Panel Discussion

Preparing HPC Codes and Software for Exascale Computing: Early results of the G8 Exascale Projects

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ANR's main features

- **A public organisation:**

  Devoted to competitive project-based funding
  in both fundamental and applied research
  and based on international standards

- **Objectives:**

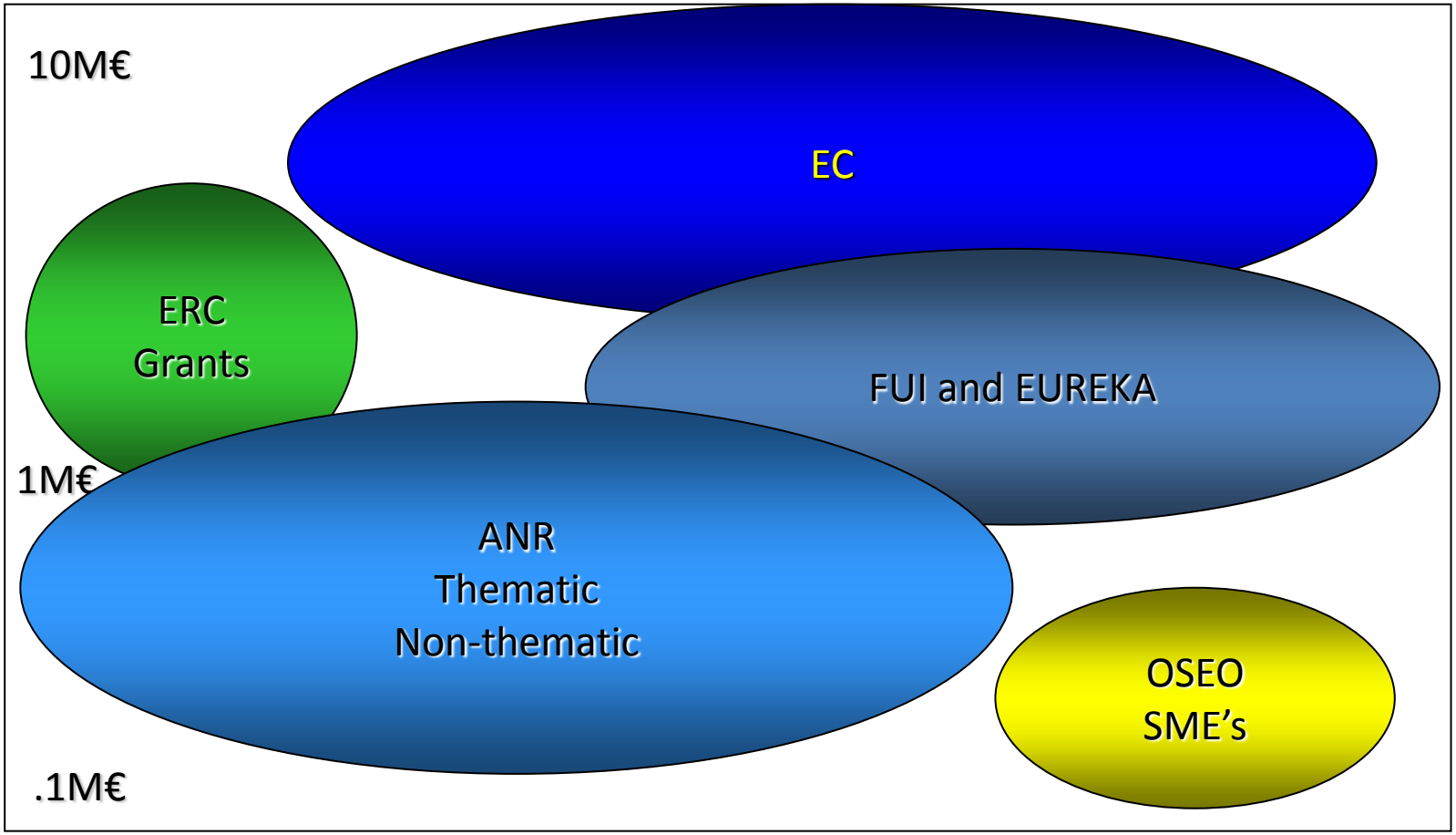
  ✓ promoting creativity
  ✓ bringing more flexibility and, subsequently, reactivity
  ✓ increasing competitiveness while maintaining a good balance between fundamental research and applied research

