



Environmental Monitoring

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Overview-Summary

Fibers for Temp and %RH monitoring on the PXD frame (IFCA)

A Standalone Temp & %RH monitoring system is being developed at IFIC for BEAST-II. Also for the VXD enclosure????:

- ✓ RH% Sensors => UPS-500 or UPS-600 from Ohmic instruments.
 - ✓ Resistive sensor, AC biasing
 - ✓ Precision 5% RH [20 - 90% RH]
 - ✓ Used in CMS ECAL and tested for radiation tolerance (at least ~50 KGy)
 - ✓ **Irradiated at ELSA up to 20 Kgy with electrons => we realized that new RO electronics had to be developed**

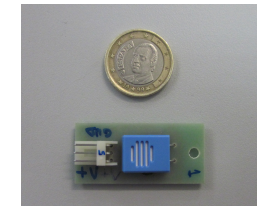
- ✓ PT100 temp sensors:
 - ✓ 2 close to the RH% sensors. Needed to correct the sensor reading
 - ✓ 4 extra sensors for temperature monitoring

- ✓ Readout => Mother-board based on ARDUINO
 - ✓ Arduino: Atmel micro-controller, 6 ADC channels
 - ✓ A mother-board with:
 - ➔ Interface: Ethernet
 - ➔ Signal conditioning for 2 %RH + 6 temp. remote sensors (up to 10m away)
 - ➔ **A prototype being tested in the lab**

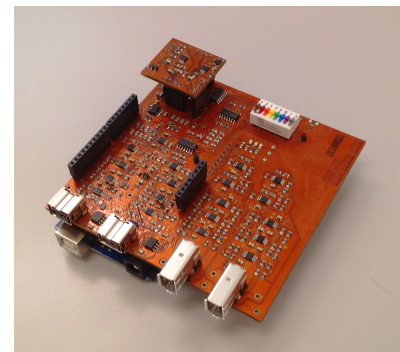
- ✓ Next steps:
 - ✓ Finalize characterization of the prototype
 - ✓ Irradiation sensors again in the next months
 - ✓ Try and test 2 other capacitive sensors. The same readout can be used. Better operational range (0-100 %RH)



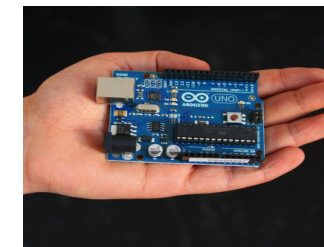
Sensor (x2 in detector ?)



Sample of sensor with integrated readout, but RO not radiation tolerant



Developed Mother-board



Arduino: 6,5 X 5,5 cm

P-14 (Innovative Sensor Technology)



HCH-1000 (Honeywell)



RH% sensors irradiation

Irradiation with 20 MeV e- at ELSA (Linac 1)

Device	Stage 1 dose	Stage 2 dose	Total
B4	792 krad	820 krad	1612 krad
A5	398 krad	514 krad	912 krad
B3		774 krad	774 krad
B1+RO		474 krad	474 krad
HIH-4000	~200 krad		200 krad

Post-Irradiation measurements:

Sensor	Measurement	Hygrometer
L1	520mV	(41%H, 28°C)
L2	520mV	(41%H, 28.8°C)
L3	570mV	(42%H, 28.4°C)
B3 (irrad)	558mV	(41.5%H, 28.3°C)
B4 (irrad)	590mV	(42.3%H, 28.3°C)
A5 (irrad)	550mV	(44%H, 28.2°C)

