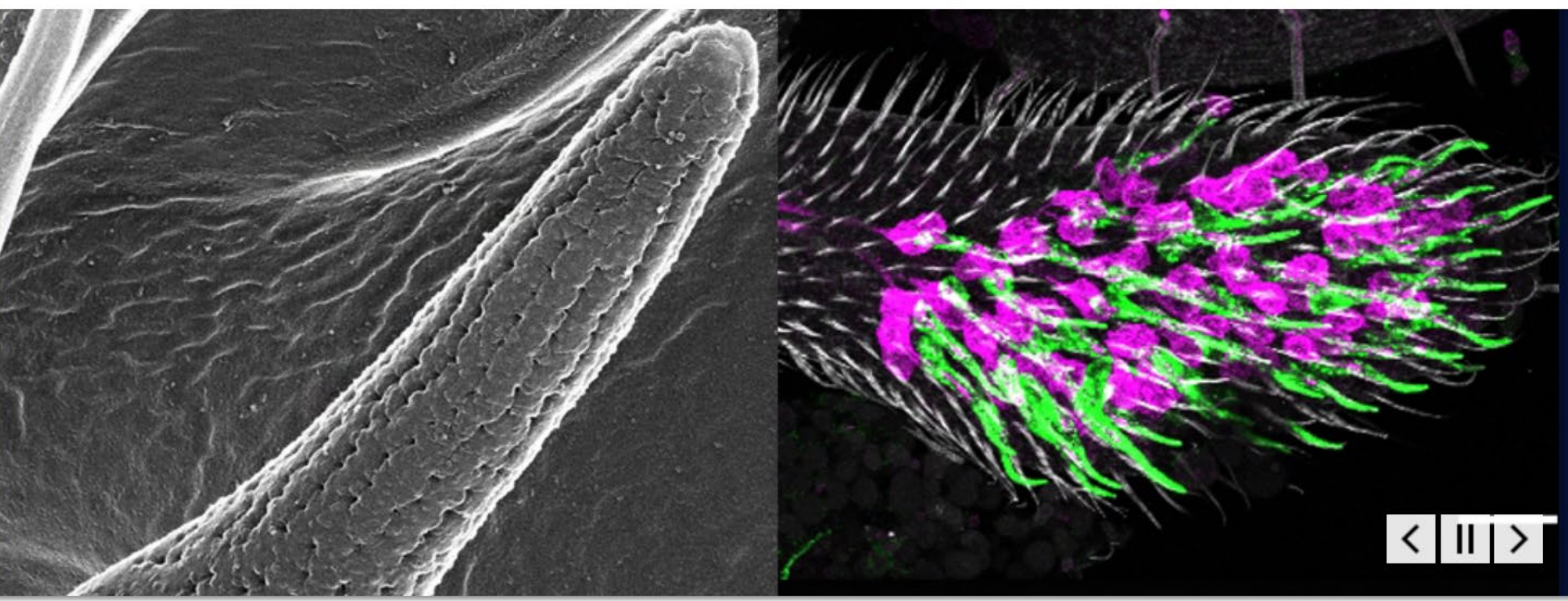


RIKEN
Center for
Computational
Science

A wide-angle photograph of the RIKEN Center for Computational Science building. The building is a modern, multi-story structure with a combination of grey panels and large glass windows. The Japanese text '理化学研究所' (RIKEN) is visible on the upper part of the building. In the foreground, there is a paved area with some young trees and a small monument. The sky is clear and blue.

