



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación





**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación

Supercomputadores, Inteligencia Artificial, Iberoamérica y Europa

Prof. Mateo Valero
Director

Barcelona, 7/11/2023

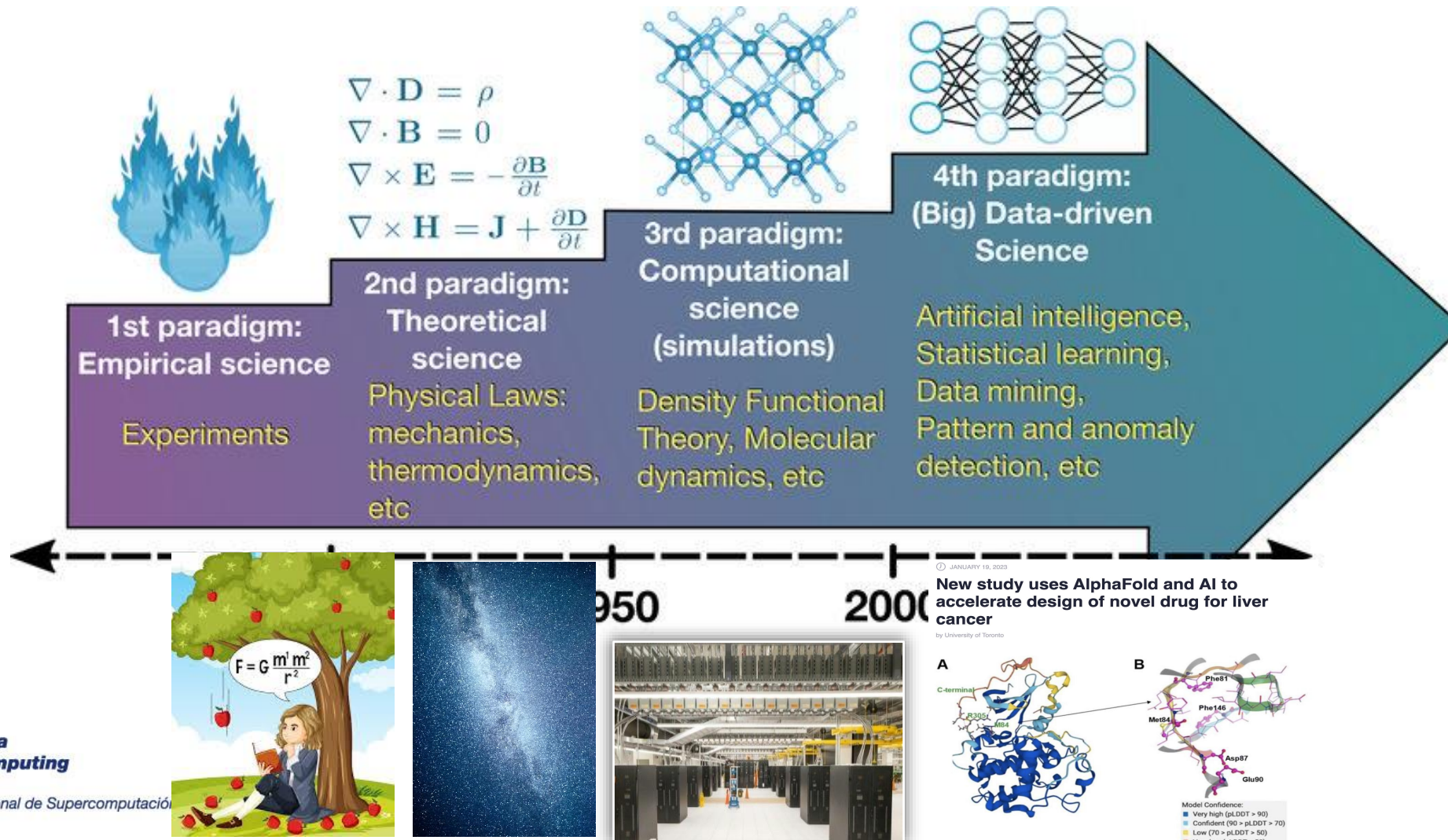


Investigación básica (investigación impulsada por la curiosidad) no tiene una aplicación inmediata:

- Penicilina, J. Lister (1871)... Fleming (1928)
- Algebra de Boole (1847)... C. Shannon (1920)
- Transistor W. Shockley, B&B (transistor)... G. Moore
- IA M. Minsky (1956)..Y. Lecun number recog. (2001)

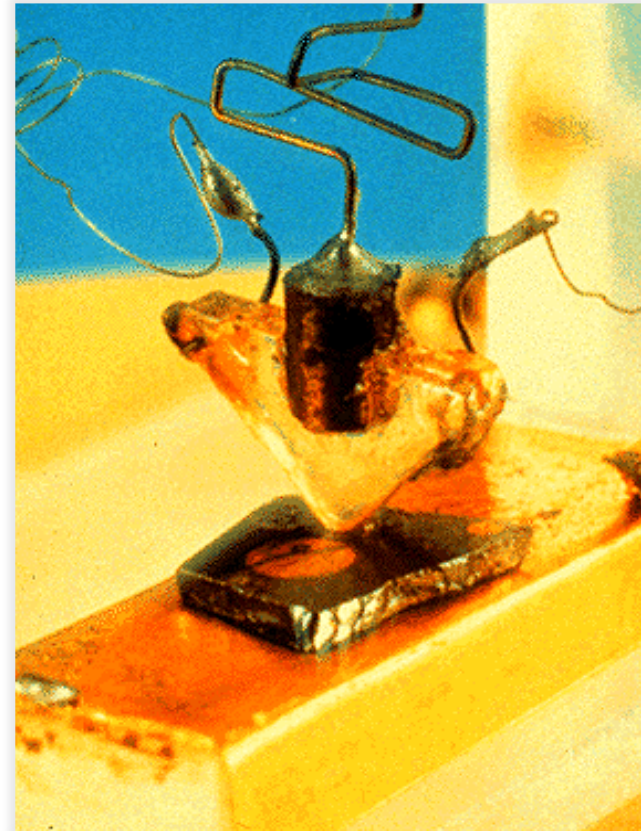


Los cuatro paradigmas de la ciencia: empírica, teórica, computacional, e impulsada por los datos



Logros Tecnológicos

- **Transistor (Bell Labs, 1947)**
 - DEC PDP-1 (1957)
 - IBM 7090 (1960)
- **Circuitos integrados (1958)**
 - IBM System 360 (1965)
 - DEC PDP-8 (1965)
- **Microprocesador (1971)**
 - Intel 4004



Frntera: Laboratorio Nacional de Oak Ridge (Tennessee)



Frontier Overview

Extraordinary Engineering



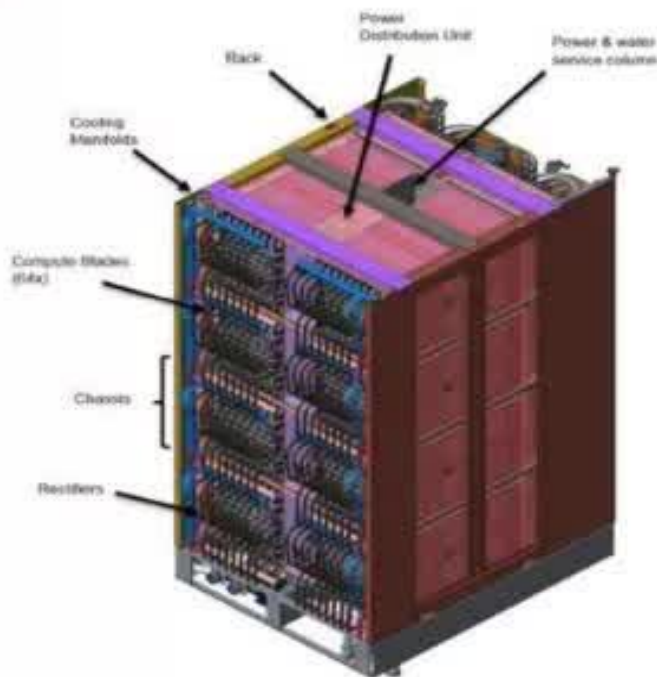
System

- 2 EF Peak DP FLOPS
- 74 compute racks
- 29 MW Power Consumption
- 9,408 nodes
- 9.2 PB memory (4.6 PB HBM, 4.6 PB DDR4)
- Cray Slingshot network with dragonfly topology
- 37 PB Node Local Storage
- 716 PB Center-wide storage
- 4000 ft² foot print

Built by HPE

Olympus rack

- 128 AMD nodes
- 8,000 lbs
- Supports 400 KW



Powered by AMD

AMD node

- 1 AMD "Trento" CPU
- 4 AMD MI250X GPUs
- 512 GiB DDR4 memory on CPU
- 512 GiB HBM2e total per node (128 GiB HBM per GPU)
- Coherent memory across the node
- 4 TB NVM
- GPUs & CPU fully connected with AMD Infinity Fabric
- 4 Cassini NICs, 100 GB/s network BW

Compute blade

- 2 AMD nodes



All water cooled, even DIMMS and NICs

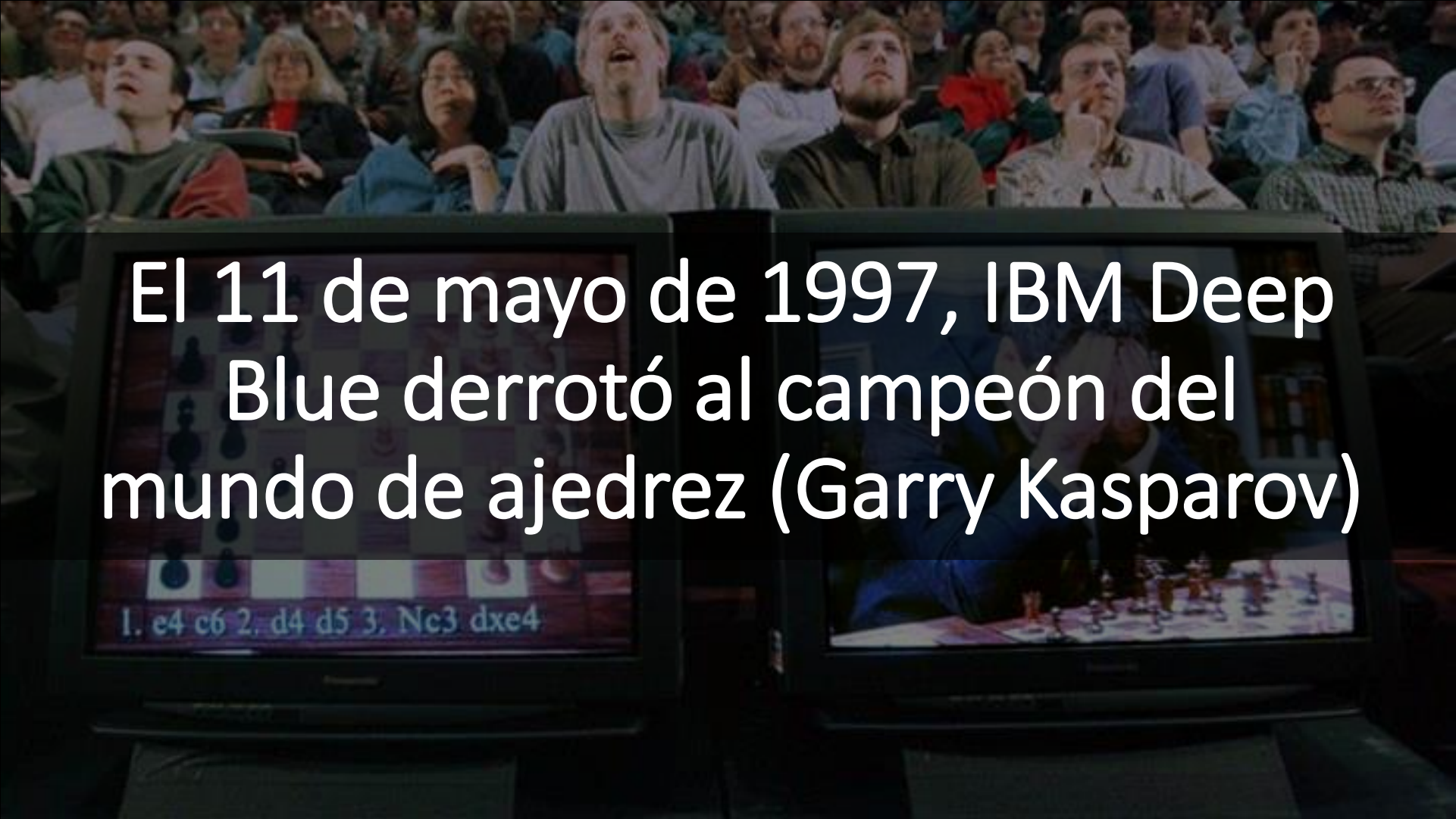
Top 10, junio de 2023

Rank	Name	Country	Cores	Accelerators	Rmax [TFlop/s]	Rpeak [TFlop/s]	HPCG [TFlop/s]	Power (kW)	GFlops/Watts	Computer	Site
1	Frontier	United States	8,699,904		1,194.00	1,679.82	14,054	22,703		HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11	DOE/SC/Oak Ridge National Laboratory
2	Supercomputer Fugaku	Japan	7,630,848		442.01	537.21	16,005	29,899		SUPERCOMPUTER FUGAKU, A64FX 48C 2.2GHZ, TOFU INTERCONNECT D	RIKEN Center for Computational Science
3	LUMI	Finland	2,220,288		309.10	428.70	3,408	6,016		HPE CRAY EX235A, AMD OPTIMIZED 3RD GENERATION EPYC 64C 2GHZ, AMD INSTINCT MI250X, SLINGSHOT-11	EuroHPC/CSC
4	Leonardo	Italy	1,824,768		238.70	304.47	3,114	7,404.40		BULLSEQUANA XH2000, XEON PLATINUM 8358 32C 2.6GHZ, NVIDIA A100 SXM4 64 GB, QUAD-RAIL NVIDIA HDR100 INFINIBAND	EuroHPC/CINECA
5	Summit	United States	2,414,592	2,211,840	148.600	200.795	2,927	10,096	14.72	IBM Power System AC922, IBM POWER9 22C 3.07GHZ, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband	DOE/SC/Oak Ridge National Laboratory
6	Sierra	United States	1,572,480	1,382,400	94.640	125.712	1,796	7,38	12.72	IBM Power System AC922, IBM POWER9 22C 3.1GHZ, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband	DOE/NNSA/LLNL
7	Sunway TaihuLight	China	10,649,600		93.015	125.436	481	15,371	6.05	Sunway MPP, Sunway SW26010 260C 1.45GHZ, Sunway	National Supercomputing Center in Wuxi
8	Perlmutter	United States	761,856	663,552	70.87	93.75	1,905	2,589	27.37	HPE Cray EX235n, AMD EPYC 7763 64C 2.45GHZ, NVIDIA A100 SXM4 40 GB, Slingshot-10	DOE/SC/LBNL/NERSC
9	Selene	United States	555,520	483,840	63.46	79.22	1,623	2,646	23.98	NVIDIA DGX A100, AMD EPYC 7742 64C 2.25GHZ, NVIDIA A100, Mellanox HDR Infiniband	NVIDIA Corporation
10	Tianhe-2A	China	4,981,760	4,554,752	61.44	100.68		18,482	3.32	TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHZ, TH Express-2, Matrix-2000	National Super Computer Center in Guangzhou
98	MareNostrum	Spain	153,216		6.47	10.30	122.242	1,632	3,96	Lenovo SD530, Xeon Platinum 8160 24C 2.1GHZ, Intel Omni-Path	Barcelona Supercomputing Center

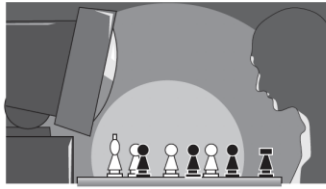


Driving ideas for AI

- 1956 Artificial Intelligence: *Study every aspect of learning or any other feature of intelligence can be so precisely described that a **machine can be made** to simulate it.*
- 1957 Perceptron
 - **Brain inspired:** An algorithm that takes its basic functionality from our understanding of how the brain operates.
 - **Neural Networks**
 - **Deep Learning**
- 1959 A. Samuel: **Machine Learning:** *Field of study that gives computers the ability to learn without being explicitly programmed (unsupervised learning).*



El 11 de mayo de 1997, IBM Deep Blue derrotó al campeón del mundo de ajedrez (Garry Kasparov)



Jueves, 6 de julio de 1995 Jaque cibernético Tema del día



El poder de los ordenadores
El desarrollo informático ha permitido en la última década crear máquinas capaces de ganar a los astros del ajedrez. Mijail Botvinnik fue uno de sus impulsores.

