Update on final LAV front-end

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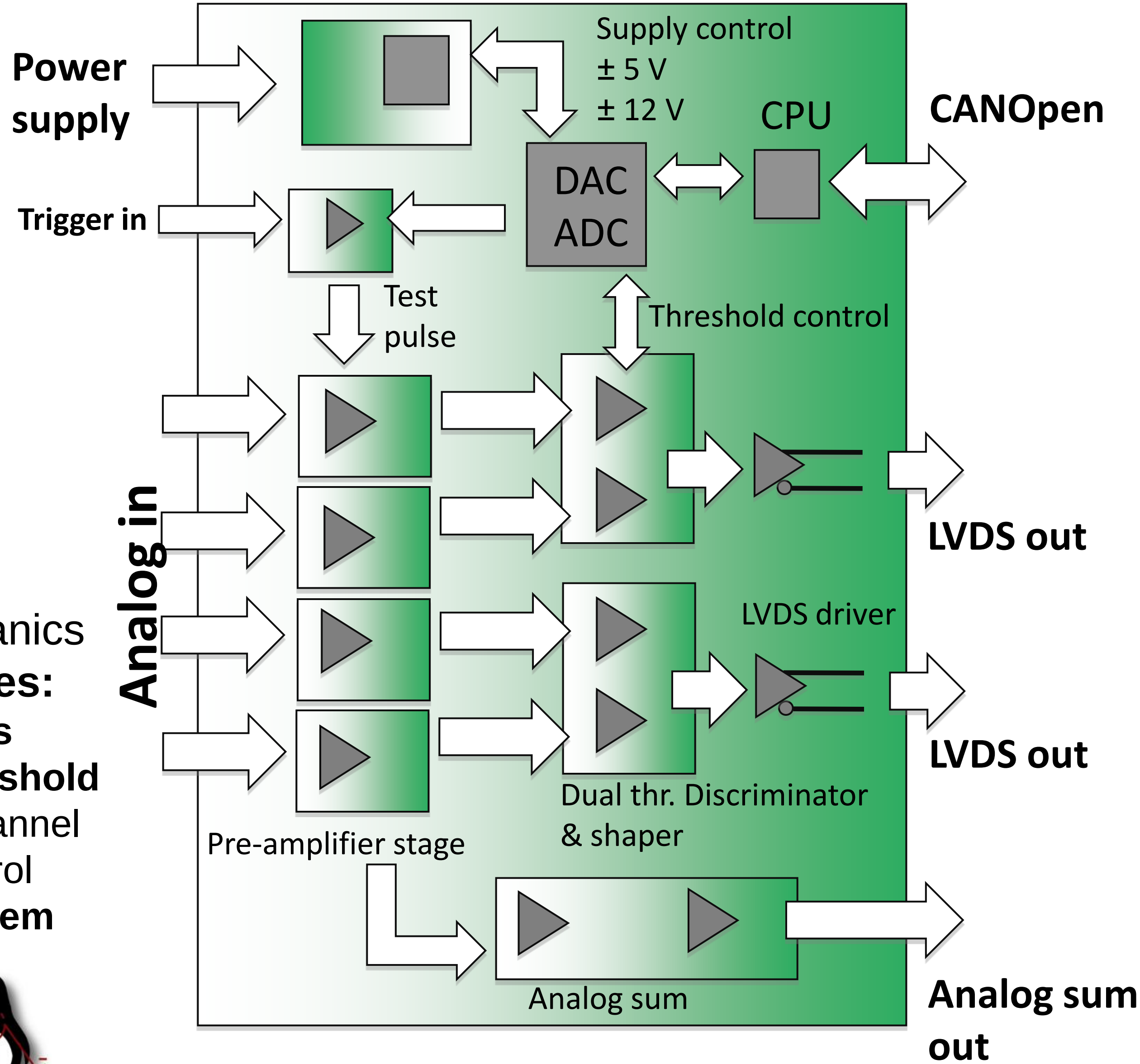
Front-end board (scheme)



Final board

- **32 channels**
- **VME 9U** mechanics
- **Include services:**
  - **Analog sums**
  - **Remote threshold**
  - Individual channel threshold control
  - **Pulsing system**

