Research at EPCC: expanding the boundaries of understanding

We are widely recognised for our world-leading research across a range of areas such as high performance computing, computational science, computing systems, data science, and machine learning. EPCC's research is often located at the intersection of science and computing, and one of our missions is to enable world-class science using computational resources and computational approaches.

Driven by curiosity

EPCC's research culture has been vibrant since its inception. Our position at the interface of different domains and our partnerships with collaborators in many disciplines enable us to locate where research can bring benefits, and implement those benefits for a wide range of communities across research domains and industry. Some current examples follow.

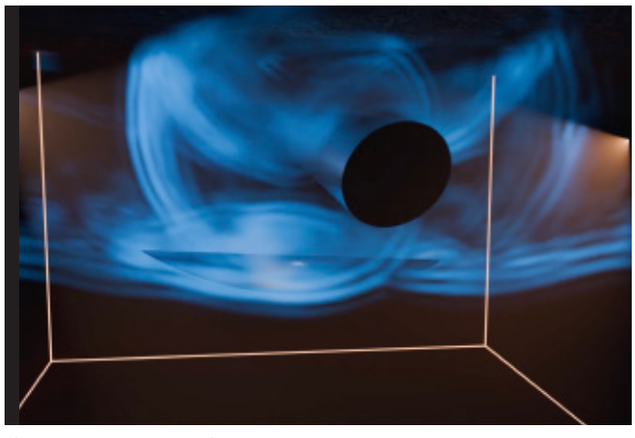
CONTINENTS collaboration

This international collaboration between EPCC, the National Centre for Atmospheric Science (NCAS) and the US National Center for Atmospheric Research (NCAR) is working towards efficient and sustainable computational modelling and simulation.

CONTINENTS aims to transform the state of the art in sustainability and power/energy efficiency of computational modelling and simulation, with a particular focus on weather and climate applications and simulations. It is driving innovations in data centre and system operation, optimal exploitation of hardware, machine learning applied to data analysis and numerical modelling, and software design and implementation strategies to minimise energy consumption and waste.

Quantum computing

EPCC is exploring the application of quantum computing to end user challenges, how quantum computers can be programmed efficiently and effectively in collaboration with traditional high performance computing systems, and where the quantum advantages might be. This includes a range of pathfinding projects for application domains on how quantum computing could be used to significantly reduce computational time or costs.



Electromagnetic simulation performed on ARCHER2: Sébastien Lemaire, Nathan Mannall, James Richings (all EPCC).

Exascale

One key theme of research at EPCC is around exploiting the very largest computing systems for research and discovery. EPCC will host the UK's next national supercomputing system and, to ensure our users and researchers can efficiently exploit the next generation of computers, we are researching new programming models and approaches to efficiently use GPUs and other accelerated compute approaches from common scientific applications and algorithms.

Sustainability

Exploring how to provide high performance compute with minimal environmental impact is key for our future. We have already delivered significant energy savings on our ARCHER2 service and are actively researching how to implement sustainable computing infrastructure, from data centre optimisations through to application level approaches, to ensure we use the minimum amount of energy to gain the maximum amount of research outputs.

epcc

THE UNIVERSITY of EDINBURGH

Research themes

Our drive for innovation includes research in the following areas.

Application performance optimisation and development

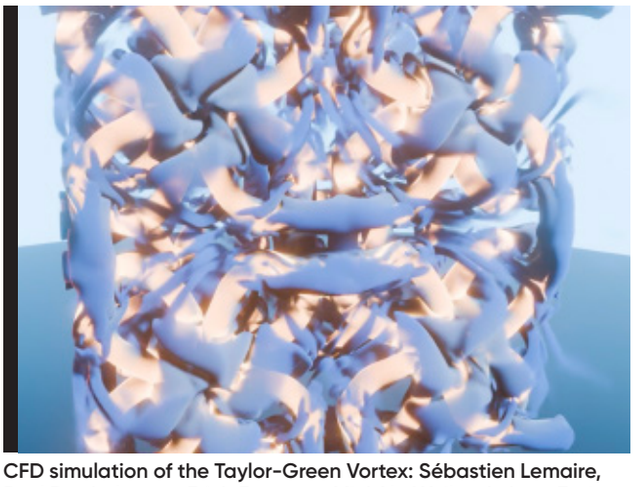
Our long history of operating high performance computing systems has given us deep experience of optimising and fine tuning scientific applications to achieve the best possible performance.

Parallel programming models

EPCC has been involved in the development of parallel programming approaches such as MPI, OpenMP, and OpenACC since their inceptions. We continue to research both how best to implement parallel programming and the features required for future applications and hardware systems, including through developments in programming languages such as Fortran and compiler technologies like LLVM and MLIR.

Parallel I/O performance

Contention for shared resources in a system can significantly impact application performance. We research techniques to mitigate such performance bottlenecks and exploit novel hardware resources to match application demands in high performance computing. We have recently demonstrated high performance data storage for weather applications using the DAOS object storage system.



CFD simulation of the Taylor-Green Vortex: Sébastien Lemaire, Paul Bartholomew, Erich Essmann, Michèle Weiland, Justs Zarins, Mark Parsons (all EPCC).

www.epcc.ed.ac.uk/research

Machine learning

We examine the possibilities and opportunities presented by machine learning in a scientific environment – specifically pattern recognition and interpretation in large data sets, as well as how to integrate machine learning with computational simulation for large scale applications.

Novel architectures

We investigate and assess the viability of novel hardware and architectures at the leading edge of high performance computing. EPCC has a RISC-V hardware testbed that is available for researchers to access and explore.

Quantum computing

EPCC's Quantum Applications Group is exploring how quantum computing will impact high performance computing and data science.

Computational imaging

In collaboration with academics and researchers from medical imaging, radio astronomy and optimisation disciplines, we are working to generate high resolution, high precision, images from medical imaging and radio telescope datasets.

Research software engineering

As the lead site for the Software Sustainability Institute, EPCC has been instrumental in the development of research software engineering as a profession and, subsequently, as an area of research.

Hardware testbeds and services

EPCC researches the exploitation of novel hardware to accelerate numerical and data intensive applications. Recent examples include work enabling porting Fortran to FPGAs with simple tools, and exploring RISC-V hardware architectures for HPC applications.

Contact

See our website for details of our research activities and publications. To discuss research collaborations please contact our Director of Research: dor@epcc.ed.ac.uk