

Chromaticity Correction for the AGS Booster with 1,2,4,7 Sextupole Configuration

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CHROMATICITY CORRECTION
for the
AGS BOOSTER
with
1,2,4,7 SEXTUPOLE CONFIGURATION

Booster Technical Note
No. 17

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ABSTRACT

THIS NOTE DESCRIBES THE EFFECT OF THE CHROMATICITY CORRECTION SEXTUPOLES 1,2,4,7 CONFIGURATION SELECTED FOR THE AGS - BOOSTER. RESULTS OBTAINED FROM SYNCHROTRON DESIGN PROGRAM SYNCH AND A SCHEMATIC LAYOUT OF THE LATTICE ARE ALSO INCLUDED.

INTRODUCTION:

We have studied the implications of various chromaticity sextupole correction configurations for the AGS - Booster. In section II we present our results for the 1,2,4,7 configuration which was selected for the Booster. Amplitude (BETAX, BETAY) and dispersion functions for the Booster are shown in Figure 1.

The AGS Booster is designed to be an intermediate synchrotron injector for the AGS, capable of accelerating protons from 200 MeV, the Linac operating energy to 1 GeV, (with the possibility of an upgrade to 2.5 GeV), at 10 Hz repetition rate and Heavy Ions to magnetic rigidity equal to 16.7 Tesla-Meter at a 1 Hz repetition rate.

As presently designed, the Booster will have [ref1]: i) a circumference equal to one quarter that of AGS; ii) it will have a FODO lattice with bending magnets missing in some cells in order to accommodate the space needed for RF acceleration, injection, ejection and abort system without otherwise interrupting the periodicity; and iii) this specific lattice structure consists of six identical superperiods [ref.1]. Booster coordinates and parameter list are given in references 2 and 3.

References:

1. The Booster Lattice, Booster Tech. Note No. 1, E. Courant, Z. Parsa, January 15, 1986.
2. Booster Coordinates, Booster Tech. Note No. 6, Z. Parsa, January 28, 1986.
3. Booster Parameter List, Booster Tech. Note No. 10, Z. Parsa, February 12, 1986.
4. usig BNLDAG::DUAO:[PARSA1.BOOSTER]SYNBOOST17.DAT as input. We obtained similar results using program MAD403 with [PARSA1.BOOSTER]MADBOOST.DAT as input).
5. Calculation of Eddy Currents, Booster Tech. Note No. 4, G. Morgan and S. Kahn, (January 1986).
6. See subsequent BST/TN on chromaticity correcting sextupoles and other correcting devices.

SECTION II

In this section we show the effect of the chromaticity correcting sextupoles 1,2,4,7 configuration for the AGS-Booster.

We have selected two families of sextupoles, located at 1,7 (SF), 2,4 (SD) per superperiod. Therefore the total number of sextupoles for the AGS-Booster is 24 (12 SF + 12 SD); each of 10 cm length; with aperture of 16.52 cm. We note that, at 1 GeV with integrated strength of 1.761 [T/m]; the injection pole tip fields for protons (including Polarized protons) is 0.45761 [KG], and for Heavy Ions is 0.03065 A/Q . Whereas, the ejection pole tip field for protons (including Polarized protons) is 1.2015 [KG], and for Heavy Ions is 3.5504 [KG] respectively.

Following tables give the summary of the parameters obtained for the AGS - Booster from program "SYNCH" [Ref. 4] with proton injection at 200 MeV, (BRHC= 2.14962 T-M and B = .156325 T), betatron tune QX = 4.82, QY = 4.83, and the Booster Circumference = 201.78 m . Tables I, II, and III shows the betatron functions and the amplitude dependence of tunes for linear lattice, eddy current sextupoles and correction sextupole configuration 1,2,4,7 [for DP/P = -0.002, 0, +0.002] respectively.

