SAP data

It is important to note that not all the data from sap can be used; I have built the distribution for all the data provided by sap; the number of different values is as follows:

```
  3 DATA/FIINC.bins
 30 DATA/GYEXC.bins
 51 DATA/GYRO_PO.bins
  3 DATA/GYTQ.bins
362 DATA/INCLIN.bins
356 DATA/LVDT.bins
 26 DATA/MGYAC.bins
166 DATA/MLIBM.bins
  3 DATA/SAPSVR.bins
1000 total
```

that is the filtered inclinometer, the gyro torque and the sap servo current may be considered as constant (see following table;)

40816.000000 241	40848.000000 68	32720.000000 4
40832.000000 35942	40864.000000 19969	32736.000000 7821
40848.000000 27715	40880.000000 43852	32752.000000 56064
Filtered inclino	Gyro torque	Sap servo

The distribution of LVDT is shown (normal and log scale) in Fig 1 and 2. The distribution of inclinometer is shown in Fig 3 and 4. Note that they closely resemble each other as it will be better discussed in the following.

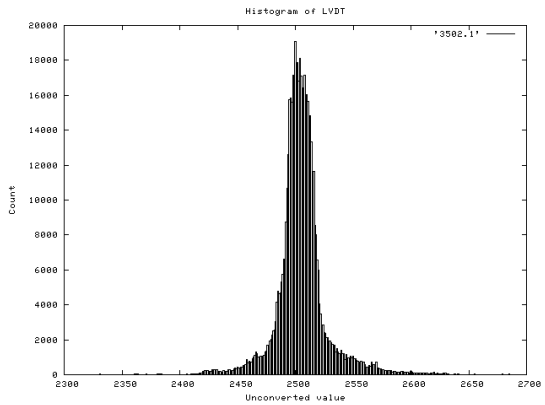

Illustration 1 LVDT distribution

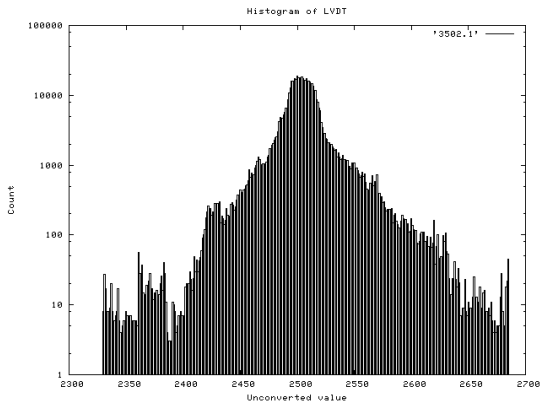

Illustration 2 LVDT distribution

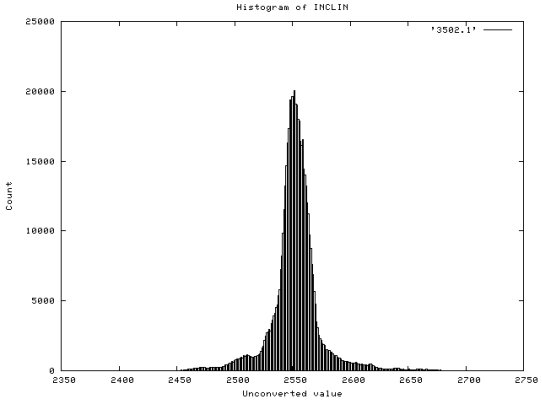

Illustration 3 Inclinometer distribution

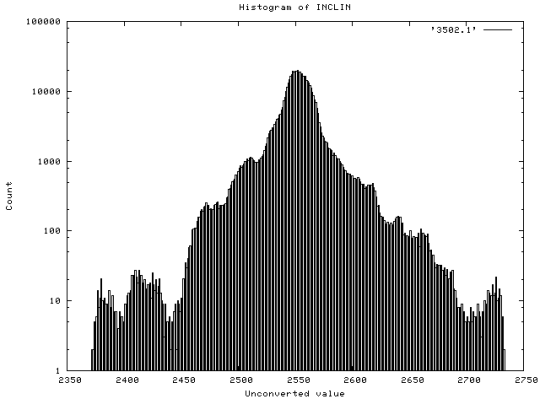

Illustration 4 Inclinometer distribution

Distribution of other sap values may less symmetrical (see for instance gyro excitation, Fig 5 or 6 and gyro ac current Fig 9 and 10) or more narrow (see for instance gyro pickoff, Fig 7 and 8)

