

In-line holography tests in BEBC used 100-micron glass beads glued to 20-micron wires to simulate particle tracks. Top, the original target, bottom, the hologram.

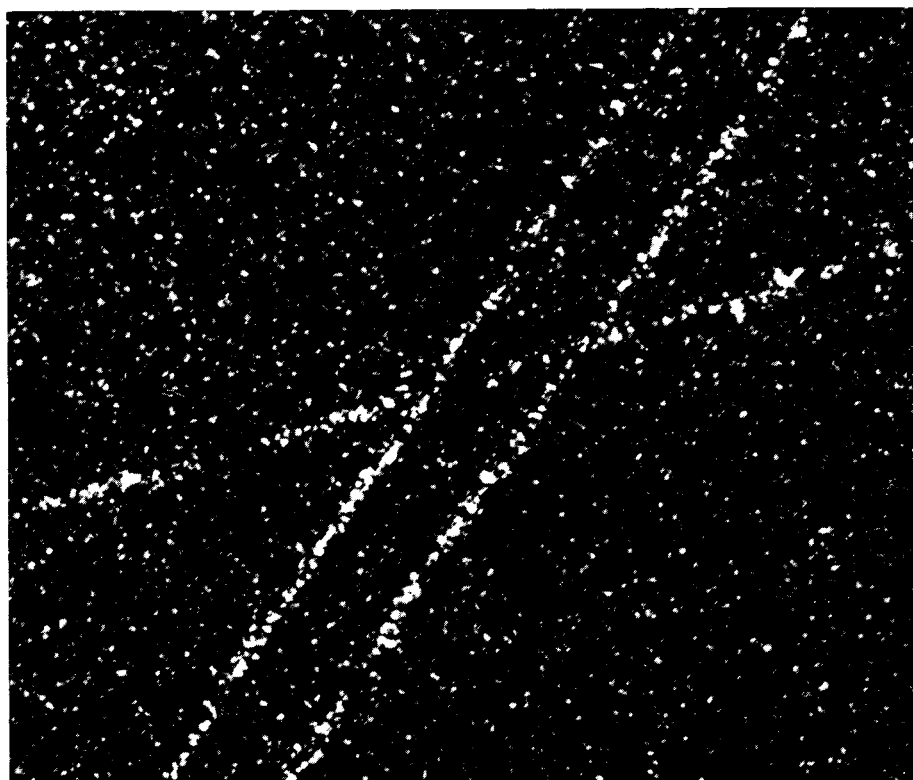
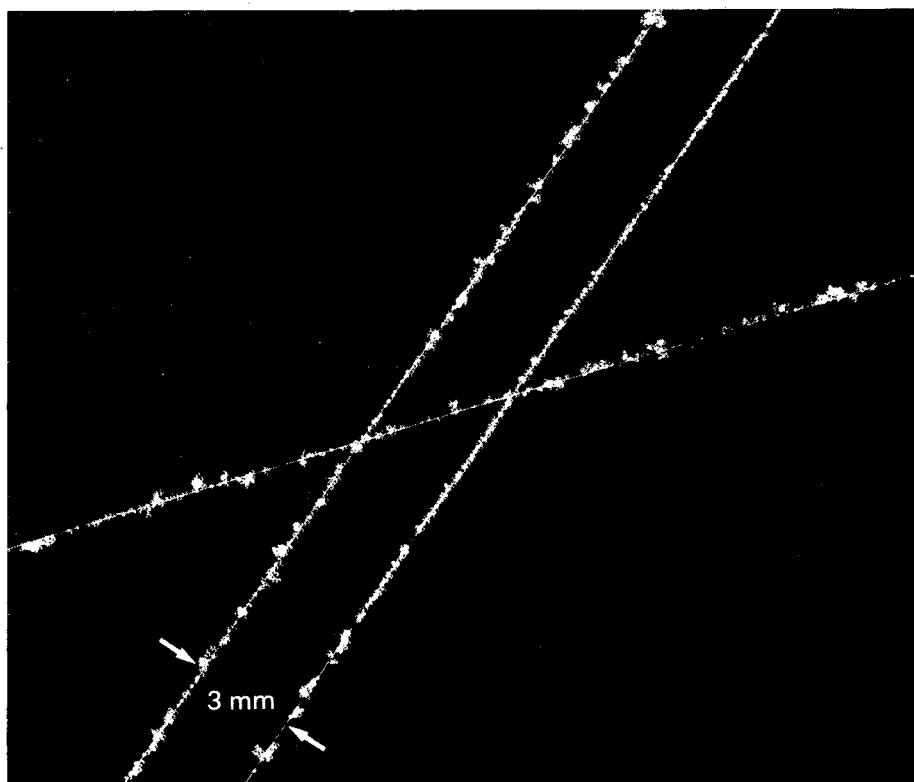
Big holograms

Short-lived charmed particles and the tau lepton live so briefly that even at very high energies they travel only a few millimetres before decaying. To identify such transient particles and measure their lifetimes requires track detectors with high enough resolution to identify clearly the decay point.

A number of groups have developed small high-resolution bubble chambers for use as vertex detectors in association with larger electronic detectors. These groups have found that holography is quite useful in helping to improve resolution. These small chambers have been successfully used in hadron experiments (see November 1982 issue, page 362), but are too small to catch neutrinos.

