

The background of the slide is a photograph of a modern, multi-story building with a light-colored facade and large windows. The building is identified as the Cyberscience Center at Tohoku University. The sky is blue with some light clouds.

Operational experience of the largest vector supercomputer, **AOBA-S.**

**May 13, 2025
NUG Society Meeting 36**

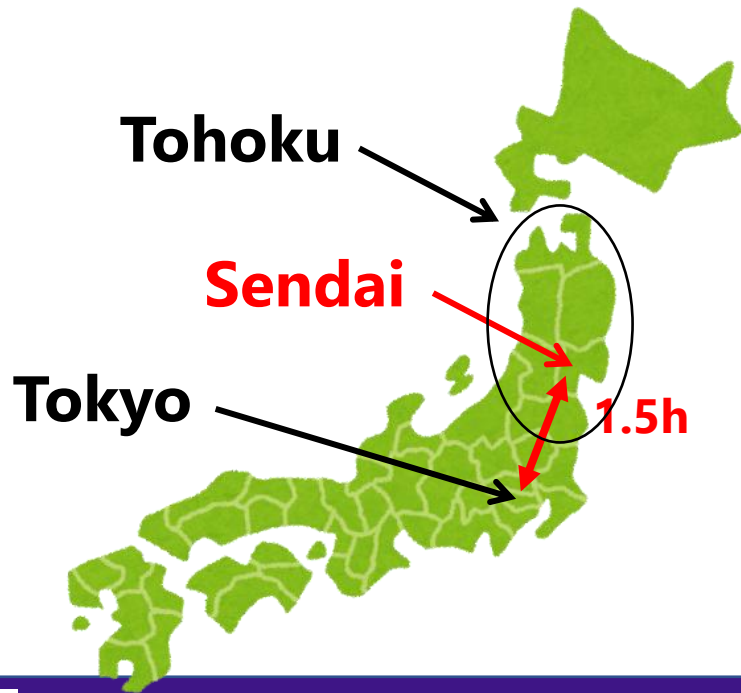
**Cyberscience Center, Tohoku University
Hiroyuki Takizawa
<takizawa@tohoku.ac.jp>**

Tohoku University 東北大学

- Tohoku University was established as Japan's third national university in 1907. Located on the ancient site of Aoba Castle in Sendai City, Tohoku University is proud to be ranked among Japan's leading universities.

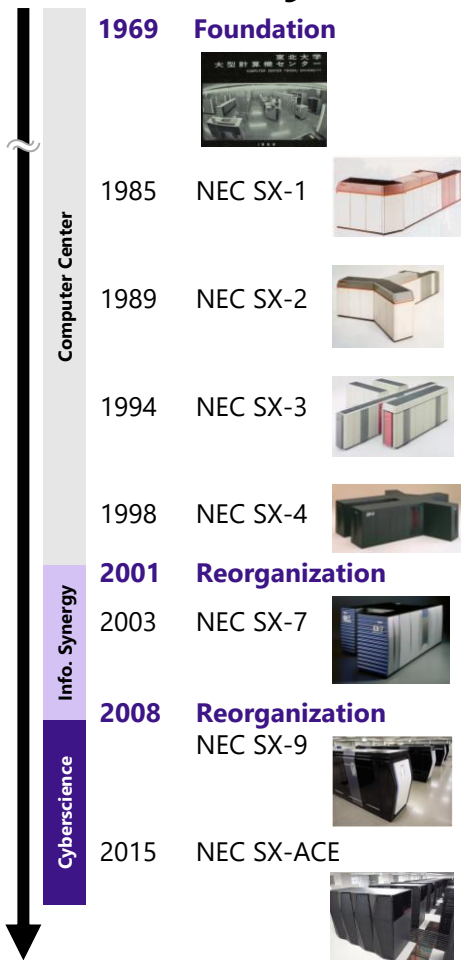
(<https://www.tohoku.ac.jp/en/about/index.html>)

17,685 Students
3,145 Faculty Staffs



History and Missions of CSC Tohoku-U

- History



- Missions of **Cyberscience Center**

- Offering leading-edge computing environments to academic users nationwide in Japan**

- 24/7 service of **Supercomputer AOBA**
- **1,688 users** (as of March 2025)

- User supports

- Benchmarking, analyzing, and tuning users' programs
- Presenting seminars and lectures on supercomputing



AOBA (2020)

- R&D on supercomputing**

- Joint research projects with users and NEC on HPC
- Designing next-generation high-performance computing systems and their applications for **highly-productive supercomputing**