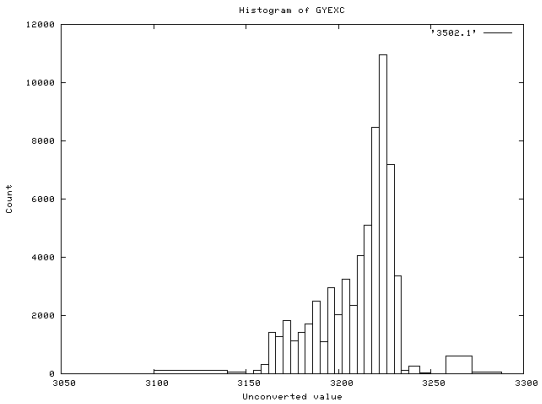

Illustration 5 Gyro excitation distribution

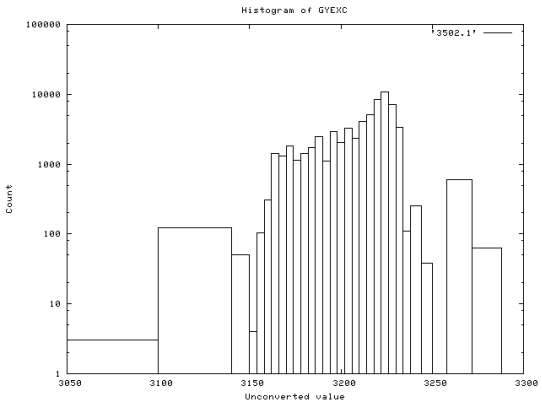

Illustration 6 Gyro excitation distribution

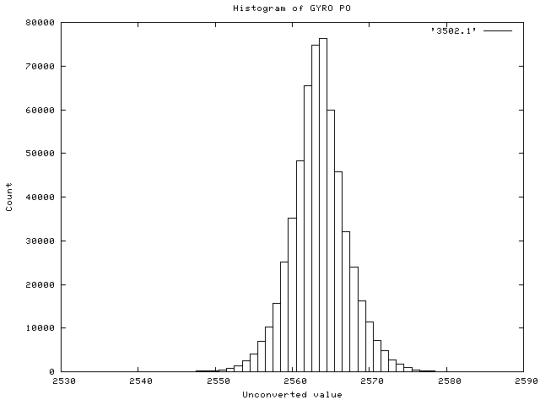

Illustration 7 Gyro pickoff distribution

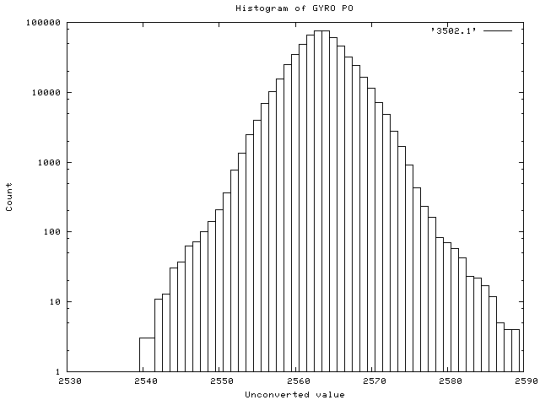

Illustration 8 Gyro pickoff distribution

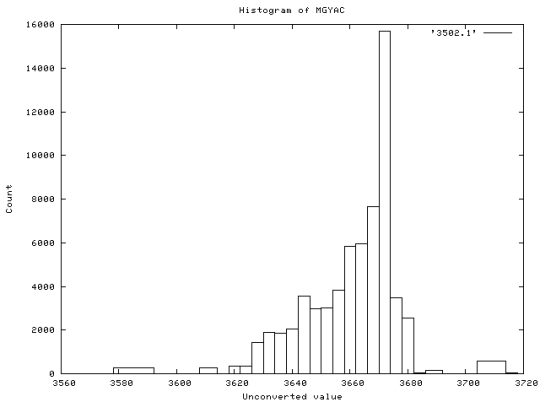

Illustration 9 Motor gyrro ac distribution

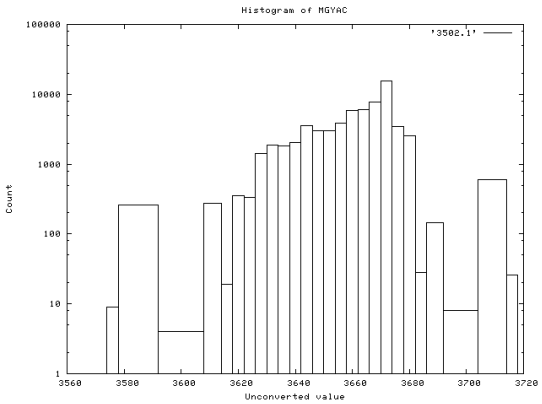

Illustration 10 Motor gyro ac distribution

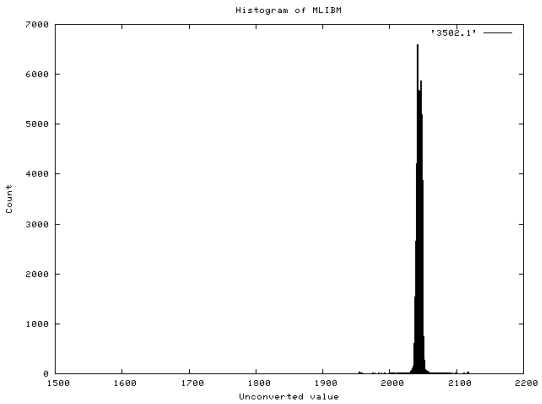

Illustration 11 limb scan motor current distribution

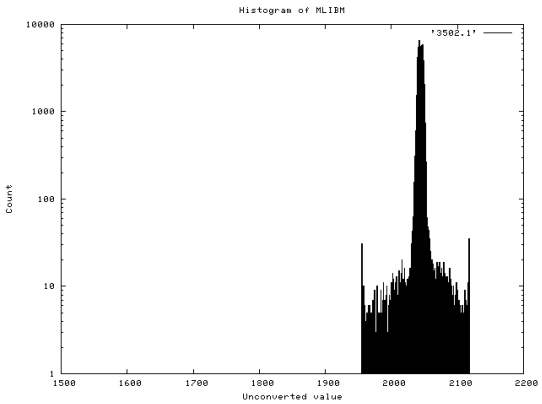

Illustration 12 limb scan motor current distribution

Distribution of the limb scan motor current (fig 11 and 12) seems slightly asymmetrical; this may be possibly due to an uncorrected unbalance of the mirror. The wide band at low value is due probably to an error in telemetry or spurious effects because only two measurements are at the origin of this effect (see excerpt below)

24400.000000 1
29440.000000 1
31264.000000 1
31280.000000 31
31296.000000 11
31312.000000 5
31328.000000 10
31344.000000 6
31360.000000 2
31376.000000 4

CAGED SAP

The gyro pickoff during ascent (before passing to normal) is shown in 13. The gyro in this configuration acts as a rate gyro (that is it measures the speed of gondola sway). Under the graph note the row bars which indicates the region of 'init' status for the sap and the region where automatic has been sent. Note that, as expected, the automatic status cover one oscillation.
By integrating (simply summing up[1]) the values of the gyro rate I have reconstructed the position of the gondola with respect to horizontal (Fig 14). Note the oscillations and the slow return to 0; note also that the last value is zero, that is, as expected, the sap switches to normal mode as soon as the vertical has been found as mean between to maxima elongations.

