How to observe the Moon with the ESA-Dresden Radiotelescope

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The ideal and complete way

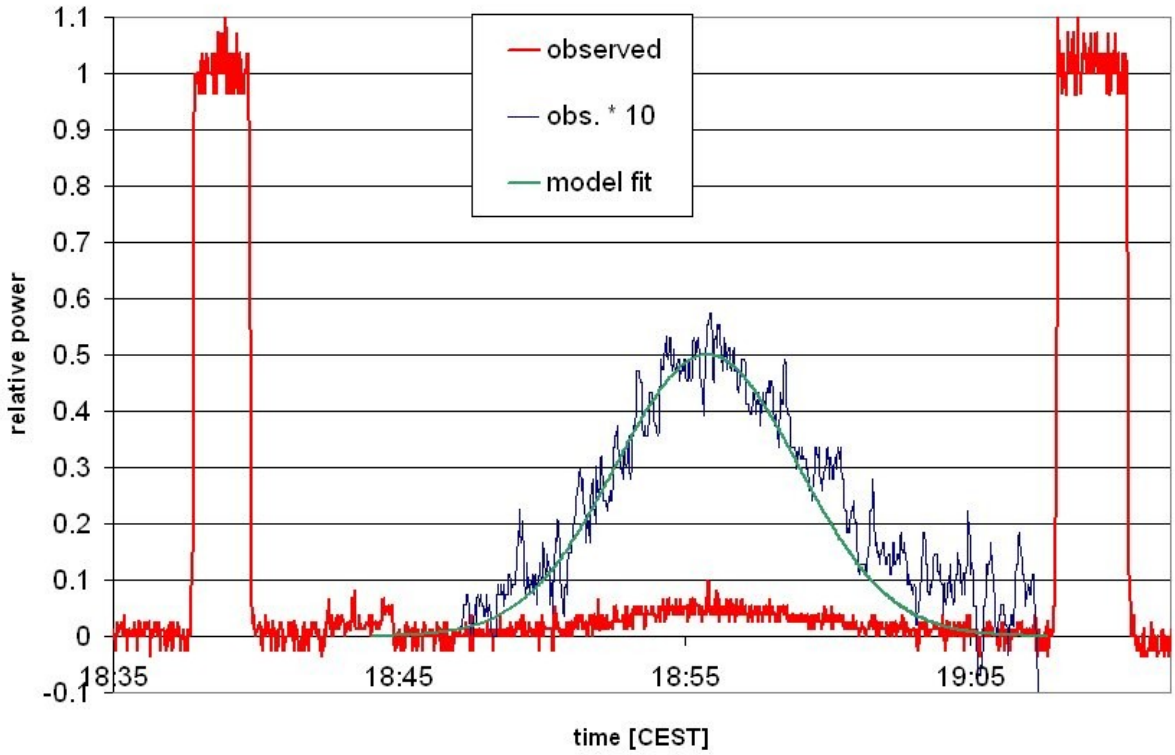
If everything was perfect, one would simply go through this procedure

1. observe the calibrator source for a couple of minutes
2. go to the position where the Moon will be in about 15 minutes
3. observe the Moon during its passage across the antenna beam
4. wait until the signal is constant, i.e. until we measure the empty sky
5. finally, observe the calibrator source again for a couple of minutes.

