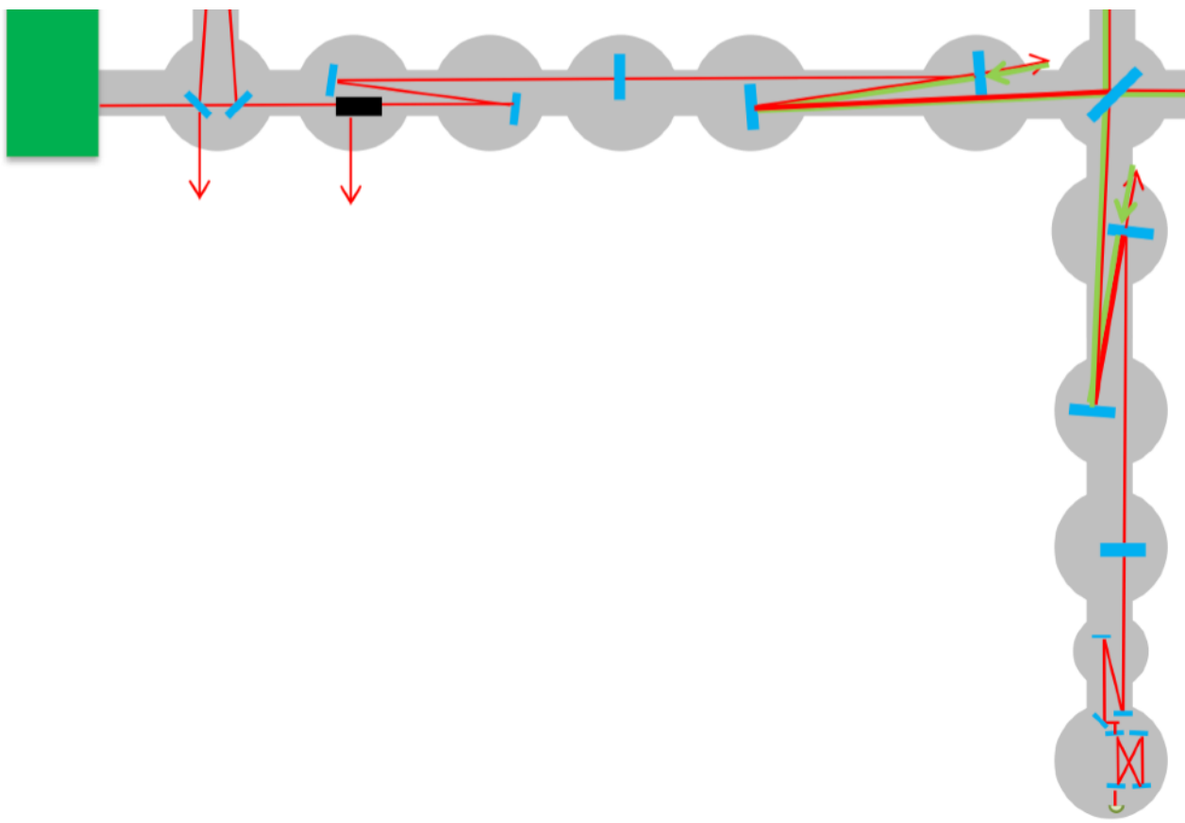
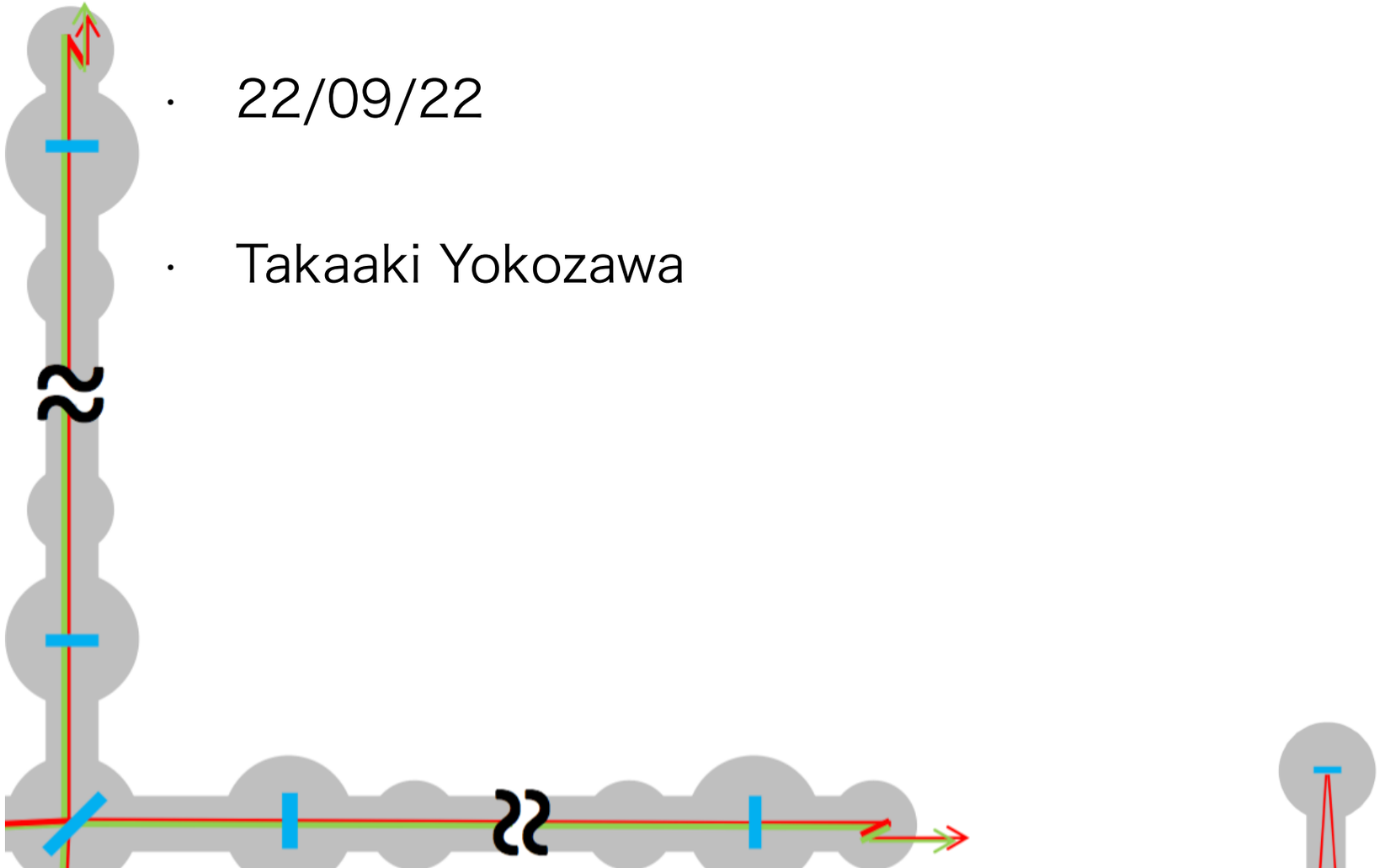


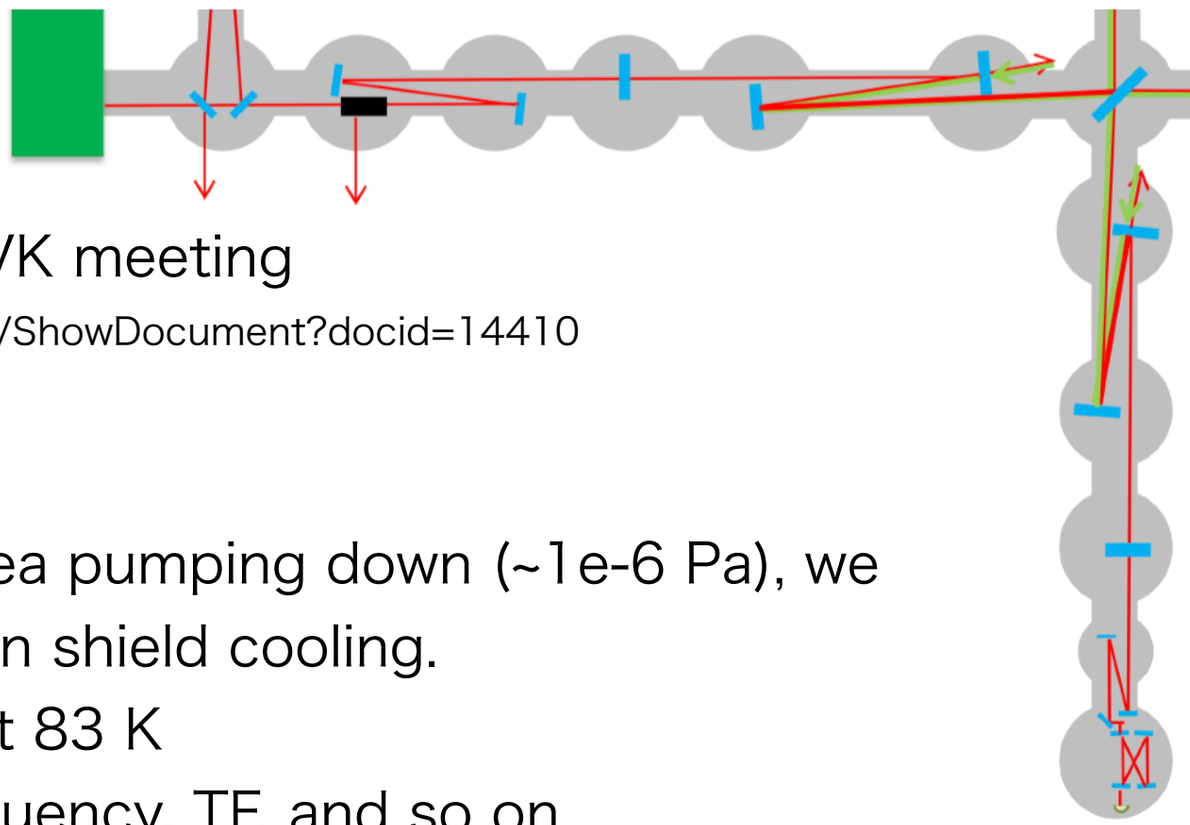
- VK PEM meeting

- 22/09/22

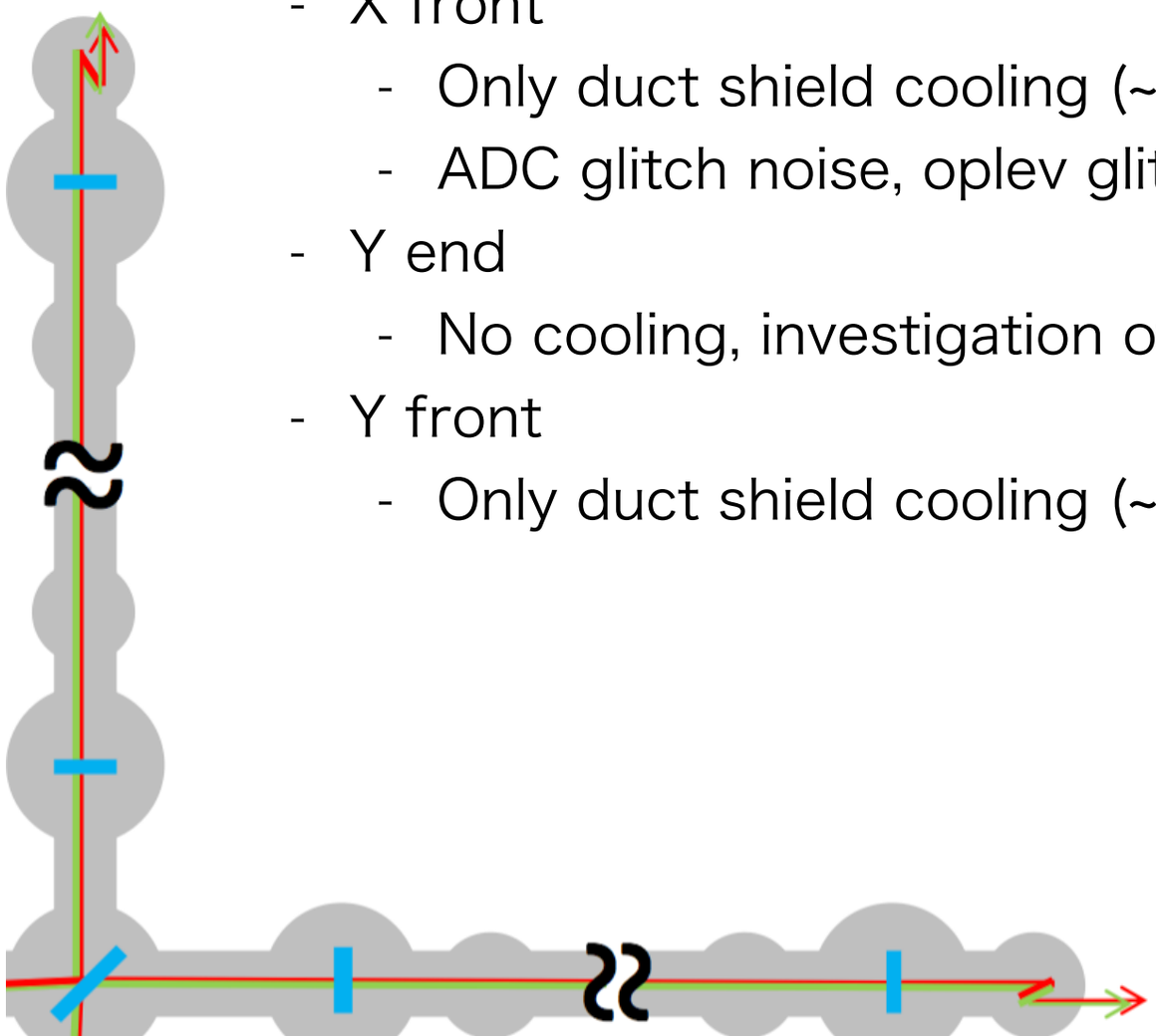
- Takaaki Yokozawa

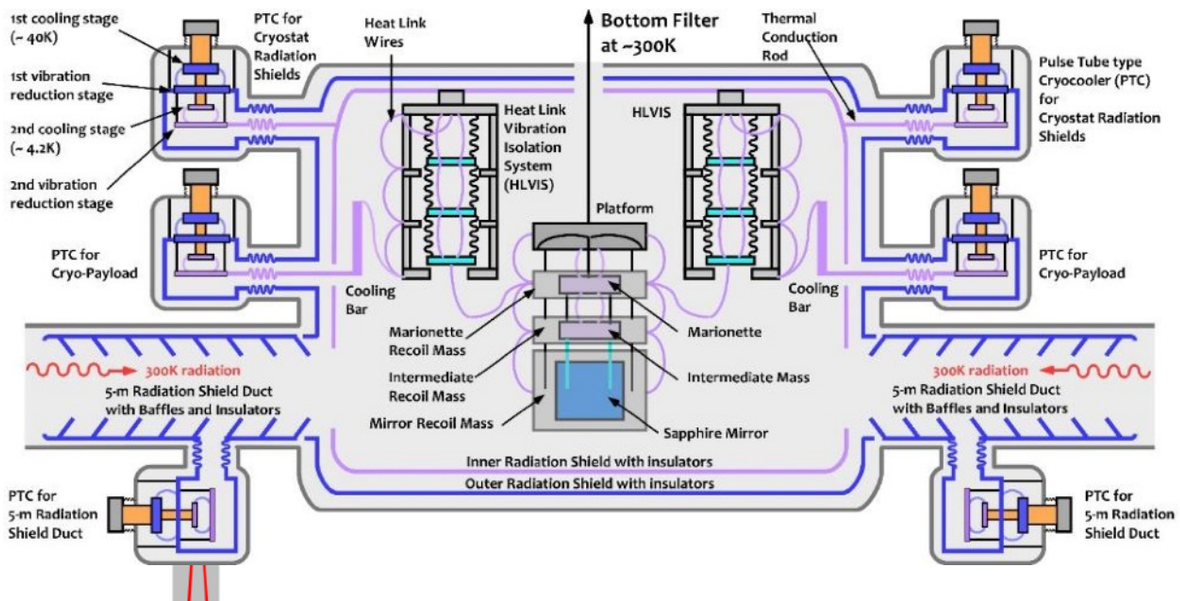


Status of KAGRA



- See detail in J.Yokoyama-san's slide in LVK meeting
  - https://gwdoc.icrr.u-tokyo.ac.jp/cgi-bin/private/DocDB/ShowDocument?docid=14410
- Vacuum and pumping down
  - X end
    - Because both Xarm and TMSX area pumping down (~1e-6 Pa), we started the both duct and radiation shield cooling.
    - Temperature of test mass is about 83 K
      - Characterize the resonant frequency, TF, and so on
  - X front
    - Only duct shield cooling (~250 K)
    - ADC glitch noise, oplev glitch noise investigation
  - Y end
    - No cooling, investigation of the TMSY pumping down
  - Y front
    - Only duct shield cooling (~250 K)





