



**GHENT
UNIVERSITY**

DEPARTMENT ICT

HPC-UGENT USER MEETING 2017

Dr. Ewald Pauwels
hpc@ugent.be
<http://hpc.ugent.be>

15/12/2017

PROGRAM

- (13h00:Optional tour of datacenter)
- 14h00: Welcoming address
- 14h15: Overview of HPC-UGent, VSC, future plans
- 14h45: Review of user poll results, Q&A
- 15h15: User in the spotlight - Pieter Reyniers, LCT
- 15h45: Slots for 1-minute poster presentations
- 16h15 - 18h00 Networking reception & poster session

ABOUT HPC-UGENT

Part of ICT department, Infrastructure office

Mission

HPC-UGent provides centralised scientific computing services, training, and support for researchers from Ghent University, industry, and other knowledge institutes.

ABOUT HPC-UGENT

Personnel

- User support
- Training
- Infrastructure installation and upkeep (software & hardware)
- Outreach + marketing
- Collaboration with other supercomputing centers



Alvaro Simon Garcia
Cloud, user support



Andy Georges
Sysadmin, integration



Ewald Pauwels
Team lead



Jens Timmerman
Security, sysadmin



Kenneth Hoste
User support



Kenneth Waegeman
Sysadmin, storage

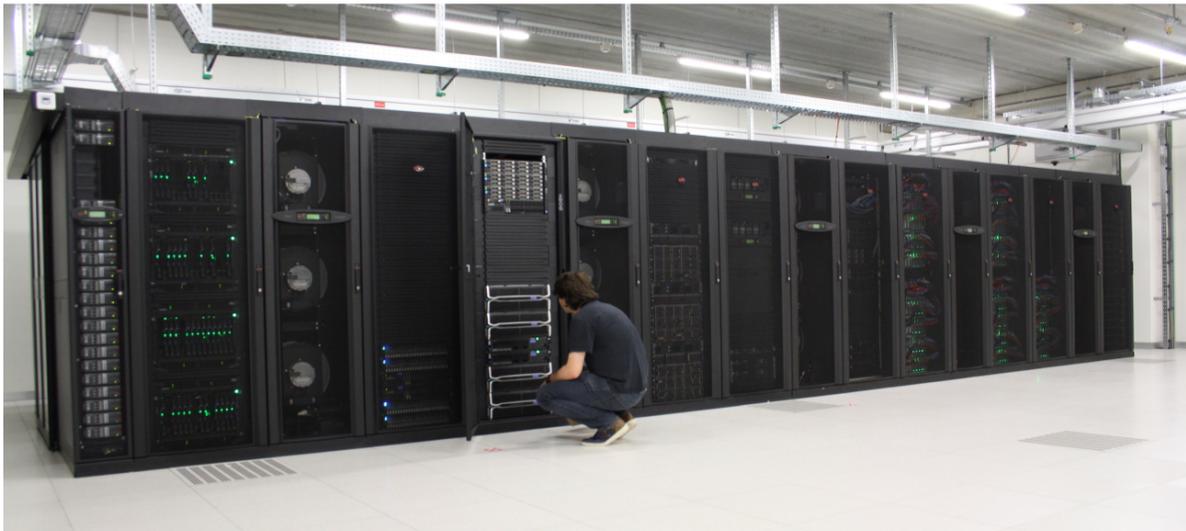


Stijn De Weirdt
Technical lead



Wouter Depypere
Sysadmin

HPC-UGENT INFRASTRUCTURE



Storage

\$VSC_HOME	35 TB	
\$VSC_DATA	702 TB (1 PB)	2017-Q2
\$VSC_SCRATCH	1 PB	2017-Q2
\$VSC_SCRATCH_KYUKON		
\$VSC_SCRATCH_PHANPY	35 TB SSD	



Compute clusters

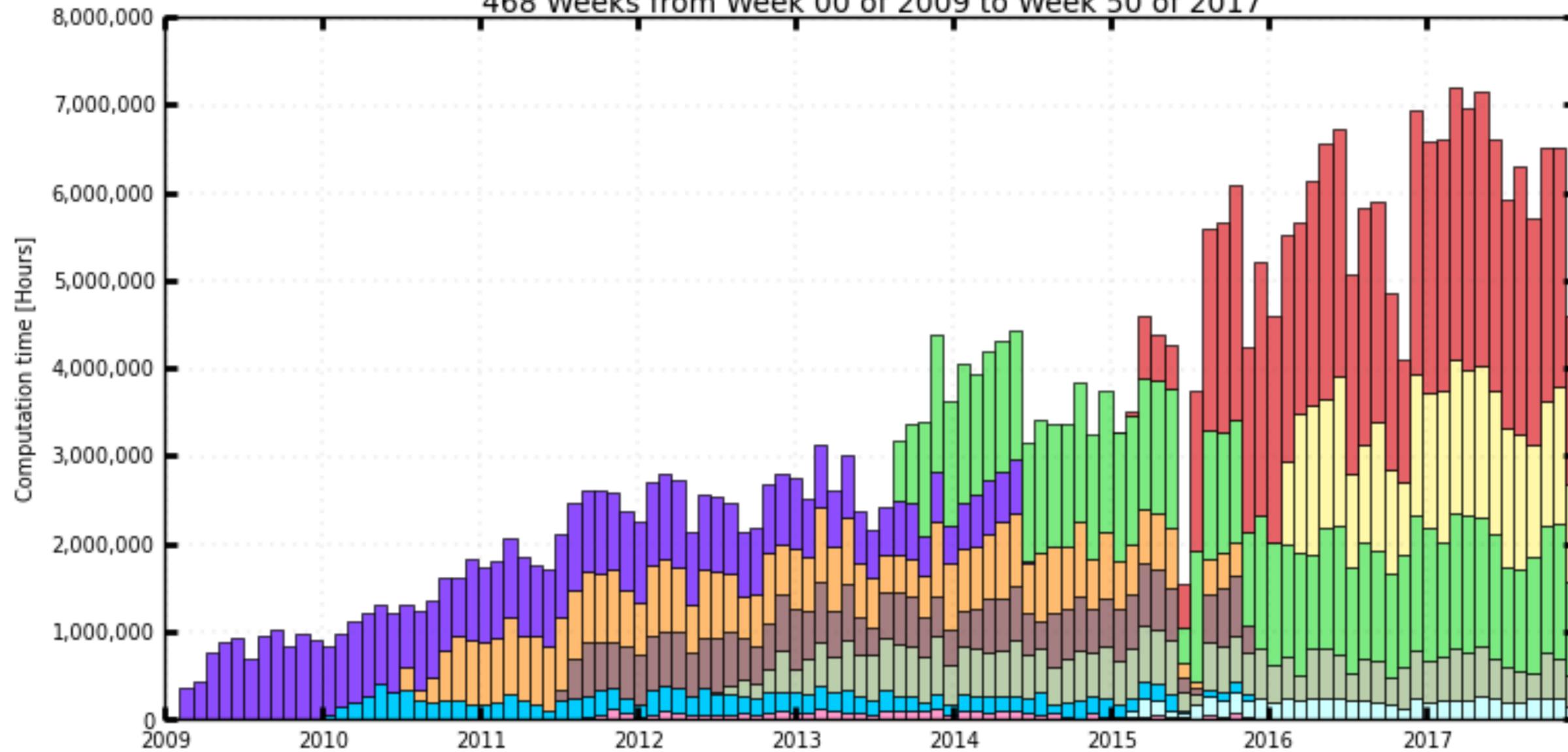


	#nodes	CPU	Mem/node	Diskspace/node	Network	
Raichu	64	2 x 8-core Intel E5-2670 (Sandy Bridge @ 2.6 GHz)	32 GB	400 GB	GbE	
Delcatty	160	2 x 8-core Intel E5-2670 (Sandy Bridge @ 2.6 GHz)	64 GB	400 GB	FDR InfiniBand	
Phanpy	16	2 x 12-core Intel E5-2680v3 (Haswell-EP @ 2.5 GHz)	512 GB	3x 400 GB (SSD, striped)	FDR InfiniBand	
Golett	200	2 x 12-core Intel E5-2680v3 (Haswell-EP @ 2.5 GHz)	64 GB	500 GB	FDR-10 InfiniBand	
Swalot	128	2 x 10-core Intel E5-2660v3 (Haswell-EP @ 2.6 GHz)	128 GB	1 TB	FDR InfiniBand	2016-Q3

OVERVIEW OF HPC-UGENT USAGE

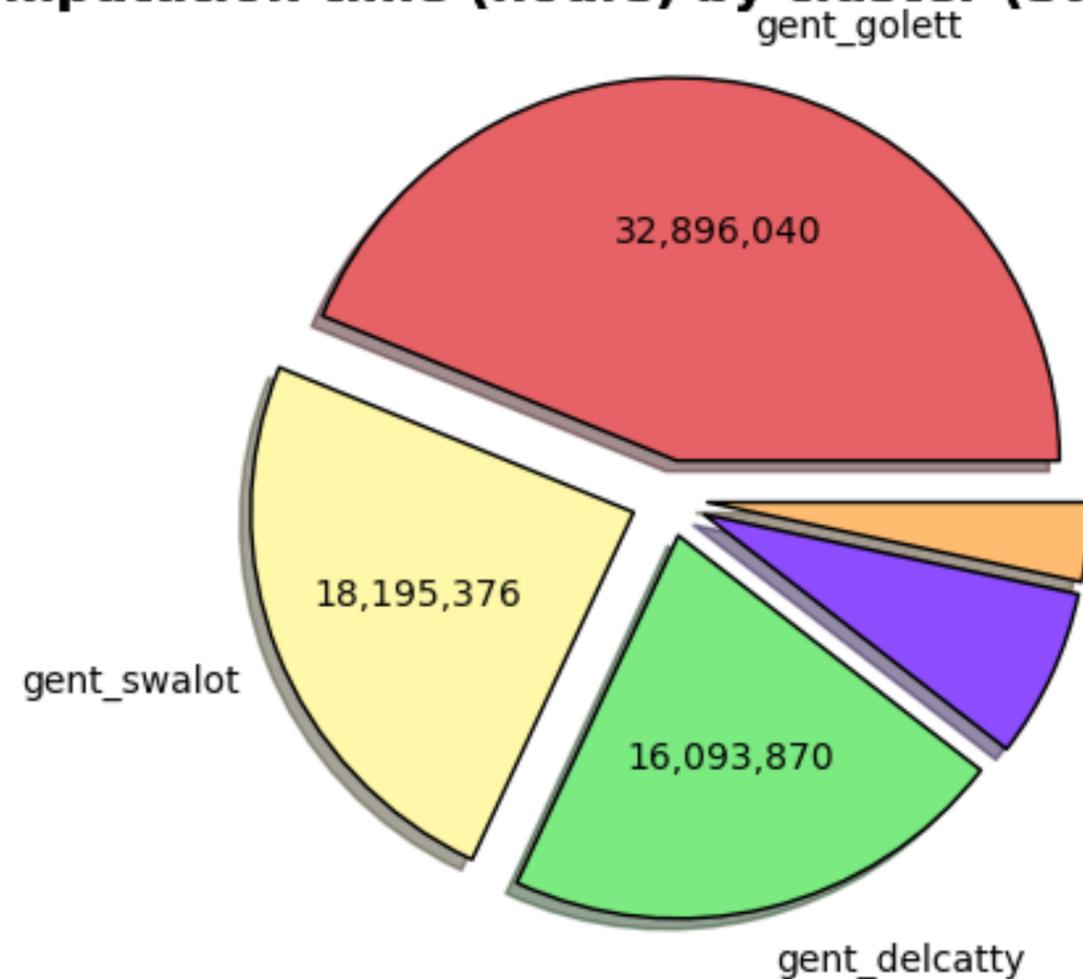
Historical consumed computation time (hours) by cluster

