A Raspberry Pi based environmental parameter system

Anna Zacharopoulou, Ioannis Papakrivopoulos,

George Bakas, Yorgos Tsipolitis

NTUA

Contents

- Raspberry Pi, Sensor BME280
- OPC UA Server
- WinCC OA
- Summary

Raspberry Pi

- Low cost credit card-sized computer

- Computer Laboratory Cambridge University

- Broadcom **S**ystem **o**n a **C**hip (**SoC**) → ARM, CPU and GPU

- Many **O**peration **S**ystems → **Raspbian** (based on Debian, Linux)

- Plenty interconnection and expansion capabilities
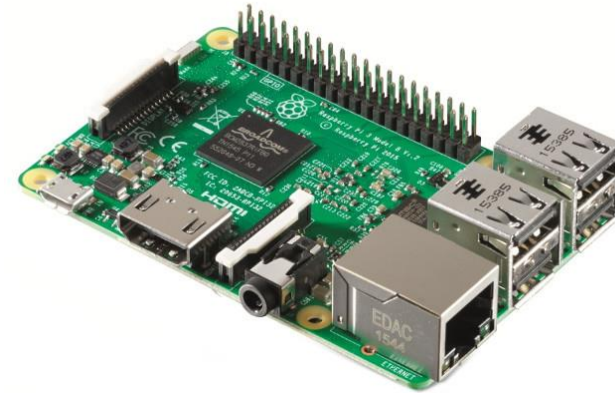
- Endless open source applications

       [Clusters, Web Server, Gaming, Media Center, Personal Cloud Service]

# Raspberry Pi

Models
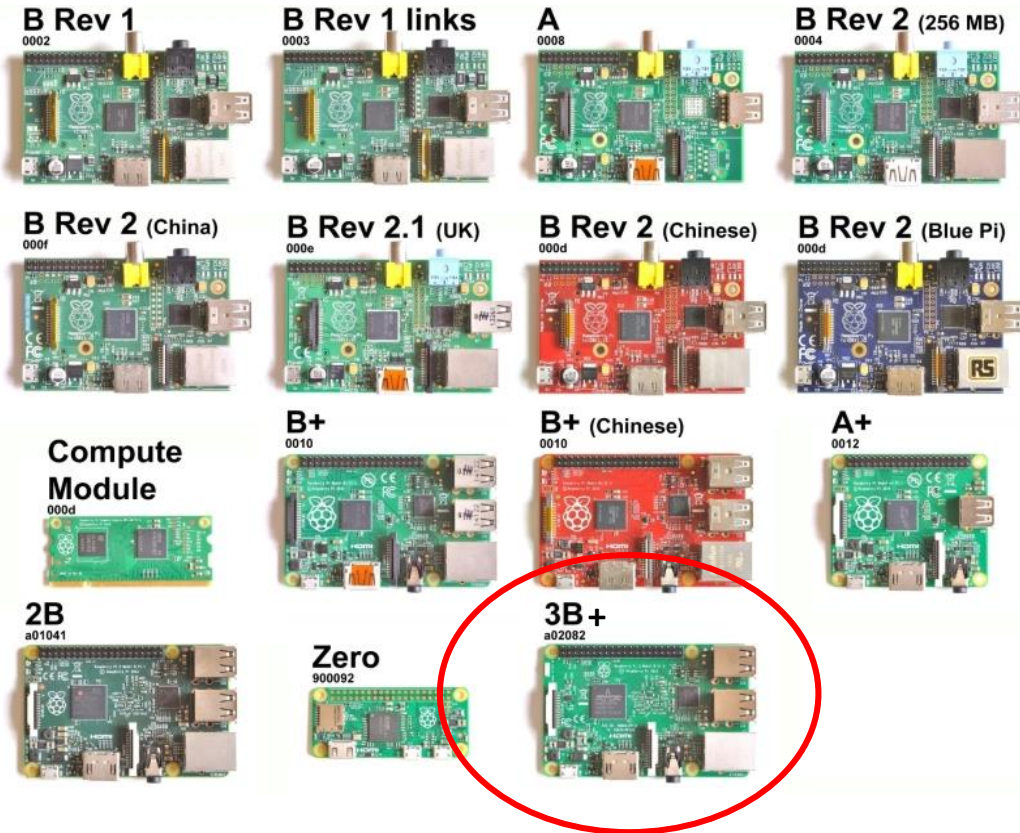

Raspberry Pi 3 B+

- Power Supply 5V 2A
- Av. Consumption ~ 3-4W

- Processor Broadcom BCM2837 SoC with a 1.2 GHz 64-bit quad-core ARM Cortex-A53
- RAM 1GB
- 802.11 b/g/n Wireless LAN
- Bluetooth 4.1 (Bluetooth Classic and Low Energy)
- GPU: Dual Core VideoCore IV® Multimedia Co-Processor. Provides Open GL ES 2.0, hardware-accelerated OpenVG

Raspberry Pi 3 B+ Expansion Ports

- 4 USB ports
- Full HDMI port
- Ethernet port
- Combined 3.5mm
  audio jack
  and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- VideoCore IV 3D graphics core
- 40 GPIO pins
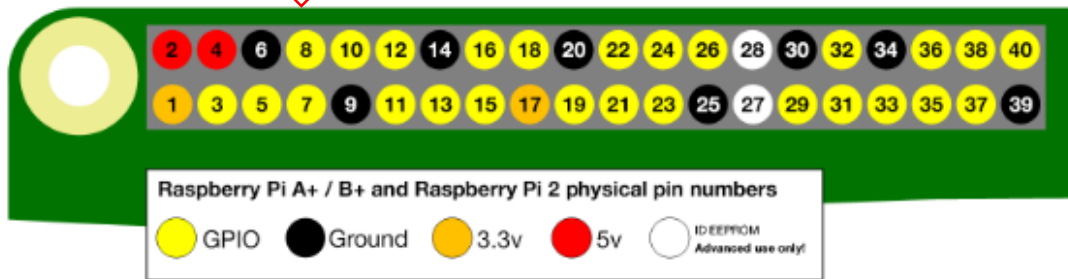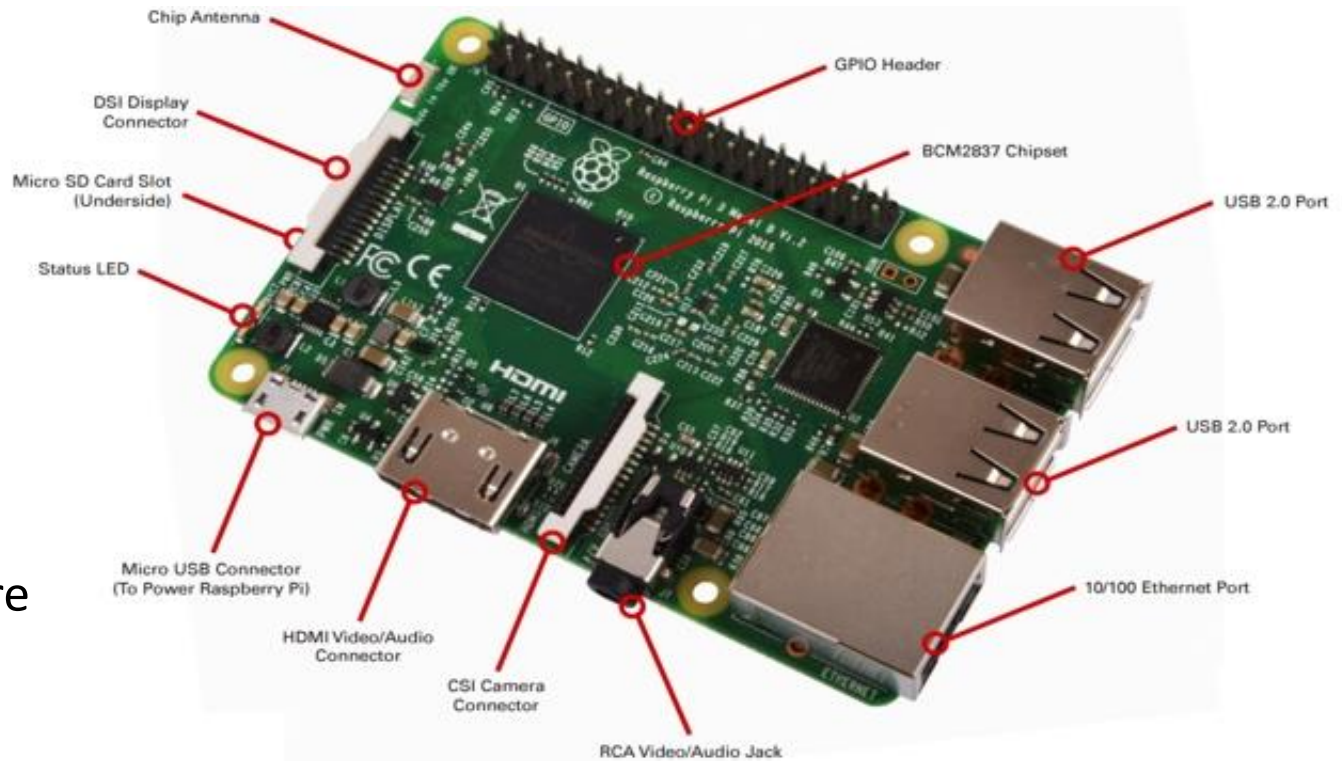
General Purpose I/O:
- 26 digital
- 4 power supply (5V & 3.3V)
- 8 ground
- 2 ID EEPROM

