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Summary of US-LHC Magnet Database Workshop

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Summary of US-LHC Magnet Database Workshop

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The "Workshop on US-LHC Magnet Database" was held at Brookhaven National Laboratory on June 2 - 3 and June 8 - 9, 1998. Total 24 participants from 4 institutions (5 from CERN, 4 from FNAL, 3 from University of Maryland, and 12 from BNL) covered areas of magnet design, measurement, accelerator physics, database management, and cable tests.

The goals of the workshop were to establish a US-LHC database structure commonly accepted by CERN and US collaborating laboratories, to establish format and procedure of data transfer, and to unify the measurement and application conventions among BNL, CERN, and FNAL. The workshop successfully fulfilled these goals.

The US-LHC Magnet Database is designed for production-magnet quality assurance, field and alignment error impact analysis, cryostat assembly assistance, and ring installation assistance. The database consists of 17 tables designed to store magnet field and alignment measurement data and quench data. The database will contain not only data of BNL and FNAL-built magnets, but also data of other relevant coldmass elements including KEK-built quadrupoles and IR correctors. Efforts will be made to ensure compatibility between US-LHC database and the main CERN magnet database currently under development.

The rest of this document contains:

- Workshop agenda
- List of participants
- Working session summary
- Measurement conventions for magnet coldmass and assembly
- Rules for multipole transformation under magnet orientation change
- Proposed diagram of database application
- US-LHC Magnet Database Structure

Workshop on US-LHC Magnet Database

Agenda

(Building 1005 S, 3rd Fl., BNL, June 2 – 3, 1998)

Tuesday, June 2, 1998
Opening Session

9:00	M. Harrison	Welcome address
9:05	J. Strait	US-LHC Project goals
9:10	J. Wei	Workshop goals and organization
9:15	D. McChesney	US-LHC magnet database plan

Session 1: Status, Magnet Performance & Data Collection
Chairman/Discussion Leader: G. Sabbi

9:25	L. Bottura	Overview of field quality issues in LHC main bending dipoles
9:50	G. Sabbi	IR Quadrupole status and performance
10:15	*Coffee Break*	
10:30	A. Jain	RF section magnet status and database issues
10:55	T. Verbeeck	ORACLE database structure for LHC main magnet prototypes
11:20	Discussion/Workshop Planning	
11:45	*Lunch*	
12:45	Tour of BNL Magnet Production and Test Facility (P. Wanderer)	

Session 2: Measurement Techniques and Conventions
Chairman/Discussion Leader: L. Bottura

13:30	A. Jain	Field & alignment measurement techniques & conventions
13:55	P. Schlabach	IR Quadrupole measurements: status and plans
14:20	L. Bottura	Analysis & storage of field quality measurement results at CERN
14:45	*Coffee Break*	
15:00	Discussion	
16:30	Adjourn	
19:00	*Workshop Dinner at Port Jefferson*	

Wednesday, June 3, 1998

Session 3: Database Applications & Requirements
Chairman/Discussion Leader: D. McChesney/F. Pilat

9:00	J. Miles	Field quality & alignment issues from an AP perspective
9:25	P. Schlabach	Measurement database for the Main Injector project
9:50	J. Wei	RHIC experience with magnet field and alignment database
10:00	F. Pilat	uslhcMag database and its applications
10:20	*Coffee Break*	
10:35	Discussion	
11:45	*Lunch*	
12:45	Tour of RHIC Tunnel (S. Peggs)	

Final Session

13:30	Preparation for Workshop Summary	
15:00	*Coffee Break*	
15:15	Workshop Summary	Status, Magnet Performance & Data Collection Measurement Techniques and Conventions Database Applications & Requirements
16:15	J. Wei/D. McChesney	Agreements on US-LHC database structure
16:30	Adjourn	

Monday, June 8, 1998

Session 4: Cable Database
Chairman/Discussion Leader: D. McChesney/A. Ghosh

9:00	J. Wei	Introduction
9:05	A. Verweij	Cable test facility at CERN & Cable measurement scheme
10:00	A. Verweij/L. Oberli	Database at CERN & data requirements from BNL
12:00	*Lunch*	
13:30	A. Ghosh	Cable test facility at BNL – Update
14:30	D. McChesney	Database structure at BNL
15:30	R. Thomas	Data acquisition & database integration
16:30	Adjourn	

Tuesday, June 9, 1998

Cable Database Discussions: Data transfer format; Data consistency; Web access.

List of participants:

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1 Session 1: Status, Magnet Performance and Data Collection

Chairman: G. Sabbi

The session consisted of four presentations:

1. L. Bottura: Overview of field quality issues in LHC main bending dipoles
2. G. Sabbi: IR Quadrupole status and performance
3. A. Jain: RF section magnet status and database issues
4. T. Verbeeck: ORACLE database structure for LHC main magnet prototypes

The following are brief summaries of the presentations:

- Field quality issues for LHC main bending dipoles (L. Bottura).

  The design of the main dipoles has reached an advanced stage; some final optimization options are being considered, then the project will move towards the start of the production phase. Field quality issues, including geometric and saturation effects, persistent currents, effect of training and thermal cycles, etc, have been extensively studied on several prototypes. Tables of field quality errors have been compiled: they include a mean systematic value, an uncertainty on the systematic, and a random component. Beam tracking studies have been performed and a set of specifications have been established.

- IR quadrupole status and issues (G. Sabbi).

  Magnetic measurements of the first two HGQ models confirm the design calculations for geometric harmonics, magnetization and Lorentz force effects, harmonic correction with geometric/magnetic shims, and the end field. The experimental results show that the goal of zero systematic value for all straight section harmonics can be met within the uncertainty range specified in the HGQ field quality table. For the end regions, the systematic harmonics which are present in the current design are expected to be substantially reduced after final end optimization. With regard to random errors, longitudinal scans carried out with a short probe show that RMS variations in the range listed in the HGQ field quality table are present. Since these variations are partly averaged along the magnet length, a smaller spread is expected for the total integrated harmonics.

