PDS cold electronics

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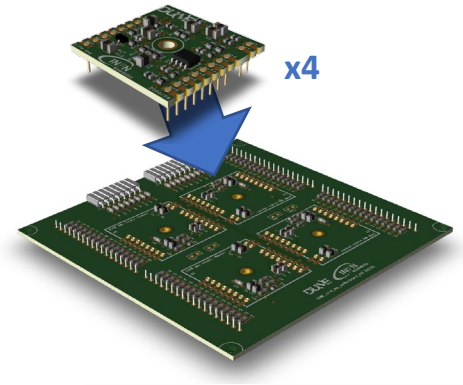
C. Gotti
INFN/Univ. Milano-Bicocca

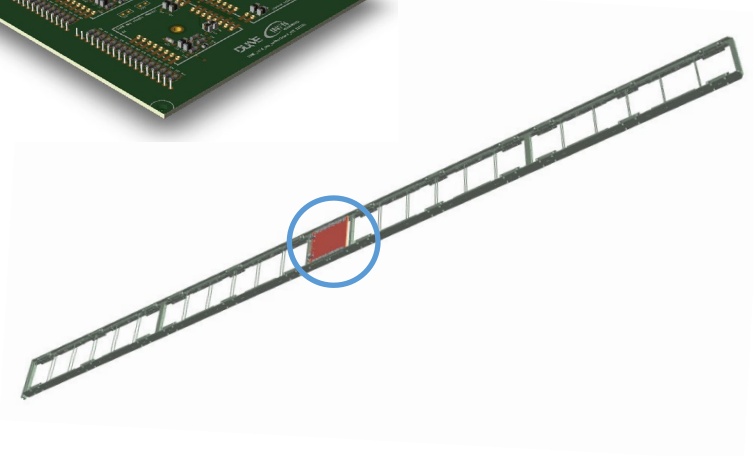
For the PDS electronics working group

FD1-HD – New cold amp 4-channel board

So far, 4-channel motherboard + single-channel daughter cards:

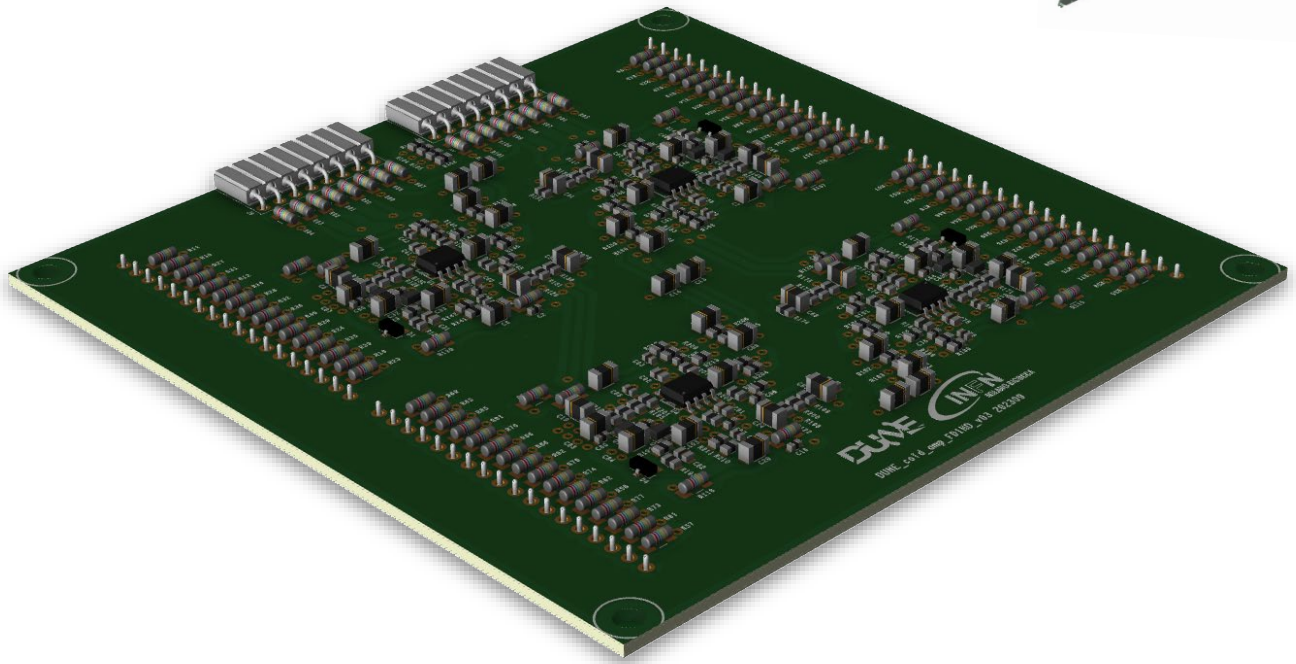
- Good for swapping/replacing amplifiers during tests
- 160 amplifiers in ProtoDUNE2-HD
- https://doi.org/10.1088/1748-0221/17/11/P11017





