


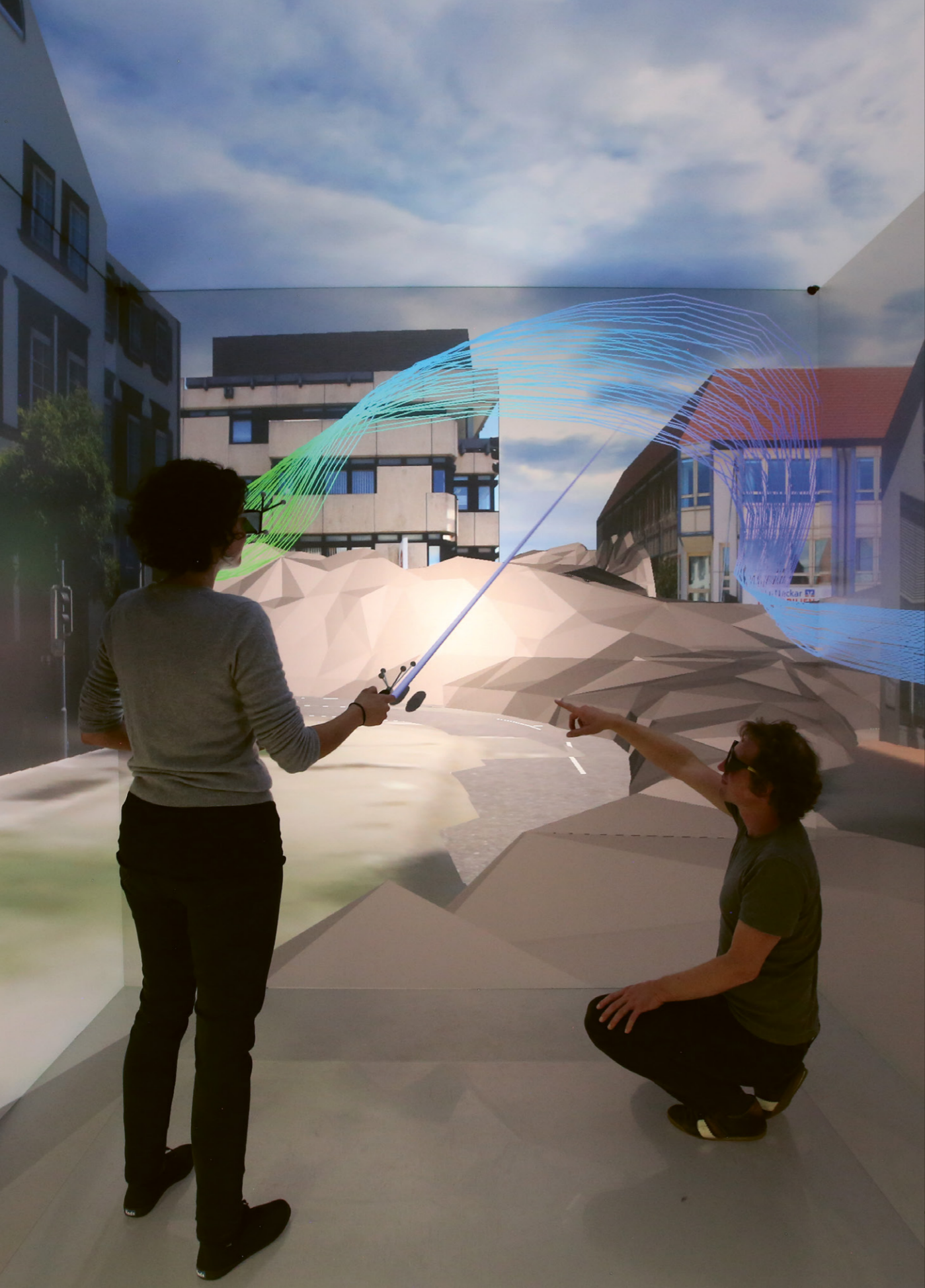
Supercomputing-
Lösungen für
Wissenschaft, Industrie
und Gesellschaft

H L R I S

High-Performance Computing Center Stuttgart



We bring
Supercomputing
to life



Addressing Global Challenges in the Digital Age **Globale Herausforderungen im digitalen Zeitalter**

Simulation, artificial intelligence, visualization, and data analytics using high-performance computing (HPC) have become critical tools for addressing many of society's most complex challenges. At the High-Performance Computing Center Stuttgart (HLRS), seizing the opportunities that HPC offers for meeting such challenges is at the center of all that we do.

