



PROGRAMME
DE RECHERCHE
NUMÉRIQUE
POUR L'EXASCALE

NumPEx & Exa-MA

Reminder / Refresher and Introductory
Organization

Hélène Barucq & Christophe Prud'homme
January 19-21, 2026 – NumPEx General Assembly

Exa-MA – Exa-scale Methodologies and Algorithms

Two-part session

- Part I (30 min slot): reminder/refresher on NumPEx & Exa-MA.
- Mandatory for newcomers; optional for those already familiar.
- Target speaking time: 20 min (15 min condensed) + Q&A.
- Part II (15 min slot): introductory words and organization.
- Target speaking time: 10–12 min + Q&A.



RÉPUBLIQUE
FRANÇAISE

Liberté
Égalité
Fraternité



PROGRAMME
DE RECHERCHE

NUMÉRIQUE
POUR L'EXASCALE



Inria

Part I — Reminder / Refresher

NumPEx & Exa-MA

Reminder / Refresher

For Newcomers & As a Quick Reference

What is NumPEx?

NumPEx: Numerical Excellence

Programme et Équipement Prioritaire de Recherche

National HPC research program

Duration: 2023–2029 (6 years)

Budget: €85M total

Scope: French national initiative

Vision

Position France as a **world leader** in numerical simulation, data science, and AI on exascale systems

Leadership

Co-directors

J. Bobin (CEA), M. Krajecki (CNRS), J.-Y. Berthou (Inria)

Key Numbers

80 R&D teams

500 Researchers

500 PY non-permanent + 170 PY permanent

Total cost: €81M

The NumPEx Program Structure

Five Priority Challenges (PC)

- **PC1 – Exa-MA:** Methods & Algorithms
C. Prud'homme / H. Barucq
- **PC2 – Exa-Soft:** Computing Stack
R. Namyst / A. Buttari
- **PC3 – Exa-Dost:** Data Science
G. Antoniu / J. Bigot
- **PC4 – Exa-AtoW:** Digital Continuum
F. Bodin / M. Asch / T. Deutsch
- **PC5 – Exa-DI:** Integration & Applications
J.-P. Vilotte / V. Brenner

Core Institutions

CNRS, CEA, Inria, Universities, Engineering schools, Industry

Exa-MA is the algorithmic foundation

Methods, algorithms, and solvers that enable all other PCs to achieve exascale performance

Why Exascale Computing?

The Exascale Milestone

Exascale = 10^{18} ops/s – 1000× petascale

Achieved: Frontier (USA), LUMI (EU)

Challenge: Energy (20MW), scalability, new algorithms

The Technological Shift

- Hybrid scalar/accelerator (GPU) systems
- Less memory per compute unit
- Massive concurrency (millions of cores)
- Convergence: HPC / Data / AI

Grand Societal Challenges

- **Climate & Environment** – climate prediction
- **Energy Transition** – fusion, renewables
- **Health & Medicine** – personalized medicine
- **Advanced Materials** – quantum, transport
- **Digital Twins** – smart cities, industry 4.0

The French NumPEX Program

Sovereignty

European sovereign exascale software stack

Integration

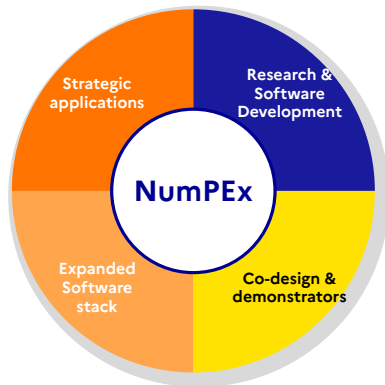
Co-designed methods, libraries, frameworks

Training

Training and software productivity

Collaboration

International **collaborations** for Exascale

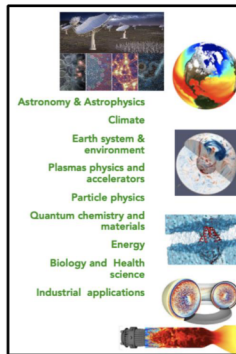


**Help aggregate the French
HPC/HPDA/IA community**

The French NumPEx Program

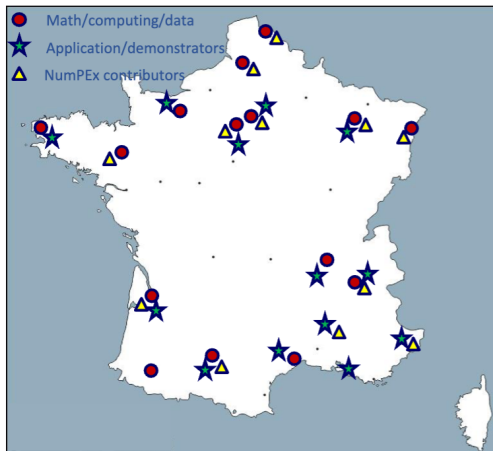


*European Pre-Exascale
system*



Co-develop the exascale software stack
Preparing the applications for the Exascale era

