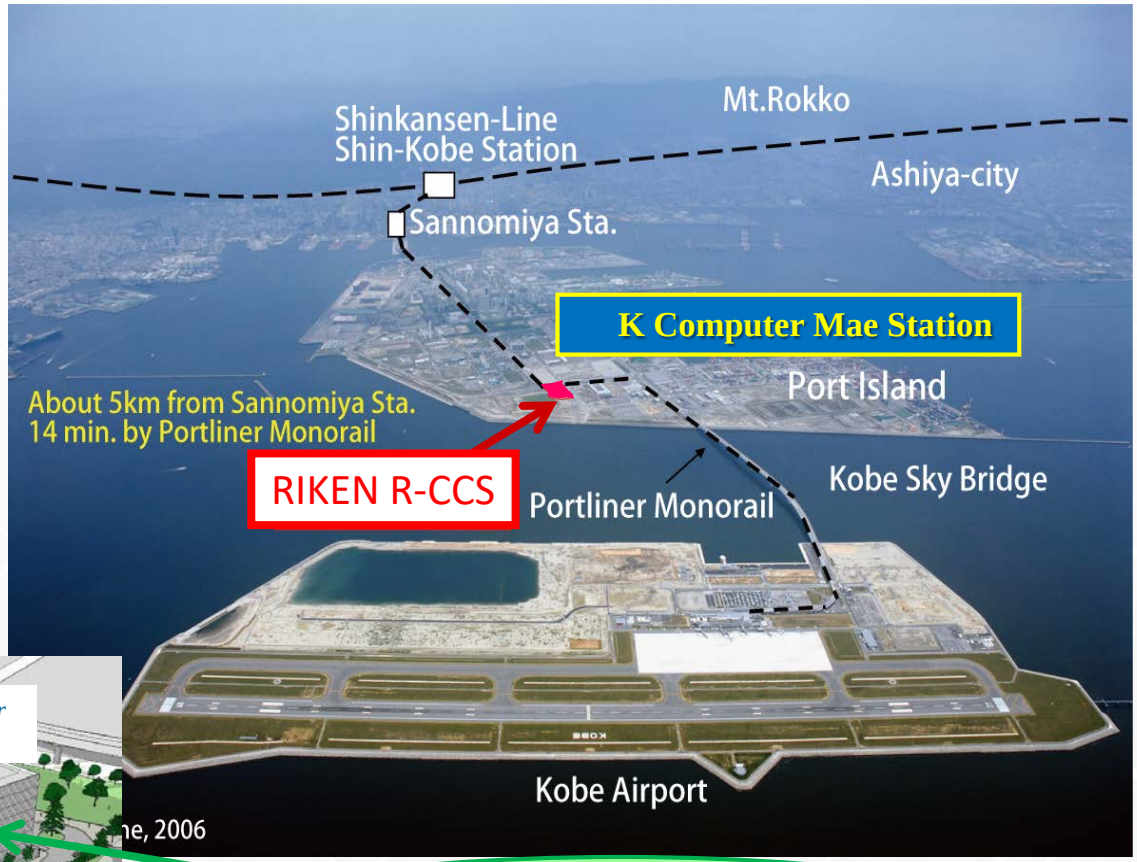
RIKEN Center for Computational Science

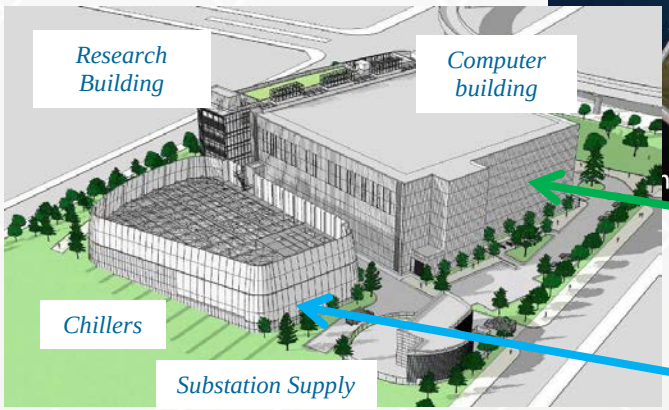
IHPCSS 2018
Ostrava
10 July 2018

Toshiyuki Imamura

R-CCS with K Computer

423 km (263 miles) west of Tokyo





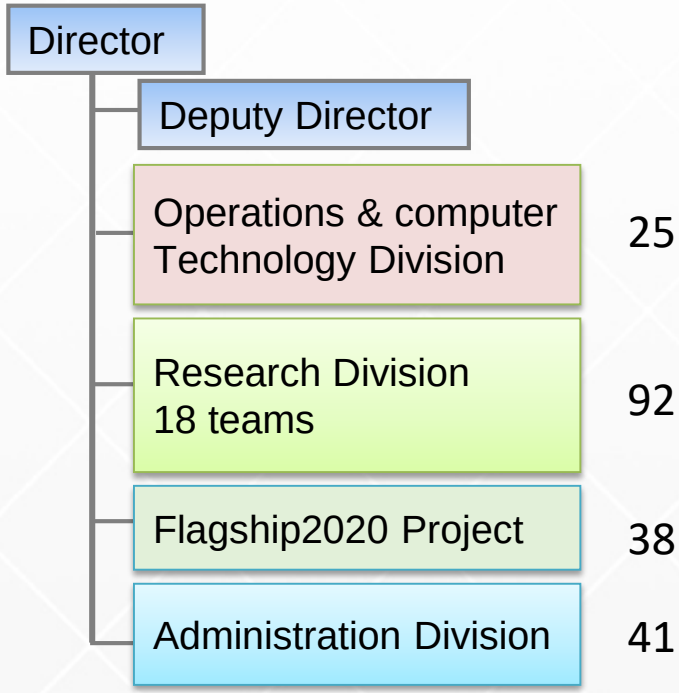
Computer room
50mx60m=3,000m²
Electric power up to 15MW
Water cooling system

Gas-turbine co-generation 5MW*2

RIKEN Center for Computational Science (R-CCS)

Computer simulations create the future

- **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 : 200 (1 June 2018)**

