# QUICK REFERENCE GUIDE FOR THE BOOSTER LATTICE AND RF PARAMETERS

AD

*Booster Technical Note*

*No. 74*

ZOHREH PARSA

MARCH 6. 1987

ACCELERATOR DEVELOPMENT DEPARTMENT

*Brookhaven National Laboratory*

*Upton, N.Y. 11973*

# QUICK REFERENCE GUIDE FOR THE BOOSTER LATTICE AND RF PARAMETERS

Zohreh Parsa
Accelerator Development Department
Brookhaven National Laboratory
Upton, New York 11973

This is a brief summary of the parameters for the Booster lattice and RF system (which indicates the present status of the Booster as of 3/6/87).

We acknowledge the assistance of E.Courant and G. Cottingham with this list.

# QUICK REFERENCE
# AGS BOOSTER PARAMETER LIST

| | Protons | Polarized Protons | Heavy Ions |
|---|---|---|---|
| **Energy** | | | |
| Injection | 200 MeV | 200 MeV | $> 1$ MeV/nucleon |
| Ejection | 1.5 GeV | 1.5 GeV | $p = 5.25\ Q/A$ (GeV/c)/nucleon |
| No. of Particles/Pulse | $1.5 - 3 \times 10^{13}$ | $\sim 10^{12}$ | $15 \times 10^9$ (S), $3 \times 10^9$ (Au) |
| **Lattice** | | | |
| Circumference | | 201.78 m (1/4 AGS) | |
| Magnetic bend radius | | 13.75099 m | |
| Periodicity | | 6 | |
| Number of cells | | 24 FODO | |
| Cell length | | 8.4075 m | |
| Phase advance/cell | | 72.3°/72.45° | |
| $\nu_x/\nu_y$ (nominal) | | 4.82/4.83 | |
| $\beta_y$ max/min | | 13.6/3.7 m | |
| $x_p$ max | | 2.95 m | |
| transition $\gamma$ | | 4.881 | |
| **RF System** | | | |
| Number of stations | 2 | 2 | 2 |
| Harmonic number | 3 | 3 | 3 |
| Frequency range (MHz) | 2.5 — 4.11 | 2.5 — 4.11 | 0.200 — 2.5 |
| Peak RF voltage | 90 | 90 | 17 |
| Acceleration time (ms) | 62 | 62 | 500 |
| Reptition rate | 7.5 Hz (4/AGS pulse) | 1 Hz (1/AGS) | 1 Hz (1/AGS) |
| **Dipoles** | | | |
| Number | | 36 | |
| Length (magnetic) | | 2.4 m | |
| Gap | | 82.55 mm | |
| Vacuum chamber aperture | | 66 mm | |
| Good field region ($< 10^{-4}$) | | $16 \times 6.6$ cm | |
| Injection field (kG) | 1.56 | 1.56 | $0.108\ A/Q$ |
| Ejection field | 5.46 | 5.46 | 12.74 |
| **Quadrupoles** | | | |
| Number | | 48 | |
| Length (magnetic) | | 50.375 cm | |
| Aperture | | 16.5 cm | |
| Vacuum chamber aperture | | 15.25 cm | |
| Injection pole tip field (kG) | 1.02 | 1.02 | $0.068\ A/Q$ |
| Ejection pole tipe filed (kG) | 3.6 | 3.6 | 8.3 |
| Field Quality 6/2 | | 0.0 | |
| All other harmonics | | $< 10^{-4}$ | |
| **Chromaticity Sextupoles** | | | |
| Number | | $2 \times 12$ | |
| Length (magnetic) | | 10 cm | |
| Max. pole tip field (kG) | | 3.0 | |
| **Max. Vacuum Pressure** | | $3 \times 10^{-11}$ torr | |

Reference: Z. Parsa, Booster Parameter List, BNL-39311, 1987; and Design Manual.

