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BTA Magnet Field Map Archive and MAD Model

J. W. Glenn

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Collider Accelerator Department
Brookhaven National Laboratory

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Collider-Accelerator Department
Brookhaven National Laboratory
Upton, NY 11973

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This note publishes some and information that has resided in private files.

The attached tables were provided by Joseph Skelly from his archives. They show magnetic field measurements versus excitation current for the Booster to AGS transfer line quadropoles and dipoles based on field measurements [we believe] were done by the Magnet Division. Also given are Ed Blesser's fifth order fits of field versus current The results are given in 'Tesla' or T-M/M. These tables are attached to provide an archive of this data.

The MAD model of the BTA line does have the same values as shown in the attached fits so the transfer was correct. MAD uses as its 'gradient' for quads Tesla per meter normalized to rigidity [B-rho]. The model of the BTA line in use uses the T-M/M given in the tables divided by the length to give T/M which is then normalized by B-rho. Thus, the input to the model appears to be correct. The original model is also attached as part of a memo by Skelly describing it.

M E M O R A N D U M

TO: E. Auerbach, M. Blaskiewicz, E. Bleser, J.W. Glenn, K. Kramer, A. Luccio, K. Reece, T. Roser, M. Tanaka

FROM: J. Skelly

TOPIC: BTA MAD Model in DSEE

DATE: 21-April-1992

A copy of the MAD model for the Booster-To-AGS transfer line (BTA) as developed by Auerbach has been placed in a DSEE library. It is proposed that this library be regarded as the formal repository of the best current model. In this spirit, anyone may copy the model, and may make any changes they please to their private copy(s); the library-resident model may be edited by anyone competent in using DSEE, but such changes should be undertaken only to implement modifications that are universally agreed to be improvements - experimentation should be pursued in private copies.

FEATURES OF INITIAL BTA MODEL

The mad model lodged in the DSEE library is that developed by Auerbach after a critical study of the BTA line geometry, and includes quadrupole magnet excitation functions provided by Bleser.

o - This model starts at a canonical location of the Booster F6 septum, and does not address the question of a detailed model of the extraction trajectory within the septum; this issue is left for future improvements.

o - This model terminates at the small hole before the AGS A5 septum; realistic modeling beyond this point requires transport matrices that are currently under development. Moreover, the version of MAD currently in use does not handle user-supplied transport matrices properly. These developments are left for future improvements.

o - This model declares the S coordinate for all points of interest in the line, and derives drift lengths from these S coordinates. The S coordinates are specified in units of meters. The S coordinates are derived by Auerbach from a critical study of BTA prints and other data, and are maintained in the booster model database. An explanation of their derivation will be the topic of a future technical note.

o - Drifts in this model are named according to the element upstream of the drift.

o - Quadrupole strengths are parameterized in terms of the quadrupole currents, using a 4th-order power series expansion provided by Bleser; the parameters for the currents are initialized to zero.

o - The corrector kicks are set to zero; a future enhancement might parameterize these as a function of the corrector currents.

o - All markers have been denominated by their S coordinates measured in feet.

o - The subline organization terminates sublines at dipoles, except that a subline termination is provided at the stripping foil.

O - Three lines are defined for general modeling:
BTA - F6 septum to small hole
BTATOFL - F6 septum to stripping foil (BTA TO FoiL)
BTAFMFL - stripping foil to small hole (BTA FroM FoiL)

O - No "USE" statement or other MAD action command (such as "TWISS", "MATCH" or "SURVEY") is specified in this model. Users are expected to append their own statements to implement such analyses as may suit them.

USE OF DSEE

The Domain Software Engineering Environment (DSEE) provides librarian type functions for maintenance of libraries of source files. Although intended for use with computer program source codes, it works just as well with other types of source files, such as documentation and MAD models. The AGS Distributed Control System (AGSDCS) employs DSEE extensively to maintain many of the source files used to organize and administer the control network and to provide data to drive some of the control programs (e.g. start_up).

Different libraries may be used by DSEE for different purposes. A library named "mad" has been provided for storage of MAD source codes and of MAD models. Files in this library may be read and copied by anyone, without even using the DSEE program. However, modification of these files, and addition of files to this library can be accomplished only by using DSEE. The "mad" library may be found under the directory:

/users/development/dsee/mad

The BTA model within this library is named:

bta.model

DSEE permits elements in a library to be modified only by use of a reservation mechanism. When a user reserves an element from a library, that element is copied into the user's working directory, where the user may edit that copy ad lib. When the user has finished whatever development was to be accomplished, the element is replaced back into the library. While an element is reserved by one user, no other user may reserve it (although an option is provided to make a "branch" on the element to permit simultaneous development). When a user reserves an element, DSEE requires input of a description of the reason for the reservation. At any time thereafter, anyone may query DSEE to see who has an element reserved and why (and when). When an element is replaced, the reason for reservation may be edited to provide a description of the changes that were made. All replacements of an element are kept as a permanent record of development, including the user identity, replacement date, and change description. Each version of the element is also preserved, and comparisons of successive versions can be done to verify the changes that were made. Each version is identified both by a version number and its date.

A user may run DSEE by entering into a shell the command:

/com/dsee

The first time you run DSEE you must specify: system, library, and model. Subsequent runs will recall this information from the last run. If you change your system, then only the system command need be entered to recover system, library, and model from the last run when that system was used. The commands to be issued the first time you run DSEE for the mad system are:

```
set system  /users/development/dsee/mad_system
set library /users/development/dsee/mad
set model   mad_model
```

The above usage of the term model refers to what is called a DSEE model, and has nothing to do with a MAD model. A DSEE model describes to DSEE how each element in a library is to be processed. For program source codes, such processing would include appropriate compilation (using fortran, c or c++ compilers for example).

