

PREINJECTOR DOUBLET

J. Brodowski, J.

January 1986

Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No. DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use 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 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 its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Accelerator Division
Alternating Gradient Synchrotron Department
BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, New York 11973

Accelerator Division
Technical Note

No. 230

PREINJECTOR DOUBLET

J. Brodowski and J. Jackson

January 20, 1986

Introduction

In order to reduce preinjector down time, a conventional pulsed quadrupole doublet has been designed and constructed as a replacement for the septier quadrupoles used in both Linac preinjectors. These new quadrupoles have proven to be extremely reliable because of their simple mechanical construction and low operating power requirements. In addition, a much higher quality field has been obtained with the new quadrupoles.

Quadrupole Parameters

A comparison of operating parameters is as follows:

	<u>Septier Quads</u>	<u>New Quads</u>
Operating Current (Pulsed)	200 Amps	40 Amps
Resistance	0.155 Ohms	0.130 Ohms
Operating Voltage	40 V	60 V
Inductance	1.5 mh	2.5 mh
Power	6,200 W x D cycle	210 W x D cycle
Gradient at Operating Current	400 G/cm	400 G/cm

(duty cycle is equal for both quads)

Construction

Quadrupole coils were constructed of 0.100" diameter copper wire with 0.002" thick Kapton insulation. The total number of turns required for one quadrupole was 140 (35 turns per pole). In order to avoid building expensive coil winding fixtures, coils were wound as shown on Figure 4, in the upward direction only. Plastic inserts equal to the thickness of the coil wire were used to eliminate uneven coil sides introduced by wire cross-overs from top to bottom. One cross-over on each side of the coil was required. Each coil was epoxy impregnated and lashed with 1" wide glass cloth.

Figure 1 illustrates construction of the quadrupole iron. The magnet yoke and pole tips were machined from epoxy painted 0.031" thick, 7" square laminations backed by two 0.100" thick low carbon steel plates and held together with 3/16 diameter x 2-3/4 long stainless steel rods and #6-32 ft. hd. screws. In all, 83 laminations were used with nominal 0.002" thick epoxy layer between them. Pole tips were machined from the plug cut out from stacked laminations as shown on Figure 1. Pole tip dimensions and their shape are shown on Figure 2. Assembly of back iron and pole tips is illustrated on Figure 3.

Magnet Design and Measurements

The pole profile for these magnets has been adapted from the LESB II 12Q12 quadrupoles and from Brookhaven "narrow quadrupole" studies.¹ The coil slot dimension has been chosen such that the integral effect of the first harmonic of the quadrupole ($6\theta/2\theta$) is essentially zero. Field harmonics have been measured at 75% of the pole tip radius and are < 0.1% except for the $10\theta/2\theta$ term which is 0.6% and agrees with the scaling prediction.

Conclusion

Initial tests indicate some increased Linac performance. A program of emittance measurements is being initiated in order to quantify this effect.

Acknowledgments

We wish to thank G. Danby, E. Jablonski, A. McNerney, and R. Horton for advice and support. Special thanks go to W. Shaffer of the Linac Group for valuable ideas and skilled efforts in the construction of the prototype quadrupole. We also wish to thank B. Briscoe and J. Weisenbloom for testing the quadrupoles.

Reference

1. G.T. Danby and J.W. Jackson. Theory, design and measurement of the Brookhaven narrow quadrupoles. Proc. 1967 National Particle Accelerator Conf., March, 1967.

.100 THK.
BACKING
PLATES

MAGNET YOKE

PLUG TO BE CUT OUT
& USED FOR MANUFACTURING OF
POLE TIPS. (SEE FIG. 2)

7" SQ.

83 LAMINATIONS

$2\frac{15}{16}$

MAT'L

- 1) BACKING PLATES -
1006/1010 LOW CARBON ST.
- 2) ELECTRICAL GRADE STEEL (M-36)
.031" THK. (AGS SPEC #2)