Toshiyuki Imamura

8 July 2019, IHPCSS2019, Kobe, Japan



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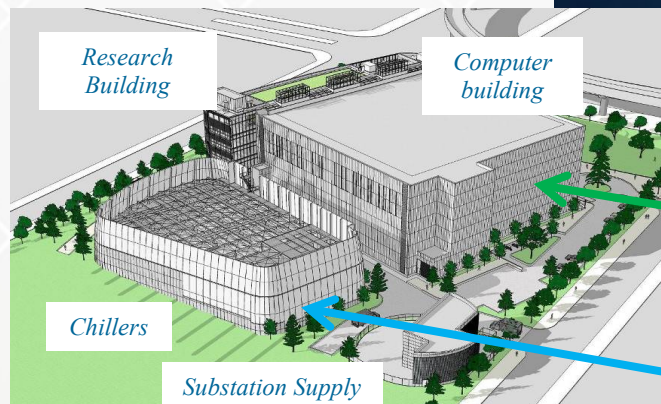
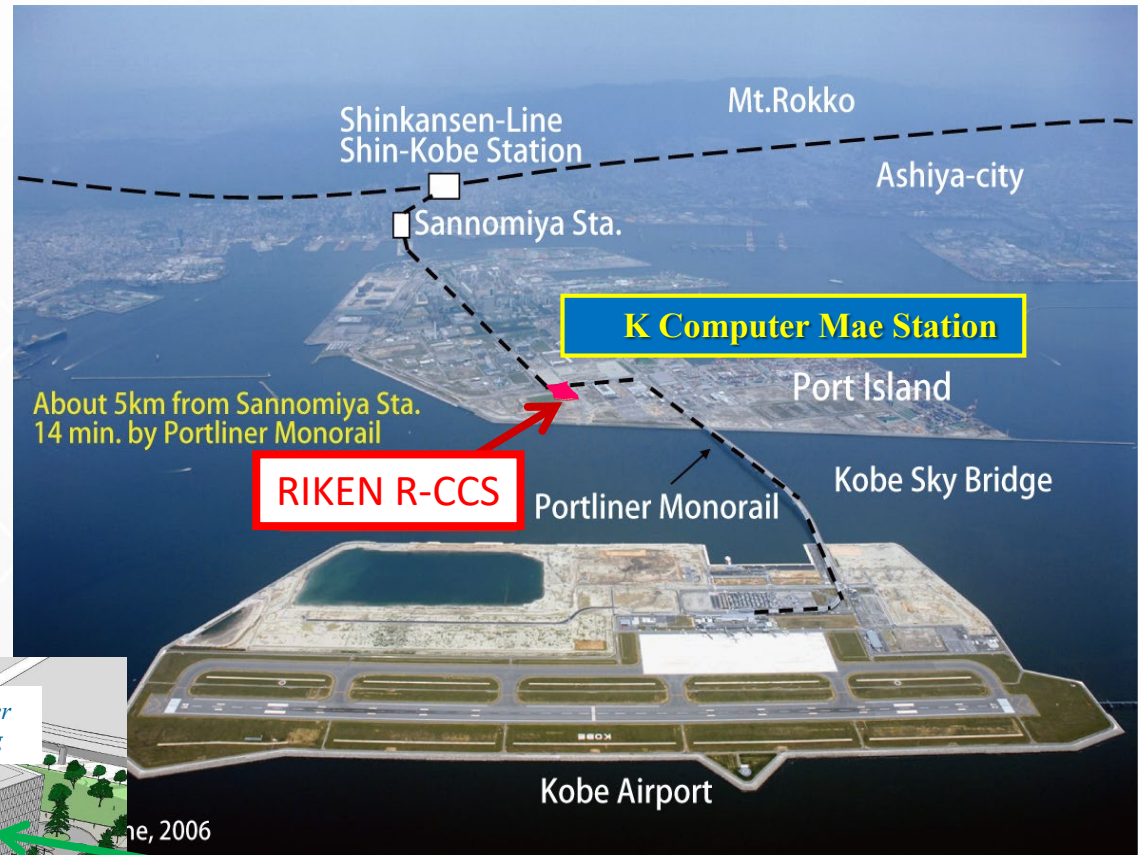
RIKEN Research

Analyzing chromatin

R-CCS with K Computer



423 km (263 miles)
west of Tokyo



Computer room
 $50\text{m} \times 60\text{m} = 3,000\text{m}^2$
Electric power up to 15MW
Water cooling system

Gas-turbine co-generation $5\text{MW} \times 2$

Foundation : July 2010

Missions :

- **Operation of K computer** for research including industry applications
- **Leading edge research** through strong collaborations between computer and computational scientists
- **Development of Japan's future strategy** for computational science, including development of the post K computer

#Personnel : 216 (1 May 2019)



RIKEN
Center for
Computational
Science

Director

Deputy Director

Operations & computer
Technology Division

24

Research Division
19 teams

105

Flagship2020 Project

35

Administration Division

48

K computer

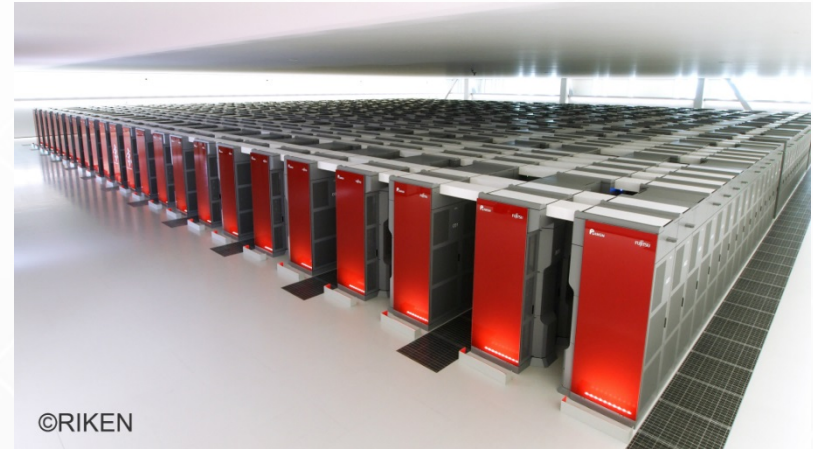
Specifications

- Massively parallel, general purpose supercomputer
- No. of nodes : 88,128
- Peak speed: 11.28 Petaflops
- Memory: 1.27 PB
- Network: 6-dim mesh-torus (Tofu)

Top 500 ranking

LINPACK measures the speed and efficiency of linear equation calculations
Real applications require more complex computations.