Sensor BME280

- Sensor by Bosh
- PCB by Adafruit

Specifications:

- Temperature : ±1°C / -40°C … +85°C
- Pressure : ±1mbar / 300mbar … 1100mbar
- Humidity : ±3% / 0% … 100%

Wiring

1 BME280
0x77 I^{2}C address

Vin	GND	SCK	SDI
3V3	GND	PIN 5	PIN 3

2 BMEs280
0x76 I^{2}C address

Vin	GND	SCK	SD0	SDI
3V3	GND	PIN 5	GND	PIN 3
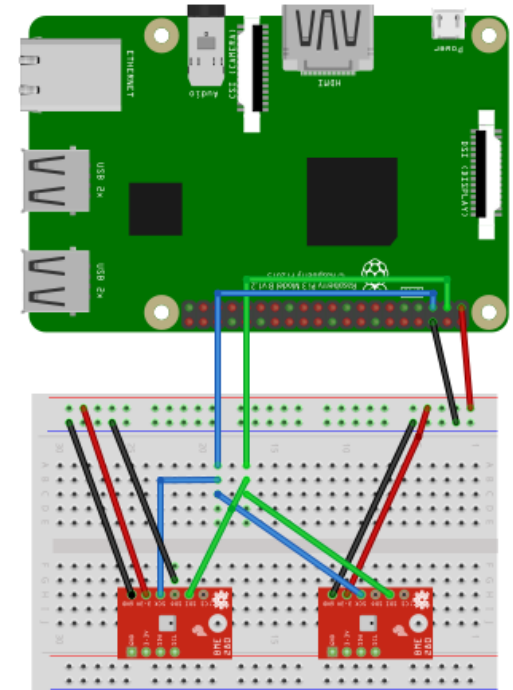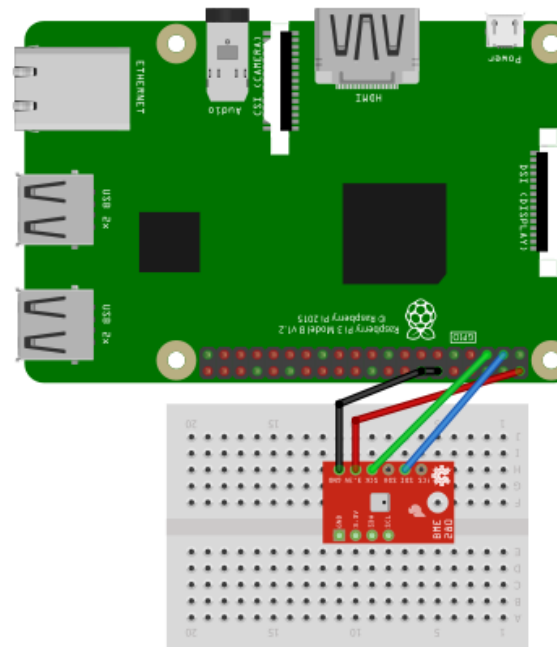
Sensor BME280

Sending data to Web Server for monitoring
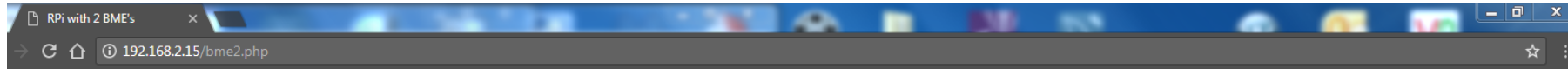
Obtaining and monitoring environmental parameters

with Raspberry Pi 3+

BME280 No 1

Time 09:44:24pm		
Temperature	26.3 (± 1)	°C
Pressure	962.16 (± 1)	mbar
Hummidity	55.0 (± 3)	%

BME280 No 2

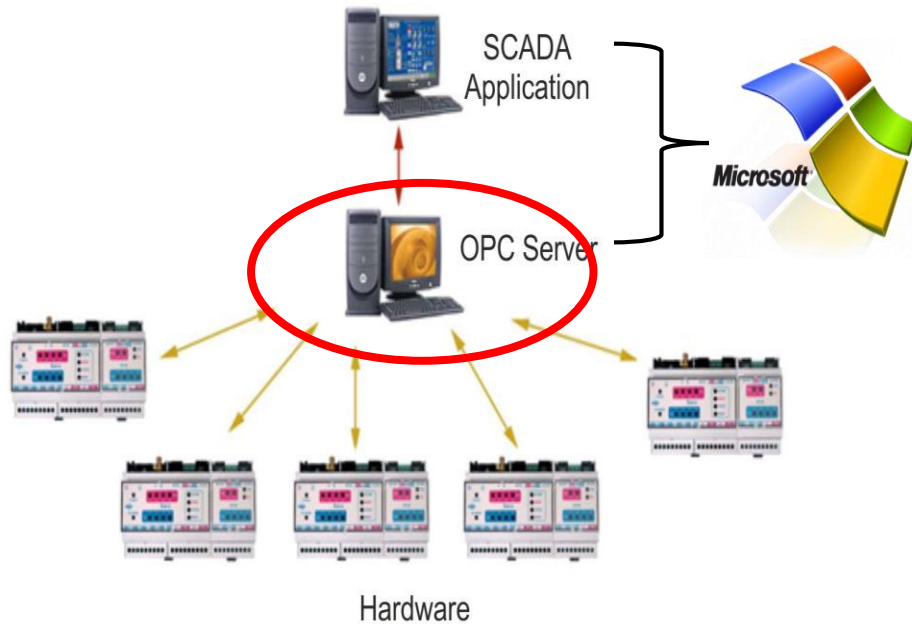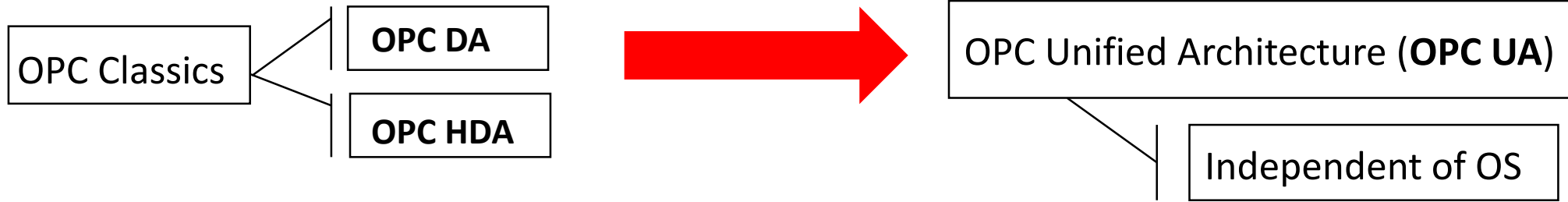| Time 09:44:25pm		
Temperature	25.9 (± 1)	°C
Pressure	960.2 (± 1)	mbar
Hummidity	54.7 (± 3)	%