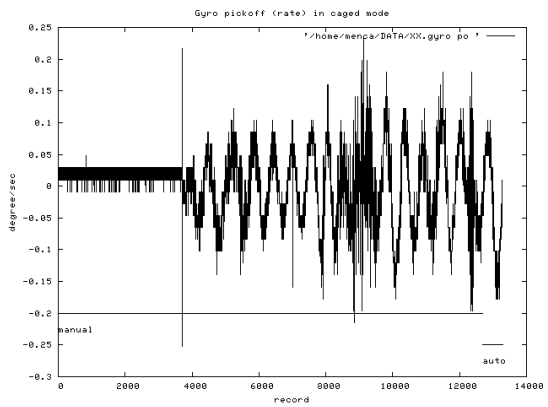

Illustration 13 Gyro pickoff in caged sap

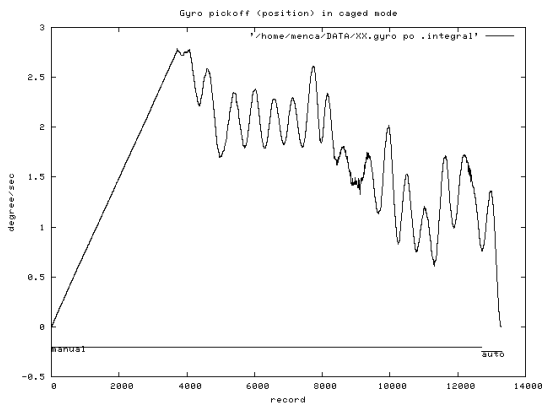

Illustration 14 Gyro position in caged sap

The power spectrum of the gyro pickoff is shown in Fig 15, 16 and 17. The peak is at about 0.04 hz, that is 25 sec. Which is by a factor 2 larger than expected[2]. **This discrepancy has still to be understood.**

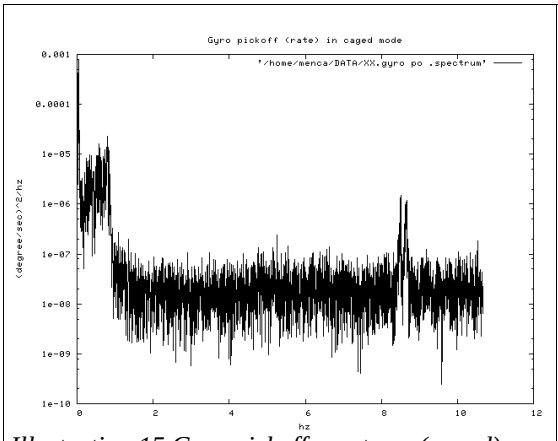

Illustration 15 Gyro pickoff spectrum (caged)

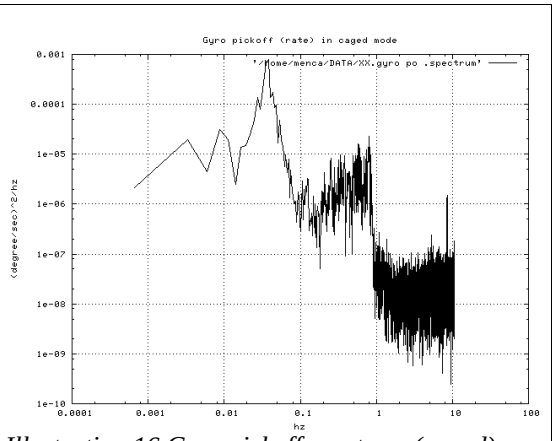

Illustration 16 Gyro pickoff spectrum (caged)

1 Time between the samples is assumed to be 1.(9*2.37) = 0.047 sec
2 Chain length is about 180 m, that is T=sqrt(2*3.14*180/9.80) = 10.7 sec

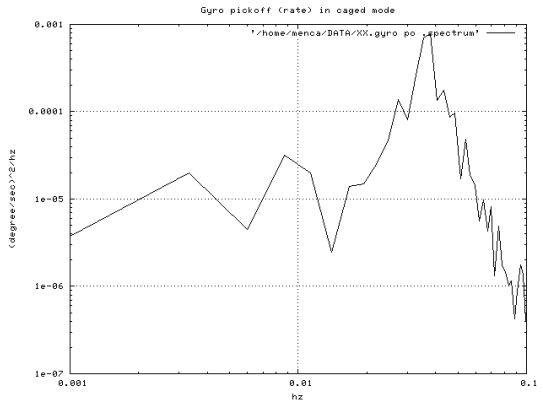

Illustration 17 Gyro pickoff power spectrum - expanded

While the gyro pickoff does not suggest major problem there is some problem of interpretation for LVD and inclinometer. In the caged mode the two parts of the SAP (mobile and fixed) should be linked one to the other by means of the LVDT. I therefore expect a constant value for LVDT (if offset well corrected the value should be 0). Values received from telemetry however show a plateau at about 2 degrees follwoed by a sudden jump to -2 degrees (Fig. 18). Similar consideration apply to the inclinometer which, in caged mode, should sense only the compound pendulum and the static offset. Again (see Fig 20) I have a plateau followed by a sudden jumos which leads to another value.