- No.1 in Jun. & Nov. 2011
- No.20 in June 2019



Graph 500 ranking

“Big Data” supercomputer ranking
Measures the ability of data-intensive loads

- No. 1 in Jun. & Nov. 2018 & Jun. 2019

HPCG ranking

Measures the speed and efficiency of solving linear equation using HPCG
Better correlate to actual applications

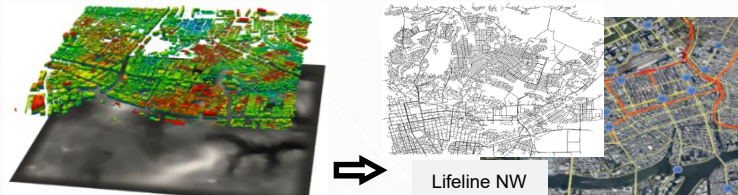
- No. 1 in Nov. 2017, No. 3 in Jun. & Nov. 2018, also Jun. 2019

K computer has a superb balance of processor speed, memory, and network.

This guarantees high performance for whole area of science.

R-CCS Research Highlights

Next generation earthquake hazard and disaster prediction



Construction of digital twin of urban area for earthquake hazard and damage prediction

Disaster in urban area

Recovery from earthquake disaster

World #1 in Graph500 & #3 in HPCG

As of Nov. 2018

- As an outcome of researching and developing the original algorithm for “K”, it acquired the first place 8 times in Graph500 from June 2015 to Nov. 2018 continuously. (9 times in total)
- Consecutive 3 times won the first rank in HPCG from Nov. 2016 to Nov. 2017. It's an indicator of the processing speed by using a computational method for Industry use. The latest ranking is the 3rd place as of Nov. 2018.



Automated optimizations for HPC codes in AMR

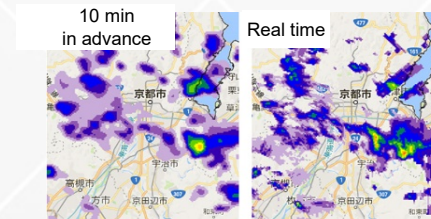
- A framework for more efficient design of applications for use on supercomputers won The Best Paper Award in SC16.



The most prestigious academic award in HPC

Real-time rain forecast via “3D Rainfall Nowcast”

- 250m resolution every 30 seconds, with data and simulation won a prestigious technology award.

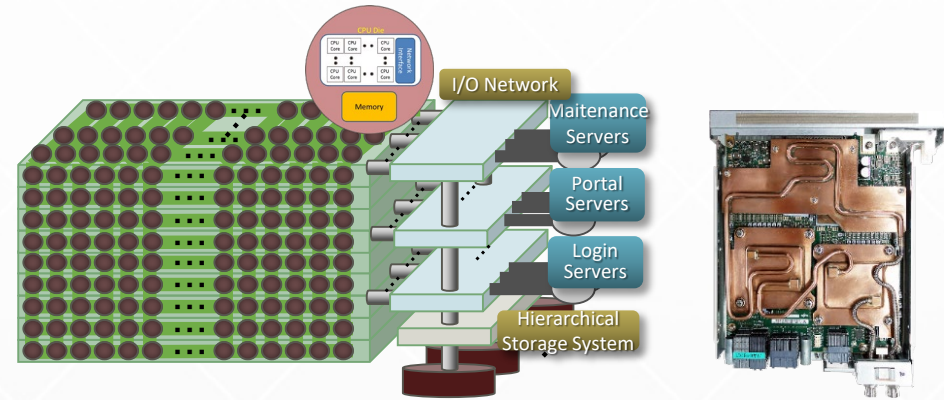


Accurate, on-the-spot weather forecasts for the future

FLAGSHIP2020 Project (Supercomputer Fugaku)

■ Missions

- Building the Japanese national flagship supercomputer, post K (Fugaku), and
- Developing wide range of HPC applications, running on post K (Fugaku), in order to solve social and science issues in Japan

