

MLAB

Research and Training Activities

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The Abdus Salam
International Centre
for Theoretical Physics



Science, Technology and Innovation

Areas of research such as fast and reliable connectivity and development of advanced instrumentation

ICTP Laboratories (MLAB, Marconi Lab, SciFabLab)

Marconi Lab

- Wireless ICT, IoT, TinyML
- Ionospheric Physics and Modelling, Space Weather

SciFabLab

- Open-source digital fabrication (3D printers)
- Science Dissemination

Multidisciplinary Laboratory (MLAB)

Research and Development of Advanced Scientific Instrumentation and Methods

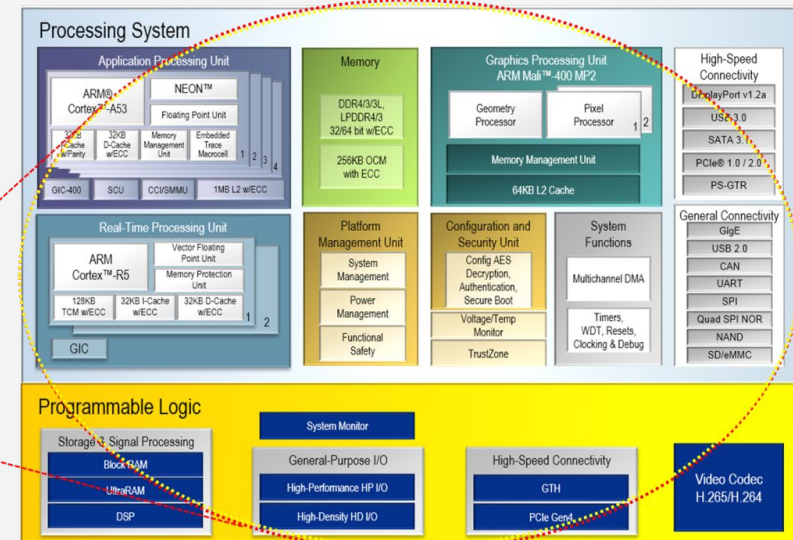
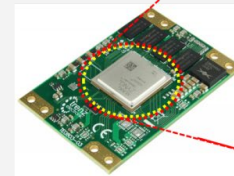
- Particle Physics Experiments
- Nuclear Applications
- Multidisciplinary Experimental Projects
- X-Ray Imaging for Cultural Heritage
- Applied Optics and Lasers



Multidisciplinary Laboratory (MLAB)

Affordable Technology for Advanced Instrumentation

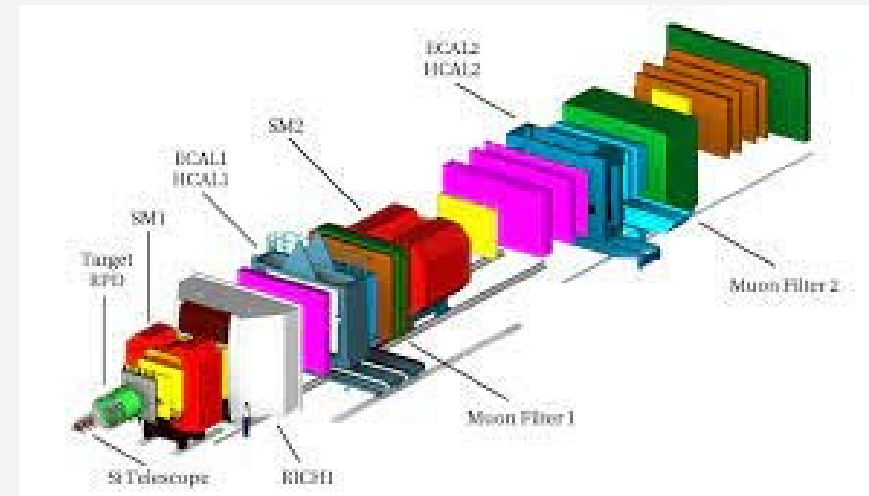
- FPGA: intrinsic parallelism, hardware re-configurability, low-latency, high-throughput and low power.
- FPGA based Systems-on-Chip (SoC)
 - Hardware's high performance of FPGAs
 - Software's flexibility of multi-core processors



