OSG-doc-1184
www.opensciencegrid.org

Open Science Grid

Annual Report

March 2014

Miron Livny	University of Wisconsin	Principal Investigator
Michael Ernst	BNL	co-PI
Ruth Pordes	FNAL	co-PI
Frank Wűrthwein	UCSD	co-PI
Lothar Bauerdick	FNAL	Executive Director

Supported by the National Science Foundation and the U.S. Department of Energy's Office of Science

Contents

Sections of this report were provided by the scientific members of the OSG Council, OSG PIs and Co-PIs, and OSG staff and partners.

Edited by
Ruth Pordes, Chair of the OSG Council
Chander Sehgal, Project Manager

1. Executive Summary

Open Science Grid (OSG) is a large-scale collaboration that is advancing scientific knowledge through high-performance computing and data analysis by operating and evolving a cross-domain, nationally distributed cyber-infrastructure. The OSG program consists of a consortium of contributing communities (users, resource administrators, and software providers), a funded project, and satellite projects; this collaborative ecosystem advances the science of Distributed High-Throughput Computing (DHTC) for researchers in the U.S. OSG provides a production-quality facility, connecting a broad variety of researchers to distributed computing centers at university campuses, national laboratories, and other community resources (Figure 4). This facility depends on a range of common services, support activities, software, and operational principles that coordinate the production of scientific knowledge through the DHTC model. In April 2012, the OSG project was extended until 2017; it is jointly funded by the Department of Energy and the National Science Foundation.

Figure 1: Open Science Grid Map

OSG serves the needs of the Large Hadron Collider (LHC) experiments by providing a platform for their contribution and consumption of distributed computing resources. The LHC experiments continued to rely on OSG for their computing in the U.S., making up approximately 2/3 of the total usage in OSG (Figure 2 and 3). The experiments, however, not only rely on OSG for computing resources, but also for operational, consulting and software services. In addition, in the U.S., OSG is a natural conduit for collaboration and joint initiatives among the LHC experiments and the Worldwide LHC Computing Grid (WLCG) project.

The goal of OSG continues to be to enable science and a useful metric of this impact is quantity of publications enabled by OSG DHTC resources. Table 1 provides a summary of the appendix, which lists the science publication enabled in 2013 via leverage of OSG.

Collaboration/Campus/Community	Number of Publications
ATLAS	84
CMS	97
CDF	97
Dzero	26
NEES	1
STAR	15
GridUNESP	18
GLOW	61
UCSDGrid	4
HCC	1
University of Notre Dame	1
User Support	43
Total	448

Table 1: Summary of 2013 Science Publications enabled by use of OSG

About 2/3 of the OSG wall hours are used by the U.S. LHC experiments. The next biggest user is the OSG Virtual Organization (VO), which provides opportunistic access to a broad range of U.S. based researchers who are not already affiliated with an existing VO; this has been a growth area in the last year.

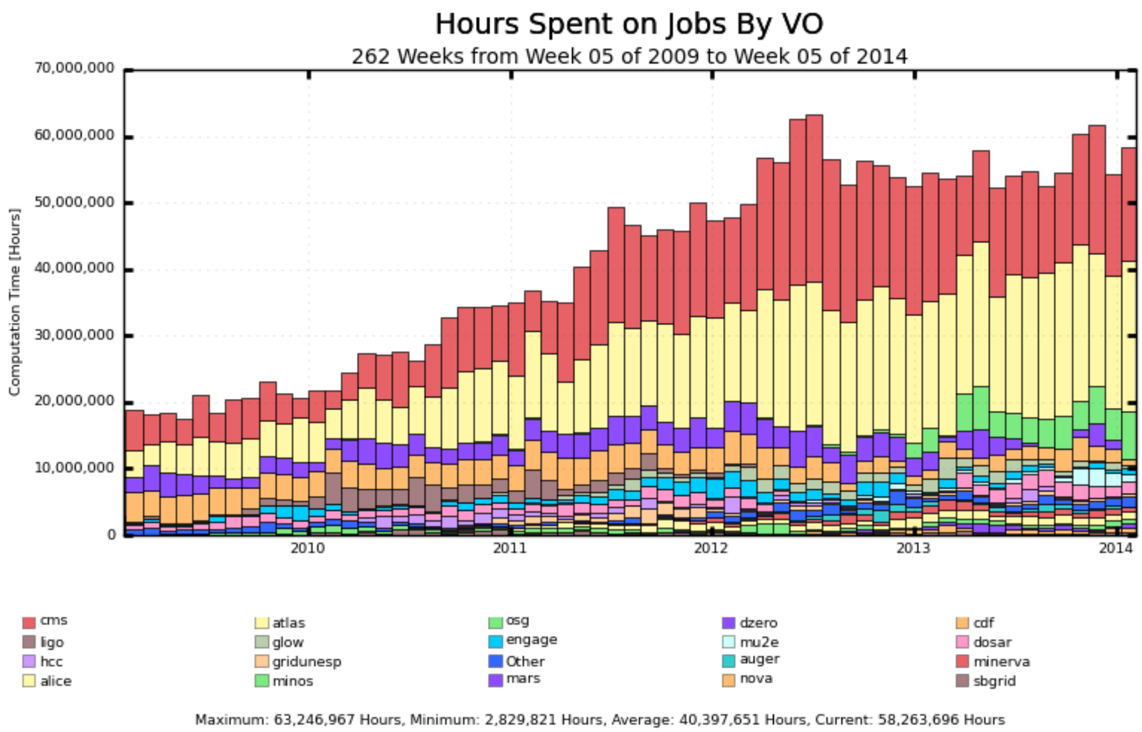

Figure 2: OSG Production from February 2009 to January 2014 (60 months)

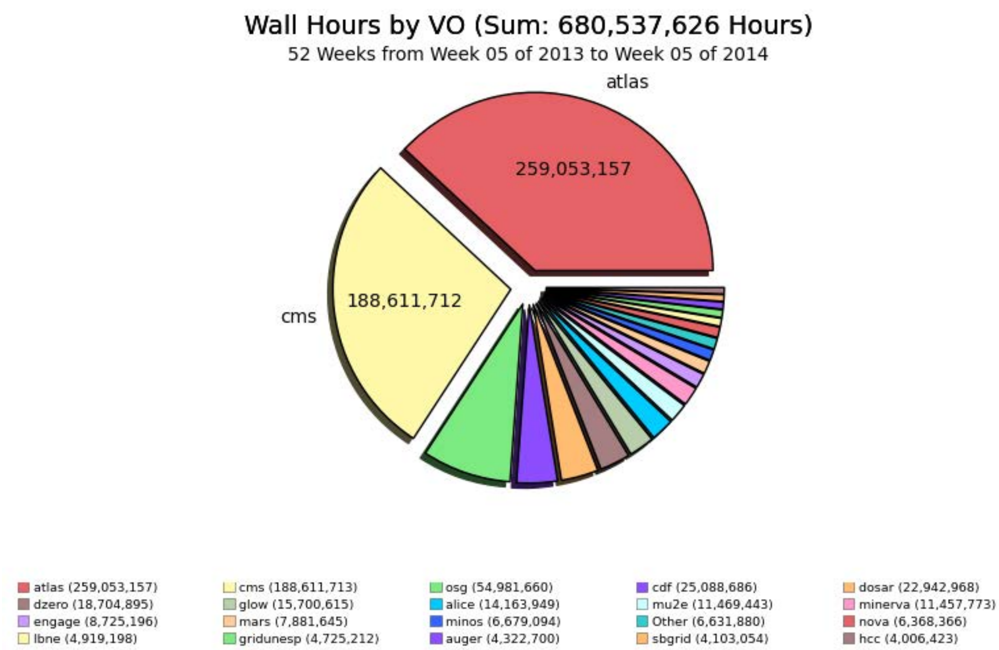

Figure 3: OSG Usage by VO from February 2013 to January 2014

In 2013, the project continued to focus on growing the access of U.S. researchers to DHTC. This was enabled by access to opportunistic resources made available through the mechanisms of Campus Grids and VOs. In the last year, non-high-energy-physics researchers accessed ~87M hours of opportunistic computing, a 60% increase with respect to the prior year. The opportunistic usage included medium to large data processing activities with increased complexity, such as in the cases of the bioinformatics groups at Indiana University or the Snowmass[1] LHC simulation group, led by Dr. Meenakshi Narain. The latter involved 5-10 researchers who ran simulations for the LHC luminosity upgrades and produced ~70 TB of data over six months consuming ~11M hours of computing. These activities demonstrate that the large amount of computing resources available as opportunistic cycles makes it possible for researchers to accomplish their goals in a compressed time. Several groups benefitted from this model:

- OSG assists researchers and groups affiliated with the OSG Campus Grids. These users typically do not bring resources to the OSG DHTC pool. They use both local and remote resources and are motivated to accomplish their computing efficiently and timely. The major OSG Campus Grids include GLOW (University of Wisconsin-Madison), the HCC (University of Nebraska), UC3 (University of Chicago), and UCSD (University of California at San Diego). Collectively, they provided ~30M hours of computational access to their local researchers.
- Through its resource allocations process (XRAC), the Extreme Science and Engineering Discovery Environment (XSEDE) project enabled PIs to access OSG, which serves as a Level 2 NSF eXtreme Digital (XD) service provider. Through this arrangement, OSG made available ~26M wall hours to 23 PIs.
- In addition, several research groups and PIs directly approach OSG for access to computing resources. Through this channel, OSG provided ~21M hours to 14 user groups.

