

Stato dell'elettronica per FD1-HD e FD2-VD

30 Ottobre 2023

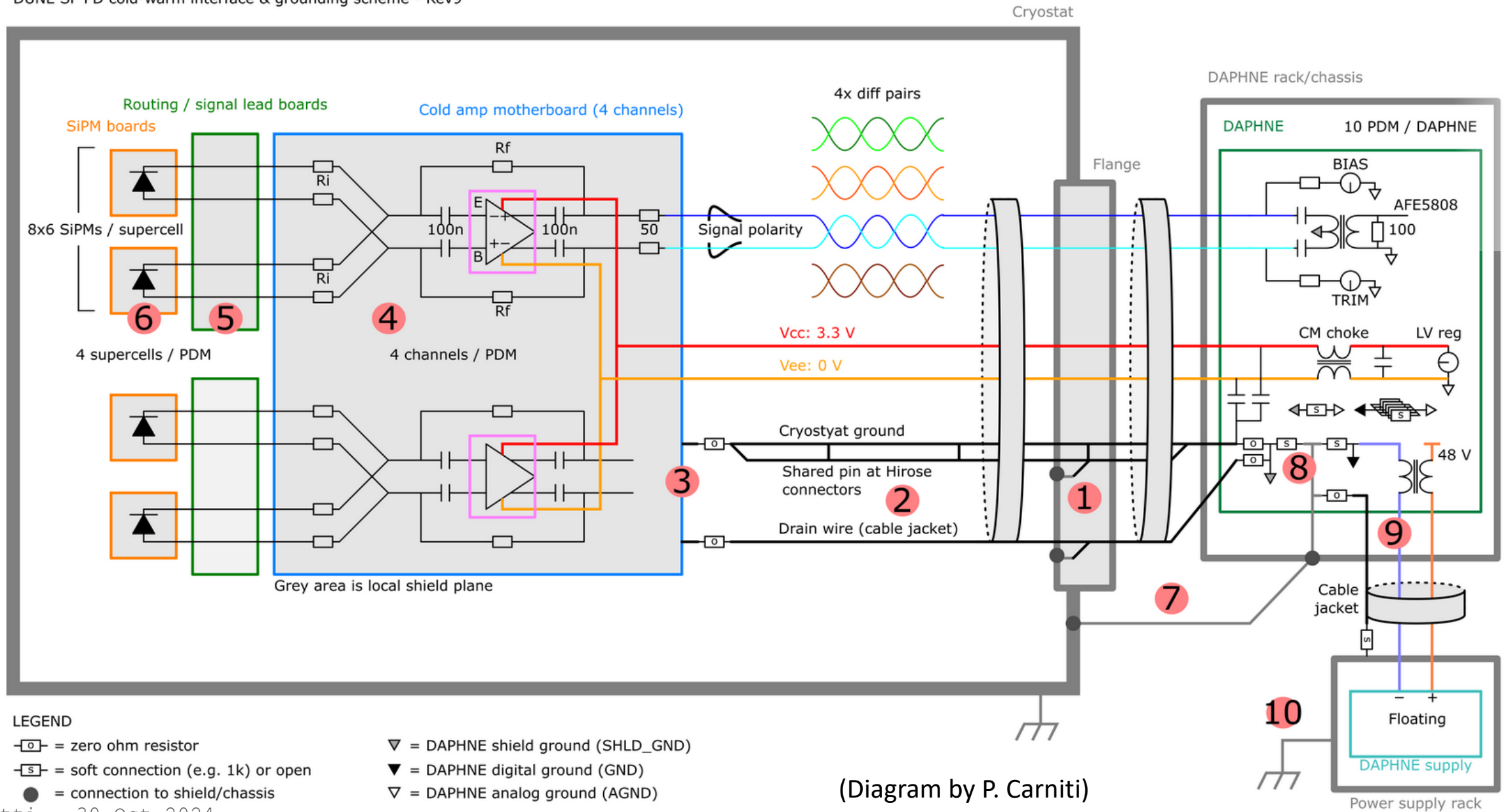
C. Gotti

INFN/Univ. Milano-Bicocca

For the PDS electronics working group

FD1-HD – Overview

DUNE SP PD cold-warm interface & grounding scheme - Rev9



