

Social Science and Humanities Research & HPC: opportunities & challenges for these minority end users

Prof. dr Julie M. Birkholz



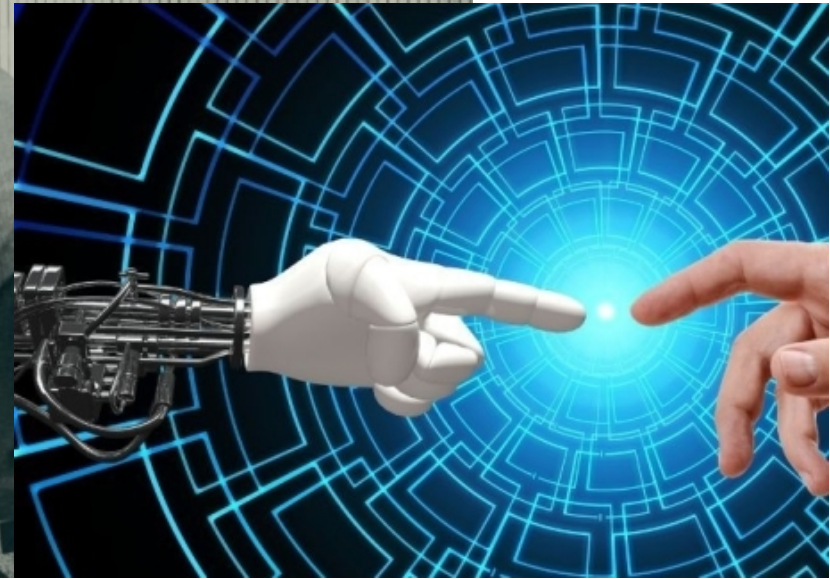
EUROHPC
summit 2024

KBR 

GHENT CENTRE FOR DIGITAL HUMANITIES



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|---------------------------|---------------------------|---------|
| West Coast Marine Elect. | Waste by Rail | 6.57 |
| Seawide | w:dder | 400.11 |
| The Mail Box | | 102.28 |
| MARVAC | Richman shipping | 34.55 |
| Business Camp | wiggins / Inventory | 144.78 |
| Newport Auto Sound | Richman / Office Supplies | 1287.18 |
| Seawide | wiggins | 141.38 |
| Staples | wiggins | 39.38 |
| Seawide | wiggins / Inventory | 91.57 |
| Stu Frazer | wiggins | 262.50 |
| Sunrise Marine | Draw | 2500.00 |
| West Coast Marine Electr. | Stalick / Inventory | 324.00 |
| | Waste by Rail | 230.45 |
| | Richman | 124.99 |
| | Scullu | 210.00 |



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ANTWERP

Introduction to

*exa*FOAM

Successes and continuing challenges

Panellist: Prof. Fred Mendonça

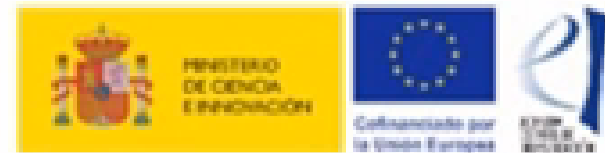
ANNOTATION



ANTWERP
18-21 MARCH

TO EXASCALE
AND BEYOND

Welcome to



EuroHPC
Joint Undertaking



Strengths

- More than 1-order of magnitude performance acceleration, using
 - Improved I/O – Industry Award
 - CPU/GPU combinations
 - Benchmark profiling
 - Industry benchmarks provided by
 - OEMs, SMEs
 - End-users in Industry
 - Computer industry partners



www.exafoam.eu

Exploitation of Exascale Systems for Open-Source Computational Fluid Dynamics by Mainstream Industry

exaFOAM

Mission

- Joining efforts to overcome the current limitations of CFD technology, with focus on massively parallel HPC architectures
- All developments will be implemented in the open-source CFD software

WP Structure and Results

Refactoring (WP3)

- Optimized the Sparse Matrix vector kernel using different approaches, all based on the unrolling technique and reduction of branch mis-predictions.
- Developed a native parallel I/O based on Adios 2 and a coherent and sliceable mesh layout that is independent from the number of processes. The code has been tested up to 524,288 CPU cores.
- Ported OpenFOAM to GPU using two different approaches, one based on OpenMP and exploiting the unified memory architecture of the latest GPU technology of AMD (MI300A), and one based on CUDA, which has required a rewriting of some core libraries of OpenFOAM.

