



**ETP 4 HPC**

**THE EUROPEAN TECHNOLOGY PLATFORM  
FOR HIGH PERFORMANCE COMPUTING**



































[www.etp4hpc.eu](http://www.etp4hpc.eu)

# **HPC Info Day 2014**

**Networking Session – 1 45 – 3 45 PM**

**Alphabetical Order**

**3 minutes each only**

 ALLINEA - Jacques Philouze	 SIMULA - Valeriya Naumova
 BIFI-UNIZAR - Guillermo Losilla Anadón	 SLOVAK ACADEMY OF SCIENCES - Jozef Noga
 BOGAZICI UNIVERSITY - Can Ozturan	 TERMOFLUIDS - Ricard Borell
 BRIGHT COMPUTING - Matthijs van Leeuwen	 THALES GROUP - Michel Barreateau
 BSC - Marcin Ostasz	 UNIVERSITEIT ANTWERPEN - Wim Vanroose
 CEA - Jean Gonnord	 UNIVERSITY OF MANCHESTER - Lee Margetts
 CEA-LIST-MELT- Basile Starynkevitch	 UPV - Jose Flich
 CERTH - Manolis Vavalis	
 CHALMERS - Georgi Gaydadjiev	
 CIMNE - Javier Mora	
 CITIUS - José Carlos Cabaleiro Domínguez	
 CLUSTERVISION - Christopher Huggins	
 CTTC - Oriol Lehmkuhl	
 DISTENE - Laurent Anné	
 EESI2 - Thierry Bidot	
 ENGINSOFT - Gino Perna	
 FLEMISH SUPERCOMPUTER CENTER - Ewald Pauwels	
 FORTH-ICS - Polyvios Pratikakis	
 FRAUNHOFER - Franz-Josef Pfreundt	
 INFN - Luca Gammaitoni	
 INTEL - Marc Dolfus	
 KALRAY - Christian Chabrerie	
 LRZ - Dieter Kranzlmüller	
 MAISON de la Simulation - CEA - Edouard Audit	
 MAXELER - Craig Davies	
 QUEENS UNIVERSITY BELFAST - Dimitrios S. Nikolopoulos	
 SICOS - Andreas Wierse	

# Allinea and H2020

- **UK Development tools company since 2004**

- Provide integrated developers and system efficiency tools accessible to the widest range of scientists and programmers
- Large worldwide installed customer base, first and only Petascale tools chain
- One of ETP4HPC founder



- **As a partner for e-infrastructure**

- Improving HPC software and developer efficiency through tools and training
  - EINFRA-2014-2 - HPC Competence Centres for SMEs,
  - EINFRA-2015-1 - Centres of Excellence for computing applications



- **R&D for future systems**

- FET HPC 1
  - (b) - Programming methodologies, environments, languages, tools
    - Allinea brings scalable debugging and profiling tools to projects
    - Many challenges in extreme (and regular) scale programming
    - Tools for hybrid and task-based and other models
    - Energy awareness for software development
  - (c) - APIs and system software for extreme scale
    - Energy efficiency APIs can enable energy profiling with Allinea tools
    - System reporting can enable better application debugging and profiling
    - Fault tolerance requires tool integration



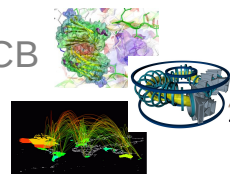


Instituto Universitario de Investigación  
**Biocomputación y Física  
de Sistemas Complejos**  
Universidad Zaragoza



175 people  
4 main research areas

BIOCHEMISTRY & MCB  
PHYSICS  
BIOPHYSICS



direct connection  
with scientific  
communities!

## COMPUTATION

two-fold role

Resources

Research

- 140 m2 data center
- 2 hpc clusters (4000 cores, 28 TFLOPS)
- EGI grid site (1250 cores)
- OpenStack cloud platform (500 cores)
- 2 special purpose computers (512 FPGAs)
- BOINC-based volunteer computing network (30.000 users)



### HPC

SCC-Computing, Spanish  
Supercomputing Network...

### Grid & cloud computing

EGI-InSPIRE, SCI-BUS,  
CloudSME, Fortissimo...

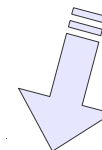
### Citizen science

Ibercivis, Societize,  
Global Excursion...

### Technology transfer

SEPS, 3D lab with immersion,  
Remote reality system...

### Special-purpose computers



Aim: "Design and development of computers  
optimized for specific applications"

### OUR H2020 INTEREST AREAS:

- **FETHPC1 - 2014:** HPC Core Technologies, Programming Environments and Algorithms
- **ICT 4 - 2015:** Customized and low power computing
- **EINFRA 5 - 2015:** Centres of Excellence for computing applications
- **FETHPC 2 - 2014:** HPC Ecosystem Development
- **EE 8 - 2014:** Public procurement of innovative sustainable energy solutions
- **EINFRA 6 - 2014:** Network of HPC Competence Centres for SMEs
- **EINFRA 4 - 2014:** Pan-European High Performance Computing infrastructure and services

### Dedicated computer background history in our group:

1985: **APE** ("Array Processor Experiment")  
Topics: Lattice Gauge Theories

1991: **RTN** ("Reconfigurable Transputer Network")  
Topics: U(1)-Higgs model (Lattice Field Theory) and Spin Glasses

2000: **SUE** ("Spin Update Engine")  
Topics: 3D Ising Spin Glasses (10-5 sec)

2008: **JANUS**  
Topics: Spin glasses and...

2013: **JANUS II**  
Topics: Spin glasses and...



Contact us!

<http://bifi.es>

[david.iniguez@bifi.es](mailto:david.iniguez@bifi.es)





***Bogazici University***, Dept. of Computer Eng.

Istanbul, Turkey <http://www.boun.edu.tr>

Contact: Can Ozturan, [ozturaca@boun.edu.tr](mailto:ozturaca@boun.edu.tr)

## **Organization Profile**

- Computer Eng. Dept. is one of the most competitive departments in Turkey. Undergraduate program is accredited by ABET (implements ACM/IEEE Curriculum).
- Bogazici University ranked as 199<sup>th</sup> in Times Higher Education University Rankings 2014.
- Participated in European projects : SEEGRID2, SEEGRID-SCI, PRACE 1IP, 2IP, 3IP
- Strong collaborations with UHeM / ITU ( National Center for High Performance Computing) in PRACE projects.

## **Areas of interest in the H2020 HPC program**

- Applications ( massive mesh generation, adaptivity, mesh management , scientific comp.)
- Resource Management (energy, topology aware scheduling, SLURM)
- Dataflow computing, Spatial Computing , Workflows.
- Parallel graph algorithms, graph databases, partitioning, time dependent graphs
- Big data processing
- HPC academic curriculum and training, best practices, accreditation

- Bright Computing: European HPC software company
- Mission: make all types of clusters easy and productive, so the scientists and engineers can focus on the real work
- Bright Cluster Manager: multi-cluster HPC cluster management software for deploying, provisioning, managing, monitoring, cloud bursting, user management, access control, Hadoop, OpenStack, and much more
- All European Intellectual Property
- A true European HPC export success story
- Customers:
  - US: Boeing, NASA, DoD, Lockheed Martin, Novartis, SpaceX
  - APJ: Sinopec, JAXA, TITEC, Uni Tokyo, Kyoto, NTU
  - EU: Sanofi, CD-adapco, Murex, CEA, CSCS, Uni Oxford, Cambridge, Amsterdam
  - ~300 others
- Interested in contributing to relevant projects:  
management / monitoring / visualization of:
  - Systems, (exa)scale, performance, health, power, networks, etc.

