SIPEARL

Energy-efficient High Performance Compute,
at the heart of Europe

DVCON Europe – November 14, 2023

Security

Climate

Health

Energy

Big problems

need

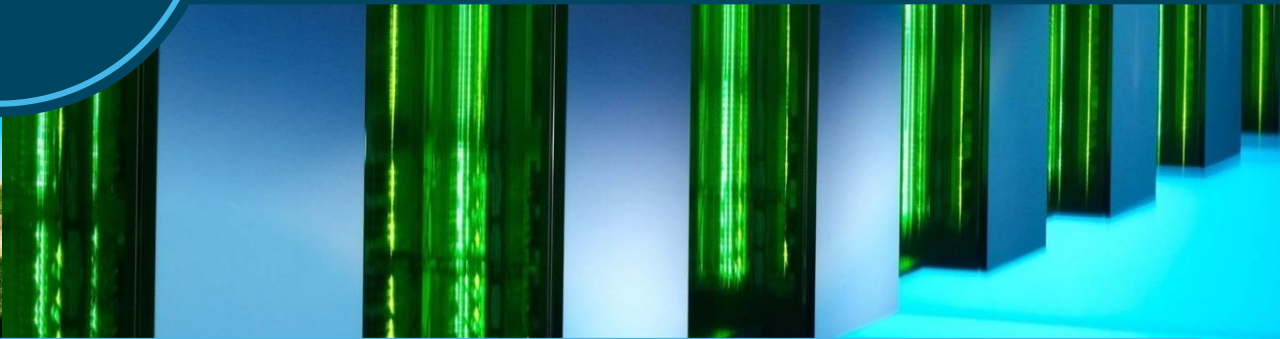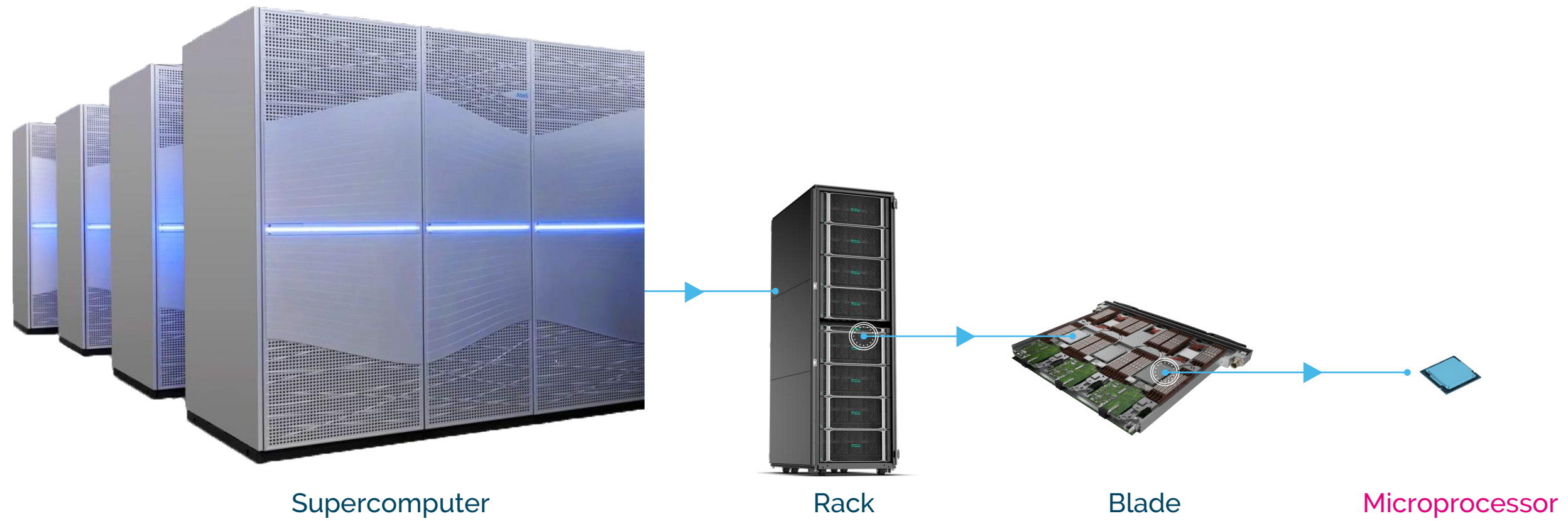# Big computers

Supercomputers are essential to ensure Europe's technological sovereignty by addressing major scientific, societal and environmental challenges.

Our business: the energy-efficient HPC microprocessor

**Tens of thousands of microprocessors in a supercomputer**

Supercomputer   Rack   Blade   Microprocessor

A leading global market driven by LLMs[1] and other AI

A healthy growth of 8% per year thanks to the supercomputers segment

Supercomputers CAGR 2022-27: +9.5%[2]

– Leading-edge technologies to achieve the highest possible performance capabilities:

  • From 1 million billion calculations per second

  • To exascale: 1 billion billion calculations per second
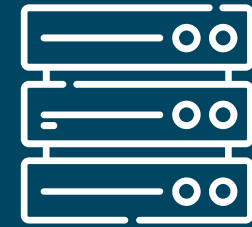
– Priced from $500k to over $300m
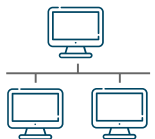
HPC servers CAGR 2022-27: +6.7%[2]

– Shared by a working group, department or division

– Priced at less than $500k

A $22.6bn market[2]

Including supercomputers:
$11.4bn

2027

European Union behind the curve

1/3
of global supercomputing ressources are consumed by Europe[1].

Europe

1/20
of global supercomputing equipment are supplied by Europe[1].