- **2011 budget:** € 728 M (€ 557 M dedicated to grants)

ANR Organisation

- 7 scientific departments:
  - "Exploratory and Emerging Research" Department in charge of the "Blanc" programme and non-thematic programmes
  - 6 thematic departments:
    - Biology and Health
    - Information and Communication Sciences and Technologies
    - Sustainable Energy
    - Environment and Biological Resources
    - Engineering, Processes and Security
    - Social sciences and humanities
- 1 transverse department:
    - Partnerships and Competitiveness

ANR and other funding sources



Basic

Industrial
Exploratory

Innovation
Development

Key figures

- **Instruments:**
  - ✓ 55 - 60 calls /year (in average)

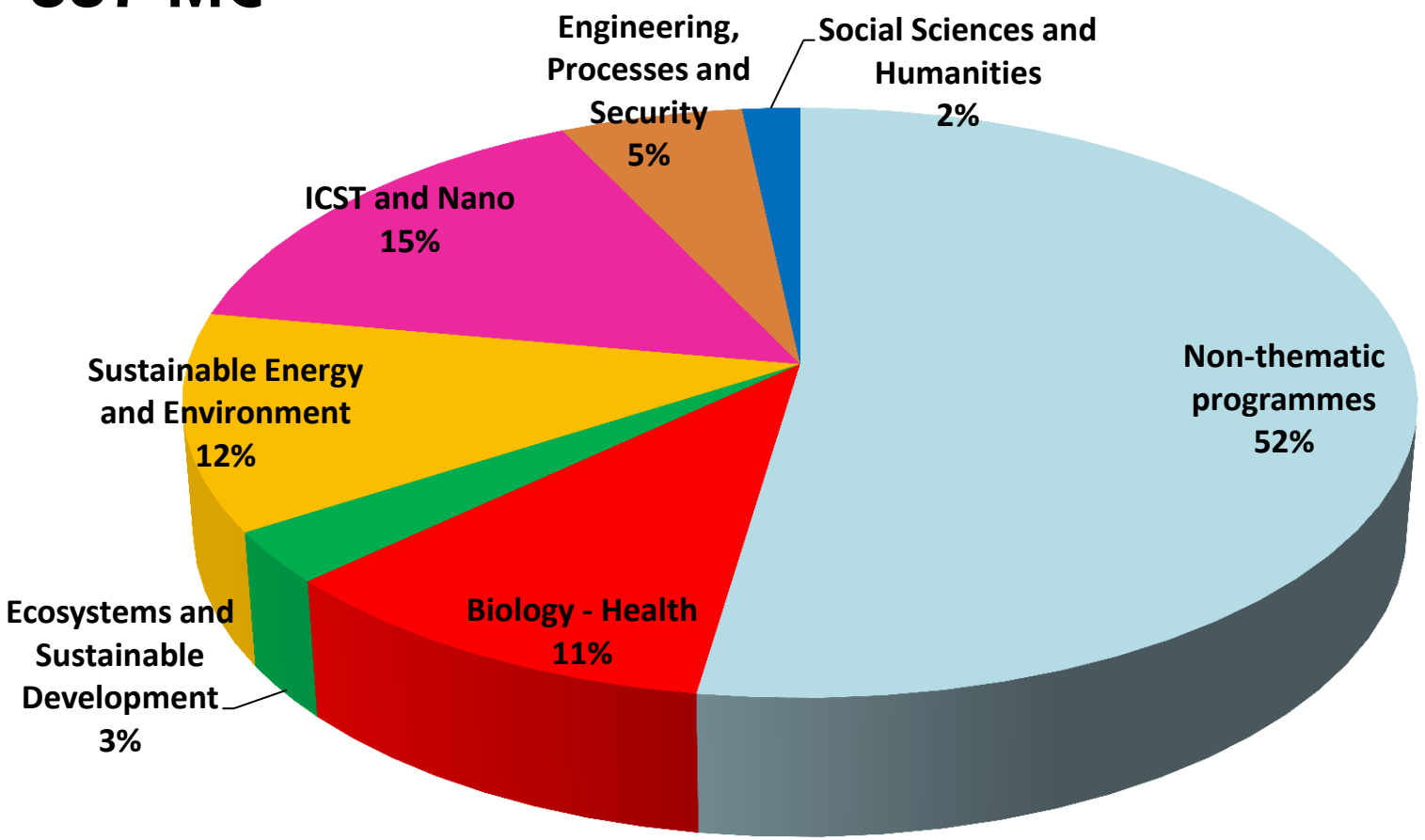
- **Peer-review evaluation of projects:**

