On the Stability of EVLA C Band Polarization

DRAFT W. D. Cotton, September 12, 2012

***Abstract*—The current EVLA C band feeds are know to have very poor polarization properties making the correction for instrumental polarization critical for polarimetry at this frequency band. Current calibration techniques assume that the instrumental polarization is stable over at least a given observing session. If the polarization is stable over timescales of weeks or longer, the need for a full calibration in each observing session is reduced. In this memo, the stability of the EVLA C band polarization is investigated using two similar, well calibrated observing sessions a week a part. The instrumental polarization spectra are determined for each antenna in each session and compared. The results vary from antenna to antenna but some portions of the spectrum may be consistent between the two measurements while other are not.**

***Index Terms*—interferometry, polarization, calibration**

I. Introduction

RADIO interferometric polarimetry requires the determination and removal of the spurious instrumental polarized response. Accurate determination and removal of this spurious response depends on the stability of the effect to be removed. In principle, even large but stable instrumental polarizations can be corrected. This memo compares the fitted instrumental polarization terms using the EVLA C band (6-8 GHz) system in two sessions seven days apart.

II. Instrumental Polarization

Phase sensitive detectors such as used in heterodyne receivers like those in the EVLA are sensitive only to a single polarization state. In order to measure the full polarization state of the incoming waves, two detectors measuring orthogonal polarizations are needed. In an interferometer, all four cross correlations of the two pairs of detectors are made. These correlations can then be transformed into those for the Stokes parameters for imaging. In practice, the polarization state measured by the detectors (AKA “feeds”) is not precisely the desired state. This imperfection, if uncorrected, will lead to a spurious polarized response which is termed “instrumental polarization”.

The response of the feeds can be described in a number of ways but in the following, it is assumes that each detector can be described as elliptically polarized and is described by the orientation and ellipticity of the ellipse. Correction of instrumental polarization for the EVLA is discussed in detail in [1].

III. Comparison of C Band Calibrations

In the following, the data from two EVLA sessions were considered. The sessions were on 3 Sept. 2011 and 10 Sept. 2011 and included the same calibrators and targets and used a similar calibration cadence. These sessions were very well calibrated. The first of these sessions is described in more detail as the second example in [1].

The calibrators for these data sets are J1331+3030 (3C286), J1504+1029 and J1651+0129. In order to obtain the most similar and accurate calibration possible, the datasets were calibrated in an identical mannar (described in [1]), using the same self calibrated calibrator models. The instrumental polarization parameters were determined using Obit[2] task PCal using a fixed polarization model for each calibrator and used the more accurate Levenberg-Marquardt least squares technique. Solutions used blocks of 5 channels each (10 MHz). Comparisons for selected antennas are given in Figures 1 – 7. IFs 1 and 9 (the low frequency ends of the EVLA 1 GHz subbands) were largely flagged in the calibration process and are not shown in the spectral plots. Ellipticities of +45° and -45° represent perfect right and left circular polarizations respectively and the orientations become unconstrained. Least squares errors are generally smaller than the corresponding symbols and are not plotted.

IV. Discussion

Figures 1 – 7 show that the EVLA instrumental polarization in the frequency range observed is not particularly stable in either time or frequency. Variability is not easily characterized; for some antennas, some frequency ranges had repeatable ellipticities or orientations while other did not. Temporal variability may be the limiting factor for the calibration seen in [1].

References

[1] W. D. Cotton, “On–axis Instrumental Polarization Calibration for Circular Feeds,” *Obit Development Memo Series*, vol. 30, pp. 1–13, 2012.
[2] W. D. Cotton, “Obit: A Development Environment for Astronomical Algorithms,” *PASP*, vol. 120, pp. 439–448, 2008.

