# INTRODUCTION TO ESIPAP COMPUTING SESSIONS

*WEDNESDAY 10 – THURSDAY 11 FEBRUARY 2021*

*ERIC CHABERT - ERIC CONTE*

# GOALS OF THE COMPUTING SESSIONS

- Computing is required for instrumentation purposes:
  - Simulation of sensor
  - Data acquisition
  - Data analysis
  - Algorithm and reconstruction of physics objects

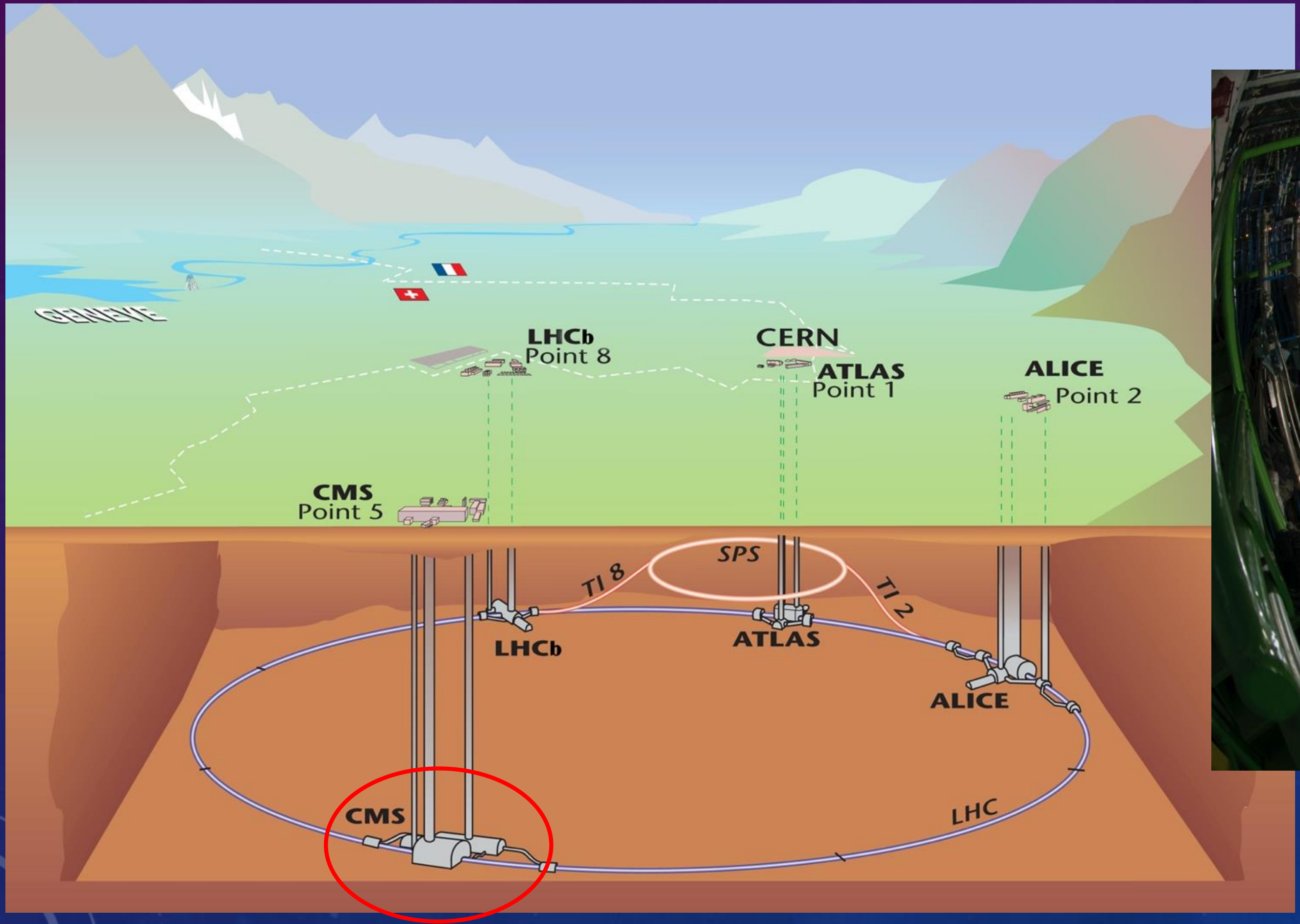
- Computing sessions target to apply your theoretical knowledge:
  - Instrumentation
  - Software programming in  C++
  - Using specific tools of high energy physics: ROOT