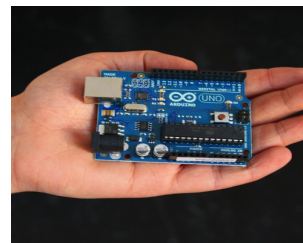
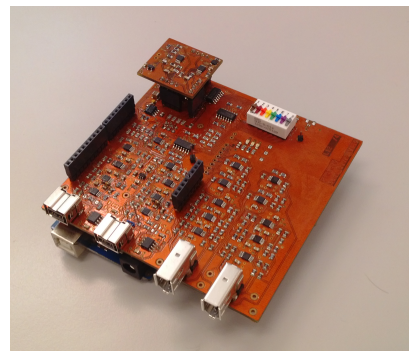
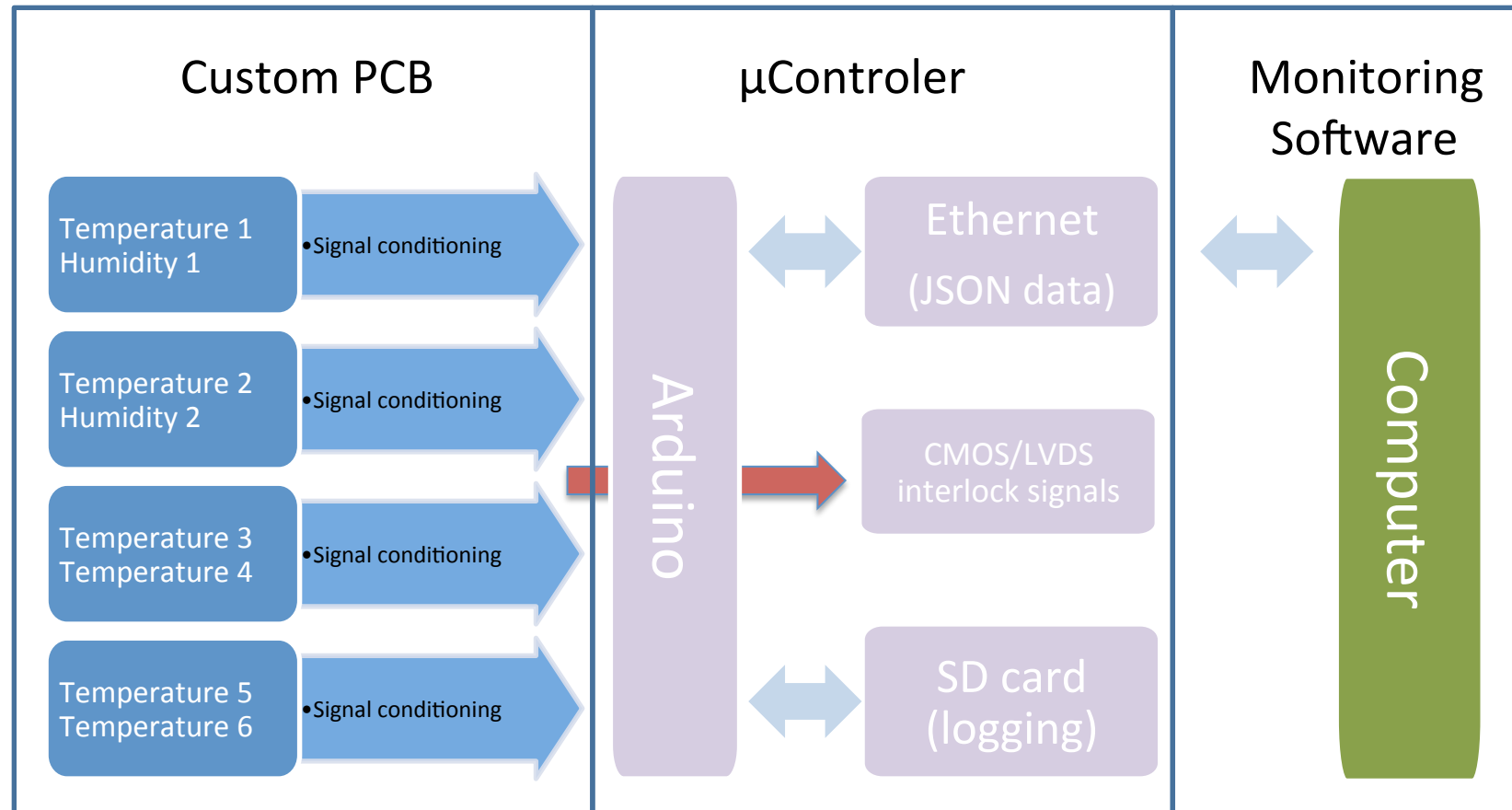


Irradiated and unirradiated samples behave rather similar. But a new RO electronics had to be designed

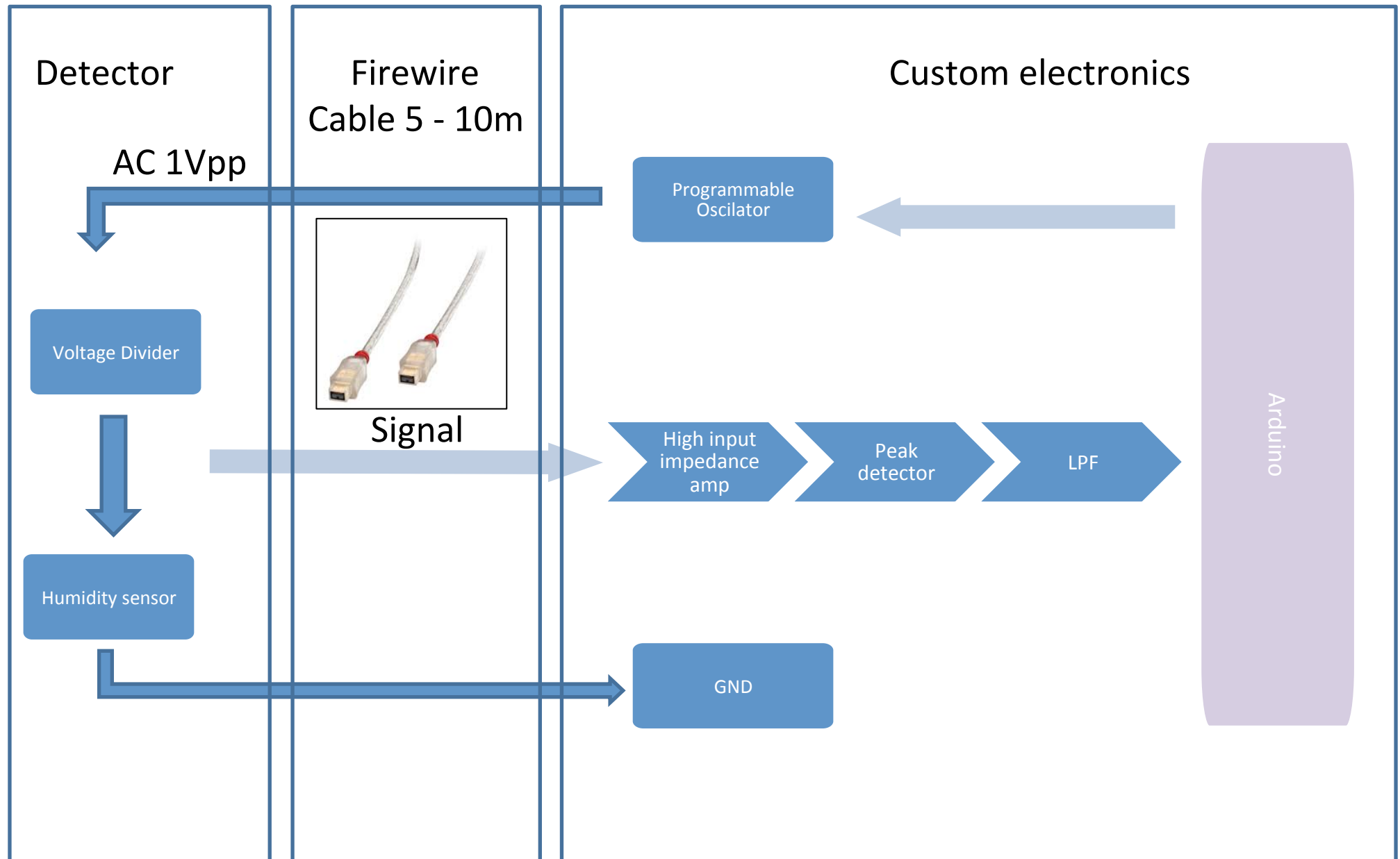
- It's not very straightforward since the sensor impedance range spans from few KOhms to 100 MOhms in logarithmic way.
- This high impedance is an issue since it's comparable to the cable capacitance
- Will have to focus in measuring a limited range
- Considerable dependence with temperature