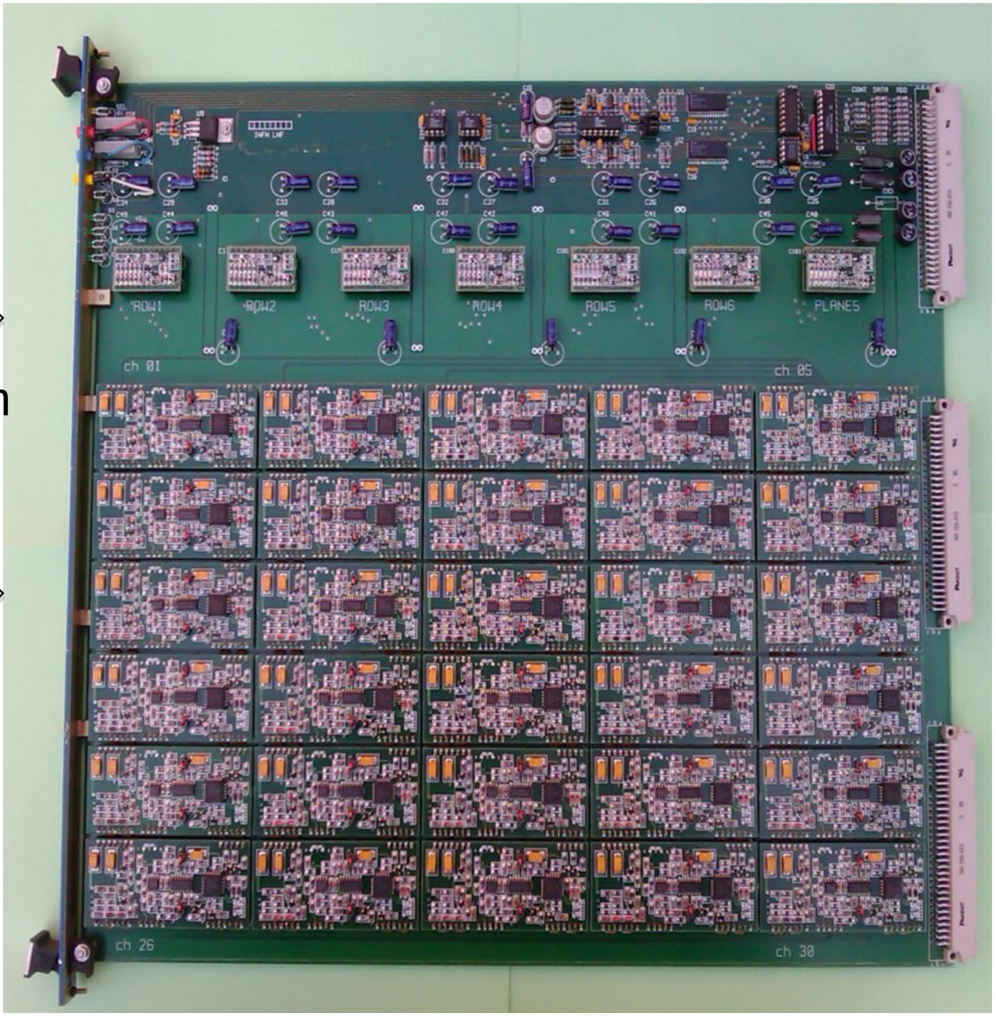
Front-end board (specs)

- **Motherboard**
  - standard VME 9U mechanics, 400x400 mm^2
  - manages all input and output connections
  - non standard power supply, $\pm$5 V $\pm$12 V
  - no VMEbus
- **Daughter boards**
  - **16 daughter** board housing **2 channels** of the ToT discriminator/LVDS driver
  - **8+2 daughter** boards for the 4-channels and 16-channels analog sums
  - **1 daughter** board housing the DAC and ADC and the slow controls.

