Gravity gradient noise from spring water in the mine

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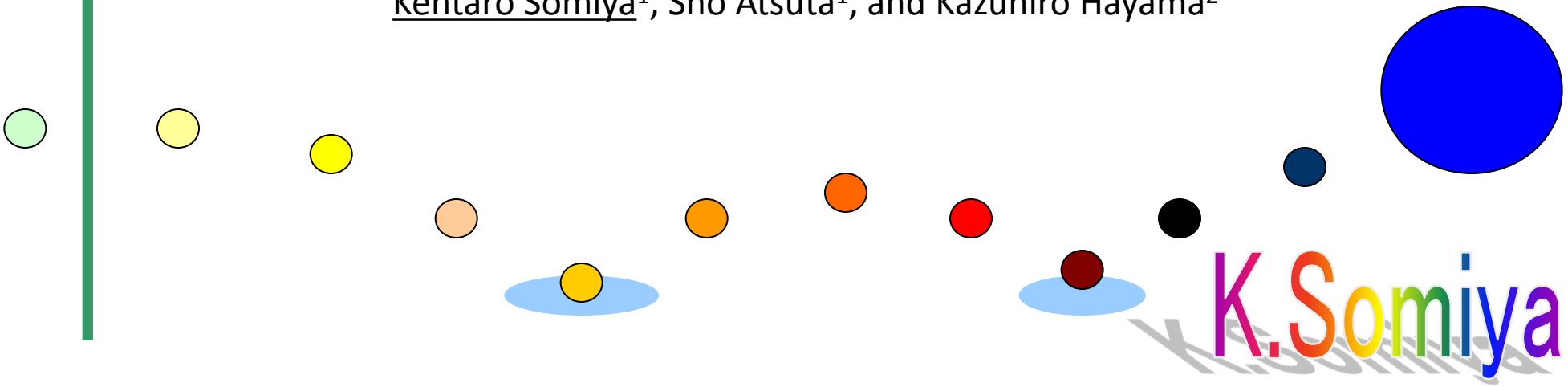
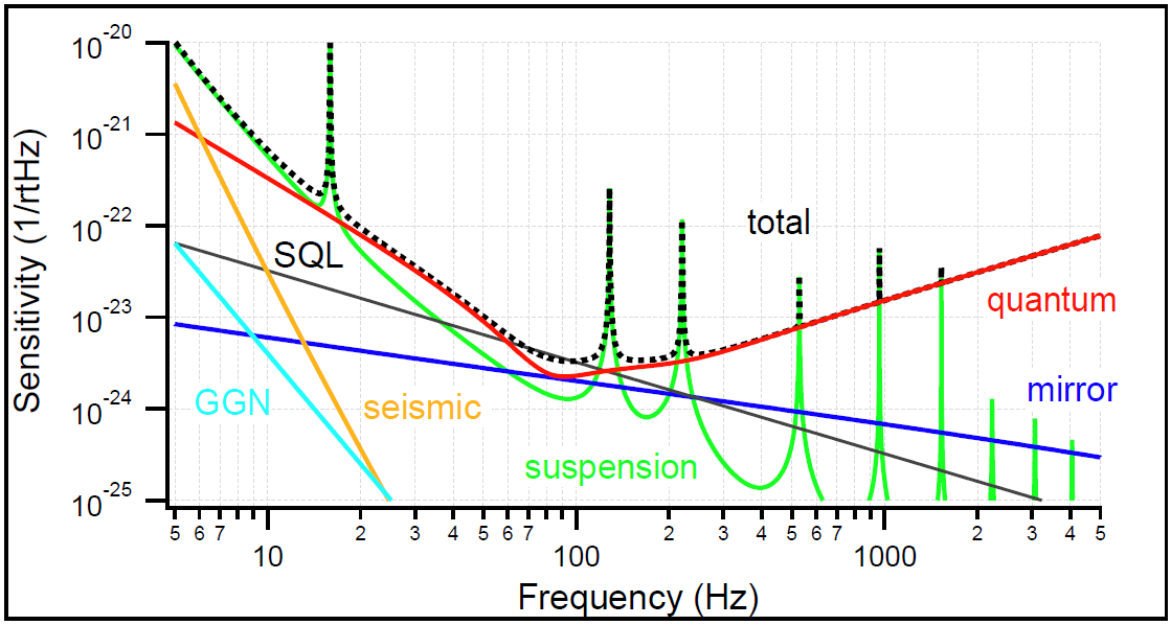