Sensor	Measurement	Hygrometer
L1	4.42V	(17.8%H, 27.4°C)
L2	4.42V	(15.9%H, 27.5°C)
L3	4.43V	(15.9%H, 27.5°C)
B3 (irrad)		
B4 (irrad)	4.42V	(15.9%H, 27.5°C)
A5 (irrad)	4.437V	(15.9%H, 27.5°C)

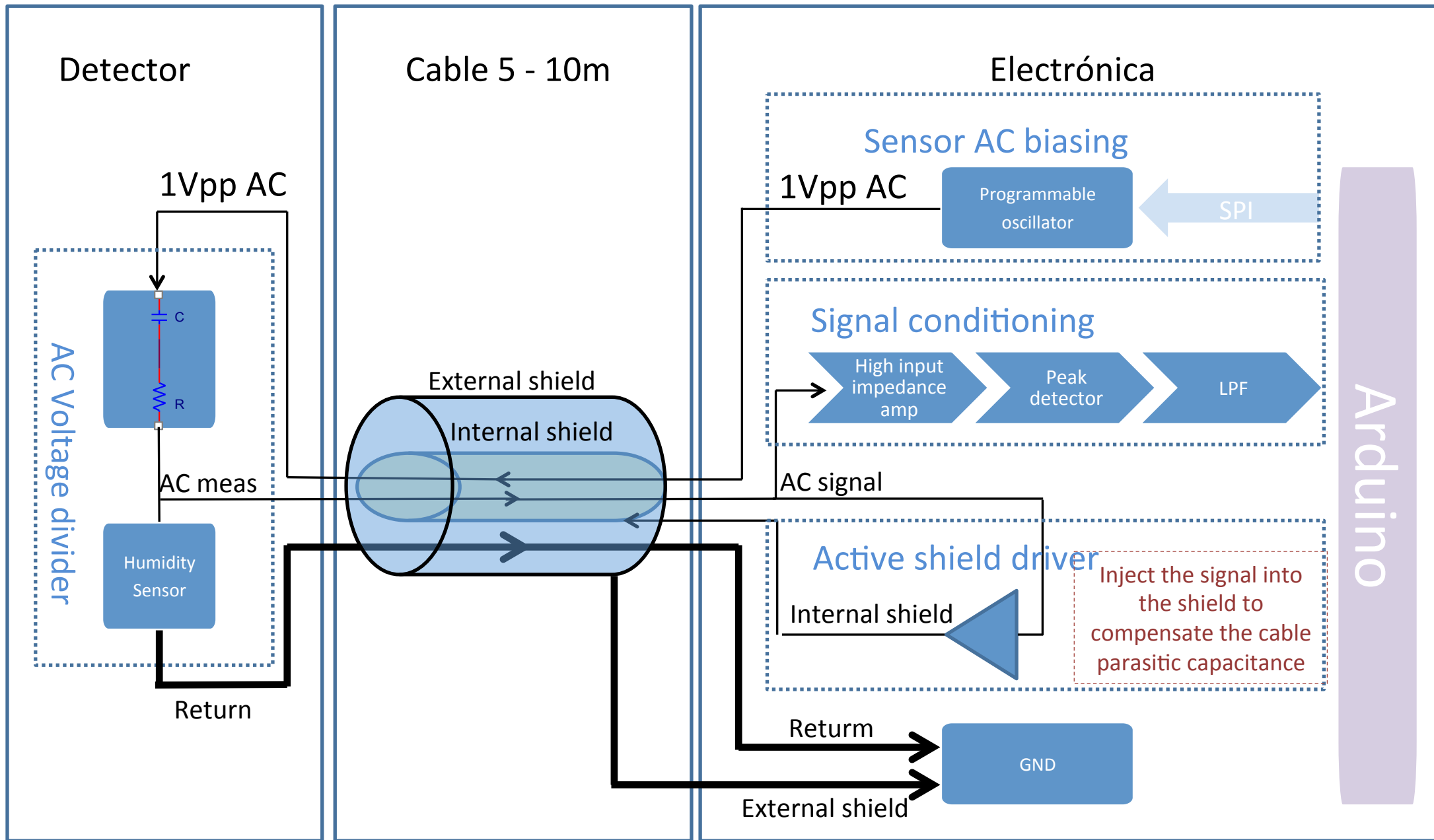
Global scheme



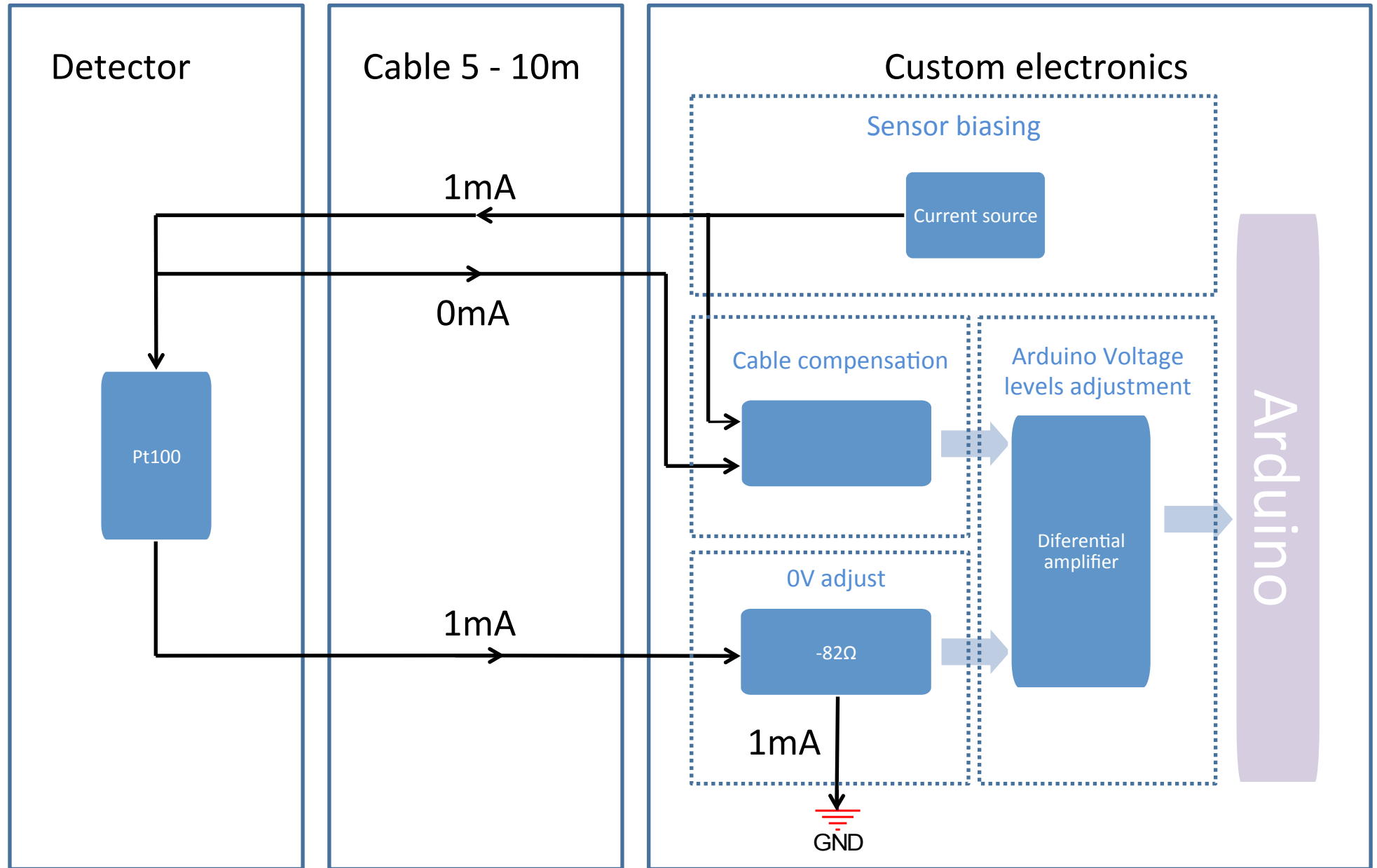
Humidity measurement



Humidity measurement



Temperature measurement





Status

- Prototype PCB built and functionalities evaluated
- V2 PCB had to be built:
 - Some bugs fixed and improvements
- Arduino programming and Ethernet/JSON data publishing tested. But not final firmware yet
- Master Thesis project writing ongoing (but in Spanish...)
- Sensor characterization partially done...

