

Correlation between vibrations, luminosity and IP beam position measurements at SuperKEKB

G. Balik³, L. Brunetti³, F. Poirier³, M. Le Garrec³, P. Bambade², S.
Wallon², M. Masuzawa¹, G. Mitsuka¹

1: KEK, High Energy Accelerator Research Organization, Tsukuba, Japan

2: IJCLab, Laboratoire de Physique des 2 Infinis Irène Joliot-Curie, Orsay, France

3: LAPP-IN2P3-CNRS, Université de Savoie Mont Blanc, Annecy, France

TYL/FJPPN workshop, May 2026

Contact:

L. BRUNETTI – brunetti@lapp.in2p3.fr

M. MASUZAWA - mika.masuzawa@kek.jp

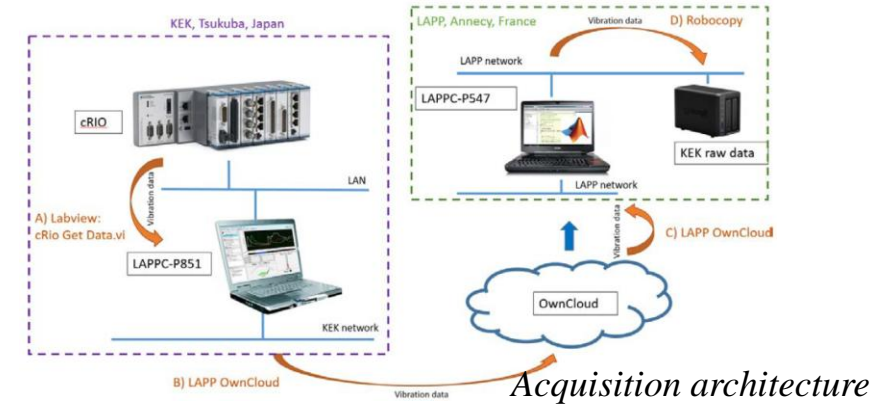
- Long-term monitoring with continuous available data for the collaboration:

4 seismic sensors - 2 at each side of the BELLE II detector

Monitoring 10'/hour to limit the data

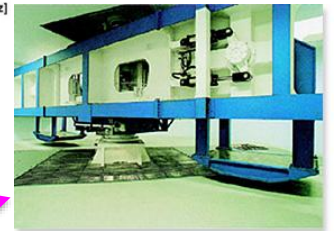
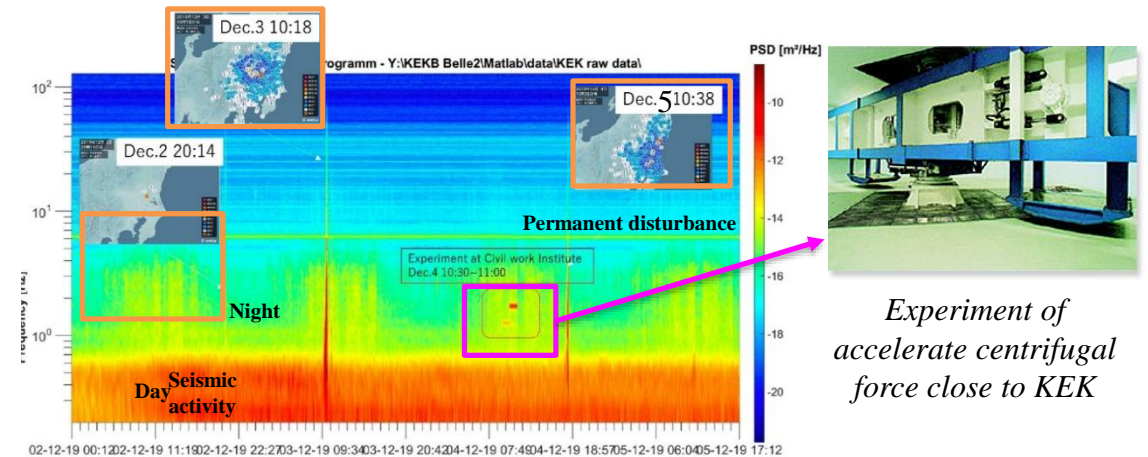


Guralp 6T



Acquisition architecture

- Weekly reports are available at : <https://lappweb.in2p3.fr/SuperKEKB/>



Experiment of accelerate centrifugal force close to KEK

Vibration analysis: *earthquake* and *external perturbations*

- Objective 1: Identification of disturbances or specific events:

- Comparison day – night
- Seismic events
- External disturbances
- Drift in time...