TABLE 1. Isotopes, Charge States, and Ionic Masses.

| | $Q$ | $Z$ | $A$ | Ionic Rest Mass (u) | Ionic Rest Mass Energy (GeV/nucleon) |
|---|---|---|---|---|---|
| p | +1 | 1 | 1 | 1.00728 | 0.93828 |
| d | +1 | 1 | 2 | 2.01355 | 0.93781 |
| C | +6 | 6 | 12 | 11.99671 | 0.93125 |
| S | +14 | 16 | 32 | 31.96439 | 0.93047 |
| Cu | +21 | 29 | 63 | 62.91808 | 0.93029 |
| I | +29 | 53 | 127 | 126.88857 | 0.93068 |
| Au | +33 | 79 | 197 | 196.94846 | 0.93126 |

TABLE 2. Injection Energies and Fields

| | $v/c$ | $f$ | $p$ | $E_{inj}$ | | $B_{inj}$ |
|---|---|---|---|---|---|---|
| | | (MHz) | (GeV/$c$) | (MeV) | (MeV/nucleon) | (kG) |
| p | 0.5662 | 2.5235 | 0.6444 | 200.0 | 200.000 | 1.563 |
| d | 0.1767 | 0.7878 | 0.3368 | 30.0 | 15.000 | 0.317 |
| C | 0.1262 | 0.5623 | 1.4211 | 90.0 | 7.500 | 0.575 |
| S | 0.1000 | 0.4457 | 2.9925 | 150.0 | 4.688 | 0.519 |
| Cu | 0.0782 | 0.3485 | 4.5969 | 180.0 | 2.857 | 0.531 |
| I | 0.0595 | 0.2653 | 7.0489 | 210.0 | 1.654 | 0.590 |
| Au | 0.0473 | 0.2131 | 8.7805 | 210.0 | 1.066 | 0.645 |

TABLE 3. Ejection Energies and Fields — $B_{max} = 12.74$ kG

| | $v/c$ | $f$ | $p$ | $E_{ejec}$ | | $B_{ejec}$ |
|---|---|---|---|---|---|---|
| | | (MHz) | (GeV/$c$) | (GeV) | (GeV/nucleon) | (kG) |
| p | 0.9230 | 4.114 | 2.251 | 1.500 | 1.5000 | 5.459 |
| d | 0.8699 | 3.877 | 3.308 | 1.927 | 0.9635 | 8.024 |
| C | 0.8714 | 3.884 | 19.847 | 11.602 | 0.9668 | 8.024 |
| S | 0.8716 | 3.885 | 52.926 | 30.952 | 0.9672 | 9.170 |
| Cu | 0.8534 | 3.804 | 95.932 | 53.810 | 0.8541 | 11.081 |
| I | 0.7900 | 3.522 | 152.345 | 74.622 | 0.5880 | 12.743 |
| Au | 0.6868 | 3.061 | 173.358 | 68.050 | 0.3500 | 12.743 |

Reference: Z. Parsa, Booster Parameter List, BNL-39311, 1987; and Design Manual.