Management and Coordination (WP1)

Improved Algorithm Development Activities

Co-Design Profiling and Performance (WP5)

Evolutionary (WP4)

Integration (WP6)

Project Output/Impact (WP7)

Validation and Assessment (WP2)

- Main objectives:**
 - Collect, prepare, validate and deliver the application test cases, driven by the industrial Observer Partner expectations.
 - Evaluate the computational performance of original and exascale-enhanced OpenFOAM code.
 - Selected domains: Aerospace, Power generation, Automotive, Environmental, Disaster (Eva) Polymer processing.
 - Identified HPC grand challenges:
- Main results:**
 - 9 industrial and grand challenge case studies published 19 micro benchmarks published through HPC case repository¹ and DaRUS².
 - Evaluation of the cases showed substantial improvements of the KPIs for some cases.

Evolutionary (WP4)

- Evolutionary development of OpenFOAM core code to approach exa-scale capability, enhancing features to utilize evolving HPC hardware.
- Focus Areas:**
 - Implementing solution algorithms for coupled equations.
 - Developing novel numerical algorithms for sparse linear systems.
 - Exploring synergies with open-source solvers and libraries.
 - Enhancing code performance in reactive flow simulations.
- Specific Enhancements:**
 - Efficient and highly parallel algorithms for linear system solutions.
 - Introducing lossy compression for memory reduction.
 - Optimizing parallel efficiency of mesh interfaces.
 - Designing efficient load balancing strategies.

Co-design Profiling and Performance (WP5)

- Main objectives:** Improve performance and efficiency of exaFOAM benchmark cases.
- Analysis of the DLRCM Grand Challenge has led to speedup in large-core executions.
- OpenFOAM integration with profiling tool improves insight into the behavior of the cases.

Base on pre-exaFOAM benchmark of 0.1-petaFlops



SWOT

- **Weaknesses**

- **General-purpose CFD involves**

- **Several Physics** demanding different acceleration techniques
 - Liquid, gas, solid, particulate physics and radiation heat transfer
 - Load balancing

- **Opportunities**

- **New Architectures**

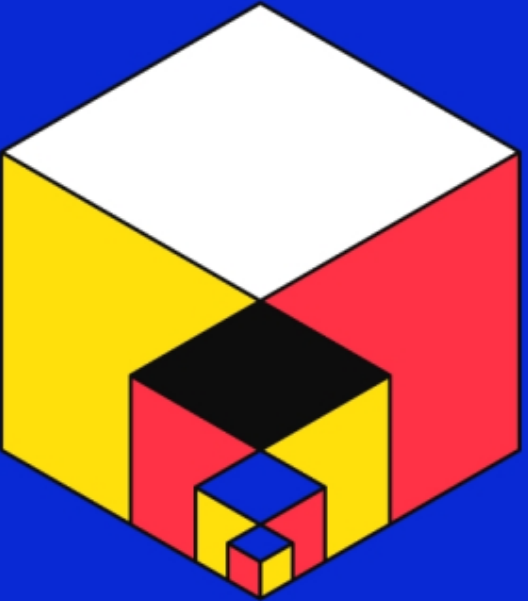
- GPUs

- **Threats**

- **To existing / legacy code** unable to take advantage of new technologies or written in older languages



Thank you!



