Introduction to VI-HPS

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Virtual Institute – High Productivity Supercomputing

- **Goal**: Improve the quality and accelerate the development process of complex simulation codes running on highly-parallel computer systems
- Start-up funding (2006–2011)
  by Helmholtz Association of German Research Centres
- Activities
  - Development and integration of HPC programming tools
    - Correctness checking & performance analysis
  - Academic workshops
  - Training workshops
  - Service
    - Support email lists
    - Application engagement

HELMHOLTZ ASSOCIATION

http://www.vi-hps.org

VI-HPS partners (founders)

Forschungszentrum Jülich
- Jülich Supercomputing Centre

RWTH Aachen University
- Centre for Computing & Communication

Technische Universität Dresden
- Centre for Information Services & HPC

University of Tennessee (Knoxville)
- Innovative Computing Laboratory

VI-HPS partners (cont.)





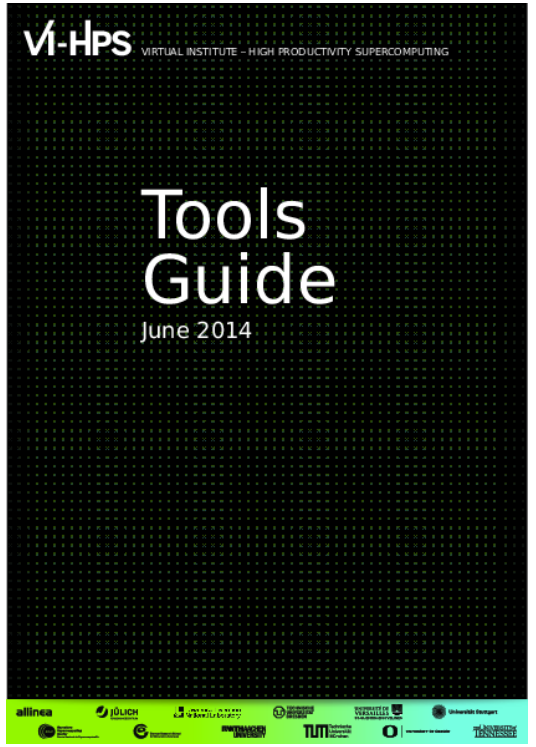



- Barcelona Supercomputing Center
  - Centro Nacional de Supercomputación
- Lawrence Livermore National Lab.
  - Center for Applied Scientific Computing
- Technical University of Darmstadt
  - Laboratory for Parallel Programming
- Technical University of Munich
  - Chair for Computer Architecture
- University of Oregon
  - Performance Research Laboratory
- University of Stuttgart
  - HPC Centre
- University of Versailles St-Quentin
  - LRC ITACA
- Allinea Software Ltd

Productivity tools

- MUST & ARCHER
  - MPI usage correctness checking & OpenMP race detection
- PAPI
  - Interfacing to hardware performance counters
- Periscope
  - Automatic analysis via an on-line distributed search
- Scalasca
  - Large-scale parallel performance analysis
- TAU
  - Integrated parallel performance system
- Vampir
  - Interactive graphical trace visualization & analysis
- Score-P
  - Community-developed instrumentation & measurement infrastructure

