

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**  
**HAYSTACK OBSERVATORY**  
**WESTFORD, MASSACHUSETTS 01886**

February 8, 2007

*Telephone: 781-981-5407*

*Fax: 781-981-0590*

To: VSRT Group  
 From: Alan E.E. Rogers  
 Subject: Laboratory demonstration projects

A] "Compact" projects using feeds only

1] Single baseline single lamp

Setup 2 feeds 6.5 cm apart and single fluorescent lamp initially about 30 cm away. Measure the correlation vs distance and angle. Make plots of the correlation vs distance and angle. The distance dependence should follow the inverse square law and the angle plots will trace the feed antenna pattern. With the lamp at 50 cm vary the distance between the feeds and measure the correlation vs the feed separation.

Model the lamp as a source of 5 cm diameter which equals 0.1 radians at 50 cm. The interferometer resolution at 6.5 cm and the wavelength of 2.5 cm (12 GHz) is 0.38 radians. As the wavelength of 2.5 cm (12 GHz) is 0.38 radians. As the baseline approaches 25 cm the source will become resolved. The feeds are circularly polarized and this can be demonstrated by reflecting the signal from the lamp off a metal sheet as illustrated in figure 1b. This will reduce the correlation which can be brought back by reflecting the signal into both feeds as shown in figure 1c.

2] Single baseline with two lamps

Two lamps can be used to simulate a double source. Set the lamps about 1 meter away from an initial baseline of 6.5 cm. Plot the correlation vs the separation of the lamps for various baseline lengths as illustrated in figure 1d.

3] Three baselines with 2 lamps

The SRT software (in VSRT mode) can analyze the fringe phase from 3 baselines to form the closure phase. The closure phase concept, which is discussed in memo 3 can be demonstrated by placing 3 feeds close together to form a triangle of baselines. When the lamp source is turned on fringes should be observed at 3 different fringe rates. The fringe rates should close and the closure phase should be zero within the noise. Non zero closure phase can be observed by using two lamps of equal strength or at different distances to form an asymmetric double source.

B] Projects using the antenna reflectors

Projects similar to those above can be performed in the laboratory if space is available. The far field distance for an antenna is the distance required to make the spherical wavefront approximate a plane wave over the aperture of the antenna to within an eighth of a wavelength. From geometry this distance is

$$D^2/\lambda \approx 8m$$

where D = the diameter of the dish (18")

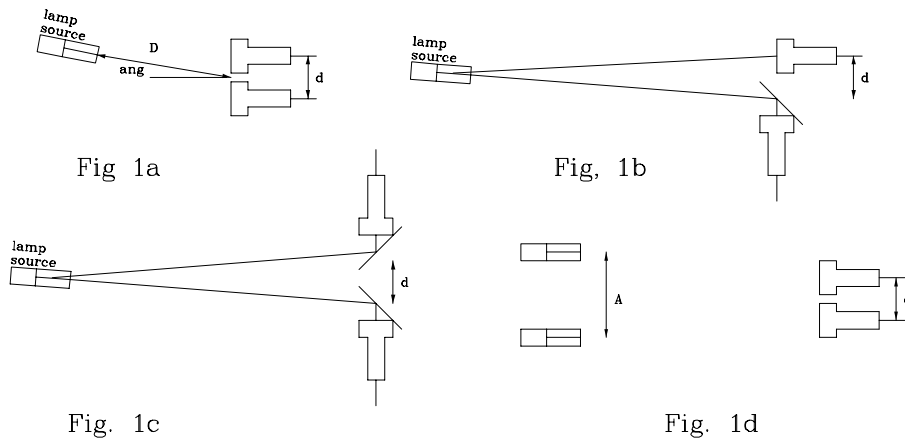
$\lambda$  = wavelength (2.5 cm)

In practice you may be able to work a little closer up to say a quarter wave deviation at a distance of 4 m.

1] Measure the satellite dish pattern

Point both dishes at the lamp source using a baseline which is short enough to be sure that the lamp is unresolved. Now explore the angular dependence of the correlation output by adjusting the pointing of one of the dishes while keeping the other pointed at the lamp as a reference. Since the correlation is the product of 2 voltage the correlation will trace out the voltage pattern which needs to be squared to obtain the power pattern of the dish.

The half power full width of the dish should be approximately  $1.22 \lambda/D \sim 3.8^\circ$



$d$  = interferometer baseline length  
 $D$  = distance to source  
 angular separation of sources in fig. 1d =  $A/D$  radians  
 interferometer resolution = wavelength /  $d$   
 wavelength = 2.5 cm (frequency = 12 GHz)

Figure 1. Suggested set-up for laboratory demonstrations using compact arrangement of 2 feeds for a single baseline