Beam Loss Monitors

CLS PRELIMINARY DESIGN NOTE – 8.2.38.3 Rev. 0

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Canadian Light Source
107 North Road
University of Saskatchewan
Saskatoon, Saskatchewan Canada

	Signature	Date
	Original on File – Signed by:	
Author	(J.M. Vogt)	2001-03-13
Reviewer #1	(E. Matias)	
Reviewer #2	(J.C. Bergstrom)	
Reviewer #3	(N.G. Johnson)	
Approver	(M. de Jong)	

REVISION HISTORY

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A	2001-01-25	Draft	J.M. Vogt
0	2001-03-13	Issued for Use	J.M. Vogt

1. Purpose

The Beam Loss Monitors will be used

- While the machine is being set up, to help assure proper steering and focussing of the beam, and to compare with previous set-ups,
- During normal operation, to watch for changes in the beam set-up,
- During debugging, to locate trouble spots by moving the detectors around,
- At any time during the operation of the machine for equipment protection.

2. Background

The beam pulses in the LINAC, LTB1 and BTS1 will be between 2 ns and 136 ns long and will occur at a rate of 1-3 Hz during injection under normal operating conditions. Beam loss will therefore occur in bursts and is expected to cause pile-up in the BLMs. Consequently the BLM signal has to be an analog signal, the amplitude of which provides a measure of the beam loss. Due to the low repetition rate of 1 Hz it is important to be able to assess the beam loss of every single beam pulse.

Beam loss in the Booster and in the Storage Ring is expected to occur over a long period of time (hours in the case of the Storage Ring, hundreds of milliseconds in the case of the Booster). Readout is desired at a rate of 10 Hz or less. It is not practical to integrate an analog signal over such an extended period of time. Since pile-up is not expected to be a problem, the preferred detection method is to count the number of pulses after discriminating the signal.

3. Definitions and Abbreviations

BLM: Beam Loss Monitor

COTS: Commercial of-the-shelf

PMT: Photomultiplier Tube

SAL: Saskatchewan Accelerator Laboratory

4. References

[1] AIP conference proceedings 451, 1998, page 107.

[2] The photon tagging facility at the Saskatchewan Accelerator Laboratory, Nucl. Inst. and Meth. **A324**(1993)198

5. BLMs for the LINAC, LTB1, and BTS1

The BLMs consist of Cerenkov detectors similar to the PEP design [1], which is also used at the APS. However, in order to reduce the cost of the system, SAL surplus hardware is used as much as possible.

5.1 The Detectors

The detectors use fused silica cylinders, 16 mm in diameter and 20 mm long, made by V-A Optical Labs Inc. The index of refraction of fused silica is 1.475 at 400 nm, which corresponds to a Cerenkov threshold of 184 keV for electrons. The fused silica cylinders are directly attached to small photomultipliers using Dow Corning Sylgard 527. Compared to optical grease or epoxy, the advantage of Sylgard 527 is that it provides solid mechanical support, but it remains elastic and it can be removed without causing damage to the silica cylinder or the photomultiplier.

The photomultipliers are Hamamatsu R1450, plug-in compatible with the Photonis (formerly Philips) XP1911. While significantly bigger than the tubes used in the PEP design, their advantages are:

- Large numbers of SAL surplus PMTs are available,
- Both Hamamatsu and Photonis still produce these PMTs (the type used at PEP is now obsolete),
- SAL PMT base assemblies are available for initial tests,
- Existing SAL magnetic shielding pipes can be used.

The available PMT bases (Fig. 7 in [2]) were used in the SAL photon tagger and were designed for very high-speed running with no emphasis on linearity or dynamic range. If initial tests of the Cerenkov detectors are successful, the PMT bases will be redesigned for improved linearity at large pulse heights.

5.2 Data Acquisition Electronics

Fig. 1 shows a block diagram of the data acquisition electronics. Initially a Fiber Optic Oscilloscope Probe (see CLS document 2.1.73) will be used as a Fiber → NIM converter. The gate generator will be a NIM module (LeCroy 222 or similar) during initial tests, and the Fan-out will not be needed until more than 1 ADC is used. Ultimately these modules may be replaced with a custom-built gate generator with a fiber optic input.

The charge integrating ADC is a VME module (C.A.E.N. V265N, EPICS driver already exists). Initially a SAL surplus LeCroy 4032 HV power supply will be used. However, these supplies are obsolete and are no longer available. For the ultimate implementation of the BLMs, a substitute will be chosen.

The BLM data acquisition electronics for the LINAC and LTB1 will be located in room 0013 (EA2). An existing SAL surplus VME controller and crate will be used initially. The electronics for BTS1 (and for the Booster and Storage Ring) will be located in room 2400 (on top of the Booster shielding). In order to keep ground noise to a minimum, the HV power supplies for the Cerenkov detectors will be located in the same rack as the data acquisition electronics.

