



DURHAM
HPC 20
DAYS 26

Welcome to Durham HPC Days 2026!

We hope you enjoy the programme, make new connections across the community, and take the opportunity to explore Durham and its surroundings.

We wish you a productive and enjoyable week!

Conference Venues

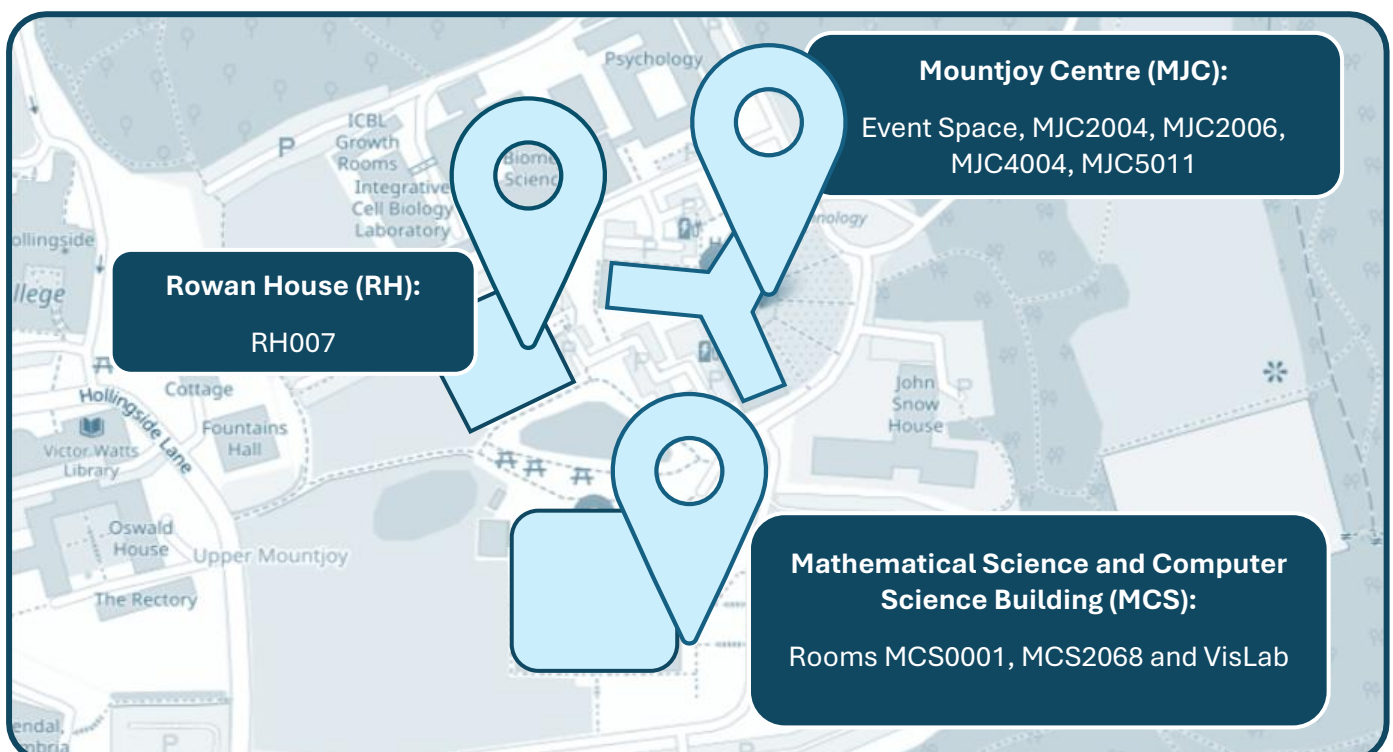
Sessions take place across three venues within Durham University:

- Mathematical Sciences and Computer Science Building (MCS)
- Rowan House (RH)
- Mountjoy Centre (MJC)

All venues are located within approximately five minutes' walking distance of each other. Please refer to the conference maps for building locations.

Other conference facilities:

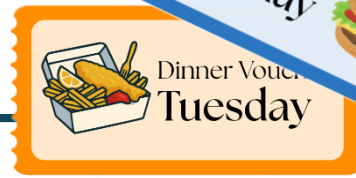
- Quiet Room: MCS 2053 This space is intended for attendees who would like a quiet place to work, read, recharge, or take a break from the conference environment.
- Multi-Faith Room: available throughout the conference in: MJC



Catering

The conference provides:

- Lunch Monday–Friday
- Tea, coffee, and refreshments during scheduled breaks
- Dinner will be provided Monday-Thursday via the food trucks next to the Mountjoy Centre. Dinner vouchers are attached to your conference badge. Please check that you have a voucher for each evening you are registered to attend. If you leave the conference earlier than expected, please return any unused vouchers to the registration desk.



Tuesday Evening Ceilidh | 19:00 pm: Our main social event of the week will be a traditional ceilidh led by local musicians and dancers. Music will include Scottish, Irish, and Northumbrian jigs and reels, with all dances explained by an experienced caller. No previous ceilidh experience is required!

Morning Walk Around Durham | 08:00 am: Join an informal morning walk before the conference sessions begin. The routes will include: Durham Market Place, Durham Castle, Durham Cathedral and Riverside paths along the River Wear. The meeting point will be Durham Market Place from Tuesday to Friday.

Morning Runs Along the River | 06:30 am: The route follows the River Wear and includes scenic views across the city. Participants may choose approximately: 2 miles or 3.1 miles depending on pace and experience. The meeting point will be: Penny Ferry Bridge (next to Durham University Business School Waterside) from Tuesday to Friday

Socials



Conference announcements, discussions, and updates will be shared through the **CAKE Slack workspace**.

Join: #hpc-days26

We encourage all attendees to join the channel throughout the week.



CAKE

COMPUTATIONAL ABILITIES
KNOWLEDGE EXCHANGE

Code of Conduct

Durham HPC Days 2026 is committed to providing a welcoming, inclusive, and respectful environment for all participants.

All attendees, speakers, exhibitors, sponsors, volunteers, and organisers are expected to follow the CAKE Code of Conduct throughout the conference.

If you experience or witness behaviour that violates the Code of Conduct, please contact a member of the organising team

<https://www.cake.ac.uk/CAKEbox/code-of-conduct/>

MONDAY 15 JUNE

09:00 – 10:30

Room: MJC5011 – Workshop
Cluster Challenge Community Breakfast

11:00 – 12:00

Room: RH007 – Meeting
RSE Leaders & Aspiring Leaders Meeting: Policy & Funding

13:00 – 14:30

Room: MCS0001 – Talks
HPC in Astrophysics and Astronomy

Room: MJC2006 – Tutorial
Model Parallelism: Training Large Neural Networks

Room: RH007 – Meeting
RSE Leaders & Aspiring Leaders Meeting: Policy & Funding

15:00 – 16:00

Room: MCS0001 – Keynote
How to have the cake and eat it too – Rank-Polymorphism for Productivity and Performance
Sven-Bodo Scholz

16:30 – 18:00

Room: MCS0001 – Talks
HPC in Astrophysics and Astronomy

Room: MJC2006 – Tutorial
Model Parallelism: Training Large Neural Networks

Room: RH007 – Meeting
RSE Leaders & Aspiring Leaders Meeting: Policy & Funding

18:00

Social

TUESDAY 16 JUNE

09:00 – 10:30

Room: MCS0001 – Tutorial
Node-level performance optimisation

Room: RH007 – Tutorial
Pocket-Sized Kubernetes: Building and Deployment with Raspberry Pi Clusters

Room: MJC2004 – Talks
Science & AI

11:00 – 12:00

Room: MCS0001 – Keynote
Why are High Performance Computing Systems still based on 1980's Architectures? - John McCalpin

13:00 – 14:30

Room: MCS0001 – Tutorial
Node-level performance optimisation

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Pocket-Sized Kubernetes: Building and Deployment with Raspberry Pi Clusters

Room: MJC2004 – Talks
Science & AI

15:00 – 16:00

Room: MCS0001 – Keynote
Earthquakes, Tsunamis, and Supercomputers: From Hero Runs to Digital Twins - Alice-Agnes Gabriel

