

# Arm Environmental Study - Water-level measurement -

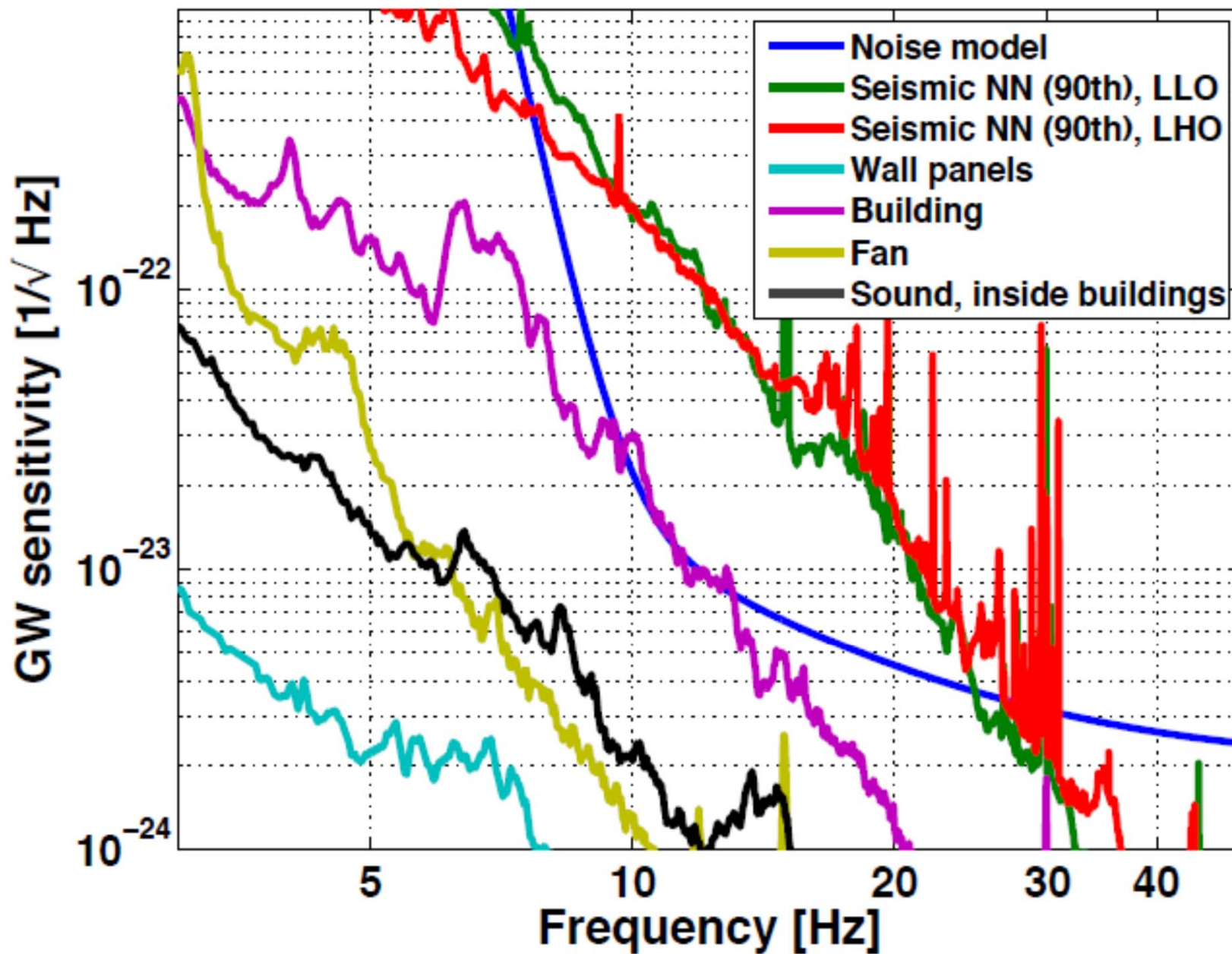
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KAGRA DetChar Group

