Preliminary Results of KEK-GM Measurement

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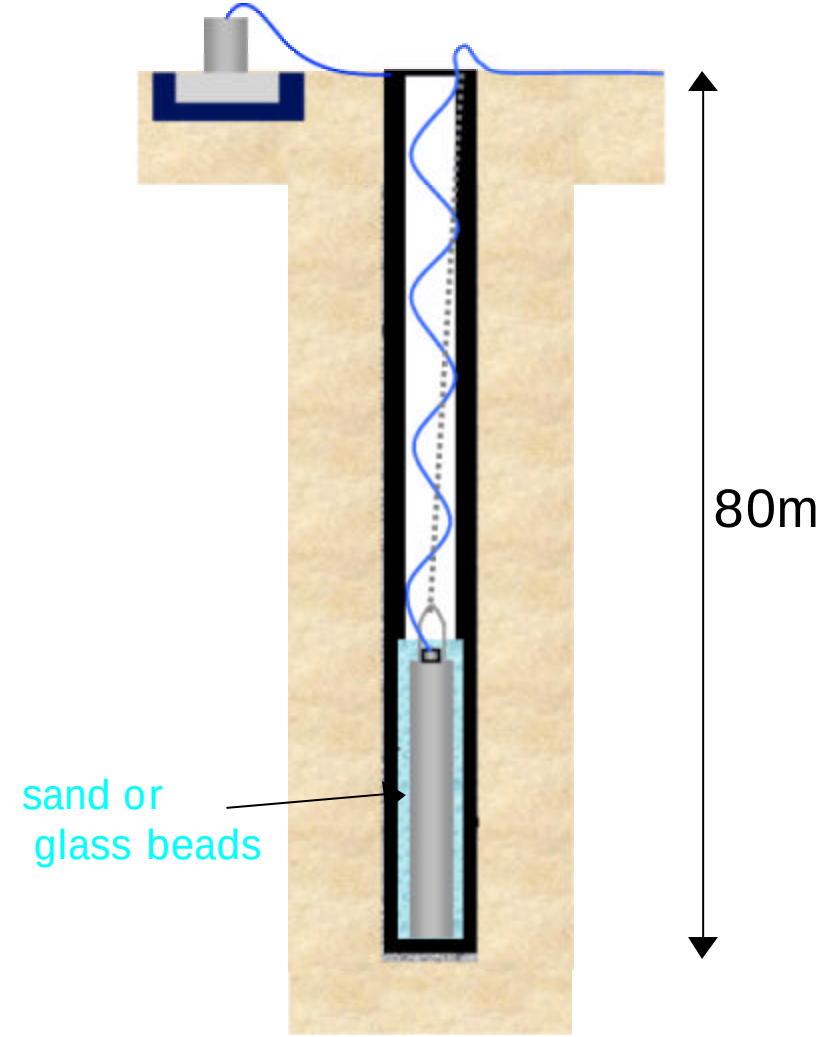
H.Yamaoka, N,Uchida, ISG10,
SLAC,2003.6.17

Ground Motion Measurement at KEK

in 2003.1 ~ 3.31

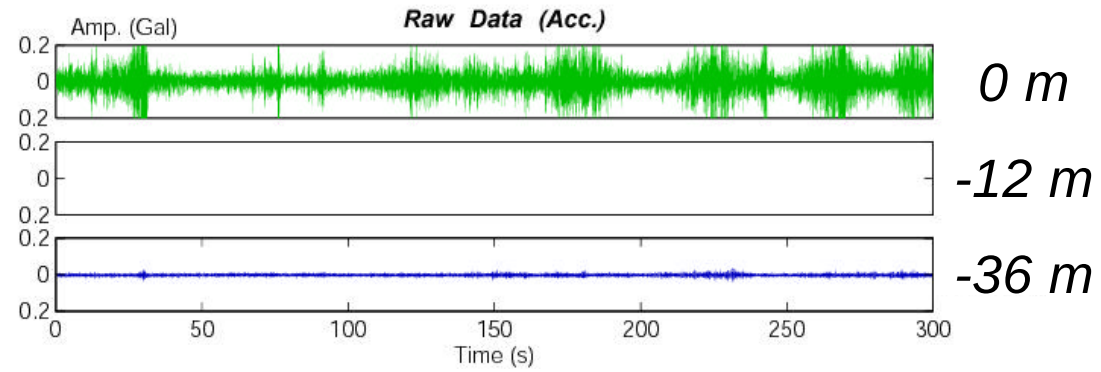
2 sensors (CMG40T)

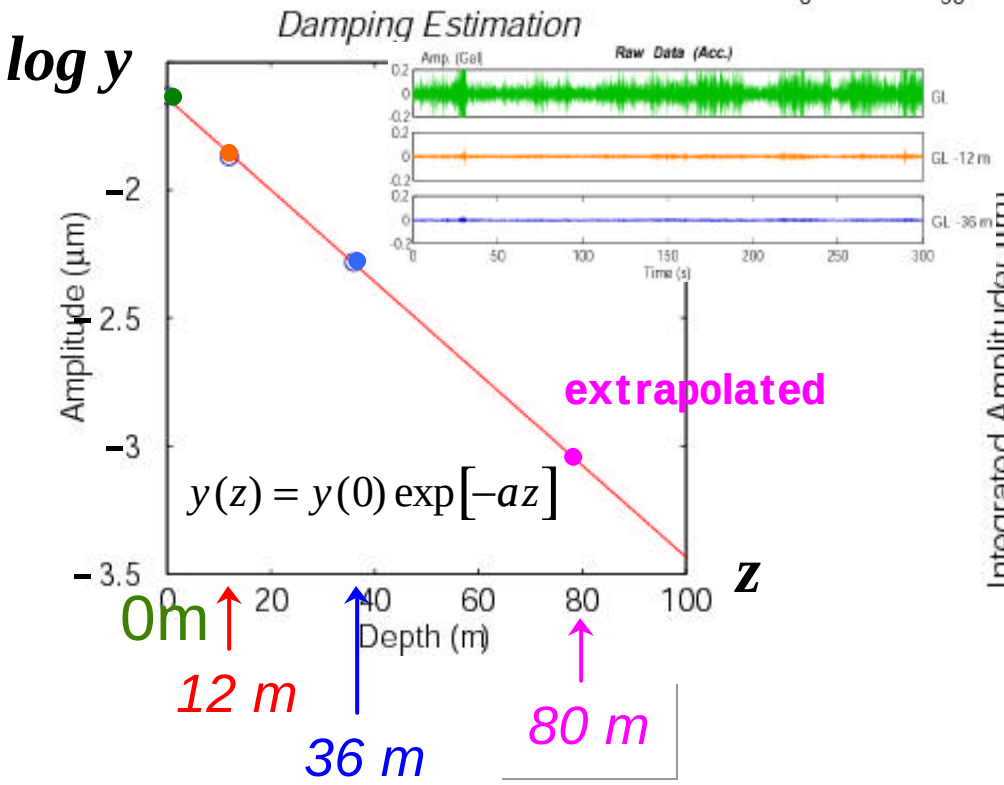


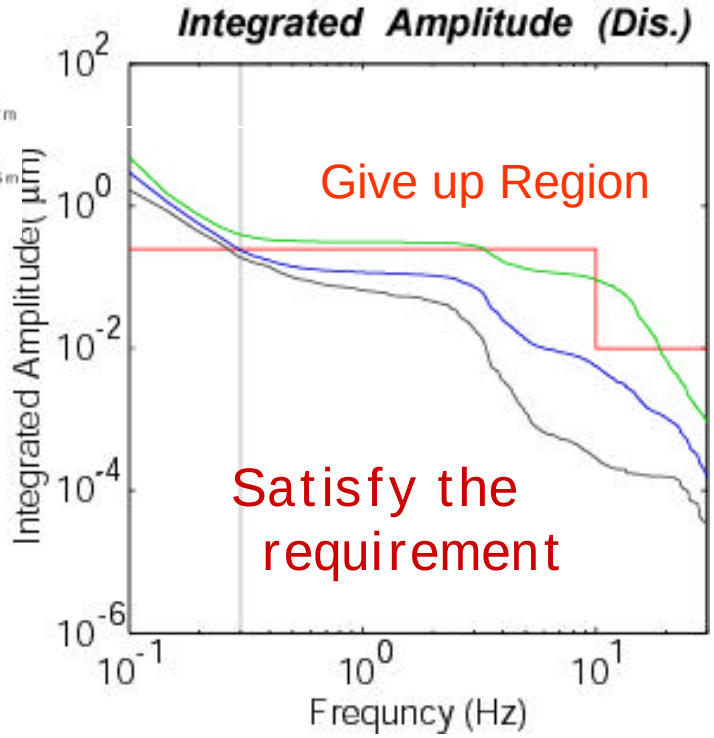
Expected Amplitude at GL-80 m

JLC Electron-Positron Linear Collider Project

- 2002/08/22
  11:00 Z-axis







Geology

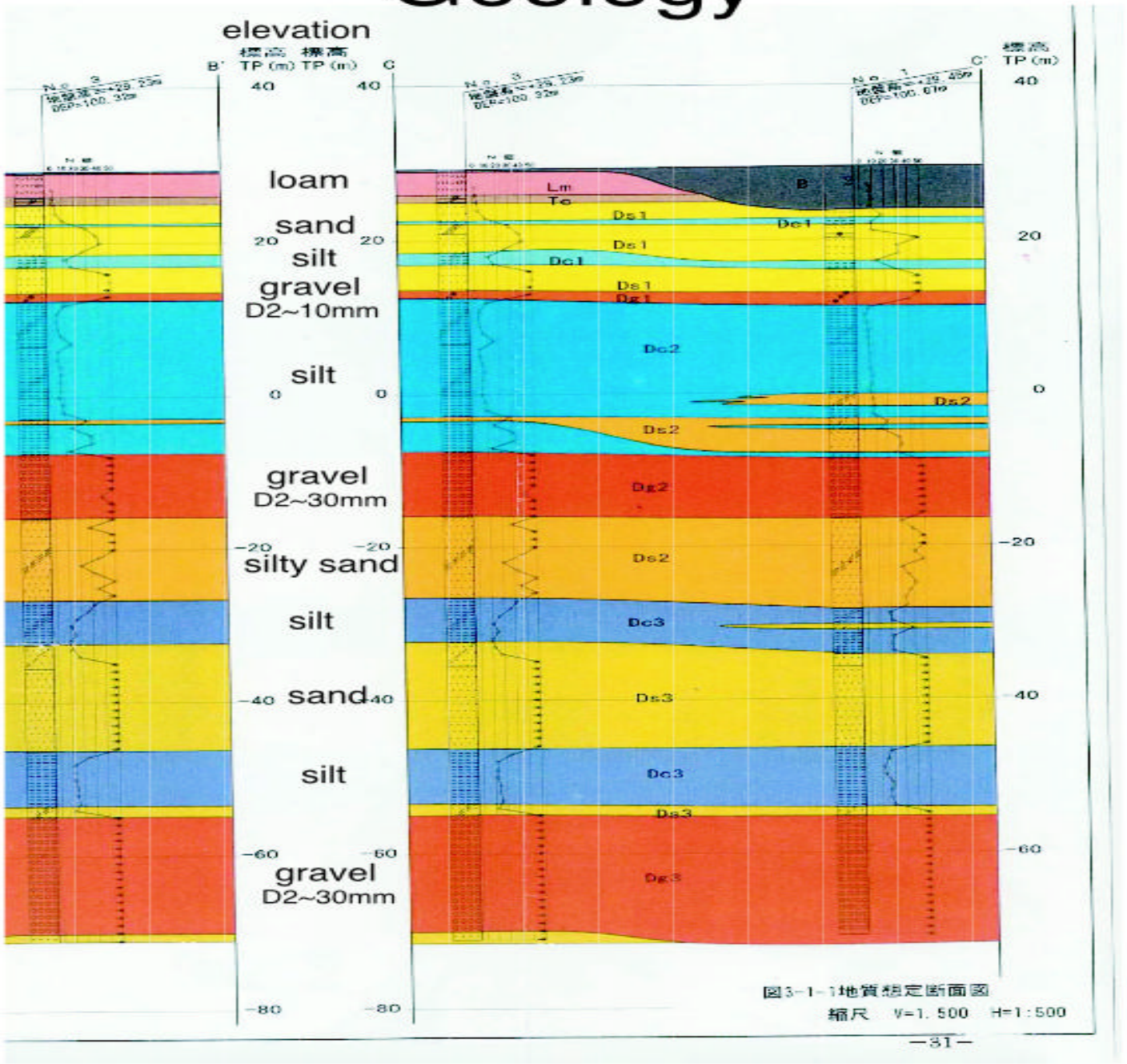


図3-1-1地質想定断面図

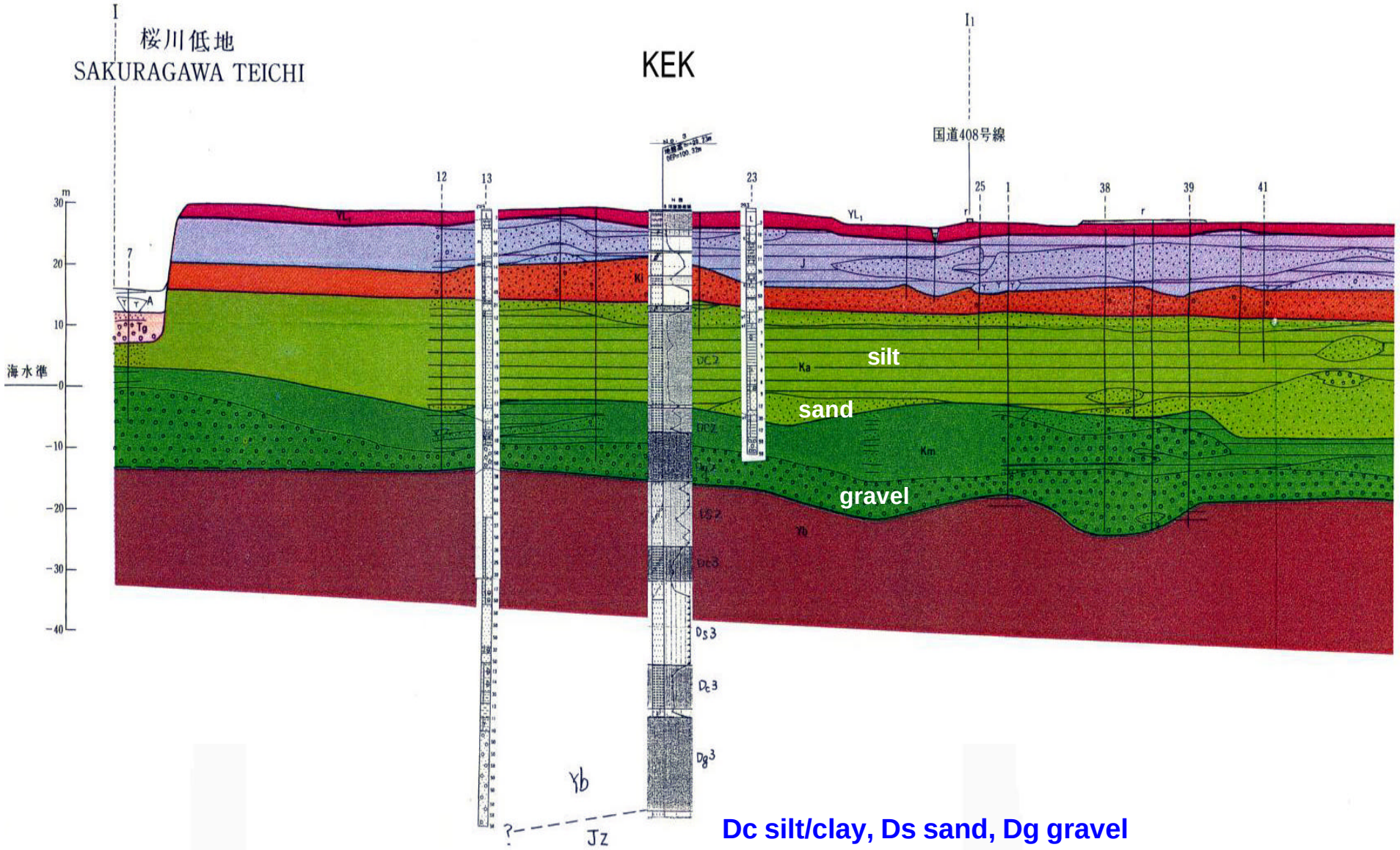
縮尺 V=1.500 H=1:500

Ground Structure Model at KEK (Oyo Co.ltd.)

depth	layer thickness	S-wave velocity	density	damping coefficient	geology
m	m	m/sec	g/cm^3	%	
3	3	110	1.4	5.0	loam
4	1	110	1.6	5.0	cohesive soil(volcanic ash)
7	3	190	1.7	5.0	sand
11	4	220	1.7	5.0	silty sand
13	2	220	1.6	5.0	sandy silt
16	3	290	1.7	5.0	sandy soil
17	1	290	1.9	5.0	gravel
22	5	200	1.8	5.0	sandy silt
30	8	230	1.8	5.0	sandy silt
37	7	280	1.8	5.0	silt
45	8	600	2.0	1.3	gravel
50	5	460	1.9	1.6	silty sand
56	6	330	1.9	2.3	silty sand
63	7	310	1.8	2.4	sandy silt
75	12	390	1.9	1.9	sand with silt
84	9	270	1.8	2.8	silt, silty sand
90	6	460	2.0	1.6	gravel
99	9	750	2.0	1.0	gravel
320*	221	750	1.9	1.0	gravel

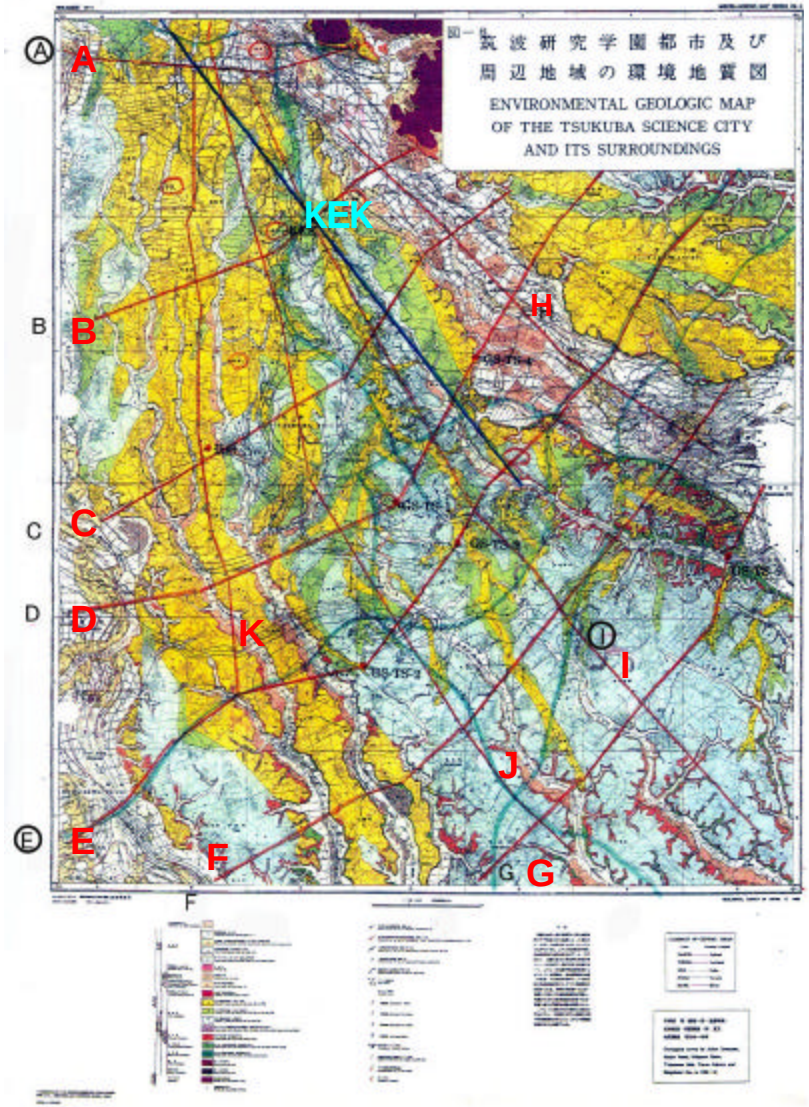
図－11　JLC ルートに沿った KEK 付近のボーリング柱状図と地質断面図

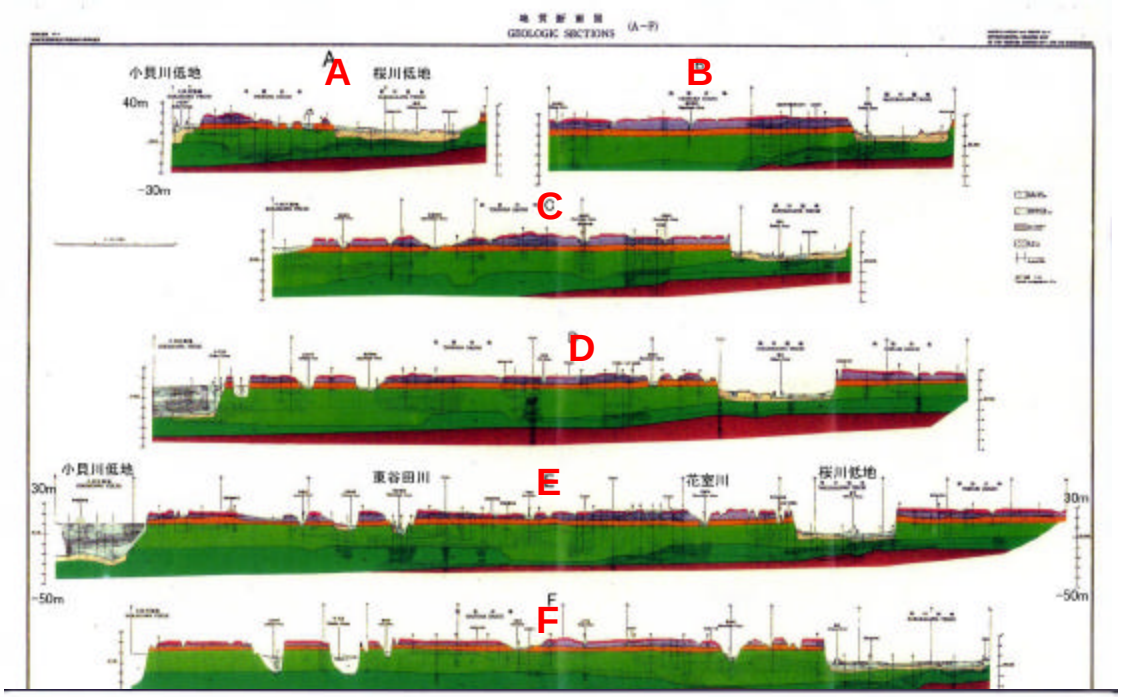
Boring result and geologic data (I)

