

Introduction to FF4EuroHPC and CoE's future Plans

EuroHPC JU Workshop, ISC 2023, Hamburg, 26.5.2023

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Motivation for this presentation

- HPC Matters – because HPC Applications matter!
- User access to HPC Systems = Users employing and benefiting from HPC Applications



Connecting business
with **cutting-edge**
technologies

FF4EuroHPC in numbers



6

project partners



42

high-quality experiments



€8

million funding budget

Experiment partners



118 organisations

22 countries



wide variety of industrial sectors, focus on

manufacturing

57%

The FF4EuroHPC Methodology



- Support the EuroHPC initiative to promote industrial uptake of HPC technology and increase the innovation potential of European industry
→ focus: small and medium sized enterprises (SMEs)
- Extend and continue the Fortissimo Approach:
Portfolio of business-oriented application “experiments” that are driven by SME end-users needs – [selected through two open calls for proposals](#)
- Furthermore...
 - Collaboration with the national HPC Competence Centres (plus EuroHPC projects CASTIEL & EuroCC)
 - Support the participating SMEs in establishment of HPC-related innovation

FF4EuroHPC Experiments in a nutshell

- Two Open Calls were offered, targeting the highest quality experiments involving innovative, agile SMEs
- In total, 42 experiments were selected for funding, **INCLUDING 118 organisations from 22 EuroHPC JU Member States**
- 62% are Small and Medium-Sized Enterprises
- Experiments address business challenges from European SMEs from varied application domains, focus on *Manufacturing 57%*

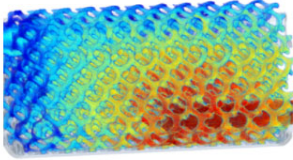



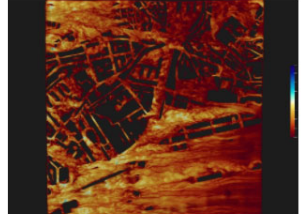



Success Stories



First tranche: 16 Success stories

<https://www.ff4eurohpc.eu/en/success-stories/>

 <p>TOpoLoGy Optimization of Micro-channel Heat-Exchangers Read more</p>	 <p>Power Systems Maintenance Planning for Energy Transition Read more</p>	 <p>Multi-head Additive Manufacturing with Optimal HPC Thermal Stabilization Read more</p>
 <p>Market-Innovation-Sourcing Read more</p>	 <p>Improving BettAir Maps Read more</p>	 <p>HPC-based vessel predictive maintenance optimization through Natural Language Assistance Read more</p>



AI/ML Computer Vision for Next Generation Hen Farms

FF4EuroHPC
YouTube
Video



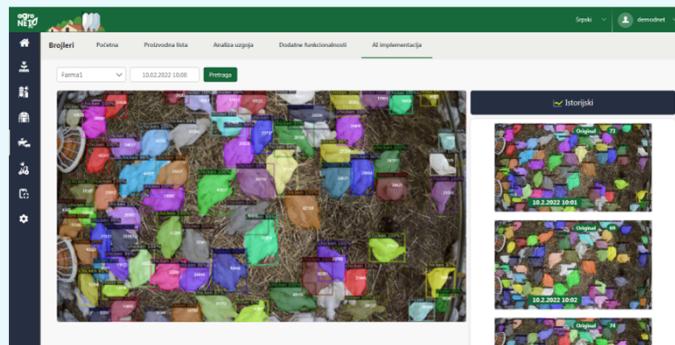
The organisations

- Montenegrin SMEs from the agri-food sector
- Montenegrin SME and Serbian ISV – tech experts in smart AI solutions & IoT/AI for agriculture
- Montenegrin HPC Expert & NCC member



Challenges & Solution

- Reducing costs while ensuring animal well-being and humane food production through monitoring with computer vision sensors
- Achieving realistic use conditions by accelerating training, selection and calibration of prediction models with HPC
- New camera + edge-computing + IoT platform contributing to the development of smart agriculture solutions for the poultry industry



Benefits

- Reduction of both manual labour costs & chicken mortality rate by 10%
- 10X speed-up of predictive model generation via HPC empowers SMEs to deliver customised commercial solutions
- Faster disease/problem detection delivering improved animal well-being and better agri-food product quality
- Better management of mortality detection and carcass disposal; lower greenhouse gas emissions

