Nuclear Physics Working Group Meeting
June 12, 2009 A110

Agenda

13:30-13:40 Update on reviews – Jerry Gilfoyle.
13:40-14:05 Meson Absorption with the g7 Data Set – Mike Wood.
14:05-14:30 Update on g10 Analysis: gd->pi-pp - Nikolay Pivnyuk.
14:30-14:55 Update on pi+ Photoproduction on 3He - Rakhsha Nasseripour.
14:55-15:15 Break
15:15-15:40 DIS2009 Hadronization Highlights - Ken Hicks.
15:40-16:05 Report on EG2 Recooking and pi0 Results - Taya Mineeva.
16:05-16:30 PID, Multiplicity Ratios, and pT Broadenings in eg2 - Raphael Dupre.
16:30-16:55 Study on how the new recooking of the EG2 dataset affects the rho Color Transparency signal - Lorenzo Zana.
16:55-17:20 Preliminary results for K0 from eg2 - Aji Daniel.
17:20-17:45 Extraction of Production Times From eg2 Data - Will Brooks.
17:45-18:15 Discussion of Project List and White Paper - All.

Current and Recent Reviews*

Dan Protopopescu - Multipole Analysis of the Delta0(1232) in 3He
Committee:Kyungseon Joo (Chair), Mike Vineyard, Mike Wood
Ongoing – DP will complete data analysis and reduce the fits used for interpreting the results.

Hovhannes Baghdasaryan - 3He(e,e'pp)n Analysis
Committee:Mike Vineyard (Chair), Dan Protopopescu, Steffen Strauch
Ongoing – Committee received revised Note on June 1 from HB.

Alex Vlasov – CAN: Source size measurements in the eHe -> e'p$\perp\!\!\!\perp$ X reaction.
Committee: Larry Weinstein (chair), Pavel Degtyarenko, Yordanka Ilieva
Ongoing – Revised Note was sent to the committee last week.

Mikhail Osipenko, G. Ricco, S.Simula, M.Battaglieri, R. DeVita, M. Ripani, M. Taiuti, M. Anghinolfi –
CAN: Moments of the nucleon structure function F2 with CLAS: Part III – nuclear target.
Committee: Mike Dugger (chair), Tony Forest, Rakhsha Nasseripour
Approved

M.Wood, R. Nasseripour, D.Weygand, C.Djalali - CAN: Absorption of the Omega and Phi
Mesons from the g7a data set.
Committee: Maurik Holtrop (chair), Pawel Nadel-Turonski, Igor Strakovsky.
Ongoing – Committee is working through the latest set of revisions from the authors.

K. Hafidi et al. - CAN:Color Transparency in eg2
Committee: Hovanes Egiyan (chair), Mike Wood, Stepan Stepanyan
Ongoing – Have complete two rounds of comments and changes and held one meeting.

* If you want to modify this list send email to gilfoyle@jlab.org

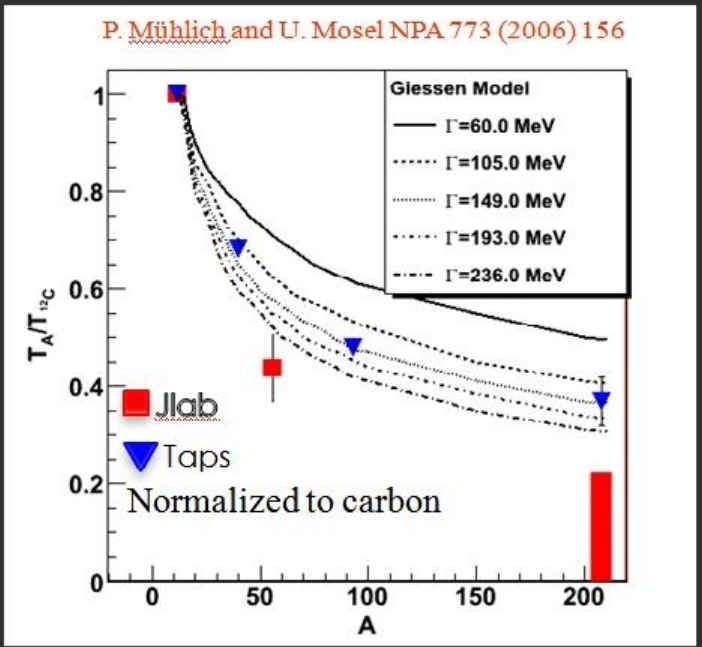
Meson Absorption with the g7 Data Set
Mike Wood, Canisius College

ω Absorption

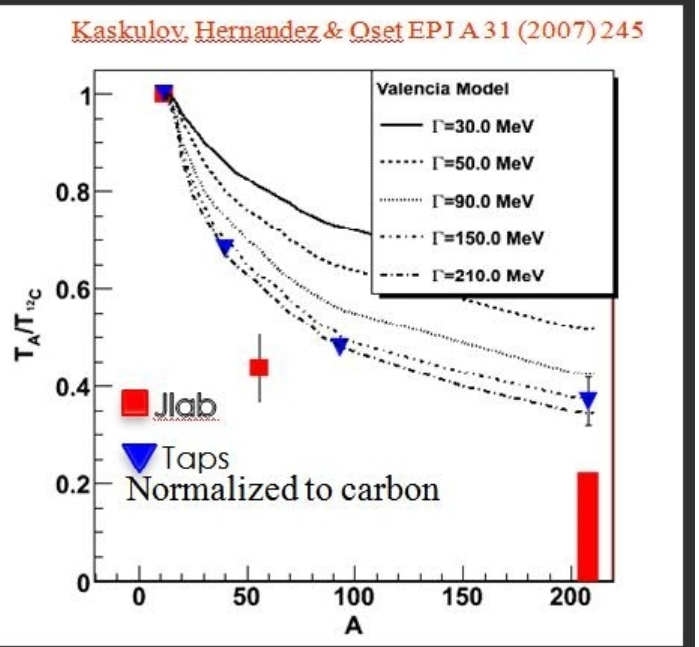
The in-medium width is
$\Gamma=\Gamma_0+\Gamma_{coll}$ where $\Gamma_{coll} = \gamma\rho v\sigma^*_{VN}$

Access to the cross section
$T_A=\sigma_A/A\sigma_N$

P. Mühlich and U. Mosel NPA 773 (2006) 156



Kaskulov, Hernandez & Oset EPJ A 31 (2007) 245



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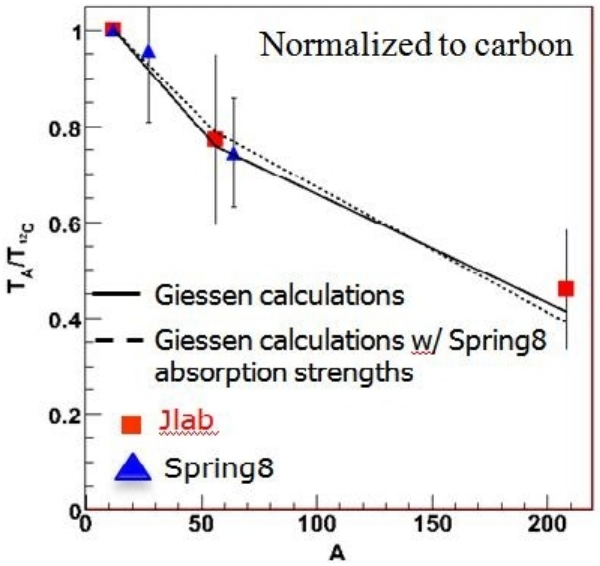
Where leaders are made

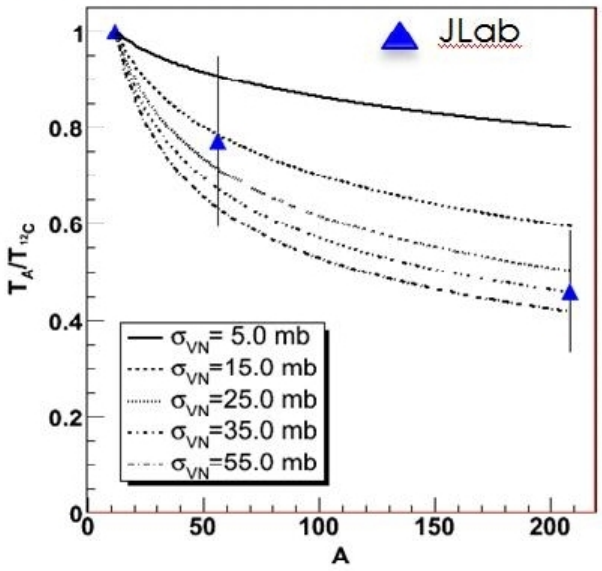
ϕ Absorption

Comparison to other work



Spring8 γ A $\rightarrow \phi$ A' $\rightarrow$ K^+K^- A' (E_γ=1.5-2.4 GeV)
T. Ishikawa et al. Phys. Lett. B 608, 215 (2005)

