RGH UPDATE

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COVERED PHASE SPACE and FUTURE IMPROVEMENT for MULTI-DIMENSIONAL SSA MEASUREMENT

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DATA ANALIZED

This analysis uses already selected data, generated from **Duke University** (provided by Matthew McEneaney).

It will consider **Semi-Inclusive DIS** processes with a **single** π^+ in the final state, from collision among e^- and a **transverse polarized target** of NH_3.

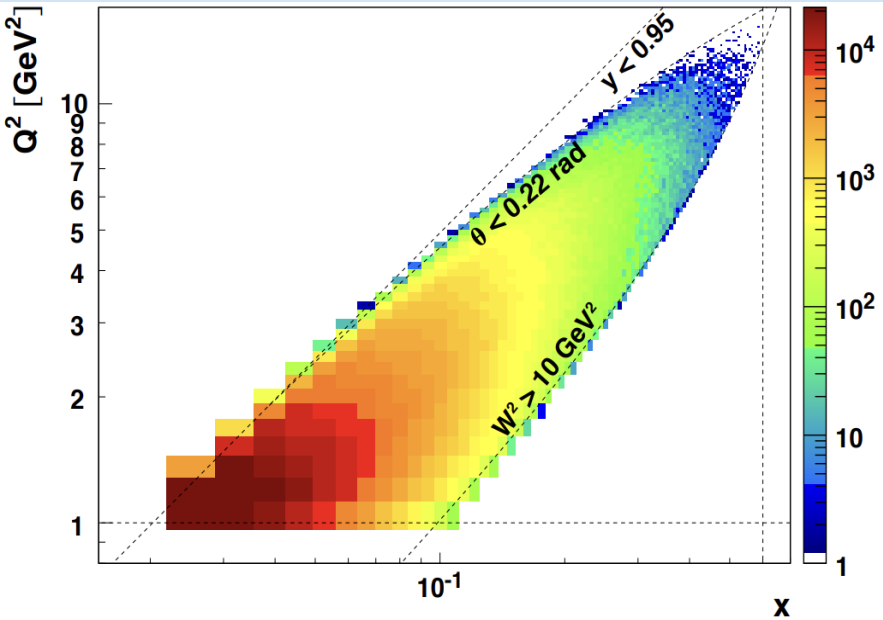
While Duke will focus on **dihadron** processes ($\pi^+\pi^-$).

The objective is to highlight that **RGH** has the potential to explore a **different** and **uncharted phase space** compared to previous **HERMES** and **COMPASS** analyses.

And also to compare the precision of spin asymmetry measurements (in 4D) with those from previous studies in lower dimensions, such as **HERMES** (3D) and **COMPASS** (2D).

