29/6/99

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Hello all,

After discussions with Frank followed by examining the the log files that have been taken and checking on gear correction issues in the TCS I have come to the following tentative conclusions.

1) There is no known mechanical resonance at this frequency in the telescope and drive system. If it is mechanical then something must have changed. Either something has got much less stiff or there is a non-linearity (such as backlash) which is producing a limit cycle.

2) It is possible that the tuning of azimuth servo card could produce a peak in the closed loop performance. The tests I did before Easter shown that there was no such peak even though the closed loop gain was a little too high.

3) The position error plots show an oscillation of 1.13 Hz when tracking at an elevation of about 61 degrees. This gives a spatial period of 0.0167 degrees. Plots where the velocity has been held constant and the telescope is still slewing give ripples at a spatial period of 0.0075 degrees. These are not related to anything in the drive gear or encoder gearing but the 0.0076 degrees is precisely the cogging frequency of the azimuth drive motor/s.

4) I have seen this sort of oscillation in the logs taken over the last year but did not see it during the electra run in May.

5) Since this is position error it represents the inability of the telescope servo to follow a smooth velocity profile. We know it is not due to gearing features but that it changes period and amplitude with velocity. This indicates to me that there is a disturbance in the closed loop that the system has difficulty rejecting completely even though it is well within the servo bandwidth. The plots which show a constant velocity demand from the TCS but a 0.5" wiggle on the position error as it decreases towards the target rule out any problem with the TCS. However it does not rule out possible problems with CAMAC and the rate generator demand, nor with the rate generator and counter board (and even the clock board) of the Marconi system. Note my comments in my

e-mail report of my last visit.

The most likely culprit is the azimuth power amplifier/s or the motor/s (e.g.
brush failure). A way of testing these is to input a velocity demand at the
velocity summing junction through the auxiliary input on the processing board.
The position feedback should be disabled using the switch (on the new servo
board) which grounds the centre point of the two 12k resistors. If a precision
DC voltage source is used for this then you should get a reasonably constant

velocity from the telescope but, because the position loop is not closed, the
disturbance rejection will not be as good and there will be variations at the
drive gear periods. What we are looking for is variations not associated with
these though so it should be possible to pick out problems with the power amps
or motors or indeed anything within the velocity loop. The tacho has a ripple
period of 0.0104 degrees which I don't think appears in the logs that have been
taken.

Remember that there are two drive motors and each will have their own

ripple/cogging torque at the same spatial frequency because it is simply

related to the number of poles/windings and commutator segments in the motor.
When Marconi installed the servo and set the motors up they adjusted the
relative positions of the motors so that the ripple/cogging torque should

roughly cancel out. If the characteristics of one of the motors was to change,
e.g. due to brush or commutator wear or poor connections, then the cancellation

would not be effective any more. My advice would be to do the test above so you
have a measure of both the position loop performance and the velocity loop
performance (assuming that you can still repeat the problem), then check out and
service both motors and repeat the tests.

Pages 71 to 73 of my Inductosyn Tape Report (a copy of this is in the library
out there) gives a diagram of all the gearing, a typical power spectrum of all
the disturbances due to gearing and motor/tacho features and a table of
periods/frequencies associated with these components. I will fax a copy of these
pages to Mavi but they may not come out so good.

6) Secondary transducer 3 is not functioning at all. Either it is off range or
the electronics is broken. When you get no change at all from the transducer

signal it means that there is no noise on the signal either and therefore the
most likely situation is that the CAMAC ADC input channel is saturated. This can
be because the transducer has exceeded its range or is not plugged in etc etc.
This will have litle or no effect on azimuth short term tracking but

ill have a
an effect on azimuth and elevation pointing.

Hope this helps with sorting out this particular problem.