ELISENDA PONS



Tablas entre el hombre y la máquina

Barcelona. - Miquel Illescas y el superordenador *Deep Blue* hicieron tablas en la primera partida de ajedrez de estas características que se celebra en España. El hombre aguantó el reto ante la máquina, que es capaz de hacer cuatro millones de jugadas por segundo. El duelo ten-

drá un segundo capítulo esta tarde. "Mañana (por hoy) habrá sangre", declaró el maestro español, clasificado en la posición número 33 del ranking mundial. En la fotografía, un momento de la partida disputada ayer en Barcelona. **PÁGINAS 2, 3 Y EDITORIAL**



ELISENDA PONS



Miquel Illescas, concentrado durante la partida de ayer. El duelo se reanuda hoy.

"La máquina podrá con el hombre"

Los expertos creen que los ingenios pronto serán invencibles




7 7 1995



7 7 1995

7 7 1995



El 15 de marzo de 2016, Google
AlphaGo venció al gran maestro de Go
surcoreano Lee Sedol

AlphaGo
Google DeepMind

AlphaFold ha cambiado el campo de la bioinformática estructural para siempre, con implicaciones inmediatas para la biotecnología y el desarrollo de fármacos.

AlphaFold covers the protein universe >200M proteins

Article

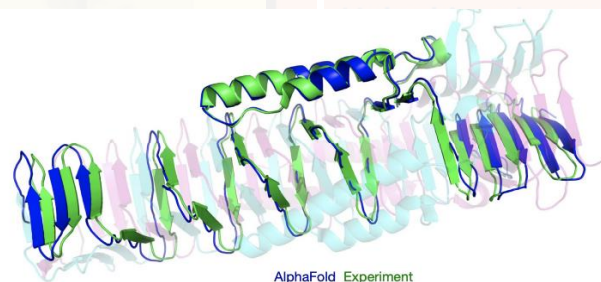
Highly accurate protein structure prediction with AlphaFold

Nature | Vol 596 | 26 August 2021 |

Article

Highly accurate protein structure prediction for the human proteome

Nature | Vol 596 | 26 August 2021

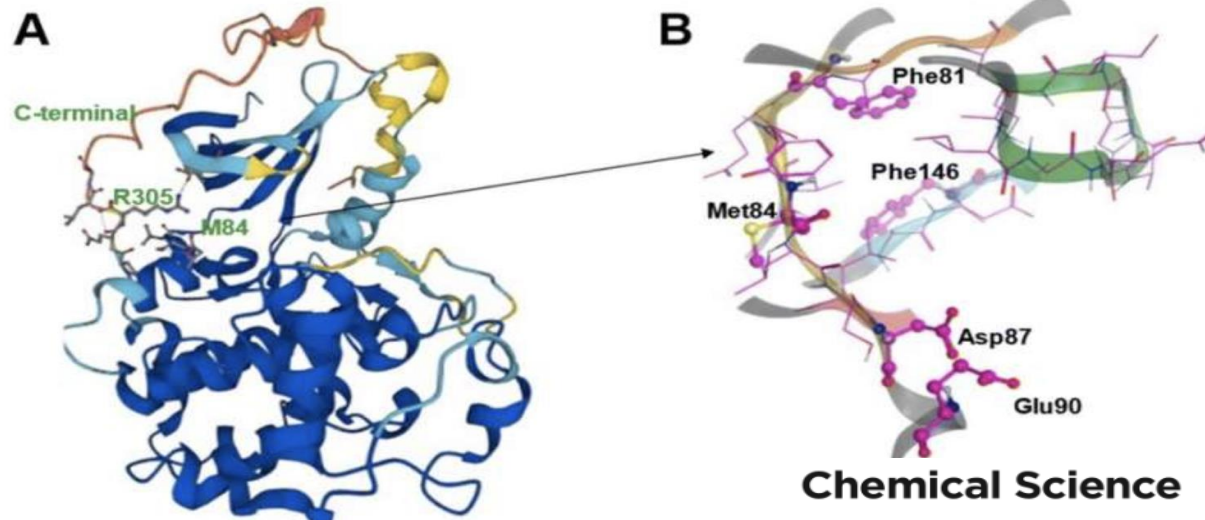


Prof Dame Janet Thornton and Mihaly Varadi are helping transform biology

JANUARY 19, 2023

New study uses AlphaFold and AI to accelerate design of novel drug for liver cancer

by University of Toronto



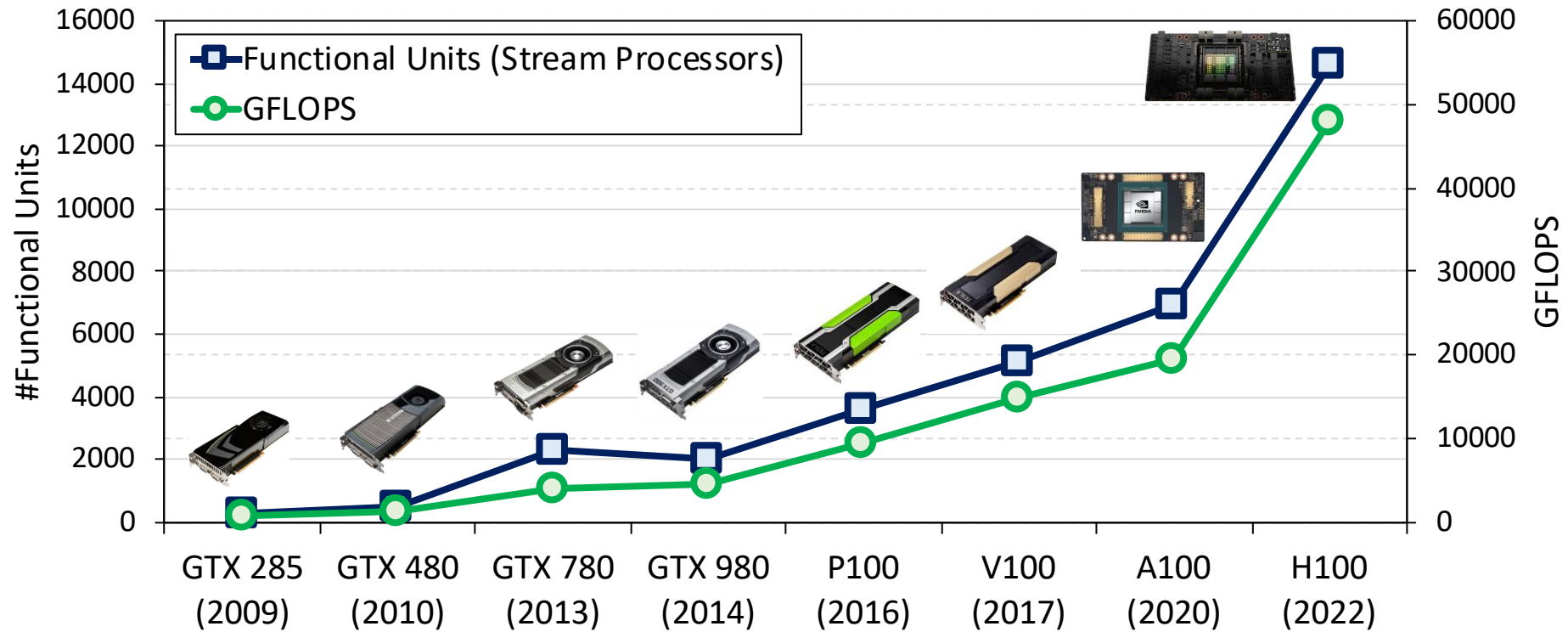
AlphaFold accelerates artificial intelligence powered drug discovery: efficient discovery of a novel CDK20 small molecule inhibitor†

Chemical Science

Received 14th October 2022
Accepted 5th January 2023

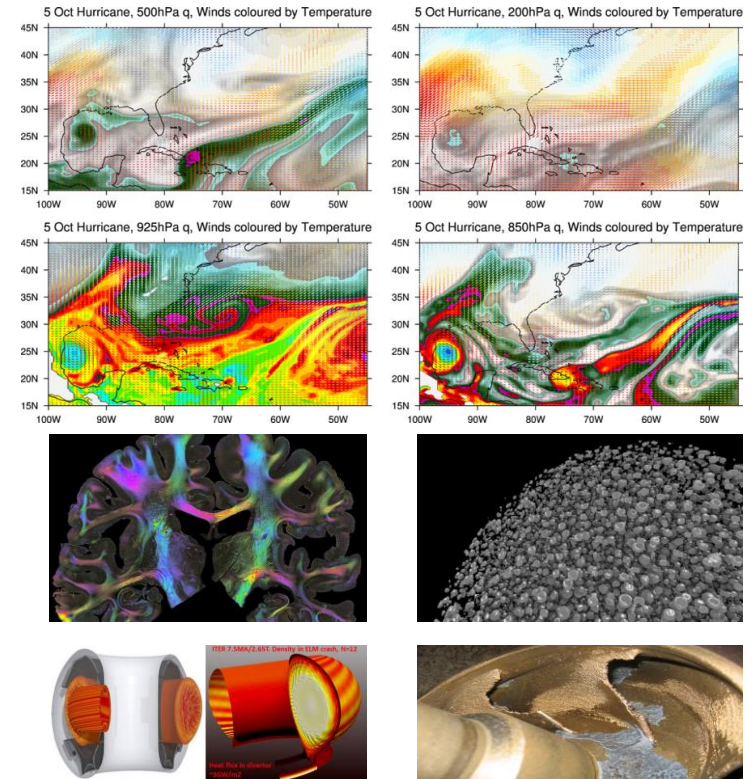
DOI: 10.1039/d2sc05709c 13

Evolution of NVIDIA GPUs



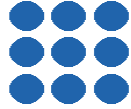
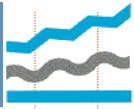
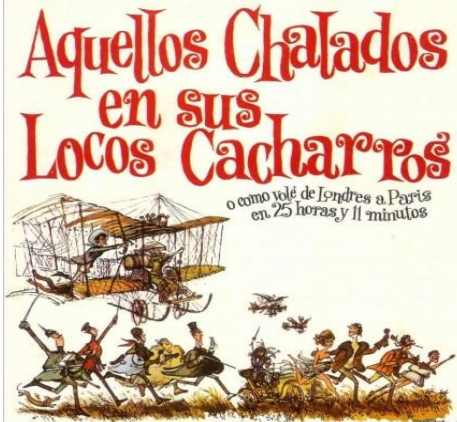
Por qué la IA y la supercomputación son necesarias: Algunos ejemplos

- Ahorrarán miles de millones ayudándonos en la adaptación al cambio climático
- Mejorarán la salud humana permitiendo la medicina personalizada
- Mejorarán la eficiencia de los combustibles de aviación y ayudarán a mejorar el diseño de los aerogeneradores
- Nos ayudarán a entender cómo funciona el cerebro humano
- Vehículos autónomos/ Robots



Images courtesy of The PRACE Scientific Steering Committee, "The Scientific Case for Computing in Europe 2018-2026"

Venimos de muy lejos ...



Barcelona Supercomputing Center
Centro Nacional de Supercomputación



Parsys Multiprocessor



Parsytec CCI-8D
4.45 Gflop/s



Compaq GS-140
12.5 Gflop/s



Compaq GS-160
23.4 Gflop/s



BULL NovaScale 5160
48 Gflop/s



Maricel
14.4 Tflops, 20 KW



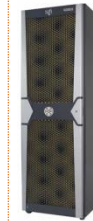
Transputer cluster



Convex C3800



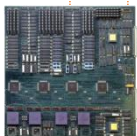
SGI Origin 2000
32 Gflop/s



SGI Altix 4700
819.2 Gflops



SL8500
6 Petabytes



Research prototypes



Connection Machine CM-200
0,64 Gflop/s



IBM RS-6000 SP & IBM p630
192+144 Gflop/s



IBM PP970 / Myrinet
MareNostrum
42.35, 94.21 Tflop/s

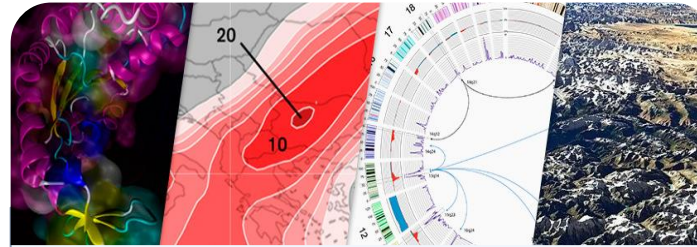
1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

Barcelona Supercomputing Center Centro Nacional de Supercomputación

Objetivos del BSC-CNS



Servicios de supercomputación a investigadores españoles y de la Unión Europea



I+D en Ciencias de la Computación, de la Vida, de la Tierra e Ingeniería



Formación doctoral, Transferencia de tecnología, Compromiso público/social

BSC-CNS es un consorcio que integra

Gobierno de España

60%



Gobierno de Cataluña

30%



Univ. Politècnica de Catalunya (UPC)

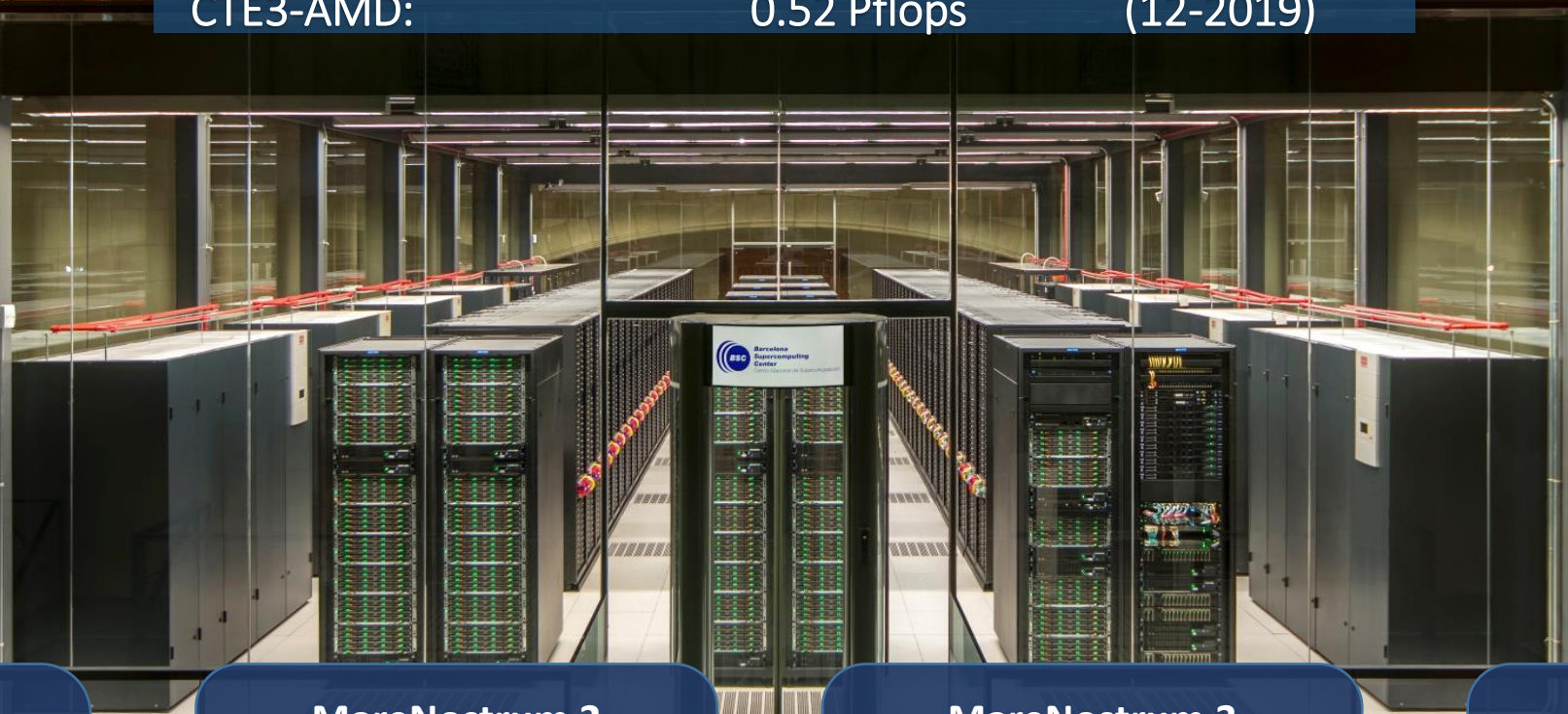
10%



MareNostrum 4

Total peak performance: **13.9 Pflops**

General Purpose Cluster:	11.15 Pflops	(1-07-2017)
CTE1-P9+Volta:	1.57 Pflops	(1-03-2018)
CTE2-Arm V8:	0.65 Pflops	(12-2019)
CTE3-AMD:	0.52 Pflops	(12-2019)