- This design minimizes the cost in term of spare

- All the slow control and communication functions are implemented using CANOpen standard in agreement with present CERN standards

Something like this…



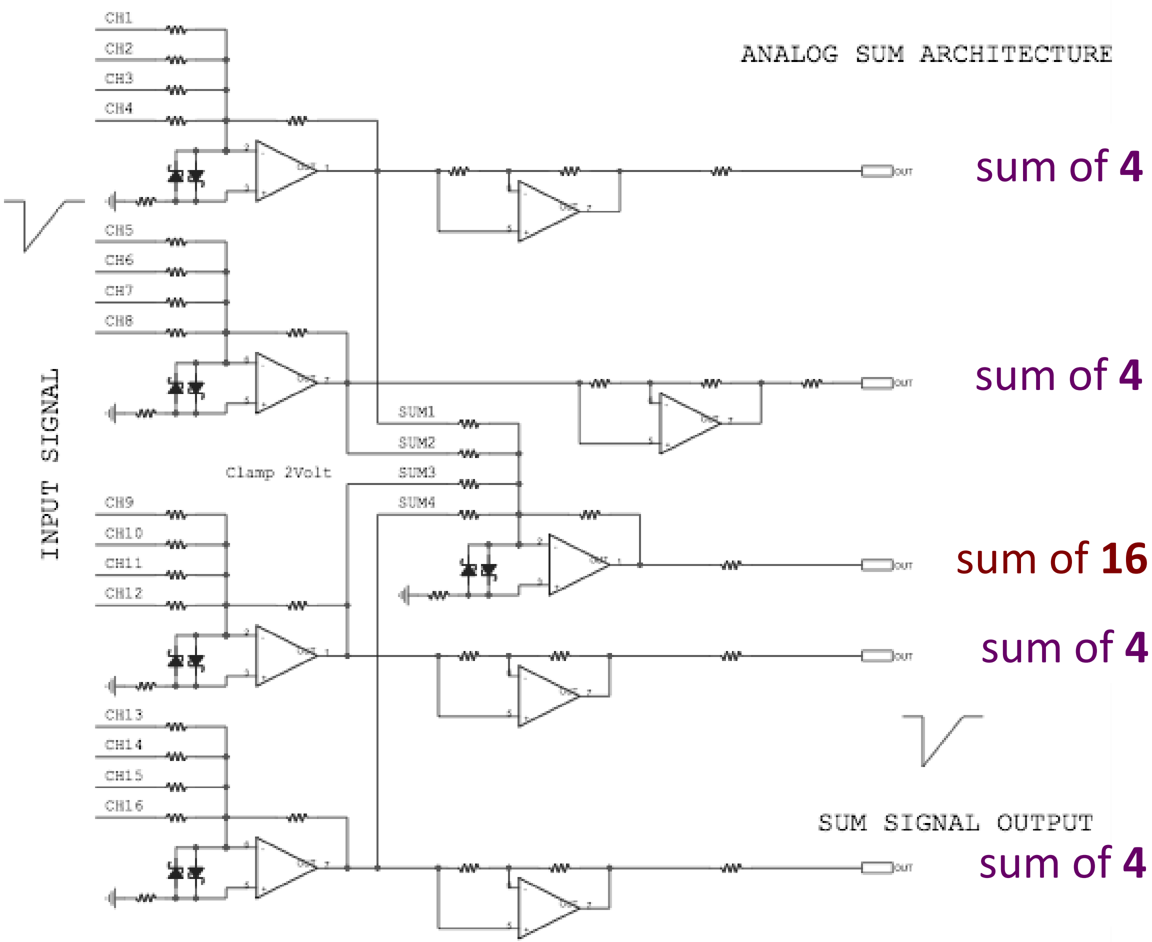
Analog Sum OUTPUTs

Digital OUT LVDS

- **KLOE VME 9U example**
- **This example houses 32 single-channel daughter boards**

