Incoherent π^0 photoproduction from ^{12}C and ^{208}Pb: Comparison between the Glauber and cascade model (Preliminary)

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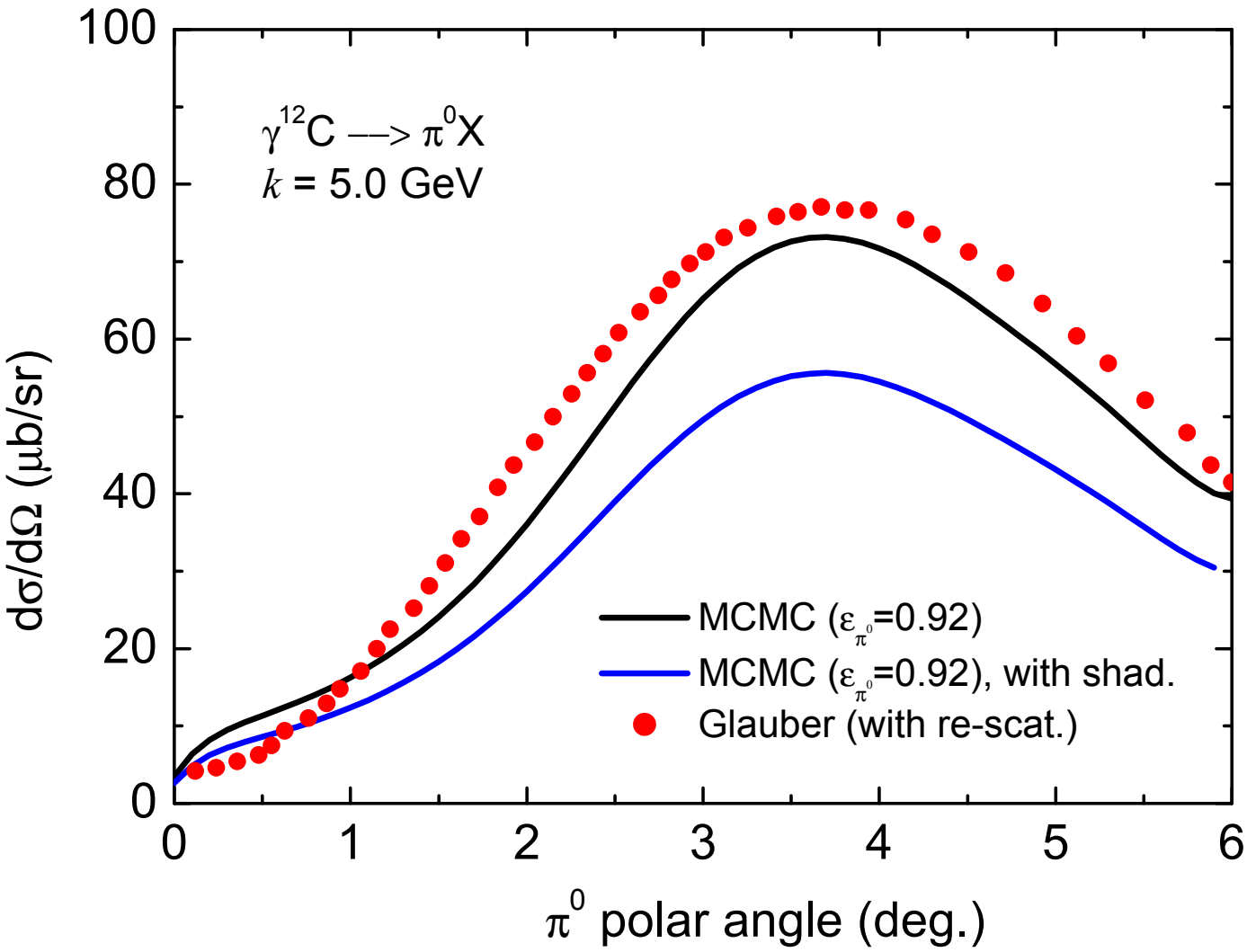
Notes used for reference:

