

WLCG/HSF Workshop 2025



Report of Contributions

Contribution ID: 1

Type: **not specified**

Test

Contribution ID: 2

Type: **Talk**

Marionette: Data Structure Description and Management for Heterogeneous Computing

Wednesday, May 7, 2025 11:20 AM (20 minutes)

Marionette is a header-only C++ library that was designed to allow the description of arbitrary data structures that can work across heterogeneous compute devices and on the host, providing complete interoperability and convenient interfaces with no impact on runtime performance. This is achieved by decoupling the description of the data to be held from the way in which data will be stored, which enables the generation of all memory allocations, transfers and deallocations at compile-time without requiring the end user to write any sort of boilerplate code, achieving the same performance as the equivalent hand-written alternatives. Furthermore, an expressive and intuitive object-oriented interface can be offered on both host and device(s), especially since arbitrary functions can be added to the interface of both the individual objects and the entire collection of them, without any runtime performance penalty as everything is resolved at compile-time. This user-extensible interface also means that the behaviour of pre-existing data structures can be replicated, allowing for immediate porting of pre-existing code with only minor adjustments to the data types. Furthermore, since the user can override and further specialize data transfers, gradual porting to the new data structures with minimal performance loss becomes possible as efficient ways to convert to and from pre-existing structures can be provided. With a focus on flexibility, customisability and extensibility without compromising expressivity, convenience or ease of use, Marionette is designed to offer a general solution for expressing data structures, catering to a wide variety of use cases and levels of expertise, with little to no runtime impact.

Requested talk length

Author: DOS SANTOS FERNANDES, Nuno (Laboratory of Instrumentation and Experimental Particle Physics (PT))

Presenter: DOS SANTOS FERNANDES, Nuno (Laboratory of Instrumentation and Experimental Particle Physics (PT))

Session Classification: HSF

Track Classification: HSF: Recognition of Sustainable Software

Contribution ID: 6

Type: **Talk**

GWOSC and gravitational-wave data analysis training

Wednesday, May 7, 2025 3:00 PM (25 minutes)

Since their discovery in 2015, gravitational waves have become a hot topic in physics research. Gravitational-wave data produced by the LVK Collaboration, formed by the LIGO, Virgo and KAGRA collaborations, become fully public after a grace period; combined with the relative simplicity of the data themselves (one time series of the main signal channel per each interferometer, plus some simple data quality information), this created a large community of professional scientists, students and even citizen scientists analyzing them.

The Gravitational-Wave Open Science Centre (gwosc.org), besides maintaining a site hosting the public data and relevant software, developed a large amount of training and teaching materials such as tutorials and documentation, and organises periodical GW Open Data Workshops, “crash courses” in GW data analysis. This contribution describes such materials and activities.

Requested talk length

15

Authors: RAZZANO, Massimiliano; Dr BAGNASCO, Stefano (Istituto Nazionale di Fisica Nucleare, Torino)

Presenters: RAZZANO, Massimiliano; Dr BAGNASCO, Stefano (Istituto Nazionale di Fisica Nucleare, Torino)

Session Classification: HSF

Track Classification: HSF: Training

Contribution ID: 7

Type: **Talk**

Julia: Sustainability and Efficiency

Wednesday, May 7, 2025 11:40 AM (30 minutes)

There a number of studies of the general energy efficiency of different programming languages, however relatively few look at HEP specific examples. Here we present examples comparing energy efficiency of different jet reconstruction codes in different languages: specifically C++, Julia and Python. We also study the evolution of efficiency over recent releases of Julia and Python.

We also discuss general aspects of sustainability of code and show how the Julia language and ecosystem helps developers to write and maintain modular, interoperable codes that reduce the code maintenance burden.

We show that Julia is an excellent language choice, combining outstanding energy efficiency and human productivity, helping sustainability in all the most meaningful senses.

Requested talk length

30

Authors: DOGLIONI, Caterina (The University of Manchester (GB)); STEWART, Graeme A (CERN); MATO VILA, Pere (CERN); SKIPSEY, Samuel Cadellin

Presenter: STEWART, Graeme A (CERN)

Session Classification: HSF

Track Classification: HSF: Recognition of Sustainable Software

Contribution ID: 8

Type: **Talk**

Understanding the scale of HL-LHC physics analyses

Tuesday, May 6, 2025 3:00 PM (30 minutes)

The existing roadmaps and computing model plans from ATLAS and CMS for the HL-LHC area are primarily focused on the centralized aspect of computing: those steps that lead up to sets of files made available to physicists for analysis. The general approaches, resources used, and software frameworks for the area of “end-user physics analysis”, which starts from those files, are much less clearly defined, understood, or prescribed.

In order to better understand these aspects, IRIS-HEP, jointly with ATLAS AMG, CMS CAT and HSF DAAA, is designing a survey to capture the computational requirements from physics analysis use cases. This contribution will show first results from the survey and discuss the broader context of the effort. Following this survey, we aim to identify a set of physics analyses and define benchmark scenarios to extrapolate the concrete computing requirements to the HL-LHC era. The described workflows will provide more clarity about the role of analysis facilities and the kinds of services they should make available. It will allow for quantitative evaluation of analysis models and be a first step towards identifying what to do about analysis use cases that do not fit into the space set out by the benchmark examples.

Requested talk length

20

Authors: HELD, Alexander (University of Wisconsin Madison (US)); SHADURA, Oksana (University of Nebraska Lincoln (US))

Presenters: HELD, Alexander (University of Wisconsin Madison (US)); SHADURA, Oksana (University of Nebraska Lincoln (US))

Session Classification: Plenary

Track Classification: Analysis at scale

Contribution ID: 9

Type: **Talk**

Power Accounting in Heterogeneous Compute Clusters

Thursday, May 8, 2025 9:18 AM (15 minutes)

Energy efficiency is a critical concern for WLCG operations. We present a proof-of-concept for dynamic power accounting in our heterogeneous compute clusters at ScotGrid Glasgow. Our approach leverages real-time metrics from Prometheus to attribute energy consumption to individual Virtual Organizations (VOs) based on actual core usage. By integrating hardware-specific power efficiency data, derived from static measurements across different node generations, we compute per-core power usage while accounting for architectural differences.