MareNostrum 1

2004 – 42.3 Tflops
1st Europe / 4th World
New technologies

MareNostrum 2

2006 – 94.2 Tflops
1st Europe / 5th World
New technologies

MareNostrum 3

2012 – 1.1 Pflops
12th Europe / 36th World

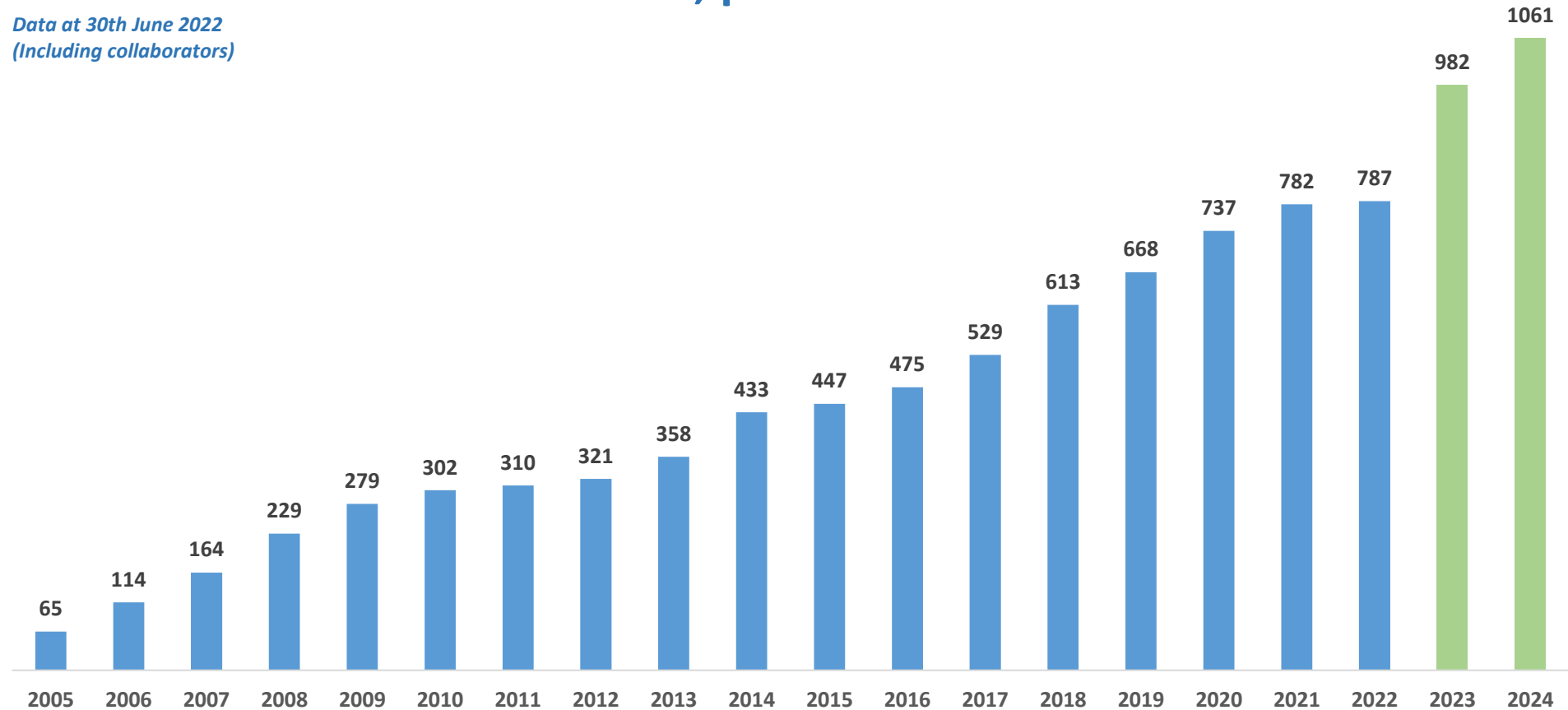
MareNostrum 4

2017 – 11.1 Pflops
2nd Europe / 13th World
New technologies

People evolution

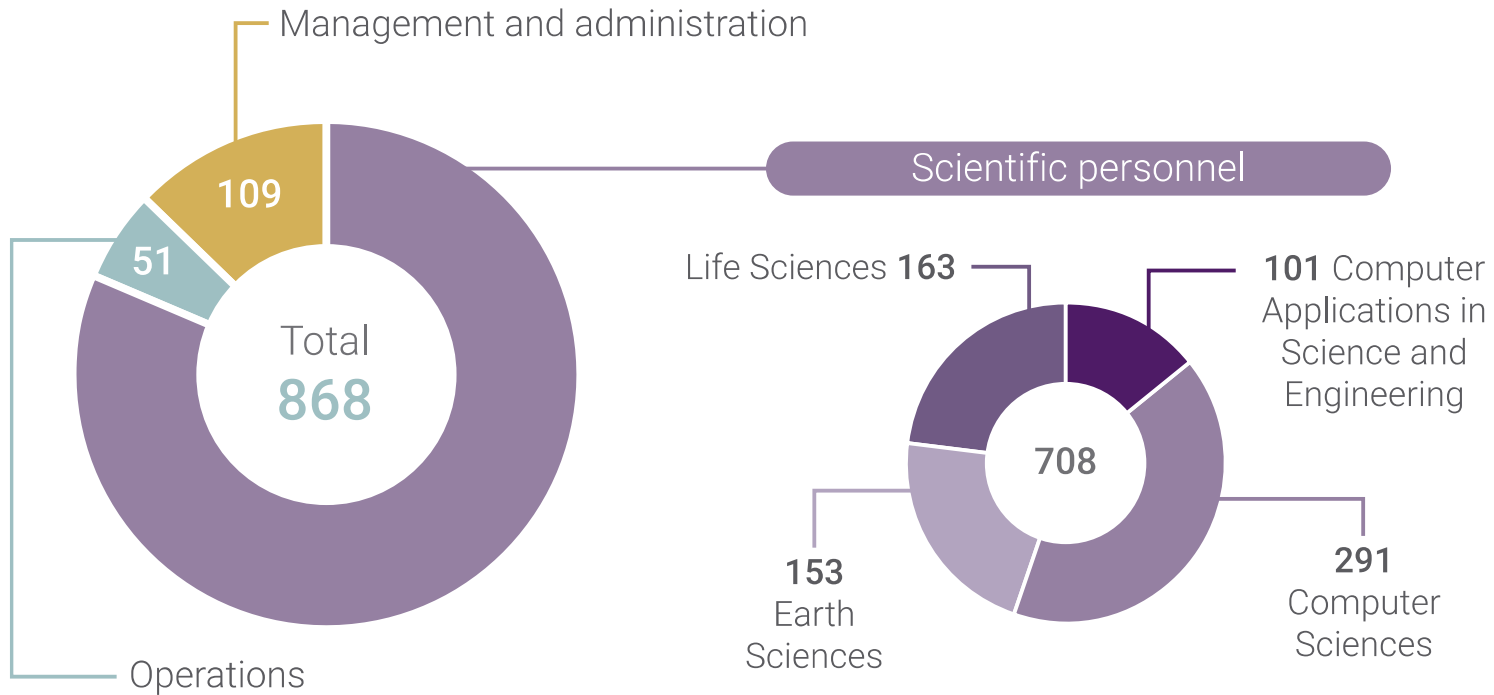
BSC Staff evolution 2005 - 2022, plus forecast 2023 & 2024

Data at 30th June 2022
(Including collaborators)



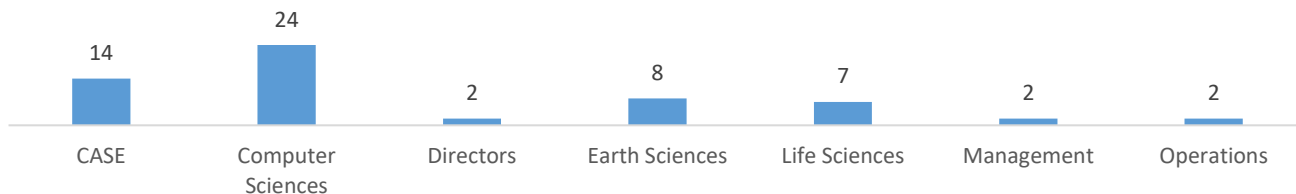
BSC-CNS en mayo de 2023

Personal



Personal Latinoamericano en el BSC-CNS

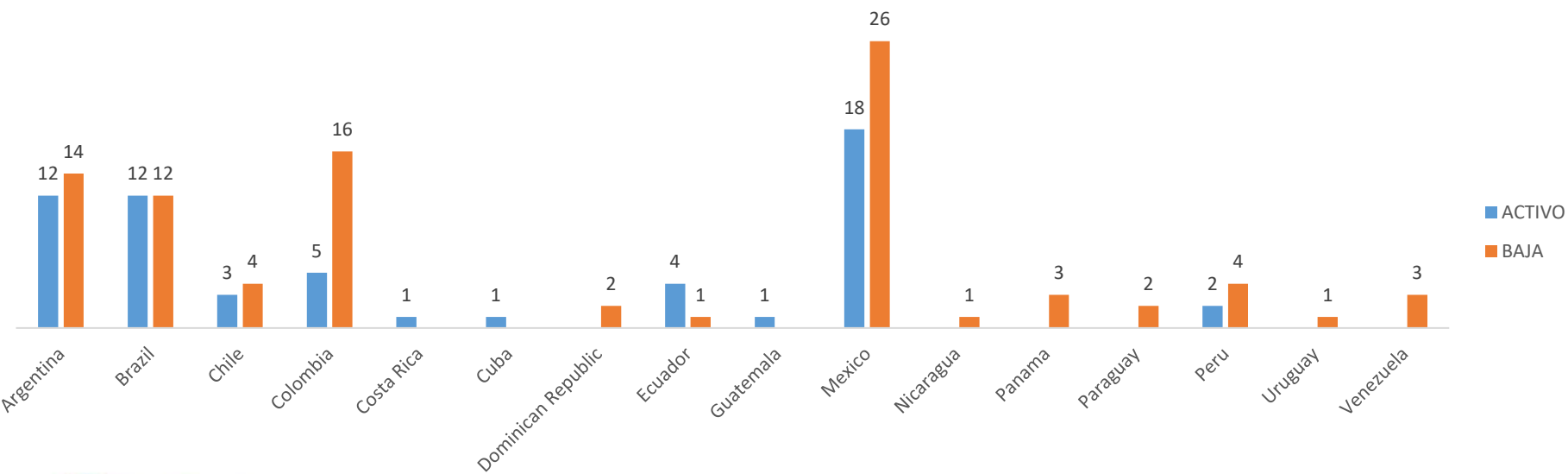
Personal Activo en el BSC en Junio 2023 por Departamento



7% del total BSC actual

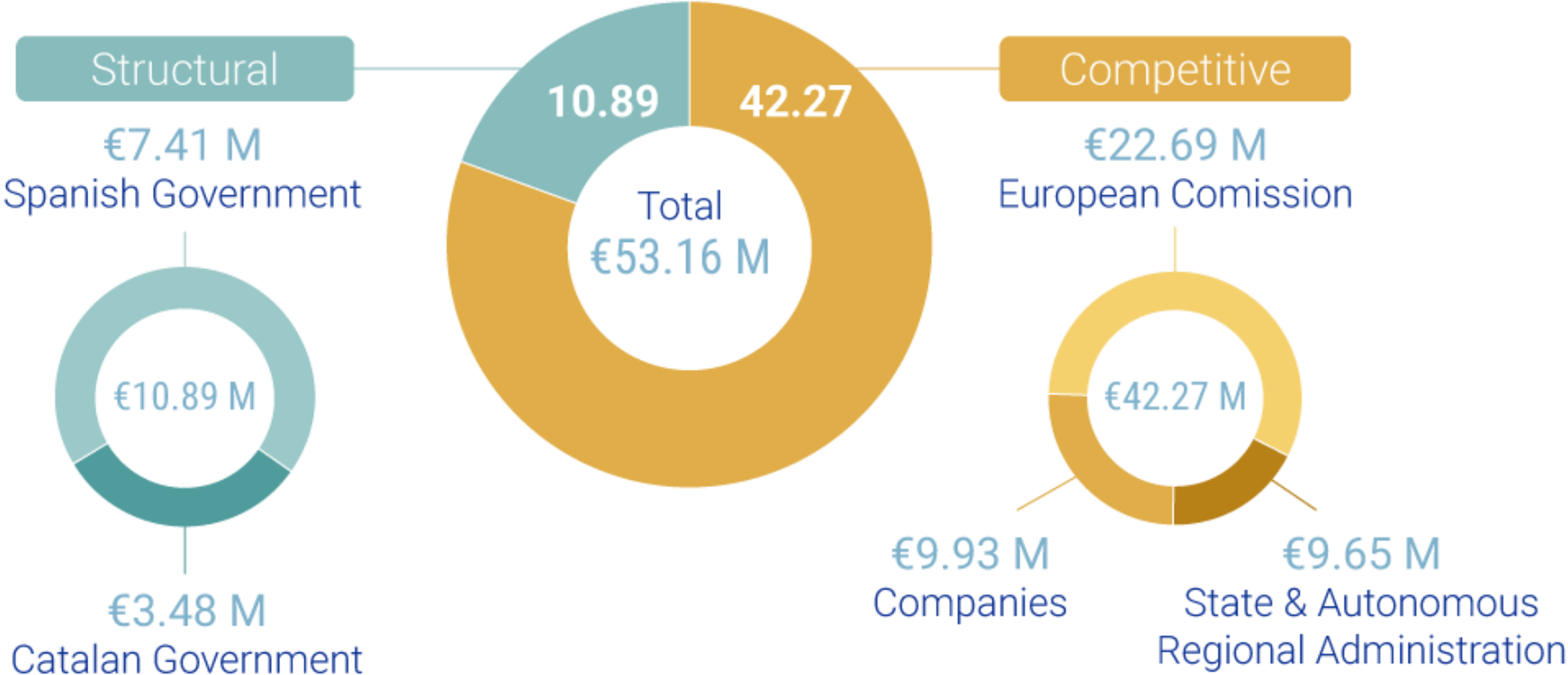
59 personas Actuales

Personal Activo en el BSC en Junio 2023 vs Personal histórico que ha pasado por el BSC



Total de 148 personas en el BSC (desde 2005)

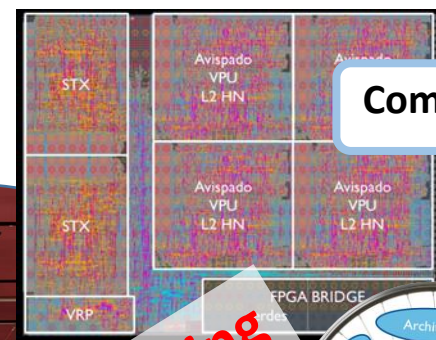
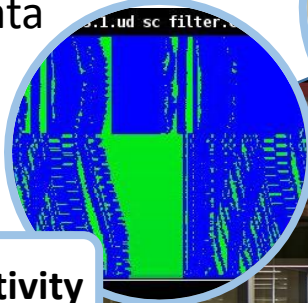
BSC-CNS en 2022



Training & Promotion of best practices

Performance analysis and tools

Data acquisition and visualization
Analytics of performance data
Analysis methodologies



Computer Architecture and processor design

Real time architectures
RISCV V design and manufacturing
RISCV vector processors for HPC

Programming models for productivity

Contribution to the OpenMP standard
Heterogeneous systems
Parallel Runtimes and interoperability

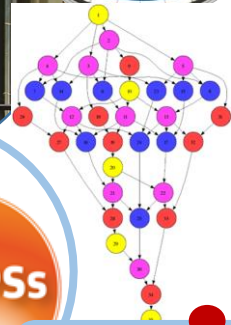


Computer Sciences
277 researchers

European/worldwide leading role in several of those areas

High-Performance AI

Explainability
AI applications



Computational workflows

Distributed workflows for HPC
Parallel AI workflows
Data management
Cloud and edge

Energy / performance Aware Resource Management

Dynamic Load balancing
Energy aware runtimes

Women in Computer science

- Data science
- Computer architecture
- Electronics
- Applied mathematics
- Software engineering
- System software
- Analytics and AI
- Algorithmics
- Languages
- Operating systems

