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To: Deuterium Array Group

From: Alan E.E. Rogers

Subject: System calibration from normalized beam power

The normalized beam power see memo 23 is relatively free of gain variations. For example the "boresight" beam, which in the current configuration of station 1, points at the zenith and rotates through the sky in a sidereal day reaching a maximum at about 20.5 LST hours when the beam points at the Cygnus region. The variation with sidereal time is very repeatable if we exclude period when the sun is close to the beam. The observed normalized power b_n can be compared with the theoretical

$$b\_n(LST) = \frac{\left[\frac{1}{N} \left| \sum_i d(az,el) e^{-i f_i} \right|^2 \otimes T(az,el) + T_{rec} \right]}{\left[|d(az,el)|^2 \otimes T(az,el) + T_{rec} \right]}$$

where $d(az,el)$ is the voltage directivity

$f(az,el)$ is the phase delay to the ith element
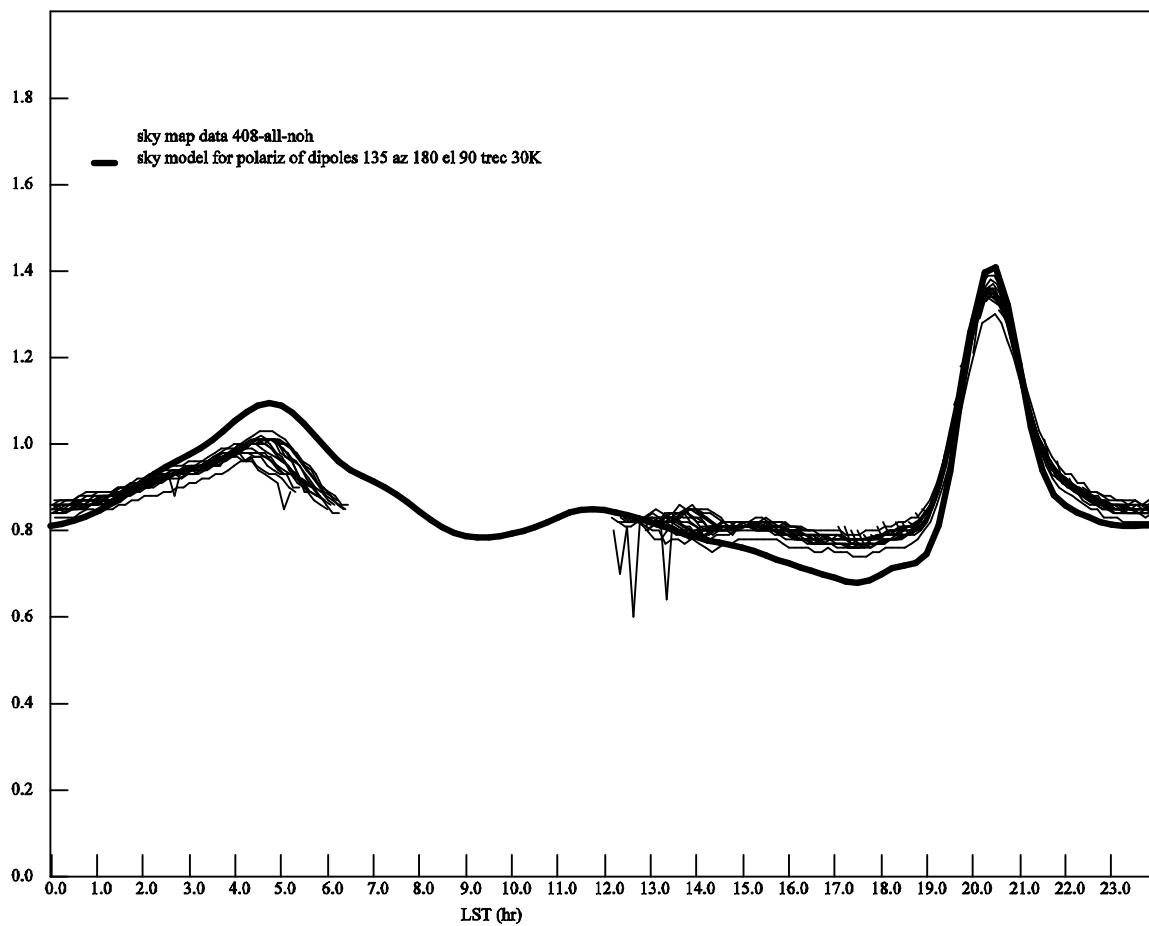
for an element of sky at az,el
N is the number of elements
T_{rec} is the receiver noise temperature
T(az,el) is the sky brightness vs az,el which array and dipole respectively in turn depend on the LST.

Ignoring any effects of mutual coupling which are small and tend to average out in the sum over many elements.

The receiver temperature is adjusted to make the best fit to the observations. The figure shows the data and the sky model from the map of Haslam using a value of 30 K for T_{rec}. The data from about 6 to 12 hours LST is omitted because the Sun is in the sidelobes of the beam during this time range.

The level of repeatability of the normalized beam is about 5%. Thus the overall accuracy of this method of calibration is about 10%. However further tests will be needed to make a better estimate of the accuracy.

sky map data 408-all-noh

sky model for polariz of dipoles 135 az 180 el 90 trec 30K

LST (hr)

D1 Array   Wed Aug 20 07:17:38 2003