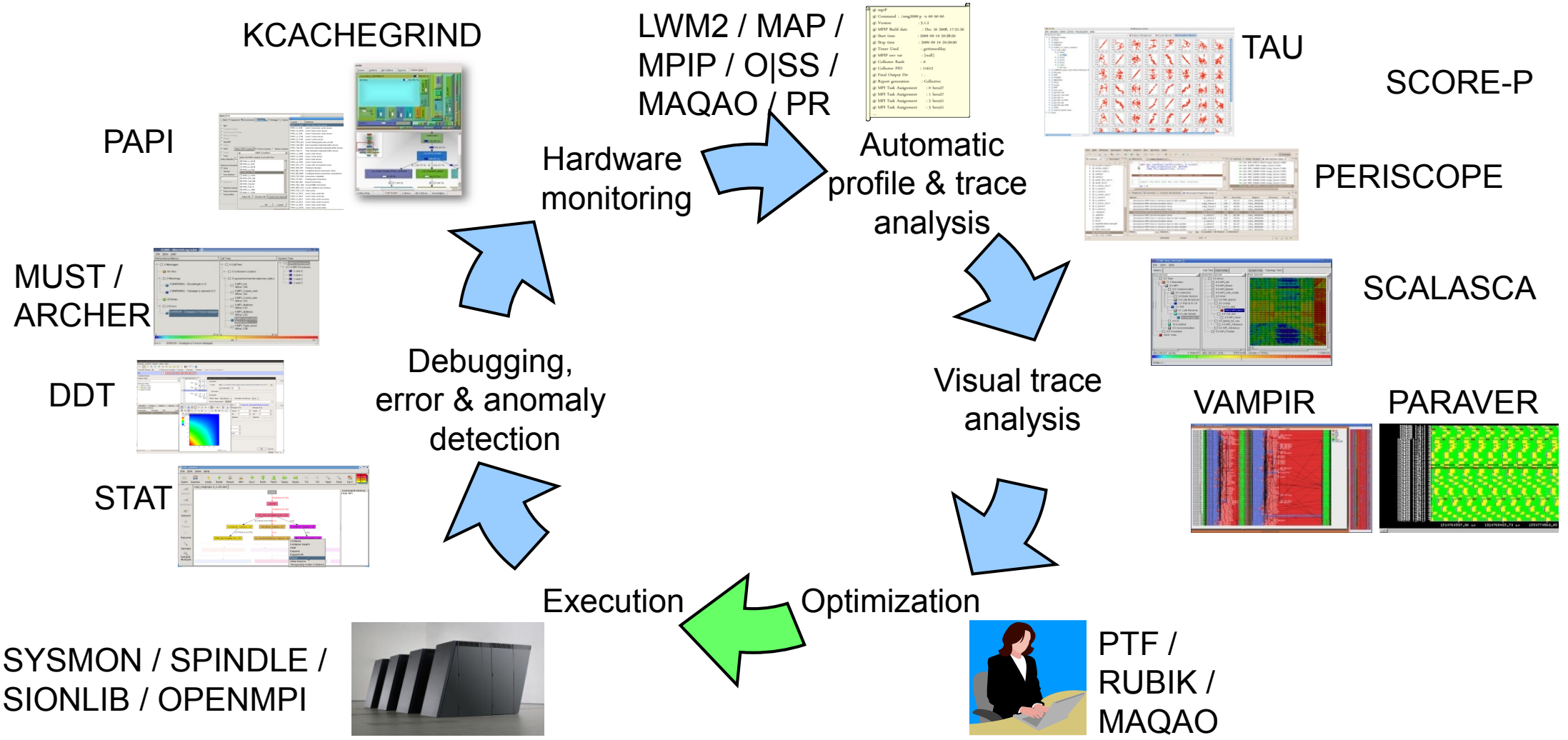
For a brief overview of tools consult the VI-HPS Tools Guide:



Productivity tools (cont.)

- DDT/MAP/PR: Parallel debugging, profiling & performance reports
- Extra-P: Automated performance modelling
- Kcachegrind: Callgraph-based cache analysis [x86 only]
- MAQAO: Assembly instrumentation & optimization [x86-64 only]
- mpiP/mpiPview: MPI profiling tool and analysis viewer
- Open MPI: Integrated memory checking
- Open|SpeedShop: Integrated parallel performance analysis environment
- Paraver/Dimemas/Extrae: Event tracing and graphical trace visualization & analysis
- Rubik: Process mapping generation & optimization [BG only]
- SIONlib/Spindle: Optimized native parallel file I/O & shared library loading
- STAT: Stack trace analysis tools
- SysMon: Batch system monitor plugin for Eclipse PTP