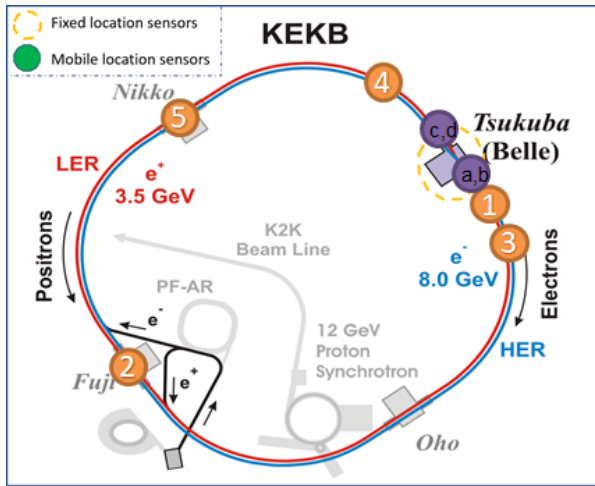
- Scheduled maintenance required (sensor and DAQ system) : DAQ system was updated on site in 2025

Objectives:

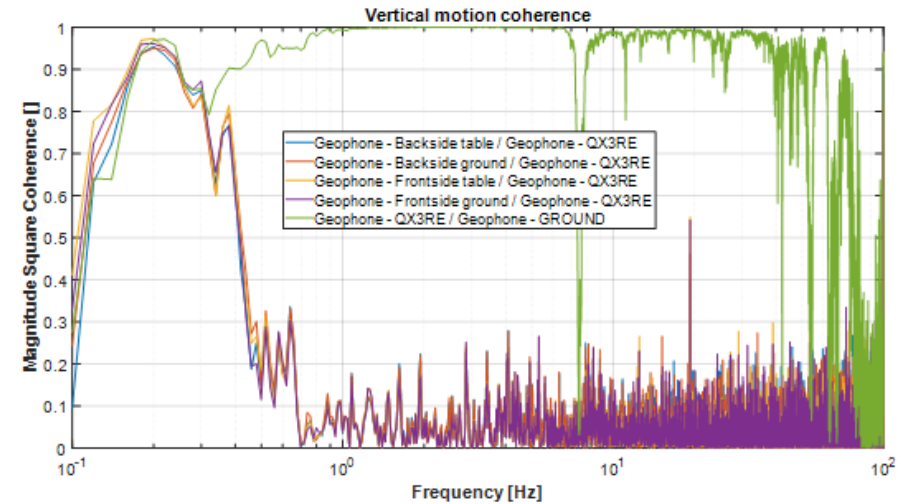
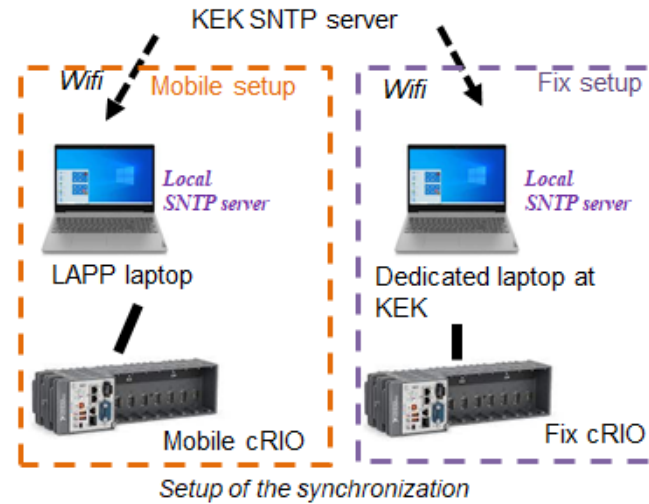
- Coherences measurements: vibrations effects analysis (SuperKEKB) and behavior of the tunnel (FCC-ee uniform waves studies and GND generator) with two synchronized ADC setups
- Evaluation of the behavior of the main impacting magnets (QLC7RE, QLC3RP, QX3RE, QLB1RE, QLB1RP, QLB1LE, QLB1LP, QW7NRP)



