EEEmcal Readout Development/Design/Testing Discussions

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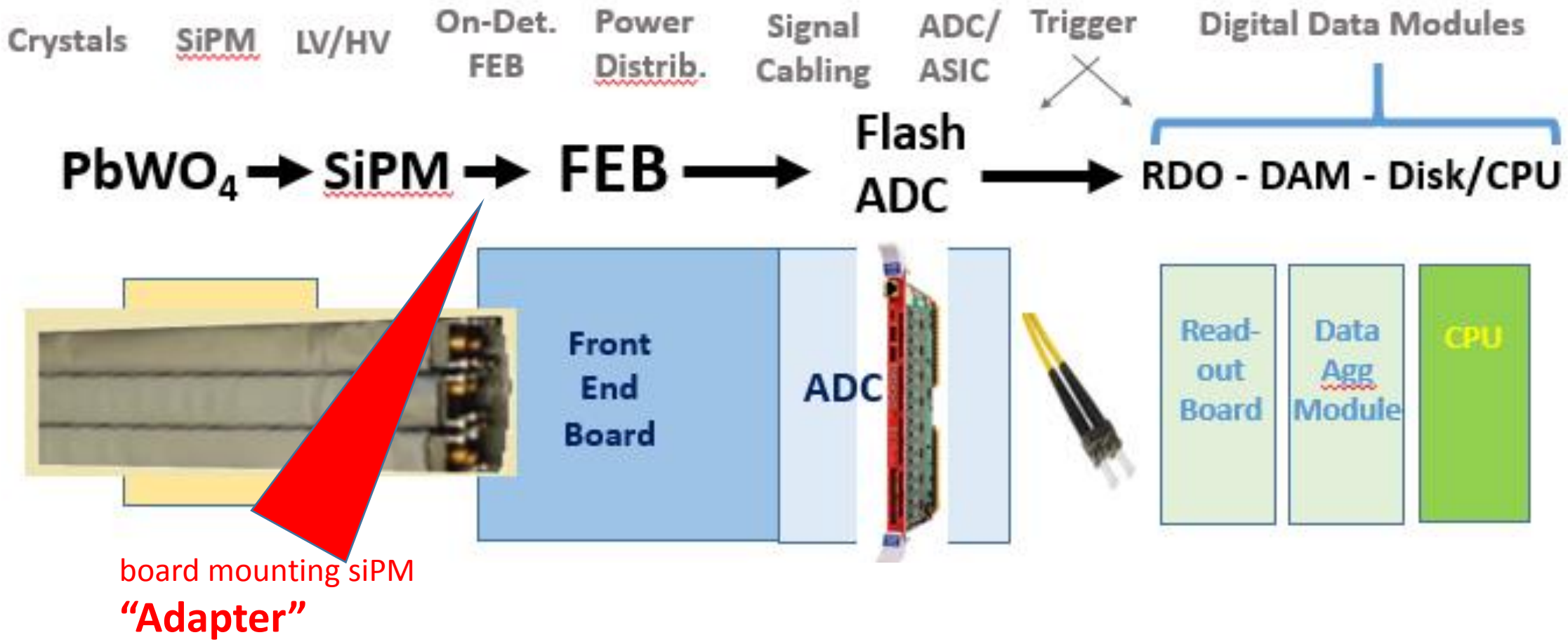
Proposal Readout/DAQ Chain

- For common terminology -- any recent changes?



Two Types of ADC Choices

- Affects FEB design
- 1) “Discrete” ADC (e.g. fADC-like) options:
  - Gerard will cover these in his talk – effort to develop these over next year
- 2) ASIC option: HGCROC (CMS) : CNRS/In2p3-OMEGA development effort over the next year
  - Other ePIC calo groups/ ORNL also pursuing
- We obviously want to stay open to both possibilities until more development/information on each
  - even though so far, solution has been expected more likely to be like 1)
- Not too much duplication of effort to pursue both, since ASIC are preferred by other groups

Review of MSRI Proposal Budget for Readout/DAQ:

- Reminder MSRI – **"Mid Scale" Research Infrastructure** : $20M limit
- For the proposal DAQ/Electronics WG was consulted – Use discrete option and prototype FEB in proposal– but this was supposed to be a stand-in
- Original plan was to provide "stand-in" funds like this to cover ~most Readout-thru-DAQ for all 3000 channels – no matter what solution eventually provided
  - Some infrastructure to be provided by the project, but mostly MSRI budget covers cost completely
- But overall budget got too close to the $20M total limit : So, project promised to provide more and we only provided funds requests for
  - Prototype-design FEB (and 9 siPM/ch) for all 3k channels – associated testing/labor funds (~$190K equip excluding siPM + ~300K test [+ ~50K contingency])
  - LV/HV bias Modules for all 3k channels (120K [+ 40K])
  - Caen fADC VX2740B VME/Racks/Cabling for 500-600 channels for e.g. beam tests (~$200 K [+50K])
- Project provides complete 3k channel production ADC solution, power infrastructure, signal cabling,etc.. [costs not estimated]
  - Also support structure/cooling/all racks-crates (?) etc.

FEB Choices

- 1) Jlab Pre-amp Board -- Prototype used in testing so far, similar/same put in the proposal
- 2) Alternative proposal w/ similar properties by INFN

- Both of these would need further development based on fixing ADC solution
  - But can some aspects be fixed/tested before that?