16:30 – 18:00

Room: MCS0001 – Tutorial
Node-level performance optimisation

Room: VisLab – Workshop
Build your own HPC - hands-on session with Raspberry Pis

Room: RH007 – Meeting
Fortran Community Meetup

Room: MJC2004 – Talks
HPC Centres

18:00

Ceilidh Evening

WEDNESDAY 17 JUNE

09:00 – 10:30

Room: MCS2068 – Talks
Computational Engineering

Room: MCS0001 – Workshop
Knowledge Exchange in the DRI Community

Room: MJC2006– Workshop
Quantum HPC

Room: MCJ2004– Talks
User-driven large-scale federated data movement

11:00 – 12:00

Room: MCS0001– Keynote
What Works? Academic-Industry Collaborations Across Borders - US vs EU models - Melyssa Fratkin

13:00 – 14:30

Room: MCS0001– Workshop
CoSeC Knowledge Exchange: HPC Across Computational Research Communities

Room: MJC2006– Workshop
Quantum HPC

Room: RH007 – Talks
Research software development funding calls

15:00 – 16:00

Room: MCS0001
Vendor Session

16:30 – 18:00

Room: Mountjoy Centre
Scavenger hunt

Room: MJC Event Space
Poster Session

Room: MJC2004
Vendor session 1

Room: MJC2006
Vendor session 2

18:00

Social

THURSDAY 18 JUNE

09:00 – 10:30

Room: VisLab – Tutorial
Responsible computing plans

Room: RH007– Workshop
RIE's and RSE working together towards user friendly, sustainable HPC

11:00 – 12:00

Room: MCS0001– Keynote
Interactive On-Demand HPC at Lincoln Laboratory and Beyond - Albert Reuther

13:00 – 14:30

Room: RH007 – Talks
Reinforcement Learning for Scientific and Computational Decision Making

Room: MCS0001– Workshop
We know what to do, so why aren't we doing it? Closing the EDI Implementation Gap with lessons from EuroHPC, UKRI and Beyond

Room: MJC2004– Workshop
What's inside the black box? Compiler developments for HPC

15:00 – 16:00

Room: MCS0001– Keynote
Implementing the Compute Roadmap – Luke Davis

16:30 – 18:00

Room: MCS2068 – Talks
Past, present and future of HPC Services in the UK, and the people who make it work

Room: RH007 – Talks
Reinforcement Learning for Scientific and Computational Decision Making

Room: MJC2004– Workshop
RIE's and RSE working together towards user friendly, sustainable HPC

18:00

Social

Room: VisLab – Meeting
Meet the funder

FRIDAY 19 JUNE

09:00 – 10:30

Room: RH007 – Tutorial
Accelerating Scientific Applications with OpenMP for GPUs

Room: MCS0001 – Workshop
Building Community

Room: MCS2068 – Workshop
Research Facilitation for DRI communities

11:00 – 12:00

Room: MCS0001 – Keynote
CCMI - PhD Training on the Interface of Data, Software, and Computation – Timo Betcke

13:00 – 14:30

Room: RH007 – Tutorial
Accelerating Scientific Applications with OpenMP for GPUs

Room: MCS0001 – Workshop
Building Community

Room: MCS Flexible Space
Poster Session

Need More Information?

This booklet contains a summary of the key information for Durham HPC Days 2026. For the latest programme updates, room information, maps, session details, speaker information, and conference announcements, please visit the conference website:

<https://hpc-days.github.io/Durham-HPC-Days-2026/>

We recommend checking the website regularly throughout the week, as any last-minute updates will be published there.

We hope you have an enjoyable and productive Durham HPC Days 2026!







Monday 15 June

Day and time: Monday 15, 09:00 – 10:30

Cluster Challenge Community Breakfast

Room: **MJC5011**

Session type: Workshop

Lead: Cristin Merritt

Description: Student cluster competitions are often where future HPC practitioners first encounter the realities of systems design, optimisation, teamwork, and operating under pressure. They also create communities that extend well beyond the competition floor itself. This informal breakfast meetup invites past competitors, prospective participants, mentors, sponsors, and supporters to gather ahead of the main conference programme for conversation, networking, and collaborative play. Alongside breakfast and discussion, attendees will take part in a fast-paced tabletop cluster design challenge that reflects real HPC trade-offs across compute, storage, networking, power, budget, and operational disruption. The session is designed to encourage interaction among students, alumni, industry, and community organisers, while creating space to discuss broader questions about accessibility, onboarding, mentorship, sustainability, and the future of student competitions in HPC. No prior competition experience is required. Whether you are curious about joining a future team, interested in supporting student initiatives, or simply want to meet others involved in the community, all are welcome. Prizes will be awarded during the challenge session.

Day and time: Monday 15, 09:00 – 10:30, 13:00 – 14:30 and 16:30 – 18:00

RSE Leaders & Aspiring Leaders Meeting: Policy & Funding

Room: **RH007**

Session type: Meeting

Leads: Samantha Finnigan, Marion Weinzierl, Elena Breitmoser, Michael Donnay, Twin Karmakharm

Description: This event will focus on the policy and funding landscape for RSEs. The Society has recently launched a Policy & Funding Working Group to help the Society better advocate for RSEs with institutions, funders, and policy makers. Attendees will contribute to the Working Group's strategy and help shape the key advocacy areas that the Society will focus on in the coming years.

The event is jointly hosted by Durham University Advanced Research Computing, SocRSE's Policy & Funding Working Group, and the RSE Leaders Network SIG.

Anyone is welcome to register, including those not attending the rest of HPC Days. Lunch will be provided. Virtual attendance is also available. If you require travel support to attend in-person, please indicate that when you register. See the event page for details and to register.

Day and time: Monday 15, 13:00 – 14:30 and 16:30 – 18:00

HPC in Astrophysics and Astronomy

Room: **MCS0001**

Session type: Talks

Facilitators: Mladen Ivkovic

Speakers: Sarah Johnston, Abouzied Nasar, Will Roper, Zhen Xiang, Romeel Dave, Britton Smith, Kyle Oman, Dmitry Nikolaenko

Description: HPC is an indispensable discipline in astrophysics and cosmology with many users running simulations, solving intricate networks of nonlinear equations, post-processing and analysing data, and synthesising images, spectra, and mock observations on a daily basis. Despite its crucial importance to the field, the presentation and discussion of our HPC work often falls short during astronomy and astrophysics conferences, which tend to focus on physics outputs and outcomes. This session serves as a platform to exchange and highlight all the underlying HPC work, both current and in progress, as well as challenges in the astrophysics and astronomy communities.

Session Part 1

Making Gravity SWIFTer: GPU offloads for gravity in the SWIFT cosmology code • Sarah Johnston

To fully utilise modern heterogeneous HPC systems and improve power efficiency, large astronomy codes must become GPU compatible. SWIFT is a versatile open-source cosmology code which is used to model a variety of astrophysical scenarios. It utilises task-based parallelism, dividing the workload into independent tasks managed by a scheduler for efficient CPU utilisation, and is highly optimised for use on memory-intensive, CPU-only clusters. A significant portion of SWIFT's runtime is dedicated to gravity calculations. However, the repetitive and non-interdependent nature of these interactions makes them ideal candidates for GPU acceleration. In this work, we build on the existing SWIFT code by replacing CPU-based gravity with new GPU kernels, while minimising changes to the rest of the code. The GPU-accelerated kernels achieve high accuracy, with <1% deviation from the CPU results. However, we are limited by a memory transfer bottleneck in moving data between the CPU and GPU. To mitigate this, we have employed a novel 'task-bundling' system which allows us to group tasks in the scheduler to give higher occupancy on the GPU. This provides more work, reducing the overhead from the CPU-GPU memory transfers. To further exploit the GPU, we explore a redistribution of the gravity calculations meaning more interactions can be carried out using direct particle-particle summations, rather than multipole-based approximations, which gives us more accurate results and provides more work for the GPU. We also investigate kernel optimisations like the use of multiple streams and tiled memory access.

Exascale SWIFT hydrodynamics, are we there yet? • Abouzied Nasar

With the recent heavy lean towards heterogeneous solutions for supercomputing, the astrophysics solver SWIFT is being adapted to leverage GPUs and accelerate its computationally intense workloads such that it retains its world leading position as one of the most scalable and efficient publicly available solvers in the UK's exascale era of supercomputing. SWIFT requires a plethora of solvers for different physics in order to create digital twins of the Universe and capture other smaller scale

cosmological phenomena. The two most computationally demanding solvers are SWIFT's hydrodynamics and gravity solvers. We therefore focus on these solvers initially with a view on extending the hard won benefits of GPU acceleration to other, less computationally demanding physics down the line. This talk focuses on the current state of GPU acceleration for the hydrodynamics solver within SWIFT's task-parallel framework. We demonstrate significant speed ups in comparison to CPU-only baselines rivalling other world-leading GPU accelerated astrophysics solvers; GPU-accelerated SWIFT achieves 22 million particle time step updates per GPU per wall clock second in comparison to 8 million for the CPU code executed on a full 72 core CPU. We also present near-perfect computational scaling for the GPU accelerated solver and greater than 30% energy consumption savings in comparison to the CPU only baselines.