ANTWERP

Some Background on HLRS

Bastian Koller, Managing Director



Background on HLRS

- **Topics/application fields**

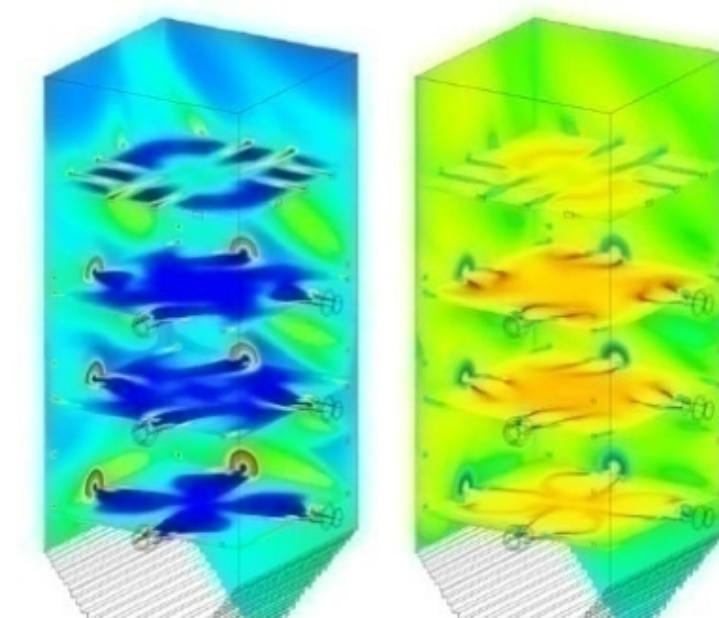
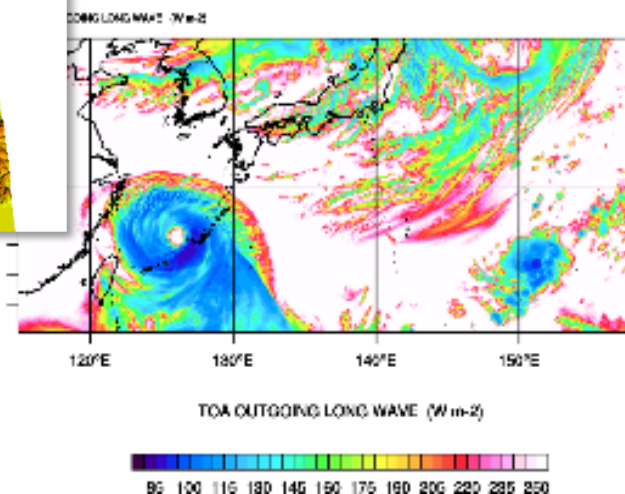