JLab electronic/RO – 9 SiPM

Signal Response: tested with pulsed laser (60ps): ~1V(10ns) to 260mV (8ns)
Dynamic range: at 10 kHz (laser) detectable amplitudes range from 2.2 mV – 1 V → ~500
Linearity of OpAmp output vs. linearly changing light with 1kHz laser
Single pe is not visible (too noisy in these tests, further tests with YAP ongoing)
Gain drops when reaching R~10kHz for signals ~2000pe (on PWO corresponds to ~1.3 GeV on a single crystals – derived by cosmics at 30 pe → 16 MeV

Testing Needs (Can we construct list?)

- Some of below already tested, e.g. Crytur or other prototype testing?
- SiPM Choice
  - Have the exact siPM's for both cases (2x2,3x3) already been included in the previous tests?
- Signal Waveform Characteristics, Linearity, Dynamic Range …
- Noise/Rad Damage
  - Need some options for irradiation – then testing for increased DC/DCR
- Power consumption - for irradiated too
- What else?

- *Recent IDEA : setup test stand based on proposal-like items - have some fADC's test bench setup for Moeller at Ohio U till spring (Paul King). Or probably could just do at Jlab too ~any time. Benefit for getting ready for tests early? Even if really needed tests aren't known yet?*

Budget

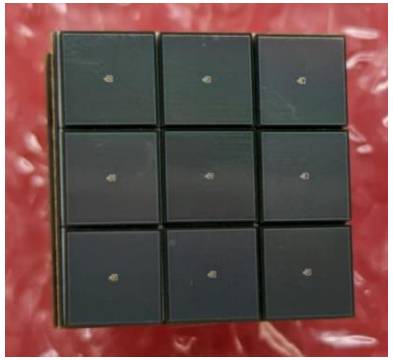
- Both development of Gerard option and testing at least would require budget in the ~next year, probably soon … (how soon for IU dev?)
  - Indiana/Gerard - engineering estimate $100K?
  - [Some of that provided by continuation of previous Jlab FEG work on FEB's?]
- HGCROC CNRS/Omega self-funded?

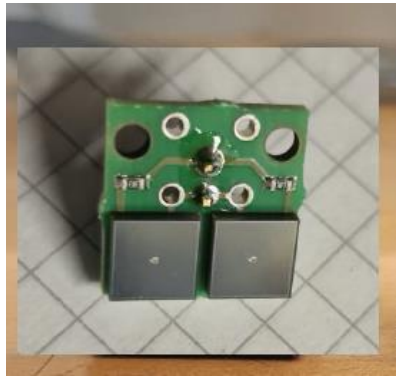
- Project funds? Fernando?
- Proposal funding: If we could divert some funds to engineering:
  - **But MOST OF PREVIOUSLY MENTIONNED FUNDS (which would be best divert candidates) are not budgeted till start of year 2**

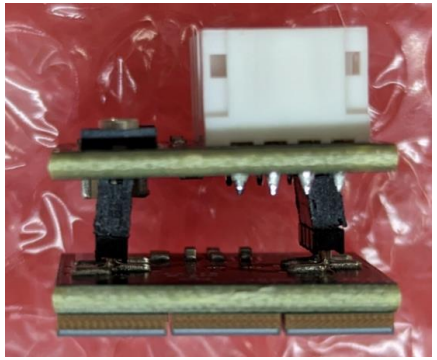
- Group Grants? Ohio U Institute Nuclear Particle Physics could probably contribute some funds O(~20K)?

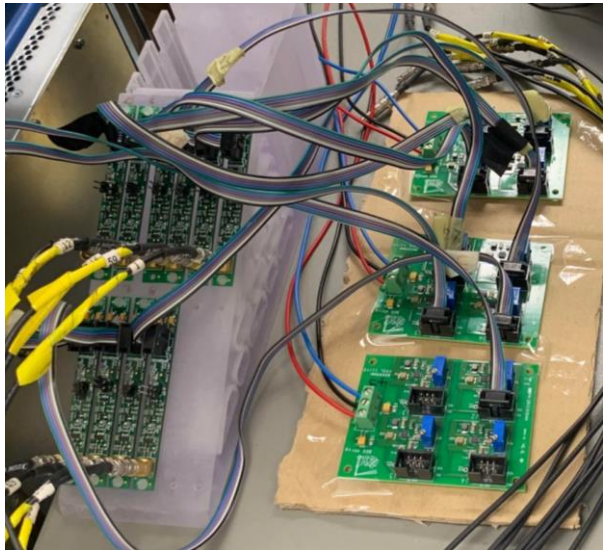
Back up

Comparison of two electronics/RO approaches

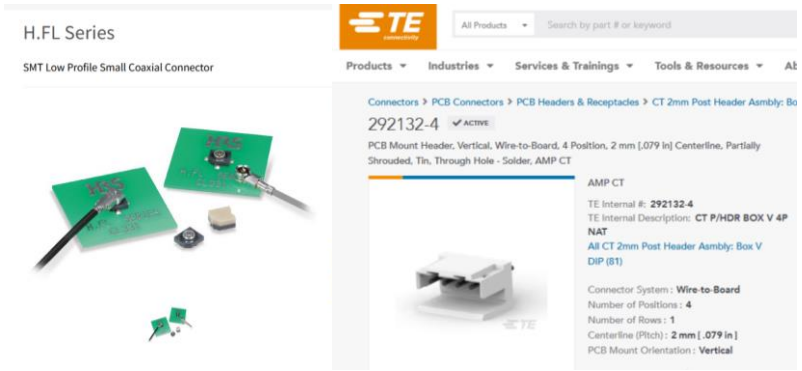








JLAB preamplifier board for SIPMs 2023



Functionality

Number of channels: 9, 16

Power Supply: +5V, -5V

Bias Voltage: each array is powered with a single bias voltage applied to pin 1 of the white connector (CT 2mm Post Header Assembly (https://www.te.com/usa-en/product-292132-4.html)

