EUROHPC SUMMIT 2024

ANTWERP

UNLEASHING THE POWER OF EUROPEAN HPC AND QUANTUM COMPUTING

European Industrial HPC Resources: Needs & Opportunity

HPC in Pharmaceutical Industry

Andrea R. Beccari

Vice President EXSCALATE, Dompe Farmaceutici spA

*

Pharma R&D Effectiveness

Clinical Development Failure Rate

> 90%

Treatment Efficacy

4% - 60%

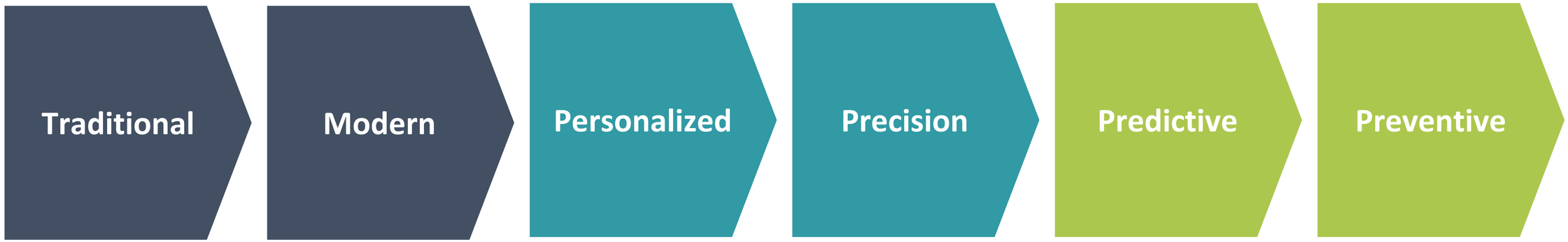
1.1 Trillion Euro Market*

Evolution of Medicine

(Clinical) Trial
&
Error

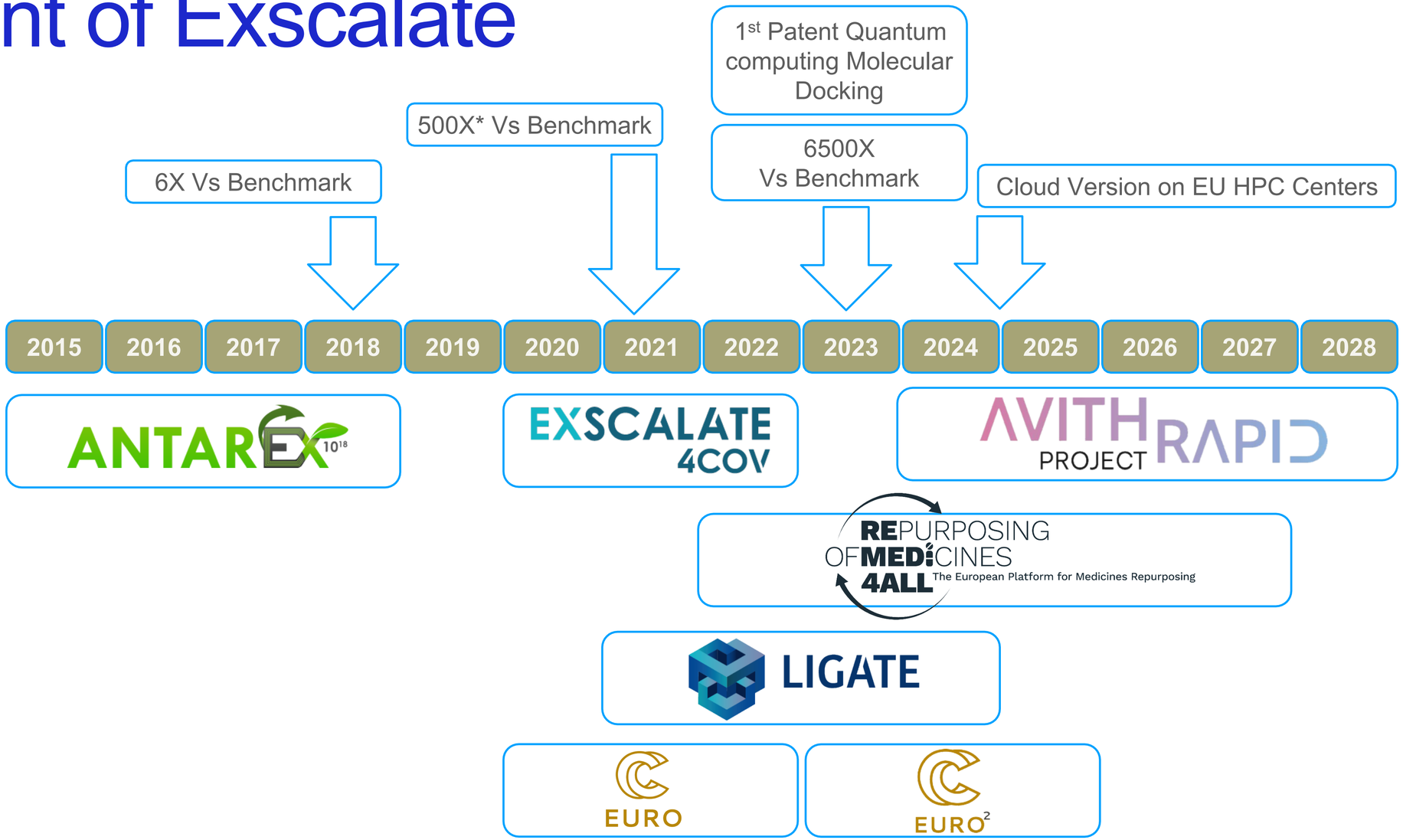
disease treatment that considers individual variability in genes, environment, and lifestyle for each person

Identify patients at risk of developing a disease, thereby enabling either prevention or early treatment of that disease



Patients in clinical trials	Real World Patients	Whole Population
Statistics	Qualitative Modelling	Quantitative Modelling
Information	Interpretation	Prediction

Horizon funding accelerates the development of Exscalate



Benchmark : Supercomputer-Based Ensemble Docking Drug Discovery Pipeline with Application to Covid-19 - 2020 [SUMMIT supercomputer + IBM + NVIDIA]

Unlock AI potentiality for EU (Pharma Industry)

Are we constructing the necessary frameworks to facilitate FAIR principles in healthcare data management?

Is a single EU framework being established for the secondary utilization of health data?

Are we organizing semiconductor investments to boost the EU's competitive edge?

Are we investing sufficiently in High-Performance Computing (HPC) centers to meet the needs of industrial applications?

Should open-source software be a prerequisite for obtaining industrial grants?

Are we nurturing public-private partnerships within the EU to propel the development of generative AI architectures and targeted training programs?

FAIR (findable accessible interoperable and reusable)

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Thank you for your kind attention !!!!

FOCUSED ENERGY

Creating the Power of the Stars on Earth

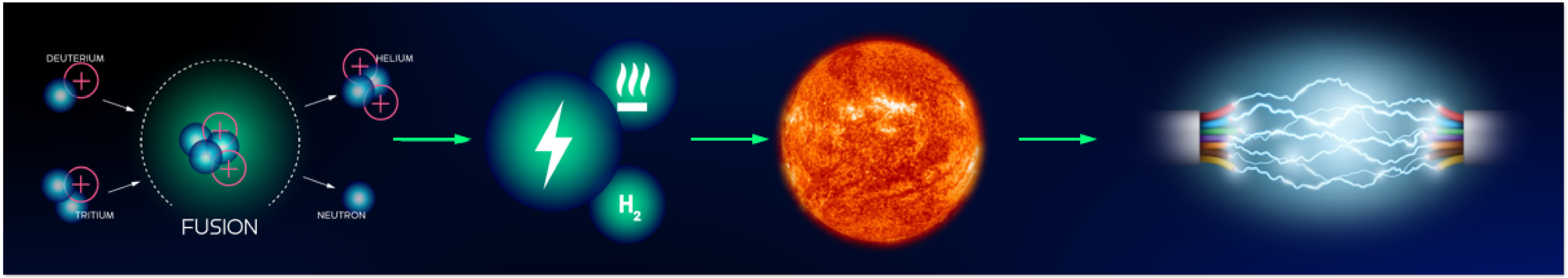
Dr. Valeria Ospina-Bohórquez
Scientist

EURO HPC Summit 2024
Antwerp, Belgium
18 – 21 March

The solution is fusion

FOCUSED ENERGY

FUSION is when light nuclei are merged into heavier nuclei which results in large releases of energy.



How do we create the power of the stars on Earth?