As a leading European high-performance computing center with a team of more than 100 HPC experts, HLRS provides essential infrastructure and solutions for science, industry, and the public sector. This includes an emphasis on supporting the applied sciences and computational engineering. At the same time, we work to solve key problems facing the field of high-performance computing, and help to identify and implement new applications of HPC in other areas where it can have an impact, such as public administration, sustainable city planning, and the arts.

Because even the largest supercomputer cannot solve problems alone, an important part of our mission is also to increase expertise in high-performance computing. Our extensive HPC training and user support programs give scientists, engineers, and others the specialized knowledge and skills they need to use supercomputers confidently and effectively. HLRS has also been a leader in supporting private industry, including small and medium-sized enterprises, in realizing the potential of high-performance computing for innovation and global competitiveness.

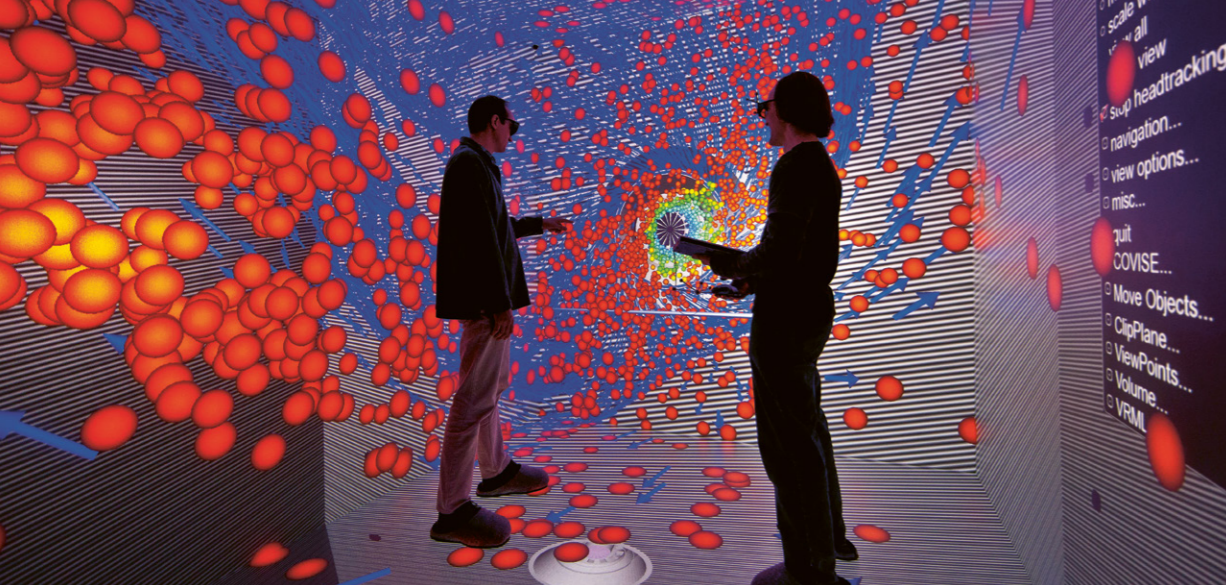
In the coming decades, meeting global challenges such as climate change, pandemics, natural disasters, and the need for more sustainable mobility, energy, and manufacturing concepts will require high-performance computing. HLRS is optimally positioned to support these important efforts.

Heutzutage sind Simulation, künstliche Intelligenz, Visualisierung und die Analyse gigantischer Datenmengen mit Höchstleistungsrechnen (High-Performance Computing, HPC) ein Muss, um viele der komplexen Herausforderungen der Gesellschaft anzugehen. Das Höchstleistungsrechenzentrum Stuttgart (HLRS) setzt alles daran, HPC zur Bewältigung dieser Herausforderungen zu nutzen.