PCB

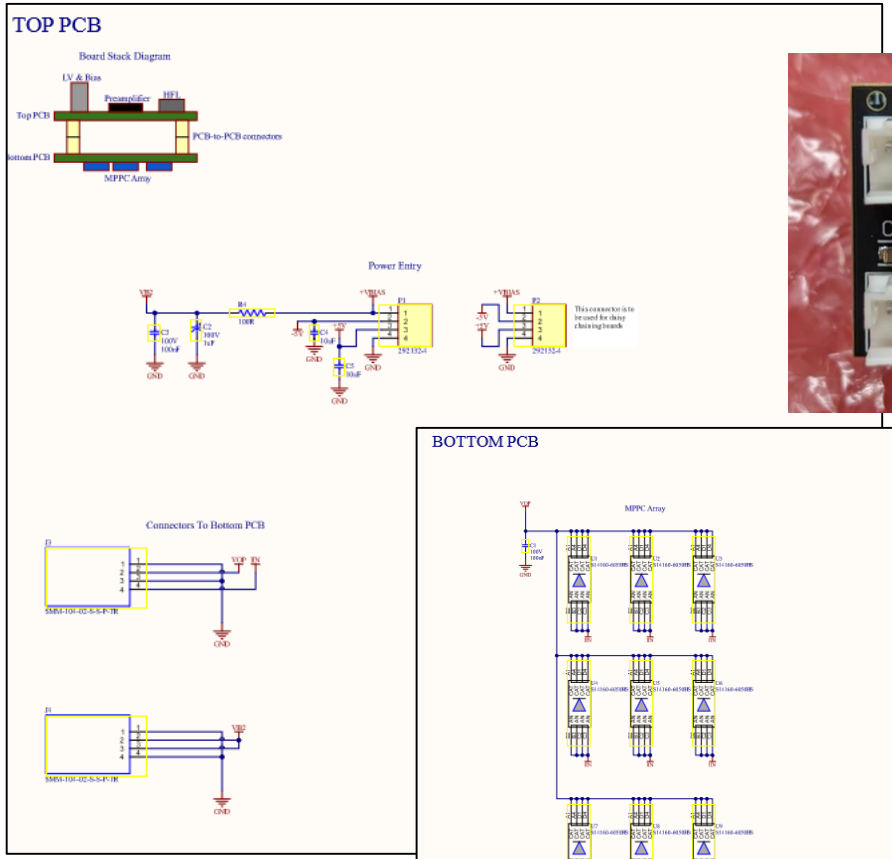
Size of ~20mm x 20mm

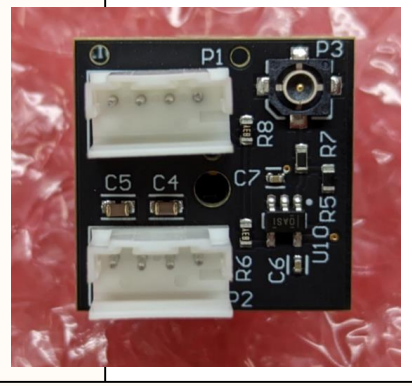
Bias voltage for the PCB ranges from 42.20 – 42.13 V

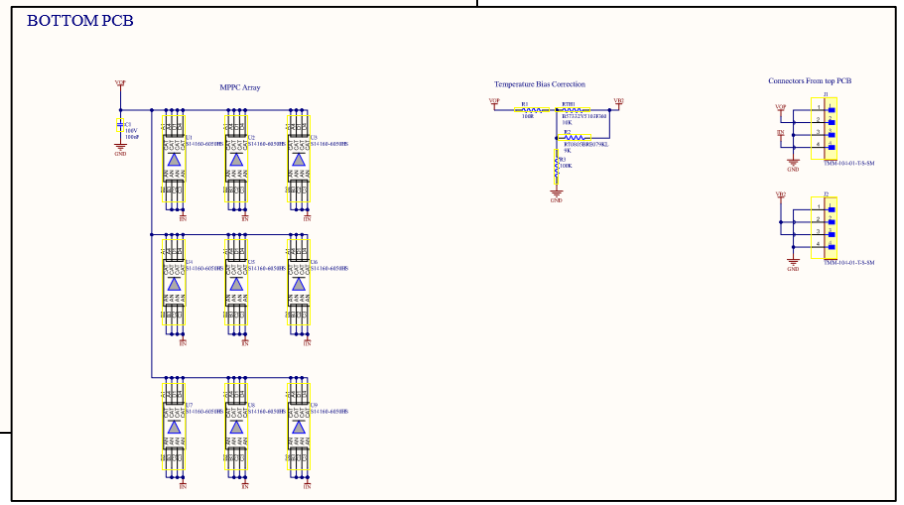
Preamplifier is OpAmp (active)

Theoretical gain of the preamplifier is 14. Based on tests with pulsed laser the signal decay takes 300-350ns

