Development of an Environmental Monitoring System Based on Arduino and WinCC_OA

Giannis Papakrivopoulos

National Technical University of Athens

School of Applied Mathematics and Physical Sciences

December 9, 2015

Outline

Outline

Introduction

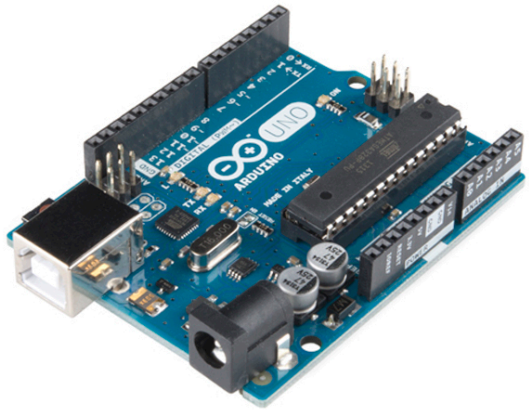
- Development of a low cost system capable of measuring the environmental parameters during test beams
- The Arduino microcontroller was used
- WinCC_OA was used for data monitoring and elaboration
- Integration of the system into the RD51 SLOw Control SYstem

Outline

Arduino

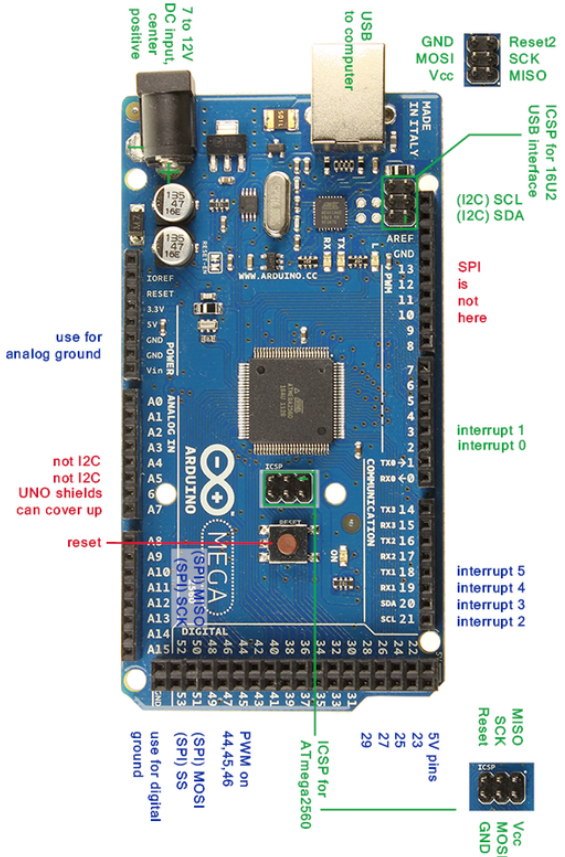
Arduino: Microcontroller, input/output pins

Variety of Arduino boards



Arduino Mega 2560

- 54 digital pins (input or output)
- 16 analog input pins
- USB port
- power jack
- 5V, 3.3V, GND
- Various functions (PWM, Interrupts, I^2C, SPI etc.)

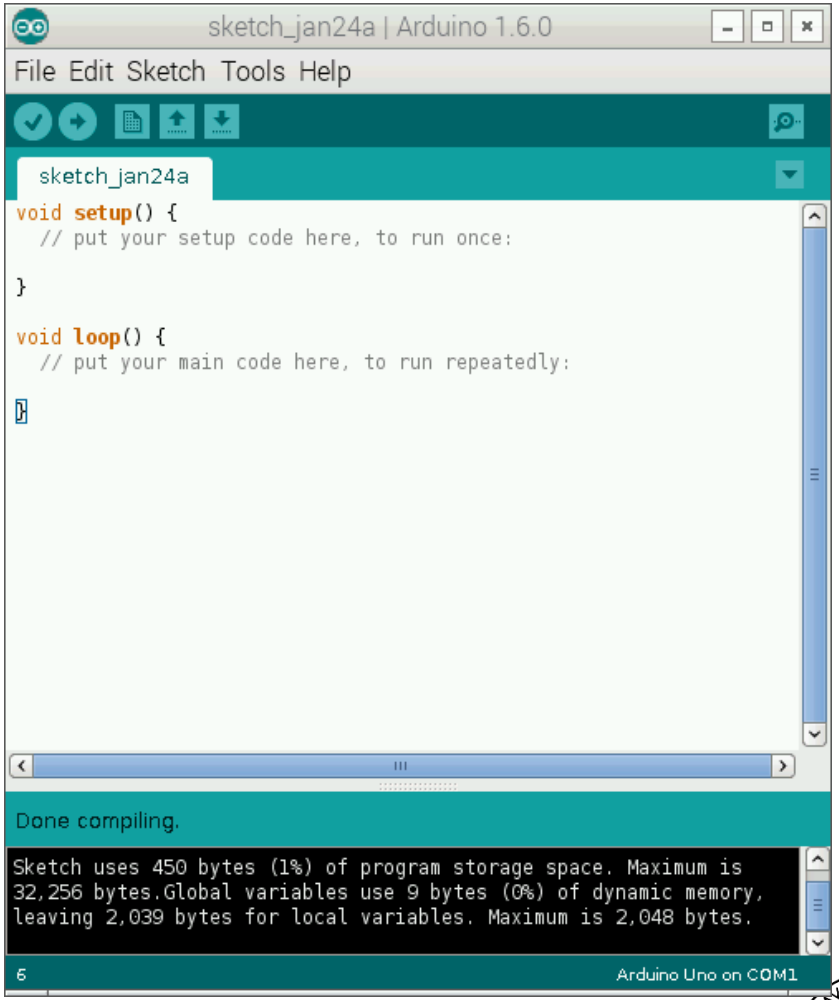


Arduino Ethernet Shield

- Expansion boards (shields)
- Extra functionalities (ethernet, wifi etc)
- Arduino Ethernet Shield
- Wiznet W5100 Ethernet Chip(TCP, UDP)
- RJ45 jack
- SD card jack

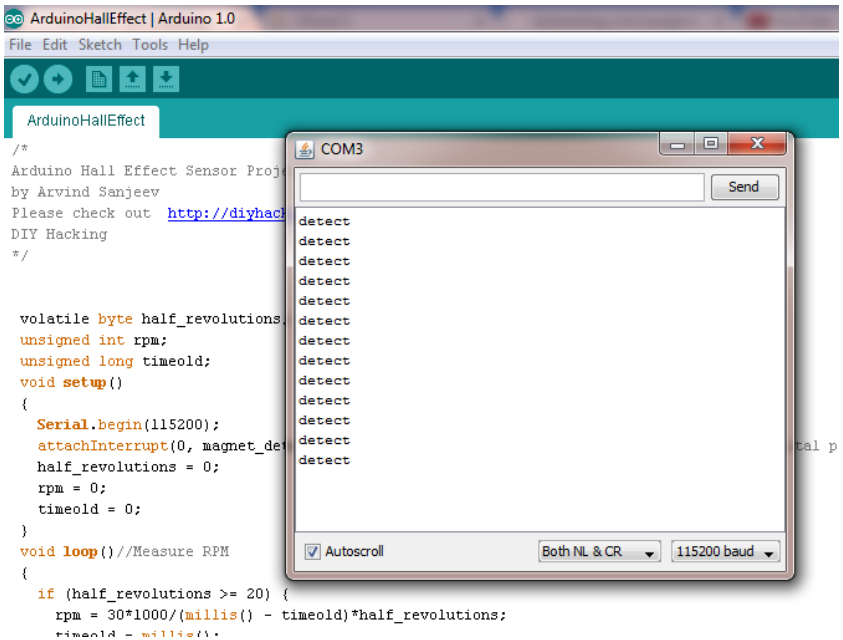
Interacting with the Arduino

- Write and upload code
- Arduino IDE(Integrated Development Environment)
- Sketch, ".ino" file
- Libraries
- Menus
- Buttons
- Serial Monitor



Interacting with the Arduino

- Write and upload code
- Arduino IDE(Integrated Development Environment)
- Sketch, ".ino" file
- Libraries
- Menus
- Buttons
- Serial Monitor



Outline

Sensors

A total of 4 sensors was used

2 digital temperature and pressure sensors

1 analog pressure sensor

1 digital temperature and humidity sensor

BMP085 Sensor

- Digital sensor, pressure and temperature
- High precision, Pressure: ± 1 mbar, Temperature: ± 1 °C
- Low consumption
- Communication via the I^2C protocol
- 3.3V power supply

BMP085 Sensor

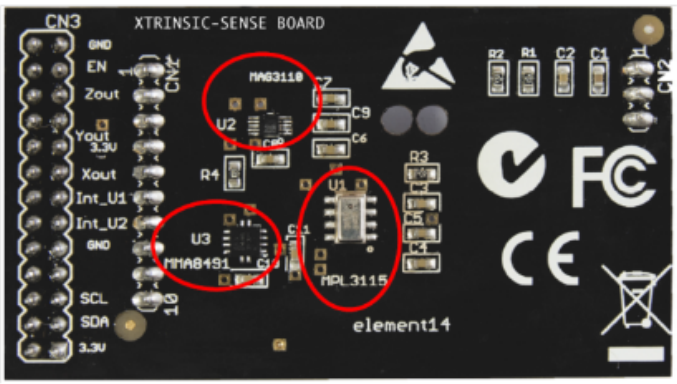
- Digital sensor, pressure and temperature
- High precision, Pressure: ± 1 mbar, Temperature: ± 1 °C
- Low consumption
- Communication via the I^2C protocol
- 3.3V power supply
- Atmel AVR4201

MPL3115A2 Sensor

- Digital sensor pressure and temperature
- High precision, Temperature: $\pm 1\ ^{\circ}\mathrm{C}$, Pressure: $\pm 4\ \mathrm{mbar}$
- Low consumption
- Communication via the $\mathrm{I}^2\mathrm{C}$ protocol
- 3.3V power supply

MPL3115A2 Sensor

- Digital sensor pressure and temperature
- High precision, Temperature: $\pm 1\ ^{\circ}\mathrm{C}$, Pressure: ± 4 mbar
- Low consumption
- Communication via the $\mathrm{I}^2\mathrm{C}$ protocol
- 3.3V power supply
- Xtrinsic Sensor Board Element14

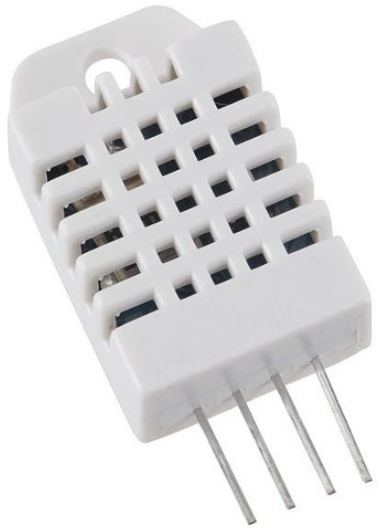


MPX5700AP Sensor

- Analog pressure sensor
- Accuracy: $\pm 2.5\% \mathrm{V_{FSS}}$
- 5V operating voltage
- Transfer function, conversion voltage to pressure

DHT22 sensor

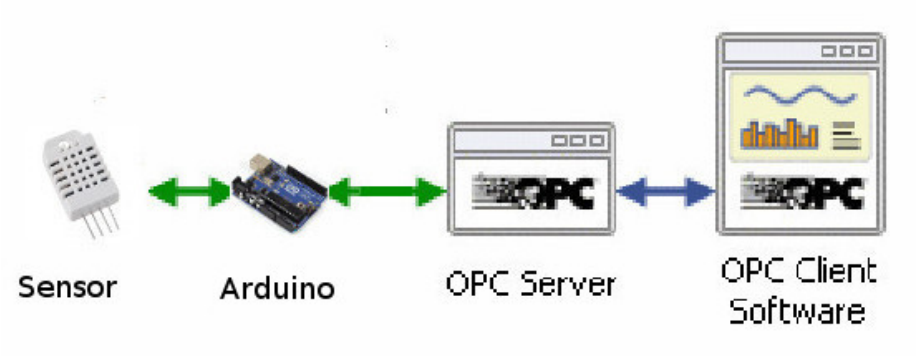
- Digital temperature and humidity sensor
- High precision, Temperature: $\pm 0.2\ ^{\circ}\mathrm{C}$, Humidity: $\pm 2\%$
- Low consumption
- Long-term stability, long transmission distance
- 5V power supply



