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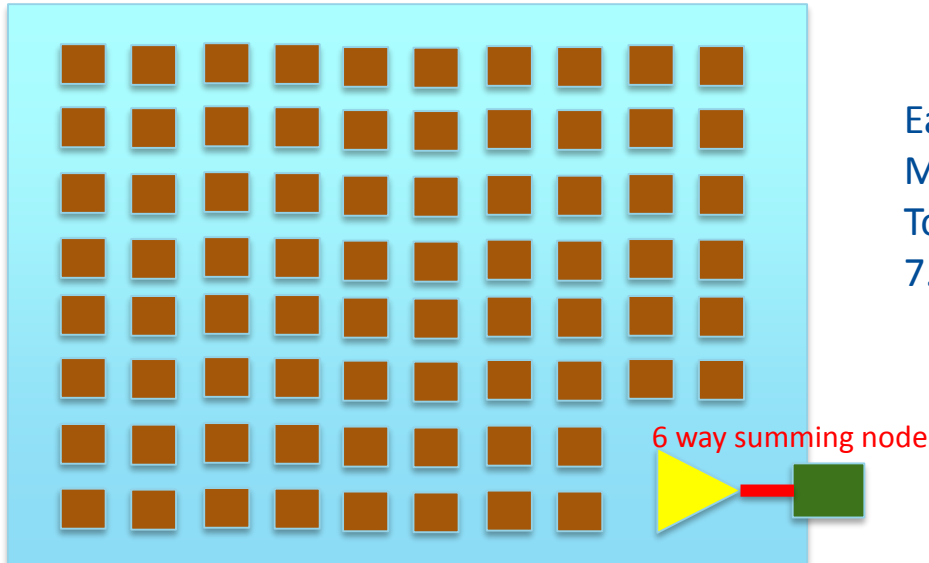
Update on MPPC passive and active ganging at FNAL.

Gustavo Cancelo

April 25, 2018

passive & active ganging test board

- Active ganging: 12 groups of 6 SiPMs summed in the operational amplifier
- Total of 72 MPPCs in 8cm by 10 cm



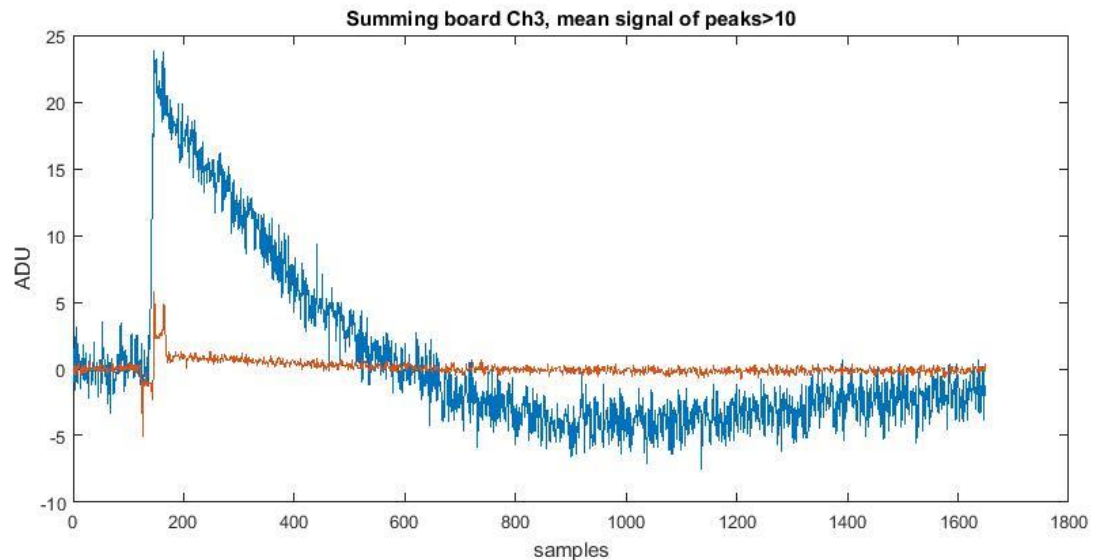
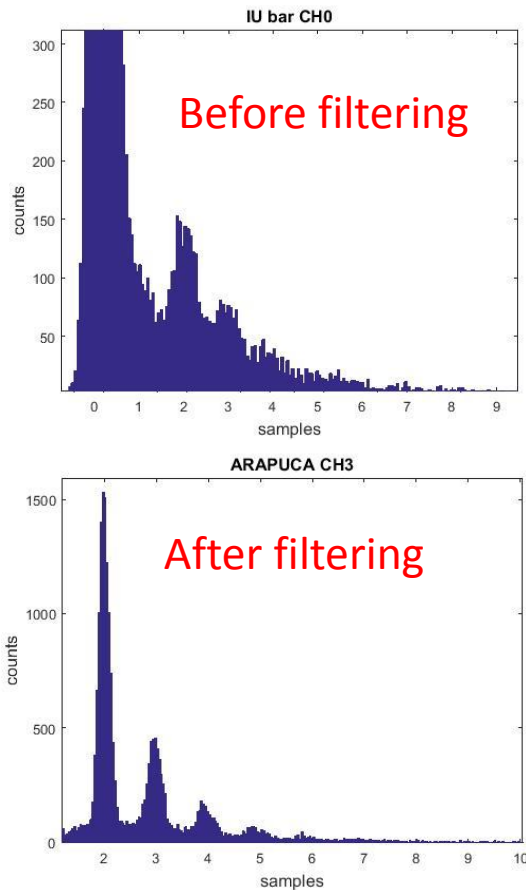
Each group has 6 SiPMs passively ganged
MPPCs are connected in parallel.
Total output capacitance per group:
7.8nF.

