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8/23/2007

Interim Analysis of the HLS Observation in SPEAR3 August 2007

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1 Introduction

Previous HLS measurements have shown that the floor in SPEAR3 is moving by up to 100 micrometers per day. The purpose of this document is to describe the correlation of temperature measurements in and around the SPEAR3 ring with floor movements.

2 Monitoring Setup

To detect a tilt of insertion device (ID) 6, one sensor has been placed on each end of the support structure along the beam. To look at the floor movement along the path of beam line 6 an HLS sensor has been installed near the mirror. Farther down the ring an HLS sensor has been installed on each side of ID 4 on the floor, Figure 1.

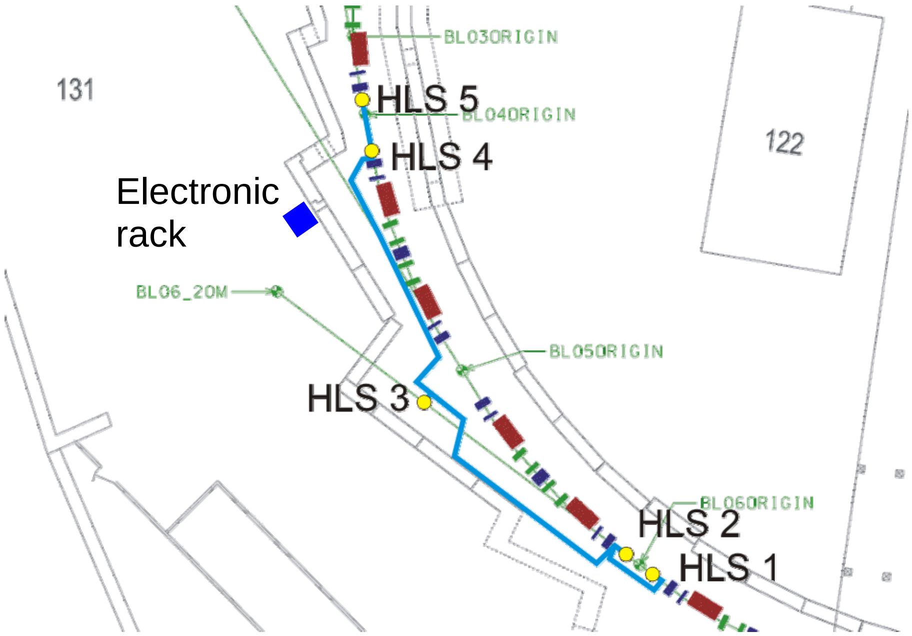


Figure 1: Set-up of the HLS sensors

3 Results

3.1 Long term analysis of the measurements

Long term stability is of less concern to the experimenters than short term movements. Nevertheless we gathered data over a time period of close to two years. The result is the observation of a sine shaped movement with a period of one year. The beginning of the downtime corresponds with the inflection point. A possible explanation is the rapid change of the temperature in the tunnel after opening the tunnel, see Figure 3.

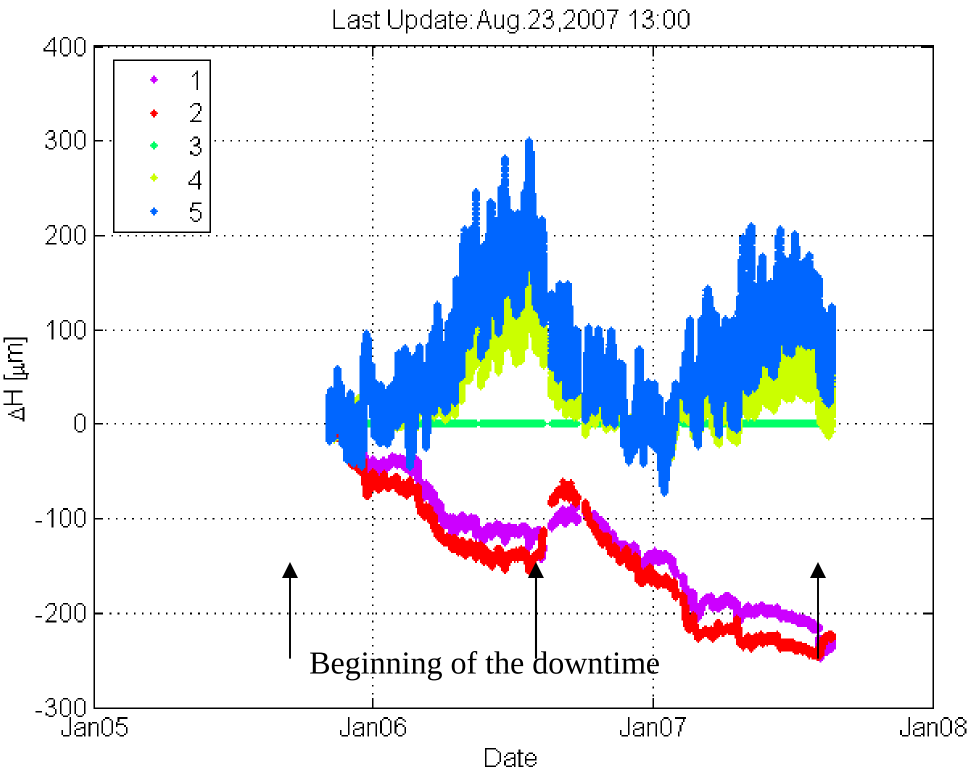


Figure 2: Long term movement of the floor with respect to HLS 3.

