

Nobel Measurement Method to Measure NVR in Real Time in an Ambient Condition Utilizing **Twin-TQCM Sensor**

Eiji Miyazaki, Yuta Tsuchiya (JAXA)

Hiroyuki Kukita, and Tsuyoshi Shiobara (NDK, Nihon Dempa Kogyo)

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Agenda

- NVR measurement
- Purpose
- Experimental procedure
- Results
- Discussion
- Conclusion

NVR Measurement

NVR Measurement

- **NVR, Non-volatile Residue**, is one of contamination issues even at AIT phase in ambient condition. NVR is originated from atmospheric air, resulted from deposition of molecular contaminant in room air on surfaces.
- In order to measure NVR, **ASTM E 1235** “Standard Test Method for Gravimetric Determination of Nonvolatile Residue (NVR) in Environmentally Controlled Areas for Spacecraft” is established and applied.

NVR Measurement

- Based on the standard **ASTM E 1235**, plates or mirrors are used to measure NVR.
 - Sampling plates or mirrors are placed in the clean room where AIT are carried out.
 - **Usually, the plates or mirrors are exposed to the environment for week(s) to get enough amount of NVR contaminant for measurement.**
 - The NVR-deposited plates are rinsed by solvent, then the NVR are analyzed by both quantitatively and qualitatively.
 - The NVR-deposited mirror are analyzed optically, e.g., IR absorption spectrum, to obtain qualitative information of NVR contaminant.

NVR Measurement

- The method is conventional, however, the measured data can be obtained after week(s) exposure.
- In addition, the analysis can take additional week(s) to obtain the results.



**In case bad results are obtained,
can we find out what happened during the measurement?**



Purpose

Purpose

- NVR should be measured in real time, in order to find out what happened during measurement.
- Then, we could take measures to eliminate the cause and/or origin of deposited NVR.
 - Thing, Event, etc.
- We have thought that QCM, Quartz Crystal Microbalance, sensor can be utilized to measure NVR in real time.
- **In this presentation, Twin-TQCM sensor was applied for the NVR real time measurement.**

Experimental Procedure

Experimental Procedure

■ Measuring device:

Twin-TQCM, manufactured by Nihon Dempa Kogyo, NDK.