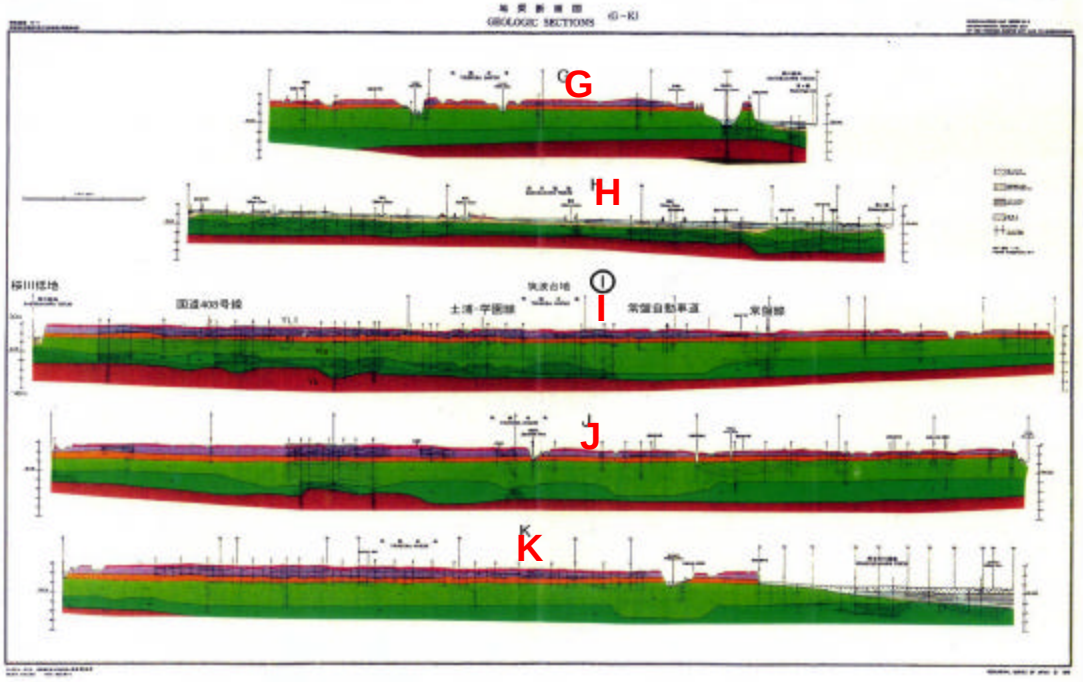


Dc silt/clay, Ds sand, Dg gravel

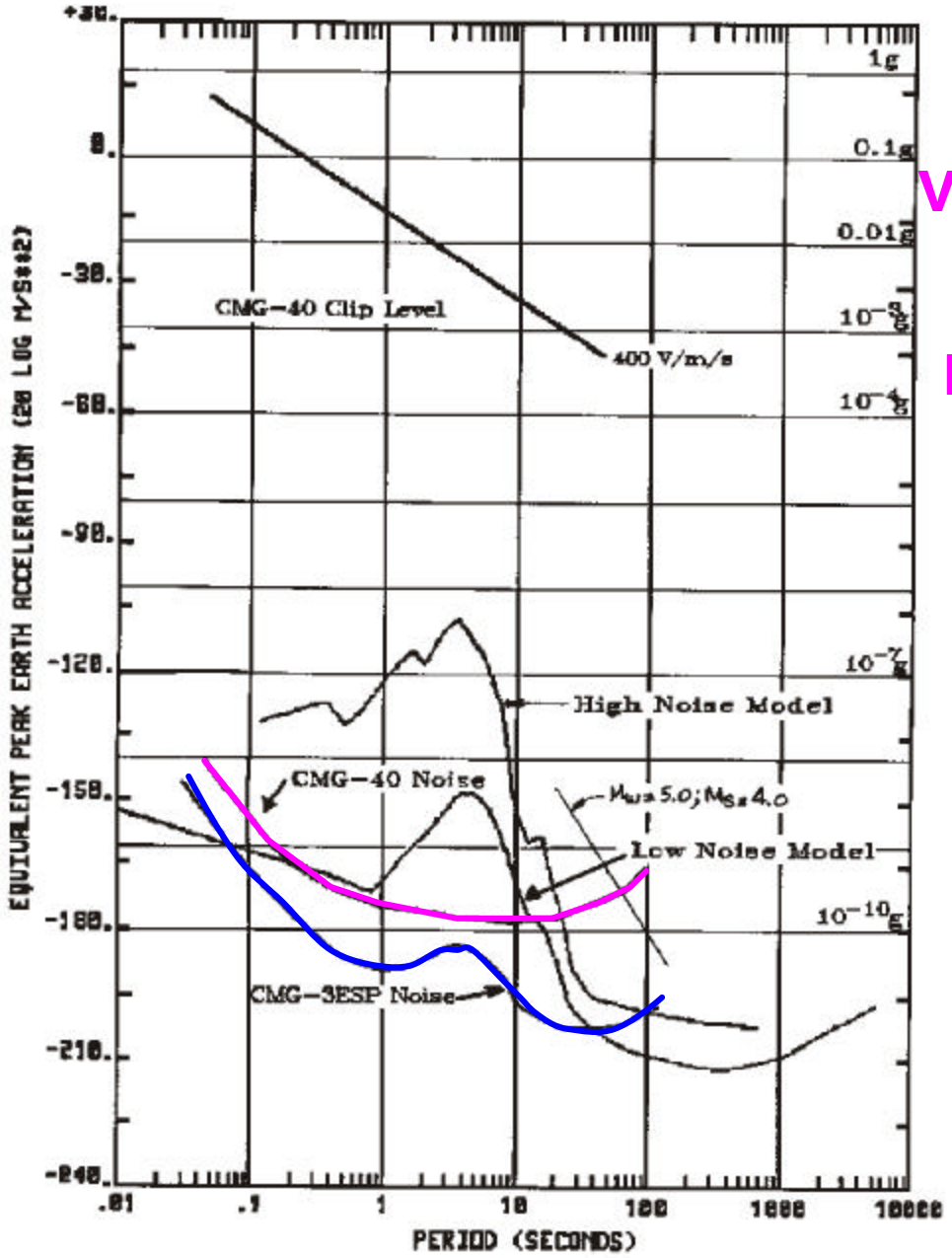
Tsukuba
Geologic Sections







“30 sec” sensor : CMG40T of GURALP



Velocity Output: 2 x 400 V/m/s

for borehole 2 x 800 V/m/s

Frequency band: 0.033 to 50Hz

CMG3T (100 sec sensor)

Velocity Output: 2 x 750 V/m/s

Flat velocity: 0.01 to 50 Hz

Huddle Test

2003.3.10

CMG40T(borehole)
Ch.7,8,9

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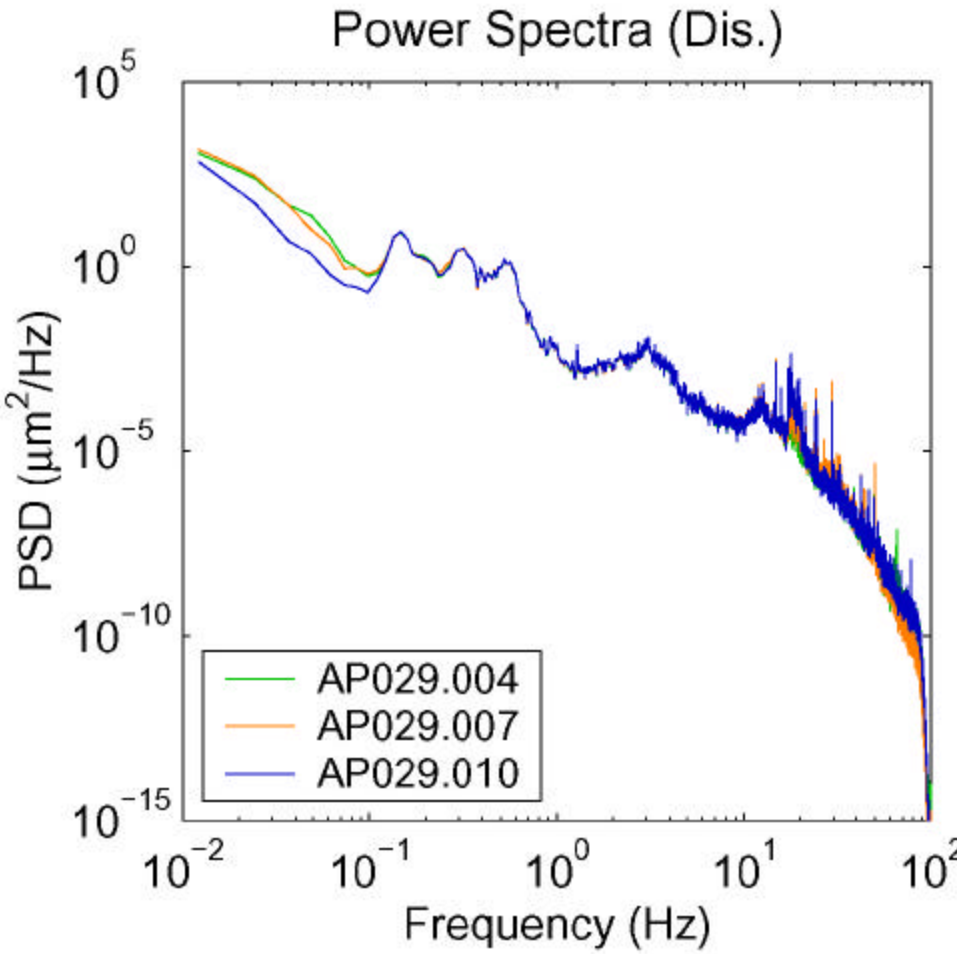
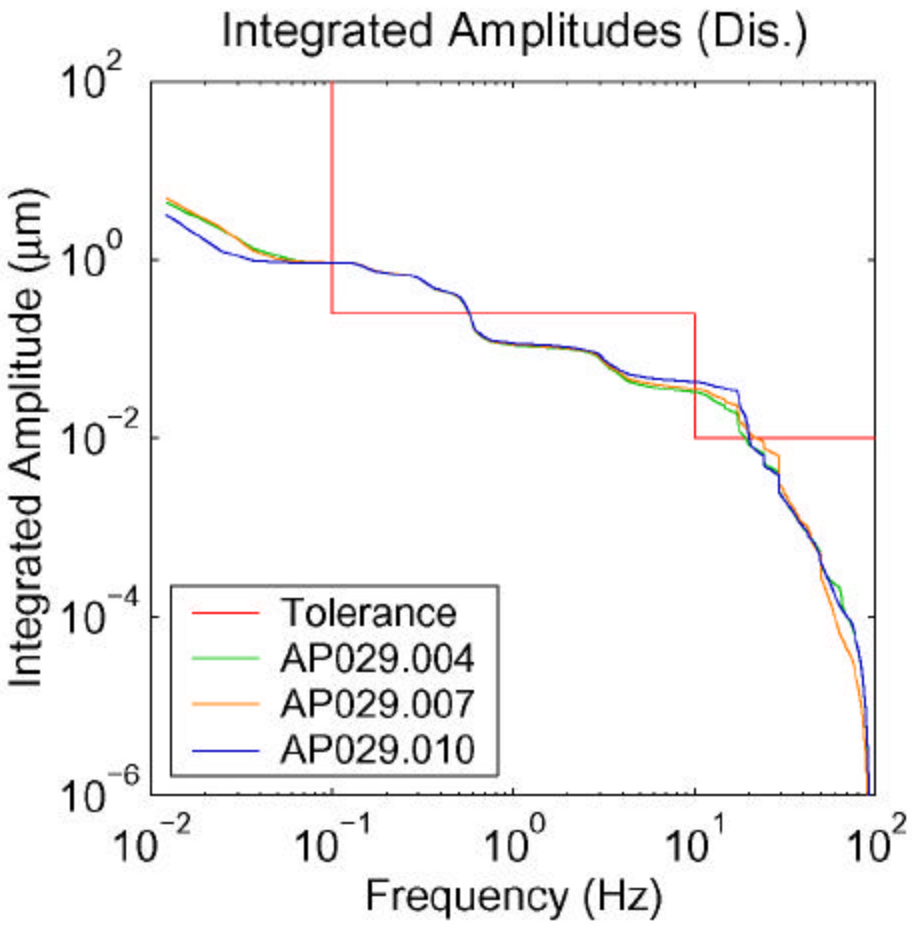
CMG3T as reference
Ch.10,11,12

CMG40T
Ch.4,5,6

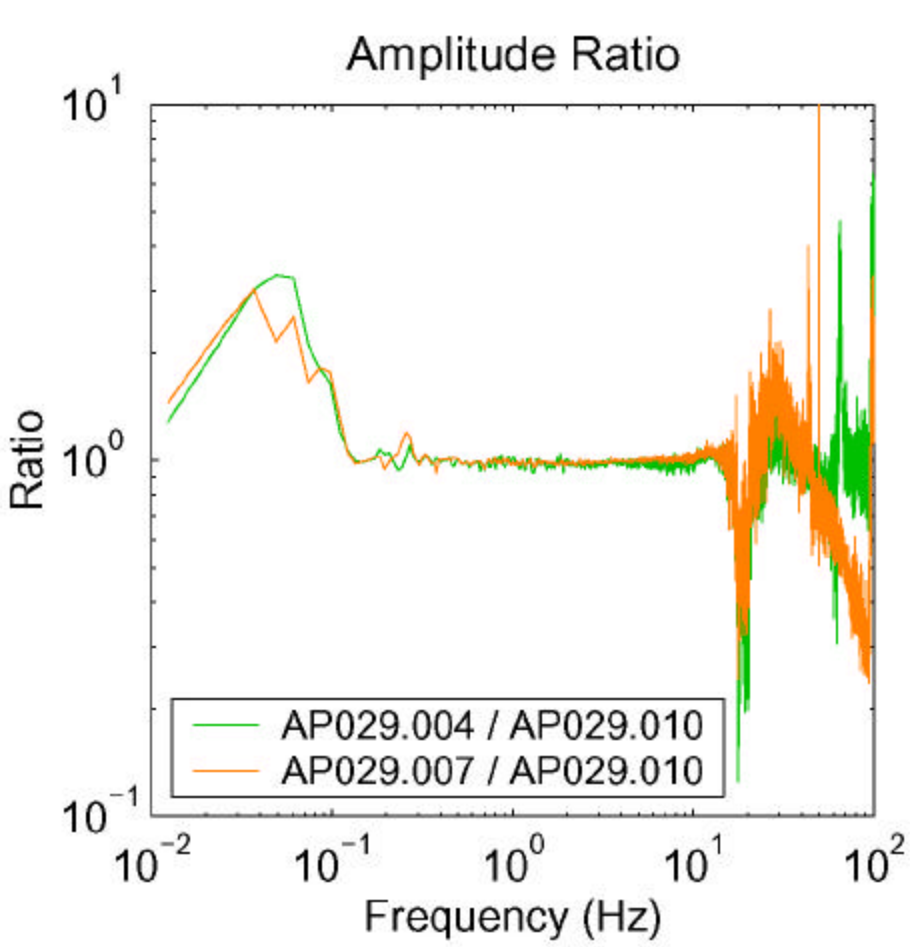
Results (1)

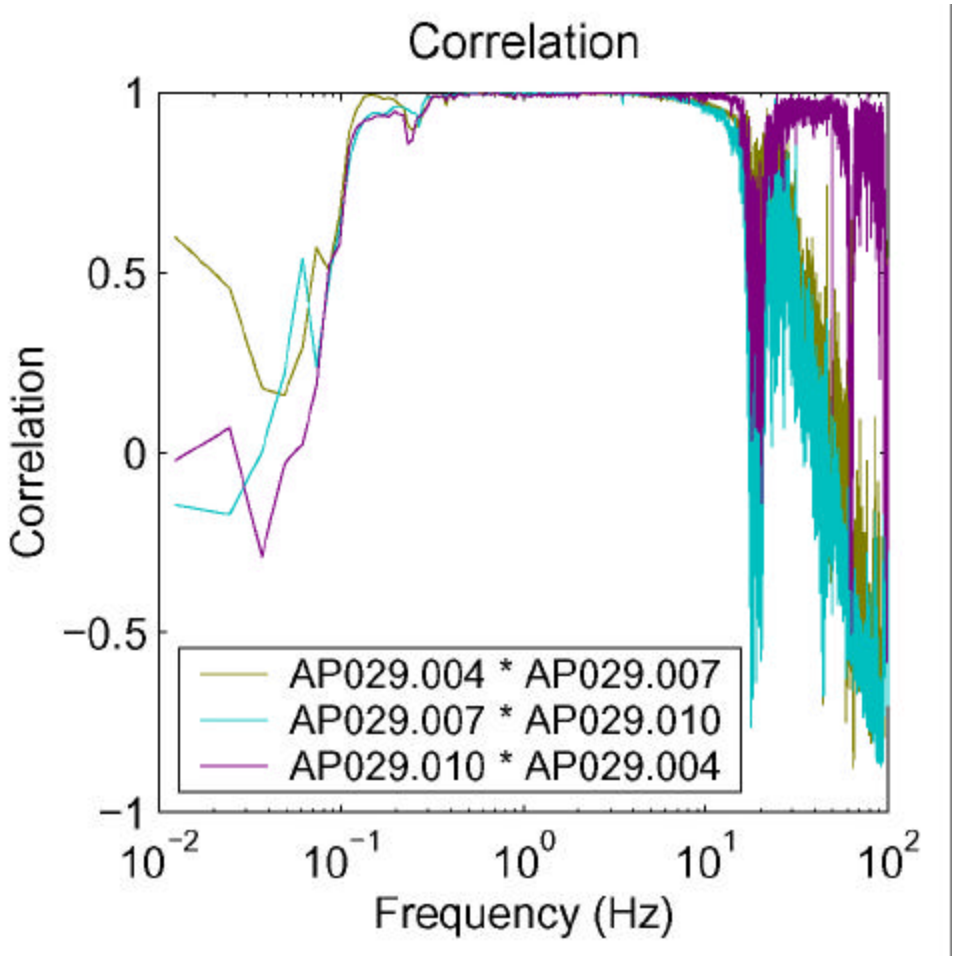
Gain constants are provided by GURALP.





Results (2)

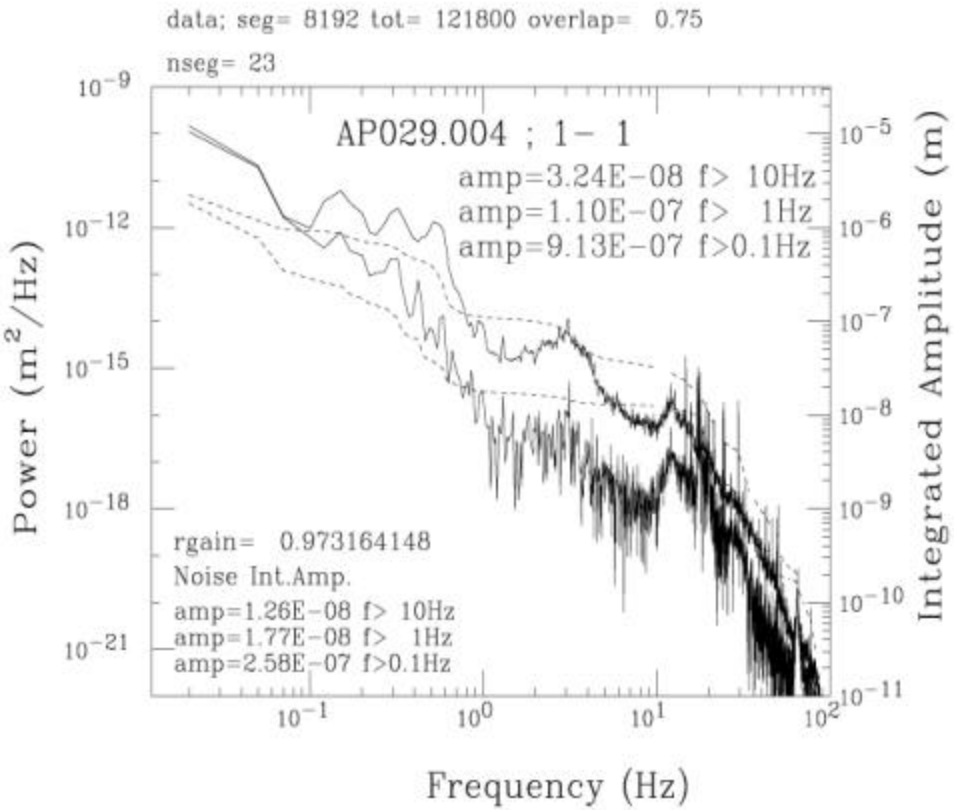

Amplitude Ratio
Ratio
Frequency (Hz)
AP029.004 / AP029.010
AP029.007 / AP029.010

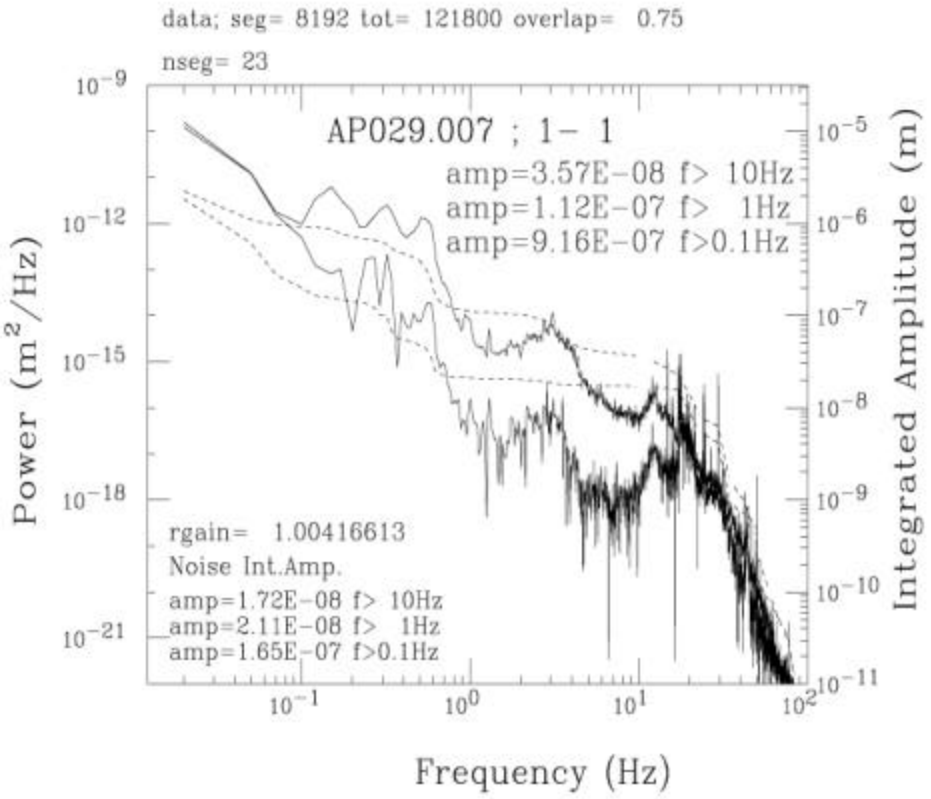

Correlation
Correlation
Frequency (Hz)
AP029.004 * AP029.007
AP029.007 * AP029.010
AP029.010 * AP029.004

Results (3)

