NIKA IRAM Open Pool 3: Update on opacity measurements

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1 Introduction

This note is to present a global investigation of all skydips taken during the NIKA IRAM OpenPool3 (Jan-Feb 2015). It brings an update to the total power measurements that can be done with NIKA in order to find the opacity of the sky with NIKA itself and then to be able to correct that opacity for flux measurements.

2 The method

The absolute KID frequency $f_{reso} = f_{tone} + df_{tone}$ is assumed to be proportional to the power load on the detector. Due to some software changes, the df_{tone} measurement could not be reliably determined during the Open Pool3. We have solved that issue here (See Fig 1).

3 Skydip results

In a second time, we have reanalyzed the skydips using the absolute frequency of the resonance as a function of the airmass for all valid samples (i.e. not only the plateaux but also the fast changes of elevation). Figure 2 shows an example of such an analysis on two detectors.

Figure 3 shows the opacity deduced on a kid-by-kid basis.

Figure 4 upper panels show the opacity at 1 mm and 2 mm in comparison with the IRAM taumeter opacity. We use the taumeter values to select valid skydips only. We do not use the taumeter in the rest of the study except for comparison purpose. The

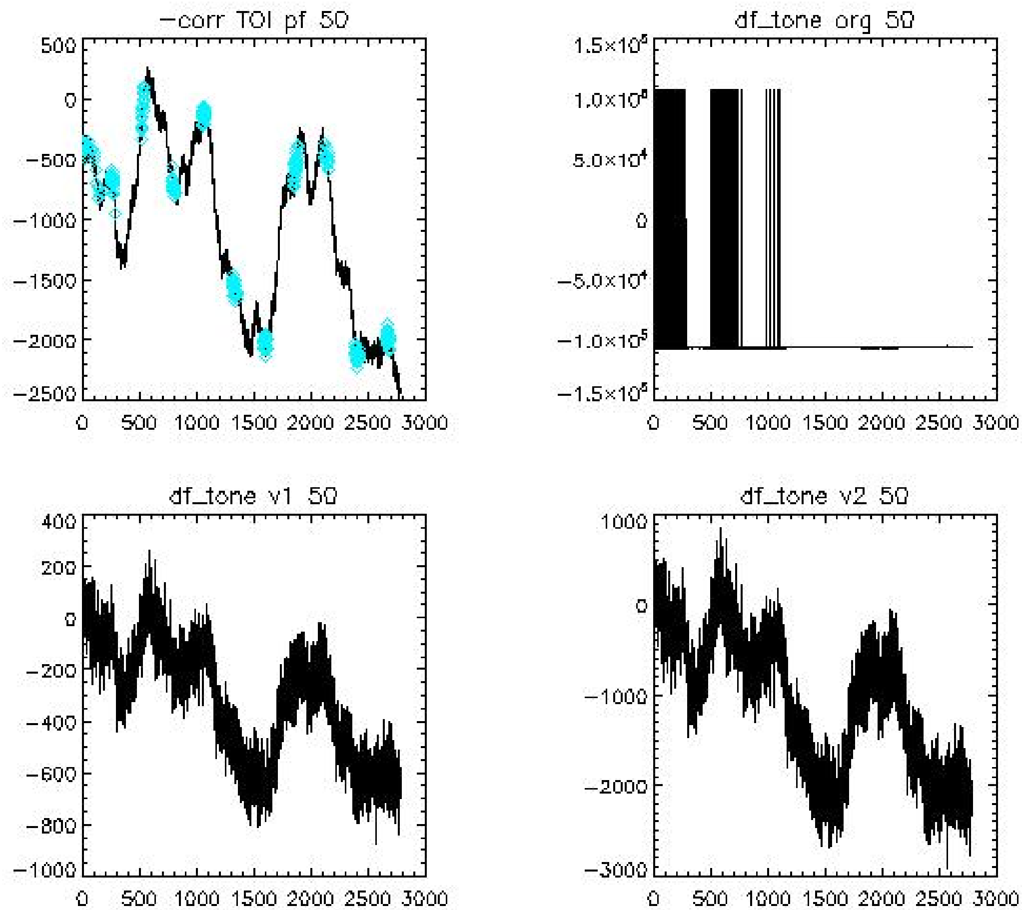

Figure 1: Comparison of the frequency signal (beyond the f_tone) for one detector and one scan. The upper right panel is the Pf method (with a minus sign; green values are not projected). The upper right panel shows the raw data (with an angle ambiguity). The lower left panel shows the v1 method for df_tone (the calibration is wrong because it uses resonance widths which are not appropriate to the scan). The lower right panel shows df_tone with a calibration deduced from Pf (v2 df_tone). Note that Pf is too large by a factor 1.43931 for the 1mm channel. This is corrected here.