- RF section dipole status and database issues (A. Jain).

  In the RF section, the nominal 194 mm separation of the beams is increased to 420 mm in order to provide sufficient space for independent RF cavities for the 2 beams. All dipoles will use the same coil design as the 80 mm aperture RHIC dipoles, but for each set of beam separation, an optimized yoke design has been developed. With regard to magnet database issues, an overview of a preliminary database structure for US LHC magnets was presented. It is based on the structure presently in use at RHIC.

- ORACLE database structure for LHC main magnet prototypes (T. Verbeeck).

  A database structure based on ORACLE has been developed for the LHC dipole prototypes. It will be used as basis for the LHC production magnet database. Applications have been developed for superconducting cable data, magnet components and assembly, field quality, spool correctors. Several access possibilities are provided: in particular, a web interface is provided with full functionality (dynamic access, insert/update, integrity check, help files). It does not require ORACLE to be installed on the client machine. A demonstration of the functionality of this interface was given.

The discussions during and after each talk were focused on the following topics:

- Error Tables: flexibility is needed in order to deal with specific issues for different types of magnets. For example, dynamic effects at injection for the main dipoles vs local end field for IR quadrupoles. Some subtleties in the definition of the quantities still need to be addressed: criterion for separating the magnet body from the end regions; the precise meaning of the uncertainty term; how to characterize the variation of the harmonics along the length of the magnet.

- Magnet database: in order for the database to efficiently describe effects which may depend on several variables, appropriate parameterizations need to be defined. Examples are field error decay and snap-back, dependence of the harmonics on training and thermal cycle, longitudinal dependence of the body harmonics, current dependent effects (saturation, conductor displacement under Lorentz forces), local end field. In dealing with issues which are specific to a particular type of magnet, different approaches may be taken, i.e. defining an all-inclusive structure which can describe every type of magnet vs. defining magnet-specific tables. The present orientation is that the first approach should be followed. The proposal to establish a US LHC magnet database independent from the CERN database poses issues of integration, alignment and data flow between the two structures. Inserting/updating procedures need to be established. The present plan at CERN is that each contractor will be responsible for inserting the necessary data in the CERN database via the web interface, according to procedures specified in the production traveler. The same approach could be followed for the magnets which will be fabricated in the U.S. laboratories. A second possibility would be for the US laboratories to insert data in the US LHC magnet database, and to create automatic procedures to align the CERN database to the US LHC database.

2 Session 2: Measurement Techniques and Conventions

Chairman: L. Bottura

The session consisted of three presentations:

1. A. Jain: Field & alignment measurement techniques & conventions
2. P. Schlabach: IR Quadrupole measurements: status and plans
3. L. Bottura: Analysis & storage of field quality measurement results at CERN

The following are the main issues identified in the presentations and the subsequent discussions.

- Reference frames and conventions for reporting data.

  A. Jain presented the conventions used at BNL. They appear to be consistent with the measurement reference frames used at CERN for twin aperture magnets. P. Schlabach believes that this is the case for the measurement system at FNAL as well. This is the first step established to avoid misunderstanding in data transmission. Further checking of the details (magnet polarities, treatment of skew magnets) may come next, based on the initial broad agreement found, to insure full consistency.

- Data exchange and definition of a minimum necessary set of data to be provided.

  We reached consensus on the fact that data that will be generated at FNAL and BNL will eventually be transferred to CERN into the CERN database. There will be an intermediate data storage containing more detailed construction, measurement and survey results. This database will be used to collect information between FNAL, BNL and, possibly, KEK magnets. CERN should have then a single site to query (if needed). Measurement raw data are in principle not necessary, but a model for the access to raw data may be useful (if needed in the future for detailed analysis and verifications).

  In any case the data responsible(s) should take care that the proper data is sent to the central site. Some questions are still open on the amount and type of measurements necessary, and on the content of the minimum set of data to be transferred to CERN. In principle this data should represent the minimum necessary for magnet characterization (harmonics), magnet installation (survey), and machine operation.

  The BNL proposed structure will be used as a working basis for the central site collecting data on US (and possibly Japan) contributed magnets. The data should eventually be transferred to CERN. For this last database, the format presented for main dipoles and quadrupoles measurement storage at CERN could be the working basis to start activities.

So far, it is not clear whether ramp-rate dependent harmonics, field decay and snap-back are important for interaction regions quadrupole and RF dipoles. These measurements may not be needed on all magnets, or not needed at all. It is however clear that the components decomposition as adopted at CERN will ease communication with beam dynamics (this is an established practice at CERN). The components table for the expected and measured field quality, not available in the present proposal of BNL, should be added as discussed at the workshop.

Some issues need evaluation and possibly table upgrades to have better uniformity in the coming months:

- the CERN tables should be revised based on the RHIC proposal and experience. In particular the split of tables depending on use and content (survey data, field components) and the creation of an index table for the magnets. New tables containing integral transfer function, body and end harmonics could be added to the CERN structure (to be defined at CERN);
- field components tables should be added to the RHIC tables;
- local measurements may be necessary, at least on a limited number of magnets to provide a model for tracking;
- a data update policy should be established. In general the data in the database should be the best possible snap-shot of the components at the time, older records may not be necessary in the database;
- addition of a qualification field for the measurement may be a quick reference to identify problem data;
- measurement accuracy table(s) could be added to give an estimate of the confidence level of the data in the database;
- quench tables need to be added to the present proposal.

