

Main Injector

Beam Position Module Electronics

Review Report.

Agenda - 12 Oct. 2006:

- Brief overview of requirements (Alberto Marchionni)
- Transition module design (Manfred Wendt)
- Timing Fanout Generator module design (Bill Haynes)
- Reviewer conference
- Review closeout

Alberto presented a summary of the system requirements including beam luminosities and bunch structures that the system must be able to measure. He included accuracy, resolution and range specifications for the position measurements and accuracy requirements for intensity measurements. The system must be able to measure signals at 53 and 2.5 MHz and at two bandwidths at those frequencies and be able to switch quickly between modes. The system must implement the following measurement operations: flash frame, turn by turn, averaged orbit, display frame, profile frame and Fast time plot.

Manfred presented the design and status of the Transition Module (TM) system using his document [Transitionboard-Prototype-Measurements](#) from Doc #1526 in the document database as a background. He described the design architecture, important circuit details and current issues. A discussion of circuitry technical detailed followed including questions on gain, linearity, pot stability, gain control voltage noise, and more. The layout design was discussed to understand the planning for separating the digital and analog circuitry to reduce noise and cross coupling into the analog signal.

Bill presented the design and status of the Timing Fanout Generator module (TGF). The design is based on the existing Tevatron TGF. The changes were itemize and include adding two A2D clock and two sync outputs, adding two additional clock inputs with decoding logic, replacing the component PLL with a PLL internal to the FPGA, and implementing a parallel port output on the backplane. Echotek clock generator and TGF clock generators compared favorably.

General Discussion.

1) The amount of bucket time slip with frequency change is larger in the MI than the Tev. The conclusion of the discussion was that it may be a problem but probably not because the Echotek filter uses the signal from approximately RF 20 buckets or more to produce a single measurement and the slip is approximately 7 RF buckets.

- 2) A Signal triggered mode is implemented in software similar to the 'safe mode' in the Tevatron. It will be a high bandwidth mode collection of a large number of data points starting comfortably before the event to be captured.
- 3) The linearity specification and the large gain range in the transition card are a concern. This is such a wide range of input signals that there may be sections of the analog circuit that are not linear over the full range. There was discussion of the Low Noise Amplifier linearity and where the first saturation occurs, discussion of signal levels and beam intensities expected during normal operation and especially during diagnostics and 'study time'. The conclusion is that the linearity of the transition module amplifiers and the capability of first amp to operate satisfactorily over a 60 db input signal range needs to be tested.

Findings:

- The TGF board design is a superset of the existing Tevatron design. The board layout changes have been completed and the board has passed an engineering review. The board is ready for production.
- The TGF firmware design is a superset of the operating Tevatron firmware. The changes to the firmware are 80% complete and have been tested as much as possible without production hardware.
- The transition module design is based on an existing transfer line module. A prototype of the signal circuitry is being tested and is available for additional characterization.
- The TM digital circuitry design is being completed and the PC board layout will be complete in approximately 2 weeks.
- The TM board layout included analog and digital circuitry on one board. The current plan is to separate the digital and analog circuitry by putting them on the two sided of the PC board. The digital circuitry is static except on the strobe signal when a change is made to operational parameters. The diagnostic signal is only switched on when needed so is not active during normal data acquisition.
- TM mode switch time 100ns or less.
- The interfaces between the components of the system replicate the Tevatron system so most are understood. The new interface is the control connection between the TGF and the TM sub rack. This interface seems to be specified yet flexible and therefore not a risk.

Comments:

- The transition module could quickly become the critical path for this project.
- The software to utilize and control this hardware was not part of this review.
- Operation quantities required are: 7 VME and TM sub racks each with a power supply, 7 TGF modules and 56 Transition Modules. Production quantities are: 11 VME and TM sub racks each with a power supply, 15 TGF modules and 75 Transition Modules.

Recommendations:

- Add Alberto's doc to doc database as reference unless the information is as clearly presented in the requirements document.
- A single specification document for the electronics hardware should be completed before the end of the project. Alternatively one document for each type of sub rack should be completed before the end of the project.
- Test transition module signal linearity, input vs. output over the full range of operational input signal levels.
- Complete layout maximizing the separation between analog and digital circuitry in order to minimize noise coupling and cross-talk into the analog circuitry.
- TGF production should start ASAP with PCB and parts acquisition.
- Review the TM board layout before releasing it to production. The parts purchase can start as soon as the PCB layout is has progressed to where it cannot change the parts list.

Responses to the charge:

- Verify that the specification addresses all relevant components needed for the Main Injector BPM system.
 - No specific specification was presented. The review covered the components that were different from the Tevatron system with the assumption that the rest of the system would be copied. The recommendations address the specifications.
- Verify that the design approach and schematics are technically sound, self-consistent and reasonably optimized.
 - This is the majority of this document.
- Check that the design can be implemented in the hardware in a reasonable manner.
 - Possible technical issues were discussed and all had reasonable or multiple solutions. No unresolved issues remain.
- Suggest improvements and/or concerns regarding the specification.
 - Suggestions were made throughout the review.

Appendix

Invitation to Jim Steimel, Peter Prieto, and Vince Pavlicek

You are invited to review the Main Injector (MI) Beam Position Monitor (BPM) Electronic design. The electronic components for the MI BPM are as follows:

- MIBPM Transition module – This is a new module.
- MIBPM Timing Generator Fanout (TFG) module – This is a modification of the Tevatron BPM TFG module that was commissioned earlier this year.
- Echotek boards – These are same as Tevatron BPM and are already purchased.
- Various crates, cables and connectors.

The review packet consists of:

- Specification document and Schematics for the Transition Modules: TBD
- Schematics and specification of TFG module: TBD

These documents can be found at

<http://projects.fnal.gov/mibpm/wbs/reviews/MIBPMdesignReview/>

Charge:

Reviewers are requested to focus their attention to the design of the Transition Module and the design difference of the MIBPM TFG module from the older Tev BPM TFG module. The Echotek board, analog and digital crates, cables etc. are not within the focus of this review; however relevant questions and comments concerning these aspects of the system are welcomed from the reviewers. Reviewers should:

- Verify that the specification addresses all relevant components needed for the Main Injector BPM system,
- Verify that the design approach and schematics are technically sound, self-consistent and reasonably optimized,
- Check that the design can be implemented in the hardware in a reasonable manner,
- Suggest improvements and/or concerns regarding the specification.

Please let me know if you have any problems or issues regarding the review.