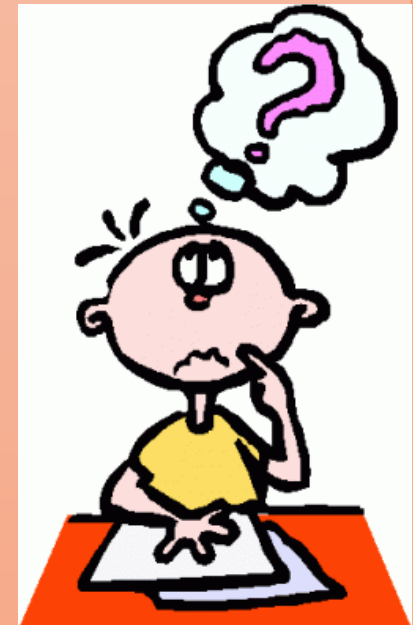


CHRISTIAN PERTEL
Centre d'élaboration de matériaux et d'études structurales

BANCS AUTOMATISÉS, MOTEURS, DANS QUELLES BARQUES EMBARQUONS NOUS NOTRE ELECTRONIQUE ?



.....BANCS AUTOMATISÉS,
... CAPTEURS,
... ACTIONNEURS,
... CONTROLEURS



**DANS QUELLES BARQUES EMBARQUONS
NOUS NOTRE ELECTRONIQUE ?**

- Contexte laboratoire
- Un projet « d'embarquement »
 - Principe, Objectifs
 - Descriptif
 - Mes outils utilisés *parmi n solutions possibles*
 - Zoom sur pilotage moteur
 - Zoom sur pilotage écran tactile
 - Zoom sur développement μ Contrôleur STM32
- Aperçu d'un autre projet *fruit d'investissement*
- Bonus/Proposition :
 - Analog Discovery, un boîtier qui remplace un banc de tests & mesures
 - Un exemple d'application

Études / Conception :

- Prototype
- Intégration

Référent technique :

- Suivi équipements scientifiques

Électronique / Instrumentation & Informatique industrielle

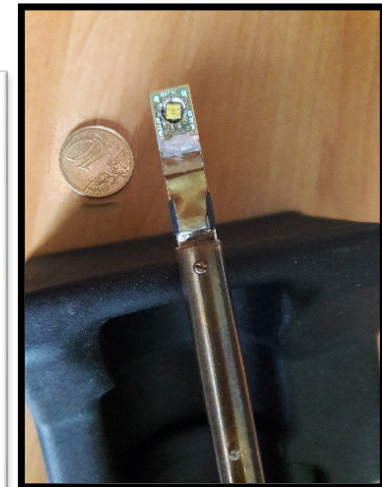
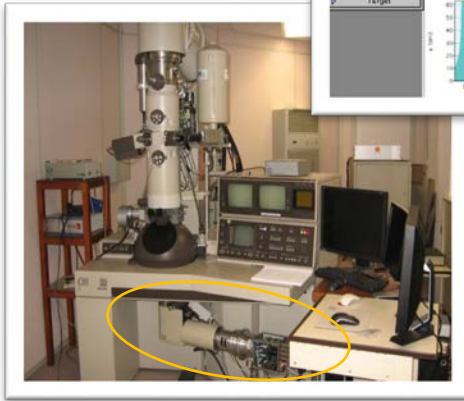
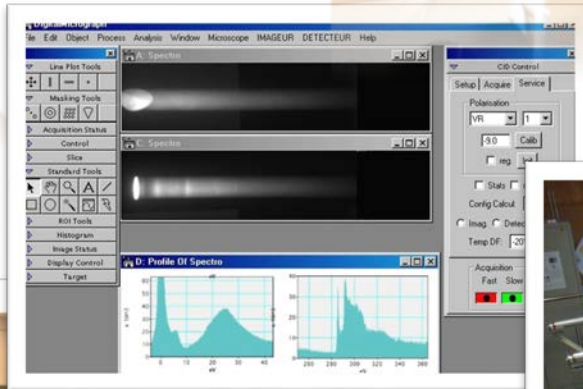
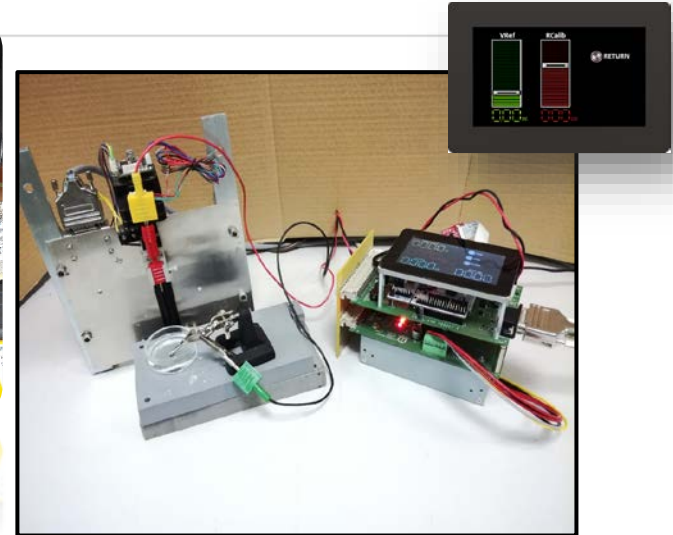
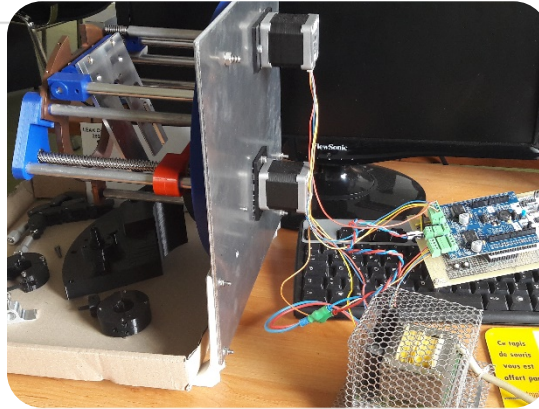
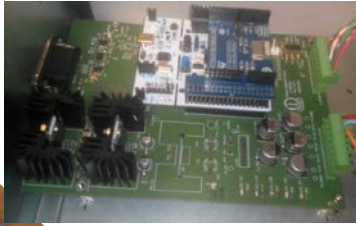
Contribution CEMES

- Réunions
- Réunions
- Réunions

Contribution Réseaux et CNRS :

- Comités de pilotage
- Actions formation et partage d'expérience

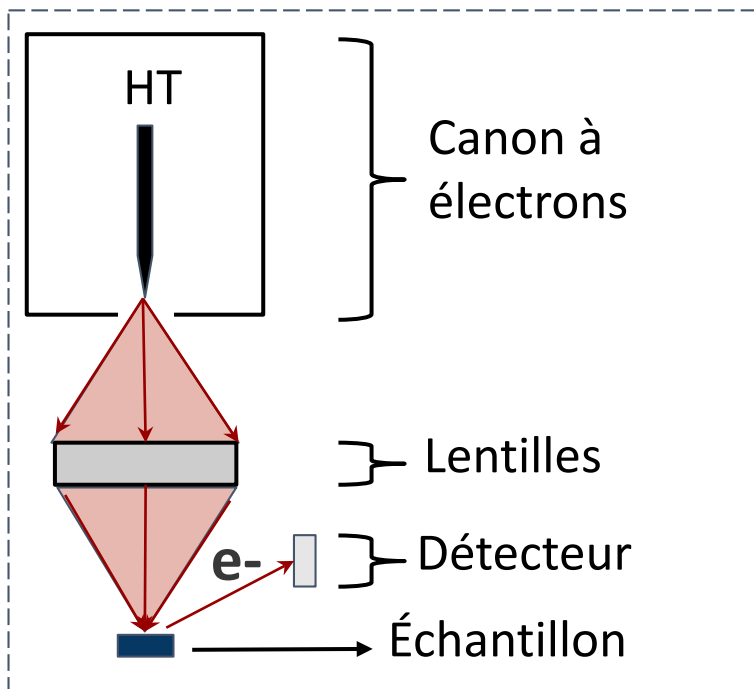
Réalisations



Contexte

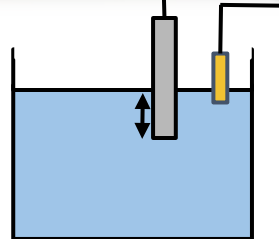
Automatiser la fabrication de pointes pour la microscopie.

Investigation dans les matériaux.