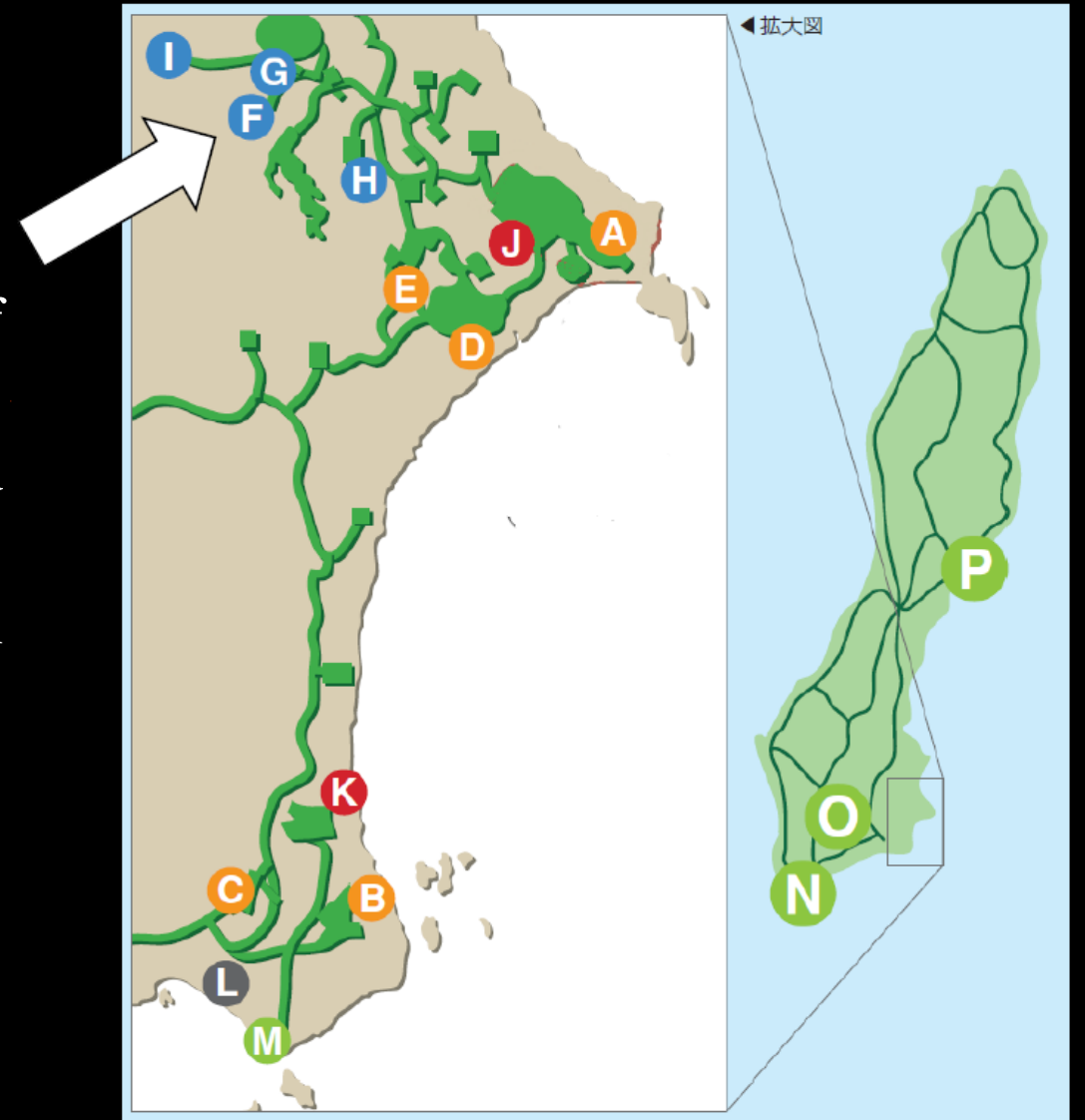
- Precise temperature control
- Temperature at sensing: kept at 20 degrees C
- Measurement duration: 16 days
- Plate measurement was also used for reference.



Experimental Procedure

■ Location

- Tanegashima Space Center, a launch site of JAXA.
- Class 8 clean room at Spacecraft and Fairing Assembly Building
- The experiment carried out in the clean room no S/C, with air conditioning.
 - Temperature: 15 ~ 25 degrees C
 - Relative Humidity: 40 ~ 60 %

