CSIRO DIVISION OF RADIOPHYSICS

THE AUSTRALIA TELESCOPE

AT/20.1.1/029

LEVEL CONTROL AND T_{sys} MONITORING IN THE AT

This note expands on an earlier discussion in AT/20.1.1/016 (level and gain control in the AT). In that document I inidicated that the coarse level control attenuators (2dB steps) should be controlled from the level monitors and the fine level control, achieved by varying the sampler reference levels, should be controlled from the measured distribution of samples amongst the various states of the digitizers. The changes to this procedure set out below have been discussed with those responsible for implementing the system but have not been documented before.

Fine and Coarse Level Control

I now propose that both coarse and fine level controllers should be driven by the sample distribution statistics. Warwick Wilson plans to generate these statistics at the samplers rather than at the correlators as previously proposed so that quite short feedback times are now possible. The system should operate as follows:-

1. At the start of an observation default values of attenuation and reference levels are set up and then the output of the level monitor used to set up the coarse level control attenuator to within ± 1dB.

2. During the first integration period the sample statistics are used to adjust the fine controller.

3. From the second integration on sample statistics are accumulated over a whole integration time and any changes required to the controllers implemented in the dead time before the next integration.

4. The difference between the required setting, (as indicated by the sample statistics during an integration) and that actually in place, (which was that value indicated by the sample statistics accumulated during the previous integration) can be passed to the correlator control computer in case corrections to the data need to be made. This will only be necessary in the worst observing conditions where T_{sys} is changing rapidly due to emission from water vapour. At these times poor dynamic range may be expected in any case so corrections may still not be warranted.

   The change in signal level is acheived in steps of 2dB in the coarse level control attenuators and in finer steps of the order 0.1dB in the reference voltages of the 2 and 4 bit samplers. These fine steps should cover a range of ± 1dB so as to integrate with the 2dB attenuation steps.

   The levels are correct when the 2 bit reference level V_R (or the 3rd level in the 4 bit digitizer) is set to 0.95 of the RMS signal voltage V_S. If the total fraction of samples above V_R and below $-V_R$ is F then for a Guassian

distribution F = 0.3421 for $V_R = 0.95\ V_S$. Table 1 shows the attenuation corrections ΔA to be applied to the total level control system for various measured values of F. For errors less than about 2dB the correction can be expressed with sufficient accuracy as:- A(dB) = 6.181 - 18.067F

T_{sys}Monitoring

Measured correlation coefficients express the correlated signal between two antennas as a fraction of the geometric mean of their system temperatures. These temperatures are variable parameters that need to be measured during each integration and conveyed to the correlator control computer. Tsys therefore needs to be measured every integration period at locations immediately prior to each sampler in the system. This is done with the level and gain monitors specified at each of these locations which measure $k_s T_{sys}$ and $k_N T_N$ respectively. T_N is the amplitude of the modulated noise added to the system at the front end and the measurement constants k_s and k_N should either be equal or constant and known. Ultimately we require to know T_{sys}/T_N to a precision of approximately 1% (AT/20.1.1/020). T_N can be determined by reference to strong calibration sources and should be stable to approximately 0.1% between such calibrations.

It should be noted that it is not necessary to measure the signal level to a precision of 1% with the level monitors but only its ratio to the modulated added noise level. If necessary signal levels can be determined to this precision from the sample statistics. It should also be noted that the signal level is controlled to a range of±1dB at the point where T_{sys}/T_N has to be determined. Non linear effects in detectors are therefore minimized.

Table 1

Attenuation correction ΔA to be applied to fine and/or coarse level controllers. F is the total fraction of time the signal is above V_R or below $-V_R$. Positive values of Δ A indicate that the attenuation should be increased.

ΔA (dB)	F	Δ A (dB)	F
10	0.7639	0	0.3421
8	0.7053	-0.1	0.3366
6	0.6340	-0.2	0.3310
5	0.5932	-0.3	0.3254
4	0.5489	-0.4	0.3198
3	0.5012	-0.5	0.3143
2	0.4505	-0.6	0.3087
1	0.3972	-0.7	0.3031
.9	0.3917	-0.8	0.2976
.8	0.3863	-0.9	0.2920
.7	0.3808	-1	0.2865
.6	0.3753	-2	0.2317
.5	0.3698	-3	0.1796
.4	0.3643	-4	0.1322
.3	0.3588	-5	0.0911
.2	0.3532	-6	0.0580
.1	0.3477	-8	0.0170
0	0.3421	-10	0.0027

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23 September, 1986