468 Weeks from Week 00 of 2009 to Week 50 of 2017



OVERVIEW OF HPC-UGENT USAGE

Consumed computation time (hours) by cluster (Sum: 75,063,045 Hours) in 2017



Consumed compute time in 2017

	core years	use %
delcatty	1837	80%
phanpy	286	78%
raichu	614	72%
golett	3755	84%
swalot	2077	85%
	8569	82%

gent_golett (32,896,040)
gent_phanpy (2,502,770)

gent_swalot (18,195,376)

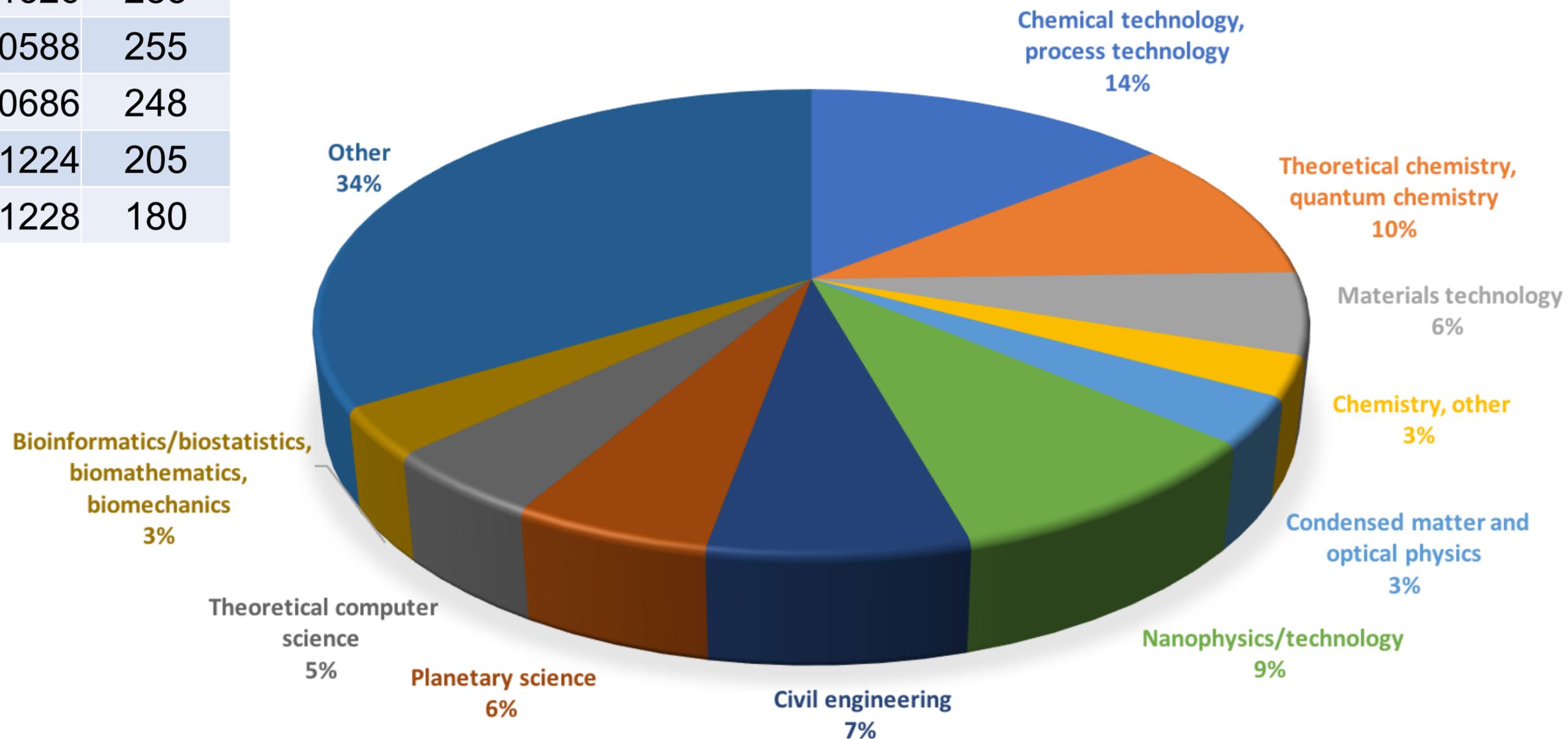
gent_delcatty (16,093,871)

gent_raichu (5,374,988)

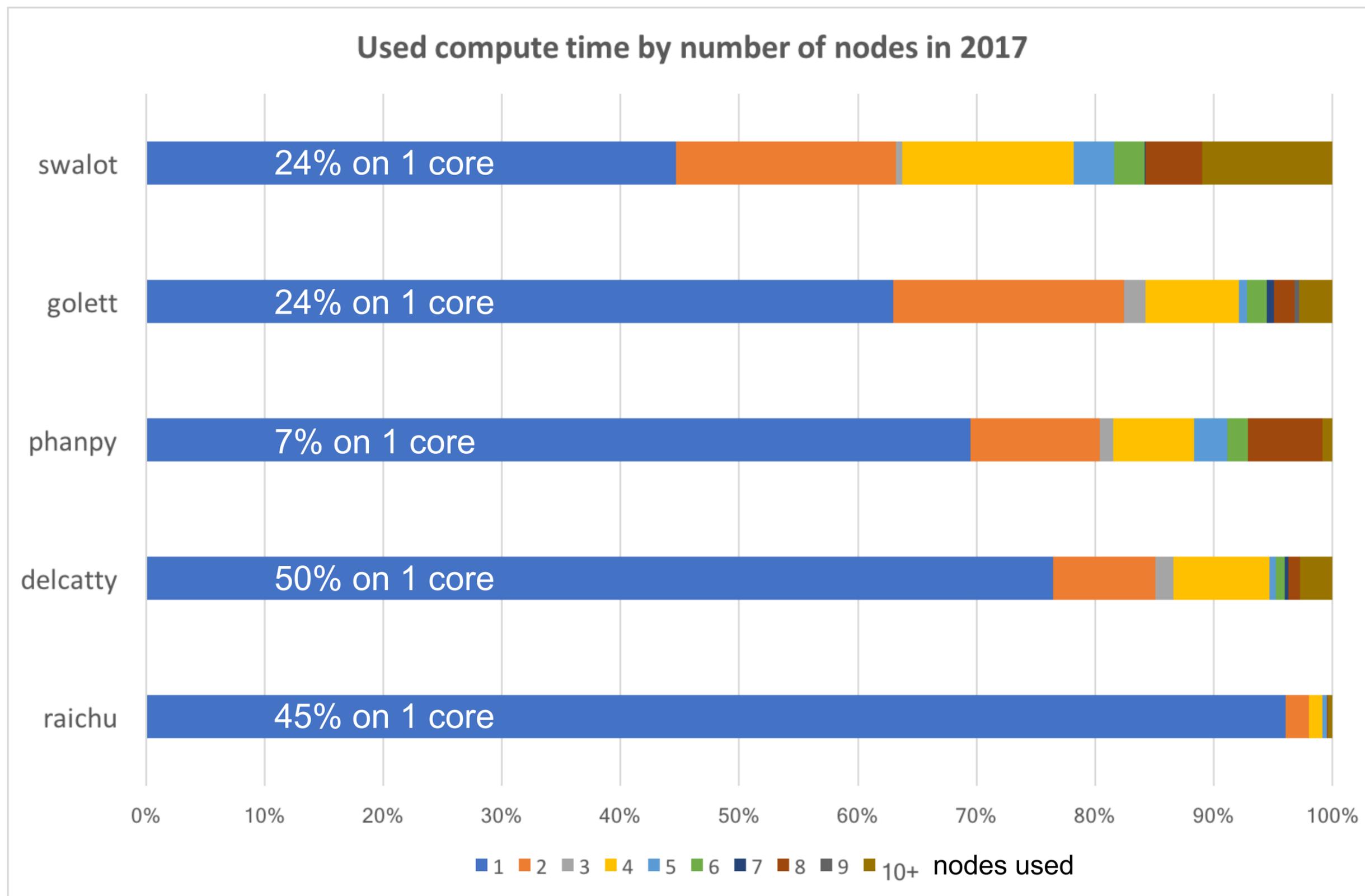
OVERVIEW OF HPC-UGENT USAGE

Top 10 users

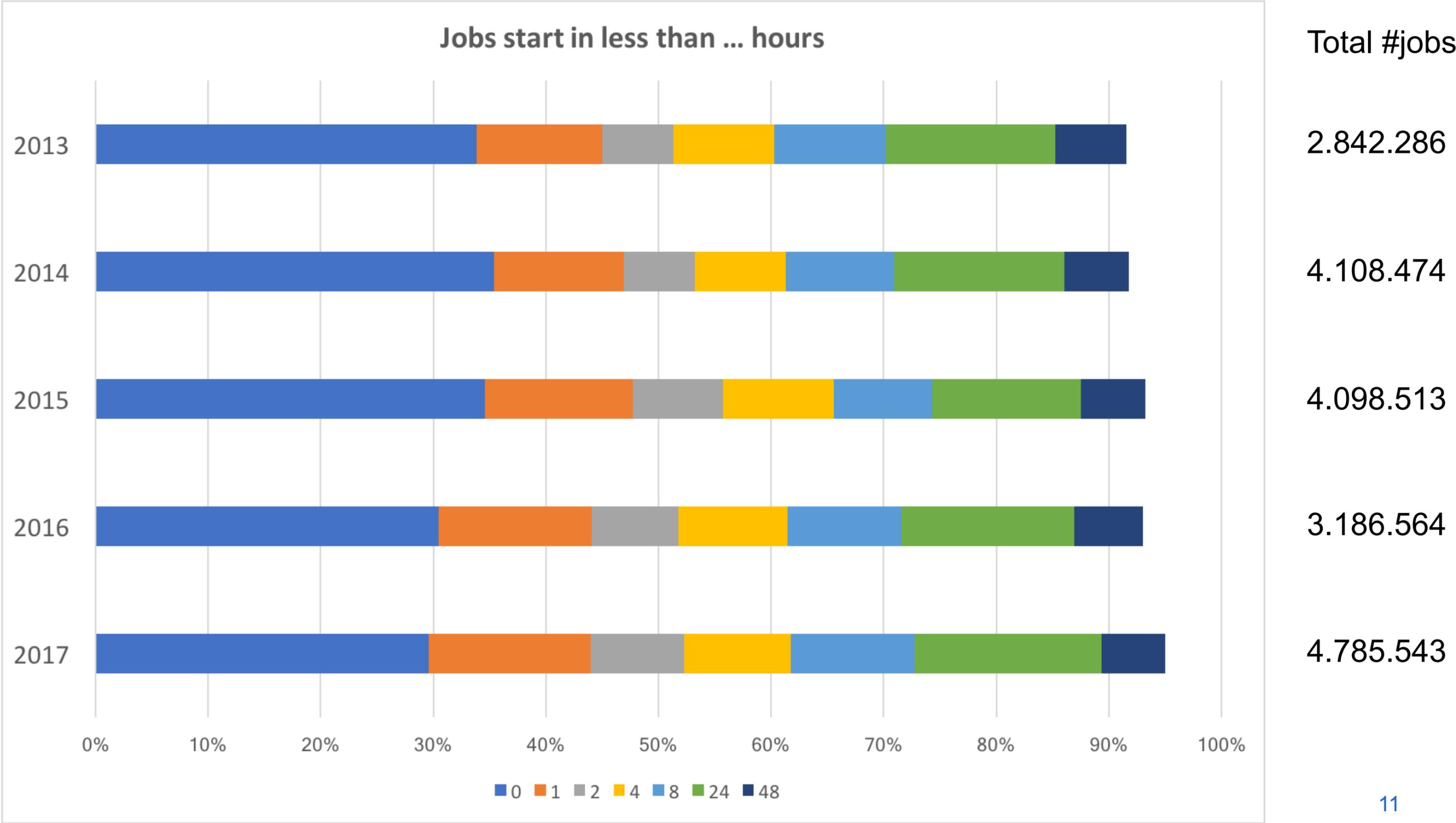
	core years		core years
vsc40941	477	vsc41326	285
vsc40944	473	vsc40588	255
vsc40484	470	vsc40686	248
vsc40309	398	vsc41224	205
vsc41948	301	vsc41228	180