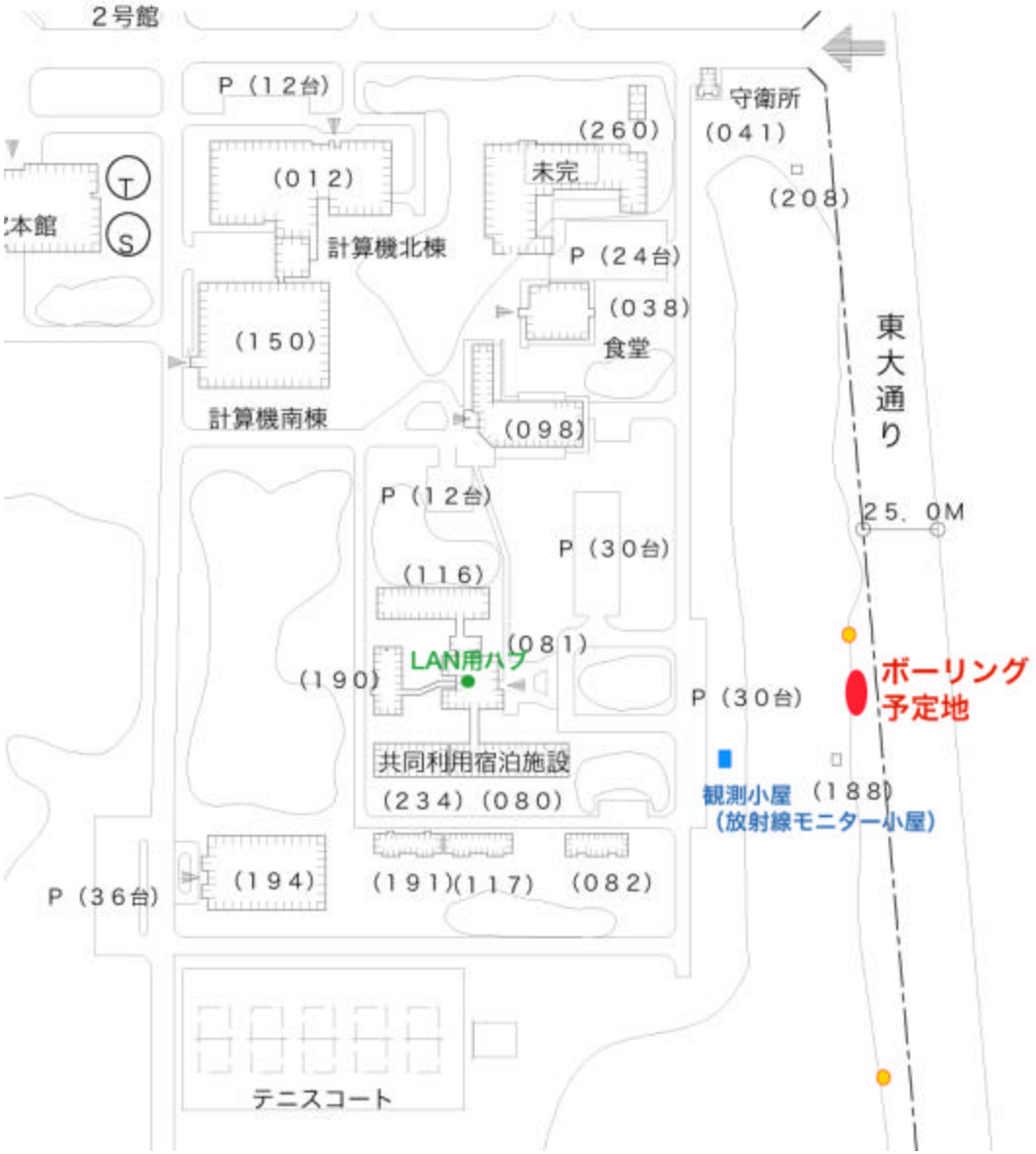
"noise" estimation by PSD(1-C(PSDxPSD')$^{1/2}$), PSD'=ch10

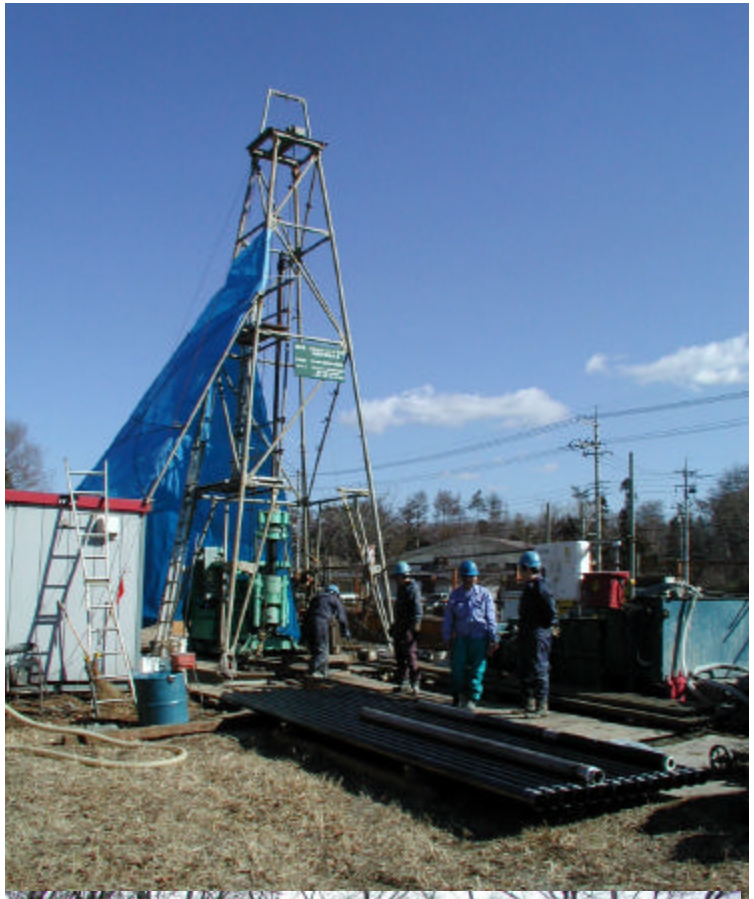
, which is true for perfect gain constants, PSD=signal +noise.





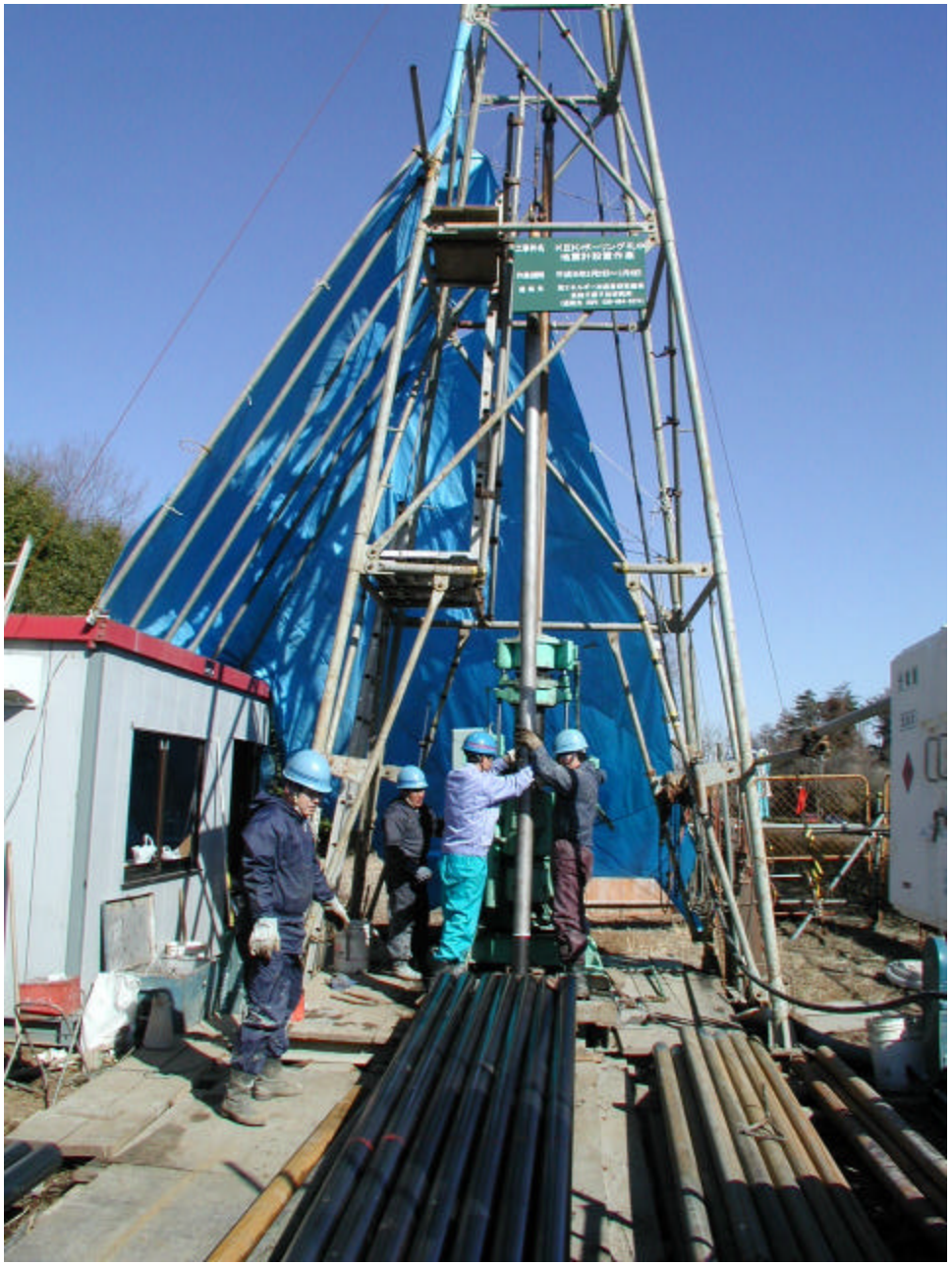
Boring Process(1)





Boring Process(2)

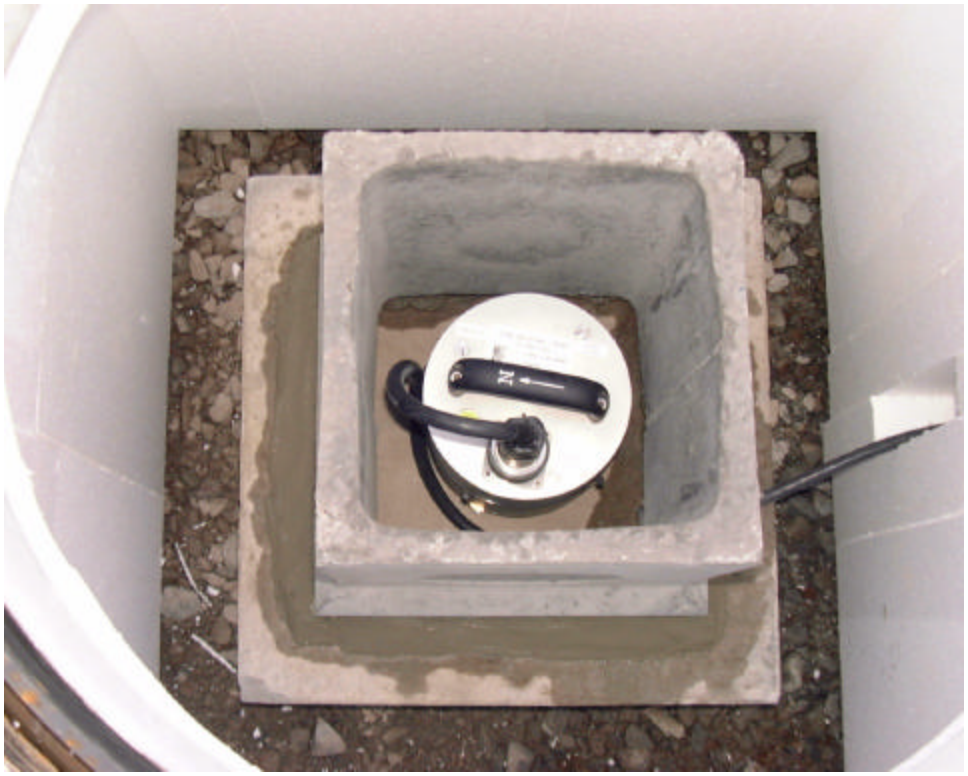
Boring machine NLC

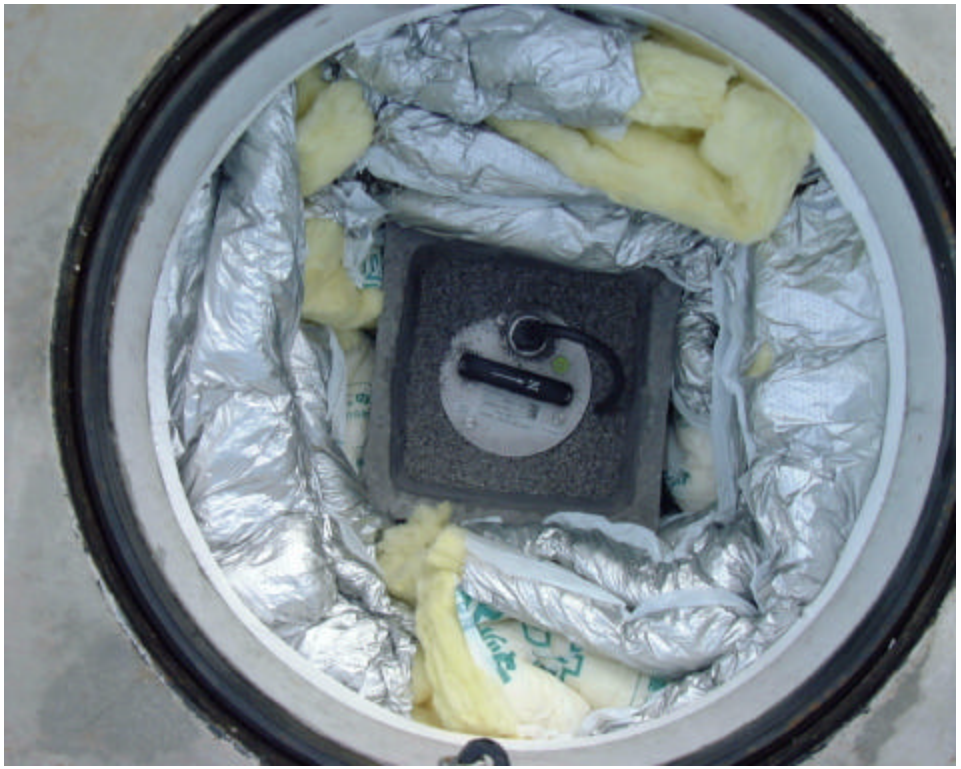


Boring Process(3)

Installing glass beads to anchore the sensor.

Setting CMG40T at GL





The sensor is surrounded by sand, and thermal insulators fill the manhole (about 1m deep).

GM Measurement

Measurement began at 10pm on 17th April, 2003.

Until 29 May, 4 times per day at 4am, 10am, 4pm, 10pm.

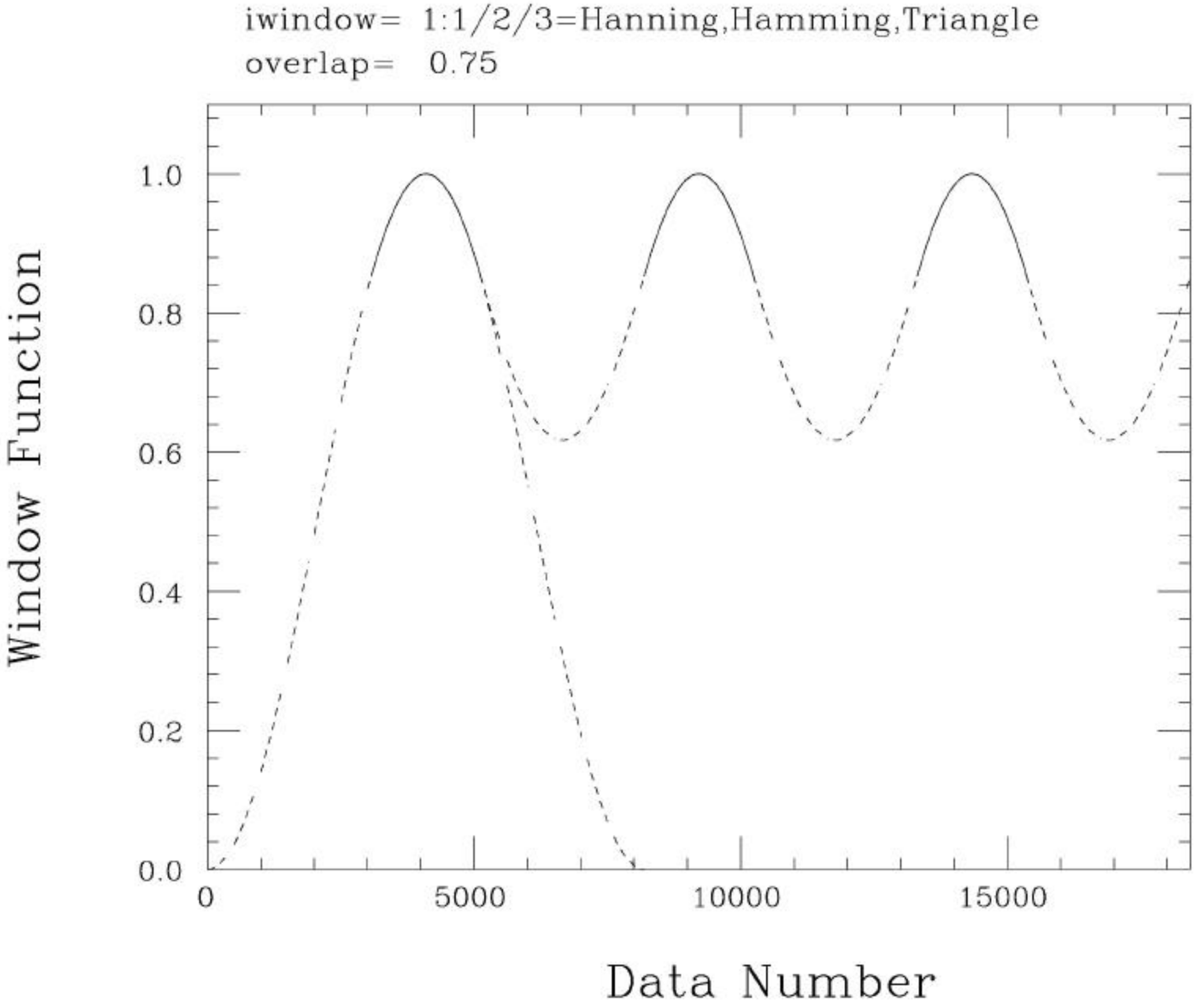
Data are taken for 30 minutes each at 200 Hz.

After 29 May, data are taken continuously at 200Hz.

The data are segmented into 40.96 sec (8192 data points) for FFT analysis with 75% overlap and Hanning window function. So, there are 69 segments for 30 minutes.

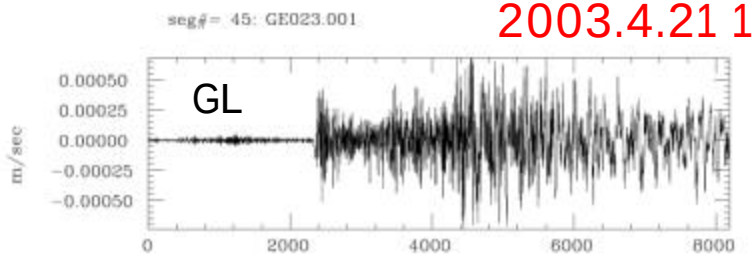
Power spectra, coherences and correlations are averages of the segments.

