BNL-105138-2014-TECH

Booster Technical Note No. 91;BNL-105138-2014-IR

ACCELERATION PARAMETERS FOR THE AGS-BOOSTER

Z. Parsa

September 1987

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

ACCELERATION PARAMETERS FOR THE AGS-BOOSTER

AD

Booster Technical Note

No. 91

ZOHREH PARSA AND EUGENE RAKA

SEPTEMBER 17, 1987

ACCELERATOR DEVELOPMENT DEPARTMENT

Brookhaven National Laboratory

Upton, N.Y. 11973

Acceleration Parameters for the AGS-Booster

Zohreh Parsa and Eugene Raka

Brookhaven National Laboratory
Upton, NY 11973

I. Introduction

This note includes the acceleration parameters for the AGS-Booster [1], assuming a uniform distribution in longitudinal phase space using the formulation given in section II. Some of the values used in our calculation were extrapolated from the tabulated information given in Reference [2]. Our results for the AGS-Booster are given in section III.

II. Summary of the Formulation

The phase area of a "stationary bucket" ($\phi_s = 0$) is given by

$$A_o = \frac{8}{h(w_s/\beta)} \sqrt{\frac{2eVE_s}{\pi h|\eta|}}$$

This is the area of one of the h buckets of the hth harmonic [2]. Where (the subscript) s refers to the synchronous particle;

eV is the maximum energy gain per turn;

E_s is the synchronous energy;

h is the harmonic number;

$\beta = v/c$ (c = velocity of light) and $\gamma = 1/\sqrt{1 - v^2/c}$ are the relativistic factors;

ϕ is the phase of a particle relative to r-f wave;

w is the angular frequency and

$w_{rf} = hw_s$

$\eta = 1/\gamma_{tr}^2 - 1/\gamma^2$ [$\eta < 0$ below transition ($\equiv$tr)]

$w_s/\beta = c/2\pi R$ ($c = 3 \times 10^8$ m/s),

R = radius of the ring.

The area of the moving bucket is given by

$$A_b = A_o\ \alpha(\phi_s)$$

whre $\alpha(\phi_s)$ is the moving bucket factor, and the area contained within some curve $H = NH_E$ (H_E is the maximum value of H, $N < 1$) is given by

$$A = A_o\ \alpha_N(\phi_s)$$

We define the "bunching factor" to be the ratio of the peak to average particle density, for uniform distribution in longitudinal phase space. This is $1/\bar{B}$, the inverse of the bunching factor $\bar{B}$ used in Ref. [2]. Additionally, we define

$\hat{I}$ = peak current,

$\bar{I}_b$ = average (DC component of the beam) current,

$\tilde{I}_b$ = rf component of the beam current,

$P_b = \bar{I}_b \sin\phi_s$, ($P_b \equiv$ power), and

$\Delta r = X_p\ \Delta p/p$ (Δr is 1/2 of the aperture taken by synchronous oscillation) where

p = momentum.

III. Booster Acceleration Parameters

	Injection	Ejection
Energy	200 MeV	1.5 GeV
β = v/c	0.5662	0.9220
p	0.6444 GeV/c	
RF amplitude [$V_{Rf} = \hat{V}$]	90 kV	70 kV
$\bar{I}_b$	~3 amp	4.93 amp
Intensity (particle/bunch)	7.5×10^{12}	7.5×10^{12}
Harmonic number [h]	3	3
RF frequency [f_{Rf}]	2.48 Mhz	4.11 Mhz
Rotation frequency [f_o]	826.67 kcycle	1.37 Mhz
ϕ_s	2.6°	22.4°
$\dot{B}$	1.5 T/s	9.6 T/s
P_b	–	131.8 kW (bucket not full)
Phase space area		
Stationary bucket A_o	1.67 eVsec	5.47 eVsec
Moving bucket A_{bunch}	1.5 eVsec	1.5 eVsec
A_{bucket}	1.5 eVsec	2.46 eVsec
α_1	0.895	0.45
bucket length	320° = 60.55m	216°
bunch length	320° = 60.55m	151°
bunching factor	1.697	3.23
peak bunch current [$\hat{I}$]	5.1 amp	16 amp
bucket height $\Delta p/p$	0.876×10^{-2} or 3.19 MeV	0.59×10^{-2} or 12.13 MeV
$\tilde{I}_b$	–	8 amp
N	1	0.66
Δr	2.45 cm	
X_p	2.8m	
η	0.6376	0.09877

