

Electron Scattering on $A=3$ Nuclei from MARATHON

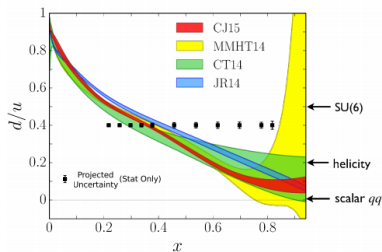
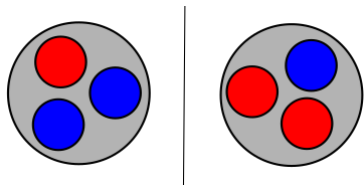
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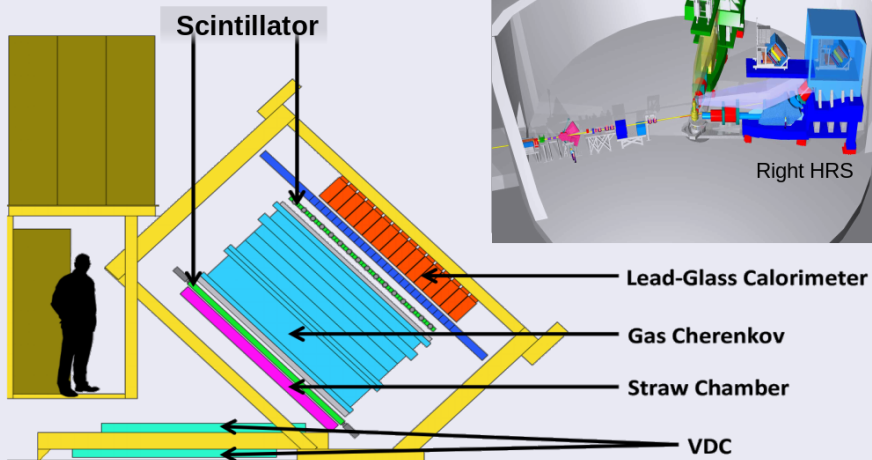
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Measurement of F_2^n/F_2^p , d/u Ratios and $A = 3$ EMC Effect in Deep Inelastic Electron Scattering off the Tritium and Helium Mirror Nuclei.



- Lightest and simplest mirror system
 - Number of protons in ^3H = neutrons in ^3He
- Differences in the nuclear effects are small
- Improve the current measurement and understanding of F_2^n/F_2^p ratio
- Restrict the assumptions and parameters made in the model calculations of the down to up quark distribution ratio
- 6 students from 4 universities

Figure: d/u quark distribution ratios





Exacting Yield from Data

$$\frac{d\sigma}{d\Omega dE'} = \frac{Yield}{Luminosity} = \frac{N_e - BG}{Luminosity * \epsilon}$$

- Luminosity \equiv # of electrons per scattering centers, needs correction due to density changes
- ϵ = efficiencies
- BG = background

Cross section by Monte carlo ratio

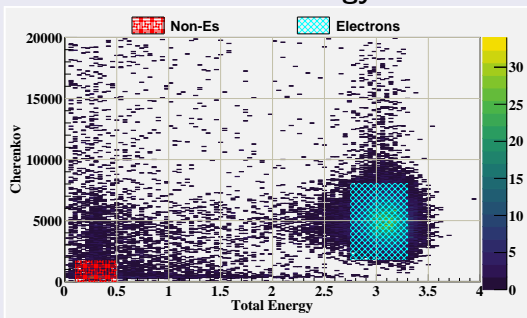
$$Yield_{data} = \frac{(N_e - Background)}{Efficiency} = L * \sigma^{data} * (\Delta E' \Delta \Omega) * A(E' \theta)$$

$$Yield_{MC} = L * \sigma^{mod} * (\Delta E' \Delta \Omega) * A(E' \theta) \quad \frac{d\sigma}{d\Omega dE'} = \sigma^{mod} * \left[\frac{Yield_{data}(E', \theta)}{Yield_{MC}(E', \theta)} \right]$$

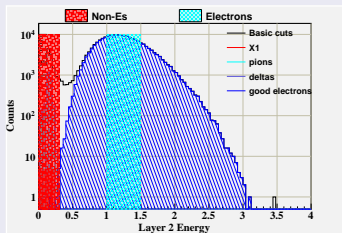
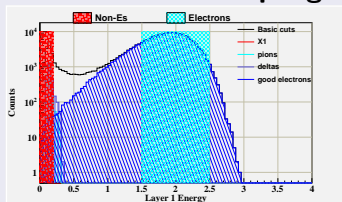
Counting Electrons

- Electron ID is done via the Cherenkov and two layers of a total calorimeter.
- Deposit large percentage of its energy into the total calorimeter system.
- Trigger significant amount of cherenkov radiation

Cherenkov vs. Total energy absorbed

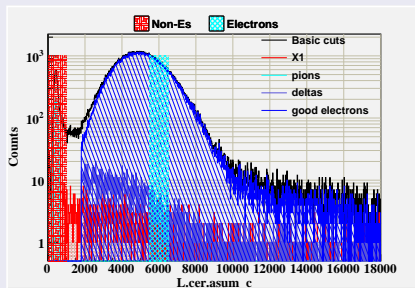


First and second layer of calorimeter with electron and non-electron sampling



Determine the Efficiency

- Electron sampling in two detectors
- Make threshold cut in the third
- Overall PID efficiency > 98%