Return

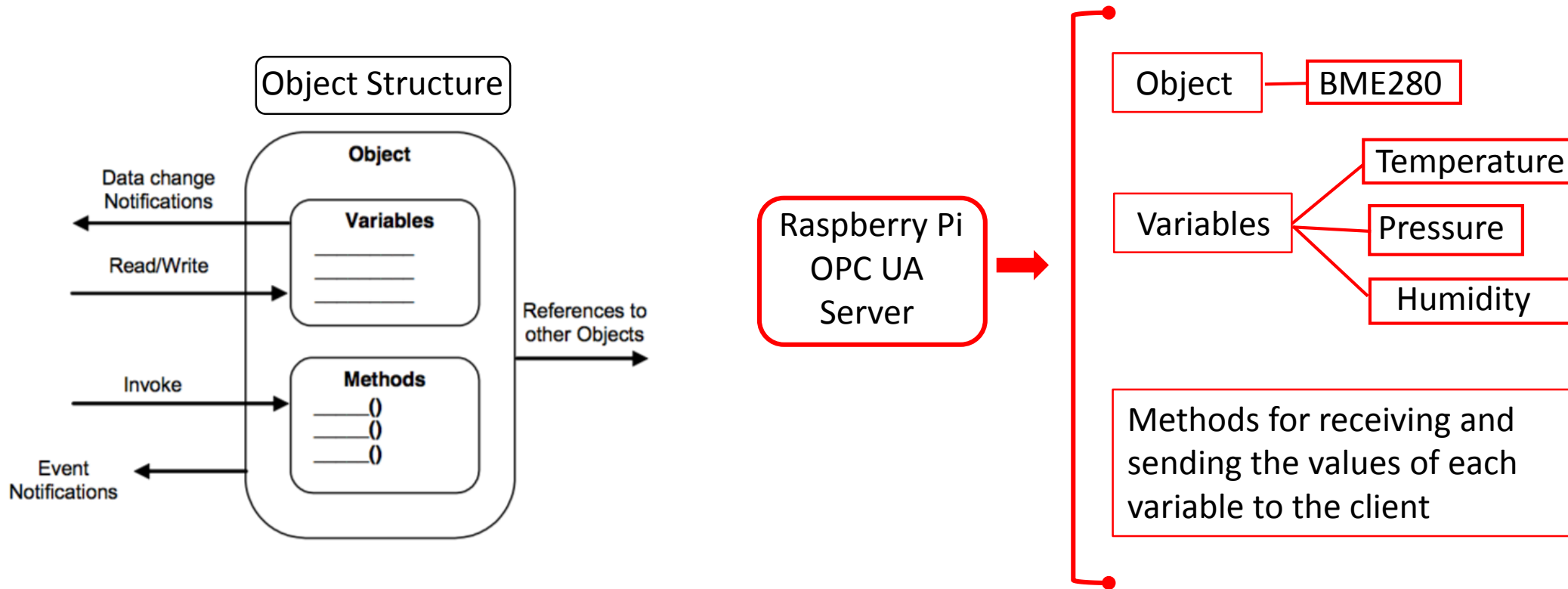Photos of Raspberry Pi connected with 2 BMEs280, a touch screen and a keyboard
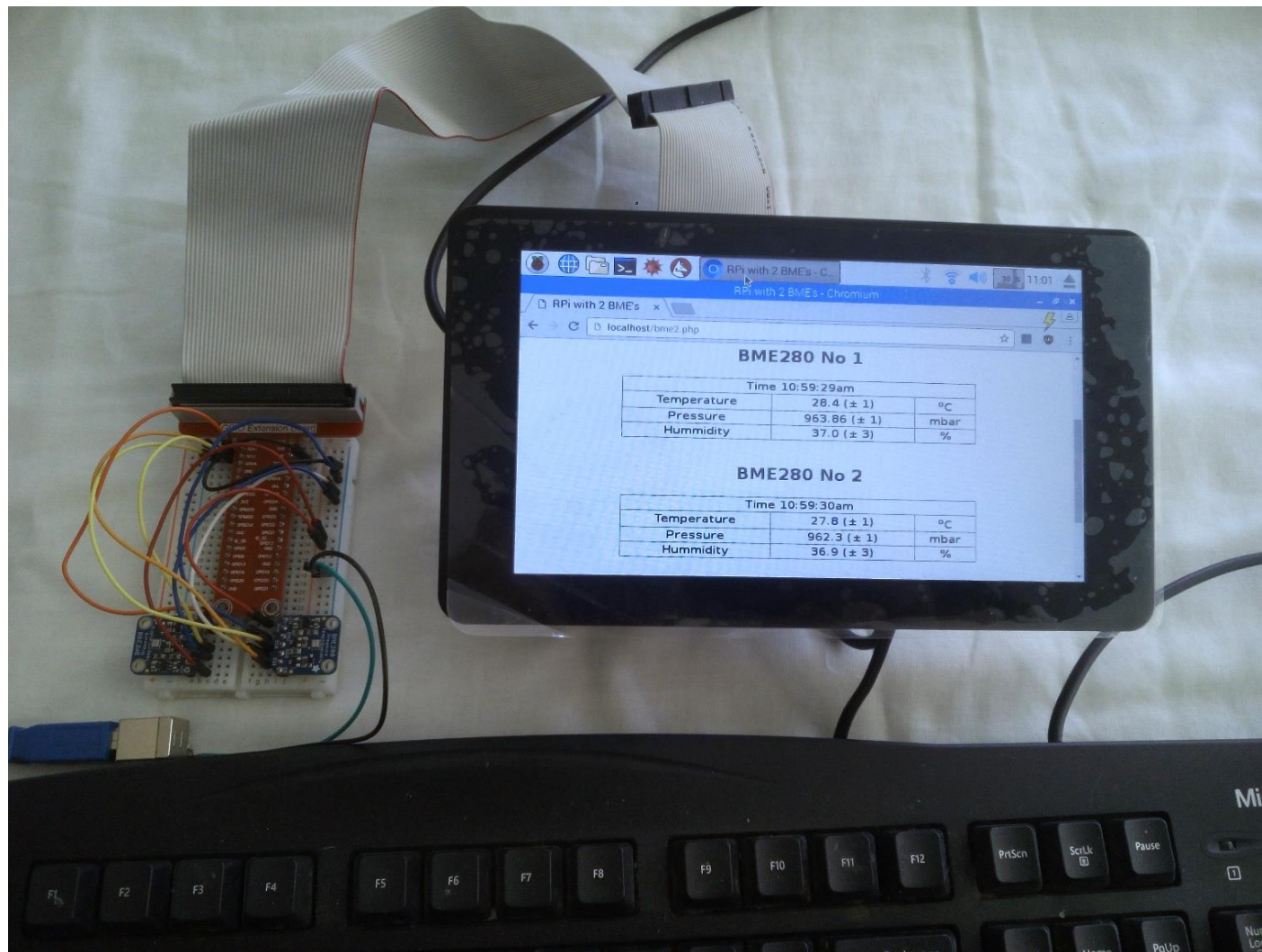
OPC Server