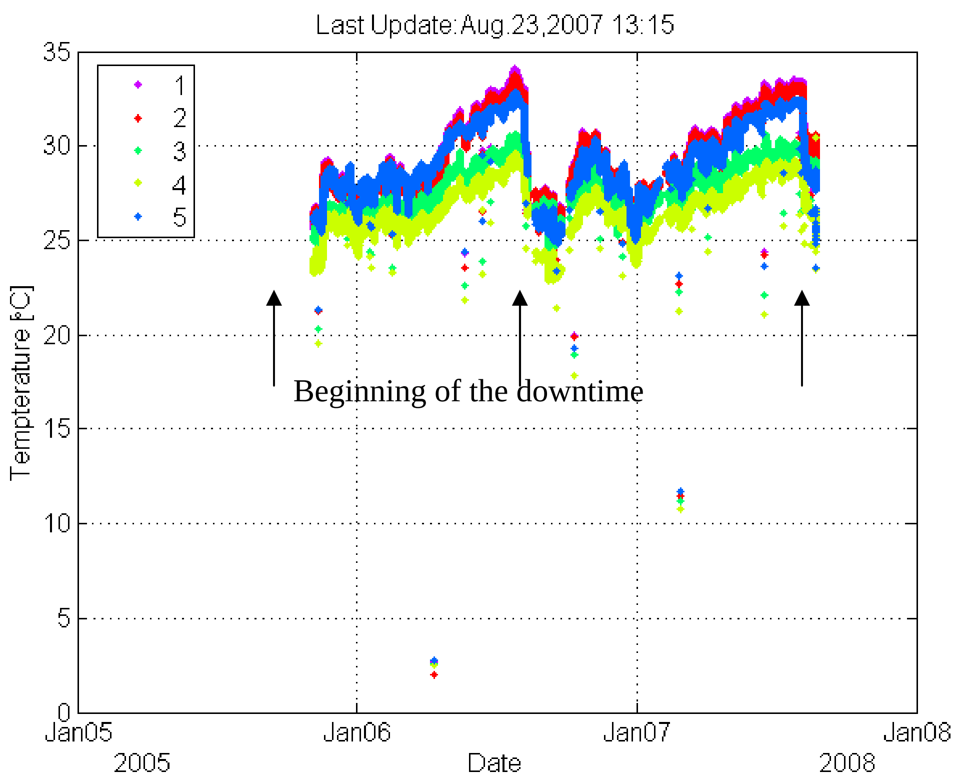


Figure 3: Temperature sensors readings at the position of the HLS sensors.

3.2 Short term analysis of the movements

To single out a possible cause for the movements several temperature sensors in and out of the tunnel were analyzed with respect to the movements between HLS3 and HLS4 (largest movements). Attachment 1 shows the correlations of all the thermocouple readings with the floor movements for a two week period in July 2007, the correlation coefficients and the time lags are summarized in Table 1. The result is that the maximum correlation between the outdoor temperature and the floor movements has a 4 hour time lag, which means that the floor movement follows 4 hours after the temperature change. The correlation between the indoor temperatures and the floor movements behave differently, the correlations are smaller and the floor movement happens before the temperature changes. With this we can eliminate the interior temperature of the ring as the driving force behind the floor movements.

Table 1: Correlation coefficients at time lag

Thermocouple	Correlation coefficient	Time lag [min]
Sensors outside the ring		
Roof, start of G13	0.94	-240
Exterior inner-ring wall, S12	0.94	-285
Building 116 ambient	0.87	-330
Sensors inside the ring		
interior inner-ring wall, S12	0.71	375
G12 ambient	0.63	345
G13 ambient	0.57	315
G05 ambient top	0.42	390

In Figure 5 and Figure 4 we focus on two three day periods with partly cloudy sky. In the figures we can identify the time lag between movements and temperature changes. A change in the temperature outdoors happens about 4 hours before the floor movement changes direction. The internal temperature in the ring changes slowly after the floor movement changed direction. Another point of interest in these figures is that the amount of floor movement seems to be correlated with the sustained temperature difference and not with short term temperature changes, see temperature peak on July 10th in Figure 4 and temperature drop on July 18th see Figure 5.

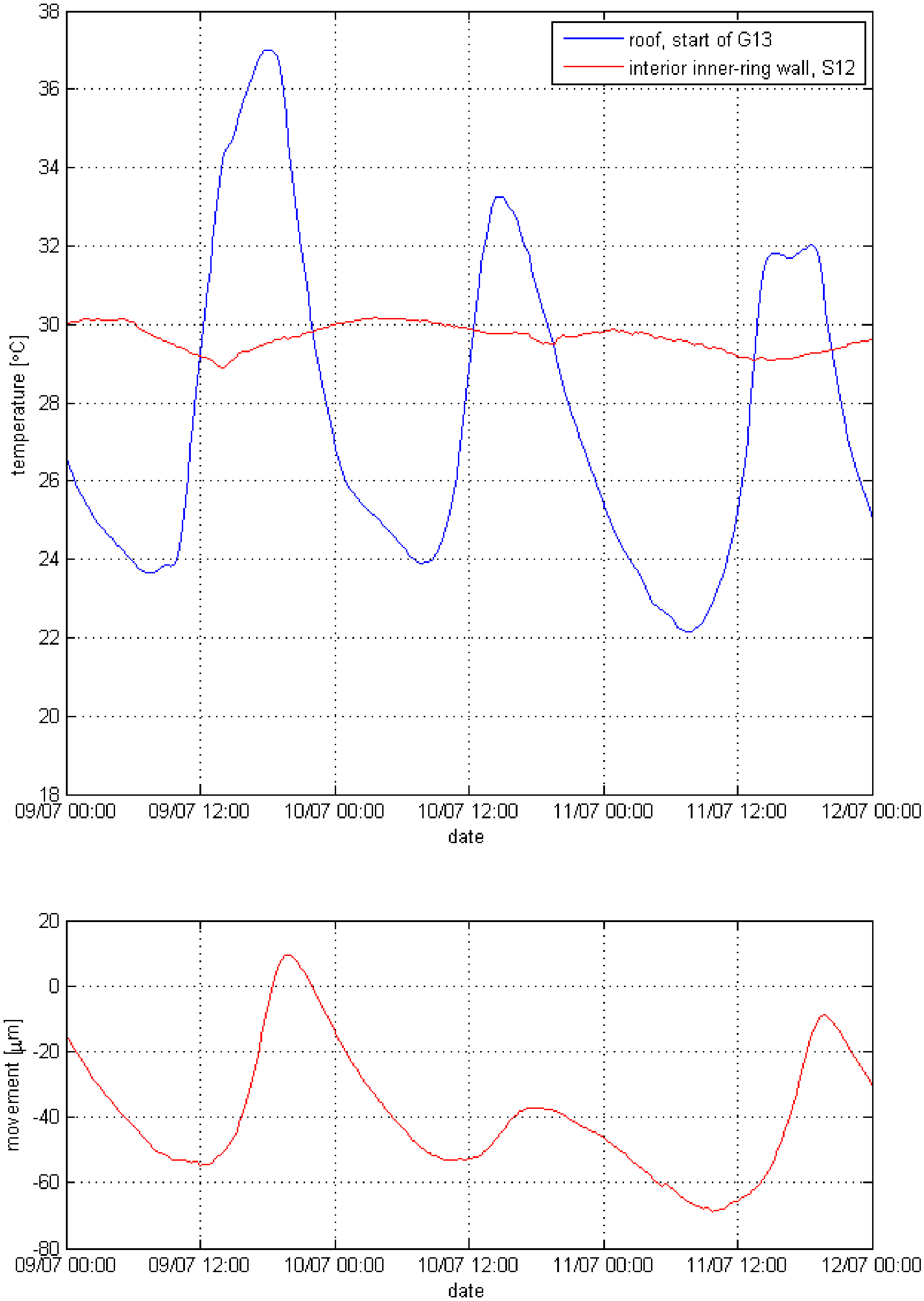


Figure 4: Temperature vs. floor movement 9-12 July, overcast sky on 10th July.

