



The Open Science Grid

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100 Million Core hours in the past 30 days

Over the last 12 months 200 Million jobs consumed 1 Billion hours of computing involving 1.5 Billion data transfers to move 223 Petabytes

This aggregate was accomplished by federating 114 clusters

that contributed 1h to 100M hours each

http://display.opensciencegrid.org

In the last 24 Hours				
543,000	Jobs			
2,087,000	CPU Hours			
5,823,000	0 Transfers			
588	TB Transfers			
In the last 30 Days				
16,096,000	Jobs			
96,656,000 CPU Hours				
155,744,000	Transfers			
20,046	TB Transfers			
In the last 12 Months				
198,318,000	Jobs			
1,087,534,000	CPU Hours			
1,525,604,000	Transfers			
223,000	TB Transfers			







We create a uniform environment across a heterogeneous set of resources that is distributed globally

Submit locally – Run Globally



OSG supports computing across different types of resources





Seamless Integration is the key to our success !!!





- Open to providers at all scales
 - from small colleges to large national labs
- Open to user communities at all scales
 - from individual students to large research communities
 - domain science specific and across many campuses
 - campus specific and across many domain sciences
- Open to any business model
 - sharing, allocations, purchasing
 - preemption is an essential part of operations







- OSG-Connect
 - OSG hosts the service on OSG hardware
- OSG Cluster in a box
 - OSG manages services on hardware placed inside Campus Science DMZs
- OSG-CE et al.
 - OSG provides software that campuses use to instantiate & operate services

In all cases, seamless integration is key !





Login for individual users, from high school to professors and lab scientists



We also offer it as a service for organizations to "re-brand".



Serving individuals & small groups



Project Name AIGDock numfpi **FFValidate** z2dqmc BioGraph EvolSims CentaurSim ceCube PainDrugs SourceCoding Errorstudy microphases ConnectTrain **OSG-Staff** mab ProtEvol uchicago RicePhenomics SouthPoleTelescope cms-org-nd MS-EinDRC FutureColliders SDEalgorithms duke-swcstaff NSNM EvolvingAl Swift scicomp-analytics DemandSC atlas-org-uchicago KnowledgeLab Paniceae-trans SNOplus ERVmodels z2qmc ContinuousIntegration PathSpaceHMC UserSchool2015 ExhaustiveSearch PTMC Phylo ABCNWHI NSLS2ID MiniWorkshopUC15 freesurfer SWC-OSG-IU15 ProbTracx pipediffusion DelhiWorkshop2015 EHEC ASPU RADICAL HTCC UserSchool2014 NeoflAnnot atlas-wg-Exotics **OSGOpsTrain** cms-org-fnal atlas-org-illinois gem5 Total

Institution David Minh Jerry Tessendorf Clemson University Vijay Pande Stanford University Snir Gazit Alex Feltus **Clemson University** Oana Carja Nathan Kaib Francis Halzen Pei Tang Ahmad Golmohammadi Christopher Richards Patrick Charbonneau **Duke University** Robert William Gardner Jr University of Chicago Chander Sehgal Fermilab Vivek Farias Premal Shah University of Chicago Robert William Gardner Jr Harkamal Walia John Carlstrom University of Chicago Robert William Gardner Jr Jacob Pessin Sergei Chekanov Argon National Lab Harish S. Bhat Robert William Gardner Jr **Duke University** Vadim Apalkov Jeff Clune University of Wyoming Michael Wilde University of Chicago Robert William Gardner Jr University of Chicago Texas A&M University; Unive Econ Fernando Luco Robert William Gardner Jr University of Chicago James Evans University of Chicago Jacob Washburn University of Missouri University of Pennsylvania Joshua R Klein Fabricia Nascimento University of Oxford Snir Gazit University of California Berke Physics Robert William Gardner Jr University of Chicago University of Cincinnati Frank Pinski Robert William Gardner Jr University of Wisconsin - Ma Education Sam Volchenboum University of Chicago University of Pennsylvania Derek Dolney UC San Diego Siavash Mirarab Yvonne Chan **Dean Andrew Hidas Robert William Gardne Donald Krieger** Robert William Gardne Dr. Bruce P. Hermann Panthea Sepehrband Robert William Gardne Chuck Kaspar ilyoup kwak Shantenu Jha Rob Quick

OSG-Connect Projects 2015/02/01 - 2016/02/01 **Feild of Science** Illinois Institute of Technolog Chemistry Computer and Chemistry University of California Berke Physics **Biological Scie** University of Pennsylvania **Biological Scie** Northwestern University Astrophysics University of Wisconsin Astrophysics University of Pittsburgh Medical Scien New Mexico State University Engineering USDA Agricultural Research Molecular and Chemistry Training Computer and Massachusetts Institute of TeInformation Th University of Pennsylvania Evolutionary S Multi-Science University of Nebraska Lincc Biological Scie Astrophysics University of Notre Dame High Albert Einstein College of Me Medi High University of California; Merc Math Multi-Georgia State University Physi