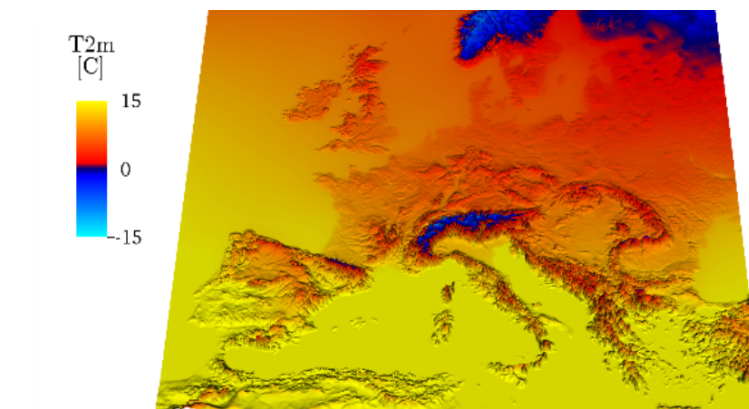
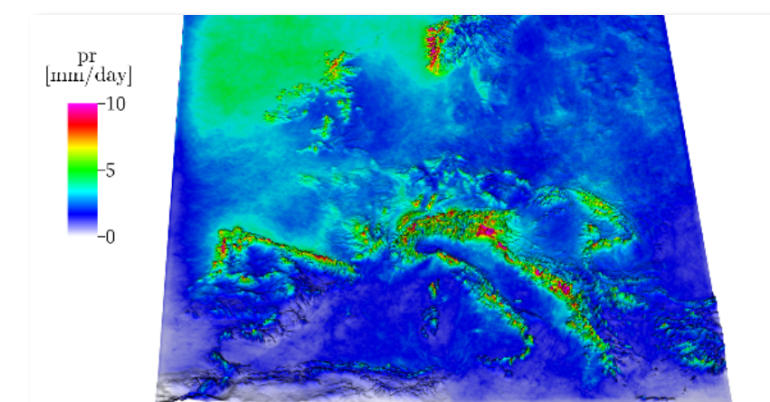
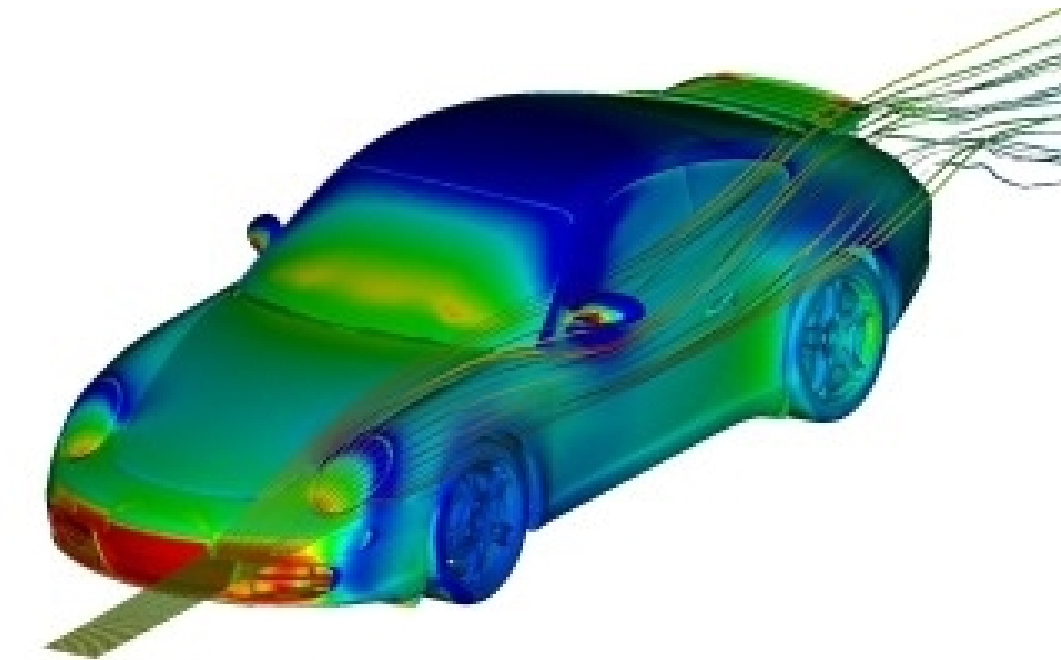
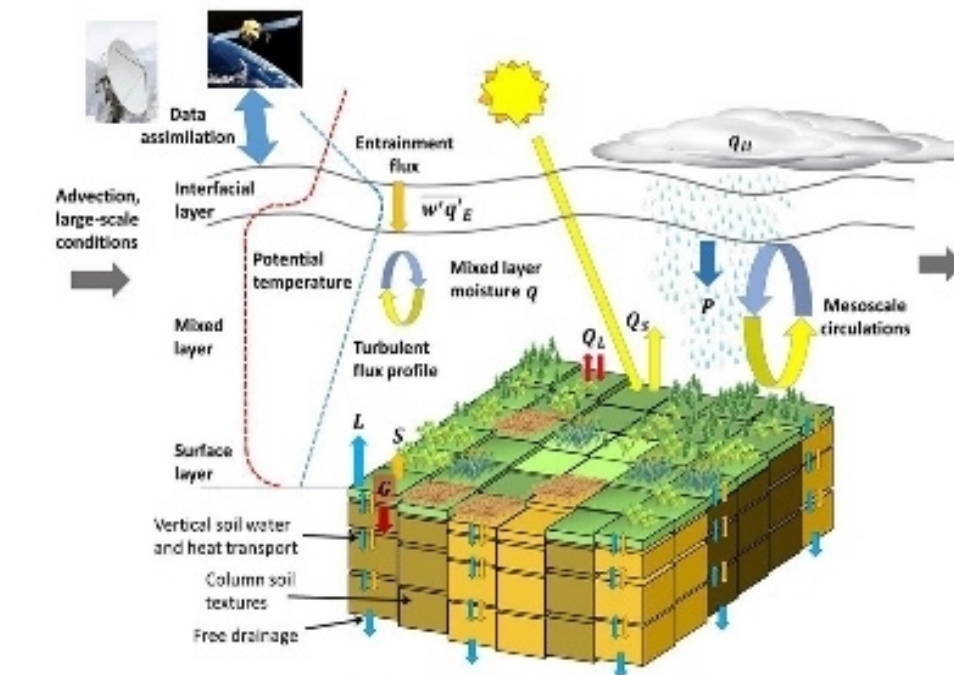
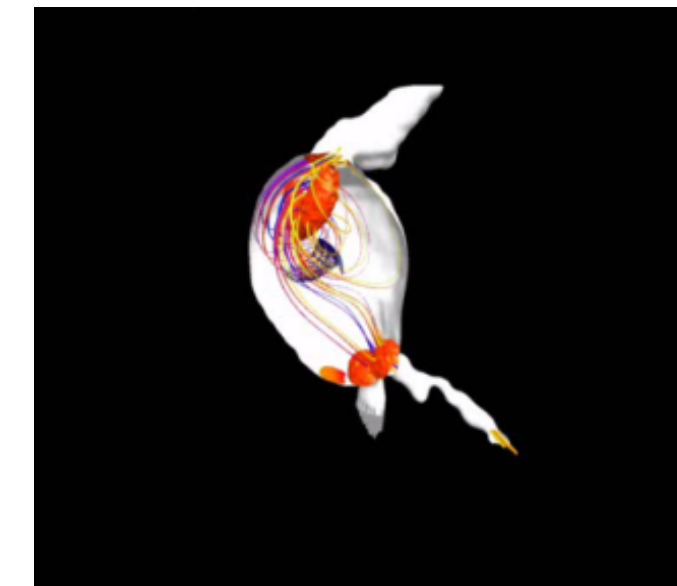
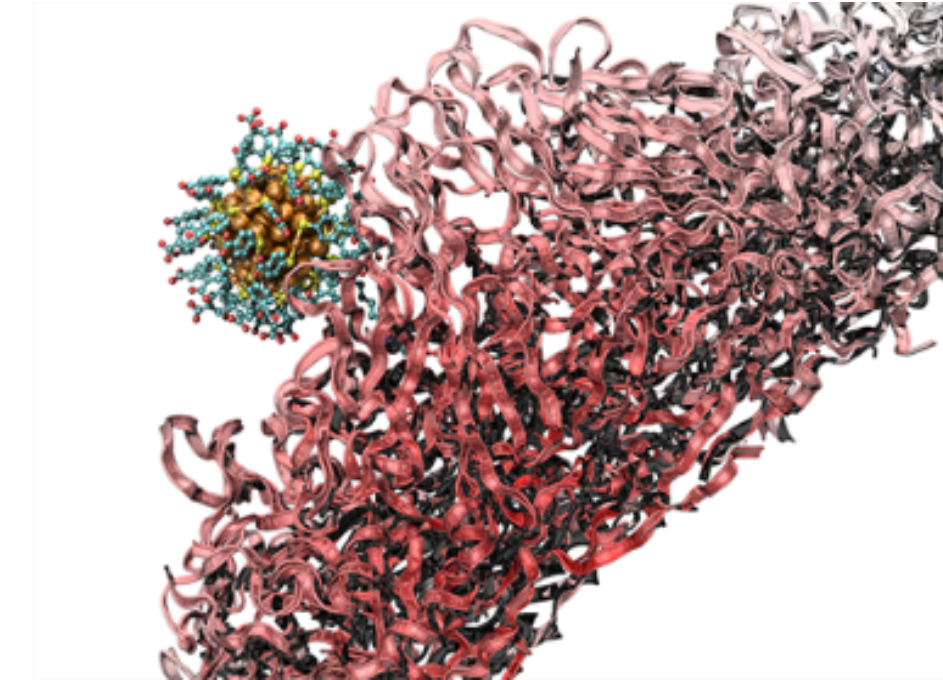
