Istituto Nazionale di Fisica Nucleare

Laboratorio di elettronica
responsabile Fabrizio Ameli
tel. +39 0649914223 - fax +39 0649914320

Electronics R&D INFN-RM1

INFN Roma LabE

General topics and staff competencies

SEP 27-28, 2018 | INFN-GE (Genova), Italy

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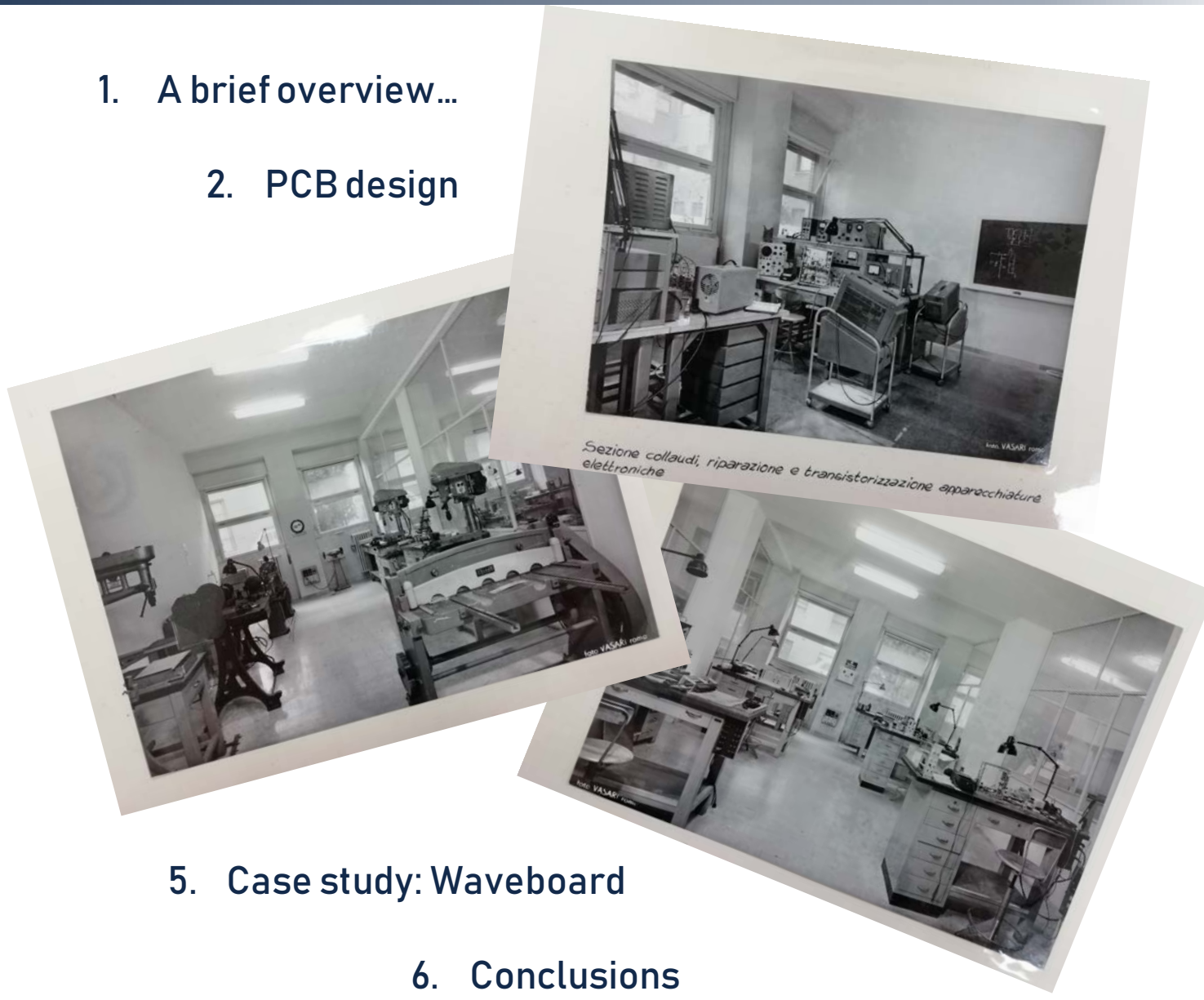
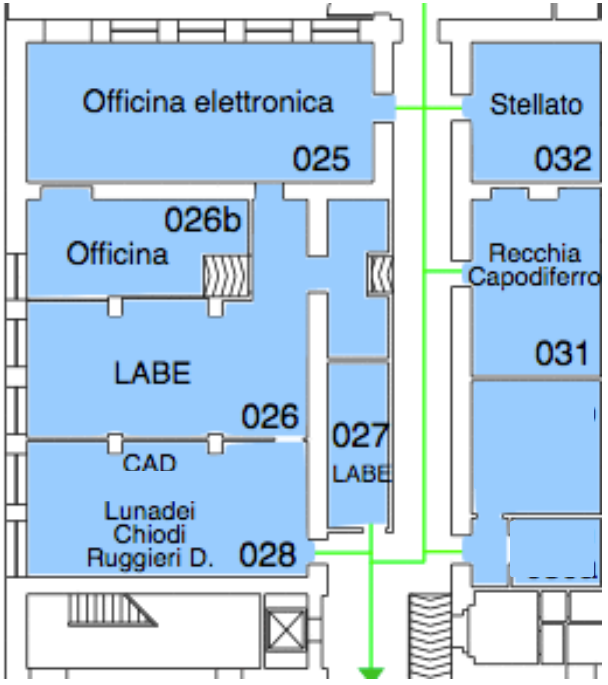


