Subject: Moon pointing at 10 GHz
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Date: 4/23/2021, 00:55
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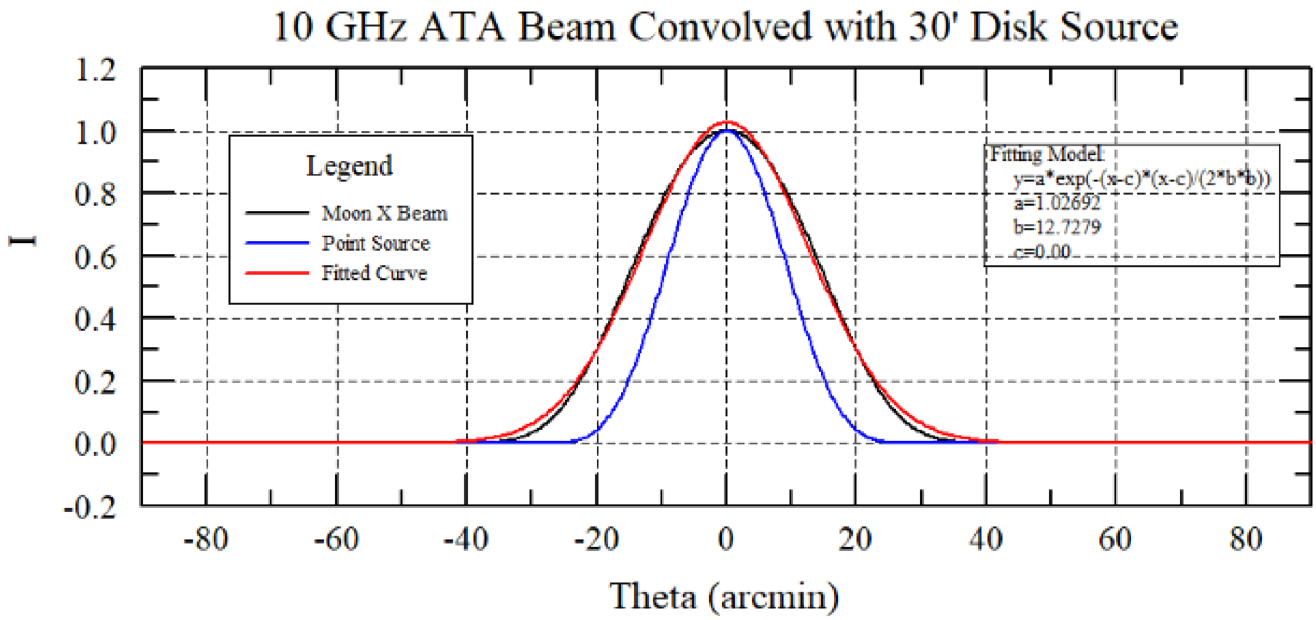
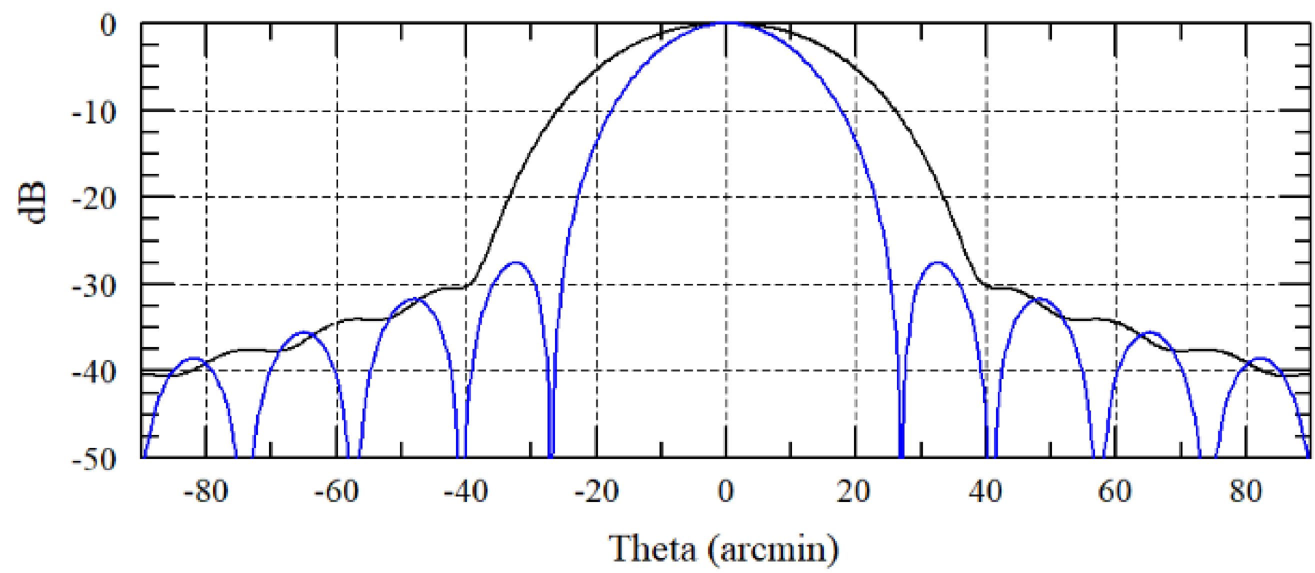
Hi Wael & David,

Much, much simpler than I thought.

I created a model of the convolution of the ATA's beam at 10 GHz with a disc source with a 30 arcmin diameter to see the degree to which the convolution is non-Gaussian. Since I'm used to what this would look like with a much larger telescope I originally thought the convolution would not look very Gaussian. But, my original impression was wrong. It's Gaussian enough that I think the modification to the data acquisition and analysis should be not too involved.

The plot below shows in black the model of the Bessel approximation of the ATA's 10 GHz beam convolved with a 30 arcmin Moon. (For comparison only, I gave in blue the Bessel approximation of the point-source beam profile at 10 GHz.) In red is a Gaussian that I fit to the convolution. As you see, the Gaussian does not do a perfect job in the wings or center of the profile but follows very close to the convolved, model beam at and around the half-power points.





So, it looks like in creating your source ephemeris for a high-frequency Moon observation, instead of specifying the inner offsets as +/- FWHM/2 (as you did for GPS observations), you need to specify either +/- whatever the Moon's half diameter is on that day -- probably +/- 15 arcmin should be good enough. The outer offsets in your observing pattern (used for estimating a baseline) should be something like +/- 1 or 1.5 deg.

In the data analysis, you're probably using a non-linear least sq fitting algorithm (e.g., Levenberg-Marquardt). Such routine usually need a starting values for the Gaussian parameters. Here, instead of using the FWHM of the beam as a 1st guess, you'd use either whatever the Moon's diameter is on that day, or probably just 30 arcmin.

In short, the changes you'll need to make to the observing tactics and analysis is to expect the source to have a FWHM of ~30 arcmin, instead of what you expected for the GPS observations (something like 120 arcmin?).

Above 10 GHz, the difference between the red and black traces grows and at about 15 GHz, the difference between red and black becomes too large to use Gaussians. Lucky us! Below 10 GHz, red and black become more similar than what's shown in the plot. Thus, 10 GHz is a reasonable high frequency for the tests which keeps your tactics relatively simple.

Another simplification: The pointing error we want to check is a frequency-dependent collimation error. Collimation errors produce a pointing offset in elevation that is constant in Az and Elevation, and a pointing offset in *cross-Elev* that is also independent of Az and El. Thus, you don't need Moon observations that are widely distributed across the sky. Just a few measurements should be enough. That's, of course, much simpler and faster than the all-sky pointing that you did using GPS.

Ron