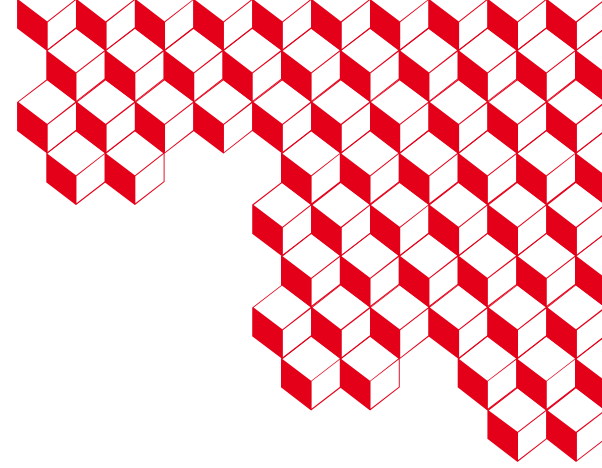


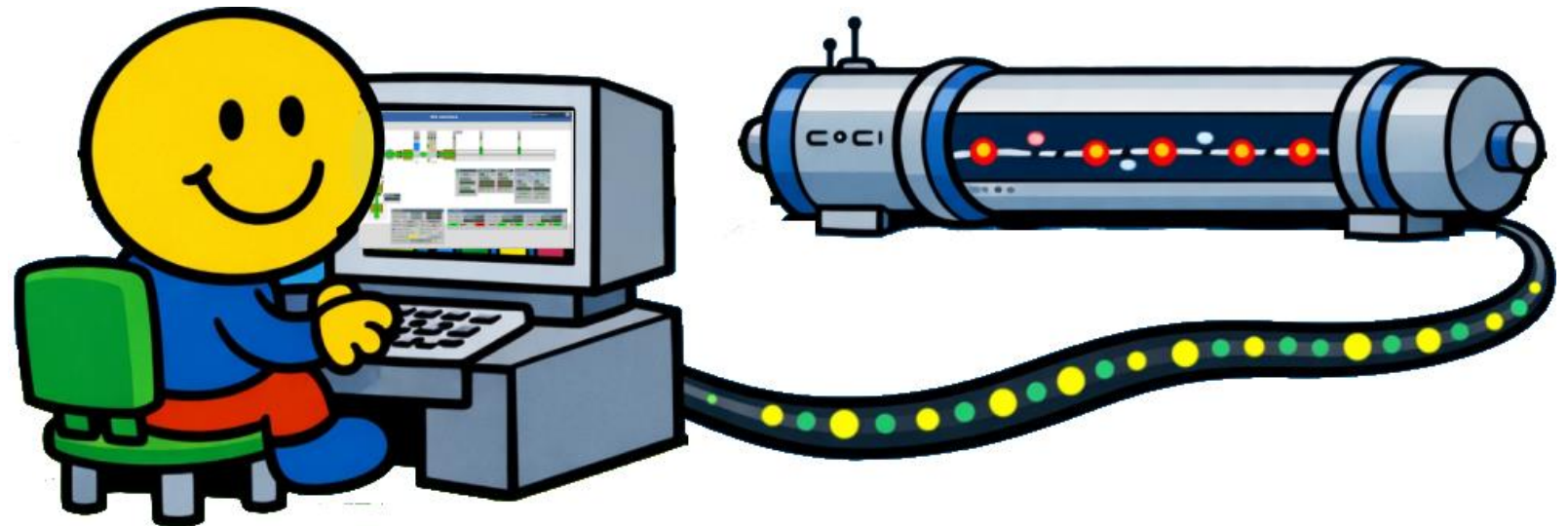


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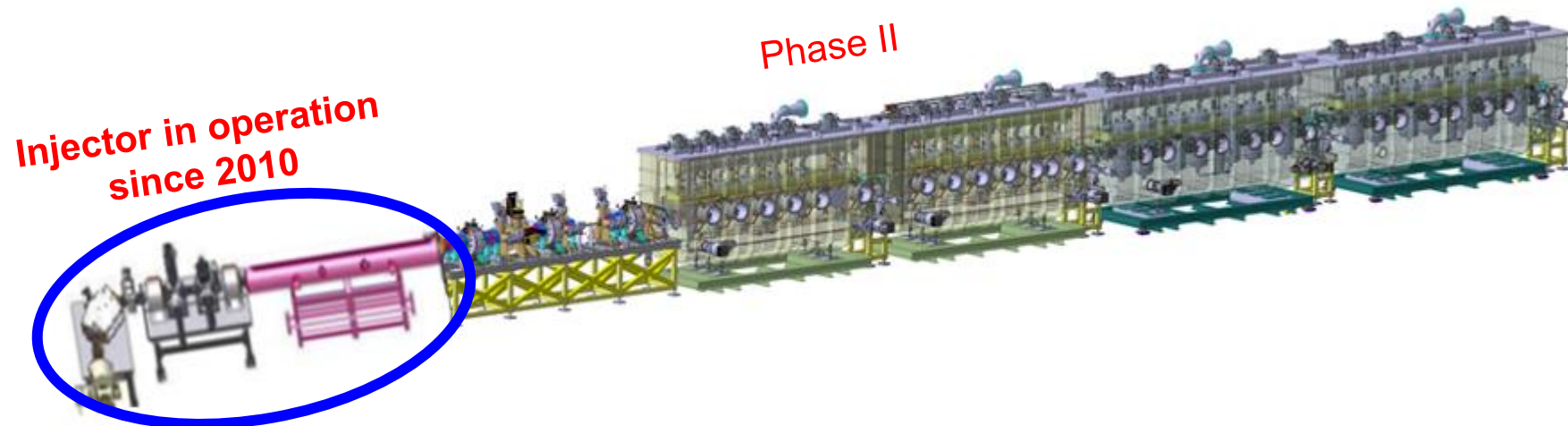
# Remote commissioning of an EPICS-controlled accelerator

Gabriel Desmarchelier



# 1. Status of the SARAF project

- Soreq Applied Research Accelerator Facility
- Collaboration between CEA-Irfu and IAEC-SNRC : upgrade of the SARAF accelerator to 5 mA CW 40 MeV, deuteron and proton beams (**Phase II**)
- SARAF is being constructed in Soreq NRC (SNRC) in Israel
- CEA is in charge of :
  - Injector control system
  - Design, construction and commissioning of MEBT and superconducting linac, including control



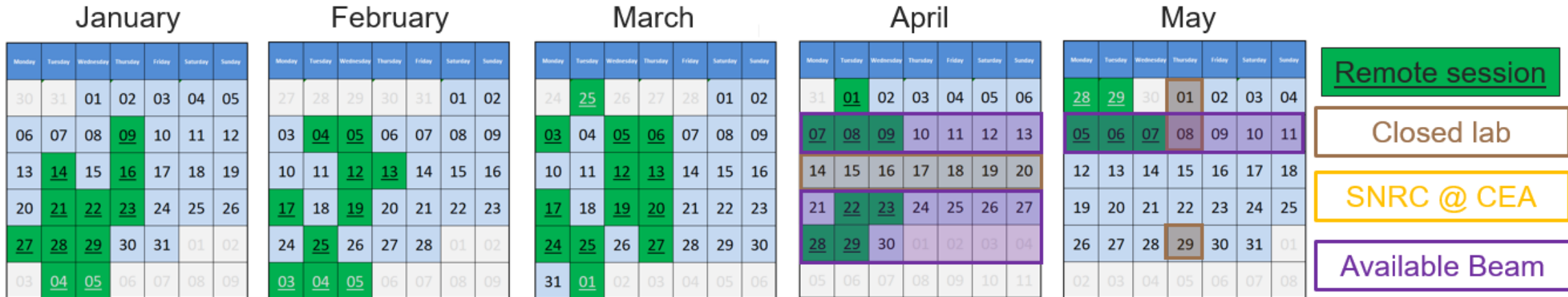
# 1. Status of the SARAF project

- Before the outbreak of the war in the Middle East by the end of 2023, the status of the SARAF project was :
  - **Injector** control system commissioned with minor reservations
  - Ongoing commissioning of the **MEBT** and of its control system
  - Ongoing installation of the first cryomodule (**CM1**) at SNRC, along with the control cabinets
  - Second cryomodule (**CM2**) ready for testing in France
  - Ongoing study on Main Control System design and integration of high-level EPICS tools
- CEA teams used to go on regular basis to SNRC from the end of 2021 to the end 2023. It suddenly stopped, with all trips to Israel being forbidden by CEA for **more than 2 years**.
- So how to keep moving ?

