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# 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

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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:

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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.

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## 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  
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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, (BRHO= 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  
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## BETATRON FUNCTIONS [LINEAR LATTICE]

CIRCUMFERENCE = 201.7800 M  
RADIUS = 32.1143 M

THETX = 6.28319424 RAD      NUX = 4.82000  
THEY = 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  
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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

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

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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

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

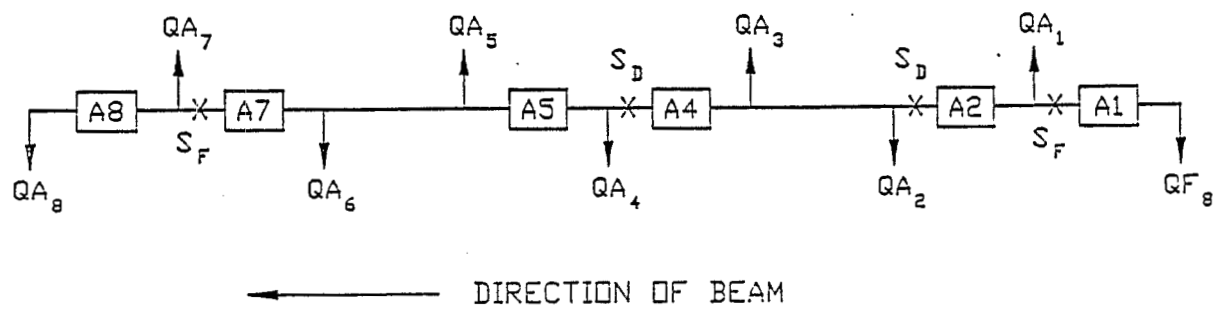
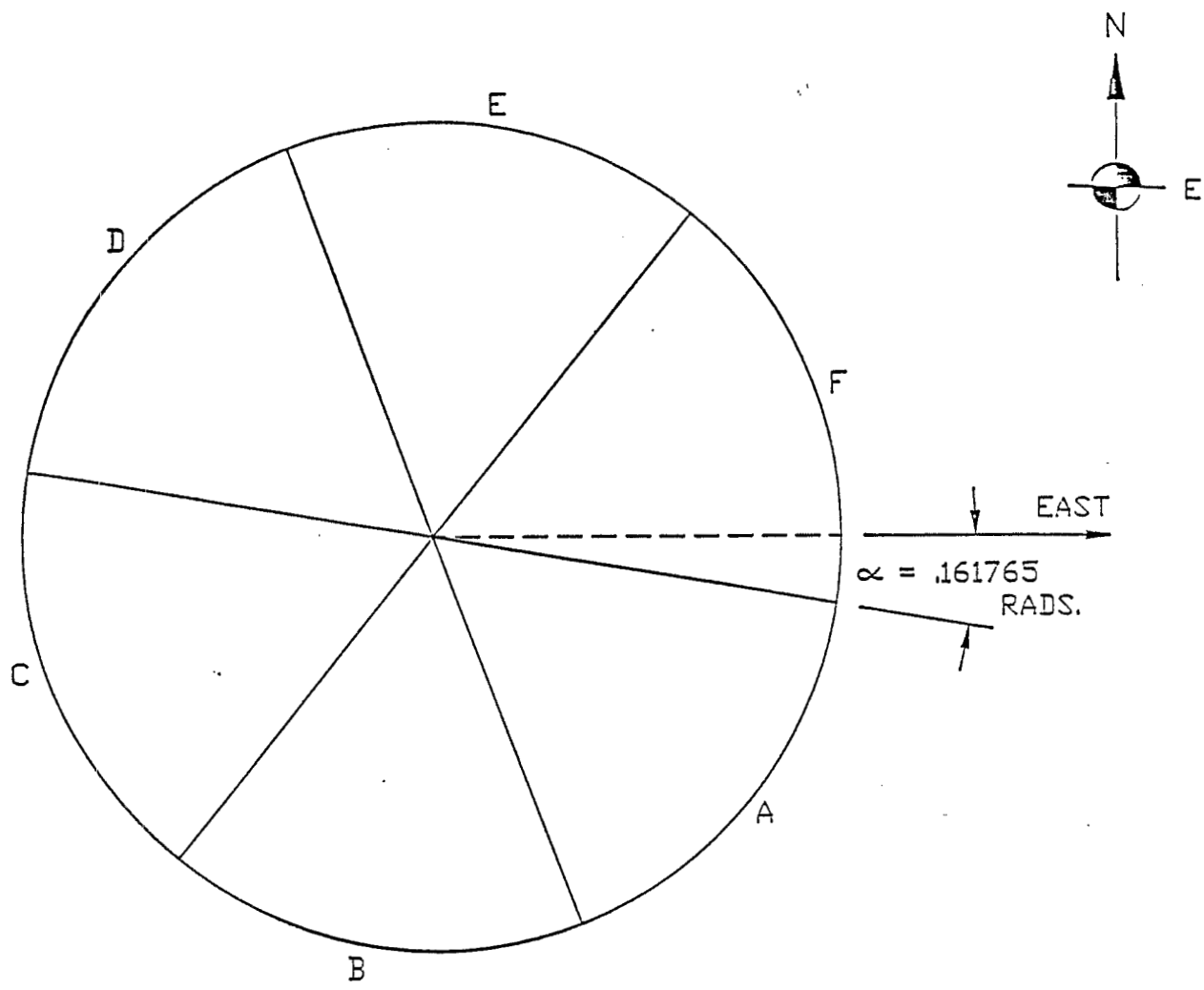
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## AMPLITUDE DEPENDENCE OF TUNES DUE TO SEXTUPOLES