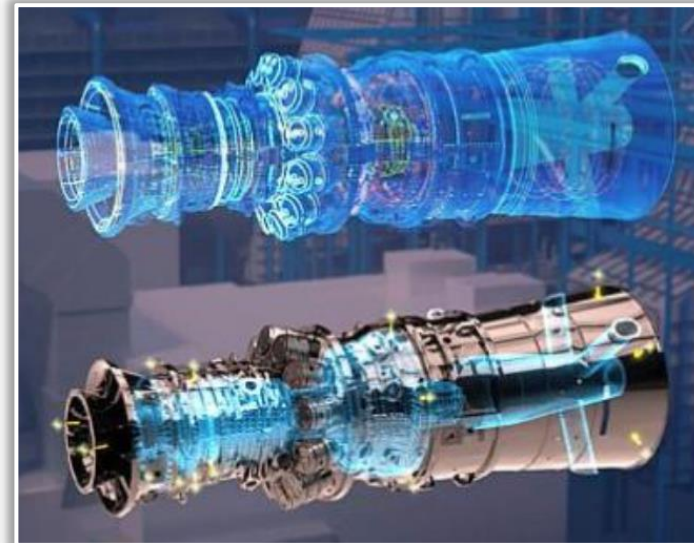
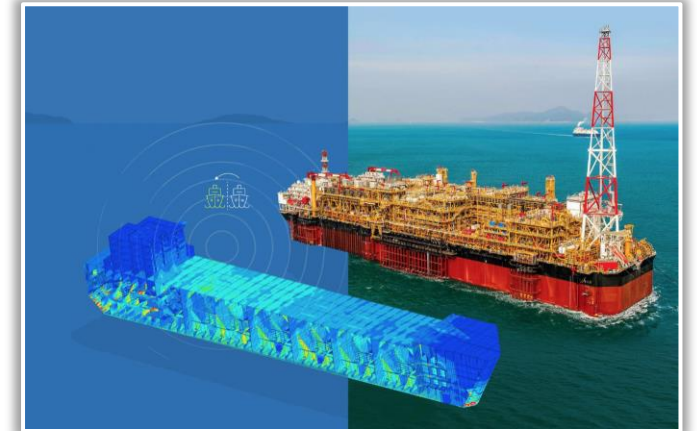
Gemelos Digitales

HORIZON
The EU Research &
Innovation Magazine

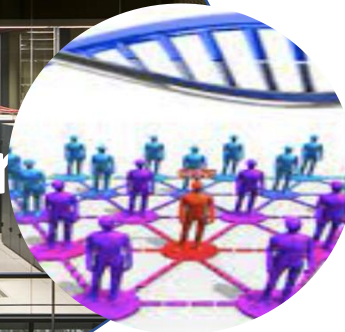
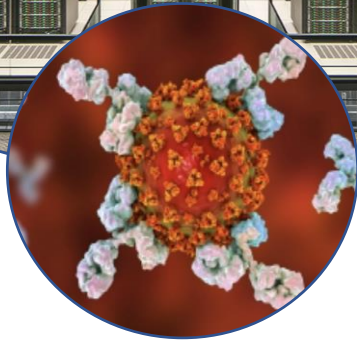
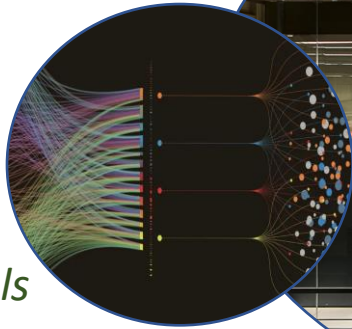
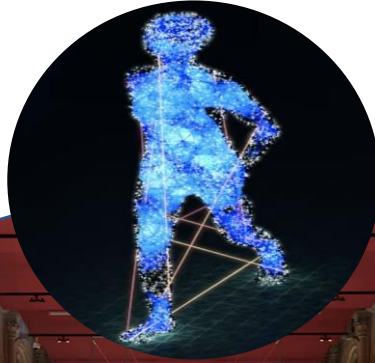
INDUSTRY SCIENCE IN SOCIETY ICT

How digital 'twins' are guiding the future of maintenance and manufacturing

15 November 2019



Gemelos Digitales Virtuales



Life Science
145 researcher



**Bio-Data
management & data
infrastructures**

*BioDatabases,
FAIRdata, workflows*

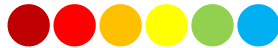
*NLP: Large
Language Models
& BioNLP*

*Data and
societal
challenges*

BIOINFO 4 WOMEN

*Biases in
Biomedicine
and AI/ML*

**Modelling
and Design**



*Design of
drugs and
vaccines*

*Language
Models and
AlphaFold*

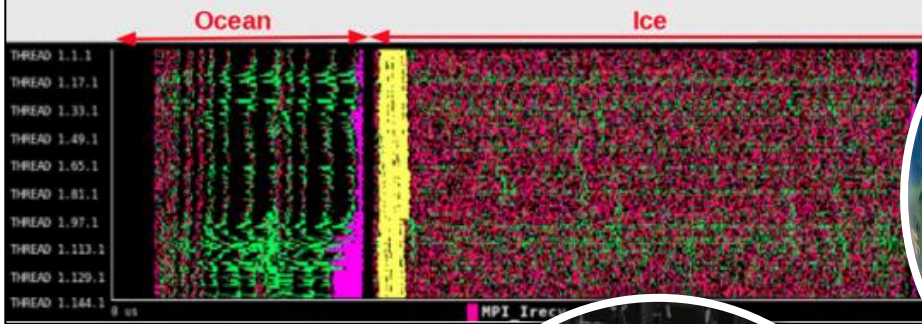
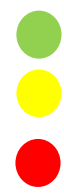


**Personalised
Medicine**

*Cancer
Data/soft
Infrastructure* *Genome
Wide studies*
*Genome
Regulation* *Rare
Diseases* *Cancer
Research*

*Cell level
simulations
(Boolean &
agent based)*

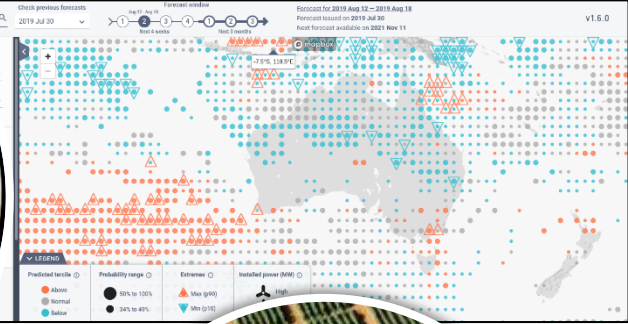
- Data science
- Physics
- Chemistry
- Applied mathematics
- Software engineering
- Computational Bio
- Bioinformatics
- Social science
- Comp. Linguistics
- Medicine
- Genomics



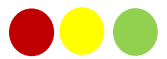
Code development



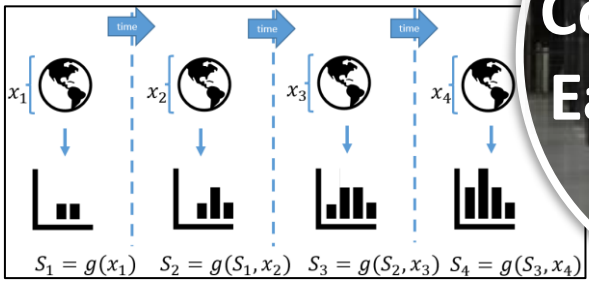
Digital Twin Earth



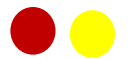
Visualisation



Climate impacts

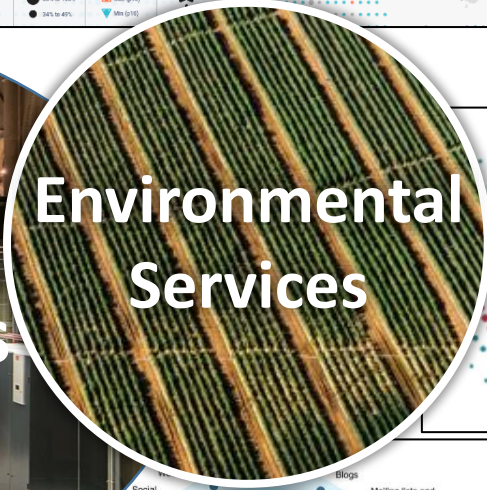


Data workflows

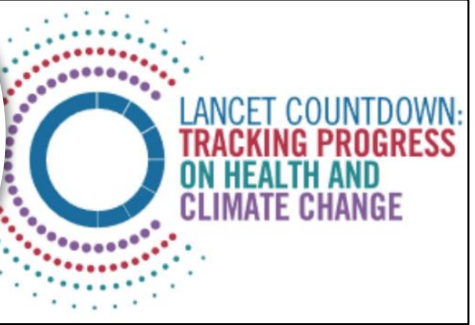


Computational Earth Sciences

Earth Science
131 researchers

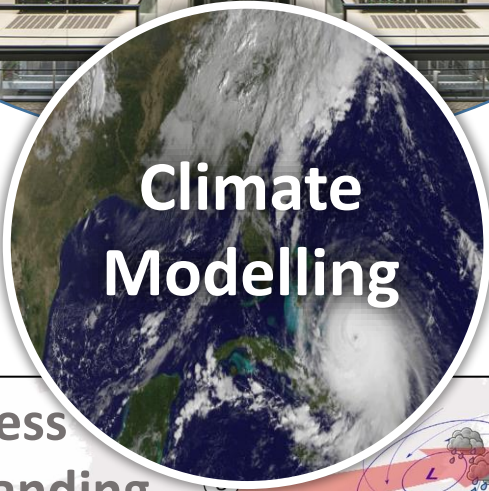


Environmental Services

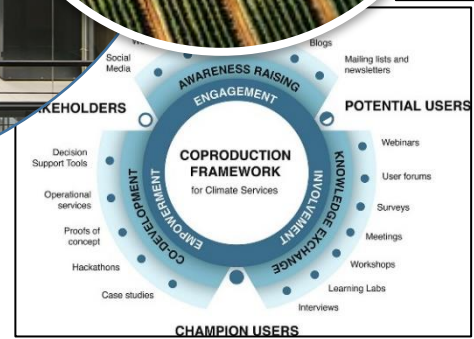


Big data

ORCA 2	ORCA 1/12
550 MB of memory	414 Gigabytes of memory
8 CPU hours	90 000 CPU hours
10 Gigabytes of output (daily)	1 Terabyte of output (daily)



Climate Modelling



User engagement



- Data science
- Physics
- Chemistry
- Applied mathematics
- Software engineering
- Environmental science
- Climatology
- Social science
- Humanities
- Environmental economy



Process understanding



Aplicaciones de la computación en Ciencia e Ingeniería (CASE)

Desarrollo de simulaciones industriales complejas

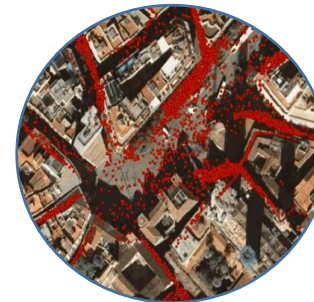
Combustion Simulations



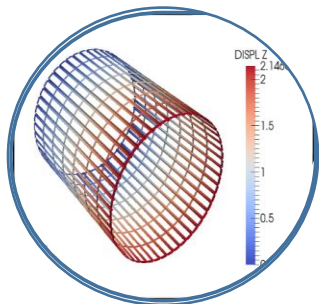
Computational Fluid Dynamics



Agent Based Models



Solid Mechanics

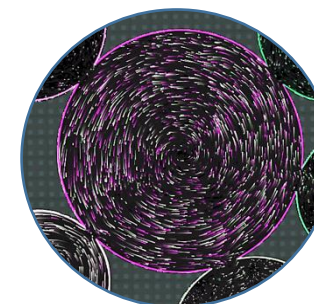


Coupled



Phenomena

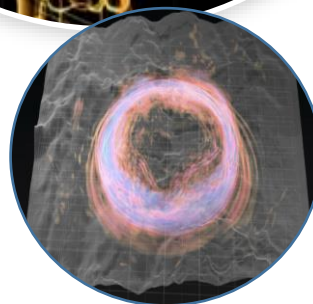
Machine Learning



Plasma Physics



Wave Simulations (EM, Elastic, acoustic)



Data science

Physics

Chemistry

Applied mathematics

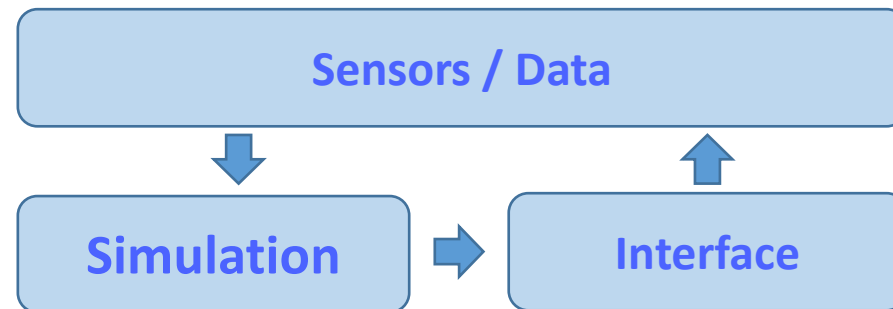
Software engineering



**Barcelona
Supercomputing
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Centro Nacional de Supercomputación

WHAT IS A CITY DIGITAL TWIN

- A generic term that defines the confluence of multiple technologies
- Components:
 1. Data in real time and historic, from IoT sensors and unstructured
 2. A simulation *kernel* (deterministic or statistical)
 3. An interface for humans and for digital systems
- Data feeds the kernel, which serves to predict scenarios
- The interface allows to see current state, the past, and possible futures.



A CITY DIGITAL TWIN

Sensors / Data



IoT:

- Cameras
- Stop lights
- Traffic
- Buses / trucks
- Bicycles



BBDD: Census

- Cadastre
- Commerce
- Alerts

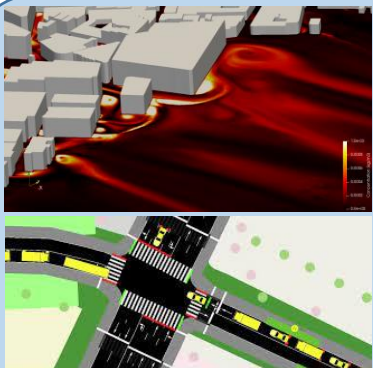


External data

- Social networks
- Citizen science
- Participative democracy
- Ext. institutions



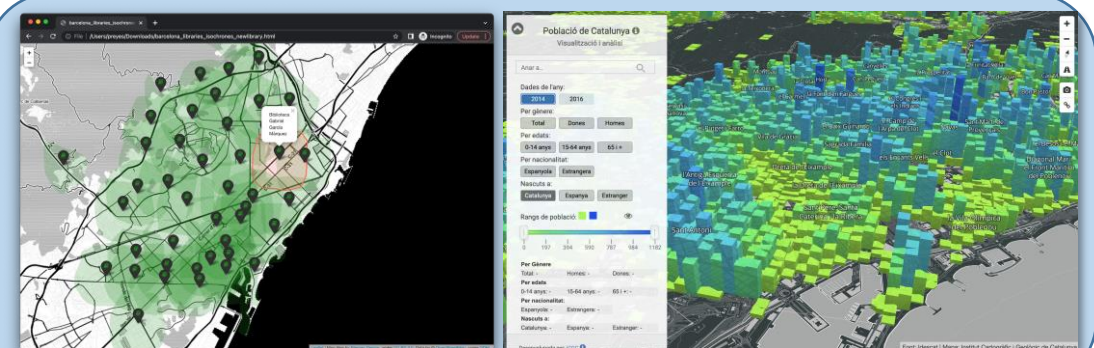
Simulation



- City micro-scale weather
- Traffic
- Mobility
- Economy / Urban systems
- Public services

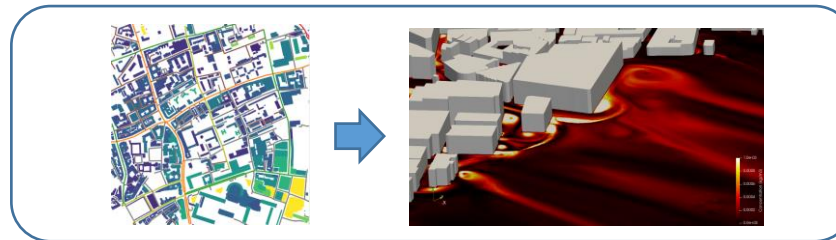


Interface



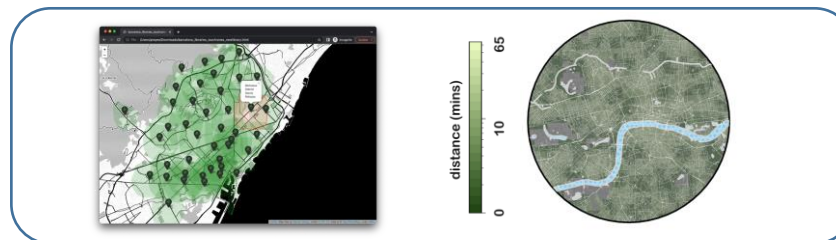
An Urban Digital Twin: BSC applications

Renaturalization of the city: How to maximize impact on air quality with new green areas?