Communication Protocol   **O**pen **P**latform **C**ommunication **(OPC)**

OPC Classics
— OPC DA
— OPC HDA

➡️

OPC Unified Architecture (**OPC UA**)
— Independent of OS

SCADA Application

OPC Server

Microsoft

Hardware

- "machine to machine" protocol
- Service Oriented Architecture (SOA)
- COM/DCOM (OPC Classics) **Vs** SOA (OPC UA)
  → Security Functionality
- Binary Protocol → **opc.tcp://server**
- Web Service (SOAP) → **http://server**

OPC UA Raspberry Pi Server

- The structure of OPC UA Server is based on **AddressSpace Model** which represents all the **Objects** that the Server sends to Clients.
- Every Object consists of **Variables** and **Methods**.
- Packages: '**FreeOPCUA**' (entirely in Python), **cryptography** (security reasons)
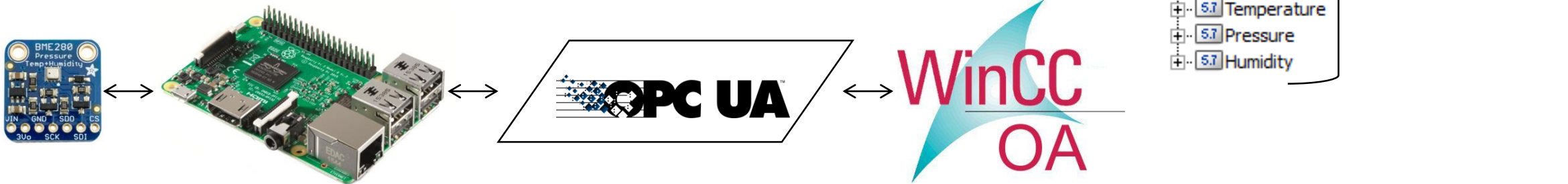
Object Structure

Raspberry Pi OPC UA Server

Object — BME280

Variables — Temperature / Pressure / Humidity

Methods for receiving and sending the values of each variable to the client

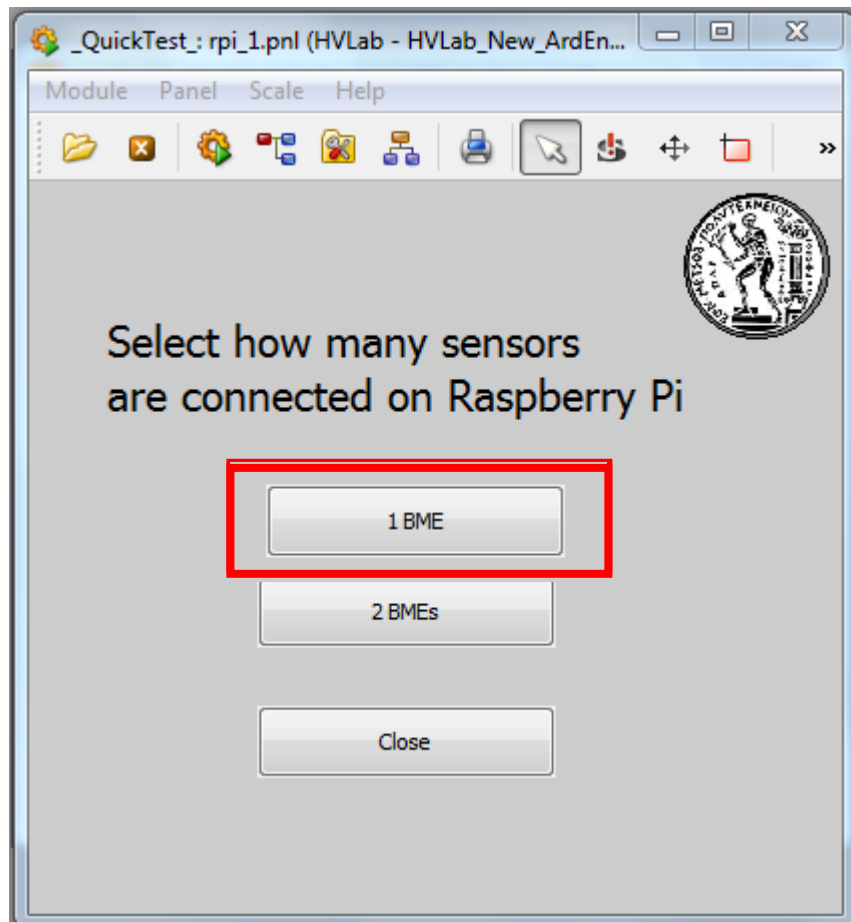# WinCC OA

Supervising Control and Data Acquisition (SCADA)

Key features

- Graphics Editor (GEDI)
- Control Scripts
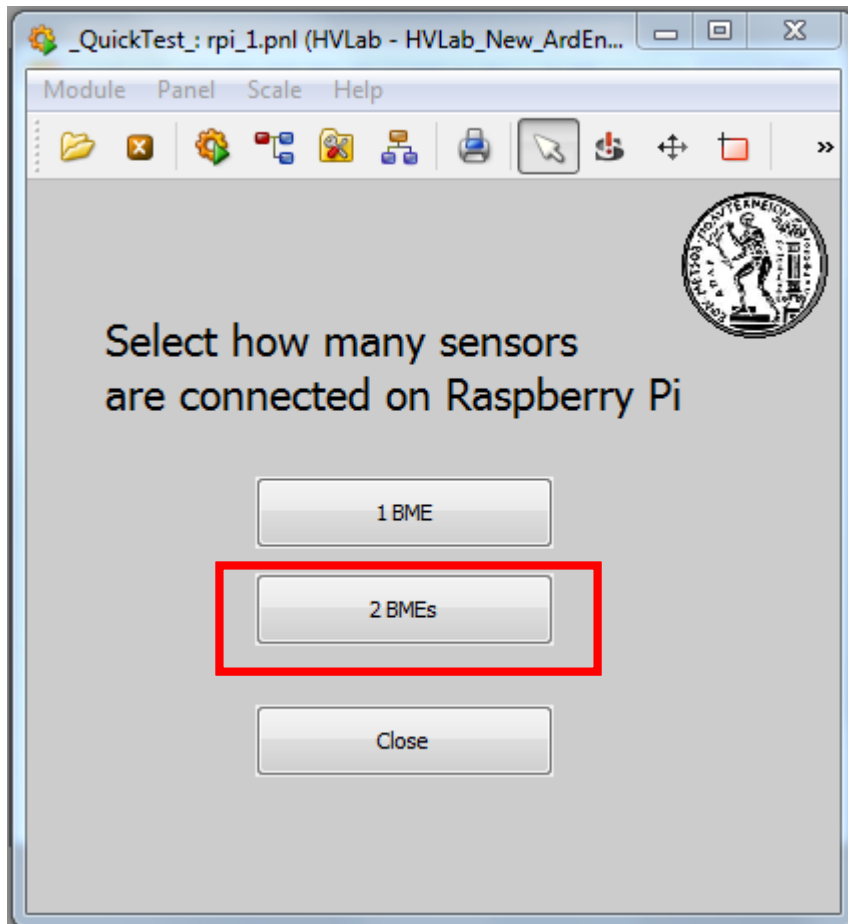- Connection with peripherals
- Database