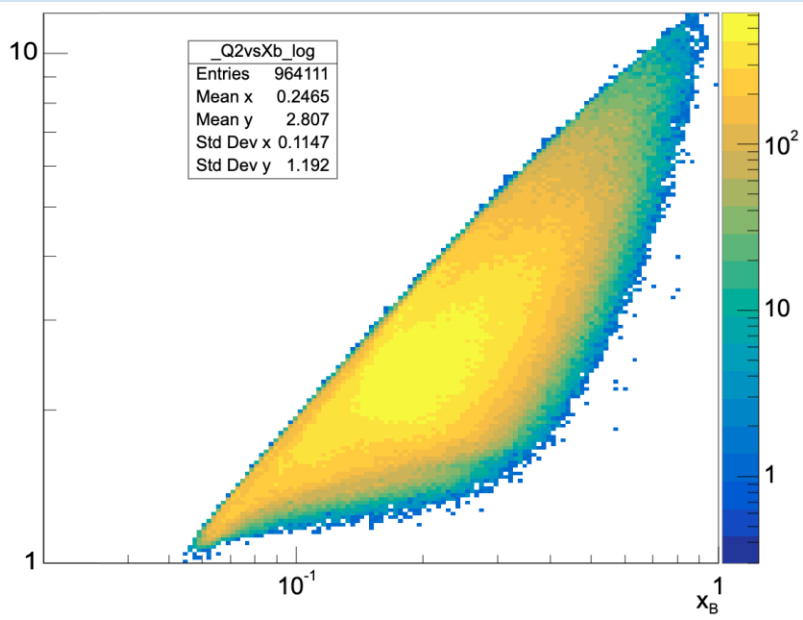
DIFFERENT REGION COVERED - x_B vs Q^2

HERMES

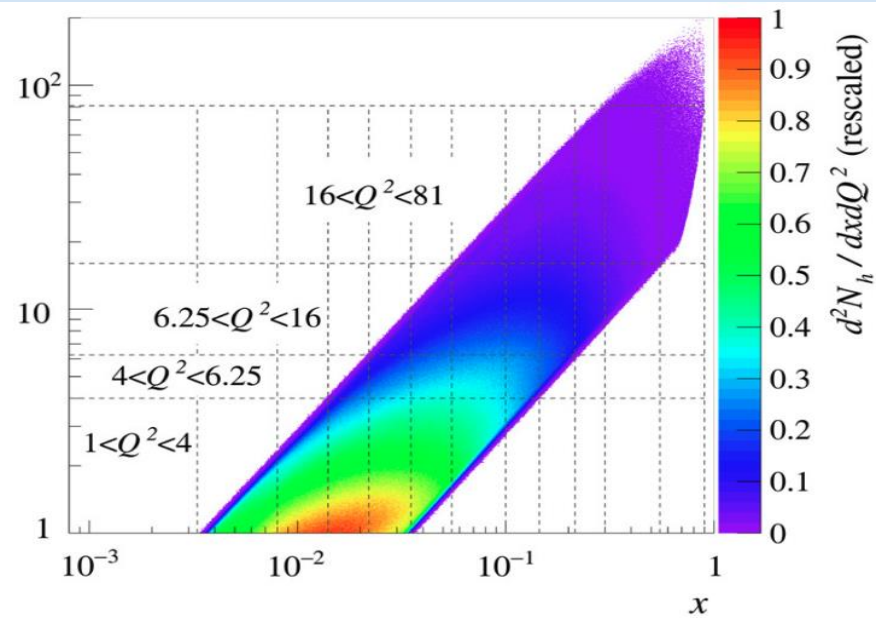


JHEP12(2020)010

CLAS RGH

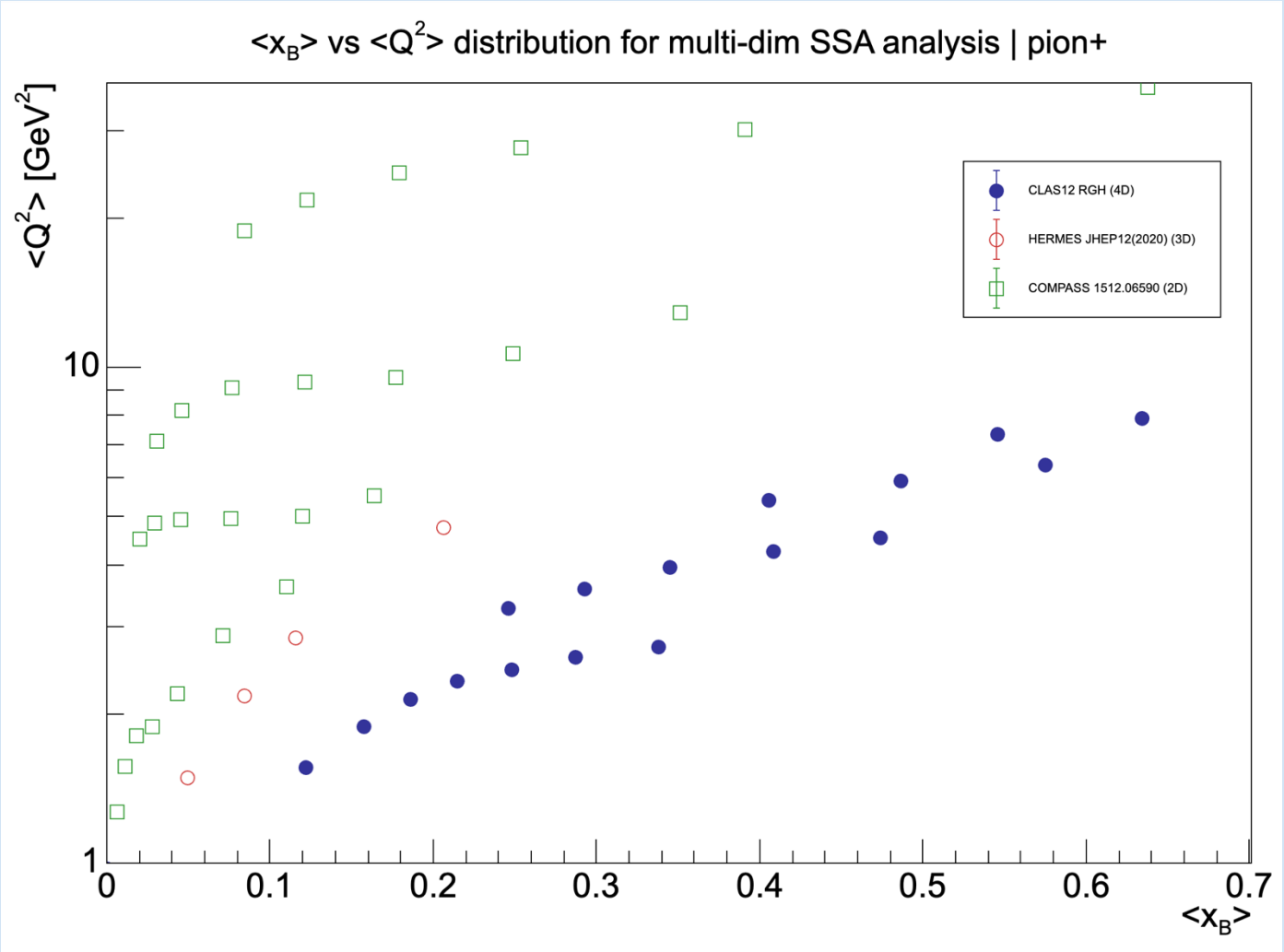


COMPASS



Physics letters B 770(2017)138-145

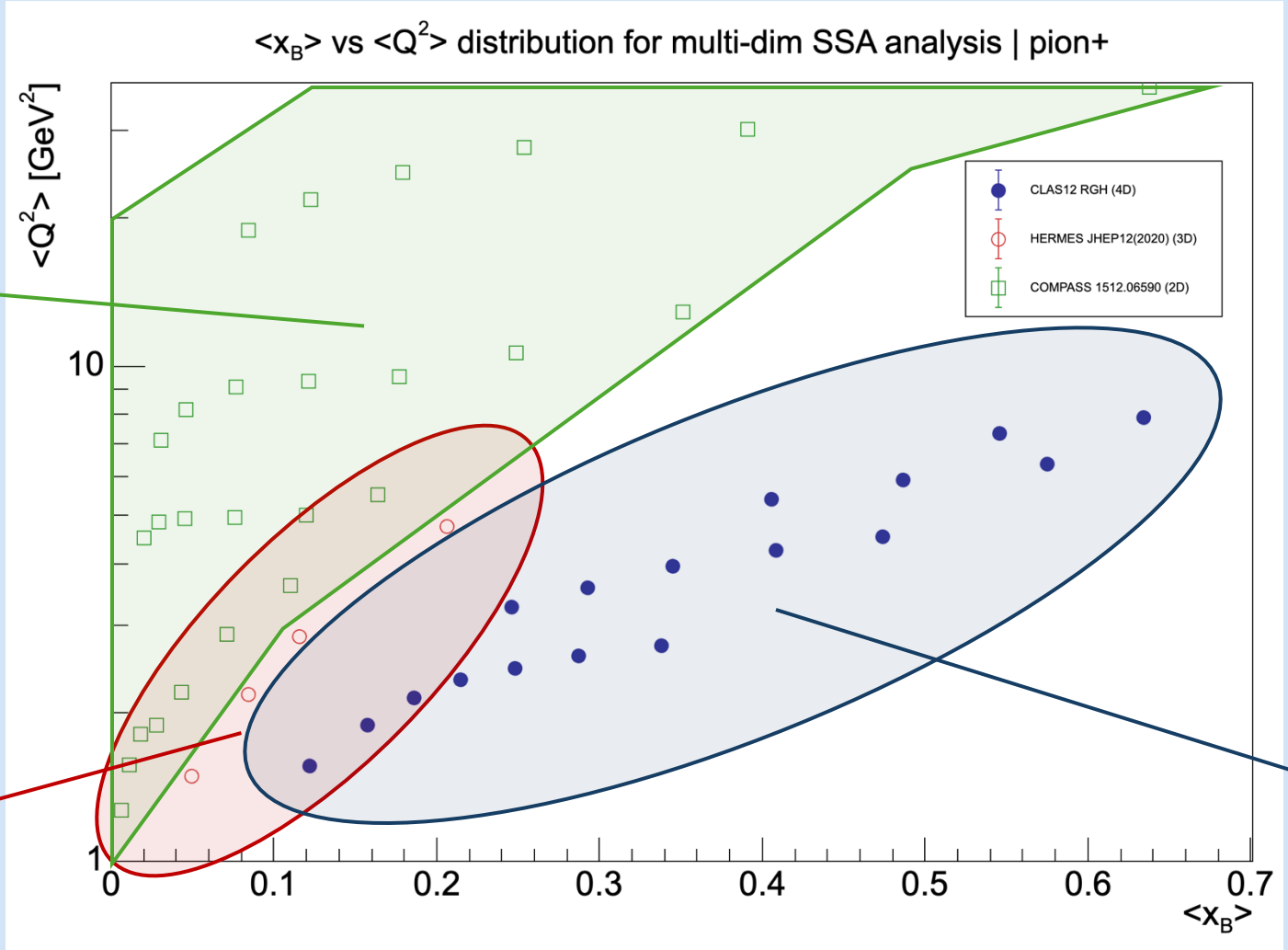
REGION COVERED - x_B vs Q^2



REGION COVERED - x_B vs Q^2

COMPASS: 2D measurement as a function of Q^2, x_B.