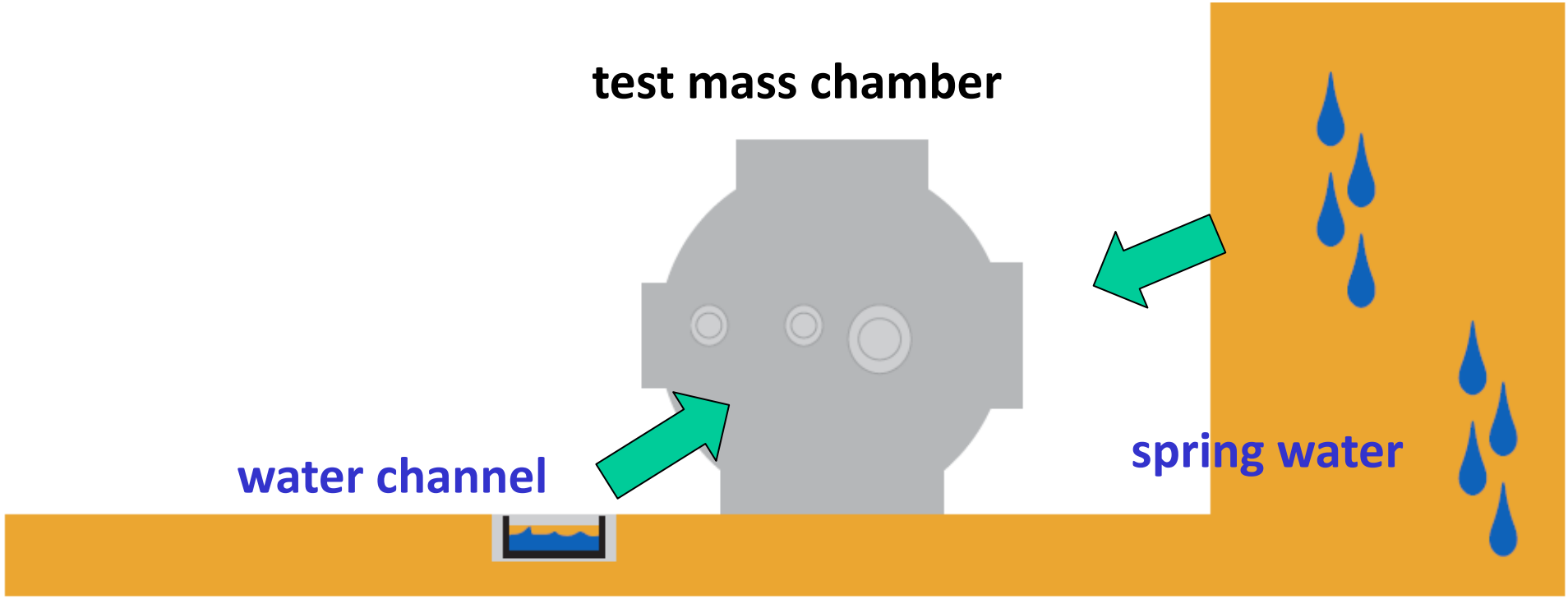
Gravity gradient noise



- **According to the model, GGN is small in KAGRA for its low seismic motion and its distance from the ground surface**
- **However, there is a lot of water flowing behind the rock, which may or may not cause excess fluctuation of the gravity gradient**

Can we estimate GGN from the spring water?

Possible mechanism of excess GGN



If the amplitude of water surface is higher than the ground motion, GGN should be larger than the one coming from the ground motion.

Can we estimate the water surface amplitude?