Als eines der führenden europäischen Höchstleistungsrechenzentren mit einem Team von mehr als 100 HPC-Expert:innen stellt das HLRS Infrastruktur und Lösungen für die Wissenschaft, Industrie und für den öffentlichen Sektor bereit. Ein Fokus liegt auf angewandten Naturwissenschaften und computergestützten Ingenieurwissenschaften. Zudem lösen wir Fragestellungen im Bereich des Höchstleistungsrechnens und helfen bei der Ermittlung und Umsetzung neuer HPC-Anwendungen in anderen Bereichen, z.B. in Behörden, der nachhaltigen Stadtplanung und der Kunst.

Da auch der größte Supercomputer allein keine Herausforderungen lösen kann, besteht ein wichtiger Teil unserer Aufgabe unter anderem darin, das Fachwissen zum Höchstleistungsrechnen zu erweitern. In unseren HPC-Schulungs- und User-Support-Programmen können Forschende, Ingenieur:innen und andere lernen, wie sich Supercomputer effektiv nutzen lassen. Das HLRS ist auch führend bei der Unterstützung der Privatwirtschaft, einschließlich kleiner und mittelständischer Unternehmen, die mithilfe von HPC wettbewerbs- und innovationsfähiger werden können.

In den kommenden Jahrzehnten wird die Bewältigung globaler Herausforderungen wie des Klimawandels, Pandemien, Naturkatastrophen und der Bedarf an nachhaltigeren Mobilitäts-, Energie- und Produktionskonzepten Höchstleistungsrechner erfordern. Das HLRS ist optimal für diese wichtigen Bemühungen aufgestellt.



Comprehensive HPC Solutions **Umfassende HPC-Lösungen**

HLRS offers world-class supercomputing power and expertise in high-performance computing, enabling scientists, engineers, and HPC users from other domains to make discoveries, design better products, solve difficult problems, or realize new ideas. At the same time, scientists at HLRS conduct research to address key technical problems facing the future of high-performance computing, including scalability, data management, energy efficiency, and the integration of traditional HPC with AI and cloud technologies. This research helps us to develop expertise that we share with our system users.

Das HLRS bietet erstklassige Rechenleistung und Expertise im Höchstleistungsrechnen, die es Forschenden, Ingenieur:innen und HPC-Nutzer:innen aus anderen Bereichen ermöglichen, neue Erkenntnisse zu gewinnen, bessere Produkte zu entwickeln, schwierige Forschungsfragen zu klären oder ihre Ideen zu verwirklichen. Gleichzeitig forschen Wissenschaftler:innen des HLRS an technischen Herausforderungen, die die Zukunft des Höchstleistungsrechnens betreffen, wie Skalierbarkeit, Datenmanagement, Energieeffizienz und der Verbindung von traditionellem HPC mit KI und Cloud-Technologien. Das gewonnene Fachwissen teilt das HLRS-Team mit Systemnutzer:innen.

HPC & Simulation

HLRS's supercomputer offers the performance necessary to realize large-scale, computationally demanding simulation projects

Artificial Intelligence

We provide infrastructure and expertise for machine learning and deep learning applications, as well as hybrid approaches combining HPC, AI, and cloud.

Visualization

By connecting our HPC systems with virtual reality and augmented reality technologies, we make it easier to gain insights from large datasets.

Learn more: www.hlrs.de/solutions



State-of-the-Art Computing Infrastructure **Modernste Rechnerinfrastruktur**

HLRS's high-performance computing systems provide infrastructure necessary for today's most important HPC applications, including simulation, artificial intelligence, high-performance data analytics, and visualization. Together, these systems are designed to address the diverse needs of multiple user communities.

Die Rechensysteme des HLRS bieten eine leistungsfähige Infrastruktur für die wichtigsten HPC-Anwendungen, darunter Simulation, Künstliche Intelligenz, Höchstleistungsdatenanalyse und Visualisierung. Unsere Systeme sind darauf ausgelegt, die vielfältigen Bedürfnisse diverser Nutzergemeinschaften zu erfüllen.