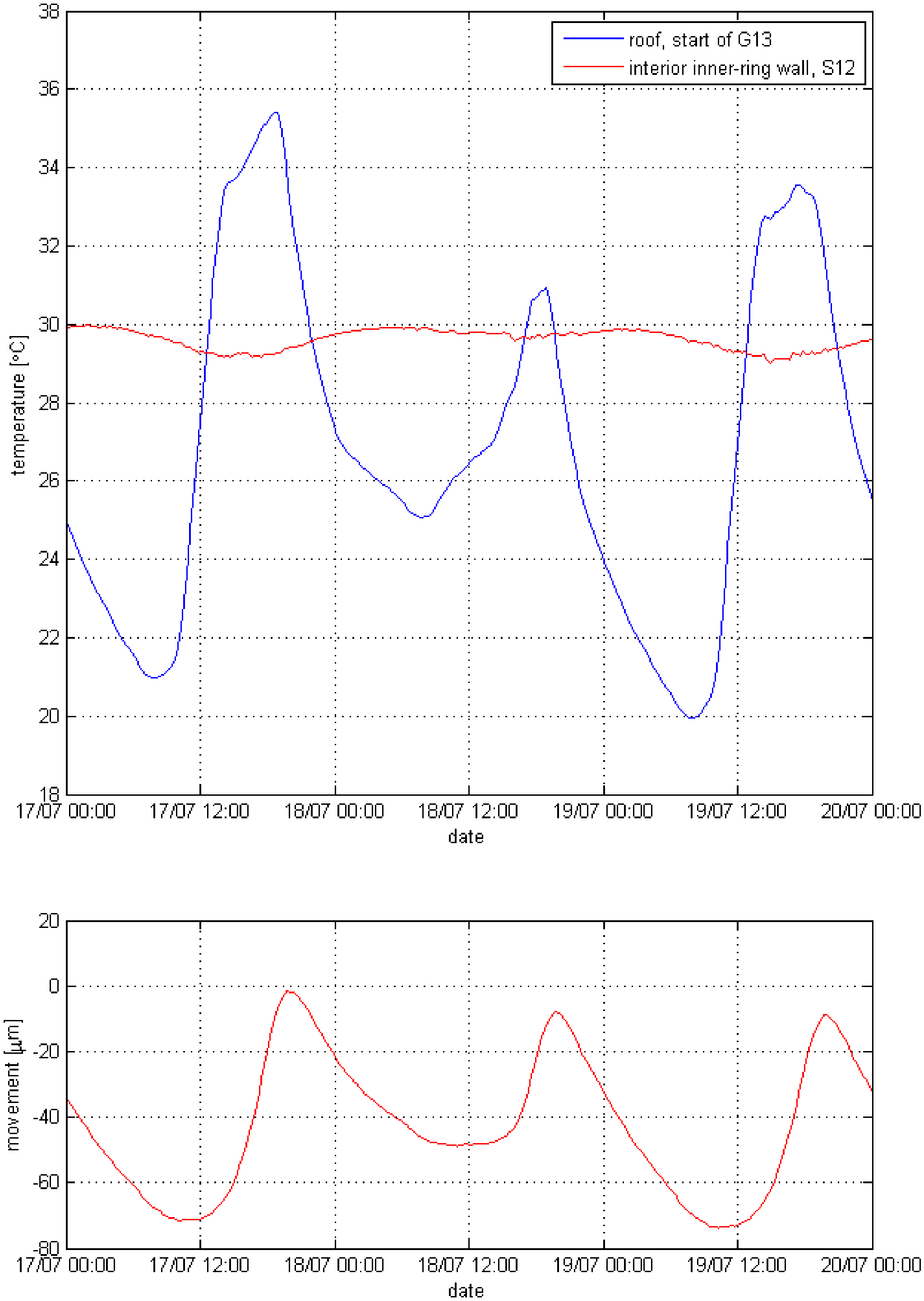


Figure 5: Temperature vs. floor movement 17-20 July, overcast sky on 18th July until 2pm.

3.3 Removal of ID4

ID 4 has been removed on August 23rd around 9:30am resulting in an uplift of the floor in this region of about 40 µm.

