Exclusive π^0 studies for calorimeter resolutions

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April 11, 2020

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1 Inroduction

Considering the very small mass of neutral pion with respect to the energies at EIC, these kinematics studies are the same for DVCS. In the following studies, I have applied the following cuts for the electron plots :

— Q^2<100 GeV^2.
— θ_e<140°.
— W^2>4 GeV^2.
— y>0.01 and y<0.95.

with in addition the following cut on the π^0-momentum for the π^0 and the recoil proton plots :

— 2 GeV<p^{π^0}<80 GeV.

Since one of the main observable is the t-dependence of the cross sections, I have looked at the π^0-momentum for t=t_{min}, -0.5 GeV^2 and -1 GeV^2. In the case where t_{min} is lower than the requested t-value, then t_{min} is used y default. If t_{max} is greater than the requested t-value, then t_{max} is used y default.

Following the recommendations of the accelerator group, I have studied the configurations :

— Electron beam at 5 GeV and Proton beam at 41 GeV.
— Electron beam at 5 GeV and Proton beam at 100 GeV.
— Electron beam at 10 GeV and Proton beam at 100 GeV.
— Electron beam at 18 GeV and Proton beam at 275 GeV.

2 Electron kinematics

Here are the electron momentum/rapidity distributions as a function of Q^2 and x_B. I have required to have y>0.01 and y<0.95. I have assumed that the maximal scattering angle we can detect for the electron is 140 degrees. These plots have been produced without applying any cut on the π^0