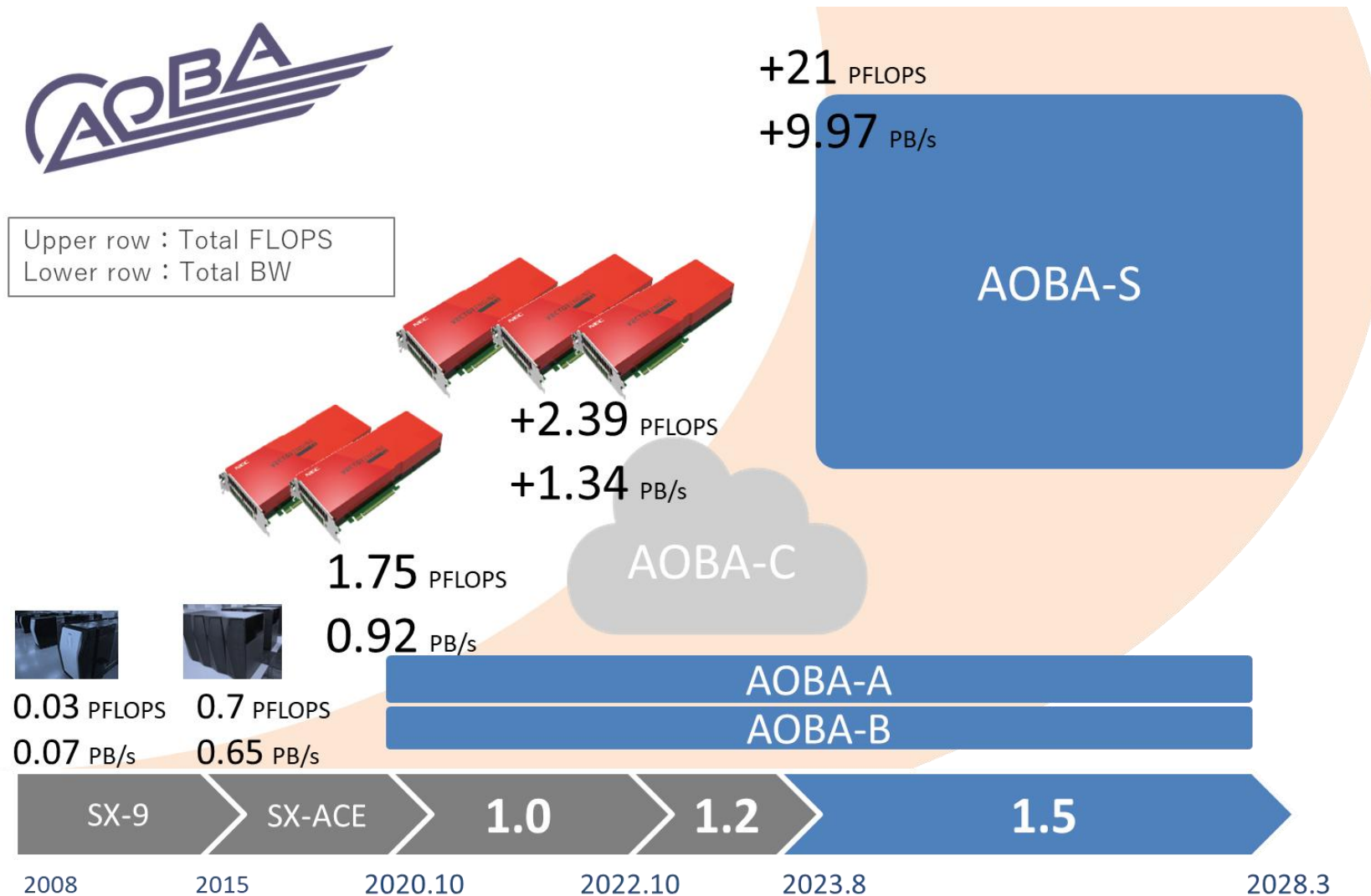
- Education**

- Teaching and supervising BS, MS and Ph.D. Students

System Updates



Upper row : Total FLOPS
Lower row : Total BW



HPL and HPCG Benchmarks

- They are **two extremes** for benchmarking HPC systems



High Performance Linpack (HPL)

solving a dense system of linear equations.

HPL performance is well correlated with **theoretical peak flop/s rate** of the system.

**76th in TOP500 List as of Nov 2024
(8th in Japan)**

High Performance Conjugate Gradient (HPCG)

solving a sparse system of linear equations.

HPCG is intended as a complement to HPL, and the HPCG performance is heavily influenced by **memory bandwidth** of the system.

**12th in HPCG List as of Nov 2024
(2nd in Japan)**

The Most Powerful **Vector** Supercomputer!

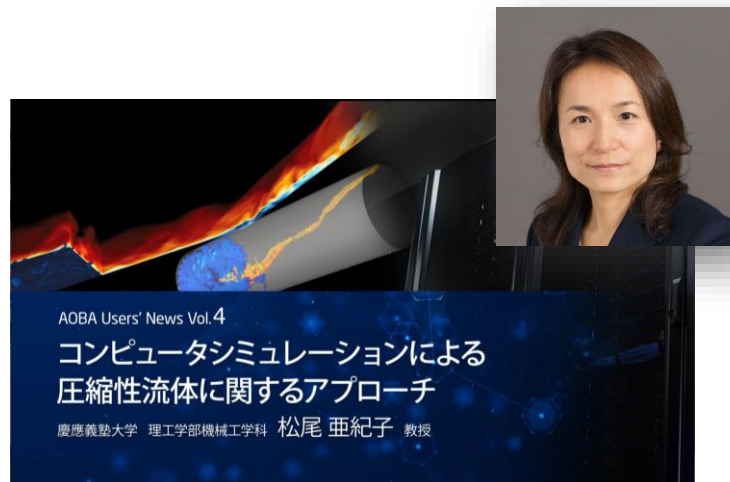
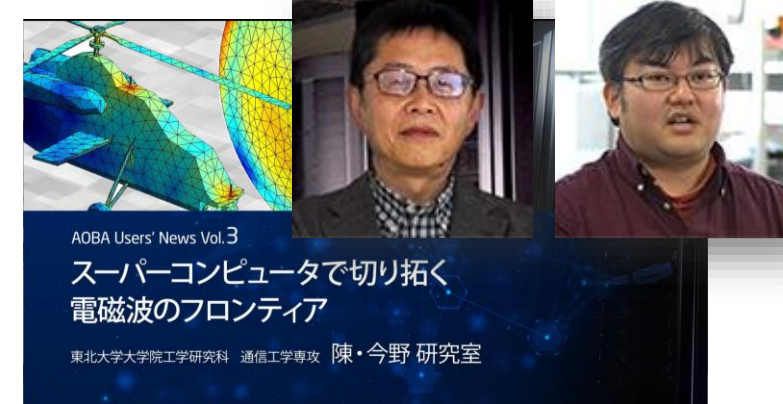
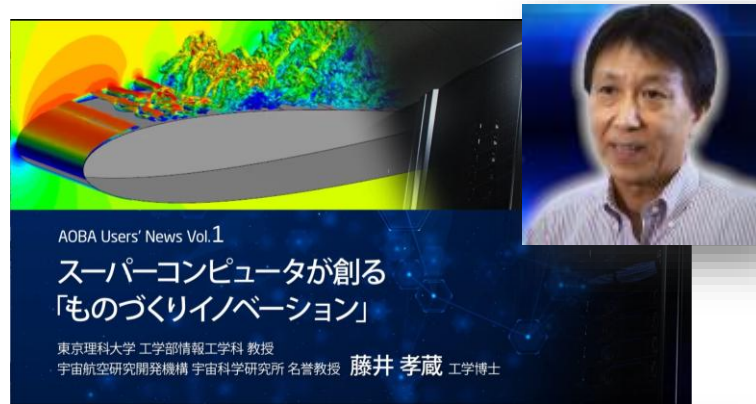
(As of Nov 2024)



Very efficient for memory-intensive workloads

Takahashi et al: Performance Evaluation of a Next-Generation SX-Aurora TSUBASA Vector Supercomputer, International Conference on High Performance Computing (ISC'23), pp.359-378, 2023.