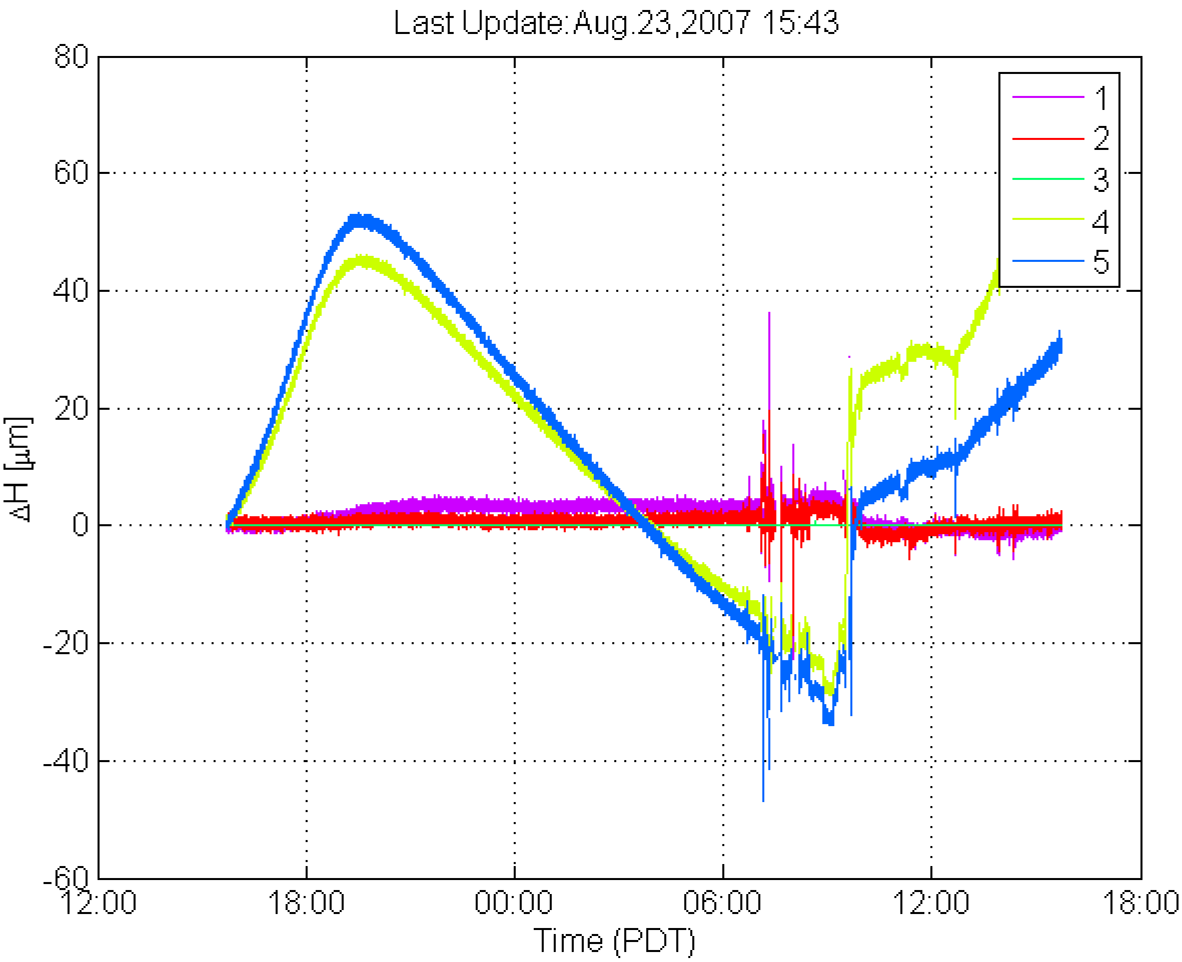
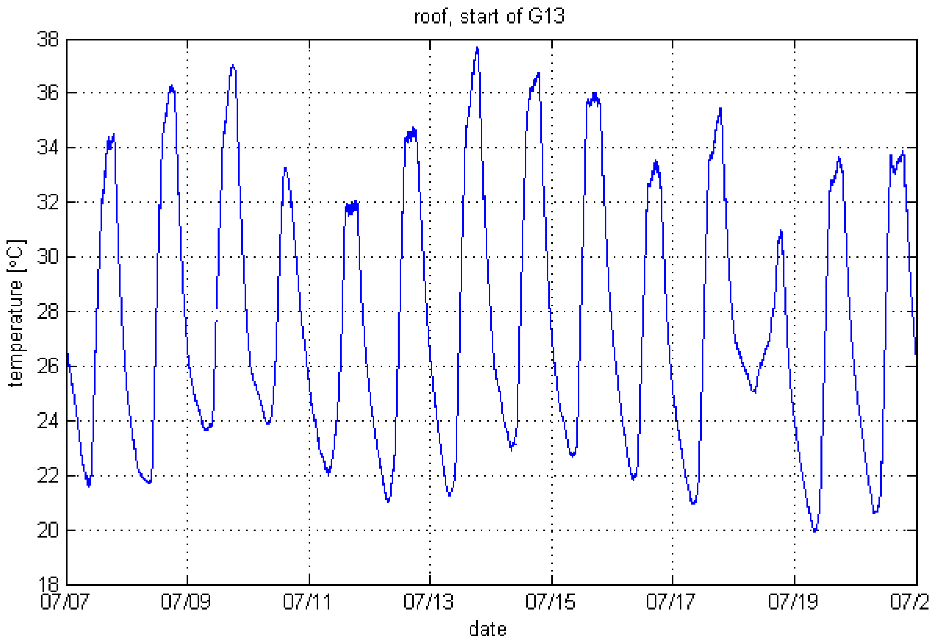


Figure 6: Floor movements on August 23rd, ID 4 removal at 9:30am.

4 Conclusion

Daily variations in the floor movements seem to be mainly influenced by the outside temperature of the SPEAR3 ring, correlated to the amount of sunshine. The interior temperature of the ring does not seem to have short term effects but seem to be responsible for the annual drift of the floor.

