



BNL-105102-2014-TECH

Booster Technical Note No. 55;BNL-105102-2014-IR

## Expected heavy ion intensity in the AGS Booster

Y. Y. Lee

July 1986

Collider Accelerator Department  
**Brookhaven National Laboratory**

**U.S. Department of Energy**

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No.DE-AC02-76CH00016 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

## **DISCLAIMER**

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

EXPECTED HEAVY ION INTENSITY IN THE AGS BOOSTER

*Booster Technical Note*  
No. 55

Y. Y. LEE  
JULY 19, 1986

ACCELERATOR DEVELOPMENT DEPARTMENT  
*Brookhaven National Laboratory*  
Upton, N.Y. 11973

# EXPECTED HEAVY ION INTENSITY IN THE AGS BOOSTER

Y Y LEE

In this note we try to estimate the expected intensity of heavy ions in the booster. A pulsed mode of operating the Tandem Van de Graaff developed at Brookhaven, showing that 300 micro-seconds long pulse of heavy ion could be accelerated without any adverse effects on the performance of the Van de Graaff. The Tandem output for the representative ion species are given in the table I.

TABLE I

IONS	Q	T MeV/amu	CURRENT part-micro-amp
CARBON	6	7.5	82.
SULFUR	14	4.7	20.
COPPER	21	2.9	11.
IODINE	29	1.65	6.
GOLD	33	1.	5.

It is hard to estimate all the factors related to the intensity of the booster, however, following are list of the assumptions used and brief justification.

i) The ion beams are injected into the booster stacking in the horizontal betatron phase space. The number of effective turns one can inject to the ring is complicated and hard to determine, however one can deduce from past experiences of other similar situation. When the AGS was injected with protons, experience shows that one can inject more than sixteen effective turns from the linac. The emittance of the linac beam was about 5 mm-mr. The acceptance of the booster is somewhat larger than the AGS and the beam from the Tandem is about 1 mm-mr, a factor of five smaller than the linac. We expect to inject over twenty effective turns of the ions.

ii) There is another limitation to the intensity of the ion beams, namely the space charge limit. A conservative estimate is that one could stack at least to a space charge tune shift of .3 tune unit.

iii) RF capture efficiency is also hard to estimate. Since the injected beam from Tandem has virtually no energy spread, so called adiabatic capture of the beam takes too long(over 100 milli-seconds). Suggestion is made to capture in certain bunch size( $\sim 0.05$  eV-sec/amu/bunch), and because we are bunching into much larger bucket than adiabatic bunch we expect veryhigh bunching efficiency for RF capture. Theoretically one can capture up to 98% of the particle even for adiabatic capture. Since we use larger bucket size, we assume better than 98% capture efficiency.

iv) The final stripping efficiency is not well known, but a plausible guess is used except for gold which had been measured.

The table II shows the expected intensity for carbon, sulfur, copper, iodine, and gold ions.

TABLE II

	CARBON	SULFUR	COPPER	IODINE	GOLD
T(MeV/amu)	7.5	4.7	2.9	1.65	1.
BETA(V/C)	.1256	.0997	.0784	.0592	.0461
Q	6(6)	14(16)	21(29)	29(53)	33(79)
I(PART-MICRO-AMP)	82	20	11	6	5
N(at injection)	55	16.8	11.8	8.5	6.6*
20 turns ( $\times 10^9$ )					
RF CAPTURE EFFICIENCY	.98	.98	.98	.98	.98
VACUM SCATT. LOSS (%)	~0	~0	~.01	~.015	~.02
N(at extraction)	54	16.5	11.4	8.2	6.3
$\times 10^9$					
STRIPPING EFFICIENCY (%)	100.	>90.	>90.	>80.	~50.
N(AGS)	54	~15	~10	~6.6	~3.2
$\times 10^9$					

\*Space charge tune shift limit of 0.3