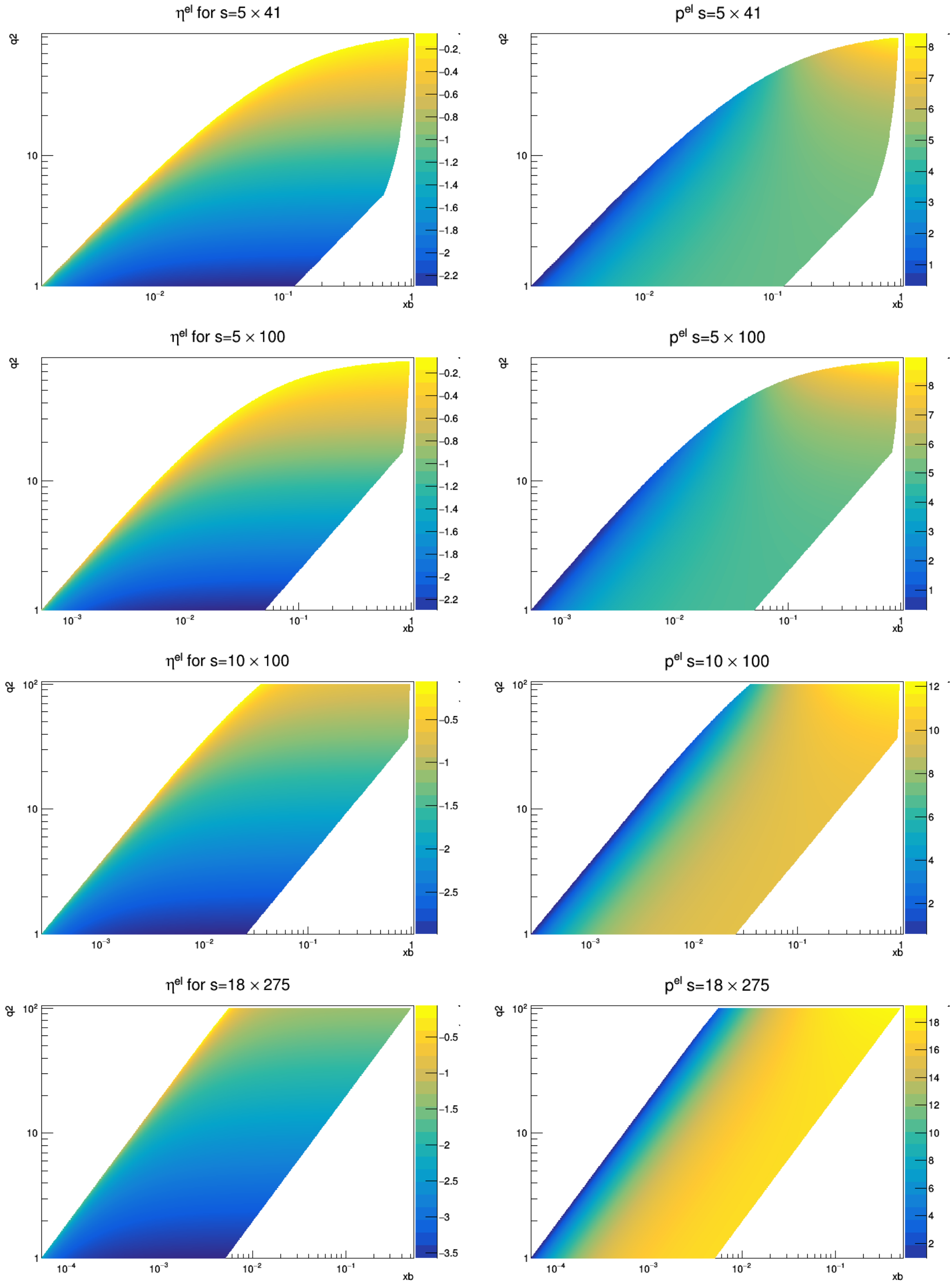

FIGURE 1 – Rapidity (Left) and momentum (right) of scattered electron as function of Q^2 and x_B.

3 π^0 kinematics

The tmin-π^0 is generated by having it collinear to the virtual photon exchanged between the proton and the electron. As Q^2 increases, the π^0 is more backward and its momentum slightly increases. The π^0-momentum has a minimum as function of x_B for Q^2 less than 600 GeV^2 for the highest $\sqrt{s}$, and then becomes a monotonic increasing function of x_B for higher Q^2 values.

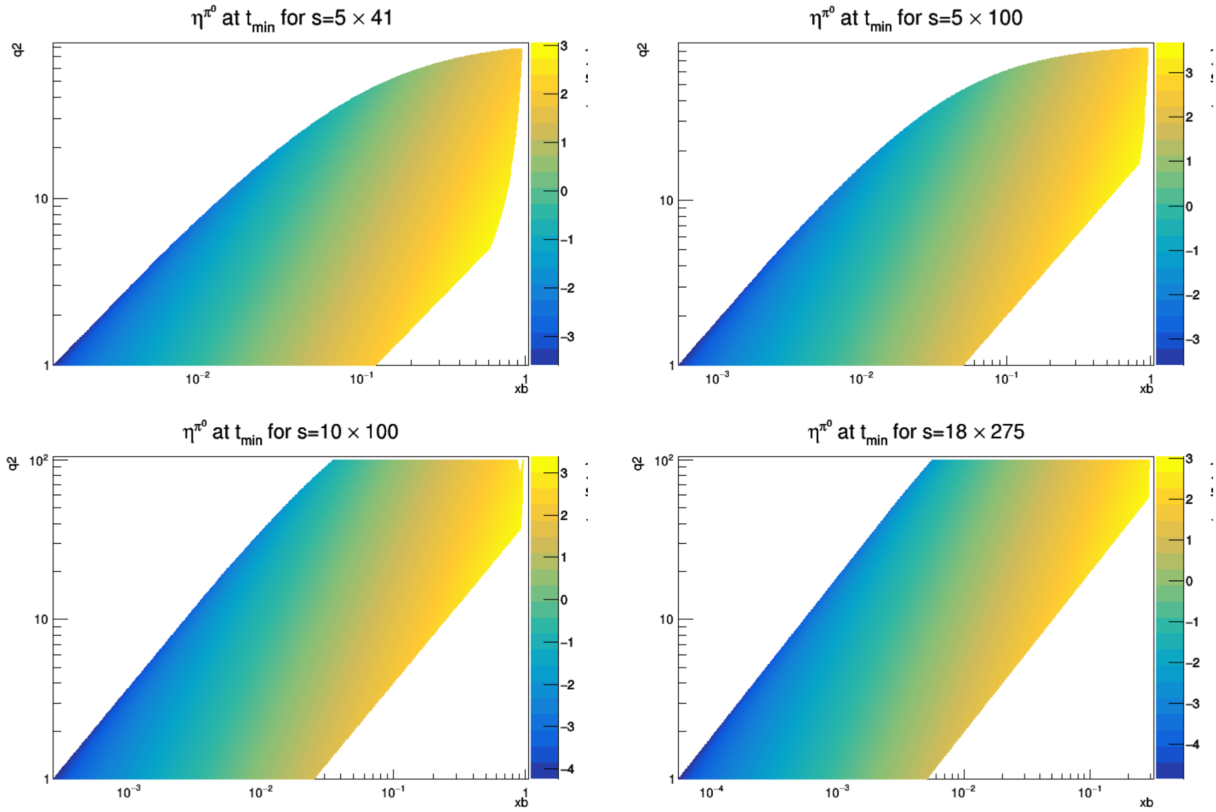

FIGURE 2 – π^0-rapidity at t=t_{min} as function of Q^2 and x_B for the four beam configurations.