# BSC at a glance

## Key Facts



- National & European HPC Infrastructure
- PRACE Tier-0 Hosting Partner
- +350 staff from +40 countries

### Key European Research partner

- Has participated in 80 FP6/7 projects
- 13 as coordinator
- Mont-Blanc, HBP, DEEP etc.

### Solid Partnerships with Industry

- Microsoft, IBM, Intel, NVIDIA, Repsol
- Bull, ARM, Eurotech (Leading role in ETP)

## BSC Departments

### Computer Sciences

- Computer Architecture, Programming Models, Performance Tools, Cloud,
  - multicore for realtime

### Life Sciences

Over 70 researchers working on computational genomics molecular and protein modelling for personalised medicine

### Earth Sciences

Air quality and climate modelling

### Computer Applications

- Specialised in Energy Applications and Biomechanical Simulation

## Interest in WP 2014-15

### FET HPC 1

- Mont-Blanc 3

### FET HPC 2

- Coordination HPC strategy: strong BSC contribution through ETP

### CoEs

- Personalised Medicine
- Performance Optimisation and Productivity

### Others

- Low power computing
- Many others from all 3 H2020 pillars

- Provide a world-class European HPC infrastructure, benefitting a broad range of academic and industry users, and especially SMEs,
- Ensure independent access to HPC technologies, systems and services for the EU



## How will CEA participate to these challenges ?

Supporting ETP4HPC at all levels: Board, Office, expertise

Supporting all consortia with the aim of ensuring Europe independent access to technology

**World class Computing facilities**

CURIE  
GEMINI

cea

The French contribution to PRACE

AIRAIN

Costs & Risks shared with industrials

**Expertise**

System architecture  
CEA/DAM/DSSI

Chip design  
CEA/DRT inc. LETI

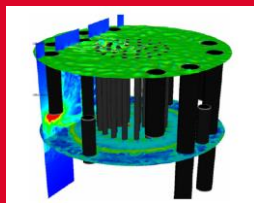
ISSCC'14

FRISBEE layout

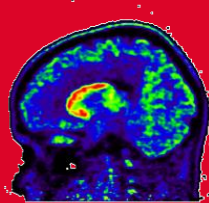
First petaflop/s computer  
Designed & built in Europe

**Transfer to Industry**  
Ter@tec

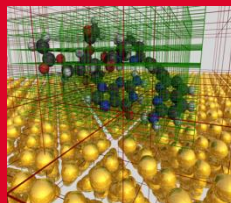
## Broad range of academic & industry users



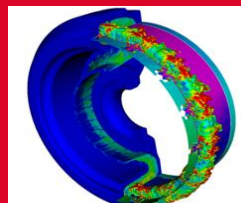
Energy



Health



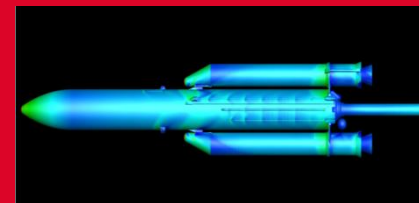
Materials



Combustion



Security



Aerospace



# HPC/H2020: competence

**Basile Starynkevitch**, CEA, LIST [DILS] (LIST=800 p. ICT institute of CEA=15000p)  
CEA/Saclay b862 PC174, 91191 GIF/YVETTE CEDEX, **France**

[basile.starynkevitch@cea.fr](mailto:basile.starynkevitch@cea.fr)

- Works within the **GCC** compiler (free software, GPLv3)
- Develop **MELT**, a domain specific language & free software plugin to customize GCC (see [gcc-melt.org](http://gcc-melt.org) for more)
- Expertise: **compilation & static analysis** (of C, C++, Ada, Go, Fortran, D, ... source code compiled with **GCC** & MELT)
- Bring: *programming methodologies, environments, language & tool* [subtopic b. FETHPC-1-2014], also support of *API & system software for future extreme scale systems* [subtopic c. FETHPC-1-2014]

Interests : API specific coding rules, whole system optimization, helping support extreme API

# Developing Web Services Landscape for High Performance “Basic” Scientific Computing

CERTH & Hellenic Multi-domain Multi-physics Consortium

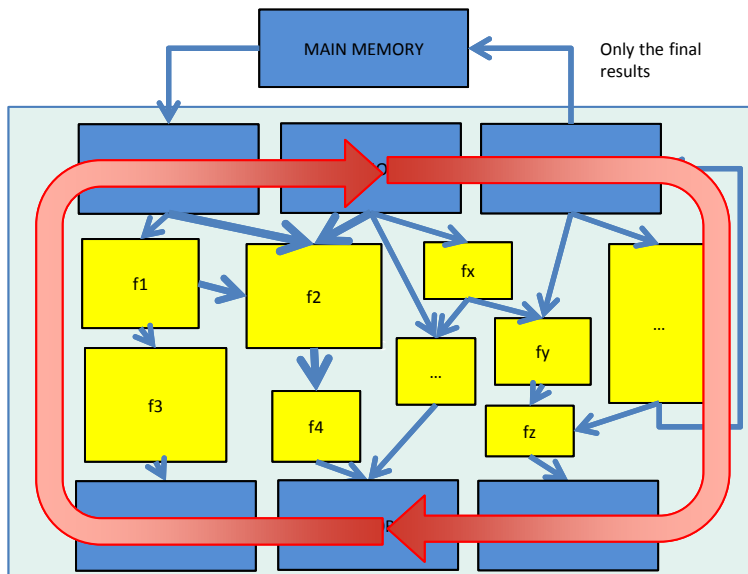
- Programmatic access to high quality scientific computing modules through web services
- Search (and retrieve) for the most appropriate web service, perhaps at runtime
- Scientific computing workflows through orchestration of existing web services
- Workflow deployment on computational infrastructure available on the web

# High Performance Computing in Space – Now!

- Semiconductor technology is ready (2003-13) #transistors from 400M to 5Bln (Intel)
- Memory performance isn't keeping up (Memory density scaled but latencies increased in CPU clock cycles → Cache area increased from 15% (1um) to 40% (32nm))
- Petascale / exascale challenges (Clock stagnated at few GHz, energy wastage of HPC is true economic burden. Requirements for annual performance improvements grow steadily. Many programmers continue to rely on sequential execution (1D approach))
- For **affordable** petascale systems → **Novel approach is needed**



What if you could easily build a customized dataflow machine (a “mega accelerator”)



- High degree of customization at all levels
  - High compute density
  - Balanced compute and communication
  - Data moves minimized
  - High energy efficiency
  - Highly predictable performance
- BUT**
- Difficult to program
  - Difficult to rate



**OpenSPL** will help us solve this



## Specify:

- Machine Model
- Memory Model
- Execution Model
- Substrate Properties

## Enable:

- Portability
- Predictability
- Productivity
- Reliability

<http://www.OpenSPL.org>

Build vivid Spatial Computer designers community in Europe and make 2D systems easier to use and by doing so accelerate scientific progress worldwide



