CMS OT Hybrids
Graphical User Interface for production testing

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https://gitlab.cern.ch/imateosd/gui-for-hybrids-testing-on-crate-systems
*Not for distribution, still under development.

- Over 50 000 hybrids will be manufactured for the Phase 2 Upgrade.
- They need to be tested in order to be used in the detector.

2S module	Quantity required [pcs]
2S front-end hybrid **1.8 mm; 4 mm** left and right variant	2x 8750 + 2x 550
2S service hybrid **1.8 mm; 4 mm**	8750 + 550
Total 2S type hybrids to be tested	**27900**

PS module	Quantity required [pcs]
PS front-end hybrid **1.6 mm; 2.6 mm; 4mm** left and right variant	2x 990 + 2x 1750 + 2x 4000
PS readout hybrid **1.6 mm; 2.6 mm; 4mm** variant	990 + 1750 + 4000
PS power hybrid **common**	6740
Total PS type hybrids to be tested	**26960**

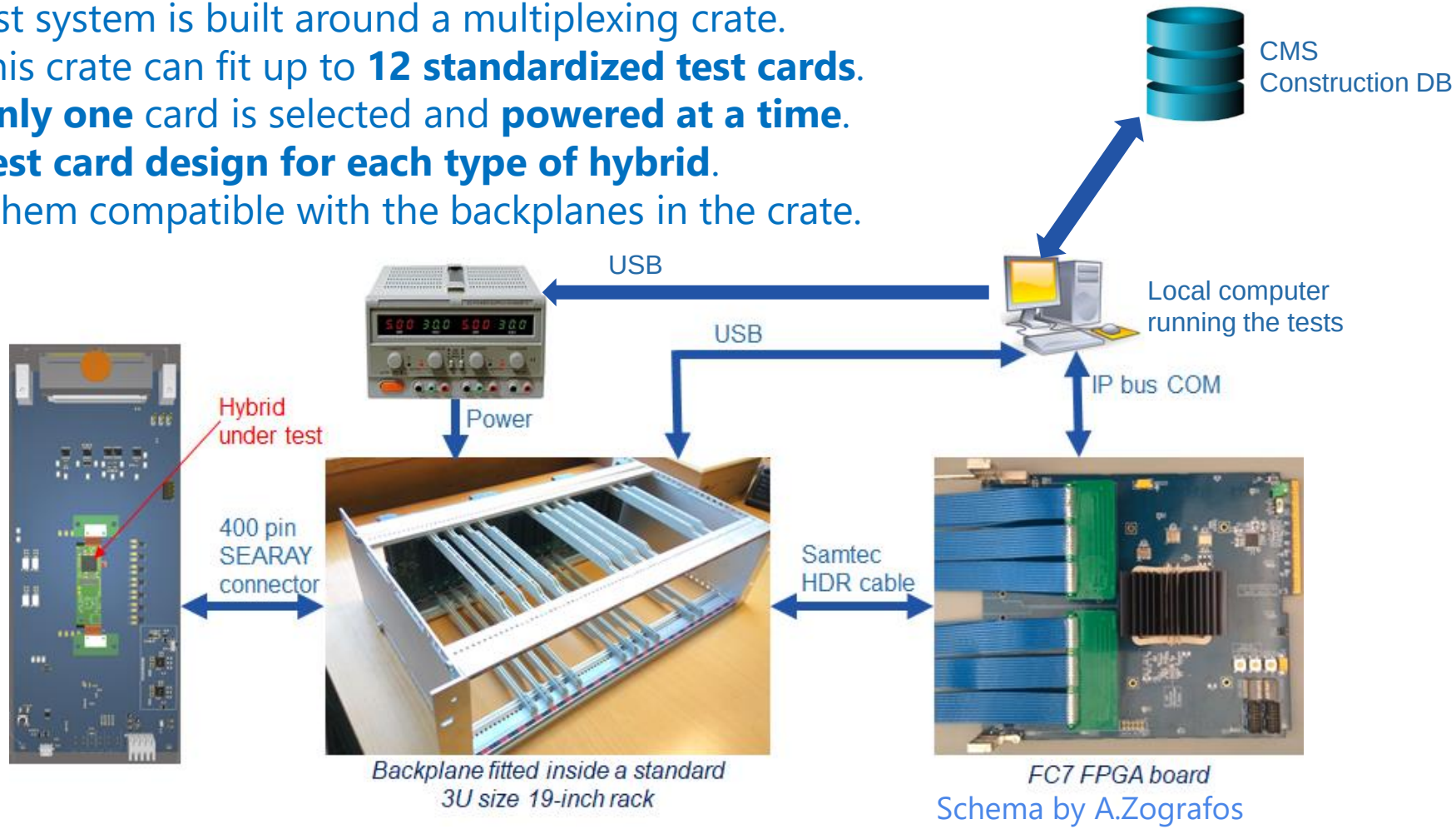
- To solve this problem, a test system has been developed to allow for the testing of the hybrids during production. This system is based on a **multiplexing crate**

The hybrids will be tested by the manufacturer. This creates the need for a complete testing system that can be used by a non-expert.

