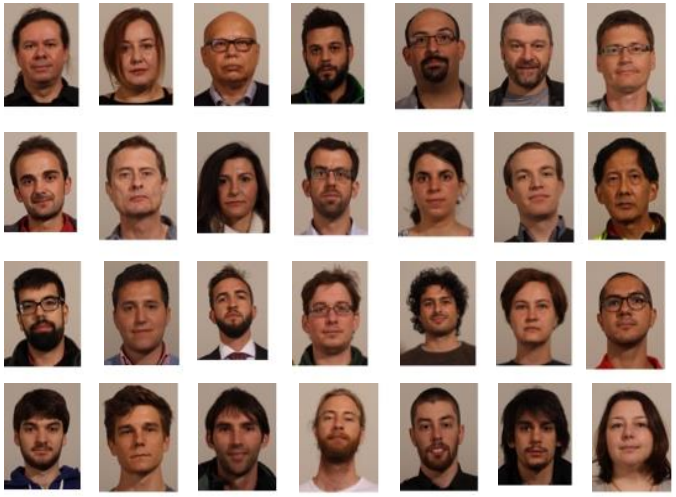
EP-DT-DD

EP-DT-DD section activities

- **Detector development, R&D and support for**
  - Silicon detectors and gas detectors
  - Strong involvement in experiments: ALICE, ATLAS, CMS, LHCb, NA62
  - Leading roles in R&D collaborations (RD50, RD51)
- **Unique service for large and varied community:**
  - Irradiation facilities (IRRAD, GIF++)
  - BONDlab
  - QARTlab
  - DSF cleanroom
  - Microfabrication

EP-DT-DD members

Staff:
Richard Fortin (ret. 1/2017)
Alan Honma (ret. 7/2018)
Martin Jaekel (LD)
Alessandro Mapelli (LD)
Florentina Manolescu
Ian McGill
Michael Moll
Eraldo Oliveri (LD)
Giuseppe Pezzulo (LD)
Federico Ravotti
Petra Riedler
Leszek Ropelewski



Ext. funded (experiments, EU, project):
Fellows (7) doctoral and technical students (7+1), PJAS (2), trainees (1)

Openings in 2018:
Replacement A.Honma (board May 28, 2018)
Replacement R. Fortin (R. Costanzi from 1/9)

Leading roles in many activities:
EP RSO: Federico
EP rep. in IMPACT steering com. and TIOC: Martin
Spokespersons: Michael (RD50), Leszek (RD51)
EP R&D work package conveners: Eraldo (gas detectors), Petra (silicon detectors)

Work package conveners in AIDA2020, RD51, ALICE, CMS, ….

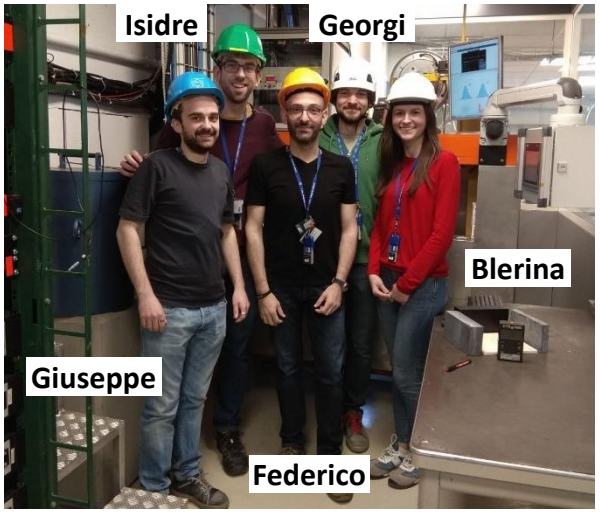
EP-DT-DD section

Projects and Services:

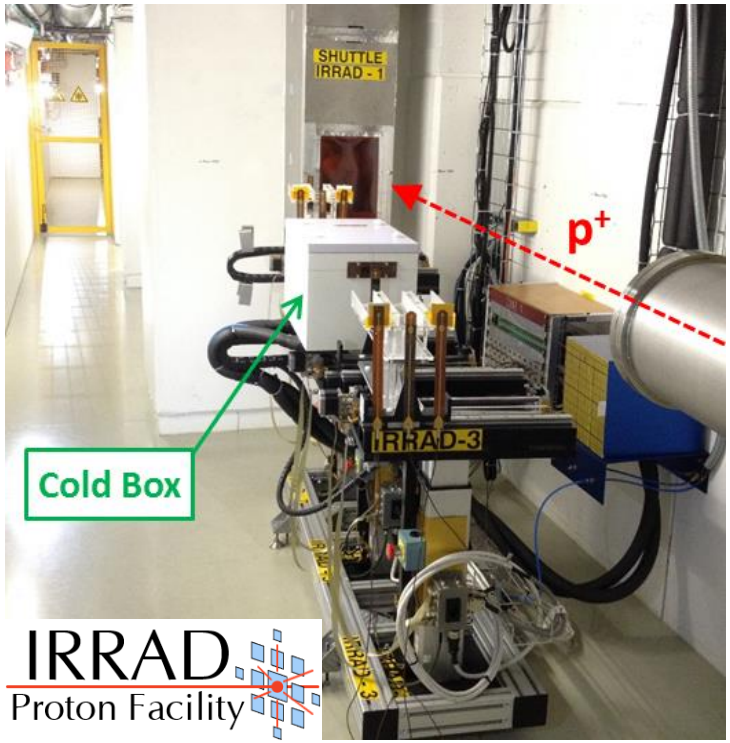
- Irradiation facilities (IRRAD, GIF++)/Radmon/FCC
- Bondlab
- QART lab
- DSF
- Microfabrication
- Pixel R&D
- SDD/RD50 → presentation by Marcos
- GDD/RD51 → presentation by Leszek

