BBDev Memo 028.0

Measurement of Westford Broadband focus setting using VLBI

A. Niell
MIT Haystack Observatory
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Introduction

On 2009 Feb 3-4 VLBI observations were made with Westford and MV3 on the source 2134+004 to measure the relative gain of Westford at different focus settings for four bands from 3.5 GHz to 9.5 GHz. As expected, the focus setting for the maximum gain in each of the four bands varied with frequency.

1. Measurements

Observations were made with the Westford Dewar box set to locations of -1.5, 0, +1.5, and +3 inches relative to the position expected from the known phase center at X-band (from the S/X feed) and the expected phase center of the Lindgren feed at X-band. Positive corresponds to the Dewar being closer to the surface of the dish.

Ten minute scans at -1.5, +1.5, and +3 were each followed by equal length scans at 0. The -1.5 observations were on 2009 DOY 034 (Feb 3), while the other two positions were observed on DOY 035 (Feb 4). The observations at 0 were used to normalize the amplitudes at the other positions to a common level, since the correlation amplitudes varied with time. The 0 values corresponding to each non-zero setting were made within one hour, while the 0/non-zero pairs were separated by twenty hours and four hours.

Each non-zero position was normalized by the nearest zero value to take into account the change in correlation amplitude at the different times. Without more careful measurements of system temperature and better knowledge of the source visibility, no statement can be made about the reason for the differences.

These normalized values were then scaled to a common zero-position value by multiplying by the amplitude at 035-2020 (Figure A). These measured values (at 035-2020 for each band) were also used as the zero-position measurements.

In order to better estimate the best focus position setting for each band, the normalized values were divided by the maximum value for each band (Figure B).

From Figure B the focus setting for maximum value for each band was estimated (visually). For Band D I assumed the maximum value occurred at the -1.5 focus setting. The focus settings are shown in Figure C. A linear fit to the focus positions for the three highest frequencies and a quadratic fit to all data are also displayed. The uncertainties in position are shown as 0.2 inches. Although this is probably too small, based on Figure A, the quadratic fit is already too good (all observations are less than one-sigma from the fitted model).

From Figure A the maximum amplitudes for each band were read off. For Band D I assumed the value at -1.5 was the maximum. The maximum amplitudes are shown in Figure D.

A manual phase cal value of 0.0 was used since the actual phase cal phases are corrupted, probably by RFI. This has not been investigated yet.

The amplitude uncertainties are difficult to estimate. Multiplying the formal errors of the amplitudes by the ratio of the actual amplitude scatter among the frequency channels to the theoretical scatter results in uncertainties of about 5% for each of the bands.

2. Results

Before the data for Band D were available, the best focus setting was chosen to be +1.5, taking into account that the amplitude falls off faster at the higher frequencies. This value was used for the remaining observations in 2009 Feb.