HERMES: 3D measurement as a function of x_B, z, P_{hT}.

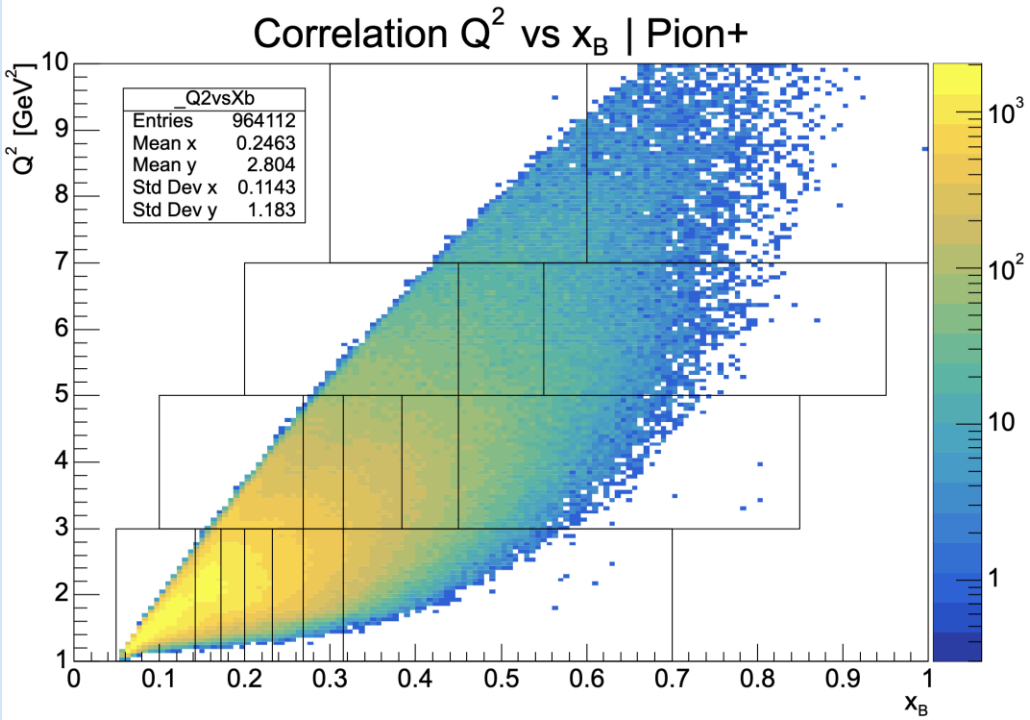


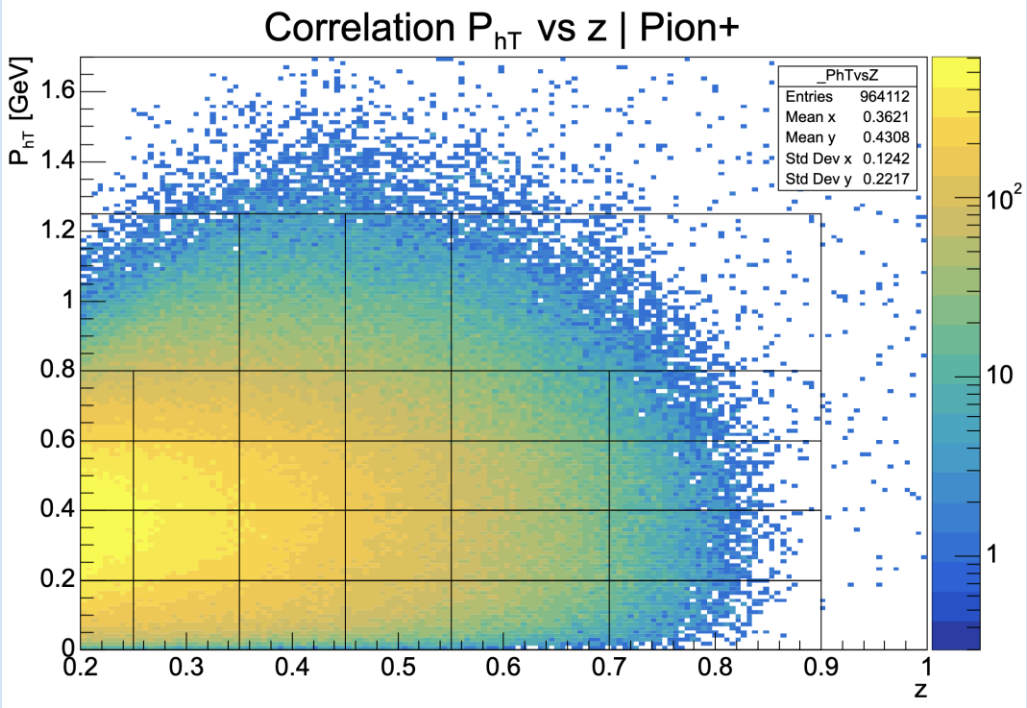
CLAS RGH: 4D measurement as a function of Q^2, x_B, z, P_{hT}.

BIN DEFINITION – CLAS RGH

Generated $2 \cdot 10^7$ events with clasdis by Matthew from Duke U.

Cuts: $Q^2 > 1\ GeV^2$; $y < 0.9$; $z > 0.2$; $P_h > 1\ GeV$; $M_x > 1.6\ GeV$; $x_F > 0$.





