X-band flux of J1051-3138

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Abstract

The project *23A-255.sb44149262.eb44380172.60150.97359678241* showed issues on the flux of the phase calibrator J1051-3138. The data were taken in 3 bit mode at X-band. Here, we repeat the experiment using the 8 bit mode and an additional observation using 3 bit and 8 bit simultaneously aiming to obtain a flux of J1051-3138 close to the real value so the users could adapt and apply to their data.

Data acquisition

The test data were taken at X-band. We set two separate observing blocks, both using the 3C286 as primary calibrator (bandpass, flux) and the J1051-3138 as target and secondary calibrator (gain), Figure 1. Figure 2 shows the elevation of the sources as a function of time. J1051-3138 is at ~24 deg while the flux calibrator is at ~56 deg of elevation. Although the opacity at X-band at around ~2.5 secz is negligible, we do see an increase in Tsys (Figure 4) that we should consider for obtaining more accurate flux density.

Archive File	Project	Instrument	Observation Start	Observation Stop	File Size	Array Config	Bands	Type	Cals	Scans
6950_TEST_sb44451369_1_1.60187.80028185185	6950_TEST	EVLA	2023-08-31 19:12:25	2023-08-31 19:37:20	7.773 GB	A	C, X	visibility		8
6950_TEST_sb44451937_1_1.60187.78291940972	6950_TEST	EVLA	2023-08-31 18:47:24	2023-08-31 19:12:20	12.560 GB	A	C, X	visibility		8

Figure 1: *Observations IDs shown in the archive (data.nrao.edu). The first one corresponds to the data taken using the 8 bit samplers, while the second is the simultaneous 3 bit and 8 bit observation.*

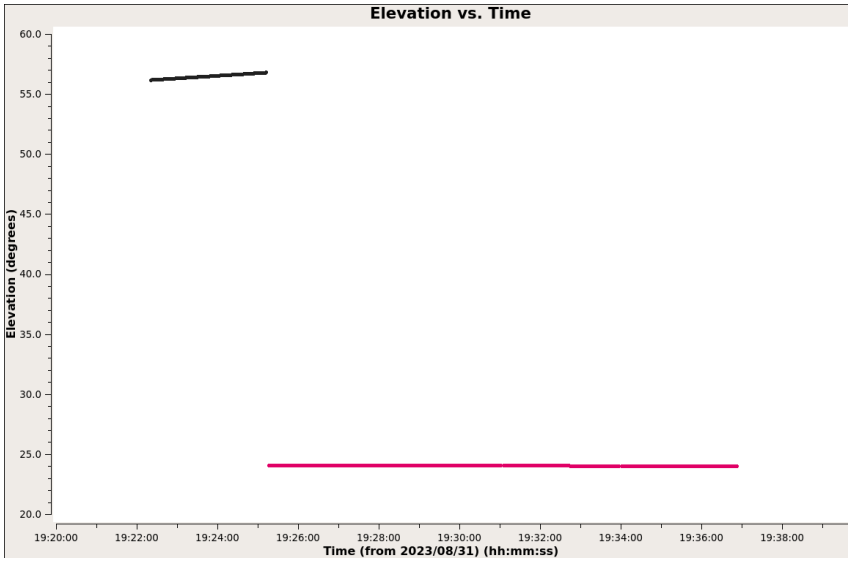

Figure 2: *Elevation as a function of time.In black is shown the 3C286 (primary calibrator) and in pink, J1051-3138 is shown.*

Results

Figure 3 shows the fluxes of J1051-3138 as a function of frequency. The 23A-255 project's data (3 bit) are shown in pink and brown. The pink represents the results of the CASA pipeline without applying any correction factor for the compression while the brown are the corrected values. The blue and the orange are the test observations taken with 8 bit samplers. The only difference between them is the calibration through the pipeline and without. The 3 bit mode data are shown in red and green while the simultaneous 8 bit data are shown in purple.
Table 1 lists the values obtained after fitting the fluxes.