- **Experts in engineering and applied science simulation** (FEM, DEM, CFD, FSI...)
  - *Scientific excellence in computational engineering: 3 ERC Advanced and 2 Starting grants + pool of FP7 projects in HPC/Cloud/Big Data;*
  - *User-oriented research. Portfolio of software products: CAE pre & post, open source simulation frameworks, highly scalable algorithms, etc;*

## H2020 HPC project ideas

- **FETHPC: New Generation of Parallel Meshers/Solvers**
  - ***Meshers and Linear Solvers** are the current **bottleneck** for having a full petascale simulation package;*
  - *Domain decomposition could be seen as the process which **distributes the simulation workload**, as a kind of tasks manager, and carefully considered attending to the nature of the problem, dimension, topology, HPC architecture;*
- **CoE: Center of Excellence in Numerical Methods for Industrial Applications**
  - See: <http://ec.europa.eu/digital-agenda/events/cf/h2020-e-infrastructures/item-display.cfm?id=12349>

## Contribution to the HPC Ecosystem building (FETHPC2)

- ***We are working on:** high performance computational engineering/physics: scalable solvers/preconditioners; parallel mesh generation; parallel adaptive algorithms, etc;*
- ***We have:** a good ecosystem for technology transfer (investors, our own corporate company, CIMNE Tecnología S.A., a wide network of companies);*
- ***We seek for:** partners with HPC infrastructures, user panels, potential stakeholders, research institutions working on HPC engineering/physics;*



## Interest areas

- Parallel apps in multicore, manycore, GPU, clusters, and Cloud
  - ▷ Natural language processing, GIS, medical image...
- Memory hierarchy optimization on multicore and hybrid CPU-GPU
- Analytical performance models of parallel applications
- Runtime hardware counters based methods for improvement of the execution of shared memory parallel codes
- Synchronization mechanisms on multithreaded applications: transactional memory and lock elision
- Embedded multicore architectures and new energy efficient and multifunctional units
- Application design for high performance reconfigurable computers
- Cloud infrastructures optimization
- HPC for Big Data applications

# ClusterVision & H2020 potential synergies

## ClusterVision

- Europe's Dedicated Specialist for HPC
  - Specialised in compute, storage & database clusters
  - At the forefront of HPC clustering technology
- HPC engineering and innovation is at the heart of what we do

## Address the HPC knowledge gap

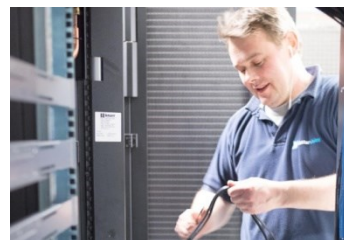
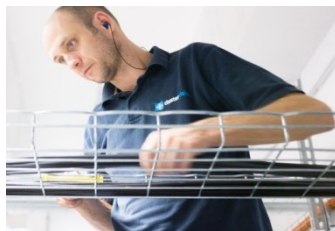
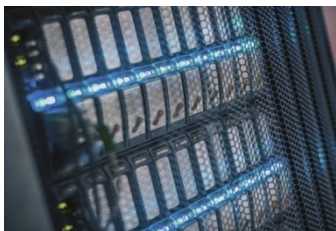
- HPC services and R&D
- ClusterVision HPC Services
- Remote System Administration
- Refine ClusterVision's programs for introducing HPC to SME's and LE's

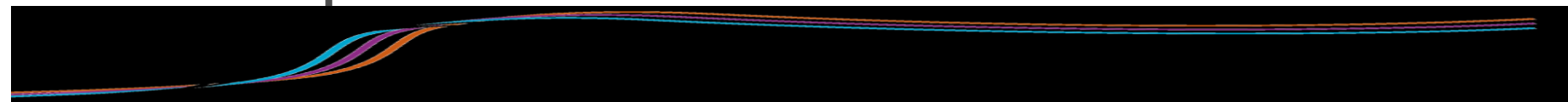
## Innovative R&D in Europe

- Convergence of HPC, Big Data and Cloud
- Development of HPC for OpenStack
- Application Analytics
- Innovative cooling / green solutions

## Interest within HPC Research Program

- Reinforce SME's presence
- Embed SME R&D in large R&D programs
- Ensure fair access to EU projects for SME's
- Grow European SME ecosystem
- Collaborate closely with European Research Centers





## CTTC personnel: 47

Professors and Ph.D. Researchers:	14
Administrative and Technical Research Suport:	4
Ph.D. Students:	29

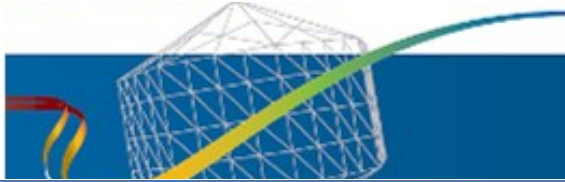
- Companies with CTTC RD projects: 21
- Number of Thesis/year since 2003: 4
- Number of international journal papers/year since 2003: 8
- Number of projects/year since 2003: 7
- Annual turnover/year since 2003: > 1 Million of Euros
- 1 spin-off created in 2006

The CTTC research activities are focused on:

- Mathematical formulation, numerical resolution and experimental validation of heat and mass transfer phenomena.
  - Natural and forced convection; Turbulence simulation: (RANS, LES, DNS); Combustion. Two-phase flow (VOF, two fluid models); Solid-liquid phase change (PCM materials); Radiation; Porous media; Computational Fluid Dynamics and Heat Transfer (CFD&HT); Aerodynamics.
  - High performance computing: Numerical algorithms and solvers, parallel computing, etc.**

## Areas of involvement and interest in the H2020 HPC

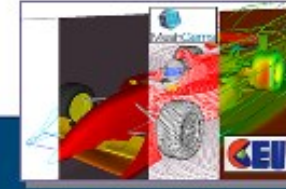
- The CTTC-UPC has been user of the Spanish Supercomputer Network with more than 15 different projects and has been also granted with a Tier-0 PRACE project.
- Incoming Exascale systems bring with them a technological disruption mainly induced by the 20 MW power consumption target.
- Porting current algorithms/implementations to new programming methodologies will not settle the matter. Disruptive changes in hardware and programming methodologies require also breakthroughs on algorithmic solutions.
- We are willing to participate on proposals focused on ***New mathematical and algorithmic approaches for existing or emerging applications on extreme scale systems.***



The maker of



Leading suite of Meshing



Suite of Industry-Level Meshing Software Components to provide **reliable** and **automatic** solutions for the CAD-to-Mesh phase (CAD cleaning, Surface/Volume Mesh generation, Mesh optimisation and adaptation, Parallel Meshing ...)

