Fermilab/AD/TEV
Beams-doc-1147
April 28, 2004
Version 1.0

Tevatron Beam Loss Monitor (BLM) Review Committee Report on the meeting of April 19, 2004

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Introduction

Pushpa Bhat formed a committee to review the specifications for an upgraded Tevatron Beam Loss Monitor (BLM) system. The committee consisted of Mike Martens (Chair), Jerry Annala, Brian Hendricks, Nikolai Mokhov, Dean Still, and Bob Webber from the Fermilab Accelerator Division, Carl Bromberg from CDF, and Ron Lipton from Dzero. The committee met on April 19th, 2004 where Stephen Pordes, Al Baumbaugh, and Craig Drennan presented talks on the specifications, initial design, and cost and schedule estimates. Following the talks there was a round table discussion with the committee members, presenters, and interested audience members. This report summarizes the conclusions and recommendations of the committee.

The Charge

The charge given to the committee on the **"Review of the BLM system specifications for Tev abort system upgrade"** was as follows:

Charge:

Following the 16-house quench caused by the CDF "Tokyo Pot" incident, a task force has been set up to design and implement upgrades to the Beam Loss Monitors (BLMs) and the Tevatron abort system logic to make the abort system more effective and robust and to significantly reduce such risks in the future. The task force has been exploring several aspects of the abort system. It has been documenting failure modes, reviewing the policy for masking aborts and developing upgrade specifications for the beam loss monitor system which will serve as the primary trigger for the abort system. The initial review that this committee is requested to perform is of the specifications for an upgraded Beam Loss Monitor system in the context of the abort logic upgrade.

1) Review and comment on the general concepts of the abort logic upgrade presented to you.

2) Review the requirements for the Beam Loss Monitor upgrade in the context of the Tevatron abort system upgrade. Are there any requirements missing? Are there unnecessary requirements?

3) Review the specifications of the Beam Loss Monitor system upgrade and comment on its appropriateness and ability to help achieve the required functionality and robustness in the abort system. Consider the following aspects of the proposal:

    a) General features of the available signals from the BLMs to the abort logic
    b) Key aspects of signal processing
    c) Control and communication interface (Note: The upgraded system should be able to allow us to abort much faster than the current 16 ms (60Hz sampling rate of the QPS).)

4) Is the technology choice for signal processing appropriate?

5) Can we obtain useful information other than for abort logic, from the BLM system, as proposed?

Amendment to the Charge:

During the presentation of the charge to the committee there was a clarification of the charge in regards to its focus and scope. Although the upgraded BLM system is part of a larger effort by the "Abort Task Force," the committee concentrated on the specifications and designs of the BLM system and did not review the larger issue of the entire Tevatron Abort system. We also noted that producing a reliable BLM system with a minimum number of false aborts may require a better understanding of the abort logic, but the committee focused only on the BLM

system and assumed the requisite work on the rest of the abort chain logic will be done separately.

Presentation on the Tev BLM Specifications and Design:

Presentations on the BLM requirements, a proposed design, and a draft schedule were presented by S. Pordes, A. Baumbaugh, and C. Drennan. The talks can be found on the Accelerator Division documents database (http://beamdocs.fnal.gov/cgi-bin/public/DocDB/DocumentDatabase) in the document numbers shown in the table below.

Document #	Title	Author
1130-v5	TeV BLM Draft Schedule	Stephen Pordes *et. al.*
1131-v1	Tevatron Proposed BLM system review Slides v3	Alan Baumbaugh
1129-v2	TeV BLM requirements	Stephen Pordes
1127-v2	TeV BLM Test Card Review Docs	Craig C Drennan

The presentations were clear and well thought out and the committee thanks the presenters for their fine work.

The plan for upgrading the BLM systems is solid and worth pursuing and the committee recommends that the upgrade be done. Their hardware data acquisition and signal thresh-holding system plan appears to be well conceived and well directed toward prototyping and testing parts of the system that might be of some concern.

Discussion and Questions from the Committee:

Following the presentation a round table discussion took place with opportunities for members of the audience and the committee to ask questions and make suggestions. Based on the presentation, the round table discussion, and further communications after the meeting the committee drafted a set of recommendations that we present in this note.

Committee Report

The plan for upgrading the BLM systems is solid, worth pursuing, and the committee recommends the BLM upgrade be done. We do have a list of suggestions which we hope will lead to a more successful project.