Sensors locations of the various measurements



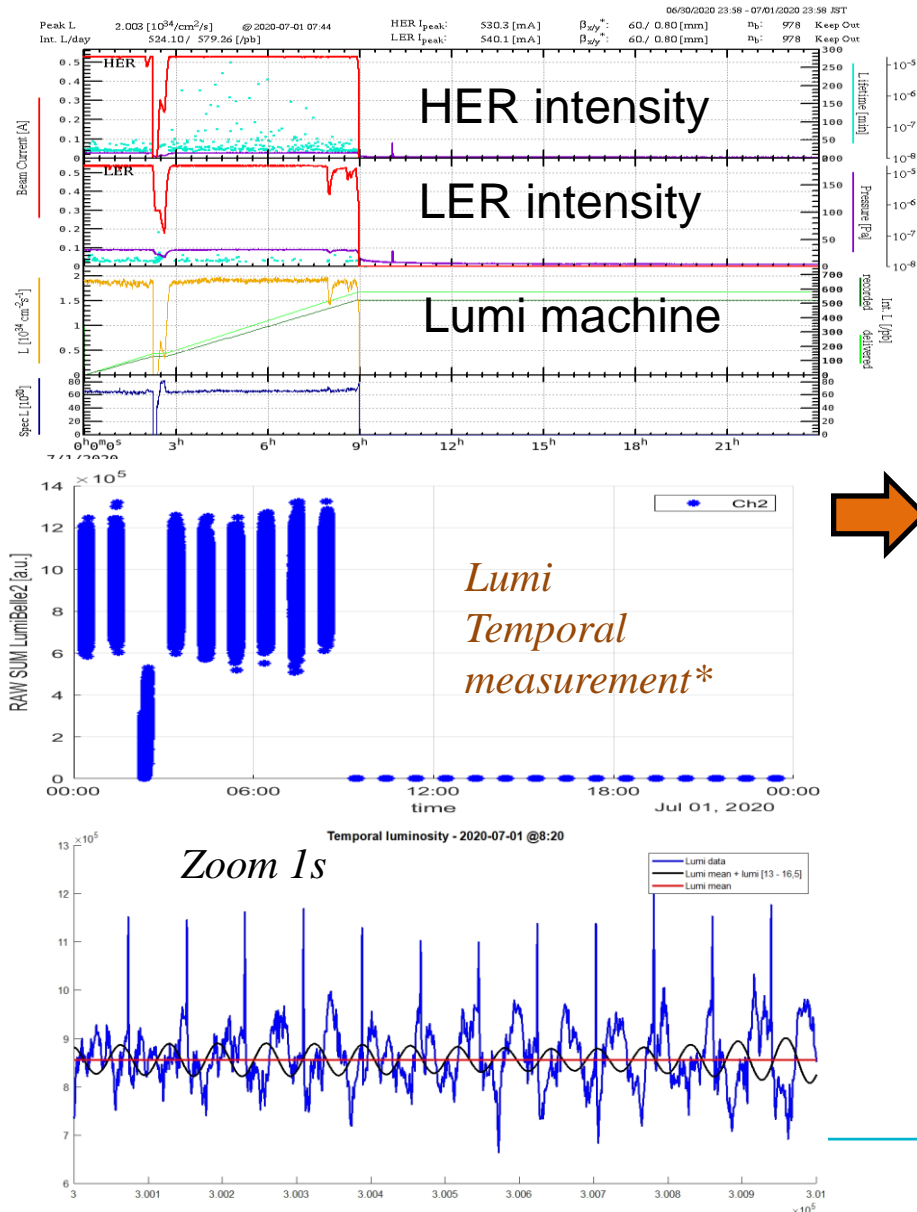
Various sensors locations in the tunnel



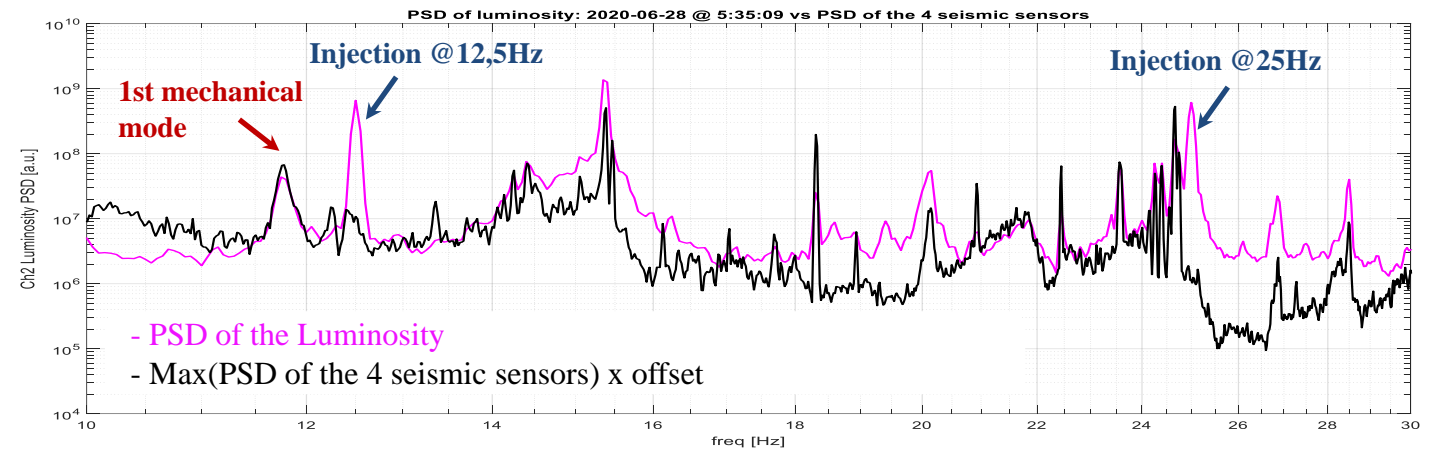
Example of results : coherence measurement at the opposite locations in the tunnel

➤ Also very interesting results for FCC-ee, could be investigated more into details with new campaigns

Comparison vibrations vs Luminosity monitoring via Bhabha scattering (IJCLab & KEK)



