



The French Alternative Energies and Atomic Energy Commission (CEA)

From research to industry

Tackling the Arm architecture for the CEA Fundamental Research Division (DRF)

France Boillod-Cerneux - Fundamental Research Division

Numerical simulation deputy

france.boillod-cerneux@cea.fr

- CEA is part of the french consortium that will apply to the EuroHPC call in order to host and manage the second exascale supercomputer in Europe



- EuroHPC is promoting European technologies, among which the European Processor

- The EuroHPC JU aims to:
 - develop, deploy, extend and maintain in the EU a world-leading federated, secure and hyper-connected supercomputing, quantum computing, service and data infrastructure ecosystem;
 - support the development and uptake of demand-oriented and user-driven innovative and **competitive supercomputing system based on a supply chain that will ensure components, technologies and knowledge limiting the risk of disruptions and the development of a wide range of applications optimised for these systems;**
 - widen the use of that supercomputing infrastructure to a large number of public and private users and support the development of key HPC skills for European science and industry.

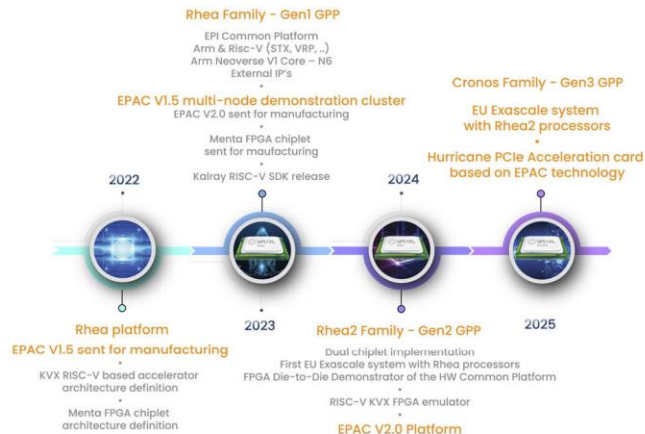
- In this context, CEA is focusing on Arm based supercomputers in order to tackle target technologies

- Among which Rhea and Cronos



- CEA is a member of EUPEX project (EuroHPC) which will provide a prototype of future European Exascale supercomputers

- Prototype blades with Rhea CPUs
- Two CEA applications are embedded within EUPEX
 - Sun modelling and material science applications



One look is worth a thousand words



GPUs

Arm

Data

Scalability

Our
applications

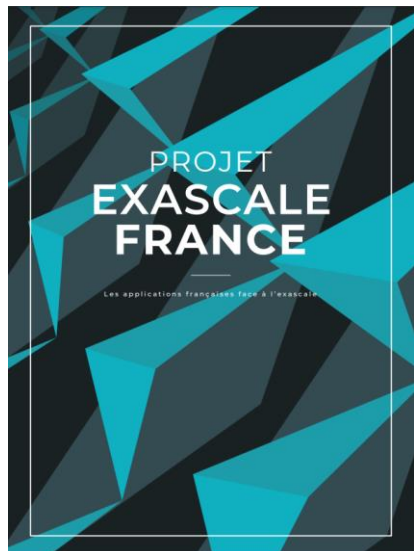


applications



exascale

- Application community in France is mobilized in order to anticipate the execution of our applications on European architectures
- CEA, CNRS, Inria and France Universities joined together to identify the spectrum of our HPC, AI, HPDA and HTC applications



- The objectives are to understand clearly what
 - Is the current state of the applications? (GPU enable? Arm enable? Current scaling? EU, international community?)
 - Are the objectives of the applications towards Exascale computing (scientific case and expected scalability)
 - Are the human resources necessary to achieve the Exascale objectives
 - Want to contribute? Mail me! France.boillod-cerneux@cea.fr