NumPEX by numbers



2023–2030

* Funding 41M€=500 man.year non permanent staff
+ 170 man.year permanent staff **Total cost: 81 M€**

6 Years
41 M€*

Math/computing/data
Applications/demonstrators

Core
Research
Institutions

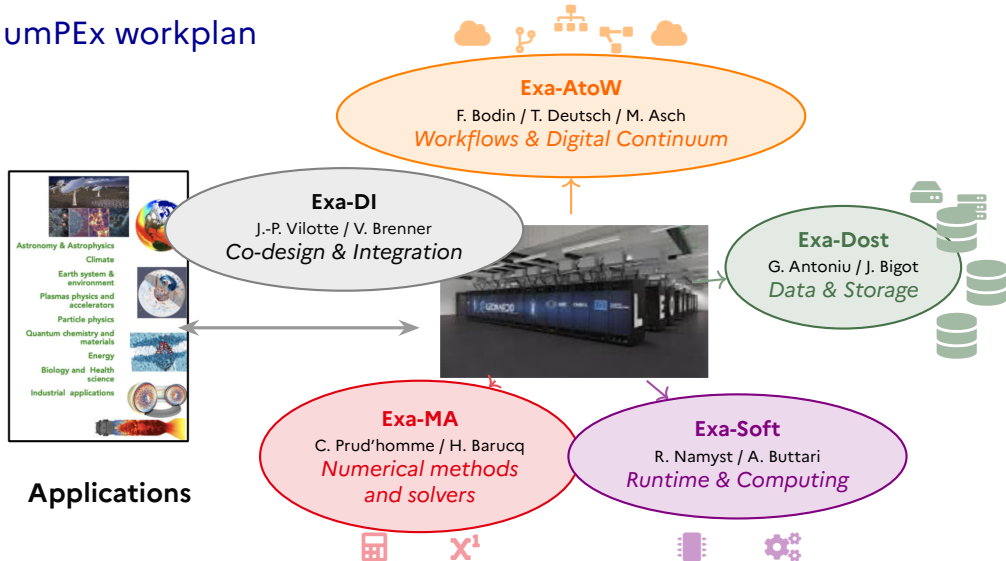
CNRS, CEA, Inria,
Universities, Eng. schools

3
Focus
Area

Software stack (PC 1-3)
Workflows (PC 4)
Integration (PC 5)

80 R&D
500 Res.

NumPEx workplan



NumPEx Transversal Groups (and Projects)

KOKTAILS

**Accelerated
architectures
and program-
ming models**

S. Thibault / M. Perache

SAGE-HPC

DAIMOS

AI

T. Moreau / E. Franck / J. Bobin

ASTRA

Computing centers

F. Bodin / N. Lardjanne

**Energy management
and optimization**

A. Guermouche / G. Da Costa

Resilience

L. Morin

Training

M. Krajecki

CSA SPE

**Software production
and integration**

B. Raffin

Gender/Equity/Diversity

A.-L. Pele / V. Grandgirard

**International
collaborations**

J.-Y. Berthou

Exa-MA

Méthodes et Algorithmes pour l'Exascale

Helene Barucq (Inria) & Christophe Prud'homme
(UNISTRA)

Project Identity

PC1 of NumPEX

Duration: 2023–2029 (6 years)

Budget: €6.255M PEPR

Total budget: €24.417M

Beneficiary Partners:

CEA, École Polytechnique, Inria, Sorbonne Université, Université de Strasbourg

Core Mission

Develop **methods, algorithms** and **implementations** for exascale architectures

Key Objectives

- Develop and contribute to software libraries for exascale
- Identify and co-design methodological patterns
- Enable AI algorithms at exascale
- Provide open demonstrators (mini-apps, proxy-apps)
- Create and foster exascale community

Enable extreme-scale computing for more accurate predictive models

Team Composition

74 permanent staff

55 PY funded positions:

- **12** PhD students
- **5** Postdocs
- **8** Research Engineers

25 recruited personnel (Year 2)

Key Institutions

Beneficiary: CEA, Inria, UNISTRA, École Polytechnique, Sorbonne Université

Partners: 15+ institutions (CNRS, universities)

Year 2 Achievements

38 publications (97% open access)

16 active software packages

18 frameworks impacted

Deliverables:

D7.1 v2.0.0 – Benchmarking Report

D7.3 v1.0.1 – Training Materials

All 7 WPs active and delivering results

Scientific Work Packages (WP1–WP6)

