REPORT ON HOLOGRAPHIC TRACK CHAMBER WORKSHOP

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An informal workshop was held at Fermilab on November 11 and 12, 1980, on holographic track chambers, with emphasis on high-resolution bubble and streamer chamber vertex detectors for fixed-target Tevatron experiments. About 85 experimenters participated, with approximately equal numbers interested in applications to hadron-photon interactions and to neutrino-beam dump studies.

The possibilities for holography offering advantages over conventional photography of bubble chambers, by providing direct three-dimensional recording as well as high spatial resolution over much larger depths of field, were explored in the late 1960's. Optics scientists in Britain, the United States, and Japan participated in these investigations. Holographic recording of spark and streamer chamber track residues was demonstrated in the early 1970's in the Soviet Union. It is chiefly in the last two years, however, that extensive practical interest has developed in holographic track recording, principally for studies of short-lived charm hadrons and heavy leptons. At the workshop it appeared that the goal for many experimenters is to achieve with practical chambers an order of magnitude improvement in spatial resolution from holograms as compared with conventional photographs. It was emphasized by Leon Lederman in his welcoming address that the realization of higher spatial-resolution detectors is important for increased physics capabilities in Tevatron experiments and would in many cases also allow the use of smaller and more economical apparatus and spectrometer arrangements.

In the first session of the workshop, T. Jeong (Lake Forest) provided background and demonstrations of a variety of general holographic techniques. C. Fisher (Rutherford Laboratory) reviewed limitations of conventional high-resolution track chambers and spectrometers, leading to recent European developments of several varieties of small holographic bubble chambers. P. Lecoq (CERN) showed reconstructed images from the first high-resolution bubble chamber holograms, taken earlier this year at the CERN SPS with the Berne freon mini-chamber (BIBC). Videotape test results with 8-micron bubble-diameter tracks were particularly dramatic. Image resolution of this quality appears to be needed for efficient observation of decay vertices for particles with lifetimes down to 10^{-13} seconds.

The second session provided additional technical perspectives on the limits for holographic techniques by F. Eisler (CUNY), and on the characteristics of the required lasers for practical holographic track chambers by R. Milburn (Tufts). Aspects of high-resolution photography and holography of streamer-chamber tracks were reviewed by J. Sandweiss (Yale), and

of big bubble chambers by H. Bingham (UC, Berkeley). Designs of two novel holographic freon bubble-chamber proposals were described by I. Pless (MIT). One design featured a very small ultrasonic chamber for hadronic interactions, aiming at approximately 5 microns bubble size, the other a 48-inch chamber for Tevatron beam-dump experiments, aiming at approximately 30 micron bubble resolution. Both designs featured classical in-line holographic optics with the addition of auxiliary lenses, providing image magnification for the small chamber and demagnification for the large chamber for similar 70-mm film formats.

Two parallel sessions were held, one on possible holographic mini-detectors for hadron-photon interactions and the other on big holographic bubble chambers for neutrino-beam dump experiments. These sessions developed several lively resonances in audience participation and interchanges of new ideas.

C. Fisher (RHEL), assisted by the "big chambers" chairman V. Peterson (Hawaii), and by on-going group interjections, ended up with an idealized big-cylinder holographic chamber geometry with internal spherical mirrors at the ends, resembling the optics in some forms of astronomical telescopes. It was later learned that T. Kitagaki and others in Japan had recently come to similar conclusions for possible design of the proposed MIT-Tohoku beam-dump holographic chamber. For the 15-ft chamber, discussions were aired on laser speckle problems, liquid turbulence and magnetic-field optical-polarization effects, which may be serious for holographic methods using bright-field Scotchlite and off-axis reference-beam illumination. Possible alternative solutions were also suggested, including possible introduction of a suitable laser beam inside the chamber independently of the camera lens assembly. This might also allow for dark-field Scotchlite illumination and more nearly in-line image holograms.

In the mini-detector session, chaired by J. Sandweiss, it was generally agreed that the holographic optics appeared to pose only minor problems for small transparent chambers. The main discussions centered on chamber types, duty factors, beam rates, laser and triggering-logic requirements, as well as a brief look at the associated problems of scanning and data reduction if millions of holograms are to be taken. C. Roos (Vanderbilt) pointed out the axial optics and high-field solenoid features of the HYBUC bubble chamber as an attractive rapid-cycling holographic target chamber for development and use with Tevatron spectrometers. R. Plano (Rutgers) described an idea for a continuously operating small holographic bubble chamber, using the Bernoulli principle for establishing an appropriate pressure drop for sensitivity together with velocity flow for removing old bubbles. (It was also learned after the workshop that A. Herve at CERN was independently already at work on a continuously sensitive Bernoulli bubble chamber, making use of leftover Gargamelle liquid-pumping facilities.) On the streamer chamber side, L. Voyvodic (Fermilab) discussed recent preprints from a joint Dubna-Leningrad team who reported holographic recording of

tracks in a pressurized hydrogen avalanche chamber. He speculated on idealized holographic streamer-cloud chambers resulting if these holographic techniques were combined with an avalanche-nucleated diffusion cloud chamber method reported several years ago by a group in Tbilisi.

The workshop ended with overviews and comments on directions for future efforts for prospective Tevatron holographic track chambers by V. Peterson and J. Sandweiss, with additional comments by J. Bjorken (Fermilab). After describing his estimates for the copious abundance of Tevatron-produced charm and bottom quarks, Bjorken stressed that their effective study with suitable detector systems may well bring about a richness of physics comparable to the discoveries that have been provided by intensive and detailed studies of strange particles in the past.

The nearly complete detector consisting of the calorimeter plus drift chamber - toroid magnet muon spectrometer for E-613, the first neutrino experiment to be done in the Meson Laboratory. Don Reeder (left) and Mark Duffy, both from the University of Wisconsin, discuss future plans.
(Photograph by Fermilab Photo Unit)