Outline

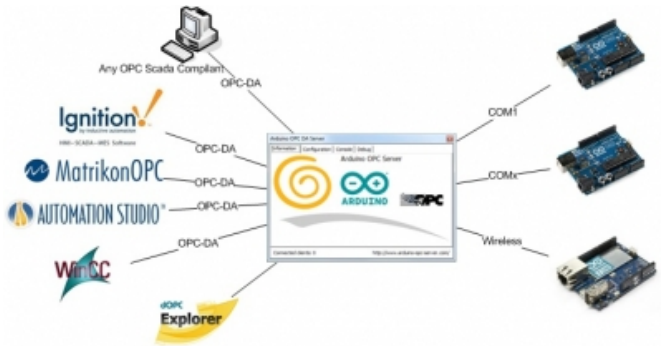
OPC Protocol

- OPC (Open Platform Communication)
- Specifications
- OLE (Object Linking and Embedding) for Process Control
- SCADA/PLC
- Server/Client
- Universal, open



Arduino OPC Server

- Ildefonso Martinez Marchena, http://www.st4makers.com
- In total compliance with the OPC specifications
- Ability to use multiple Arduino boards of any type simultaneously
- Serial, wifi, ethernet communication



Outline

WinCC_OA

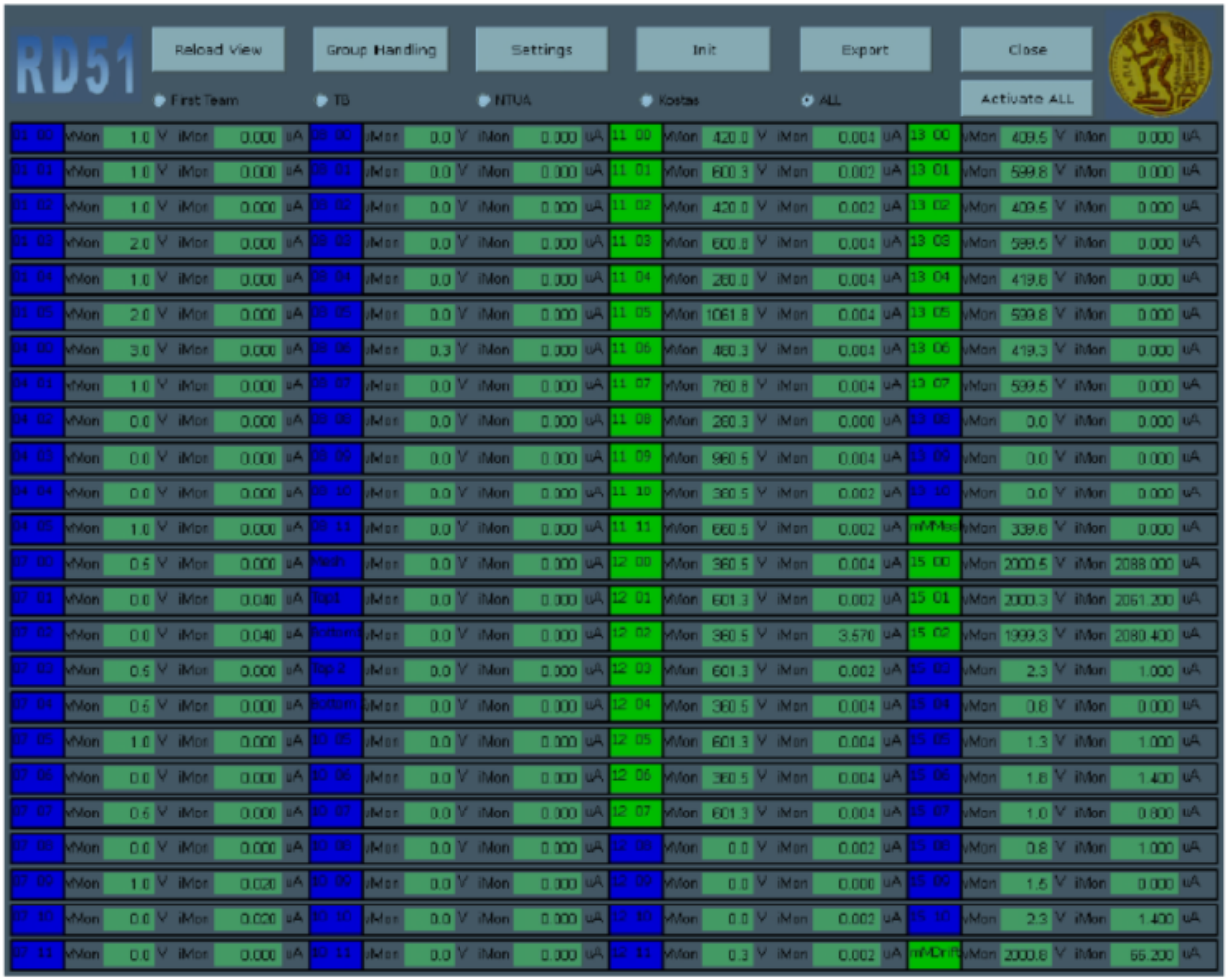
SCADA (Supervisory Control And Data Acquisition)

A tool for the development of control system

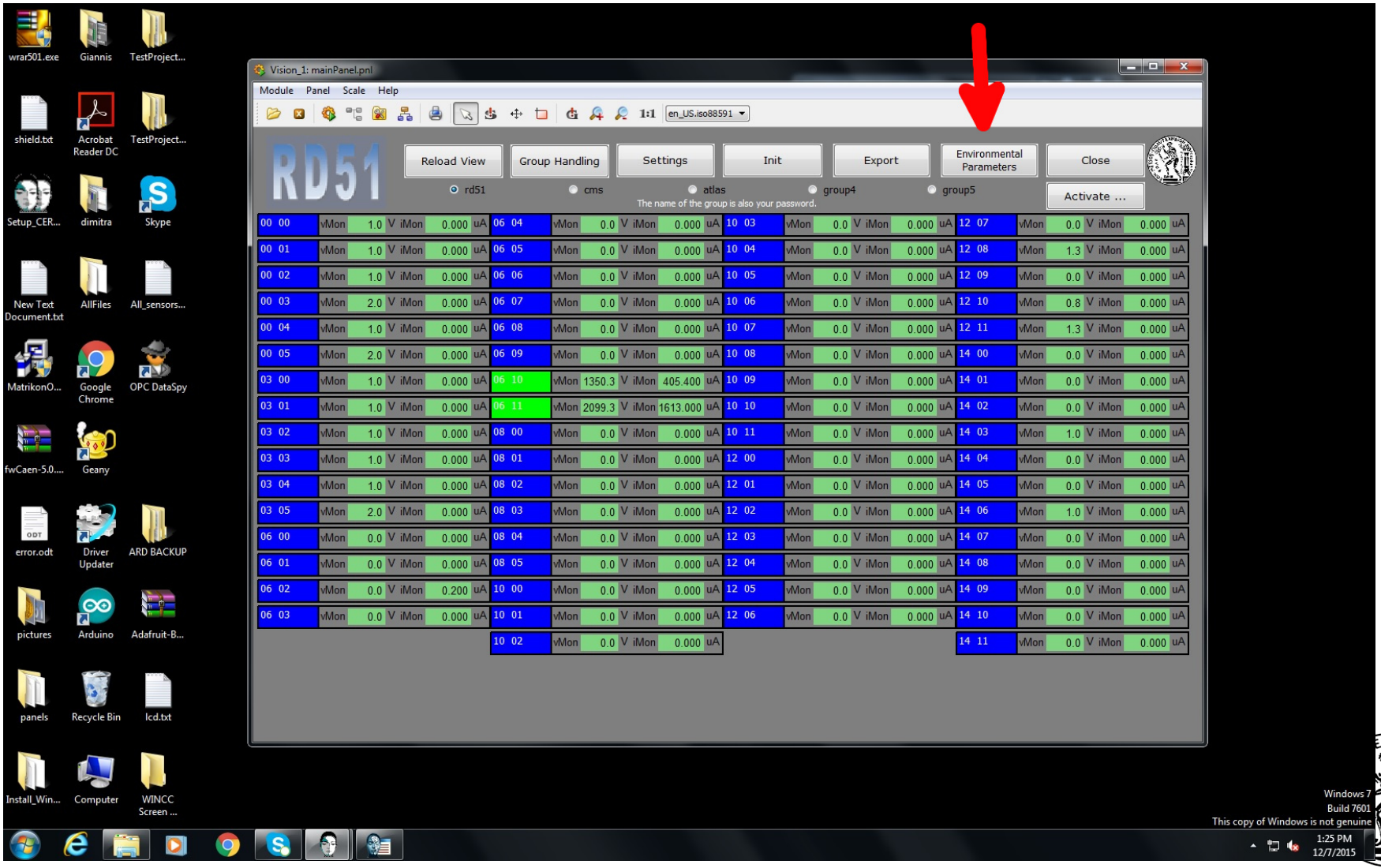
- Database
- GEDI (Graphics EDItor)
- Control Scripts
- Connection with hardware devices (OPC, Modbus, DIM)

JCOP (Joint COntrols Project) framework

RD51 Slow Control System (SLOCSY)

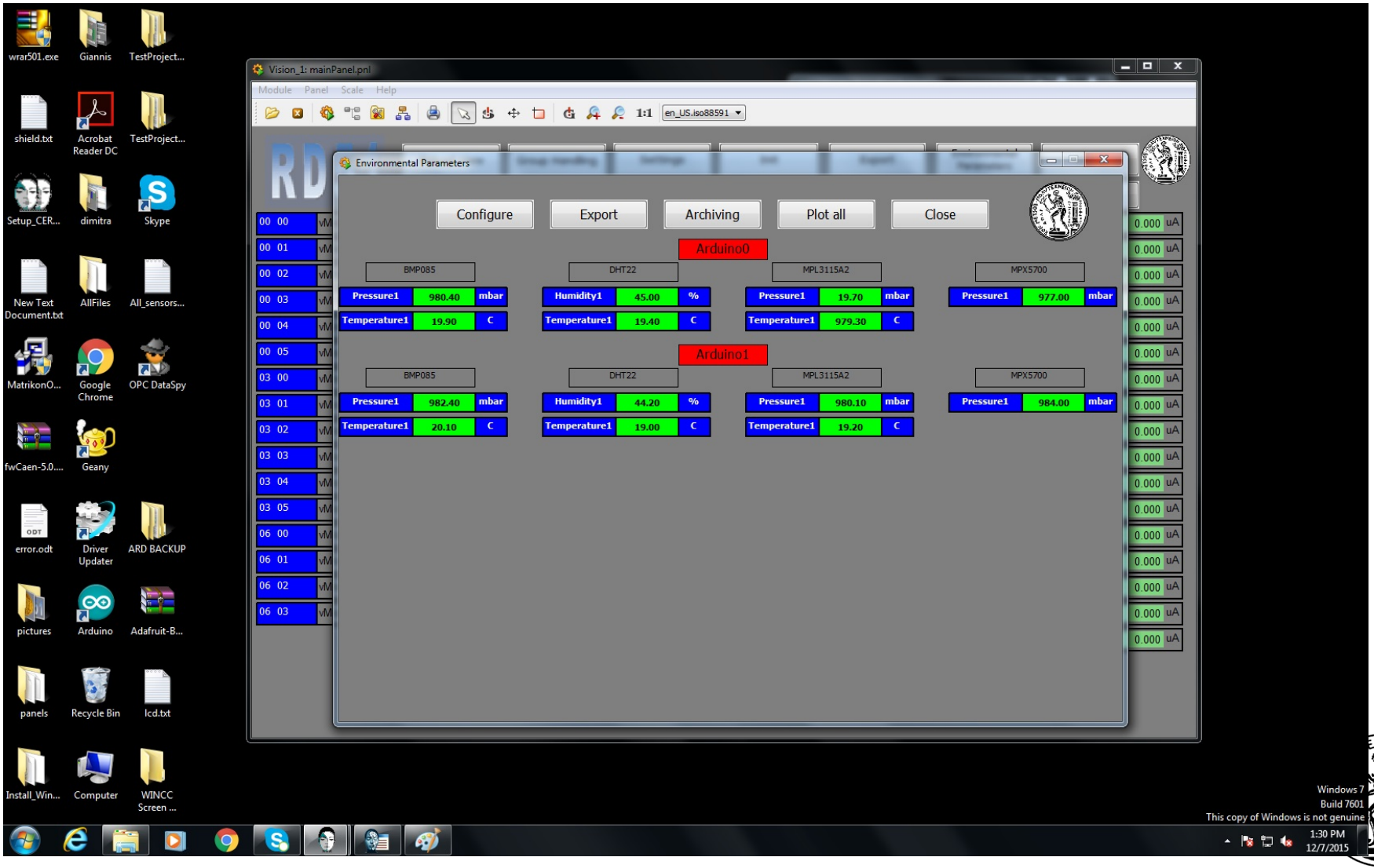


RD51 Slow Control System (SLOCSY)



