

## SAP data

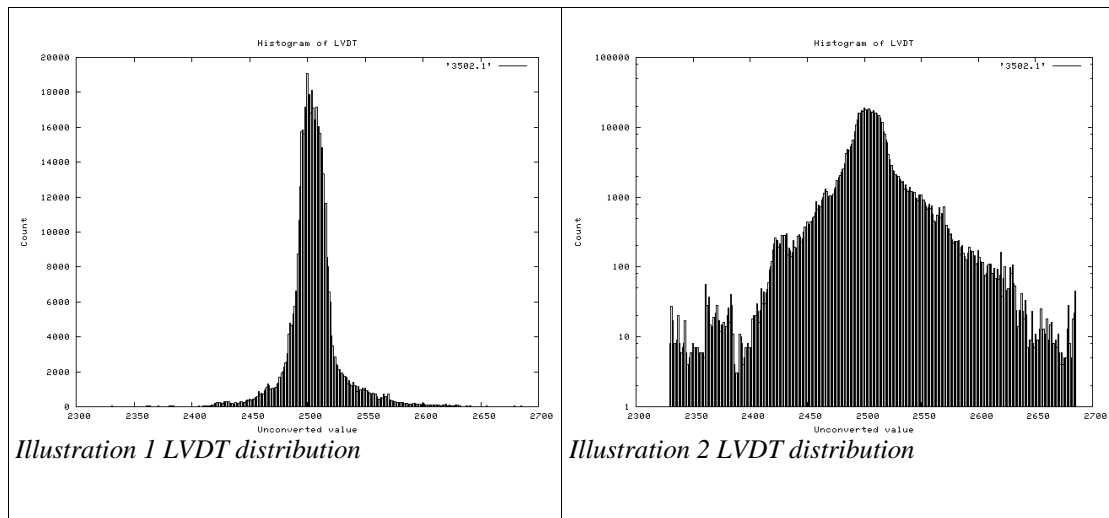
It is important to note that not all the data from sap can be used; I have built the distribution for all the data provided by sap; the number of different values is as follows:

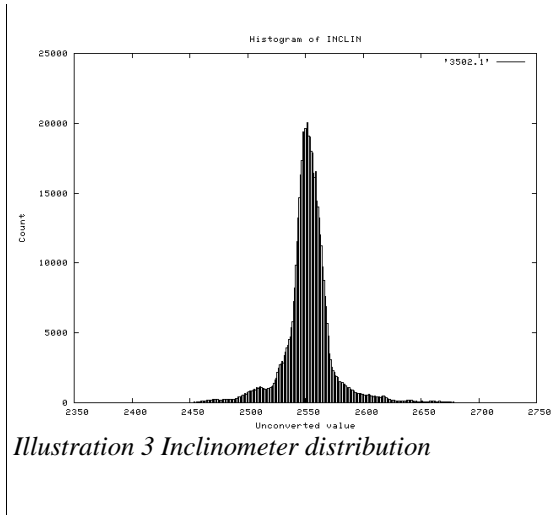
3 DATA/FIINC.bins  
 30 DATA/GYEXC.bins  
 51 DATA/GYRO\_PO.bins  
 3 DATA/GYTQ.bins  
 362 DATA/INCLIN.bins  
 356 DATA/LVDT.bins  
 26 DATA/MGYAC.bins  
 166 DATA/MLIBM.bins  
 3 DATA/SAPSVR.bins  
 1000 total

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

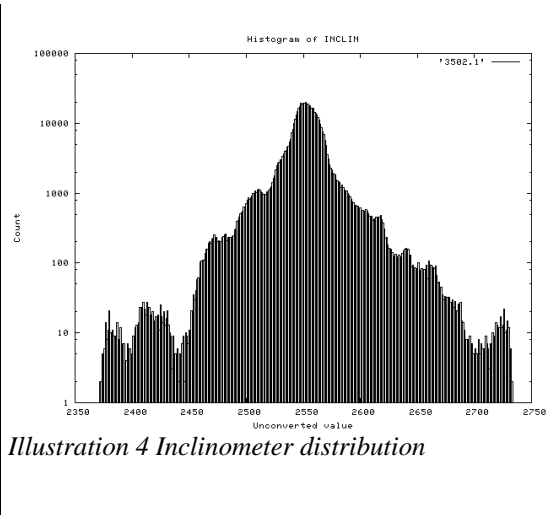
40816.000000 241	40848.000000 68	32720.000000 4
40832.000000 35942	40864.000000 19969	32736.000000 7821
40848.000000 27715	40880.000000 43852	32752.000000 56064
Filtered inclino	Gyro torque	Sap servo

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.