## 2. Remote sessions

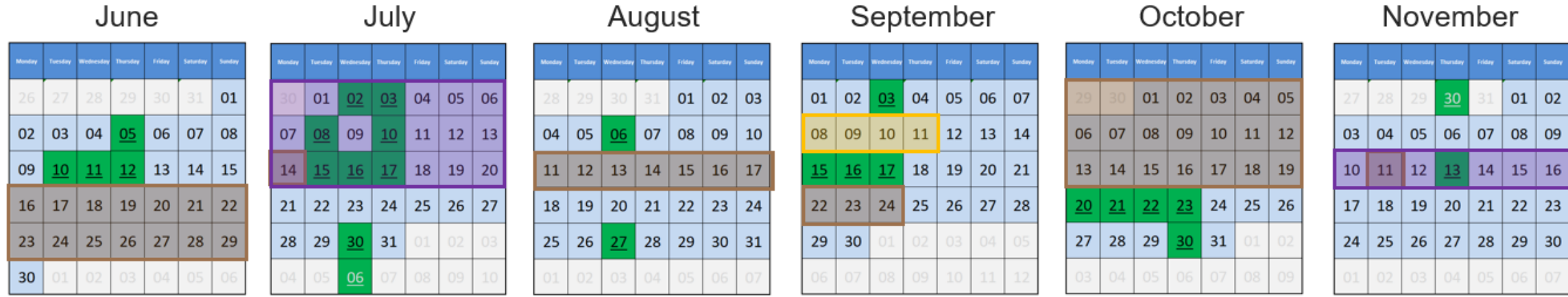
- A remote access service has been set up. The remote access allows us to use almost any tool we need : command-line, Phoebus, PLC engineering software.
- Several remote sessions are planned each week, following a schedule established by the end of the previous week.
- The accelerator being under construction, the needs of various teams used to collide often:
  - Assembly
  - Cabling
  - Control system integration and upgrade
  - Beam operation
  - ...
- Now we have defined clear beam-reserved time slots:
  - Monday to Wednesday, starting at 15:00
  - Thursday all day

# 2. Remote sessions



Awaiting safety autorisation for beam

No beam due to maintenance



SNRC closed

EIS SOL 1 Power supply failure

RFQ amplifier failure



## 2. Remote sessions

- Integration is much less efficient than it was when on-site presence was possible
- On the other hand, there was no remote access at all by that time, so day-to-day support was difficult
- We felt the need to improve on various aspects to make things smoother :
  - Detect bugs before delivery : **test benches, continuous integration**
  - Implement production-side tests and alarms : **check scripts, IOC Shell Parser**
  - Enable SNRC teams to understand problems and find fixes by themselves : **training, doc**
  - Track everything that happens : **bug tracker, beam operation logbook with automatic logging**

# 3. Enhancing the quality of software deliveries

- Testing strategy was presented by Victor N. during EPICS Meeting, Spring 2025.
- Focus on the two most developed aspects of this strategy :
  - Pre-delivery tests with Gitlab CI (Continuous Integration)
  - Post-delivery tests with custom tools

# 3. Enhancing the quality of software deliveries

- Gitlab CI (run daily) :
  - Checks syntax (EPICS, Python, XML, JSON...)
  - Checks EPICS top compilation
  - Runs IOCs (x64 only) and parse logs
  - Checks GUI (Phoebus .bob) :
    - Paths to other .bob or files
    - Some widget properties (e.g. tooltip is filled)
    - Contrast between trace color and background color to ensure plots are readable
    - Trace colors on a same plot are distinguishable
  - Checks no special characters in file and folder names
  - Checks that no compilation products were committed
  - Monitors topSaraf archive size