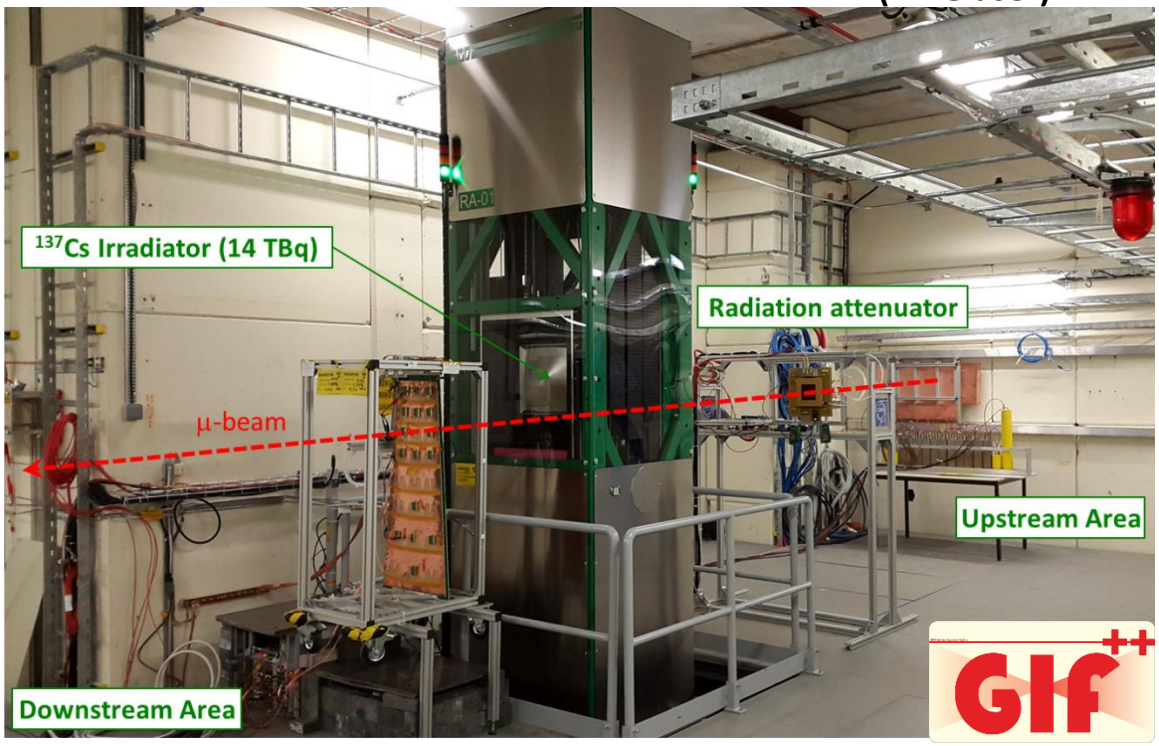
EP-DT-DD Irradiation Facilities Team

- Operates, maintains & upgrades:
  - Proton Irradiation Facility (IRRAD) @ PS-EA
  - Gamma Irradiation Facility (GIF^{++}) @ SPS-NA
- Provide users coordination & safety (EXSO)
- Support users in planning/executing irradiations
- Organize irradiations in facilities outside CERN
- R&D on radiation monitoring & dosimetry for HEP
- Involved in AIDA-2020 project & FCC Study Group



- 2.5 STAFF
- 1 FELL (50%)
- 2 DOCT
- 1 Hon. Member (M. Glaser)