A brief overview…

- The INFN-Roma LABE supports the experiments' staff with electronics design and prototypes
- The area is divided in 4 different main rooms:
  - CAD + Service (R&D and IT)
  - LABE + workshop
  - Electronics workshop
    - experimental set-up
    - "free" access
- dedicated instrumentation for fast prototyping of 2-layer PCB
- Advanced inspection instruments for assembly and reworking of SMD parts of almost any size
- The electronic workshop is equipped with oscilloscope, generators and power sources as well as a thermal chamber



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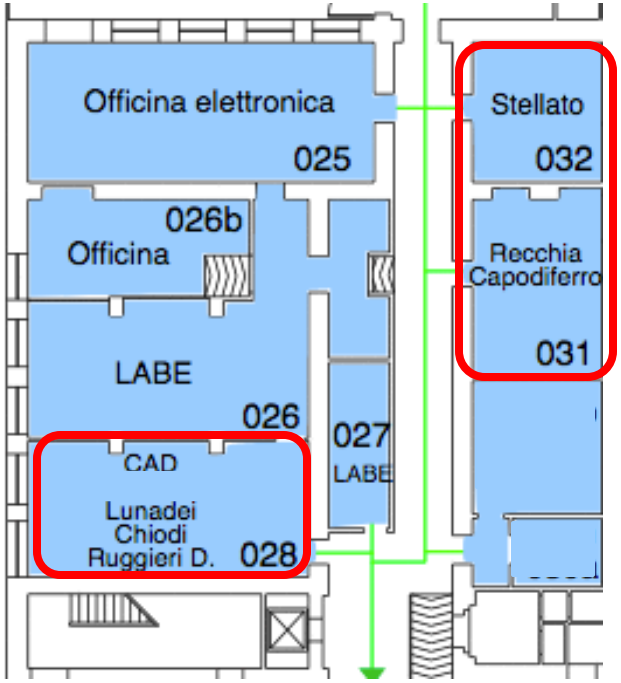

