WSTAR

WSTAR opening and networking event
24 October 2025

# A Look to EuroHPC Supercomputers and Excess Heat Utilization Case Example

## EuroHPC LUMI Supercomputer


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CSC

Co-funded by the European Union

# Outline

- EuroHPC supercomputers
- CSC intro
- LUMI supercomputer
- Excess heat reuse with LUMI
- Kajaani Data Center Ecosystem (KDCE)
- LUMI AI Factory

# Greetings from Köln!

https://hpcinfra.org

HPCinfra workshop

Upcoming workshop | Past editions | About us | Organization | Contact

## Upcoming workshop

# Cologne

**20 - 22 October 2025**

The 15th edition of the highly successful series of European Workshops on HPC Infrastructures will be hosted by JSC and will take place in Cologne, Germany, from October 20th (welcome dinner) till 22th, 2025.

Please note, that this is an on-invitation-only event.

The organization committee is looking forward to welcome you at the workshop!

**Register now!**

Learn more

# The EuroHPC Joint Undertaking – leading the way in European Supercomputing

The first generation of EuroHPC systems announced in June 2019

- 3 pre-exascale systems to Finland, Italy and Spain
- 5 petascale systems to Czech Republic, Bulgaria, Luxembourg, Portugal and Slovenia

Two exascale system coming (Germany and France)

New AI Factories announced in December 2024 and March 2025

- LUMI AI Factory to Finland with budget of 612 million EUR

# The EuroHPC Joint Undertaking – leading the way in European Supercomputing

## Our Supercomputers

Up to now, the EuroHPC JU has procured eleven state-of-the-art supercomputers, located across Europe.

## New Call to Procure the European Exascale Supercomputer, Alice Recoque

**The EuroHPC Joint Undertaking (EuroHPC JU) has launched a call for tender to select a vendor for the acquisition, delivery, installation and maintenance of Alice Recoque, the European exascale supercomputer to be located in France.**