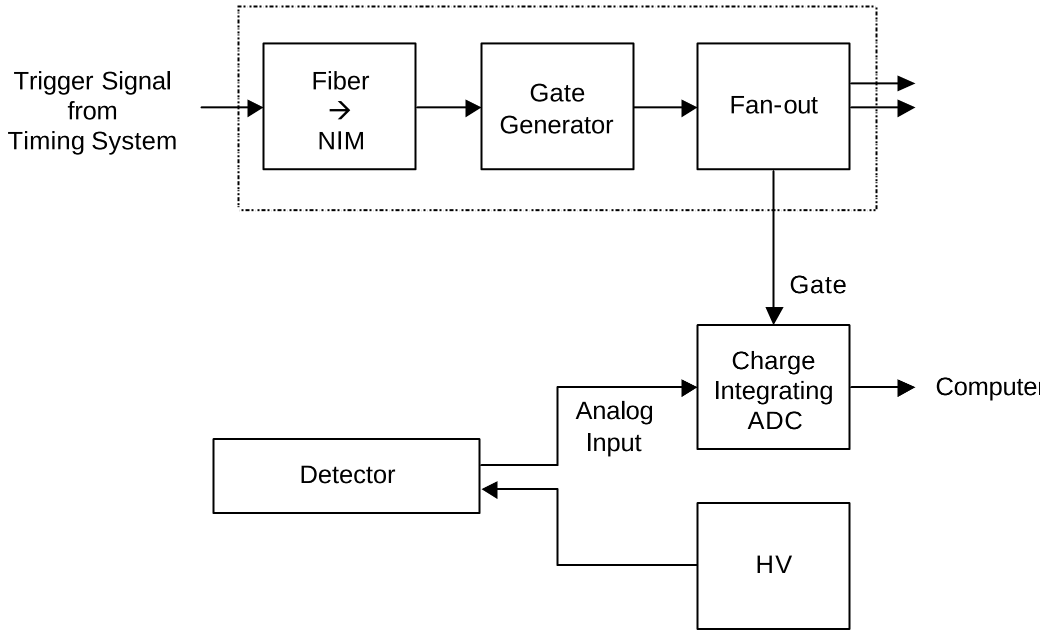

Fig. 1: Block diagram of the data acquisition electronics for the Cerenkov BLMs in the LINAC, LTB1, and BTS1. Delays are not shown.

6. BLMs for the Booster and the Storage Ring

6.1 The Detectors

COTS BLMs made by Bergoz will be used in the Booster and in the Storage Ring. These detectors generate a TTL pulse when a charged particle hits their active volume. Their deadtime is about 100 ns, which rules out their use in the LINAC, LTB1, and BTS1. However, they are well suited to measure the beam loss in both rings, where the loss is expected to occur at a low rate, over a long time.

Some of the Cerenkov detectors described in 5.1 will be used in the Booster and in the Storage Ring. However, at this time the requirements for their operation are not known yet.

6.2 Data Acquisition Electronics

Fig. 2 shows a block diagram of the data acquisition electronics. A fiber optic link is used to transmit the signals from the detector to the scaler. This fiber connection allows powering and grounding the detector locally. The scaler is a VME module with ECL inputs (C.A.E.N. V560E or similar). One scaler channel counts the signals of a crystal oscillator to provide a time base for accurate calculation of the count rates of the Bergoz detector. Readout of the scaler will be triggered by the data acquisition software.

The data acquisition electronics for the Bergoz BLMs will be located in the same rack in room 2400 as the electronics for the Cerenkov BLMs in BTS1. However, during initial detector tests along the LINAC and LTB1, the electronics will be located in room 0013.

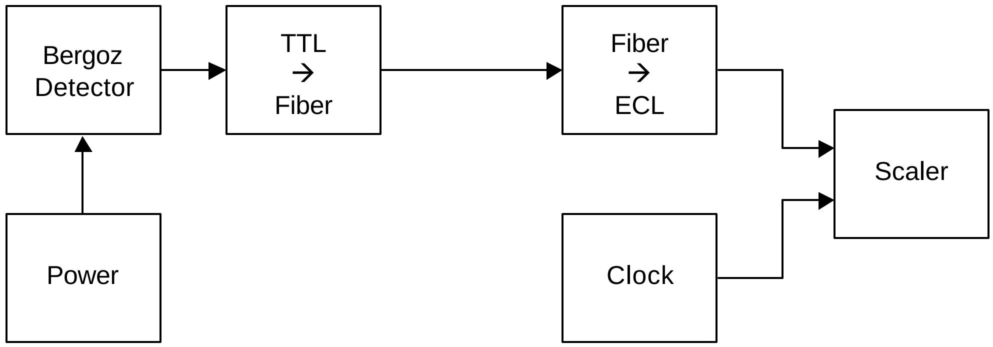

Fig. 2: Block diagram of the data acquisition electronics for the Bergoz BLMs in the Booster and in the Storage Ring.