Taking into account the possible limitation of the calorimeter on the lowest photon energy at 1 GeV, I have applied a cut at 2 GeV on the π^0 momentum for three t-values which are t_{min}, -0.5 and -1 GeV^2.

For all $\sqrt{s}$-configuration, a significant phase space is lost at lower Q^2 and high x_B for t ranging from t_{min} to -1 GeV^2.

4 Recoil proton kinematics

For the moment, no constrain are applied on the proton side. Here are the proton kinematics in the same configurations as it was presented for the π^0 in the previous section.

5 Discussion

In order to determine the most suitable configurations for a GPD extraction with DVCS data, we must go further with pseudo-phenomenological analysis. To cover x_B>0.1, it seems that the configuration 5×100 is more suitable than 5×41 because of 2 GeV cut on the π^0-momentum. Although, because of the cut on y>0.1, we are losing low Q^2 phase space for x_B above 0.2. Would we get enough satistics at 5×100 compared to 5×41 for x_B above 0.2 despite the higher Q^2-values ? Or is there any technical reasons behind the cut y>0.01 ? Otherwise we could even recover these low Q^2-points.

Finally the region x_B from 10^{-3} to 10^{-2} for Q^2 smaller than 3 GeV^2 will not be accessible for DVCS studies because the π^0 cannot be studied. I remind that the π^0 cross sections increases with x_B and decreases with Q^2.