$\frac{3}{16}$ DIA. ST. STEEL RODS

FIG. 1

LAMINATIONS STACKED WITH EPOXY

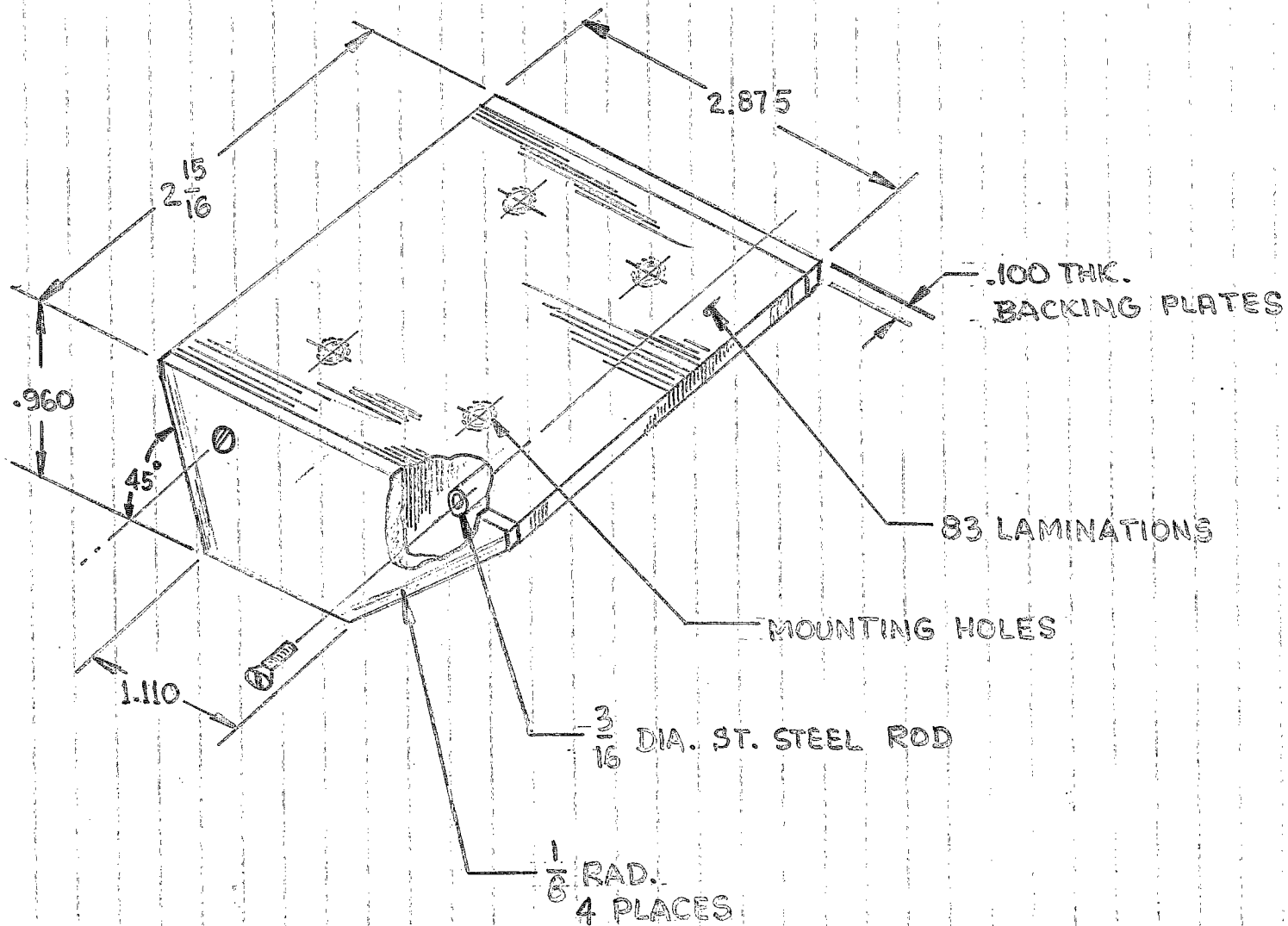


FIG. 2
 POLE TIP

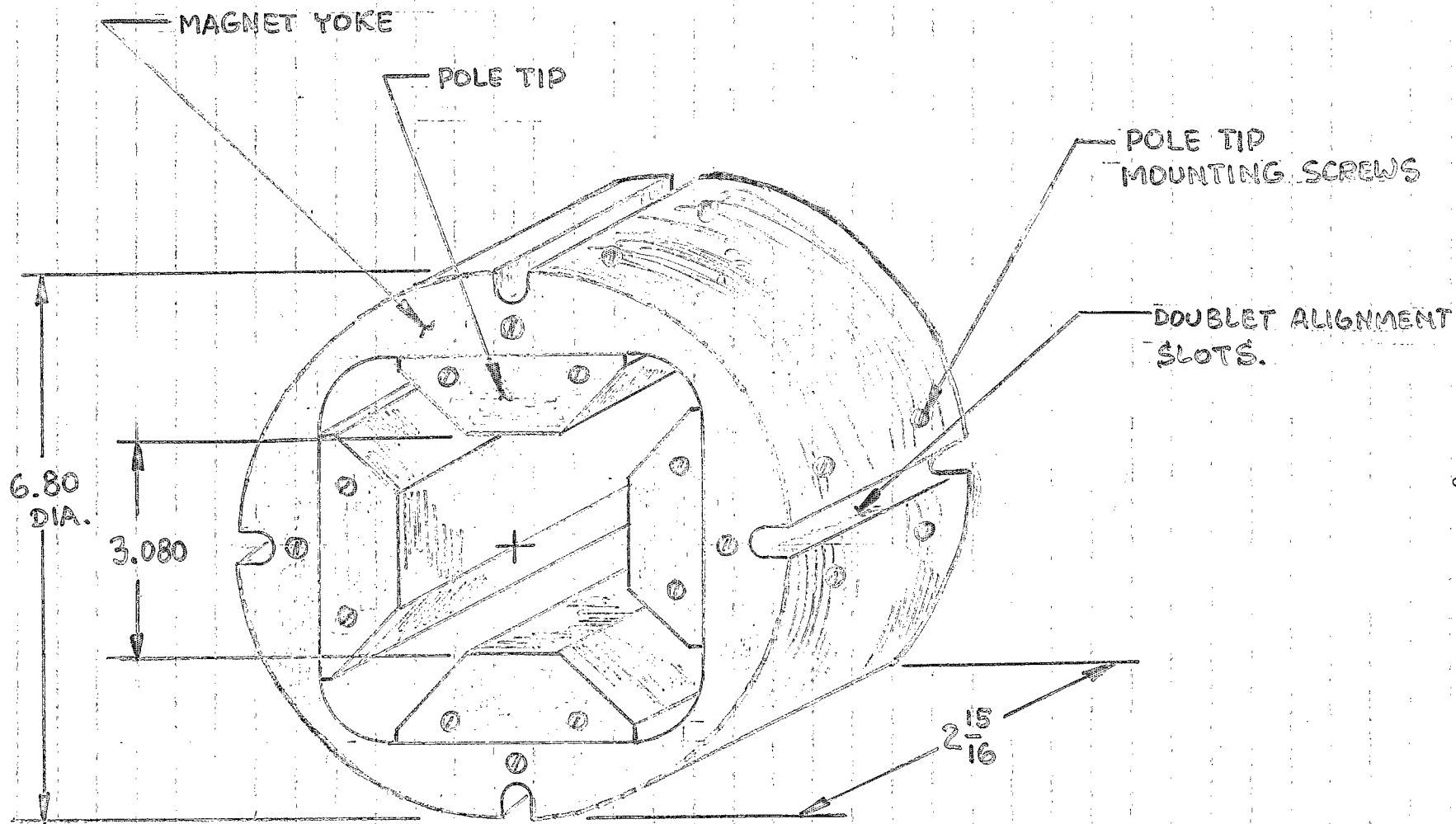
