

INTRODUCTION TO ESIPAP COMPUTING SESSIONS

WEDNESDAY 8 – THURSDAY 9 FEBRUARY 2023

ERIC CHABERT - ERIC CONTE

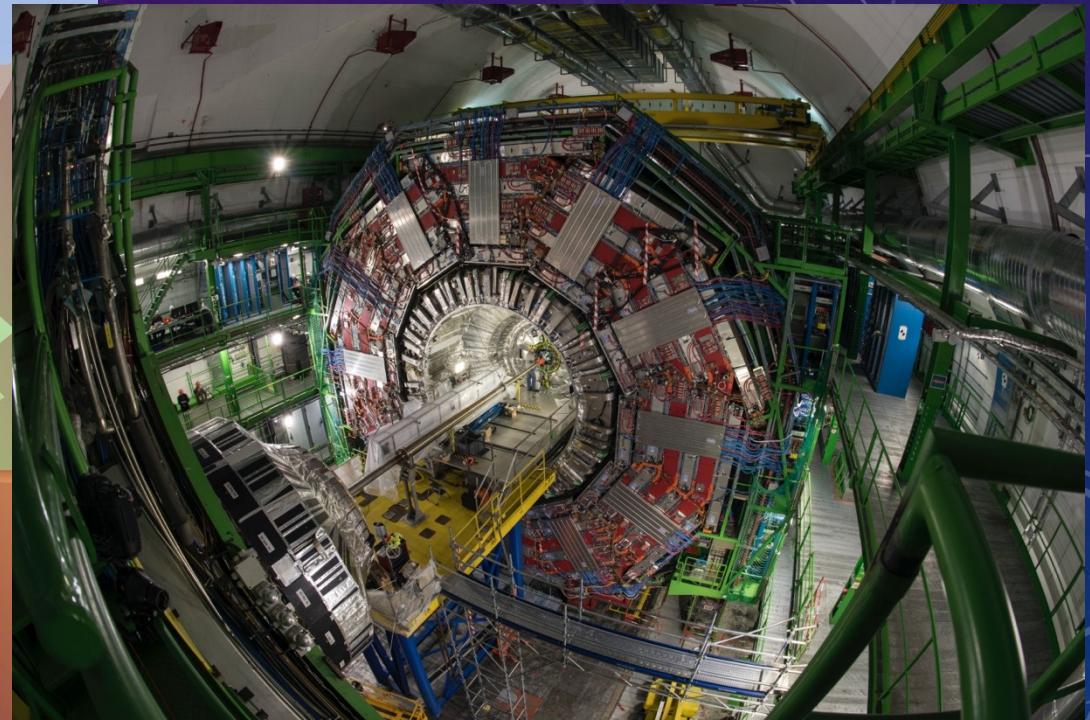
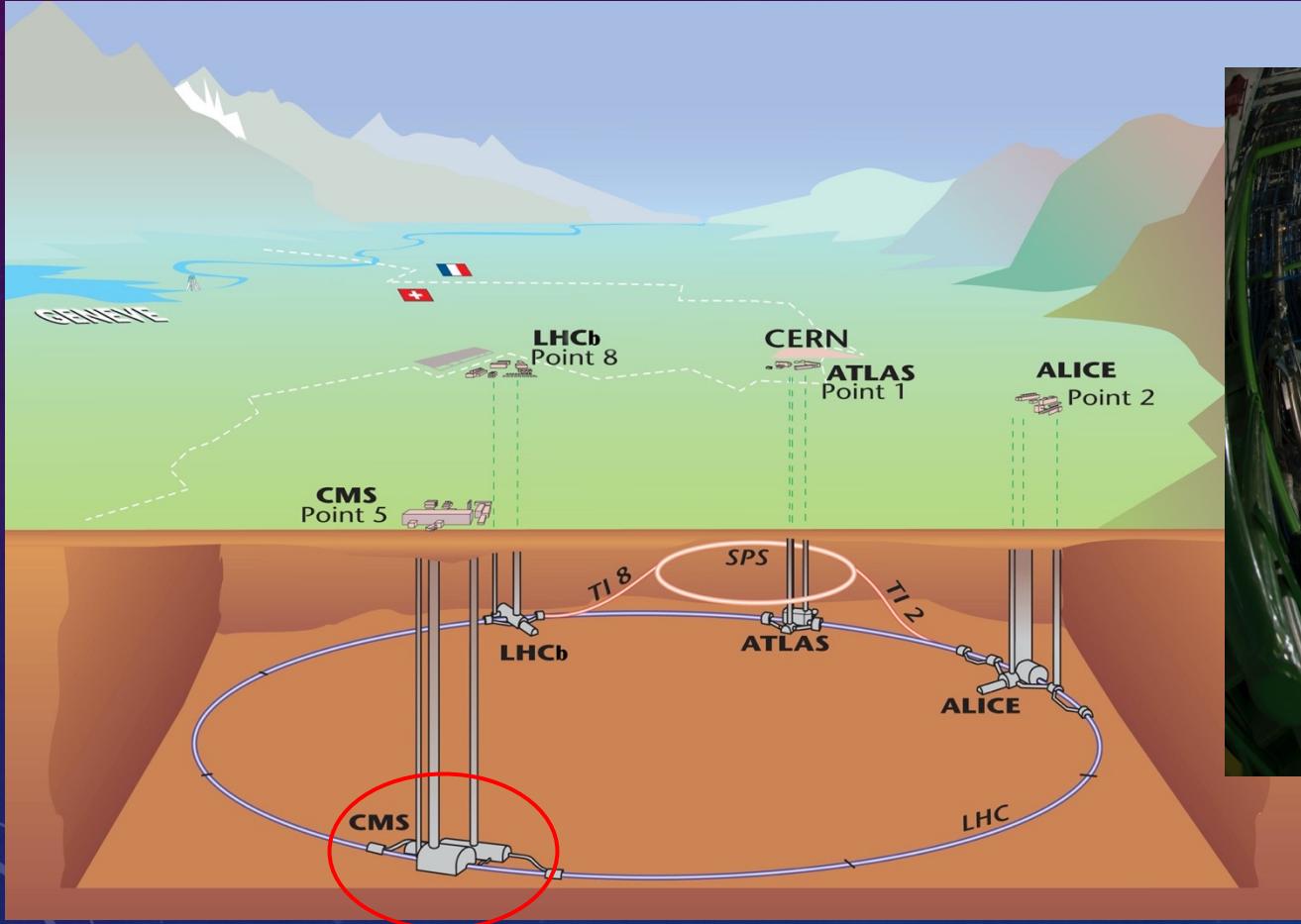
GOALS OF THE COMPUTING SESSIONS