Goals for the software:

- Simplification of test process.
  - Single software for all types of hybrids.
  - Easy-to-use graphical user interface.
  - Tool to walk the user through the test run.
- Transparency of the test system to the user.
- Upload of test results and test measurements to database
  - Allows for monitoring of test progress from CERN.
  - Early detection of problems and quick reaction time.

- The test system is built around a multiplexing crate.
  - This crate can fit up to **12 standardized test cards**.
  - **Only one** card is selected and **powered at a time**.
- **One test card design for each type of hybrid**.
- All of them compatible with the backplanes in the crate.



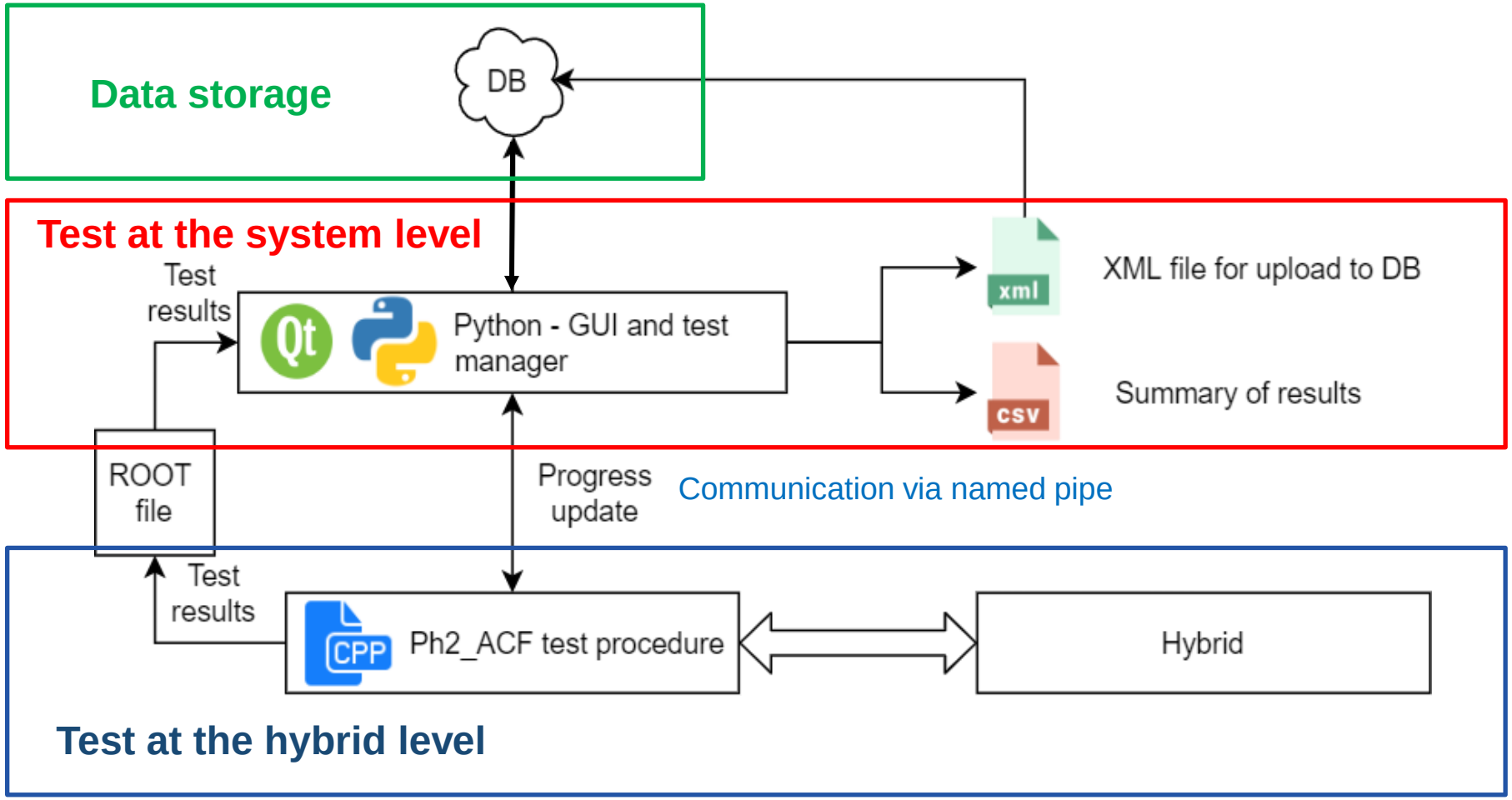
Schema by A.Zografos

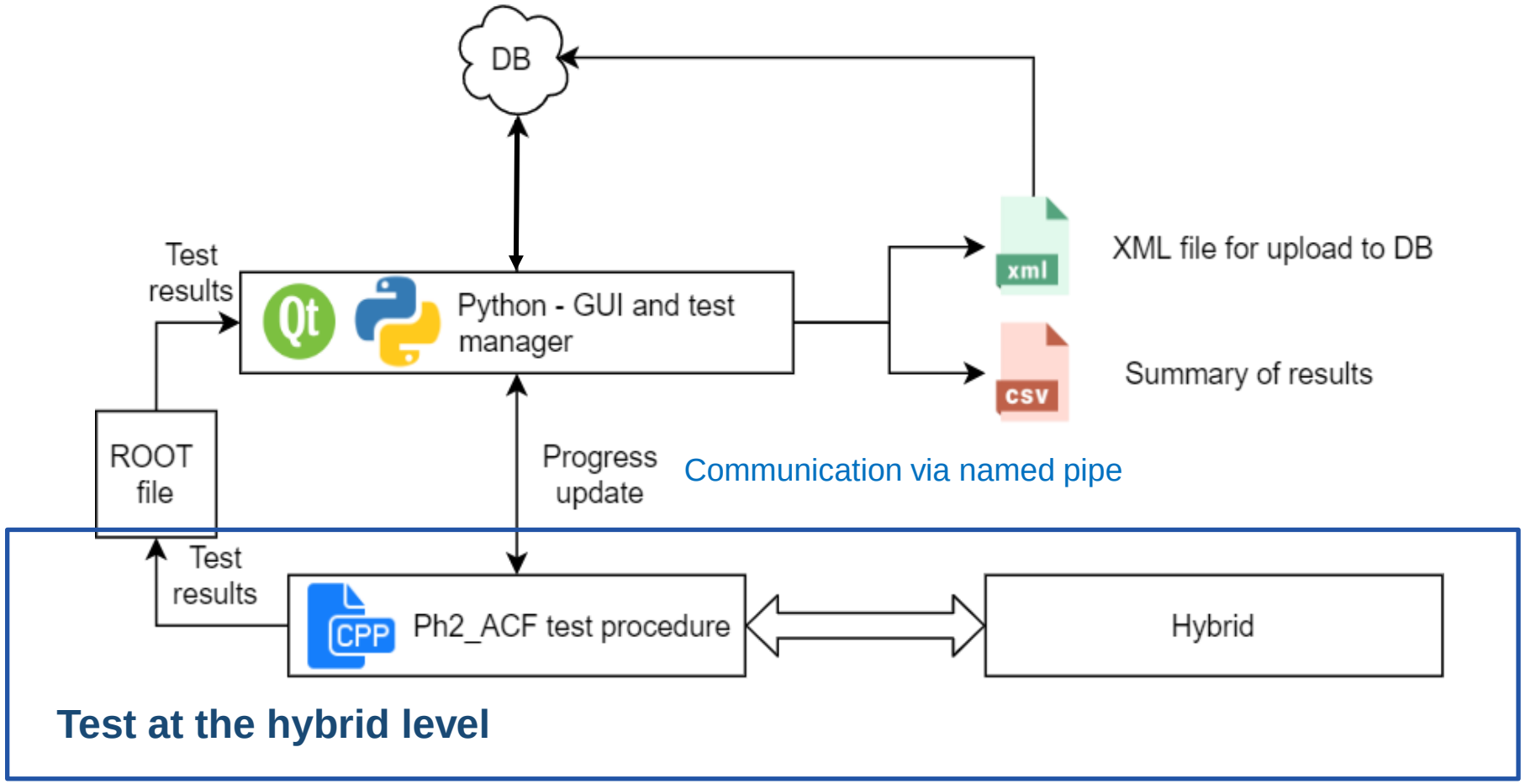
- Each crate allows for the **serialized testing** of 12 hybrids.
- Default setup will have three crates: allows for parallel testing processes (one process of serialized testing on each crate).

The software infrastructure can be divided into two main parts:

1. Testing at the hybrid level
   - FC7 FPGA firmware with specific blocks to interact with the hybrid under test.
   - Low level software.
     - Ph2_ACF test procedure to test individual hybrids via the FC7.
     - USB libraries to control the test card-specific features.

2. Testing at the system level (GUI)
   - Management of the testing of the hybrids at a larger scale.
   - Configuration of setup: power supplies, firmware and test procedures.
   - Processing and monitoring test results.
   - Upload of data to database.