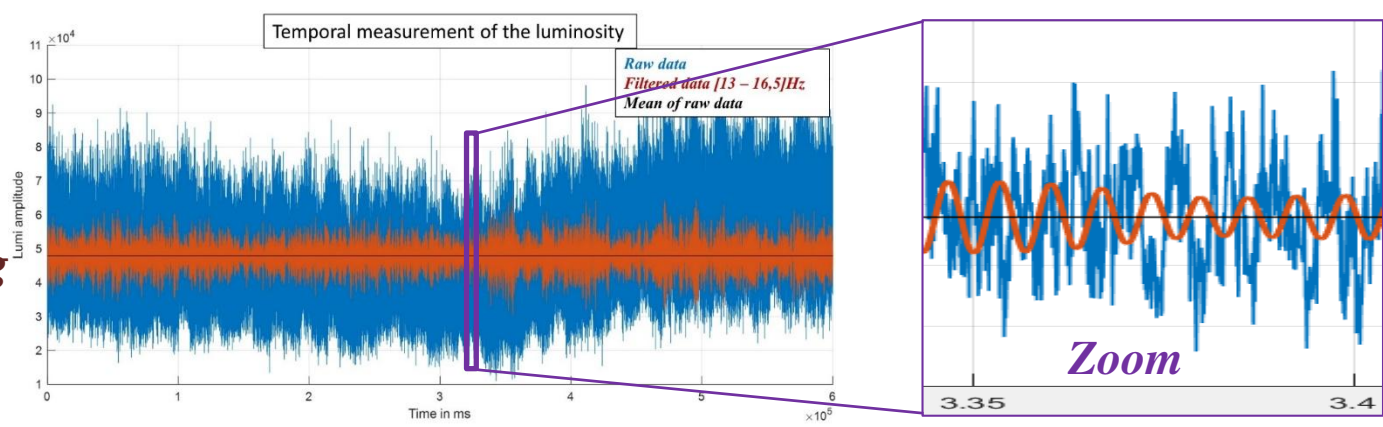
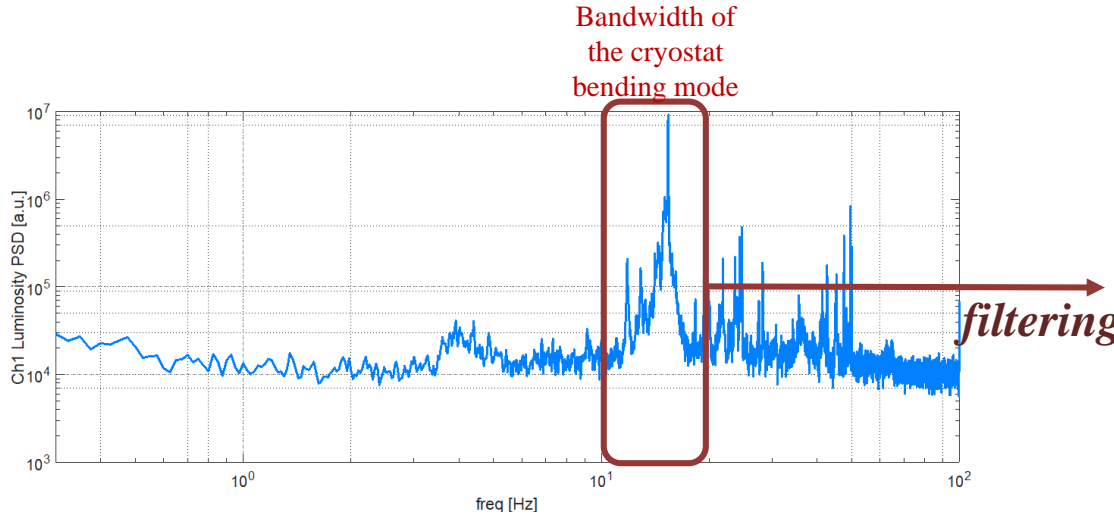
*: The 4 permanent luminosity measurements are managed by the IJCLab team:
C. G. Pang et al., “A fast luminosity monitor based on diamond detectors for the SuperKEKB collider”, *Nucl. Instrum. Methods Phys. Res., Sect. A*, vol. 931, pp. 225–235, Jul. 2019.



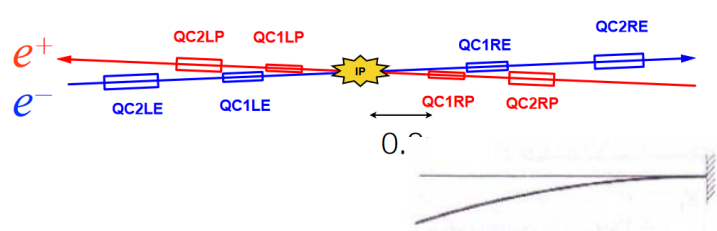
- Except the peaks at 12,5 Hz & 25 Hz due to the injection, all the luminosity peaks are mainly due to vibrations amplified by asymmetrical mechanical structures
- **Publication:** M. Serluca, G. Balik, L. Brunetti, B. Aimard, A. Dominjon, P. Bambade, S. Wallon, S. Di Carlo, M. Masukawa, S. Uehara, *Vibration and luminosity frequency analysis of the SuperKEKB collider*, NIMA (2021).
- **This study highlights the effects of the dynamic of the cryostat on the beam**

Comparison of the measured and theoretical ratio of luminosity disturbance due to the cryostat vibrations

(vs beam energies, HER or LER, beam size...)



