INFN
Istituto Nazionale di Fisica Nucleare

LabE

Retreat INFN Roma

16-18 June 2019

LABE overview

- The INFN-Roma LABE supports the experiments with electronics design and prototypes
- Three main services:
  - R&D, CAD and IT:
    - board design (schematics and layout)
  - Electronics workshop:
    - dedicated instrumentation for fast prototyping of 2-layer PCB
    - advanced inspection instruments for assembly and reworking of SMD parts
  - “LABE aperto”:
    - experimental set-up, “free” access
    - benches with reworking stations
    - oscilloscopes
    - generators and power sources
    - thermal chamber

Staff:

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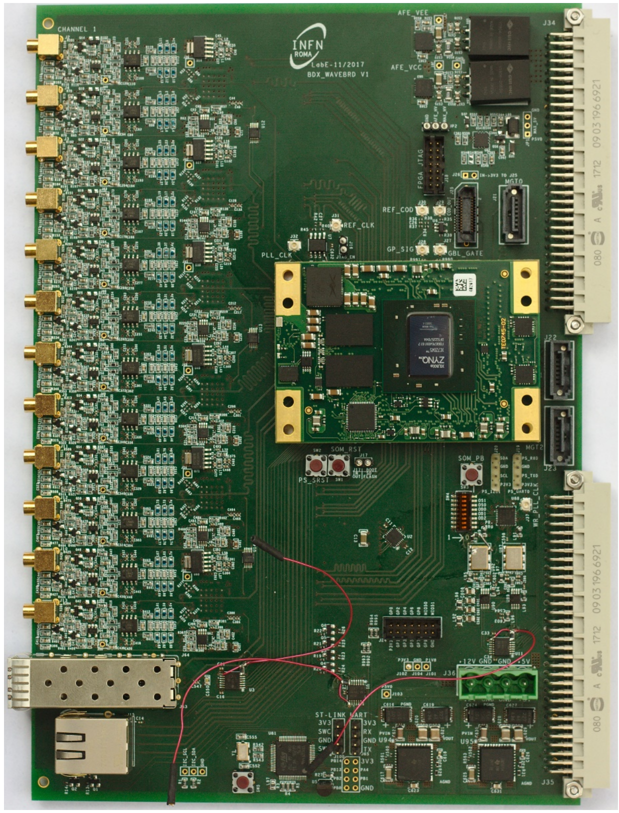

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PCB Milling machine

Digital Stereo Microscope (7x ÷ 120x)

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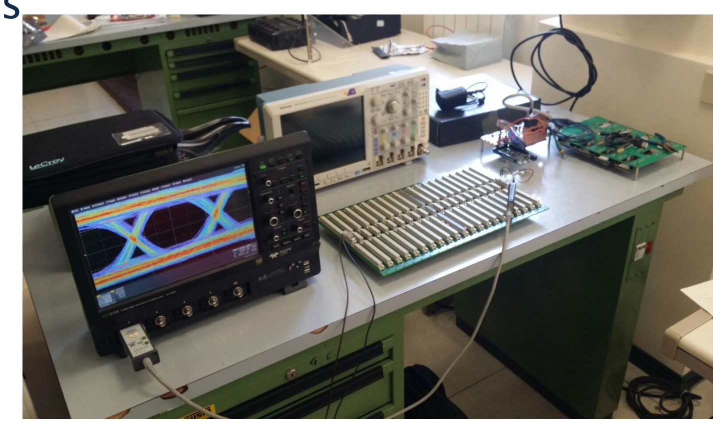
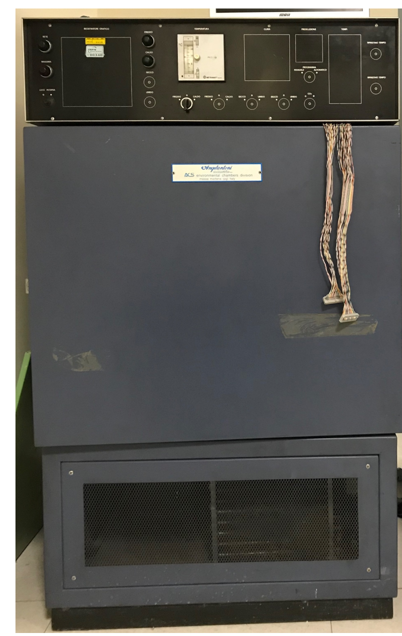




