Vibration studies in KEK

KEK

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Conclusions@IWLC2010 Geneva

Consistency between measurement and calculation

1. Detector floor → KEKB floor
   Good consistency, FEM model is simple.
   Vibration effect is small above 1Hz/10Hz because of high natural frequ
2. KEKB floor → QCS magnet
   Good consistency.
3. Detector floor → Belle platform
   Relatively good.
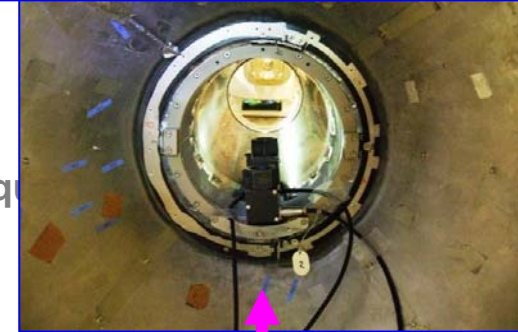   If the FEM model makes more precisely, it will become better cons
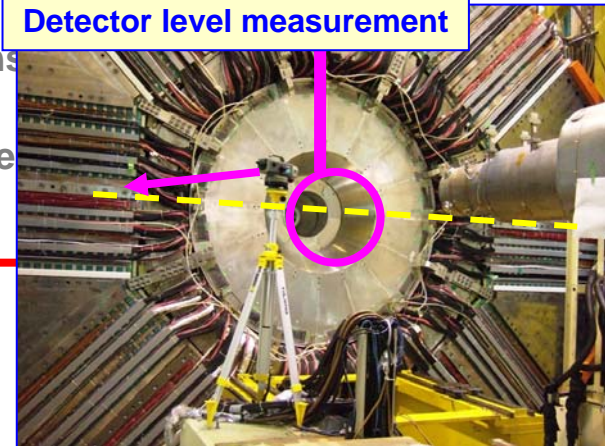4. Detector floor → End caps/Barrel yoke: Not yet.
   Some special techniques for FEM needed due to very large mode
   Effect of the magnetic force should be taken into account.

Vibration measurement at IR region

Detector level measurement

Vibration measurements at KEK

- Belle roll-out will be done in early/middle of Dec.
  → 1. Vibration/motion during roll-out will be measured.
- Silicon Vertex detector will be removed from the Belle in mid. Nov.
  → 2. Vibration at central region will be measured.

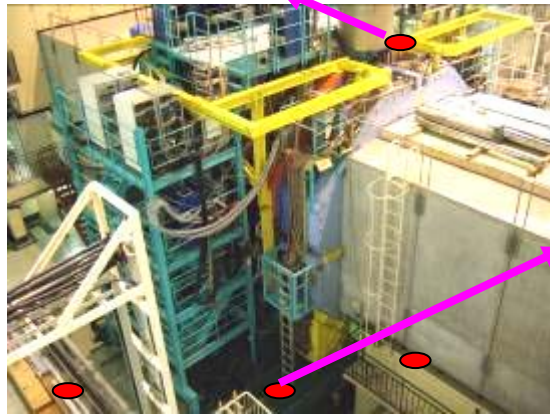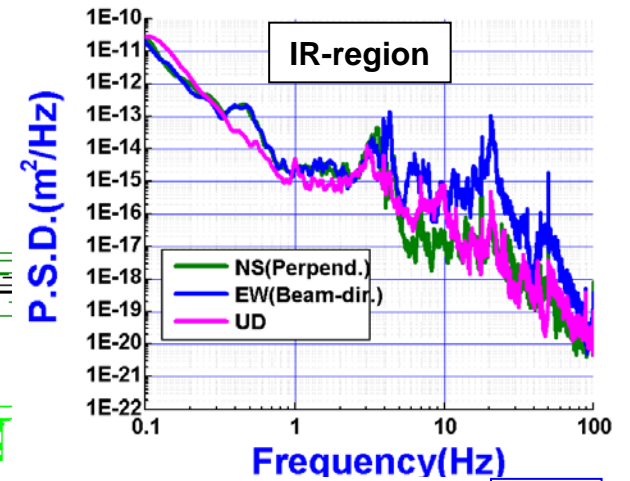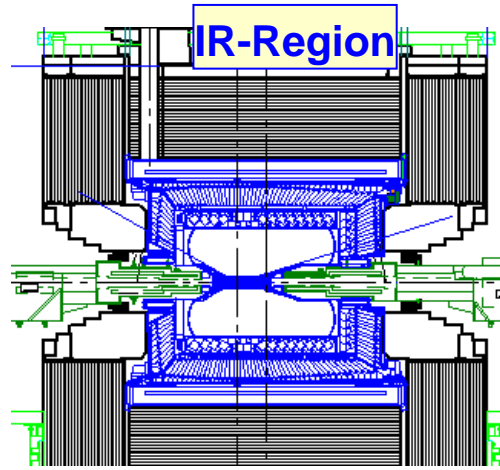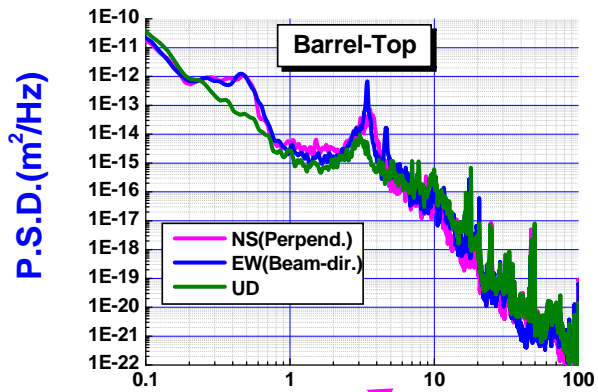## Detector level was adjusted to the beam level 12 years ago.
   Re-adjustment to the beam level hasn't been done so far.
   Detector level also hasn't measured.
   → 3. Detector level will be measured before roll-out.

→ **Measured.**

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Vibration data at IR region

IR-Region

Barrel-Top

P.S.D.(m²/Hz)
- NS(Perpend.)
- EW(Beam-dir.)
- UD

IR-region

P.S.D.(m²/Hz)
- NS(Perpend.)
- EW(Beam-dir.)
- UD

Frequency(Hz)

On the Table

P.S.D.(m²/Hz)
- NS(Perpend.)
- EW(Beam-dir.)
- UD

Frequency(Hz)

IR-region

Integ. Amplitude(m)

>10Hz
18
267
22

156
340
93

- NS(Perpend.)
- EW(Beam-dir.)
- UD

Frequency(Hz)

Detector floor

P.S.D.(m²/Hz)
- NS(Perpend.)
- EW(Beam-dir.)
- UD
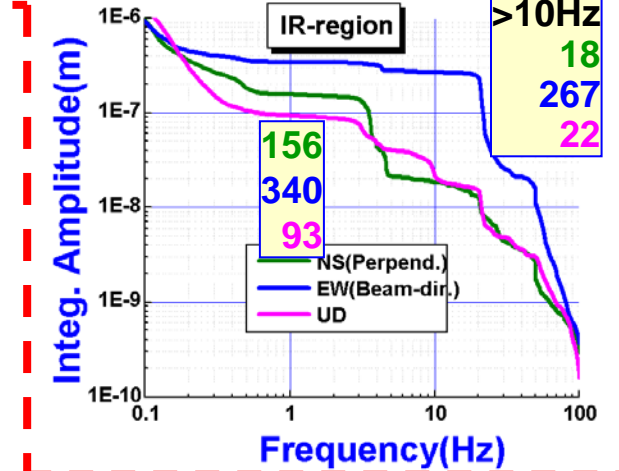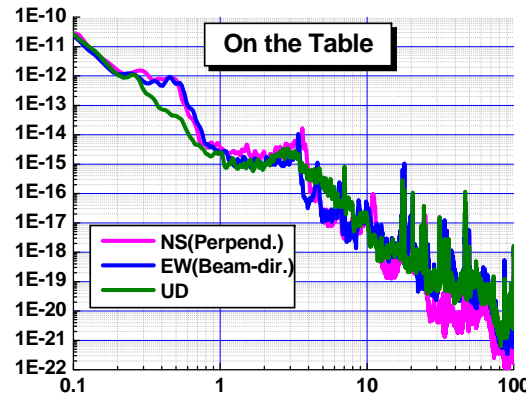
Frequency(Hz)