Moving towards DUNE production (1500 modules):

- A single board with 4 channels
- Easier to keep track of things (1 board = 1 ID code), easier QC, lower cost
- Possibility to inject a test signal (to be used only in QC)



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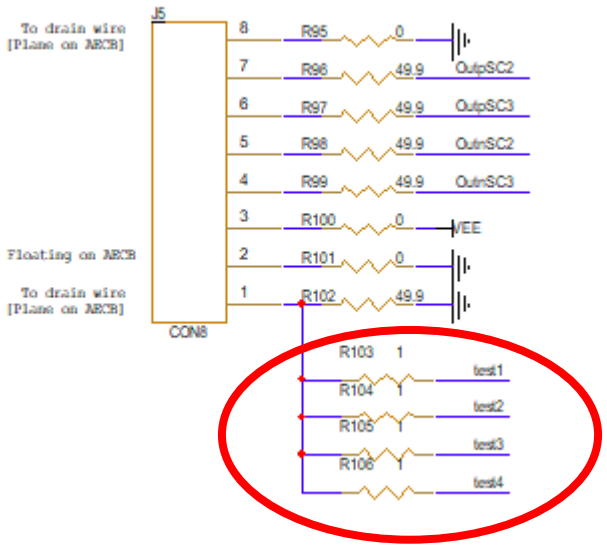
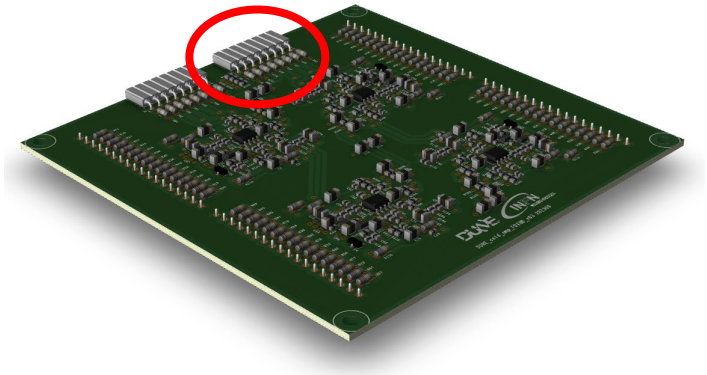
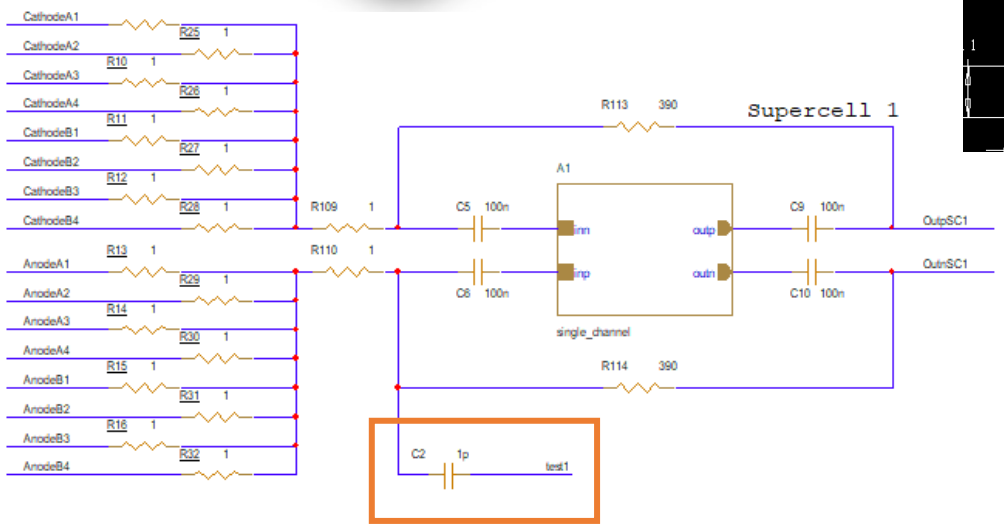
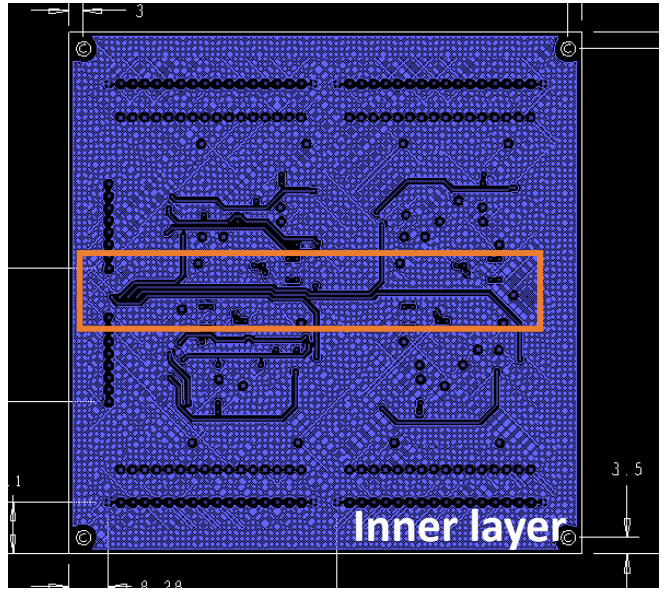
A test signal can be injected on one of the four (redundant) pins connected to ground (drain wire) on AECB:

- 1 pF capacitor in series, close to each channel (1V step → 6.25×10^6 e^-)
- To check if all channels are alive during QC, also check gain uniformity, by contacting only one side of the board
- When the board is mounted in the module, the test traces are shorted to ground









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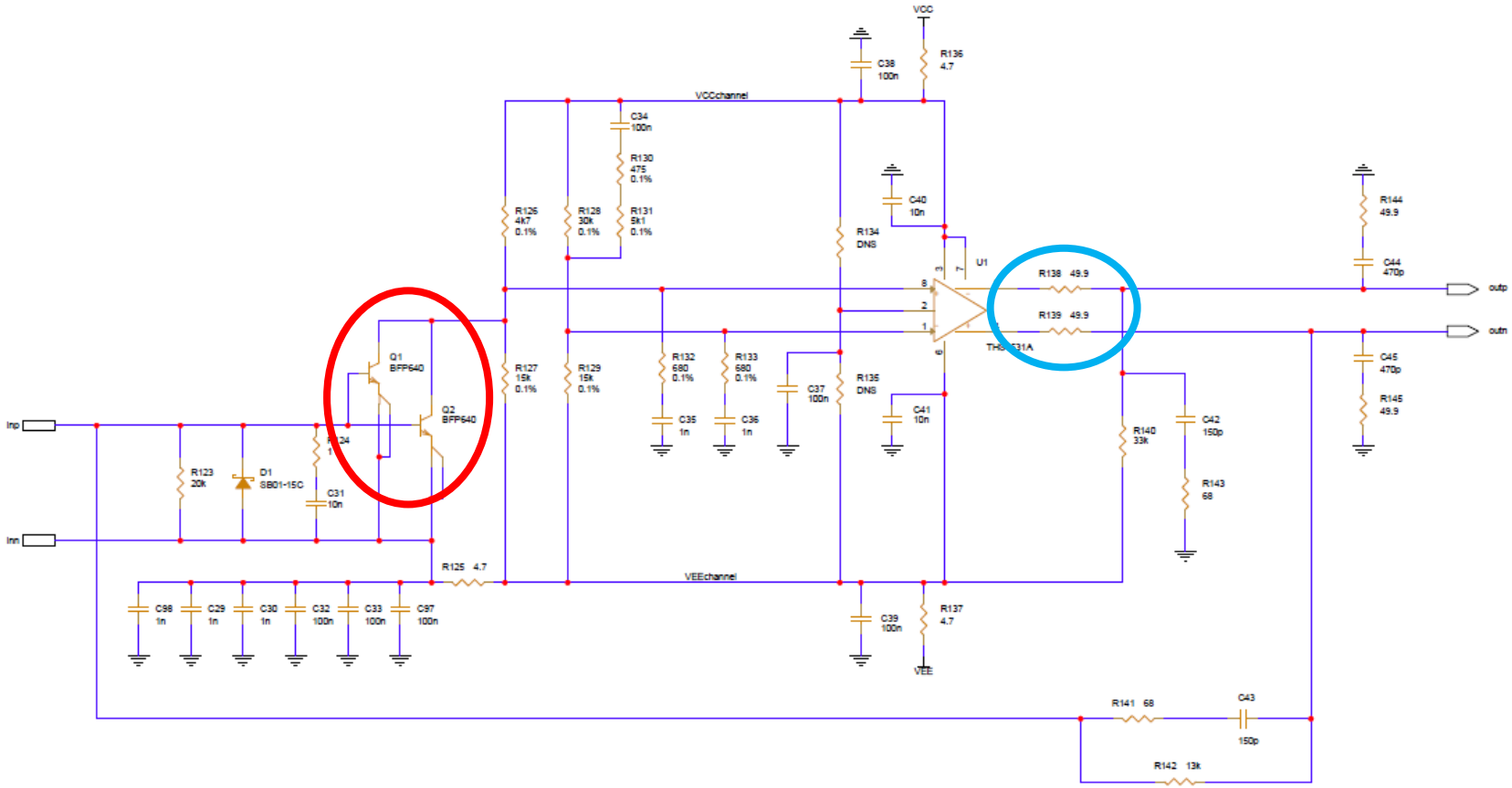
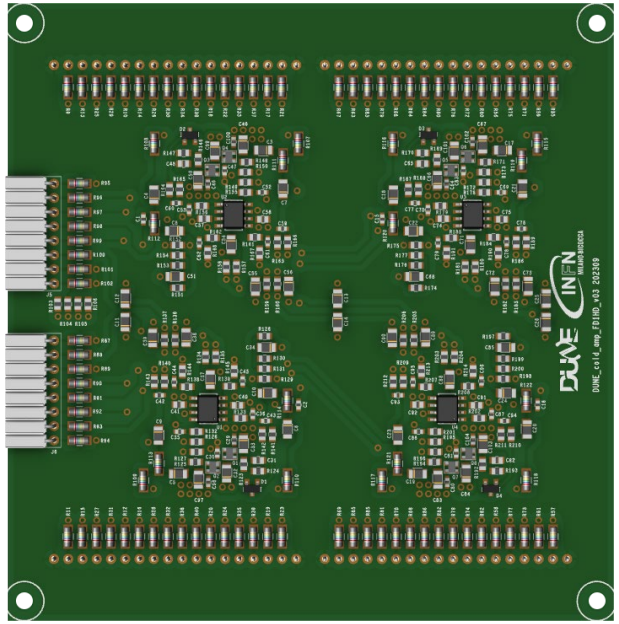