Readout connector: SMT Low Profile Small Coaxial Connector







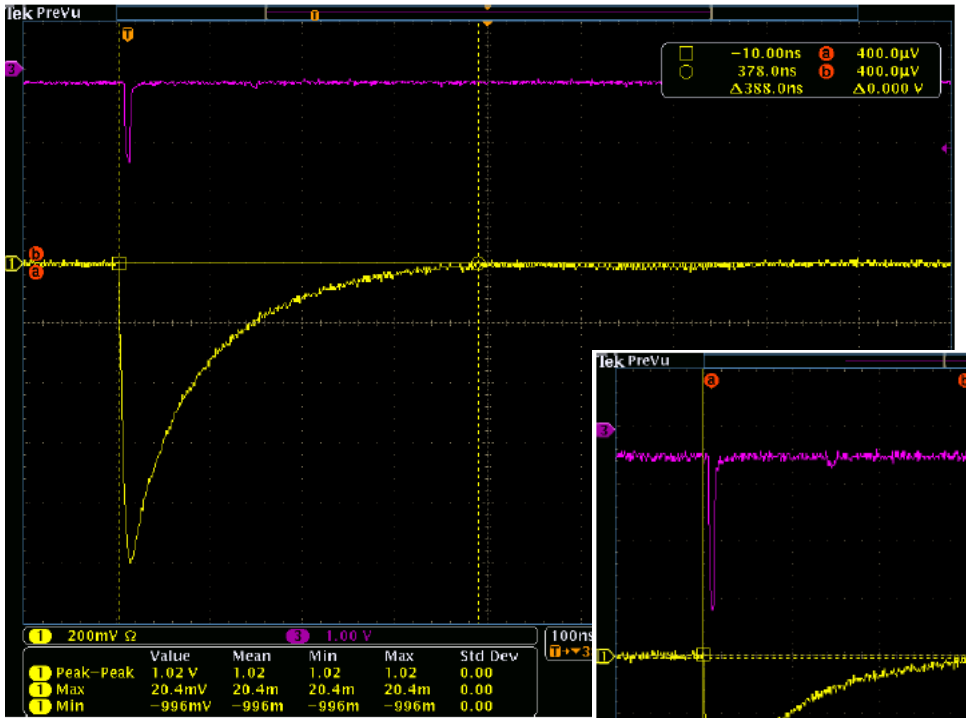


Figure 5: Output response - Laser 6

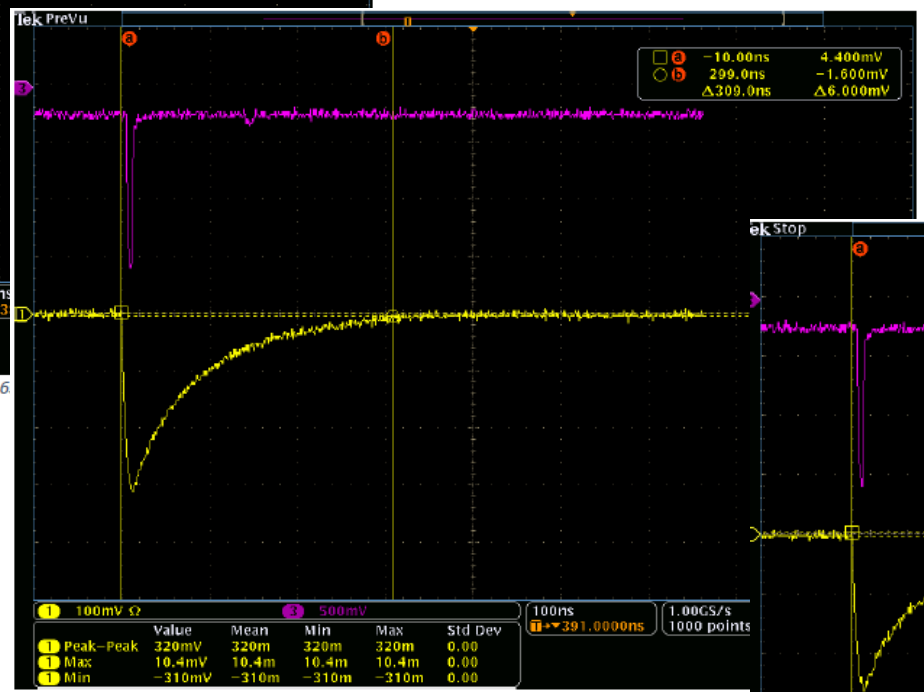


Figure 6: Output Response - Laser 62.5%

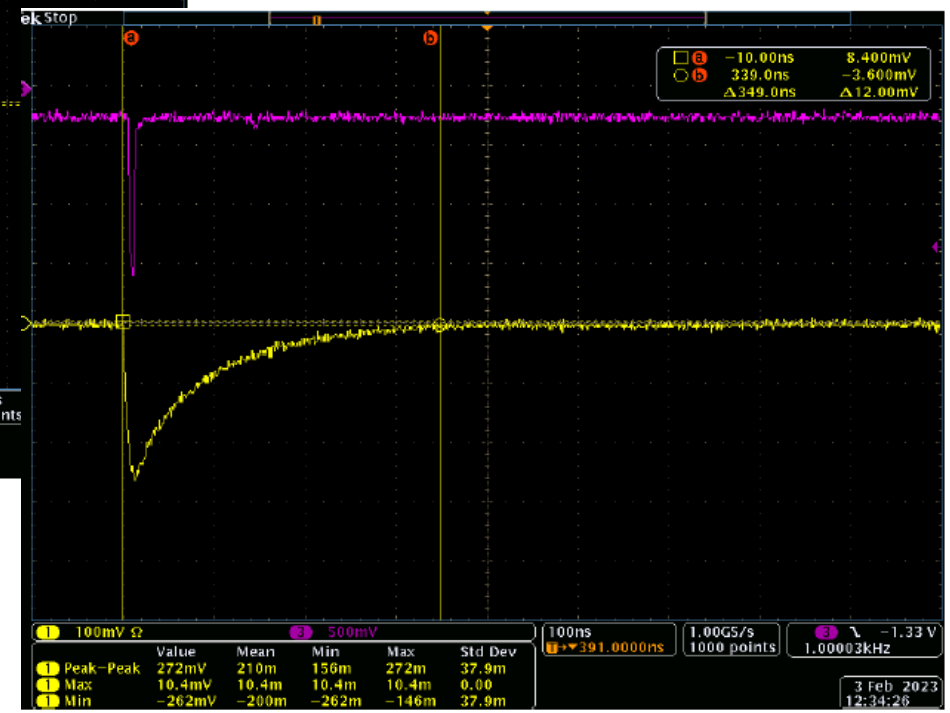


Figure 7: Output Response - Laser 60%

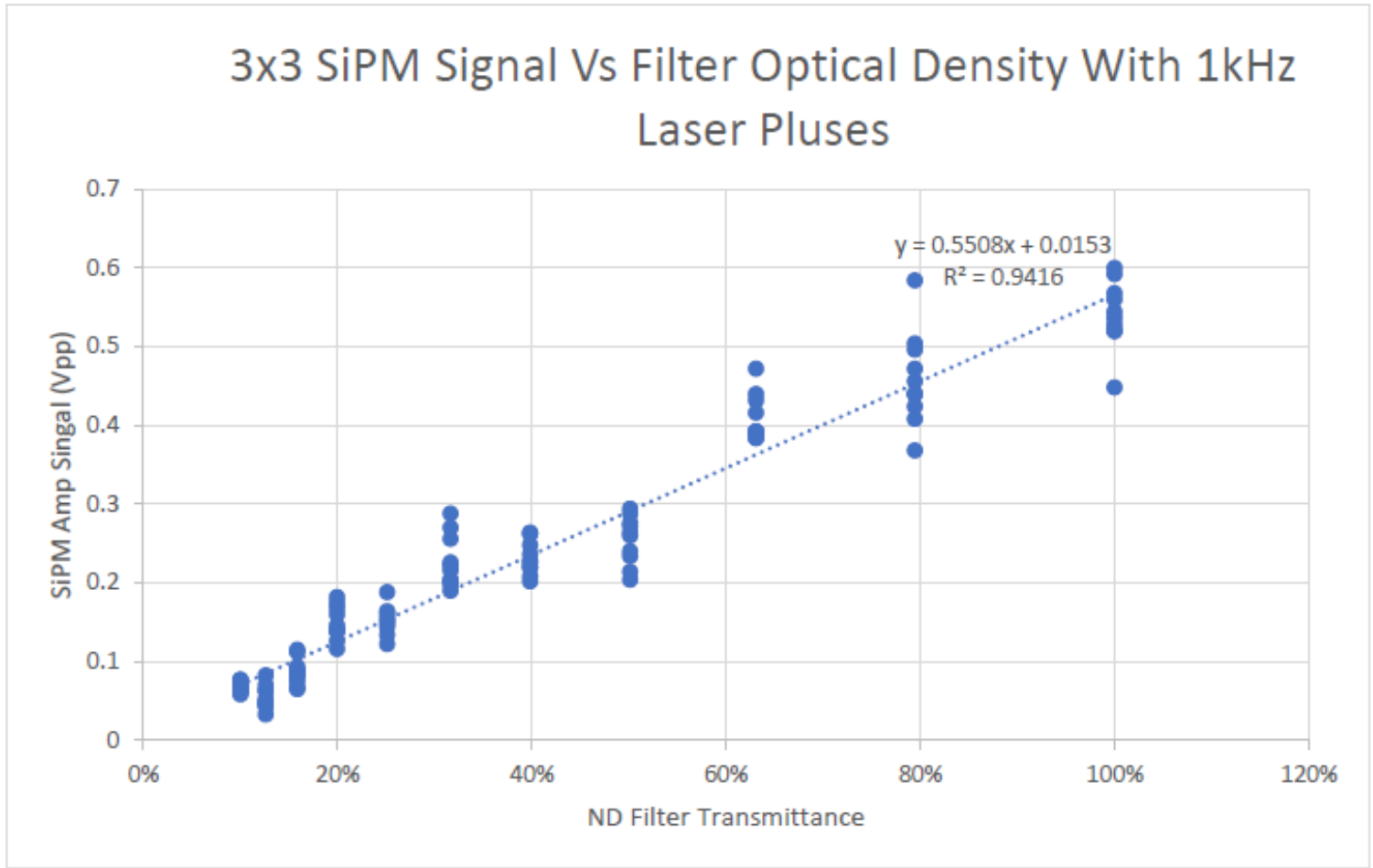


Figure 9: OpAmp Signal Vs Filter Transmittance - 1kHz Laser