Our methodology distinguishes between active power (consumed by running jobs) and infrastructure overhead (idle power and other services), the latter is allocated to the hosting institute. This granular, data-driven model not only provides transparent energy allocation but also encourages system administrators to optimize resource utilization and improve overall Power Usage Effectiveness (PUE).

Our work lays the foundation for integrating energy accounting into existing monitoring infrastructures and provides insights into sustainable cluster operations.

Requested talk length

20

Author: SIMILI, Emanuele**Co-authors:** BORBELY, Albert Gyorgy (University of Glasgow (GB)); BRITTON, David (University of Glasgow (GB)); STEWART, Gordon; SKIPSEY, Samuel Cadellin**Presenter:** SIMILI, Emanuele**Session Classification:** Plenary**Track Classification:** Environmental sustainability

Contribution ID: 10

Type: **not specified**

ROOT: Taking stock of the Run 3 experience towards ROOT7

Tuesday, May 6, 2025 9:00 AM (30 minutes)

ROOT is a unified software package for the storage, processing, and analysis of scientific data: from its acquisition to the final visualization in the form of highly customizable, publication-ready plots. Successfully used by experiments and thousands of physicists, the ROOT Project is preparing its seventh release cycle, sustained by intense R&D activities.

In this contribution, after briefly reviewing the status of the project, we'll focus on the results harvested along the R&D activities conducted so far and how those will shape the future of ROOT. The areas on which we'll concentrate will mainly be three. Firstly, we discuss how hardware accelerators can be exploited by users with ROOT and how these new features are relevant at present and future Analysis Facilities. Then, we review the current development status of RNTuple and its adoption by experiments, illustrating both advancements in terms of performance but also usability, in C++ and Python. Finally, we'll concentrate on the Python-C++ integration, at a low level, and the recent advancements in the interoperability of ROOT and Scientific Python, at the user-facing level.

Requested talk length

20

Authors: PIPARO, Danilo (CERN); REMBSER, Jonas (CERN)**Presenter:** PIPARO, Danilo (CERN)**Session Classification:** HSF**Track Classification:** HSF: Common Software and Software Projects

Contribution ID: 11

Type: **Talk**

Introduction to the Virtual Research Environment: an end-user perspective

Tuesday, May 6, 2025 10:00 AM (20 minutes)

One of the objectives of the EOSC (European Open Science Cloud) Future Project was to integrate diverse analysis workflows from Cosmology, Astrophysics and High Energy Physics in a common framework. This led to the inception of the Virtual Research Environment (VRE) at CERN, a prototype platform supporting the goals of Dark Matter and Extreme Universe Science Projects in compliance with FAIR (Findable, Accessible, Interoperable, Reusable) data policies. The goal of the project was to highlight the synergies between different dark matter communities and experiments, by producing new scientific results as well as by making the necessary data and software tools fully available. The VRE makes use of a common authentication and authorisation infrastructure (AAI), and shares the different experimental data (ATLAS, Fermi-LAT, CTA, Darkside, Km3Net, Virgo, LOFAR) in a reliable distributed storage infrastructure via the ESCAPE Data Lake. The entry point of such a platform (for an end-user) is a jupyterhub instance deployed on top of a scalable Kubernetes infrastructure, providing an interactive graphical interface for researchers to access, analyse and share data. The data access and browsability is enabled through API calls to the high level data management and storage orchestration software (Rucio). The VRE aims to streamline the development of end-to-end physics workflows, granting researchers access to an infrastructure that contains easy-to-use physics analysis workflow from different experiments. In this contribution, I will provide an overview of the VRE, highlight its use cases as an analyser for implementing and reproducing experimental analyses on a REANA cluster, and showcase the successful integration of an ATLAS experimental analysis workflow into the VRE platform.

Requested talk length

Author: SINHA, Sukanya (The University of Manchester (GB))

Presenter: SINHA, Sukanya (The University of Manchester (GB))

Session Classification: HSF

Track Classification: HSF: Common Software and Software Projects

Contribution ID: 12

Type: **Talk**

The European Virtual Institute for Research Software Excellence (EVERSE)

Wednesday, May 7, 2025 9:00 AM (20 minutes)

The EVERSE EU-funded project aims to create a framework for research software and code excellence, collaboratively designed and championed by research communities that include physics and astronomy.

EVERSE's ultimate ambition is to contribute towards a cultural change where research software is recognized as a first-class citizen of the scientific process and the people that contribute to it are credited for their efforts.

In this contribution, we will outline the aims of the network and present the achievements of the first year of the project, towards building a European network of Research Software Quality and setting the foundations of a future Virtual Institute for Research Software Excellence, including the creation of the EVERSE Network. The goal of this contribution is also to interactively discuss how these best practices can map to the HSF's sponsored project requirements.

Requested talk length

20

Authors: DOGLIONI, Caterina (The University of Manchester (GB)); STEWART, Graeme A (CERN); SPARKS, Michael (BBC); ROISER, Stefan (CERN)

Presenter: STEWART, Graeme A (CERN)

Session Classification: HSF

Track Classification: HSF: Recognition of Sustainable Software

Contribution ID: 13

Type: **Talk**

The EVERSE/ESCAPE use cases: evaluating and improving the quality of HEP software

Wednesday, May 7, 2025 9:20 AM (20 minutes)

This contribution will present how the EVERSE project interfaces with the European Open Science Clusters (ENVRI-FAIR for environmental sciences, Life Sciences RI, ESCAPE for Particle physics and astrophysics, PaNOSC for Photon and neutron science and SSHOC for social sciences and humanities) through use cases of software packages or infrastructures that are in current used by researchers.

It is through these use cases that EVERSE draws best practices from the different communities, and where the various elements of the software excellence framework are tested and implemented prior to their release to the wider community. In this talk, we will describe the three ESCAPE use cases, highlight the elements that these use cases have contributed to EVERSE so far, and outline the expected improvements and pathway to obtain them by the end of the project in 2027.

