HADRONIZATION STUDIES

via $\omega(782)$ electroproduction off D, C, Fe and Pb

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CLAS

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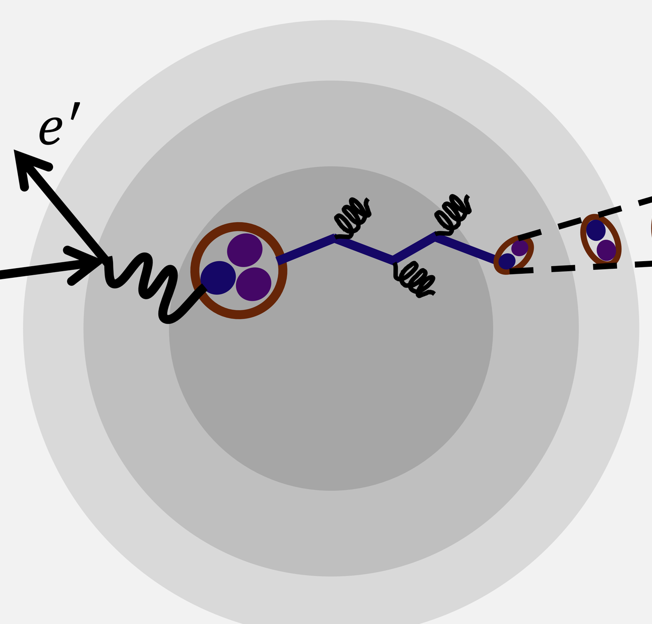
Hadronization is the formation of quarks and gluons into hadrons, but how do nuclei of **different sizes** change this **process?**



Introduction

Hadronization is a phenomenon of Quantum Chromodynamics (**QCD**) that has not yet been fully understood. For this reason, several models have been proposed. **[1-3]**

These models can be tested using experimental techniques. One of them consists in measuring **hadron production** in **Semi-Inclusive Deep Inelastic Scattering** (**SIDIS**) of leptons from nuclei of various sizes.

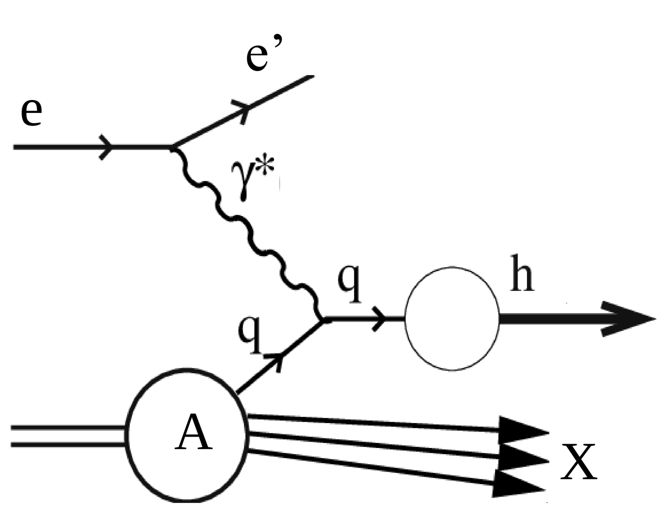


Fig 1. Semi-Inclusive Deep Inelastic Scattering diagram. The reaction of this process is: $e\,A \rightarrow e'X\,h$.

Nuclear modification of hadron production in **SIDIS** was first observed at **SLAC [4]**, followed by **EMC [5]**, **E665 [6]** and more recently at **HERMES [7]** and **CLAS [8]**.

Multiplicity Ratio

The experimental data is presented as the **ratio of hadron multiplicities** R_h^A observed in the scattering of a nucleus (A) to those on the deuteron (D).

$$R_h^A \equiv \frac{\left(\frac{N_h(Q^2,\nu,z,p_T^2)}{N_e^{DIS}(Q^2,\nu)}\right)_A}{\left(\frac{N_h(Q^2,\nu,z,p_T^2)}{N_e^{DIS}(Q^2,\nu)}\right)_D}$$

Where $\boldsymbol{N_h}$ is the number of semi-inclusive hadrons h in a given (Q^2,ν,z,p_T^2) bin and $\boldsymbol{N_e^{DIS}}$ the number of inclusive DIS electrons in the same (Q^2,ν) bin.