The DSEE program provides extensive help facilities. Users wishing to develop expertise in the use of DSEE should consult with their favorite programmer in the Controls Section.

```
TITLE, "BTA (Revised 3-92)"
!
!    rev 31 mar 92 to BTA-line dwg D37-M-0413-5,rev H
!            plus Survey Group reported variations "as built"
!
E0:       CONSTANT=938.28
EK:       PARAMETER=1200.            !  1.2 GeV Kinetic Energy
PC:=      SQRT(EK*(EK+2*E0))
BRHO:=    PC/299.7924
BETA:=    sqrt(1-1/((1+EK/E0)*(1+EK/E0)))
VALUE, BRHO
VALUE, PC
VALUE, BETA
!
!     element lengths (meters)
!
LD1: CONSTANT=0.5333       ! lengths for D1, D4
LD2: CONSTANT=2.4200       ! lengths for D2, D3
LD5: CONSTANT=1.2456       ! length  for D5
!
LC1:  CONSTANT=0.2286      ! length for DV007
LC2:  CONSTANT=0.2438      ! lengths for all other correctors
!
LQ1:  CONSTANT=0.5588      ! lengths for Q1-4 & 15
LQ5:  CONSTANT=0.4985      ! lengths for Q5-14
!
D_PUE:      PARAMETER =  0.3676       ! pue offset from quad
!
!     s-coordinates (meters)
!
S_DH1:  PARAMETER =  5.4156        ! Note: distances at dipoles
S_DH2:  PARAMETER = 12.2109        !    have been adjusted from
S_DH3:  PARAMETER = 16.5877        !    apex-measurements (survey
S_DH4:  PARAMETER = 30.6886        !    points) to arc-centers
S_DH5:  PARAMETER = 56.1414        !    (beam-path points).
!
S_QV1:   PARAMETER =  4.4664
S_QH2A:  PARAMETER =  6.3410
S_QH2B:  PARAMETER =  7.0156
S_QV3:   PARAMETER =  8.3600
S_QH4:   PARAMETER = 10.2334
S_QV5:   PARAMETER = 14.1435
S_QH6:   PARAMETER = 18.5386
S_QV7:   PARAMETER = 20.4386
S_QH8:   PARAMETER = 29.4386
S_QV9:   PARAMETER = 33.0124
S_QH10:  PARAMETER = 35.9920
S_QV11:  PARAMETER = 42.6097
S_QH12:  PARAMETER = 47.2102
S_QV13:  PARAMETER = 52.5781
S_QH14:  PARAMETER = 54.7626
S_QV15:  PARAMETER = 58.6443
!
S_DV007:  PARAMETER =  3.9121
S_DH127:  PARAMETER = 41.8238
S_DV141:  PARAMETER = 46.4244
S_DH158:  PARAMETER = 51.7922
S_DV168:  PARAMETER = 53.9767
S_DH181:  PARAMETER = 57.3377
!
S_PUE001: PARAMETER =  2.2803
S_MW006:  PARAMETER =  3.3652
S_XF019:  PARAMETER =  7.7549
S_XF059:  PARAMETER = 19.2593
S_MW060:  PARAMETER = 19.7292
S_MW125:  PARAMETER = 41.2714
S_MW166:  PARAMETER = 53.4243
S_XF183:  PARAMETER = 57.8394
!
S_BOOSTF6:  PARAMETER =  0.0
S_FOIL024:  PARAMETER =  9.0100
S_MK139:    PARAMETER = 45.8719
```

```
S_MK156:    PARAMETER = 51.2397
S_SHOLE:    PARAMETER = 59.1600
S_AGS_L20CTR:  PARAMETER = 62.4927
!
!
!
!  Construct Drifts from coordinates and lengths
!
DR000:   DRIFT,  L = S_PUE001 - S_BOOSTF6
DR001:   DRIFT,  L = S_MW006 - S_PUE001
DR006:   DRIFT,  L = S_DV007 - S_MW006 - LC1/2
DR007:   DRIFT,  L = S_QV1 - S_DV007 - LC1/2 - LQ1/2
DRQ1:    DRIFT,  L = S_DH1 -S_QV1 - LQ1/2 - LD1/2
DRD1:    DRIFT,  L = S_QH2A - S_DH1 - LD1/2 - LQ1/2
DRQ2A:   DRIFT,  L = S_QH2B -S_QH2A - LQ1
DRQ2B:   DRIFT,  L = S_XF019 - S_QH2B - LQ1/2
DR019:   DRIFT,  L = S_QV3 -S_XF019 - LQ1/2
DRQ3:    DRIFT,  L = S_FOIL024 - S_QV3 - LQ1/2
DR024:   DRIFT,  L = S_QH4 - S_FOIL024 - LQ1/2
DRQ4:    DRIFT,  L = S_DH2 - S_QH4 - LQ1/2 - LD2/2
DRD2:    DRIFT,  L = S_QV5 - S_DH2 - LD2/2 - LQ5/2
DRQ5:    DRIFT,  L =  D_PUE - LQ5/2
DR046:   DRIFT,  L = S_DH3 - S_QV5 - D_PUE - LD2/2
DRD3:    DRIFT,  L = S_QH6 - S_DH3 - LD2/2 - LQ5/2
DRQ6:    DRIFT,  L = S_XF059 - S_QH6 - LQ5/2
DR059:   DRIFT,  L = S_MW060 - S_XF059
DR060:   DRIFT,  L = S_QV7 - S_MW060 - LQ5/2
DRQ7Y:   DRIFT,  L = (S_QH8 - S_QV7 - LQ5)/2
DRQ7Z:   DRIFT,  L = (S_QH8 - S_QV7 - LQ5)/2
DRQ8:    DRIFT,  L = S_DH4 - S_QH8 - LQ5/2 - LD1/2
DRD4:    DRIFT,  L = S_QV9 - S_DH4 - LD1/2 - LQ5/2
DRQ9:    DRIFT,  L = S_QH10 - S_QV9 - LQ5
DRQ10:   DRIFT,  L = S_MW125 - S_QH10 - LQ5/2
DR125:   DRIFT,  L = S_DH127 - S_MW125 - LC2/2
DR127:   DRIFT,  L = S_QV11 - S_DH127 - D_PUE - LC2/2
DR129:   DRIFT,  L =  D_PUE - LQ5/2
DRQ11:   DRIFT,  L = S_MK139 - S_QV11 - LQ5/2
DR139:   DRIFT,  L = S_DV141 - S_MK139 - LC2/2
DR141:   DRIFT,  L = S_QH12 - S_DV141 - D_PUE - LC2/2
DR143:   DRIFT,  L =  D_PUE - LQ5/2
DRQ12:   DRIFT,  L = S_MK156 - S_QH12 - LQ5/2
DR156:   DRIFT,  L = S_DH158 - S_MK156 - LC2/2
DR158:   DRIFT,  L = S_QV13 - S_DH158 - D_PUE - LC2/2
DR160:   DRIFT,  L =  D_PUE - LQ5/2
DRQ13:   DRIFT,  L = S_MW166 - S_QV13 - LQ5/2
DR166:   DRIFT,  L = S_DV168 - S_MW166 - LC2/2
DR168:   DRIFT,  L = S_QH14 - S_DV168 - D_PUE - LC2/2
DR170:   DRIFT,  L =  D_PUE - LQ5/2
DRQ14:   DRIFT,  L = S_DH5 - S_QH14 - LQ5/2 - LD5/2
DRD5:    DRIFT,  L = S_DH181 - S_DH5 - LD5/2 - LC2/2
DR181:   DRIFT,  L = S_XF183 - S_DH181 -LC2/2
DR183:   DRIFT,  L = S_QV15 -S_XF183 - LQ1/2