- Most of the developers of high-end CAD/CAE software package relies on MeshGems® : *Dassault Systèmes, Ansys, Autodesk, PTC, MSC.Software, Siemens-PLM, SALOME* and more than 40 others.
- A **unique R&D team** of highly focused experts backed by a long-term R&D partnership and common Lab with *INRIA*

➤ **Contact**

- Laurent Anné, Dir. Commercial & Marketing
- [laurent.anne@distene.com](mailto:laurent.anne@distene.com)
- +33 (0)9 70 65 02 19



# European Exascale Software Initiative - EESI2

## Toward EFFICIENT Exascale Applications



**Build & consolidate an updated vision/roadmap** at the Eu level, including applications, both from *academia and industry* to address the challenge of *performing scientific computing* on **hundreds of Petaflops/PBytes** in 2017 and **Exaflops/ExaBytes** in 2020/2022 computers.

**Propose & Initiate international collaborations in order to tackle & leverage key issues**

**150 experts, 100 entities, TOTAL, PRACE - Working groups: Applications Grand Challenges** (Climate, Energy, Aeronautics, Engineering, Life Sciences, Materials, ...) , **Enabling Technologies** (Numeric's, ecosystem, tools), **Cross cutting issues** (Resilience, data management, ...), **Software Maturity, Education**  
**Links with ETP4HPC, PRACE, CoE, BDEC, ... Funding agencies,**

**Exascale, a technological breakthrough, imposes To think different and differently**  
**Exascale cannot be justified only if we are just planning to do the usual things but bigger**  
**Exascale needs breakthroughs in several domains (Algorithms, Algebra, UQ, Couplers, Meshing ...)**

- **Scientific key issues to be tackled**
  - **hierarchical algorithms** which reduce **communications** and tasks synchronizations
  - **multi-physics methods** in order to **minimize data transfers** and include multi scaling and **parallel space-time methods**
  - **reshaping of operating systems** and management tools such as **MPI and OpenMP** and **mesh generation tools** to the new developed algorithms
  - **in situ data processing**
- **Detailed periodic roadmaps** on the key challenges, including:
  - **Gap analysis, Breakthroughs, Identification of priority actions**
  - **Recommendations of R&D projects : 8 in October 2013**  
Ultra scalable algorithms, Resilience, Big Data, Couplers, High productivity programming models, Mini Apps, Software Engineering, Uncertainties
  - **R&D Global Estimation Budget (Recom. EESI1): ~ 2.5 Billions € over 10 years**
- **Define educational programs for Exascale**



# EnginSoft SpA - Italy



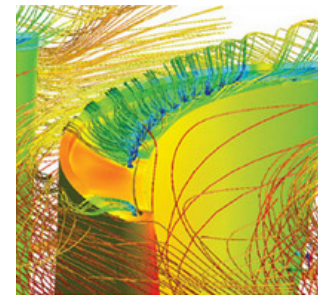
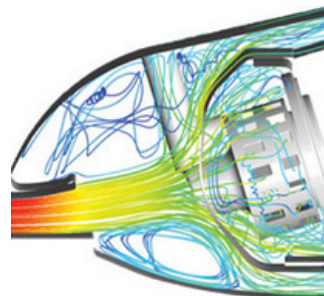
Consulting Company in the field of  
Simulation Based Engineering Science (SBES)

Founded in 1984, 130+ employee

Wide experience in FP7 (coordinator & active partner)

## **Areas for H2020 (FETHPC):**

1. HPC Application testing, deployment, integration in CAE ecosystem
2. Algorithms, Parallel solvers for Engineering problems
3. Process Integration and Design Optimization in complex coupled engineering problems



□ [www.enginsoft.com](http://www.enginsoft.com)

□ Italy, France, Germany, UK, Sweden, USA

# Flemish Supercomputer Center



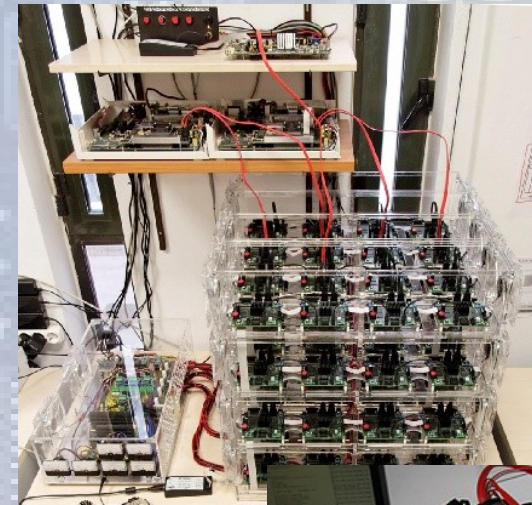
- ▶ Flanders – Belgium
- ▶ Initiated 2008
- ▶ 5 Flemish University Associations  
Coordinated by Herculesstichting



- ▶ Tier-2 and Tier-1 infrastructure
- ▶ Academic and industry users
- ▶ <http://www.vscentrum.be>
- ▶ Training, stimulate industrial usage

# FORTH-ICS

- **CARV Laboratory**
  - Scalable architectures, Parallel programming, Storage and I/O
- **Project Ideas – Areas of Expertise**
  - Interconnection networks, memory hierarchies
  - Storage, high-performance I/O
  - Parallel programming models, languages, runtimes
- **Actions of interest**
  - FETHPC 1 & 2, FET Open





# FRAUNHOFER CENTER FOR HIGH PERFORMANCE COMPUTING

Franz-Josef Pfreundt [pfreundt@itwm.fhg.de](mailto:pfreundt@itwm.fhg.de)



- CC-HPC is part of Fraunhofer ITWM
- Staff : 50 scientists and developers
- HPC programming tools and industry applications

## H2020 HPC contributions and project ideas

**GPI** : Global Address Space Programming Interface - One Sided , Asynchronous, fault tolerance  
The European programming approach to Exascale - Open Source [gpi-site.com](http://gpi-site.com)  
→ *update numerical libraries ( Sparse LinAlg ..)*

**GPI-Space** : Convergence of Big Data&HPC, Separation of Coordination and Programming  
DRTS, Petri-nets, autoparallelization, virtual memory space (GPI), resource management  
Enables easy development of domain specific programming environments  
→ *Domain specific parallel software environments (life science, engineering,..)*

**FhGFS** : The leading European Parallel File System

→ *Hardware & Software Codesign Project for Stencil based applications FETHPC 1 -a*

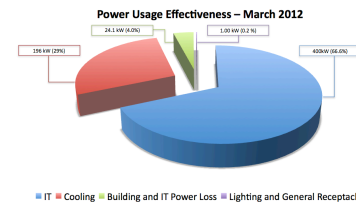
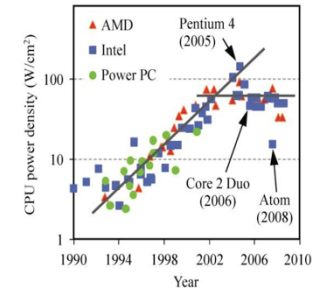
**Energy consumption of computing devices** is a strategic topic for the **future of HPC**

Three main objectives:

1) To reduce the heat production associated with computation

2) To reduce the energy consumption in data center

3) To enable autonomous mobile devices (wireless sensors)



Energy required to operate the portable devices

We need to bridge the gap by acting on both arrows

Energy available from portable sources



**ICTenergy**

FET Proactive Coordination Action 2013-2016

10 partners including the coordinators of project funded under:

Call **FP7 CALL 5**, ICT 2009.8.6 Towards Zero-Power ICT

Call **FP7 CALL 8**, ICT 2011-9.8 FET Proactive:MINECC

To know more: - [www.ict-energy.eu](http://www.ict-energy.eu), [www.zero-power.eu](http://www.zero-power.eu)

Contact: **Luca Gammaitoni**

NiPS Laboratory, Università degli Studi di Perugia, Italy, [www.nipslab.org](http://www.nipslab.org)

**NiPS** Laboratory  
Noise in Physical Systems



# Intel in Europe in HPC

- **Technology provider and active member of the European HPC ecosystem**
- **Investing in Europe:**
  - . For code modernization and exascale: 4 collaborative labs (Belgium, France, Germany, Spain), launch of Parallel Computing Centers to prepare applications for exascale
  - . For cooperation: 4 HPC FP7 projects (DEEP, DEEPER, EXA2CT, Fortissimo), ETP4HPC Board member, SKA SDP member
  - . For latest technologies: new 14 nm fab in construction in Ireland
- **Preparing for H2020**
  - . Development of European IP in view of potential integration in silicon
  - . Platform development with high memory content (HPC/BigData)
  - . Open source exascale framework stack in particular for SW tools
  - . Interested to collaborate with vendors, ISVs, Computing Centers and R&D centers

# Kalray MPPA® Many-Core Microprocessors

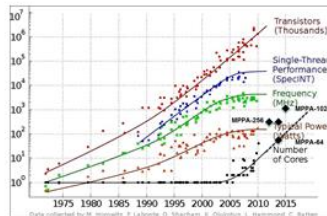


## A New Era of Processing

for Next Generation ExaFLOP Low Power Super Computers

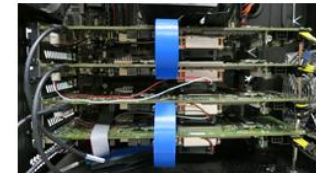
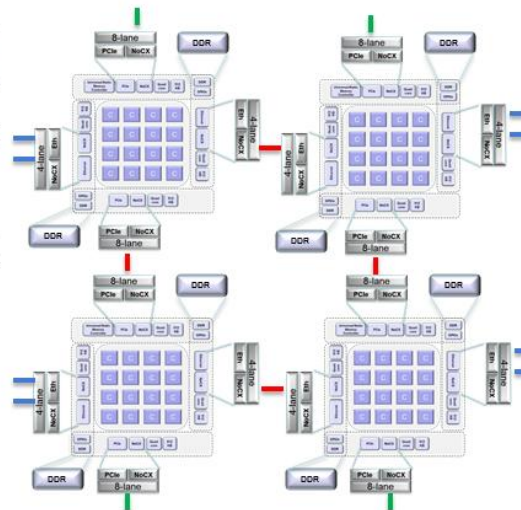
MPPA-256

In production  
since Q4 2012



Many-Core Architecture optimized for :

- Best Flops/Watt ratio,
- Low Power,
- Scalable,
- Easy Partitioning,
- Deterministic Time Critical
- Scalable NoC
- Easy Debugging



### Scalability Demonstrations

- FFT - Fast Fourier Transform
- DGEMM - Matrix multiply on 1000+ MIMD cores at less than 30 Watts

### Applications:

- Oil and Gas
- Finance
- Numerical Simulations
- Video
- Cloud based Services
- Data Security
- Storage
- Biology
- Big Scientific Instruments

World First Hyper Scalable 1000+ processor complete MIMD cores architecture  
(about 1 TeraFlops, and up to 0.5 TeraBytes of DDR)  
for Next Generation ExaFLOP Low Power Super Computers

[www.kalray.eu](http://www.kalray.eu)

Christian CHABRERIE, Ph.D., VP Business Development  
Contact: [christian.chabrerie@kalray.eu](mailto:christian.chabrerie@kalray.eu)

# MAISON DE LA SIMULATION



**Back-up and maximize the scientific output of the computing infrastructure.**

**Build the pluri-disciplinary teams necessary to meet the challenges of HPC**

Three main axis of development:

- A multidisciplinary research centre dedicated to numerical simulation
- A service and expertise centre, opened to scientific communities
- A nerve centre for education and scientific animation in HPC



Prace Advanced Training Center

**We are building an HPC Center of Excellence proposal based upon:**

- A cross-cutting platform in applied maths, computer sciences, visualisation...
- A few cutting-edge applications european communities to draw out the best from new HPC technologies
- A distributed dissemination and education network on the know-how acquired



<http://www.maisondelasimulation.fr> ; [edouard.audit@cea.fr](mailto:edouard.audit@cea.fr)



# Maxeler Technologies: Building Real Spatial Computing Systems

February 27th 2014

## STFC in new collaboration

The Science and Technology Facilities Council's (STFC) Harwell Centre and Maxeler Technologies are now collaborating with the aim of creating highly energy efficient supercomputers.

This work should lead to better ways of speeding up dataflow computing and reducing the energy costs for the scientific and data computing workloads of our industrial and academic partners.

## IN CLOUD COMPUTING, IT'S THE ERA OF CONVERGENCE

CME Group has partnered with Maxeler, Chevron, Juniper, Stanford University, the University of Tokyo, and the Imperial College of London to create Open Spatial Programming Language (OpenSPL), an open programming language based on Maxeler's innovative technology to support the high performance computing and security needs of the future. In Spatial Programming, dataflow is laid out in space on a chip and every operation executes in parallel rather than in a time sequence.



CME Group | DSF Analytics

**About This Page**

The DSF Analytics tool allows clients to view the relationship between the DSF's price, rate, and risk to its respective corresponding CTE Spot and Forward Swap. The tool calculates the implied swap rates by converting the net present value of the futures market quote (Futures Price - 100) into an equivalent rate (NPV/PV01) and subtracting this rate from the coupon. The simple method provides an excellent approximation of the implied forward rate of the DSF contract. In addition, clients can view the PV01, a risk measure for the particular swap, as well as CME and Bloomberg Tickers for the DSF contracts.

**Analytics powered by Maxeler Technologies®**



**Frost & Sullivan Lauds Maxeler for Employing Multiscale Dataflow Computing Technology rather than the Conventional CPU Technology**

Unlike competing technologies, Maxeler's multiscale dataflow computing puts emphasis on minimising the movement of data by using large scale spatial computing.

Share | Twitter | LinkedIn | Google+ | Facebook

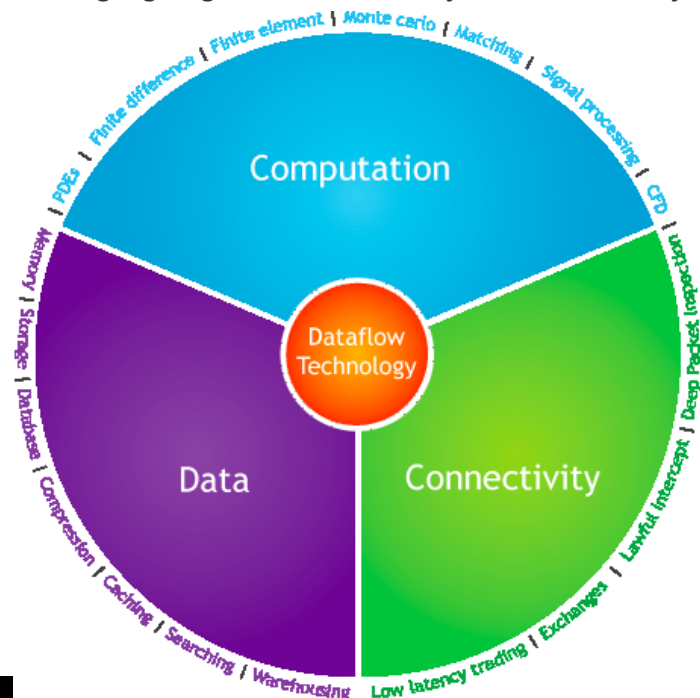
LONDON, Feb. 24, 2014 /PRNewswire/ -- Based on its recent research on the mission critical computing market, Frost & Sullivan presents Maxeler Technologies with the 2014 European Technology Innovation Leadership Award. The Frost & Sullivan award for Technology Innovation Leadership evaluates the top thought leading companies across a range of metrics, benchmarking and success criteria.