Analog input

Analog sum architecture

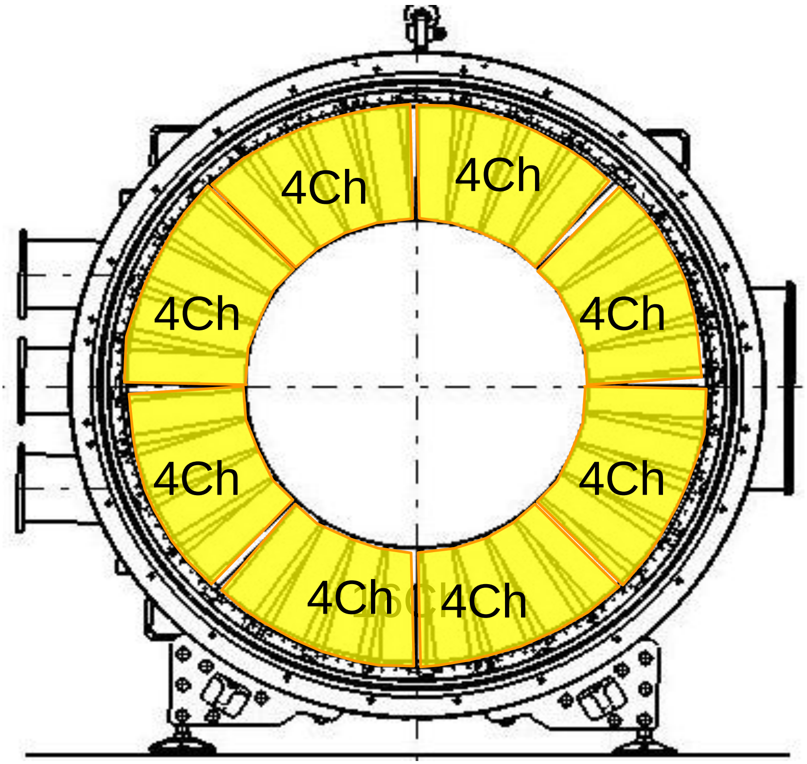


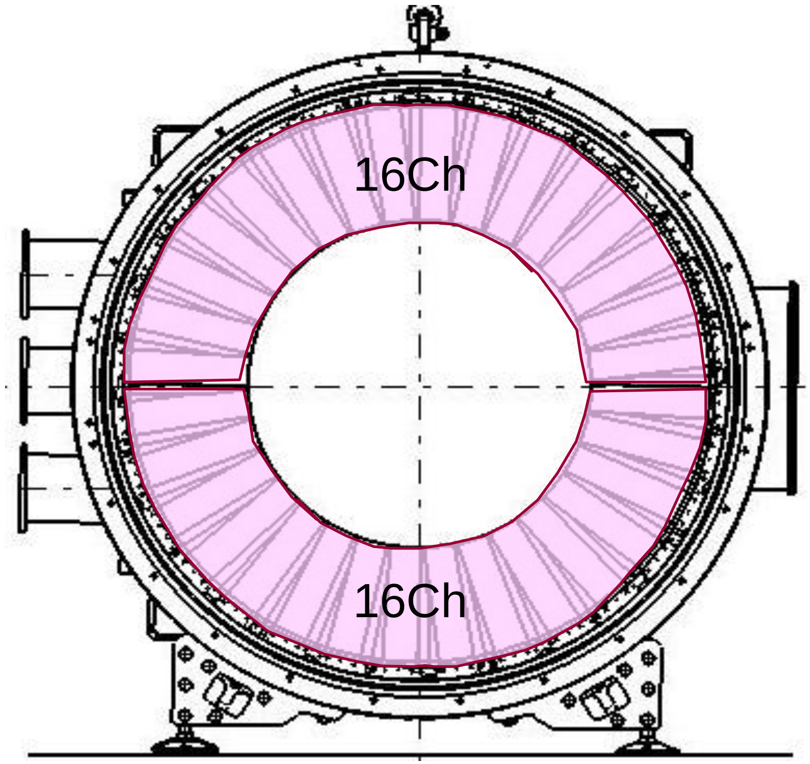
Sum scheme

- **4 channels × 8 sections**
- **1 Sum output × 16 channels**
  - All analog outputs **buffered** and **50Ω matched**
  - Dynamic range 2V, with clamp circuit

Analog sum output

- 1 FEE board serves 32 channels = 1 layer
- 32×2 thresholds = 64 LVDS outputs
- 32 analog outputs can not be housed (not enough room on the panel):
  - sum **4 analog signals** (e.g. **1 “banana”**)
  - sum 4 bananas (**16 channels** = **half a layer**)
  - Coax 50 Ω, Lemo-00





Threshold circuit

- **Two thresholds per channel**
- **Remotely programmable** (CANOpen)
- Common threshold with trimmer

(for redundancy, jumper-selectable)

- **0-500 mV** range, **12 bit** resolution

(standard low-cost components, more than enough)

- **2 LSB** stability
- Easy to implement automatic threshold scan

Pulsing system

- Provide a **test pulse**:
  - **free-running** (controlled by local **CPU**)
  - or on **external trigger**

  - pulse **all channels** or a programmable **pattern**
    - **10-50 ns** programmable width
    - **10-500 mV** programmable amplitude
    - Useful to check time-over-threshold performance
    - Ensure width and amplitude stability at 1% level

