LEVEL CHANGES IN THE SUPERKEKB MAIN RING TUNNEL

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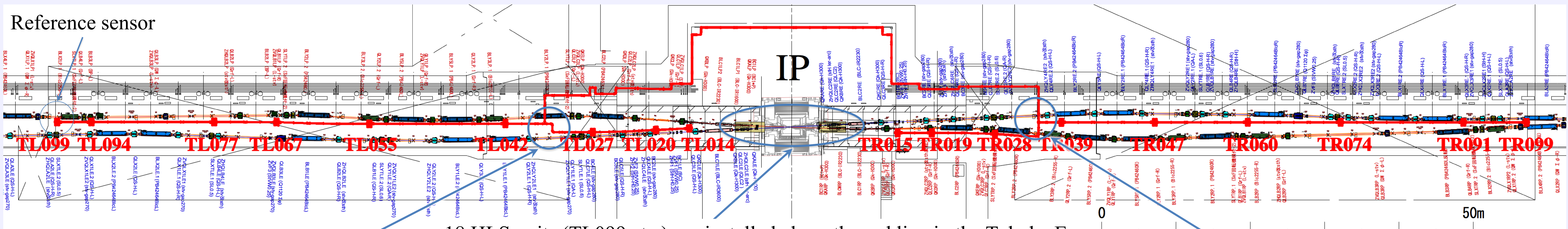
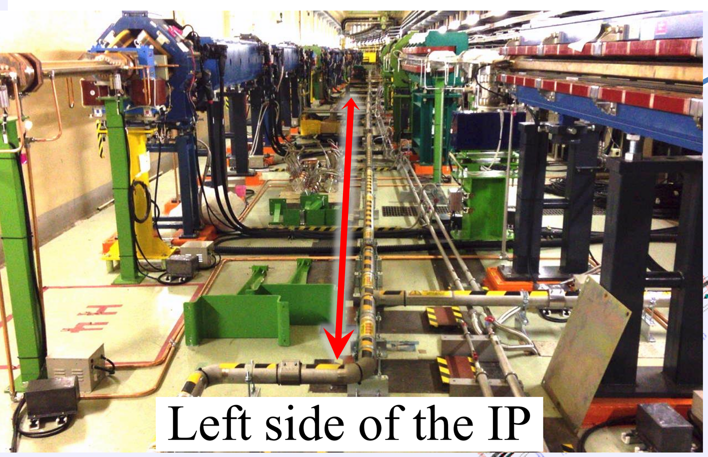
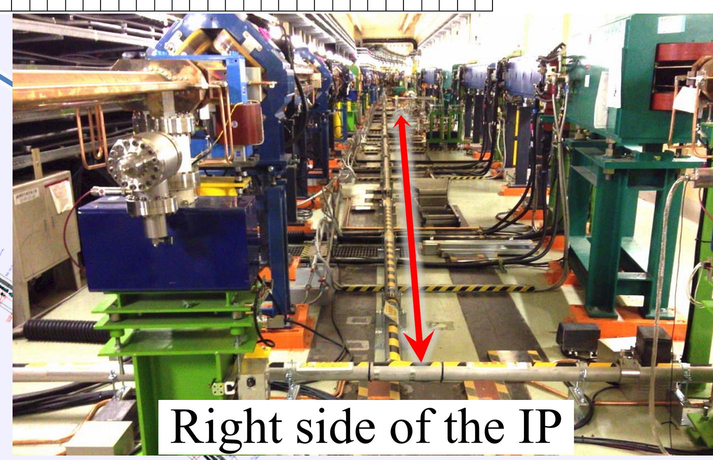
The floor level change along the 3 km SuperKEKB main ring tunnel has been surveyed using DNA03 and N3 periodically. The south arc section continues to sink with respect the interaction point at an average speed of a few millimeters per year, resulting in a net sinkage of 35 mm. The floor level of the south arc section and around the interaction point have been monitored continuously with the BINP HLS system. The level is affected by the outside temperature, rainfall etc.