Europe

0%
of the microprocessors powering Europe supercomputers are European[2]
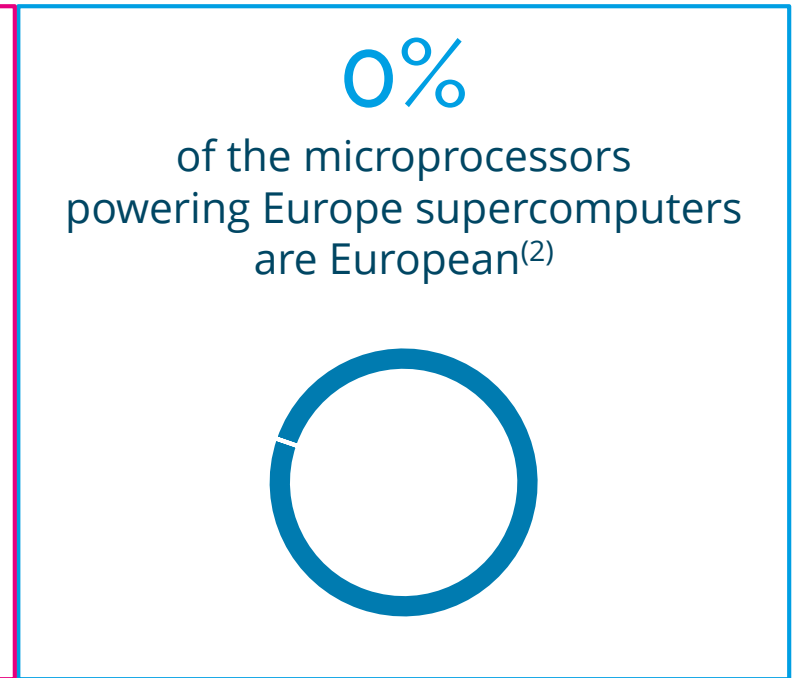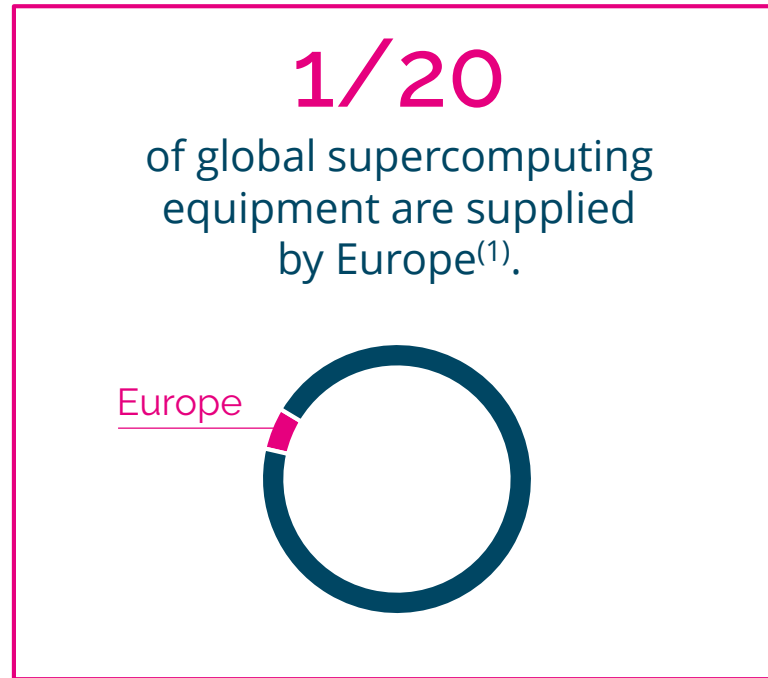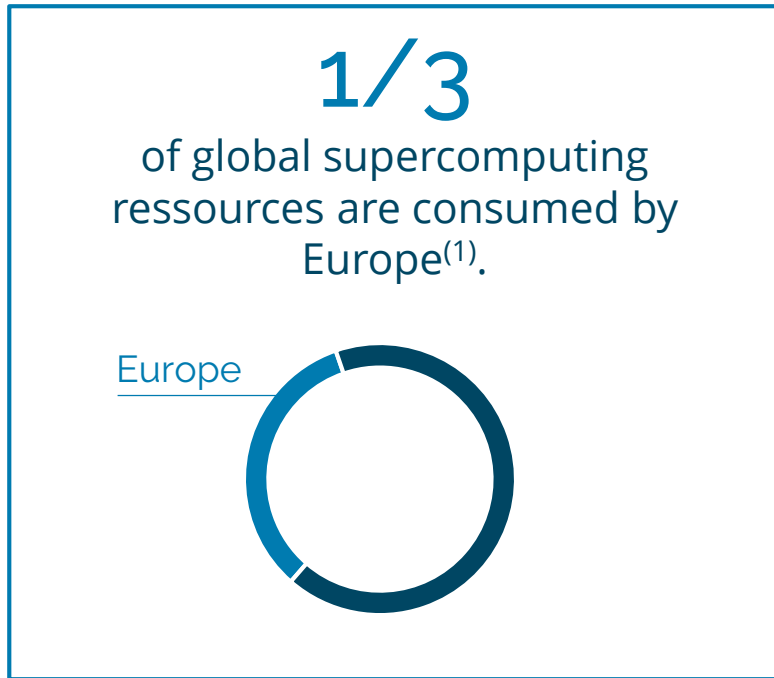
This lack of homegrown technology has serious implications on Europe sovereignty, intellectual property and security.

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September 2018

Launch of the EuroHPC Joint Undertaking
backed by a €8bn budget
to deploy in Europe a world class exascale
supercomputing infrastructure

December 2018

Launch of a call for proposals in 2017 for developing
a new generation of high-end European microprocessors

– Budget: €150m

– Target: high-performance and energy-efficiency

Coordinated by Bull (Atos Group), the European Processor Initiative (EPI)
consortium won this call for proposals. It has currently 30 members:

– Scientists: research institutes, universities and supercomputing centres

– Industry: European leaders, IT, electronics and automotive specialists

June 2019

SiPearl is the private company created within the EPI
to launch a strategic industry for Europe.

The company

SIPEARL
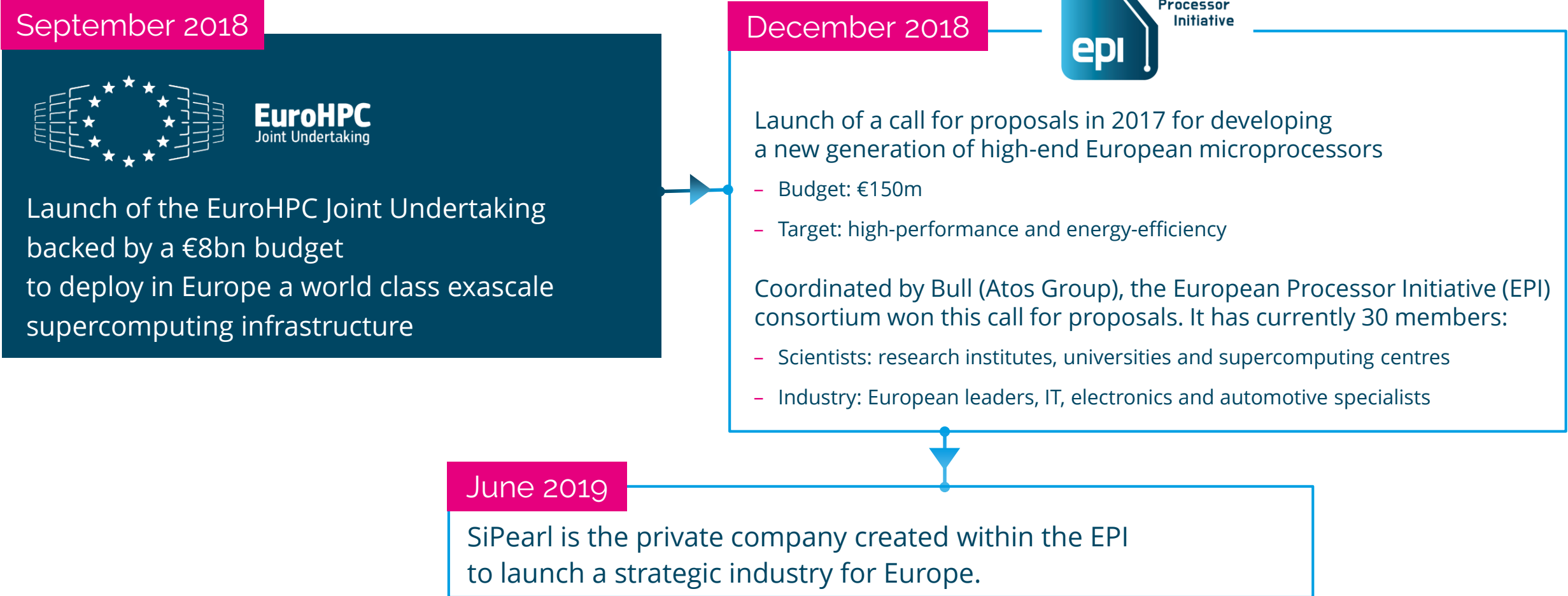
From a European Union concern to SiPearl 1st lead customer

Our common goal: fostering the return of high-performance, low-power microprocessor technologies in Europe

EPI consortium, winner of the call for proposal

Operational launch of SiPearl: €6.2m Horizon 2020 grants

€90m Series-A initial closing incl. up to €25m convertible bonds from EIB

June 2017

June 2019

Dec. 2021

Oct. 2023

Dec. 2018

Jan. 2020

April 2023

Microprocessor call for proposal launched by the EU

Creation of SiPearl as a member of the EPI consortium

SiPearl awarded by the European Innovation Council (EIC) Accelerator

JUPITER, lead customer for SiPearl's 1st generation microprocessor

SiPearl in a nutshell

Building the European energy-efficient HPC microprocessor for exascale supercomputers
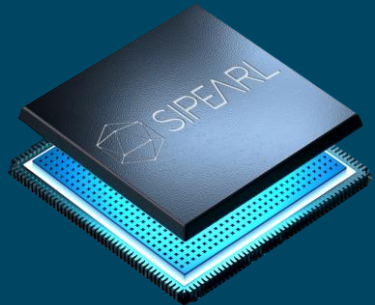
Incorporated in June 2019

Key personnel from
AtoS MEDIATEK ST MARVELL
NXP Infineon intel NOKIA

Funded by the European Union

Financing
Initial closing of the Series-A: €90m

arm European Innovation Council Fund Banque européenne d'investissement EVIDEN FRANCE 2030

Arm architecture
Energy-efficiency, quick time to market, proven ecosystem

Identified customers
Server manufacturers based on user specifications: First, EuroHPC ecosystem before going global.

