The EP/DT Quality Assurance and Reliability Testing Lab

Alessandro La Rosa (CERN EP/DT)

RSA Working group meeting
June 17, 2021

https://indico.cern.ch/event/1042458/

Detector Technology Group

The **mandate of the EP-DT** group comprises development, construction, operation and maintenance of **particle detectors for the experiments** at CERN. The group also offers a range of **services and infrastructure** for experiments and detector R&D

Services

Infrastructure for experiments:

- Gas systems
- Detector cooling systems
- Instrumentation and controls

Infrastructure for Detector R&D:

- Thin film & glass Lab
- Silicon facility
- Wire-bonding
- **QART Lab**
- Micro-Pattern Technologies
- Irradiation facilities
- Specialized labs (optics, gluing…)
- Scintillator production

Engineering office

R&D Projects

- Radiation tolerant silicon detectors (RD-50)
- Gaseous detectors (RD-51)
- Scintillating fibre detectors
- Micro-systems engineering

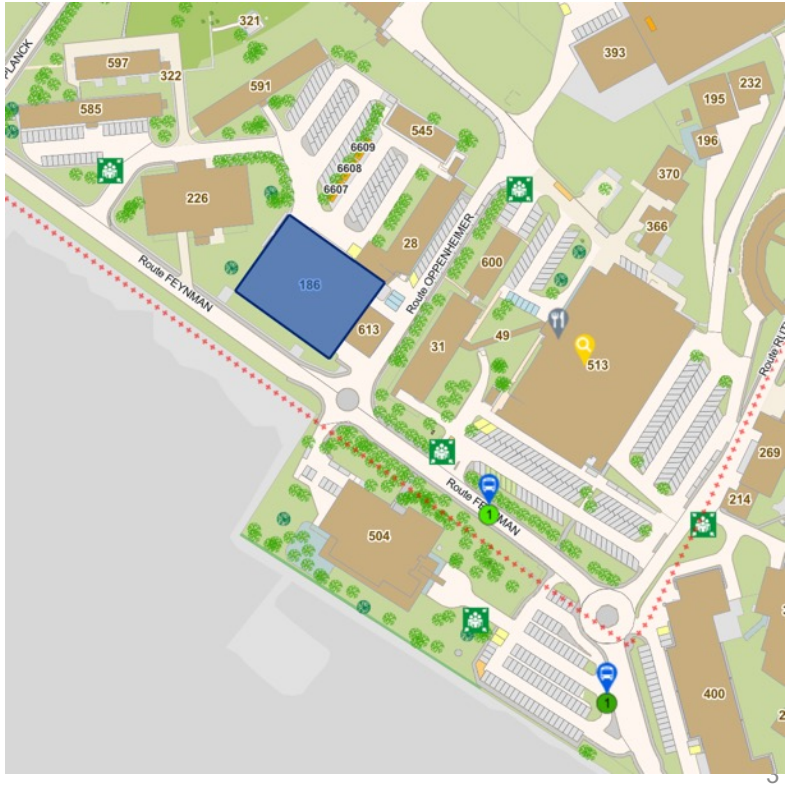
Joint Projects

- M&O and Upgrades of the LHC experiments
- AEgIS, CAST, CLOUD, NA62
- R&D for Linear Collider Detectors

In 2008 the **Quality Assurance and Reliability Testing** (**QART**) lab was founded to help with the LHC detector upgrade projects.

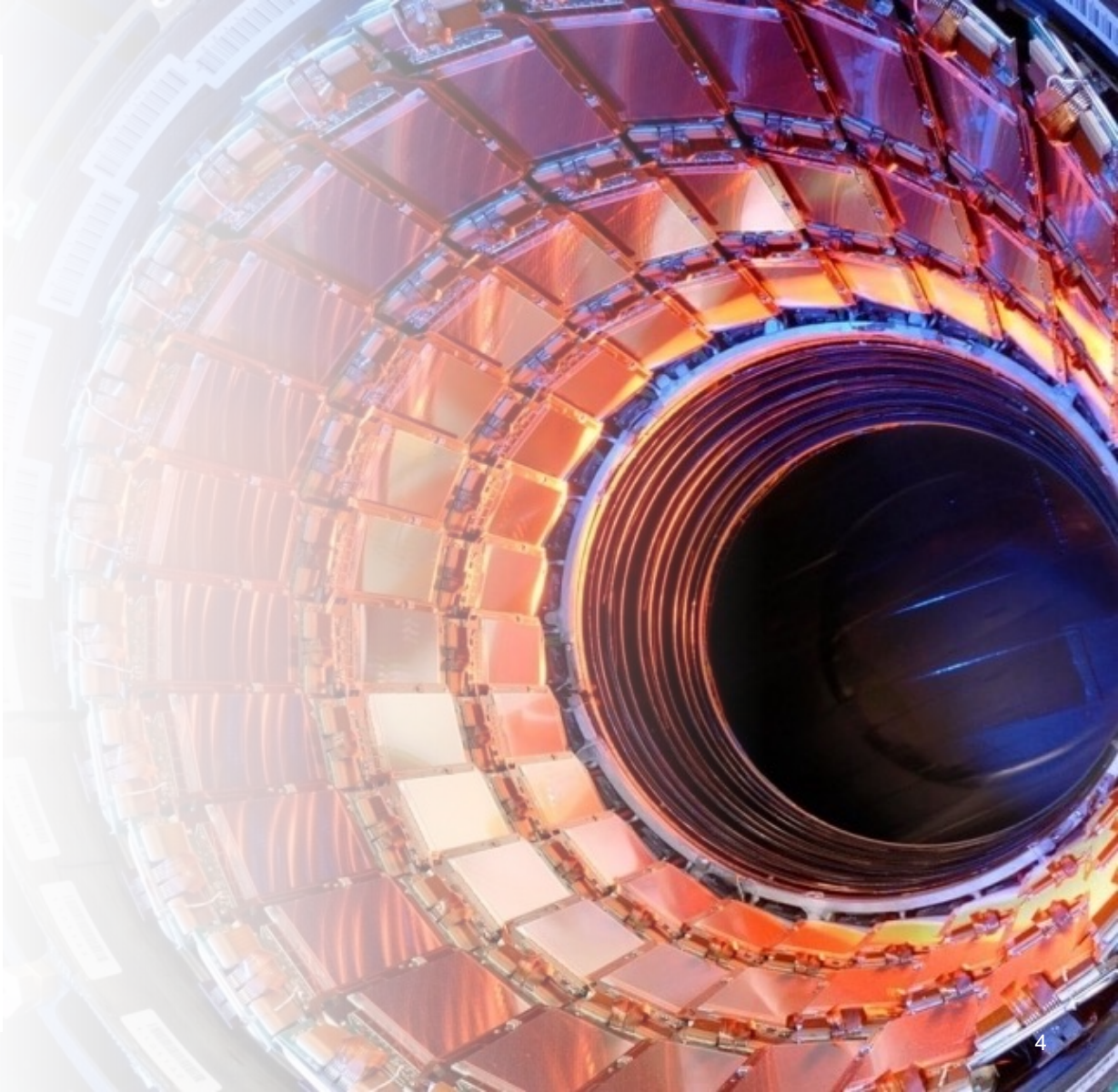
Since then, the following services are maintained by the EP-DT group in B186 :