Comparison to Glauber calculations



Γ_{coll} ~ 11 – 25 MeV
Spring8 result : 20 MeV

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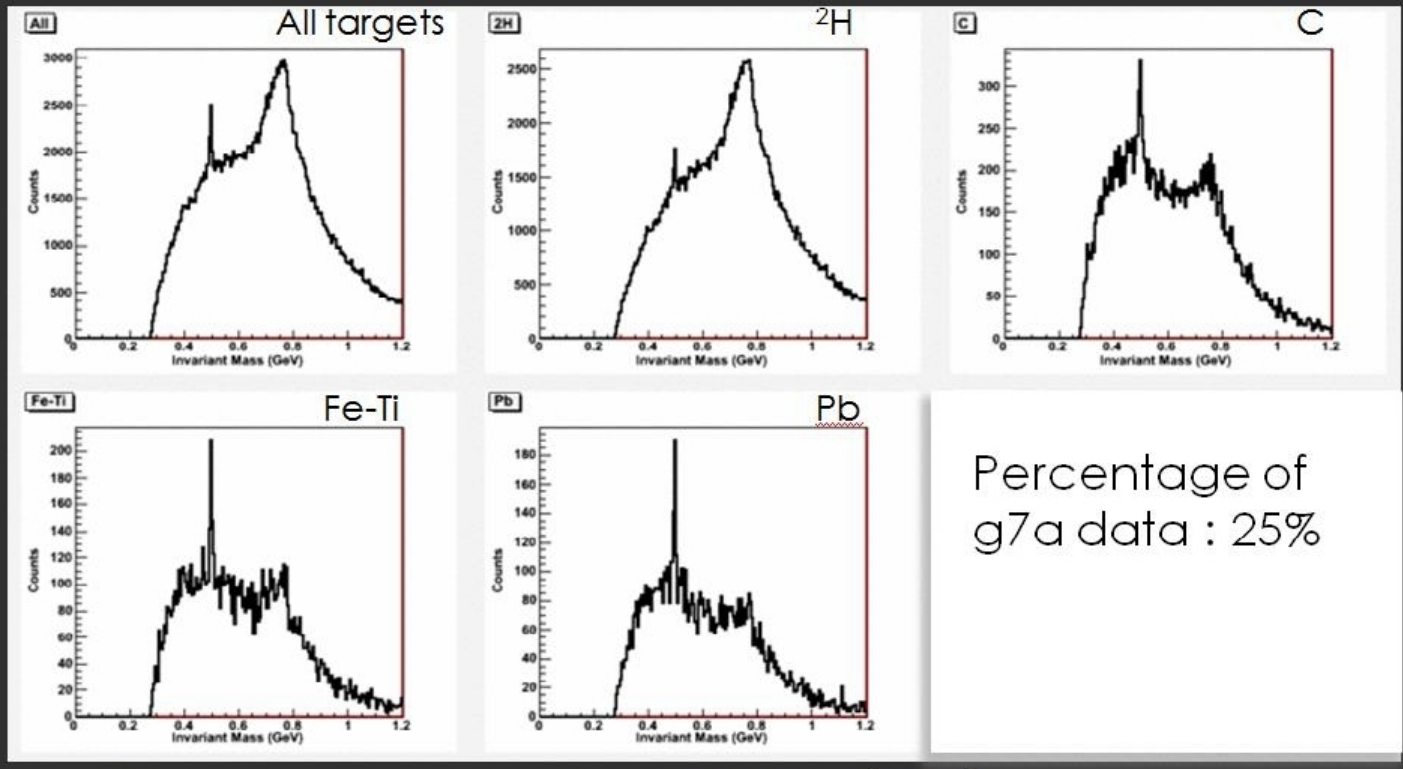
K_s Absorption: $\pi^+\pi^-$ Mass Spectra



Percentage of g7a data : 25%

$\pi^+\pi^-$ Invariant Mass (GeV)

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Where leaders are made

Summary and Conclusions

CLAS is an excellent tool for meson absorption studies:

Vector mesons:

- ★ Identified e^+e^- from rare leptonic decay of light vector mesons.
- ★ Clear ρ, ω and ϕ signals in the invariant mass spectrum.
- ★ Definite absorption of the ω and ϕ mesons in nuclei.
- ★ The ω meson: collisional width > 200 MeV!
- ★ The ϕ meson: in medium width range of 11-25 MeV.
- ★ Analysis note submitted to the review committee.

The Kaon:

- ★ Clear K_S signal in the $\pi^+\pi^-$ mass spectra.
- ★ Interesting preliminary yield distribution as a function of target A.
- ★ Investigating the target selection and vertex reconstruction.
- ★ Extended to the g7b run with larger target spacings.

Canisius COLLEGE
Where leaders are made

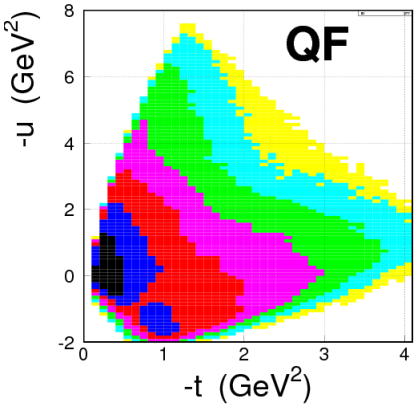
Mechanism of Quasi-Coherent π^- - photoproduction off Deuterium in $\gamma D \rightarrow \pi^- p p$ reaction

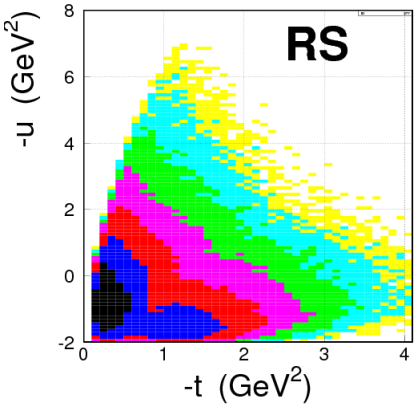
CLAS Experiment g10
JLab

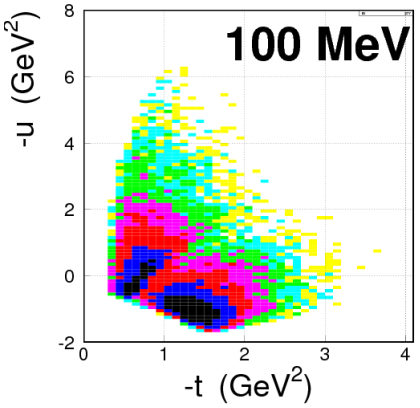
N.Pivnyuk, J.-M. Laget, E.Pasyuk,
T.Mibe

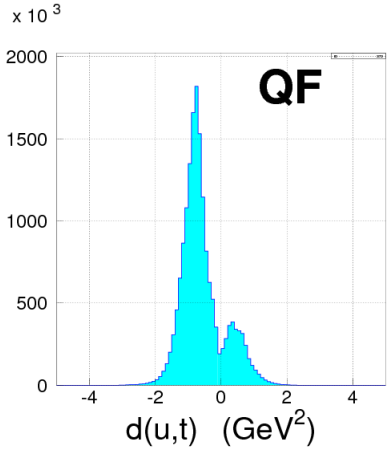
Peculiarity everywhere

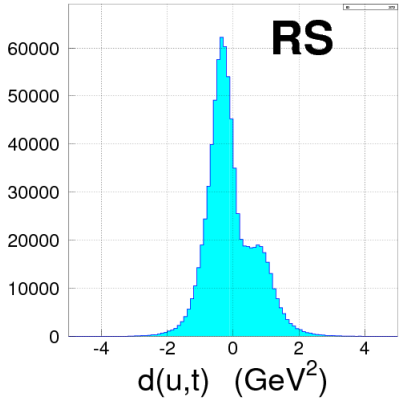
Quasi-Free | **FSI Rescatterings** | **Quasi-Coherent**

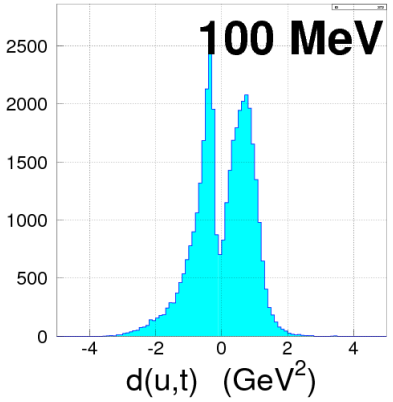






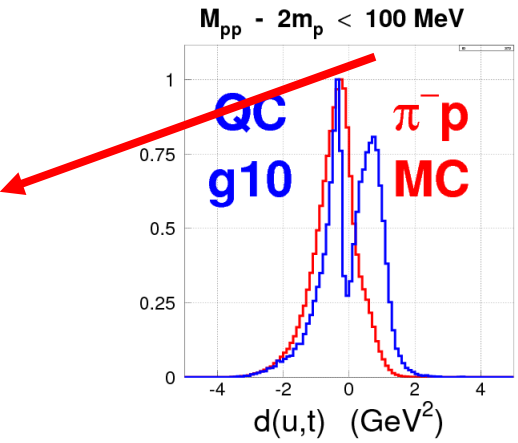


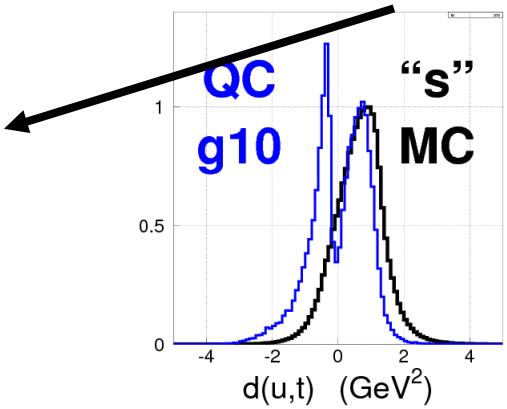


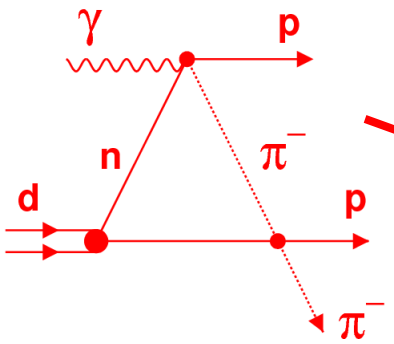


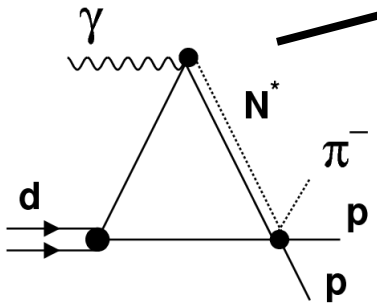
“ t and s ”