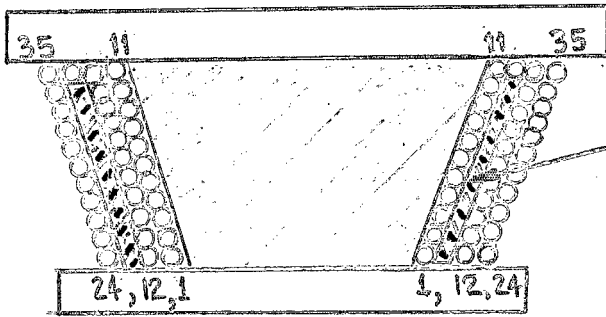


FIG. 3
MAGNET IRON ASS'Y

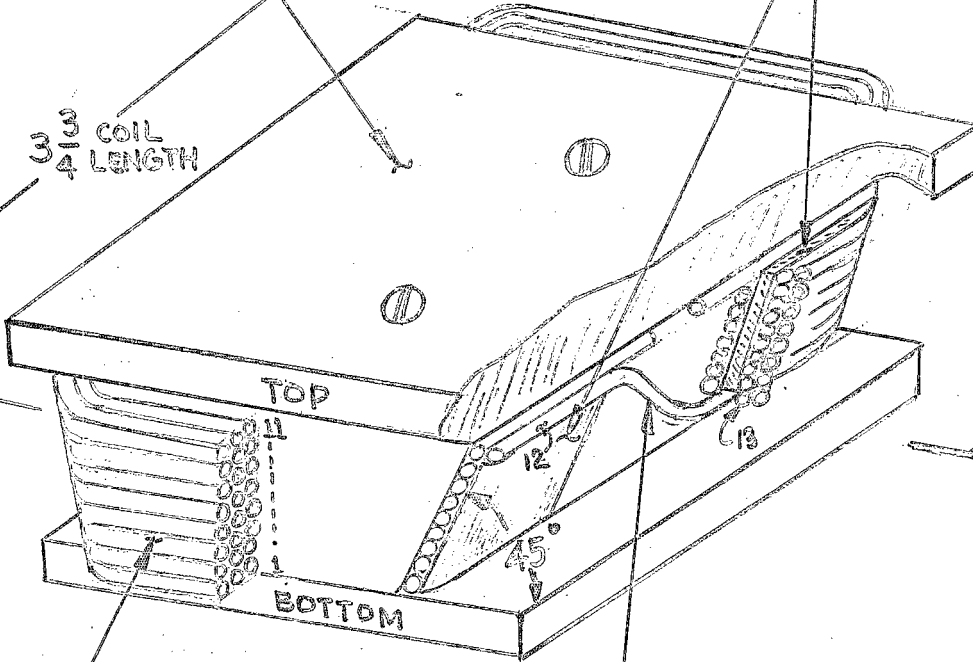


SECTION "X-X"

COIL WINDING
FIXTURE

G-10 SPACES
ONE SET ON BOTH
SIDES OF COIL.