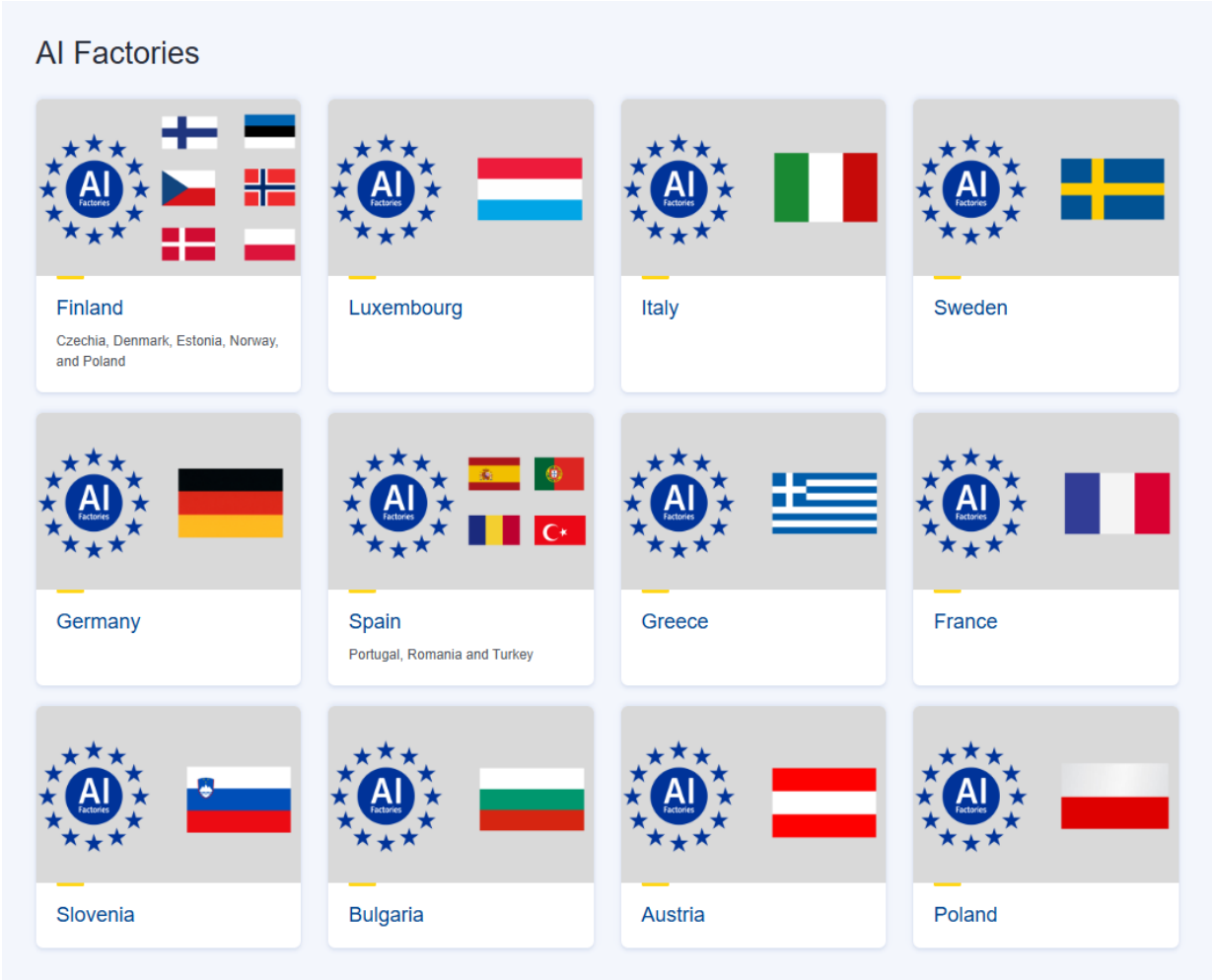
EuroHPC
Joint Undertaking

PAGE CONTENTS

AI Factories:

Computing power and customised support services for free!

EuroHPC Joint Undertaking



CSC develops, integrates, and provides high-quality ICT services for research, education, culture, and public administration

Revenues in 2024

**95**M€

csc

LUMI

Owned together with EuroHCP JU and unique consortium of 11 countries – Finland, Belgium, the Czech Republic, Denmark, Estonia, Iceland, the Netherlands, Norway, Poland, Sweden, and Switzerland.


Headquarters in Espoo, datacenter in Kajaani

Non-profit state enterprise with special tasks owned by the state of Finland **70 %**
and
Finnish higher education institutions
**30 %**

**+700**

Employees

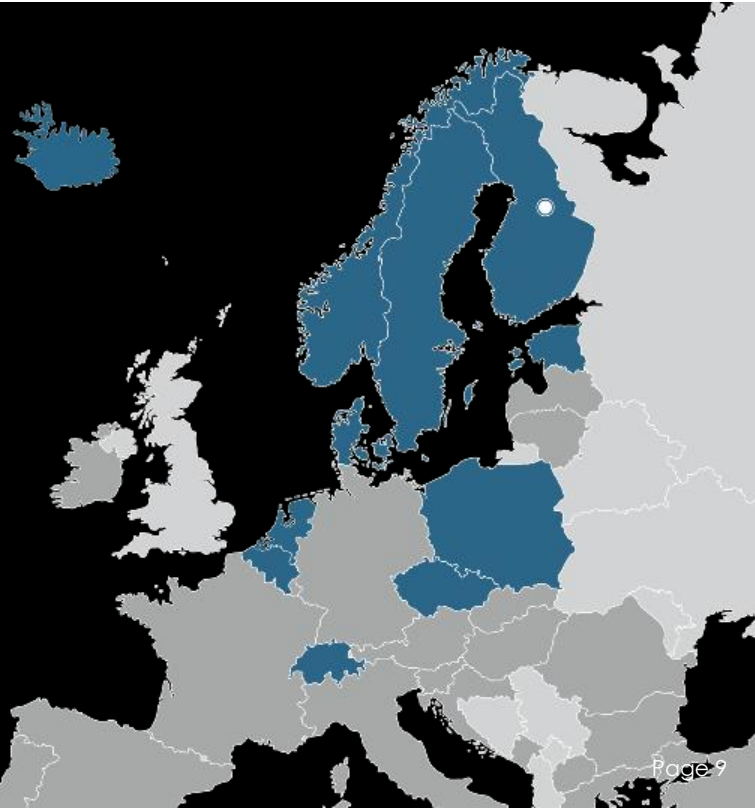

www.lumi-supercomputer.eu #lumisupercomputer #lumieurohpc

LUMI supercomputer is hosted by the LUMI consortium of eleven countries and the EU.

