EMC Effect for A=3

Jason Bane

University of Tennessee

jbane1@vols.utk.edu

November 7, 2018

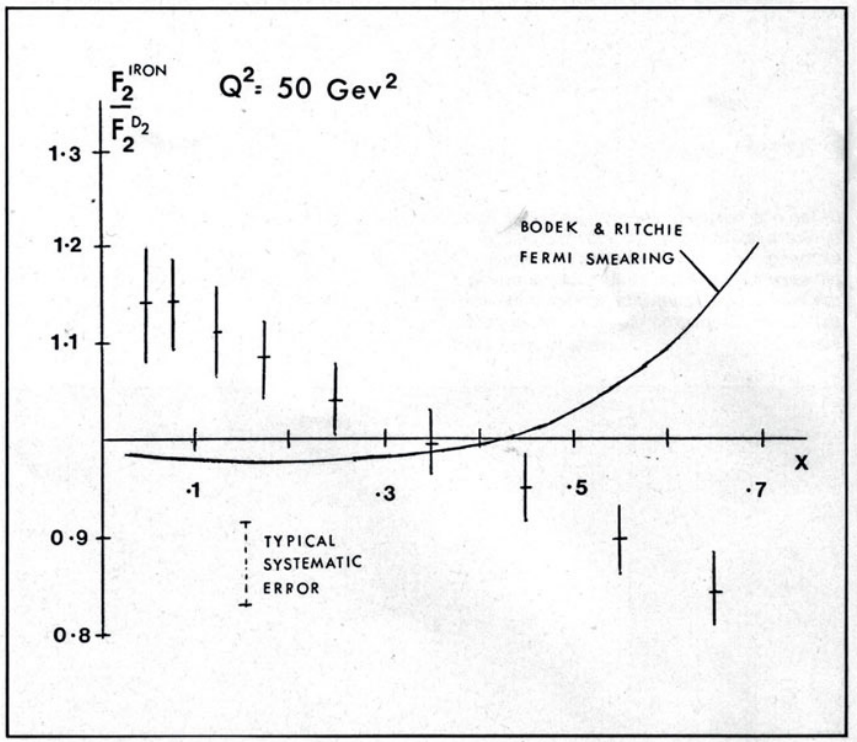
Outline

EMC Effect

European Muon Collaboration's (EMC) 1983 results for the lepton scattering experiment on Iron and Deuterium.

- Nucleon Structure Functions
- Sea-Quark Distributions
- Gluon Distributions
- Expected $F_A = NF_2^N + ZF_2^P$
- Because the binding energies of the nucleons are several orders of magnitude smaller then the momentum transfer for an interaction in DIS region
- Fermi interaction causing differentiation at high momentum transfer.

Figure: EMC data of F_2^{Fe}/F_2^D from 1982 [Higinbotham D., 2013].