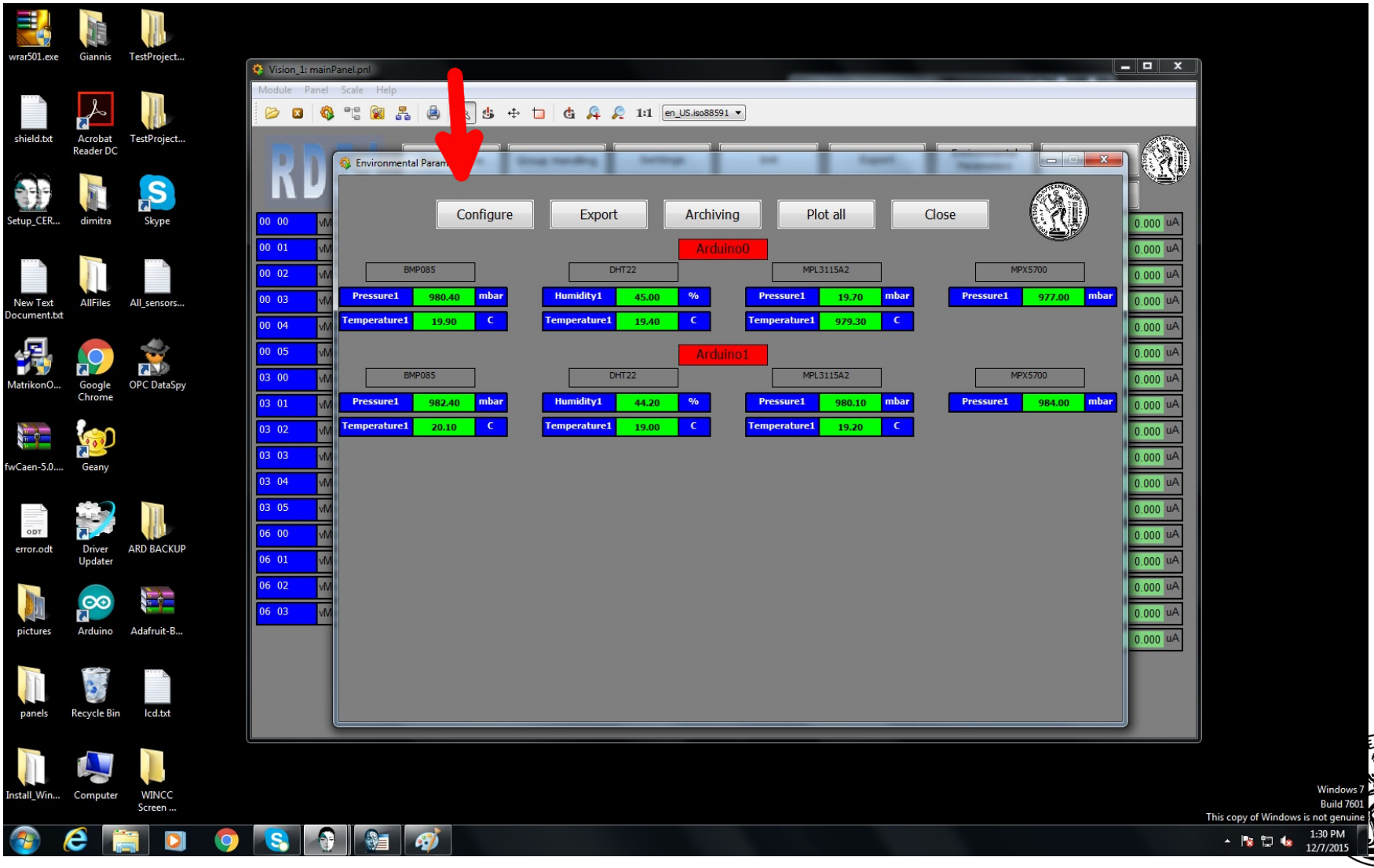
Slow Control System

Environmental parameter monitoring window



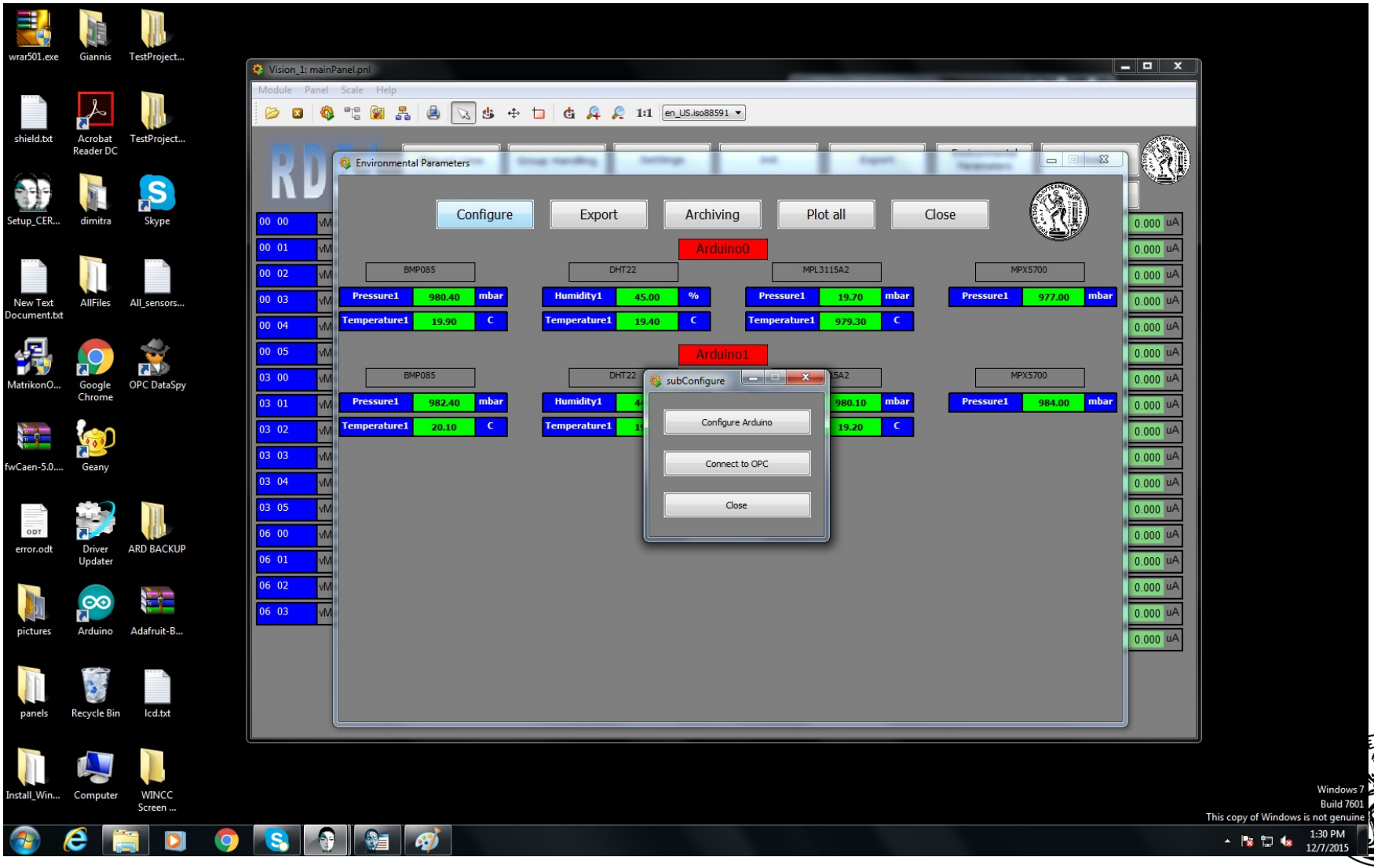
Slow Control System

Environmental parameter monitoring window



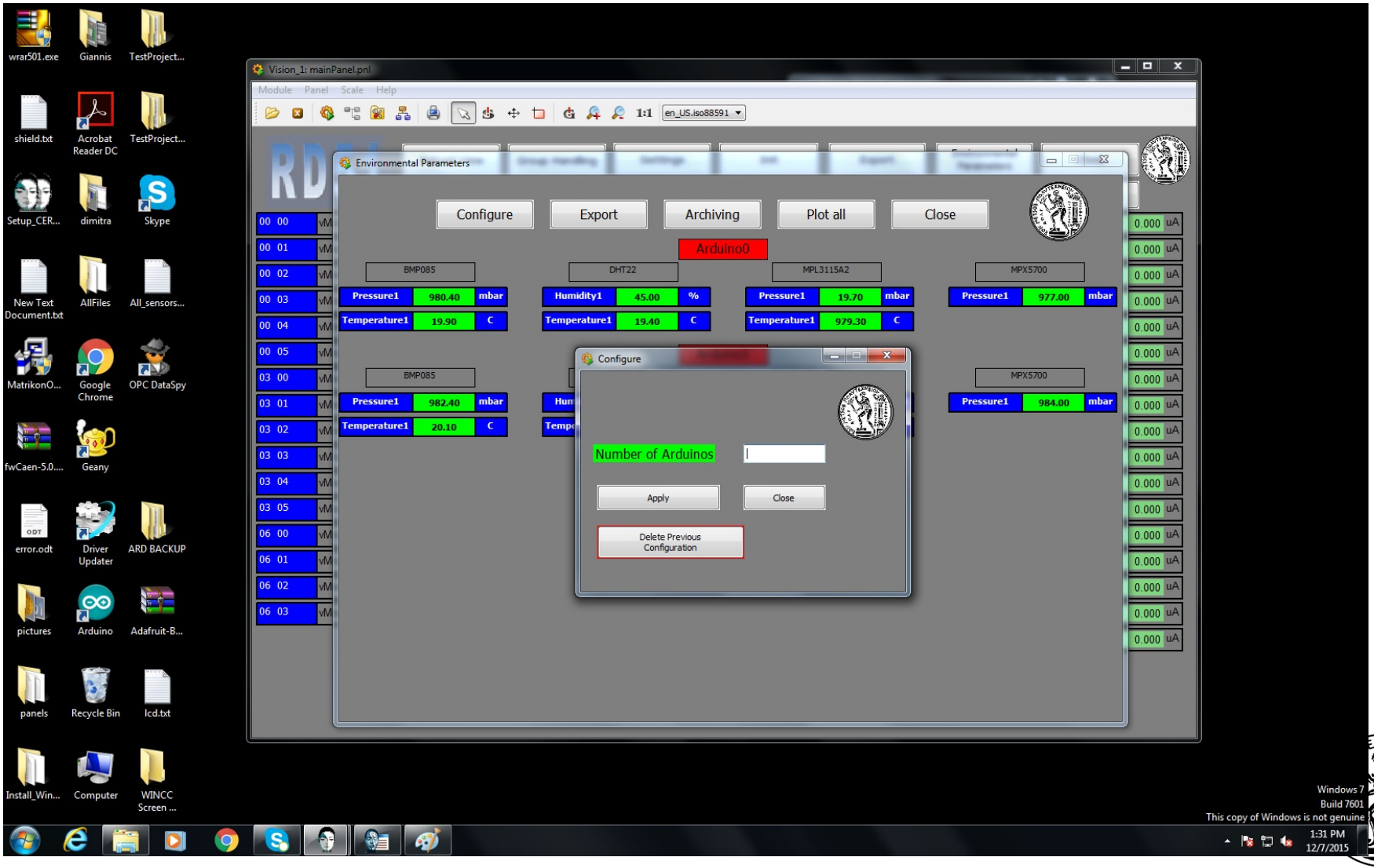
Slow Control System

Environmental parameter monitoring window



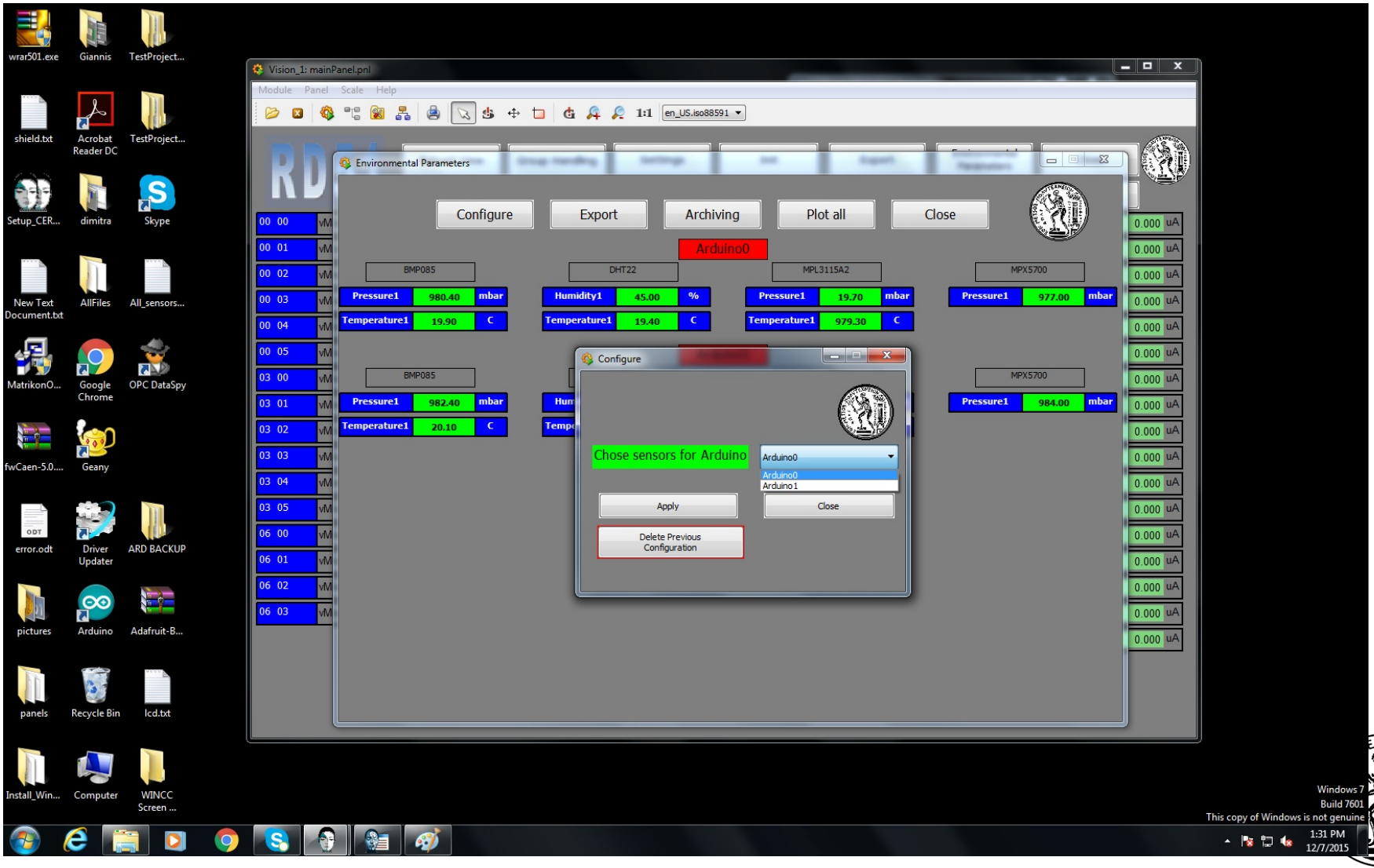