18 HLS units (TL099 etc.) are installed along the red line in the Tukuba Exp.

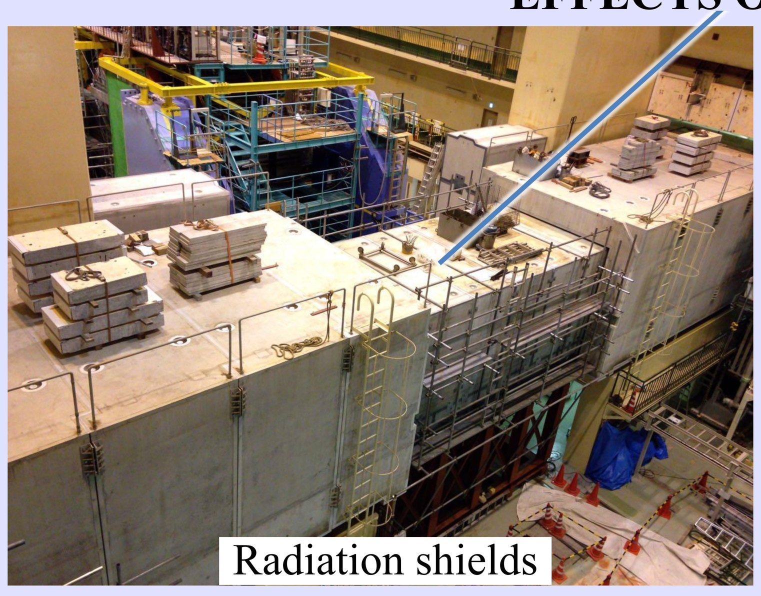
Tsukuba Exp.