The NIF shots changed the world

August 8th, 2021

Singular scientific event that changed commercial viability of IFE

>1.3 MJ of fusion yield was produced

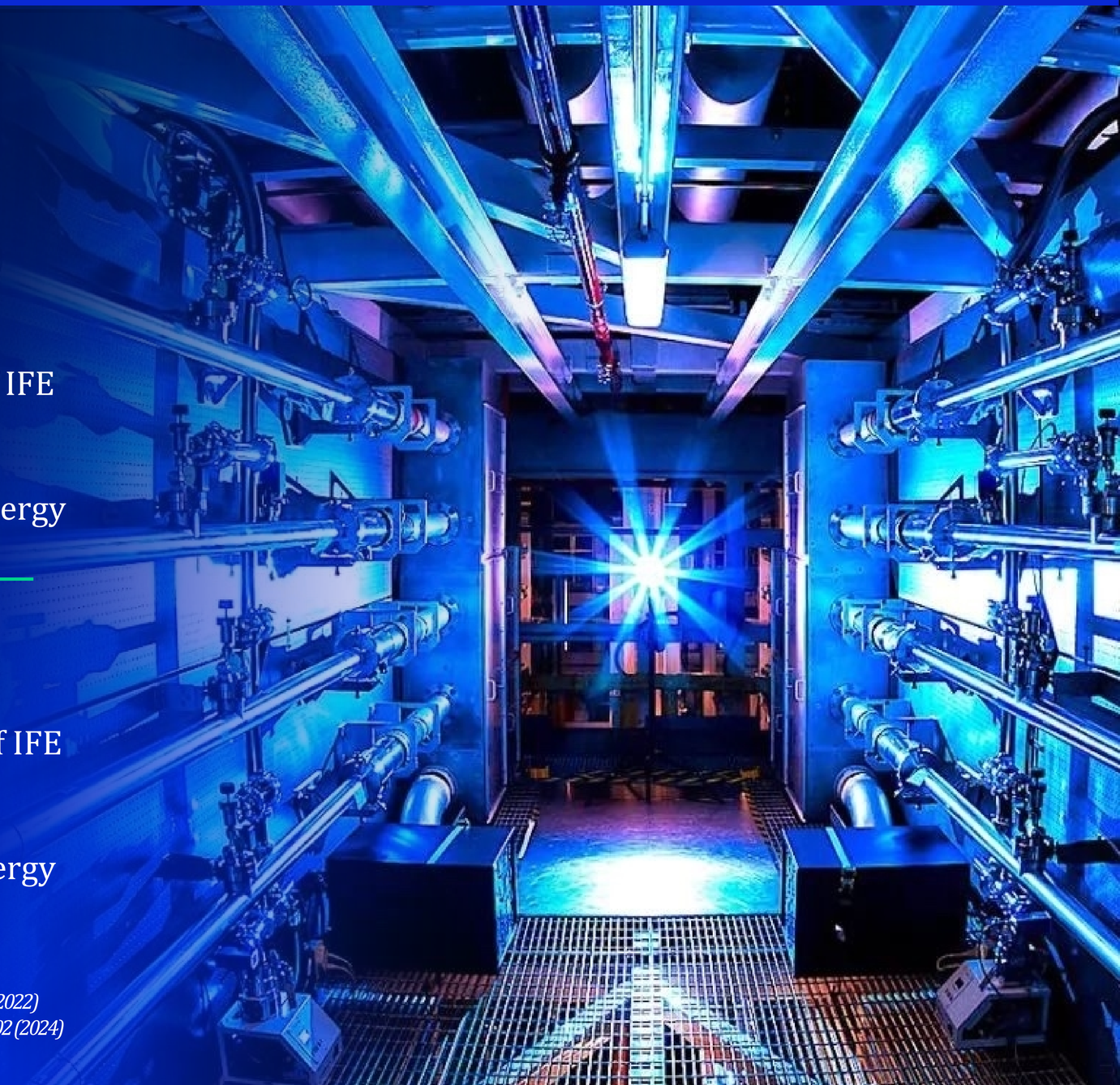
70% conversion of laser energy to fusion energy

December 5th, 2022 [1,2]

Singular scientific event that changed commercial viability of IFE

> 3.1 MJ of fusion yield was produced

150 % conversion of laser energy to fusion energy



[1] Abu-Shawarebet al, "Lawson Criterion for Ignition Exceeded in an Inertial Fusion Experiment", Phys. Rev. Lett. ***129****, 075001 (2022)*
[2] Abu-Shawarebet al, "Achievement of target gain larger than unity in an inertial fusion experiment", Phys. Rev. Lett. ***132****, 065102 (2024)*

A power plant will need higher gain and higher robustness compared to NIF

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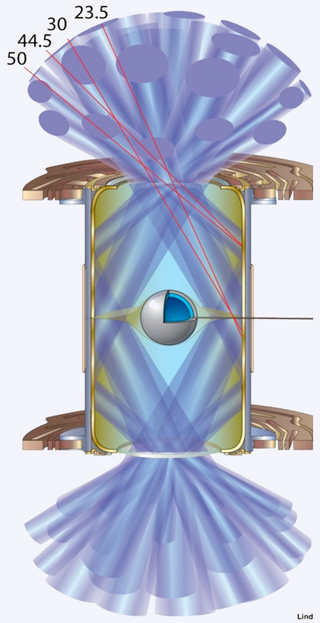
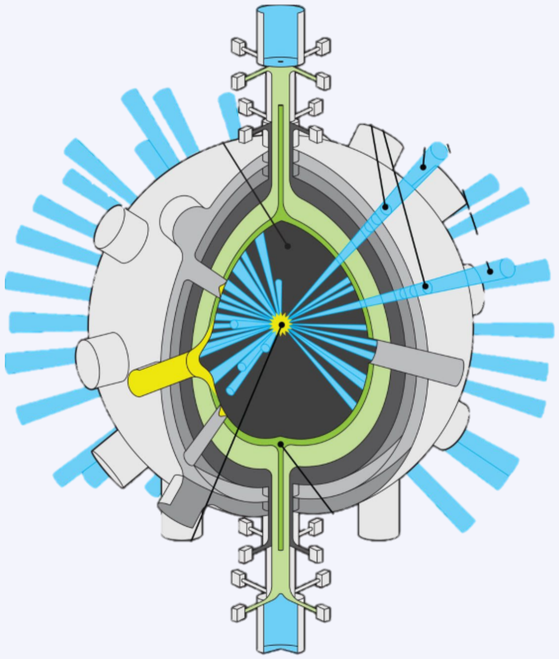
NIF IGNITION

Gain ~ **2x**
Single shot



Higher gain and physical robustness

INERTIAL FUSION ENERGY



Gain ~ **100x**
10 Hz

Focused Energy was founded in July 2021

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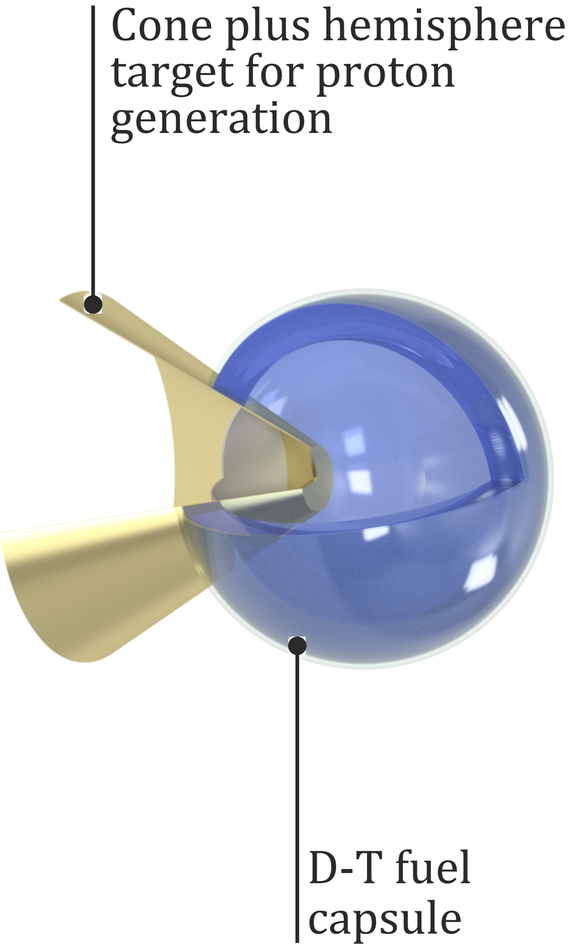
Our goal is to develop and build a Fusion Power Plant by the end of the 2030s, based on an advanced inertial confinement fusion concept called PROTON FAST IGNITION (PFI)

Inertial Fusion Energy (IFE)

FOCUSED ENERGY

Focused Energy is centered on proton fast ignition as our approach to IFE.



