The Silicon Radiation Monitoring and Protection System for Run II

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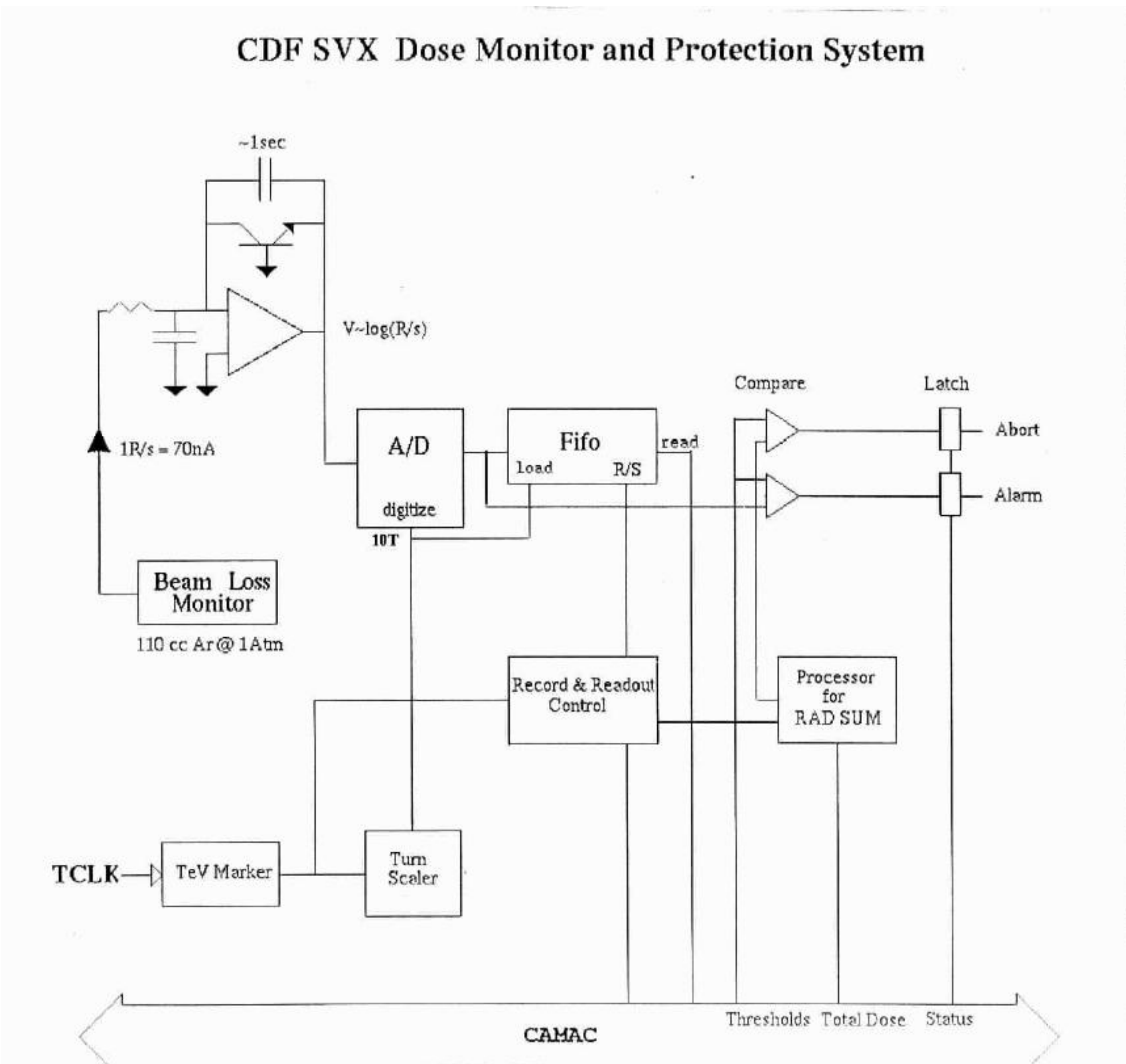
1. Overview and Hardware Description

The CDF radiation protection system is designed to both monitor and limit the radiation dose incurred by the silicon tracking system during Run II and beyond. The system, shown in the following schematic, is essentially identical to the one used in Run I.



The radiation is measured with two pairs of Beam Loss Monitors (BLM) that for Run II will be in the horizontal plane +4.3m and -4.3m from the center of the interaction region at an average radius of 10.7 cm from the beamline. Each BLM is a sealed glass ion chamber that contains 110cc of argon at STP. This yields an ionization current of 70 nA for 1 Rad/s. The BLMs are read out through a logarithmic integrating amplifier housed in what is called the BLM Chassis. The BLM chassis used by CDF has one slight modification from the Tevatron standard. The signal rise time is the standard 24 microseconds, but the signal decay time constant has been altered from the standard 61ms to 940ms. Thus the BLMs, as read out through this system, are sensitive to extraordinary single-turn accidents and also slower but persistent beam losses. Note that the position of the BLMs is the only essential difference between the system used in Run I and the proposed Run II system. In Run I the BLMs were 2.0m from the center of the interaction region and were centered at a radius of 8.3 cm from the beamline.

The Run II system provides some additional BLM monitoring capabilities over Run I. Since the BLM HVs are daisy-chained together on each side, the two HVs will be run back to the CDF control room where they will be divided down and monitored/alarmed in ACNET. In addition the BLM outputs will be outfitted with 50-Ω feed-through terminators, allowing one to use line-termination tests to easily check that the signal cables are connected to the BLMs.