  About:
  - ✓ 6 000 projects submitted yearly (6 237 in 2011)
  - ✓ 1 300 projects funded yearly (1 260 in 2011)
  - ✓ Success rate: 20.5% in average for 2011

- **Substantial funding to the selected projects:**
  - ✓ Academic Projects: <430 k€>
  - ✓ Public-Private Partnership Projects: <870 k€>

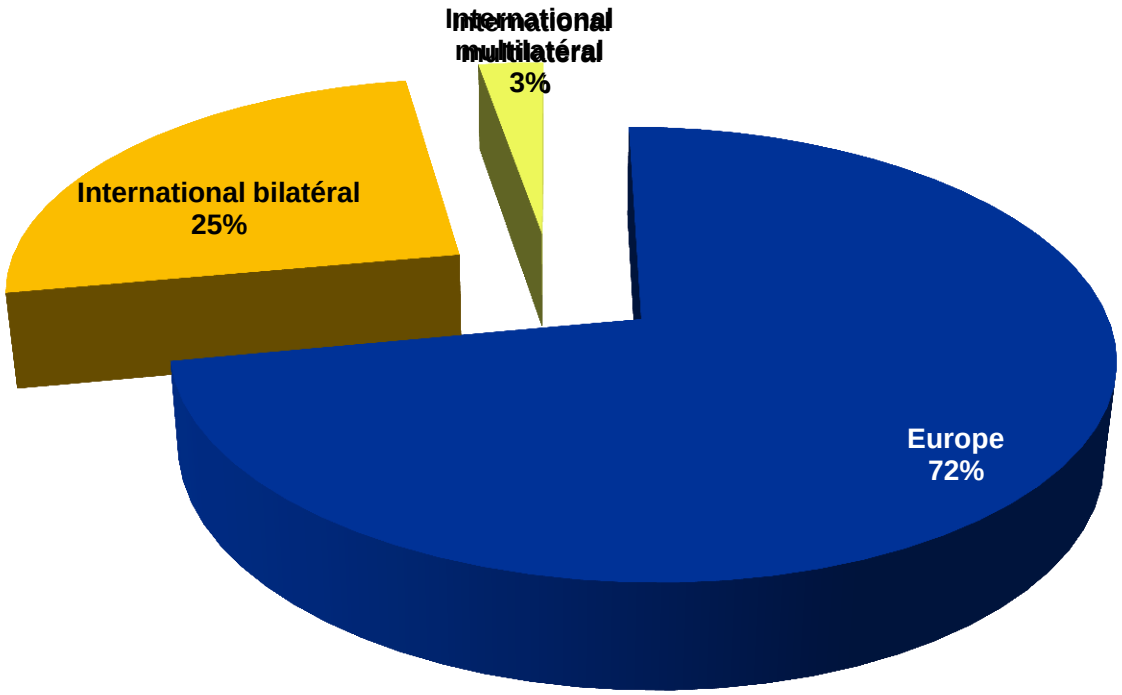
ANR grants in 2011

557 M€



Europe vs International (2)