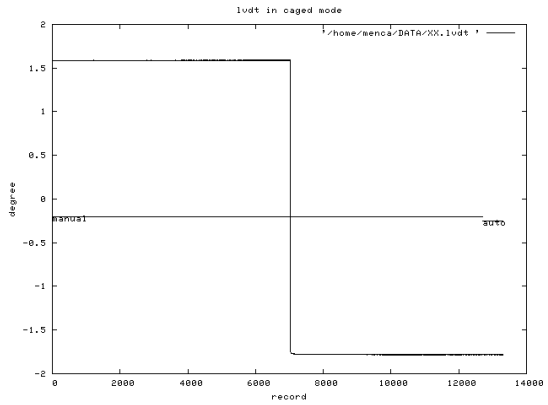

Illustration 18 LVDT - caged mode

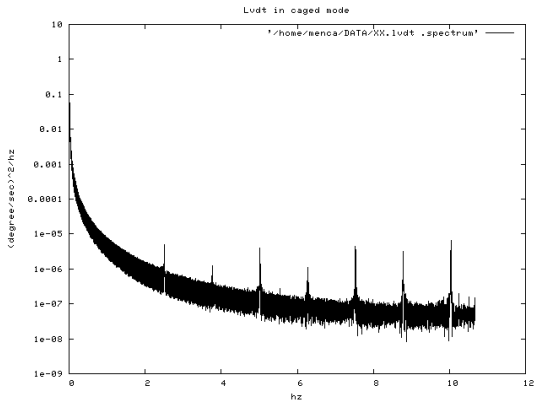

Illustration 19 LVDT spectrum - caged mode

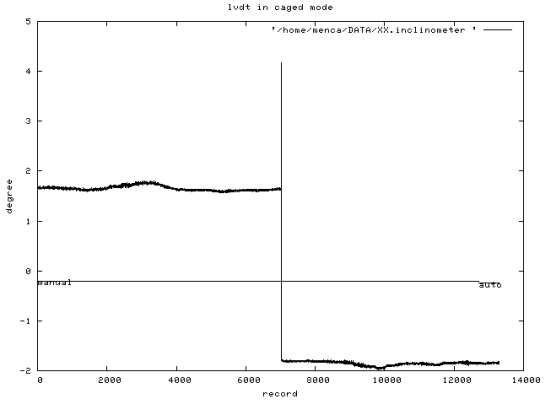

Illustration 20 Inclinometer - caged mode

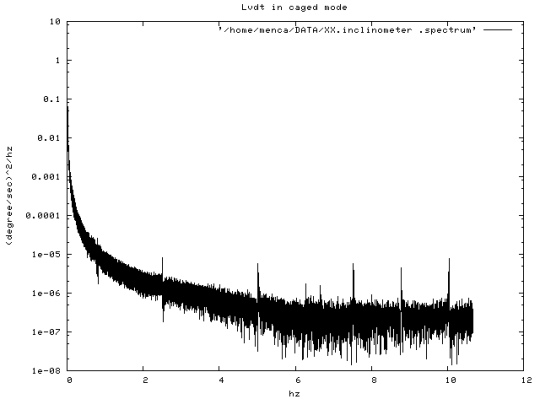

Illustration 21 Inclinometer spectrum - caged mode

LVDT

The LVDT is a sensor which measured the displacement between the gondola (or better: the fixed part of the SAP platform) and the mobile part of the SAP platform. When the sap is in normal mode the mobile part is unlocked from the gondola so the value should give the difference between the mobile part (nominally: horizontal) and the gondola baseplane; so ir should contain the sway and the static tilt. Results are shown here below for all flight (Fig. 22 and 23), for the float region (Fig. 24 and 25) and for the ascent region (Fig 26and 27).