Requested talk length

10

Authors: DOGLIONI, Caterina (The University of Manchester (GB)); SMITH, James (The University of Manchester (GB)); SPARKS, Michael Philip (The University of Manchester (GB)); FITSCHEN, Tobias (The University of Manchester (GB))

Presenters: SMITH, James (The University of Manchester (GB)); SPARKS, Michael Philip (The University of Manchester (GB)); FITSCHEN, Tobias (The University of Manchester (GB))

Session Classification: HSF

Track Classification: HSF: Recognition of Sustainable Software

Contribution ID: 14

Type: **Talk**

The EVERSE Research Software Quality Toolkit

Wednesday, May 7, 2025 9:40 AM (20 minutes)

The Research Software Quality Toolkit (RSQKit - <https://everse.software/RSQKit/>), developed by the EVERSE project, lists curated best practices in improving the quality of your research software. It is intended for use by researchers, research software engineers, as well as those running research infrastructures involving software or involved in research software-related policy and funding.

These practices are informed by software excellence and quality in the context of research; with a focus on FAIR software, Open Research, community development and software engineering practices at different tiers of research software (analysis scripts, prototype tools and research software infrastructure). RSQKit links to tools and resources which support best practices. It includes software quality dimensions and links to indicators and tasks to guide the usage of the best practice, as well as links to training resources and existing guides and materials.

This contribution will introduce RSQKit and its aims and architecture. It is presented in a way to attract and consider feedback from researchers who code from the particle physics community and from WLCG infrastructure experts.

Requested talk length

15

Authors: DOGLIONI, Caterina (The University of Manchester (GB)); STEWART, Graeme A (CERN); SPARKS, Michael Philip (The University of Manchester (GB)); ROISER, Stefan (CERN)

Presenter: SPARKS, Michael Philip (The University of Manchester (GB))

Session Classification: HSF

Track Classification: HSF: Recognition of Sustainable Software

Contribution ID: 15

Type: **Talk**

The EVERSE training and recognition plan

Wednesday, May 7, 2025 2:30 PM (25 minutes)

The EVERSE project aims to collect, enhance and curate training resources aligned with domain-specific practices, create a long-term training activity supported by community services and platforms and establish a framework for recognizing Trainers and RSEs.

This contribution will describe how EVERSE plans to collect and provide training, guidance and education to researchers, software developers, and other stakeholders in the research community to help them understand the importance of software and code quality, as well as how to apply established best practices and standards for assessing, verifying, and improving the quality of their software and code.

We will describe the registry of training initiatives compiled so far, and how this registry will be maintained and presented through the TESS infrastructure. We will also outline recent activities in terms of recognition of software activities and roles.

Our aim is to get feedback from the community at the workshop and to highlight missing aspects in training and recognition that we can bring back to the project.

Requested talk length

15

Authors: DOGLIONI, Caterina (The University of Manchester (GB)); STEWART, Graeme A (CERN); RIOJA, Kenneth Brian (IT-FTI); ROISER, Stefan (CERN)

Presenter: RIOJA, Kenneth Brian (IT-FTI)

Session Classification: HSF

Track Classification: HSF: Training

Contribution ID: 16

Type: **Talk**

Green software in HEP: benchmarks and studies on MC generators

Thursday, May 8, 2025 11:10 AM (15 minutes)

In this talk, we will describe the studies undertaken at the University of Manchester to estimate and improve the energy efficiency of computing hardware and software used by students and researchers.

The goal of these studies is to build an understanding of the environmental impact of particle physics research focusing on two fronts:

- 1) the carbon cost of the hardware uses for high power computing hardware and the local computing cluster
- 2) the energy efficiency of data analysis software and machine learning models in “big data”-related scientific fields including as high-energy particle physics.

The focus of this contribution will be the energy efficiency of scientific software algorithms and MC generation packages, taking Herwig, ML data compression and top tagging algorithms as examples. We will discuss different tools and benchmarks and review their methodologies.

We will then describe our plans towards a lifecycle analysis for computing hardware, and work undergoing to estimate the power consumption of our local cluster more precisely.

Requested talk length

15

Authors: VILLAR, Luis (University of Manchester); FITSCHEN, Tobias (The University of Manchester (GB))

Co-authors: DOGLIONI, Caterina (The University of Manchester (GB)); SMITH, James (The University of Manchester (GB)); SPARKS, Michael (The University of Manchester (GB))

Presenters: VILLAR, Luis (University of Manchester); FITSCHEN, Tobias (The University of Manchester (GB))

Session Classification: Plenary

Track Classification: Environmental sustainability

Contribution ID: 17

Type: **Talk**

Latest Developments in RooFit and Plans

Tuesday, May 6, 2025 9:30 AM (30 minutes)

RooFit is a software package written in C++ for statistical data analysis that is part of ROOT. It is widely used in the High Energy Physics (HEP) community, with the most prominent users being the LHC collaborations. Recent RooFit development has focused on performance improvements and supporting new statistical analysis approaches to enable cutting-edge analyses, such as combined Higgs measurements with ATLAS or CMS. In this contribution, the development pillars that helped to achieve this goal are elaborated on. The first pillar is code optimization and refactoring to optimally use both CPU and GPU resources. Then, there is supporting Automatic Differentiation (AD) with Clad, a compiler plugin for Clang. Furthermore, RooFit now provides new Python interfaces to include ML models as likelihood surrogates, enabling Simulation-Based Inference (SBI). Finally, this contribution will also report on the development status of the Minuit2 library for numerical minimization since it is a key dependency of RooFit, and the two packages are developed hand-in-hand to implement performance-optimal statistical analysis workflows for HEP.

Requested talk length

30

Author: REMBSER, Jonas (CERN)**Presenter:** REMBSER, Jonas (CERN)**Session Classification:** HSF**Track Classification:** HSF: Common Software and Software Projects

Contribution ID: 19

Type: **Talk**

Analysis at the HL-LHC: Data Delivery, ServiceX, and Addressing Our Analysis Challenges

Tuesday, May 6, 2025 5:05 PM (40 minutes)

As the HL-LHC era approaches, the scale and complexity of data present challenges for analysis workflows within ATLAS and other HL-LHC experiments. This contribution reports on recent developments in ServiceX, a cross experiment utility, and its role as a data delivery and transformation service within the analysis ecosystem. Designed to bridge the gap between centrally produced datasets and user-level analysis code, ServiceX now supports a broader range of input formats—including custom non-ROOT ATLAS data—and has seen significant improvements in reliability, scalability, and ease of use.