DRQ15:   DRIFT,  L = S_SHOLE - S_QV15 - LQ1/2
!
!
!
!
!
! Dipoles
!     angles in rad
!
ANG2: CONSTANT=0.27570
RHO2:= LD2/ANG2
E00 := 0.0536    ! SINCE USED TO BEND MORE THAN IN BOOSTER
!
DH1: RBEND, L=LD1,   ANGLE=0.036364
DH2: SBEND, L=LD2,   ANGLE=ANG2, K1=-3.918E-3/RHO2, &
                     E1=E00, E2=E00, K2=-0.4438/RHO2    !booster dipole
DH3: SBEND, L=LD2,   ANGLE=ANG2, K1=-3.918E-3/RHO2, &
                     E1=E00, E2=E00, K2=-0.4438/RHO2    !booster dipole
DH4: RBEND, L=LD1,   ANGLE=0.01708
DH5: RBEND, L=LD5,   ANGLE=-0.14079
```

```
!
!
! Quadrupoles
!
!   Strengths and Currents
!      (T/m)*m power series vs I, per Blesser 3/24/92
!
NQA := 4.363E-02          !Narrow, Q1-Q4, Q15
NQB := 9.266E-03
NQC := 6.309E-06
NQD :=-8.609E-09
NQE := 2.226E-12
!
BQA := 1.907E-02          !Broad, Q5-Q14
BQB := 3.868E-03
BQC := 2.538E-06
BQD :=-2.952E-09
BQE := 6.995E-13
!
IQ1  :=  0.0
IQ2  :=  0.0
IQ3  :=  0.0
IQ4  :=  0.0
IQ5  :=  0.0
IQ6  :=  0.0
IQ7  :=  0.0
IQ8  :=  0.0
IQ9  :=  0.0
IQ10 :=  0.0
IQ11 :=  0.0
IQ12 :=  0.0
IQ13 :=  0.0
IQ14 :=  0.0
IQ15 :=  0.0
!
! Quad Gradients
!
Q1G  := (NQA +  IQ1*(NQB +  IQ1*(NQC +  IQ1*(NQD +  IQ1*NQE))))/LQ1
Q2AG := (NQA +  IQ2*(NQB +  IQ2*(NQC +  IQ2*(NQD +  IQ2*NQE))))/LQ1
Q2BG := (NQA +  IQ2*(NQB +  IQ2*(NQC +  IQ2*(NQD +  IQ2*NQE))))/LQ1
Q3G  := (NQA +  IQ3*(NQB +  IQ3*(NQC +  IQ3*(NQD +  IQ3*NQE))))/LQ1
Q4G  := (NQA +  IQ4*(NQB +  IQ4*(NQC +  IQ4*(NQD +  IQ4*NQE))))/LQ1
Q5G  := (BQA +  IQ5*(BQB +  IQ5*(BQC +  IQ5*(BQD +  IQ5*BQE))))/LQ5
Q6G  := (BQA +  IQ6*(BQB +  IQ6*(BQC +  IQ6*(BQD +  IQ6*BQE))))/LQ5
Q7G  := (BQA +  IQ7*(BQB +  IQ7*(BQC +  IQ7*(BQD +  IQ7*BQE))))/LQ5
Q8G  := (BQA +  IQ8*(BQB +  IQ8*(BQC +  IQ8*(BQD +  IQ8*BQE))))/LQ5
Q9G  := (BQA +  IQ9*(BQB +  IQ9*(BQC +  IQ9*(BQD +  IQ9*BQE))))/LQ5
Q10G := (BQA + IQ10*(BQB + IQ10*(BQC + IQ10*(BQD + IQ10*BQE))))/LQ5
Q11G := (BQA + IQ11*(BQB + IQ11*(BQC + IQ11*(BQD + IQ11*BQE))))/LQ5
Q12G := (BQA + IQ12*(BQB + IQ12*(BQC + IQ12*(BQD + IQ12*BQE))))/LQ5
Q13G := (BQA + IQ13*(BQB + IQ13*(BQC + IQ13*(BQD + IQ13*BQE))))/LQ5
Q14G := (BQA + IQ14*(BQB + IQ14*(BQC + IQ14*(BQD + IQ14*BQE))))/LQ5
Q15G := (NQA + IQ15*(NQB + IQ15*(NQC + IQ15*(NQD + IQ15*NQE))))/LQ1
!
QV1:    QUAD,  L=LQ1,   K1=-Q1G/BRHO
QH2A:   QUAD,  L=LQ1,   K1=Q2AG/BRHO
QH2B:   QUAD,  L=LQ1,   K1=Q2BG/BRHO
QV3:    QUAD,  L=LQ1,   K1=-Q3G/BRHO
QH4:    QUAD,  L=LQ1,   K1=Q4G/BRHO
QV5:    QUAD,  L=LQ5,   K1=-Q5G/BRHO
QH6:    QUAD,  L=LQ5,   K1=Q6G/BRHO
QV7:    QUAD,  L=LQ5,   K1=-Q7G/BRHO
QH8:    QUAD,  L=LQ5,   K1=Q8G/BRHO
QV9:    QUAD,  L=LQ5,   K1=-Q9G/BRHO
QH10:   QUAD,  L=LQ5,   K1=Q10G/BRHO
QV11:   QUAD,  L=LQ5,   K1=-Q11G/BRHO
QH12:   QUAD,  L=LQ5,   K1=Q12G/BRHO
QV13:   QUAD,  L=LQ5,   K1=-Q13G/BRHO
QH14:   QUAD,  L=LQ5,   K1=Q14G/BRHO
QV15:   QUAD,  L=LQ1,   K1=-Q15G/BRHO
!
! Correctors
```

```
!
DV007: VKICK, L=LC1, KICK=00
DH127: HKICK, L=LC2, KICK=00
DV141: VKICK, L=LC2, KICK=00
DH158: HKICK, L=LC2, KICK=00
DV168: VKICK, L=LC2, KICK=00
DH181: HKICK, L=LC2, KICK=00
!
! Beam position monitors
!
PUEH001: MONITOR
PUEV046: MONITOR
PUEV129: MONITOR
PUEH143: MONITOR
PUEV160: MONITOR
PUEH170: MONITOR
!
! Beam profile monitors
!
MW006: MARKER
MW060: MARKER
MW125: MARKER
MW166: MARKER
!
! Markers
!
SPTMF6:   MARKER       !Booster extr septum
XF019:    MARKER
FOIL024:  MARKER
XF059:    MARKER
MK077:    MARKER       !  mid-point of long drift (Q7 - Q8)
MK139:    MARKER
MK156:    MARKER
XF183:    MARKER
SHOLE:    MARKER       !single hole
SPTMA05:  MARKER       !AGS inj septum
!
! Sublines
!
L1:  LINE=(SPTMF6, DR000, PUEH001, DR001, MW006, DR006, DV007, DR007,     &
                                              QV1, DRQ1, DH1)
!
L2A: LINE=(DRD1, QH2A, DRQ2A, QH2B, DRQ2B, XF019, DR019, QV3,             &
                             DRQ3, FOIL024)
L2B: LINE =(DR024, QH4, DRQ4, DH2)
!
L3:  LINE=(DRD2, QV5, DRQ5, PUEV046, DR046, DH3)
!
L4:  LINE=(DRD3, QH6, DRQ6, XF059, DR059, MW060, DR060, QV7,              &
                              DRQ7Y, MK077, DRQ7Z, QH8, DRQ8, DH4)
!
L5:  LINE=(DRD4,    QV9, DRQ9,              QH10, DRQ10, MW125, DR125,   &
                DH127, DR127, PUEV129, DR129, QV11, DRQ11, MK139, DR139,  &
                DV141, DR141, PUEH143, DR143, QH12, DRQ12, MK156, DR156,  &
                DH158, DR158, PUEV160, DR160, QV13, DRQ13, MW166, DR166,  &
                DV168, DR168, PUEH170, DR170, QH14, DRQ14,              DH5)
!
L6:  LINE=(DRD5, DH181, DR181, XF183, DR183, QV15, DRQ15, SHOLE)
!
! BTA
!
BTA:      LINE = (L1, L2A,L2B, L3, L4, L5, L6)
BTATOFL: LINE = (L1, L2A)
BTAFMFL: LINE = (L2B, L3, L4, L5, L6)
```