2016/8/26

# Low-frequency noise budget on LIGO

From noise budget in Feb. and Mar. 2011

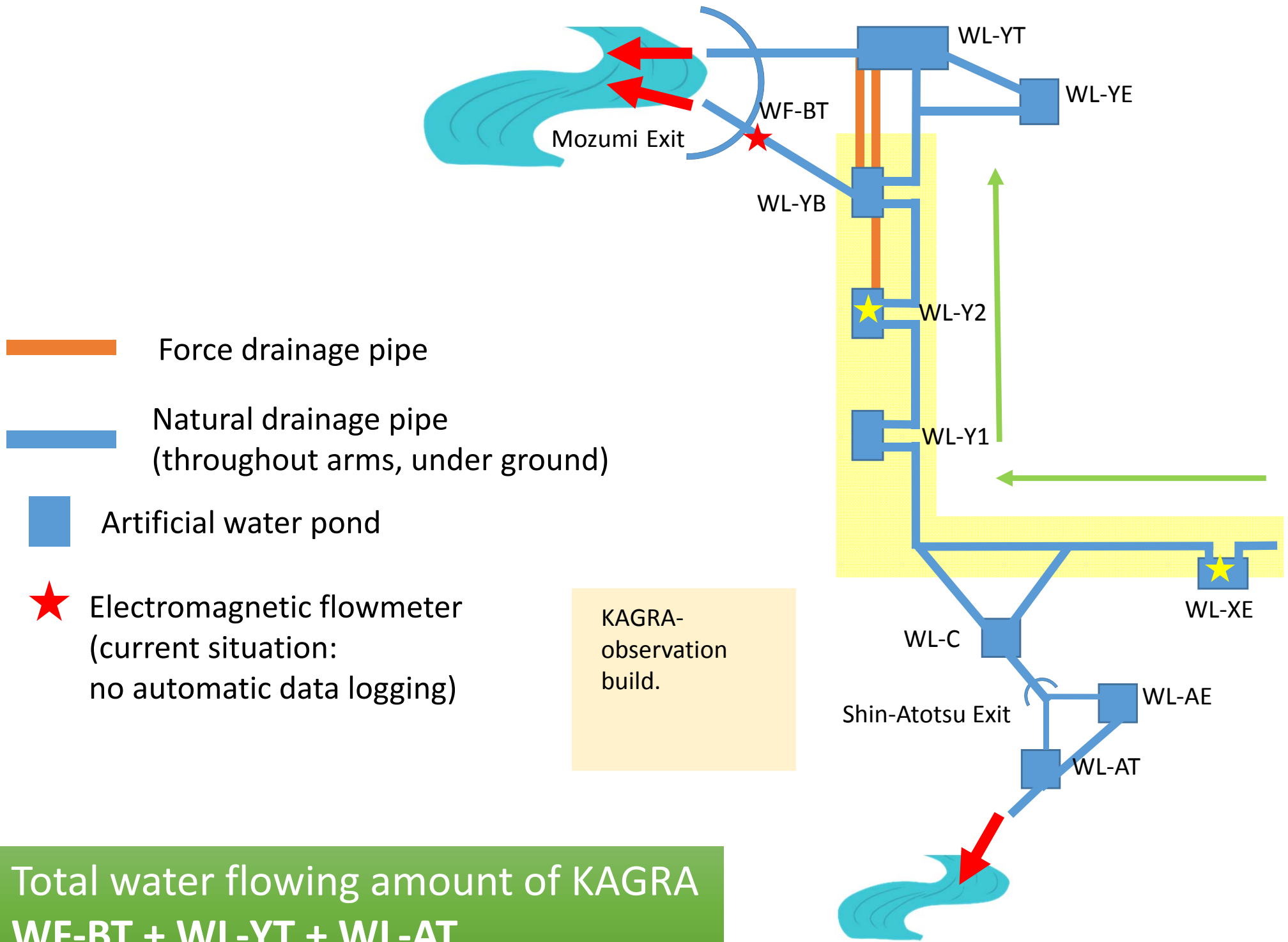






# Aim

- Toward the stable operation of KAGRA, environmental status inside KAGRA mine should be identified.
  - The expected noise sources around the low frequency are
    - **Underground water**
    - Air pressure (due to the dead end of X arm)
    - Temperature
    - Humidity

DetChar group strategy:

What physical quantities should be measured?



