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THE INTERNATIONAL CYCLOTRON CONFERENCES
TWENTY-FIVE YEARS OF PROGRESS

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Introduction

It is my honor to open this Tenth International Conference on Cyclotrons and Their Applications. We sincerely appreciate the excellent arrangements and organization for this meeting by Professor Blosser and the staff of the Michigan State University National Superconducting Cyclotron Laboratory. This brief introduction will review a few of the highlights of the nine previous meetings to perhaps convey an appreciation of the time-scale of the significant achievements of past years and to leave the thought that the future is as filled with promise as was the past.

Sector-Focused Cyclotrons — 1959

This year marks the twenty-fifth anniversary of the International Cyclotron Conference series. The first conference was held at "The Cloisters" in Sea Island, Georgia, a resort area near Savannah, Georgia. The Cloisters is a resort hotel well known for its elegance and the conferees were dined in the most grand style reminiscent of fine European hotels. The meeting was organized by Oak Ridge National Laboratory; Dr. A. H. Snell was the chairman. There were 92 participants, a much smaller group than attended subsequent meetings.

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The conference was notable for its almost complete lack of formality. Some 50 contributions of varying lengths and formality were presented. Manuscripts were not required ahead of time and most of the proceedings was prepared from stenographic notes. Many of the figures were reproduced from copies of slides. There was only one report on an operating isochronous cyclotron, the 12 MeV proton machine at the Technical University, Delft, Holland. Also operating, but not reported on at the conference, were cyclotrons at the Joint Institute for Nuclear Research, Dubna (13 MeV deuterons), and at the Atomic Energy Institute, Moscow (24 MeV deuterons). Eight cyclotrons were in design or construction and five serious studies were underway. The largest machine under construction was the K-140 Berkeley 88-inch cyclotron. The largest cyclotron in the study phase was the 240 MeV proton cyclotron proposed by A.E.R.E., Harwell, England, which was to be a conversion of the Harwell Synchrocyclotron to isochronous operation.

It should be noted that the work reported on theory at the Sea Island meeting formed the basis for almost all of the computer programs for cyclotron analysis that are used today. In those days, digital computers were both quite small and slow by modern standards and calculations that now take seconds took many minutes or perhaps hours. Large computers were not generally available; consequently there was a much greater dependence on analytical work then than at the present time.

International Conference on Sector-Focused Cyclotrons — 1962

The next conference, held in 1962, was the first truly International Conference and was more formally organized than the first one. It was held under the chairmanship of Professor J. Reginald Richardson on the campus of the University of California, Los Angeles. I remember that we were housed in a women's dormitory near the conference hall. There was ample space for informal discussions in the evening. Seventy-six papers were presented and there were 178 attendees. There was an air of excitement at the meeting. Most of the cyclotrons discussed at the 1959 meeting were in operation and showing signs of good performance, others were only a few weeks (or even hours) from "first beam." The beam transport systems and experimental apparatus of most installations were not yet completed.

The "Meson Factory" era was just beginning. Papers from Oak Ridge, UCLA, CERN, and ETH, Zurich, were presented on plans for proton cyclotrons in the energy range 450-800 MeV. None of these large machines discussed at the UCLA Conference were ever built, but many of the concepts presented found their way into later designs.

International Conference on Sector-Focused Cyclotrons and
Meson Factories — 1963

With so much excitement in the community and the expectation of rapid progress, it was decided to hold the next conference the following year at CERN under the chairmanship of Dr. Pierre Lapostolle. The main emphasis of the meeting was on new results from the cyclotrons already in

operation and on design studies for machines being planned. The interest in meson factories continued with the presentation of the concept of the ETH ring cyclotron for 500 MeV protons by Hans Willax and the concept of a 700 MeV H^- cyclotron by Reginald Richardson of UCLA. Both of these designs were later to be realized. The ETH design was built at Villigen in Switzerland, now the Swiss Institute for Nuclear Research (SIN). The UCLA design was built at Vancouver, Canada, as the Tri-Universities Meson Physics Facility (TRIUMPF).

International Conference on Isochronous Cyclotrons — 1966

The next conference was held at Gatlinburg, Tennessee, a resort town some fifty miles from Oak Ridge. Dr. Robert S. Livingston was the chairman. By that time, 25 cyclotrons were in use, 17 were the design or construction phase, and there were about 20 cyclotrons in various stages of study or proposal. Design of the SIN cyclotron was well advanced. The UCLA H^- Cyclotron concept was being vigorously pursued. There was much discussion of instrumentation for cyclotrons including emittance measurement apparatus, non-intercepting beam phase monitors, and design of research instrumentation.