LABE skill summary

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

LABE criticalities

- Cadence license halt:
  - abruptly stop of running projects (3 revisions and 1 brand new)

- At the end, useful push to evaluate new software:
  - Altium (5 licenses from this year)
  - KiCAD (open source CERN project)
  - Mentor Graphics (10 seat license)

LABE future plans

- Future systems require boards based on big and powerful FPGAs:
  - SoC (System On Chip)
  - SoM (System on Module)
- A dedicated person with FPGA skills is mandatory

BACKUP SLIDES

List of Experiments using LabE facility

- CSN 1:
  - Atlas
  - LHCb
  - PADME
  - MEG
- CSN 2:
  - KM3
  - Darkside
- CSN 3:
  - FOOT
  - JLAB12 (BDX, Altro)
- CSN 5:
  - CHIR2

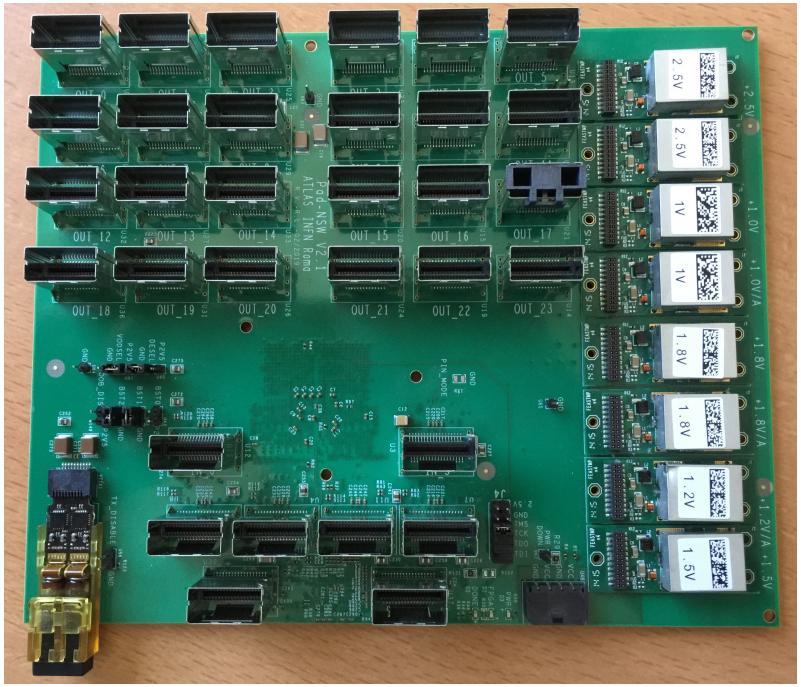
PCB design