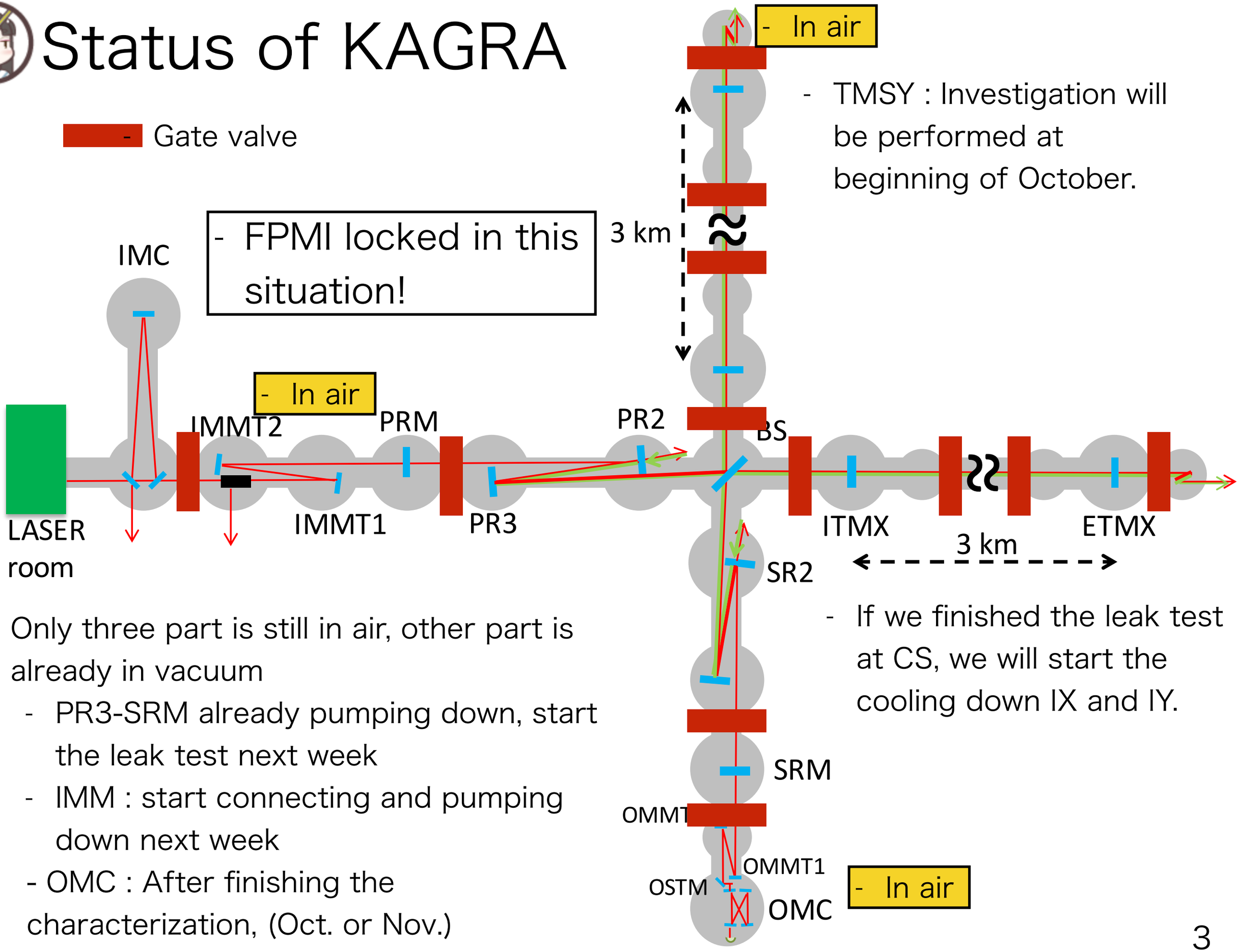
Status of KAGRA

- Gate valve

- FPMI locked in this situation!

- In air

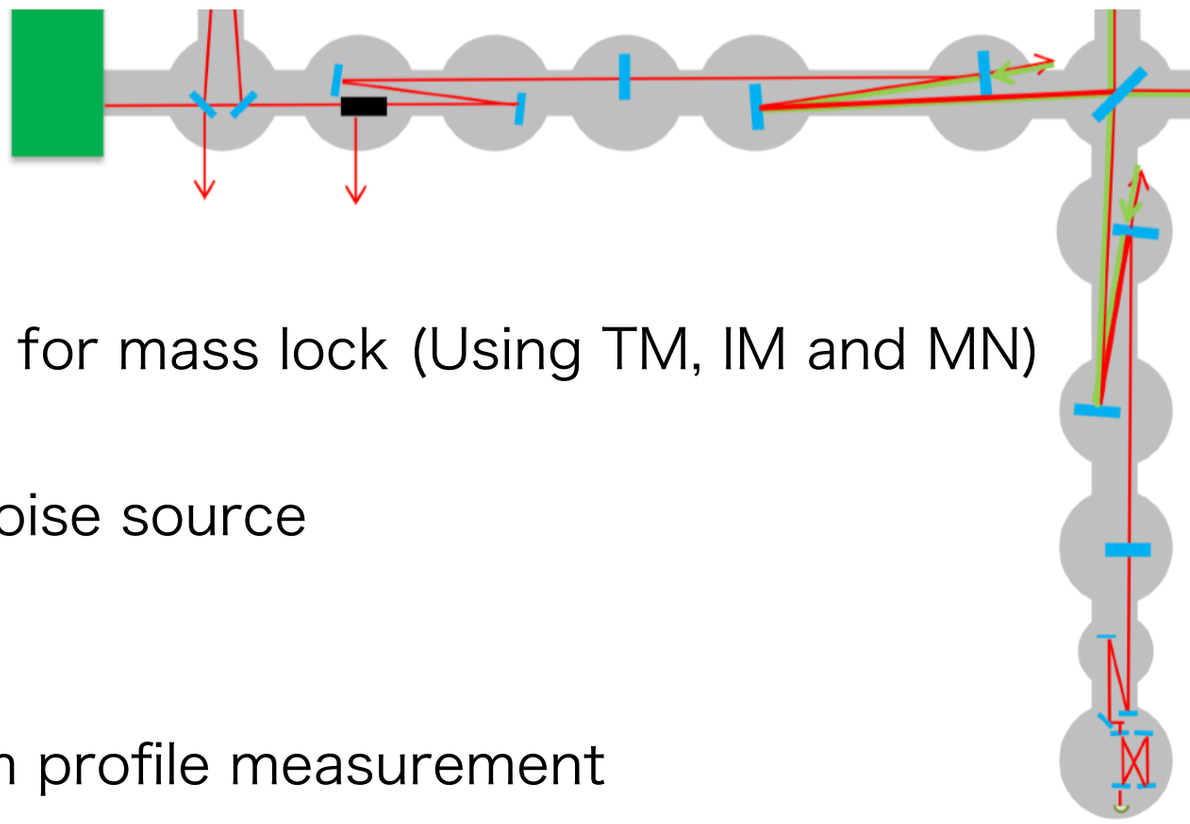
- TMSY : Investigation will be performed at beginning of October.



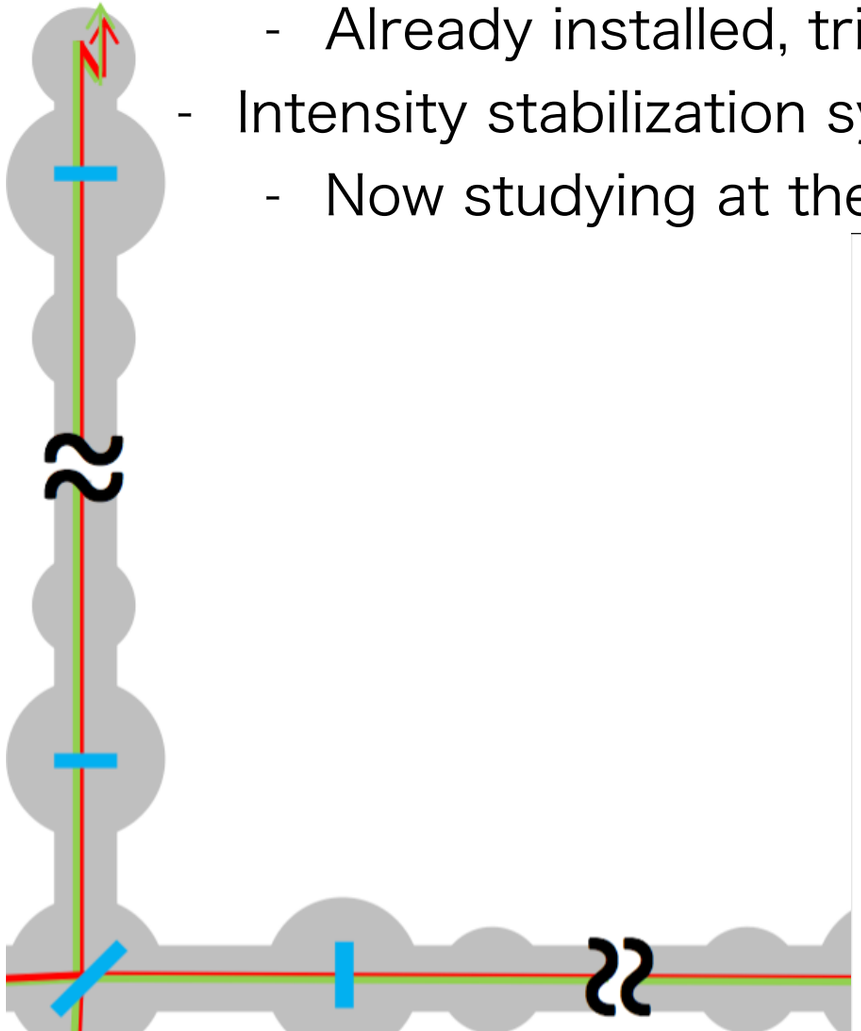
- Only three part is still in air, other part is already in vacuum
  - PR3-SRM already pumping down, start the leak test next week
  - IMM : start connecting and pumping down next week
  - OMC : After finishing the characterization, (Oct. or Nov.)

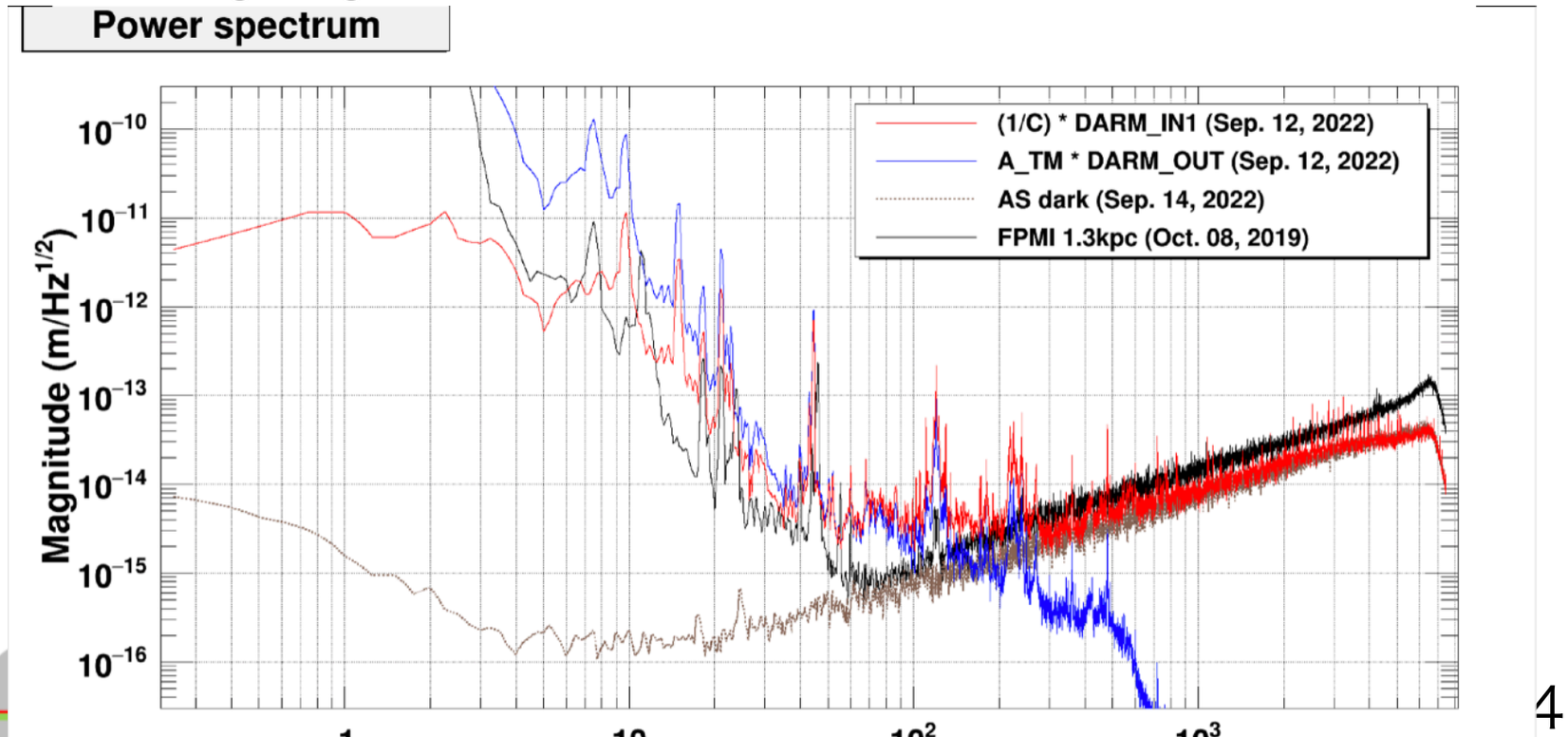
- If we finished the leak test at CS, we will start the cooling down IX and IY.

