

Comment on RHIC-PG-52 "Electron Trappings In RHIC From A Debunched  
Proton Beam"

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May 1984

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USDOE Office of Science (SC)

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RHIC-PG-55

COMMENT ON RHIC-PG-52

"ELECTRON TRAPPING IN

RHIC FROM A DEBUNCHED

PROTON BEAM"

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May 4, 1984

5/4/84

# Comment on RHIC-PG-52

## "Electron Trapping in RHIC from a Debunched Proton Beam"

The following drift distances are quoted in RHIC-PG-52 for electrons moving for a time  $t = \eta \tau_e$ , where  $\eta$  is the allowable charge neutralization coefficient for a betatron tune depression  $\Delta \nu = 0.0025$  and  $\tau_e$  is the production time for one electron per proton. Values are  $\eta = 0.0005$  and  $\tau_e = 1.21$  sec.

The drift velocities are

- free  $v_e \sim 1 \times 10^7$  cm/sec
- dipole trapping  $v_D = 3.5 \times 10^5$  cm/sec
- quadrupole trapping  $v_Q = 6.8 \times 10^6$  cm/sec.

The drift lengths  $v \eta \tau_e$  quoted were

$$l_D = 212 \text{ m}$$

$$l_Q = 4119 \text{ m}$$

These should be

$$l_D = 2.12 \text{ m}$$

$$l_Q = 41.19 \text{ m}$$

The dipole term dominates; it is less than the length of the proposed CBA dipoles. Thus these electrons cannot be cleared; one must use less beam or go to bunched proton operation.

In CBA there was even more current, but the vacuum was much better notably in the dipoles  $10^{-11}$  torr, not cold. Half the problem at present comes from CO in the warm region at an assumed pressure of  $10^{-9}$  torr.

A solution to the problem would be to drop the warm pressure to  $10^{-11}$  torr and ensure ~~that~~ leakage of all gas except  $H_2$  which is always there.

Then one gets the following gas composition (see RHIC-PG-51)

warm 25% of circumference  
 Equivalent Nitrogen pressure  $10^{-11}$  torr  
 100%  $H_2$  300°K

cold 75% of circumference  
 Equivalent Nitrogen pressure  $10^{-11}$  torr  
 50% He, 50%  $H_2$  , 4.2°K

Gauge efficiency 100% CO, 50%  $H_2$ , 50% He

in warm  $(0.5) n_{H_2} = n_{N_2}$   
 in cold  $(0.5) n_{H_2} + (0.5) n_{He} = n_{N_2}$   
 and  $n_{H_2} = n_{He}$

By Definition

$$n_{N_2} = 2.687 \cdot 10^{19} \frac{P_{\text{torr}}}{760} \cdot \frac{273.16}{T_{\text{°K}}}$$

so

$$n_{N_2} = 3.22 \cdot 10^5 / \text{cm}^3 \text{ warm}$$

$$2.30 \cdot 10^7 / \text{cm}^3 \text{ cold}$$

Densities	warm (25%)	cold (75%)
$H_2$	$6.44 \cdot 10^5 / \text{cm}^3$	$2.3 \cdot 10^7 / \text{cm}^3$
He	—	$2.3 \cdot 10^7 / \text{cm}^3$

Then the electron production rates are  $\frac{dn}{dt} = \text{~~0.5~~ } 0.5n$

where  $\sigma = 1.8 \times 10^{-19} Z_{\text{target}} \text{ cm}^2$  for relativistic protons ionizing residual gas

$\text{H}_2^+ \quad .188 \text{ /s /proton}$

$\text{He}^+ \quad .186$

total  $e^- \quad .374 \text{ /s /proton}$

or a time between electron productions of 2.67 sec which is 2.2 times longer than before.

This gives a dipole drift length of  $l_D = 4.68 \text{ m}$

which is tantalizingly close to the length of 5 m dipoles. Clearing electrodes could then handle the electron load.

Better cold region vacuum would solve this.