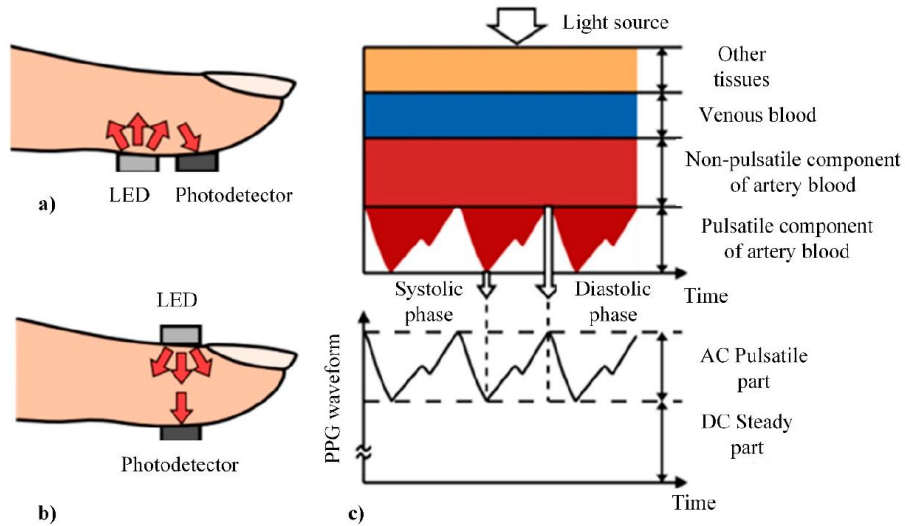


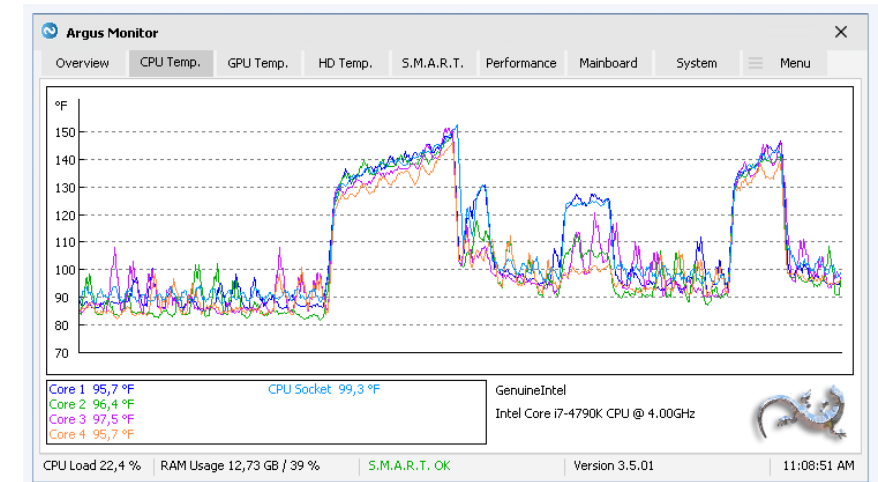
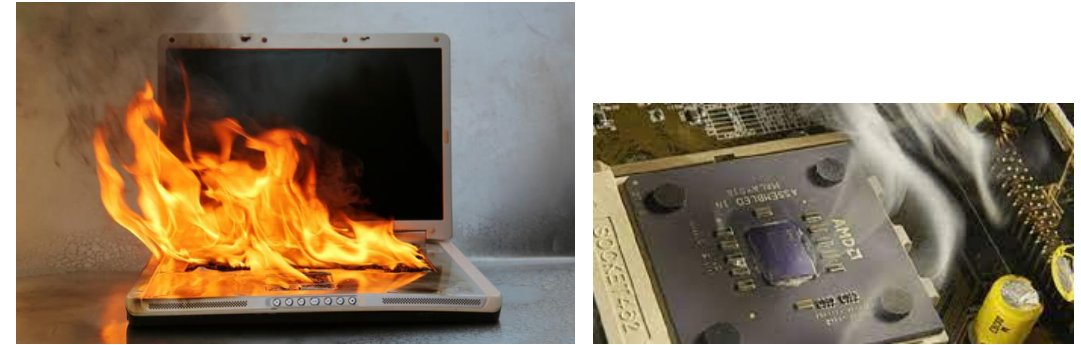
Mini-Project: Kickoff