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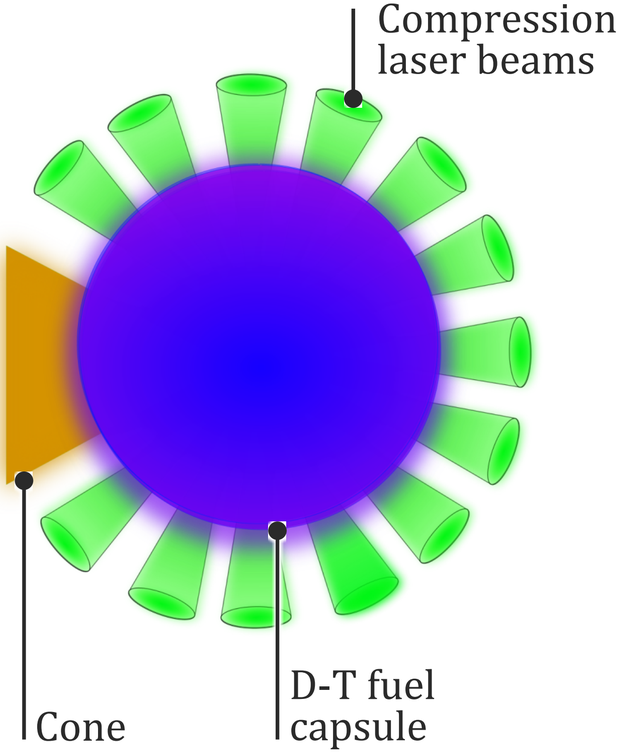
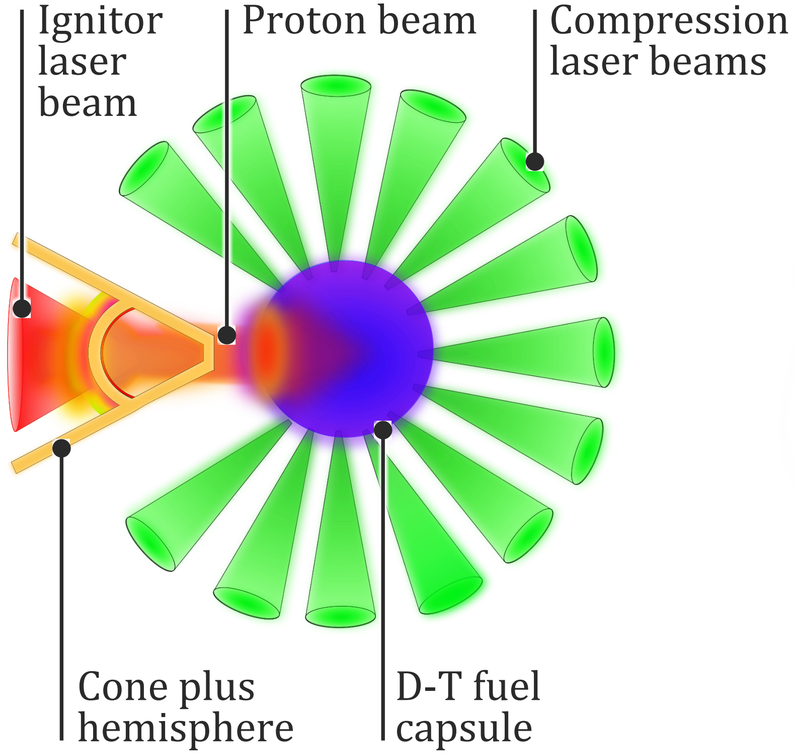
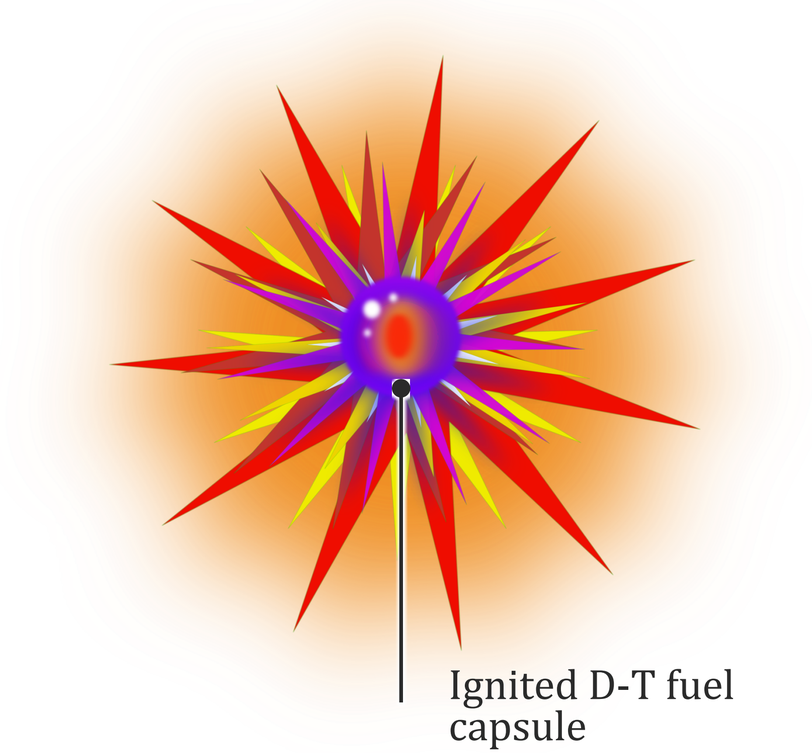
Proton Fast Ignition

In PFI we separate the compression from the ignition phases of the D-T fuel capsule.

1. Compression of the D-T (hydrogen) fuel
2. Ignition and burn of the compressed fuel with a proton beam
3. Ignition = Energy to be harvested