5/27/92

new: I → B1 map

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA NARROW QUAD
LOCATIONS: QH1,QH2A,QH2B,QV3,QH4,QV15
PREPARED: 3/24/92, EJB

B1*Leff = A + B*I + C*I^2 + D*I^3 + E*I^4

MEASURED DATA FOR BTAQ1

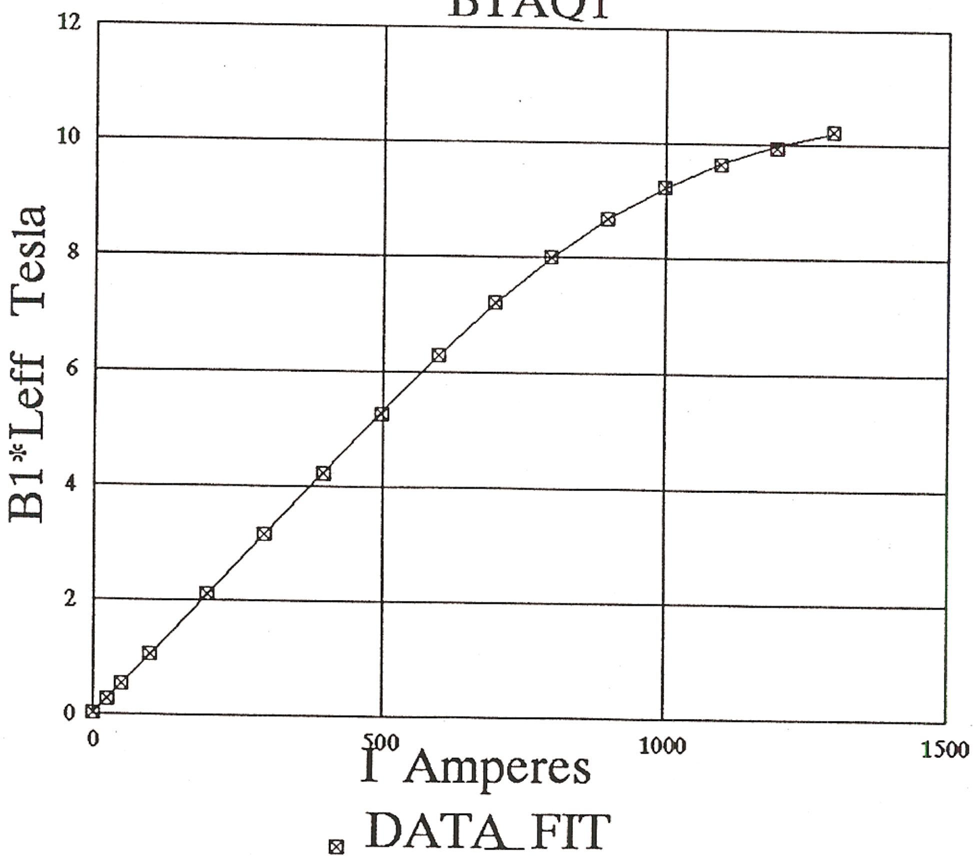
I Amperes	B1*Leff Tesla
0.0	0.016
24.6	0.265
49.5	0.527
99.4	1.053
199.2	2.108
298.7	3.160
398.4	4.212
498.2	5.257
598.0	6.280
697.5	7.213
797.3	8.003
897.1	8.675
996.9	9.232
1096.5	9.631
1196.3	9.943
1296.1	10.217

RESULTS OF FITTING

	COEFF
A =	4.363 E−02
B =	9.266 E−03
C =	6.309 E−06
D =	−8.609 E−09
E =	2.226 E−12

	STD ERROR
A =	3.16 E−02
B =	0.31 E−03
C =	1.09 E−06
D =	1.30 E−09
E =	0.50 E−12

FIT TO NARROW BTA QUAD DATA
BTAQ1



MARCH 23, 1992
E:\BTAMAG\BBTA\BTAQ1FT.WK3; FIT4

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA NARROW QUAD
LOCATIONS: QH1,QH2A,QH2B,QV3,QH4,QV15
PREPARED: 5/18/92, EJB

LET X = B1*Leff

I = A + B*X +C*X^2 + D*X^3 + E*X^4 +F*X^5

DATA FOR BTAQ1

B1*Leff Tesla	MEAS I Amperes	FIT I Amperes
0.016	0.0	-16.5
0.265	24.6	16.3
0.527	49.5	47.4
1.053	99.4	102.7
2.108	199.2	199.8
3.160	298.7	295.7
4.212	398.4	396.9
5.257	498.2	500.4
6.280	598.0	601.9
7.213	697.5	697.9
8.003	797.3	791.6
8.675	897.1	892.6
9.232	996.9	1002.0
9.631	1096.5	1101.8
9.943	1196.3	1195.9
10.217	1296.1	1292.8