Various ways to measure a water flow

Turbine flowmeter

Supersonic

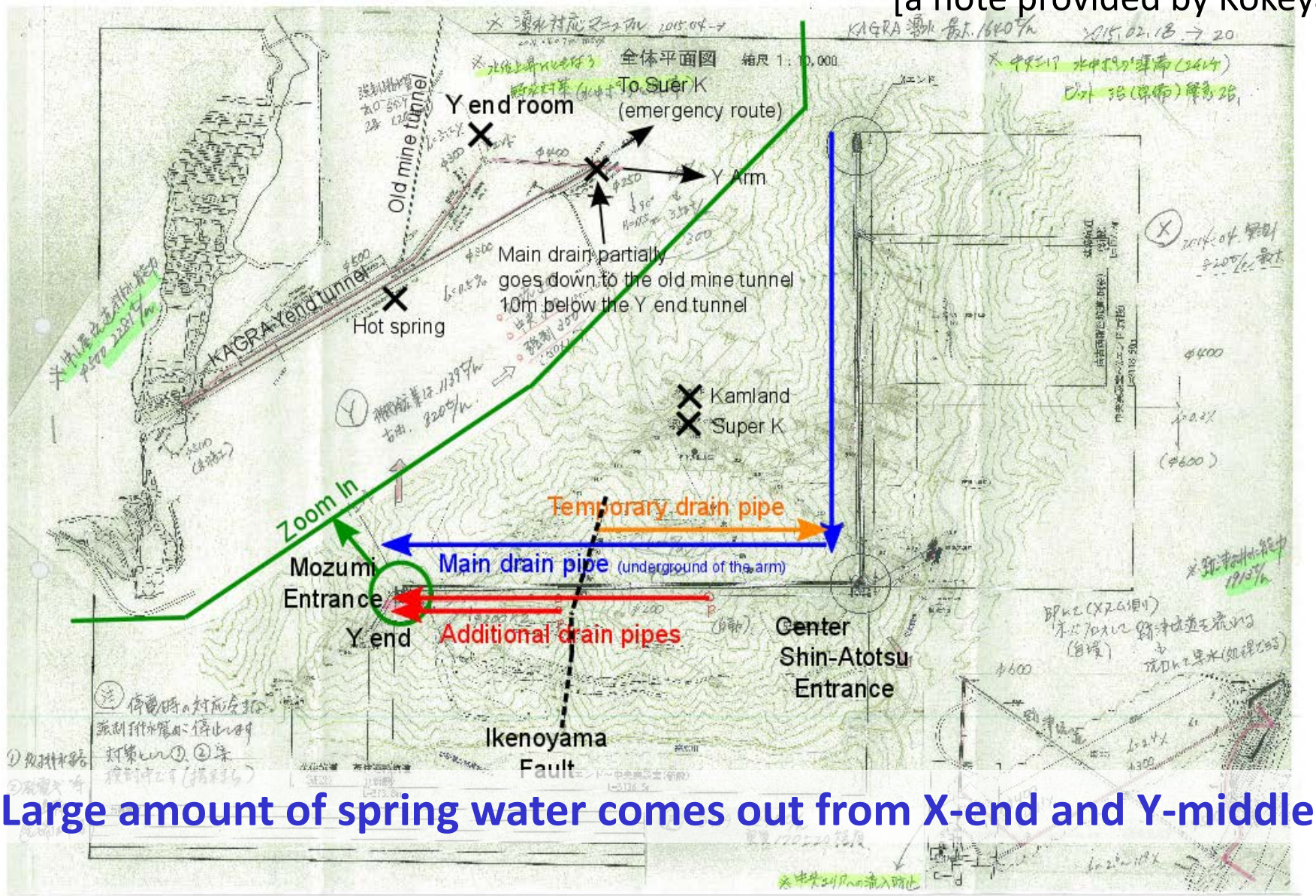
Microwave

What we need is actually not the amount of water flow, but the amplitude of the water surface.

Are there any better ways?
- Sound? Thermography? Seismometer?

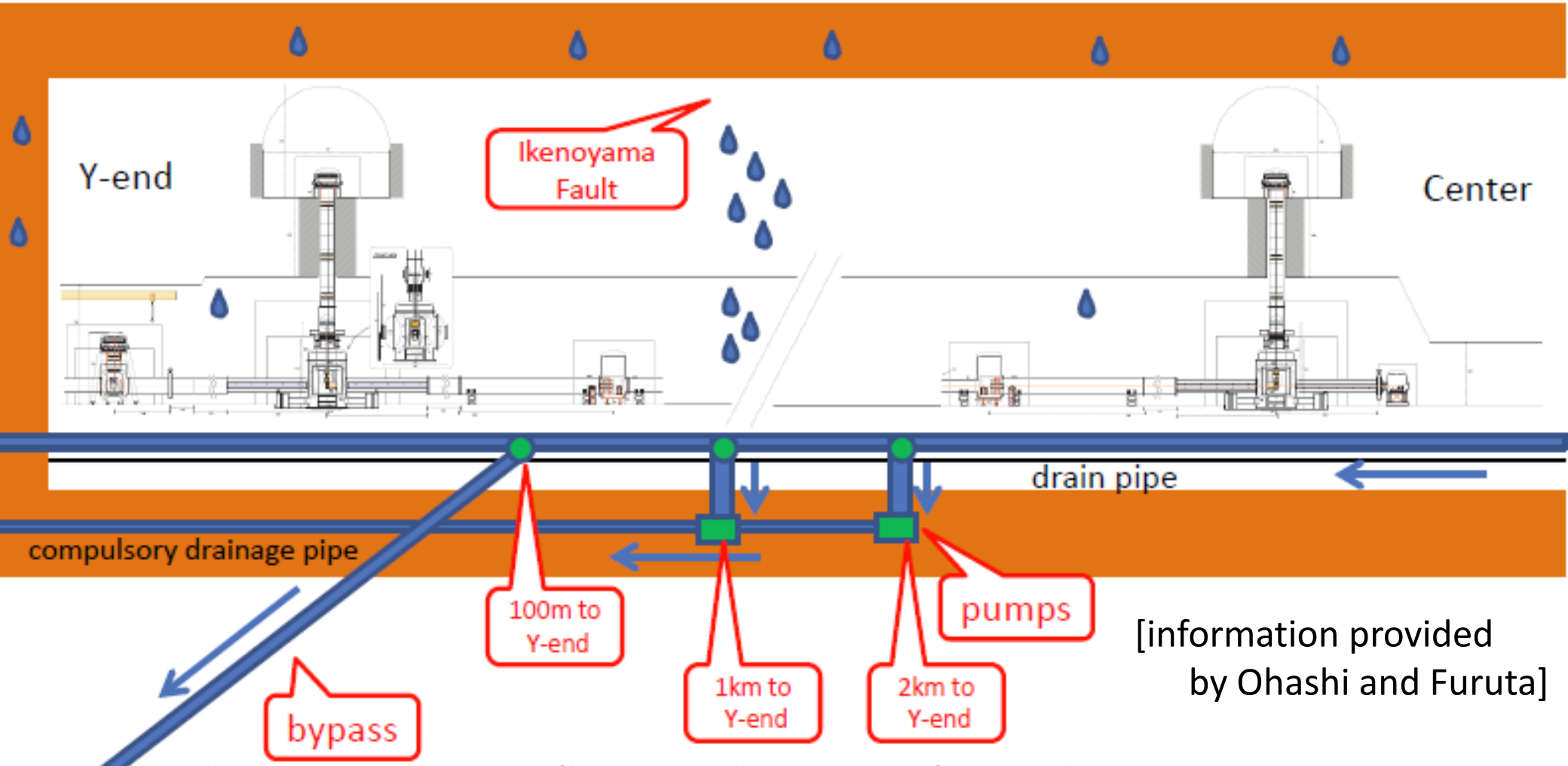
How do we drain the spring water in KAGRA?