6 locations in Europe

+160 employees

Duisburg
Maisons-Laffitte
HQ
Massy
Barcelona
Sophia Antipolis
Grenoble
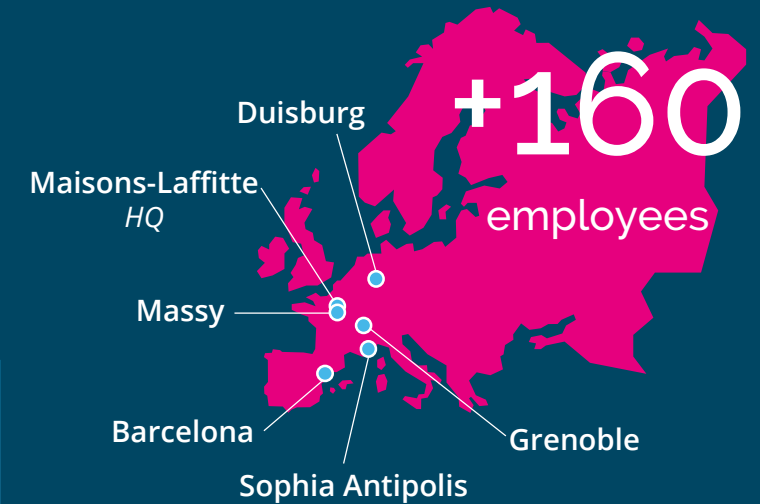
Leadership

Executive Committee

Philippe Notton
CEO & founder
AtoS · ST · MEDIATEK

Laure Perfetti
Head of Human Resources
ST

Frédéric Hannoyer
COO
éolane · ST

Ying-Chih Yang
CTO
AtoS · ST · MEDIATEK

Craig Prunty
VP Marketing & Development
MARVELL · applied micro · CAVIUM

Vincent Casillas
SVP Software R&D
Valeo · ST

Vivian Blanchard
VP Hardware R&D
AtoS

Management Committee

Anna Riverola
Head of Research Programs
BSC Barcelona Supercomputing Center Centro Nacional de Supercomputación

Pierre Marchal
CFO
SAINT-GOBAIN · KEOLIS

Sébastien Kamphuis
CIO
ENGIE · Capgemini

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10

Our EPI partners, a powerful ecosystem

Close collaboration with our partners of the EPI consortium

Scientists: research institutes, universities and supercomputing centres

Industry: European leaders, IT, electronics and automotive specialists

A joint project involving 200 engineers since December 2018

– Development of elementary hardware and software technological bricks

Stakeholders

– Privileged access to IP of European leaders and innovative startups

End-users

– Supercomputing centres

Key partnerships with leading IT providers

Partnership with Arm:
SiPearl, the only European licensee to use Neoverse V1 platform

– The global semiconductor IP provider
– A robust software ecosystem
  ▶ Accelerated design of a very high-end offering in terms of both computing power and energy efficiency

Partnerships with IP providers

– EDA software: Synopsys
– Hardware emulation: Siemens Digital Industries Software Veloce Strato emulation platform
– Validation of semiconductor power integrity, minimization of power consumption: Ansys
– …

Manufacturing initially entrusted to the Taiwanese TSMC

– 1st independant semiconductor foundry
– Etching: 6nm or better

World leading industrial partnerships

Our ecosystem to accelerate Europe's adoption of exascale supercomputers

Leading manufacturers

EVIDEN

Europe No1

Hewlett Packard Enterprise

Global leader

Developing joint solutions for HPC applications

Acceleration specialists

AMD
Instinct™ accelerators
with ROCm™ open software

GRAPHCORE
Intelligence Processing Unit (IPU), designed
to support artifical intelligence workloads

intel
GPU Ponte Vecchio
with the open unified software stack oneAPI

NVIDIA
Portfolio of world-leading accelerated
computing and networking solutions

Supercomputing:
where we are in Europe

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Supercomputing EU sovereignty is on track!

Thanks to the EuroHPC JU program, a historic first:
Europe ranked 2 supercomputers in the TOP10 most powerful supercomputers [1]

No5: LUMI in Finland
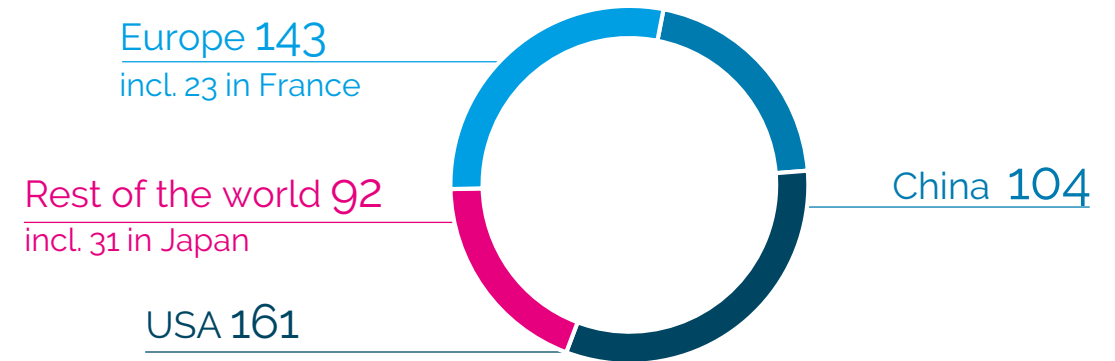**309 million billion calculations / s**

No6: Leonardo in Italy
239 million billion calculations / s

Europe ranks **143** supercomputers in the Global TOP500
vs **97** [2] before the launching of EuroHPC in 2018

Europe **143**
incl. 23 in France

China **104**

Rest of the world **92**
incl. 31 in Japan

USA **161**

(1) Source: 62nd edition of the top 500 most powerful supercomputers in the world - November 2023
(2) Source: 52nd edition of the top 500 most powerful supercomputers in the world - November 2018

EuroHPC JU supercomputers

To exascale

Supercomputer	Country	Performance
JUPITER (launch in 2024)	*Germany*	*1 exaflop*
LUMI	Finland	377 petaflops
LEONARDO	Italy	250 petaflops
MARENOSTRUM 5	Spain	205 petaflops
MELUXINA	Luxembourg	13 petaflops
KAROLINA	Czech Republic	10 petaflops
DEUCALION	Portugal	7 petaflops
VEGA	Slovenia	7 petaflops
DISCOVERER	Bulgaria	5 petaflops