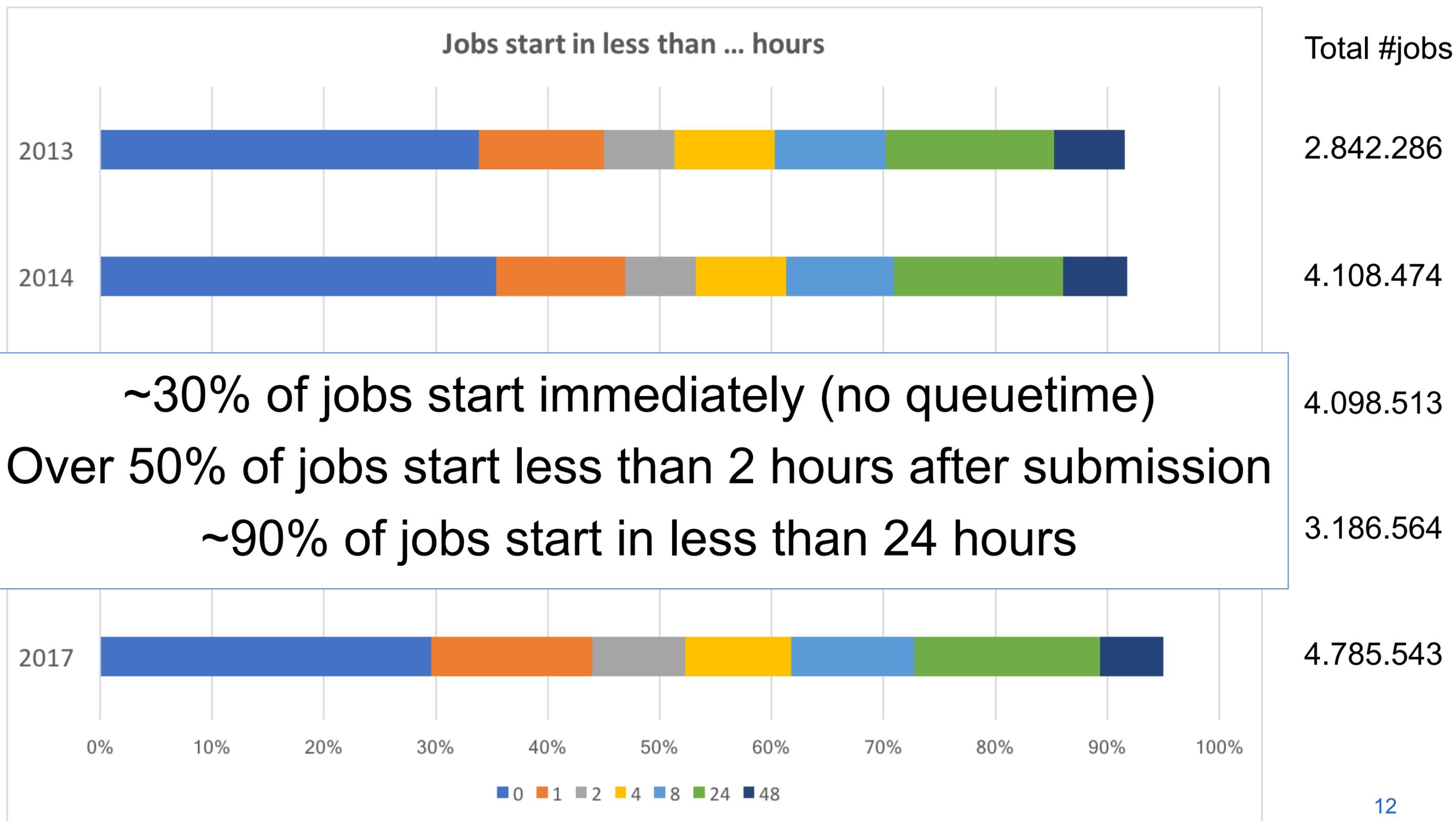
OVERVIEW OF HPC-UGENT USAGE



OVERVIEW OF HPC-UGENT USAGE



OVERVIEW OF HPC-UGENT USAGE



HPC-UGENT – NEW SERVICES

Extra compute clusters

- 2.2M euro investment
- Production expected by summer 2018

#nodes	CPU	Mem/node	Disk/node	Network
72	2 x 18-core Intel Xeon Gold 6140 (Skylake @ 2.3 GHz) 2592 cores in total	192 GB	1 TB 240 GB SSD	EDR InfiniBand
96	2 x 18-core Intel Xeon Gold 6140 (Skylake @ 2.3 GHz) 3456 cores in total	96 GB	1 TB 240 GB SSD	10 GbE

HPC-UGENT – NEW SERVICES

Extra compute clusters

- 2.2M euro investment
- Production expected by summer 2018

	#nodes	CPU	Mem/node	Disk/node	Network	
	skitty	72	2 x 18-core Intel Xeon Gold 6140 (Skylake @ 2.3 GHz) 2592 cores in total	192 GB	1 TB 240 GB SSD	EDR InfiniBand
	victini	96	2 x 18-core Intel Xeon Gold 6140 (Skylake @ 2.3 GHz) 3456 cores in total	96 GB	1 TB 240 GB SSD	10 GbE

These clusters will replace delcatty and raichu

HPC-UGENT – NEW SERVICES



Cloud testbed ‘grimer’

- 16 hypervisors - 256 CPU cores – 200 TB storage (Ceph)
- Reuse of decommissioned muk (old Tier-1) hardware
- For users with specific requirements
 - Public cloud infrastructure
 - Graphical user interface
 - Software with wallclock > 72h ? (But checkpointing is far more advisable)
- VM(s) managed by user! Currently free of charge
- Testbed to gather expertise – underlying technology may change

HPC-UGENT – NEW SERVICES



Cloud testbed 'grimer': example application

Galaxy / Galaxy @ VIB-UGent Analyze Data Workflow Shared Data Visualization Admin Help User Using 55.5 GB

Tools

- RNA-SEQ ANALYSIS
 - Summarization
 - Quantification using lightweight alignment
 - Read Mapping
 - FastQ Quality Control
 - CHIP-SEQ ANALYSIS
 - Extract motifs from peak data
 - Binding and Expression Target Analysis (BETA)
 - Model-based Analysis of CHIP-Seq
 - CRISPR ANALYSIS
 - Genome editing
 - STATISTICAL ANALYSIS
 - Differential expression
 - DATA MANIPULATION
 - Samtools
 - Bedtools
 - DeepTools
 - Picard tools
 - DEFAULT OPERATIONS
 - Get Data
 - Send Data
 - Collection Operations
 - Text Manipulation
 - Filter and Sort
 - Join, Subtract and Group
 - Convert Formats
 - Extract Features
 - Fetch Sequences
 - Fetch Alignments
 - Statistics
 - Graph/Display Data
 - Workflows
 - All workflows

GHENT UNIVERSITY

Welcome to the Galaxy Instance of VIB-UGent

VIB

How to use Galaxy ?

Tools: In the left panel of this page you will find the list of available tools, you can see this page at any point by clicking 'Analyze Data' in the top menu.

History: The history of your current data analysis is shown in the right panel. A good practice when running multiple analysis in parallel is to create several histories and give each one a unique name. You can click on 'View all histories' button (upper right corner in histories panel) to get an overview and switch between the current histories.

Input Data: Every analysis starts with getting the input data into your current history (right panel). To do this you can upload your own input files or use shared datasets. To upload files from your computer or instruct Galaxy to download files from the web you have to use of the upload tool: Get data (tool panel on the left) -> upload file. Please DO NOT UPLOAD LARGE FILES (~GB), but contact the administrator to create a central data repository! To use available shared data you have to click on Shared data (top menu) -> Data Libraries. You can then browse the available libraries and select the file/s you want to use. By clicking 'to History' button and choosing the desired History name you will import these files and make them available to use as input for future analysis.

Execution: To run a job select the tool from tool panel on the left, then the corresponding interface will be loaded and you will be able to select corresponding input data and (re)define parameters. Please read carefully the labels and help text next to the input fields. After clicking Execute you will be able to see entries for each in your history. The color of a dataset designates the current status of the underlying job

 - Grey: The job is being evaluated to run (new dataset) or is queued. Allow this to complete.
 - Yellow: The job is executing.
 - Green: successful processing
 - Red: The job has failed.
 - Light blue: The job is paused. This indicates either a problem with an input (a previous step in the workflow may have failed) or that you have exceeded disk quota set by the administrator of the Galaxy instance you are working on.

Workflows: You can automate your analysis pipeline by using workflows composed of several tools linked by their input/output data. In the Workflows section (upper menu) you can see a list of current workflows and also create your own ones. It is also possible (and highly recommended) to use the shared, and widely tested, workflows available under Shared Data (top menu) -> workflows. To use one of these you first need to import it to your workflows list by clicking on the name and selecting Import. To execute any workflow listed under your workflows first click on it and select run, then choose the input data as with any tool.