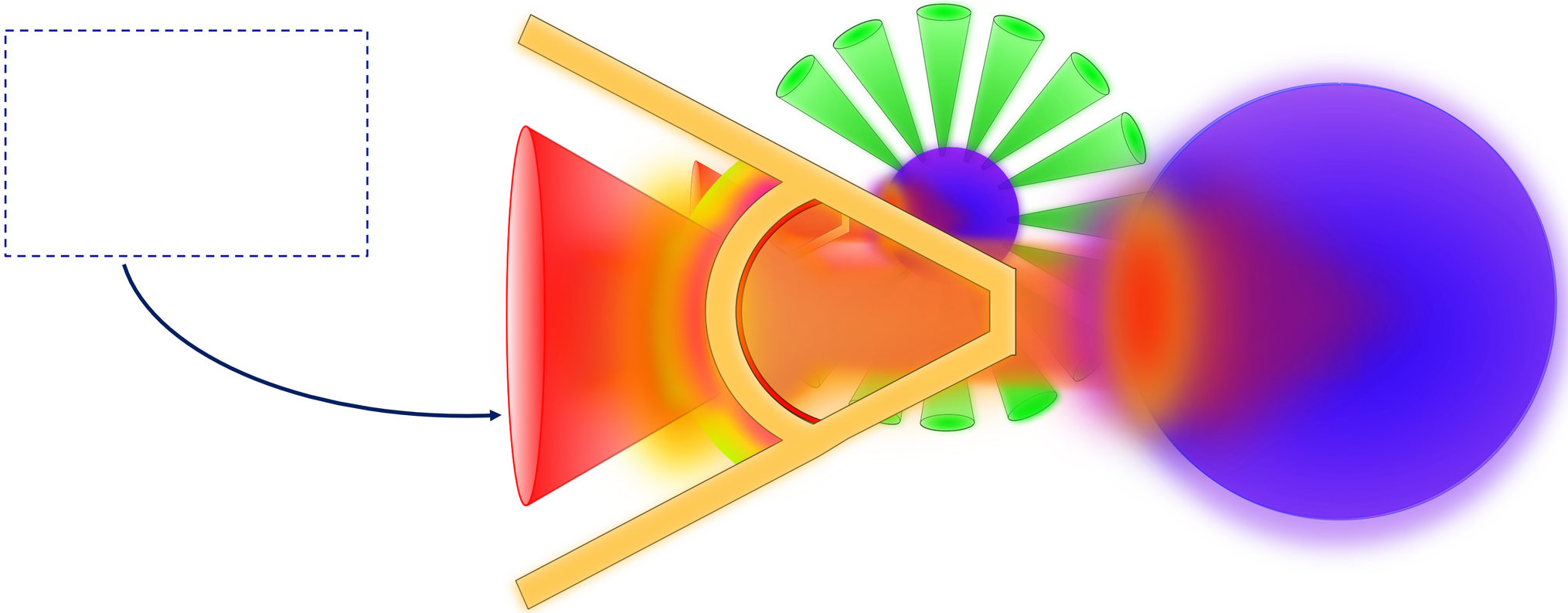






HPC resources are fundamental for us

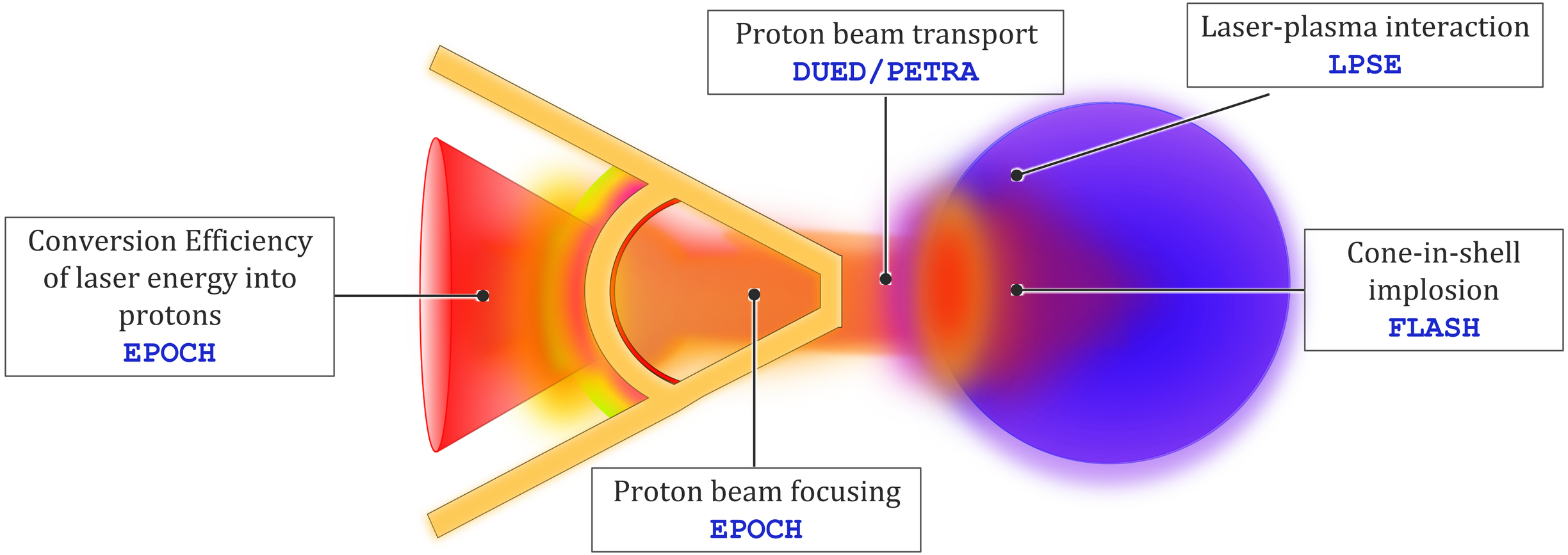
FOCUSED ENERGY



HPC resources are fundamental for us

FOCUSED ENERGY

We use state of the art computational codes to simulate the physics involved in many of these processes.

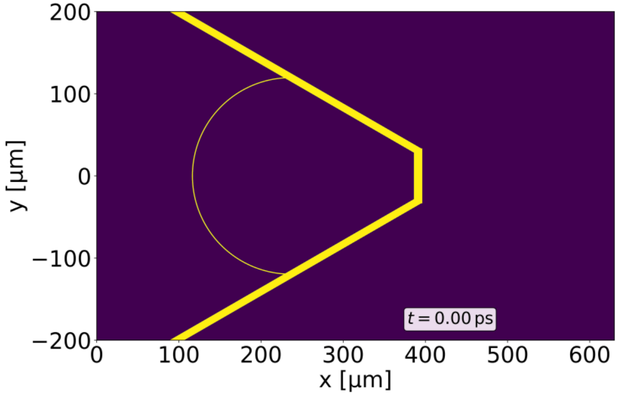


HPC resources are fundamental for us

HPC access through EuroHPC is helping Focusing Energy to tackle these computational challenges.

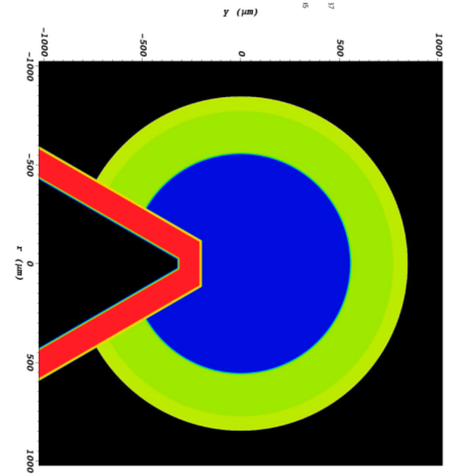
HPC Vega, IZUM, Maribor
28 M core-hours*

Proton acceleration from hemispherical foils simulated with the particle-in-cell kinetic code **EPOCH**



Karolina supercomputer
IT4Innovations, Ostrava
13.4 M core-hours*

Spherical implosion of a cone -in-shell D-T (hydrogen) target simulated with the hydrodynamic code **FLASH**



FOCUSED ENERGY

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ANIMATION goes HPC

Calculating high end images for animated movies on an HPC

Holger Weiss , CEO of M.A.R.K.13- Group

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ANNOTATION

ANIMATION goes HPC

Rendering state of the art images for animated movies

ANIMATION goes HPC

Who is M.A.R.K.13

- Animationstudio based in Stuttgart/ Germany
- Founded 25 years ago
- Producing our 15th animated feature movie and TV series (Maya the Bee, Vic the Vikking, Giants of La Mancha etc)

ANIMATION goes HPC

- **Why do we render on the HLRS (HPC in Stuttgart)**
  - Complex high end, contemporary images to calculate
    - High usage of data IO
    - Huge rendertimes on conventional renderblades (1h to 0,2h)
    - Rendering in Time (huge resources of CPU power)
    - Excelent Support and high Data- Security
      - Development of Tools and Apps for the HPC to optimize the Pipeline by MSC (Media Solution Center)

ANIMATION goes HPC

Rendering state of the art images for animated movies

Showreel

ANIMATION goes HPC

Rendering state of the art images for animated movies

Trailer
Giants of LaMancha

Slide Title

- Body Level One
  - Body Level Two
    - Body Level Three
      - Body Level Four
        - Body Level Five

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Navigating the New World of HPC...and AI...and Quantum...and Clouds...

Bob Sorensen
Senior Vice President of Research
Hyperion Research, LLC

UNLEASHING THE POWER OF EUROPEAN HPC AND QUANTUM COMPUTING

bsorensen@hyperionres.com

March 20, 2024

The HPC Landscape is Undergoing Significant Changes

- Multiple Developments Are Significantly Altering the Overall HPC Landscape
  - Applications in machine learning and deep learning
    - Generative AI is a near-term game changer
  - Computing at the edge
    - Supporting real-time decision making
  - CSP's HPC-related impact
  - End user decisions for On-Premises vs. Cloud vs. Hybrid
  - Dark HPCs on the horizon
  - Quantum computing making strides
  - Traditional modeling and simulation remains crucial

One Size No Longer Fits All

- HPC systems are becoming more complex due to the diverse workloads they are required to address
  - Variety in workloads demand variety in architecture
  - Accurately charactering workloads in an imperative, and simple benchmarking is no longer enough
- Happily, there are technical options to address this
  - Trends are moving away from monolithic architectures built around a single base of processors and accelerators towards a more flexible, heterogenous design consisting of multiple hardware partitions or multiple systems
  - Each partition can be uniquely configured to address key workloads spanning processors, accelerators, memory and storage schemes, programming styles, and associated software suites
  - Sampling of options for underlying computational engines
    - Processors: x86, ARM, RISC-V
    - Superchips: Nvidia Grace Hopper, AMD MI300
    - Accelerators: Nvidia Hopper, AMD MI300, and AI-centric Habana, Graphcore, Cerebras, Sambanova, Cambracon