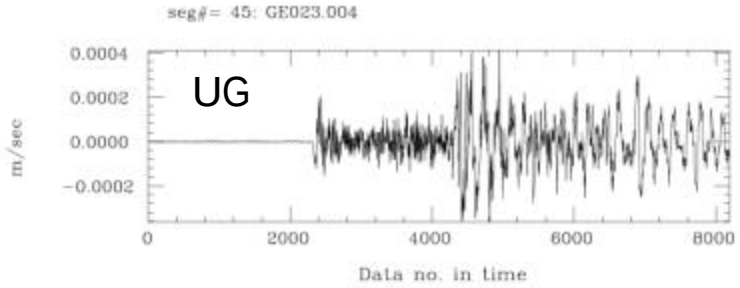
Hanning Window Function

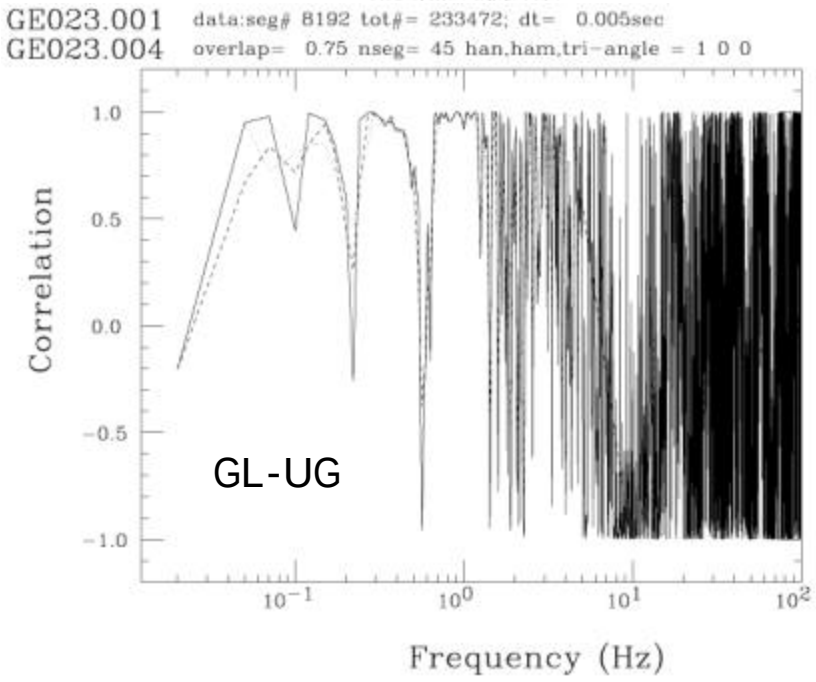


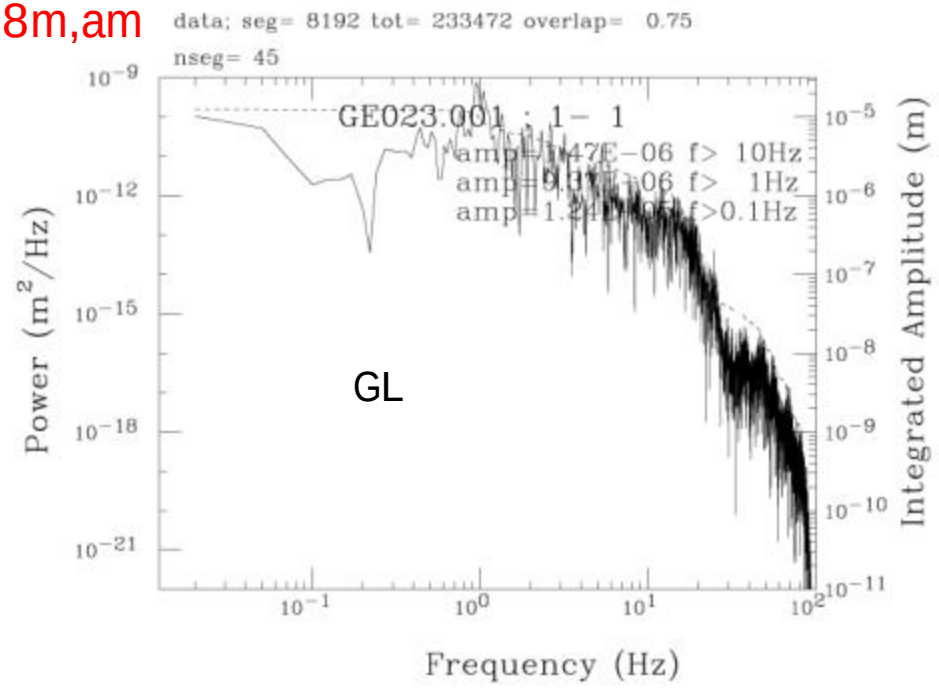
Observation of Earth Quake

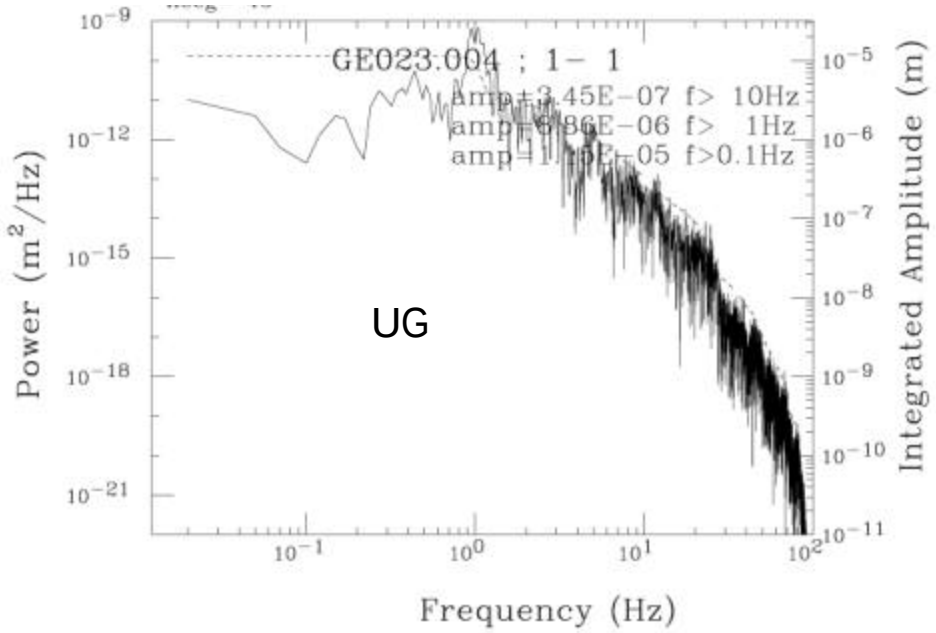
2003.4.21 10h18m,am



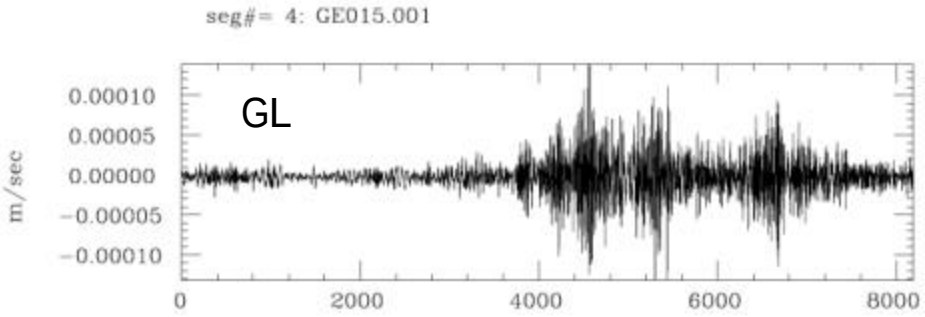


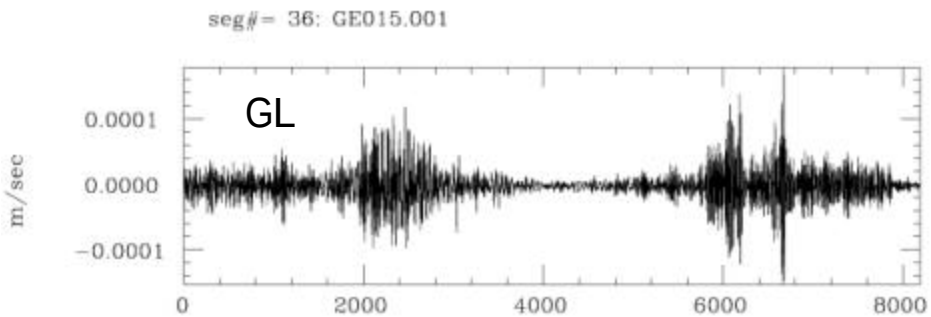


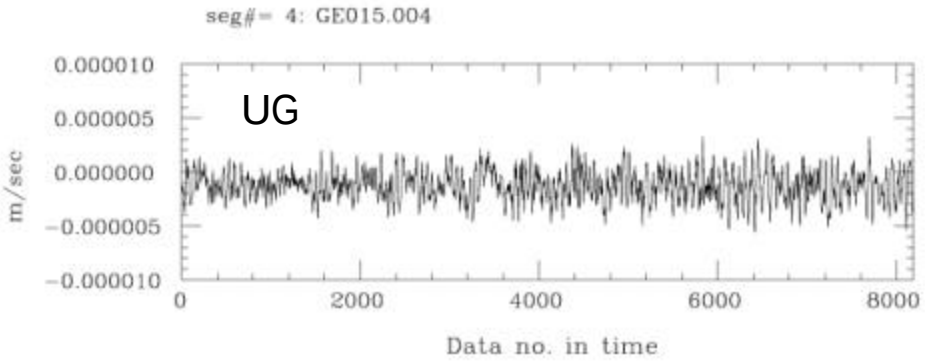


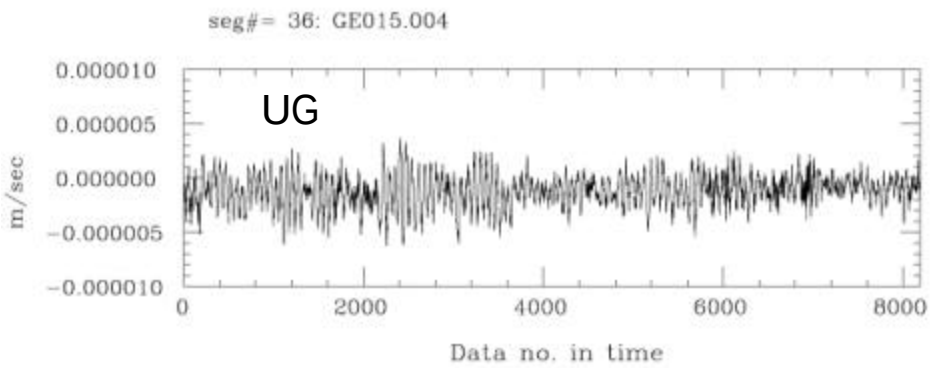


2003.4.19, 10am (1)

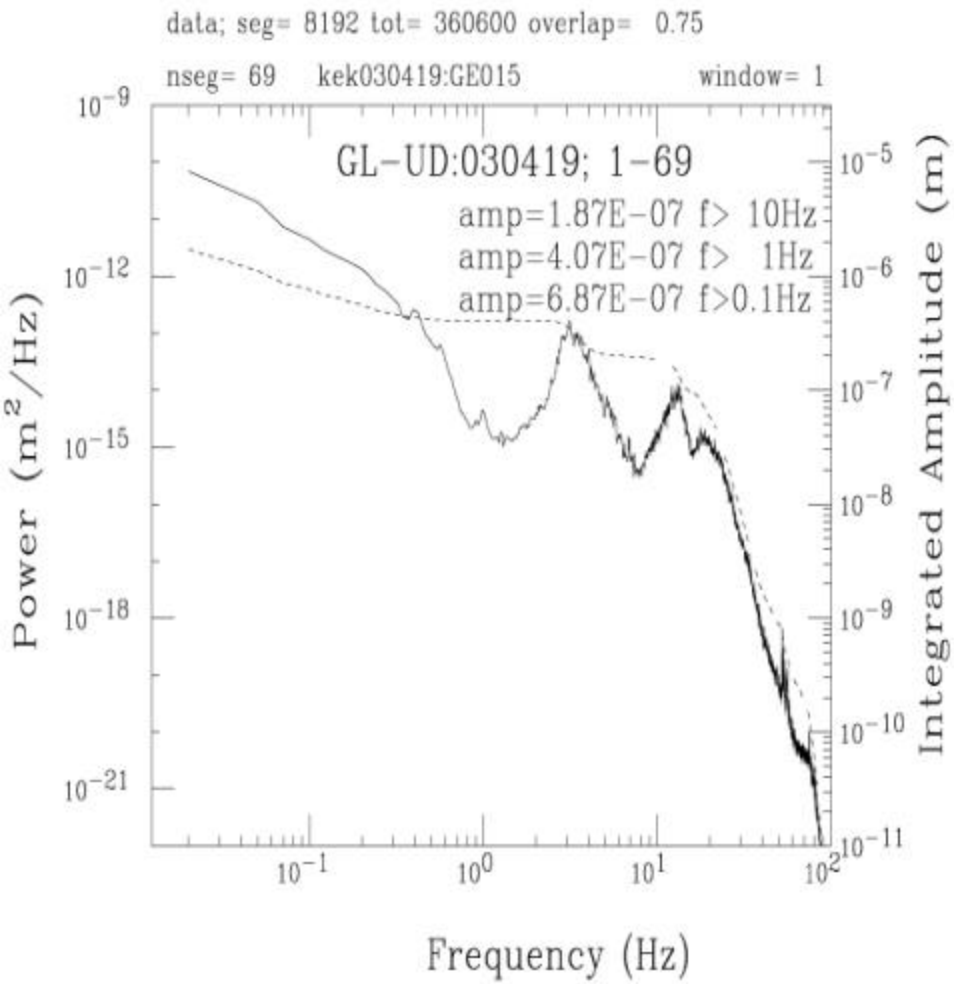


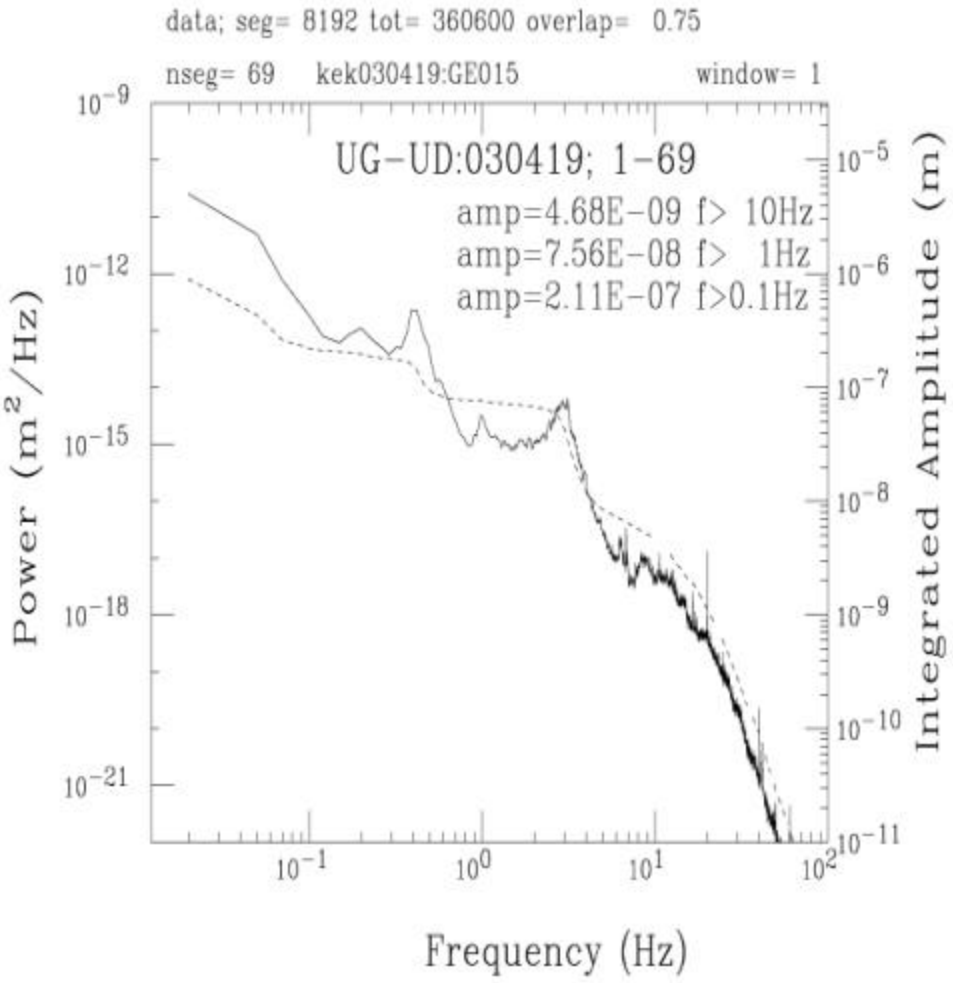




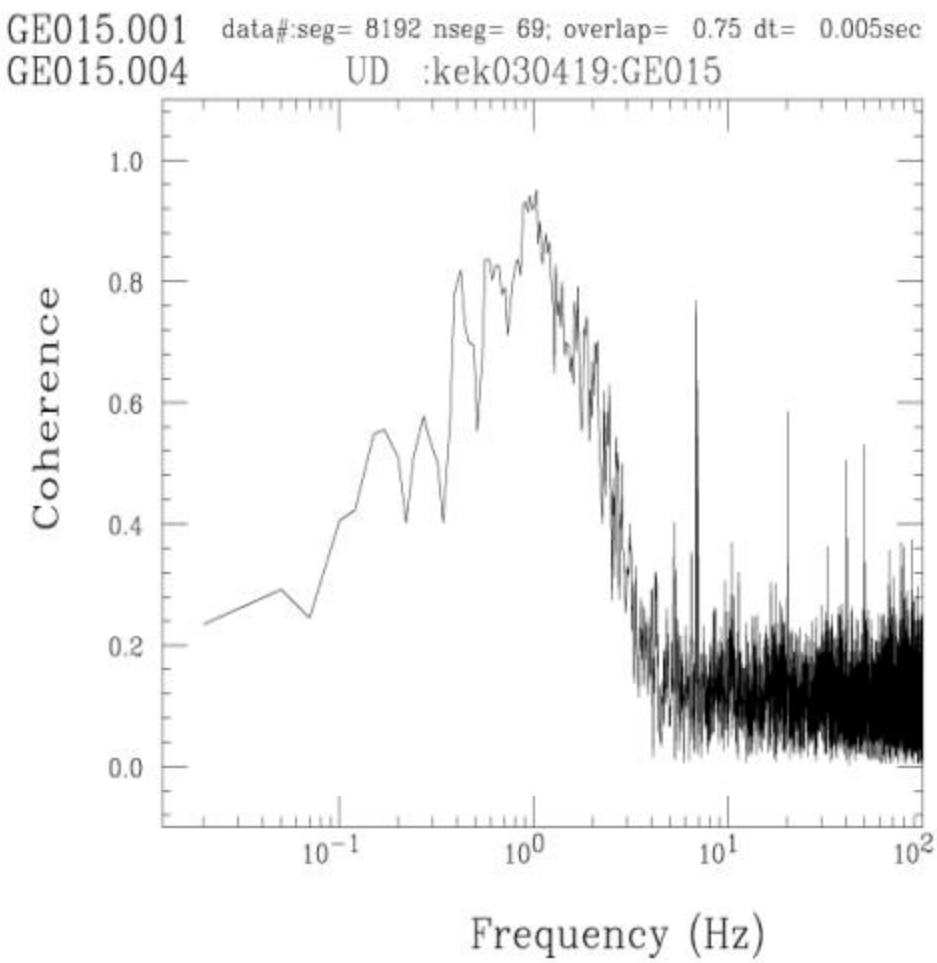


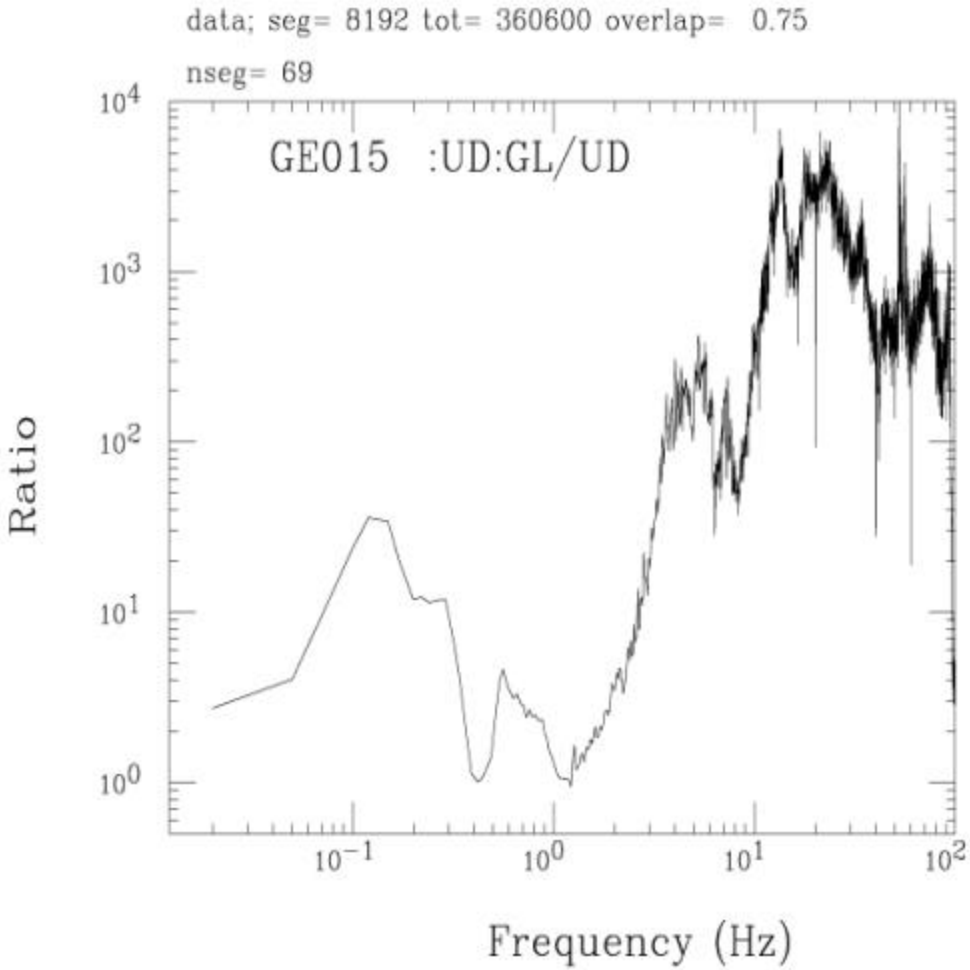
2003.4.19, 10am (2)



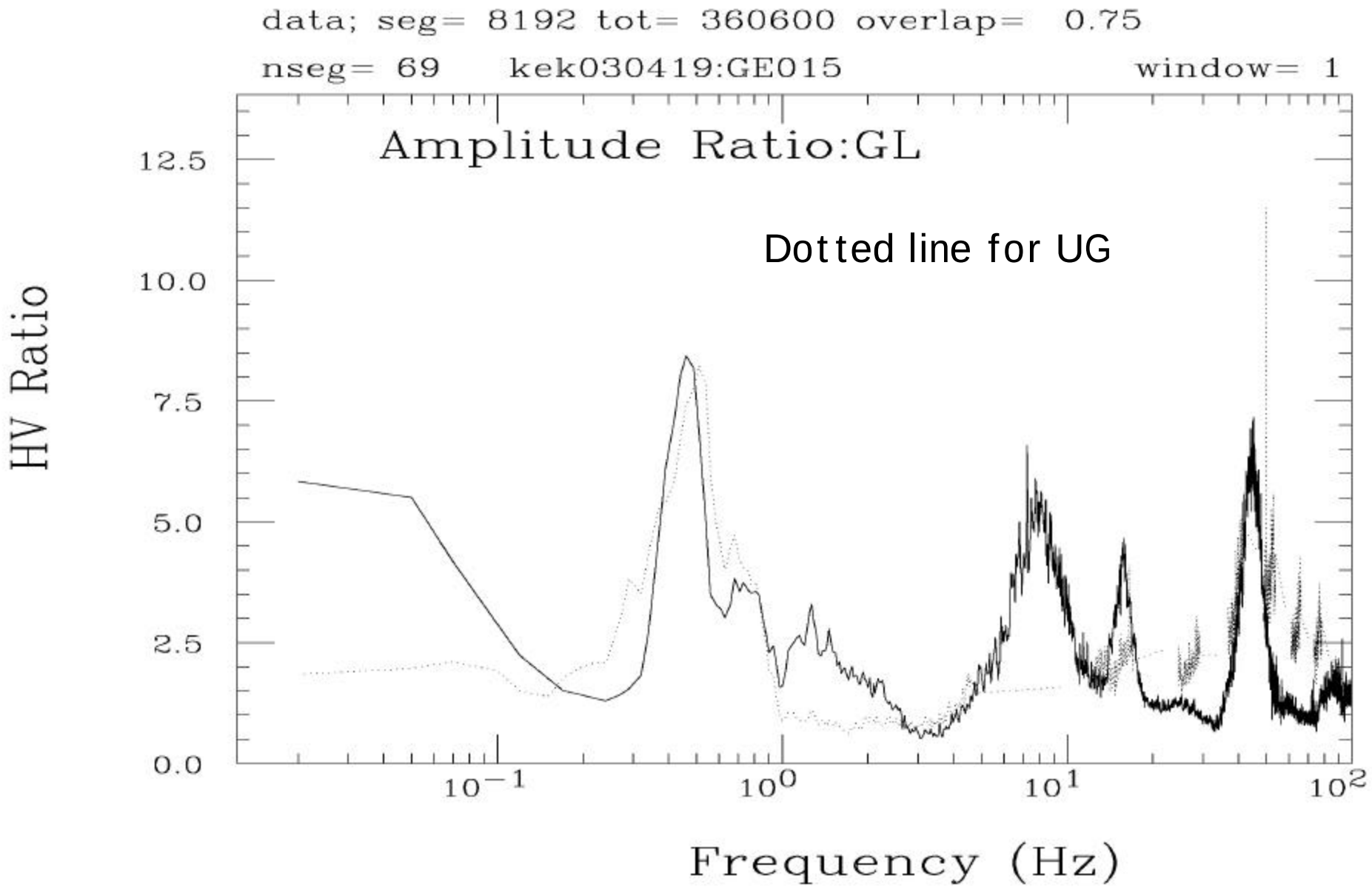


2003.4.19, 10am (3)



