Meeting Minutes

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**Date:** April 9, 2018

**Re:** Meeting Minutes, PIP-II Machine Protection Kick-Off

**Meeting Time: 2:00 pm to 3:00 pm**

**Meeting Location: AD / Huddle**

**Attendees:**

Jim Steimel, PIP-II/Technical Integration/Deputy Proj. Engineer

Lionel Prost, AD/PIP-II

Sasha Shemyakin, AD/PIP-II

Arden Warner, AD/Accelerator Physics Center

Craig Drennan, AD/Instrumentation (Presenter, Secretary)

Peter Prieto, AD/Instrumentation

Vic Scarpine, AD/Instrumentation

Jim Patrick, AD/Controls

Rich Neswold, AD/Controls

**Not Able to Attend:**

Paul Derwent, PIP-II/Technical Integration/Proj. Scientist

Fernanda Garcia, PIP-II/Linac Installation & Commissioning

**Request for Feedback:**

Please send any additions, corrections, rephrasing and/or comments to Craig Drennan. There has been liberal use of paraphrasing in recalling what others have said in the meeting. There may also be some editorializing and introduction of new thoughts that could use some review. Thank You.

**Minutes:**

Introductions

The meeting was called as a startup for the PIP-II Machine Protection System (MPS) specification and design effort. In this meeting Craig Drennan showed some system block diagrams of his interpretation of the existing Functional Requirements for the MPS, last revised August 2015, and diagrams that elaborate on a proposed topology for beam instrumentation electronics involved with the MPS.

Craig’s Presentation

The slides for the presentation are available on the AD DocDB at Beams-doc-6261. Craig presented a small set of slides with system level, functional flow type block diagrams intended to highlight specification in the existing Functional Requirements Specification (FRS) for the MPS. It was later expressed that this FRS needs to be revisited. Arden Warner and Sasha Shemyakin have been working with the PIP2IT Injector Test and have new thoughts and insights as to what the MPS for PIP-II should be and how it should be specified.

Craig continued, showing block diagrams that were more implementation specific. The diagrams alluded to three possible architectures that involved beam instrumentation inputs to the MPS permit system. There was a small amount of discussion regarding the trade-offs of each architecture. I believe there was general agreement with the point that data should be digitized and transmitted over fiber optic links to avoid signal degradation and EMI issues of analog signals delivered over long runs of copper cables.

Craig’s final recommendation was to assign or hire a common drafter who could translate FRS requirements for each PIP-II system into a standardized form of Functional Flow Diagrams to aid in design and review of the systems we are putting together.

Discussion of MPS Levels

The architecture block diagrams presented were still very general and did not place bounds on the number of inputs to the MPS, or the complexity of the logic for making MPS decisions. In this regard Sasha reminded us that, in the early functional specification of the MPS, and the MPS they had been developing for the PIP2IT tests, that it was desired to keep the MPS logic simple and reliable. The number of Primary beam instrumentation MPS fault detecting devices and methods would be very small. Primary, beam instrumentation MPS fault detecting measurements and hardware would be limited to sufficiently fast and reliable systems that could not be masked off from inhibiting beam and would need a high level of review and testing if revisions are to be made to the hardware or firmware of the electronics involved. A measurement of a difference in beam current at different spots in the Linac would be used to detect beam loss and is the main method identified as a Primary MPS fault detection system.

There are many other devices and systems that are needed to protect various components of the Linac and can remove their beam permit to stop the beam. There is another category of MPS fault detecting devices and systems that are considered to exist in the Secondary level of the MPS system. These Secondary systems can remove their permit causing the designated beam-inhibiting devices to actuate and stop beam from going down the Linac. The Secondary MPS devices or systems can have their beam-inhibit signal masked off from impacting the delivery of beam under certain modes of operation.

In summary, the distinction between the Primary and Secondary levels is that the devices and systems chosen to be Primary are such that accelerator commissioning and other required operations modes can be accomplished without inhibiting the Primary MPS, and Primary MPS will protect the machine even if a Secondary MPS system is inhibited or fails. Given these distinctions, it is concluded that the Primary MPS be limited to only a very few, reliable systems.