Different Workloads/Different Solutions

HPC Use Case Characteristics/Use Cases	Modeling/Simulation	Big Data/Data Science	AI: Large Language Models	Cloud-based HPC
Data Format	64-bit floating point numerical formats	64-bit floating point or integer data format	Low, mixed, or AI-specific precision formats	Variable formatting
General Code Characterization	Mix of both parallel and serial codes	Primarily parallel codes suited to cluster architectures	Distributed parallel codes, tightly coupled compute engines	Favors either small serial or large task parallel codes, loosely clustered systems
Processor and Accelerator Configuration	High core count CPU-based, GPUs support/augment CPU computation	High GPU counts, CPU managed data flows	Emphasizes GPU or related AI-specific accelerators, strong GPU-GPU interactions	Flexible node configurations of CPU/GPU/Accelerators, both virtual and bare metal options
Data Storage	Consistent, uniform storage formats, typically with large file size and consistent storage access patterns	Varying data storage formats: text, semi-structured data, structured data, binary, random data access patterns	Large numbers of small read-only files, multiple re-read iterations during training, high rate of data reuse	Supports multiple instances of varying storage configurations. Can be geographically distributed
Job Characterization	Small data input, compute intensive, large data output	Large data input, processes data at high velocity, small data output	Significant aggregate Flops count, large data input, matrix operation intensive	Wide job specifics addressable by both virtual and bare metal options
Exemplar Software	C++, Fortran, MPI	Python, Java, R, Scala, MATLAB	BERT, GPT, Megatron-Turing	Docker, Fargate, Kubernetes
Data Characterization	Program accuracy dependent on empirical validation/verification process	Verifiable data with strong statistical underpinnings	Dependent on existing training data availability/validity	Data physical location affects data size, access, performance, and price

Source: Hyperion Research, 2024

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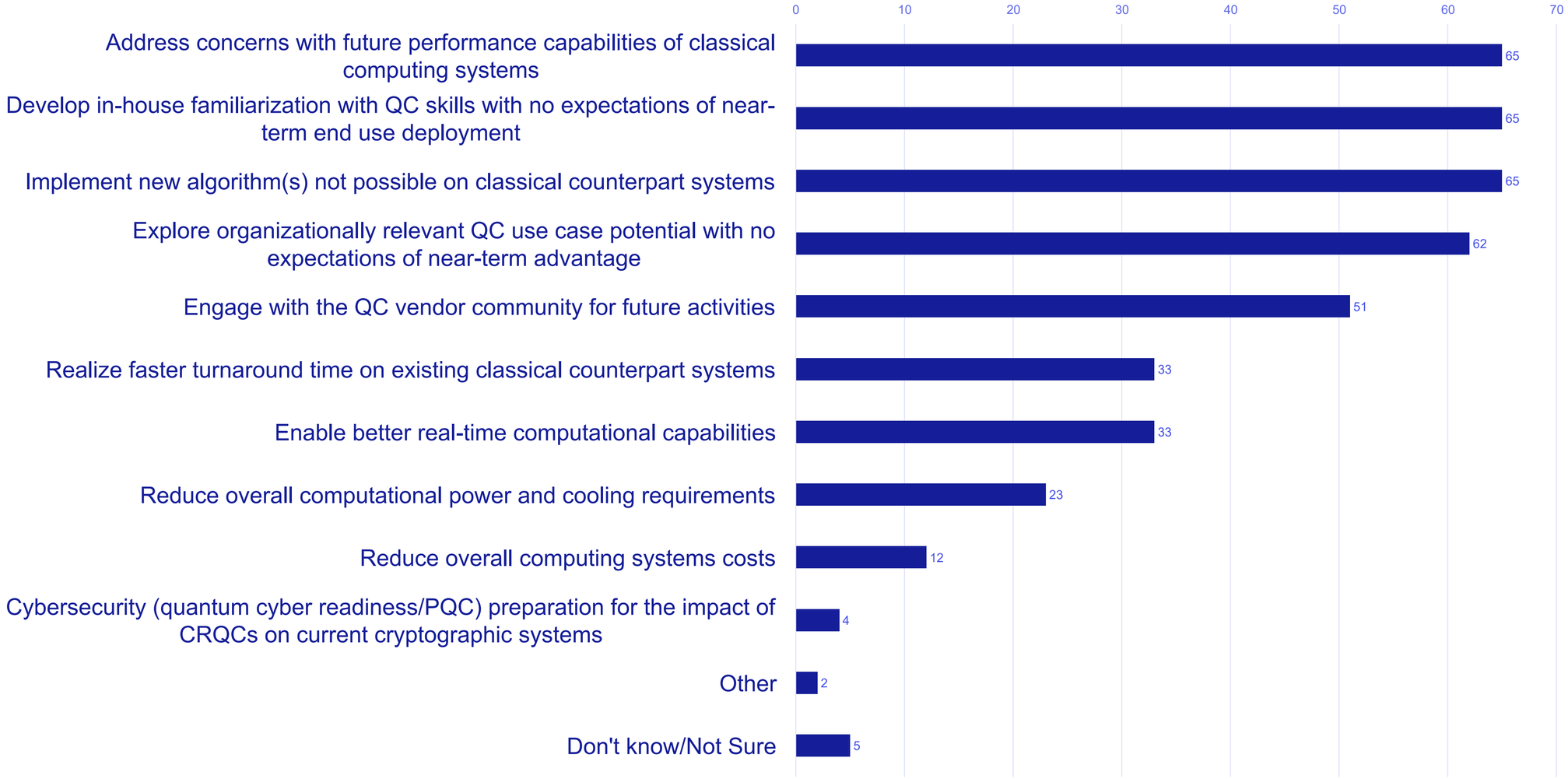
ANTWERP 18–21 MARCH

TO EXASCALE AND BEYOND

QC 2026: QC End User Perceptions



EuroHPC Joint Undertaking

beEU belgium24.eu

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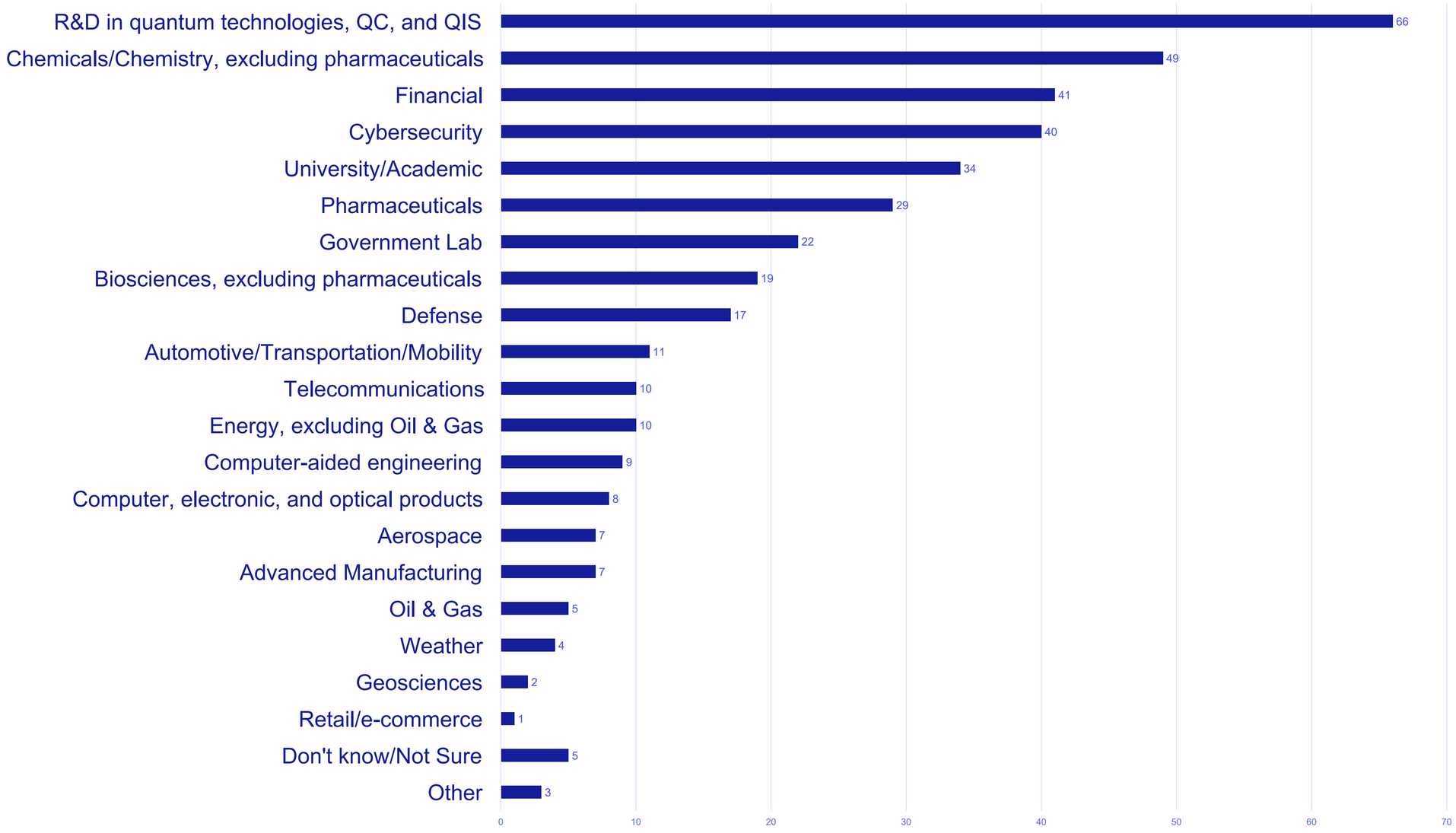
TO EXASCALE AND BEYOND

