QUBIC's in-lab(*) calibration

Caveat:

Still very preliminary…will have to work hard in the coming months to have everything ready !

All your inputs/ideas/comments/criticisms are very welcome !!

What follows came out from discussions with

Francois, Jean Christophe, Laurent, Michel, Olivier, …

(*) meaning @APC, no "on-site" calibration discussion foreseen in this talk

Preparation for the calibration

The questions that we will need to answer/solve:

1/ What do we want to measure and to which accuracy:
- on the TD
- on the FI

2/ What are
* the calibration setups that we need ?
* the data format and storage
* software developments (QubicStudio ?)

estimation of missing budget if any

3/ Planning of measurement (data taking) with manpower

4/ Data analysis

=> Toward a publication with results of the calibration measurements

When to start ?

when the Integration (@APC!) stops => the Calibration starts ?

From the Integration Document

The ultimate tests that have to be passed successfully for the TD, before switching to the Calibration phase, are the following ones:

- All the subsystems functionnal tests have been performed successfully at each phase of the integration: in warm and cold cryostat configurations: switches, HWP, acquistion system, housekeeping data providers (pressure, temperatures, ...).
- The instrument alignment has been checked successfully
- The detectors have been cooled down to at least 320 mK,
- The noise measured on the detectors with a 300K load on the cryostat window is within the specs.
- The acquisition system produces usable data at the nominal rate.

TBD: need to decide wrt to optimisation of the number of cooling down we can afford

Which parameters ?

3.1.1. Cryogenic measurements and functional tests

During the cooling downs (for both the blind and the opened configurations of the cryostat) successive tests with respect to the thermal behaviour of the instrument will be pursued. Beyond the follow up of the achieved temperatures on the different stages (40K, 4K, 1K and 320mK), we will measure the thermal conductance of each stage:

- 320mK: through regulation stage
- 1K: through heater
- 4K: through heater and switches
- 40K: through ASIC

Thermal behaviour measurements,
Transfer functions
Stability….
=> Thermal Model

We will also cross-check the thermal stability of the cryogenic chain. A comparison of the results with respect to the model of the thermal transfer within the cryostat will be assessed.

For different temperatures configurations, we will also measure the R(T) behaviour of the detectors.

In parallel functional tests on the use of the half wave plate and of the switch array will be performed. We will then be able to check the EMI/EMC their use induces in the instrument. Eventual repercussions on the cryostat temperature at the different stages, and the corresponding amount of time needed to come back to the optimal values will be extracted from the housekeeping data.

Which parameters ?

3.1.2. Detector characteristics determination

When the nominal values for the temperature of the different stages will be reached, the I(V) curves will be determined, as well as the working points of the detectors. A comparison of the measurements of the integrated instrument with respect to already existing ones on the response of the electronics, the SQUIDS and the TES will be assessed [46].

R(T) and I(V) measurements
Noise (NEP, slope, fknee)
Cross talk
EMI/EMC compatibility
Time constants

⇒ Detector Model

All the measurements described above can be done under different load configurations, which can be mimicked either by playing (within some extend) with the different cryogenic stages, and/or by the comparison between the two cryostat configurations (blind or opened). This would permit to further refine the Instrument Model. Depending on the availability of a temporary mounting system, the stability of the temperature stages and the noise on the detectors will be measured for different inclinations of the cryostat to check the elevation domain in which the instrument will work (in which the pulse tube is efficient enough).

Which parameters ?

Noise
Intercalibration
Spectral response
Time constant
Polarisation angle
Sensitivity to T, bckgnd
Linearity
Self Calibration
Crosstalk
Synthetic beam
...

⇒ Instrument Model

TBD: list is not exhaustive ! ….
Your inputs are more than welcome !!

Calibration setup

Planned (so far...)

- Calibration source
- Full beam source
- Vectorial analysis (available @APC)
- Carbon Fiber sources
- do we need something else ?? a FTS ??

(see dedicated presentations for some setup @this meeting)

Within the Integration phase are foreseen the checks that all those setups are available and work properly (functionnal tests).