Status of KAGRA



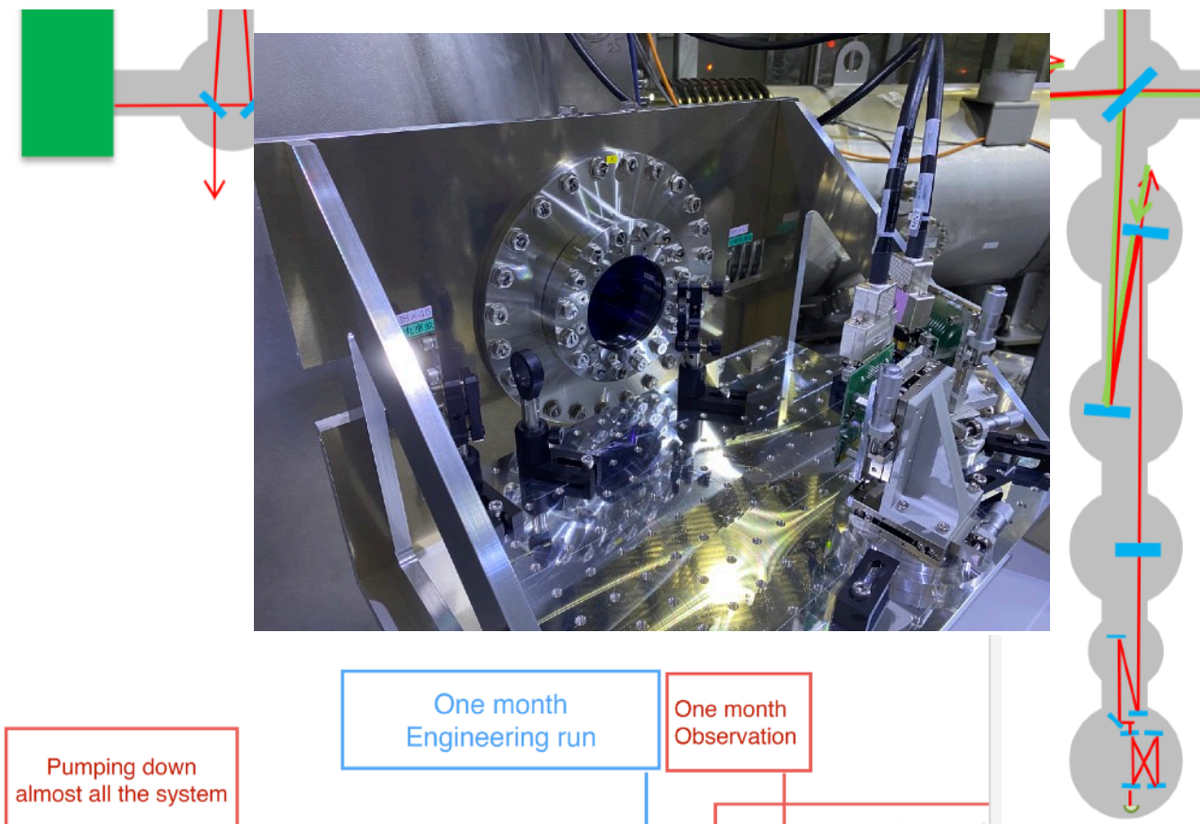
- FPMI lock succeeded
  - ALS DARM lock with appropriate filter for mass lock (Using TM, IM and MN)
  - Hand over from green to IR stable
  - We will start the investigation of the noise source
  - And we will start the PRFPMI lock trial
- OMC
  - Fixing the PD, power budget and beam profile measurement
- New high power laser
  - Already installed, trial to take over from old laser source
- Intensity stabilization system
  - Now studying at the site ongoing

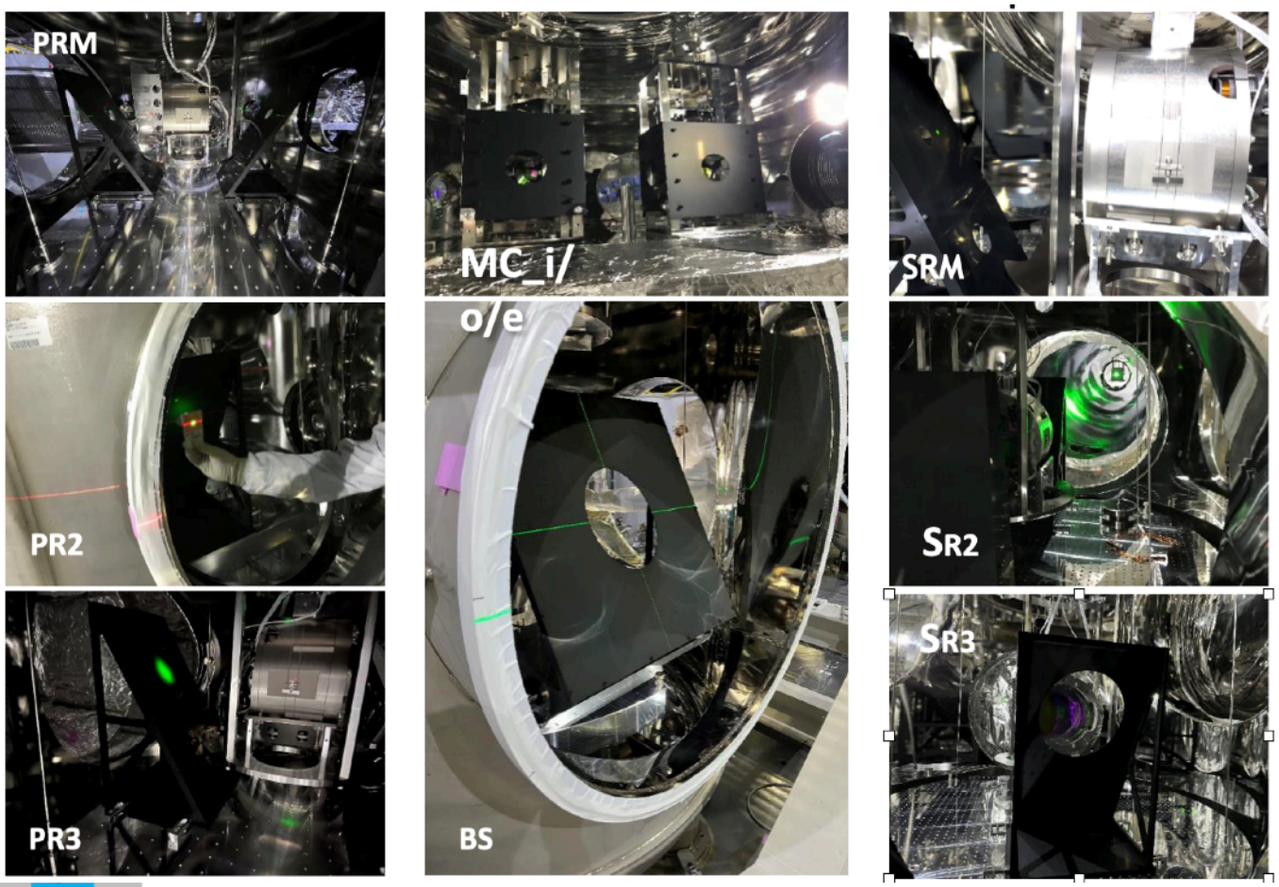


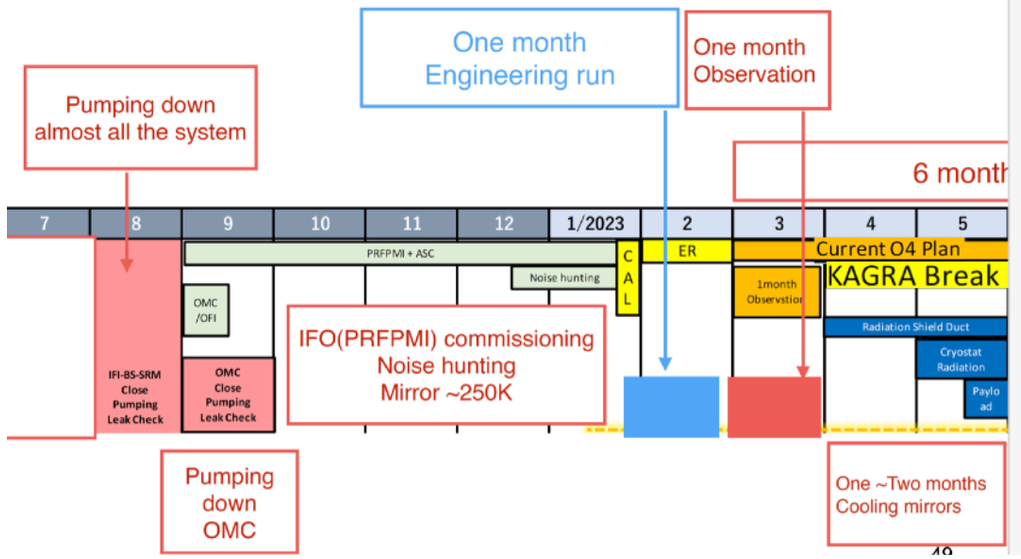


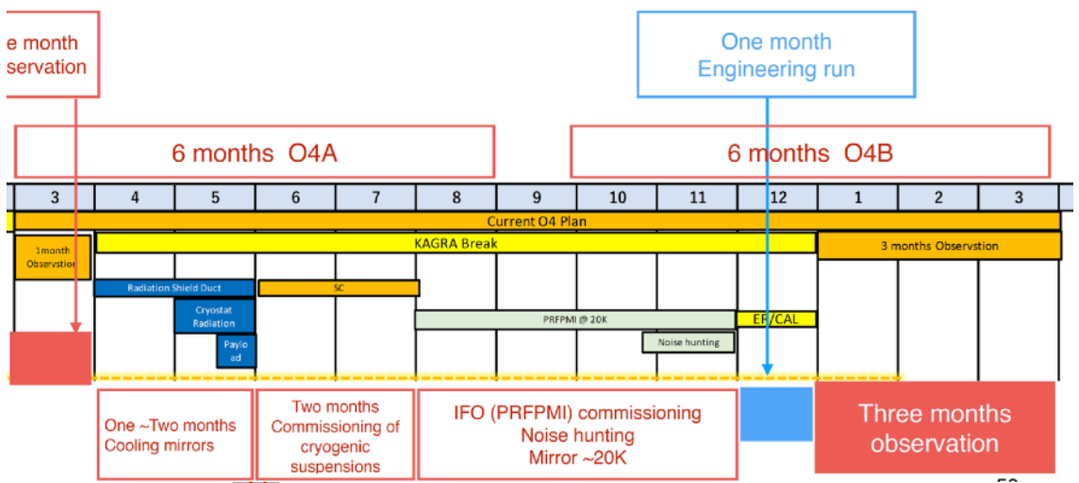
Status of KAGRA

- All planned mid-size baffles were installed
- All planned new optical lever were installed
- SRM mirror replaced to 0% reflection one
  - No RSE but improved the shot noise









Status of KAGRA PEM

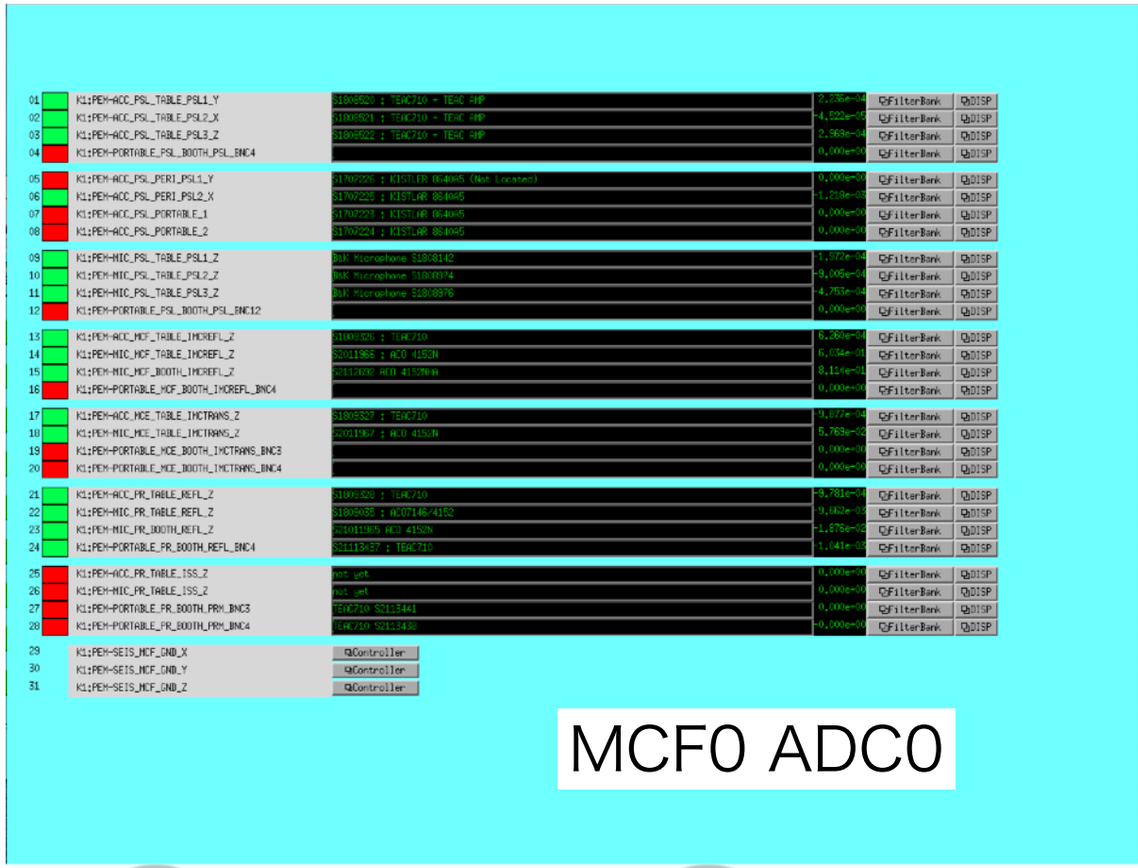
The 29th KAGRA F2F meeting in hybrid style

2022/08/01Session 04 SEO(1)

Takaaki Yokozawa (ICRR)