• Acceptance and characterization procedures

It is not clear how to proceed on this matter. In particular the hot topics are:

- the definition of an acceptance procedure (including responsible's for the decision-taking process);
- the information needed to accept a magnet.

Clearly these topics go beyond the agreement on a database structure, requiring a wider discussion and involving all laboratories concerned. In fact a workshop on database is not the appropriate place to settle them. Nevertheless, a working example based on the procedure for RHIC magnet acceptance is circulated and discussed (see attachment).

3 Session 3: Database Applications

Chairmen: D. McChesney and F. Pilat

The goal of this session was to report on present activities at the US Laboratories and CERN in the domain of database applications and to discuss how to develop applications for the US LHC database. The session consisted of four presentations:

1. J. Miles: Field quality & alignment issues from an AP perspective
2. P. Schlabach: Measurement database for the Main Injector project
3. J. Wei: RHIC experience with magnet field and alignment database
4. F. Pilat: uslhcMag database and its applications

The following are brief summaries of the presentations:

- Field quality and alignment issues from an AP perspective (J. Miles).

  J. Miles summarized the present use of field and alignment information for LHC accelerator physics analysis at CERN and discussed the possible role of the database as the project evolves. Specifically, he identifies the design phase, where we are right now, the production phase and finally the commissioning/operation phase. The model for the analysis of field harmonics at CERN is a well defined one in which expected harmonics from the magnets group gets analysed by the AP Group. The latter feeds back target harmonics, which optimize dynamic aperture, and become the specifications for the magnet builders. The data exchange and inclusion in the MAD model is by now largely "manual" and will need to be automated when large amounts of measured data are exchanged and processed. A similar analysis has begun for the alignment data but improvements are needed in the process of data gathering and analysis. For the installation phase, Statistical Process Control (SPC) is proposed as a tool for Quality Assurance in magnet production. SPC is well established process largely used in industry for production tracking and charting. The database should provide a structure to implement SPC.

- Fermilab Main Injector magnet measurement database (P. Schlabach).

  P. Schlabach described the database developed for the Main Injector Project. The database, designed to store both measurement data as well as magnet measurement support data have proved itself adequate in basically all areas except data access. The lack of an easy-to-use interface to the database has greatly reduced its overall usefulness. The message is that planning user interface and integrating it in the database design is an absolute must. Tools exist on the market and their adoption should be a priority for the development of the US LHC database.

- RHIC experience with magnet database (J. Wei).

  J. Wei discussed the RHIC magnet database which has been used for cold mass and assembly acceptance, impact analysis and tracking, cryostat assembly assistance as well as installation assistance. The database was developed and integrated early in the life of the project and has been very useful and relatively stable over the years. Relevant data from the FoxPro database in Magnet division are loaded into the Accelerator Physics SYBASE server on a weekly basis. The server also hosts the survey database. Applications have been developed that generate automatic reports which in turn are integral part of the magnet and assembly acceptance process.

- The uslhcMag database and its applications (F. Pilat)

  F. Pilat described further applications for RHIC magnet and survey data analysis that can be ported to the LHC project and the use of these data for modeling. The RHIC model has been discussed as an example of fully automated derivation of the simulation model from the database. When new magnet, survey, and installation data come in, or the lattice is modified, a collection of programs and scripts generate an accelerator object model where each magnet is associated with its own individual measurements, and the resulting model is analyzed by a modular physics software package (UAL). Significant progress towards the goal of a fully automated model of LHC has been already achieved. The CERN optics database, which in the future will load data automatically from the CERN ORACLE magnet measurement database, generates the LHC MAD model. From MAD (via DOOM) it is possible to generate an LHC SXF. (SXF is a standard machine format that was agreed upon to exchange lattice and error information). Parsers to and from SXF exist for all major codes used for simulation in the US-LHC collaboration. Filling magnet data into SXF from the uslhcMag database, or later, by loading data directly into the CERN Oracle database from uslhcMag, would effectively result in an automated model of LHC.

A discussion ensued about the best way to handle data flow within the US-LHC laboratories as well as interfacing with CERN. The creation of a public US-LHC database (uslhcMag) seemed to be the best way to communicate as well as interface with CERN. uslhcMag could be mirrored on servers at BNL and FNAL, where magnets will be produced and measurement data generated, and data from uslhcMag could be directly loaded onto the CERN Oracle magnet database, which ultimately is the repository of all project data. It was agreed to initiate development of the uslhcMag database as well as its applications in the next few months using expected harmonics as data, so that the software will be in place when magnet data will be available in a 9 months to 1 year time scale.

The discussion focused eventually on the uslhcMag database structure with the following proposed modifications to the structure:

- Magnets table
  Aperture units changed to mm
- Assembly table added
- Quench table added
- Integral table
  BenchName column added
  RefRadius units changed to mm
  UpDown changed to +1 or -1
  RampRate column added
  MeasTemp column added
  Transfunc column removed
- LocalHarm table added
- BodyHarmAvg table (formerly known as BodyHarm)
  BenchName column added
  RefRadius units changed to mm
  UpDown changed to +1 or -1
  RampRate column added
  MeasTemp column added
- EndsHarm table
  BenchName column added
  RefRadius units changed to mm
  UpDown changed to +1 or -1
  RampRate column added
  MeasTemp column added
- IntField table
  BenchName column added
  RefRadius units changed to mm
  UpDown changed to +1 or -1
  RampRate column added
  MeasTemp column added
- Magz table
  BenchName column added
  RefRadius units changed to mm
  UpDown column removed

UpDown2 column added [= (Up − Dn)/2]
RampRate column added
MeasTemp column added
ProbeLength column added