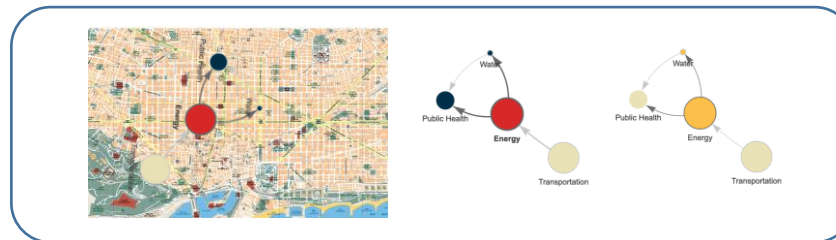
AI trained on HPC air quality simulations lets policy makers explore quickly

The 15 minute city: How to make the city more accesible and inclusive by redistributing infrastructure



A tool to measure the impact of infrastructure placement on different demographics

Critical Infrastructure Resilience:
Coupled digital twins of critical infrastructures to improve resilience



Serious games simulations to identify cascading effects and improve resilience against natural and social hazards

Big data, AI, and HPC for Smart cities:
Technology for hybrid real time monitoring and analysis of data



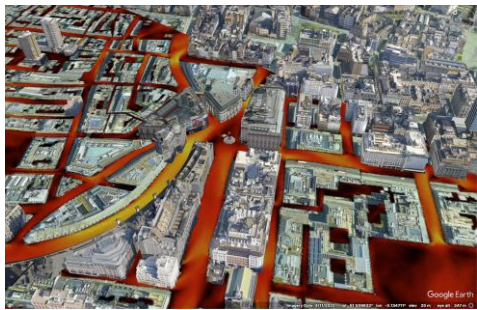
NagareDB, a cascading polyglot DB for IoT and time series data, providing efficient monitoring and historical queries.

Pronóstico de la calidad del aire urbano en microescala en tiempo real utilizando IA

- Se han utilizado más de **20.250** muestras de entrenamiento de alta fidelidad (con una **resolución de 1m**).
- Se han considerado **30** geometrías urbanas europeas y **450** escenarios de emisiones.
- 6M horas de núcleo para calcular los conjuntos de datos (utilizando 2000 CPUs).
- El modelo de Red Neuronal resultante ofrece **predicciones en tiempo real utilizando un único GPU**.
- Modelo válido para cualquier geometría urbana (incluso no conocida a priori) manteniendo buena precisión (<15% error).



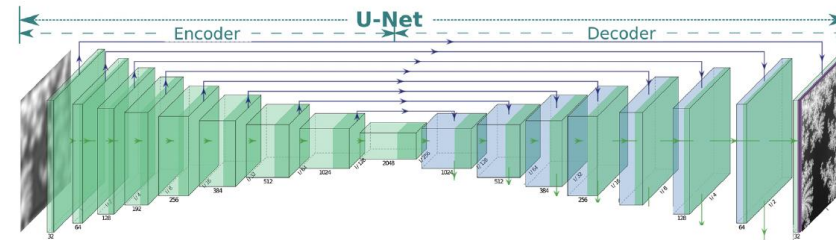
Madrid
Plaza Castilla



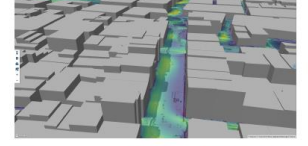
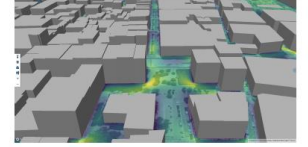
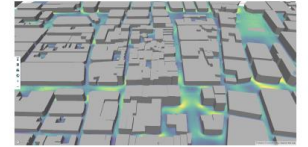
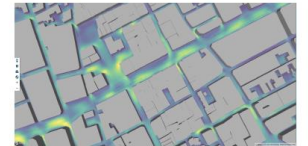
London
Picadilly Circus



Input: Geometry



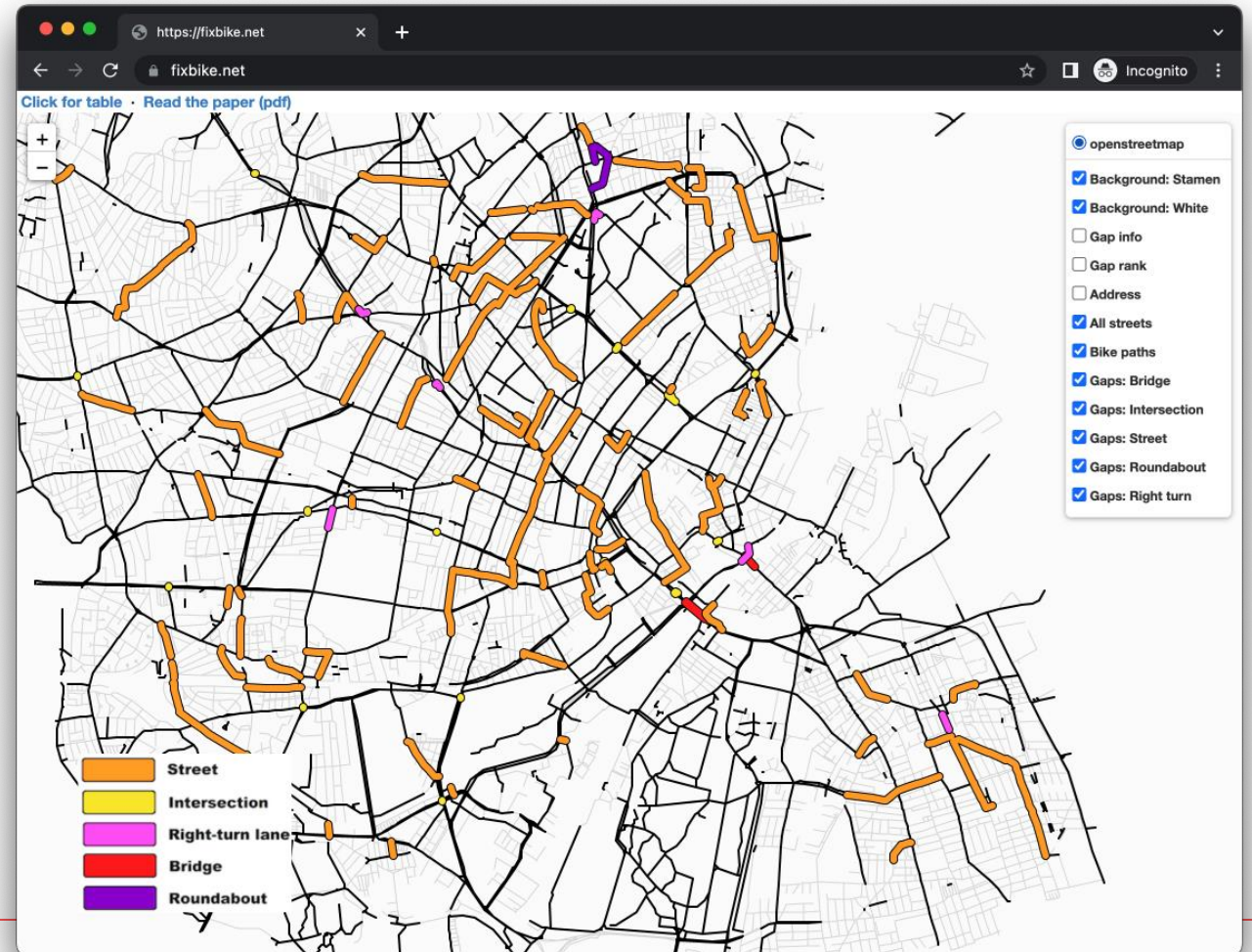
CFD-based training dataset



Output: Wind Field

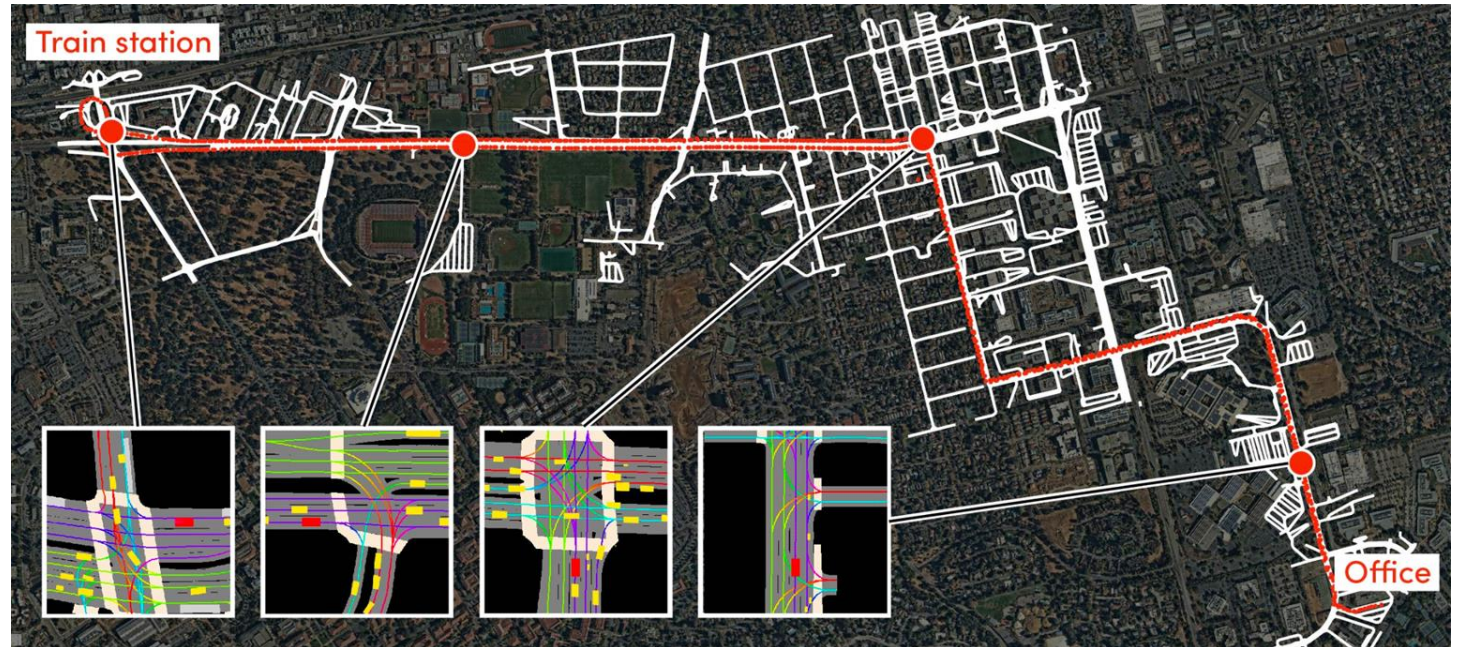
NEW TRANSPORTATION MEANS

- Analysis of transport networks in the city
 - Public transportation,
 - Bicycles, scooters,
 - Electric cars.
- What links in the network should we add first to improve resilience and connectivity?
- Use case on cycle lanes analysis



IMPACT ON TRAFFIC

- How does a new park or super-illa affects surrounding streets?



Traffic simulator SUMO



**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación



BSC: Multidisciplinary AI

	CASE	CS	Earth	Life
AI surrogates & simulation	Aeronautical design (CFD, Materials) Propulsion technologies (Hydrogen, SAFs)	Generative AI imaging for health	Extreme climate event prediction	Synthetic biomedical data generation (genomes, EHRs, images)
Digital Twins	Urban and Industry digital twins, Medical applications, Solid Earth and Natural Hazards mitigation	Mobility Edge digital twins	Earth digital twins (Destination Earth and Digital Twin Ocean)	Digital Twins for Human Body. Agent-based multicellular simulations, in-silico drug response screening
Foundational Models & LLMs	Semantic search & Classification Music and voice generation	Multimodal Visual Question Answering for medical domain (Aleu-7B)	LLMs for climate change adaptation	Language model Aguila-7B EN/ES/CAT. Translation model Aina ES/CAT/ENG Speech models (TTS & STT)
Image processing	Medical ultrasound images, Radar and thermal images	Embryo selection, atom detection, space exploration,...		Oncology, virology, risk assessment
Support, efficiency & parallelism	Communication Network design	OneDNN, Dislib, pyCOMPSs for hybrid HPC/AI workflows, RISC-V VEC and systolic architectures, homomorphically encrypted DL		
Trustworthy, Safety & Ethics	Explainability	Explainable AI, Synthetic content detection		Desinformation and biases

Spanish Supercomputing Network (RES), since 2006

RES
RED ESPAÑOLA DE SUPERCOMPUTACIÓN

www.res.es

Membership update: September 2022

HPC and data management resources for the scientific community

- 14 institutions
 - 16 supercomputers
 - 9 data management centres
- +22 PFlop/s combined capacity
- +20 PB storage in 2022 (and growing)
- +800 million CPU hours/year ²⁰²²
- +1.000 regular users
- +200 scientific papers annually

- 3 HPC/AI calls per year
- 1 Data call per year
- Continuous call for AI small access
- Applications Support Teams

- Member of Spanish Unique Scientific and Technical Infrastructure network (ICTS)
- Access Committee and Users Committee
- EuroHPC National Competence Centre
- Coordinated by **BSC-CNS**



RISC (2011-2013)

10 PARTNERS



Universidad Veracruzana | Universidad de Chile | Universidad de Buenos Aires | Universidad Autónoma de Manizales | COPPETEC Fundação Coordenação de Projetos, Pesquisas e Estudos Tecnológicos do Rio de Janeiro | Barcelona Supercomputing Center | Universidade de Coimbra | UPM | Menon | CINECA



RESULTS

- Identified research clusters for targeted research collaboration.
- Produced a Green Paper on HPC Drivers and Needs in Latin America.
- Produced a Roadmap for HPC strategic R&D in Latin America.
- Enhanced HPC R&D policy dialogue between policymakers and stakeholders.



RISC2 mission










The **RISC2** European project ([RISC2 Project \(risc2-project.eu\)](https://www.risc2-project.eu)) 2021-2023, was established to promote more collaboration between EU and LATAM HPC communities and foster a policy dialogue among the respective funding agencies and authorities.

Most notable results so far:

- The White Paper on HPC RDI in Latin America at [White Paper on HPC RDI in LATAM - RISC2 Project \(risc2-project.eu\)](https://www.risc2-project.eu/white-paper)
- The HPC Observatory, available at <https://www.risc2-project.eu/hpc-observatory/>
- Policymakers event (Brussels, 18 July, 6:00-9:00 PM)
- Dedicated and policy-focused activities at CARLA 2022 (Porto Alegre, Brazil) and CARLA2023 (Cartagena de Indias, 18-22 Sep)



BSC Projects with Latin American Partners

2011-2013		EU-Brazil Open Data and Cloud Computing e-Infrastructure for Biodiversity	Brazil
2011-2013		Network to Coordinate EU-Latin American Supercomputing Research	Countries?
2015-2017		Enhancing prediction of tropical Atlantic climate and its impacts	Brazil
2016-2017		Seasonal-to-decadal climate prediction for the improvement of EU Climate Services	Brazil
2019-2021		Exascale HPC techniques for energy industry simulations for Mexico	Mexico
2019-2023		Tropical and South Atlantic - climate-based marine ecosystem prediction	Brazil
2020-2023		Worldwide Analysis and Forecasting of Atmospheric Composition for Health	Chile
2020-2024		Land Use Based Mitigation for Resilient Climate Pathways	Colombia
2021-2023		Exploring the real and potential impact of HPC on Latin America and Europe	Countries?

The road ahead

- Strengthen scientific collaboration *between* LAC and the EU and *within* LAC.
- Foster **bilateral agreements**, following the example of the EU-Japan Digital Partnership.
- Establish **centres of excellence** in LAC focused on specific scientific applications, building upon the experience of the European HPC CoEs.
- Improve and coordinate **HPC infrastructure** throughout LAC, sharing HPC resources and following joint action plans.
- Leverage the **BELLA Programme** in the region and initiatives like RedCLARA and SCALAC.
- **Education is key!** Promote specialised degrees in HPC organised in cooperation between LAC and EU institutions, foster student exchange experiences and increase scientific mobility.



