# Performance and calibration of the NIKA camera at the IRAM 30m telescope

**Comments by Rémi ADAM**

**General comments:**

- Author list: I think N. Bondou is in fact N. Boudou. If not, his name is wrong in the SZ paper so please let me know.
- A few things that I noticed:
    - Units (italic or not)
    - Spaces between number and units
    - One should use KIDs Kids or kids but not all of them
    - I think we should be clear when refering to the bands: 1mm, 1.25mm or 240 GHz channels (idem for 2mm). I suggest to use either mm or GHz but not to change all the time. The figures should be in agreement with the text when quoting the NIKA channels.
    - Words in italic, such as skydip, should be in italic all the time.
    - Planet name (with or without upper case)
    - IRAM 30m telescope or 30m IRAM telescope? I don't know if it matters.
- I suggest to use detector instead of "pixel", that can be confused with pixel on maps.
- When I give precisions about the pipeline I am only talking about the "official pipeline", under your_SVN_path/Processing/Pipeline/

**Abstract:**

- "Cygnus A": I strongly suggest we remove this source from the paper. See the reasons in the concerned section.
- "NIKA can reconstruct angular scales up to three arcminutes": I agree but how is it quantified? It depends on the source and the acceptable RMS noise level of the map.
- "SZ ": I suggest Sunyaev-Zel'dovich instead of SZ

**1 Introduction:**

- "... at the 30m IRAM telescope...": I suggest to write what IRAM means
- "... development of NIKA2 , the full-blown instrument": beware of the space before the " ,"
- "... about 3 arcmin scale ...": same as abstract
- "... via the Sunyaev-Zel'dovich effect ...": write (SZ) after Zel'dovich since SZ is not defined and still used after that.
- "In a companion paper ... (Adam et al. 2013)": this sentence does not make sense to me. I think "where" should be removed.
- "These improvements ... calibration of NIKA": I think the sentence is too long. I suggest "These improvements ... Run6. We report ... calibration of NIKA"

**2 The NIKA instrument:**

- "... NIKA channels with signal to noise of a few per cent.": I guess what is meant is "signal to noise of a few hundred"
- " rather then 2.14 mm channel, sensitive also to the roto-vibrational emission": I think it is "rather than"?
- (proportional to \nu^2 ): define what is \nu maybe
- "... for a total of more than 300 pixels.": I suggest to replace this with "... for a total of 315 pixels."

**3 REU optimisation procedure”**

- “... starting from I(t) and Q(T) ...”: one should use lower case for T.
- “software at a rate of 22.842 Hz ...”: it is 23.842 Hz as stated above and not 22.842 Hz.
- “We use the name RFdIdQ to refer to this estimate ...”: in fact RFdIdQ is the sum of all Delta f_0 from t=0 to a given sample.
- “The new tuning method is simply based on ...”: I suggest removing the word simply.
- Figure 4: one should use the same theta and phi in both the figure and the text.

**4 Focal plane properties and main beam characterization**

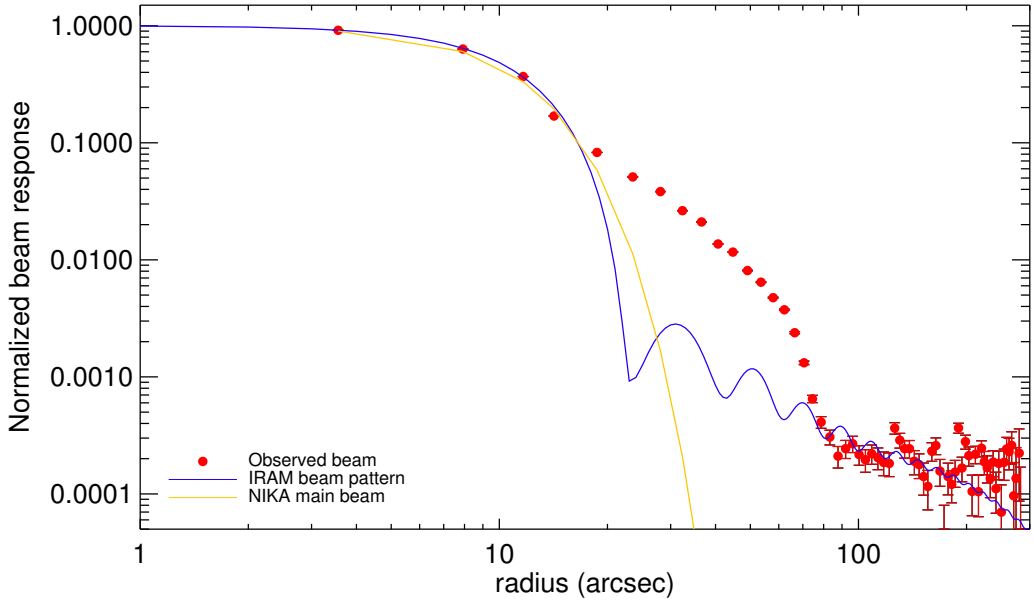
- “The calibration source ... is small compared to our beam and can be considered as a point source”: this needs to be quantify. For Uranus Run5: “we neglect the angular diameter of Uranus at the time of the observations, 3.54 arcsec, compared to the size of the main beam since the convolution of the corresponding disk with a gaussian with 12.5 and 18.5 arcsec FWHM broaden our beam by only 0.17 and 0.12 arcsec at 240 and 140 GHz, respectively.”
- “These timelines ... is fitted”: it seems to me that a word is missing at the end (e.g. on the source)
- “... signal with no filtering”: this needs to be quantify. One should say less than some number. My guess would be less than 1% at scales smaller than 2.5 x FWHM based on simulations.
- The difference between individual detector beams and the combined beam should be emphasized. The combined beam is larger than individual beams since we average over all shifts of detector position in the focal plane. The given numbers are for individual detectors and might not be what we want to quote for NIKA.

