TUPV032

CHALLENGES OF AUTOMATING THE PHOTOCATHODE FABRICATION PROCESS AT CERN

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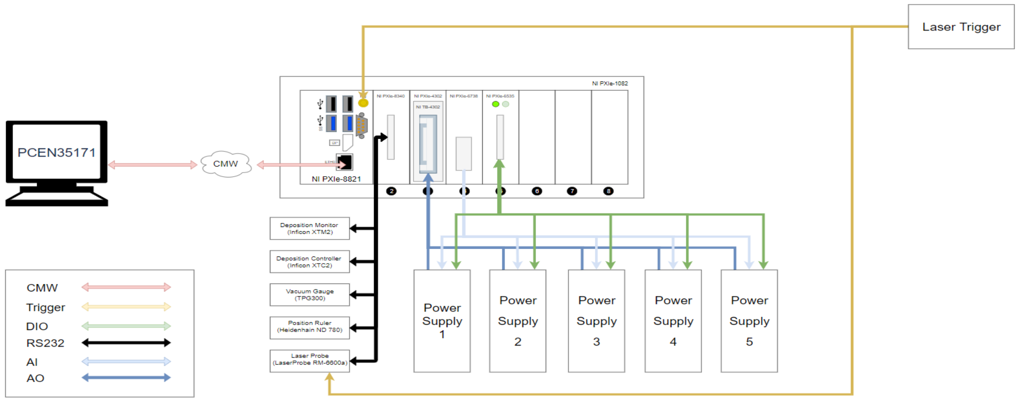
FABRICATION OF THE PHOTOCATHODE:

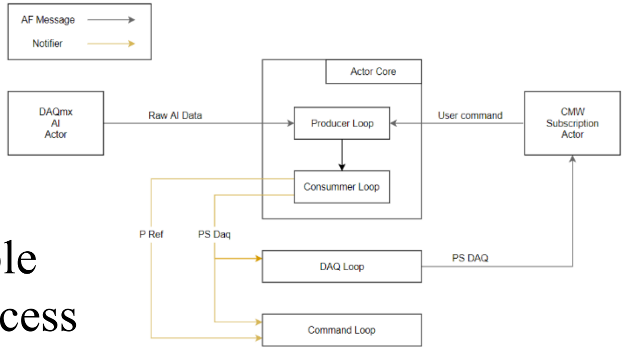
- Coating a substrate, the Cu photocathode plug, with a mixture of alkali metals and another element, tellurium or antimony.
- The cathode is illuminated with a laser.
- A photoemission reaction occurs and produces an electron current, collected and measured to quantify the cathode's performance.
- The goal is to maximize the photo-current and the quantum efficiency of the cathode.

EQUIPMENT USED

- Real-Time embedded system to control each device deterministically.



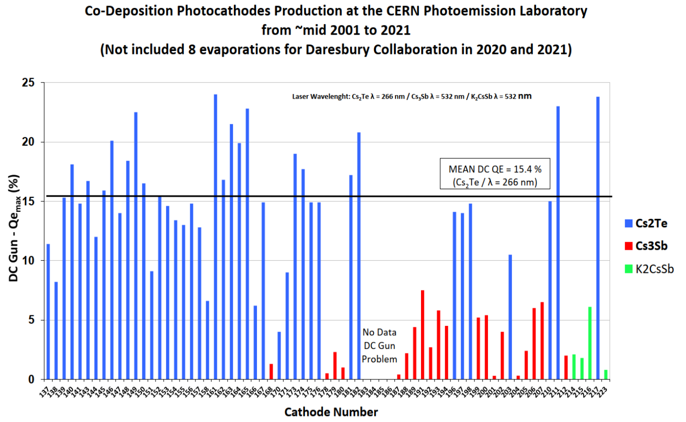
CHALLENGES



- results not easily reproducible
- From R&D to industrial process
- Final result affected by many parameters
- Requires good knowledge and control of each parameter
- Handmade power supply requires dedicated PID

RESULTS

- Expert knowledge allows to obtain quantum efficiency greater than 20%
- PXI provides flexible and deterministic solution



