SLAC Particle Physics
before the November Revolution

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“Observation and experiment can and must dramatically restrict the range of admissible scientific belief, else there would be no science. But they cannot alone determine a particular body of such belief. An apparently arbitrary element, compounded of personal and historical accident, is always a formative ingredient of the beliefs espoused by a given scientific community at a given time.”

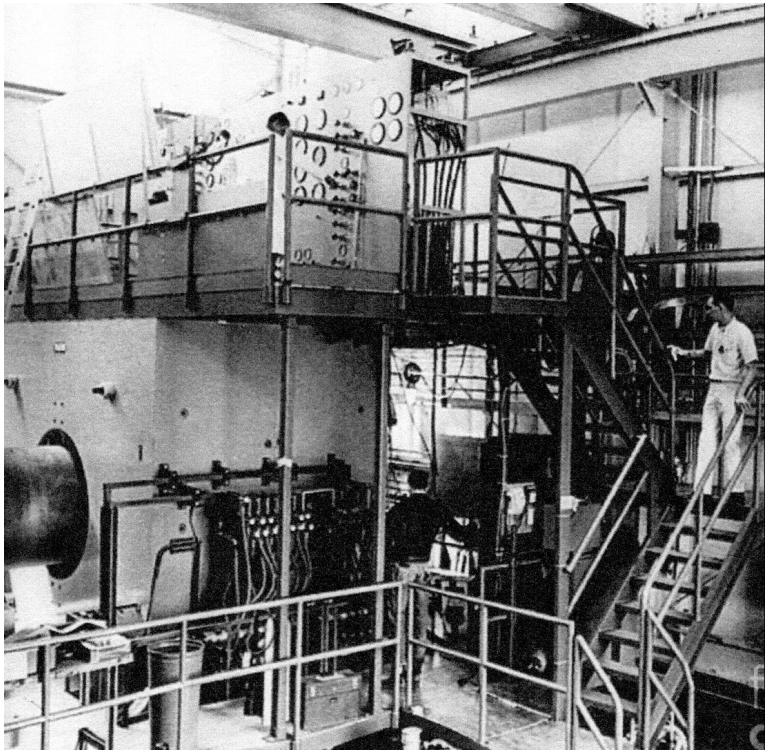
“And when the profession can no longer evade anomalies that subvert the existing tradition of scientific practice, then begin the extraordinary investigations that lead the profession at last to a new set of commitments, a new basis for the practice of science. The extraordinary episodes in which that shift of professional commitments occurs are the ones known as scientific revolutions.