WinCC OA

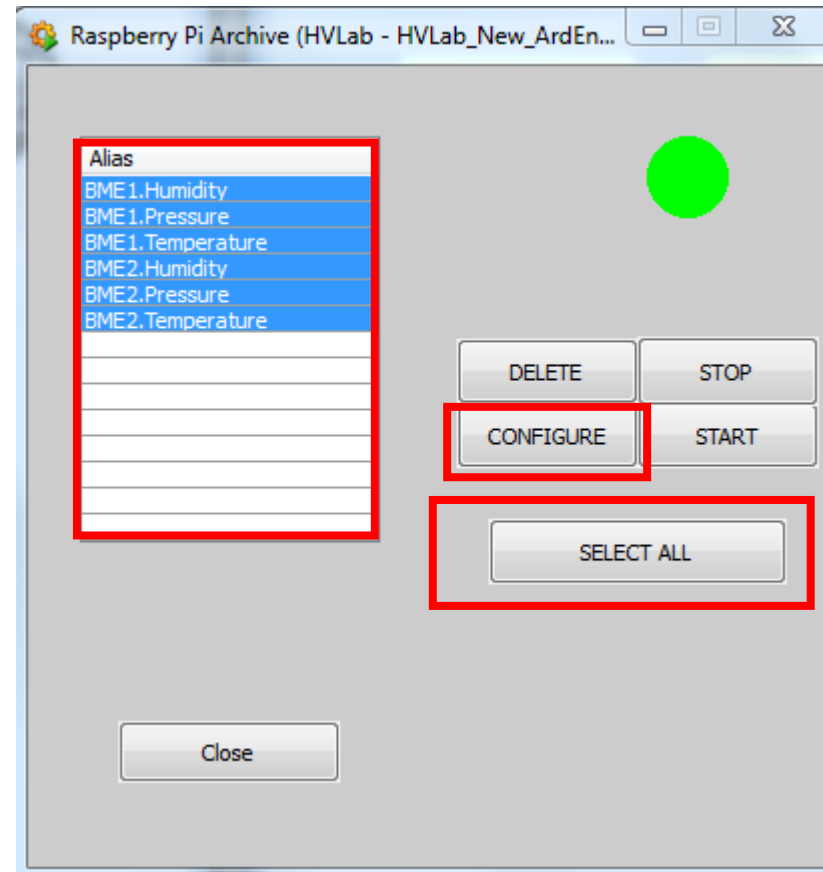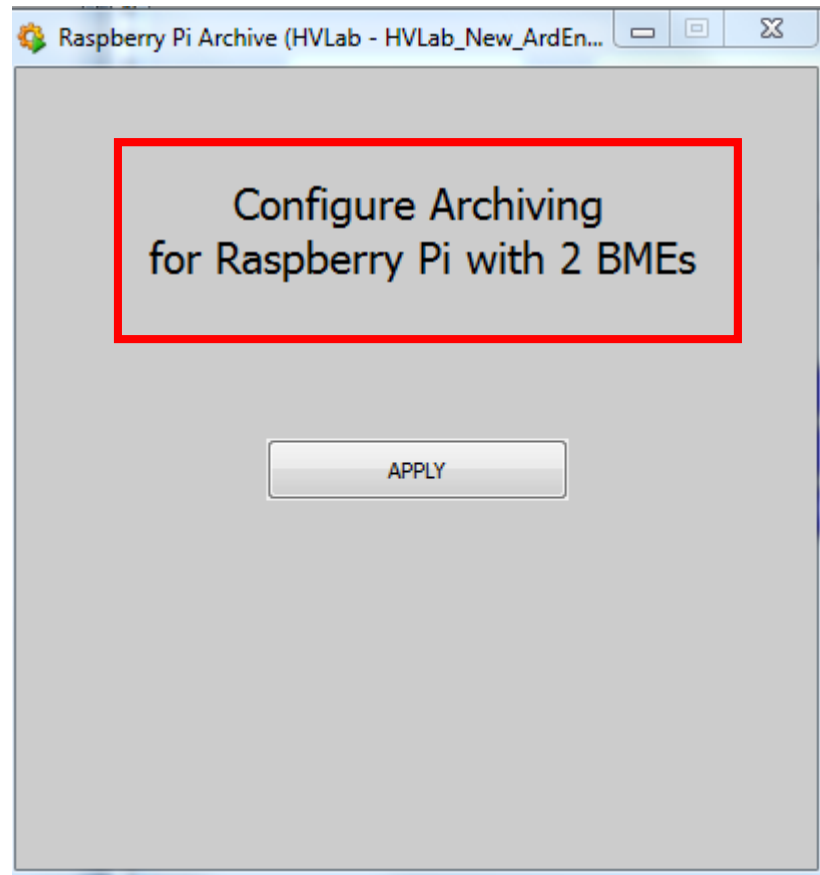## Raspberry Pi Project – Main panels
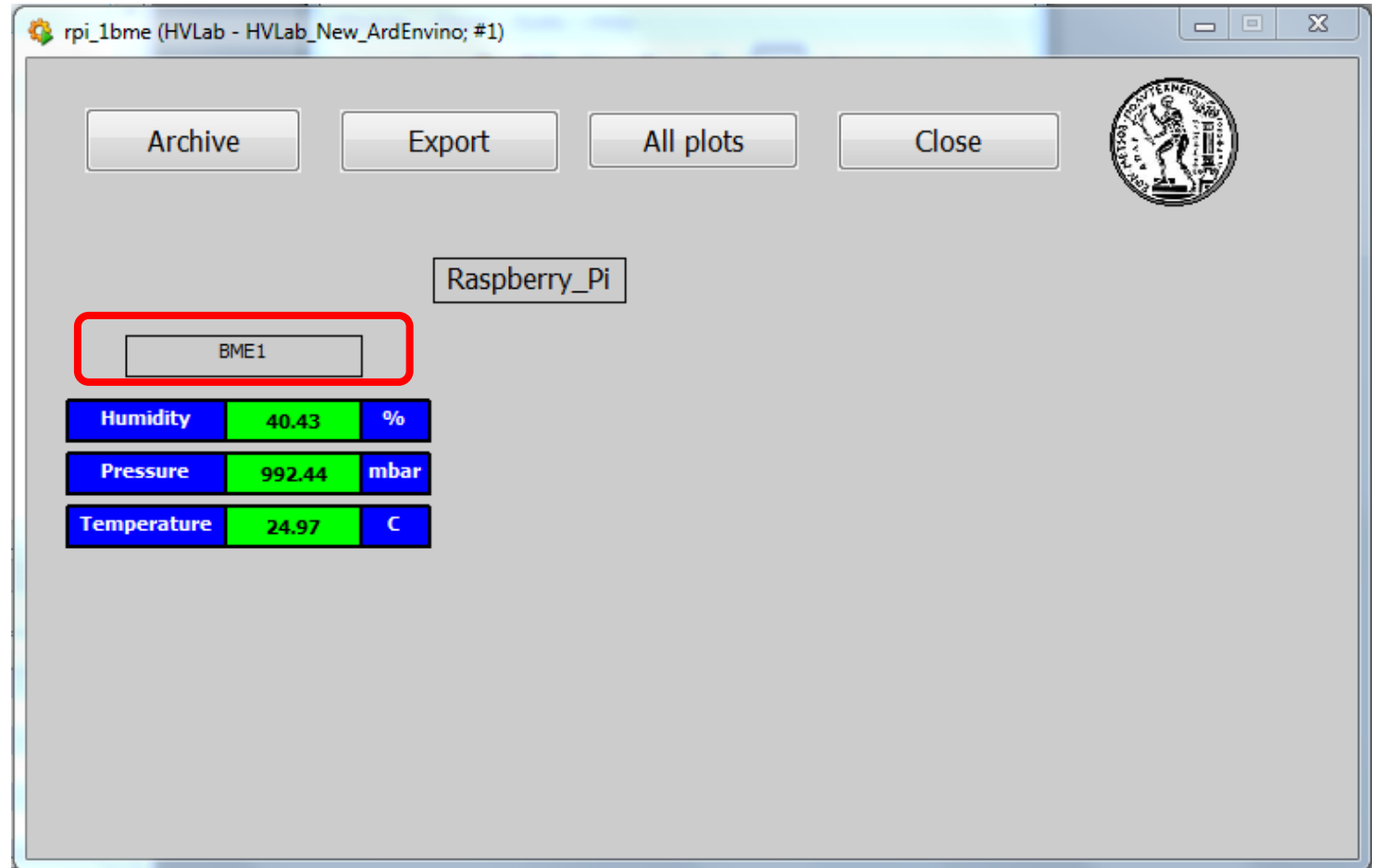
WinCC OA