Integrated amplitude(nm)						
	>1Hz			>10Hz		
	Perpend	Beam	Vertical	Perpend	Beam	Vertical
IR	156	340	93	18	267	22
Barrel-Top	196	301	93	18	12	9
Belle stand	105	69	71	13	11	13
Detector floor	50	46	67	4	3	9
KEKB floor	55	45	68	10	5	9
Mag.-table	90	50	76	12	16	19
QCS-boat	250	60	118	15	21	30
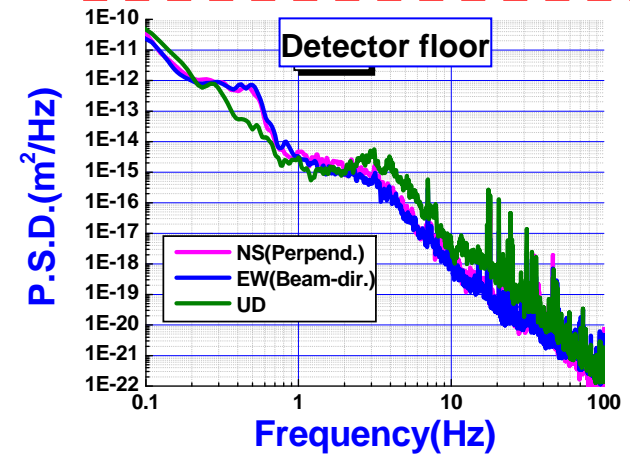
Compare detector level to the data taken 12 years ago.
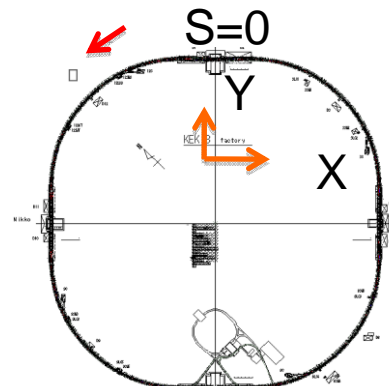
➔ **Detector level has been measured before roll-out.**
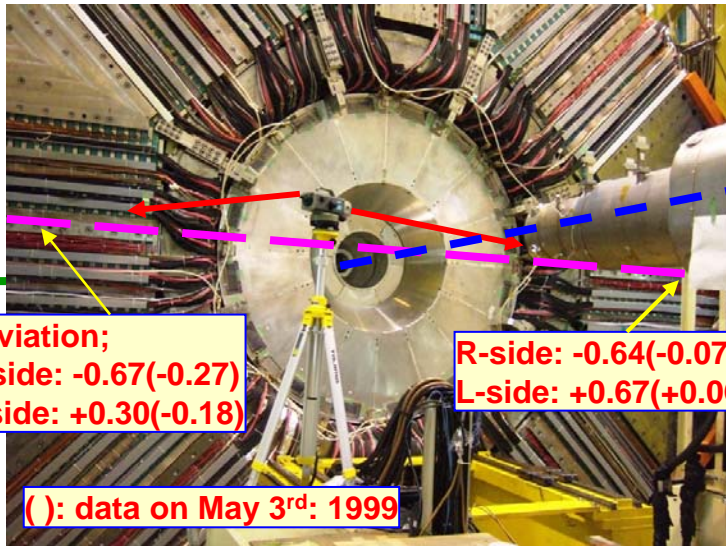
➔ **~0.6mm deviated(moved?) compared to the data taken at roll-in in 1999.**

Made by Masuzawa-san@KEKB Review

Deviation;
R-side: -0.67(-0.27)
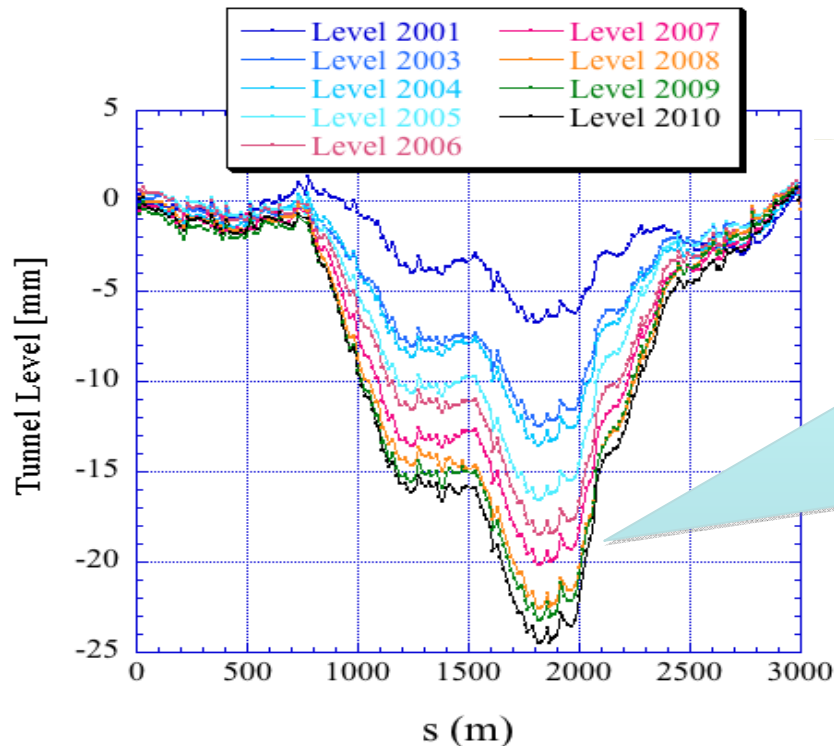**L-side: +0.30(-0.18)**

R-side: -0.64(-0.07)
L-side: +0.67(+0.06)

( ): data on May 3rd: 1999

S=0

Y

X

KEKB factory

S=1500

South arc continues to sink
at an average rate of ~2 mm/year,
though the rate seems to vary year to year.
The reason why this particular part
of the tunnel sinks is not known.

Optics people say
Overall leveling is not needed.
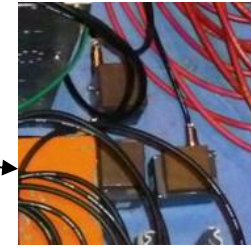Just smoothing out locally.

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Belle roll-out
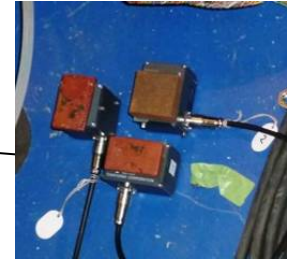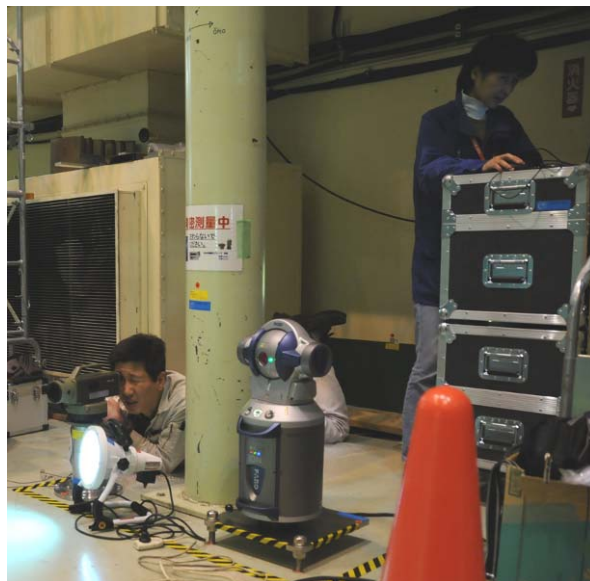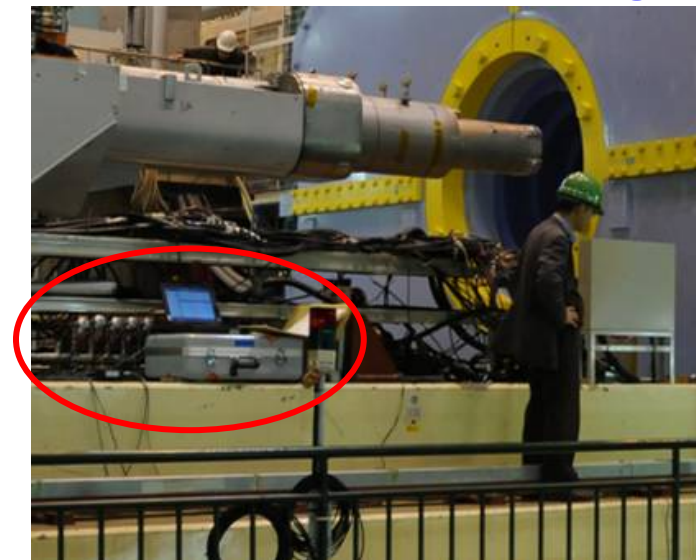