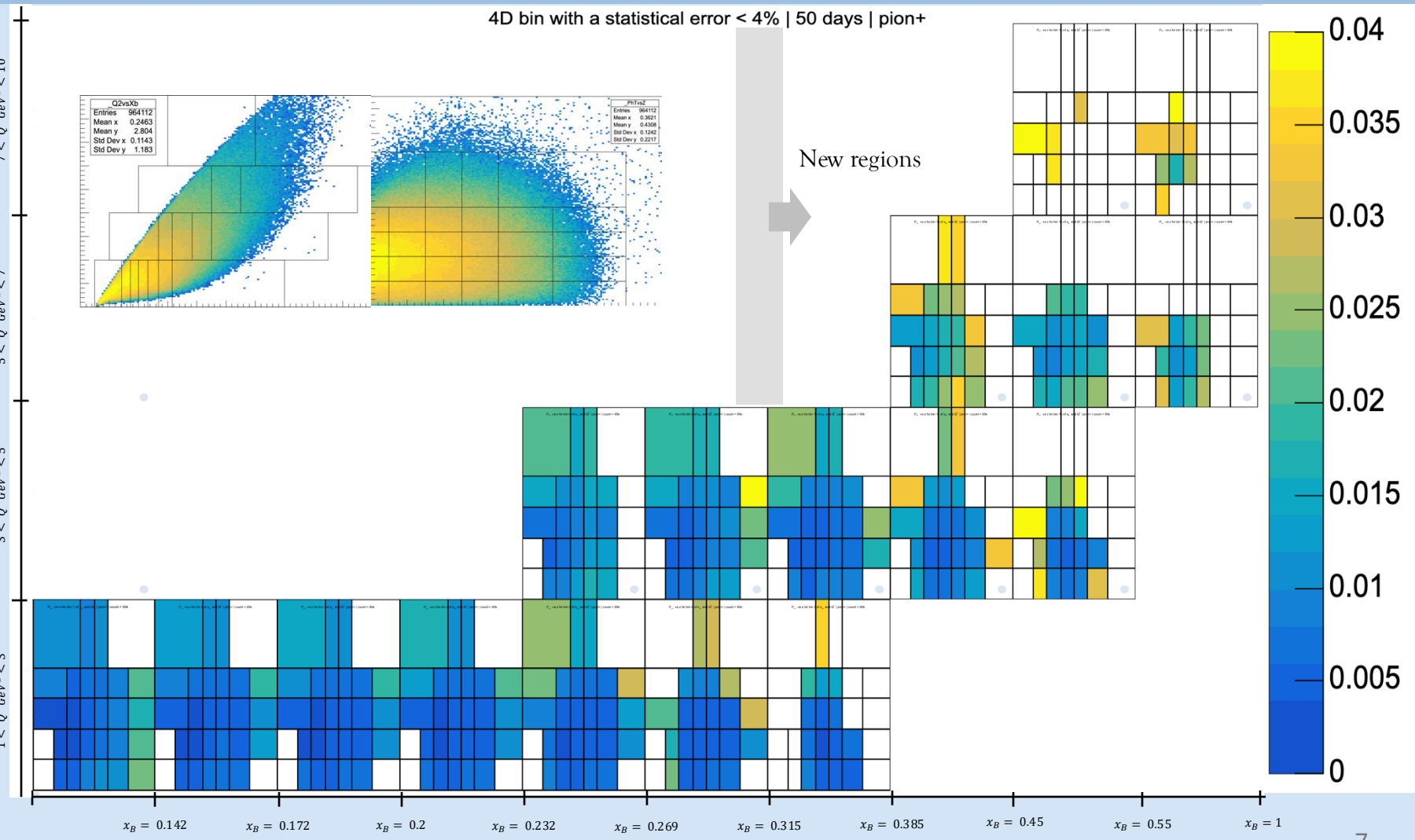
SSA STATISTICAL ERROR OVER THE 4D SCALE (50D)

The **RGH projected statistics** where performed by Duke U. using the fall2022 RGC. The **error** on the A was calculated as:

$$\sigma_{RGH} = \sigma_{RGH} \cdot \frac{P_{t,RGC}}{P_{t,RGH}} \cdot \sqrt{\frac{N_{RGC}}{N_{RGH}}}$$

Assuming a target polarization $P_{t,RGH} = 0.85$ and $A = 0.1$.

Only **bin** with a **statistical error** $< 4\%$ are filled in the plot.



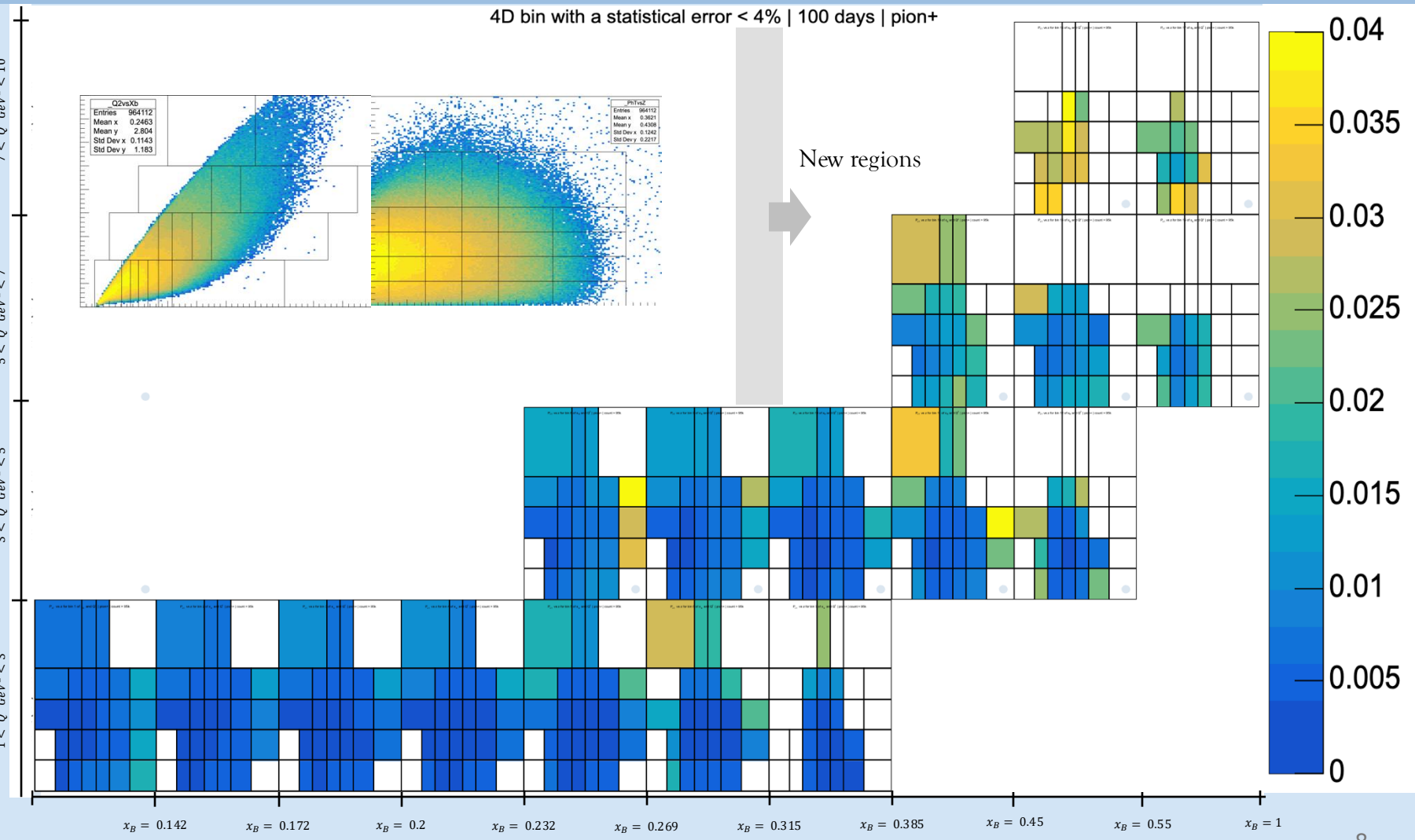
SSA STATISTICAL ERROR OVER THE 4D SCALE (100D)

The **RGH projected statistics** where performed by Duke U. using the fall2022 RGC. The **error** on the A was calculated as:

$$\sigma_{RGH} = \sigma_{RGH} \cdot \frac{P_{t,RGC}}{P_{t,RGH}} \cdot \sqrt{\frac{N_{RGC}}{N_{RGH}}}$$

Assuming a target polarization $P_{t,RGH} = 0.85$ and $A = 0.1$.

