



PROGRAMME  
DE RECHERCHE  
CALCUL HAUTE  
PERFORMANCE



# The NumPEX Program

**Co-directors:** Dr J. Bobin (CEA), Pr M. Krajecki (CNRS), Dr J-Y. Berthou (INRIA)

## Project leaders and co-leaders

ExaMa - Pr C. Prudhomme, U. de Strasbourg– H el ene Barucq (Inria)

ExaSoft - Pr R. Namyst, Inria/U. de Bordeaux - Alfredo Buttari, IRIT

ExaDost - Dr G. Antoniu, INRIA - Julien Bigot, CEA

ExaAtoW - Pr F. Bodin, U. de Rennes - Mark Asch, U. Picardie - Thierry Deutsch, CEA

ExaDIP - Dr J-P. Vilotte, DR CNRS - Val erie Brenner, CEA

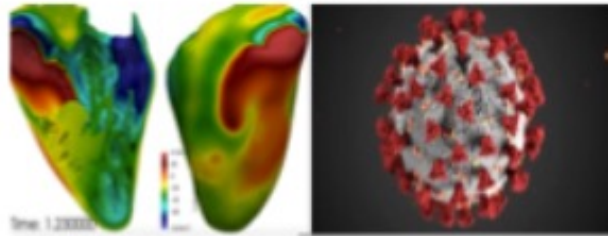
# The French NumPEX Program

## Exascale, what's at stake ?

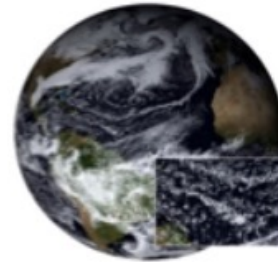
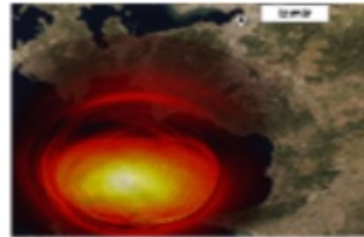
**Exascale for scientific breakthrough, environmental sustainability, resilient society, and industrial competitiveness**

### Answering key scientific questions

Supporting the development of COVID-19 treatments



Weather and climate models



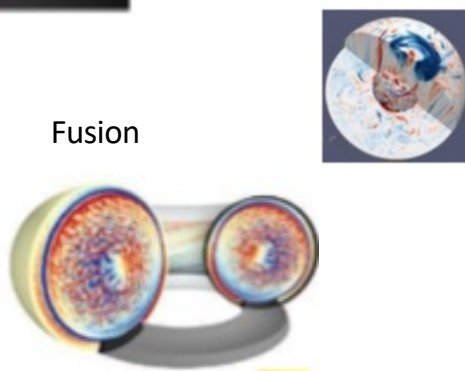
Earthquake simulation

### Leading to engineering breakthrough

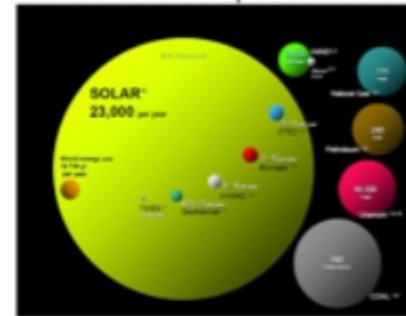
Astrophysics



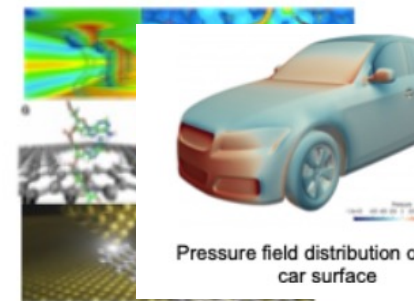
Fusion



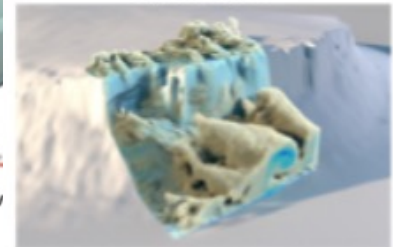
Renewables can power the world



Materials simulation



AI for wind farm layout optimization



Transportation



# The French NumPEX Program

## Context and motivations



### A technological breakthrough

Hybrid scalar/acc.  
fewer memory/node  
more concurrency

In the digital continuum  
Increased flux/volume  
from the edge to the  
HPC system

Convergence  
HPC/HPDA/IA

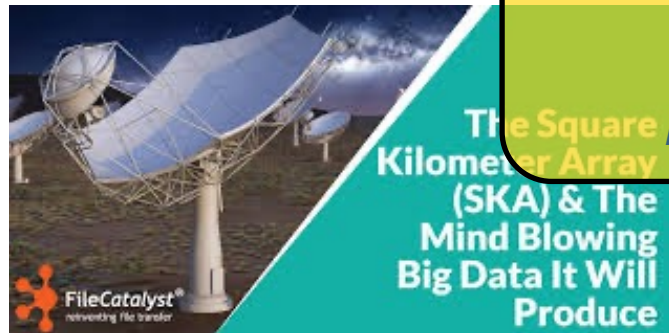
Traditional  
HPC  
Systems

Large-Scale  
Numerical  
Simulation

Scalable  
Data Analytics

Deep  
Learning

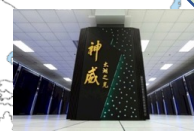
Capable  
Exascale system



# Context - International initiatives pre-arrival of exascale computers

## China initiatives:

- development of applications in preparation for the arrival of the Tianhe3 machine.