Other changes:

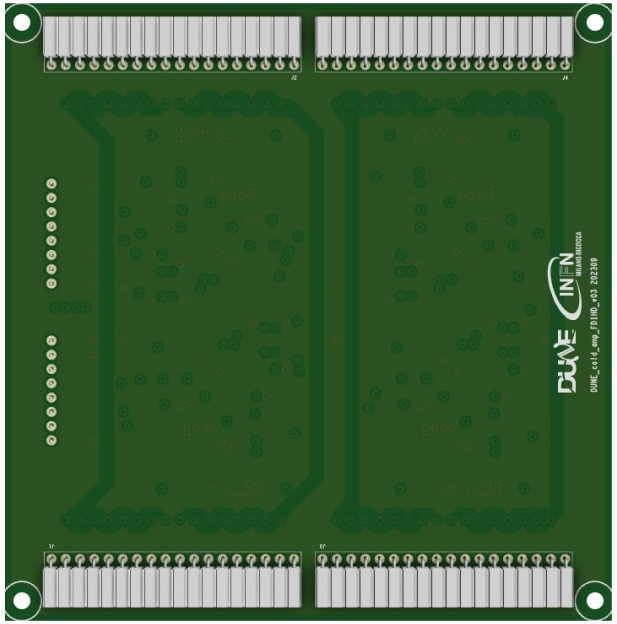
- Two input transistors in parallel, gives (slightly) lower noise for the same power consumption (tested)
- 50 ohm resistors at the outputs of the THS4531, for improved stability with unlucky batches of THS4531 (lesson learned from DMEM tests)
- In case of any issue, both these changes can be undone just by changing the BOM