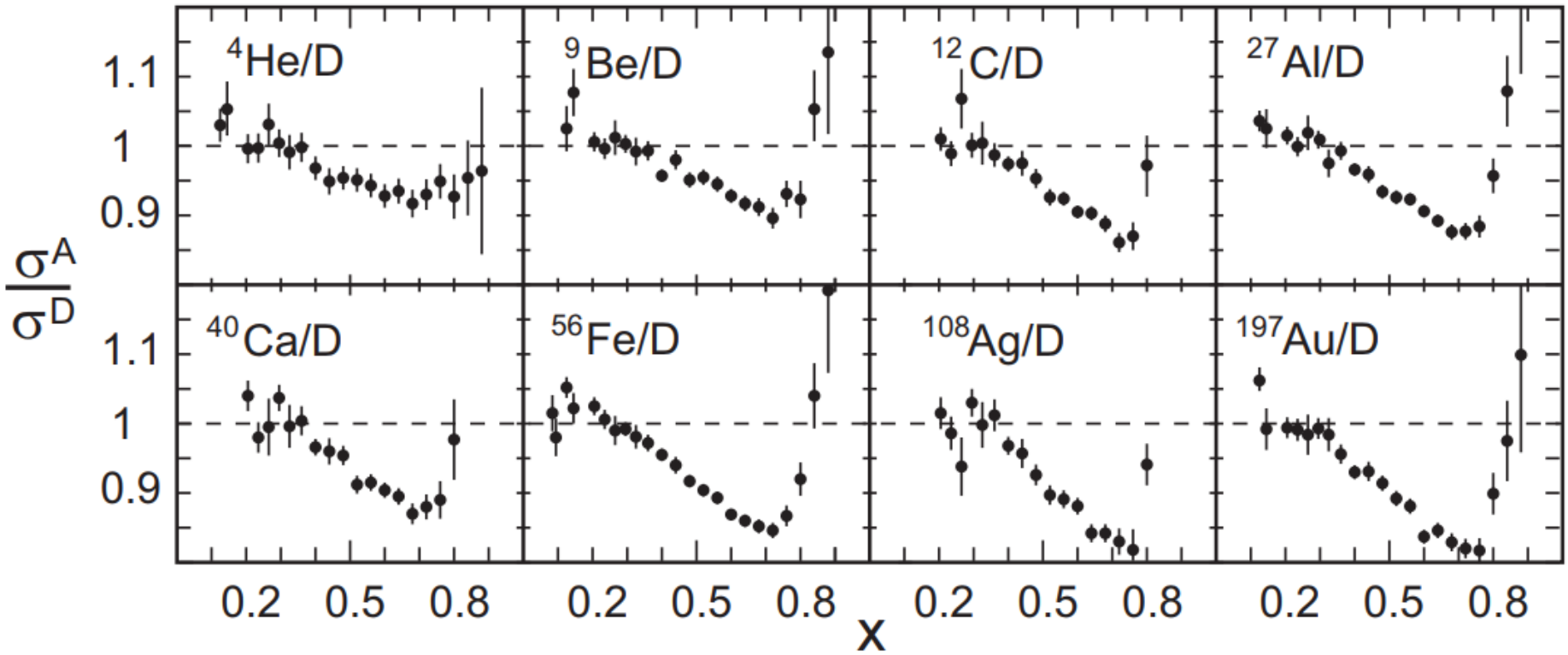
EMC Effect

European Muon Collaboration:

- Nuclear F2 structure function per nucleon different than that of deuterium
- Quark distribution functions modified in the nuclear medium
- Defined the magnitude of the EMC effect as the slope of the $\frac{A}{D}$ per nucleon cross section ratio from 0.3 to 0.7 in x.
- Current Explanations
  - Binding effects beyond nucleon Fermi motion
  - Enhancement of pion field with increasing A
  - Influence of possible multi-quark clusters
  - Change in the quark confinement scale in nuclei
- No unique/universally accepted theory for explanation of effect up to date.

EMC Effect

Figure: SLAC experiment E139 [J. Gomez et al., 1994].



EMC Effect

Figure: JLab experiment "EMC in light Nuclei" [J.Seely, A. Daniel et al].