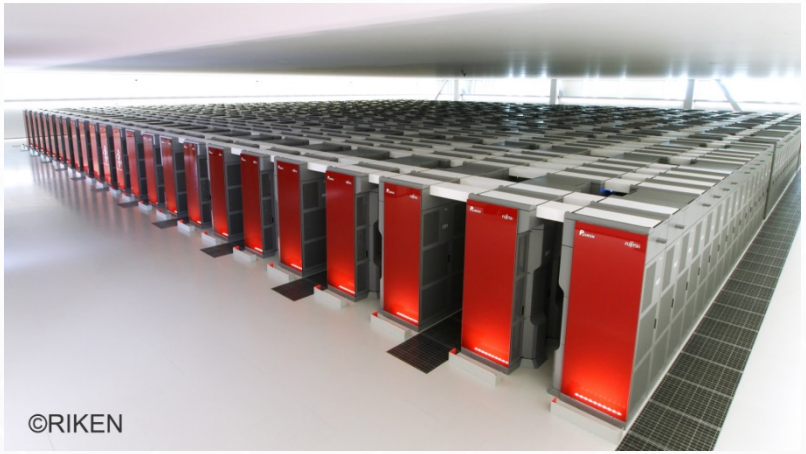


K computer

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.16 in Jun. 2018

Graph 500 ranking

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

- No.1 in Nov. 2017
- No.1 in Jun. 2018

HPCG ranking

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

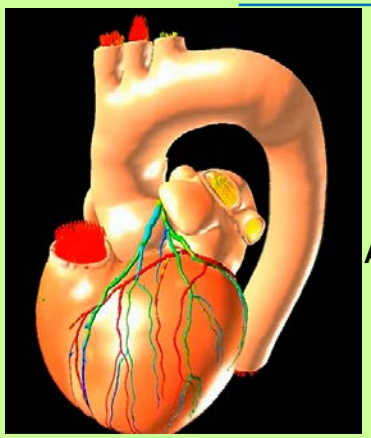
- No. 1 in Nov. 2017
- No. 3 in Jun. 2018

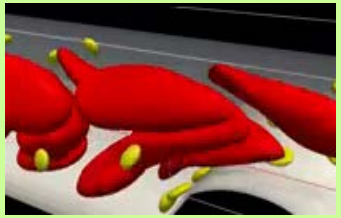
K computer has a superb balance of processor speed, memory, and network.
This guarantees high performance for whole area of science.