— Thomas S. Kuhn, *The Structure of Scientific Revolutions*

SLAC circa 1970

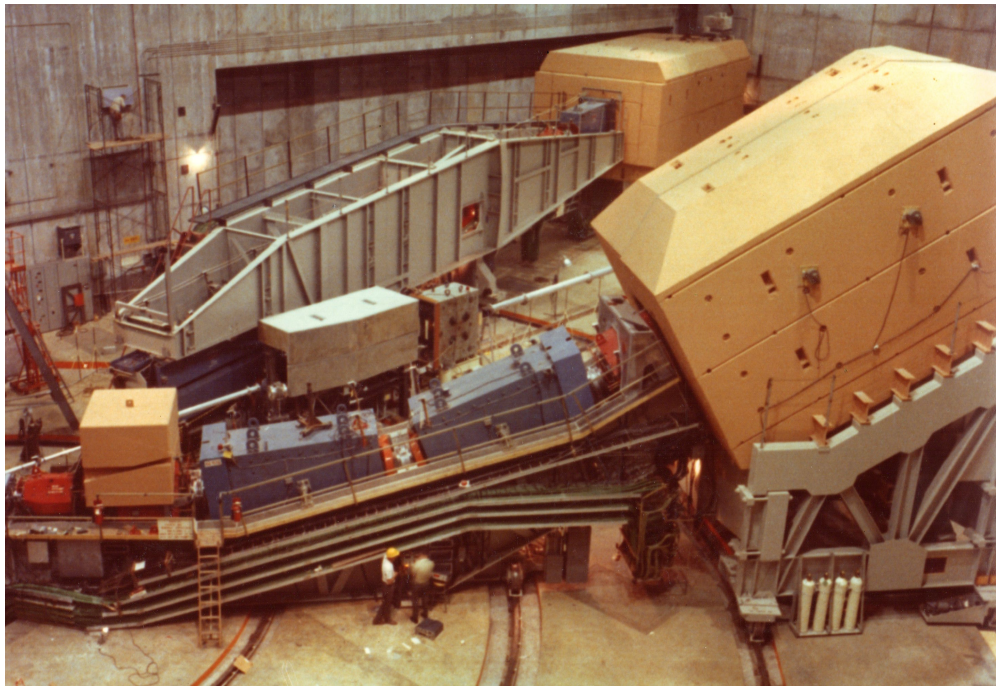
SLAC Bubble Chambers

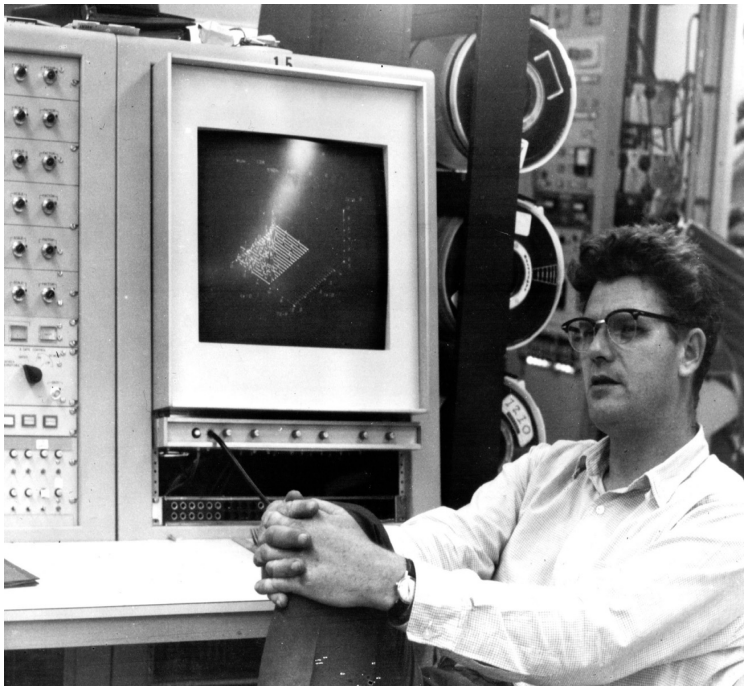
40-inch bubble chamber



82-inch bubble chamber

ESA 8 GeV and 20 GeV Spectrometers





D. Luckey and R.F. Schwitters

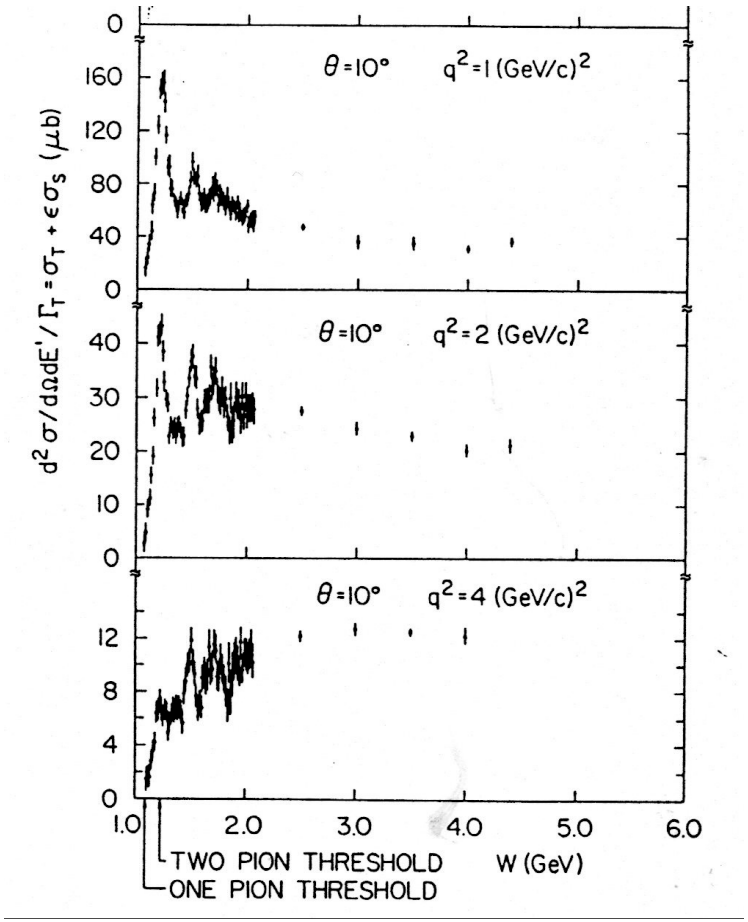
Methods of crystal alignment for the production of coherent bremsstrahlung

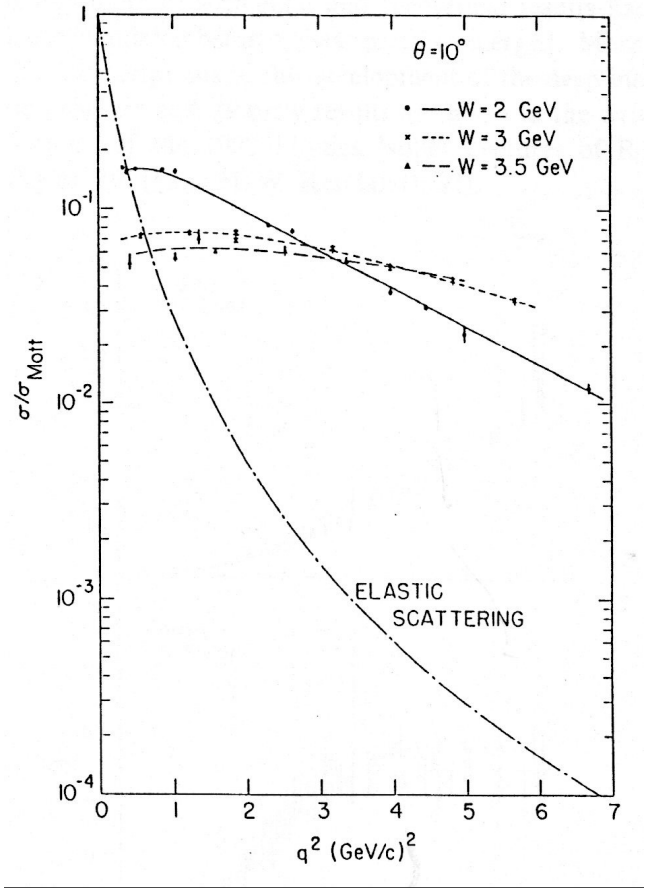
Nuclear Instruments and Methods **81:1** (May 1970) 164–172.