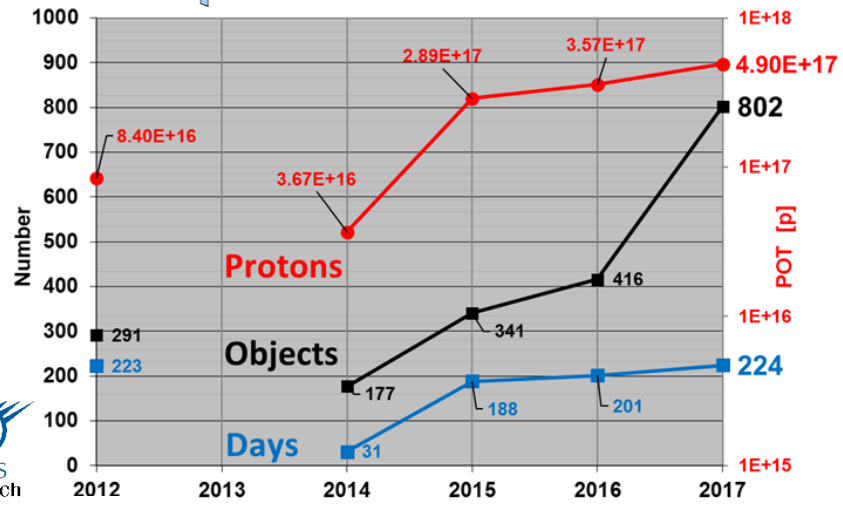




Irradiation Facilities Operation & Upgrade

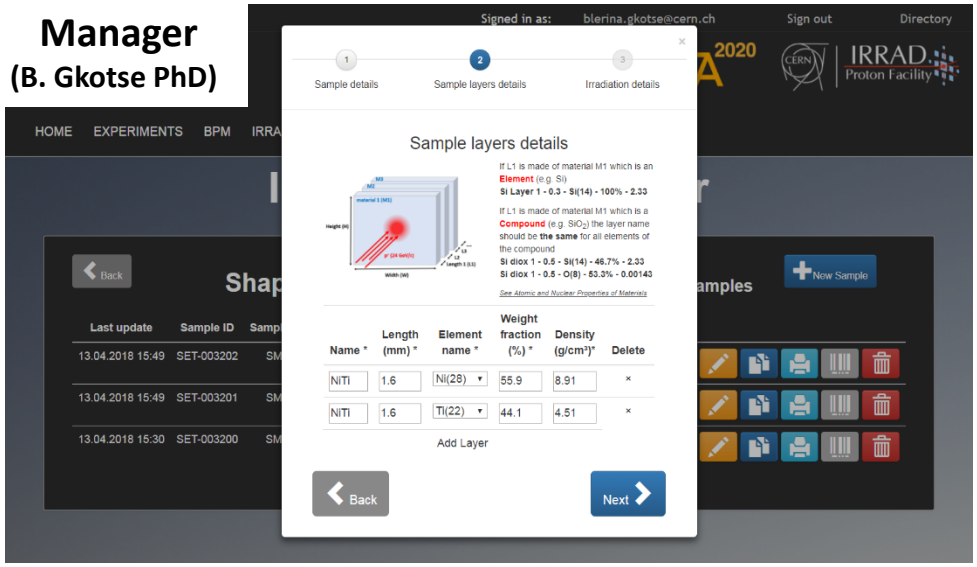
IRRAD Proton Facility

- **46 experiments** in 2017



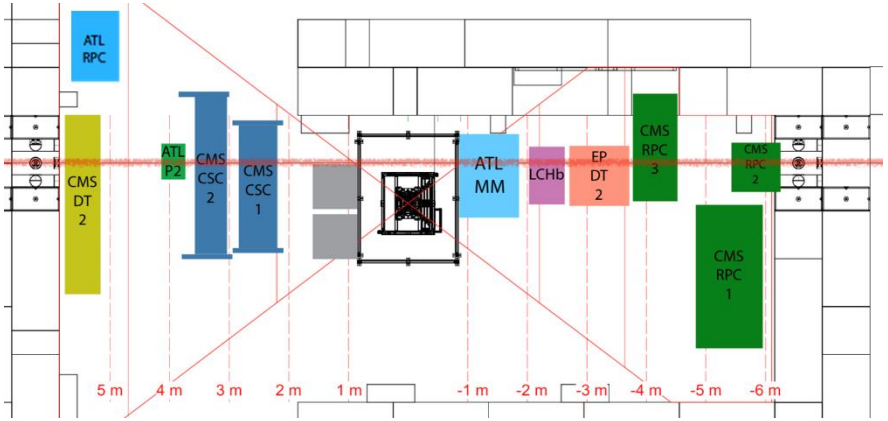
MINES ParisTech

IRRAD Data Manager
(B. Gkotse PhD)



