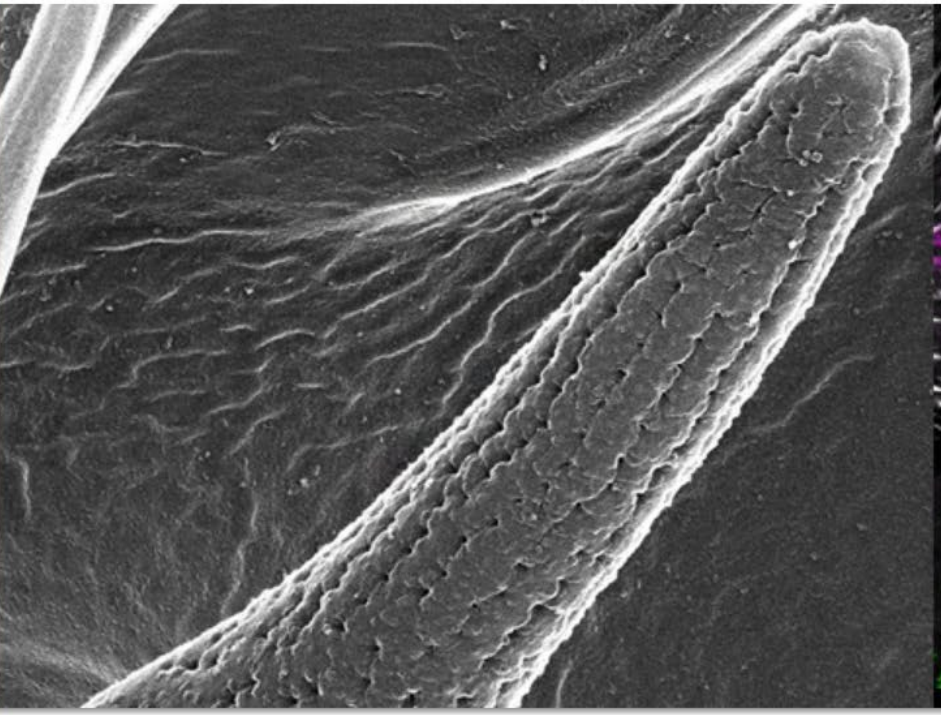
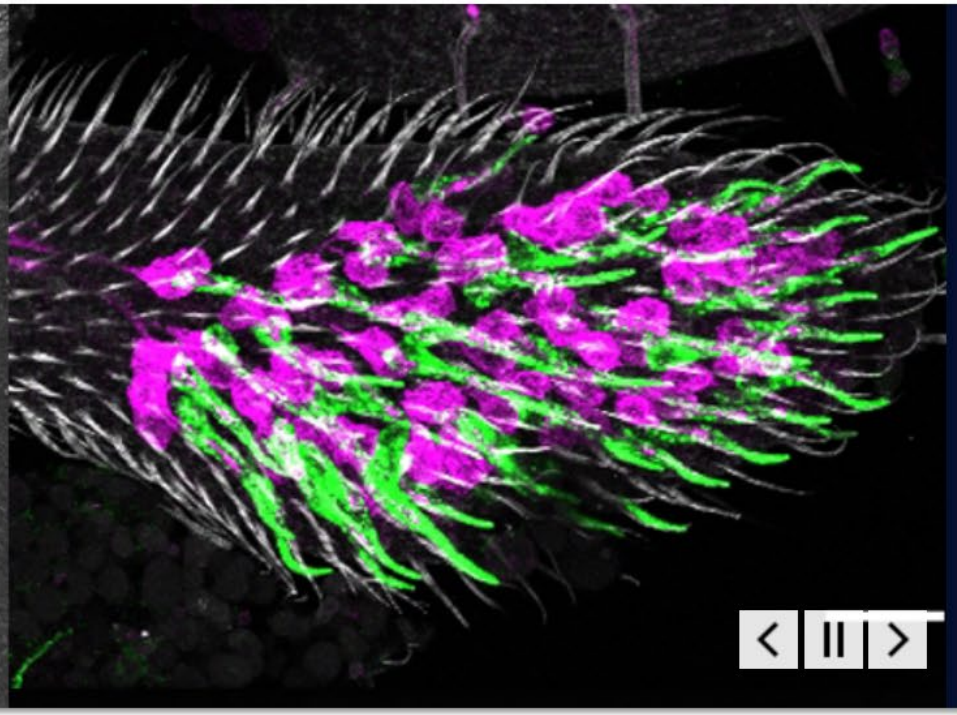
RIKEN Center for Computational Science