Multi-head Additive Manufacturing with Optimal HPC Thermal Stabilization

FF4EuroHPC
YouTube
Video



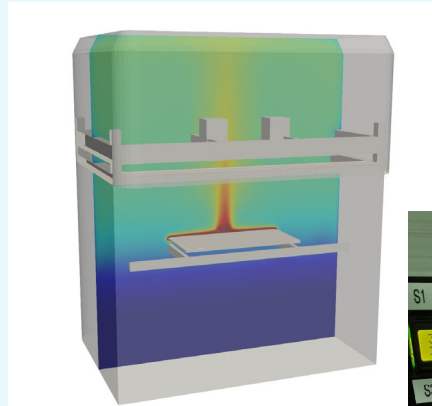
The organisations

- Croatian SME vendor of 3D Printers with expertise in additive / digital manufacturing
- Croatian scientific institute as HPC expert



Challenges & Solution

- Managing heat distributions inside 3D printers is crucial for guaranteeing reliable, high quality manufactured products
- Mikrotvornica had a need to understand the impact of (high) temperatures and temperature distributions on the 3D printer and final 3D-printed pieces
- Validated HPC CFD simulations provide predictions for the development and production process of new machines and for defining temperature settings



Benefits

- Time for product delivery to the customer reduced by 30-50%
- Production costs reduced by 15-30%
- Expected sales increase for 3D printers of 20-30% through higher accuracy
- Creation of jobs for new, highly skilled-employees

Topology Optimization of Micro-Channel Heat Exchangers

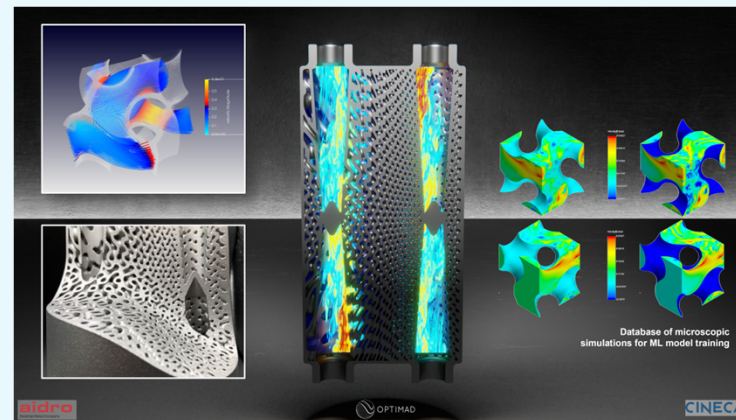


The organisations

- Italian (former) SME manufacturer specialised in hydraulic parts and metal devices
- Politecnico di Torino SME spin-off - numerical simulation ISV
- Italian HPC Centre and NCC member

Challenges & Solution

- Topology optimisation (TO) meets the multi-constraints design requirements of micro-channel heat exchangers but then requires additive manufacturing (AM)
- TO + AM needs fast, accurate solution methods to fit to industrial design cycles
- TOLOMHE SaaS platform providing the required set of HPC-based computational tools



Benefits

- Automated design workflow has the potential to reduce: time-to-design (75%); time-to-market (50%); time-to-prototype (90%)
- SME end-user can re-deploy skilled-labour to other added-value activities
- TOLOMHE platform expected to generate revenue of the order of €250-500 K in first 36 months

HPC Vessel Maintenance Optimization by Natural Language Assistance



The organisations

- Spanish SME with a lead position in marine surveying and maintenance engineering
- Spanish SME whose expert system platform enables digital assistants powered by AI and Natural Language Understanding (NLU)
- Spanish HPC Centre and NCC member



Challenges & Solution

- Maritime industry demand for virtual assistants integrated into their maintenance processes and digitalisation developments
- Complexity extremely high due to the need to function in highly noisy environments
- Natural Language Processing system developed that meets the needs – after HPC training the NLU algorithms work with an accuracy above 95% with environments up to 80 dBm noise



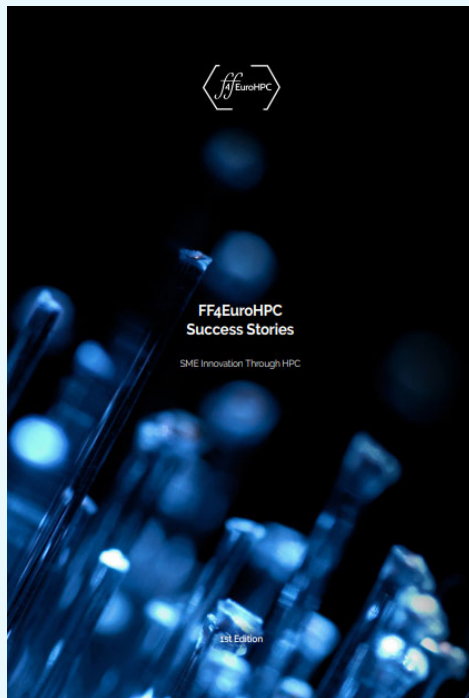
Benefits

- New robust vessel maintenance assistant can reduce maintenance costs by 30%
- SME vendor expects to be able to apply the technology to other domains and increase income by 20%
- Both SMEs expect to increase number of employees

Success Stories



Get inspired – read the Booklet!



