Magnet sign conventions and shunts configuration

JLAB-TN-05-008

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Introduction

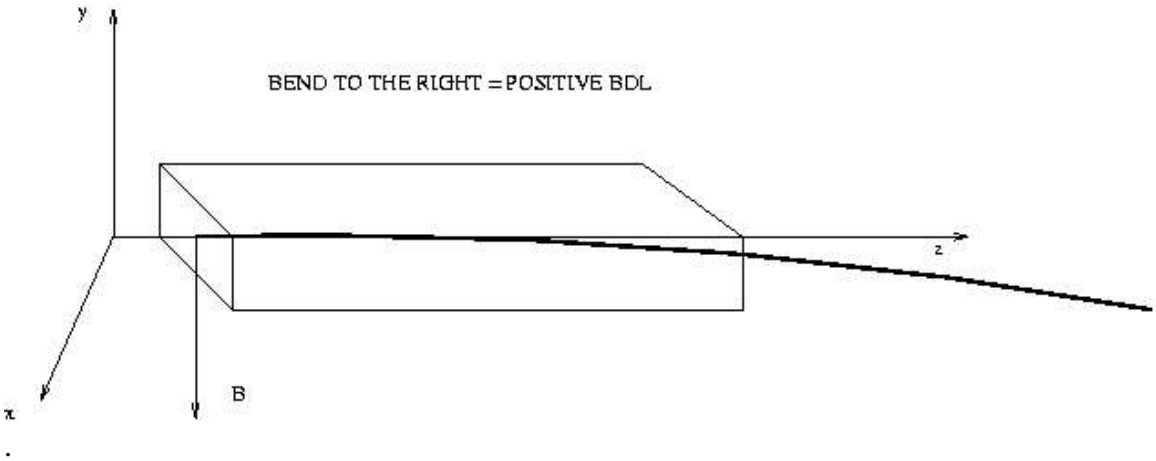
The goal of this document is to define the magnet sign conventions for the BDL value reported by the control system in the CEBAF accelerator. It is meant to be used as a reference from which every artifact dealing with beam line configuration (MEDM screens, software, optics decks, etc..) has to adhere. The document is broken down in subsections, each of them dealing with a particular section of the machine. This document does not address the topic of magnet naming convention which will be the object of another document as it is recognized that many magnets do not properly follow the CEBAF naming convention. Whenever appropriate we will mention departures from the naming convention in the document but we will use the name that are on the songsheets even if the naming convention is not properly followed. We will also indicate if a magnet is directly powered by a power supply or through a shunt.

Sign conventions

The commonly accepted sign conventions at CEBAF are the following:

for dipoles:

A electron bending to the right or up corresponds to a positive BDL value.



for quadrupoles:

A positive gradient correspond to an horizontally focussing quadrupole, A negative gradient correspond to a vertically focussing quadrupole. This is also the DIMAD convention.

For solenoid lenses:

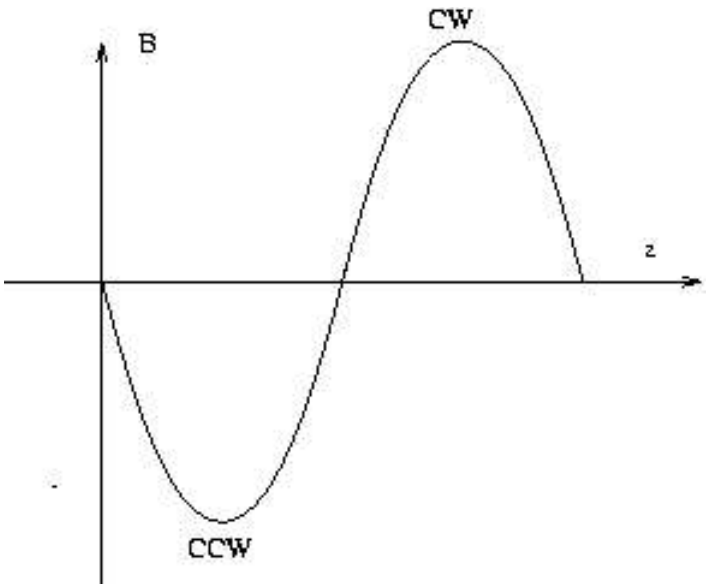


Figure 1: Profile of the field along a counterwound solenoid for a positive current. The direction of spiraling of the electrons inside the solenoid is indicated on the figure by

CCW (counter-clockwise) and CW (clockwise).

For a singlewound solenoid, the convention is that a positive current generates a clockwise (CW) rotation and a positive B field.