## Japan initiatives:

- Fugaku: co-design of an exascale system.
- Riken SC: transverse eco-system

## US initiatives:

- Dedicated support of the NSF
- Exascale Computing Project (DoE) creation of 6 co-design centers



A strong effort in both hardware, software and applications/co-design



# Context - European initiatives





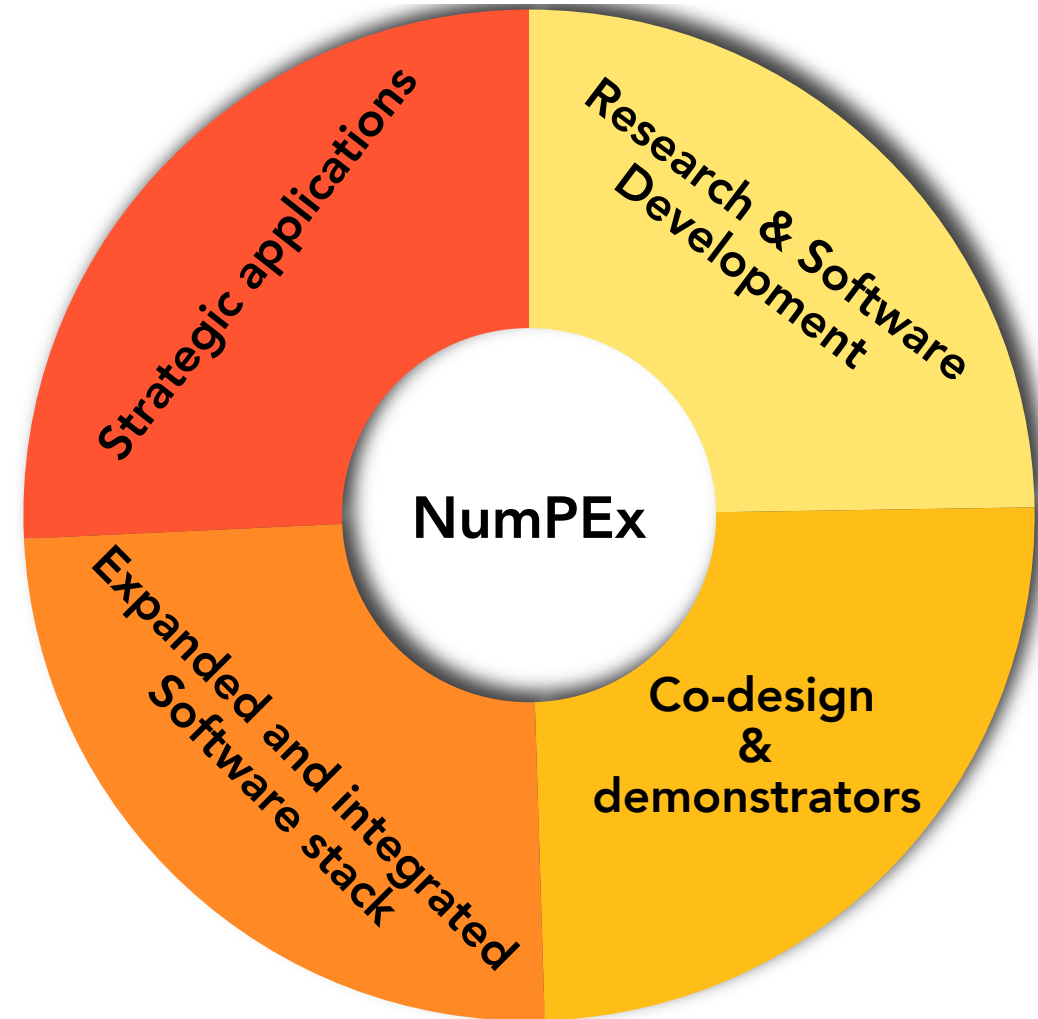
# The French NumPEX Program Objectives

Contribute and accelerate the emergence of a **European sovereign exascale software stack** and **strategic applications exascale capability** in a **coherent and multi-annual framework**

Integrate and validate **co-designed** innovative methods, libraries and software stack with demonstrators of strategic applications.

Accelerate science-driven and engineering-driven developers **training and software productivity**

Foster national and international collaborations to prepare for the Exascale and post-Exascale era