We highlight progress in several areas: improved bullet-proofing of the data transformation infrastructure to avoid errors at scale; new convenience utilities for introspecting datasets (e.g., listing available branches); and tighter integration with common ATLAS frameworks such as TopCPTools, enabling more standardized analysis environments. We also share results from recent scaling tests demonstrating performance at analysis-scale workloads, and discuss how ServiceX fits into the broader analysis software stack, helping to address long-standing challenges of reproducibility, data access, and user efficiency.

This talk will provide a view of the design of ServiceX, the technical and usability gains made in recent months, and what's coming next as we prepare for the HL-LHC's analysis demands.

Requested talk length

30

Authors: CORDEIRO OUDOT CHOI, Artur (University of Washington (US)); GALEWSKY, Benjamin (Univ. Illinois at Urbana Champaign (US)); WATTS, Gordon (University of Washington (US)); VUKOTIC, Ilija (University of Chicago (US)); CHOI, Kyungeon (University of Texas at Austin (US)); ONYISI, Peter (University of Texas at Austin (US)); JANUSIAK, Roger (University of Washington)

Presenter: WATTS, Gordon (University of Washington (US))

Session Classification: Plenary

Track Classification: Analysis at scale

Contribution ID: 20

Type: **Talk**

Environmental impact, carbon and sustainability of computing in the ATLAS experiment

Thursday, May 8, 2025 11:30 AM (10 minutes)

In this contribution, we will describe the efforts within the ATLAS experiment to evaluate and mitigate various aspects of the environmental impact of ATLAS computing sites, such as building awareness in the experiment community, adjusting aspects of the computing policy, and modifications of data center configurations, either in ways that take advantage of particular features of ATLAS work or in generic ways that reduce the environmental impact of the computing.

Requested talk length

10

Author: WALKER, Rodney (Ludwig Maximilians Universitat (DE))

Co-author: MARSHALL, Zach (Lawrence Berkeley National Lab. (US))

Presenter: WALKER, Rodney (Ludwig Maximilians Universitat (DE))

Session Classification: Plenary

Track Classification: Environmental sustainability

Contribution ID: 21

Type: **Talk**

AdePT - Offloading electromagnetic showers in Geant4 simulations to GPU

Tuesday, May 6, 2025 11:20 AM (20 minutes)

The Geant4 simulation throughput of LHC experiments is limited by increasing detector complexity in the high-luminosity phase. As high-performance computing shifts toward heterogeneous architectures such as GPUs, GPU-accelerated particle transport simulations offer a potential way to improve performance. Currently, only electromagnetic showers can be offloaded to GPUs, making an efficient CPU–GPU workflow essential. In this contribution, we present state-of-the-art detector simulations for LHC experiments using GPUs, outline the outstanding challenges, and discuss future directions.

Requested talk length

20

Authors: GHEATA, Andrei (CERN); MORGAN, Benjamin (University of Warwick); APOSTOLAKIS, John (CERN); HAHNFELD, Jonas (CERN & Goethe University Frankfurt); GONZALEZ CAMINERO, Juan (CERN); NOVAK, Mihaly (CERN); DIEDERICHS, Severin (CERN); HAGEBOECK, Stephan (CERN); POKORSKI, Witold (CERN)

Presenter: DIEDERICHS, Severin (CERN)

Session Classification: HSF

Track Classification: HSF: Common Software and Software Projects

Contribution ID: 22

Type: **Talk**

Accelerating HEP detector simulations using G4HepEm

Tuesday, May 6, 2025 11:00 AM (20 minutes)

Geant4 based detector simulations make a significant contribution to the overall computing budget of the LHC experiments. The individual experiments have been investing considerable effort in making their simulations more and more efficient. These performance optimisations are now even more important in order to cope with the special computing challenges of the HL-LHC era.

G4HepEm is one of the R&D projects that have been launched with the goal of contributing to this effort. It provides an efficient simulation of the electromagnetic shower, tailored for HEP detector simulations, in the form of a Geant4 extension. A significant performance improvement (~20 %) of the ATLAS and CMS full detector simulations has been achieved recently after integrating G4HepEm into the ATLAS Athena and CMS-SW frameworks while preserving the accuracy of the results. The motivations, ideas and results obtained for ATLAS and CMS will be presented.

Requested talk length

Author: NOVAK, Mihaly (CERN)

Co-authors: MORGAN, Benjamin (University of Warwick (GB)); HAHNFELD, Jonas (CERN & Goethe University Frankfurt)

Presenter: NOVAK, Mihaly (CERN)

Session Classification: HSF

Track Classification: HSF: Common Software and Software Projects

Contribution ID: 23

Type: **Talk**

Scikit-HEP project news and future directions

Wednesday, May 7, 2025 11:00 AM (20 minutes)

Scikit-HEP is a community-driven and community-oriented project with the goal of providing an ecosystem for particle physics data analysis in Python fully integrated with the wider scientific Python ecosystem. The project provides many packages and a few “affiliated” packages for data analysis. It expands the typical Python data analysis tools for particle physicists, with packages spanning the spectrum from general scientific libraries for data manipulation to domain-specific libraries. An overview of where the project is will be presented. Future developments and matters of sustainability will be discussed.