[a note provided by Kokeyama]



Large amount of spring water comes out from X-end and Y-middle

How do we drain the spring water in KAGRA?



[information provided by Ohashi and Furuta]

- **The Y-end used to flood in the spring for melting snow**
- **Now 400t/h water can be drained via each new pipe and 700t/h water can go through the main channel (1500t/h in total)**

How do we drain the spring water in KAGRA?

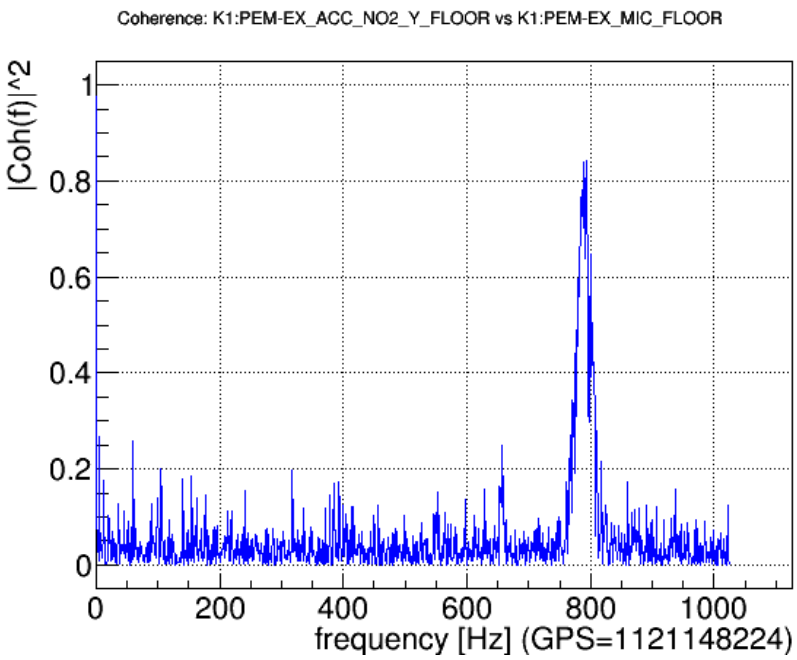
left: drain system (2km to Y-end)
middle: water pipes after the bypass
right top: water flow meter at the Y-end
right bottom: Y-end station