Abstract

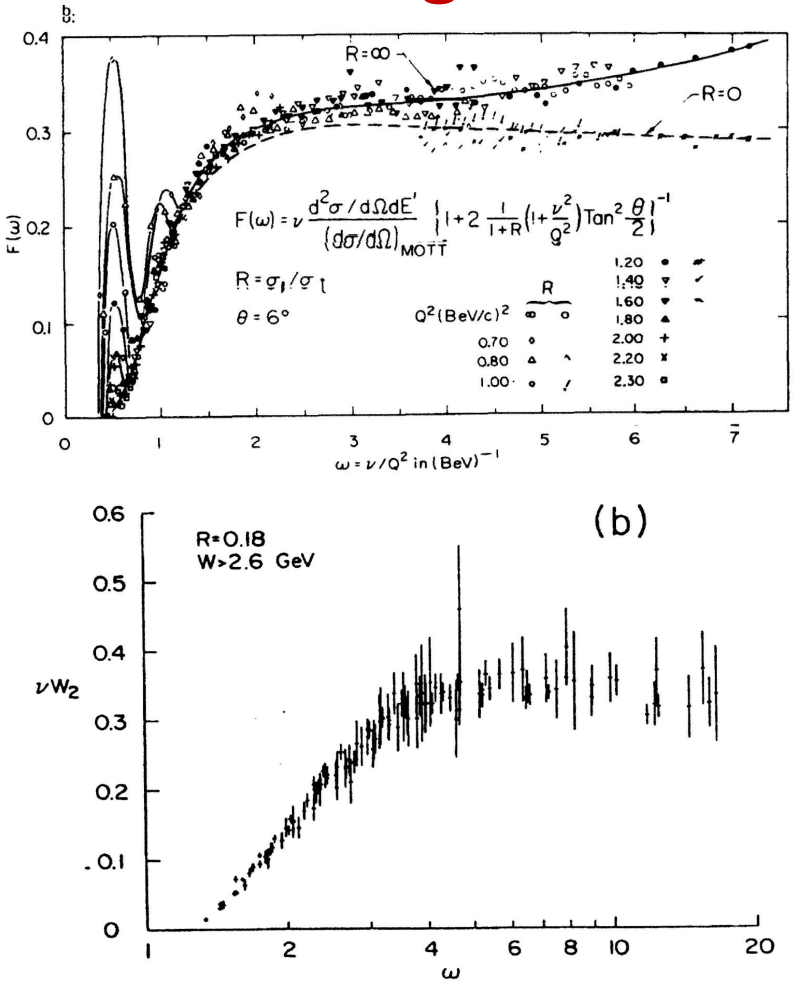
Various methods of precisely aligning crystals in order to make use of the Uberall-Diambrini Effect for the production of plane-polarized gamma rays are discussed. One method is explained in detail to provide a practical guide for accurately and efficiently aligning crystal radiators.

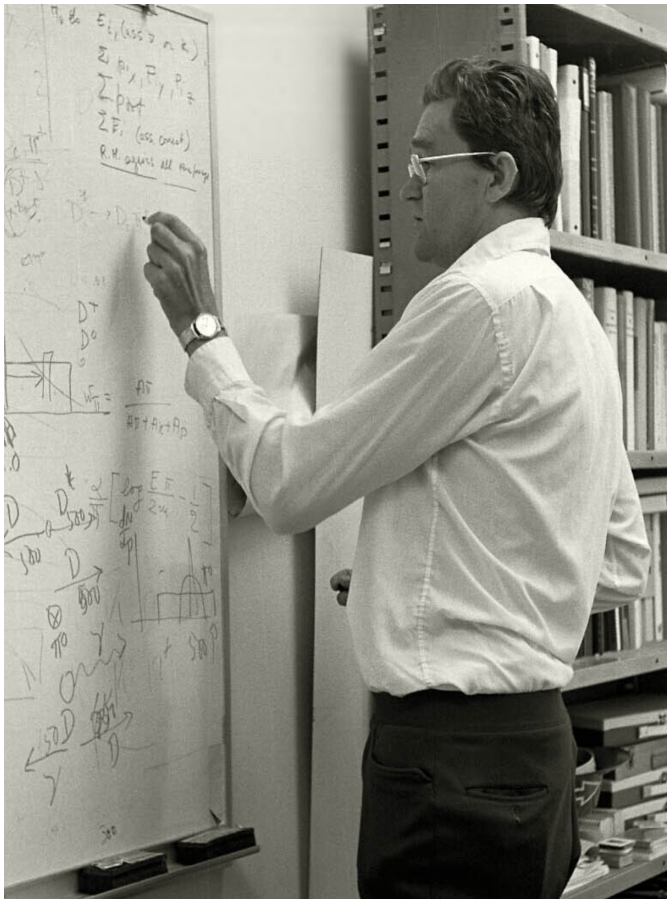
SLAC Experiment 4B: Inelastic e-p Scatterng