HPE Cray EX4000 (Hunter)

With an APU-accelerated architecture, Hunter provides large-scale computing power for simulation, data generation, data analytics, and artificial intelligence. It is also a stepping stone for HLRS's transition to exascale computing, which is scheduled to occur in 2027.

Cray CS-Storm

The Cray CS-Storm is optimized for machine learning, deep learning, high-performance data analytics, and artificial intelligence.

CAVE

This immersive 3D facility offers powerful tools for visualizing and interacting with large, complex data sets in virtual and augmented reality.

NEC Cluster (Vulcan)

Vulcan is continually adapted with the most recent technology platforms to meet increasing user demands and provide requirement-optimized solutions. It contains CPU, GPU, and vector computing components.

HPSS Data Management

Our high-performance storage system is designed to safely manage and archive petabytes of data saved on disks and in tape libraries.

Learn more: www.hlrs.de/systems



Powering Advanced Research in Science and Engineering **Spitzenforschung** in Wissenschaft und Technik

High-performance computing has become an essential tool for researchers working at the forefront of nearly all scientific and technical disciplines. HLRS's supercomputing resources enable researchers in the basic and applied sciences to study extremely complex problems that would be impossible to investigate in any other way. Some typical application areas in which our users are active include climate and weather modeling, automotive and aerospace engineering, combustion, biomedical engineering, astrophysics, molecular dynamics, computational chemistry, materials science, particle physics, and bioinformatics.

Das Höchstleistungsrechnen ist zu einem unverzichtbaren Instrument für die Spitzenforschung in fast allen wissenschaftlichen und technischen Disziplinen geworden. Die Supercomputing-Ressourcen des HLRS ermöglichen die Untersuchung von komplexen Fragestellungen der Grundlagen- und angewandten Forschung, die auf andere Weise nicht zu erforschen wären. Zu den typischen Anwendungsbereichen, in denen unsere Nutzer:innen tätig sind, gehören Klima- und Wettermodellierung; Automobil-, Luft- und Raumfahrttechnik; Verbrennung; Biomedizintechnik; Astrophysik; Molekulardynamik; computergestützte Chemie; Materialwissenschaft; Teilchenphysik und Bioinformatik.

Sustainable energy

Machine learning and computational fluid dynamics (CFD) simulations are helping to identify opportunities for more efficient and durable wind and hydroelectric power generation.

Climate and environment

Scientists use our supercomputers to develop high-resolution predictions of climate change, understand atmospheric chemistry, and improve conservation in waterways.

Engineering

Simulations provide knowledge needed to design more efficient aircraft and automobiles, more versatile materials, and more productive biochemical processes.

Learn more: www.hlrs.de/research



Guiding the Future of Supercomputing **Supercomputing** für morgen

HLRS scientists and other staff lead and contribute to numerous collaborative research projects, working closely with academic and industrial partners to address key problems facing the future of high-performance computing. In many projects, solving such technical problems also supports the implementation of practical solutions for urgent local, national, and international challenges. In addition, HLRS is the coordinating center for EU-funded projects focused on increasing HPC expertise across Europe.

Wissenschaftler:innen und andere Mitarbeitende des HLRS beteiligen sich an zahlreichen Kooperationsprojekten, in denen sie eng mit Partnern aus Forschung und Wirtschaft an Lösungen für wichtige Fragestellungen zur Zukunft des Höchstleistungsrechnens arbeiten. In vielen Projekten unterstützt technische Forschung auch die Umsetzung praktischer Lösungen für dringende lokale, nationale und internationale Herausforderungen. Darüber hinaus koordiniert das HLRS einige EU-geförderte Projekte, die das Wissen und die Fähigkeiten rund um HPC in Europa fördern und erweitern.

EuroHPC Centres of Excellence

HLRS coordinates or participates in projects that are preparing the transition to exascale performance in European HPC, addressing applications in engineering (EXCELLERAT P2, CEEC), global challenges (HiDALGO), and solid Earth science (ChEESE).

AI Factory "HammerHAI"

HLRS is coordinating a EuroHPC Joint Undertaking project that will provide a secure, AI-optimized supercomputer that improves artificial intelligence capabilities for academic research, SMEs, startups, industry, and the public sector in Germany and Europe.