- The LHCb muon Front-End electronic control system

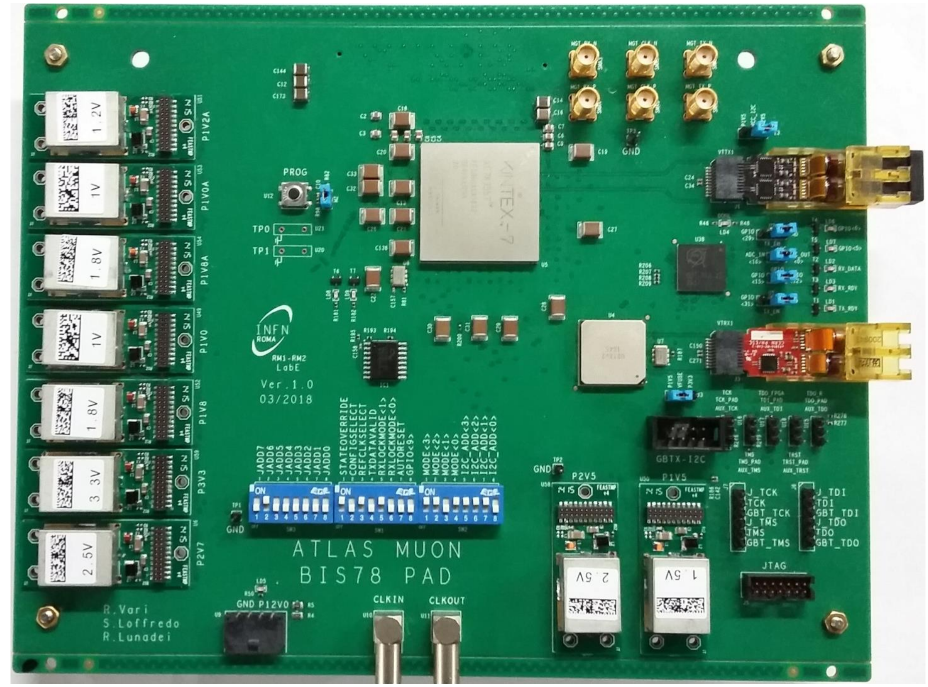
- Board overview
  - 3 multilayer (up to 10) designs
  - matched impedance wires (1-80-4000 Mbps)
  - Standard VME 6U fit
- Components overview
  - Custom CERN RadHard ASIC (GBT family)
  - low density Flash-based FPGA (IGLOO2)
  - Optical transceiver (SFP form factor)

PCB design

ATLAS NSW sTGC Pad trigger



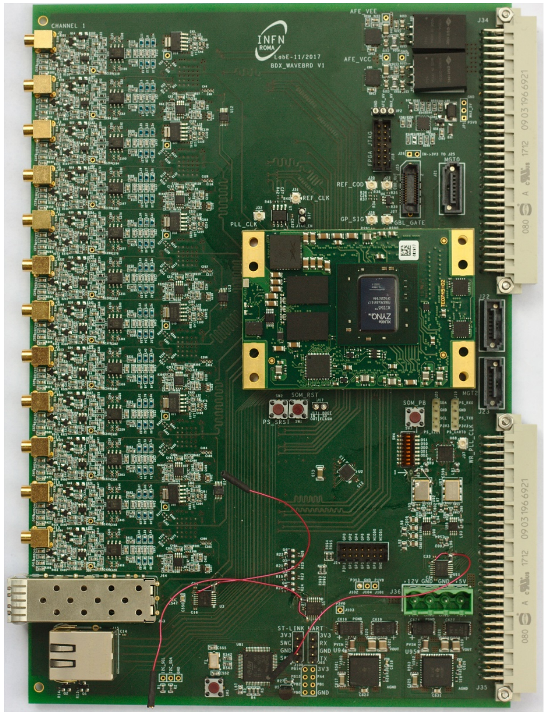
ATLAS RPC BIS78 Pad trigger



- Board overview
  - 1 multilayer (up to 14) designs
  - matched impedance wires (@ 360Mb/s, @6Gb/s)
  - Custom form factor

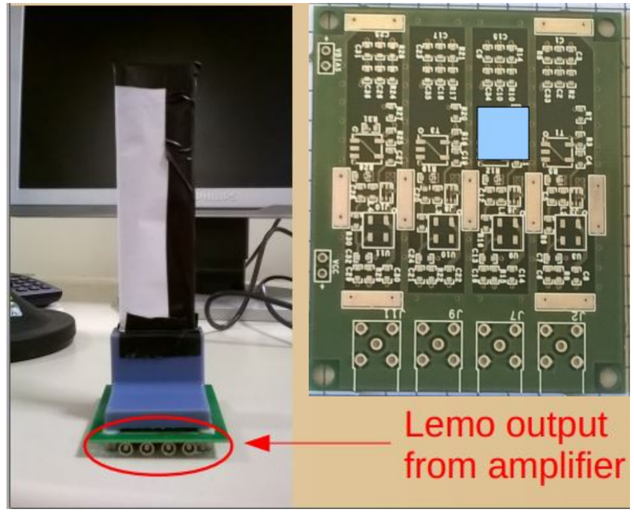
- Components overview
  - Custom CERN RadHard ASIC (GBT family)
  - High density FPGA (Kintex-7)
  - Optical transceiver (SFP form factor)
  - High speed connectors (Molex??)