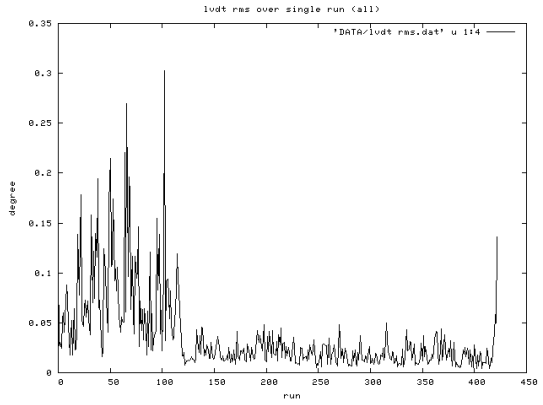

Illustration 22 LVDT rms per run - all flight

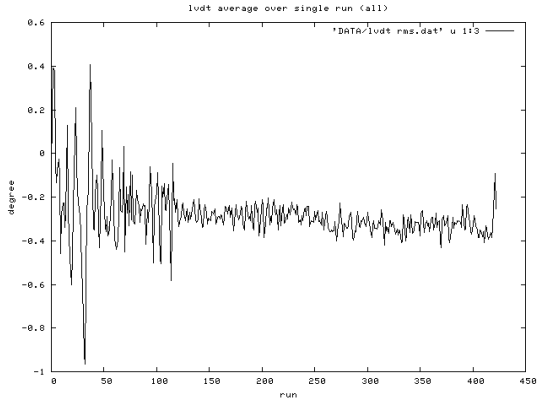

Illustration 23 LVDT average all flight for each run

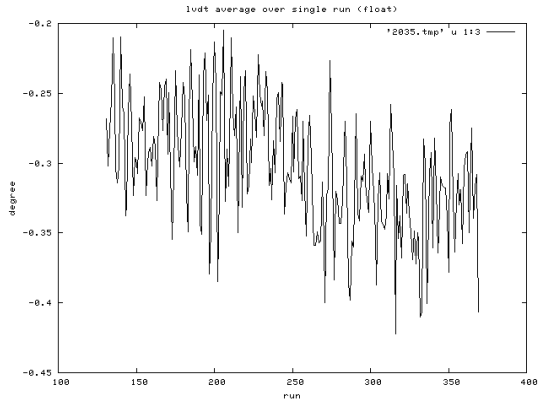

Illustration 24 LVDT average at float

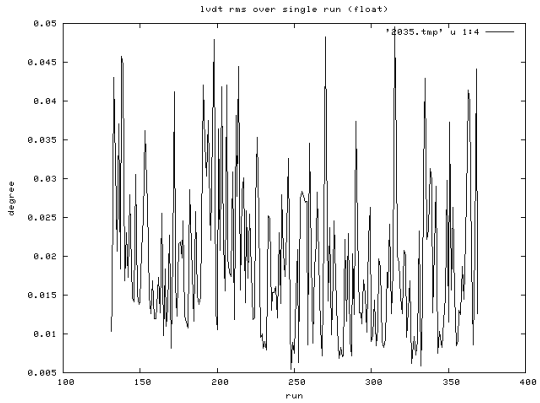

Illustration 25 LVDT rms at float

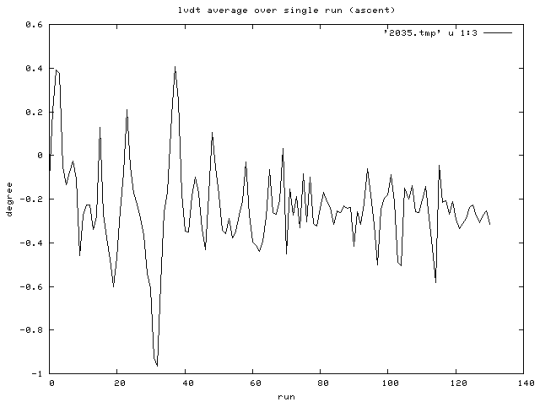

Illustration 26 LVDT average during ascent

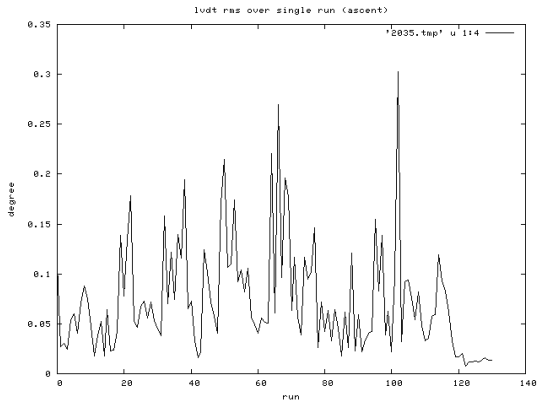

Illustration 27 LVDT rms during ascent

Inclinometer

In the normal mode the inclimometer senses the gondola sway as acceleration; it should therefore contain the oscillating part of the gondola. Here below we show the values (averaged for each run) for all the flight (Fig 28 and 29), for the float part of the flight (Fig 30 and 31) and for the ascent part of the flight (Fig. 32 and 33).

