light? One uses an autocorrelation technique "that makes the pulse measure itself," as Shank describes it. The compressed pulse is split into two components, which are then directed onto a 0.2-mm-wide crystal of potassium dihydrogen phosphide by different optical paths of variable length. In the crystal, pairs of 6200-Å photons combine to generate 3100-Å ultraviolet light. Only when both pulses are simultaneously present in the narrow, frequency-doubling crystal is there sufficient photon intensity to produce an observable level of this second-harmonic generation. The ultraviolet output intensity is thus a measure of the overlap of the two pulses in the crystal. By varying the path length difference in submicron steps (light travels a third of a micron in a femtosecond) one produces an autocorrelation function of ultraviolet output intensity that yields the pulse width. A time measurement has thus been converted into a measurement of distance. One might imagine that with a pulse width of only 30 fs, dispersion in the lenses and other optical components would seriously distort the measurement. Happily, Shank explained us, the grating pair can be adjusted to cancel precisely all these unwanted dispersions.

With two stages of fiber-optic compression, Shank told us, the Bell Labs group hopes ultimately to get down to "just a few cycles of light—perhaps 5 fsec." With uncompressed 70-fsec pulses from the ring laser, the group has already performed a study[7] of the picosecond dynamics of photoexcited gap states in polyacetylene, a polymer that behaves like a one-dimensional semiconductor. Greene has investigated time-resolved induced birefringence with a time resolution of about 100 fsec.

Mourou and his colleagues have also recently employed[8] a ring laser similar to the Bell Labs instrument to probe ultrafast electrical transients in GaAs photoconductive detectors with a temporal resolution better than 2 psec, using 100-MHz train of 120-fsec pulses. At Cornell, Jean-Marc Halbout and C. L. Tang have recently used 70-fsec pulses from a similar colliding-pulse ring laser to do time-resolved observation of the orientational relaxation of molecules in liquids. Tang told us that in 1979 his group had been able to achieve a significant reduction[10] in the width of pulses from a synchronously-pumped, mode-locked, cw dye laser by replacing the usual linear laser cavity with a ring cavity.

Starting with a modest kilowatt of power and using a multistage laser amplifier, the Bell Labs group has been able to deliver *gigawatts* of peak power to various semiconductor materials with these extraordinarily brief light pulses. "It's the most intense way we have of interacting with condensed matter without destroying it," Shank told us. —BMS

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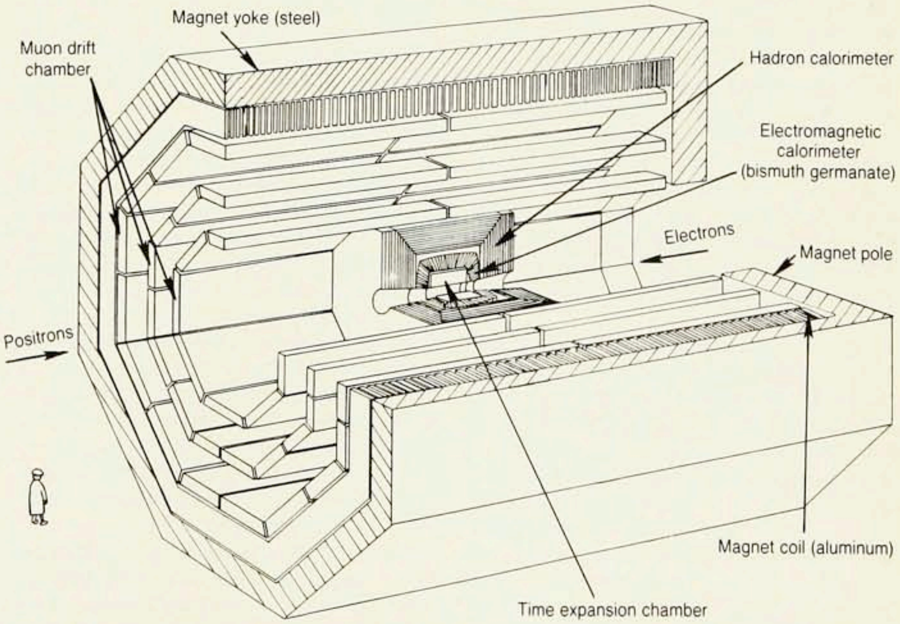
Selection of LEP detectors nears finish