- 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

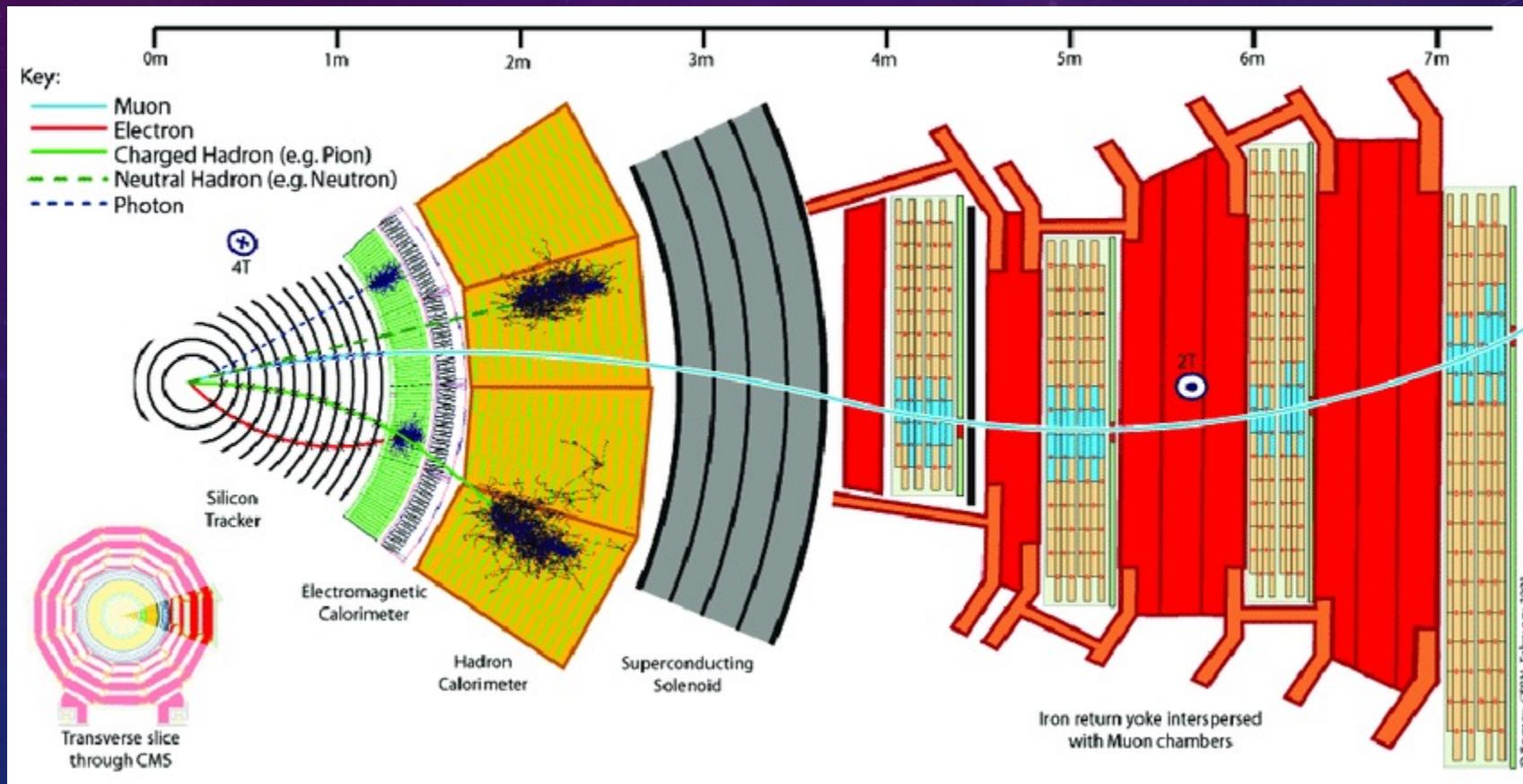


PHYSICS CONTEXT

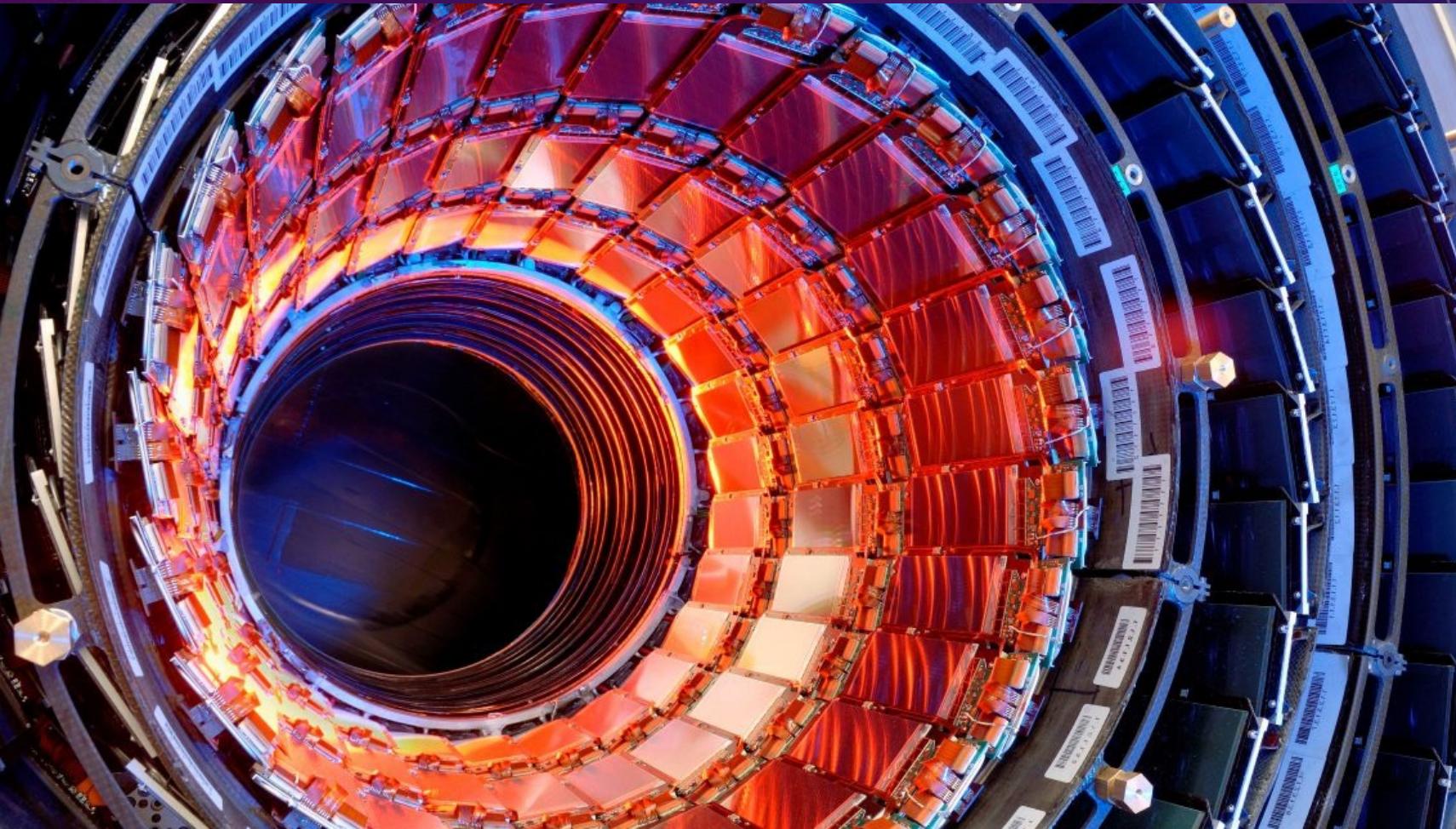
THE CMS (COMPACT MUON SOLENOID) DETECTOR