RESULTS OF FITTING

	COEFF
A =	-18.752
B =	140.000
C =	-31.868
D =	9.123
E =	-1.150
F =	0.0539

	STD ERROR
A =	4.56
B =	21.83
C =	11.98
D =	2.73
E =	0.27
F =	0.010

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA NORMAL QUAD
LOCATIONS: QV5,QH6,QV7,QH8,QV9,QH10,QV11,QH12,QV13,QH14
PREPARED: 3/24/92, EJB

B1*Leff = A + B*I + C*I^2 + D*I^3 + E*I^4

MEASURED DATA FOR
BTAQ05

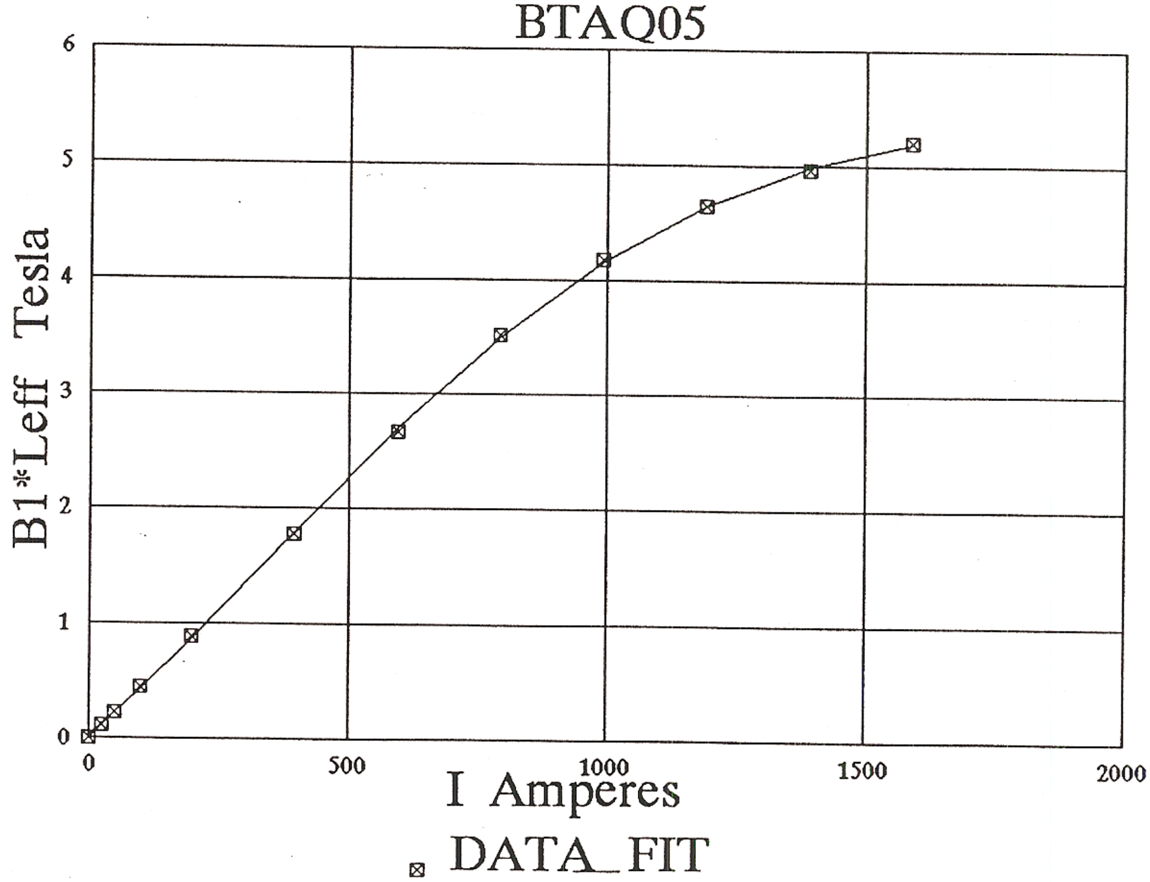
I Amperes	B1*Leff Tesla
0.0	0.000
24.7	0.112
49.5	0.222
99.2	0.443
198.6	0.887
397.3	1.774
596.4	2.658
795.1	3.511
994.4	4.180
1192.8	4.647
1391.6	4.964
1591.1	5.200

RESULTS OF FITTING

	COEFF
A =	1.907E−02
B =	3.868E−03
C =	2.538E−06
D =	−2.952E−09
E =	6.995E−13

	STD ERROR
A =	2.36E−02
B =	2.14E−04
C =	6.17E−07
D =	6.05E−10
E =	1.89E−13

FIT TO NORMAL BTA QUAD DATA
BTAQ05



MARCH 24, 1992
E:\BTAMAG\BBTA\BTAQ5FT.WK3; FIT4

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA NORMAL QUAD
LOCATIONS: QV5,QH6,QV7,QH8,QV9,QH10,QV11,QH12,QV13,
PREPARED: 5/18/92, EJB

LET X = B1*Leff

I = A + B*X + C*X^2 + D*X^3 + E*X^4 + F*X^5

DATA FOR BTAQ05

B1*Leff Tesla	MEAS I Amperes	FIT I Amperes
0	0.0	-8.967
0.111513	24.7	20.719
0.221845	49.5	48.484
0.44326	99.2	100.744
0.887082	198.6	198.733
1.774034	397.3	395.580
2.657603	596.4	598.009
3.511294	795.1	796.234
4.180247	994.4	990.584
4.647032	1192.8	1194.419
4.963837	1391.6	1393.833
5.19978	1591.1	1589.472