AOBA Users' News (AOBAの杜)



<https://www.cc.tohoku.ac.jp/usersnews/>

Concept of “Connected Supercomputing”

- **Connected Supercomputer** = a supercomputer with batch job scheduling connected to external data sources

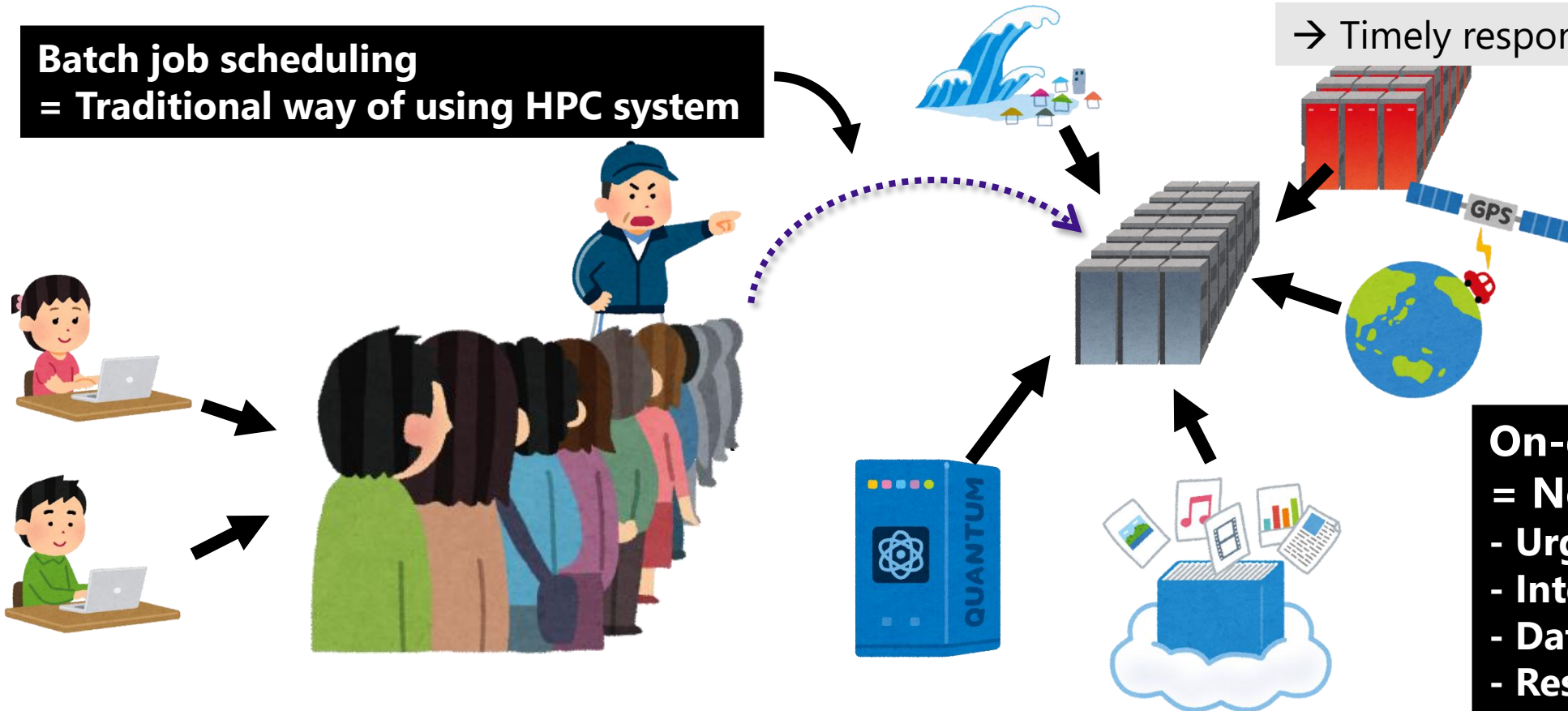
Batch job scheduling
= Traditional way of using HPC system

→ Timely response to real-world events!

External factors could dynamically affect the resource management.

On-demand job execution
= New ways of HPC usage

- Urgent computing
- Interactive computing
- Data streaming
- Resource sharing, etc

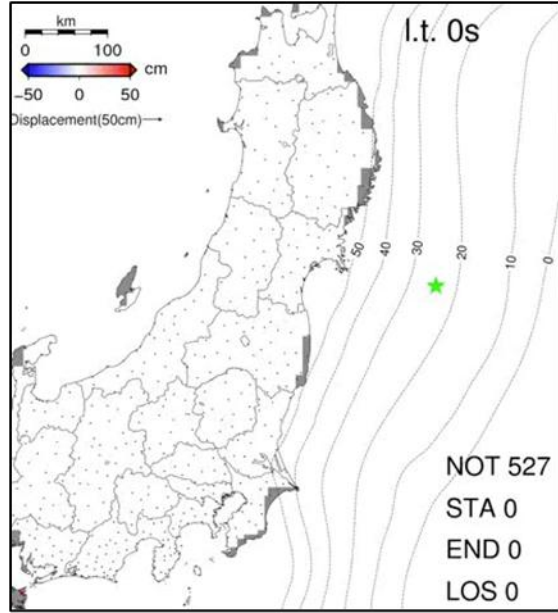


Full-automatic real-time estimation of tsunami damage

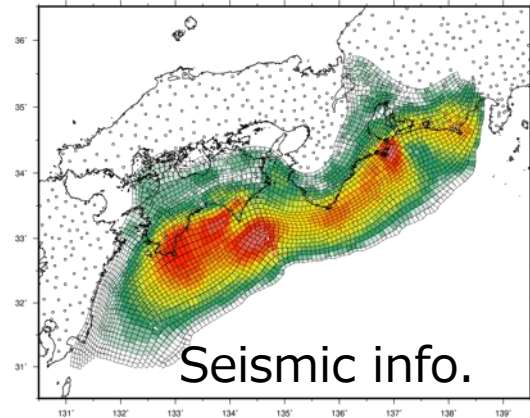
Courtesy of Prof. Koshimura

>7min (present)

>3min (target)



Real-time estimation of fault model from GEONET data (REGARD; GSI)



>10min (present)

>1min (target)



Real-time simulation on Supercomputer AOBa at Tohoku University with considering current costal facilities and tide height at the occurrence.



