Contribution ID: **429** Type: **Oral Presentation**

Cryogenic Loss Monitors with FPGA TDC Signal Processing

Friday, 10 June 2011 14:50 (20 minutes)

Radiation hard helium gas ionization chambers capable of operating in vacuum at temperatures ranging from 5K to 350K are designed, fabricated and tested and will be used inside the cryostats at Fermilab's Superconducting Radiofrequency beam test facility. The chamber vessel is made of stainless steel and all materials used including seals are known to be radiation hard and suitable for operation at 5K. The chamber is designed to measure radiation up to 30 k(Rad/hr) with sensitivity of approximately 1.9 pA/(Rad/hr). The current is measured with a recycling integrator current-to-frequency converter to achieve a required measurement capability for low current and a wide dynamic range. A novel scheme of using an FPGA-based time-to-digital converter (TDC) to measure time intervals between pulses output from the recycling integrator is employed to ensure a fast beam loss response along with a current measurement resolution better than 10-bit. This paper will describe the results at low temperature and highlight the processing techniques used.

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Session Classification: Machine Det. Interface and Beam Instr.

Track Classification: Machine Detector Interface and Beam Instrumentation