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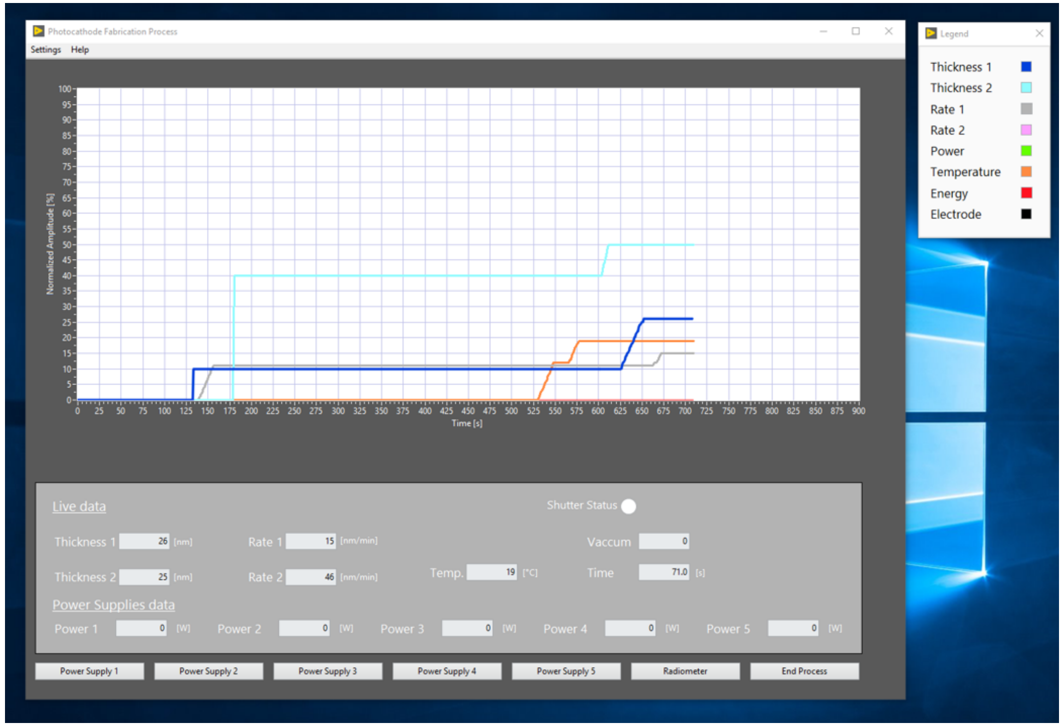
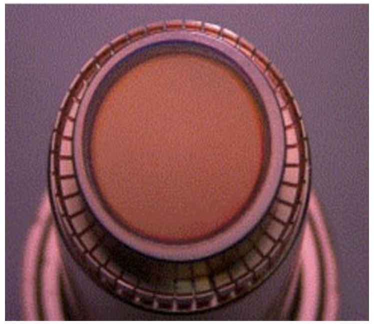
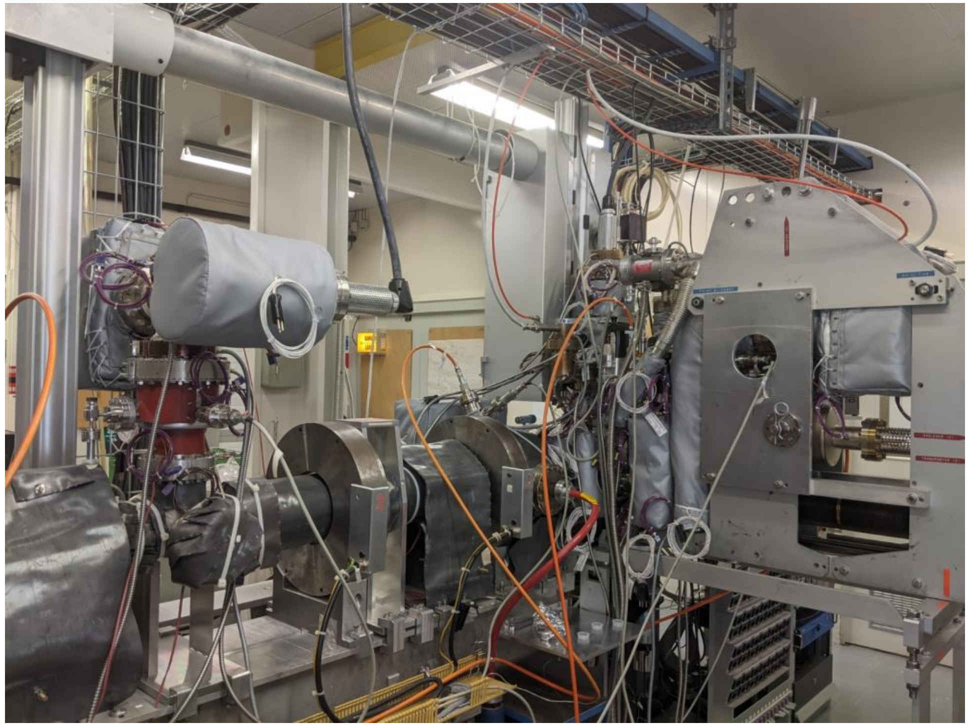


