Henry Blosser

1928-2013

Prepared by Felix Marti (NSCL)
Presented by Michael Craddock (UBC & TRIUMF)
Henry Blosser

- Greatest cyclotron builder of the late 20th century
- the first to convert the basic tool of the pioneers into a precision instrument, turning an art into a science!

His cyclotrons provide an extraordinary catalogue of excellence and innovation:

- Analog I - reached $\beta(e^-) = 0.69$ in 1958!
- K50 - first precision cyclotron
- K500 - first operating superconducting cyclotron
- K1200 - most powerful heavy-ion cyclotron
- K500-K1200 - Coupled Cyclotron Project
- Harper K100 - first flying cyclotron for neutron therapy
- Varian/ACCEL/NSCL K250 - for proton therapy
- 8-T magnet test stand $\rightarrow$ Mevion (Monarch) S250 synchrocyclotrons

As a direct result of his work:

- MSU has become the leading university nuclear physics lab in the US
- MSU has produced an impressive stream of talented accelerator physicists
Young hiker
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Four-Sector Azimuthally Varying Field Cyclotron

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(Received July 14, 1958)

An electron model relativistic fixed-frequency cyclotron of the azimuthally varying field type has been constructed for the purpose of testing the orbit dynamics of such a device. An iterative technique used in designing an acceptable magnetic field shape is described in some detail. A brief description of the various components of the device is given as well as an account of the beam phenomena observed in the initial period of operation. Results strongly indicate the feasibility, from an orbit dynamics standpoint, of large proton machines of this type.

Henry's first cyclotron, this same year (1958) he moved from ORNL to MSU
Oct. 4, 1961

Dr. John A. Hannah, President
Michigan State University
East Lansing, Michigan

Dear Dr. Hannah:

I am pleased to inform you that the sum of $700,000 is hereby granted by the National Science Foundation to the Michigan State University of Agriculture and Applied Science for support of the "Construction of a 40-MeV cyclotron," under the direction of Henry G. Blosser, Department of Physics and Astronomy, for a period of approximately three years, effective October 1, 1961. Payments under this grant will be scheduled on a periodic basis upon notification to the Foundation by the grantee of the need for funds and the estimated timing of financial requirements.

Construction of the K50 approved in 1961
K50 model magnet measurement (early 1960s)
Checking alignment of the K50 Cyclotron
standing, left to right:
Mort Gordon, theoretical development
Henry Blosser, magnet and overall director
Bill Johnson, RF system
Martin Reiser, central region

K50 cyclotron
THE TEACHER

“...At one of our meetings in his house, we complained about how hard it was to tune the K50. There were no operators or instruction manuals at the time. He told us that the phenomena we were observing were not possible because they violated Liouville's theorem. In the discussion that followed it became clear to Henry that we knew absolutely nothing about beam dynamics. What resulted from this was a series of lectures which he gave to us weekly. They were excellent lectures, and I kept my notes for years. It is too bad Henry never became a teacher ...”

W. Benenson (MSU Faculty)
THE HANDS-ON PHYSICIST!

Henry often invited groups to his house in East Lansing, sometimes for lab business and sometimes for socializing. One evening in the 1970’s there was a party at his house, and the conversation got around to difficulties with getting the cyclotron running. This was the 50 MeV original room temperature machine. At that time, the faculty and staff researchers operated the cyclotron themselves to perform their experiments. Henry felt that the cyclotron settings needed to run it were reproducible, and those that needed to be tuned were few enough and within a range that was easy to tune to optimum. He stated that he, unassisted, could get a beam within half an hour of starting from “Off.” Everyone knew that the cyclotron was not running at that time. He suggested that he would do it then. A number of witnesses followed him to the lab to watch.

He turned on the control power for the machine and began clearing interlocks and presetting power supplies. Once the main magnet current was up he wanted to get the rf running, but in dismay he said that he had forgotten about the warm-up delay interlock for the rf system. After some minutes the delay time interlock cleared and he could proceed. In the end he succeeded in having proton beam current extracted from the cyclotron by half an hour from starting.

