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BEAM INTENSITY MEASUREMENTS WITH A SWIC

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The SWIC with its corresponding multichannel integrator and scanner has proved useful in the absolute measurement of extracted beam intensity. So far the results agree with the toroid beam intensity monitors. The details of the measurement are revealed so that others may use the technique.

Two numbers are essential for the measurement;

1. The sensitivity of the chamber, and
2. the capacitance per channel of the integrator;

however, in the many applications where relative beam intensity only is desired, the output may be used directly without concern for these numbers.

As SWIC is a multiwire ionization chamber with no internal gain, the ions created by the incident beam are the only ones collected by the electrodes. If the chamber is filled with argon at 1 atm, the calculated sensitivity is close to 100 ion pair per proton, which agrees with our measurements.

The reed relay SWIC scanner has an internal capacitance of 0.01 μf per channel in parallel with the cable capacitance.

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In most installations, the magnitude of the cable capacitance is comparable with that of the scanner. Although the former can be calculated from the length of cables, which have 30 pf/ft, it is better to measure the capacitance directly. This way one is certain to include all capacitance particularly in those installations where several SWIC are installed in parallel on one scanner or where the length of cables is unknown. It is necessary to measure only the capacitance of one channel; therefore, the measurement is convenient and quick.

The following is the equation to give the beam intensity from a SWIC operated as described above:

$$n_p = 6.25(10)^{16} \frac{C_T}{G} \sum_{i=1}^{m} V_{channel}$$

where n_p = number of protons

C_T = the total capacitance in farads per channel of the scanner (including cable)

G = gain of the scanner (normally 1)

$V_{channel}$ = the voltage in volts on each channel of the scanner output profile

i = individual channels with observable signal

m = number of channels with observable signal.

We have constructed a circuit which performs the above calculation and presents a voltage proportional to the number

of protons passing through the chamber. The circuit is operating on the scanner serving the four SWIC in the beam transfer hall. When this circuit is used,

$$n_p = 8.94(10)^{13} \frac{C_T}{T_D} V_o$$

where T_D = dwell time, in seconds, per channel of the scanner,

V_o = output voltage in volts.

For the system in the beam transfer hall where presently

C_T = 27.8 nf/channel

and $T_D \simeq$ 2.5 ms,

$n_p \simeq 10^9$ protons/volt.

A switch is provided to change the sensitivity to 10^{10} protons/volt.

Again, where relative beam intensity only is desired the output voltage may be used directly without concern for the multiplier.