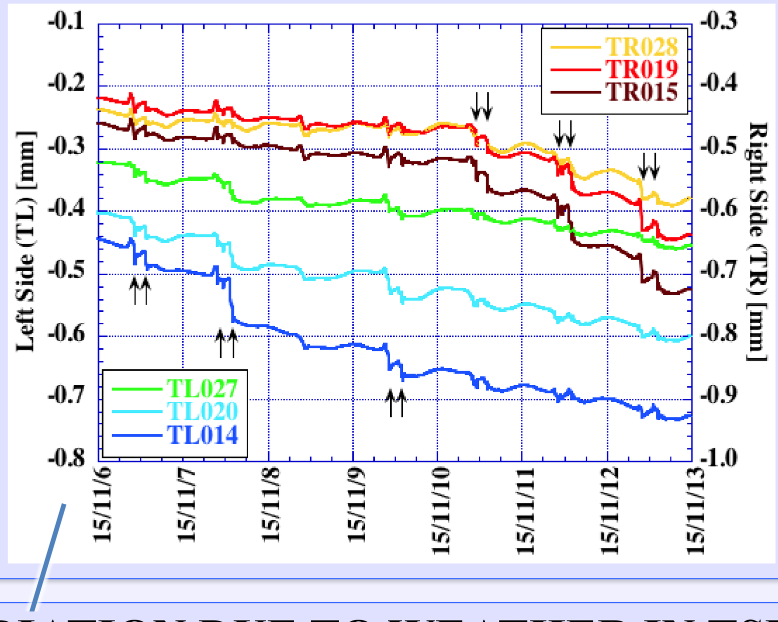

Left side of the IP


Right side of the IP

12M D12 3M D3

EFFECTS OF THE RADIATION SHIELDS INSTALLATION

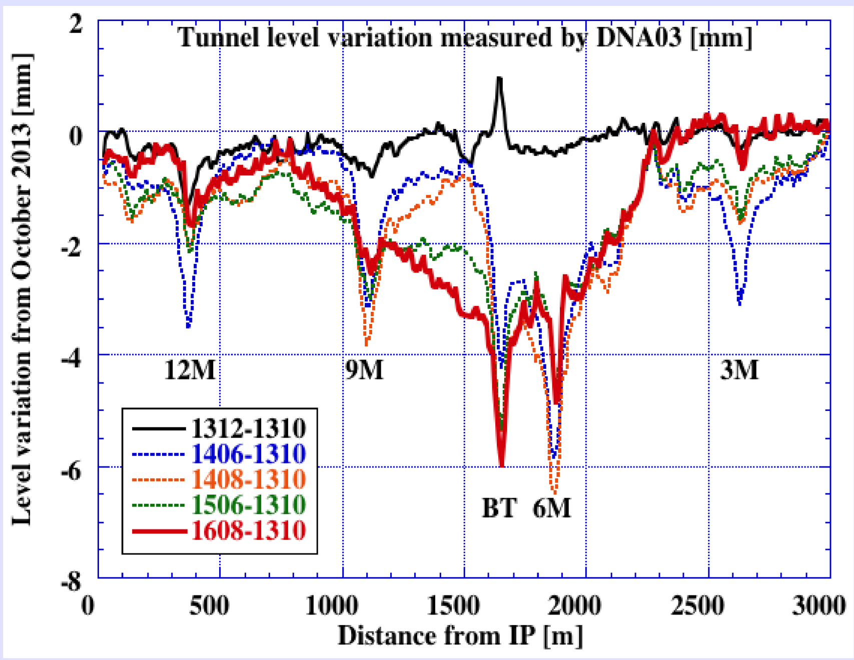

Radiation shields



The both side of the IP sections are covered by radiation shields. Each section weighs about 60 tons. The floor levels during the radiation shield installation are shown. Two shields were installed per day. The sensors near the IP presented the largest variation of approximately 200 μm.

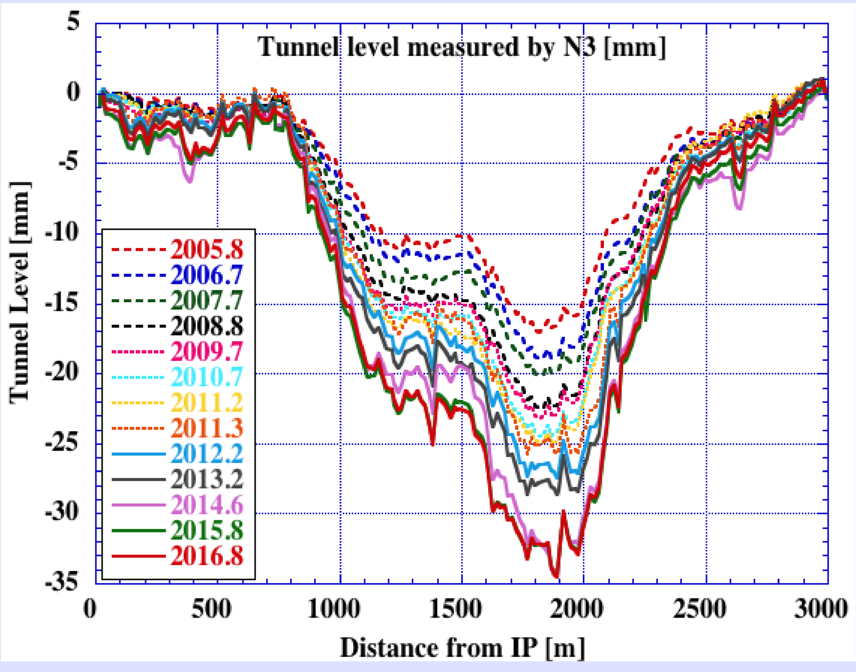

BINP HLS sensor

CONSTRUCTION OF THE NEW FACILITY BUILDINGS (3M-12M) AND NEW BT LINE AND EFFECTS ON THE TUNNEL



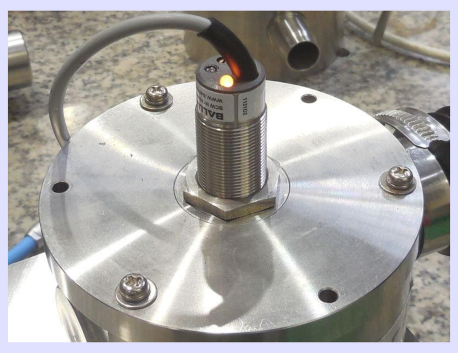
Relative level change measured by DNA03 is plotted against the distance from the IP.