Other diagnostics on-board:

- monitoring of the voltage
- monitoring of the board temperature

Crates

1 LAV station:

- VME 9U non standard crate housing
- 5-8 FEE boards (160-256 channels)
  - ±5 V ±12 V power, no standard VME bus

- LED drivers (5-8 if 32 channels)
- HV control
- 1 TELL1 (512 TDC channels), 2 slots (need also 3.3V and 48V)

Our proposal:
ask for modification of **Wiener 6023 crate** in order to accommodate TELL1 (only 3U power backplane)

+ 3 standard 6U VME slots

L0 primitives

- Ring primitives (circle of N blocks)
  - E_{bl} = Reconstructed charge in a block
  - E_{ring} = Sum of the energy of all 32 blocks in the ring
  - N_{ring} = Number of blocks above threshold in the ring
- Station primitives
  - E_{tot} = Total energy of all blocks in the LAV station
  - N_{tot} = Total number of blocks above threshold in the station
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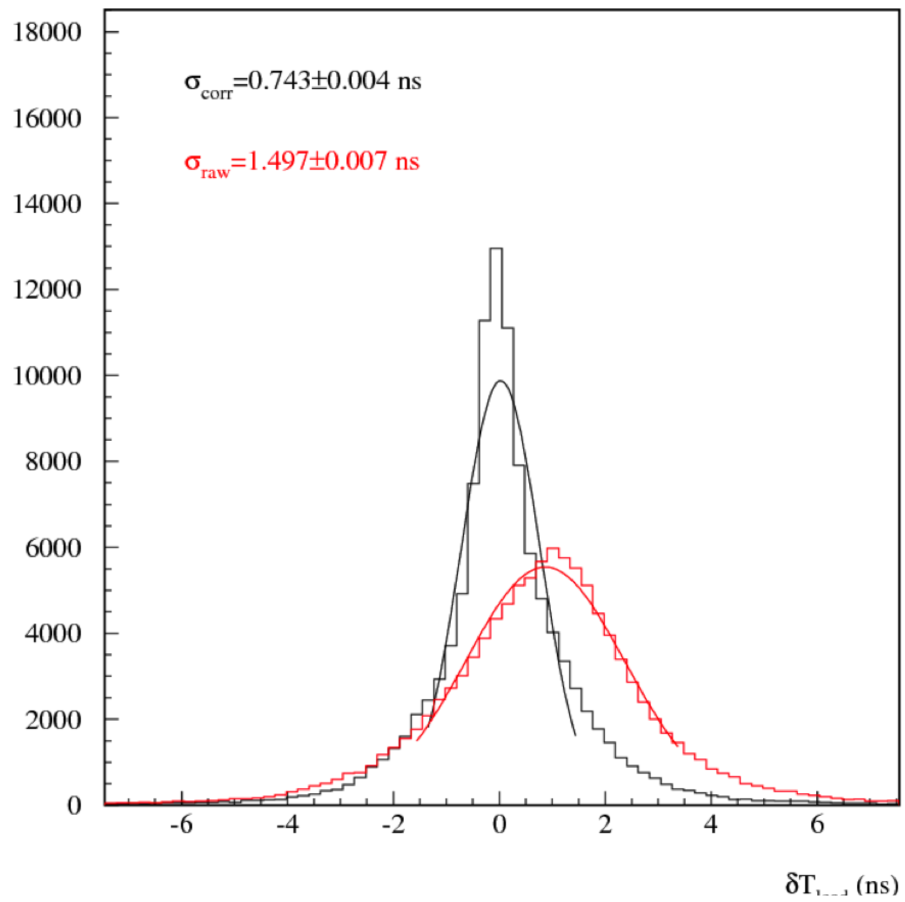
Time resolution test beam



$$T_0 = T_L - L_{THR} \cdot \frac{T_H - T_L}{H_{THR} - L_{THR}}$$

Time Resolution after slewing:
750 ps resolution on $\Delta T = T_1 - T_2$
500 ps for a single block

- MIP signals (single station):
    - 4 or more blocks
    - we will get ~350 ns
- Electron shower:
    - 16-20 blocks
    - We will get 150 ps

Single station information

Using the information of a single LAV station

1) MIP trigger (identify MIP(μ or π) from e^- and γ)