The total budget is over 202 Meur (half from the EU, half from the consortium countries.)

The resources of LUMI will be allocated per the investments. The share of the EuroHPC JU (50%) will be allocated by a peer-review process.

LUMI is located in CSC's data center in Kajaani, Finland.



# LUMI is an HPE Cray EX Supercomputer

LUMI


Hewlett Packard Enterprise

Its powerful processors can perform millions of calculations simultaneously, so it can operate millions of times faster than conventional computers and help us solve highly complex problems.

# LUMI is the 4th Fastest Supercomputer in Europe
## (9th in Global Ranking)

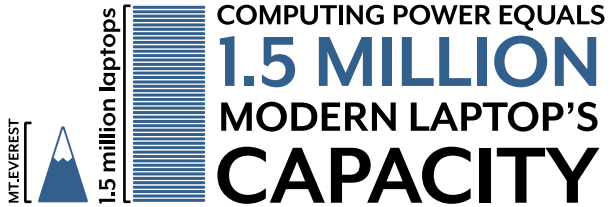
Operating 2022-2027

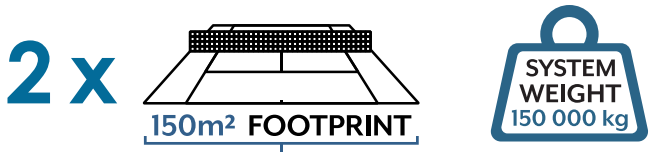
LUMI

SUSTAINED PERFORMANCE

**380 PETAFLOP/S**

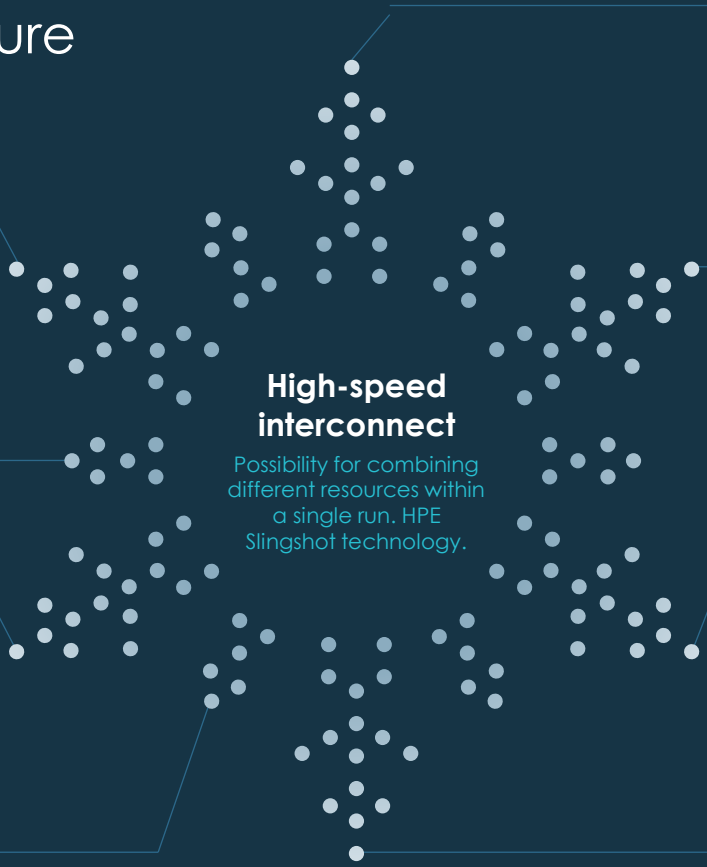
= performs 380 x $10^{15}$ calculations per second




Massively parallel simulations | **AI** | Data analytics

# Modern architecture



**LUMI-C:**
x86 Partition

Supplementary CPU partition:
262,000
AMD EPYC CPU cores.