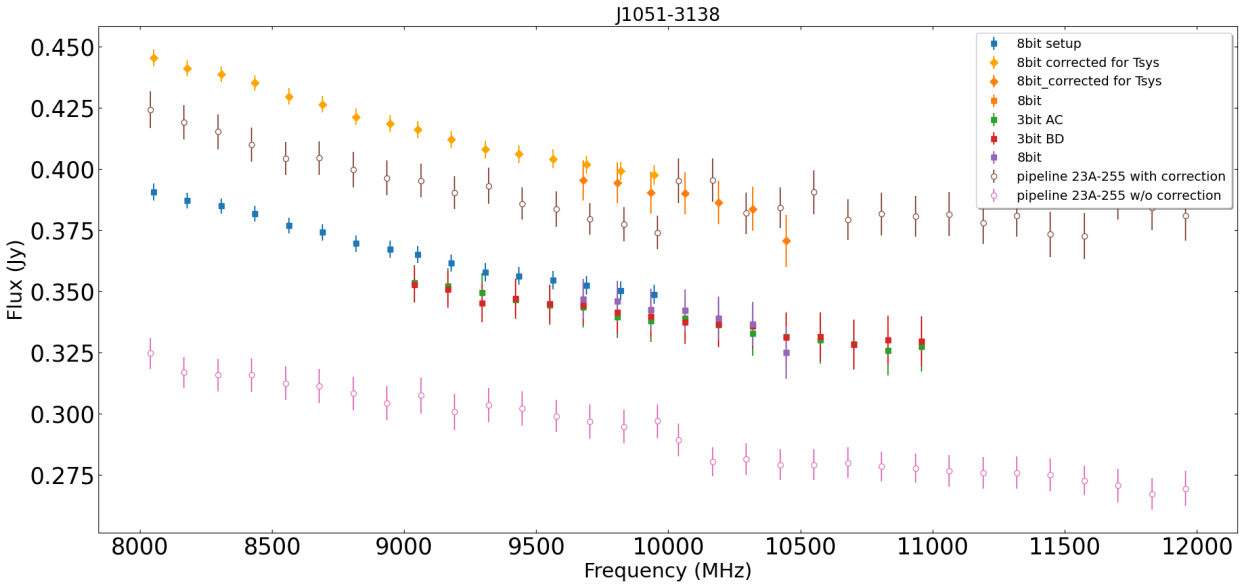

Figure 3: *Flux of J1051-3138 as a function of frequency. The 23A-255 project's data (3 bit) are shown in pink and brown. The pink represents the results of the CASA pipeline without applying any correction factor for the compression while the brown are the corrected values. The blue and the orange are the test observations taken with 8 bit samplers, but we have applied the correction for Tsys in the orange ones. The 3 bit mode data are shown in red and green while the simultaneous 8 bit data are shown in purple.*

J1051-3138 has a flux of 0.38+/-0.0003 Jy at 8.98 GHz central frequency as it is measured using the 8 bit samplers at X-band. However, we note that the above flux is not corrected taking into account the system temperature (Tsys). Figure 4 shows the Tsys variation during the course of the observation where the value of Tsys increases by a factor of ~15% during the observing scan of J1051-3138. This value should be considered in order to account for the Tsys changes and apply it in the calculations of the source flux. Similarly, the 3 bit tsys values during the 23-255 project observations are shown in Figure 5.

DATA set	Flux (Jy)	Flux error	Frequency (GHz)	Spectral index	Spectral index error
8 bit test	0.36	0.0003	8.98	-0.56	0.01
8 bit with Tsys correction	0.414	0.0003	8.98	-0.56	0.01
3 bit test	0.34	0.0004	9.98	-0.43	0.01
23A-255 with correction	0.38	0.0013	9.938	2.8	0.43

Table 1: *Table showing the resulting fluxes from the test observations and the 23A-255 project.*

Furthermore, Figures 6 and 7 showing the flux of the J1051-3138 as it has been monitored by VLBA and ATCA, accordingly. In 2018 with VLBA at short baselines, the source has a flux of ~0.4. The ATCA database shows the source flux evolution since 2017. The most recent observations (2023/01/18 resulted in a flux of 0.418+/-0.007 Jy and a spectral index of -0.561 at 9 GHz, which is in agreement to our 8 bit test results taking into account the correction for the Tsys changes (Table 1).

Using the task setjy() and filling manual the column model of the secondary calibrator (J1051-3138) might be a good solution. This can be done by using the manual mode of setjy() task force the flux at a certain frequency using the spectral index. ATCA calibrator database is also a very useful source.

