# MEMO

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Nançay/Calibration/23.11.11

**DRAFT**

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**Objet** : Data calibration for Abell85, Abell1205 and Abell2440 (2011)

# Introduction

The DAB (“diode a bruit”) is used for calibration in the Nançay Radio Telescope, i.e. converting the arbitrary units measured by the electronics into Janskys.

In this note we investigate the utilization of the DAB to calibrate the data. Firstly we explain the calculation of the calibration coefficients and show the values obtained from Abell 1205 and Abell 2440 data. Then we study the effect of the calibration in the signals from both galaxy clusters. We finally show the frequency dependence of the DAB signal.

# Calculation of calibration coefficients

The calibration of the DAB is done through the measurement of a source with known flux. Let us suppose that the RT follows regularly the flux from a calibrator source and compare it to the signal delivered by a stable noise diode (noted DAB hereafter). Then, at a given frequency (not shown but it is implicit) one has the following relationships between signal from the source and from the DAB

So, the RT thanks to the source can express the DAB signal in Jy as:

Similarly, in principle the same relation occurs for the BAO electronic chain as

But, we do not yet have the opportunity to take data of a calibrator source with the BAO electronics. So, first we take for granted that the intensity of the DAB is the same as measured by the RT or the BAO chains, so , and secondly for another source S’ (or signal) observed at the same frequency, we get using above formula:

This is the basic calibration formula only valid at a specific frequency.

For BAO electronic chain to determine the coefficients we proceed as followed (extracted from Nançay/Abell85/21.11.11 MEMO).

* First, for each power spectrum registered every 120ms during 14sec around ON or OFF DAB signals, we compute the power at a given calibration frequency in a 6.25MHz band width. So, we can follow the time power intensity behavior as illustrated in Figure 1. The DAB signal is injected at two distinct positions inside the horn, so in practice it produces a 2-levels intensity pattern.

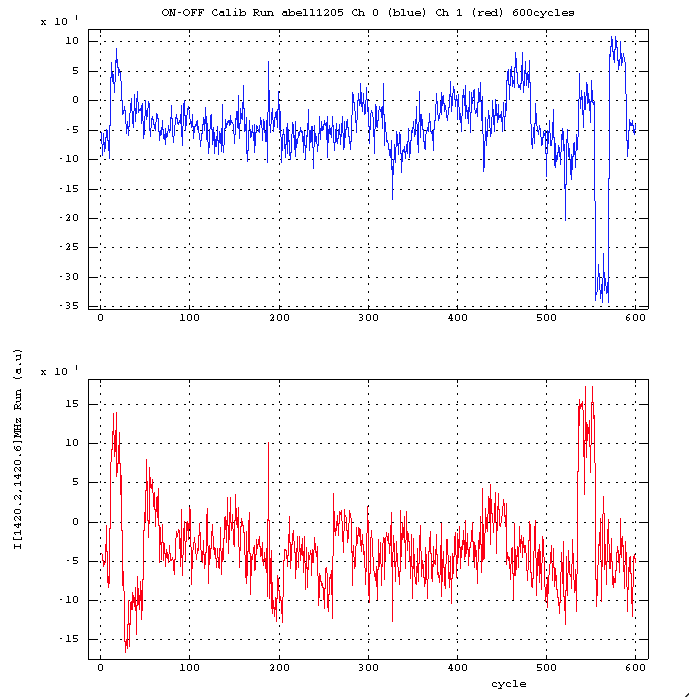
|  |
| --- |
| Figure 1 Example of normalized power time evolution cumulated over all cycles of a run (ex. Abell85 May 7th 2011). The t0=0sec corresponds to the start of the DAB in the SCA file (see Nançay/Abell85/21.11.11). |