Swift-Zoom: Efficient and scalable zoom simulations • Will Roper

Zoom simulations are becoming an ever more important tool for investigating the Universe. Whether pushing volumes and resolution to the extreme to probe the rarest regions of the Universe, or sampling highly dimensional parameter spaces with numerous individual simulations, cosmological simulations are becoming increasingly costly, with many studies forced to compromise due to this expense. Zoom simulations alleviate this problem by focusing computational effort on the regions of interest for a particular problem, while degrading the resolution elsewhere, a simple proposition that makes the intractable tractable. However, these simulations are inherently unbalanced, and few codes (if any) have fully optimised their computations for this configuration. In this talk, I will present how we have optimised SWIFT for exactly this use case.

Simulating the Epoch of Reionization: Physical Complexity and Computational Challenges • Zhen Xiang

The Epoch of Reionization is the period when the first galaxies ionized the intergalactic medium. Simulating this process is challenging because it involves the interaction between radiation and gas across a wide range of scales. In this talk, I will give a simple overview of these challenges and show how they appear in practice in cosmological simulations. Using examples from my work with Kiara-RT, a new radiation-hydrodynamics simulation suite, I will focus on the thermal evolution of gas and discuss how numerical choices affect the results. I will conclude with some open questions and future directions.

Session Part 2

HPC Challenges in Next-Generation Galaxy Formation Simulations • Romeel Dave

I will give a brief overview of the current landscape in galaxy formation simulations, with a focus on our upcoming Kiara simulation suite. The increasingly physics-rich and multi-scale modelling of a wide range of physical processes presents new challenges for HPC efficiency and scalability. I will highlight some of the performance bottlenecks associated with Kiara, and identify possible ways forward including machine learning-based approaches and the use of GPUs.

The Grackle Chemistry and Cooling Library: What Happens Next • Britton Smith

Chemistry and radiative cooling are together a critical component of galaxy simulations. Even employed with limited sophistication it is a significant and often dominant portion of a simulation's computational cost. As well, it represents a nearly infinitely hungry endeavor in terms of both human and computational resources. The Grackle project has provided an open-source library for chemistry and cooling with a stable API that has been used in more than a dozen simulation codes and hundreds of publications for over a decade. In this talk, I will give a brief overview of the project and the functionality it provides and present ongoing development efforts toward new features and improved performance that will enable Grackle to support the next generation of astrophysical simulations.

High-level tools for galaxy simulations analysis • Kyle Oman

Galaxy formation simulations produce large outputs with information-rich metadata catalogues. Some analysis tasks can be completed with the metadata alone, others require small, sparsely distributed subsamples of the full outputs, while others still require full datasets that may not fit in memory. Such diverse access patterns pose challenges for data storage and software tools for data access. I will give an overview of how we have addressed some of these in the `swiftsimio` and `swiftgalaxy` analysis packages, and highlight others that remain.

Peano and load balancing • Dmitry Nikolaenko

Peano is an open-source framework for dynamically adaptive Cartesian meshes derived from spacetimes. It ties mesh traversal to mesh storage through space-filling curves (SFC), enabling scalable simulations on shared- and distributed-memory supercomputers. The framework underpins several scientific codes, including ExaHyPE 2 (hyperbolic PDE solvers) and Swift 2 (particle methods), and targets modern HPC platforms ranging from multicore workstations to GPU-accelerated supercomputer nodes. At the heart of Peano lies a hierarchical spacetime that is constructed level by level during the simulation set-up. Each node of this tree represents a spatial cell; leaves carry the actual computational work. As the mesh grows, the distribution of leaves across MPI ranks and CPU threads becomes uneven, leading to idle processors and wasted wall-clock time. Achieving a balanced partition is therefore critical for strong scaling. Peano's load balancing toolbox provides a suite of strategies — from simple spread-out schemes to recursive bipartition and cascade combinatorics — each triggering splitting calls at the right moment to redistribute subtrees across compute resources. A key challenge is that splitting decisions must be made online, without knowledge of the final mesh structure, while the cost of moving data grows with the current tree size. In this talk we present an offline load balancing approach that transforms this online problem: the mesh is first constructed without any decomposition and checkpointed; an offline analysis tool then inspects the complete spacetime, derives an optimal multi-level splitting sequence, and encodes it as a hardcoded strategy for a warm restart. We describe the Python API that automates this workflow — including leaf distribution, bottom-up topology propagation, and a planned hierarchical optimisation stage that minimises splitting cost whilst preserving load balance — and share lessons learned from applying it to black-hole simulations with the CCZ4 solver in ExaHyPE 2.

Day and time: Monday 15, 13:00 – 14:30 and 16:30 – 18:00

Model Parallelism: Training Large Neural Networks

Room: **MJC2006**

Session type: Tutorial

Instructors: Andrea Pilzer and Paul Graham

Description: This tutorial covers the full workflow of training large neural networks using model parallelism, split across two sessions that build on each other.

Part 1 — Introduction to Training of Large Models [this session, 13:00–14:30]

Theoretical foundations: scaling laws and parallelization techniques for large neural networks.

Part 2 — Practical Session with Megatron Bridge [16:30–18:00] Hands-on session: setting up training scripts, running experiments with different distributed settings, and exploring lower precision training. The session is instructor-led with materials provided for replication on the Durham cluster.

Day and time: Monday 15, 15:00 – 16:00

How to have the cake and eat it too -- Rank-Polymorphism for Productivity and Performance

Room: **MCS0001**

Session type: Keynote

Speaker: Sven-Bodo Scholz

Abstract: Performance tuning for HPC traditionally requires combinations of non-trivial algorithmic changes.

Tiling for improved locality, data reorganisation for improved vectorisation, data distribution for minimised communication, scheduling of parallel compute units, to name just a few.

Most of these optimisations are architecture-specific rendering the optimisation process not only challenging in itself but also very costly when switching from one architecture to the next.

As a consequence, we typically have to choose how much productivity we are willing to sacrifice for performance.

In this talk, I advocate for Rank-Polymorphism as programming technique for shifting key optimisations from code into data shapes. That way, adjustments for new architectures do not require changes in the algorithm itself but solely in the shape of the data. In the context of the programming language SaC we have shown the potential of this approach for a few core algorithms, delivering competitive performance from very concise, easily verifiable, rank-polymorphic specifications.

Tuesday 16 June

Day and time: Tuesday 16, 09:00 – 10:30, 13:00 – 14:30 and 16:30 - 18:00

Node-level performance optimisation

Room: **MCS0001**

Session type: tutorial

Instructors: Thomas Gruber

Description: This course covers performance engineering approaches on the compute node level.

Even application developers who are fluent in OpenMP and MPI often lack a good grasp of how much performance could at best be achieved by their code. This is because parallelism takes us only half the way to good performance. Even worse, slow serial code tends to scale very well, hiding the fact that resources are wasted. This course conveys the required knowledge to develop a thorough understanding of the interactions between software and hardware. This process must start at the core, socket, and node level, where the code gets executed that does the actual computational work. We introduce the basic architectural features and bottlenecks of modern processors and compute nodes. Pipelining, SIMD, superscalarity, caches, memory interfaces, ccNUMA, etc., are covered. A cornerstone of node-level performance analysis is the Roofline model, which is introduced in due detail and applied to various examples from computational science. We also show how simple software tools can be used to acquire knowledge about the system, run code in a reproducible way, and validate hypotheses about resource consumption. Finally, once the architectural requirements of a code are understood and correlated with performance measurements, the potential benefit of code changes can often be predicted, replacing hope-for-the-best optimizations by a scientific process

Requirements

Basic understanding of C/C++/Fortran and basic knowledge of OpenMP parallelisation

Day and time: Tuesday 16, 09:00 – 10:30 and 13:00 – 14:30

Pocket-Sized Kubernetes: Building and Deployment with Raspberry Pi Clusters

Room: **RH007**

Session type: tutorial

Instructors: Lewis Sampson, Piper Fowler-Wright

Description: This hands-on workshop introduces Kubernetes deployment and orchestration from the ground up. Working in small groups, you will build lightweight Kubernetes clusters using Raspberry Pi hardware, progressing from initial cluster setup to deploying containerised applications and establishing cross-cluster communication. We will cover essential Kubernetes concepts and practical skills including cluster initialisation, pod management, deployments and basic observability. No prior Kubernetes experience is required, though familiarity with containers (Docker), SSH, and the Unix shell will be helpful. Participants will need to

bring their own laptops to interact with the clusters. Target audience: Anyone interested in setting up a Kubernetes cluster on their own infrastructure, or getting experience interacting with such systems and container orchestration. This workshop is delivered by the Cloud-Native SIG team with support from the Computational Abilities Knowledge Exchange Network+.