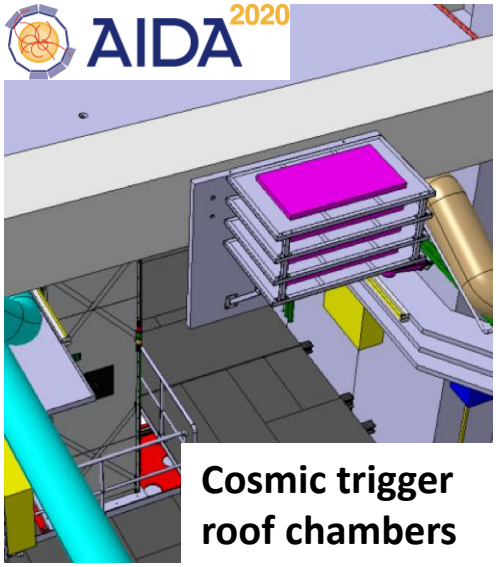
GIF++

- **26 setups** (μ-beam or long irradiation experiments) in 2017



Material door

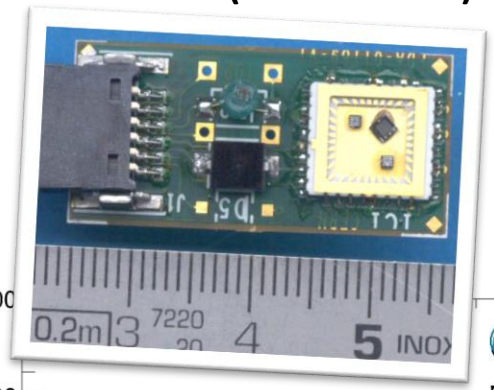
AIDA 2020



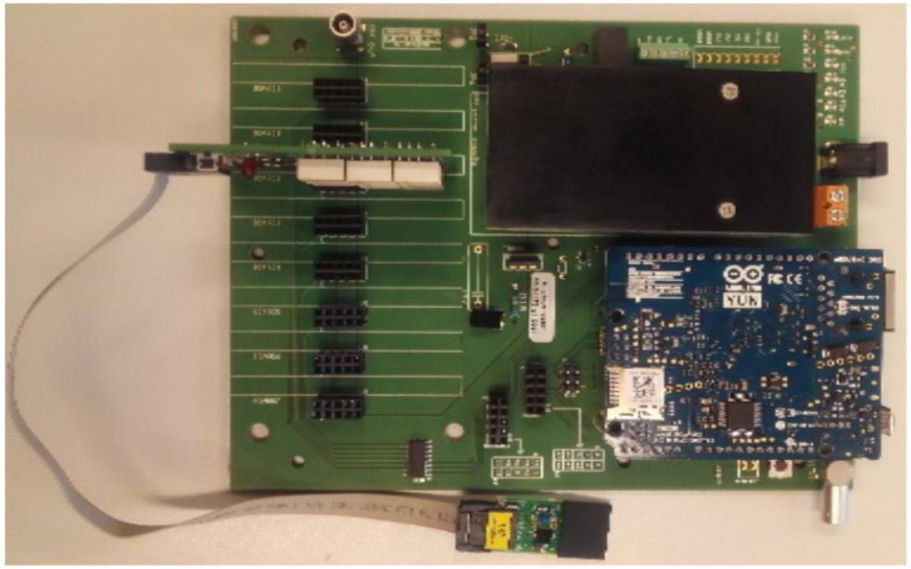
Cosmic trigger roof chambers

RADMON & ReadMON

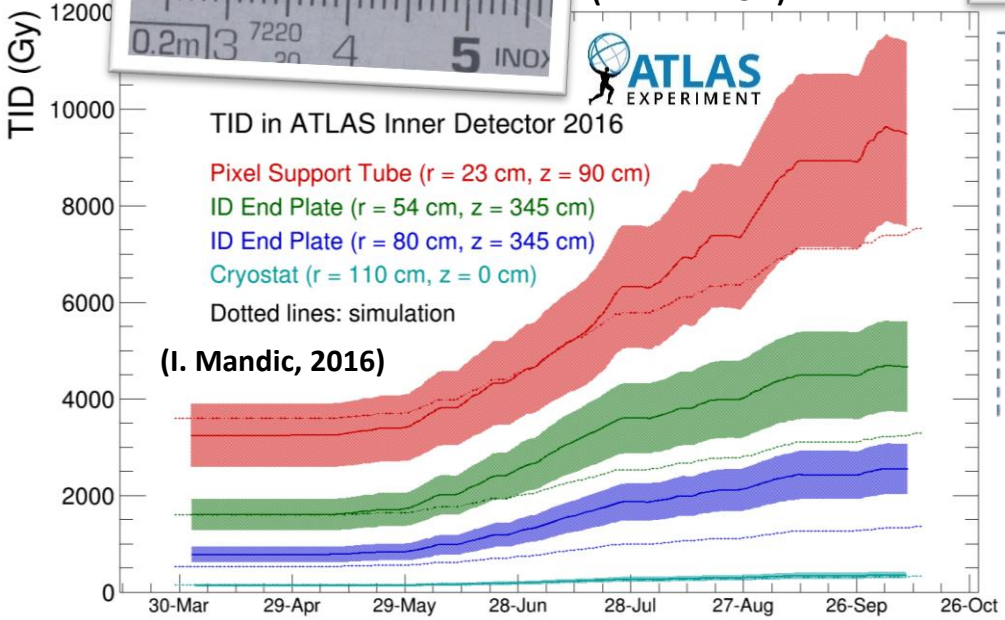
- Integrated radiation monitoring device for LHC experiments (PH-RADMON)
  - ~300 units used today at CERN and outside
- Development of a compact, portable & low-cost readout unit ("ReadMON")



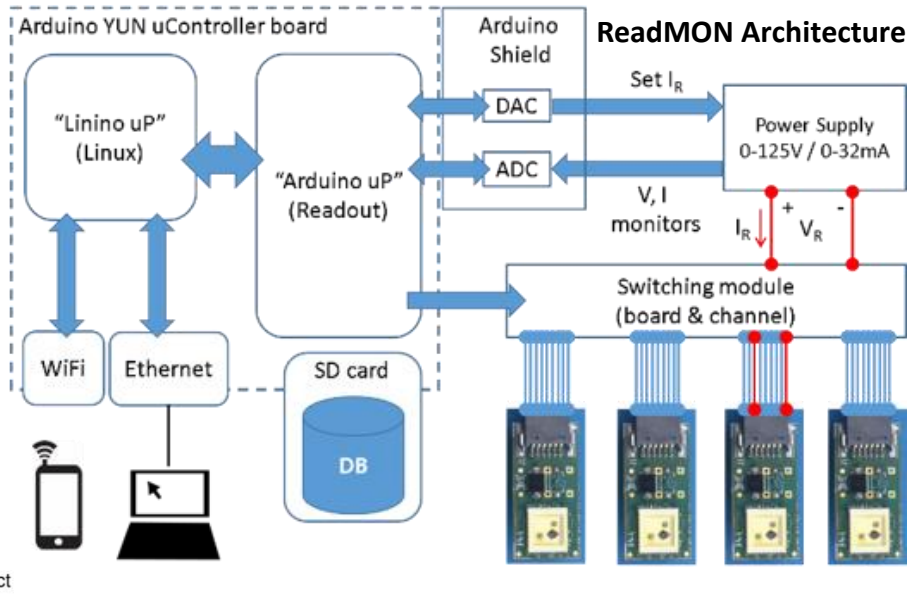
Integrated radiation monitoring device (PH-RADMON)



ReadMON Prototype (I. Mateu)

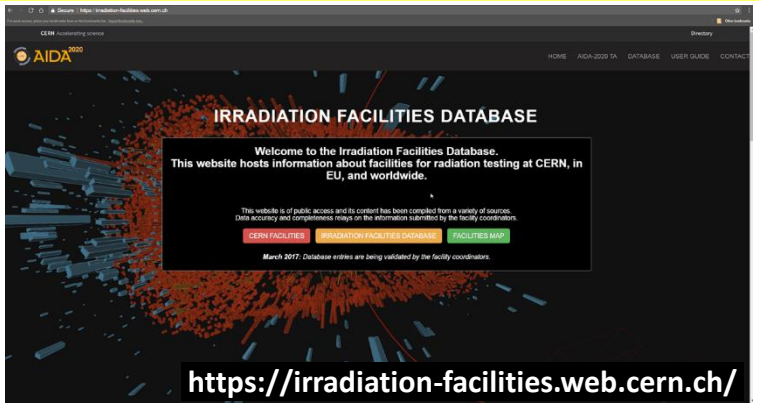


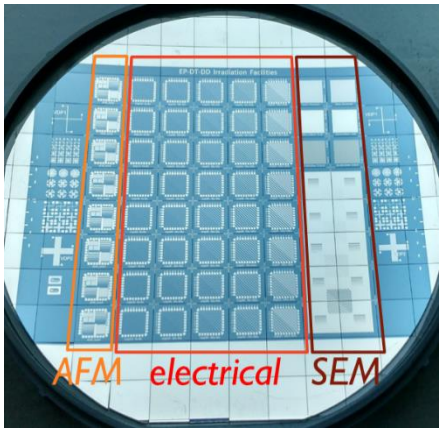
(I. Mandic, 2016)



FCC Study Group

- Special Technologies WP 11: "Radiation Hardness Assurance of Electronics" (EP-ESE, EN-STI, EN-EA)
- Task 2: FCC radiation qualification requirements
  - evaluation of radiation facilities
- Task 5: new technologies for ultra-high level dosimetry (10-100 MGy)
  - novel solution based on metal thin film technology: Radiation Dependent Resistor (RDR)
  - Extend to HEP a novel technology of nano-sized Vacuum Transistors (readout electronics)