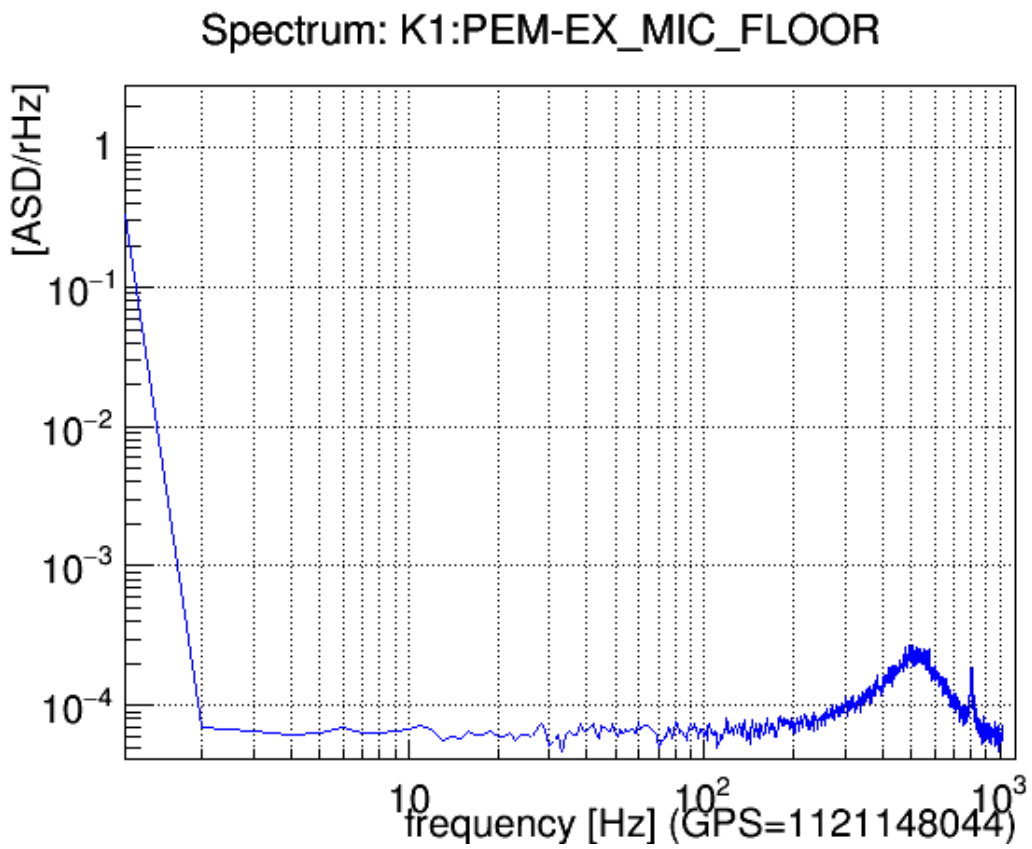
Acoustic measurement at the X-end

Acoustic measurement at the X-end

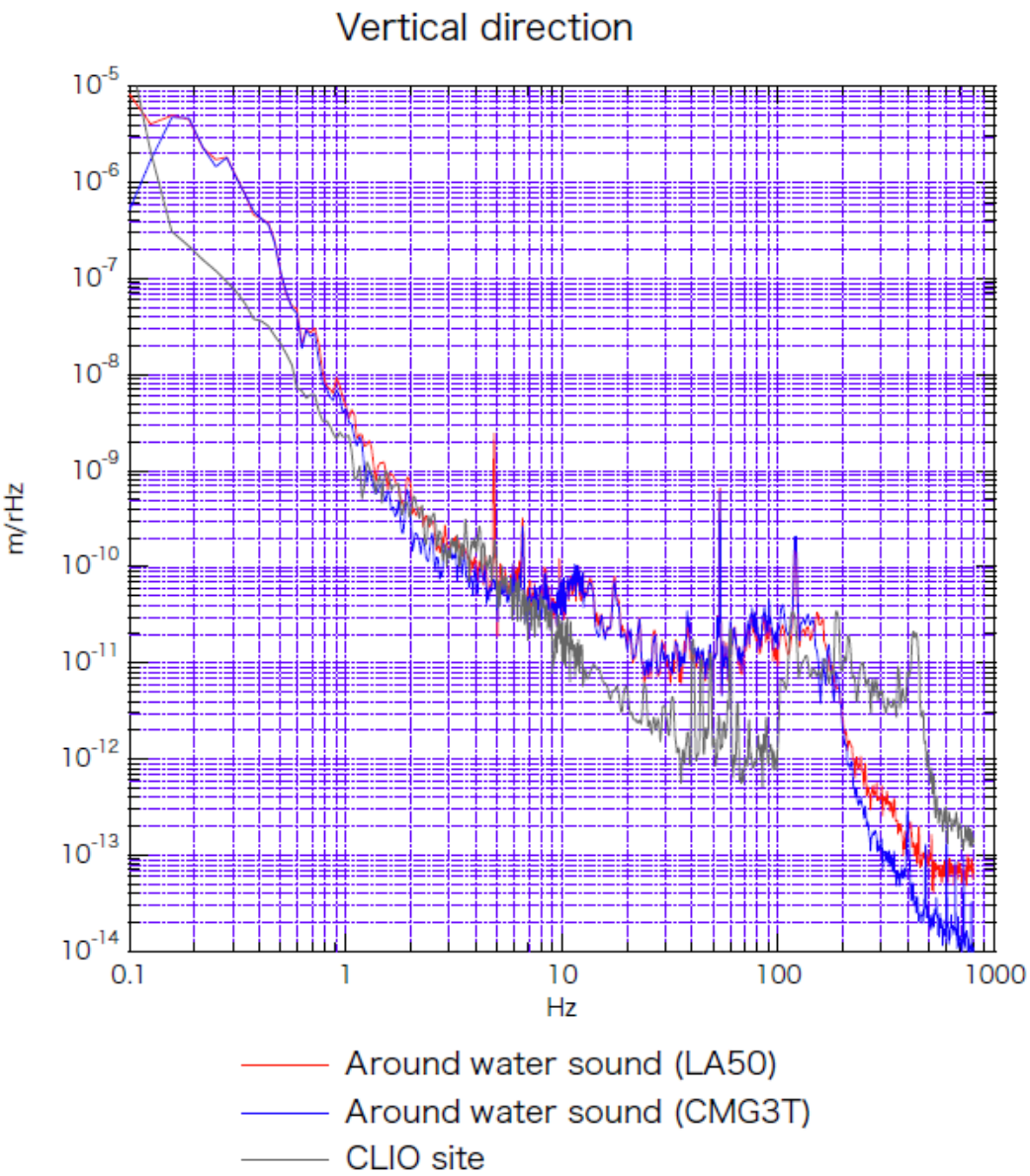
[figure provided by Hayama]