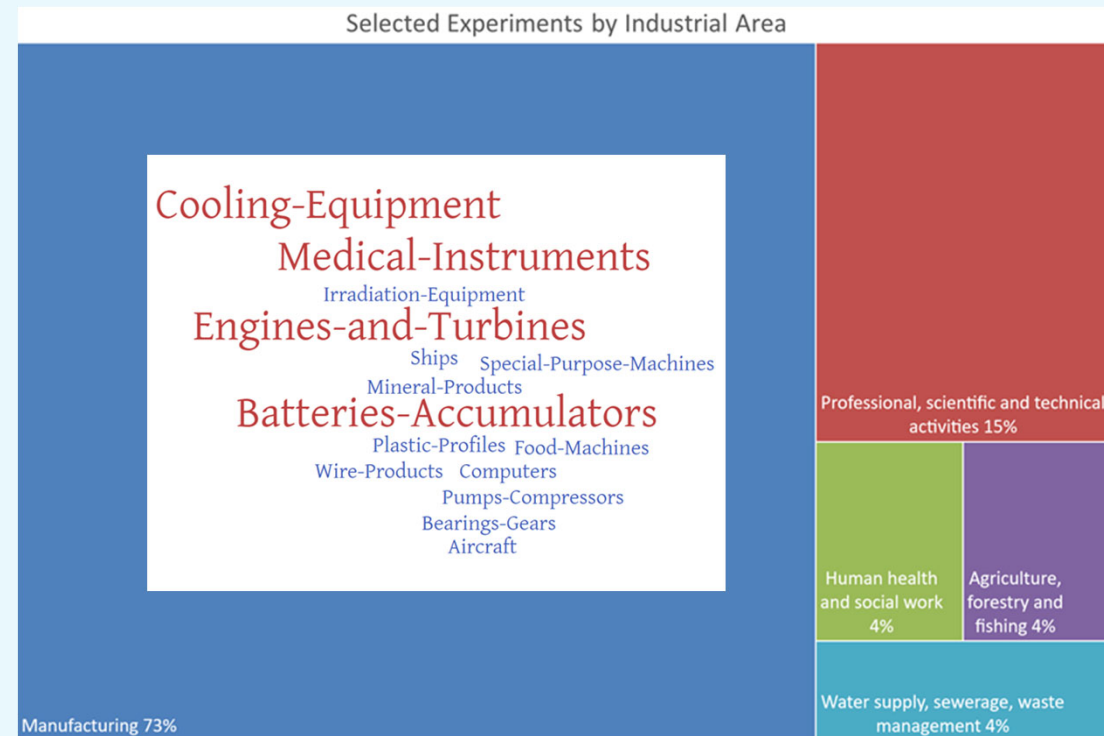
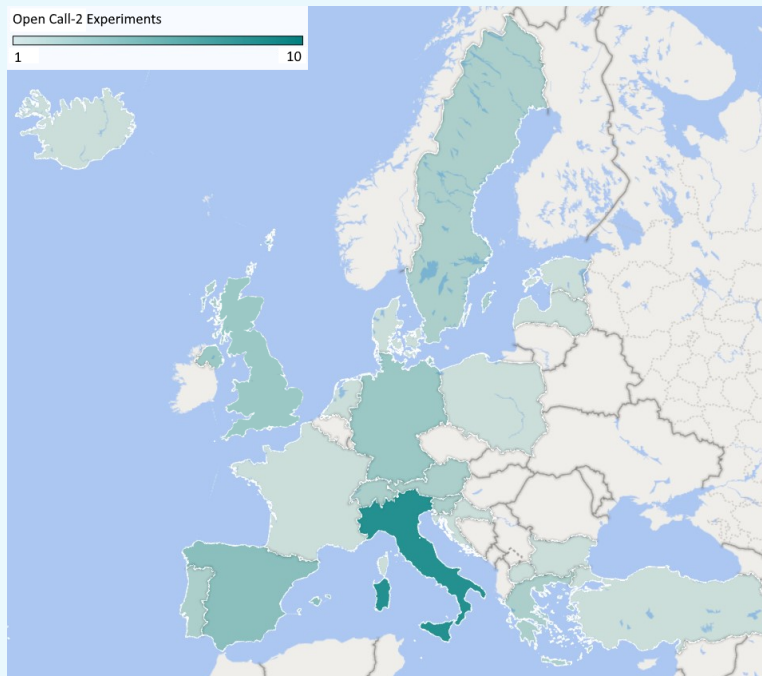
Coming soon... 26 more success stories