Technologies and their integration

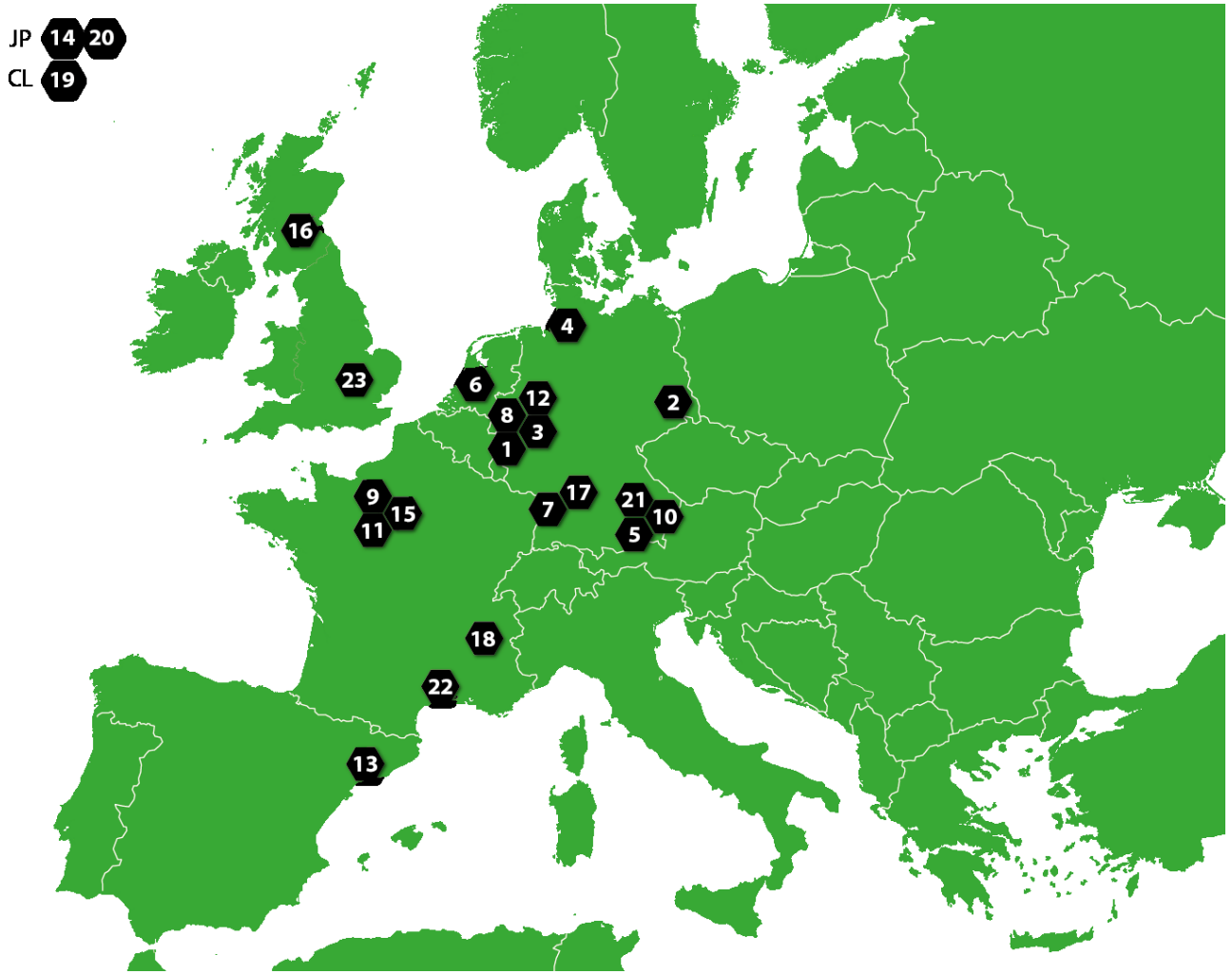


VI-HPS training & Tuning Workshops

- Goals
  - Give an overview of the programming tools suite
  - Explain the functionality of individual tools
  - Teach how to use the tools effectively
  - Offer hands-on experience and expert assistance using tools
  - Receive feedback from users to guide future development
- For best results, bring & analyze/tune your own code(s)!

- VI-HPS Hands-on Tutorial series
  - SC'08/09/10/11/13/14/15, ICCS'09, Cluster'10, EuroMPI'12/14, XSEDE'13, ISC-HPC'15
- VI-HPS Tuning Workshop series
  - 2008 (Aachen & Dresden), 2009 (Jülich & Bremen), 2010 (Garching & Amsterdam/NL), 2011 (Stuttgart & Aachen), 2012 (St-Quentin/F & Garching), 2013 (Saclay/F & Jülich) 2014 (Barcelona/Spain, Kobe/Japan, Saclay/France, Edinburgh/UK) 2015 (Stuttgart & Grenoble/France & Santiago/Chile)