**LUMI-K:**
Container Cloud Service

**LUMI-O:**
Object Storage Service
30 PB
encrypted object storage (Ceph) for storing, sharing and staging data.

**LUMI-Q:**
Quantum Computing

**High-speed interconnect**
Possibility for combining different resources within a single run. HPE Slingshot technology.

**LUMI-G:**
GPU Partition
Sustained performance
380
Pflop/s powered by AMD Radeon Instinct™ MI250X GPUs
(2978 x 4 GPU = 11.192 total)

**LUMI-D:**
Data Analytics Partition
Interactive partition with
32 TB
of memory and graphics GPUs for data analytics and visualization.

**LUMI-F:**
Accelerated Storage
10 PB
Flash-based storage layer with extreme I/O bandwidth of 2 TB/s and IOPS capability.

**LUMI-P:**
Lustre Storage
80 PB
parallel file system.

# What makes LUMI unique?

LUMI

- **Modern system architecture** – catering the needs of the scientific computing and data-driven discovery of the 2020's
- **Sustainability** – the greenest large supercomputer installation in the world
  - 100% $CO_2$ free renewable energy
  - Waste heat utilization in the Kajaani district heating, or 100% free cooling
  - Very energy-efficient (performance / Watt) architecture
- **Societal impact** – focus on solving societal grand challenges
  - Understand the impact of climate change and help in related decision-making
  - Democratize generative AI
  - Develop new materials
  - Improve agricultural yields
  - Improve the quality of life on an aging society: come up with new medicine and treatments
- **European collaboration** – first truly joint investment and collaborative hosting effort in European supercomputing

# LUMI: Excess Heat Utilization Process Overview

**Annual $CO_2$ savings around 2.900 tonnes (2023)**

DRY AIR COOLING FOR BACK UP ~ 10 MW

DISTRICT HEATING NETWORKS ~ 10 MW
-Renforsin Ranta Business Park
-CITY of Kajaani

+31 °C
+43 °C
+58 °C
+80 °C

HEAT EXCHANGERS

HEAT PUMPS

+32 °C
+44 °C
+32 °C
+44 °C

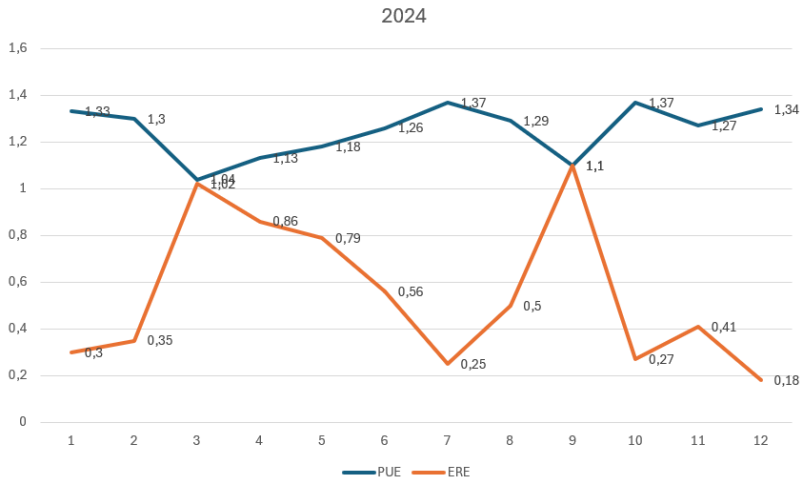
Service demarcation point for the excess heat utilization

Heat pumps use renewable energy


HPC load

In addition of Direct Liquid Cooling there is approximately 1 MW of capacity for the air-cooled servers (e.g. storage and management servers).