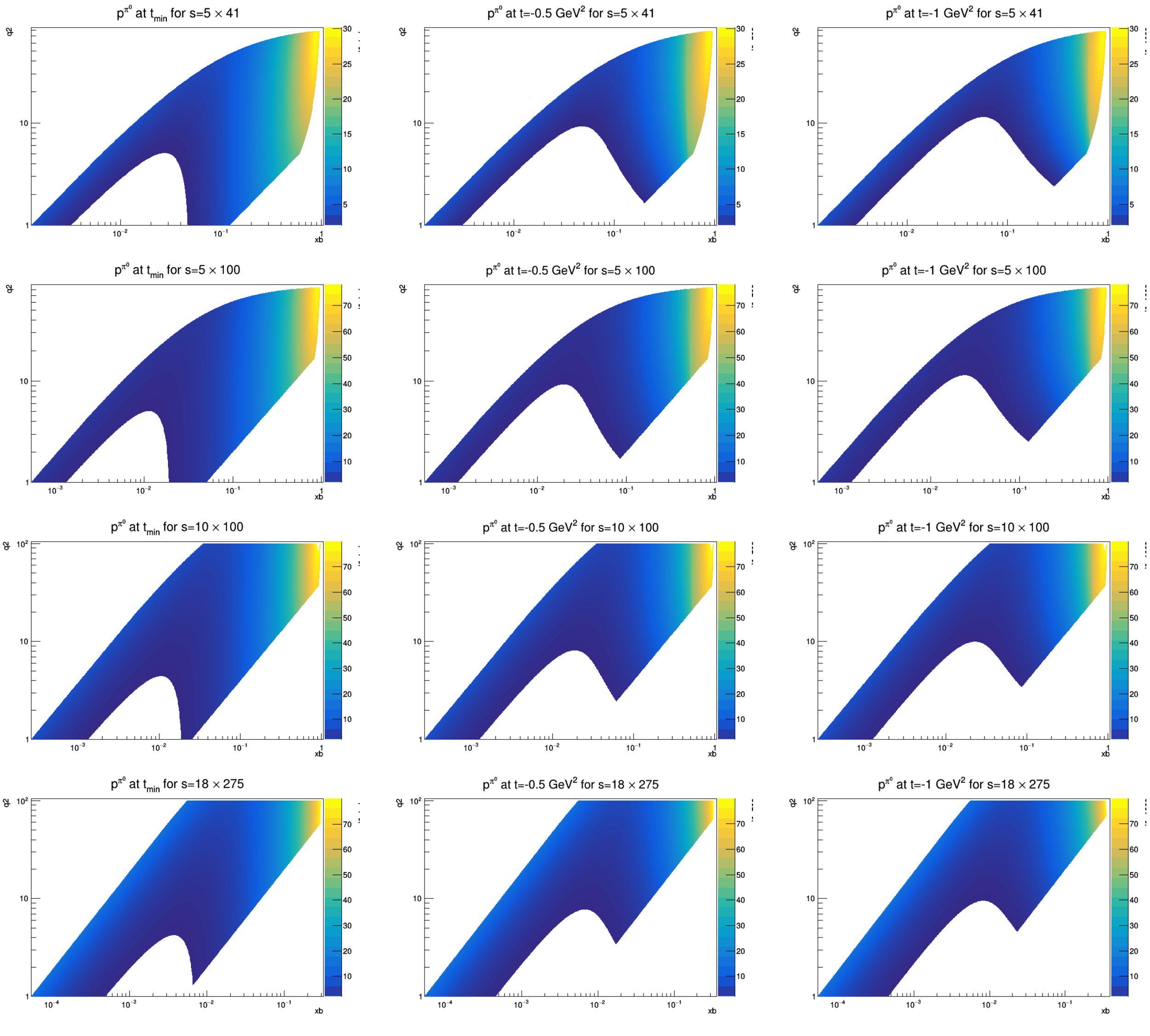

FIGURE 3 – π^0-momentum as function of Q^2 and x$_B$ for t=t$_{min}$, -0.5 and -1 GeV^2.

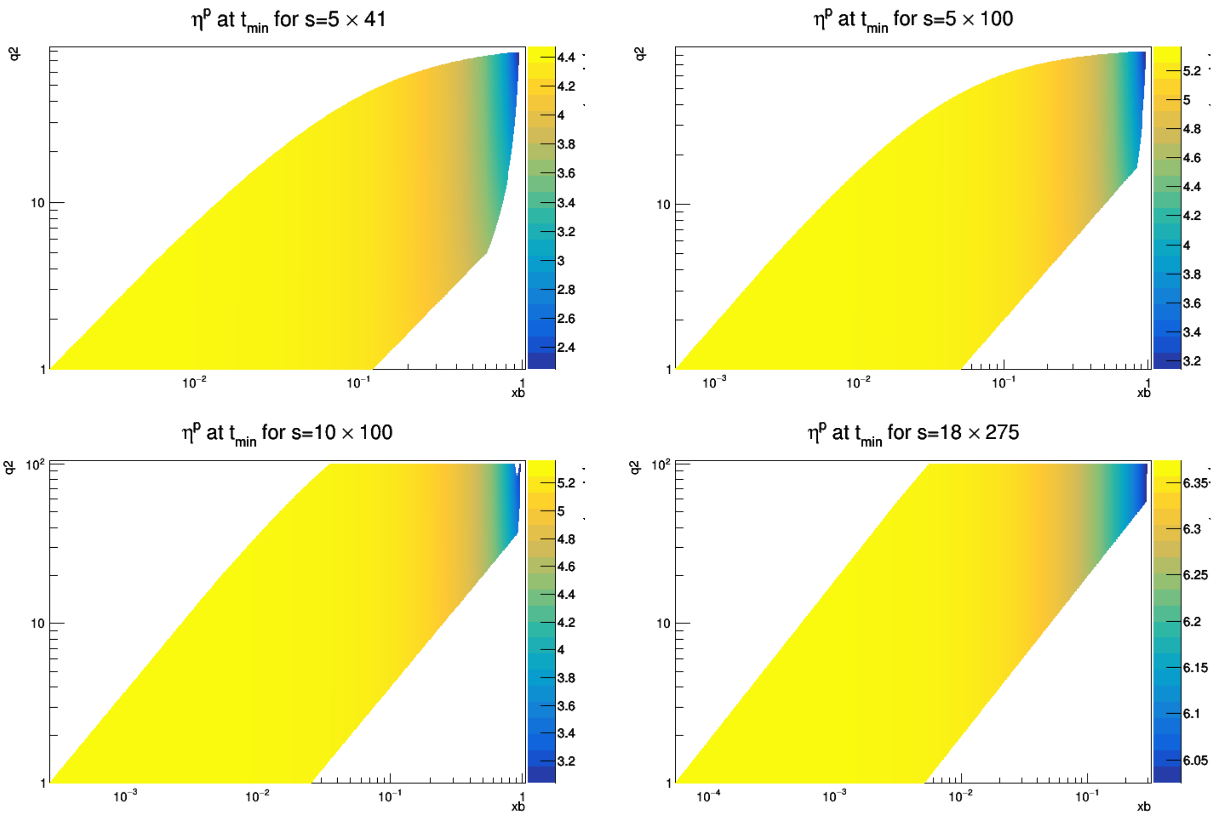

FIGURE 4 – Proton rapidity at t=t_{min} as function of Q^2 and x_B for the four beam configurations.