Recently some groups have been trying to develop high resolution techniques for the large bubble chambers, BEBC at CERN and the 15 foot chamber at Fermilab. At present the resolution of these chambers is limited to about 500 microns by the conventional optics used to photograph the bubble tracks. Higher resolution with conventional optics means giving up depth of field, thereby reducing the usable volume of the chamber. One possible solution is to use holography in conjunction with conventional optics. Holography holds the promise of a considerable improvement in resolution throughout a large depth of field. This is only achieved at the expense of more complicated recording and measuring, where the playback scheme has an additional third dimension.

The conventional pictures would be scanned and measured in the usual way and selected interesting events examined with the high reso-



lution provided by the holographic pictures. With this in mind two groups have been developing two different techniques for recording tracks in large chambers holographically.

A hologram is produced by the interference of coherent light from a 'reference beam' with coherent light scattered by an object. The two schemes for using holography in the large bubble chambers differ essentially in the method used to get the reference beam to the film.

The first method uses a modest intensity laser beam which is split into a low power reference beam, passing directly to the photographic emulsion, and a higher intensity part, which traverses the fisheye window, goes through the liquid, is reflected from the 'Scotchlite' surface back to the same optic port. The returning light wave is disturbed by the bubbles and forms an interference pattern with the reference beam. Applying this technique, cosmic ray tracks were photographed last summer in BEBC by a CERN / Institut Saint-Louis group. More recently, a CERN / Rutherford collaboration has demonstrated that 40 micron wires can be reconstructed from holograms in a realistic model of BEBC. This promises well for high resolution holography.

The other method needs a more powerful laser beam, which enters BEBC through a small window on the bottom of the chamber. This beam diverges through a specially designed lens. A small fraction of the light goes directly to a fisheye window to form the reference beam, while the rest illuminates the bubble chamber tracks. The intensity at larger angles increases to compensate for the decrease of the light scattered by the bubbles under these conditions. The scattered light interferes with the reference beam to

form a hologram. This idea was developed at Columbia University and perfected with help from Hawaii, Rutgers-Stevens and CERN.

A 10 Joule Ruby laser with a pulse duration of some 20 ns was installed underneath BEBC in order to test this second scheme. With the chamber still empty, 100-micron glass beads glued onto 20-micron wires, to simulate particle tracks, were photographed with excellent contrast.

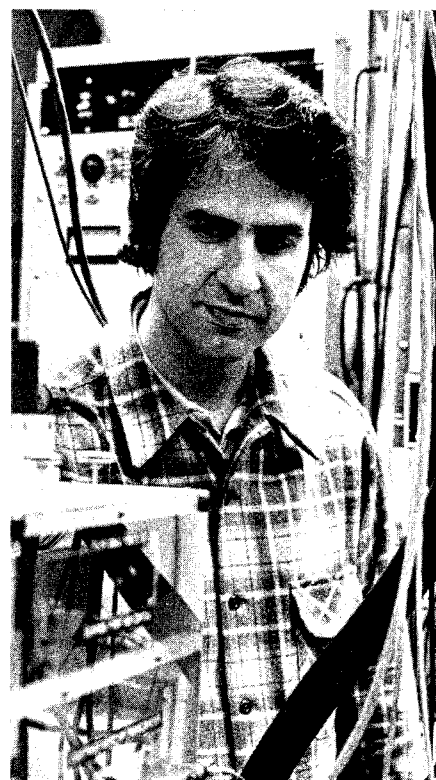
This scheme was then tried in a cold-test, parasitically with a physics run, this spring. High contrast holograms were obtained of bubble chamber tracks produced by cosmic rays traversing the neon/hydrogen filled chamber. Due to the random timing of cosmic rays, tracks of various diameters were photographed. Small tracks were seen with bubble diameters of some 120 microns. Potential visibility problems due to local heating or liquid turbulence, or magnetic field were not observed. However at the present laser power level, there was some laser-induced parasitic boiling which obscured the view of the conventional photographs taken several milliseconds after the laser fired. This boiling can be suppressed by a reduction in laser power by lengthening its pulse duration and using a higher sensitivity holographic film. It is intended to install such a system in the 15 foot chamber at Fermilab for Tevatron neutrino exposures.

Magnetic monopole meeting

The attendance of more than a hundred physicists at an 'Interdisciplinary Meeting on Magnetic Monopoles' demonstrated the interest of European physicists in this branch of research. The meeting, held in

Blas Cabrera — in the continuing hunt for magnetic monopoles.

(Photo Stanford)



Orsay, followed the Wingspread Colloquium (see January issue, page 11).

F. R. Klinkhammer of the Leiden Observatory felt that the main question facing theoreticians was not so much the existence of monopoles, but rather how many were left. Contrary to limits from astrophysics (the mass of the universe, the existence of galactic magnetic fields), conventional Big Bang cosmology predicts a monopole abundance. Theoreticians are at present doing a great deal of work on the 'inflationary model': at the phase transition when grand unification symmetry breaks down, the magnetic monopoles are thrown far away from our universe during its formation. If this is correct, it would be impossible to detect a single monopole. (See the article by John Ellis and Dimitri Nanopoulos on Particle Physics and Cosmology, July/August issue, page 217).