The effects of the construction is clearly seen.



Tunnel level measured by N3 is plotted against the distance from the IP.

Relative level with respect to the IP is shown.



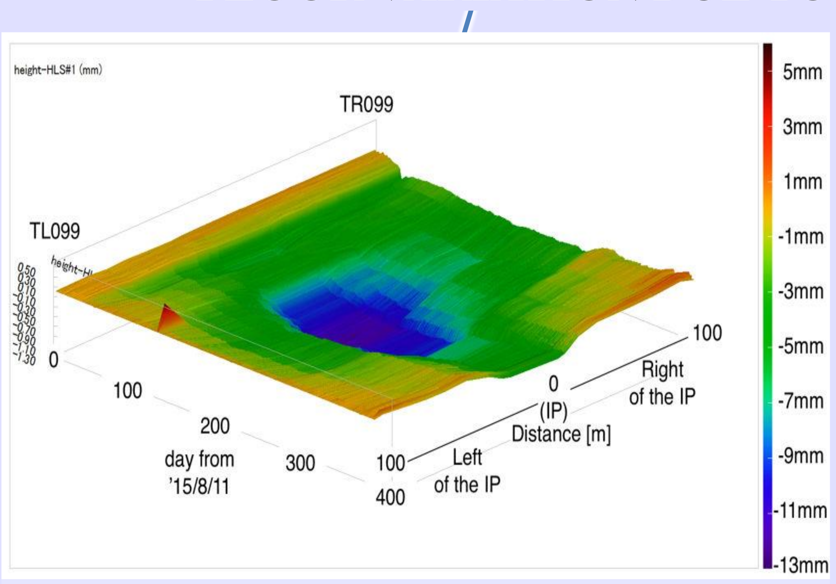
We are looking into the possibility of monitoring the tunnel level along the entire tunnel.

Inexpensive sensors with an OK resolution are helpful (Balluff sensor, for example).