Raspberry Pi Project – Main panels
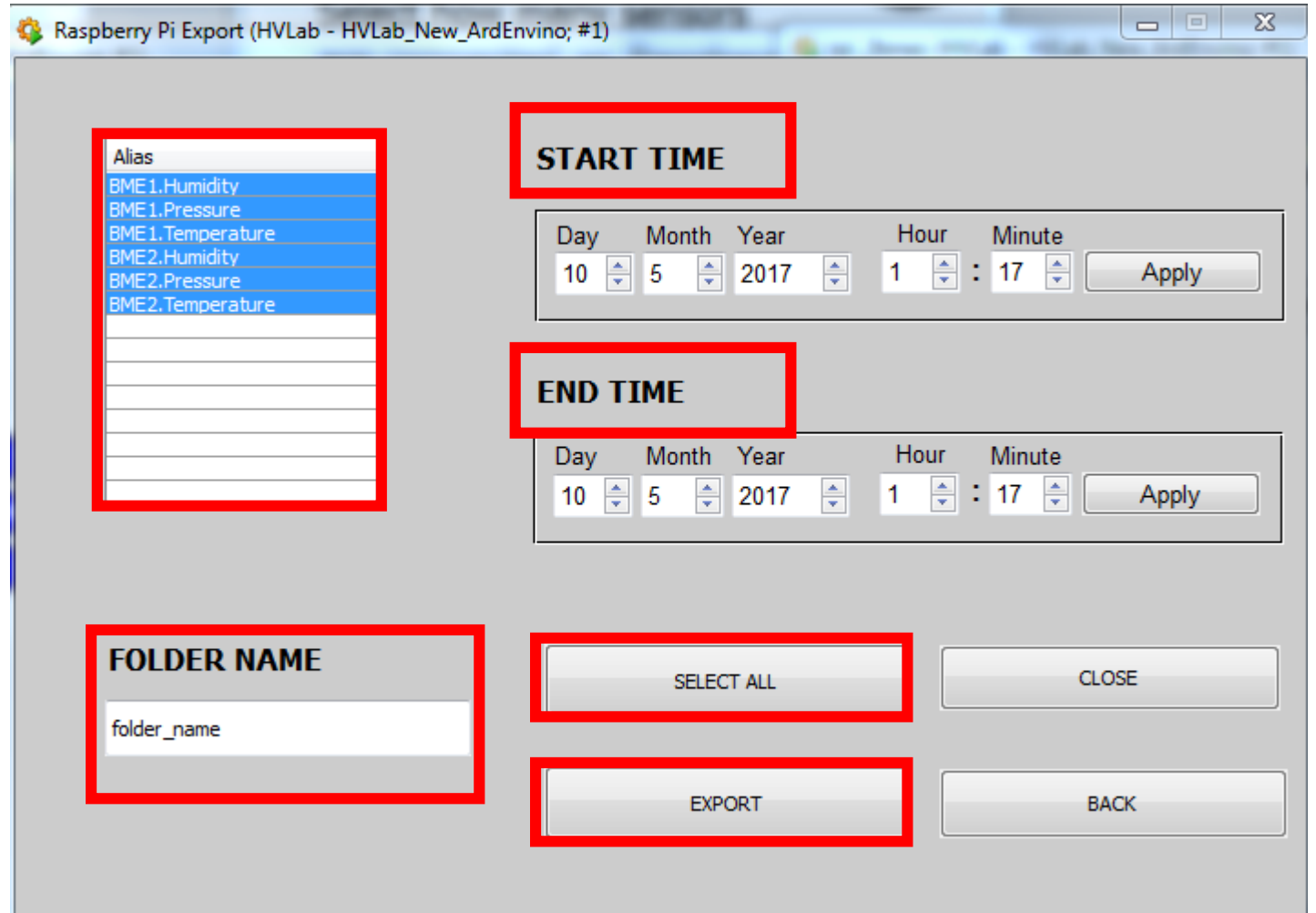
WinCC OA