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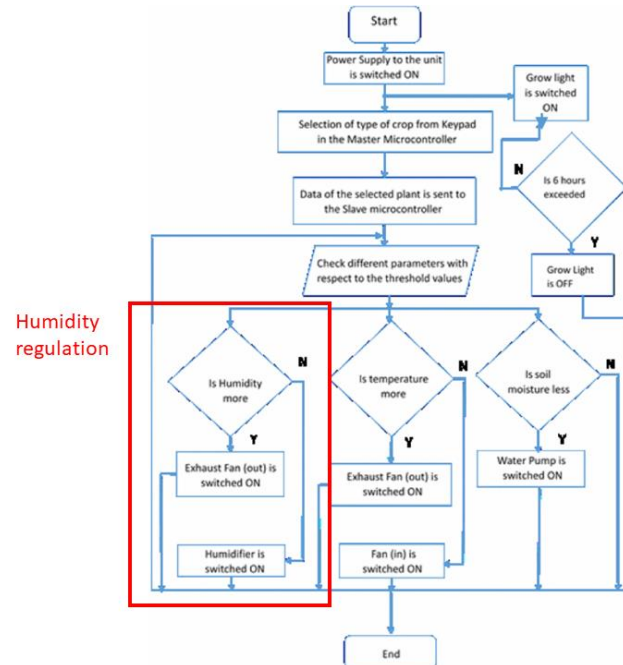
- Heartbeat monitoring with photoplethysmography



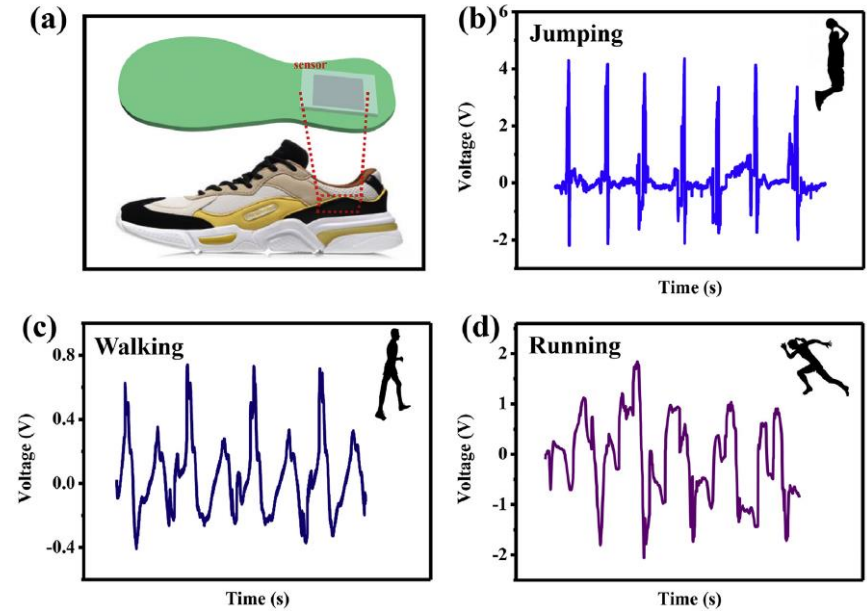
- CPU Temperature monitoring



- Humidity regulation for greenhouse with exotic plants



- Feet activity monitoring



- Master the implementation of a complete sensing chain
- Prepare you for the final Project

Provided to you

Specifications

- Specifications will orient your engineering choices and define performance targets to reach
- Depends on the application
- Defining clear specifications is crucial because it will shape the entire project from the beginning
- Specifications can potentially be revised during the project

For the final project, you will have to define them by yourself

Ex: T° sensor

Which temperature range ??

Medical ?

[30; 50] °C

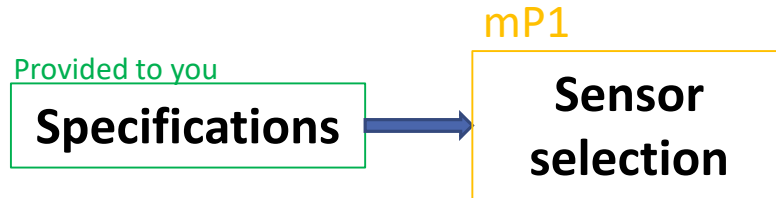
Space ?

[0; 400] °K

Steel manufacturing ?