Toshiyuki Imamura

8 July 2019, IHPCSS2019, Kobe, Japan





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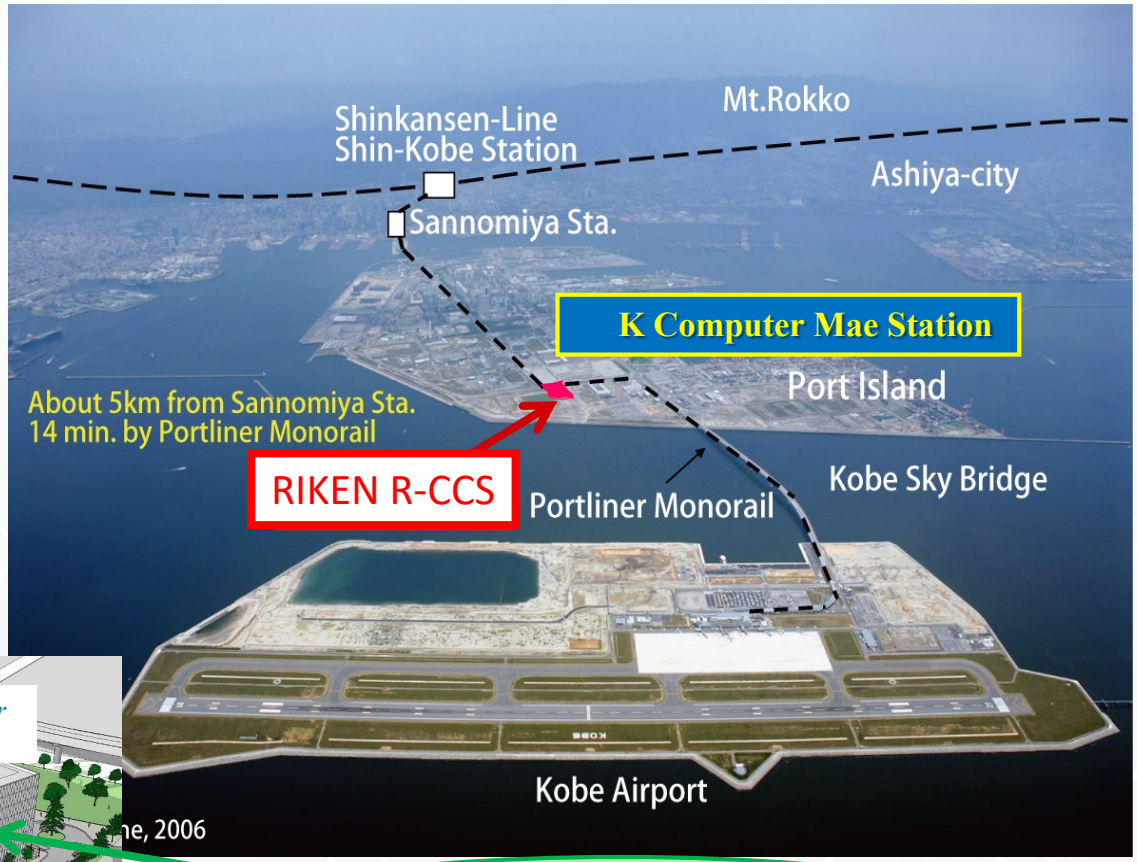
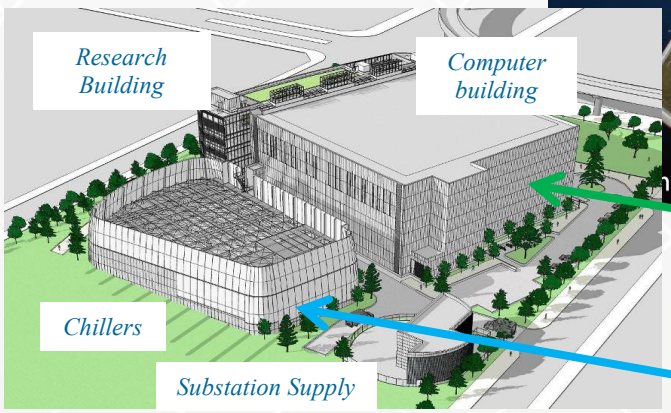
RIKEN Research

Analyzing chromatin

R-CCS with K Computer

423 km (263 miles) west of Tokyo





Computer room
50mx60m=3,000m²
Electric power up to 15MW
Water cooling system

Gas-turbine co-generation 5MW*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)