- Characterize the sensors and the new PCB:
 - ❑ New prototype PCB arrived. Being populated
 - ❑ Measurements in climate chamber
 - ❑ New irradiation test
 - ❑ Test the sensors in a very low temperature and humidity environment
- Test the “new” capacitive sensors
- Finalize the Arduino firmware
- The cable is bulky... study lower mass cable scheme??



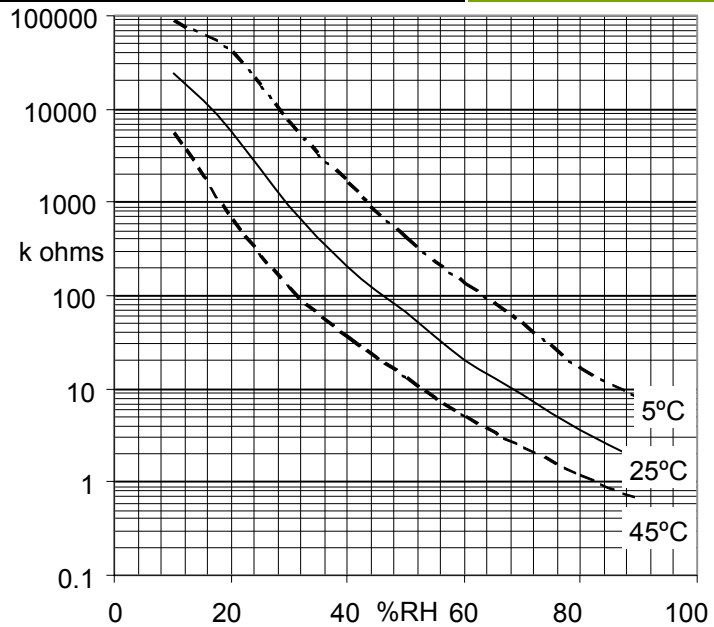
THANK YOU VERY MUCH!!