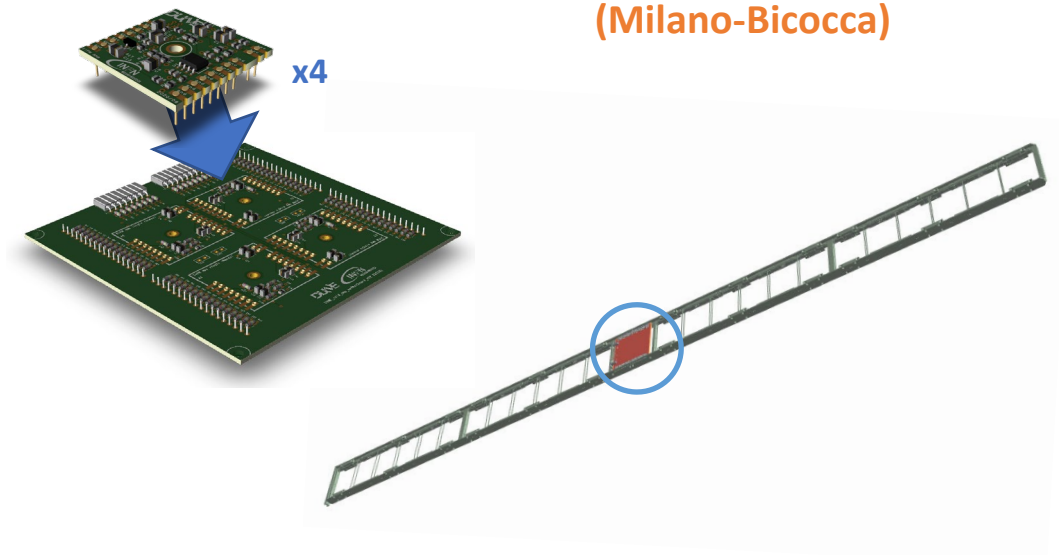
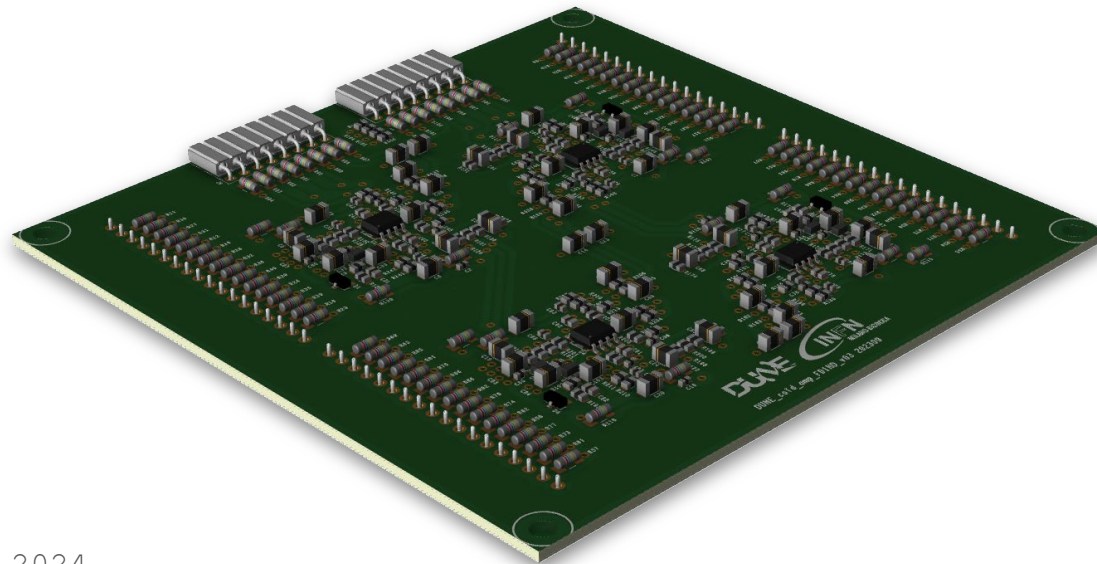
FD1-HD – Cold amp 4-channel board

ProtoDUNE 2 (40 modules):

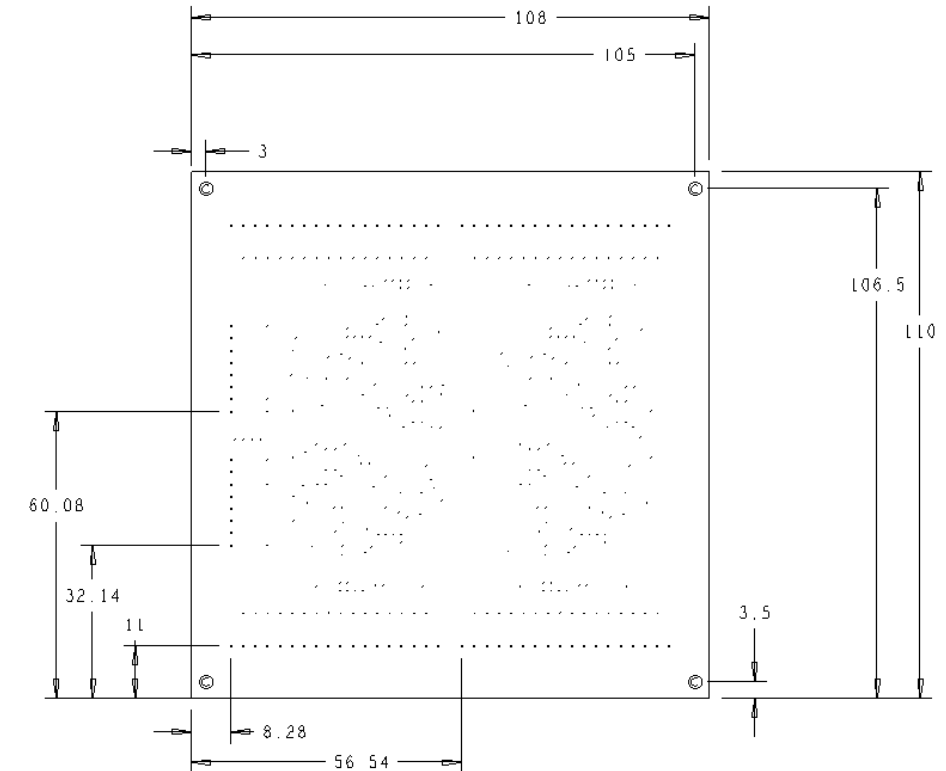
- Motherboard + 4x single-channel daughter cards:
- <https://doi.org/10.1088/1748-0221/17/11/P11017>