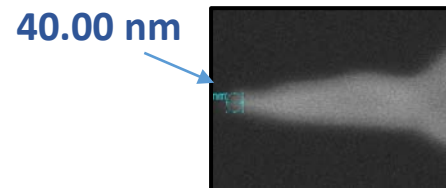
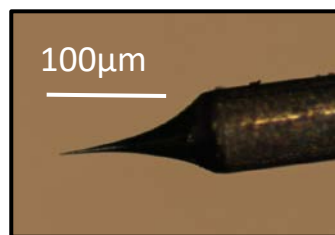


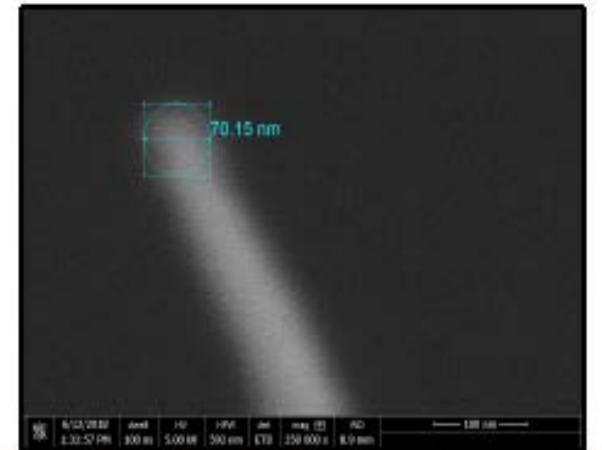
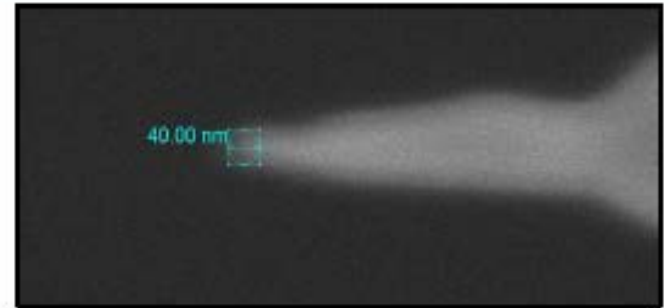
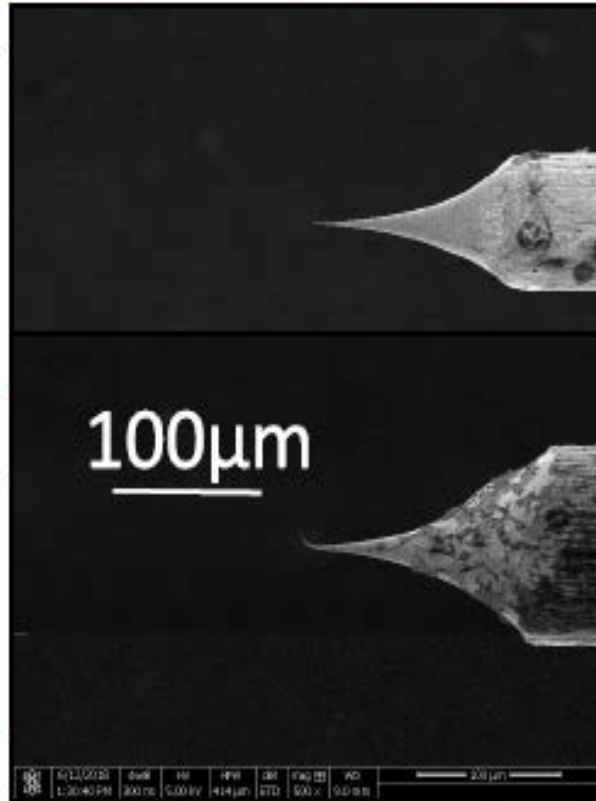
Contributeurs :

C Pertel - A Masseboeuf
R Pessato, G Villavicencio Sanchez, C Cam



IAttack,
VAttack,
RAttack

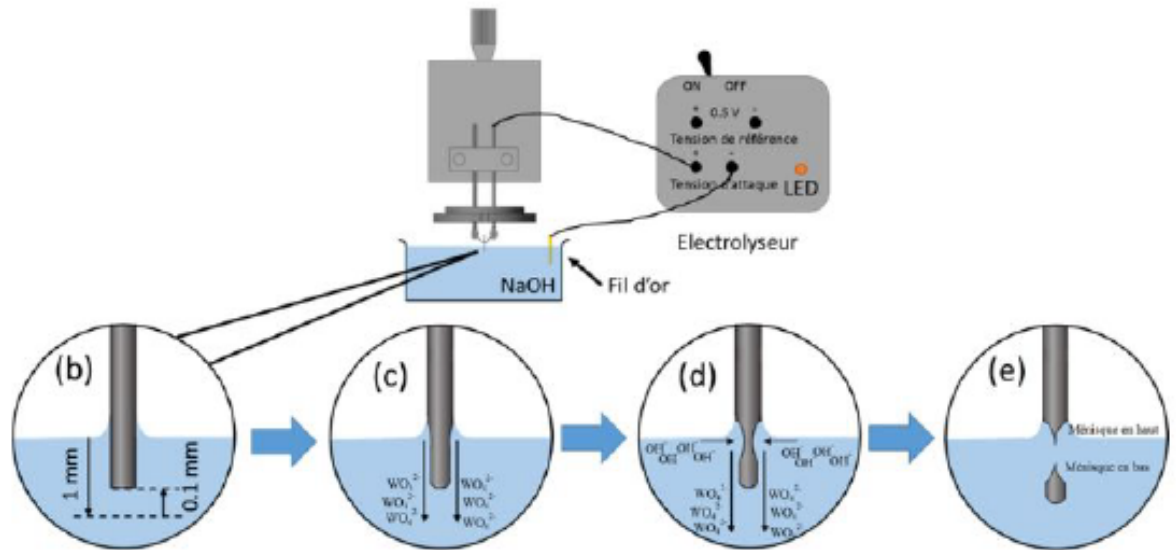
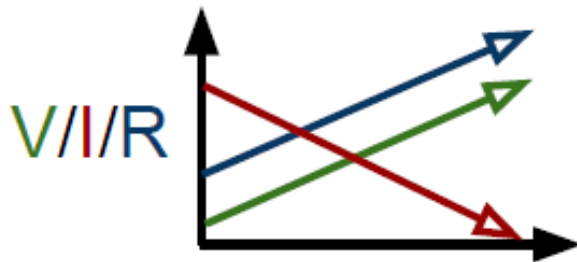




Élaboration des pointes

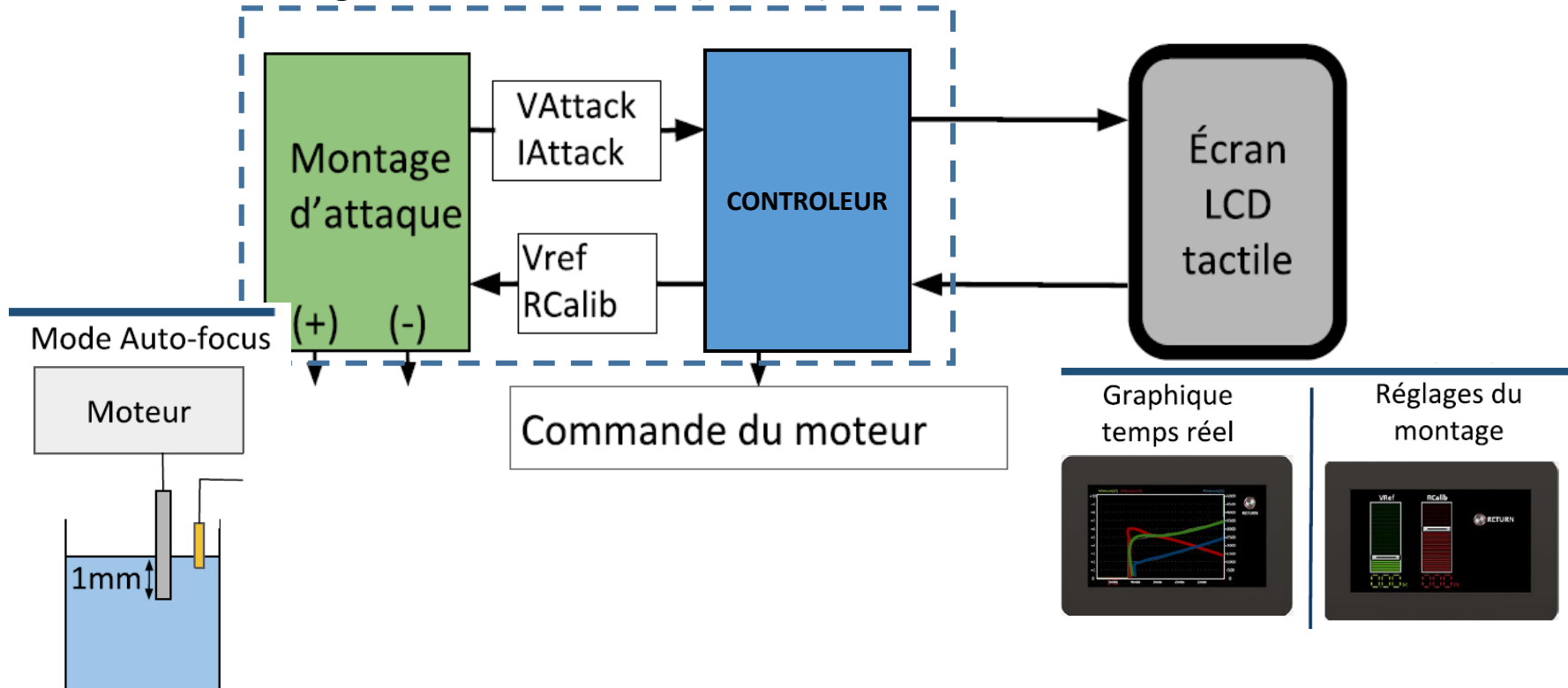
- Procédé électrochimique:

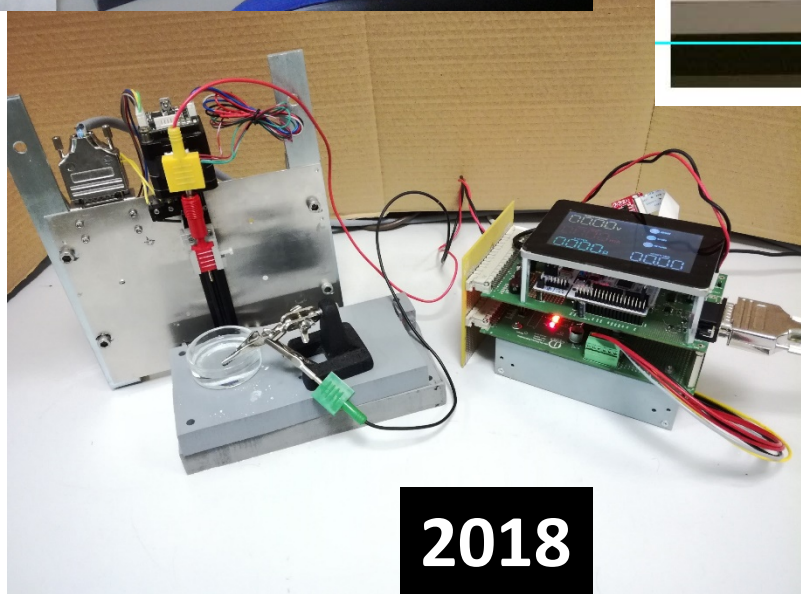
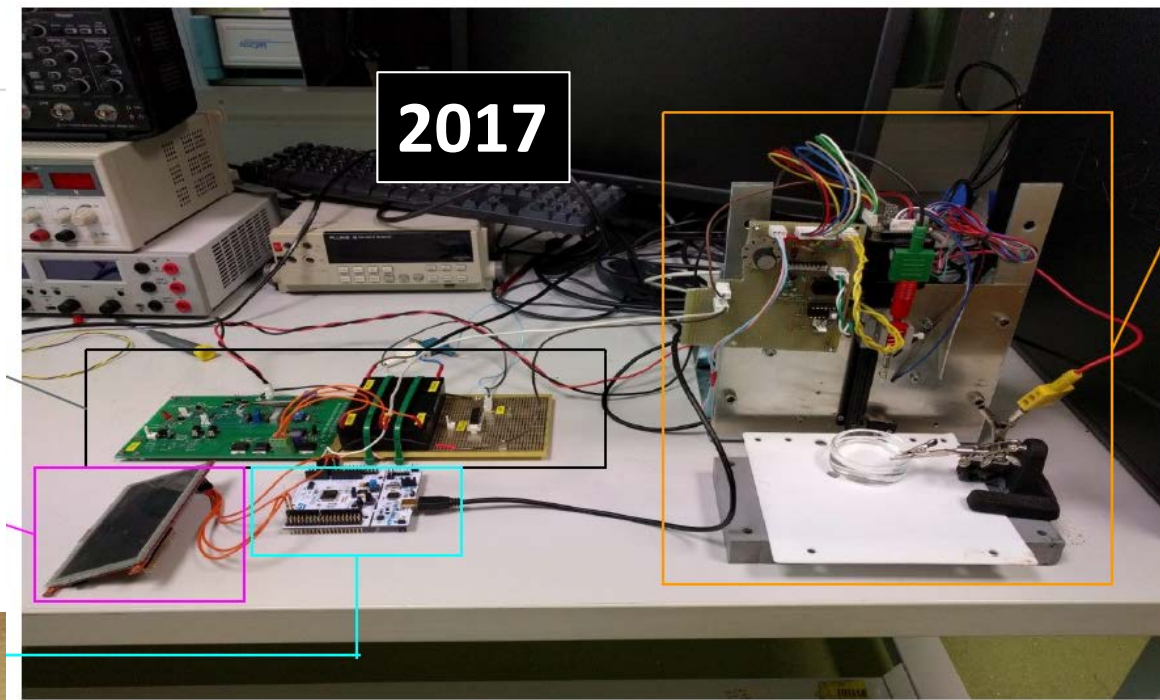
- (-): Fil d'or
- (+): Pointe
- Électrolyte



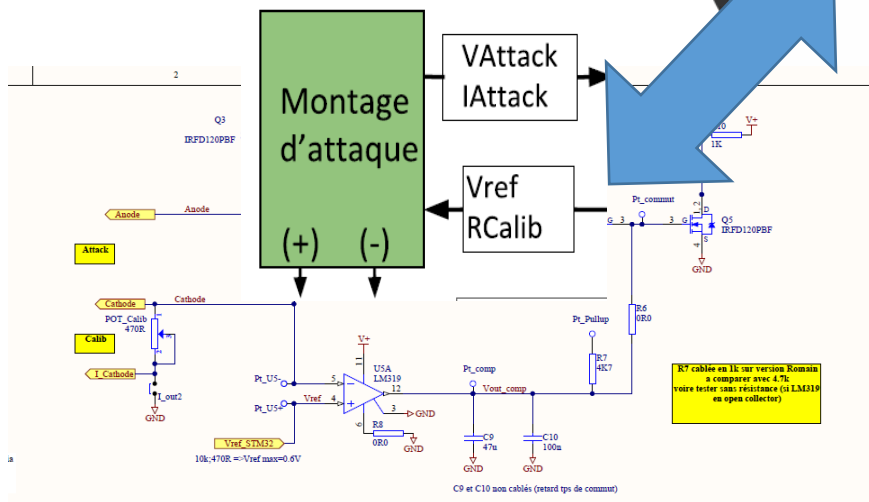
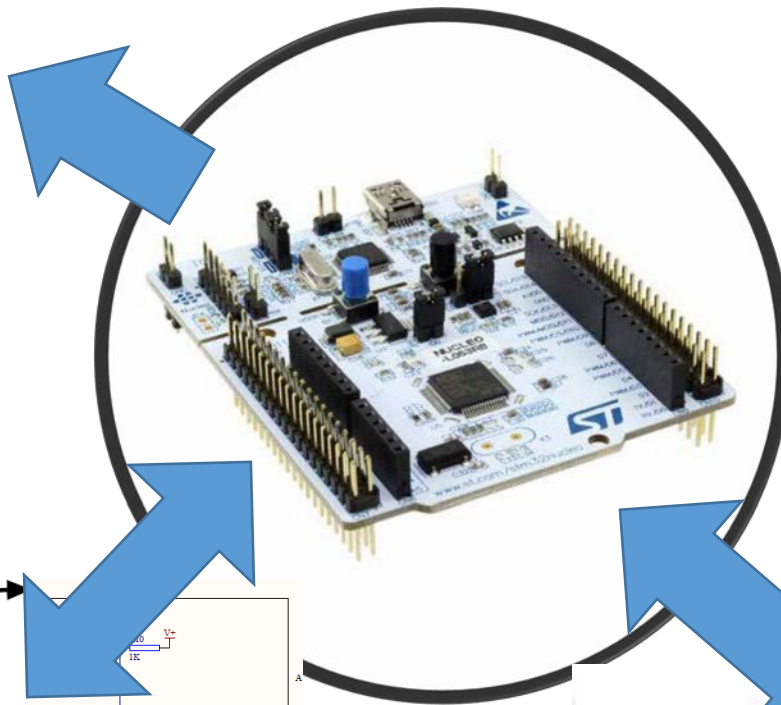
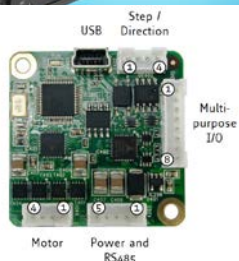
Objectifs et Descriptif du système

- Électronique :
 - Commande (gravure + mesures courant/tension)
 - Alimentation
- Platine Moteur : positionner et remonter la pointe
- Écran LCD tactile : affichage et réglages
- Intégration dans un rack (boîtier)





Intégration des éléments



Électronique :

- CAO : schéma, circuit imprimé
- Prototype
- Mesures



Contrôle-commande :

- Kit nucléo STM32 Cortex M4
- Outils de développement (... TruStudio) : code et debug
- Configurateur Cube MX



Outils utilisés



Pilotage moteur

- Platine Haydon Kerk et carte contrôleur Trinamic TMCM1141 (A2V)