Reported by P. Miller (MSU Physicist)
Henry wasn’t infallible!

Reviewing the prospects for “Future Cyclotrons” at the 1972 Cyclotron Conference in Vancouver, Henry discussed superconductivity for magnets and rf cavities at some length, concluding:

The size of the new large synchrotrons has reached the proportions of a critical problem. The size of cyclotrons is however much less of a problem and the virtues of making cyclotrons smaller are at best mixed. On the positive side there would be savings in building and shielding costs, both tending to go as the square of the size. On the other hand, reducing the space available for the beam is a definite disadvantage—space charge effects are increased, extraction is more difficult, and the design of the central region (or the inflection mechanism) is more difficult. Use of superconducting and phase control. Superconductivity then seems unlikely to make a contribution to cyclotrons in the foreseeable future primarily because there is no overriding problem which would thereby be solved such as is the case for synchrotrons and linacs.

But he certainly redeemed himself later!
Beginnings of the superconducting cyclotron development at MSU

Historical Outline of
MSU Superconducting Cyclotron Program

1962-63  Computer study of coil design for superconducting cyclotron (and experiments on small coil) conclude that available conductor is not adequate.

June 1973  Chalk River visitors report on their studies and tell of low-cost, high-quality conductor.

Nov. 1973  Studies of 400 MeV superconducting magnet begin.

July 1974  Proposal to build prototype K400 superconducting cyclotron magnet submitted to NSF.

July 1975  Grant received from NSF for constructing prototype magnet.

May 1977  The prototype magnet operates at full field (K=500) and an amended proposal (Phase I) requesting funds to build a complete cyclotron is submitted to NSF. Beamlines and experimental areas for this "Phase I" program are to consist of rearranged equipment from the K50 cyclotron program.

Aug. 1977  Grant received for Phase I.
Checking the superconducting coil

He loved to operate the 40 ton crane
Inside the K500 cyclotron beam chamber adjusting the dees,
K500 is finished!  1981
Time to celebrate!!!
1981
Inside K1200
In deep thoughts...
Smashing cancer

Soon-to-be-completed medical cyclotron will take aim at tumors.

By CHARLES DOWNS

A

“...smackers are absolutely mind-boggling, Dr. Blumer. But what good are they...”

As director of MSU’s world-class National Superconducting Cyclotron Laboratory (NSCL), Henry Blumer has heard this question many times from reporters and other associates. It always used to be tough to answer.

He would talk about the many contributions that cyclotron research has made over the past 50 years to the basic understanding of atoms. And he would point out that such understanding has built-in, so much of today’s technology.

He would also say that he was sure that today’s cyclotron research would result in new technology in the future but that it was impossible to predict exactly what those advances would be.

He still talks about such things as the principal justifications for building and operating cyclotrons. Now, however, he has a clincher to satisfy the most practically-minded people—a superconducting medical cyclotron to help cancer patients now hitherto helped by drugs or conventional radiation.

This new machine, designed by Blumer and colleagues, has started from a theoretical concept to a specific design, to actual main components now being assembled at MSU.

If all continues to go well, the new cyclotron will be tested at NSCL this fall and then moved to Harper Hospital in Detroit.

Harper, which is funding the construction, will house it in a new wing being built specifically to accommodate in and outpatients.

By late May it is expected to be in use for the treatment of deep-seated tumors that cannot be effectively treated by other means.

What it does

Like X-ray machines and cobalt sources, a medical cyclotron generates a radioactive beam. However, instead of X-rays and gamma rays, the cyclotron generates a beam of neutrons.

Neutrons and protons set the major components of atomic nuclei. Neutrons, because they have no charge, cannot be directly accelerated by a cyclotron. Instead, deuterons—the nuclei of heavy hydrogens, each composed of one proton and one neutron—are accelerated and focused on a bremsstrahlung target.

(During the collisions, the deuterons are... (Continued on page 6))
SUCCESS!!!