€58.8 M of ANR funding to transnational projects



16% of ANR projects are co funded with foreign countries
10% of budget : cost sharing

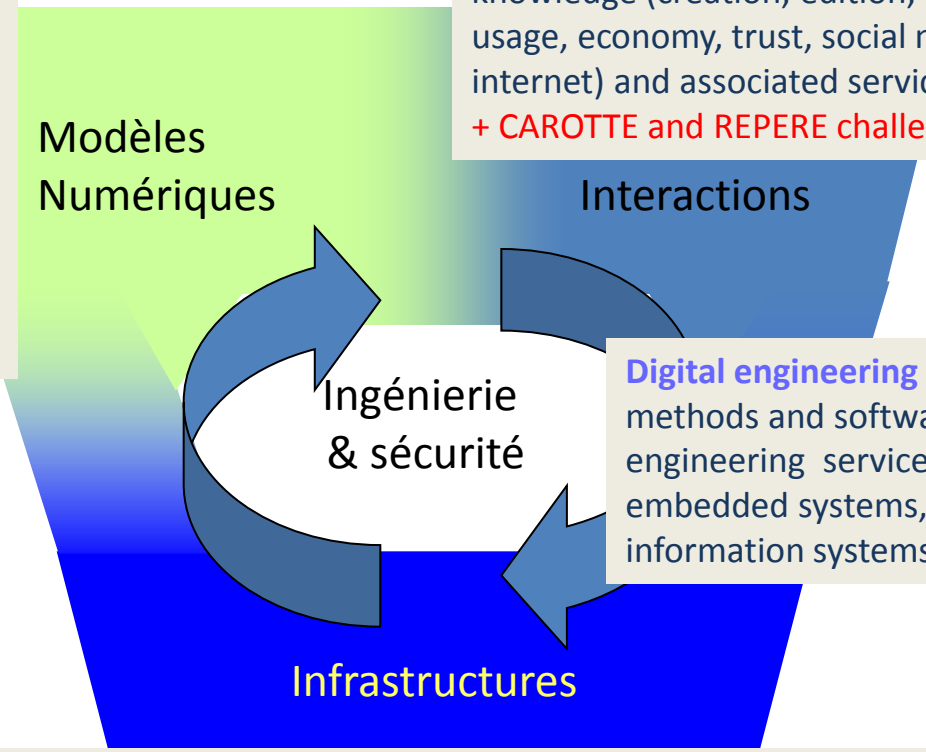
ICT 2011-2013 programming

Numerical Society

Manufacturing (Design and production), services industry, culture, health, energy, smart city, smart home, e-education, transport, entertainment, …

Digital Models - Simulation, HPC, Big Data and Design (MN): development of a digital "double» through modelisation and simulation of the physical world, objects, services and human behavior (modelisation , simulation, intensive computing, big and complex data production and management, virtual reality , visualisation

Digital Content and Interactions (CONTINT): production and exchange of digital contents and knowledge (creation, edition, mining, interfaces, usage, economy, trust, social network, futur of internet) and associated services, robotic
+ CAROTTE and REPERE challenges



Digital engineering and security (INS): methods and software tools for engineering services and digital systems, embedded systems, security and trust of information systems

Infrastructures for the digital society (INFRA): Communication, Data, High Performance Computing Infrastructure, including "cloud computing", components/sub-systems for operating them (e.g optical components, photonic)

