In August, a 6 metre-long superconducting magnet of the 'cold-iron' type, built by Brown Boveri and Co of Mannheim (see March issue, page 52) was successfully tested at DESY. The magnet reached a current of 7860 ampere at 4.69 kelvin, which corresponds to a field of about 5.75 tesla, computed taking into account saturation effects in the iron. Only 4.53 tesla are required for 820 GeV protons in HERA. This magnet type offers the advantages of simpler quench protection using passive components and better mechanical suspension with smaller heat losses.

In order to add the benefits of this cold-iron magnet with those of the warm-iron type already produced and tested at DESY, a hybrid model is now being produced for HERA. Two one metre-long test magnets will be built at DESY and four 9 metre-long prototypes (see June issue, page 184) will be built under contract by BBC Mannheim. DESY will wind and 'collar' the coils (aluminium collars are now used instead of stainless steel to support the coils) and BBC will assemble the magnet yokes and the cryostats.

A six metre-long coil with the new collars and with a vacuum pipe already provided with the correction coils required for HERA (which have been built by NIKHEF Amsterdam and the Dutch HOLEC company) is being tested in a vertical bath cryostat at DESY.

Meanwhile, the excavations for HERA's South experimental hall, which began on 15 May, have been completed and the concrete floor 23 metres below ground level has been poured. Work on the West experimental hall, located on the DESY site, is underway.

An important modification has been made to the HERA parameters. The beams should now cross at zero degrees in the four interaction regions, instead of the earlier proposed 20 mrad. This decision is based on new results of tracking calculations for crossing beam geometries which indicate a blow-up of the proton beam by the space charge forces of the electron beam. This effect already happens at very low electron currents. The mechanism of this blow-up is the excitation of satellite resonances, an effect which was first observed at the DORIS storage ring (in the days when it had two rings). The computer simulations show that this effect is more serious at HERA due to the absence of synchrotron damping for the protons.

Work on many other components of HERA is progressing according to plan. A source for negative hydrogen ions has been purchased from Fermilab and a model radiofrequency quadrupole to accelerate them to 750 keV is under construction at the University of Frankfurt.

The HERA refrigeration plant will be subdivided into three units, all located at the West Hall on the DESY site. Liquid helium will be piped around the ring and gaseous helium will be returned to the central units. Each of these units will provide 6500 Watt at 4.3 K, 20.5 g/s liquid helium and 20 kW between 40 and 80 K. Two of the three plants are required for steady-state operation.

As well as HERA, there is research work going on at the PETRA and DORIS electron-positron storage rings. At DORIS, a new run at the upsilon energy began in August to carry out further studies on the recently reported zeta particle (see September issue, page 266) with twice the present statistics. About 200 000 upsilons should be collected and analysed within a few months. Over 200 new events are expected in the 1.07 GeV peak observed in the energy spectrum of single photons emitted in upsilon decays.

WORKSHOP
Radiofrequency superconductivity

The Second Workshop on Radiofrequency Superconductivity was held at CERN from 23-27 July, four years after the first, organized at Karlsruhe. 35 invited talks were presented to the about 80 participants from Australia, Brazil, Europe, Japan and the United States. For the first time, ten Laboratories operating or planning superconducting accelerators for heavy ions participated and shared their experience with the community proposing the use of superconducting accelerating sections for electron accelerators.

The meeting opened with status reports from the Laboratories. The Argonne Superconducting Heavy Ion Post Accelerator has so far collected successfully 16 000 h of beam time for experiments and further development of this accelerator using niobium split-ring resonators is under way. At Saclay a heavy ion accelerator is under construction based on the Karlsruhe experience with helix resonators. At Stony Brook a different technology is pursued by the use of superconducting lead-plated copper resonators in their ion post accelerator. The running experience of this machine demonstrates the applicability of this technique to low frequency (100 MHz) resonators. In the field of heavy ion accelerators the use of superconducting cavities appears to be generally accepted today.

Very good results were reported by the CERN group. Accelerating fields of 5 MV/m were obtained in a

The second Workshop on Radiofrequency Superconductivity was held at CERN from 23-27 July, four years after the first meeting in Karlsruhe.

(Photo CERN 311.7.84)

500 MHz five-cell cavity used previously for a test in PETRA and an encouraging 13 MV/m could be reached in a single cell cavity made from high thermal conductivity niobium. Efforts are now concentrated on single and multicell cavities at 352 MHz, a frequency which is presently favoured also for the superconducting cavities for LEP at CERN. At Cornell a storage ring experiment is being prepared with two five-cell cavities with rotational symmetry at 1.5 GHz fabricated from purified niobium. 15.3 MV/m were obtained in one of these cavities fully equipped with the r.f. couplers necessary for accelerator use.