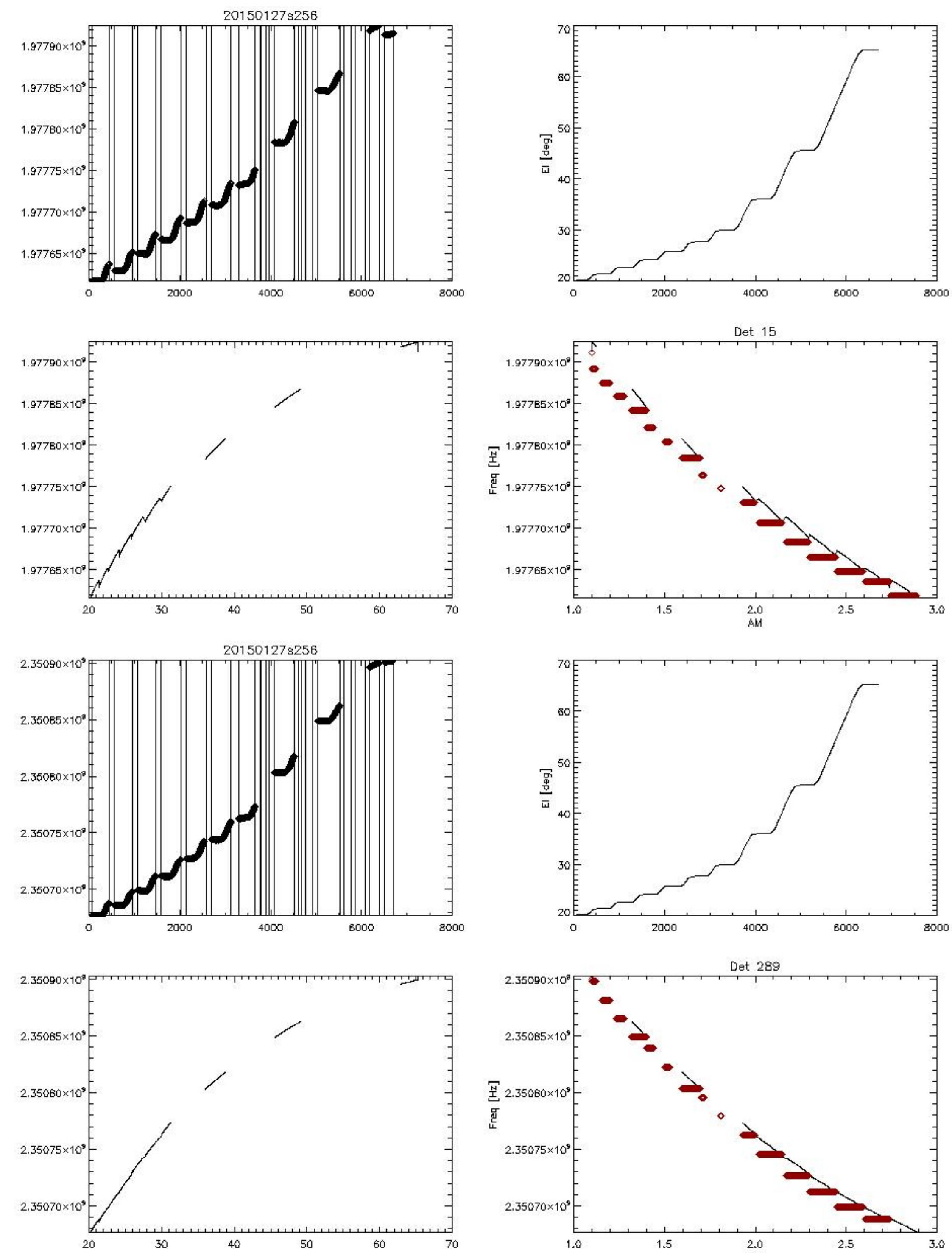

Figure 2: Skydip analysis for two detectors. For a given detector, the absolute frequency is shown as a function of the sample number (upper left panel) along with the flagging. On the right upper panel, the elevation is shown as a function of the sample number. On the lower left panel, the KID frequency is plotted as a function of elevation. On the right lower panel, the KID frequency (black line) and the tone frequency (red diamonds) is shown as a function of airmass. The non-linearity implies the opacity