According to Frost & Sullivan's research, Maxeler Technologies uniquely offers cutting-edge dataflow computing hardware and software solutions that are not only low in total cost of ownership, but also boast high performance levels in line with the complex needs of companies that are heavily reliant on mission critical computations such as data analytics.

More by this Source

Frost & Sullivan Presents Open Solutions with Its 2014 Global Frost & Sullivan Award for Customer Value Leadership  
Apr 24, 2014, 10:00 ET

Bringing together Scalability and Efficiency



Roots at Stanford University, Bell Labs, and Imperial College London



Founded in 2003, incorporated in Delaware and England



2006: R&D contract with Chevron in San Ramon CA



2010: ENI (Italy) buys largest Maxeler Supercomputer for Imaging

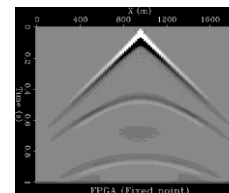


2011: sold 20% stake to JP Morgan's strategic investments group

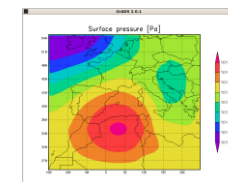


Series B Partnerships, HotChips talk w/ CME

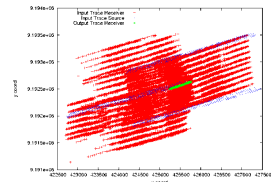
Maxeler over Intel (1-to-1) Box Speed Advantage



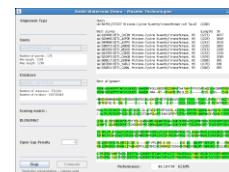
Modelling 25x



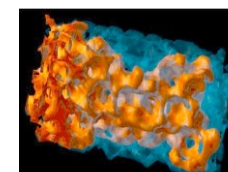
Finite Difference 60x



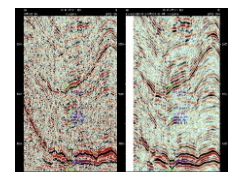
Data Correlation 22x



Smith-Waterman 16-32x



Fluid Flow 30x



Imaging 29x

Supported by over 130 Maxeler University Program Members Worldwide

www.maxeler.com





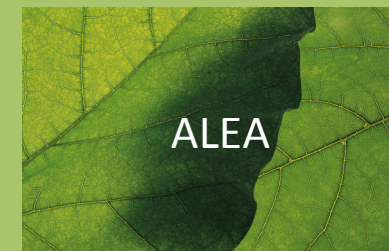
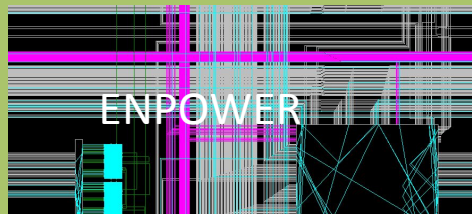
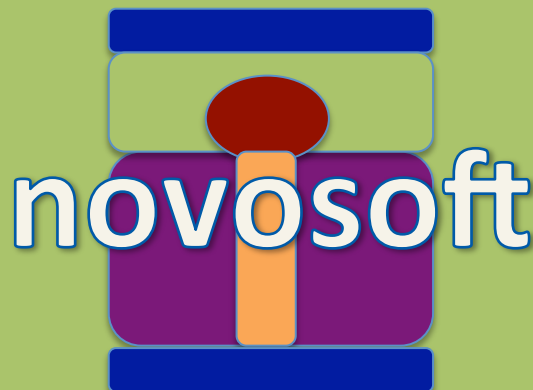


*HPC Server and storage technologies at the  
extremes of energy-efficiency*



**SCoRPiO**

Significance-Based Computing for  
Reliability and Power Optimization



*Real-time, large-scale data analytics*



**SAP** QUB partnerships

**CREDIT SUISSE**

*Datacenter monitor analytics*



**swan**

*Scale-free parallel  
programming*



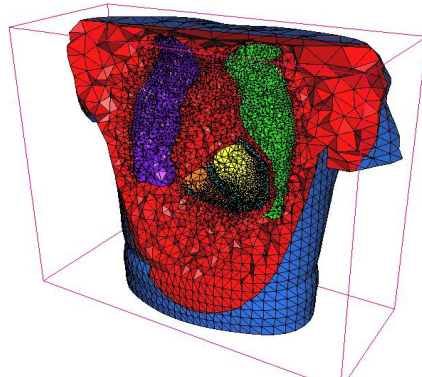
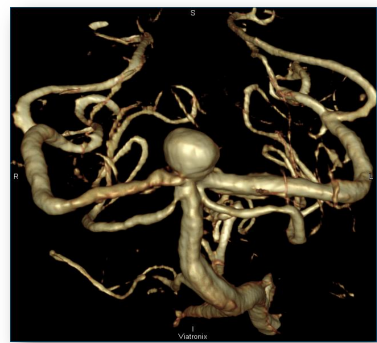
## SICOS BW GmbH and its Tasks

- Enable access to high-performance computing and Big/Smart Data (especially for SMEs)
- Support SMEs to find the right competence partners (co-operation with Solution-Centers)
- Support HLRS and SCC/KIT in their optimization effort towards their offering for industry and public institutions
- SICOS BW is interested in everything that supports the access to HPC resources and Big/Smart Data for SMEs

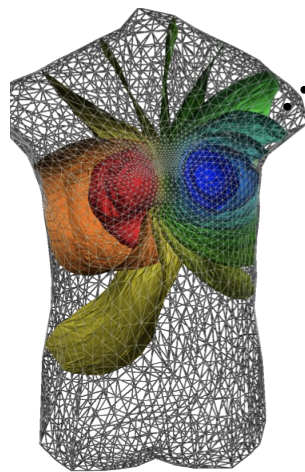
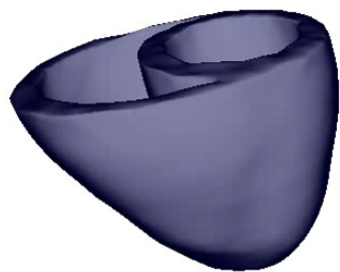
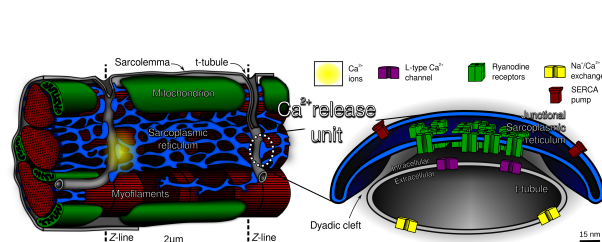