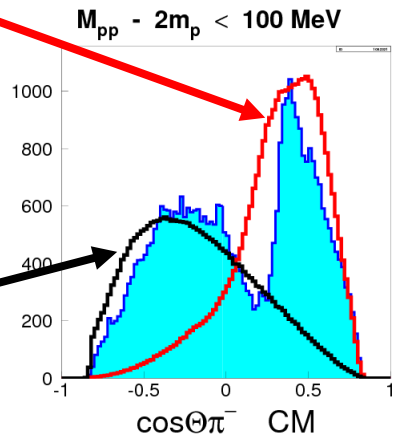
$M_{pp} < 2m_p + 100$ MeV









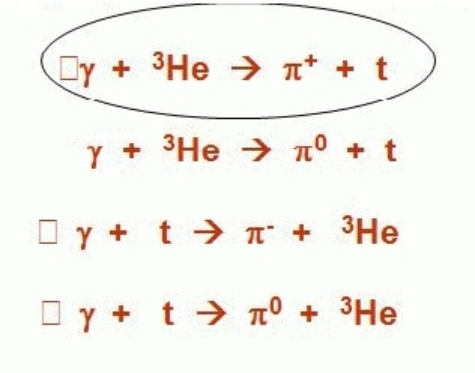


Elastic π^+ Photoproduction on ^{3}He

Rakhsha Nasseripour and Barry Berman

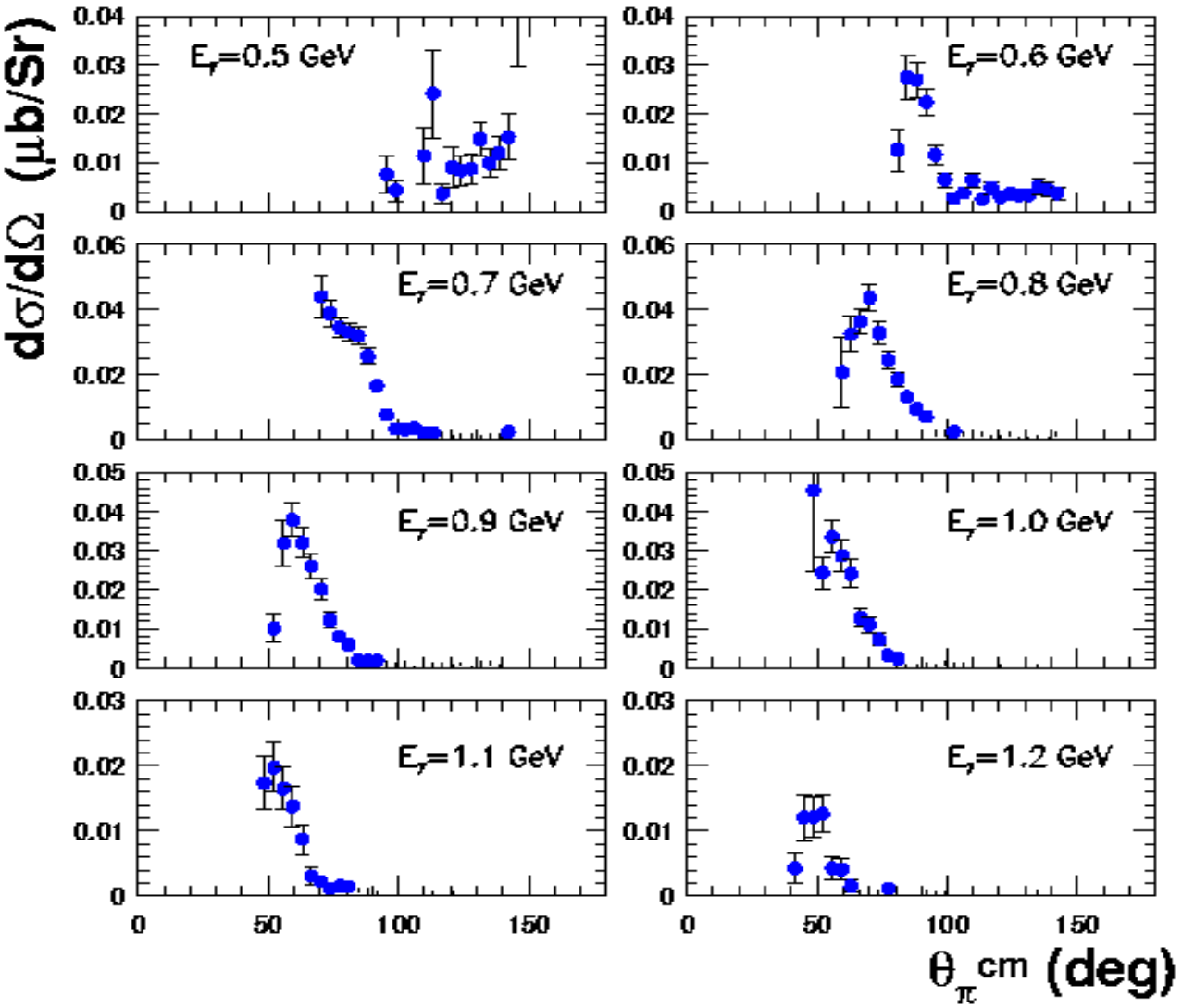
The George Washington University

Comparing an elementary meson production process on a free nucleon with the same process on the nucleus

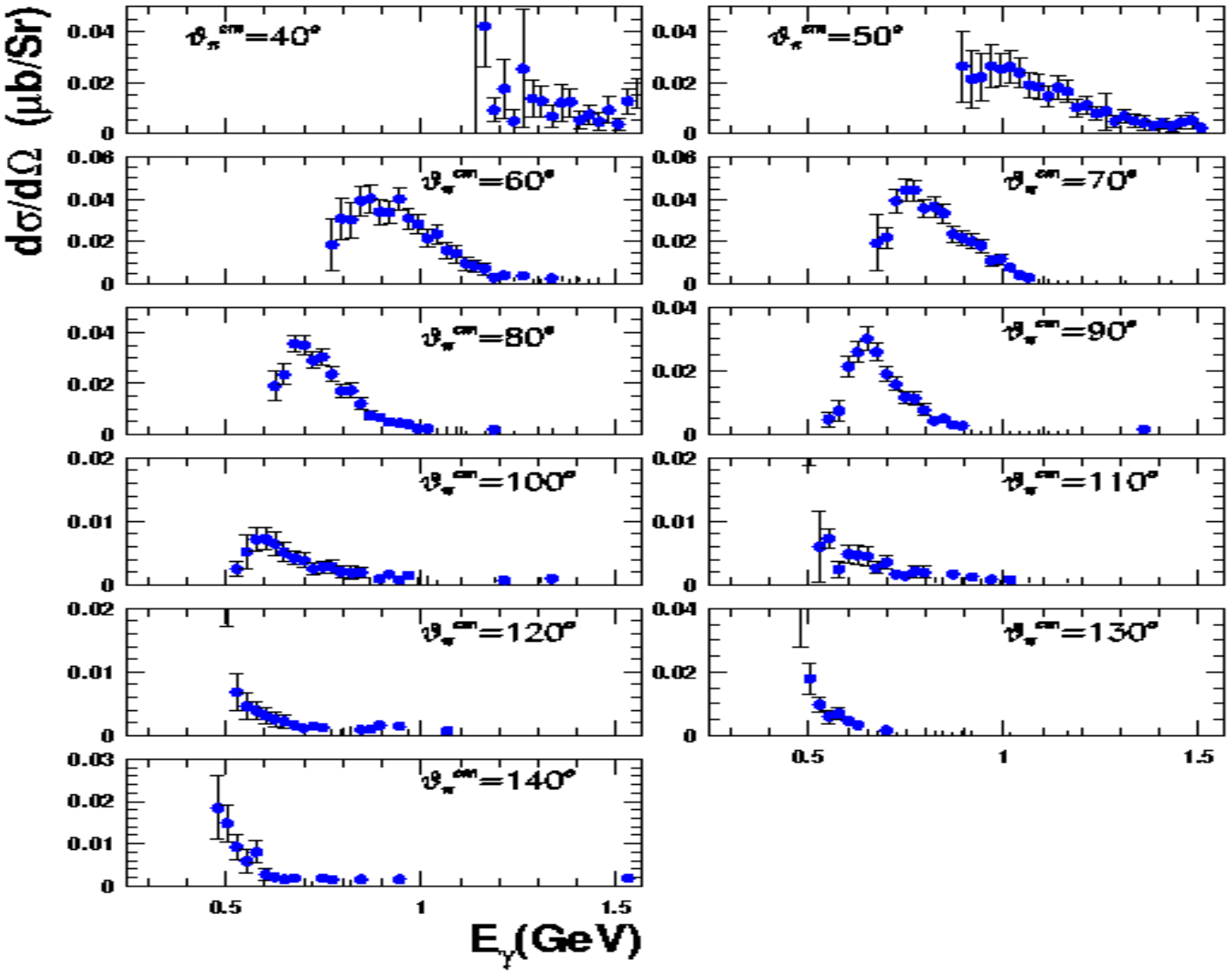


- *Useful in developing our understanding of the nuclear structure and long-range Part of the nucleon-nucleon interaction described by one pion exchange model*
- *A good tool to explore the importance of the pion cloud and thus to investigate the contribution of mesonic degrees of freedom*

Cross Sections (Angular Dependence)



Cross Sections (Energy Dependence)



Summary:

- We have extracted the cross sections for elastic π^+ photoproduction on ^{3}He for photon energies between 0.5 and 1.2 GeV and pion scattering angles between 40 and 130 degrees.