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

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

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

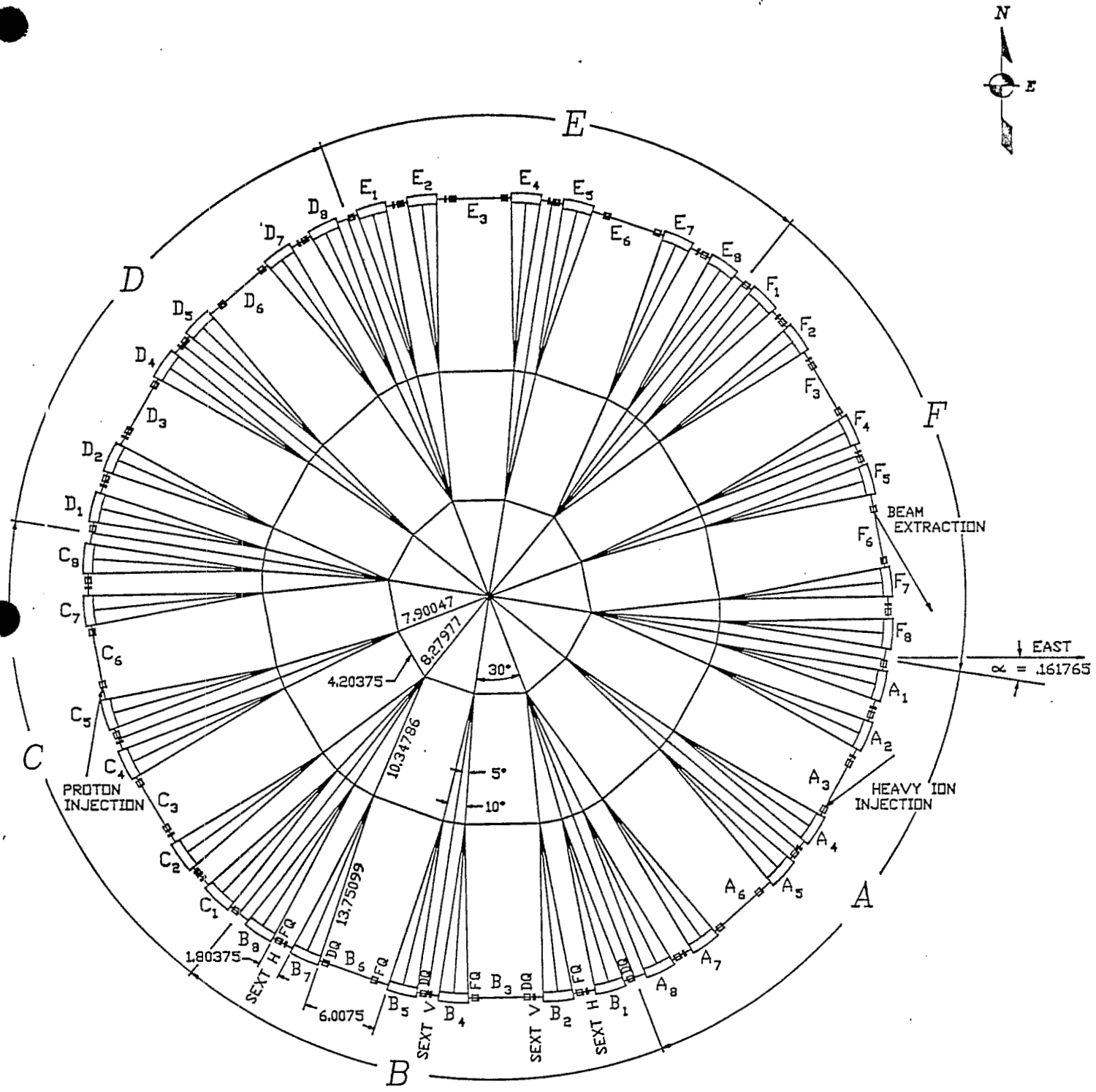


Fig. 3 Overall Layout of the Booster [Ref. 1]

0 5  
METERS

NOTE: ALL DIMENSIONS ARE IN METERS