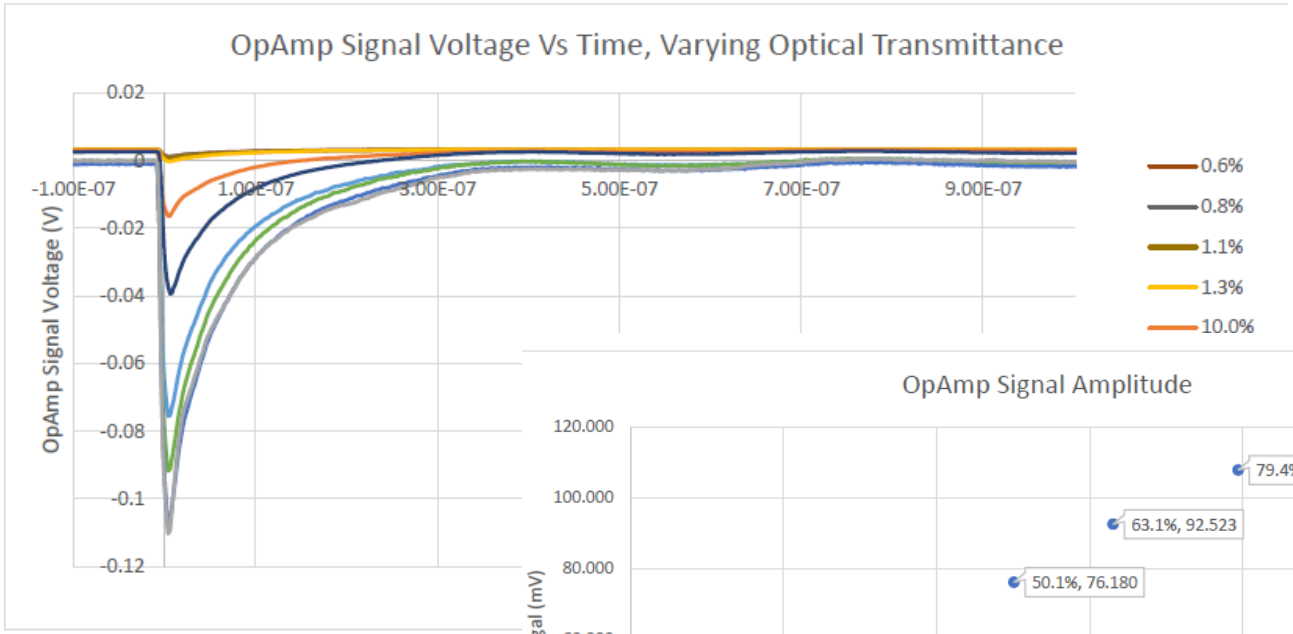


Figure 10 - OpAmp Signal Vo

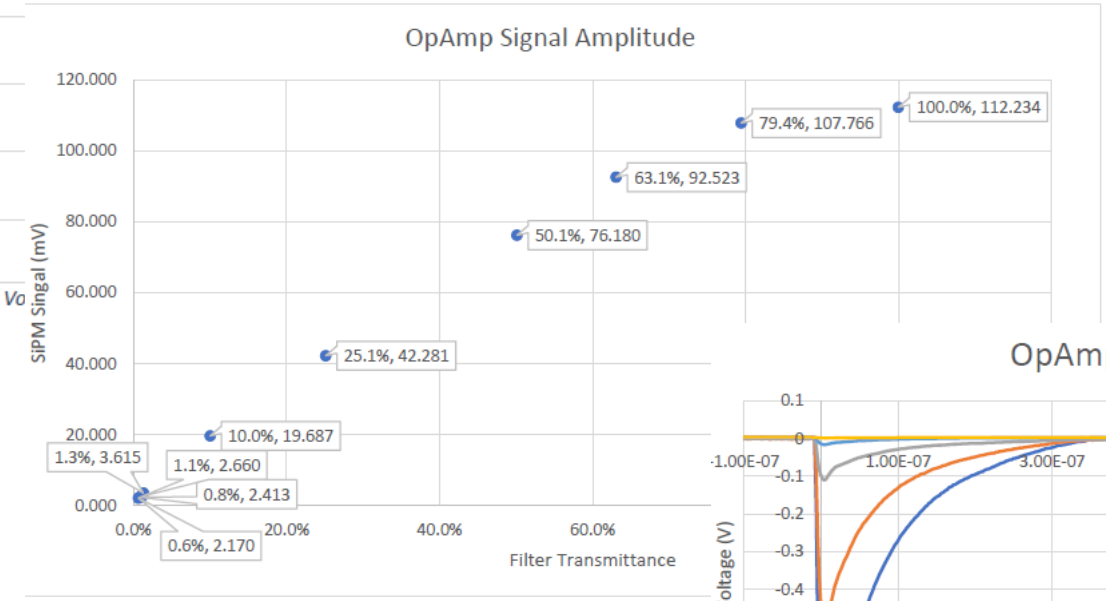


Figure 12 - OpAmp Signal Amplitude

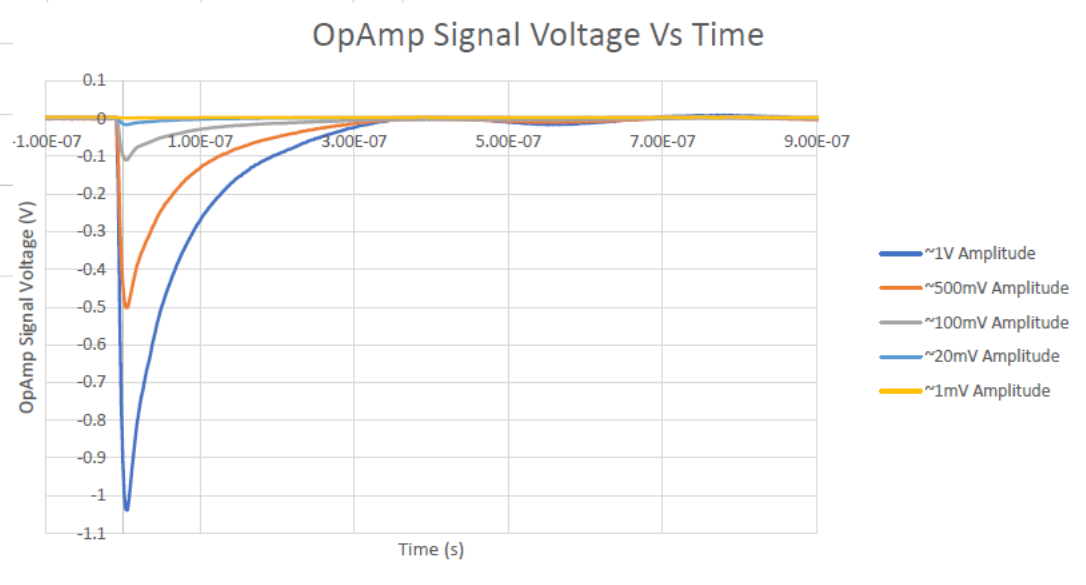


Figure 13 - OpAmp Signal Voltage Vs Time - Amplitude Range

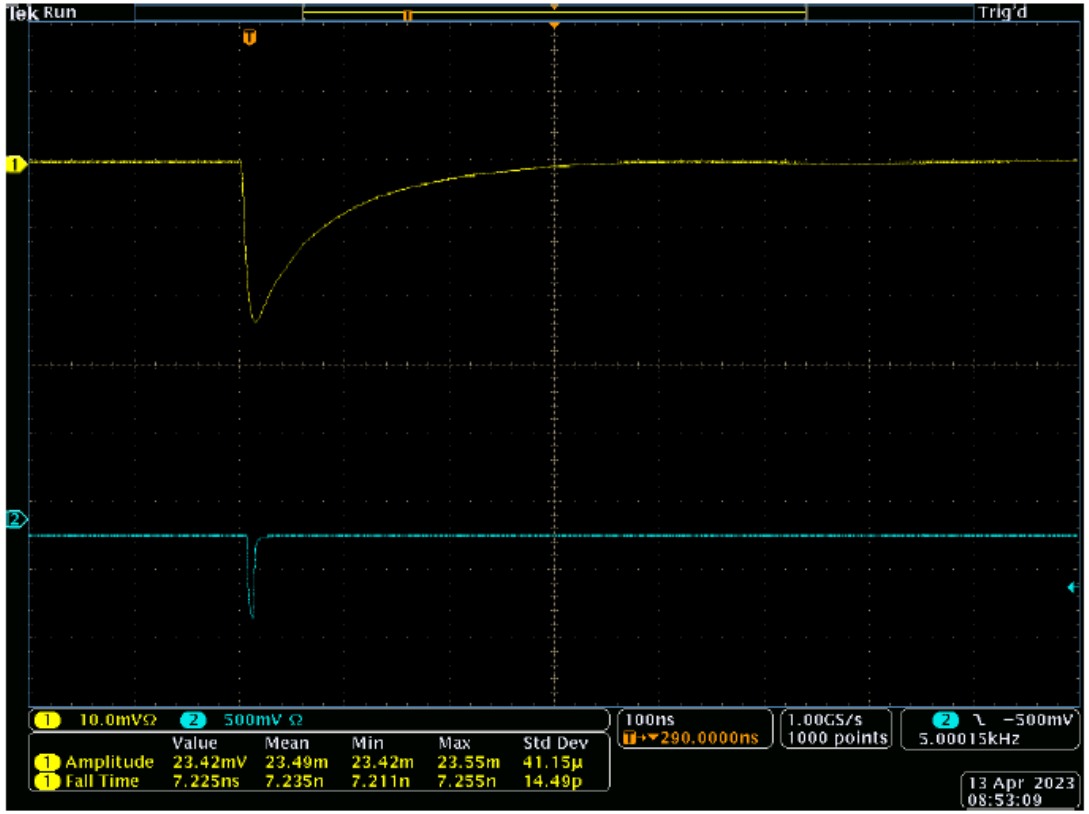


Figure 18 - SiPM Response with No Masking

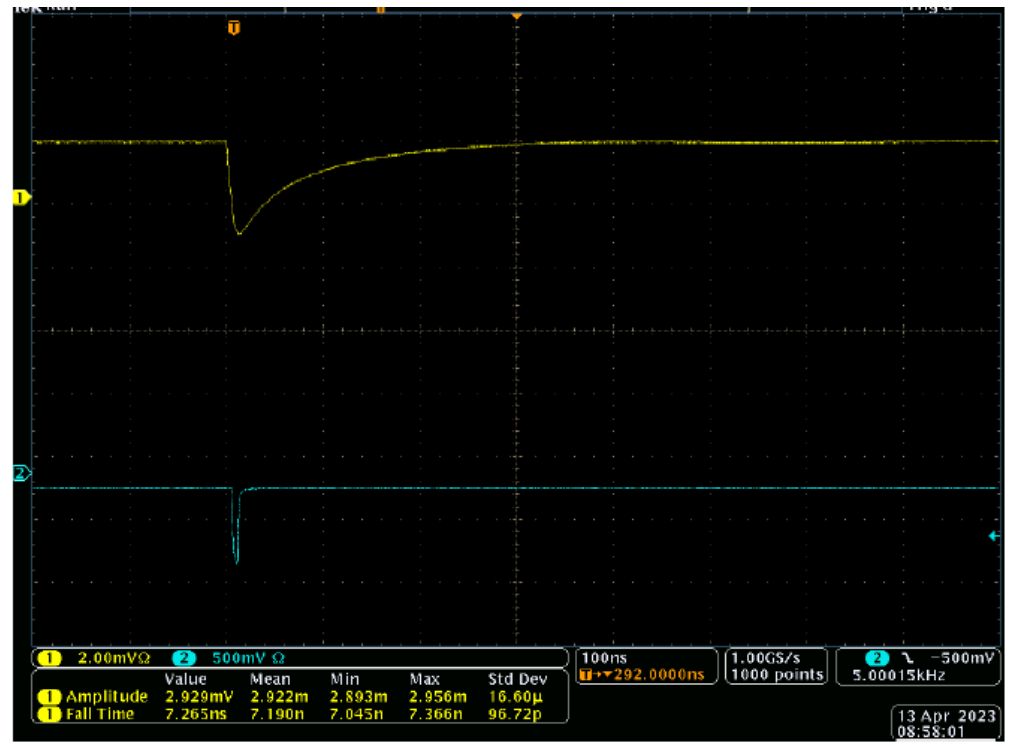


Figure 20 - SiPM Response with Masking on All Except for Center SiPM