Slow Control System

Environmental parameter monitoring window



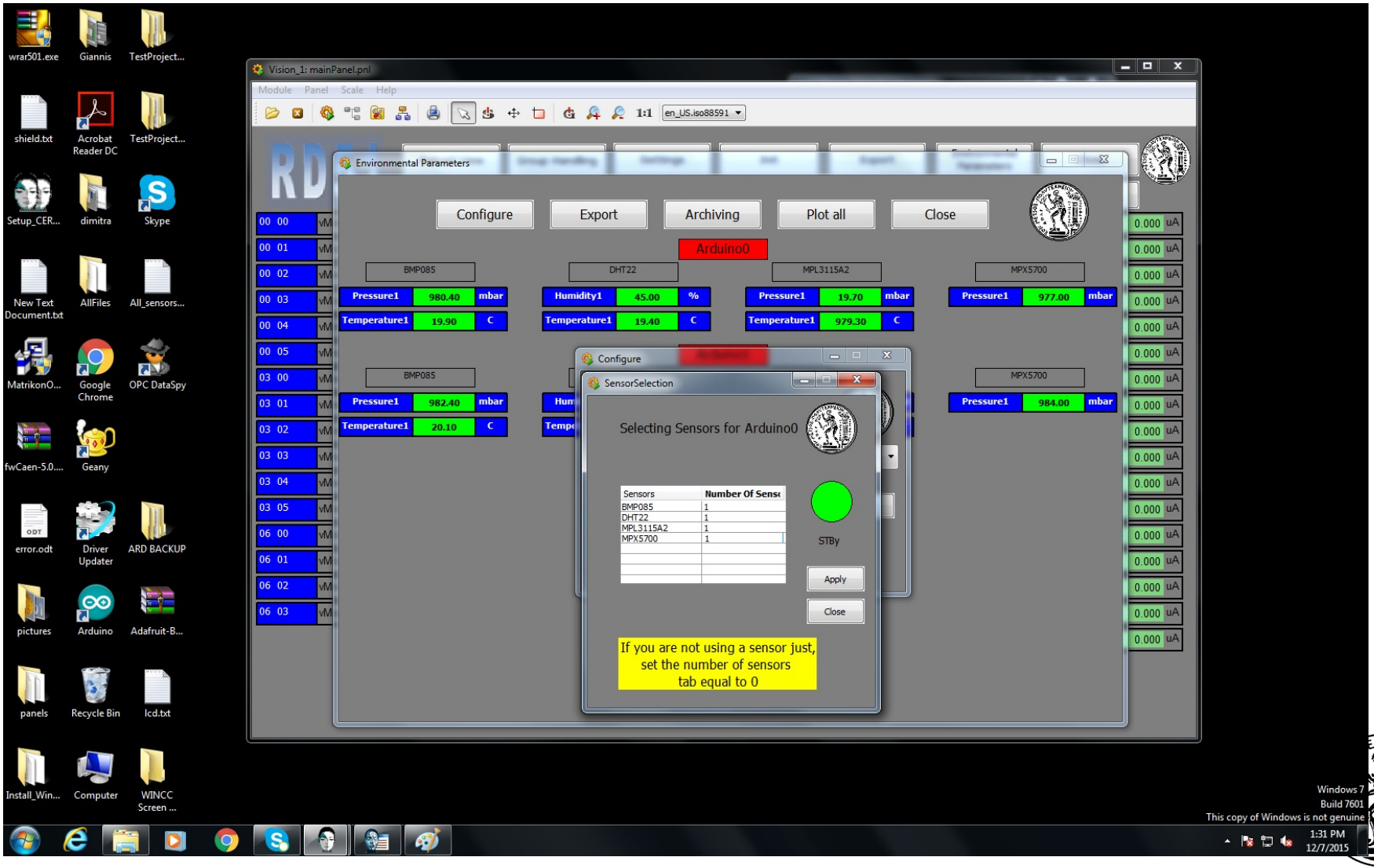
Slow Control System

Environmental parameter monitoring window



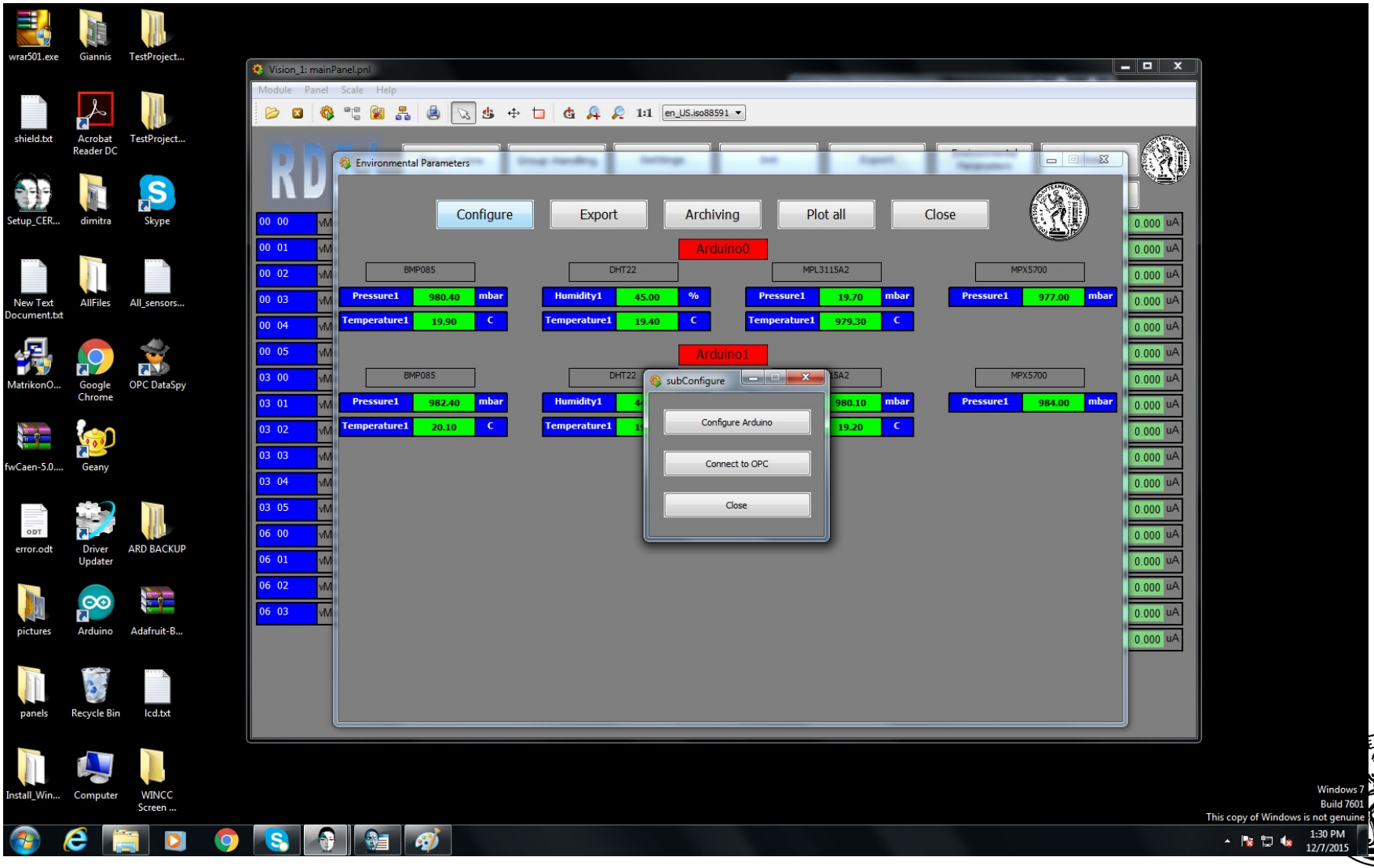
Slow Control System

Environmental parameter monitoring window



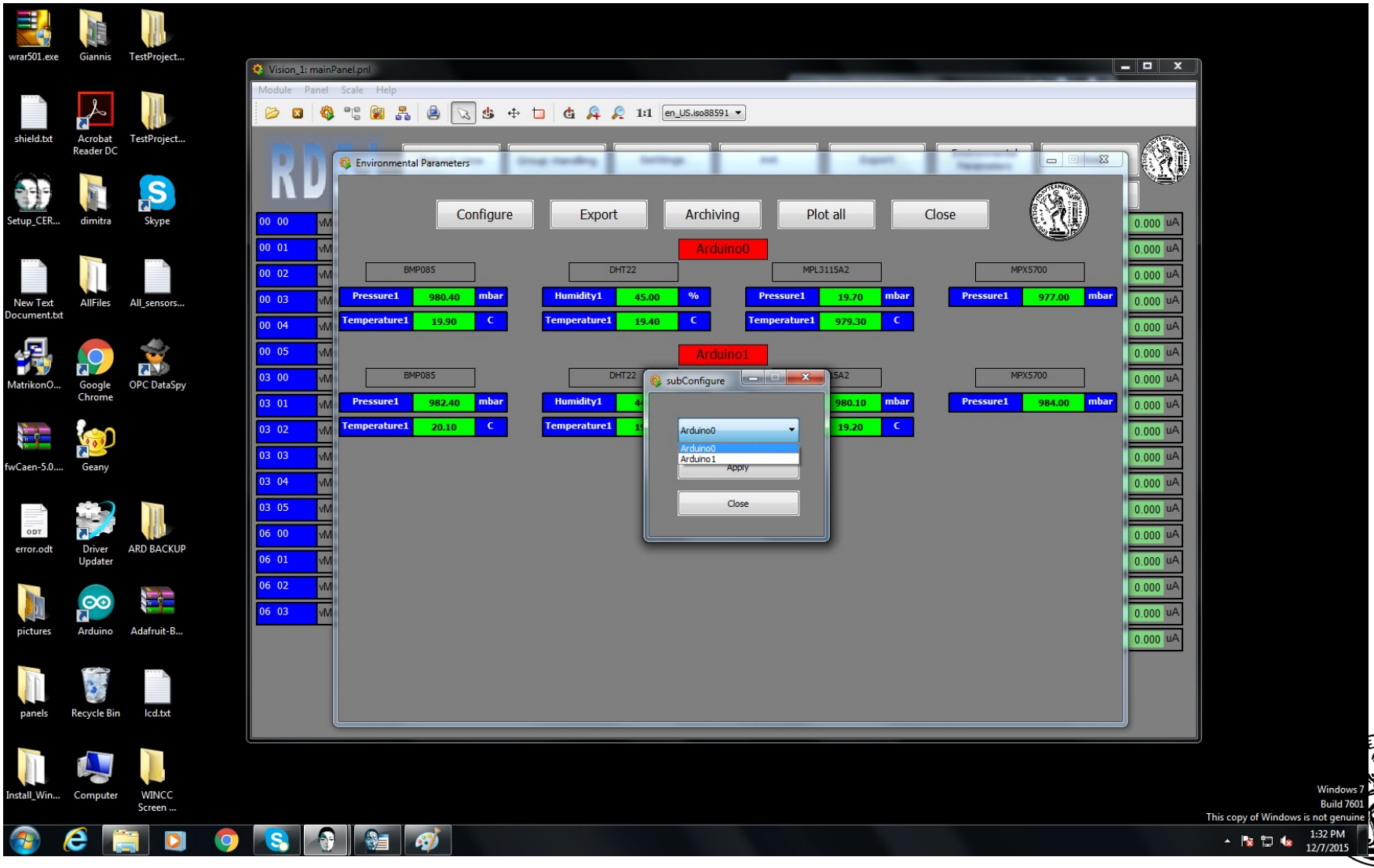
Slow Control System

Environmental parameter monitoring window