We note that; Eddy Current sextupole strengths are taken to be 0.12 Tesla per meter square [Ref. 5]; and in case III, chromaticity correction sextupoles are added (to Eddy Current sextupoles) to make the overall chromaticity zero. Alternate sextupole configurations was studied but the 1,2,4,7 configurations was selected since it exhibits reasonably small amplitude dependence of tunes, and sextupole strength; also accommodates the space required for the injection and ejection; (although we will continue with our studies of other sextupole configurations which may become more suitable for the Booster) [Ref. 6].

TABLE I

BETATRON FUNCTIONS [LINEAR LATTICE]			

CIRCUMFERENCE =	201.7800 M		
RADIUS =	32.1143 M		
THETX =	6.28319424 RAD	NUX =	4.82000
THETY =	0.00000000 RAD	NUY =	4.83000
DNUX/(DP/P) =	-4.92970	DS/S)/(DP/P) =	.0419702
DNUY/(DP/P) =	-5.26488	TGAM =	(4.88123, 0.00000)
MAXIMA			

BETX(13) =	13.86571	BETY(36) =	13.64403
XEQ(23) =	2.95145	YEQ(36) =	0.00000
MINIMA			

BETX(10) =	3.57537	BETY(23) =	3.70334
XEQ(1) =	.54003	YEQ(36) =	0.00000

TABLE II

NO CHROMATICITY SEXTUPOLE [EDDY CURRENT SEXTUPOLES +.12 TM-2 @ PROTON INJECTION]			
CIRCUMFERENCE =	201.7800 M	THETX =	6.28319424 RAD
RADIUS =	32.1143 M	THETY =	0.00000000 RAD
NUX =	4.82000	DNUX/(DP/P) =	4.03907
NUY =	4.83000	DNUY/(DP/P) =	-13.15549
(DS/S)/(DP/P) = .0419702		TGAM=(4.88123, 0.00000)	
MAXIMA -----			
BETX(21) =	13.86571	BETY(56) =	13.64403
XEQ(37) =	2.95145	YEQ(56) =	0.00000
MINIMA -----			
BETX(18) =	3.57537	BETY(37) =	3.70334
XEQ(1) =	.54003	YEQ(56) =	0.00000
SEXTUPOLE CORRECTIONS -----			
DKSF =	.68771833E-01	DKSD =	-.81038396E+00
KSF =	.68771833E-01	KSD =	-.81038396E+00

AMPLITUDE DEPENDENCE OF TUNES DUE TO SEXTUPOLES			
NU-X =	4.820000 - .223E+02EX + .110E+02EY		
NU-Y =	4.830000 + .110E+02EX - .188E+02EY		

TABLE III A

CHROMATICITY SEXTUPOLES at 1,2,4,7 for DP/P = -0.002		
CIRCUMFERENCE =	201.7631 M	THETX = 6.29578581 RAD
RADIUS =	32.1116 M	THETY = 0.00000000 RAD
NUX = 4.82120	DNUX/(DP/P) = -.09800	
NUY = 4.82989	DNUY/(DP/P) = .15190	
(DS/S)/(DP/P) = .0417355 TGAM=(4.89494,0.00000)		
MAXIMA		

BETX(21) = 13.78978	BETY(18) = 13.72915	
XEQ(37) = 2.96406	YEQ(56) = 0.00000	
MINIMA		

BETX(18) = 3.56555	BETY(49) = 3.64829	
XEQ(1) = .52395	YEQ(56) = 0.00000	

MAXIMA	XCO(56) = -1.06329	YCO(56) = 0.00000
MINIMA	XCO(37) = -5.91570	YCO(56) = 0.00000

AMPLITUDE DEPENDENCE OF TUNES DUE TO SEXTUPOLES		
NU-X =	4.821203 + .121E+02EX - .972E+00EY	
NU-Y =	4.829891 - .972E+00EX + .866E+02EY	

