Meeting Minutes

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**Date:** January 17, 2019

**Re:** Meeting Minutes, IOTA BPM Post-Review Planning

**Meeting Time: 9:00 am to 12:30 pm**

**Meeting Location: WH13NW Oscillatorium**

**Attendees:**

Craig Drennan, AD/Instrumentation

Nathan Eddy, AD/Instrumentation

Sasha Valishev, AD/Headquarters (IOTA)

Daniel Broemmelsiek, AD/AST (IOTA)

Valeri Lebedev, AD/AST (IOTA)

Aleksandr Romanov, AD/AST (IOTA)

Jinhao Ruan, AD/AST (IOTA)

**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:**

Sasha Valishev started the meeting by expressing that they had achieved fairly stable beam. The beam in the IOTA ring is 0.33 milli-amp to 1.0 milli-amp with no phase oscillations below 1.0 milli-amp. Bunch lengths are 10 cm at an RF voltage of 400 V. They are hoping to get 1kV of RF voltage within 2 weeks which would reduce bunch lengths by 30%. Circulating beam has been centered through the quadrupoles and is hence believed to be centered through the BPMs. The timing setup for the BPM system is expected to be the same as it was before the Christmas break.

There are a couple BPMs with some obvious issues. These can be addressed soon.

The near term goals and other notes for the IOTA BPMs are

1. Achieve 100 micron resolution for turn-by-turn measurements on each of the BPMs, BPMs with and without pre-amplifiers. Seven of the 21 BPMs have the pre-amplifiers. Beam currents for this case are expected to be 0.5 milli-amp to 1.0 milli-amp.
2. Nathan said that to reach this goal they will need to do the following

* New front-end processor software needs to be written and installed to interface with the new FPGA Firmware. The front-end driver for the IOTA BPM digitizers is being re-written now.
* The new FPGA firmware that was written, before the Christmas break, needs to be tested with the new front-end driver and then installed into digitizers at IOTA. The new firmware includes the use of revolution markers for synchronizing the ADC sampling instead of using the injection trigger and counting RF cycles.

1. The new front-end processor software is expected to implement a new Read/Write mutex memory management that will make delivery of ACNET data faster and more reliable.
2. Nathan reported that they had found ways to optimize the gains, bandwidths and scaling of signals into the RF detector. These modifications of the analog transition boards will not occur during the immediate iteration to achieve the 100 micron resolution turn-by-turn measurement.
3. In this iteration, a general RF detector calibration will be determined and applied to all of the BPM pickup channels. I am assuming that the individual channel calibrations will not be made until the analog transition boards are modified.
4. Sasha Valishev is hoping to get turn-by-turn data from each BPM detector after the new firmware is installed and the front-end software is updated.
5. Preform closed-orbit measurements with 0.1 to 1.2 milli-amps of beam in the ring.
6. Nathan expects to reach a resolution of less than 100 micron for the orbit measurement using a single, general calibration for all the BPM RF detector channels.
7. He hopes to achieve resolution of 10’s of microns after deriving independent calibrations for each RF detector channel.

* I am assuming that we will not try to determine independent calibrations, until we have carried out the hardware modifications of the analog transition boards.
* Modification of the analog transition boards requires time to order and receive parts.
* This may mean that the 10’s of micron resolution on the orbit measurement will not be achieved this beam run.

1. The test stand used for calibrating the analog transition boards uses a signal source that can produce a beam like signal of different intensities. The bunch length that he can represent is ~20 cm (70 pico-sec RMS) or longer. Valeri said we should perform these measurements and then evaluate the results. He suggested looking at the difference between a 20 cm signal and a 40 cm signal and consider the difference in the response. Dan Broemmelsiek stressed that it is the charge line-density that the calibration should address.

Valeri Lebedev was asked to help AD/Instrumentation with the calibrations.

1. Dan Broemmelsiek and Aleksandr Romanov mentioned being able to do BPM pickup calibrations using beam.
2. It was felt that we should still perform stand-alone calibrations of the analog transition boards on the bench, as opposed to only doing an end-to-end calibration using the IOTA beam. Having a calibration of the analog transition boards allows the swapping out of these boards without having to do beam studies to recalibrate the channel. Doing the calibrations on the bench provides better control over the signal parameters.
3. Doing the beam calibration afterwards has the benefit of verifying the effectiveness of the analog transition board calibration and/or possibly identifying another non-linearity in the system.
4. Non-linearities associated with the deviation of the beam from the center of the detector were discussed. Changes in beam intensity are commonly associated with changes in the instantaneous charge seen by the pickup due to the lengthening of the bunch. Intensity measured by a BPM pickup is also impacted by the distance of the beam from the pickup, the beam position. The largest deviation of the beam position is expected to by when the beam is kicked to make a tune measurement.

The BPM pickup response is mapped using a stretched wire. With this mapping correction terms can be derived to linearize the BPM detector response. Nathan said that he considers this mapping out to +/-15 mm in X and Y. Nathan stated that he believes the detector response is fairly linear within +/-12 mm. Within +/-5 mm it is really good.

Sasha said that in the low Beta locations the variation is typically within +/-5 mm, but in the maximum Beta locations the synchrotron oscillation can be as high as +/-20 mm.

1. Nathan has in mind several other modifications to improve the BPM measurements with the existing hardware.
2. There are the gain, bandwidth and scaling optimizations of the analog transition cards.
3. Changing the digitizer input coupling from DC to AC.
4. Implementing a Sum over Difference linearization using statistical methods in the digitizer FPGAs.
5. Building pre-amplifiers for all 84 of the BPM detector pickups.
6. The future may hold considerations for going from RF detector analog front-ends to ringed filter style analog front-ends (?).

**The next meeting is expected to be on Thursday, January 24.**

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