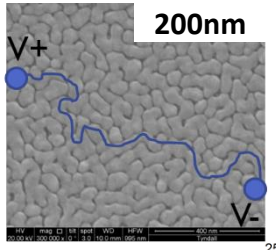




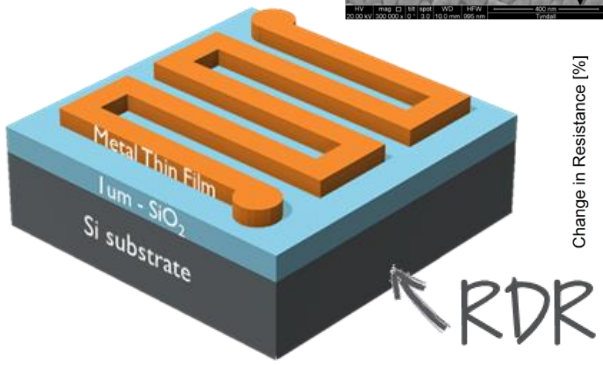
CMi EPFL Center of MicroNanoTechnology — ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
✓ Design and Microfabrication

CERN EP DT Irradiation Facilities
✓ Irradiation and Characterization

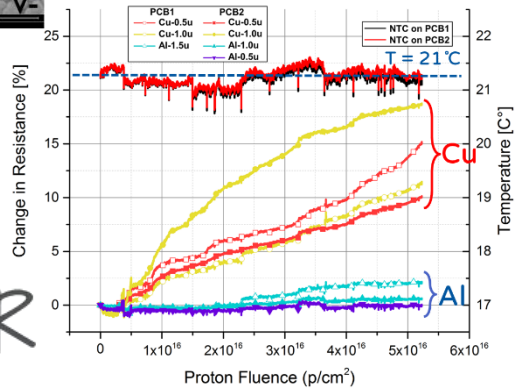
Dosimetry Nanostructures

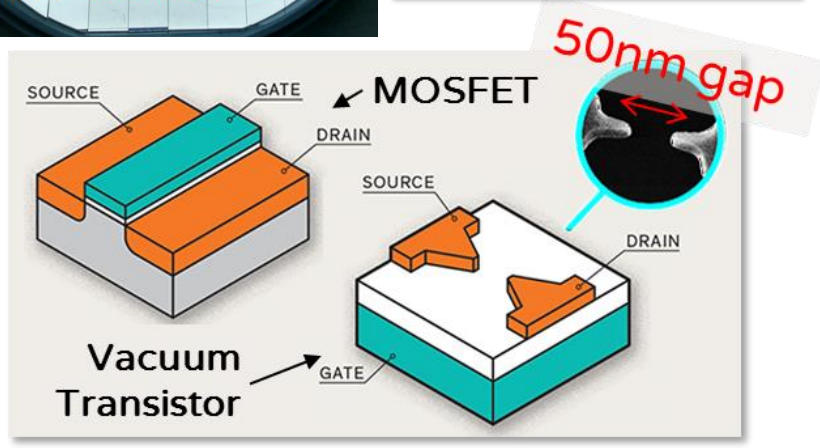


5nm÷1μm (3x3mm die)



Proton Irradiation Results





Bond Lab

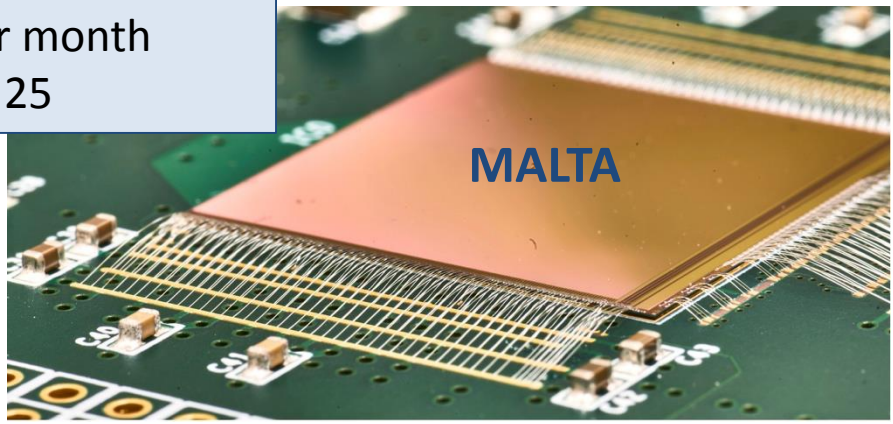
Team: Alan, Ian (50%),Florentina

Providing service to all experiments and the community (selection 2018):

- CMS upgrade, HCAL, GEM
- ATLAS STREAM, ITK
- ALICE ITS, MFT, OB
- NA62 GTK
- RADMON
- EP-ESE: prototypes
- Medipix,TMPX,CLICpix
- Prototypes and R&D test structures, e.g. RD50, RD51,RD53

Bond Lab 2017 (until June):

- Number of pieces: ~450 with about 100 pieces per month
- Number of projects: 25



Significant support for Alice production: IB bonding, OB QC, support for outside institutes with same machines

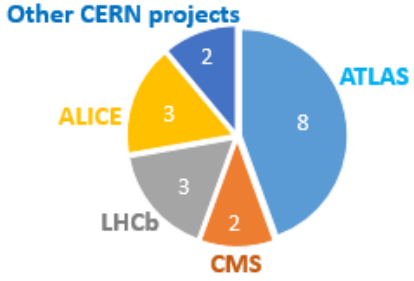
Extend communication on fine pitch wire bonding: Share information about issues, solutions and bond system optimization within the CERN community and external institutes in the common effort of facing the new challenges within HEP such as decreasing pitch and higher density interconnectivity.