- Analysis-note nearly complete > Would like to request for an analysis review committee

To be done:

- Complete the systematic error analysis

Report on DIS2009
Ken Hicks, Ohio U.

Medium-modified fragmentation functions

Rodolfo Sassot
Universidad de Buenos Aires

in collaboration with M. Stratmann and P. Zurita

DIS2009, Madrid, April 2009

Motivation

- significant progress in the pQCD description of hadroproduction.
- nuclear benchmark: hadroproduction data off nuclear targets shows clear signals of A-dependence
- heavy ion collisions (Au-Au) at RHIC (LHC?).
- model/calculations: reproduce the main features of the data(in spite of very different approaches and ingredients!).
- a different approach: isolate effective FFs (nFFs) from data, factoring out: nPDFs (as in nDIS) for nPDFs and nFFs.

Convolution approach:

$$D^h_{i/A}(z,Q_0^2) = \int_z^1 dy\, W_i(y,A,Q_0^2)\, D^h_i(\frac{z}{y},Q_0^2)$$

works for nPDFs
re-scalings/shifts
modifies FFs
natural language NLO

$W_i(y,A,Q_0^2) = \delta(1-y)$ no effects

$W_i(y,A,Q_0^2) = \delta(1-\epsilon-y)$ z-shift $\sim$ energy loss

$W_i(y,A,Q_0^2) = n_i\, y^{\alpha_i}(1-y)^{\beta_i}$ enhancement/suppression, re-shape

weighting coefficients $\epsilon_i, n_i, \alpha_i, \beta_i$ with a smooth A dependence

$n_i = \lambda^{n_i} + \gamma^{n_i} A^{\delta^{n_i}}$ with $\lambda^{n_i}, \gamma^{n_i}, \delta^{n_i}$ parameters to be fitted

Refined parameterization:

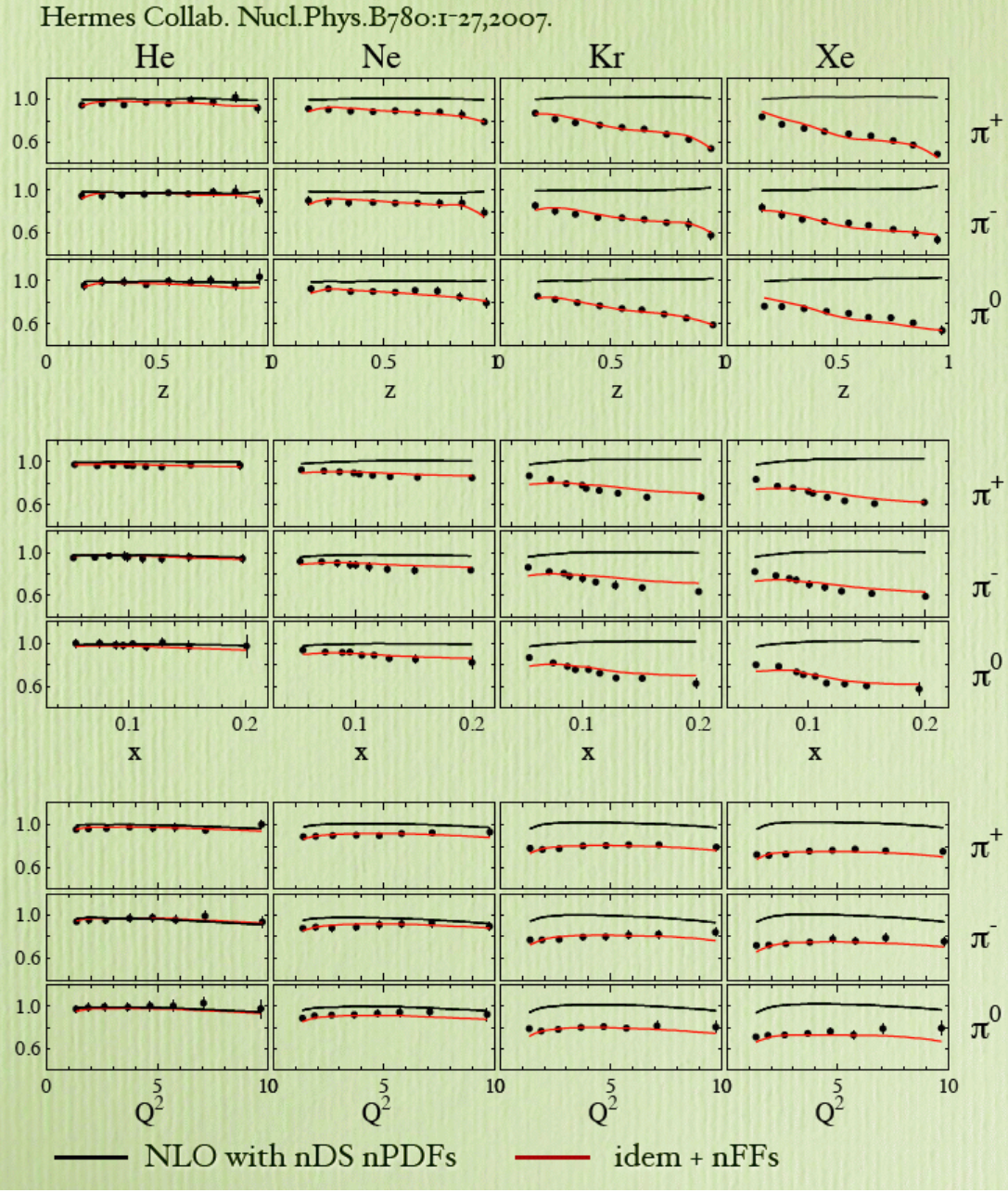
$$W_q(y,A,Q_0^2) = n_q\delta(1-\epsilon_q-y) + n'_q\, y^{\alpha_q}(1-y)^{\beta_q}$$

quark/anti-quark fragmentation

$$W_g(y,A,Q_0^2) = n_g\delta(1-\epsilon_g-y) + n'_g\, y^{\alpha_g}(1-y)^{\beta_g}$$

gluon fragmentation

needs to be constrained by dAu collision data



$\chi^2 = 350.45$

368 data points

17 parameters

$\chi^2/d.o.f = 0.997$

x (or ν)-dependence reproduced

no conflict with standard evolution?

Conclusions

data reproduced in a factorizable scheme with effective nFF

- z,$Q^2$and ν-dependence of data
- process-independent universal nFF
- standard evolution equations

effective nFFs as tools for "distilling" data

- changes in quark fragmentation "look like" mostly energy loss
- effects in gluons are stronger and less clear
- not a purely partonic effect

nice picture for pions, not so precise for other hadrons

- uncertainties in $p/\bar{p}$ and kaon FFs are not a minor issue
- less data available
- sensitivity to quark/antiquark fragmentation?

π^0 electroproduction off C, Fe,Pb in SIDIS. Space-time description of hadronization.

Taisiya Mineeva

Reasons for EG2 data recooking

π^o analysis update:

Electron and photon identification

π^o and η extraction

Multiplicity Ratio

Reasons for data recooking

Comparison from the ntuple10 file 042011_01.