Open Call 2 - 26 proposals selected for funding, with a funding budget just below € 5M

Involving 79 organisations, 47 of which being SMEs

A range of computational disciplines covered but with an emphasis on manufacturing (73%)



- Success Stories
- HPC related events
- HPC related content

Let's get **in touch**

—
www.ff4eurohpc.eu

   #FF4EuroHPC



Subscribe to the newsletter
and **get inspired!**

Thank you!



This project has received funding from the European High-Performance Computing Joint Undertaking Joint Undertaking (JU) under grant agreement No 951745. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Germany, Italy, Slovenia, France, Spain.



CASTIEL 2

**(Brief) Introduction to CoEs
& future plans**

What are the CoEs?



- *HPC Centres of Excellence*
- Multinational European Projects: focus on an HPC application or technology area
- Make key applications ready for (pre-) Exascale
 - new CoEs starting Jan 2023: make key applications available on the JU systems
- Make key applications ready for use by non-specialists
 - science, industry, public bodies
- Offer training and community building in the application domain
- Work on HW/SW co-design

A bit of history – CoEs since 2015



2015-18 "Wave 1" (~10)

2019-22 "W2" (10)

2019-22 FocusCoE

2020-23 "W2.1" (5)

2023-26 "W3" (10)

2023-25 CASTIEL2

2024-27 (?) "W3.1" (4-5)

CoEs (# number)

CSA

More info:
www.hpccoe.eu
& impact paper
www.hpccoe.eu/impact

2016

2018

2020

2022

2024

2026

2028

18

Current CoEs and their areas



Earth & Space Systems



Fundamental Physics



Biology



Materials







Engineering & Tools



CoEs from "Wave 3"

- Running January 2023 – December 2026 (4 years)
- **Topic 1: Development of exascale-ready applications**

Acronym	Full title	Topics
	Scalable Parallel and distributed Astrophysics Codes for Exascale	astrophysics and cosmology
	Plasma Exascale-Performance Simulations CoE	plasma science: magnetic confinement fusion, industrial plasmas , medical applications, basic plasma experiments, plasma accelerators, laser-plasma interactions, high energy density physics / laboratory astrophysics, space physics, and astrophysics
	Center of Excellence for Exascale CFD	aeronautic & atmospheric engineering: boundary layers , shock-boundary layer interaction, high fidelity aeroelastic simulation, erosion, ship hulls and aircraft wings, topology optimization of static mixers
	MA terials design at the eXascale	quantum simulations of materials

CoEs from "Wave 3"

• Topic 2: Supporting supercomputing applications for Science & Innovation

Acronym	Full title	Topics
<u>MultiXScale</u> 	Centre of Excellence in exascale-oriented application co-design and delivery for multiscale simulations	software development: performance, productivity, and portability Use cases: helicopter design & certification for civil transport, battery applications for the sustainable energy transition, ultrasound & biomedical applications
<u>BioEXCEL-3</u> 	BioExcel Centre of Excellence for Computational Biomolecular Research	life science, especially biomolecular research, drug development , and molecular dynamics, by using simulation, artificial intelligence, and machine learning
<u>ChEESE-2P</u> 	Center of Excellence for Exascale in Solid Earth - Second Phase	focus on earthquakes, seismic, tomography, tsunamis, magneto-hydrodynamics, volcanology, geodynamics, and glacier hazards.
<u>HiDALGO2</u> 	HPC and Big Data Technologies for Global Challenges	urban air quality, energy efficiency of buildings, renewable energy sources, spread of wildfires, meteo-hydrological forecasting
<u>EXCELLERAT-P2</u> 	European Centre of Excellence for Engineering Applications on HPC and associated technologies	engineering use cases, manufacturing, energy, and mobility: aircraft, rotors, emissions, aero-dynamics, and aero-acoustics.
<u>ESIWACE3</u> 	Center of excellence for weather and climate phase 3	efficient and scalable simulations for earth system modeling , weather, and climate prediction.