Quality Assurance and Reliability Testing Laboratory

- **Guidance and support regarding QA (quality assurance) planning:**
  - methods & processes, risk analysis, standards, specifications, quality control
  - technology development and design feed-back
- **Consulting regarding reliability testing :**
  - ageing tests, failure analysis, evaluation & qualification of component or assemblies

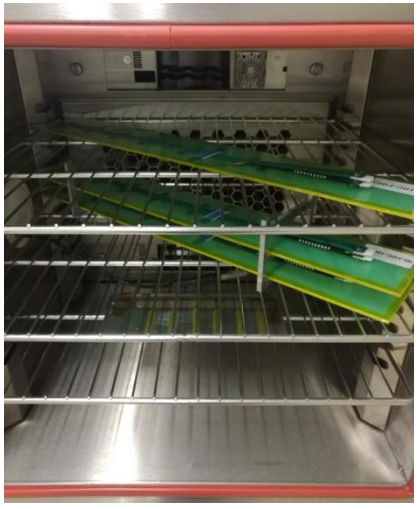
Main equipment for reliability testing at our lab : 2 climatic chambers (-70C to +180C), one electromagnet, one vibration system, IR camera, high magnification stereomicroscopes…

QART Climatic Chambers Work Requests, 1st Semester 2018
(total : 18 work requests) – **can last several weeks depending on the scenario!**



Other QART Work Requests, S1 2018 :
- Vibration work request : 1 (HSE-RP)
- Electromagnet work request : 1 (ALICE)

Optical Fiber Sensors for CMS Gem

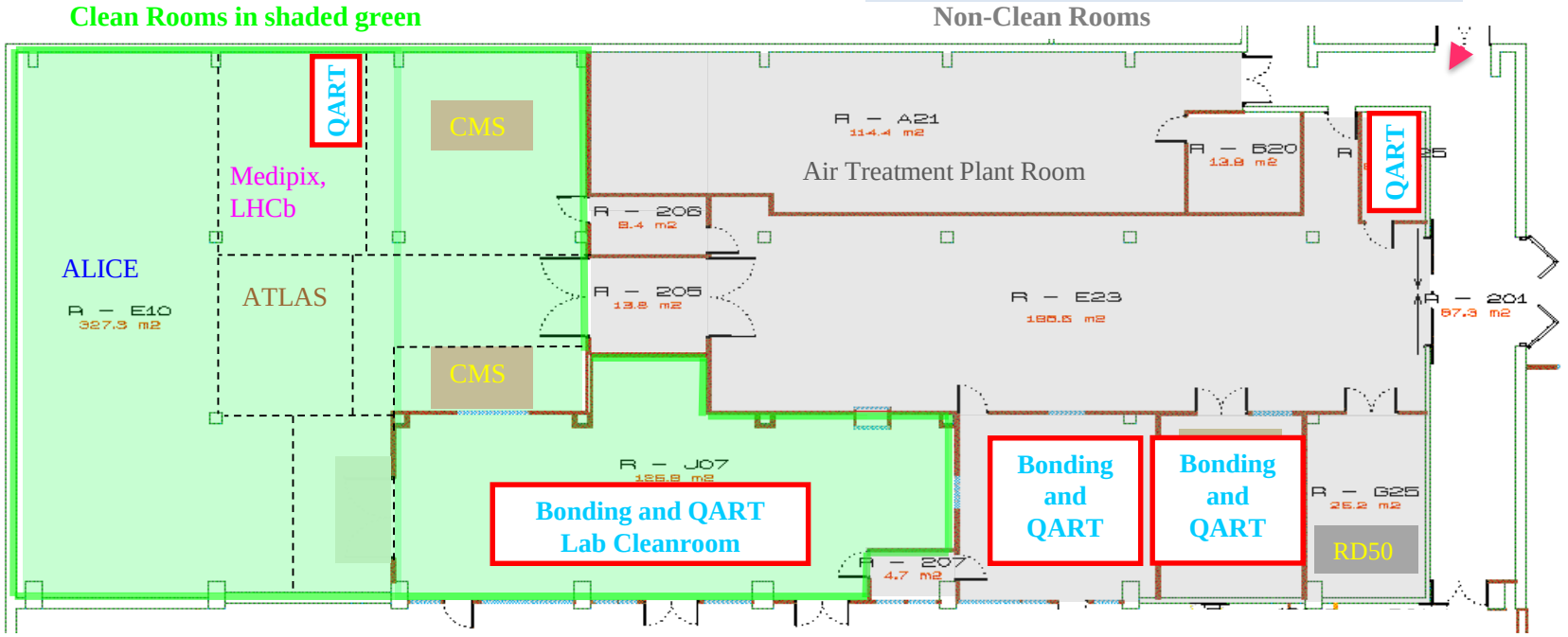


IB and OB Hybrids for ALICE ITS

Departmental Silicon Facility (Bat. 186)

- Built in 2002 for the LHC silicon detector development and construction (~800 m^2) with cleanroom space for experiments close to the bond lab.
- DSF cleanroom:
  - Shared clean room: 330m^2
  - Bond/QART lab clean room: 130m^2

Extended gas supply system: will require revision and updating!



Users in 2018: ALICE ITS, ALICE MFT, LHCb upgrades (chip R&D), Medipix, ATLAS ITK (pixel), CMS phase 2 tracker upgrade, CMS silicon forward ECAL phase 2 upgrade, LCD silicon calorimeter R&D

Microfabrication

- **Technical and administrative support to users across CERN** for microfabrication activities in external silicon-processing facilities.
- **EPFL cleanroom activities and R&D on new particle detector concepts**
  - Microchannels embedded in monolithic CMOS pixel detectors (MALTA chip)
  - Interface characterization of monolithic silicon detectors
  - Thermal management solutions for HEP and space missions
  - Radiation monitoring technologies for FCC
  - Post-processing of silicon dies
  - Thermal mapping of superconducting cavities
  - Silicon microchannel cooling frames for stave configurations
  - Additive manufacturing for future detector configurations

BRONUZZI Jacopo DOCT	01.09.2015 - 31.08.2018
CALLEGARI Riccardo TRAINEE	01.02.2018 - 31.07.2018
FREI Timothée DOCT	01.10.2017 - 30.09.2021
MAPELLI Alessandro STAFF	01.07.2013 - 30.06.2021

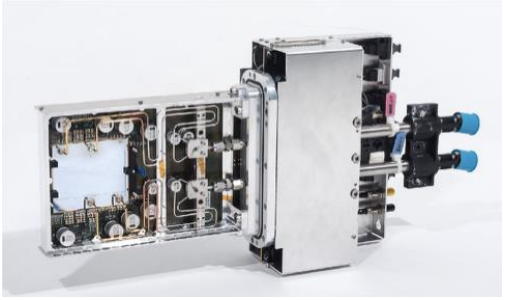
EP-DT is supervising the activities of CERN personnel (from EP, BE, TE) in the silicon processing facilities and metrology of the **EPFL cleanrooms → unique service offered to the community!**