These activities have benefitted from improved capabilities in the OSG services and processes. The project has worked at reducing obstacles for communities to access and contribute resources. Some examples are the following:

- In the last year, OSG has transitioned the credential provider from the retiring DOEGrids Certificate Authority (CA) to the OSG Public Key Infrastructure (PKI) CA (using a commercial vendor, DigiCert, as the underlying CA), thus providing seamless support of strong authentication for OSG users and services.
- In parallel, the project has investigated mechanisms to loosen the dependency of the infrastructure on end-user certificates. This is achieved through a certification and auditing process demonstrating that administrators of job submission services have enough reliable information to trace the identity of the users of resources, even without certificates.
- OSG is in the process of deploying the HTCondor-CE as the next generation of Compute Element gateway technology, with the goal of delivering 20% of the CPU hours of OSG production through the new service. This will improve reliability, scalability, and fault propagation. HTCondor-CE shares underlying technology with both BOSCO[2] (developed in collaboration between HTCondor and OSG), and the CREAM CE (developed by the European Middleware Initiative, EMI) and, long-term, reduces the OSG's unique dependence on GRAM.
- The OSG Connect service has made it easier for campuses to connect local researchers with the full array of DHTC resources in OSG.
- The OSG Application Software Installation Service (OASIS) was deployed at the OSG sites as a mechanism to transparently deploy VO software distributions across OSG resources. This service is based on the CERN Virtual Machine File System (CVMFS) software and accelerates the use of DHTC resources in particular for small and medium size VOs.

At the start of the planning process for year three, the project has developed additional understanding of the key challenges and is working to address these opportunities; below are some examples:

---

[1] http://www.snowmass2013.org/tiki-index.php .
[2] http://bosco.opensciencegrid.org/about/

- The OSG cyber-infrastructure is growing more and more diverse with the integration of new resource types, including public and commercial clouds, high-performance computers, etc. To manage such diversity, the project is exploring opportunities for improved resource provisioning mechanisms, with the goal to enable communities to organize OSG resources in tiers and define complex provisioning policies.
- The project is seeking mechanisms to improve identity management to enable resource access as seamlessly as possible. These efforts range from certificate-less access to resources, to the reductions of host certificates, to better integration of central user identity information with the campus grid (OSG Connect) submission mechanisms.
- We are working on integrating tools from the community to increase network awareness. We plan to collect and store metrics associated with network connectivity in OSG. Using network management probes at OSG sites through the PerfSONAR-PS, we are prototyping a dashboard with the goal of gathering, storing, and publishing current and historical network metrics for alarming, troubleshooting, and higher-level service integration.
- As we grow the community of U.S. researchers who want to use OSG for their science, the project is working with resource providers to improve our ability to harvest opportunistic cycles and to make them available to all OSG users in a timely fashion.

In summer 2013 the project ran another of the successful week-long student schools. More than 22 attendees learned about the principles of DHTC and how to build and execute their applications on local and remote resources. The OSG Consortium continued its partnership with four satellite projects that are delivering benefit to OSG communities future needs - including in networking and middleware.

2. Science enabled by OSG

2.1 Virtual Organizations

2.1.1 ATLAS

The ATLAS collaboration, consisting of 174 institutes from 38 countries, completed construction of the ATLAS detector at the LHC, and first began colliding-beam data taking in late 2009. The 44 institutions of the U.S. ATLAS group made major and unique contributions to the construction of the ATLAS detector, provided critical support for the ATLAS computing and software program and detector operations, and contributed significantly to physics analysis, results, and papers published.

Experience gained during the first three years of ATLAS data taking gives us confidence that the grid-based computing model has sufficient flexibility to process, reprocess, distill, disseminate, and analyze ATLAS data in a way that utilizes both computing and manpower resources efficiently.

The computing facilities in the U.S. are based on the OSG middleware fabric of services and provide currently a total of 300k HEP-SPEC[3] 2006 of processing power, 26 PB of disk space and 10 PB of magnetic tape archive. The Tier-1 center at Brookhaven National Laboratory (BNL) and the five Tier-2 centers located at nine universities (Boston University, Harvard University, Indiana University, Michigan State University, University of Chicago, University of Illinois in Urbana Champaign, University of Michigan, University of Oklahoma and University of Texas at Arlington) and at SLAC have contributed to the worldwide computing effort at the expected level (23% of the total). Time critical reprocessing tasks were completed at the Tier-1 center within the foreseen time limits, while the Tier-2 centers were widely used for centrally managed production and user analysis.

A large fraction (~60%) of the available CPU resources available to the ATLAS collaboration at the Tier-1 and the Tier-2 centers are used for simulated event production. The ATLAS simulation requirements are completely driven by the physics community in terms of analysis needs and corresponding physics goals.

The current physics analyses are looking at real data samples of roughly 2B events taken in 2011 and 3B events taken in 2012, and ATLAS has roughly 3.5B Monte Carlo (MC) events for 2011 data and 2.5B MC events for 2012. Given the resource requirements to fully simulate an event using the GEANT4 package, ATLAS can currently produce about 4M events per day using the entire capacity available to production worldwide. ATLAS has close to 200 analyses in the stage of formal collaboration review, and the collaboration has published 274 papers in peer-reviewed journals and 544 public notes since 2010.

An example of the physics analysis work that has been enabled by OSG is shown in Figure 4 below. This is the first strong evidence (4.1σ) from the ATLAS experiment for the fermionic (tau) decay of the 125 GeV Higgs boson that was discovered at the LHC in 2012. This was a delicate blind analysis that required a lot of care and simulation to optimize and make sure that the data is fully understood.

[3] https://dvinfo.ifh.de/HEPSPEC

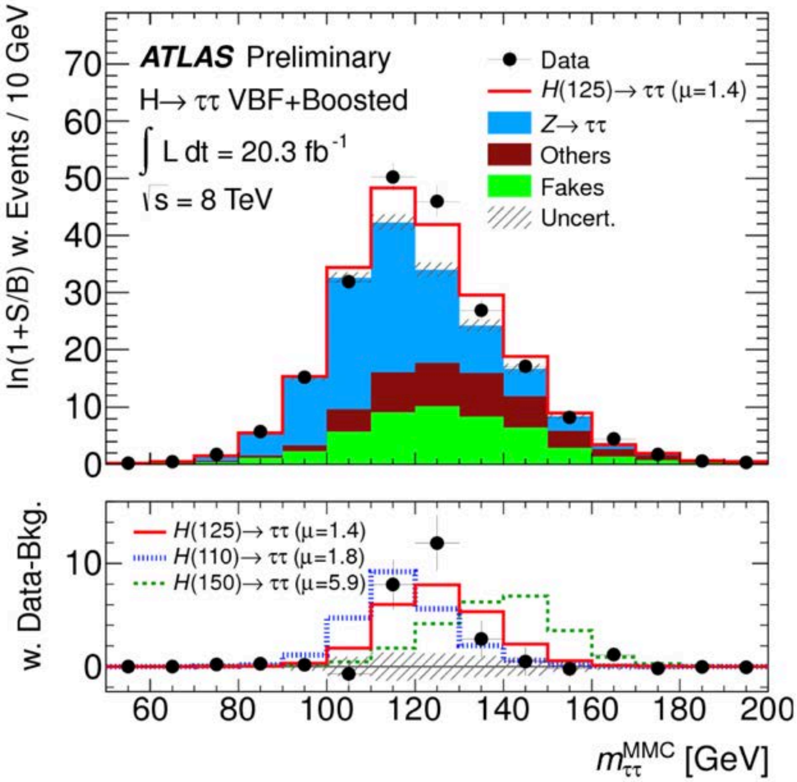

Figure 4: Distribution of $m_{\tau\tau}^{MMC}$ where events are weighted by $\ln(1+S/B)$ for all channels in the ATLAS $H\rightarrow\tau\tau$ search. The bottom panel in each plot shows the difference between weighted data events and weighted background events (black points), compared to the weighted signal yields. From ATLAS-CONF-2013-108.

At the time forecasts for computing and storage resources were being prepared, before first collisions, much of the effort concentrated on searches, and only partial and not very sophisticated background samples were included. Today, roughly half of the analyses are careful measurements, most of which were not evaluated in detail prior to the arrival of data. These analyses are critical to our understanding of the Standard Model at 7 and 8 TeV, and they are also key ingredients to tuning and validating the existing MC generators so that they can reliably be used for background estimates in search analyses. The search analyses rely on very large background samples, with higher equivalent luminosity than the data samples and with very precise modeling. Although data-driven techniques are used wherever possible, in the end, these techniques are most often used to normalize the MC background samples, but the shape determinations in multidimensional spaces require pure signal samples that do not exist in the data. The statistical precision of the background estimates needs to be significantly better than that of the data samples themselves, in order to take maximum advantage of the data. All of this adds up to a large need for high-quality MC samples. There would have been a significant impact to physics if ATLAS had not been able to take advantage of services and the amount of resources as they are provided through OSG in the U.S. and sites in other regions contributing to ATLAS computing.

ATLAS decided to dedicate significant effort to using their best understanding of how Higgs, SUSY, and exotics analyses have to be done today in order to predict how well ATLAS could do with 300 fb^{-1} of 14 TeV data, as well as 3000 fb^{-1} of data. These studies were a critical input to the European Strategy and U.S. Snowmass processes, so ATLAS could provide a forecast of their physics reach for the High

Luminosity Large Hadron Collider (HL-LHC) based on their best knowledge today. This work was done with very simple parameterized simulations of the detector response, tuned against the full simulation results. However, they required generating hundreds of millions of events at the generator level in order to properly estimate background levels in these searches in a new energy regime. This is important work that needs to continue in view of the design optimization of a HL-LHC detector upgrade.