Requirements

Personal Device/Laptop

Day and time: Tuesday 16, 09:00 – 10:30 and 13:00 – 14:30

Science & AI

Room: **MJC2004**

Session type: talks

Instructors: Fawada Qaiser, Jeyan Thiyagalingam

Description: This session serves as the main forum for work at the intersection of scientific research and Artificial Intelligence during Durham HPC Days, bringing together methods, applications, and infrastructure focused on using high-performance computing (HPC) to enable modern AI in science.

We highlight contributions that use machine learning, deep learning, and data-driven approaches to accelerate or augment scientific discovery on CPUs, GPUs, and emerging accelerators, including both mature results and work-in-progress studies.

The session spans a wide range of domains, including astrophysics and cosmology, climate and weather, materials and chemistry, life sciences, engineering, finance, and the social sciences. We also welcome cross-cutting work on scientific machine learning, surrogate models, AI-guided simulation and experiment design, scalable training and inference, workflow orchestration, and the robustness and trustworthiness of AI in scientific settings.

We strongly encourage participation from all career stages (from students and early-career researchers to senior academics, Research Software Engineers, and industry partners), and particularly from colleagues in under-represented groups. Both technical deep-dives and application-driven case studies are welcome.

As part of this session, we invite short talks from researchers and practitioners working at the intersection of AI and HPC.

Day and time: Tuesday 16, 11:00 – 12:00

Why are High Performance Computing Systems still based on 1980's Architectures?

Room: **MCS0001**

Session type: Keynote

Instructors: John McCalpin

Abstract: I begin with a brief review of the history of high performance computing systems with a focus on the 'balances' between computations and different classes of memory accesses. Technology scaling and multi-core processing has led to astounding increases in the computational capabilities of microprocessors over the

past decades, while the cycle time of the DRAM cells in memory systems has barely changed. The increasing imbalance between computation and memory access costs has led to stunningly complex processor implementations with astronomical design and fabrication costs, rapidly growing power requirements, and increasingly opaque and confounding performance characteristics.

If these increasing costs were forced on us by the physics of computation there would be little point in complaining. Here I will argue that much of the increasing cost is directly attributable to the continuing refusal to reconsider the basic assumptions of the processor and system architectures in light of the completely different 'balances' of semiconductor technology today.

I conclude with several examples of how changing basic architectural assumptions can allow much simpler implementations to deliver competitive application performance at greatly reduced implementation costs and power requirements. Projects such as the European Processor Initiative have enabled some exciting research in these areas, but huge opportunities for architectural innovation remain.

Day and time: Tuesday 16, 15:00 – 16:00

Earthquakes, Tsunamis, and Supercomputers: From Hero Runs to Digital Twins

Room: **MCS0001**

Session type: Keynote

Speaker: Alice-Agnes Gabriel

Abstract: Earthquakes and earthquake-triggered tsunamis are multiscale, nonlinear processes whose understanding challenges both our physical understanding and our computational infrastructure. Large-scale physics-based simulations now allow us to model earthquake rupture, seismic wave propagation, ground deformation, and tsunami generation in a single computational framework, exposing dynamics that cannot be inferred from observations or simplified models alone. Such simulations have become “hero runs” of computational geoscience, enabled by close collaboration between domain scientists, research software engineers, applied mathematicians, and HPC centres. I will discuss how supercomputing is changing earthquake and tsunami science, from rapid-response dynamic rupture models of recent large earthquakes to fully coupled earthquake-tsunami simulations and our 2025 ACM Gordon Bell Prize work on a real-time tsunami digital twin for Cascadia. I will focus not only on the scientific results, but also on the computational and algorithmic challenges underlying them, including meshing, solvers, hardware-aware optimization, uncertainty quantification, inverse problems, and reduced-order modeling. These challenges are central as we transition from individual high-fidelity simulations to ensemble approaches and, ultimately, toward digital twins of earthquake and tsunami systems.

Day and time: Tuesday 16, 16:30 – 18:00

Build your own HPC - hands-on session with Raspberry Pis

Room: **VisLab**

Session type: Workshop

Instructors: Jannetta Steyn, Contributor: Samantha Finnigan

Description: Nothing beats hands-on experience. But very few people will ever get to work with real HPC hardware. Most of us have probably never seen the HPCs we are working on. An easy way to get hands on experience with real and relatively affordable hardware is to use Raspberry Pi single board computers.

In this session we will have attendees work in pairs. Each pair will receive a pair of Raspberry Pis and a 5 port switch. We will then work through configuring one of the Pis as a login node and the other as a compute node. We will install and configure slurm, nfs, munge, lmod, EESSI and cvfms. At this point attendees should be able to to srun the Amdahl script from the Carpentries' Intro to HPC lesson.

If time allows we can also look at putting all the RPis together to create one large HPC. Large being a relative concept of course.

We currently have 10 RPis and five switches available which means we can accommodate at least ten people. If people can bring their own hardware we could accommodate more. Or, if we can manage to get sponsorship for more hardware we will also be happy to accommodate more people.

Day and time: Tuesday 16, 16:30 – 18:00

HPC Centres

Room: **MJC2004**

Session type: Talks

Speakers: Cristin Merritt, Richard Knepper, Syed Ibtisam Tauhidi

Every Supercomputer is a Record of Decisions: Navigating New Tensions in HPC

• **Cristin Merritt**

High-Performance Computing systems are often discussed in terms of architecture, performance, and scale. Yet every HPC system is ultimately shaped by a series of decisions: what hardware to buy, how resources are allocated, which users are prioritised, and how policies evolve over time.

This short, interactive talk explores HPC systems through the lens of decision-making. Using live polls and discussions, we will take the community's pulse at Durham HPC Days and examine the factors that most influence operational and infrastructure decisions across HPC centres.

Participants will be invited to consider common decision scenarios reflecting the tensions HPC centres face today, including capacity planning, scheduler policies, user growth, and strategic direction.

The session will also introduce Season 2 of Move the Needle: Decision Making in HPC, a community project exploring how HPC centres make decisions and how small improvements in decision processes can lead to better outcomes for researchers, operators, and institutions.

What's next? Genesis Mission, NAIRR, and the next phase of science in the US

• **Richard Knepper**

The US Department of Energy has initiated the Genesis mission to 'double the science productivity of the US', the National AI Research Resource is moving beyond its Pilot Phase, and the National Institutes of Health and National Science Foundation have had massive restructuring in the interim. Meanwhile, regional initiatives like New York's Empire AI and California Compute are beginning to take shape. This talk describes what new developments are being built, what directions

are encouraged under funding initiatives, and where the US computational research community may be pointed as it moves forward. This discussion will cover new computational investments (and changes to how those investments takes shape), new points of focus from the administration, and maybe even some discussion of those difficult supply chain issues.

A Frequency-Invariant Approach to Energy-Efficient Computing • Syed Ibtisam Tauhidi

Modern CPUs use Dynamic Voltage and Frequency Scaling (DVFS) to manage the explosive growth in energy consumption in computation, including in High-Performance Computing (HPC) and AI inference workloads. However, standard governors rely on coarse utilisation heuristics, operating on a 'race-to-idle' philosophy, assume that high CPU utilisation correlates with productive computation. This assumption collapses during memory-bound phases, such as LLM token generation or sparse matrix operations, where cores are stalled due to cache misses, despite utilisation remaining near 100%. Thus, such systems waste energy maintaining peak frequencies waiting for cache fill. Previous software solutions face adoption barriers, demanding intrusive source code modifications, offline training, or dense telemetry with heavy overhead.