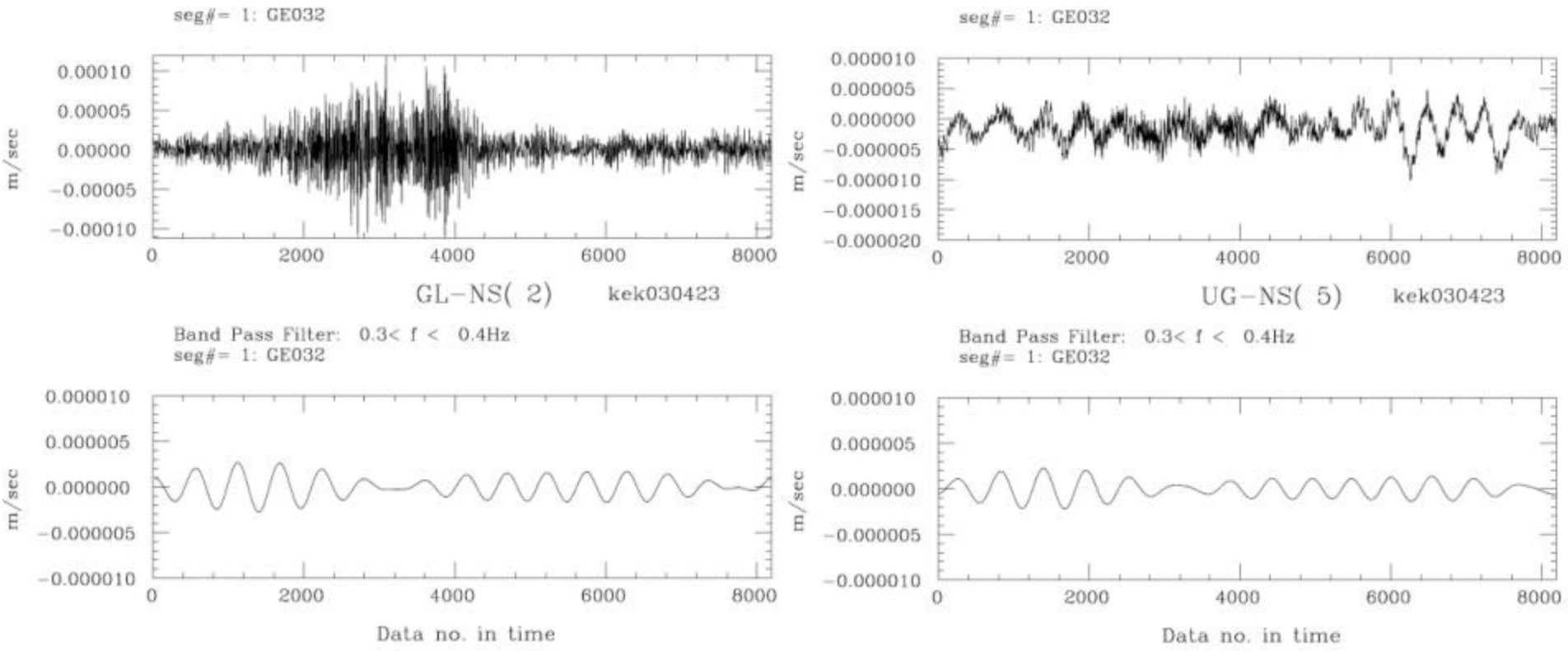


2003.4.19, 10am (4)



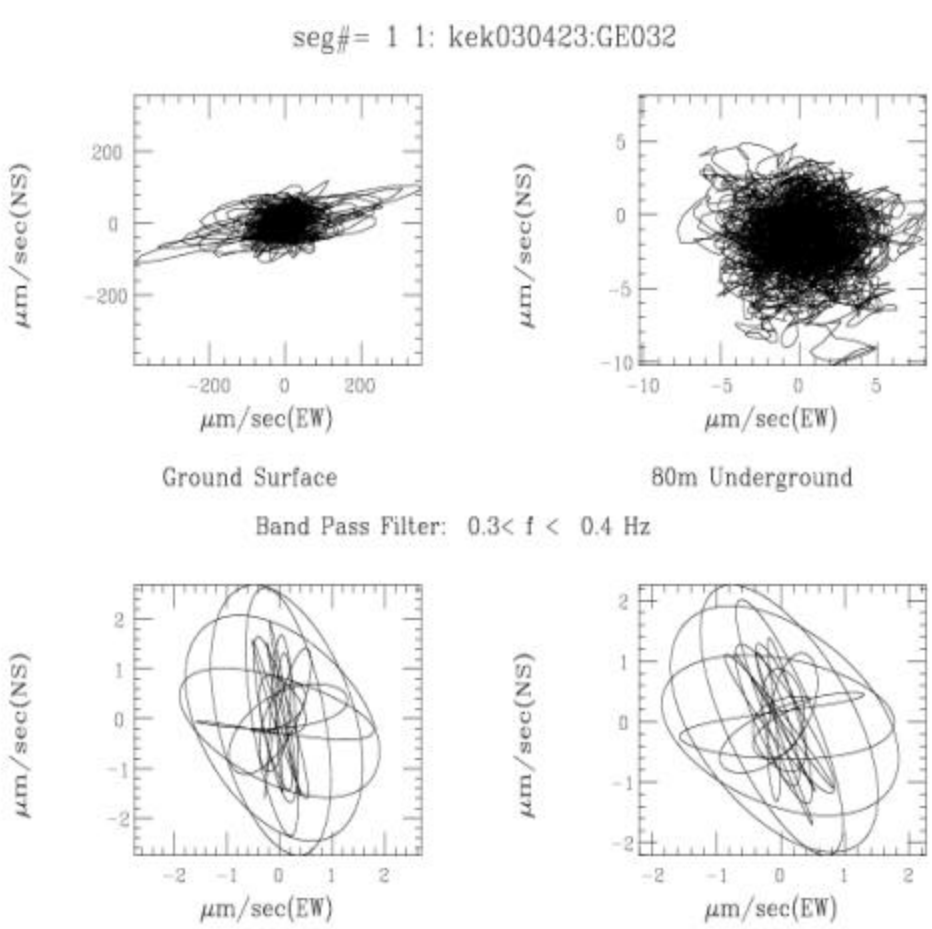
Peak at 0.3~0.4 Hz (1)

2003.4.23, 4pm

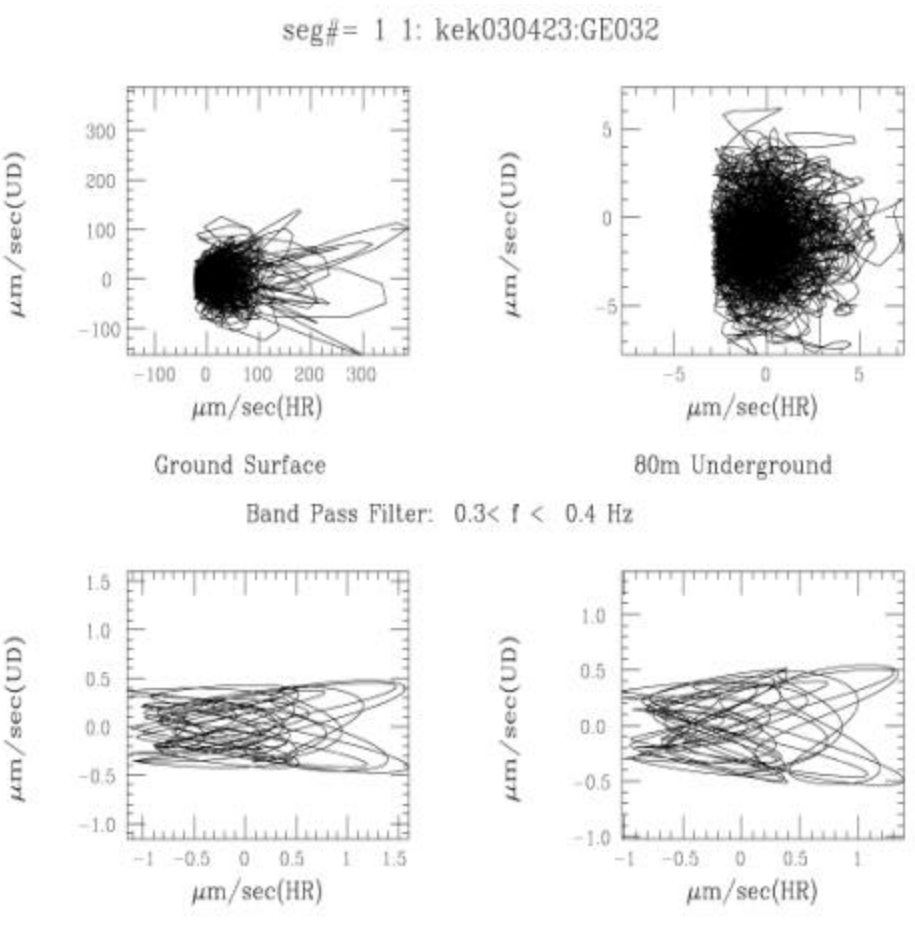


Peak at 0.3~0.4 Hz (1)

NS - EW

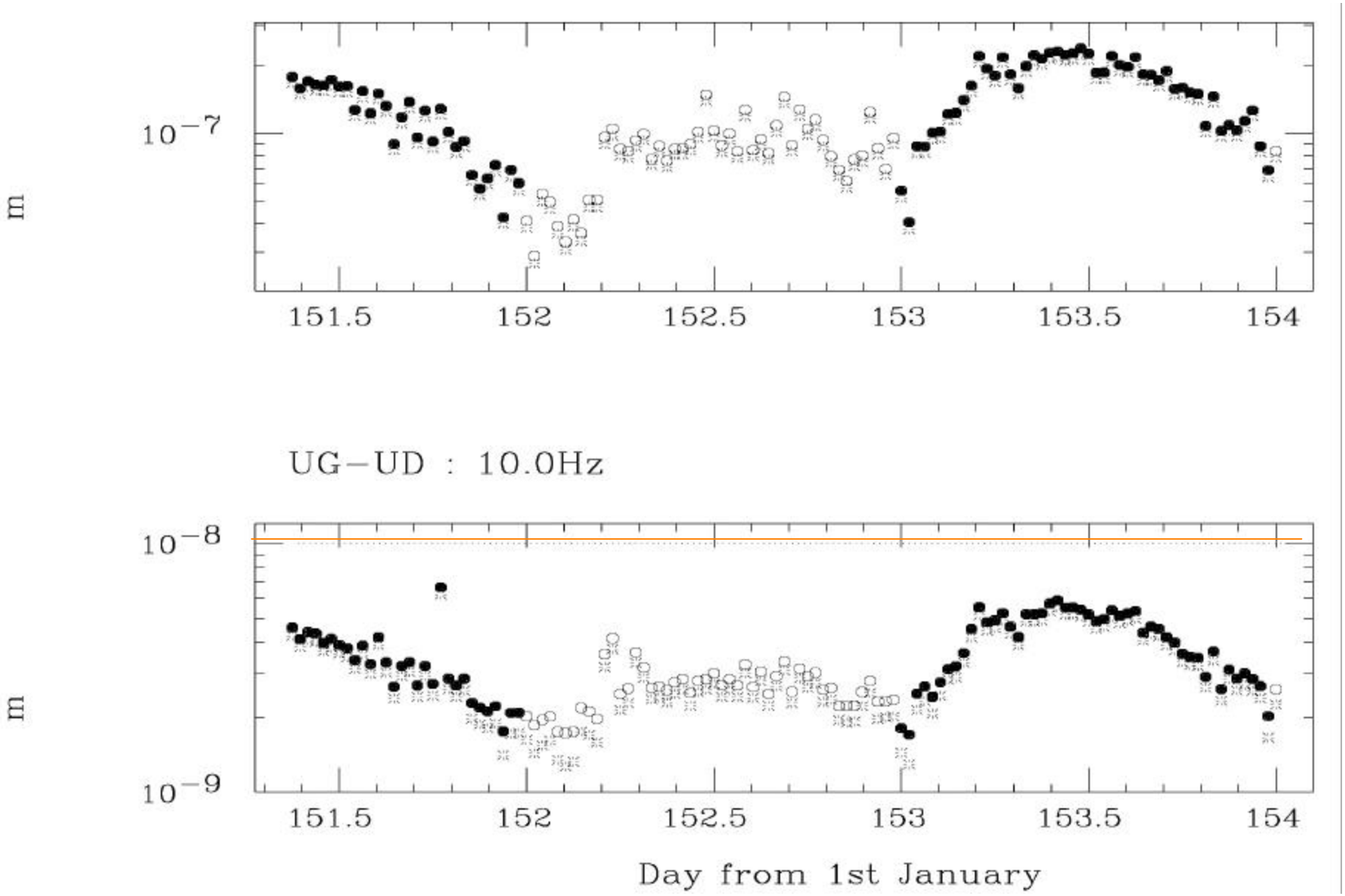


H - UD



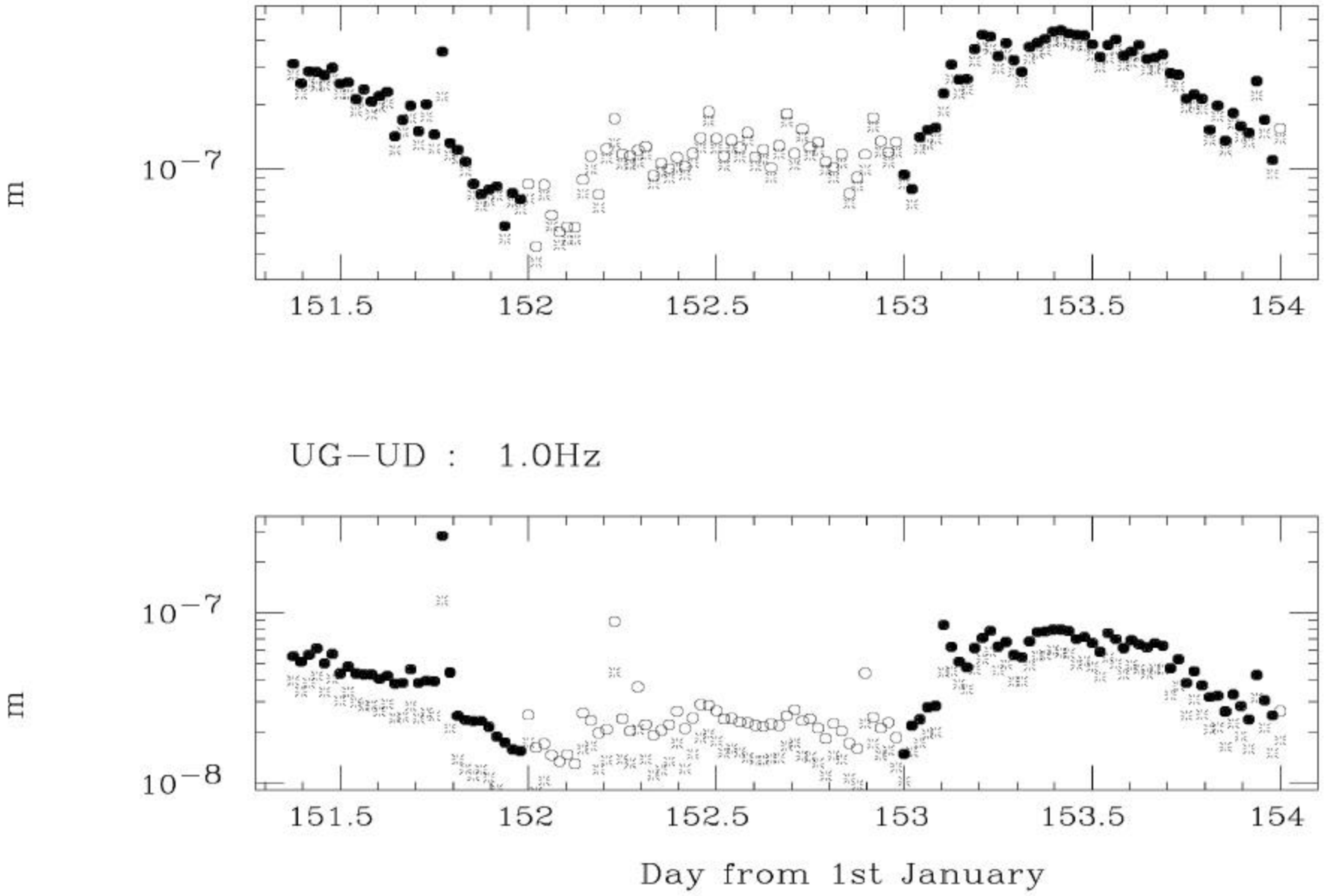
UD:Integrated Amplitude at f>10Hz

Daily variation;31May(sat.)~2June(mon.)



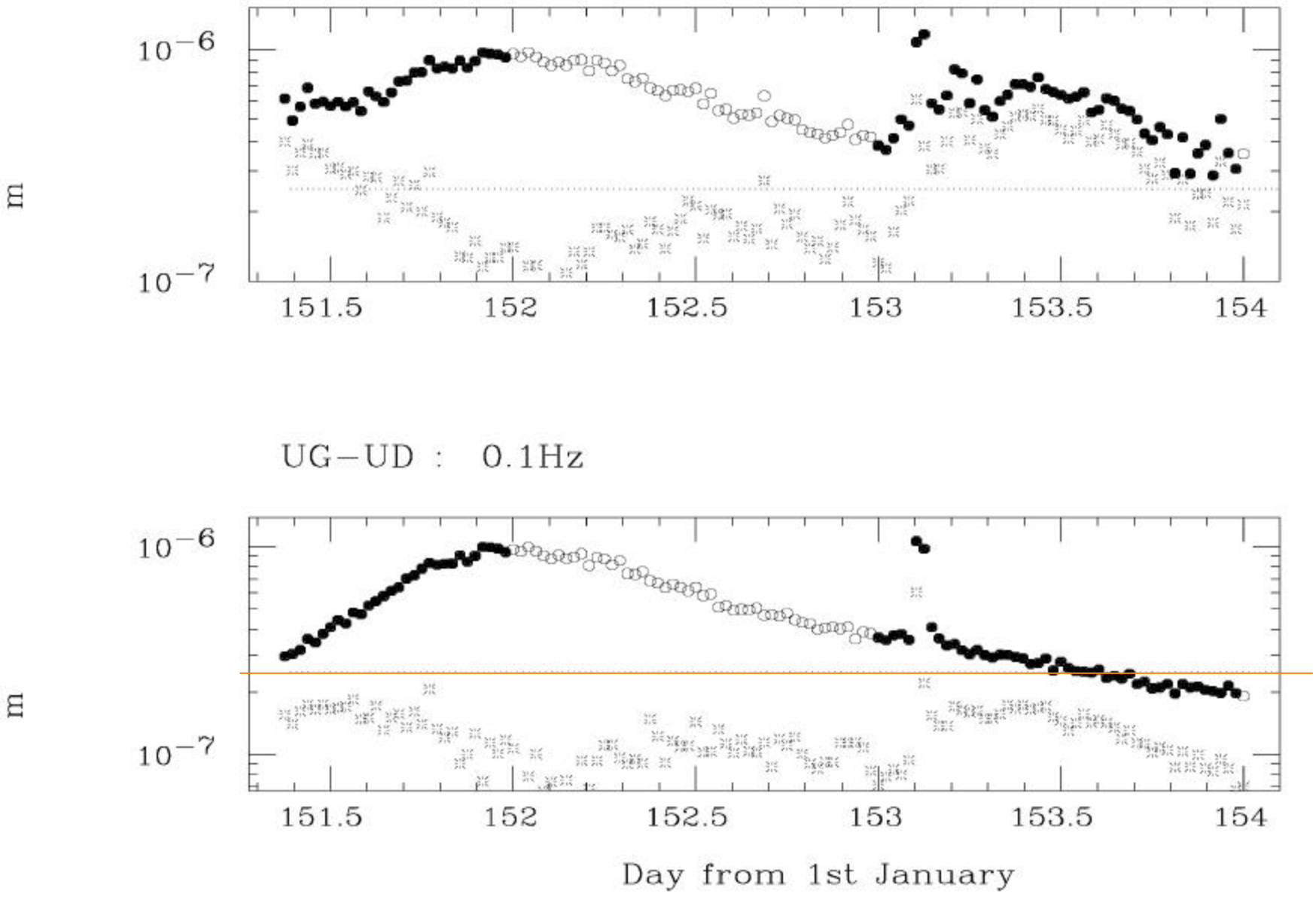
UD:Integrated Amplitude at f>1Hz

Daily variation;31May(sat.)~2June(mon.)



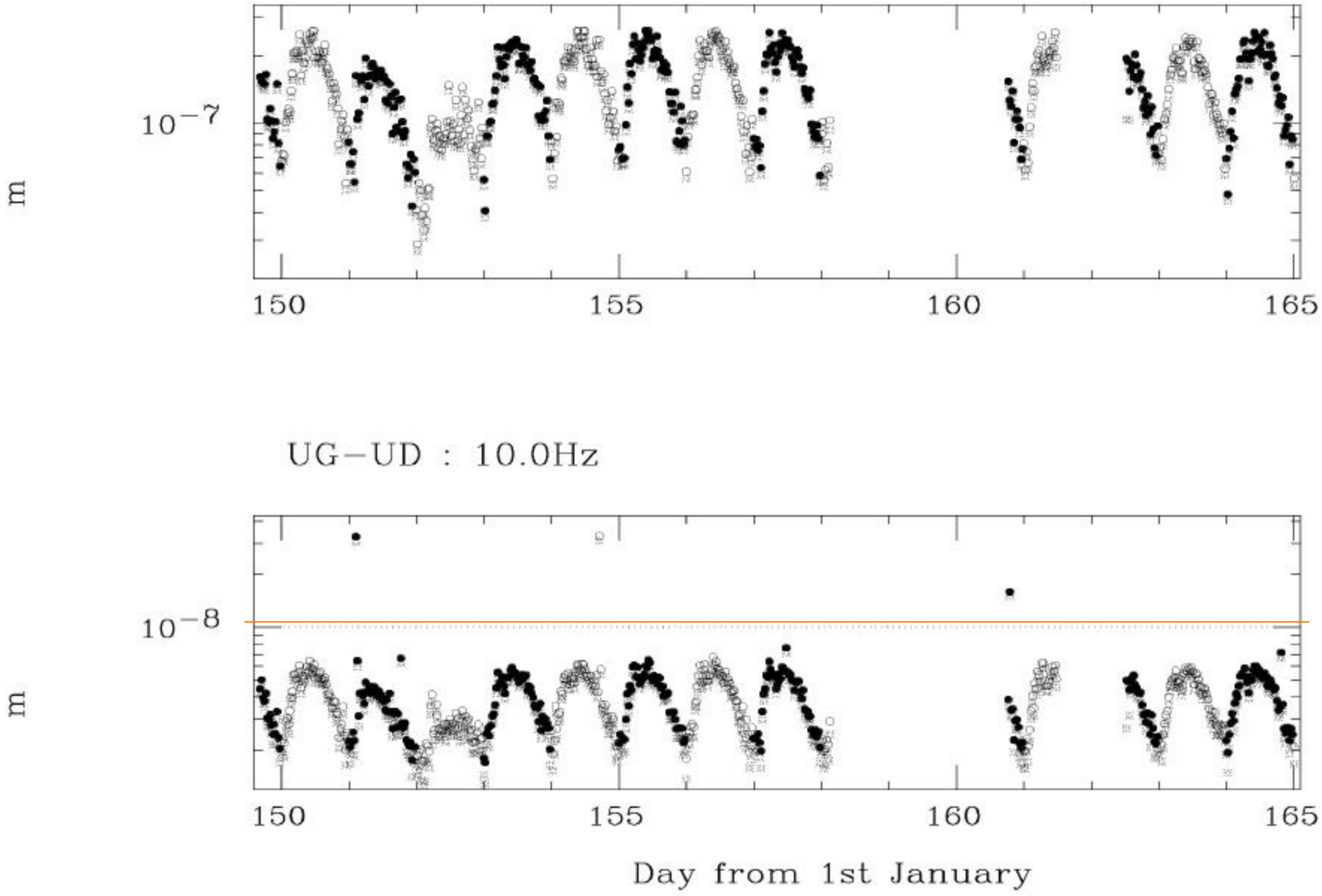
UD: Integrated Amplitude at f>0.1Hz

Daily variation;31May(sat.)~2June(mon.)