- **Common cleanroom area** for experiments and projects working on silicon detector development
  https://ep-dep-dt.web.cern.ch/department-silcon-facility-dsf
- **Bond lab** providing micro-connection service and advice for detector connectivity
  https://ep-dep-dt.web.cern.ch/wire-bonding-lab-bondlab
- **QART lab** providing support and advise for detector QA matters
  https://ep-dep-dt.web.cern.ch/quality-assurance-and-reliability-testing-lab-qartlab



QA and **Reliability Testing** are **important in large projects** as the **silicon detector upgrades**, where there are:

- **Huge number** of identical or similar components (~20’000 modules)
- **Extreme environmental conditions** (radiation, operating temp)
- **No access → no chance to repair** the devices
- **Mass production** with **tight time scale**
- **Limited budget**

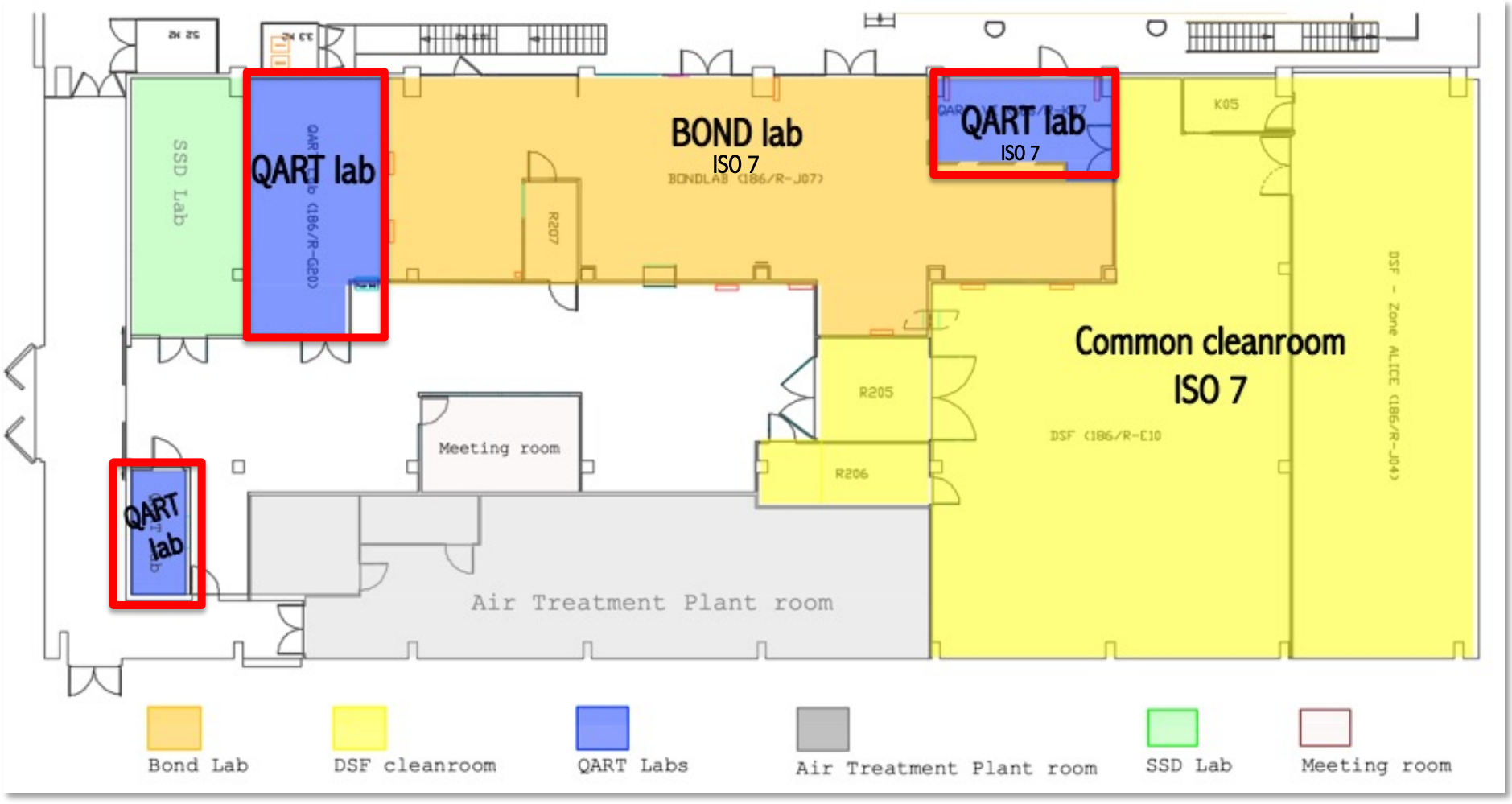


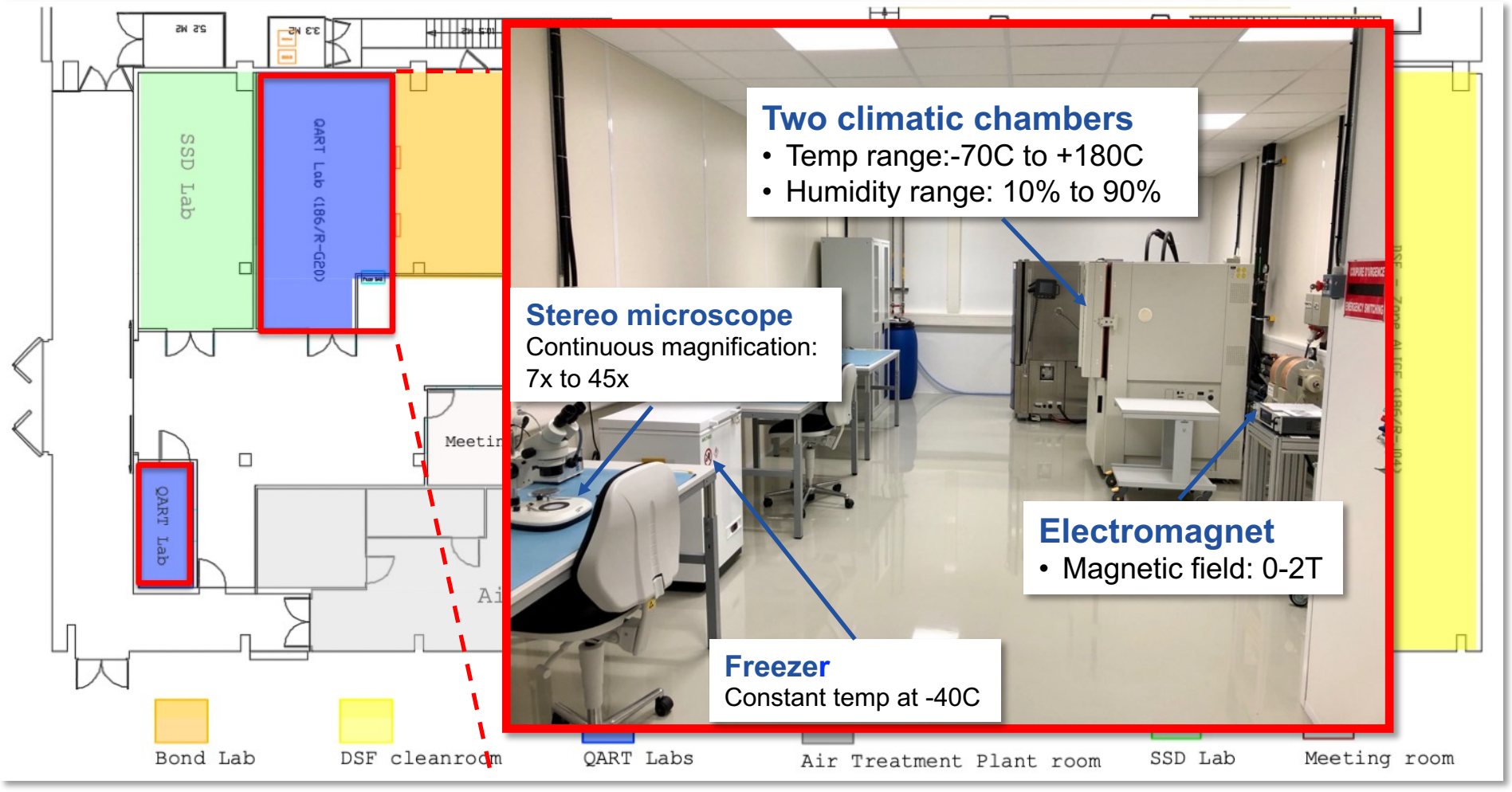
The QART lab

- Provides resources concerning **quality assurance** to the CERN detector technology community
- Provides equipment and expertise in order to perform **reliability testing** and **visual inspection**
- Provides also advice and assistance in many aspects of silicon detector design, construction, and operations