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SILICON STRIP TRACKER



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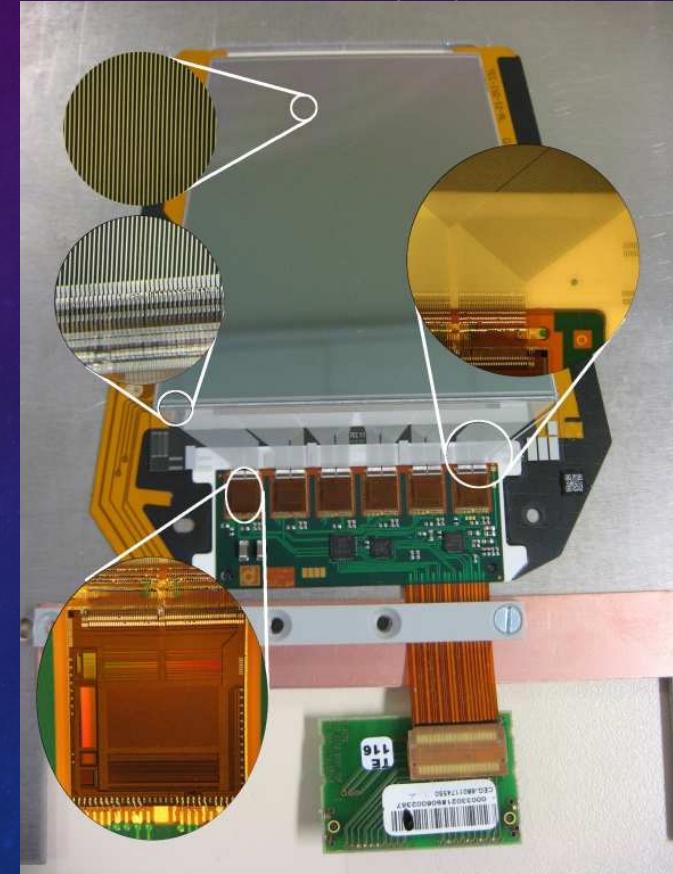


Instrumental activities

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

CMS silicon strip tracker in few numbers:

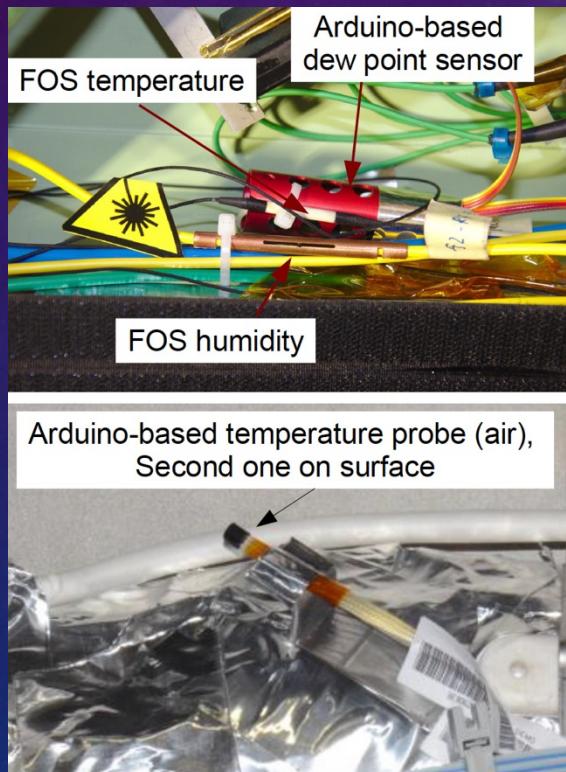
- 15 000 modules
- Surface: $\sim 200 \text{ m}^2$
- 10^6 channels



Performances:

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

SILICON STRIP TRACKER



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:

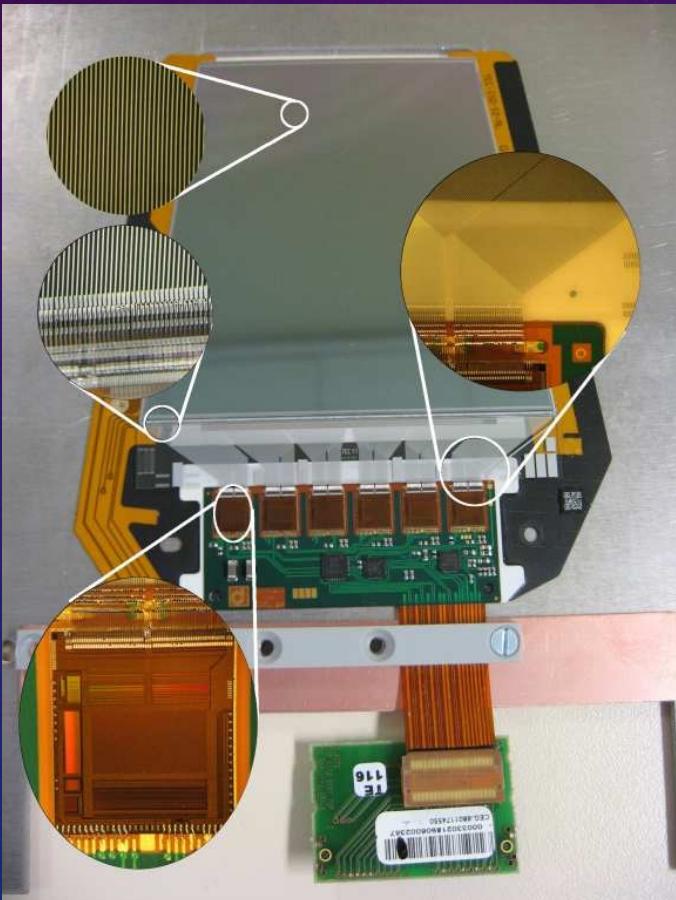
- On-board sensors
- External sensors

→ 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

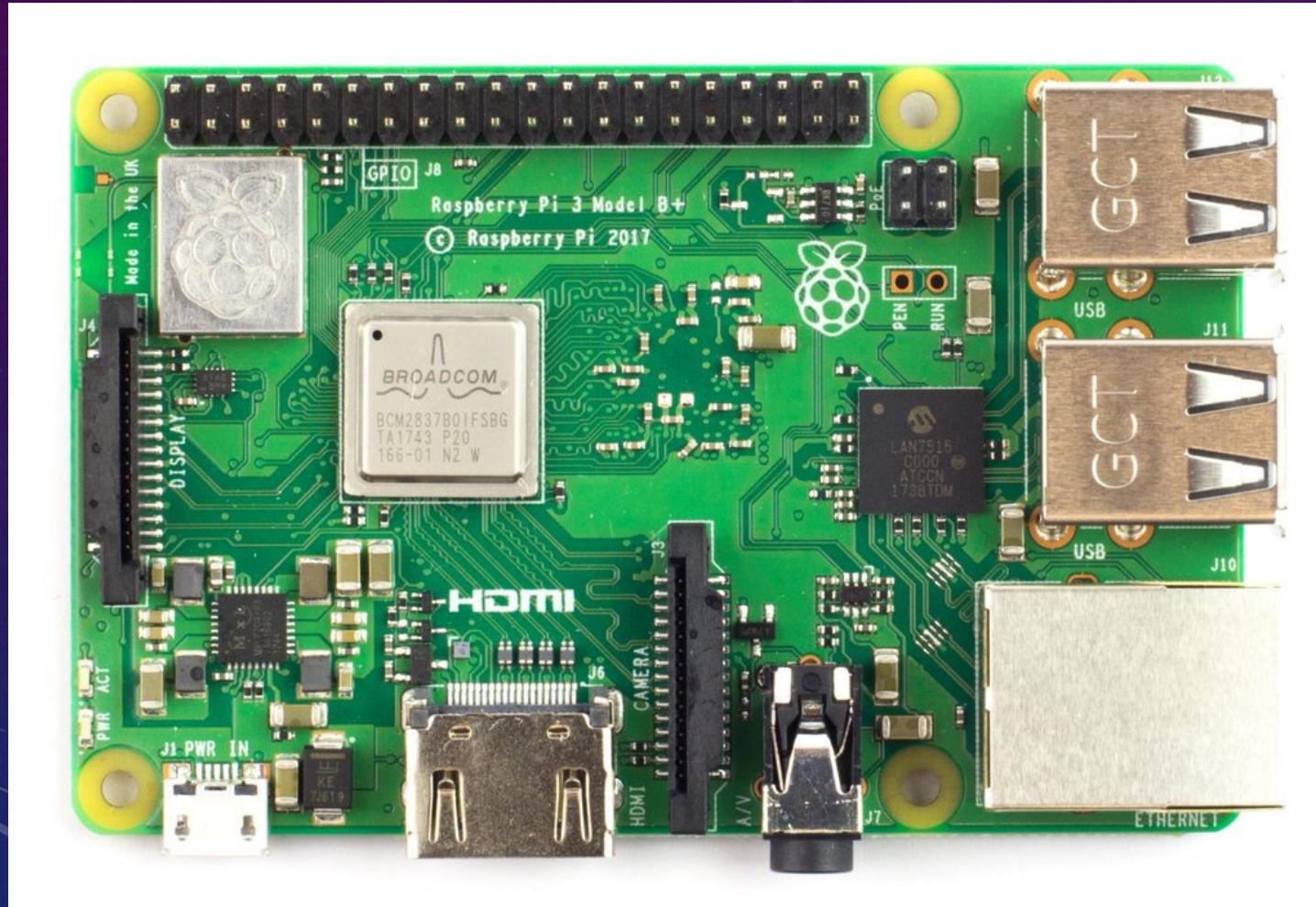
- Calibration of the temperature sensors
- Evaluation of the sensor resolution

3. Simulation

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

SETUP

THE RASPBERRY BOARD



Raspberry Pi 3 B+ motherboard

- Quad-core 64 bits processors @ 1,4 GHz
- ARM (Acorn Risc Machine) architecture used mainly in smartphones, tablets, robotics, automation