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Particle Physics Instrumentation

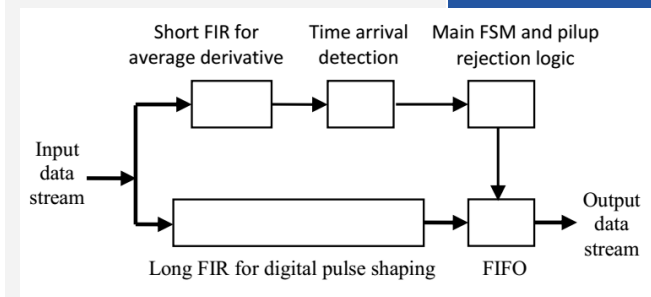
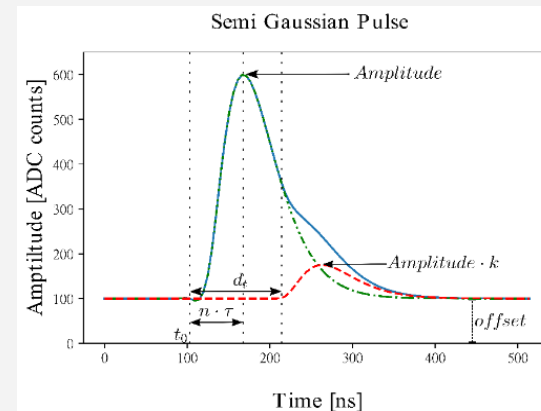
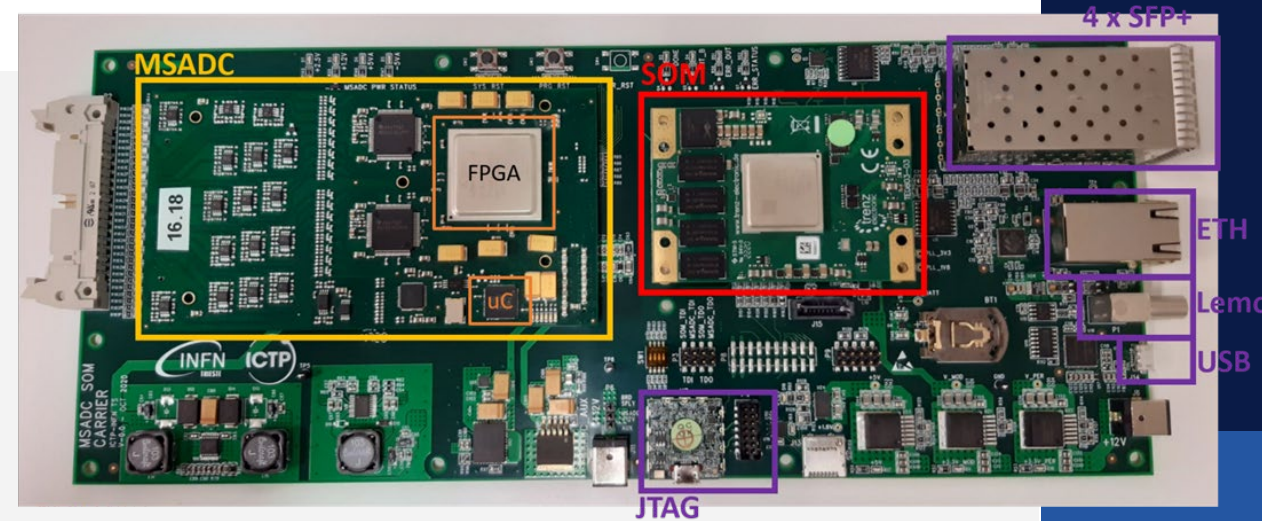
- Large number of multichannel detectors ($>10^4$ chn)
- Huge amount of data per unit of time (\sim TB/sec)
- Data need to be acquired in real-time by complex acquisition systems (DAQ)
- Online data processing methods to extract useful information contained in the acquired data
- Reduce data rate and save computational and storage resources for further offline analysis



Multidisciplinary Laboratory (MLAB)