To further improve efficient usage of resources, ATLAS is investing significant efforts in innovative approaches to simulation. One relies on large samples of "zero bias" data acquired during data taking in 2012, which can then be merged with precise simulations of high-PT physics signal events to provide a very accurate and efficient simulation of the ATLAS performance at high levels of pileup. The other relies on an advanced framework (the Integrated Simulation Framework) which provides the ability to use different levels of accuracy in simulating different particles in a single event. For example, full GEANT simulation can be used for the critical simulation of the leptons in an event, while simpler models of the calorimeter response can be used to simulate the impact of pileup events. Both of these approaches will require considerable validation against the current 7 and 8 TeV data samples, effectively generating large parallel samples of MC events using these new tools. Again, without the OSG fabric of services and resources at least at the present level, this key validation work would have had to be reduced in priority compared to the more urgent analysis of the 7 and 8 TeV data for publications.

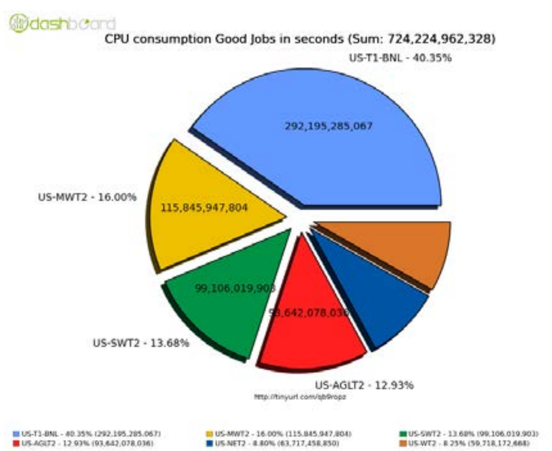

Figure 5:
CPU contribution of US ATLAS sites for 2013

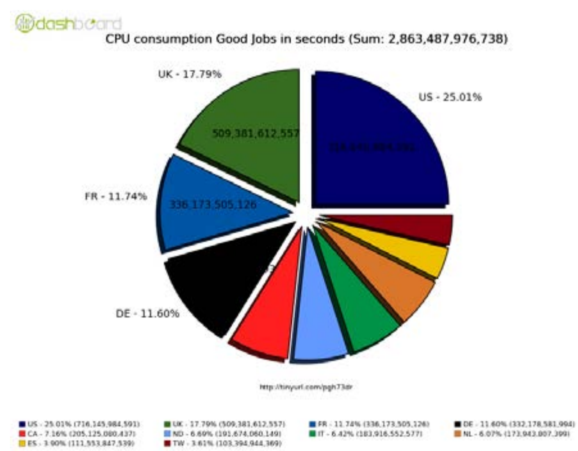

Figure 6:
US ATLAS CPU contribution vs. others for 2013

Moving from the computational side to data storage and data access, U.S. ATLAS is in the process of adding direct access to data that is not available locally. This means that rather than requiring a process to wait until a programmatic replication of a data set is completed, the process uses a mechanism that allows it to transparently discover the location of the needed data and access it over the Wide Area Network (WAN). U.S. ATLAS is currently using xrootd at both the individual site level and the U.S. ATLAS computing facility level. Tier-2 sites at SLAC and University of Texas at Arlington use xrootd as their baseline storage system, while the Tier-1 at BNL, University of Chicago, and University of Michigan are using xrootd as an interface system on top of their dCache-managed storage to serve user analysis activities. The sites each have between 3 PB and 12 PB of usable disk storage installed and serve heavy user analysis activities.

U.S. ATLAS recently deployed a Federated ATLAS Xrootd system (FAX) aimed at providing direct data access over the WAN. The system allows users to access any data file in the federation via its global unique file name using the xroot protocol. FAX is implemented via a global xrootd redirector at BNL and some regional redirectors deployed at Tier-2 sites. In addition to Tier-1 and Tier-2 sites, Tier-3 sites are important members of this federation because, quite often, "hot" user analysis data are initially produced at Tier-3 institutions.

ATLAS intends to implement and evaluate a still more fine-grained approach to caching below the file level. The approach takes advantage of a ROOT-based caching mechanism as well as recent efficiency gains in ROOT I/O implemented by the ROOT team that minimize the number of transactions with storage during data read operations, which, particularly over the WAN, are very expensive in terms of latency. It also utilizes development work performed by CERN-IT on a custom xrootd server which operates on the client side to direct ROOT I/O requests to remote xrootd storage, transparently caching at the block level data that is retrieved over the WAN and passed on to the application. Subsequent local use of the data hits the cache rather than the WAN. This benefits not only the latency seen by a client utilizing cached data, but also the source site, freed from the need to serve already-delivered data. In addition, caching obviously saves network capacities.

Deriving benefit from fine-grained caching depends upon re-use of the cache. As one approach to maximizing re-use, PanDA's (the ATLAS workload management system) existing mechanism for brokering jobs to worker nodes on the basis of data affinity will be applied to this case, such that jobs are preferentially brokered to sites which have run jobs utilizing the same input files.

Non-PanDA-based applications using data at the cache site will also automatically benefit from the cache. The approach will integrate well with the federated xrootd system; it adds an automatic local caching capability to the federation. It may also be of interest in the context of serving data to applications running in commercial clouds, where the expense of data import and in-cloud storage could make fine-grained caching efficiencies valuable.

Once integrated into the OSG DHTC services, some or all above described capabilities will be available to the entire spectrum of scientific communities served by the OSG. This will be accomplished through the Virtual Data Toolkit (VDT) software infrastructure.

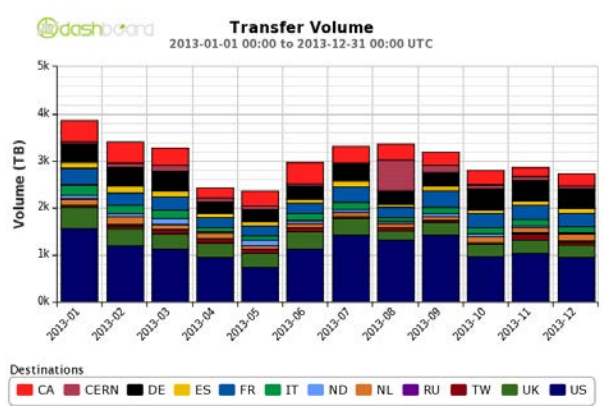

Figure 7:
Transfer volume from US sites to sites in other ATLAS Clouds for 2013

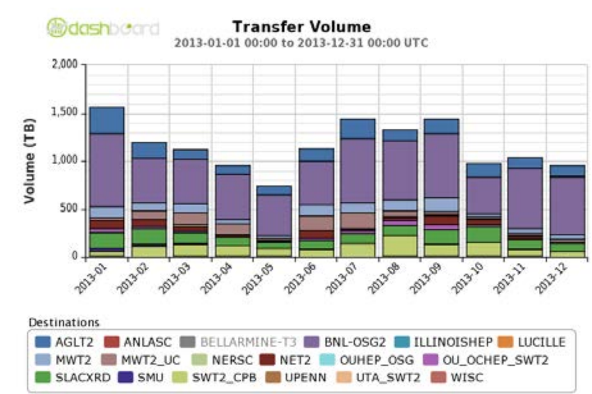

Figure 8:
Transfers volume from sites in other ATLAS Clouds to US Atlas sites for 2013

U.S. ATLAS (contributing to ATLAS as a whole) relies extensively on services and software provided by OSG, as well as on processes and support systems that have been developed and implemented by OSG. OSG is essential for the operation of the worldwide distributed ATLAS computing facility and OSG efforts have aided the integration with WLCG partners in Europe and Asia. The derived components and procedures are the basis for support and operation covering the interoperation between OSG, the European Grid Infrastructure (EGI), and other grid sites relevant to ATLAS data analysis. OSG provides software components that are interoperable with European ATLAS grid sites, including selected components from the gLite middleware stack such as client utilities.

In addition to the services and operations mentioned above, U.S. ATLAS has also benefited from recent activities with OSG in the areas of network monitoring, development of the next-generation CE, Grid Uniform Identity Mapping Service (GUMS), OSG architecture, and native packaging and configuration management.

U.S. ATLAS is also participating in the OSG Campus grids and inter-campus bridging efforts through the OSG Campus Infrastructures Community and contributes to the pool of opportunistic resources in OSG in support of the GLOW, HCC, Engage, UCSD, UC3 and OSG VOs, as well the larger community of users which access U.S. ATLAS resources via the OSG-XSEDE Glidein service.

Substantial effort in U.S. ATLAS computing during 2013 has been put into developing ways to best support and expand the capabilities of U.S. Tier-3 (institutional) computing in preparation for the next LHC run. A key part of this thrust is ATLAS Connect. ATLAS Connect is a set of computing services designed to augment existing tools and resources used by the U.S. ATLAS physics community, focusing on batch-like analysis processing familiar to Tier-3 users. It draws the majority of its functionality from the OSG Connect environment, which is already quite mature as a means of connecting data and CPU cycles to scientific applications. A single sign-on service provides direct institutional and working group access to the U.S. ATLAS computing facility, potentially using your campus network identity if your institution participates in the InCommon identity federation. A login host allows HTCondor job submission to the Midwest Tier-2 center, the Tier-3 center at Fresno State University, and the UChicago Computing Cooperative campus grid. The Remote Cluster Connect Factory (RCCF) allows a local cluster, such as a Tier-3 cluster managed by HTCondor, to be logically extended to use Tier-1, Tier-2, campus grids, or Amazon cloud resources using HTCondor flocking mechanisms. ATLAS Connect has a storage service called FAXBox for staging user job input and output data sets.