Advantages : price, flexibility, performances

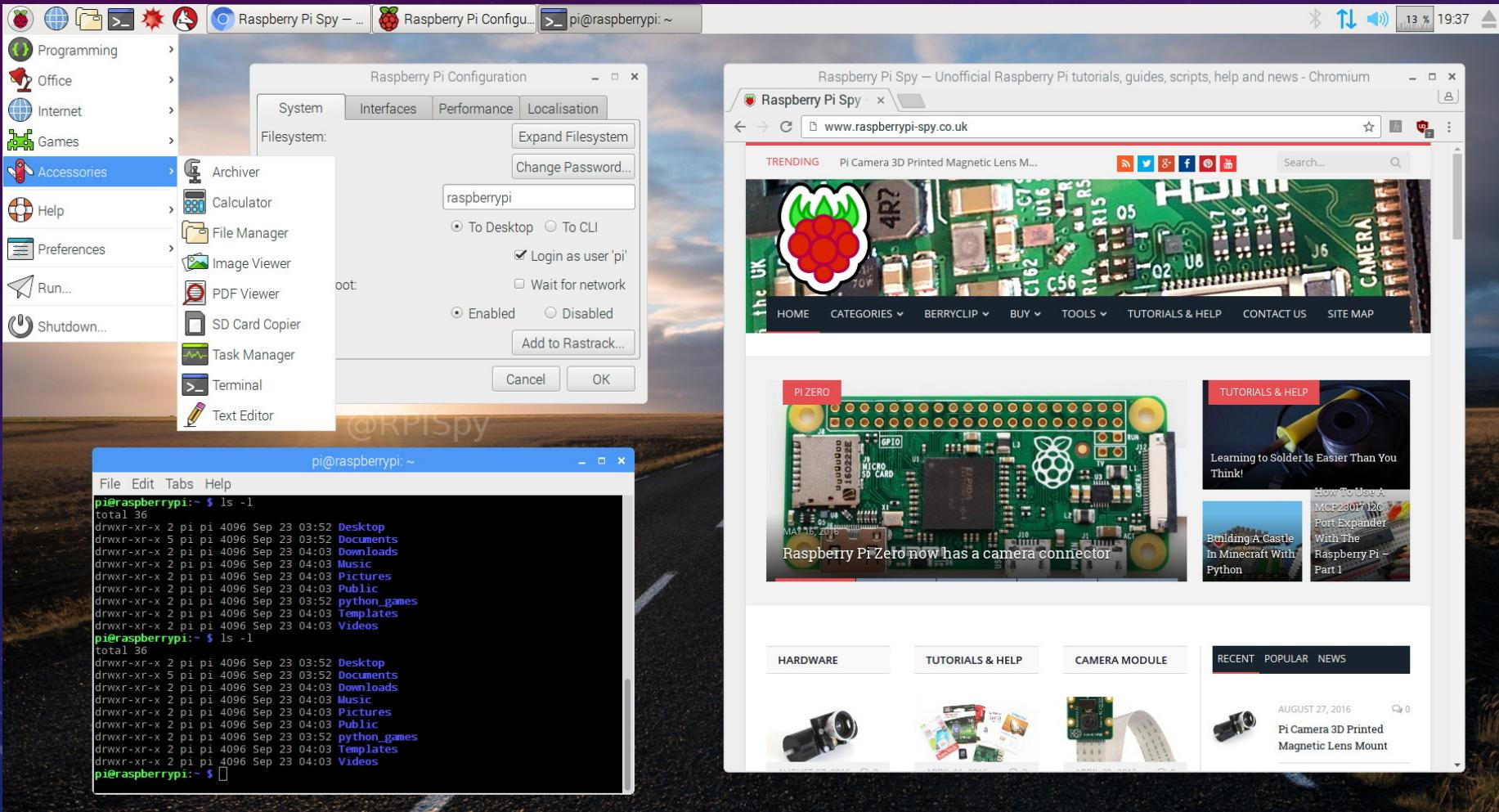
CONNECTIONS TO PERIPHERICAL DEVICES



- 4 USB ports
- 1 ethernet port
- 1 HDMI plug
- 1 GPIO (General Purpose Input/Output) port for connecting sensors
- Powered by micro USB (5V, 2.5A min)

+ WIFI
+ Bluetooth

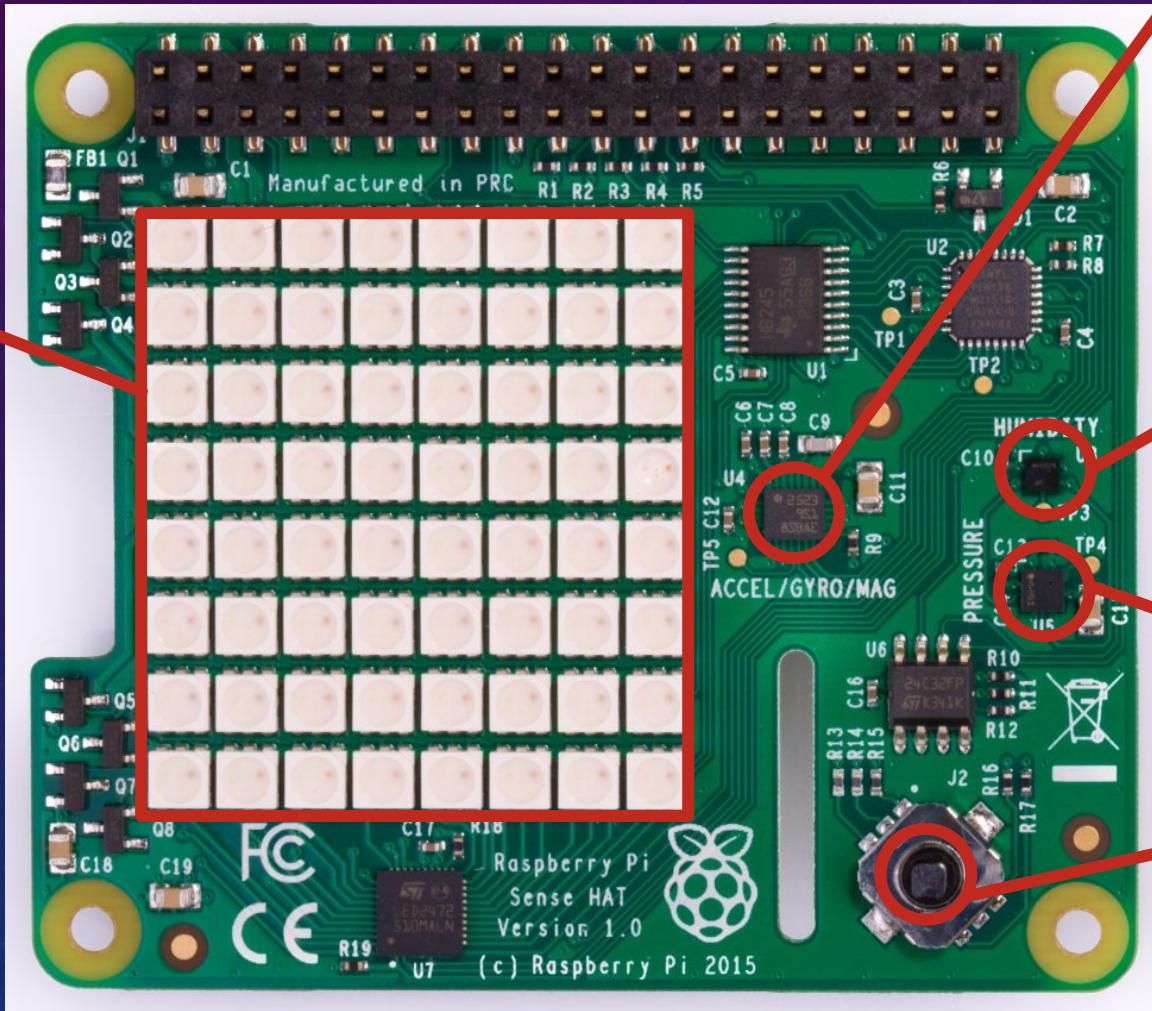
LINUX DISTRIBUTION: RASPBIAN



Stored on a
micro SD card

SENSE HAT BOARD

8x8 LEDs for display



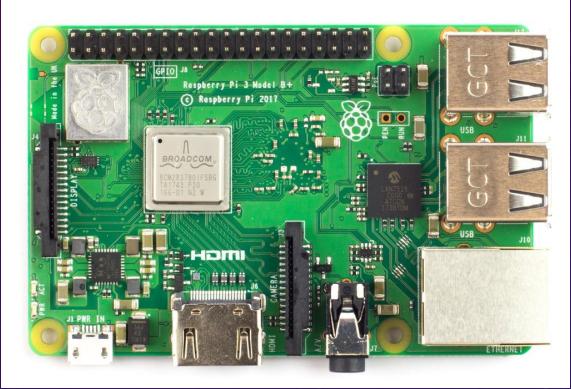
3D accelerometer,
3D gyrometer and
3D magnetometer
sensor