4 mid-range supercomputers to be hosted in Greece, Hungary, Ireland and Poland
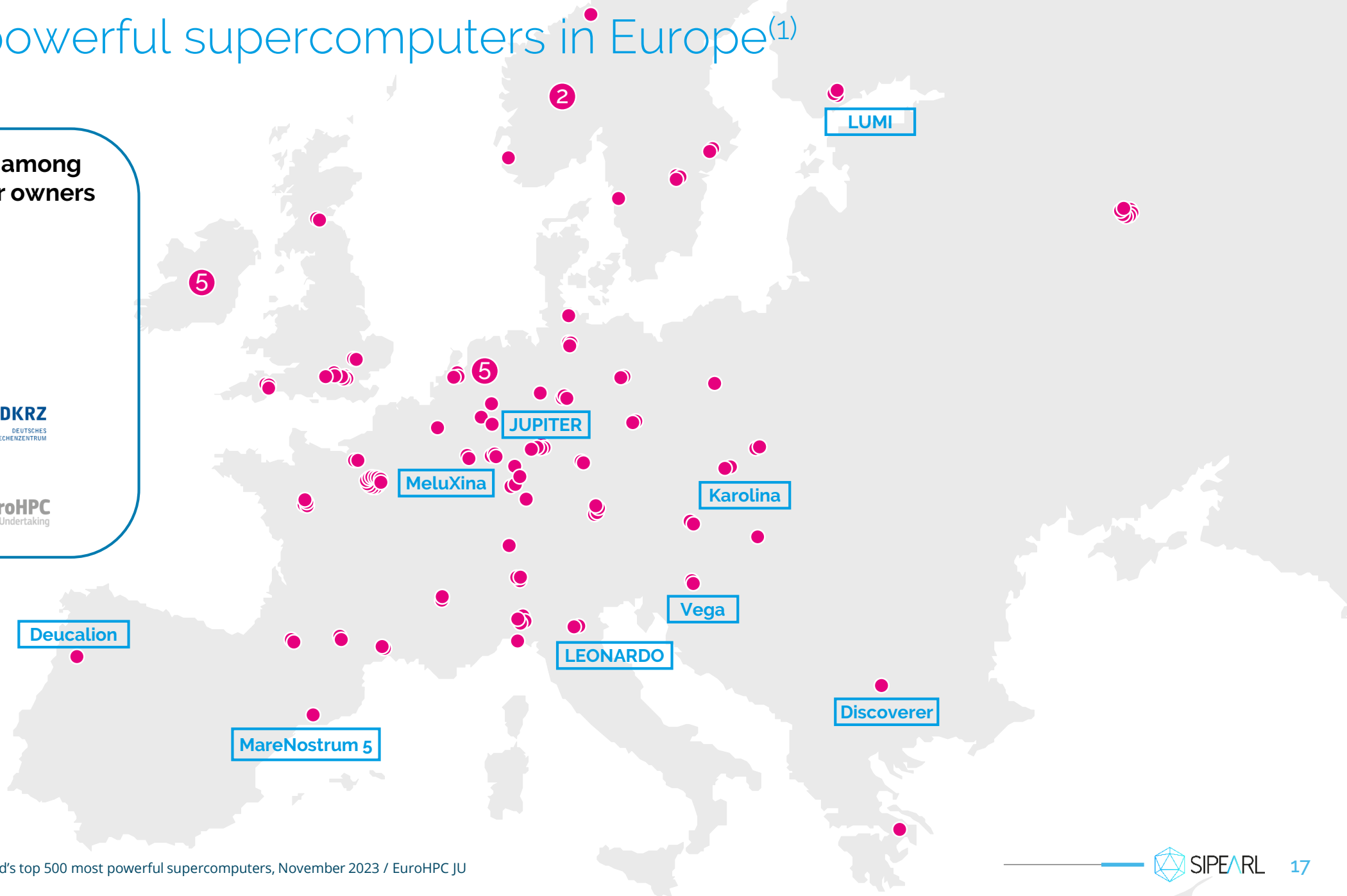
The most powerful supercomputers in Europe[1]

Private companies among the supercomputer owners

Legend labels on map: LUMI, JUPITER, MeluXina, Karolina, Vega, LEONARDO, Deucalion, Discoverer, MareNostrum 5

Company logos: eni, TotalEnergies, EDF, METEO FRANCE, Met Office, VW, DKRZ Deutsches Klimarechenzentrum, EuroHPC Joint Undertaking

Energy-efficient supercomputing: where we are.

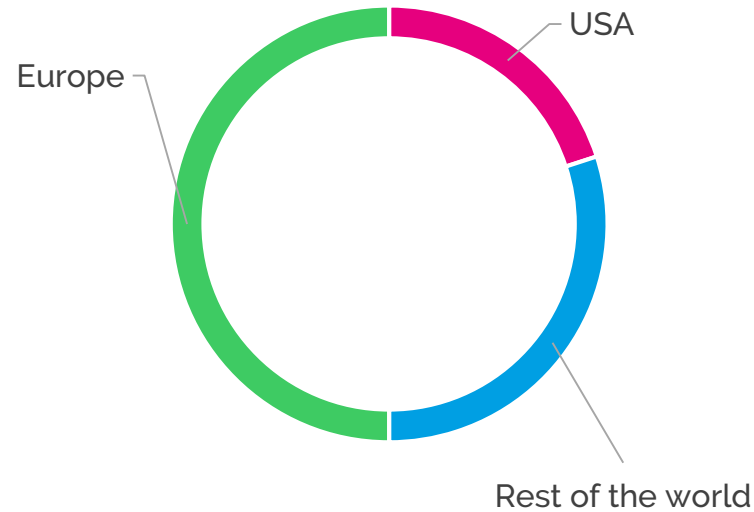Europe best-in-class supercomputers
need to improve their energy-efficiency

TOP20 supercomputers

Compute performance TOP500

Europe

USA

China

Rest of the world
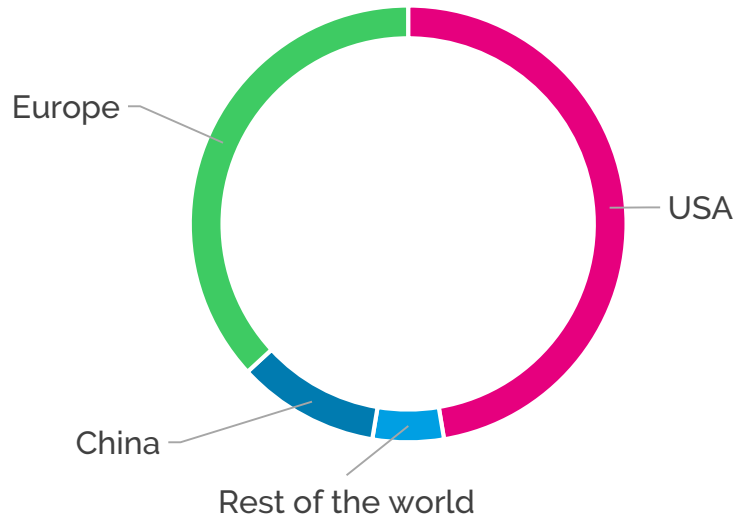
Energy-efficiency Green500

Europe

USA

Rest of the world

Adastra (France): No3 Green500 / No17 TOP500

Energy-efficiency: 58 GFlops/Watt

LUMI (Finland): No5 TOP500 / No7 Green 500

Energy-efficiency: 53.4 GFlops/Watt

Soon, a "designed in Europe" microprocessor inside

to meet strategic scientific industrial and societal challenges
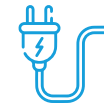for Europe sovereignty

Health
Medical research, vaccine development, clinical trials, personalised medicine.

Climate
Localised weather forecasts, prediction of storm pathways, climate change mitigation.

Energy
Optimization
of renewable energy parks, power grid management.

AI
Prediction models, conversational agents using artificial intelligence.

Engineering
Design of new land and air vehicles, crash test simulation, creation of greener materials.

Security
Cybersecurity, armies, nuclear deterrent force.

Rhea1, our 1ˢᵗ generation microprocessor

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Rhea1, our 1ˢᵗ generation microprocessor

With its high-performance energy-efficient Arm Neoverse V1 architecture, Rhea will meet the needs of all supercomputing workloads.