>10min (present)

>1min (target)



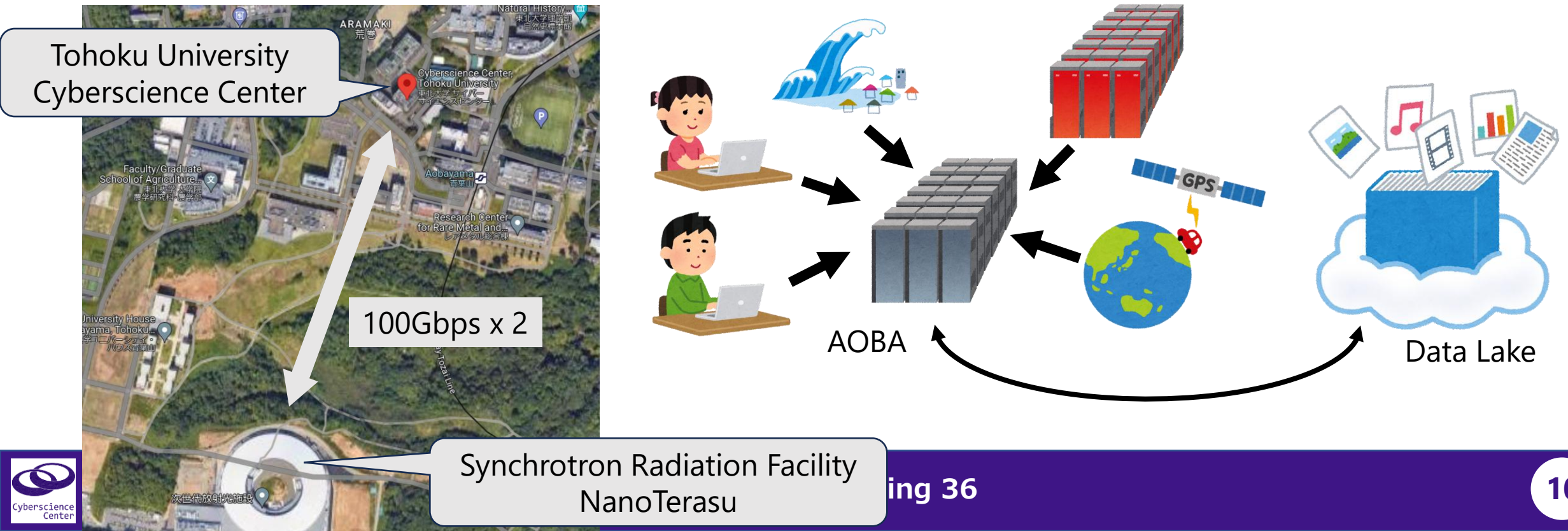
Quantitative estimation of damages



Successfully operated upon every massive earthquake since the operation start

AOBA for Big Data Analysis

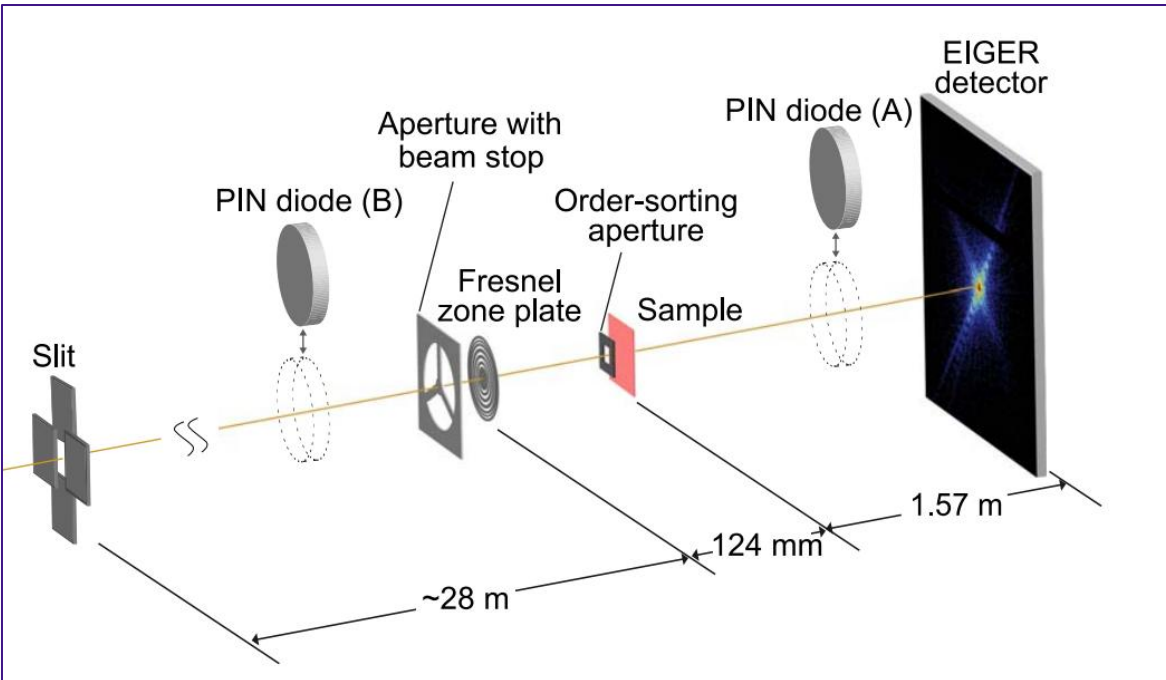
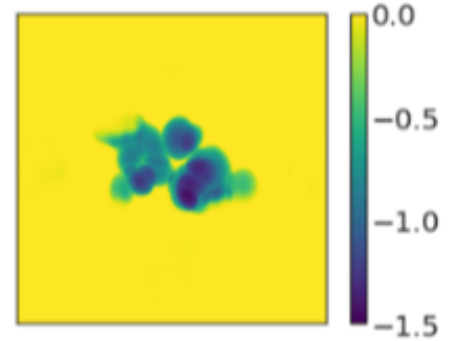
- The most important metric at AOBA system design was memory bandwidth
 - The highest priority is given to efficient execution of numerical simulations
- **AOBA is now expected to work as an infrastructure for data analysis.**