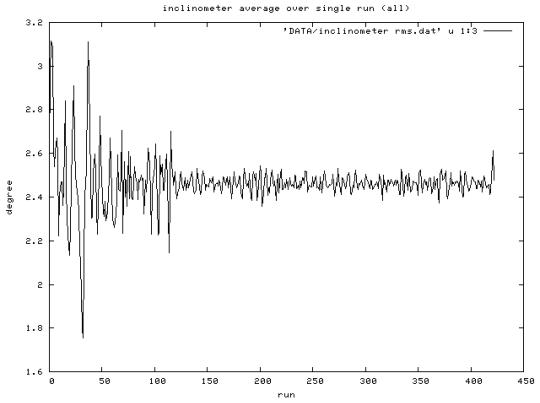

Illustration 28 Inclinometer average per run - all flight

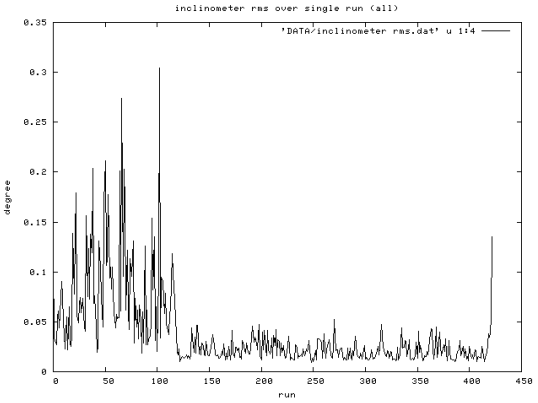

Illustration 29 Inclinometer rns per run - all flight

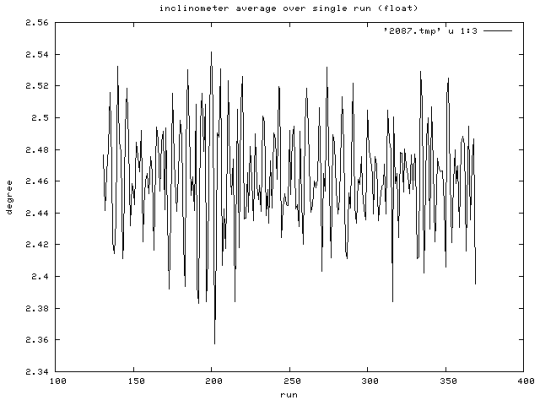

Illustration 30 Inclinometer average per run - float

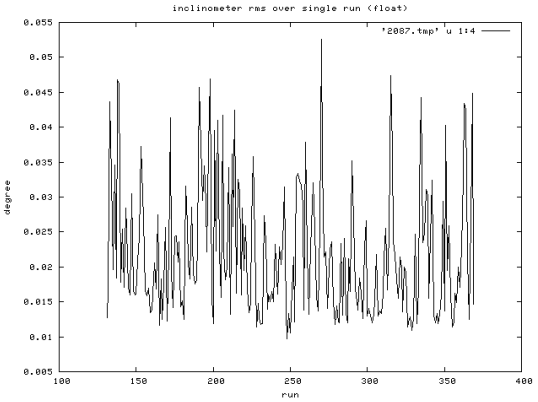

Illustration 31 Inclinometer rms per run - float

It is interesting to note that, as expected the overall behavior of the inclinometer closely resembles the one of the LVDT (the difference between the two should me mostly the static tilt). This is better seen in Fig 34 where I show a raw estimate of the static tilt obtained by differences from LVDT and inclinometer.

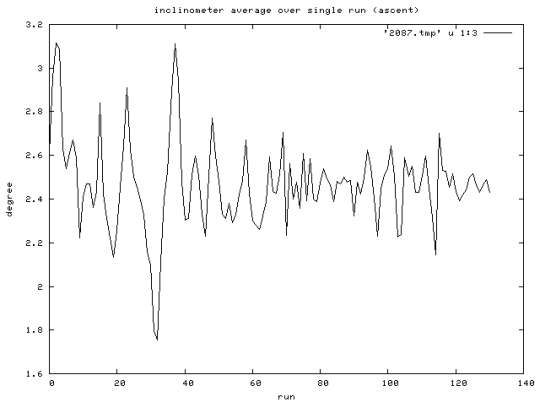

Illustration 32 Inclinometer average per run - ascent

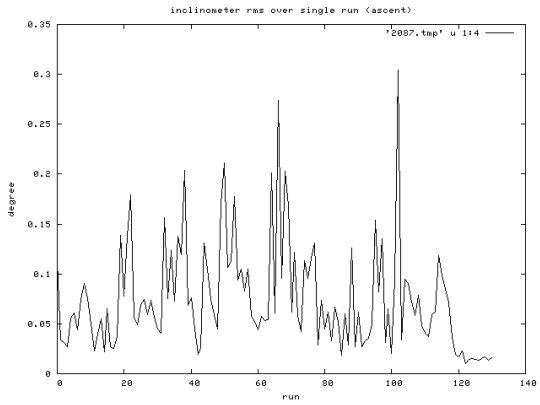

Illustration 33 Inclinometer rms per run - ascent

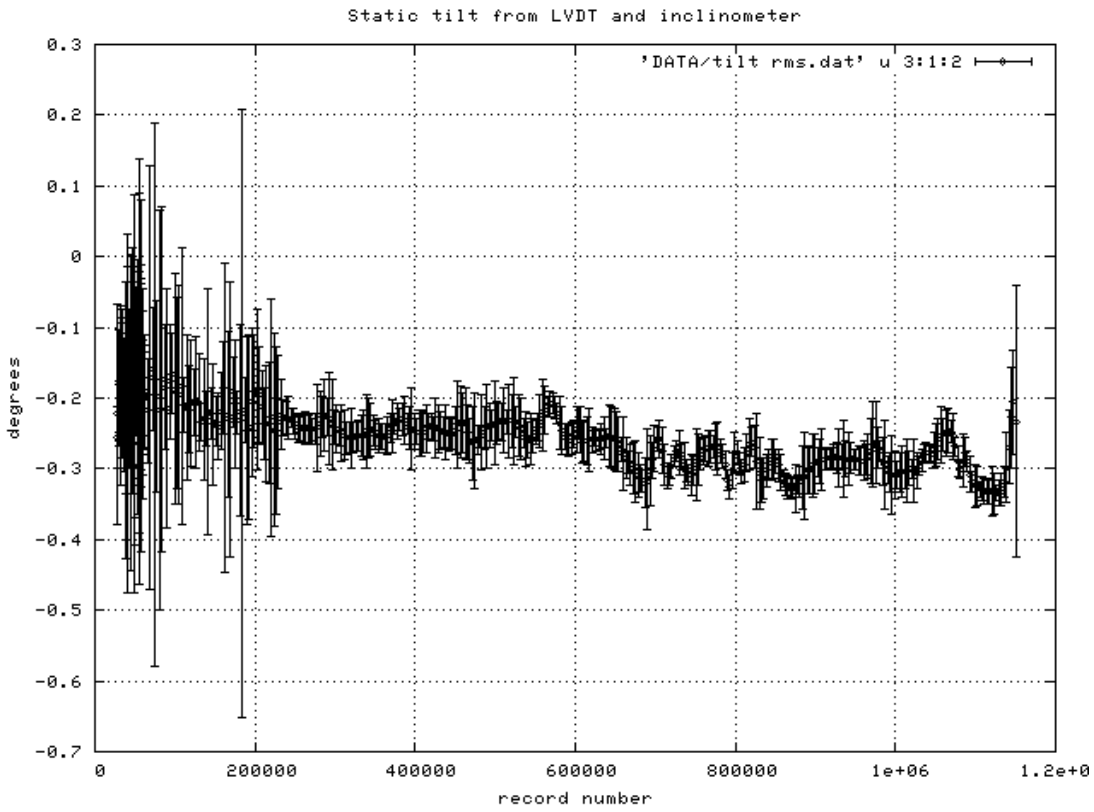

Illustration 34 Tilt evaluated from LVDT and inclinometer

Shaft encoder

The shaft encoder read the returned position of the telescope with respect to the mobile platform. Result for all the flight are shown in Fig 35 and 36.