VI-HPS Tuning Workshop series



1. 2008/03/05+3: RWTH, Aachen, Germany
2. 2008/10/08+3: ZIH, Dresden, Germany
3. 2009/02/16+5: JSC, Jülich, Germany
4. 2009/09/09+3: HLRN, Bremen, Germany
5. 2010/03/08+3: TUM, Garching, Germany
6. 2010/05/26+3: SARA, Amsterdam, Netherlands
7. 2011/03/28+3: HLRS, Stuttgart, Germany
8. 2011/09/05+5: GRS, Aachen, Germany
9. 2012/04/23+5: UVSQ, St-Quentin, France
10. 2012/10/16+4: LRZ, Garching, Germany
11. 2013/04/22+4: MdS, Saclay, France
12. 2013/10/07+5: JSC, Jülich, Germany
13. 2014/02/10+5: BSC, Barcelona, Spain
14. 2014/03/25+3: RIKEN AICS, Kobe, Japan
15. 2014/04/07+4: MdS, Saclay, France
16. 2014/04/29+3: EPCC, Edinburgh, Scotland
17. 2015/02/23+5: HLRS, Stuttgart, Germany
18. 2015/05/18+5: UGA, Grenoble, France
19. 2015/10/27+3: NLHPC, Santiago, Chile

20. 2016/02/24+3: RIKEN AICS, Kobe, Japan
21. 2016/04/18+5: LRZ, Garching, Germany
22. 2016/05/23+5: CINES, Montpellier, France
23. 2016/07/06+3: Univ. of Cambridge, England

Upcoming events

- 22nd VI-HPS Tuning Workshop (CINES, Montpellier, France, 23-27 May 2016)
  - Using *Occigen* Bull Xeon 'Haswell' Linux Cluster
  - Score-P, Scalasca, Vampir, TAU and MAQAO
- Full-day tutorial at ISC-HPC (Frankfurt am Main, Germany, 19 June 2016)
  - Hands-on practical hybrid parallel application performance engineering
- 23rd VI-HPS Tuning Workshop (University of Cambridge, UK, 06-08 July 2016)
  - Using *Darwin* Dell Xeon 'SandyBridge' Linux cluster & *Archer* Cray XC30
  - Score-P, Scalasca, TAU, MUST, ARCHER & Allinea tools suite

- Further events to be determined
  - (one-day) tutorials: with guided exercises sometimes using a Live-ISO/OVA
  - (multi-day) training workshops: with your own applications on actual HPC systems
- Check **www.vi-hps.org/training** for announced events
- Contact us if you might be interested in hosting a training event

VI-HPS Linux Live ISO/OVA

- Bootable Linux installation on DVD (or USB memory stick)
- Includes everything needed to try out our parallel tools on an 64-bit x86-architecture notebook computer
  - VI-HPS tools: Score-P, Periscope, Scalasca, TAU, Vampir*
  - Also: Eclipse/PTP, DDT*, MUST, PAPI, TotalView*
    * evaluation licences provided for commercial products (limited time/capability)
  - GCC (w/ OpenMP), OpenMPI
  - Manuals/User Guides
  - Tutorial exercises & examples
- Produced by U. Oregon PRL
  - Sameer Shende

VI-HPS Linux Live ISO/OVA

- ISO image approximately 5GB, OVA approximately 12GB
  - download latest version from website
  - **http://www.vi-hps.org/training/live-iso/**
  - optionally create bootable DVD or USB drive
- Boot directly from disk
  - enables hardware counter access and offers best performance, but no save/resume
- Boot within virtual machine (e.g., VirtualBox)
  - faster boot time and can save/resume state, but may not allow hardware counter access
- Boots into Linux environment for HPC
  - supports building and running provided MPI and/or OpenMP parallel application codes
  - and experimentation with VI-HPS (and third-party) tools

lrz

21st VI-HPS Tuning Workshop

Leibniz-Rechenzentrum, Garching-bei-München, Germany

PRACE

18-22 April 2016

http://www.**vi-hps.org/tws/tw21.html**

21st VI-HPS Tuning Workshop (LRZ)