# 3. Enhancing the quality of software deliveries

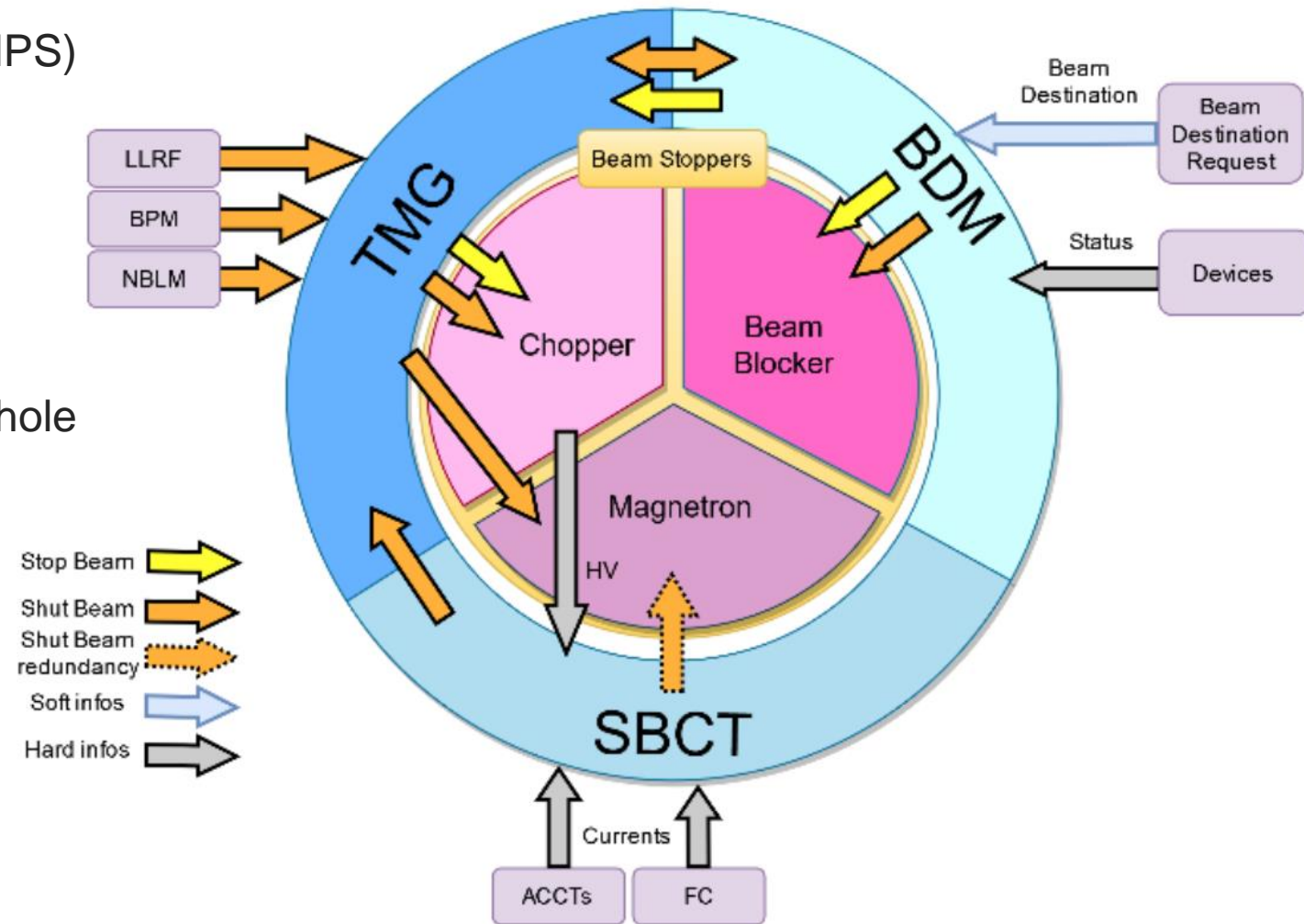
- Post-delivery tests :
  - Some tests cannot be run before delivery (lack of interface with physical systems)
  - Tests to be run without beam, before allowing the machine to restart
  - Early spotting of regressions
- As of today :
  - *check\_hosts* : a script that checks that all devices are alive
  - *check\_startup* : a scripts that checks the status of IOC hosts and of IOCs themselves
- Soon :
  - *IOC Shell Parser* : an IOC that looks for any warning or error in the logs of all IOCs.