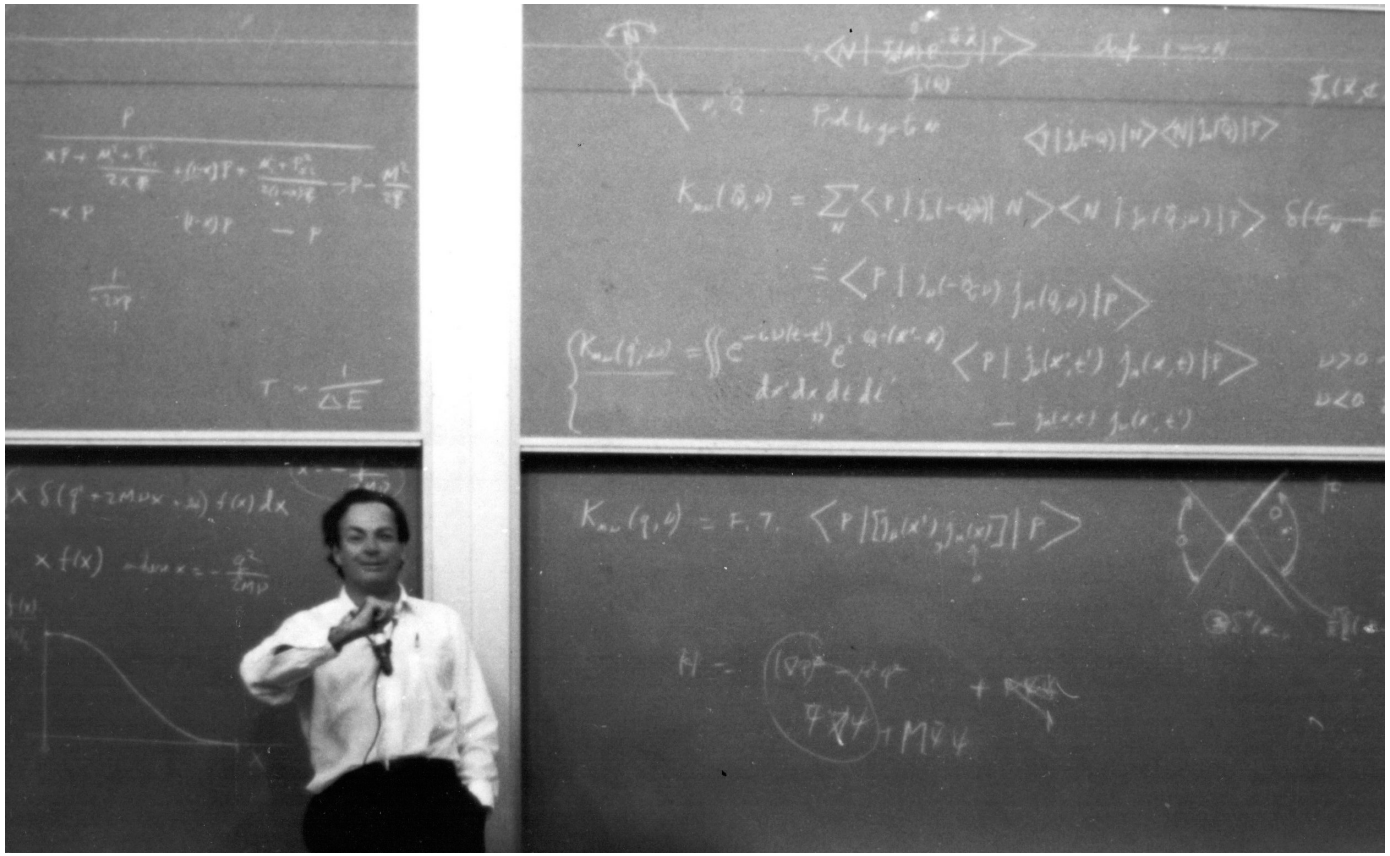


Bjorken Scaling of the Structure Function $F_2 = \nu W_2$

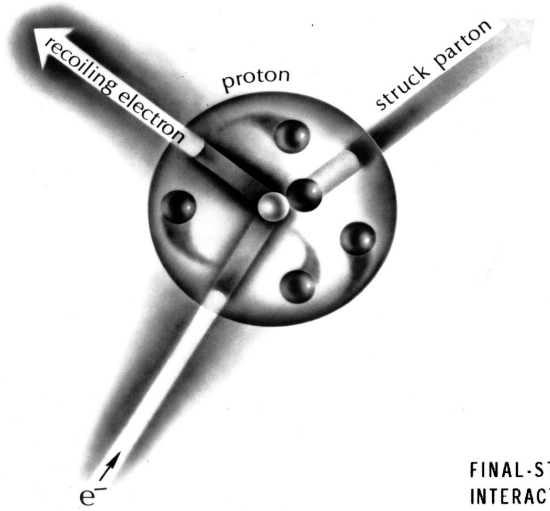


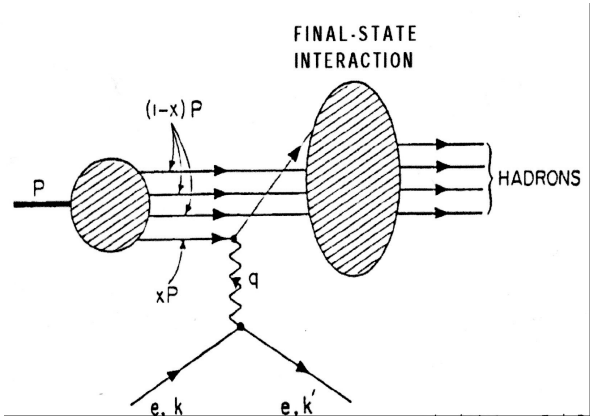


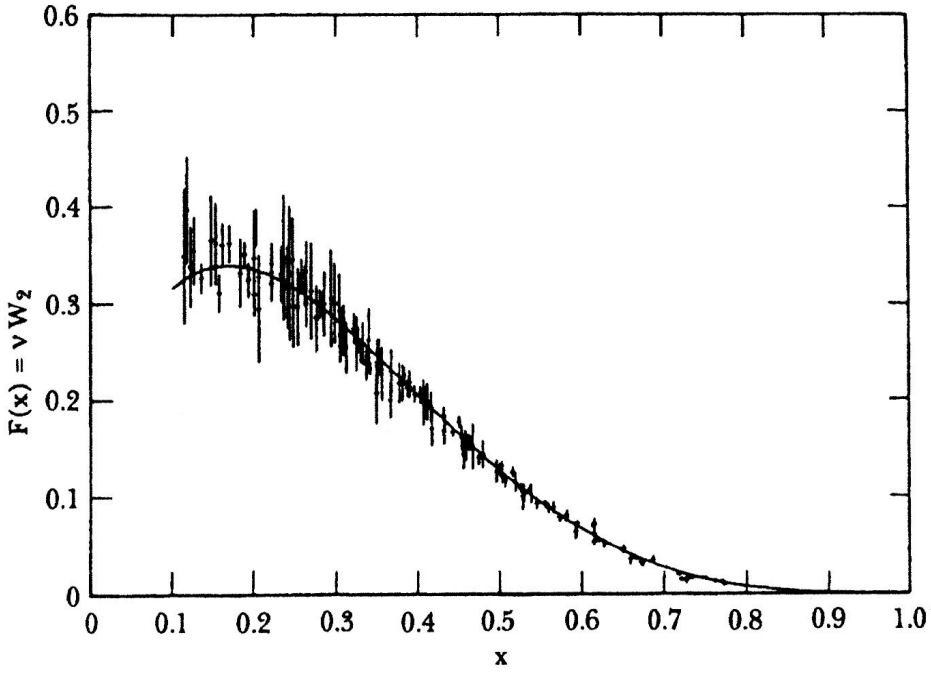
Feynman's Parton Lecture — October 1968



Feynman's Parton Model







The structure function $F_2(x) = \nu W_2$ was interpreted to represent the fractional momentum distribution of charged partons, as viewed by an observer in the infinite momentum frame.

