

HPC IN EUROPE

Organisation of public HPC resources

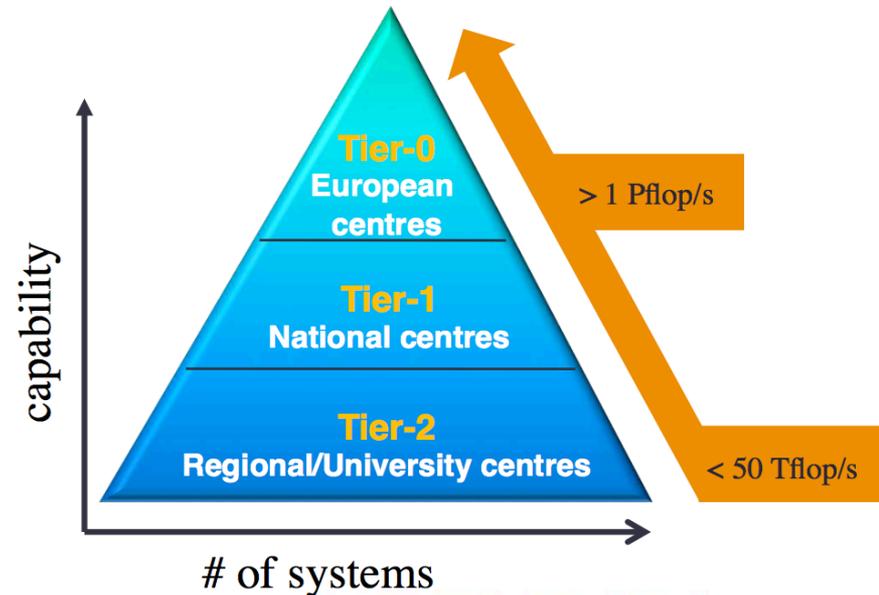
Context

- Focus on publicly-funded HPC resources provided primarily to enable scientific research and development at European universities and other publicly-funded research institutes
- These resources are also intended to benefit industrial / commercial users by:
 - facilitating access to HPC
 - providing HPC training
 - sponsoring academic-industrial collaborative projects to exchange expertise and accelerate efficient commercial exploitation of HPC
- Do **not** consider private sector HPC resources owned and managed internally by companies, e.g. in aerospace design & manufacturing, oil & gas exploration, fintech (financial technology), etc.



European HPC Infrastructure

- Structured provision of European HPC facilities:
 - Tier-0: European Centres (> petaflop machines)
 - Tier-1: National Centres
 - Tier-2: Regional/University Centres
- Tiers planned as part of an EU Research Infrastructure Roadmap
- This is coordinated through “PRACE” – <http://prace-ri.eu>



PRACE

Partnership for Advanced Computing in Europe

- International non-profit association (HQ office in Brussels)
- Established in 2010 following ESFRI* roadmap to create a persistent pan-European Research Infrastructure (RI) of world-class supercomputers
- Mission: enable high-impact scientific discovery and engineering research and development across all disciplines to enhance European competitiveness for the benefit of society.

