LoCo Lab EDGES Memo 174
Low-Band 2 Antenna S11 in February-March 2020

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1 Description

The calibrated sky spectrum is very sensitive to the antenna S11, and if the S11 variations over time are significant, using the right measurement during spectrum calibration is critical.

Here we show calibrated S11 measurements of the 45°-rotated Low-Band 2 antenna done in February-March 2020. The measurements were captured on:

- 2020-057 (UTC), 3pm (local time)
- 2020-072 (UTC), 12am (local time)
- 2020-072 (UTC), 7am (local time)
- 2020-073 (UTC), 7am (local time)
- 2020-074 (UTC), 7am (local time)
- 2020-075 (UTC), every one hour between 1am and 7am (local time)
- 2020-076 (UTC), every one hour between 0am and 23pm (local time)

2 Figures

- Figure 1 shows, as a reference, the S11 from day 074. Whenever the hour is mentioned (7am in this case), it corresponds to local time. The sunrise time during the period of the measurements in this memo is between 6am and 6:20am. In this memo, all the measurements are consireded over the range 50-120 MHz because even at 120 MHz the reflection magnitude is not too high (~ 8 dB).
- Figure 2 shows the difference between the measurements from 057 through 073, and that from 074. We see that the largest difference is with day 057. This indicates that a significant change occurred in the antenna between day 057 and the next measurement. With days 072 and 073, the differences are smaller, mostly within 0.025 dB and 0.25°. Because the 074 measurement was done at 7am (daytime), the differences are smaller with the measurements also done at 7am on 072 and 073. The difference in magnitude is larger at low frequencies with the measurement at 12am (midnight) on 072.
- Figure 3 shows the changes of the S11 magnitude throughout (UTC) day 076. As a reference we use the measurement at 6am (local time, right before sunrise). As expected, the changes are larger during the day, more specifically in the afternoon/evening, and are smaller at night.
- Figure 4 is equivalent to Figure 3, and shows the changes of the S11 phase throughout (UTC) day 076 relative to 6am. Here the changes are also larger during the day and smaller at night.

