

Updates on AC-LGAD Testing @ BNL

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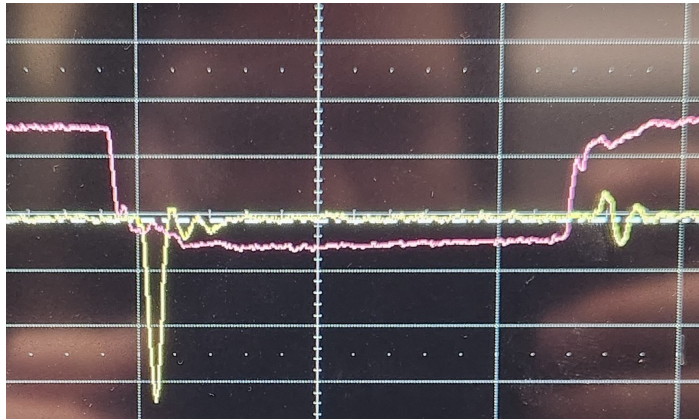
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Overview

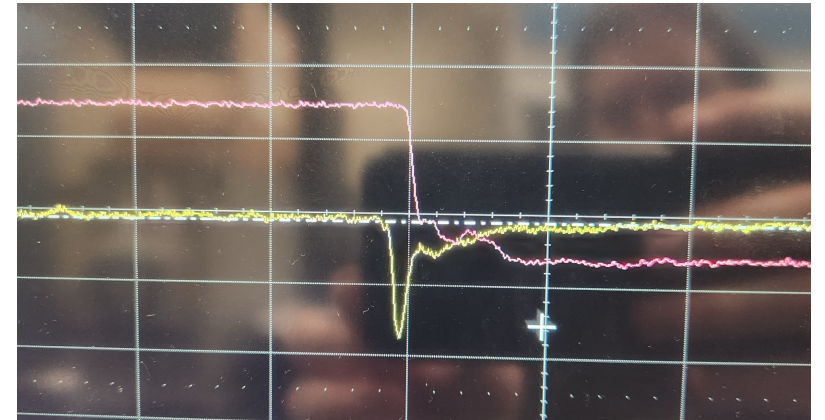
- New firmware provided by IJCLab at the end of July (right before the ePIC meeting in Lehigh).
 - Supposed to fix issues with the clock and the digital output.
 - Drastically speeds up data-taking → everything runs directly on FPGA, previously run on local laptop, commands sent serially to board. (e.g. previously 2k events took 60 seconds to run; now **200k** events takes about 10-20 seconds)
- First bump-bonded sensor + ASIC provided by BNL.
- **Goals from past few weeks:**
 - Test new firmware with old ("A1") board (wire-bonded) and reproduce [Adrien's results](#) shown at ePIC meeting – **in progress (see next slide)**.
 - Fix issues with the new boards (B1 + B2) and test bump-bonded sensor package.
 - Test B1 board with new firmware.
 - Set up TCT scans for the "A1" boards.
 - Send "B2" board to IO for bump-bonding with AC-LGAD – **in progress**.

New Firmware

- New firmware is a complete overhaul – required re-learning how to send configurations to the board, and (still) requires learning to analyze the output.
- Successfully able to use new setup to see charge injection and analog signals on scope (with both "A1" and "B1" boards).
- Analog output looks similar to before with charge injection.