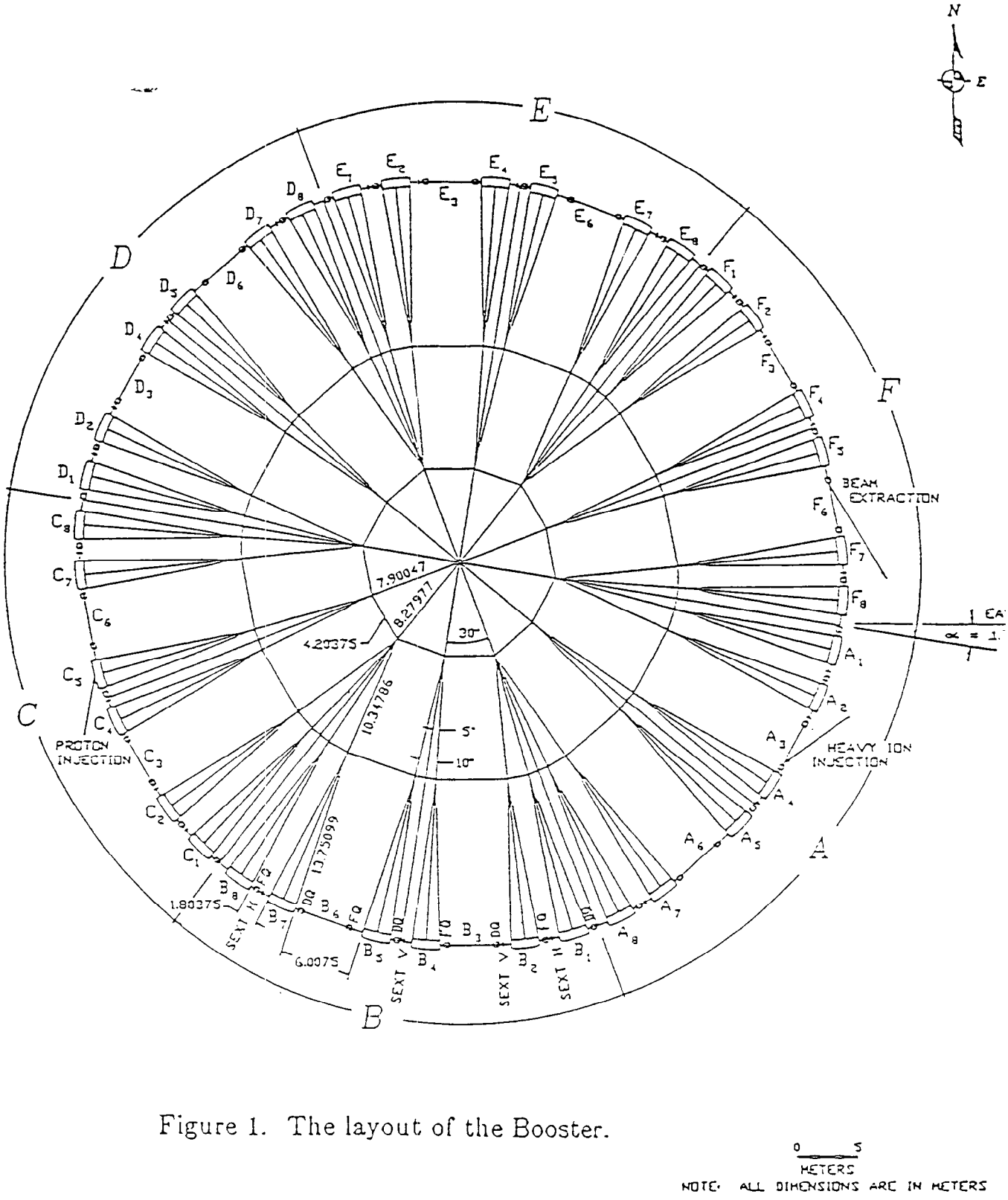


Figure 1. The layout of the Booster.

Reference: Z. Parsa, Booster Parameter List, BNL-39311, 1987; and Design Manual.

TABLE 4 RF Systems.