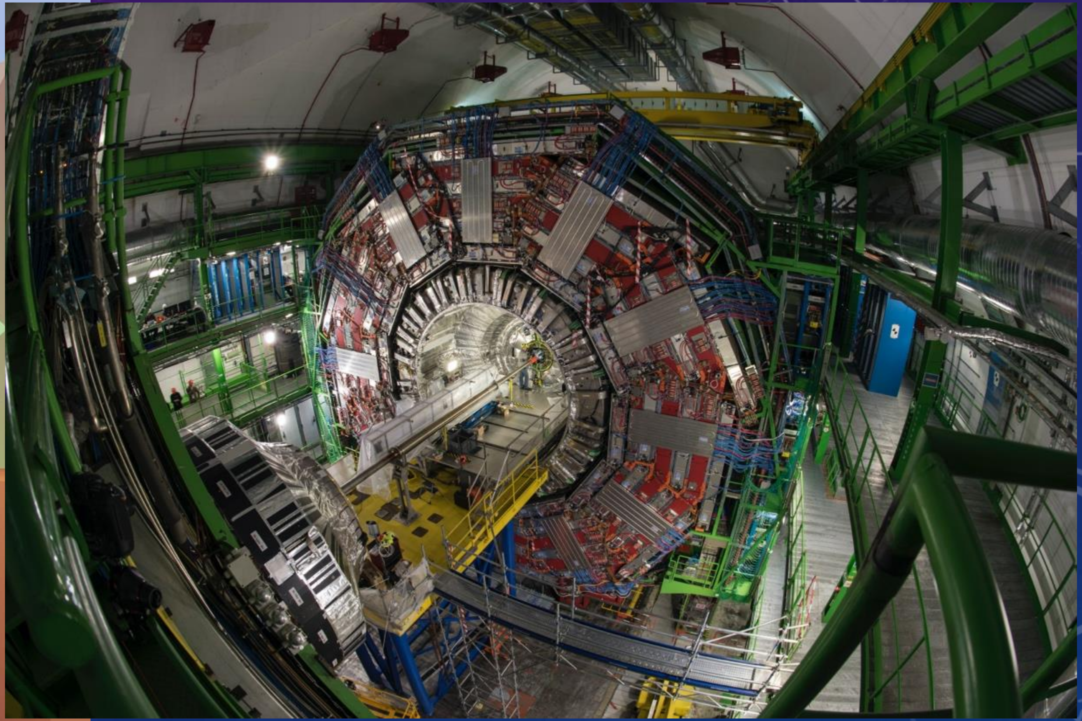
- Working by yourself and experimenting

- Getting the good practice

# PHYSICS CONTEXT

# THE CMS (COMPACT MUON