INFN 16 channel preamplifier board for SIPMs 2023

Functionality

Number of channels: 16

Power Supply: +5V, -5V

Bias Voltage: single DC-DC converter up to 75 V, common to all channels

Bias Regulation: 1V single channel regulation by means of a multi turn trimmer

Dual Output on MCX coaxial connectors

Single input connector: 34 pin male IDC

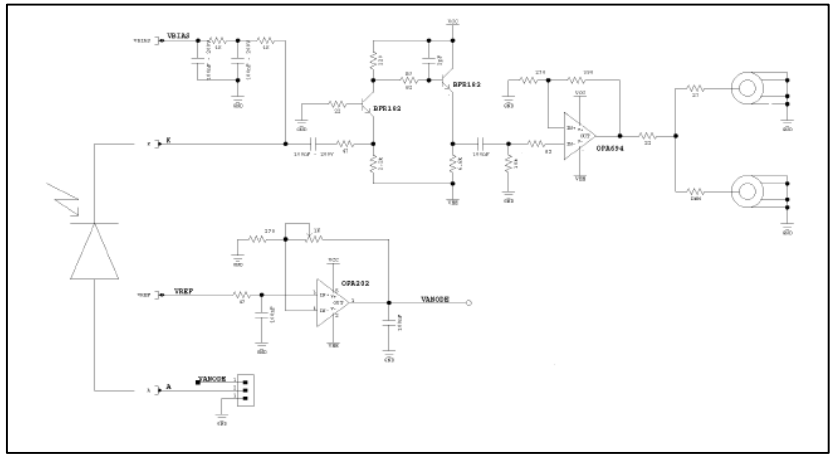
PCB