In this talk, I present URJA, a purely online, user-space DVFS framework that eliminates energy waste without disrupting workflows. URJA employs a minimalist design using a sparse set of hardware counters, specifically Last-Level Cache Misses Per Kilo Instruction (MPKI). We demonstrate MPKI is a robust, frequency-invariant proxy for memory pressure, enabling accurate phase classification without dynamic recalibration. To prevent control thrashing, URJA replaces continuous scaling with a reactive ternary control model (minimum, maximum, and stable intermediate frequencies) combined with adaptive window-based smoothing and hysteresis. Furthermore, the control parameters for our DVFS framework are rigorously derived using various data-driven methodologies. Comprehensive evaluations across Intel and ARM platforms using NAS Parallel Benchmarks, SPEC CPU2017, and LLM inference tasks (Ministral 3, GPT-OSS) demonstrate URJA's efficacy. URJA drives execution toward the Energy-Delay Product (EDP) Pareto frontier, achieving a ~10% EDP improvement. It yields up to 29% energy savings without significant runtime degradation, maintaining a negligible ~1% overhead.

Day and time: Tuesday 16, 16:30 – 18:00

Fortran Community Meetup

Room: **RH007**

Session type: Meeting

Lead: Liam Pattinson

Contributors: Connor Aird, Joe Wallwork, Austen Rainer, Jason Klebes

Description: The Fortran community has historically been somewhat fragmented, but recent years have seen a surge in community activity and engagement. Keeping up momentum from Back to the Fortran Future meetups at RSECon and the SSI Collaborations Workshop, this session will bring together Fortran programmers to share best practices and discuss recent developments in the community. It will

consist of a series of short talks followed by a breakout discussion session to identify the challenges facing the community and prioritise future work. Possible topics could include tooling, testing, and community engagement.

Wednesday 17 June

Day and time: Wednesday 17, 09:00 – 10:30 and 13:00 – 14:30

Quantum HPC

Room: **MJC2006**

Session type: Workshop

Facilitators: Omer Rathore, James Richings

Description: This session will explore how quantum computing can be integrated into HPC. It is designed to bring together both classical computing specialists interested in the potential of quantum technologies and quantum experts looking for meaningful applications in classical scientific domains. The session will begin with a series of talks setting out the broader quantum-HPC landscape, including current capabilities, integration models, and emerging opportunities. The second part will open with application-focused talks to provide practical context and inspiration, before moving into an interactive breakout discussion. During the breakout, participants will be grouped by domain science area. Each group will first map out a tangible, representative classical workflow in its domain, then consider where quantum methods could realistically contribute, accelerate, or transform parts of that workflow. Quantum-classical experts will be available throughout the room to support and guide the discussions. By the end of the session, participants will have developed a clearer view of where quantum computing may offer value, where it is unlikely to help, and what practical steps are needed to move from possibility to application.

Schedule:

- 09:00–09:20 — Beyond GEMM: GPU Optimization Strategies for Sparse, Irregular Graph Algorithms in Real-Time Quantum Error Correction — Jules Gransden, Riverlane
- 09:20–09:40 — QRMI — an open-source vendor neutral software for quantum resource management — Oscar Wallis, STFC UKRI
- 09:40–10:00 — NQCC Software Stack: Kwon — Tim Boyle, STFC UKRI
- 10:00–10:30 — Integrating quantum computing with HPC – prospects and challenges — Viv Kendon, University of Strathclyde
- 13:00–13:20 — Fourier extensions for block encoding matrix functions with exponential convergence — Peter Brearley, The University of Manchester
- 13:20–13:40 — Accelerating advanced computing: Quantum, HPC and AI — Chris Derson, Fsas Technologies, Fujitsu
- 13:40–14:30 — Breakout Discussion

Day and time: Wednesday 17, 09:00 – 10:30

Knowledge Exchange in the DRI Community

Room: **MCS0001**

Session type: Workshop

Facilitators: Marion Weinzierl

Speakers: Joe Wallwork, Lewis Sampson and Louise Chisholm

Description: Meet our first cohort of DRI knowledge exchange (KE) fellows! In this session, our KE fellows will present their work on championing and facilitating knowledge exchange in their subcommunities, reflect on the challenges they encountered during their first months, and talk about future plans. We will also discuss general hurdles and tools for knowledge exchange and sharing, and what each of us can do to make sure we stay connected and informed, and create synergy in our field.

Day and time: Wednesday 17, 09:00 – 10:30

Computational Engineering

Room: **MCS2068**

Session type: Talks

Facilitator: Gokberk Kabacaoglu

Speakers: Ashutosh Shankarrao Vahid Jafari, Henrique Bergallo Rocha and Robert Bird

Description: This session will feature three talks:

Advancing DNS Turbulent Reacting Flow Simulations with Performance Portability Using OPS • Ashutosh Shankarrao Londhe

This session introduces computational engineering concepts.

SENGA+ is a high-order finite difference compressible direct numerical simulation (DNS) code for simulating turbulent reacting flows. It incorporates detailed chemical reactions and transport with high order numerical schemes to achieve high-fidelity simulations and excellent parallel scaling. This talk presents our experience in deploying SENGA+ on next-generation high-performance computing systems, using the OPS DSL. We discuss the key challenges encountered during the porting process, underpinned by specialized optimizations to gain near-optimal performance on multi-core/many-core systems. OPS enables automatic generation of multiple parallelizations, highly customized for the target architectures, reducing developer effort and increasing code longevity. Performance evaluation shows up to 22× speedup on a GPU node with 4 AMD MI250X compared to the original CPU-only code. We also present validation simulations using the re-engineered application with near-optimal scaling on up to 2k GPUs. The new code enables simulating production-level combustion problems at high-fidelity within tractable time-frames that were previously prohibitively expensive.

Scalable Coupled CFD–DSMC Simulations for Hypersonic Flows: Accuracy–Performance Trade-offs on Modern HPC Systems • Vahid Jafari

Hypersonic flows in transitional and rarefied regimes present significant modelling challenges, as continuum assumptions progressively break down and neither classical CFD nor particle-based approaches alone are sufficient. This work presents

a coupled CFD–DSMC framework for hypersonic flow simulations, integrating an in-house finite-volume CFD solver with the SPARTA DSMC code through the Macro-Micro-Coupling (MaMiCo) tool. The approach employs spatial domain decomposition to restrict DSMC calculations to non-equilibrium regions, thereby avoiding the prohibitive cost of full-domain particle simulations. Rarefied gas behaviour in transitional regimes is investigated, with emphasis on consistency and conservation properties across the CFD–DSMC coupling interface. Particular attention is given to the relationship between physical accuracy and computational cost on distributed-memory HPC systems. In DSMC simulations, increasing the number of simulation particles leads to a steep rise in computational cost, limiting achievable particle densities in large-scale problems. To reduce statistical fluctuation errors without excessively increasing particle numbers within a single simulation, multiple independent DSMC instances are executed concurrently. Ensemble averaging of these independent realisations improves statistical convergence while maintaining feasible per-instance computational requirements. Error estimation capabilities provided by the Macro-Micro-Coupling (MaMiCo) tool are used to quantify statistical and coupling uncertainties, enabling a systematic assessment of the trade-off between accuracy and computational effort. Performance characteristics—including runtime, parallel scalability, memory footprint, and energy consumption—are analysed for different coupling configurations and DSMC ensemble sizes. The results provide practical guidelines for selecting particle numbers, DSMC subdomain sizes, and ensemble strategies, enabling efficient and scalable high-fidelity simulations of hypersonic transitional flows on modern HPC architectures.

Finite Element Method Scaling and Performance on MI300X GPUs Through MFEM-Enabled MOOSE • Henrique Bergallo Rocha

With the new generation of GPU-accelerated HPC systems opening new avenues in large-scale physical modelling, nuclear fusion applications through the Finite Element Method (FEM) require code that is performant at scale, parallelisable, and that can faithfully reproduce highly coupled, complex multiphysics on meshes with up to $O(10^{10})$ degrees of freedom. MFEM-Enabled MOOSE, i.e. a build of the MOOSE framework that utilises the MFEM FEM library as opposed to libMesh, has been shown to fulfil these requirements on CPUs and on GPUs with a CUDA backend. However, so far the scalability and general performance of MFEM-Enabled MOOSE on recent AMD hardware has not been explored to great extent, which may turn to be a blind spot when it comes to the deployment of large HPC systems in the UK with AMD GPUs. In this talk, we present our results from benchmarking, profiling, and measuring the scalability of MFEM-Enabled MOOSE on the MI300X nodes in the CSD3 system. We perform weak and strong scaling analyses across a variety of sample FEM problems utilising different solvers and preconditioners. The sample problems studied represent different kinds of physics and span the entire De Rham complex, and they are tested to up to $O(10^2)$ GPU cards on a single problem. We then compare these results to those tested on equivalent NVIDIA hardware and discuss their relative strengths and weaknesses.