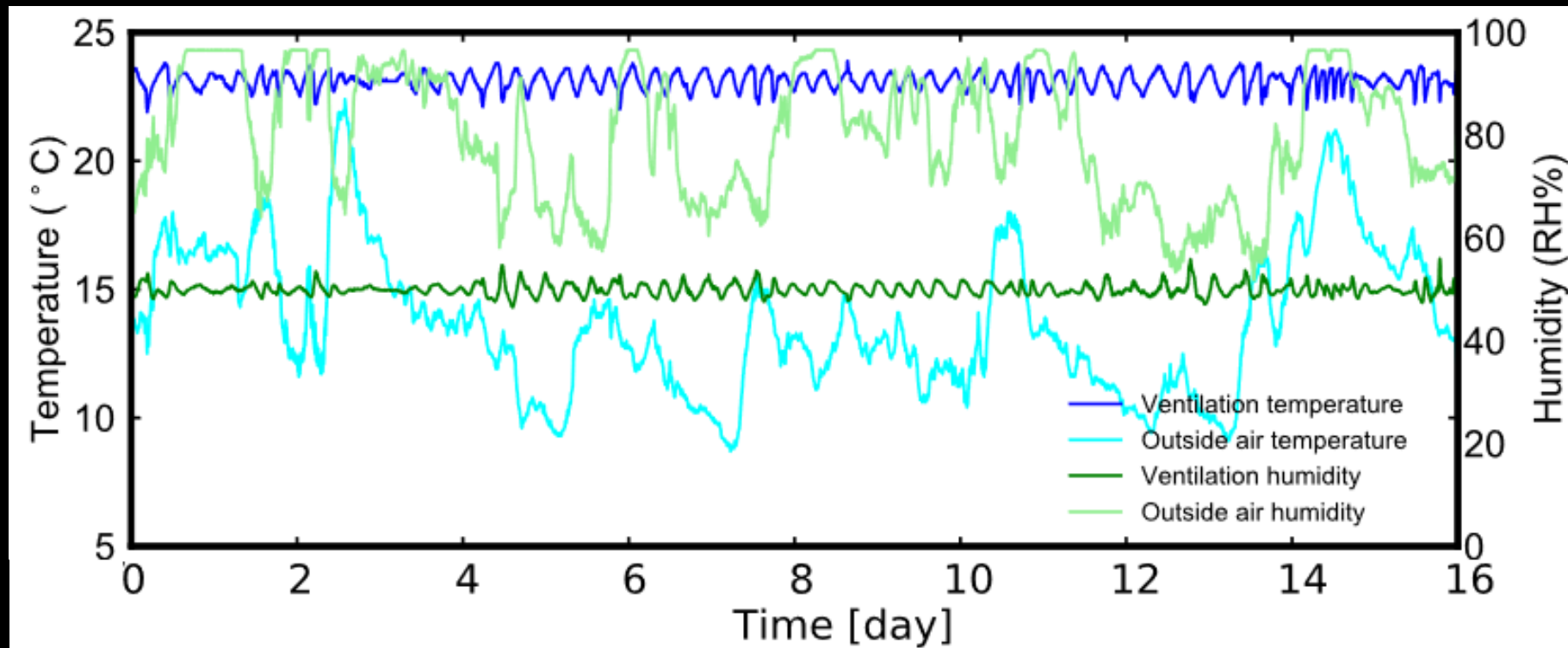


Results

Results

■ Ambient condition

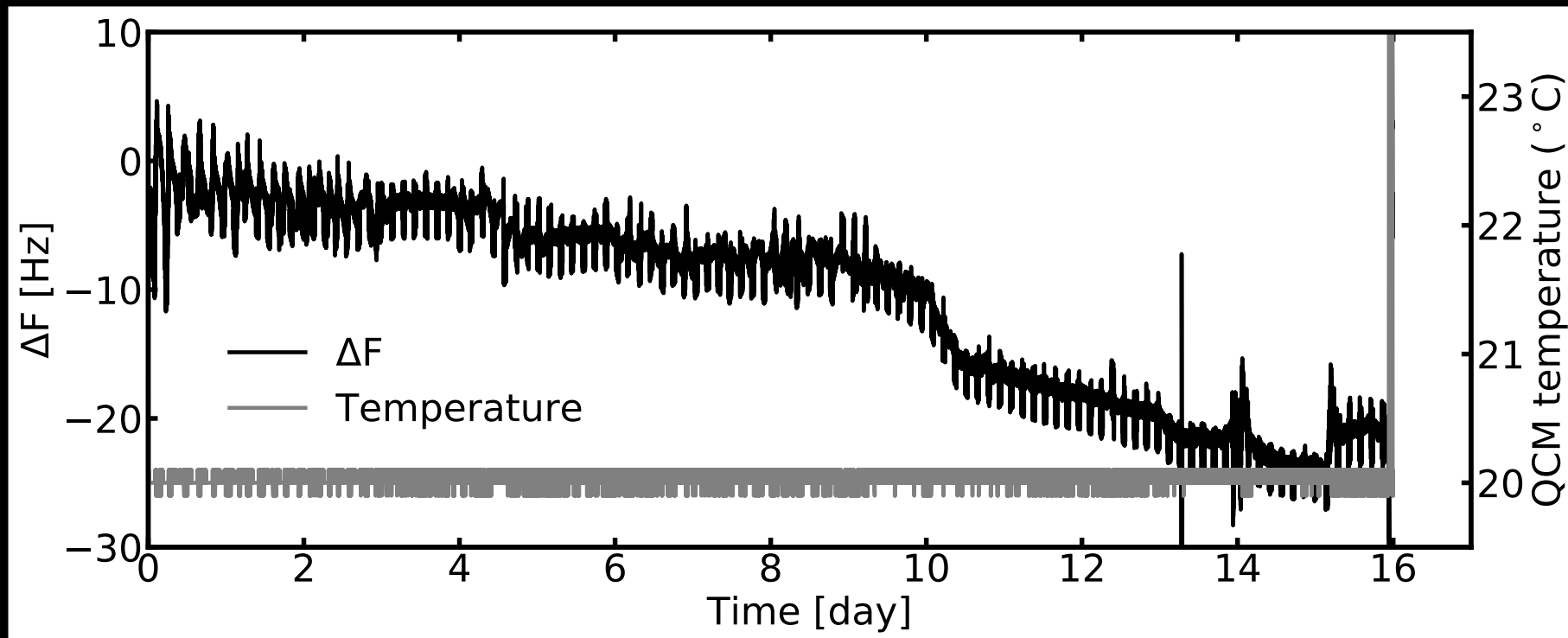
- Stable temperature / relative humidity condition were established by air conditioner.



Results

■ Output from **Twin-TQCM**

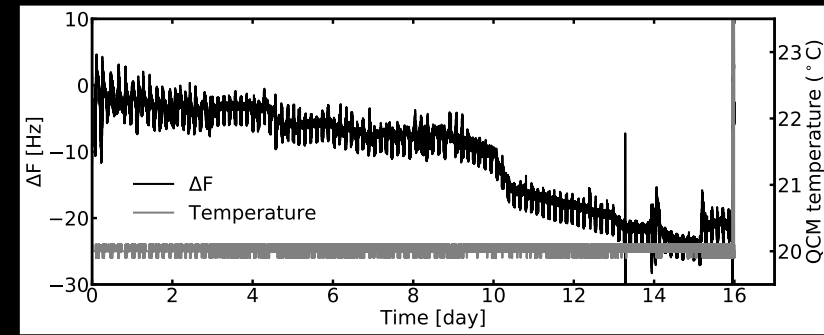
- Stable output was obtained for 16-day continuous measurement.
- Temperature control was also stable.



