National Radio Astronomy Observatory
Tucson, Arizona

April 19, 1987

MEMORANDUM

To: D. T. Emerson and E. B. Stobie

From: P. R. Jewell

Subject: Continuum Data Analysis Using Vane Calibration

The continuum vane cal procedure implemented by EBS last week worked very well. The vane cal method has been shown to provide a more reliable correction for atmospheric attenuation than the conventional method of scaling by $\exp(\tau A)$. It will also correct for system gain changes when there is no other calibration method available, such as a noise tube. The technique is, thus, particularly valuable for our high frequency receivers, for which we have no noise tube. We should now proceed with a method of automatically scaling data when the vane method is selected. I suggest the following:

1. Define a flag in FORTH which indicates whether the vane method or the conventional method of calibration is in effect. Transmit this flag through the Link Task to the analysis system.

2. When a vane cal is performed, treat it the same as a spectral line vane cal, i.e.,
   a) write the scan to the GAINS file, not the PDFL, and
   b) do not increment the scan number.

3. In the header of ON/OFF or mapping scans, write the scan number of the associated vane cal that is stored in the GAINS file. If there is room in the header, store the following information:
   a) the antenna temperature (uncalibrated) of the vane from the cal scan;
   b) the antenna temperature of the noise tube, measured during the cal scan, when a noise tube is present.

4. There are two cases for the calibration:

   a) No Noise Tube

      The basic calibration is given by

$$T_R^* = (ON - OFF) * \frac{TC}{(VANE - SKY)} \qquad (1)$$

The value of VANE is taken from the cal scan. SKY could be taken from the cal scan, but it would be better to take it from an average of all OFF (=REF) samples from the scan. By doing the latter, we get an average of the sky temperature over the course of the scan, in between vane cals. It also may allow observers to do fewer vane cals, since in the absence of receiver gain changes, the antenna temperature of the vane will stay the same. When averaging the REFs, we must take care that they are all really blank sky, since SIG and REF change phase during the OFF-ON-ON-OFF cycle.

b) Noise Tube Present

When a noise tube is present, we can correct for both atmosperic changes and receiver gain changes that occur during the course of the scan. During the vane cal procedure, measure the antenna temperature of the noise tube, and call it T_o. Measure the antenna temperature of the noise tube during the samples of the scan, T_i. Then multiply the data of the scan by T_o/T_i. (We can either average the T_i or do the multiplication sample by sample.) We then apply Equation (1) above. This should leave us with gain corrected to the time of the vane cal and atmospheric variations averaged over the scan.

5. The conversion from T_R^* to flux density (janskys) is given by the equation

$$S_{nu} = \frac{2\,k}{A_p} \frac{eta_A}{eta_l\ eta_{fss}} T_R^* \qquad (2)$$

where eta_l is the rear (warm) spillover efficiency and eta_{fss} is the forward (cold) spillover efficiency. These cal factors can be entered in place of existing FORTH parameters: put the vane TC (about 400) in place of the usual TC and the term $eta_A/(eta_l * eta_{fss})$ in place of %EFF. This latter term will be about 0.7 at 3 mm and about 0.4 at 1.3 mm.