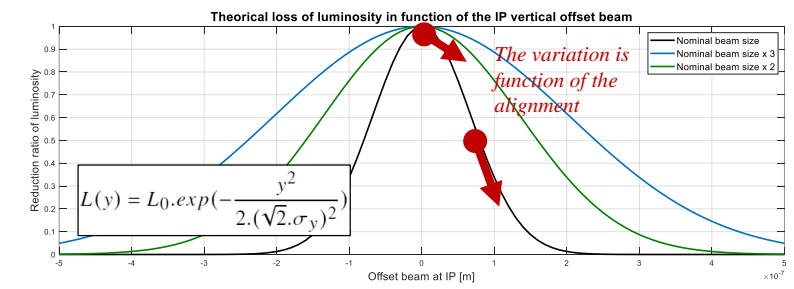
➤ **Measured ratio of luminosity disturbance** due to the cryostat bending mode, [2 : 20]% of amplitude compared to the luminosity average



Differential motions between QC1RP, QC1RE, QC2RP QC2RE

Optics simulation (SAD) with magnet movement amplitudes as maximum misalignments

➔ Induced residual offset between the two beams at IP



➔ **Theoretical ratio of luminosity disturbance**

➤ **LAPP request in collaboraton with IJClab and KEK:**

☐ 2 Travels on site

➤ **Total 3 Keuros**

▪ **Work on site:**

- **Common campaign on site dedicated to IP BPMs measurements**
- Calibration of the sensors
- Complementary ground motion measurements in the pit and in the tunnel

} Beam ON
 } Beam OFF



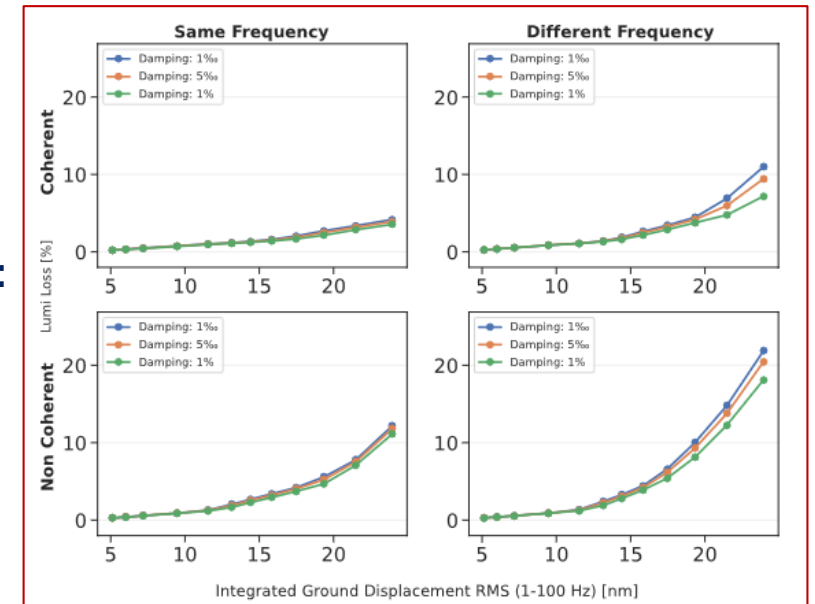
μTCA performs calculation on each channel of each BPM

▪ **Communication**

- FCC-ee collaboration (ex: FCC week, IPAC...)

▪ **Benefits to have the knowledge of the beam positions at the IP in real time:**

- To quantify the vibration influence on the beam parameters which depend to the beam alignment
- Singular coupling for a leptonic collider (vibration, luminosity and alignment)
- Could be very valuable for the IP feedback and alignment studies
- **Also very important for FCC-ee studies**



FCC-ee loss luminosity simulation due to vibrations in taken into account the coherence and the behavior of the SuperKEKB cryostat