Requested talk length

Author: RODRIGUES, Eduardo (University of Liverpool (GB))

Presenter: RODRIGUES, Eduardo (University of Liverpool (GB))

Session Classification: HSF

Track Classification: HSF: Recognition of Sustainable Software

Contribution ID: 24

Type: **not specified**

Welcome in Orsay

Monday, May 5, 2025 1:30 PM (15 minutes)

Requested talk length

Presenters: JOUVIN, Michel (Université Paris-Saclay (FR)); CHAMBERT, Valerie

Session Classification: Plenary

Contribution ID: 25

Type: **not specified**

Introduction - WLCG

Monday, May 5, 2025 1:45 PM (20 minutes)

Presenters: BRITTON, David (University of Glasgow (GB)); CAMPANA, Simone (CERN); BOCCALI, Tommaso

Session Classification: Plenary

Contribution ID: 26

Type: **not specified**

Introduction - HSF

Monday, May 5, 2025 2:10 PM (20 minutes)

Presenters: RODRIGUES, Eduardo (University of Liverpool (GB)); LAYCOCK, Paul James (Universite de Geneve (CH))

Session Classification: Plenary

Contribution ID: 27

Type: **not specified**

Introduction to the OPS session

Wednesday, May 7, 2025 2:15 PM (5 minutes)

Presenter: ANDREEVA, Julia (CERN)

Session Classification: WLCG

Contribution ID: 28

Type: **not specified**

AUDITOR. First results of the assessment by the WLCG sites

Wednesday, May 7, 2025 2:20 PM (1h 30m)

AUDITOR (Accounting Data Handling Toolbox for Opportunistic Resources) is a flexible and extensible accounting system designed to support a wide range of use cases and infrastructures. Its integration with APEL enables it to function as a generic component within the WLCG accounting infrastructure, tracking the usage of various types of site computing resources. Several WLCG sites have evaluated AUDITOR, and the outcomes of these assessments will be reviewed and discussed.

Requested talk length

Presenters: PASCOLINI, Alessandro (Universita e INFN, Bologna (IT)); KLEINEMUHL, Alexander Raphael (Bergische Universitaet Wuppertal (DE)); ALANDES PRADILLO, Maria (CERN); FISCHER, Max (Karlsruhe Institute of Technology); BOEHLER, Michael (Deutsches Elektronen-Synchrotron (DE)); BOEHLER, Michael (University of Freiburg (DE)); HARTMANN, Thomas (Deutsches Elektronen-Synchrotron (DE))

Session Classification: WLCG

Contribution ID: 29

Type: **not specified**

Accounting of jobs submitted with tokens and changes required in the WLCG accounting infrastructure.

Wednesday, May 7, 2025 4:10 PM (15 minutes)

Requested talk length

Presenter: Mr DACK, Tom

Session Classification: WLCG

Contribution ID: **30**

Type: **not specified**

GGUS: past, present, future

Wednesday, May 7, 2025 4:25 PM (45 minutes)

Requested talk length

Presenters: HRYNEVICH, Aliaksei (Karlsruher Institut für Technologie); HRYNEVICH, Aliaksei (Karlsruhe Institute of Technology (KIT)); GREIN, Guenter; WEBER, Pavel

Session Classification: WLCG

Contribution ID: 31

Type: **not specified**

Job Allocation and Handling, status report from the WG

Wednesday, May 7, 2025 5:10 PM (20 minutes)

Presenter: PEREZ-CALERO YZQUIERDO, Antonio (Centro de Investigaciones Energéticas Medioambientales y Tecnológicas)

Session Classification: WLCG

Contribution ID: 32

Type: **Talk**

ATLAS analysis facility contribution

Tuesday, May 6, 2025 2:45 PM (15 minutes)

Requested talk length

Presenter: TORRO PASTOR, Emma (Univ. of Valencia and CSIC (ES))

Session Classification: Plenary

Contribution ID: 33

Type: **Talk**

CMS analysis facility contribution

Tuesday, May 6, 2025 2:30 PM (15 minutes)

Presenter: SHADURA, Oksana (University of Nebraska Lincoln (US))

Session Classification: Plenary

Contribution ID: **34**

Type: **not specified**

LHCb analysis facility contribution

Tuesday, May 6, 2025 4:00 PM (15 minutes)

Presenter: Dr SKIDMORE, Nicole (University of Warwick)

Session Classification: Plenary

Contribution ID: 35

Type: **not specified**

Exploiting extremely-parallel technologies for future large-scale physics analyses demands

Tuesday, May 6, 2025 4:30 PM (20 minutes)

The HEP experiments and community face complex computing and storage requirements which are expected to increase by several factors with the advent of HL-LHC. By the end of Run3, the machine will have accumulated roughly 10% of the total dataset. These data, stored in the ROOT data format, are then analysed by the various experiment communities, with varying levels of coordination and centralisation.

Very often, the computational complexity of these physics analyses is such that parallelisation must be employed to ensure a reasonable time-to-insight for the physicists. Batch computing on the grid is a well-oiled workflow that has enabled obtaining a plethora of important physics results. In recent times, interactive scheduling approaches have emerged that lower the programming entry barrier and allow for a more ergonomic end-user experience. In this context, a specific combination of storage, computing resources, software distribution and distributed engines can be identified and is sometimes referred to as an “analysis facility”.

In this contribution, we highlight existing technologies such as ROOT, SWAN, EOS, XRootD and others that represent concrete building blocks available in production today to help the community in addressing the expected complexity of HL-LHC analyses. We also display how various current and future physics use cases can benefit from such technologies. These are used both in analyses facilities and other distributed computing infrastructures to minimise the time-to-insight and enable ergonomic and user-friendly distributed computing.

