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AGS Modifications for High Transition Energy

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AGS MODIFICATIONS FOR HIGH TRANSITION ENERGY

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1 Introduction

The transition energy in the AGS is at approximately 8 GeV ($\gamma \cong 8.5$), right in the middle of the acceleration range. This inevitably causes some beam loss, especially at high intensity. If the transition energy could be moved ouside the acceleration range these problems could be avoided; this would be advantageous for high- intensity operation, and especially for operation with heavy ions.
The transition energy γ_t is related to the momentum compaction as: $\alpha_0 = 1/\gamma_t^2$, while the momentum compaction defined to the lowest order in δ is related to the horizontal dispersion function D_x by:

$$\alpha_0 = \frac{1}{C_0} \oint \frac{D_x(s)}{\rho(s)} ds \,, \tag{1.1}$$

where ρ is the radius of curvature and s is the longitudinal path length measured along the reference orbit with a circumference C_0.

2 An Example of the AGS Lattice Without Transition

A value of the transition energy could be adjusted by additional quadrupoles which introduce oscilations of the dispersion within dipoles between positive and negative values. We have found a way of accomplishing this by inserting extra quadrupoles in some of the "5 foot" straight sections of the existing AGS lattice; however, several of the dipoles in each superperiod have to be shifted azimuthally. The drawbacks are that the new orbit is moved radially compared to the old one (but still fits well within the tunnel), and that the peak beta functions and dispersion function are considerably larger than in the standard AGS.
The modified lattice is obtained from the standard one by the following modifications (in each of the 12 superperiods):
Move magnets 15 and 16 by 3.7 mm away from the symmetry point, e.g. lengthen the straight section 15 by 7.4 mm to 1.5314 m. Move magnets 14 and 17 by 41.84 cm away from the symmetry point:
Straight sections 14 and 16 lengthened from 0.6096 to 1.0243 m.

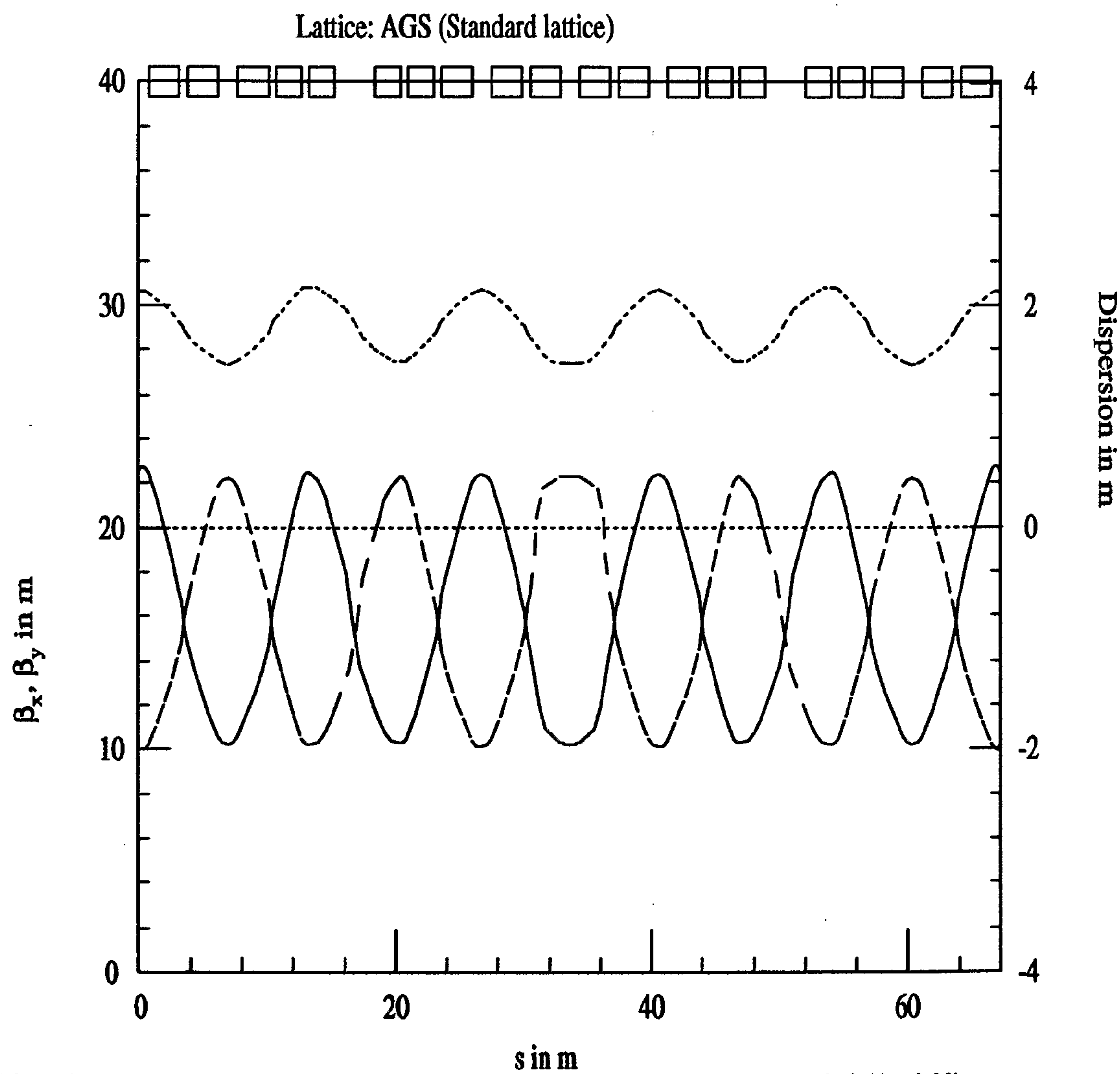
Table I: New and Old AGS Betatron Lattice Functions