Por qué promover la supercomputación en Iberoamérica

- Impulsar la colaboración intraregional
- Atender los desafíos sociales y económicos
- Mejorar la cooperación internacional
- Avanzar en la investigación científica
- Fortalecer la educación y la capacitación

Historias exitosas

- **SCALAC:** El Sistema de Cómputo Avanzado para Latinoamérica y el Caribe (SCALAC) es una infraestructura estratégica que brinda a los investigadores de la región acceso a recursos de supercomputación. SCALAC se ha utilizado para apoyar la investigación en campos como el modelado climático, el descubrimiento de fármacos y la respuesta a desastres naturales.
- **RISC2:** El proyecto RISC2, con base en la Red Iberoamericana de Supercomputación (RISC), está construyendo una red para promover la investigación en supercomputación entre Europa y América Latina, apoyando la interacción birregional entre investigadores y fomentando el intercambio de las mejores prácticas a través de reuniones, talleres y capacitación. El proyecto tiene como objetivo mejorar la capacidad de supercomputación en Latinoamérica y promover la colaboración entre continentes.

Aplicaciones de la supercomputación en Iberoamérica

- **Agricultura:** La supercomputación se ha utilizado para desarrollar modelos de cultivo para ayudar a los agricultores a optimizar el rendimiento de sus cultivos. Mediante su uso, los investigadores pueden simular el crecimiento de los cultivos en diferentes condiciones ambientales, lo que puede ayudar a los agricultores a tomar decisiones informadas sobre la siembra y la cosecha.
- **Modelado del clima:** La Supercomputación se ha utilizado para desarrollar modelos climáticos que pueden ayudar a predecir el impacto del cambio climático. Estos modelos pueden ayudar a los formuladores de políticas a desarrollar estrategias para mitigar los efectos del cambio climático.
- **Descubrimiento de fármacos:** La supercomputación se ha utilizado para acelerar el descubrimiento de nuevos medicamentos para enfermedades prevalentes en Latinoamérica, como la enfermedad de Chagas o el dengue. Mediante su uso, los investigadores pueden simular el comportamiento de las moléculas y predecir sus interacciones con otras moléculas, lo que puede ayudar a identificar posibles fármacos candidatos.
- **Energía:** La supercomputación se ha utilizado para optimizar la producción de energía en LATAM al simular el comportamiento de las redes eléctricas e identificar áreas donde se puede mejorar la eficiencia energética. Mediante su uso, los investigadores pueden desarrollar modelos que pueden ayudar a reducir el consumo de energía y mejorar la confiabilidad de la red eléctrica.
- **Respuesta a desastres naturales:** La supercomputación ha mejorado la respuesta a desastres naturales al proporcionar simulaciones en tiempo real de desastres naturales como terremotos y huracanes. Estas simulaciones pueden ayudar a los servicios de emergencia a planificar y ejecutar operaciones de rescate de manera más efectiva.

EuroHPC: towards European HPC technologies



EuroHPC-Ju members:

Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Montenegro, the Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and Turkey



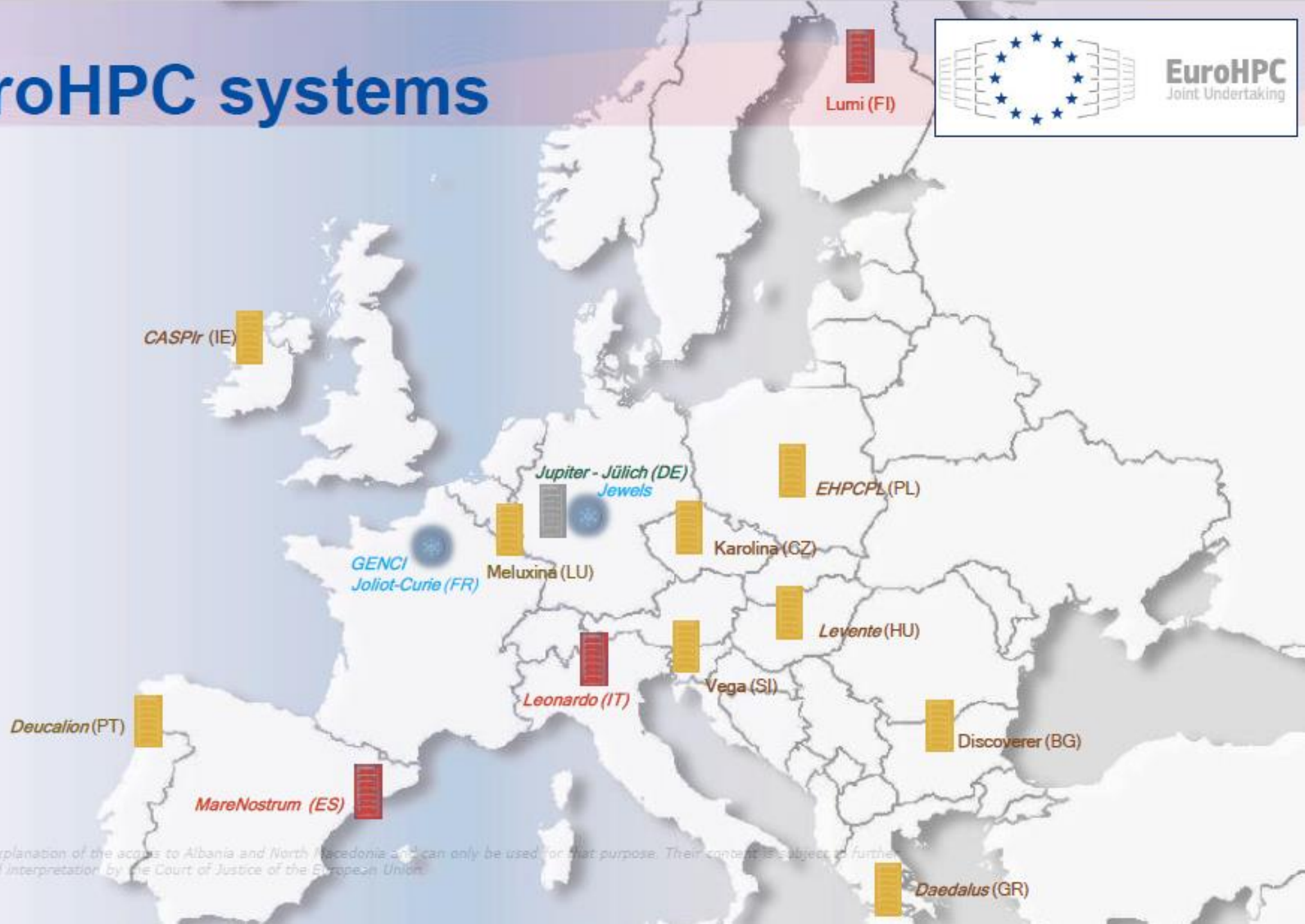
“A new legal and funding structure – the EuroHPC Joint Undertaking – shall acquire, build and deploy across Europe a world-class High-Performance Computing (HPC) infrastructure.

It will also support a research and innovation programme to develop the technologies and machines (hardware) as well as the applications (software) that would run on these supercomputers.”

EuroHPC systems



- Exascale
- Pre-exascale
- Petascale
- Qsimulator



GPP - General Purpose

Intel Sapphire Rapids

Peak performance: 45,4 Pflops
Sustained HPL: 35,4 Pflops

April 2023

NGT GPP - Next Generation

NVIDIA Grace

Peak performance: 2,82 Pflops
Sustained HPL: 2 Pflops

June 2023

MareNostrum5

InfiniBand NDR 200
Fat Tree

Spectrum Scale File System

248 PB HDD
2,81 PB NVMe
402 PB tape

January 2023

ACC – Accelerated

Intel Sapphire Rapids
NVIDIA Hopper

Peak performance: 260 Pflops
Sustained HPL: 163 Pflops

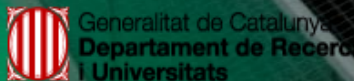
June 2023

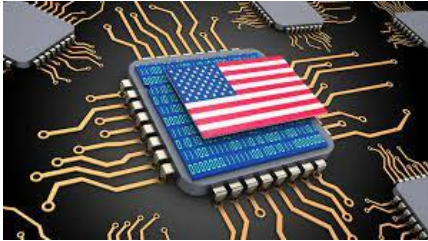
NGT ACC - Next Generation

Intel Emerald Rapids
Intel Rialto Bridge

Peak performance: 6 Pflops
Sustained HPL: 4,24 Pflops

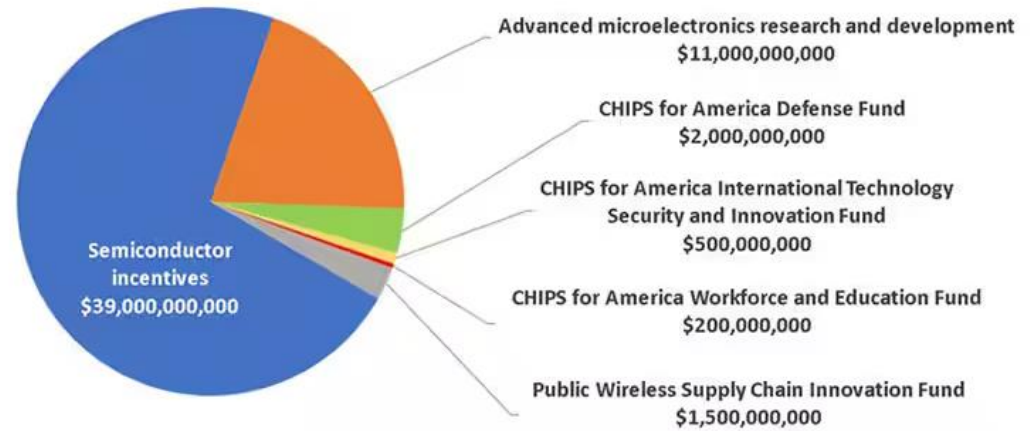
December 2023





CHIPS for America Act of 2022

39,000 M\$

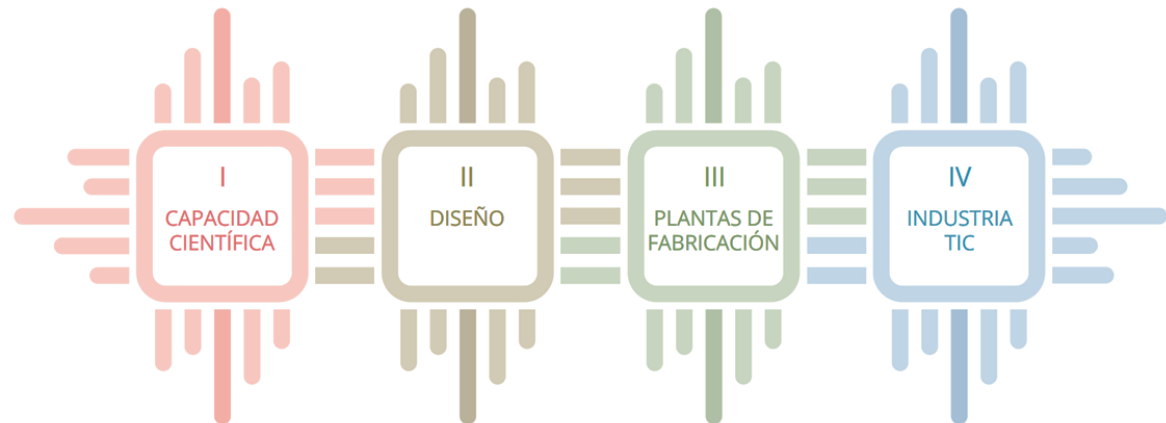


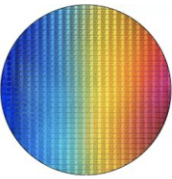
The EU CHIPS Act 2023 & Technological Sovereignty

43,000 M€



12,400 M€





La hoja de ruta de Chip BSC

Closed + Open

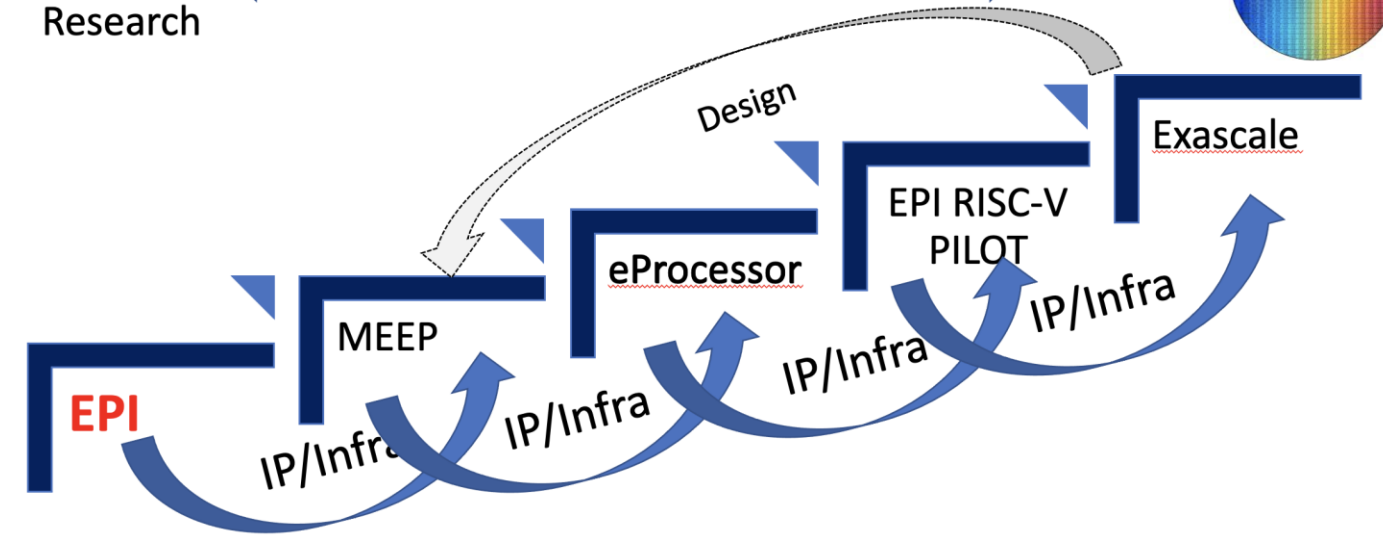
Open

Research

Accelerators

VPU EPAC V1.0

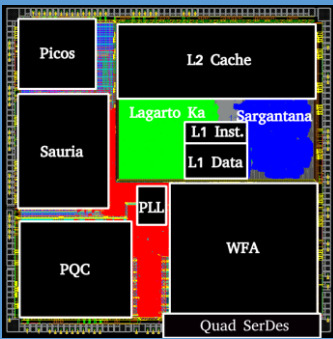
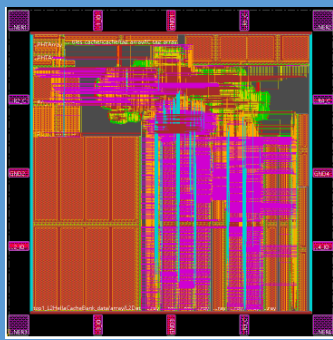
EPAC



Complexity

CPUs

Lagarto based cores evolution from Hun (in-order) to Ka (out-of-order)