WP1 – Discretization & Geometry

Meshing, CAD, space-time coupling

WP2 – Machine Learning

Physics-informed ML, neural operators

WP3 – Solvers

Domain decomposition, mixed precision

WP4 – Data Assimilation

Variational methods, ensemble techniques

WP5 – Optimization

Bayesian optimization, shape optimization

WP6 – Uncertainty Quantification

Gaussian processes, sensitivity analysis

Transversal Work Packages

WP7 – Software & Benchmarking

Application taxonomy, CI/CD, performance

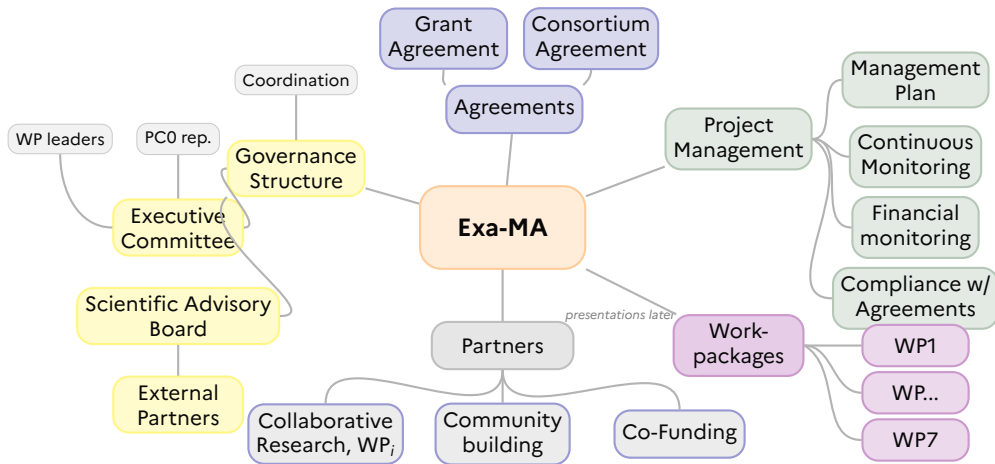
WP0 – Coordination

Management, dissemination, training

Cross-WP Synergies

- Surrogates (WP2, WP6) → Optimization (WP5)
- Solvers (WP3) → All WPs
- Software (WP7) → Integration

Exa-MA Coordination: WP0



Executive Committee



H. Barucq

Coordinator, INRIA



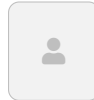
C. Prud'homme

Coordinator, Unistra



L. Pernollet

Project Mgr, CEA



J. James

Mgmt Support, CEA



J. Antonczak

Mgmt & Valor., Unistra



P. Alliez

WP1, INRIA



I. Ramière

WP1, CEA



S. Lanteri

WP2, INRIA



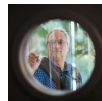
E. Franck

WP2, INRIA



V. Faucher

WP3, CEA



L. Giraud

WP3, INRIA



F. Nataf

WP3, CNRS/Sorbonne



M. Asch

WP4, Univ. Picardie



A. Vidard

WP4, INRIA



E.-G. Talbi

WP5, Univ. Lille



J. Garnier

WP6, EP



C. Gauchy

WP6, CEA



A. Calloo

WP7, CEA

Scientific Advisory Board



WP1: C. Geuzaine
Univ. of Liège, Belgium



WP1: J. Hesthaven
KIT, Germany



WP2: K. Willcox
UT Austin, USA



WP2: G. Rozza
SISSA, Italy



WP3: J. Brown
Colorado Univ., USA



WP3: L.C. McInnes
Argonne Lab, USA



WP4: L. Nерger
AWI, Germany



WP5: A. Zomaya
Univ. Sydney, Australia



WP5: P. Bouvry
Univ. Luxembourg



WP6: B. Sudret
ETHZ, Switzerland

Scientific Advisory Board

💡 Strategic Guidance

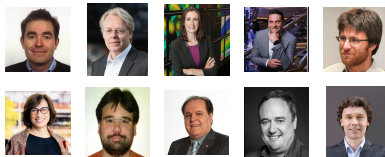
High-level insights for research agenda; innovative ideas & emerging HPC trends

✅ Evaluation & Feedback

Review deliverables; assess progress toward objectives

📈 Trend Monitoring

Stay current with HPC, numerical methods, AI; advise on best practices



🌐 Alignment with HPC Objectives

Synergies with NumPEx, EuroHPC, international strategies

📅 Yearly Meetings

Attend GA (virtual/in-person); engage with WP teams

External Partners

Overview

13

External Partners

Public

EPIC: 2 | Academic: 2 | Infra: 1

Private

Large Groups: 5 | SMEs: 3

Co-funding

PhD: 4

Large Groups

 Airbus CRT

 EDF

 Roche

 Safran

 TotalEnergies

SMEs

 Avnir Energy

 Cerfacs

 Geometry Factory

Research (EPIC)

