

c.2



Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

LAWRENCE
BERKELEY LABORATORY

FEB 9 1983

Accelerator & Fusion Research Division

LIBRARY AND
DOCUMENTS SECTION

Presented at the 7th Conference on the Application
of Accelerators in Research and Industry, Denton, TX,
November 8-10, 1982

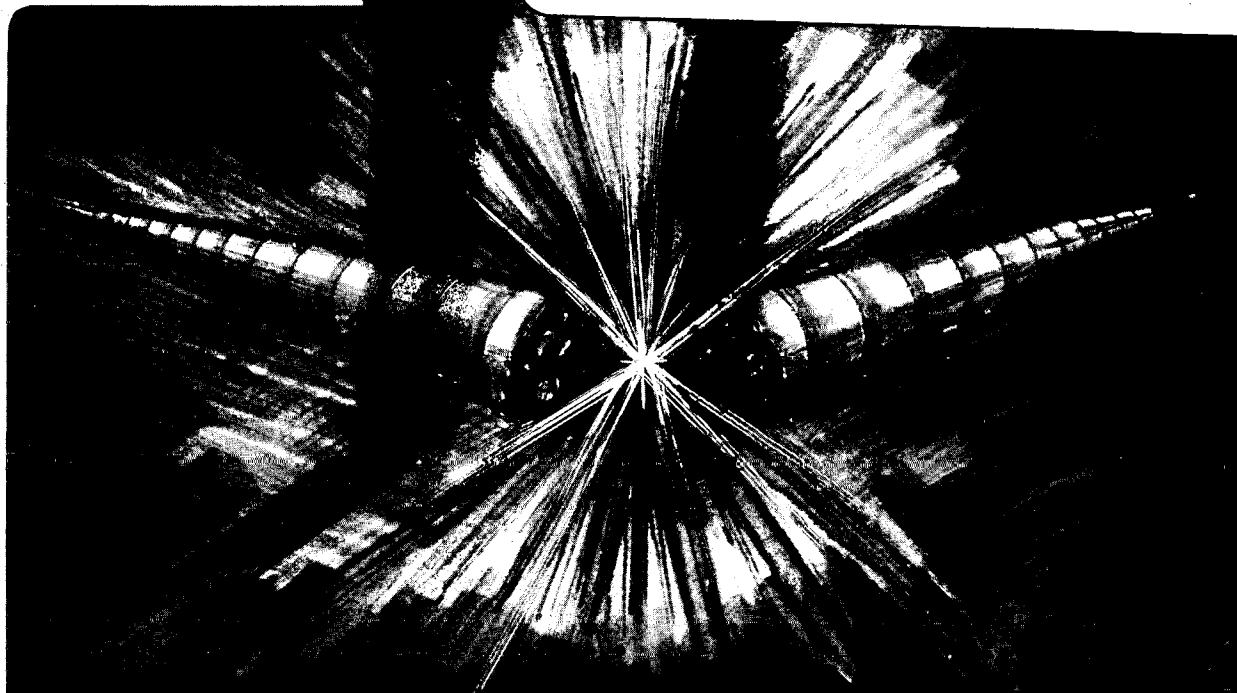
BETATRONS WITH KILOAMPERE BEAMS

Jack M. Peterson

November 1982

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 6782.*



LBL-15206
c.2

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

BETATRONS WITH KILOAMPERE BEAMS*

Jack M. Peterson

Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

November 1982

*This work was supported by the Defense Advance Research
Projects Agency under Contract No. N60921-81-LT-W0031 and
the U.S. Department of Energy under Contract No. DE-AC03-
76SF00098.

for the induction core as well as the image currents. Thus the system of image conductors replaces the normal betatron induction coil.

As a result of using the method of image compensation the vacuum aperture can be reduced considerably. For example, using only a modest factor of 4 as the reduction of the image force effects, we can reduce height of the vacuum chamber by a factor of 2. The smaller vacuum chamber produces a lower longitudinal impedance, and thus the longitudinal collective instability is also alleviated by the use of image compensation. This instability typically has a lower threshold than the transverse collective (resistive wall) instability (which favors a large vacuum chamber). In summary, the method of image compensation has provided a basis for designing a betatron system for accelerating a 10-kilo-ampere electron beam to several hundred MeV. In this arrangement all of the known instabilities can be controlled with a reasonable amount of energy spread.

The ion-electron type of collective instability can be avoided through good vacuum technique. This translates to a vacuum requirement of about 2×10^{-8} torr for an acceleration time of one millisecond.