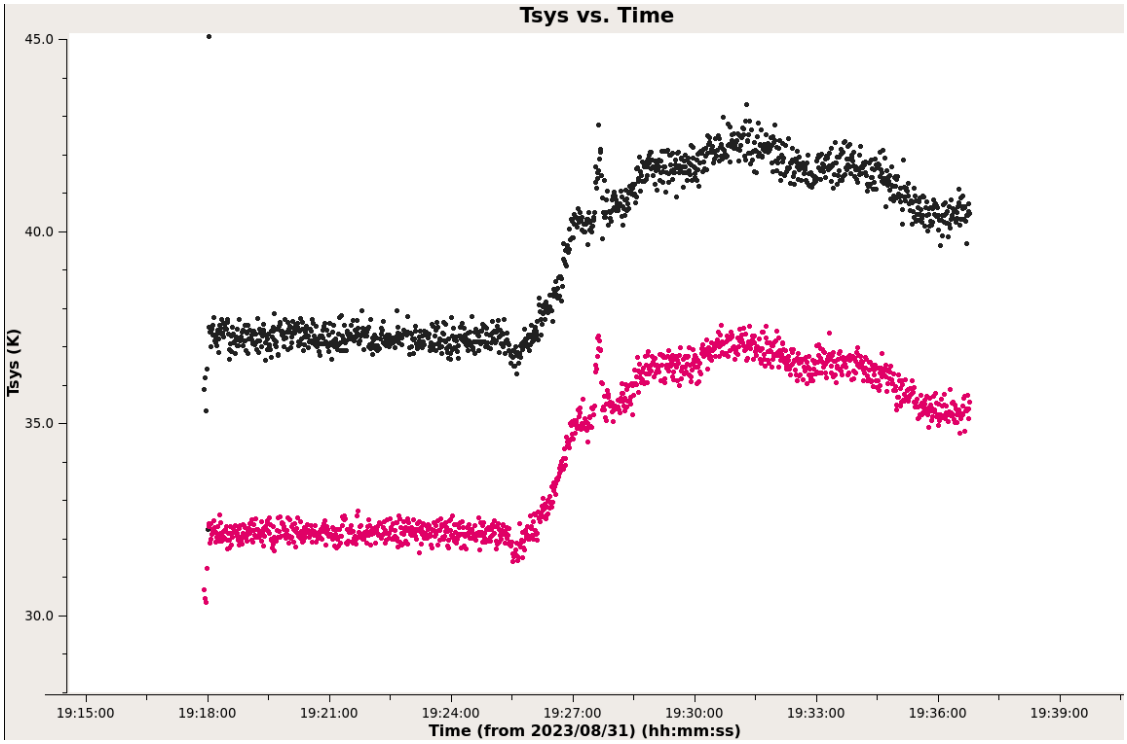

Figure 4: *A representative of tsys is seen here as a function of time for ea28 and SPW 5. The color is the two different polarizations (RR, LL). Starting with the 3C286 observations the Tsys increases by 15% (~5 Kelvin) as the J1051-3138 is at lower elevation.*