Humidity / Temperature
sensor

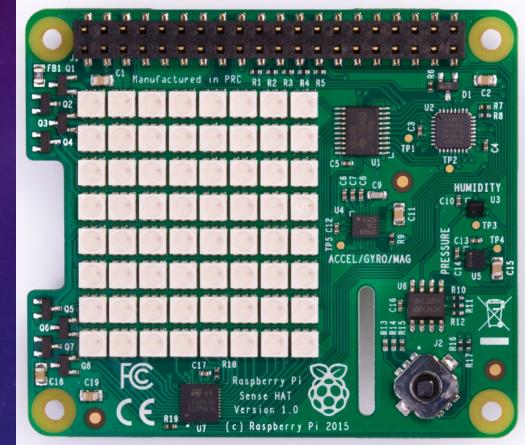
Pressure / Temperature
sensor

Joystick

PRICE



Raspberry Pi 3 B+
~ 40 €



Sense HAT
~ 30 €



Connectors
~ 15 €

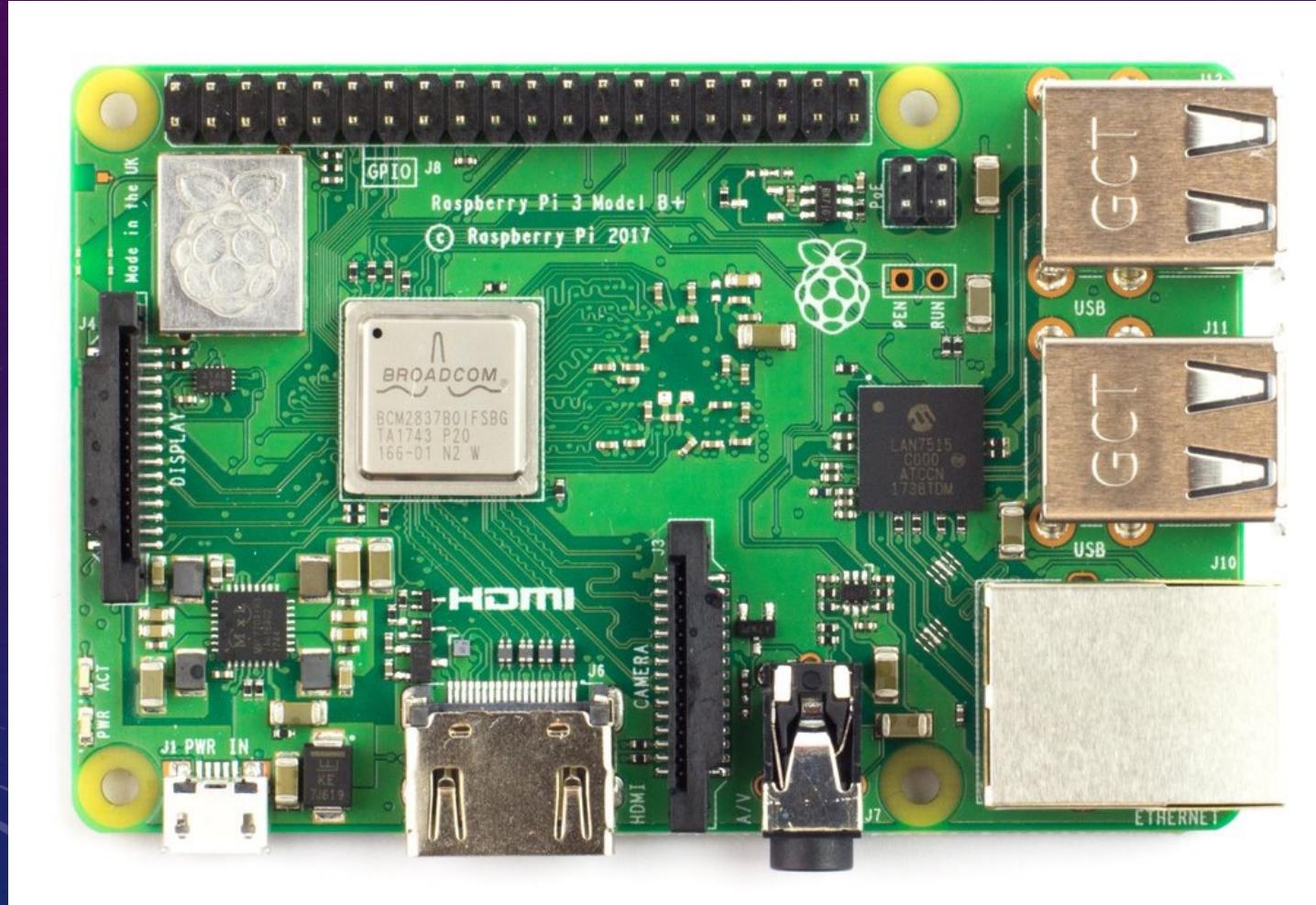
Micro SD
~ 10 €



Total: ~ 100€
(good gift for Saint-
Valentin's day)