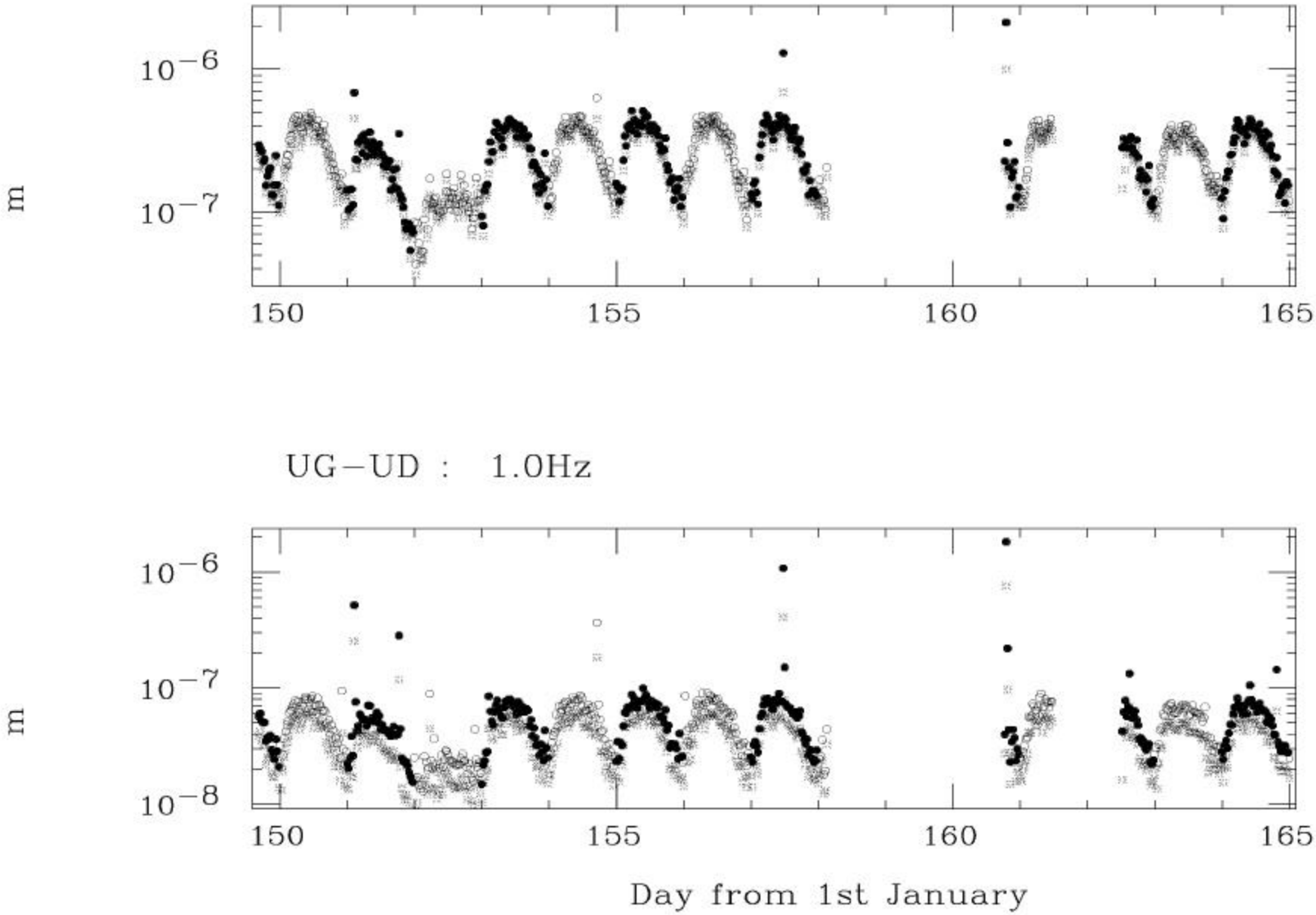
UD:Integrated Amplitude at f>10Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



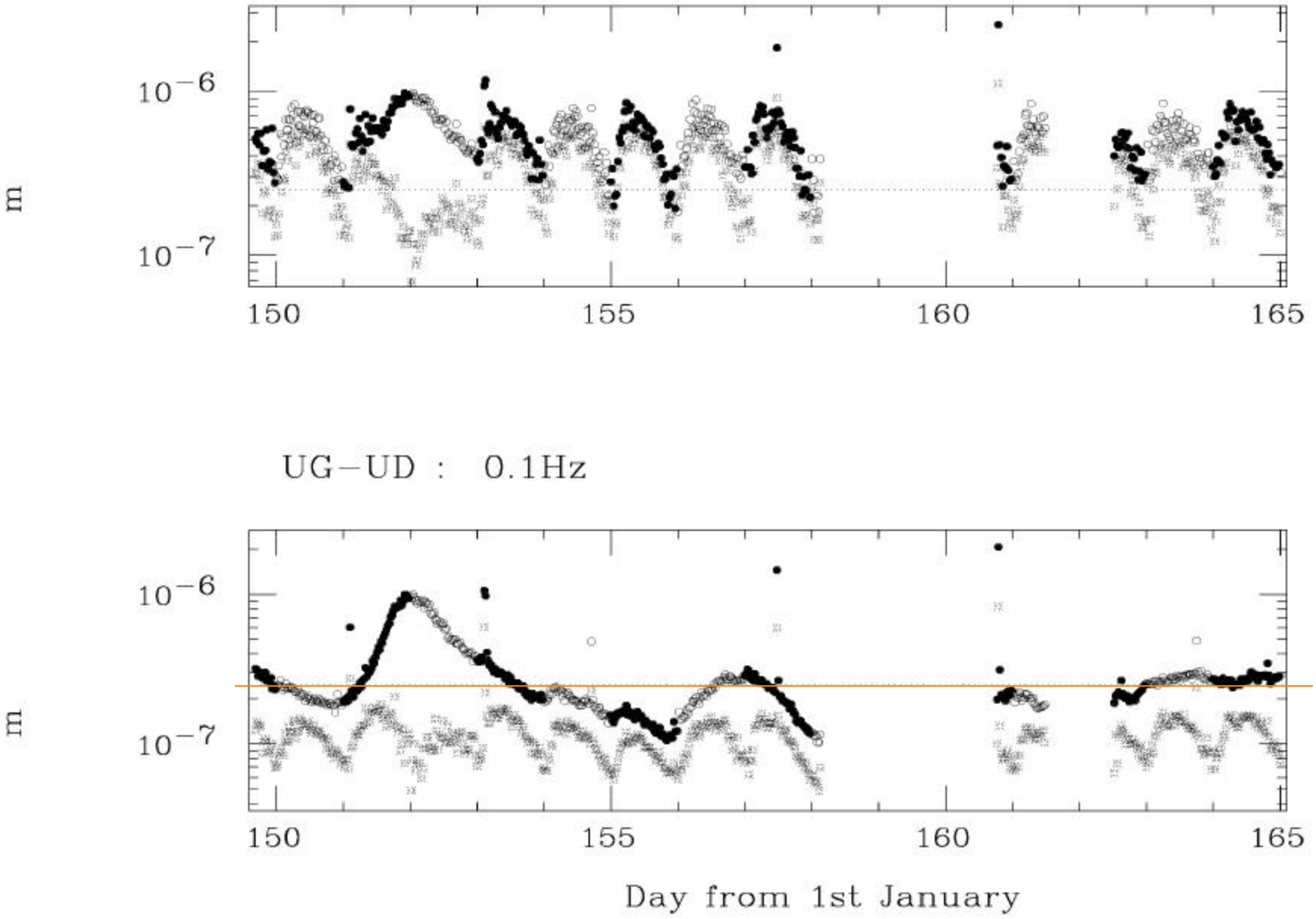
UD:Integrated Amplitude at f>1Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



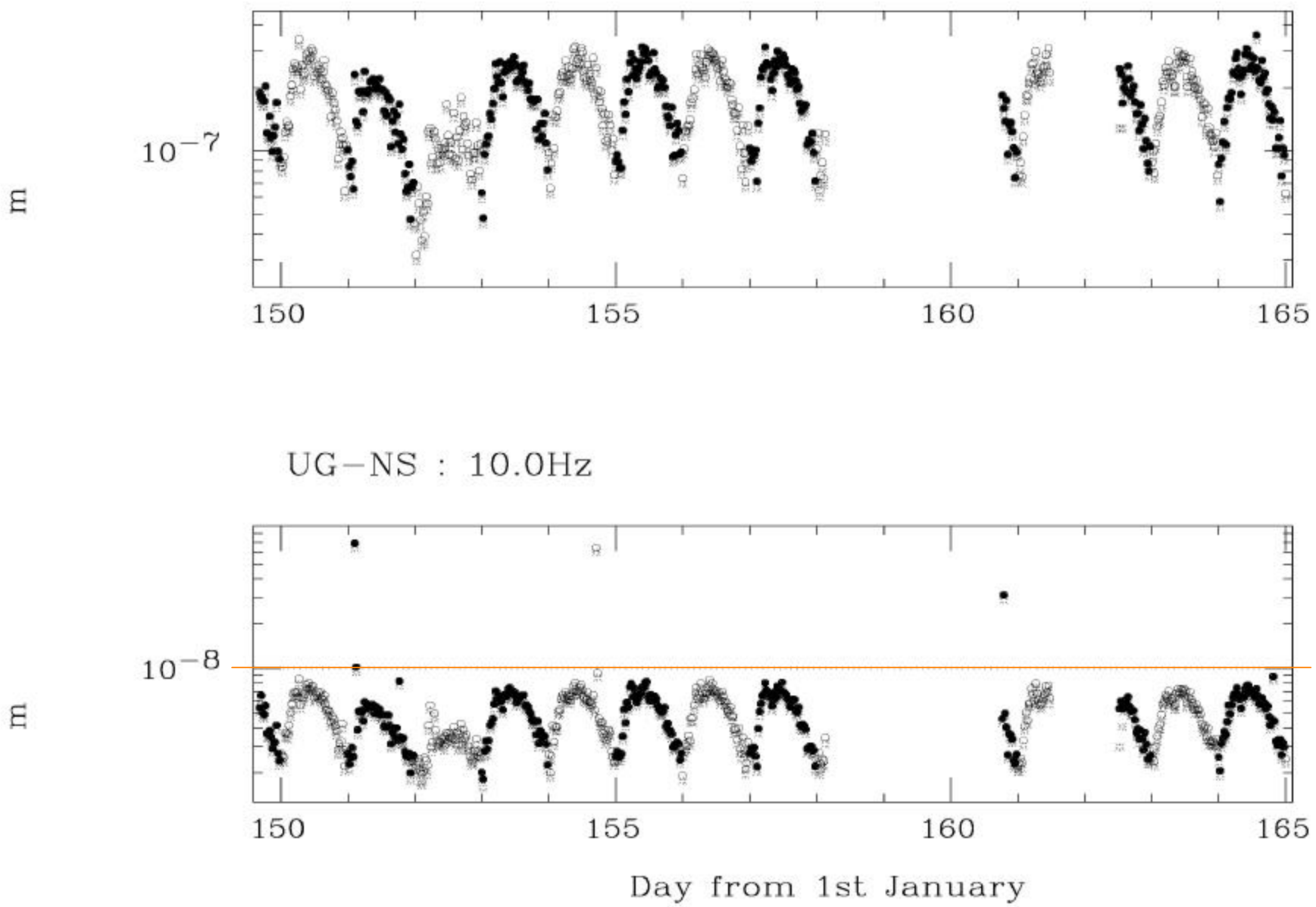
UD:Integrated Amplitude at f>0.1Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



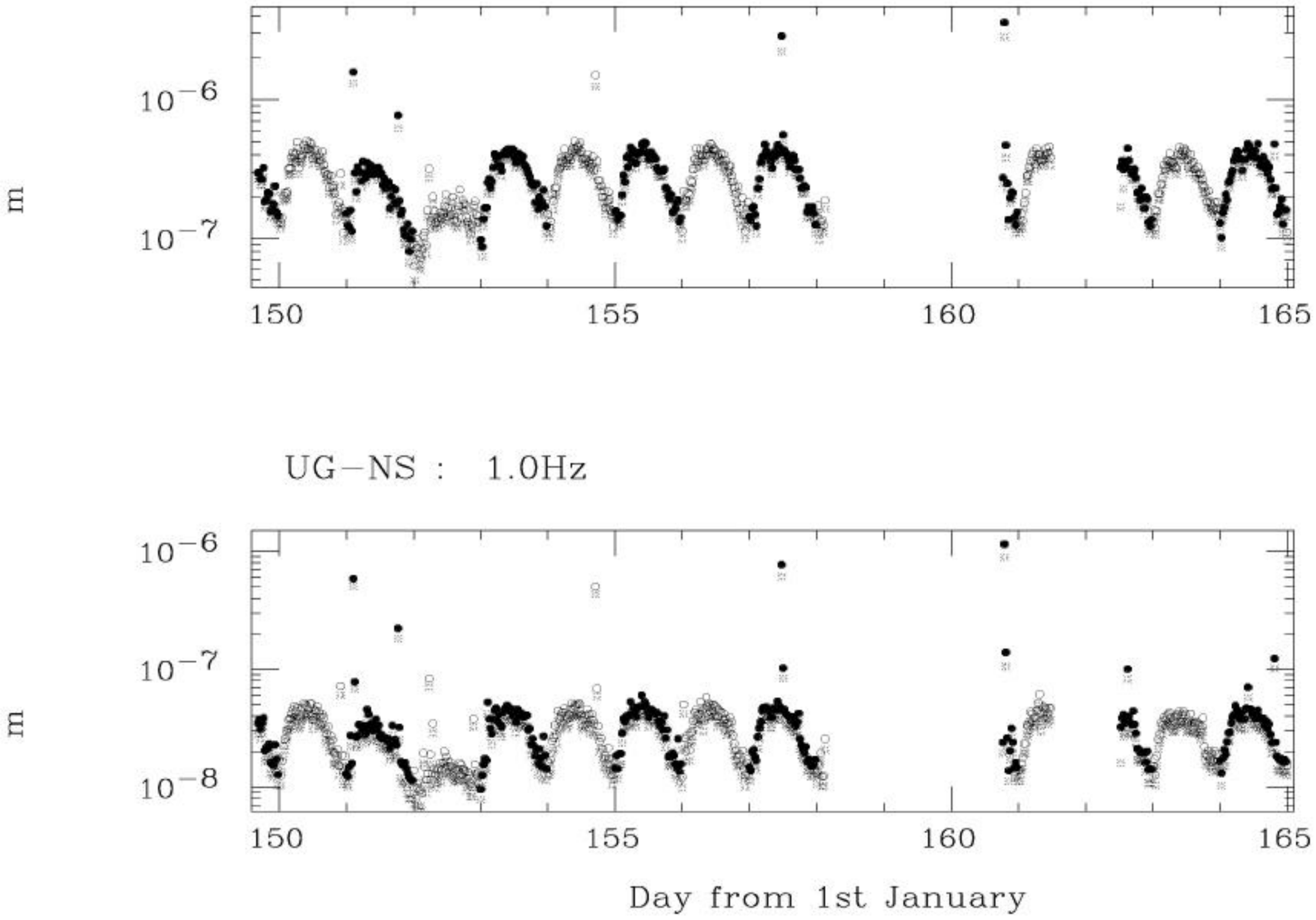
NS:Integrated Amplitude at f>10Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



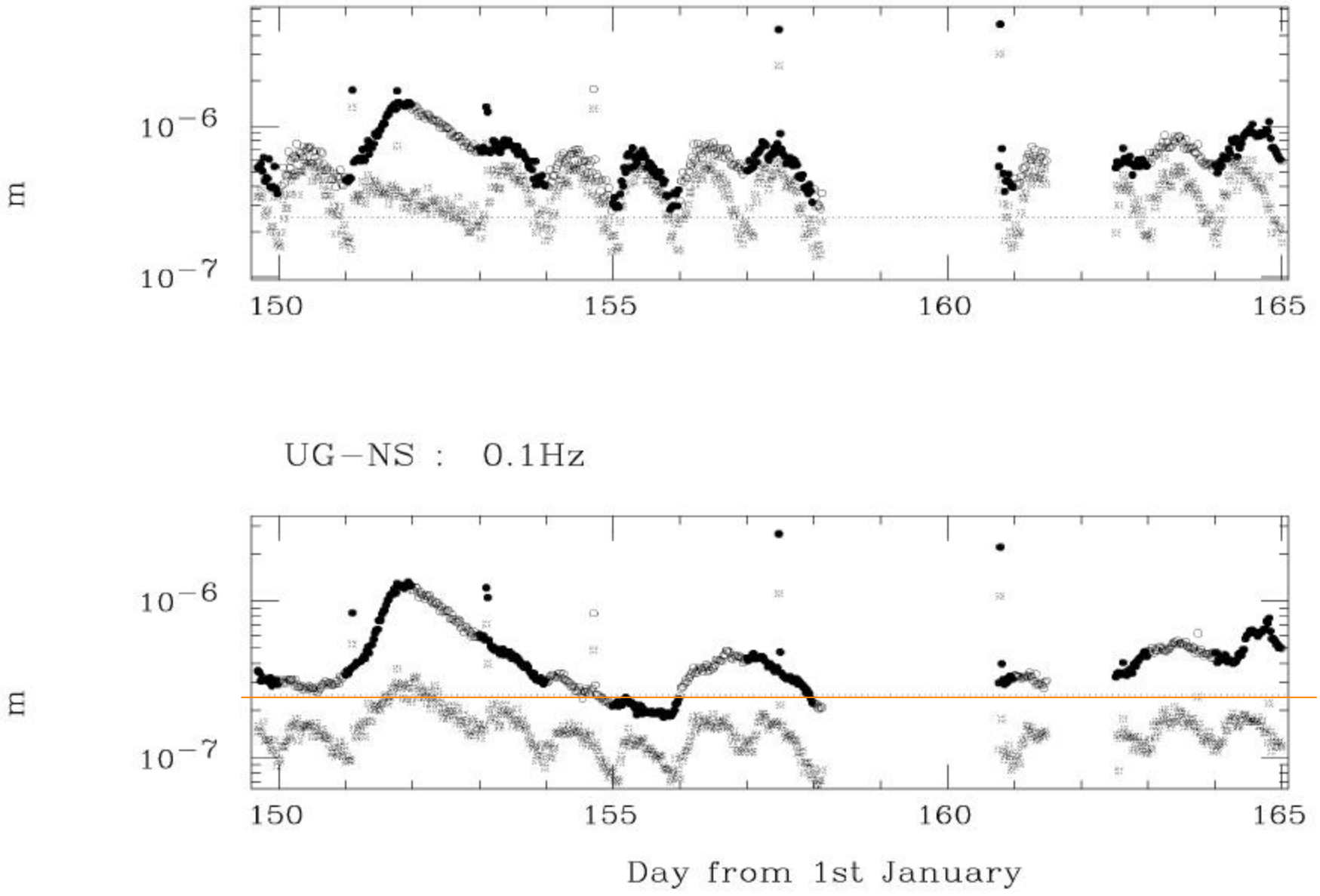
NS:Integrated Amplitude at f>1Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



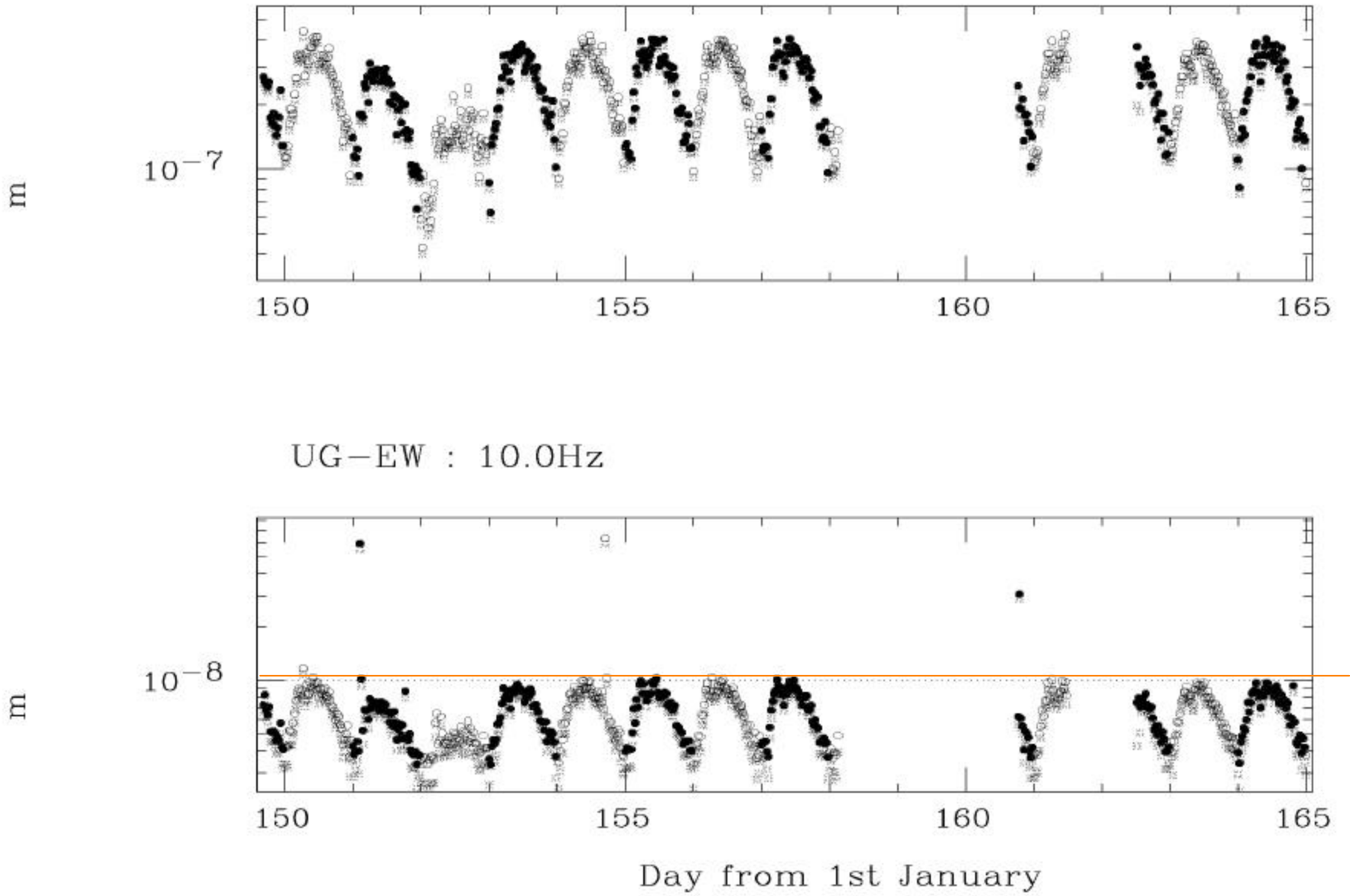
NS:Integrated Amplitude at f>0.1Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