Report (in french) is available at CEA's booth

230 researchers involved

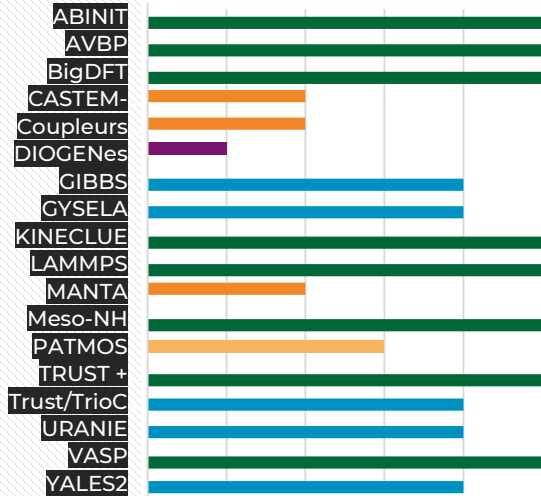


PARITY - ENERGY

WOMEN
: 7; 14%MEN;
44;
86%

COMMUNITY - ENERGY

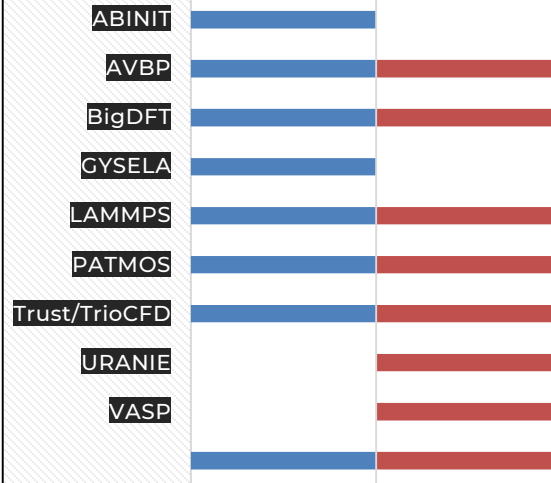
■ Equipe ■ Organisme ■ Nationale ■ Européenne ■ Internationale



CURRENT PORTABILITY - ENERGY

ARM

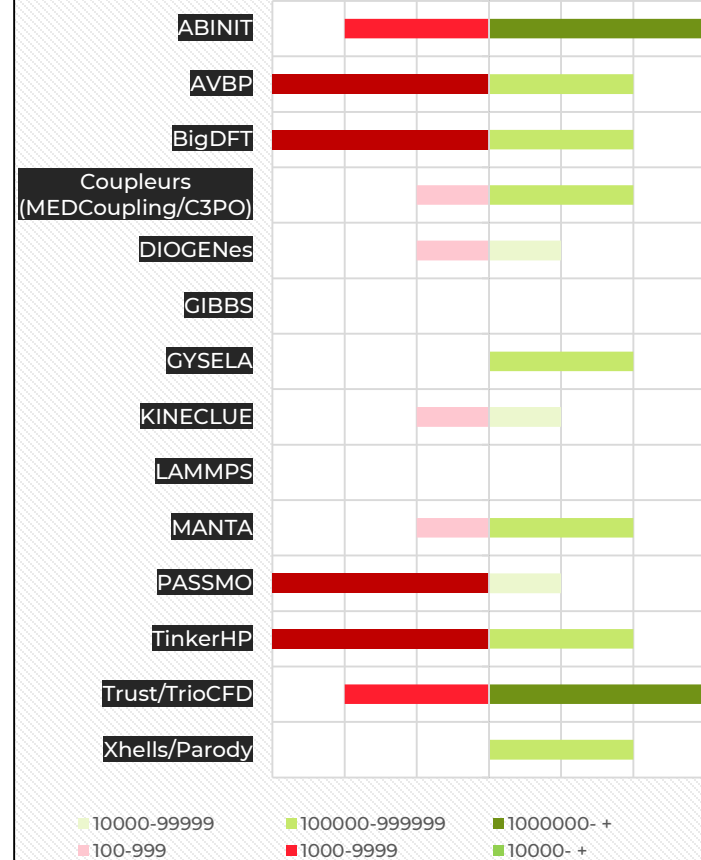
GPU



EXPECTED SCALABILITY FOR 2025 - ENERGY

GPU

CPU



10000-99999

100000-999999

1000000- +

100-999

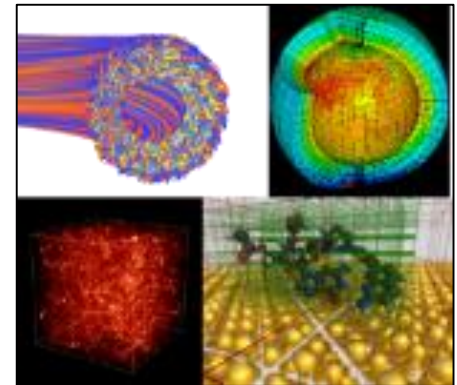
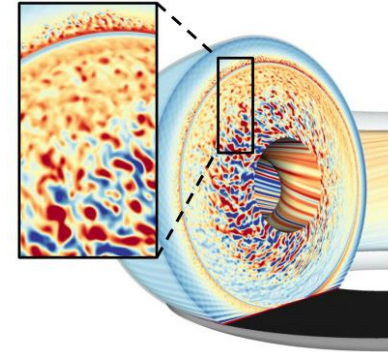
1000-9999