Attachment I



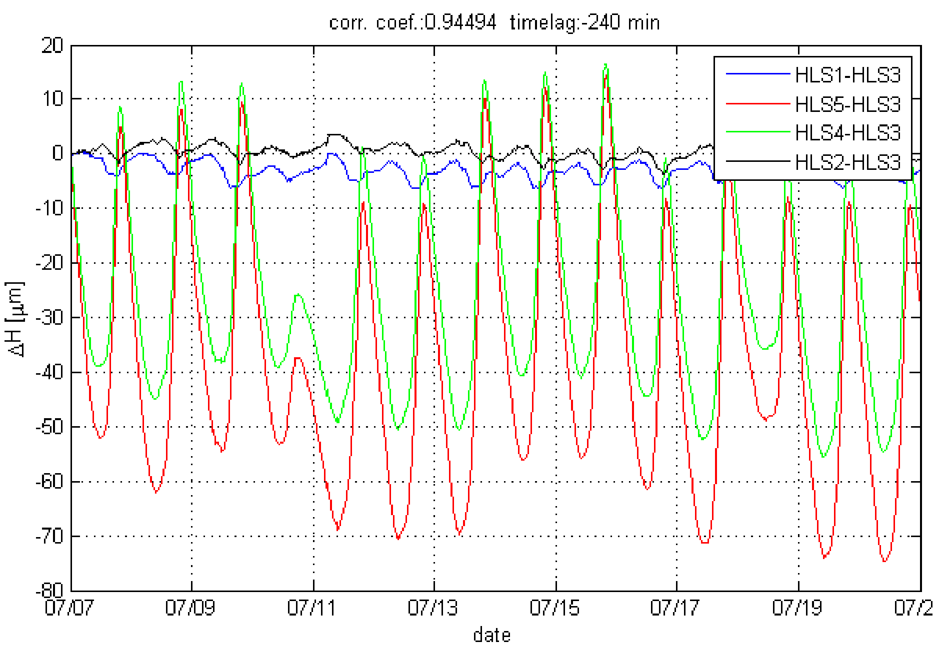
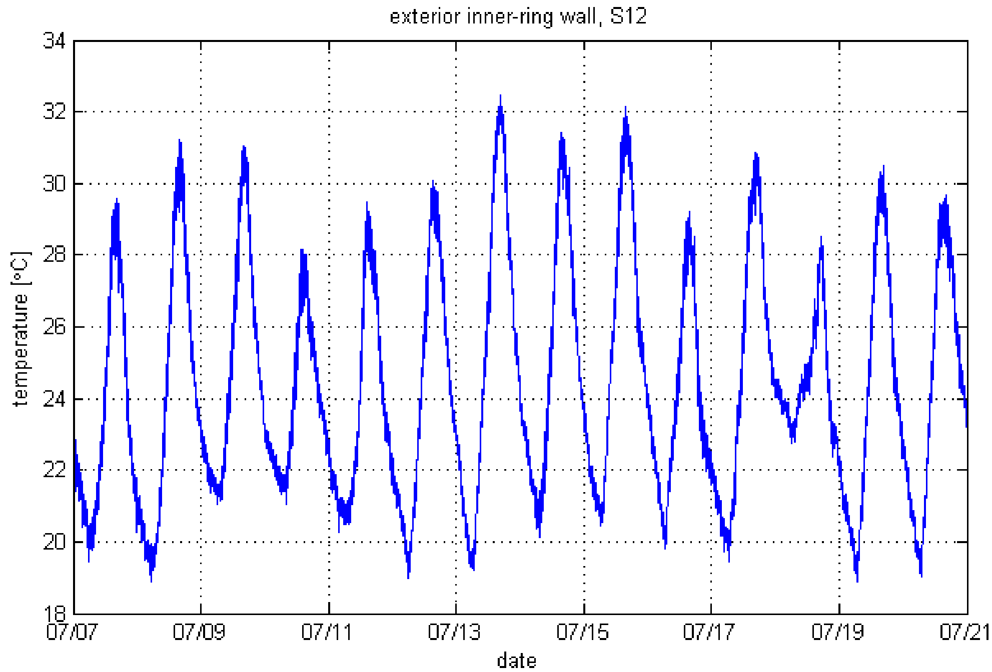


Figure 7: Temperature roof at start of G13 vs. floor movement.



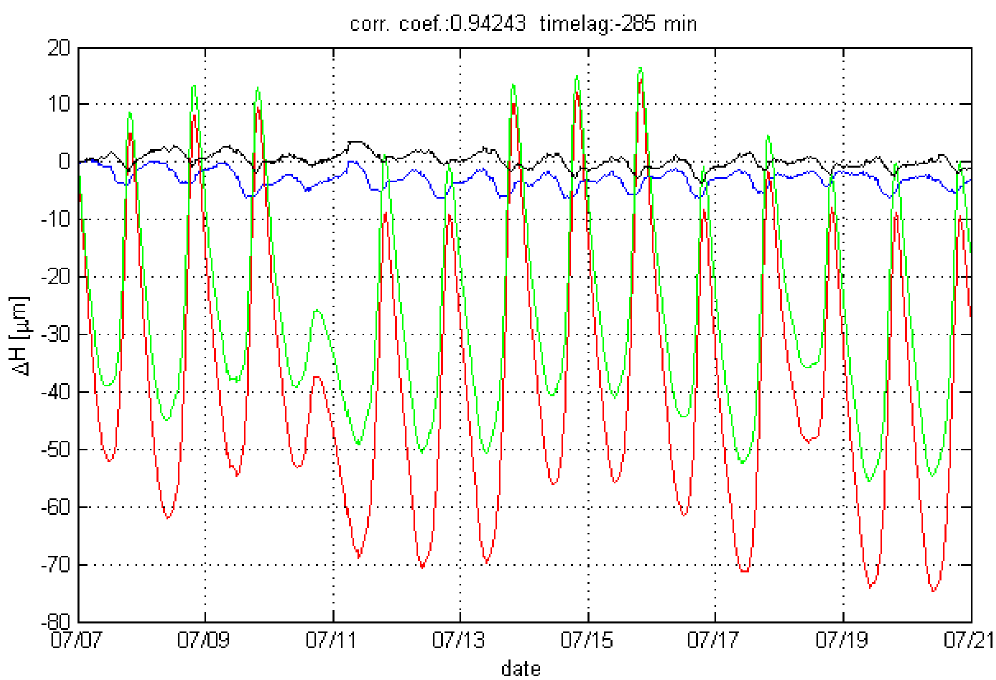


Figure 8: Temperature exterior inner-ring wall vs. floor movement.

