New SRT: The Sun's Brightness Temperature

1 Objective

- Complete a 5x5 npoint scan of the sun
- Complete an azimuth scan and an elevation scan of the sun using angular offsets ranging from $-30°$ to $+30°$ in steps of $2°$

2 Introduction

When an npoint scan is executed, a series of measurements surrounding the target object in a 5 $\times$ 5 grid are made with the step size set by the antenna beamwidth (default value 5 degrees). The measured power/temperature at each of these grid points is displayed just above the text input box and at the completion of the scan, a 2D contour plot of the grid is displayed in the graph box at the top of the page. Information about the sweep is then displayed in the information sidebar. The telescope offsets are also adjusted so as to point the dish to the maximum observed signal within the sampled region. The "npoint" scan is also useful for verifying the targeting accuracy of the system. If the computer clock is set incorrectly or the local latitude and longitude have been inadvertently changed, the sun will not appear well centered in this gridded scan.

An azimuth-elevation scan of the sun is completed by measuring antenna temperature at various angular offsets from the sun (this angular offset can be either in degrees azimuth or degrees elevation). Scans of this kind will enable you to derive an empirical value for the half-power beamwidth (HPBW) of the antenna, which can be compared to the theoretical value. Measurement of the beam pattern can help the user discover problems with optical alignment or aid in the determination of antenna focus.[Jlab,]

3 Procedure

3.1 Old SRT

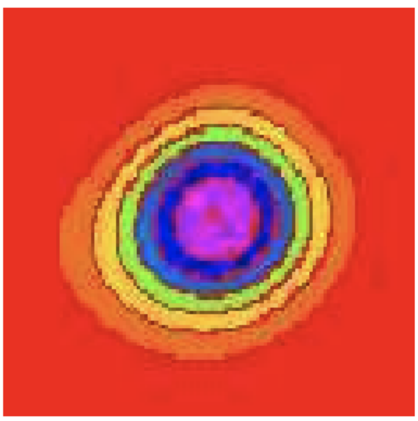

Figure 1: Typical contour plot from a 5x5 npoint scan of the sun. [Jlab,]

An npoint scan is done by clicking the "npoint" button in the old SRT GUI, and the antenna beamwidth used is defined in the srt.cat file with a default value of 5°.

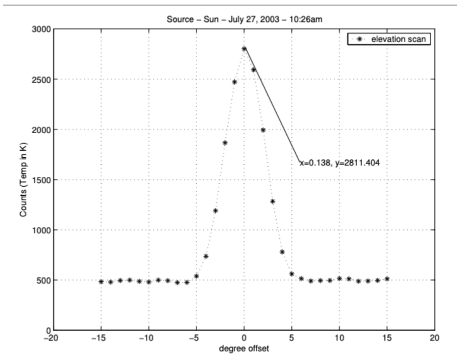

Figure 2: Example elevation scan of the sun. [Jlab,]

An azimuth or elevation scan is done by writing a .cmd file specifying the various offsets from the sun where you want to take data. You can also use the “drift” button to cause the dish to be pointed “ahead in time” and then stopped. This will permit the sun, or any other object, to drift through the antenna beam.[Jlab,]

3.2 New SRT: Npoint Scan

1. Click the "npoint" button in the srt dash interface (alternatively, the user can write up their own command file and run it on the interface to achieve the same outcom
2. This will initiate an automated procedure in which temperature/power measurements will be taken surrounding the sun in a 5x5 (default) grid with a step size defined by the antenna beamwidth (default 5°)
3. Navigate to the "Sun Brightness Temperature" file in Jupyter Notebooks and specify the filepath containing your observations. Then, use the notebook to generate a 2 dimensional contour plot of the data.

3.3 New SRT: Azimuth/Elevation Scan

1. Write a .cmd file specifying the various offsets from the Sun that you want to take data. For example, these offsets may range from $-30°$ to $30°$ in steps of $2°$. An example file can be found in the cmdfiles/ directory under the title "azelscan.cmd".
2. Navigate to the "Sun Brightness Temperature" file in Jupyter Notebooks and specify the filepath containing your observations. Then, use the notebook to generate power vs azimuth/elevation plots of the data.

4 Analysis

Using the npoint scan is a good way to verify targeting accuracy, and make sure the system is well calibrated. Measuring the beam pattern using this method can help the user discover problems with optical alignment or aid in the determination of antenna focus; as shown in fig.3 , things do not always look as they are supposed to. Using this data, derive an empirical value for the Half-Power Beamwidth of the antenna (see corresponding jupyter notebook), and compare it to the theoretical value.

What is the convolution of a finite source with the radiation pattern of the antenna beam? Can you model this? An interesting comparison can be made by comparing your results with the solar flux measured by other antennas around the world, see `http://web.haystack.mit.edu/SRT/solar.html`.

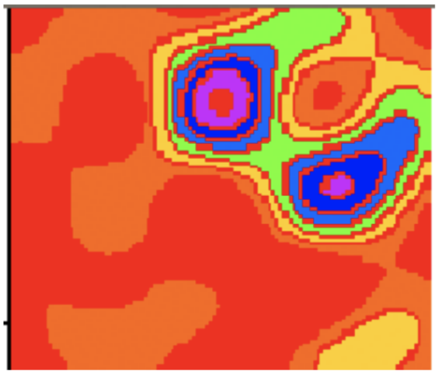

Figure 3: Atypical contour plot from a 5x5 npoint scan of the sun, from an independently built srt that was thought to have beam alignment issues. [Varghese,]

References

[Jlab,] Jlab. 21 cm radio astrophysics. http://web.mit.edu/8.13/www/JLExperiments/JLExp46.pdf.

[Varghese,] Varghese, K. Radio astronomy the galactic rotation curve. http://www.physics.smu.edu/ kehoe/ugradRes/kv$_thesis.pdf$.