Proposed conventions:

We will adopt the conventions described above for choosing the sign of the BDL reported by the control system. We will always express the field maps in the local frame of the magnets. The sign of the BDL value reported from the control system will take into account the transform from this local frame to the accelerator frame defined by the CEBAF design handbook and drawn on the song sheets. For example, a dipole bending to the right (inboard) will have a positive BDL by convention. When rolled 90 degres CW, it will bend down (towards the ground) and will have a negative BDL by convention. Each magnet will have an associated reference frame transformation from which one can compute the sign of the BDL. This can be done offline and downloaded in the magnet record.

We precomputed all the signs for the dipoles that are located in the machine. The rest of this document is intended to be a reference list for the sign of these magnets. It was obtained by inspecting the song sheets and cross-compared with the original 'asbuild' DIMAD decks provided by D. Douglas.

Injector and injection chicane

Power supply	magnet name	BDL sign
MDS0I01	MDS1I01	(+) for gun3, (-) for gun2
MBL0R01	MBL0R01	(-)
MDK0R02	MDK0R02	(+)
MBL0R03	MBL0R03	(+)
MBL0R04	MBL0R04	(-)

Doglegs

The doglegs are located in the extraction regions before the start of the west and east arcs. There are two doglegs per pass. They are composed of 2 outboard magnets and one inboard magnet. The beam is bend to the left and then bend back in. The power supplies are denoted by MDOG1E through MDOG9E.

The doglegs for passes 1 and 2 are wired differently than the higher passes doglegs and we need to take into account the relationship between the power supply and the shunted magnets in order to properly assign the sign for the BDL.

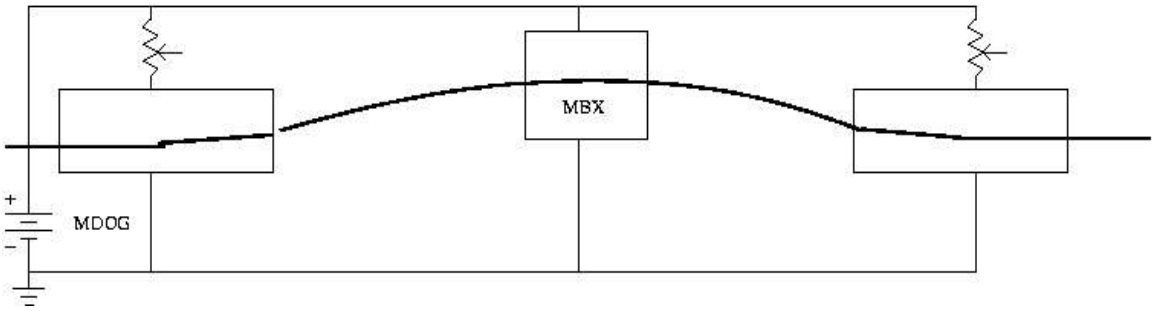


Figure 1: Relationship between magnets, power supply and shunts in doglegs 1 through 4.

Figure 1 shows the beam deflection in the doglegs for passes 1 and 2 (thats a total of four doglegs, two even and two odd.) . For these passes the inboard magnet is directly powered by the MDOG power supply and bends to the right. Hence, the sign of MDOG1E, MDOG2E, MDOG3E and MDOG4E has to be positive. (by convention if we bend to the right, its positive.). The shunted outboard magnets MBW's are powered together and are bending to the left and hence, the sign has to be negative.

For the higher passes doglegs (see figure 2), the outboard magnets are directly powered by the MDOG power supply and the inboard MBZ magnet is shunted.

As a result, the outboard magnets drive the sign of the MDOG and it has to be negative

since they bend to the left. Likewise the shunted MBZ magnet has to be positive since it bends to the right.

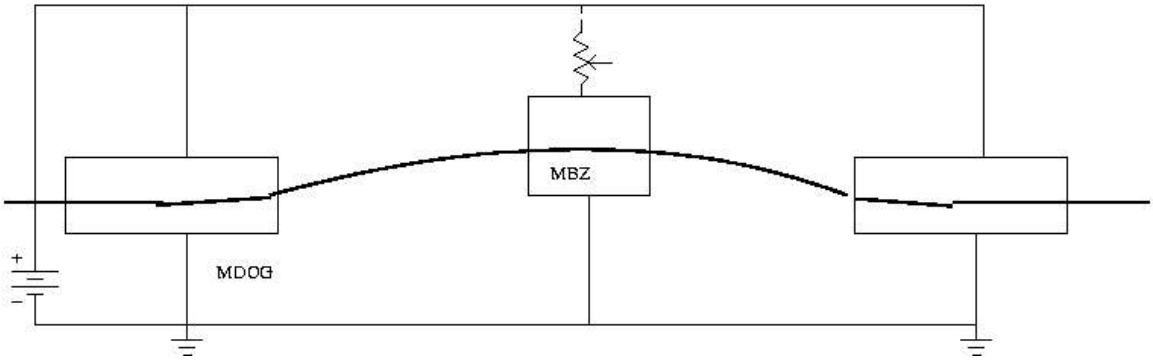


Figure 2: Relationship between magnets, power supplies and shunts in doglegs 5 through 9.

