

Determination of Pointing offsets and Beam Pattern using 3-m SRT

1 Introduction

The aim of the experiment is to align the 4-m telescope at NCRA East campus with the proper ALT/AZ coordinate system allowing it to be pointed to the given astronomical source. This requires determining the offsets between the electronic reference of the telescope and the astronomical ALT/AZ coordinate system at the observatory. Using the calculated offsets, scans in AZ and AL direction are taken to calculate the Beam-Width of the 3-m Telescope.

The understanding of the issues of practical astronomy is tested by the brain teaser section, which require solutions to problems listed in this sheet and familiarization with directions in sky.

The procedure for the initialization of the telescope and receiver should be followed first, which is given in the previous document. The procedure of the experiment is described which includes the operation of the telescope and receiver system. The observation section provides a log sheet for the experiment, which requires observations of Sun to determine ALT and AZ offsets. It is followed by an analysis section which consists of analysis procedure and log. Finally a results section is provided for listing results alongwith the errors.

1.1 Initialization of the Telescope

1. Make the connections as instructed and switch ON the power supply. Click on the SRT software icon, The telescope will start moving automatically untill it attains a home position called as ‘Stow’ position.

2. Familiarize yourself with the concerned option on the command toolbar e.g. Stow, Azel, Offset, freq. and record.

1.2 Experimental Procedure

Find out the RA, DEC (in 1950 epoch) of the sun for the time of observation. Update the RA, DEC of the sun in the SRT.cat file.

1. Stow position is (Az=0 Al=10). Click on **AZel** and type 0 30 (This is usually a direction of cold sky).
2. Press **Cal** to calibrate the telescope. Note down the value of T_{sys} shown in the right side table.
3. Click on the sun visible on the map.
4. Set the antenna offsets as calculated from the Experiment 1. Press **offset** button followed by typing **azoffset eloffset**
5. Look at the shadow of the feed on the dish. It should be centered properly.
6. Move the antenna by 10 deg. away from the sun, first in Az. Press **Azel** followed by the required coordinated 10 deg off the sun.
7. Press **record** and type the file in the format below
wsr_sun_batch1_yymmdd_hhmmss. Press **record** again to start recording data.
8. Use **Azel** and keep on moving across the sun by steps of 1 deg, untill you reach 10 deg. beyond the sun.
9. Wait for 5 sec at each step to Record data (data is automatically saved). Once the scan is finished stop recording by, Pressing **record** again.
10. Position on sun again and repeat the similarly for altitutde scan and recording the data in a separate file.

2 Observation Log

1. Az scan 1 & Data file name and time :
2. Az scan 2 & Data file name and time :
3. Alt scan 1 & Data file name and time :
4. Alt scan 2 & Data file name and time :

3 Analysis Procedure and Log

3.1 Procedure

1. Open the data file in EXCEL spreadsheet format in the laptop.
2. The typical data file has the following format - time, Az, Alt, azimuth offset, altitude offset, RF, freq resolution, receiver mode, number of channels, powers in ch1, ch2,, ch N.
3. To get accumulated spectrum, add the powers in all channels and store it in the last column of the spreadsheet
4. Export the time, Az, Al and th summation column to ASCII file using excel export option to write to an ASCII file with similar name but .asc extension.
5. Repeat this for all data files.

6. Copy exported data files to a PEN drive and transfer to MATLAB PC (located in Room No 8 on the first floor) for analysis.
7. Copy data files to MATLAB local working directory and rename to shorter names such as "Azscan1.data" and so on.
8. load data in MATLAB using `load scan1.dat`
9. Generate X axis using the Az angle `>> for i=1:n x=Azscan1(2,i); end` where, 2 is the column no. and n is the number of datapoint.
10. Generate Y axis by `>> for i= 1:n y=Azscan1(2,i); end`
11. plot data
`plot(x,y)`
12. To fit a curve
`>> cftool(x,y)` This will open an interactive data plot.
Click on - **Fitting** - **new fit**. Select **gaussian** in Type of fit. Then select the gaussian function from the list below. For the purpose select single peaked function of the form: $a_1 e^{-\left(\frac{x-b_1}{c_1}\right)^2}$, click **Apply**.
13. Note down values of the fitting parameters a_1, b_1 and c_1 . Parameter b_1 = Mean = peak of gaussian.
14. From the Almanac, Calculate the Al/Az coordinates of the sun at the time of the scan. The difference between the calculated Az/Al and the Peak of gaussian (for both Az and Al scans) are the offset of the telescope.
15. Parameter $c_1 = \sqrt{2}\sigma$, where sigma (σ) is the width of the gaussian. The FWHM is then calculated from the Width (σ) as,
$$FWHM = 2.35 \times \sigma$$
16. To save the plot obtained in cftool
got to **File** - **print to figure** - **Insert x label, y label** - **file**
- **save as** - **name.jpg** - **save**
17. Attach fitted plots and write the following log

3.2 Log

3.2.1 Altitude Scans

	Altitude Scan -1	Altitude Scan -2
Datapoint selected	_____ to _____	_____ to _____
Peak of Gaussian (Deg.)	_____ \pm _____	_____ \pm _____
FWHM of Gaussian (Deg.)	_____ \pm _____	_____ \pm _____
Expected Azimuth	_____ Deg.	_____ Deg.
Expected Altitude	_____ Deg.	_____ Deg.
Offset	_____ Deg.	_____ Deg.

3.2.2 Azimuth Scans

	Azimuth Scan -1	Azimuth Scan -2
Datapoint selected	_____ to _____	_____ to _____
Peak of Gaussian (Deg.)	_____ \pm _____	_____ \pm _____
FWHM of Gaussian (Deg.)	_____ \pm _____	_____ \pm _____
Expected Azimuth	_____ Deg.	_____ Deg.
Expected Altitude	_____ Deg.	_____ Deg.
Offset	_____ Deg.	_____ Deg.

4 Results and Discussion

The estimate of **pointing offsets** are as follows -

1. Azimuth Offset : _____ Deg.
2. Altitude Offset : _____ Deg.

The Beam-Width of the 4-m telescope is the FWHM obtained from the beam pattern as -

3. Beam-Width: _____ Deg.

The theoretical expected value is -

4. Beam-Width: _____ Deg.

The sources of error in my experiment are as follows -