OrCAD™ CADENCE PCB SOLUTIONS

Altium

EUROPRACTICE

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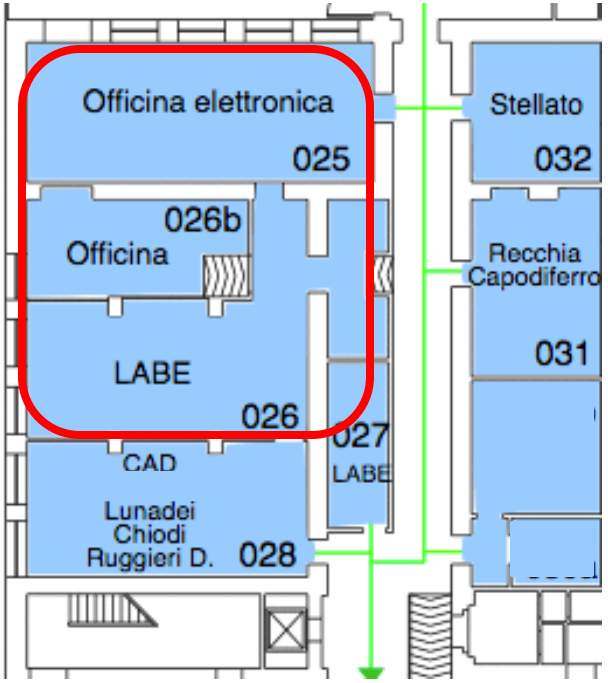

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PCB Milling machine

Digital Stereo Microscope (7x ÷ 120x)

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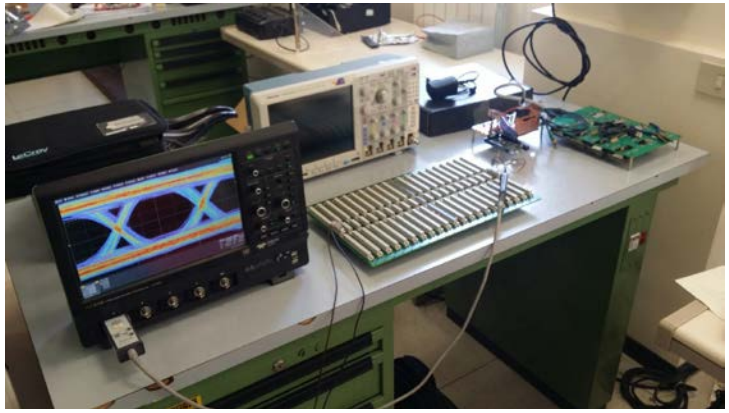
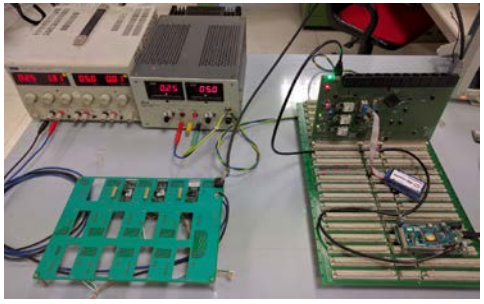
- The electronic workshop is equipped with:
  - Benches with reworking stations
  - oscilloscopes
  - generators and power sources
  - climatic chamber