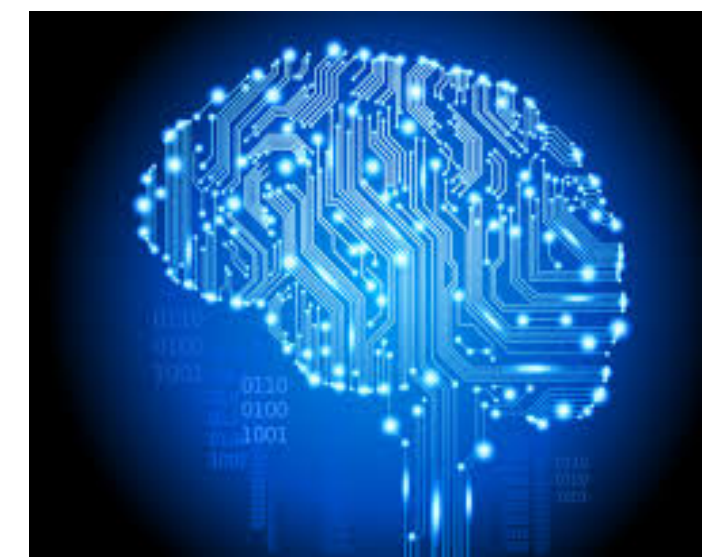
- Energy
- Climate change and environment
- Health and the ageing society
- Mobility in the 21st century
- Digital societies
- Various combinations of the themes