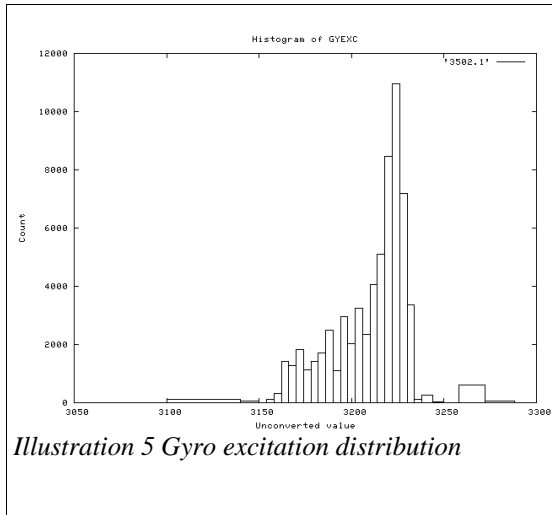


*Illustration 3 Inclinometer distribution*

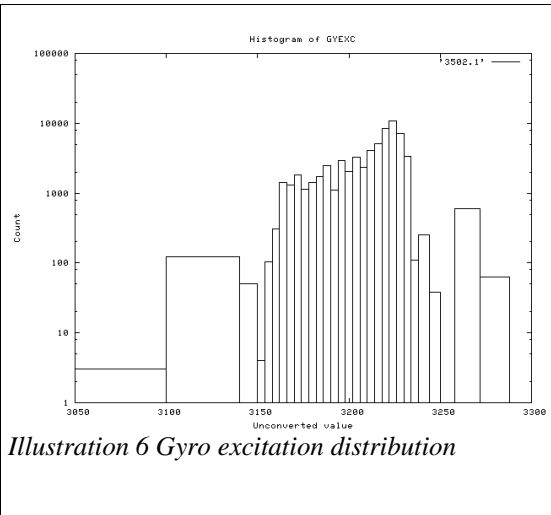


*Illustration 4 Inclinometer distribution*

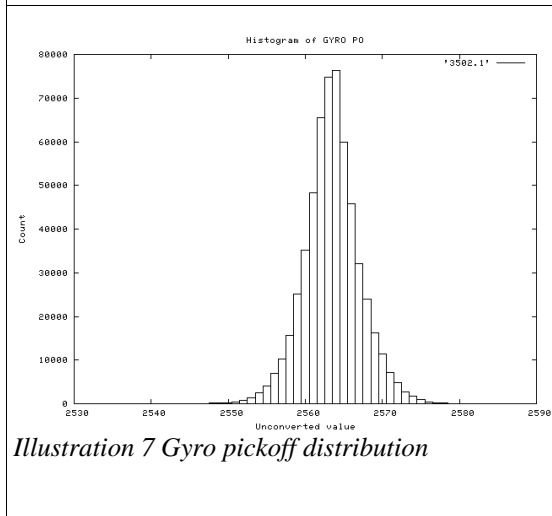
Distribution of other sap values may less symmetrical (see for instance gyro excitation, Fig 5 or 6 and gyro ac current Fig 9 and 10) or more narrow (see for instance gyro pickoff, Fig 7 and 8)



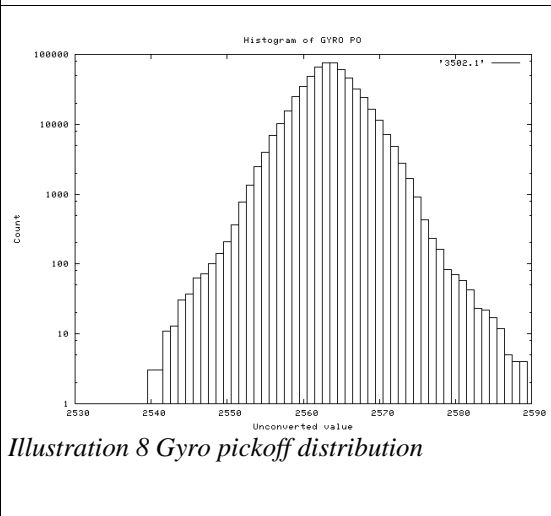
*Illustration 5 Gyro excitation distribution*



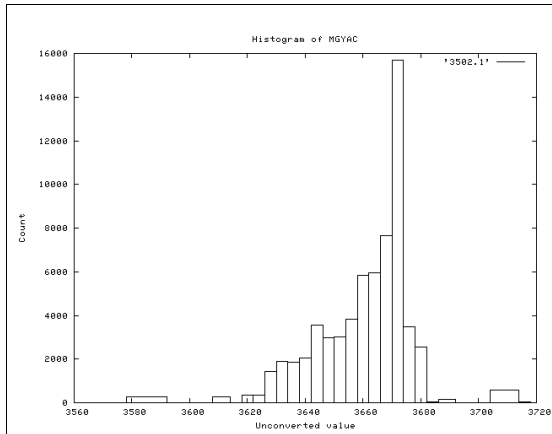
*Illustration 6 Gyro excitation distribution*



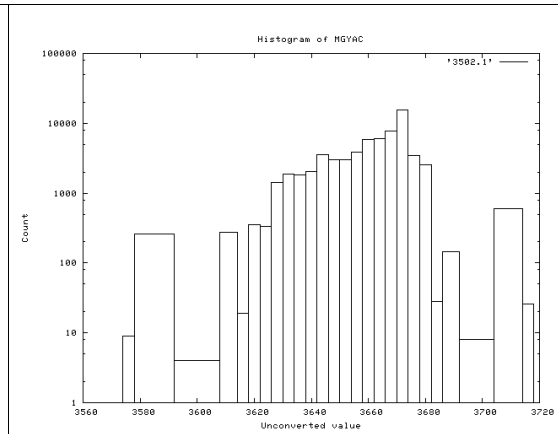
*Illustration 7 Gyro pickoff distribution*



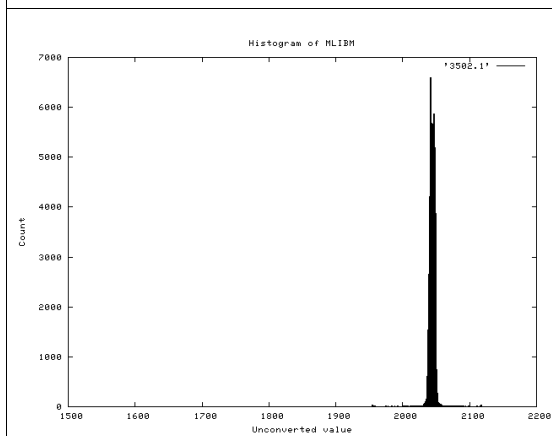
*Illustration 8 Gyro pickoff distribution*



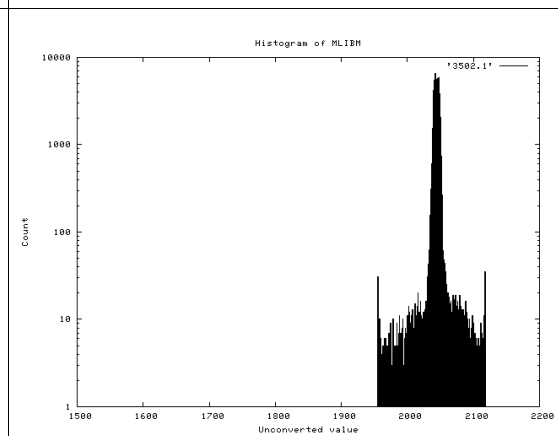
*Illustration 9 Motor gyro ac distribution*