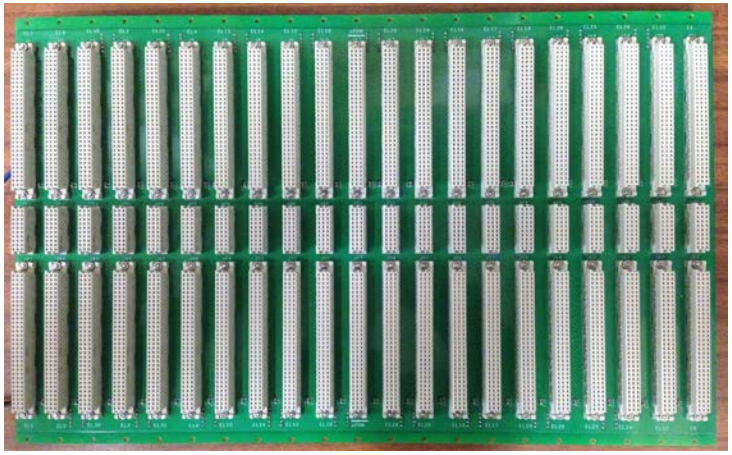
A brief overview…

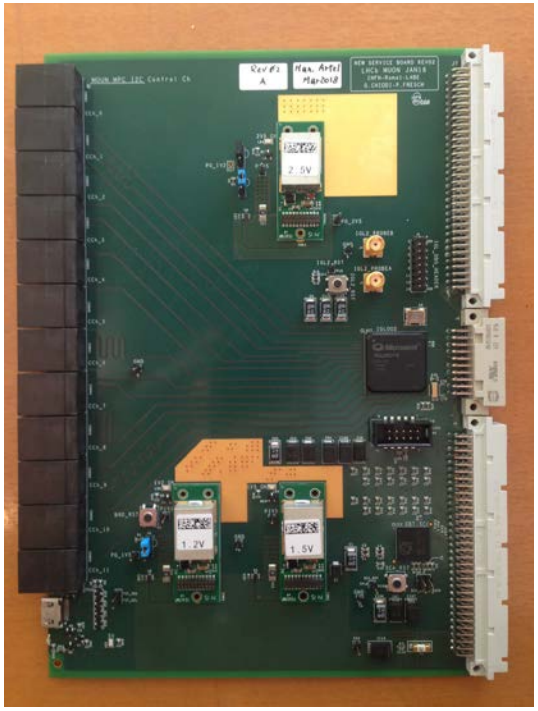
List of Experiments using LabE facility:

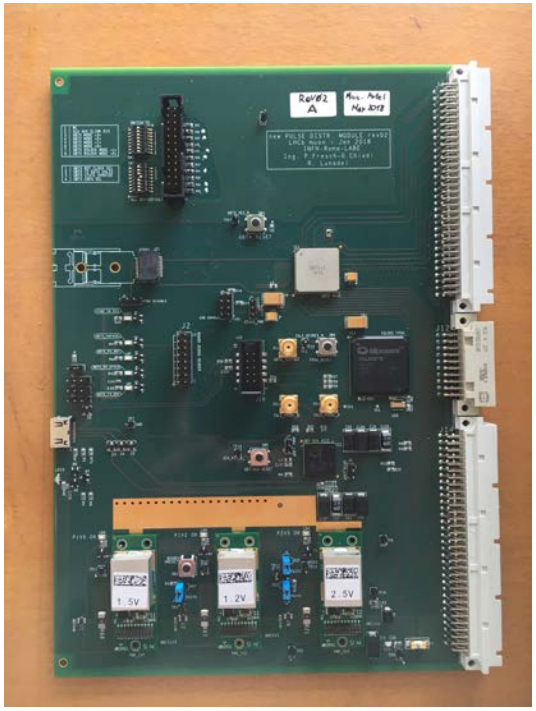
- CSN 1:
  - ATLAS
  - LHCb
  - PADME
  - MEG
- CSN 2:
  - KM3
  - DARKSIDE
- CSN 3:
  - FOOT
  - JLAB12 (BDX and Others)
- CSN 5:
  - CHIR2
  - BULLKID