RESULTS OF FITTING

	COEFF
A =	-8.967
B =	274.726
C =	-82.028
D =	52.747
E =	-14.700
F =	1.504

	STD ERROR
A =	2.950
B =	26.034
C =	29.537
D =	13.721
E =	2.777
F =	0.203

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA SHORT DIPOLE
LOCATIONS:DH1 , DH4
PREPARED: 3/24/92, EJB

B0*Leff = A + B*I + C*I^2 + D*I^3 + E*I^4

MEASURED DATA FOR
BTAD01

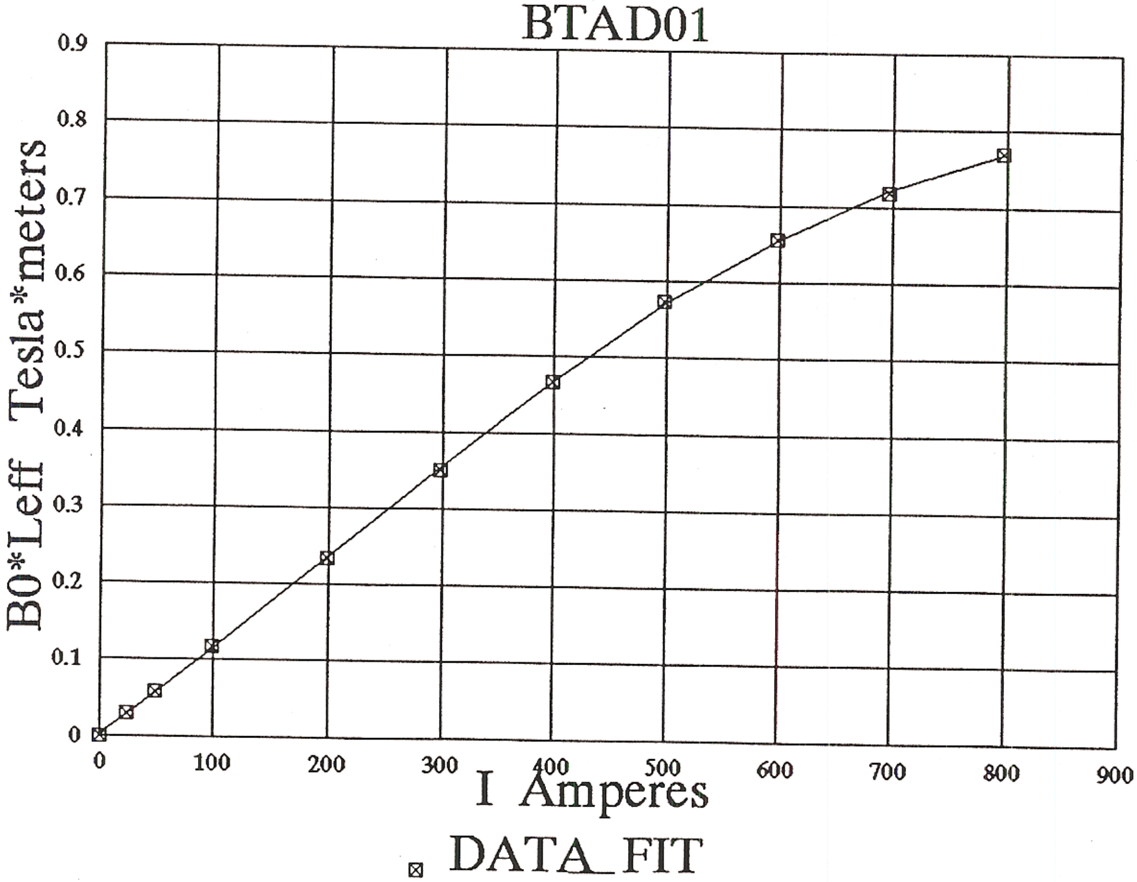
I Amperes	B0*Leff Tesla*meters
0.0	0.0000
24.4	0.0287
49.3	0.0580
99.2	0.1168
199.0	0.2341
298.6	0.3508
398.2	0.4660
498.0	0.5736
597.8	0.6547
697.3	0.7176
797.0	0.7695

RESULTS OF FITTING

	COEFF
A =	1.990E−03
B =	1.071E−03
C =	7.783E−07
D =	−1.531E−09
E =	4.798E−13

	STD ERROR
A =	3.28E−03
B =	6.24E−05
C =	3.51E−07
D =	6.80E−10
E =	4.23E−13

FIT TO 18 INCH BTA DIPOLE DATA
BTAD01



MARCH 24, 1992
E:\BTAMAG\BBTA\BTAD01.WK3; FIT4

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA SHORT DIPOLE
LOCATIDH1, DH4
PREPARED: 5/18/92, EJB

LET X = B0*Leff
I = A + B*X +C*X^2 + D*X^3 + E*X^4

DATA FOR BTAD01

B0*Leff Tesla*met	MEAS I Amperes	FIT I Amperes
0	0.00	7.50
0.028693	24.37	27.58
0.057981	49.32	49.83
0.11675	99.21	98.10
0.234087	199.02	199.86
0.350777	298.61	299.07
0.466035	398.15	396.41
0.57355	497.96	499.31
0.654678	597.77	598.04
0.71762	697.26	696.31
0.769532	797.03	797.40

RESULTS OF FITTING

	COEFF
A =	7.50
B =	664.69
C =	1320.39
D =	-3504.62
E =	3118.41

	STD ERROR
A =	1.45
B =	63.43
C =	300.22
D =	532.77
E =	316.42

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA LONG DIPOLE
LOCATIONS: DH5
PREPARED: 5/18/92, EJB

B0*Leff = A + B*I +C*I^2 + D*I^3 + E*I^4

DATA SCALED FROM
BTAD01

I AMPS	MEAS B0*Leff Tesla*met	FIT B0*Leff Tesla*met
0	0.0000	0.0110
24.37	0.0607	0.0645
49.32	0.1226	0.1215
99.21	0.2469	0.2413
199.02	0.4950	0.4942
298.61	0.7417	0.7484
398.15	0.9854	0.9886
497.96	1.2128	1.2033
597.77	1.3843	1.3835
697.26	1.5174	1.5240
797.03	1.6272	1.6247

RESULTS OF FITTING

	COEFF
A =	1.103E-02
B =	2.141E-03
C =	2.217E-06
D =	-4.204E-09
E =	1.555E-12

	STD ERROR
A =	6.956E-03
B =	1.827E-04
C =	9.453E-07
D =	1.748E-09
E =	1.054E-12

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA LONG DIPOLE
LOCATIONS: DH5
PREPARED: 5/18/92, EJB

LET X = B0*Leff
I = A + B*X +C*X^2 + D*X^3 + E*X^4

DATA SCALED FROM
BTAD01

B0*Leff Tesla*met	MEAS I Amperes	FIT I Amperes
0	0.00	3.81
0.060672	24.37	25.27
0.1226	49.32	48.58
0.246868	99.21	98.16
0.494977	199.02	200.39
0.741718	298.61	299.04
0.98543	398.15	396.08
1.212772	497.96	499.22
1.384315	597.77	598.25
1.517407	697.26	696.51
1.627176	797.03	797.21