QC Market 2026: Top End User Sectors



EuroHPC Joint Undertaking

beEU belgium24.eu

Summary of HPC-related LLM-related Activities

	Currently	Next 12-18 months	Change Over Time
Exploring the range of potential performance enhancements by integrating LLMs into existing HPC-based workloads	58%	48%	-10%
Exploring in-house requirements for integrating LLMs into HPC-based workloads	55%	51%	-4%
Testing/assessing LLM-integrated workload performance	34%	45%	11%
Procuring access to necessary LLM software	31%	31%	0%
Reaching out to LLM hardware and software suppliers for information	30%	35%	5%
Passively monitoring LLM technology developments	27%	14%	-13%
Procuring access to necessary LLM hardware	26%	28%	2%
Standing up limited LLM-integrated pilot programs	26%	36%	10%
Porting LLM capability into existing workloads	25%	34%	9%
Running production level LLM-enabled workloads	22%	50%	28%
Standing up a fully funded LLM research efforts	17%	27%	10%
No current activity	1%	0%	-1%
Other	1%	0%	-1%

N = 100, Respondents could select multiple options.

Source: Hyperion Research, 2023

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ANTWERP 18-21 MARCH

TO EXASCALE AND BEYOND

Thanks

- Questions and comments are most welcome and can be sent to

bsorensen@hyperionres.com

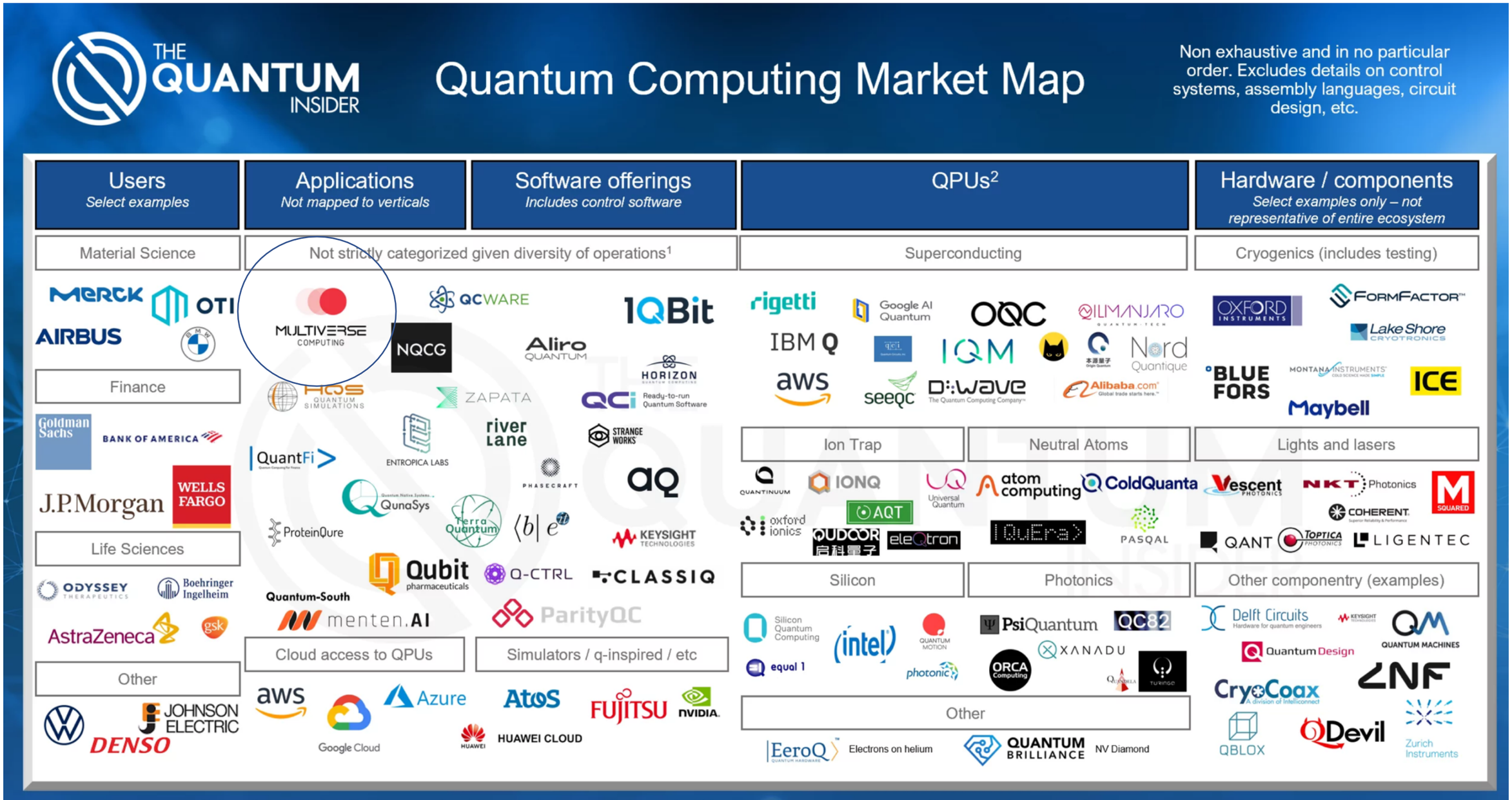
EuroHPC Joint Undertaking

beEU belgium24.eu

MULTIVERSE

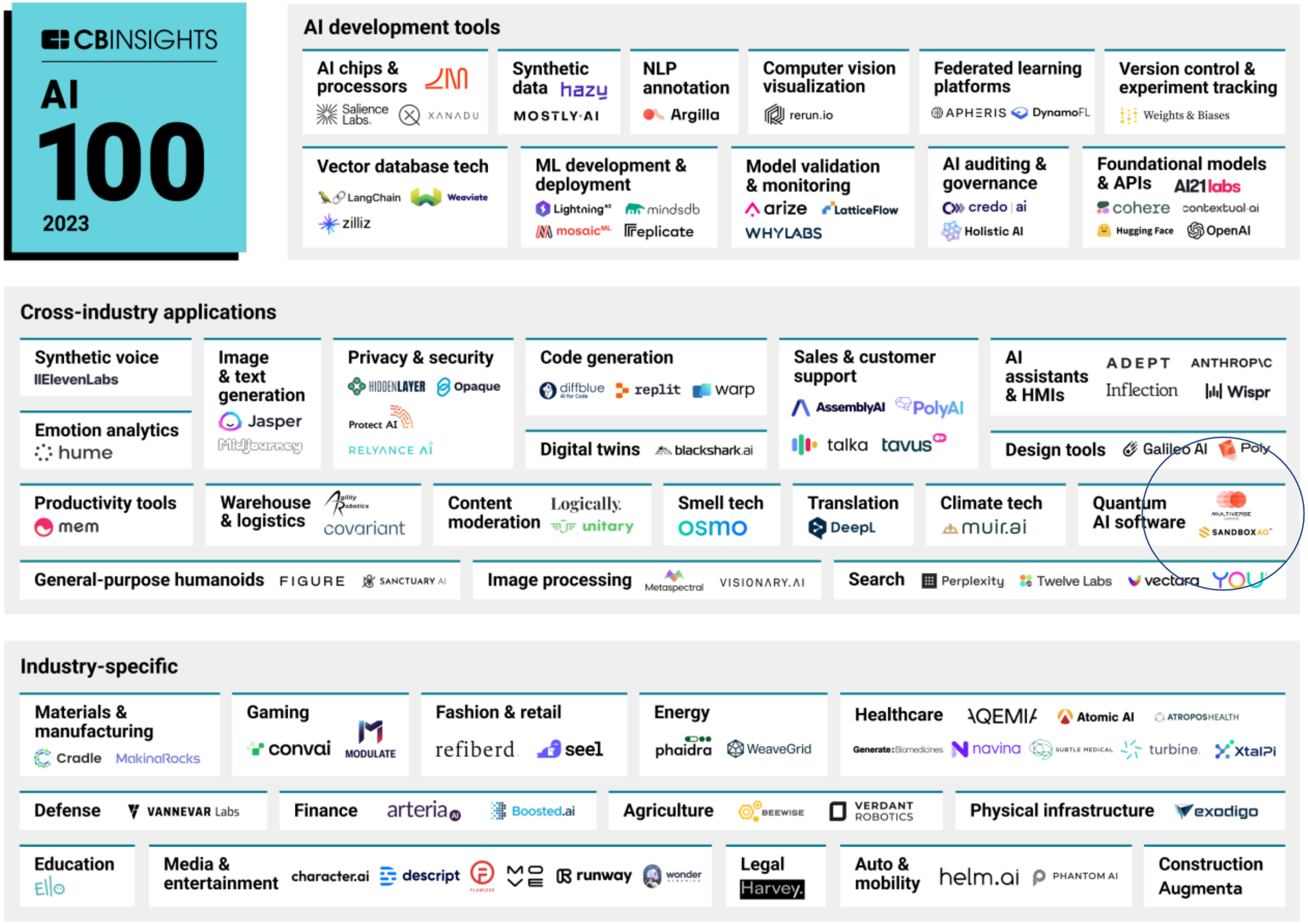
The largest Quantum Software company in the EU
One of the 100 most promising AI companies in the world in 2023 (CB Insights)