Total cerenkov ADC signal with electron and non-electron sampling

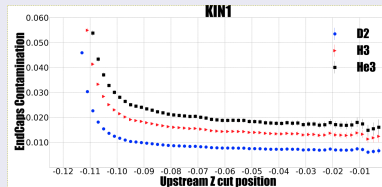
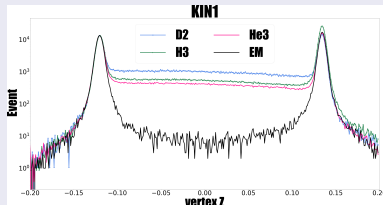


$$\frac{Ne-BG}{Luminosity * \epsilon}$$

- Pion contamination
- Charge Symmetric background
- Pion contamination is corrected for via the PID efficiency $< 1\%$
- Beta Decay of Tritium to Helium was discussed by Tyler Kutz - Stony Brook University
- End ap contamination
- Beta decay of tritium

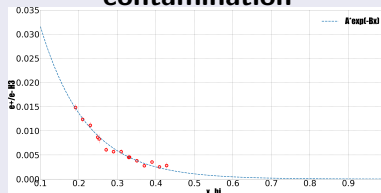
Contamination from Aluminum end caps

- Normalize end caps of Empty target to Gas filled target
- Normalized by measured thickness of end caps
- Scan Vertex Z location
- 3% at low x_{bj} for Helium-3 and Tritium
- Study by Tong Su and Tyler Hague
- images from Tong Su



- High energy photons decay into an e^+e^- pairs
- Account for the pair produced e^- by detecting the pair produced e^+
- Used HRS positive polarity settings at kinematics 1,2 and 3
- Fit results with an exponential function to determine the contamination factor at high x_{Bj} kinematics.
- Images from Tong Su

Tritium positron contamination

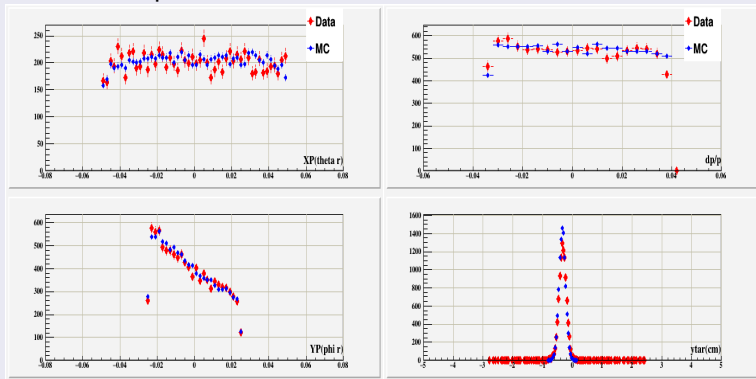


Monte Carlo Comparison



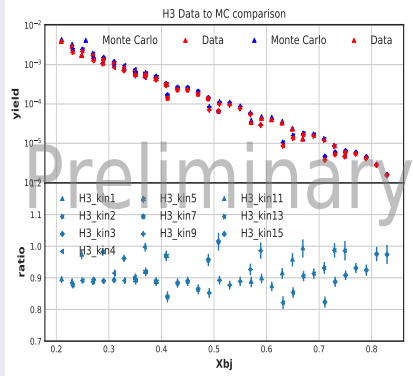
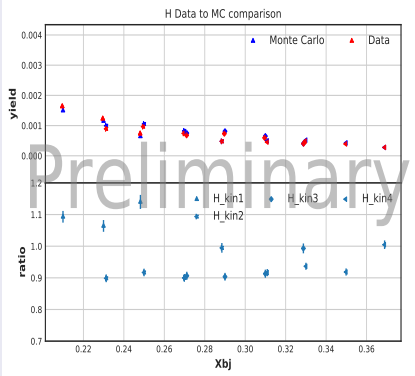
Compare Monte Carlo to Data

Spectrometer acceptance variables.

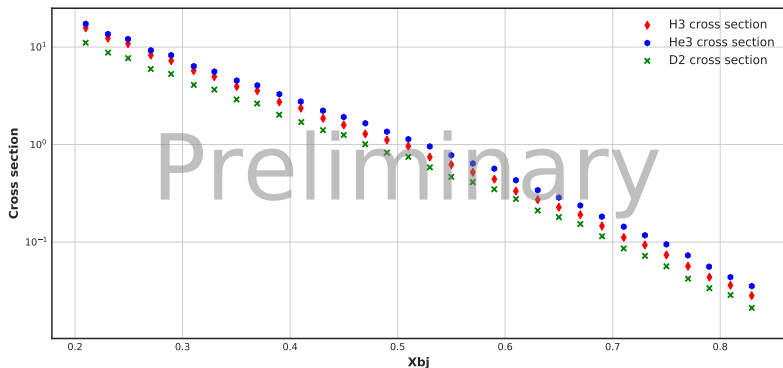


Top Left :theta(out of plane angle in rads from center) Top Right: Dp/p(momentum from center). Bottom Left :phi(in plane angle in rads from center) Top Right: Y target(vertex location in spectrometer coordinate frame).

Data to Monte Carlo ratio



Cross Section





Task still in progress

- Complete acceptance study and determine the systematics associated
- Study the systematic error from cross section model
- Finalize absolute cross section for helium-3, tritium, and deuterium
- Study nuclear corrections and their systematics
- EMC effect for $A=3$ nuclei

Special Thanks

- JSA and University of Tennessee
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- The Tritium group
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