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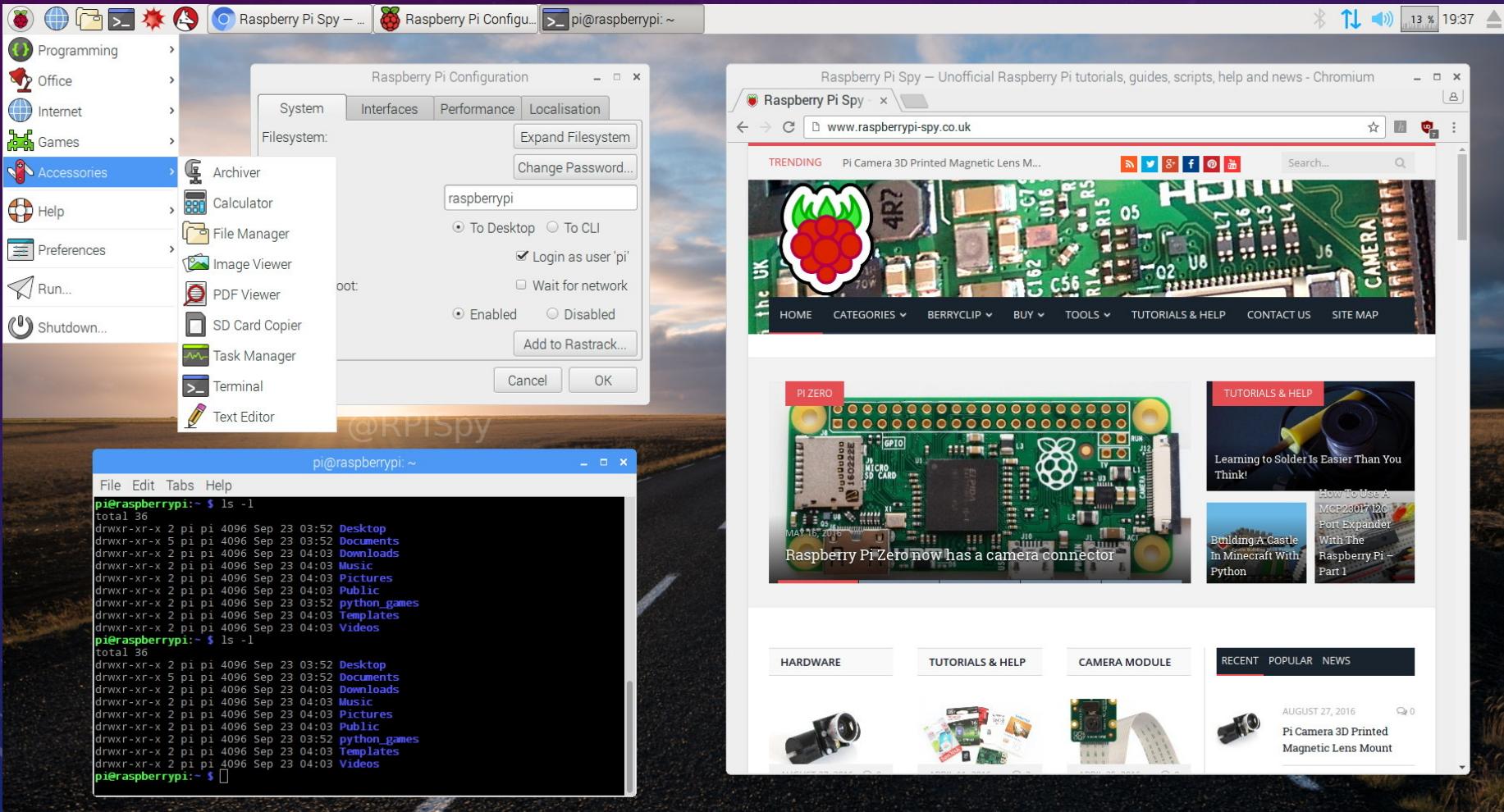
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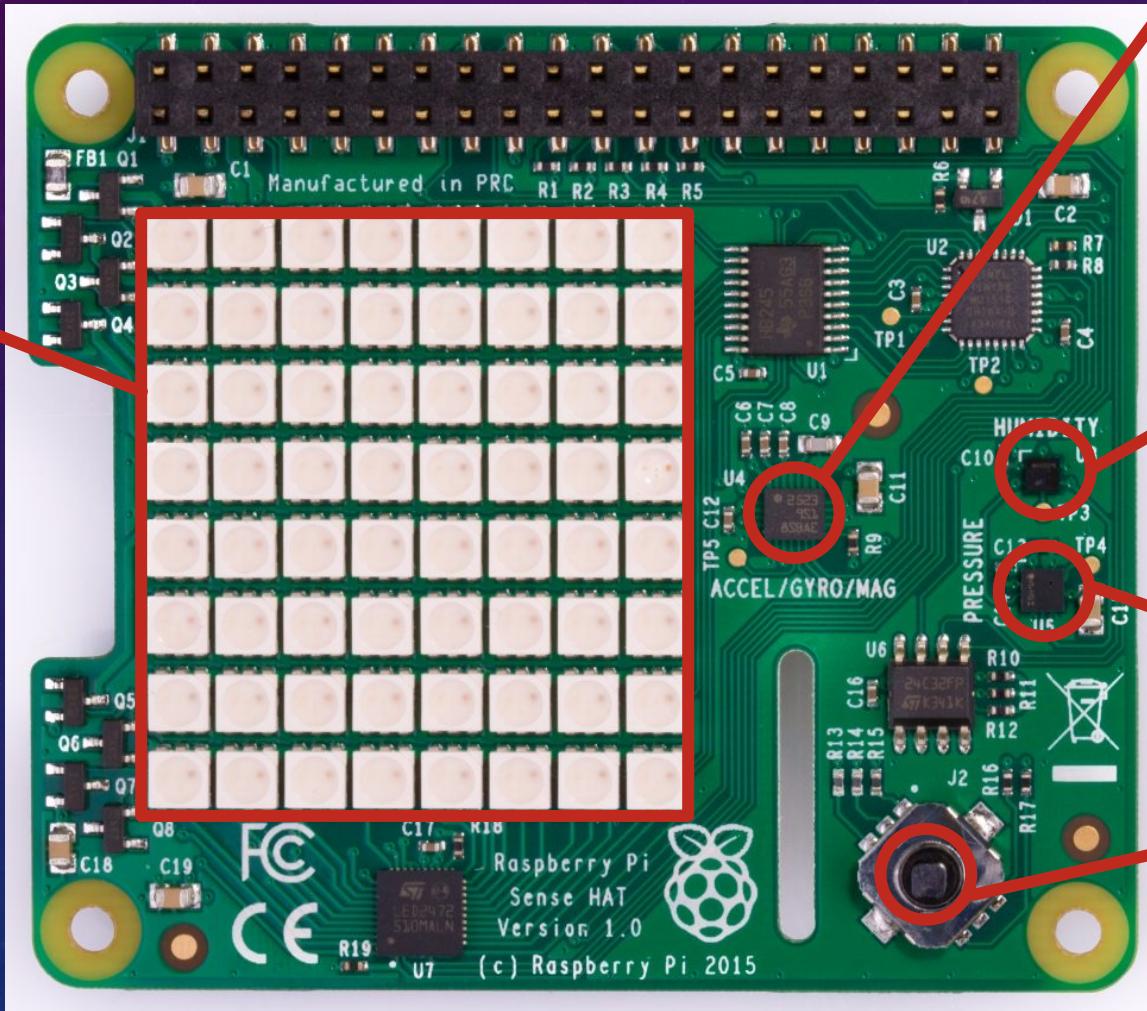
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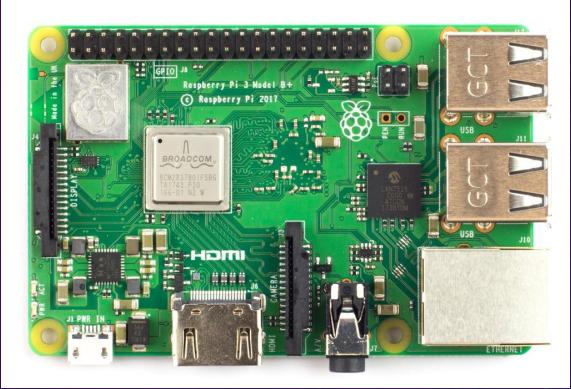
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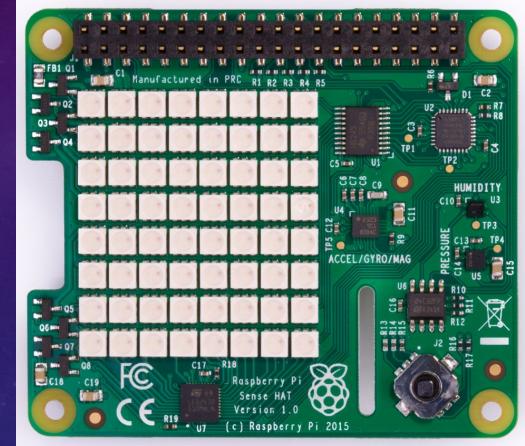
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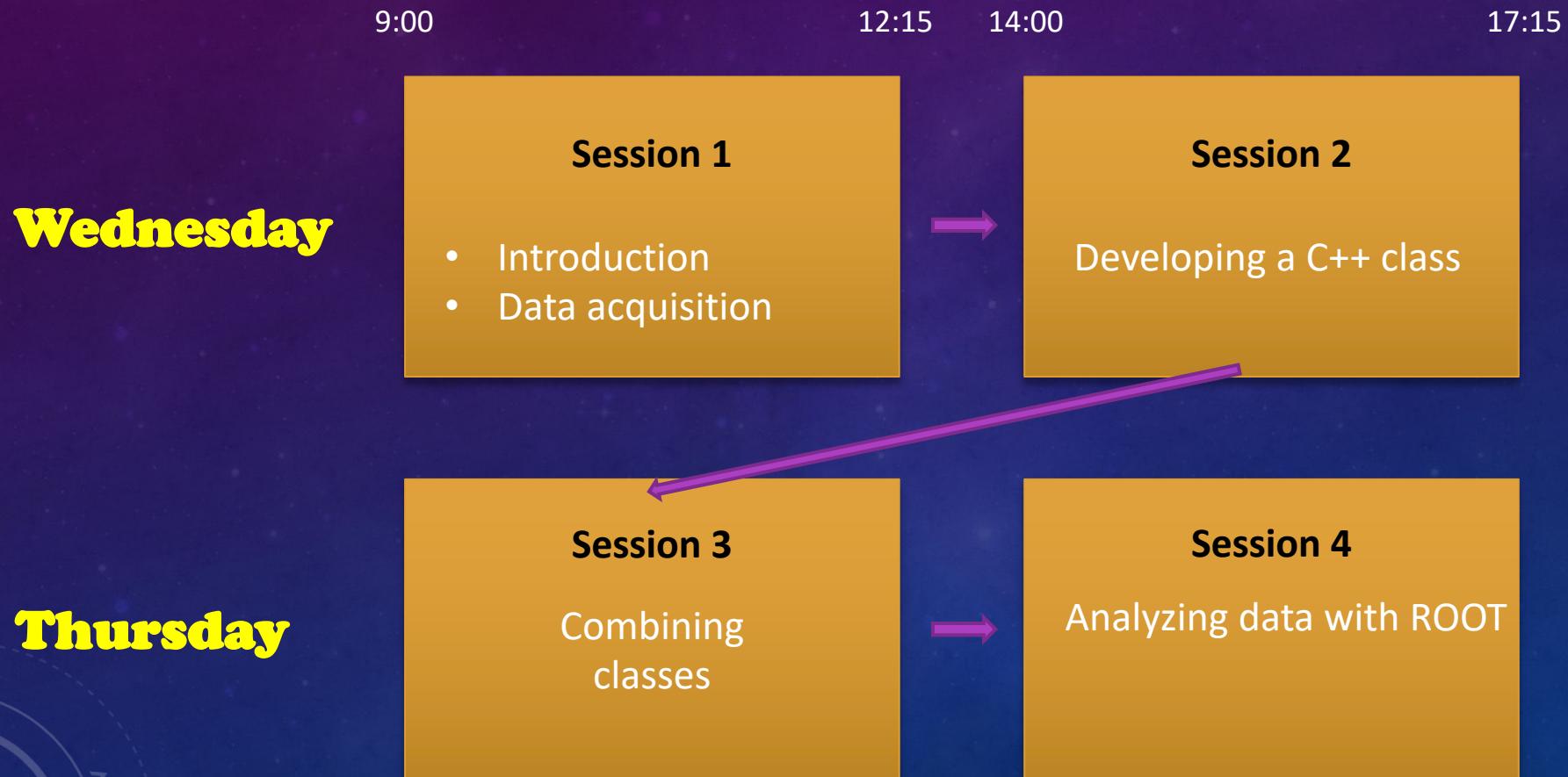