2005-2011 ANR ICT programs funding: 646 M€

Submissions: 4143 projects

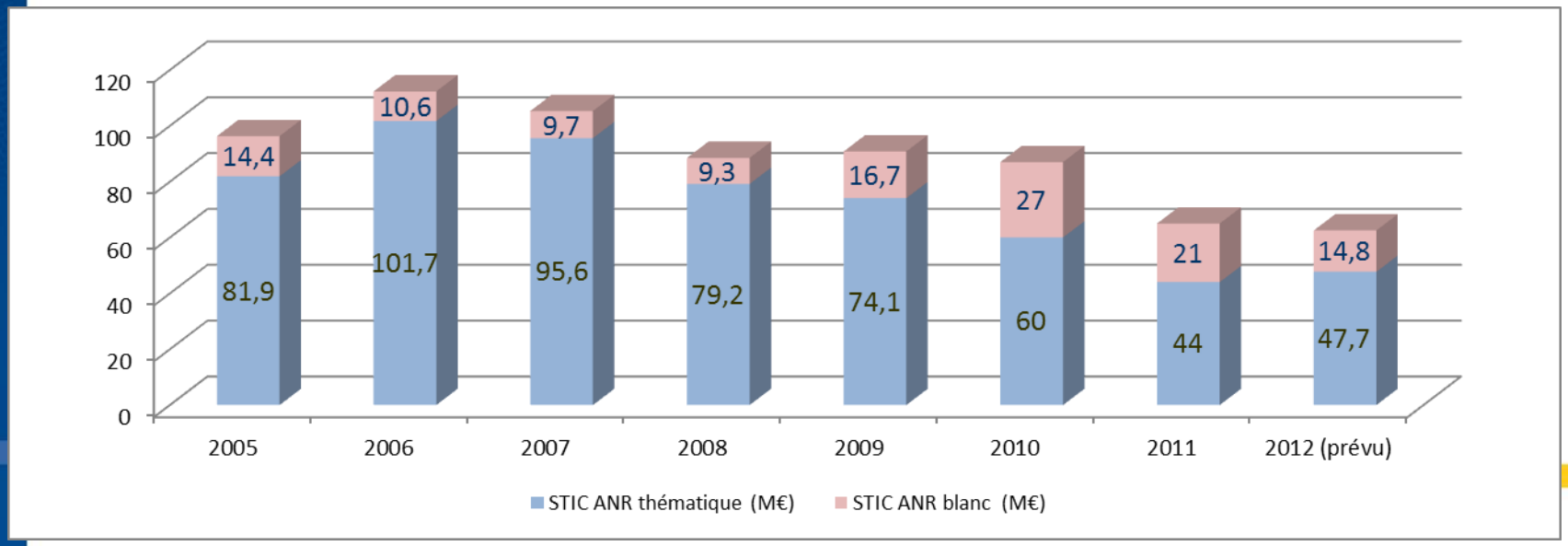
- 2612 thematic
- 1531 non thematic

Funding: 1113 projects

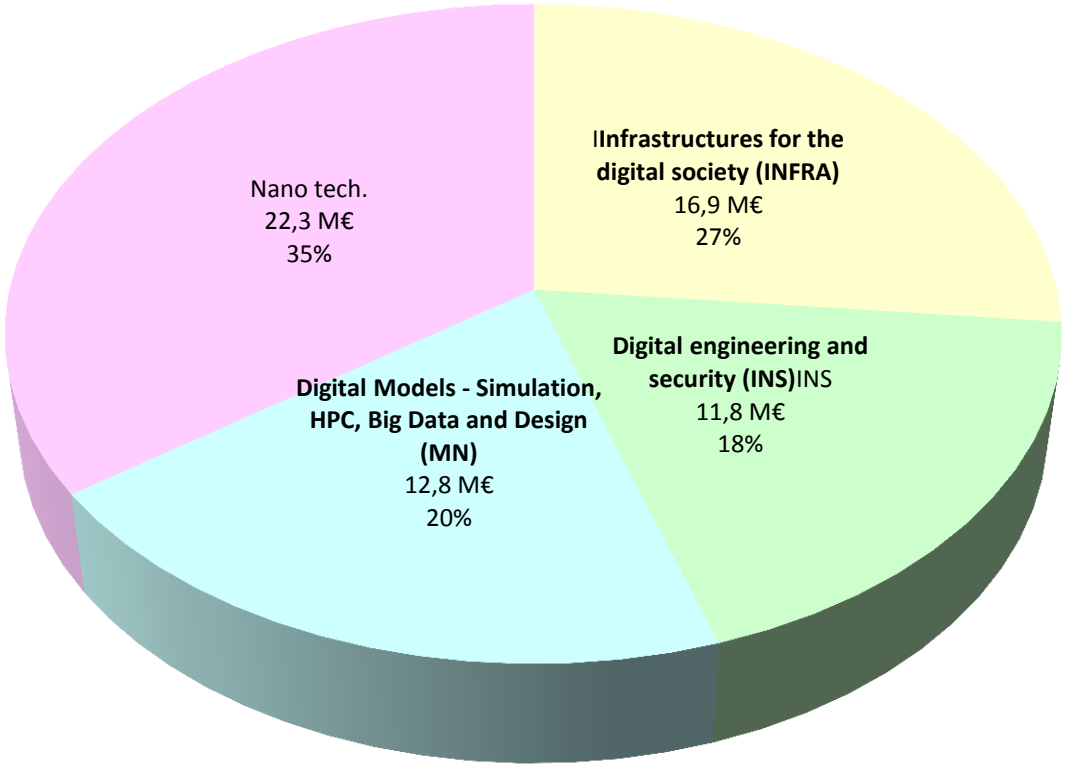
- 775 thematic
- 338 non thematic

Funding : 646 M€

- 537 M€ thematic
- 109 M€ non thematic



2011 ANR funds for Nano and ICT programs



Common backbone for the funding agencies

- Exchange of best practices for selection, programming, follow-up
- Exchange of strategic objectives and build common vision
- Definition of common evaluation, selection, implementation process
- Launch common call for proposals
- Projects follow up after funding
- one call, two subjects every year