## Our Applications

### Biomedical Flows and Structures



### Cardiac Computations



## We run our computations on

[ **simula** . research laboratory ]



THE UNIVERSITY OF  
**TEXAS**  
— AT AUSTIN —

Goal  
**HPC CoE in  
physiology**

China: **Tianhe-2, Tianhe-1A;**  
USA: **Stampede;**  
Norway: **Abel, Hexagon.**

## Our Know-How

1  
Development of  
Computational  
Middleware

2  
Mathematical  
modelling

3  
Advanced  
Numerical  
Simulations

4  
GPU Computing  
for HPC



# Computing Centre of Slovak Academy of Sciences

## IBM POWER 775

Configuration:	1 rack, 12 enclosers, (2 racks, 16 enclosers after upgrade July 2014) 3072 (4096) cores 96 (128 ) nodes, GPFS High-speed Compute Network, Fiber Channel 8 Gb/s
Memory:	256 GB per compute nod
Operating System:	AIX 7.1
Theoretical Output:	94,4 TFLOP/s
Storage System:	IBM System Storage DS5300 Total Capacity 600 TB
SW environment:	ACES 3, CP2K, CPMD, DL POLY, QUANTUM ESPRESSO, ESPRESSO, GAMESS (DFT), GROMACS, MPQC, NAMD, QWALK, VASP, Molcas (CCSD)
Prepared :	Gaussian, Linda, Molpro, Schroedinger, Crystal09, ADF, Q-chem, Turbomole

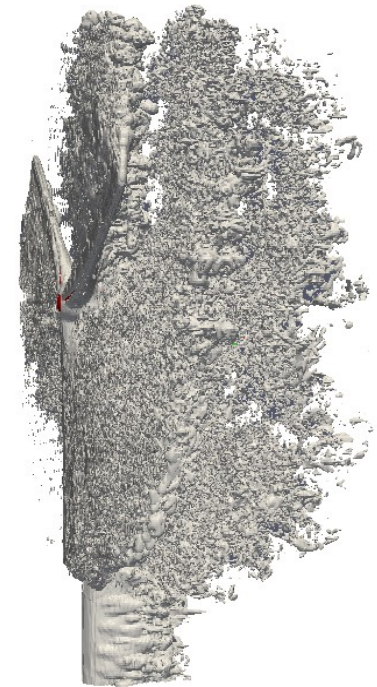


# Termo Fluids: *High Performance Computing for Computational Fluid Dynamics*

[www.termofluids.com](http://www.termofluids.com)



- **SME** providing **high-end CFD consulting** services with **in-house HPC codes**
- We work mainly for the energy sector and we are involved in different EU-funded projects (Clean Sky, KIC InnoEnergy, ...)
- Our Multi-physics CFD software shows an **outstanding parallel performance** in modern HPC systems (PRACE Tier0 supercomputers)
- We are focused in advancing **new computing models**: we are running complete CFD simulations on multi-GPU systems achieving **3.5x speedup in power efficiency** (TGCC Curie hybrid nodes – PRACE preparatory access project)



We aim to contribute to the mandatory development of new algorithms and software prototypes to fit the exascale computing paradigm for CFD



**ALSTOM**



**ABENGOA SOLAR**



**MONT BLANC**



## Thales Research & Technology (France)

### ◆ High Performance Programming Methods & Tools

### ◆ Tool purpose

- Rapid prototyping to target several heterogeneous parallel machines (e.g. GPP, GPU, DSP, multi/manycores)
- Virtual prototyping (early validation or architecture sizing)
- Simulation acceleration

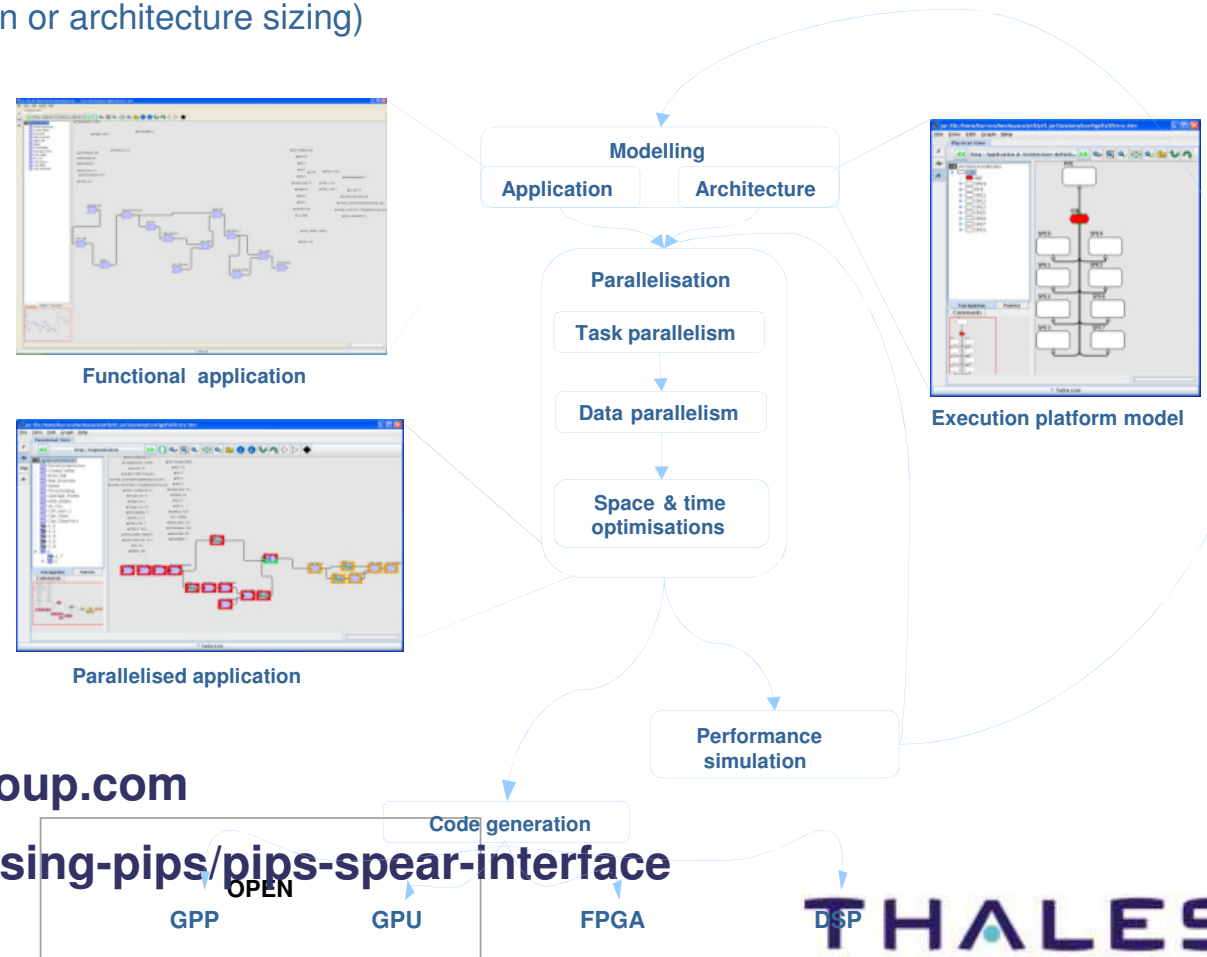
### ◆ Strengths

- Parallelism abstraction (high level modeling)
- Seamless design flow
- Automatic check of parallelisation steps
- Memory occupancy optimisation
- Push button approach for parallel code generation