In just four years, a Spanish company called Multiverse playing in the strategic Quantum Computing field….



…cited as one of the most promising 100 artificial intelligence startups of 2023….

CB INSIGHTS
AI 100
2023

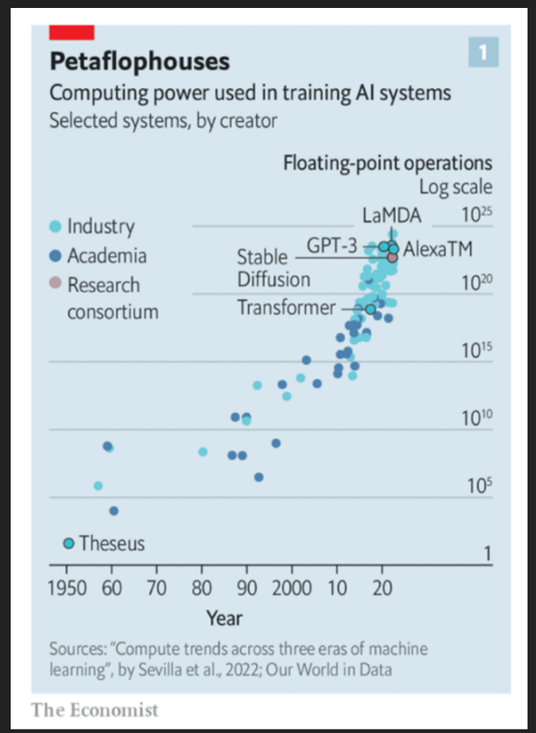


Note: Companies are private as of 6/20/23.

CB INSIGHTS

First, because there are two kind of Pervasive, Multi-billion computational challenges that are not well solved and even warming up our planet

Inefficient AI



The algorithms to train an AI system are tremendously inefficient. E.g., $ 100M is the cost of a single training round of ChatGPT 4. And growing.

Inefficient Optimization

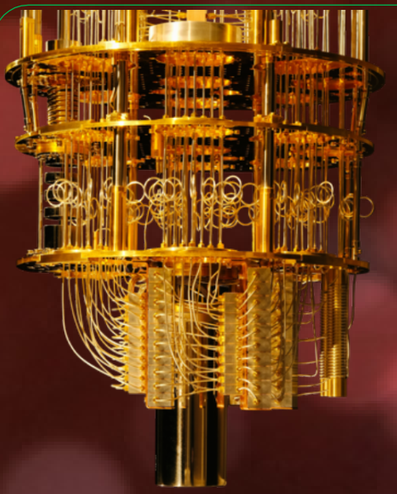
Optimization algorithms cannot cope with real cases. Electricity distribution - blocking the green transition.

These problems are a growing pain in all industries. Customer are willing to pay for solutions to them. Multiverse has tested solutions (our Quantum and Quantum-Inspired solutions). And Multiverse's solutions have the potential of saving a 2% of the global emissions of CO_2.

Third, because we have the Best Technology coming from the Quantum and Quantum-Inspired Fields, available now

Exascale and Petascale Supercomputers

Typically require 15MW-25MW to operate



Quantum Computers

Typically consume 25KW of energy

When Quantum Supremacy is achieved, no computer will be able to match the energy efficiency of quantum computers

Approx 40% of our Customers use these kind of solutions

This is what we use most: 100-1,000x faster, no need to adopt quantum, success guaranteed

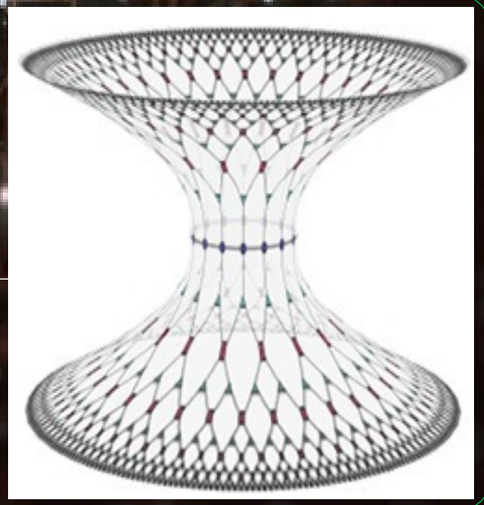
Typical AI / ML Algorithm Platforms

Massive (over 1,000 units) GPUs and CPUs clusters

Tensor Networks

Already 100x – 1000x faster requiring 80x less memory and providing higher precision

Uses 100x-1000x less energy to deliver same results while also minimizing data flow required for training



Consequently, we have a lot of customers we are proud of…

E.g., Zapata Computing is working now with 5 Customers, compared with Multiverse's 50s

Defense / Cybersecurity

Aerospace Predictive Maintenance

AI- Trading

Forex Trading

AI- Finance

Price Derivatives Accurately

Manufacturing / Supply Chain

Quantum Digital Twin

Logistics

Routing Optimization

Renewable Energy

Simulate Energy Demand

Chemistry

Green Hydrogen

Life / Healthcare

Predict Patient Health Crises

Government

Market Simulation

Automotive

Optimize Component Functionality

Customers and Qualified Prospects

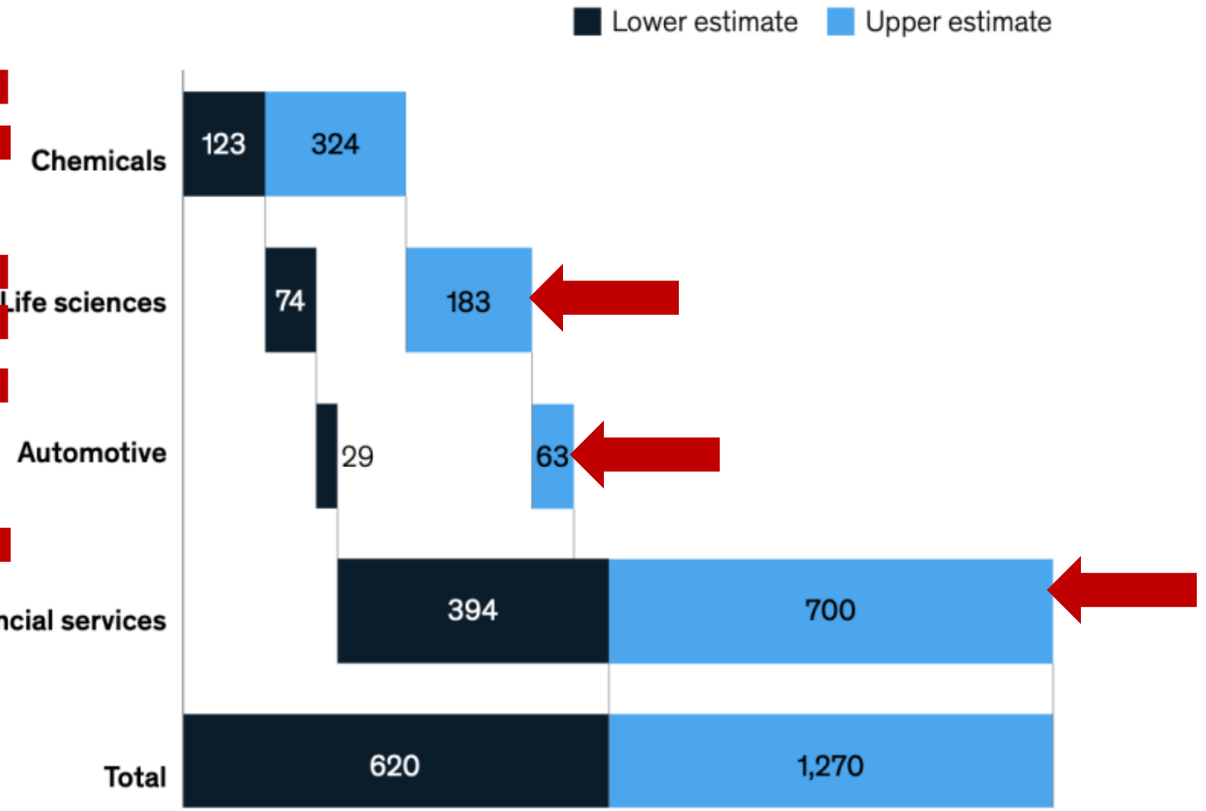
The estimated value at stake for QC in the four industries most likely to see impact first has now reached nearly $1.3 trillion.