CMi EPFL Center of MicroNanoTechnology
EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
✓ *Design and Microfabrication*

Microfabrication

Support to LHC and non-LHC experiments for microfabrication technologies, microsystems engineering and module assembly with essential contributions to:

- **NA62 GTK production and installation**
  - 6 GTK detectors assembled and delivered in 2017 (WP EDMS 1738693).
  - 9 GTK detectors are being assembled and delivered by end 2019 (WP in preparation).
  - Installation, removal and technical support for GTK detectors in the experiment.
- **LHCb Velo Upgrade (LS2)**
  - Technical follow-up of cooling plates production.
  - QA/QC of cooling plates during manufacturing and after delivery at CERN.
  - Fabrication of thermo-mechanical prototypes, pad chips and sensors at EPFL.
  - Metrology of the cooling plates and fluidic connectors (Keyence).
  - Soldering optimization of metallic connectors to silicon cooling plates.
- **ATLAS ITk Demonstrator (LS3)**
  - Participation in the assembly of electrical modules.
  - Definition of an in-house microfabrication process for silicon thermo-mechanical prototypes with integrated resistive temperature detectors.

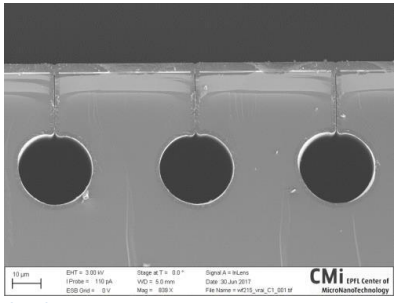


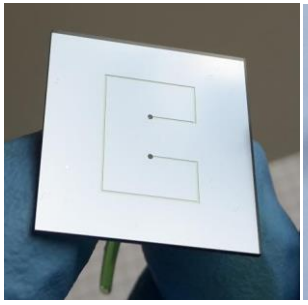
MICRO-NANOSYSTÈMES

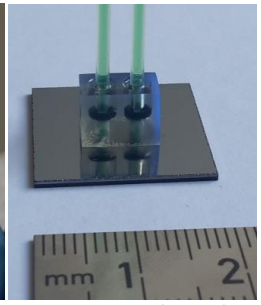
Premiers micro-refroidisseurs en silicium au monde

Ce sont les premiers micro-refroidisseurs en silicium au monde que le CEA-Leti livre au Cern pour son expérience NA62 dédiée à vérifier certaines prédictions du modèle standard de l'Univers. Ils forment un réseau de microcanaux de quelques dizaines de microns de profondeur, dans lesquels circule un fluide qui maintient le système à sa température de fonctionnement. Parfaitement étanches, notamment par une soudure à base de métallisation titane/nickel/or, ces microcanaux sont obtenus par gravure plasma dans des plaques de silicium sur lesquelles sont posées, par collage moléculaire, de secondes plaques. Installés sur NA62, ils font déjà leur preuve, certains résistant même à des pressions de plusieurs centaines de bars.

CEA news

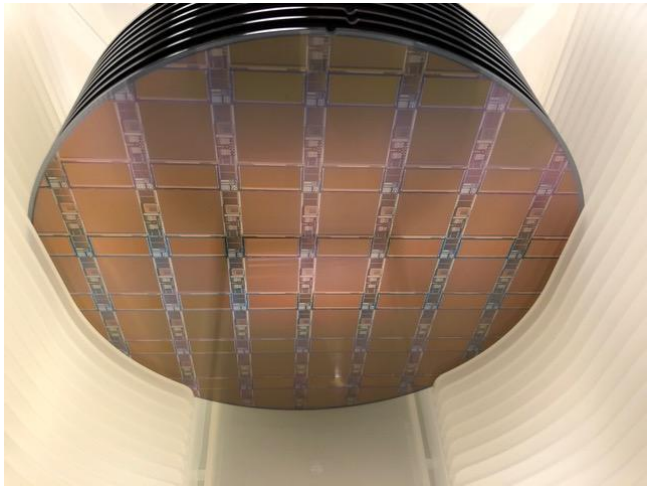




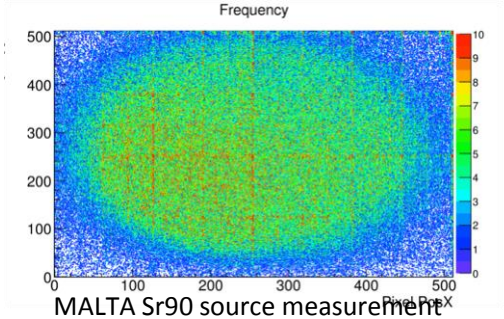


Pixel R&D

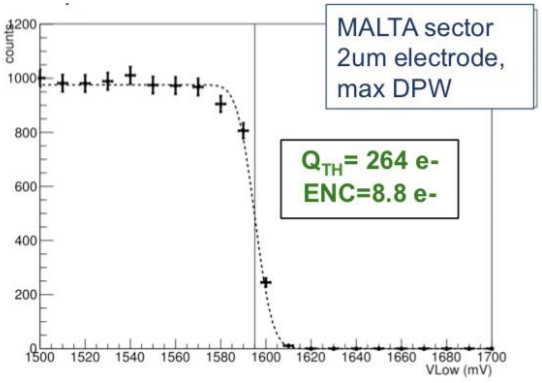
- STREAM EU Marie Curie training network, working closely within DT, with EP-ESE, EP-ADE and outside institutes
  - Team: Roberto Cardella (MC STREAM ESR), Petra
- **In 2017 submission of an engineering run in modified 0.18 um TowerJazz CMOS imaging process including:**
  - **2 large pixel chips (**MALTA and MONOPIX) compatible with ATLAS L4 requirements
  - **Test structures** to study interconnections techniques and module assembly
  - **Processing on two different starting materials** (epi thickness)