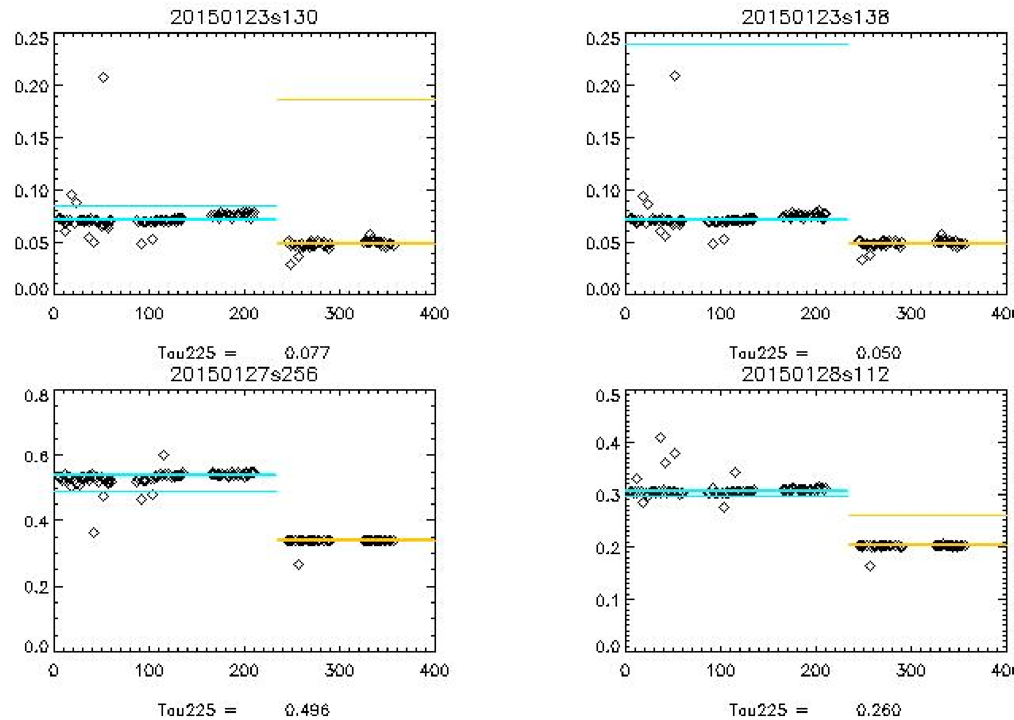

Figure 3: For 4 skydips, we show the zenith opacity deduced for each KID (diamonds). The IRAM taumeter opacity is given below each panel. The opacity is deduced by using always the same set of c_0 and c_1 coefficients for a given KID. The thick line is the median average of the opacity values per band. The thin line is the opacity obtained by solving for the skydip one scan at a time.