[900; 1000] °C

- Prepare you for the final Project
- Master the implementation of a complete sensing chain :



- Based on the specifications you will have to choose the most suitable raw sensor
- A sensor could be completely useless for this application or on the contrary several sensors could be suitable

Ex: T° range of the raw sensor

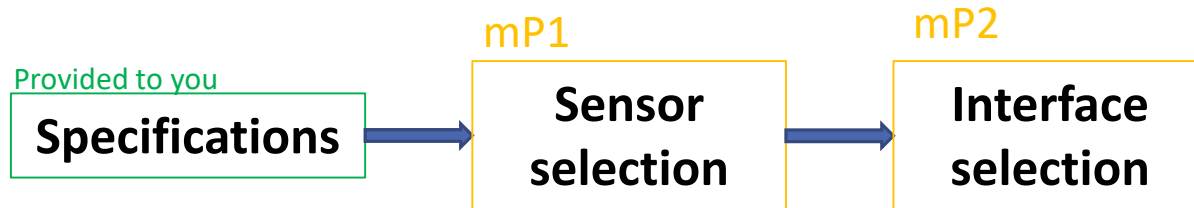
[-150; -50] °C ?

[30; 50] °C ?

[0; 500] °C ?

Which sensor for medical applications ??

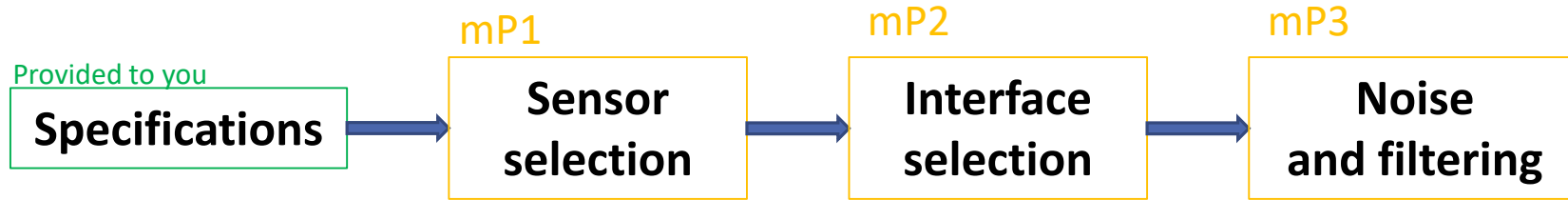
- Prepare you for the final Project
- Master the implementation of a complete sensing chain :



- Once the raw sensor is selected, you will need to modelize it
- Then you will have to select the interface that will convert the raw sensor signal into a voltage that can be digitized
For these mPs, we stay in the analog world
- You will use Spice to simulate the sensor and its interface

Ex: Should I use a bridge (DC, AC) or something else ?
Amplification ?

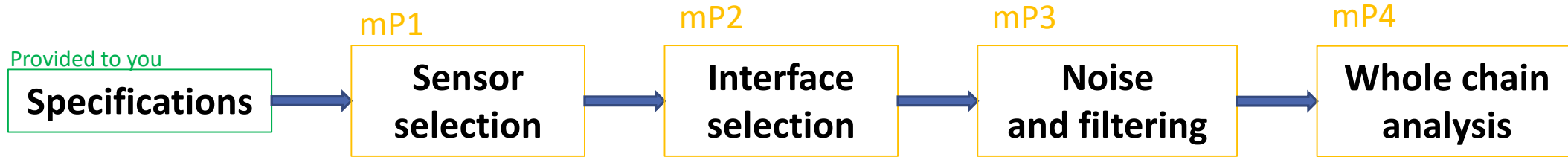
- Prepare you for the final Project
- Master the implementation of a complete sensing chain :



- Noise is an important aspect of a sensing chain. At this stage, you will only focus on noise at the conditioning interface level

Ex: Impact of resistors, op-amps ?
Is it necessary to add a filter ? What kind, active passive?

- Prepare you for the final Project
- Master the implementation of a complete sensing chain :



- Merge all the work accomplished into one big chain and compute the IRN

- Kickoff
 - Preparation: photodiode comparison
- mP1 - Raw sensor selection – Photodiode
 - mP1 debriefing
 - Preparation: E3 optional exercise
- mP2 - Raw sensor modeling and sensor interface selection - Capacitive
 - mP2 debriefing
 - Preparation: Interface noise analysis methodology
- mP3 - Filtering and interface noise - Piezoelectric
 - mP3 debriefing
 - Preparation: Whole chain noise analysis methodology
- mP4 - Whole chain characterization – Resistive
 - mP4 debriefing

- Kickoff
 - ↳ - Preparation: photodiode comparison
- mP1 - Raw sensor selection – Photodiode
 - mP1 debriefing
 - ↳ - Preparation: E3 optional exercise
- mP2 - Raw sensor modeling and sensor interface selection - Capacitive
 - mP2 debriefing
 - ↳ - Preparation: “Noise analysis” document Part 1: “Exact IRN calculation at the circuit block level”
- mP3 - Filtering and interface noise - Piezoelectric
 - mP3 debriefing
 - ↳ - Preparation: “Noise analysis” document Part 2: “Approximate IRN calculation at the conditioning chain level”
- mP4 - Whole chain characterization – Resistive
 - mP4 debriefing

Before each session, some preparation...