The schematic below summarizes the shunt configuration and sign conventions for all the dogleg magnets in the machine. For each group, the first line is the power supply name along with its sign, the second line shows whether or not it is shunted, the third line are the elements names in the optics decks along with the BDL signs.

```
MDOG1E---------  ---(+)-------------MDOG1E
      |                 |                 |
   Shunt              |               Shunt
      |                 |                 |
MBW1E01(-)     MBX1E02 (+)     MBW1E03(-)
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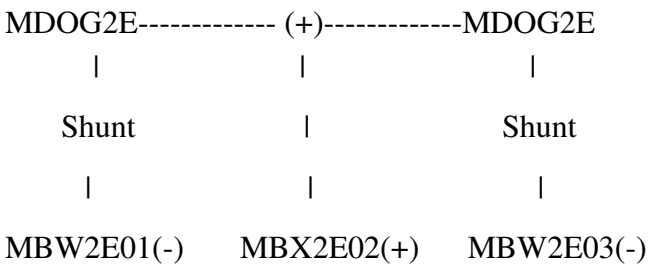
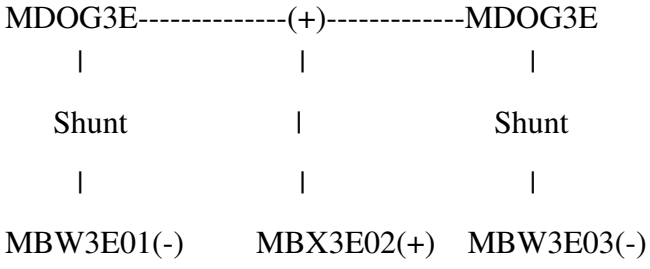
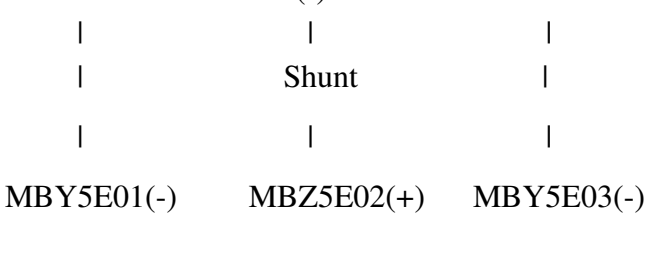
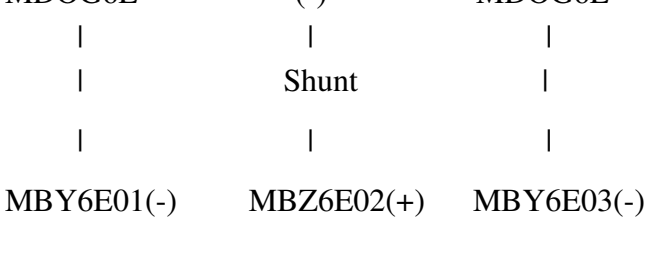
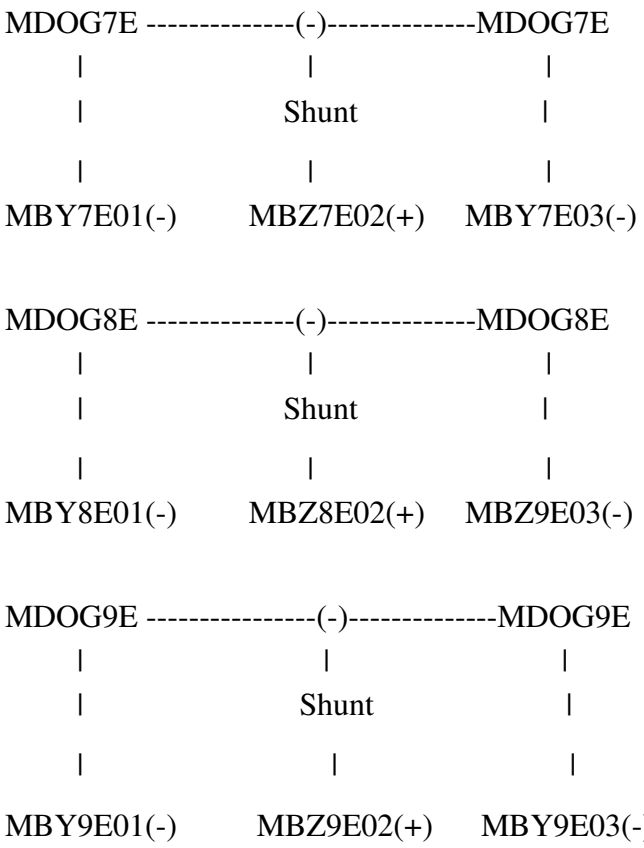

MDOG2E (+) MDOG2E
Shunt Shunt
MBW2E01(-) MBX2E02(+) MBW2E03(-)


MDOG3E (+) MDOG3E
Shunt Shunt
MBW3E01(-) MBX3E02(+) MBW3E03(-)


MDOG4E (+) MDOG4E
Shunt Shunt
MBW4E01 (-) MBX4E02(+) MBW4E03(-)


MDOG5E (-) MDOG5E
Shunt
MBY5E01(-) MBZ5E02(+) MBY5E03(-)


MDOG6E (-) MDOG6E
Shunt
MBY6E01(-) MBZ6E02(+) MBY6E03(-)



ARCS Dipoles

This is pretty simple. They all bend to the right and hence, they have positive BDL. All the dipoles in a given ARC are on a single power supply denoted MARC1A, MARC2A, etc.., there is no shunt involved.

Spreader and Recombiner

Spreader and recombiner dipoles are shunted and they either bend up or down.

The tables below are following the path of the beam and show the box supply name, whether or not the magnets are shunted, their physical name and the sign that the BDL

has to have.

Power supply		magnet name	BDL sign
MARC1A	Shunt	MAQ1S01	(+)
MARC1A	Shunt	MAI1S03	(-)
MARC1A	Shunt	MAI1S04	(+)
MARC1A	Shunt	MAI1S06	(-)
MARC1A	Shunt	MAI1R01	(-)
MARC1A	Shunt	MAI1R03	(+)
MARC1A	Shunt	MAI1R04	(-)
MARC1A	Shunt	MAQ1R06	(+)
MARC2A	Shunt	MAW2S01	(+)
MARC2A	Shunt	MAL2S03	(-)
MARC2A	Shunt	MAI2S04	(+)
MARC2A	Shunt	MAI2S06	(-)
MARC2A	Shunt	MAI2R01	(-)
MARC2A	Shunt	MAI2R03	(+)
MARC2A	Shunt	MAL2R04	(-)
MARC2A	Shunt	MAW2R06	(+)
MARC3A	Shunt	MAS3S02	(+)

MARC3A----------Shunt---------MAM3S03 (-)

MARC3A----------Shunt---------MAA3S04 (+)

MARC3A----------Shunt---------MAA3S06 (-)