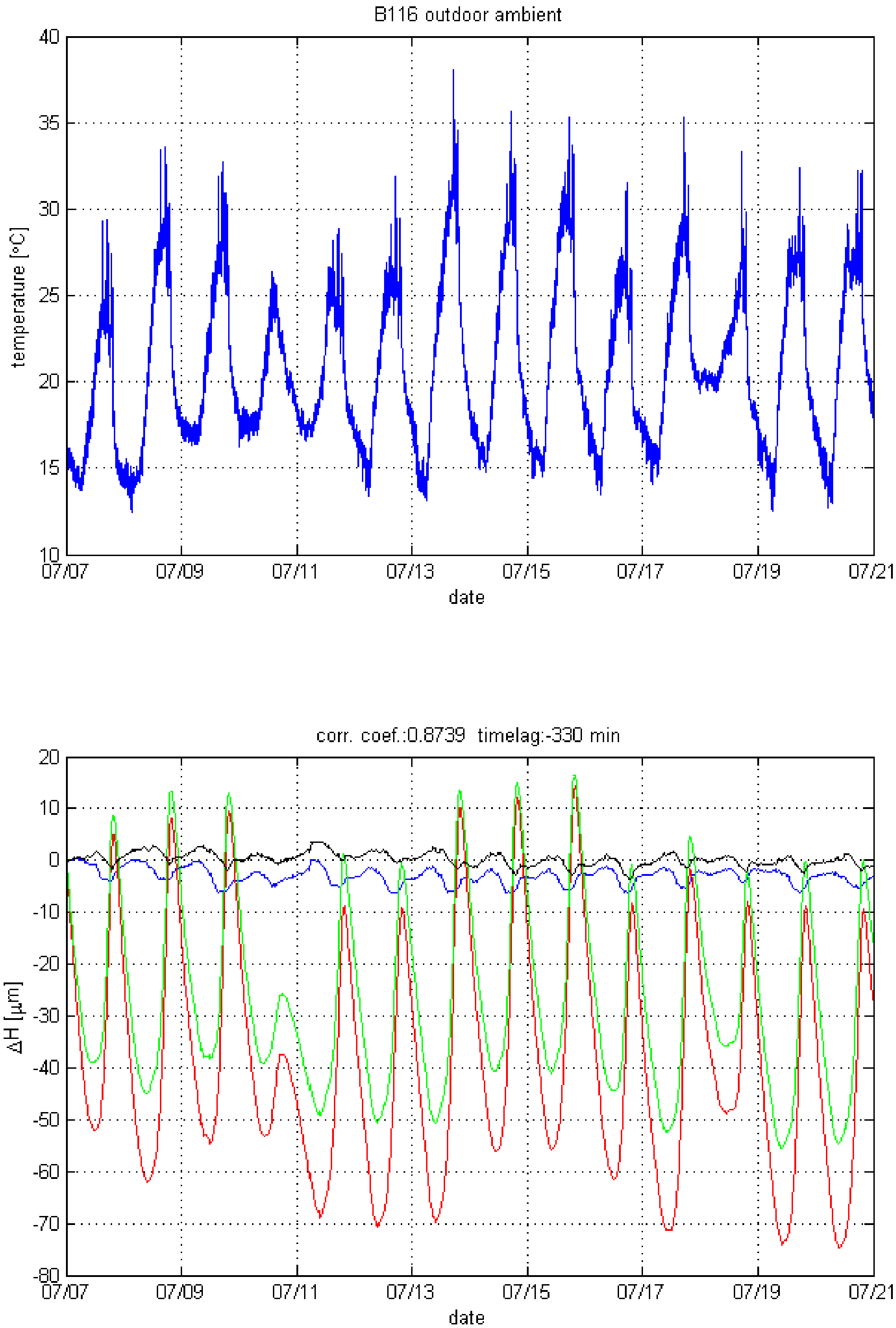


Figure 9: Temperature Bldg. 116 vs. floor movement.

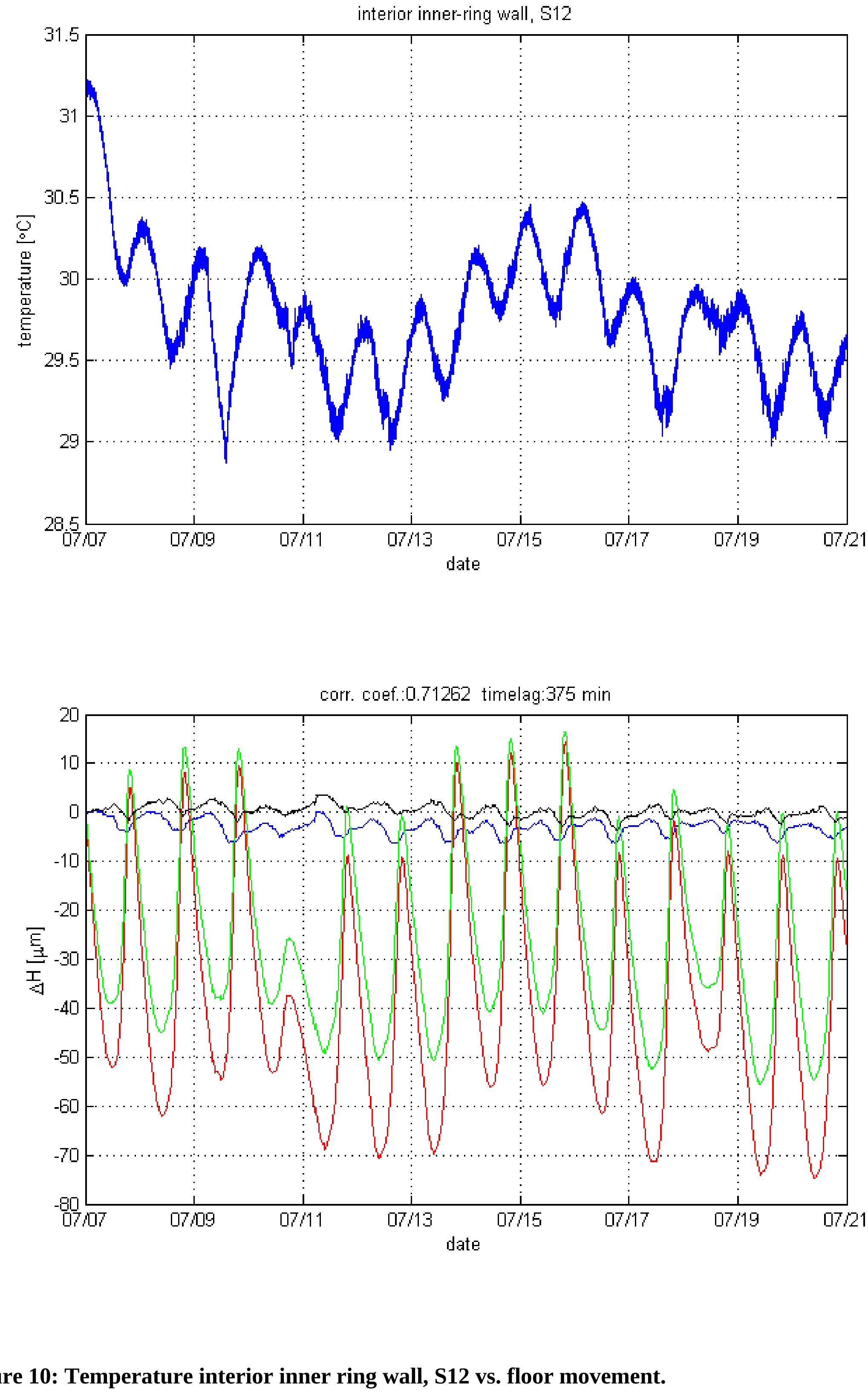


Figure 10: Temperature interior inner ring wall, S12 vs. floor movement.