History

search datasets

Salmon strandedness test
115 shown, 12 deleted, 1 hidden

50.97 GB

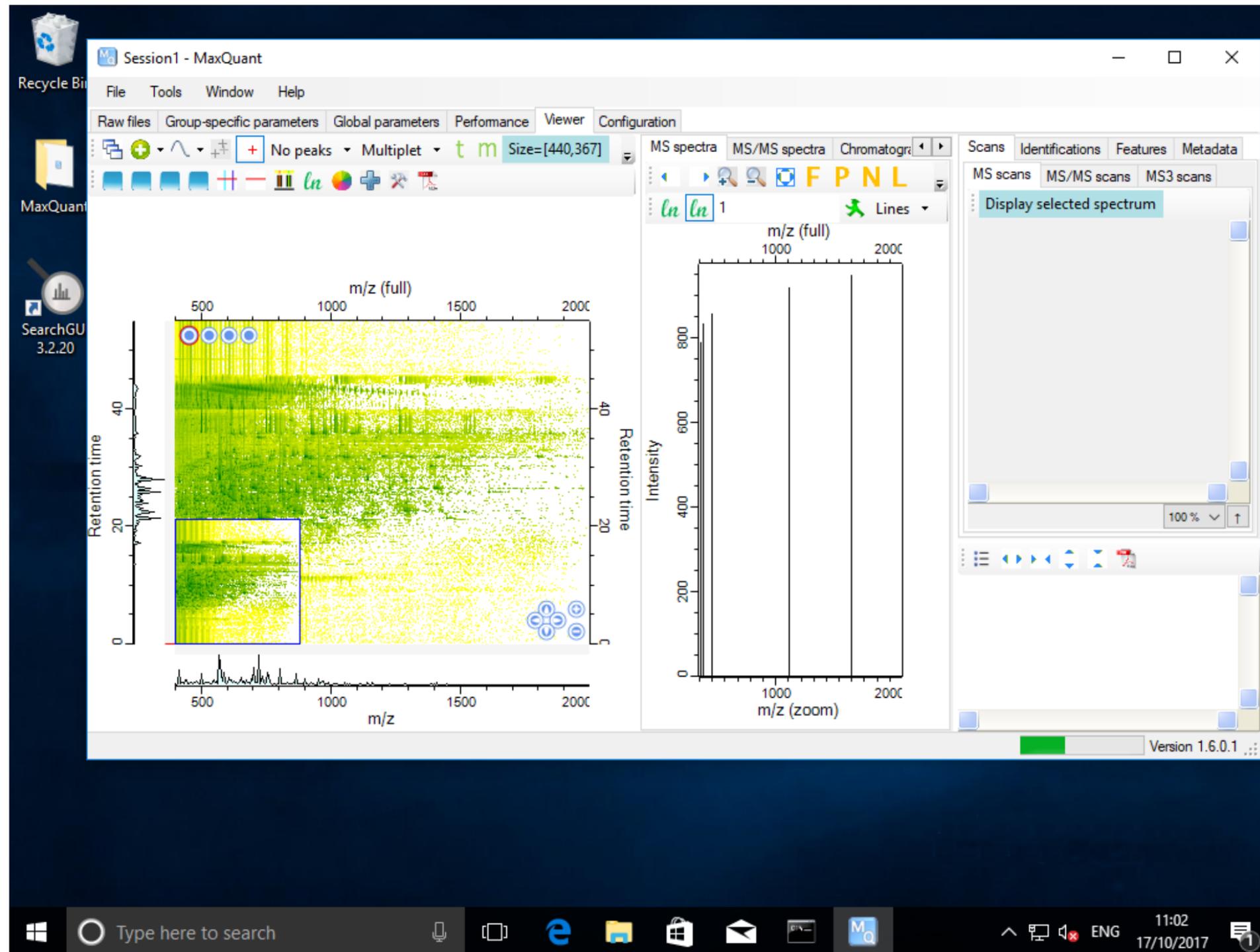
 - 127: Salmon on data 1 (SAM format)
 - 126: Salmon on data 1 (Gene Quantification)
 - 125: Salmon on data 1 (log)
 - 124: Salmon on data 1 (Quantification)
 - 123: Salmon on data 1 (SAM format)
 - 122: Salmon on data 1 (Gene Quantification)
 - 121: Salmon on data 1 (log)
 - 120: Salmon on data 1 (Quantification)
 - 119: Salmon on data 1 (SAM format)
 - 118: Salmon on data 1 (Gene Quantification)
 - 117: Salmon on data 1 (log)
 - 116: Salmon on data 1 (Quantification)
 - 115: Salmon on data 1 (SAM format)
 - 114: Salmon on data 1 (Gene Quantification)
 - 113: Salmon on data 1 (log)
 - 112: Salmon on data 1 (Quantification)
 - 110: Salmon on data

Galaxy is an open, web-based platform for data intensive biomedical research. The Galaxy team is a part of BX at Penn State, and the Biology and Mathematics and Computer Science departments at Emory University. The Galaxy Project is supported in part by NHGRI, NSF, The Huck Institutes of the Life Sciences, The Institute for CyberScience at Penn State, and Emory University.

HPC-UGENT – NEW SERVICES



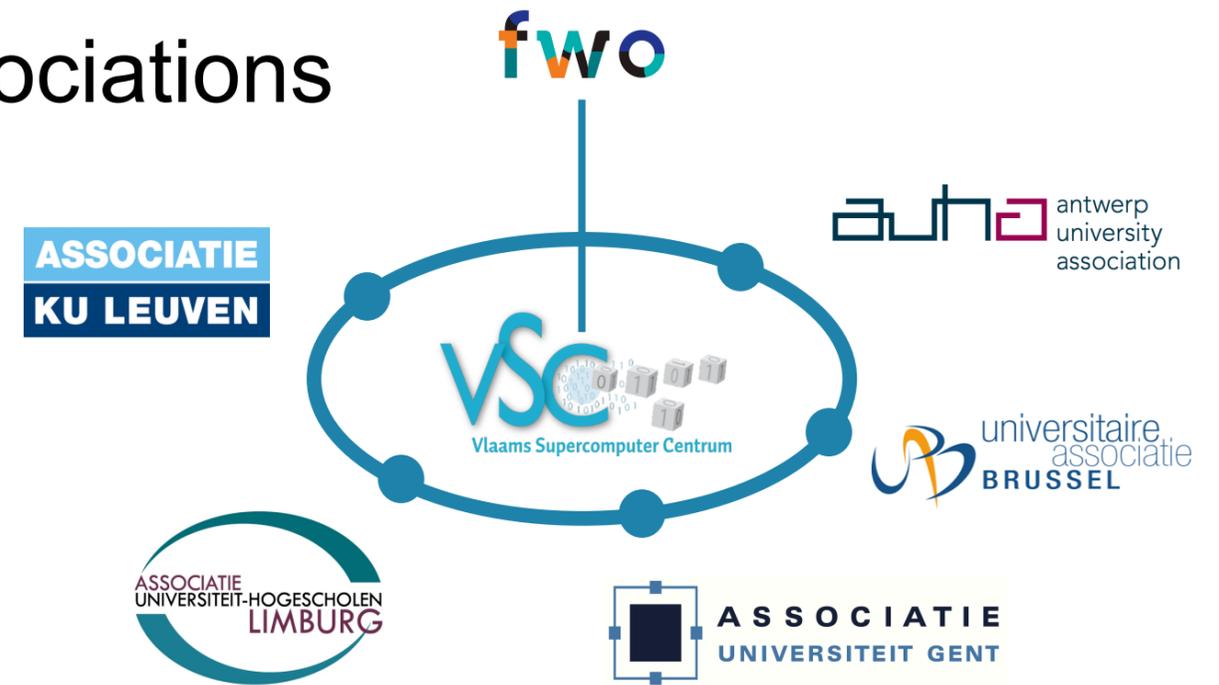
Cloud testbed 'grimer': example application



ABOUT VSC

VSC – Flemish Supercomputer Center

- Partnership between Flemish university associations
- Infrastructure in four hubs
- Managed by FWO



Mission

The VSC encourages the use of scientific and technical computing in the Flemish academic and industrial landscape. To this end, it offers infrastructure, training and services. In addition, VSC acts as a lever to promote the importance of scientific and technical computing and its added value to society.

ABOUT VSC – GOVERNING BODIES

VSC steering group

Daily (monthly) management of VSC, consensus

UGent representative: Ewald Pauwels

Users committee

Map user needs, advise on Tier1/2 operation, VSC user day

UGent representatives: Veronique Van Speybroeck, Marie-Françoise Reyniers

Tier1 evaluation committee (non-Flemish experts)

Technical evaluation of Tier-1 applications

Industrial board

Advise to increase involvement of industry

FWO

Funding, final governance

ABOUT VSC - GOALS

1. Offer its target audience **access to diversified ICT infrastructure** that is tailored to the needs of scientific/technical computing.
2. Provide a **common user environment** on the computing infrastructure, which is available in the local hubs.
3. **Support** its users so that they can lift their research and development to a higher level by using scientific/technical computing.
4. **Inform about the capabilities and achievements** of scientific/technical computing and its potential added value.
5. Actively **promote scientific/technical computing in Flemish industry** and foster the exchange of ideas and expertise between research institutions and industry.
6. Offer a diverse and coordinated **training program** across the VSC consortium to stimulate and advance the uptake of scientific/technical computing in new and existing users.
7. Engage and actively participate in **international initiatives** such as PRACE and Horizon 2020, and cooperate with other centers focusing on scientific/technical computing.

VSC INFRASTRUCTURE

<https://www.vscentrum.be/infrastructure/hardware>

Available hardware

Tier-1

- Our [current Tier-1 system is BrENIAC](#), operated by KU Leuven. The system is aimed at large parallel computing jobs that require a high-bandwidth low-latency interconnect. Compute time is again only available upon approval of a project. See the [page on Tier-1 project access and links in that page](#).
- Our [first Tier-1 system is muk](#), was operated by UGent but is no longer in production.

Experimental setup

- [There is a small GPU and Xeon Phi test system](#) which is can be used by all VSC members on request (though a project approval is not required at the moment). [The documentation for this system is under development](#).

Free of charge

→ <http://hpc.ugent.be/userwiki/index.php/Tips:Software:GPGPU>

Tier-2

Four university-level cluster groups are also embedded in the VSC and partly funded from VSC budgets:

- [The UAntwerpen clusters \(hopper and leibniz\)](#)
- [The VUB cluster \(hydra\)](#)
- [The UGent local clusters](#)
- [The KU Leuven/UHasselt cluster \(ThinkKing and Cerebro\)](#)

Free of charge

Not free of charge, but heavily discounted

VSC INFRASTRUCTURE

Using other VSC infrastructure

- Don't hesitate
- If unsure about pricing, ask KULeuven for quote
- Feel free to ask support at another VSC site, e.g.
 - Error reporting
 - Trouble with credit system
 - Software installation
- **Always** put hpc@ugent.be in cc

VSC INFRASTRUCTURE – TIER-1

Muk @ UGent

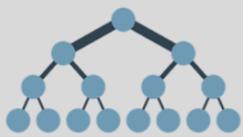


BrENIAC @ KULeuven



PEAK PERFORMANCE
600⁺
TERAFLOPS

x3

 **EDR**

x2

 **GPFS**
600⁺ TB

x2

16,240 cores
Intel ES-2600 V4

x2

 **Memory per node**

x2

x4

- 580 nodes
- 2 Intel Xeon Broadwell → 16.240 cores
- 128/256 GB RAM
- InfiniBand EDR interconnect
- 634 TB storage

TIER-1 ACCESS – STARTING GRANT

<https://www.vscentrum.be/en/access-and-infrastructure/tier1-starting-grant>

- Purpose = explore, do scaling tests of your software, prepare for project
- 100 node days (= $100 \times 28 \times 24 = 67.200$ core hours)
- Available for 2 months
- Personal grant
- Fast submission procedure, very short proposal
- Constantly reviewed
- Success rate = 100%

- FREE OF CHARGE

TIER-1 ACCESS – PROJECT ACCESS

<https://www.vscentrum.be/en/access-and-infrastructure/project-access-tier1>

- 500 - 5000 node days (= 336.000 – 3.360.000 core hours)
- Available for 6 months
- Can be granted to multiple researchers
- Reviewed 3x per year by Tier-1 Evaluation Committee
 - Next deadline = 5 February 2018
- Success depends on quality of your proposal
 - Send your proposal to hpc@ugent.be for prior review
- FREE OF CHARGE