AMBER Experiment at CERN

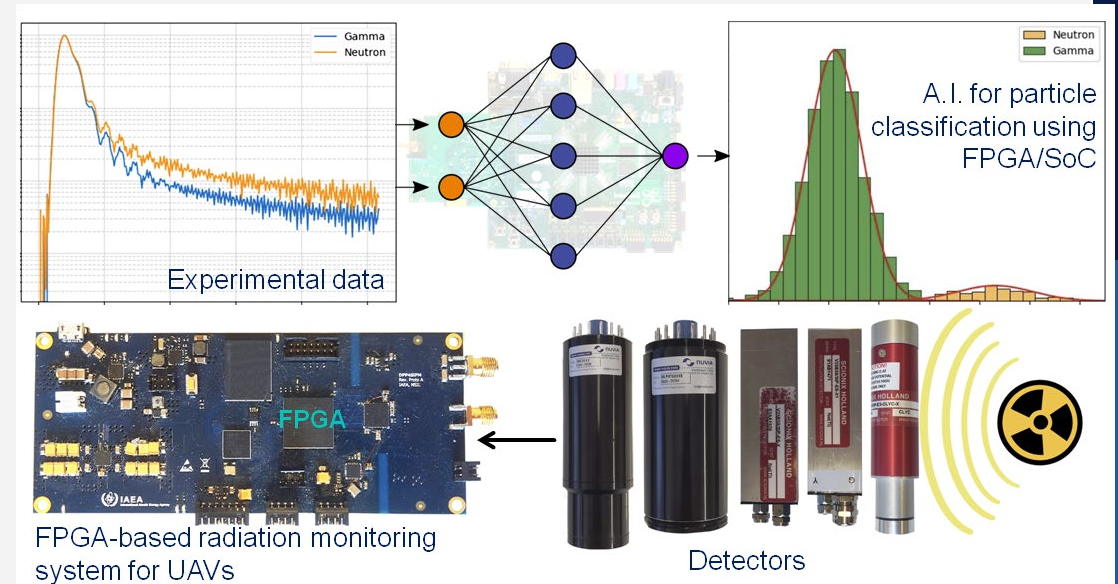
- AMBER is a particle physics experiment at the CERN SPS starting its data-taking in 2023
 - Fundamental properties of the proton and its relatives
- DAQ system for the 3000-chn ECAL2 detector
- Digital Pulse Processing for online feature extraction
 - Pulse detection and Arrival time
 - Precise amplitude measurement (proportional to the energy of the particle)
- Reduction of the data rate and the amount of data to be stored for offline analysis



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Nuclear Instrumentation with IAEA