- Team: A. La Rosa (contact person), R. Costanzi, F. Manolescu, I. McGill

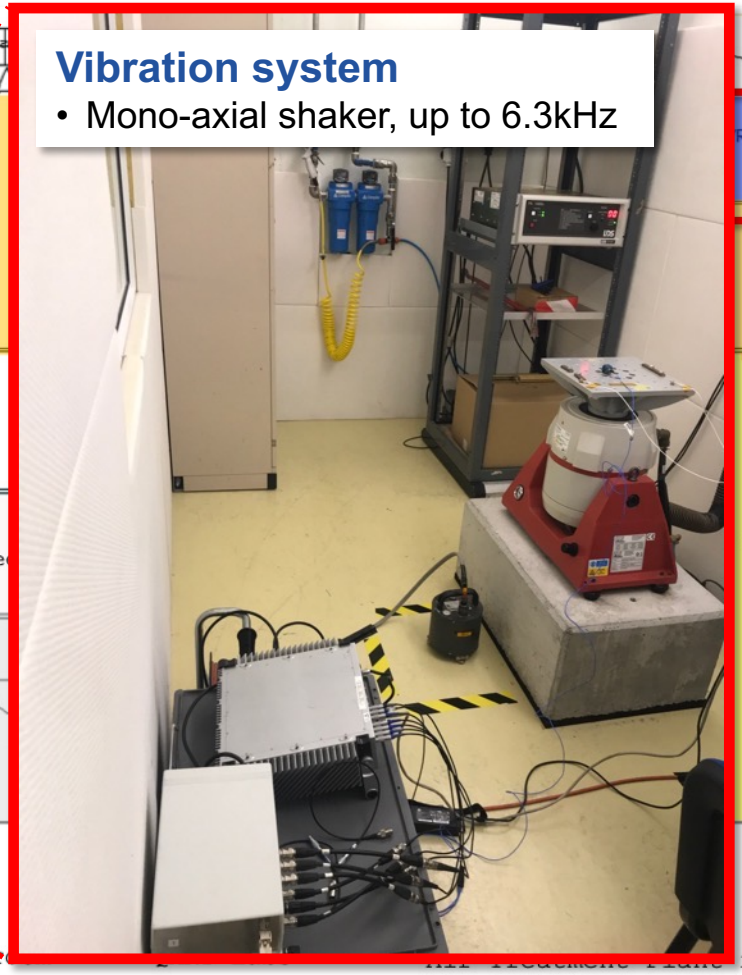
https://qartlab.web.cern.ch/home

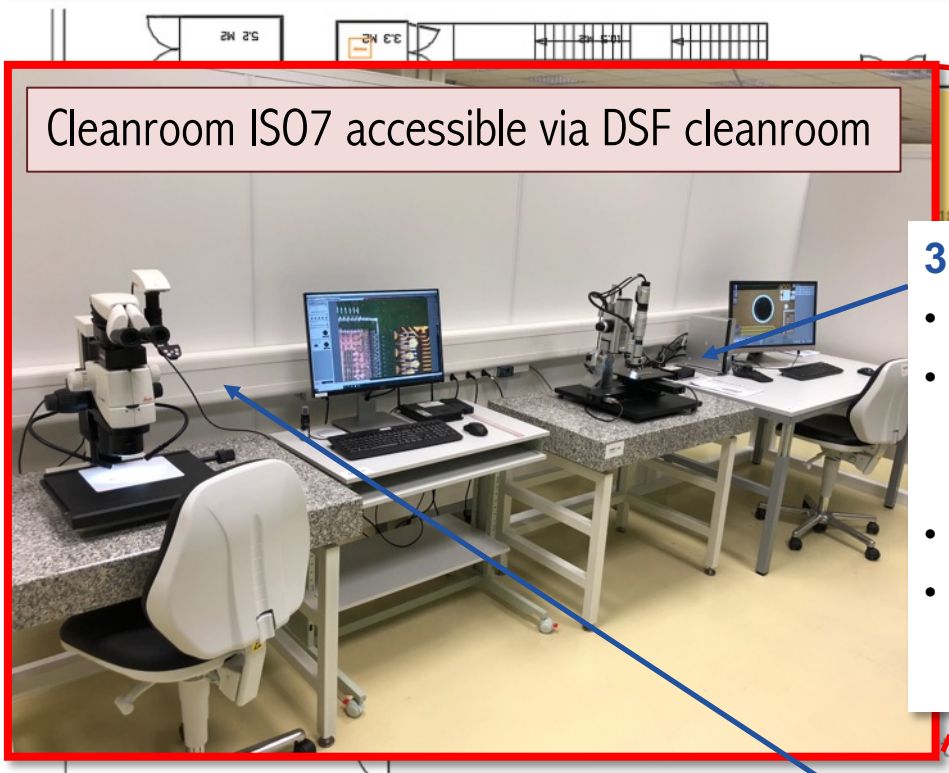

QART lab
BOND lab
ISO 7
QART lab
ISO 7
SSD Lab
K05
R207
Common cleanroom
ISO 7
DSF (186/R-E10
DSF - Zone ALICE (186/R-J04)
R205
Meeting room
R206
QART lab
Air Treatment Plant room
Bond Lab
DSF cleanroom
QART Labs
Air Treatment Plant room
SSD Lab
Meeting room


SSD Lab
QART Lab (186/R-G20)
QART Lab
Meetin
Ai
Two climatic chambers
• Temp range:-70C to +180C
• Humidity range: 10% to 90%
Stereo microscope
Continuous magnification:
7x to 45x
Electromagnet
• Magnetic field: 0-2T
Freezer
Constant temp at -40C
Bond Lab
DSF cleanroom
QART Labs
Air Treatment Plant room
SSD Lab
Meeting room

Vibration system

- Mono-axial shaker, up to 6.3kHz





3D digital microscope

- CMOS 2.4 MPixel captor
- x35-x5'000 triple objective zoom lens, including auto-calibration system and dual illumination mechanism with both coaxial- and ring-lighting
- 2D and 3D stitching application
- 3D profiling & roughness measurements (Ra, Rz), and angle & radius measurements

Stereo-microscope

- revolving nosepiece with two objectives (1.0x and 1.6x)
- continuous magnification range from 7.8x to 384x
- 5M pixel HD Camera (MC170) and measurement sw kit
- manual 6x4" XY stage

Equipment and examples of use-case

Equipment and example of use-case

Climatic chambers

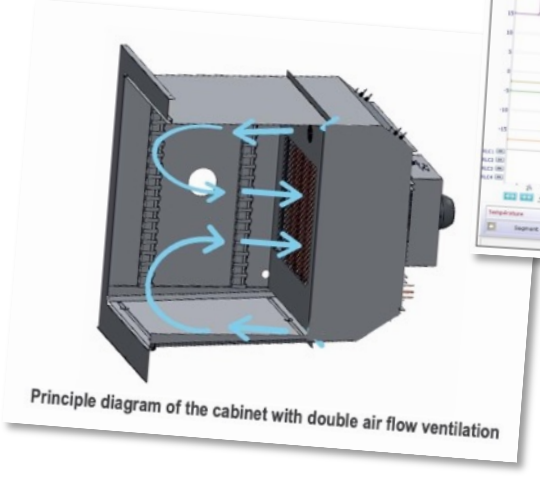
ESPEC (380L)

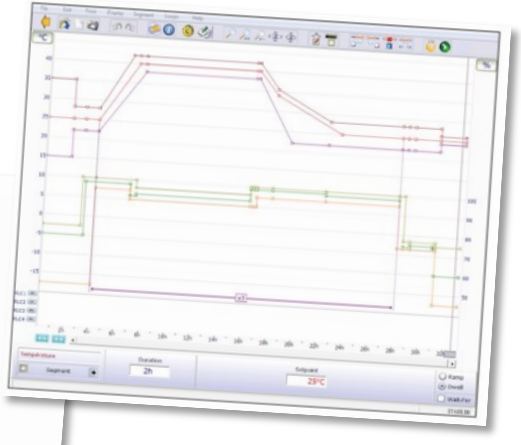
CLIMATS (140L)

- Temp range:-70C to +180C
- Humidity range: 10% to 95%
- Max heating speed: 15C/min
- Max cooling speed: 11C/min

Expected use:

- Thermal cycling, Accelerated lifetime,
- Humidity tolerance, Cold tolerance,
- Stress screening, Environment simulation