- N_{ring} < 2 for each of the five rings
- $E_{bl}(i)$ < 250 MeV for each block over threshold
- 0.5 < $E_{ring}(i)/E_{ring}(i+1)$ < 2 for each two rings
- N_{cl} = 1 only one cluster in the LAV station

2) High multiplicity trigger (identify high energy showers in the station)

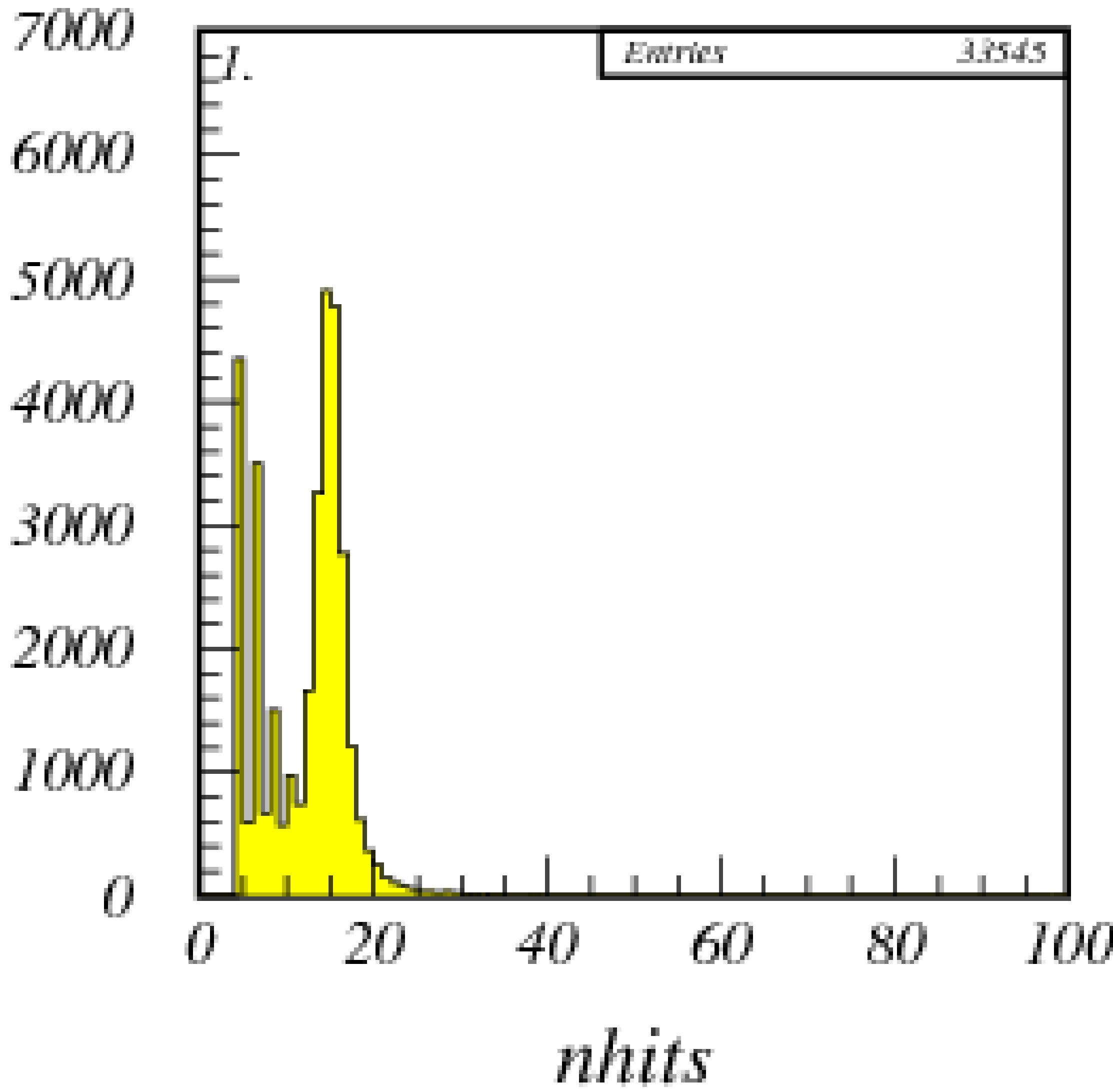
- N_{tot} > 15 OR E_{tot} > 20 GeV
- E_{ring} > 2.5 GeV · N_{ring} for al least 2 rings
- N_{cl} > 2 more than 2 clusters in the LAV station