*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)

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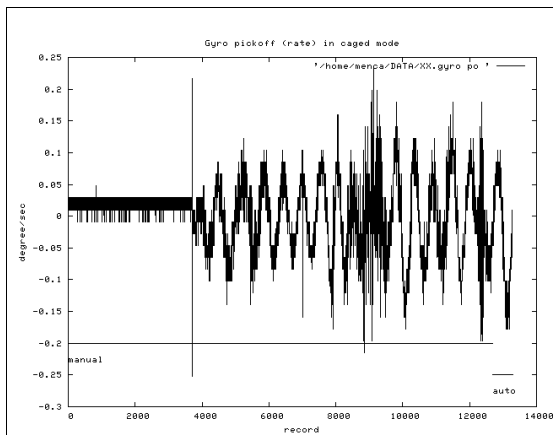
24400.000000 1
29440.000000 1
31264.000000 1
31280.000000 31
31296.000000 11
31312.000000 5
31328.000000 10
31344.000000 6
31360.000000 2
31376.000000 4

```

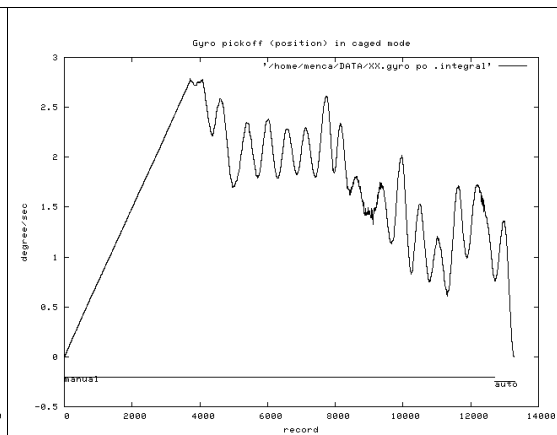
## CAGED SAP

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<sup>1</sup>) 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.

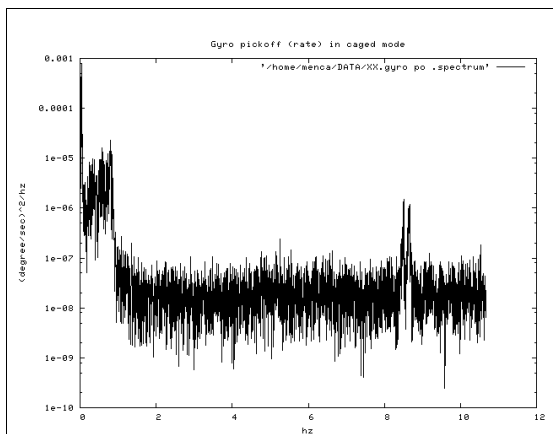


*Illustration 13 Gyro pickoff in caged sap*

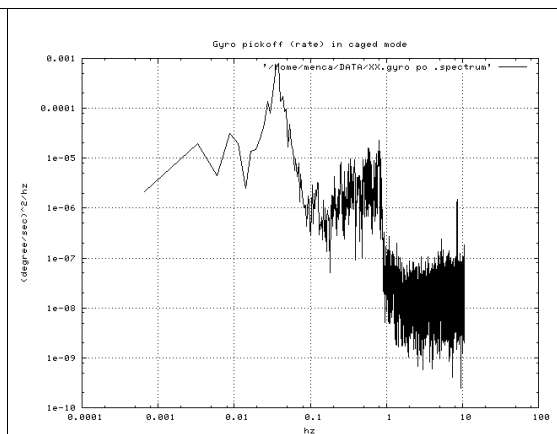


*Illustration 14 Gyro position in caged sap*

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<sup>2</sup>. **This discrepancy has still to be understood.**

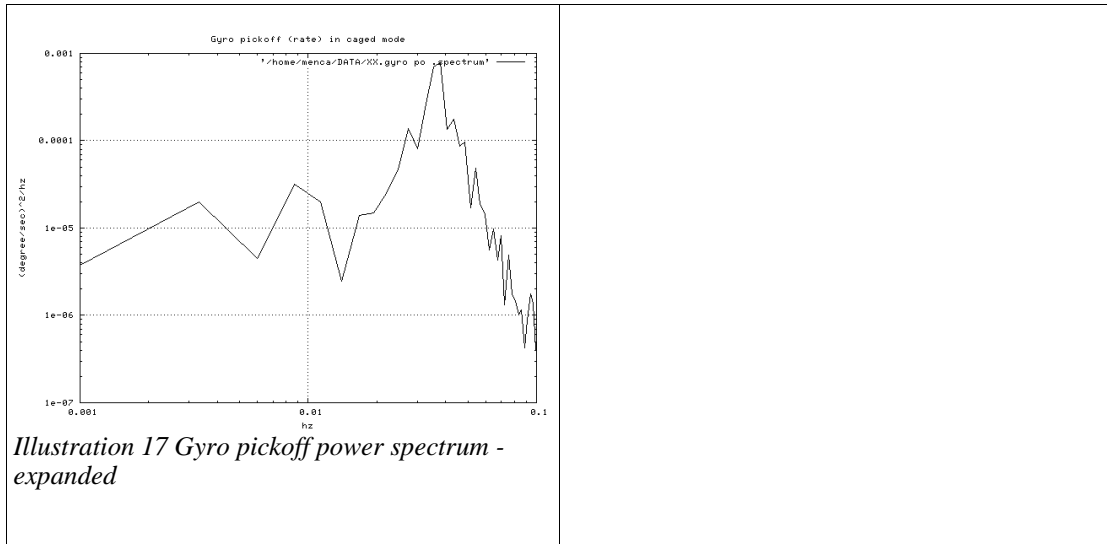