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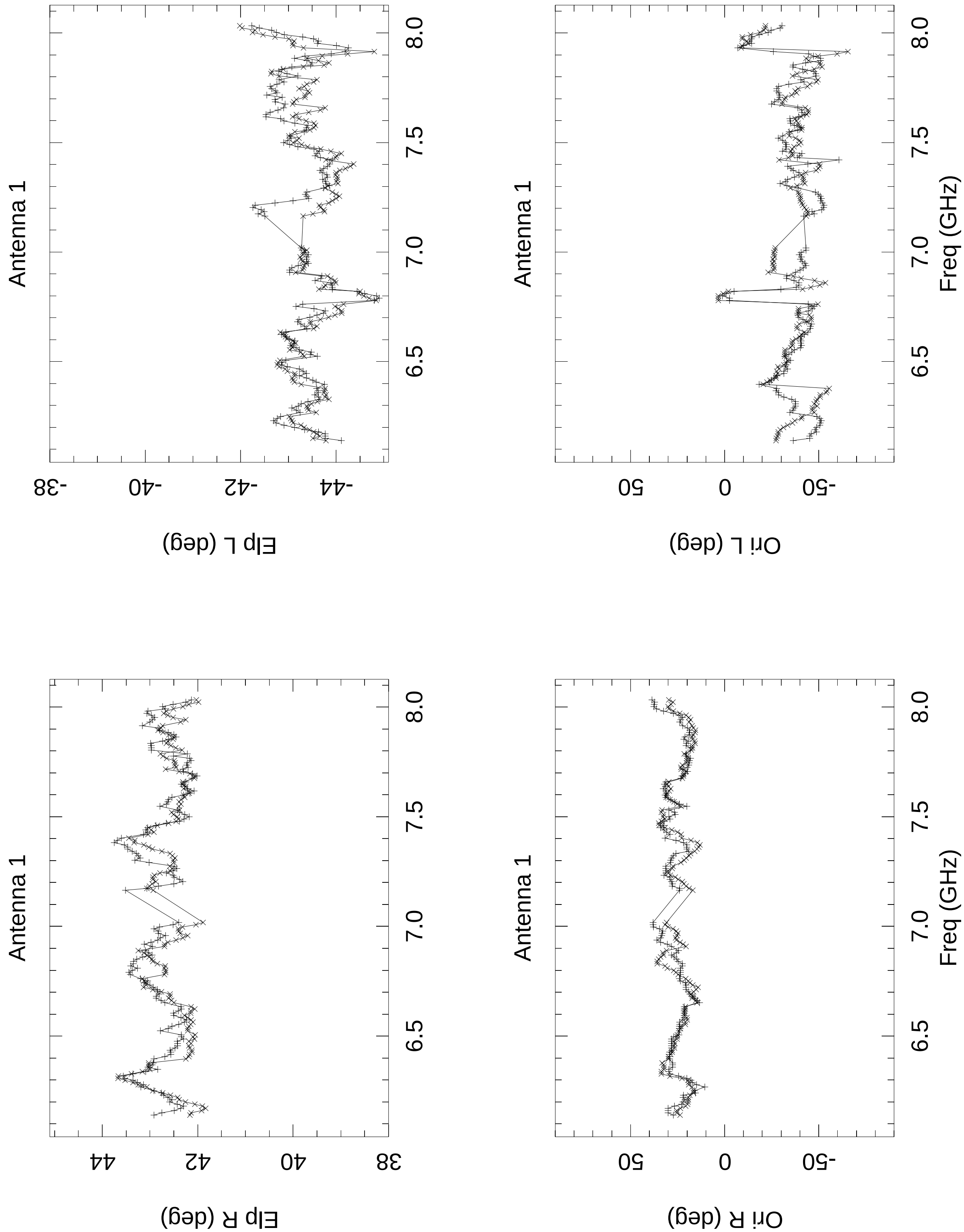

Fig. 1. Comparison of the polarization spectra for Antenna 1. Ellipticities (deg) are show above and orientations (deg) are shown below; right circular is on the left and left on the right. Pluses ("+") indicate data from 3 Sept 2011 and xes ("x") from 10 Sept 2011.