| | p | pi | $S^{+4}$ | $Au^{+32}$ |
|---|---|---|---|---|
| RF Amplitude | | | | |
| Injection | 90 kV | 7.35 kV | 0.61 kV | 1.5 kV |
| Ejection | 90 kV | 40 kV | 17 kV | 17 kV |
| Harmonic Number | 3 | 3 | 3 | 3 |
| RF Frequency | | | | |
| Injection | 2.5 MHz | 2.5 MHz | 0.446 MHz | 0.206 MHz |
| $E/A$ | 200 MeV | 200 MeV | 4.69 MeV | 1.07 MeV |
| Ejection | 4.11 MHz | 4.11 MHz | 4.13 MHz | 3.06 MHz |
| Phase Space Area/A | $\geq$ 1.0 eV-s | 0.3 eV-s | 0.066 eV-s | 0.066 eV-s |
| Intensity (particles (per bunch) | $10^{13}$ | $\sim 1 \times 10^{11}$ | $5 \times 10^{9}$ | $8 \times 10^{9}$ |
| Total Gap Impedance ($f_{rf}$ = 4.1 MHz) | < 24 kΩ | No limit | No limit | No limit |
| Acceleration Time | 62 ms | $\leq$ 0.5 s | $\leq$ 0.5 s | $\leq$ 0.5 s |
| Maximum Power Delivered to Beam | 156 kW | < 2 kW | < 1.0 kW | < 2 kW |
| Maximum $\dot{B}$ | 9.5 T/s | 4.5 T/s | 4.5 T/s | 4.5 T/s |
| $\dot{B}_{inj}$ | 1.5 T/s | ? | < 0.15 T/s | < 0.15 T/s |

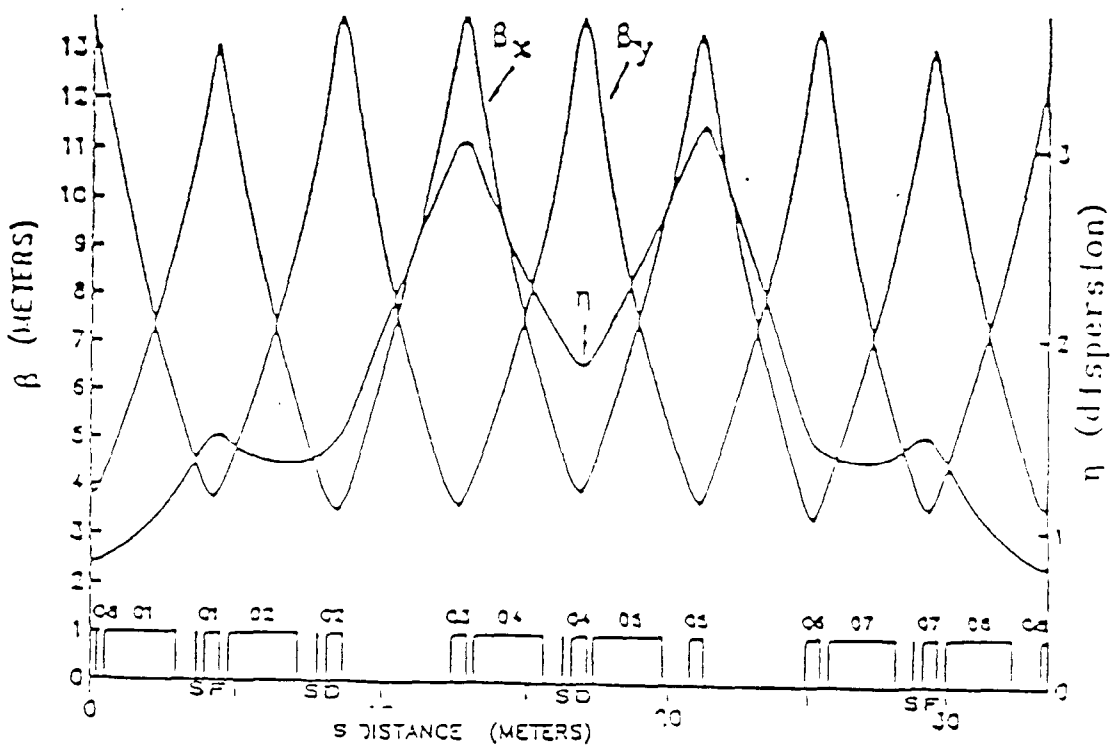


Fig. 2, shows the betatron functions and the amplitude dependence of tunes for the AGS Booster.