	Original	Modified
Transition γ	8.427	30.59
H. Tune ν_x	8.687	11.232
V. Tune ν_y	8.780	7.436
max β_x	22.33	22.53
min β_x	10.23	3.19
max β_y	22.33	32.64
min β_y	10.13	10.13
max η	2.17	3.88
min η	1.48	-3.90

Move magnets 13 and 18 by 14.74 cm toward symmetry point:
Straight sections 13 and 17 shortened from 1.524 to 0.9582 m.
Insert quadrupole (H-focusing) in center of straight sections 13 and 17; length 0.2 m, gradient 25.905 T/m at peak energy ($B\rho = 98.144$ T-m).
Insert trim quadrupole ($0.2m, 60$ Gauss/m) in straight sections 3 and 7. (This one is so weak that it should be possible to find a solution where it is absent). With these modifications the lattice functions are presented in Table I as follows:

The lattice functions and layout are pictured for the original AGS and the modified lattice in Figs. 1 and 2; the figures show one superperiod starting with magnet 6 and ending with magnet 5 of the next superperiod.

The main drawback of this scheme is that it requires moving six magnets per superperiod (72 in all), which implies a major rebuilding of the AGS. And with the incrase maximum dispersion function and vertical β function some aperture problems may become more severe. Furthermore some of the existing sextupoles might have to be moved.



Dispersion max/min: 2.16942/ 1.47640m,

γ_t: (8.43, 0.00)