Requested talk length

Presenter: REMBSER, Jonas (CERN)

Session Classification: Plenary

Contribution ID: **36**

Type: **not specified**

Discussion

Requested talk length

Presenters: FORTI, Alessandra (The University of Manchester (GB)); Dr SKIDMORE, Nicole (University of Warwick)

Session Classification: Plenary

Contribution ID: 37

Type: **not specified**

Introduction and Status of DOMA

Thursday, May 8, 2025 2:15 PM (15 minutes)

Requested talk length

Presenters: ELLIS, Katy (Science and Technology Facilities Council STFC (GB)); ELMSHEUSER, Johannes (Brookhaven National Laboratory (US))

Session Classification: WLCG

Contribution ID: **38**

Type: **not specified**

Rucio in DOMA

Thursday, May 8, 2025 2:35 PM (15 minutes)

Presenter: BARISITS, Martin (CERN)

Session Classification: WLCG

Contribution ID: 39

Type: **not specified**

FTS evolution towards DC27

Thursday, May 8, 2025 2:55 PM (20 minutes)

Requested talk length

Presenters: PATRASCOIU, Mihai (CERN); MURRAY, Steven (CERN)

Session Classification: WLCG

Contribution ID: 40

Type: **not specified**

Status of DOMA BDT activity

Thursday, May 8, 2025 4:05 PM (20 minutes)

Presenters: PATRASCOIU, Mihai (CERN); VOKAC, Petr (Czech Technical University in Prague (CZ))

Session Classification: WLCG

Contribution ID: 41

Type: **not specified**

Status of Monitoring of DOMA components

Thursday, May 8, 2025 3:45 PM (20 minutes)

Requested talk length

Presenter: GARRIDO BEAR, Borja (CERN)

Session Classification: WLCG

Contribution ID: 42

Type: **not specified**

Mini data challenges

Thursday, May 8, 2025 4:30 PM (20 minutes)

Presenters: ELMSHEUSER, Johannes (Brookhaven National Laboratory (US)); ELLIS, Katy (Science and Technology Facilities Council STFC (GB))

Session Classification: WLCG

Contribution ID: 43

Type: **Talk**

AI & WLCG/HSF - scope of the session

Monday, May 5, 2025 2:35 PM (5 minutes)

Presenters: DI GIROLAMO, Alessandro (CERN); LAYCOCK, Paul James (Universite de Geneve (CH))

Session Classification: Plenary

Contribution ID: 44

Type: **not specified**

AI and Facilities

Monday, May 5, 2025 2:40 PM (25 minutes)

Presenter: VUKOTIC, Ilija (University of Chicago (US))

Session Classification: Plenary

Contribution ID: 45

Type: **not specified**

AI/ML for Physics use cases

Monday, May 5, 2025 3:45 PM (25 minutes)

Presenter: BOCCALI, Tommaso

Session Classification: Plenary

Contribution ID: 46

Type: **not specified**

Heterogeneous resources and experiment software

Monday, May 5, 2025 4:20 PM (25 minutes)

Presenter: CALAFIURA, Paolo (Lawrence Berkeley National Lab. (US))

Session Classification: Plenary

Contribution ID: 47

Type: **not specified**

Facility view: Heterogeneous resources deployment and usage

Monday, May 5, 2025 4:55 PM (20 minutes)

Requested talk length

Presenters: JONES, Ben (CERN); WALKER, Rodney (Ludwig Maximilians Universitat (DE))

Session Classification: Plenary

Contribution ID: 48

Type: **not specified**

Discussion

Monday, May 5, 2025 5:20 PM (20 minutes)

Session Classification: Plenary

Contribution ID: 49

Type: **not specified**

ALICE analysis facility contribution

Tuesday, May 6, 2025 4:15 PM (15 minutes)

Presenter: LITMAATH, Maarten (CERN)

Session Classification: Plenary

Contribution ID: 50

Type: **not specified**

Proposal for Interdisciplinary Analysis Facilities

Tuesday, May 6, 2025 4:50 PM (15 minutes)

Next to HEP other scientific communities have emerged producing large amounts of data and require correspondingly processing power. While Analysis Facilities can be optimized to specific workflows, the underlying risk is a highly specialised and inflexible lock-in. By aiming for an interdisciplinary approach concentrating on established industry standards and establishing generic interfaces, Analysis Facilities can profit from a broader usage scope.

Requested talk length

Presenter: HARTMANN, Thomas (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Plenary

Contribution ID: 51

Type: **not specified**

User experience

Tuesday, May 6, 2025 2:15 PM (15 minutes)

A users perspective on typical problems faced throughout an analysis cycle, the ad-hoc solutions implemented, and the limited view a user has of the Grid and how it is displayed to them.

Requested talk length

Presenter: BORBELY, Albert Gyorgy (University of Glasgow (GB))

Session Classification: Plenary

Contribution ID: 52

Type: **not specified**

Summary of the HEPiX Spring 2025 Workshop

Tuesday, May 6, 2025 9:00 AM (20 minutes)

Presenter: FLIX MOLINA, Jose (CIEMAT - Centro de Investigaciones Energéticas Medioambientales y Tec. (ES))

Session Classification: WLCG

Contribution ID: 53

Type: **not specified**

Status and evolution of French sites

Tuesday, May 6, 2025 9:20 AM (20 minutes)

Presenter: DUFLOT, Laurent (CNRS (FR))

Session Classification: WLCG

Contribution ID: 54

Type: **not specified**

Storage relocation: INFN-CNAF experience

Tuesday, May 6, 2025 9:40 AM (20 minutes)

Requested talk length

Presenter: RENDINA, Andrea

Session Classification: WLCG

Contribution ID: 55

Type: **not specified**

Responding Faster: Lessons from a security incident

Tuesday, May 6, 2025 1:45 PM (30 minutes)

NOTE: this contribution was actually part of the *Facilities* session, which overflowed into the afternoon.

Requested talk length

Presenter: LUNA DURAN, Jose Carlos (CERN)

Session Classification: Plenary

Contribution ID: 56

Type: **not specified**

WLCG Technical Roadmap - introduction

Wednesday, May 7, 2025 9:00 AM (20 minutes)

Presenters: DI GIROLAMO, Alessandro (CERN); LETTS, James (Univ. of California San Diego (US))

Session Classification: WLCG

Contribution ID: 57

Type: **not specified**

Technical Roadmap - setting the scene - estimates of requirements for Run4 and Run5

Wednesday, May 7, 2025 9:25 AM (15 minutes)

Presenter: COUTURIER, Ben (CERN)

Session Classification: WLCG

Contribution ID: 58

Type: **not specified**

Technical Roadmap - setting the scene - estimates on capacity increase at flat budget scenario

Wednesday, May 7, 2025 9:45 AM (15 minutes)

Presenter: Dr SCIABÀ, Andrea (CERN)