60% area coverage (of the 8cm x 10cm) should give us a 10 to 15% photon collection efficiency.

The layout was done with bypasses to partially load the OpAmp with less MPPCs.

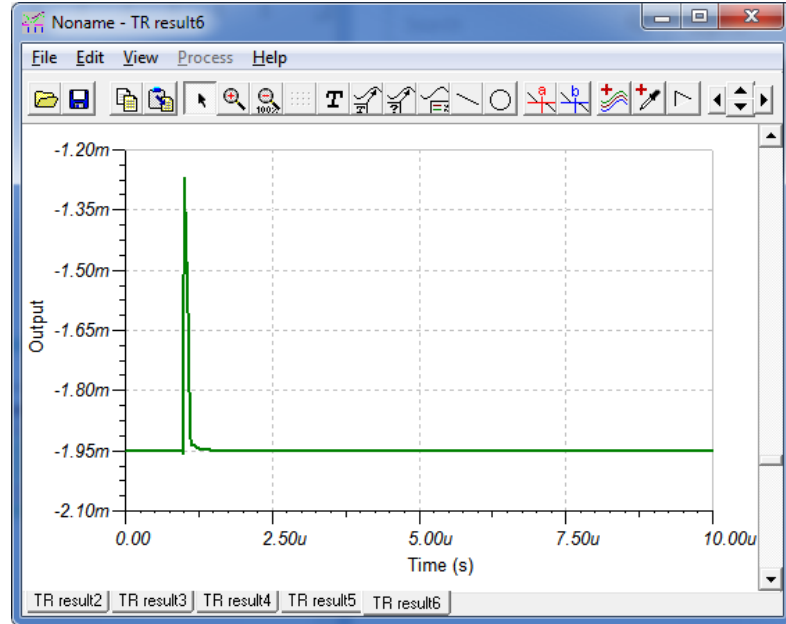
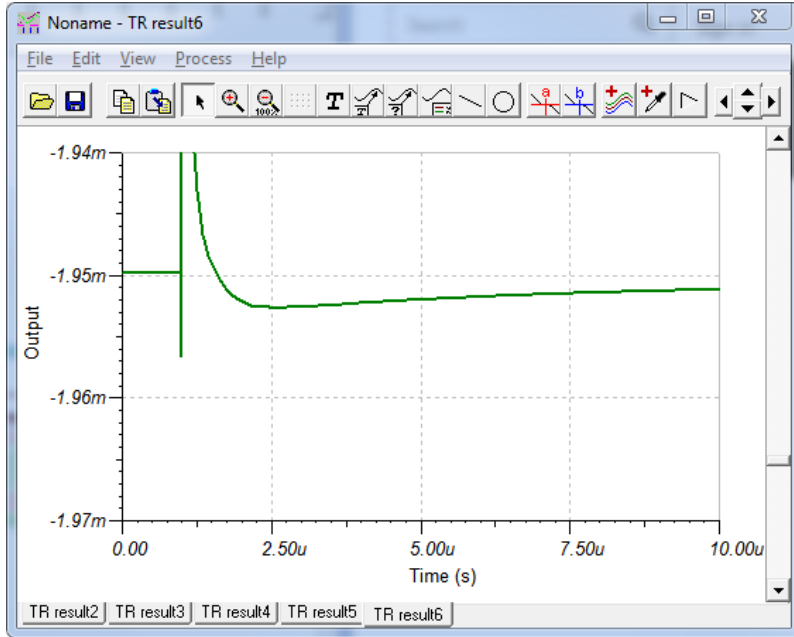
Active ganging of 12 SENSL (6x6 mm C series) summing board for IU light bars, used in the TalBo run of Oct-Nov 2017

- The Op Amp adds noise to the signal.
- It was hard to see single PEs without filtering the data.
- A digital filter (such as a Matched filter) worked well and a good calibration was achieved.