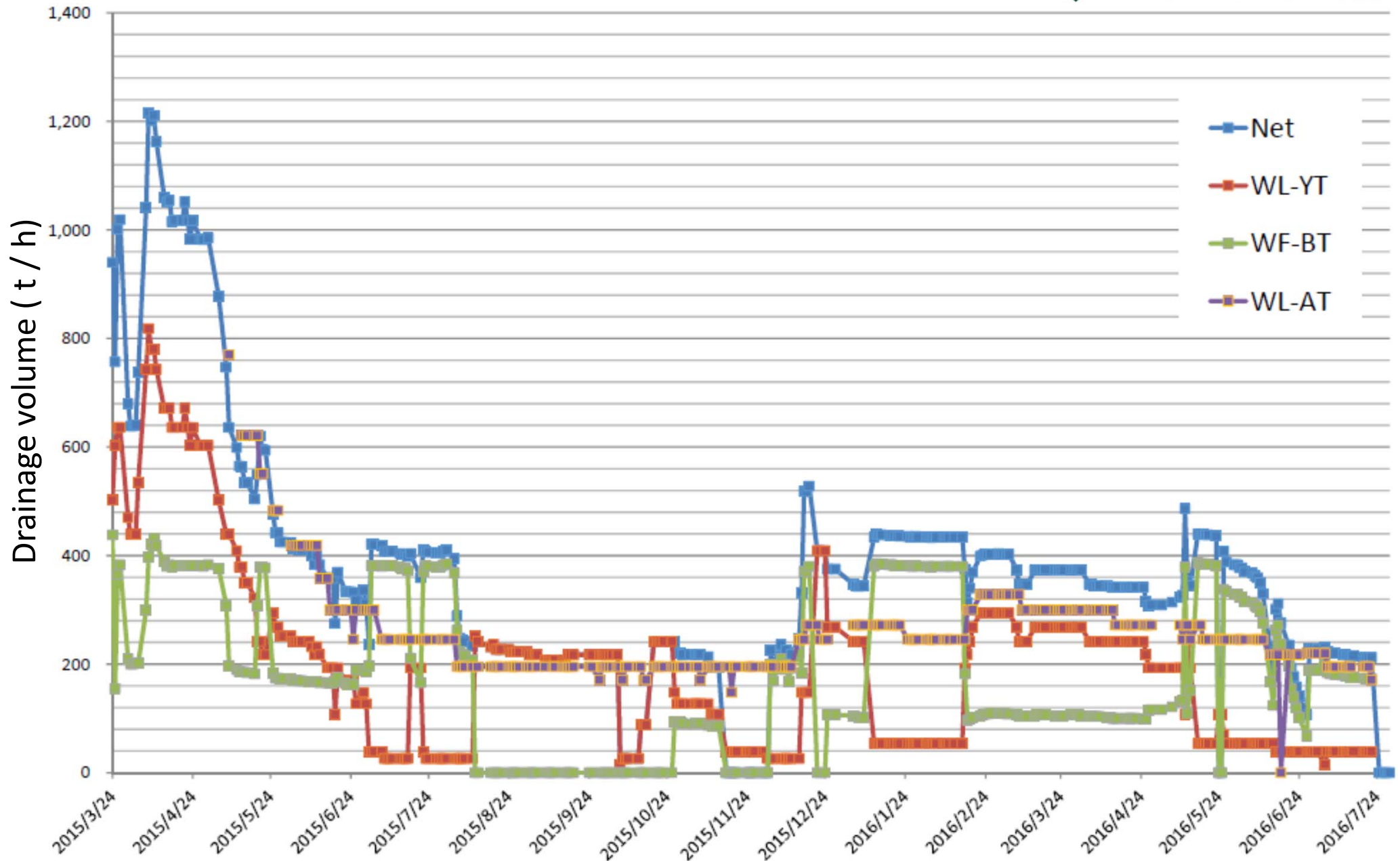
-  Force drainage pipe
-  Natural drainage pipe (throughout arms, under ground)
-  Artificial water pond
-  Electromagnetic flowmeter (current situation: no automatic data logging)

KAGRA-  
observation  
build.