*European Strategy Forum on Research Infrastructures



PRACE

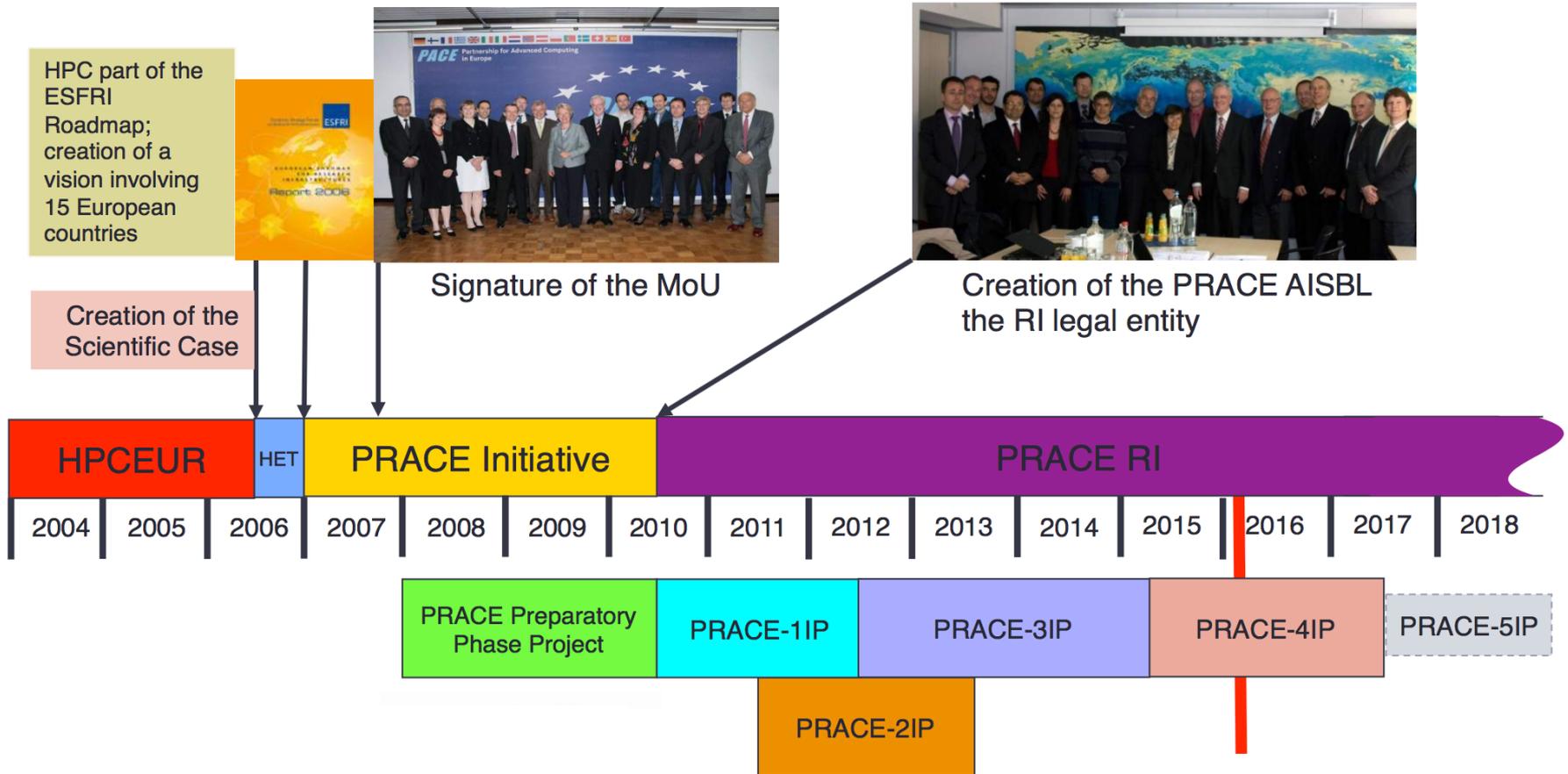
Partnership for Advanced Computing in Europe

Aims:

- Provide access to leading-edge computing and data management resources and services for large-scale scientific and engineering applications at the highest performance level
- Provide pan-European HPC education and training
- Strengthen the European users of HPC in industry



A Brief History of PRACE



PRACE Phases & Objectives

- Preparation and implementation of the PRACE RI was supported by a series of projects funded by the EU's FP7 and Horizon 2020 funding programmes
 - 530 M€ of funding for the period 2010-2015.
- Different focus in each phase (“IP” = implementation phase):
 - **PRACE PP (01/2008 – 06/2010)**: legal, administrative, and technical preparations
 - **PRACE 1IP (07/2010 – 06/2012)**: began implementation of PRACE services, including application support, education and training program, resource management and future technologies explorations
 - **PRACE 2IP (09/2011 – 08/2013)**: started providing Tier-0 access, integrated the national (Tier-1) HPC resources and services; Continued providing user community support, technology assessment, training
 - **PRACE 3IP (07/2012 – 06/2014)**: Continued, extended and complemented the previous and on-going PRACE work; Piloted joint pre-commercial procurement and joint ownership; Expanded services to industrial users
 - **PRACE 4IP (02/2015 – 05/2017)**: Continuing and further improving the previous and on-going PRACE work; Establishing links and providing support to CoEs; Evaluate new tech and define path to use Exascale resources
 - **PRACE 5IP (01/2017 – 2019?)**: Continue & extend advanced HPC training; Coordinate and enhance the operation of multi-tier HPC services; Prepare strategies & best practices towards Exascale computing; Support users and applications in exploiting massively parallel systems and novel architectures.