3. Figures

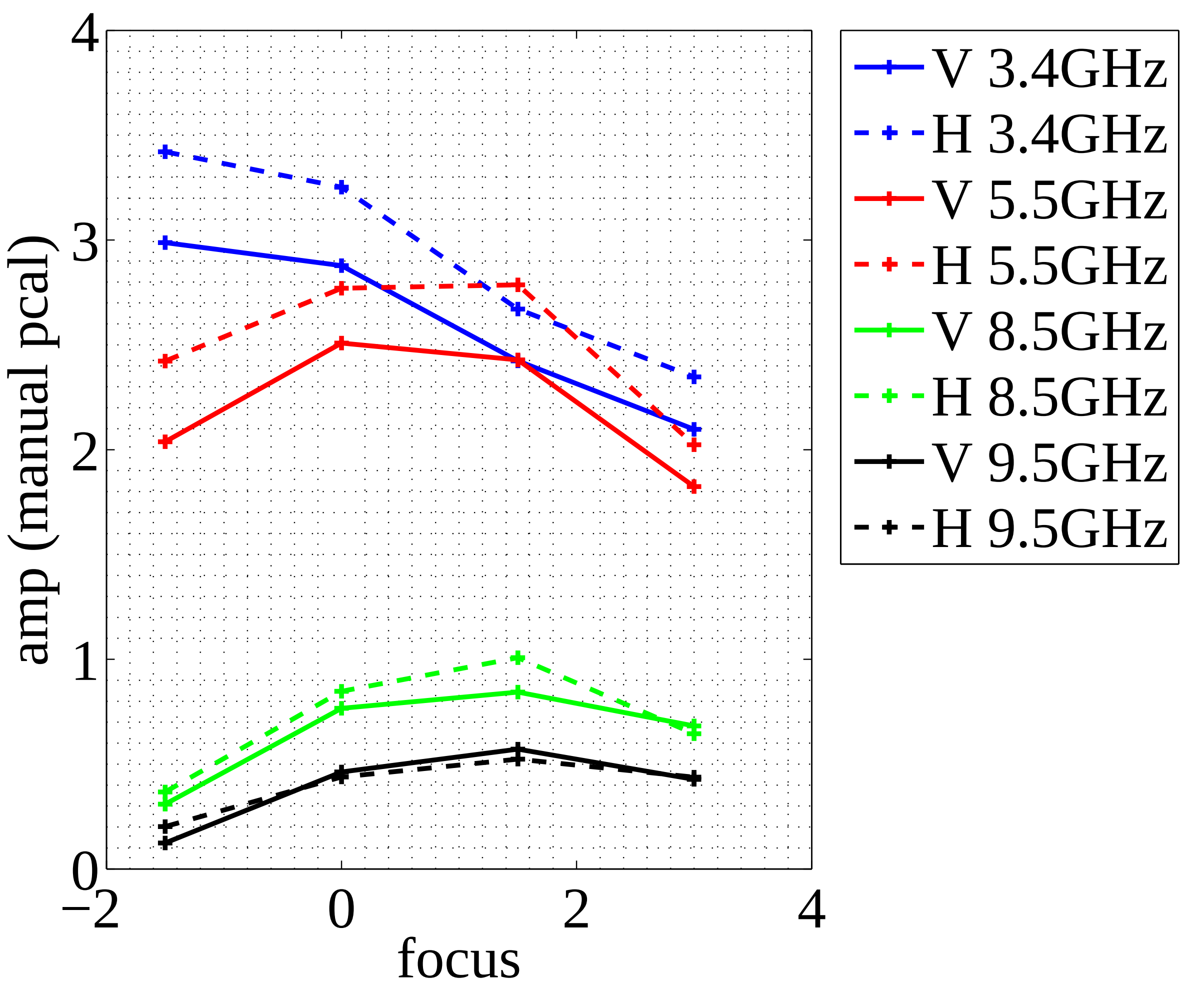

Figure A. Amplitude for all bands and polarizations as a function of Dewar position relative to the expected value. *(focus_amp_wfrd.eps)*