Only **bin** with a **statistical error** $< 4\%$ are filled in the plot.



TMD FACTORIZATION REGIME - HERMES

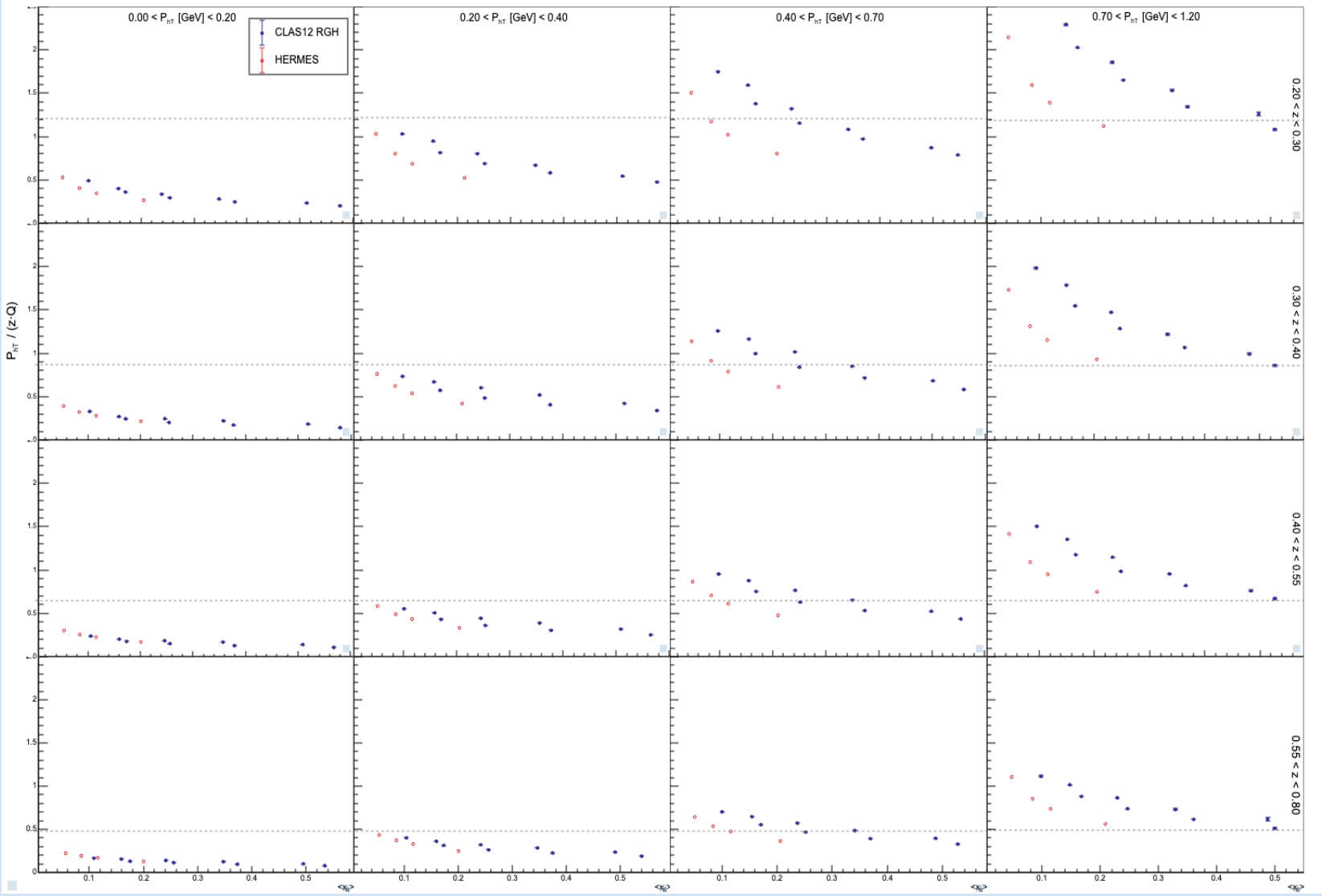
This plot display the **mean value** of the fraction $\frac{P_{hT}}{zQ}$ in each bin.

The upcoming **RGH** analysis will enable the exploration of a **higher** x_B region compared to that accessed by **HERMES**, remaining in a similar **TMD regime**.

Here the RGH bins are modified to imitate the ones from HERMES.

z **bins**	$P_{h\perp}$ **bins**
]0.20; 0.28]	]0.00 GeV; 0.23 GeV]
]0.28; 0.37]	]0.23 GeV; 0.36 GeV]
]0.37; 0.49]	]0.36 GeV; 0.54 GeV]
]0.49; 0.70]	]0.54 GeV; 2.00 GeV]