- Eddy Table
  BenchName column added
  RefRadius units changed to mm
  UpDown changed to +1 or -1
  RampRate column modified
  MeasTemp column added

- TDecay table
  BenchName column added
  RefRadius units changed to mm
  MeasTemp column added

- Centers table
  BenchName column added
  UpDown changed to +1 or -1
  MeasTemp column added

- WarmCold table
  MagnetRev column added
  BenchName column added
  UpDown changed to +1 or -1

- FidMagInfo table
  MeasBy column added

- FidOpt table
  MeasBy column added

- CentMag table
  MeasBy column added

- Angle table
  MeasBy column added

4 Session 4: Cable Database

Chairmen: A. Ghosh and D. McChesney

The purpose of this session was for the BNL and CERN Cable measurement people to discuss their methods for measurement and data handling, and to work out methods for receiving cables and identification information at BNL, and transferring BNL data to CERN. The session consisted of five presentations:

1. A. Verweij: Cable test facility at CERN & Cable measurement scheme
2. A. Verweij/L. Oberli: Database at CERN & data requirements from BNL
3. A. Ghosh: Cable test facility at BNL – Update
4. D. McChesney: Database structure at BNL
5. R. Thomas: Data acquisition & database integration

J. Wei presented a brief review of the first three sessions of the US-LHC Magnet Database Workshop held on June 2-3, 1998.

A. Verweij presented an overview of the CERN Cable Test Facility and the measurement scheme used. He also discussed the format of the measurement data files used at CERN and the methods for storing the files.

L. Oberli presented the current database structure which has recently been revised from it's earlier structure.

A. Ghosh discussed the BNL measurement facility.

D. McChesney presented the database structures used at BNL and discussed modifications to be made to them.

R. Thomas presented the measurement testing software and discussed the methods for analyzing the data.

The following agreements were made:

- The BNL CableTrack table will be modified:

  Estimated Ic will be added. Data will be delivered with the cable.

  Cable LayPitch will be added. Data will be delivered with the cable.

- The BNL CableElec table will be modified:

  Hc2 will be added.

  ReportNum will be added.

  R295 will be changed to R293

- The CableStrand table will be modified:

  R295 will be changed to R293

- Once data is approved at BNL no further modifications will be allowed.

- BNL will ship only new data. Deletions will be handled as special cases.
- BNL will ship a report via ftp, a record from CableElec, a ".res" file, and ".ui" files for each completed cable.

  The report will be an Excel file.

  The CableElec record will match the structure in the BNL database.

  The ".res" file will match the structure requested by CERN.

  The ".ui" file will match the structure requested by CERN.
- Sample #'s will be restricted to 1-4 at BNL and 5-9 at CERN.
- For extracted strands, the sample # is replaced with a 2 digit wire # and "E".
- WWW access is desirable for the tables CableTrack, CableElec, and CableStrand.

CERN would like some cable test data within the next several months to test the system.

Measurement conventions for magnet coldmass and assembly:

- Magnetic multipoles are defined in the reference system illustrated in Figure 1. The description is 2-dimensional with $x - y$ axes chosen such that the skew (or normal) component in the main field of a normal (or skew) magnet is zero.

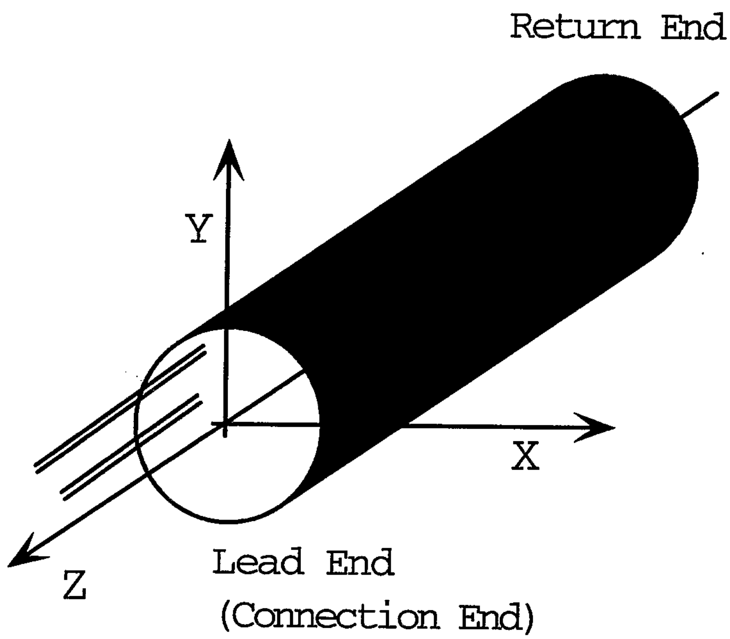


Figure 1: Reference frame for measurement magnetic multipoles.

- If the measurement is performed on a single magnet element (coldmass), the reference frame is defined with respect to the lead end of the element.
- If the measurement is performed on a magnet element contained in a combined element assembly, the reference frame is defined with respect to the lead end of the assembly (which may be opposite to that of the individual element), as shown in Figure 2.

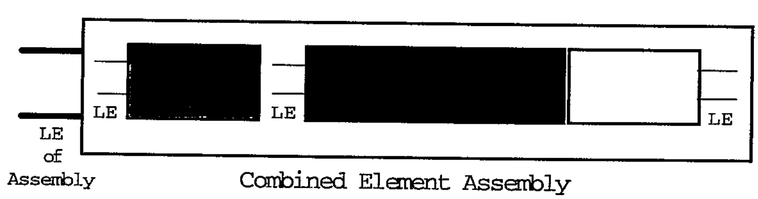


Figure 2: Lead end of a combined element assembly.