DUNE (1500 modules):

- 4 channels integrated onto a single board
- Ordine per l'intera produzione emesso a luglio 2024
- Acquisto componenti in corso
- Pre-produzione (20 schede) entro la fine del 2024; test prima della PRR
- Produzione di 1500 schede (+ 100 spares) dopo la PRR

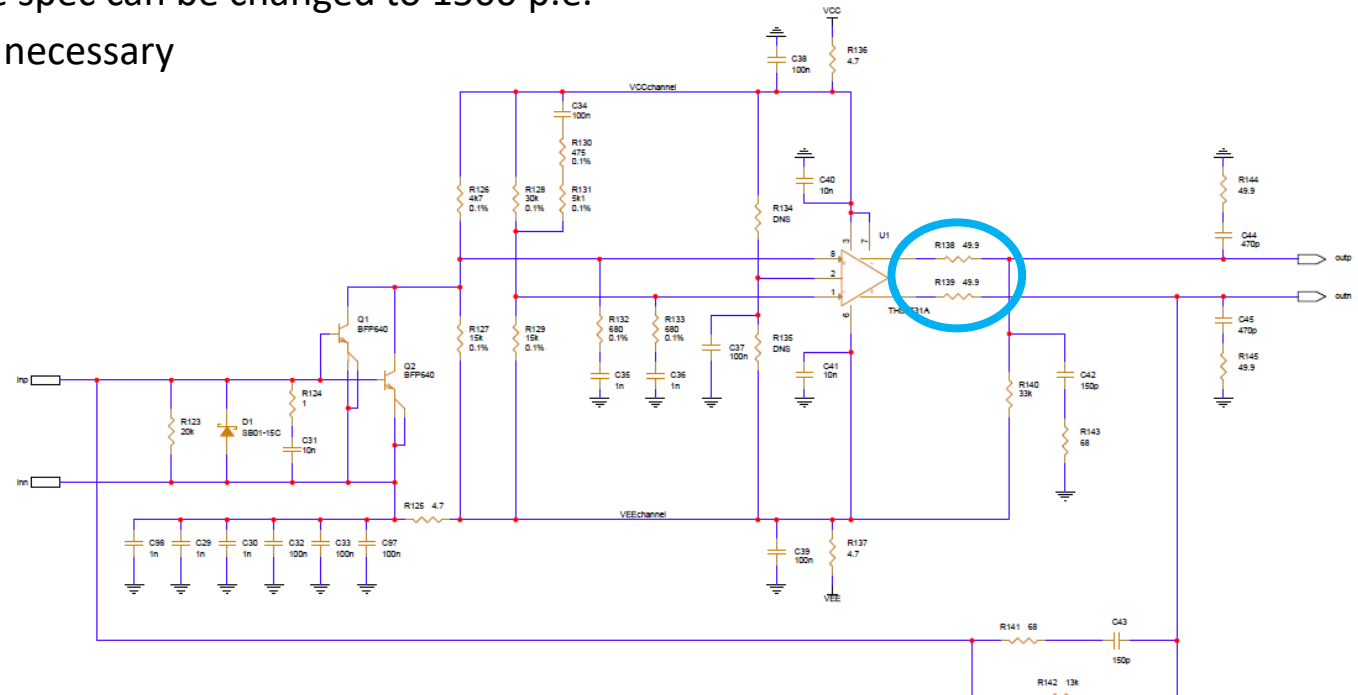
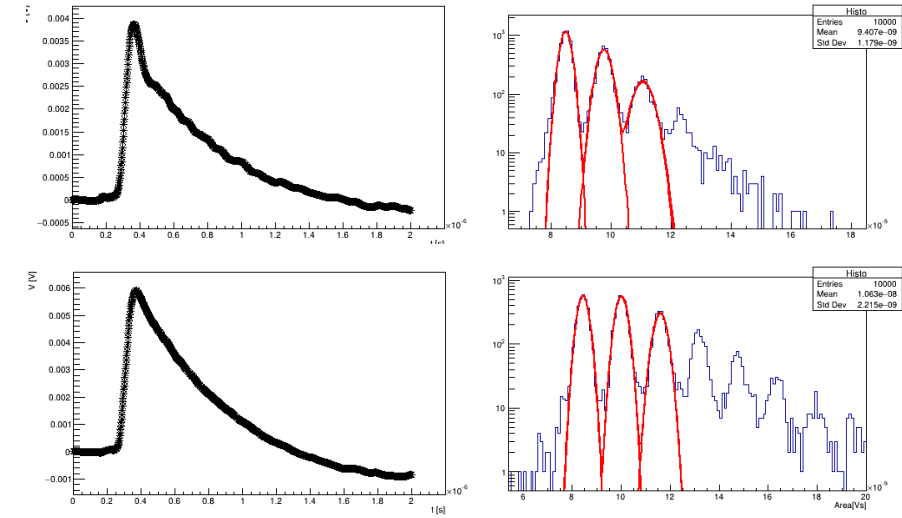