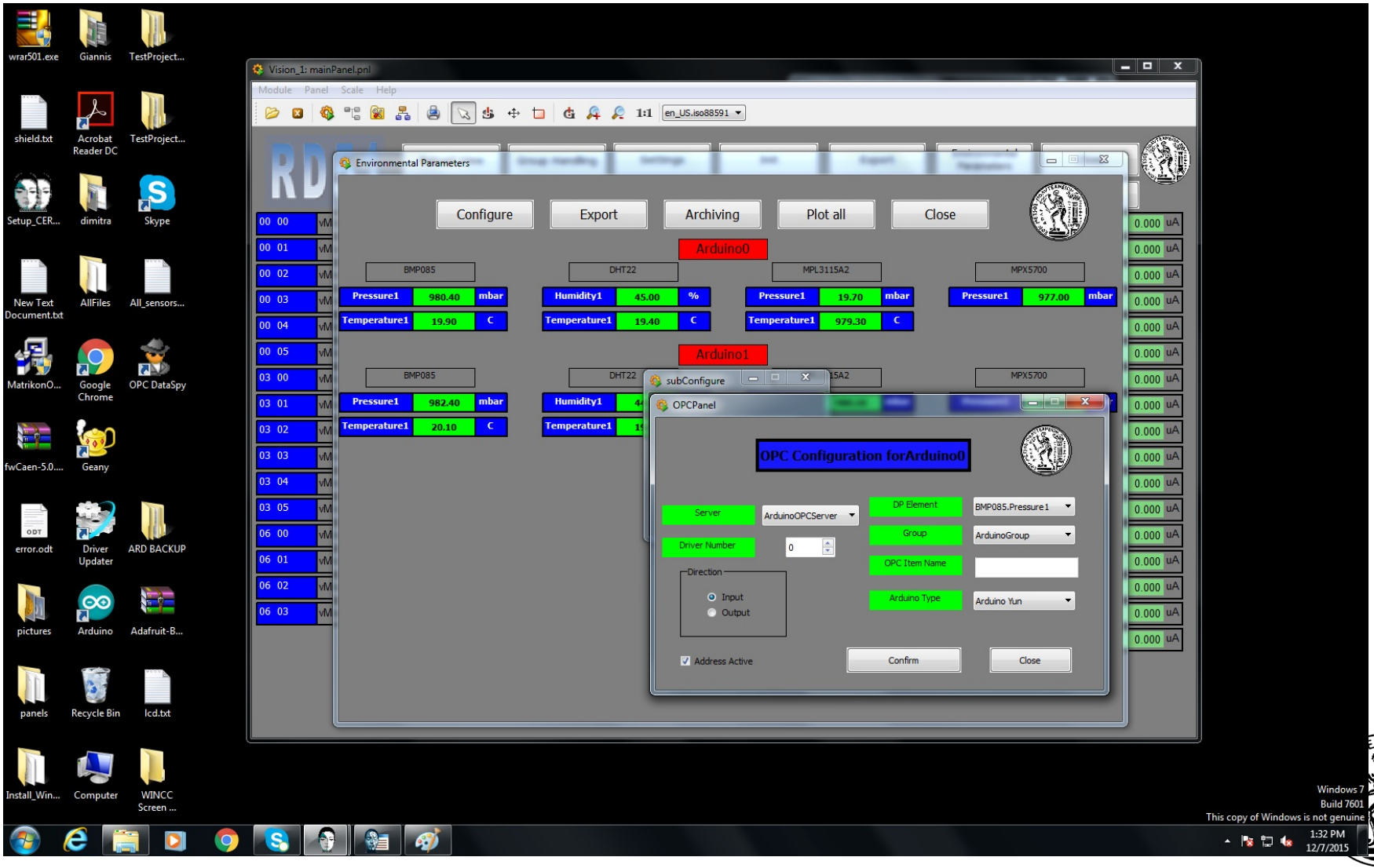
Slow Control System

Environmental parameter monitoring window



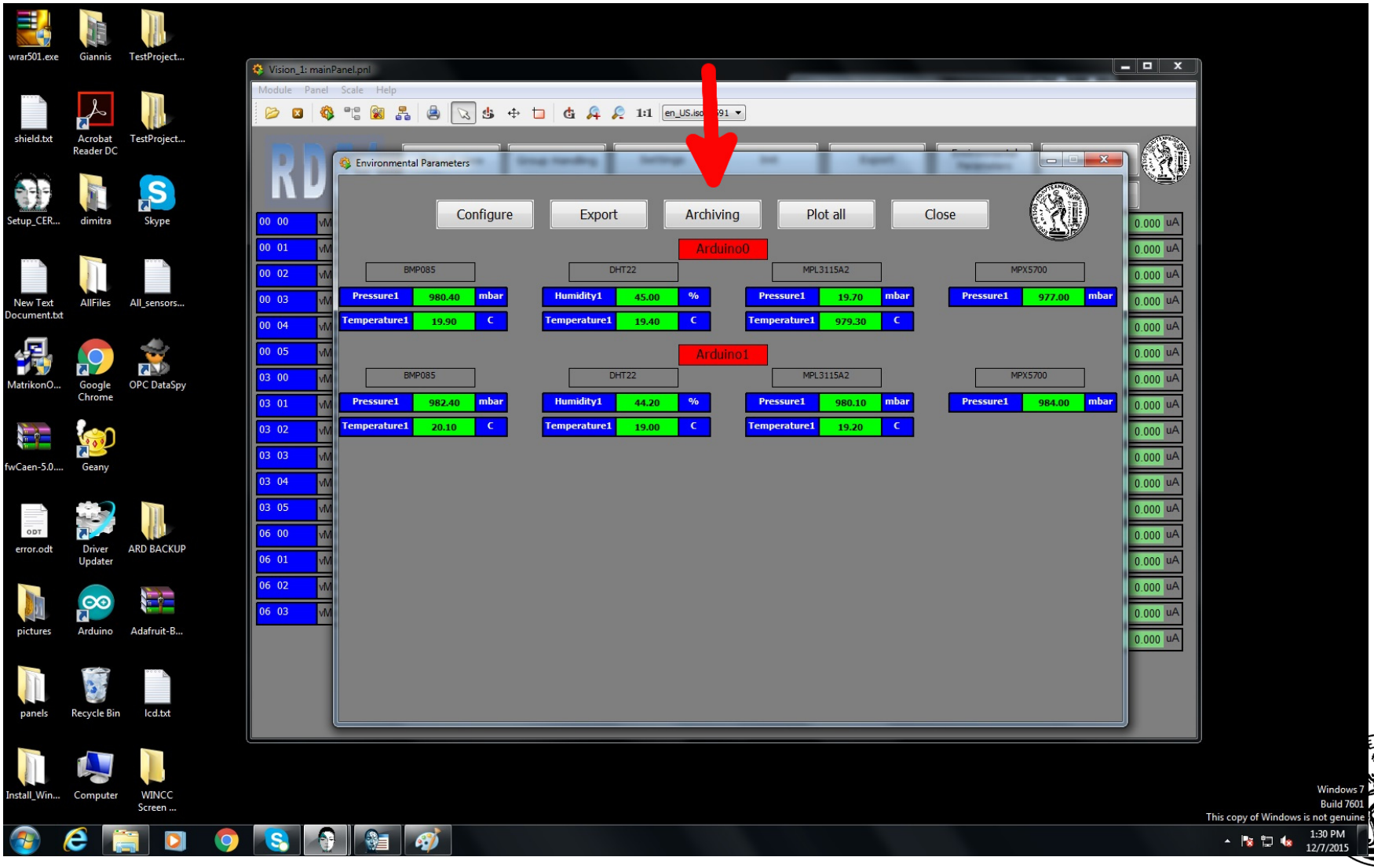
Slow Control System

Environmental parameter monitoring window



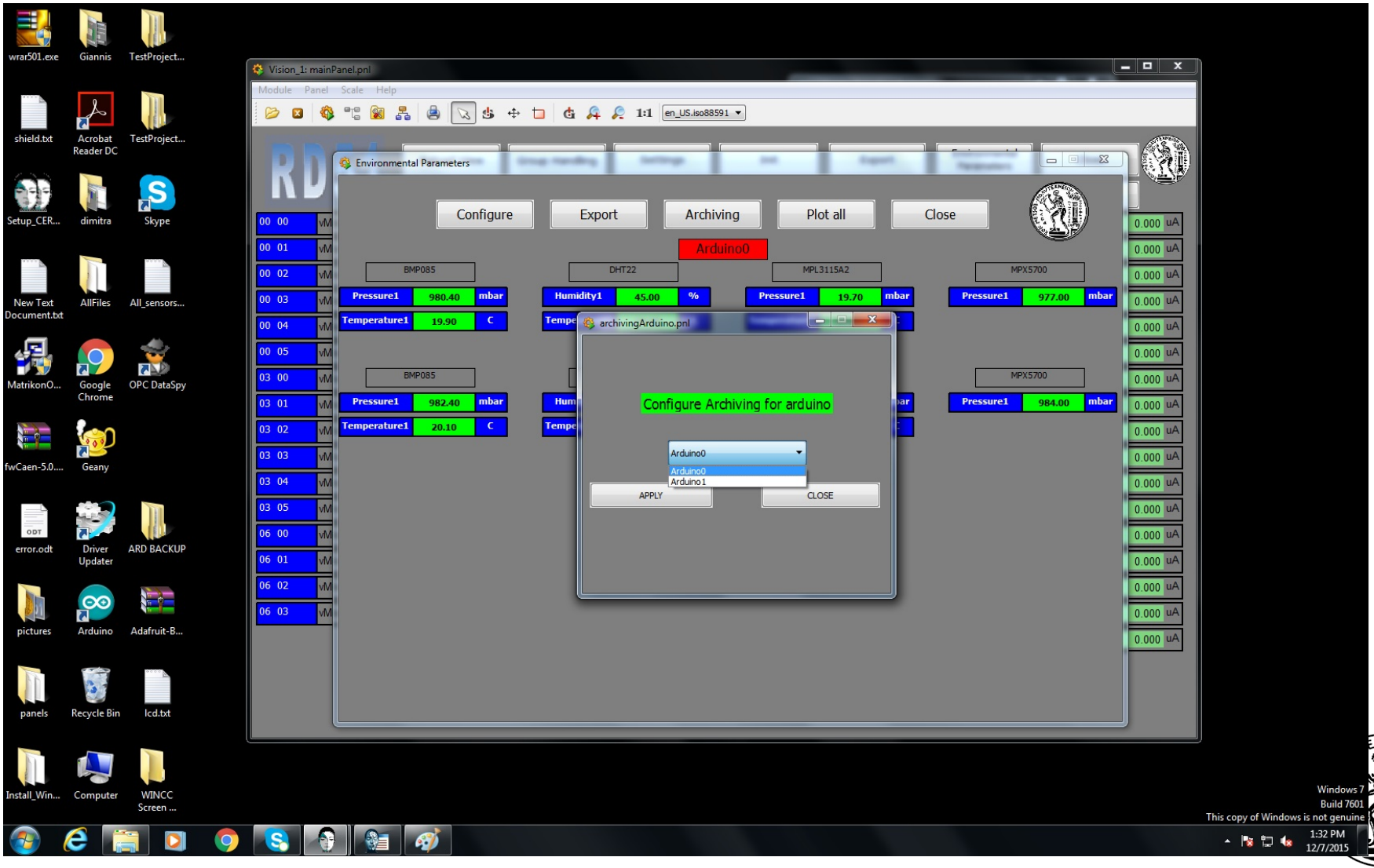
Slow Control System

Environmental parameter monitoring window



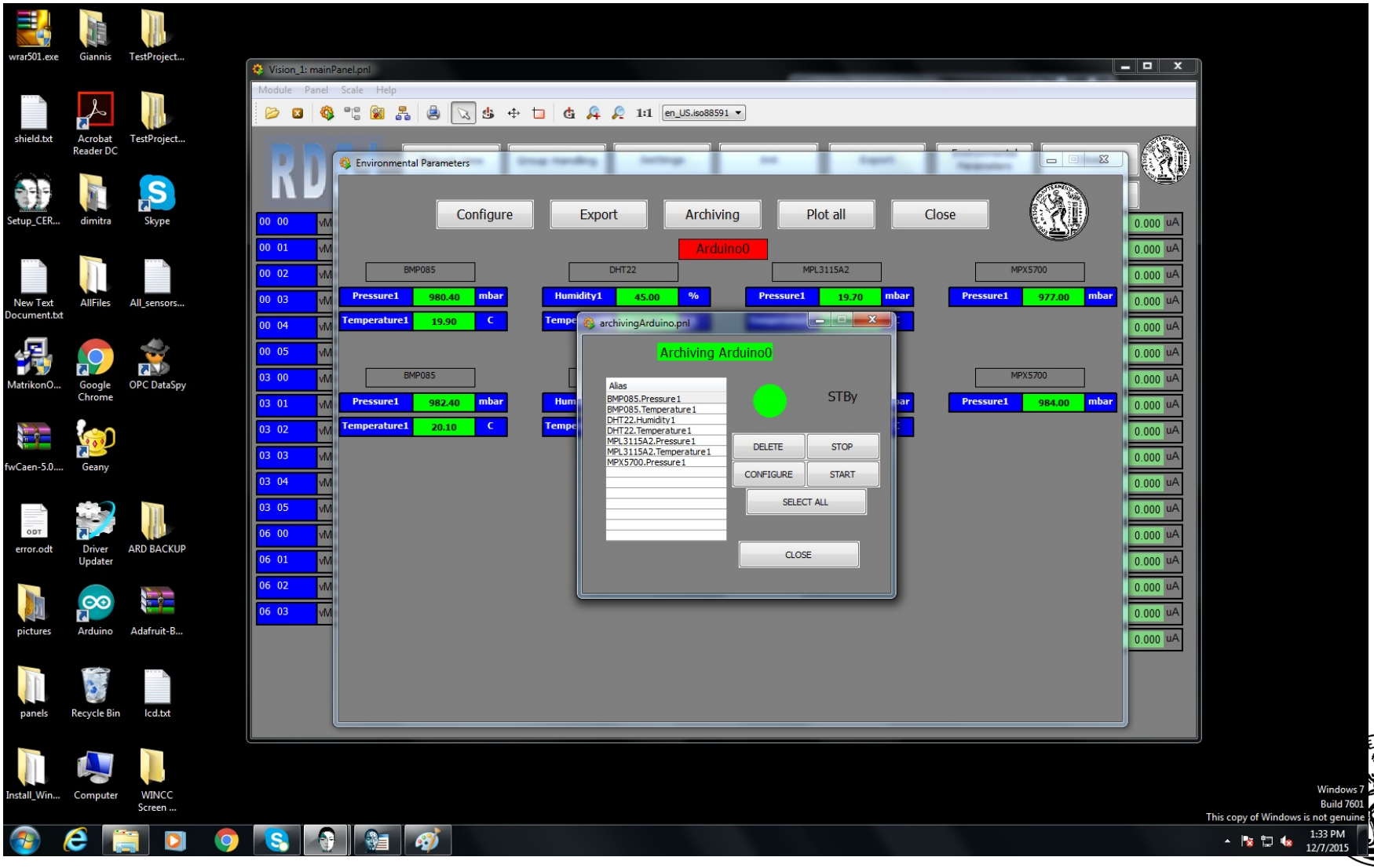