RESULTS OF FITTING

	COEFF
A =	3.81
B =	340.11
C =	243.11
D =	-330.30
E =	145.40

	STD ERROR
A =	1.50
B =	21.19
C =	52.13
D =	46.25
E =	13.48

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA SHORT CORRECTION MAGNET
LOCATIONS:DV007
PREPARED: 3/24/92, EJB

B0*Leff = A + B*I + C*I^2

MEASURED DATA FOR
BTAC01

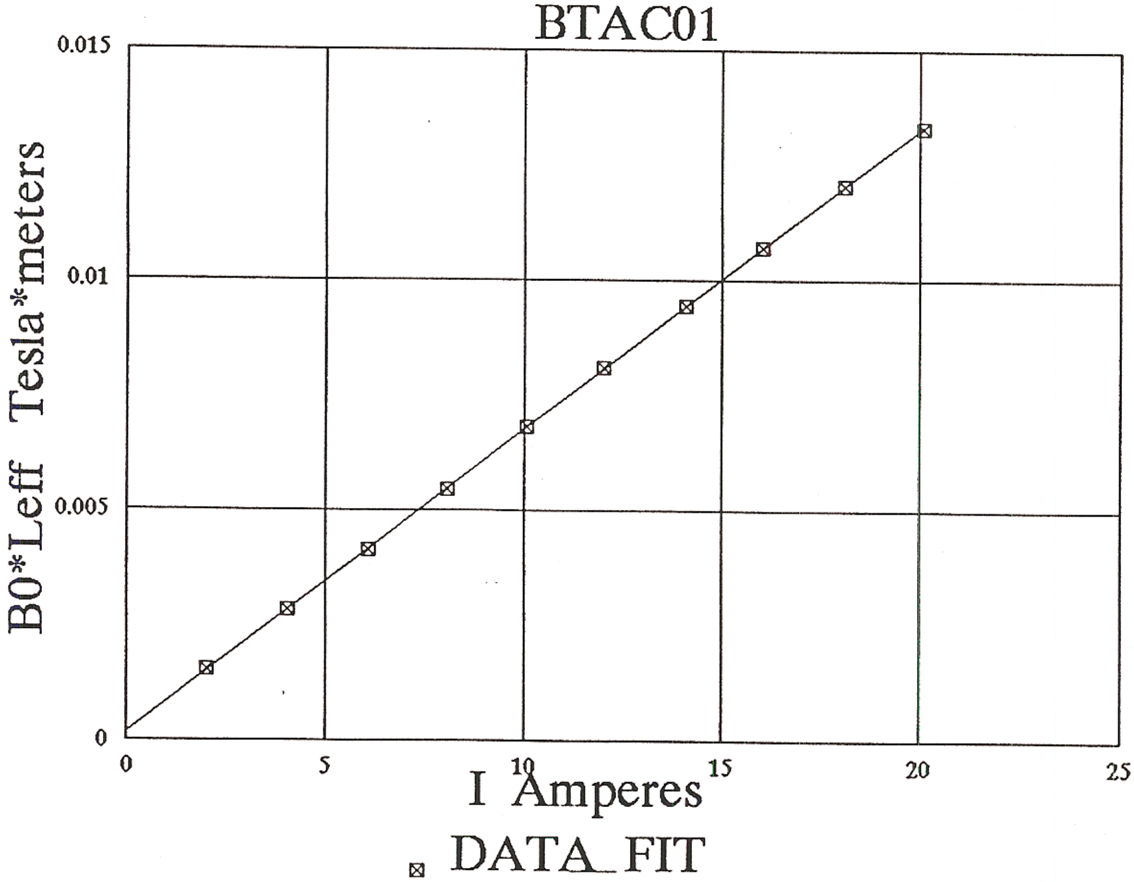
I Amperes	B0*Leff Tesla*meters
0.00	NA
2.05	0.00154
4.06	0.00281
6.07	0.00413
8.06	0.00544
10.07	0.00678
12.00	0.00808
14.09	0.00945
16.03	0.01071
18.10	0.01205
20.07	0.01332

RESULTS OF FITTING

	COEFF
A =	1.586E−04
B =	6.589E−04
C =	−9.611E−08

	STD ERROR
A =	2.48E−05
B =	6.09E−06
C =	2.68E−07

SHORT BTA CORRECTION MAGNET DAT
BTAC01



MARCH 24, 1992
E:\BTAMAG\BBTA\BTAC01FT.WK3; FIT2

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA SHORT CORRECTION MAGNET
LOCATIONS: DV007
PREPARED: 5/19/92, EJB

X = B0*Leff
I = A + B*X + C*X^2

MEASURED DATA FOR
BTAC01

B0*Leff Tesla*met	MEAS I Amperes	FIT I Amperes
NA	0.00	NA
0.00154	2.05	2.0975
0.002814	4.06	4.0332
0.004128	6.07	6.0309
0.005443	8.06	8.0294
0.006777	10.07	10.0595
0.008077	12.00	12.0401
0.009446	14.09	14.1248
0.010706	16.03	16.0465
0.012052	18.10	18.0987
0.013322	20.07	20.0385

RESULTS OF FITTING

	COEFF
A =	-0.240
B =	1517.373
C =	354.740

	STD ERROR
A =	0.038
B =	14.555
C =	956.178

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA NORMAL CORRECTION MAGNET
LOCATIONS:DH127, DV141, DH158, DV168, DV181
PREPARED: 3/24/92, EJB

B0*Leff = A + B*I + C*I^2

MEASURED DATA FOR
BTAC02

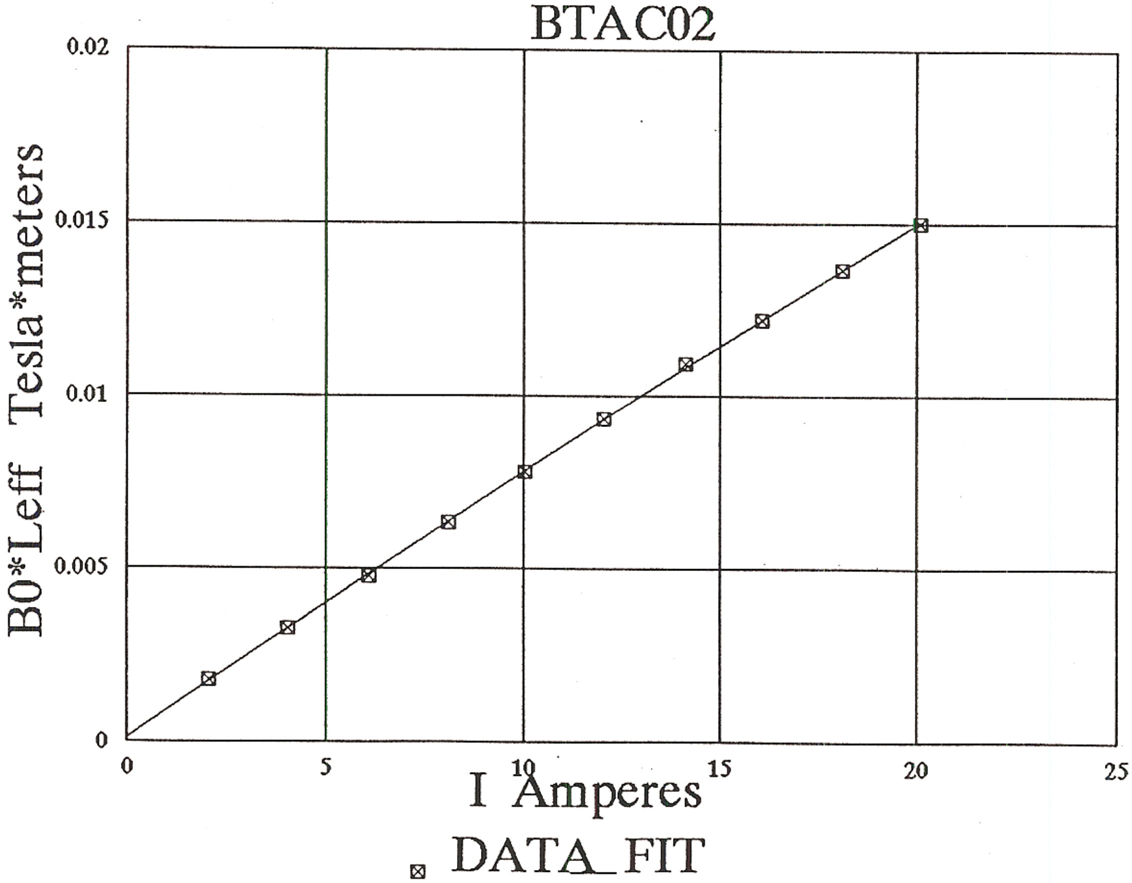
I Amperes	B0*Leff Tesla*meters
0.0	NA
2.1	0.0018
4.1	0.0033
6.1	0.0048
8.1	0.0063
10.0	0.0078
12.0	0.0093
14.1	0.0109
16.0	0.0122
18.1	0.0137
20.1	0.0150