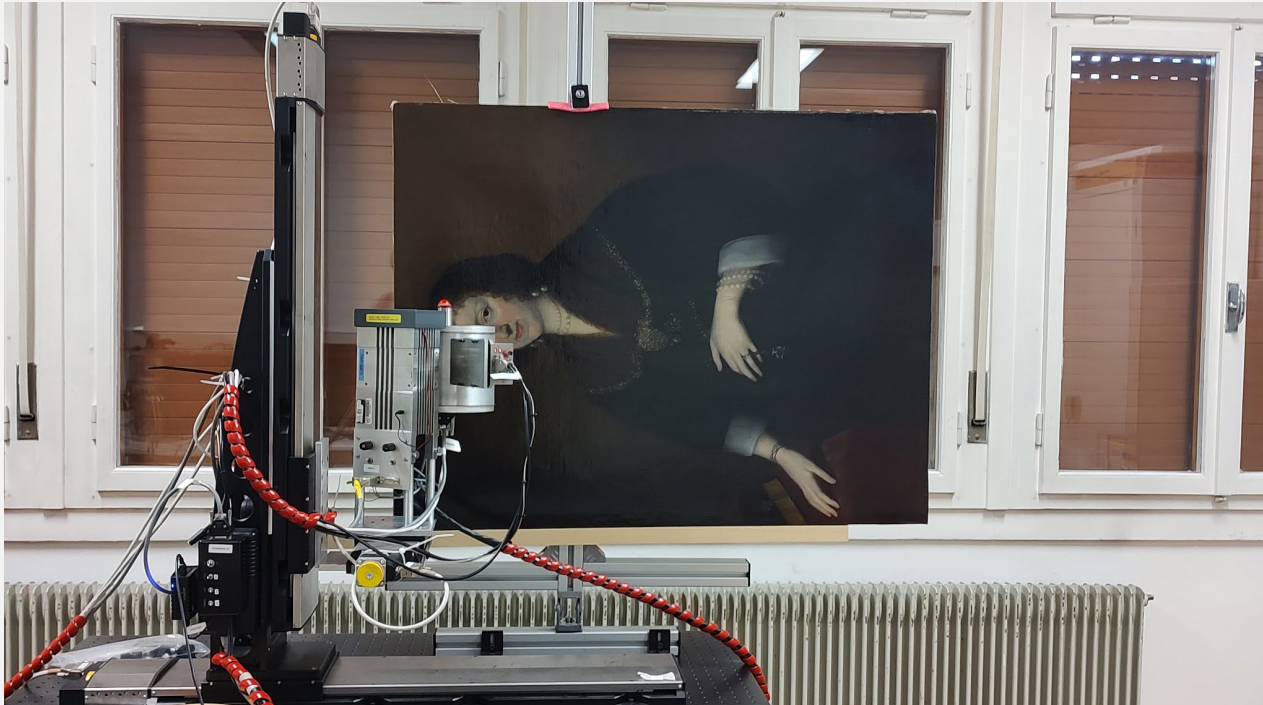
- Radiation Monitor and Spectrometer
 - SiPM detectors and FPGAs
 - UAV system integration
- Real-time Classification of ionizing radiation (Gamma - Neutron)
 - Pulse Shape Discrimination methods
 - ML and compression techniques



Multidisciplinary Laboratory (MLAB)