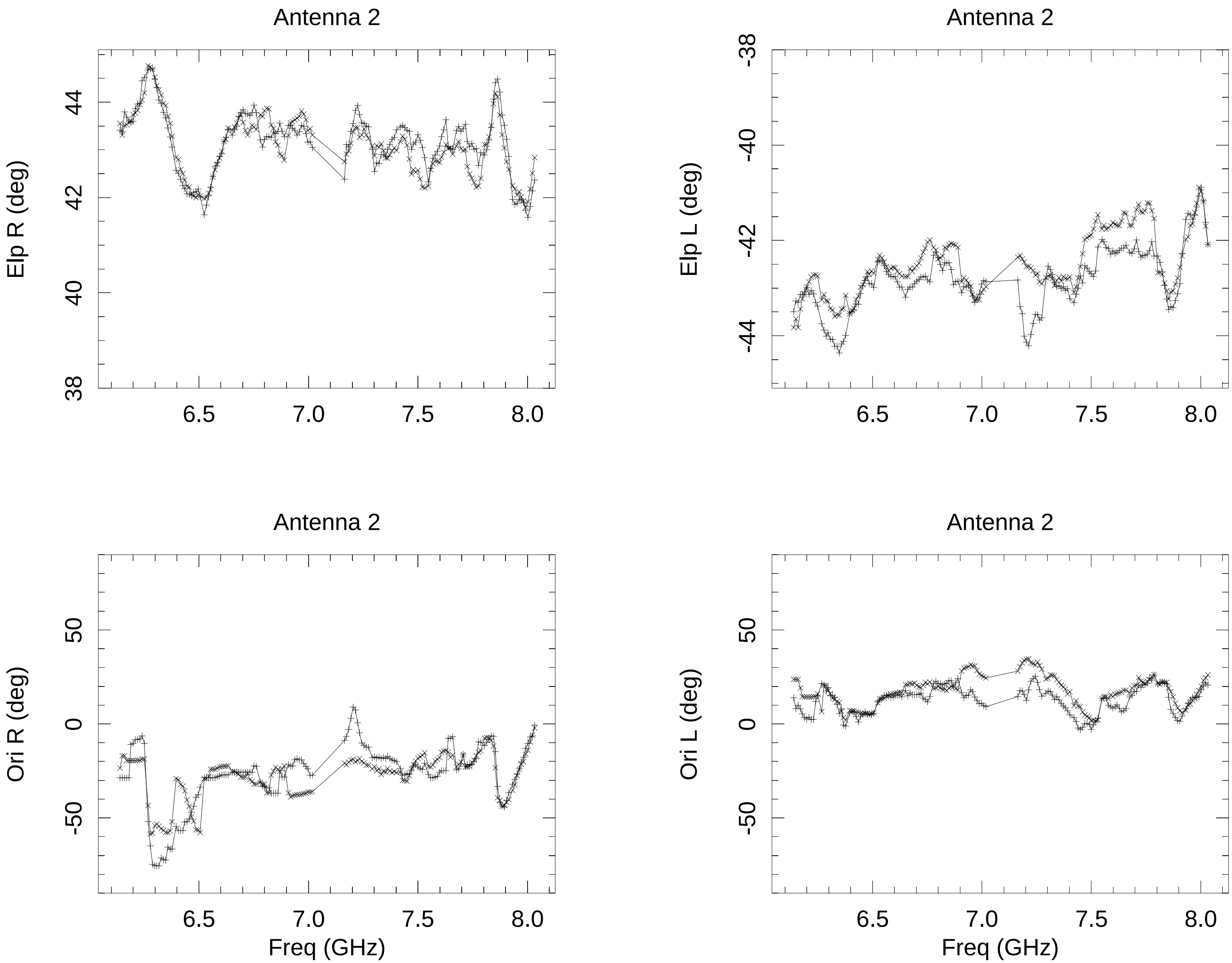

Fig. 2. Like Figure 1 but for antenna 2.