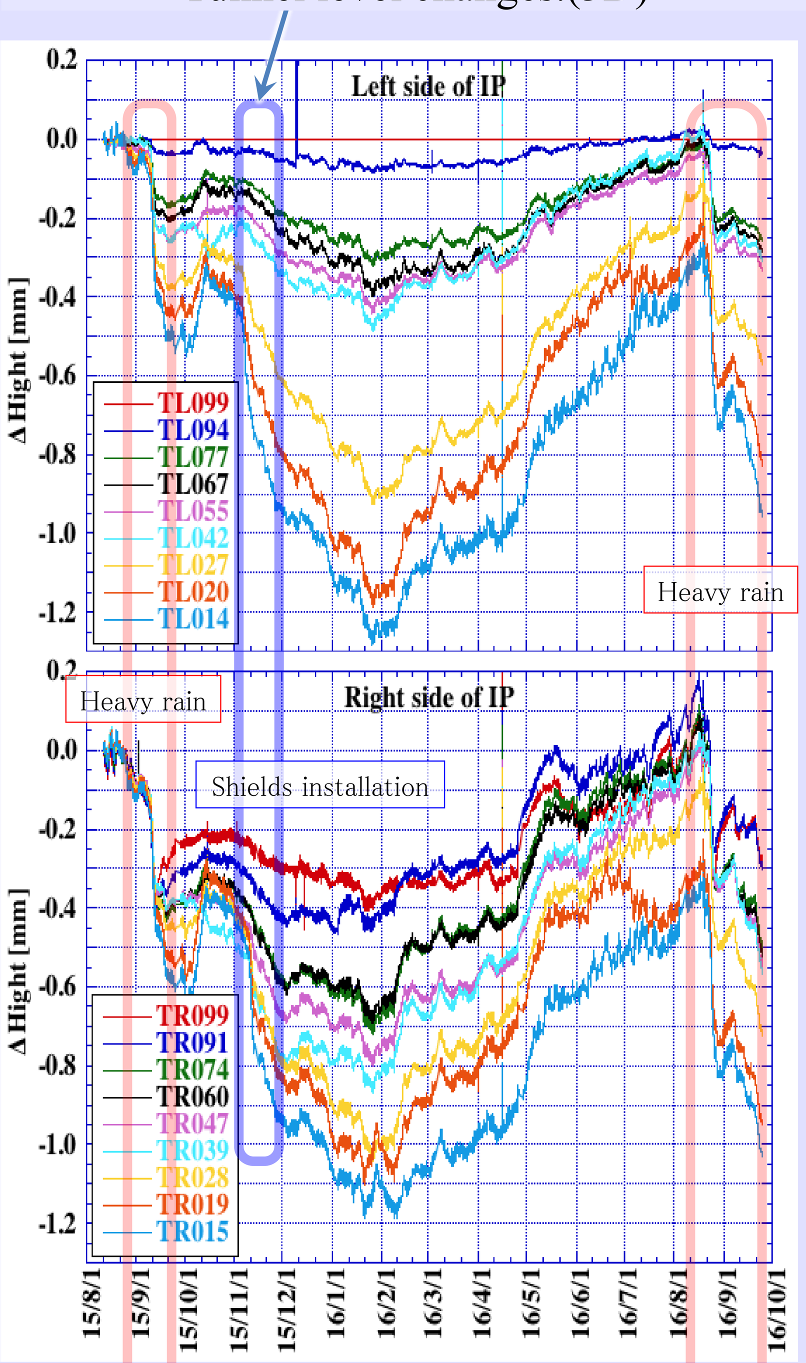
9M D9

Nikko Exp.

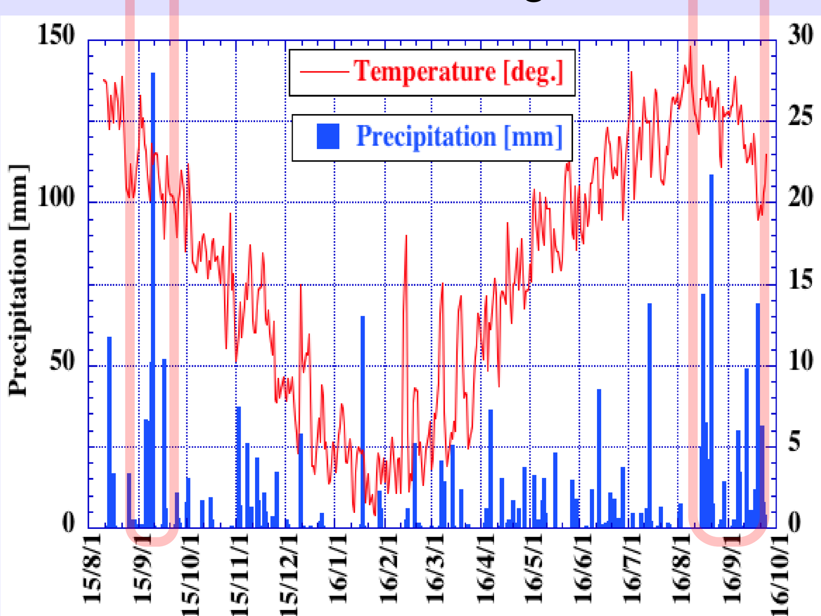
FLOOR VARIATION DUE TO WEATHER IN TSUKUBA EXP.



Tunnel level changes.(3D)



Tunnel level changes.