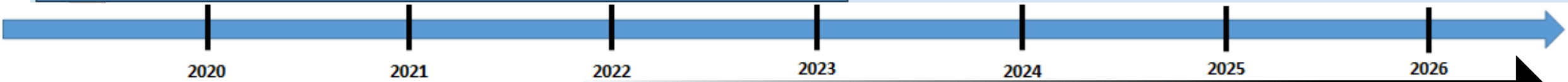


eP1

eP2

Ka2

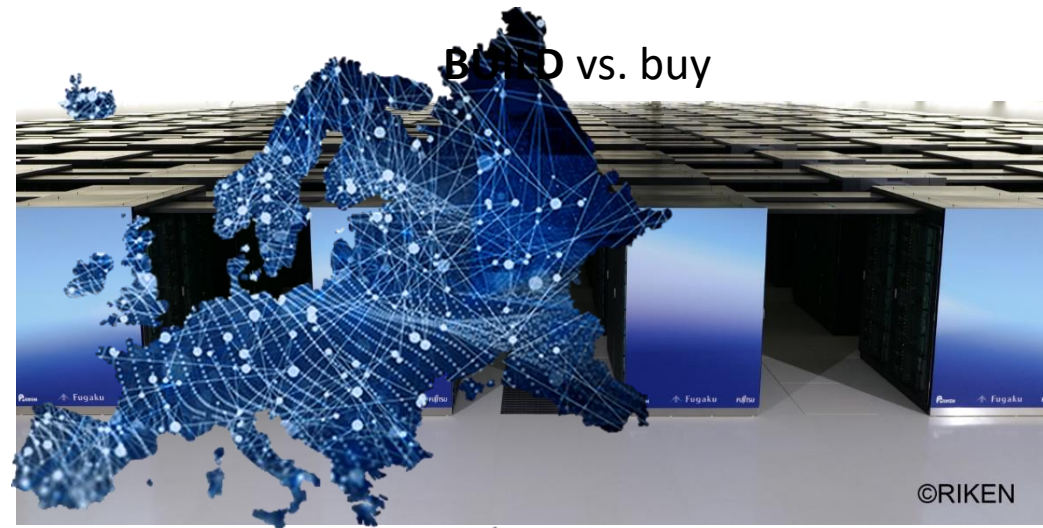
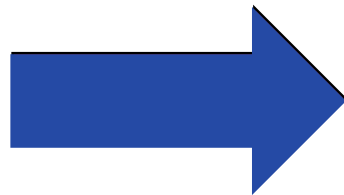
MT2



The BSC Vision of the Future of European HPC



MontBlanc @ BSC

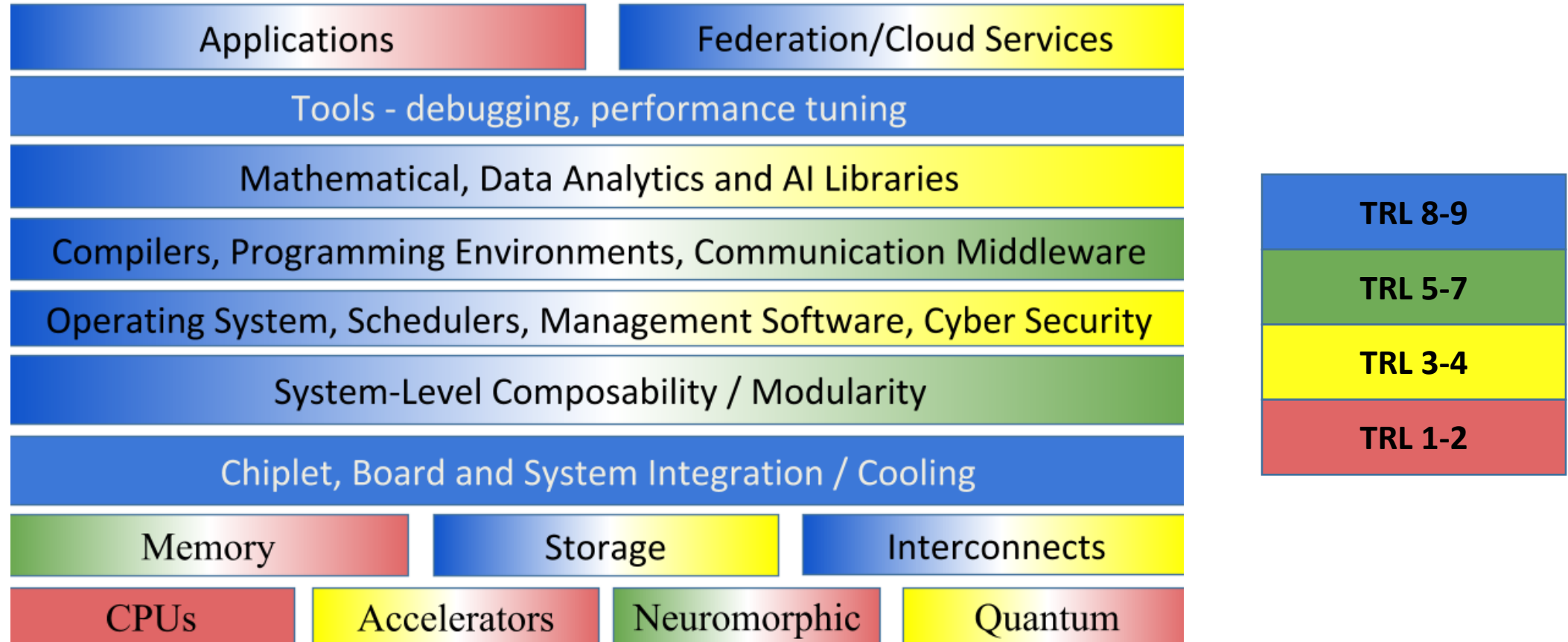


Fugaku #1 Top500 @ Riken for \$1B over 7 years (CAPEX)

MareNostrum6

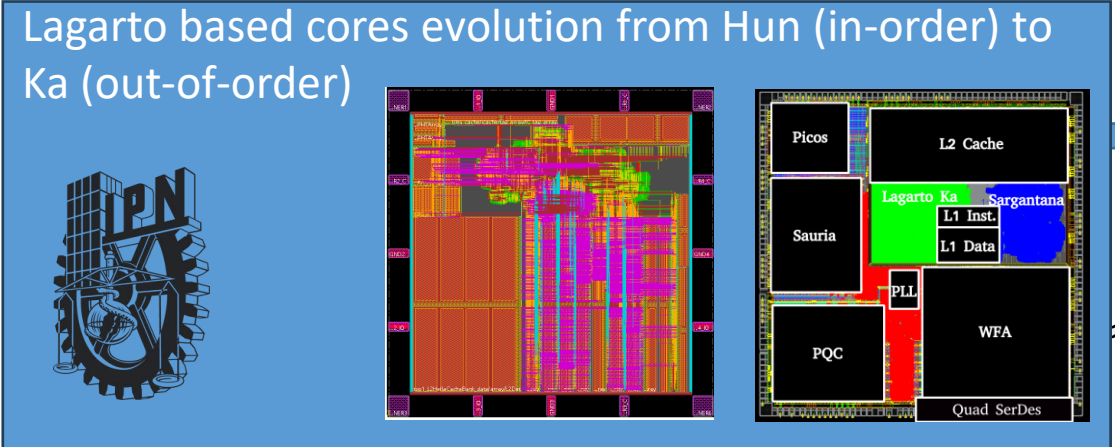
European Supercomputers @ Top500

RIAG: European Open System Stack Today

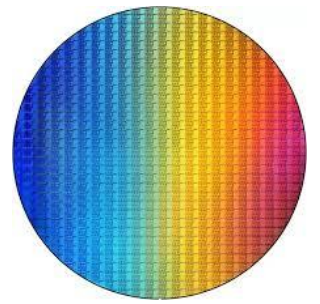


Rebuilding the European CPU Industry

Production



Open



Design

Exascale

EPI RISC-V
PILOT

eProcessor

MEEP

EPI

IP/Infra

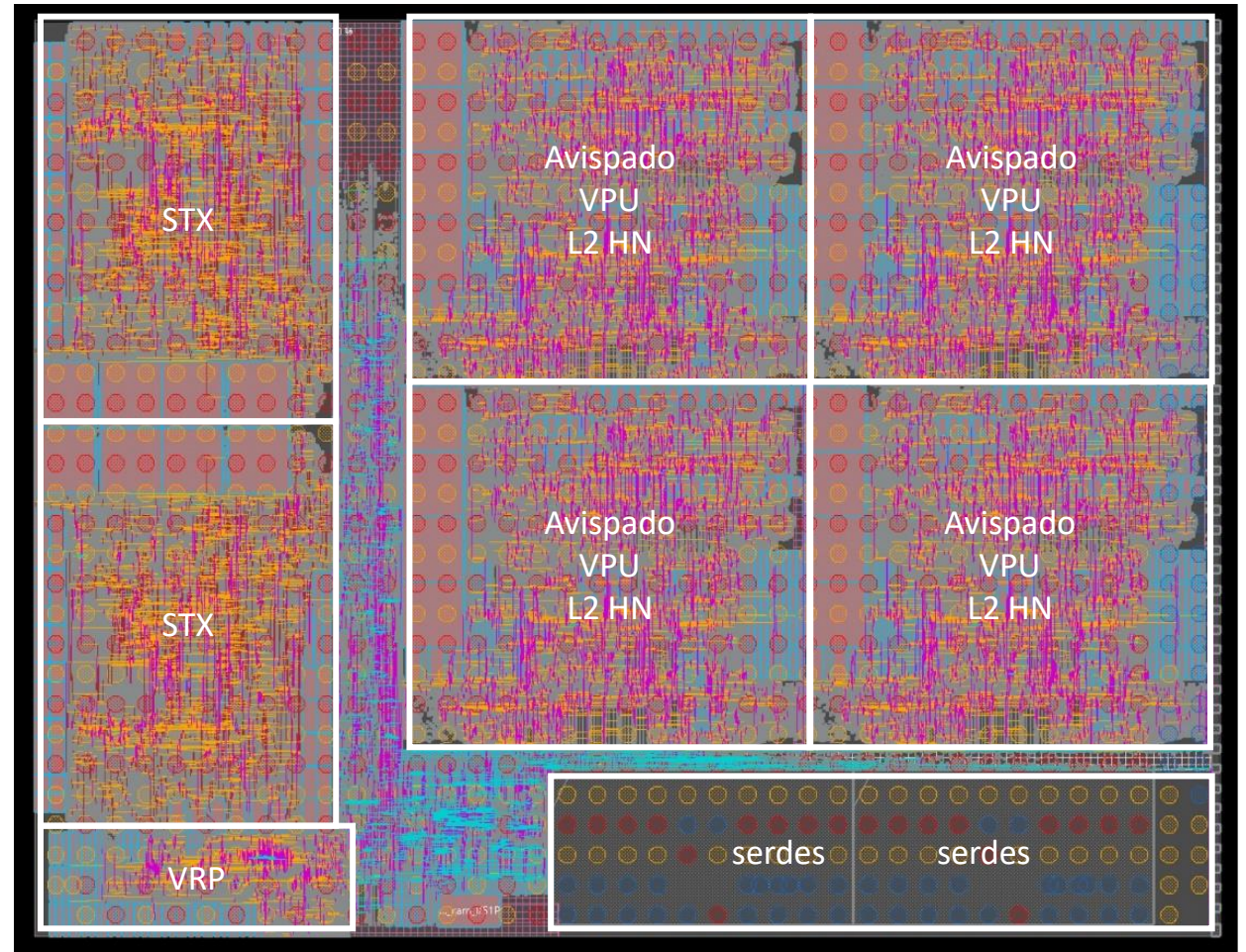
IP/Infra

IP/Infra

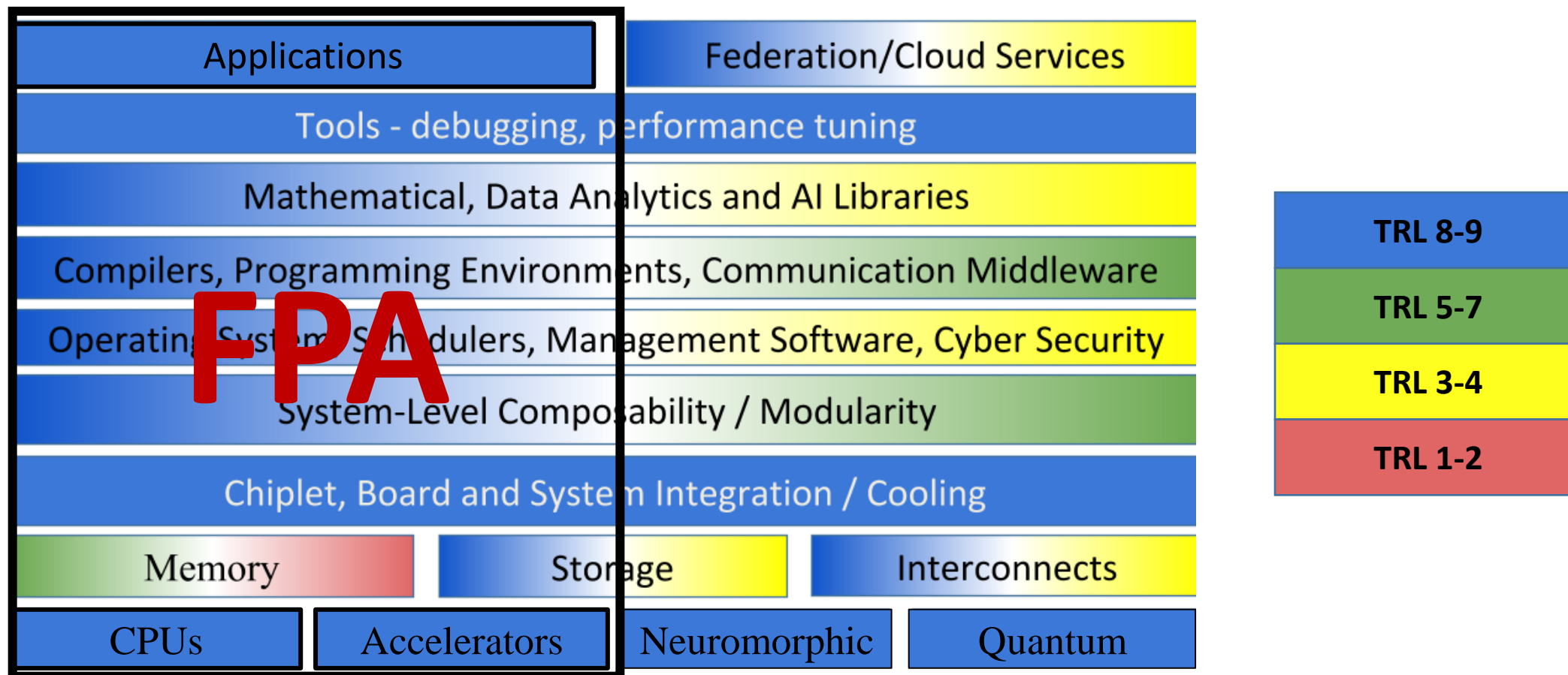
IP/Infra

EPAC V1.0, GF22FDX

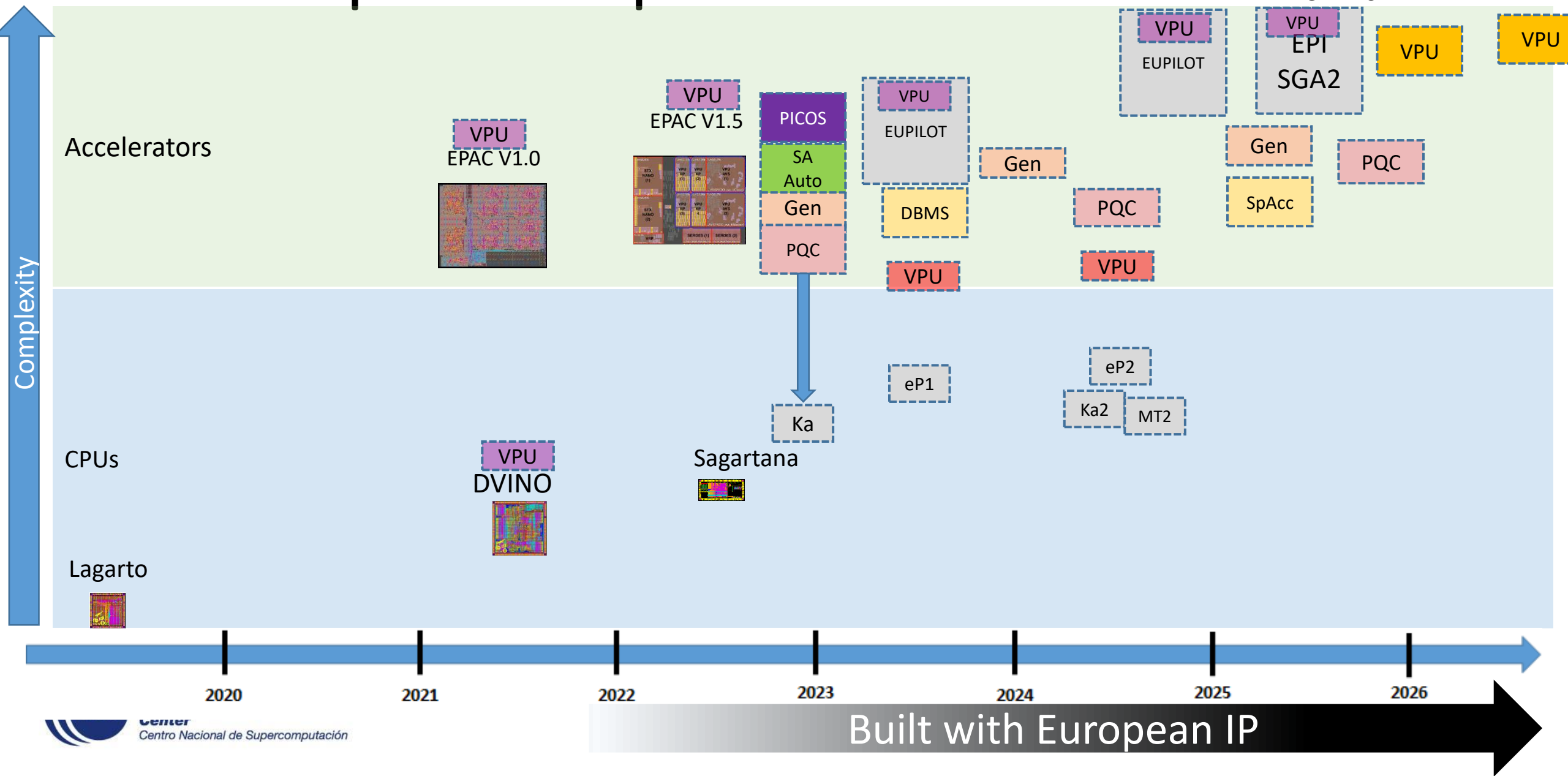
- Chip fabrication Q2 2021
- Final Top level chip floorplan
- Total area:
 - 5943 X 4593 μm^2
 - (27.297 mm^2)