XRF Scanner for Cultural Heritage with IAEA

Elemental Composition Analysis of Ancient Paintings



Ti-Ca



Fe



Pb



XRF System

Preliminary Scans

Elemental Composition Analysis & Reconstruction
Painting Size: 220x170 mm



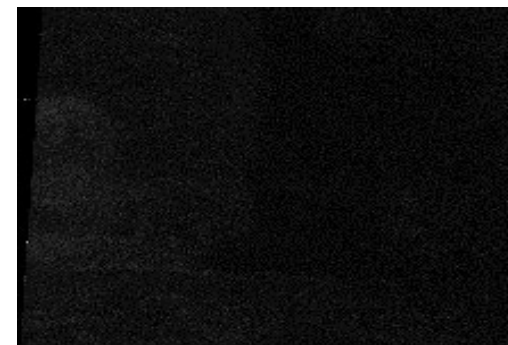
Ca



Fe



Ti



Cu

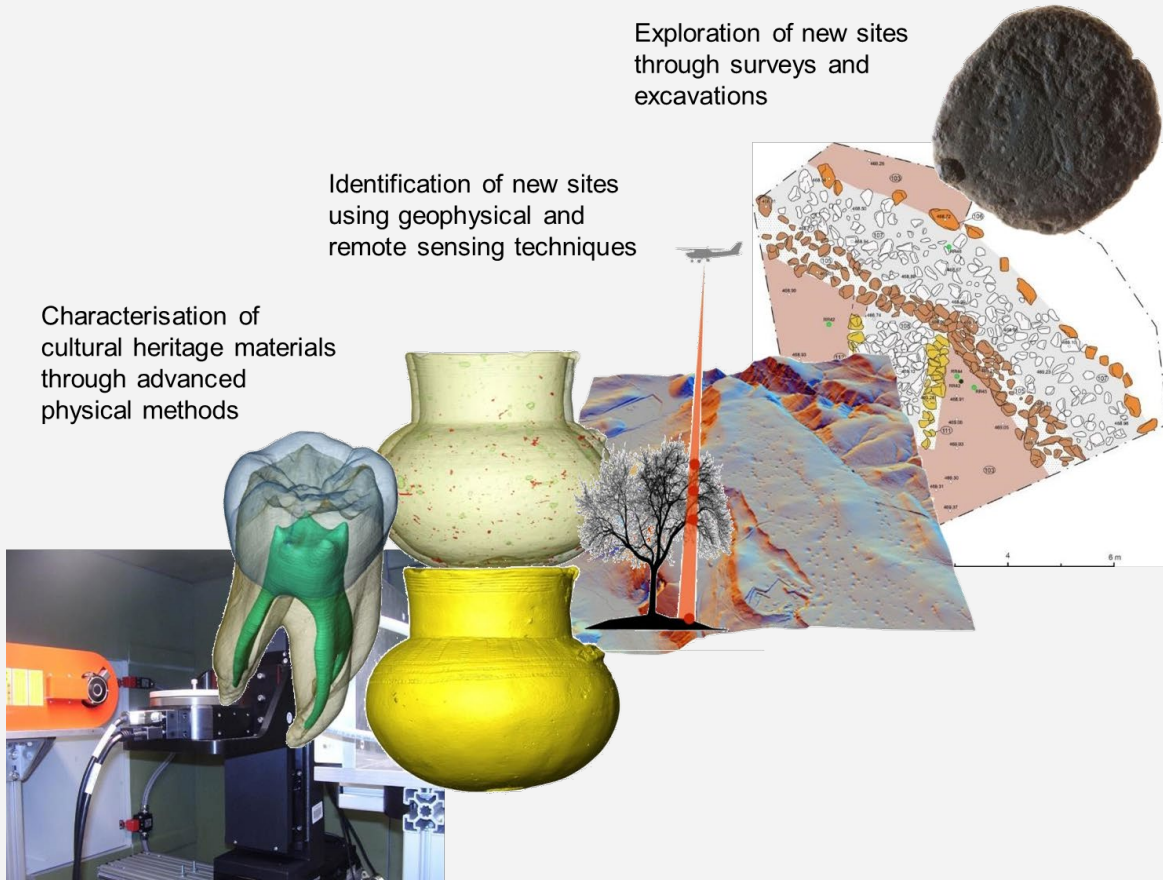
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X-Ray Imaging and Applied Science for Cultural Heritage

Exploration of new sites through surveys and excavations

Identification of new sites using geophysical and remote sensing techniques

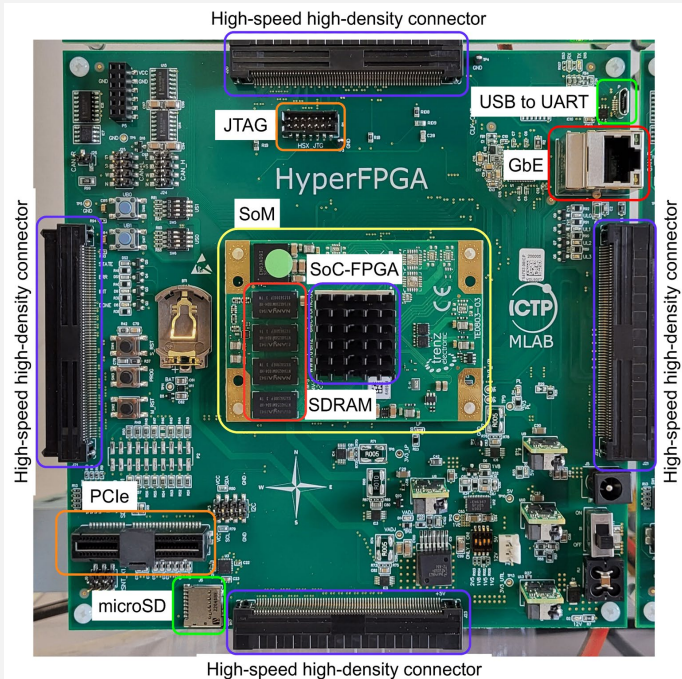
Characterisation of cultural heritage materials through advanced physical methods