VSC INFRASTRUCTURE TIER-1

BrENIAC: A year celebrating curiosity

3
calls



81
users



59
projects



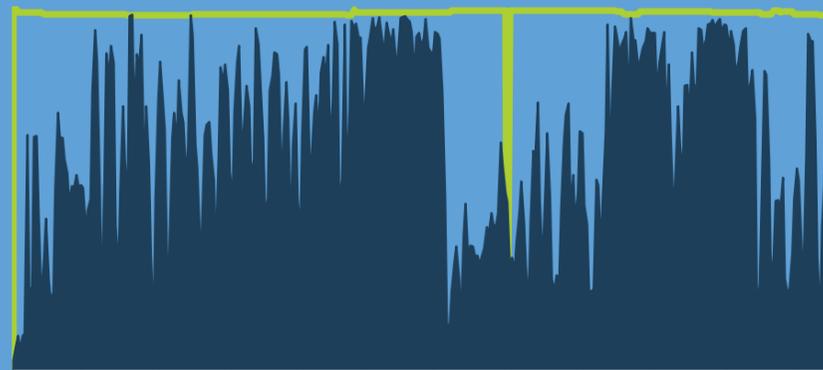
72,000
jobs



87M
core hours



98%
uptime



30 Oct 2016

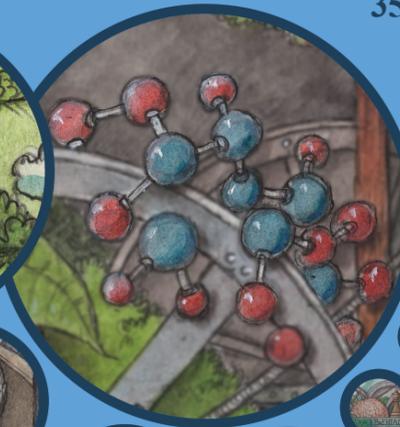
12 Oct 2017

61%
usage

Technology
25%



Molecular Modelling
35%



Earth Science
1%



Computational Science
0.5%



Chemistry
3%



Psychology
5%



Physics
12%



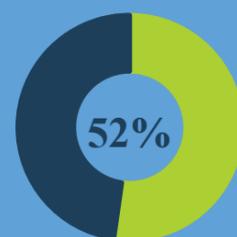
Life Science
10%



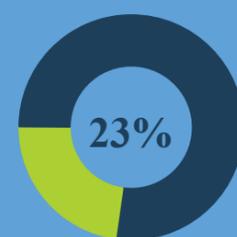
Astronomy and Astrophysics
9%



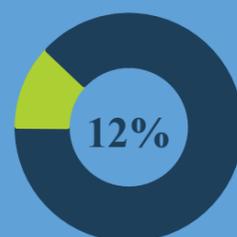
U Gent



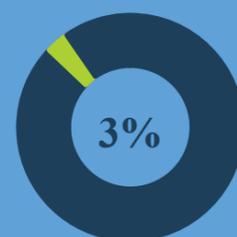
KU Leuven



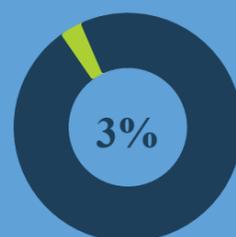
U Antwerpen



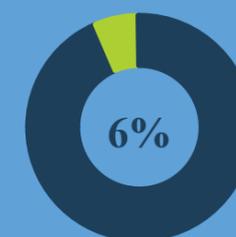
U Hasselt



VUB



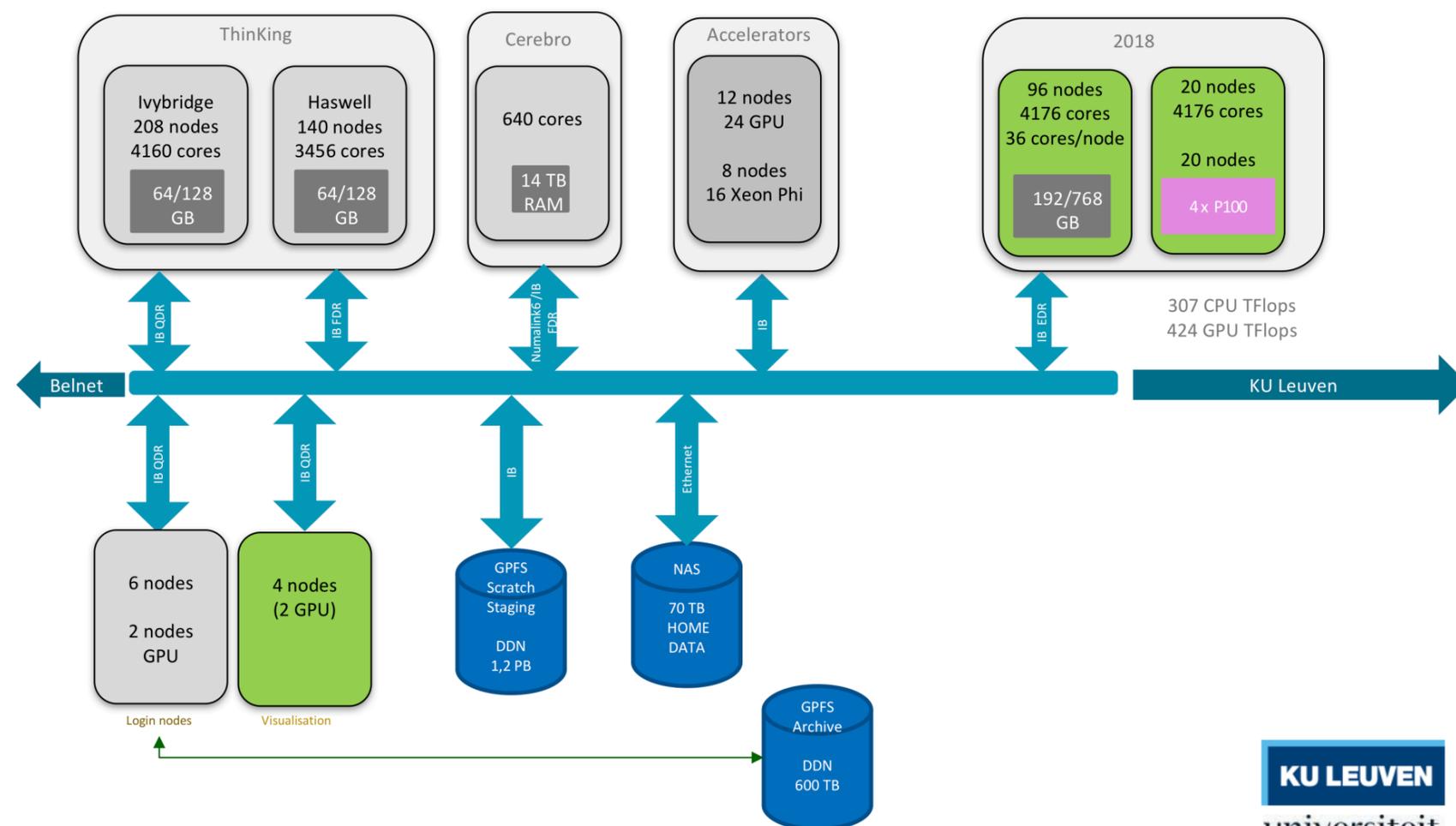
Others



VSC - FUTURE PLANS

New GPU cluster at KU Leuven

- 20 nodes with each
4 x Nvidia Tesla P100



- KU Leuven will likely open (free) pilot access to GPUs
- Let us know via hpc@ugent.be if you would like to use these GPUs

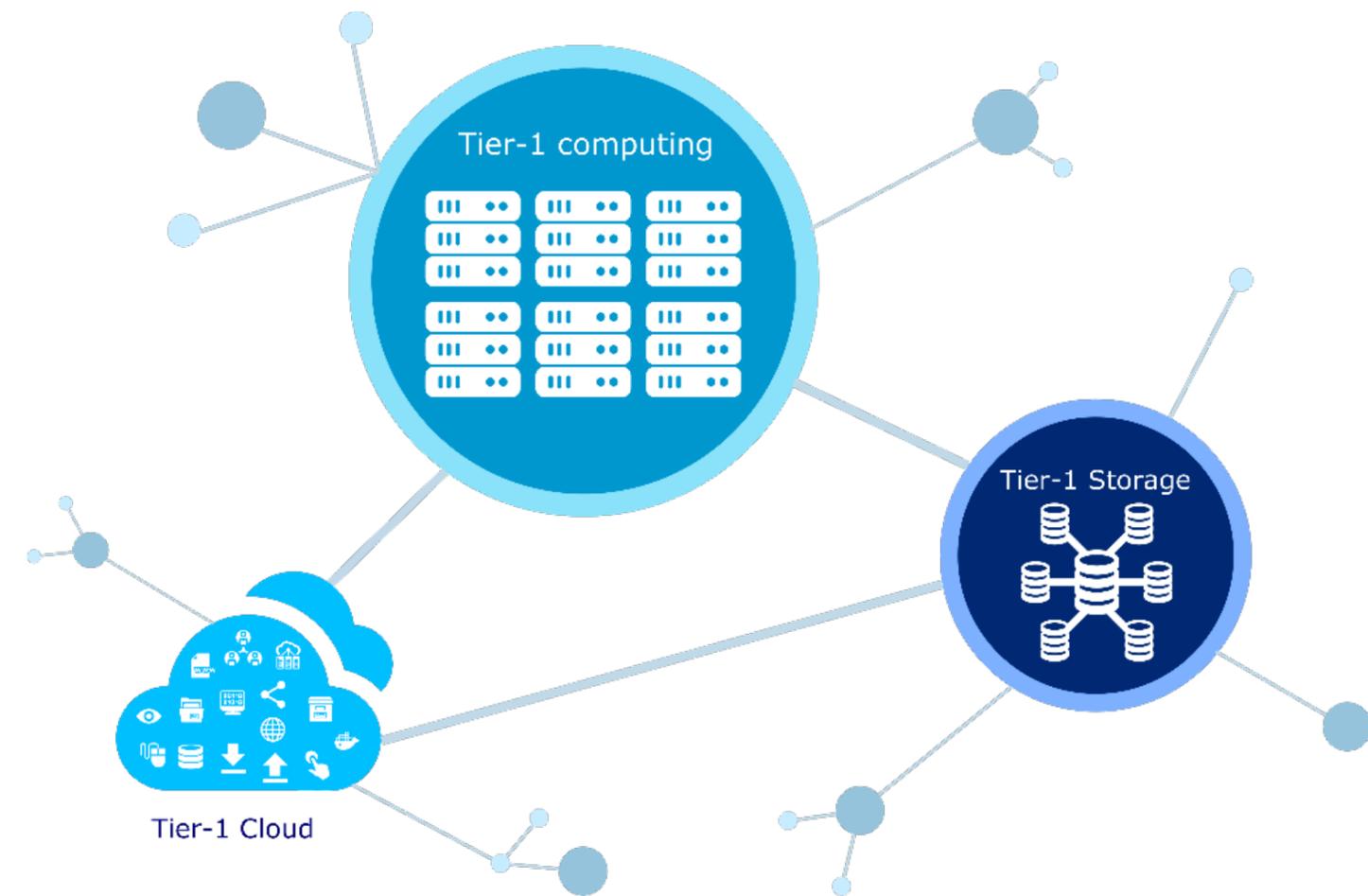
VSC - FUTURE PLANS

New Tier-1 supercomputing platform

(Subject to final approval by government)

- Intention to be structural
- Complementary programs
 - Cloud
 - Storage } very challenging
- Compute: extending current Tier-1 service