At DESY, work is concentrating on two nine-cell cavities (1 GHz) to be installed and operated in PETRA this fall. New and easy-to-apply surface treatments were developed together with a silver plating technique to lead the way to a more economical cryostat design. At DESY, cavity fabrication is carried out with significant industry participation. The same is true for the work done at KEK (Japan) where a first test of a 500 MHz three-cell cavity has been performed in the TRISTAN accumulation ring. An accelerating field of 5.2 MV/m was reached and a beam of 10 mA was stored at 2.5 GeV with the superconducting cavity alone. At Wuppertal efforts are focused on a 130 MeV superconducting 'recyclotron' for electrons which is constructed at the Technische Hochschule Darmstadt. Their frequency is 3 GHz and research is concentrated on field limitations, niobium-tin covered cavities and resonators in the very high frequency regime (20 to 90 GHz). At Orsay work is in progress to study surface cleaning techniques by gas discharge methods and Stanford University is planning to apply r.f. superconductivity to a free electron laser. Next door at SLAC, very high peak surface fields (up to 70 MV/m) are obtained by exciting superconducting single-cell cavities (2.85 GHz) with microsecond r.f. pulses.

After this grand tour, attention turned to special topics. The use of niobium of higher purity and thereby increased thermal conductivity was considered as one of the main improvements of the past year. The new material increases the thermal stability of cavities and reduces their sensitivity against lossy defects which so far were the prime reasons for field limitations. The progress in diagnostic methods since the last workshop, especially the temperature mapping technique which today allows the guided removal of field limiting defects, was reviewed. Refinements in surface treatment and clean work in dust-free environments were discussed. The importance of all these manufacturing techniques was recognized and is considered responsible for the higher degree of reliability with which superconducting resonators can be fabricated today.

Electron loading in superconducting cavities was another important topic. The plague of resonant electron loading (multipactor) appeared to be quantitatively defeated by the introduction of spherical or elliptical shaped cavities, a shape now unanimously accepted.

In recent experiments at CERN a very special kind of two-point electron multiplication was discovered which asks for a revival of attempts to lower the secondary emission yield on technical niobium surfaces.

Aside from this singular effect, field emission is certainly the next hard barrier to be overcome if much higher fields have to be reached, for example in superconducting cavities for future linear colliders. New fabri-

LEP Project Director Emilio Picasso has been a driving force in the push for superconducting cavities for the future of the LEP electron-positron ring now being built at CERN.

(Photo CERN 307.7.84)

cation techniques like sputter deposition of niobium onto copper, copper or silver-plated niobium cavities or niobium cavities with a niobium-tin surface were reviewed and are considered to be very worthwile directions for future research aiming particularly to reduce cryogenic losses even further and to simplify cryostat designs. For the time being however, shaping half cells from niobium sheet and subsequent electron beam welding is the generally accepted fabrication technique.

One morning of the workshop was given over to detailed discussions on specific questions of superconducting heavy ion accelerators. A new design, the quarter-wave resonator, was introduced, new acceleration ideas, like the Munich separated cyclotron ring with a superconducting acceleration cavity, and special questions regarding vibration disturbances in resonators of complex shape were discussed.

The last day was devoted to the application of superconducting cavities to large electron-positron storage rings. Up to now four accelerator tests have been performed — by the groups at Cornell and KEK in their storage rings and by groups from Karlsruhe and CERN (at the PETRA ring at DESY). Two more are under preparation at Cornell and DESY. All these tests were 'premières' for the respective groups and all of them were successful, revealing no major or unexpected problems. A number of non-fundamental failures of equipment were observed but no test was seriously interrupted. It was felt nevertheless that more tests have to follow to apply the initial lessons learned. In particular, attention should be paid to the long term behaviour and to the routine operation of superconducting cavity arrays in the environment of a large storage ring.

During the final session, the CERN effort to introduce superconducting accelerating sections into LEP was covered. The LEP project and its special requirements for r.f. energy was introduced to the workshop participants and the challenge of using r.f. superconductivity for LEP was outlined. Based upon the experience from the first test of an experimental prototype module in PETRA, a new cavity design and improved coupling schemes for the fundamental and higher order mode r.f. power have been introduced.

A discussion on cryogenic engineering applied to cavity cryostats and refrigeration systems revealed that a great deal of work has to be devoted to this essential matter.

Comparing the results reported at this workshop with those of four years ago, no significant advance in the maximum fields or cavity quality factors is apparent. The main and most important development is demonstrated by the fact that the design performance of extended cavity arrays can be reached today with a much higher degree of reliability than in the past. This has to be attributed to the improved understanding of field and quality factor limiting phenomena and is of decisive importance for future large scale projects.

(From H. Lengeler and H. Piel)

MICHIGAN Cyclotron conference

A sense of excitement was in the air as cyclotron physicists and engineers from 17 countries convened on 30 April for the opening of the Tenth International Conference on Cyclotrons and Their Applications. Some 50 years after its invention, the redoubtable cyclotron remains a topic of compelling current interest. Cyclotron experts gathered at Michigan State University's Kellogg Center to hear of latest developments, of progress and successes on new machines which had come into operation, of new projects which were underway, and of dreams which lay ahead.

Both the first speaker, John A. Martin of Oak Ridge, and the last, J. R. Richardson of TRIUMF, reminded the audience of historical perspectives. The conference was occurring just 25 years after the first conference at Sea Island, Georgia and Martin reviewed highlights of intervening meetings at Los Angeles, Geneva, Gatlinburg, Oxford, Vancouver, Zurich, Bloomington, and Caen. Richardson began his talk by noting that the conference was being held almost precisely 50 years after the date on which he began working with E. O. Lawrence as a graduate