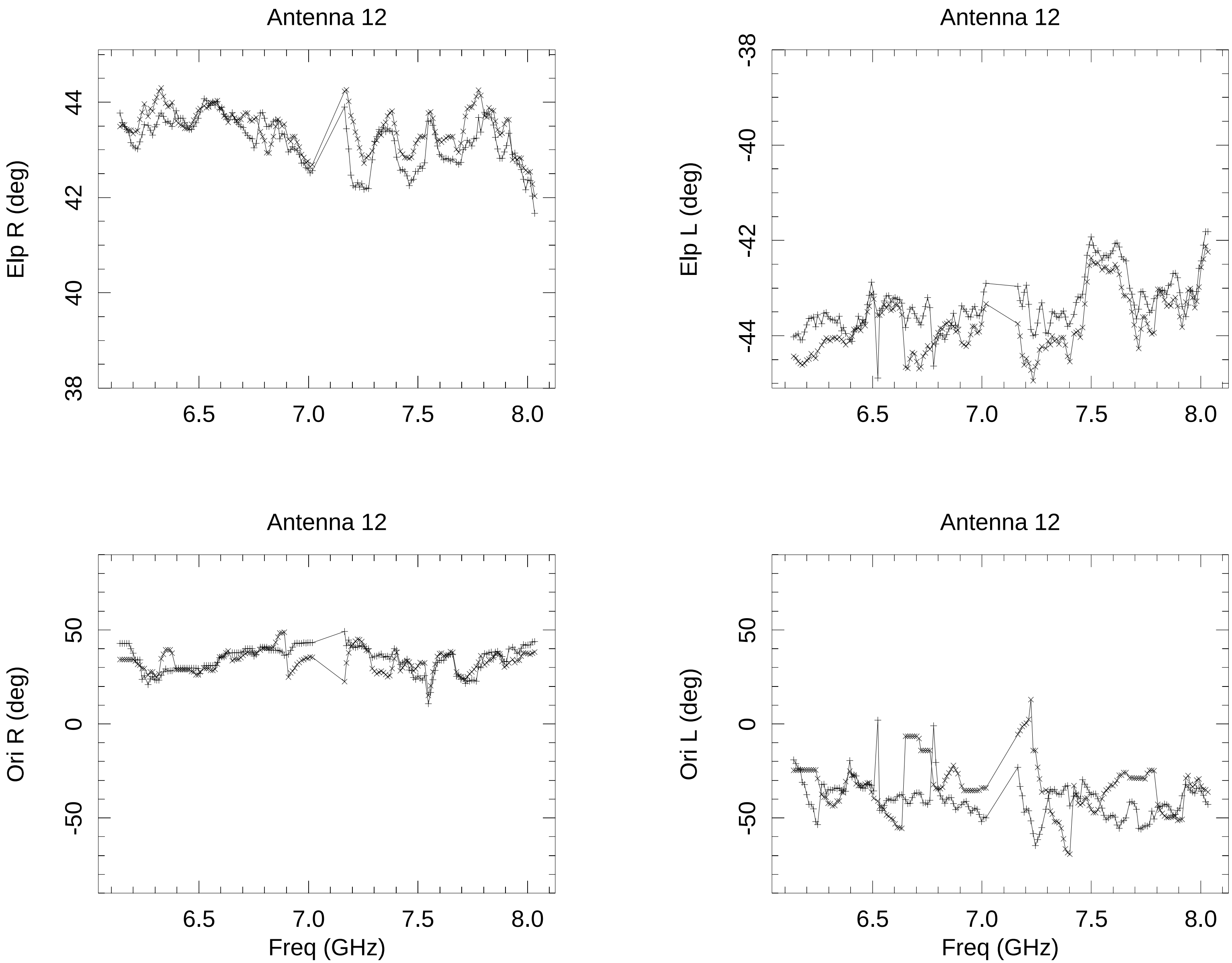

Fig. 3. Like Figure 1 but for antenna 12.

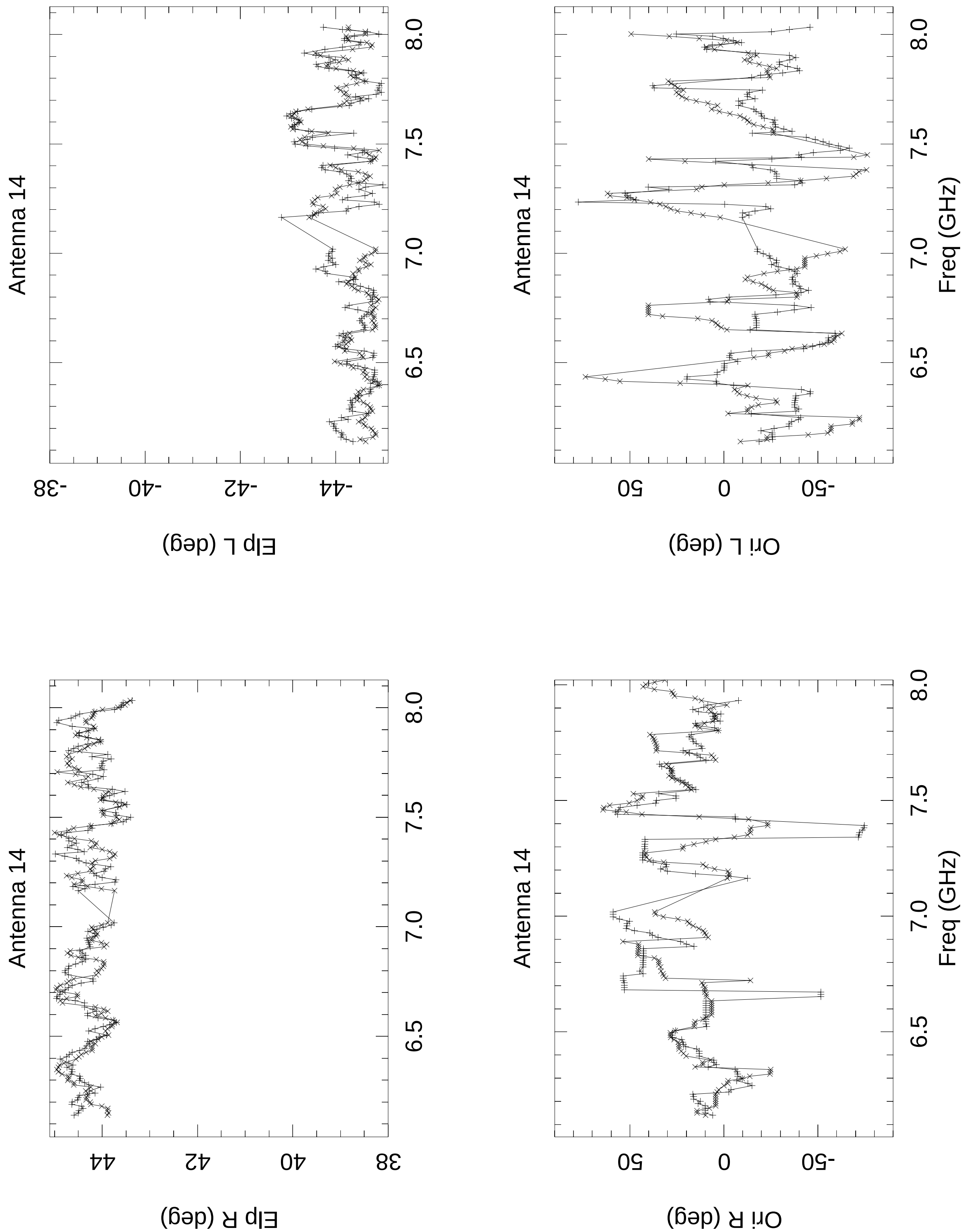

Fig. 4. Like Figure 1 but for antenna 14.

