The Module Tester Guide.

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Introduction
This is a procedure description of performing CMS-BPIX-Module-Full-Qualification with the ETH Cleanroom-Cold-Box-setup. It also describes the procedure of performing X-ray Qualification with the ETH Pixellab X-ray setup. The latest version can be found here. One can also get the github project here.

Contents

Part I
Cold Box Qualification

1. Before starting

For the Full Qualification in the cleanroom you will need the following components.

- 1 Cold Box (currently Red October)
- 1 PC dedicated to the Cold Box (currently Daim)
- 4 (at least one) digital Modules
- As many Digital Test Boards as Modules
- 2 power suppliers for the Cold Box TEMs
- 1 Keithley High Voltage Source

Check that everything except the PC is turned off. Place the Module Transportation Box/Tray in a stable position close to the Cold Box.

2. Placement of modules on the plate

Wear the ESD armband while performing this operation. Place one module at the time, starting from position 0 as marked on the plate. Then, connect the adapter cards to the adapter boards. In this phase, attention should be put at the length of the Molex cable. Some cables might be too short to allow a proper insertion of the card, and the cable can be pulled off from the connector in the attempt to connect it. It is thus important to check that the position of the Testboard-plate allows for a safe installation of the adapter cards. The Molex cable should not be stretched and should be loose enough to be able to close the lid of the box without pulling it. The box can then be closed and turned on. A lead block is put on top of the lid to improve the sealing of the controlled volume. Now we can start and configure our devices for the Full Qualification.

3. Activating and configuring the setup

Until now, everything except the PC should still be turned off. It is important now to follow the procedure described below in the correct order.

3.1 Reducing the humidity

Turn on the Cold Box, select the program $p17$ and start it. Wait until the relative humidity reaches a value below 20% (typically around one minute). End the program $p17$. Leave the Cold Box on.

3.2 Activating the setup

1. Activate the chiller by turning the main red switch to the vertical position. The set temperature can be changed using up/down arrows and confirmed using the return button. It is usally set to 5°C. The chiller will now start to cool/heat the liquid, while pumping it through the cooling box pipes.

2. Turn on both power supplies of the TEM outside the Cold Box. The voltage should be set to 12.7V on both PSs.

3. Activate all DTBs by plugging in the power cable. Check that the USB connection is also established. One can verify this by typing *usbview* in the Terminal. Also check that all DTBs are correctly connected to the Keithley.

4. Turn on the Keithley. From now on, high voltage can be applied to the setup - be careful.

5. Turn on the program p17 using the JUMO control panel of the Cold Box.

3.3 Configure softwares

One has to be sure that both softwares, *pXar* and *elComandante*, are correctly configured before starting. By default, the minimum amount of configuration needed is to adjust the *elComandante.ini* file. It is assumed that one is logged in with the *production* user.

3.3.1 pXar

This subsection is only needed if manual investigations are necessary. Go to the pXar build directory.

```
$ cd  /pxar/build
```

Switch to the masterbranch.

```
$ git checkout master
```

If new default parameters need to be set (e.g. a module with a new TBM) or if on wishes to start pXar manually, do the following

```
$ ../main/mkConfig -h
```

and follow the instructions. An example for a L2 Module would be

```
$ ../main/mkConfig -d ../data/MXXXX -t TBM09C
-r digv21respin -m
```

To start pXar for module MXXXX, do

```
$ ../bin/pXar -d ../data/MXXXX -g
```

3.3.2 elComandante

Elcomandante is supervising pXar, the Keithey and the Cold Box. There is an elComandante installation dedicated to Full Qualification with the cleanroom Cold Box in

```
$  ~/elComandanteFullQualification
```

Do not use elComandanteXray or elComandanteReception.

Stadard configuration files are already written. They can be called by tying

```
$ python el_comandante.py -I [.ini File 1] -I
[.ini File 2] -C [Config File]
```

. If no manual changes are necessary, proceed to section 4. Performing Full Qualification.

For manual adjustments of the configuration files, edit the follwing files:

```
$ configure/elComandante.ini
```

and

```
$ configure/elComandante.conf
```

In elComandante.ini, the main fields to check are:

- [*Modules*]: insert here the module IDs
- [*Tests*]: for the Preliminary Test:
  Test = leakageCurrentPON@17,Pretest@17
  TestDescription = LeakageCurrentPON
- [*Tests*]: for the Full Qualification:
  Test = FulltestPxar@-20,Cycle,FulltestPxar@-20,IV@-20,FulltestPxar@17,IV@17
  TestDescription = FullQualification

  This is the standard test sequence for the Full Qualification.
- [*TestboardUse*]: Should be *True* for the used Testboard.
- [*ModuleType*]: For TBM09C, use
  tbm09c-prod11
  For TBM08C, use
  tbm08c