Session Classification: WLCG

Contribution ID: 59

Type: **not specified**

Discussions on the structure and the content of the chapters

Wednesday, May 7, 2025 10:00 AM (20 minutes)

Presenters: DI GIROLAMO, Alessandro (CERN); LETTS, James (Univ. of California San Diego (US))

Session Classification: WLCG

Contribution ID: **60**

Type: **not specified**

Discussions on the structure and content of the chapters

Wednesday, May 7, 2025 11:00 AM (1 hour)

Presenters: DI GIROLAMO, Alessandro (CERN); LETTS, James (Univ. of California San Diego (US))

Session Classification: WLCG

Contribution ID: **61**

Type: **not specified**

Computing Challenges for the Einstein Telescope

Friday, May 9, 2025 9:30 AM (20 minutes)

Presenter: LAYCOCK, Paul James (Universite de Geneve (CH))

Session Classification: Plenary

Contribution ID: 62

Type: **not specified**

Recap and next steps - DOMA and WLCG Ops

Friday, May 9, 2025 9:50 AM (15 minutes)

Requested talk length

Presenters: ELLIS, Katy (Science and Technology Facilities Council STFC (GB)); PAPARRIGOPOULOS, Panos (CERN)

Session Classification: Plenary

Contribution ID: 63

Type: **not specified**

Recap and next steps - WLCG/HSF Sustainability

Friday, May 9, 2025 10:05 AM (15 minutes)

Requested talk length

Presenters: DOGLIONI, Caterina (The University of Manchester (GB)); BRITTON, David (University of Glasgow (GB))

Session Classification: Plenary

Contribution ID: **64**

Type: **not specified**

Recap and next steps - HSF

Friday, May 9, 2025 10:50 AM (15 minutes)

Requested talk length

Presenter: STEWART, Graeme A (CERN)

Session Classification: Plenary

Contribution ID: 65

Type: **not specified**

Recap and next steps - WLCG Technical Coordination

Friday, May 9, 2025 11:05 AM (15 minutes)

Session Classification: Plenary

Contribution ID: 66

Type: **not specified**

Recap and next steps - Analysis at scale

Friday, May 9, 2025 11:20 AM (15 minutes)

Presenters: FORTI, Alessandra (The University of Manchester (GB)); Dr SKIDMORE, Nicole (University of Warwick)

Session Classification: Plenary

Contribution ID: 67

Type: **not specified**

Introduction

Thursday, May 8, 2025 9:00 AM (15 minutes)

Talk to set the scene and summarise the actions from the WLCG environmental sustainability workshop in December 2024: <https://indico.cern.ch/event/1450885/timetable/>

Presenters: DOGLIONI, Caterina (The University of Manchester (GB)); BRITTON, David (University of Glasgow (GB))

Session Classification: Plenary

Contribution ID: **68**

Type: **not specified**

Discussion on power accounting benchmarks part 1: sites perspective

Thursday, May 8, 2025 10:20 AM (20 minutes)

Session Classification: Plenary

Contribution ID: 69

Type: **not specified**

Discussion on power accounting and beyond part 2: inputs from sites, users and experimental collaborations

Thursday, May 8, 2025 11:55 AM (35 minutes)

Session Classification: Plenary

Contribution ID: 70

Type: **not specified**

Training on sustainable computing at DESY

Wednesday, May 7, 2025 4:00 PM (25 minutes)

A few years ago, primarily young scientists of the DESY particle physics division founded a forum for sustainability to enhance awareness of the environmental impact of research and to propose measures to reduce the energy footprint. Since computing is a substantial consumer of resources in particle physics, the forum initiated a series of workshops on computing with the aim of training scientists in best practices for efficient computing and software. Roughly twice per year, there is a workshop for beginners and newcomers to DESY with an introduction to the local computing facilities and hands-on exercises employing tools like ROOT, Git, and HTCondor. About once per year, there is a workshop on a slightly more advanced topic, such as software testing and performance, or using and building containers. The workshops are organized by a team of scientists from the IT department and from the experimental groups. All exercises are constructed along examples that are typical for particle physics and employ, e.g., CMS Open Data.

Requested talk length

Presenter: WISSING, Christoph (Deutsches Elektronen-Synchrotron (DE))

Session Classification: HSF

Contribution ID: 71

Type: **not specified**

Overview, goals

Wednesday, May 7, 2025 2:15 PM (15 minutes)

Presenter: HERNANDEZ VILLANUEVA, Michel (Brookhaven National Laboratory (US))

Session Classification: HSF

Contribution ID: 72

Type: **not specified**

HOWTO Train: the HSF Training experience

Wednesday, May 7, 2025 5:00 PM (25 minutes)

The HSF Training group has built a fruitful learning environment within the high-energy and nuclear physics community through the organization of numerous training events. This talk will share practical insights gained from years of experience in planning and executing training events. We have learnt that organizing effective training requires careful planning, continuous adaptation, and the crucial role of community feedback. We will highlight strategies for engaging participants, adapting to diverse skill levels, and building a sustainable training ecosystem that upskill the next generation of researchers and software developers.

Requested talk length

Presenter: HERNANDEZ VILLANUEVA, Michel (Brookhaven National Laboratory (US))

Session Classification: HSF

Contribution ID: 73

Type: **not specified**

Open Discussion

Session Classification: HSF

Contribution ID: 74

Type: **not specified**

User Learning for ePIC

Wednesday, May 7, 2025 4:30 PM (25 minutes)

The ePIC Software User Learning group supports the ePIC Collaboration by providing resources and opportunities for new user onboarding, software training events, and maintaining documentation. The ePIC Software employs a User-Centered Design model and supports the detector simulation and geometry design, analysis of physics and event reconstruction, and provides benchmarks to ensure a cohesive and consistent framework is available to users. This talk will discuss the strategies and resources available so far for developers with plans for future growth and support.

Requested talk length

Presenter: SZUMILA-VANCE, Holly (Florida International University)

Session Classification: HSF

Contribution ID: 75

Type: **Talk**

Enhancing Job Monitoring with Power Consumption Metrics

Thursday, May 8, 2025 9:36 AM (15 minutes)

To support the sustainability of WLCG compute infrastructure, we propose a strategy to extend the current job monitoring system to include energy consumption data. Currently, WLCG monitoring systems primarily focus on traditional job metrics such as CPU time, memory usage, runtime, and failure rates.