*Illustration 15 Gyro pickoff spectrum (caged)*

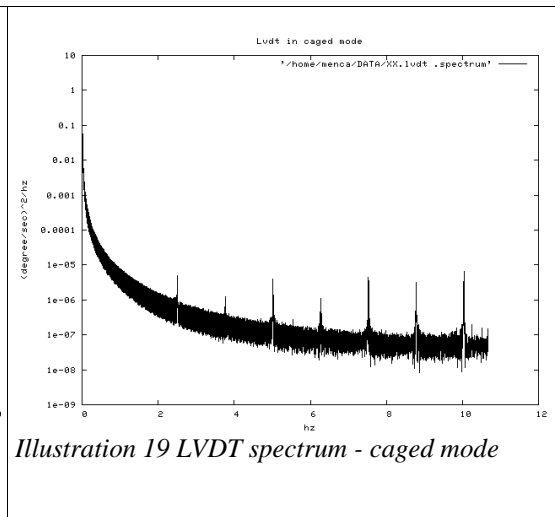
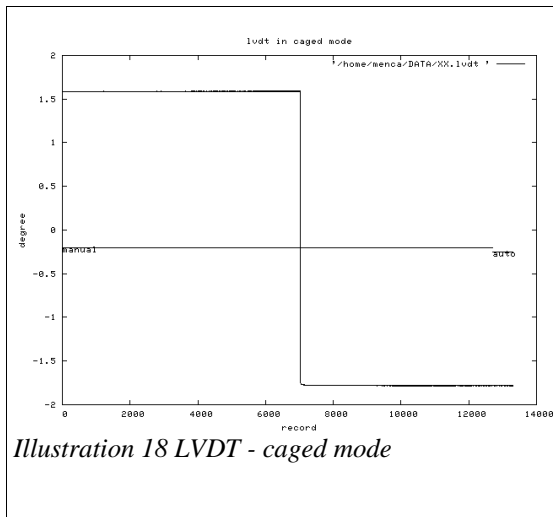


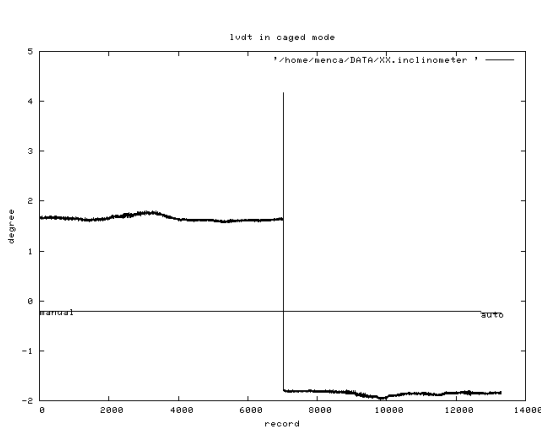
*Illustration 16 Gyro pickoff spectrum (caged)*

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

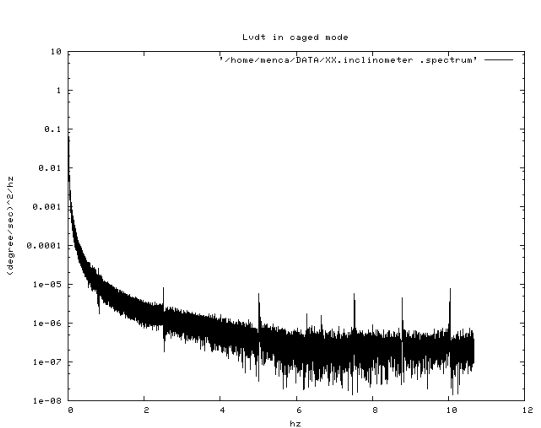


While the gyro pickoff does not suggest major problem there is some problem of interpretation for LVD and inclinometer. In the caged mode the two parts of the SAP (mobile and fixed) should be linked one to the other by means of the LVDT. I therefore expect a constant value for LVDT (if offset well corrected the value should be 0). Values received from telemetry however show a plateau at about 2 degrees followed 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 jump which leads to another value.