JUPITER Design Win

Core	- Arm Architecture Neoverse V1 cores - SVE 256 per core supporting 64/32/BF16 and int8 - Arm Virtualization Extensions
SoC	- Arm Mesh fabric - Advanced RAS support including Arm RAS extensions - Link protection for NOC and high-speed IO - ECC support for selected memory
Cache	- RAS supported for all Cache levels
Memory	ECC for memory and link protection for controllers - HBM2e - DDR-5
High Speed I/O	PCIe or CCIX/CXL: root and endpoint support
Other I/O	USB, GPIO, SPI, I²C…
Power Management	Power management block to optimize perf/watt across use cases and workloads.
Security Block Support	- Secure boot and secure upgrade - Crypto - True Random Number Generation

Block diagram
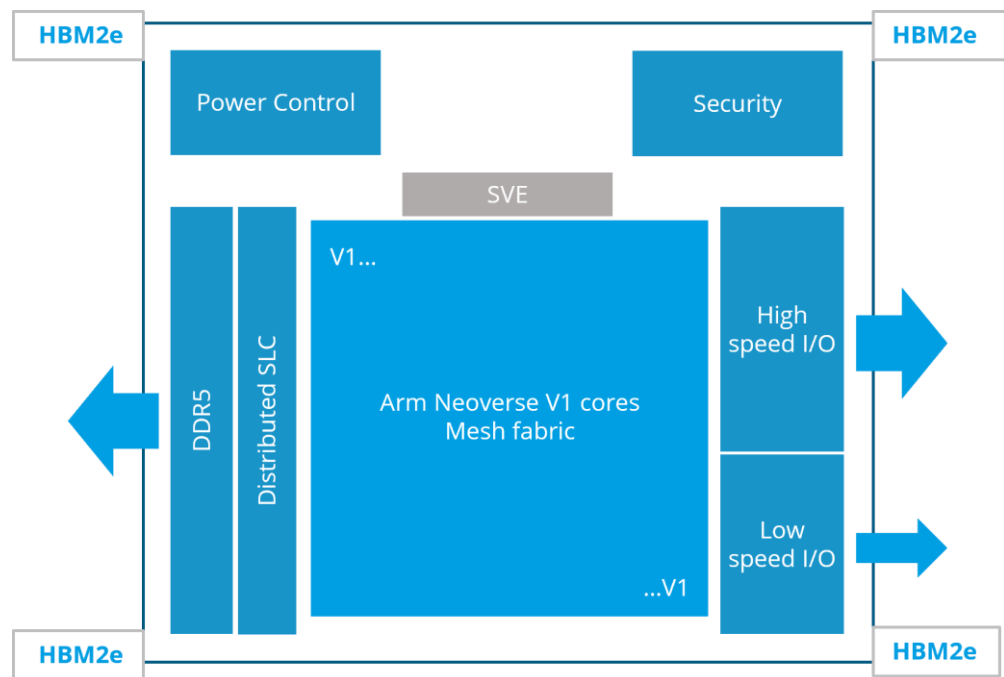
Rhea1 will deliver extraordinary compute performance and efficiency with an unmatched Byte/Flop ratio.

Rhea1: differentiating factors

**Pre-integration
with proven accelerators**

- Strategic partnerships with AMD, Intel, Graphcore, Nvidia
- More to come with Quantum computing

Energy-efficient HPC dedicated

- Arm Neoverse V1 based
- Chiplet based

Unique European supplier, preferred solution addressing Sovereignty

High performance per watt

- Arm is global leader in the smartphone business
- Arm ISA power efficiency

Very high memory bandwidth

Unique memory architecture

- High Byte/Flop
- 2 first patents

Built-in HBM

- Ideal performances for Inference Generative AI

Openness

- Arm ecosystem from IoT/edge to HPC and cloud
- Common platform – chiplet-based ecosystem
- Fully auditable – backdoor-free

Rhea1 in a nutshell

The world's first energy-efficient HPC-dedicated microprocessor designed to work with any third-party accelerator: GPU, artificial intelligence, quantum.

Sovereignty
To further Europe's technological leadership and independence.

High Performance
To surpass the performance of 10,000,000 desktop computers.
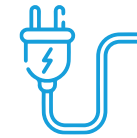
Energy-efficiency
To halve power consumption for equivalent computing power.

Flexibility
Designed to work with any third-party accelerator (GPU, artificial intelligence, quantum).

Backdoor-free security
To protect data with secure end-to-end network transmission.

Rhea1 sampling: 2024

JUPITER, lead customer for Rhea1

**The 1st European exascale supercomputer
owned by EuroHPC, operated by Jülich in Germany**

Built by a European consortium

– Eviden: the Atos Group business leading in advanced computing
– ParTec: the German modular supercomputing company

General-purpose Cluster Module of JUPITER to be based on Rhea1

– Very high memory bandwidth
– Extraordinary compute performance and efficiency

This contract signs the return of high-performance,
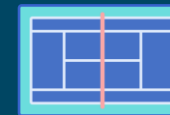low-power microprocessor technologies in Europe.

JUPITER
Key figures

€273m
expected budget

10 million desktop computers
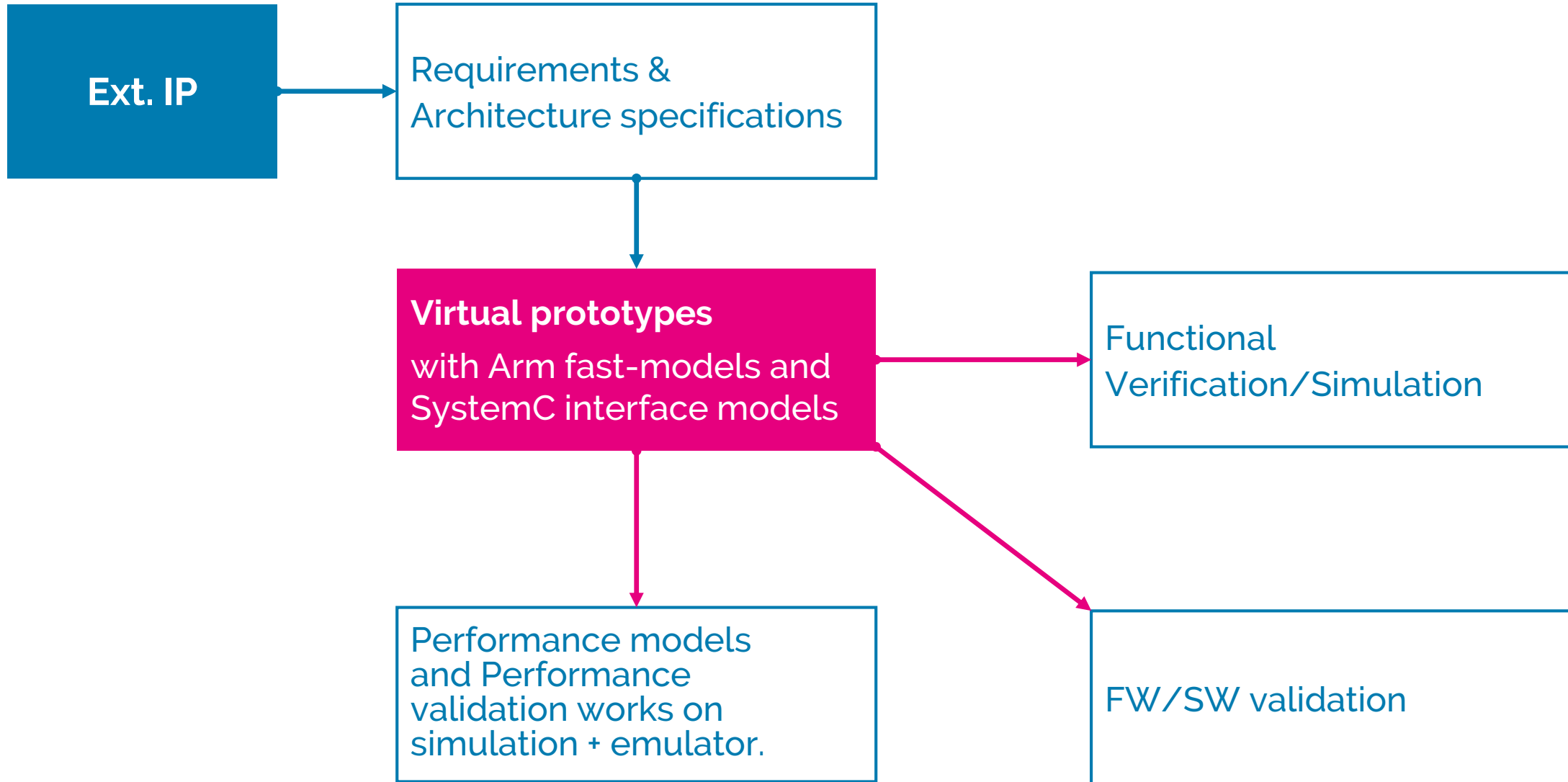equivalent power