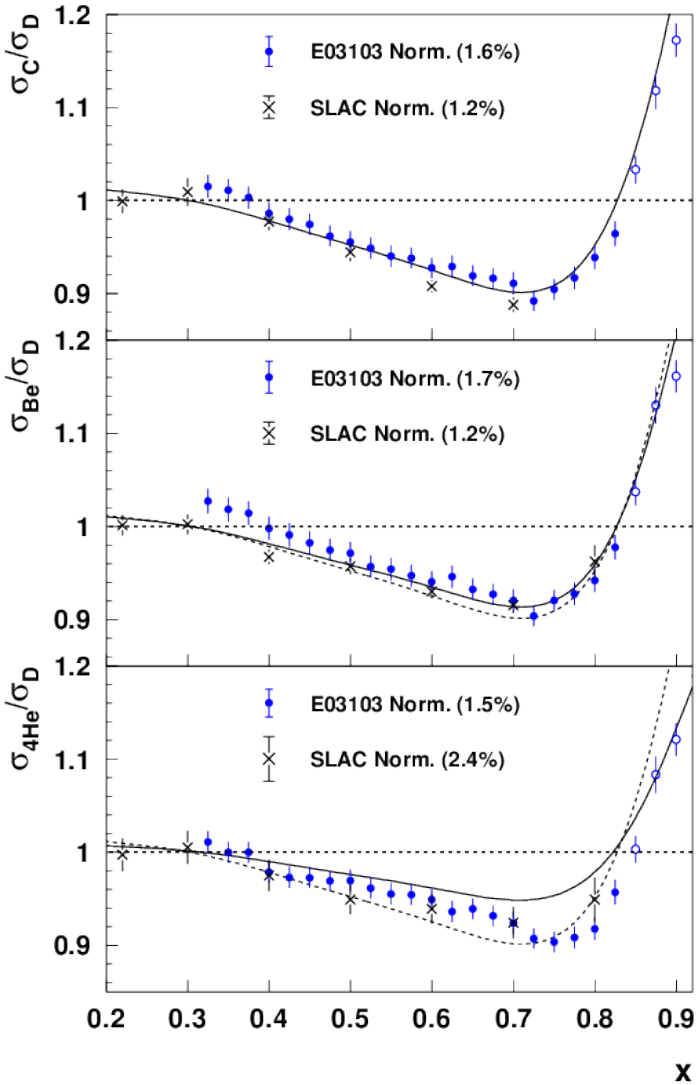
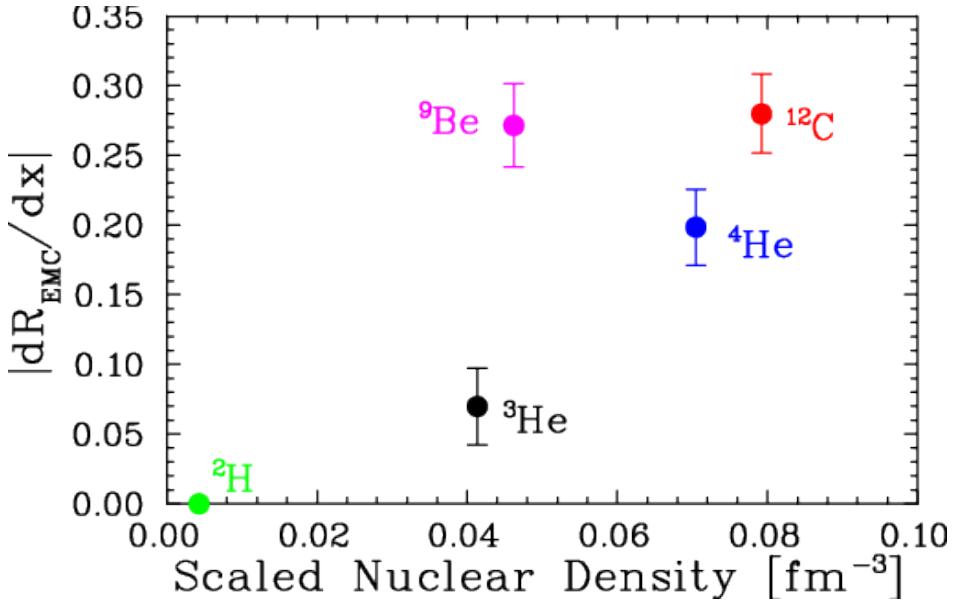
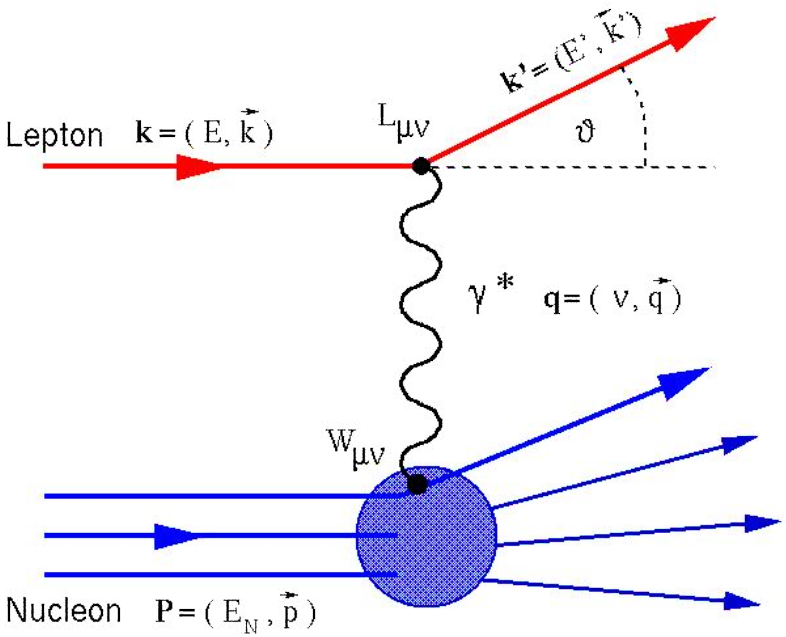


Figure: EMC as a function of Nuclear Density [J.Seely, A. Daniel et al].