13m
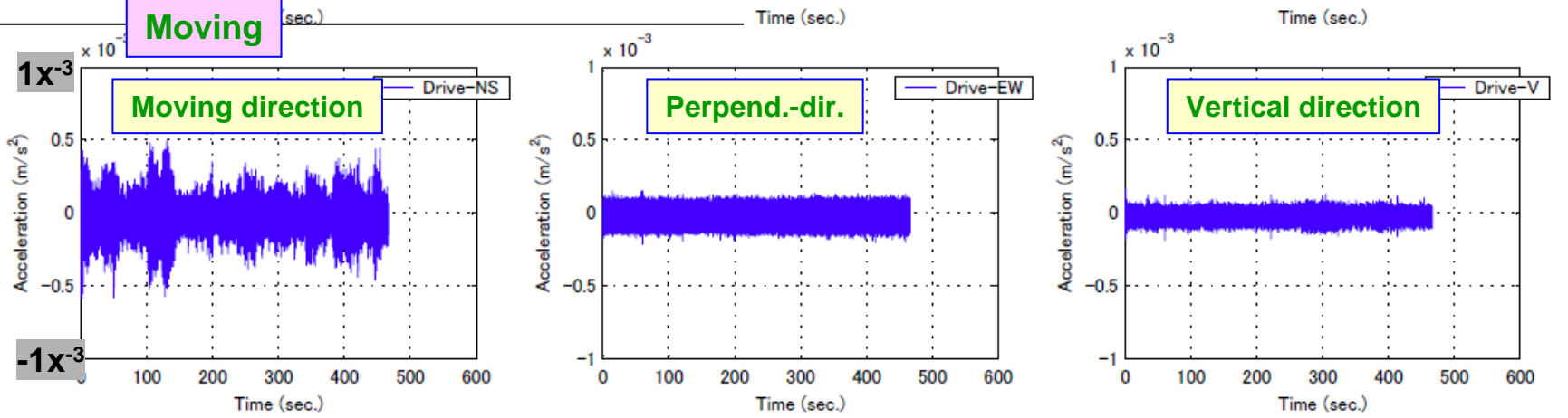90cm/min
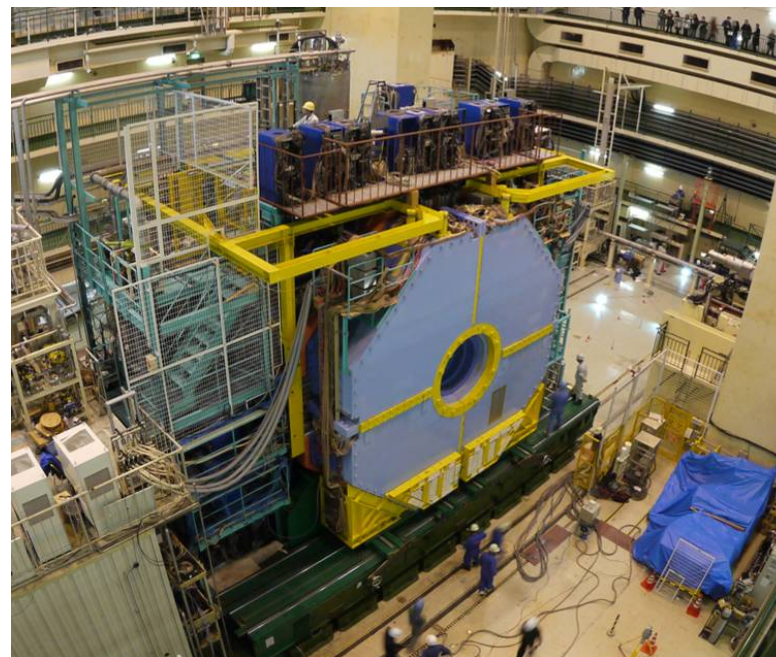
Control Unit: Hydraulic system
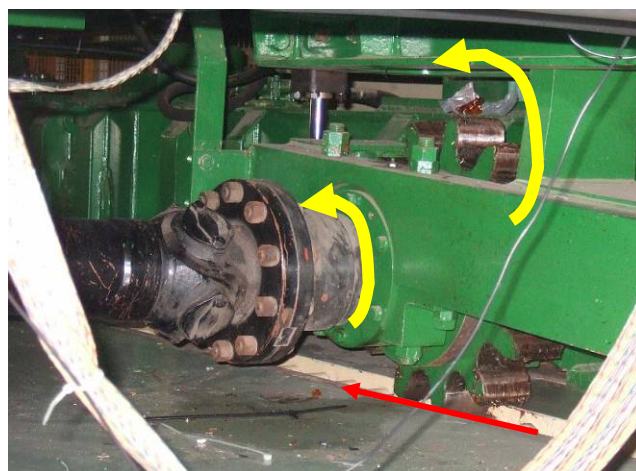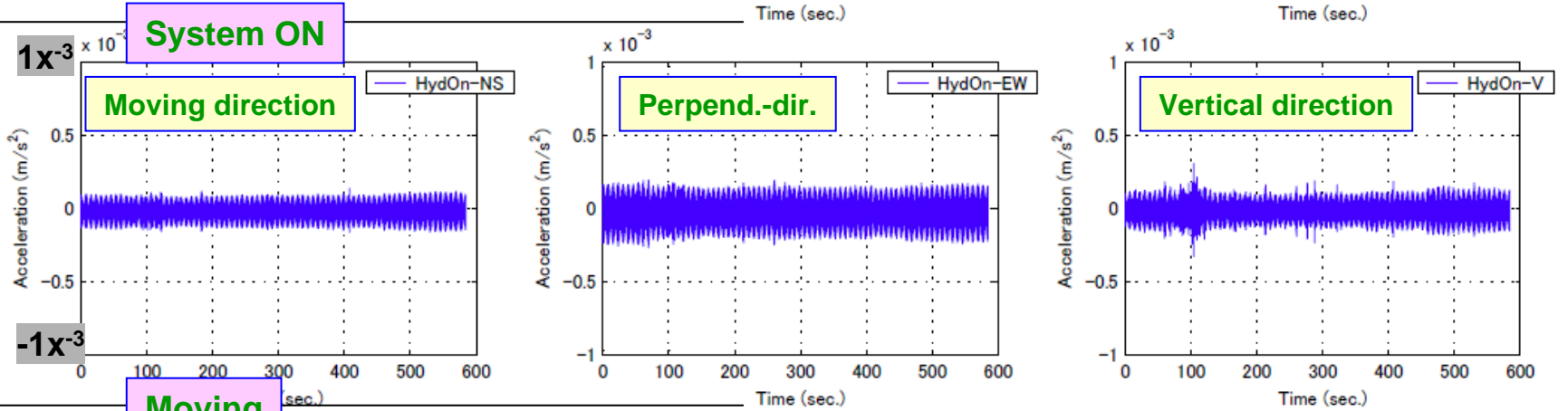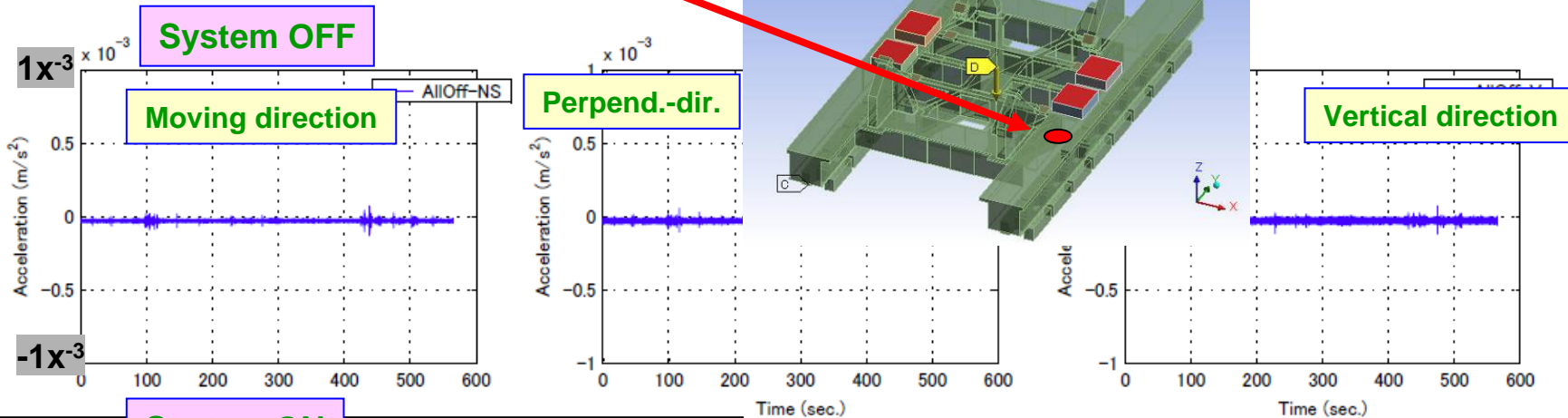
Rail

5

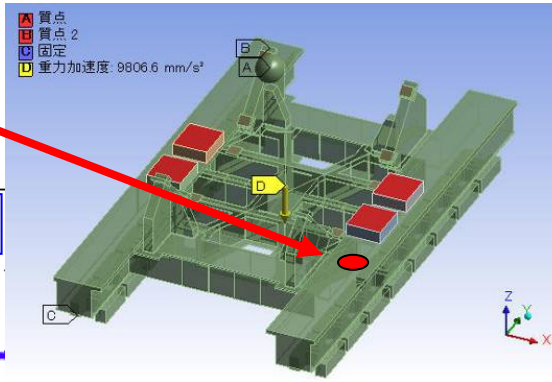**Vibration measurement during Belle roll-out**

Measurement of floor motion

Measurement of floor tilting

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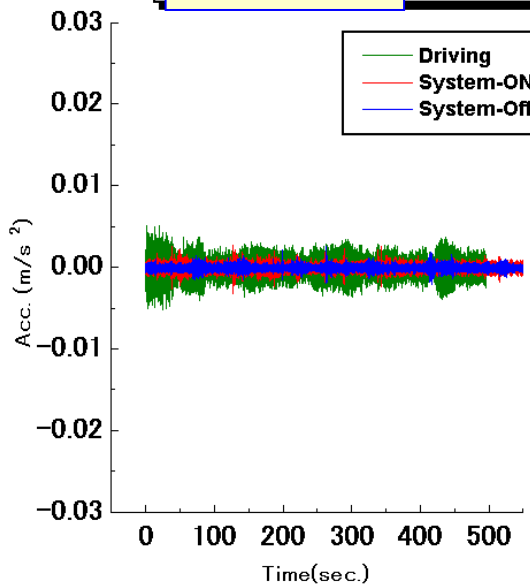
Vibrations：On the platform

System OFF

1×10^{-3} $\times 10^{-3}$

Moving direction   AllOff-NS

Perpend.-dir.

Vertical direction

-1×10^{-3}

System ON

1×10^{-3} $\times 10^{-3}$

Moving direction   HydOn-NS

Perpend.-dir.   HydOn-EW

Vertical direction   HydOn-V

-1×10^{-3}

Moving

1×10^{-3} $\times 10^{-3}$

Moving direction   Drive-NS

Perpend.-dir.   Drive-EW

Vertical direction   Drive-V

-1×10^{-3}

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On the barrel yoke

Moving direction /Yoke

Perpend.-dir. dir.- @B.Yoke

Vertical direction oke

On the end yoke @E.Yoke

Moving direction

Perpendicure dir.- @E.Yoke

Vertical dir.- @E.Yoke

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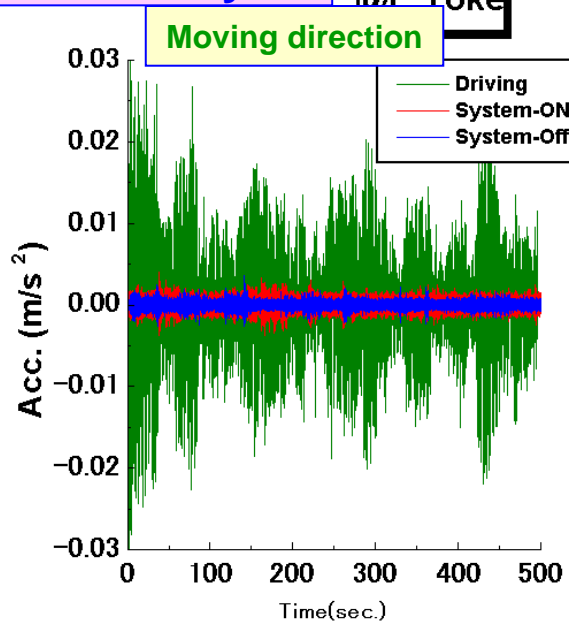**On the barrel yoke**