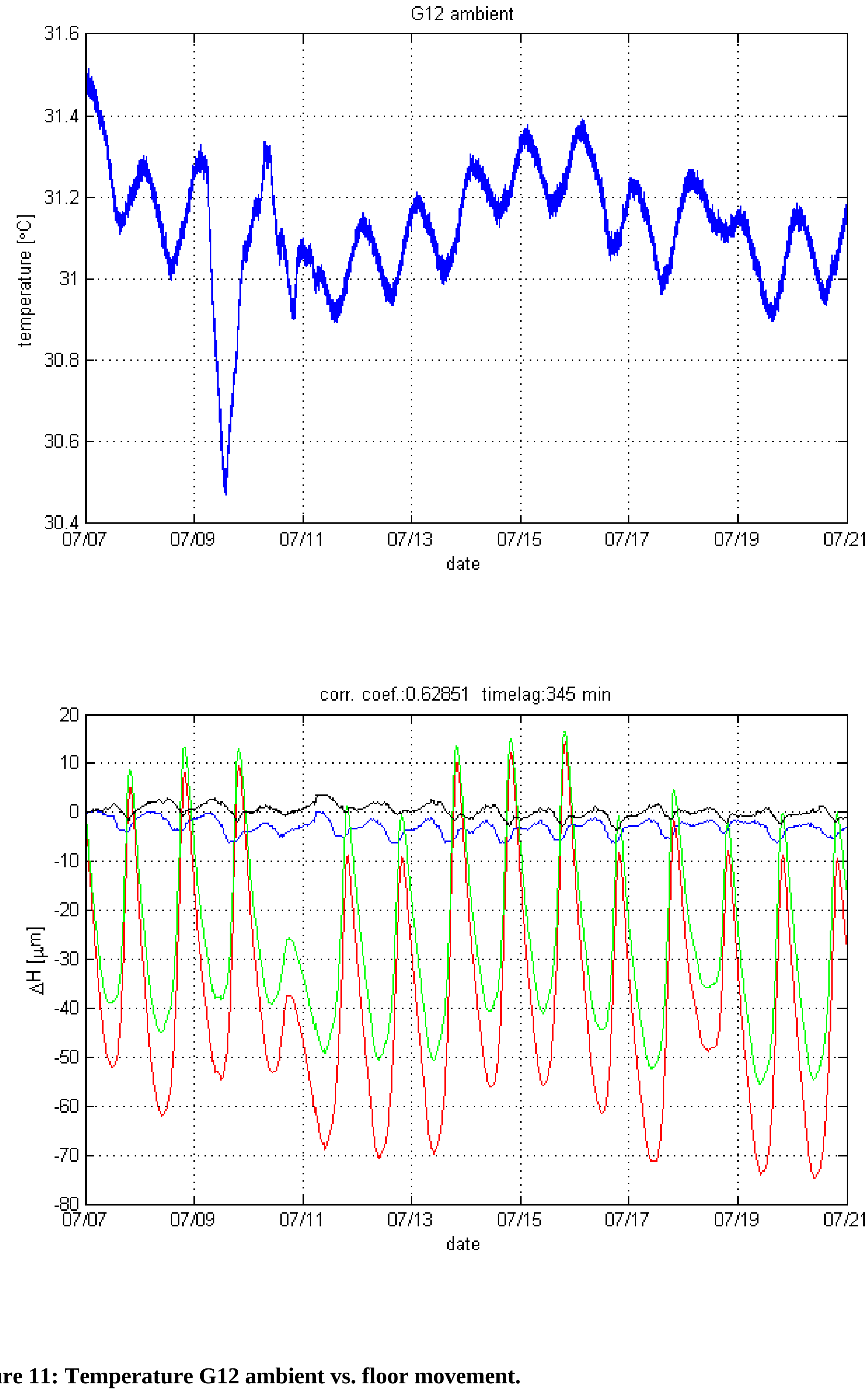
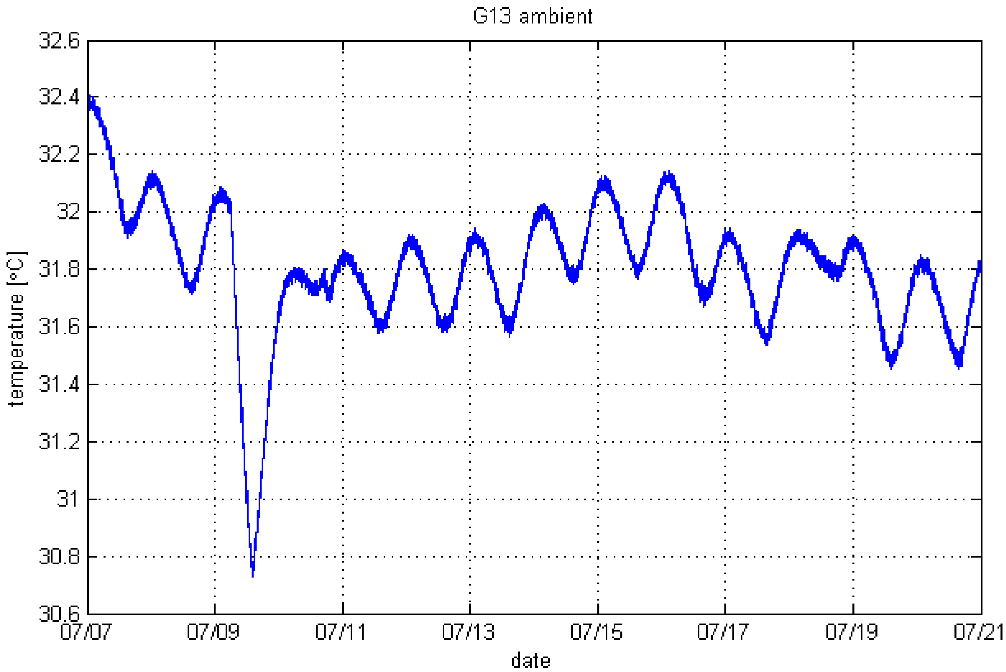


Figure 11: Temperature G12 ambient vs. floor movement.