PCB design

- The LHCb muon Front-End electronic control system



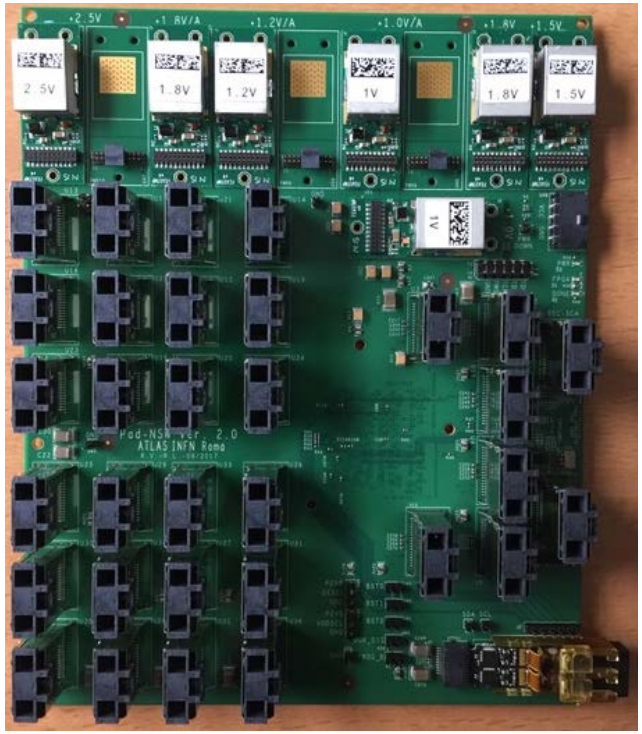


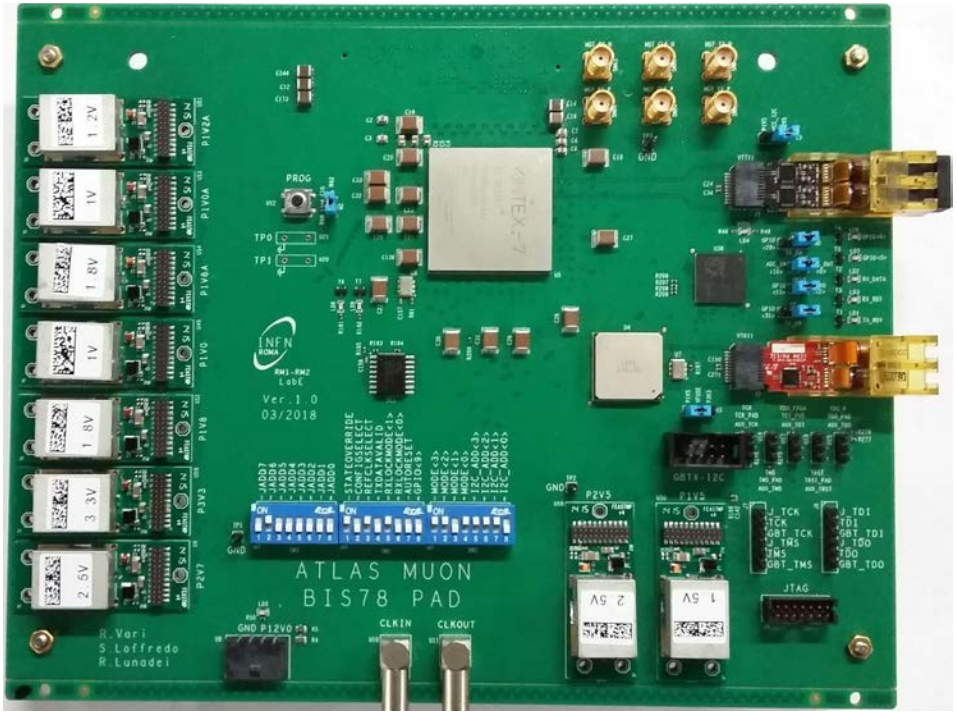


- Board overview
  - 3 multilayer (up to 10) designs
  - matched impedance wires (1-80-4000 Mbps)
  - Standard VME 6U fit
- Components overview
  - Custom CERN RadHard ASIC (GBT family)
  - low density Flash-based FPGA (IGLOO2)
  - Optical transceiver (SFP form factor)