As contracts are being tendered for the construction of LEP, the gargantuan electron–positron colliding-beam accelerator that will straddle the French–Swiss frontier at CERN, the time has come to settle on the four detectors that will occupy the four underground experimental halls to be used in the first phase of LEP operation, which is scheduled to begin toward the end of 1987. In January, letters of intent outlining detector designs for the four experimental beam-intersection areas were submitted by six large multinational collaborations.

Throughout the year, the LEP Experiments Committee, headed by Günther Wolf (DESY), has been meeting at regular intervals to consider these proposals in the context of the accelerator's overall experimental program, to suggest modifications, and to advise CERN director Herwig Schopper on the selection of four detector designs from among the six contenders. Because LEP will be the dominant feature of the European high-energy-physics landscape in the late 1980s and 1990s, much is at stake in this selection process.

In its first phase, the 27-km-circumference, $400-million collider ring will accelerate countercirculating beams of electrons and positrons to 50 GeV, providing a center-of-mass collision energy of 100 GeV—presumably sufficient to produce the much-sought-after Z^0, the supposed neutral quantum of the weak force (although some predictions of the Z^0 mass do go as high as 110 GeV). LEP is intended eventually to produce collision energies as high as



The still nameless detector proposed for LEP by Samuel Ting and his collaborators will have an extraordinary magnetized volume exceeding 1000 m³. Placing the muon drift chambers inside the magnet solenoid is expected to yield exceptionally precise measurement of muon momenta. The detector is also specialized for hadron and electromagnetic calorimetry. The 12 000 bismuth germanate crystals of the electromagnetic calorimeter promise very high-resolution measurements of photon and electron energies. The magnet yoke, which encloses the entire system, is about 14 m long and 16 m across.

260 GeV (PHYSICS TODAY, July 1980, page 19).

Seeking to provide the broadest possible experimental program for the first LEP phase with a minimum of duplication and a judicious balance between risky new detector technologies and more conservative, proven techniques, the Experiments Committee at its July meeting addressed a number of questions and suggestions for design modifications to the detector collaborations. Four of the six collaborations were then invited to prepare revised proposals to be considered for "conditional approval" in November.

The philosophy set out by the Committee in July was that there should be two general, "universal" detectors and two more specialized instruments stressing different detection techniques. One of the universal detectors, it was felt, should be based on conventional techniques, while the other should be of a more advanced, hence necessarily riskier, design.

Thus, Schopper told us, by July the selection process had in effect been *informally* narrowed down to four detectors:

▶ OPAL (Omni-Purpose Apparatus for LEP), a large general-purpose detector based largely on conventional techniques—more or less an upscaled version of the Jade detector at PETRA in Hamburg (PHYSICS TODAY, August 1982, page 19). The original OPAL collaboration consisted of 16 groups, 12 from Europe, two from Canada and one each from Japan and the US (University of Maryland). Its spokesman is Aldo Michelini (CERN).

▶ ALEPH (Apparatus for LEP Physics), an advanced-technology, general purpose detector proposed by 18 European groups and the University of Wisconsin. The central feature of ALEPH is a time-projection chamber, essentially a much larger version of the TPC detector developed at the Lawrence Berkeley Lab and recently installed in the PEP e^+e^- collider at SLAC. The collaboration's spokesman is Jack Steinberger (CERN).

▶ An as yet unnamed, specialized detector proposed by a 22-group collaboration (11 European, 9 American and 2 Chinese [PRC]) whose spokesman is Samuel Ting (MIT). Seven additional groups, including a large Soviet contingent, have recently joined the collaboration. Ting's detector (as it is generally called) is specialized for electromagnetic and hadron calorimetry, and the particularly accurate measurement of muon momenta.

▶ DELPHI (Detector with Lepton, Photon and Hadron Identification) puts special emphasis on hadron identification, employing a novel ring-imaging Cherenkov detector to measure particle velocities. The spokesman for this 25-group European collaboration is Ugo Amaldi (CERN).