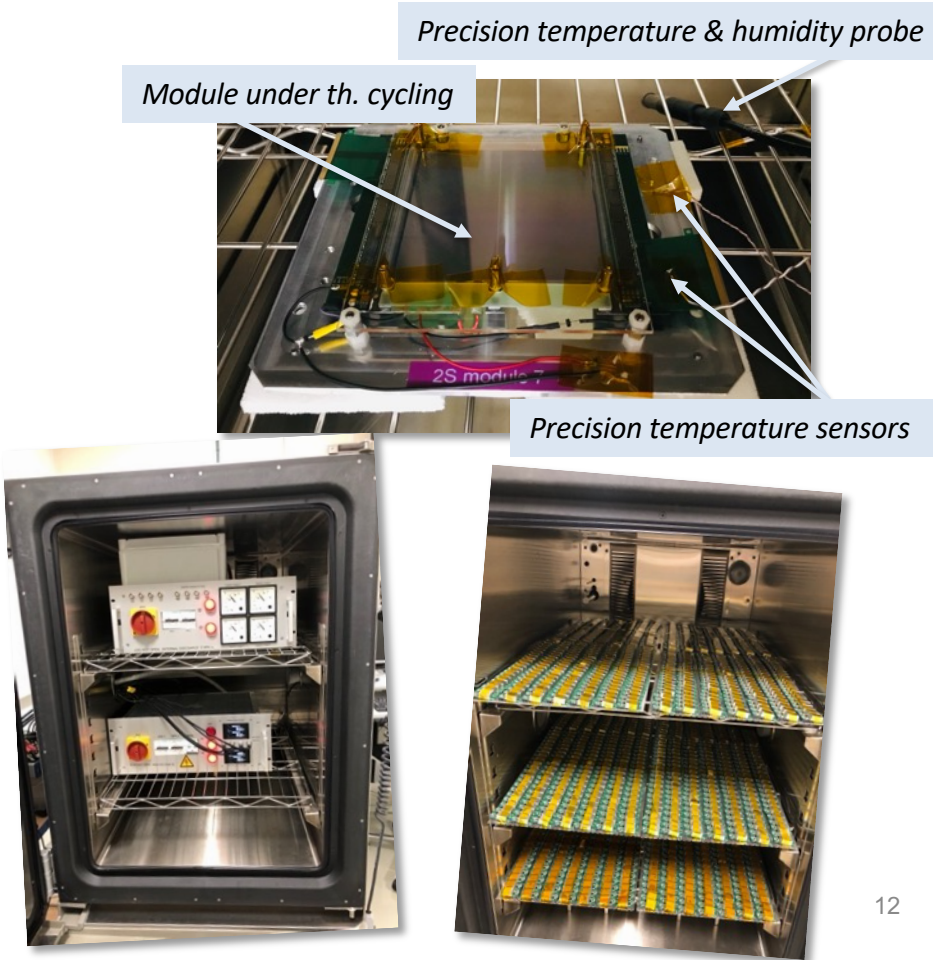


Equipment and example of use-case

Climatic chambers

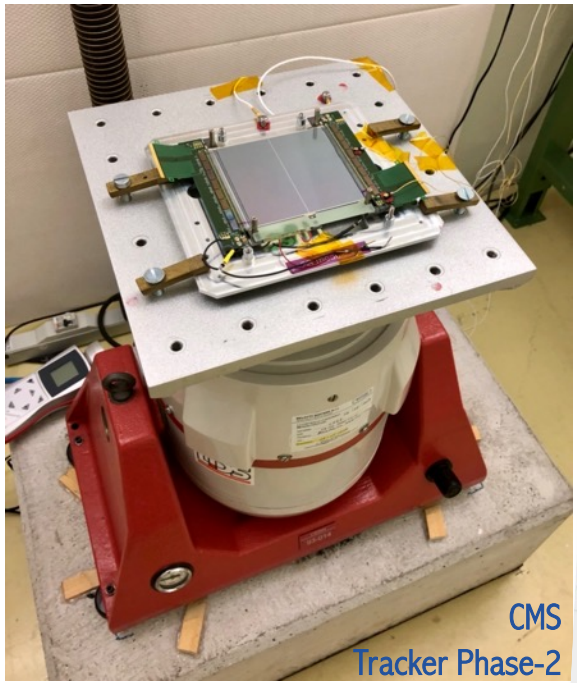
Some tests recently made:

- ATLAS NSW: 1’000 elect cards th. cycling
- ATLAS ITK: encapsulated wire bonds th. Cycling
- ATLAS ITK: silicon/flex heaters temp calibration
- ALICE ITS: upgrade module accelerate lifetime
- CMS Tracker: 2S module thermal cycling
- CMS ECAL: elct cards accelerate lifetime (high temp)
- EP-ESE: > 12’000 DC-DC converters th. cycling
- LHCb RICH: upgrade elect cards th. cycling
- TE-MPE control module of beam energy extraction system th. cycling