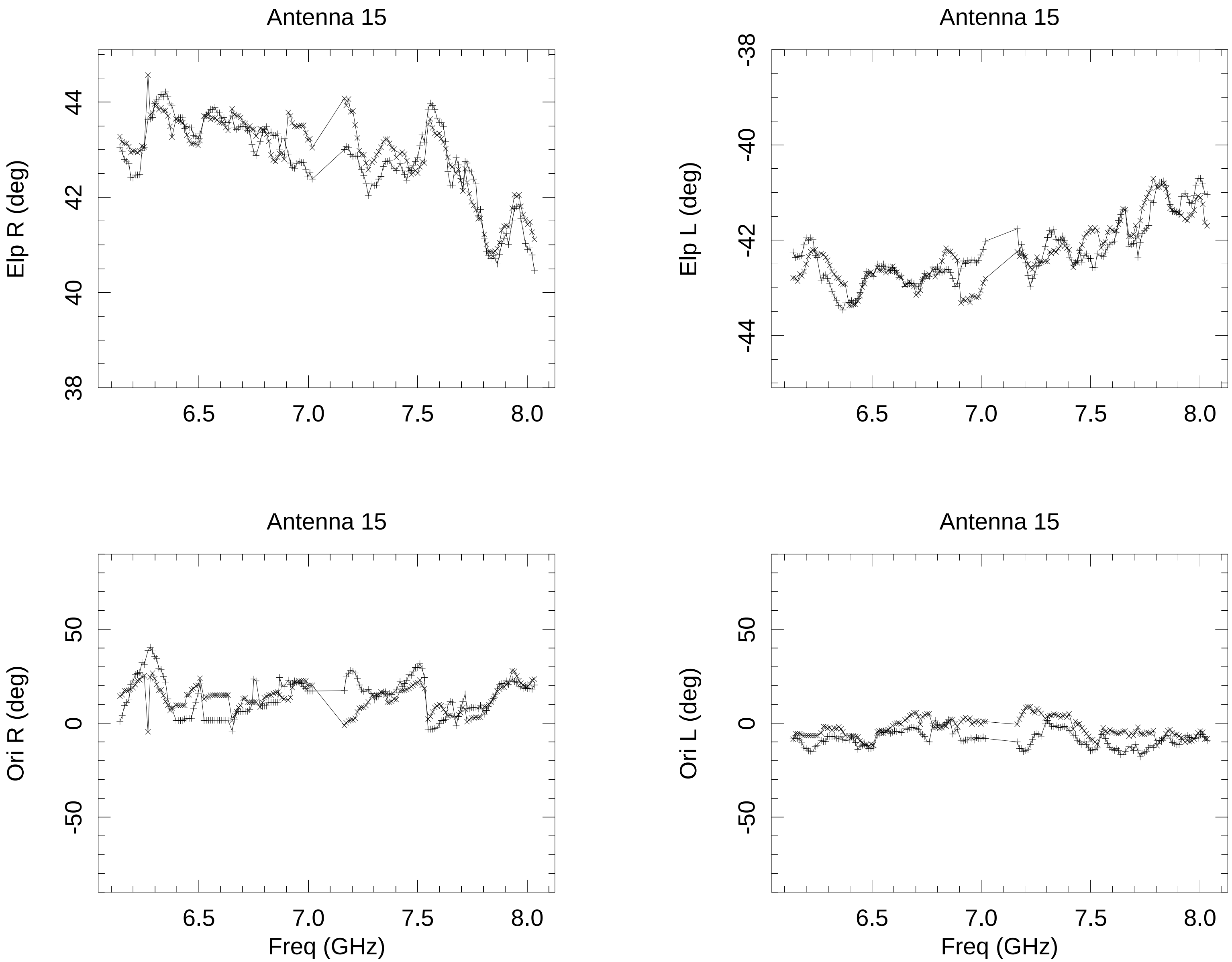

Fig. 5. Like Figure 1 but for antenna 15.