- Kickoff

- Preparation: photodiode comparison

- mP1 - Raw sensor selection – Photodiode

- ↳ mP1 debriefing

Debriefing with correction and introduction to the next mP

- Preparation: E3 optional exercise

- mP2 - Raw sensor modeling and sensor interface selection - Capacitive

- ↳ mP2 debriefing

- Preparation: Interface noise analysis methodology

- mP3 - Filtering and interface noise - Piezoelectric

- ↳ mP3 debriefing

- Preparation: Whole chain noise analysis methodology

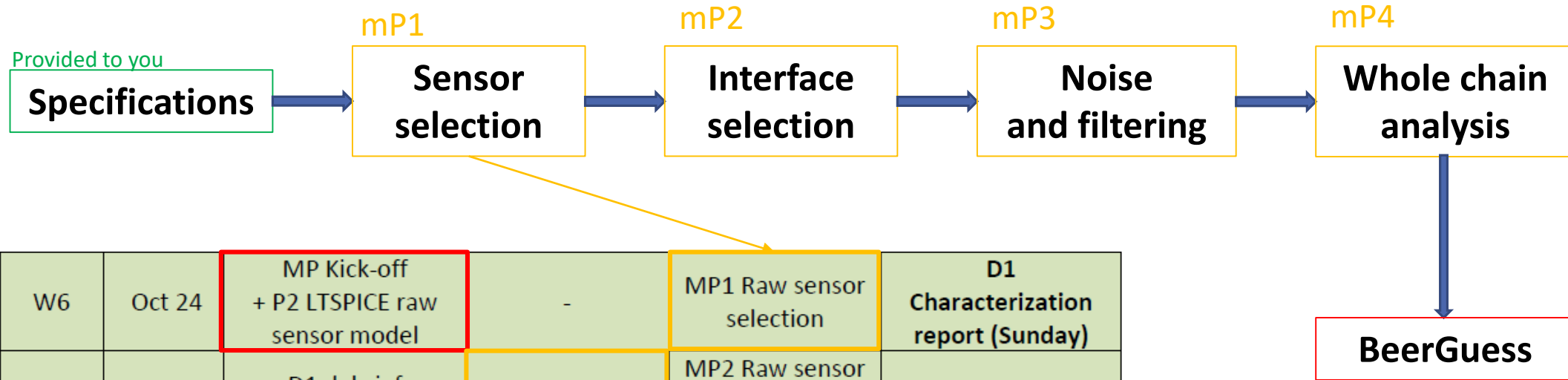
- mP4 - Whole chain characterization – Resistive

- ↳ mP4 debriefing

As the sensor will be different for each session, the equivalent content of the old sensor for the new sensor will be summarized.

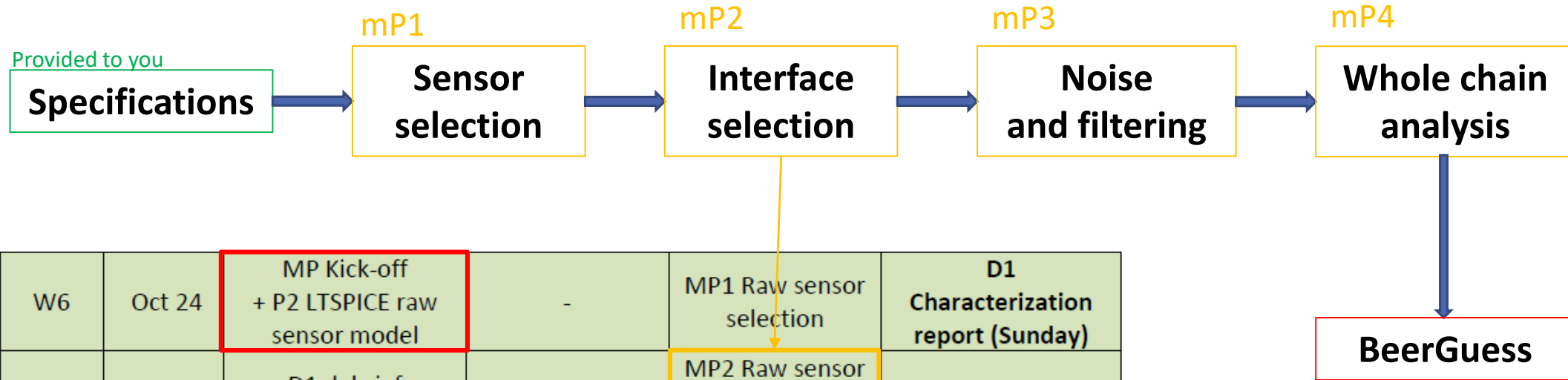
For clarity, during the whole mPs, you will follow the single example of the Resistive sensor that you will tackle in the end.