SOLENOID) DETECTOR





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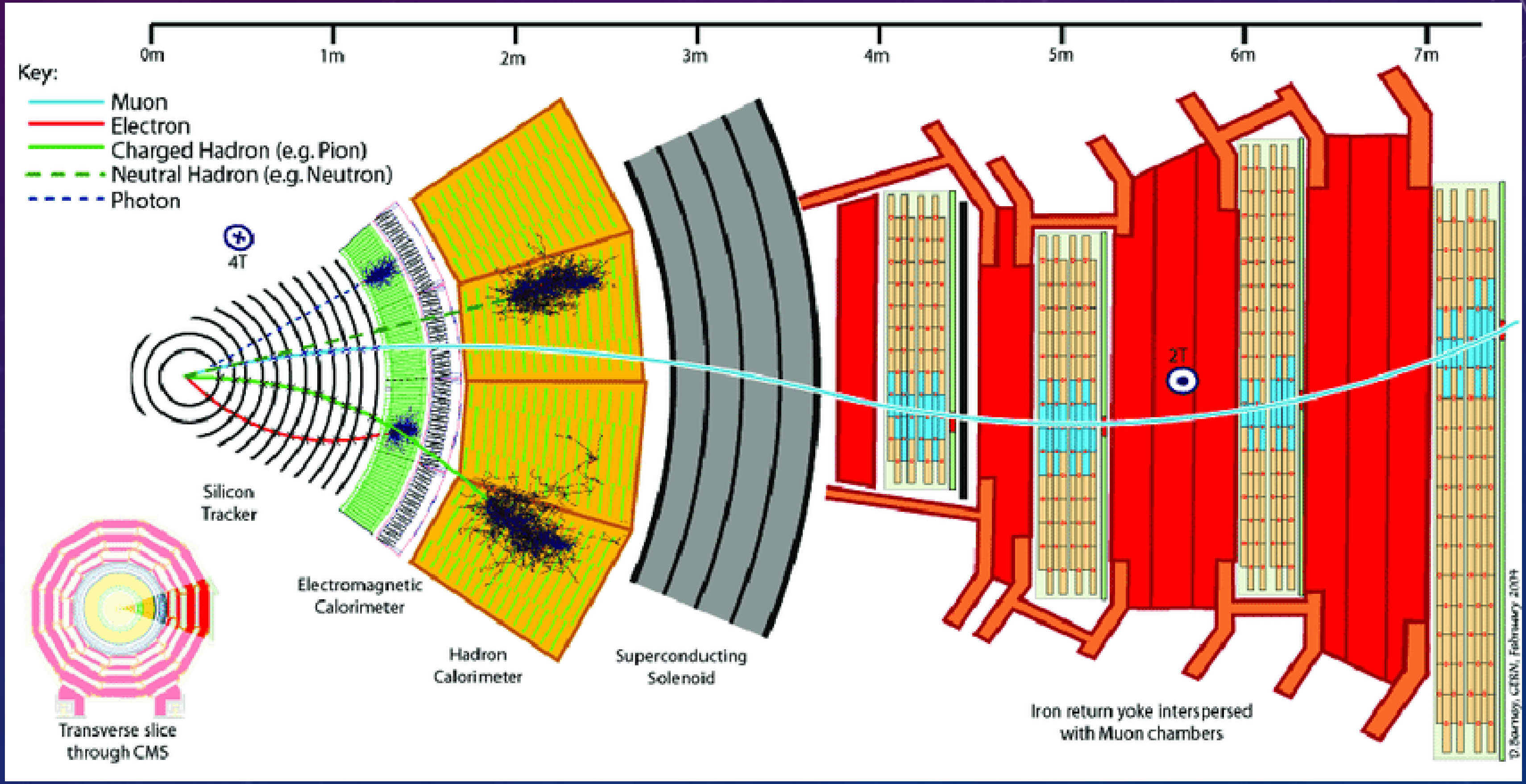
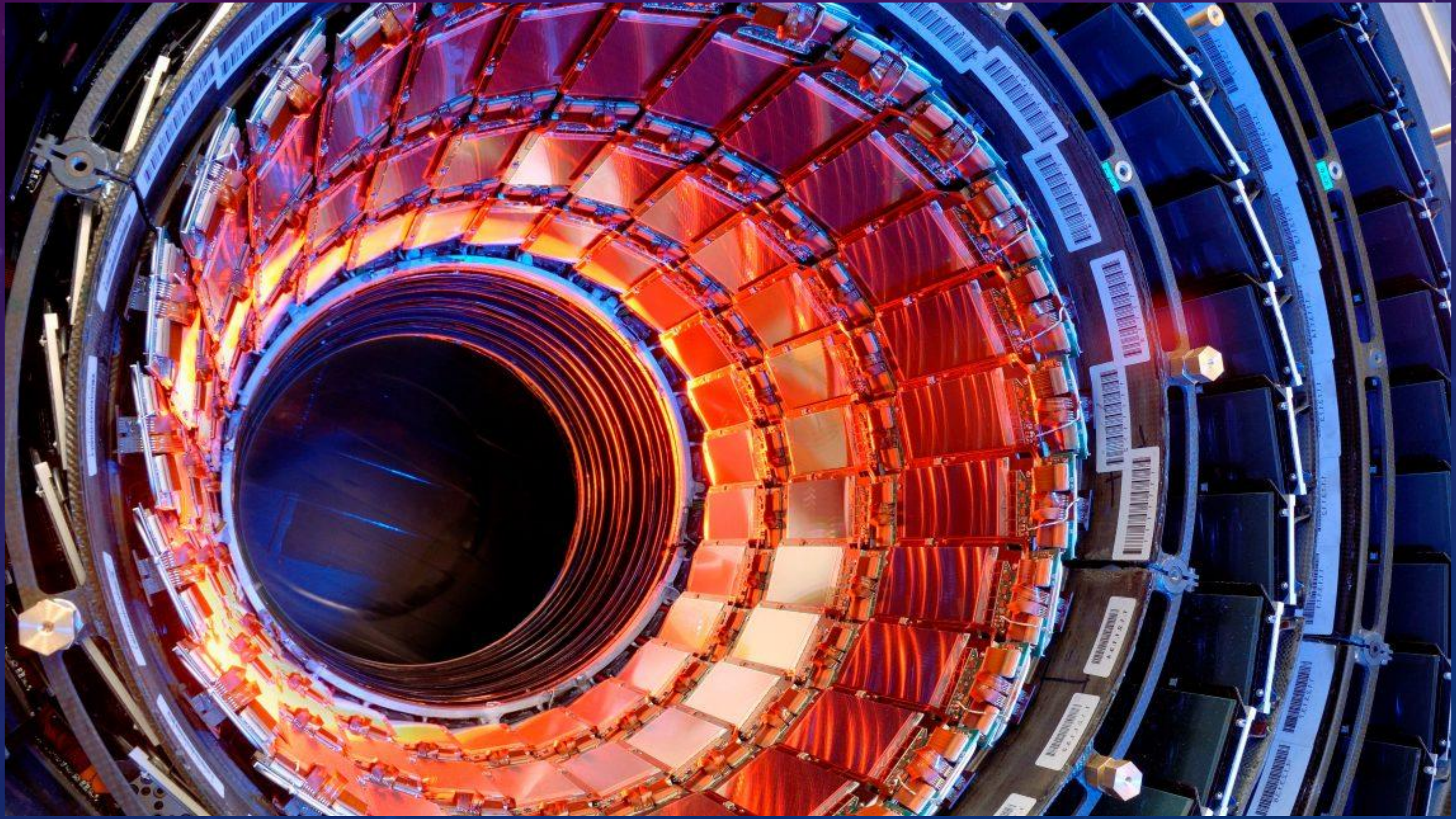

