Determination of the Pointing Offsets and Beam Pattern for the 4-m Telescope

1 Goal of the experiment

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 electroninc 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 4-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.

2 Brain Teaser

1. Go out on the terrace and identify different directions on the sky. If sun is visible, roughly find the direction of North pole, which is one of the reference for telescope control system. Indicate approximately the Alt-azimuth position of the telescope.
   Ans.:

2. Track the path of the Sun on the sky. How does the azimuth and altitude change through the day at NCRA campus ? How would this change if you were located +50 N at the time of the experiment? How would this change if you were located -50 N at the time of the experiment?
   Ans.:

3. Find out the RA/Dec of Sun and the constellation in which the Sun is, at the time of observation. Familiarize yourself with the equatorial coordiante system as it is visible from the telescope location. In what direction then RA/Dec increases/decreases? Where is the 0,0 RA/Dec point located in the sky?
   Ans.:

4. Indicate the approximate time of rise and set in IST today when the sources with following RA and Dec can be observed using our 4-m telescope at NCRA East Campus. (Assume that the sky 17° above horizon is visible with the telescope)

RA	Dec	Time (IST)
01h 30m	$+33^o$ 20'	
05h 31m	$+21^o$ 10'	
04h 37m	-56° 01'	
17h 10m	-30° 23'	
21h 05m	$+40^o$ 21'	

5. What is the angular size of Sun disk in the sky? What is the resolution of an typical optical telescope (lets take D=10cm)? What should be the diameter of the telescope at 21 cm, to achieve the same resolution?
   Ans.:

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3   Procedure for the experiment

Before starting with the experiment, initialization of the telescope and receiver has to be done. For this purpose please refer to the document titled *'Initialization of the 4-m Telescope System'*. Follow the experimental procedure given below.

3.1   Experimental Procedure

This experiment can be done by visually pointing the antenna towards the Sun if the sky is not cloudy. Look at the shadow of the feed at the center of the dish and rotate the antenna till the shadow is centered approximately. If the sky is cloudy, then the experiment is not recommended. Notedown the approximate ALT/AZ of the Sun. Then, the following procedure is to be followed.

1. Select the following settings for continuum mode.

Parameter	Value
IF Gain	12
DC Gain	5
DC offset	1
Time/step	1
Source name	'name'

2. Go to "DESIGNATE mode", select the last enter block, enter the approximate Alt and Az coordinates and ALT/AZ speeds of 0.5^o/sec. each.

3. Slew over the position of Sun FROM $+ 10^o$ TO $- 10^o$ in altitude using the designate mode and speed options. Notedown the start and end Alt and Az angles in the log sheet.

4. Also simultenously START the SCAN on receiver. Notedown the start time in the log sheet and save the scan.

5. Repeat the steps 2 and 3, this time FROM $- 10^o$ TO $+ 10^o$.

6. Go to approximate position of Sun again and Rotate the antenna till the shadow is centered approximately.

7. Repeat steps 2 to 5 for 2 times.

8. Go to approximate position of Sun again and Rotate the antenna till the shadow is centered approximately.

9. Similarly repeat steps 2 to 7 for two Azimuth Scans.

10. Copy data files on a CD (DO NOT USE PEN-DRIVES) and transfer to MATLAB PC for analysis.

11. Once the experiment is over, park the telescope as per step-9-10, mentioned in the document titled *'Initialization of the 4-m Telescope System'*.

4 Observation Log

4.1 Observation Table for Altitude Scans

	Altitude Scan -1	Altitude Scan -2
Azimuth angle	Start: End:	Start: End:
Altitude angle	Start: End:	Start: End:
Slew Speed Start time of scan Time/Step		
Scan Data file name 1) Scan Data file name 2)		

4.2 Observation Table for Azimuth Scans

	Azimuth Scan -1	Azimuth Scan -2
Azimuth angle	Start: End:	Start: End:
Altitude angle	Start: End:	Start: End:
Slew Speed Start time of scan Time/Step		
Scan Data file name 1) Scan Data file name 2)		

5 Analysis Procedure and Log

5.1 Procedure

1. Click on MATLAB icon

2. Create a directory in the area /Data/students/date

3. Copy data files to MATLAB local working directory and rename to shorter names such as "altscan1.data" and so on.

4. Edit each data file and remove header after noting down the start time

5. load data in MATLAB using "load altscan1.dat"

6. Generate X axis using "x=altscan1" and "for i=1:sizeof(altscan1) x(i) = altstart $\pm$ (i-1)*timeperstep*speed"

7. plot data using "plot(x,altscan1)"

8. Choose the datapoints near the peak of the deflection on sun.

9. Copy these data points to two arrays datax and datay

10. Type "cftool" to go to curve fitting tool box

11. select datax and datay as X and Y arrays in DATA tab

12. Select "New fit" and "Gaussian fit" in fit tab. This will fit a Gaussian and display its parameters and errors

13. Calculate Sun Alt-Azimuth at the time of the scan from the Almanac. The difference is the offset.

14. Enter the above calculated offsets in the Log provided below and attach fitted plots.

5.2 Log

5.2.1 Altitude Scans

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

5.2.2 Azimuth Scans

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

6 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 -