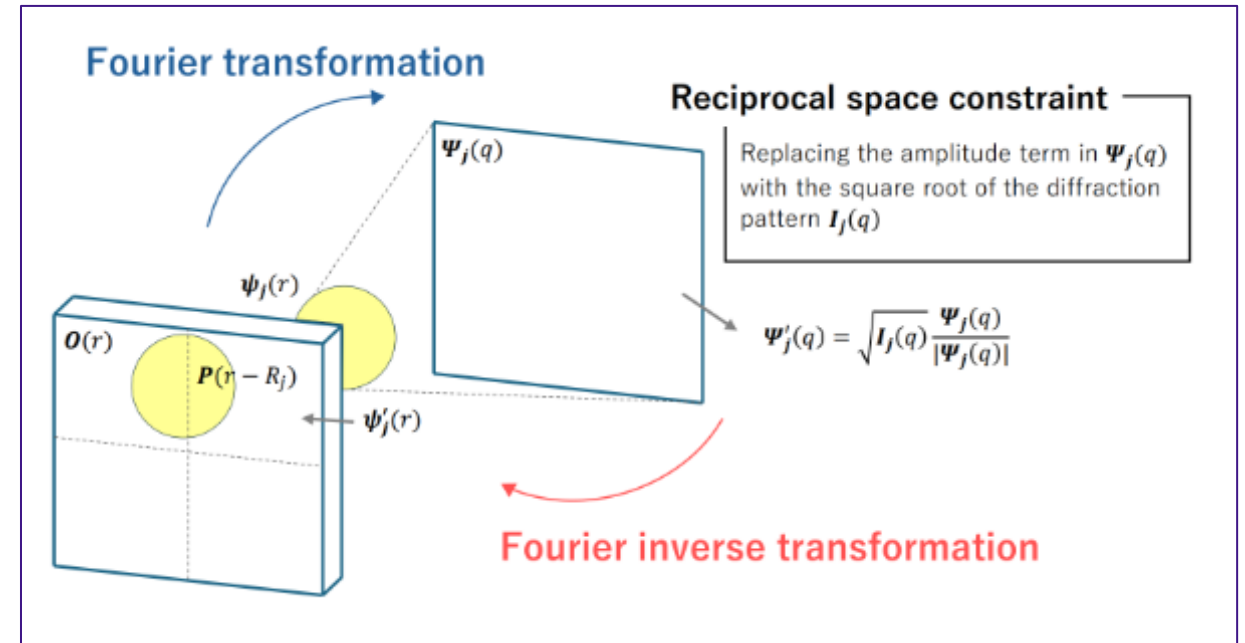
Real-time Data Processing

Visualized image of a nano-scale sample

Diffraction intensity patterns are obtained.
(phase information is not)



Tender X-Ray PCDI at BL10U in NanoTerasu
(Ishiguro et al. 2023)