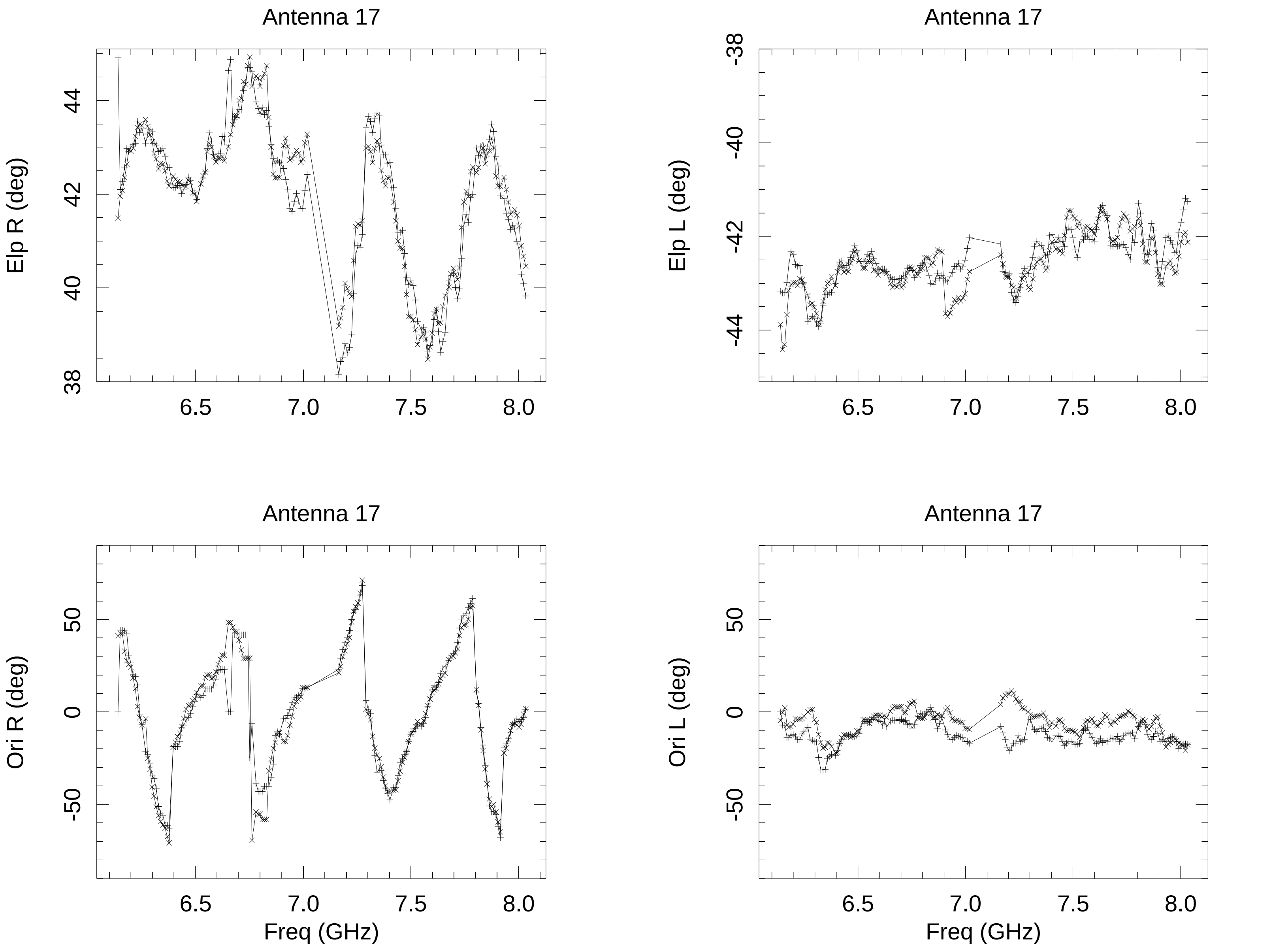

Fig. 6. Like Figure 1 but for antenna 17.