Also placed 4.3m away for the interaction region are thermo-luminescent devices (TLDs) used to measure the r-phi distribution of the dose and cross check the BLM calibration. The TLDs are lithium fluoride crystals, the luminescent properties of which change after exposure to radiation. The TLDs are to be replaced approximately monthly. Early in Run 1 we also used a silicon PIN diode detector system but these were found to be too sensitive and the system was therefore abandoned.

The output from the integrating amplifier in the BLM chassis is processed by a CAMAC-based system developed by the Beams Division in collaboration with Paul Derwent and the University of Michigan CDF group. One double-wide CAMAC card, the so-called 335-336 modules handles inputs from two BLMs. The 335-336 modules actually have two boards, a 335 and a 336 card in each. The 335 card samples and digitizes the BLM signal every 210 microseconds, corresponding to 10 turns of the beam.[*] This signal is compared to alarm and abort thresholds that are downloaded to the 335 card through ACNET. These thresholds are set depending on the Tevatron state; there are separate thresholds for Shot Setup and for Store conditions. The 335 card or's the condition of the two BLM signals and sends the abort status via the CAMAC backplane to the Abort Combiner Card. This card takes the 2 potential abort signals from the two 335 cards and or's them, dropping a 5V line if any are in abort status. The 5V line is connected to the TeV abort system at TeV CAMAC crate $1B in the B0 service building, approximately 400 ft away.

The digital signal for each BLM from the 335 card is also sent to the 336 card which holds the signal in a 2048 deep FIFO. A second FIFO keeps the integral of the dose for each BLM.

A slightly more thorough description of the radiation monitoring system can be found starting on Page 112 of Nucl. Instr. And Meth. In Phys. Res. A 350 (1994), provided in this document.

1.1 Alarm, Abort, and Manual Abort Thresholds

Table 1 contains relevant physical parameters of the detectors and radiation monitoring system. It also gives the expected radiation dose for both Run I and Run II conditions. During Run I the dose at the innermost layer of the SVX was a factor of approximately 2.5 higher than the dose at the BLM. In Run II this ratio is likely to change because (1) the above mentioned change in the

[*] The schematic shows the readout being clocked by the TeVatron $AA marker. In order to protect the abort system from possible failures of $AA, an independent 47.7 kHz clock will be used instead and continuously monitored for possible failure.

BLM position (2) the SVXII innermost layer is at 2.5cm instead of 3.0cm (3) there is more material in front the BLMs in Run II. To estimate the physics dose at the BLM we simply extrapolated the Run I value of rads/s to larger radius. To do this we use the observed Run I radial dependence of the dose, r**(-1.68). Thus we are essentially assuming the larger z position of the BLM and the additional material in front of the BLM will effectively cancel leaving only the affect of the change in radii.

Table 1

Item	Run I	Run II
Radius of SVX L0	3 cm	2.5 cm
BLM Z Position	2m	4.3 m
BLM radius	8.3 cm	10.7 cm
Dose due to Physics at L0 of SVX	0.0025 Rad/sec at 1x10**31	0.067 Rad/sec at 2x10**32
Max estimated dose at L0 in a 15 hour store	135 Rads	3.6Krads
Dose due to Physics at BLM	0.001 Rads/sec at 1x10**31	0.0131 Rad/sec at 2x10**32
Max estimated dose at BLMs in a 15 hour store	54 Rads	707 Rads

Table 1. Relevant positions of the BLM and inner silicon layers. Also given are dose estimates for Run I and Run II. The affects of the larger z position and more material in front of the BLMs have not been included in the Run II BLM dose estimates.

Table 2 contains the Abort and Alarm thresholds for Run I and the proposed thresholds for Run II.

Table 2

Threshold	Description	Run I	Run II
1. Automated Shot Abort	CAMAC Trip Threshold during Shot setup	10 Rad/sec	10 Rad/sec
2. Automated Store Abort	CAMAC Trip Threshold during stores and at all other times	2 Rad/sec	2 Rad/sec
3. Manual Shot Alarm	CDF to alert MCR of high losses during shot setup	Integrated dose of 50 Rads	Integrated dose of 1Krad
4. MCR Manual Shot Abort	MCR to abort shot	Integrated does of 150 Rads	Integrated dose of 2Krads
5. CDF Manual Shot Abort	CDF to abort shot	Integrated dose of 250 Rads	Integrated dose of 3Krads
6. Manual Store Alarm	CDF to alert MCR of High losses during a store	Integrated dose of 50 Rads	Integrated dose of 3Krad
7. MCR Manual Store Abort	MCR to Abort Store	Integrated dose of 150 Rads	Integrated dose of 4Krad
8. CDF Manual Store Abort	CDF to Abort Store	Integrated dose of 250 Rads	Integrated dose of 5Krads
9. Manual Studies Alarm	CDF to alert MCR of High losses during a shift of Acc. Studies	Integrated dose of 50 Rads	Integrated dose of 4Krad
10. MCR Manual Studies Abort	MCR to Abort Studies	Integrated dose of 150 Rads	Integrated dose of 5Krad
11. CDF Manual Studies Abort	CDF to Abort Studies	Integrated dose of 250 Rads	Integrated dose of 6Krads

Table 2. Alarm and Abort Thresholds for the Run I and Run II Radiation Protection System. Items 1 and 2 are the proposed automatic aborts, downloaded to the 335 CAMAC Card. Items 3-11 are the proposed thresholds for manual action by either CDF or MCR shift members during Shot Setup, Store or Tevatron Study periods. All radiation levels are as recorded by the BLMs, NOT the value extrapolated to the innermost silicon layer of the SVXII.