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

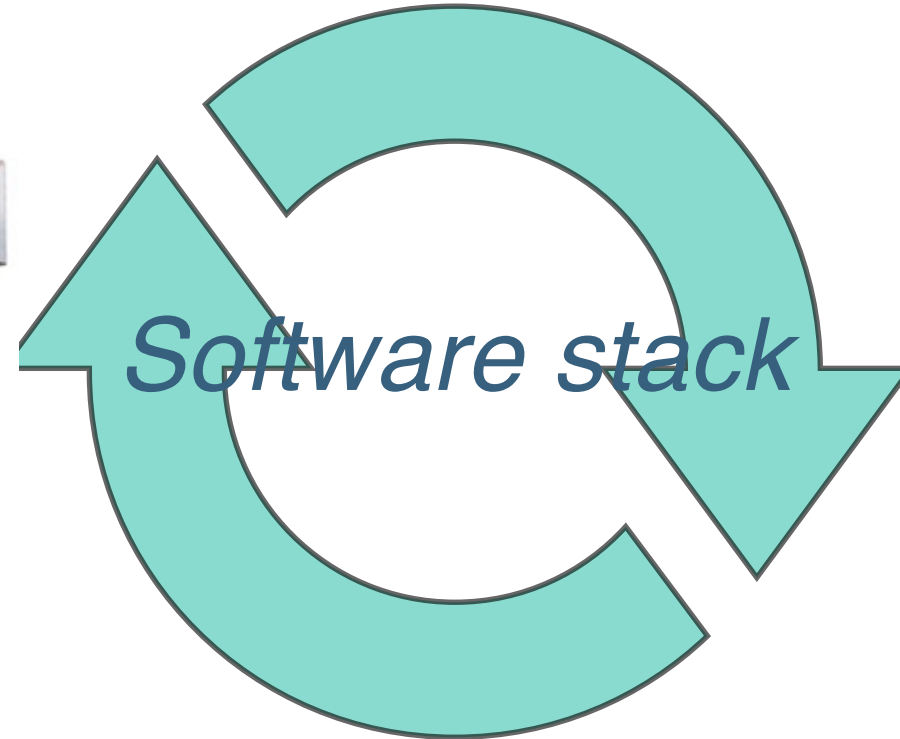


# The French NumPEX Program

## Objectives



European Pre-Exascale system

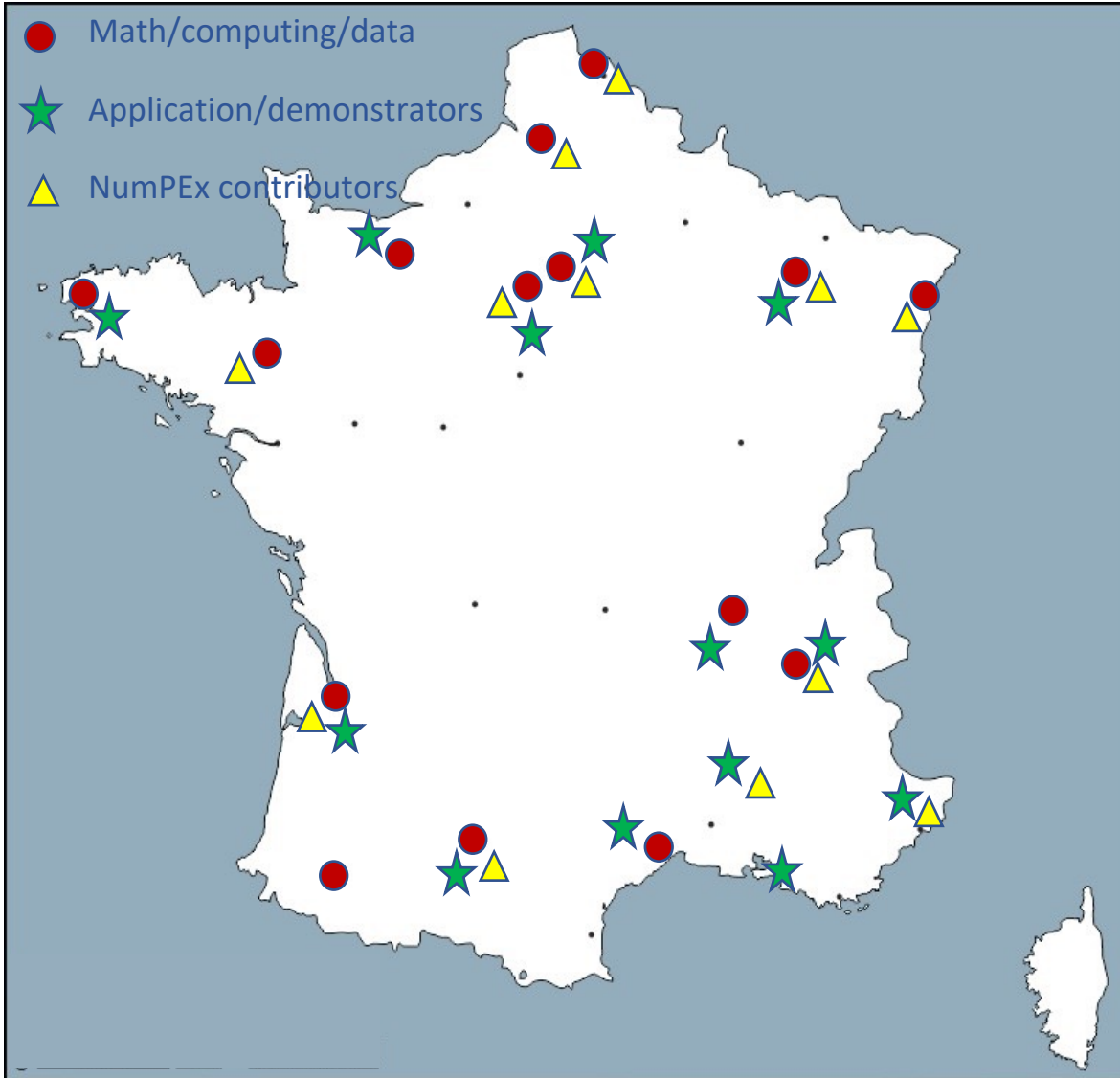


### Applications

- Astronomy & Astrophysics
- Climate
- Earth system & environment
- Plasmas physics and accelerators
- Particle physics
- Quantum chemistry and materials
- Energy
- Biology and Health science
- Industrial applications

**Co-design the exascale software stack**  
**Preparing the applications for the Exascale era**

# NumPEX by numbers



**6 Years**  
**41 M€\***

2023-2028

\* Funding 41M€=500 man.year non permanent staff

+ 170 man.year permanent staff

**Total cost : 81 M€**

**Core Research Institutions**

Core national Research Institutions: CNRS, CEA, INRIA, Universities, Engineer schools, Industry

**3 Focus Area**

Software stack development (PC 1-3)  
Wide-area workflows and architecture (PC 4)  
Integration and application development (PC 5)