Total water flowing amount of KAGRA  
**WF-BT + WL-YT + WL-AT**

# One-day period measurement

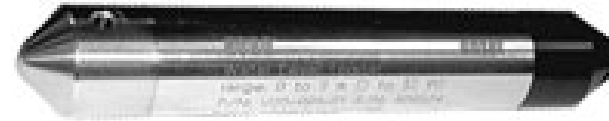
By  神岡鉱業株式会社  
KAMIOKA MINING AND SMELTING CO.,LTD



# Stand-alone water level logger

[http://www.weather.co.jp/catalog\\_html/hobo/U20.htm](http://www.weather.co.jp/catalog_html/hobo/U20.htm)

- CO-U20-001-04 (Onset)



Part number	U20-001-04/ U20-001-04-Ti	U20-001-01/ U20-001-01-Ti	U20-001-02/ U20-001-02-Ti	U20-001-03/ U20-001-03-Ti
<b>HOBO Water Level Specifications</b>				
Range	0-4 m (0-13 ft) 0-145 kPa (0-21 psia)	0-9 m (0-30 ft) 0-207 kPa (0-30 psia)	0-30 m (0-100 ft) 0-400 kPa (0-58 psia)	0-76 m (0-250 ft) 0-850 kPa (0-123 psia)
Factory Calibrated Range (0° to 40°C; 32° to 104°F)	69 to 145 kPa (10-21 psia)	69 to 207 kPa (10-30 psia)	69 to 400 kPa (10-58 psia)	69 to 850 kPa (10-123 psia)
Water Level Accuracy (Typical Error)	± 0.3 cm (0.01 ft) (± 0.075% FS)	± 0.5 cm (0.015 ft) (± 0.05% FS)	± 1.5 cm (0.05 ft) (± 0.05% FS)	± 3.8 cm (0.125 ft) (± 0.05% FS)
Resolution	0.14 cm (0.005 ft)	0.21 cm (0.007 ft)	0.41 cm (0.013 ft)	0.87 cm (0.028 ft)
Burst Pressure	310 kPa (45 psia) 18 m (60 ft) depth		500 kPa (72.5 psia) 40.8 m (134 ft) depth	1200 kPa (174 psia) 112 m (368 ft) depth
<b>Temperature Specifications (all models)</b>				
Range	-20° to 50°C (-4° to 122°F)			
Accuracy	± 0.37° @ 20°C (± 0.67° @ 68°F)    ± 0.44° from 0° to 50°C (± 0.79° from 32° to 122°F)			
Resolution (10 bit)	0.1° @ 20°C (0.18° @ 68°F)			
Response time	5 minutes (to 90% in water)			
Dimensions	2.46 cm diameter x 15 cm (0.97 x 5.9 in) hole in mounting bail 6.3 mm (0.25 in)			
CE compliant	Yes			