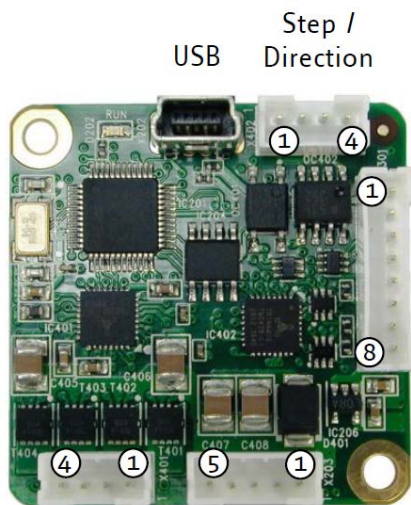


Interface tactile :

- LCD Gen4-uLCD-43DCT
- Outils de développement Workshop 4

Zoom sur pilotage moteur pas à pas

*Motorized RGS04
with Size 17
Hybrid Linear Actuator
Stepper Motor*



Step /
Direction
USB

Multi-
purpose
I/O

Motor Power and
RS485

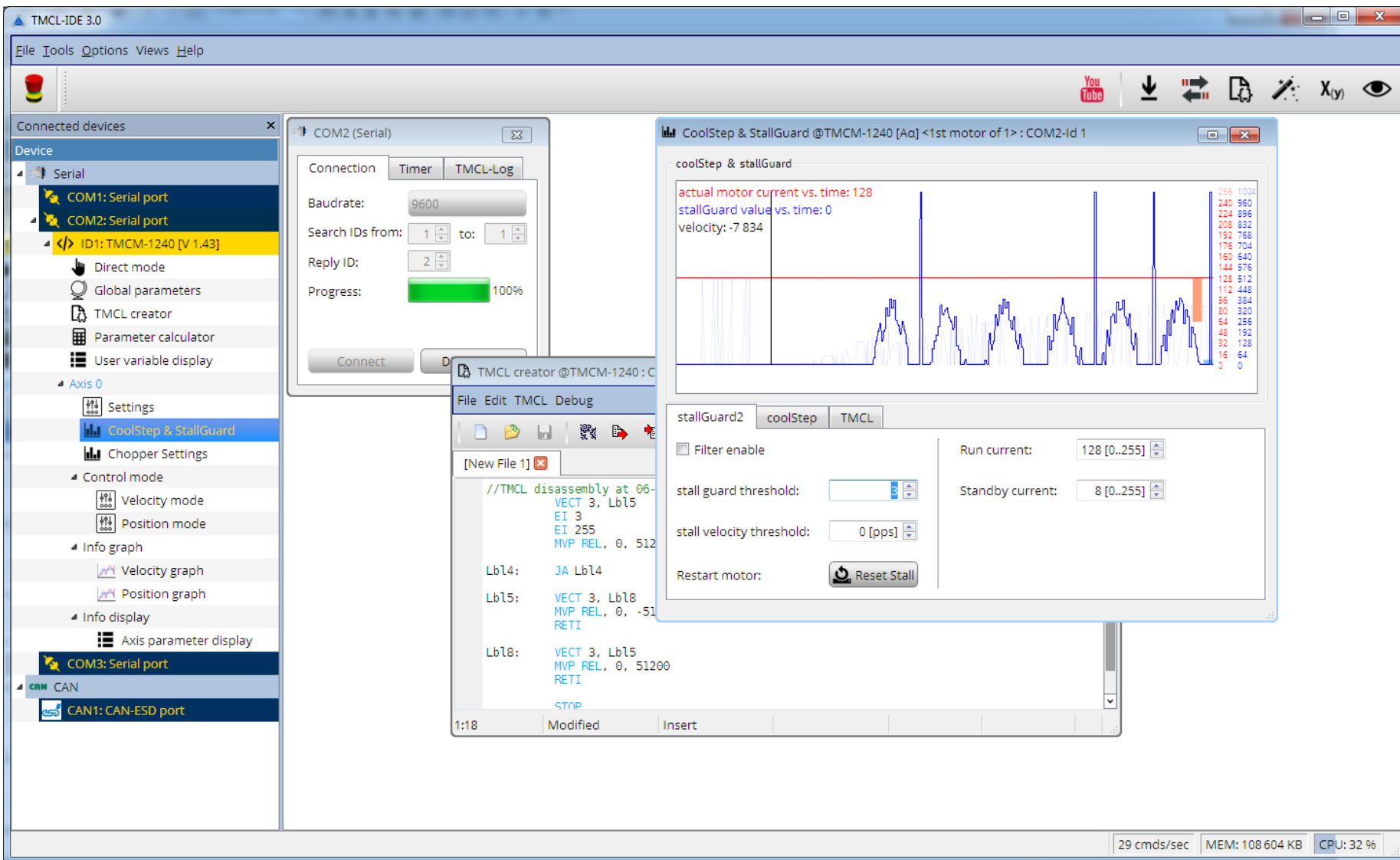


Supported Interfaces :
USB, RS232, RS485, CAN

TMCL™ Drivers

Send TMCL Datagram in C or C++
Example for LabView
TMCL-IDE with Linux

Zoom sur pilotage moteur pas à pas vue d'ensemble de TMCL-IDE



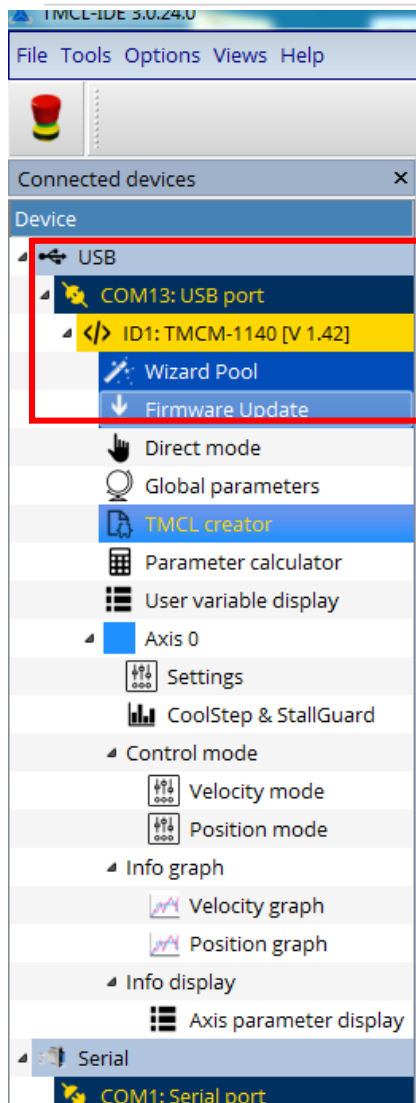
The screenshot displays the TMCL-IDE 3.0 software interface. On the left, a 'Connected devices' tree shows 'COM2: Serial port' selected. The main window is divided into several panes:

- COM2 (Serial) Settings:** Shows connection parameters: Baudrate: 9600, Search IDs from: 1 to 1, Reply ID: 2, and Progress: 100%.
- coolStep & StallGuard @TMCM-1240 [Ac] <1st motor of 1> : COM2-Id 1:** A graph showing 'actual motor current vs. time: 128', 'stallGuard value vs. time: 0', and 'velocity: -7 834'. The graph displays a blue waveform with a red horizontal line at 128.
- TMCL creator @TMCM-1240 : C:** A disassembly view showing code for Lb14, Lb15, and Lb18, including instructions like VECT, EI, MWP REL, and RETI.
- Motor Control Parameters:** A panel with tabs for 'stallGuard2', 'coolStep', and 'TMCL'. It includes settings for 'Filter enable', 'Run current: 128 [0..255]', 'Standby current: 8 [0..255]', 'stall guard threshold', and 'stall velocity threshold: 0 [pps]'. A 'Restart motor: Reset Stall' button is also present.

The bottom status bar shows system metrics: 29 cmds/sec, MEM: 108 604 KB, and CPU: 32 %.