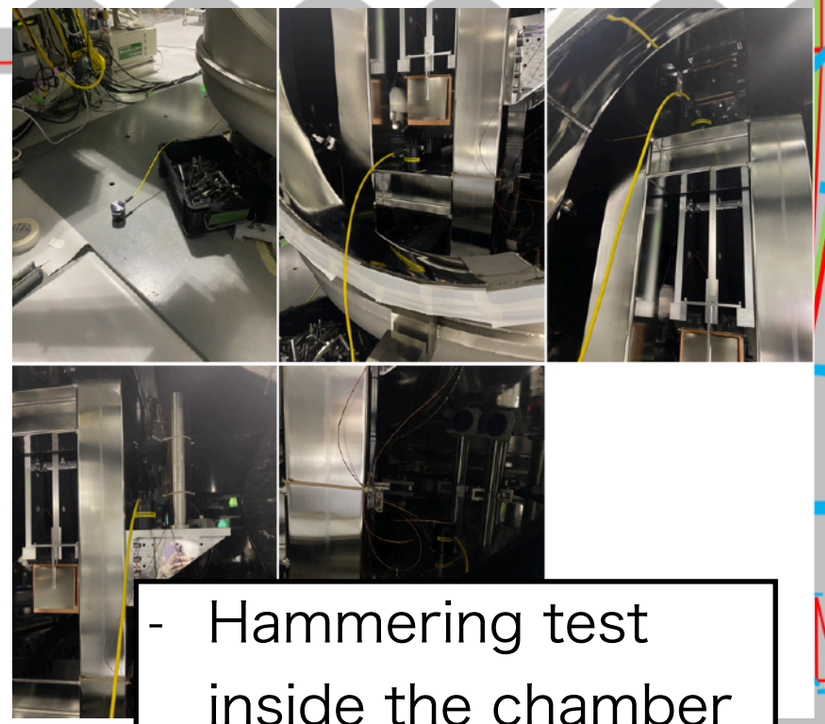
Install the PEM toward O4

- Toward the O4, several PEMs are re-installed (including re-cabling)
  - AMP Boxes for portable PEM
  - New medm screen
  - PEM Map for O4 (preparing)
- Need the help to evaluate the sensor ex. for Rapid Response Team

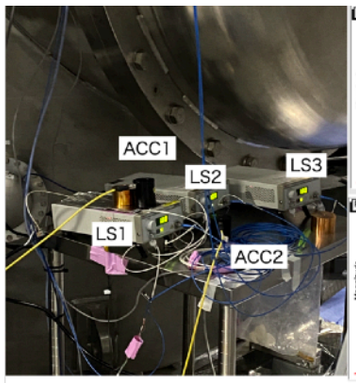


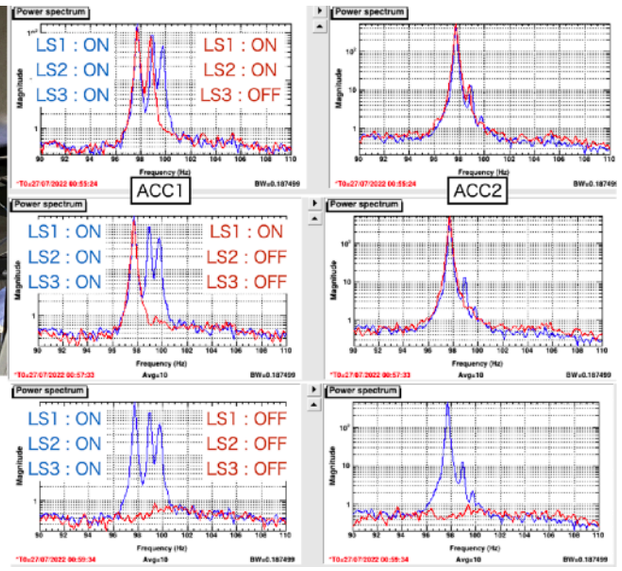
Portable PEM work

- Many environmental evaluation work were done
  - Easy setting the portable PEMs (ACC, MIC, …)
  - Checking the vibration from the grooving work
    - Judge this work is safe to interferometer or not
  - Eigen frequency check before closing the chamber
    - Photon calibration, Yagura, optical table, …

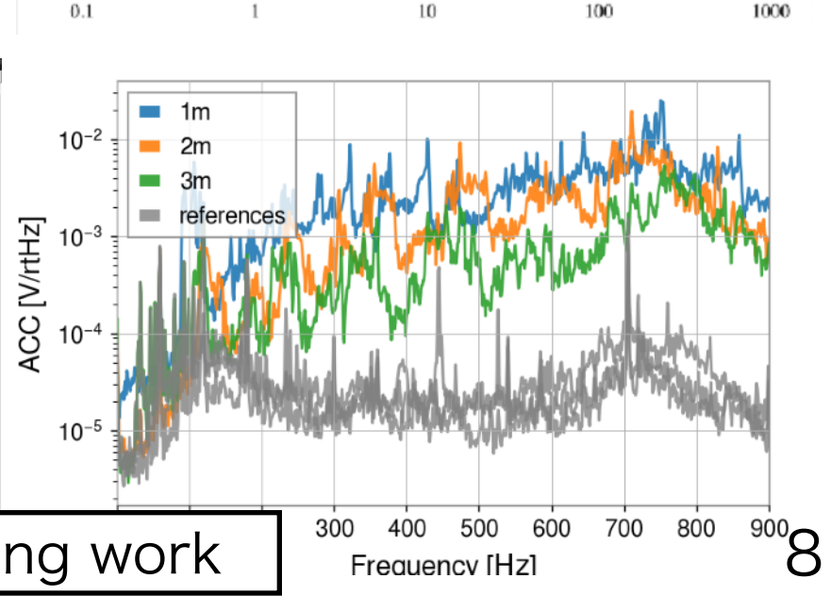


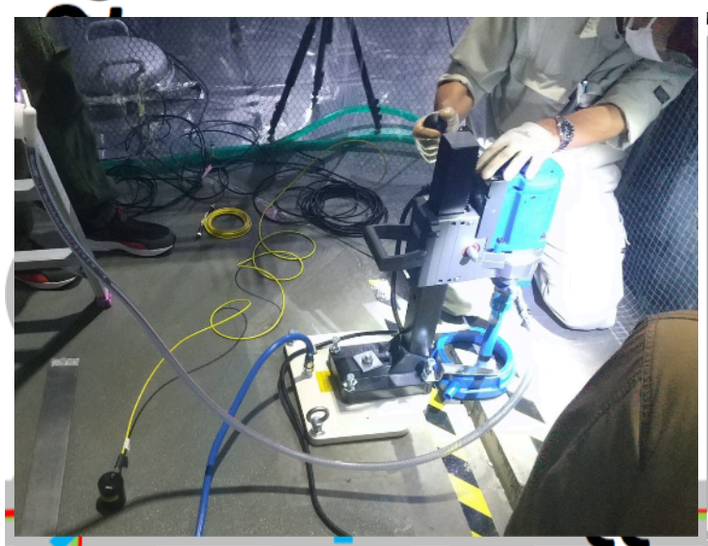
- Hammering test inside the chamber

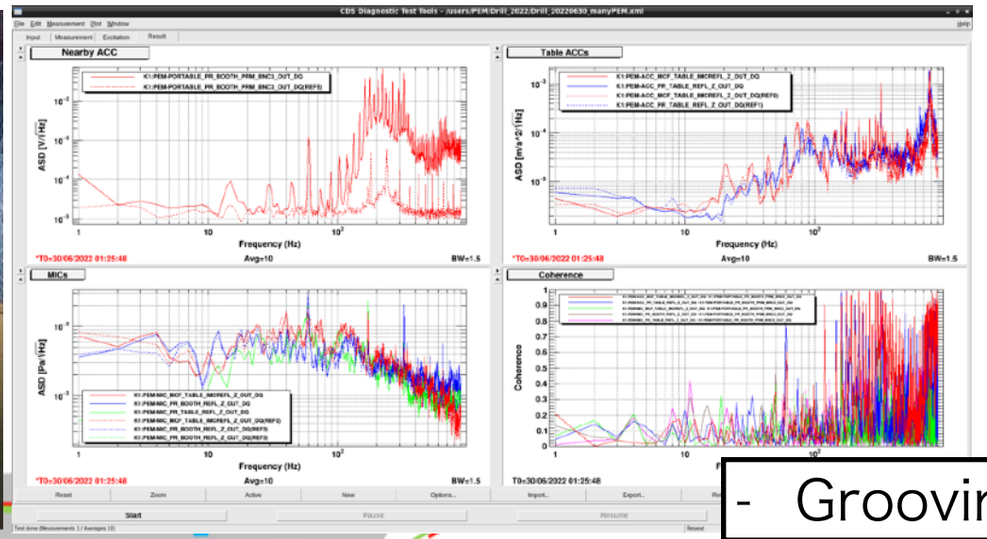




- Oplev glitch investigation



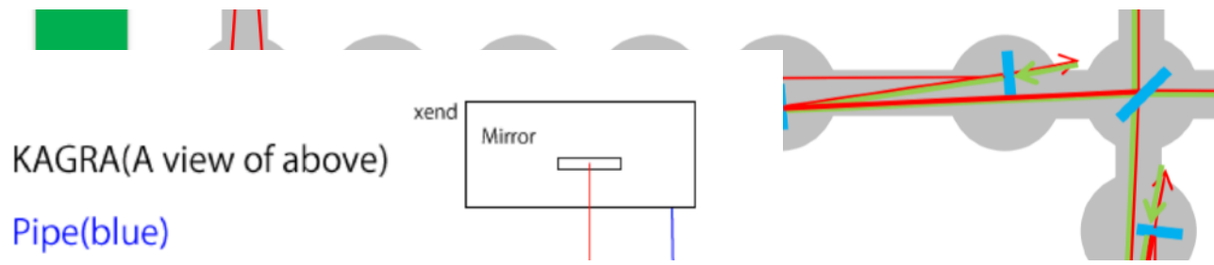


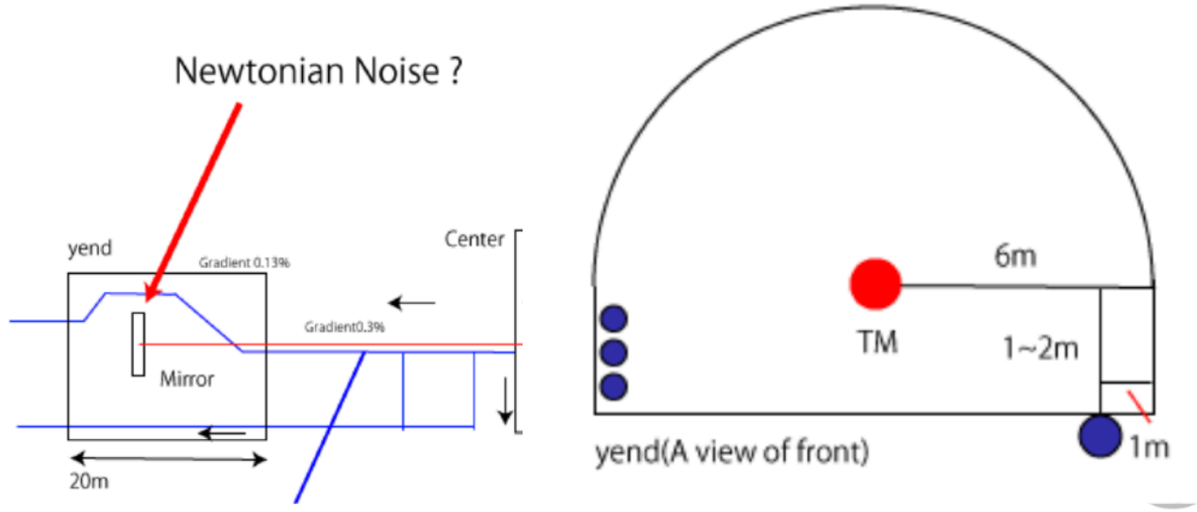


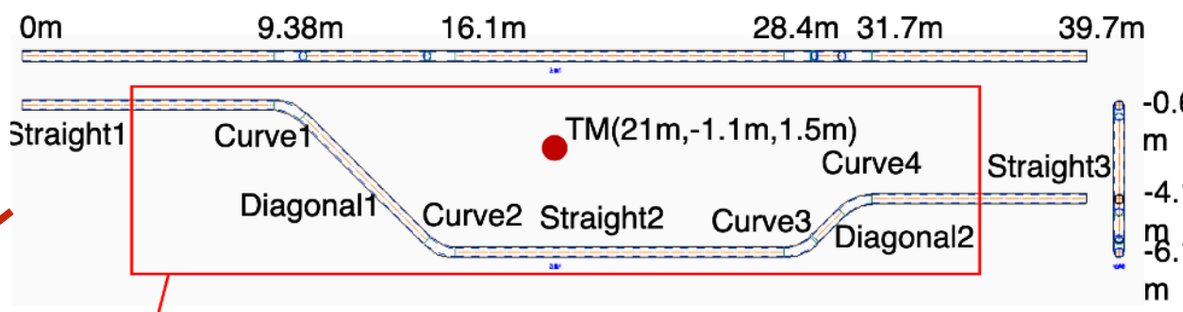
- Grooving work

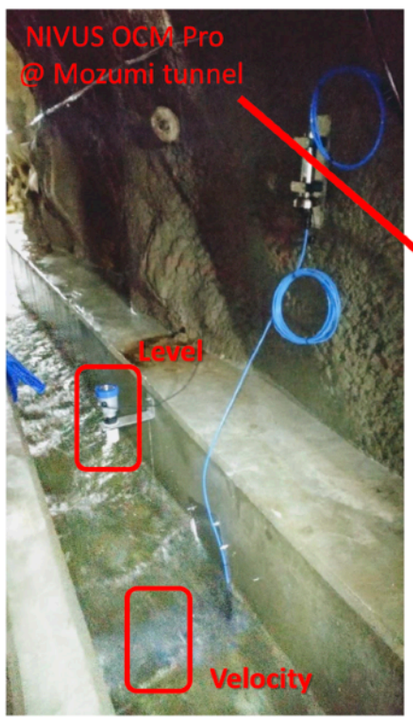
Water fluid and NN noise

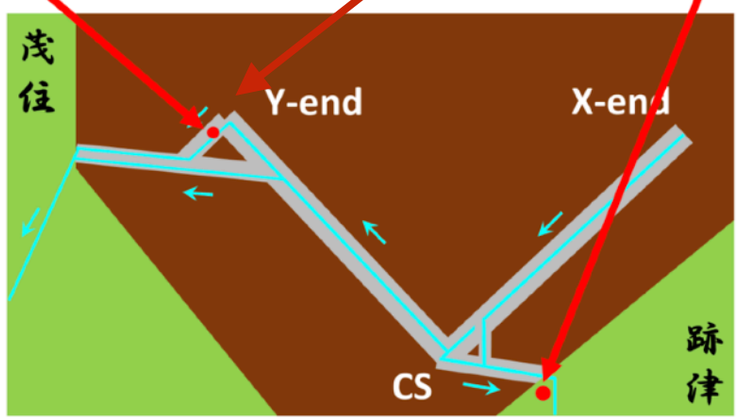
- Water fluid monitor at the Yend
  - Checked the relationship between weather station and water fluid
  - One of the important topic to understand the underground waters
- Newtonian noise evaluation from water
  - Now simulation is ongoing
    - More realistic water path
- T. Suzuki(TITECH) future