Data storage
DB
Test at the system level
Test results
Python - GUI and test manager
xml
XML file for upload to DB
csv
Summary of results
ROOT file
Progress update
Communication via named pipe
Test results
CPP
Ph2_ACF test procedure
Hybrid
Test at the hybrid level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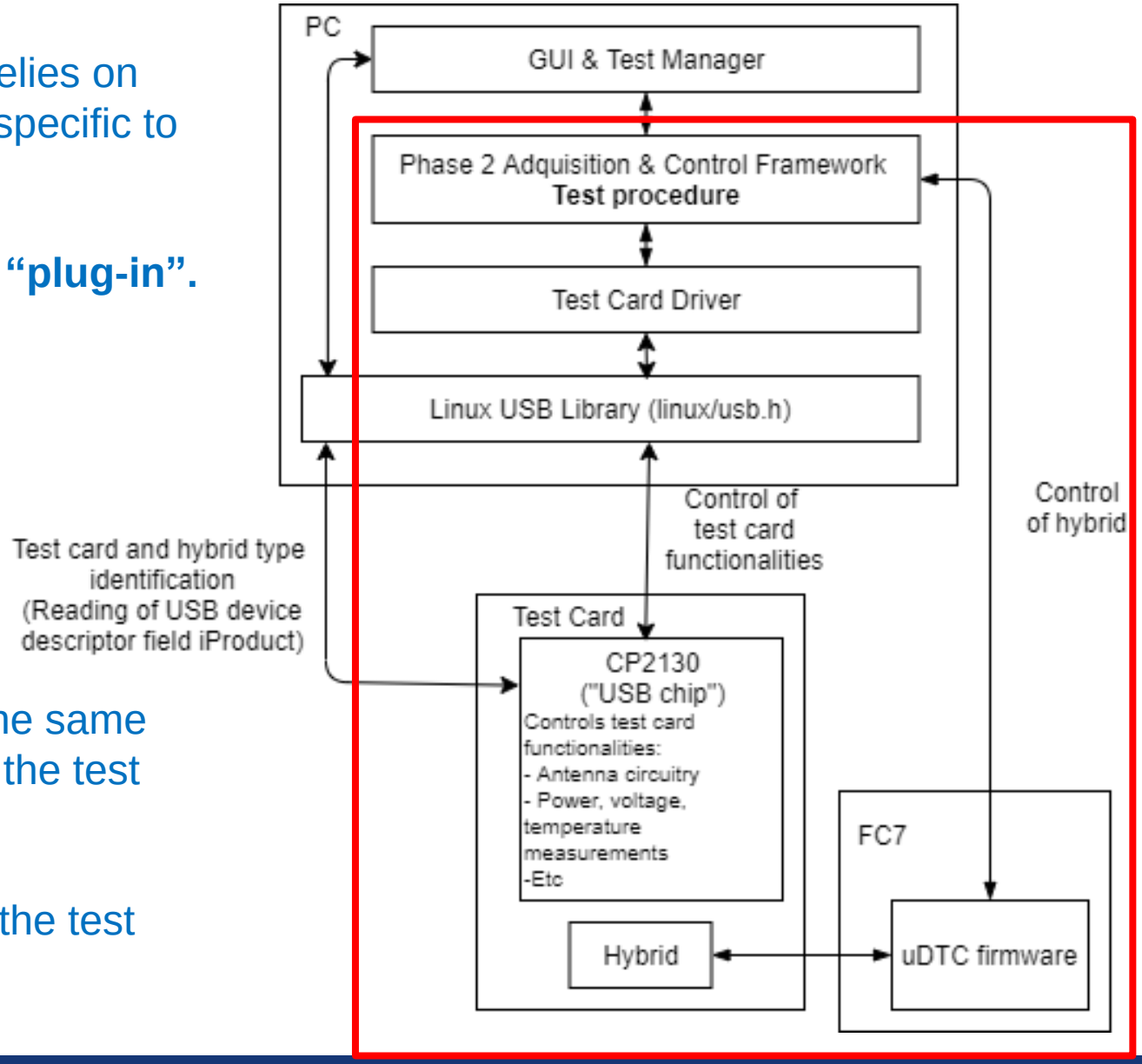
Hybrid
Test at the hybrid level

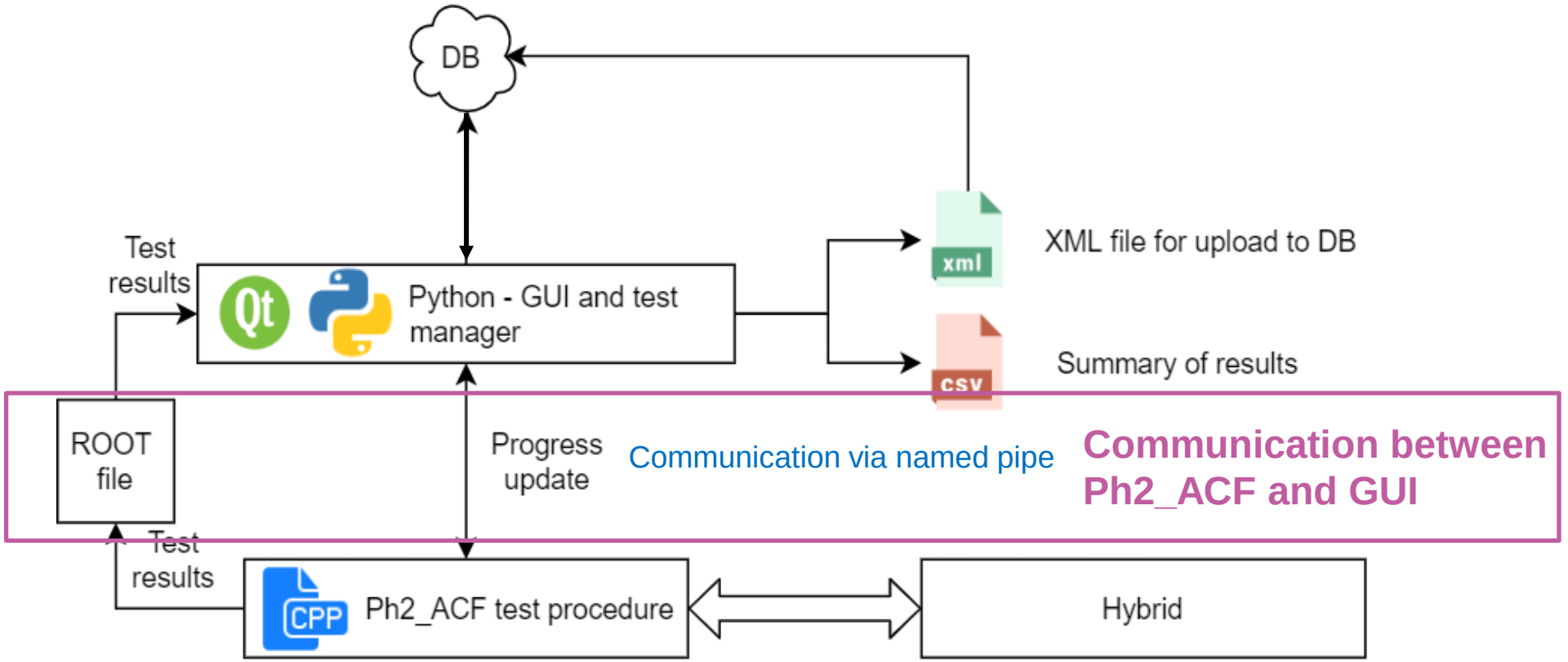
The testing at the hybrid level relies on three main pieces of software, specific to the hybrid type:

- Test procedure – **Ph2_ACF**.
- Test card driver – **Ph2_ACF "plug-in".**
- FC7 firmware.

All the test card designs share the same USB to SPI chip, which controls the test card features.

The chip is also used to identify the test card.

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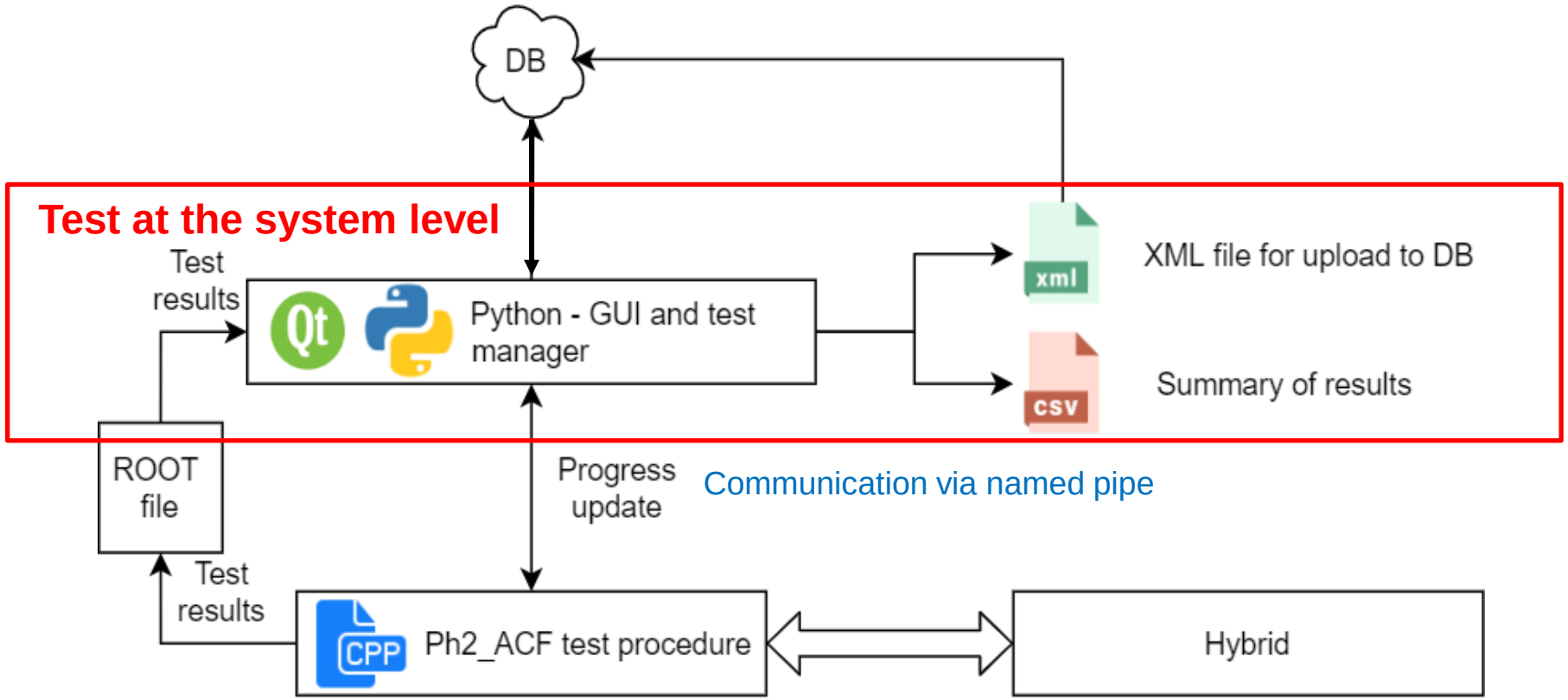
Communication via named pipe
Communication between Ph2_ACF and GUI
Test results
Ph2_ACF test procedure
Hybrid

- Two parts:
  - During the run (progress report – **named pipe**):
    - The Ph2_ACF procedure writes to a named pipe that is read by the Python GUI.
    - Throught this named pipe, status messages and progress percentage are sent.