4 tennis courts
equivalent surface

260 km
of high-performance cabling

Focus:
Rhea1 design flow

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Virtual Prototype: Key component of our verification strategy

```
┌─────────────┐         ┌──────────────────────────┐
│             │         │ Requirements &           │
│   Ext. IP   │────────▶│ Architecture specifications │
│             │         │                          │
└─────────────┘         └──────────────────────────┘
                                     │
                                     ▼
                        ┌──────────────────────────┐      ┌──────────────────────────┐
                        │ Virtual prototypes       │─────▶│ Functional               │
                        │ with Arm fast-models and │      │ Verification/Simulation  │
                        │ SystemC interface models │      │                          │
                        └──────────────────────────┘      └──────────────────────────┘
                             │              ╲
                             ▼               ╲
        ┌──────────────────────────┐    ┌──────────────────────────┐
        │ Performance models       │    │                          │
        │ and Performance          │    │ FW/SW validation         │
        │ validation works on      │    │                          │
        │ simulation + emulator.   │    │                          │
        └──────────────────────────┘    └──────────────────────────┘
```

Simulation & Co-simulation (RTL-VP)

One top level verification environment for all verifications (sub-system, top Level,…)
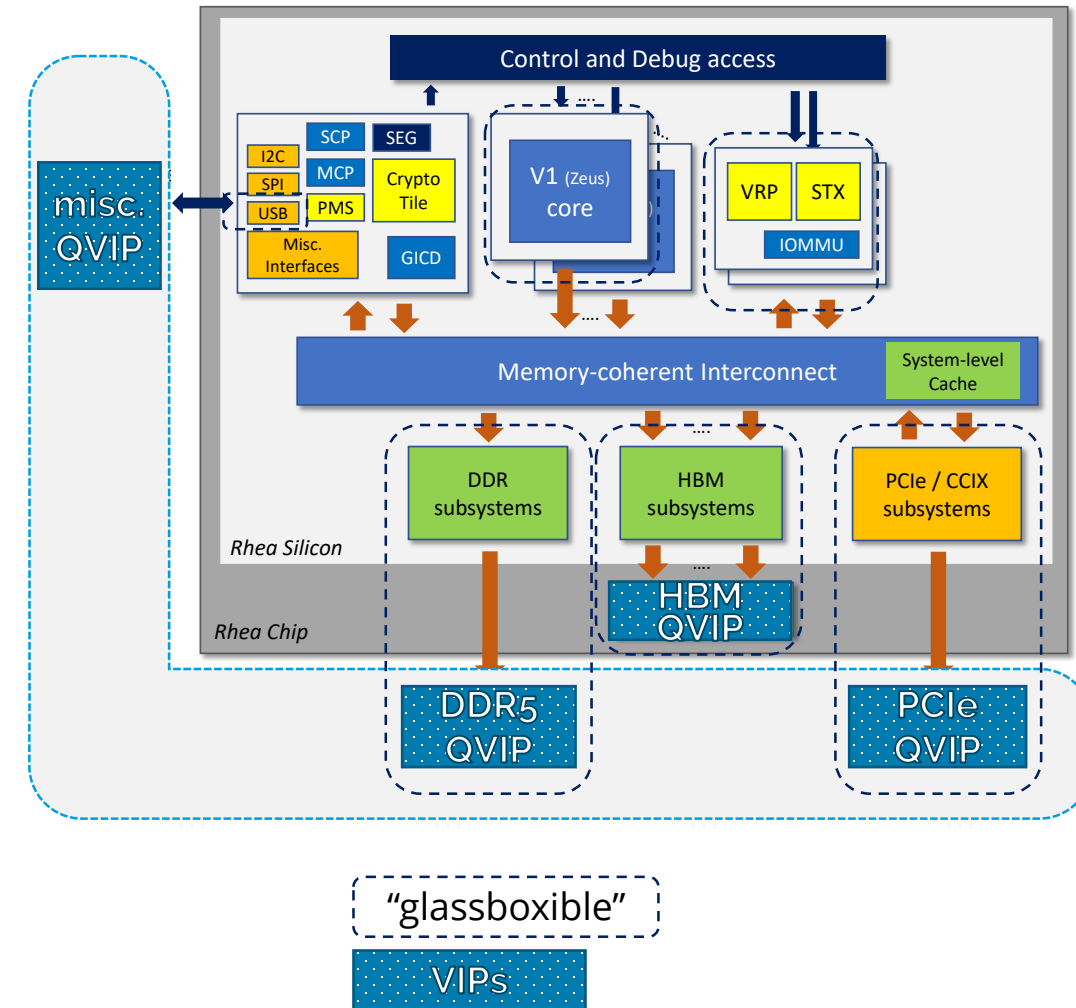
Environment highly configurable to optimize speed

- Environment can focus on a specific sub-system, by glass boxing other subsytems
- Use of VP models to replace compute core(s)
- Memory Preload

Use the VIP (compatible with emulation) to connect to interfaces:

**as SPI Flash for the bootstrap and test firmware**

- as I2C and SPI devices; as USB2.0 devices
- as JTAG master
- as DDR5 components and I3C slaves on DDR5 RDIMMs
- as PCIe devices, directly connected or behind an ext. PCIe switch

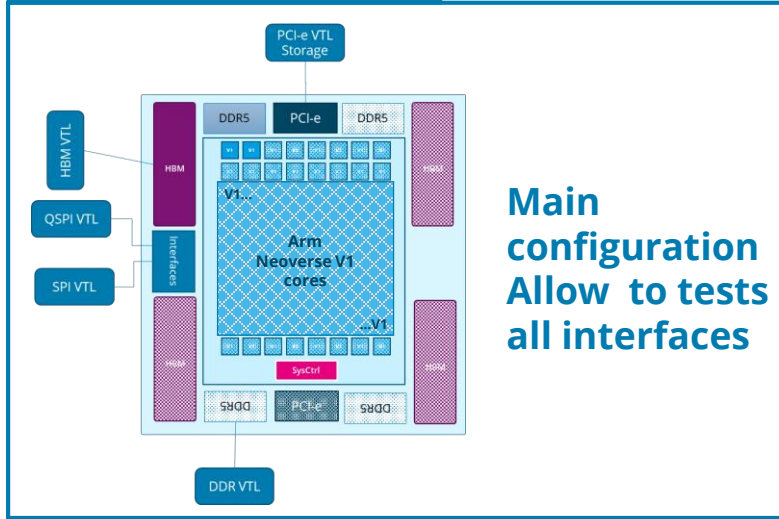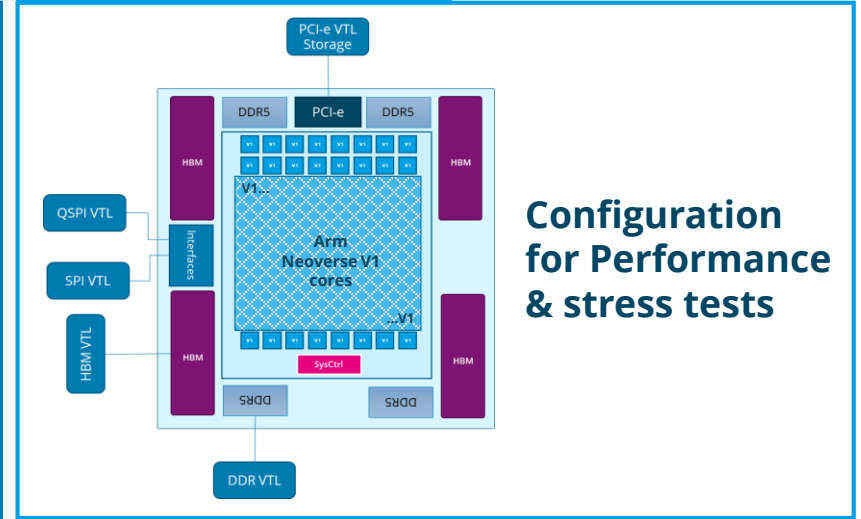**+ One dedicated verification environment (UVM) for PCI-e**
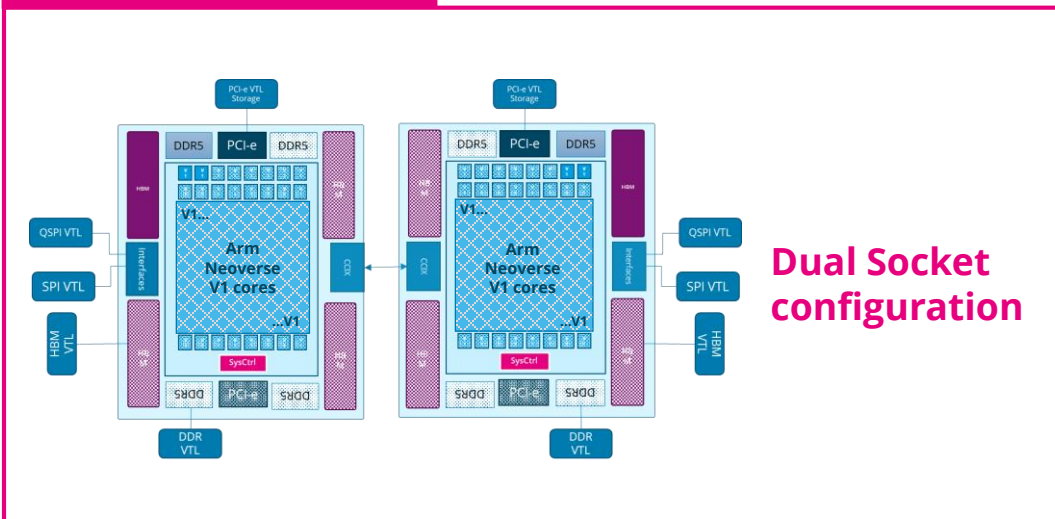
Emulation