"A1" – clock off



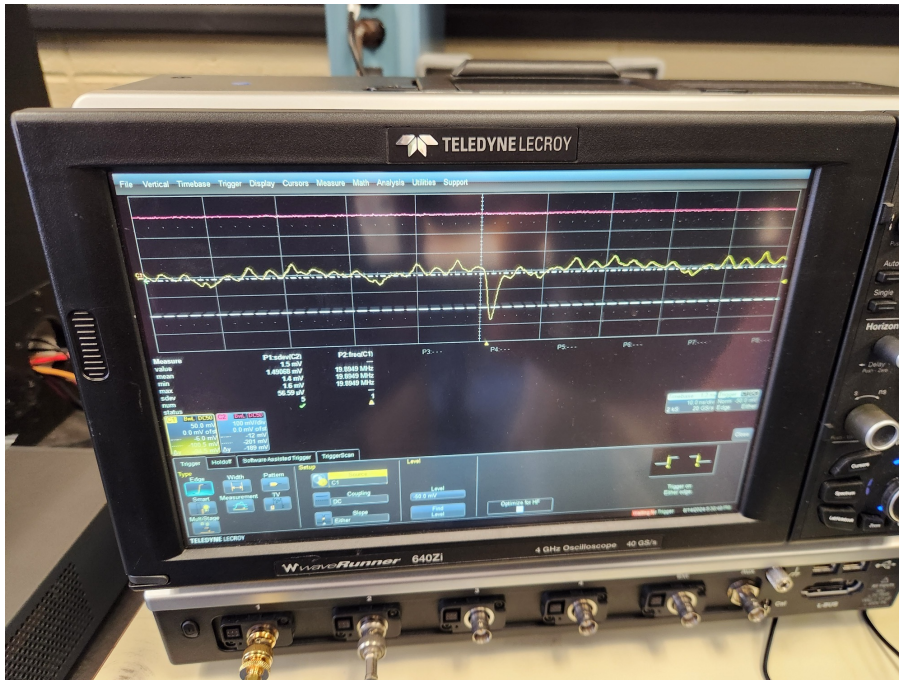
"B1" – clock off

New boards

- New board had several issues with missing or incorrect components.
- BNL techs fixed the noted issues in June. → boards still did not draw any current.
- Alex found missing jumpers on both boards, replaced them, and then had to adjust the potentiometers on the board until the correct voltages were read at test terminals.
 - Board B1 and B2 now both functioning properly.
 - B1 has bump-bonded assembly mounted, B2 in progress.

Bump-bonded assembly (board B1)

- Basic charge injection tests carried out to check ASIC functionality.
- All 16 pixels tested with Sr-90 source to ensure bonding was successful. → **all channels showed clean analog output via the ASIC!**

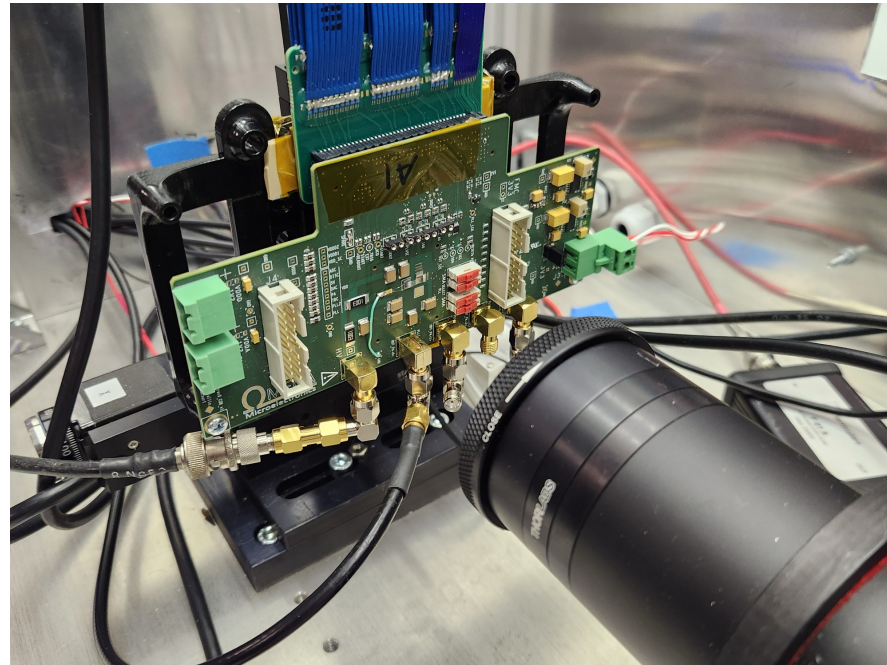


- Next step is to use new firmware to extract digital information (TDC, ADC) from both A1 and B1 boards to compare.