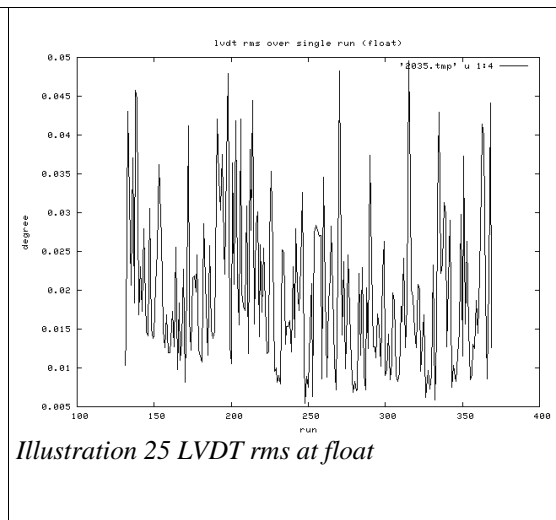
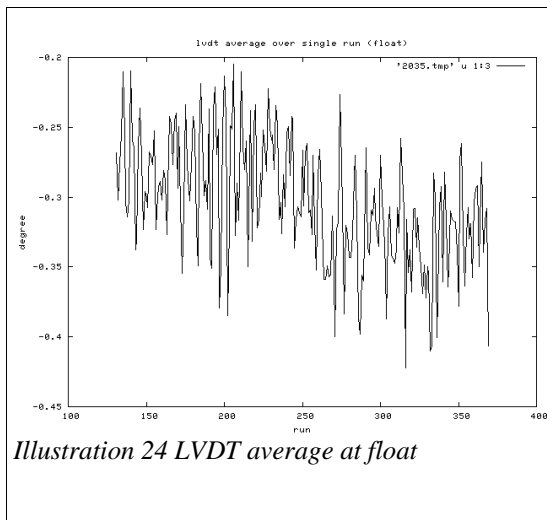
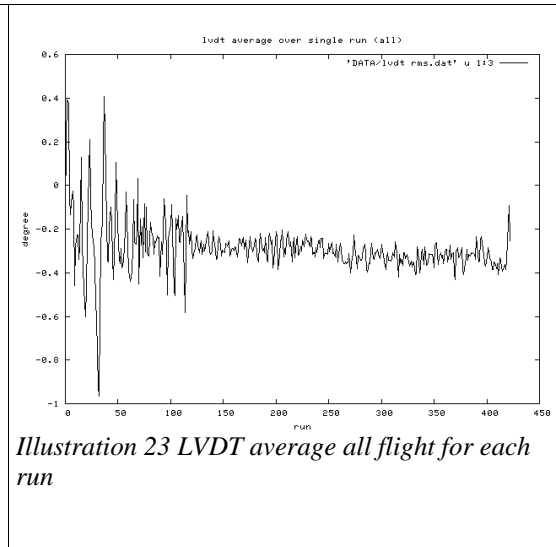
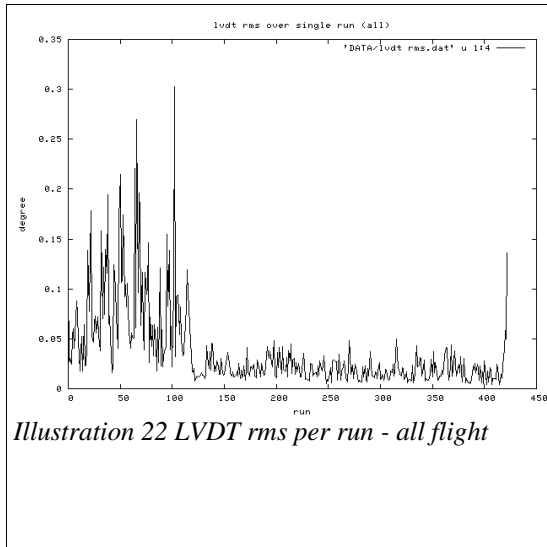
*Illustration 20 Inclinometer - caged mode*

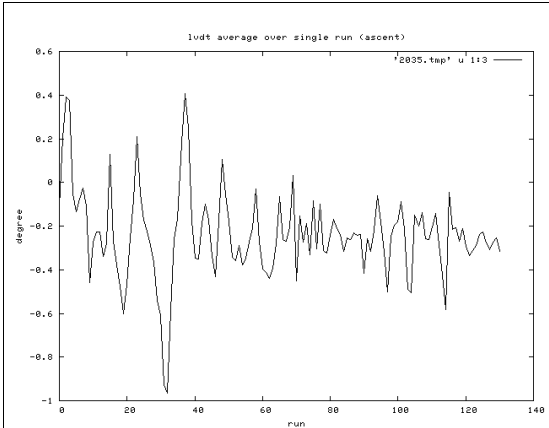


*Illustration 21 Inclinometer spectrum - caged mode*

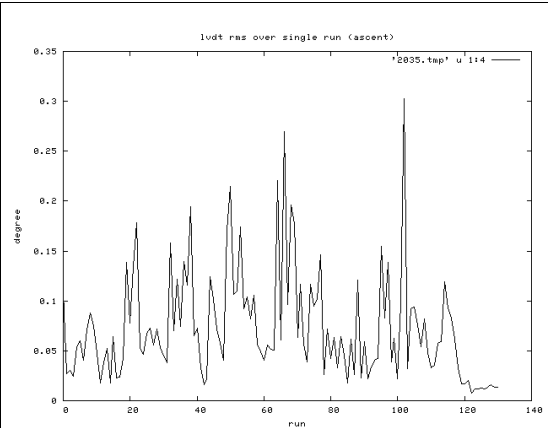
## LVDT

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 it 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 26 LVDT average during ascent*

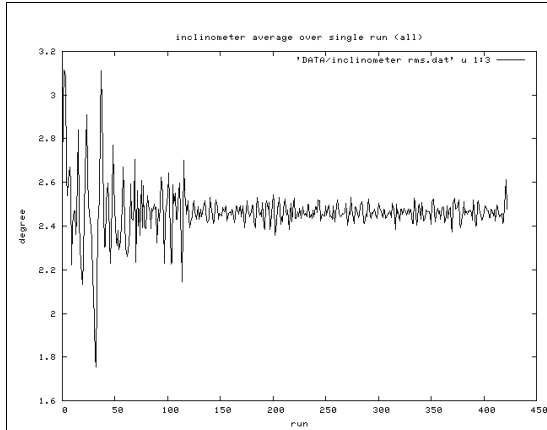


*Illustration 27 LVDT rms during ascent*

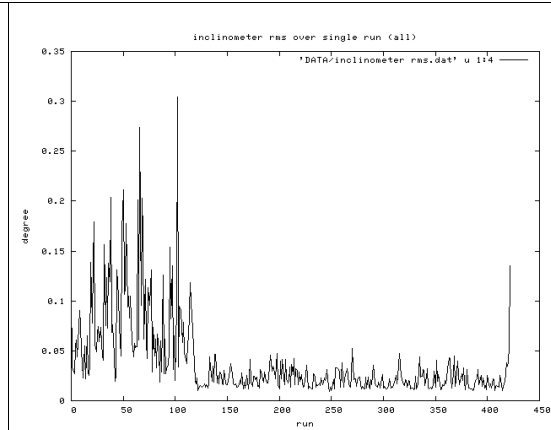


## Inclinometer

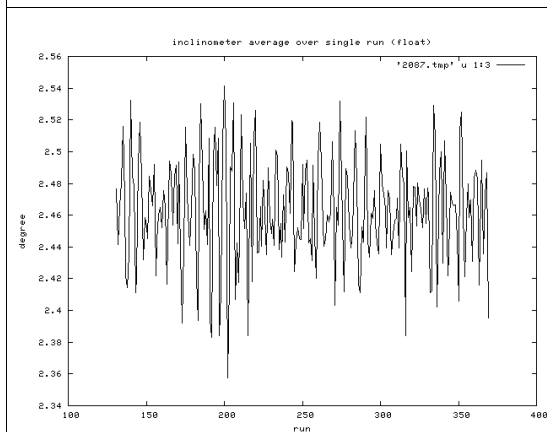
In the normal mode the inclinometer senses the gondola sway as acceleration; it should therefore contain the oscillating part of the gondola. Here