

# Juice/SWI during the Lunar-Earth-Gravity-Assist (LEGA).

## IV. Antenna pointing and beam characterisation

**JAuthor(s):** Raphael Moreno et al.

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### Reply to the Referee

General Comments: The paper describes the observed properties of the beams of the two frequency bands of SWI onboard Juice. For this a point source and an extended source (earth) were repeatedly observed to construct 1D cuts and 2D maps. These allowed to derive half-power beamwidths, ellipticity, alignment, pointing and errors. Beam properties were compared with simulations of the far-field beam pattern. The paper is well written, to the point, concise, and represents an important contribution to the success of this mission. I still have a couple of largely minor points:

Table 1 gives a mean of CTS1 FWHM<sub>AT</sub> of 8.32+-0.07. How is this error of 0.07 derived ? What is it ? The standard deviation of the measured FWHMs is much larger, 0.78 ! This comment concerns all errors or 1sigma values given in the paper.

**RM :** In this work we compute weighted means and their uncertainties using the method of propagation of error, assuming normally distributed random values, following the standard formula for propagation of uncertainties :

$$\sigma_{\text{mean}} = \sqrt{\frac{1}{\sum_i \sigma_i^2}} (1)$$

the Caption of Table 1 has been updated accordingly.

Specific Comments:

+ Abstract: say that the calibration efficiency factor was obtained from simulations only.

**RM :** This is now updated in the abstract

+ Sec.2: CTS has 1GHz or 4.4GHz bandwidths ? The text is confusing.

**RM :** The CTS has 1 GHz bandwidth and the ACS has a 4.4 GHz bandwidth, as indicated by the "respectively" at the end of the sentence.

+ Sec.3.1: When discussing observations of a point source, which source was actually observed and what was its angular diameter ?

**RM :** we have updated now the sentence in the text indicating that we observed the Earth when it's angular diameter was 2.045'.

+ "...scans that cross the limb of the target" for targets that are much larger than the main beam.

**RM : updated now in the text**

+ Sec.4: Observations are done in DSB mode, i.e. both sidebands are observed simultaneously. When comparing the observations with the GRASP simulations, how were the two sidebands taken into account ?

**RM : to better describe this aspect, we have now added in the text that : "We compared the observations with the Grasp optical model calculated at the LO frequency corresponding to that of the measurements. It should be noted that the frequency difference between the LSB and USB bands causes a slight variation in the beam size, on the order of  $\pm 1\%$ . Nevertheless, we do not expect any significative change in the sidelobes spatial distributions."**

+ Sec.3.1.1: "samling  $\Delta = 2\text{arcmin}$ " Better give range of sampling, i.e.  $2'$  to  $6'$ .

**RM : replaced in the text now by : "a sampling range from  $2'$  to  $6''$ "**

+ "two pairs of observations" Scanning Back and forth ?

**RM : indeed, it is now replaced in the text by : "we have two pairs of observations scanning back and forth,"**

+ Figure 1: The CT scans show the temperatures to vary over the limb of earth. For 1107.45GHz, there even is a discontinuity. I suggest to add a sentence, describing in how are such effects were taken into account and how they may effect the overall accuracy of the beam properties.

**RM: Variations in the continuum of approximately 5 to 10% are observed, primarily in the inner part of the disk along the CT direction, which correspond mainly to spatial variations in latitude (see Figure 1 the CT images). These variations can also disrupt the transition edge at the limb used for pointing measurements. However, it should be noted that the FWHM measurement depends essentially on the derivative of the continuum at the limb, which is less sensitive to these continuum variations in the inner part of the disk. Nevertheless, in order to minimize sensitivity to these variations, we conducted numerous tests to determine the optimal width to consider for beam fitting at the limb. The best solution found was to consider a width of  $\pm 2$  half-beams around each limb. The text has been now updated accordingly.**

+ Figure 6: The extended main beam seems to be not exactly symmetrical, showing a broadening or "shoulder" at negative offsets, which is especially prominent at CT 1119GHz. This seems worth mentioning. In the future, 2D maps may help to study this feature in more detail.

**RM: you're right, it's worth pointing out the presence of this shoulder more clearly. A paragraph now mentions it in the text.**

+ "mb=3xFWHM" seems arbitrary. Maybe say that this corresponds roughly to the main beam down to the 1st null of the simulated diffraction pattern.

**RM :** Given the observed asymmetry of the calculated beam, it is obviously not easy to define exactly what the main beam represents. Nevertheless, I agree that it corresponds approximately to the main beam up to the first zero in the simulated diffraction pattern, which can ultimately be approximated quite well by a calculation up to 3xFWHM. A sentence regarding the diffraction limit has now been added to the text.

Technical Corrections:

+ slated -> scheduled/foreseen to arrive...

**RM : corrected**

+ Sec.2: Say that each band is observed in single polarisation

**RM : included now in the text**

+ Sec.3.1.2 "arrange the measured data by" -> plot as function of...

**RM :** We feel it is important to specify that we did indeed arrange the data based on the distance from the center of the target. However, we have now revised this sentence in the text as follows: "and arrange the measured data as function of the ..."

+ "fit them with a model" refer to section in which the model is presented.

**RM :** The section was mentioned at the beginning of the sentence. However, we have now added in the text a reference to the equation used by the model.

+ Figure 4: Explain the white circle in the centers.

**RM :** The white circles at the centers represent the beam sizes. This now added in the caption.

Thank you for your suggestions and constructive feedback.

Raphael Moreno