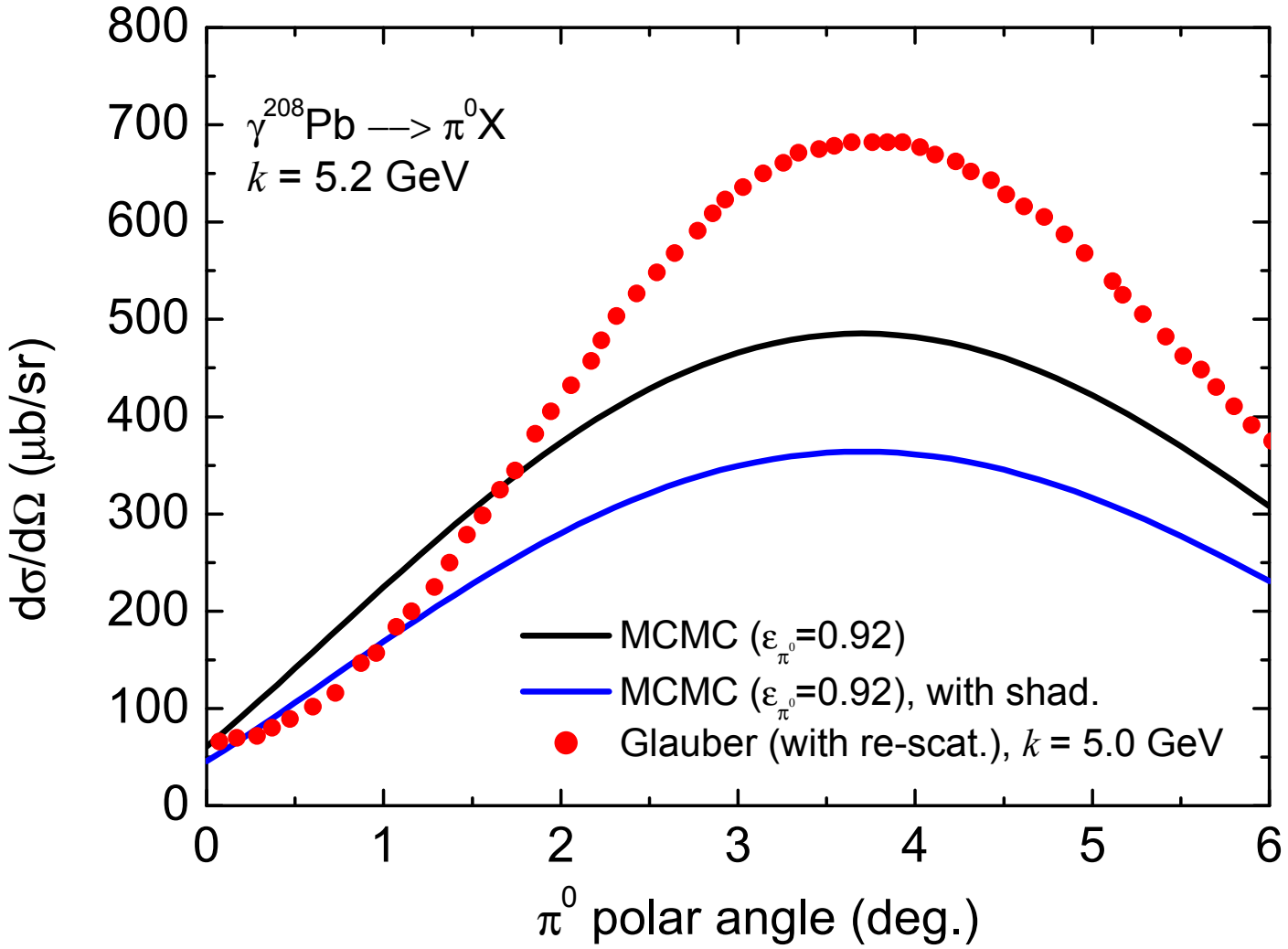
1) PrimEx Note 50: S. Gevorkyan, A. Gasparian, L. Gan and I. Larin, *Incoherent Photoproduction of π^0 Mesons off Nuclei*.