10000- +

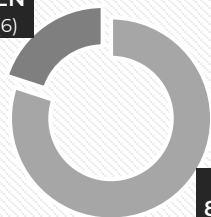
GYSELA-X is a semi-Lagrangian code addressing gyrokinetic full-f global simulations of flux driven tokamak plasmas



- Ongoing collaborative work with Atos, Arm and RIKEN to execute efficiently GYSELA on Fugaku and joliot-curie supercomputers

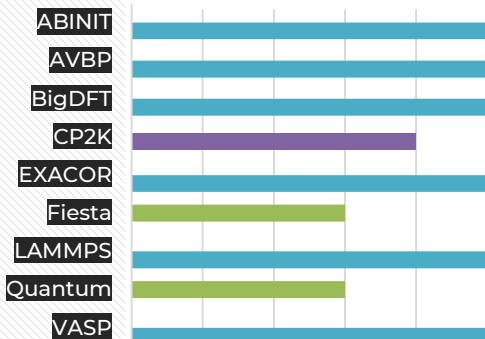


PARITY – FUNDAMENTAL RESEARCH

WOMEN
20% (6)MEN
80% (24)

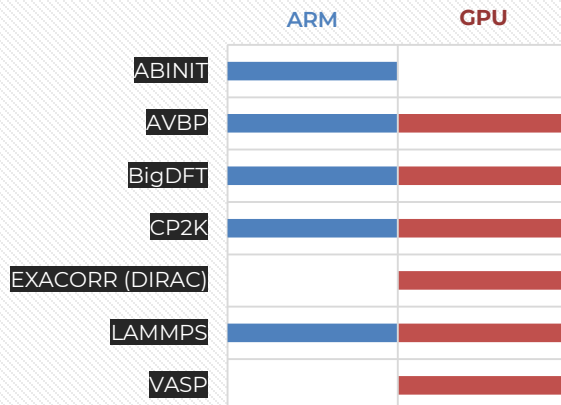
COMMUNITY – FUNDAMENTAL RESEARCH

■ Equipe ■ Organisme ■ Nationale
■ Européenne ■ Internationale

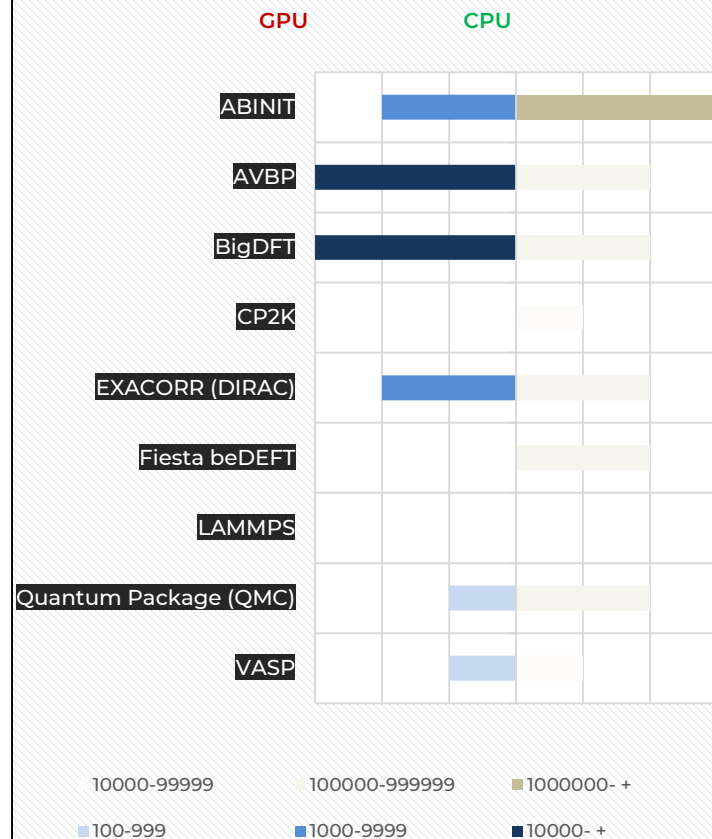


(CEA)

