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Subject:	Calibration system
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Dear Colleagues,

Following discussions with Matt Carter, Bernard Lazareff, Doris Maier (on the receiver side) and Rafael Moreno (on the astronomy side), I would like to emphasize a few points in the decision to be made on the receiver design concerning the calibration system.

The calibration system should be derived from the ultimate goal of providing 1 % ABSOLUTE calibration accuracy. Whether this is realistic or not will come out the on-going studies, but this goal should not be compromised too early by unjustified choices.

I have read Dick Plambeck's document in which he concludes that cold load may not be needed, but would like to challenge his conclusion. Though I follow perfectly Dick's approach, I believe one cannot conclude from this approach that cold loads should be discarded.

My conclusions come from 5 facts. A more thorough analysis would be required to go further.

1) In Dick's approach, the goal of 1 % accuracy can never be reached. So we cannot base definite conclusions on this document alone.

2) In Dick's document, cold loads still give the best results at mm wavelength, while "hot" loads work equally well or better at sub-mm wavelengths. This is indeed a fairly general conclusion, which holds because calibration works well when the calibration levels are "as close as possible" to the working level, yet "as widely separated as possible".

3) The assumption of 1 % precision on the receiver gain ratio is unfounded. Better accuracy can be obtained.

4) Similarly, the assumption of 1 % error on the forward efficiency is unfounded. To quantify the precision of the determination of this parameter is difficult, and requires more work, with different approaches. In some cases, this assumption (with the assumption in 3)) is the dominant cause of error.

5) Dick's analysis in fact points out that, besides the two parameters mentionned in 3) and 4) which can NOT be calibrated at the receiver level anyhow (but can be calibrated by other techniques), the key parameter is the saturation curve of the receiver.

With Rafael Moreno, I have been working on a global calibration scheme for ALMA which includes primary and secondary calibrators, and various techniques to measure the atmospheric transparency. We cannot yet conclude on what level of accuracy is required in the "initial" Ta*-like temperature scale from the receiver to fulfill the final goal. There is still quite some work to do for that, but in our proposed method, what is important is the differential opacity between source and primary/secondary calibrators.

>From these premises, I conclude that

A) The receiver group should find a method to measure with "sufficient accuracy" the saturation curve of the receivers (i.e. the conversion "Input Power" to output voltage). The "sufficient accuracy" has to be quantified too, however, starting from the final goal of 1 % accuracy, I would suggest not to allow more than 0.3 % of error for this sole cause.
B) Because of point 2) , it would be highly premature to propose a front-end design which does not include a cold load for the millimeter domain at least.
C) The selection of which calibration scheme is actually included in the front-end design cannot be made by the JRDG alone. It has consequences for the back-end group (input power range), as well as for the "Calibration and Imaging" group (atmospheric transparency calibration), and should be made under control from the Systems group.

Since I understood that this topic is now becoming a bottleneck in the receiver design, I suggest we discuss that at the next telecon, and decide on strategies to get as fast as possible to a decision.

Best regards,

Stephane

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