Moving direction
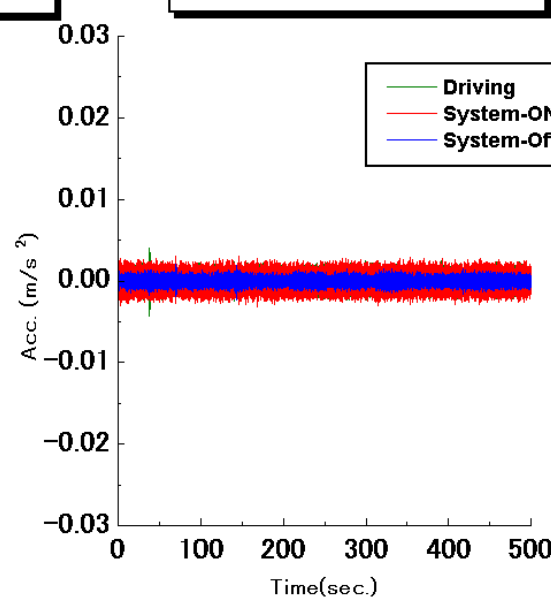
Perpend.-dir. dir.- @B.Yoke

Vertical direction

On the end yoke @E.Yoke

Perpendicure dir.- @E.Yoke
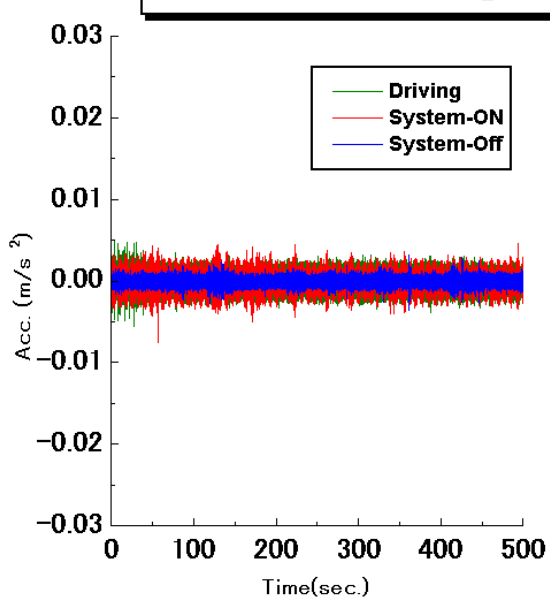
Vertical dir.- @E.Yoke