TCT scans of A1 board sensor

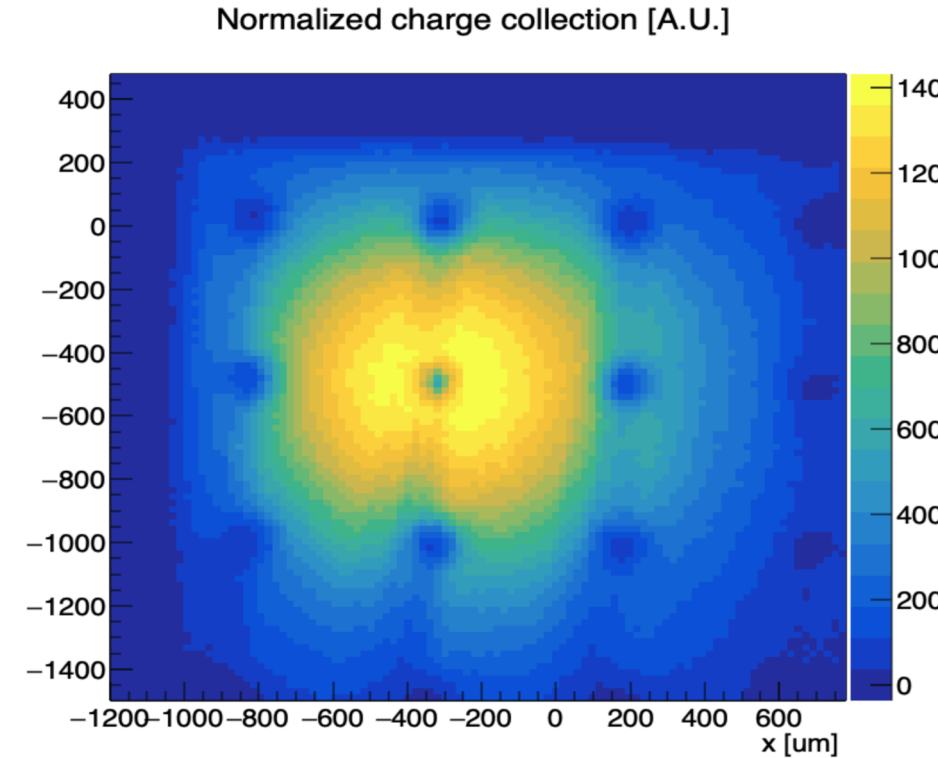
- Alex and Enrico Rossi (expert in lab at BNL) setup TCT apparatus yesterday morning.
- Initial tests were successful*.
- Work is now focused on scanning one column of pixels, second will be added today.
- B1 board cannot be used for TCT due to bump-bonding (AC-LGAD is upside down, backplane blocks photons).

*There is not a GUI to switch on the preamps on the board – we found that we can send a configuration to the board, and it stays in that state until the board is reset.



TCT scans of A1 board sensor

- Still having issues with focusing the laser on the pixels.
- Should hopefully have issues solved this week.
- Need to figure out the best configuration of pixels for testing since we can only read out columns of 4.
- A1 board connected with ribbon cable to FPGA outside of the TCT box.
 - Initial testing was done to ensure no obvious issue with ribbon cable - seemed okay.



Next Steps

- TCT scans will continue over next few days → crucial to test performance with integrated AC-LGAD + EICROC0.
- Data analysis using new firmware (Ashik and Souvik are working on this).
 - **Will follow-up with Adrien on a few issues in the data analysis itself.**
- When B2 board is ready, we will do same tests as for B1.
- Working on a QA procedure for new boards and fully-assembled setups to make troubleshooting more efficient.
- Ultimate goals are to ensure we have several bump-bonded assemblies which are well-understood to use in test-beam, and to provide feedback to IJCLab and OMEGA.