The Generalised Implicit Material Point Method, octrees and the CPU/GPU crossroad • Robert Bird

Recently, an implicit Generalised Implicit Material Point Method has been developed within the Computational Mechanics group at Durham Engineering to model soil-structure interaction problems. The initial objective was to create a numerically stable simulation framework that was validated against a range of geotechnical centrifuge experiments. Although the method was successfully validated, simulations using conforming meshes proved computationally expensive, with runtimes of approximately one month and a significant environmental impact, equivalent to the carbon emissions of a return flight between Dublin and Paris. To address these limitations, the Material Point Method has been extended with an adaptive octree mesh refinement strategy. This approach reduced simulation runtimes and associated carbon costs by factors of approximately 12 and 50, respectively. The authors present the remaining challenges in improving the scalability of the code and critically assess the feasibility and effectiveness of implementations on CPUs and/or GPUs.

Day and time: Wednesday 17, 09:00 – 10:30

User-driven large-scale federated data movement

Room: **MCS0001**

Session type: Talks

Facilitators: Alastair Basden

Description: Large-scale data transfer between HPC facilities ought to be a solved problem. However, from a user perspective, it is often unnecessarily complex. This session will explore use cases and successes in large scale transfer, and report on outcomes from several NFCS+ projects based around large scale data transfer. Steps taken towards this in areas such as cosmology, nuclear fusion and astronomy will be presented, including facilities with large data sets such as the Vera Rubin telescope.

Day and time: Wednesday 17, 11:00 – 12:00

What Works? Academic-Industry Collaborations Across Borders - US vs EU models

Room: **MCS0001**

Session type: Keynote

Speaker: Melyssa Fratkin

Description: Academic-industry partnerships are important to spur innovation (for both partners) and increasingly to offer a new source of funding at universities. How does the difference in attitudes about corporate responsibility between the US and Europe change the way academic HPC centers interact with companies? Are industry relations *that* different on opposite sides of the Atlantic? This talk will compare the cultural and political impact of working with companies, including GDPR and Intellectual Property, and look at how AI may influence these relationships in the future.

Day and time: Wednesday 17, 13:00 – 14:30

CoSeC Knowledge Exchange: HPC Across Computational Research Communities

Room: **MCS0001**

Session type: Workshop

Facilitator: Wei Wang and Damian Jones

Speaker: Stephen Longshaw, Stefano Rolfo, Mayank Kumar, Tom Durrant and Wei Wang

Description: This CoSeC session brings together representatives from several Collaborative Computational Projects (CCPs) and High-End Computing (HEC) communities to discuss how high-performance computing (HPC) is used across different research domains. The session will highlight the diversity of HPC workloads supported by CoSeC, including turbulence, wave-structure interaction, molecular simulation, engineering modelling, and nuclear thermal hydraulics.

The aim is to compare computational patterns across domains, identify shared challenges and opportunities, and gather community input to help inform future UK national HPC services beyond ARCHER2.

Agenda

13:00-13:05 Welcome - Wei Wang

13:05-13:15 CoSeC Overview: HPC Roles Across Computational Research Communities - Stephen Longshaw

13:15-13:25 CCP-Turbulence and UKTC: a community based effort to support high fidelity fluid modelling for the UK academic and industrial ecosystem - Stefano Rolfo

13:25-13:35 CCP-WSI - Mayank Kumar

13:35-13:45 CCP5 - Tom Durrant

13:45-13:55 CCP-NTH: HPC for nuclear thermal hydraulics and emerging AI/HPC workflows - Wei Wang

13:55-14:25 Structured panel and audience discussion: shared HPC workload patterns, bottlenecks, and future national HPC service needs - All speakers

14:25-14:30 Summary and next steps - Stephen Longshaw / CoSeC office

The panel discussion will focus on common HPC workload patterns across communities, shared technical and community bottlenecks, and requirements for future UK national HPC services. Audience input may be gathered through brief questions and Slido if available.

Day and time: Wednesday 17, 13:00 – 14:30

Research software development funding calls

Room: **RH007**

Session type: Talks

Facilitator: Chris Johnson

Speaker: Chris Johnson, Neil Chue Hong and Lorna Smith

Description: Scientific research relies heavily on software which in turn must be maintained. In this session we will introduce two recent endeavours to fund the maintenance and development of such software. The Embedded CSE (eCSE) software development programme has been running since 2013 supporting nearly 200 projects. Initial calls were to develop software to run on the UK National

Services, ARCHER and ARCHER2 with more recent calls focusing on a wider range of systems, systems based on GPU hardware. More recently, the Software Sustainability Institute (SSI) has run the Research Software Maintenance Fund (RSMF), which supports work to reduce technical debt, improve user experience, and build communities with the overall aim of improving the sustainability of software; Round 1 funded 13 projects and funding decisions for Round 2 are expected in early summer 2026.

The session will begin with an introduction to relevant calls (e.g. the eCSE and RSMF calls) and will lead into a speaker-led discussion about these types of funding and the extent to which they satisfy the research communities' needs, and the challenges that arise from managing such funding calls. Participants will discuss topics such as the frequency of calls, submission and reviewing process, size of awards, remit, etc. There will also be a discussion on the role calls play in advancing environmental sustainability. Should this be integrated into calls? And if how should this be done?

Day and time: Wednesday 17, 15:00 – 16:00

Vendor Session

Room: **MCS0001**

Description: Join us for a fast-paced vendor showcase featuring a series of short, high-impact talks from leading HPC industry partners. Each vendor will deliver a 2–3 minute overview highlighting their latest technologies, services, and innovations supporting high-performance computing.

This will be followed by a panel session.

Participating vendors include BeeGFS, BIOS-It, Computacenter, Cornelis, Dell, DDN, Fsas Technologies, Midas, Novatech, OCF, PeakAIO, Quantum, Spectra Logic, StackHPC, VAST and Vespertec

Day and time: Wednesday 17, 16:30 – 18:00

Vendor session 1

Room: **MJC2004**

Description: This session offers a series of focused presentations from selected vendors, providing a deeper look into their technologies and solutions for high-performance computing. With a smaller audience, attendees will have the opportunity to engage more directly and explore specific tools and services in greater detail. Each talk will be up to 8 minutes long.

Schedule:

- 16:30 - BeeGFS
- 16:40 - Computacenter
- 16:50 - DDN
- 17:00 - OCF
- 17:10 - PeakAIO
- 17:20 - StackHPC
- 17:30 - Vespertec

- 17:40 - Alces
- 17:50 - Quantum

Day and time: Wednesday 17, 16:30 – 18:00

Vendor session 2

Room: **MJC2006**

Description: This session offers a series of focused presentations from selected vendors, providing a deeper look into their technologies and solutions for high-performance computing. With a smaller audience, attendees will have the opportunity to engage more directly and explore specific tools and services in greater detail. Each talk will be up to 8 minutes long.

Schedule:

- 16:30 - BIOS-IT
- 16:40 - Dell
- 16:50 - Fsas Technologies
- 17:00 - Midas
- 17:10 - Novatech
- 17:20 - Spectra Logic
- 17:30 - VAST
- 17:40 - PeakAIO
- 17:50 - Cornelis

Thursday 18 June

Day and time: Thursday 18, 09:00 – 10:30
Responsible computing plans
Room: VisLab
Session type: tutorial
Instructors: Andy Turner
Description: This session will introduce the concept of a responsible computing plan for HPC use and the practical actions you can take to reduce emissions from your use of HPC. It will cover different stages of the project from planning, data management, actions during the project, to finishing the project well. C/C++/Fortran and basic knowledge of OpenMP parallelisation

Day and time: Thursday 18, 09:00 – 10:30 and 13:00 – 14:30
RIE's and RSE working together towards user friendly, sustainable HPC
Room: RH007 (09:00-10:30) Room: MJC2004 (13:00-14:30)
Session type: Workshop
Lead: Helen Cooper Contributor: Dean Roe
Description: Discover how Research Infrastructure Engineers (RIEs) and Research Software Engineers (RSEs) can work together to boost HPC user confidence and improve cluster efficiency. We'll be sharing results from the first ACIT hub hackathon, showcasing approaches for improving user efficiency on accelerated compute clusters, along with dashboards for system administrators and users that can help highlight issues at a glance. Take part in facilitated discussions to shape future hackathons, get under the hood of the cluster and into the minds of users, explore real pain points at the software–hardware boundary, and help define where intervention could have the biggest impact.

