

BNL-104684-2014-TECH

AGS/AD/Tech Note No. 266;BNL-104684-2014-IR

A THOUGHT ON VERY LOW ENERGY ANTI-PROTONS

Y.Y.Lee

October 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.

Accelerator Division Alternating Gradient Synchrotron Department BROOKHAVEN NATIONAL LABORATORY Associated Universities, Inc. Upton, New York 11973

Accelerator Division

No. 266

A THOUGHT ON VERY LOW ENERGY ANTI-PROTONS

October 17, 1986

Y.Y. Lee

A THOUGHT ON VERY LOW ENERGY ANTI-PROTON -

Y. Y. LEE

INTRODUCTION

It is has been proposed to use the AGS Booster¹ as a time stretcher purifier of for the anti-protons of momentum 65 to 5.2 GeV/c.².¹ In this note, we would like to extend the idea to very low energy of tension of a KeV anti-protons.

Assubrief description of the system is as followes: In each AGS cycle: the booster field is set to accepts anti-protons of momentums 3.5-GeV/c; where one expects maximum production of anti-protons, after: injecting: protons, into the AGS. The AGS extracts three rf buckets of w protons, from either H10 or I10 to strike an anti-proton production target... The anti-protons will be collected by an appropriate lens system (eg. lithium lens) and transported to the booster area and injected into the booster through the channel identical to its extraction channel. Since anti-proton is the anti-particle of the proton; injections of the antimproton is identical to the extraction work the second protons. Once the stanti-protons, area injected and captured, inc, the booster, ... one can either accelerate or decelerate them in the booster. After deceleration to 200 MeV kinetic energy, they can be further. decelerated through the linac and an RFQ preinjector down to ion source. energy.

ANTI-PROTONS WITHOUT COOLING

Assuming standard production rate at AGS energies of a

1..

1056 anti-protons/m-str/%/interactingsprotonss

anti-protons at 3.5 GeV/c, one can estimate the number of anti-protons which can be accumulated in the booster acceptance of 50 mm-mr and 2% momentum which. Realistically the AGS proton beam at 30 GeV/c: can be focussed down to immispotesize, and therefore the angular acceptance one can expect in each dimension would be

50 mm-mr/0.50 mma = 100 mra

And the solid angle subtended would be 04040 steradians.

Because: of the, finite length of the target; the collection of efficiency would be reduced further. For a 10 cm long target, particle production studies show that only one third of the particles falls into the useable phase space; and thus the effective solid angle becomes:

.04/3 str = 13.3 mstr

The anti-proton production rate is therefore.

Np = 1076 x 13.3 x 2(%) x Np/3 = 8.89 x 1076 Np

where Npais number of incident protons and the factor 3 is to p correct for interacting versus incident protons.

The post booster: AGS will accelerate .5 x 10¹³ protons/bucket and ... if one uses three of those buckets for the production per cycle.

 $N_{\rm D} = 8.89 \times 10^{-6} \times 1.5 \times 10^{13} = 1.33 \times 10^{8}$ anti-protons/pulse

at 3.5 GeV/c.

If one decelerates; the collected anti-protons, assuming frame

2

system as has enough debunching to take care of the anti-proton beam energy spread(i.e. while making the bunch longer, reduce the energy spread); then while making the bunch longer, reduce the energy spread); then while betatron phase space decreases by the factor 1/P². The normalized emmitance of the collected beam at 3.5 GeV/c is 186.5 mmemmer and this emmitance will be trimmed through the deceleration process: The normalized acceptance of the booster at 200 MeV linace energy is 34.3 mmemmer. Figure 1 shows the resultant anti-proton intensity as a function of final decelerated energy in the booster. DECELERATION THROUGH THE LINAC

The decelerated anti-protons can be extracted nears the booster injection channel, and transported through either injection transport system with sits dipoles reversed for separate transport system to the 200 MeV linac. The beam can be decelerated through the linace to a kinetic energy of 750 KeV at the "entrance" of linace tank 1. The acceptance of the system is dominated by the normalized admittance³ at the 750° KeV® point of 100mm-mr. Thus one will lose beam intensity of through the 200 MeV linace by a factor of 5

(10/34.3)2 = .085

and in a addition by an additional factor of two due to a beam bunching efficiencies. As a resultable

1.9 x 10⁵ anti-protons

will...survive to 750 KeV.T The anti-protons can be further: decelerated through the RFQ pre-injector to energies of 20 KeV.

EFFECT OF COOLING

If one cools the anti-protons in the booster to less than 1000 mm and mr. normalized or 014.60 mm at 2000 MeV energy, theoretically half of the

3 .

the 1.33%x0108 anti-protons collected at 3.5 GeV/cocould be decelerated to 750 KeV and then to 20 KeV.

REFERNCES

1) AGS booster conceptual design report, BNL 34989 R; 1985

2) A. S. Carroll, Y. Y. Lee, DisC. Peaslee, and L. S. Pinsky, tomber published

3) G. W. Wheelersetsal. Particle Accelerators Vol. 9 No. 1/2: 1979

E protons (Collected AT 35GeV/c) WITHOUT COOLING 拤 10-1-7 8 9 1 З Б

T (MeV)