Hermes bin definition



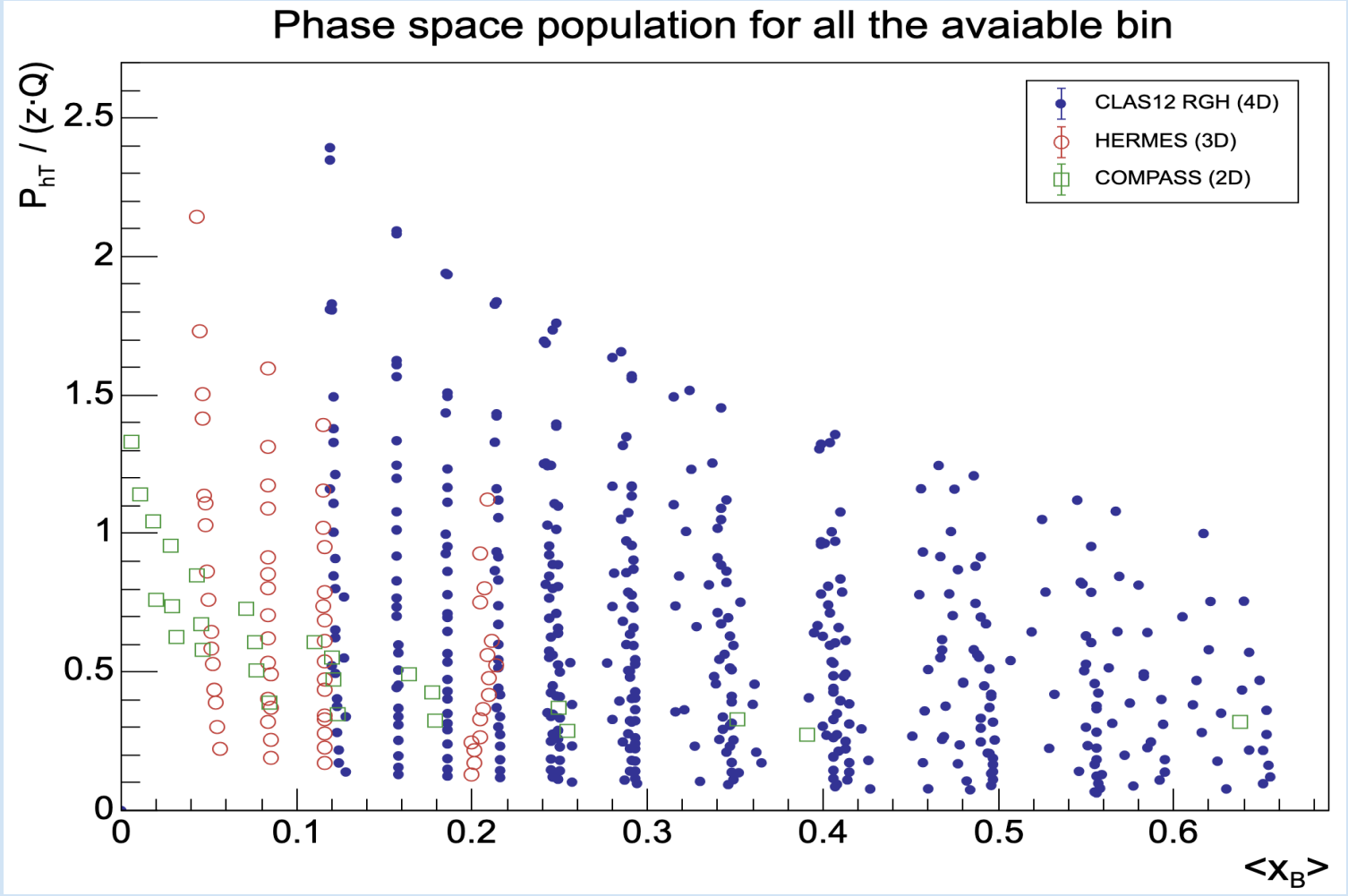
TMD FACTORIZATION REGIME - COMPASS

COMPASS (avaiable data at the moment) performed a two dimensional measurement.

The **bin distributions** of each experiment in the $\langle x_B \rangle - \frac{\langle P_{hT} \rangle}{\langle z \rangle \langle Q \rangle}$ plane is shown here.

This plot emphasize the power of the multi-dimensional measurement avaiable with RGH.

Large number of bins are present in the lower sector of the rescaled transverse momentum.



CONCLUSION & NEXT STEPS

- **Single hadron** and **dihadron RGH analyses** would bring new insights into uncharted region of the nucleon's structure thanks to the new avaiable phase-space coverage.

- The physics of the process should be able to provided **sensible measurement** for the **TMD** calculations as **HERMES** and **COMPASS** have done previously.

- The **uncertainty** in the SSA measurment is **still undestudies**, for this reason, the bin selection is still under evaluation and the results are to be taken with proper considerations

- **Creation** and **extrapolation** of a hand-generated **asymmetry** (following the implementation steps provided by **HERMES** in the polarization of a Monte Carlo set) by ourself has to be implemented.

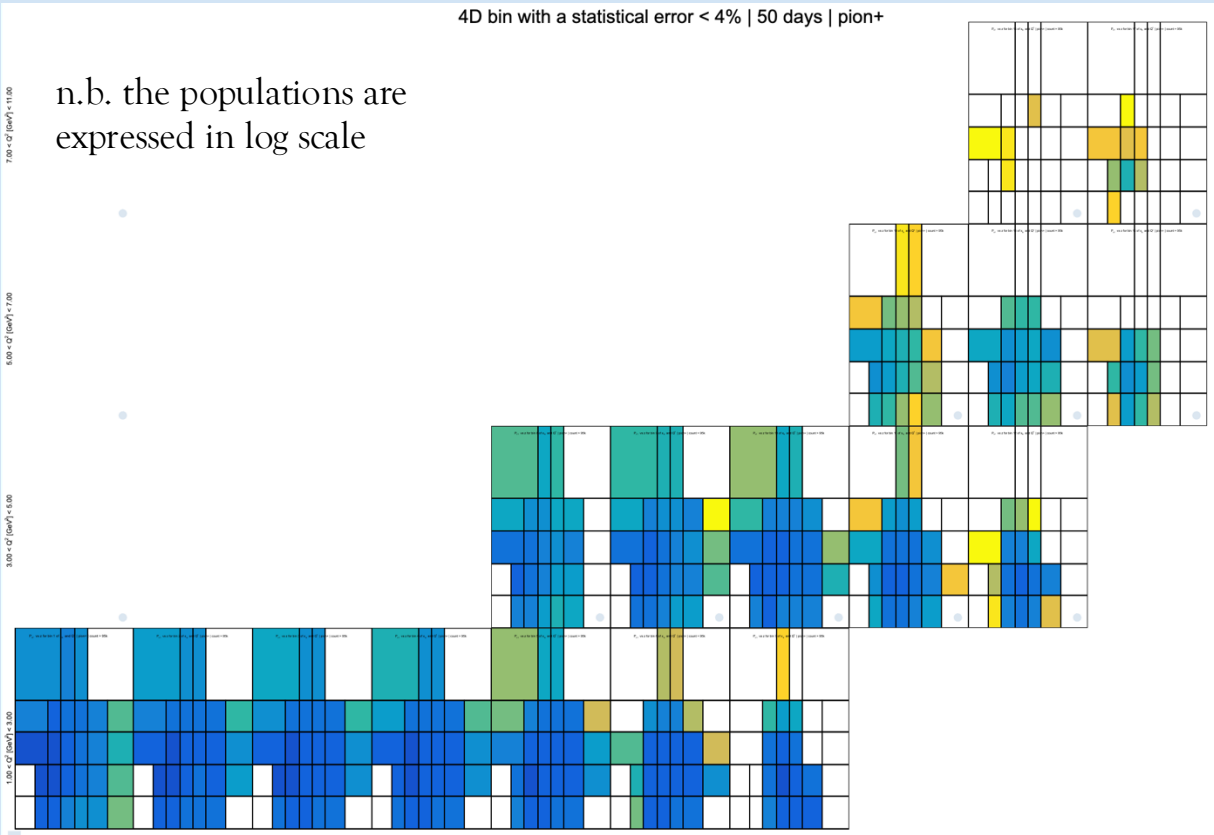
  + studies of asymmetries such as Sivers, Collins and higher leading-order terms will be added.