Equipment and example of use-case

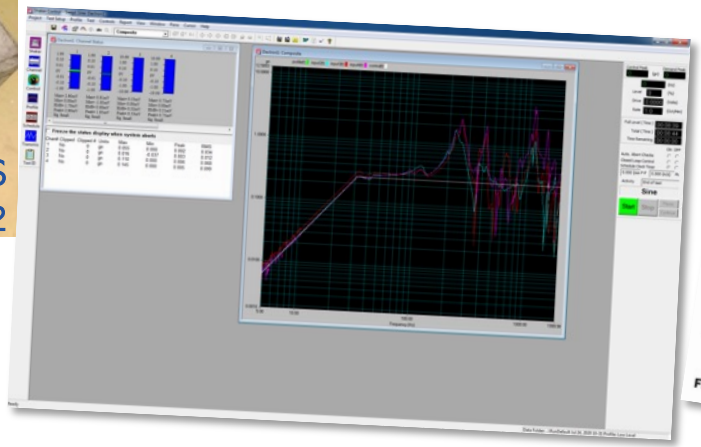
Vibration Tester

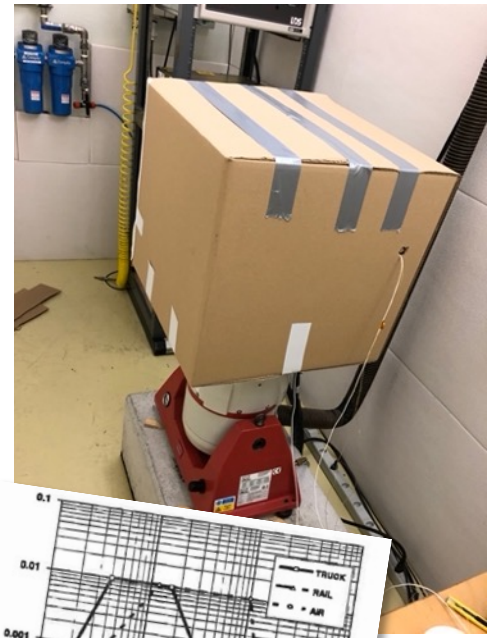


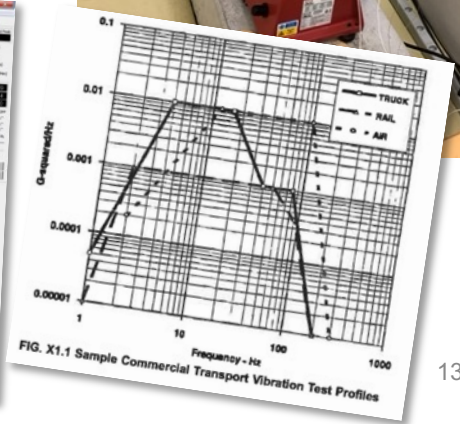
- Mono-axial shaker
- Frequency range: DC -6300 Hz
- Max acceleration - sine peak: 100G
- Max displacement: 25mm
- Armature diameter 110cm

Mono-axial shaker with control system and analysis tools for Random, Sine, Shock, and Recorded vibration inputs.
It can perform:

- Destructive testing
- Stress screening
- Playback of transport and handling vibrations and shocks