### ◆ FETHPC1 b)

### ◆ michel.barreteau@thalesgroup.com

### ◆ <http://pips4u.org/projects-using-pips/pips-spear-interface>



# Extreme-scale sparse linear algebra solvers

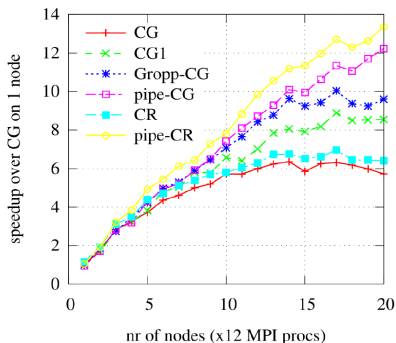
Wim Vanroose, Applied Mathematics

Universiteit Antwerpen and Intel Exascale Lab, Belgium

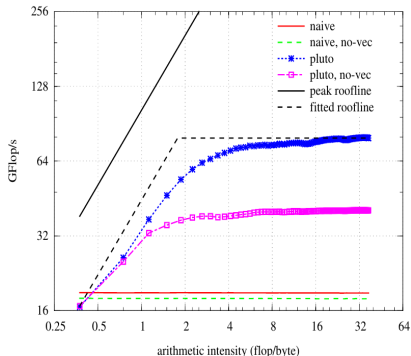
► [www.exa2ct.eu](http://www.exa2ct.eu)

► [www.exascale.com](http://www.exascale.com)

## Latency Hiding



## Communication avoiding





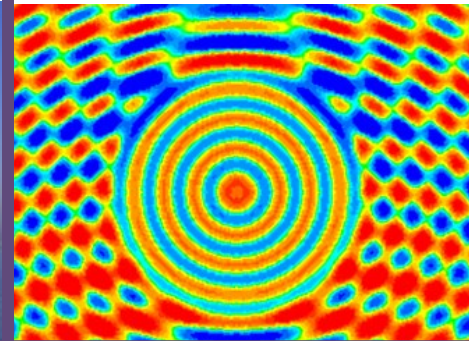
Northwest Composites  
Centre



BP ICAM Centre for  
Advanced Materials



EDF Modelling and  
Simulation Centre



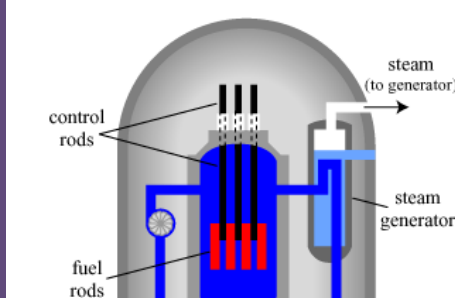
Manchester X-ray  
Imaging Facility



Aerospace Research  
Institute



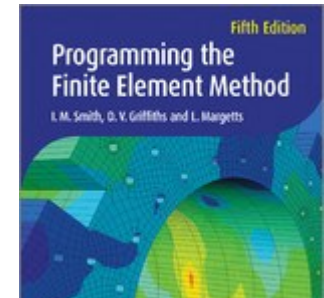
Dalton Nuclear  
Institute



Queen's Award  
Nuclear and Imaging



Parallel Finite Element  
Software ParaFEM



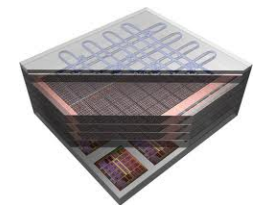
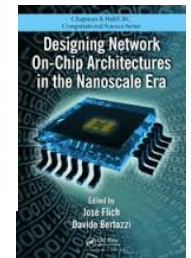
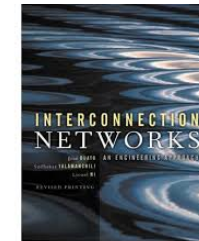
World leading facilities - turning Exascale  
simulation into engineering innovation

## ■ The institution

- +38,000 students, 2,500 faculty members, 1,500 administrative stuff
- Modern and flexible degrees tailored to the needs of society
- UPV stands out in technological research in numerous areas (patents, licensing, R&D contracts)
- Ranked as one of the top universities worldwide and one the students usually prefer most (94.5%)

## ■ UPV leading research in HPC areas

- **Interconnects** (for different application scenarios: HPC systems, datacenters, embedded, manycore)
  - >25 years expertise: Innovative and efficient solutions provided for most interconnect challenges
    - Routing algorithms, topologies, fault-tolerance, reconfiguration, QoS, congestion, switch architecture, ...
  - High-performance interconnects incorporate our solutions (BlueGene/L, Cray T3E, InfiniBand, Alpha 21364)
  - On-chip networks for multicore systems, both for Chip Multiprocessors (CMPs) and for embedded systems (MPSoCs)
  - Silicon photonic integrated circuits: design and test expertise
- **On-chip memory hierarchy** for homogeneous and heterogeneous (superscalar cores and GPGPUs) CMPs
  - Alternative solutions to directory-based protocols, tailored to NoC topologies
  - Covering different memory technologies, cooperative prefetching, efficient MC policies and on-chip DRAM
- **Remote GPU virtualization middleware**, in the context of NVIDIA CUDA library and InfiniBand
- Current/Past International Collaborative Projects: FP6 SARC, FP7 NaNoC, FP7 vIrtical



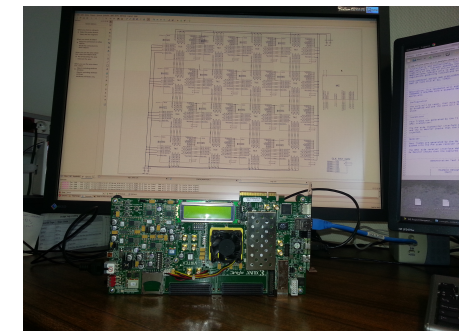
## ■ Potential Partnership to H2020 HPC Programme (FETHPC)

- HPC core technologies and architectures (**focus on interconnect & memory core technologies**)
  - Design of advanced manycore with the goals of HPC, Security, Virtualization, Partitionability
    - NoC-Memory and Interconnect-Memory co-design approach
  - Scalable research manycore architecture (target: **256-core FPGA prototype** running by fall 2014)

## ■ HPC Ecosystem building and coordination effort (FETHPC2)

- Participation in Education & Training activities, interconnect- & multicore-related activities

## ■ Contact: José Flich, [jflich@disca.upv.es](mailto:jflich@disca.upv.es), <http://www.disca.upv.es/jflich>



*current 16-core prototype running with advanced NoC-memory codesign allowing partitionability for capacity computing HPC*