# WL-AT



pic1



Pic2

# WL-WT



pic3



pic4



pic5



# WL-Y2



Pic6



Pic7

WL-XE

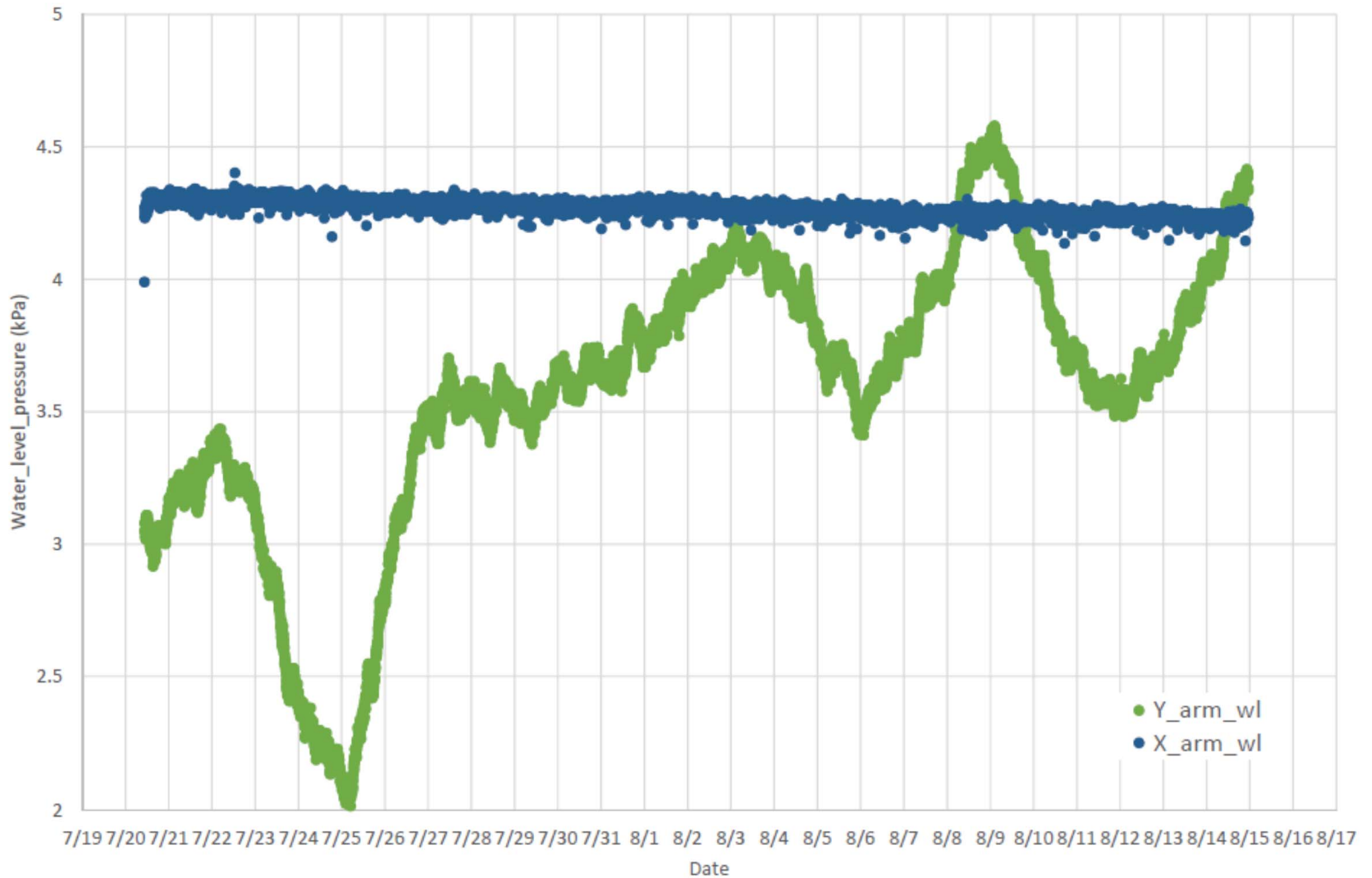


Pic8

The water-level logging system is needed for the modification by the air pressure.

Therefore, we can measure two points (WL-XE and WL-Y2) only.

# 5-min period sampling



# Toward more high sampling water-level measurement

Raspberry Pi 3 / OS: Raspbian



+ WEB camera  
+ Image recognition

Target Sampling Rate: 50 Hz, Cost: < 10,000 JPY

+ Alert system on water-level

Schedule: By August 2017

# Additional measurement?

Drainage pipe flow meter will be installed.