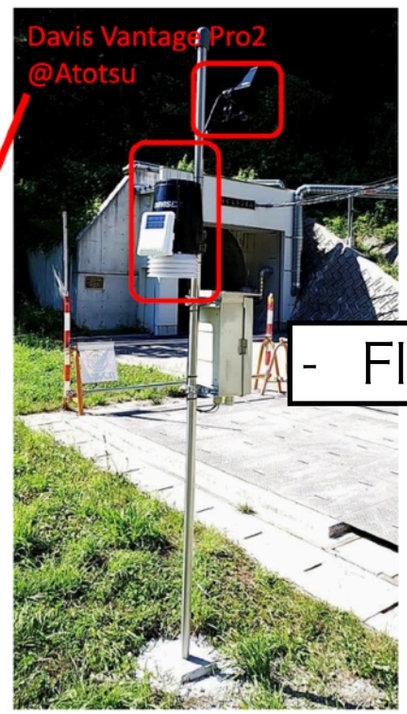




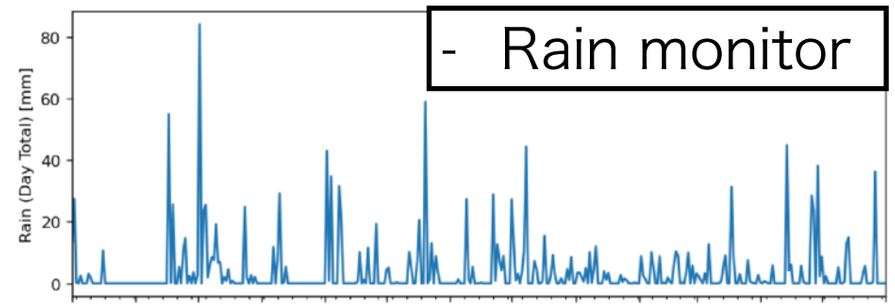




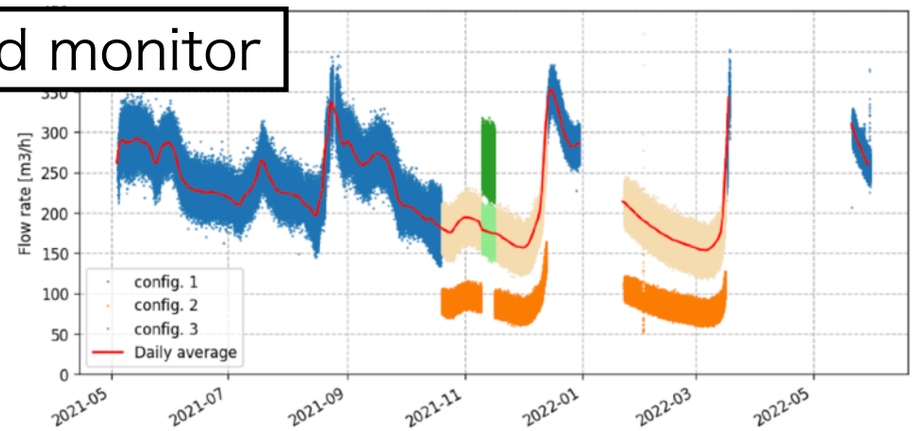




- Rain monitor

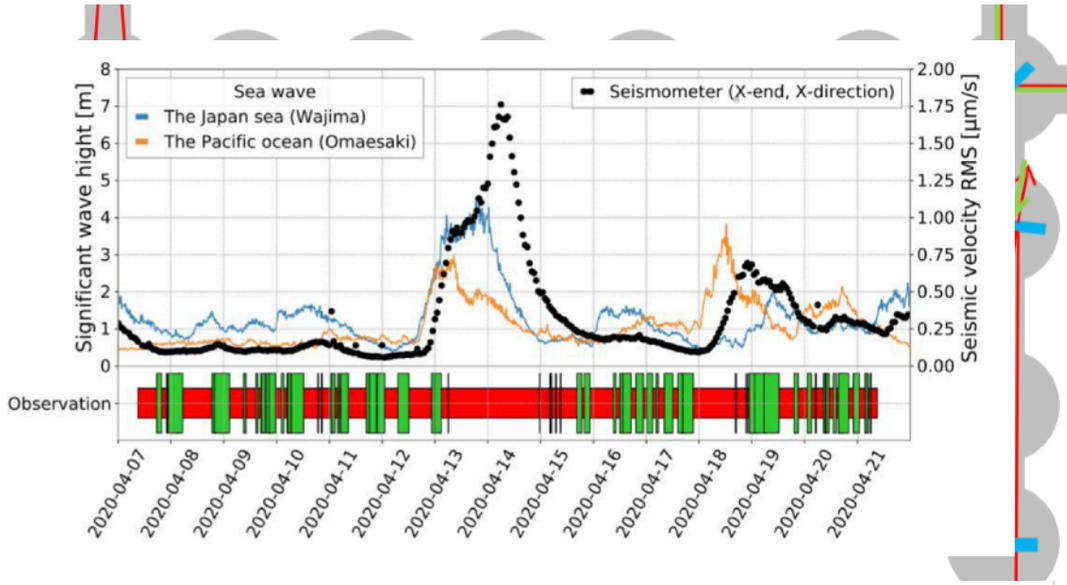


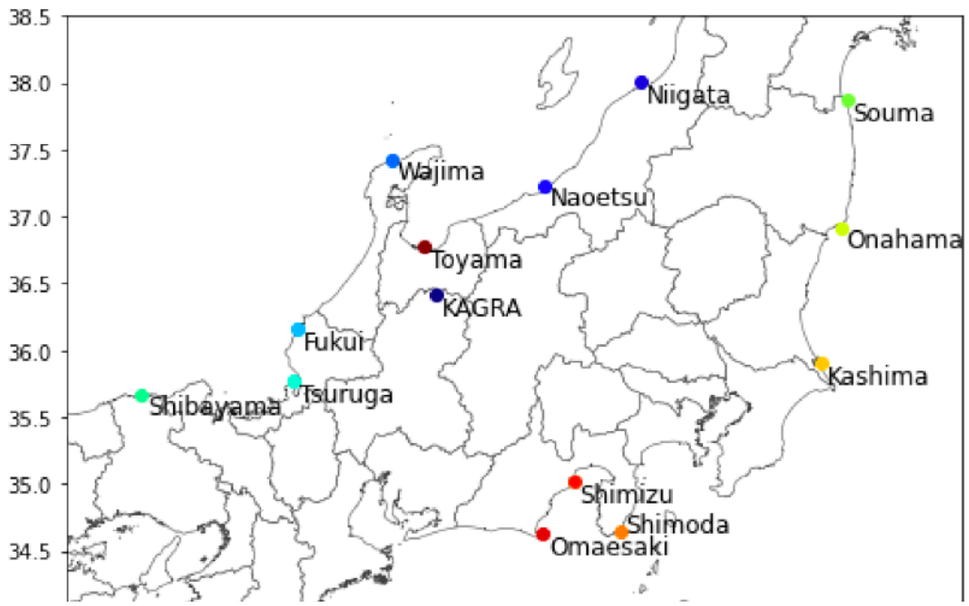
- Fluid monitor

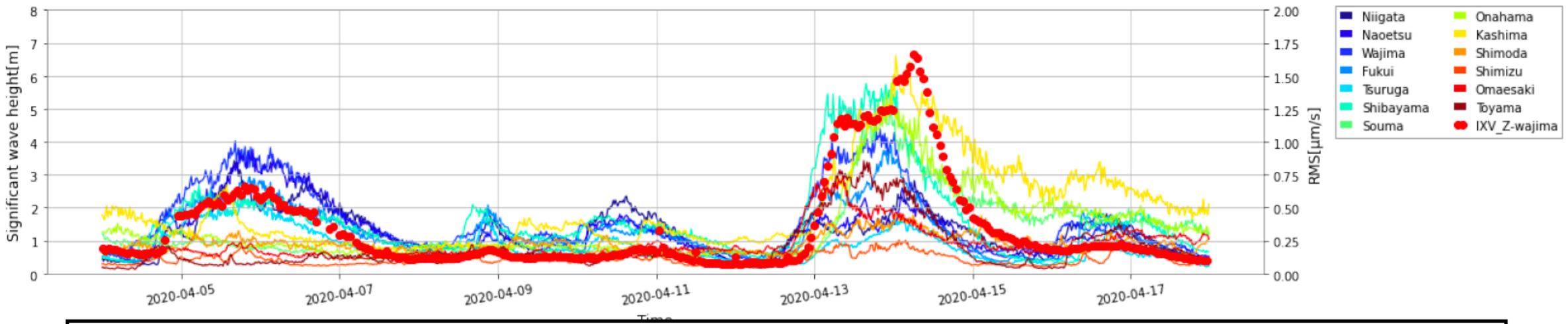


Microseismic analysis

- Microseismic from ocean wave affect to the interferometer
  - Dead time to bKAGRA phase1, O3GK
- Investigate the relationship between KAGRA seismometers and ocean wave
- Ocean wave data is obtained from NOWPHAS for each bays
- See detail in S.Hoshino poster (m05)
  - Seasonal ocean wave change
  - Correlation coefficient
  - Principal component analysis
  - Multiple regression analysis

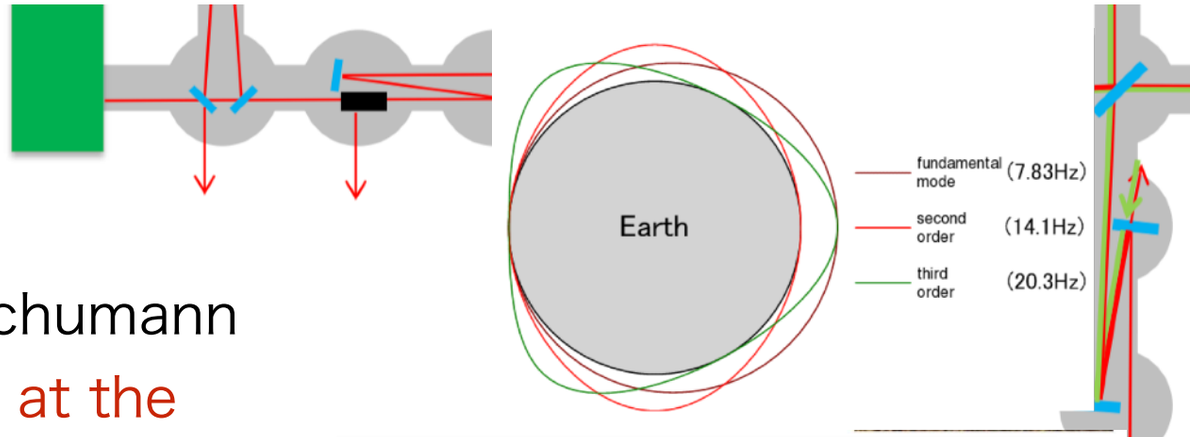




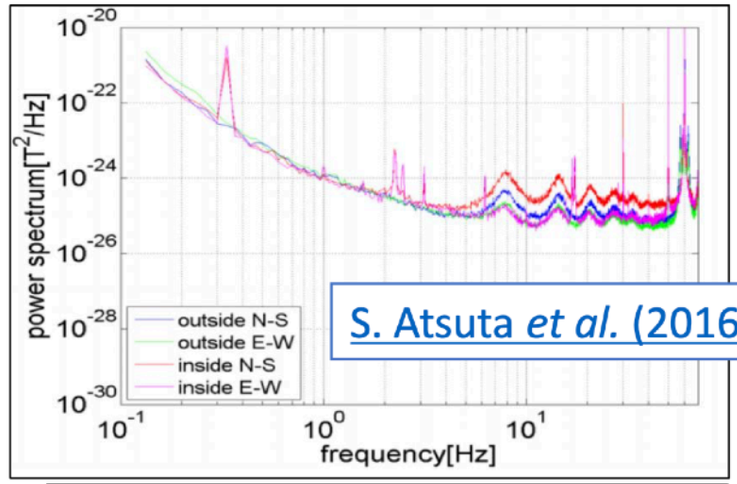


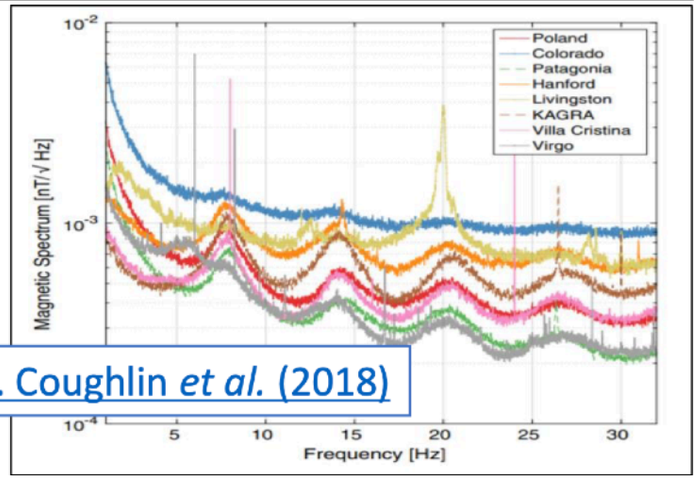
- Time series of the KAGRA seismometer(red) and ocean wave data(Color)

KAGRA Schumann resonance

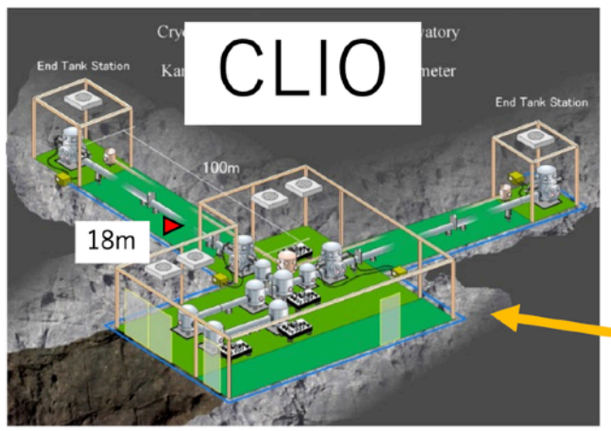


- From the previous study, the amplitude of Schumann resonance at the underground is larger than at the surface(Typically, 1 pT)
- Beginning of July(7/3-7/9), we measured the magnetic field, focusing near the beam duct
  - Y-30m, X-1500m, X-2440m, CLIO Yarm, …
- See detail in I.Fukunaga poster (m03)
  - New portable magnetometer system
  - Distance from beam duct
  - Direction of magnetic field