Four Pivotal 1969 Papers

- James D. Bjorken, “Asymptotic Sum Rules at Infinite Momentum,” *Physical Review* **179** (25 March 1969) 1547.
- J. D. Bjorken and E. A. Paschos, “Inelastic Electron-Proton and γ-Proton Scattering and the Structure of the Nucleon,” *Physical Review* **185** (25 September 1969) 1975.
- E. D. Bloom *et al.*, High-Energy Inelastic e-p Scattering at 6° and 10°,” *Physical Review Letters* **23** (20 October 1969) 930.
- M. Breidenbach *et al.*, “Observed Behavior of Highly Inelastic Electron-Proton Scattering, *Physical Review Letters* **23** (20 October 1969) 935.

The 1990 Nobel Prize in physics for the experimental discovery of quarks was awarded based largely on the last two papers.

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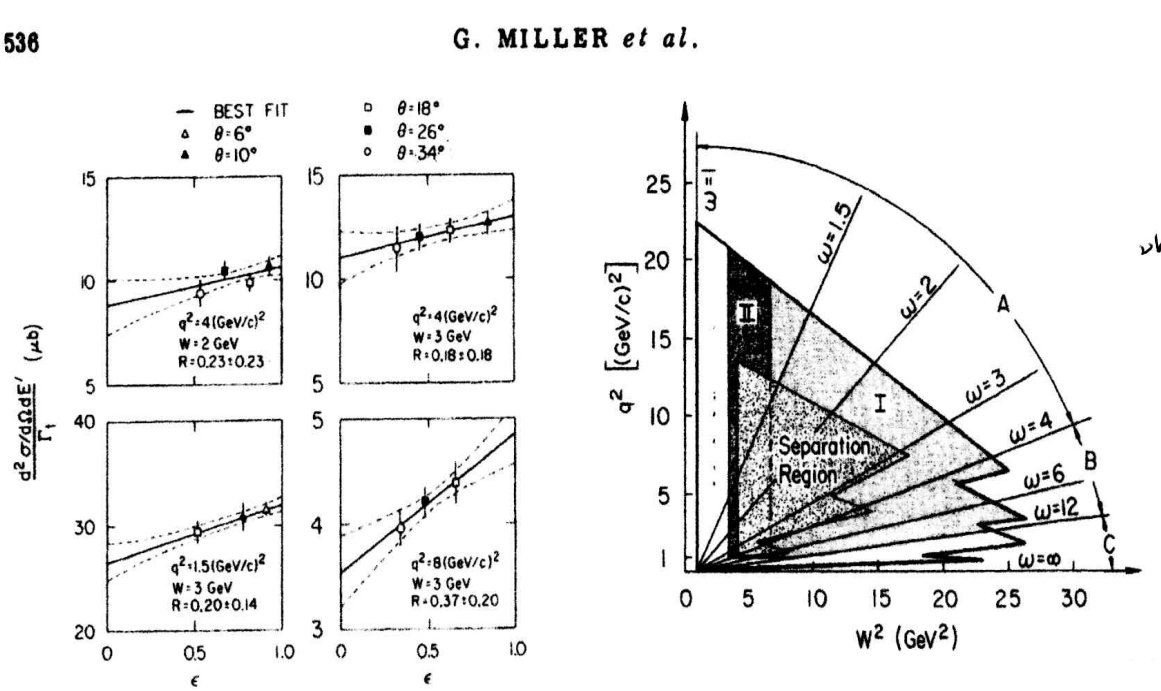
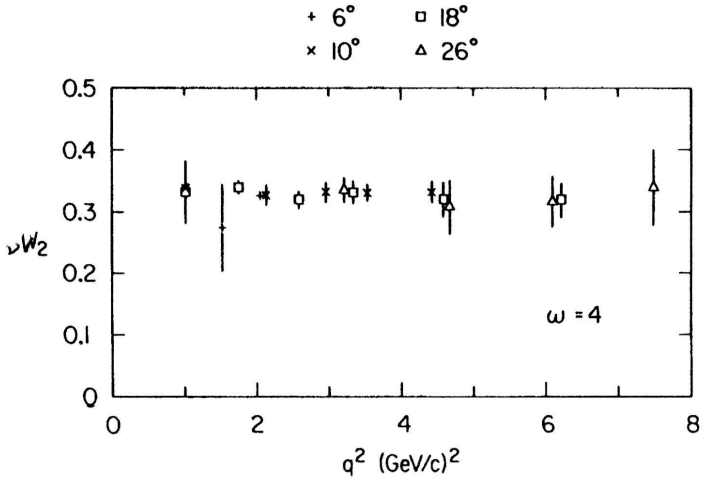
- James D. Bjorken, “Asymptotic Sum Rules at Infinite Momentum,” *Physical Review* **179** (25 March 1969) 1547.
- J. D. Bjorken and E. A. Paschos, “Inelastic Electron-Proton and γ-Proton Scattering and the Structure of the Nucleon,” *Physical Review* **185** (25 September 1969) 1975.
- E. D. Bloom, *et al*., High-Energy Inelastic *e-p* Scattering at 6° and 10°,” *Physical Review Letters* **23** (20 October 1969) 930.
- M. Breidenbach, *et al*., “Observed Behavior of Highly Inelastic Electron-Proton Scattering, *Physical Review Letters* **23** (20 October 1969) 935.
- S. D. Drell, Donald J. Levy and Tung-Mow Yan, “Theory of Deep-Inelastic Lepton-Nucleon Scattering and Lepton-Pair Annihilation Processes. I,” *Physical Review* **187** (25 November 1969) 2159.

E4B Structure Function Separations





E4B structure functions extracted from deep-inelastic e-p cross sections assuming R = 0.18, as presented by Elliott Bloom at the 1970 Kiev Conference.

$R = \sigma_L/\sigma_T$ found to be slowly varying, consistent with 0.18±0.10.