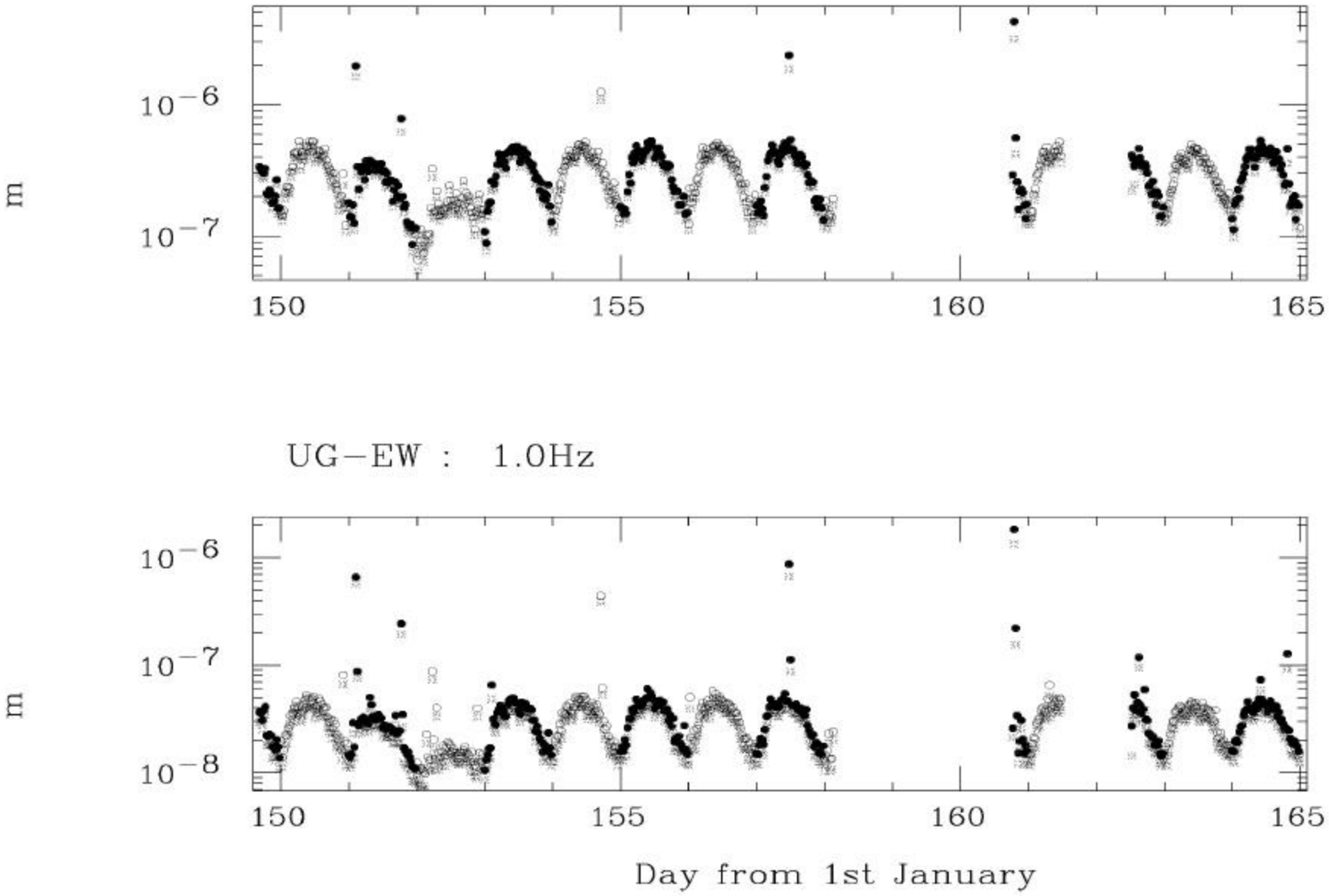
EW:Integrated Amplitude at f>10Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm



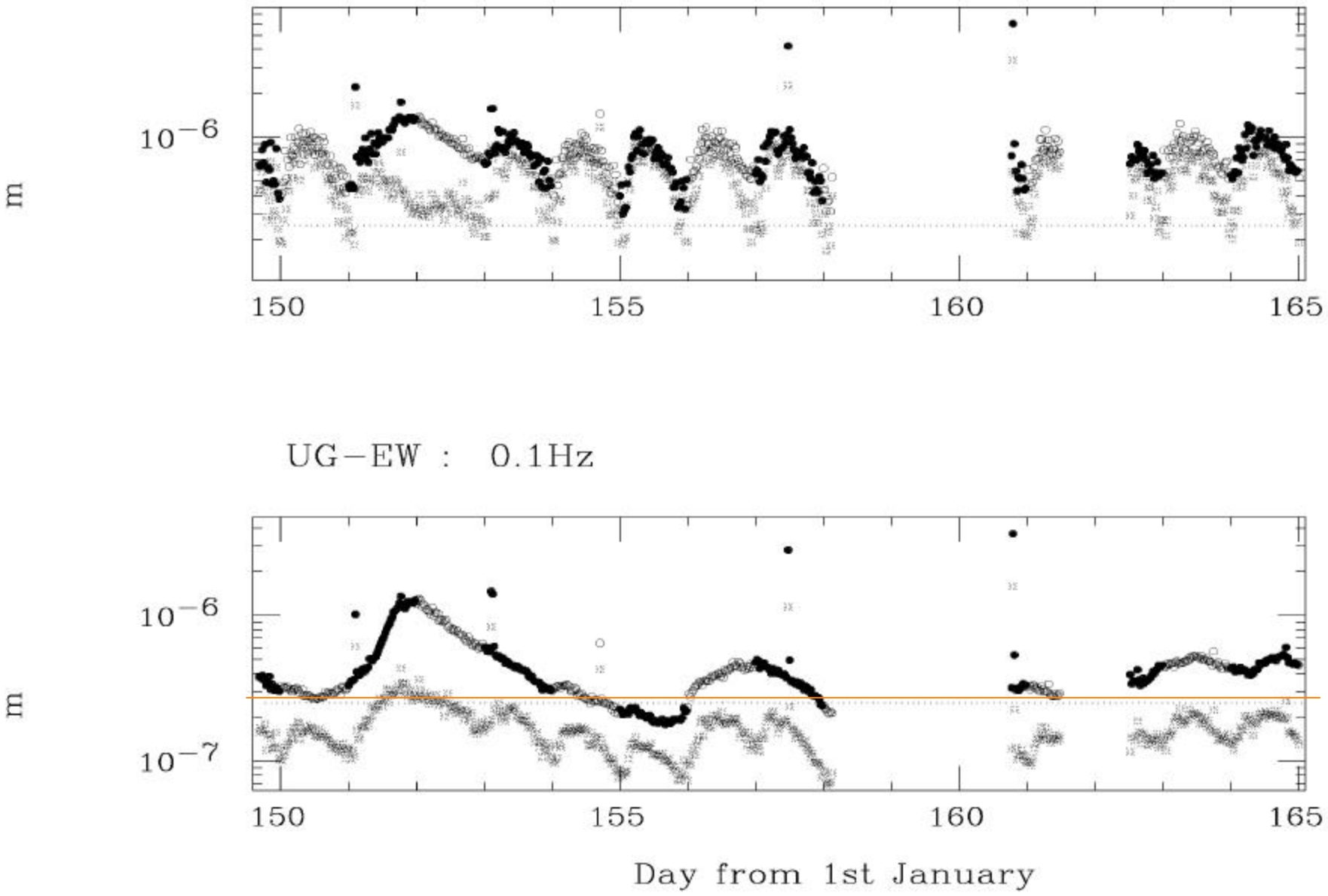
EW: Integrated Amplitude at f>1Hz

for 2003.5.29,4.5pm ~ 2003.6.13,12pm

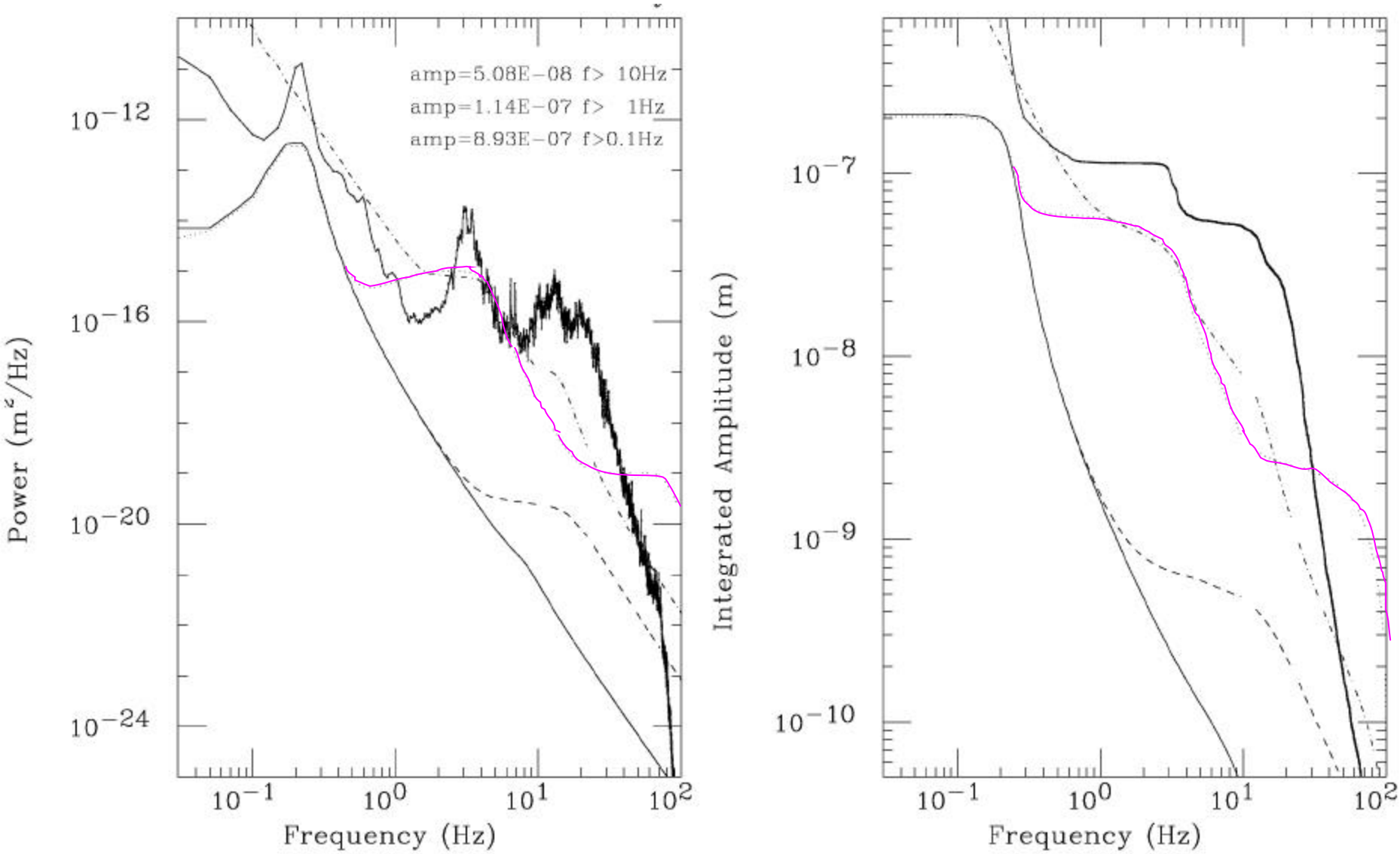


EW:Integrated Amplitude at f>0.1Hz

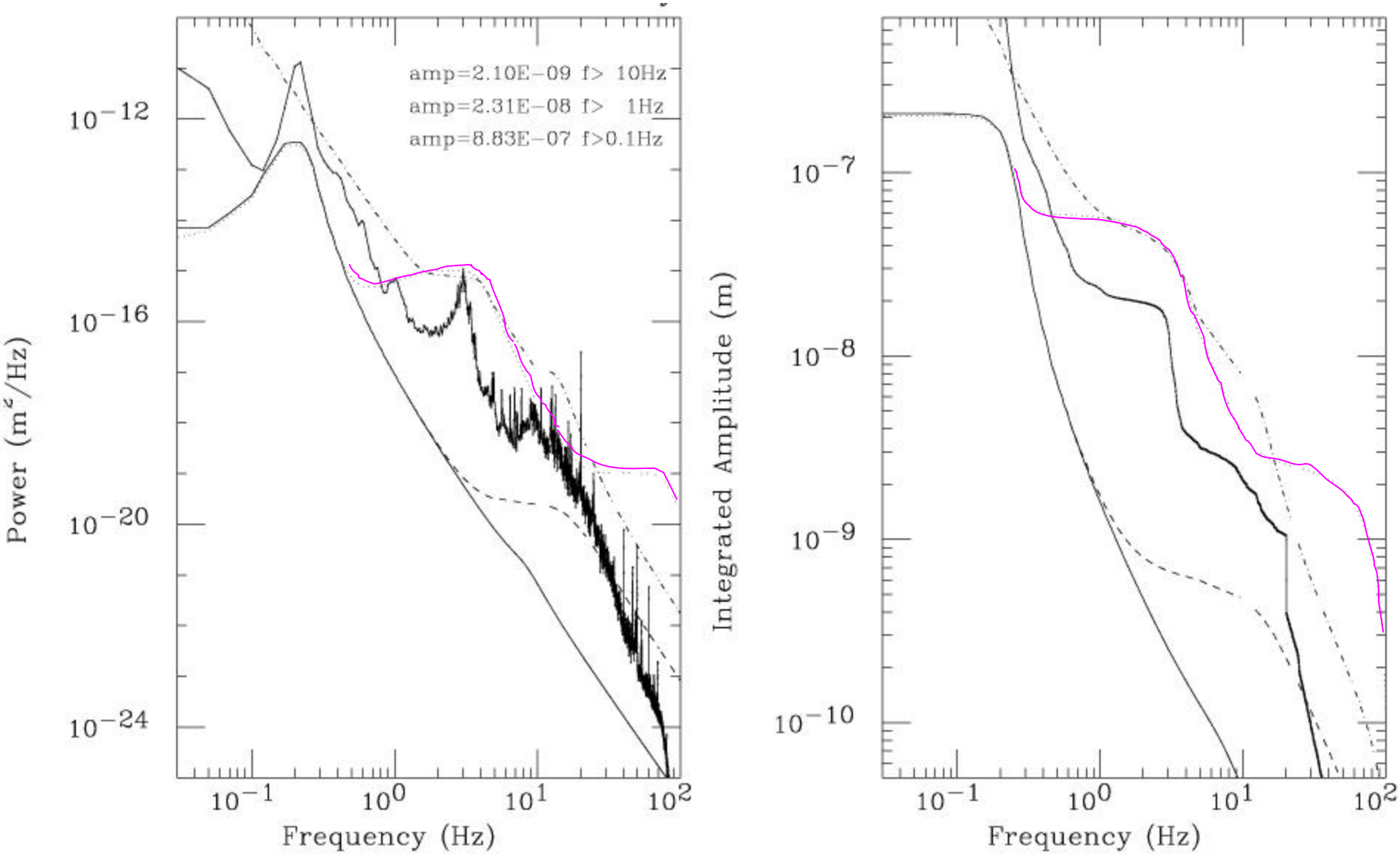
for 2003.5.29,4.5pm ~ 2003.6.13,12pm



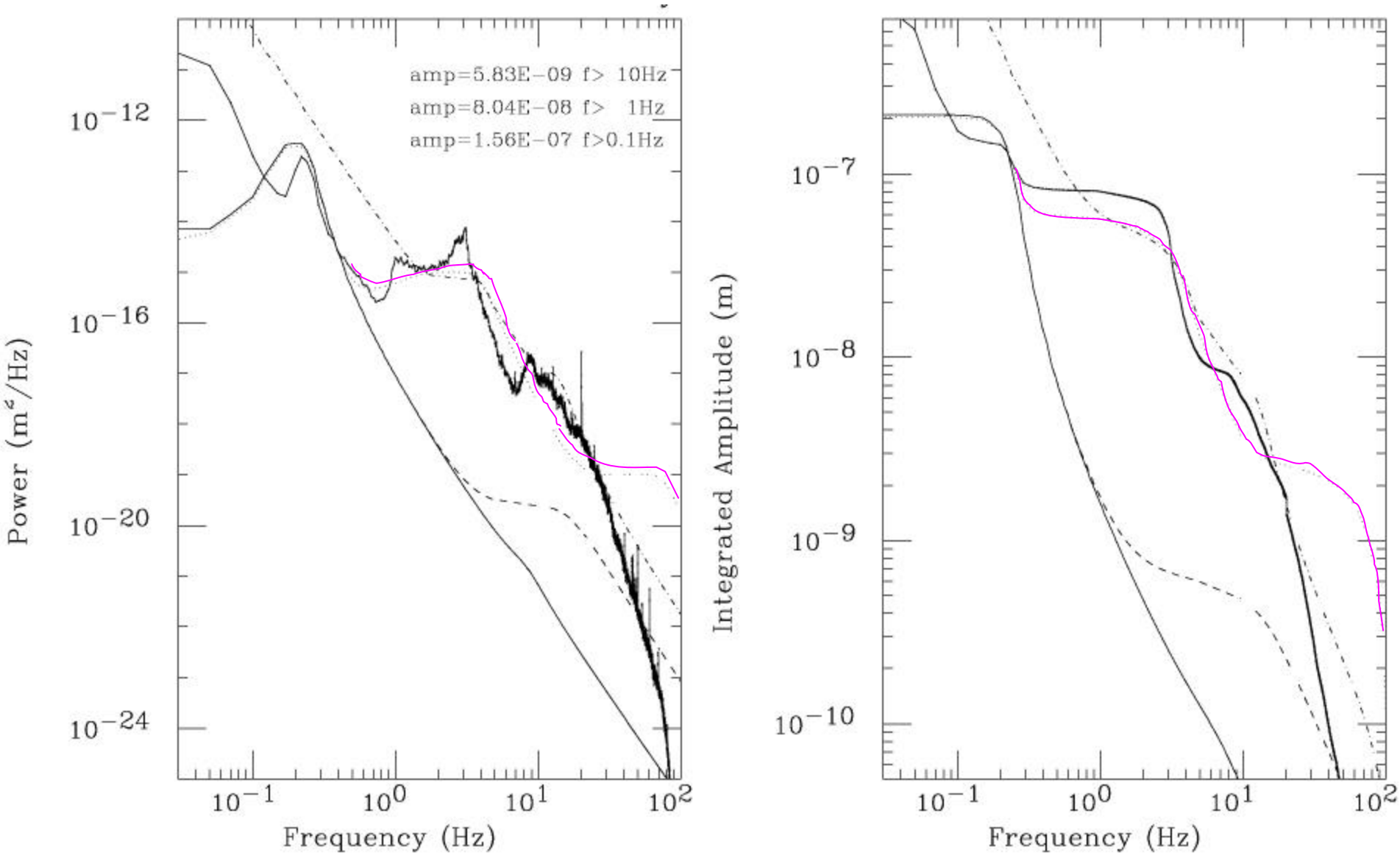
GM-**GL**(2003.6.1,4am) with Models of A,B,C -36m



GM-**UG**(2003.6.1,4am) with Models of A,B,C -36m

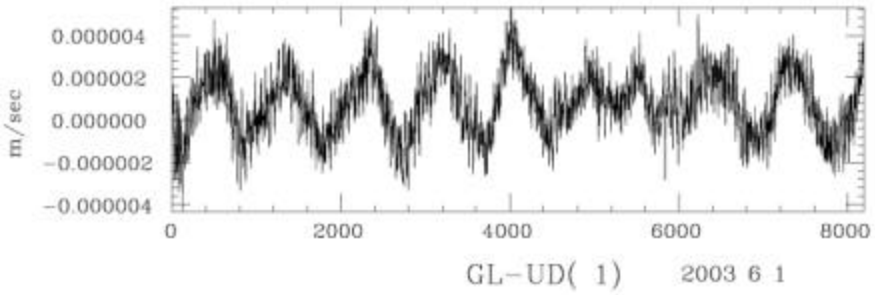


GM-**UG**(2003.6.4,10am) with Models of A,B,C -36m

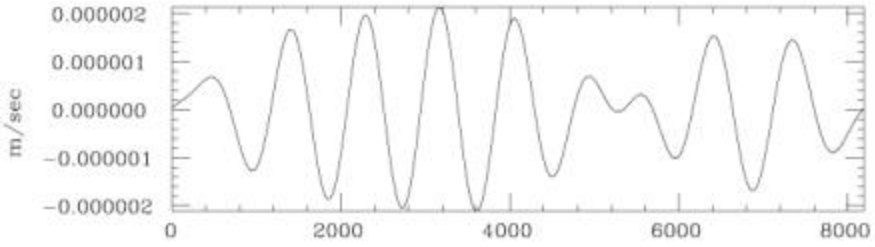


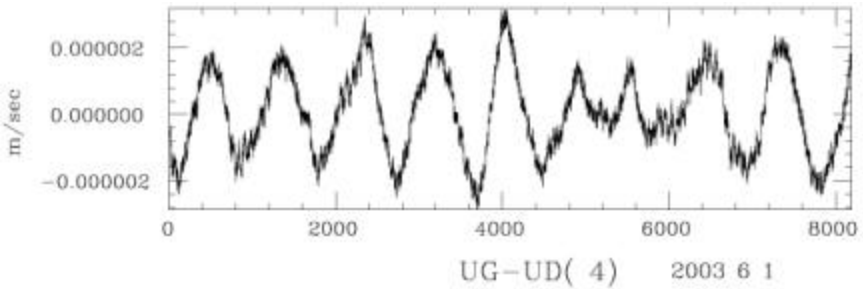
Peak at 0.15~0.25 Hz

2003.6.1.4am

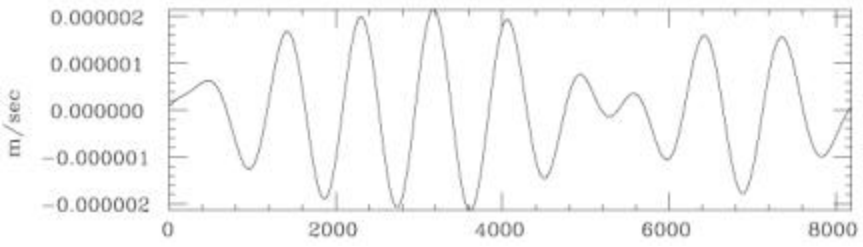


Band Pass Filter: 0.15< f < 0.25Hz
seg#= 1: 2003yr 6mn 1d 4h 0min

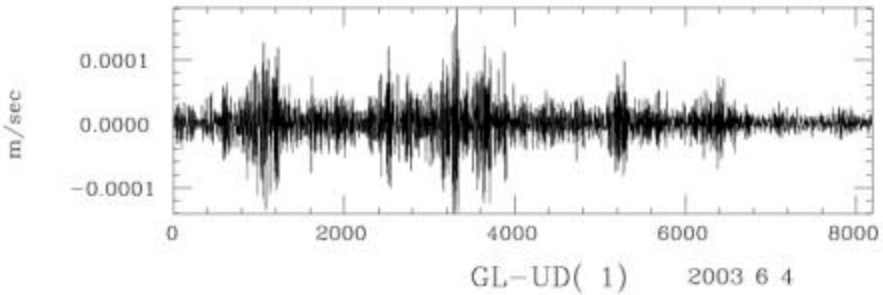




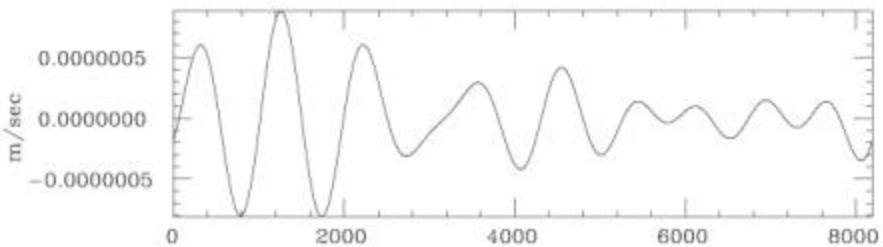
Band Pass Filter: 0.15< f < 0.25Hz
seg#= 1: 2003yr 6mn 1d 4h 0min