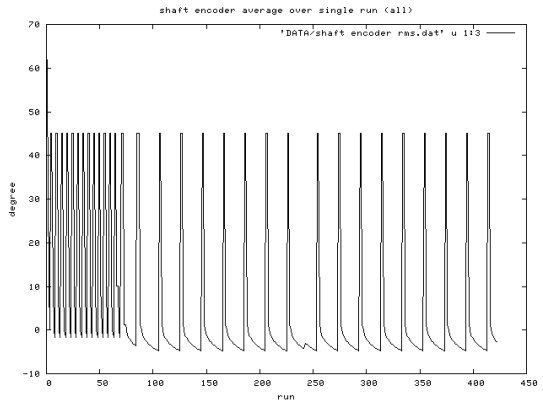

Illustration 35 SAE per run - all flight

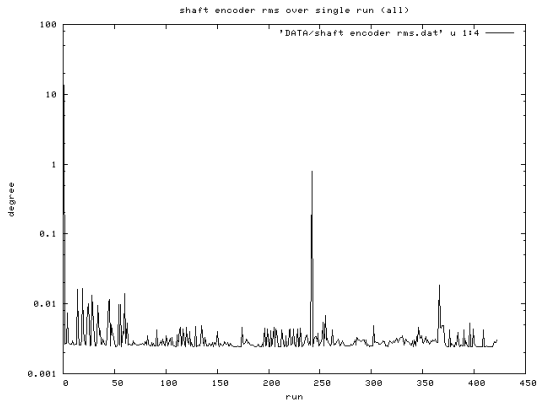

Illustration 36 SAE rms (log scale) per run - all flight

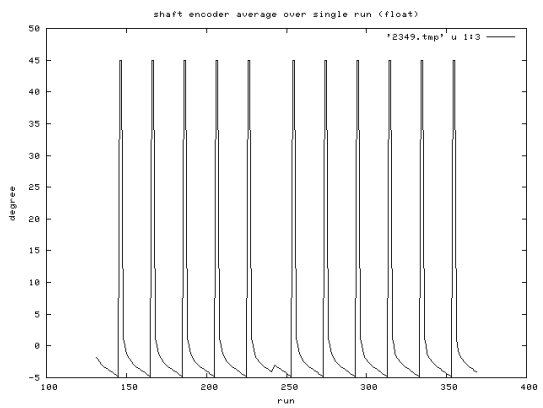

Illustration 37 SAE per run - float

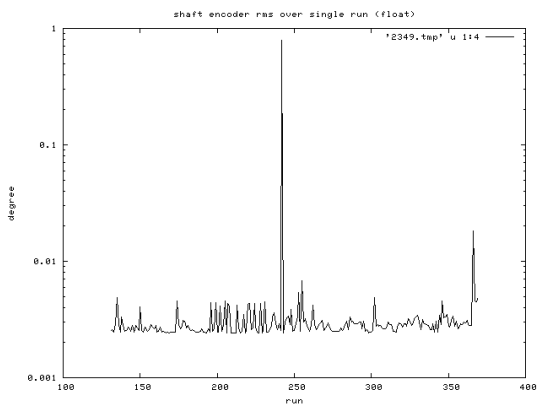

Illustration 38 SAE rms (log scale) per run - float

At float the rms of shaft encoder is significantly smaller than in the first part (more or less by a factor 2-3). The peaks in the rms plot for the float have value of about .005 degrees, that is about 18” which correspond to 1 bit. The shaft encoder therefore does not contribute significantly to the noise in the pointing.

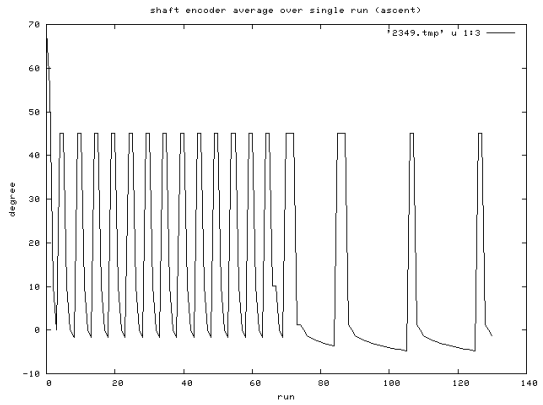

Illustration 39 SAE per run - ascent

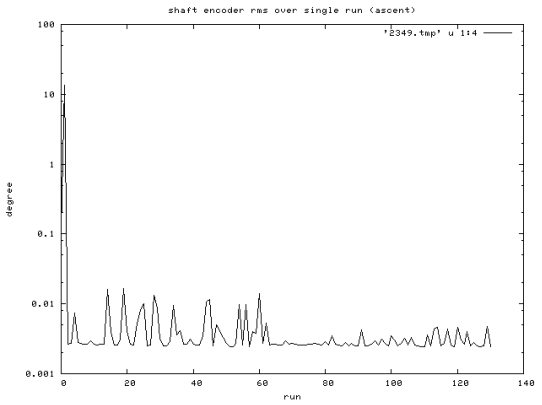

Illustration 40 SAE rms (log scale) per run - ascent

Gyro pickoff

The gyro pickoff in normal mode should give the uncorrected (residual) component of the sway. Its value is shown here below for all flight (fig 41), for float (fig 42) and for ascent (fig 43). There are no significant differences between the different conditions and an uncorrected value of 0.015 degrees (54” , nearly 1') seems to be always present.