# 3. Enhancing the quality of software deliveries

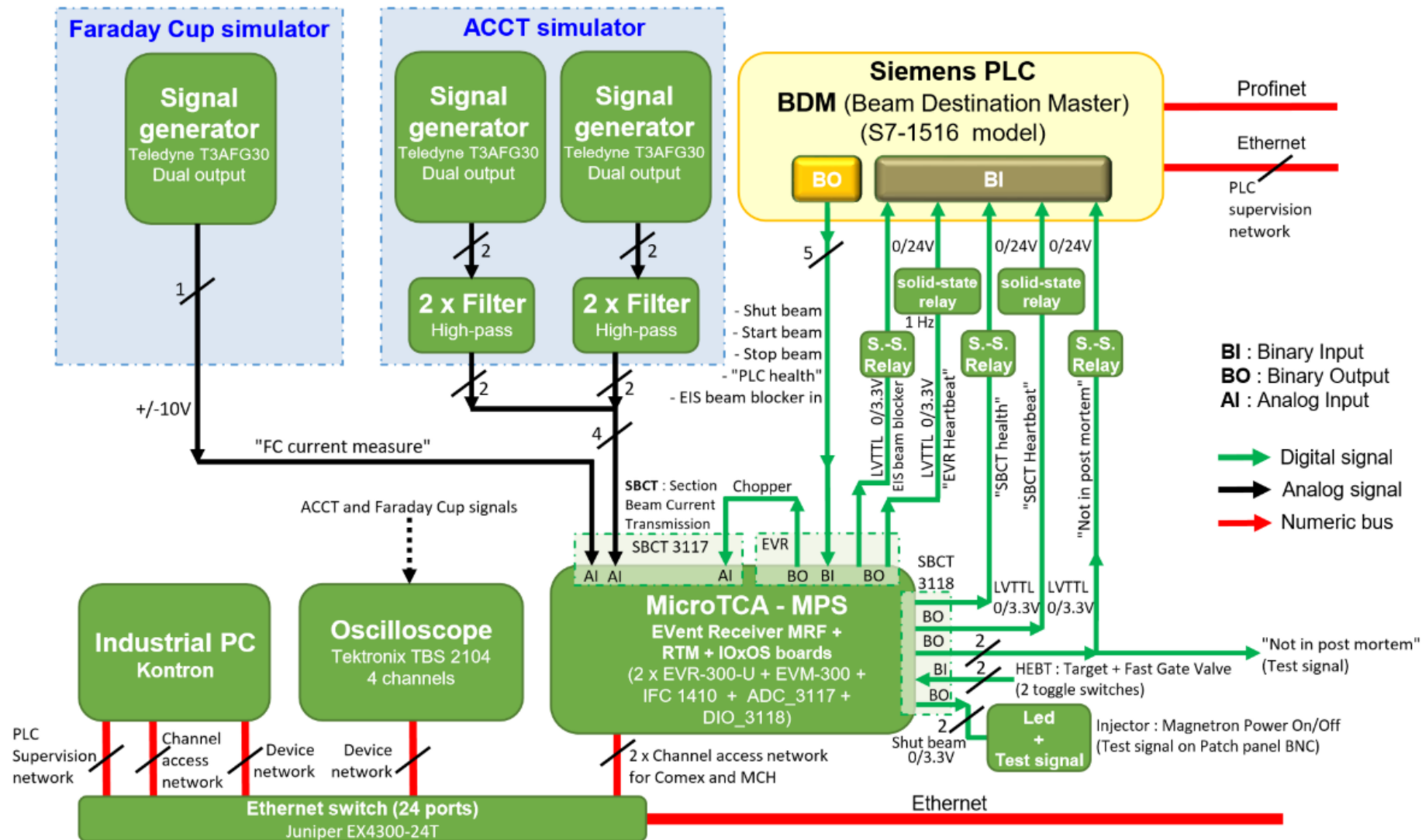
- Good progress on our testing strategy.
- Still nowhere close to Test Driven Development.
- Quality of tests varies a lot from one application to another : the focus is mainly on critical systems, such as the Machine Protection System.