2013:

- **User-driven, context- and content-aware communication networks**
- **Intelligent User Interfaces**

Interest in others ANR programs

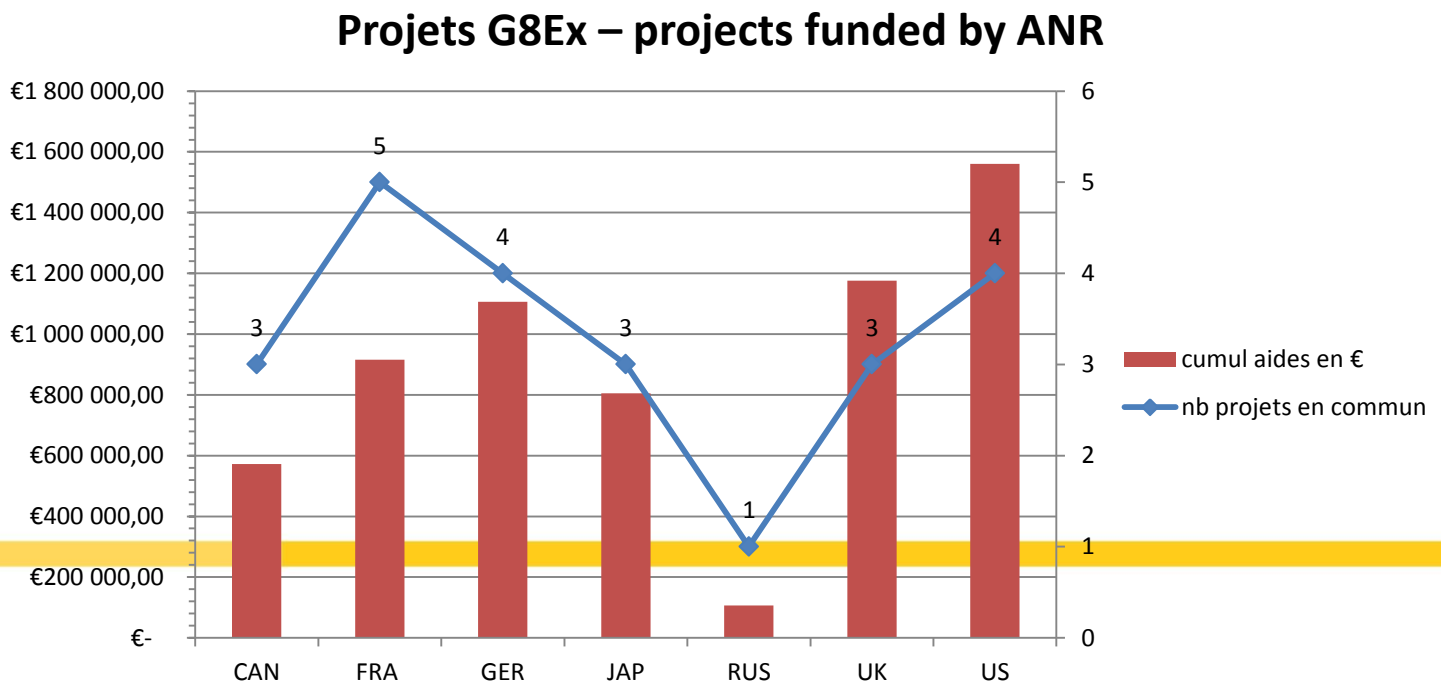
- French Non thematic (Emergence, SIMI, …)
- International ICT
  - ERA-NET CHISTERA
  - ….
- Multi-disciplinary
  - (Renewable) production and electricity management
  - Sustainable buildings and cities
  - Sustainable production and environmental technologies
  - Sustainable land transportation
  - Humanities & Social Sciences « Innovation, Technology, Society »
  - G8 research
  - Emotion et cognition
  - TecSan and e-Health,
  - ICT Agriculture
  - Global Security
  - Etc.