The informal selection of these four detectors was, of course, contingent on there being sufficient money for four. Last summer one still had to consider the possibility that there would be only three. It has since been decided that Phase One at LEP would indeed begin with four detectors, Schopper told us.

At its mid-October meeting, the Committee considered the modifications proposed by the four collaborations in response to its queries and suggestions. The responses, Schopper told us, "were generally positive." After its November meeting, the Committee was to make a formal written recommendation to the CERN Research Board, which was scheduled to meet on 18 November.

The Board was then expected to give conditional approval to the chosen detector collaborations—conditional in the sense that the detailed costs and funding of the detectors must be clarified before final approval is granted next Spring. The average cost of the detectors will be about $30 million. Most of that money is expected to be provided by the collaborations themselves; about 20% would come from the CERN budget.

Although no formal selection, conditional or otherwise, had been made public as of this writing, a "marriage market" is now in full swing at CERN. A number of groups originally involved in the LOGIC collaboration, a largely American enterprise that now appears to be a dead issue, are actively negotiating to join one or another of the four presumptive winners. The ELECTRA collaboration, whose design was rather similar to that of its chief rival, OPAL, held out some hope through September. But now its member groups are also on the marriage block.

Recommendations. The size of the detector originally proposed by Ting's collaboration was extraordinary, even by the standards of the other LEP detector designs, all of which are unprecedentedly large. Measuring more than 13 meters in length and 14 meters in diameter, it would not have fit easily into a standard LEP experimental hall. In response to the Committee's recommendation, the detector design has now been reduced by 40 cm in both length and radius, obviating the need to excavate an outsize hall.

The Ting detector is in fact described as a "magnetic hall;" the iron magnet yoke will serve as the hall's walls. This unusual configuration is intended to provide a large magnetized volume outside the detector's hadron calorimeter, to make possible a very precise measurement of muon momenta. In a more conventional design, the magnet yoke would have served as the hadron calorimeter, with the muon detectors outside the magnetic field. The detector's electromagnetic calorimeter will employ 12 000 crystals of bismuth germanate—a material (new to high-energy physics) that promises to provide unusually good energy resolution for electrons and photons. The design of the detector's hadron calorimeter has recently been expanded significantly in response to another of the Committee's suggestions.

The Experiments Committee expressed some concern that the central magnets of three of the detectors (all but Ting's) were to be superconducting—always a risky business. The OPAL collaboration was asked to consider using a conventional magnet for this conservative detector, which was intended, after all, to be the bastion of reliability. Although the power cost of running a room-temperature magnet of that size would be very high, the OPAL group is now actively investigating this option.

The DELPHI collaboration has responded positively to the Committee's suggestion that its system of ring-imaging Cherenkov detectors be expanded. These unique RICH detectors, as they are called, will permit hadron identification by measuring the diameter of the circle of Cherenkov light generated by a charged particle traveling in an arbitrary direction. At the center of DELPHI will be a time-projection chamber only slightly larger than its Berkeley progenitor, thus much smaller than the ALEPH time-projection chamber. Although these ultrasophisticated drift chambers promise to be general detectors of prodigious power, very little physics has as yet been done with TPCs.

"LEP will be a unique facility," Schopper told us, "but so will the Tevatron [at Fermilab]." He therefore thinks it important that interregional collaboration be strengthened in the coming years. "We will welcome American participation at LEP, as we hope for reciprocity at the new US facilities. We will not ask exorbitant nonmember contributions, expecting a *quid pro quo* in the long run."

On this side of the Ocean, the SLAC equivalent of the LEP Experiments Committee began deliberations in November to choose one or two detector designs for the SLAC Linear Collider from among nine competitors. Although the SLC, being a single-pass collider rather than a storage ring, will have only one e^+e^- collision region (PHYSICS TODAY, January 1980, page 19; October 1981, page 17), the proposed "pushpull" design of its experimental hall would accommodate two detectors. The SLC may be providing experimenters with 100-GeV e^+e^- collision as early as the end of 1986. —BMS□