PRACE Members

Currently 25 members:

- Austria
- Belgium
- Bulgaria
- Cyprus
- Czech Republic
- Denmark
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Israel
- Italy
- The Netherlands
- Norway
- Poland
- Portugal
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- UK



UK represented by EPCC and STFC*,
through EPSRC**

*The Science and Technology Facilities Council

**The Engineering & Physical Sciences Research Council



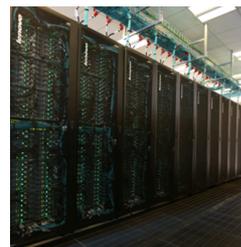
PRACE Members

- Currently 5 members host a total of 7 Tier-0 systems:
 - Germany (3 systems)
 - France (1 system)
 - Italy (1 system)
 - Spain (1 system)
 - Switzerland (1 system)
- UK hosts 2 Tier-1 systems:
 - ARCHER@EPCC
 - DiRAC (BlueGene/Q component@EPCC)
- Access to Tier-0 systems is through a peer-reviewed application process



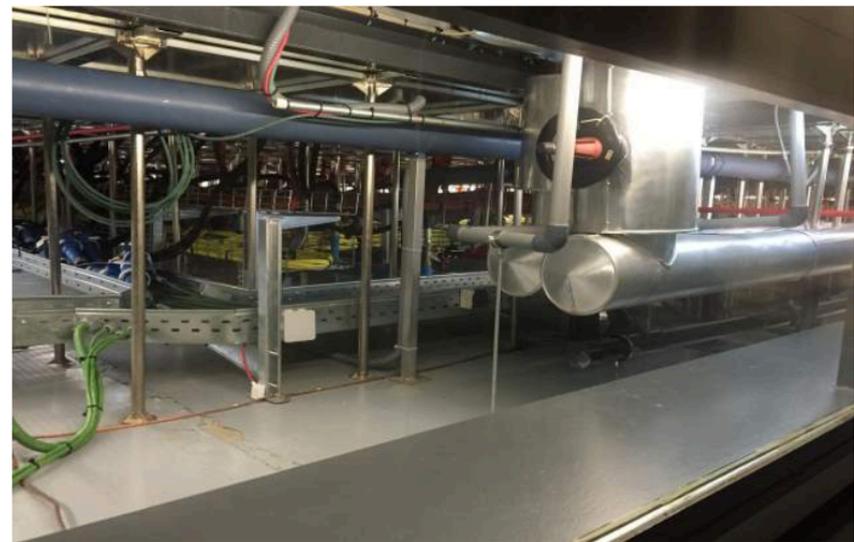
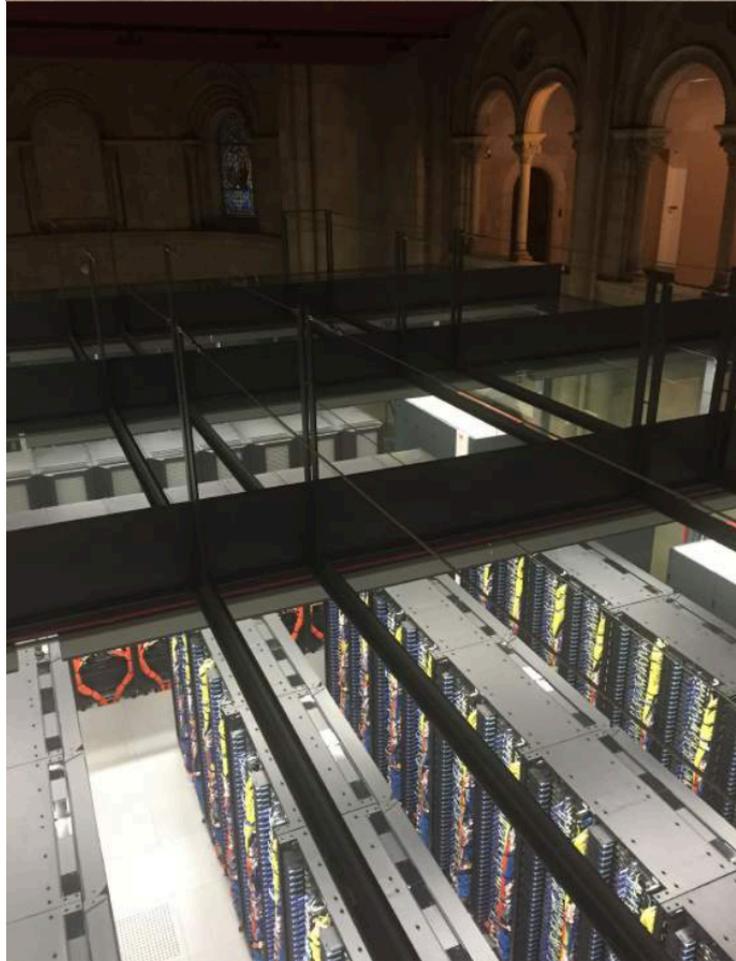
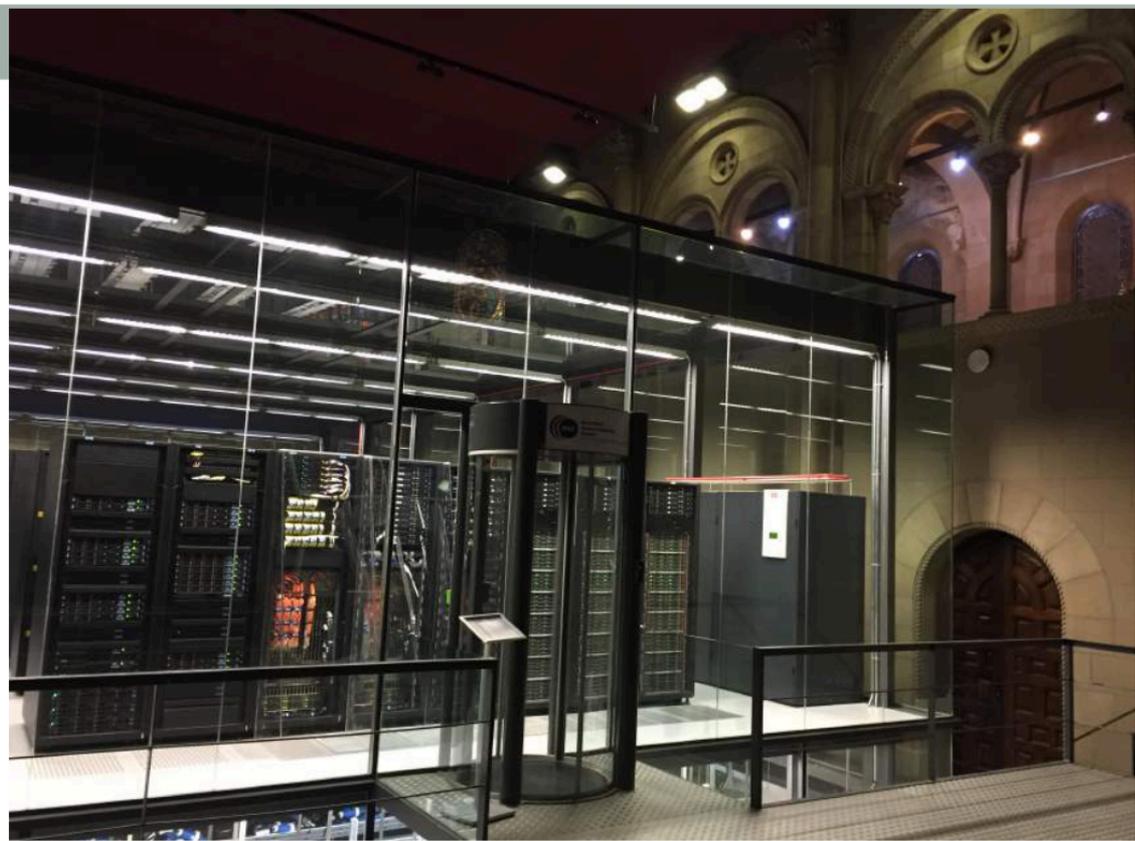
PRACE Tier-0 HPC Systems