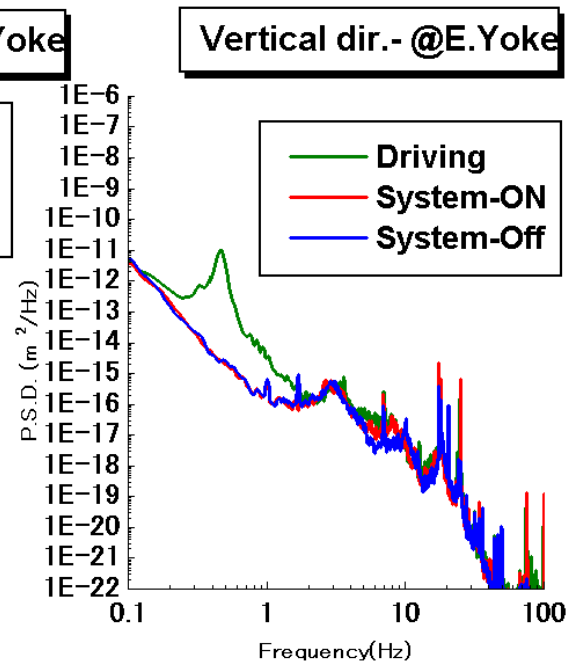## On the barrel yoke

Moving direction B.Yoke

Perpend.-dir. dir.- @B.Yoke

Vertical direction Yoke

On the end yoke . @E.Yoke

Perpendicure dir.- @E.Yoke
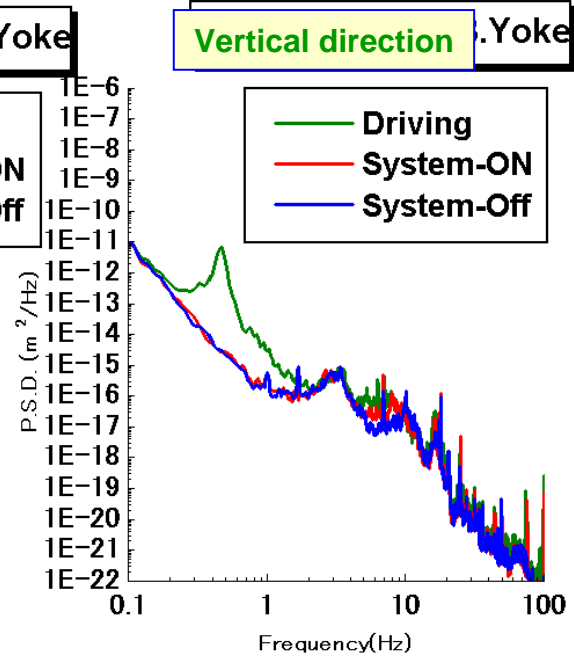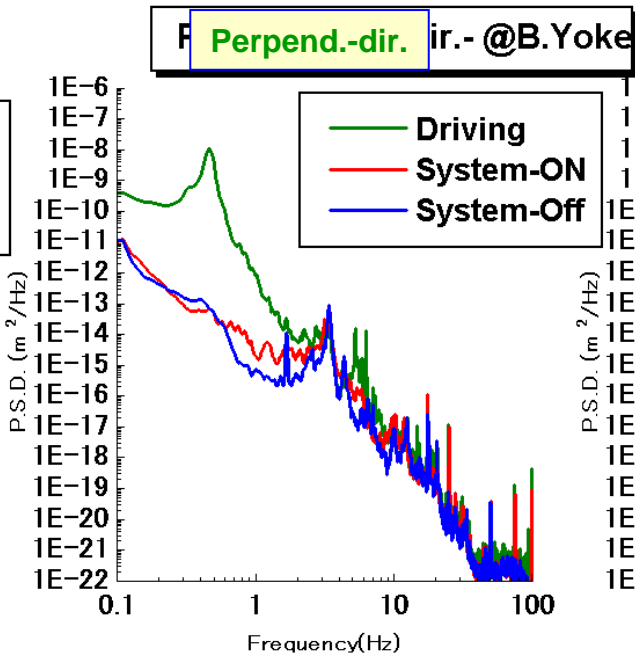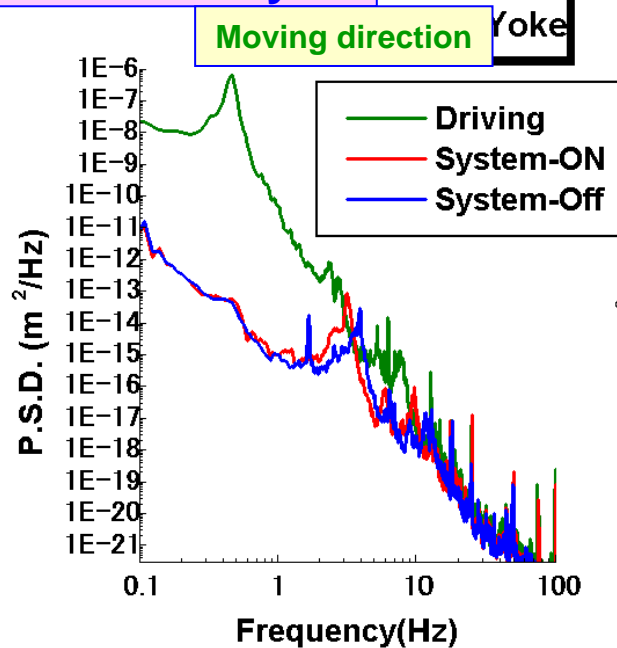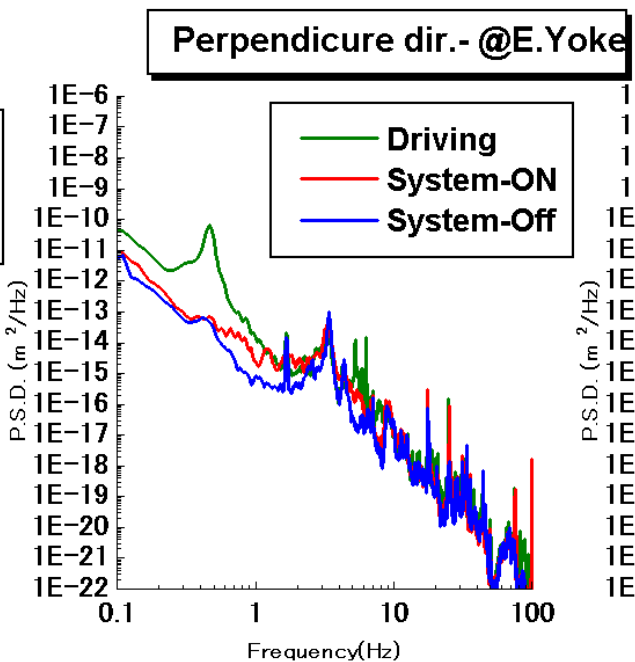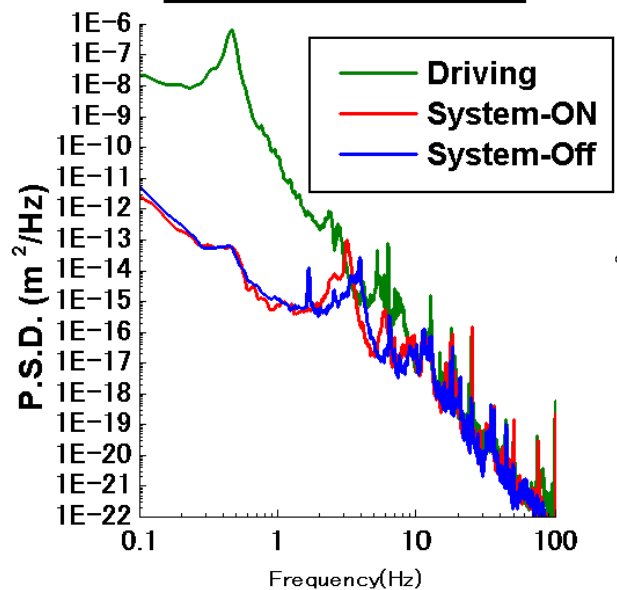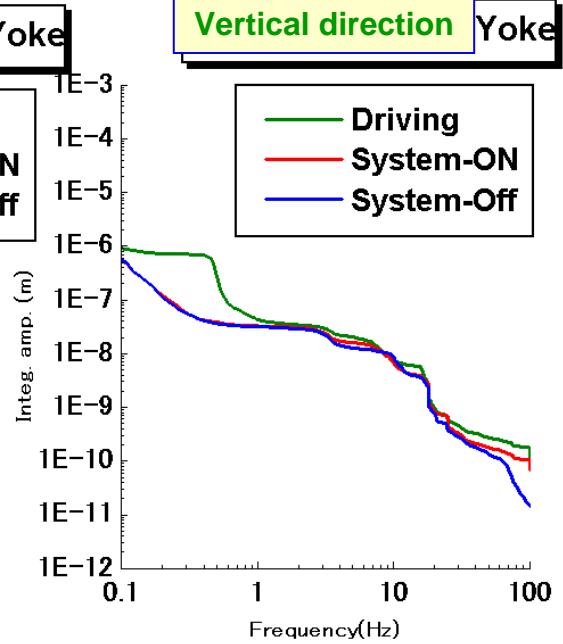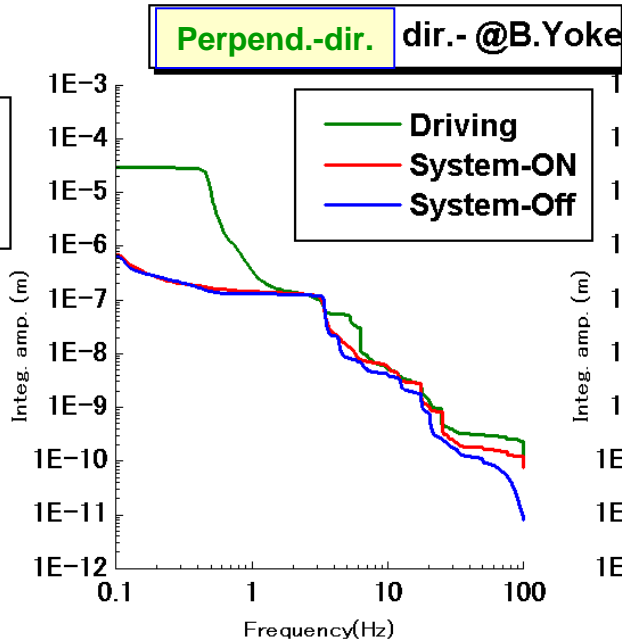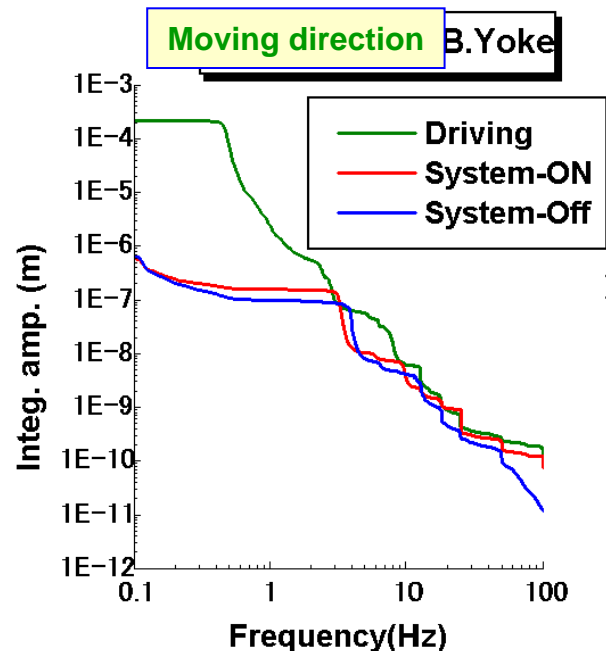
Vertical dir.- @E.Yoke
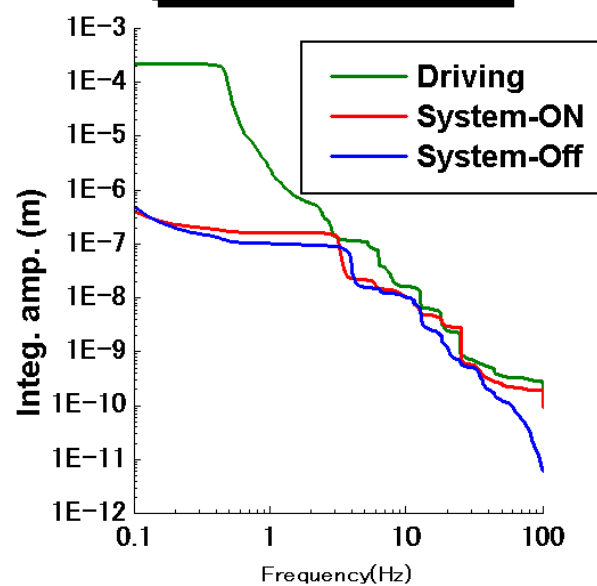
Response acceleration @platform
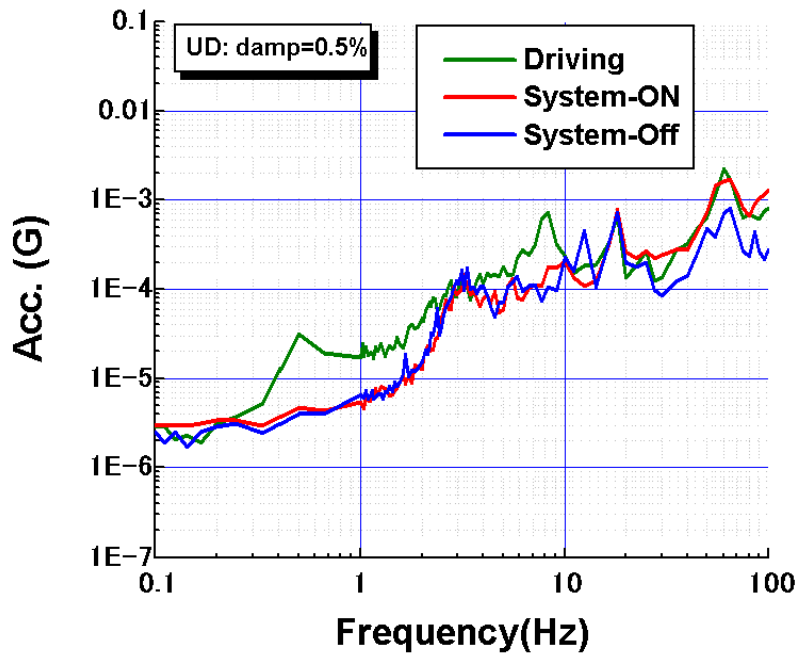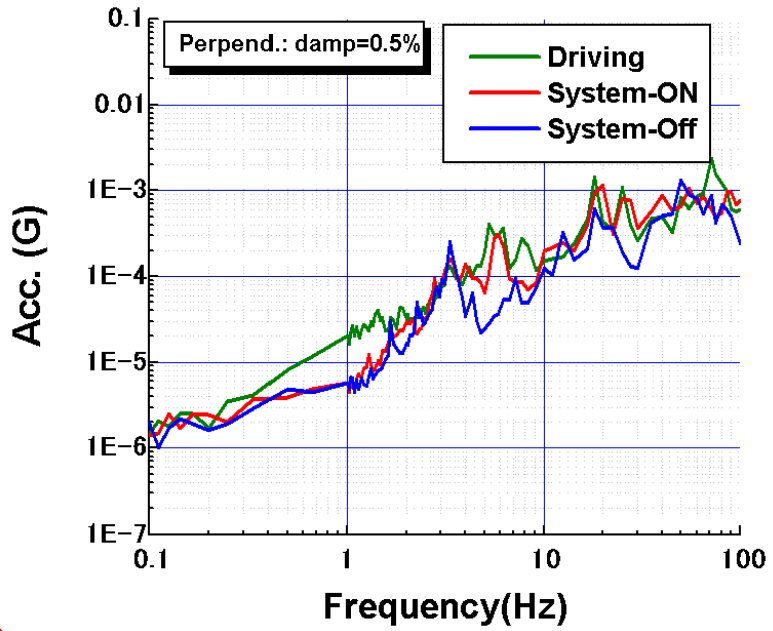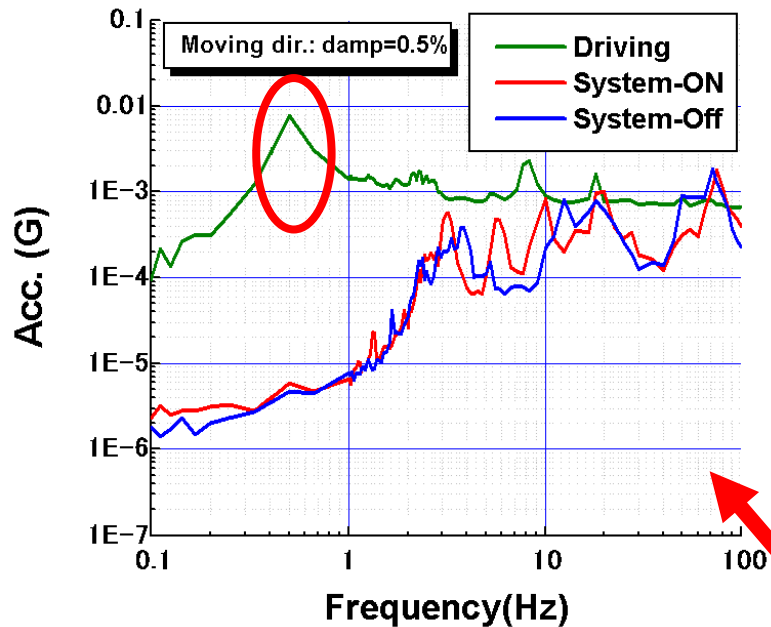
Max. response acceleration ➔ ~0.01G