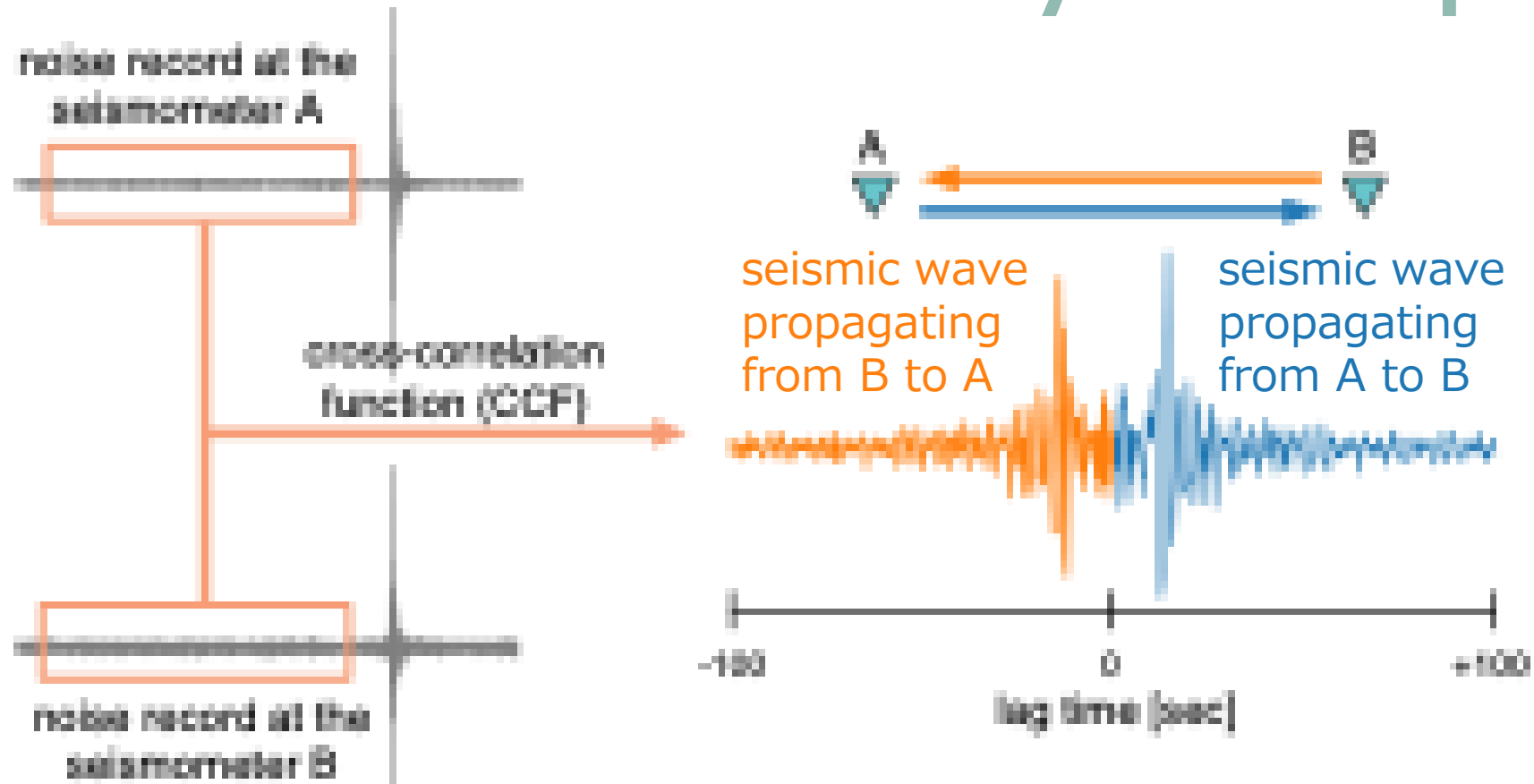
Phase retrieval (ePIE) on **AOBA**

Seismic interferometry analysis of Sakurajima DAS data using Tohoku University “AOBA-S”

Takashi Hirose*, Takeshi Nishimura, Hisashi Nakahara, Kimiko Taguchi, Yoichi Shimomura, Hiroyuki Takizawa (Tohoku Univ.), Haruhisa Nakamichi (Kyoto Univ.), Kentaro Emoto, Kohei Yonemori, Syed Idros Bin Abdul Rahma (Kyushu Univ.)

Acknowledgments: The DAS observations were supported by the Osumi River and National Highway Office, Kyushu Regional Bureau, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The authors thank the Japan Meteorological Agency (JMA) for providing seismic data. We used the supercomputer “AOBA-S” at the Cyberscience Center of Tohoku University for the calculation of seismic ambient noise CCF.

Seismic interferometry technique



Seismic ambient noise cross-correlation function (CCF)

- > Seismic wave propagation between two seismometers
- > Useful tool to estimate subsurface structure beneath volcanoes

The more seismometers (seismic station pairs), the more detailed the subsurface structure can be estimated.

Data

Interogator : ONYX™ peta
(Sintela)

Period : November 20-December
21, 2023

number of channels : 7824

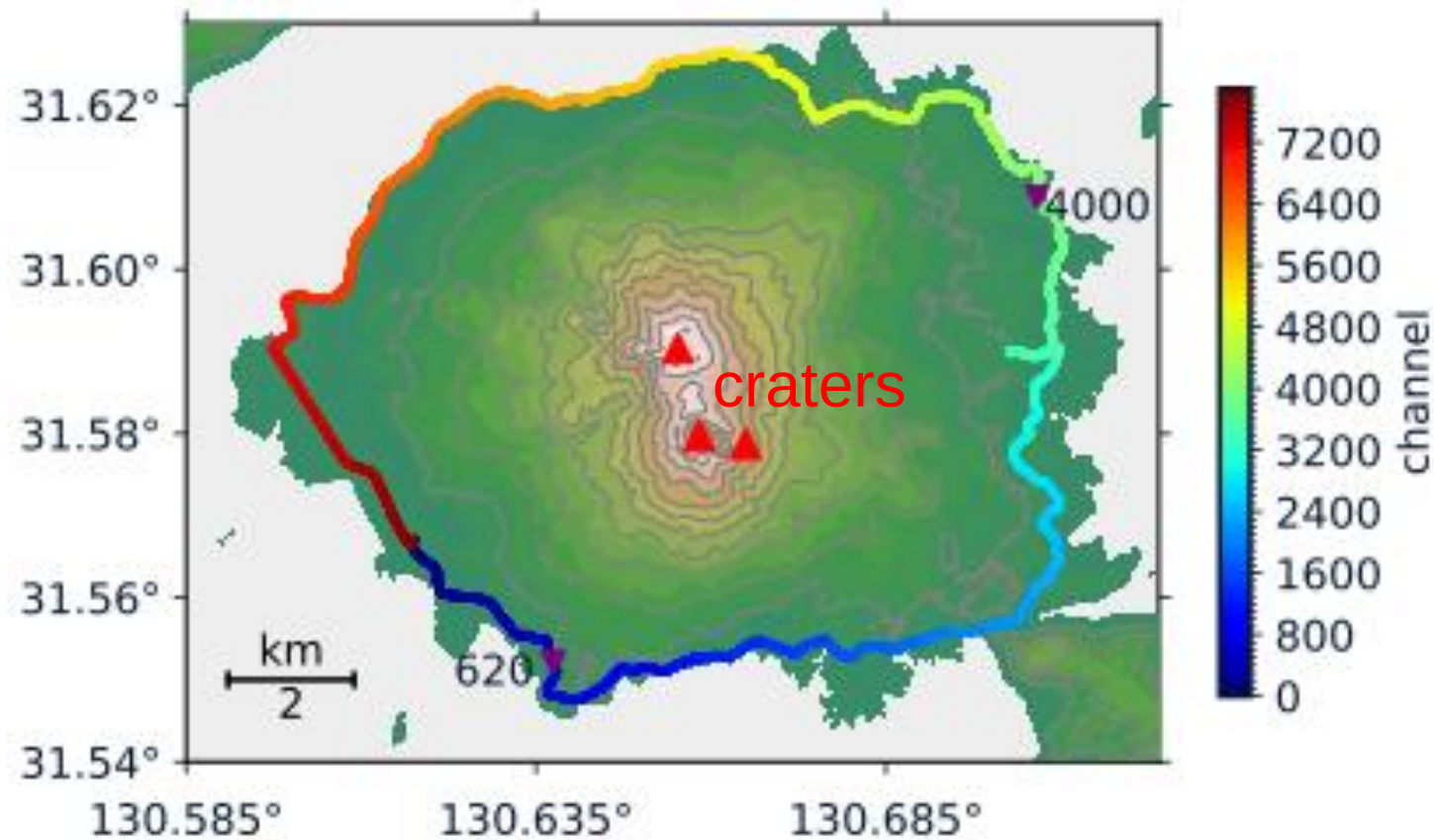
sampling rate : 250 Hz

channel interval : 5 m

gauge length : 10 m

This study used DAS data on
December 1, 2023.