0m
1m
2m
3m
4m
5m
6m
7m
Key:
Muon
Electron
Charged Hadron (e.g. Pion)
Neutral Hadron (e.g. Neutron)
Photon
4T
2T
Silicon Tracker
Electromagnetic Calorimeter
Hadron Calorimeter
Superconducting Solenoid
Iron return yoke interspersed with Muon chambers
Transverse slice through CMS

©D.Barney, CERN, February 2004

# SILICON STRIP TRACKER



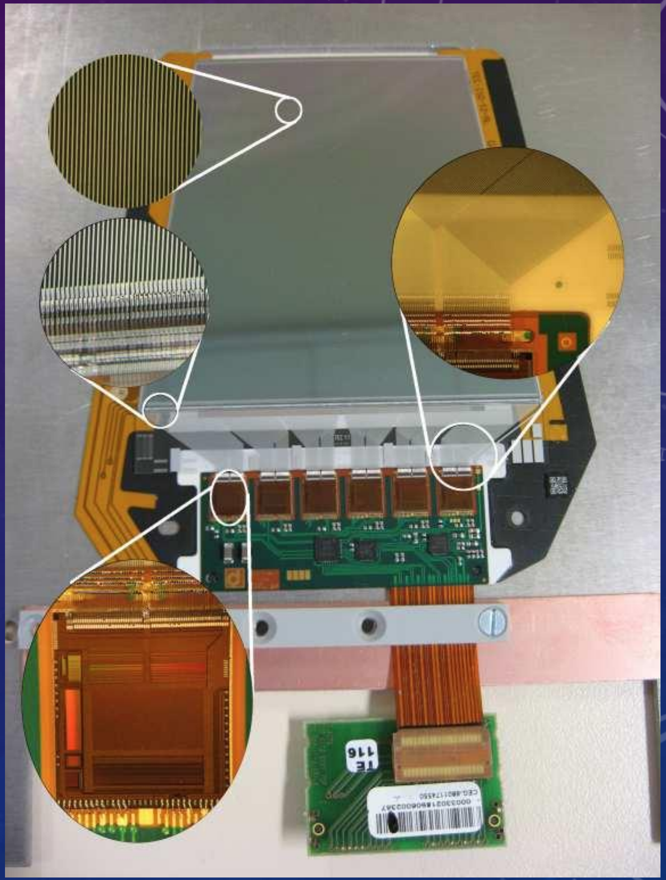
# SILICON STRIP TRACKER

**Instrumental activities**

- R&D
- Construction
- Operation (online)
- Alignment & calibration
- Offline analyses
- Simulation
- Radiation damages evaluation
- …