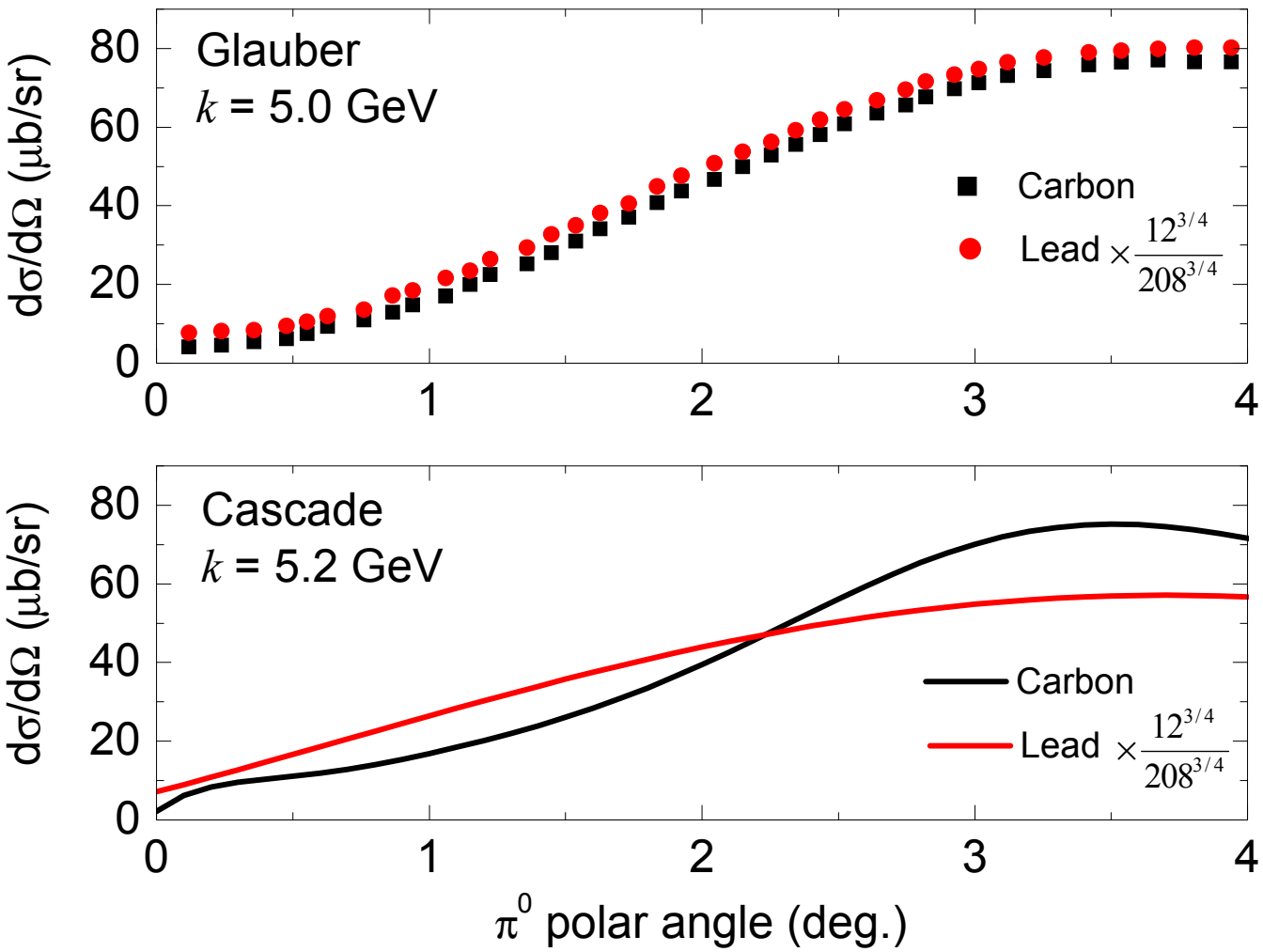
2) PrimEx Note 52: T. E. Rodrigues, *Incoherent π^0 photoproduction in the PrimEx kinematics via the MCMC intranuclear cascade model.*