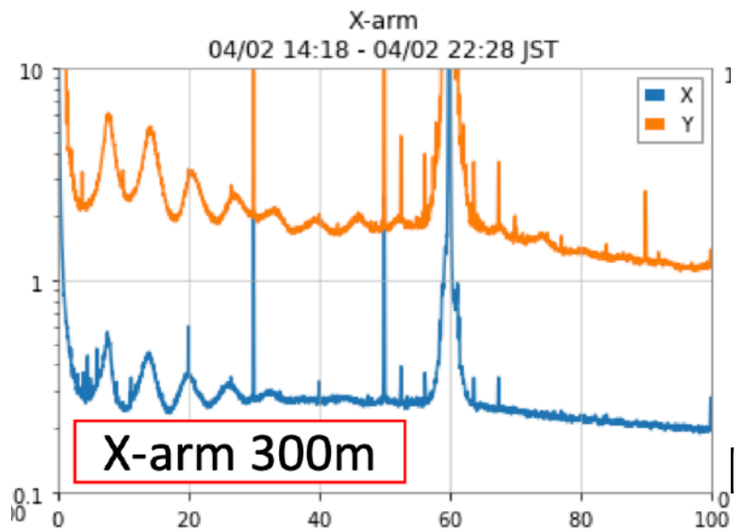




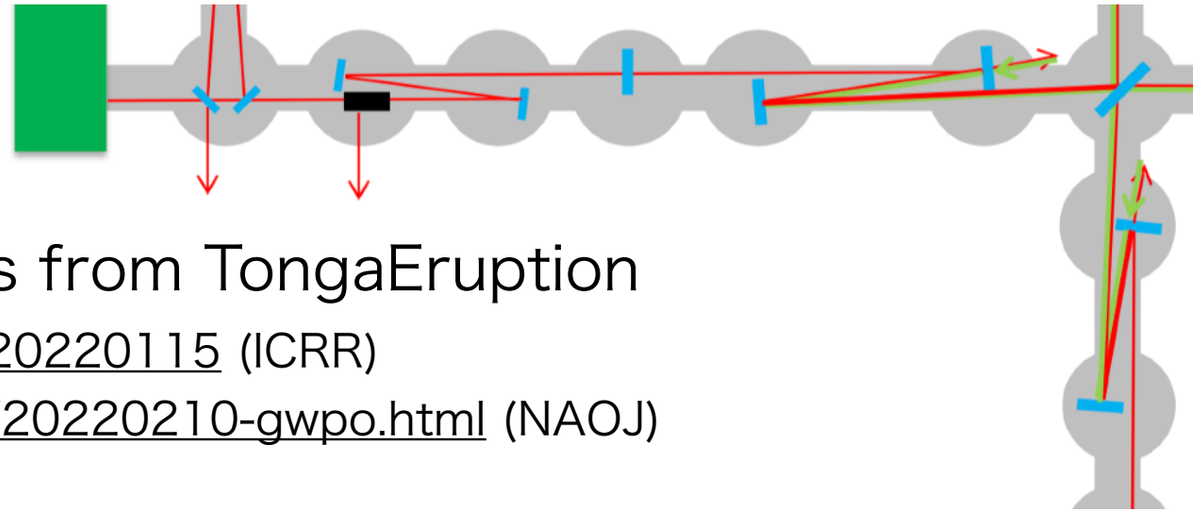
Measurement Location



Location
PEM area
Yarm(30m)
CLIO Yarm (18 m)
KAGRA Front room
Xarm(1500 m)
Xarm(2440 m)

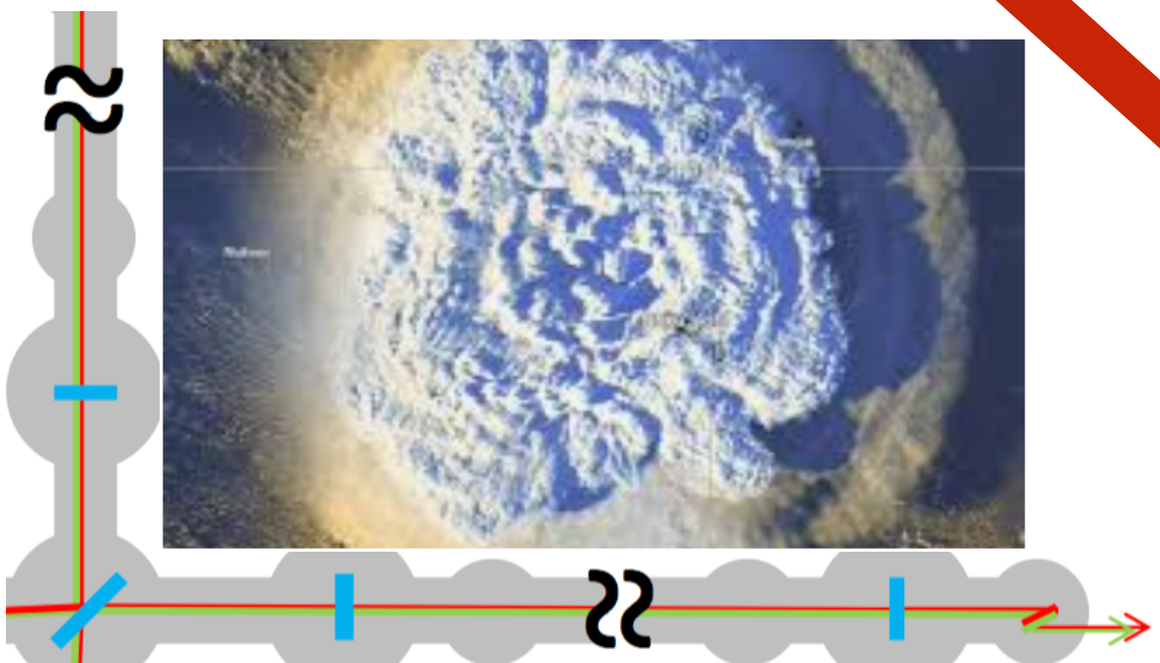


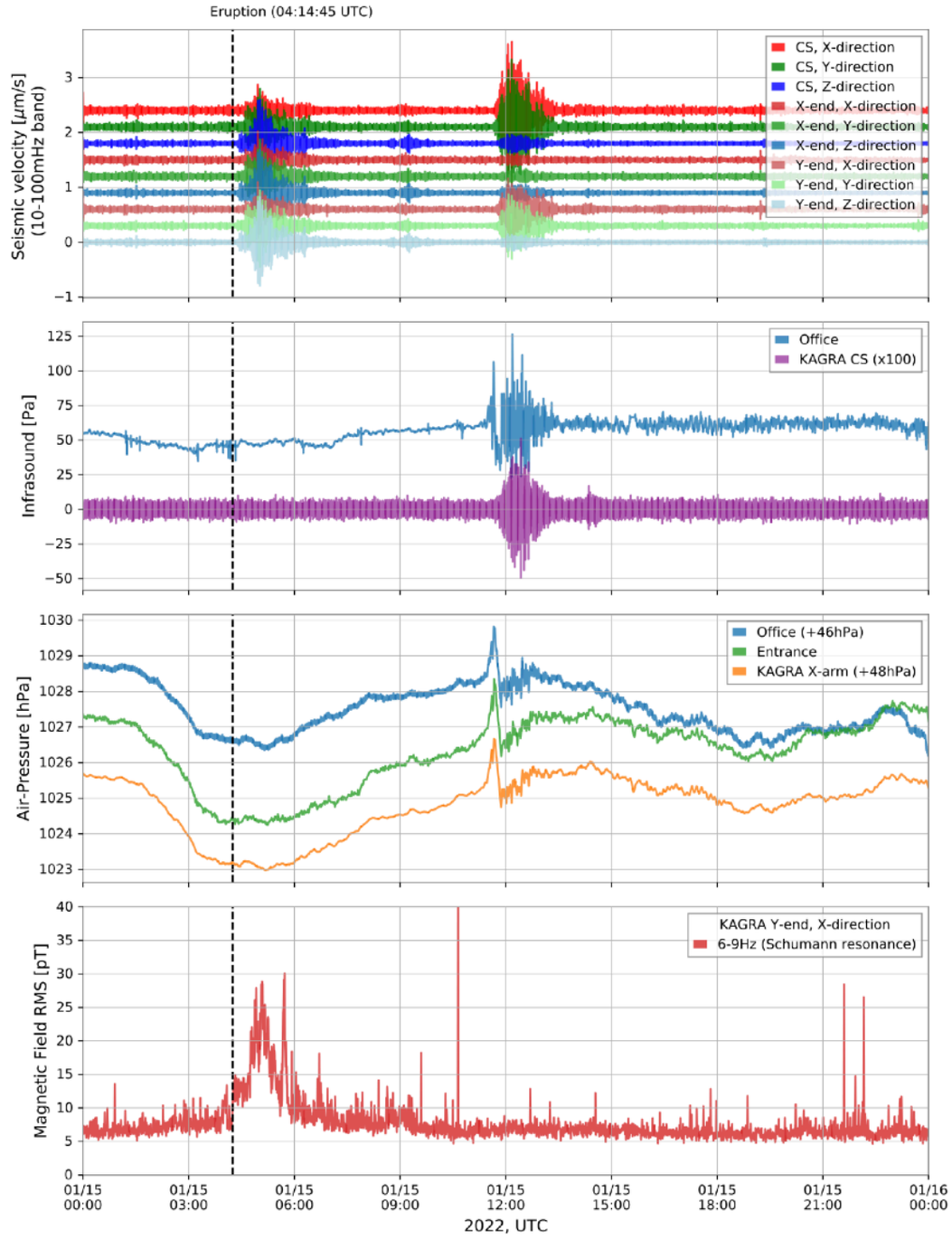
Signals from Tonga Eruption



- KAGRA PEM detected several signals from TongaEruption
  - https://gwcenter.icrr.u-tokyo.ac.jp/en/tonga-20220115 (ICRR)
  - https://www.nao.ac.jp/en/news/topics/2022/20220210-gwpo.html (NAOJ)

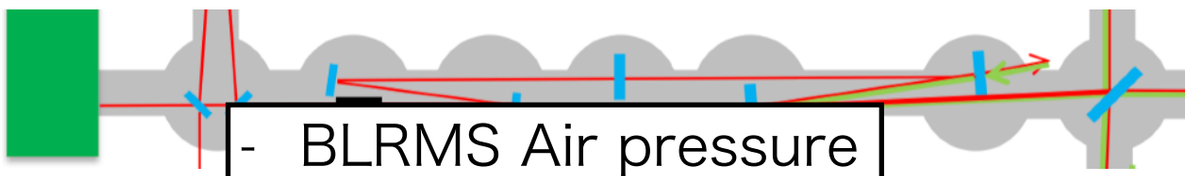
- Submitted to PTEP
  - https://arxiv.org/abs/2206.14396
- Seismometers
  - Ground motion (p,s)
  - Air pressure wave
- Infrasound sensors, barometers
  - Air pressure wave
- Magnetometer
  - Increasing the amplitude from Schumann resonance



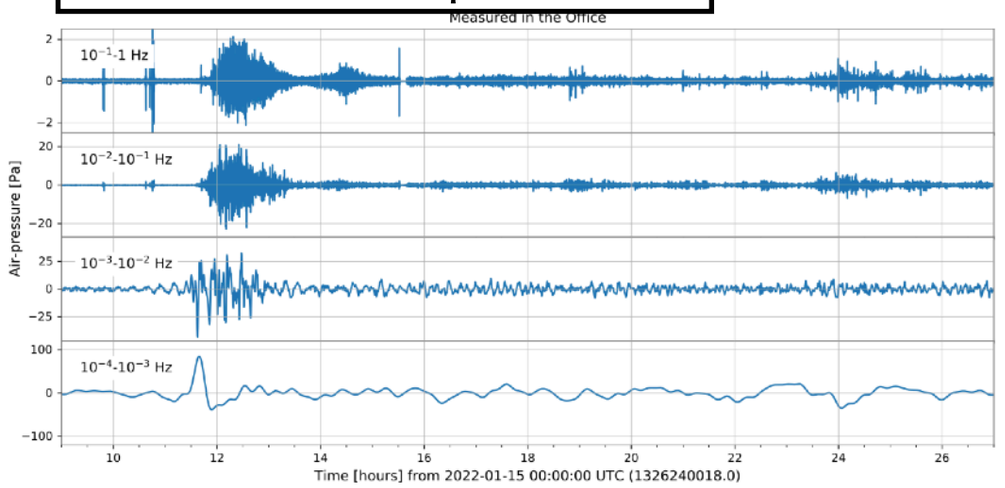


Signals from Tonga Eruption

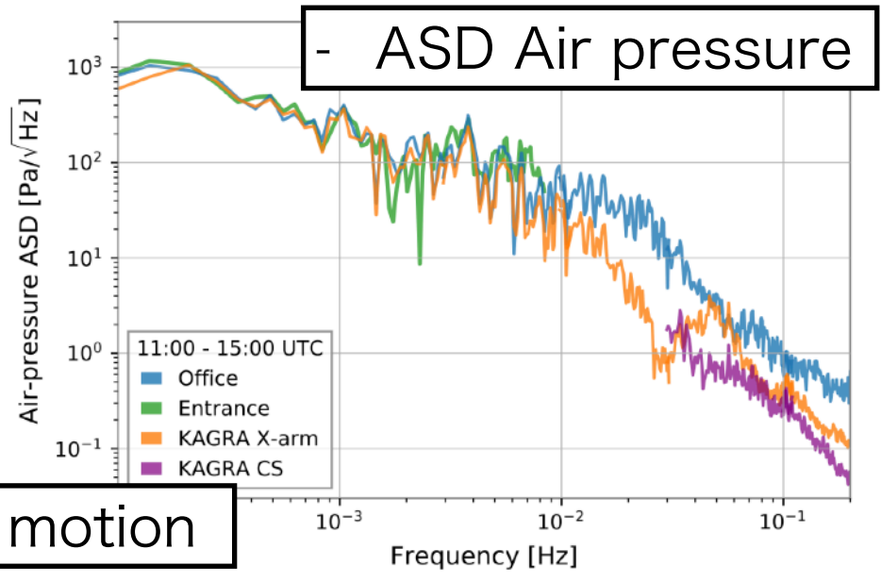
- The detail in JGW14072
  - KAGRA Internal seminar
- Band limited RMS (seismic motion, magnetic field)
- Spectrum analysis
  - With evaluating the sensor noise, calibration
- Transfer function measurement
  - Outside(surface) to underground
  - Velocity of the air pressure wave
  - Center area to X arm
- From this event, we started the rich environment for the infrasound and the air pressure
- See also Takamori-san talk (next talk)