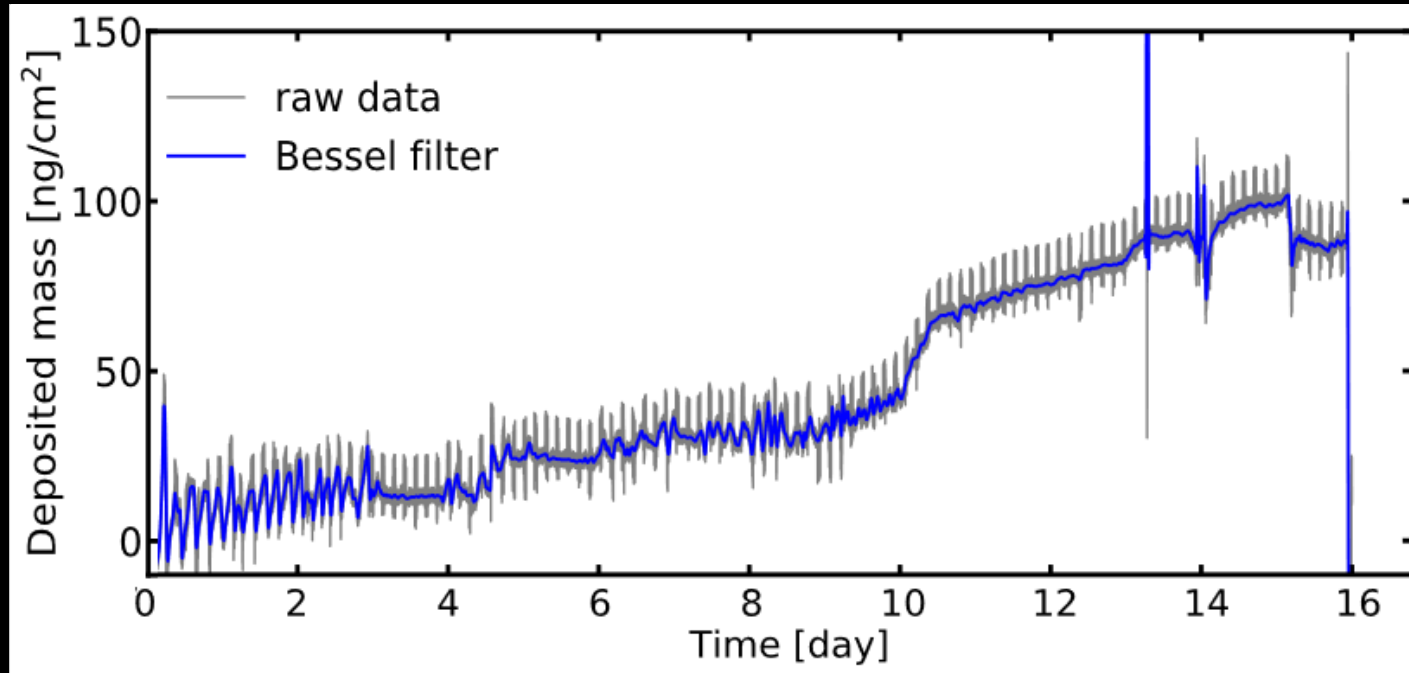
Results

■ Deposited mass

- Calculated from the output.
- Deposition mass increased as time elapsed.



$$\Delta m = \frac{\Delta f}{\alpha} \quad \alpha = 2.39 \times 10^8 \text{ [(Hz/g)cm}^2\text{]}$$



Results

■NVR plate analysis

- Quantitative measurement results were shown on the table:

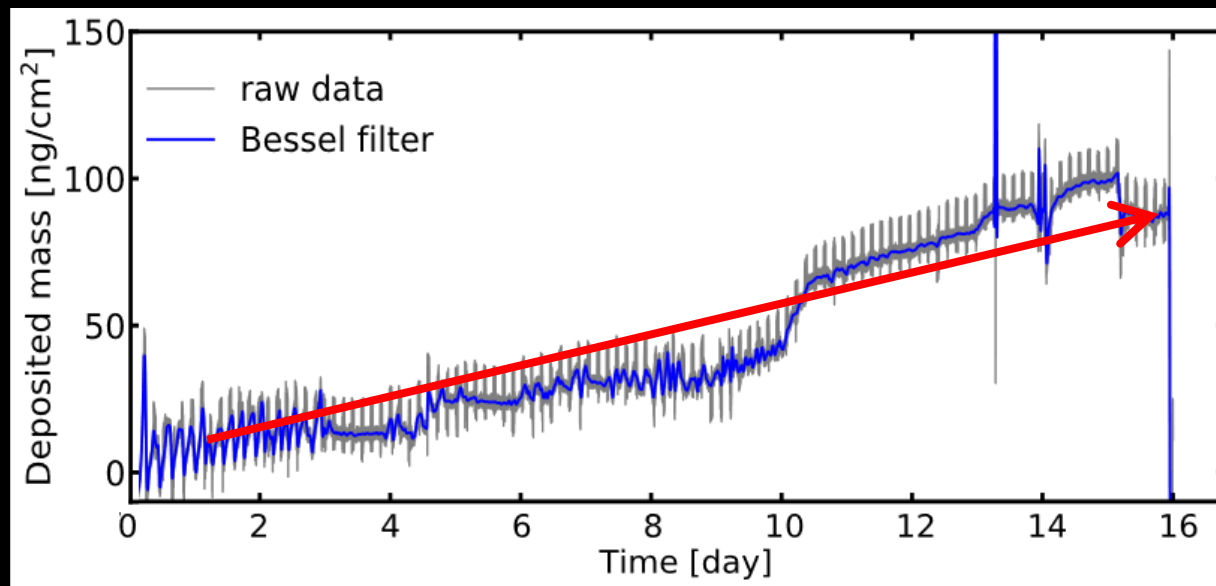
Surface area of NVR plate [m ²]	Measured mass of NVR [mg]	NVR amount per area [mg/0.1m ²] (=mg/ft ²)
0.0929	0.010	0.011