2.1.2 CMS

The scientific research performed by collaborators in the Compact Muon Solenoid (CMS) experiment at CERN's LHC has captivated the interest of the general public around the world, and many of the results have been powered by the OSG. CMS is a worldwide collaboration of more than 2,000 physicists working in 182 institutes in 42 countries. The approximately 600 signing authors from the U.S. make up about one third of the collaboration, coming from 49 universities and federal labs.

The LHC entered a long shutdown at the start of 2013, beginning a two-year period of accelerator and detector refurbishments and upgrades. When operations resume in spring 2015, the LHC will operate with a new beam energy of 6.5 TeV, compared to the 2012 beam energy of 4 TeV. The higher particle collision energy will give the experiment the ability to discover new massive particles that were not accessible during previous collider runs. Theoretical physics gives very strong motivations for the existence of such particles that should be observed with the new data. Indeed, should they not be observed, the paradigms that have successfully described particle physics for decades will face significant challenges.

Even though CMS did not record any new data in the past year, it was still a very busy time for doing the science and for using the OSG to get the science done. Physicists continued to sift through the data recorded in 2011 and 2012 to make new measurements of particle properties (and improve old ones) and to continue to search for new particles. The collaboration published more than 100 papers in 2013, as detailed in the appendix.

An important focus of the scientific studies has been the continuing exploration of the properties of the Higgs boson, whose discovery was announced with great fanfare and to worldwide acclaim in July 2012. Since that time, more detailed analyses that have made use of additional data have confirmed that the properties of this new particle are consistent with that of a Higgs boson and not an imposter particle. No additional such bosons have been observed. The understanding of this unique fundamental particle will be a continuing focus of the CMS collaboration in the next data run.

In addition, the collaboration has made a number of ground-breaking discoveries in the past year. The most notable has been the observation of a very rare decay of the Bs meson, a particle that is composed of a bottom quark and a strange antiquark, to a muon-antimuon pair. In the standard model of particle physics, only about three Bs mesons out of every billion will decay in this fashion. But this decay has great sensitivity to the existence of exotic massive particles; should they exist, the decay rate could actually be either larger or smaller than the standard-model prediction. In July 2013, CMS announced its first observation of this decay mode, at the expected rate. This result has provided very strong constraints on new theories of particle physics that predict exotic particles. The analysis relied very heavily on simulations of various background and calibration processes, and these compute-intensive studies were performed at the U.S. CMS Tier-2 site at the University of Nebraska-Lincoln, a member of the OSG.

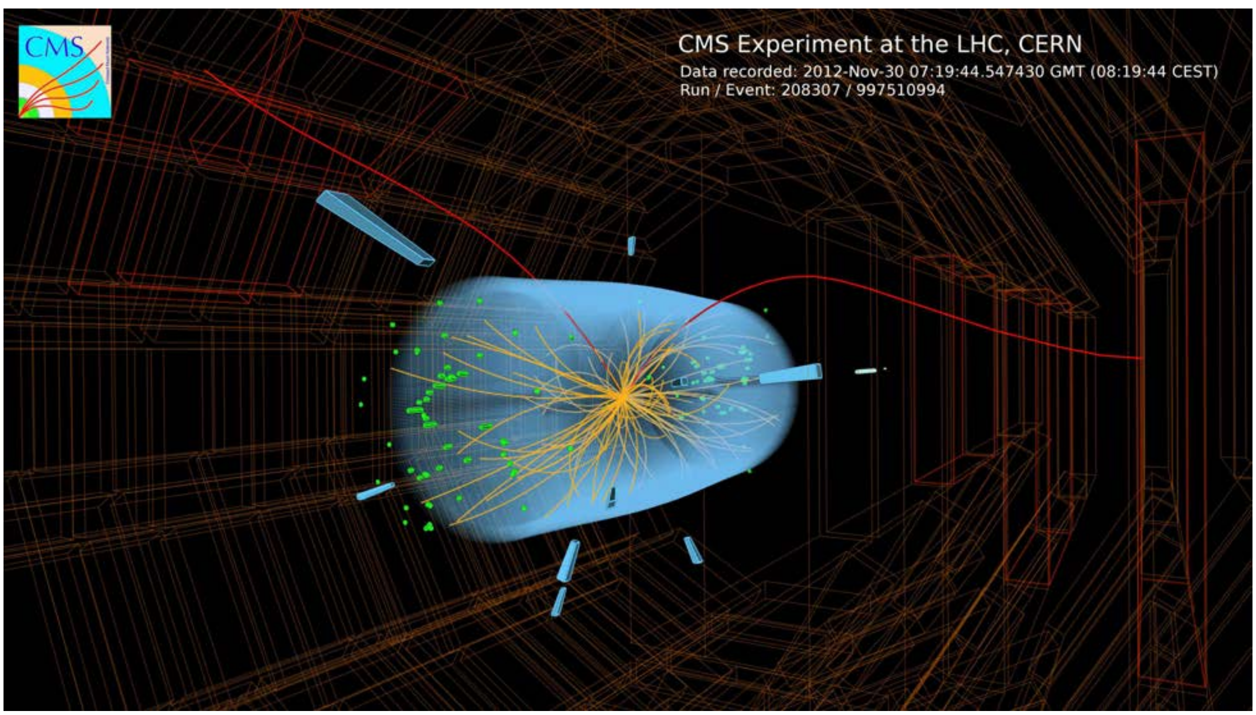

Figure 9: A candidate B_s to μμ decay.

But beyond these specific results, the physics program remains quite broad. There have been many studies of the production and properties of standard model particles, including the first observation of a mechanism for producing single top quarks through the electroweak interaction. Searches for new phenomena have all led to null results; so far, no heavy resonances, leptoquarks, fourth-generation quarks, supersymmetric particles, vector-like quarks, or quark and lepton compositeness have been observed. However, these numerous null results have led to significant constraints on theories of particle physics beyond the standard model and have challenged our understanding of energy scales beyond those that we have been able to explore with these experiments.

The development of these physics results relies on tremendous computing resources that are used to process and store recorded data and to run the simulations of physics processes and detector response that are needed to understand the recorded data. When the experiment is operating, it produces 1-2 PB of data per month. The LHC experiments have deployed a worldwide infrastructure of computing sites to perform all of the computing tasks. The infrastructure is "tiered," with sites at each tier having specific computing responsibilities and a configuration that is matched to those responsibilities. In the U.S., the DOE and NSF support the operation of the Tier-1 and Tier-2 centers. All of those U.S. centers are members of the OSG, which provides the middleware that allows CMS to use the distributed centers as an integrated high-throughput infrastructure for data processing and storage.

The U.S. CMS facilities include the Tier-1 center at Fermilab and the seven Tier-2 centers at seven universities (California Institute of Technology, University of Florida, Massachusetts Institute of Technology, University of Nebraska-Lincoln, Purdue University, University of California, San Diego and University of Wisconsin-Madison). In total these centers provide about 38,000 CPU cores of processing power, 28 PB of disk space and 24 PB of tape library space. This is about 40% of the total computing resources for the CMS experiment. At such a large fraction, it is safe to say that the experiment's scientific productivity depends strongly on these computing sites. Because all the sites are part of the OSG, these resources are also available for opportunistic use by other OSG VOs.

The U.S. sites have been excellent performers. Figure 10 below shows the total number of CPU hours used at Tier-2 centers throughout CMS during 2013. As can be seen, the U.S. sites provided more than a third of the processing resources, with each site among the top performers. This demonstrates the impressive impact that the OSG has had on the productivity of the CMS experiment.

Figure 10: Fractional contributions of processing time by all CMS Tier-2 facilities. The seven U.S. CMS sites are indicated with stars.

The CMS computing infrastructure also includes Tier-3 facilities that are owned and operated by collaborating institutions. Many university groups rely on these computing clusters to carry out their local data analysis projects. About 15 Tier-3 sites have joined the OSG. In doing so, CMS as a whole, beyond the local groups, can make opportunistic use of these facilities, as can other OSG VOs at lower priority. These sites can also be considered “beachheads” for the OSG as it works with university campuses around the country to broaden participation in high-throughput computing.

Other projects supported by the OSG, beyond the basic middleware, have been essential for participation in CMS computing and have also had significant impact on shaping the operation of the computing infrastructure. There is support for basic functionality like accounting services through the Gratia project, identity management services through the PKI project, and support for middleware components like Bestman, software packaging, testing and deployment, etc.

OSG support also includes a number of important forward-looking technology projects that are considered essential elements of future CMS computing operations. Examples are the Parrot and CVMFS systems that were first used to support software and configuration setup at non-CMS sites, but are now becoming a standard part of the installation at CMS sites. This software reduces the operational burden of installing each new release of the CMS software at each site. The Any Data Anywhere, Anytime (AAA) project has the goal of providing data access to any CMS data on disk, from anywhere with a network connection, at any time, with low latency and low operational overhead for users. The project collaborates with OSG and CMS and other projects in the OSG ecosystem, like the core Root development team at

CERN and xrootd developers in the U.S. and Europe, to achieve its ambitious goals. AAA has provided significant new flexibility to CMS operations, as it allows for easier distribution of workflows across many sites and also greatly simplifies data discovery and access issues for users who are performing the physics measurements. We see 10s of terabytes accessed through the AAA system each day, and scale tests have shown that analysis jobs at a single site can successfully read in more than 200 TB per day over the WAN, supporting 5000 simultaneous jobs. Finally, OSG's development and use of pilot-job infrastructures, such as glideinWMS, have allowed pilots to become the baseline job-submission system for CMS, for both user analysis and bulk simulation production. The reliability and flexibility of such systems have led to much more efficient data processing for the experiment.