MARC3A----------Shunt---------MAA3R01 (-)

MARC3A----------Shunt---------MAA3R03 (+)

MARC3A----------Shunt---------MAM3R04 (-)

MARC3A----------Shunt---------MAS3R05 (+)

MARC4A----------Shunt---------MAX4S02 (+)

MARC4A----------Shunt---------MAV4S03 (-)

MARC4A----------Shunt---------MAF4S04 (+)

MARC4A----------Shunt---------MAF4S06 (-)

MARC4A----------Shunt---------MAF4R01 (-)

MARC4A----------Shunt---------MAF4R03 (+)

MARC4A----------Shunt---------MAV4R04 (-)

MARC4A----------Shunt---------MAX4R05 (+)

MARC5A----------Shunt---------MAN5S03 (-)

MARC5A----------Shunt---------MAC5S04 (+)

MARC5A----------Shunt---------MAC5S06 (-)

MARC5A----------Shunt---------MAC5R01 (-)

MARC5A----------Shunt---------MAC5R03 (+)

MARC5A----------Shunt---------MAN5R04 (-)

MARC6A----------Shunt---------MAU6S03 (-)

MARC6A----------Shunt---------MAB6S04 (+)

MARC6A----------Shunt---------MAB6S06 (-)

MARC6A----------Shunt---------MAB6R01 (-)

MARC6A----------Shunt---------MAB6R03 (+)

MARC6A----------Shunt---------MAU6R04 (-)

MRSEP9A----------Shunt---------MYR7S03 (-)

MARC7A----------Shunt---------MAC7S04 (+)

MARC7A----------Shunt---------MAC7S06 (-)

MARC7A----------Shunt---------MAC7R01 (-)

MARC7A----------Shunt---------MAC7R03 (+)

MRSEP9A----------Shunt---------MYR7R04 (-)

MRSEP8A----------Shunt---------MYR8S03 (-)

MARC8A----------Shunt---------MAE8S04 (+)

MARC8A----------Shunt---------MAE8S06 (-)

MARC8A----------Shunt---------MAE8R01 (-)

MARC8A----------Shunt---------MAE8R03 (+)

MRSEP8A----------Shunt---------MYR8R04 (-)

MRSEP9A----------Shunt---------MYR9S04 (-)

MARC9A----------Shunt---------MAO9S05 (+)

MARC9A----------Shunt---------MAG9S06 (+)

MARC9A----------Shunt---------MAG9R01 (+)

MARC9A----------Shunt---------MAO9R02 (+)

MRSEP9A---------Shunt---------MYR9R03 (-)

MRSEP8A---------Shunt---------MYRAS04 (-)

MARC8A----------Shunt---------MAYAS05 (+)

MARC8A----------Shunt---------MAHAS06 (+)

Beam switchyard from tangency point to Lambertson.

MRSEP2T---------Shunt----------MBP2T03 (+)

MRSEP2T---------Shunt----------MBQ2T04 (-)

MARC2A---------Shunt----------MAI2T01 (-)

MARC2A---------Shunt----------MAI2T03 (+)

MARC2A---------Shunt----------MAL2T04 (-)