**5 Data reduction**

- Flags: we have other flags that might be quoted (saturated KIDs, KIDs for which the tone is not well placed, KIDs that are overlapping)
- Cosmic rays: one should mention that the data are not projected onto maps where a glitch is found.
- “... (essentially muons with a rate of the order of 2 events/ cm2/ minRamesh et al. (2012 ))” Mr Ramesh needs some space before his name.
- Decorrelation: dual-band. I suggest writing:
    1) Sunyaev-Zel’dovich dual-band decorrelation: the 140 GHz channel corresponds to the maximum decrement of the SZ effect while the 240 GHz band is close to the frequency where it cancels out (Birkinshaw, M. 1999, Phys. Rep., 310, 97 for a review on SZ effect). An atmospheric noise template can therefore be built using the 240 GHz (free of SZ signal) detectors and removed from the 140 GHz data by template fitting. This method allows recovering diffuse faint SZ signal (see Adam et al. (2013) for further details).”
- “So far the electronic noise is not dealt with.”: one should mention that it is at first order common to all detectors of a given array and is therefore mostly removed with the atmosphere for single channel decorrelation.
- “We optimally project and ...”: this needs clarification. We do not perform optimal mapmaking by accounting for detector noise left over correlations. The TOI are just weighted by the inverse of their variance measured outside the source.
- “Noise is also similarly propagated onto maps”: this sentence seems meaningless to me. It seems that the signal is separated from the noise and now we add back the noise in the map. I suggest to clarify what is meant or remove this sentence.

## 6 Photometric calibration

- "... requires a very accurate calibration ...": I suggest we remove the word "very" since it is not quantitative and depends on the scientific target.
- I suggest to give the overall calibration uncertainty for point sources only, because of filtering effect in the case of extended sources.
- "The flux of Uranus is deduced from Planck ...": this is not properly cited. One should cite Moreno 2010.
- "The deduced brightness temperature ...": it seems that we are measuring the brightness temperature with NIKA. I suggest we clarify this sentence.
- "We assume that ... 5%": we do not assume that but we trust Moreno and Planck who give this number.
- "Elevation dependant gain": comments below are based on Greve et al. 1998 (The gain-elevation correction of the IRAM 30-m telescope) but apparently there is an updated note on this. So please verify what I quote.
    - "According to the design ... elevation 50 degrees ...": Greve et al. 1998 (The gain-elevation correction of the IRAM 30-m telescope) should be cited here.
    - The gain is equal to 1 at 43 degrees and not 50 degrees, based on Greve et al.
    - The rms-value of the residual surface deformations is 55um at 0 degree, 65um at 90 degrees and 0um at 43 degrees), so 55um must be replaced by 65um.
    - The associated error should be quantified. According to Fig 1 in Greve et al., it can go up to 20% at 1mm and 10% at 2mm.
    - But it can be corrected easily, why don't we do it? In the pipeline we have a module which does it (Pipeline/Modules/nika_pipe_gain_cor.pro
    - The error on the correction is typically less than 2% at 2mm and 5% at 1mm.
- Secondary beam fraction: this paragraph is not clear.
    - Individual detector beam cannot be used to measure the secondary beam
    - The effect of atmospheric noise should be clarified.
- "Data reduction filtering:" where does the 5% comes from. It has never been estimated properly. Moreover it strongly depends on the source. If one wants to estimate this, we should use complete simulations.
- "6.1 Secondary beam fraction":
    - Here is what I suggest to write: "The secondary beam fraction needs to be estimated and accounted for in the case of extended sources. Observations of planets have shown that the overall beam volume, measured up to 100 arcsec, is larger then a pure Gaussian beam. Since larger angular scales are not well measured with NIKA itself, we extrapolate the NIKA beam using the IRAM 30-meter beam pattern (Greve et al. 1998) in order to estimate the secondary beam fraction at such scales. In Fig 8, we show profiles and maps of the beam emphasizing the contribution of the secondary beam for both NIKA channels. The results on the estimation of its contribution are presented in Table 1."
    - I should clearly redo the Fig 8 plots (we need to discuss it as well as what is written in the caption). Here is shown a better profile but only at 2mm (I do not have the IRAM beam pattern at 1mm).
    - Caption of Fig 8 :
        - I am not sure we should use the term far side lobe which might not correspond to what we have with NIKA.
        - " These maps are compatible with the the 2-dimensional...": the profile is clearly not compatible with the IRAM beam pattern so I do not think the map is compatible.