below we show the values (averaged for each run) for all the flight (Fig 28 and 29), for the float part of the flight (Fig 30 and 31) and for the ascent part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



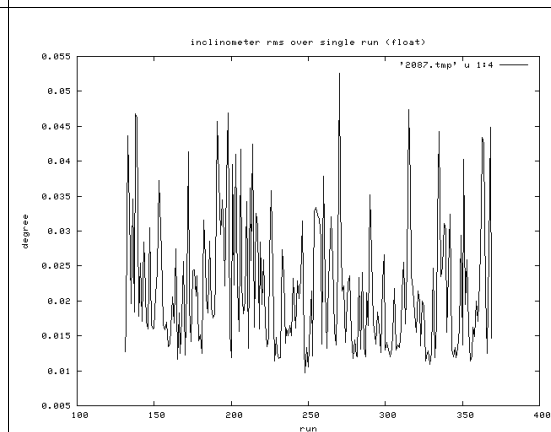
*Illustration 28 Inclinometer average per run - all flight*



*Illustration 29 Inclinometer rms 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 be 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.

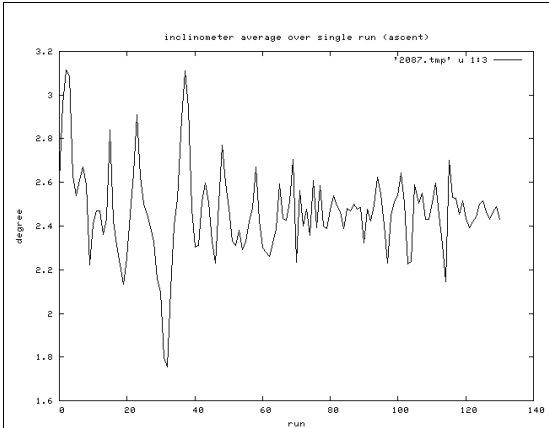


Illustration 32 Inclinometer average per run - ascent

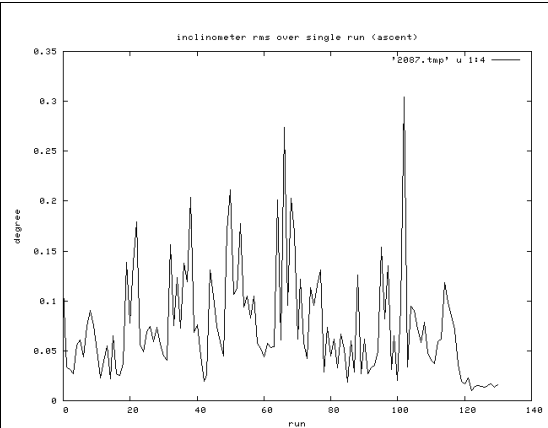


Illustration 33 Inclinometer rms per run - ascent

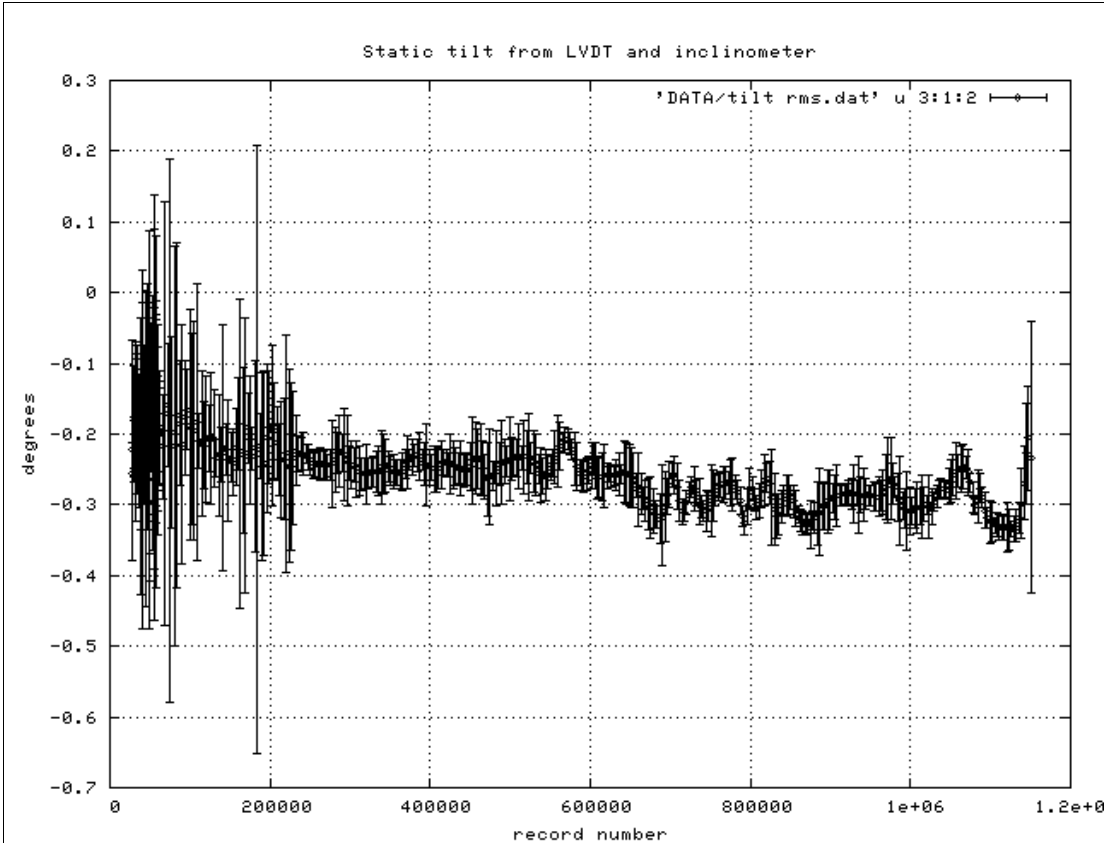
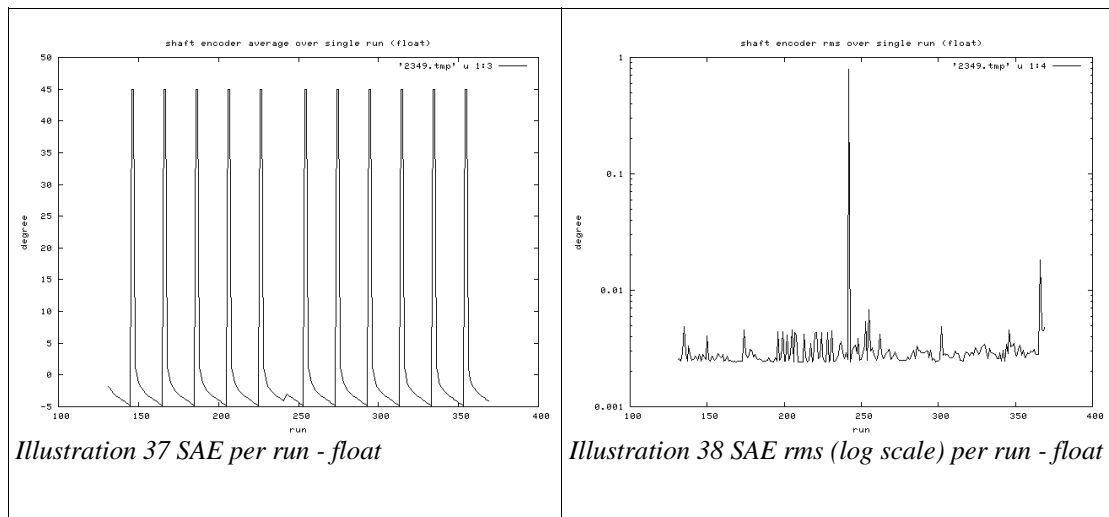
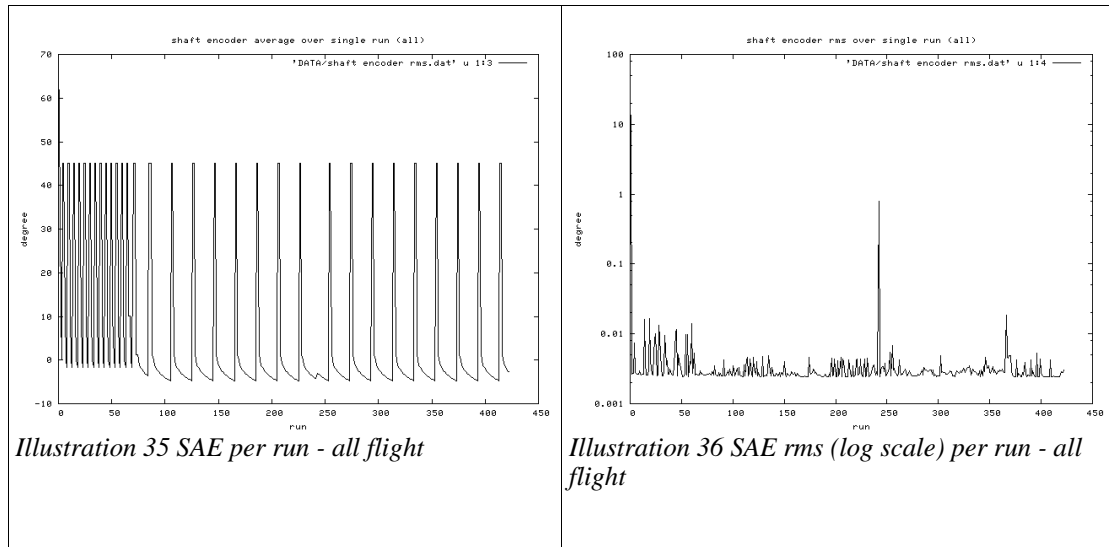


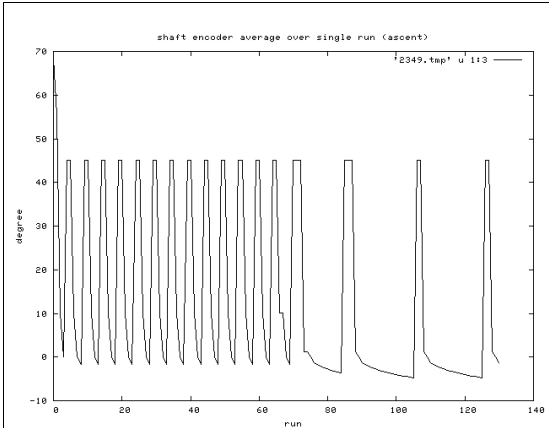