# LUMI DC – PUE / ERE 2024

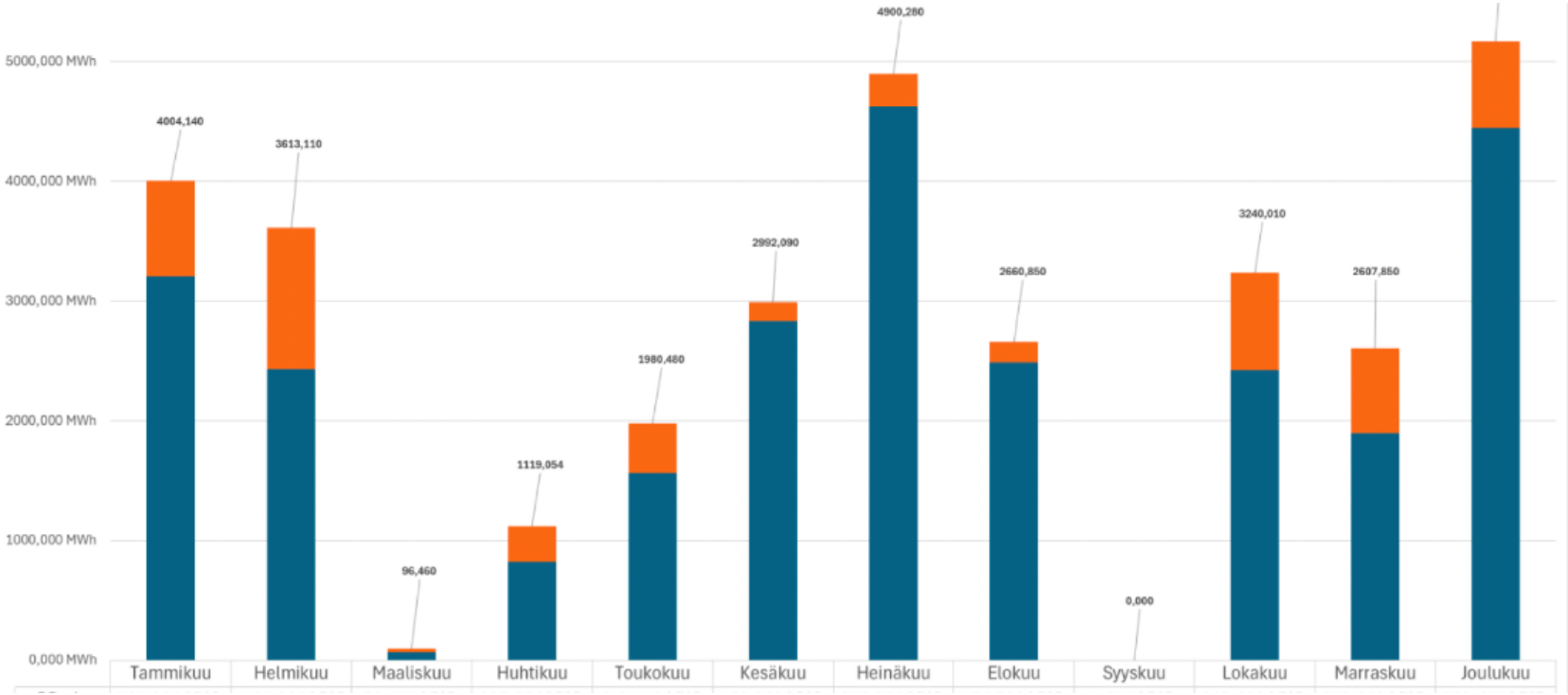



| Metric | Value (2024) |
|---|---|
| PUE | 1.27 |
| Heat re-use COP | 4,00 |
| ERE | 0.54 |
| ERF | 0.55 |
| Annual heat production | 32.4 GWh |
| Reduced co2 emissions | ~ 2.900 CO2 tonnes (2023) * |
| Source of electricity | 100% hydro power |

Lower ERE/Higher PUE => More heat recovery
ERE and PUE in the same level => most time of the month with free cooling

* LUMI reduced CO2 emissions based on district heating production plant average CO2 emissions / year (2023: 98 kg/MWh). No real-time data available.

# Monthly LUMI Heat Production 2024, total 32,4 GWh



# Conclusions
# Lessons Learned in Excess Heat Utilisation

- Utilisation of excess heat should be set as a target and planned in advance!
  - Good cooperation with local stakeholders is needed: land owner(s), city authorities, energy company, data center(s)
- District heating is the most obvious choice for excess heat utilisation in Finland
- However, if there is even more excess heat available (over district heating needs), the situation becomes much more complex:
  - Finding new companies and industries to utilise excess heat is challenging
  - Business motivation for relocating near excess heat?
  - How to ensure the amount and stability of the excess heat for various users?
- A separate operator (so called middle-man) should be found to guarantee and ensure the minimum energy needs for the end user companies (district heating, green house, biomass drying, fish farming …)
  - Like Loiste in kajaani case!