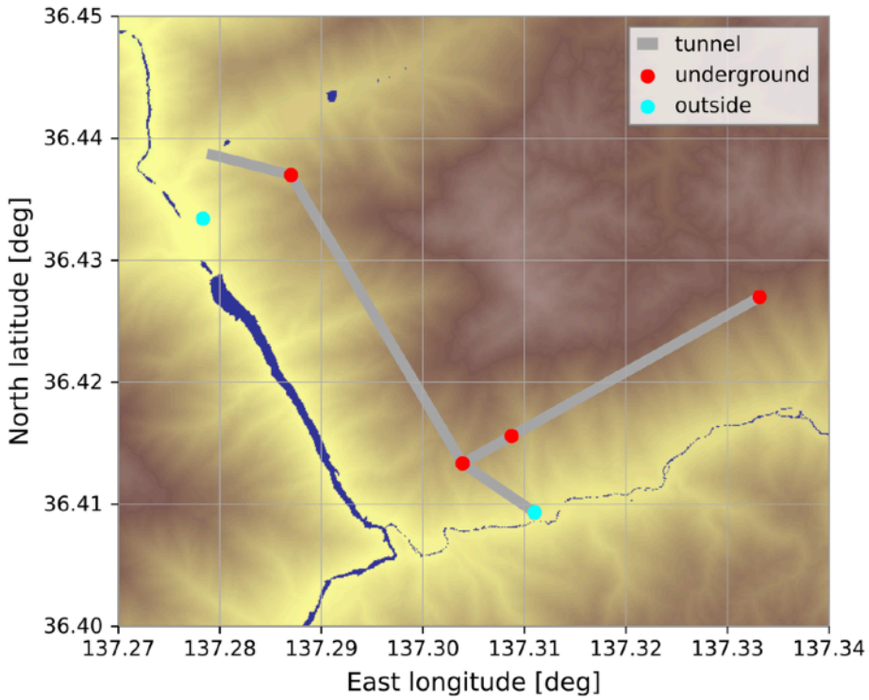


- BLRMS Air pressure

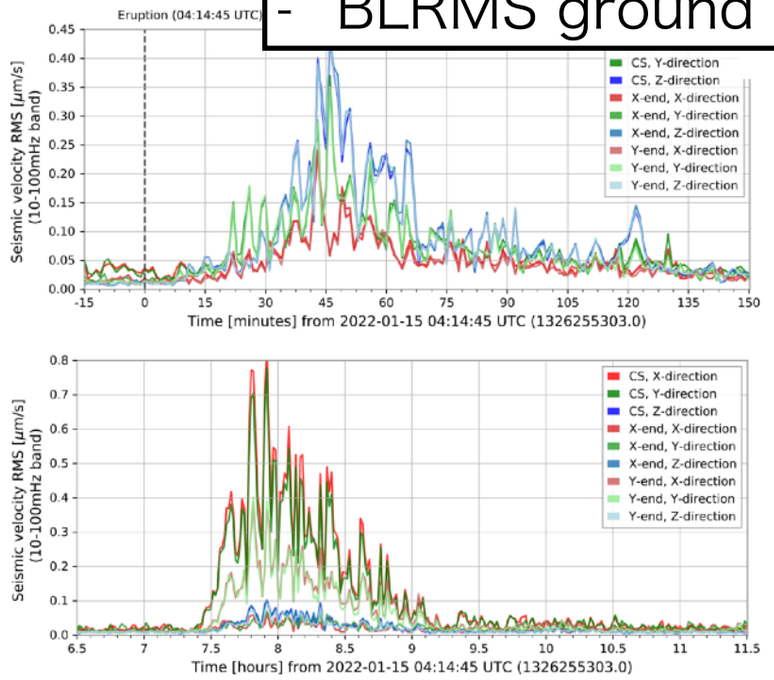


- ASD Air pressure

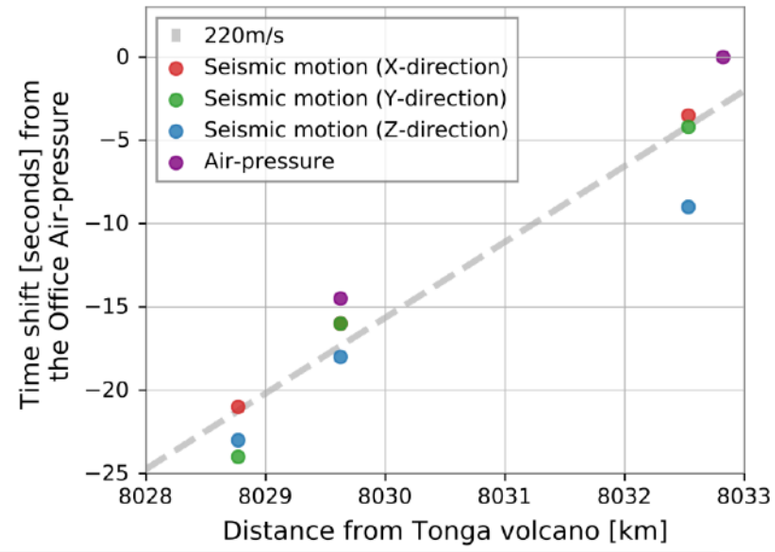




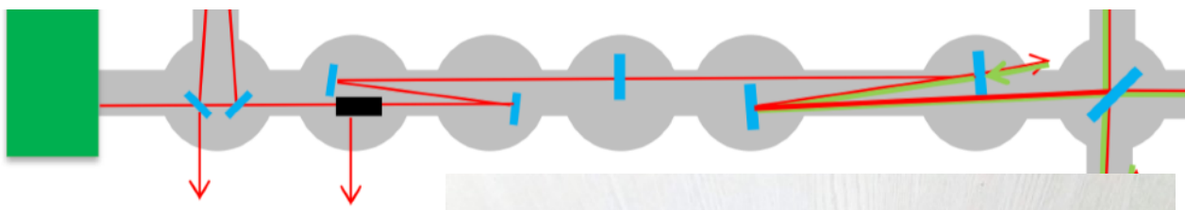
- BLRMS ground motion



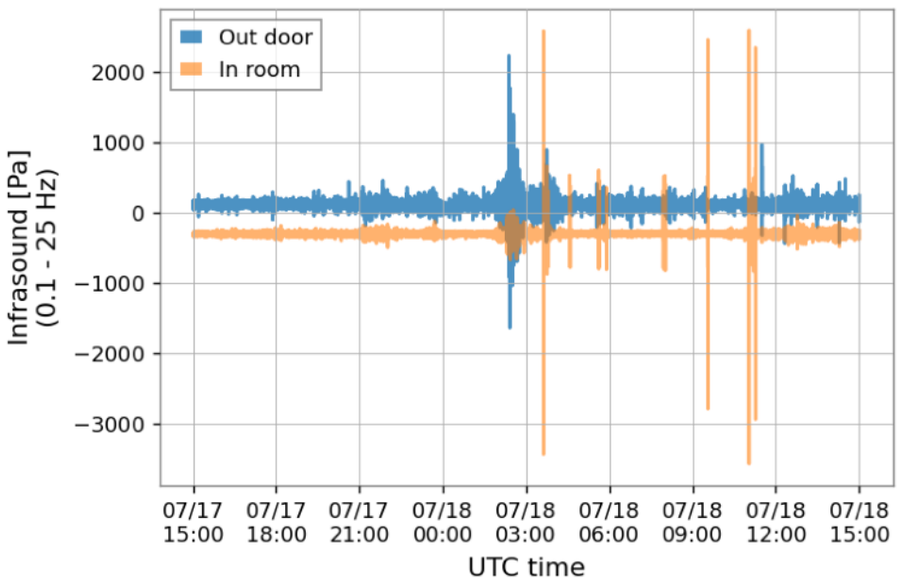
- Time shift Air pressure



Infrasound analysis

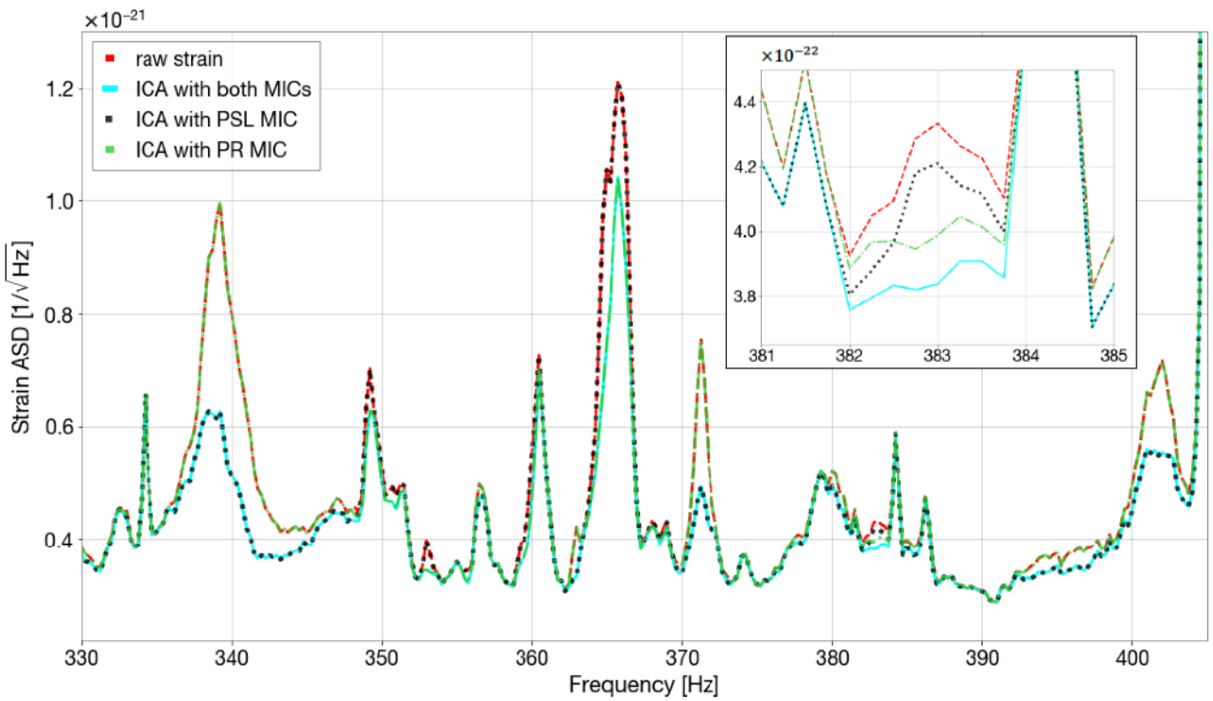


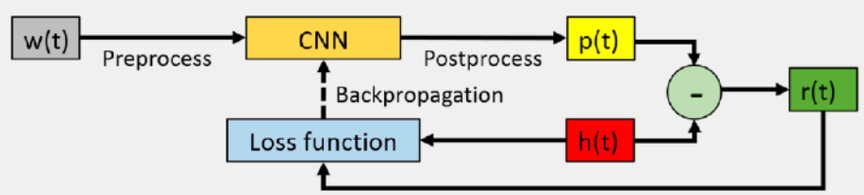
- Set the storeroom outside of the analysis building
  - Reducing the effect of the human activity
    - Talk, door open/close
  - We can detect the sound from dam
- Combination of the barometer and infrasound at the underground
  - We can cover wide frequency range for each area
- Discussion topic
  - Set the infrasound at Atotsu entrance, near the XYend
  - Data logging
  - With weather station and/or temperature monitor
  - Network KAGRA/Niigata/Toyama



Offline noise subtraction

- Independent Component Analysis (ICA)
  - Noise subtraction from KAGRA O3GK data using ICA
  - Already presented in previous F2F meeting
  - English correction and submitted to CQG (arXiv 2206.05785)
  - Non-linear noise subtraction study
- Denoising by DeepClean
  - Check the performance by software and hardware injection test
  - 60 Hz noise subtraction using O3GK data
  - See detail in Chia-Jui Chou in oral(Session 08 DAC)
  - See detail in Yi Yang in poster (Poster s05)



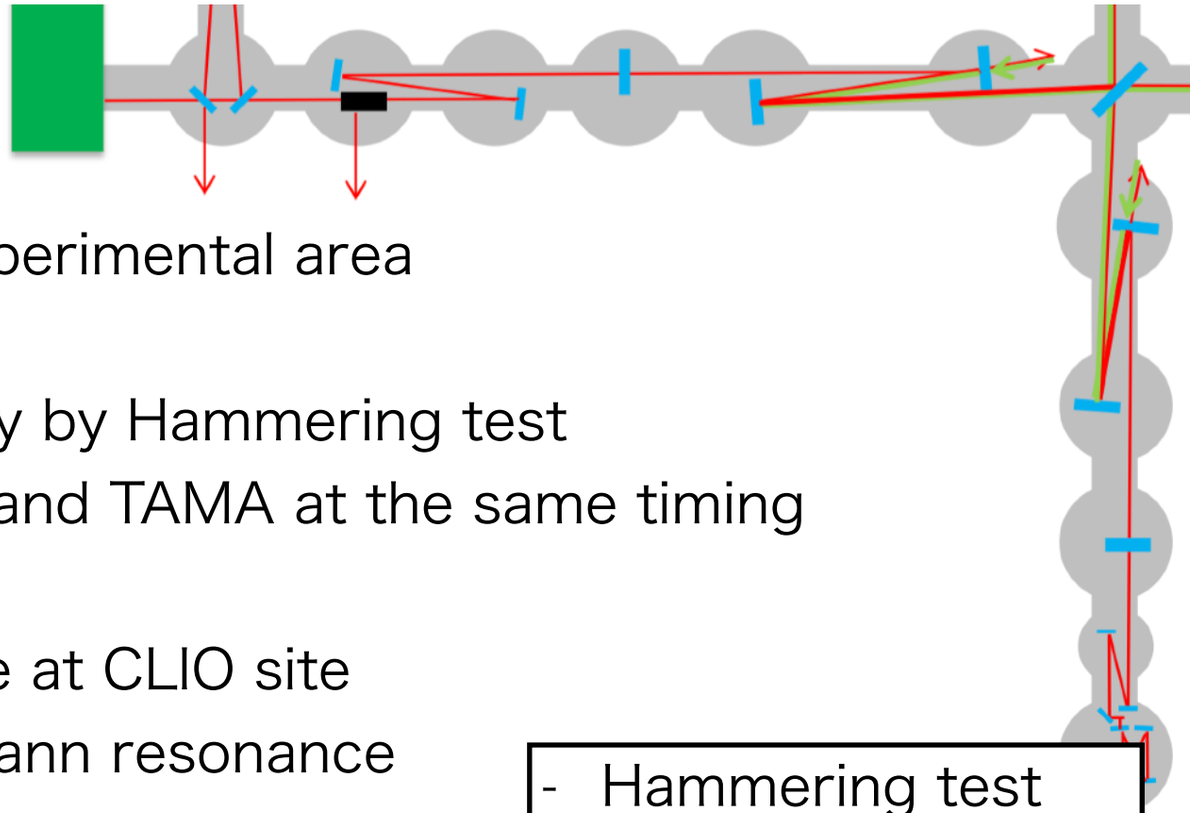


- w(t): witness channels
- p(t): predicted noise
- h(t): raw strain
- r(t): cleaned strain
- Loss function:
  $J = \omega J_{asd} + (1-\omega) J_{mse}$

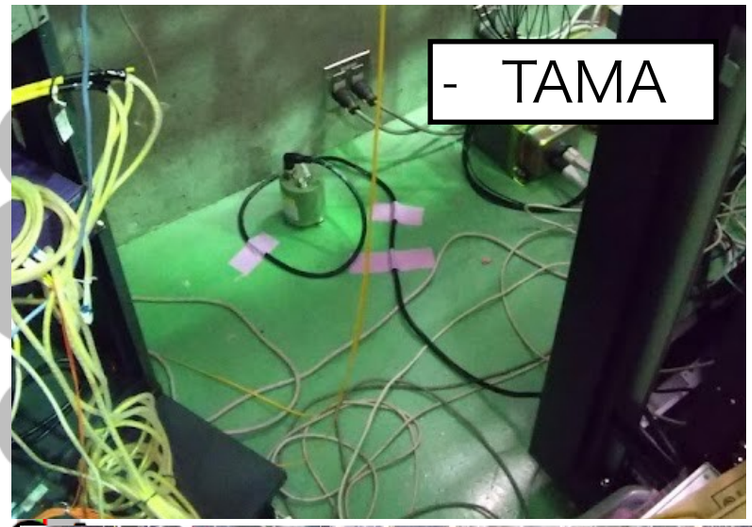
$$J_{asd} = \frac{1}{M}\sum_{i=0}^{M-1}\sqrt{\frac{S[r,r][i]}{S[h,h][i]}},$$