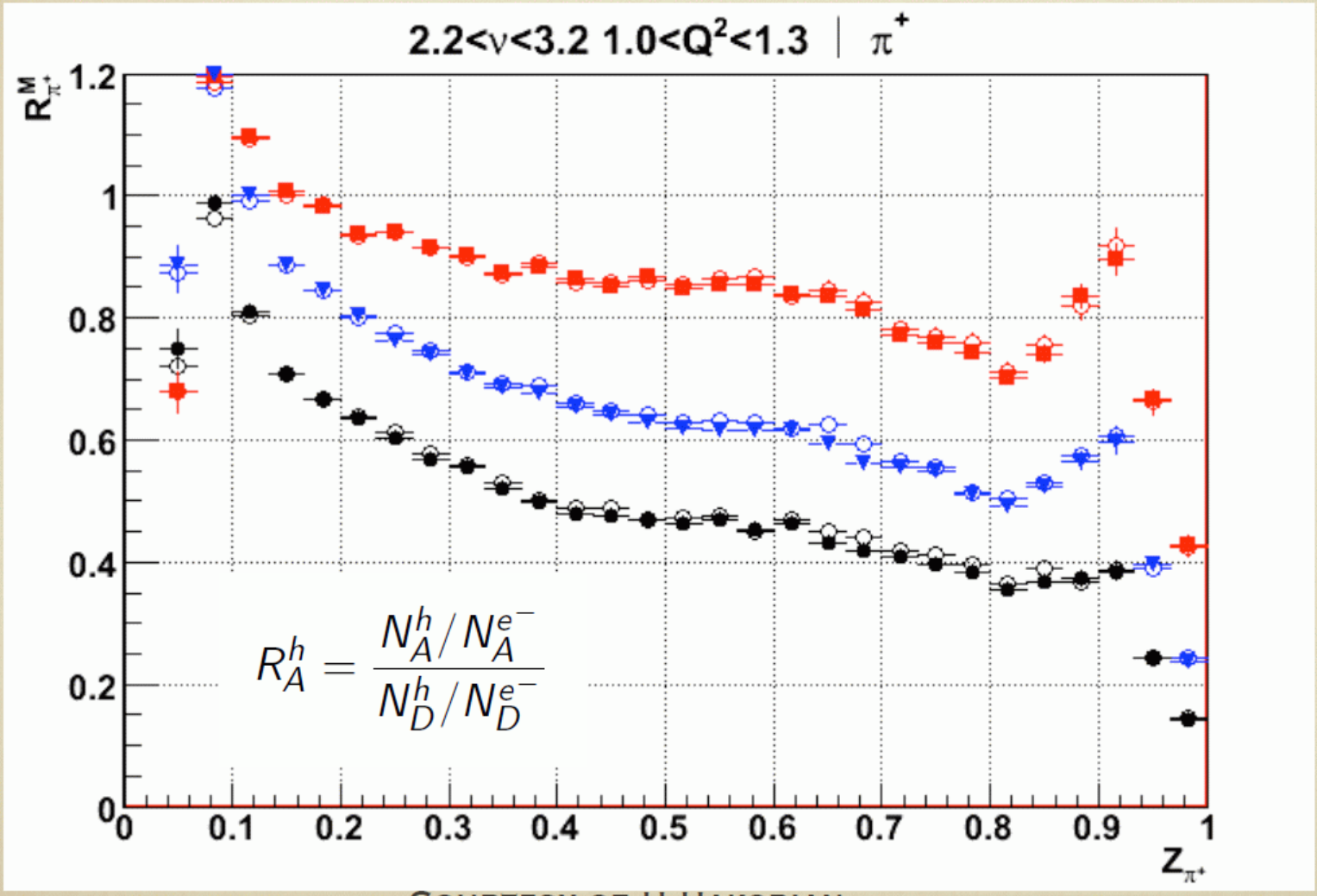
	Old Cooking (touchi_id=2?)	New Trk (touch_id=2)	New Trk (touch_id=1)	New Trk+ New Ec
N of events processed	194308	202748	202978	202939
N of e with id[0]=11	79571	88343	88209	(+11%) 88067
N of e with refined Id	9502	13897	13748	(+44%) 13675
N of e with refined Id that contain a 2gamma pair	859	1352	1482	(+74%) 1495
N of 2 gamma pairs (pi0, eta, etc)	1334	2110	2364	(+86%) 2487
N of pi0 events w/o backgrd	295	473	617	(+90%) 560

Comparison from the Clastool one run 042011.

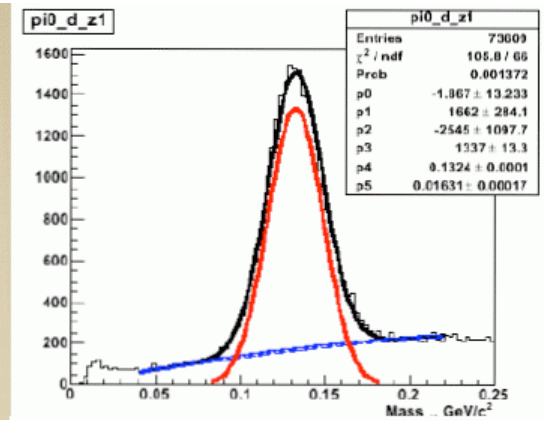
N of pi0 events w/o backgrd	5063			(+89%) 9594

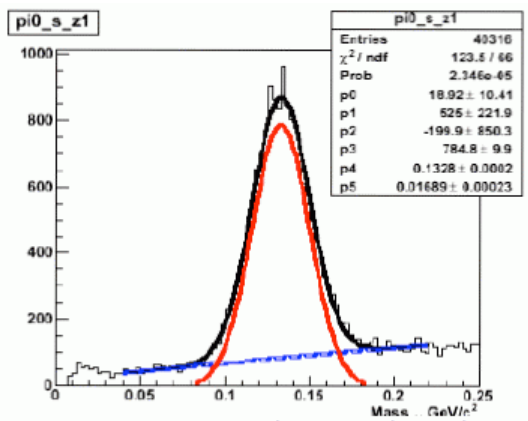
For more info: http://www.jlab.org/~mineeva/ReasonsToRe/

Comparison of preliminary results for R in case of old cooking (empty) and newly cooked data (full)



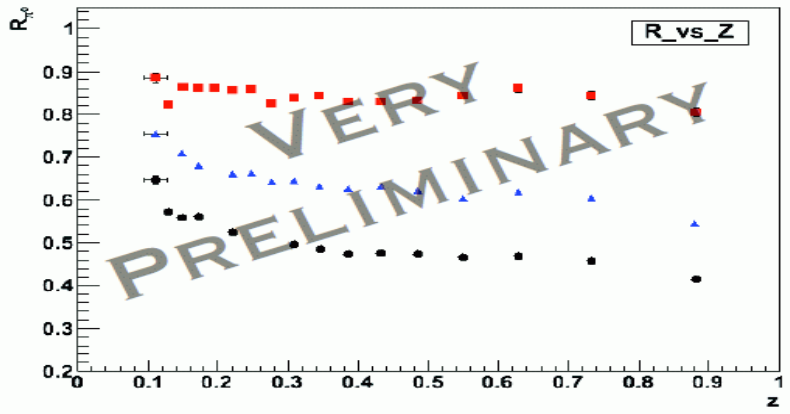
Courtesy of H.Hakobian

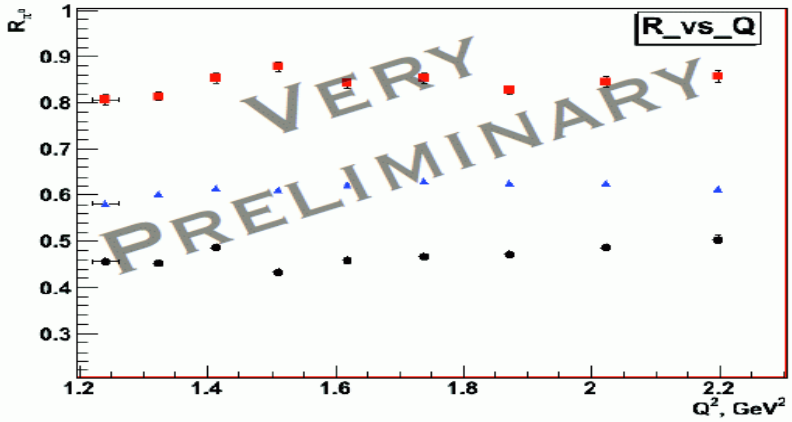


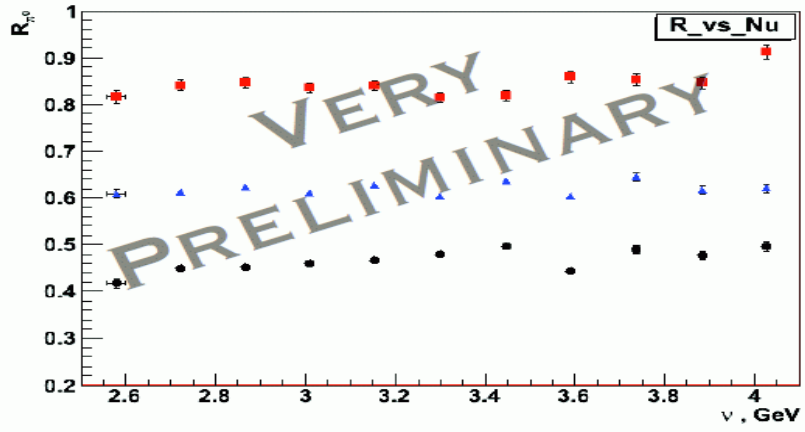


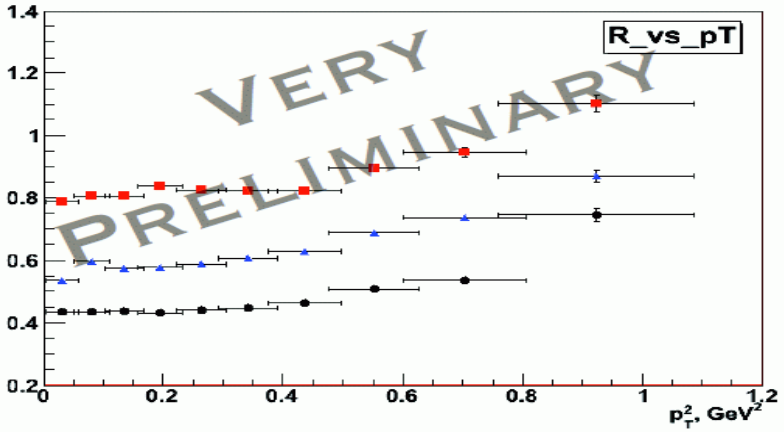
Example of π^0 invariant mass fit

$0.4 < z_1 < 0.42$









Summary

EG2 data has been recooked resulting in ~45% more 'clean' electrons and ~90% π^0

Procedure for the clean identification of electrons and photons was developed.

Events were distinguished between two targets using corrected electron vertex.