Cancer-treatment cyclotron passes final test at MSU

The newly built and expanded cyclotron for cancer treatment has passed its final test at the National Superconducting Cyclotron Laboratory (NSCL) at MSU.

The "monstrous" 26-inch medical cyclotron used a tight beam of heavy hydrogen nuclei (deuterons) to produce an intense neutron beam, thus achieving the major design goal.

"This means we will be ready to deliver and install the cyclotron at Harper Hospital in Detroit in about two months," said its chief designer, Henry Henney. "We are currently reviewing the final report of the cyclotron's performance and are working to finalize the installation schedule." The cyclotron had been designed and built by the NSCL and will be installed in the Radiation Oncology Pavilion on the Harper Hospital Campus.

The cyclotron will be used to treat cancer patients suffering from advanced disease who are not candidates for conventional radiation therapy. The technique has been used successfully in Europe and has now been adapted for use in the United States.

"We are very excited about this new addition to our cancer treatment capabilities," said Dr. John Thompson, director of the Radiation Oncology Pavilion. "This new technology will allow us to treat patients with more precision and fewer side effects than ever before."

The NSCL is currently accepting applications for a clinical trial of the new cyclotron. Interested patients should contact the Radiation Oncology Pavilion at (313) 920-4444 for more information.

Photo by Bill Mitchell
In 1932 Ernest Lawrence and Stanley Livingston envisaged a device for basic research on the atomic nucleus; today modern versions of their device provide healing radiations at many medical centers.

Henry G. Blosser

Comparison of magnet weight vs bending power for the large cyclotron magnets of the world. I have drawn trend lines through points for room temperature and superconducting cyclotrons. For a given bending power, the trend lines differ by a factor of 17, illustrating the great impact of superconductivity in reducing the weight of cyclotrons. Figure 4.
COMMISSIONING OF THE ACCEL 250 MEV PROTON CYCLOTRON

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M. Schillo, T. Stephani, J.H. Timmer,
Accel Instruments GmbH, Bergisch Gladbach, Germany

C. Baumgarten, now at PSI, Villigen, Switzerland

the PSI machine is in routine operation. The design of the compact machine, proposed by Henry Blosser and his team [1] and further developed and manufactured by ACCEL, proved to be very successful in operation with

Proton therapy superconducting cyclotron proposed in 1993 but it did not get support from the funding agencies.
Revived when ACCEL became interested and eventually developed into the 250 MeV PSI COMET cyclotron (2007)
Working on the ACCEL- PSI medical cyclotron 2005
CONSTRUCTION OF 8 T MAGNET TEST STAND FOR CYCLOTRON STUDIES*

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Abstract—A superconducting magnet designed to study cyclotron central regions and ion sources is under construction. Two split coils are used to provide an approximately flat field in the range of 2-8 tesla. The coils are epoxy potted and banded by stainless steel wire, and the winding form is removed from the coil to reduce the shear stresses. The horizontal and vertical support links are attached to the median plane structure, and the pairs of the coils are weakly connected for independent excitations. The stresses in the coils and quench protection have been studied to ensure coil safety.

I. INTRODUCTION

Compact cyclotrons whose acceleration energy depend on magnetic rigidity (Br) become more economical at the high magnetic field since the overall mass decreases as the cube of radius. However, the first orbit of ion is so small that the central region is difficult to design, and the internal ion source may behave differently.

In achieving fields up to 8 tesla our main concern was the high internal stresses in the coil. The main two options studied were 'tightly banded coil', and 'free coil'[1,2]. With strong preloads on the winding and banding, the coil could

Fig. 1. Schematic view of a quarter of the magnet. The two section coil is shown with an 'X'; numbered elements are, 1) stainless steel banding, 2) 77K heat shield, 3) vertical support link, and 4) welded shell composed of three sections to maintain the cyclotron symmetry.
For a full obituary, see: *Henry Gabriel Blosser* by Sam Austin

*Physics Today, August 2013, p.57*

2007, 79th birthday