Used channel: 5-7820 (every 5
channel)



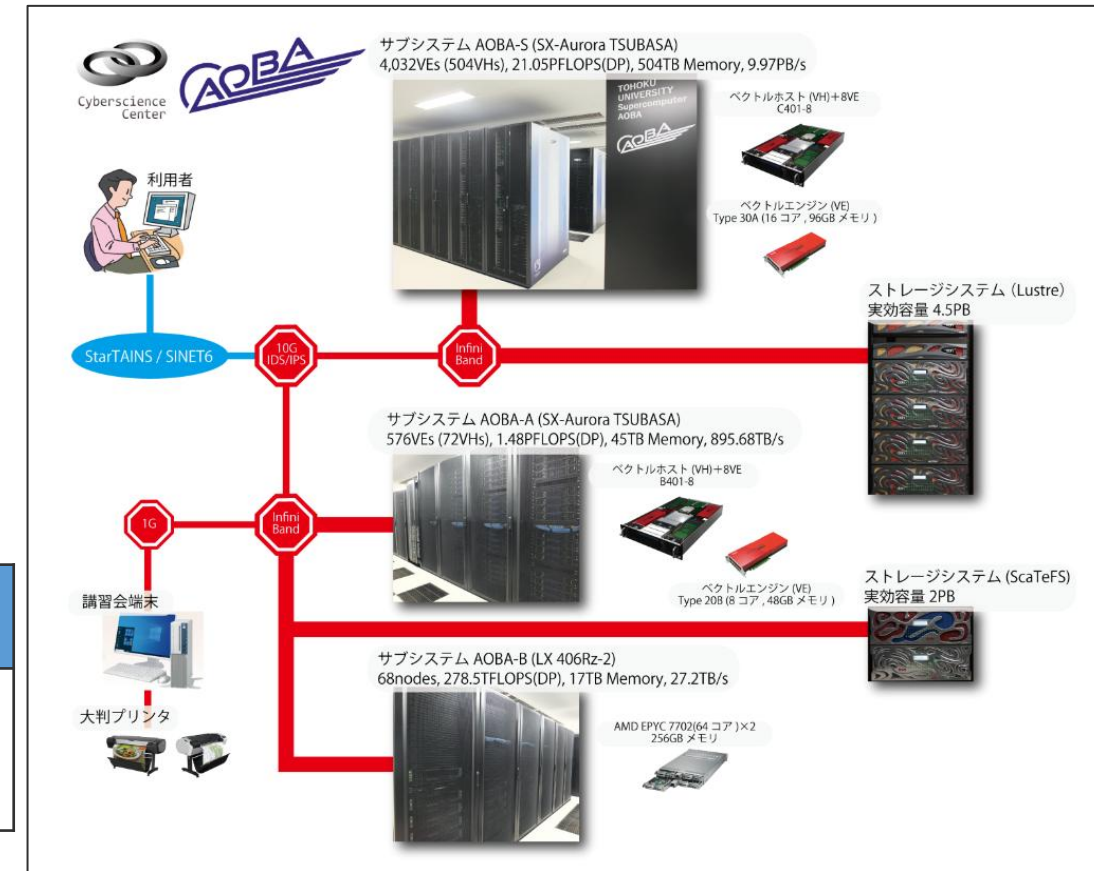
Calculation of seismic ambient noise CCFs using the supercomputer "AOBA-S"

AOBA-S

- High memory bandwidth
- > Memory-intensive applications can be executed at high speed.

calculation time of daily CCFs

	before	After (8 VE)
1,564 channels (1,222,266 pairs)	~1,086 hours (~45 days)	~100 minutes



<https://www.ss.cc.tohoku.ac.jp/>

-> "AOBA-S" can allow real-time monitoring using seismic ambient noise CCFs from numerous channel pairs.



The Cyberscience Center will begin a new data service this year.



It's named “IZUMI”. Followings are the origin of the name:

- Fountain of Knowledge (Japanese for Fountain is Izumi(泉))
- Name of a mountain in Sendai (Izumi-gatake: 泉ヶ岳)
- One of the names of a ward in Sendai city
- Affinity with the name of the Super Computer AOBA (AOBA is also the name of a ward in Sendai city)