Drain pipe  
under ground



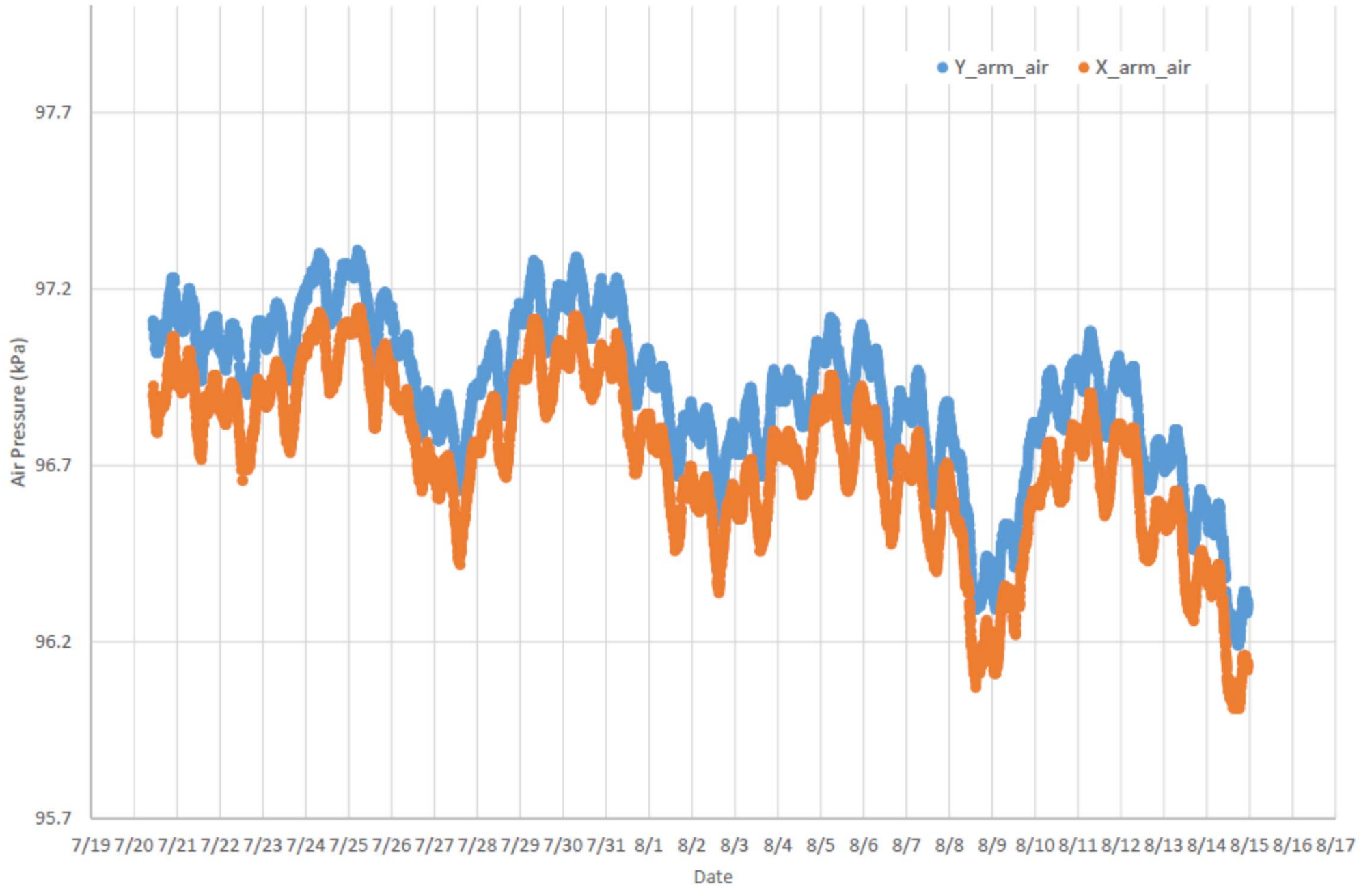
Sampling Rate: 50 Hz  
Water flow velocity