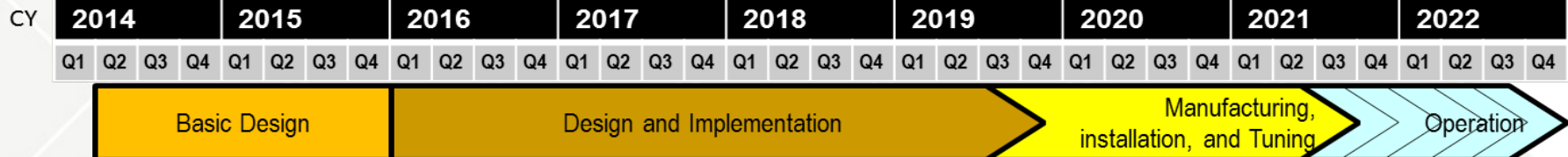
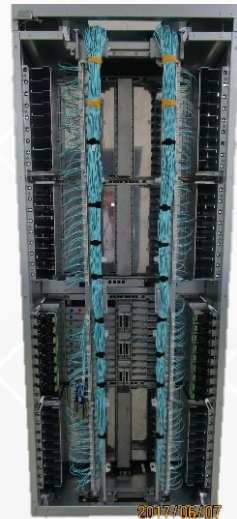


■ Project organization

- Post K Computer (Fugaku) development
- RIKEN R-CCS is in charge of development
- Fujitsu is vendor partner.
- International collaborations: DOE, JLESC, ..
- Applications
 - The government selected 9 social & scientific priority issues and their R&D organizations.

■ Status and Update

- “Basic Design” was finalized and now in “Design and Implementation” phase.
- **Now, we are working on detail evaluation by simulators and compilers**
- We have decided to choose **ARM v8 with SVE as ISA** for post-K manycore processor.
- Some delay of delivery will be expected.



R-CCS Research Teams

Computer Science



System Software
Y. Ishikawa



Programming
Environment
M. Sato



Advanced Processor
Architectures
K. Sano



Parallel Numerical
Technology
T. Imamura



HPC Usability
H. Matsuba



High Performance
Big Data Systems
K. Sato



Next Gen
High Performance
Architecture
M. Kondo



High Performance
AI Systems
S. Matsuoka

Computational Science



Discrete Event
Simulation
N. Ito



Molecular Science
T. Nakajima



Quantum Physics
S. Yunoki



Biophysics
Y. Sugita



Particle-based
Simulations
J. Makino



Climate Science
H. Tomita



HPC
Engineering Applications
M. Tsubokura



Field Theory
Y. Aoki



Disaster Mitigation
& Reduction
S. Oishi



Data Assimilation
T. Miyoshi



Structural Biology
F. Tama

Researcher Development 1

- **International Summer School by PRACE, XSEDE, Compute Canada and RIKEN R-CCS**

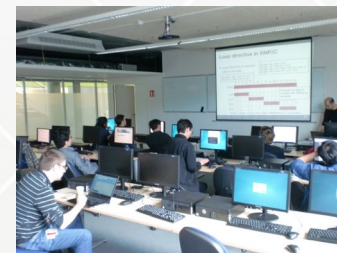
NY(USA) in 2013, Budapest(Hungary) in 2014,
Toronto (Canada) in 2015, Ljubljana(Slovenia) in 2016,
Boulder (US) in 2017, Ostrava(Czech Republic) in 2018
For graduate students and post-docs
79 participants for 2018 event (10 students from Japan)



- **CEA-RIKEN HPC School (2017-) by CEA and RIKEN R-CCS**

The first CEA and Riken school on HPC was hold at
Maison de la Simulation in 2017, 2019.

Riken R-CCS in 2018.



Researcher Development 2

- **RIKEN International HPC Summer School (2018-)**

R-CCS will be holding a summer school to give early career researchers in computational science an opportunity to learn programming techniques for parallel computers, aiming to foster scientists who will lead the field on the international stage in the future.

Scientists from R-CCS will provide lectures and the K computer will be used for hands-on training.



- **KOBE Spring (2014 -) and Summer School (2011 -)**

5 days at Kobe Univ., Hyogo Pref. Univ. or R-CCS to learn basics of programming for parallel computing

For graduate students and post-docs, and technical college students

About 20-30 participants every year



Researcher Development 3

- **International Internship Program (2017 -)**

3 months at R-CCS Research Division

Approximately 5 graduate students will participate



- **R-CCS Youth Workshop Program (2016 -)**

3 days at the R-CCS site

About 20 international young researchers participate

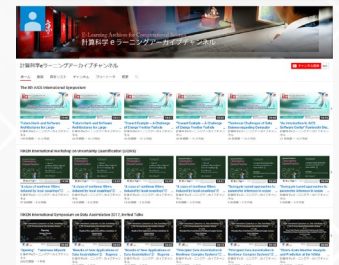
Cooperate with **JLESC (Joint Laboratory on Extreme Scale Computing)** or R-CCS International events.



- **E-Learning Website (2014 -)**

On-line, Videos of lectures, presentations, hands-on and slides on web

Main target is graduate students



Further information

will be provided by face-to-face consulting during this summer school and afterward.

For example,

Fostering programs, internship, schools, job opportunities