Zoom sur pilotage moteur pas à pas

Configuration rapide du moteur



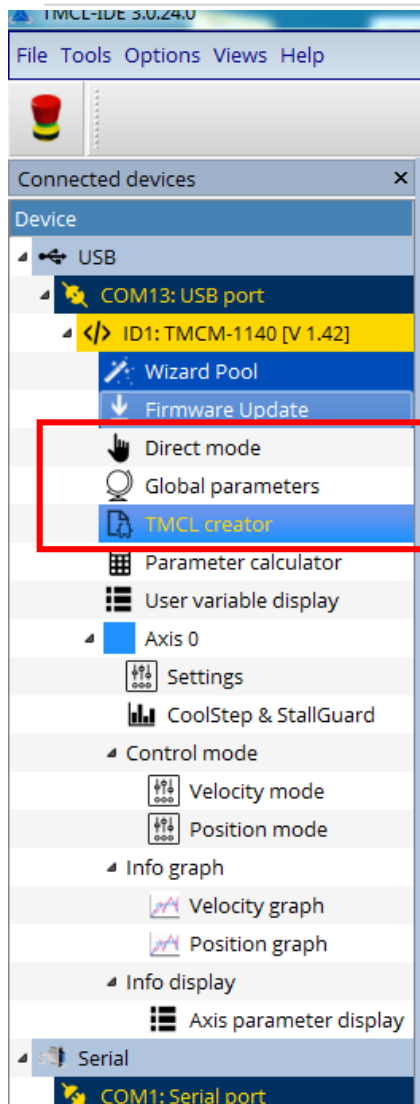
```

TMCL/PC host
File Edit TMCL/PC
20190927_16.12.25_TMCM-1140_Settings.tmc

//=== module settings for axis 0 ===
SAP 4, 0, 100 // Maximum positioning speed [int]
SAP 5, 0, 100 // Maximum acceleration [int]
SAP 6, 0, 63 // Maximum current
SAP 7, 0, 7 // Standby current
SAP 12, 0, 1 // Right limit switch disable
SAP 13, 0, 1 // Left limit switch disable
SAP 130, 0, 1 // Minimum speed [int]
SAP 140, 0, 3 // Microstep Resolution
SAP 149, 0, 0 // Soft stop flag
SAP 150, 0, 0 // End switch power down mode
SAP 153, 0, 7 // Ramp divisor
SAP 154, 0, 3 // Pulse divisor
SAP 160, 0, 0 // Step interpolation
SAP 161, 0, 0 // Double step enable
SAP 162, 0, 2 // Chopper blank time
SAP 163, 0, 0 // Constant TOFF Mode
SAP 164, 0, 0 // Disable fast decay comparator
SAP 165, 0, 2 // Chopper hysteresis end / fast decay time
SAP 166, 0, 3 // Chopper hysteresis start / sine wave offset
SAP 167, 0, 5 // Chopper off time
SAP 168, 0, 0 // smartEnergy current minimum (SEIMIN)
SAP 169, 0, 0 // smartEnergy current down step
SAP 170, 0, 0 // smartEnergy hysteresis
SAP 171, 0, 0 // smartEnergy current up step
SAP 172, 0, 0 // smartEnergy hysteresis start
SAP 173, 0, 0 // stallGuard2 filter enable
SAP 174, 0, 63 // stallGuard2 threshold
SAP 175, 0, 3 // Slope control high side
SAP 176, 0, 3 // Slope control low side
SAP 177, 0, 0 // Short to Ground Protection
SAP 178, 0, 0 // Short detection timer [us]
SAP 180, 0, 0 // smartEnergy actual current
SAP 181, 0, 0 // smartEnergy stall velocity [int]
SAP 182, 0, 0 // smartEnergy threshold speed [int]
SAP 183, 0, 0 // smartEnergy slow run current
SAP 184, 0, 0 // Random TOFF mode
SAP 193, 0, 1 // Reference Search Mode
SAP 194, 0, 200 // Reference Search Speed
SAP 195, 0, 200 // Reference switch speed
SAP 200, 0, 0 // Boost current
SAP 204, 0, 0 // Freewheeling delay
SAP 210, 0, 25600 // Encoder prescaler
SAP 212, 0, 0 // Maximum encoder deviation [encoder steps]
SAP 214, 0, 200 // Power down delay [10ms]
SAP 217, 0, 512 // Encoder prescaler external encoder
SAP 218, 0, 0 // Maximum external encoder deviation [encoder steps]
    
```

Zoom sur pilotage moteur pas à pas

Test en direct et programmation script facile



TMCL-IDE 3.0.24.0

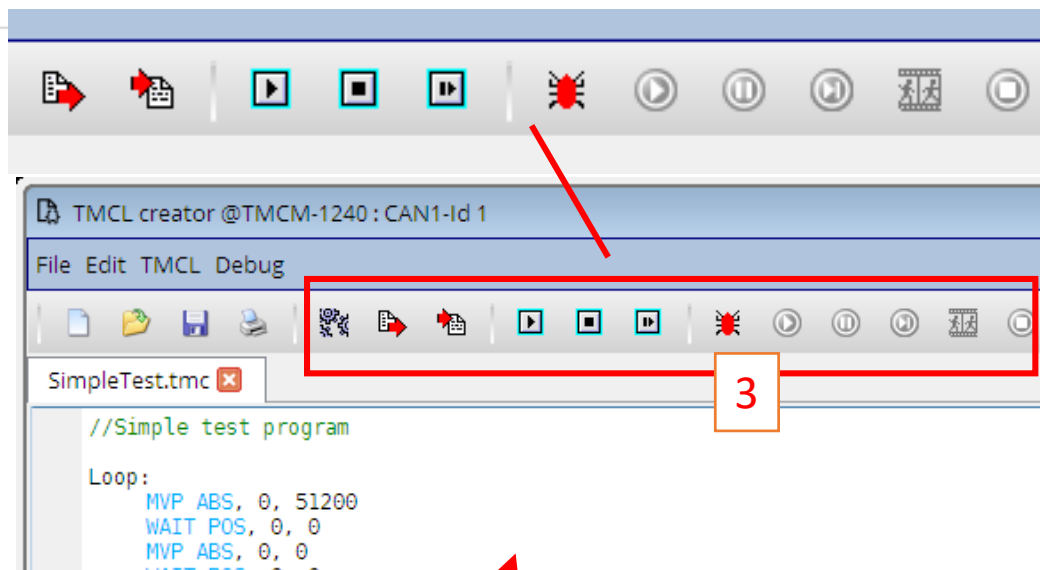
File Tools Options Views Help

Connected devices

Device

- USB
- COM13: USB port
 - ID1: TMCM-1140 [V 1.42]
 - Wizard Pool
 - Firmware Update
 - Direct mode**
 - Global parameters
 - TMCL creator
 - Parameter calculator
 - User variable display
- Axis 0
 - Settings
 - CoolStep & StallGuard
 - Control mode
 - Velocity mode
 - Position mode
 - Info graph
 - Velocity graph
 - Position graph
 - Info display
 - Axis parameter display
- Serial
 - COM1: Serial port

1



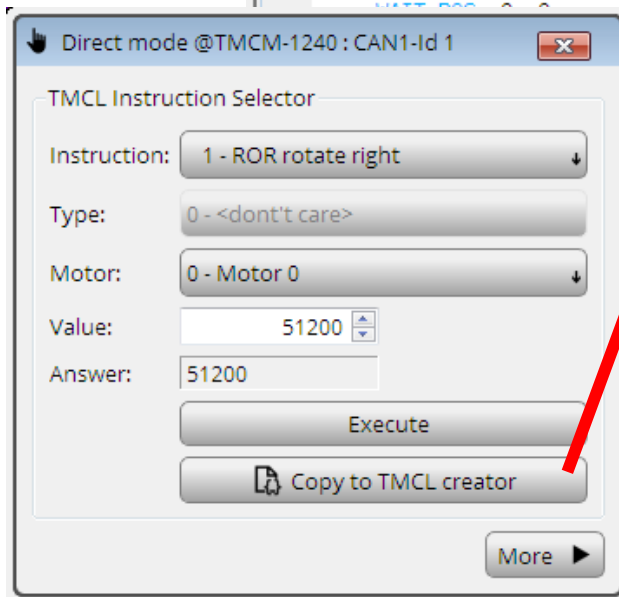
TMCL creator @TMCM-1240 : CAN1-Id 1

File Edit TMCL Debug

SimpleTest.tmc

```
//Simple test program
Loop:
MVP ABS, 0, 51200
WAIT POS, 0, 0
MVP ABS, 0, 0
WAIT POS, 0, 0
```

3



Direct mode @TMCM-1240 : CAN1-Id 1

TMCL Instruction Selector

Instruction: 1 - ROR rotate right

Type: 0 - <don't care>

Motor: 0 - Motor 0

Value: 51200

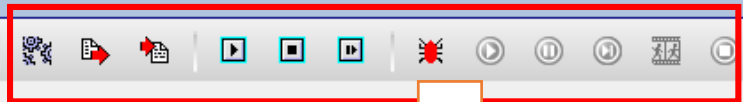
Answer: 51200

Execute

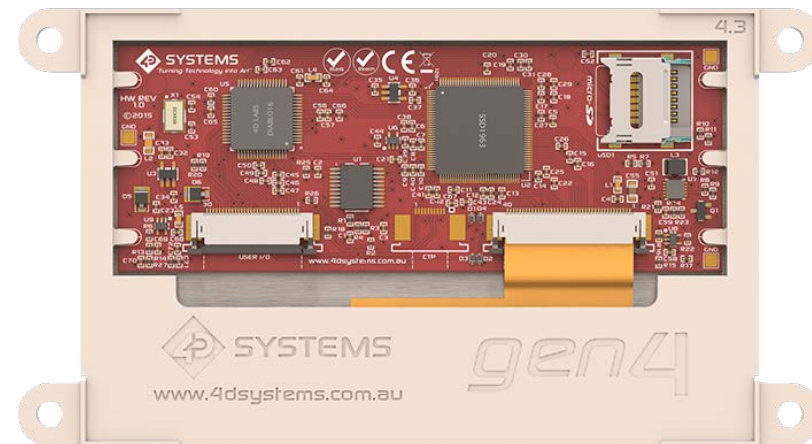
Copy to TMCL creator

More ▶

2



3



Bundles with hardware interface boards for Arduino and Raspberry Pi also available



Create a new 4D Systems Project
Start building a new Visi, Genie, Designer or Serial program.