For this particular case, the hadron h corresponds to $\boldsymbol{\omega}$**(782).**

This analysis follows a **line of investigation** in hadronization of the **meson sector** such as π^0**[9]** and η**[10]**, and corresponds to the **first ω hadronization studies** in the world.

CLAS6 EG2 Experiment

The measurements were perfomed by the **CLAS** spectrometer in the **EG2 run**, which took place at the **Hall B** of the Thomas Jefferson National Accelerator Facility (**Jefferson Lab**), USA.

An electron beam with **5.014 GeV** energy was incident simultaneously on a **double-target system** composed by a liquid deuterium target and a solid target (C, Fe, Pb). **[11]**

Fig. 2. The double-target system from the EG2 run. Solid target (black square) is held by a mechanical arm and liquid target (blue square) is enveloped in thermally insulated aluminium foils.

Preliminary Results

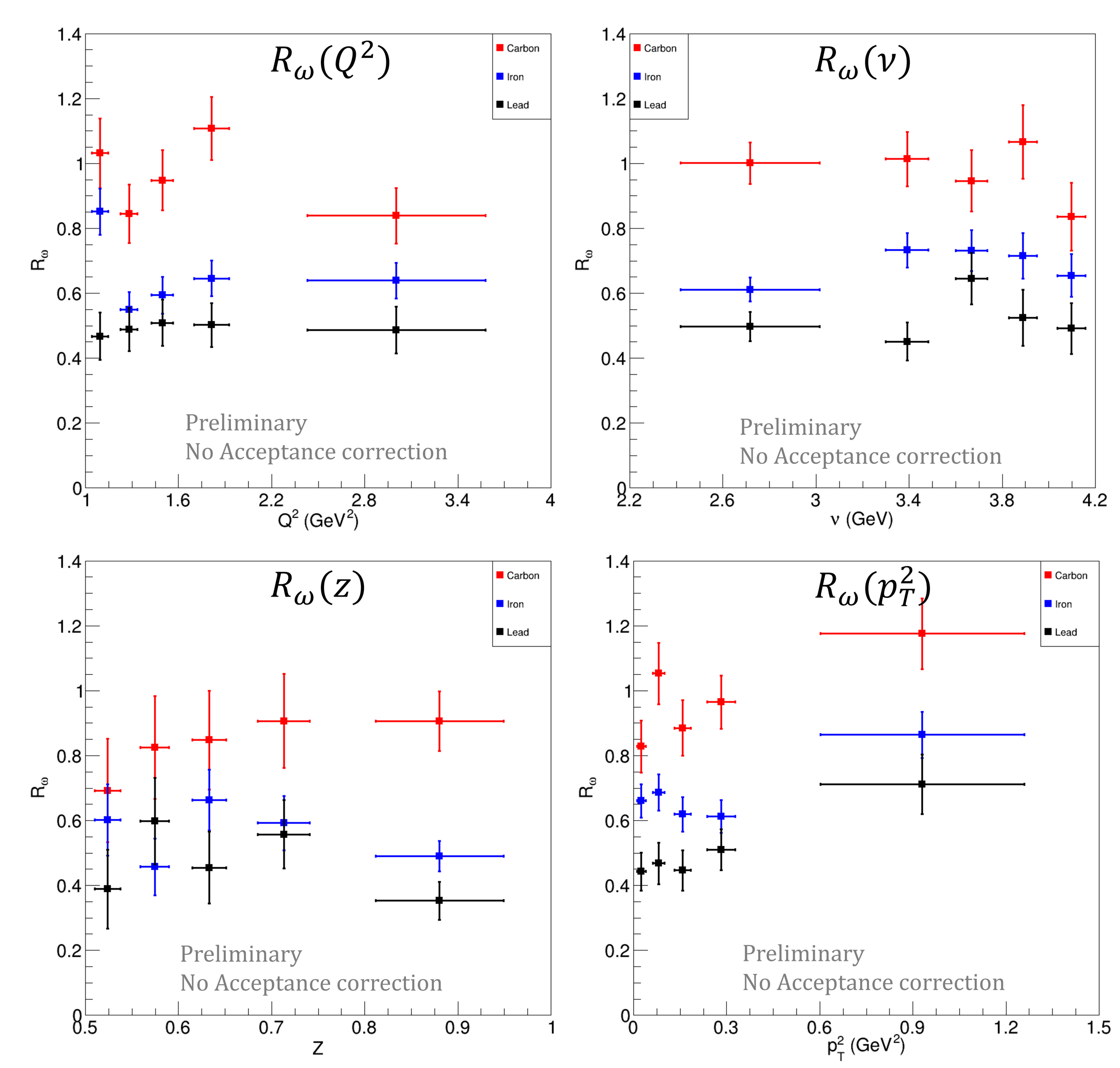


