Accelerating state-of-the-art nuclear physics research.

How the **Research Center for Nuclear Physics at Osaka University** used Lenovo ThinkSystem SD530 and SR630 servers, featuring 2nd Gen Intel® Xeon® Scalable processors, to power big data analytics and high-performance computing.

Lenovo Infrastructure Solutions for The Data-Centered

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Background

Established in 1971, the Research Center for Nuclear Physics (RCNP) at Osaka University is a state-of-the-art institution for research into nuclear physics and its applications. RCNP owns the largest cyclotron accelerator facility at any Japanese university and was certified as an International Joint Usage/Research Center in 2018.

Professor Takashi Nakano, Director of RCNP, says: “A defining characteristic of RCNP is our research into precision nuclear physics, where we collide various particles against the nucleus of an atom and accurately measure changes in vibration and energy. We also conduct theoretical research based on this experimental data.”

RCNP also collaborates with other institutions to conduct full-scale research in fields that have a direct application to daily life, such as the use of muons in material science research, and the adoption of accelerators in medical research.

Professor Nakano explains: "For example, in the medical field, we are working on alpha-ray nuclear medicine treatment. This is useful for treating patients who have cancer cells throughout their body—cases that may be intractable with other types of treatment."

RCNP is also a central facility for the university’s outstanding graduate program, which aims to develop exceptional researchers who can advance the social implementation of biomedical science.

“As an International Joint Usage/Research Center, we are a hub for exchanges with researchers from all over the world,” says Professor Nakano. “Researchers who have studied at RCNP are now working at research institutes and universities worldwide, and we participate in many international collaborations.”

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Challenge

In 2019, RCNP began planning the replacement of its nuclear physics computer systems, which are responsible for storing data from experiments, performing analysis of the results, and processing theoretical calculations.

These systems currently serve more than 600 users, including both researchers based at RCNP and remote users from other domestic and international institutions. The data held by the center is utilized in many collaborative research projects, so remote users make up a significant proportion of the total.

As Professor Nakano says: "IT is just as important to our research center as our laser electron light facilities and accelerator facilities. It’s only possible to establish a perfect research environment if the right IT systems are available."

He adds: "Our systems are at the core of the research facility. An experiment might only last a few weeks, but researchers around the world may continue to analyze the experimental data for months or even years. By asking new questions about our data, we can gain new insights.”

For these reasons, RCNP realized that the replacement for its nuclear physics systems would need to meet several key requirements. It needed to provide easy access to users all over the world, enable analysis in a universal language, and above all, deliver extremely fast data analysis processing.

Why Lenovo? High-performance, resilient systems.

RCNP decided to adopt Lenovo ThinkSystem as the server platform for its new nuclear physics computer system. Associate Professor Tomoaki Hotta, a researcher at RCNP's Ring Cyclotron Building, was a leading figure in the system renewal project, and explains the key factors in the upgrade:

"Our first priority was high processing power, because it is indispensable for processing huge experimental datasets for nuclear physics and for large-scale research in nuclear theory. Second, stability is very important, and we wanted to be able to operate the new system easily without any problems even with a large number of users. And third, our experimental data is highly confidential and cannot be recovered if it is lost, so we needed to consider data security and protection."

Professor Nakano confirms: "Computing power and the ability to store large amounts of data were key, and we also needed to build an environment where we could analyze research data accumulated over many years without interruption. That meant finding out how much we could enhance our IT support capabilities within the budget available. For example, if there was a problem, could we work with our on-site computer room team to solve it?"

He adds: "In addition to reliability, we also need to respond to increasing data volumes and the need to accelerate analytics processing, so we emphasized the Lenovo solution's high potential for future development."

Successful delivery in difficult circumstances.

The selection of the Lenovo ThinkSystem solution took place, and RCNP team successfully delivered the new nuclear physics computer system in approximately five months.

To handle RCNP's nuclear physics calculations, the new platform uses 24 Lenovo ThinkSystem SD530 servers, equipped with 2nd Gen Intel® Xeon® Scalable processors, providing around 800 CPU cores for data analysis processing. In addition, eight Lenovo ThinkSystem SR630 servers are used as management nodes, responsible for transmitting and receiving data and controlling jobs. The Lenovo ThinkSystem SD530 is an ultra-dense 2U 4 node (2U4N) system specifically designed to deliver maximum performance in a small space, and features advanced hardware security features. Meanwhile, the Lenovo ThinkSystem SR630 is a 1U rack server that provides versatility and high reliability for business-critical workloads.