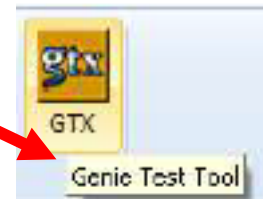
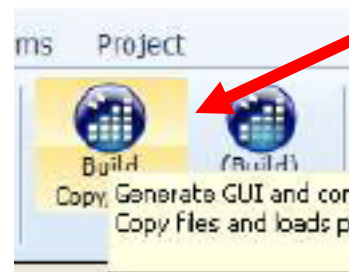
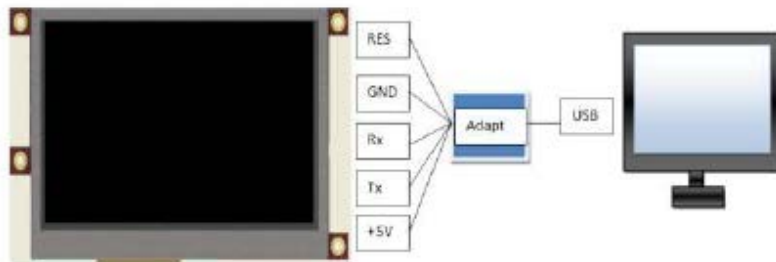
Create a new 4D Labs Project
Start building a new Visi, Genie, Designer or Serial program.
Coming Soon.

Zoom sur affichage tactile

Interconnexions STM32-Nucleo avec LCD 4D Systems :



Interconnexions PC avec LCD 4D Systems :



Tutoriel maison dispo



Utilisation de VISI V2.pdf

STM32CubeIDE

All-in-one STM32 development tool

TrueSTUDIO[®] for STM32



-> This product is now replaced by STM32CubeIDE

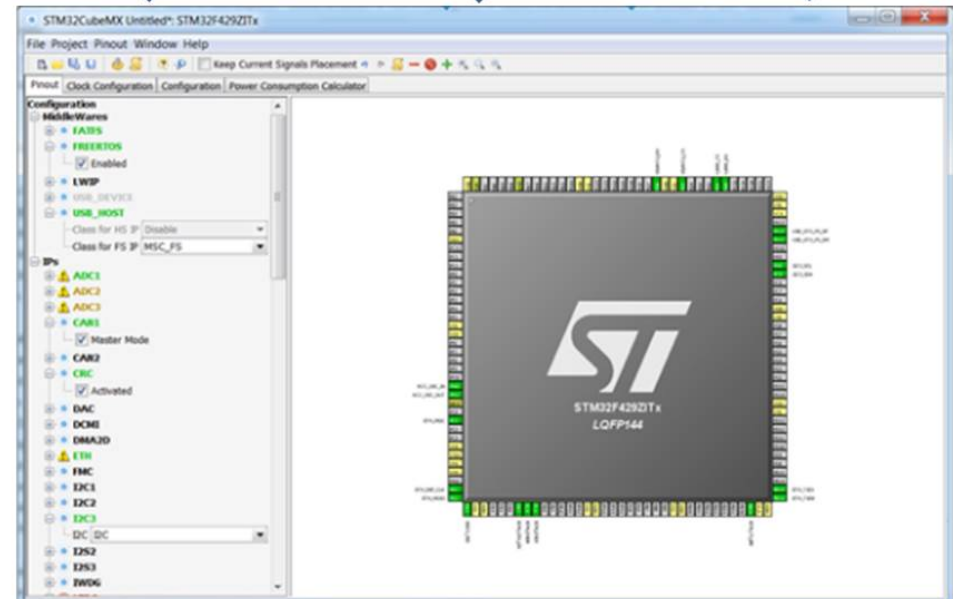
STM32 Open
Development Environment



STM32Cube
Drivers

Manuals and
Datasheets

STM32Cube
Middleware



IDE Specific
Projects

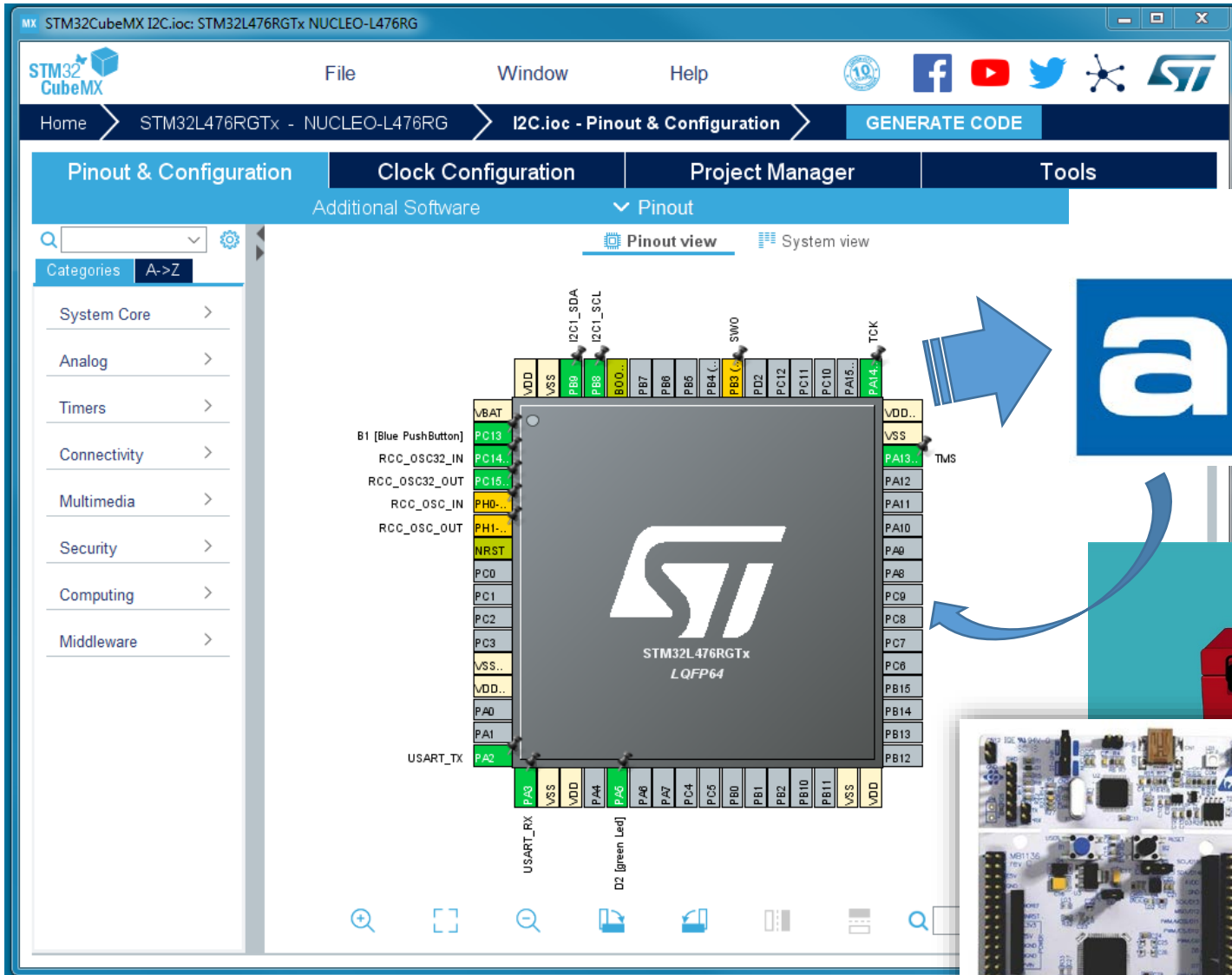
Configured
Drivers and
Middleware

Pin
Configuration
Report

Hardware
Initialisation
Code

Power
Consumption
Estimates

- Compatible Arduino, Mbed, Keil.
- Ressources matérielles et logicielles énormes

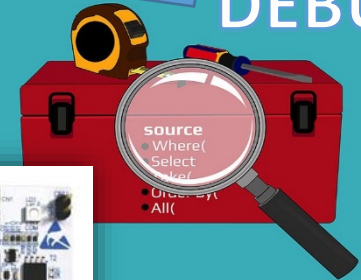


The screenshot shows the STM32CubeMX software interface. The main window displays the 'Pinout & Configuration' tab for the STM32L476RGTx microcontroller. The interface includes a menu bar (File, Window, Help), a breadcrumb trail (Home > STM32L476RGTx - NUCLEO-L476RG > I2C.ioc - Pinout & Configuration > GENERATE CODE), and a sidebar with categories like System Core, Analog, Timers, etc. The central area shows a pinout diagram of the STM32L476RGTx LQFP64 package with various pins labeled (e.g., VDD, VSS, PB0, PB8, B00, PB7, PB6, PB5, PB4, PB3, PD2, PC12, PC11, PC10, PA15, PA14, PA13, PA12, PA11, PA10, PA9, PA8, PA7, PA6, PA5, PA4, PA3, PA2, PA1, PA0, PC3, PC2, PC1, PC0, VSS, VDD, VBAT, NRST, PH1, PH0, RCC_OSC32_OUT, RCC_OSC32_IN, RCC_OSC_IN, RCC_OSC_OUT, USART_TX, USART_RX, D2 (green Led), I2C1_SDA, I2C1_SCL, SWO, TCK, TMS, PB15, PB14, PB13, PB12).



