VSRT MEMO #030

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
HAYSTACK OBSERVATORY

WESTFORD, MASSACHUSETTS 01886

Revised July 14, 2008

Telephone: 781-981-5407
Fax: 781-981-0590

To: VSRT Group
From: Alan E.E. Rogers, P.A. Shute, P. Pratap, M. Arndt
Subject: Simple set-up to observe fringes on the Sun and measure the solar diameter.

Moving the simple set-up described in VSRT memo #028 outside it is possible to observe "fringes" on the Sun and possibly measure the solar diameter. However, there are some potential problems:

1] The dishes have a beamwidth of only 4 degrees and have offset feeds making it difficult to manually point at the Sun. This problem can be ameliorated by
   a. Screwing the dish mount to a piece of plywood. A 12"×12" base is a reasonable choice.
   b. Attaching a mirror to the center of the dish with double sided sticky tape so that the Sun's reflection on the active feed (the active feed is the feed on the right looking from the dish) can be used to center the beam on the Sun. The Sun can be tracked in elevation by rotating the base and in elevation by adjusting the mount.

2] Owing to the problem of pointing the dishes it is recommended that the experiment or demonstration be done on a sunny day.

3] Satellite signals will also produce fringes and the time during the months of September and October the Sun is very close to the satellite belt.

4] As in the simple indoor set-up the cable lengths from each LNBF need to be of equal length. In addition, the baseline needs to be perpendicular to the direction to the Sun so that the path lengths to the Sun from each dish are equal to within the inverse bandwidth of the IF signals. With approximately 1 GHz bandwidth the path lengths should be equal to within about 6 inches. In optical interferometry this condition is often known as being within the "white fringe".

Figure 1 is a photograph of a typical outside set-up. With 6 foot cable lengths between the LNBF and power combiner the baseline can be as long as about 120 inches. Longer cables are desirable if you want to explore the fringes on the Sun as a function of baseline length up through the first null. The first null occurs at the first null of the first order Bessel function (see VSRT memo #019). The Bessel function null is about at 3.85 so that a baseline b of $b = 3.85/(\pi d)$ wavelengths is at the null for a uniform disk.

On 2 April 2008 we did the experiment with manually pointed antennas as described above and obtained the results shown in Figure 3. The theoretical functions for a uniform disk are also plotted on the same graph. The Sun appears larger at radio wavelengths because of the refraction of the rays in the solar corona. [For more details see VSRT memo #24]. The accuracy is limited by the following factors:

1] Precise knowledge of the effective wavelength of the interferometer. [This error could be avoided by using a precise I.F. filter or using the CFLs and the same hardware to first measure the wavelength from the "double source" experiment done inside.]
2] Precise measurement of the projected baseline when it is not quite perpendicular to the Sun.
3] The Sun deviates from a uniform disk due to limb brightening and the presence of Sun spots.

Figure 1. Simple outside set-up to observe the Sun.

Figure 2. Using reflection of Sun from mirror to point at the Sun.

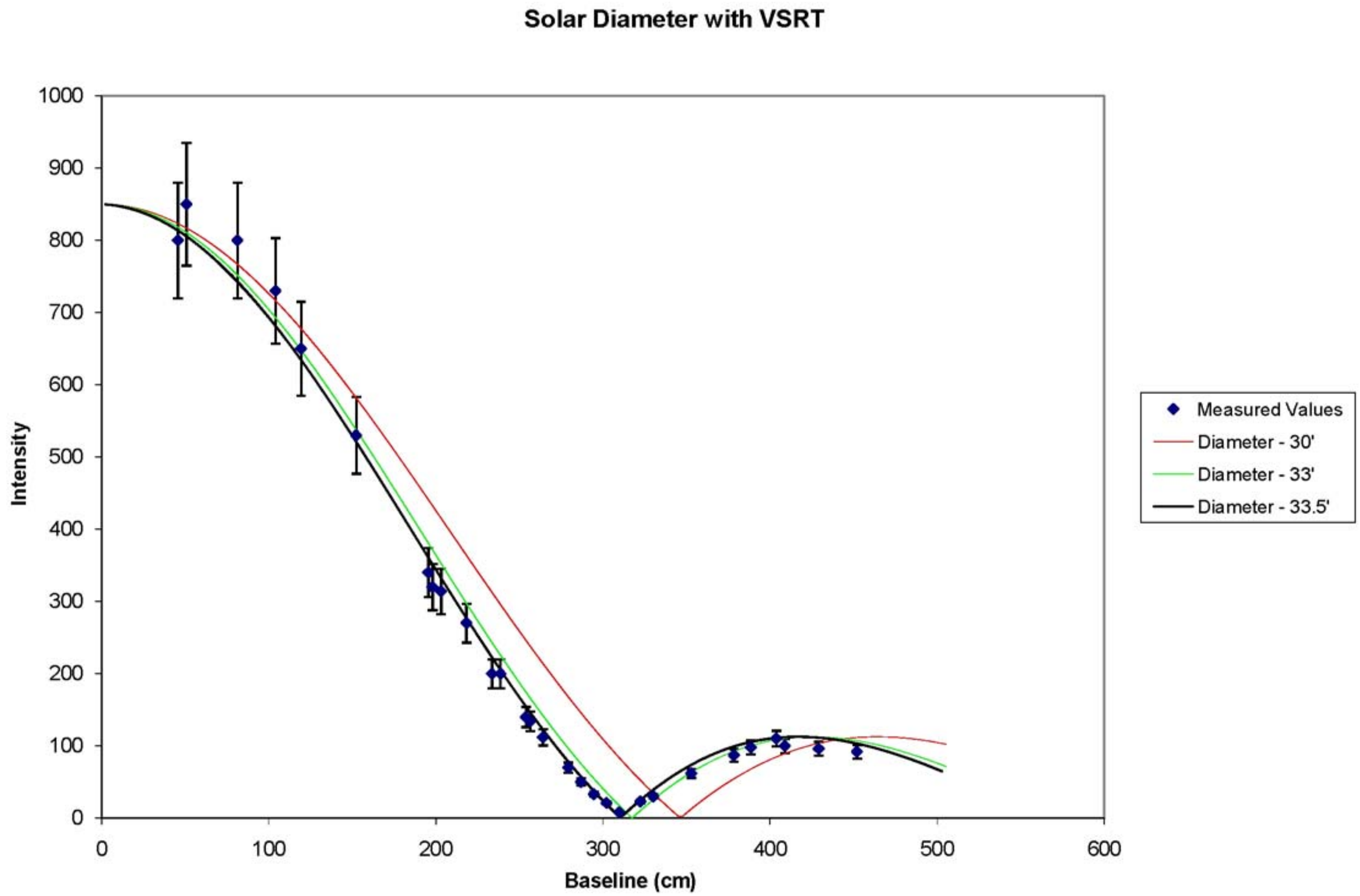

Figure 3. Measurements taken with manual pointing of the antennas.