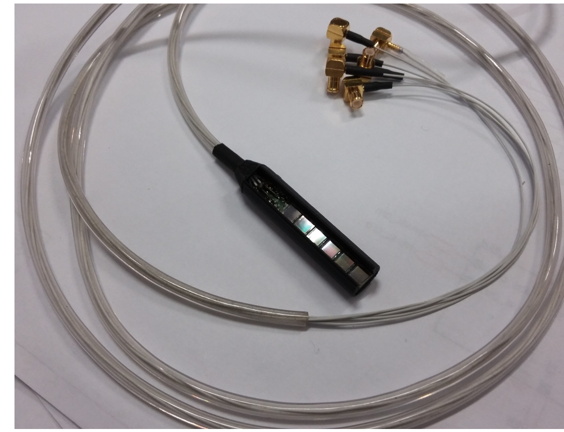
Board design: BDX experiment Front End readout



- 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 transceiver (SFP form factor)

PCB design





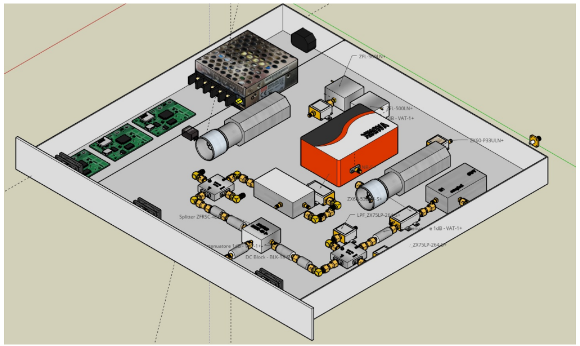
- SMASH (CHIR2)
  - Very small for factor
  - Aptina 1Mpix MT9x cmos sensor
  - MIPI interface (sub-LVDS up to 750Mbps)
  - Single micro-HDMI

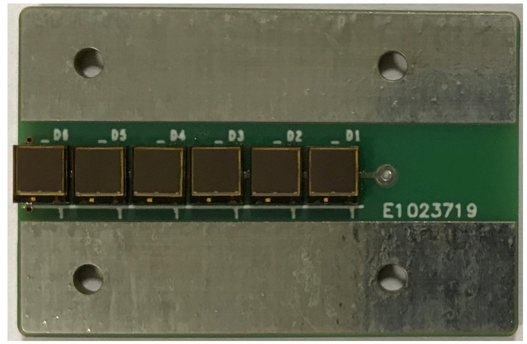
- PADME
  - Fast output SiPM (SENSL)
  - Fast Preamp electronics
  - 4-ch for time-of-flight measurements
  - Front end evaluation board

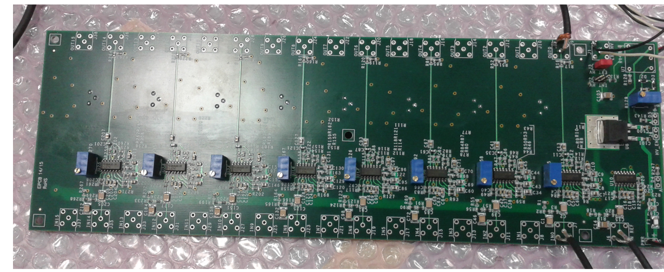
- DaVinci probe (CHIR2)
  - 6-ch SiPM readout
  - Miniaturized form factor
  - Micro coaxial cables
  - Endoscopic applications
  - Mate with WaveBoard

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
- Acoustic-WTS (MEG)
  - wire tension measurements of MWPC
  - Audio amplifiers
  - Adaptive filtering for 50Hz interference reduction
  - Mate with a NI DAQ (16-ch ADC)

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