Illustration 34 Tilt evaluated from LVDT and inclinometer

## Shaft encoder

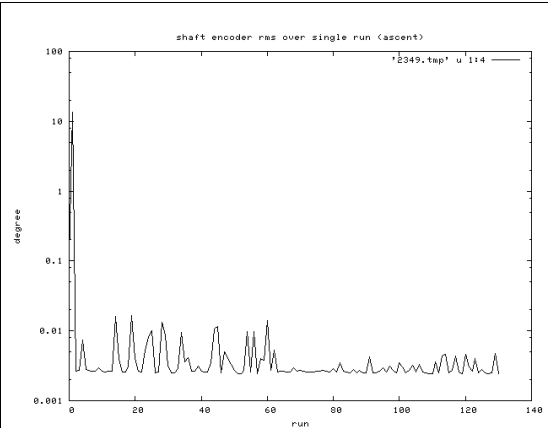
The shaft encoder read the returned position of the telescope with respect to the mobile platform. Result for all the flight are shown in Fig 35 and 36.



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.



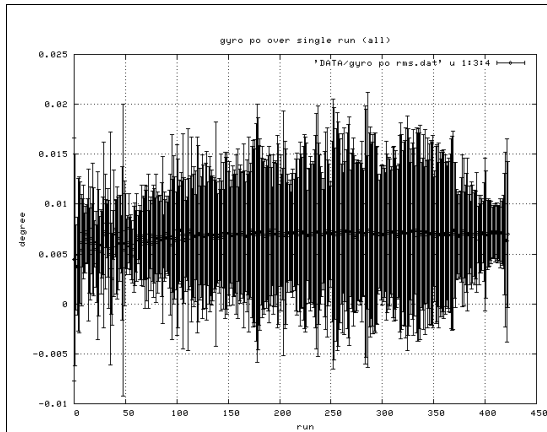
*Illustration 39 SAE per run - ascent*



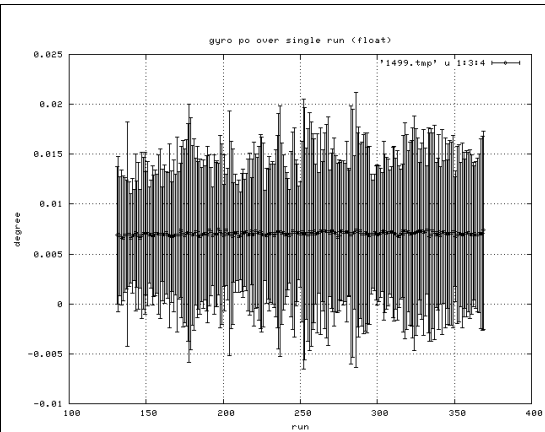
*Illustration 40 SAE rms (log scale) per run - ascent*

# Gyro pickoff

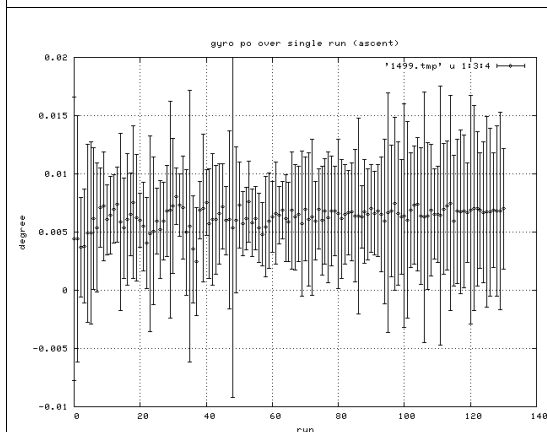
The gyro pickoff in normal mode should give the uncorrected (residual) component of the sway. Its value is shown here below for all flight (fig 41), for float (fig 42) and for ascent (fig 43). There are no significant differences between the different conditions and an uncorrected value of 0.015 degrees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



