EPS09 — Global NLO analysis of nuclear PDFs and their uncertainties

K.J. Eskola\textsuperscript{a}, H. Paukkunen\textsuperscript{a} and C.A. Salgado\textsuperscript{b}

\textsuperscript{a} Department of Physics, University of Jyväskylä & Helsinki Institute of Physics, Finland
\textsuperscript{b} Departam. de Física de Partículas & IGFAE, Univ. de Santiago de la Compostela, Spain
email: kari.eskola@phys.jyu.fi

We present the results of our next-to-leading order (NLO) global DGLAP analysis of the nuclear parton distribution functions (PDFs) and, in particular, their uncertainties \cite{1}. In line with the earlier studies, we confirm that the good description of world data obtained already at the leading-order level can be lifted up to NLO. This lends strongly support to the conventional factorization-theorem-based approach in describing hard processes in nuclear collisions. Compared with earlier analyses, the present work is an extension in two important ways.

First, the experimental input in our analysis consists of three types of processes instead of the usual two: deep inelastic scattering (DIS), Drell-Yan dilepton production (DY), and inclusive pion production. Out of these, the pion production data has not been traditionally included in the global analyses. A careful analysis shows, however, that the shape of the nuclear modification factor $R_{d\text{Au}}$ of the pion $p_T$-spectrum at midrapidity, measured in $d+\text{Au}$ collisions at RHIC, retains some sensitivity to the large-$x$ gluons, which provides evidence for an EMC-effect in the gluon sector. Also, the suppression in the low-$p_T$ part of $R_{d\text{Au}}$ can be easily reproduced down to $p_T \sim 1.7$ GeV by gluon and quark shadowings alone. Thus, this type of data (at $\eta = 0$) is found to be fully consistent with DIS and DY in the factorization framework. Although not included in the EPS09 global fit, we also compare our results with the forward-$\eta$ $R_{d\text{Au}}$ data.

Our second main objective is to bring the error analysis of the nPDFs up to a similar level as it is in the free proton PDFs. We use the Hessian method to quantify the nPDF uncertainties which originate from the uncertainties in the data. In this method the sensitivity of $\chi^2$ to variations of the fitting parameters is mapped out to a collection of ($\sim 15$) nPDF error sets. We will release a computer code for practical applications, allowing a general user to independently calculate how the nPDF uncertainties propagate to any factorizable nuclear cross section. Such error analysis should be particularly important for detailed analyses of the signatures and properties of QCD matter at the LHC and RHIC.

\cite{1} K.J. Eskola, H. Paukkunen, C.A. Salgado, to be submitted to arXiv [hep-ph] and JHEP.