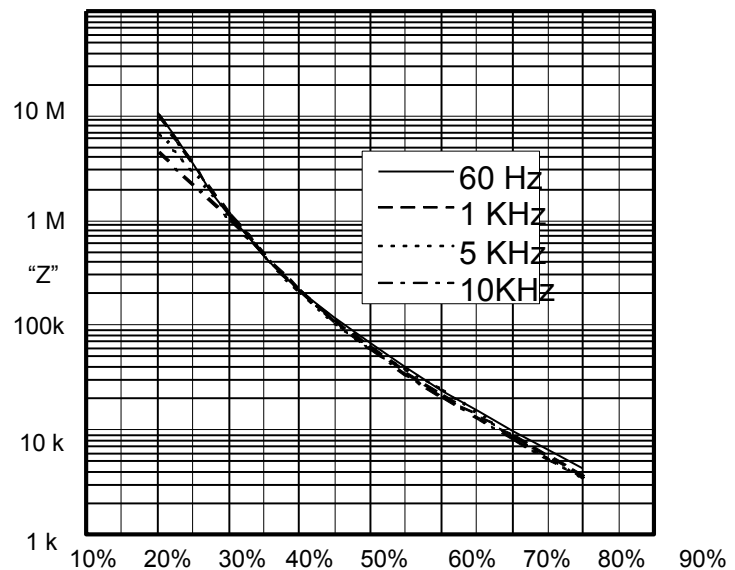
BACKUP



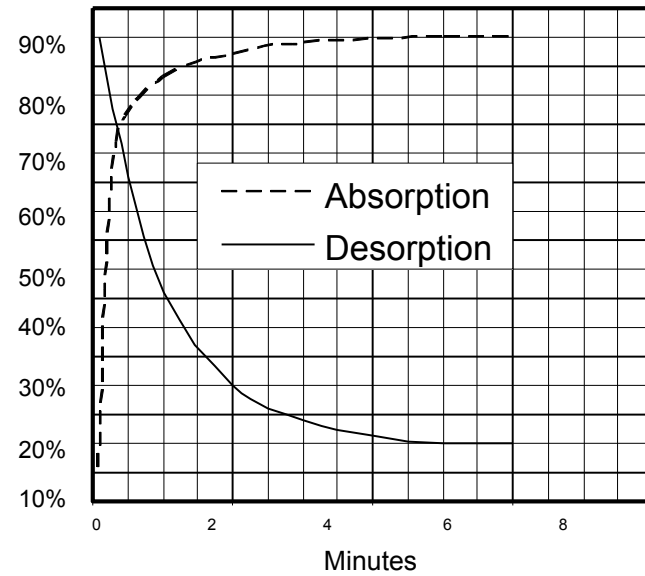
RH% sensor



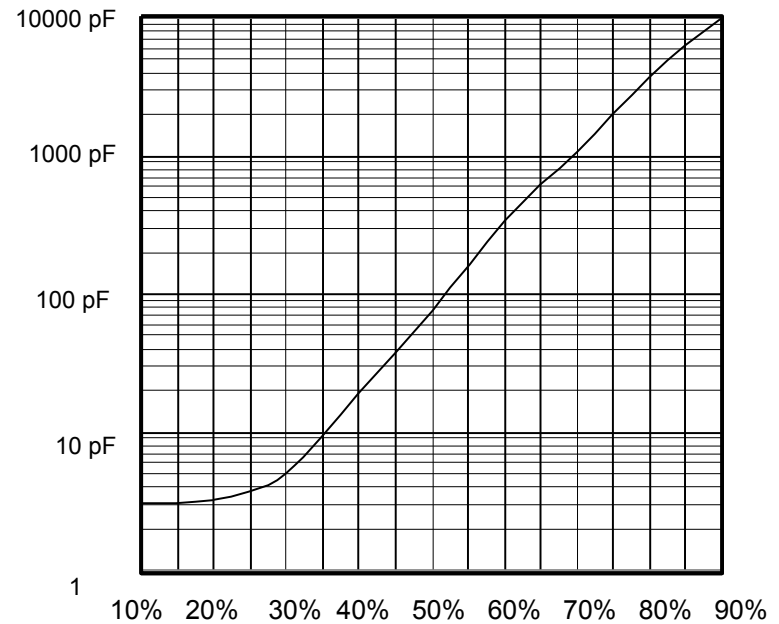
Impedance vs. RH at 5°C, 25°C, & 45°C Temperatures



"Z" vs. %RH @ 60 Hz, 1/5/10KHz @25°C

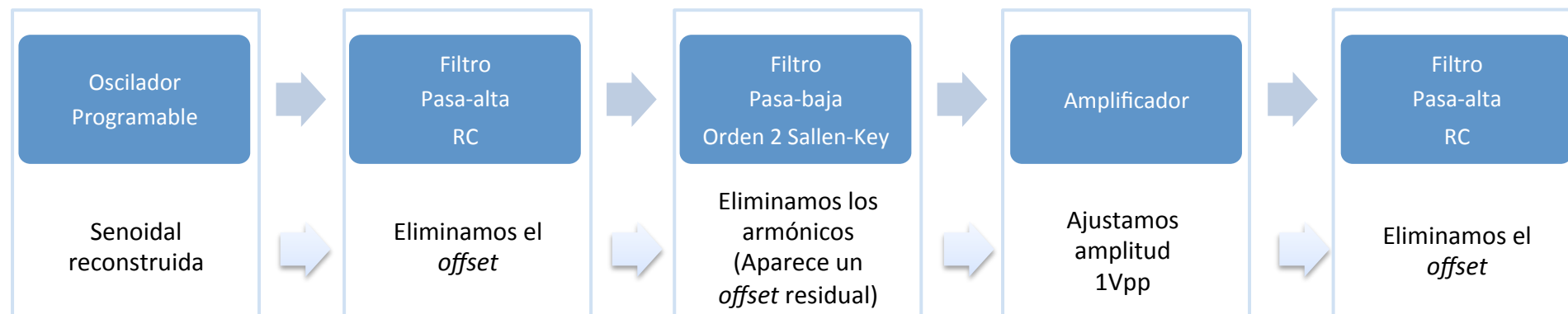
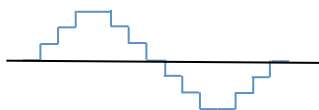
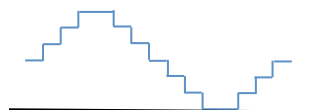


%RH vs. Time in minutes @ 25°C.