Craig presented a table indicating, from the existing FRS, how the beam current difference would have two different time scales over which the difference would be averaged and compared to a threshold to determine when beam should be inhibited. Sasha stated that he no longer considered this averaging method as the best thing to do. Rather he is now promoting an integration method that would be an indication of the power or energy lost into the machine components. After a very short discussion, several people were still unclear on the calculation being proposed and it would be good to have the formulas and assumptions for this written out for people to consider and perhaps discuss.

Issue of BPMs Used in the MPS

Peter Prieto stated that somewhere along the way someone had said that the BPMs would be part of the MPS, or at least a few of the BPMs would be part of the MPS. Sasha did not consider BPMs as part of the MPS but stated that there are different opinions. Peter stated that we now need to decide whether it is going to be required of Instrumentation to include them. Arden commented that the larger part of the Linac, beyond the LEBT and MEBT may require BPMs as part of the MPS. Vic Scarpine added that it may take some time before we can know for sure. Peter said, that since it is a possibility that information from BPMs may be required, that we need to choose an architecture for the instrumentation that will support adding BPMs to the MPS in the future.

Jim Steimel brought up two issues he saw at this point. The first is that we must be concerned with having a reliable MPS for PIP2IT. The second, longer term issue is how do we come up with an architecture for PIP-II. Both are complex for different reasons, and that we need to improve our understanding. Jim said that we need to give more consideration as to what to do for PIP-II.

Discussion of Near-Term Tasks

Sasha reiterated the need for further work on the MPS FRS. The FRS needs to be finalized, reviewed and signed off. Jim Steimel stated that the Technical Integration Team is currently compiling a full catalog of the FRSs and re-organizing to make sure that things are consistent.

Craig showed a sample outline of a system design and asked Jim Steimel whether they had templates for writing TRSs that would help people ensure they included all the desired information. Jim said not yet. That is a little further down the list. Our priority now is determining interfaces and interface specifications. We will eventually need to iterate between the interface specifications and the technical specification to ensure everything is synced up.

Jim stated that they are asking people to define their interfaces in a qualitative sense, from a WBS standpoint. Asking people to name the interfaces that they think they have with other WBS systems. Then the Technical Integration Team will iterate back and ask whether the technical details have been addressed. Once we know what our interfaces are and have agreed on the technical specification of the interface, that’s when someone can get into the details of how the interface will be implemented.

Jim Patrick pointed out that there was a request for lists of interfaces to be submitted in the next few days. Jim Steimel seemed to indicate that they did not expect the lists to be 100% complete, that this was just a start. **Someone should check this interpretation**.

Reasonableness of Proposals Up to Now

Vic Scarpine addressed Jim Patrick saying, that some of what was presented here are big architecture changes, not just in terms of the Linac, but possibly for the rest of the complex with regard to fiber data transport, board designs, communications, etc. Is that something, in AD/Controls, you are interested in pursuing? This is going to affect instrumentation radically, how we build our boards, etc. Jim Patrick said he thought the things discussed so far were reasonable and that the MPS considerations were comparable to the NuMI machine protection they worked on 15 years ago.

Craig proposed that they hear from Greg Vogel who has ideas for the Timing System for PIP-II, in a meeting sometime soon. Greg has ideas on how the new things and the old things get merged and the pitfalls and trade-offs involved.

Agenda Items for Future Meetings

1. The responsibilities for the MPS system currently fall to AD/Controls in the project structure. Manpower and other considerations need to be made in this regard and a decision on leadership of MPS system effort needs to be solidified.
2. Greg Vogel has ideas on the timing systems for PIP-II that should be presented. Details of the MPS will likely drive or be driven by the specifications of the timing system.
3. The PIP-II MPS FRS will be going through some revision and this will need to be discussed.
4. Sasha has a new recommendation for the beam current difference signal integration and threshold comparison that should be reviewed.
5. Iterations will need to be made to choose an architecture for the Beam Instrumentation portion of the MPS system and these decisions will lead to more detail on the interfaces that need to be worked out.
6. There was some confusion as to whether WBS assignment in the project would be the sole basis for determining the interfaces that need to be defined. Jim Steimel had more to say as to how interfaces would be determined. This should be discussed.

If you remember something you found important that we should include in these minutes, let me know and I will add it.