Rules for multipole transformation under orientation change:

* Orientation flip (180° rotation around y-axis)

  – normal magnet of multipolarity N

$$\begin{aligned} b_n &\Rightarrow (-)^{n+N}\, b_n \\ a_n &\Rightarrow (-)^{n+N+1}\, a_n \end{aligned} \tag{1}$$

  – skew magnet of multipolarity N

$$\begin{aligned} b_n &\Rightarrow (-)^{n+N+1}\, b_n \\ a_n &\Rightarrow (-)^{n+N}\, a_n \end{aligned} \tag{2}$$

* Upside-down (180° rotation around z-axis)

  – both normal and skew magnets of multipolarity N

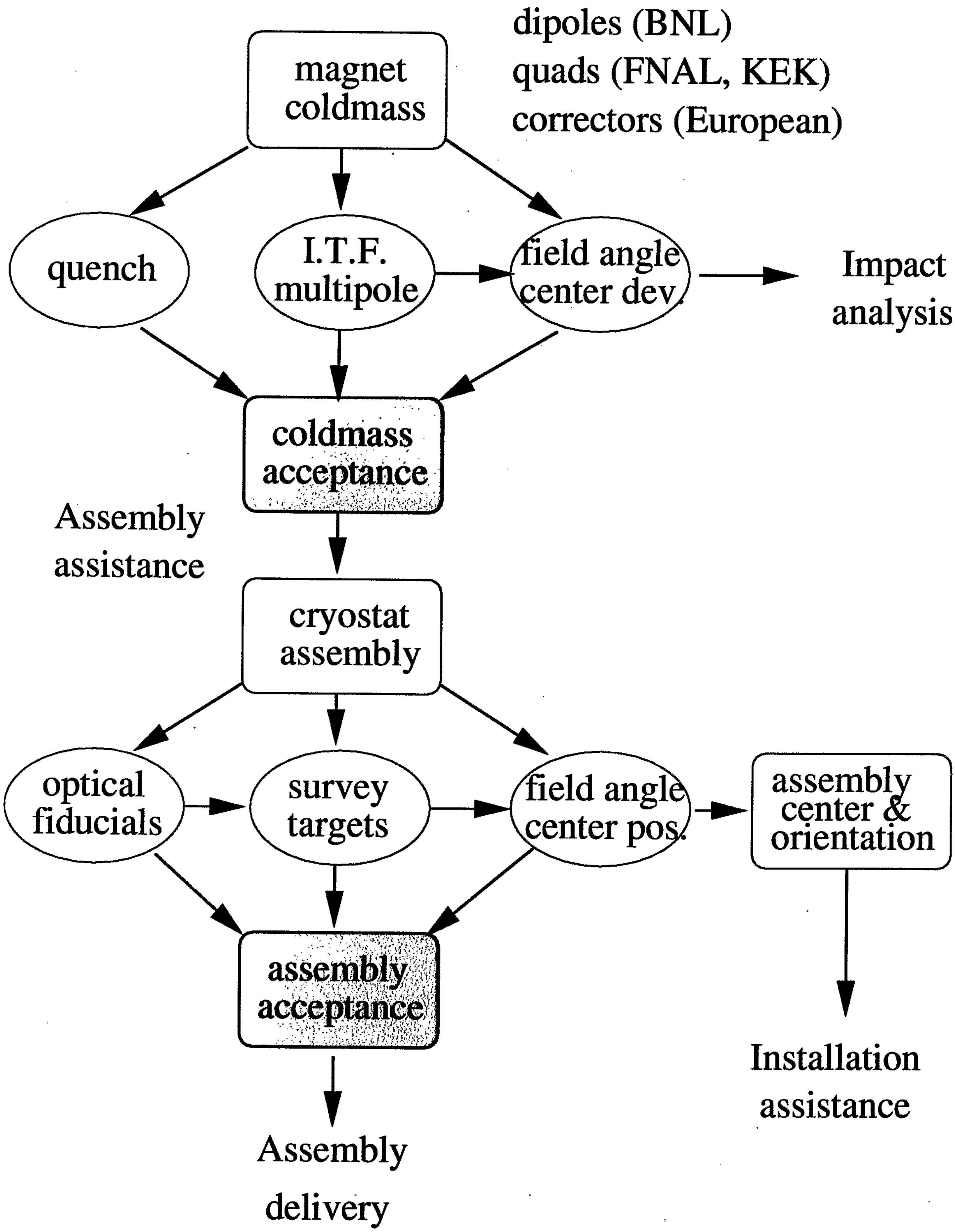
$$\begin{aligned} b_n &\Rightarrow (-)^{n+N}\, b_n \\ a_n &\Rightarrow (-)^{n+N}\, a_n \end{aligned} \tag{3}$$

* 180° rotation around x-axis

  product of the above two rotations (commutable)

Note:

- In deriving the above transformation, it is assumed that the magnet polarity is adjusted, if necessary, so that the fundamental term remains positive.



dipoles (BNL)
quads (FNAL, KEK)
correctors (European)
magnet coldmass
quench
I.T.F. multipole
field angle center dev.
Impact analysis
coldmass acceptance
Assembly assistance
cryostat assembly
optical fiducials
survey targets
field angle center pos.
assembly center & orientation
assembly acceptance
Installation assistance
Assembly delivery

US-LHC Magnets Database

Table: Magnets

Magnet name table. Each magnet will have one row in this table.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ModelNum	Character	3	-	-	-	-	Combined element magnet model number
Length	Numeric	4.2	0	9.99	m	x.xx	Magnet length at room temperature
Aperture	Numeric	4	0	200	mm	xxx	Magnet aperture
TunnelLoc	Character	10	-	-	-	-	Exact location in ring
Leads	Character	3	-	-	-	-	Leads at which end (CW, CCW)
SeqNum	Numeric	3	1	999	-	xxx	Vendor's construction sequence number
PartNum	Character	12	-	-	-	-	Part number of the magnet
Revision	Character	2	-	-	-	-	Revision to which the magnet was built
Completed	DateTime	8	-	-	-	xx/xx/xxxx	Date completed or recieved at BNL
Dispo	Character	10	-	-	-	-	Disposition: Accepted, Rejected, Returned
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: Assembly