Under normal circumstances, this type of system renewal project would involve on-site work by a large number of personnel to perform tasks such as hardware installation, OS, software installation, configuration, and go-live. However, RCNP's project took place during the coronavirus crisis when people's movements were restricted, making it necessary to compress the project timeline and deliver with a much smaller team.

> "Despite the impact of coronavirus, we were able to successfully launch the system with the support of Lenovo's efficient operations teams and remote management functionality."

Associate Professor Tomoaki Hotta
Research Center for Nuclear Physics,
Osaka University

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Results

RCNP is currently conducting research in accelerator and beam physics using the world's highest-performance accelerators. In addition, the center is also taking on the challenge of developing and researching next-generation accelerators and irradiation systems for innovative cancer treatment and diagnosis through collaborations with medical science institutions.

Professor Nakano says: "In the type of accelerator research we do, it is necessary to accumulate a huge amount of data and store it in our systems. We then grant data processing time to users all over the world. We want to continue to provide an environment that is always available, stable, and easy to access."

He adds: "When we first introduced the system, I was mainly attracted to the performance of the Lenovo hardware. In the future, with Lenovo as a strategic partner, I would like to focus more on problem-solving and system improvements, which means deepening our collaboration on the software side."

In addition to practical and theoretical research, Professor Nakano considers IT skills development to be an important mission of the research center. By using systems from Lenovo, which has a large market share in international research and education, he hopes that RCNP will be able to develop technically skilled researchers who can play an active role in the field.

Associate Professor Hotta says, "At RCNP, we have various ways of using computers depending on the content and method of research. So, our Lenovo system is not just an HPC platform that is specialized for a specific application—it can adapt to many kinds of use cases. For example, we have teams who want to incorporate machine learning into their research and perform large-scale parallel computation. Our aim is to develop an optimal system that can respond flexibly to such needs."

He continues: "In the future, we are considering using the cloud to augment our on-premises server and storage environment. This would help us provide computer resources that meet users' needs in diverse fields of research. Cloud vendors can not only provide inexpensive and high-performance hardware, but also reduce the burden on the personnel who operate and support the system. We hope that Lenovo will be able to provide us with the right technologies and know-how—an advanced system that provides high overall value by combining both hardware and operational support."

Planning for the future.

Looking at the bigger picture, Professor Nakano comments: "In order to build a better future society in an increasingly complex world, we can ‘backcast’ from the future we want to realize to understand what we need now. We’ve realized that we need to develop our researchers and build our human resources.”

IT is expected to play an increasingly important role in achieving RCNP’s vision—but at the same time, Professor Nakano points out: “If we continue to use our systems at the current pace, electricity usage will increase, and storage space will be limited.”

Associate Professor Hotta agrees: “When installing and operating a computer system, it is natural to consider power consumption and its impact on the environment. This perspective is directly related to the effective use of research funds, and it’s important to bear in mind going forwards.”

Since 2019, Lenovo has been offering Lenovo TruScale Infrastructure Services, a comprehensive power-based pay-as-you-go subscription service for data center hardware and services. The company is also working to improve power consumption efficiency and reduce costs with its Lenovo Neptune™ liquid cooling technology. “By adopting these measures, Lenovo is getting in line with the UN’s Sustainable Development Goals [SDGs],” says Associate Professor Hotta. “Like Professor Nakano, I think it is necessary to shift our thinking and use backcasting in order to steadily develop an optimal system environment that aligns with the SDGs.”

Professor Nakano concludes: “In the future, we will need a system environment that is more compact, consumes less energy, and delivers higher computing power than ever before. By building and properly maintaining such a system, we will be leaders in the field of nuclear physics.”

50th ANNIVERSARY RCNP
International Joint Usage/Research Center
International Research Center of Subatomic Sciences
Research Center for Nuclear Physics
Osaka University

- **One of the top three research universities in Japan**
- **Ranked 75th in the world by QS World University Rankings[1]**
- **Home to the largest cyclotron accelerator facility at any Japanese university**

[1] Ranked 75th in the 2022 QS World University Rankings: https://www.topuniversities.com/universities/osaka-university

“Our goal is to produce results that are useful for solving human problems beyond research, and that means driving the future development of the center by even more effective use of IT.”

Professor Takashi Nakano
Director, Research Center for Nuclear Physics, Osaka University

What will you do with Lenovo HPC solutions?

The Data-Centered give researchers seamless access to data sets and analytics with Lenovo smarter infrastructure solutions, powered by Intel® Xeon® Scalable processors.

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