Machine Name	Hosting Centre	Architecture	Capability	TOP500* 11/2016
Marconi	CINECA, Italy	Lenovo NeXtScale (Xeon Phi KNL)	6.2 Pflop/s	#12
Hazel Hen	GCS@HLRS, Germany	Cray XC40 (Xeon)	5.6 Pflop/s	#14
Juqueen	GCS@JSC, Germany	IBM BlueGene/Q (Power BQC)	5 Pflop/s	#19
SuperMUC	GCS@LRZ, Germany	IBM iDataplex (Xeon) / Lenovo NeXtScale (Xeon)	5.7 Pflop/s	#36 + #37
Piz Daint	CSCS, Switzerland	Cray XC50 (Xeon + Nvidia Tesla P100)	10 Pflop/s	#8
CURIE	GENCI@CEA, France	Bull Bullx (Xeon)	1.3 Pflop/s	#74
MareNostrum	BSC, Spain	IBM iDataPlex (Xeon)	1 Pflop/s	#129



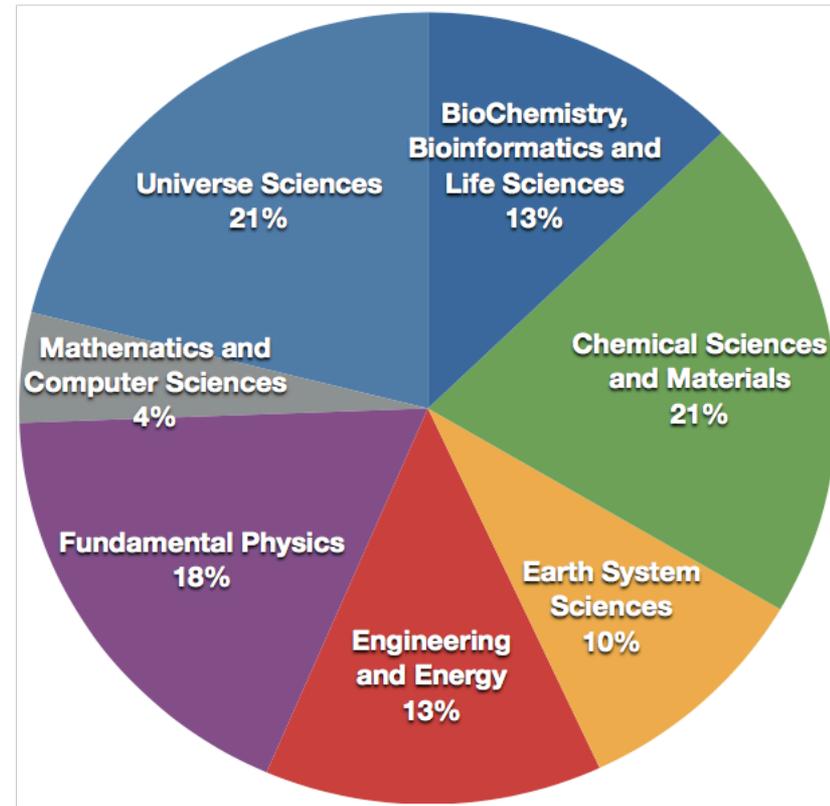
*ARCHER@EPCC = #61, 1.6Pflop/s



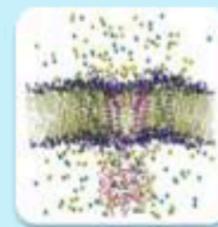
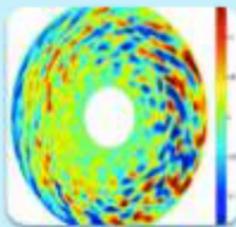
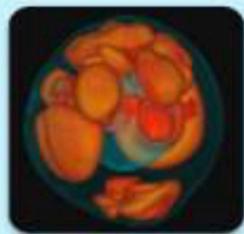
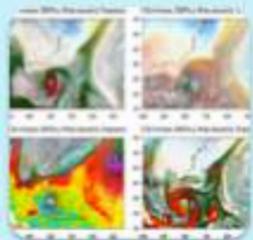


Access to PRACE Tier-0 Systems

- Types of Access
 - Preparatory Access
 - Code scaling and optimisation, to prepare future proposal for Project Access
 - Applications accepted at any time, with cut-off dates every three months
- Project Access
 - Large-scale, computationally intensive projects
 - Twice yearly “calls”. Awards are for a duration of 12, 24 or 36 months
- Center of Excellence (CoE) Access
 - A certain amount of resources reserved for Centres of Excellence selected by the EC
- More than 10.2 thousand million core hours have been awarded since 2010 following peer review



Example Projects using PRACE Tier-0



Climate

144 million core hours on Hermit (DE) for UK

PRACE will give to UK Met a 3 years advance in the development of high resolution global weather & climate models.