*Illustration 41 Gyro pickoff - all flight*



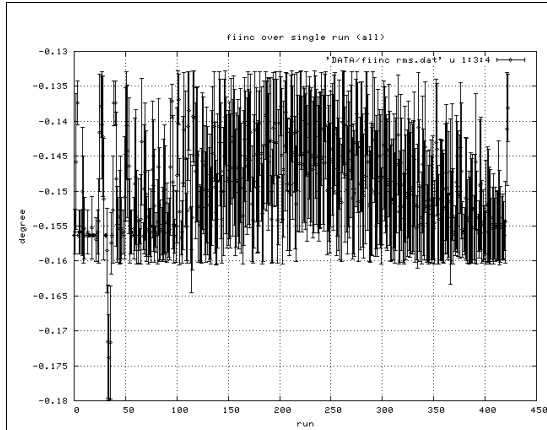
*Illustration 42 Gyro pickoff - float*



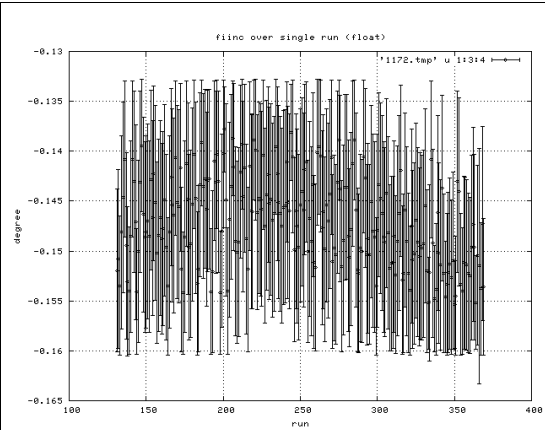
*Illustration 43 Gyro pickoff - ascent*

## Filtered inclinometer

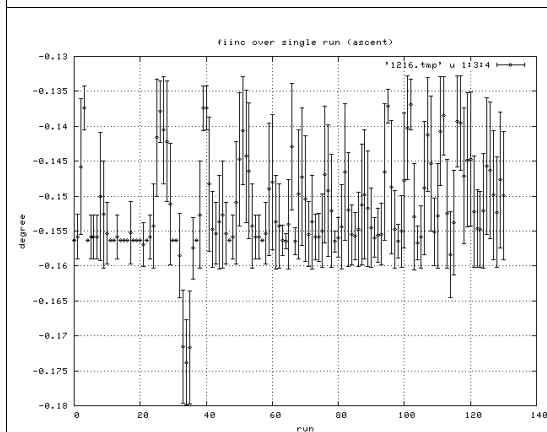
We have seen above (pg 1) that the filtered inclinometer does not change appreciably during the flight. Just for completeness I show here below the average values (fig 44 45 and 46). Note that the gross average value is around  $-0.15$  degrees, more or less  $10'$ .



*Illustration 44 Filtered inclinometer per run - all flight*



*Illustration 45 Filtered inclinometer per run - float*



*Illustration 46 Float inclinometer per run - ascent*