2011 - G8 call: Interdisciplinary Program on Application Software towards Exascale Computing for Global Scale Issues

- France, Germany, UK, Japan, USA, Canada, Russia

Support interdisciplinary projects targeting the exploration and development of open source algorithms and data operations that are resilient, sustainable and scalable to exascale for application solutions to socially relevant global scale issues. It is only through the close cooperation of computing specialists with global scale issues specialists, including related humanity and social scientists where appropriate, that future high performance computing systems can successfully be applied to tackle essential challenges for mankind in the 21st century.

- 2 step call, 1st step, 84 proposals received and 24 selected for full proposal submission
- 6 Projects co funded, 5 with french partners, academic partners only
- Mid term workshop Nov 2012



Questions to the panel

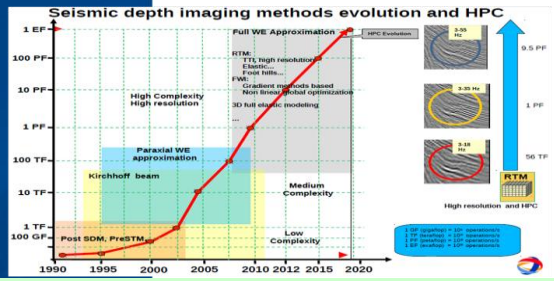
- Funding agency view on the relevance of exascale research within the broader context of computational and data science needs;
- Relevance of exascale topics to broader needs of the scientific community and vice versa

Some conclusions from *the European Exascale Software Initiative* (www.eesi-project.eu)

Funding: FP7 Support Action, DG Information Society and the unit e-Infrastructures

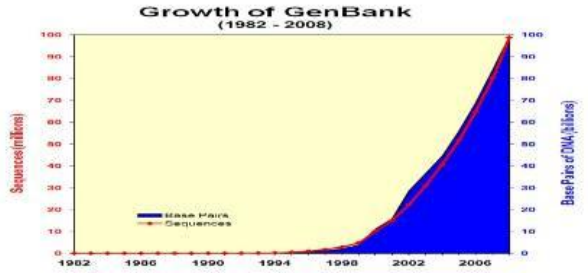
What and Why is Exascale?