Economic value + Incremental ++ Significant +++ Disruptive

Industry	Key segment for QC	2025–30	2030–35
Global energy and materials	Oil and gas	+	++
	Sustainable energy	+	+++
	Chemicals	++	+++
Life sciences	Pharmaceuticals	++	+++
Advanced industries	Automotive	++	++
	Aerospace and defense	+	++
	Advanced electronics	+	++
	Semiconductors	+	++
Finance	Financial services	++	+++
Telecom, media, and technology	Telecom	+	++
	Media	+	+
Travel, transport, and logistics	Logistics	+	++

Four industries expected to see first impact

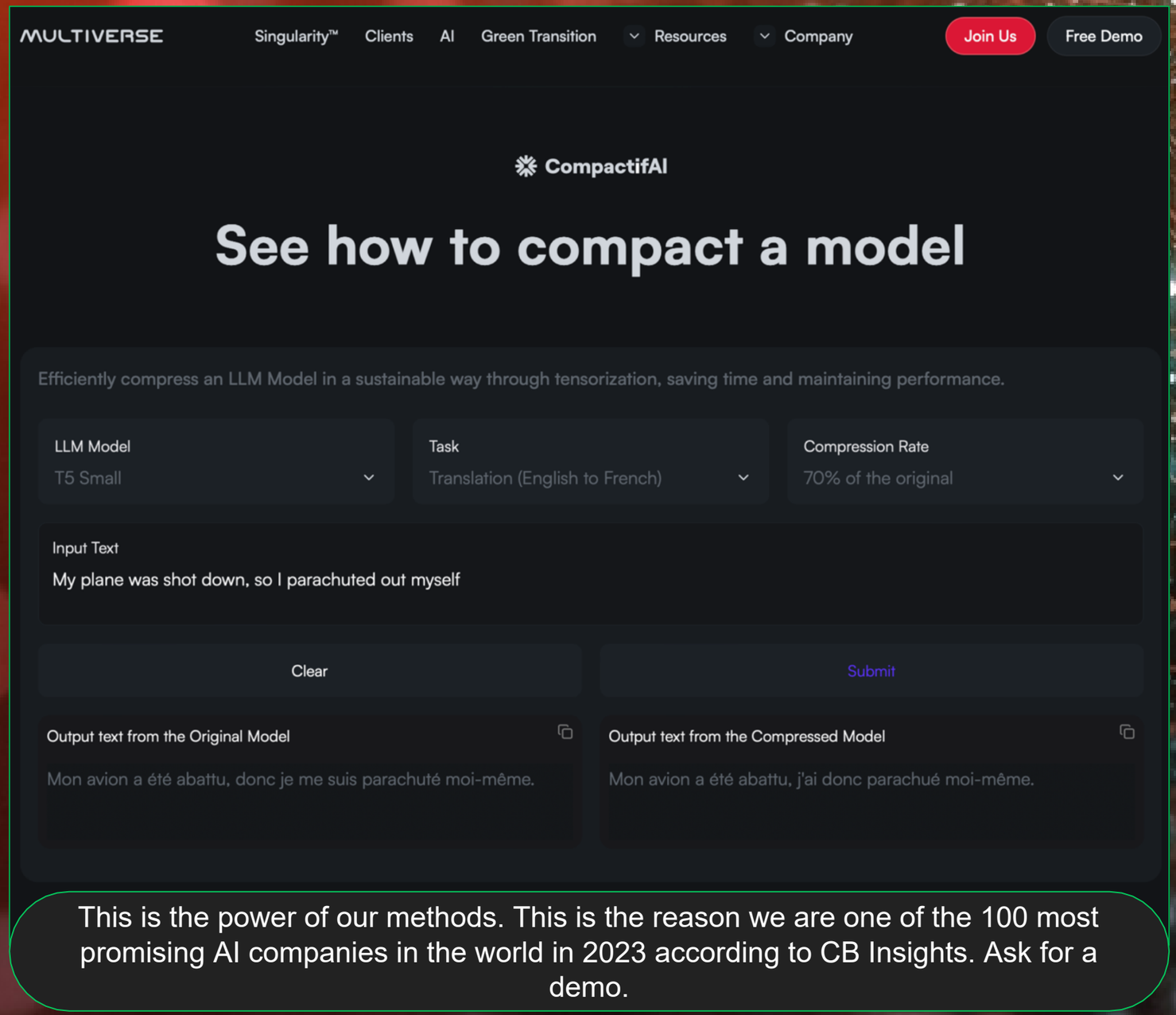
Value at stake with incremental impact of QC by 2035, $ billion



Source: "Quantum computing use cases are getting real—what you need to know," McKinsey, December 14, 2021; expert interviews

Singularity is changing AI

Singularity-fueled LLM Compressor *CompactifAI* reduces the bill of train/retrain LLMs models by 30 to 70%



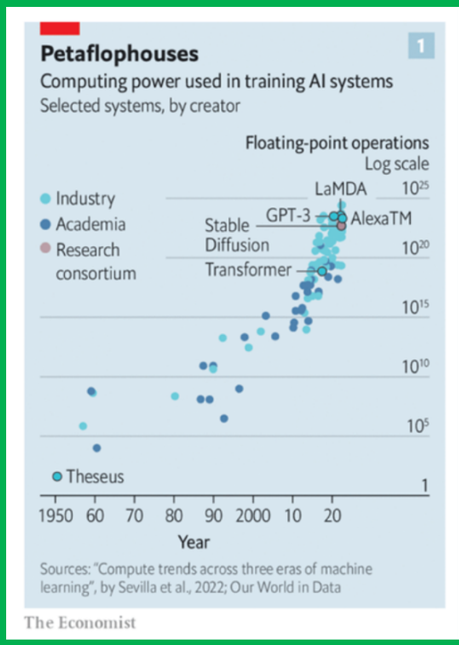
This is the power of our methods. This is the reason we are one of the 100 most promising AI companies in the world in 2023 according to CB Insights. Ask for a demo.

WHY *CompactifAI* is ground-breaking

1. The cost of train an LLM is doubling each 10 months (last training round of chatGPT-4, cr. $ 100M).

2. *CompactifAI* uses quan-tum inspired Tensor Networks to reduce the size of the model 30-70%, maintaining the accuracy., Further re-training of LLM is 50-80% cheaper.

3. *CompactifAI* generates cheaper, faster, greener AI models, including LLM and Generative.



While *CompactifAI* is impressive, it is nothing with our newer, ground-breaking accompanying solutions, *Lobotomizer.ai*, and *trAIn*. Let's talk.

(CompactifAI is fueled by Singularity. Test it on https://beta.multiversecomputing.com – launch on Nov 15th)

Finance Products

At a glance

Asset Management

Porfolio Optimization

Quickly optimize large portfolios with constraints and multistep rebalancing

Index Tracking

Improve fund performance with smaller portfolios and lower risk ratios

Algorithmic Trading

Quantum boosted machine learning to learn optimal trading signals

Derivatives Pricing

Deep Learning for Complex Derivatives

Tensor neural networks enhance the training of deep pricers for derivatives:

- High-dimensional Baskets
- Path dependency (Bermudans, Autocallables)

Parametric Pricing Models
(Coming soon)

Learn the full solution of pricing models for rapid acceleration

Risk Management

Anomaly Detection

Identify fraud more accurately with explainable models

Downgrade Prediction

Use quantum machine learning to improve credit risk identification

Financial Stability

Model complex network dynamics and analyse the cascading effects of market perturbations

THANK YOU!