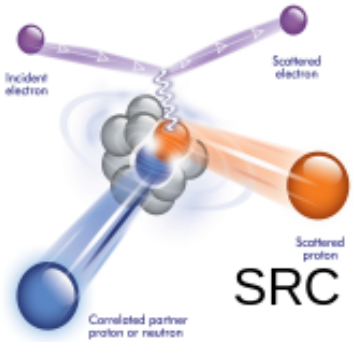


Deep Inelastic Scattering (DIS)



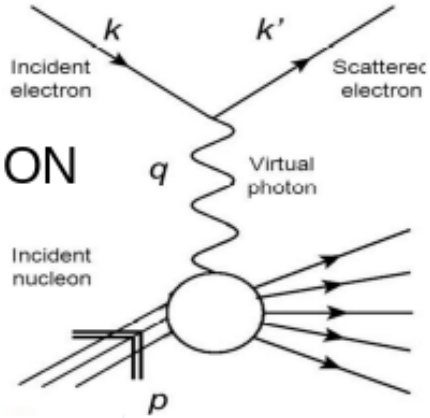
- Momentum Transfer
  $Q^2 \equiv 4EE'sin\frac{\theta}{2}$
- Bjorken X $(X_{bj}/x) = \frac{Q^2}{2\nu M}$
- $\sigma_{eN} = \frac{\alpha^2}{eE^2 sin^4(\frac{\theta}{2})}[\frac{F_2}{\nu}cos^2\frac{\theta}{2} + \frac{2F_2}{M}sin^2\frac{\theta}{2}]$
- Invariant Mass
  $W^2 = 2M\nu + M^2 - Q^2$
- $W^2 > 4 \rightarrow$ DIS