The resumption of data-taking in 2015 will bring an order of magnitude increase in the data rate from the experiment, with corresponding increasing demands on the computing infrastructure. CMS will continue to rely on its close collaboration with the OSG to meet this challenge and continue our exploration of the highest energy scales ever realized in the laboratory.

2.1.3 CDF

Over two years after the end of Tevatron operations, CDF continues to produce valuable physics results with its accumulated data set. OSG resources and infrastructure continue to play a key role in the experiment's computing and have been vital to all physics results produced in the past year. In 2013, 33 CDF papers were published or accepted for publication while a further five were submitted. Highlights of the past year's physics program at CDF include final top quark mass measurements in several channels, a more complete exploration of top-pair production asymmetry, 4-standard-deviation evidence of s-channel single top quark production, and, in combination with D0, the first observation of s-channel single top quark production at any collider (Figure 11).

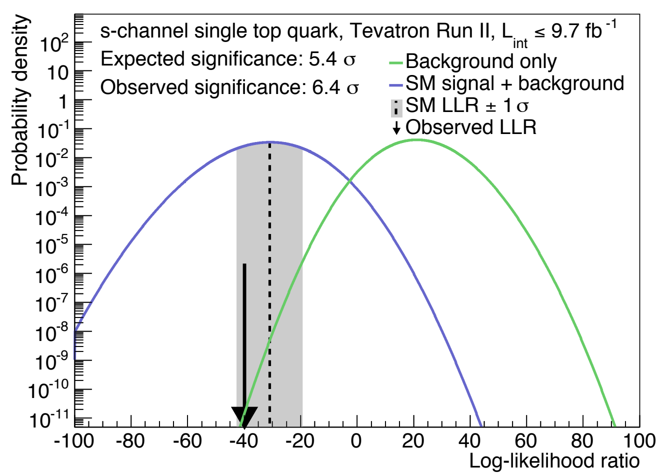

Figure 11: Log likelihood ratios of background-only and standard model single top plus background hypotheses for the combined CDF+D0 s-channel single top search

OSG resources support the analysis work for the collaboration and were crucial in the processing of the CDF dataset—both for reconstruction of raw data events (also referred to as "production") and creation of analysis n-tuples from the reconstructed data, as well as for CPU-intensive advanced analysis techniques, such as the use of artificial neural networks and generating large numbers of simulated experiments needed for advanced fitting techniques. An ongoing study of bottom quark-pair asymmetry required the MC generation of several trillion events, of which several billion were then passed through a full detector simulation. Without the means to efficiently access these resources that is enabled by the OSG infrastructure, producing these results on such a short timescale would not have been possible.

While the main raw data reconstruction processing ended in fall 2011, OSG resources and infrastructure continues to be heavily used in order to update n-tuples of production-level data and create MC events. Major processing projects included a custom reprocessing of data for the final W boson mass measurement, generation of simulated events for the bottom quark-pair asymmetry measurement, and the generation and simulation of a large volume of MC events for legacy flavor physics analyses. Despite over a year passing since the Tevatron shutdown, processing remained active during the past year.

The OSG resources available to CDF include those accessed via the CDFGrid portal and the North American Grid portal (NAmGrid). Additionally, WLCG grids in Europe have been available for CDF projects for almost two years under the EuroGrid portal, which utilizes the glidein factory run on OSG resources at UCSD. CDFGrid, consisting of several thousand virtual machines (VMs) running on almost 400 Fermilab-based nodes, is the most heavily used grid resource on the CDF experiment, providing access to CDF software packages and data handling capability on every node. At any given time, a large fraction of these VMs are typically in use with many jobs waiting to run. NAmGrid, consisting of opportunistically accessible nodes at CDF, CMS, D0 and general purpose (GP) nodes at Fermilab, as well as nodes at MIT and KISTI (Korea Institute of Science and Technology Information), does not possess the CDF software and data handling capabilities of CDFGrid nodes. Nonetheless, the VMs provided by NAmGrid are highly useful for projects such as the creation of MC events, which have no need of these resources. NAmGrid and EuroGrid remained actively used throughout most of the past year and currently are in heavy use for the generation of MC events for flavor physics analyses.

During this past year, CDF has produced numerous important physics results, all of which rely on the invaluable OSG resources and infrastructure at its disposal. While fewer full-time equivalents (FTEs) are expected to be dedicated to the experiment over the coming years, OSG computing will continue to play the same critical role in future CDF results.

2.1.4 DZero (D0)

The Tevatron collider is no longer in operation; however, the D0 experiment is continuing to use its well understood data set to produce many interesting physics publications. Since the D0 experiment has been shut down for several years, the number of active physicists on the experiment has been dropping and so the need for MC simulated events has dropped slightly over the past year. The primary use of OSG for D0 is generating MC simulations for use in physics analyses. It is critical for almost all physics analyses to have large MC simulations provided in a timely manner and OSG has been invaluable for this task.

During the past year, OSG has produced ~500 million MC events, which amounts to ~1/3 of all MC events produced. When a physics analysis needs a large sample of events quickly, OSG has done extremely well in helping provide these events. During the past year, OSG has been able to produce nearly 30 million Monte Carlo events in a single week when required. This has proved invaluable to those physics analyses that need large samples of events quickly.

D0 has been using OSG for many years, and through 2013 OSG has produced a total of nearly 3.5 billion generated events for D0. This shows the reliability and robustness of OSG resources over the many years. In 2013, 26 papers have been published on topics relating to the top quark, heavy flavors, electroweak, quantum chromodynamics (QCD), new phenomena and the Higgs Boson, see Figure 12.

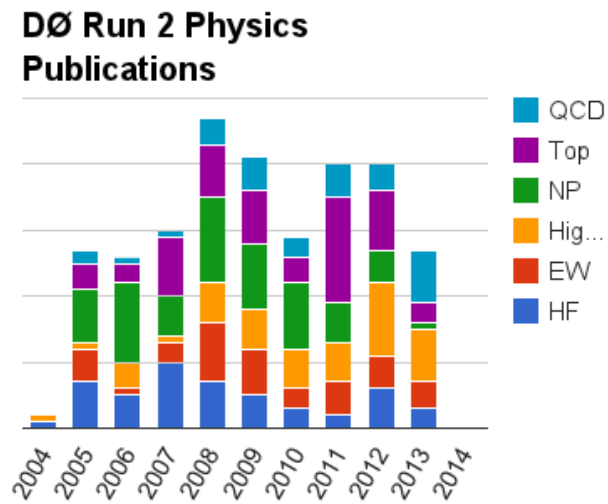

Figure 12: History of D0 Publications using OSG

These papers have produced nearly 2000 citations in 2013, which shows the importance of the D0 physics results. Since it is unlikely that another collider will ever again run at the energy of the Tevatron, it is important to produce a large variety of physics measurements that depend on the collision energy. D0 is continuing to produce these legacy measurements, and so it is expected that D0 will continue to rely on OSG resources for the next several years. It is important for these legacy measurements that OSG continues to provide resources at such a high level for D0. In 2013, there were 26 publications that relied on use of OSG.

2.1.5 Fermilab VOs

FermiGrid is the name of the Fermilab campus infrastructure. FermiGrid interfaces to the U.S. CMS Tier-1 center resources as well as the GP scientific resources. In addition to specific allocations by experiment, all can be opportunistically shared across the experiments, local scientific projects, the OSG VO and other OSG communities.

The Fermilab VO is a catchall for the local Fermilab projects and small experiments. The laboratory has taken the strategic decision to provide tools for distributed computing that are compatible with the use of OSG resources and is gradually adapting any application that can benefit from the use of OSG opportunistic resources. The FIFE project acts as a coordination point for the integration of the applications with distributed computing tools. Thus, OSG User Support and FIFE work closely together ensure user services in OSG are compatible with those of the FIFE stakeholders.

Early tests of using Amazon cloud resources using the standard OSG toolset are also in progress for NOvA, and running of simulation codes in production is anticipated to include these in the next year.

The following VOs are included:

VO Name	
Accelerator	Using FermiGrid for some applications; interested in multi-core remote resources

Argoneut	Using FermiGrid for final analyses
CDMS	Using FermiGrid
Gendetrd	Using FermiGrid
Muon g-2	Transition to use other OSG resources in progress
Lariat	Once MicroBooNE use of OSG in production will follow shortly thereafter
MicroBooNE	Testing of use of OSG resources at SLAC.
Minerva	Transition to use other OSG resources in progress
Miniboone	Using FermiGrid for final analyses
Minos	Uses XSEDE resources at Texas Advanced Computing Center as well as local FermiGrid resources.
Mu2e	Transition to use other OSG resources in progress
NOvA	Simulation production running across >12 OSG sites since fall 2013.