EXAFLOP in two flavors (**capability and capacity**)…



10^{18}

… and/or **ExaBytes**



Capacity

Drug design: realistic cell membrane models, including **drug permeation and binding**

Industrial applications /Oil&Gas: identify the most probable knowledge of the underground: huge 3D seismic wave inversion and robust optimization

Capability

Quantum Chemistry : material properties identification x10^3 runs of 100 TF

Industrial applications/Aeronautics-Greening the aircraft: Real-time simulation of aircraft in flight, Multidisciplinary aircraft design, aerodynamic loads and derivatives of the aircraft for every imaginable flight situation x1000 runs of 100-1000 TF

Climate: satellite sensors create floods of data (x 1000), leading to Exa-scale archives, ex. projected frequency of intense tropical cyclones in some region of the globe

Industrial applications: management of data generated from micro/macro sensors and automated measurement devices

Quantum Chemistry: discover a material and properties: ab initio databases of materials and molecular properties connected to existing databases of experimental properties

Astronomy: **Square Kilometre Array**, 3600 antennas, Vital to process data from observing to archive with no human decision making at 1 EB/s rate

What and Why is Exascale (and not just extrem computing & Big Data)?

Exascale, a **technological breakthrough**, thus a subject scientifically interesting

- Compare to Petascale computers: memory per core 1/10, CPU heterogeneity, total node interconnect BW & node memory 1/10, concurrency *10
- => *concurrency/load balancing, data locality/Memory management, resilience/fault tolerance*
- Software layer and applications need to exploit these new hardware trends that cannot be handled by existing software stack
- Community codes unprepared for sea change in architecture while:
  - designing and developing a new generation of Scientific Applications **takes 5 to 10 years,** lifetime of Scientific Applications are **several decades**

What and Why is Exascale?

EXAFLOP also means a Petaflop in a box

…for $200 000 and 20 KW

System attributes	2010	"2015"		"2018"		Difference Today & 2018
System peak	2 Pflop/s	200 Pflop/s		1 Eflop/sec		O(1000)
Power	6 MW	15 MW		~20 MW		
System memory	0.3 PB	5 PB		32-64 PB		O(100)
Node performance	125 GF	0.5 TF	7 TF	1 TF	10 TF	O(10) – O(100)
Node memory BW	25 GB/s	0.1 TB/sec	1 TB/sec	0.4 TB/sec	4 TB/sec	O(100)
Node concurrency	12	O(100)	O(1,000)	O(1,000)	O(10,000)	O(100) – O(1000)
Total Concurrency	225,000	$O(10^8)$		$O(10^9)$		O(10,000)
Total Node Interconnect BW	1.5 GB/s	20 GB/sec		200 GB/sec		O(100)
MTTI	days	O(1day)		O(1 day)		- O(10)

Huge impact for those, academic, industrial, large and small structures, including SMEs, that will be **able to take advantage** of "Exascale" technology, not just for few heroes applications

What and Why is Exascale?

- Europe need for a **sustainable, long term and coordinated** effort
- **International** collaboration is required
- A 2,5 to 3,5 billions euros total budget over 10 years, supported by EC, National European funding agencies, industry, … **a several decades** engagement
- Scientific Computing at Exascale, from a computing and data intensive point of view are **strategic** for maintaining and developing both **European Scientific Excellence and Industry Competitiveness**
- Europe should encourage the development of **Open Source solutions** to foster international collaborations and the emergence of international *de facto* standards, enabling commercial exploitation

Questions to the panel, the ANR feedback

- Examples of existing funding models that could be leveraged or enhanced for exascale research topics
- Opportunities for joint funding for shared computational and data cyber infrastructure, application research and education

International collaboration

- Strategic in the *Extreme computing& Big Data* field because of the scientific complexity challenge to address and of the level of investment needed

Regarding this first G8 Exascale call

- Very high level of submission, great success
- Was complex to put in place but works, would be a lost of time and money not continue to take advantage of this tool if this first call is successful
- Multi-disciplinary dimension, challenge driven call is essential
- Small amount of money compare to what is needed in this field and the global cost for managing it

Questions to the panel, the ANR feedback

- Examples of existing funding models that could be leveraged or enhanced for exascale research topics
- Opportunities for joint funding for shared computational and data cyber infrastructure, application research and education

Other possible funding tools

- Challenges: one identified scientific challenge to address, competition between teams at international level
- Network of projects, enabling existing projects funded at national level to collaborate at international level
- Network of Excellence, enabling existing experts to exchange at international level