Com

Com

Multi-

High

Socio

Evolu

High

Zoology

Technology

information ocien	3073030	Duke-QOF
	3556135	SPHENIX
	2241066	UPRRP-MR
ences	1322596	IU-GALAXY
inces	1286555	BNL-PHENIX
	1050911	DetectorDesign
	901601	Pheno
ces	785932	DeerDisease
	753884	OSG-Staff
Structural Bioscie	573448	UNC-RESOLVI
	516830	IBN130001-Plu
	377906	Total
Information Scien	329686	
eory	277125	Project Name
ciences	163930	TG-IBN130001
Community	156912	TG-DMR13003
nces	122319	TG-CHE140110
	118223	TG-AST140088
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115M CPU ho	ours
2/1/2015-2/1/20)16

13151 IG-MCE 9598 8537 Computational Condensed Matte 8434 8163 Bioinformatics 4889 Molecular and Structural Bioscie 3263 Bioinformatics 2315

46	SPLINTER	Rob Quick
98	Duke-QGP	Steffen A. Bass
35	SPHENIX	Martin Purschk
66	UPRRP-MR	Steven Massey
96	IU-GALAXY	Rob Quick
55	BNL-PHENIX	Matthew Snow
11	DetectorDesign	John Strologas
01	Pheno	Stefan Hoeche
32	DeerDisease	Lene Jung Kjae
84	OSG-Staff	Chander Sehga
48	UNC-RESOLVE-ph	David Stark
30	IBN130001-Plus	Donald Krieger
06	Total	
86	0	SG-XD Projects
25	Project Name	PI

Wall Hours Project Name

52408

PI

OSG-Direct P

ro	ects 2015/02/01 - 2	016/02/01	
20.07	Institution	Feild of Science	Wall Hours
	Indiana University	Medical Sciences	3274696
	Duke University	Nuclear Physics	9591924
1	Brookhaven Nation	Nuclear Physics	558961
	Universidad de Pue	Bioinformatics	1593405
	Indiana University	Bioinformatics	1266000
all	Brookhaven Nation	Nuclear Physics	519229
	University of New M	Medical Sciences	376994
	SLAC	High Energy Physic	26075
	Southern Illinois Ur	Biological Sciences	157624
Í.	Fermilab	Computer and Infor	13887
	UNC Chapel Hill	Physics and astron	3484
	University of Pittsb	Neuroscience	200

52278216

G-DMR1300	36	Emanuel Gull	
G-CHE140110		John Stubbs	
G-AST14008	8	Francis Halzen	
	2	Gregory Snyder	
	18	Paul Siders	
_	4	Jennifer Lotz	
	0	Francis Halzen	
M	90	Emiliano Brini	
	3	Juliette Becker	
	50	David Rhee	
IIKC)3	Jon Pelletier	
UIS.	1	John Chrispell	
	72	Adrian Del Maest	
	3	Yvonne Chan	
16	4	Qaisar Shafi	
10	0	Neranjan Edirisin	
	6	Suzanne Hawley	
G-MCB1402	32	Alan Chen	
G-CCR14002	28	Shantenu Jha	
G-TRA10000)4	Andrew Ruether	
G-MCB0600	61N	Jeffry D. Madura	
G-MCB1402	68	Graziano Vernizz	
G-STA11001	15	Stephen McNally	
otal	100000		

Donald Kri

G-XD Projects 20	15/02/01 - 2016/02/	01	
2	Institution	Feild of Science	Wall Hours
Donald Krieger	University of Pittsbi	Biological Sciences	34454812
Emanuel Gull	University of Michig	Materials Science	1269854
John Stubbs	University of New E	Chemistry	1048149
Francis Halzen	University of Wisco	High Energy Physic	552688
Gregory Snyder	Space Telescope S	Mathematical Scier	420545
Paul Siders	University of Minne	Chemistry	318432
lennifer Lotz	Space Telescope S	Astrophysics	128107
Francis Halzen	University of Wisco	Physics and astron	83901
Emiliano Brini	SUNY at Stony Brc	Molecular Bioscien	77481
luliette Becker	University of Michig	Astrophysics	68490
David Rhee	Albert Einstein Coll	Molecular and Stru	39368
Ion Pelletier	University of Arizor	Geographic Informa	36641
Iohn Chrispell	Indiana University	Other	21074
Adrian Del Maestro	University of Vermo	Materials Science	18098
vonne Chan	University of Hawa	Ocean Sciences	17884
Qaisar Shafi	University of Delaw	Physics and astron	17594
Veranjan Edirising	Georgia State Univ	Mathematical Scier	3933
Suzanne Hawley	University of Washi	Mathematical and F	3020
Alan Chen	SUNY at Albany	Molecular and Stru	598
Shantenu Jha	Rutgers; the State	Computer and Infor	455
Andrew Ruether	Swarthmore Colleg	Training	204
leffry D. Madura	Duquesne Universi	Molecular and Stru	49
Fraziano Vernizzi	Siena College	Molecular and Stru	19
stephen McNally	University of Tenne	Other	1
		-	30301397