Fig. 3. 1-dimensional **Multiplicity Ratios** of ω for C, Fe and Pb, relative to Deuterium. These ratios are determined as a function of Q^2, ν, z and p_T^2. The dependence on nuclear size is observed in all cases.

ω Invariant Mass Reconstruction

Due to the ω meson's **short lifetime** of 7.75×10^{-23} [s], its invariant mass is reconstructed from the particles at the **final state** of its **main decay channel** $\omega \rightarrow \pi^+\pi^-\pi^0 \rightarrow \pi^+\pi^-\gamma\gamma$, which has a **branching ratio** of **89%**. **[12]**

Such particles are identified under: DIS requirements ($Q^2 > 1,\ W > 2,\ y < 0{,}85$), exclusion of charged kaons, π^0 invariant mass reconstruction, among other conditions.

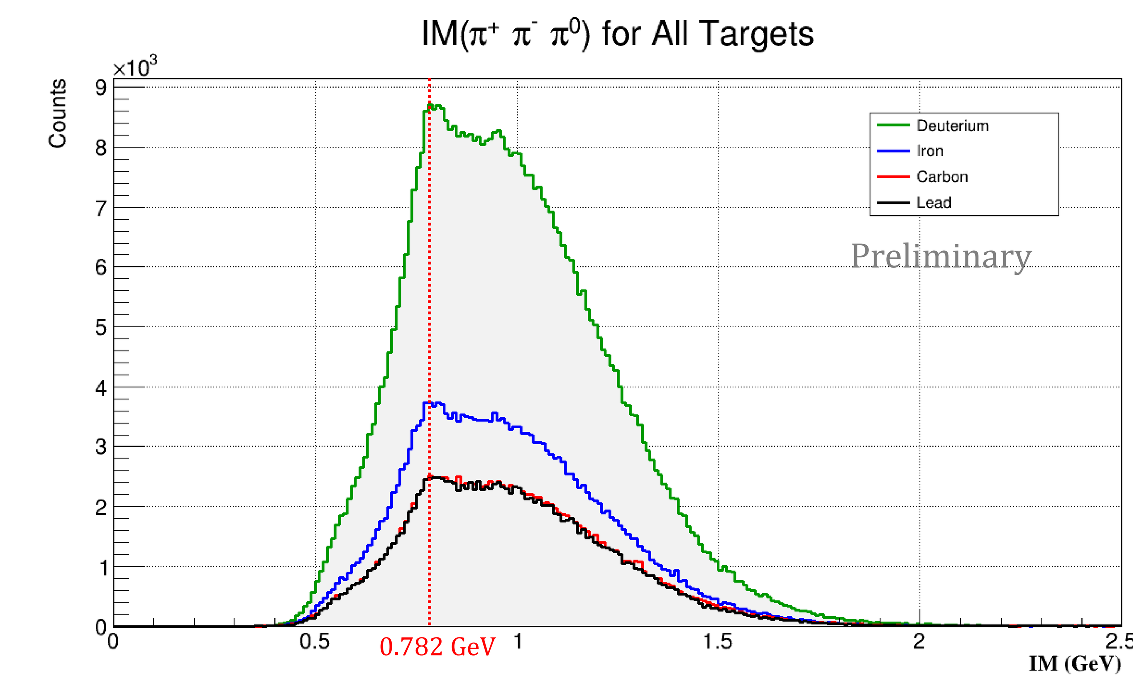


Fig. 4. Invariant mass of omega candidates for all targets. This plot represents a summary of all the **available data**. Red line corresponds to the expected mass value. **[12]**

Background subtraction

To extract the number of ω particles N_ω, it's necessary to subtract the background from the signal region.