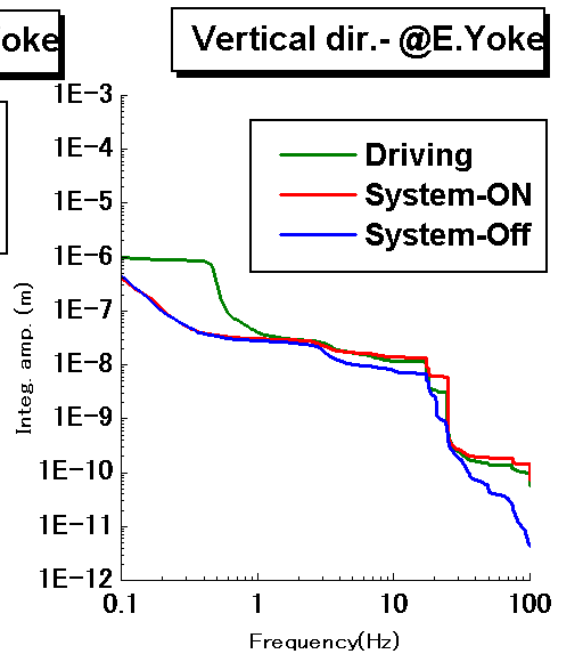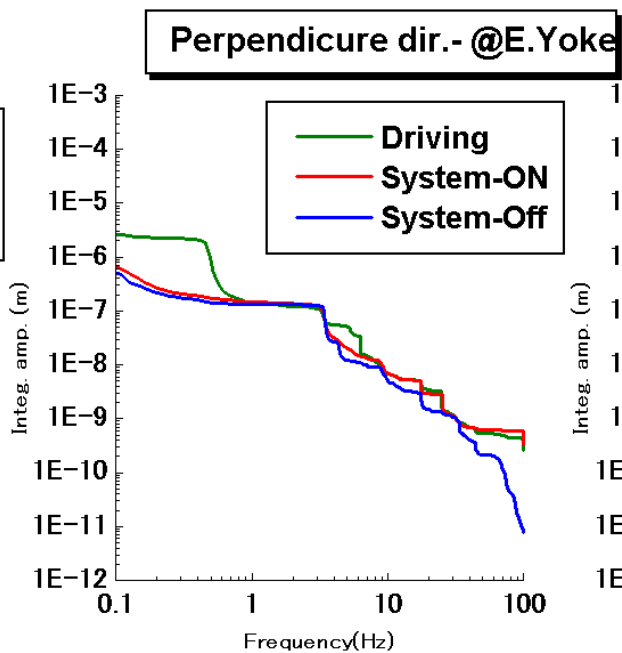**Seismic criteria for the Belle detector**
➔ **0.3G**
➔ **0.01G of respond acc .is very small.**
➔ **This seismic level is safe enough.**

Compare response acc. to the other moving system

ND280@J-Parc

~450tons

Yoke is Stopped.

Yoke is moving.

While arms are extending.
Yoke is stopped.

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Response acceleration@ND280

On the roller: Rail dir.

During the moving

Hydraulic system: ON

Background

Legend: 1%, 2%, 5%

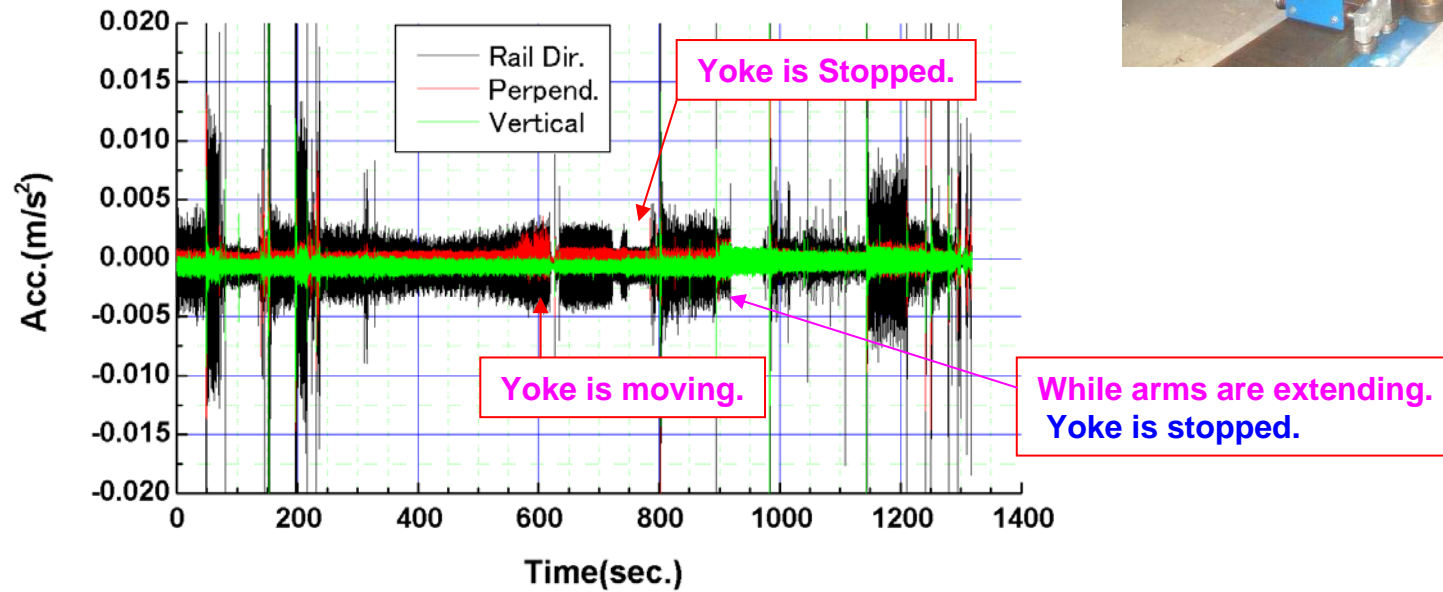Acc. (G) vs Frequency(Hz)

On the roller: Vertical

During the moving

Background

Legend: 0.1%, 0.2%, 0.5%

Acc. (G) vs Frequency(Hz)
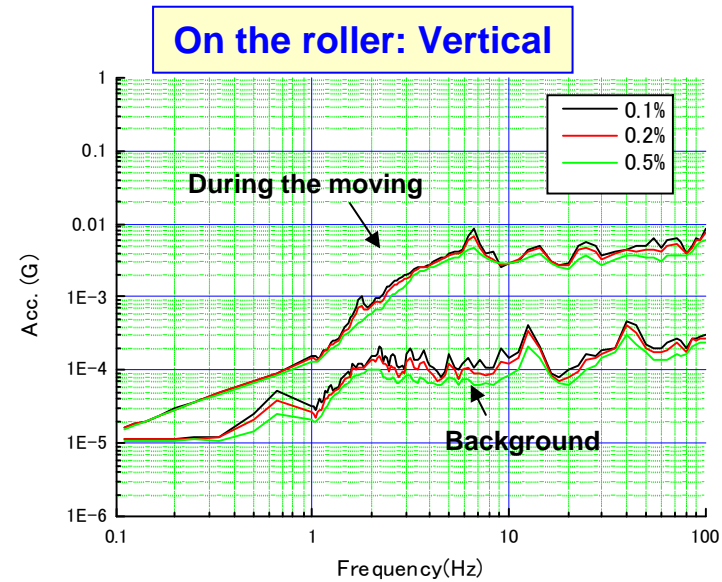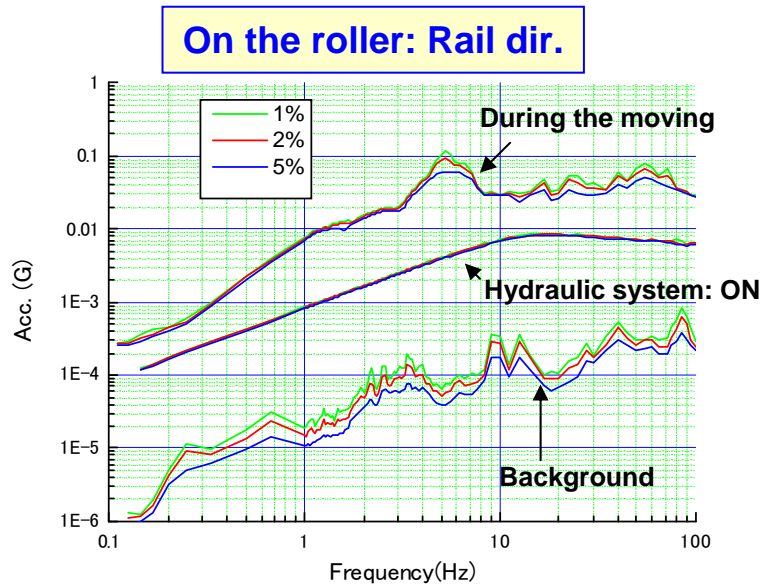
Response acceleration ➔ ~0.1G

➔ ~0.01G(Belle)