  An example can be found here: https://gitlab.cern.ch/alpapado/rundialog

  - After the run (results storage/communication – **ROOT file**):
    - All the results from the Ph2_ACF procedure are stored in the ROOT file.
    - The results to be used by the GUI are stored in a TTree that contains the most important measurements.
    - These results are processed by the GUI to define the hybrid status.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Hybrid

- Graphical tool, developed in Python.

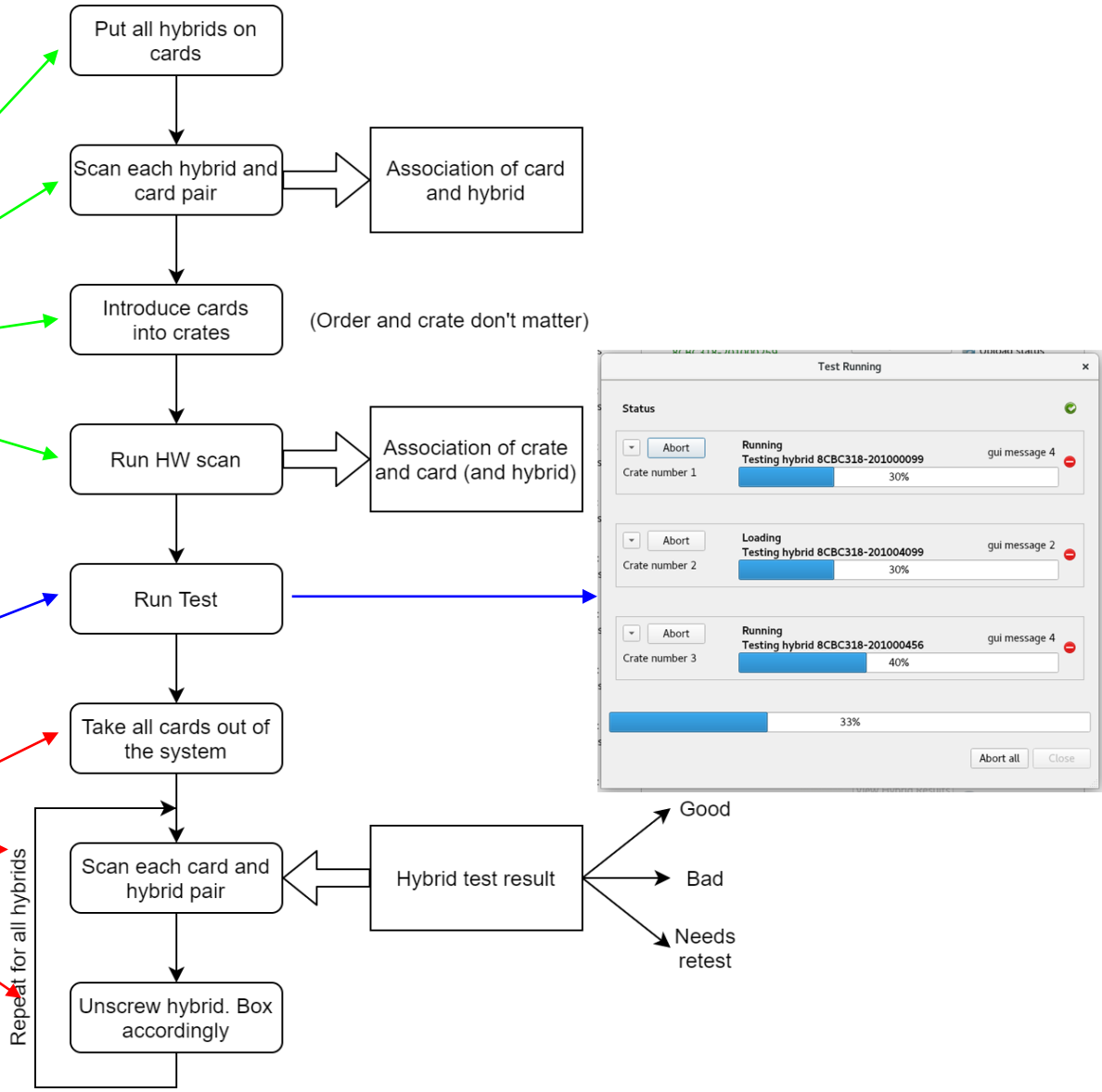
- Manages testing at the level of the system.
  - Manages connected hybrids and their positions in the crates.
  - Manages serialized testing in one crate/parallel testing across the crates.
  - Selects necessary firmware and test procedure.
  - Processes output of Ph2_ACF procedure and decide hybrid status.
  - Presents hybrid status to user and generates user-readable files with measurements.
  - Monitors results for detection of systematic errors.