CURRENT PORTABILITY – FUNDAMENTAL RESEARCH



EXPECTED SCALABILITY FOR 2025 – FUNDAMENTAL RESEARCH



- BigDFT is a fast, precise, and flexible DFT code for ab-initio atomistic simulation. With BigDFT, atomistic modeling is more powerful and accessible



- BigDFT is able to tackle large Arm supercomputers
 - Running on A64FX architecture
 - ThunderX2 architecture
 - Collaborative work with



- Collaborative work on Covid19: Fugaku has been exploited by BigDFT to perform full quantum mechanical modeling of the main protease of the SARS-CoV-2 virus in complex with a large database of potential inhibitors

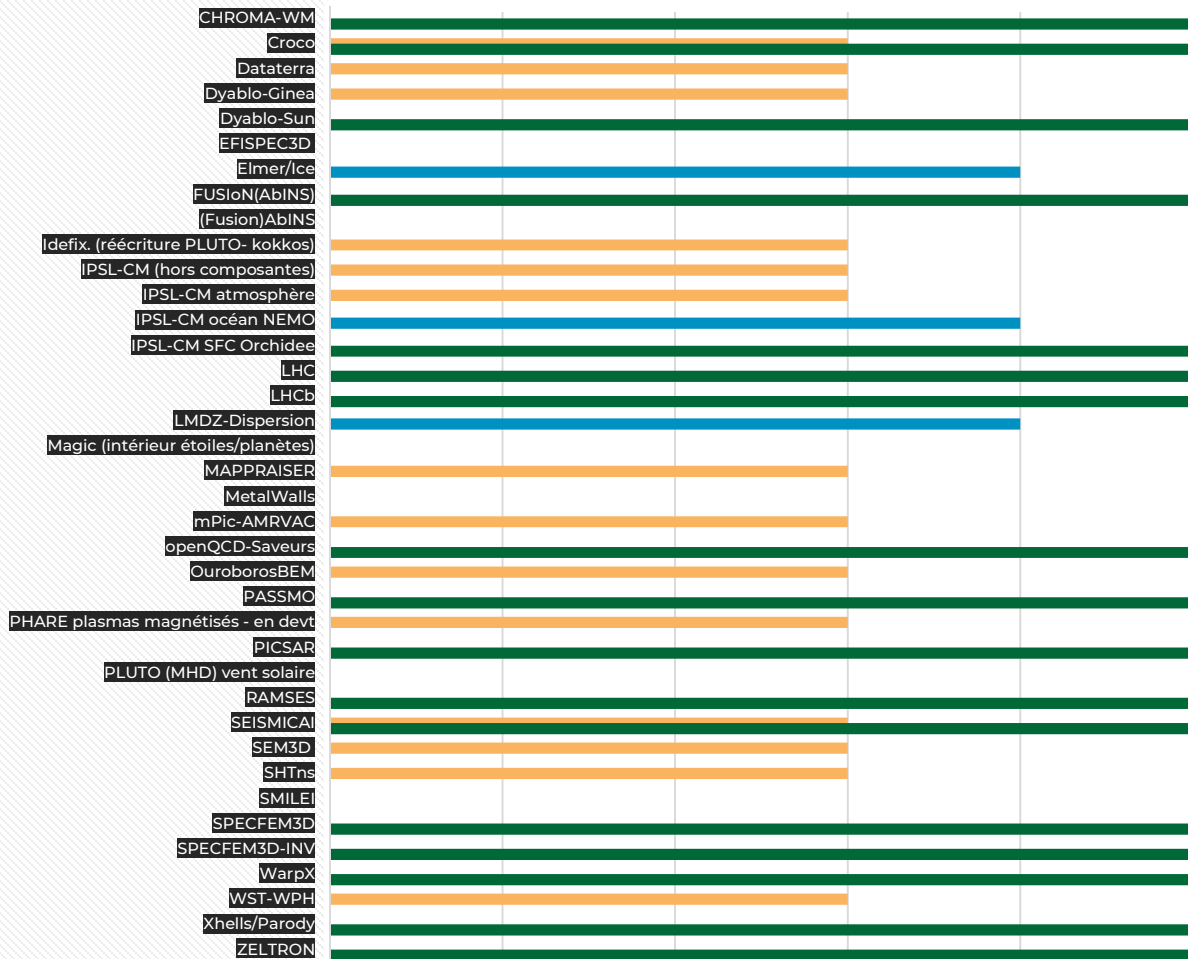
PARITY – UNIVERSE SCIENCES

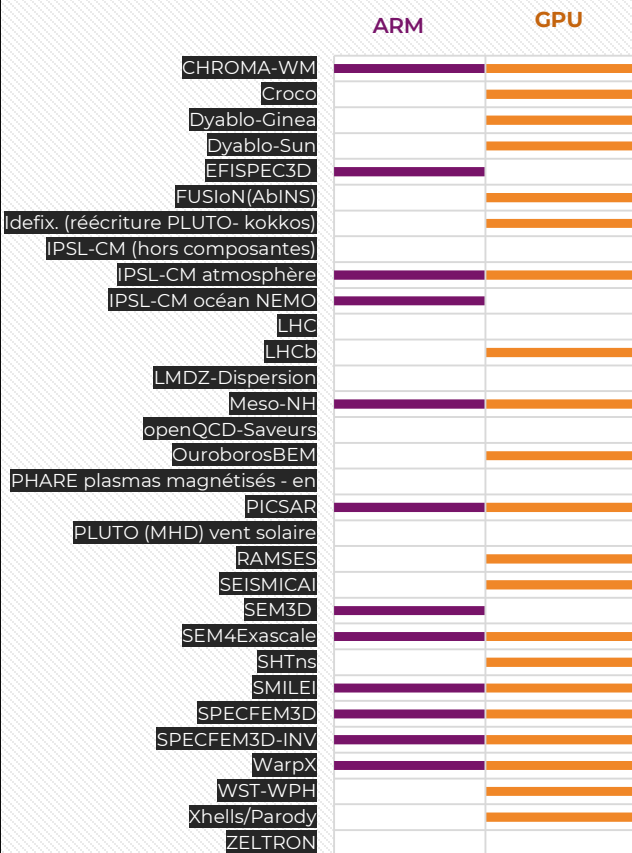
WOMEN 14% (14)



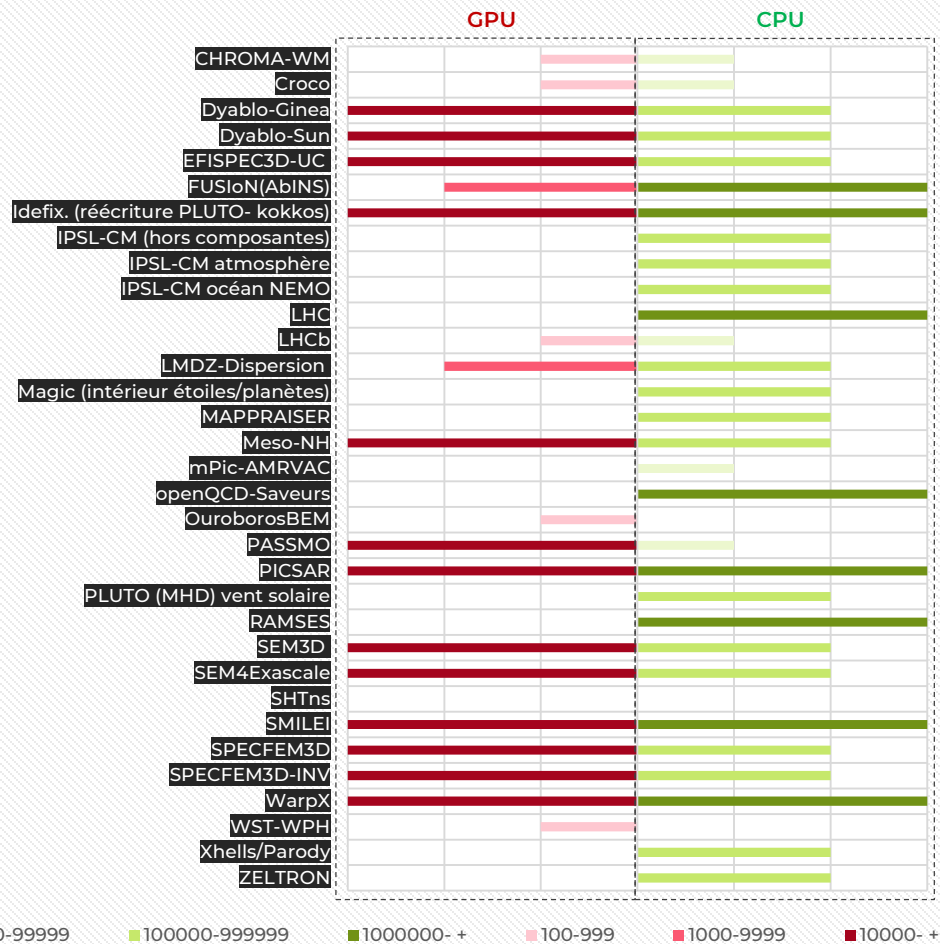
MEN 86% (85)