- Qualitative analysis results:
 - Paraffins, Phthalates

Discussion

Discussion

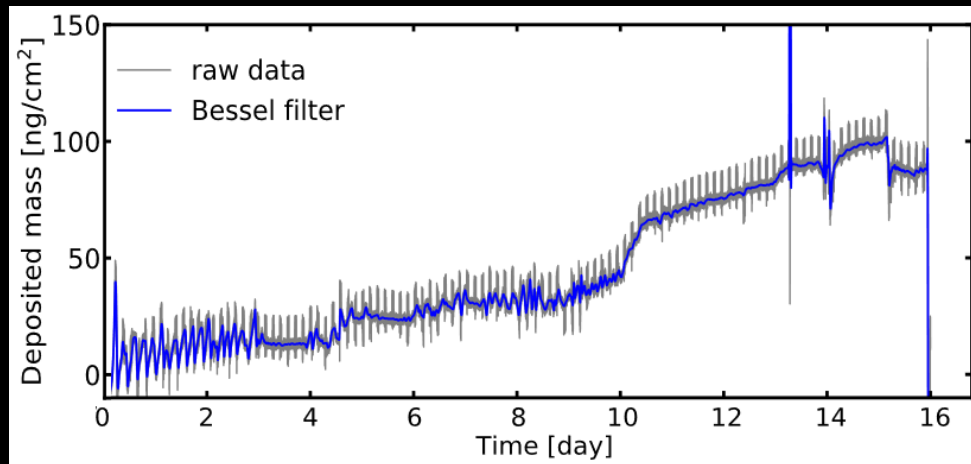
- Comparison between the results obtained by **Twin-TQCM** and NVR plate
 - Total amount of deposited mass measured by Twin-TQCM was **59.1[ng/cm²]**.
 - **59.1 [ng/cm²]** can be calculated as **0.059 [mg/0.1m²]**, unit of NVR plate.



**Deposited mass
= 59.1[ng/cm²]**

Discussion

- Comparison between the results obtained by **Twin-TQCM** and NVR plate
 - The results were in the same order, however, 5 times difference was observed.
 - It is found that **Twin-TQCM** can measure NVR deposition in real time.



Twin-TQCM [mg/0.1m ²]	NVR plate [mg/0.1m ²]
0.059	0.011

This result suggests that real time NVR measurement by **Twin-TQCM** is possible, opening new methods for NVR control in ambient condition during AIT phase.

Conclusion

Conclusion

- In the present study, Twin-TQCM sensor was applied for the measurement.
- As a result, it is found that Twin-TQCM has a capability to measure NVR in real time. The measured quantity is in the same order between both results.
- On the other hand, the measured amount of Twin-TQCM is 5 times higher than that of NVR plate. It is necessary to further investigate to improve the quantitative accuracy.

Acknowledgments

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Thank you very much for your attention.

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