(left-top) Listening to the water flow
(right-bottom) Microphone spectrum
(left-bottom) Coherence between the microphone and acidometer outputs





Seismic noise measurement at the X-end

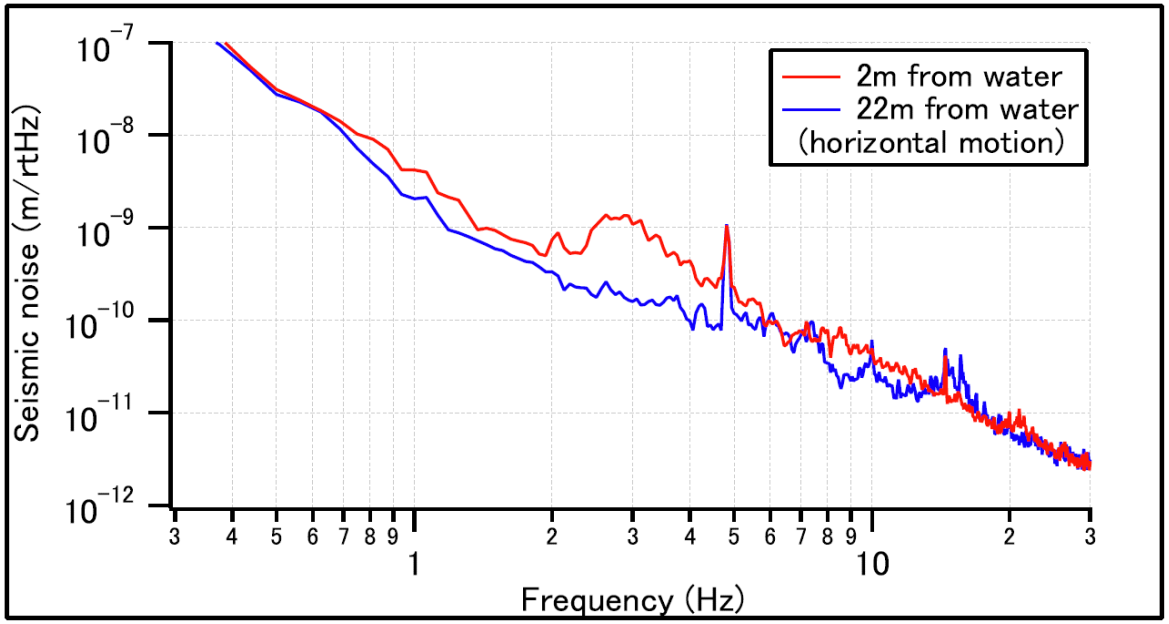


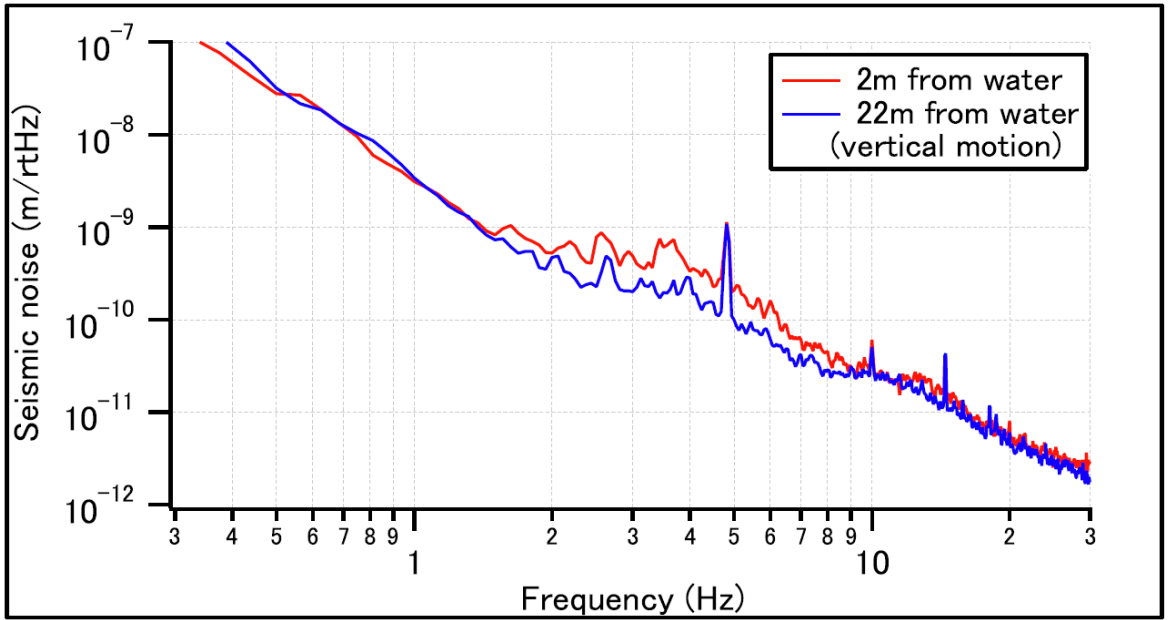
[figure provided by Tomaru]

Compared with the seismic level at the CLIO site, seismic level at the X-end is higher at 10-200Hz.