# Conclusions
# Excess Heat Utilisation in a Multi-DC Environment

- An operator (i.e. middle-man) is recommended to collect the excess heat from several data centers, and to transfer it further to end-user companies
- Hopes for the middle-man from DCs:
  - The middle-man should guarantee that the heat returning to each data center is appropriate
  - The middle-man should help in reporting data center-specific figures for each DC so that ERE and ERF calculations can be done

# Kajaani Data Center Ecosystem for Responsible and Sustainable Data Center Industry

- CSC with its supercomputers is an active member of Kajaani Data Center Ecosystem (KDCE)
  - Ensuring education, training and recruitment of DC professionals
  - Promoting new business opportunities for local companies in DC industry
  - Developing excess heat utilization with local partners
  - Following and contributing to the EU and national level DC and energy regulation
  - Raising the general awareness of DC sector in the region and in Finland
- CSC contributes also to DC research
  - LUMI operational data is opened and shared for research use
  - Development of digital twin of HPC infra
  - Focus on green DC operations with excess heat utilisation, energy optimization, etc.
- More information about KDCE visit https://kdce.fi

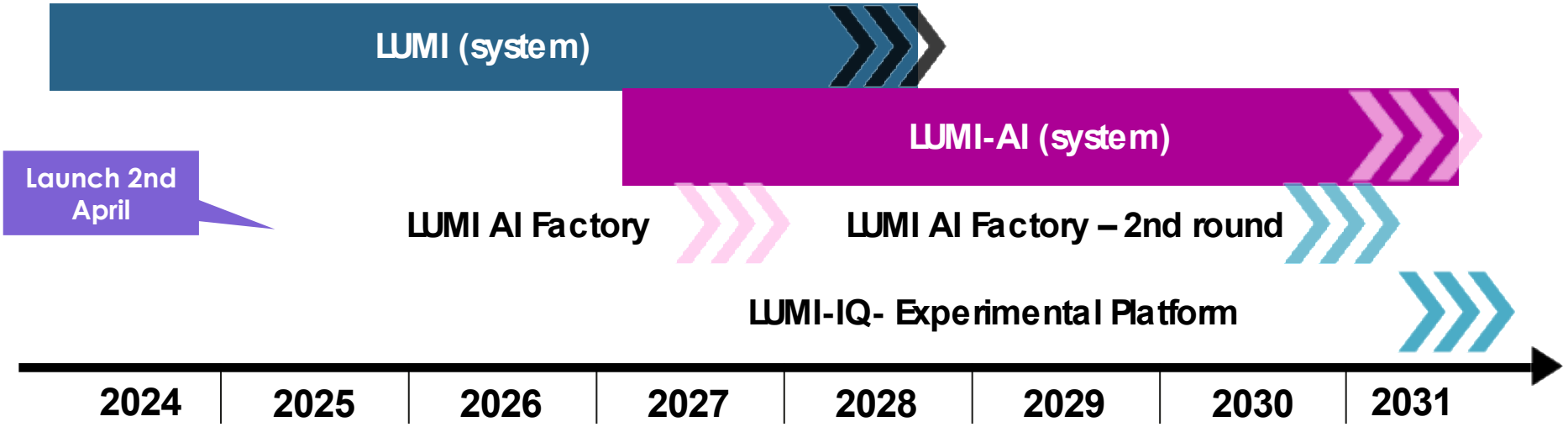

LUMI AI Factory

# LUMI AI Factory

LUMI AI Factory

- The three pillars of LUMI AI Factory
  - AI-optimised supercomputer **LUMI-AI**
  - AI Factory **Service Center**
  - Experimental quantum-computing platform **LUMI-IQ**
- CSC (Finland) coordinates consortium with participation from Czechia, Denmark, Estonia, Norway and Poland
  - Other Finnish partners are FCAI (Aalto University, University of Helsinki) and AI Finland (Technology industries)
- Total budget over 612 million euros
  - EU 306.4 M€, FI 250 M€, CZ 11 M€, DK 10 M€, EE 5 M€, NO 20.4 M€, PL 10 M€
  - largest public computing ecosystem investment in Finland, among the largest in Europe
  - largest EuroHPC AI Factory investment
- Significant investment in talent and competence development

# LUMI AI Factory timeline



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- Juha Torvinen

KAJAANI DATA CENTER ECOSYSTEM

REGIONAL COUNCIL OF KAINUU

Euroopan unionin rahoittama

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