- **Tools presenters**
  - Christian Feld (Jülich Supercomputing Centre)
  - Michael Firbach & Josef Weidendorfer (Technische Universität München)
  - Judit Gimenez & German Llort (Barcelona Supercomputing Center)
  - Florent Lebeau (Allinea Software Ltd)
  - Joachim Protze (RWTH Aachen University)
  - Martin Schulz (Lawrence Livermore National Laboratory)
  - Sergei Shudler (Technische Universität Darmstadt)
  - Cédric Valensi & Emmanuel Oseret (Université de Versailles Saint-Quentin)
  - Bert Wesarg & Johannes Ziegenbalg (Technische Universität Dresden)
- **Local organisation**
  - Anupam Karmakar & Volker Weinberg
- **Sponsor: Gauss Centre for Supercomputing PRACE Advanced Training Centre**

Outline

Monday 18 April

- 09:00 Welcome [Anupam Karmakar & Volker Weinberg, LRZ]
  - **Introduction to VI-HPS and overview of tools [Michael Gerndt, TUM]**
  - **Introduction to parallel performance engineering [Michael Gerndt, TUM]**
  - **Building and running NPB-MZ-MPI/BT-MZ on *SGI UV2* [Christian Feld, JSC]**
- 10:30 (break)
- 11:00 **MAQAO performance analysis tools** [Cédric Valensi & Emmanuel Oseret, UVSQ]
  - **MAQAO hands-on exercises**
- 12:30 (lunch)
- 13:30 Hands-on coaching to apply tools to analyze your own code(s)
- 17:30 Review of day and schedule for remainder of workshop
- 18:00 (adjourn)

- Hands-on exercises part of each presentation to familiarise with tools every morning session
- Hands-on coaching to apply tools to analyse and tune your own codes each afternoon

Outline of rest of week

Tuesday 19 April
- 09:00-10:30 **Allinea performance tools suite** [Florent Lebeau, Allinea]
- 11:00-12:30 **Open|SpeedShop & mpiP performance tools** [Martin Schulz, LLNL]

Wednesday 20 April
- 09:00-10:30 **Score-P instrumentation & measurement** [Christian Feld & Bert Wesarg]
- 11:00-12:30 **CUBE profile explorer** [Christian Feld, JSC]
  Extra-P automated performance modelling [Sergei Shudler, TUDarmstadt]

Thursday 21 April
- 09:00-10:30 **Scalasca automated trace analysis** [Christian Feld, JSC]
  Vampir interactive trace analysis [Bert Wesarg & Johannes Ziegenbalg, TUDresden]
- 11:00-12:30 **Paraver tracing tools suite** [Judit Gimenez & German Llort, BSC]

Friday 22 April
- 09:00-10:30 **Kcachegrind & Periscope TF** [Josef Weidendorfer & Michael Firbach, TUM]
- 11:00-12:30 **MUST/ARCHER runtime error detection** [Joachim Protze, RWTH]
  STAT stack trace analysis [Martin Schulz, LLNL]
- 13:30-14:00 Conclusion & Review

Participant survey

We'd like to know a little background information about you, your application code(s), and your expectations and desires from this workshop

- What programming language(s) do you use?
  - Fortran, C, C++, multi-language, …
- What parallelisation mode(s) do you use?
  - only MPI, only OpenMP, mixed-mode/hybrid MPI+OpenMP, …
- What platforms/systems *must* your code run well on?
  - SuperMUC, Cray, IBM BlueGene, Linux cluster, …
- Are you already familiar with *serial* performance analysis? Using which tools?
  - time, print/printf, prof/gprof, VTune, …
- Are you already familiar with *parallel* performance analysis? Using which tools?
  - time, print/printf, prof/gprof, ITAC, Paraver, Scalasca, TAU, Vampir, …

Prepare to analyse your own application code(s)

- Ensure that your application code(s) build and run correctly to completion with appropriate datasets
  - initial configuration should ideally run in less than 15 minutes with 1-4 compute nodes
    - to facilitate rapid turnaround and quick experimentation
  - larger/longer scalability configurations are also interesting
    - turnaround may be limited due to busyness of batch queues, but perhaps overnight

- Compare your application performance on other computer systems
  - VI-HPS tools are already installed on many HPC systems
    - if not, ask your system administrator to install them (or install a personal copy yourself)

Evaluation / Feedback

- Please also complete and return the VI-HPS workshop paper form, which provides valuable feedback
  - to tools developers for improving their tools and training material
  - to improve future workshops and training events
  - can be anonymous if desired

- Tools support queries and bug reports are also welcome
  - should be submitted to respective support mailing lists