 IFPEN

 Onera

Academic

 AMU (LMA)

 MPG (Inst. du Soleil)

Research Infra

 LNCMI (CNRS-TGIR)

 = Co-funding

Q&A



RÉPUBLIQUE
FRANÇAISE

Liberté
Égalité
Fraternité



PROGRAMME
DE RECHERCHE

NUMÉRIQUE
POUR L'EXASCALE



Inria

Part II — Introductory Words

General Assembly Agenda, Content and Objectives

Monday 19th

12:00 Welcome lunch

13:45 NumPEx & Exa-MA intro

14:15 Introductory words

14:30–16:00 WP presentations

WP1 → WP6 (15 min each)

16:00 ☕ Coffee break

16:30–18:00 Intra-WP meetings

19:30 🍴 Dinner

Tuesday 20th

9:00–10:00 Framework talks

Feel++, Scimba, Composyx, Uranie

10:30–12:00 Breakout #1

Feel++ × WP1/2, Composyx × WP3

13:45–15:15 Breakout #2

Scimba × WP1/2, Feel++ × WP4/6

15:45–17:15 Breakout #3

Composyx × WP1/2/4, Uranie

17:30–18:30 👥 SAB meeting

19:30 🍴 Dinner

Wednesday 21st

9:00–9:30 New projects

SAGE-HPC (AI4HPC)

DAIMOS (HPC4AI)

9:30–10:15 WP1–3 feedback

10:45–11:45 WP4–7 feedback

11:45–12:00 Closing remarks

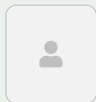
12:00 🍱 Packed lunch

📍 Arts et Métiers ParisTech
Aix-en-Provence

2026 Workplan

Define a workplan for 2026 in terms of **research and development**, including interaction **in** and **out** of Exa-MA

+ New Team Members



Jimmy James

Management

Support

CEA

Welcome to the project office!



**Juliette
Antonczak**

Mgmt &

Valorization

Unistra

🔗 New Partnership: PhD co-funding



EDF joins as external co-financing partner

Strengthening industry collaboration

🎓 YoungPEx Opportunity

Exa-MA is seeking a motivated PhD student to replace **Thomas Saigre**

Thank you Thomas for your work!

Exa-MA – Methods and Algorithms for Exascale Computing

Exa-MA
Home
About Exa-MA
Team
Consortium
External Partners
Collaborative Projects
Contact

Work Packages
Results and Impact
News and Events
NumPEx Work Group
Software & Benchmarking

Exa-MA: Methods and Algorithms for Exascale

Building the future of exascale computing through advanced numerical methods, AI-enhanced algorithms, and production-ready open-source software.

Our Mission

The Exa-MA project is part of France's PEPR NumPEx initiative, dedicated to pushing the frontiers of exascale computing. We develop and deploy:

- Advanced Methods**
Novel discretizations, solvers, and algorithms optimized for exascale architectures
- AI Integration**
Scientific machine learning for simulation, model reduction, and optimization
- Open Software**
Production-ready libraries that abstract hardware complexity and enable seamless portability
- Validated Impact**
Demonstrations, benchmarks, and real-world applications across scientific domains

Exa-MA brings together leading French institutions (CEA, École Polytechnique, Inria, Sorbonne Université, Université de Strasbourg) with a budget of 6.255 M€ over the project duration.

Recent Achievements

2025 Highlights

- Up to 50x Speedup**
GenIO preconditioning on large-scale problems (45M DoFs, 2318 cores)
- 8000 GPU Scale**
Bayesian optimization on LLM supercomputer with hierarchical decomposition

<https://numpex.github.io/exa-ma/>

Deliverables

D7.1 Research & Benchmarking – Oct 2025
D7.3 Training – April 2026

Exa-MA Ecosystem

Arrivals & departures funded by Exa-MA
Collaborations with public/private partners
National & international collaborations/projects

Publications

Mention in acknowledgments:
Exa-MA (Methods and Algorithms at Exascale) project under grant ANR-22-EXNU-0002
13 journals, 15 preprints, 6 conferences

✉ Send us any useful information!



Agenda & Rooms

See the **agenda slide** for detailed schedule and room allocation

Timekeeping

Please **respect session timing**
Speakers: stay within allocated time

Microphones

Please **use** them and **do not switch them off**

Essential for recording & remote participants

 **Q&A** at the end of each segment
unless otherwise announced

 **Emergency exits** are located at the back of the room

Questions?