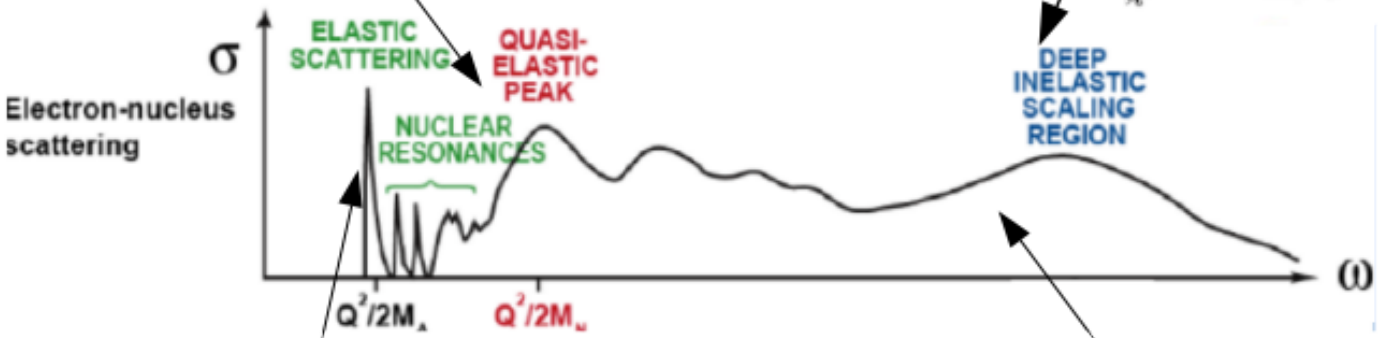
Tritium Experiments

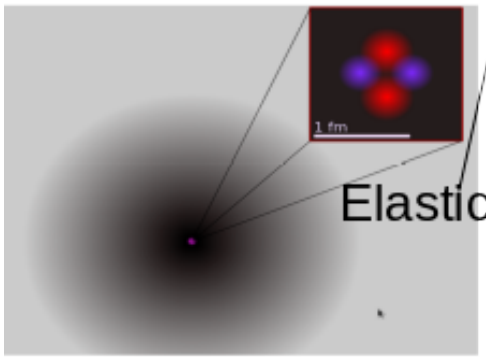


SRC

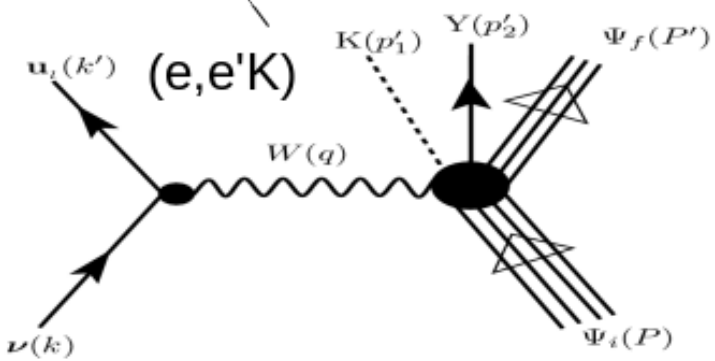
MARATHON





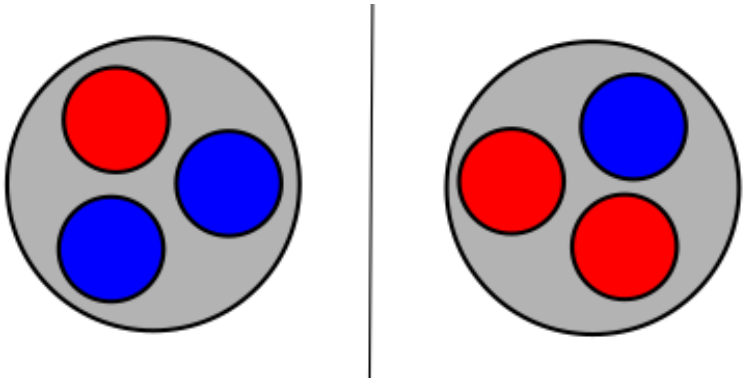


Elastic form Factors



MARATHON

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.



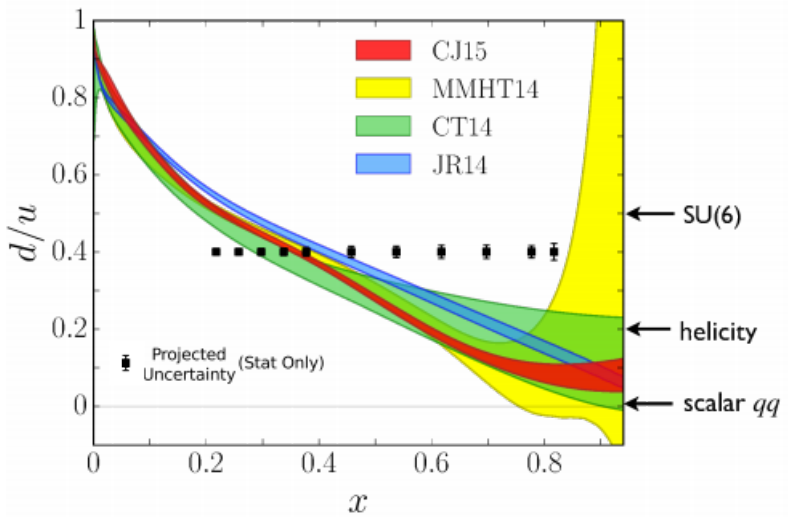
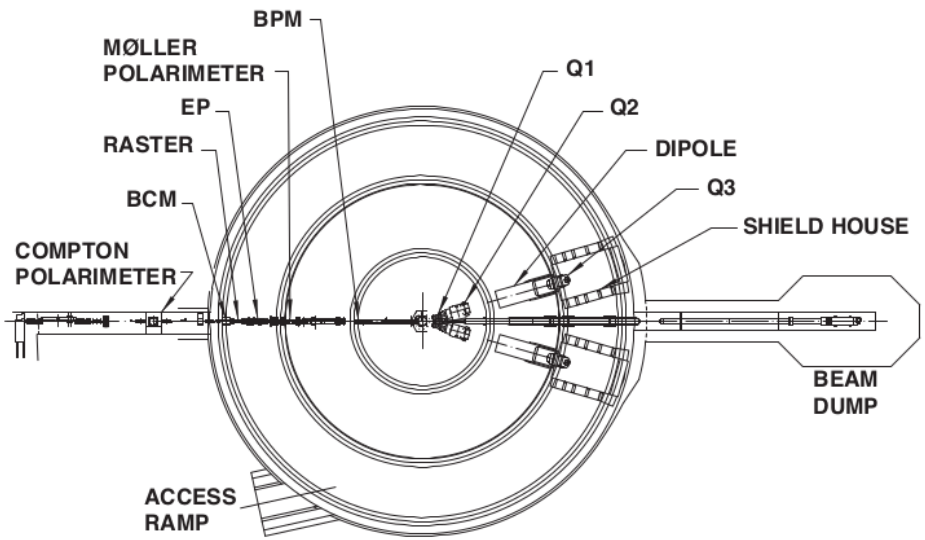