However, they do not capture job-level power consumption, as this data is typically managed by fabric-level monitoring systems and is not directly accessible within jobs.

Our proposal is to bridge this gap by including node-level power measurements within the job data reports.

We have successfully demonstrated the feasibility of this idea with a prototype approach that uses standard WLCG grid jobs submitted to a set of pilot sites (DESY, AGLT, Glasgow).

Although this approach is valid for any kind of job payload, we have leveraged the HEPBenchmark Suite as payload, which organically captures both the performance of the node in terms of HS23 and a set of utilization metrics, including CPU load, memory usage, frequency, and power consumption.

This setup enables correlation between performance and energy efficiency metrics. It provides a more comprehensive view of job efficiency, revealing opportunities for optimization.

This is just the start of an R&D process that would need the involvement of the whole WLCG community to implement that strategy.

Requested talk length

Presenters: GIORDANO, Domenico (CERN); SZCZEPANEK, Natalia Diana (CERN)

Session Classification: Plenary

Track Classification: Environmental sustainability

Contribution ID: 76

Type: **not specified**

GreenDIGIT: updates from the WLCG Environmental Sustainability Workshop

Thursday, May 8, 2025 10:07 AM (10 minutes)

GreenDIGIT (<https://greendigit-project.eu/>) is a TECH-01-01 Horizon Europe project that started in March 2024 to pursue environmental sustainability within digital services and service ecosystems that research infrastructures (RIs) rely on. GreenDIGIT brings together institutes from 4 digital RIs: EGI, SLICES, EBRAINS, and SoBigData to address the pressing need for sustainable practices in digital service provisioning.

Central to GreenDIGIT's mission is the identification of good practices in emphasized textow-impact computing, which involves evaluating the broader computing landscape and identifying opportunities for improvements across various stakeholder groups both within, and beyond the RIs represented in the project consortium. The project will establish reference architectures and design principles that facilitate environmental impact considerations throughout the entire RI lifecycle, ensuring that sustainability is embedded within the entire design-implementation-operation-termination phases of RIs at the level of nodes, services and components.

Moreover, GreenDIGIT will develop and validate innovative technologies and methodologies that empower digital service providers to reduce energy consumption and/or overall operational environmental impact. By supplying technical tools for both providers and researchers, the project promotes the design and execution of environmentally conscious digital applications, aligning with principles of Open Science and FAIR data management.

Through education and support initiatives GreenDIGIT will foster a culture of sustainability among researchers and service providers, equipping them with best practices for lifecycle management and operation. By mapping the landscape of environmentally friendly computing, and by offering policy and technical recommendations, the project not only enhances the sustainability of research infrastructures but also contributes to the broader goal of mitigating climate change.

The first tangible outcome of the project is a landscape analysis that was conducted within the 4 participating RIs, and within other RIs that operate significant digital infrastructures. The presentation will share the first findings from this landscape report, which included responses from 15 EGI sites, many being present in WLCG too.

In the second phase of the project EGI members will extend the EGI-WLCG service configuration database (GOCDB) with environmental metrics to fuel "green workload optimisation strategies" in HTC and Cloud infrastructures. Based on the metrics the DIRAC workload manager (CNRS), the AI4OS AI/ML framework (CSIC), the Terraform DevOps tool (SZTAKI) and a Data Center Energy scheduler (CESNET) will be extended to optimise job/VM/task execution according to green strategies.

In summary, the GreenDIGIT project is a transformative initiative that champions environmental sustainability in digital research services, offering various outcomes and collaboration opportunities to the WLCG community.

This contribution will present updates since the last presentation at the WLCG Environmental Sustainability Workshop in December, focusing on (a) Framework for managing the full digital RI lifecycle from the environmental perspective (b) Software tools for power usage efficiency

Requested talk length

Presenter: SIPOS, Gergely

Session Classification: Plenary

Track Classification: Environmental sustainability

Contribution ID: 77

Type: **not specified**

Token Transition Overview

Tuesday, May 6, 2025 11:00 AM (30 minutes)

Presenter: LITMAATH, Maarten (CERN)

Session Classification: WLCG

Contribution ID: 78

Type: **not specified**

Tape REST API, Tokens & FTS: A Unified Proposal

Tuesday, May 6, 2025 11:30 AM (30 minutes)

Presenter: PATRASCOIU, Mihai (CERN)

Session Classification: WLCG

Contribution ID: 79

Type: **not specified**

Discussion

Tuesday, May 6, 2025 12:00 PM (30 minutes)

Session Classification: WLCG

Contribution ID: **80**

Type: **Talk**

Energy saving measures during peak summer at DESY

Thursday, May 8, 2025 9:54 AM (10 minutes)

This contribution will detail initial plans for reducing peak day loads at the DESY computing center during the summer.

Requested talk length

Presenter: HARTMANN, Thomas (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Plenary

Track Classification: Environmental sustainability

Contribution ID: **81**

Type: **not specified**

Environmental impact of computing in LHCb

Thursday, May 8, 2025 11:45 AM (10 minutes)

This contribution will present the activities in LHCb online and offline towards environmentally sustainable computing.

Presenters: SBORZACCHI, Francesco (CERN); GIEMZA, Henryk (National Centre for Nuclear Research (PL)); GIEMZA, Henryk (National Centre for Nuclear Research (PL))

Session Classification: Plenary

Contribution ID: **82**

Type: **not specified**

Security training opportunities

Wednesday, May 7, 2025 5:30 PM (10 minutes)

Requested talk length

Presenter: CROOKS, David

Session Classification: WLCG

Contribution ID: **83**

Type: **not specified**

Social Dinner

Thursday, May 8, 2025 8:00 PM (2h 30m)

in La Mère Catherine

Contribution ID: **84**

Type: **not specified**

Some final words ...

Friday, May 9, 2025 11:35 AM (10 minutes)

Session Classification: Plenary