Day and time: Thursday 18, 11:00 – 12:00
Interactive On-Demand HPC at Lincoln Laboratory and Beyond
Room: MCS0001
Session type: Keynote
Speaker: Albert Reuther
Description: Since their emergence in the 1980s, supercomputers have been considered high-value assets, and like telescopes, they have been scheduled with batch queue and reservation systems. However, human-in-the-loop research, rapid prototyping, and engineering activities do not lend themselves well to such scheduling. For over 20 years, MIT Lincoln Laboratory Supercomputing Center and several other organizations have been researching, developing, and implementing an alternative paradigm: interactive, on-demand HPC. In this talk, we will overview a number of facets of implementing interactive, on-demand HPC capabilities including

scheduling and organizational policies, software tools, system design, data management, user support, and user education/training.

Day and time: Tuesday 16, 13:00 – 14:30 and 16:30 – 18:00

Reinforcement Learning for Scientific and Computational Decision Making

Room: **RH007**

Session type: Talks

Lead: Gokberk Kabacaoglu

Contributors: Bidipta Sarkar, Junyan Hu, Andrew Mole, Shruti Mishra and Giorgio Maria Cavallazzi

Description: Reinforcement Learning (RL) is increasingly used to make intelligent decisions in complex computational systems, ranging from fluid mechanics and large-scale scientific simulations to optimisation, robotics, control, healthcare, and autonomous systems. This minisymposium focuses on applied and scalable RL approaches that interact directly with simulations, models, and high-performance computing (HPC) environments.

The session will feature talks on RL at scale including applications such as robotics, flow control, and data-driven modelling in fluid mechanics. The aim is to bring together AI researchers and computational scientists to explore how RL can be embedded within scientific workflows to improve efficiency, robustness, and physical fidelity. The session includes these talks:

Evolution Strategies at the Hyperscale • Bidipta Sarkar (joint work with Prof. Shimon Whiteson)

Evolution Strategies (ES) is a class of powerful black-box optimisation methods that are highly parallelisable and can handle non-differentiable and noisy objectives. However, naïve ES becomes prohibitively expensive at scale on GPUs due to the low arithmetic intensity of batched matrix multiplications with unstructured random perturbations. We introduce Evolution Guided GeneRal Optimisation via Low-rank Learning (EGGROLL), which improves arithmetic intensity by structuring individual perturbations as rank- r matrices, resulting in a hundredfold increase in training speed for billion-parameter models at large population sizes, achieving up to 91% of the throughput of pure batch inference. We provide a rigorous theoretical analysis of Gaussian ES for high-dimensional parameter objectives, investigating conditions needed for ES updates to converge in high dimensions. Our results reveal a linearising effect, and proving consistency between EGGROLL and ES as parameter dimension increases. Our experiments show that EGGROLL: (1) enables the stable pretraining of nonlinear recurrent language models that operate purely in integer datatypes, (2) is competitive with GRPO for post-training LLMs on reasoning tasks, and (3) does not compromise performance compared to ES in tabula rasa RL settings, despite being faster. Our code is available at <https://eshyperscale.github.io/>

Cooperative Learning and Control in Swarm Robotics • Junyan Hu

Recent advances in computing, communication, and control techniques, as well as increasing computational power of embedded systems, provide a great opportunity to deploy networked intelligent robots in complex tasks for higher accuracy, safety and efficiency. However, current demonstrations of robot swarms are mainly restricted to controlled or structured environments, which significantly limits their

deployment in complex scenarios. The main challenge in designing practical cooperative robotic systems is to determine the individual agents' controllers that enable the collective to achieve the desired global objectives. This talk will briefly introduce some pioneering works on swarm robotic learning and control with their real-world applications.

Reinforcement Learning in High-Fidelity Simulations for Responsive Wind Farm Control • Andrew Mole (joint work with Prof. Sylvain Laizet and Prof. Georgios Rigas)

We present a reinforcement learning (RL) framework for closed-loop control in turbulence resolving simulations of a wind farm. Traditional wind farm control strategies rely on static or low-fidelity models, that fail to capture the transient and stochastic nature of atmospheric turbulence, limiting their effectiveness for real-time decision making. In this work, we couple a RL algorithm with large eddy simulations (LES) to enable dynamic and flow responsive control of turbine yaw angles. The controller learns directly from high-fidelity simulation data, using spatially distributed velocity measurements to adapt its actions in response to evolving flow conditions. This results in a closed-loop strategy that exploits transient turbulent structures in the atmosphere to improve the total wind farm performance. We demonstrate that the learned policy increases the wind farm power output by over 4% relative to standard operation, outperforming both static and quasi-dynamic optimisation baselines. Analysis of the learned behaviour reveals coordinated, time-delayed control strategies and dynamic switching between symmetric operating modes, highlighting the ability of RL to uncover non-trivial control mechanisms in complex physical systems. Beyond wind energy, this work illustrates a broader paradigm in which RL enables data-driven decision making in scientific computing. This is achieved by leveraging high-fidelity simulations as training environments for adaptive, real-time control policies.

A Reinforcement Learning Approach for Mixing in Stratified Shear Flows • Shruti Mishra

The prediction of transport in the ocean is limited by large uncertainties. In fluid flows, reinforcement learning has been used to discover navigation strategies, achieve flow control, and recover model parameters. I will present a policy-based deep reinforcement learning approach for optimal mixing in a stratified shear flow, a canonical model for flows in the ocean. In this continuous control setting, a reinforcement learning agent introduces small perturbations to the flow, with the goal of efficiently achieving a desired turbulent flux coefficient. I will describe the reinforcement learning setup and present results on mixing in the stratified shear flow environment and other fluid mechanical environments. Finally, I will argue that such environments offer grounded benchmarks for reinforcement learning challenges in evolving, high-dimensional environments.

Multi-agent reinforcement learning and its pathologies: how can we actually control wall bounded turbulent flows • Giorgio Maria Cavallazzi (joint work with Prof. Alfredo Pinelli)

Deep reinforcement learning has become a standard route to active drag reduction in wall-bounded turbulence, with multi-agent formulations routinely reporting impressive headline figures. This talk argues that those figures are, in many cases, physically meaningless. Three structural pathologies are identified in the centralised-

training, decentralised-execution template. The zero-net-mass constraint coupling all agents' outputs corrupts per-agent credit assignment unless differentiated through the actor. A memoryless policy acting on instantaneous snapshots cannot resolve the near-wall regeneration cycle and converges instead to a frozen standing wave, a reward-hacking artefact indistinguishable from trivial open-loop forcing. Most consequentially, the drag-reduction percentage is not an energy-honest objective: it measures only saved pumping power while ignoring the thermodynamic work the actuated wall does on the fluid, a loophole that both learned and open-loop controllers exploit to report positive drag reduction while raising total dissipation. All three failure modes are demonstrated concretely before presenting the corrected architecture: a recurrent multi-agent policy with a differentiable projection layer, a widened sensing stencil, and a reward scored against the true wall power. The resulting controller achieves 17% genuine drag reduction in a turbulent channel, trained on a minimal flow unit and evaluated on a large domain (4x4 times larger in wall-parallel area) without retraining, at opposition control's energy efficiency and less than half its actuation amplitude. The lessons generalise beyond turbulence to any multi-agent system acting under a global conservation law, controlling a process slower than its sensing cadence, or optimising a partial energy budget.

Day and time: Thursday 18, 13:00 – 14:30

We know what to do, so why aren't we doing it? Closing the EDI Implementation Gap with lessons from EuroHPC, UKRI and Beyond

Room: **MCS0001**

Session type: Workshop

Leads: Eleanor Broadway, Marion Weinzierl, Tom Meltzer and Jack Franklin

Contributors: Luigi del Debbio and Charlotte Bell

Description: Our community broadly agrees on the importance of improving equality, diversity and inclusion (EDI). We also often know what we should be doing, or how to get help, due to the wealth of guidance and expertise that has already been developed and curated. Yet, progress is slow. Why isn't this happening? How do we take our ambitions and drive real, impactful change?