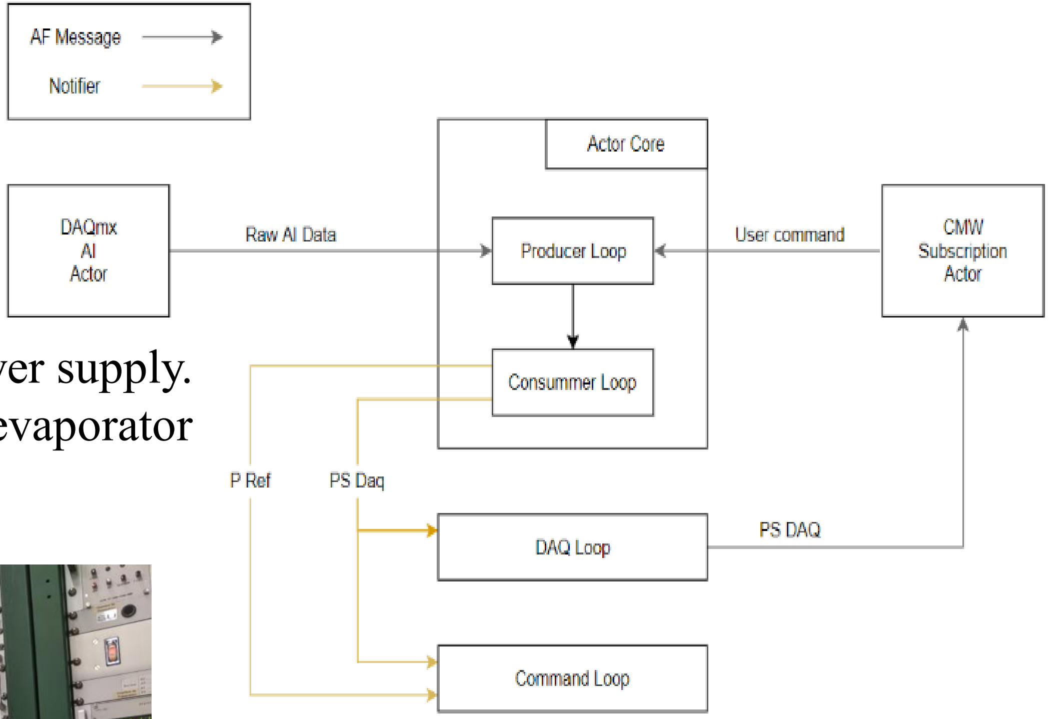




In order to optimize the process, the system should be able to control several power supplies used to heat the evaporators and monitors the applied electrical power, temperature, laser's energy, intensity produced by the photoelectron current, thickness of the coatings and vacuum pressure.