CoE Wave3 Codes planned for deployment on the EuroHPC JU Systems



exascale-ready applications

The logo for CEEC, consisting of the letters "CEEC" in white on a dark blue rectangular background.	<p>ALYA: Fluid + Structural Parts FLEXI: DGSEM-based CFD code Nek5000 & NekRS – CFD Codes Neko – SEM code (optimisation) waLBerla multiphysics framework</p>
The logo for MAX, consisting of the letters "MAX" in white on a red rectangular background.	<p>YAMBO – 1st principles code for excited-state properties of solid-state systems Quantum ESPRESSO – set of apps for ab initio calculations based on DFT SIESTA - pseudopotentials + strictly localized pseudo-atomic orbitals FLEUR – all-electron DFT code BigDFT - package suite with a wide variety of features</p>

CoE Wave3 Codes planned for deployment on the EuroHPC JU Systems





exascale-ready applications

The logo for PLASMA PEPSC, consisting of a stylized circular graphic with blue and red elements, followed by the text "PLASMA PEPSC" in a bold, sans-serif font.	<p>GENE - Plasma microturbulence BIT1 – full-size kinetic modelling of plasma edge Vlasiator – Earth plasma simulation (solving 6D Vladov equation) PIConGPU – plasma accelerators at full resolution and scale</p>
The logo for SPACE, featuring the word "SPACE" in a stylized, blue, sans-serif font, with a small black dot and a curved line suggesting an orbit or path.	<p>PLUTO – fluid dynamics + magnetohydrodynamics (MHD) OpenGADGET - N body simulations (cosmology volumes [CV], galaxy clusters...) CHANGA/GASOLINE – SPH with tree-gravity (zoom-in galaxies, CV) iPic3D - particle-in-cell for electric, magnetic and gravitational simulations RAMSES – compressible MHD for radiation, cosmic rays, dust dynamics, ... WhiskyTHC - General Relativistic Hydrodynamics FIL - simulations of Binary Neutron Star and Neutron Star - Black Hole mergers BHAC - accretion flows (electromagnetic emission, radio wavelengths, ...)</p>



CoE Wave3 Codes planned for deployment on the EuroHPC JU Systems



 <p>bioexcel Centre of Excellence for Computational Biomolecular Research</p>	<p>Biomolecular Codes: GROMACS, HADDOCK, PMX BioBB library for workflows with those codes</p>
 <p>ChEESE Center of Excellence for Exascale in Solid Earth</p>	<p>SeisSOL – complex earthquake simulation SPECFEM3D – linear seismic wave propagation; ExaHyPE – special emphasis on ExaSeis collection of seismic models; Tandem – linear elasticity + sequences of earthquakes and seismic slips xSHELLS – flows, magnetic fields incl. Geodynamo simulations; HySEA – earthquake –induced Tsunamis; FALL3D – atmospheric transport & ground deposition OpenPDAC – simulation of volcanic fluids LaMEM – thermo-mechanical geodynamic modelling pTatin3D – simulation of long time-scale geodynamics processes ELMER/ICE – Multio-physics package</p>

CoE Wave3 Codes planned for deployment on the EuroHPC JU Systems



 <p>esiwace CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER AND CLIMATE IN EUROPE</p>	<p>Climate modelling - EC-Earth (coupled earth system), NEMO (ocean), ICON (coupled earth system) Weather Modelling – IFS (atmospheric), HPCW (weather & climate benchmarks)</p>
 <p>EXCELLERAT</p>	<p>mAIA – CFD-focused Multi-Physics AVBP – CFD (LES) for multi-scale, multi-physics <u>reactive</u> flows Neko - SEM code (optimisation) CFD Codes - ALYA (compressible flow), CODA (aerodynamics), OpenFOAM (transient heat transfer), FLEW Mitsuba-2: Monte-Carlo ray tracing - optical & radiative heat transfer</p>

CoE Wave3 Codes planned for deployment on the EuroHPC JU Systems



The logo for HIDALGO2 CENTRE OF EXCELLENCE, featuring the text "HIDALGO2" in blue with a yellow dot above the 'I', and "CENTRE OF EXCELLENCE" in smaller blue text below it.	<p>Urban Development Pilots – Urban Airflow, Buildings Renewable Energy Sources – RES two-scale weather prediction Wildfires – ensemble, coupled prediction models (Modelling/simulation + HPDA /AI)</p>
The logo for MultiScale, featuring the text "MultiScale" in black with a blue circuit-like graphic connecting the 'i' and 's'.	<p>ESPreSo - Molecular Dynamics many-particle simulations for soft-matter research LAMPPS - classical molecular dynamics focused on materials modeling. waLBerla multiphysics framework EESI – complete build and deployment environment for all MultiXscale apps</p>

Thanks



This project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 101102047. The JU receives support from the Digital Europe Programme and Germany, Italy, Spain, France, Belgium, Austria.

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