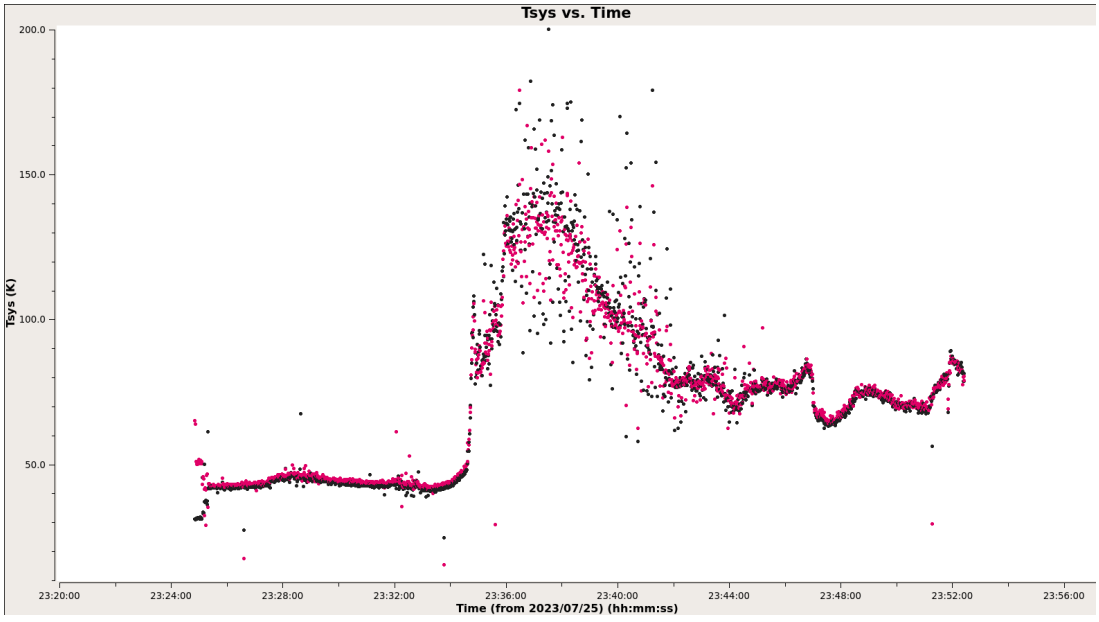

Figure 5: *A representative of tsys is seen here as a function of time for ea28 and SPW 5 for the 3 bit data of the 23A-255 project. The color is the two different polarizations (RR, LL). Starting with the 3C286 observations the Tsys increases by more than 100% as a function of time.*

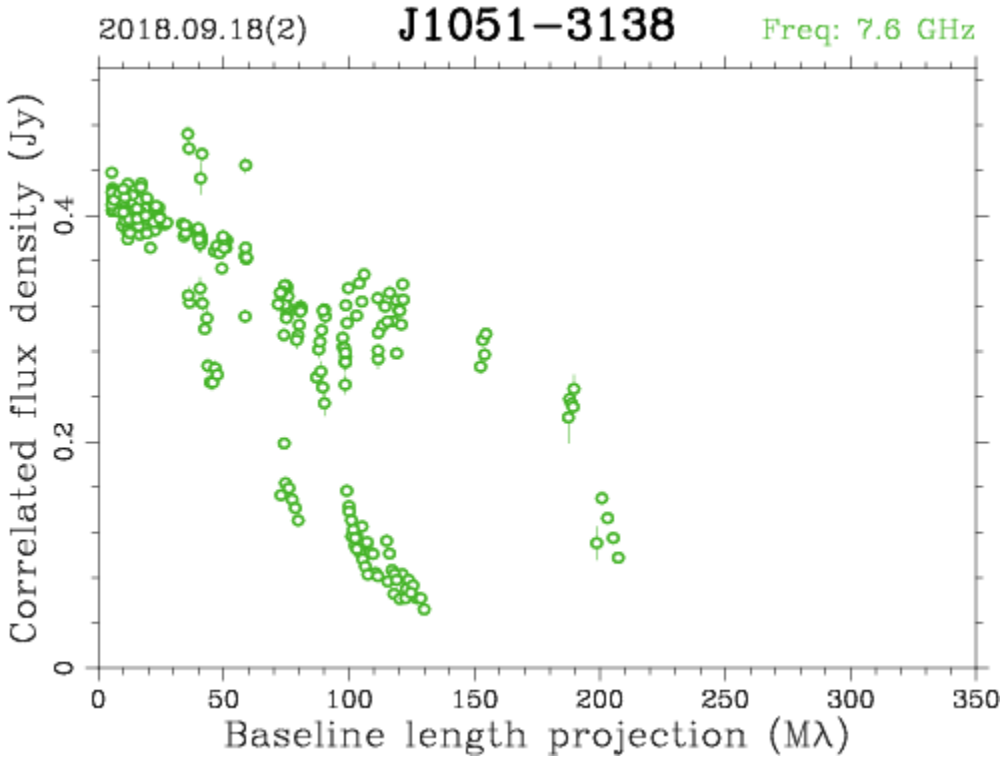

Figure 6. *VLBA calibrator database showing the flux of J1051-3138 on 2018: https://obs.vlba.nrao.edu/cst/calibsource/8196*

Figure 7: *ATCA calibrator database showing the flux of J1051-3138 since 2007: https://www.narrabri.atnf.csiro.au/calibrators/calibrator_database_viewcal?source=1048-31*