Configuration 1

Boot Control configuration

Configuration 2

Main configuration Allow to tests all interfaces
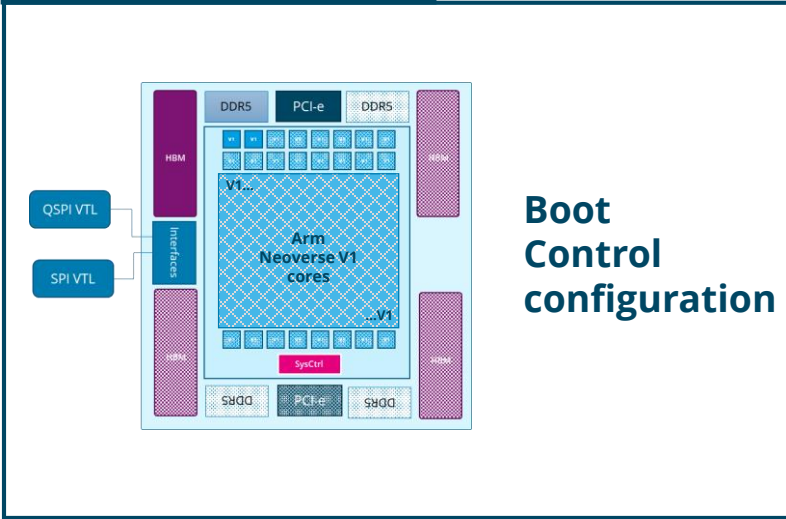
Configuration 3

Configuration for Performance & stress tests

Configuration 4
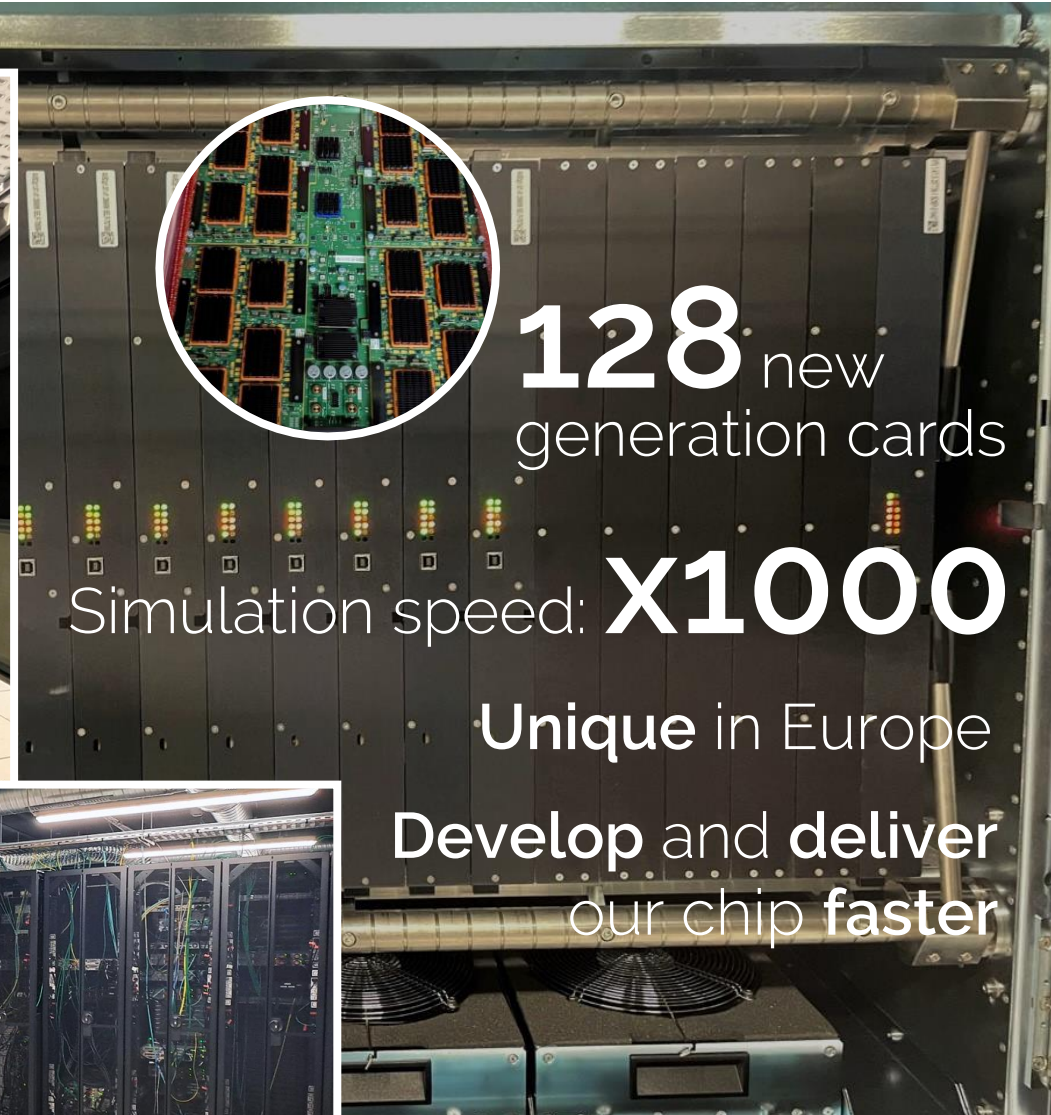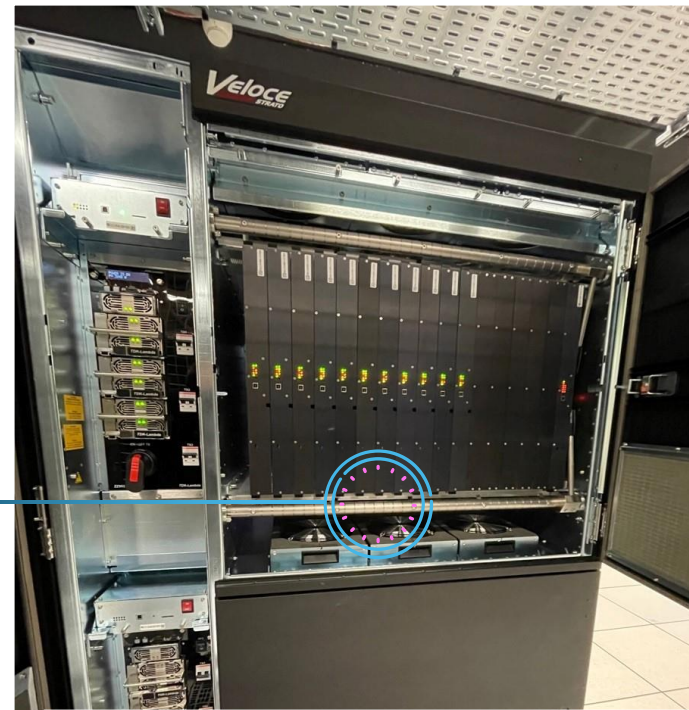