**80 R&D teams**  
**500 Researchers**



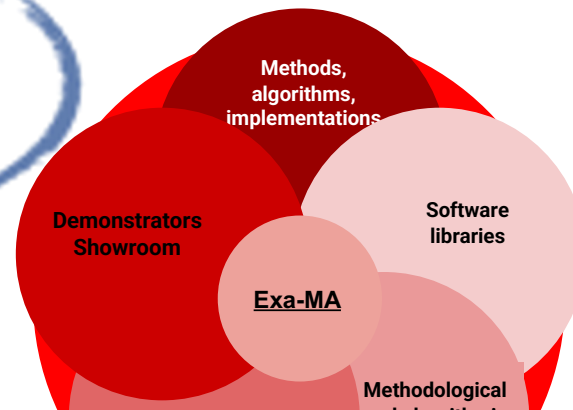
# NumPEX - workplan



Applications



*ExaMA*  
Numerical methods  
and solvers  
C.Prudhomme/H.Barucq



# NumPEX - workplan

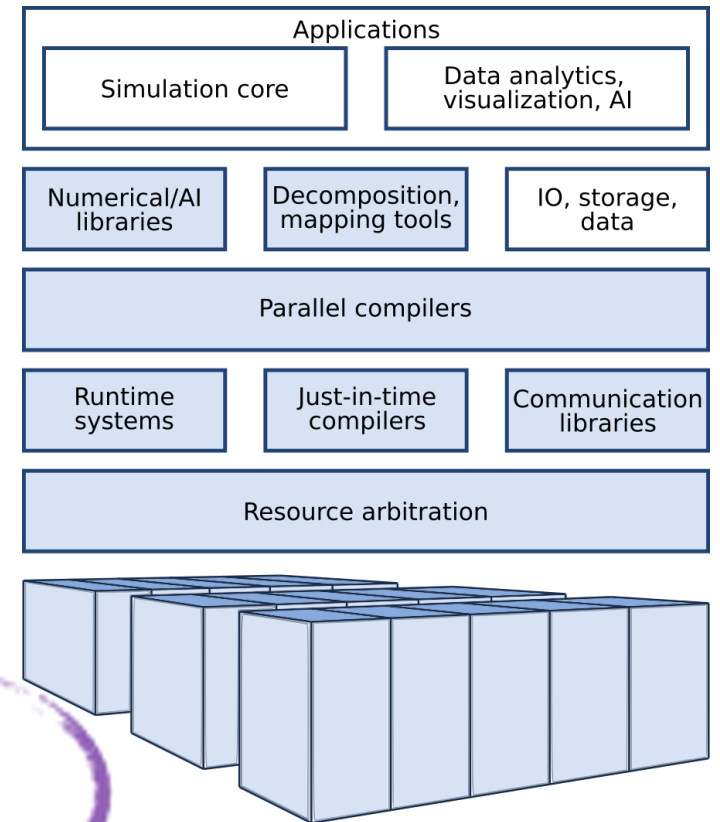


Applications



*ExaMA*  
Numerical methods  
and solvers  
C.Prudhomme/H.Barucq

*ExaSoft*  
Computing  
R.Namyst/A.Butari



# NumPEX - workplan

**WP1:**  
Exascale I/O  
and storage

**WP2:**  
Exascale in-  
situ data  
processing

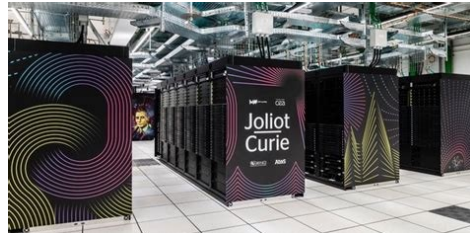
**WP3:**  
Exascale ML-  
based data  
analytics

**WP4:** Shared building blocks  
& integrated illustrators

**WP5:** Management, dissemination and training



Applications



*ExaMA*  
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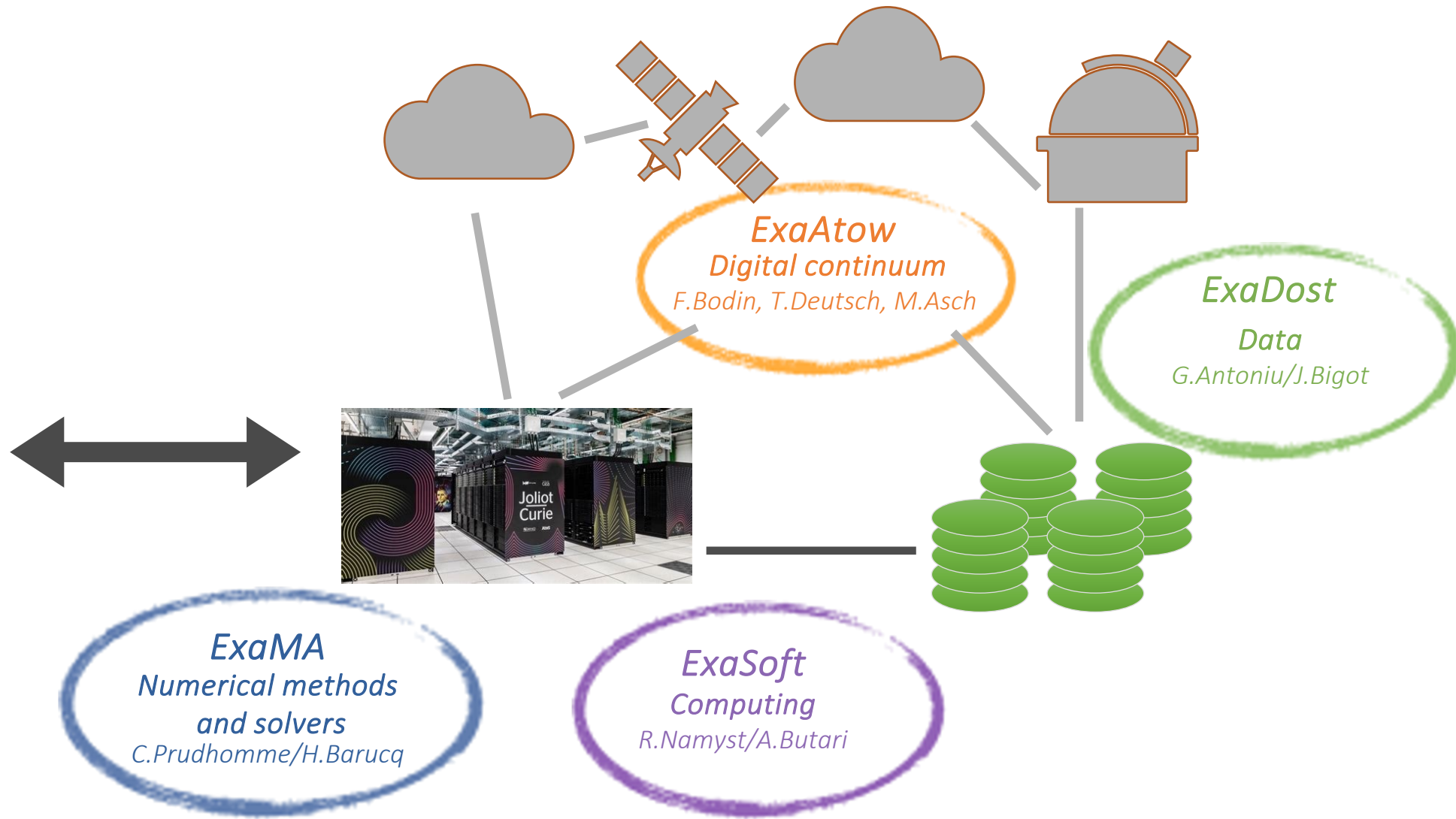
*ExaDost*  
Data  
G.Antoniu/J.Bigot