(Milano-Bicocca)



FD1-HD – Cold amp 4-channel board

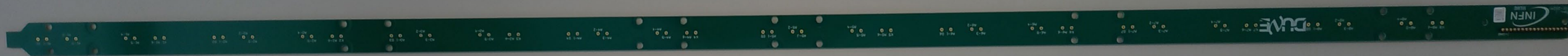
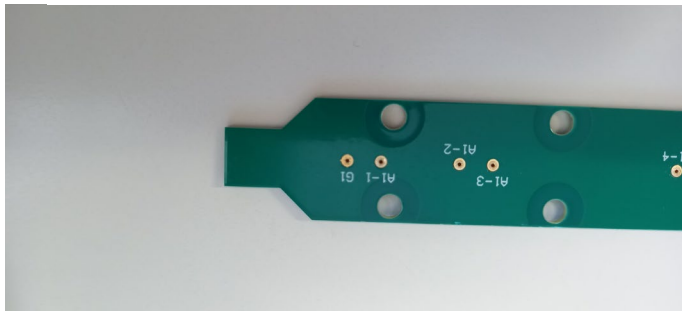
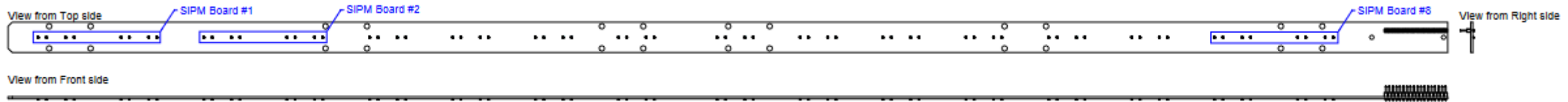
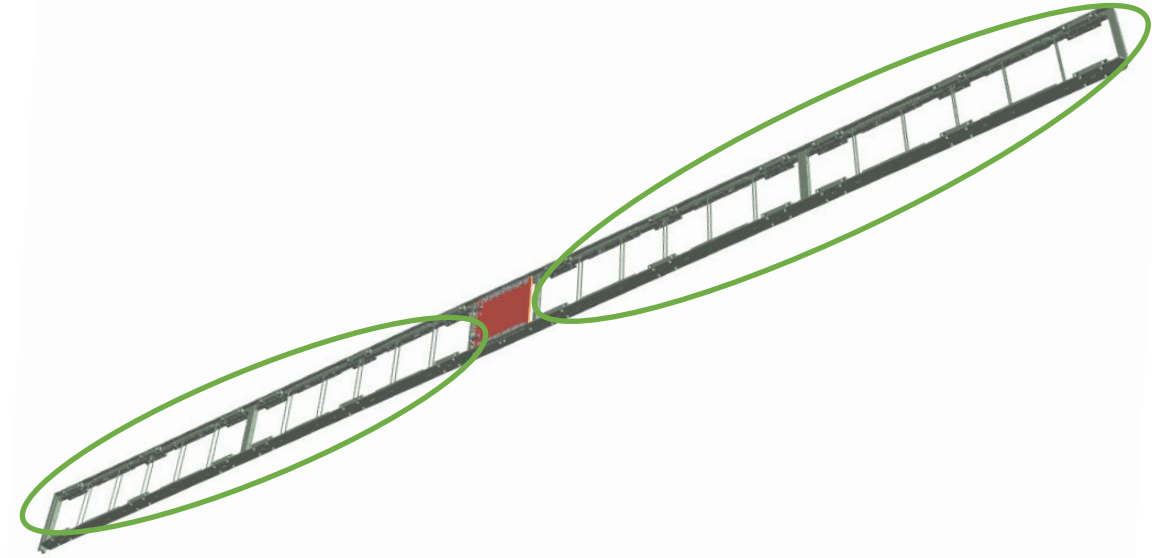
- S/N well within specification (>4)
- Bandwidth well within specification (rise time <100 ns)
- Aging by hot carrier effects well under control
- Dynamic range still under study
 - Original specification: ≈ 2000 p.e.
 - The introduction of 2 resistors to improve stability reduced the DR to ≈ 1500 p.e.
 - Studies ongoing to understand whether the spec can be changed to 1500 p.e. and/or whether those 2 resistors are really necessary