Overall Strategy for the TD

3 steps implementation (plans written for the TDR):

- "blind" cryostat (*)
- "opened" cryostat
- cryostat outside of the APC Hall

(*) first 2 steps are done in the APC Hall

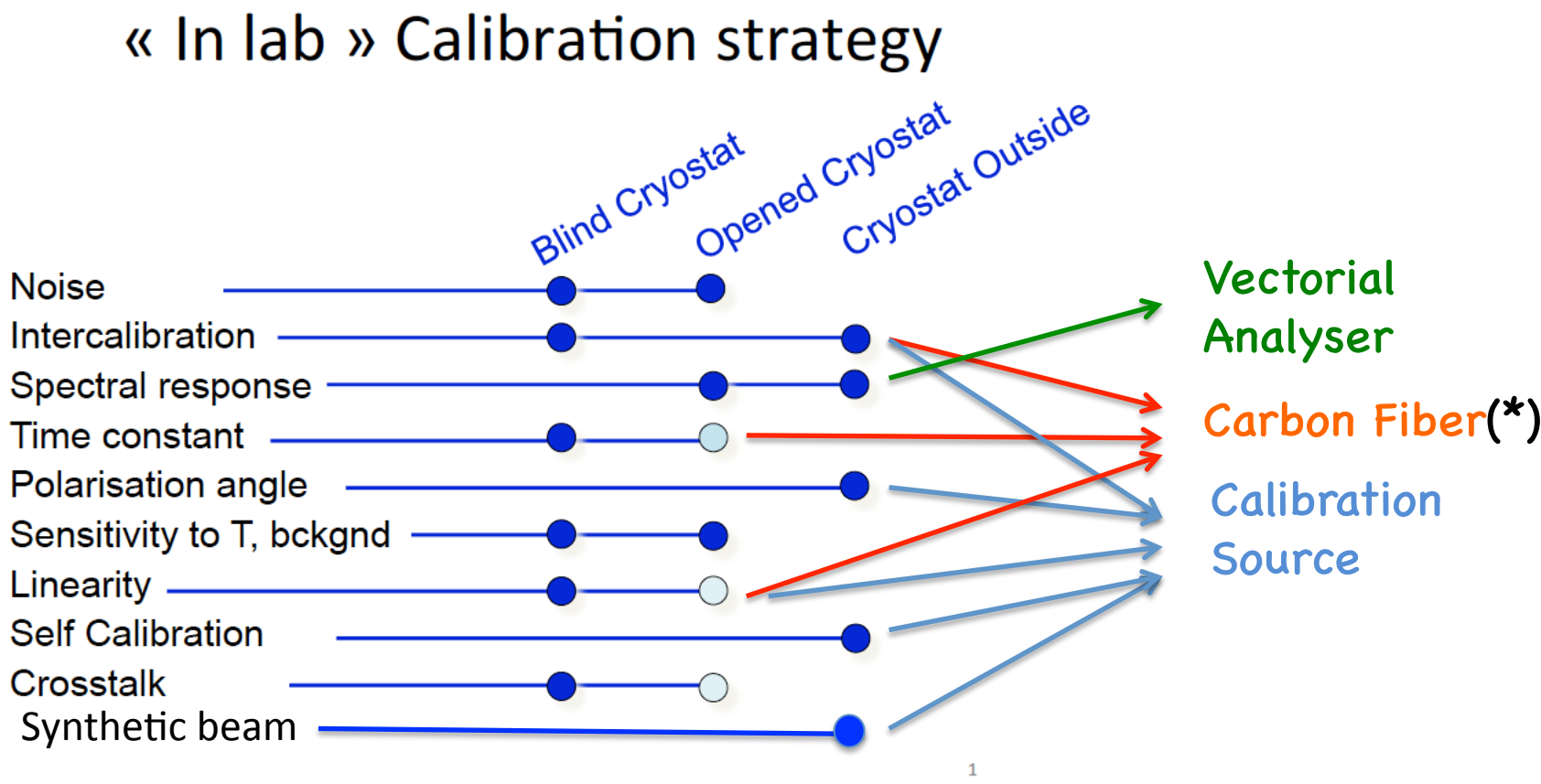
We need to decide whether this phase is needed or not, and if yes, which load we want (temperature of the entrance window)

1. First, the measurements will be achieved with the entrance window of the cryostat closed by a metal plate: this phase is here-after called "Blind cryostat" configuration.
2. Then, the metal plate will be removed. A density filter installed inside the cryostat will insure that there is no saturation of the detectors (from the 300K). This configuration is called "opened cryostat"
3. Finally, while the first two steps will be done inside the APC Hall, the instrument will be transported outside pointing at the calibration source placed on the roof of a building facing the Hall entrance.

From the TDR

NB: * need a system to bring the cryostat outside of the APC Hall (CEA?)
* need to find a way to scan the source (or…cf. Yesterday's discussions)
* need a density filter

Overall Strategy for the TD



(*) For the time constants: rather an upper limit and checks of stability with time

How far do we want/need to go ?

* May answer differently for the TD vs. The FI

* I would say: up to (@least to some extend) provide a proof that the self calibration works ! (would help convincing our funding agencies....but not only !)

- We have to all agree on the goals !

Still a lot of things to do ahead of us !
Let's prepare it altogether !