Vision: European Open System Stack Tomorrow

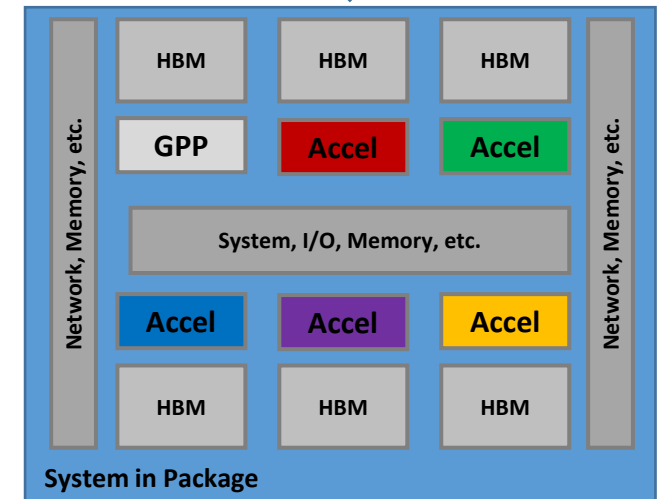
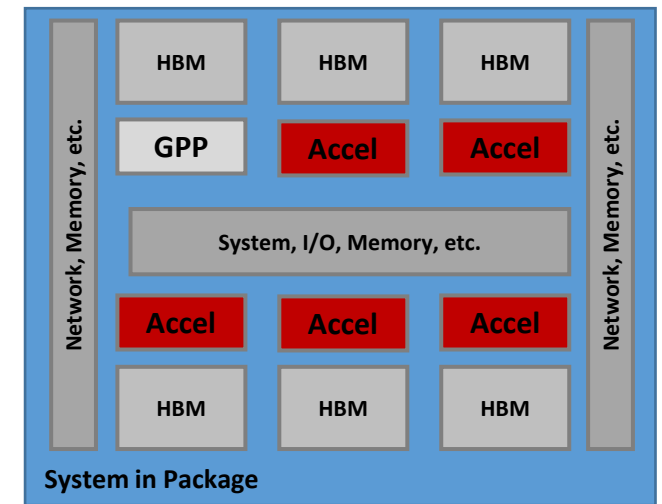
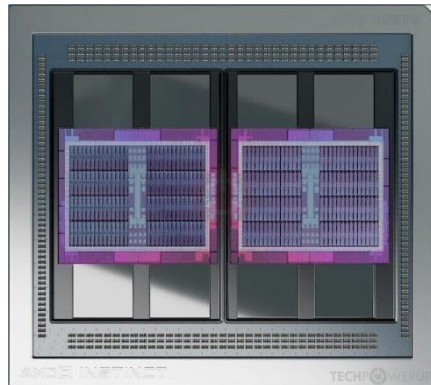
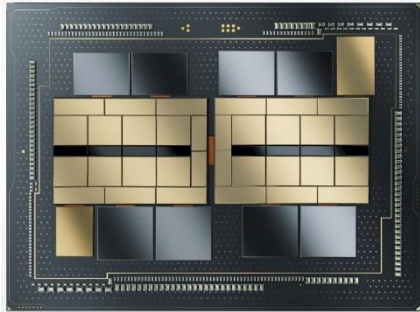


The BSC Chip Roadmap

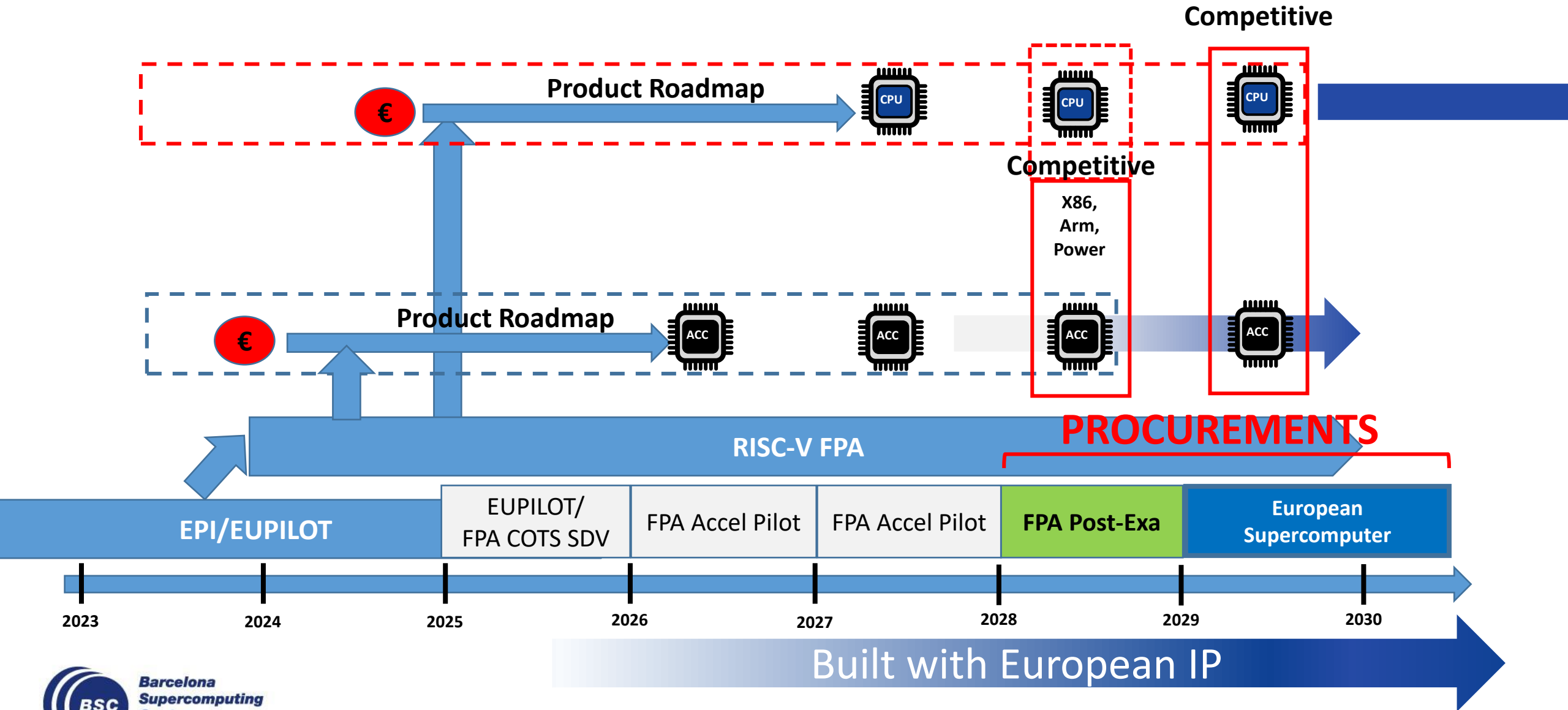


Future European System in the Package(s) (SiP)

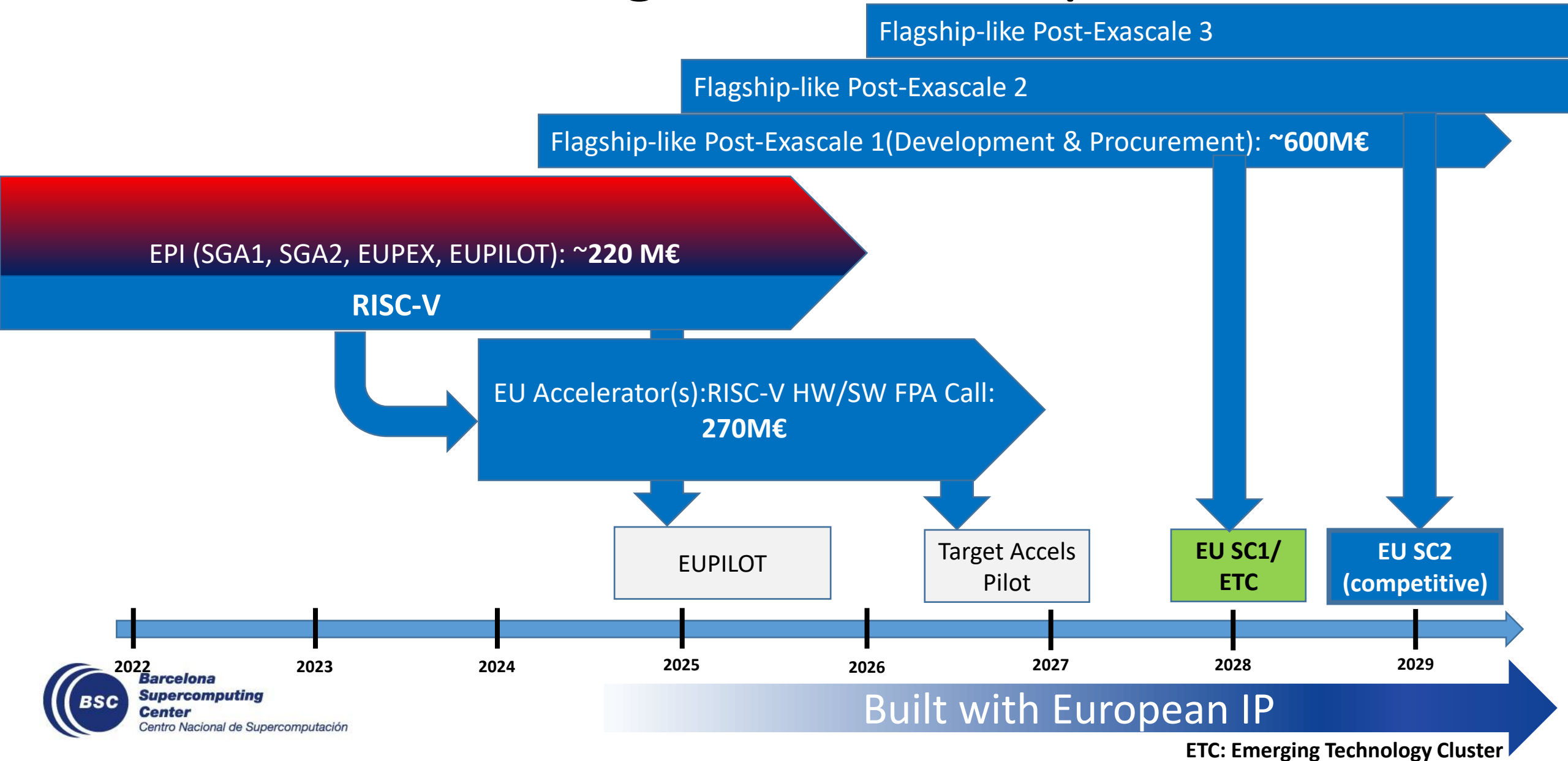
State of the Art
(US&China)



Ideal RISC-V Timeline for EU Supercomputer



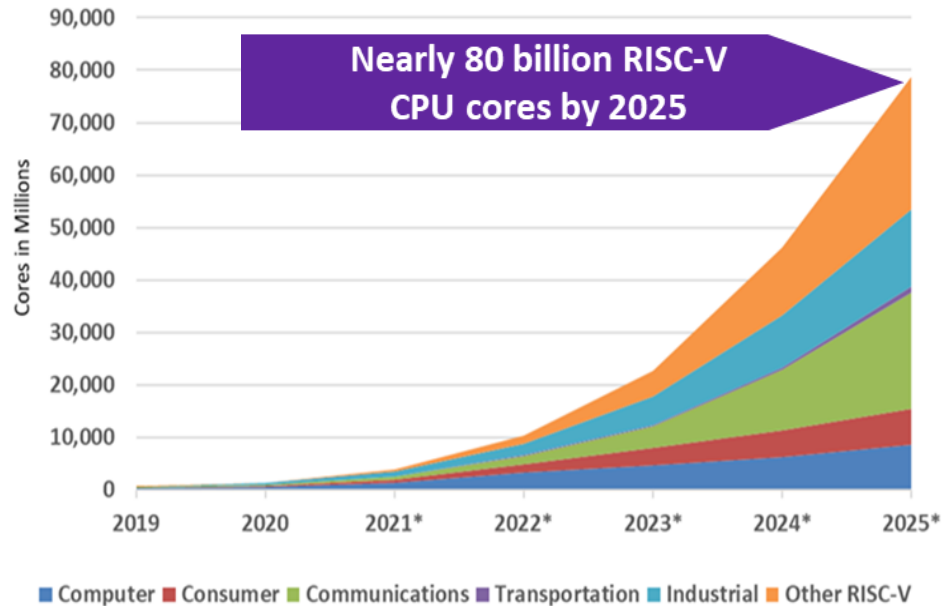
Possible EuroHPC Long Term Roadmap



Openchip

A **fabless** semiconductor company building **RISC-V** based **High Precision, High Performance Accelerators** targeting **HPC and adjacent Enterprise AI/ML/DL** real world workloads with dense and **sparse access patterns**.

We have a unique opportunity that we must seize

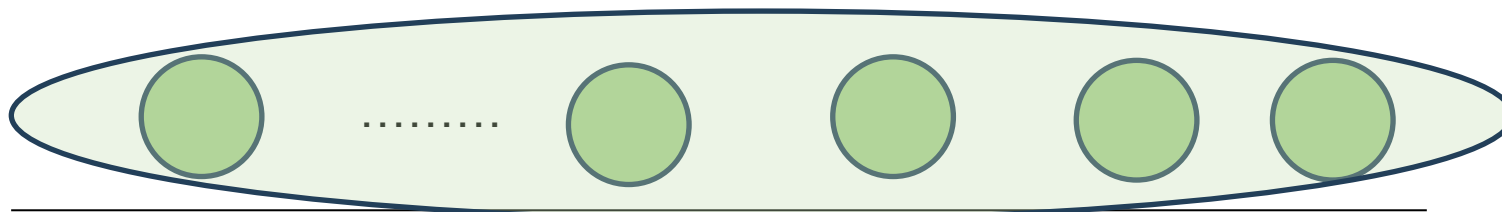


Reissuing a Successful Strategy :
 Linux: Open Software → RISC-V :Open Hardware

RISC-V is the opportunity to **position our country as a chip design powerhouse** and reduce our current heavy technological dependence

We need to create a new generation of chip designers, for that we need **to put universities at the heart of strategic training plans**. To fulfill this mission, we have created the association **SOHA (Spanish Open Hardware Alliance)**

SOHA : Spanish Open Hardware Alliance



Universities offering education on computer architecture and technology.

27 universities and 3 research centers will join forces to share proposals and coordinate activities. Several working groups have already started .

- **Without universities, there is no talent nor chips.**
- Our ecosystem is emerging and dispersed, **collaboration rather than competition** should be encouraged.
- We need to create the entities and coordination mechanisms that allow us to **influence the academic and industrial context** in an efficient and agile way.

Intel Labs Barcelona are back!



- New joint Intel – BSC Laboratory to design HPC processors based on RISC-V technology
- Funding: 400M\$ in the next 10 years. Headcount: ~200 (estimated)

Other companies will also come to Spain!

RISC-V has the opportunity to be like Linux. It would be global and go beyond Airbus and Galileo!



EuroHPC
Joint Undertaking





**Barcelona
Supercomputing
Center**
Centro Nacional de Supercomputación

THANK YOU!

mateo.valero@bsc.es