Hit multiplicity during October test beam

Hit multiplicity for 2 GeV electron run:

The peak on the left is due to muon of the beam halo while the peak on the right is due to electrons

The distribution is such to allow good performance in the muon electron separation based on multiplicity only



Whole LAV information

When the information of all LAV stations are collected (need inter-board communication)

- Particle time (@ ANTI-A12 position?)
- Particle total energy deposit
- Total energy deposit in each of the crossed stations
- Phi position (@ ANTI-A12 position?)
- Total number of crossed stations
- Total number of hits in each crossed station

How do we divide this two steps into trigger levels?
Who (TELL1s or PCs) will be charged with the computation?

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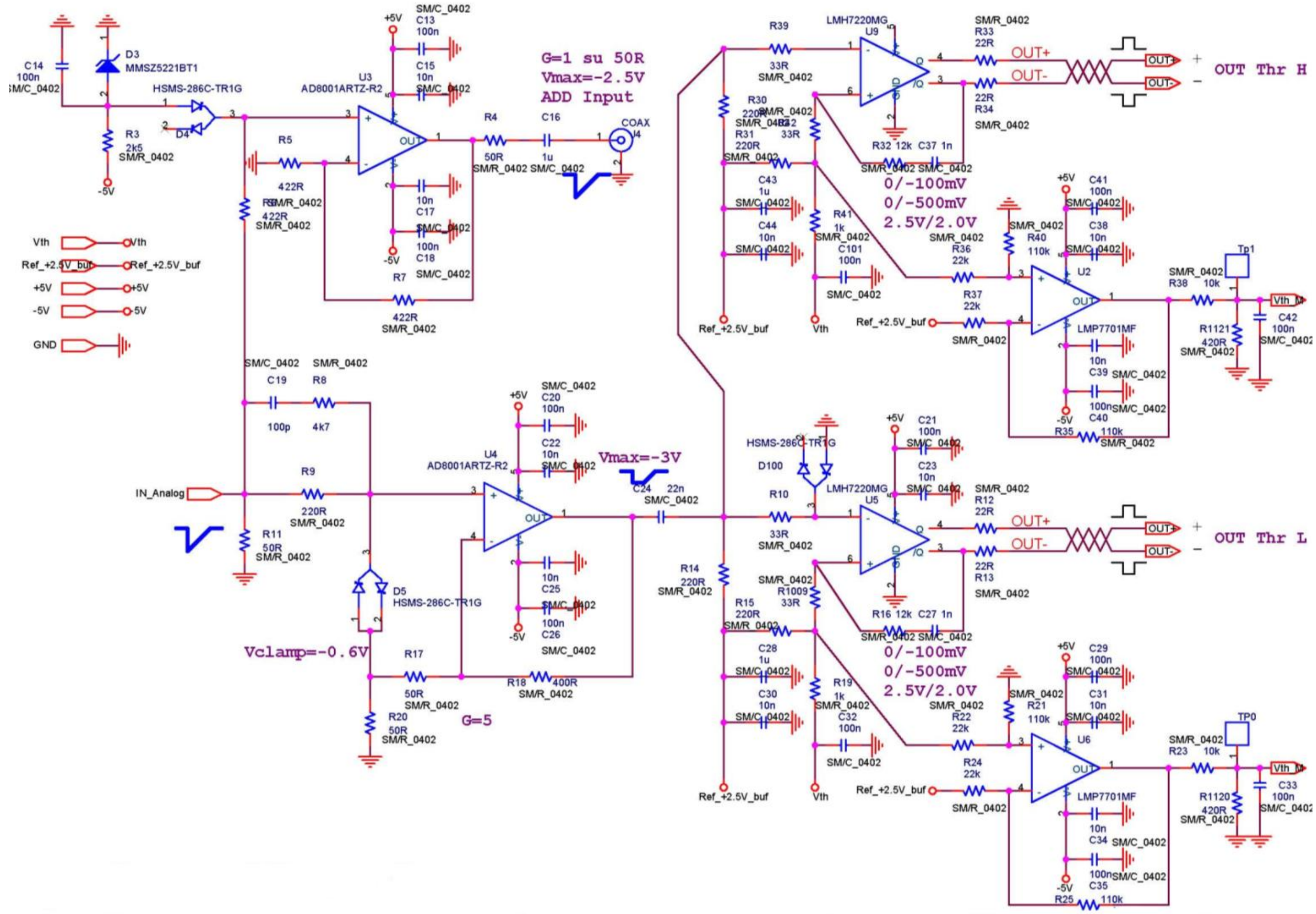
Conclusions

