

# Magnetic Field Calculations for Recycler Magnets

Bruce C. Brown and James Volk

*Fermi National Accelerator Laboratory\**

*P.O. Box 500*

*Batavia, Illinois 60510*

8 July 2015

\*Operated by the Fermi Research Alliance under contract with the U.S. Department of Energy

## Abstract

The Recycler permanent magnet designs were carefully documented by Bill Foster. In response to the need for 2-D field maps, we have used the original input files, updated for the current POISSON version, to create field maps for use in MARS energy deposit simulations. Along with brief comments are all input files and output files for gradient magnets and quadrupole designs.

The Fermilab Recycler was built with hybrid permanent magnets with the field strength and shape determined using the POISSON magnetic field design code. Bill Foster (G. William Foster or George W. Foster in the Beams Document Author list) carried out the design and documented his efforts in MI-Notes which have now been transferred to the Beams Document Database (<http://beamdocs.fnal.gov/AD-public/DocDB/DocumentDatabase>). In preparation for designing a collimation system to localize beam loss when using the Recycler as a proton stacking ring, we sought magnetic field calculations as input for the MARS energy deposition software. For this application, 2-dimensional fields employed with a hard edge end description are desired. The documents which described the field calculations included a text file of the inputs for POISSON (PANDIRA) but we have only a .pdf version of the documents. In seeking suitable magnetic field descriptions, we found that only Jim Volk had the files we needed, updated to POISSON Version 7. He provided the input files and calculations with a 0.1 inch grid as suggested for the MARS calculations. We will preserve these files in this Beams Document along with some descriptive materials. Let us list the magnets, MI-Notes and Beams Document numbers and POISSON input and output files included here.

MI-0227

Beams-doc-318-v2

Magnetic Design of Recycler Ring v.18 Gradient Dipoles

Input Files: RGF.am RGD.am SGF.am SGD.am

Output Excel: RGF table.xlsx RGD table.xlsx SGF Table.xlsx SGD table.xlsx

Description: Field Tables RGF and RGD Recycler magnets.docx

These field calculations should provide both field strength and field harmonics for the design properties of these Recycler magnets.

MI-0249

Beams-doc-338-v1

Recycler Quadrupole Magnetic Designs

Input Files: quad-20 inch.am quad-40 inch.am

Output Excel: RQxx 20 inch table.xlsx RQEx 40 inch table.xlsx

The calculations are done for only one field strength. The field integral is specified in separately for each of the 12 RQxx design and each of the 3 RQEx designs. The POISSON calculations were to determine the field shape (harmonics).

MI-0212

Beams-doc-296-v1

Mirror Magnet Designs for the Recycler Ring

Input Files: MDA.am MGD.am MGS.am

MI-0256

Beams-doc-345-v1

Recycler Lambertson Magnetic Design

Input Files: Lambertson.am

For those seeking information on Recycler Lambertson magnets, see also

Beams-doc-322-v1 Recycler Lambertson Magnet Configurations Main Injector -- Recycler Transfer Lines

Additional information included in this document is the `ReadMePoissonSuperfish.txt` file which came with POISSON Version 7 when Jim downloaded it on July 9, 2013.