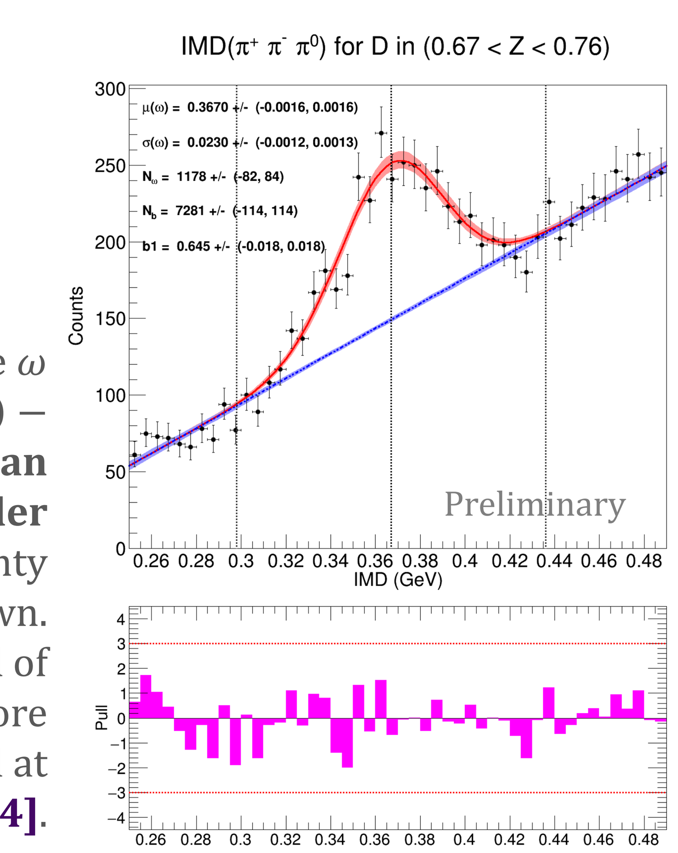


Fig. 5. Background subtraction by fitting the ω **invariant mass difference** distribution $m(\omega) - m(\pi^+) - m(\pi^-) - m(\pi^0)$, by using a **gaussian function** (red) for the signal and a **1st order polynomial** (blue) for the background. Uncertainty bands and pull distribution are also shown. The invariant mass difference is used instead of invariant mass as it enhances the signal. More information about this method can be found at **[13,14]**.

Monte-Carlo Simulations

To proceed with the **Acceptance Correction**, events with at least one ω particle were generated with **LEPTO [15]** and also reconstructed through the official **CLAS reconstruction software.**

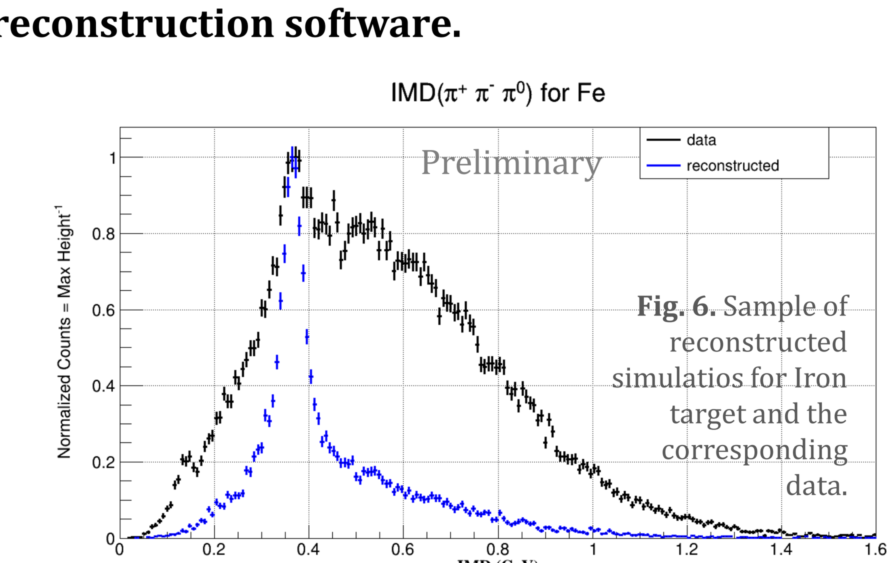


Fig. 6. Sample of reconstructed simulations for Iron target and the corresponding data.

Next steps

- Acceptance correction
- Radiative corrections
- Systematic uncertainties studies

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