**CMS silicon strip tracker in few numbers:**

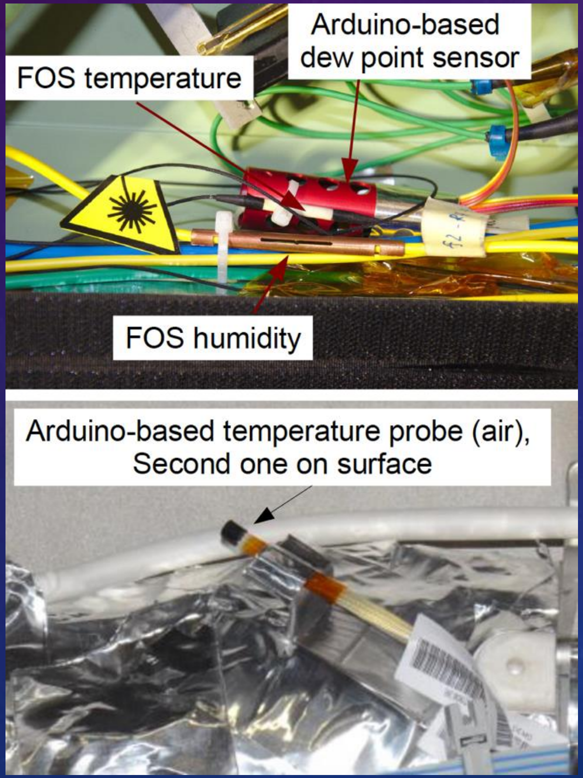
- 15 000 modules
- Surface: ~ 200 m$^2$
- 10$^6$ channels



**Performances:**

- Hit resolution: 20-40 µm
- Hit efficiency > 98% (at high Pile-Up)
- Timing alignment accuracy: 1ns
- …

# SILICON STRIP TRACKER


Arduino-based dew point sensor
FOS temperature
FOS humidity
Arduino-based temperature probe (air),
Second one on surface

**During its operation it is important to monitor environment conditions:**

- Temperature
  - Leakage current
  - Noise
  - Thermal dissipation
  - Radiation damages
  - …
- Humidity
  - Dew points & condensation
  - Front End electronics
  - …

**Monitoring tools**

Several probes are used to monitor that:

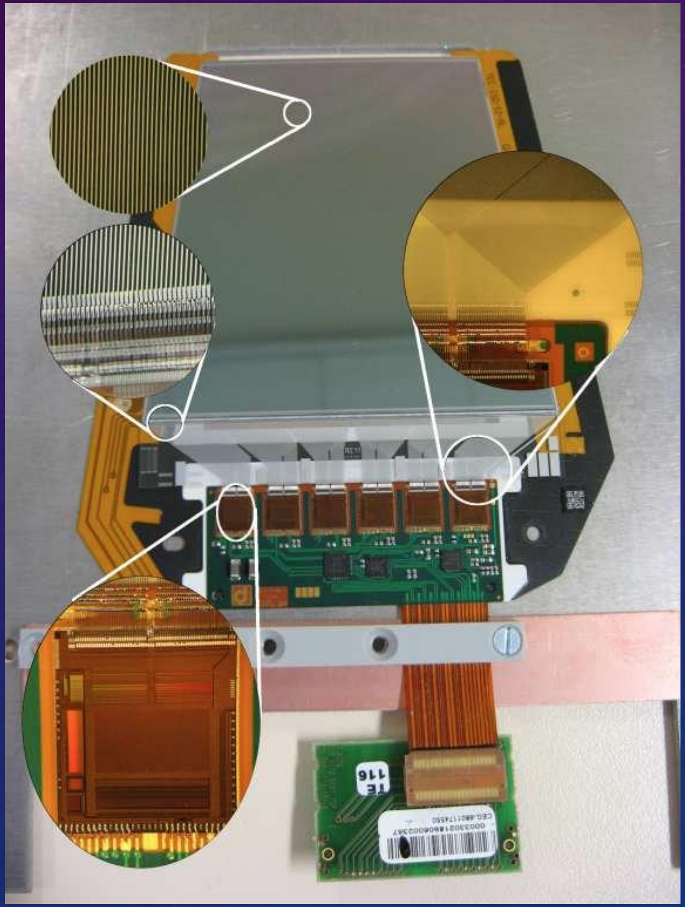
- On-board sensors
- External sensors

→ Some are ARDUINO-based!