Second-Generation Deep Inelastic Experiments

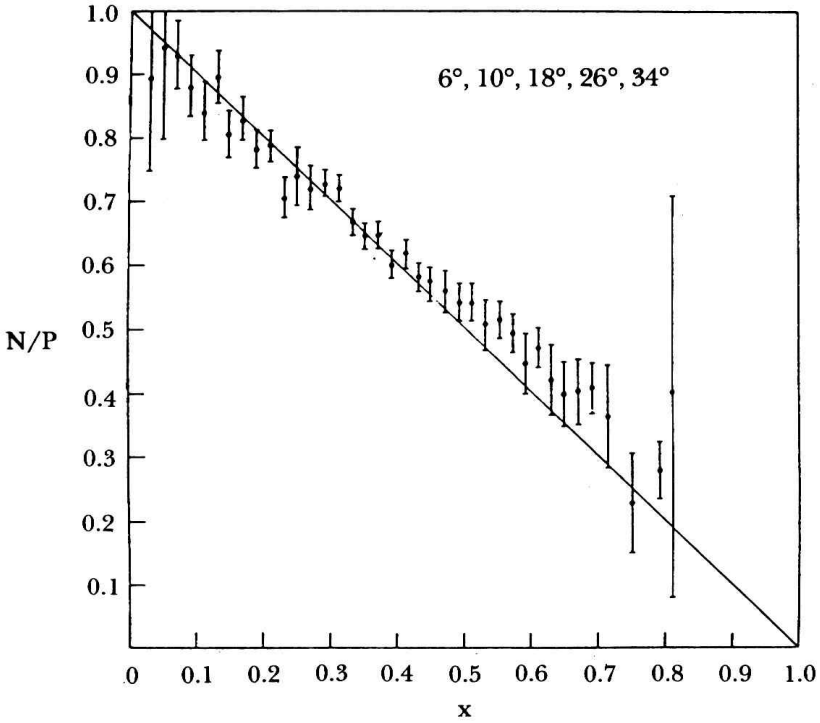
Aimed to measure inelastic e-p *and* e-d — and thus e-n — scattering cross-sections and structure functions with much higher statistics.

Ask: What are the parton properties — i.e., their charges and spins?

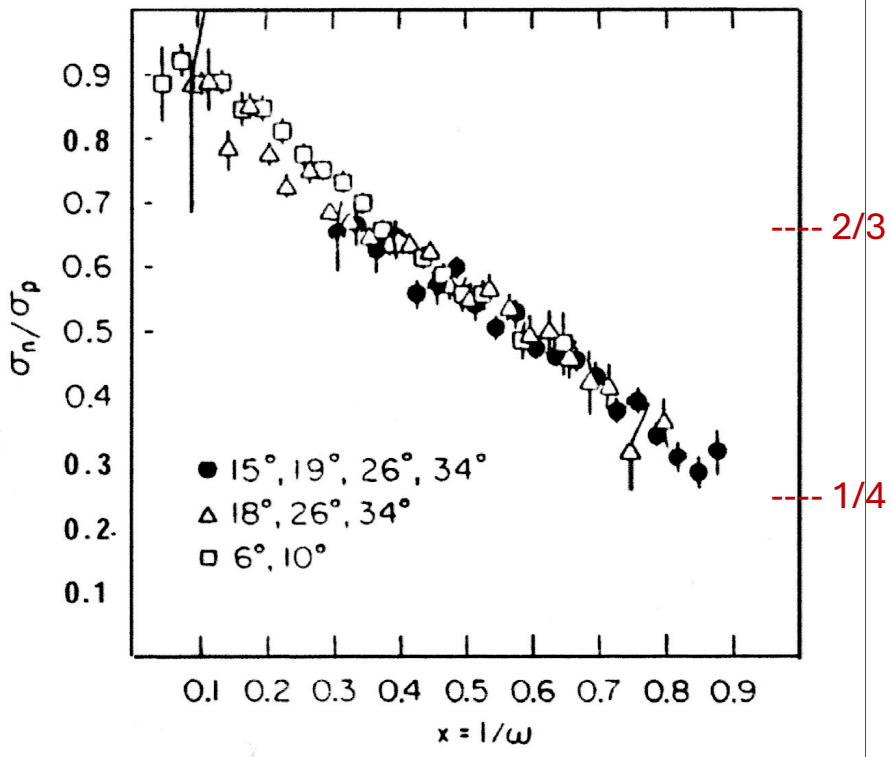
- E49A: 6° and 10° scattering, by SLAC Group A and MIT, 1970
- E49B: 18°, 26° and 34° scattering, by MIT and SLAC SFG, 1970
- E61: 4° scattering, by SLAC Group A, 1970 – 1971
- E87: 15°, 19°, 26° and 34° scattering, by MIT and SLAC SFG, 1972
  — measured threshold behavior of νW_2 as x approaches 1
- E89: 50° and 60° scattering, by SLAC Group A, 1973
  — measured behavior of $2MW_1$ at highest Q^2 attainable at SLAC

E49A and E87: Neutron to Proton Ratio

Preliminary E49B data presented by Henry Kendall in the 1971 Lepton-Photon Symposium at Cornell

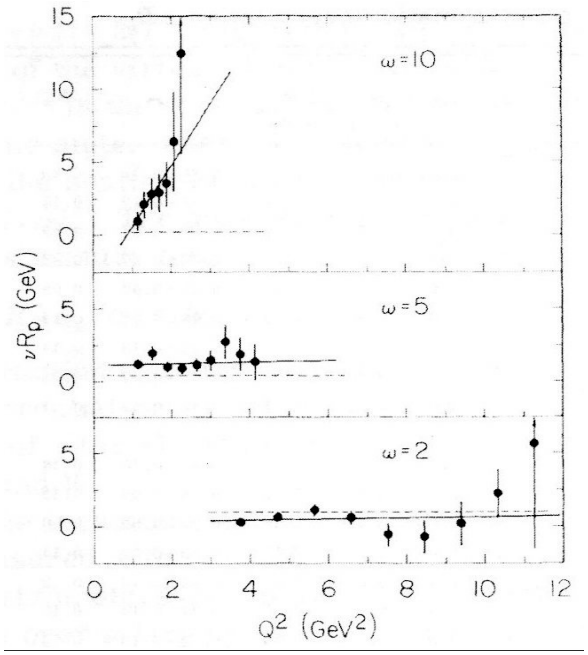


The Ratio of Deep-Inelastic e-n to e-p Cross Sections in the Threshold Region [*PL* **51B** (1974) 417]

