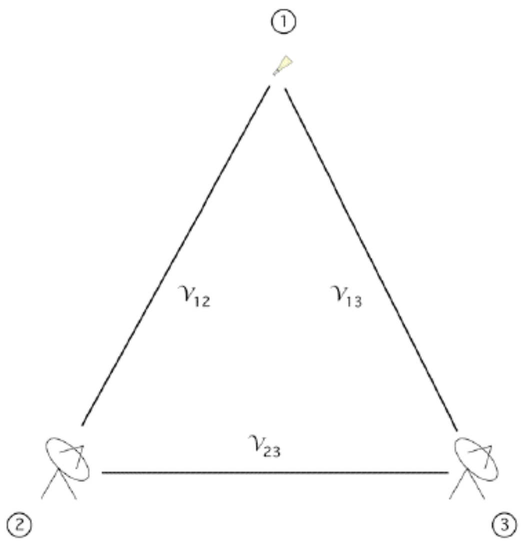
The Welch/Gibson/UCB direct antenna gain/flux measurement experiment was done at Hat Creek in Summer 2004 with the last four dishes of the BIMA array. The idea was to test a method proposed by Stephane Guilloteau ("Guilloteau Method") to measure the flux of an astronomical source directly, using a small standard horn as an element of an interferometer composed mainly of large dishes. To test the accuracy of this method, this flux was measured concurrently using the method of Gibson/Welch 2003 for calibrating the gain of a single dish by interferometric comparison with a standard horn, followed by single-dish total power flux measurements of the source.

This experiment was carried out at 86 GHz using a custom receiver in one of the BIMA antennas. The Guilloteau method is similar to an amplitude phase closure, and relies upon the gain of one of the antennas being known. In this instance, that is our standard gain horn, mounted at the edge of BIMA dish 1 and co-tracking with it.



$$S = \mathcal{V}_{12} g_{12} k_{12} = \mathcal{V}_{12} g_1 g_2 k_1 k_2$$
$$= \mathcal{V}_{13} g_1 g_3 k_1 k_3$$
$$= \mathcal{V}_{23} g_2 g_3 k_2 k_3$$

$$= \mathcal{V}_{12} g_1 k_1 U_2$$
$$= \mathcal{V}_{13} g_1 k_1 U_3$$
$$= \mathcal{V}_{23} U_2 U_3$$

$$U_2 = \frac{S}{\mathcal{V}_{12} g_1 k_1} \qquad U_3 = \frac{S}{\mathcal{V}_{13} g_1 k_1}$$

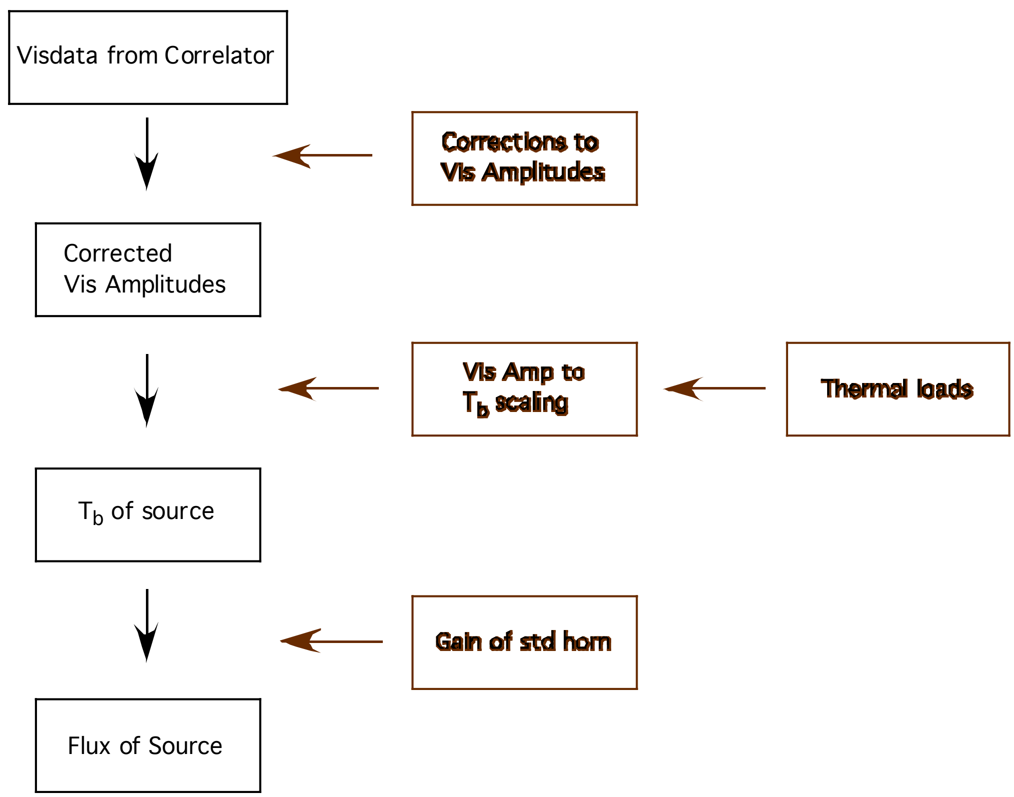
$$S = \frac{\mathcal{V}_{23} \; S \; S}{\mathcal{V}_{12} g_1 k_1 \; \mathcal{V}_{13} g_1 k_1}$$

$$S = \frac{|\mathcal{V}_{12}||\mathcal{V}_{13}|}{|\mathcal{V}_{23}|} (g_1 \, k_1)^2$$