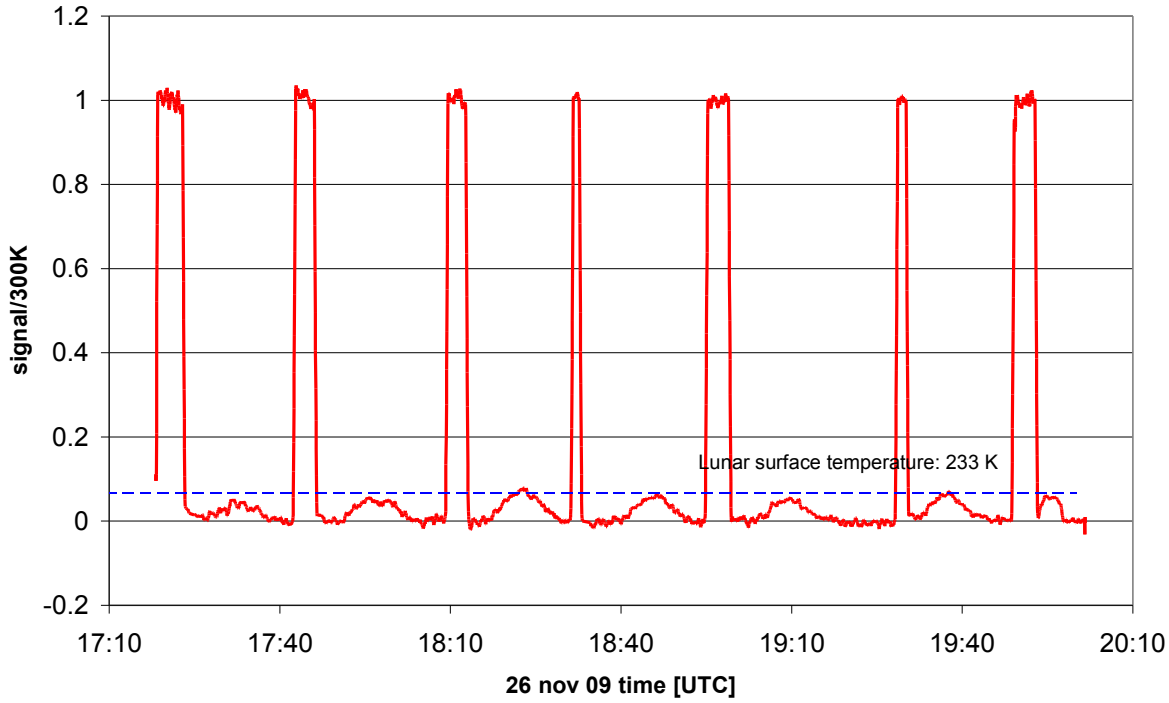
However, the positioning system of the telescope is neither that accurate – positions are given in integer degrees only, hence there is a positional error of ±0.5° – nor had it been designed for such an accurate positioning – the manufactures specify an uncertainty of 4°. Furthermore, the electronics of the motor controller needs about 2 hours to warm up to give stable readings, thus initially the position is typically 3 to 4° east of the azimuth indicated by the software. All these aspects can be dealt with in an easy way:

2a. go to the present position of the moon
2b. search for the maximum in the signal by manually move around within a few degrees
2c. the difference of the best position and the predicted one gives an offset, which we can apply for the predicted position
2d. … or, we simply move the telescope manually a bit to the West, and depending on whether the Moon is rising or dropping in elevation, also go up or down a bit. It makes life easier, if we observe the Moon close to its culmination, when it crosses the meridian in the south and moves almost horizontally.
3. if we were lucky with our estimates, we get a nice transit curve

The plot below shows the reduced data obtained with this technique: one notes the small bump in the trace just before 18:45 when we searched for the Moon.



One can do this around the lunar culmination, and get several observations whose results can be averaged to get hopefully a more accurate temperature value