In elComandante.conf, one usually does not need to change anything. The main fields to check are:

- [*TestboardAddress*]: Check that the DTB names and positions are correct.
- [*keithleyClient*]: For the cleanroom setup, it should be
  port: /dev/ttyUSB1
- [*defaultParameters*]: If one has created a new set of default parameters, they can be inserted here.
- [*jumoClient*]: By default, it should be
  port: /dev/ttyJUMO
  programName: coolingBoxClient.py

4. Performing Full Qualification

For starting elComandante, one does the following:

1. End any programs running locally on the JUMO.
2. Immediately (less than 2 minutes) run the preliminary test ($\approx$ 15 min) and afterwards the Full Qualification ($\approx$ 9 hours).

To run the preliminary test, go to

```
$ cd ~/elComandanteFullQualification/elComandante
```

and type

```
$ python el_comandante.py -I LeakageCurrentPON -I Alerts -C Cleanroom
```

At this stage modules with communication problems (errors in the log files) or bad sensors (high leakage current) can be identified and taken out of the box, replaced by new modules. For the Full Qualification, type

```
$ python el_comandante.py -I FullQualification -I Alerts -C Cleanroom
```

It is recommended to first do the Preliminary test and then proceed with the Full Qualification. The setting changes are explained in section 3.3.2. During the whole procedure, it would be wise to keep an eye on the log-output of elComandante, pXar client, JUMO client and Keithley client in case of any problems. Principally, one can now wait until the Test is done.

5. Finishing the test

When elComandante has completed all foreseen tests, it will ask the user to take out the modules. Do so. Then it will ask to press enter and the test summary will be displayed. Then it will ask to press enter again to and the program and store the data. Do so.
After the Modules are taken out and put in a safe place and the software is terminated, turn of the setup by.

1. Turn off the Keithley.
2. Unplug the power cables for the DTBs.
3. Turn off the PSs.
4. Turn off the chiller by pressing the return button on the control panel until the program terminates. Then turn the main red switch to the horizontal position.
5. For the last, turn off the Cold Box.

6. What to do with the data

6.1 Create backup

The results are stored in a local folder and have to be moved to a shared folder. In order to do so, please copy only the new *.tar files results from

```
$ /usr/local/coldboxDATA
```

to

```
$ /home/production/dataCH
```

6.2 MoReWeb Analysis

MoreWeb results should be carried out on an external hard drive at /mnt/sdb1/. Connect to the PC with the external harddrive, copy the results from /home/production/data to the external drive, untar them by doing

```
$ tar -xf [FILE]
```

and run MoReWeb by doing

```
$ python ~/MoReWeb/Analyse/Controller.py -new
```

. The results will be available in

```
$ /mnt/sdb1/Overview/Overview.html
```

6.3 Synchronize with the Group-Webserver

In order to synchronize with the ETH IPP groupserver (www.cmspixel.phys.ethz.ch), run the shellscrip in the external harddrive by doing

```
$ ./synchronize_webserver.sh
```

6.4 Upload to the database

This can be done by doing

```
$ scp -P 23481 -i /data/Equipment/labcomputer/eth-pisa-key.rsa [tarFILE] eth@cmspixelprod.pi.infn.it:/home/eth/dropbox/
```

If modules tested already exist in the DB, just run:

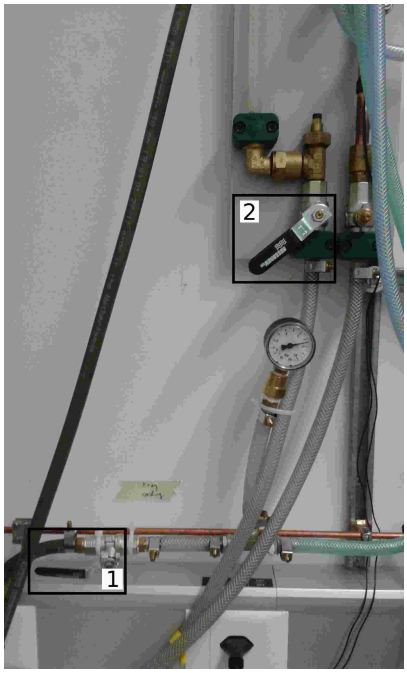
```
$ scp -P 23481 -i /data/Equipment/labcomputer/eth-pisa-key.rsa [tarFILE] eth@cmspixelprod.pi.infn.it:/home/eth/dropbox/
```

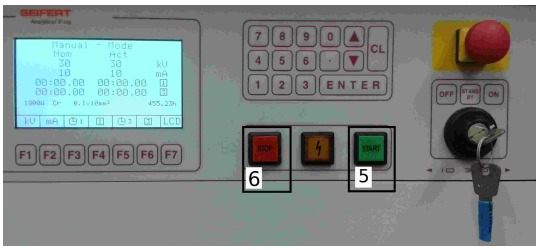
changing the tar archive with the needed one for every module.