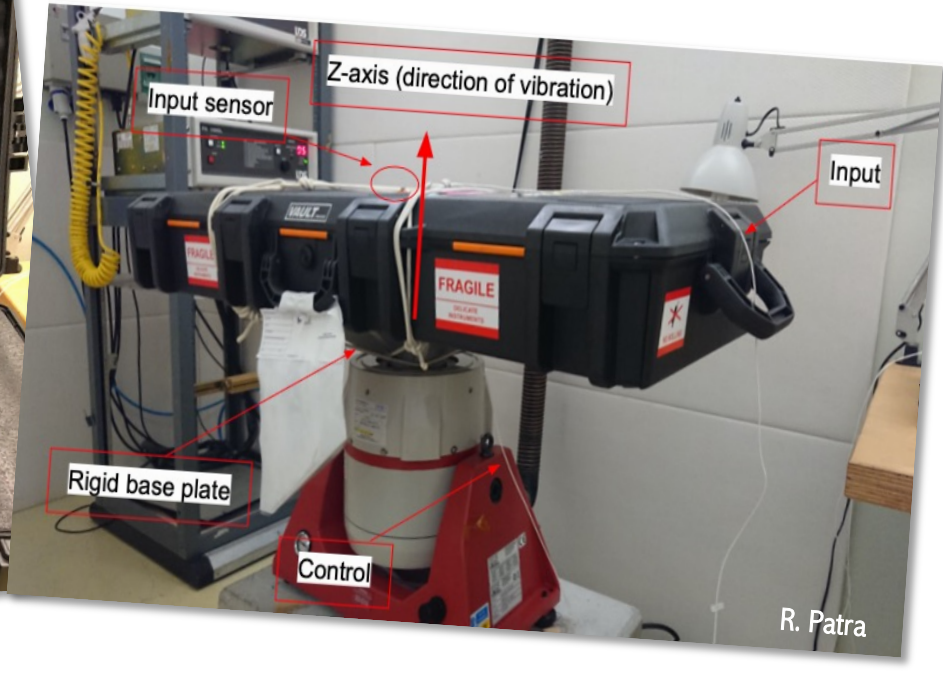




Equipment and example of use-case

Vibration Tester

Playback of transport and handling vibrations

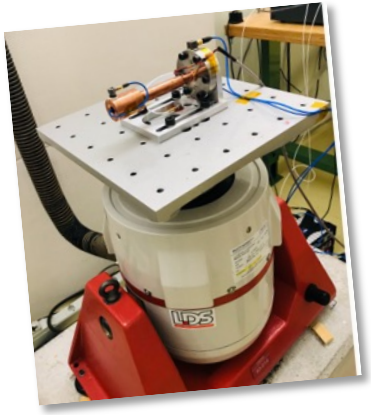


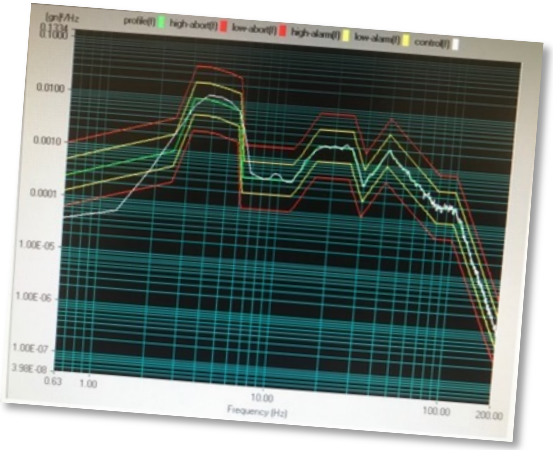
Equipment and example of use-case

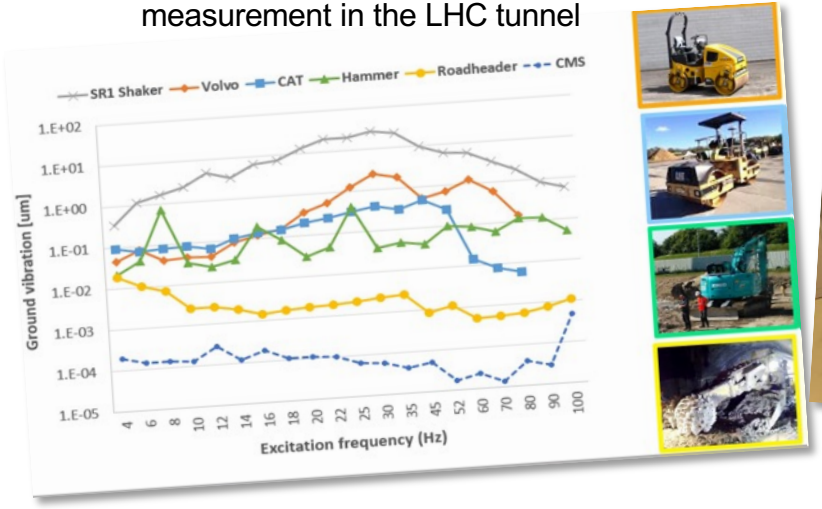
Vibration Tester

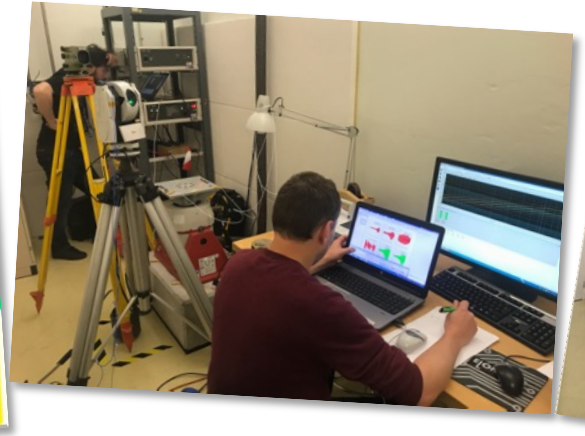
Some other tests recently made:

- EN & BE: 10G shock-test and random truck transport profile excitation for a RF antenna cavity for HL-LHC upgrade