Combined element assembly information.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
AssemblyID	Character	10	-	-	-	-	Assembly magnet ID
ColdMass	Character	10	-	-	-	-	Cold mass ID
Position	Character	1	-	-	-	-	Position of cold mass in assembly
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: Quench

Quench performance table. Each quench for each magnet cold tested will have an entry here.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # of quench for this magnet
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
QuenchTime	Character	8	-	-	-	xx:xx:xx	Time of quench
QuenchNum	Numeric	2	1	20	-	xx	Quench number for this magnet
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Quench current
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
MoleFinger	Character	1	-	-	-	-	Mole finger warm or cold
UpLow	Character	5	-	-	-	-	Half where quench occured (U/L) or coil number.
LE	Numeric	7.3	0	20	°K	xxx.xxx	Lead end temperature at quench
RE	Numeric	7.3	0	20	°K	xxx.xxx	Non-lead (return) end temperature at quench
MIITS	Numeric	5.2	0	99	MIITS	xx.xx	MIITS
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

US-LHC Magnets Database

Table: Integral

Integral geometric multipoles table.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
TestType	Character	10	-	-	-	-	Horizontal or vertical test
Current1	Numeric	8.2	-7000	+7000	amps	xxxx.xx	Current at which measurements were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
WarmCold	Character	1	-	-	-	-	Warm or Cold measurements
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
a1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dipole
a2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew quadrupole
a3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew sextupole
a4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew octupole
a5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew decapole
a6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dodecapole
a7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 14-pole
a8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 16-pole
a9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 18-pole
a10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 20-pole
a11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 22-pole
a12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 24-pole
a13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 26-pole
a14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 28-pole
a15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 30-pole
b1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dipole
b2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal quadrupole
b3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal sextupole
b4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal octupole
b5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal decapole
b6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dodecapole
b7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 14-pole
b8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 16-pole
b9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 18-pole
b10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 20-pole
b11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 22-pole
b12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 24-pole
b13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 26-pole
b14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 28-pole

b15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 30-pole
FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Integral field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: LocalHarm

Multipoles measured at one position.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
WarmCold	Character	1	-	-	-	-	Warm or Cold measurements
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
Position	Numeric	10.3					
ProbeLength	Numeric	4.2					
a1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dipole
a2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew quadrupole
a3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew sextupole
a4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew octupole
a5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew decapole
a6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dodecapole
a7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 14-pole
a8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 16-pole
a9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 18-pole
a10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 20-pole
a11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 22-pole
a12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 24-pole
a13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 26-pole
a14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 28-pole
a15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 30-pole
b1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dipole
b2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal quadrupole
b3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal sextupole
b4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal octupole
b5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal decapole
b6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dodecapole
b7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 14-pole
b8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 16-pole
b9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 18-pole
b10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 20-pole
b11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 22-pole
b12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 24-pole
b13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 26-pole

b14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 28-pole
b15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 30-pole
BTransFunc	Numeric	9.5	-10	+10	tesla/kA	±xx.xxxxx	Transfer function at reference radius
FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Average field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: BodyHarmAvg

The Dipoles and Quadrupoles will have multipoles measured at the ends and at the center. If so the average center(body) data will be stored in this table.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
WarmCold	Character	1	-	-	-	-	Warm or Cold measurements
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
a1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dipole
a2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew quadrupole
a3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew sextupole
a4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew octupole
a5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew decapole
a6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dodecapole
a7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 14-pole
a8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 16-pole
a9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 18-pole
a10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 20-pole
a11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 22-pole
a12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 24-pole
a13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 26-pole
a14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 28-pole
a15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 30-pole
b1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dipole
b2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal quadrupole
b3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal sextupole
b4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal octupole
b5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal decapole
b6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dodecapole
b7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 14-pole
b8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 16-pole
b9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 18-pole
b10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 20-pole
b11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 22-pole
b12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 24-pole
b13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 26-pole
b14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 28-pole
b15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 30-pole

BTransFunc	Numeric	9.5	-10	+10	tesla/kA	±xx.xxxxx	Transfer function at reference radius
FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Average field angle
FldAngVar	Numeric	6.2	-10	+10	mrad	±xx.xx	Maximum difference from the mean
FldAngRMS	Numeric	6.2	-10	+10	mrad	±xx.xx	RMS variation in field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: EndsHarm

This table will store the multipole data from the ends. There should be twice as many rows here as in the BodyHarm table. Typically, higher order end harmonics are negligible and hard to measure. Therefore harmonics above a11 and b11 will not be recorded.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
Region	Character	8	-	-	-	-	Region covered (lead, return)
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measuments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
WarmCold	Character	1	-	-	-	-	Warm or Cold measurements
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
a1	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew dipole
a2	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew quadrupole
a3	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew sextupole
a4	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew octupole
a5	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew decapole
a6	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew dodecapole
a7	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew 14-pole
a8	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew 16-pole
a9	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew 18-pole
a10	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew 20-pole
a11	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Skew 22-pole
b1	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal dipole
b2	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal quadrupole
b3	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal sextupole
b4	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal octupole
b5	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal decapole
b6	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal dodecapole
b7	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal 14-pole
b8	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal 16-pole
b9	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal 18-pole
b10	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal 20-pole
b11	Numeric	10.3	-999	+999	Units*m	±xxx.xxx	Normal 22-pole
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: IntField