Some Recent Results from the K computer

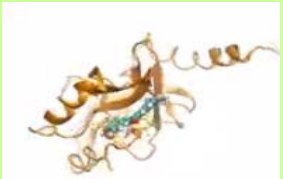
RIKEN R-CCS Computer simulations create the future

Life sciences





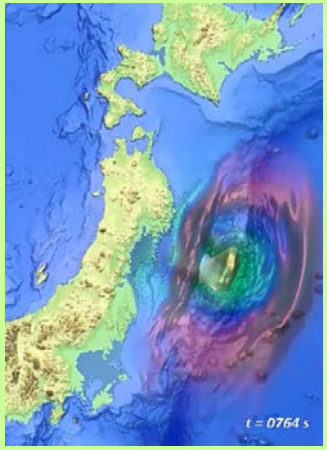
Artificial heart and blood flow



Neuronal simulation with 10^13 neurons

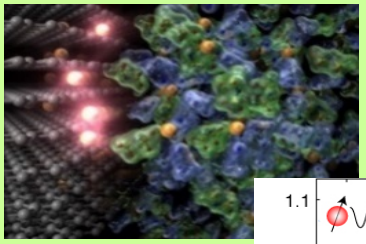
Disaster prevention

Cloud resolving NICAM run with less than 1km mesh

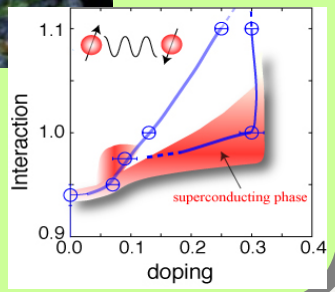


Coupled earth quake-plate dynamics-tsunami simulation

Materials & Energy



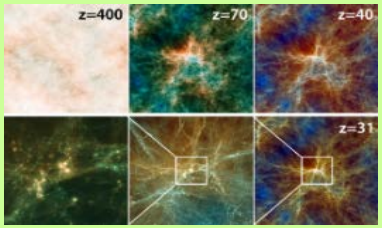
Fast Charging mechanism of Lithium Ion battery

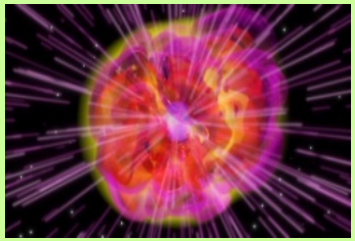


Charge-fluctuation origin of iron-based superconductors

Fundamental science

Dark matter with 2x10^{12} particles Gordon Bell 2012

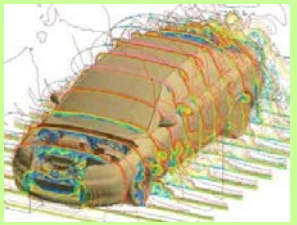


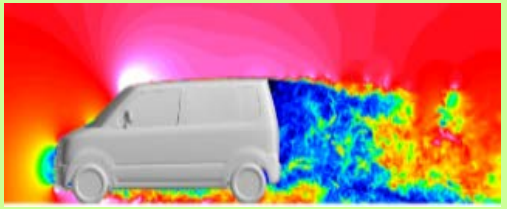


Supernova explosion through neutrino heating

Engineering

Fluid flow simulation accelerates design of transport vehicles





Flagship2020 Project

Flagship 2020 Project

Computer simulations create the future

- Develop the next Japanese flagship computer, *post K,* which is planned to go on line in 2021/2022
- Simultaneously develop a range of application codes, to run on *post K*, to help solve major societal and science issues

- Co-design of architecture and application is crucial
- Budget:110 billion JPY
- Power consumption: 30～40MW（12.7MW in the case of K computer)

Our aim is to balance various factors, such as

i) power consumption,

ii) computational performance,

iii) user convenience,

iv) ability to produce ground-breaking results characterized by its all-around capabilities compared to any other system in the world in the 2020's.