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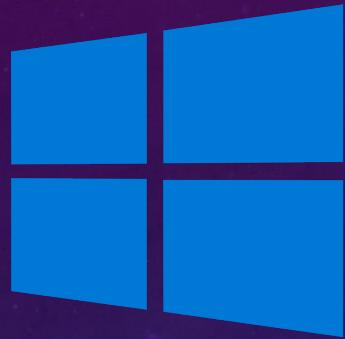
DATA USED IN THE COMPUTING SESSIONS

ORGANIZATION

ORGANIZATION IN SESSIONS



MULTI-PLATFORM DEVELOPMENT



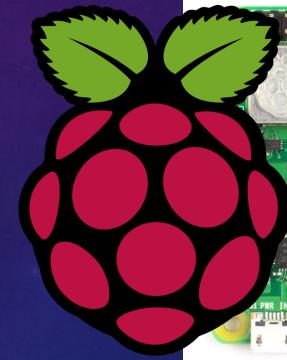
Windows



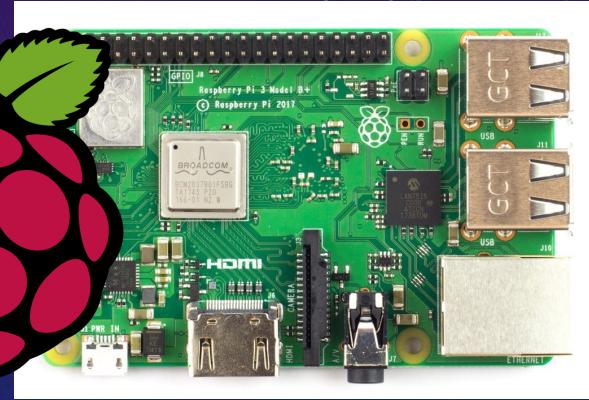
Linux



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 with several files
(Linux / Mac OSX only)

SKILL ASSESSMENT

Computing sessions 2021: assessment skill list

Skill category	Minimum	Satisfying	Very satisfying
1. Knowing C-programming basics	<ul style="list-style-type: none">Writing a "Hello World!" programAsking questions to the userWriting functions		
2. Using the standard library	<ul style="list-style-type: none">Using std::cout, std::string, std::fstream	<ul style="list-style-type: none">Using std::vector, std::stringstream and cmath.	<ul style="list-style-type: none">Using algorithms, iterators and manipulators.
3. Writing a C++ class	<ul style="list-style-type: none">Writing a simple class with: constructor without and with arguments, destructor, mutators, accessors and "print" function.Instantiating and testing the implemented class.	<ul style="list-style-type: none">The class contains all the functionalities required by the specifications.	<ul style="list-style-type: none">Implementing operator overloading and copy constructor.Using properly the reserved keywords "const" and "static".

- 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