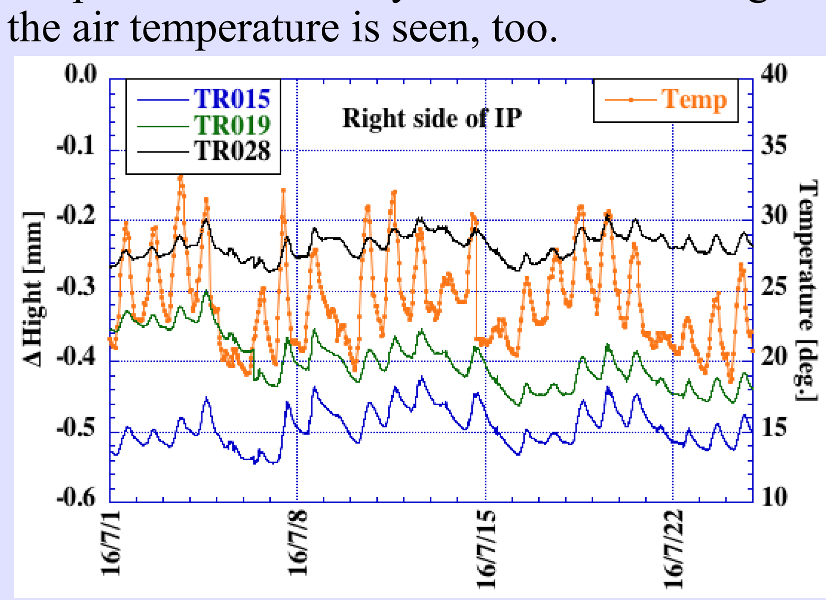
Precipitation and outside air temperature.

The floor level has been continuously monitored since the installation of the HLS units in August 2015. The levels are relative to the reference sensor (TL099) located at the left end.

The floor near the IP started sinking with respect to the reference point (or the left end and right end started floating with respect to the IP) and reached the lowest level in winter. It started floating up again, as spring came.

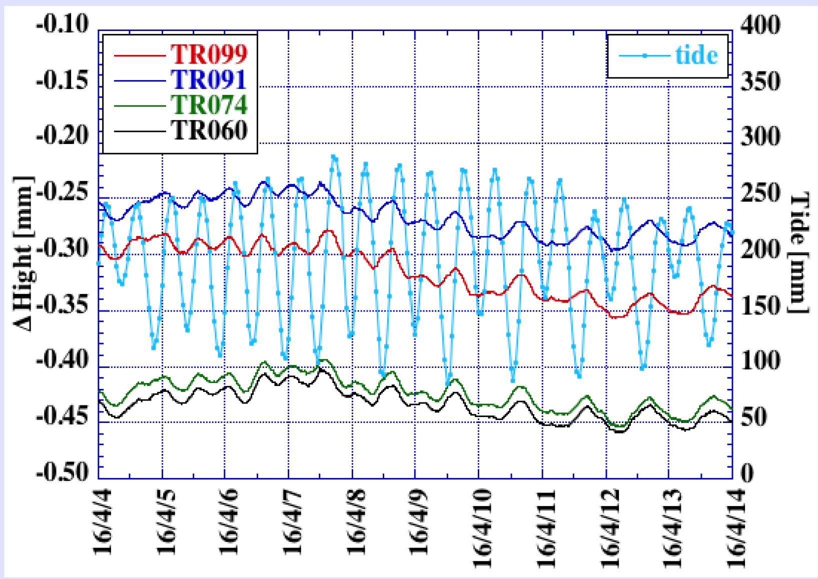
The seasonal change of the floor level is observed to be more than 1 mm over the approximately 8-months period.

The floor level variation appears to follow seasonal changes of the out-side air temperature. The daily variation following to the air temperature is seen, too.



Effects of outside air temperature.