Table 2: Major sub-VOs in the Fermilab VO

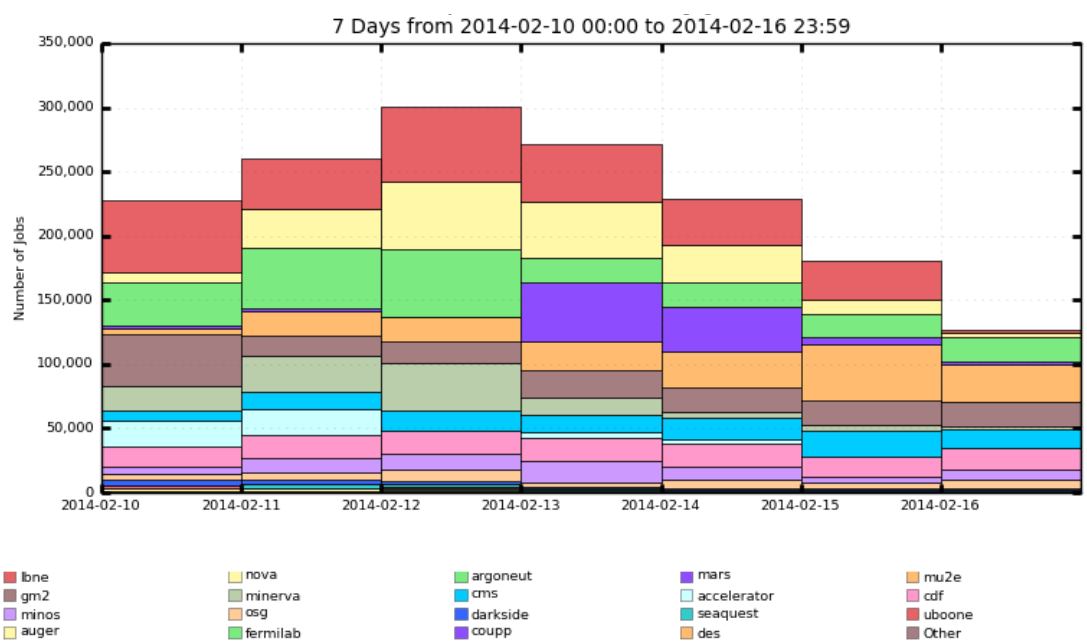

Figure 13: Example of Daily Number of Jobs Run on FermiGrid

2.1.6 NOvA

NOvA is attempting to measure the appearance of electron neutrinos as a result of neutrino oscillations within a dominantly muon neutrino beam produced by the Neutrinos at the Main Injector (NuMI) accelerator complex at Fermilab. The NOvA far detector is located in Ash River, Minnesota, 810 km away from Fermilab. The detector's readout synchronizes through a GPS timing system with the beam spills that occur at Fermilab and collects data corresponding to the oscillated neutrino signals.

Because the NOvA detector is located on the surface, instead of deep underground, it is critical to understand the backgrounds induced by the cosmic-ray fluxes that hit the detector in order to extract the oscillated neutrino signals. This background is determined through a combination of extensive computing simulations of the cosmic-ray fluxes combined with data from the detector. The computationally intense nature of these simulations has made this computing problem the focus of NOvA's activity on OSG. NOvA has been running jobs on OSG resources since October 2013. The experiment makes use of the OASIS software distribution service to supply their application code and uses the SAM data-handling system in combination with the dCache storage system to catalog and manage the data transfers. NOvA uses a common experiment interface "jobsub" to access the glideinWMS system for job submission. Using this system, NOvA jobs have run on over 12 major OSG clusters during the 2013 production run and continue to expand as the experiment's computing needs increase. During the 2013 production efforts, two NOvA collaborating institutions were integrated into the OSG and made accessible. These major clusters were the Southern Methodist University High Performance Computing Cluster and the Ohio SuperComputer Center.

In the initial simulation effort the collaboration targeted the generation of 1,000,000 background events — about three times as many events as have ever been produced. This was achieved by running 10,000 jobs through the OSG resources, requiring almost 90,000 CPU hours and producing 2 TB of data during two weeks of operations.

2.1.7 GlueX

The GlueX experiment is currently in the construction phase as a part of the 12 GeV upgrade of the Jefferson Lab electron accelerator. In preparation for the first physics run, expected to begin in late 2015, the collaboration is carrying out a series of data challenge exercises to test the computing system's ability to handle the volume of simulation and analysis that is required by the experiment. The first data challenge was conducted in December 2012, consuming approximately 5 million CPU hours on the OSG to produce 5 billion MC events over a period of 10 days. Data from this simulation were compressed into a sample of 10 TB and shared out using OSG storage infrastructure to all members of the collaboration. Analysis of these data enabled high-statistics studies of rare channels in the GlueX detector and provided the basis for a proposal for a Particle Identification (PID)upgrade to the baseline apparatus, incorporating components from the BaBaR DIRC detector. This proposal has been submitted to SLAC, and is presently under review.

Another key outcome from the first GlueX data challenge was the exposure of bottlenecks in the GlueX production workflow. These bottlenecks were primarily due to weaknesses in the analysis code, which allowed certain rare events to consume very large amounts of time and memory resources. Flaws of this kind can only be found by running very large samples. Other bottlenecks were uncovered, related to the way that jobs communicate with central services and interact with various firewalls. In the end, many lessons were learned and useful results obtained that moved the experiment forward, in terms of readiness for production of physics and simulations at the required rates. Having remedied the major problems that were exposed during the first data challenge and having made many improvements to the simulation and analysis codes, we are now preparing for a second major data challenge in 2014. This exercise is expected to consume the same order of magnitude in terms of CPU hours and produce a factor of two more data. As before, these data will be archived on OSG storage resources and made available to the GlueX collaboration for physics studies, leading up to the start of actual physics data taking in late 2015.

2.1.8 STAR

The Solenoidal Tracker At RHIC (STAR) Experiment is one of the two large Nuclear Physics (NP) U.S. based experiments at the Relativistic Heavy Ion Collider (RHIC). The RHIC program is a multi-prong program and study of nuclear natter and its properties. Three main programs can be identified:

(a) The heavy ion program had already shown unusual results. Whereas the matter produced in near-central RHIC collisions was shown to flow as a nearly viscosity-free fluid (a.k.a. "perfect liquid"), this program is evolving toward the study of rare probes for establishing a fine-grained study of the nuclear properties.
(b) Combined with the spin program, RHIC has made great strides towards unraveling the decades-old question about the partonic origin of the proton's spin. Longitudinally polarized proton collisions are currently the world's best source of information about the gluon helicity distribution, andthe study of the W-boson, one of the high-visibility studies from this program, is underway.
(c) Finally, the recent Beam Energy Scan (BES) program aims to study and probe the plasma in the vicinity of the transition by varying both temperature and baryon density.
RHIC/STAR has now completed a set of major upgrades facilitating the next decade of science. The physics program ahead could be summarized as two major campaigns of studies. The first one, from 2014-2016, is focused on the heavy flavor and di-leptons measurement to study the properties of the sQGP produced in the high-energy nuclear collisions at μ_B close to 0. The second phase of studies, from 2018 to 2019, will refocus on the RHIC BES Phase-II. The physics will then be focused on the search for the QCD critical point and study the QCD phase structure at the high-baryon-density region $\mu_B >$ 250MeV.

The STAR collaboration and detector system is being upgraded with several new components and detectors, but the challenge is also that unprecedented data samples will be required to carefully study the behavior of the nuclear matter with rare probes. STAR is already equipped with enhanced PID systems and is therefore able to study a wide variety of secondary decays (including the study of hyper-nuclei as an offshoot of STAR's physics program). With its new Muon Telescope Detector (MTD), STAR enhances the muon-to-hadron ratio by orders of magnitude and will be able to separate upsilon states and study the heavy flavor collectivity using color force screening. Combined with the Heavy Flavor Tracker (HFT), STAR will be able to study the prompt J/ψ and non-prompt J/ψ (from B decay) as well as perform detailed studies of the D^0 meson (Run 14 objectives) and later study the charmed lambda or Λ_c.

Ever growing data sets require expanding STAR resources. The collaboration has been developing a strategy to leverage the computational resources available at remote sites, especially those provided by the KISTI. Acquiring a status of Tier-1 center for STAR in 2013, significant resources (of the order of several 1,000 CPUs) are available there and not always fully used by local non-grid-based workflows. Initially viewed as supplemental resources for simulation purposes, the sites are accessible via grid interface (leveraging the standard OSG software stack), and in the end of 2013, the STAR collaboration had added to its workflows a fully grid-based data reconstruction process which is taking place at KISTI – several hundred jobs are currently running there, each month ramping up by a factor of two until the slots are filled. (We plan to fill all the slots if available and unused by the local simulation jobs.) This adds to the already well-established simulation workflows we have had for years at our NERSC/PDSF center and remote grid-based library validation for Tier-1 centers. At this stage, however, it appears our jobs are not showing up as part of the STAR VO - the KISTI site views it is sharing its resources with Fermilab.

The second noticeable activity we have undertaking is in the area of cloud computing. For STAR, the interest in cloud computing rests in its vision and principle of truly elastic and adaptable resources. While native resources require pre-existing code to be validated on unknown platforms, cloud computing and its virtualization component at the heart provide the ultimate flexibility to harvest unused resources as well as helping remote sites to provision their resources with STAR-workflows-ready middleware components and environment. Partnering with Argonne National Laboratory and the team led by Kate Keahey, we have also established contacts with the team at Fermilab led by Gabriele Garzoglio. Several meetings were organized to share our findings and intent for a common direction and a common strategy for partnership established. While at an early stage, we feel confident such activity could benefit the OSG and its cloud blueprint activities.

2.1.9 Belle II

The Belle II high-energy physics experiment is a next-generation B factory that is expected to record over 100 PB of raw data between 2015 and 2022. To manage and process this large data volume, the Belle II collaboration has adopted a distributed computing model based on existing technologies. The Belle II computing model is similar to the hierarchical structure found at the WLCG. The raw data is recorded and processed at KEK in Japan and copied to Pacific Northwest National Laboratory (PNNL). The raw data stored at PNNL enables the data (re)processing load to be shared with KEK and provides data security. The outputs of the processed data are then distributed to grid sites around the world for user analysis. In addition, the MC effort is distributed among grid sites based on the number of scientists at each site. The Belle II collaboration has chosen DIRAC[4] as the grid software stack.