Focus on the Tev BLM system. The focus should be on meeting the requirements of the Tevatron and using the BLM system as part of the Abort System to protect the Tevatron from damage due to extreme beam loss. Using the same system for the Main Injector or Booster should be considered as well, but these considerations should not delay the work on the Tevatron. Specifications on limits and system sensitivity and dynamic range need to be worked out for the Main Injector and Booster magnets and operation conditions. It can be done on basis of corresponding energy deposition calculations

Continue efforts on protecting the Tevatron with the existing BLM system. While an upgraded BLM system is recommended, this will not directly address the more immediate concern of protecting Tevatron from damage until the BLM upgrade is completed approximately August 2005. Therefore the effort to replace the old system should not divert attention from or consume resources needed to address immediate concern of protecting Tevatron until the BLM project is finished approximately Aug 2005.

Create a requirements/specifications document. The design of the upgrade BLM system was presented in significant detail for the committee to form an opinion regarding the proposed system. For completeness, we recommend that a single, working requirements/specification document including software interface and applications programs should be created ASAP and maintained as project progresses to establish common reference for all working on and reviewing the project. This could be a "living" document which is updated as the design of the system matures.

Include application programs as part of the BLM upgrade. Flexibility of the new system implies a well thought-out and implemented software system to provide a user friendly set-up and diagnostic interface in order to be successfully integrated into machine operations. Therefore, the development of the applications programs for the BLM system should be included as part of the project. This should include specifications for the software and estimates for the time and manpower. This will involve members of the Tevatron group since they will be responsible for configuring the BLM system to protect the Tevatron.

Consider using a BLM front-end system which is separate from the BPM upgrade front-end and make a decision in this regard as soon as possible. It is important that a decision regarding the BLM "front-end" processing be made quickly since it will impact both the BLM upgrade and the BPM upgrade. As proposed, the MOOC/ACNET interface (or the BLM "front-end") would become a part of the BPM upgrade project and use the resources of the BPM front-ends. In this regard, we ask that the BLM project consider using its own front ends and separating itself from the BPM project. We make no recommendations about this expect that it should be considered. There are advantages/disadvantages for both a separate front end system and for using the BPM front end system. For example, separate front ends will have more M&S cost for VME processors, but the convenience of a separate system may be worth the extra cost. We also note that the CPU in the proposed system serves a specific dedicated function in the chain of abort logic. Therefore, that same CPU must not also be expected to serve MOOC/ACNET interface functionality if decision is to not use BPM CPU for that purpose. (One downside of making the BLMs into a separate front end is that the GAS speaking BPM modules would have to remain in place and functional until the end of the BLM replacement project in late 2005 rather than being replaced by the BPM project this year.)

Use C-language for development of the CPU system. We recommend using C language instead of assembly for programming the abort logic. It seems like a clear advantage to program a modern processor in a language like C which will be easier to maintain in the future. There should be a more compelling reason for writing in assembly language. Along these same lines, it would not be necessary to use a Z80 microprocessor if assembly language was not used.

Use the more standard and larger "6U" crates instead of the smaller "3U" crates. Rack space does not seem to be the issue as it was once believed. Therefore we suggest the project consider using the taller "6U" crates rather than the less standard "3U" crates. This change would also allow for the use of VME front ends if needed. Also, the "6U" is a much more standard form factor, increases the amount of board real estate available for the digitizer boards, and also improves the availability of commercial cards. All of our standard CPU cards are apparently "6U."

Control the abort threshold states via a newly created MDAT channel. The Tevatron states are not broadcast on T-clock or MDAT and this affects the communication methods mentioned in the review. It is a combination of parameters, such as the collider state (V:CLDRST), the mode of operations (V:TEVMOD), the beam energy, collimator activity, SVX status and beam intensity that would be used to determine abort thresholds. At this time we do not know how to specify when different limits might be needed. We imagine that the BLM system will have a handful of states with different abort thresholds. The BLM state will be broadcast by an MDAT channel and will depend on many

factors of the Tevatron operations such as beam type, state of the Tevatron, and beam intensity. Therefore relying on TCLK events is not sufficient.

Keep CDF and D0 in mind. D0 and CDF use a slightly modified version of the present BLM system to protect their detectors. It should be considered that D0 and CDF may want to use the upgraded hardware as well.

Use of the multiplicity feature may require rearrangement of the loss monitors. When implementing multiplicity of loss monitors to generate beam aborts, it may be necessary to obtain loss signals from monitors that are currently in different houses. This means that we may need to communicate from house to house, or simply add an additional loss monitor to the end of a house.

Check with the Tevatron group before choosing clock events. If clock events are to be used for BLM operation, these should either be programmable or reviewed with Tevatron personnel. Many clock events are used differently that originally intended, and there will be more changes in the future.

Alarm on loss reading levels. In addition to alarming on the hardware status, (such as HV readback) also provide the capability to alarm on loss readings.