Part II
X-ray Qualification

7. Operation of the X-ray setup

- Open valve entirely for X-ray cooling (1), and valve for module cooling (2) until the pressure is about 2 bar (check with left barometer in the X-ray setup).
- Switch on X-ray machine (3).
- (Re)close the door of the X-ray setup housing, press round, green **START** button (4).
- Turn key to **ON**.
- Warm up X-ray tube by selecting **F7**. Enter the required current and voltage settings by selecting **F2, F4 or F6**. One shouldn't have very small values for currents





with large voltages as well as the other way around. Suggested values are 60 kV and 30 mA for warming up the tube. Press **Enter** when finished, then **START** (square green one, 5). This will take up to 30 minutes depending on when the tube was operated the last time at this or a higher voltage. If the voltage is not set, check green interlock button (4) and the door, press **CL** to delete the error message.

- To control X-ray tube settings and targets during operation, use respectively **id3003** and **xrf** programs. Shutter 1 directs the beam to the targets, shutter 3 directs it to the modules. Available targets are Zn, Cu, Mo, Ag, Sn, Ba, Br (Screen). Some examples:

```
$  id3003.py open shutter 1
id3003.py close shutter 1
id3003.py set hv on
id3003.py set hv off
id3003.py set voltage 30
id3003.py set current 10
id3003.py get voltage
id3003.py get current
xrf Ag, xrf Mo
xrf Screen
```

- When taking a break, turn off high voltage and close the shutter. Turn key to **STAND BY**.

8. Set-up parameter directory

The parameters for the X-ray test are copied from the FULLTEST@17 from the ColdBox.

- copy coldbox parameter folder **004_FulltestPxar_p17** to /data/moduleParameters, and rename to module name **Mxxx**
- either manually delete .root and .log files or (in /data/moduleParameters) use the script **python ./clean_parameters_folder.p -d Mxxx**
- (temporary) copy **testParameters.dat** from /data/moduleParameters/testParameters.dat to **/data/moduleParameters/Mxxx/testParameters.dat**

9. elComandante configuration

- use elComandante from **/home/production/elComandanteXray/**
- check test chain in .ini file
- [*Tests*]:
  Test = *PixelAlive@17> GainPedestal@17> RetrimHotPixels @150MHz/cm2> HRData@50MHz/cm2, HRData @150MHz/cm2, HRSCurves@100MHz/cm2, XraySpectrum@Zn, XraySpectrum@Mo, XraySpectrum@Ag, XraySpectrum@Sn, CalDelScanAndSaveDacs@4mA25kV> HREfficiency@50MHz/cm2, HREfficiency@100MHz/cm2, HREfficiency@150MHz/cm2, HREfficiency@200MHz/cm2, HREfficiency@250MHz/cm2*
  TestDescription = *XrayQualification*

10. Run test

- use elComandante from **/home/production/elComandanteXray/elComandante**
- run ./el_comandante.py
- scan modules with scanner from left to right, press enter for an empty position or if the module is the same than in the previous test.

11. After test

- check test list in elComandante output (below "Final cleanup after all tests ..."), status code should always be 1. A status code of $\neq 1$ or red color means error
- copy files from local directory (eg. /usr/local/data/) to /home/production/data, copying .tar files and extracting them is faster.
- analyze with MoReWeb
- update MoReWeb overview on our webserver, script **/home/production/ synchronize_webserver.sh**
- write Elog entry
- upload to database
- the steps mentioned above are similar to the Cold Box qualification, which is documented in section 6.

12. Switching off X-ray setup

- Close the shutter, turn off high voltage.
- Press **STOP** (6).
- Turn key to **OFF**.
- Turn off X-ray machine.
- Close both water valves.

13. Troubleshooting

Problem: DTBs are not detected by the computer, typical error message: Unable to detach testboard. Usbview is very slow and might or might not list all connected DTBs
Solution: Run the script **/home/production/reset_usb.sh** (as root) or restart computer (only after agreement from the group).

Problem: Hot Pixel Re-trimming takes very long or finds more hot pixels than usual
Solution: Might be missing HV or wrong testParameters.dat file (for instance from an old pXar version)

Problem: Keithley is not turned on by elComandante
Solution: check if the **port** option in section **keithleyClient** in **elComandante.conf** is pointing to the correct device. Find the device by running the command **findkeithley** on production user. This device number can reset after reboot!

Problem: How to abort the program?
Solution: In case of emergency, terminate elComandante with Ctrl-C. The data should be stored in /usr/local/coldbox-DATA. Then one can turn off the setup as described in section 5.