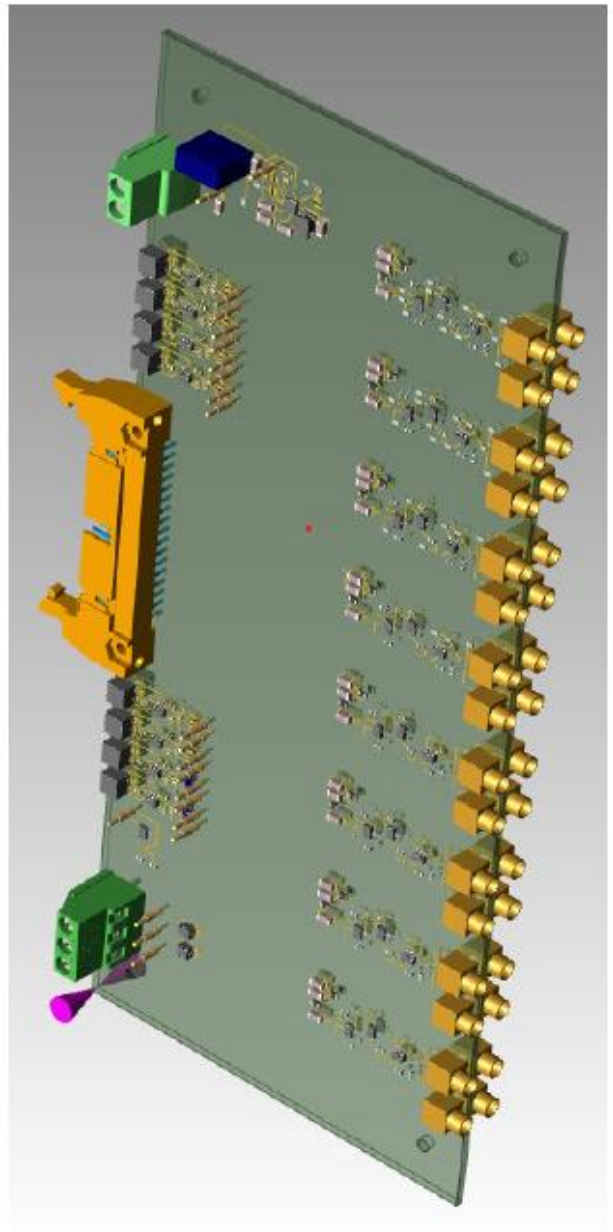
Size of 100 x 233 mm

6 layer boards with components on both sides

Minimize cross talk between neighboring channels

Board fits in a standard 6U crate





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Single pe is not visible (too noisy in these tests, further tests with YAP ongoing)
Gain drops when reaching R~10kHz for signals ~2000pe (on PWO corresponds to ~1.3 GeV on a single crystals – derived by cosmics at 30 pe → 16 MeV

INFN electronics/RO – 2 SiPM

Cosmic signal at 8 pe
Shows saturation at R~10kHz for signals around 800pe (corresponds to 1.6 GeV)

Overall the two electronics behave similarly, but JLab electronics are capable of handling 4x the NPE providing a better statistics resolution (2x better) at the cost of not having the single pe reference and placing 4.5x more SiPMs