# COMPUTING SESSION AIMS

**Instrumental activities**

- R&D
- Construction
- **Operation (online)**
- Alignment & calibration
- **Offline analyses**
- **Simulation**
- Radiation damages evaluation
- …



1. **Slow control**
   - Using a dedicated electronic board (Sense Hat) read by a Raspberry
     - Monitor the temperature & humidity
     - Send warning when conditions are not fulfilled

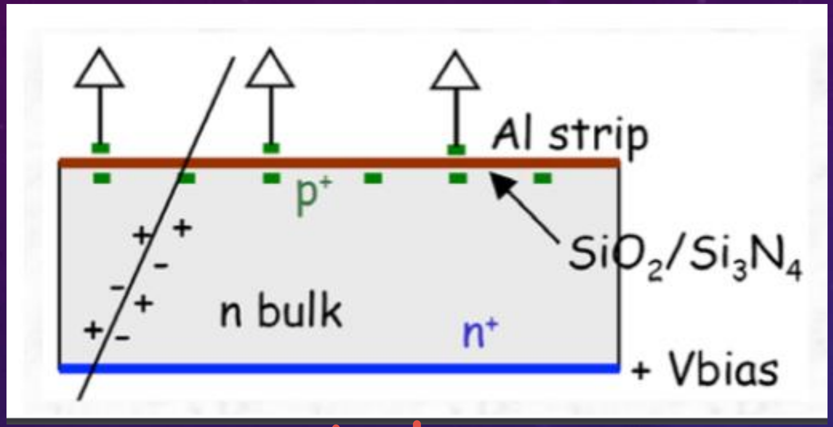
2. **Offline analyses**
   - Calibration of the temperature sensors
   - Evaluation of the sensor resolution

**3. Simulation**

- Basic simulation with the GEANT4 package of a CMS silicon strip sensor

# DATA USED IN THE COMPUTING SESSIONS

# SENSORS TO STUDY



CONDITIONNING
Analogic Front-End + ADC + Signal treatment

2 channels
= collected charged
= energy (0 to 255)