MARC2A---------Shunt----------MAW2T06 (+)

MRSEP4T--------Shunt---------MBP4T03 (+)

MRSEP4T--------Shunt----------MBQ4T04 (-)

MARC4A---------Shunt---------MAF4T01 (-)

MARC4A---------Shunt---------MAF4T03 (+)

MARC4A—--------Shunt---------MAV4T04 (-)

MARC4A---------Shunt---------MAX4T05 (+)

MRSEP6T--------Shunt----------MBP6T03 (+)

MRSEP6T--------Shunt----------MBQ6T04 (-)

MARC6A---------Shunt---------MAB6T01 (-)

MARC6A---------Shunt---------MAB6T03 (+)

MARC6A---------Shunt---------MAU6T04 (-)

MRSEP8T--------Shunt---------MBP8T03 (+)

MRSEP8T--------Shunt---------MBQ8T04 (-)

MARC8A---------Shunt---------MAE8T01 (-)

MARC8A---------Shunt---------MAE8T03 (+)

MRSEP8A--------Shunt---------MYR8T04 (-)

MARC8A---------Shunt---------MAHAT01 (+)

MARC8A---------Shunt---------MAYAT02 (+)

MRSEP8A---------Shunt---------MYRAT03 (-)

Beam switchyard to BSY dump

MBSYBD----------Shunt--------MBJ4C01 (-)

MBSYBD----------(-)----------MBJ4C02 (-)

MBSYBD----------Shunt--------MBJ4C03 (-)

Hall A dipole string

MLAM1C----------MBN1C04 (+)

MBSY1C----------MBA1C05 (+)

MBSY1C----------MBA1C06 (+)

MBSY1C----------MBA1C07 (+)

MBSY1C----------MBA1C08 (+)

MBSY1C----------MBA1C09 (+)

MBSY1C----------MBA1C10 (+)

MBSY1C----------MBA1C11 (+)

MBSY1C----------MBA1C12 (+)

Note that the CEBAF naming convention was not properly followed for these dipole magnets. The numbering is supposed to be relative to the closest quadrupole and this is not reflected by the names on the song sheets.

Hall B dipole string

MBSY2C----------MBE2C01 (+)

MBSY2C----------MBE2C02 (+)

MBSY2C----------MBE2C03 (+)

MBSY2C----------MBE2C04 (+)

MBSY2C----------MBE2C05 (-)

MBSY2C----------MBE2C06 (-)

MBSY2C----------MBE2C07 (-)

MBSY2C----------MBE2C08 (-)

Here too, the naming convention regarding the numbering of the dipoles was not followed.

Hall C dipole string

MLAM3C----------MBN3C04 (-)

MBSY3C----------MBA3C05 (-)

MBSY3C----------MBA3C06 (-)

MBSY3C----------MBA3C07 (-)

MBSY3C----------MBA3C08 (-)

MBSY3C----------MBA3C09 (-)

MBSY3C----------MBA3C09 (-)

MBSY3C----------MBA3C10 (-)

MBSY3C----------MBA3C11 (-)

MBSY3C----------MBA3C12 (-)

The same comments as in hall A and hall B regarding the naming convention apply here.