- **Technologies**

- "Data to Solution"(D2S)/AI
- Cybersecurity
- Supercomputing
- Green IT
- Quantum

- **Customer/User Base**

- Academia
- Industry
- Public Bodies





RECOM SERVICES

Eberspächer

CFD SCHUCK

Miele

FIFTY 2

OPTIMA Ingenieurgesellschaft mbH
EXCELLENCE IN PHARMA

PFINDER CHEMIE

3DEXCITE
CD-adapco

st w Steinbeis
sidion

STIHL

MANNK

ebmpapst

Patentstar

PORSCHE

ingrid cloud
by adaptive simulations

GWT forschung+innovation



CFD Consultants! ADVANCING TECHNOLOGY!

MANN + HUMMEL

- 244 Mio C-hours (2021)
- 258 Mio C-hours (2022)
- 325 Mio C-hours (2023)
- ~ 330 Mio C-hours (2024)



Ecosystem Setup

Public-private partnership for HPC in industry



Consulting and training for SMEs



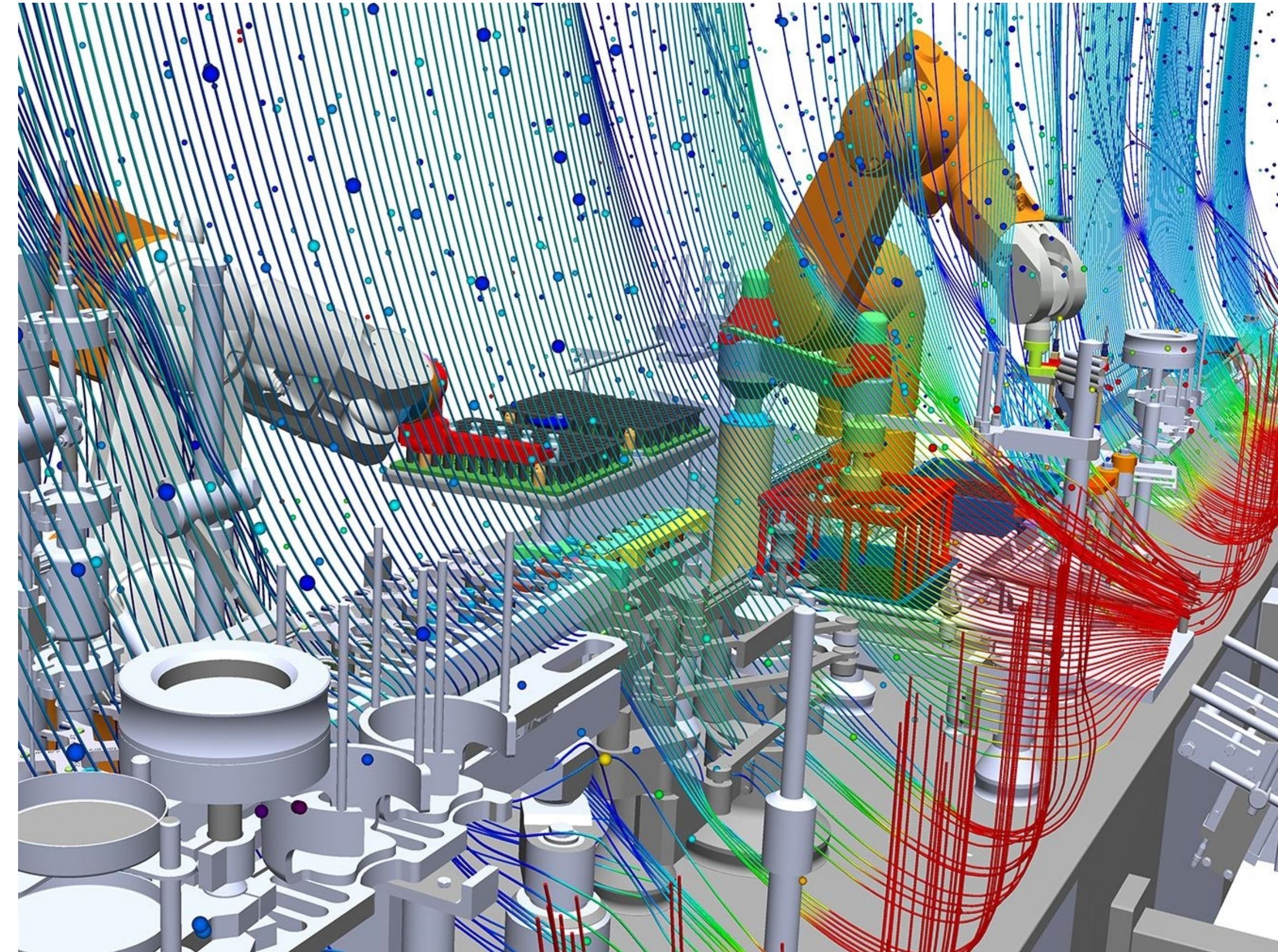
Solution Centers



Preparing industry and public bodies for HPC/HPDA/AI



Support of public organisations/bodies in Crisis Management





Laurent DAUDET

Co-CEO and Co-Founder



March 2024

ABOUT LIGHTON

**Private, scalable and
customizable
Gen AI built for the
Enterprise**

+

Founded 2016 in
Paris, France