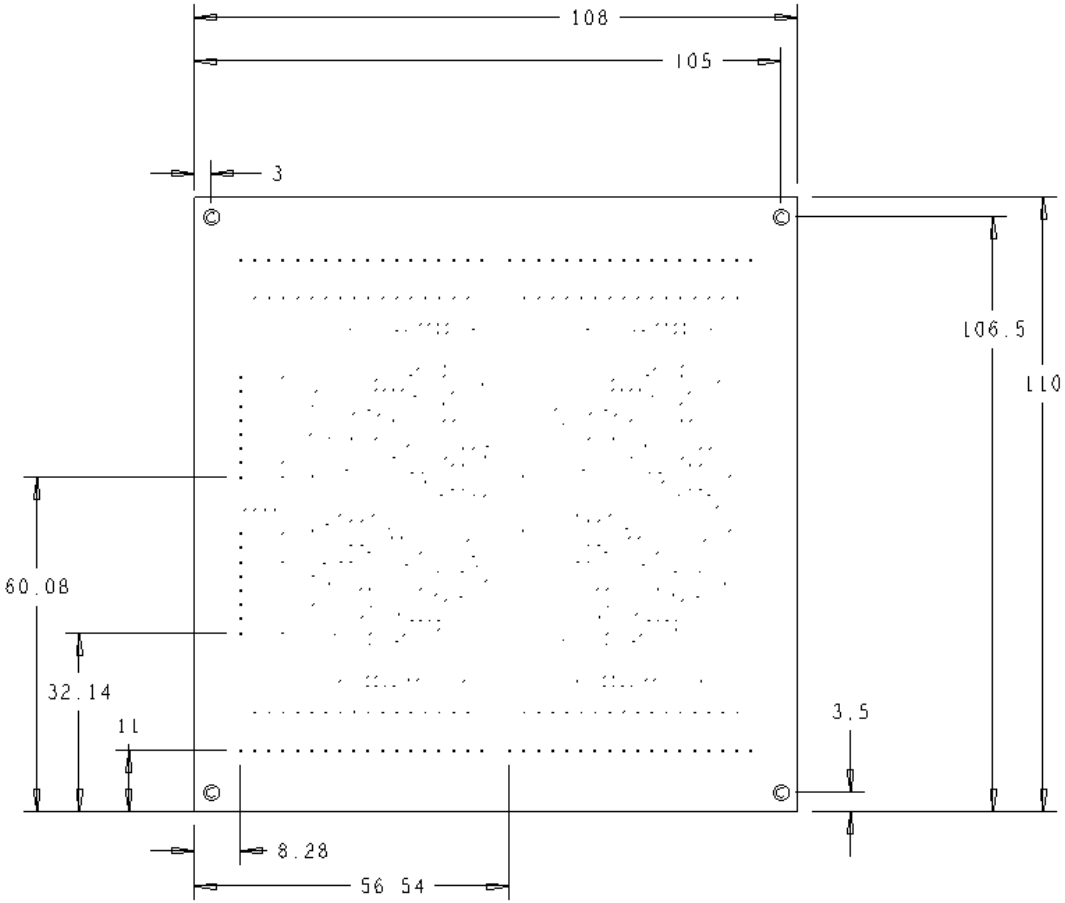


FD1-HD – New cold amp 4-channel board

- We ordered 15 populated boards from 2 different companies (30 boards in total)
- Prototypes expected around mid november
- This will validate 2 companies, in view of the full order next year (1500 boards+spares)