# NumPEX - workplan



Applications



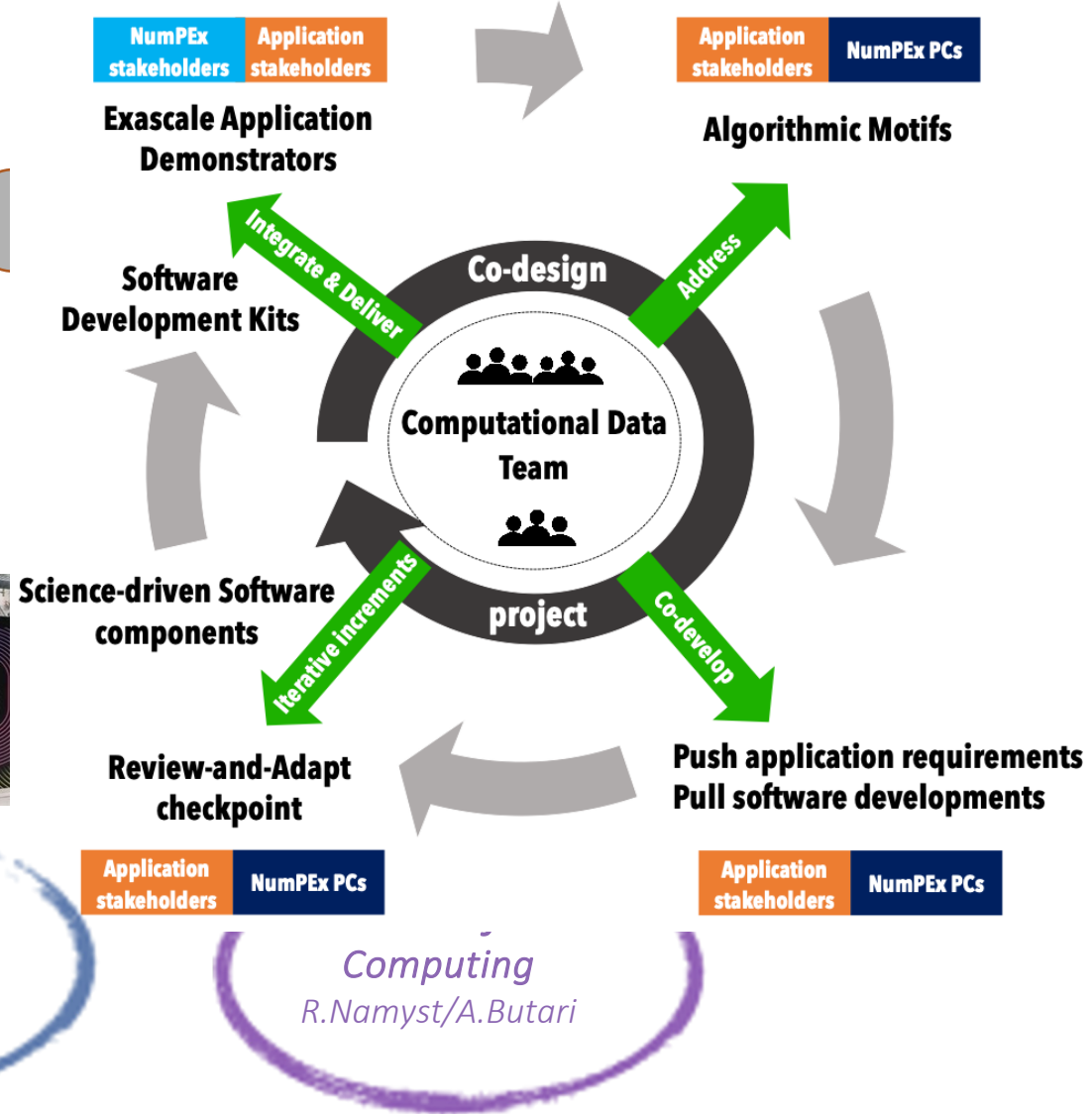
# NumPEX - workplan



Applications

**ExaDip**  
Application co-design and software integration  
JP.Vilotte/V.Brenner

**ExaMA**  
Numerical methods and solvers  
C.Prudhomme/H.Barucq

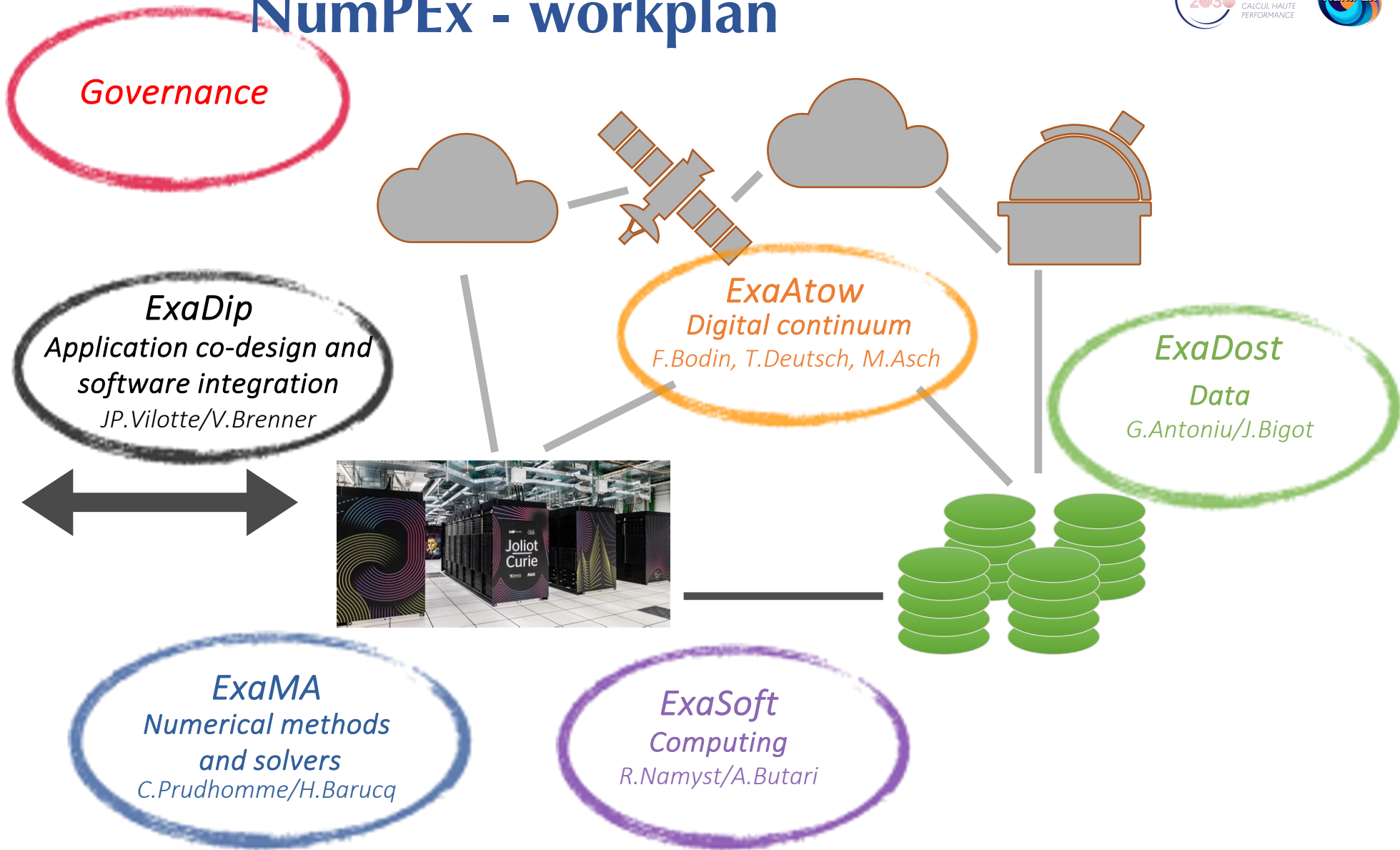


*aDost*  
Data  
oniou/J.Bigot

**Computing**  
R.Namyst/A.Butari



# NumPEX - workplan

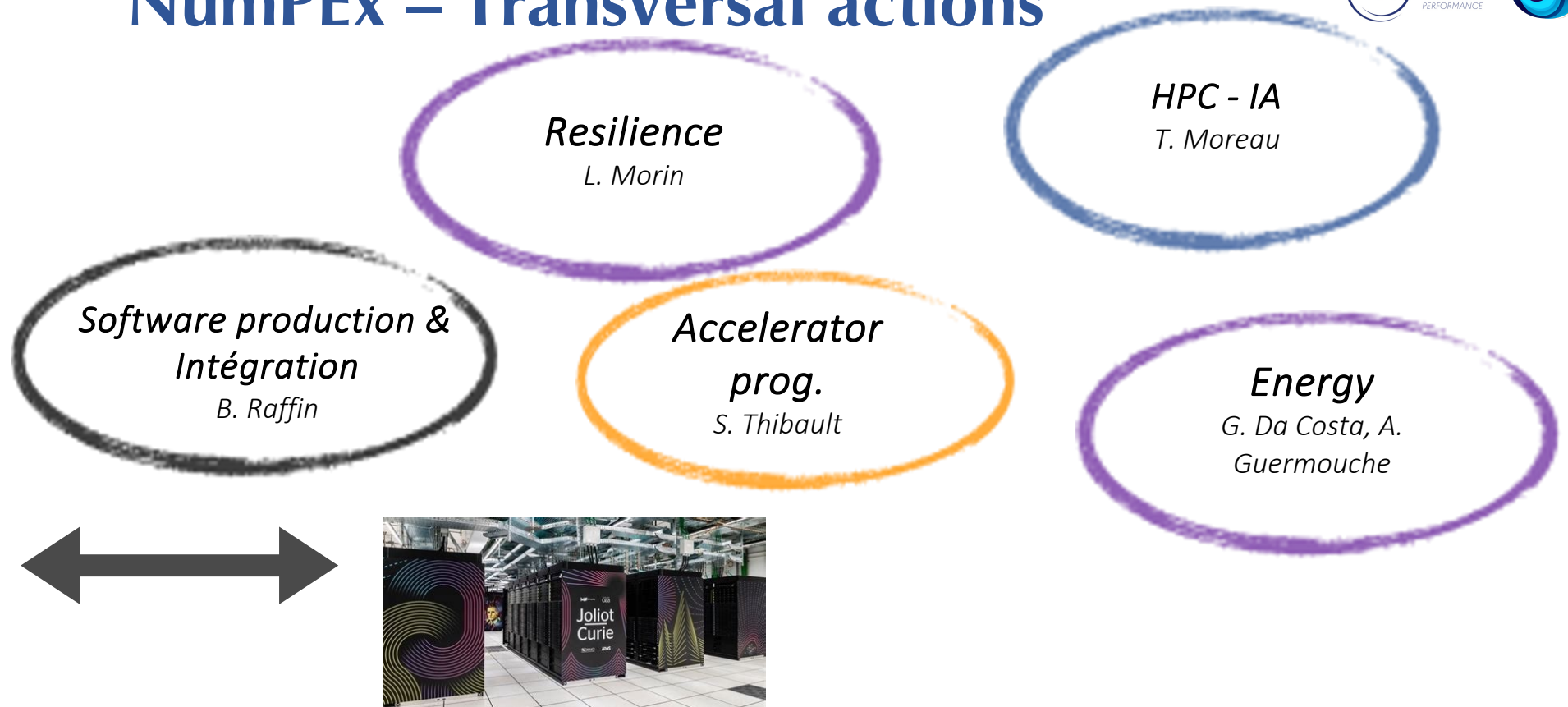


Applications

# NumPEX – Transversal actions



Applications



# NumPEX – Transversal actions



Applications

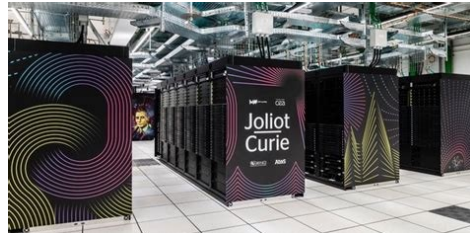
**Software production & Intégration**  
B. Raffin

**Resilience**  
L. Morin

**Accelerator prog.**  
S. Thibault

**HPC - IA**  
T. Moreau

**Energy**  
G. Da Costa, A. Guermouche



**Gender/Equity/ Diversity**  
Anne-Laure Pelé & Virginie Grandgirard

**Training**  
M. Krajecki, R. Namyst, C. Prudhomme

**Int. Collaborations**  
JY Berthou, E. Jeannot

# Take-away messages

NumPEX is an ambitious programme to:

- *contribute to the European Exascale software*
- *help preparing scientific and industrial applications to the Exascale*
- *bridge the gap between the computer science/application communities*
- *help building a French community for advanced scientific software development*
- *Foster national and international collaborations (e.g. other PEPRs, CoEs, etc)*