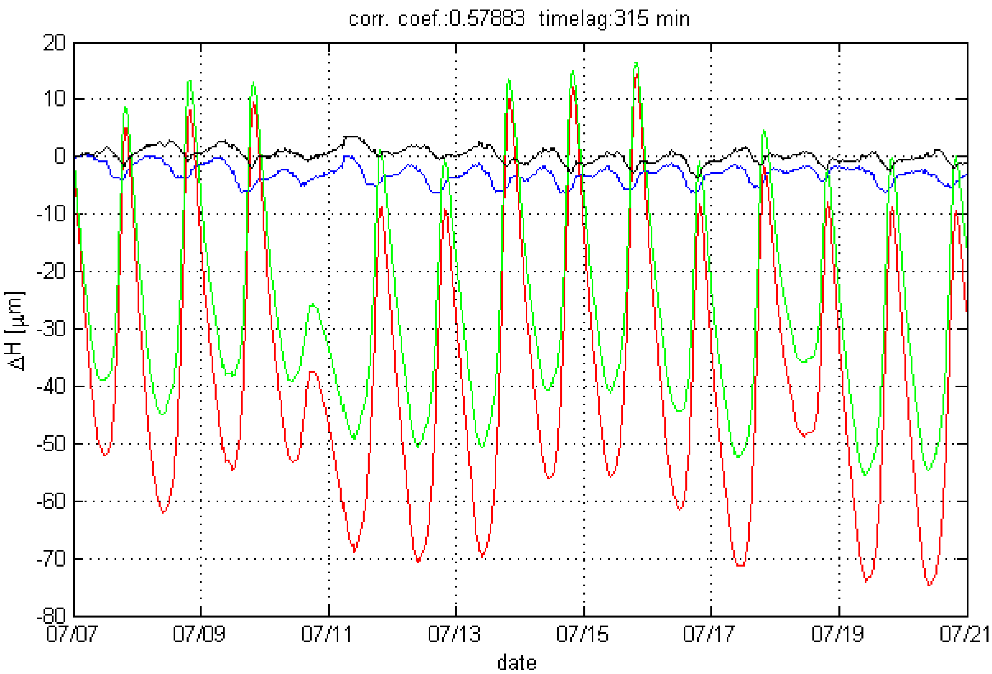


Figure 12: Temperature G13 ambient vs. floor movement.

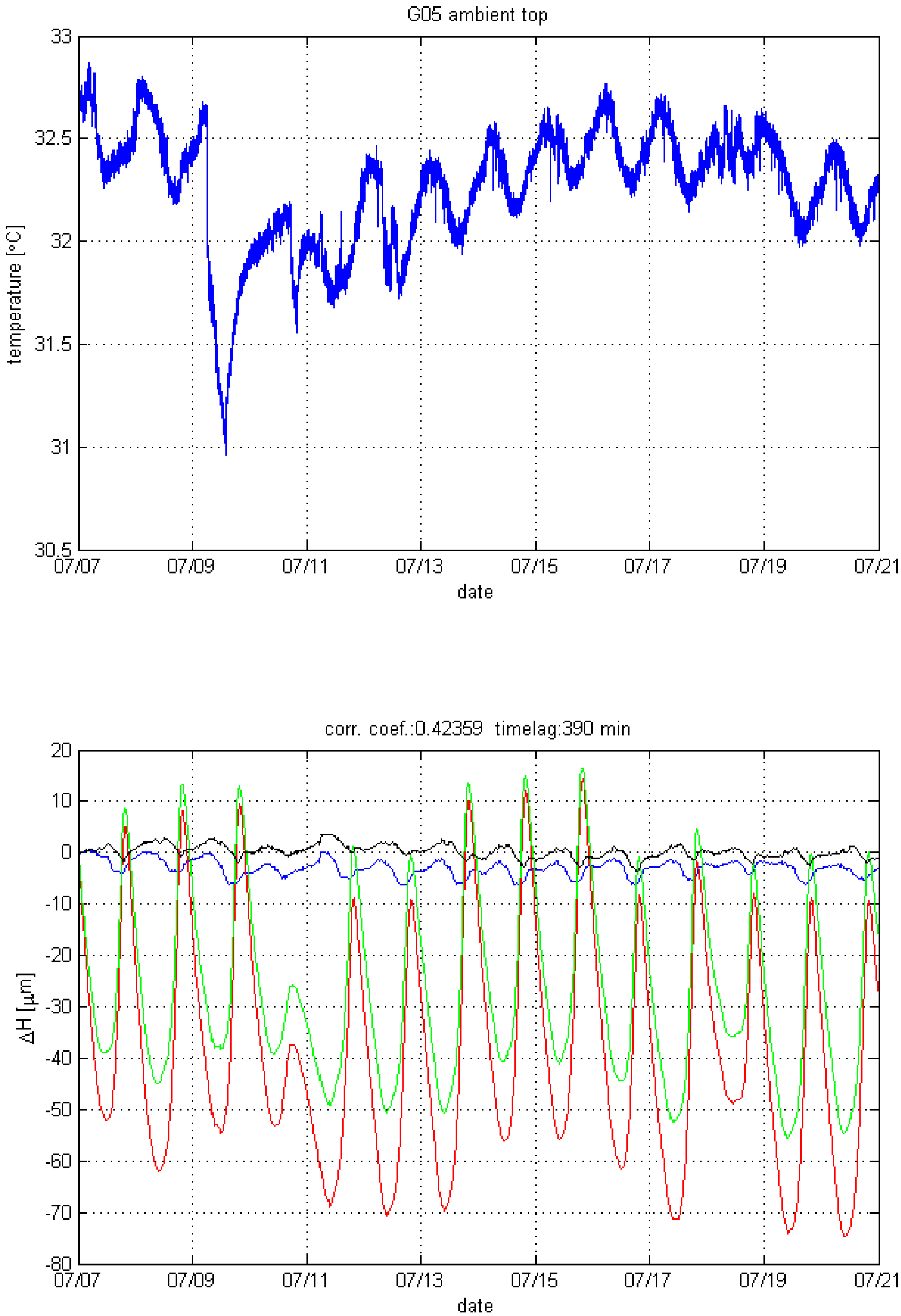


Figure 13: Temperature G5 ambient top vs. floor movement.