- EN/MME: measurement of ground motion condition due to HL-LHC civil engineering works as validation of survey equipment for measurement in the LHC tunnel



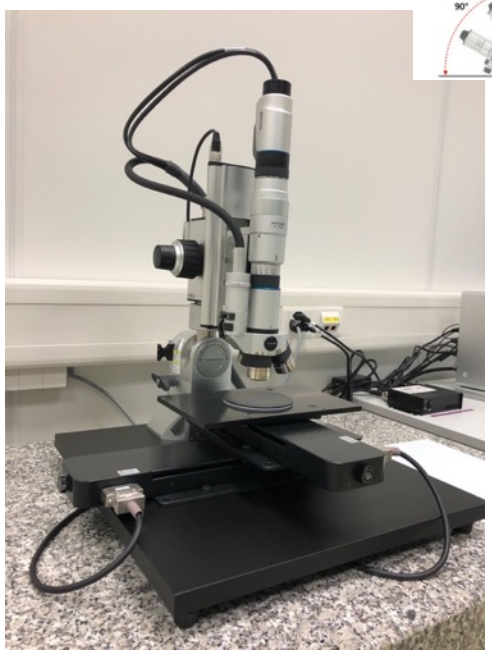


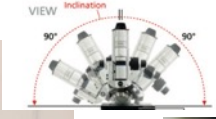


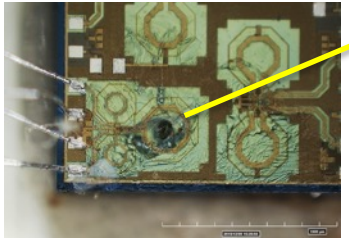


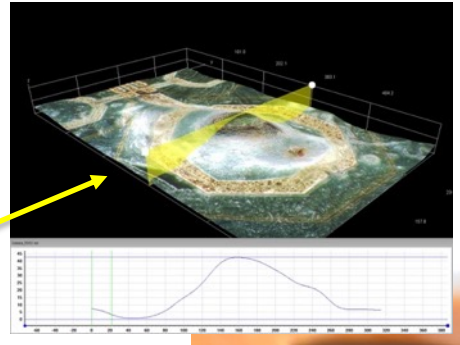
Equipment and example of use-case

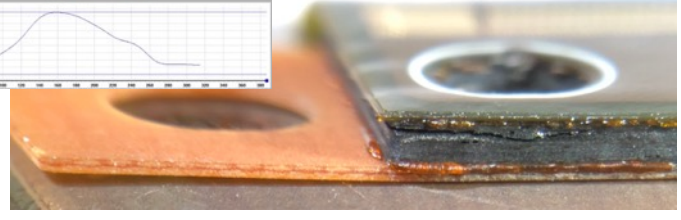
3D digital microscope

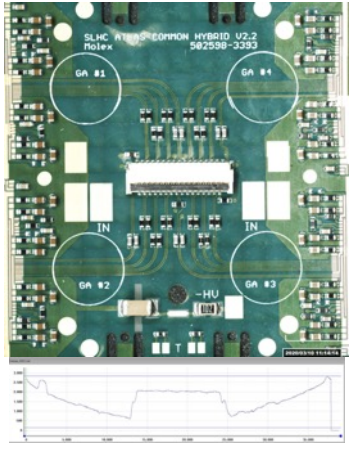












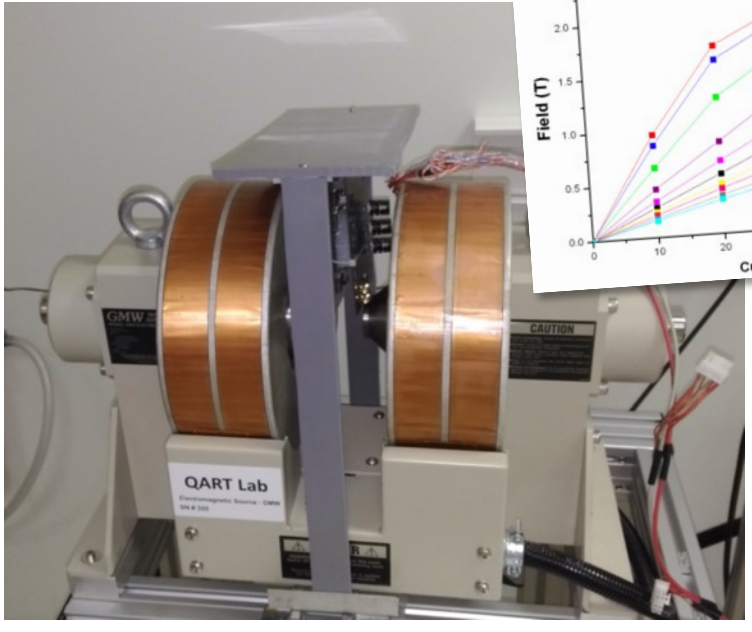
- CMOS 2.4 MPixel captor
- x35-x5'000 triple objective zoom lens
- 2D and 3D stitching application
- 3D profiling & roughness measurements