- Temperature
- Relative humidity

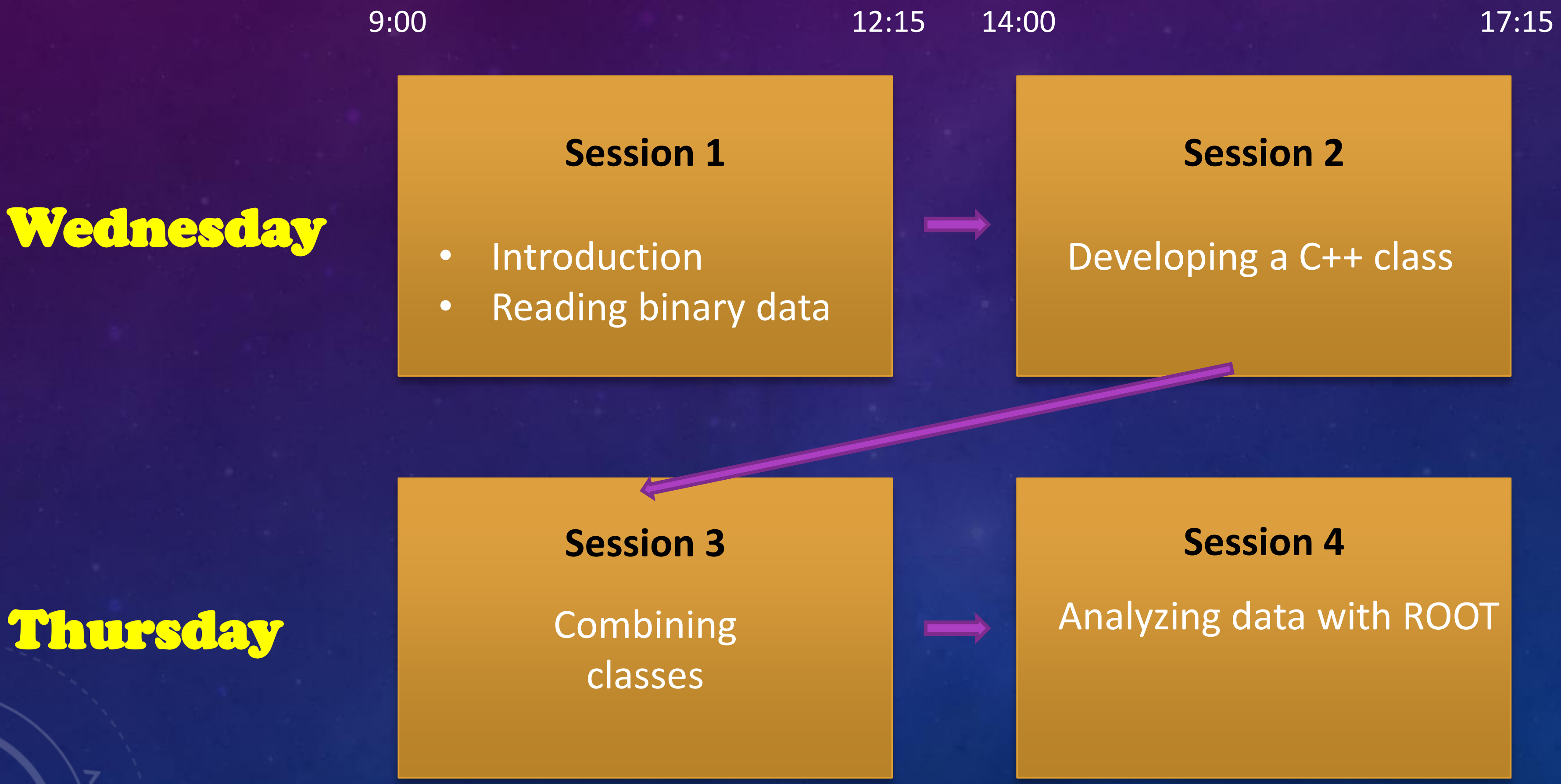
Pressure

# SUMMARY ON ADC SENSITIVITY

| | Pressure | Temperature | Humidity |
|---|---|---|---|
| Full scale | 13.25 hPa to 2013.25 hPa | -20°C to +100°C | 0% to 100% |
| ADC resolution | 12 bits | 12 bits | 8 bits |
| Sensitivity | 0,49 hPa | 0,029 °C | 0,39 % |

# ORGANIZATION

# ORGANIZATION IN SESSIONS



9:00 12:15 14:00 17:15

**Wednesday**

**Session 1**

- Introduction
- Reading binary data

**Session 2**

Developing a C++ class

**Thursday**

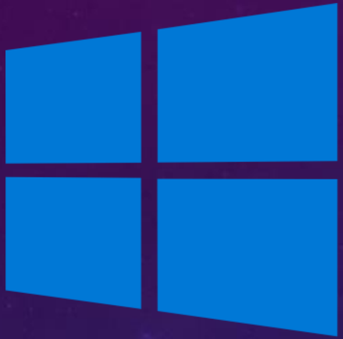
**Session 3**

Combining classes

**Session 4**

Analyzing data with ROOT

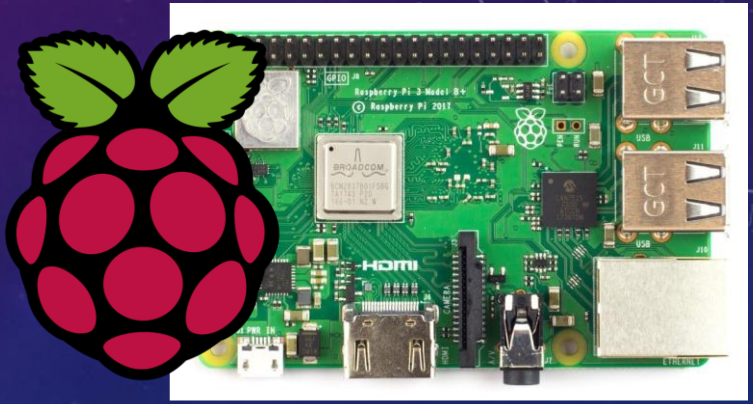
# MULTI-PLATFORM DEVELOPMENT



Windows

Linux

Mac OS X



Raspberry board
(ARM architecture)