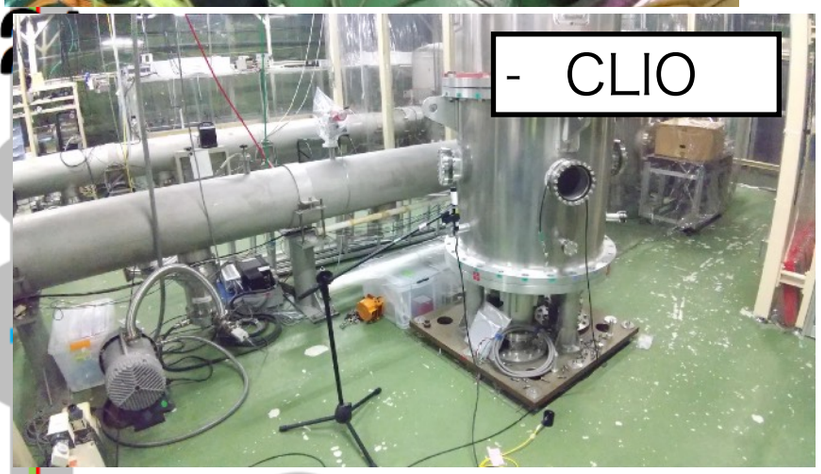
$$J_{mse} = \frac{1}{N}\sum_{i=0}^{N-1} r[i]^2,$$

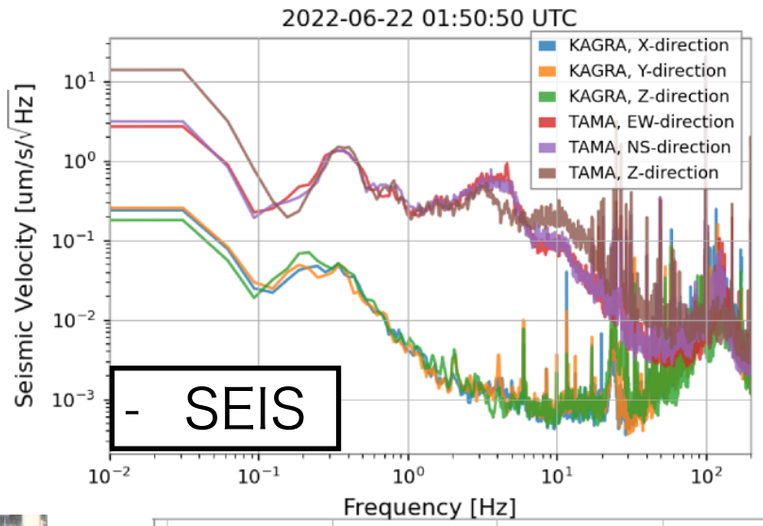
PEM work at TAMA and CLIO

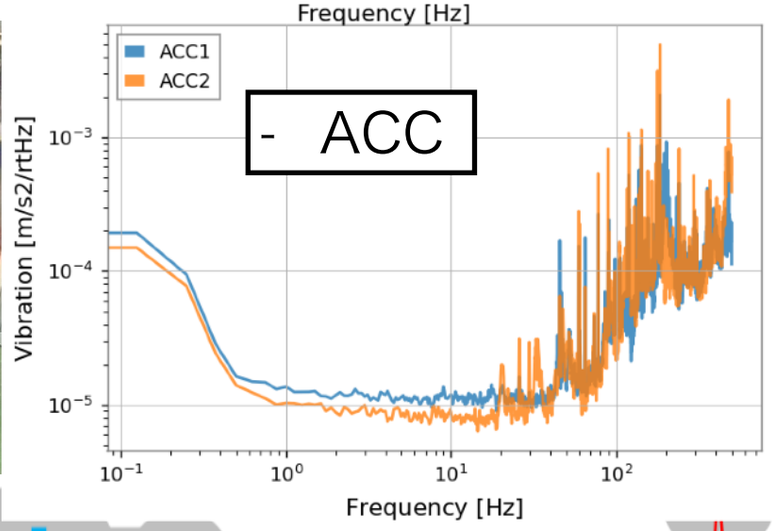


- PEM measurement outside of the KAGRA experimental area
  - TAMA
    - Search the 170 Hz noise in Filter Cavity by Hammering test
    - Seismic motion measurement KAGRA and TAMA at the same timing
  - CLIO
    - Set the accelerometer and microphone at CLIO site
      - During the measurement of Schumann resonance

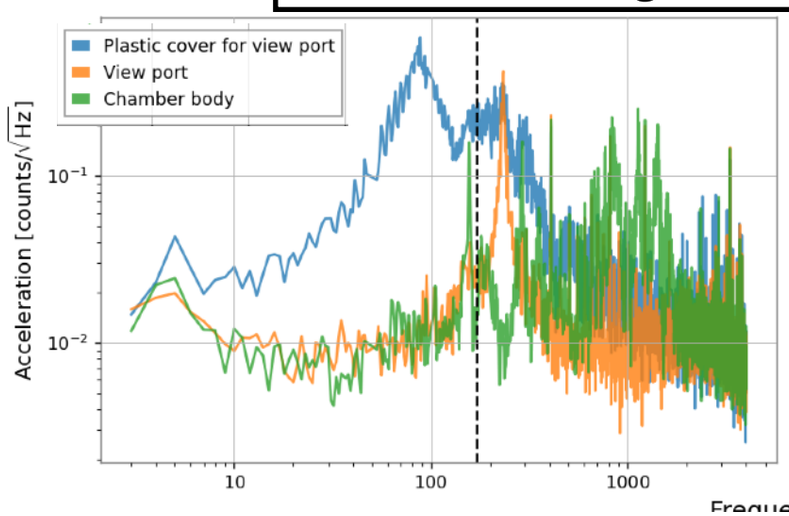


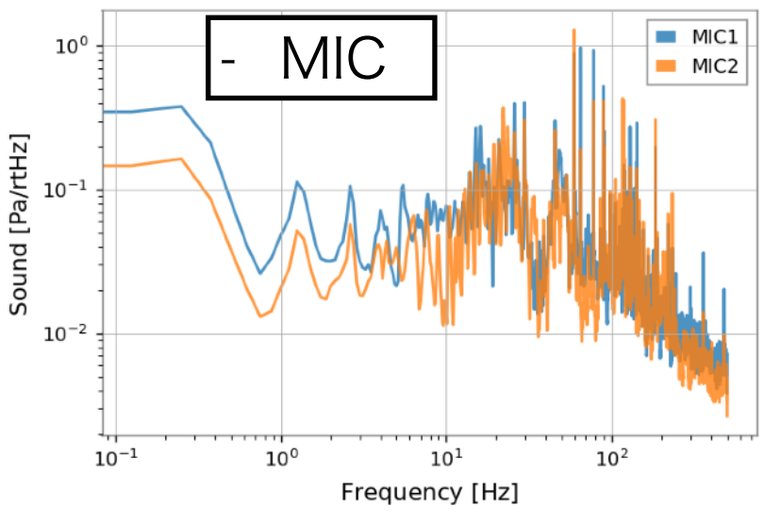




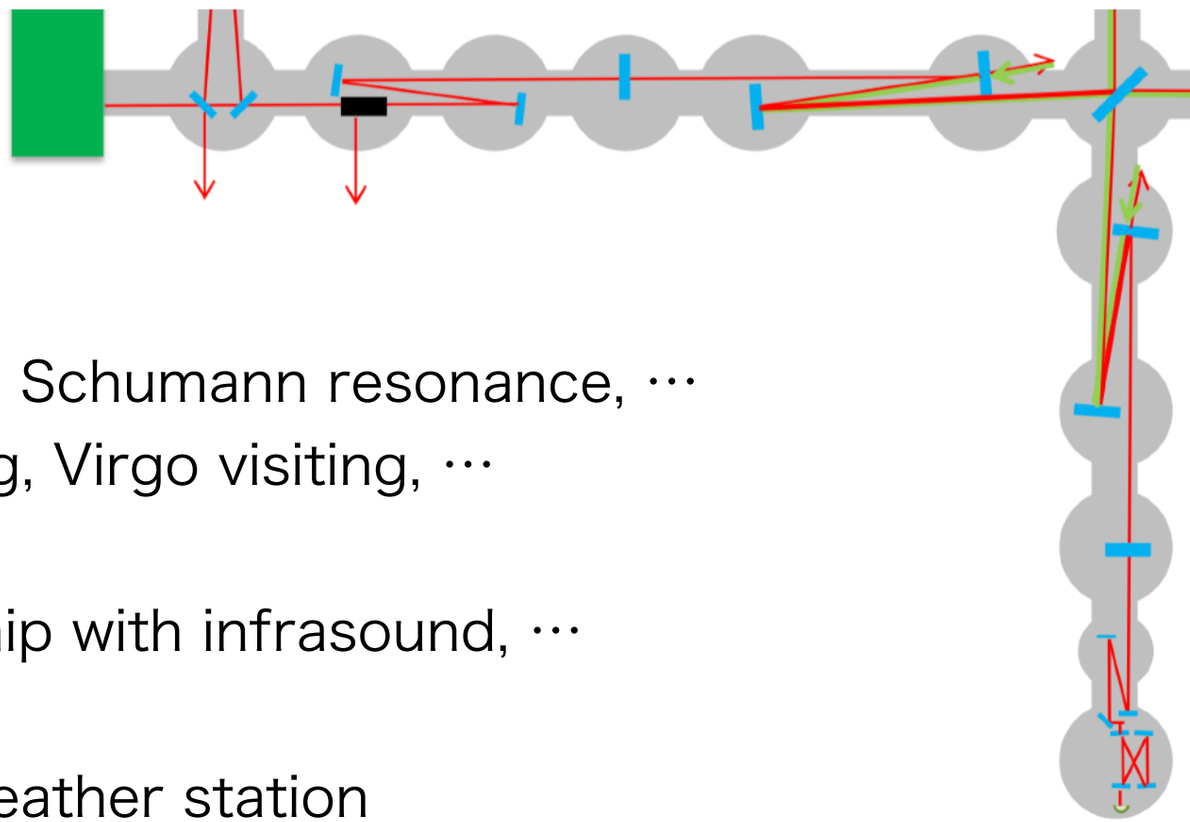


- Hammering test

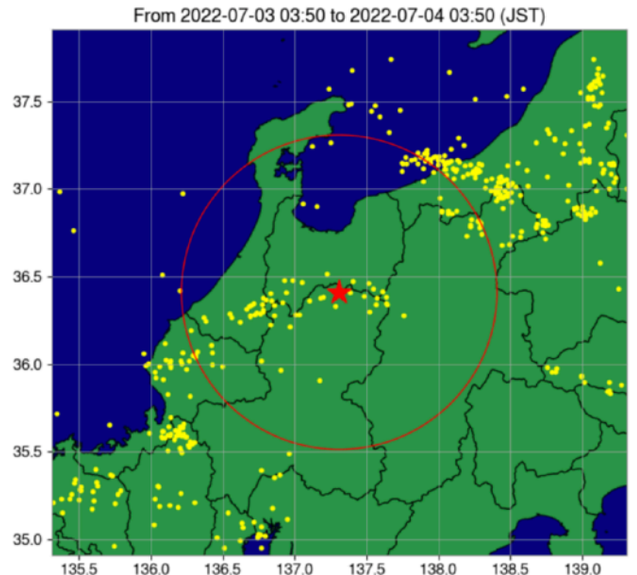




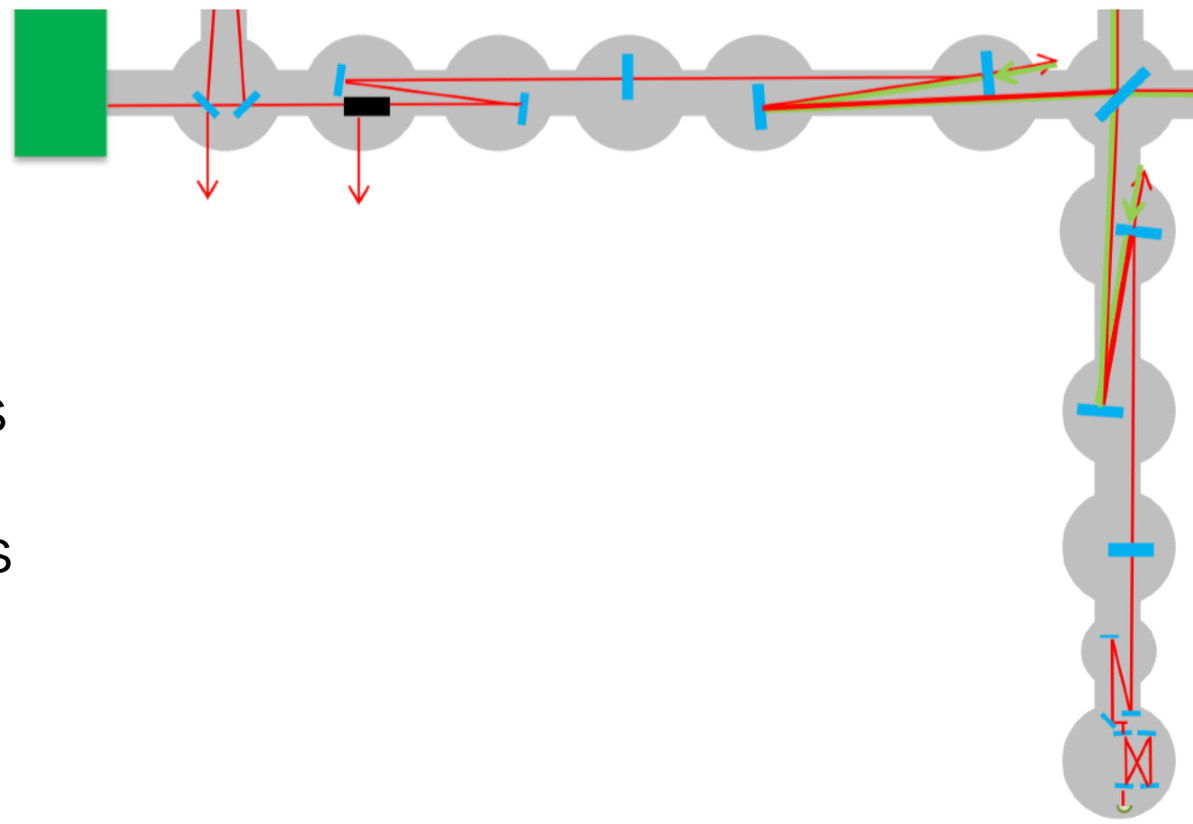
Future tasks



- Discussion with ET collaborators
  - Newtonian noise, infrastructure noise, Schumann resonance, …
  - ILANCE workshop, Bi-monthly meeting, Virgo visiting, …
- Seismic motion analysis
  - Earthquake, human activity, relationship with infrasound, …
- Increasing the weather information
  - Characterize the weather using the weather station
  - Investigate the rail monitor with heavy snow
  - New weather station
- Infrastructure noise
  - Sound mapping, magnetic field mapping, vibration mapping, …
  - Evaluate the effect from KAGRA environment
    - PEM injection, hammering test, global magnetic injection test
    - Contribution to ET and future detectors
- Setting and developing the PEM injection
- Support of the PEM injection at the site
- There were many lightening near the KAGRA site
- etc. etc.



Summary



- Presented the current PEM activities
  - See also the related talks, posters
    - Poster : S. Hoshino (m05)
    - Poster : I. Fukunaga (m03)
    - Oral : A.Takamori (Session 04)
    - Oral : C.J. Chou (Session 08)
    - Poster : Y.Yang (s05)
- There are many activities related with PEM, so if you have interested in our activity, please contact us
- There are also many activities in the commissioning toward O4