This session aims to address the "implementation gap": the disconnect between knowing what needs to be done to improve EDI and successfully putting those actions into practice. The focus is on moving beyond awareness-raising towards practical, actionable change.

The session will begin with short presentations introducing different contexts where EDI challenges have been identified, alongside the efforts made to address them.

These will include gender imbalance in EuroHPC applications, experiences of forming diverse panels within UKRI and challenges faced by the CAKE-CoSeC EDI working group when implementing existing EDI advice.

Participants will take part in interactive breakout discussions to identify and propose solutions at different levels of influence: individual actions ("what can I do?"), leadership responsibilities ("what can my boss do?"), and changes required at the structural, policy and decision-makers level. These discussions will focus on developing strategies that can be taken forward to EuroHPC, UKRI, CAKE and CoSeC, to directly contribute to closing the gap between intent and impact.

Day and time: Thursday 18, 13:00 – 14:30

What's inside the black box? Compiler developments for HPC

Room: **MJC2004**

Session type: Workshop

Leads: Pawel Radtke

Contributors: Sven-Bodo Sholz, Nick Brown, Maurice Jamieson and Shounak Chakraborty

Description: What's inside the black box? Compiler developments for HPC brings together compiler developers, standards contributors, and HPC practitioners to discuss how recent advancements in compilation techniques impact the performance, portability, and correctness of scientific codes on today's increasingly heterogeneous systems. Speakers from academia and industry will highlight emerging compiler infrastructures, advances in optimisation, directive-based programming, data layout, accelerator support, tools for understanding and guiding optimisation decisions, and domain-specific approaches that raise productivity while preserving trust, reproducibility, and predictable behaviour in high-performance computing workflows for real-world scientific applications.

Day and time: Thursday 18, 15:00 – 16:00

Implementing the Compute Roadmap

Room: **MCS0001**

Session type: Keynote

Speakers: Luke Davis

In this presentation Luke will talk about the UK Compute Roadmap written by DSIT and UKRI and published in July 2025. 12 months on, we are still in an exciting place for Computational Science, covering an update on the state of implementation, as well as the work still to do to achieve the vision.

Day and time: Thursday 18, 16:30 – 18:00

Past, present and future of HPC Services in the UK, and the people who make it work

Room: **MCS2068**

Session type: Talks

Speakers: Deepak Aggarwal, Simon Burbidge, Simon Clifford, Marion Weinzierl and Jannetta Steyn

Description: This is a joint session organised by the HPC SIG and the HPC RSE SIG. We will look back on how past technologies have shaped the sector and the dRTP roles, review current development and challenges, and think about where these developments - in particular the AI boom and recently appointed national supercomputers and resources - will lead the computational research community in the coming years.

Agenda:

- 16.30 - 16.40: Intro from HPC SIG and HPC RSE SIG - Deepak and Marion
 - 16.40 - 17.00: History of HPC - Simon and Simon
 - 17.00 - 17.15: HPC Carpentries - Jannetta Steyn
 - 17.15 - 17.55: Panel discussion on the Future of HPC and HPC Services -Chair: Deepak
 - 17.55 - 18.00: Wrap-up - Marion
- Confirmed Panellists:
Andy Turner (EPCC)
Wojciech Turek (University of Cambridge)
Mark Wilkinson (DiRAC)
Silvia Ramos (UCL)
Luke Davis (UKRI)

Day and time: Thursday 18, 18:00 – 20:00

Meet the funder

Room: **VisLab**

Session type: Meeting

Lead: Afia Masood

Description: Participants have the opportunity to speak to EPSRC's Afia Masood, Portfolio Manager for research software and digital infrastructure opportunities in an informal setting about current grants, future bids and recommendations how to engage with the council.

There will also be an opportunity to ask about upcoming funding calls. Afia and her team will be around for the HPC Days and be available for 1:1 conversations (please book directly via email). This open session on the Thursday evening will however handle questions FCFS - bring your drink, food, and all the questions to EPSRC with you.

Friday 19 June

Day and time: Friday 19, 09:00 – 10:30 and 13:00 – 14:30
Accelerating Scientific Applications with OpenMP for GPUs
Room: RH007
Session type: Tutorial
Instructors: Johanna Potyka and Giacomo Capodaglio
Description: 2 x 1.5 hours including hands-on. Target audience: Part 1: attendees with some HPC background but little or no prior experience with OpenMP GPU offload. Part 2: attendees with prior exposure to OpenMP offload, including participants from Part 1. OpenMP has become a valuable option for porting scientific applications to GPUs: what makes it attractive are portability, relative simplicity and a quick ramp up time compared to other GPU programming approaches. In this tutorial, we will show how to implement OpenMP offloading in practice for C/C++ and Fortran applications. This hands-on tutorial is organized into two parts: First, we introduce the fundamentals of OpenMP offload for GPUs and discuss how unified shared memory on systems such as the AMD Instinct MI300A can simplify the transition of your codebase from CPU to GPU. Participants will explore these concepts through practical exercises in C/C++ and Fortran, with a particular focus on how OpenMP can support incremental porting of existing CPU HPC applications. In the second part, we move towards intermediate and advanced topics, focusing on performance-oriented OpenMP programming: using application examples, we will discuss common performance pitfalls, how to address them and strategies for improving GPU utilization in real codes. We will also compare OpenMP target offload with HIP, a lower-level GPU programming model from AMD. With this information, attendees will be empowered to make a well-informed decision on the choice of programming model for their own CPU to GPU porting. Attendees will be allowed to perform the hands-on portion of the tutorial on an AMD Instinct MI300A system that features different ROCm versions as well as the latest Fortran compilers from AMD.

Day and time: Friday 19, 09:00 – 10:30 and 13:00 – 15:00
Building Community
Room: MCS0001
Session type: Workshop
Facilitator: Simon Hands Speakers: Luke Davis, Luigi del Debbio, Sarah Harris, Jonathan Hays, Eugene Lim, Crispin Miller, Karina Rodriguez Echavarria, Katherine Rooke, Matthieu Schaller, Andrea Townsend-Nicholson, Mark Wilkinson, Scott Woodley
Description: Inspired by on-going discussions about plans to establish Community Centres of Excellence within the UKRI DRI, this workshop brings together

practitioners, community champions and programme managers from diverse areas of scientific computation in the UK to articulate what we each mean by 'community' and map out what challenges and opportunities may lie ahead. The morning session will consist of presentations from practitioners representing a broad spread of HPC-based science.

Day and time: Friday 19, 09:00 – 10:30

Research Facilitation for DRI communities

Room: **MCS2068**

Session type: Workshop

Leads: Jeremy Cohen, Samantha Wittke and Eirini Zormpa

Description: With the ever more team-based nature of research, ensuring efficient and effective connections between team members across different fields and roles is a vital part of the research process. This has led to an increasing number of dedicated research facilitation roles. This is especially important in the High Performance Computing (HPC) space where research computing infrastructure professionals may speak a very different technical language to the researchers from a wide range of different domains who are using the infrastructure they support and maintain. In this session we hope to understand more about what support research facilitators can provide to the community and how we can elevate the role of the research facilitator from something that often appears as an afterthought when planning project teams and institutional infrastructure, to a core, highly-valued team role. The session will focus specifically on the Digital Research Infrastructure (DRI) context, and in particular HPC. We're looking to understand more about, and raise awareness of, all types of research facilitation support in the DRI/HPC space, from public engagement and community building, through training activities to more low-level aspects around technical support.

Day and time: Friday 19, 11:00 – 12:00

CCMI - PhD Training on the Interface of Data, Software, and Computation

Room: **MCS0001**

Session type: Keynote

Lead: Timo Betcke

The EPSRC Centre for Doctoral Training in Collaborative Computational Modelling at the Interface (CCMI) is a newly created Doctoral Training Centre between UCL and Imperial College. Its vision is to create a modern graduate training programme that lifts Research Software Engineering from being a Professional Service to being a core academic activity of a Computational Researcher. In our first cohort we had 20 students and are soon welcoming 16 more students for the second cohort, aiming to train over 70 students in the lifetime of the CDT. In this talk I will give an overview of what the CDT is and how we try to tackle the core training challenges on the interface of data, software, and computation.