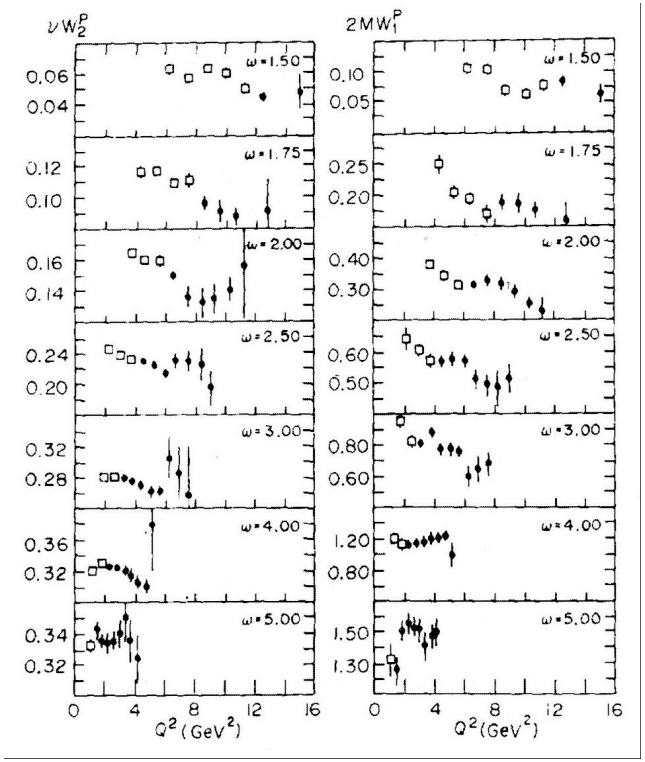


Two More 1974 MIT-SLAC SFG Publications

Extraction of $R = \sigma_L/\sigma_T$ from Deep Inelastic e-p and e-d Cross Sections [*PRL* **33** (1974) 561]

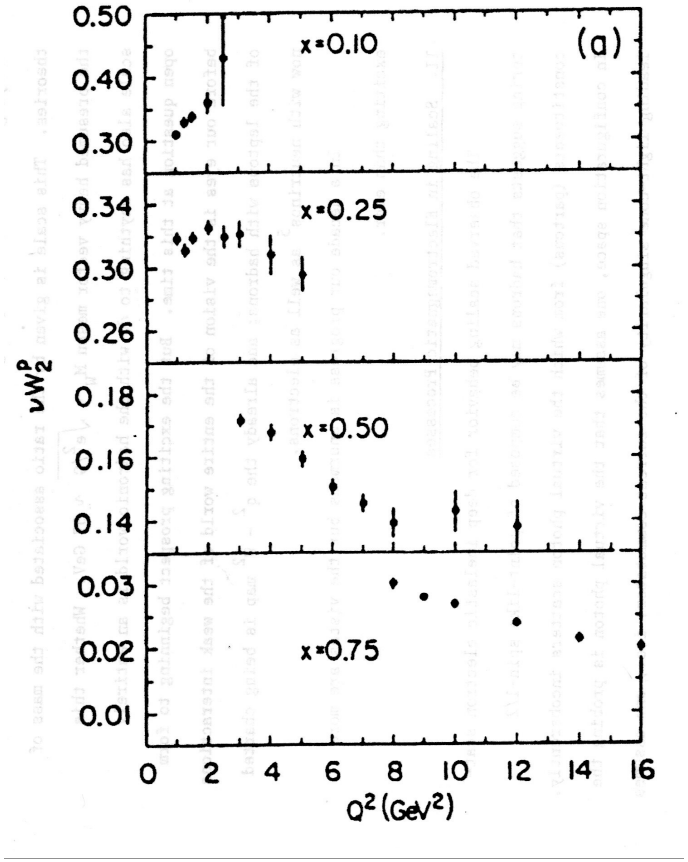


Tests of Scaling of the Proton Electromagnetic Structure Functions [*PL* **52B** (1974) 249]