- First developments proposed starting 2018

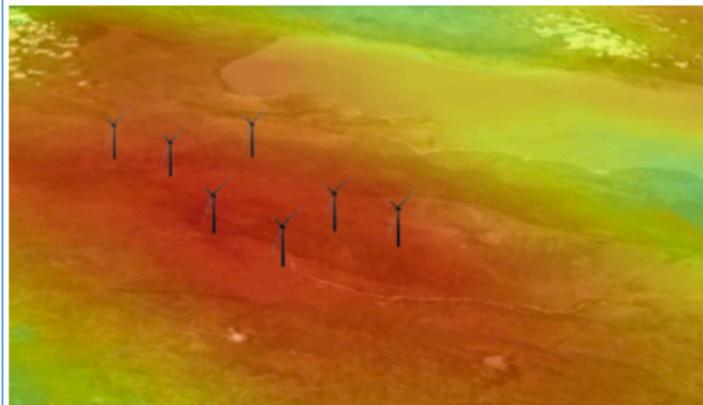


VSC – CALL FOR SUCCESS STORIES

Cases and projects

Achievements on our infrastructure

Industrial use cases



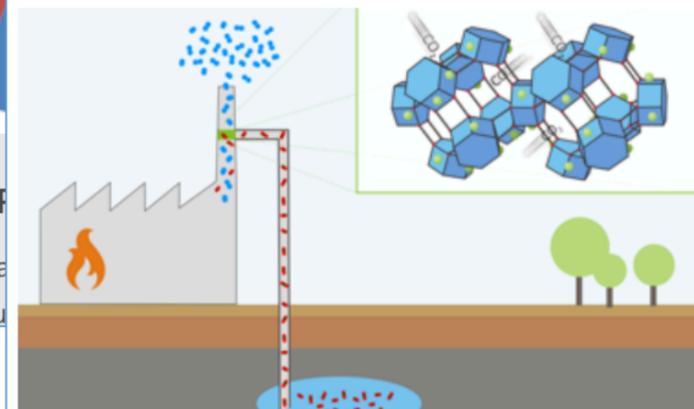
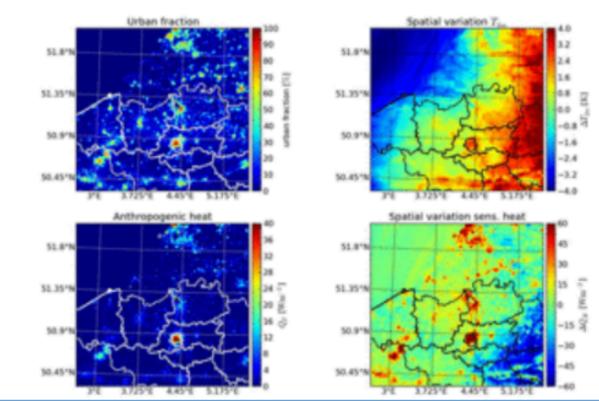
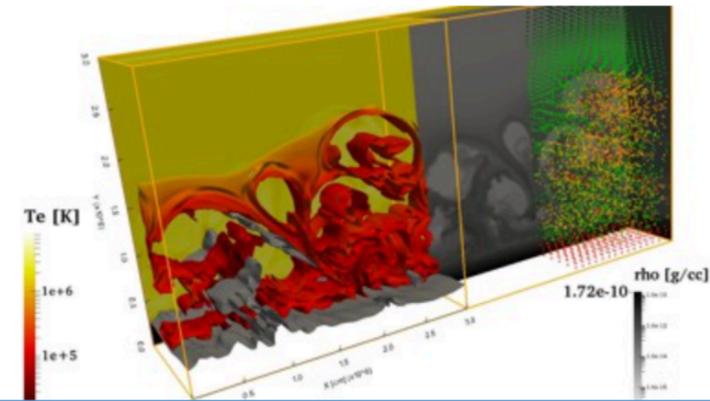
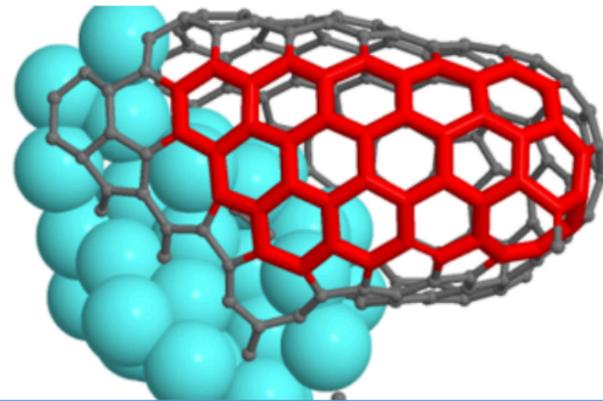
Wind energy simulations at 3E NV

3E NV, a Belgian renewable energy consultancy firm, makes use of the VSC infrastructure and

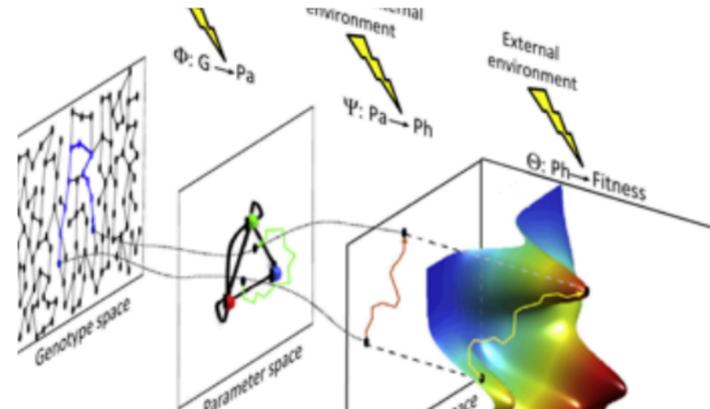


Janssen P
Janssen Pha
infrastructu

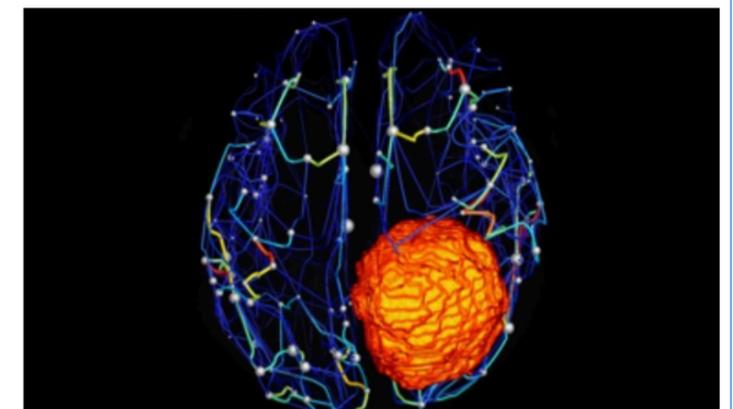
Academic use cases



Molecular modeling spurs innovative technology against global warming



Mechanistic modeling and in silico evolution of gene regulatory networks



Modeling brain dynamics in health and disease using supercomputing

Prof. Daniele Marinazzo (UGent) uses

<https://www.vscenrum.be/en/project-and-cases>

Contact hpc@ugent.be if you could contribute

REVIEW OF USER POLL RESULTS

- 104 respondents
- ~8 questions
- Average completion time: 5 minutes

REVIEW OF USER POLL RESULTS

How often do you use the HPC-UGent scientific computing infrastructure?