Ex: In mP2 you will select an interface for the capacitive sensor. In mP3, you will do the noise analysis on the Piezoelectric interface.



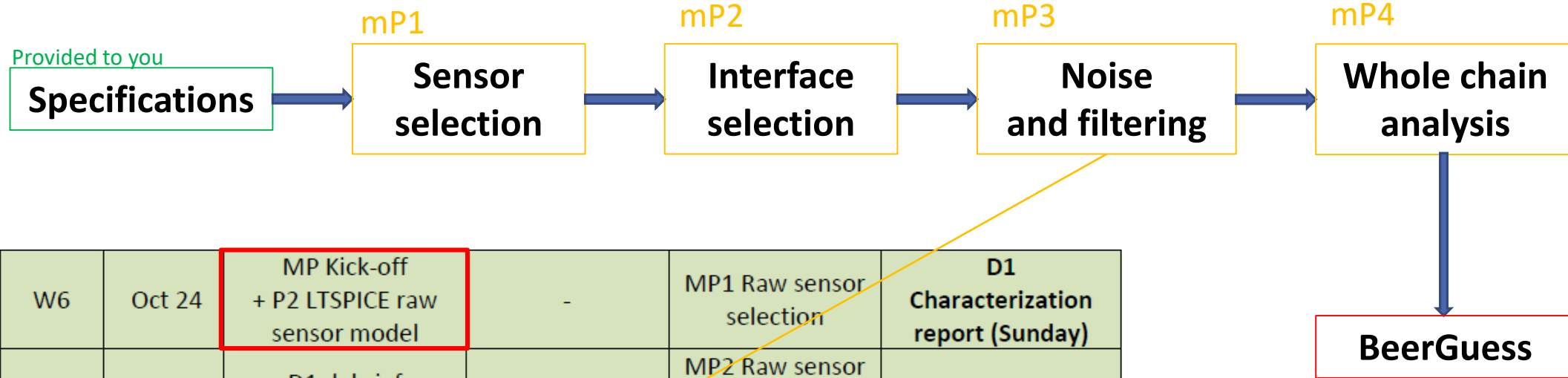
W6	Oct 24	MP Kick-off + P2 LTSPICE raw sensor model	-	MP1 Raw sensor selection	D1 Characterization report (Sunday)
W7 Smart	Oct 31	D1 debrief (Wednesday 4:15pm MERC14)	Debrief MP1	MP2 Raw sensor modeling and sensor interface selection	-
W8	Nov 7	Debrief MP2	-	- (Public holiday)	-
W9	Nov 14	MP3 Filtering and Noise	-	Debrief MP3	-
W10	Nov 21	MP4 Whole chain characterization	-	Debrief MP4	Component selection presentation

By the end you will have knowledge about the interfacing of 4 different types of sensors...



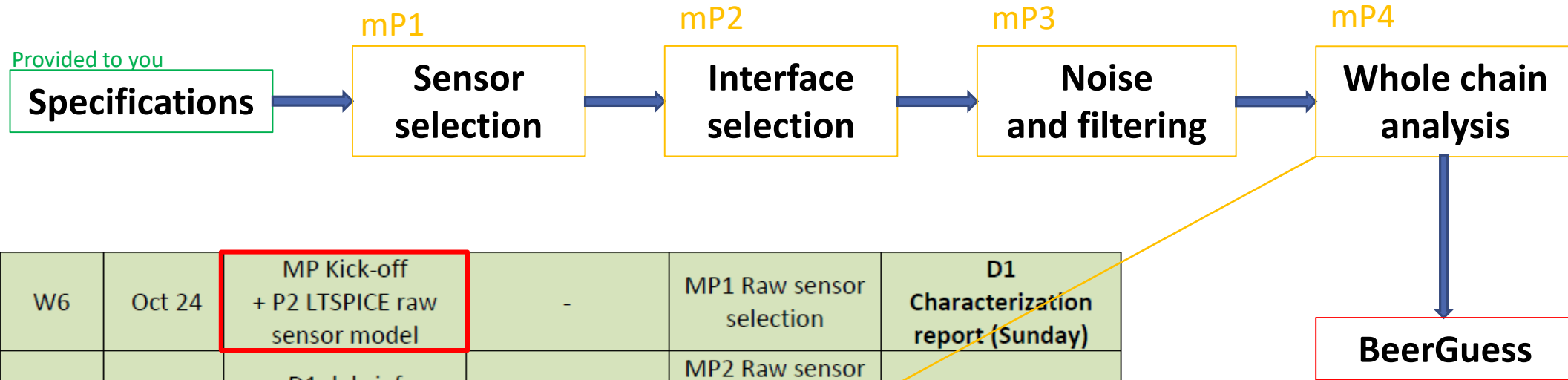
W6	Oct 24	MP Kick-off + P2 LTSPICE raw sensor model	-	MP1 Raw sensor selection	D1 Characterization report (Sunday)
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W10	Nov 21	MP4 Whole chain characterization	-	Debrief MP4	Component selection presentation