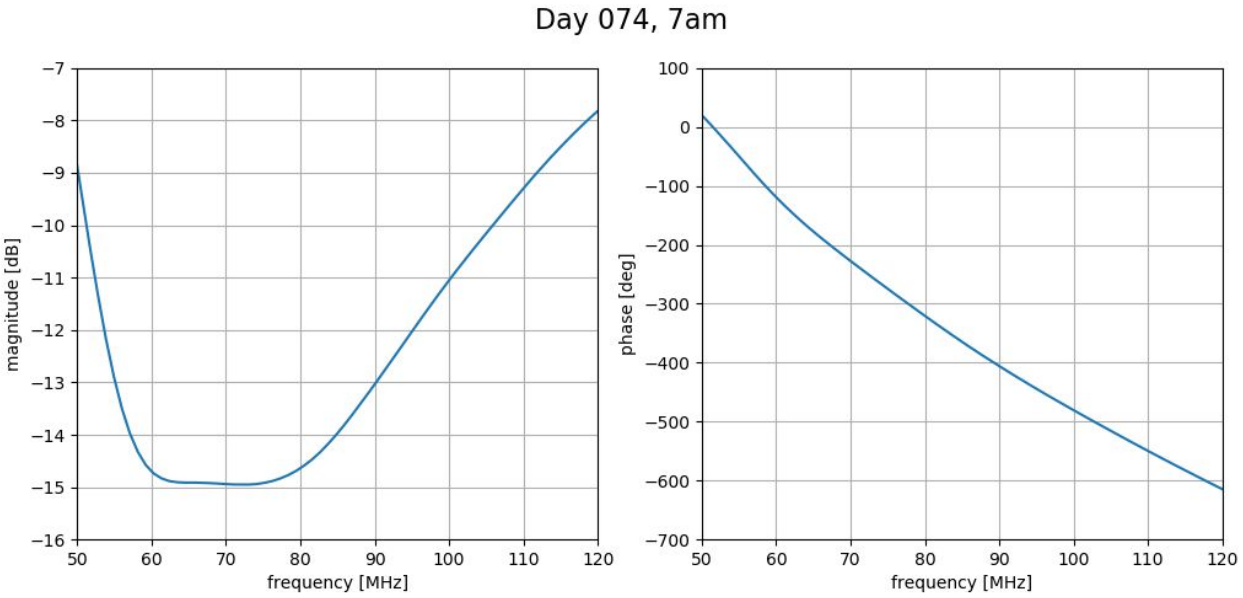

Figure 1: S11 of the 45°-rotated Low-Band 2 antenna.

- Figure 5 shows the difference in measurements taken at the same local time on days 076 and 075. Surprisingly, there is a large difference between the two days at 1am. The reason for this is not clear because there is no indication of bad weather on either day. The differences at the other hours is within expectations (±0.02 dB, ±0.1°).

- Figure 6 shows the residuals after fitting and removing a 12-term polynomial (in both, magnitude and phase) to the measurement from day 074 over 50-120 MHz. Similar ripples are seen in the S11s from all the days. The peak of the residuals is ±0.005 dB and ±0.05°. The ripples have a period of about 10 MHz. This is similar to the S11 measurements at the end of a 100-m cable shown in Figures 4 and 5 of LoCo memo 74 done at ASU with a similar setup and VNA model (Keysight Fieldfox). Because these ripples are believed to be due to the measurement setup and not the antenna, it seems better not to try to fit these ripples with the S11 polynomial model.

- Figure 7 shows residuals for the same data as Figure 6 but using a polynomial model with 42 terms (for each, magnitude and phase). A similar number of terms is necessary when using a Fourier series model. We do this here only as an exercise, but again, it is not recommended to fit the ripples seen in Figure 6.

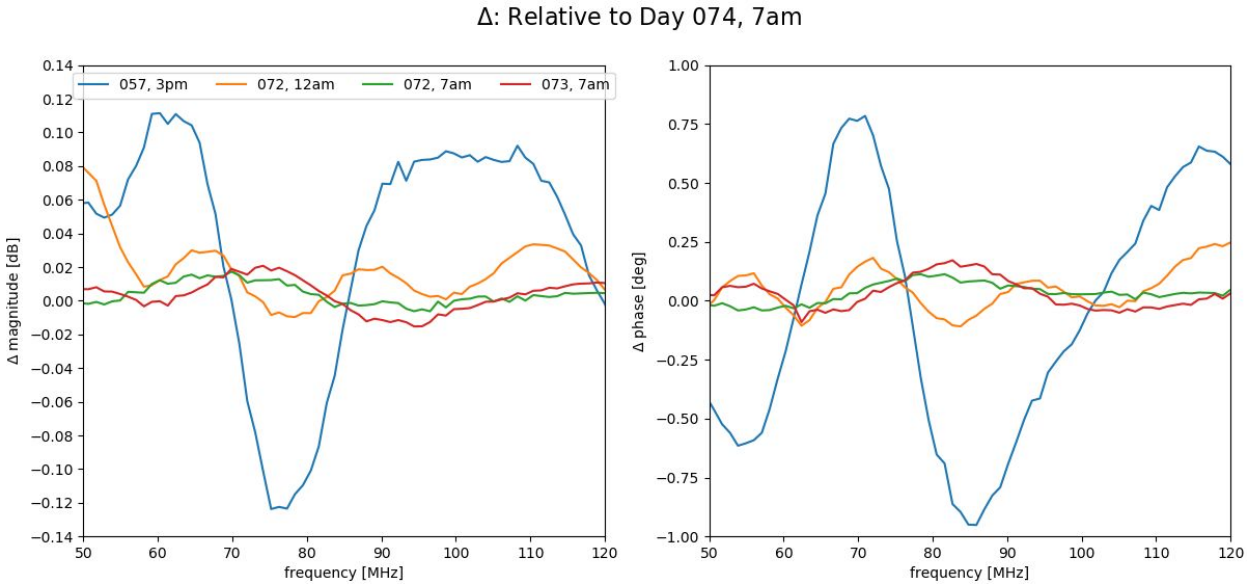

Figure 2: Differences between the first few S11 measurements (days 057 through 073) and day 074.