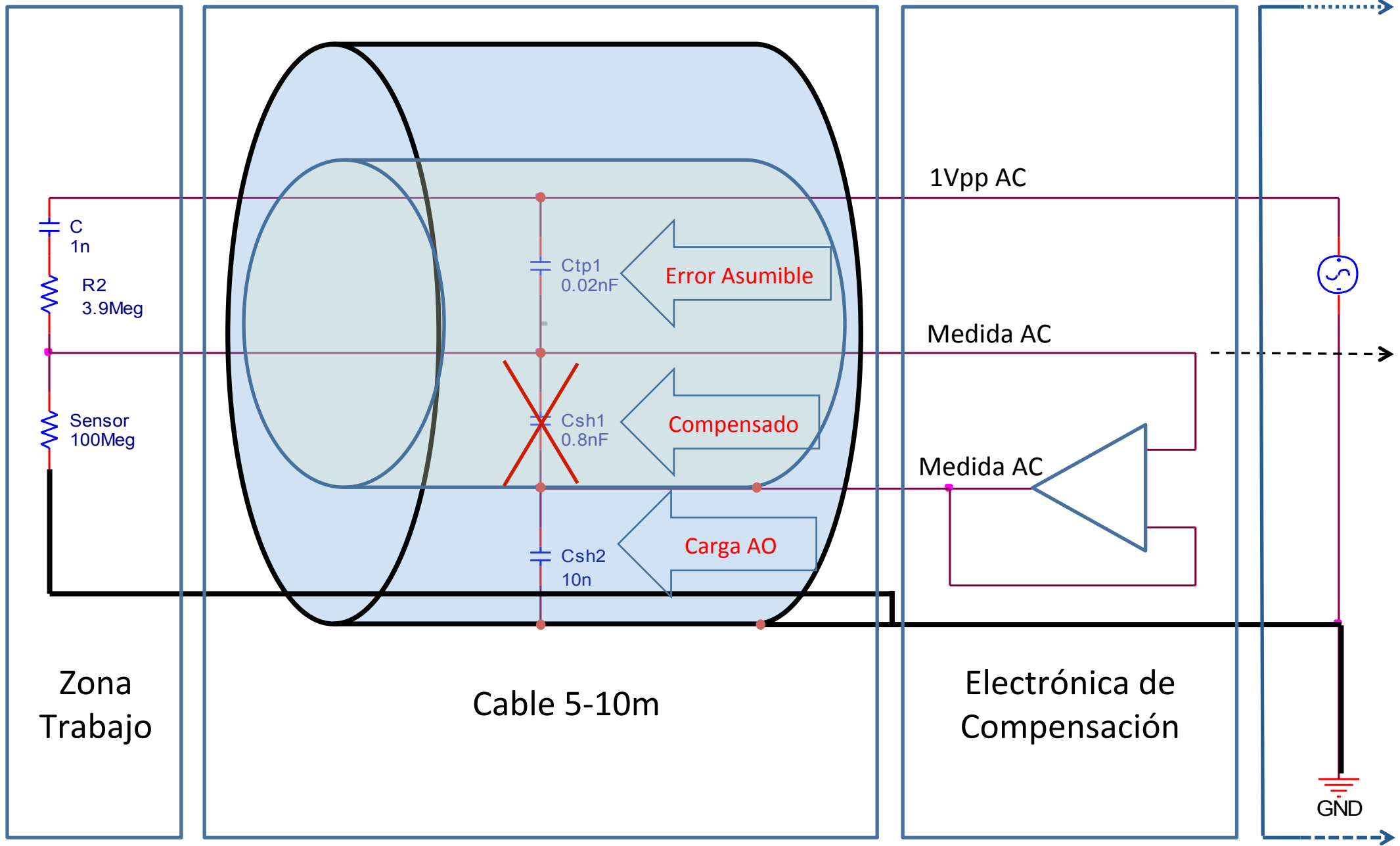


Capacitance vs. %RH, @25°C 1KHz

Programmable oscillator



Compensación de la capacidad del cable





Humedad

Zona Trabajo

Cable 5 - 10m

Electrónica

1Vpp AC

Polarización del Sensor

1Vpp AC

Oscilador Programable

SPI

tensión

Divisor de

Medida AC

Acondicionamiento de la señal

1er Amplificador

Detector de Picos

Acoplamiento Arduino

Arduino

Sensor Humedad

Malla Interna

Medida AC

Malla Activa

Inyectamos la medida en la malla interna

Malla Externa

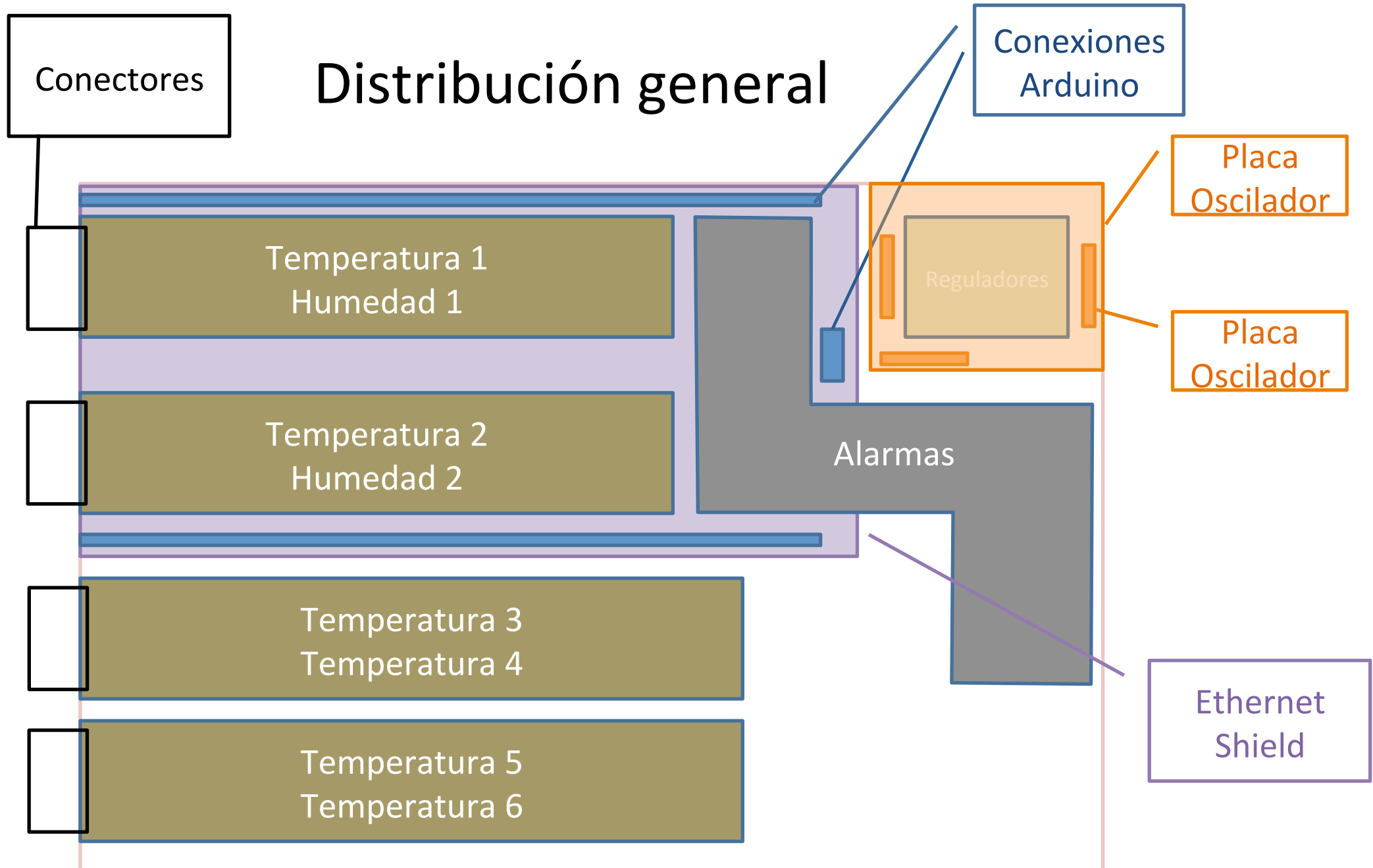
El retorno se produce por la malla externa