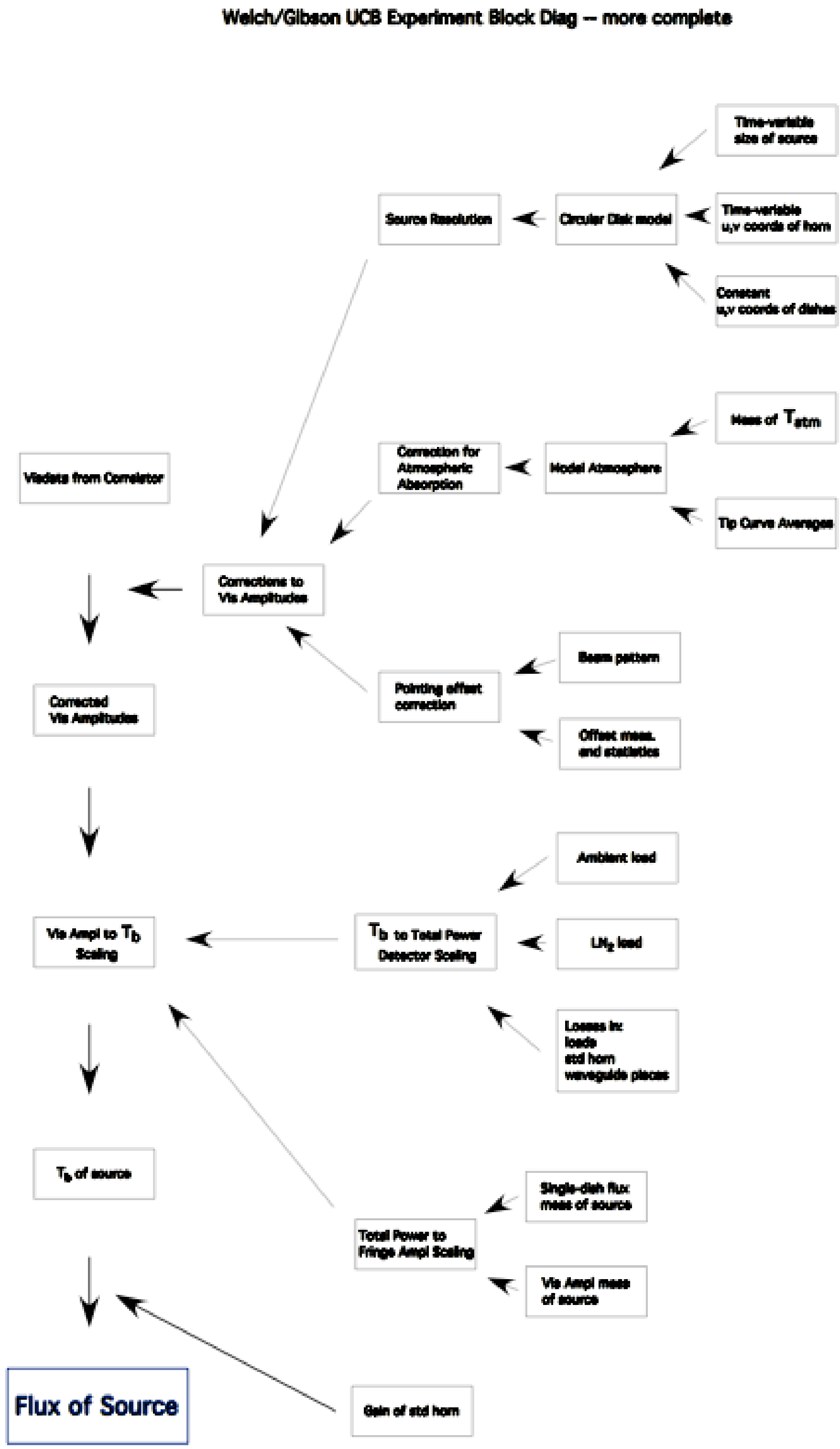
$$S = \frac{|\mathcal{V}_{12}||\mathcal{V}_{13}|}{|\mathcal{V}_{23}|} G_1 \, K_1$$

A simplified data-reduction flowchart is as follows:

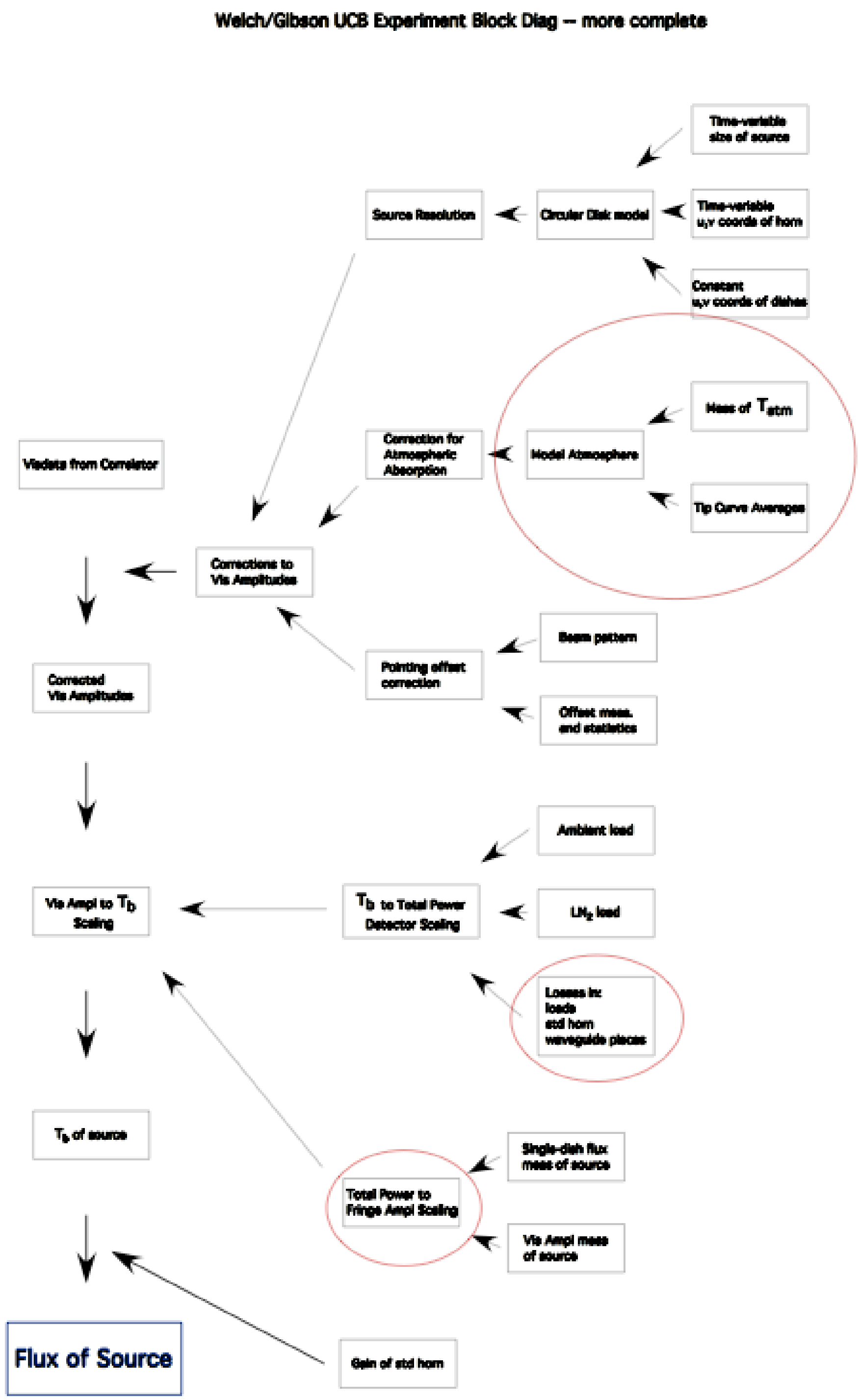
Welch/Gibson UCB Experiment Block Diag -- simple



A more complete flowchart looks like this:



Most of the measurements/corrections are good to about 1%. Certain areas are still problematic or TBD. These are highlighted here:



Getting reliable and timely atmospheric data is a concern. We think that under reasonably-good weather conditions, with continuous monitoring of atmospheric temperature and water-vapor content, and frequent tipping curves from a well-understood system, that the uncertainty due to atmospheric opacity can be nailed down to around 1%. In our experiment, we acquired these data as best we could (eg. atmospheric temperature structure measured in-situ with Jack's airplane, but not frequently enough -- tipping curves were complicated by close-spacing of the array) and are still assessing the final accuracy.

The method relies on a relation between fringe amplitudes at the correlator and power into the receiver. We calibrated the input power with thermal loads but realize that we should have had some sort of phase-locked stabilized source at the recievers to scale intermediate total power to the correlator output. This would not be hard to do, but we didn't do it. We're trying to establish this relation by comparison of single-dish flux measurements (for the other experiment) with visibility data of the same source. This seems to work at the couple-of-percent level but the observations were not made as systematically as they should have been, for this purpose. To get maximum accuracy out of the available data will require some strenuous reduction.

Finally, to know the effective load temperature difference at the reciever, the ohmic loss in the loads, standard horn (over which the loads were mounted) and connecting waveguide lengths must be measured at 1% accuracy. This requires some dedicated time with an 8510 network analyser (or equivalent) and mm-heads. Several weeks in a controlled climate are needed.

Nevertheless, pending these TBDs, our assessment is that this method is viable and with effort can be made to work.