Raspberry Pi Project – Archiving

WinCC OA

Raspberry Pi Project – Export
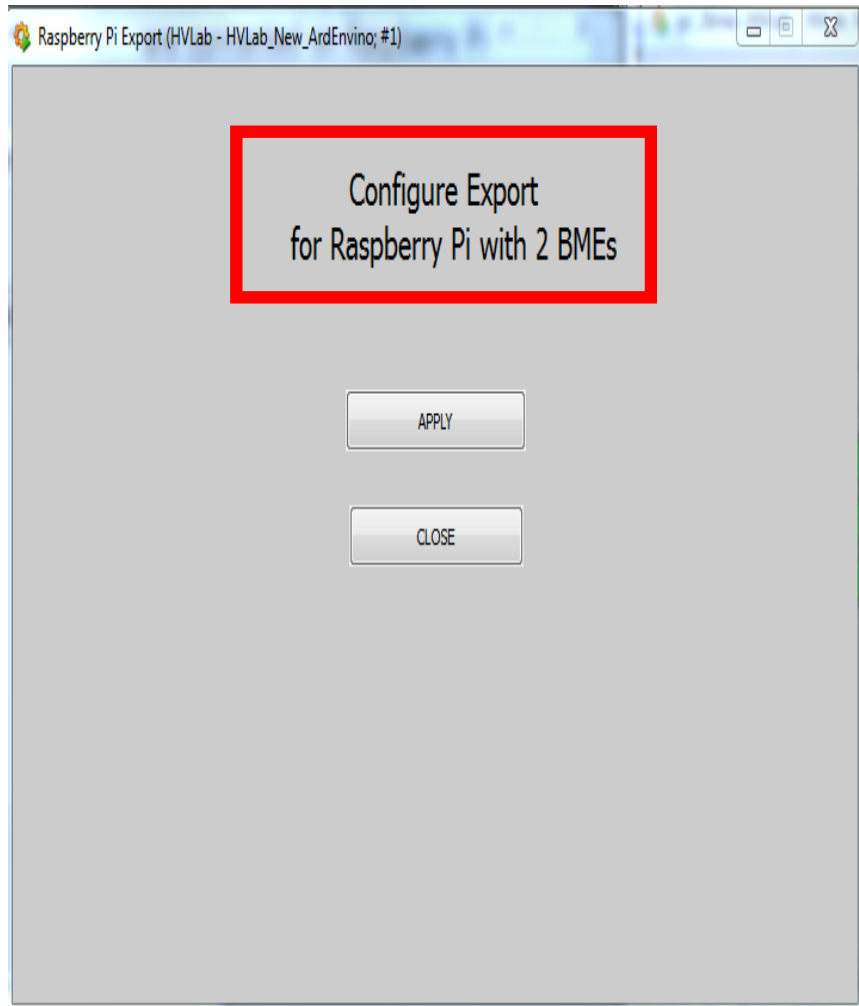
WinCC OA

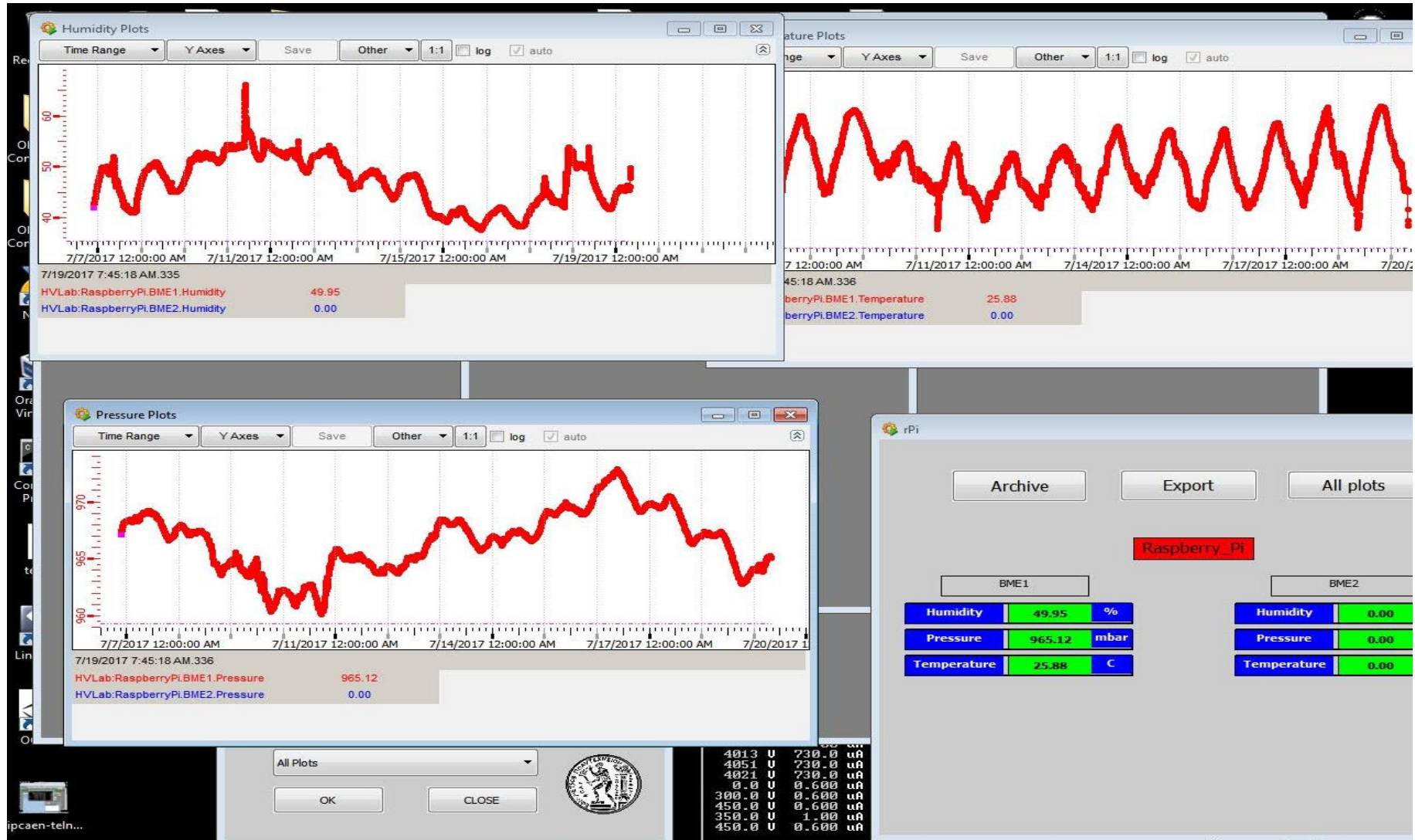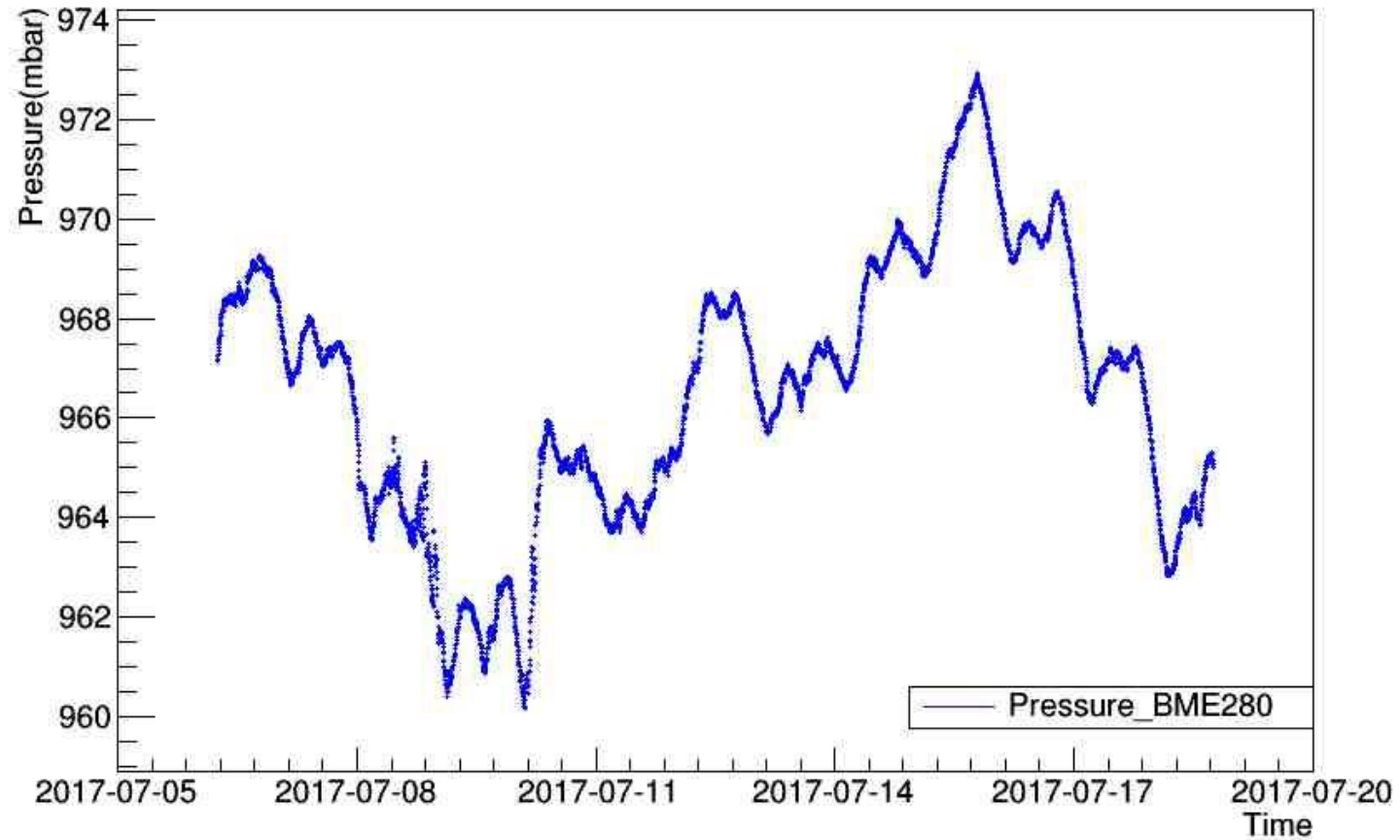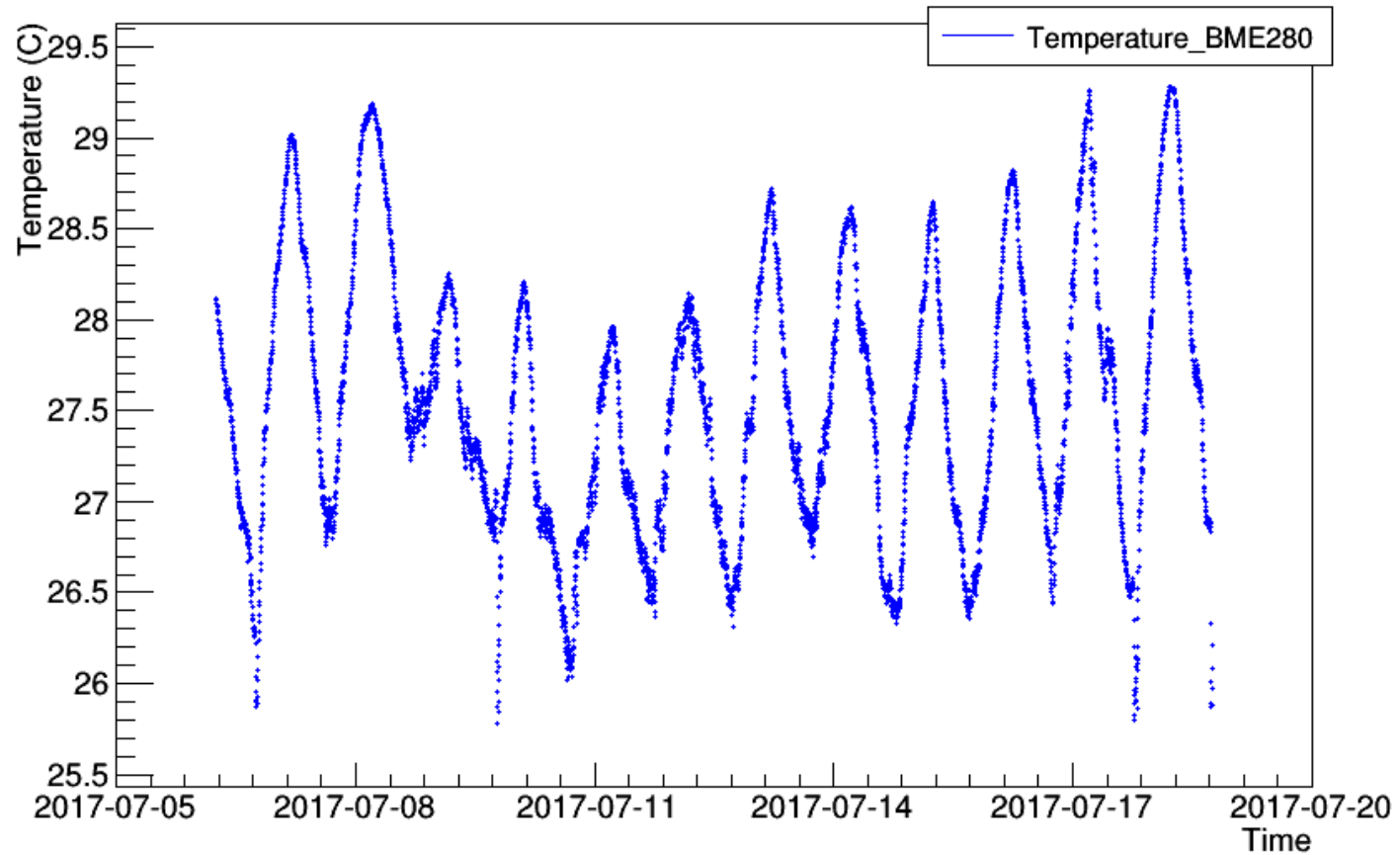## Raspberry Pi Project – Live plots from test beam 7/7- 19/7