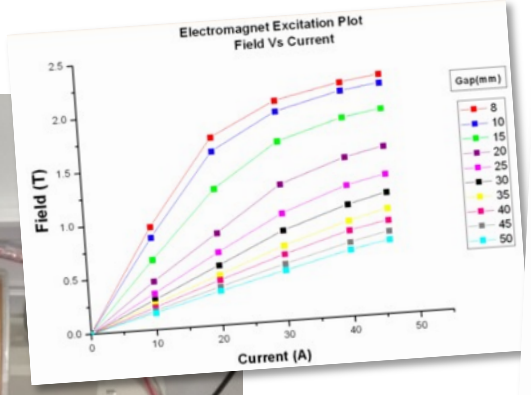
Some inspection recently made:

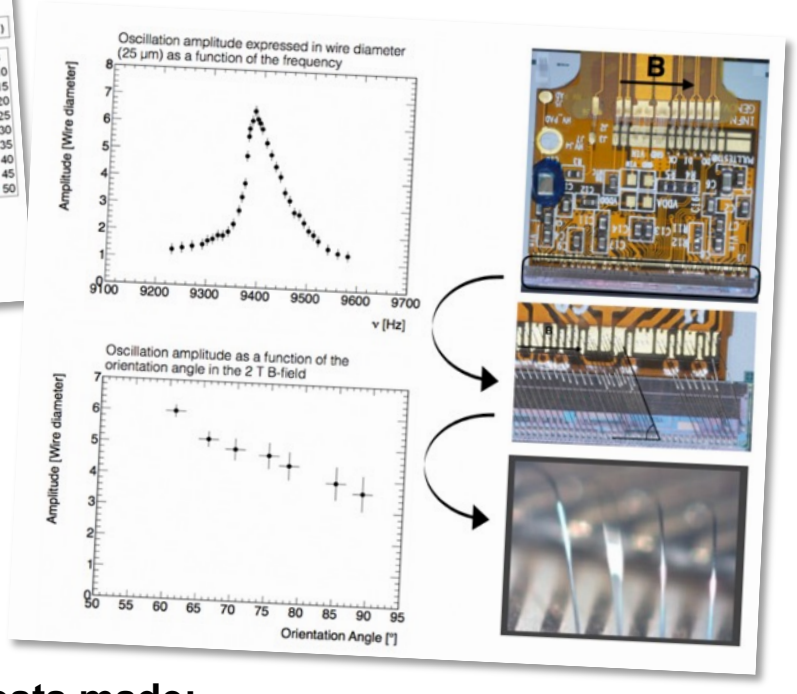
- ATLAS ITK Pixel module flex inspection and bowing measurements
- CMS Tacker 2S Front-End Hybrids visual inspection
- RD50 silicon sensors inspection
- STREAM MALTA chip visual inspection
- ATTRACT-SWaP temp sensors inspection
- TE-MSC PCB inspection and 3D profiling and roughness measurements

Equipment and example of use-case

High Field Magnet







Electromagnet:

- Pole diameter: 38 mm
- Variable pole gap: 0-86 mm
- Magnetic field: 0-2T

Some tests made:

- ATLAS IBL: study of wire-bonds operation in 2T magnetic filed
- ALICE CPV: operation validation of electronic modules in 0.5 T magnetic field

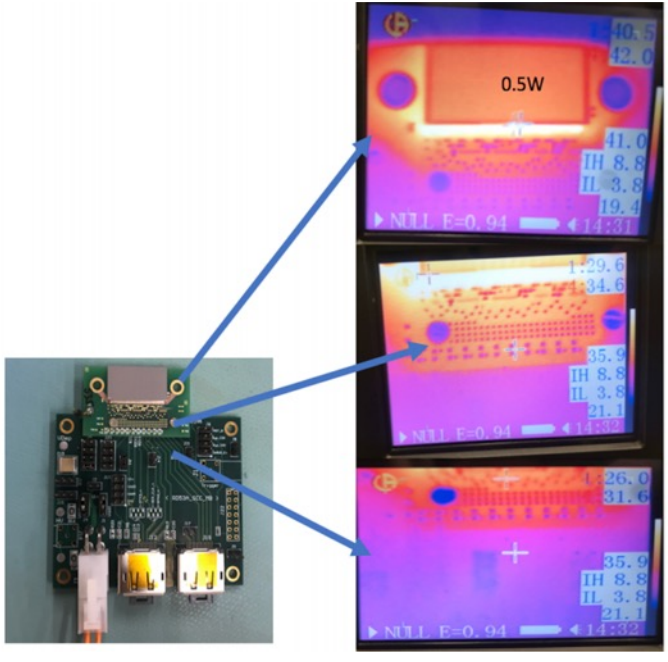
Equipment and example of use-case

IR thermal imaging Video Camera

High sensitivity (0.1°K) thermal imaging IR video camera 160 x 120 pixels.
Measurement range: -20°C to +250°C.

Expected uses:

- Identifying hot spots in detectors
- Heat flow study on front-end PCBs and detector modules



Some example of tests made:

- CMS Inner Tracker (RD53 module)
- ATLAS ITK (Heaters)
- ATLAS Pixel (FEI4 chip on PCB)

Summary

- Projects that require **High Levels of Reliability** should carefully evaluate the operation and environmental conditions of the devices in the final functioning system and testing for long-term reliability
- The **QART lab** is a dedicated lab with a variety of **reliability test** and **visual inspection equipment**
- The lab provides services to the CERN community supporting projects working mainly on novel detectors
- All the 4 main LHC experiments have upgrade projects that used the lab facilities as well as groups in as EN, TE and BE depts.

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You are welcome to make use of our facility !!!

https://qartlab.web.cern.ch/home