Seismic criteria for the ND280

➔ **0.5G**

➔ **0.1G of Acc is less than the criteria.**

➔ **But 10 time bigger than the Belle moving system.**

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<u>Beam line & floor motion during Belle roll-out analyzed.</u>

Beam line floor & Cryostat (retracted) motion

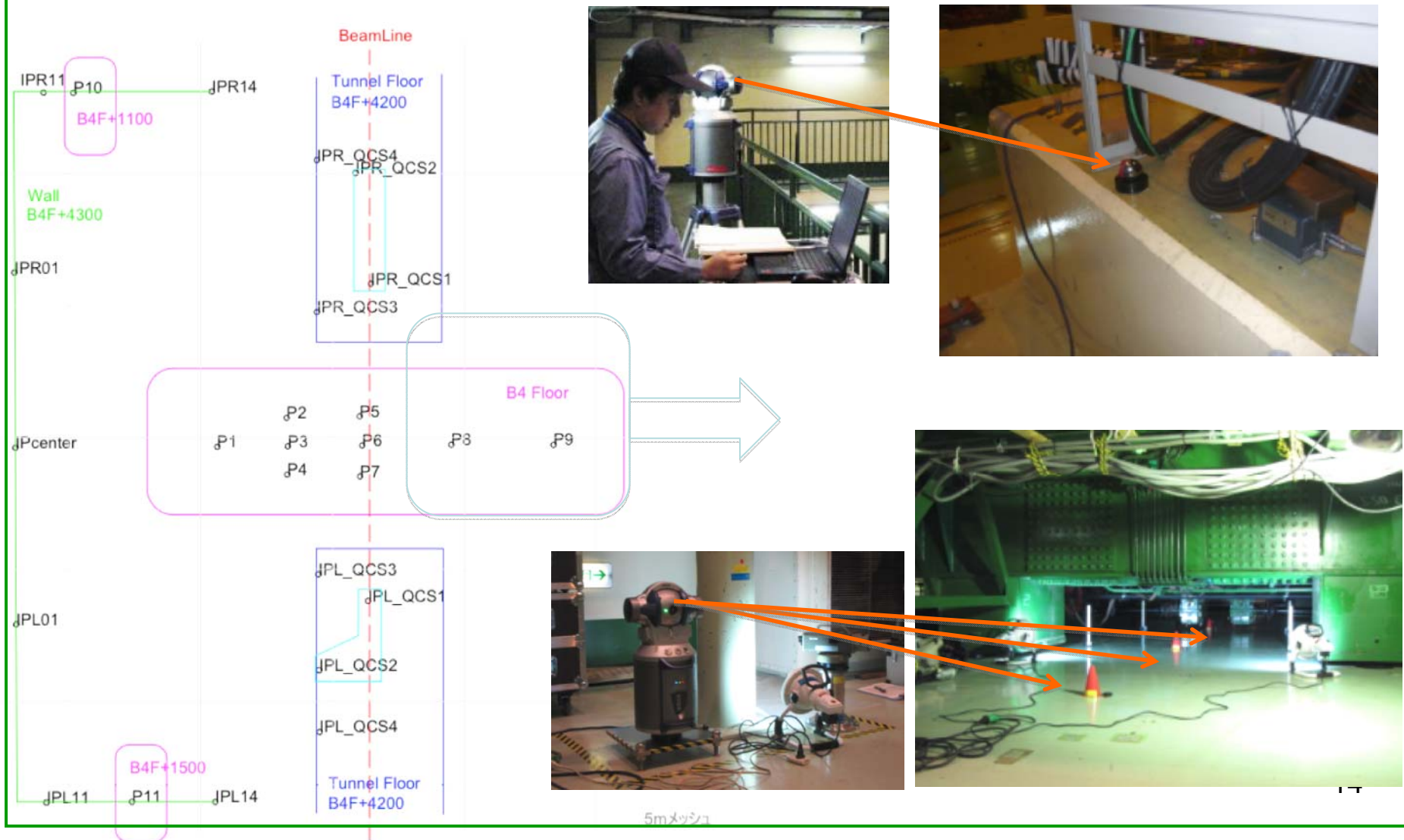# Vertical motion of the B4 floor

Dec.10 9:00
13m

after
~22 hours

Experimental building floor (B4 floor) tilts towards Belle
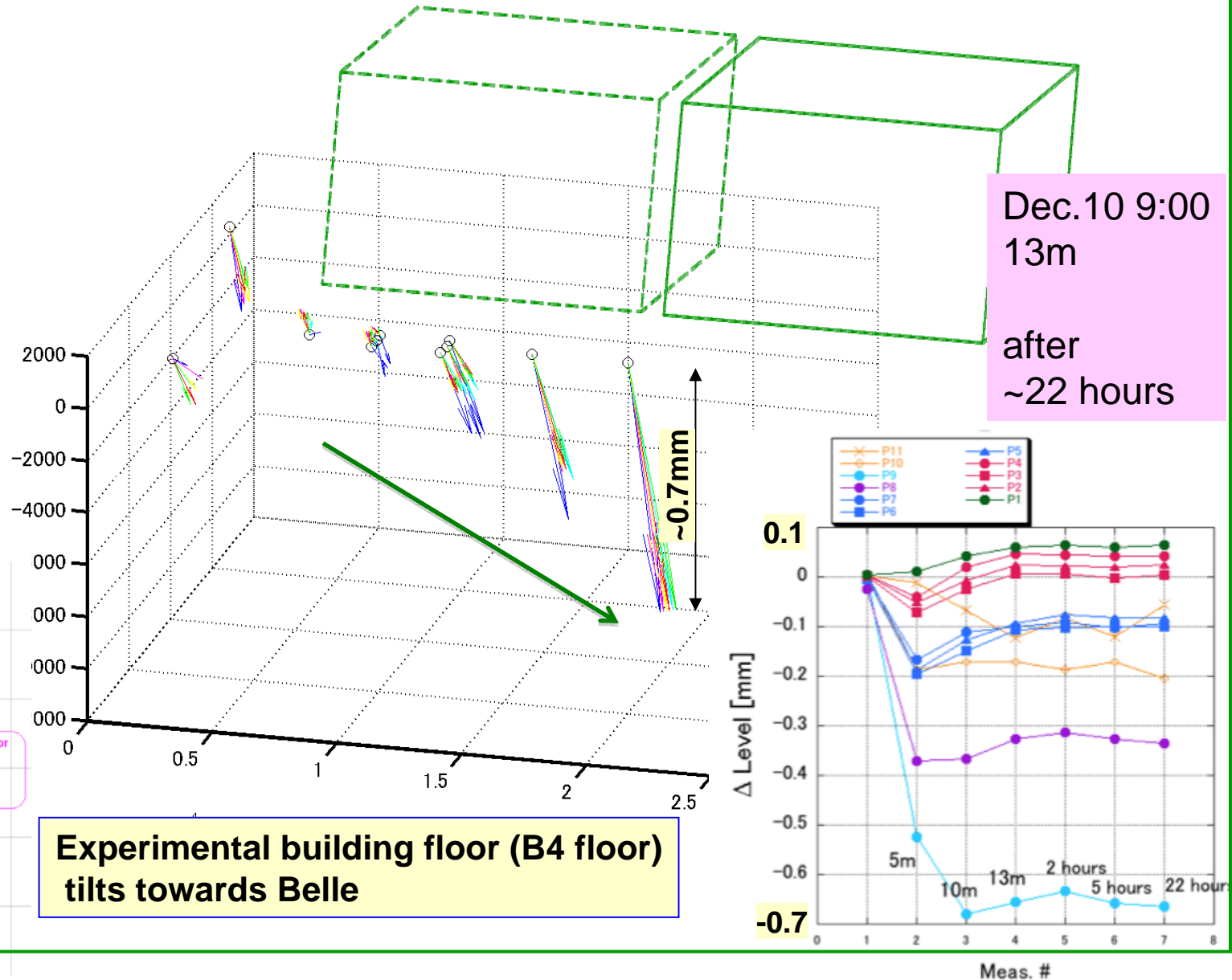
Made by Masuzawa-san@KEKB Review
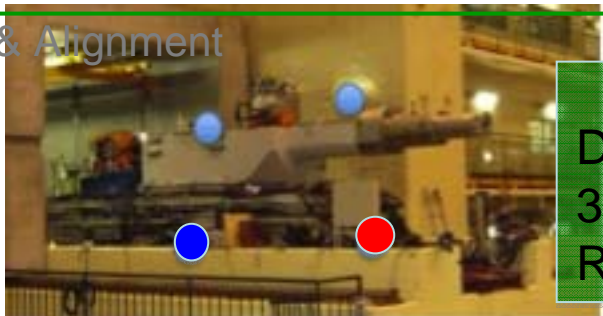
Dec. 9th 14:00
3 hours from
Roll-out completion