spinoff from
university research

+

Track record :
built 15 LLMs
ranging from 1B to
over 100B params.

+

International
team of 35

+

A dozen of Enterprise
or Public Sector
clients

Lightn's dual offering

Forge : Comprehensive tooling to develop some of the **world's best LLMs**



Alfred, optimized for RAG

*Pre-training on **HPC** or cloud provider*

The platform to manage the lifecycle of LLMs for the Enterprise



Deployment on private cloud or on-premises

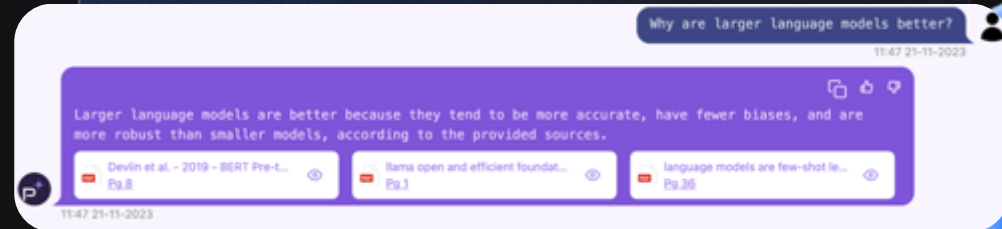
The insight machine



RAG systems

Combining LLM with Search

→ Chat with Documents



Useful across business units :
customer service, legal, HR, engineering...

The impact of GenAI

40% of working hours
could be impacted by
Large Language Models

Accenture*

Generative AI is poised to
unleash the next wave of
productivity.

McKinsey**

*Accenture Technology Vision 2023: Generative AI to Usher in a Bold New Future for Business, Merging Physical and Digital Worlds, 2023

**The economic potential of generative AI: The next productivity frontier, McKinsey report, 2023