Focal Plane Quicklook

N. Ponthieu

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1 Overview

I compare focal plane reconstructions from various observations during the Oct. 2011 run. Results are very stable accross the campaign. Although no complete optical model is derived, we show that the observed beam size variation accross the focal plane is likely to be due to the optics and not the detectors.

2 Focal plane reconstruction

The method we use is very similar to that presented in FP_quicklook_11212.pdf on this wiki. We use planet (Uranus and Mars) observations. We median filter the TOIs (8.46 seconds window) to suppress most of the atmospheric contamination and fit beam centroids for each individual detector. Maps are done in $(\alpha' = \alpha \cos \delta, \delta) = (\text{co-elevation}, \text{elevation})$ coordinates. We then fit the required translation (x_c, y_c) , rotation ϕ and magnification γ to go from the hard coded Nazmyth pixel indices (integers $0 \le x_{pix}, y_{pix} \le 12$) given by Camadia to these sky coordinates:

$$\begin{pmatrix} \alpha'\\ \delta \end{pmatrix} = \gamma \begin{pmatrix} \cos\phi & -\sin\phi\\ \sin\phi & \cos\phi \end{pmatrix} \begin{pmatrix} x-x_c\\ y-y_c \end{pmatrix}$$
(1)

By construction, ϕ should be close to $90 - \delta_{source}$. Figure 1 shows the reconstructed (x, y) for 4 observations at different times of the campaign. Figure 2 shows the reconstructed elliptical FWHM's.

3 Focal plane and beam distortion

Two main effects can be seen at this stage. First, as mentionned earlier in FP_quicklook_11212.pdf, the reconstructed pixel positions do not fall on the integer nodes of a regular square grid in Nazmyth coordinates. The focal plane appears to be squeezed on the edges. This distortion can be fit to very good approximation by a polynomial (Fig. 3). Second, the beams seem systematically larger around the focal plane center than on the edges. We suggest that this effect is not linked to the detectors themselves but is a consequence of the same optical distortion as mentionned above. Indeed, this distortion is continuous and should affect all incoming light rays and hence the reconstructed FWHMs. Beams would appear narrower but this would not mean that the angular resolution is better, only that the PSF gets squeezed.

To test this, we attribute a perfectly circular beam to each integer node occupied by a pixel and apply the polynomial distortion to it. This results in distorted beam around the reconstructed/fitted Nazmyth coordinates. We then fit these beams by an elliptical gaussian and compare its average FWHM to the average FWHM of the beam reconstructed from the data. The comparison is shown on Fig. 3 and shows a good correlation, especially at 1mm. Results are very consistants throughout the different observations.

This correlation suggest that the larger PSF's at the center of the focal plane have a common cause with the displacement of pixels positions on the sky and is not due to pixel characteristics.

References

[1] http://www.iram.es/IRAMES/mainWiki/OffProcNika3



Figure 1: Crosses represent the beam centroids reprojected to Nazmyth coordinates. Diamonds represent the rotation center (x_c, y_c) . Only pixels with a single beam image in all observations were kept for these analysis. The average standard deviations of positions in x and y are resp. 0.063 and 0.068.



Figure 2: Reconstructed beams for each observation. Only the main axis of the ellipse is represented for clarity.



Figure 3: *Top:* Reconstructed beam distortion on scan "Uranus 220". *Middle:* Fit of the reconstructed elliptical FWHM agains the measured elliptical FWHM on "Uranus 220". *Bottom:* Same fit on "Uranus 73". The correlation at 1mm is as good as on Uranus 220, that at 2mm is clearger.