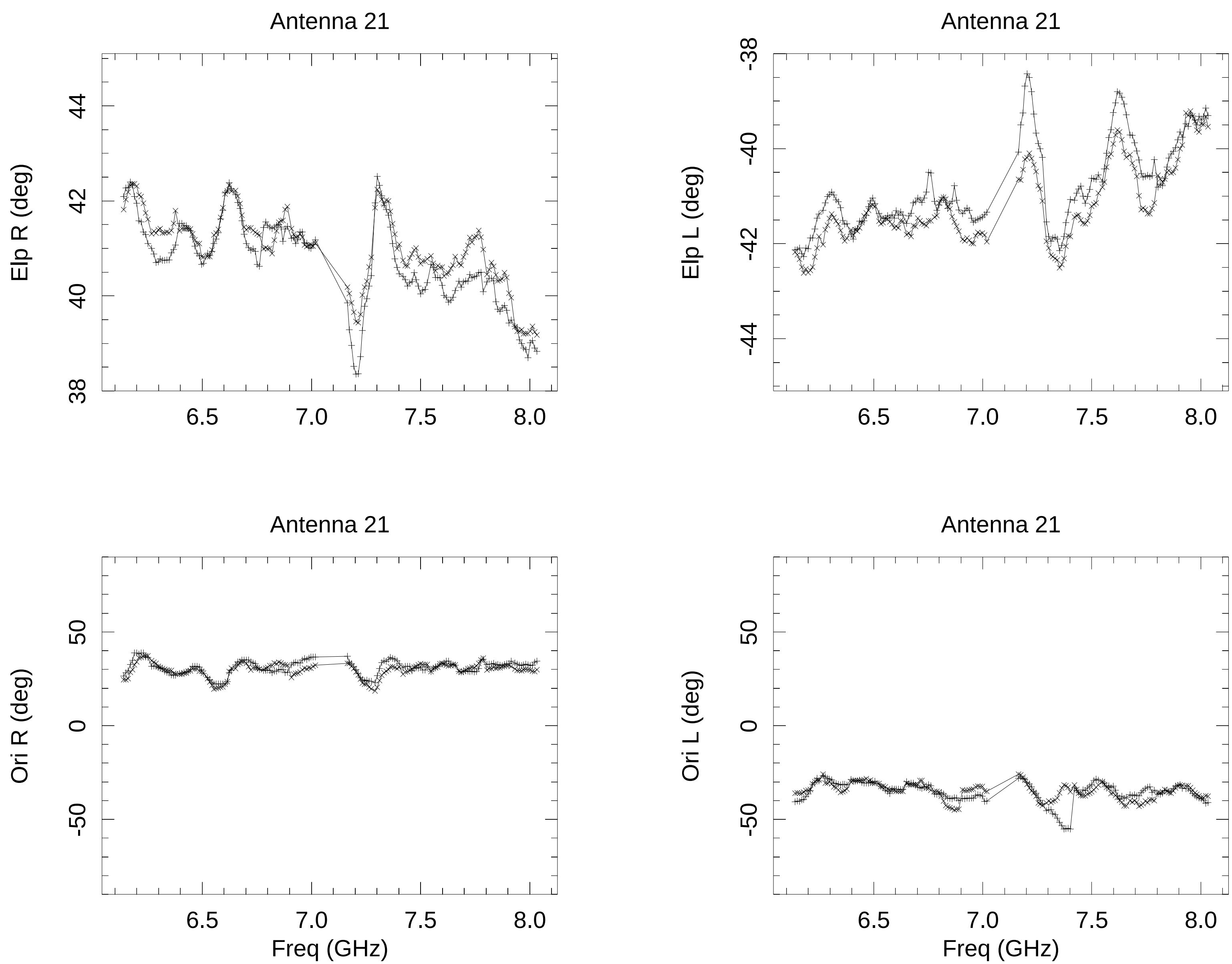

Fig. 7. Like Figure 1 but for antenna 21.