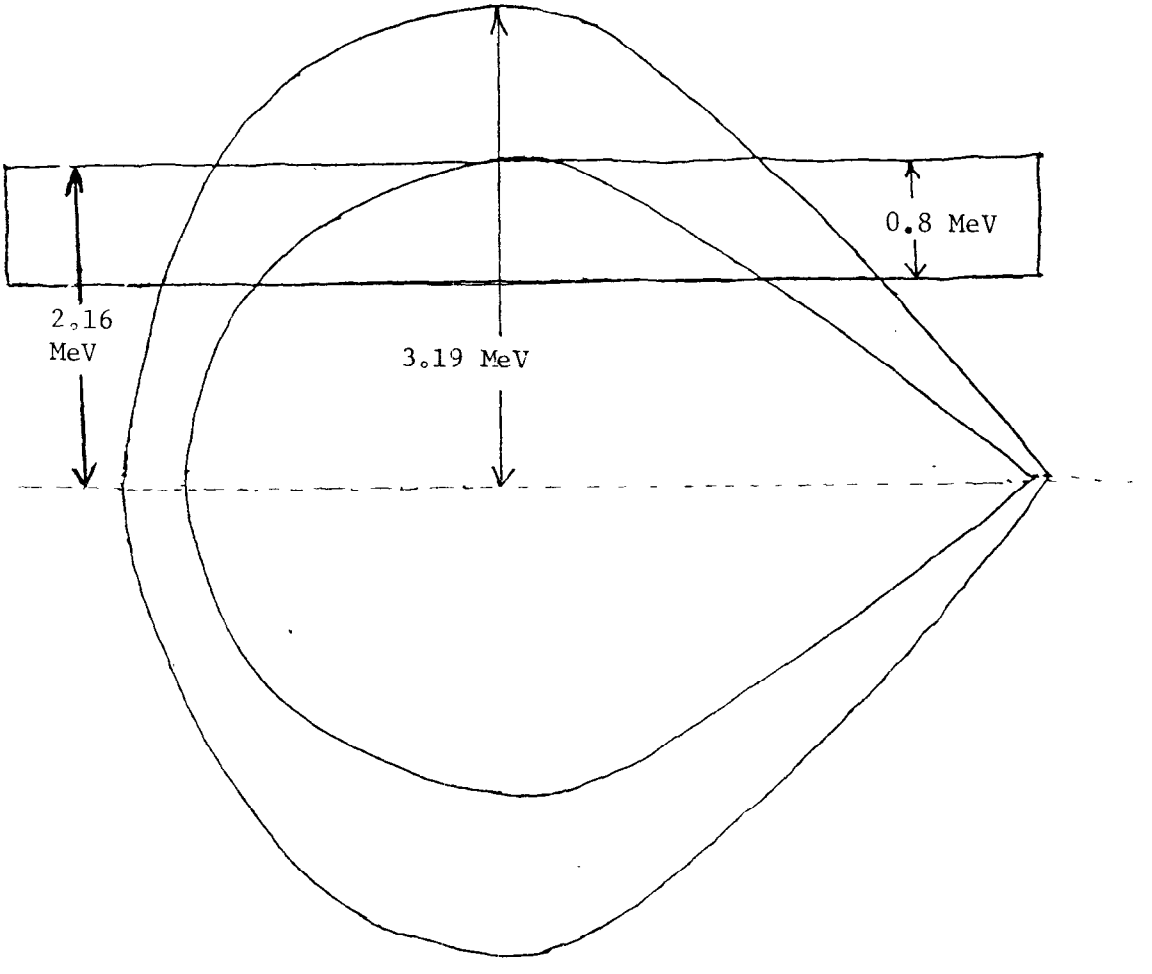

Figure 1. Booster Bucket at injection. Initial and final Bucket heights at injection are shown.

References

1. Z. Parsa, Booster Parameter List, BNL-39311; and Design Manual.

2. F.T. Cole and P.L. Morton, UCID 10130, ASI Theoretical/02, Sept. 21, 1964.