Priority Issues Program

Drug manufacture

Innovative computing infrastructure for drug discovery using AI

Climate and environment

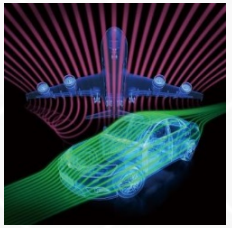
Meteorological global environmental predictions using big data

Energy issues

New technologies for energy creation, conversion/storage, and use

Industrial innovation

Development of innovative design and production processes

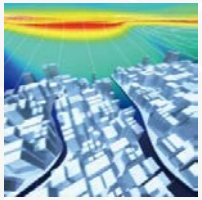


Health and longevity

Personalized and preventive medicine using big data

Disaster prevention

Integrated simulation systems induced by earthquake and tsunami

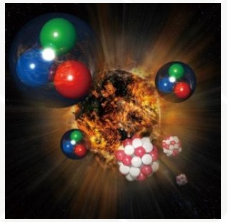


Functional materials

Creation of new functional devices and high-performance materials

Basic science

Elucidation of fundamental laws and evolution of the universe



Post-K: The Game Changer

Computer simulations create the future

1. **Heritage of the K-Computer, HP in simulation via extensive Co-Design**
- High performance: up to x100 performance of K in real applications
- Multitudes of Scientific Breakthroughs via Post-K application programs
- Simultaneous high performance and ease-of-programming

2. New Technology Innovations of Post-K

- **High Performance, esp. via high memory BW**
  Performance boost by "factors" c.f. mainstream CPUs in many HPC & Society5.0 apps
- **Very Green e.g. extreme power efficiency**
  Ultra Power efficient design & various power control knobs
- **Arm Global Ecosystem & SVE contribution**
  ARM Ecosystem: 21 billion chips/year, SVE co-design and world's first implementation by Fujitsu, to become global std.
- **High Perf. on Society5.0 apps incl. AI**
  Architectural features for high perf on Society 5.0 apps based on Big Data, AI/ML, CAE/EDA, Blockchain security, etc.

Global leadership not just in the machine & apps, but as cutting edge IT

Technology not just limited to Post-K, but into societal IT infrastructures e.g. Clouds

International Collaborations & Human Resource Development

Research opportunities at RIKEN R-CCS

International Partnership

Computer simulations create the future

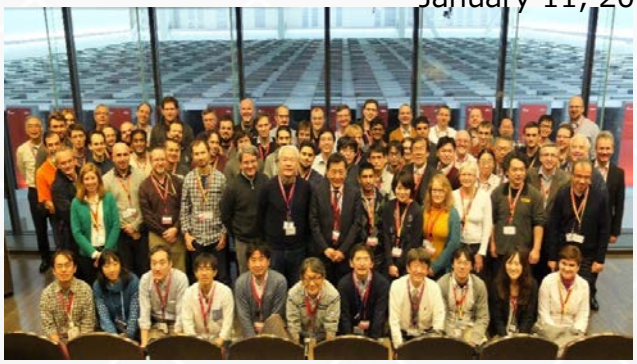
R-CCS serves as a core center for international brain circulation promoting international cooperation

Ongoing partnership

The Joint-Laboratory for Extreme-Scale Computing (JLESC) : The University of Illinois at Urbana-Champaign, INRIA the French national computer science institute, Argonne National Laboratory, Barcelona Supercomputing Center, Jülich Supercomputing Centre and the Riken R-CCS	**USA Europe**
Jülich Supercomputing Center	**Germany**
National Center for Supercomputing Applications (NCSA)	**USA**
National Computational Infrastructure	**Australia**
Maison de la Simulation (MDLS), Centra National de la Recherche Scientifique (CNRS)	**France**
The Scuola Internationale Superiore Di Studi Avanzati (SISSA)	**Italia**
French Alternative Energies and Atomic Energy Commission (CEA)	**France**

RIKEN President Hiroshi Matsumoto and CEA Chair Daniel Verwaerde at signing ceremony

January 11, 2017



6th JLESC Workshop at R-CCS
Nov.30 – Dec.2 (2016)

Japan MEXT and US DOE have signed MOU in 2014 in support of computer science and software related to current and future HPC for open scientific research. R-CCS leads the Japanese teams as the facilitator.

Human Resource 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

  For graduate students and post-docs

  80 participants for 2017 event (9 students from Japan)

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

  The first CEA and Riken school on HPC was held in Maison de la Simulation in 2017.

  This year, it will be held in RIKEN R-CCS in next week.

Human Resource 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

Human Resource 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

If you need Further information, please contact me during the summer school or send me e-mail to imamura.Toshiyuki@riken.jp.

Thank you