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

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RHIC-PG-55

COMMENT ON RHIC-PG-52

"ELECTRON TRAPPING IN

RHIC FROM A DEBUNCHED

PROTON BEAM"

G. R. Young

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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 η is the allowable charge neutralization coefficient for a betatron tune depression $\Delta \nu = 0.0025$ and τ_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

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

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

	warm (25%)	cold (75%)
Densities		
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.