Slow Control System

Environmental parameter monitoring window



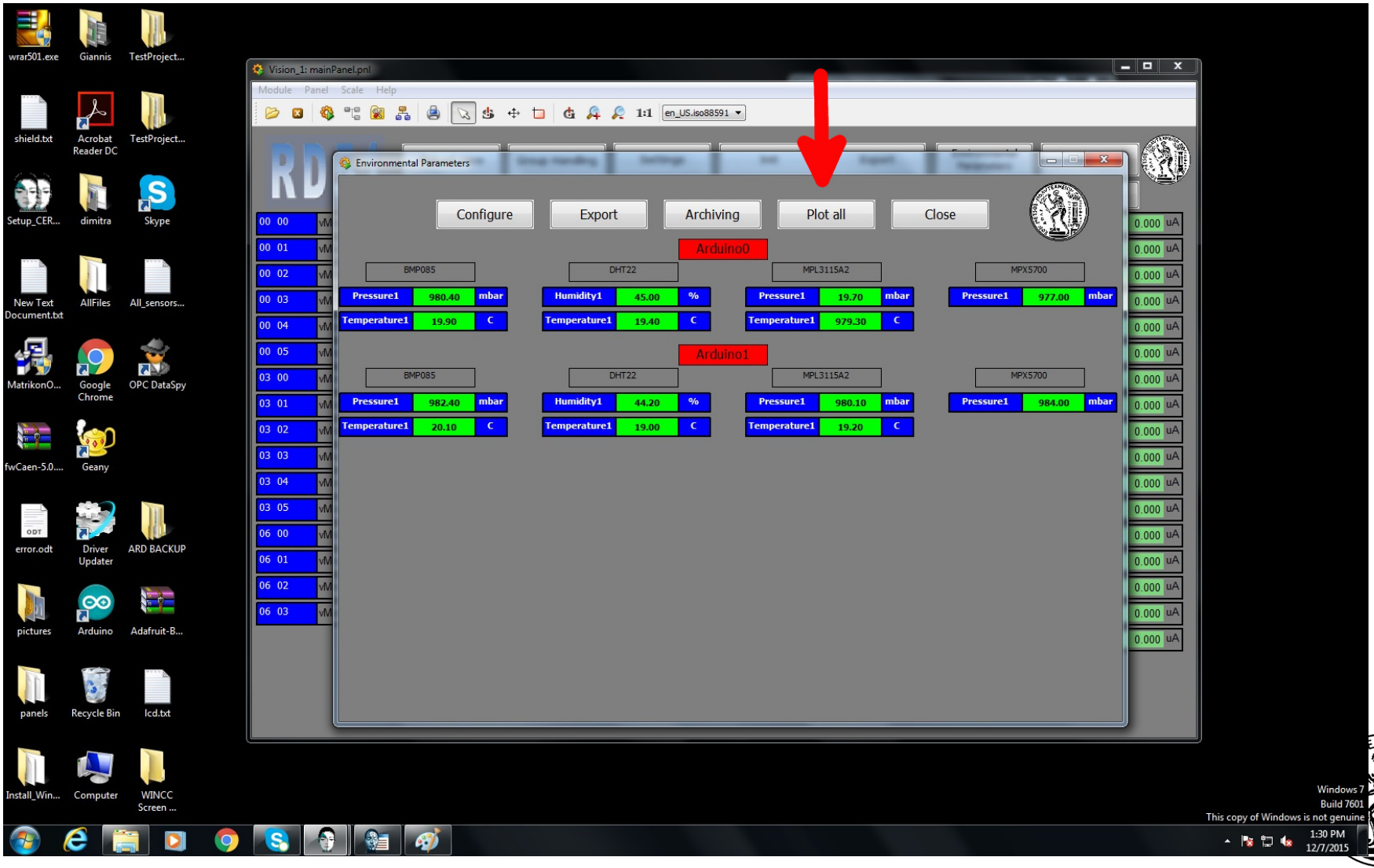
Slow Control System

Environmental parameter monitoring window



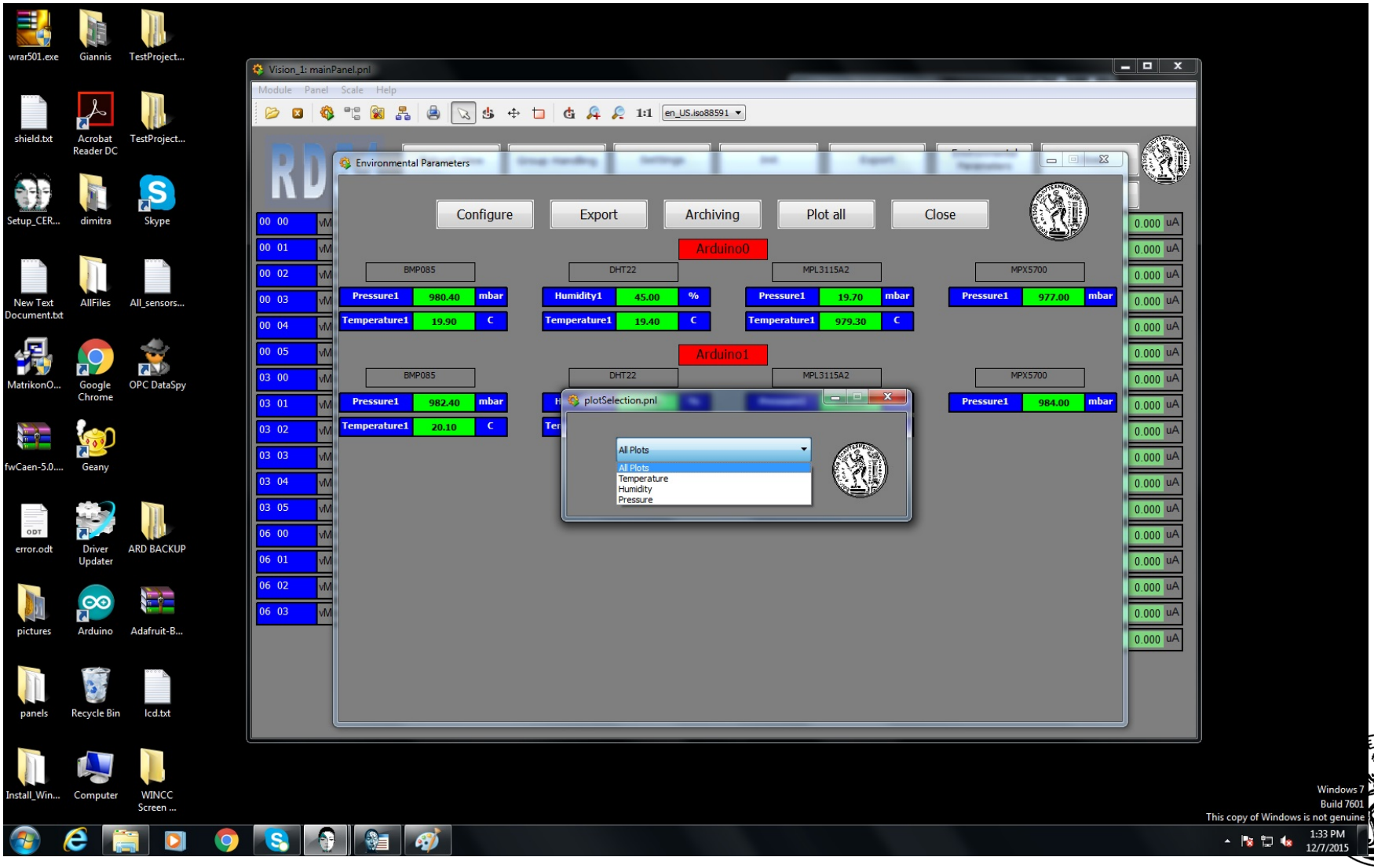
Slow Control System

Environmental parameter monitoring window



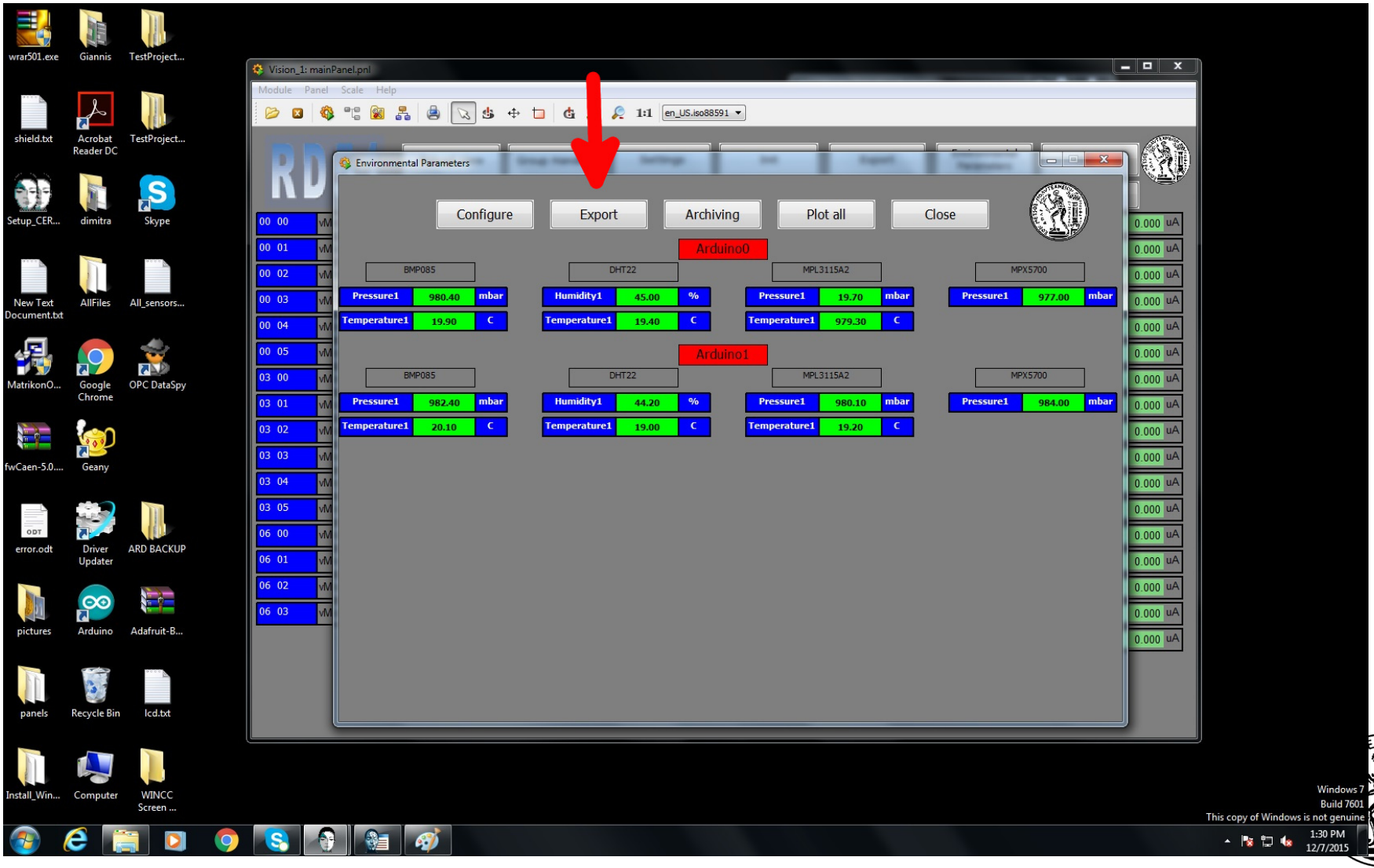
Slow Control System

Environmental parameter monitoring window