TABLE III B

 CHROMATICITY SEXTUPOLES at 1,2,4,7 for DP/P = 0.000

CIRCUMFERENCE = 201.7800 M THETX = 6.28319424 RAD
 RADIUS = 32.1143 M THETY = 0.00000000 RAD

NUX = 4.82000 DNUX/(DP/P) = .00000
 NUY = 4.83000 DNUY/(DP/P) = -.00000

(DS/S)/(DP/P) = .0419702 TGAM=(4.88123,0.00000)

 MAXIMA

BETX(21) = 13.86571 BETY(56) = 13.64403
 XEQ(37) = 2.95145 YEQ(56) = 0.00000

 MINIMA

BETX(18) = 3.57537 BETY(37) = 3.70334
 XEQ(1) = .54003 YEQ(56) = 0.00000

MAXIMA	XCO(56) = 0.00000	YCO(56) = 0.00000
MINIMA	XCO(56) = 0.00000	YCO(56) = 0.00000

AMPLITUDE DEPENDENCE OF TUNES DUE TO SEXTUPOLES

NU-X = 4.820000 + .117E+02EX - .502E+00EY
 NU-Y = 4.830000 - .502E+00EX + .870E+02EY

TABLE III C

CHROMATICITY SEXTUPOLES at 1,2,4,7 for DP/P = +0.002			

CIRCUMFERENCE =	201.7969 M	THETX =	6.27065293 RAD
RADIUS =	32.1170 M	THETY =	0.00000000 RAD
NUX =	4.81900	DNUX/(DP/P) =	.09520
NUY =	4.82989	DNUY/(DP/P) =	-.15310
(DS/S)/(DP/P) = .0421948 TGAM=(4.86822,0.00000)			
MAXIMA			

BETX(21) =	13.94219	BETY(56) =	13.72988
XEQ(37) =	2.93877	YEQ(56) =	0.00000
MINIMA			

BETX(18) =	3.58513	BETY(21) =	3.64963
XEQ(56) =	.55591	YEQ(56) =	0.00000

MAXIMA XCO(37)=	5.89008	YCO(56)=	0.00000
MINIMA XCO(1)=	1.09668	YCO(56)=	0.00000

AMPLITUDE DEPENDENCE OF TUNES DUE TO SEXTUPOLES			
NU-X =	4.818997 + .114E+02EX - .960E-01EY		
NU-Y =	4.829890 - .960E-01EX + .874E+02EY		