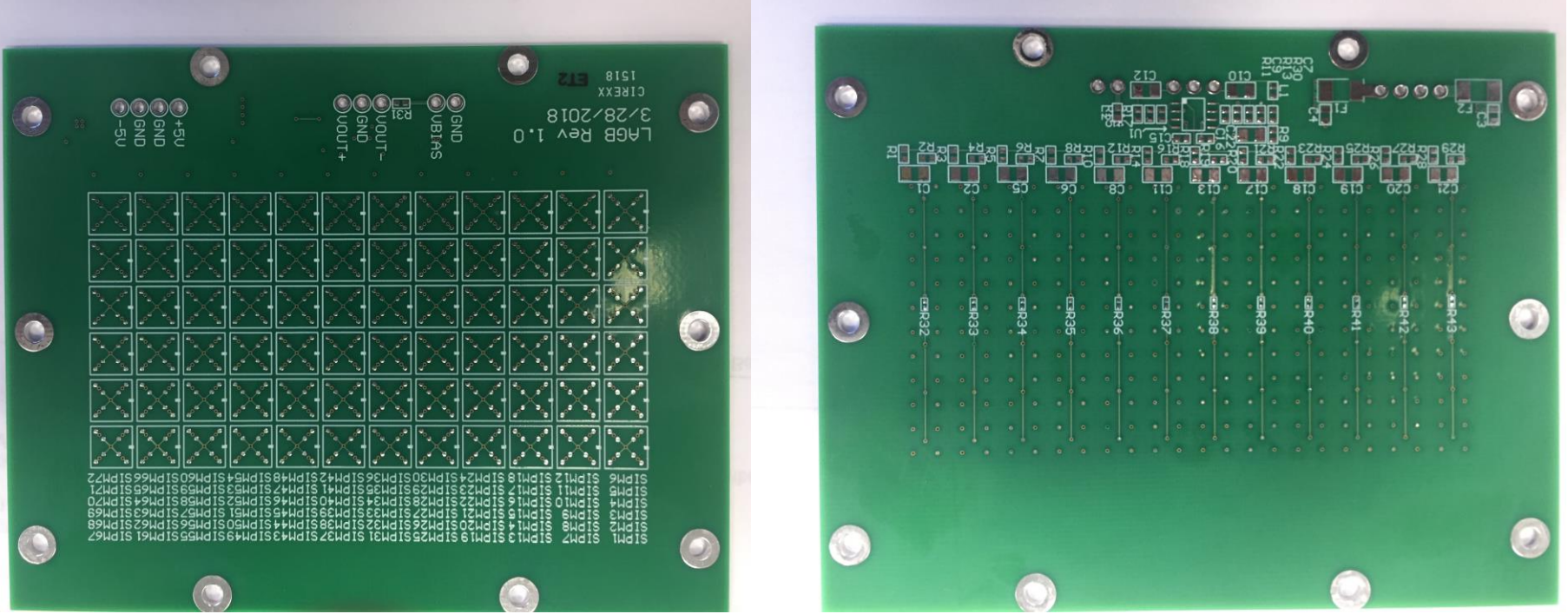
There was also an undershoot in the signal. This is due to AC coupling time constants, not to the summing Op Amp. And it can be fixed by increasing capacitor values. There was also a “glitch” feature. We believe that is related to the SSP trigger but we are not sure.

passive & active ganging test board: OpAmp simulation



- Simulation of undershoot generated by AC coupling.
- Can be minimized to $<0.3\%$ of signal size by adjusting the input pole of the electronics.

72 MPPC boards are here



- Zero ohm resistors allow us to test different configurations.
- Each 6 MPPC branch has a zero ohm resistor that splits it in 3 + 3 MPPC.
- All branches connect to the OpAmp through a resistor that can be removed to remove the entire branch from the test.

Schedule of passive/active ganging

- 100 MPPCs will be shipped next week.
- 1 week for assembly.
- Estimated start of testing with 48 MPPCs: May 15.
- Tests schedule:
 - At room temperature:
 - Characterization and performance of passive gangs of 6 MPPCs.
 - Performance of active ganging, OpAmp response.
 - Cold test using a CCD dewar. The dewar cools down to 140K and is connected to a lamp , integrating sphere, narrow band filters and optical power meter.
 - Test in LN2.
 - Test in LAr. If Luke is available we can test using the Am241 source, previously coating the MPPCs with TPB or placing a window coated with TPB on top.



Using the 72 MPPC board for ARAPUCA

- The 72 MPPC board has the same size of the ARAPUCA ackplane that we used in TallBo 2017.
- The idea is to populate one or more boards with different number of MPPCs and measure the Number of collected photons (hence, efficiency and effective area) as a function of MPPCs on the board.
 - This test will be done in LAr (probably Luke dewar) using a radioactive source.
- Tentative schedule: July-August.