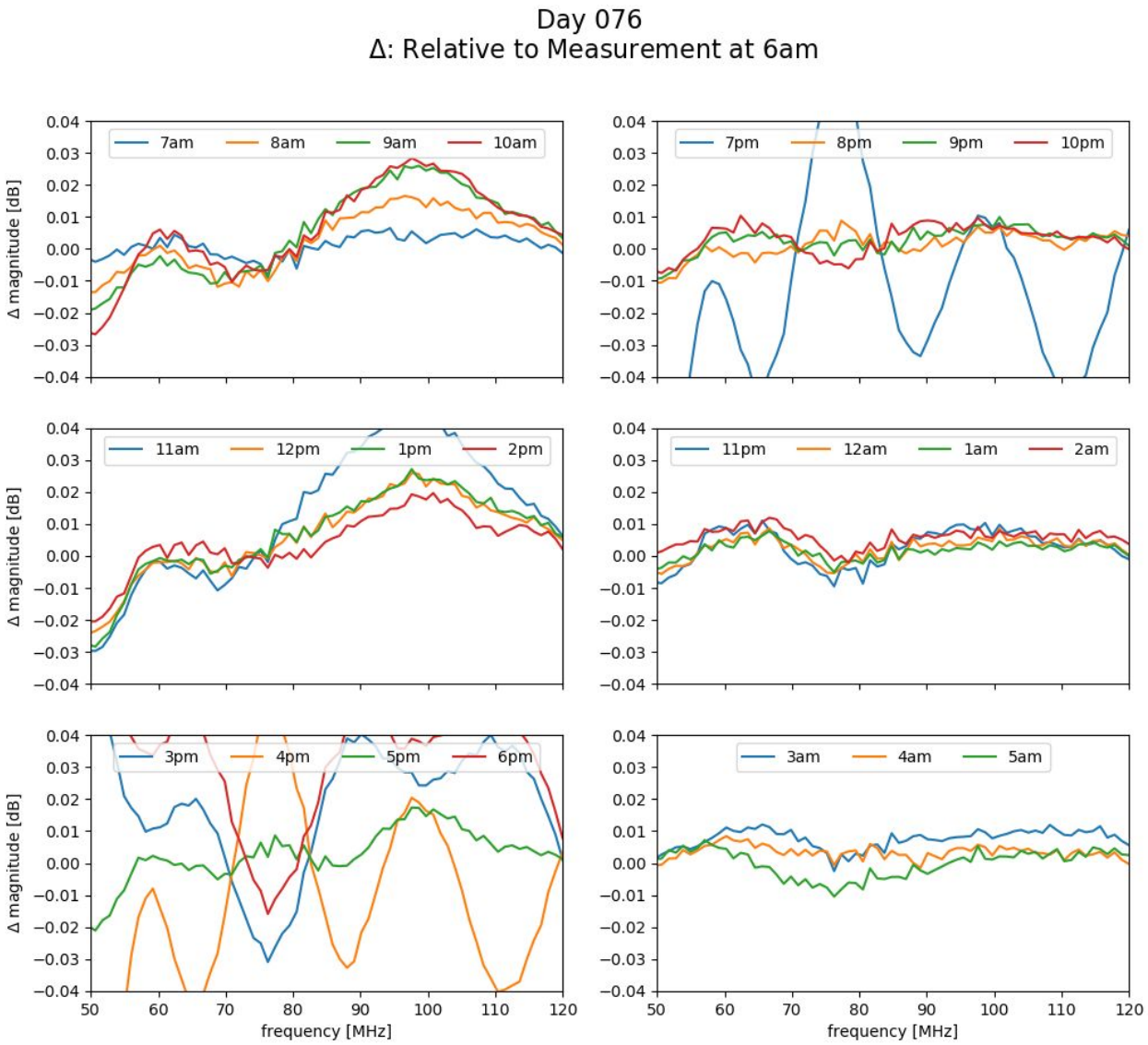

Figure 3: Changes in S11 magnitude on day 076. Measurements were done every one hour. The reference is the measurement at 6am local time.