FD1-HD – Cold signal routing (a.k.a. signal lead) boards

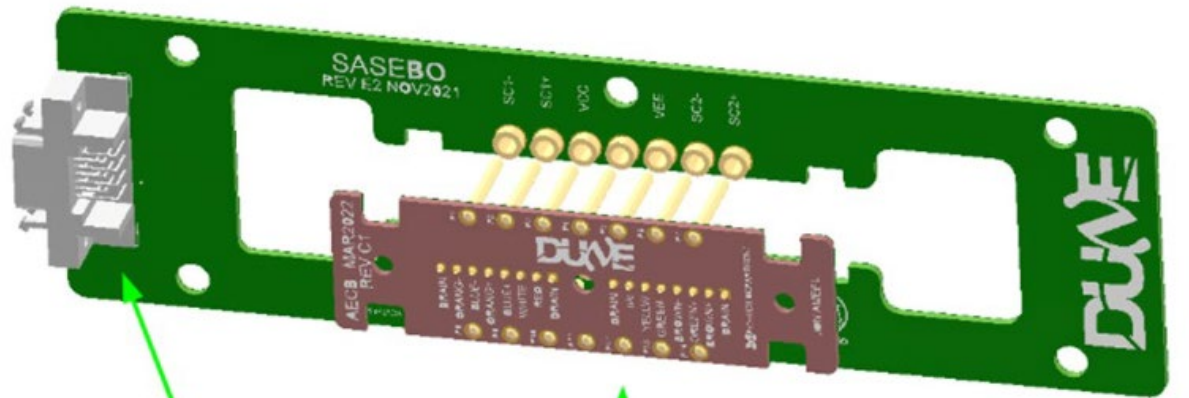
(Milano Statale)

- Passive boards $\approx 1\text{m}$ long
- 4 boards per module
- Carry signals from SiPMs to the cold amplifier
- Production in 2025 (after the PRR)
- Recentemente modificate ad una estremità, per questioni di compatibilità meccanica
- L'ordine per almeno una parte delle schede sarà emesso a breve



FD1-HD – Other cold boards

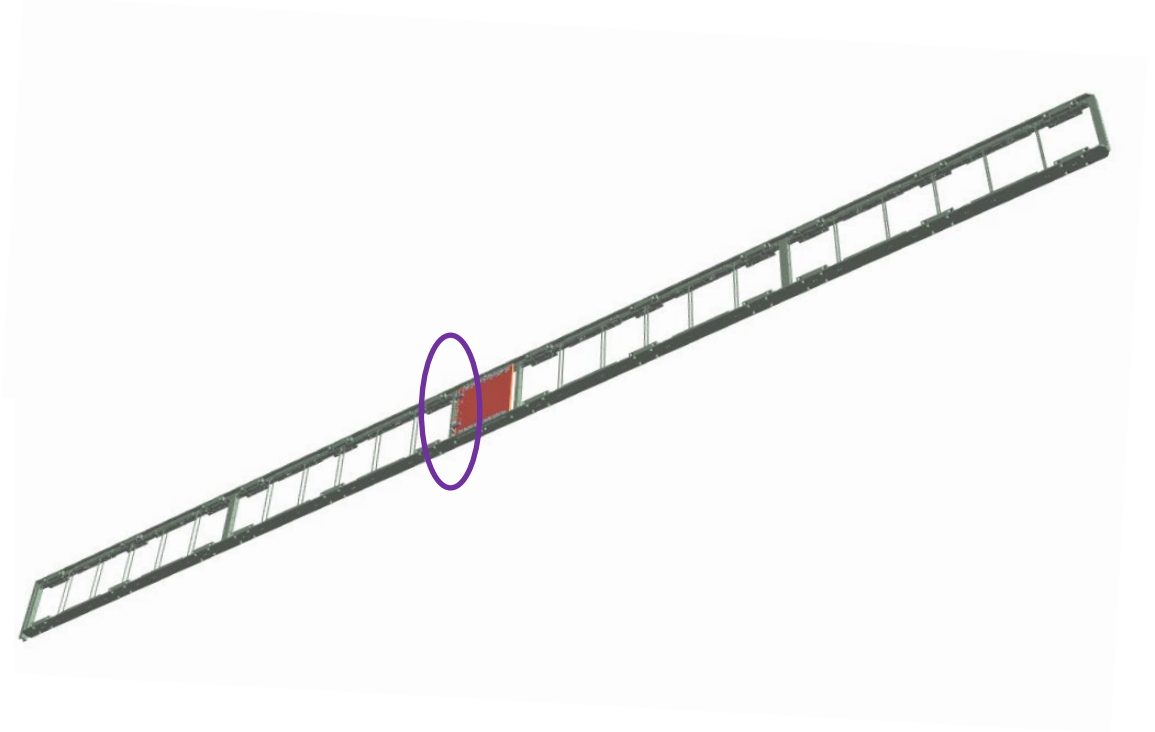
- AECB and SASEBO
- Passive boards, designed by D.Warner, Z.Rautio, J. Ameal
- AECB is part of the module
- SASEBO is part of the APA