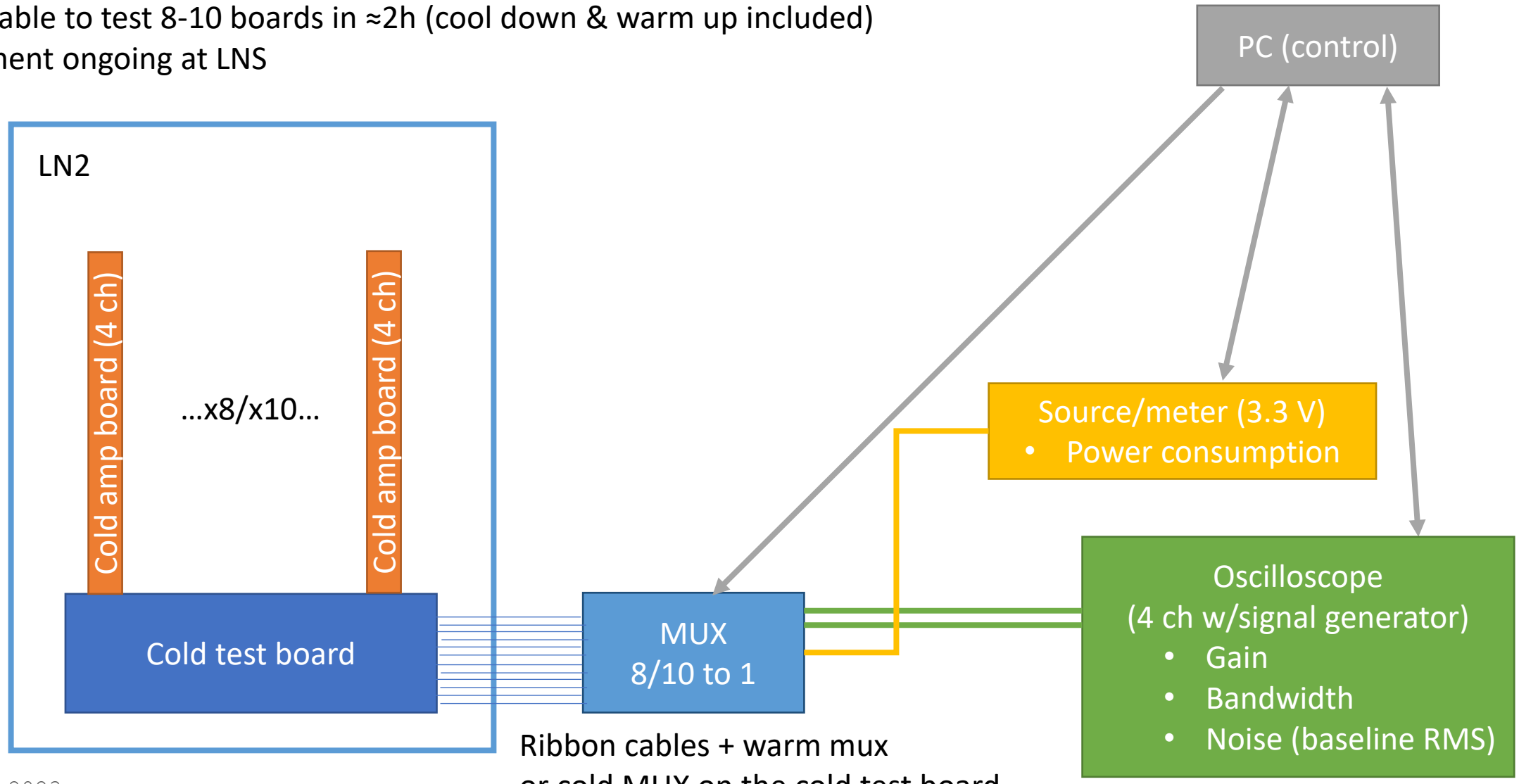






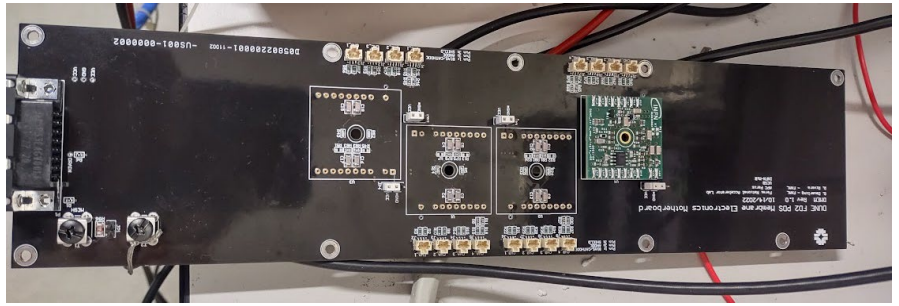
FD1-HD – Production testing

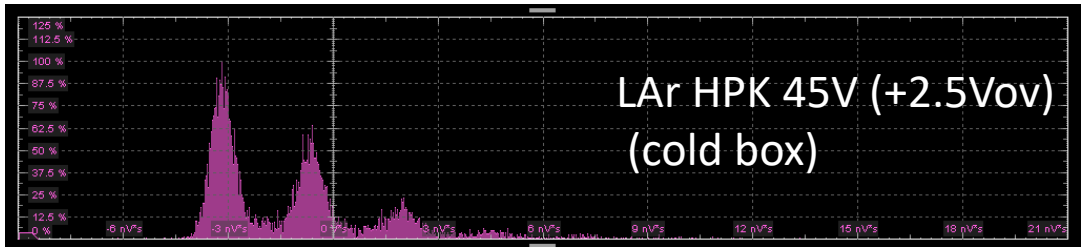
- Total number of 4-channel boards: 1500
- Need to build a setup to test ≈8-10 at a time
- Probably able to test 8-10 boards in ≈2h (cool down & warm up included)
- Development ongoing at LNS

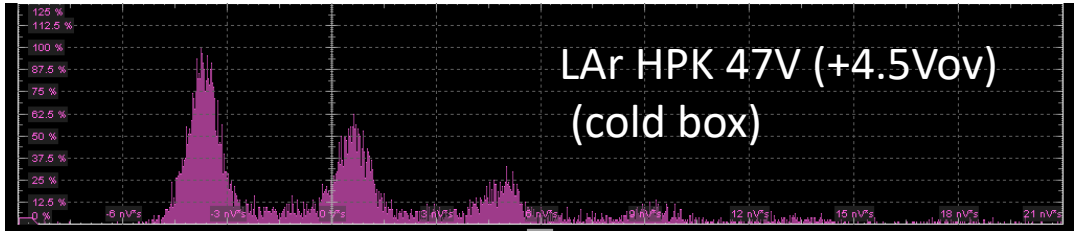


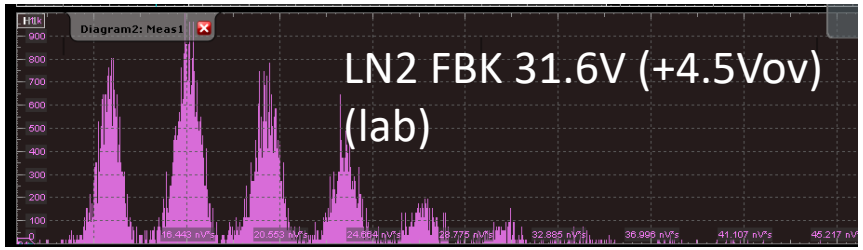
FD2-VD – DMEM

- Stability issues solved since february 2023
- The latest configuration is the same as mounted in ProtoDUNE-VD M3&M4
- In the march cold box:
  - S/N≈6.7 with HPK SiPMs at 45V in LAr (+2.5Vov)
  - S/N≈8.2 with HPK SiPMs at 47V in LAr (+4.5Vov)
- Also tested with FBK SiPMs in LN2 Milano-Bicocca:
  - S/N≈7.5 with FBK SiPMs at 31.6V in LN2 (+4.5Vov)
- 1 DMEM and 2 amplifiers ready for Module 1
  - Installation at CERN ≈ next week









Spares

Warm II stage

- Simple warm board to readout the cold amplifier with the oscilloscope
- Not needed if DAPHNE is used
- Two modes, set with a switch:
  - Transformer (as in DAPHNE) + 1 opamp
  - No transformer (negligible undershoot),
    diff to single-ended conversion done with 2 opamps
    → Better in case of high rate (e.g. light leakage in the cold box)
- 10 boards made and received before summer,
  some already sent to labs for tests (Naples, CIEMAT, NIU)