CIRCE

Following a study to assess potential applications of HPC in crisis situations and ways to ensure that computing resources are available when needed, HLRS is planning a more permanent model for supporting government agencies.

Learn more: www.hlrs.de/projects



Expert Training in High-Performance Computing Schulungen für HPC-Nutzer:innen

HLRS's HPC training program is among the most extensive and experienced in Europe, with more than 40 continuing professional education courses that reach more than 1,100 trainees each year. Our training curriculum addresses topics in parallel programming, computational fluid dynamics, visualization, cluster usage and administration, performance optimization and debugging, artificial intelligence, accelerators, and programming languages for scientific computing. Additionally, HLRS conducts "train the trainer" programs to spread its HPC know-how across Europe, and helped launch the Supercomputing-Akademie to address HPC needs in industry.

Das HPC-Schulungsprogramm des HLRS gehört mit mehr als 40 fortlaufenden Kursen zu den umfangreichsten und am längsten bestehenden in Europa. Es bietet jedes Jahr professionelle Aus- und Weiterbildung für mehr als 1.100 Kursteilnehmer:innen. Unser Schulungsprogramm behandelt Themen wie parallele Programmierung, numerische Strömungsmechanik, Visualisierung, Clusternutzung und -verwaltung, Leistungsoptimierung und Debugging, künstliche Intelligenz, Beschleuniger sowie Programmiersprachen für wissenschaftliches Rechnen. Darüber hinaus leitet das HLRS die Supercomputing-Akademie, um den Bedarf an HPC-Expertise in der Industrie zu decken, und bietet „Train the Trainer“-Programme, um das HPC-Wissen in ganz Europa zu erweitern.

Supercomputing-Akademie

The Supercomputing-Akademie enhances HLRS's core training program by offering continuing education for HPC users, developers, and administrators in industry. Courses use a "blended learning" format, so trainees can complete courses alongside their other responsibilities.

Learn more: www.hlrs.de/training

Professional Certification in HPC

With professional certification tracks in simulation, machine learning and artificial intelligence, parallel programming, and HPC administration, HLRS helps HPC users build expertise that helps them to stand out in today's rapidly evolving tech landscape.

HPC SPECTRA

The EU-funded project HPC SPECTRA is building a comprehensive online platform of HPC training opportunities across Europe, making it easier for trainees to find courses that fit their interests and needs.



Comprehensive User Support Umfangreiche Anwenderunterstützung

Because programming HLRS's high-performance computing systems requires specialized knowledge, our user support staff works closely alongside our system users to provide expert advice on technologies and tools for HPC and AI. We offer mentoring as well as extended user support that assists research teams in optimizing the performance of their codes on our systems. Our emphasis on performance optimization both enhances our users' scientific capabilities and enables a more sustainable operation of HLRS's computing resources.

Die Programmierung von Hoch- und Höchstleistungsrechnersystemen erfordert besondere Fachkenntnisse. Unser User-Support-Team arbeitet eng mit Systemnutzer:innen zusammen und bietet fachkundige Beratung zu Technologien und Tools für HPC und KI. Wir bieten Mentoring sowie Extended User Support Services, die Forschungsteams dabei helfen, die Leistung ihrer Codes auf unseren Systemen zu optimieren. Unser Schwerpunkt auf Leistungsoptimierung steigert sowohl die wissenschaftlichen Fähigkeiten unserer Nutzer:innen als auch den nachhaltigen Betrieb der HLRS-Rechenressourcen.

