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Subject: 1/f noise
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I have more or less completed an analysis of HFET receiver 1/f noise, but have not written it up as a formal memo. I think more lab work needs to be done on SIS receivers, and some input from the science group about atmospheric fluctuations is needed as well. This note summarizes my conclusions which I hope to write up formally in the not too distant future (end of July?).

These tentative conclusions are based on published work by Wollack and Pospieszalski, and by Kooi et al. in Internation Journal of Infrared and Millimeter Waves, Vol. 21, No. 5, 2000, pp689-716.

The Wollack & Pospieszalski data were based on tests using 3 GHz and 20 GHz bandwidths and 10 stages of amplification by 0.1 by 50 micron InP gates. I have transformed the data to make predictions for 16 GHz bandwidth and 6 stages, which gives about 34 dB gain; this will dominate any IF noise, which I have ignored.

HFET amplifier

The "knee" of the 1/f noise is at several kHz; for integration times greater than about 1 msec, the expected sample-to-sample noise is about 3e-4, changing very slowly with integration time. This means that, for example, at 1 sec integrations it will take about 1000 times more integration time to reach a given total power noise level than would be expected from a simple calculation of 1/sqrt(Bt)--6e-6 in 1 sec.

Kooi SIS receiver

Kooi et al. express the noise as an "Allan variance" without giving the normalization used to set the vertical scale of the noise plots. I have privately gotten additional information from Kooi, which implies that for his 345 GHz real receiver, for time scales from about 0.5-15 seconds the noise level is roughly constant at about 1e-4. Although this is about a factor of 10 in required integration time better than the prediction for the HFET receiver, it is still far above the ideal theoretical noise level.

Atmosphere

If the atmospheric noise is worse than either of these two receivers, then 1/f noise is not a factor in making a decision between them. I request help from the science group in resolving this question. Mark Holdaway started but did not complete a memo on this subject; I have a copy of his notes but have been unable to make any use of them.

Recommendations

The data for the HFET receiver are pretty clear. If we use such a receiver and need better results than the instrumental noise imposes, a more complex radiometric scheme is needed (beam switching? optically difficult; load switching? hard to balance; correlation receiver? more components).

The Kooi et al. data are interesting but we need to know more. I propose making similar measurements on a lab receiver here, once we have a good noise temperature with the 8 GHz IF. This might be started in August 2000.