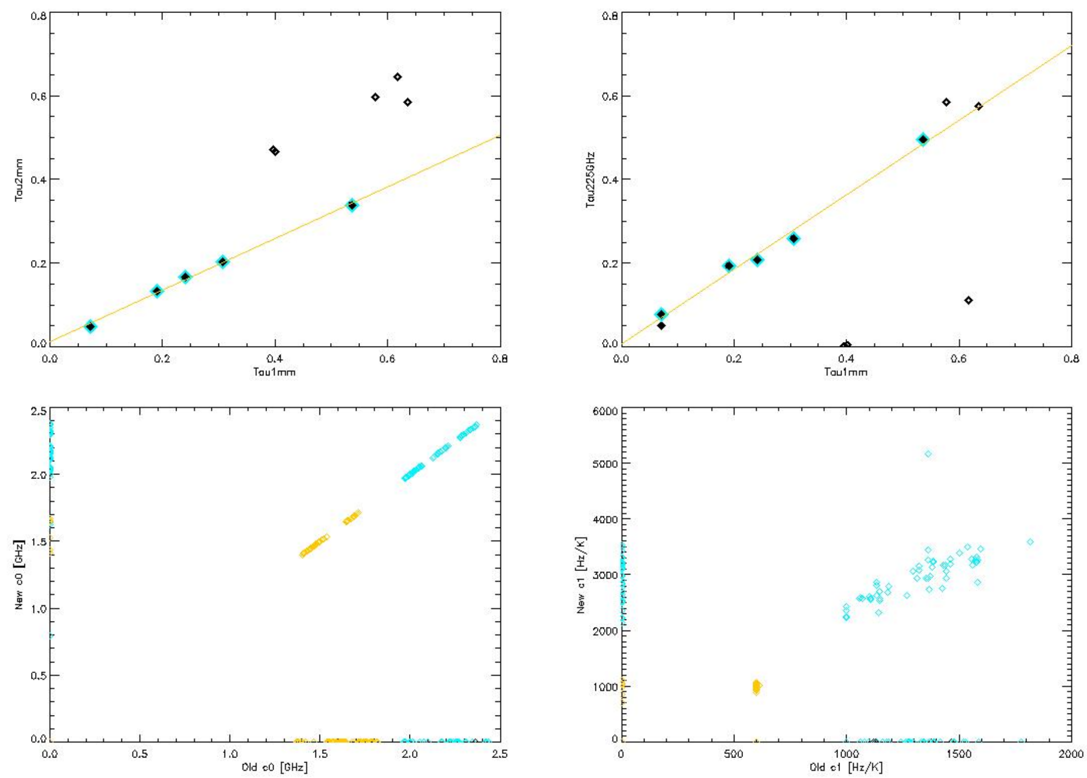

Figure 4: Upper panels show the obtained skydip opacity at 1 and 2 mm. The IRAM taumeter (right panel) value is used to select correct skydips (some of them are taken with the polarimeter on; they are not considered any more). The lower panel shows the comparison of the skydip coefficients for each kid. Note that the c_1 coefficient has been reevaluated upward by a factor of almost 2. The 2 mm channel shows a remarkably low dispersion. Some KID values are at zero if the fitting process did not work.

lower panels show how the skydip coefficients are changing in the new method. Let us recall that the absolute frequency of a KID changes with airmass as:

$$f_{KID} = c_0 - c_1 T_{atm}[1 - \exp(-\tau AM)],$$

where τ is the zenith opacity and $T_{atm} = 270\,\mathrm{K}$ is the fiducial sky temperature. c_0 is thus the KID frequency at zero opacity and c_1 is the frequency response per temperature unit (Hz/K) *i.e.* the forward beam efficiency.

4 The opacity during the pool

Figure 5 describes the opacity measurements obtained for all 1600 scans of either Lissajous, On-the-fly or Pointing mode.

