ROSEN07
Measurement of R = σ_L / σ_T on Deuterium in the Nucleon Resonance Region.

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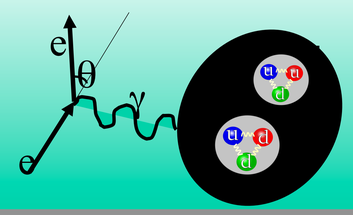
Inclusive e + d → e + X *Scattering*



Physics

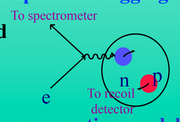
- F_L, F_1, F_2 Fundamental Structure Function Measurements on Deuterium
  - These structure functions provide us important information about internal structure of nucleon, i. e. distribution of quarks and gluons inside the nucleus.
- No L/T separated resonance region (large x) data on deuterium currently
- Structure Function Moments

$$M_n(Q^2) = \int dx\, x^{n-2} F(x,Q^2)$$

Moments of the Structure Functions(non-singlet calculations)
Calculated on the lattice at $Q^2 = 4$ GeV^2

- Lattice QCD comparisons
  - *Singlet* (*p-n*) and *non-singlet* (*p+n*) distribution functions: Nucleon structure composed of singlet (gluons, sea) and non-singlet (valence) distributions
- Quark-hadron duality studies
- Support Broad Range of Deuteron Physics
  - Spin structure functions
  - Elastic form factors
  - BONUS (BOund NUcleon Structure) neutron structure functions:
    - Hall B experiment for NEUTRON cross sections via spectator tagging

Neutron L/T SFs can be extracted using proton and deuteron L/T SFs combined with BoNuS neutron cross sections.

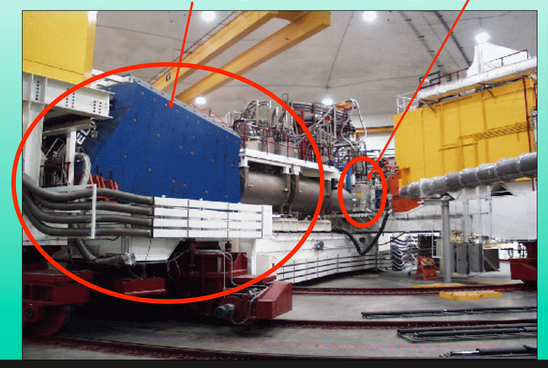


- Important input for neutrino physics: Input for neutrino cross section models, needed for new generation of oscillation experiments around the world.

Experimental Setup:

Standard Hall C equipment:

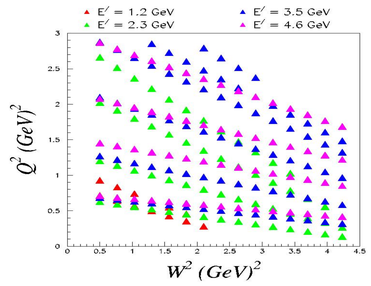
HMS(High Momentum Spectrometer), Cryogenic LD2, C, Fe, Al, Cu targets



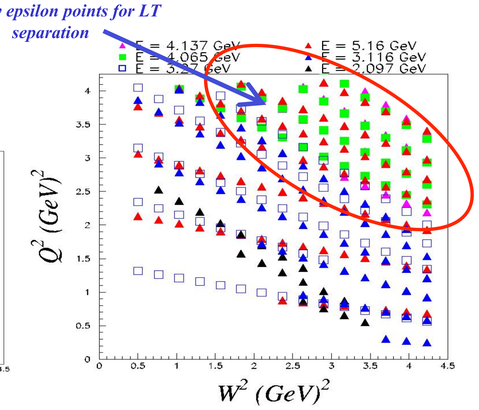
HMS Properties (pt-pt tune)	
Kinematic Range:	
Momentum:	0.5 – 7.5 GeV/c
Angular:	10.5° - 80°
Acceptance:	
ΔΩ:	~6.5 msr
Dp/p:	+/-9%
Resolution:	
Dp/p:	< 0.1 %
Θ:	~ 1 mrad

- ROSEN07 experiment is the second phase of this experiment, the first phase was JAN05 experiment…