- FEE boards in production, expected delivery **end of July** (just in time for the August test-beam)
- Keep FEE board cost ≤ 3000€
- Need to finalize final TDC cable choice
- Crate choic
- It's time to start LAV trigger studies
  - Can profit of august test beam on ANTI-A2

Spares

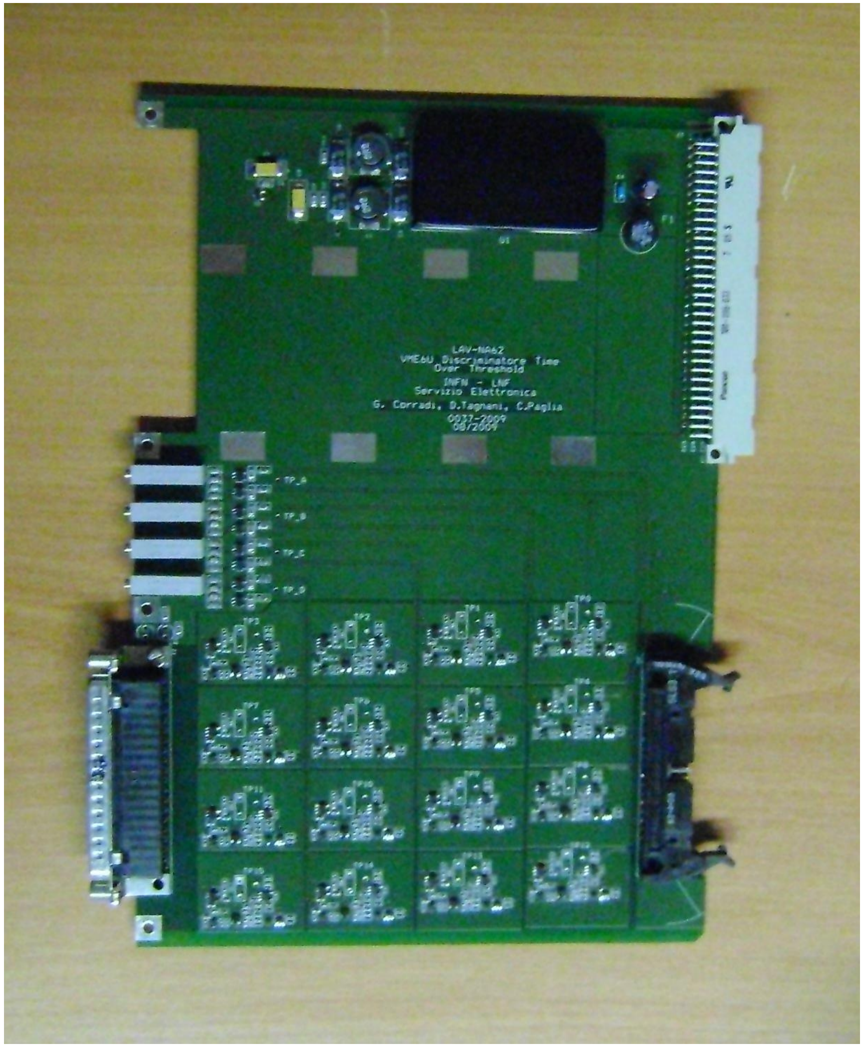
Front-end board (single channel)



Front-end board prototype

Prototype board

- **16 channels**
- **VME 6U** mechanics
- **Manual** threshold control
- 4 by **4 channels** threshold
- Single channel analog output
- **Successfully tested** at NA62 beam-test (Oct. 2009)



Board connections

• 8 Analog sums of 4 channels
• 2 Analog sums of 16 channels
10× Lemo-00 on front panel

• 32 analog inputs from flange
DB37 connector

• 64 LVDS outputs to TDC
2× Robinson-Nugent (1.27 mm)

• 1 Rj11 connector for communication CAN-OPEN