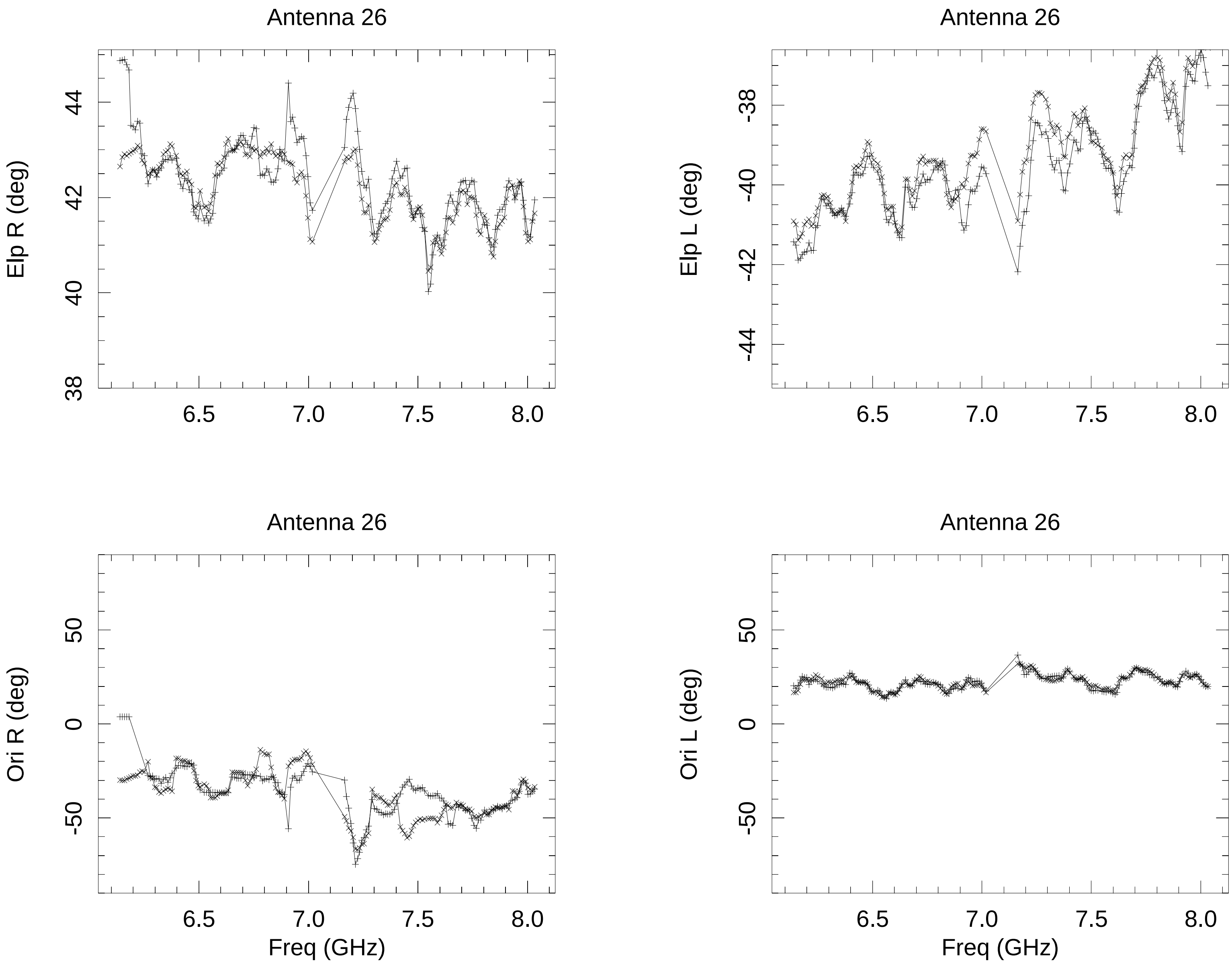

Fig. 8. Like Figure 1 but for antenna 26.

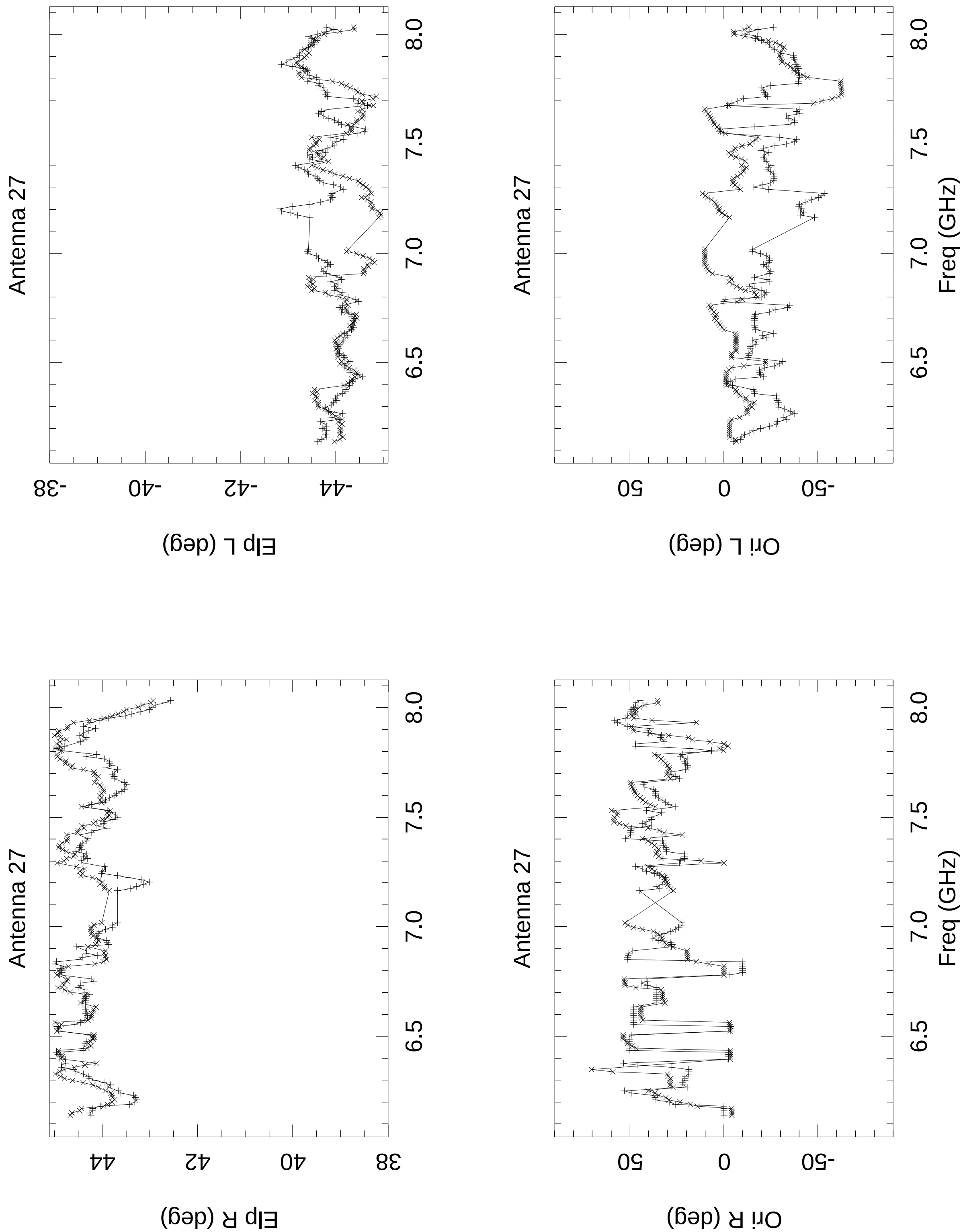

Fig. 9. Like Figure 1 but for antenna 27.