Tsukuba experimental hall

KEKB beam line
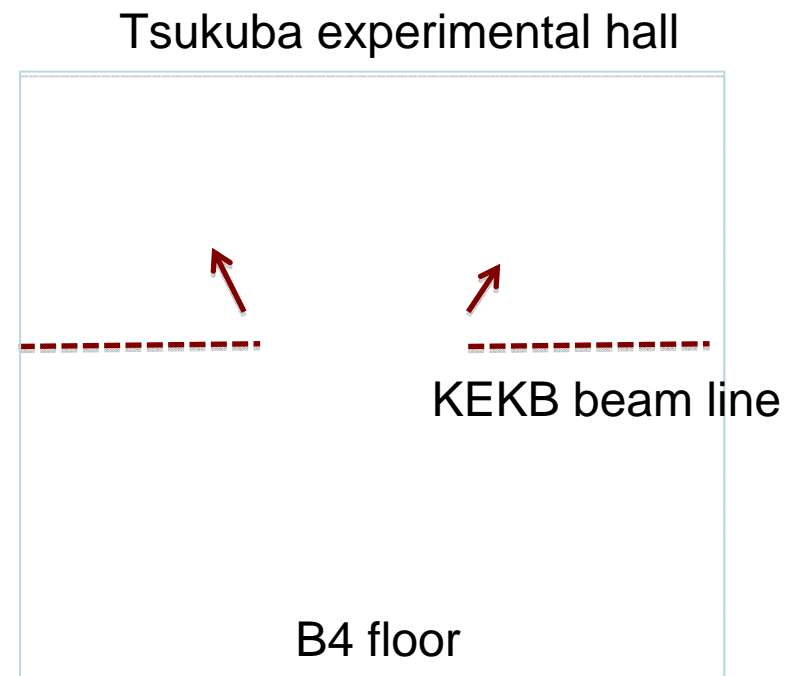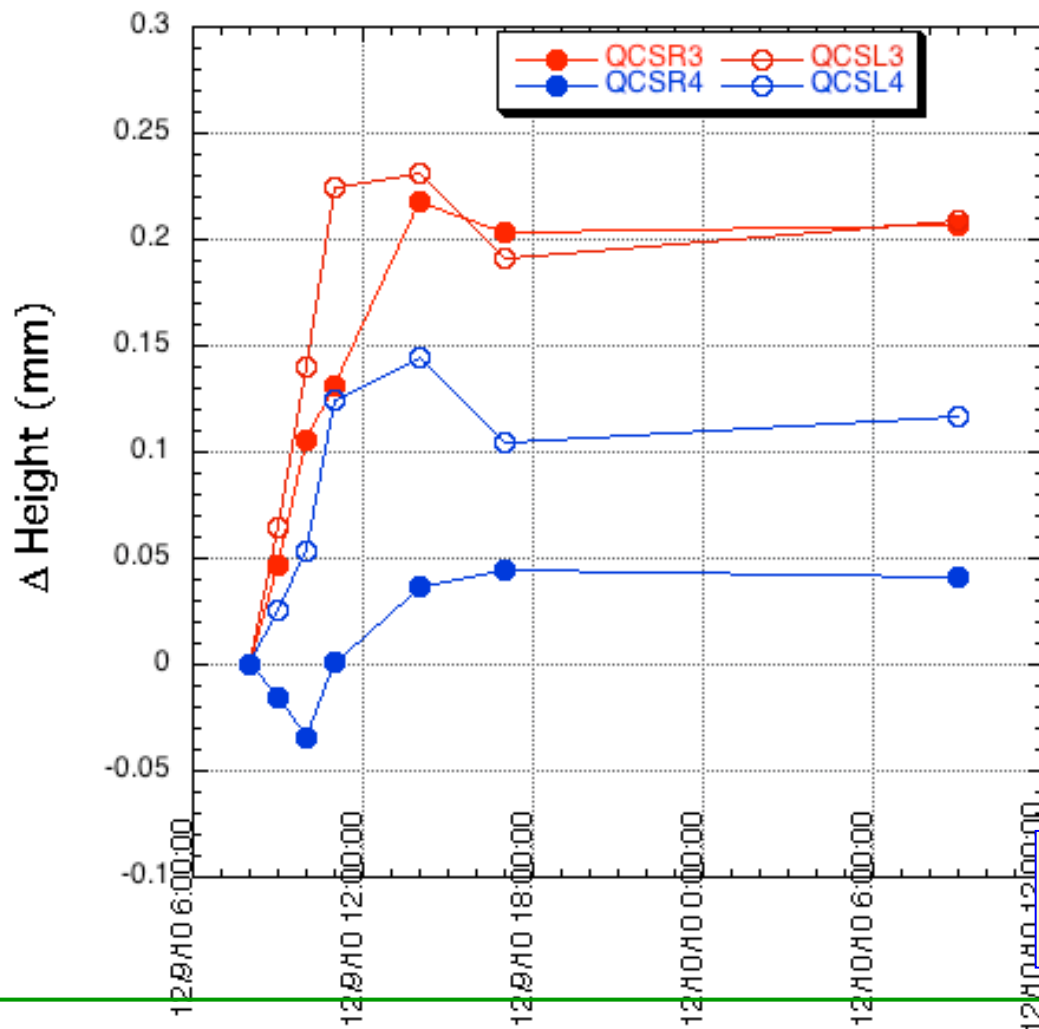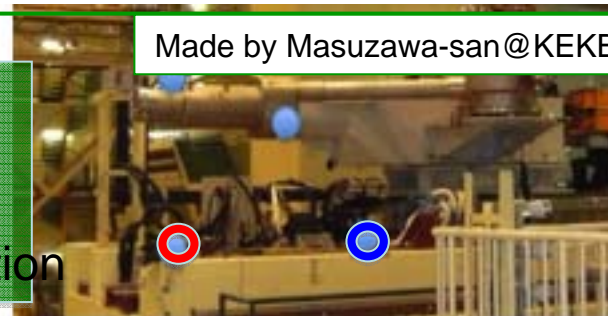
B4 floor

KEKB beam line opens up like
a drawbridge when Belle moves away.

Made by Masuzawa-san@KEKB Review

Horizontal motion of the B4 floor & beam line floor & Cryostat (retracted)

Dec.10 9:00
Dec.9 17:00
Dec.9 14:00
Dec.9 11:30 @13m(Final position)
Dec.9 11:00 @10m
Dec.9 10:00 @5m

QCSR

~0.15mm

B4 Floor

QCSL
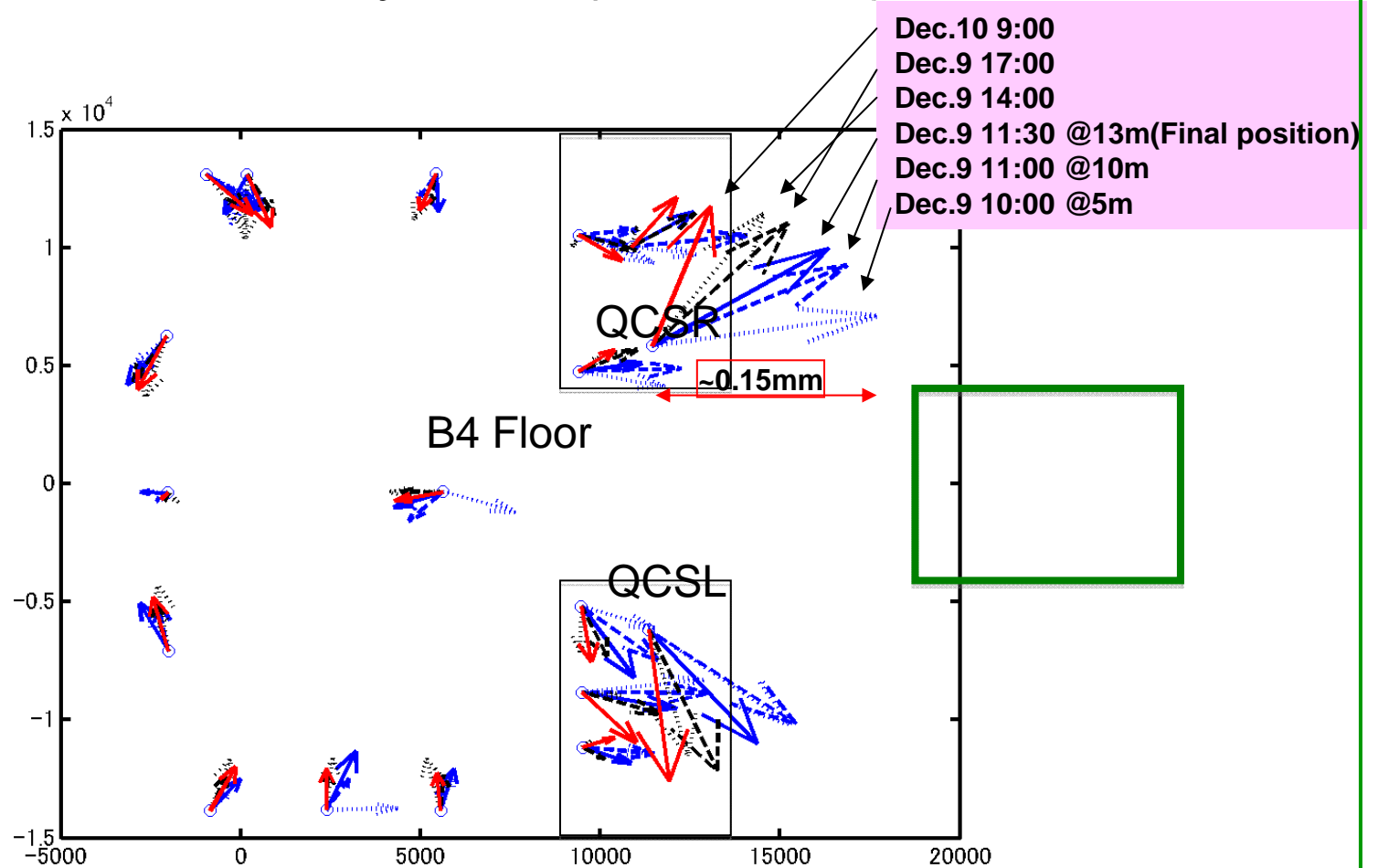
Belle pulls the beam line with it.

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Conclusions

Several measurements have been done before/during/after Belle roll-out.

Before roll-out;

- Vibrations at central region have been measured.

  The maximum vibration level was measured.

  → Sub-detectors are supported by barrel yoke

- Detector level was first measured in 12 years.

  ~0.6mm deviated to the data taken 12 year ago.

  → Tunnel/Floor moves year to year.

During Belle roll-out

- Vibrations during roll-out have been measured.

  Response accelerator of 0.01G was measured.

  → This is small enough than the Belle seismic criteria(0.2G).

  → ND280(Hilman roller) → 0.1G

  → This respond acceleration should be take into account on the seismic design.

- Floor motion/Beam line were measured.

  Floor level sank(Max. ~0.7mm) following the belle moving.

  Motion of the beam line rises up about 0.2mm. It looks a drawbridge.

  Floor moves after roll out.

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