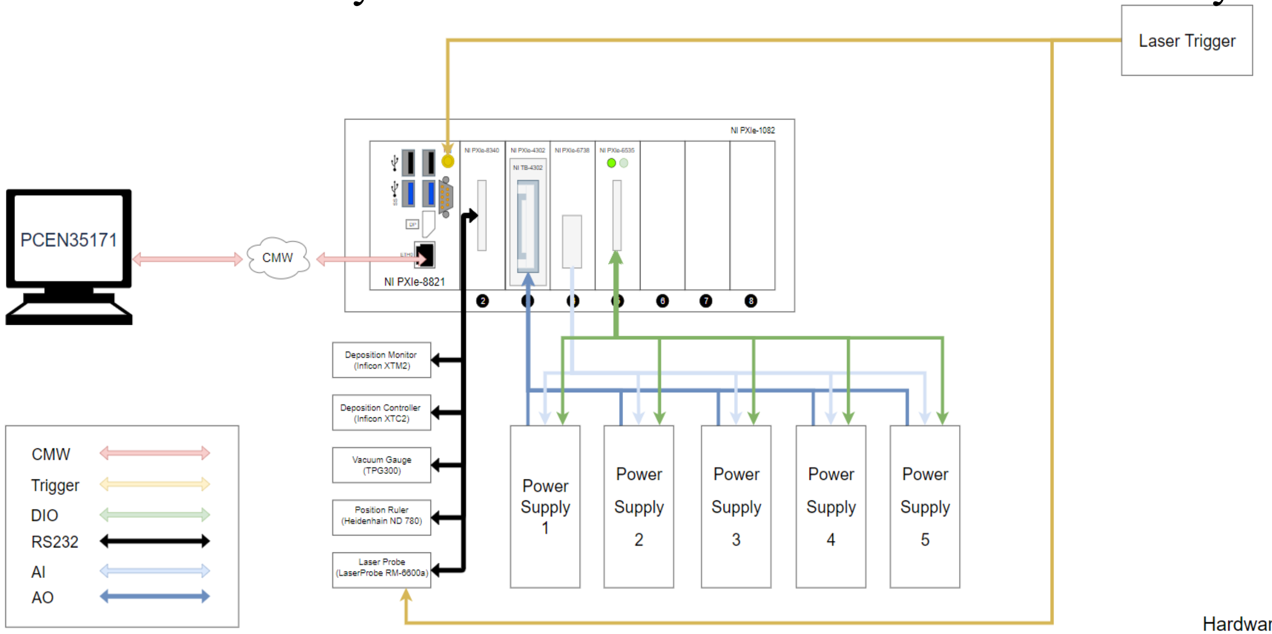
CHALLENGES

- results not easily reproducible
- From R&D to industrial process
- Final result affected by many parameters
- Requires good knowledge and control of each parameter
    - Deposition Flow Rate of Cs or Te (called Stoichiometric Ratio Control)
    - Cesium avaibility in the evaporator
    - Vacuum Quality
    - Temperature (Alkalic Antimony Cathode only)
    - Evaporators mechanical positioning (ruler)
- Handmade power supply requires dedicated PID
    - power supplies are controlled in power.
    - In the hardware, only the current parameter is controlled at the power supply.
    - The voltage of the evaporator is used to compute the power of the evaporator
    - $P_{Evaporator} = U_{Evaporator} * I_{Power\ Supply}$



EQUIPMENT USED

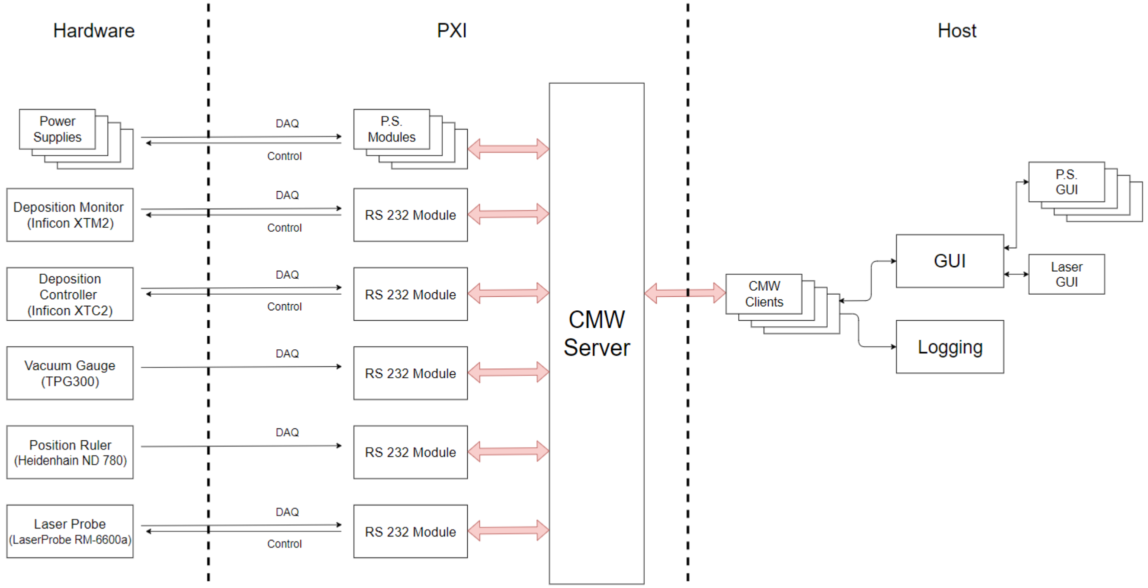
Real-Time embedded system to control each device deterministically.



The software is implemented using the Actor Framework, which abstracts the communication between the different modules, thereby increasing development efficiency. This framework is object-oriented, which allows us to add several layers of abstraction.

The readings of the different devices are made at 4 Hz. 10 to 20 seconds are needed to get a proper deposition, and within this time we can pass from a good to a bad cathode. A good quantity of matter is needed to maximize the quantum efficiency (QE).

$$QE = K\frac{Laser_{Energy}}{U_{Electrode}}$$



Standard 3 tiers design

RESULTS

- The increasing knowledge of the expert allows to obtain quantum efficiency greater than 20%
- PXI provides flexible and deterministic solution