

NATIONAL RADIO ASTRONOMY OBSERVATORY
TUCSON, ARIZONA

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To: 36-Foot Telescope Spectral Line Observers

From: R. Howard

Subject: CO Spectral Line Calibration with new Fabry-Perot Filter

Prior to April, 1979 the only Fabry-Perot filter available had meshes (BTL) with a mesh period(P) of 2.11 mm. This filter did not have ideal rejection at ^{12}CO or even ^{13}CO . Thus the TC(SSB) values used had to be increased (see ULICH, B.L., NRAO MEMO, March 3, 1977, "Accuracy of Spectral Line Intensity Calibration with Cassegrain Receiver").

A new Fabry-Perot filter is now available (since September, 1979) which has been specifically designed ($P=1.98$ mm) for ^{12}CO , ^{13}CO and C^{18}O . The filter can be installed in or removed from the quasi-optics box in 15-20 minutes by the operator. Table I gives the insertion loss at the sky frequency (USB), isolation of the image frequency (LSB) and the gain ratio of the filter (G_i/G_s). The isolation is the insertion loss at the image frequency minus the insertion loss at the signal frequency.

TABLE I: CO FILTER #1 ($P=1.98$ mm)

USB SIGNAL FREQUENCY (GH _z) LINE	115.27 ^{12}CO	110.2/109.8 $^{13}\text{CO}/\text{C}^{18}\text{O}$
INSERTION LOSS (dB)	0.50	0.65
ISOLATION OF LSB (dB)	21.5	23.8
G_i/G_s OF FILTER	0.007	0.004

Using the values for G_i/G_s listed in Table I one can calculate the TC(SSB) values that should be used at ^{12}CO , ^{13}CO and C^{18}O . However, since the quasi-optics box reduces the amplitude of the spectral line vane calibration signal, the calculated TC values must be reduced by 7% (See ULICH, B.L., NRAO MEMO, September 18, 1979, "Calibration with Quasi-Optics Box Installed"). Table II lists the calculated values of TC for frequencies in the 80-115 GHz range. The TC(DSB) values are calculated for receiver gain ratio (G_i/G_s) of 1.0. In general the receiver G_i/G_s is not exactly 1.0 and will depend on the diodes used and how they are tuned. For the TC(SSB) values in the 80-105 GHz range, the image rejection was assumed to be perfect ($G_i/G_s = 0$). This is not true for all

frequencies in that range. To determine to correct G_1/G_S , one should look at the Isolation/Insertion loss curves for the image rejection filter being used.

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TC VALUES FOR CO SPECTRAL LINE CALIBRATION --TABLE II
 USING CASSEGRAIN RECEIVER WITH QUASI-OPTICS BOX

Frequency (GHz)	80-105	110	115
Spectral Line(s)	HCN, HCO ⁺ , CS, etc.	¹³ CO, C ¹⁸ O	¹² CO
G _s (With Filter)*	0.000	0.004	0.007
τ _s (Nepers)	0.080	0.120	0.350
τ _i (Nepers)	0.080	0.075	0.085

CALCULATED VALUES OF TC USING IMAGE REJECTION FILTER*

ELEVATION	TC(SSB)	TC(SSB)	TC(SSB)
90	367	369	375
80	367	369	376
70	367	369	376
60	367	369	377
50	367	370	378
40	368	370	380
35	368	371	382
30	369	371	385
25	369	372	390
20	370	374	397
15	371	377	415

CALCULATED VALUES OF TC WITHOUT IMAGE REJECTION FILTER (G₁/G_s=1.0 FOR ALL FREQUENCIES)

ELEVATION	TC(DSB)	TC(DSB)	TC(DSB)
90	735	751	850
80	735	752	852
70	735	753	859
60	735	755	872
50	736	758	893
40	736	764	932
35	737	767	963
30	737	773	1007
25	738	780	1076
20	740	793	1194
15	743	816	1442

VALUES USED FOR ABOVE CALCULATIONS

T_{bg} = 2.7K T_m = 280K η_{source} = 0.64
 T_{sbr} = 280K η_{sky} = 0.87 T_{amb} = 290K

REFERENCES

Hollis, J.M., and Rhodes, P.J. 1976, NRAO Documentation Memo #1: Spectral Line Calibrations.
 Ulich, B.L., and Haas, R.W. 1976, *Ap. J. (Suppl.)*, 30, 247-258.
 Wannier, P.G., Arnaud, J.A., Pelow, F.A., and Saleh, A.A.M. 1976, *Rev. Sci. Instr.*, 47, 56-58.
 Ulich, B.L., March 3, 1977, NRAO Memo: Accuracy of Spectral Line Intensity Calibration With Cassegrain Receiver.
 Ulich, B.L., September 18, 1979, NRAO Memo: Calibration with Quasi-Optics Box Installed