Astrophysics

300 million core hours:
200 on CURIE (FR) + 100 on SuperMUC (DE) for DE

Research on supernovae and heavy chemical elements. This PRACE grant is one of the biggest worldwide allocation in this domain.

Energy

30 million core hours on SuperMUC (DE) for Finland

PRACE resources enable the 1st European comparison of first-principles simulations to multi-scale experimental data for fusion energy

Chemistry

59,8 million core hours on JUQUEEN (DE) for Switzerland

The goal: catching CO_2 in a solvent, making the exhausts cleaner and reducing the cost of regenerating the solvent by optimizing the regeneration process.

Seismology

53.4 million core hours on SuperMUC (DE) for Italy

PRACE resources are used to explore the non-linearity involved in the dependence of local ground shaking on geological structure.

Life Sciences

56 million core hours on CURIE (FR) and 82 million core hours on SuperMuc for FR

Research on nervous impulses to contribute to the design of drugs that will modulate their activity. 30 times larger than a typical allocation.

Access to PRACE Tier-1 Systems

- **Distributed European Computing Initiative (DECI)**
- Resource exchange / pooling scheme to provide projects with cross-national access to European Tier-1 systems
- Tier-1 resources are provided by a subset of PRACE members, and awarded via the *juste retour* principle:
 - Each contributing country receives in total at least 70% equivalent of the resources they contribute to the DECI pool
 - Projects are allocated to a machine with an architecture and set up that best matches their needs
 - Remaining time (up to 30%) is reserved for projects from countries that are not providing resources to the call

Access to PRACE Tier-1 Systems

- Range of compute architectures available, e.g.
 - ~60% of DECI resources on Cray XC30 or XC40 systems, ~ 65 million core hours
 - ~40% of DECI resources on various Intel-based cluster configurations and hybrid systems (clusters with GPGPU accelerators / Xeon Phi co-processors – KNC or KNL)
- PRACE compute resources (Tier-0 and Tier-1) coupled to pan-European Collaborative Data Infrastructure (EUDAT) to provide long-term data management and preservation (~150TB per project)

Activities: Training

- PRACE provides top-class training events in many fields of scientific computing
- This happens through 6 **PRACE Advanced Training Centres (PATCs)**
 - These provide education and training opportunities for computational scientists throughout Europe
 - Also responsible for producing materials for the PRACE training portal
 - EPCC is a PATC

PATCs	Location
Barcelona Supercomputing Center (BSC)	Spain
Consorzio Interuniversitario (CINECA)	Italy
CSC - IT Centre for Science Ltd	Finland
EPCC at the University of Edinburgh	UK
Gauss Centre for Supercomputing	Germany
Maison de la Simulation	France

- Seasonal schools, workshops, scientific and industrial seminars
- More than 3000 people have attended PRACE training at PATCs or other PRACE events
- Materials are provided for users and user communities
- Further PRACE training info can be found at the PRACE training portal: <http://www.training.prace-ri.eu>

Activities: Training

- Summer of HPC
 - Offers summer placements at top HPC centres across Europe, e.g one training week at Barcelona Supercomputing Centre + two months on placement at EPCC working on a small project
- Late-stage undergraduates and early-stage postgraduate students are invited to apply:
 - <http://summerofhpc.prace-ri.eu>



The European HPC Ecosystem

- PRACE embodies a European HPC Ecosystem:
 - Allows pooling of EU research infrastructure funding to establish a diverse range of large-scale state-of-the-art HPC resources and coordinate shared access to these, leveraging buying power to drive innovation
 - Provides a framework for member states to coordinate HPC service provision on different tiers and on national and transnational levels to efficiently meet users' needs
 - Identifies EU-wide academic and industrial HPC user communities and provides them with training in new technologies
 - Forges collaborative links and knowledge exchange between HPC centres, researchers / users, application developers, etc.
 - Engages with SMEs to transfer expertise and foster adoption of HPC