PCB design

- The ATLAS muon PAD

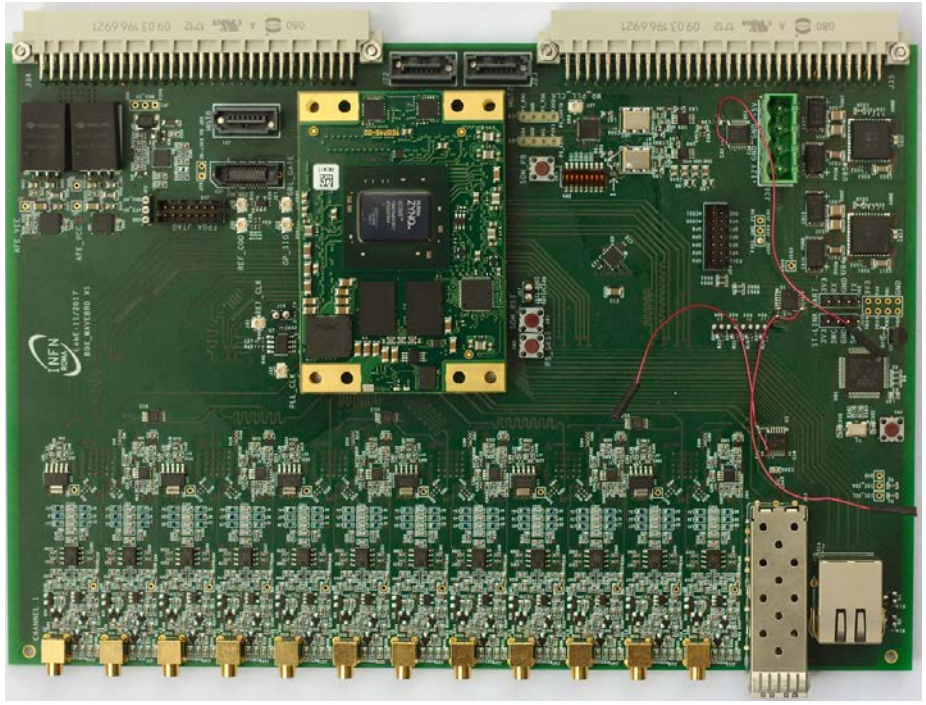




- Board overview
  - 1 multilayer (up to 14) designs
  - matched impedance wires (@ 360Mb/s, @6Gb/s)
  - Custom form factor
- Components overview
  - Custom CERN RadHard ASIC (GBT family)
  - High density FPGA (Kintex-7)
  - Optical transceiver (SFP form factor)
  - High speed connectors (Molex??)

PCB design

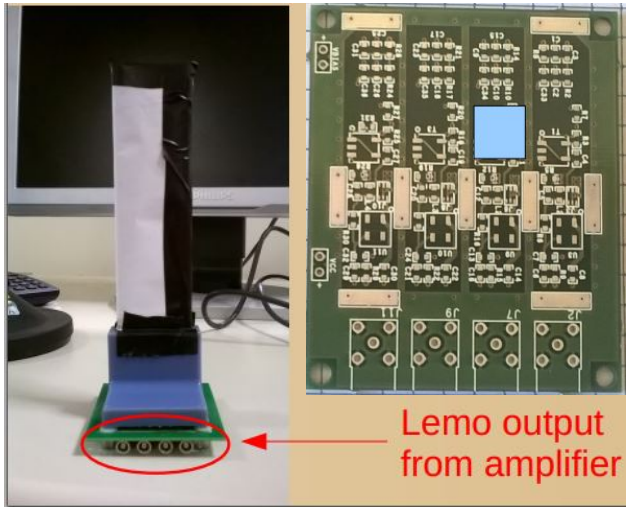
- BDX experiment Front End readout (WaveBoard)



- Board overview
  - multilayer design
  - matched impedance wires
  - Standard VME 6U fit
- Components overview
  - 12 channel digitizer 14bit@250MHz
  - SiPM HV on board
  - COTS SOM (Zynq Based)
  - White Rabbit Enabled
  - Optical TRx (SFP form fact.)

PCB design

- SMASH (CHIR2)
  - Very small for factor
  - Aptina 1Mpix MT9x cmos sensor
  - MIPI interface (sub-LVDS up to 750Mbps)
  - Single micro-HDMI