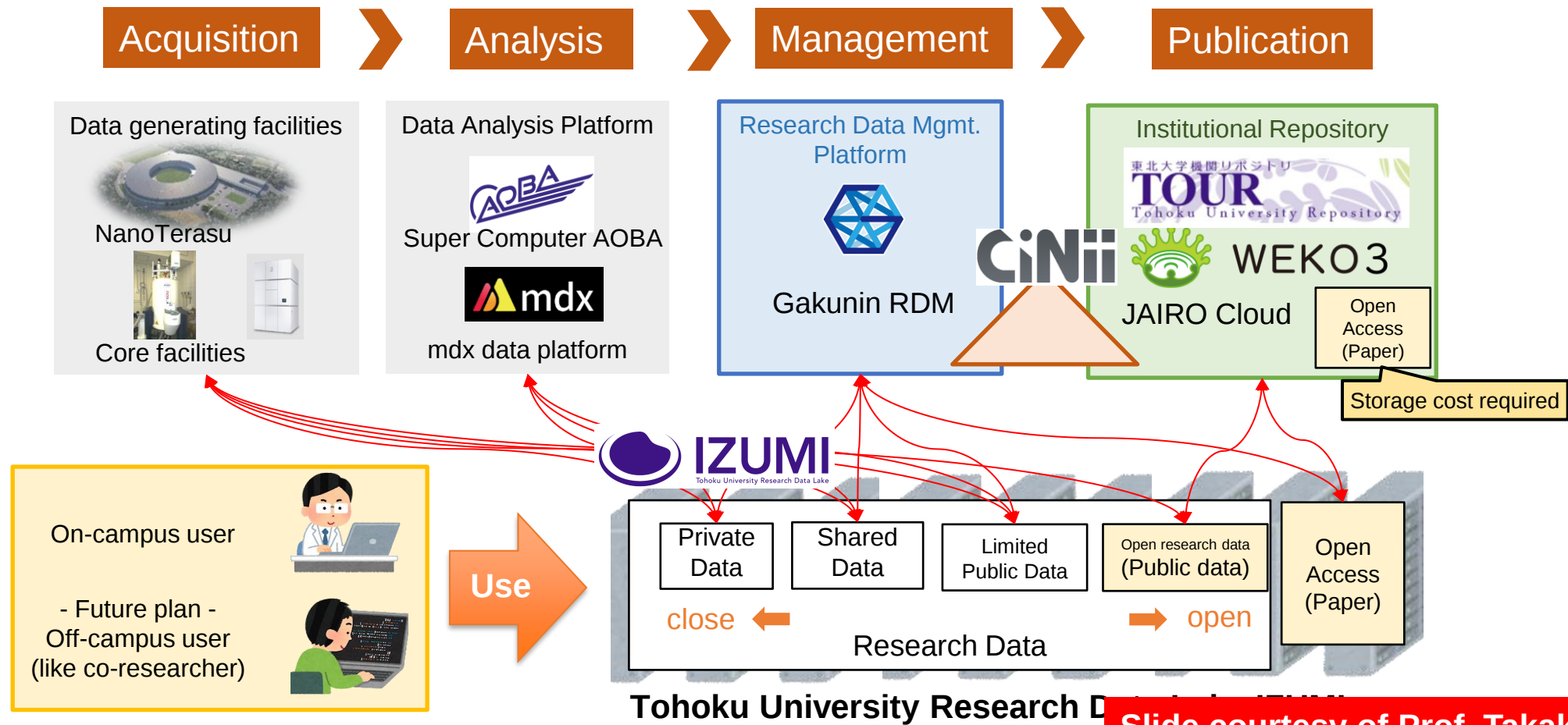




Purpose of Data Lake “IZUMI” installation

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- Research data repositories for various levels of disclosure that contribute to open and close strategy
 - Wide range of public research data to private data available
 - Research-data-centric architecture to prevent silos and data management complexity
- Each researcher can choose to set their own disclosure level by self-service
- Reduce external infrastructure storage costs by placing open papers and data on the data lake side

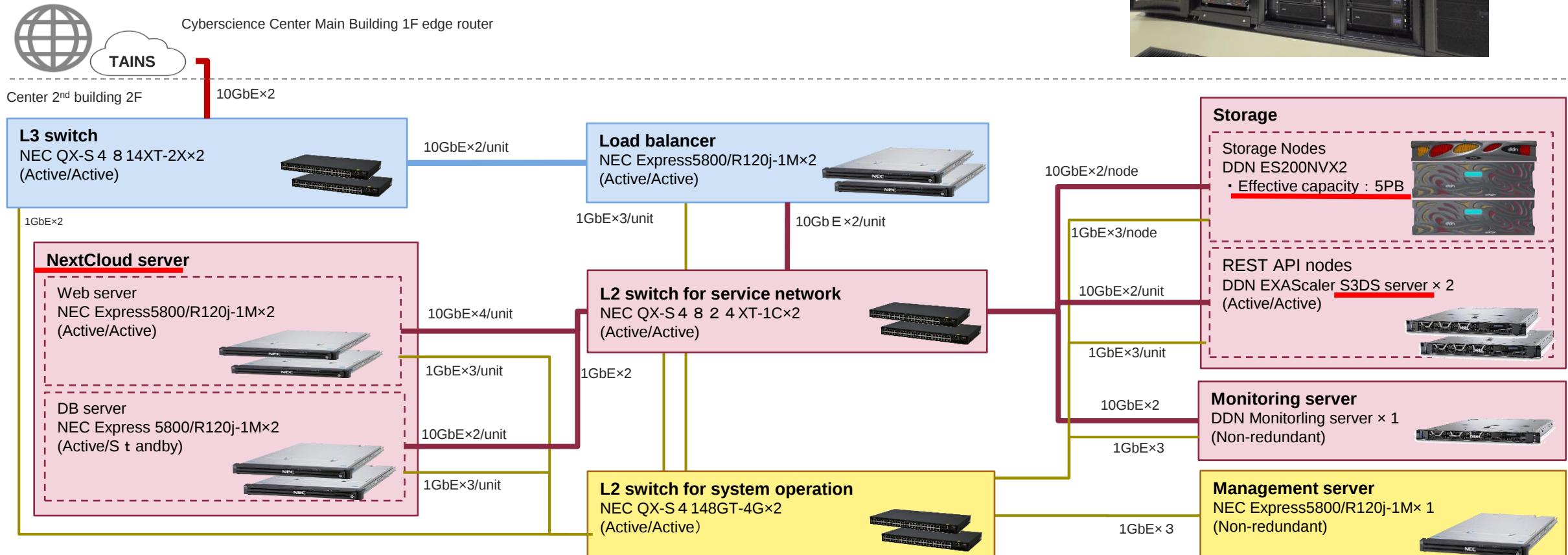




System Configuration of IZUMI

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- Effective Capacity: 5PB
- Web(NextCloud) service and S3 service are available
- Target Users: Teaching/Research Staff (about 3,500 people)



Slide courtesy of Prof. Takaki Nakamura

Summary

- **AOBA-S (2023.8-2028.3)**

- The largest vector supercomputer operating at Tohoku University since 2023.
- Contributing to widely-ranging application areas of numerical simulation that require high memory bandwidths.

- **Connected Supercomputing**

- AOBA-S is now connected to real-world information end events and expected to respond in a timely manner.
 - Tsunami damage estimation in operation
 - Synchrotron Radiation Facility (NanoTerasu)
 - Seismic sensors

- **Data lake IZUMI**

- Data platform for resource data management at Tohoku University
 - Prof. Takaki Nakamura is leading the operation, working together with NEC.