Few Remarks:

1. The results presented here are preliminary. The Glauber model results were taken directly from the plots. I could not reproduce Sergey´s calculations with the material I have in hand. I am sure that we can improve this analysis when Sergey gets to JLab.
2. The results from the Glauber model were taken from Sergey´s Note # 50 for Carbon (p.14) and Lead (p.15). These results include the so-called re-scattering effect at forward angles. Question: Which results (with or without re-scattering) were used to fit the PrimEx data (p. 11 and 12)? This is an important question to clearly show where we are.
3. Since Sergey´s results are presented at 5.0 GeV, I have also used the cascade results at 5.0 GeV for Carbon. For Lead, I have used the results at 5.2 GeV to save running time (they are not very different at all).
4. The results from the cascade model are presented with and without shadowing for elasticity in the range 0.92-1.0. The fitted polynomials for 5.2 GeV are given in table 3 of Note 52.
5. I have also scaled the Carbon and Lead results (Glauber and cascade) with $A^{3/4}$ in order to verify the effect of the nuclear structure.


$\gamma^{12}C \longrightarrow \pi^0 X$
k = 5.0 GeV
MCMC (ε_{π^0}=0.92)
MCMC (ε_{π^0}=0.92), with shad.
Glauber (with re-scat.)
dσ/dΩ (μb/sr)
π^0 polar angle (deg.)
0
20
40
60
80
100
0
1
2
3
4
5
6


γ^{208}Pb —> π^0X
k = 5.2 GeV
MCMC (ε_{π^0}=0.92)
MCMC (ε_{π^0}=0.92), with shad.
Glauber (with re-scat.), k = 5.0 GeV
dσ/dΩ (μb/sr)
π^0 polar angle (deg.)
0
100
200
300
400
500
600
700
800
0
1
2
3
4
5
6


Glauber
k = 5.0 GeV
Carbon
Lead $\times \frac{12^{3/4}}{208^{3/4}}$
dσ/dΩ (μb/sr)
0
20
40
60
80
0
1
2
3
4
Cascade
k = 5.2 GeV
Carbon
Lead $\times \frac{12^{3/4}}{208^{3/4}}$
dσ/dΩ (μb/sr)
π^0 polar angle (deg.)

Few comments and open questions:

1. It is clear that the Glauber and cascade model give different results for the NI cross sections both for Carbon and Lead in shape and magnitude. The magnitude of the cross sections are closer using the cascade results without shadowing. This is qualitatively correct, since the Glauber model does not include shadowing.
2. The Carbon results seem to match accidentally or not at zero degree, when the re-scattering is included in the Glauber model. Such result is also observed for Lead and might indicate that both models are similar with respect to the fraction of re-scattering but they differ in some nuclear structure aspects (momentum distribution), which reflect on the influence of the Pauli-blocking mechanism. Since the cross sections (without re-scattering) vanish at zero degree, only the contribution from secondary scattering is relevant.
3. The scaling of the cross sections is very interesting. For the case of the Glauber model, we verify that the Carbon and Lead cross sections are quite proportional. This is an indication that the details of the Carbon structure are probably missing during the evaluation of the Pauli-blocking factor. The cascade model result for Carbon clearly exhibits two structures (at approx. 0.25 deg. and 3.5 degrees), which might be associated with the contributions from s and p-shell nucleons.

4. The fact that the models give rather different predictions may be useful to establish a worst case scenario for the systematic uncertainty of the decay width due to the nuclear model.
5. The cascade results both for Carbon and Lead are always above the Glauber results for lower angles if we normalize both calculations at larger angles (4 deg). This indicates qualitatively that the cascade results will tend to decrease the contribution of the interference term when fitting the π^0 yield, increasing the value of the decay width. It would be very interesting if we could extend the analysis up to 4 degrees or so in order to fix more accurately the NI contribution.
6. Please send me your suggestions, comments and questions.