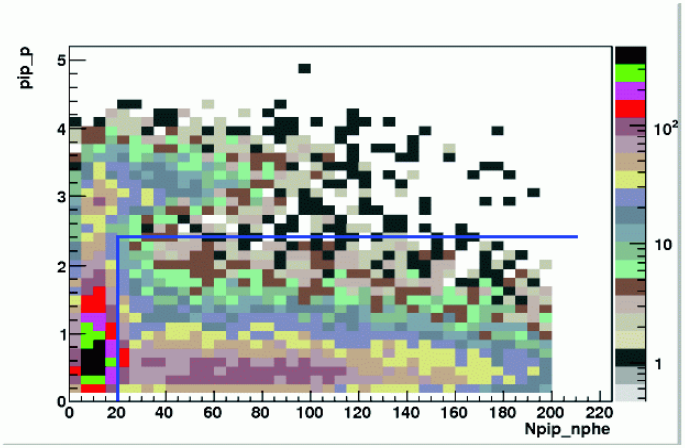
Machinery for extracting multiplicity ratio and transverse momentum broadening of π^0 with its background subtracted was developed.

Progress of EG2 analysis: charged pion hadronization

Raphaël Dupré

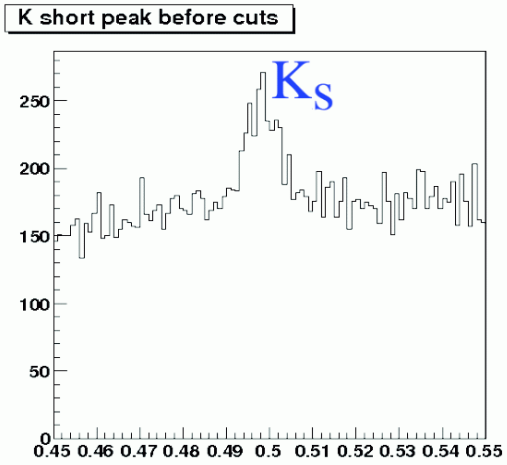
Argonne National Laboratory
Physics Division
and
Université Claude Bernard Lyon 1
UFR de Physique

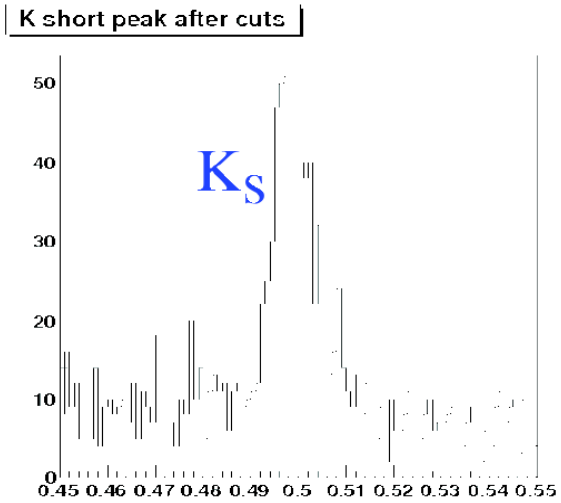
- The position of the hit must match with the theta of the pion (like for electrons)
- The CC allow us to remove electron contamination



$\pi^+\pi^-$ reconstruction

- The K_s mass have a huge background

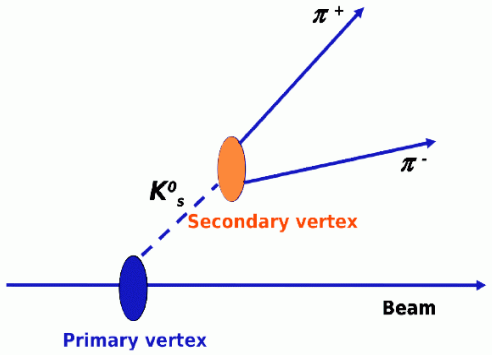




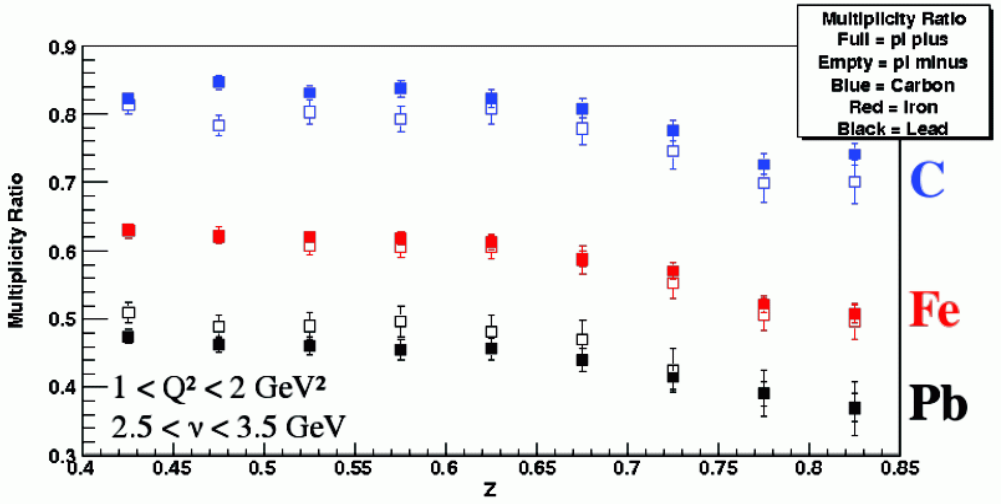
3. Future work
   - Acceptance correction
   - Simulation
   - Radiative correction
   - Systematics error estimation

Background rejection

- Secondary vertex detection can reduce the background
  - Existence (DCA < 1.5 cm)
  - Distance (D > 1 cm)
  - Direction ($cos(\theta) > 0.95$)



- Full : π^+ ; Empty : π^-

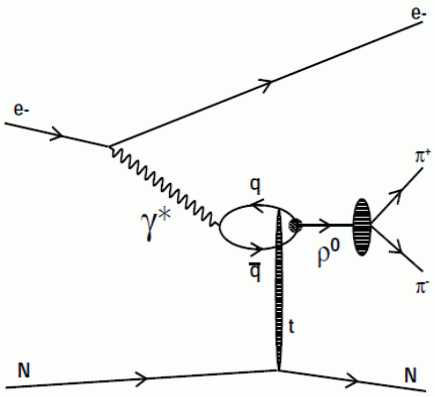


Study on how the new recooking of the EG2 dataset affects the ρ^0 Color Transparency signal

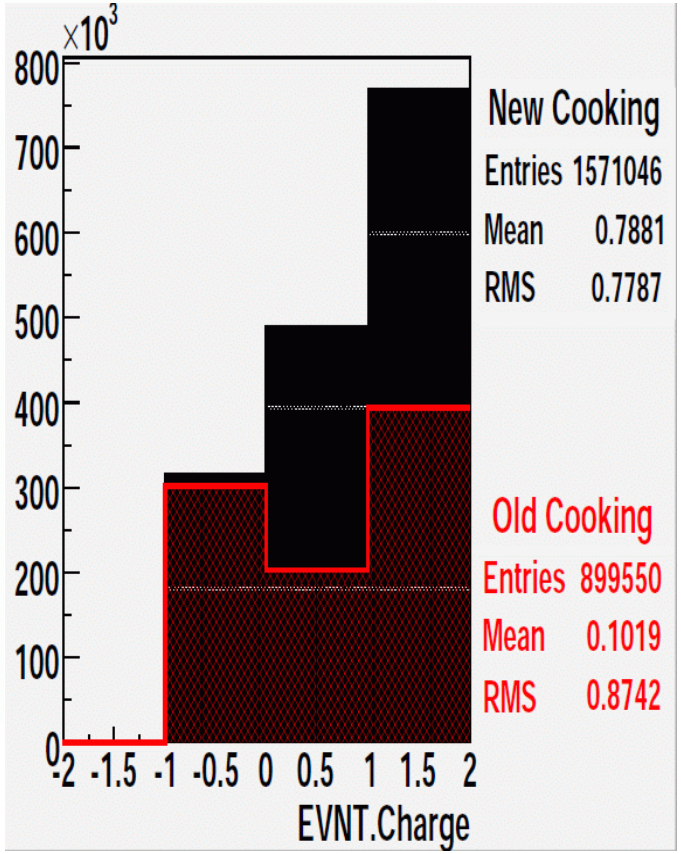
Lorenzo Zana, L. Elfassi, M. Holtrop, K. Hafidi, B. Mustapha, eg2 collaborators,
CLAS collaboration