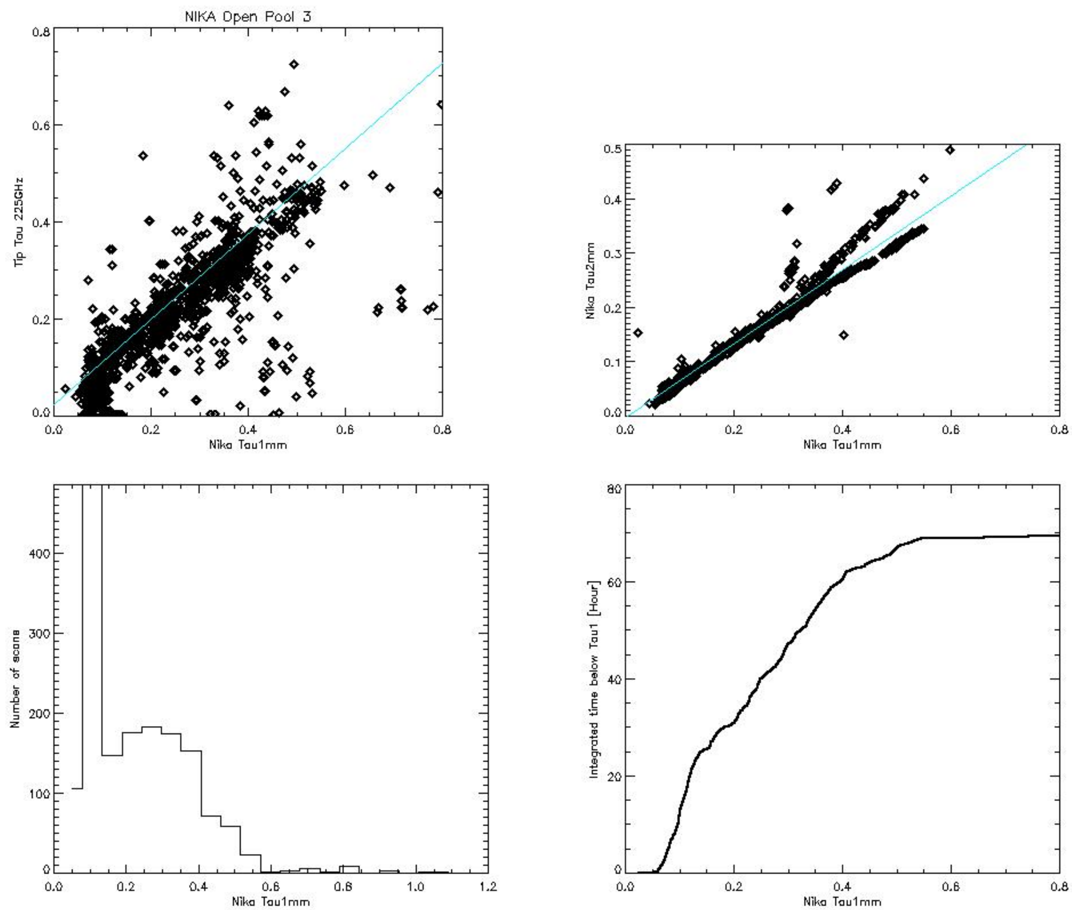

Figure 5: Upper panels show the comparison of the opacity obtained for almost all scans of the NIKA IRAM Open Pool3. The lower panels show some statistics describing the weather during the 3rd Open Pool.

The dispersion between the taumeter value and the 1 mm NIKA opacity is of 0.05 for most scans (0.24 if all scans are used) and the taumeter tends to underestimate the opacity at values below 0.1. The error in the opacity measurement with NIKA is below 0.01 because the dispersion between the two independent opacities at 1 and 2 mm is of 0.010. The upper branch of the 2 mm is unexplained at this moment.

5 Conclusion

The NIKA opacities look now robust for the whole campaign. The pipeline routines have been changed but not the rta skydip yet. We need to apply the same technique to polarization measurements and other pools.