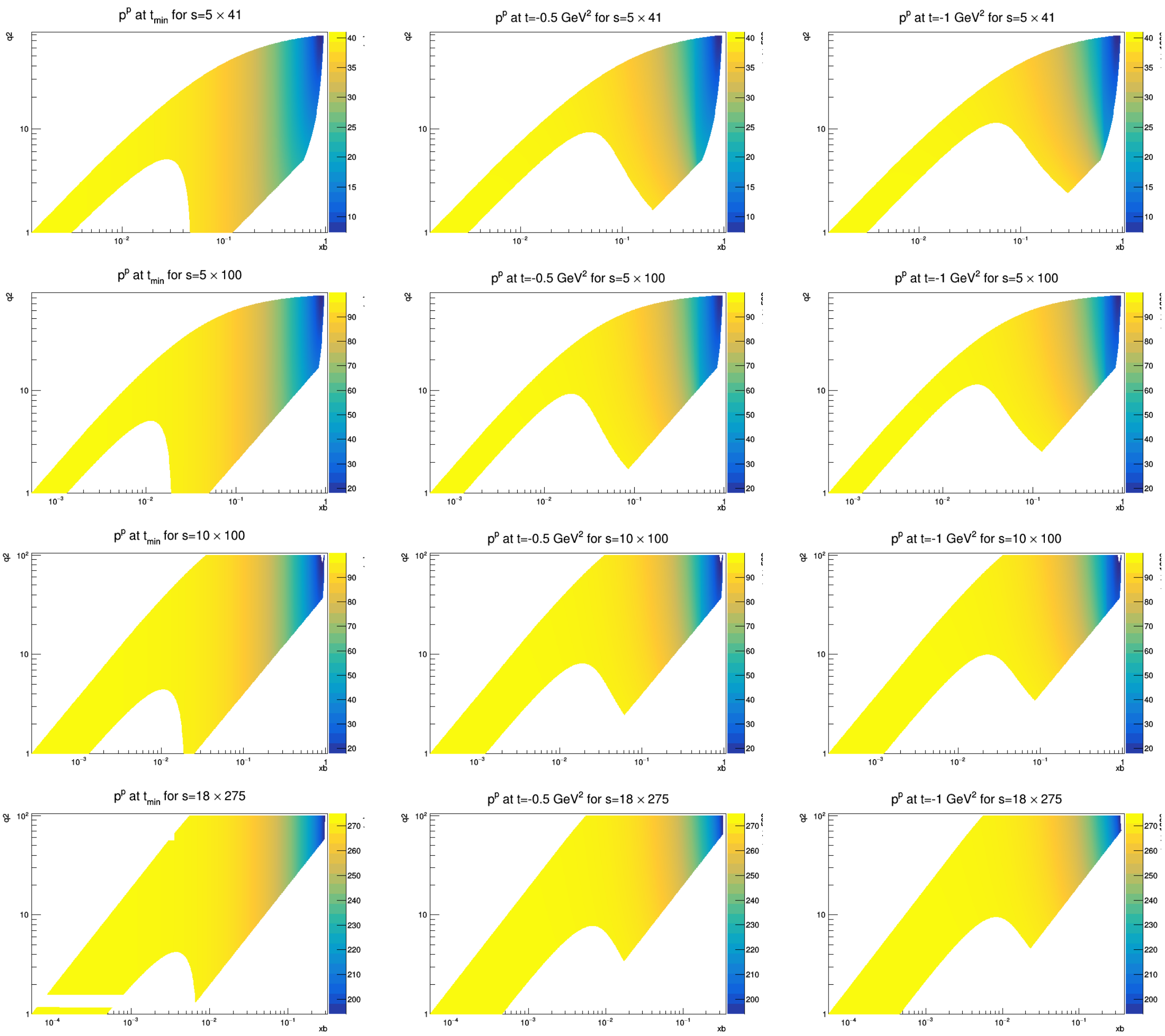

FIGURE 5 – Proton momentum as function of Q^2 and x_B for t=t_{min}, -0.5 and -1 GeV^2.