Retorno

Malla Externa

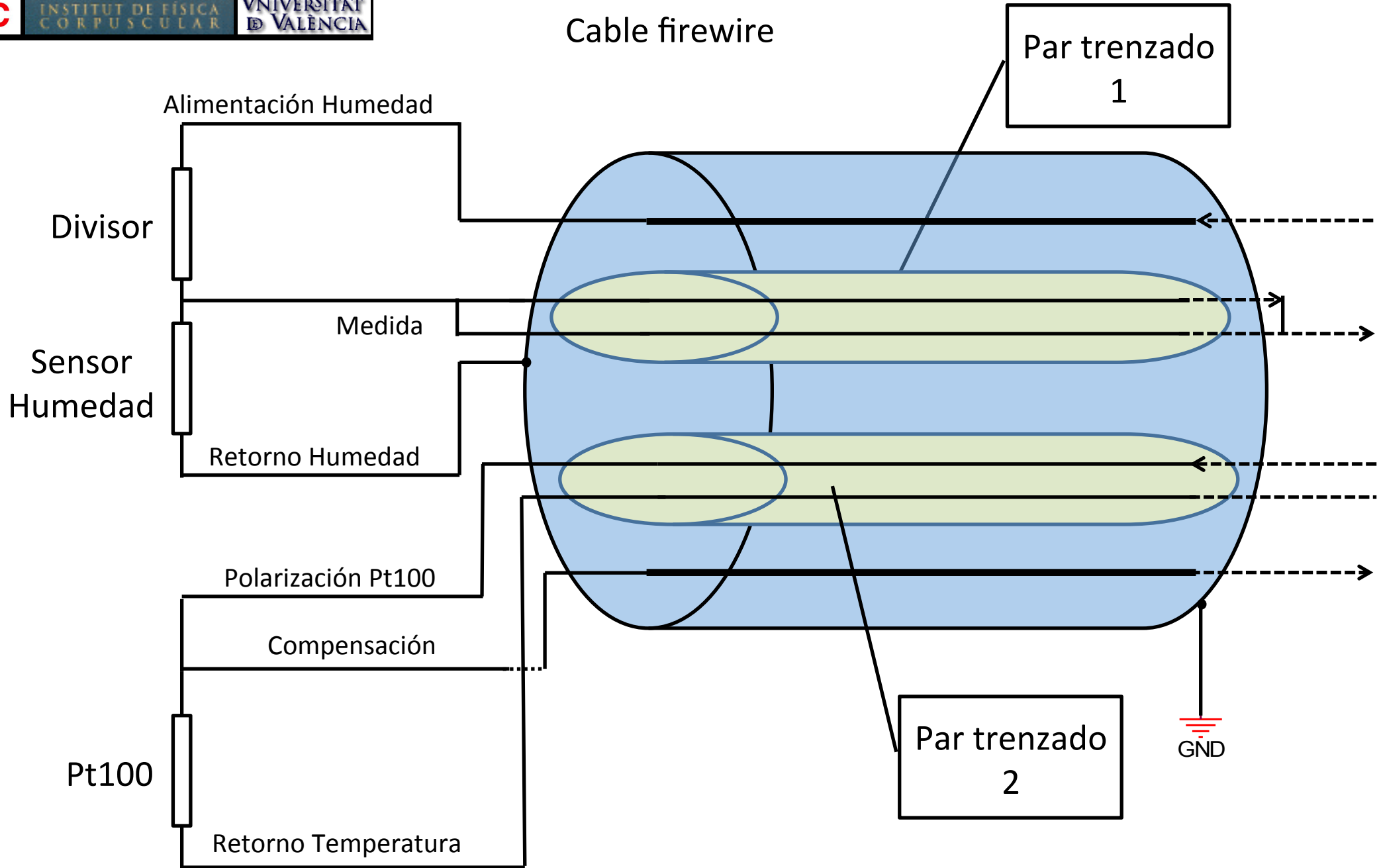
GND

Distribución general





Cable firewire



Conector firewire para humedad