IV. High-Current Betatron Model

A high-current betatron has been designed to test the concepts that we have developed for accelerating electron beams in the kilo-ampere range. It was designed to use the 10-kilo-ampere, 50-MeV Advanced Test Accelerator at the Lawrence Livermore National Laboratory as an injector.

The proposed machine is illustrated in Figure 3. It consists of a stack of three betatron rings with a common induction core. The three beams are accelerated simultaneously to 250 MeV and extracted in a controlled sequence during the magnetic flat-top.

The magnet is divided into three 120° sectors separated by three 1.8-meter straight sections, which provide field-free regions for the injection and extraction magnets. Each system has a vertically-deflecting iron-septum magnet plus a horizontally-deflecting full-aperture kicker magnet separated by 90 degrees in betatron phase. The orbit circumference is 18.0 meters, and the bending radius is 2.0 meters. The peak magnetic field at 250 MeV is 4.18 kilogauss. The stored energy in the magnetic field is 1.0 megajoule. The height of the magnet is 2.8 meters and its radial width is 1.3 meters. The magnet weight is 260 tons.

The ceramic vacuum chamber has a vertical aperture of ± 20 cm and a horizontal aperture of ± 25 cm. The injected beam has a vertical width of ± 4.4 cm, a horizontal width of ± 19 cm, and a momentum spread of $\pm 3.5\%$.

V. Betatron Study Group

The group that studied the use of betatrons for accelerating kiloampere beam included Robert Avery, William Barletta (LLNL), Andris Faltens, Donald Kerst (Univ. of Wisconsin), Robert Kuenning, L. Jackson Laslett, Edward Lee, Jack Peterson, Andrew Sessler, and Lloyd Smith.

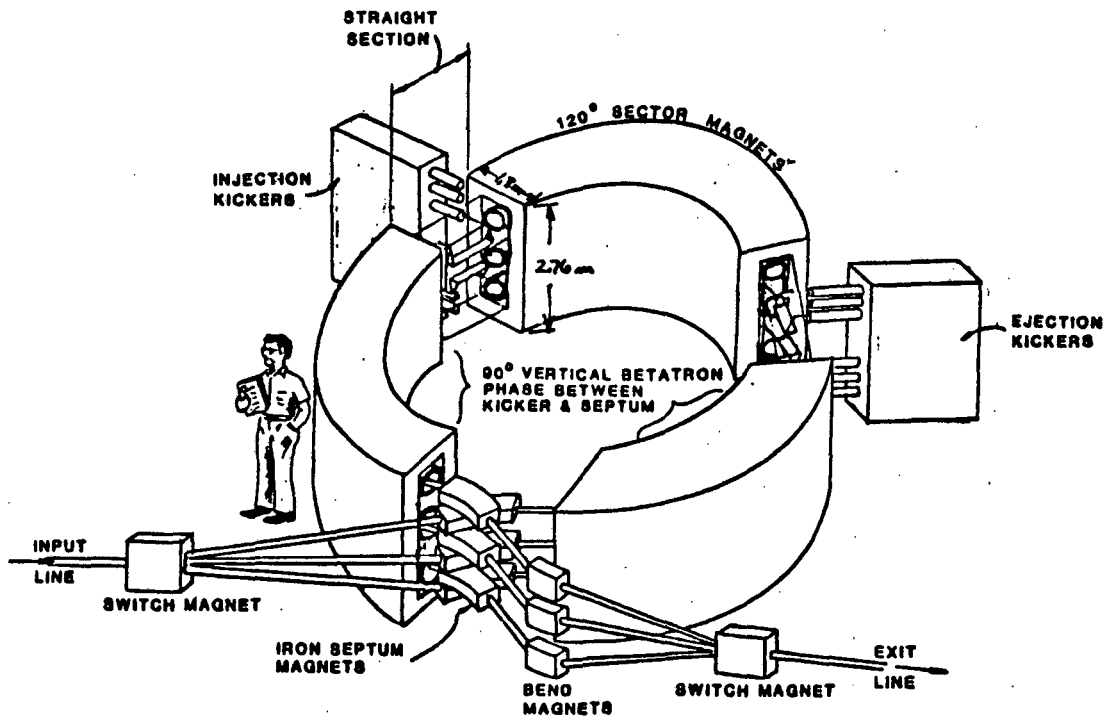


Fig. 3. INJECTION & EXTRACTION SYSTEM
for
3 RING ATA ADD-ON.

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720