A Cerenkov Radiation Detection System for the Advanced Photon Source Storage Ring

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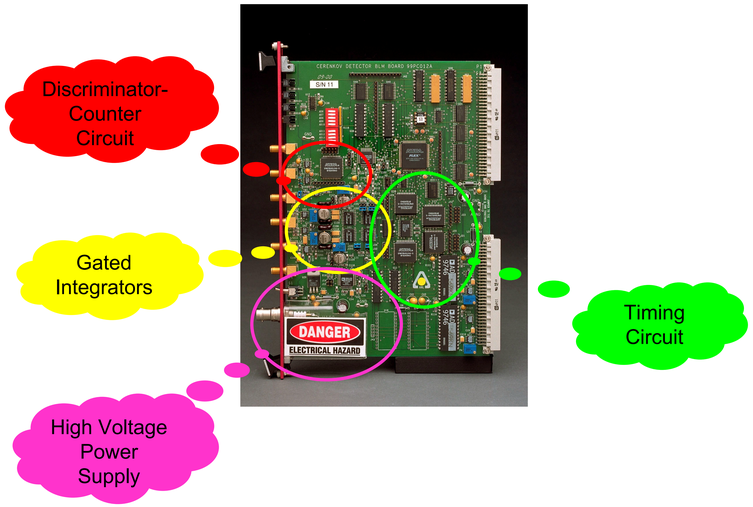
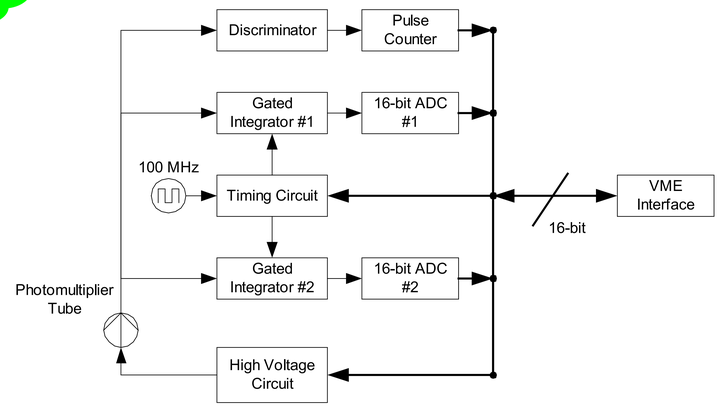
Cerenkov Detector VME board.



Abstract

A Cerenkov radiation detection system has been designed for Argonne National Laboratory's Advanced Photon Source 7-GeV electron storage ring. This system is intended for monitoring and measuring localized beam losses. The Cerenkov radiation detection system includes a detector assembly mounted at selected locations in the storage ring tunnel and an electronics package in a VME format. The electronics package consists of a high-voltage power supply, a 16-bit pulse discriminator-counter, two gated integrators, and two 16-bit analog-to-digital converters. The design of the timing circuit offers an extended range of 655 µs for both the gated integrator gate width and gate delay. The detectors have been installed near all storage ring scrapers, the storage ring thin-septum magnet, and at several insertion device locations. Plans are to instrument all present and future insertion devices. This paper discusses the electronics design as well as the mechanical design of the Cerenkov detector system.

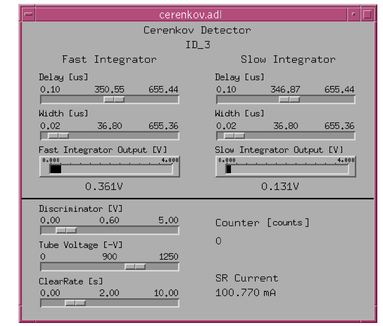


Block Diagram of the Cerenkov Detector System

Gated Integrator Specifications:
- Timing synchronous with injection
- Max timing uncertainty: 10ns
- Adjustment resolution: 10ns
- Max Integrator Delay: 655.34µs
- Max Integrator Width: 655.34µs
- 75ns and 250ns integration constants

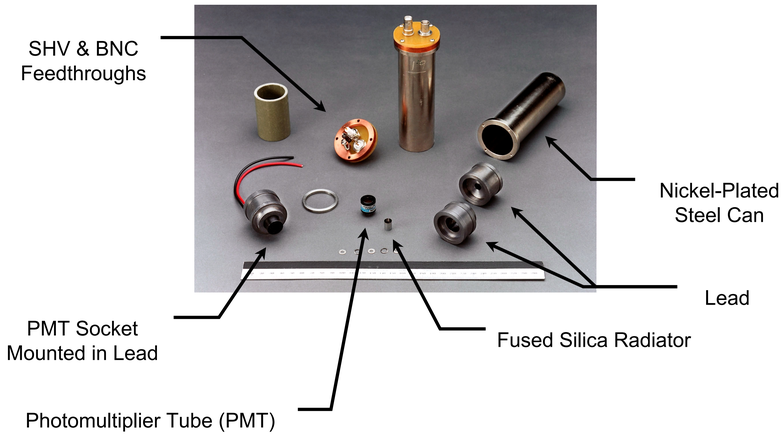
Counter-Discriminator Specifications:
- Max count: 65535 (16-bits)
- Count period resolution: 152.6µs
- Max count period: 10s

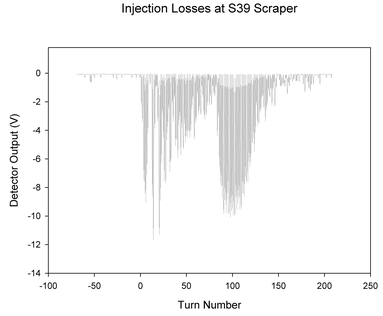
PMT Specifications:
- 16mm diameter
- Peak wavelength: 240nm
- Gain: $5x10^4$ typ.



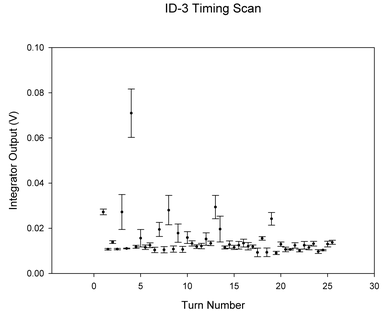
MEDM Screen for ID 3. The MEDM control screen example in Figure 2 shows the "slow integrator" starting its integration period 1 turn (3.68µs) earlier than the "fast integrator". It also shows an integration period of ten turns for both of the integrators.

Exploded view of the in-tunnel detector

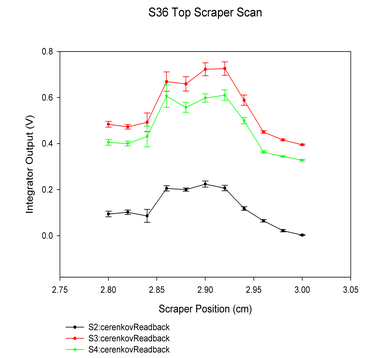




This plot shows that losses occur for many turns following injection. The data shows the characteristics of both the injection betatron oscillation, seen in the first few 10's of turns, as well as the synchrotron oscillation, seen in turn 80 and beyond.



This plot demonstrates that for this particular location, ID 3, the most loss occurs during the fourth turn. This data was taken by scanning the gate delay while continually injecting into the storage ring.



Losses at three consecutive IDs as a function of the S36 top scraper position. The losses increase to a certain point then decrease as the scraper digs into beam. There also indicates different background readings as well as electronic offsets for two of the integrators.