Integral field table.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
WarmCold	Character	1	-	-	-	-	Warm or Cold measurements
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
Transfunc	Numeric	9.5	-10	+10	tesla*m/kA	±xx.xxxxx	Integral transfer function at reference radius
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

US-LHC Magnets Database

Table: Magz

Magnetization multipoles.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown2	Numeric	5.2	-	-	-	-	(Up + down)/2
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
Position	Numeric	2	0	99	-	xx	Axial position of test coil in magnet
ProbeLength	Numeric	4.2					
a1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dipole
a2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew quadrupole
a3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew sextupole
a4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew octupole
a5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew decapole
a6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dodecapole
a7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 14-pole
a8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 16-pole
a9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 18-pole
a10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 20-pole
a11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 22-pole
a12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 24-pole
a13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 26-pole
a14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 28-pole
a15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 30-pole
b1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dipole
b2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal quadrupole
b3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal sextupole
b4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal octupole
b5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal decapole
b6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dodecapole
b7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 14-pole
b8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 16-pole
b9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 18-pole
b10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 20-pole
b11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 22-pole
b12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 24-pole
b13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 26-pole
b14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 28-pole

b15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 30-pole
BTransfunc	Numeric	9.5	-10	+10	tesla/kA	±xx.xxxxx	Transfer function at reference radius
FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Primary field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: Eddy

Eddy current multipoles.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	9999	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
RampRate	Numeric	6.2	-200	+200	amp/sec	±xxx.xx	Ramp rate
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
Position	Numeric	2	0	99	-	xx	Axial position of test coil in magnet
a1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dipole
a2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew quadrupole
a3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew sextupole
a4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew octupole
a5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew decapole
a6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dodecapole
a7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 14-pole
a8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 16-pole
a9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 18-pole
a10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 20-pole
a11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 22-pole
a12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 24-pole
a13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 26-pole
a14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 28-pole
a15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 30-pole
b1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dipole
b2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal quadrupole
b3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal sextupole
b4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal octupole
b5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal decapole
b6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dodecapole
b7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 14-pole
b8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 16-pole
b9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 18-pole
b10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 20-pole
b11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 22-pole
b12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 24-pole
b13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 26-pole
b14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 28-pole
b15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 30-pole

BTransFunc	Numeric	9.5	-10	+10	tesla/kA	±xx.xxxxx	Transfer function at reference radius
FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Primary field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: TDecay

Time decay multipoles - up ramp only.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	ID of Cold mass being tested
RunNum	Numeric	4	1	100	-	xxxx	Run # for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
RefRadius	Numeric	4	0	200	mm	xxx	Reference radius
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurments were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
Time	Numeric	5	0	99999	sec	xxxxx	Time in seconds since start of constant current
Position	Numeric	2	0	99	-	xx	Axial position of test coil in magnet
a1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dipole
a2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew quadrupole
a3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew sextupole
a4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew octupole
a5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew decapole
a6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew dodecapole
a7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 14-pole
a8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 16-pole
a9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 18-pole
a10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 20-pole
a11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 22-pole
a12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 24-pole
a13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 26-pole
a14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 28-pole
a15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Skew 30-pole
b1	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dipole
b2	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal quadrupole
b3	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal sextupole
b4	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal octupole
b5	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal decapole
b6	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal dodecapole
b7	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 14-pole
b8	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 16-pole
b9	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 18-pole
b10	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 20-pole
b11	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 22-pole
b12	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 24-pole
b13	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 26-pole
b14	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 28-pole
b15	Numeric	10.3	-10000	+10000	Units	±xxxxx.xxx	Normal 30-pole
BTransFunc	Numeric	9.5	-10	+10	tesla/kA	±xx.xxxxx	Transfer function at reference radius

FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Primary field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

US-LHC Magnets Database

Table: Centers

This table will contain the centering offsets from the magnetic measurements.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	Cold Mass ID
RunNum	Numeric	4	1	100	-	xxxx	Run number for this magnet
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
BenchName	Character	20	-	-	-		Test station
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
Element	Character	3	-	-	-	-	Magnet element being tested (beam tube, corrector element, etc.)
Analysis	Character	8	-	-	-	-	History number generated by field program
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current at which measurements were made
Current2	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current in other half of dual aperture magnets
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
WarmCold	Character	1	-	-	-	-	Warm or Cold measurements
MeasTemp	Numeric	5.2	0	310	°K	xxx.xx	Temperature (K)
Xoff	Numeric	6.3	-5	+5	mm	±x.xxx	x offset
Yoff	Numeric	6.3	-5	+5	mm	±x.xxx	Y offset
FieldAngle	Numeric	6.2	-10	+10	mrad	±xx.xx	Integral field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: WarmCold