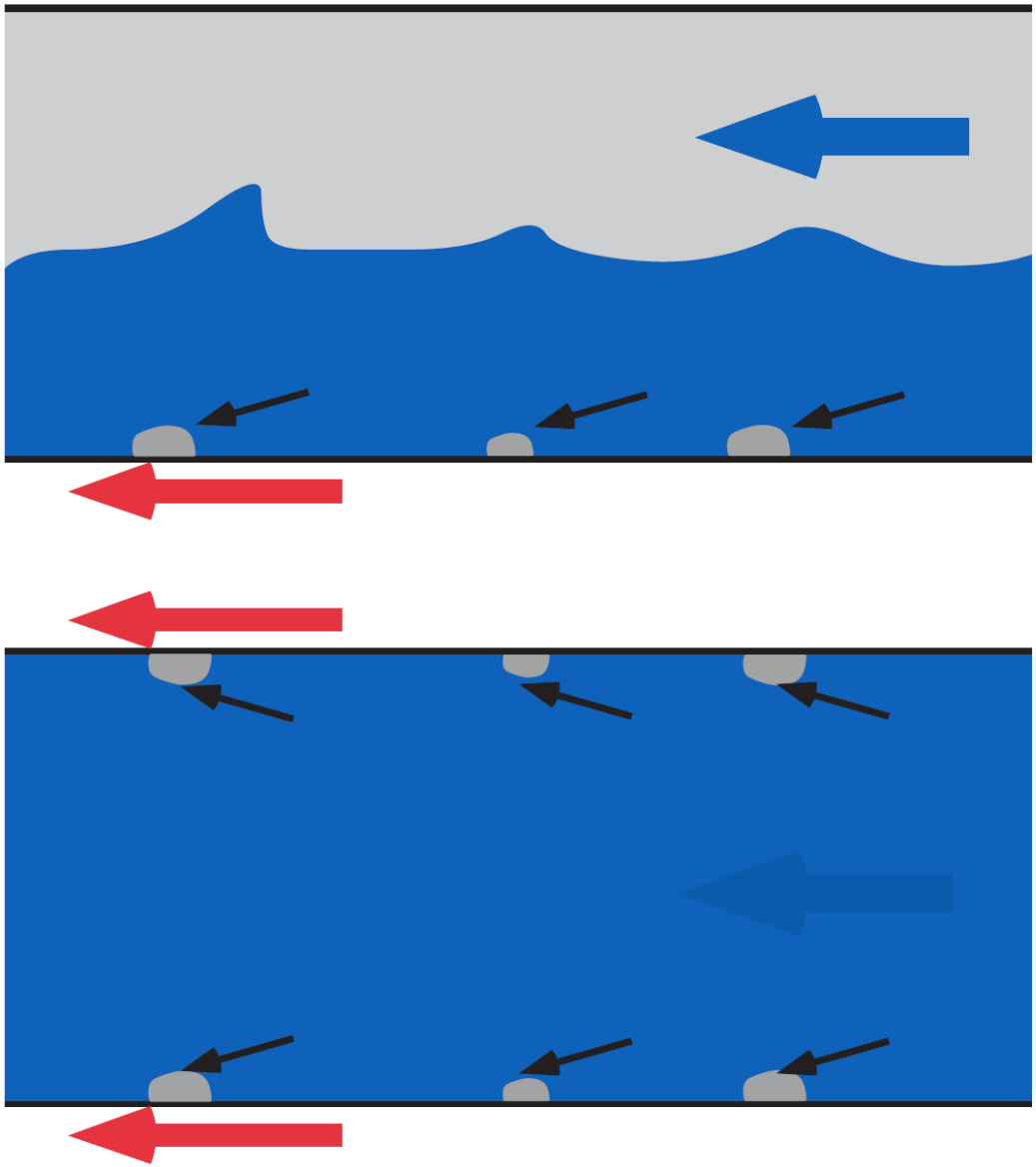
Seismic noise measurement at the Y-end

[data provided by Uchiyama]