COMMUNITY – UNIVERSE SCIENCES

■ Equipe
■ Organisme
■ Nationale
■ Européenne
■ Internationale


CURRENT PORTABILITY – UNIVERSE
SCIENCES

EXPECTED SCALABILITY FOR 2025 – UNIVERSE SCIENCES



10000-99999

100000-999999

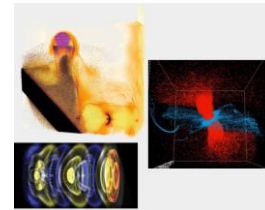
1000000-+

100-999

1000-9999

10000-+

- Warpx is an open-source Particle-In-Cell code for the exascale era



Running pretty well on A64FX: Finalists to the ACM Gordon Bell award for SC22

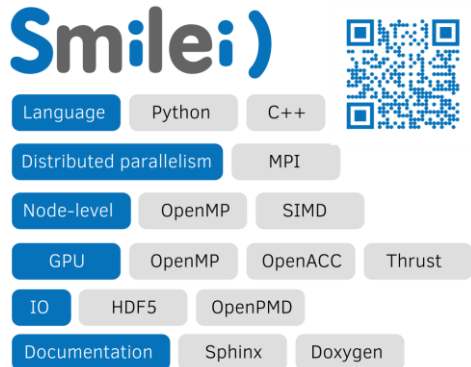
CEA: Luca Fedeli, Neil Zaim and Henri Vincenti;

RIKEN: Miwako Tsuji, Hitoshi Murai & Mitsuhisa Sato;

Partners: Atos, GENCI, Arm and Fujitsu



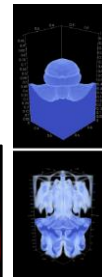
- Smilei is an open-source multi-physics massively parallel scientific application designed to simulate a broad range of plasma physics scenarios
- The code is built around the standard Particle-In-Cell method enriched by many additional physical modules: particle collision, ionization, nuclear reactions, synchrotron-like radiation, strong-field quantum electrodynamics (SF-QED) processes (via Monte-Carlo procedures).



arm



- Dyablo *dyablo* is a new simulation code developed at CEA in Saclay for the modelling of magneto-hydrodynamics on AMR grids
- To reach exascale performances, the code relies on the portability performance library Kokkos to do shared parallelism while distributed parallelism is done using MPI



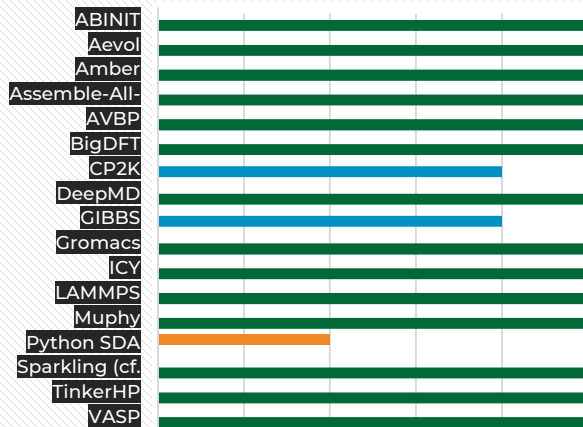
PARITY – LIFE SCIENCES

WOMAN 18% (12)