A few projects selected from OSG Connect

Universi

Duke Ur

96 projects across 81 institutions Most prolific individual consumed	
~34M hours in 2015	of Science

24253300

TG-CCF

TG-TRA

TG-MCE

TG-MCE

TG-STA

Total

University of Illinois HIGH ENERGY PHYSICS University of California San I Multi-Science Community

cms-ora-na Kevin Lannon duke-swcstaff Mark DeLong Total

	of Science	Wall Hours
	Science Com	234514
	Science Com	156912
ty of Notre	High Energy Physic	116187
iversity	Multi-Science Com	73112
		580725

March 15th, 2016

Tim Cartwright

Lothar Bauerdick

Mark Neubauer

Dean Tullsen

Robert William Gardne

Petra Lenz

Rob Quick

Wall Hours

377906 234514

73112

8163

643

286

244

694877



User Support & Training Team





190 application modules supported for scientists from 81 institutions. Held 4 training workshops last year, plus summer school. Available for consulting on a regular basis.







This way you can offer OSG access at minimal operational costs.





\$10k hardware we shipped



(aka the "brick")



Hardware:

- 40 cores
- 12 x 4TB data disks
- 128 GB ram
- 2 x 10 gbit network interface

Software:

- Full HTCondor pool
- XRootD server, redirector, and proxy cache
- cvmfs w/ optional Squid

Work with recipients on integrating the brick into the rest of their campus IT





Science on OSG





Science other than LHC makes up ~34% of the OSG hours Science other than Physics makes up ~20% of the OSG hours



LHC continues to be the dominant force in OSG







Particle Physics beyond the LHC



Particle physics other than the LHC scaled up from 2.5M to more than 50M within the last year



Experiments range from those built in 1980s to fresh



March 15th, 2016



Nuclear Physics beyond the LHC



Theory meets experiment on the OSG ...

... for 50 Million hours in 2015





March 15th, 2016



LIGO recording a chirp from a long time ago in a galaxy far far away











IceCube GRID jobs





IceCube is pioneering **GPU Processing on OSG**



The Tusker cluster at UNL is the first campus cluster to share their GPUs on OSG.

Row Labels	▼	Count Jobs	Sum of wall_time	Hours
glow		26774	116169618	32269.33833
hcc		110	98480	27.35555556
osg		2006	18890593	5247.386944
Grand Total		28890	135158691	37544.08083

~ 40,000 hours of GPU computing in 2015.

GPU use on Comet via OSG just starting. Other XD resources expected to follow.





AMS on the Space Station





OSG helping MIT to integrate Earth, Atmospheric, and Planetary Science and Laboratory of Nuclear Science computing with OSG and XD resources to produce AMS simulations. ~ 3 Million hours so far





3rd Largest Science Gateway across NSF operates exclusively on OSG





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Computing Resources
- Get H

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SBGrid Portals

SBGrid uses OSG as "compute engine" for its portals.

3.4 Million hours in 2015



Wide Research Molecular Replacement

Wide Research Molecular Replacement (WSMR) performs a molecular replacement search with the application Phaser against approximately 100,000 SCOP domains. The search results are presented in the form of an LLG/TFZ graph and computations usually converge within 4-14 days. Before you submit your computations you will need to create an SBGrid portal account (request an account here) and upload your mtz file. Protein sequence files are not required. For a full description of this method please see our publication Stokes-Rees I and Sliz P, PNAS 2010. 107(50):21476-81.



Deformable Elastic Network

Deformable Elastic Network (DEN) restraints are a powerful tool for refining structures from low-resolution X-ray crystallographic data sets.

Our DEN web service provides access to resources for running computationally intensive DEN refinements in parallel on the Open Science Grid, a US cyberinfrastructure. Refinements combined with full parameter optimization that would take many thousands of hours on standard computational resources, can be completed in several hours using the DEN portal. For a full description of this service please see our publication O'Donovan D et. al, Acta Cryst. D. 2012. 68:261-7.





Openness, flexibility, and integration continue to be key to the success of OSG