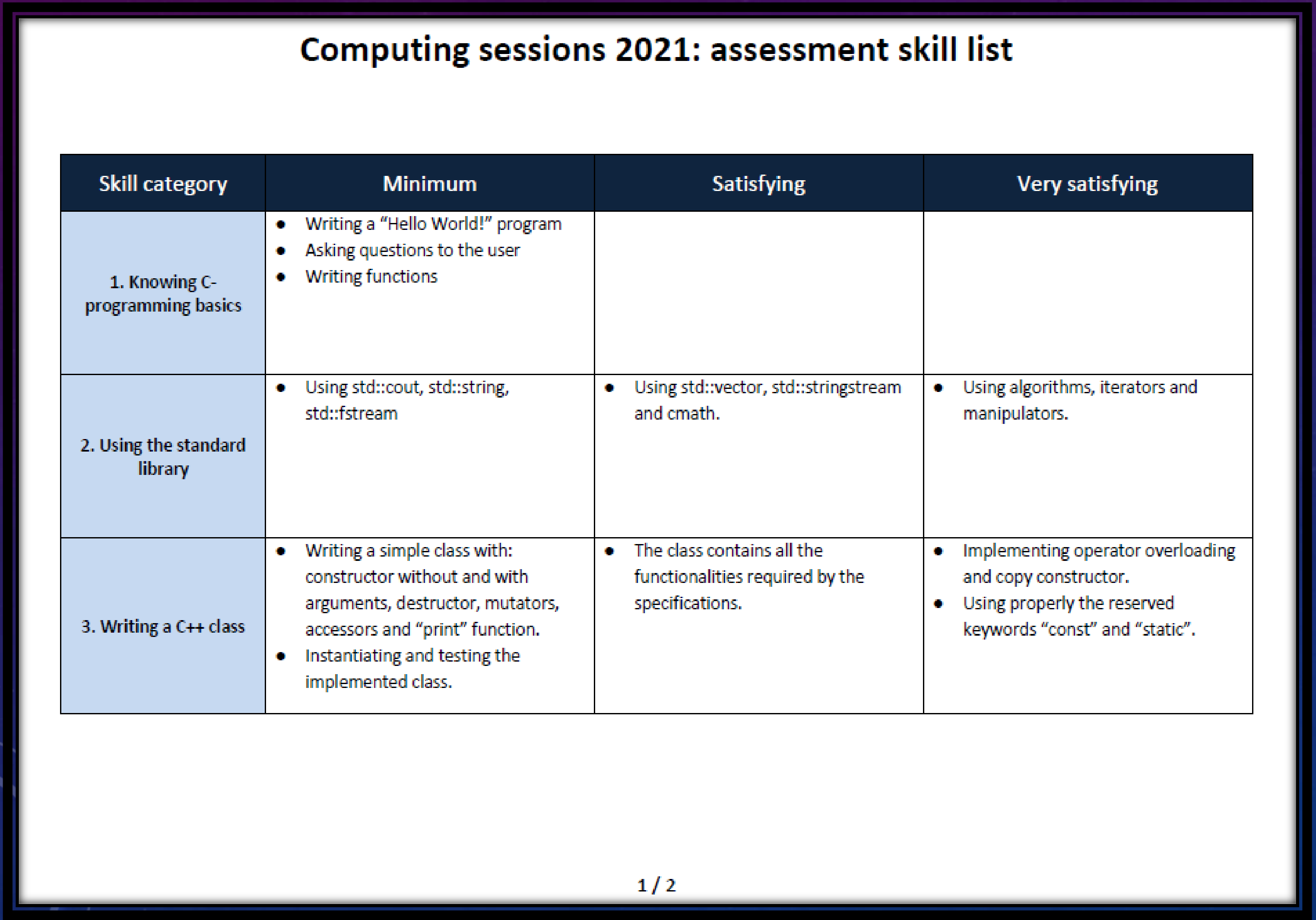
# TOOLS TO USE

- Saving and preserving code on the internet: site github
- Sharing codes with others.

Generating automatically documentation of your code (in HTML and LaTex)

Building a C++ project
witch several files
(Linux / MacOSX only)

# SKILL ASSESSMENT



## Computing sessions 2021: assessment skill list

| Skill category | Minimum | Satisfying | Very satisfying |
|---|---|---|---|
| 1. Knowing C-programming basics | • Writing a “Hello World!” program<br>• Asking questions to the user<br>• Writing functions | | |
| 2. Using the standard library | • Using std::cout, std::string, std::fstream | • Using std::vector, std::stringstream and cmath. | • Using algorithms, iterators and manipulators. |
| 3. Writing a C++ class | • Writing a simple class with: constructor without and with arguments, destructor, mutators, accessors and “print” function.<br>• Instantiating and testing the implemented class. | • The class contains all the functionalities required by the specifications. | • Implementing operator overloading and copy constructor.<br>• Using properly the reserved keywords “const” and “static”. |

1 / 2

- Individual work is required
- Evaluation over 8 categories
- For validating the module
  - Minimum level must be reached for all the 8 categories
  - Satisfying level for at least 4 categories