Compulsory  
Drainage pipe

@ Y-end

# Air pressure: Daily fluctuation



# DetChar Env arm monitor

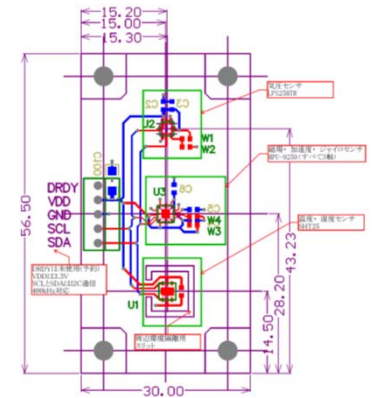
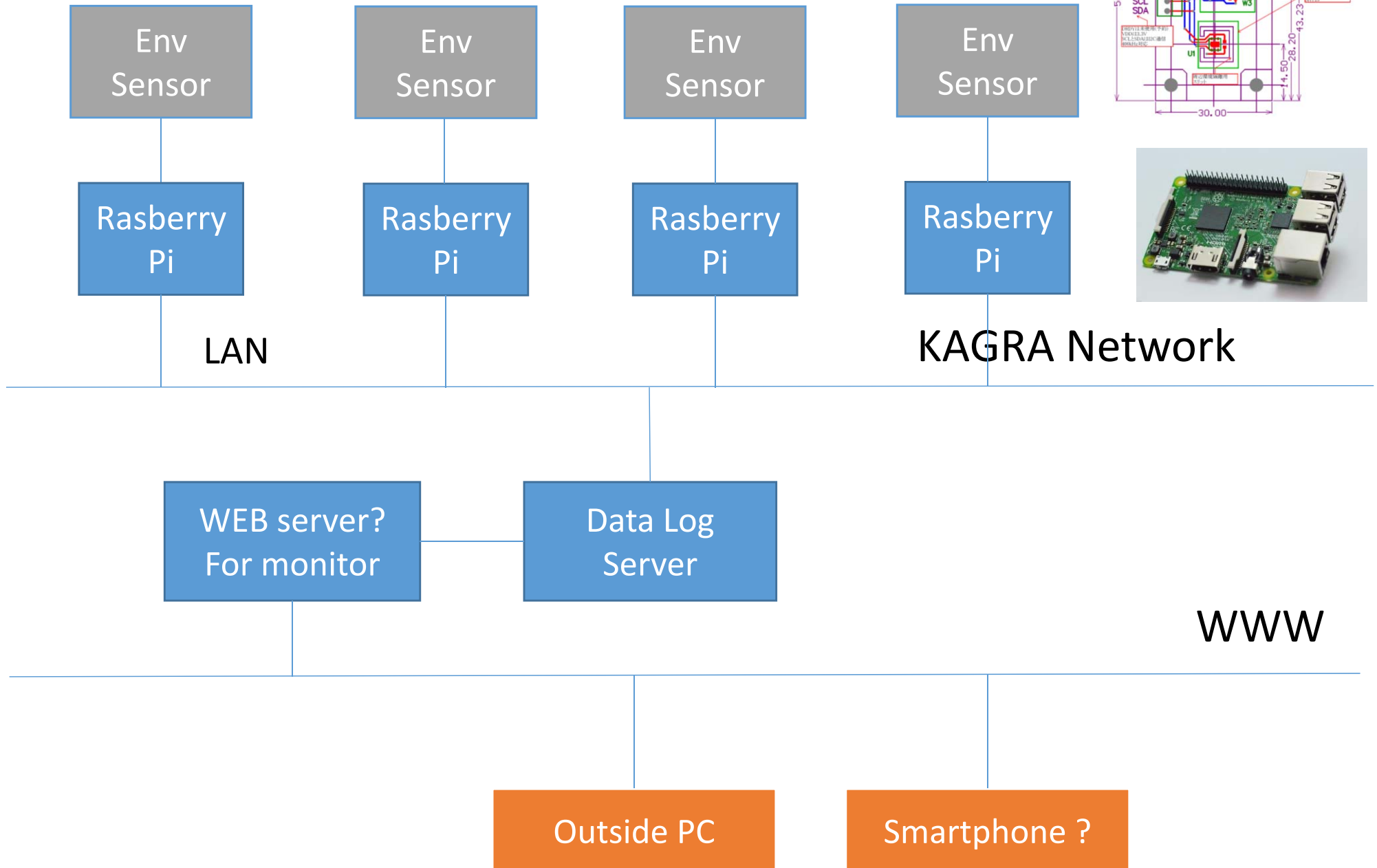
As the minimum setup

- Temperature (arm distribution)
- Humidity (arm distribution)
- Air pressure (arm distribution / daily fluctuation)
- Magnetic Field (arm distribution (mainly DC component))

As add-on function, we will prepare the mini-amp system to measure the USB-based module.

Ex. Accelerator / High-precision magnetic field

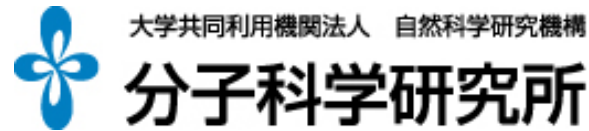
# Setup





# Schedule

- - Nov. 2016
  - Set up at IMS, NINS
  - Test operation at IMS, NINS
- Dec. 2016
  - Test installation at KAGRA
- Jan. – Mar. 2017
  - Adjustment and full installation at KAGRA
- Budget
  - Tentative budget from Shikano group at IMS, NINS



# Summary

- Toward the construction of arm environmental monitor system, we measure the underground water by 5-min period.
- Underground water-level is oscillated daily.
- Air pressure inside KAGRA arm is oscillated daily.
- Environmental modelling is needed.