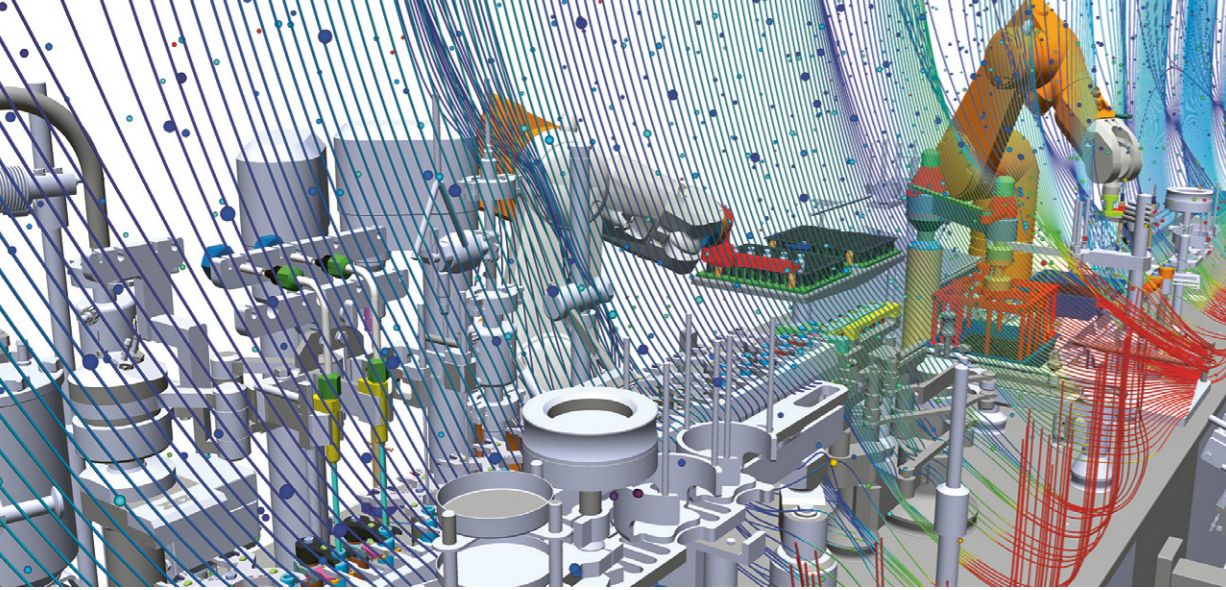
Extended User Support

HLRS supports close cooperation between users, vendor staff, and HLRS experts to optimize code performance and develop more efficient methods. In special User Support Workshops mentors from HLRS work one-on-one with code owners.

Learn more: www.hlrs.de/user-support

EuroCC 2 and CASTIEL 2

Through these projects HLRS leads European efforts to increase and coordinate HPC competencies across 32 European nations, and to improve HPC uptake in academia, public administration, and industry.



High-Performance Computing for Industry HPC für die Industrie

Besides supporting academic research, HLRS makes its supercomputing resources available for private industry. From large, globally recognized corporations to small and medium-sized enterprises (SMEs), companies can access world-class computing resources for simulation, artificial intelligence, and data analytics without the need to purchase and operate their own systems. In addition, HLRS holds events and provides specialized training designed to address the unique needs of HPC users in industry. These comprehensive services support the competitiveness of high-tech engineering companies across Germany and Europe.

Über die Unterstützung der akademischen Forschung hinaus ermöglicht das HLRS auch der Privatwirtschaft den Zugang zu seinen Supercomputern. Sowohl weltweit bekannte Großkonzerne als auch kleinere und mittelständische Unternehmen greifen für Simulation, künstliche Intelligenz und Datenanalyse auf unsere HPC-Systeminfrastrukturen zu. Außerdem bietet das HLRS spezielle Workshops und Schulungen an, die auf die dezidierten Bedürfnisse dieses Nutzerkreises ausgerichtet sind. Diese Angebote und Dienstleistungen unterstützen die Wettbewerbsfähigkeit von Hightech-Unternehmen in Deutschland und Europa.

Consulting for small and medium-sized enterprises (SMEs)

Our partner organization SICOS BW offers free consulting services to SMEs interested in using data analytics, artificial intelligence, or simulation, and facilitates access to HLRS's computing resources.

HPC training for industry professionals

HLRS's Supercomputing-Akademie enables working professionals to develop HPC skills and knowledge alongside their other obligations.

Preparing industry for the future of supercomputing

In EU-funded projects such as FFplus and EXCELLERAT P2, HLRS is working to increase the adoption of HPC in industry and to develop applications that will enable companies to utilize the capabilities of exascale supercomputers.