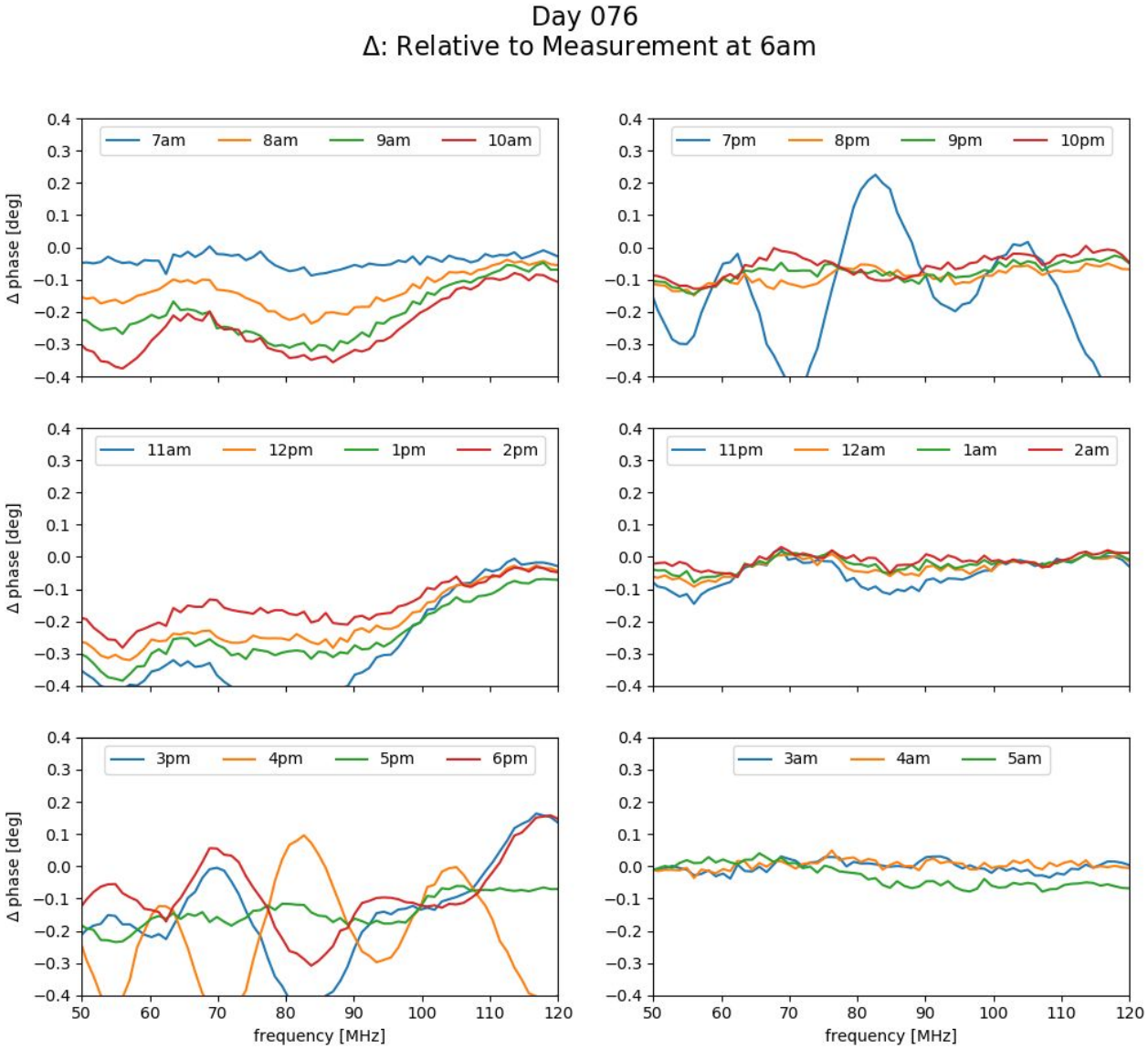

Figure 4: Changes in S11 phase on day 076. Measurements were done every one hour. The reference is the measurement at 6am local time.