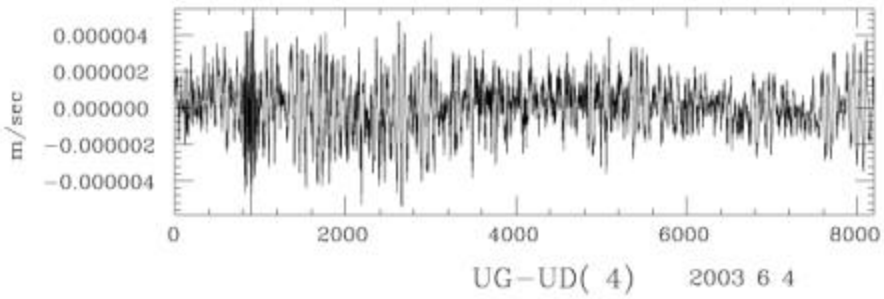


2003.6.4.10am

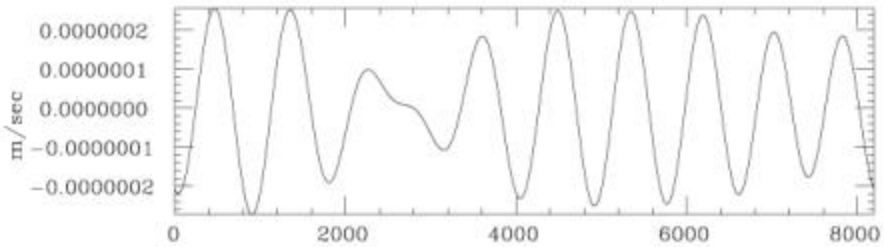


Band Pass Filter: 0.15< f < 0.25Hz
seg#= 1: 2003yr 6mn 4d10h 0min



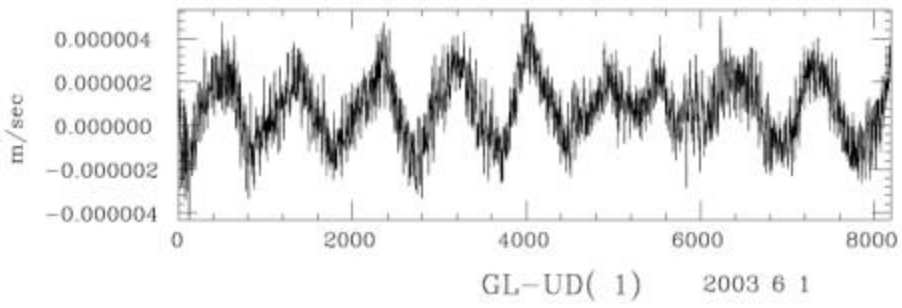


Band Pass Filter: 0.15< f < 0.25Hz
seg#= 1: 2003yr 6mn 4d10h 0min

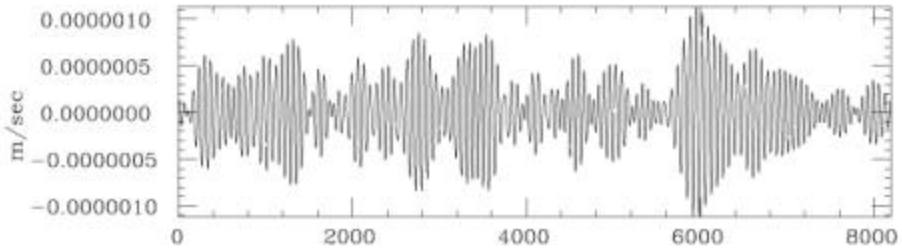


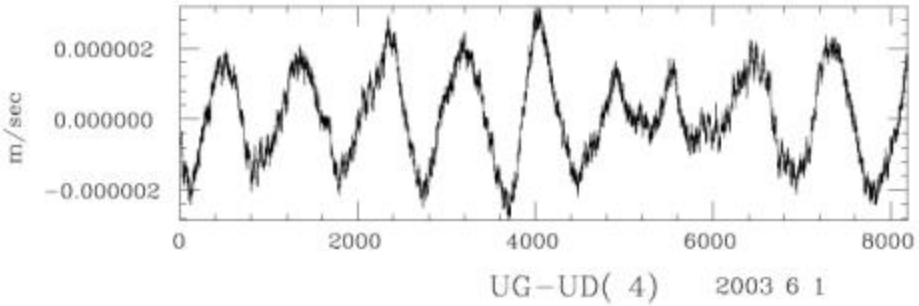
Peak at 2.5~3.5 Hz

2003.6.1.4am

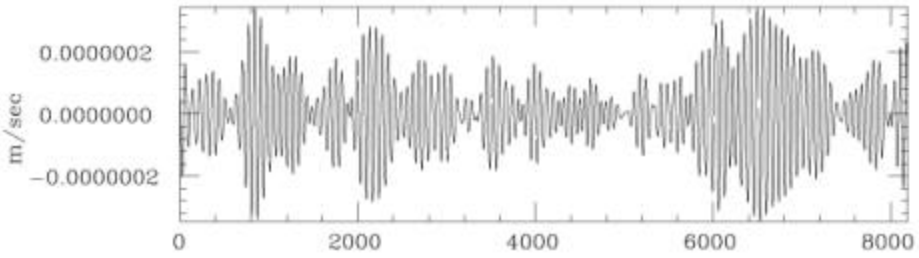


Band Pass Filter: 2.5< f < 3.55Hz
seg#= 1: 2003yr 6mn 1d 4h 0min

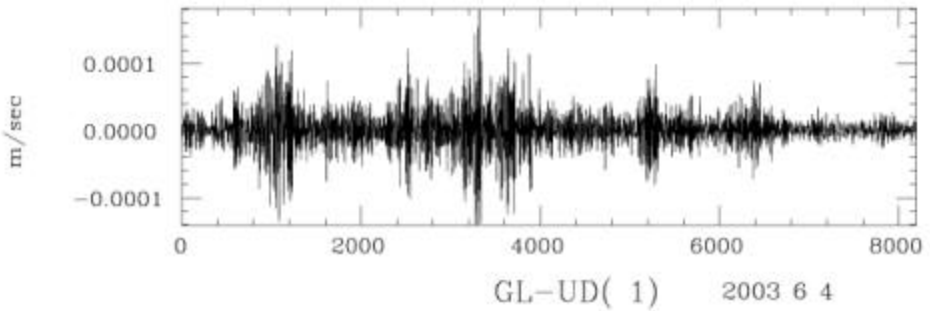




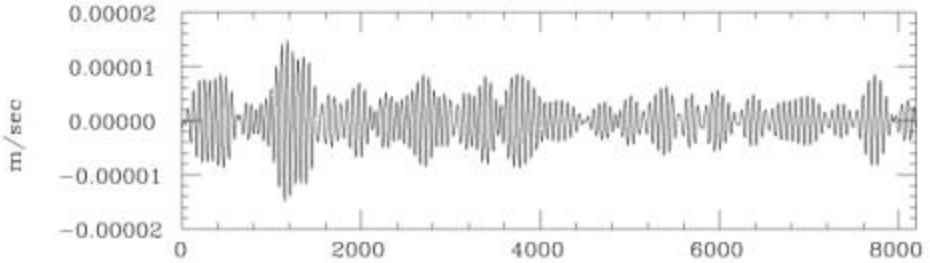
Band Pass Filter: 2.5< f < 3.55Hz
seg#= 1: 2003yr 6mn 1d 4h 0min

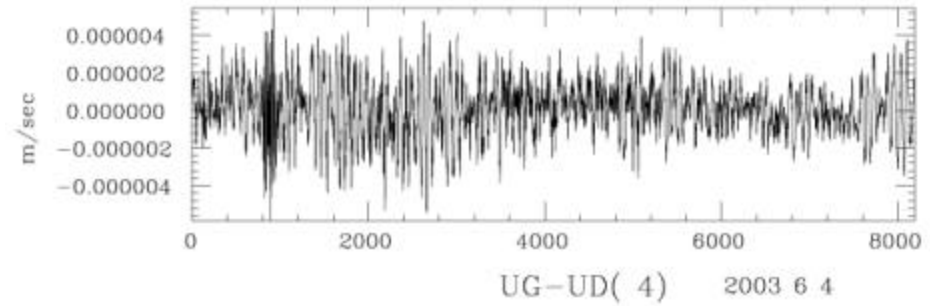


2003.6.4.10am

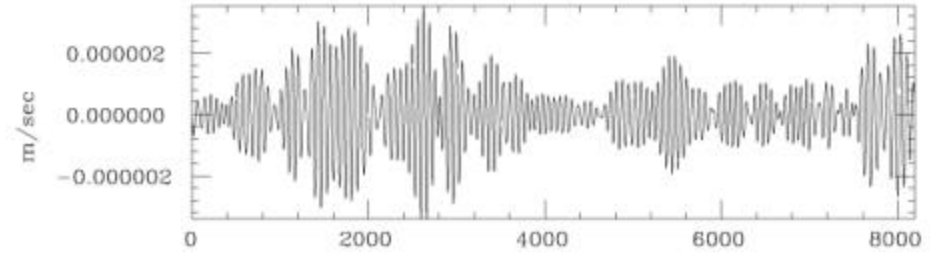


Band Pass Filter: 2.5< f < 3.55Hz
seg#= 1: 2003yr 6mn 4d10h 0min



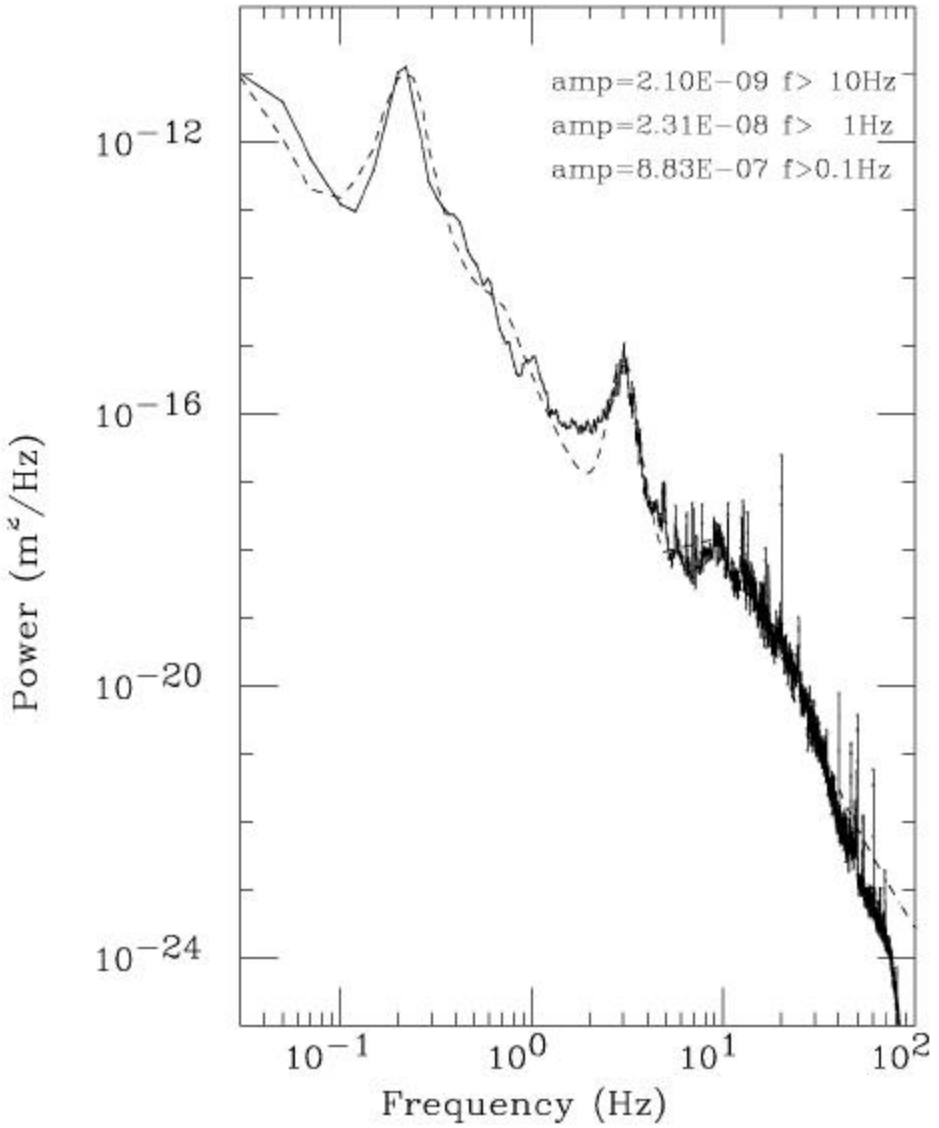


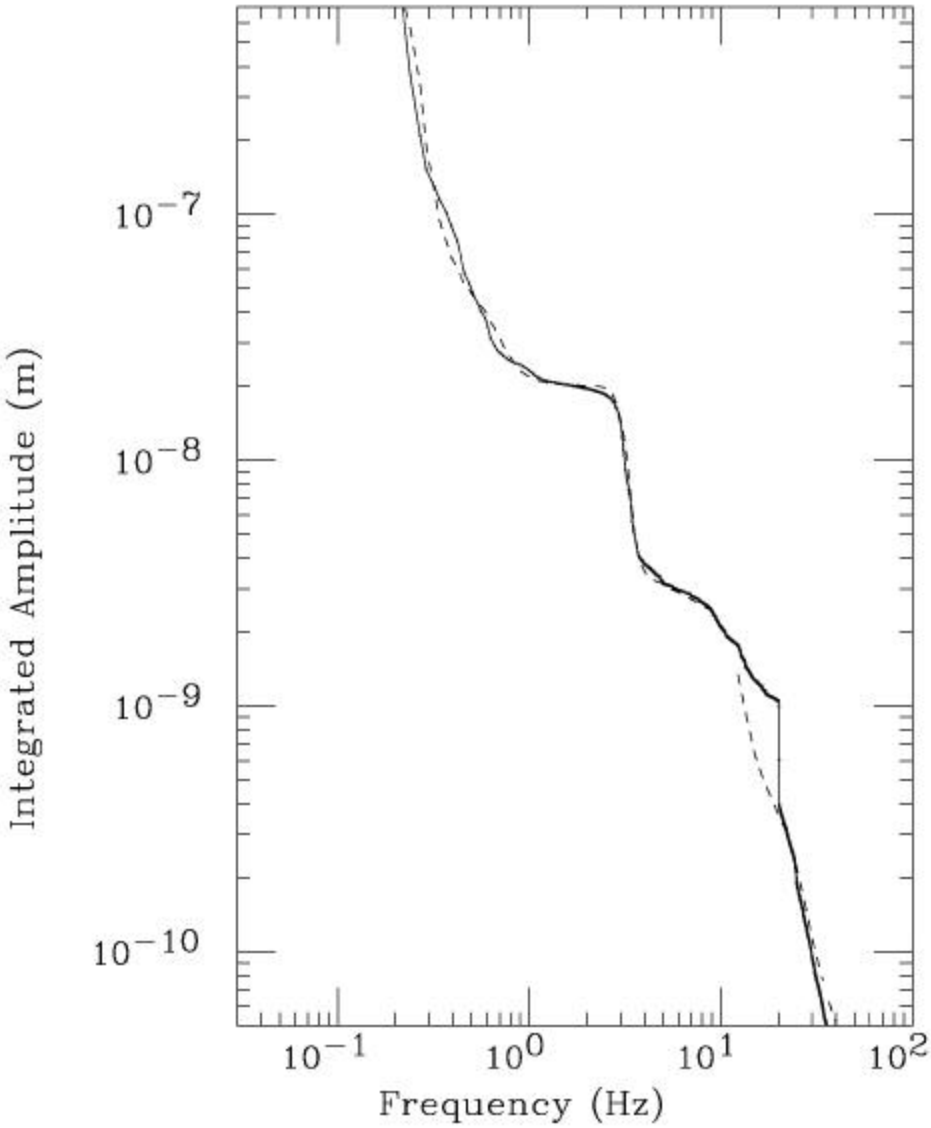
Band Pass Filter: 2.5< f < 3.55Hz
seg#= 1: 2003yr 6mn 4d10h 0min



KEK-GM Model (2003.6.1,4am)

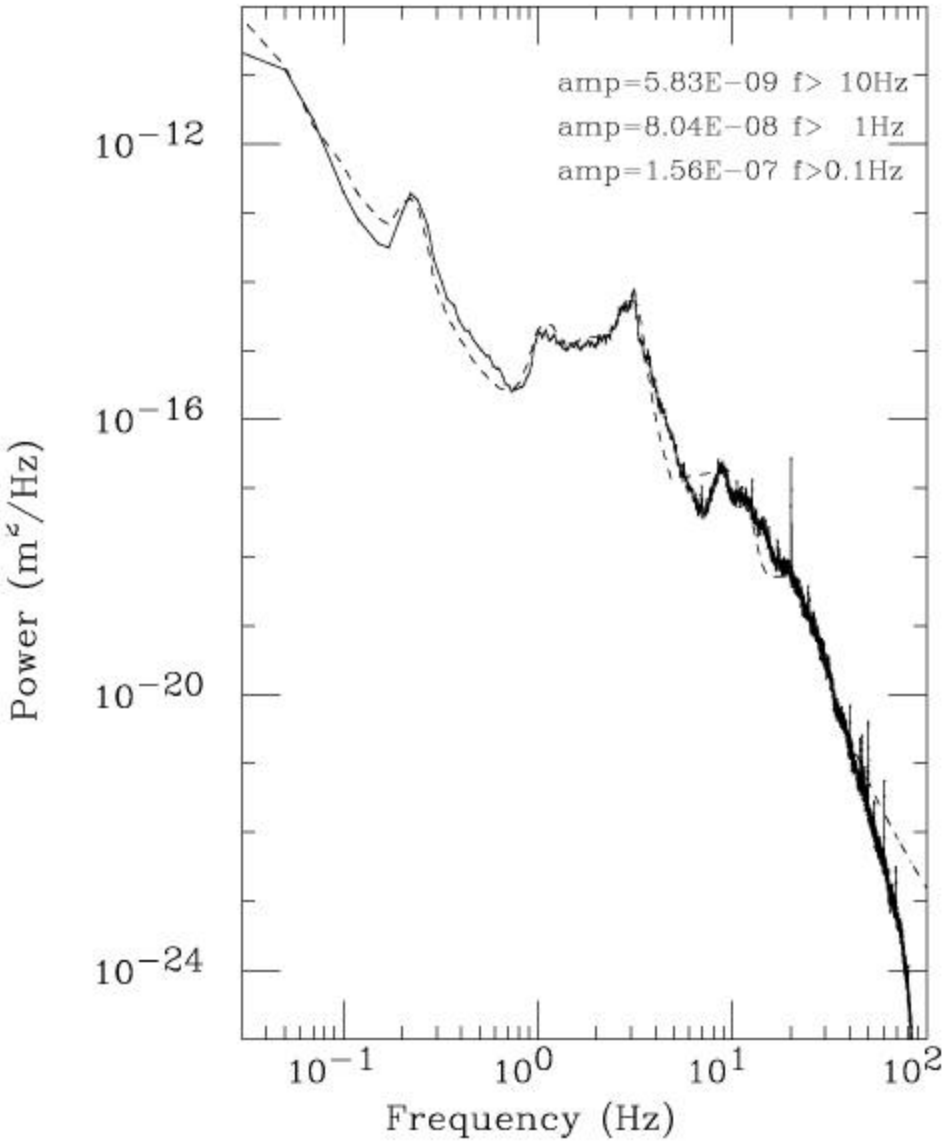
6 “peaks” at 0.012,0.22,0.5,3.0,10.0,20.0 Hz

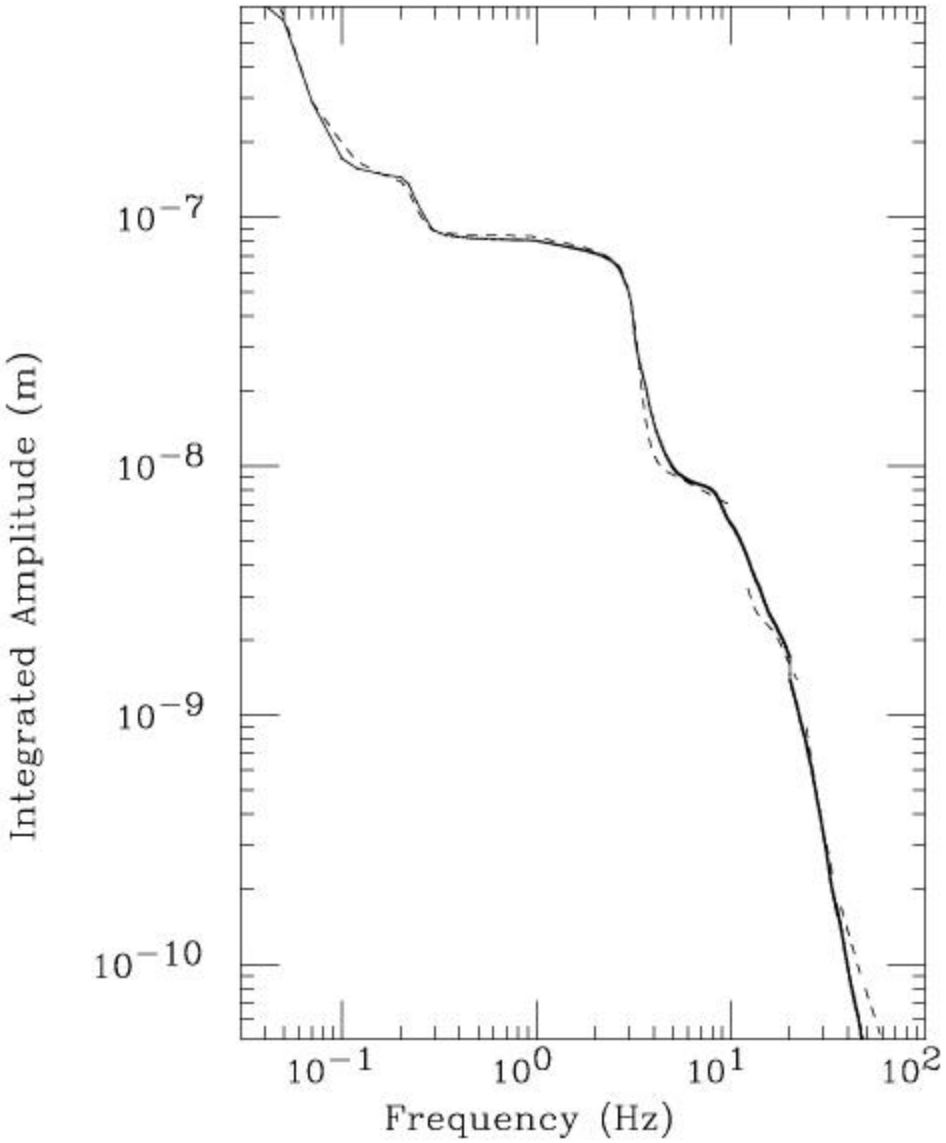




KEK-GM Model (2003.6.4,10am)

7 “peaks at 0.012,0.22,1.1,2.0,3.0,10.0,20.0 Hz”





Summary

Ground motion will be measured 80m underground as well as the surface at KEK , very near to R408(Higashi-Odori), at 200Hz for a year.

Daily and “weekly” variations were observed at higher and lower frequency regions, respectively.

GM-tolerances at 10Hz and 0.1Hz were satisfied, although daily variations were observed underground at f>0.3Hz.

GM models are made for quiet and noisy times at KEK.

The KEK GM models shall be implemented in SLEPT calculations for detailed study on the stabilization.