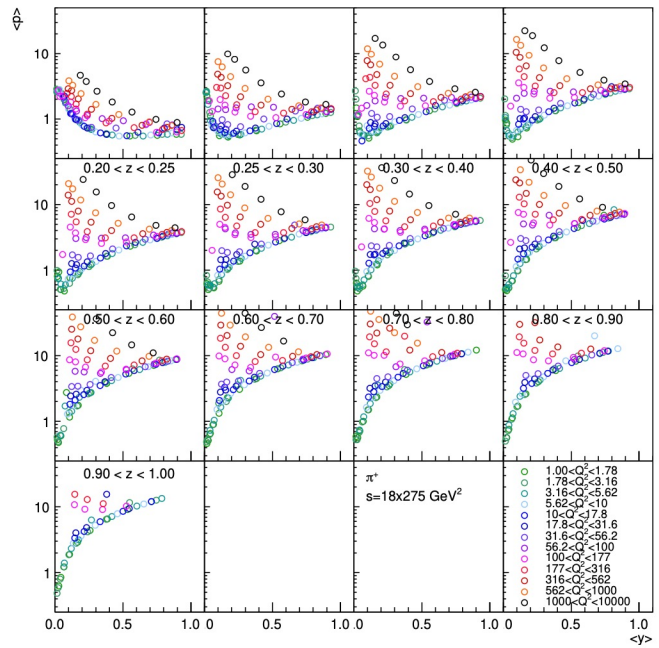
average p close to threshold of 0.6 GeV cut —> increase in statistical Uncertainty

Momentum as a function of x_B



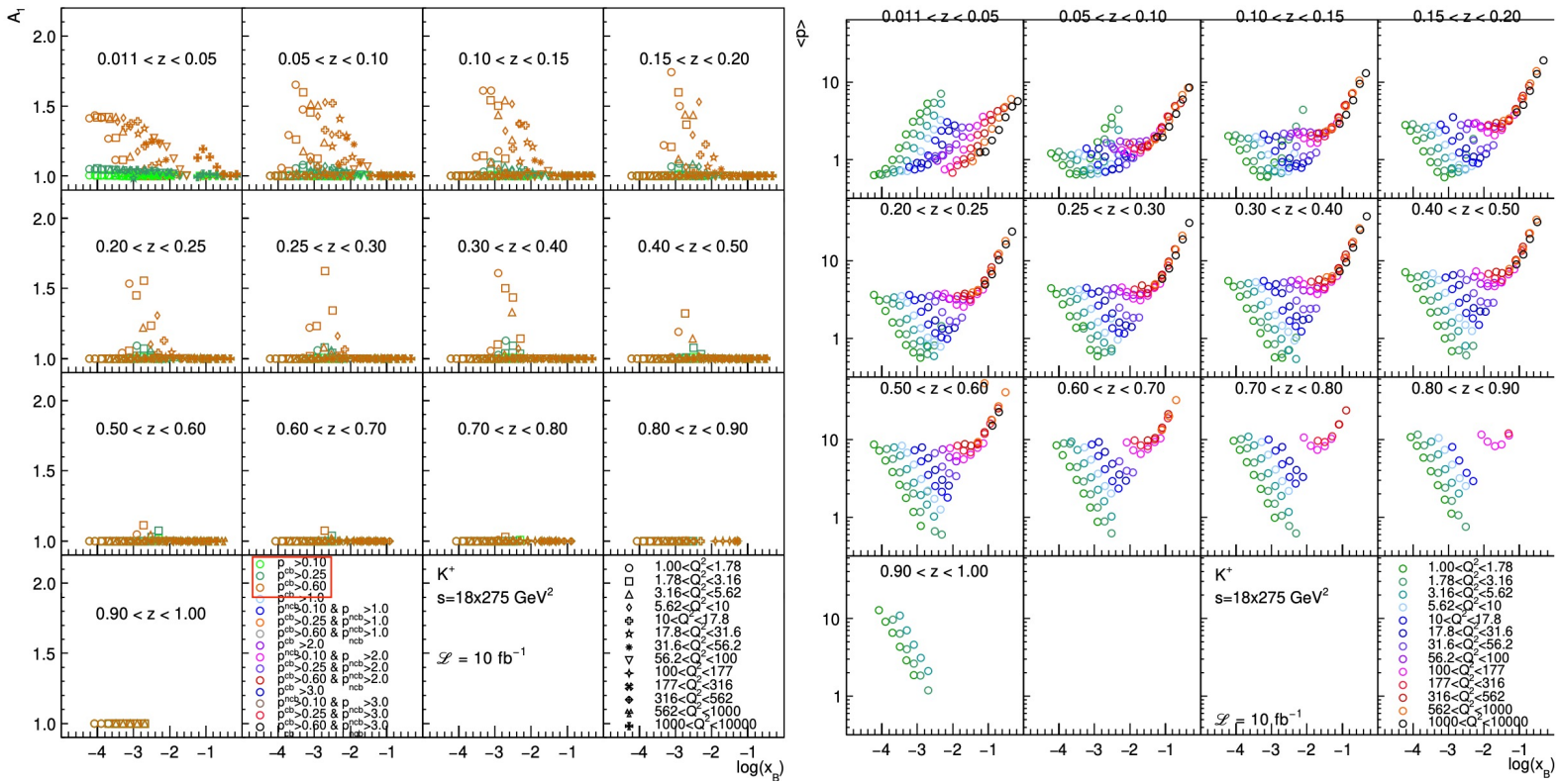
pions E=18x275 GeV²





Ratio of statistical uncertainty of A_{LL} for various p cuts

kaons E=18x275 GeV²



- For more, see Charlotte’s study at the SIDIS meeting 8/23:
- https://indico.bnl.gov/event/16763/contributions/67265/attachments/42926/72139/pcutstudies_ALL.pdf