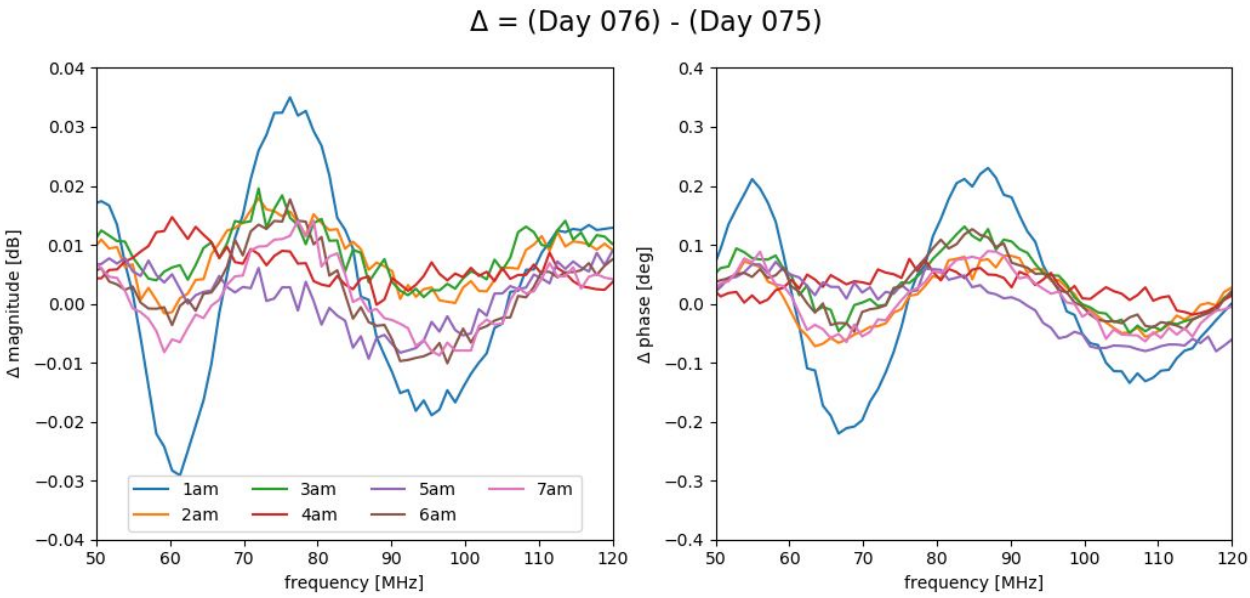

Figure 5: Differences between S11 measurements done at the same hour on days 076 and 075.