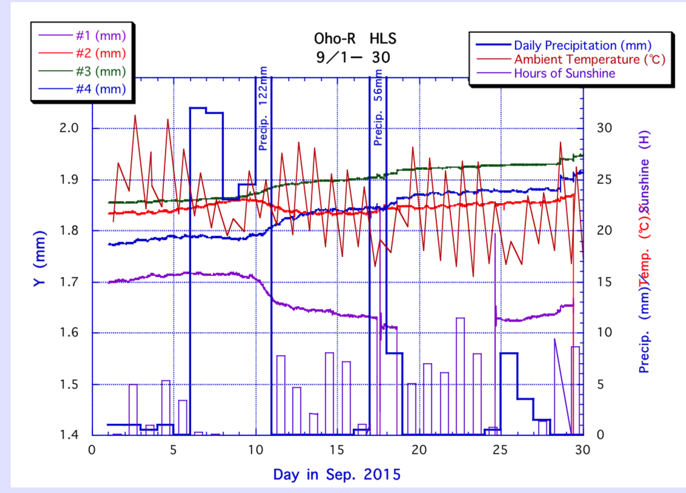
Tidal effects are also seen. Tidal data from the nearby port are plotted for comparison. A clear diurnal effect is seen in the floor motion and the peak-to-peak was measured to be approximately 25 μm during this period.



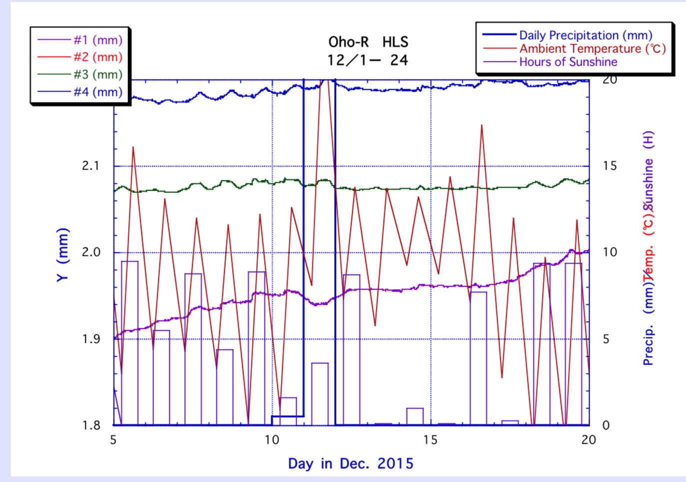
Tidal effects.

The IP floor started sinking rapidly in early September 2015 and late August 2016, which seems to have some correlation with the precipitation. We had a localized torrential downpour in this area at that time and this likely changed the underground water level and the tunnel level.

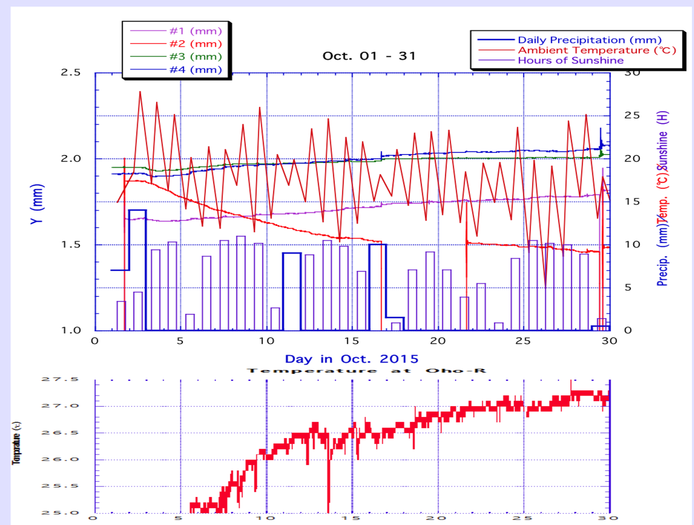
HLS #1-#4 (offered by DESY) OUTPUTS, WHICH WERE PLACED IN THE ARC SECTION OF OHO AREA



The floor is tilted because of the heavy rain.