Plots of extracted data from the test beam 7/7 – 19/7

Pressure vs Time

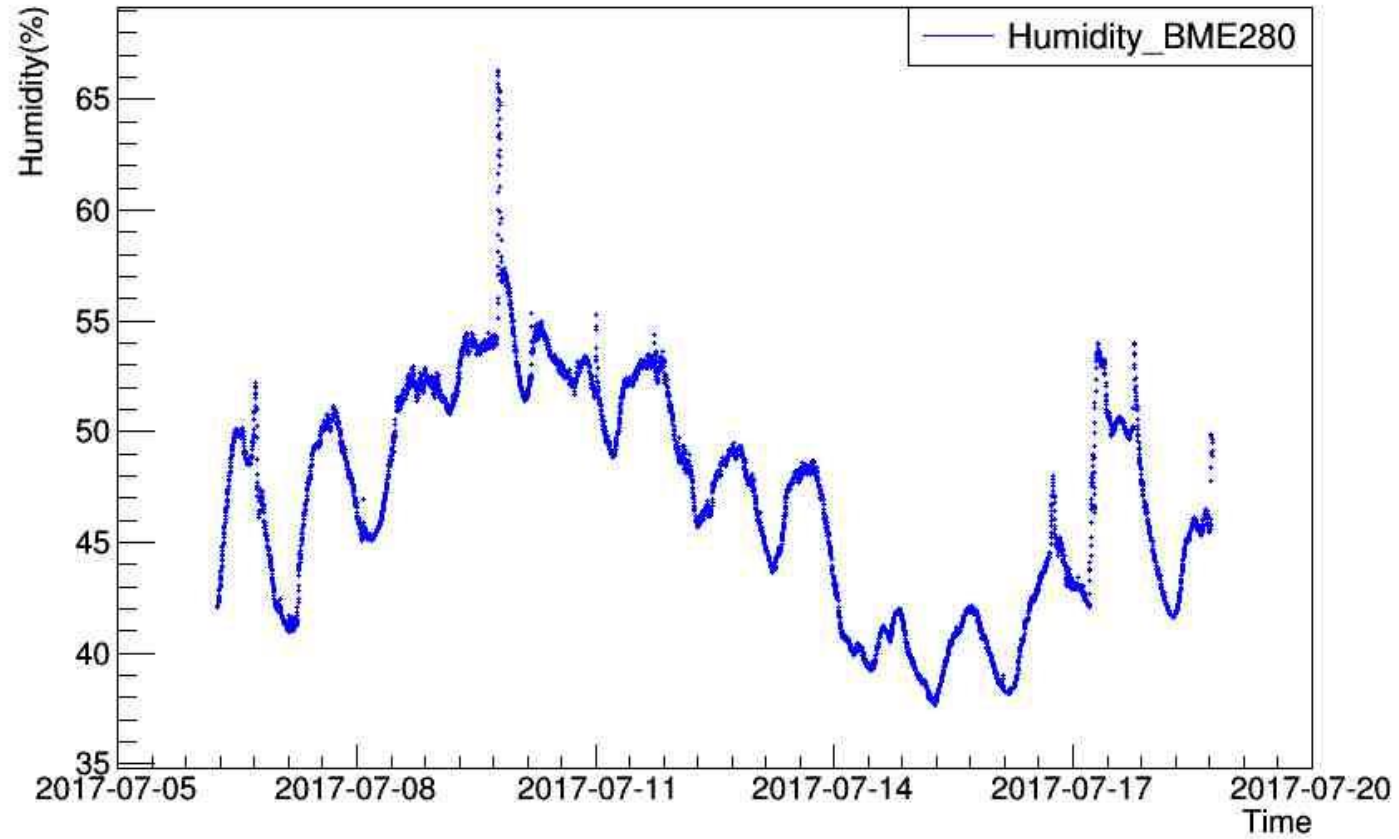# Plots of extracted data from the test beam 7/7 – 19/7

Temperature vs Time

Plots of extracted data from the test beam 7/7 – 19/7

Summary

- Setup and Configuration of Raspberry Pi 3 B+.
- Created a web page for monitoring in real time the values of each parameter.
- Created a customized and dynamic OPC UA Server which sends the collected data of the sensors to WinCC OA, which consists the OPC UA Client.
- Created panels in WinCC with the purpose of monitoring and storing the data in order to process them, the processing was done with ROOT.
- The system is available for everyone who wishes to use it.

Thank you!

Any questions?