Learn more: www.hlrs.de/industry



Solution Centers Promote Innovation **Solution Center für mehr Innovation**

Many companies could benefit from high-performance computing, although its uptake in certain industries has been slow due to gaps in knowledge, methods, or resources. To eliminate such barriers, HLRS has worked with representatives of the automotive, medical, and culture industries to develop a model called the solution center. Solution centers bring together multidisciplinary expertise – for example, engineers, computer scientists, HPC specialists, artists, and other interested specialists – to identify industry-wide challenges and develop solutions in a collaborative manner.

Viele Unternehmen könnten vom Höchstleistungsrechnen profitieren, obwohl es in manchen Branchen aufgrund von Wissenslücken oder Ressourcenmangel nur langsam eingeführt wird. Um Hindernisse aus dem Weg zu räumen, hat das HLRS gemeinsam mit Vertreter:innen der Automobil-, Medizin- und Kulturbranche sogenannte Solution Center gegründet. Solution Center bündeln multidisziplinäres Fachwissen – z. B. aus dem Ingenieurwesen, Informatik, HPC, Kunst und anderen Disziplinen – um branchenweite Herausforderungen zu identifizieren und gemeinsam Lösungen zu entwickeln.

Automotive Solution Center for Simulation

The asc(s) connects companies from across the automotive branch to exchange knowledge, access HPC resources, and develop solutions to shared problems.

CASE4Med: The Medical Solution Center

CASE4Med supports companies in the medical technology industry in developing solutions that use high-performance computing, simulation, data analytics, and artificial intelligence.

Media Solution Center Baden-Württemberg

International in scope, the MSC supports innovation in the culture and creative industries by facilitating access to HPC expertise and resources for artists and arts organizations.



Certified for Environmental and Energy Management **Zertifiziert für Umwelt- und Energiemanagement**

Because the operation of high-performance computing centers requires sizable amounts of energy and other resources, HLRS has committed itself to taking practical measures whenever possible to reduce its CO₂ footprint, prevent pollution, and limit other negative effects on the environment. HLRS is certified under the Eco-Management and Audit Scheme (EMAS) and works continually to improve its environmental and energy performance. At the same time, HLRS computing resources provide essential tools for research related to climate change, green energy, and more sustainable mobility and city planning concepts.

Der Betrieb von Höchstleistungsrechenzentren erfordert erhebliche Mengen an Energie und weiteren Ressourcen. Das HLRS hat sich dazu verpflichtet, praktische Maßnahmen zu ergreifen, um seinen CO₂-Fußabdruck zu verringern, Umweltverschmutzung vorzubeugen und andere negative Auswirkungen auf die Umwelt zu begrenzen. Das Zentrum ist nach dem Eco-Management and Audit Scheme (EMAS) zertifiziert und verbessert kontinuierlich seine Umwelt- und Energieleistung. Gleichzeitig stellen die Computerressourcen des HLRS wichtige Instrumente für die Forschung in den Bereichen Klimawandel, grüne Energie und nachhaltigere Mobilitäts- und Stadtplanungskonzepte bereit.

Eco-Management and Audit Scheme
HLRS was the first high-performance computing center to receive EMAS certification, the most demanding system for environmental management worldwide.

Practical Guide for Sustainability in Computing Centers
Information published on the HLRS website can benefit other computing centers interested in improving their environmental performance.

SRI DiTEns
HLRS is a partner in this University of Stuttgart research initiative to develop methods for energy system transformation, using urban digital twins to support decision making in communities.

Learn more: www.hlrs.de/sustainability



Social and Ethical Dimensions of Simulation **Soziale und ethische Aspekte der Simulation**

Computer simulation is changing science, technology, politics, and society in fundamental ways that are so far only vaguely understood. HLRS's Department of Philosophy of Computational Sciences is investigating this transformation, conducting and promoting research that considers how to evaluate results generated by simulation and artificial intelligence. By enabling philosophers, social scientists, and historians of science to work side-by-side with simulation scientists at HLRS, the department is uniquely positioned to conduct research that considers the practice of simulation and its implications.

