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Measurement of Nuclear Transparency for the $A(e, e'\pi^+)$ Reaction

B. Clasie[1], X. Qian[2], J. Arrington[3], R. Asaturyan[4], F. Benmokhtar[5], W. Boeglin[6], P. Bosted[7], A. Bruell[7], M. E. Christy[8], E. Chudakov[7], W. Cosyn[9], M. M. Dalton[10], A. Daniel[11], D. Day[12], D. Dutta[13,2], L. El Fassi[3], R. Ent[7], H. C. Fenker[7], J. Ferrer[14], N. Fomin[12], H. Gao[1,2], K. Garrow[15], D. Gaskell[7], C. Gray[10], T. Horn[5,7], G. M. Huber[16], M. K. Jones[7], N. Kalantarians[11], C. E. Keppel[7,8], K. Kramer[2], A. Larson[17], Y. Li[11], Y. Liang[18], A. F. Lung[7], S. Malace[8], P. Markowitz[6], A. Matsumura[19], D. G. Meekins[7], T. Mertens[20], G. A. Miller[17], T. Miyoshi[11], H. Mkrtchyan[4], R. Monson[21], T. Navasardyan[4], G. Niculescu[14], I. Niculescu[14], Y. Okayasu[19], A. K. Opper[18], C. Perdrisat[22], V. Punjabi[23], A. W. Rauf[24], V. M. Rodriquez[11], D. Rohe[20], J. Ryckebusch[9], J. Seely[1], E. Segbefia[8], G. R. Smith[7], M. Strikman[25], M. Sumihama[19], V. Tadevosyan[4], L. Tang[7,8], V. Tvaskis[7,8], A. Villano[26], W. F. Vulcan[7], F. R. Wesselmann[23], S. A. Wood[7], L. Yuan[8], and X. C. Zheng[3]

[1] *Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge, MA, USA*
[2] *Triangle Universities Nuclear Laboratory, Duke University, Durham, NC, USA*
[3] *Argonne National Laboratory, Argonne, IL, USA*
[4] *Yerevan Physics Institute, Yerevan, Armenia*
[5] *University of Maryland, College Park, MD, USA*
[6] *Florida International University, Miami, FL, USA*
[7] *Thomas Jefferson National Laboratory, Newport News, VA, USA*
[8] *Hampton University, Hampton, VA, USA*
[9] *Ghent University,Ghent, Belgium*
[10] *University of the Witwatersrand, Johannesburg, South Africa*
[11] *University of Houston, Houston, TX, USA*
[12] *University of Virginia, Charlottesville, VA, USA*
[13] *Mississippi State University, Mississippi State, MS, USA*
[14] *James Madison University, Harrisonburg, VA, USA*
[15] *TRIUMF, Vancouver, British Columbia, Canada*
[16] *University of Regina, Regina, Saskatchewan, Canada*
[17] *University of Washington, Seattle, WA, USA*
[18] *Ohio University, Athens, OH, USA*
[19] *Tohoku University, Sendai, Japan*
[20] *Basel University, Basel, Switzerland*
[21] *Central Michigan University, Mount Pleasant, MI, USA*
[22] *College of William and Mary, Williamsburg, VA, USA*
[23] *Norfolk State University, Norfolk, VA, USA*
[24] *University of Manitoba, Winnipeg, Manitoba, Canada*
[25] *Pennsylvania State University, University Park, PA, USA and*
[26] *Rensselaer Polytechnic Institute, Troy, NY, USA*

We have measured the nuclear transparency of the $A(e, e'\pi^+)$ process in ^{2}H,^{12}C, ^{27}Al, ^{63}Cu and ^{197}Au targets. These measurements were performed at the Jefferson Laboratory over a four momentum transfer squared range $Q^2 = 1.1$ to 4.7 (GeV/c)^2. The nuclear transparency was extracted as the super-ratio of (σ_A/σ_H) from data to a model of pion-electroproduction from nuclei without π-N final state interactions. The Q^2 and atomic number dependence of the nuclear transparency both show deviations from traditional nuclear physics expectations, and are consistent with calculations that include the quantum chromodynamical phenomenon of color transparency.

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Brodsky and Mueller in 1982 [1] predicted, in the context of perturbative Quantum Chromo Dynamics (QCD), that a hadron could, at sufficiently high momentum transfers, be produced as a 'color neutral' object of a reduced transverse size. If this compact size is maintained for some distance in traversing the nuclear medium, it would pass undisturbed through the nuclear medium. This is the so-called phenomenon of color transparency (CT). Nuclear transparency, defined as the ratio of the cross section per nucleon for a process on a bound nucleon in the nucleus to that from a free nucleon, is the observable used in searches for CT. A clear signature for the onset of CT would involve a rise in the nuclear transparency as a function of Q^2. Later works [2] have indicated that this phenomenon also occurs in a wide variety of models which feature non-perturbative reaction mechanisms.

More recently, CT has been discussed in the context of a QCD factorization theorem derived for meson electroproduction [3], which states that the meson production