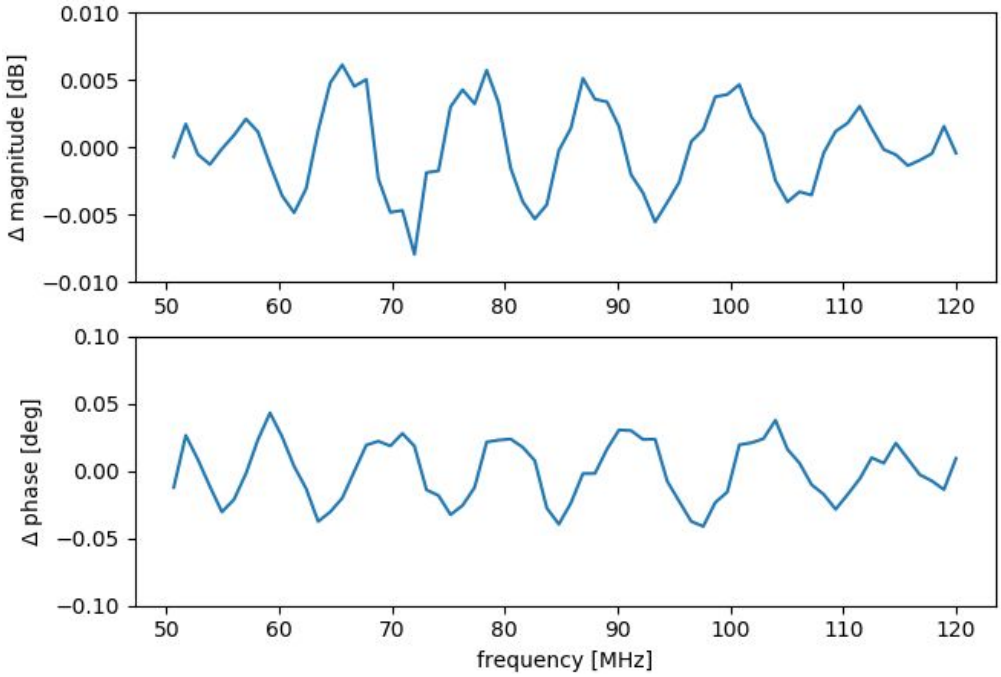

Figure 6: Residuals from fitting 12-term polynomial model to magnitude and phase of S11 measurement. Almost the same ripples are seen after fitting all the measurements discussed in this memo. Most likely, these ripples are produced by the measurement setup and are not a property of the antenna S11.

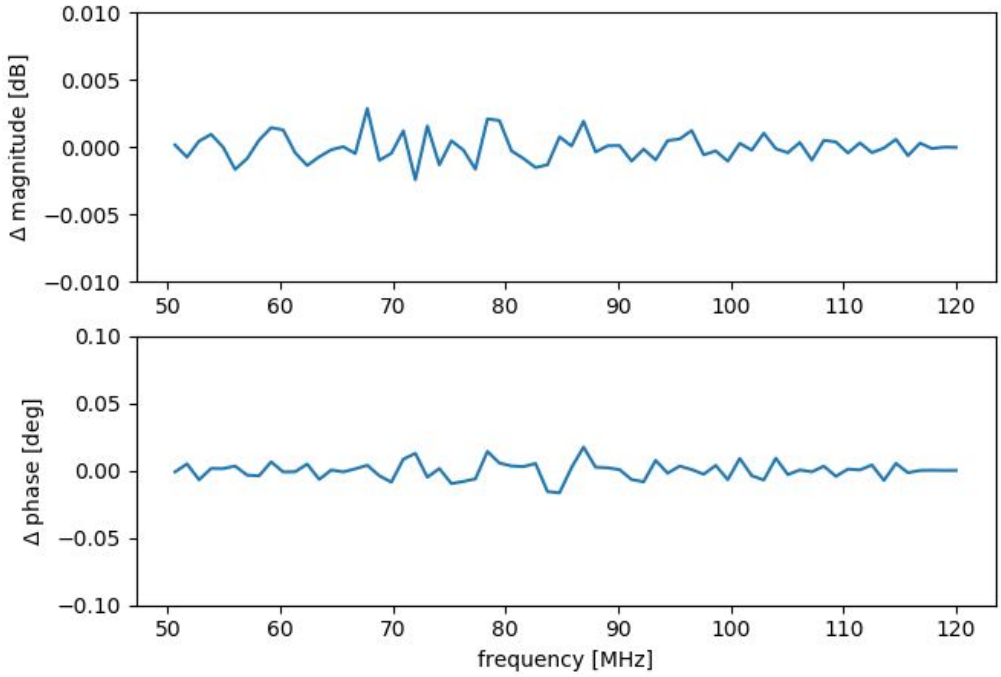

Figure 7: Residuals from fitting 42-term polynomial model to magnitude and phase of S11 measurement.