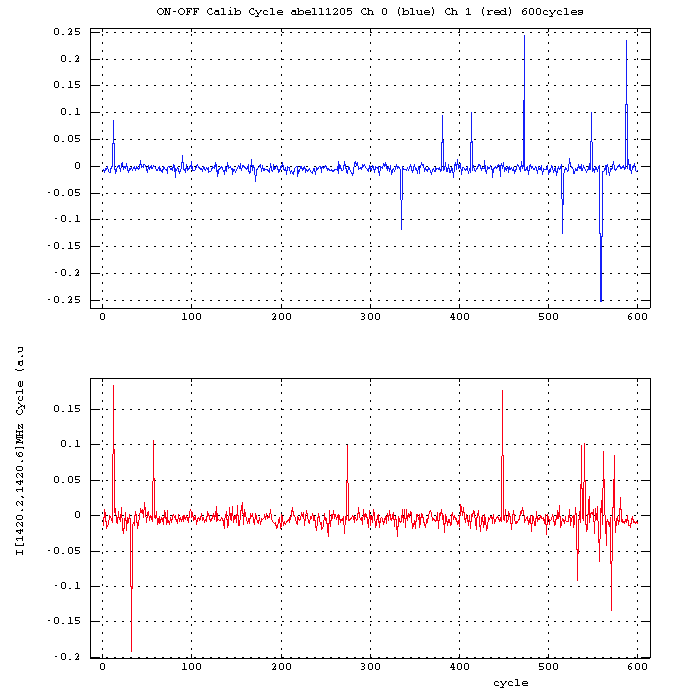
* Secondly, thanks to the normalization by the gain, one extracts the spectra of the time window [-3sec,-1sec] and [6sec,8sec]. The mean of these spectra is most probably the Tsys. Then, by setting a threshold at 20% of the min-max above the min power, the 2-levels pattern is recognized and the mean of the two median power of each level is computed. Finally, the difference between this mean power and the Tsys is nothing but the BAO coefficients (ie ) for both channels valid for the given cycle of the run (and kept in mind at the given frequency). The mean upon the cycles of a run is used as the unique coefficient valid for all the cycles of that run.

# Effect of calibration in signal data

We show the effect of calibration in the data, i.e. the ON-OFF which is approximately equal to the source signal…

This is clearly seen in the Abell 1205 data. We show the ON-OFF signal in the 21-cm line vs. data cycle in the following cases: non calibrated, and calibrated using calibration coefficients per run and calibrations coefficients per cycle. The calibration coefficients per run are the mean of the ones obtained in each cycle.





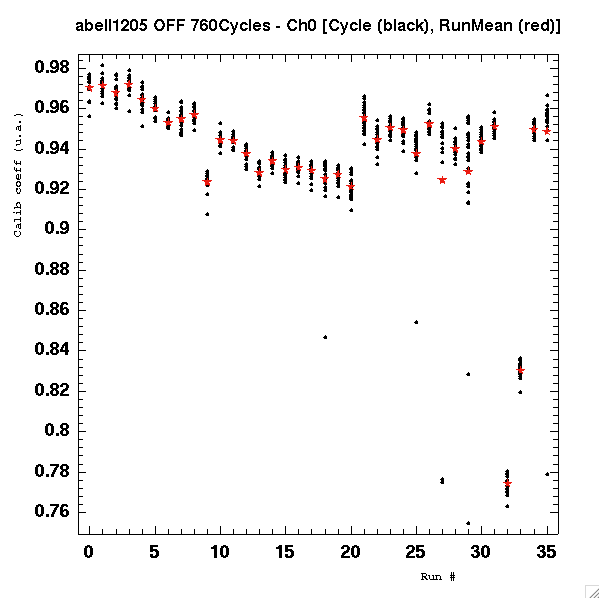
We see that the non-calibrated data are the most stable. The calibration coefficients per run are different from each other, which translates into a signal evolution showing a pattern which depends on runs. The calibration per cycle does not introduce any pattern in the signal, but in some cycles it yields a signal value quite different from the bulk. The cycles where this is seen are different in each channel.

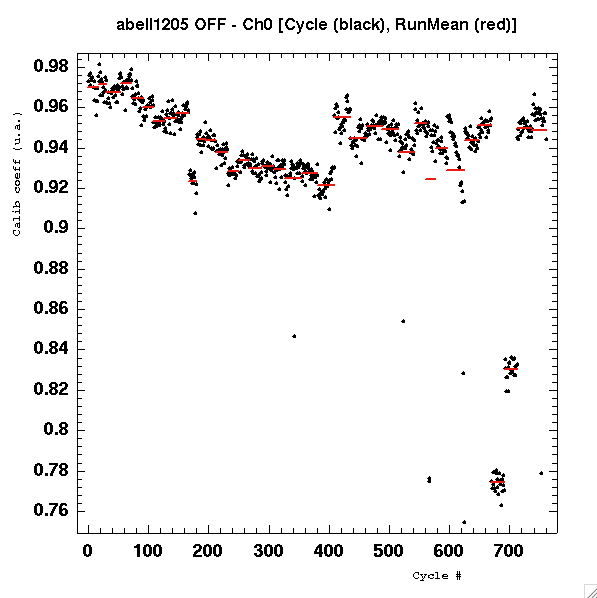
In the case of Abell 2440 we find:

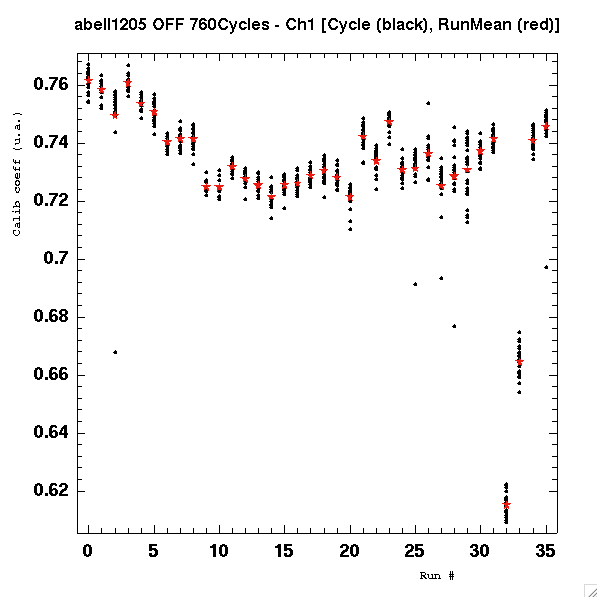
The results are similar to that obtained for Abell 1205. The non-calibrated data are the most stable. The calibration per run shows no clear dependence on the run but for the first (15th April 2011) and last (13th June 2011) runs. The calibration per cycle shows ‘bad’ cycles which are different in both channels.

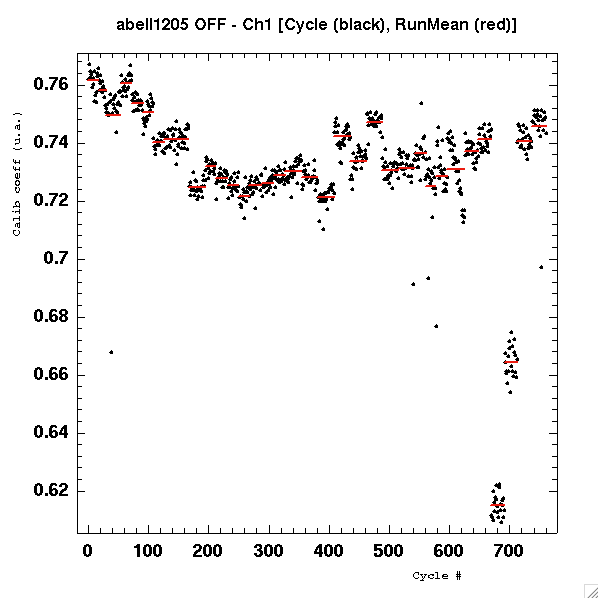
We could take two different approaches to solve the instability of the DAB calibration:

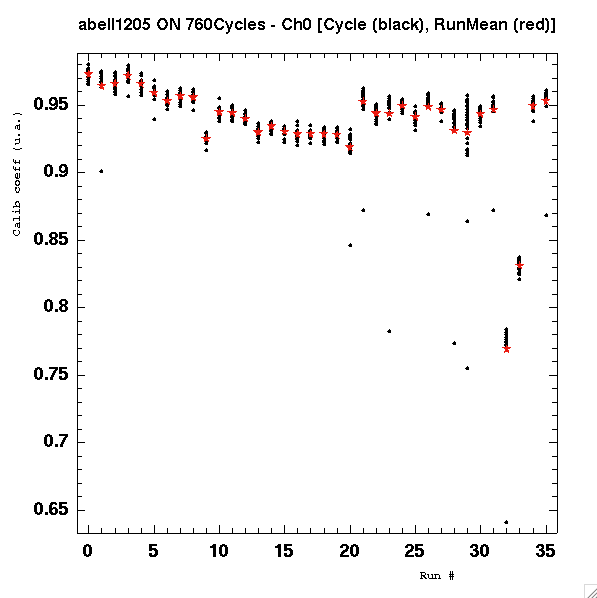
* Use one mean calibration coefficient per channel for the whole dataset. However, this would introduce a bigger error in the Jansky estimation (as it will include all the coefficient variations occurred during the whole observation period).
* Keep the calibration per cycle. In this case, one could just dismiss the ‘bad’ cycles from the analysis or set the coefficients in the ‘bad’ cycles equal to the mean of the adjacent cycles, which is a bit of ‘cooking’.