- “6.2 Atmospheric absorption correction”:
    - “F_0 is ... frequency tone excitation ... ”: it is not clear to me, I though F_0 was the resonance frequency of the KID and not necessarily the exiting tone.
    - Figure 9:
        - top: what are the blue and red lines. I suggest we explain what they are or remove them
        - middle: The plot is not clear (too messy), what are the black lines. Also use the same notation on the ytitle and in the text.
        - bottom: why does the xrange go up to 1 while it could stop at 0.5 only. I suggest to change the ytitle.
    - Figure 10: In the error bar, does it include the effect of changing atmospheric temperature? For how much does it account for the error?
    - “6.2.1 Consistency ...”:
        - does this really need a specific subsection?
        - The ATM model should be referenced here. Is it Pardo et al.?
        - Fig 11 bottom: it seems that the model is incompatible with the data for low opacity, and the data point themself seem incompatible between them. How is the error computed here. I suspect that the error is underestimated here. Maybe this needs to be discussed.
- Table 1:
    - The errors quoted for the gain versus elevation do not correspond to the Greve et al. paper (up to 20% at 1.25mm and 10% at 2mm).
    - I suggest we give errors on the secondary beam fraction and not being that precise.
    - We agreed to use a 2% error on the spectral response at 2mm in the SZ paper. Why is it now 1%? We should not quote different numbers. Moreover I guess this depends on the spectrum of the source. How is itcomputed
    - data reduction filtering: where does this number come from? It very strongly depends on the source and has never been measured properly. If it is not quantify properly it should be removed, and in order to quantify this properly we need to describe simulations in this paper.

- "The secondary beams fraction is estimated with a single gaussian fit": no, it is done by measuring the main beam volume (2 pi sigma^2) over the integral of the beam volume up to a considered angular radius (i.e. the quoted cuts).

**7 Noise equivalent flux density (NEFD)**

- "Here the FWHM ... TOI processing": how are this 10% measured? And why using 13" and 18" while the quoted beam is 12.3 and 18.1
- "to MAMBO-2Lestrade et al. (2009 )" space after "2"
- "... at the 30m telescope.": I suggest "... at the IRAM 30m telescope."
- Note that we found similar sensitivities with the "official pipeline".

**8 NIKA observations**

- "... reconstruct angular scales up to three arcmin": same as abstract, this clearly depends on the source and the scientific objectives. I suggest to clarify this sentence.
- 8.1 Millimeter SED:
    - "... NIKA observation are in very good agreement ...": I suggest removing very good. We do not even agree between us yet, we cannot be in very good agreement with others.
    - We give fluxes at 140 and 240 GHz but how are color correction taken into account, and with which spectrum?
    - MM18423:
        - I suggest showing only one measurement and not 3 that are incompatible between them (same thing for SXDF).
        - "The discrepancy ... at that time.": I suggest we remove this with the corresponding data point.
    - Table 2: I do not agree with the number in this table in general. I need however a new kidpar to recompute properly all the fluxes.
        - HAT084933: I suggest putting a lower limit at 2mm since we do not even have 2 sigma. With the "official pipeline" we have no detection at 2mm and a detection at 1mm.
        - PSS2322: we detect the source at 2mm with the "official pipeline".
        - 4C05.19: The quoted flux is the one obtain with the official pipeline. Why is it so while all the other are not? Moreover, the error has been multiply by 10 for some reason. Using new flags I have now 0.026293773 Jy +/- 0.00088445721 (stat.) at 2mm and <0.0061962954 (stat.) at 1 sigma for 1mm.
- 8.2 Extended sources:
    - "...angular scales up to 3": same as above
    - What is the smoothing applied. Is it accounted for in the given RMS, if not what is the resolution of the map. The rms is not constant over the map. How is the spectral index computed and at which resolution.
    - Cygnus A: the Cygnus A data are the worst NIKA data I have ever seen personally. If we apply the saturation flag, a maximum of 4 KIDs pass the test at 2mm and all the 1mm KIDs are flagged for quasi all scans. I have serious doubts concerning the quality of the maps, in particular at 1mm. I suggest we remove Cygnus A and why not replacing it with another source. For example NGC7538 is nice, extended and observed during the Run6 unlike the other extended sources shown here.
    - DR21OH is saturated (grey) at 2mm
    - Add the beam size on the spectral index map (keyword beam=beam_FWHM_arcsec in radec_bar_map.pro)
    - Figure 15:

- “Spectral index map are presented on the left column”: I suggest replacing left with right.

**9 Conclusion and perspectives**

- Table 4:
    - What do the quoted bandpasses correspond to (FWHM?).
    - The quoted beam is the beam per pixel, which is not exactly the overall beam. Do we really want to quote this number? In the SZ paper the quoted beams are 12.5 and 18.5.

**Acknowledgements:**

- Please add “R. A. would like to thank the ENIGMASS French LabEx for funding this work.”