UNIVERSITY OF NEW HAMPSHIRE

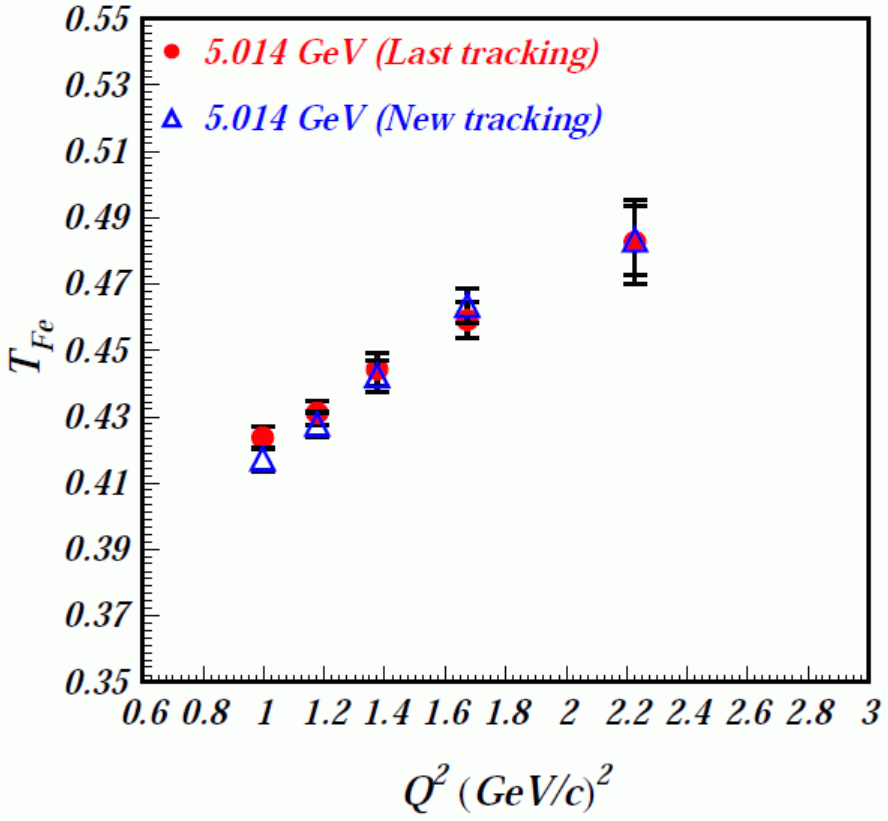
Selection Events



- 1 e^-
- At least 1 π^+
- At least 1 π^-
- 0 e^+
- No events with a second e^-



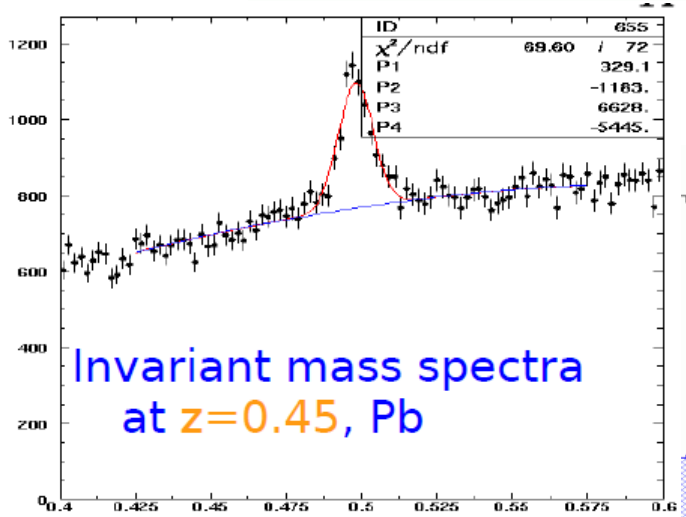
Color Transparency effect

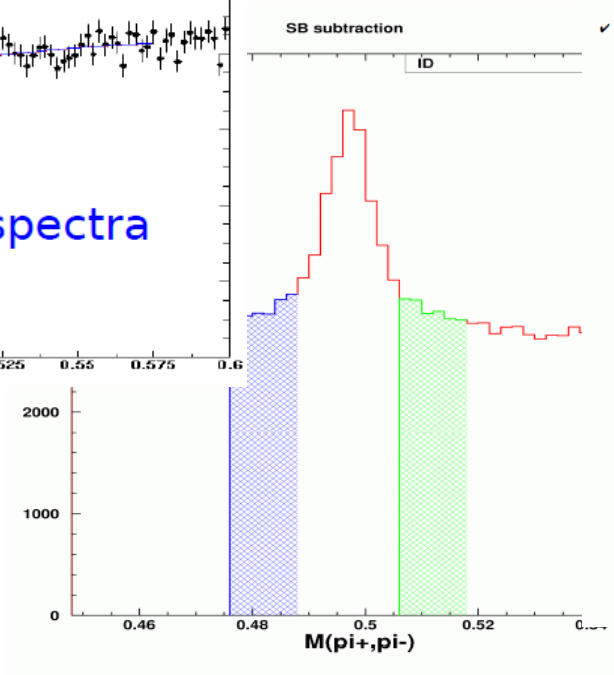


K^0 hadronization studies

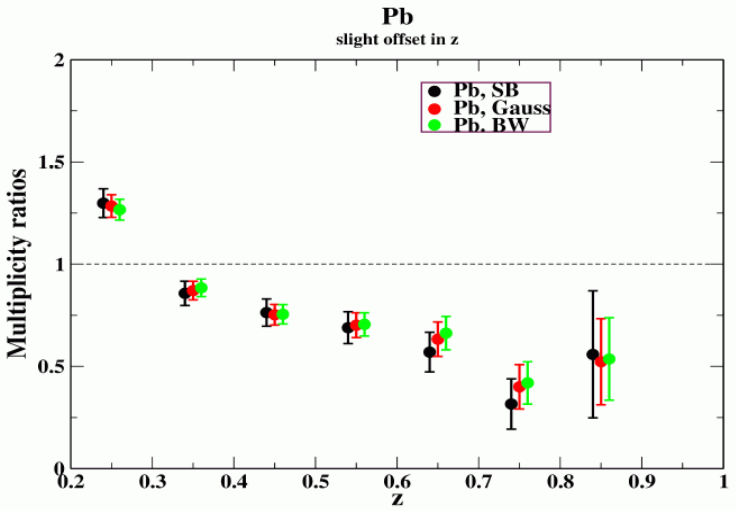
(preliminary results from CLAS EG2 experiment)

Aji Daniel
Ohio University
(in collaboration with K. Hicks)

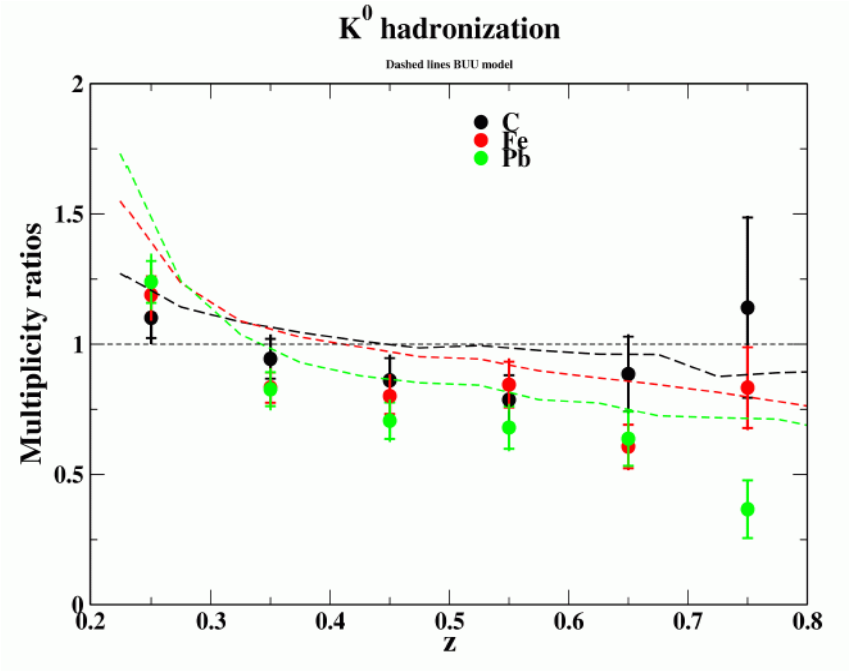




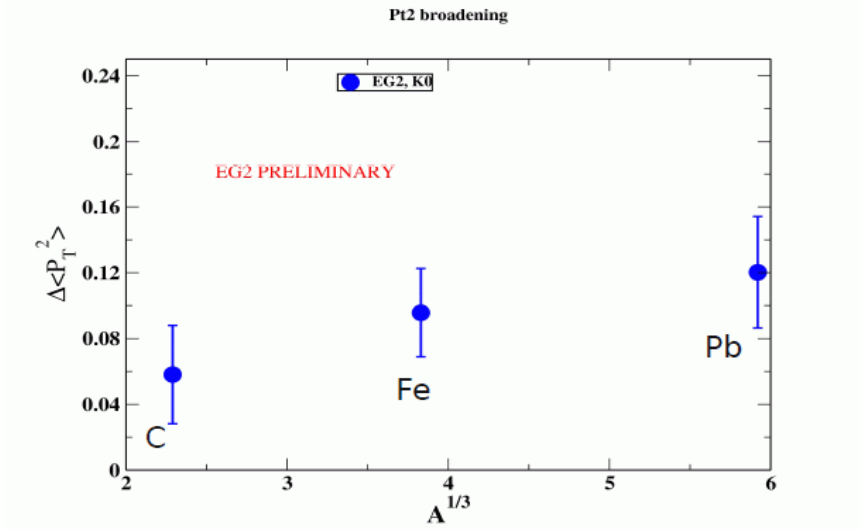
- Sideband subtraction
- Briet Wigner +2nd order poly
- Gaussian + 2nd order poly