Fifth International Cyclotron Conference — 1969

The Fifth Conference was organized by the Atomic Energy Research Establishment (A.E.R.E.), Harwell, England. The Conference was held at St. Catherine's College, Oxford, under the chairmanship of Dr. R. W. McIlroy. This meeting marked the beginning of intense interest in heavy ion accelerators employing the separated-sector style of magnet

design. Proposals from Argonne National Laboratory, Oak Ridge National Laboratory, and MSU were presented for machines in the $K = 400-700$ range which would use large tandem electrostatic accelerators or cyclotrons as injectors. The H^- meson factory cyclotron had found its home at Vancouver, BC, on the campus of the University of British Columbia, and design of the cyclotron had begun. First operation of the K-180 cyclotron at Jülich, Germany, was reported. Design of the K-240 Indiana Cyclotron facility was well along. The 1969 conference also marked the first meeting at which compact cyclotrons designed specifically for practical application were discussed. Also, because of the strong developing interest in applications, a separate conference was arranged to follow the cyclotron conference.

Sixth International Cyclotron Conference — 1972

1972 found the conference at TRIUMPF in Vancouver, BC, under the leadership of Professor J. B. Warren. Construction of the 500 MeV H^- cyclotron was in an advanced stage and the delegates were able to appreciate first-hand the size and complexity of the TRIUMPF cyclotron. Construction of the Indiana University and SIN cyclotrons was well advanced. There were many interesting reports from throughout the world on new ideas and the latest operating experiences. First operation of the K-160 cyclotron at Louvain, Belgium was reported. There were many papers on proposed large heavy ion cyclotrons but none of those projects had been funded. Heavy ion acceleration was becoming an important part of the programs at many institutions. Computer control

systems occupied a significant fraction of the program. For the first time the conference included a large number of papers on cyclotron applications.

Seventh International Conference on Cyclotrons and
Their Applications - 1975

The 1975 meeting was held in Zürich at the Swiss Federal Technical University under the sponsorship of the Swiss Institute for Nuclear Research (SIN) with Professor J. P. Blaser as Chairman. In the three years since the last meeting, several large cyclotrons had begun operation. These included the University of Indiana Cyclotron, the SIN cyclotron, and TRIUMPF. Design of the GANIL heavy ion accelerator facility was beginning but the site had not been selected. We heard reports on exciting superconducting cyclotron plans from Michigan State University and from the Chalk River Nuclear Laboratory. This was the first meeting at which poster sessions were used. Use of poster sessions made it possible to reduce the number of papers in regular sessions to realize a more relaxed pace. A total of 128 papers were presented at the conference. There were 231 participants.

Eighth International Conference on Cyclotrons and
Their Applications - 1978

The Indiana University Cyclotron Facility in Bloomington, Indiana, hosted the 1978 meeting. Professor Robert E. Pollock was chairman of the Conference. We learned of further progress on the MSU and Chalk River superconducting cyclotrons and of plans for a similar cyclotron at Milan. A K-800 second-stage cyclotron had been added to the MSU plans. Plans

for large separated-sector cyclotrons at the Institute of Physical and Chemical Research, Saitama, Japan, the Research Center for Nuclear Physics, Osaka, Japan, and at Dubna, U.S.S.R., were presented. The K-140 VICKSI facility in Berlin was now in operation. Caen, France, had been chosen as the site for the GANIL heavy ion facility. The beginning of the present intense interest in electron cyclotron resonance (E.C.R.) ion sources was evident with papers presented from Grenoble and Louvain. The earliest plans for very high energy cyclotron as a "kaon factory" for the TRIUMPF facility were described. There was an extensive program on cyclotron applications encompassing the field of isotope production, analytical and medical applications of isotopes, and neutron therapy.

Ninth International Conference on Cyclotrons and
Their Applications - 1981

The most recent conference, held in 1981, was hosted by GANIL in Caen, France. The Chairman of the conference was Dr. M. Gouttefangeas. The GANIL facility was almost complete and nearing early testing. Plans for large separated-sector cyclotrons were presented by several laboratories. There was much discussion of beam dynamics in such machines with emphasis on the effect of the very high rate of energy gain. There were many interesting papers on technology development for those machines. Plans for superconducting cyclotrons were presented by many laboratories. The largest of these machines were the K-1400 separated-sector superconducting cyclotron of the Technical University, Munich, and the 9 GeV kaon factory cyclotron planned for TRIUMPF in Vancouver, BC. Extensive interest in E.C.R. ion sources for multi-charged heavy

ions had developed and plans were presented from several laboratories. The tradition of a strong program on applications continued as evidence that the importance of cyclotrons extends far beyond the field of nuclear physics.

Conclusion

It has been an exciting 25 years. The number of cyclotrons has grown to well over 100. These machines represent the major tools for nuclear research throughout the world. In addition, cyclotrons are the source of almost all neutron deficient radioisotopes and support a major fraction of all high energy neutron therapy research.

In reviewing the proceedings of the nine conferences, one is impressed with the striking progress that has been made in both physics and engineering. The complexity and technological challenge of the new cyclotrons being built, and the improvements being made to existing cyclotrons, are far beyond what could have been conceived in early years. The progress of the last 25 years is due, in no small part, to the close associations developed and maintained through these conferences. This conference promises the same excitement as the previous ones. It is fitting that it is being held at Michigan State University, which over the years, has been a premier laboratory in the development of new ideas and the pursuit of technical and scientific excellence.