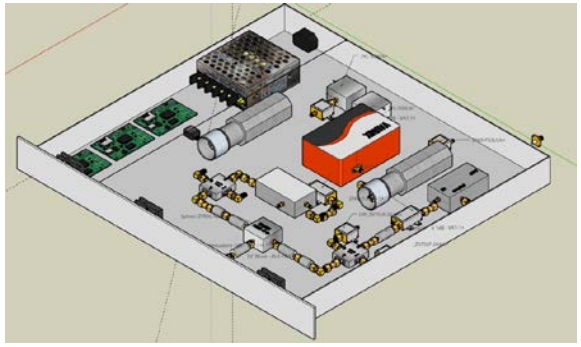


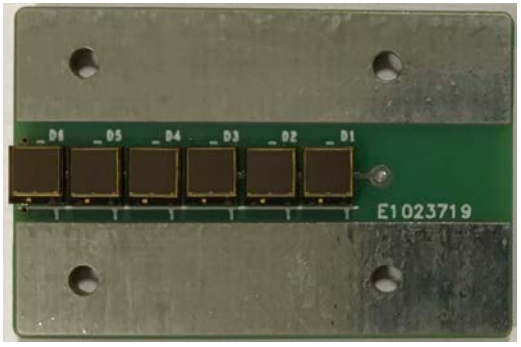
- PADME
  - Fast output SiPM (SENSL)
  - Fast Preamp electronics
  - 4-ch for time-of-flight measurements
  - Front end evaluation board

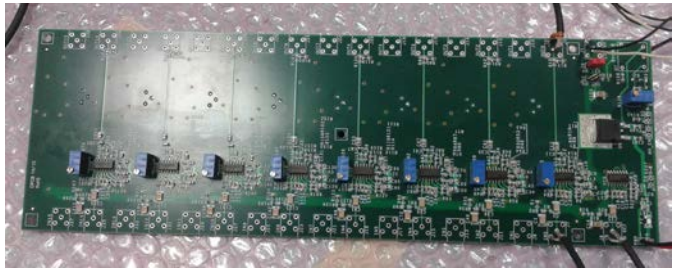
- DaVinci probe (CHIR2)
  - 6-ch SiPM readout
  - Miniaturized form factor
  - Micro coaxial cables
  - Endoscopic applications
  - Mate with WaveBoard

Other activities

- Other electronics R&D topics not related with PCB CAD







- Multitony (Bullkid)
  - two 19" 1U sub-rack
  - 2.4 and 1 GHz
  - 200 MHz bandwidth
  - Ultra-low noise DC-DC modules
  - Ethernet control module
- FOOT
  - 6 SiPM
  - series connection
  - 1 readout channel
  - Mate with WaveBoard
- Acoustic-WTS (MEG)
  - wire tension measurements of MWPC
  - Audio amplifiers
  - Adaptive filtering for 50Hz interference reduction
  - Mate with a NI DAQ (16-ch ADC)

Summary

Topic	Manpower
High-speed digital PCB design	5
SMD/SMT reworking	3
Analogue design (discrete components)	1
Fast PCB prototyping (no BGA, max 2 layers)	2
Firmware development (C++)	1
FPGA development	1
Lab IT	1
Cabling	3
Mechanics for electronics	1

Case study: WAVEBOARD

- Using OrCAD modularity, the project was split in different modules
- Each module has been independently developed from schematic to routing and layout
- In the end, the modules have been merged together in the final board

- PROS:
  - ✓ Object-oriented PCB development
  - ✓ Easy to modify (correct one module, apply to all)
  - ✓ Skills differentiation
  - ✓ Design Reuse (building a common library)
  - ✓ Board generated by script which places modules

- CONS:
  - ✓ Need to conform with special constraints (eg, layers number)
  - ✓ Requires all to use the same tool

Conclusions

- Lesson learned from the "Waveboard experience" we understood the benefits of a common library of modules (schematic + routing):
  - ✓ design reuse and modularity, in particular the design gains:
    - ❖ Flexibility
    - ❖ Reliability
    - ❖ Time to data
  - ✓ Focusing on specific tasks (dc-dc layout, firmware development, etc.)
  - ✓ Know-how increase
  - ✓ Manpower optimization
  - ✓ Team building

We believe that a central repository of libraries, sources and manuals can really contribute to speed up the design of the equipment for experiments

- Of course this do not come for free:
  - ❖ It is required to adhere to a common design standard
  - ❖ Each user has access to projects: protection required
  - ❖ CAD and Software tool may need specific licensing features

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Thank you!

Questions?