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W9	Nov 14	MP3 Filtering and Noise	-	Debrief MP3	-
W10	Nov 21	MP4 Whole chain characterization	-	Debrief MP4	Component selection presentation

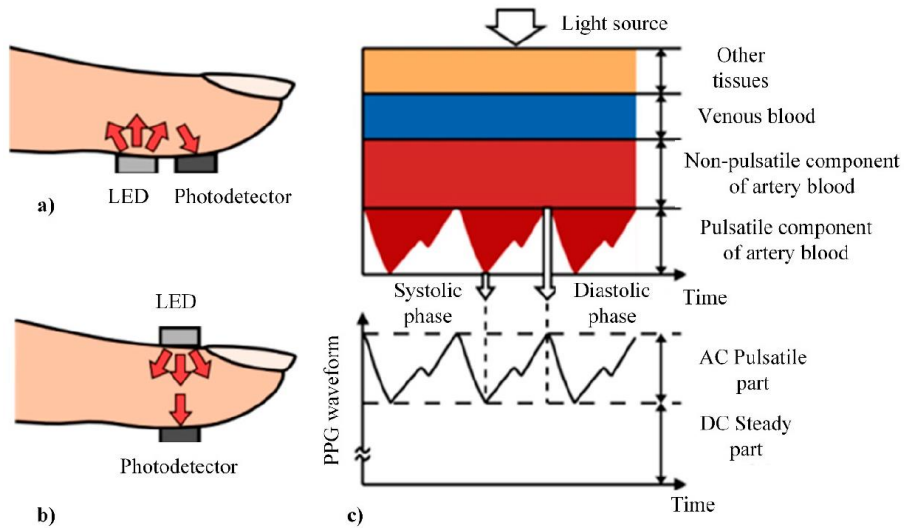
By the end you will have knowledge about the interfacing of 4 different types of sensors...

End

Specs

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Heartbeat monitoring with photoplethysmography



The conditioning chain that you are asked to design must operate continuously and needs to convert the measured light intensity into an analog voltage. This voltage will then be digitized by an ADC at a sampling rate of 100 samples per second.

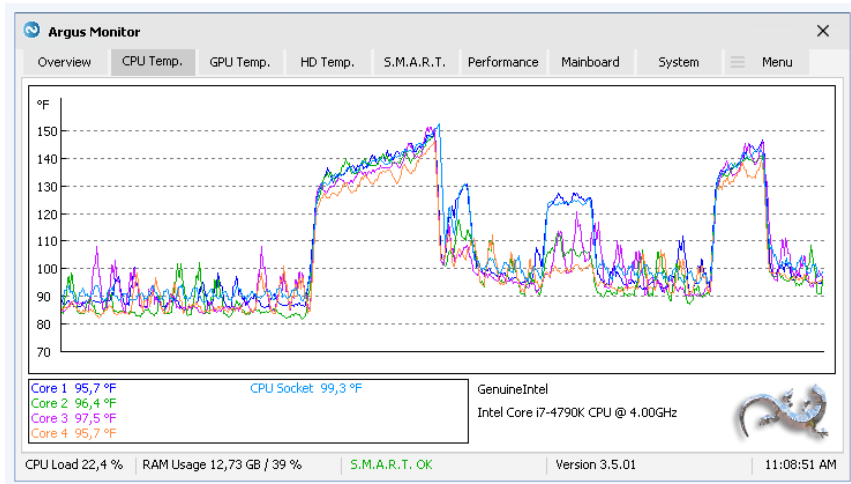
- Bandwidth: 40 to 200 beats per minute (bpm);
- Power consumption: No restrictions;
- Light wavelength: To be chosen by the design team;
- Radiant intensity of emitted light: As high as possible;
- Sensitivity of the photodiode/phototransistor: As high as possible.