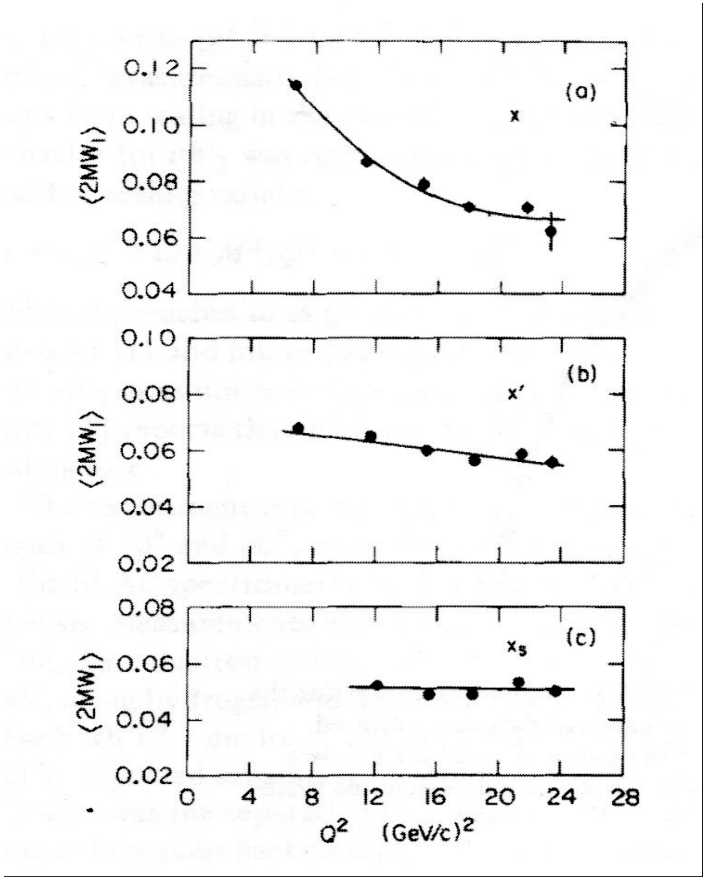


Scaling Violations at SLAC, 1975

Using Both E49 and E87 Data



From E89 Data at x = 0.6 to 0.7



A Memorable Stockholm Reunion, December 1990

1990 Nobel Prize in Physics awarded Friedman, Kendall and Taylor . . .

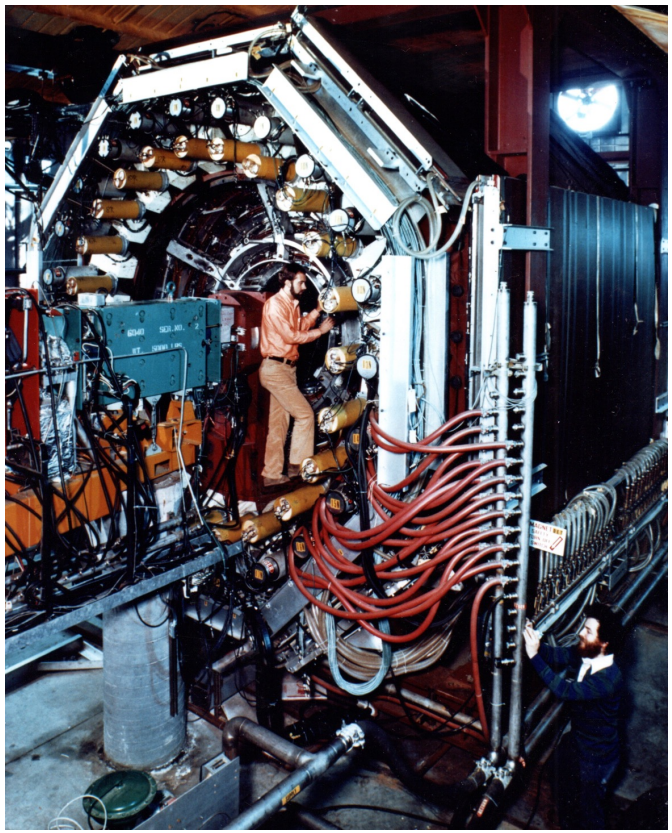
"for their pioneering investigations concerning deep inelastic scattering of electrons on protons and bound neutrons, which have been of essential importance for the development of the quark model in particle physics."

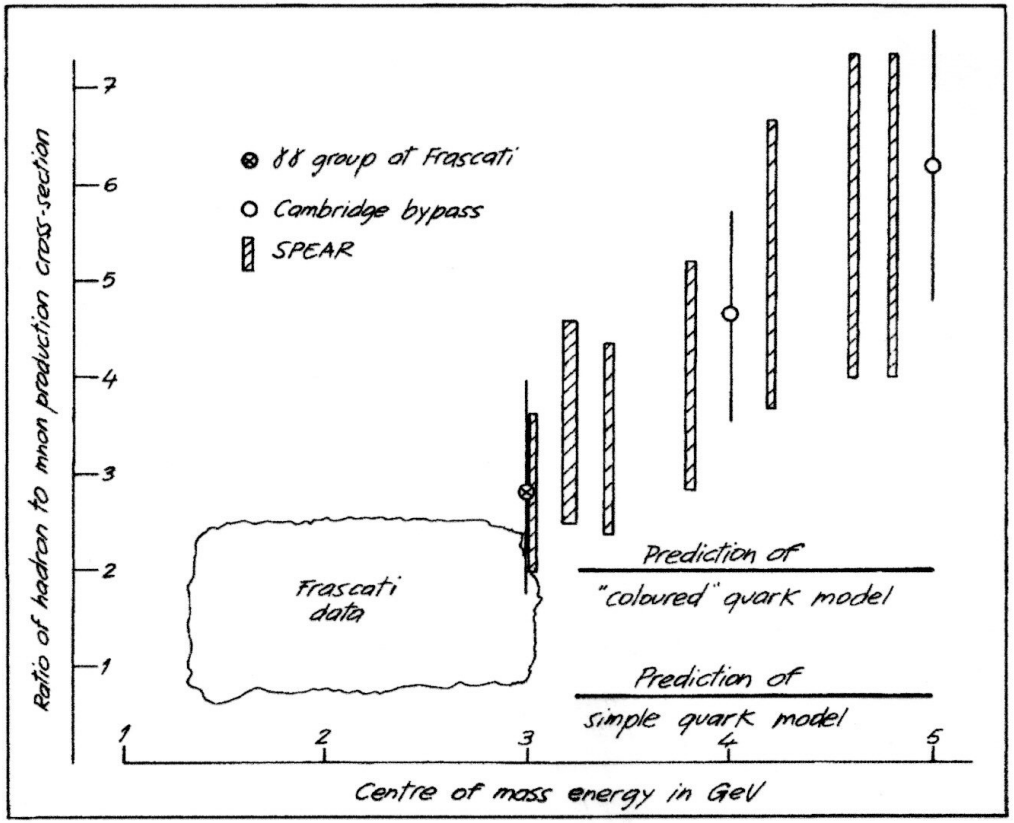
"This year's Laureates lit a torch in the darkness. They and their coworkers examined the proton (and later the neutron) under a microscope — not an ordinary one but a 2-mile long electron accelerator built by Wolfgang K. H. Panofsky at Stanford, California."

— Cecilia Jarlskog, Presentation Speech

The SPEAR Collider, mid-1970s

First Results from SPEAR, December 1973





For Further Reading and Insights . . .