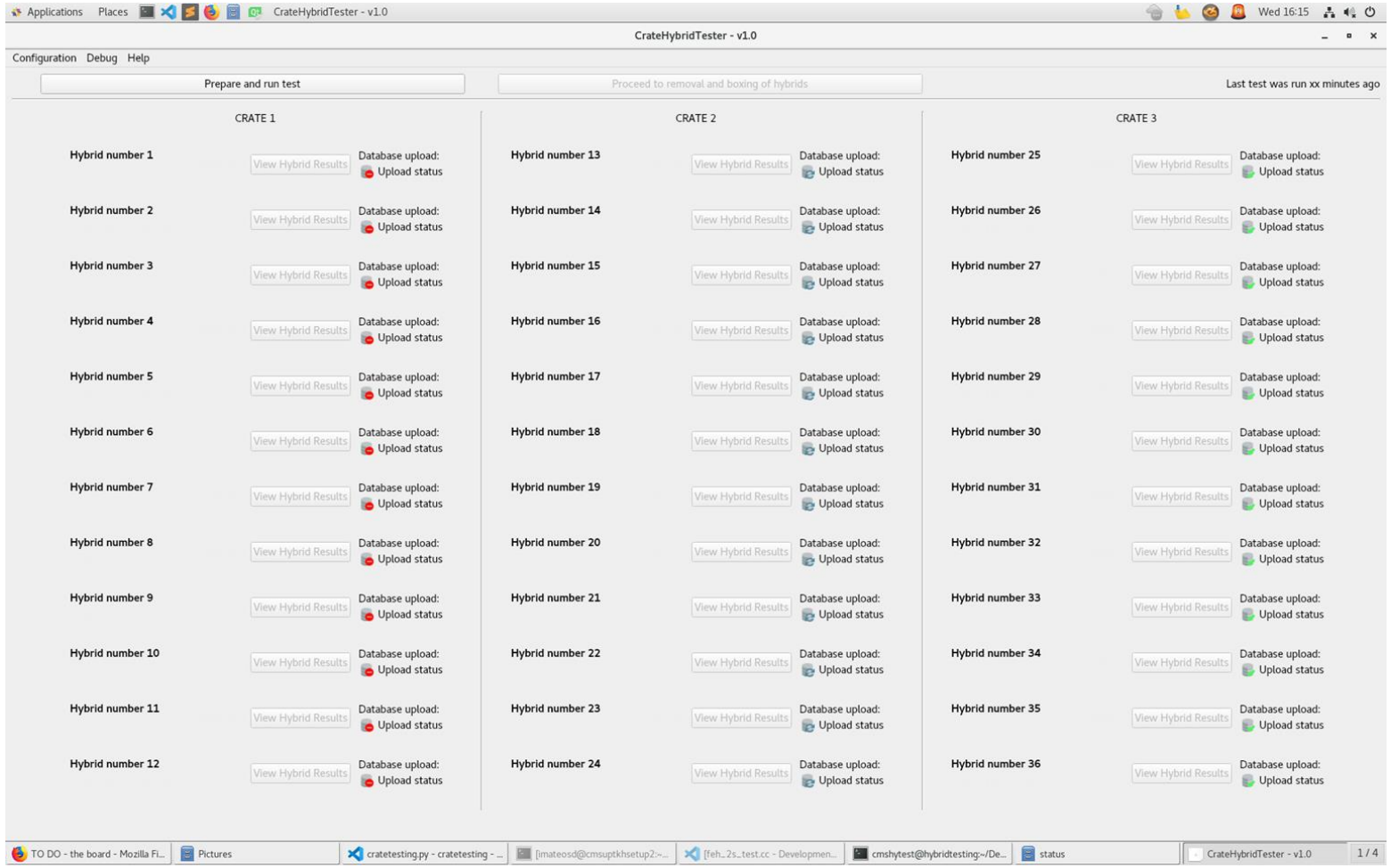
- Will store results in common database for general access.

TEST WORKFLOW

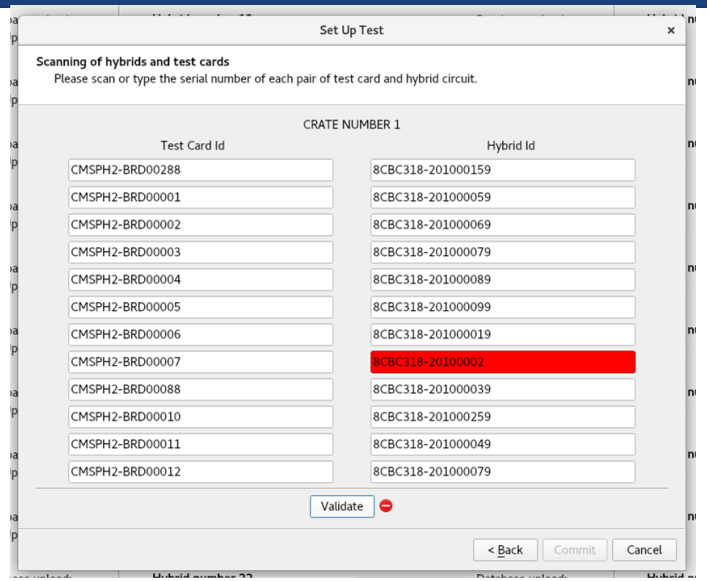
Parts of the GUI:

1. **Main window**: for results and launching of the test.
2. **Scanning wizard**: for the scanning of all the cards and hybrids. Walks the user through the process of inserting the hybrids on the system.
3. **Dialog of test run**: for monitoring the test.
4. **Dialog of hybrid removal**: for recovering the test results.

