Riunione Gruppo III – Sezione di Catania 31 Maggio 2021

JLAB12: "status" di SBS (Tracker e HCAL) e degli esperimenti coinvolti

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Proton G_E/G_M – an «unexpected» discrepancy



$${d\sigma\over d\Omega} \propto G_{Ep}^2 + { au\over {arepsilon}} G_{Mp}^2$$

Rosenbluth Separation: assume single photon approximation

Prior to JLab/2000, expectations were that proton G_E/G_M fairly constant with Q^2

$$\mu \frac{G_{Ep}}{G_{Mp}} = -\mu \frac{P_t}{P_l} \frac{(E_{beam} + E_e)}{2M_p} \tan \frac{\mathcal{G}_e}{2}$$

Polarization transfer from the incident electron to the scattered proton

At JLab, new class of experiments show proton G_E/G_M decreasing linearly with Q^2

- Description of the reaction mechanism is wrong (?)
- $\rm G_{\rm E}$ and $\rm G_{\rm M}$ do not scale the same way

New SuperBigbite Spectrometer (SBS) in Hall A



SBS components GEM TRACKER



GEM Module construction process - Clean Room INFN/CT



GEM Chambers in BigBite in Feb 2021 !!



Thanks to onsite work of *Ezekiel Wertz Holly Szumila-Vance Chuck Long* and many others

UVA GEMs at JLab



HCAL

It's a sampling calorimeter with a modular structure



Carnegie Mellon University **INFN** Catania JLab Collaboration

HCAL-J Requirements

- -Matching acceptance with SBS magnet/polarimeter
- -Linear energy response
- -Good energy resolution
- -95% efficiency with trigger threshold at 25% peak signal
- -Spatial resolution ~ 5 cm rms
- -Time resolution < 1.0 ns rms
- -Angular resolution 5 mrad



HCAL single module

HCAL single module includes:



40 layers plastic scintillator and iron per Module

Each module is made up of alternating 2x7.5x15 cm² layers of 1.5 cm thick iron and by plastic scintillators with a thickness of 1 cm

Wavelength shifter (WLS) readout through 2" photomultipliers (PMTs)



SBS/BB Form Factors Experiments EP - Polarization transfer E-12-09-016: GEN - Double Polarization





Flexible detector configurations (sort of «LEGO detectors») optimized for experimental needs



A flexible and efficient microscopic simulation of multiple GEM chamber based on Garfield++

V. Brio, V. Bellini, E. Cisbani, K. Kmiec, L. Lagamba, R. Perrino, C. Petta, L. Re, C. M. Sutera Journal of Physics Conference Series (JPCS) (2020) Vol. 1498, N° 1. DOI: 10.1088/1742-6596/1498/1/012009

Deeply virtual Compton scattering off the neutron M. Benali et al. (V. Bellini, A. Giusa, M.L. Sperduto and C,M, Sutera) Nature Physics (2020) Vol.16 N°2 pag. 191-198

Measurement of the Ar(e, e'p) and Ti(e, e'p) cross sections in Jefferson Lab Hall A

L. Gu et al. (V. Bellini) Physical Review C 103 (2021) 034604 DOI: 10.1103/PhysRevC.103.034604

Novel observation of isospin structure of short-range correlations in calcium isotopes

D. Nguyen et al. (V. Bellini) Physical Review C 102 (2020) 064004 DOI: 10.1103/PhysRevC.102.064004

Probing Few-Body Nuclear Dynamics via ³H and ³He (e, e'p)pn Cross-Section Measurements

J. Zhang et al. (V. Bellini, F. Tortorici) Physical Review Letters 124 (2020) 212501 DOI:10.1103/PhysRevLett.124.212501

Grazie !!!

Nucleon Form Factors



The electromagnetic structure of the nucleon, in the elastic scattering with an electron, can be described with

SACHS FORM FACTORS

The Form Factors of the nucleons can be considered as the 3D Fourier Transforms of charge and current distributions



Recoil polarization method

It is possible to measure, in the same time, the transverse (P_t) and the longitudinal (P_l) polarization component of the recoil proton to obtain the ratio ...



Approved SBS Experiments

GEP-5 (E12-07-109)	GEp/GMp to 12 GeV2	Polarization Transfer (the most demanding experiment)
GMN (E12-09-019)	GNM/GD up to 13.5 GeV2	Ratio Method D/H
GEN-II (E12-09-016)	GEn/GMn up to 10 GeV2	Beam-target double spin asymmetry on 3He
SIDIS (E12-09-018)	Extract Sivers, Collins and Pretzelosity neutron asymmetries on pi and K with high statistics in high x valence region	Transversely Polarized ³ He Target 3D binning on the relevant variables: x, P _{perp} and z, for both hadrons; 2 Q ² values
GEN-RP (E-12-17-004)	GEn/GMn at 4.5 GeV2	Charge-exchange recoil polarimetry (first time!), on deuterium
nTPE (E12-20-010)	Resenbluth slope in e+n scattering at Q2=4.5 GeV2, with high accuracy	Same apparatus of GMN; measure s(e,n)/s(e,p) on deuterium
WAPP (E12-20-008)	KLL from $\vec{g} n \rightarrow \vec{p} p$	Same apparatus of GEN-RP, on LD2 target; Cu radiator for gamma production;