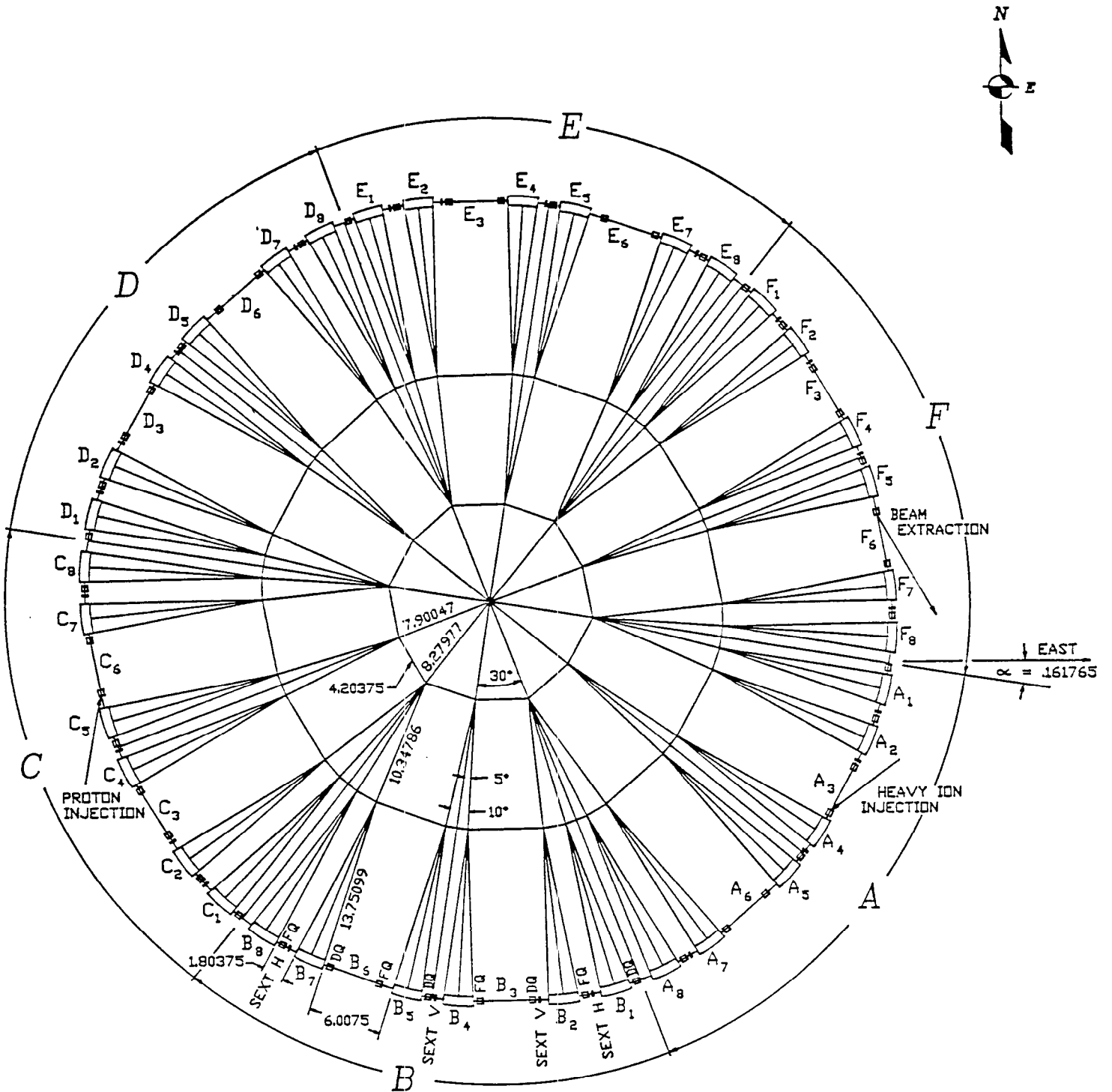
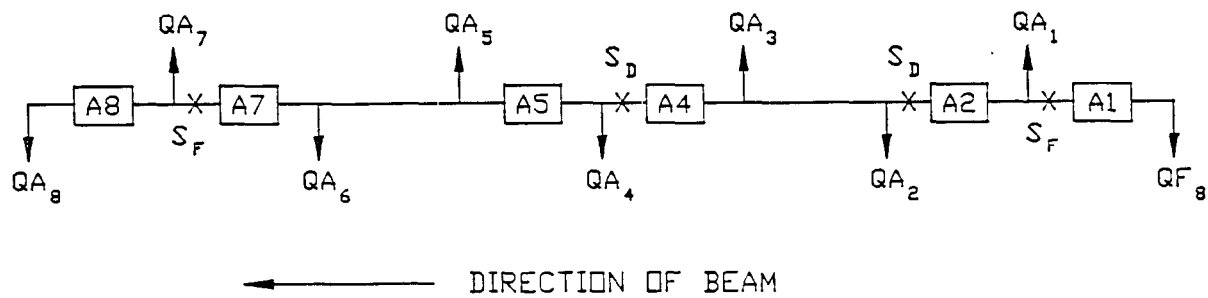
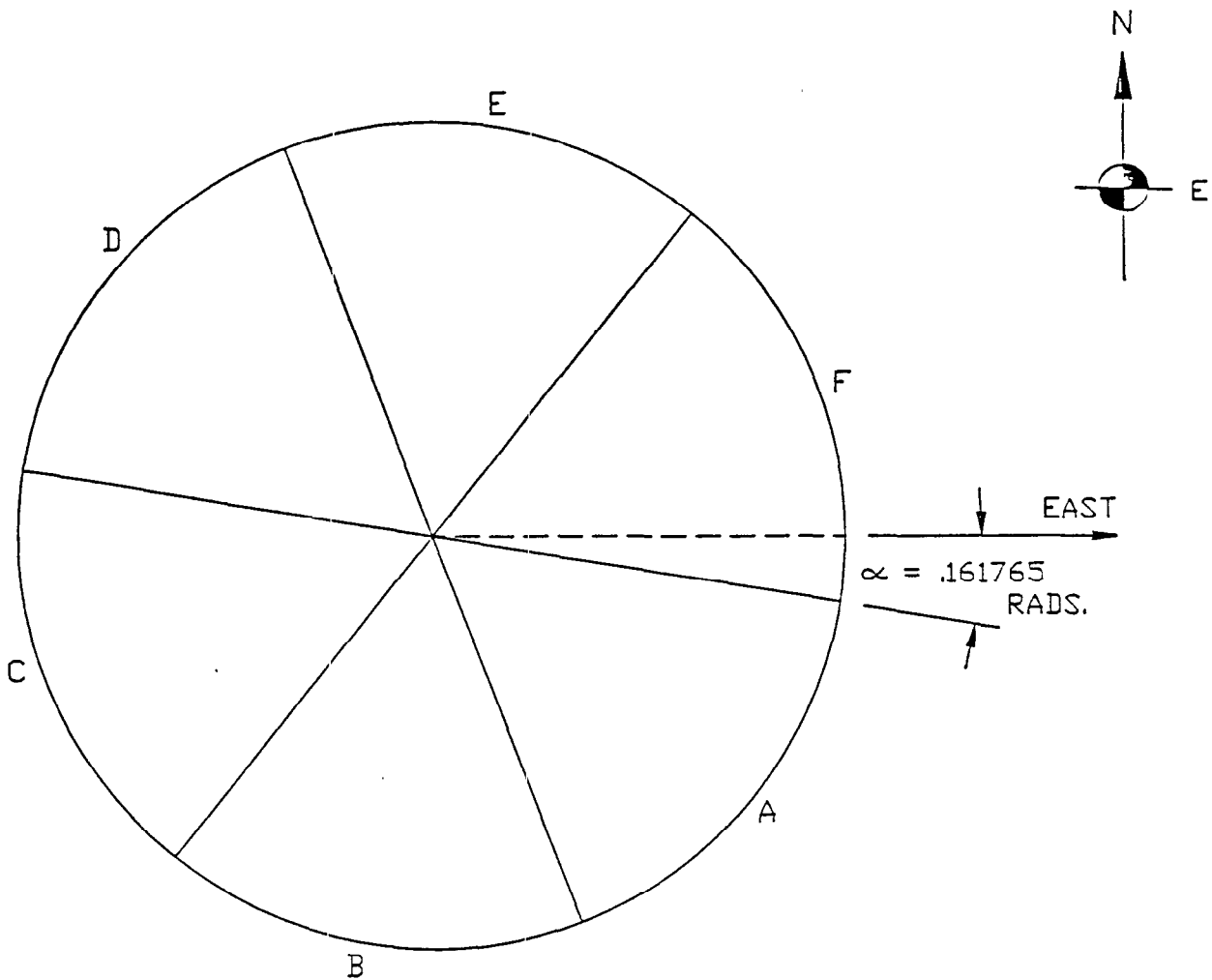


Fig. 3 Overall Layout of the Booster [Ref. 1]

0 5
METERS
NOTE: ALL DIMENSIONS ARE IN METERS



- ↑ = FOCUSING QUADRUPOLE
- ↓ = DEFOCUSING QUADRUPOLE
- = BENDING MAGNET (DIPOLE)
- X = SEXTUPOLE

FIG. 2 a) Schematic Diagram of the Booster and
b) Components of the Superperiod