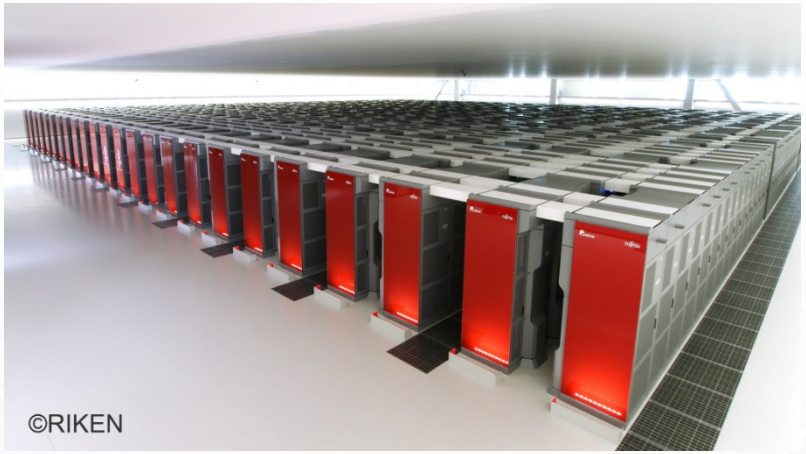
RIKEN Center for Computational Science

K computer

RIKEN R-CCS Computer simulations create the future

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

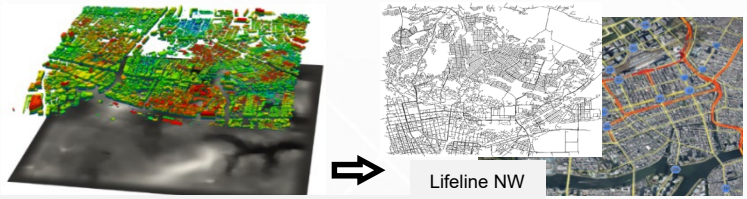
- No. 1 in Nov. 2017, No. 3 in Jun. & Nov. 2018, also Jun. 2019

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

Computer simulations create the future

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.**

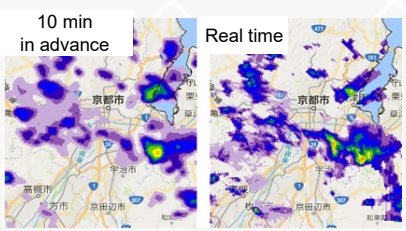
Automated optimizations for HPC codes in AMR

- **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.**



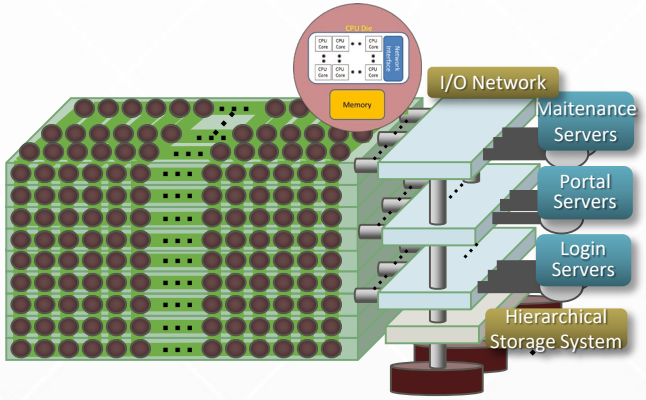
Accurate, on-the-spot weather forecasts for the future

FLAGSHIP2020 Project (Supercomputer Fugaku)

Computer simulations create the future

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

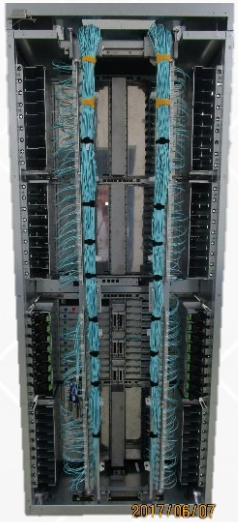


Project organization

- 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.



CY	2014				2015				2016				2017				2018				2019				2020				2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Basic Design | Design and Implementation | Manufacturing, installation, and Tuning | Operation

R-CCS Research Teams

Computer simulations create the future

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

Computer simulations create the future

- **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

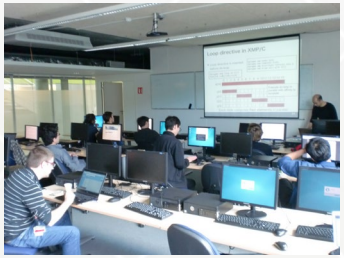
  For graduate students and post-docs

  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

Computer simulations create the future

- **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

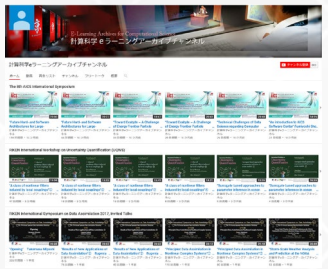
  About 20 international young researchers participate

  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