THANKS FOR YOUR ATTENTION

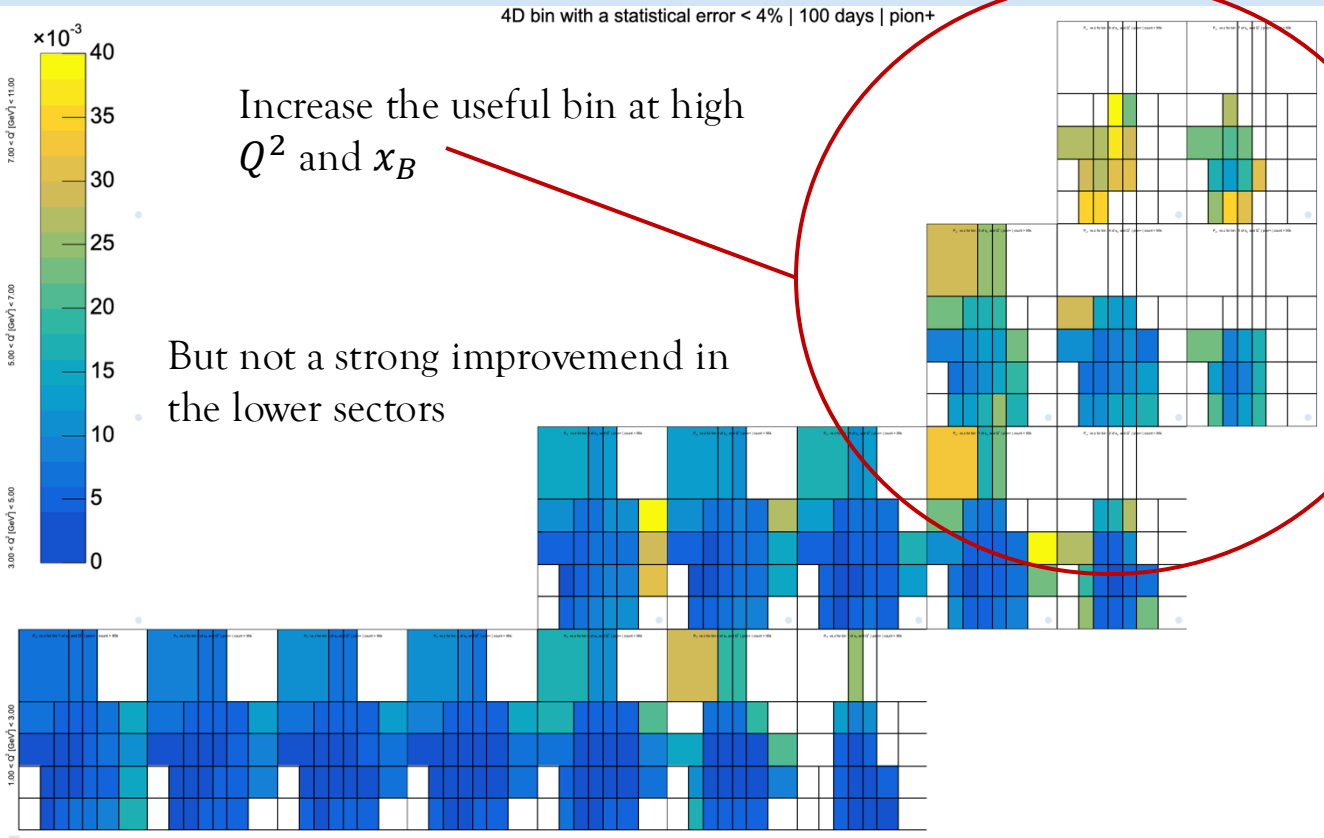
z vs P_{hT} BIN QUALITY ON x_B vs Q^2 SCALE

With half the days of data taking (50 day)