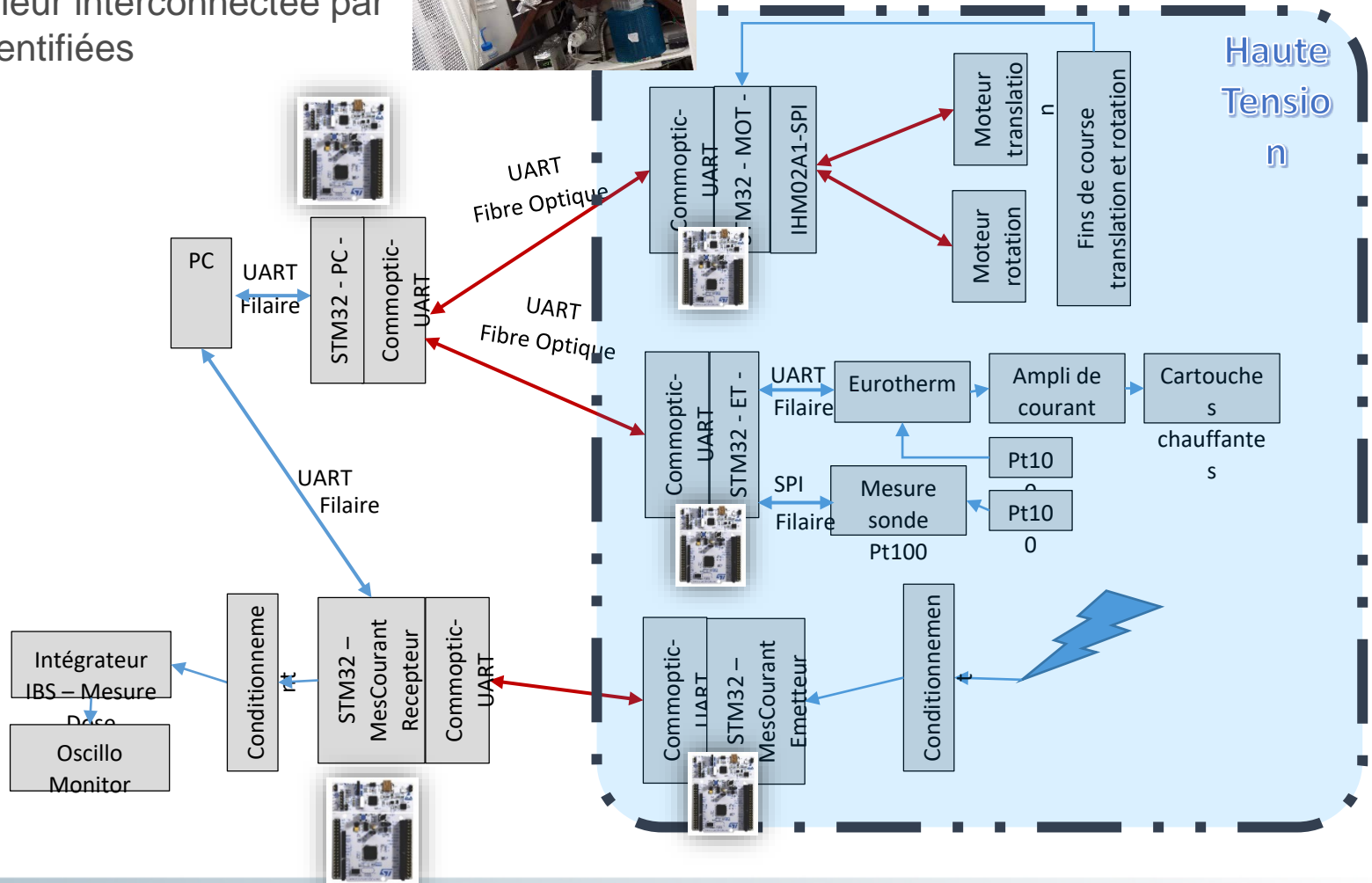
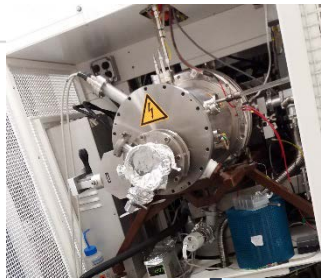
atollic

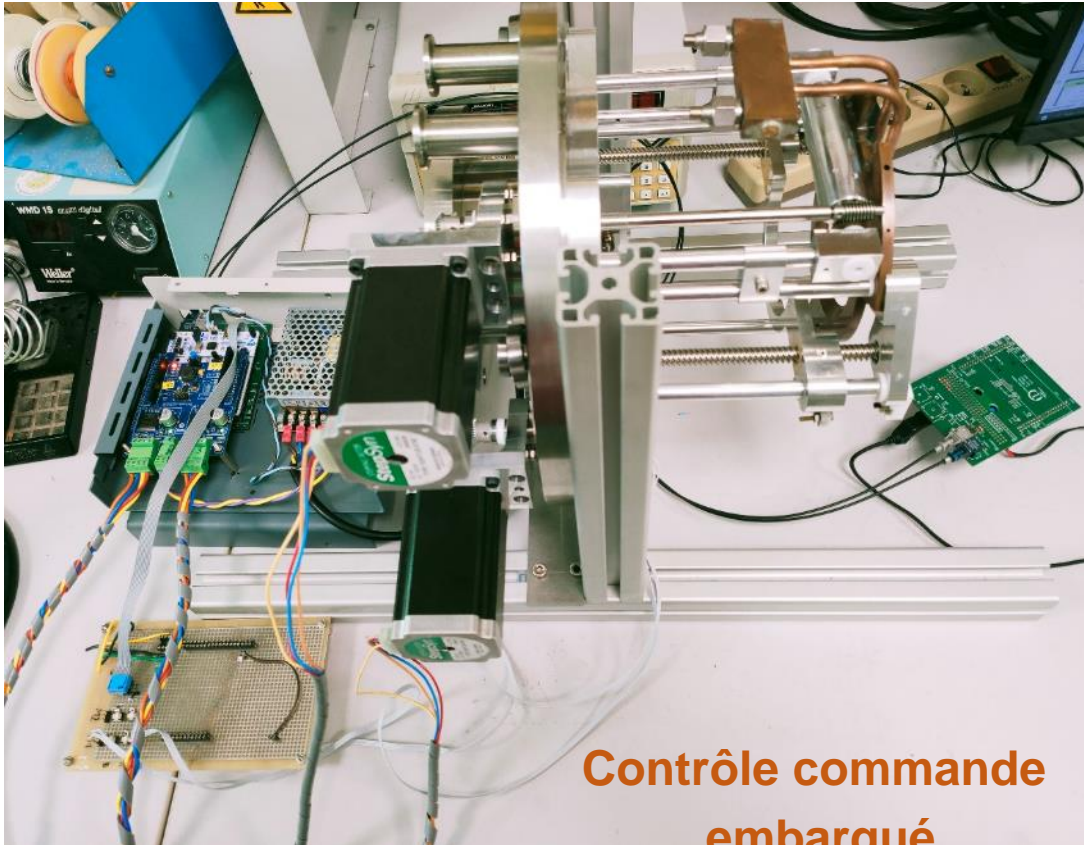
DEBUG



Contexte

Systématiser une solution microcontrôleur interconnectée par fonctions identifiées

