



BNL-209039-2018-TECH

CBETA/024

## Data directory for Halbach magnets

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March 2018

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**U.S. Department of Energy**  
USDOE Office of Science (SC), Nuclear Physics (NP) (SC-26)

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# Data Directory for Halbach Magnets

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2018-Mar-02

CBETA machine note #024

## 1. Introduction

The data for measurement and survey of the CBETA Halbach magnets is stored on the “DISCOVERY” network computer at BNL Superconducting Magnet Division (SMD), on the network share called “C\_Beta”. This serves as storage for the measurements, under systematic filenames, as well as generated reports and other relevant per-magnet documentation such as travellers.

The network folder is backed up regularly at SMD, as well as copied nightly to the CLASSE server at Cornell (server Inx201.classe.cornell.edu folder /nfs/erl/online/BNL, via SFTP). Stephen Brooks’s workstation also has a daily backup of it.

## 2. Root Directory at \\DISCOVERY\C\_Beta

The topmost directory contains files deposited there by John Cintorino or SMD magnet technicians.

Files with names of the form ERHIC-PMQ\_mmmm\_rrrr\_001.dat are rotating coil output files, with mmmm being the 4-digit magnet identifier (see note CBETA019 section 7) and rrrr being the rotating coil run number, which starts at 0001 for the first measurements and increments from there, including all measurements regardless if they are used for final processing.

Other files deposited here may include photos or other notes (e.g. text files).

## 3. Main Data Directory at \\DISCOVERY\C\_Beta\NOTES

This contains the bulk of the data, processed or unprocessed, with files that are the inputs and outputs of software having systematic filenames. Most of the software packages are described in note CBETA019 section 6.

### 3.1.Subdirectory “CoilFiles”

This contains a backup copy of all rotating coil input files that have been processed via PM\_Correct. This is only needed because sometimes the coil input files come from \\DISCOVERY\C\_Beta and sometimes from \\DISCOVERY\NewData. Thus, this folder provides all the files in one place. The filename format is ERHIC-PMQ\_mmmm\_rrrr\_001.dat again.

### 3.2.Subdirectory “Harmonics”

This contains multipole harmonics tables generated by PM\_Correct. These have been derived from the rotating coil .dat files and the origin and rotation of the multipoles have been adjusted to make the integrated dipole vector correct at (0,0) and also for the integrated quadrupole to be upright. The filename format is Harmonics\_mmmm\_rrrr.csv. For the CBETA QF, BD and QD magnets, all harmonics are stated at R=25mm. Convention has not yet been set for the BDT1 and BDT2 magnets that have larger beam apertures.

The first row of the CSV file is the integrated strength of the quadrupole component of the magnet in Tesla (and a zero). The following rows are the integrated dipole, quadrupole, sextupole etc. with the first cell being normal and the second being skew. All values are normalised to the main quadrupole being 10000 units. With the re-centering and rotation, this means the skew dipole and skew quadrupole entries are always zero up to rounding errors. The normal dipole should be zero for pure quadrupoles and equivalent to exactly the desired field for combined-function magnets. At the end of the harmonic components, there is a blank line, followed by the offsets and rotations that were applied to the magnet to get from the original rotating coil measurement to these re-centered harmonics.

There may also be files called `Harmonics_mmmm_rrrr_tuned_predicted.csv`, which are output from the magnet tuning simulation. These should usually show nearly zero harmonic errors.

### 3.3.Subdirectory “LatticeIndex”

This contains files required to generate the full loop survey from the individual surveys and magnet measurements, which is done by software `PM_Survey`. The file “`Halbach_geometry_170901a-02.csv`” (generated by Scott Berg) contains the desired magnetic axes of the magnets in the BMAD frame and with the BMAD magnet names. The files “`LocationIndex_xxxx.csv`” contain the mapping of which real magnet identifiers go in which BMAD location, for various machine configurations.

### 3.4.Subdirectory “Reports”

This contains human-readable output tables generated from the magnet data. It may be extended to have other sorts of report in the future but below are the current types.

`MagnetHistory_mmmm.csv` shows various field quality metrics across all runs of a particular magnet.

`FieldError_mmmm.csv` contains field error vector values across the mid-plane calculated from the harmonics of a particular magnet, for every run of that magnet.

`allmagnets.csv` contains field quality and some debugging information (such as coil rotation and displacement used), for all magnets. `finalmagnets.csv` is similar but only for the final run of each magnet.

### 3.5.Subdirectory “Software”

This contains the software packages described in note CBETA019 section 6, together with “`MagnetHistory`”, which generates the tables in the Reports subdirectory.

### 3.6.Subdirectory “SurveyFiles”

This contains the survey files taken at the rotating coil for each magnet. These are identified by both the magnet number and the run number of the coil that was done with the survey (the coil and survey data form a pair that can determine the magnetic centre). Survey filenames are of the form `CBETA SURVEY_mmmm_rrrr.txt`.

Files called “`CBETA SURVEY_mmmm_rrrr ACCURACY.txt`” contain the 1 sigma uncertainties of the survey points.

The subdirectory “`older_surveys`” contains surveys that are not used to determine the final magnet position. In the main “`SurveyFiles`” directory, only one or two survey files are allowed for each

magnet, with two being in the case of an end-for-end coil roll calibration where the second survey is of a magnet placed backwards. Thus, if repeat surveys are done, the older ones are moved to the “older\_surveys” folder.

The subdirectory “First Girder” contains full surveys of the whole first girder. Another directory for further girder surveys may be added as available.

The file \_ball\_sizes.txt explains the survey ball sizes used on the first girder. The file \_orientation\_notes.txt explains the frame used at the rotating coil bench.

### **3.7.Subdirectory “Travellers”**

This contains further subdirectories “BNL” and “KYMA” to contain the per-magnet traveller documents generated by each organisation. The KYMA travellers are received from Jure Pockar and the BNL ones are from Rob Michnoff.

### **3.8.Subdirectory “TunedMagnets”**

This contains the tuning wire configurations generated by PM\_Correct, in the form of CSV files that save the entire 2D magnet model, including permanent magnet polygons as well as the wires. The filename magnet\_mmmm\_rrrr\_tuned.csv refers to tuning that is *based on* run rrrr of magnet mmmm. This means the rotating coil measurement of this wire configuration will have a higher run number than rrrr.

The Excel files are currently used to generate more easily-readable tables of wire lengths to use during construction of the tuning wire holders.

### **3.9.File “coilroll.csv”**

This is a really important file that contains the coil roll calibration measured at various dates. This can sometimes change suddenly, so the history is important. The program PM\_Survey uses this data in generating the full machine survey, while the roll values themselves are generated by PM\_CoilRoll but manually added to this history file as necessary.