New data with high Q^2 above 3
And new epsilon points for LT separation



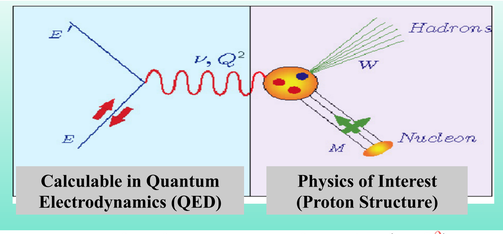
JAN05



ROSEN07

"..highly precise deuteron data are forming a conditio sine qua non for any real precision test of QCD." – Johannes Bluemlein

Structure Functions: F1, F2, FL



$$\frac{d^2\sigma}{dE'd\Omega}(\downarrow\Uparrow + \uparrow\Uparrow) = \frac{8\alpha^2\cos^2(\theta/2)}{Q^4}\left[\frac{F_2(x,Q^2)}{\nu} + \frac{2F_1(x,Q^2)}{M}\tan^2(\theta/2)\right]$$

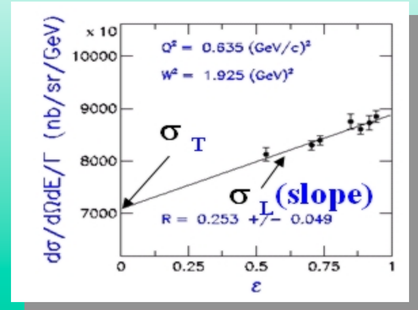
Structure functions (F1 and F2) which have the Information of the protons internal structure.

Rosenbluth Separation Technique:

Rosenbluth separation technique is used for extraction of structure functions σ_L and σ_T, the cross sections for scattering of longitudinally polarized and transversely polarized virtual photon respectively, and hence the ratio R = σ_L / σ_T …

$$\frac{d\sigma}{d\Omega dE'} = \Gamma(\sigma_T + \varepsilon\sigma_L)$$

Where: Γ = flux of transversely polarized virtual photons
ε = relative longitudinal polarization



$$R = \frac{\sigma_L}{\sigma_T} = \frac{F_L}{2xF_1}$$

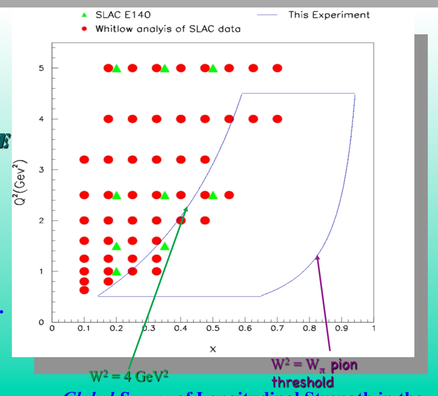
TRANSVERSE

$$F_L = (1 + \frac{4M^2x^2}{Q^2})F_2 - 2xF_1$$

longitudinal

m Ix Ed

F_L can probe the gluon distributions…..



Global Survey of Longitudinal Strength in the Deuteron Nucleon Resonance Region

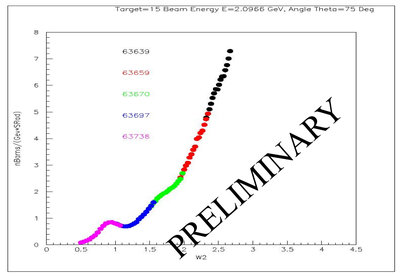
Extraction of Cross Sections

Monte Carlo ratio method is used to extract data cross sections:
We can simulate Monte Carlo data using a cross section model to obtain

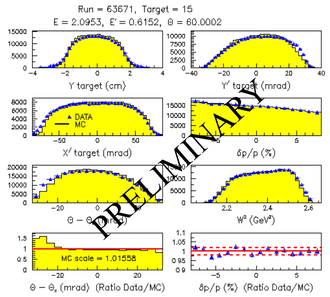
$Y_{MC}(E',q) = L*s^{mod}*(DE\ DW)*A_{MC}(E',q)$:

Taking ratio to data and assuming that A_{MC} = A, yields

$d\sigma/dWdE' = \sigma^{mod} * (Y(E',q)/Y_{MC}(E',q))$ (MC ratio method)



Data cross section by MC ratio method



Data to Monte Carlo simulation comparison

Currently…

- Calibrations are mostly done.
- Charge Symmetric Background, Radiative corrections etc. are done.
- Continue data analysis…
  - •Continue data analysis…
    - •Continue data analysis…
      - •Continue data analysis…
        - •Continue data analysis…
          - •Continue data analysis…
            - •Continue data analysis…