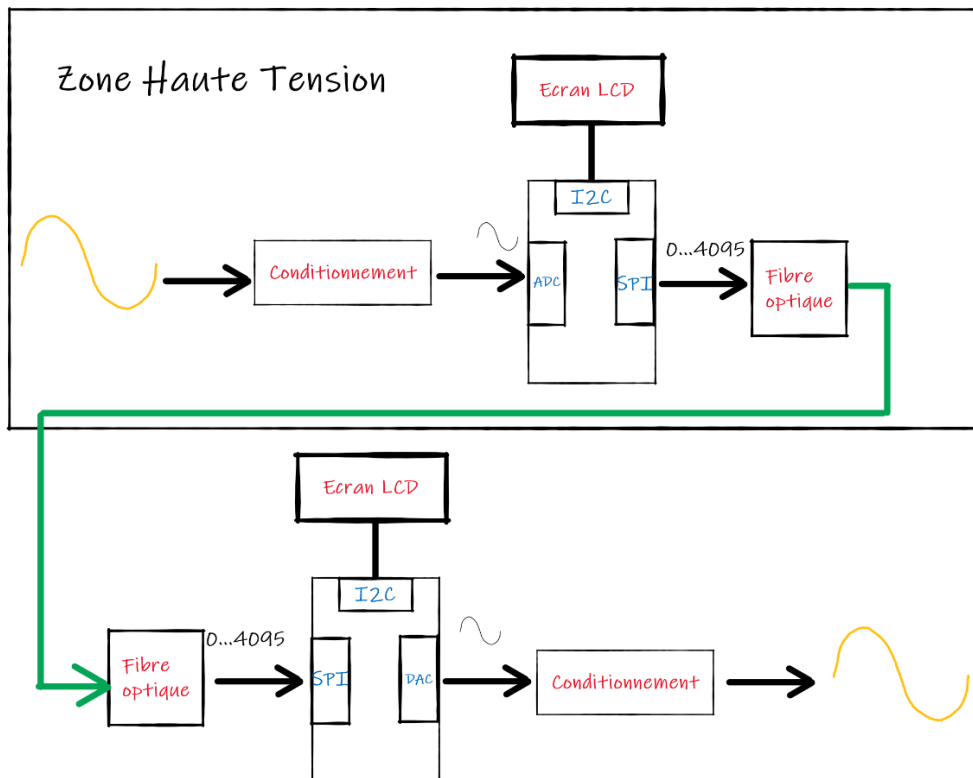




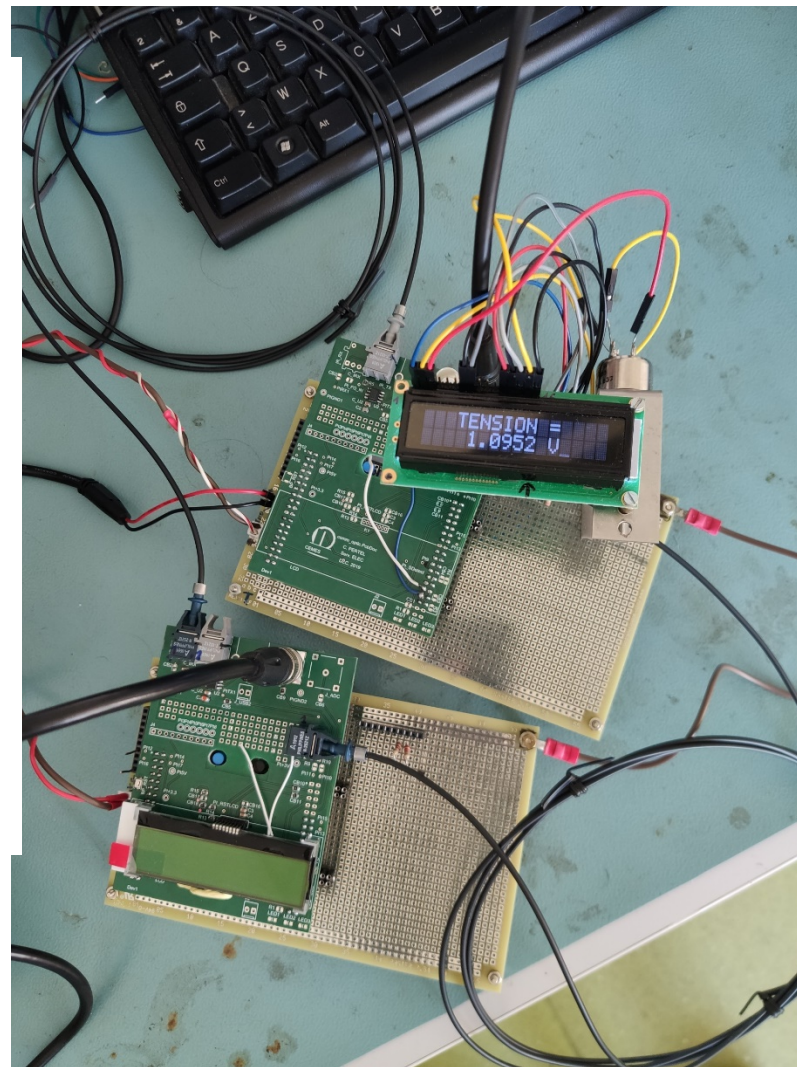
**Contrôle commande
embarqué
de 2 moteurs**



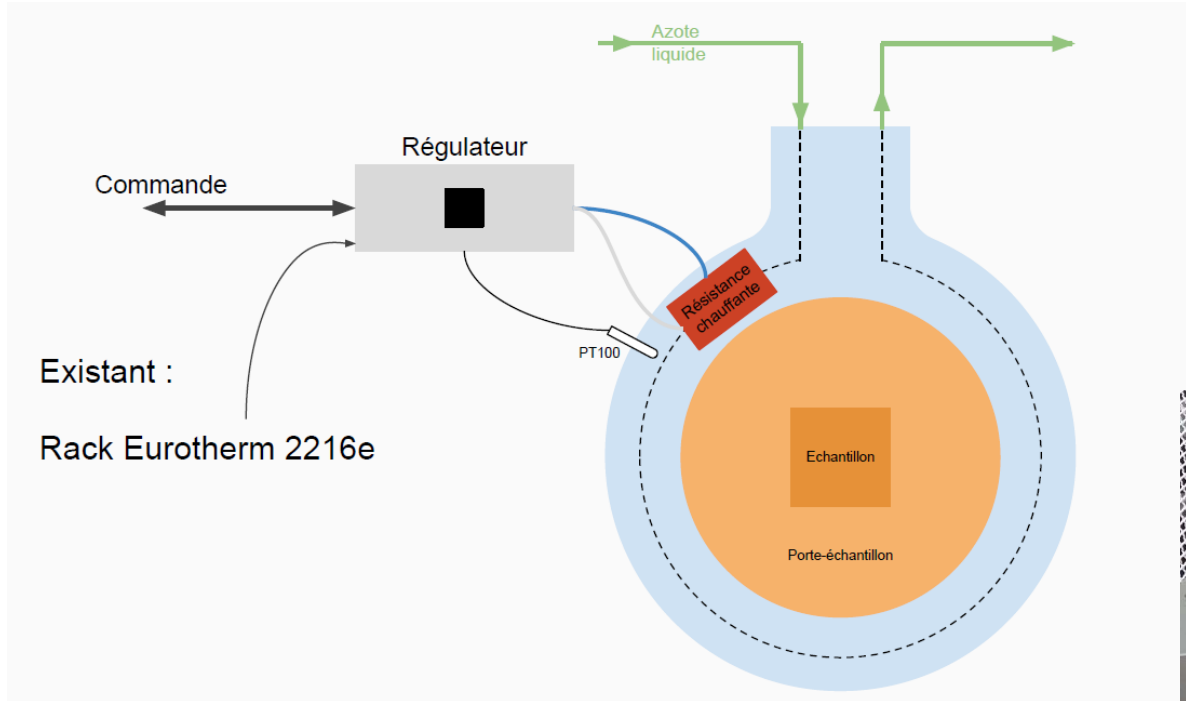
Mesure de courant



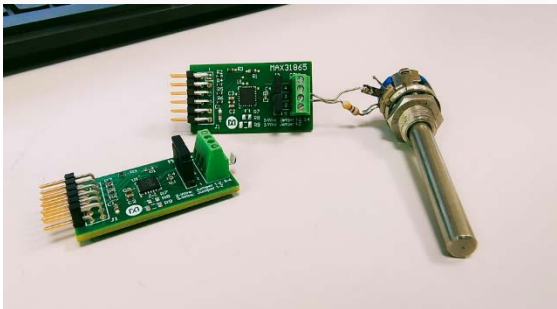
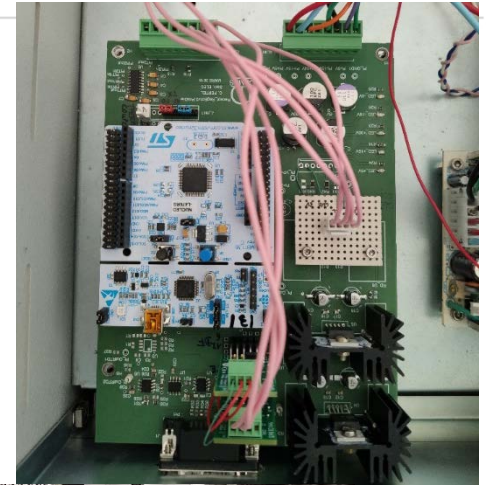
Mesure de courant isolée Haute tension avec option de gain programmable



Régulation de température



Existant :
Rack Eurotherm 2216e



**Régulation PID
Sans Eurotherm et
mesure Pt100
numérique**



Questions

....

Ou je vous fais une proposition ?