On a daily basis

#resp

41

Usually once per week

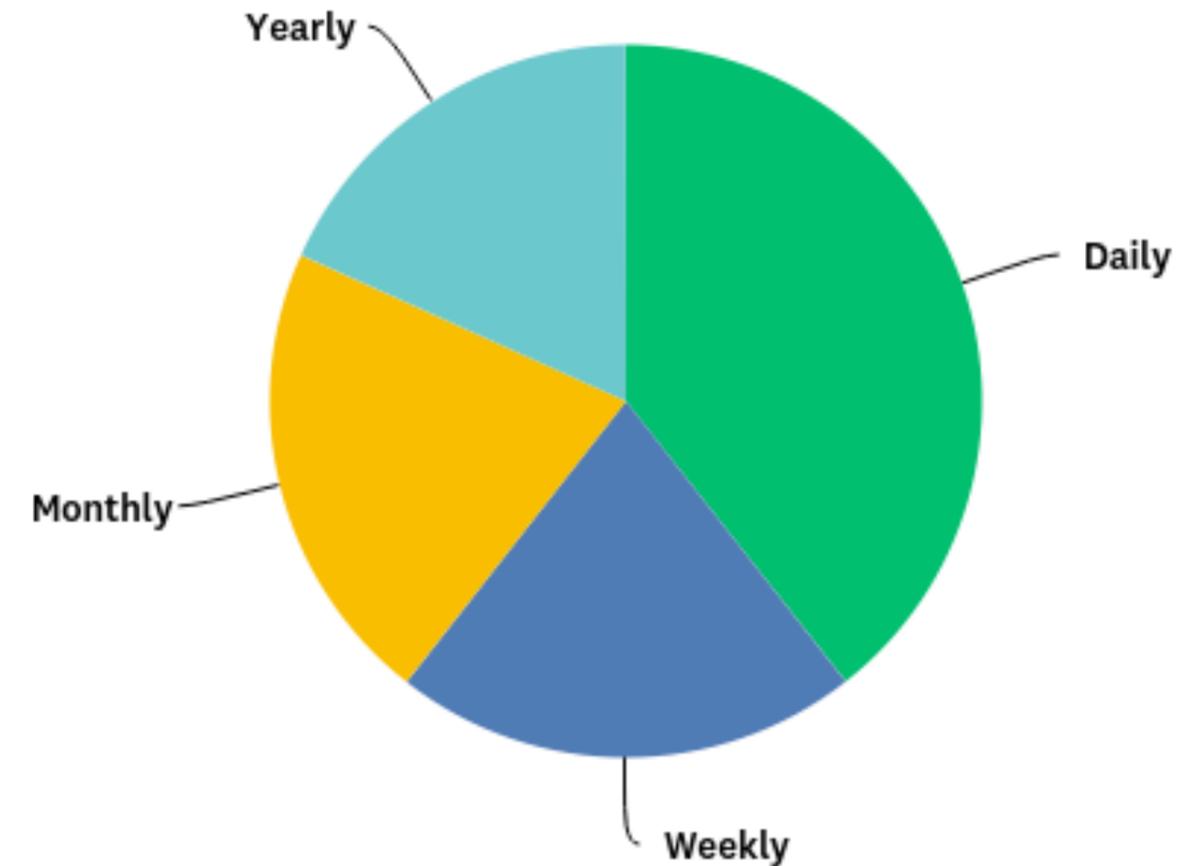
22

Once per month

22

1-2 times per year or less

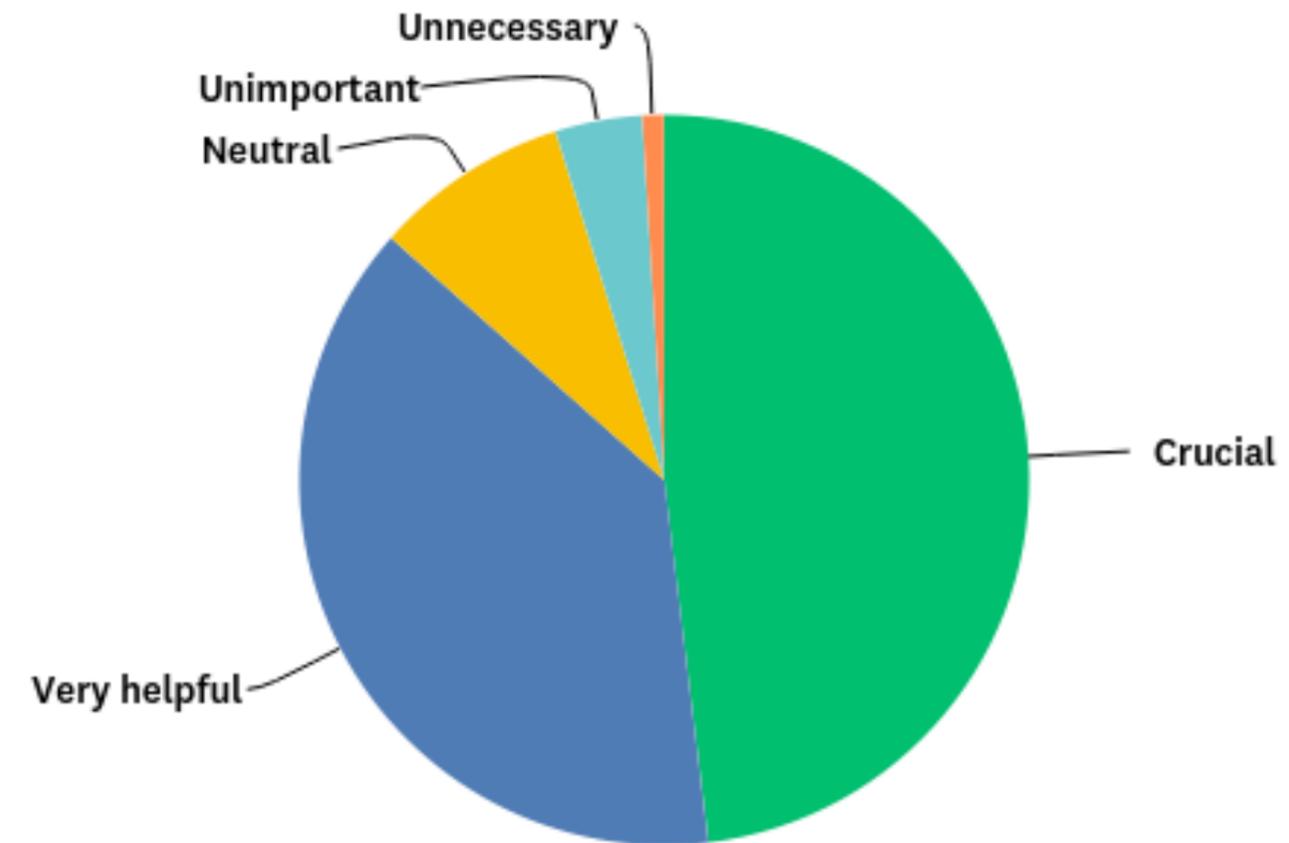
19



REVIEW OF USER POLL RESULTS

How important is HPC-UGent for your research?

	#resp
Crucial. I can't do my research without.	50
Very helpful. It allows me to do my research at a faster pace and at a higher level.	40
Neutral	9
Unimportant. I can just as well do my research in another way.	4
Unnecessary. I don't need it at all to do my research.	1



REVIEW OF USER POLL RESULTS

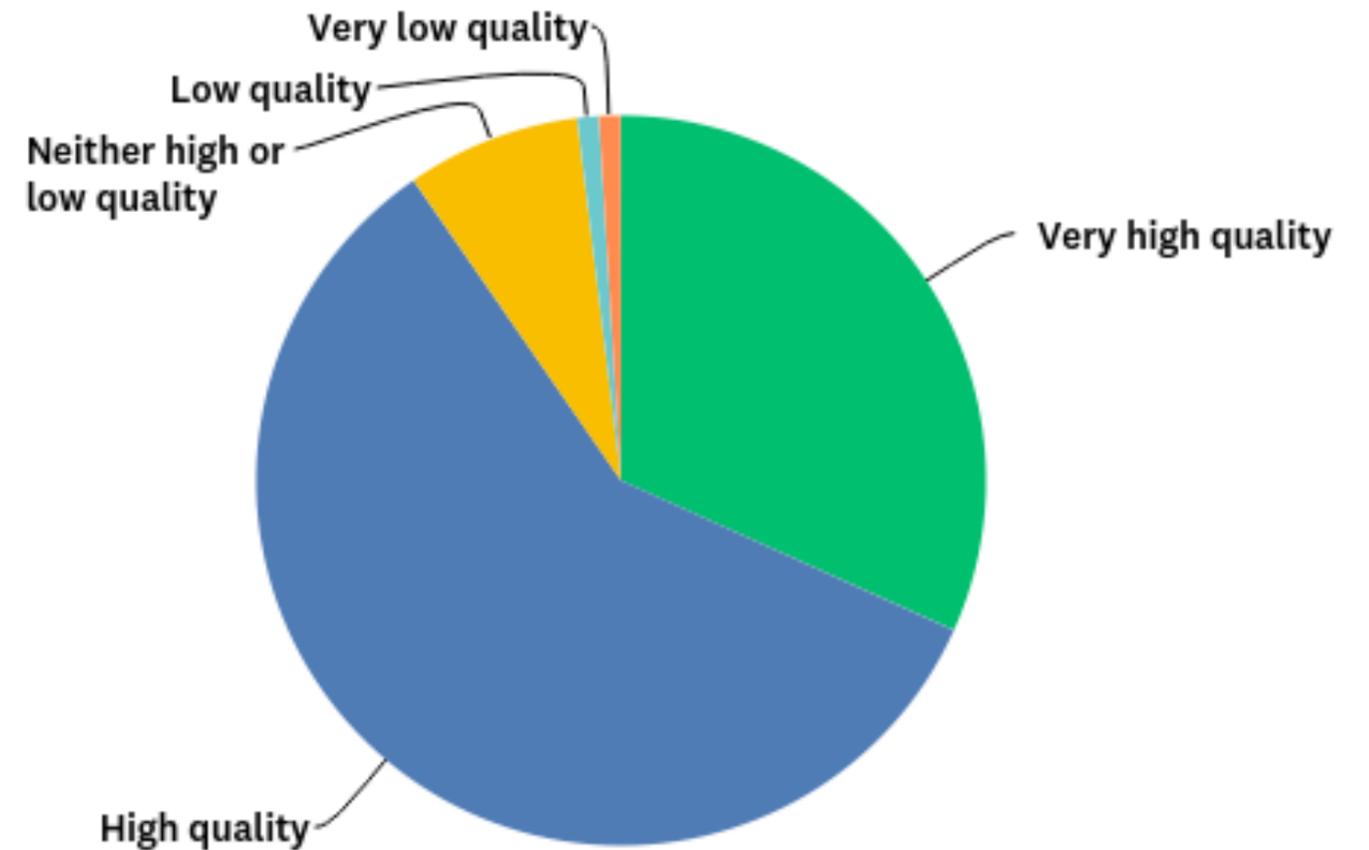
How often / How important?

	How often do you use?				
		Daily	Weekly	Monthly	Yearly
How important for your research?	Crucial	32%	7%	7%	3%
	Very helpful	7%	14%	13%	5%
	Neutral	1%	0%	2%	6%
	Unimportant	0%	0%	0%	4%
	Unnecesary	0%	0%	0%	1%

REVIEW OF USER POLL RESULTS

**How would you rate the services that HPC-UGent provides?
(compute clusters, login nodes, training, user support, website)**

	#resp
Very high quality	33
High quality	61
Neither high or low quality	8
Low quality	1
Very low quality	1



More than 90% of poll participants rate our services as 'high quality' or above.

REVIEW OF USER POLL RESULTS

How often / Your rating?

		How often do you use?			
		Daily	Weekly	Monthly	Yearly
Your rating of our services?	Very high quality	15%	8%	7%	2%
	High quality	21%	12%	13%	13%
	Neither high or low quality	2%	2%	0%	4%
	Low quality	1%	0%	0%	0%
	Very low quality	0%	0%	1%	0%

REVIEW OF USER POLL RESULTS

Is there a particular service that stands out or you care to comment about? 😊😊😊

#comments	Service	
16	User Support	<i>excellent, fast, friendly</i>
8	Training	<i>regular, hands-on</i>
6	Infrastructure	<i>diverse, reliable, updated</i>
5	Software	<i>fast installation, version flexibility, module system</i>
4	Documentation	<i>good, excellent, usable by newbies</i>

REVIEW OF USER POLL RESULTS

Is there a particular service that stands out or you care to comment about? 😊😊😊

“The clusters in Ghent are still the best managed systems I've been working with. Keep up the nice work guys!”

”The Helpdesk is extremely supportive and helpful! Thank you!”

”The consistent use of the system status page in the User Portal of the VSC website is much appreciated. It is good to have this page as the single point of information for cluster related updates and during upsets.”

→ <https://www.vscentrum.be/en/user-portal/system-status>

REVIEW OF USER POLL RESULTS

Is there a particular service that stands out or you care to comment about? 😞😞😞

#comments	Service	
5	Infrastructure	<i>long queues, wallclock, regular downtimes</i>
1	Training	<i>software-specific training sessions</i>
1	Documentation	<i>spread out, no overview of basic commands</i>

REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

- 62 responders
- 92 suggestions
- Detailed follow-up in future
- Recurring suggestions in next slides



REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

Documentation (21)

More structured wiki/website that is SPOI (6)

Documentation better geared towards new users (9)

- Checklist for starters
- Different clusters + storage locations
- Frequently used commands

More examples: scripts, software (3)

Updated documentation (2)

Newsletter

REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

Documentation (21)