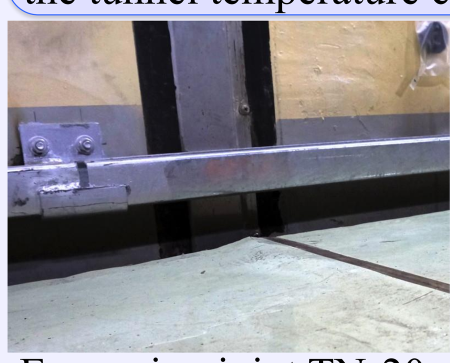


Daily variation of the tilt of the tunnel floor is as small as 20 μm / 10 m, but it is noticeable when the daily variation of the ambient temperature is large or the time of the sun-shine is long.



HLS #2 was placed near the expansion joint TN-20. The tilt of the floor takes place when the tunnel temperature changes.

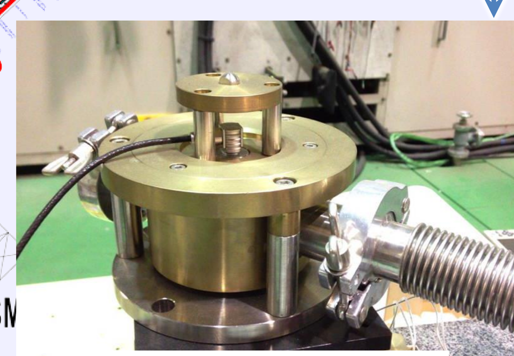
Oho Exp.



Expansion joint TN-20.

The bump of the floor concrete can be seen.

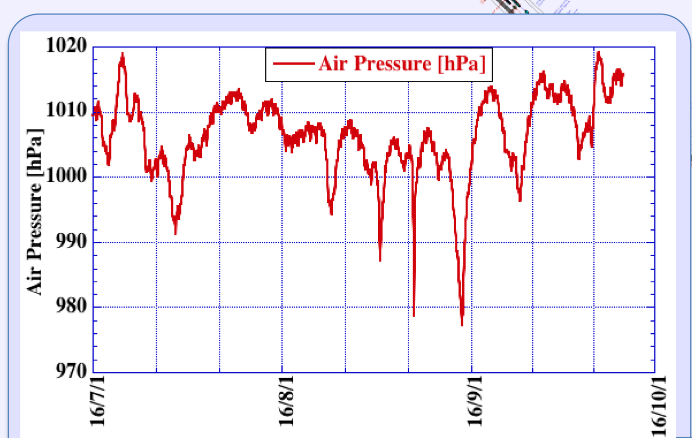
6M D6

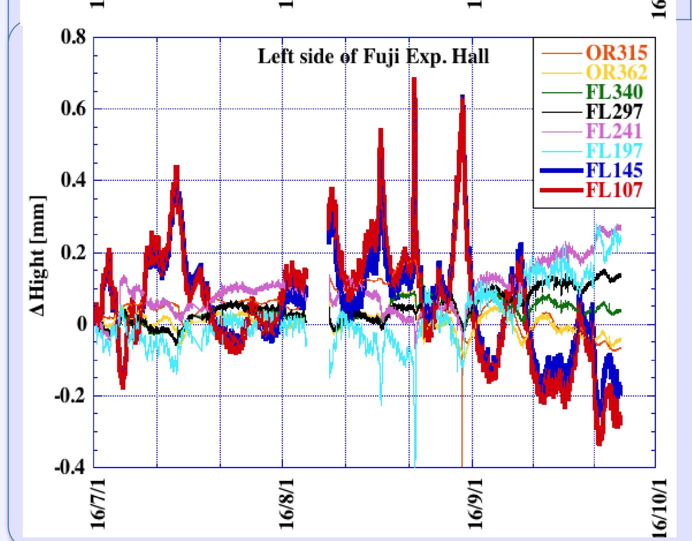

DESY HLS sensor

9LC5 9SM5 6LC4 6SM

Fuji Exp.

EFFECT OF ATMOSPHERIC AIR PRESSURE





<-- Tunnel level changes monitored by the HLS are shown. Atmospheric air pressure in the area is plotted for the same period.

Correlation between some of the sensors and the pressure is observed. -->

The excavation of the new BT tunnel might have something to do with this strong correlation between the tunnel level and air pressure.