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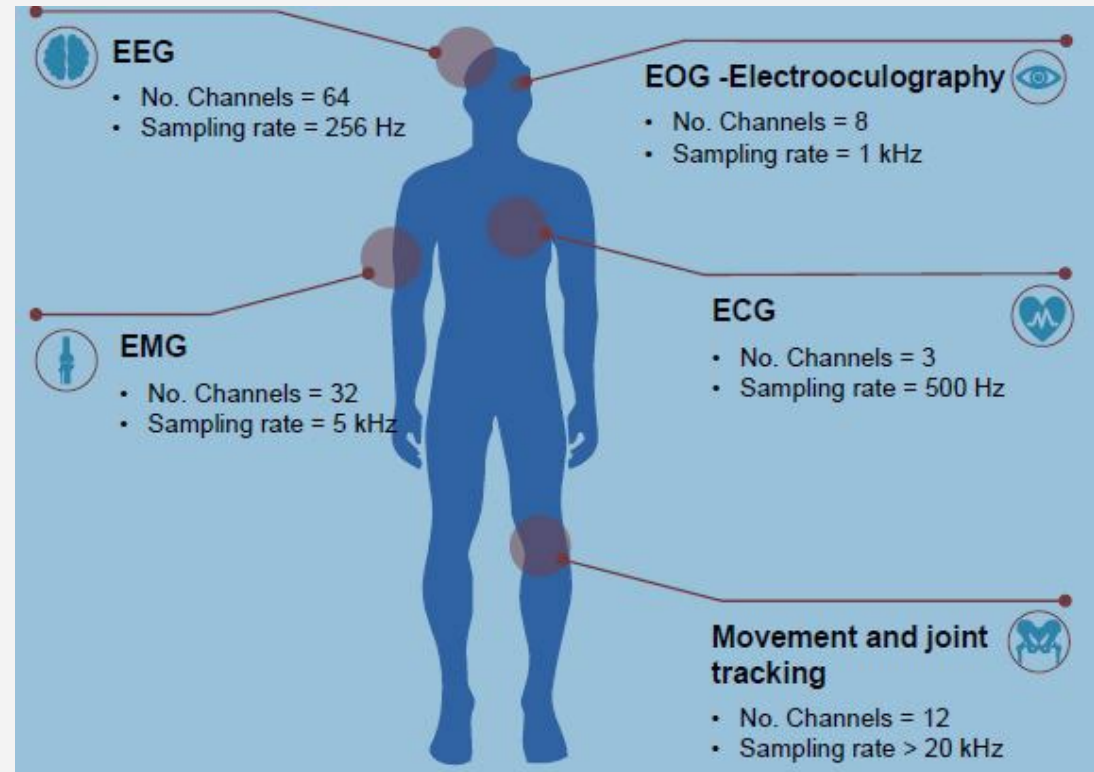
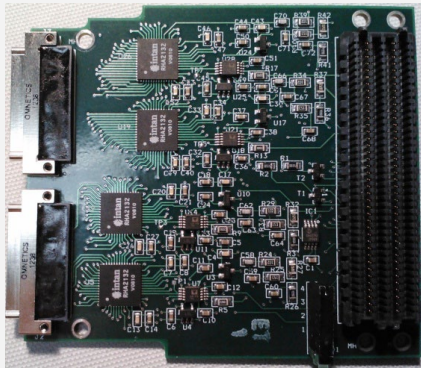
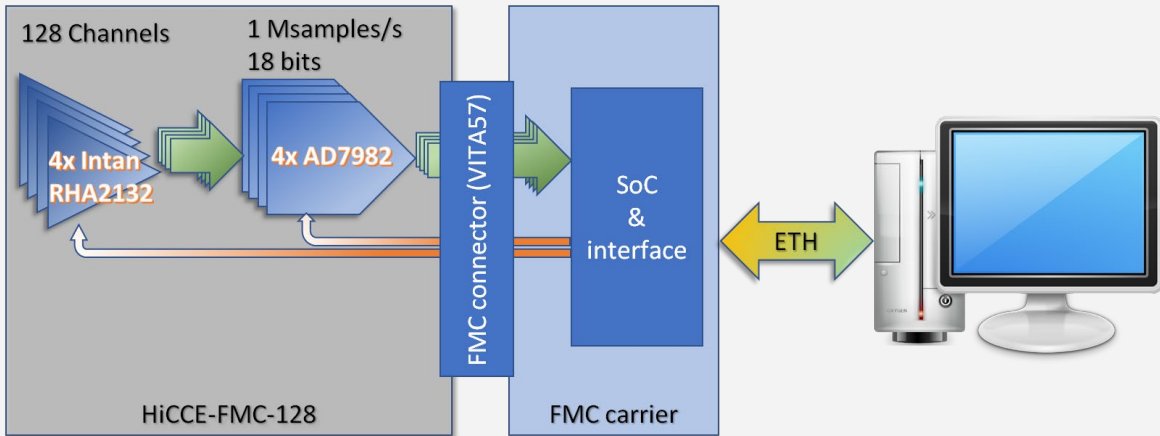
HyperFPGA: Cluster of SoC-FPGA for Reconfigurable Supercomputing