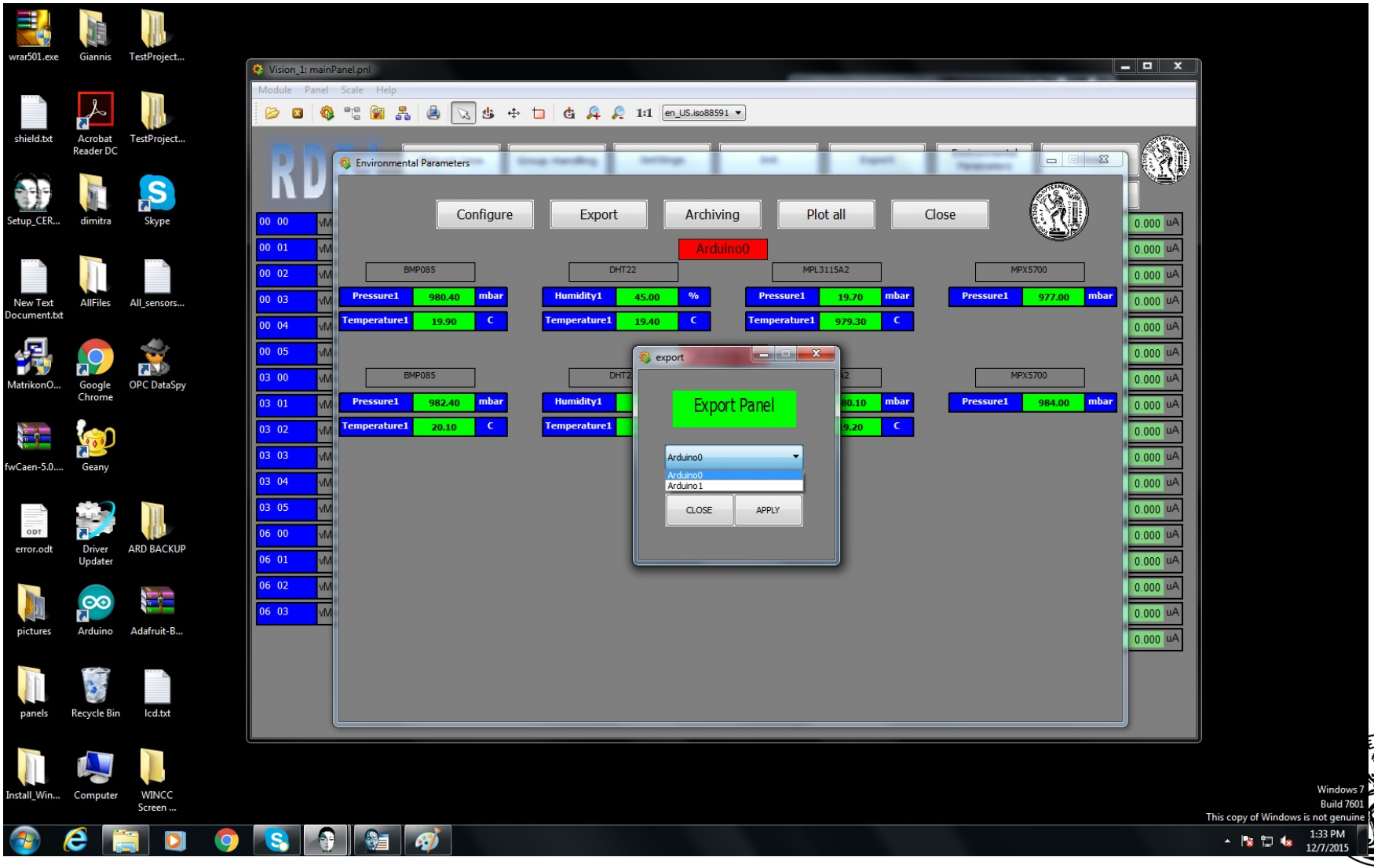
Slow Control System

Environmental parameter monitoring window



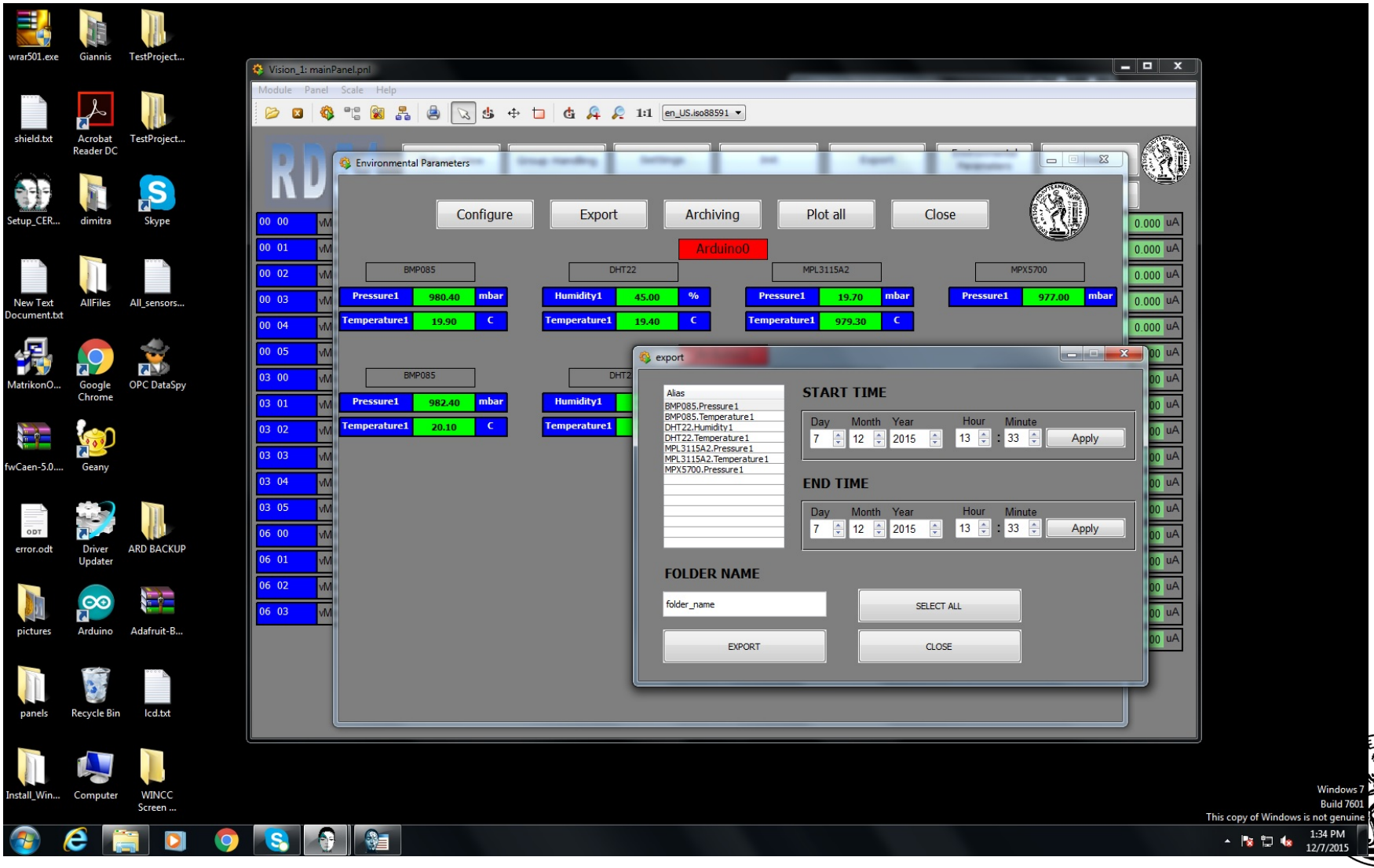
Slow Control System

Environmental parameter monitoring window



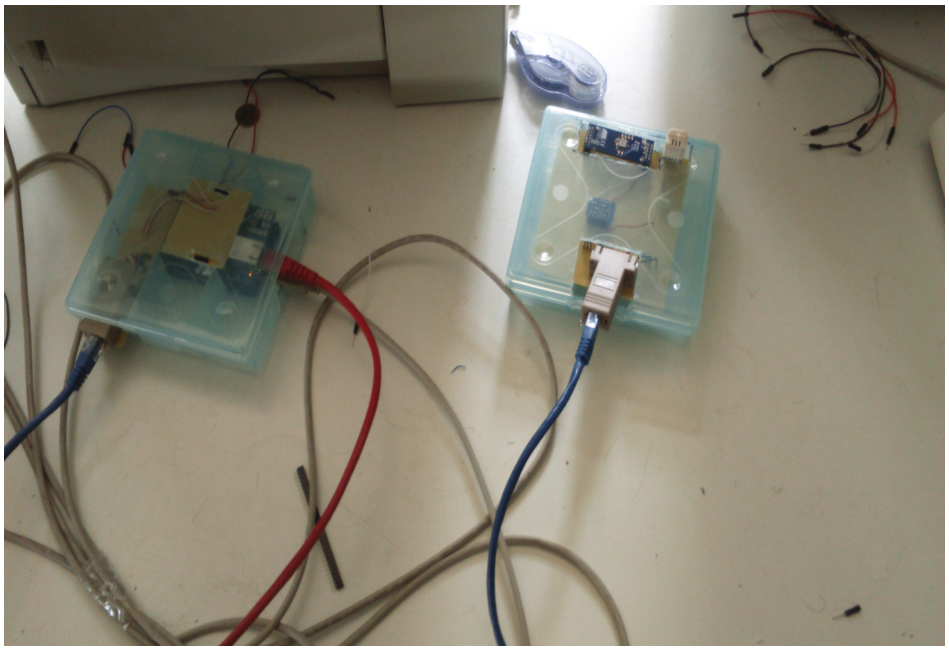
Slow Control System

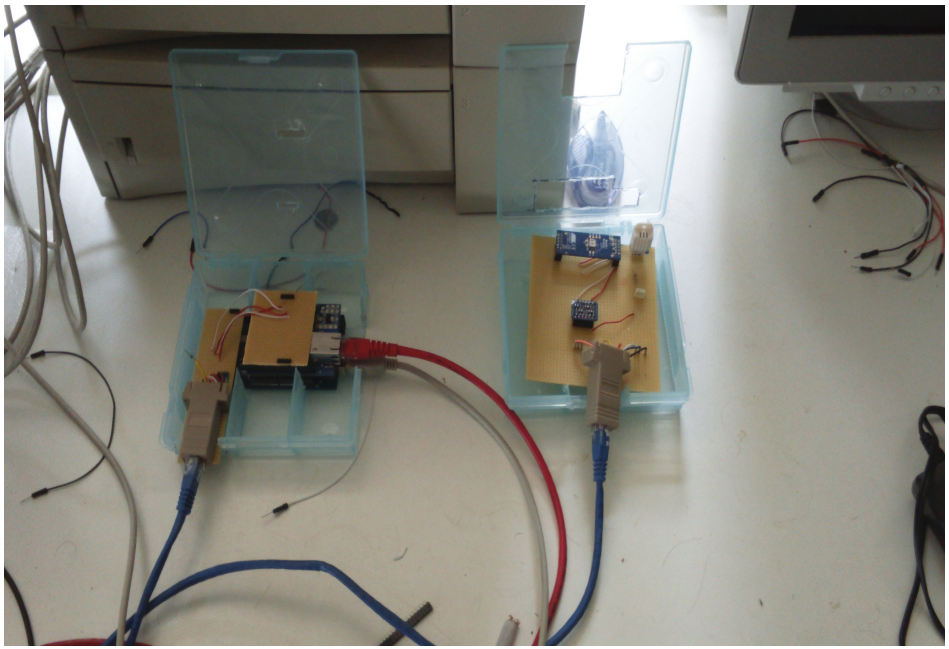
Environmental parameter monitoring window