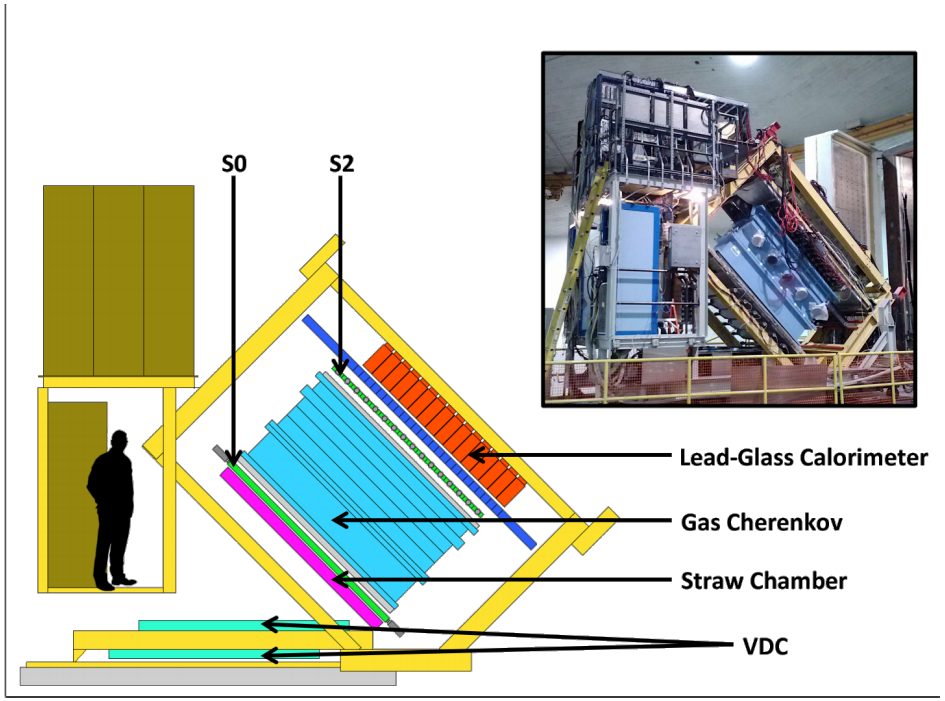
Figure: d/u quark distribution ratios

- 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 Fn2 to F p2 ratio
- Restrict the assumptions and parameters made in the model calculations of the down to up quark distribution ratio

Hall A & The HRSs

Use CEBAF(Continues Electron Beam Facility) to provide 10.6 GeV beam for electron scattering.