# 4. The Machine Protection System Test Stand

- SARAF Machine Protection System (MPS) was presented by Alexis G.
- Critical system : failing is not allowed
- Need for a test bench to test the whole hardware - firmware - software chain !



# 4. The Machine Protection System Test Stand



# 4. The Machine Protection System Test Stand

- Variety of tests scenarios and simulated defaults :
  - Loss of Beam Destination conditions
  - Loss of PLC network
  - Loss of SBCT heartbeat
- **Turns out to be a must-have !**
  - A second MPS test stand is being assembled and will be shipped to SNRC

# 5. Training SNRC teams

- SNRC had no experience of EPICS before the start of the SARAF project collaboration.
- Training of SNRC teams has many benefits :
  - Understanding CEA developments for future maintenance and upgrades
  - Developing their own EPICS applications
  - Quick reaction when facing issues to avoid beam time loss
  - Being able to provide support for day-to-day operation
- Last training session in France :
  - September 2025
  - 2 EPICS engineers, 2 PLC engineers
  - 3 days

# 5. Training SNRC teams

| Day       | Time        | Subject  | Presented by    |
|-----------|-------------|--|-----------------|
| Monday    | 9:00-9:30   | Welcome  | Françoise       |
|           | 9:30-12:00  | Timing design  | Alexis          |
|           | 13:30-16:30 | Timing workshop  | Alexis, Gabriel |
| Tuesday   | 9:00-9:45   | Machine Protection System overview   | Alexis          |
|           | 9:45-12:00  | SBCT (beam transmission monitor) design  | Astrid, Victor  |
|           | 13:30-15:00 | SBCT (beam transmission monitor) workshop  | Astrid, Victor  |
|           | 15:00-16:30 | Beam Destination Master workshop   | David, Tom, Seb |
| Wednesday | 9:00-12:00  | Beam Operation Mode workshop   | Alexis, Gabriel |
|           | 13:30-16:00 | Main Control system workshop (Olog, Channel Finder, Save-and-Restore, Databrowser) | Antoine         |

## 6. What lies ahead...

- After more than 2 years without on-site presence for CEA teams:
  - **Injector** EPICS control system fully validated.
  - **MEBT** and its control system commissioned with minor reservations.
  - Ongoing commissioning of the first cryomodule (**CM1**) at SNRC.
  - **CM2, CM3** and **CM4** delivered and being installed, along with the control cabinets.
  - Several Phoebus services deployed at SNRC :
    - Phoebus alarm server and alarm logger
    - Phoebus save-and-restore
    - Phoebus Olog
    - Channel Finder

## 6. What lies ahead...

- CM1 commissioning is stuck to warm conditioning due to **strong requirements on cryogenics**:
  - Interface with systems not made by CEA (helium liquefier, valve boxes)
  - Need of 24/7 monitoring and ability to intervene for CEA cryogenics experts during the cooldown
  - CEA cryogenics experts are not so familiar with EPICS and can be somewhat timorous about combining the difficulty of remote operation with the discovery of a new control system

## 6. What lies ahead...

- All in all, these circumstances have set our team on a good path :
  - More testing
  - More documenting
  - More follow-up of operations
- As evidence of that, several talks given during this meeting are about topics that were encouraged by this context :
  - *IOC Shell Parser (by Alain S.)*
  - *Automated testing and validation of critical MPS applications using Hardware-in-the-Loop before production deployment (by Victor N.)*
  - *AutOlog (by Antoine C.)*



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**Merci**