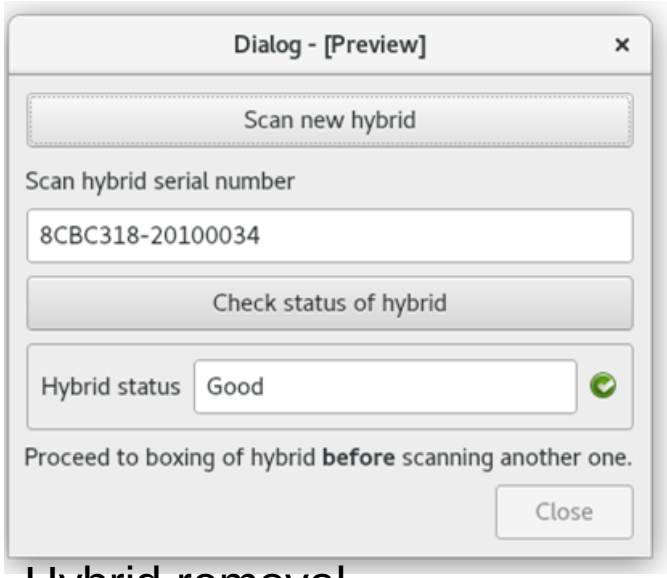




Main window

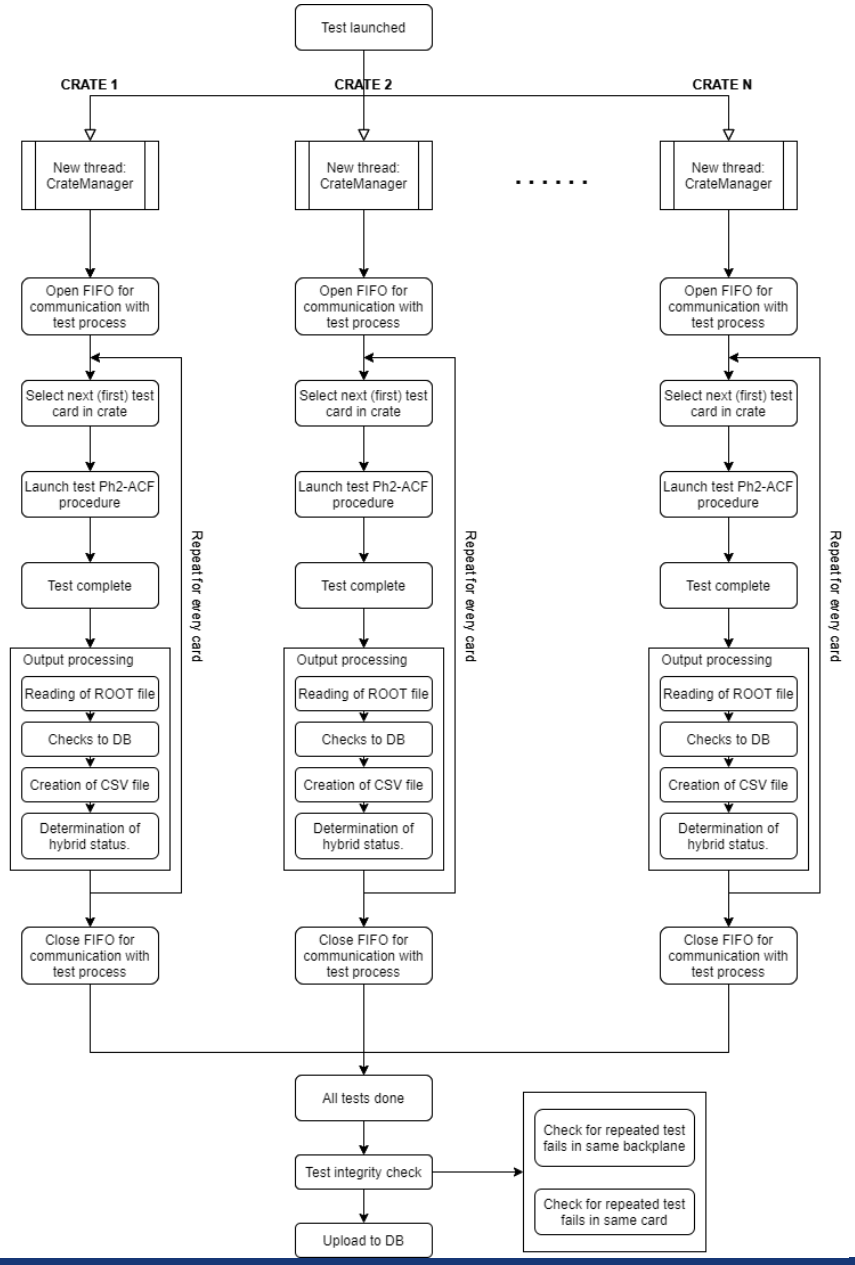


Scanning wizard



Hybrid removal

Structure of GUI for running tests on multiple crates.



- GUI based in Python.
  - Goal: to make the test system, the Ph2_ACF and the firmware images transparent to the user for all different hybrids.
  - Walks the user through the process of testing the hybrid.
  - Communicates with Ph2_ACF
    - via named pipe during run.
    - via ROOT file for the results.
  - Processes the output and decides the hybrid status based on the results.
  - Will upload all the data to the CMS Construction Database.

Thank you and enjoy the school!