CPU Temperature monitoring



The output of the conditioning chain must present an analog voltage that depends on temperature. The signal will then be digitized by an ADC.

- Temperature span: from 0 to 100 °C
- Calibration: must work without calibration
- Accuracy: between 3 and 5 °C [1]
- Resolution: 0.5 °C
- Supply voltage: <3.3 V, must be low power
- Bandwidth: <30 Hz

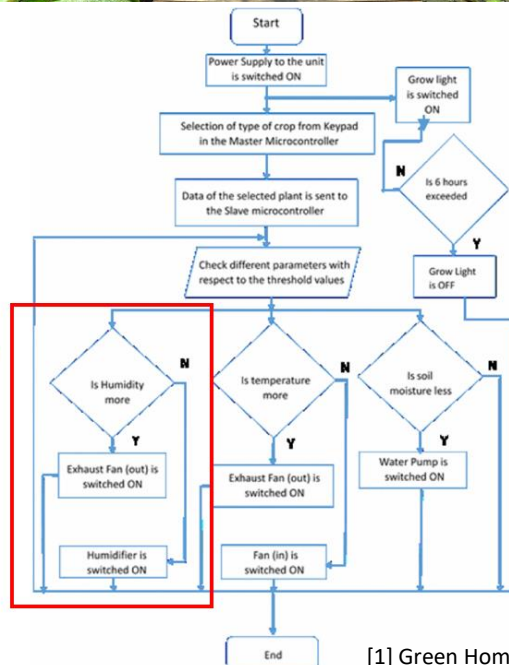


Humidity regulation for greenhouse with exotic plants



- %RH span: from 40 to 100 %RH [1].
- Bandwidth: <1 Hz
- Temperature dependence: must be resistant to temperature variations in the greenhouse. T° for exotic plants should be between 15 and 30 ideally [1][2].
- Supply voltage: <3.3 V
- Accuracy: <5%

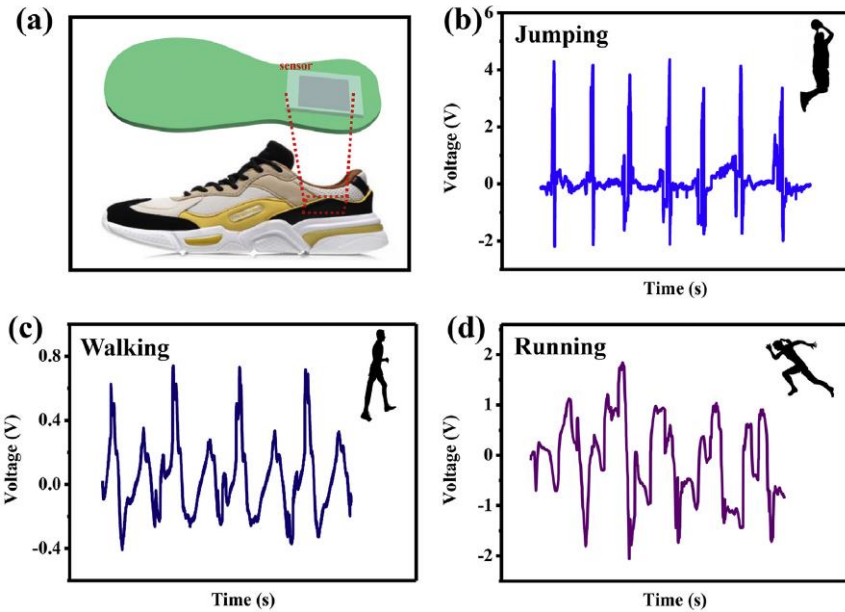
Humidity
regulation



[1] Green Home Gnome (September 30, 2014) , 7 Tips for Growing Tropical Plants in a Greenhouse, <https://www.greenhomegnome.com/tips-growing-tropical-plants/>

[2] Krostrade, Température idéale pour cultiver des tomates dans une serre, <https://krostrade.fr/fr/blog/post/temperature-ideale-pour-cultiver-des-tomates-dans-une-serre>