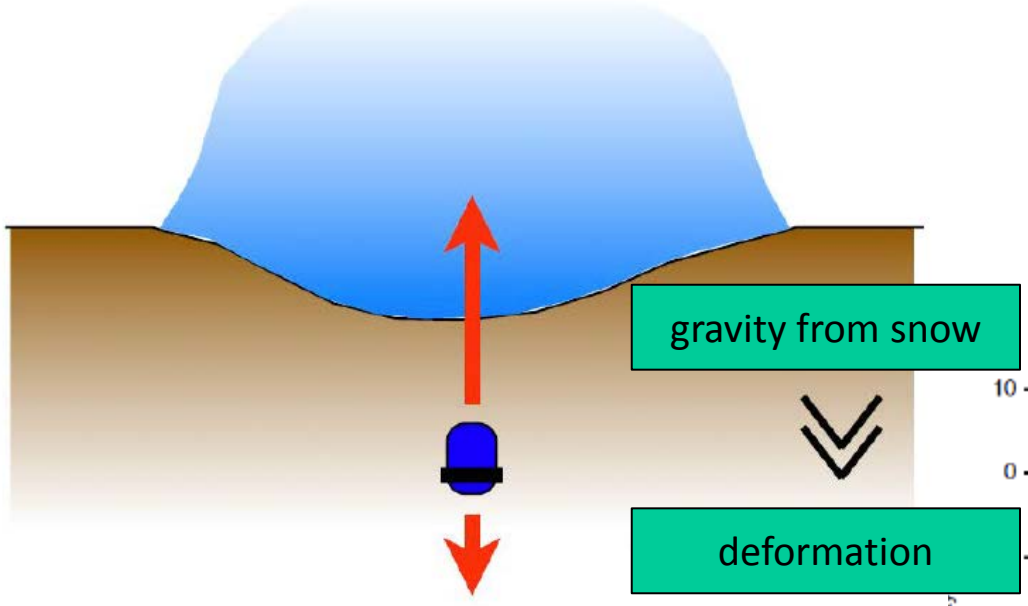
More excess noise in the horizontal direction?



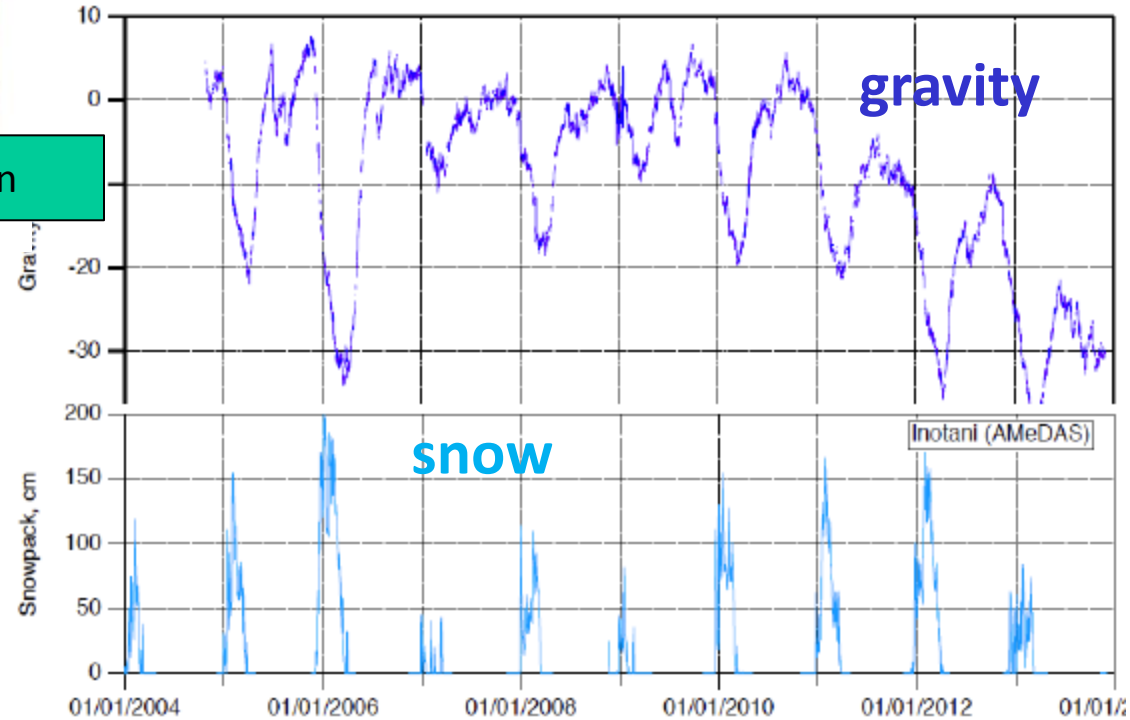
Maybe it can be explained in such a way that the ground could receive larger momentum in the horizontal direction when 1000t of water flows under the ground.

Gravity change due to snow

[figure provided by Araya]



Coherence between gravity and amount of snow



Summary

- Water flow GGN can be excess noise if the water flow is too close to the test masses and the amount is too much

- We have started investigating the problem and are looking for a good way to estimate its amplitude

- Seismic noise measurement result may give us some clue for the estimation

- Water flow will be bypassed before the Y-end and it should not be a too serious problem (so is GGN); GGN at the X-end can be more serious than Y-end.