- Fully in-house developed
- Modular design for user customization
- Open software, open hardware



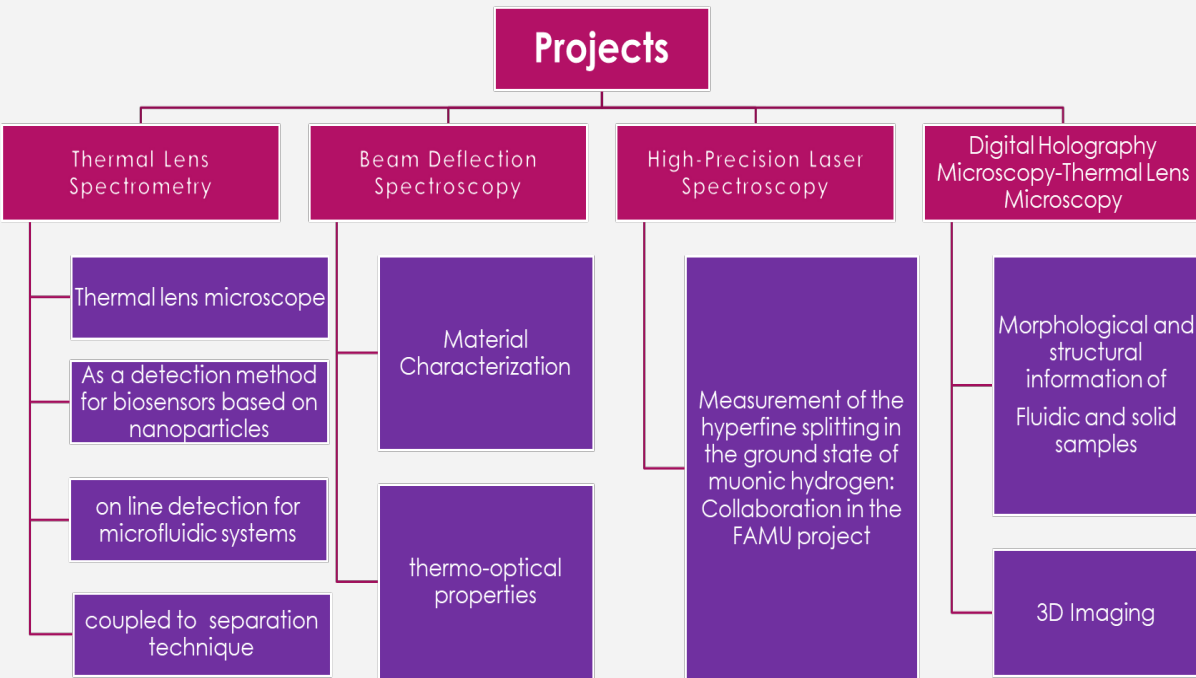
Multidisciplinary Laboratory (MLAB)

HiCCE: 128-channel Acquisition System for Electrophysiology



Multidisciplinary Laboratory (MLAB)

Optics and Lasers



Multidisciplinary Laboratory (MLAB) Training

- PhD students (Joint students with UniTS and STEP fellows)
- TRIL and postdoctoral fellows, associates and other visitors
- Organized several:
 - Schools and Workshops on FPGA and SoC for Scientific Instrumentation, held at ICTP
 - Conferences and Workshops in many countries: Argentina, Bangladesh, Brazil, Colombia, Costa Rica, Cuba, India, Malaysia, Mexico, Pakistan, Peru, Qatar.





Thank you!