Wiring Harness Connector

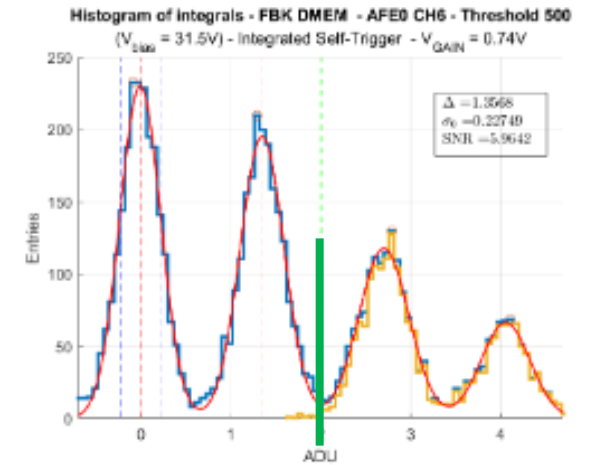
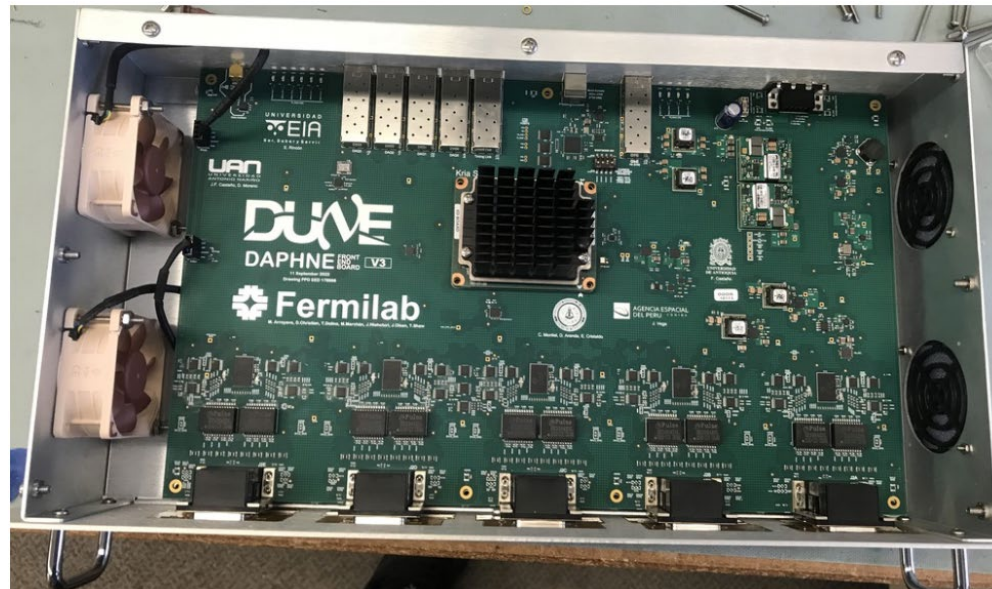
AECB Arapuca Electrical Contact Board

SASEBO Screw and Socket Board

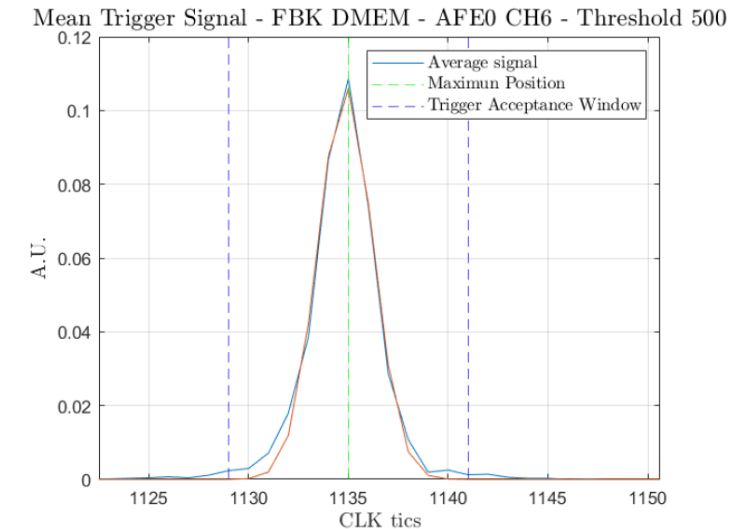


FD1-HD – DAPHNE

- DAPHNE v2A: took data at ProtoDUNE2
 - S/N and dynamic range performance satisfy requirements
 - Self-trigger algorithms demonstrated (merging and testing coordinated by E. Cristaldo)
- DAPHNE v3: under development
 - FPGA replaced with KRIA System on Module (more FPGA resources, faster Ethernet links to DAQ)
 - Minimal changes to analog front-end
 - 10 boards produced in late 2023; some assembly issues were found
 - Firmware well advanced



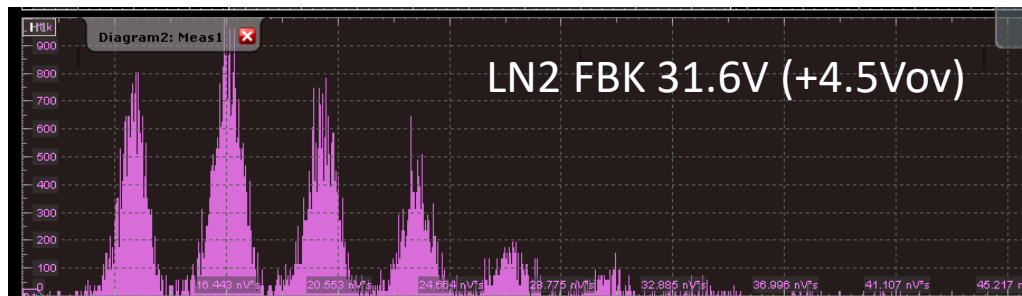
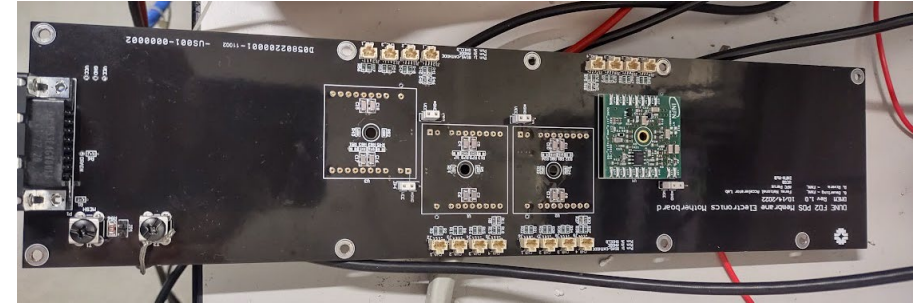
Threshold at 1.5 p.e.