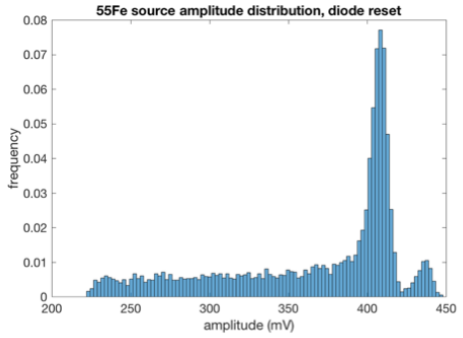


MALTA 512x512 pixels (36 x 36 µm² pixels)
– Active area 18.3 x 18.3 mm²
– No hit memory in active matrix
– All hits are asynchronously transmitted over high-speed bus to EoC logic
– No clock distribution over active matrix



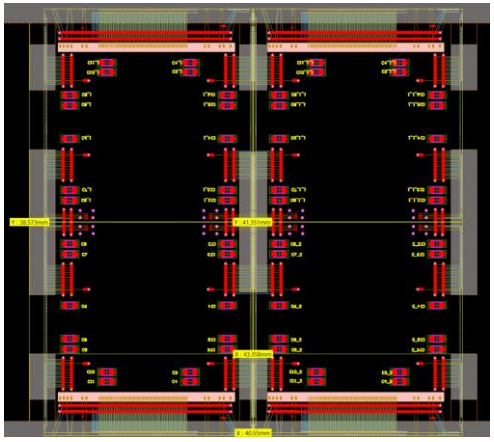
MALTA Sr90 source measurement
uniform response across all sectors





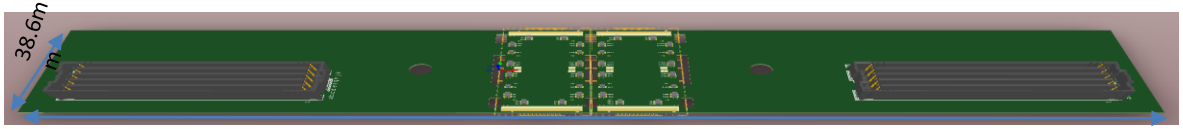
MALTA: ^{55}Fe source 5.9 keV (1640 e- signal)

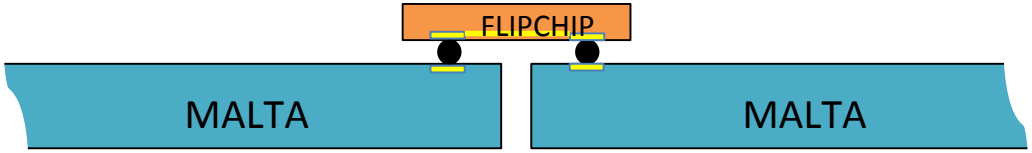
Pixel R&D: MALTA Module and LAPA



Flex design compatible with ATLAS pixel quad module in preparation.

Interface matched to MALTA test board to allow using the same test system as for single chip PCBs.





Dedicated flip-chip structure to explore MALTA features of high speed chip-to-chip data transmission and power distribution.

LAPA: test chip with 10 data transmission channels

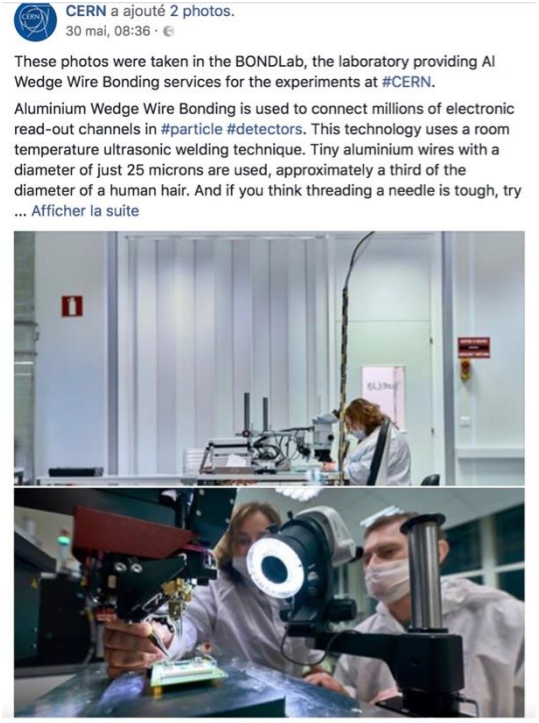
- CMOS/LVDS selectable in/out
- 5 Gb/s LVDS I/O
- Successfully tested at 5.12 Gb/s!
- Tests adding flex cable ongoing (alreasy working at 1.28 Gb/s)

- 40 transmitters embedded in MALTA

LAPA eye diagram – 5.12 Gb/s

- SDD+GDD

Some news from May 2018…

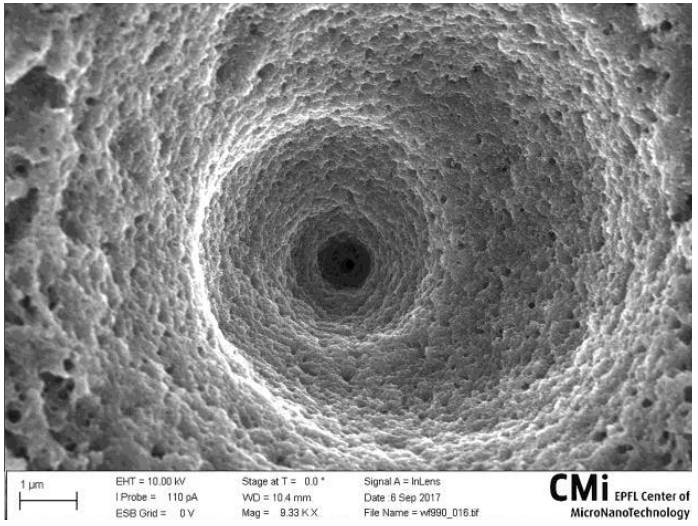


EPFL Micro-Nano fabrication review(8 (!) posters, Microfabrication), 600 attendees

Frontier detectors for frontier physics prize (F. Brunbauer, GDD)

CERN “What is this” competition on facebook (F. Manolescu and Ian McGill, Bondlab)

CERN picture of the week (F. Manolescu, Bondlab)



Winner of the EPFL monthly SEM picture contest (C. Lipp, Microfabrication)