19 January 1999

To: Gene Lauria, Edgar Castro, Bill Sisik, Tapasi Ghosh, Chris Salter, Mike Davis, Phil Perillat, Murray Lewis, JoAnn Eder, Karen O' Neill, Dan Altschuler

From: Riccardo Giovanelli and Jeremy Darling

Re: Feed Resonances in Wide L–Band Gregorian Feed

In the course of inspecting the rfi environment between 1100 and 1400 MHz, we have observed unexpectedly strong spectral features affecting the L band passband. The features have roughly Gaussian shape, with broad pedestals. They stick like sore fingers over the passband, emerging between 15% and 30% of T_{sys}, some 5 to 10 K; they are about 0.4 to 0.7 MHz wide at half power and appear extremely stable in the time domain. They do, in fact, subtract quite well in total power *on–off* observations, leaving no signature stronger than 2×10^{-4} of T_{sys} in difference spectra. They track with the RF, i.e. changes in the upstairs or downstairs LO's do not affect their frequency. They are of comparable but not equal strength in the two polarizations. They are present all the time.

Plots of the bandpasses over 25 MHz bandwidths for the six such features identified between 1100 and 1400 MHz are enclosed. The similarity in shape, time behavior and width suggests a common origin for the lot. Frequencies (and widths) are respectively: 1141.70 (0.74) MHz, 1229.33 (0.54) MHz, 1250.14 (0.60) MHz, 1303.85 (0.42) MHz, 1339.84 (0.55) MHz and 1384.60 (0.77) MHz. We observed the 1384.6 MHz feature in rapid succession with the Gregorian wide and "narrow" L–band receivers; the feature is invisible with the latter, relating it to the front end of the wide band system.

After conversations with Gene and Mike, the most likely explanation for the origin of the described features is that they correspond to trapped resonant modes in the cavity formed near the fins of the OMT of the feed. They are analogous to a similar feature previously noticed near 1665 MHz, with the same feed.

These features present a significant limitation in L–band spectroscopy. While they subtract very well when there is no difference in the continuum power between *on* and *off*, a difference of even a few tens of mJy between those powers will introduce a significant local distortion in the difference spectrum, of width disturbingly similar to those of typical extragalactic signals. The direction of the distortion is positive if the *off* has more power than the *on*. Note that the frequency span affected by this distortion is several times the half–power width of the features, so that the affected sections of spectrum that require cautious approach add up to a few MHz around each feature. Even at very small differential continuum power levels between *on* and *off* (say those corresponding to stochastic variations in the sum of power of faint background sources within the beam), the $t^{-1/2}$ decrease of the noise in the spectral channels affected will cease at some flux level (my guess at a few tenths of mJy of spectral noise), as the imperfect subtraction of the steep–sided feature starts playing a role. Remedial action is thus recommended if technically possible.