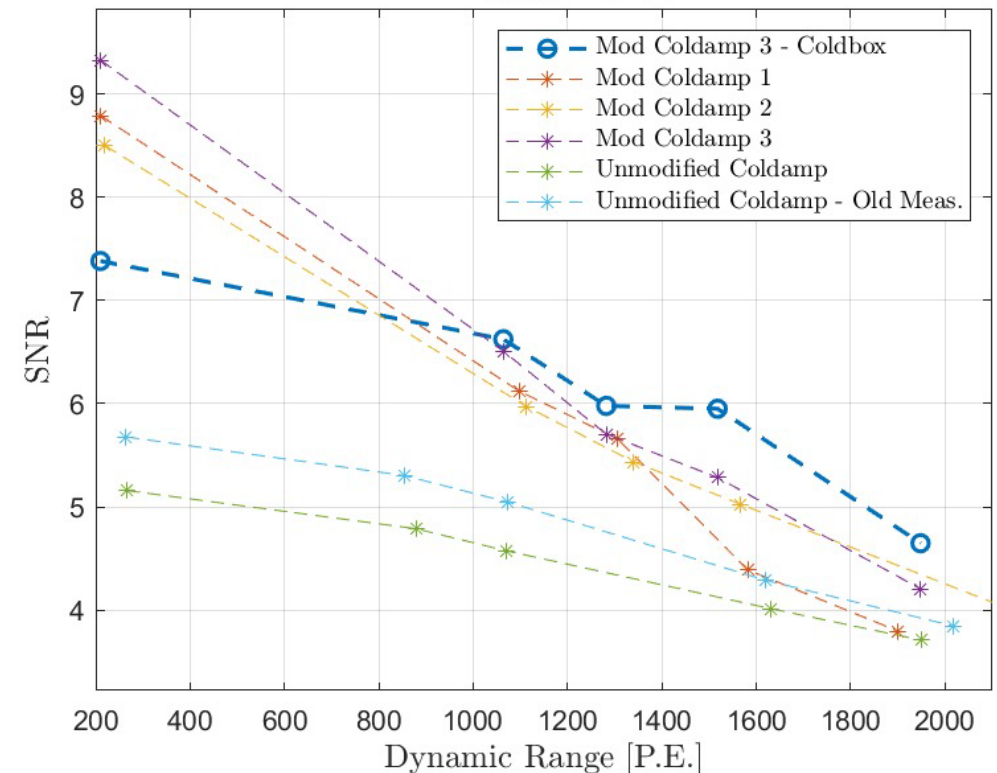
Jitter \approx 5 ticks (80 ns) FWHM

FD2-VD – Membrane-FBK cold amp (DMEM)

- DMEM v1.0
 - Originally designed for up to 4 plug-in channels
 - Uses the FD1-HD cold amplifier
 - Well tested
 - Mounted in Module-0 (ProtoDUNE-VD) and Module-1 (cold box)
 - Reads out membrane modules equipped with FBK sensors
- DMEM v2.0
 - Under design
 - 2 channels integrated onto the board
 - Same dimensions as the new cathode board (DCEM)
 - Expected ready for testing in the cold box in January 2025