This table will hold the warm/cold transfer function and harmonics conversion values. The Delta_a1 --> Delta_b15 values are in Units*m for the lead and return regions and in Units otherwise.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
MagnetType	Character	3	-	-	-	-	3 letter magnet type (DRG,D5I, etc)
MagnetRev	Character	2	-	-	-	-	Magnet revision designation
Region	Character	8	-	-	-	-	Magnet region (Lead, Return, Body, Integral)
BenchName	Character	20	-	-	-		Test station
Current1	Numeric	8.2	-7000	+7000	amps	±xxxx.xx	Current for which conversion is calculated
UpDown	SmallInt	2	-1	+1	-	±1	Up (+1) or down (-1) ramp measurements
TFRatio	Numeric	8.4	0	+99	-	xx.xxxx	Transfer function ratio cold/warm
Delta_a1	Numeric	6.2	-999	+999	Units	±xx.xx	Skew dipole
Delta_a2	Numeric	6.2	-999	+999	Units	±xx.xx	Skew quadrupole
Delta_a3	Numeric	6.2	-999	+999	Units	±xx.xx	Skew sextupole
Delta_a4	Numeric	6.2	-999	+999	Units	±xx.xx	Skew octupole
Delta_a5	Numeric	6.2	-999	+999	Units	±xx.xx	Skew decapole
Delta_a6	Numeric	6.2	-999	+999	Units	±xx.xx	Skew dodecapole
Delta_a7	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 14-pole
Delta_a8	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 16-pole
Delta_a9	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 18-pole
Delta_a10	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 20-pole
Delta_a11	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 22-pole
Delta_a12	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 24-pole
Delta_a13	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 26-pole
Delta_a14	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 28-pole
Delta_a15	Numeric	6.2	-999	+999	Units	±xx.xx	Skew 30-pole
Delta_b1	Numeric	6.2	-999	+999	Units	±xx.xx	Normal dipole
Delta_b2	Numeric	6.2	-999	+999	Units	±xx.xx	Normal quadrupole
Delta_b3	Numeric	6.2	-999	+999	Units	±xx.xx	Normal sextupole
Delta_b4	Numeric	6.2	-999	+999	Units	±xx.xx	Normal octupole
Delta_b5	Numeric	6.2	-999	+999	Units	±xx.xx	Normal decapole
Delta_b6	Numeric	6.2	-999	+999	Units	±xx.xx	Normal dodecapole
Delta_b7	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 14-pole
Delta_b8	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 16-pole
Delta_b9	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 18-pole
Delta_b10	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 20-pole
Delta_b11	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 22-pole
Delta_b12	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 24-pole
Delta_b13	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 26-pole
Delta_b14	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 28-pole
Delta_b15	Numeric	6.2	-999	+999	Units	±xx.xx	Normal 30-pole
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: FidMagInfo

Summary information about magnet survey data including measurement date and data analysis date. In the case of more than one measurement for a magnet, only one will have BestData set to True.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
JobName	Character	8	-	-	-	-	Unique survey filename
MeasDate	DateTime	8	-	-	-	xx/xx/xxxx	Measured date
MeasTemp	Numeric	4.2	-	-	°C	xx.xx	Magnet temperature during survey (°C)
MeasBy	Character	4	-	-	-	-	Measured by FNAL, BNL, CERN
ProcDate	DateTime	8	-	-	-	xx/xx/xxxx	Data processed date
ProcBy	Character	15	-	-	-	-	Data processed by
BestData	Character	1	-	-	-	-	Best data flag (T or F)
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: FidOpt

Fiducial positions from optical survey in external coordinates.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	Cold mass ID
PointName	Character	10	-	-	-	-	Measurement point name
JobName	Character	8	-	-	-	-	Unique survey filename
MeasDate	DateTime	8	-	-	-	xx/xx/xxxx	Measured date
MeasBy	Character	4	-	-	-	-	Measured by FNAL, BNL, CERN
ProcDate	DateTime	8	-	-	-	xx/xx/xxxx	Data processed date
Xvalue	Numeric	8.4	-	-	cm	±xxx.xxxx	Radial coordinate (cm)
Yvalue	Numeric	8.4	-	-	cm	±xxx.xxxx	Longitudinal coordinate (cm)
Zvalue	Numeric	8.4	-	-	cm	±xxx.xxxx	Vertical coordinate (cm)
Xstd	Numeric	5.4	-	-	-	x.xxxx	Radial standard deviation
Ystd	Numeric	5.4	-	-	-	x.xxxx	Longitudinal standard deviation
Zstd	Numeric	5.4	-	-	-	x.xxxx	Vertical standard deviation
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: CentMag

Magnetic center measurement relative to external references from antenna measurement (or an equivalent technique), and position of the external references in external coordinates.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	Cold mass ID
PointName	Character	10	-	-	-	-	Measurement point name
JobName	Character	8	-	-	-	-	Unique survey filename
MeasDate	DateTime	8	-	-	-	xx/xx/xxxx	Measured date
MeasBy	Character	4	-	-	-	-	Measured by FNAL, BNL, CERN
Xvalue	Numeric	8.4	-	-	cm	±xxx.xxxx	Radial offset
Yvalue	Numeric	8.4	-	-	cm	±xxx.xxxx	Logitudinal position
Zvalue	Numeric	8.4	-	-	cm	±xxx.xxxx	Vertical offset
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified

Table: Angle

Magnetic field angle relative to external refernce from coil measurement, and position of the external refernces in external coordinate system. This will be used for combined element assemblies only.

Column Name	Data Type	Size	Minimum Value	Maximum Value	Units	Display Format	Description
Magnet	Character	10	-	-	-	-	Magnet ID
ColdMass	Character	10	-	-	-	-	Cold mass ID
Element	Character	3	-	-	-	-	Magnet element being tested
RunNum	Numeric	4	1	1000	-	xxxx	Run # for this magnet
JobName	Character	8	-	-	-	-	Unique survey filename
TestDate	DateTime	8	-	-	-	xx/xx/xxxx	Date tested
MeasBy	Character	4	-	-	-	-	Measured by FNAL, BNL, CERN
MeasCoil	Character	10	-	-	-	-	Serial number of measurement coil used
WarmCold	Character	1	-	-	-	-	Warm or cold measurements
FieldAngle	Numeric	5.2	-30	+30	mrad	±xx.xx	Field angle
Notes	Character	255	-	-	-	-	Comments
LoginName	Character	15	-	-	-	-	Login name of person entering or modifying data
ModDate	DateTime	8	-	-	-	-	Date & time row of data was last modified