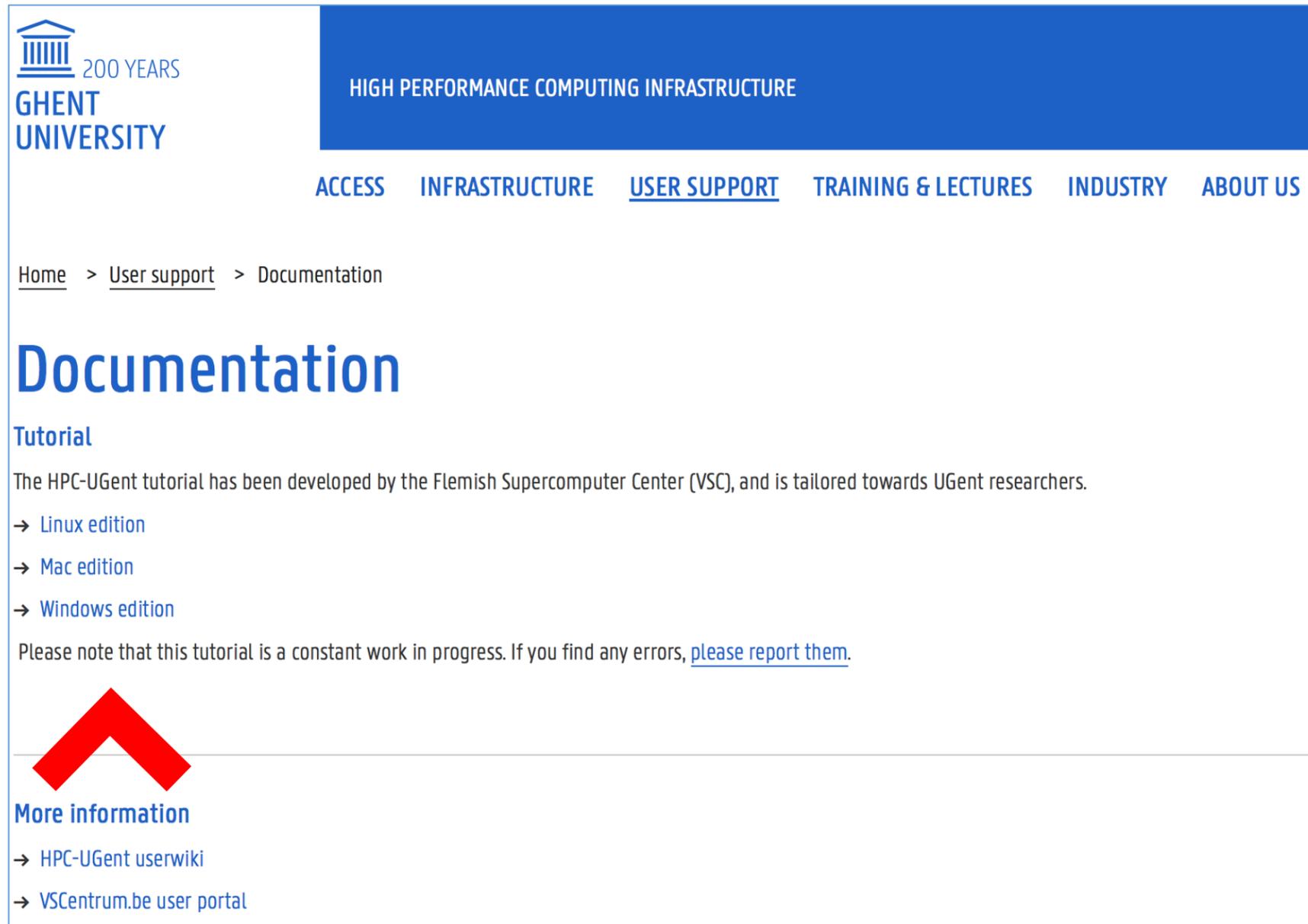
The screenshot shows the HPC-UGent website with the following elements:

- Header:** Ghent University logo (200 Years), "HIGH PERFORMANCE COMPUTING INFRASTRUCTURE", and a search bar.
- Navigation:** ACCESS, INFRASTRUCTURE, USER SUPPORT, TRAINING & LECTURES, INDUSTRY, ABOUT US.
- Tagline:** Centralised scientific computing services, training, and support for researchers and industry.
- Support and services:** Documentation, Training and lectures, User support, Publications.
- Access to infrastructure:** Access for staff & academics, Access for industry, Infrastructure overview.
- Focus on:** fwo (12 December 2017) - Vacancy relationship manager VSC and industry @ FWO; vsc (Vlaams Supercomputer Centrum).
- News:** PRACE Digest 2017 (12 December 2017), Machine Learning and Deep Learning recordings (6 December 2017).
- Footer:** Ghent University logo and "VSC looking for 'relationship manager industry', employed by FWO".

REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

Documentation (21)



The screenshot shows the 'Documentation' page of the HPC-UGent website. The page header includes the Ghent University logo (200 Years) and the text 'HIGH PERFORMANCE COMPUTING INFRASTRUCTURE'. The navigation menu contains 'ACCESS', 'INFRASTRUCTURE', 'USER SUPPORT', 'TRAINING & LECTURES', 'INDUSTRY', and 'ABOUT US'. The breadcrumb trail is 'Home > User support > Documentation'. The main heading is 'Documentation'. Under the 'Tutorial' section, it states: 'The HPC-UGent tutorial has been developed by the Flemish Supercomputer Center (VSC), and is tailored towards UGent researchers.' It lists three links: 'Linux edition', 'Mac edition', and 'Windows edition'. A note says: 'Please note that this tutorial is a constant work in progress. If you find any errors, [please report them.](#)' A large red arrow points to the 'More information' section, which contains two links: 'HPC-UGent userwiki' and 'VSCentrum.be user portal'.

REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

User experience (21)

Shorter queue times (7)

Way to estimate queue time (4)

Longer wallclock time (4)

<http://hpc.ugent.be/userwiki/index.php/User:Checkpointing>

contact hpc@ugent.be if you have checkpointing issues

Feedback on efficiency of specific job (4)

Infrastructure (17)

Larger compute power (7)

GPU (4)

 Debug infrastructure, remote visualization (2)

REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

Data (10)

More storage

Easier sharing of data

- Between VOs

VSC_DATA_SHARED in <https://account.vscentrum.be/django/vo/edit>

- Public → VMs ?

Staging in/out data

Archive data of inactive users

REVIEW OF USER POLL RESULTS

How could we further improve HPC-UGent services?

User support (3)

More HPC-UGent staff

Training (7)

More (5)

Policy (4)

Collaboration within VSC

Keep services free of charge

Security (6)

ftp connectivity (5) ?

Node sharing, data visible to other users

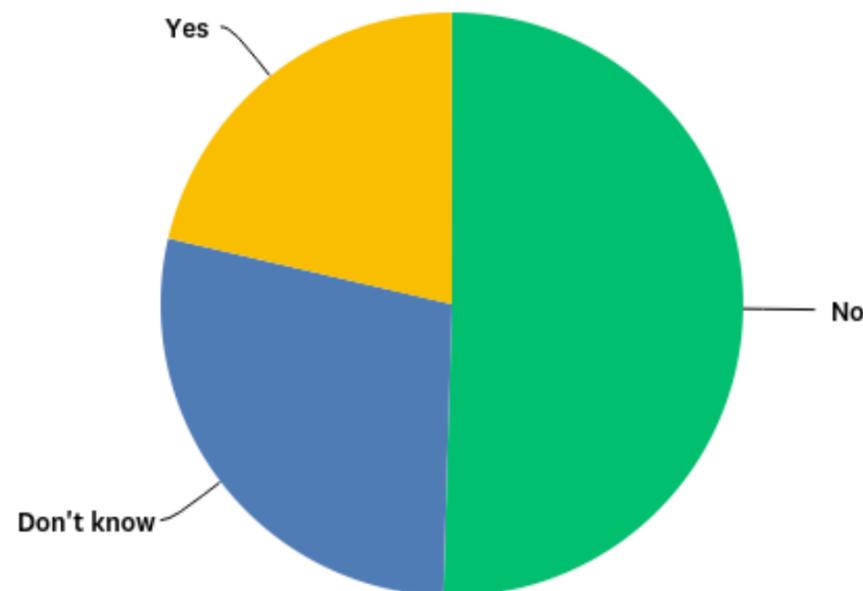
Software (3)

Form to request software install/update

REVIEW OF USER POLL RESULTS

Would your research benefit from specific IT hardware or services that HPC-UGent currently does not provide?

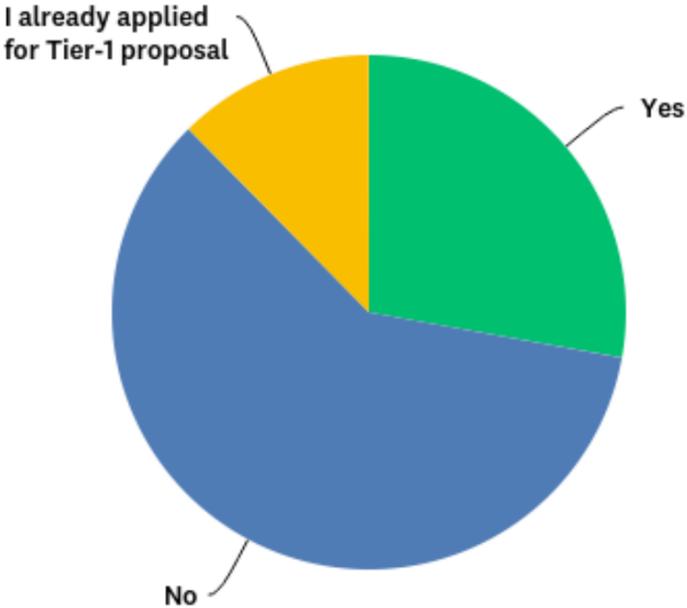
	#resp	<u>Specific hardware/services suggested</u>
No The current compute platform suffices	52	Bigdata cluster with fast I/O Large, shared storage (many TB)
I don't know	29	Very high memory machine (1 TB)
Yes I need specific hardware/services	22	GPU More cores / node Other compilers than Intel Longer wallclock time Personnel to support coding design Additional personnel for software installs



REVIEW OF USER POLL RESULTS

Would you be interested in applying for a Tier-1 proposal?

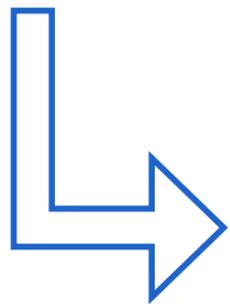
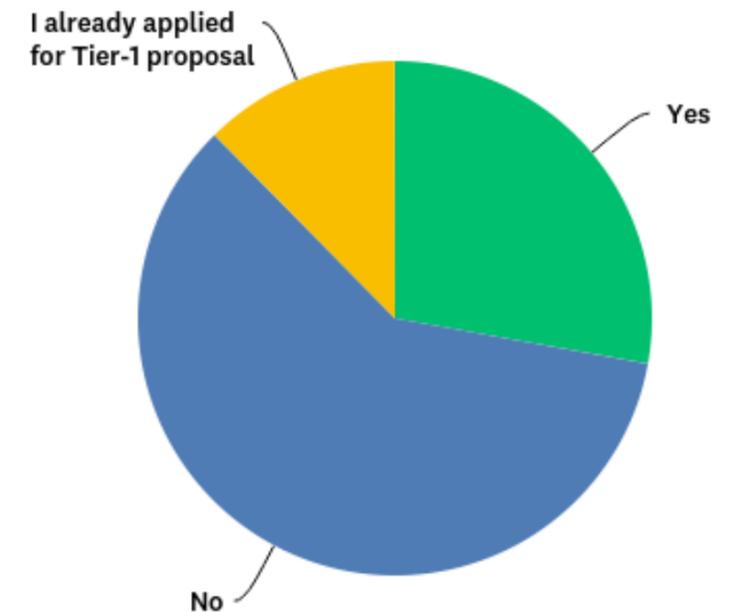
	#resp
Yes	27
I already applied for Tier-1 proposal	22
No	58



REVIEW OF USER POLL RESULTS

Would you be interested in applying for a Tier-1 proposal?

	#resp
Yes	27
I already applied for Tier-1 proposal	22
No	58



What is holding you back to submit a Tier-1 proposal?

Why do you consider Tier-1 not suitable for your research?

Tier-2 suffices (33)

Lack of experience (3)

Don't know what Tier-1 is (3)

Too much work (1)

Gaussian does not scale (1)

Additional cost (1)

Dr. Ewald Pauwels

Scientific coordinator HPC @ Ghent University

Vice-coordinator VSC

HPC-UGent

E hpc@ugent.be

www.ugent.be/hpc

RECEPTION: BEERS



Pils 13 Fresh Hop

The Ministry of Belgian Beers
Pils (4% Alc. Vol)



Zwaluw

Siphon Brewing
Session IPA (3,3% Alc. Vol)



Cendre

Siphon Brewing
Black saison (6.5% Alc. Vol)



Huldra

Brouwerij Totem
Session IPA (2,7% Alc. Vol)



Kornkråke Double Dry Hopped

Brouwerij Totem
Chili IPA (5,3% Alc. Vol)



Narvi

Brouwerij Totem
Mandarine Radler (2,1% Alc. Vol)