Computersimulationen verändern Wissenschaft, Technik, Politik und Gesellschaft auf eine Weise, die bisher nur vage zu begreifen ist. Die HLRS-Abteilung Philosophy of Computational Sciences untersucht diesen Wandel mithilfe von Forschungsprojekten, die sich mit der Frage befassen, wie die durch Simulation und künstliche Intelligenz erzeugten Ergebnisse zu bewerten sind. Sie bringt Wissenschaftler:innen aus der Philosophie, den Sozialwissenschaften und der Wissenschaftsgeschichte mit Simulationswissenschaftler:innen am HLRS zusammen, wodurch sich eine einzigartige Gelegenheit zur methodischen Forschung ergibt, die Simulation und deren Auswirkungen im Detail untersucht.

The Science and Art of Simulation
This international, interdisciplinary conference and book series investigates computational methods from an interdisciplinary point of view, building bridges between researchers in the STEM disciplines and the humanities.

Trust in Information
A funded project led by the HLRS Philosophy Department developed perspectives for assessing the trustworthiness of computational science and limiting the spread of misinformation.

Modeling for Policy
A 2024 conference explored the challenges that arise when the simulation sciences are used in public policy development, and how this process could be improved.

Learn more: www.hlrs.de/philosophy



Education and Public Outreach Bildung und Öffentlichkeitsarbeit

As supercomputers have become more powerful, simulation, artificial intelligence, visualization, and related technologies have become a part of our daily lives. HLRS organizes and participates in a variety of activities intended to increase public understanding of what high-performance computing is, why it is important for science and engineering, and how it affects society. These include events and outreach activities for the general public, as well as projects that bring simulation and high-performance computing into schools in ways that encourage young people to consider future careers in computer science.

Mit der zunehmenden Leistungsfähigkeit von Supercomputern sind Simulationen, künstliche Intelligenz, Visualisierung und verwandte Technologien zu einem Teil unseres Alltags geworden. Das HLRS organisiert und beteiligt sich an einer Vielzahl von Aktivitäten, die das Verständnis der Öffentlichkeit dafür fördern, was Höchstleistungsrechnen ist, warum es für Wissenschaft und Technik wichtig ist und welche Auswirkungen es auf die Gesellschaft hat. Dazu gehören Veranstaltungen für und Kommunikation an eine breitere Öffentlichkeit sowie Projekte, die Simulation und Höchstleistungsrechnen in die Schulen bringen, um junge Menschen zu ermutigen, eine Karriere in der Informatik in Betracht zu ziehen.

Simulated Worlds

This education enrichment program offers motivated students the chance to complete research fellowships at HLRS, and organizes events for the general public to help improve understanding of computer simulation.

Tag der Wissenschaft (Science Day)

During the University of Stuttgart's annual campus-wide open house event, visitors can tour HLRS's computing room, experience virtual reality in our CAVE facility, and learn more about our latest activities.

Girls' Day

HLRS is a long-time participant in this nationwide program, which encourages girls to consider careers in IT, the sciences, engineering, and the skilled trades.

Learn more: www.hlrs.de/outreach

1996
founded



since 2007
member of GCS



more than 1,100 researchers at
training programs every year



more than 130 scientific papers
by our system users each year

Quick Facts HLRS – Zahlen und Fakten

- HLRS was founded in 1996 as Germany's first national high-performance computing center.
- HLRS is a central unit of the University of Stuttgart and a founding member of the Gauss Centre for Supercomputing (GCS), the alliance of Germany's tier-0/1 supercomputing centers.
- HLRS staff consists of approximately 150 employees.
- Approximately 130 scientific research projects use computing hours at HLRS each year.
- More than 70 companies, including internationally recognized brands and regional small- and medium-sized enterprises use HLRS's high-performance computing resources.
- HLRS coordinates or is a partner in multiple EuroHPC Joint Undertaking projects, including several Centres of Excellence, EuroCC 2 and CASTIEL 2, as well as the first German AI Factory.
- More than 1,100 researchers participate in our HPC training program each year.
- HLRS is the only HPC center to be certified for environmental management under the Eco-Management and Audit Scheme (EMAS).
- HLRS is certified for information security under ISO 27001 and has completed a Level 3 audit in accordance with the TISAX framework.
- HLRS has established international cooperation agreements with more than a dozen leading high-performance computing and computational research centers across Europe, Asia, and the Americas.

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