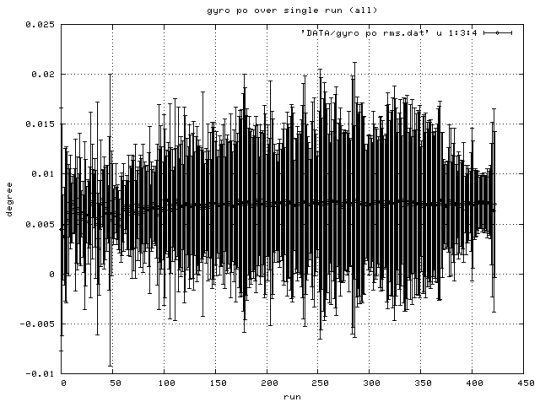

Illustration 41 Gyro pickoff - all flight

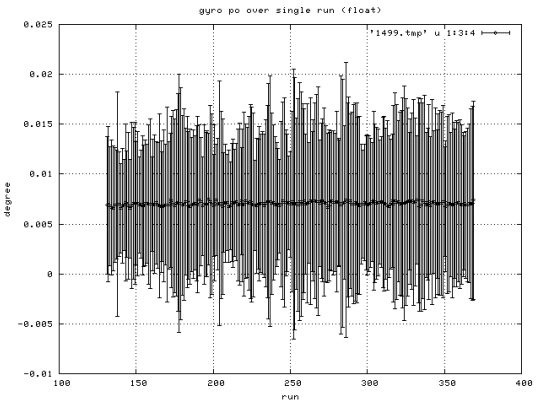

Illustration 42 Gyro pickoff - float

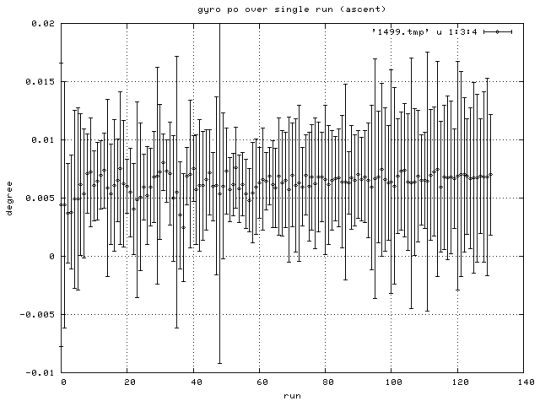

Illustration 43 Gyro pickoff - ascent

Filtered inclinometer

We have seen above (pg 1) that the fileterd inclinometer does not change appreciably during the flight. Just for completeness I show here below the average values (fig 44 45 and 46). Note that the gross average value is around -.15 degrees, more or less 10'.

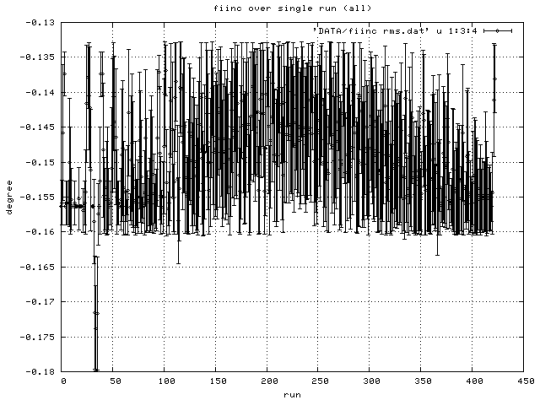

Illustration 44 Filtered inclinometer per run - all flight

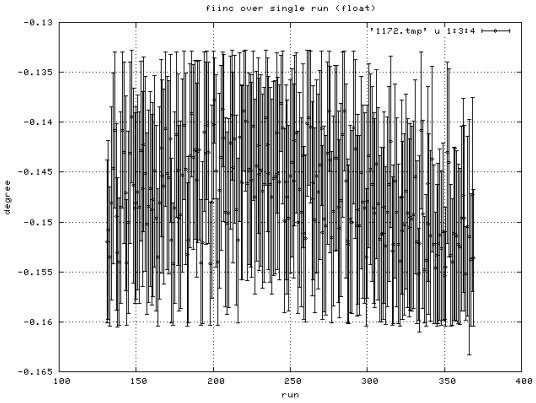

Illustration 45 Filtered inclinometer per run - float

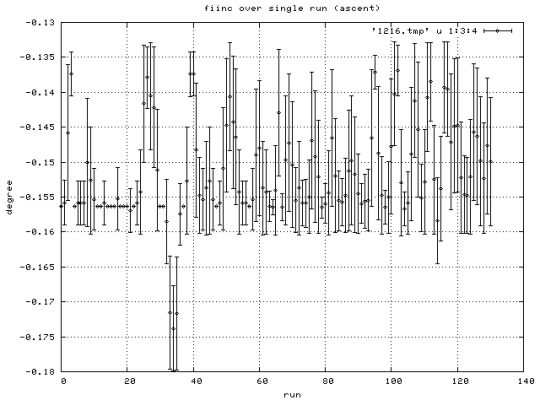

Illustration 46 Float inclinometer per run - ascent