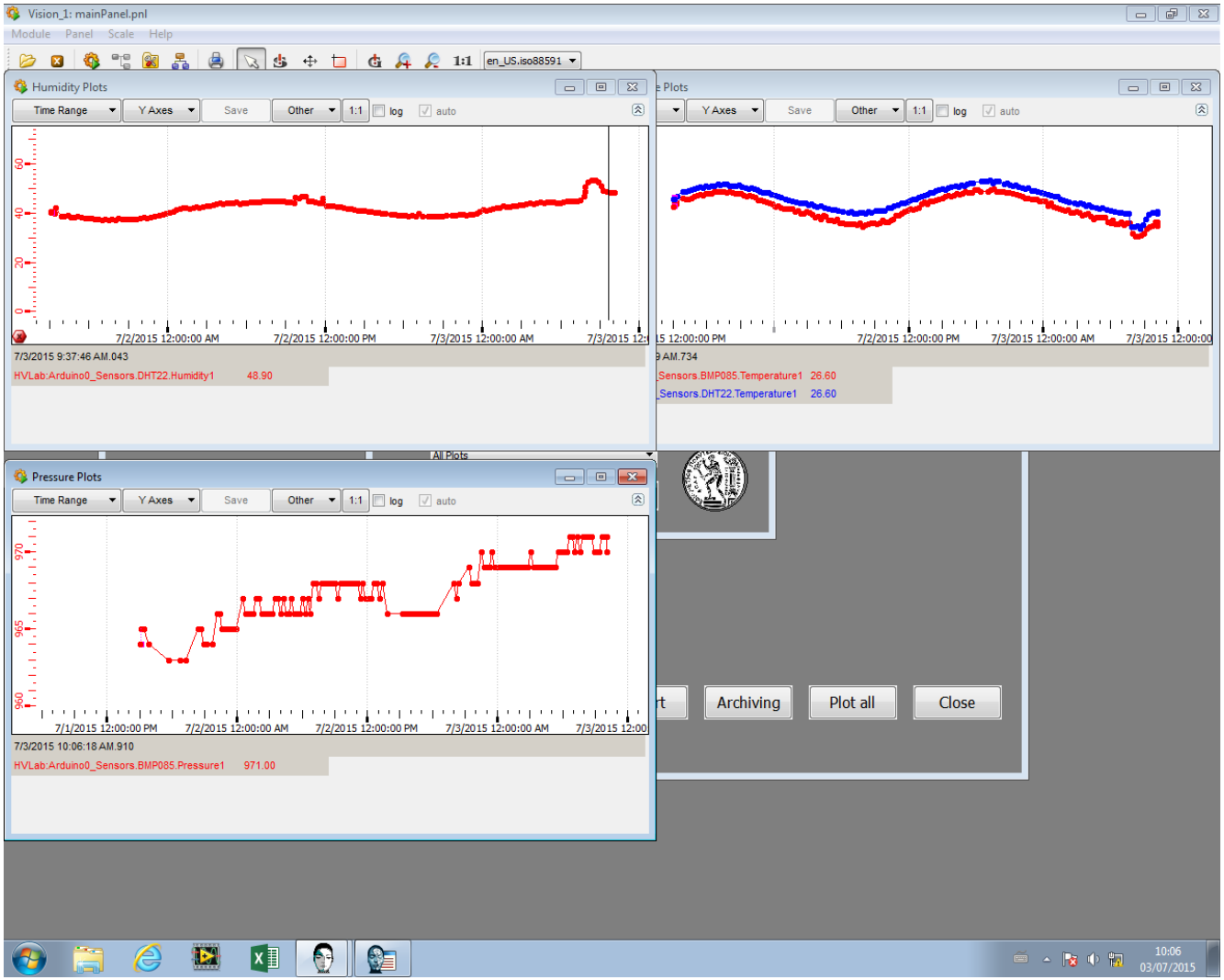
RD51 Test Beam

The system was used in the test beam conducted at the beginning of July at the facilities of the RD51 collaboration at CERN





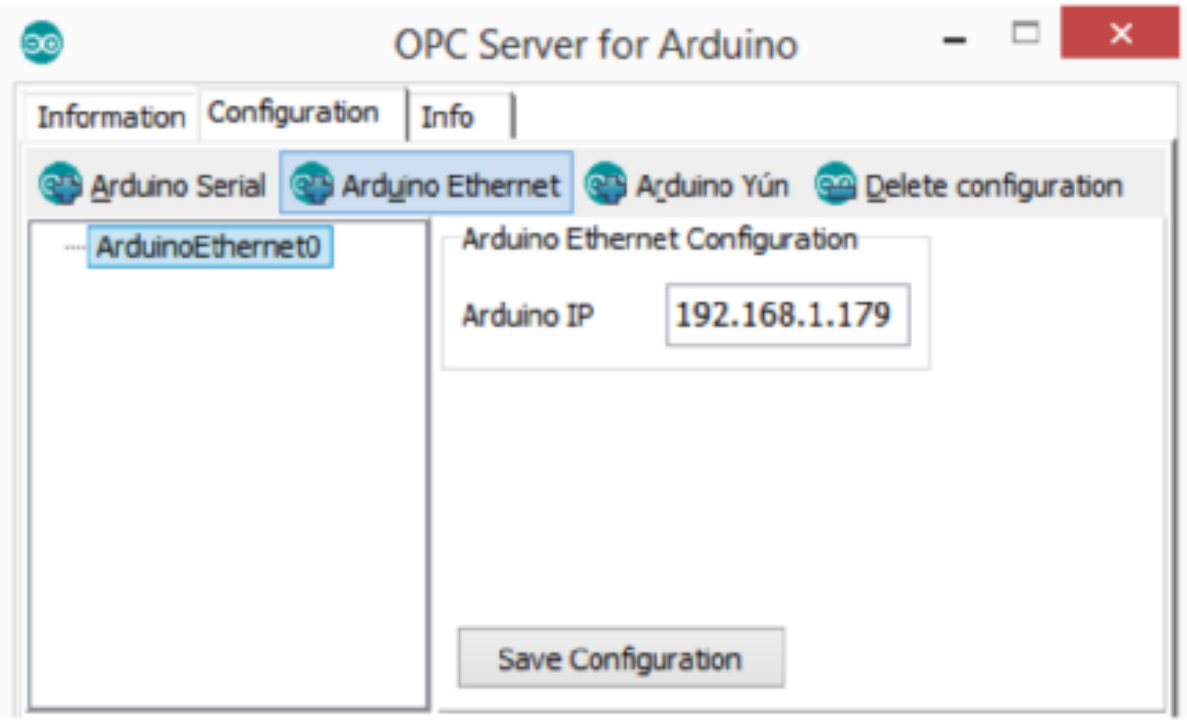
Environmnetal plots during Test Beam



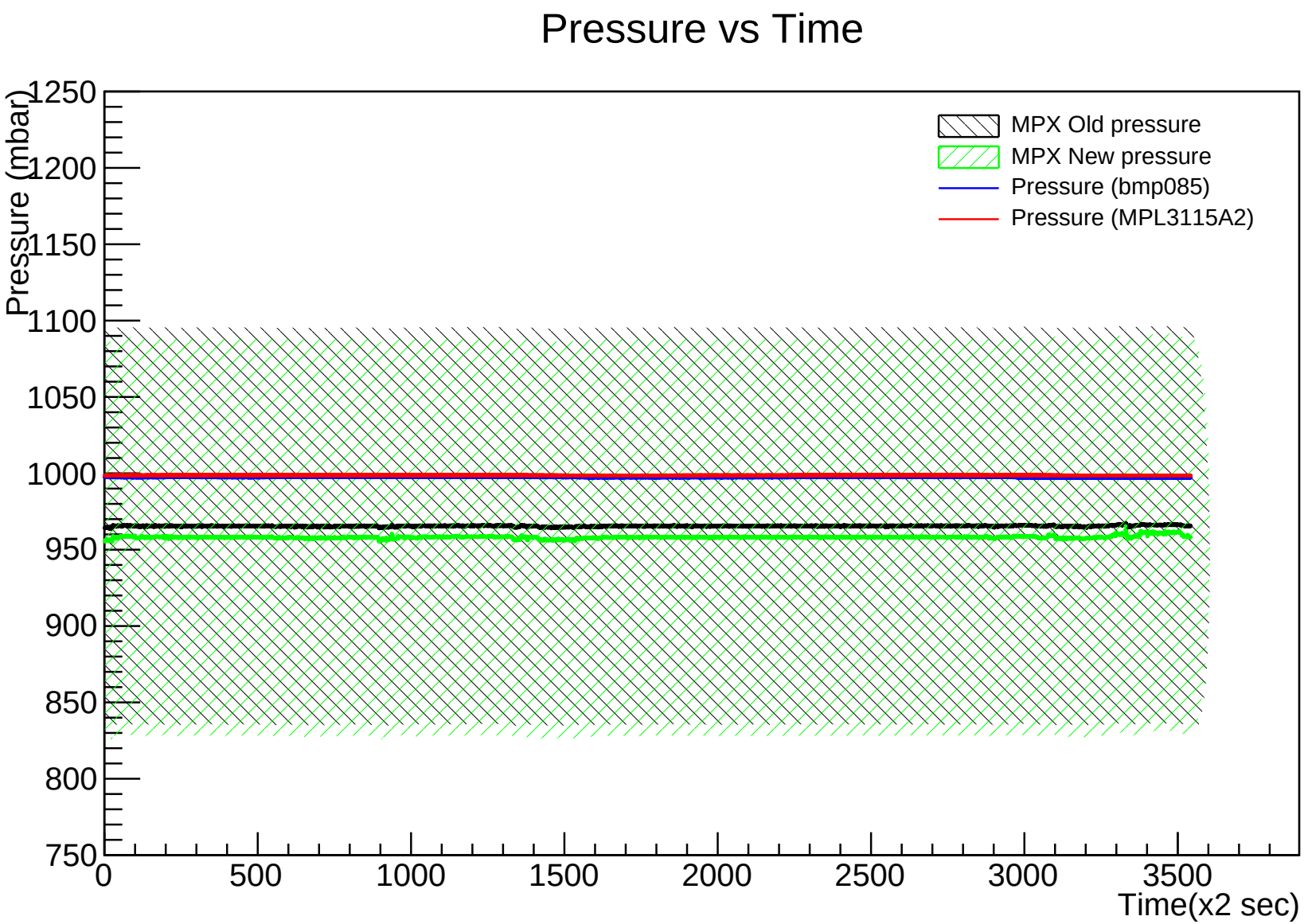
Conclusion

- A low cost system capable of monitoring the environmental parameters was developed
- Supports 4 different sensors measuring temperature, pressure, humidity
- Completely dynamic
- The system has been fully integrated in the RD51 Slow Control System
- It was used and tested at test beams at the RD51 facilities at CERN
- Ongoing process, wifi data trasmission, PCB

Backup Slides



Backup Slides



Backup Slides