Cheers,

Martin

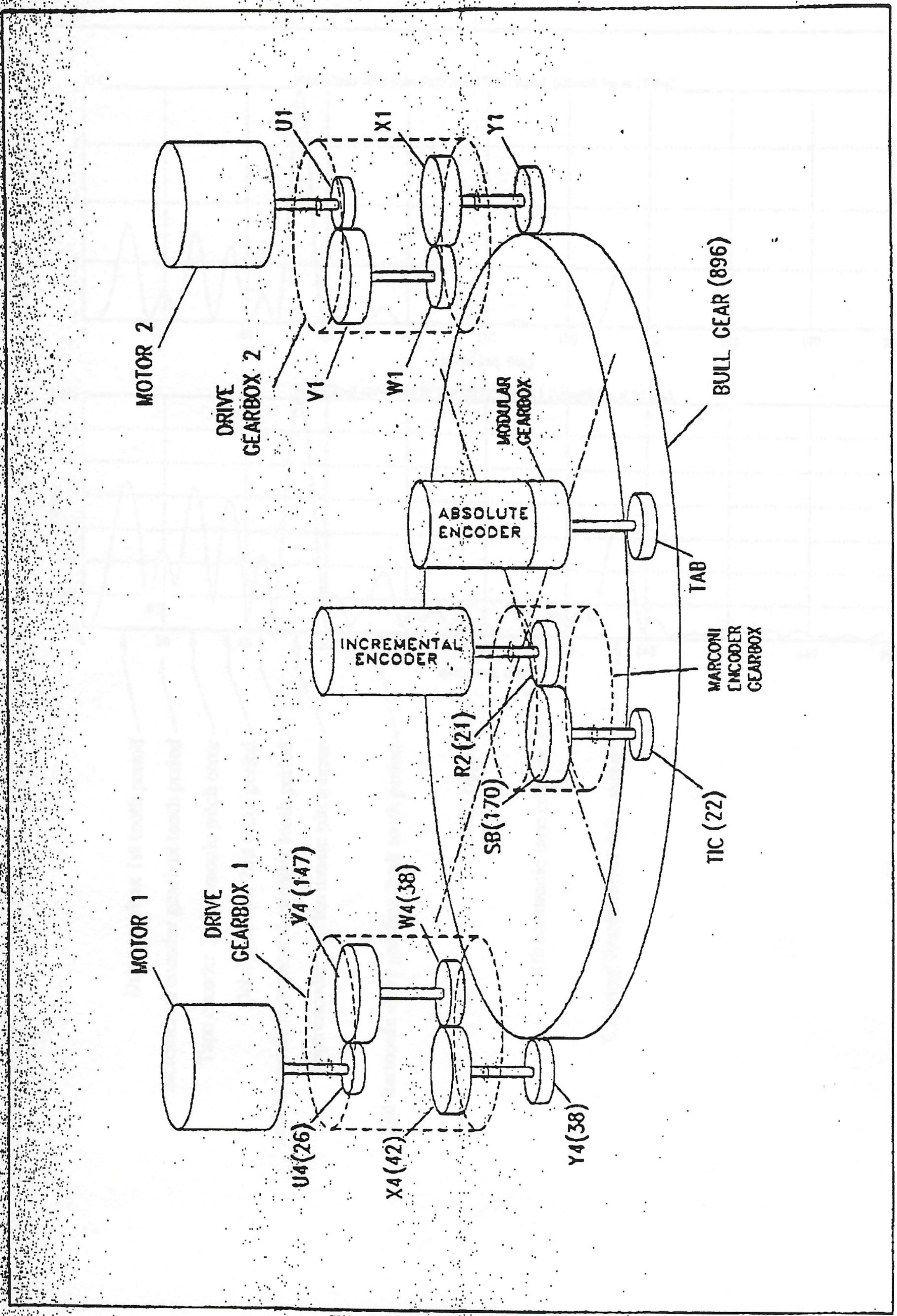

Fig. 4.12 Azimuth gear train

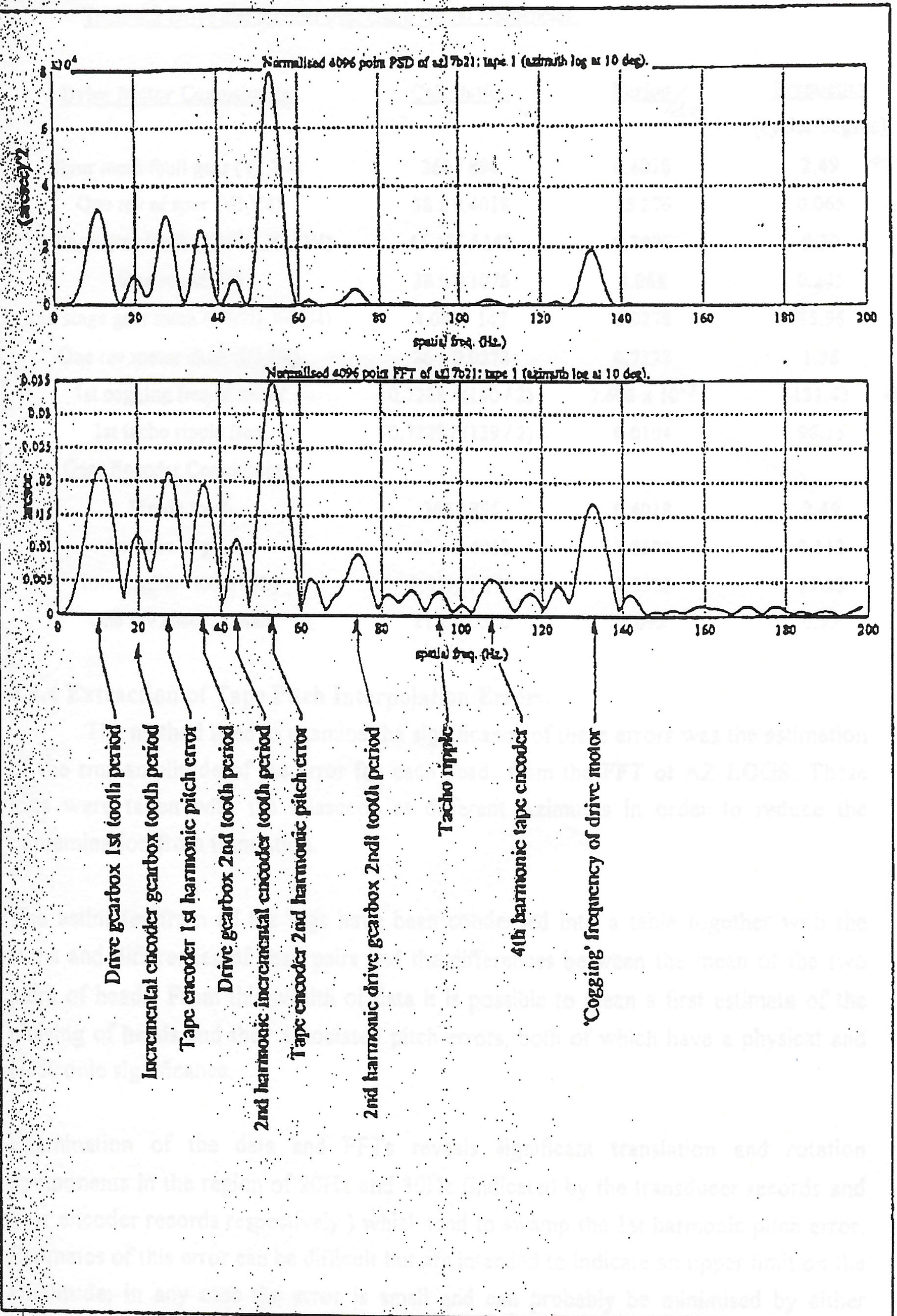

Fig. 4.13 Azimuth drive and encoder frequencies

Table 4.2 Drive and encoder gear chain spatial frequencies.

Drive Motor Components:	Calculation	Period /deg	Frequency (cycles/degree)
Spur tooth /bull gear (Y1,Y4)	360 / 896	0.4018	2.49 ←
One rev of spur (Y1,Y4)	38 x 0.4018	15.276	0.065
1st stage gear tooth (X1/W1,X4/W4)	15.276 / 142	0.1076	9.30
One rev of W4	38 x 0.1076	4.088	0.245
2nd stage gear tooth (V1/U1,V4/U4)	4.088 / 147	0.0278	35.96
One rev motor shaft (U1,U4)	26 x 0.0278	0.7228	1.38
1st cogging freq of motor	0.7228 / (190 / 2)	7.608×10^{-3}	131.43 ← ~1Hz
1st tacho ripple freq.	0.7228 / (139 / 2)	0.0104	96.15
Gear Encoder Components:			
Pinion tooth	360 / 896	0.4018	2.49
One rev of pinion	22 x 0.4018	8.8392	0.113
Intermediate tooth (SB)	8.8392 / 170	0.0520	19.23
One rev encoder shaft	21 x 0.0520	1.092	0.92

4.4.4 Extraction of Tape Pitch Interpolation Errors.

The method used to examine the significance of these errors was the estimation of the rms amplitude of the error for each head from the FFT of AZ LOGS. These logs were taken with the telescope at different Azimuths in order to reduce the contamination from translation.

The estimates from all the logs have been condensed into a table together with the sums and differences of head pairs and the differences between the mean of the two pairs of heads. From this wealth of data it is possible to glean a first estimate of the phasing of heads and their associated pitch errors, both of which have a physical and electronic significance.

Examination of the data and FFTs reveals significant translation and rotation components in the region of 20Hz and 30Hz (indicated by the transducer records and gear encoder records respectively) which tend to swamp the 1st harmonic pitch error. Estimates of this error can be difficult but are intended to indicate an upper limit on the amplitude; in any case the error is small and can probably be minimised by either electronic trimming or nulled by averaging heads deliberately positioned in anti-phase.