"X"
3 3/4 COIL
LENGTH



"X"

COIL WIRE
(.100 O.D. COPPER)
WITH 2 MILS THK.
KAPTON INSULATION.

EACH CONSECUTIVE
LAYER OF COIL
STARTS AT THE BOTTOM
OF WINDING FIXTURE.
(SEE SECTION "X-X")

FIG. 4

COIL & COIL WINDING
FIXTURE

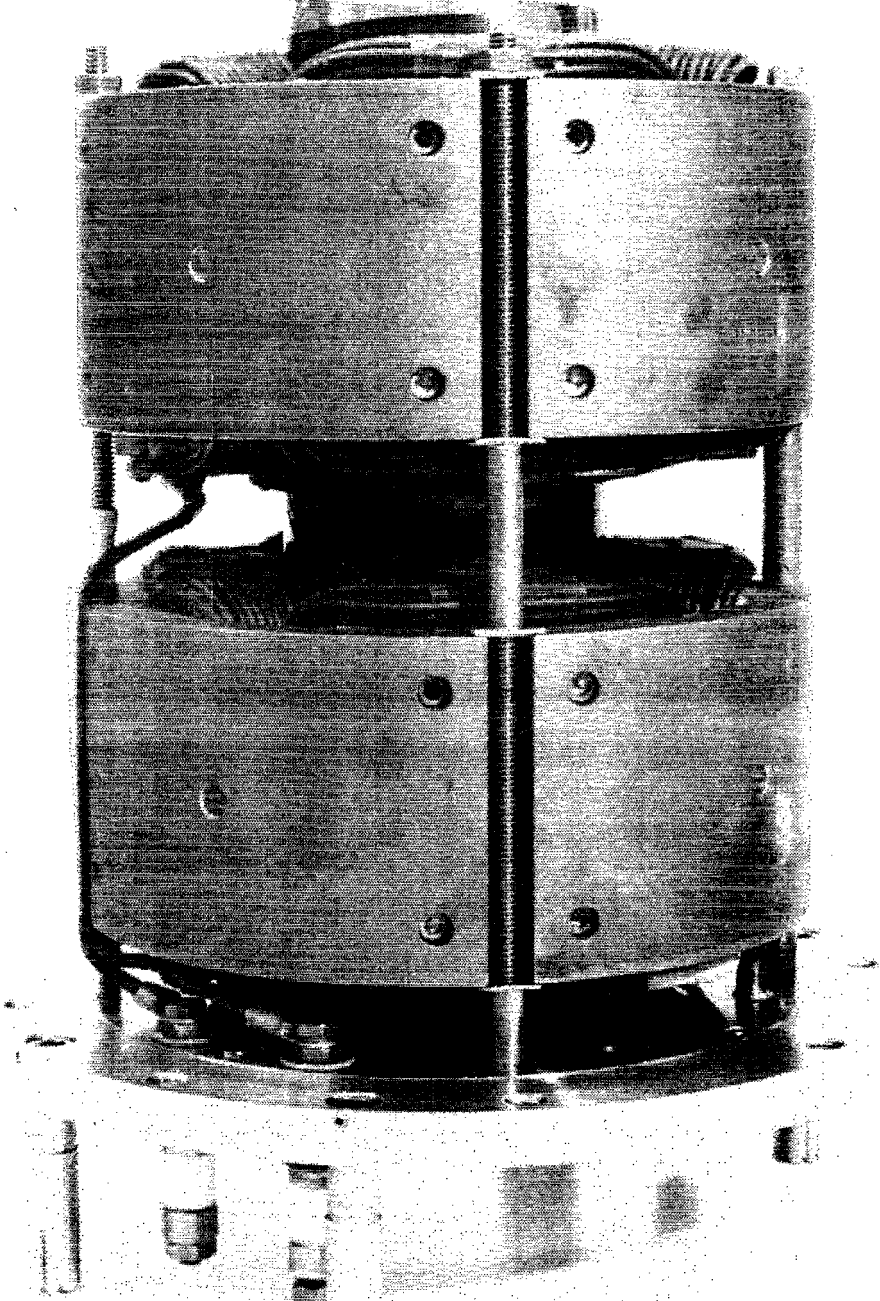


FIG. 5

MAIN ASSEMBLY