SNR - Risettime improvement - DMEM Cold Amplifier
FBK $V_{BIAS} = 32.5V$

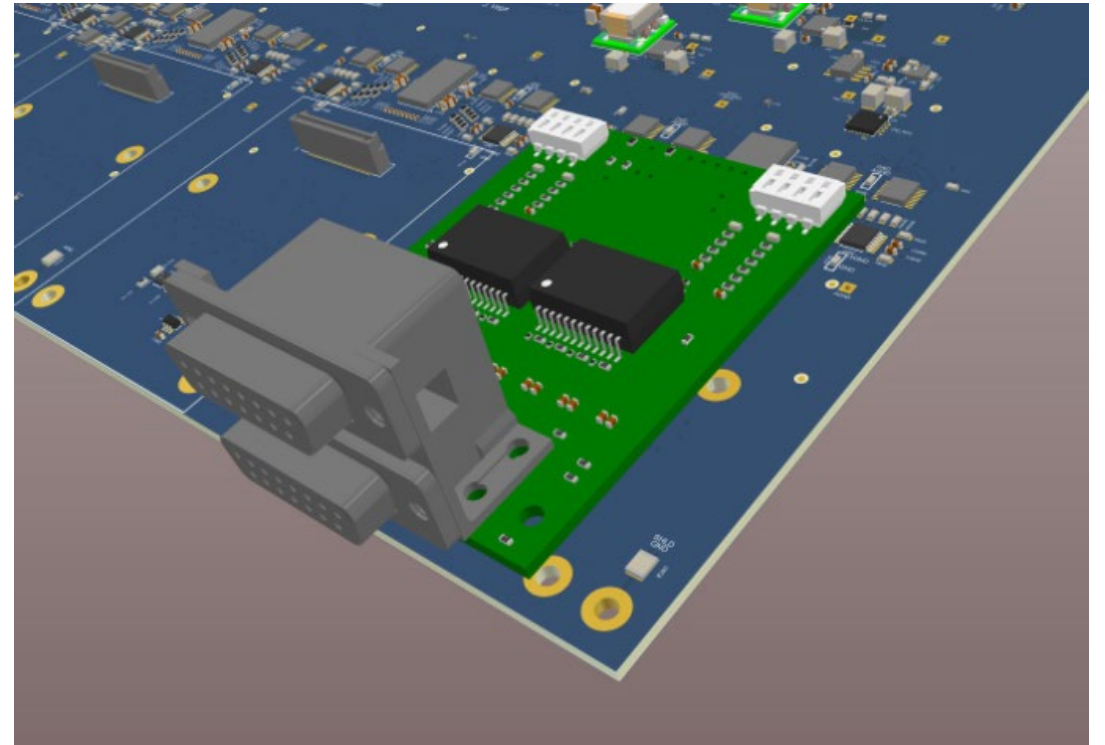
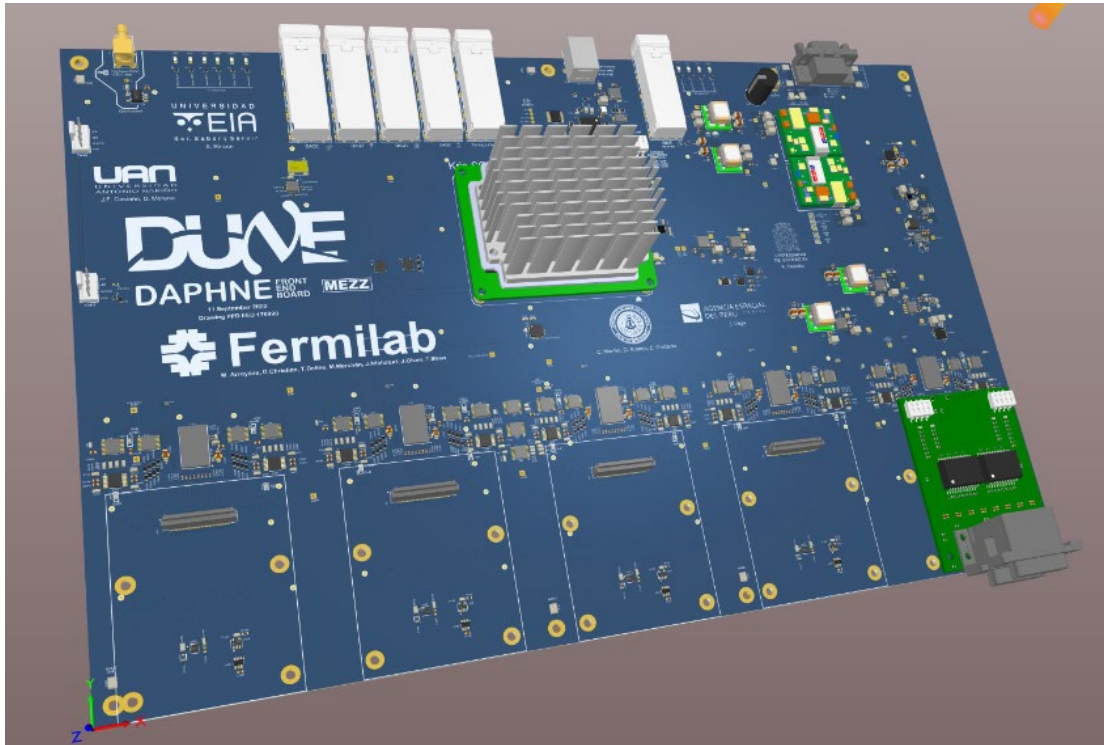


FD2-VD – DAPHNE

- Cathode and membrane electronics need different front-end circuits
- Successful preliminary tests at the cold box DAPHNE v2A

Moving forward:

- DAPHNE v3 modified to have the analog front-end (before the AFE5808) on a mezzanine board
- Different mezzanines tailored for different cold circuits
- Common digital processing



FD2-VD – DAPHNE mezzanine

Different options for the membrane (copper) readout:

- Option 1:
 - Differential to single-ended conversion done with transformers, as in DAPHNE v3
 - Well tested; low cost; does not introduce extra noise
 - Known to introduce undershoot (which can be compensated in software)
- Option 2:
 - Differential to single-ended conversion done with opamps
 - Chance to introduce a filter that also compensates for the undershoot due to the transfer function of the AFE front-end chip and of the AC coupling at cold
 - Developed by E. Cristaldo (M. Bicocca)
 - Plan to test it with a modified DAPHNE v2A in the november cold box run