Feet activity monitoring

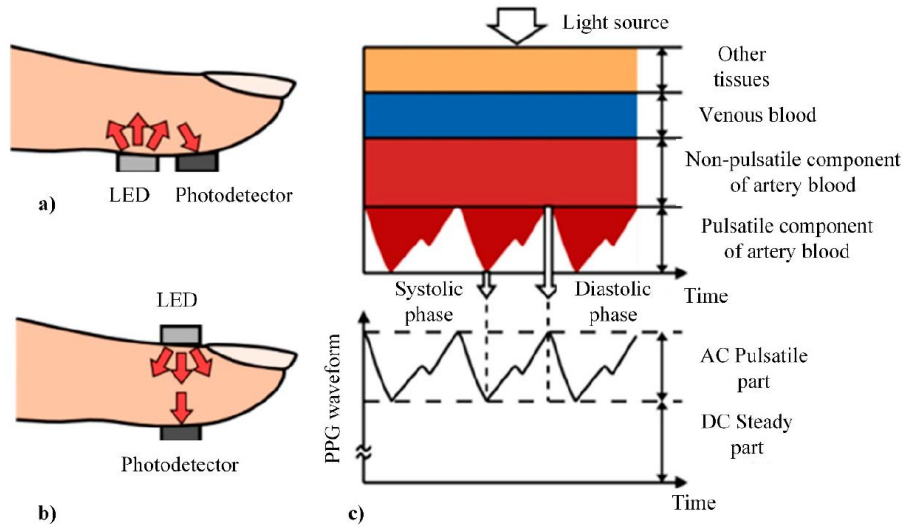


- Pressure range: 5 to 50 kPa
- Signal bandwidth: 0,5 to 40 Hz
- Supply voltage: ≤ 3.3 V
- Ergonomy: Can be placed inside a shoe without discomfort

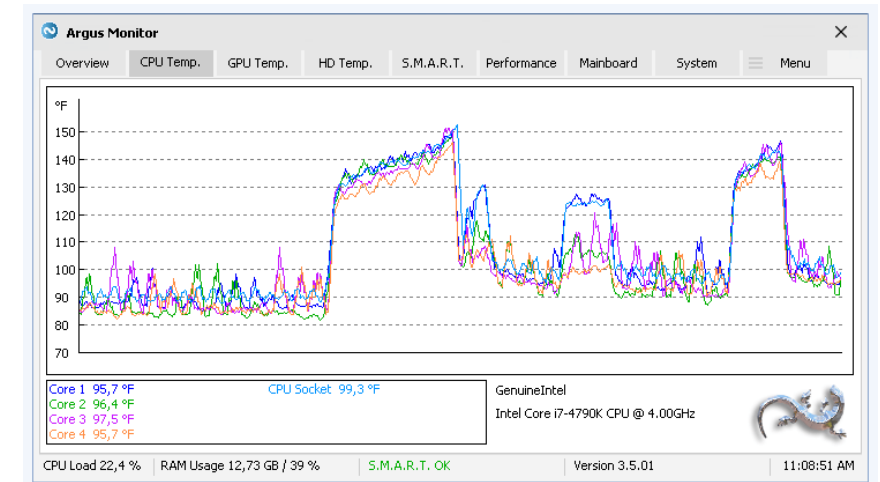
Applications

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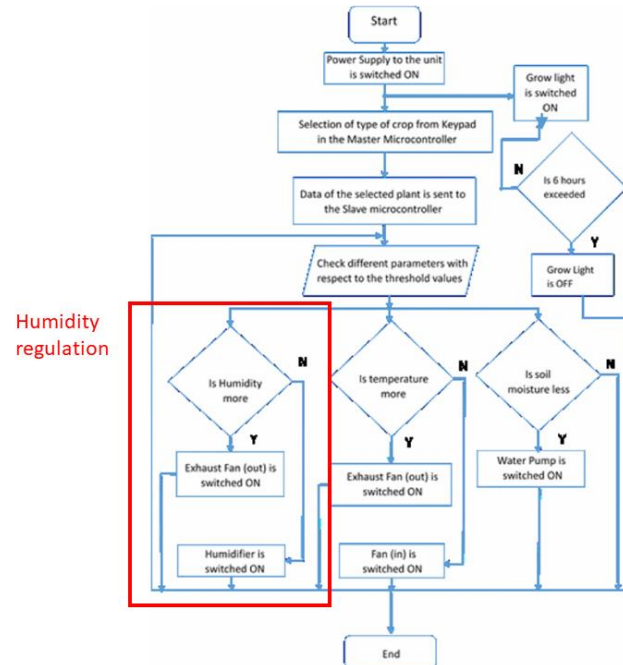
Heartbeat monitoring with photoplethysmography



CPU Temperature monitoring



Humidity regulation for greenhouse with exotic plants



Feet activity monitoring