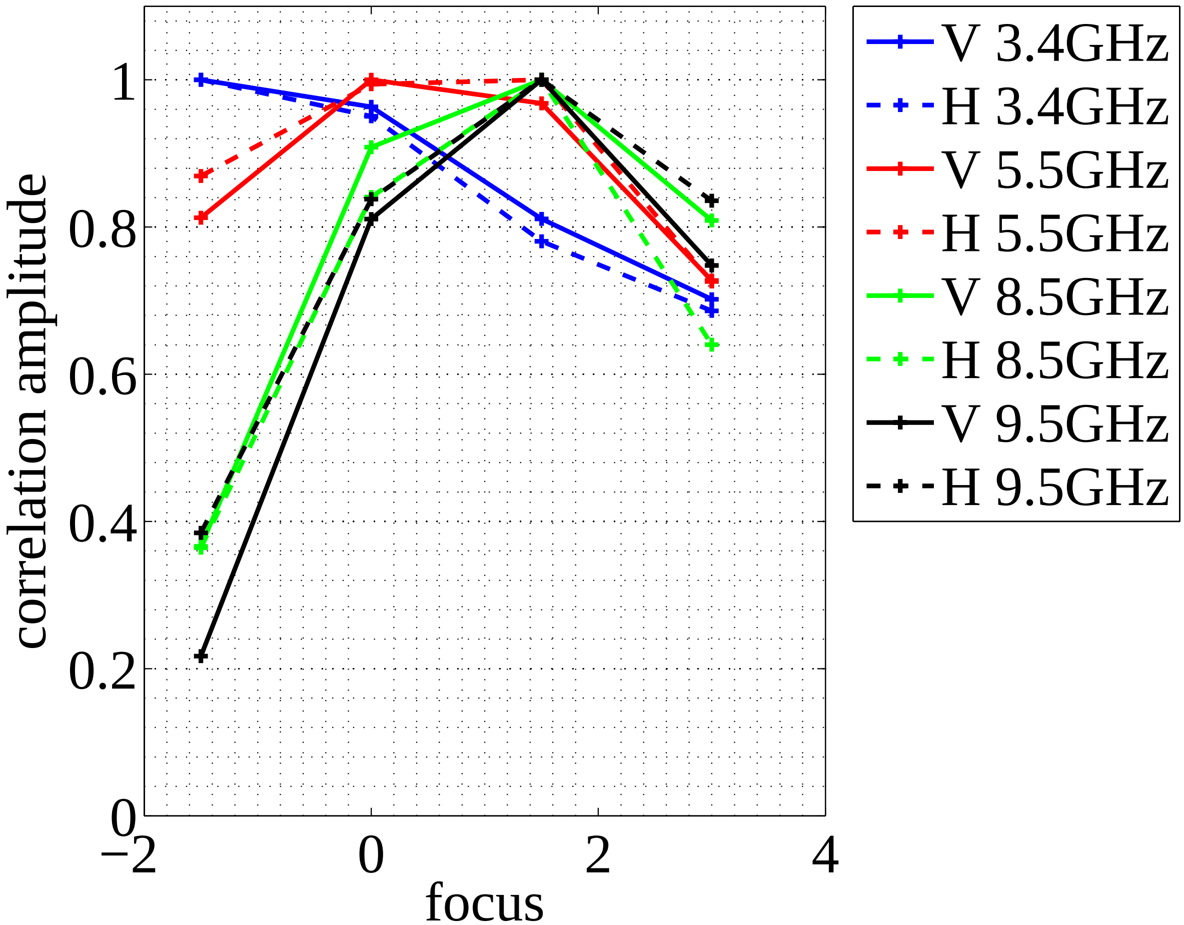

Figure B. Amplitudes normalized to maximum value. (*focus_ampnorm_wfrd.eps)*

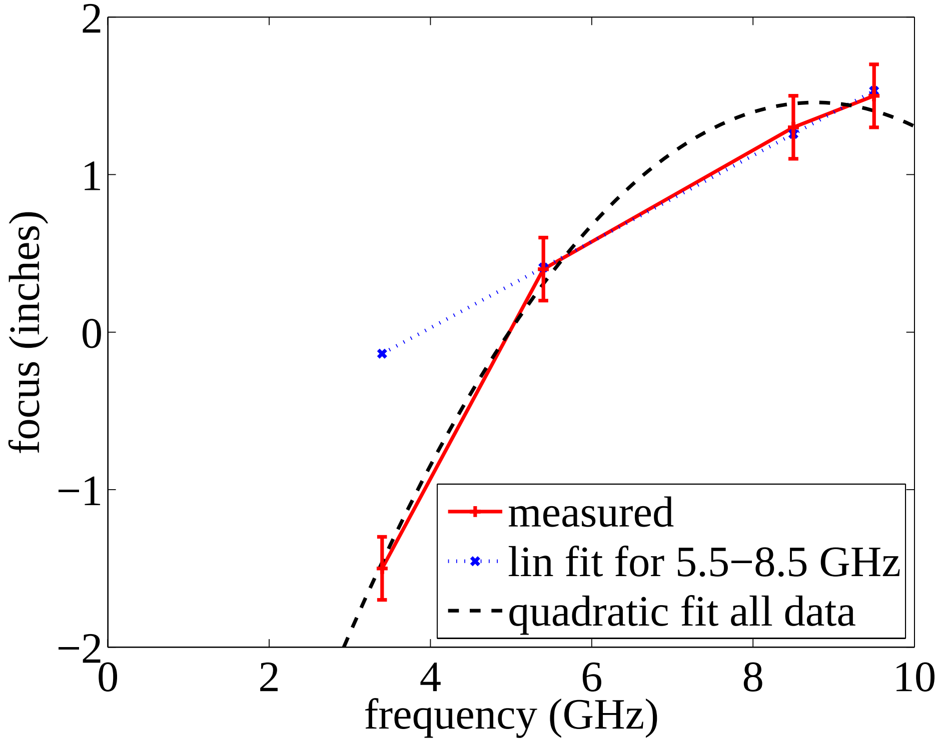

Figure C. Solid red (+): focus setting for maximum amplitude at each band. Dotted blue (x): linear fit to frequencies 5.4 – 9.5 GHz. Dashed black: quadratic fit to all values. Error bars are 0.2 inches. (*focus_ max_wfrd.eps*)

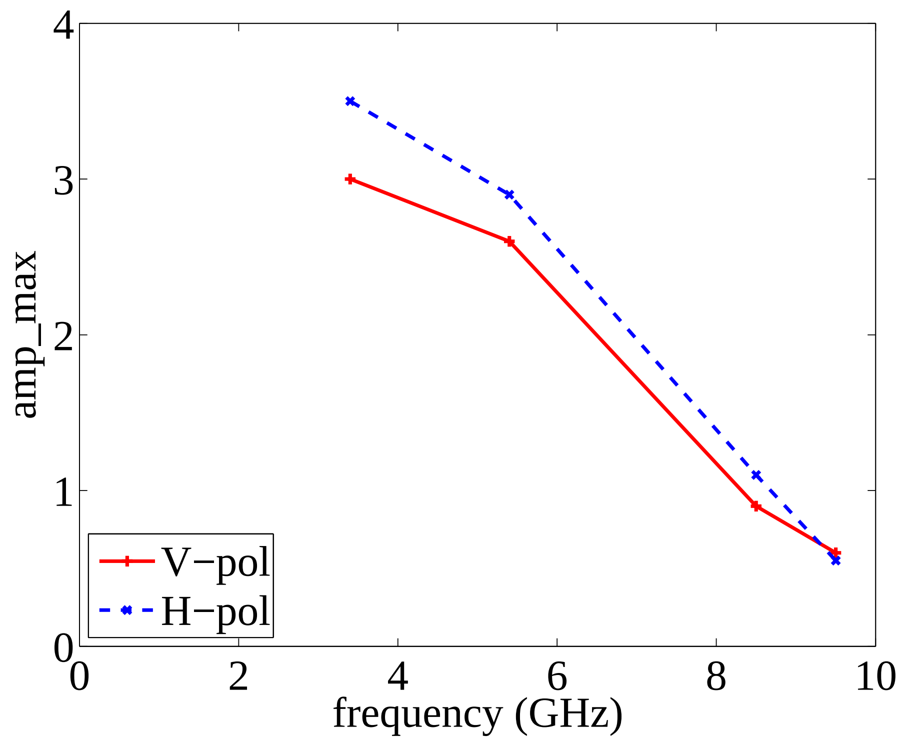

Figure D. Maximum amplitude at each band. (*focus_amp_max_wfrd.eps*)