A better way

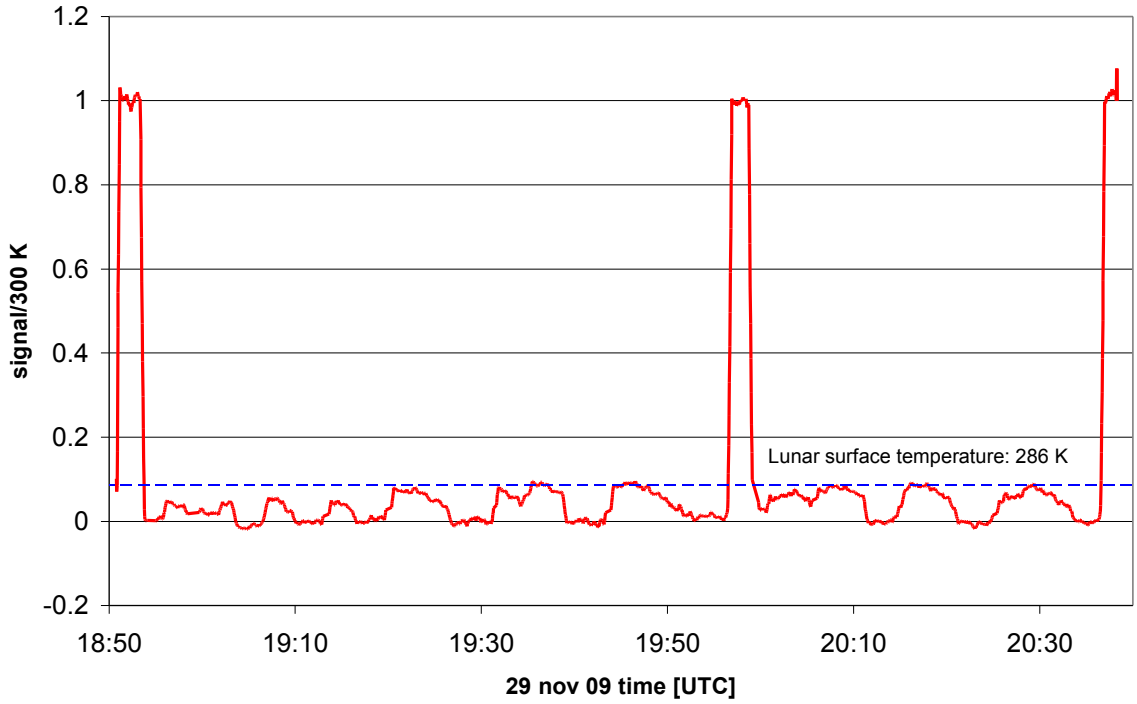
The Moon's signal is very weak, usually only 0.3 .. 0.5 dB above the background signal from the empty sky, but the fluctuations of individual measurements may also reach that value. Searching for such a slight increase in the signal is rather difficult, especially when one has to wait for about 2 seconds for the next measurement.

The other point is that the lunar transit curve is too noisy to try to determine the antenna's HPBW from those data – but we do not really need that: the antenna pattern is well known from solar observations, and it does not change between observations. Hence we can simply take the HPBW as a constant and known value of about 1.7°. All we need to measure is the peak signal from the moon, and of course the sky background and the calibrator.

We can adopt this sequence of events:

1. observe the calibrator source
2. go to the predicted present position of the moon
3. "stop" the measurement … this makes the receiver to show on its display about 2 measurements per second, so it is easy to:
4. search for the maximum signal by manually adjusting the position
5. move in azimuth (and elevation) around that position, back and forth, to make sure that it is a genuine maximum surrounded by smaller values!
6. now "resume" the measurement and observe the signal until it starts dropping – check whether it drops with the same speed as expected for an object moving with the sky (from solar or earlier lunar observations)
7. now move manually in azimuth to a position at least 5° to the east. Stay there for a couple of minutes to measure the sky background. Important: because the sky background increases towards lower elevations, measure it always at the same elevation as the source
8. go back to the Moon, search for maximum signal … and re-observe the Moon. Perhaps move a little bit to the west of the maximum position, so you can catch the signal already when it is still rising to the maximum.
9. observe until it starts falling .. then go east to catch the sky background …
10. repeat this as often as possible, and once in a while, observe the calibrator …
11. … and finish with the calibrator

The results of this method are shown below:



Each ‘bump’ is such a partial lunar pass, some of which were not so good. The one near 19:50 shows that the rise before maximum got successfully caught; during the one at 20:30 the elevation was slightly adjusted to get the maximum …
Incidentally, at this evening the Moon was behind a thin layer of fog or high clouds, but it shown brightly enough to see the mare on its surface, and when I went home, I could see that I cast a shadow when passing a dark road.