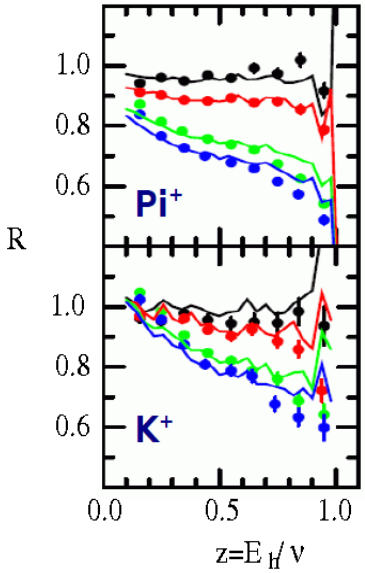
Preliminary Results



$$\Delta P_T^2 = < P_T^2 >_A^{DIS} - < P_T^2 >_D^{DIS}$$

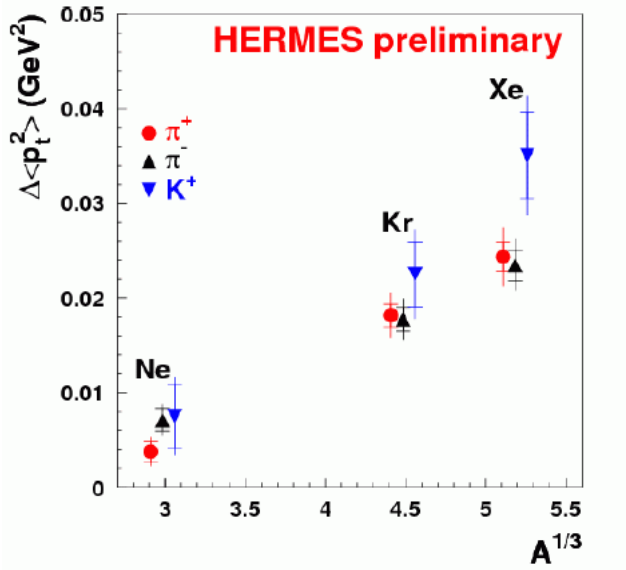


Example: Multiplicity vs z, HERMES data@27GeV



- Primary eP interaction using JETSET part of PYTHIA
- Some nuclear effects are accounted for (Fermi motion, Pauli blocking, nuclear shadowing)
- FSI of the reaction products are described coupled channel BUU (Boltzmann-Uehling-Uhlenbeck) transport equations
- QCD inspired time dependent cross sections for pre-hadrons
- Reasonable agreement with EMC 100-280 GeV and HERMES (12-27 GeV).

Nucl.Phys.A801:68-79,2008



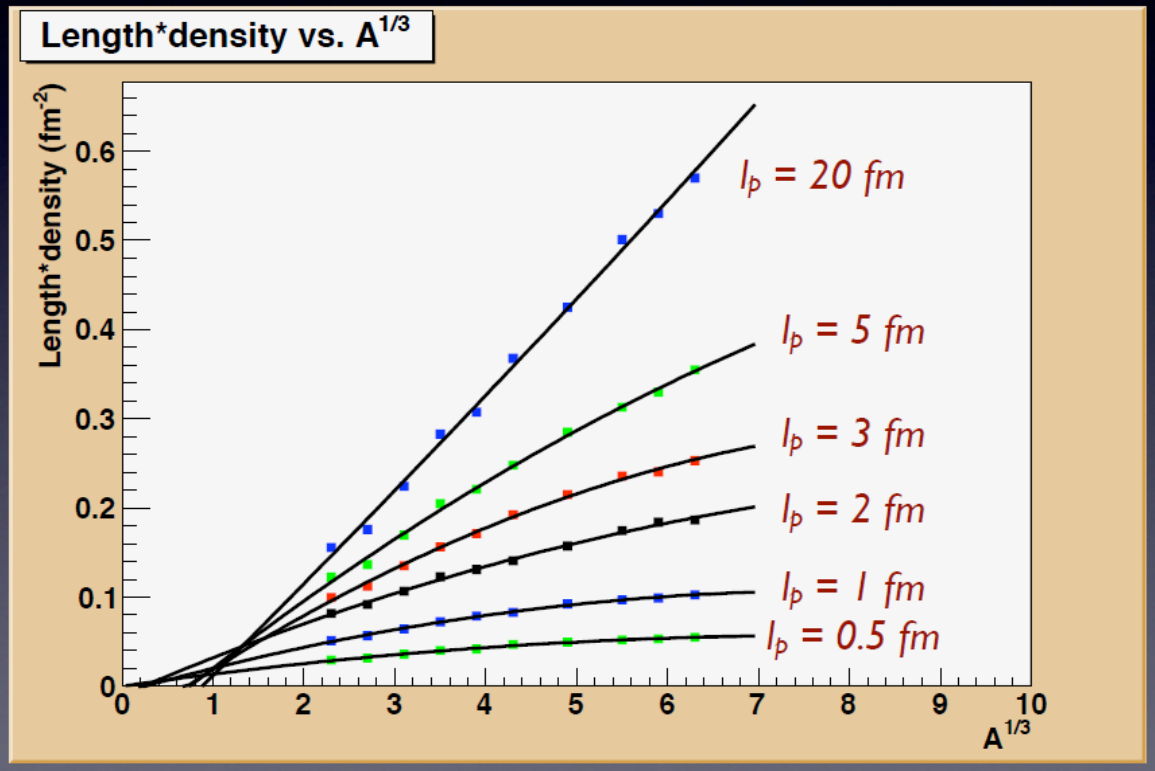
(Yves Van Haarlem,9th Workshop on Non-Perturbative Quantum Chromodynamics, 2007)

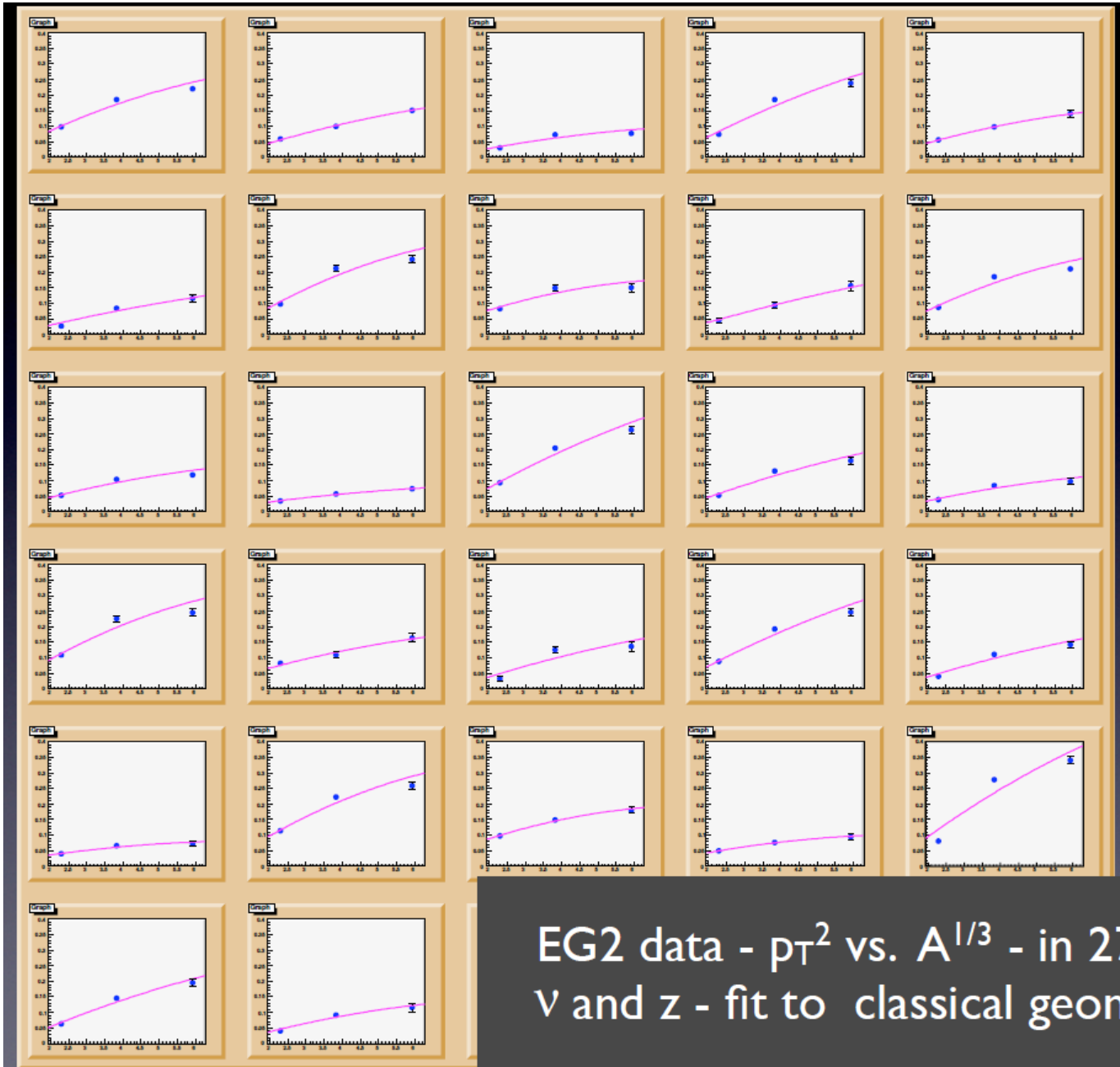
Summary

- Information about the space-time evolution of hadronization is important to understand the confinement mechanism.
- Several hadron species are needed to give insight into fundamental principles governing the hadron formation.
- Though the precision is modest, clear demonstration of nuclear dependence of K^0 hadronization (First world data).
- Data shows a nonzero broadening of transverse momentum.
- 12 GeV upgrade of Jlab will improve these measurements with an increase in the luminosity, and also covers a bigger range in DIS kinematics.

Extraction of Production Times From EG2 data
Will Brooks, UTFSM

Variation of broadening with A and l_p from classical geometrical model





EG2 data - p_T^2 vs. $A^{1/3}$ - in 27 bins in Q^2, ν and z - fit to classical geometric model

Conclusions

- Now experimenting with the elements needed to extract production lengths
    - Classical geometric model produces correct qualitative features
- Moderate sensitivity to assumed distribution (constant, exponential) is observed
- Still to explore:
    - sensitivity to assumptions on attenuation mechanism
    - pattern of dependence on kinematic variables
- A straightforward extraction seems feasible