MEN 82% (53)

COMMUNITY – LIFE SCIENCES

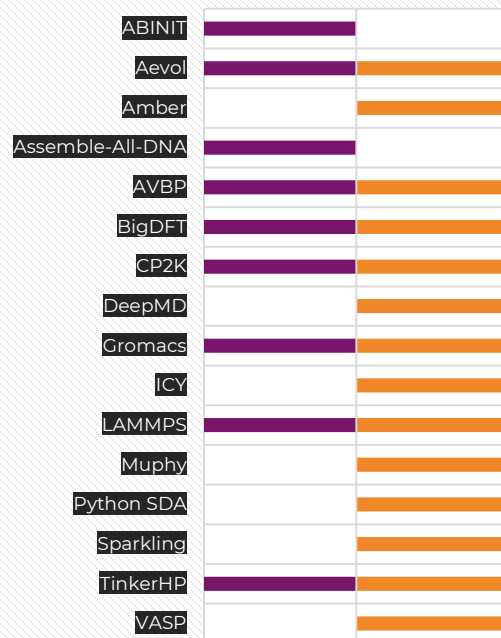
■ Equipe ■ Organisme ■ Nationale ■ Européenne ■ Internationale



PORTABILITY – LIFE SCIENCES

ARM

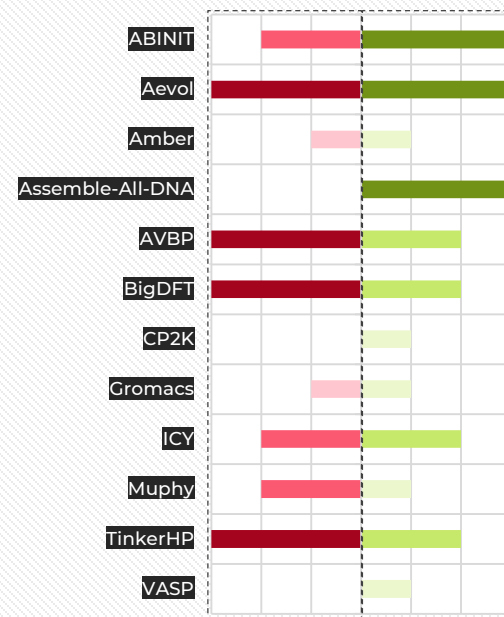
GPU



EXPECTED SCALABILITY FOR 2025 – LIFE SCIENCES

GPU

CPU



10000-99999

100000-999999

1000000- +

100-999

1000-9999

10000- +

- ❑ Gather the scientific community to accelerate the ongoing work around applications portability
 - ❑ Arm architectures
 - ❑ GPU architectures
- ❑ Academic & industrial researchers, we need you!



So that we come from this ...

Exascale

... To THIS

Our applications

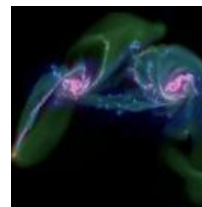
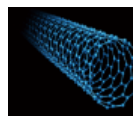
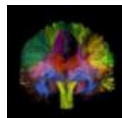
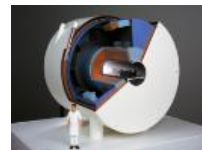


Our applications



Exascale

- Environment and Climate modelling (hpc – hpda – ia)
- Neurosciences (hpda – ia)
- Laser/matter interactions, plasma modelling (hpc)
- Material sciences (hpc – hpda – ia)
- Astrophysics and cosmology (hpc – hpda – ia – htc)
- Nuclear Physics and high energy physics (htc – ia)
- Drug design(hpc – hpda – ia)
- Omics (htc – hpda – ia)
- Fusion energy (hpc – ia)
- *Might have forgotten some more applications...*



- ☐ Open science
- ☐ National, European or international applications
- ☐ (a lot of) real/observational data

- ❑ Anticipate future architectures so we can execute our applications on future European exascale and post-exascale supercomputers
- ❑ Regular exchange and work with Arm experts and RIKEN researchers

- ❑ Strong focus on A64FX CPUs

- ❑ Thanks to a bilateral CEA-RIKEN collaboration, CEA's researchers can access Fugaku supercomputer
- ❑ Long term collaboration (since 2017)





Thank you for your attention

From research to industry