The Belle II collaboration includes 600 scientists from 100 institutions in 23 countries. The U.S. membership of the Belle II is presently 12% of the collaboration from 13 institutions: PNNL, Carnegie Mellon, Cincinnati, Hawaii, Indiana, Kennesaw State, Luther College, Mississippi, Pittsburgh, South Alabama, South Carolina, Virginia Tech and Wayne State.

The OSG is a vital component of the U.S. Belle II computing, providing the middleware fabric of services and operations support across participating institutions. The U.S. Belle II Tier-1 site at PNNL has successfully deployed all key grid computing site elements that allowed the PNNL site a key role in the MC and data challenges.

The MC production campaigns performed in 2013 allowed the testing and evaluation of the Belle II distributed computing system. The first MC production was generated using EvtGen, the detector response was simulated with Geant4 and the output mimicked the raw data files. A total of 240,000 jobs were executed, requiring a total of 40 k-HEP-Spec06 days. A total of 60M events were simulated and reconstructed, producing an output of 190 TB. A second MC production was conducted from July 23 to September 8, 2013. Jobs performed event generation, detector simulation and reconstruction. Only the final data format was stored, reducing the data-to-CPU ratio. A total of 560M events were generated, consuming 700 kHEPSpec06 days and 85 TB of data. Compared to the first MC campaign, the CPU resources increased by an order of magnitude while reducing the job failure rates to ~1% by the end of this second MC campaign. A third MC production campaign is planned for March 2014 and will include both grid and cloud resources.

In addition, the computing model relies on high-bandwidth network connections between sites. In particular, the network connection from KEK to PNNL is required to transfer the raw data at a rate of ~20 Gbps during peak design luminosity. To determine the current status of the networking resources between Belle II sites, a data challenge was performed in May 2013. Key tools from the OSG software stack used to perform these tests at the U.S. Tier-1 site include bestman2 Storage Element (SE) and gridftp servers. The data transferred were scheduled using a FTS2 service running at GridKa. The results of the transfers identified areas in need of improvement, such as transfer from Japan or US to Europe. The latest data challenges now utilize FTS3 service running at PNNL and will consider other protocols such as xrootd.

---

[4] http://diracgrid.org/

2.1.10 DOSAR

DOSAR continues to support grid education and grid middleware installations across the globe. Most recently, the University of Johannesburg cluster was upgraded to OSG Software Release-3, which was particularly challenging because the cluster is also supporting EMI, so several middleware conflicts had to be addressed.

We are also planning to hold another OSG grid school at the next African School of Fundamental Physics, ASP2014, to be held this August at Université Cheikh Anta Diop in Dakar, Senegal.

Top five science drivers of DOSAR jobs running on Oklahoma Supercomputing Center for Education and Research (OSCER): weather and meteorology (35%), materials engineering (25%), high energy and cosmology (15%), chemistry and biochemistry (5%), and aerospace and mechanical engineering (2.5%).

In addition, DOSAR members have always been instrumental in OSG middleware integration testing, most recently in debugging the last OSG update with the latest RHEL/Scientific Linux 6.5 openssl upgrade.

2.1.11 GridUNESP

The São Paulo State University (UNESP) has built and now operates one of the largest multicampus grid infrastructures in Latin America, with computing resources distributed over different campuses throughout the state of São Paulo. GridUNESP, as the facility is known, is a long-term project conceived to leverage the scientific research at UNESP – a statewide, multipurpose grid infrastructure that is providing reliable and high-performing computational power to university research groups from several areas of science and engineering. [5]

The infrastructure, deployed with full support of the U.S. OSG, consists of a central cluster located in São Paulo city, and seven secondary clusters at different UNESP campuses spread over the state. The central cluster is most appropriate for running tightly coupled parallel applications using message passing interface (MPI) and proprietary parallel libraries, whereas the secondary clusters are more suitable for running loosely coupled (HTC) applications or near pleasantly parallel (parallelism across the cores on a single CPU) computations. The eight sites are interconnected through the KyaTera network, a research and engineering experimental optical network provided by FAPESP[6] in association with Telefonica Brazil, a subsidiary of the Spanish company that provides fixed-line telecommunications services in the state of São Paulo.

A formal partnership between UNESP and the OSG Consortium was signed in 2009,[7] which enabled GridUNESP to use the OSG middleware stack to integrate its computational resources and share them with other R&E institutions worldwide. The GridUNESP VO, established in December 2009 as the first

---

[5] R. L. Iope, N. Lemke, G. A. von Winckler, "GridUNESP: a multi-campus Grid infrastructure for Scientific Computing", in Proc. of the 3rd Latin American Conference on High Performance Computing (CLCAR 2010), 25-28 August 2010, Gramado, Brazil, pp. 76-84.

[6] http://www.fapesp.br/en/

[7] OSG Document 827-v1: GridUNESP and OSG Agreement. Available at http://osg-docdb.opensciencegrid.org/cgi-bin/ShowDocument?docid=827

VO outside U.S., is a multipurpose VO which includes projects from different research fields: astronomy, biology and biophysics, biomedical engineering, chemistry, computer science, geosciences, materials science, meteorology, and physics.

In four years of operation, GridUNESP resources have processed 6 million jobs, accounting for 46.5 million CPU hours [Fig. 1]. The project supports more than 50 research groups, with almost 250 registered users [Fig. 2] working on different areas [Fig. 3]. The technical staff provides continued support on high-performance computing (HPC) software according to the users' needs. GridUNESP successfully runs scientific applications like Crystal, Dirac, GAMESS, Gaussian, Gromacs and POY with MrBayes parallel (MPI-like) support. Due to those efforts, the number of researchers interested in using the infrastructure has been growing systematically since January 2010, when the system became operational. There is a real demand for high-end computational resources and for qualified technical support inside UNESP. The utilization of resources by the users of the GridUNESP VO, represented by the mean occupancy of computing resources over the year, evolved from 19% in 2010 to 53% in 2011, increased to 74% in 2012 and achieved a peak of 89% in 2013. A major upgrade of the GridUNESP physical infrastructure is planned for 2014.