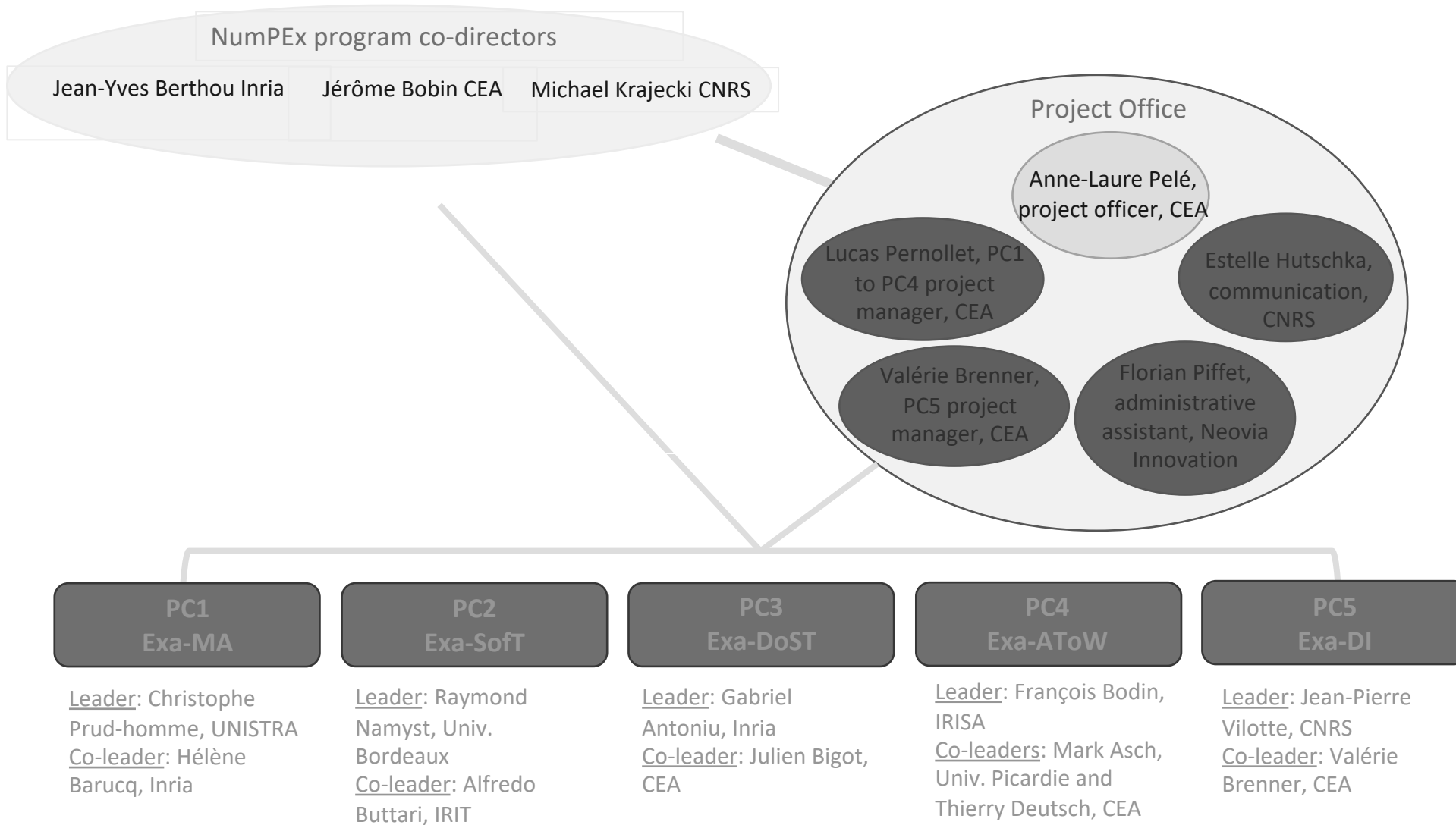
Stay tuned

[www.numpex.fr](http://www.numpex.fr)

 #NumPEX



# Project office & Operational committee





Coordination



Evaluate



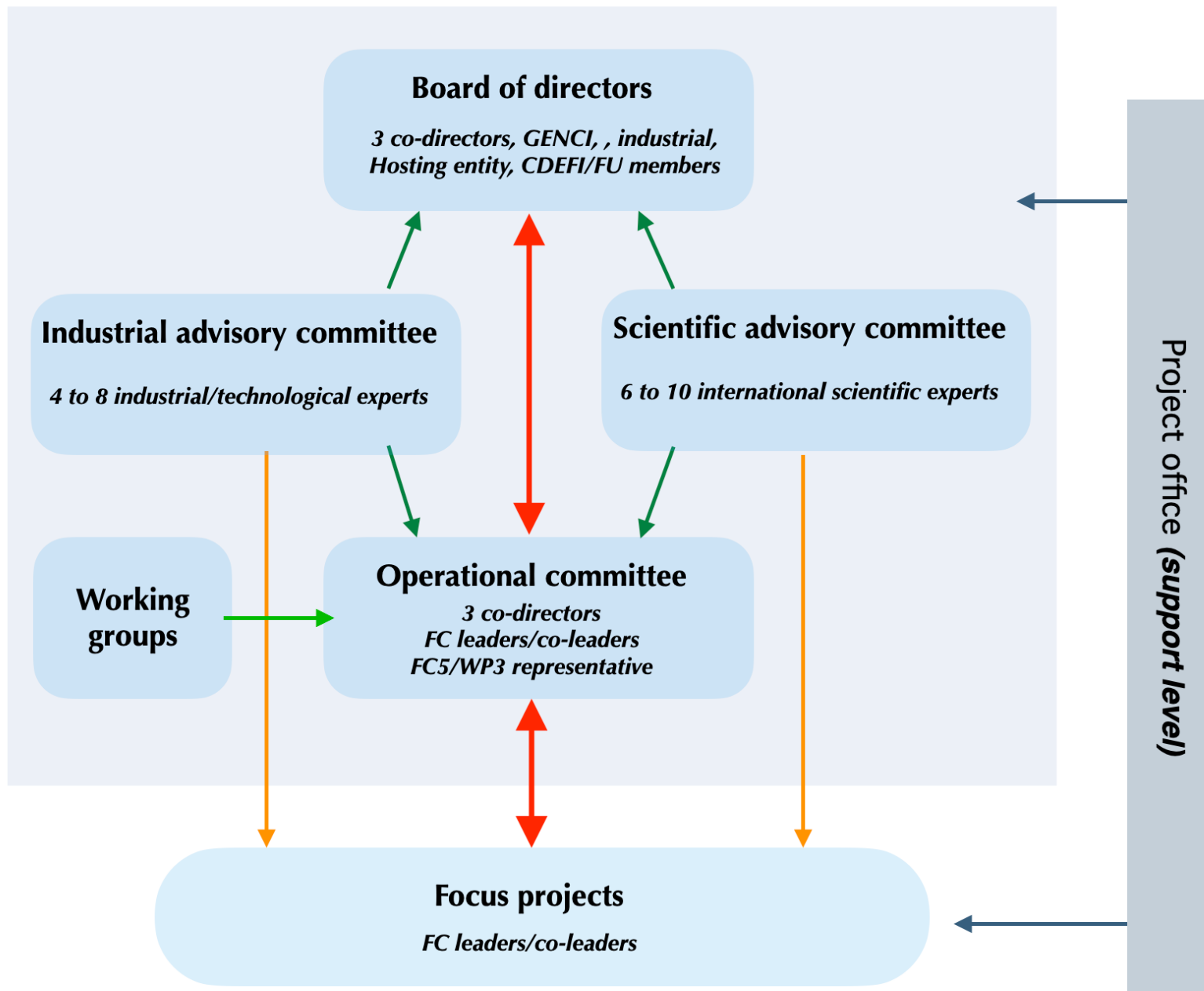
Advise



Support



Report



# NumPEX consortium



## National Research Organisation

CEA, CNRS, Inria

IFPEEn

Onera

## Industry

Atos

DataDirect networks – DDN

Airbus

Sipearl

Fermat

Intel

En discussion : Safran, EDF, Total, Thales, ...

## Engineering school

Bordeaux INP

Institut Polytechnique de Paris/Ecole

Polytechnique, Telecom Sud Paris

## University

Université de Bordeaux

Université Paris 1 Panthéon-Sorbonne

Université de Lorraine

Université de Strasbourg

Université Clermont-Auvergne

Université de Toulouse 3

Université Gustave Eiffel

Université de Lille

Université de Pau

Université de Picardie

Sorbonne Université

Université Paris Saclay

Université de Rennes

Observatoire de Paris

Observatoire de la Côte d'Azur

Université de Grenoble