Dual Socket configuration

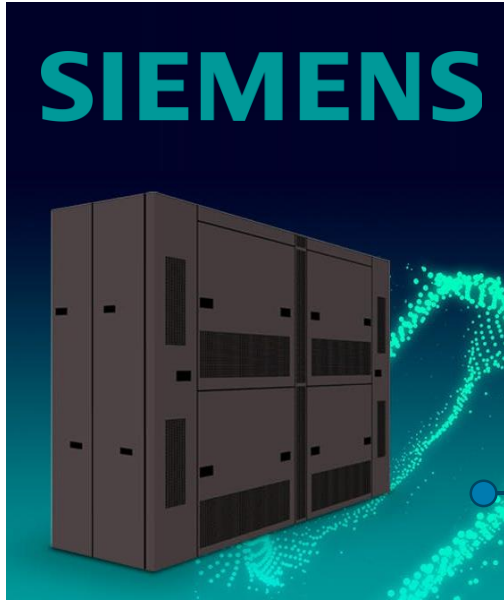Use same environment for simulation & emulation

Can run "simulation tests", real FW/SW, boot linux, etc.

Veloce Configuration:

– Strato 2M

– 64 AVB+

Veloce Strato
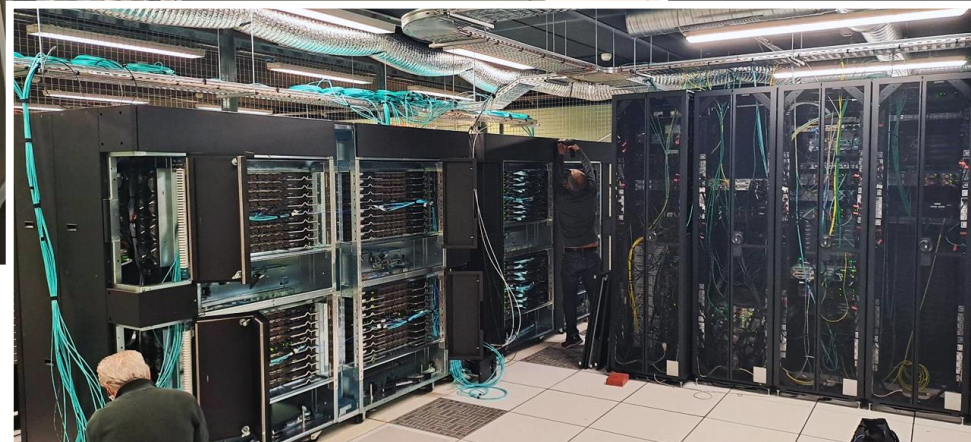
Veloce Strato at its full capacity

2 Veloce with
2x64 new generation cards

Veloce control servers

128 new generation cards

Simulation speed: **X1000**

Unique in Europe

Develop and **deliver** our chip **faster**

Outlook

SiPearl involved in core European projects to ensure sovereignty

Cloud

AERO

Development of an open source software ecosystem needed to optimize the efficiency of EPI hardware and facilitate the integration of SiPearl's microprocessors in the cloud.

Riser

Development of the 1st all-European RISC-V cloud server infrastructure, significantly enhancing Europe's open strategic autonomy.

OpenCUBE

Development of a custom cloud installation with the guarantee that an entirely European solution can be deployed reproducibly.

Centres of Excellence

EXCELLERAT P2

Making some of the most used HPC application suites in engineering and manufacturing work on exascale EuroHPC supercomputers based on SiPearl's microprocessors.

MAX DRIVING THE EXASCALE TRANSITION

Development of materials modelling, simulations and discovery technologies, and making them accessible to a vast community of researchers.

PLASMA PEPSC

Promoting scientific and technological progress in key areas such as magnetic confinement fusion, industrial plasmas, medical applications…

And also regional projects:
Emopass (France), FlexFMM (Germany)

Deployment on the EuroHPC market, then worldwide

SiPearl corporate vision and strategy

A range of HPC microprocessors with a reduced environmental footprint to conquer the European market and beyond

HPC & supercomputing
SiPearl entry business: European HPC

HPC-dedicated

Data Center-Central
Data centers, private and public cloud

DATA CENTER

Public cloud

Private cloud
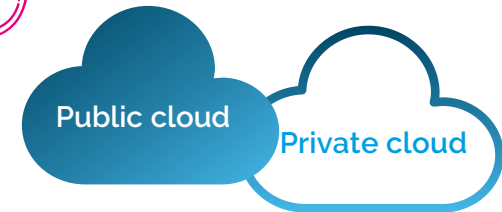
Data center-Edge
Smaller Data centers,
including around 6G infrastructure

6G

6G infrastructure

Automotive

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Help us fill production lines of a future European manufacture by creating more high-end semiconductor startups in Europe!

By the way...

About... SiPearl

SiPearl is building the world first energy-efficient HPC-dedicated microprocessor designed to work with any third-party accelerator (GPU, artificial intelligence, quantum). This new generation of microprocessors will first target EuroHPC Joint Undertaking ecosystem, which is deploying world-class supercomputing infrastructures in Europe for solving major challenges in medical research, artificial intelligence, security, energy management and climate while reducing its environmental footprint.

SiPearl is working in close collaboration with its 27 partners from the European Processor Initiative (EPI) consortium - leading names from the scientific community, supercomputing centres and industry - which are its stakeholders, future clients and end-users.

SiPearl employs more than 160 people in France (Maisons-Laffitte, Grenoble, Massy, Sophia Antipolis), Germany (Duisburg) and Spain (Barcelona).

European Processor Initiative
epi

TOP500 & GREEN500 – November 23

TOP500

Rank	Name	Country	Rmax [TFlop/s]
1	Frontier	United States	1 194 000,00
2	Aurora	United States	585 340,00
3	Eagle	United States	561 200,00
4	Supercomputer Fugaku	Japan	442 010,00
5	LUMI	Finland	379 700,00
6	Leonardo	Italy	238 700,00
7	Summit	United States	148 600,00
8	MareNostrum 5 ACC	Spain	138 200,00
9	Eos NVIDIA DGX SuperPOD	United States	121 400,00
10	Sierra	United States	94 640,00
11	Sunway TaihuLight	China	93 014,59
12	Perlmutter	United States	79 230,00
13	Selene	United States	63 460,00
14	Tianhe-2A	China	61 444,50
15	Explorer-WUS3	United States	53 960,00
16	ISEG	Netherlands	46 540,00
17	Adastra	France	46 100,00
18	JUWELS Booster Module	Germany	44 120,00
19	MareNostrum 5 GPP	Spain	40 101,80
20	Shaheen III - CPU	Saudi Arabia	35 658,30

GREEN500

Rank	TOP500 Rank	Name	Country	Energy Efficiency [GFlops/Watts]
1	293	Henri	United States	65,40
2	44	Frontier TDS	United States	62,68
3	17	Adastra	France	58,02
4	25	Setonix – GPU	Australia	56,98
5	92	Dardel GPU	Sweden	56,49
6	8	MareNostrum 5 ACC	Spain	53,98
7	5	LUMI	Finland	53,43
8	1	Frontier	United States	52,59
9	84	Goethe-NHR	Germany	46,54
10	496	Olaf	South Korea	45,12
11	223	ATOS THX.A.B	France	41,41
12	226	Pegasus	Japan	41,12
13	442	MN-3	Japan	40,90
14	412	Champollion	France	38,55
15	16	ISEG	Netherlands	35,26
16	142	Grete	Germany	34,65
17	429	SSC-21 Scalable Module	South Korea	33,98
18	6	Leonardo	Italy	32,24
19	434	Tethys	United States	31,54
20	456	Phoenix - 2022	Australia	31,06