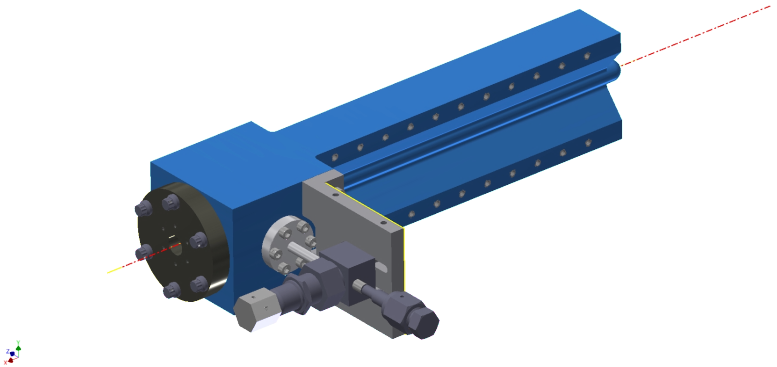


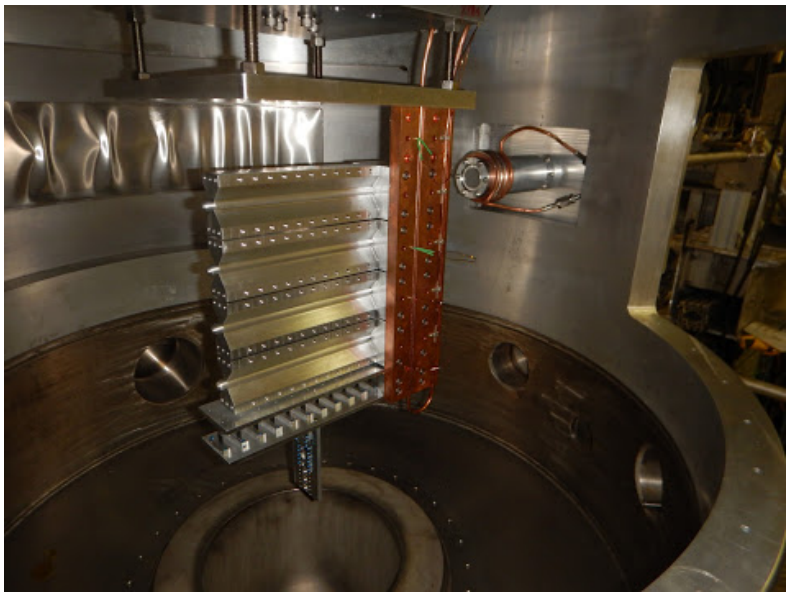


Tritium Target Cell

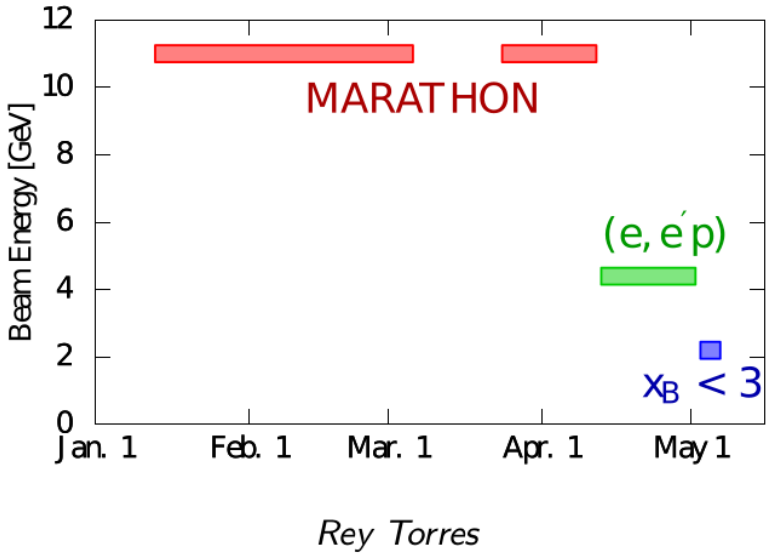
First tritium target at JLab

- Thin Al entrance and exit windows 0.01 inches
- 1090Ci of Tritium (0.1 g)
- 25 cm long
- Tritium Cell was filled in Savannah River
- 40 kelvin Helium is used to cool an attached heat sink





The Run Period



- MARATHON began on

References

Douglas Higinbotham (2013)

The EMC effect still puzzles after 30 years

Cern Courier April 2013.

J. Gomez et al. (SLAC-E139)

Phys. Rev D 49 (1994) 4348

J.Seely, A. Daniel et al (2013)

New Measurements of the EMC Effect in Very Light Nuclei

nucl-ex/0904.4448.

The End