With 100 days of data taking



n.b. the populations are expressed in log scale

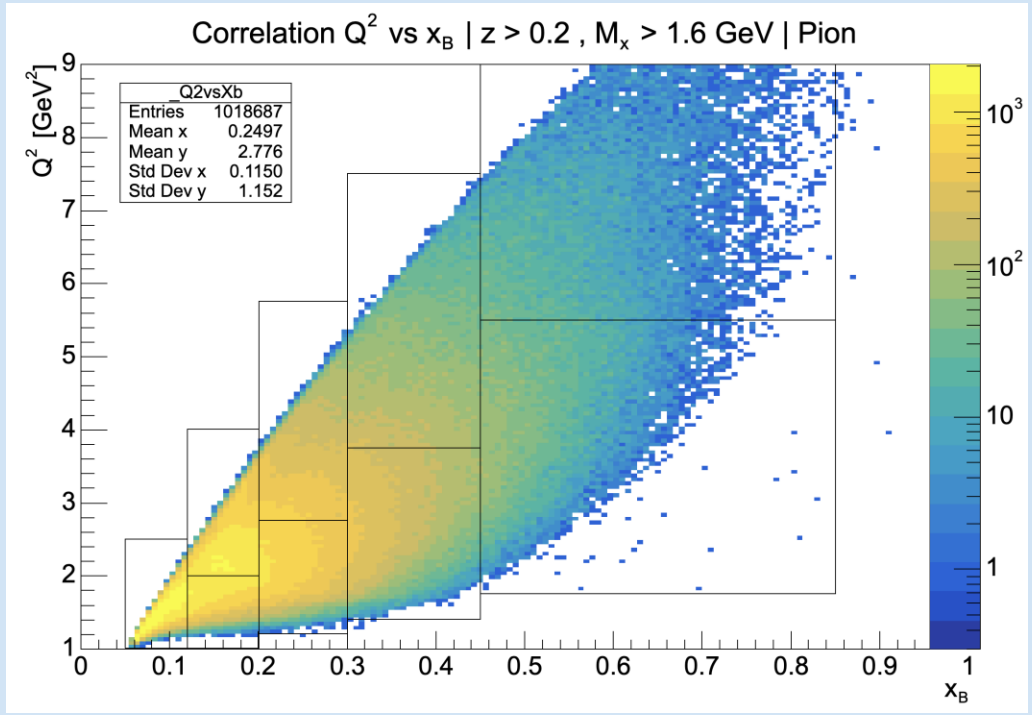


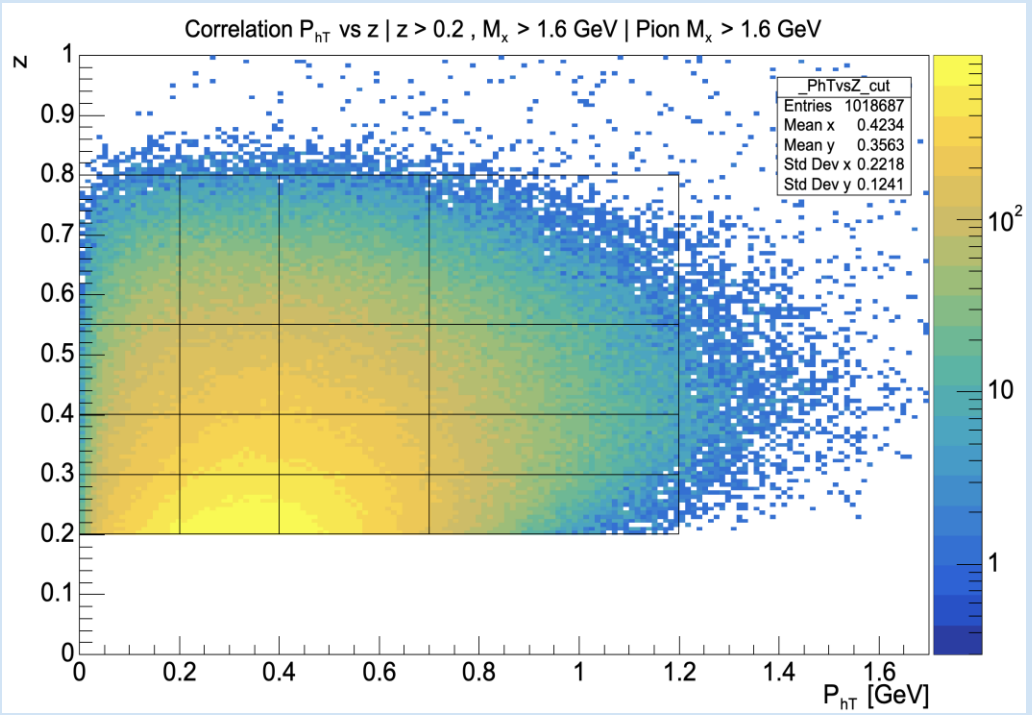
Increase the useful bin at high Q^2 and x_B

But not a strong improvemend in the lower sectors

OLD BIN DEFINITION – CLAS RGH

Q^2 $[GeV^2]$	x_B	z	P_{hT} $[GeV]$
$1.00 - 2.50$	$0.05 - 0.12$	$0.20 - 0.30$	$0.00 - 0.20$
$1.00 - 2.00$ & $2.00 - 4.00$	$0.12 - 0.20$	$0.30 - 0.40$	$0.20 - 0.40$
$1.20 - 2.75$ & $2.75 - 5.75$	$0.20 - 0.30$	$0.40 - 0.45$	$0.40 - 0.70$
$1.40 - 3.75$ & $3.75 - 7.50$	$0.30 - 0.45$	$0.45 - 0.80$	$0.70 - 1.20$
$1.75 - 5.50$ & $5.50 - 9.00$	$0.45 - 0.80$		





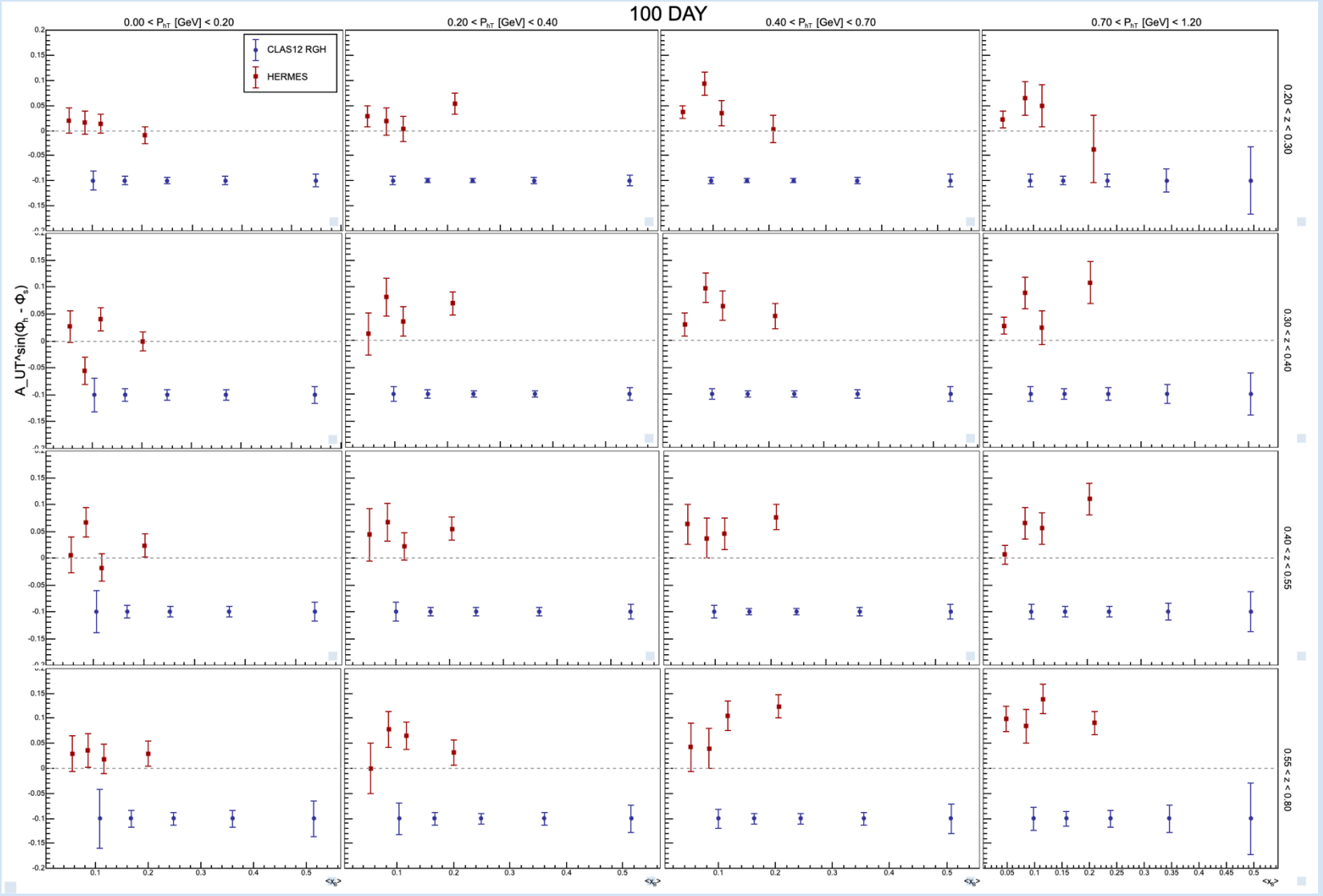
SIVERS UNCERTAINTY

In this plot the Q^2 regions were keep togheter to have a correct comparison with the measurement of HERMES JHEP12 in 2020.

The errors where calculated as:

$$\sigma_{UT} = \frac{1}{P}\sqrt{\frac{1-(P\cdot A)^2}{Y_{RGH}}}$$

With: $P = 0.85$ and $Y_{RGH} = evt \cdot \frac{5}{4}$ which represent the projection of the statistic over 40mln events taking into account dilution.



SIVERS UNCERTAINTY

In this plot the Q^2 regions were keep togheter to comparison with of HERMES JHE

The errors wher

$$\sigma = \frac{1}{P}\sqrt{}$$

With: $P = 0.85$ which represent the statistic over 40mln events taking into account dilution.