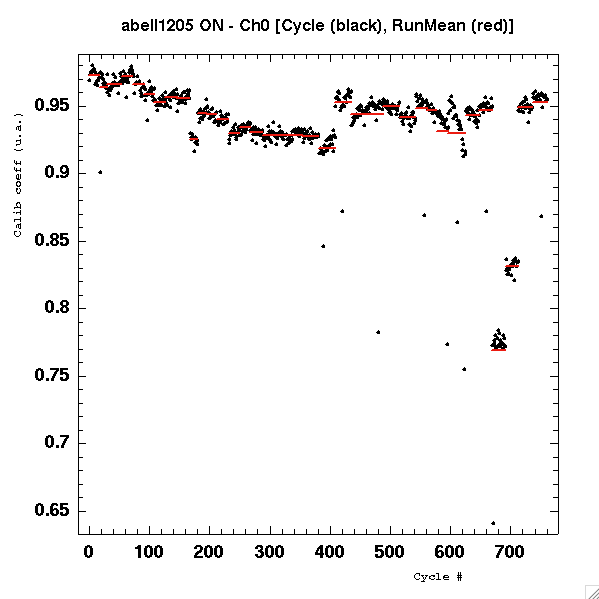


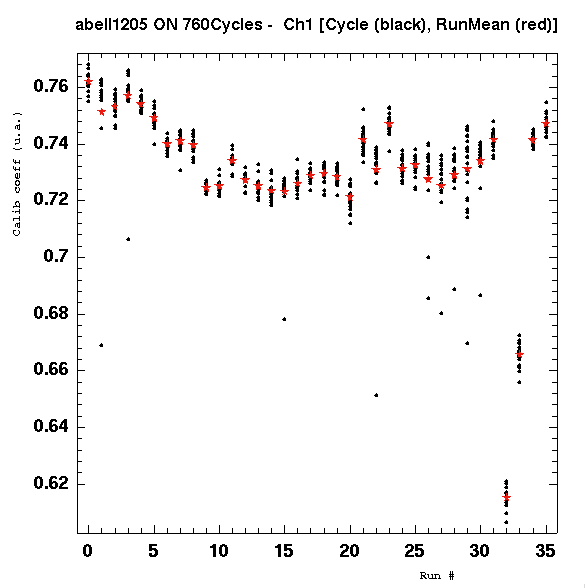


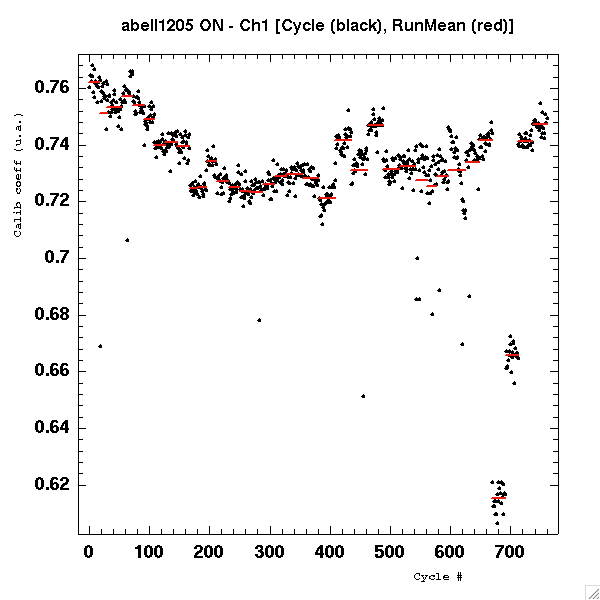








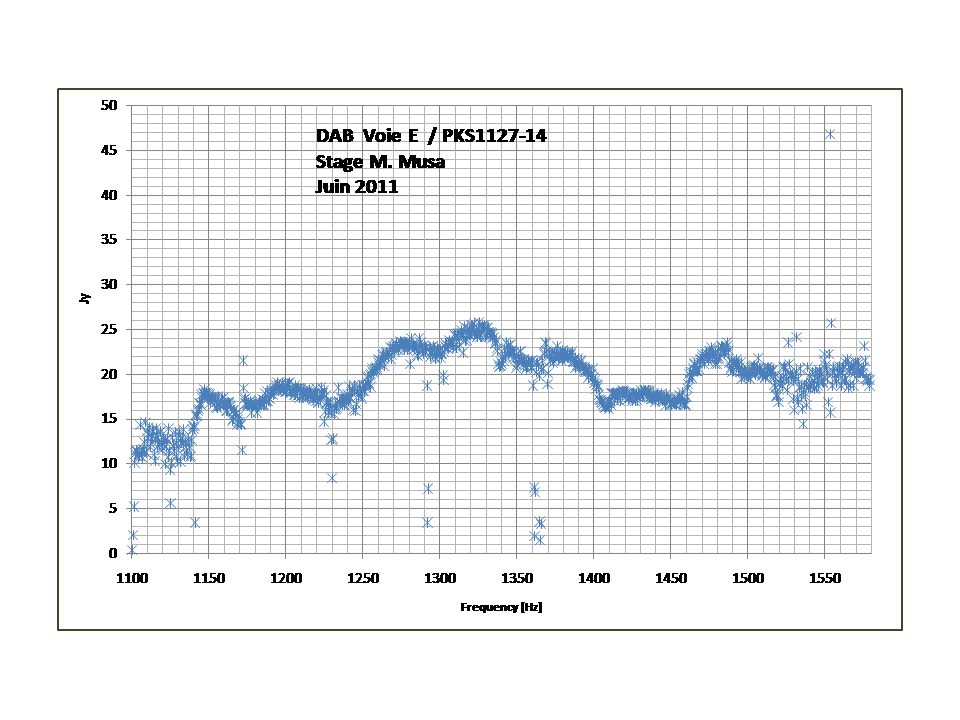




# DAB chromaticity

The DAB shows a chromatic response, which is independent of the electronic chain used to acquire the data.

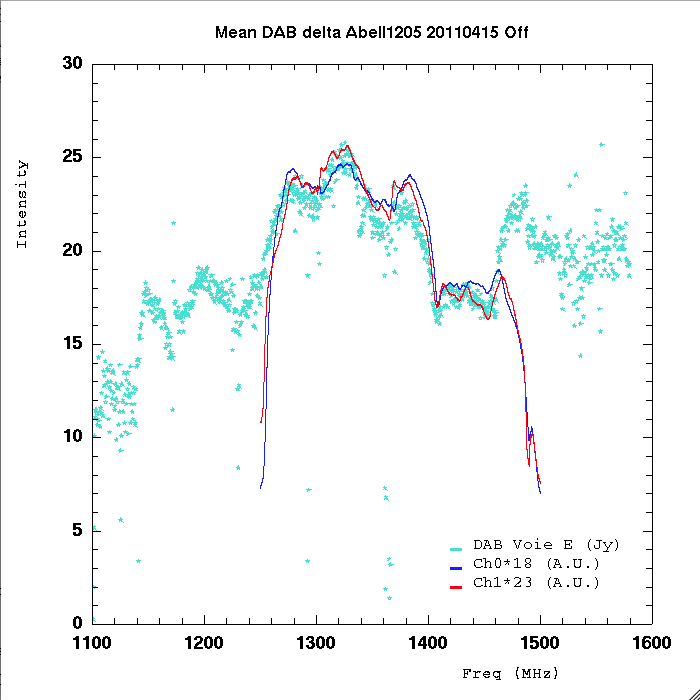
We show below the DAB spectrum obtained for the “Voie E” during the observation of the PKS1127-14 radio source, using WIBAR (ROACH card) in the frequency band [1100,1580] MHz. The resulting spectrum has been normalized by the system-passing band.



In the following plot we include the DAB spectrum obtained from the observations of Abell 1205 using the BAO electronics, for both channels Ch0 (blue) and Ch1 (red).

The curve for each channels is the mean of the two DAB steps. To superimpose these curves to the one in Janskys, we have multiplied arbitrarily Ch0 by a factor 18 and Ch1 by a factor 23.

The resemblance of the spectra is quite remarkable, given that in the first case the analogic signals are transmitted through cables to the ADC, whereas the BAO electronics makes the digitization in the chariot.



Calibration coefficients Abell 2440