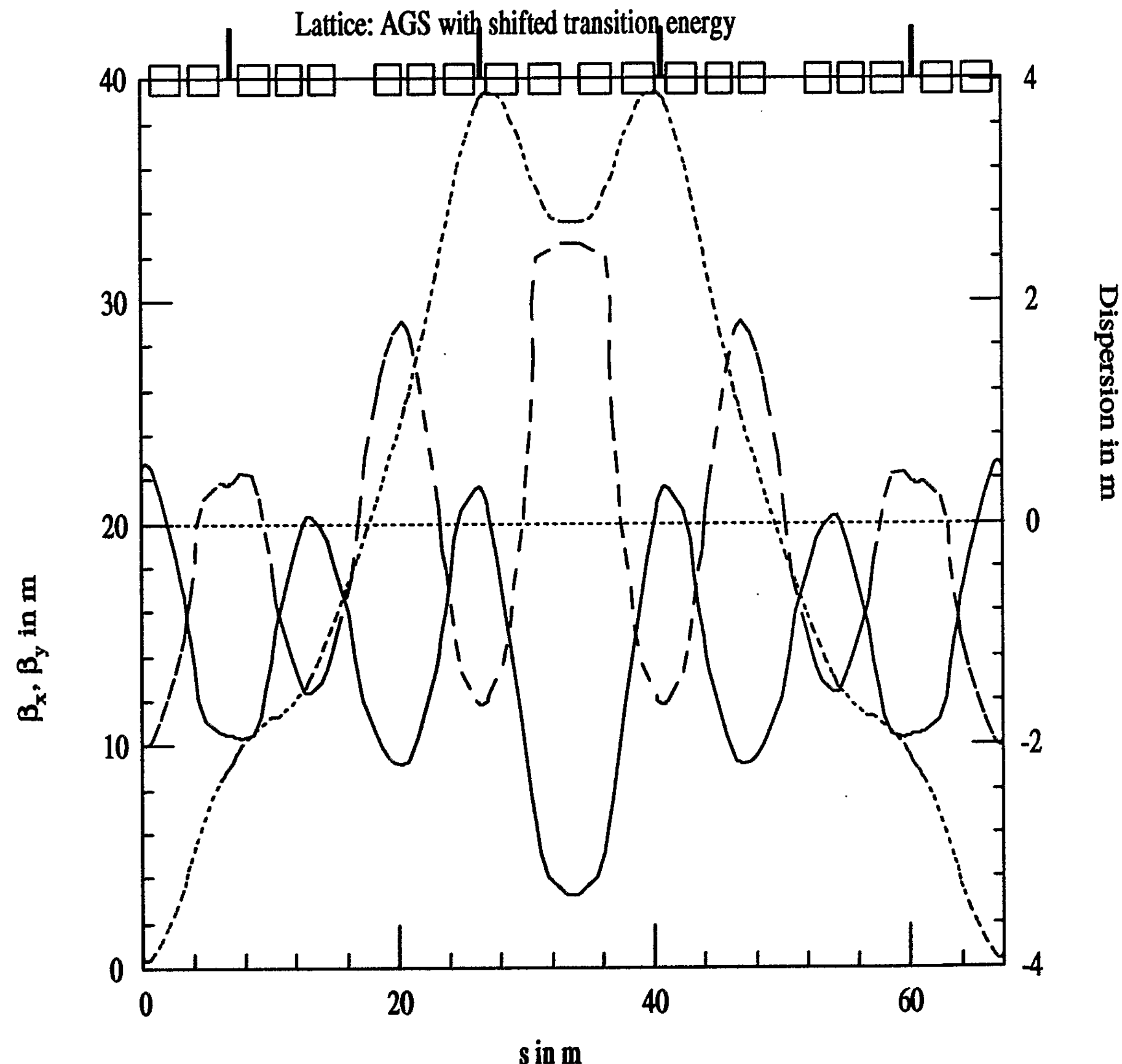
β_x max/min: 22.53/10.23229m, ν_x: 8.68689, ξ_x: -8.93,

Module length: 807.1104m

β_y max/min: 22.33/10.12588m, ν_y: 8.78018, ξ_y: -9.29,

Total bend angle: 6.28319311 rad

Figure 1: Orbit Functions in standard AGS Lattice



Dispersion max/min: 3.88070/-3.90000m,

β_x max/min: 22.53/3.18925m, ν_x: 11.23200, ξ_x: -11.95,

β_y max/min: 32.64/10.12588m, ν_y: 7.43633, ξ_y: -10.32,

γ_t: (30.59, 0.00)

Module length: 807.1104m

Total bend angle: 6.28319311 rad

Figure 2: Orbit Functions in AGS lattice with shifted magnets and quads