RESULTS OF FITTING

	COEFF
A =	1.000E−04
B =	7.944E−04
C =	−2.479E−06

	STD ERROR
A =	5.56E−05
B =	1.37E−05
C =	6.04E−07

NORMAL BTA CORRECTION MAGNET DA
BTAC02



MARCH 24, 1992
E:\BTAMAG\BBTA\BTAC02FT.WK3; FIT2

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
BTA NORMAL CORRECTION MAGNET
LOCATIONS: DH127, DV141, DH158, DV168, DV181
PREPARED: 5/19/92, EJB

X = B0*Leff
I = A + B*X + C*X^2

MEASURED DATA FOR
BTAC02

B0*Leff Tesla*met	MEAS I Amperes	FIT I Amperes
NA	0.00	NA
0.001795	2.08	2.1539
0.003261	4.05	4.0296
0.004785	6.09	6.0063
0.006326	8.09	8.0353
0.007793	10.02	9.9938
0.009319	12.05	12.0592
0.010936	14.13	14.2797
0.012199	16.05	16.0349
0.013658	18.09	18.0877
0.01502	20.08	20.0274

RESULTS OF FITTING

COEFF
A = -0.107
B = 1248.492
C = 6129.282

STD ERROR
A = 0.078
B = 27.183
C = 1576.848

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
MAIN DIPOLE
LOCATIONS: DH2, DH3
PREPARED: 5/19/92, EJB

X = B0*Leff
I = A + B*X + C*X^2 + D*X^3 + E*X^4 + F*X^5

MEASURED DATA FOR BMD000

B0*Leff T*m	MEAS I AMPERES	FIT I AMPERES
0.001791	0	-2.19451
0.030826	50	49.14203
0.059972	100	100.2885
0.118428	200	201.8603
0.235754	400	402.6912
0.353368	600	601.5655
0.471099	800	799.6678
0.588934	1000	997.9986
0.824388	1400	1396.611
1.059633	1800	1798.624
1.294521	2200	2202.034
1.528859	2600	2603.834
1.762699	3000	3002.666
1.994625	3400	3397.975
2.223399	3800	3794.553
2.336137	4000	3996.295
2.446223	4200	4200.207
2.55121	4400	4403.569
2.650123	4600	4605.708
2.740747	4800	4802.319
2.823939	5000	4994.585

RESULTS OF FITTING

COEFF

A = -5.37434
B = 1776.103
C = -255.124
D = 301.8492
E = -146.187
F = 25.15767

STD ERROR

A = 3.557049
B = 23.25641
C = 59.03624
D = 56.31998
E = 22.46429
F = 3.172225

BTA MAGNETS
FIT TO FIELD SHAPE MEASUREMENTS
MAIN DIPOLE
LOCATIONS: DH2, DH3
PREPARED: 5/19/92, EJB

B0*Leff = A + B*I + C*I^2 + D*I^3 + E*I^4 + F*I^5

MEASURED DATA FOR BMDOOO

I Amperes	MEAS B0*Leff T*m	FIT B0*Leff T*m
0	0.001791	0.002266
50	0.030826	0.031036
100	0.059972	0.059925
200	0.118428	0.118013
400	0.235754	0.235121
600	0.353368	0.352991
800	0.471099	0.471182
1000	0.588934	0.589391
1400	0.824388	0.825201
1800	1.059633	1.059943
2200	1.294521	1.294008
2600	1.528859	1.527996
3000	1.762699	1.762061
3400	1.994625	1.995242
3800	2.223399	2.224812
4000	2.336137	2.336743
4200	2.446223	2.445611
4400	2.55121	2.550283
4600	2.650123	2.64939
4800	2.740747	2.741311
5000	2.823939	2.824148

RESULTS OF FITTING

COEFF

A	=	0.002266
B	=	0.000574
C	=	2.7E-08
D	=	-1.8E-11
E	=	5.2E-15
F	=	-5.4E-19

STD ERROR

A	=	0.000742
B	=	2.7E-06
C	=	3.9E-09
D	=	2.1E-12
E	=	4.7E-16
F	=	3.8E-20

BTASER 12/18/91

SERIAL NUMBERS OF MAGNETS ALONG BTA LINE

QH1	?		9"
QH2A	BTAQ2A	N	
QH2B	BTAQ2B	N	
QV3	BTAQV3	N	
QH4	BTAQV4	N	
QV5	BTAQ05	B	
QH6	BTAQ06	B	
QV7	BTAQ07	B	
QH8	BTAQ08	B	
QV9	BTAQ09	B	
QH10	BTAQ10	B	
QV11	BTAQ11	B	
QH12	BTAQ012	B	
QV13	BTAQ013	B	
QH14	BTAQ014	B	
QV15	BTAQ15	N	
DH1	BTAD01		18 "
DH2	BMD06	B	
DH3	BMD00	B	
DH4			18"
DH5	BTAD5		44"
DV007	?		9"
DH127	BTAC06		9.5"
DV141	BTAC05		9.5"
DH158	BTAC07		9.5"
DV168	BTAC03		9.5"
DV181	BTAC02		9.5"