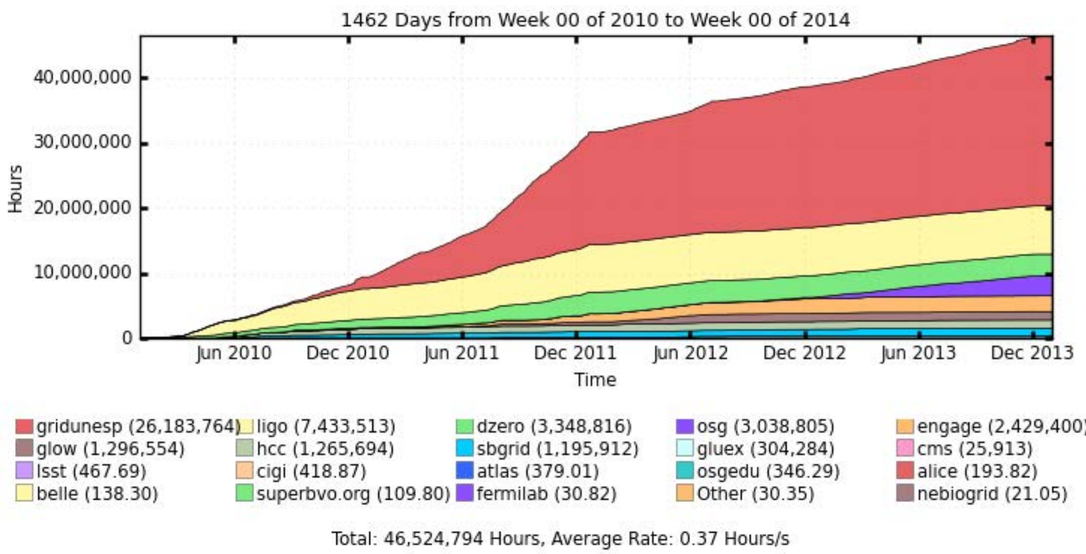

Figure 14: GridUNESP - cumulative hours by VO

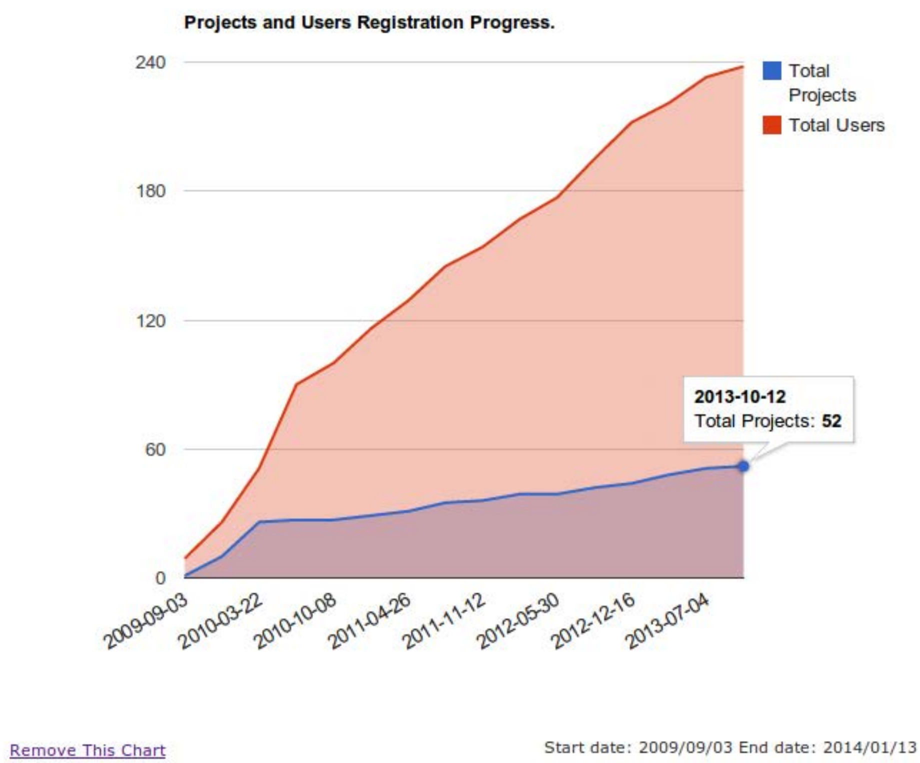

Figure 15: GridUNESP Registered projects and users

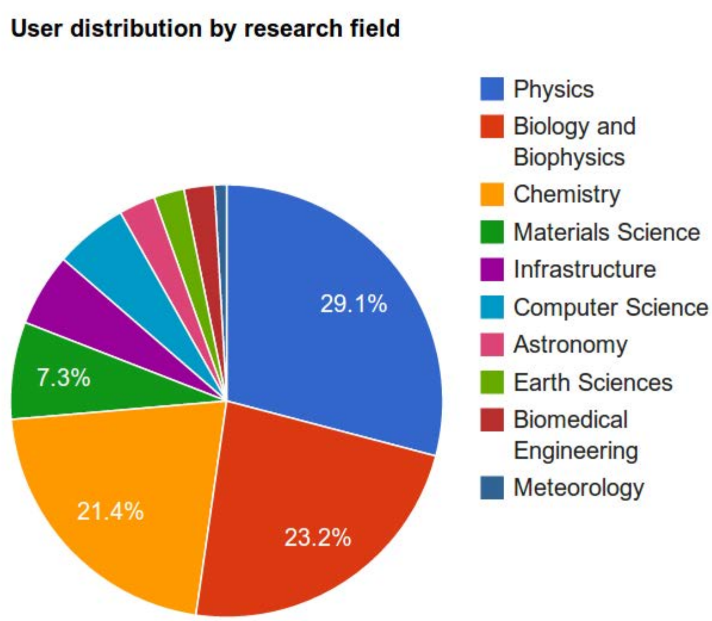

Figure 16: GridUNESP User distribution per research field

2.2 Campus Researchers

The OSG project leverages its geographic and institutional diversity to bring DHTC computing to a broad and growing cross section of U.S. researchers, both as individuals and groups. Typically these researchers do not bring computing resources to connect to OSG and are motivated to accomplish their scientific computing in the most efficient and timely manner. The OSG team assists these researchers in adapting their applications to run in the DHTC environment, helps them get access to OSG for submitting their jobs and supports them in completing their research computation.

2.2.1 GLOW

Established in 2006, the Center for High Throughput Computing (CHTC) at the University of Wisconsin-Madison (UW-Madison) provides numerous resources to support the computational needs of campus researchers. UW-Madison maintains multiple on-campus clusters for DHTC, as well as a cluster dedicated to HPC. These campus resources provided roughly 100 million CPU hours during the 2013 calendar year. As an active member of the OSG, the CHTC provided an additional 15 million CPU hours to campus researchers via the OSG in 2013. To support software testing in a diverse environment with multiple platforms, researchers also have access to the UW Build and Test Lab (BaTLab). All of the above computing resources are managed with the HTCondor resource scheduling system, which is actively developed at UW-Madison by the HTCondor team. Together, CHTC and HTCondor staff provide support to other on-campus cluster administrators. In order to aid researchers in utilizing all of these resources, the CHTC employs a team of Research Computing Facilitators who provide consulting, matchmaking and support. All standard CHTC resources and services are provided to UW-Madison researchers and collaborators at no charge, but with buy-in opportunities for groups needing priority access to specific, local hardware. The CHTC, located in the Department of Computer Sciences, is funded by grants from the NSF and DOE, and by various UW-Madison funding efforts. In the last year, 48 researchers were enabled with access to DHTC as shown below.

Principal Investigators	University	Science Domain	Hours
John Markley, Eldon Ulrich, Miron Livny	University of Wisconsin-Madison	Structural Biology, Biophysics	2,735,439
Kam-Wah Tsui	University of Wisconsin-Madison	Statistics	2,388,644
Francis Halzen	University of Wisconsin-Madison	Particle Physics	1,546,297
Mark Friesen, Susan Coppersmith	University of Wisconsin-Madison	Nanotechnology	1,530,260
Barry Van Veen	University of Wisconsin-Madison	Statistical Signal Processing	930,004
Juan dePablo	University of Chicago (previously UW-Madison)	Molecular Thermodynamics, Statistical Mechanics	827,099
Miron Livny, HTCondor Team	University of Wisconsin-Madison	High Throughput Computing	804,283
Karl Broman	University of Wisconsin-Madison	Statistical Genetics	753,174

Ned Kalin	University of Wisconsin-Madison	Neuroscience, Behavioral Genetics	718,080
Nicolas Roys	University of Wisconsin-Madison	Economics	515,819
Chris Ré	Stanford University (previously UW-Madison)	Optimization, Geology	439,127
Paul Campagnola	University of Wisconsin-Madison	Biomedical Optics	409,111
Natalia Perkins	University of Wisconsin-Madison	Condensed Matter Physics	395,123
Ruth Litovsky, Tyler Churchill	University of Wisconsin-Madison	Hearing Science	340,937
John Pool	University of Wisconsin-Madison	Population Genomics, Evolutionary Genomics	232,167
Julie Mitchell	University of Wisconsin-Madison	Structural Biology, Machine Learning	211,802
Duncan Carlsmith, Sridhara Dasu, Matthew Herndon, Wesley Smith	University of Wisconsin-Madison	High Energy Physics	200,731
David Schwartz	University of Wisconsin-Madison	Molecular and Synthetic Genomics	175,368
Grace Wahba, Sijian Wang	University of Wisconsin-Madison	Biostatistics	128,345
Brad Postle	University of Wisconsin-Madison	Cognitive Neuroscience	107,250
Giulio Tononi	University of Wisconsin-Madison	Cognitive Neuroscience	72,673
Jess Gregory	University of Wisconsin-Madison	Economics	71,632
Michael Gofman	University of Wisconsin-Madison	Finance	69,625
David Krakauer	University of Wisconsin-Madison	Interdisciplinary	52,523
Vikas Singh	University of Wisconsin-Madison	Computer Vision, Neuroimaging	43,778
Arun Yethiraj	University of Wisconsin-Madison	Theoretical Chemistry	26,116
Andrew Alexander	University of Wisconsin-Madison	Neuroscience, Neuroimaging	16,592
Yingqi Zhao	University of Wisconsin-Madison	Biostatistics	14,467
Yongna Xing	University of Wisconsin-Madison	Molecular Biology	8,951
Madeline Meyer	University of Wisconsin-Madison	Theoretical Chemistry	8,567
Saulan Wu	University of Wisconsin-Madison	Particle Physics	7,319
Edgar Spalding	University of	Botany	6,496

	Wisconsin-Madison		
JR Schmidt	University of Wisconsin-Madison	Materials Chemistry	5,629
Guilherme Rosa	University of Wisconsin-Madison	Plant and Livestock Genetics	5,123
Peter Steiner	University of Wisconsin-Madison	Educational Psychology	5,006
Amit Gandhi	University of Wisconsin-Madison	Economics	3,551
Irena Knezevic	University of Wisconsin-Madison	Physics	3,414
Jun Shao	University of Wisconsin-Madison	Clinical Statistics	2,816
Katherine McMahon	University of Wisconsin-Madison	Microbial Ecology	1,332
Jignesh Patel	University of Wisconsin-Madison	Computer Sciences	1,251
Michael Hoffman	University of Wisconsin-Madison	Small Molecule Screening	1,133
Paul Mitchell	University of Wisconsin-Madison	Agriculture, Agronomy	1,008
Tomy Varghese	University of Wisconsin-Madison	Medical Physics	315
Tim Rogers, Rob Nowak	University of Wisconsin-Madison	Cognitive Neuroscience	226
Carol Hirschmugl	University of Wisconsin-Madison	Biophysics	217
Kalin Vetsigian	University of Wisconsin-Madison	Systems Biology	193
Bryan Bednarz	University of Wisconsin-Madison	Medical Physics	170
David O'Connor	University of Wisconsin-Madison	Metagenomics, Virology	100
		Total	15,819,283

Table 3: GLOW/CHTC based Researchers

2.2.2 HCC

The Holland Computing Center (HCC) and the University of Nebraska provide high-performance and high-throughput computing resources to researchers from multiple campuses in the Nebraska University system and collaborators worldwide. A combination of methods, including a semester-long course, various short tutorials and individual meetings are employed to support and facilitate the deployment of scientific workflows from a variety of scientific disciplines on HCC and OSG resources.

Principal Investigators	University	Science Domain	Hours

Patricia Clayton	University of Washington	Earthquake Engineering	71,435
Derrick Stolee	Iowa State University	Computational Combinatorics	3,075,601
Natasha Pavlovikj	University of Nebraska-Lincoln	Protein-Guided Assembly	19,735
Sarah Behrens	University of Nebraska-Lincoln	Computational Combinatorics	1,000
		Total	3,167,771

Table 4: HCC based Researchers

2.2.4 UCSD

Science:
In 2013, two science activities at UCSD/SDSC directly benefitted from collaborative work with OSG. The POLARBEAR experiment relied on the UCSD/SDSC infrastructure for its first two science papers, listed in the appendix. POLARBEAR measures the Cosmic Microwave Background (CMB) polarization. Fluctuation in intensity and polarization of the CMB and the large-scale structure of the universe provide information about the earliest times in the universe. In addition, these measurements allow for constraints on the sum of neutrino masses, as well as the effective number of neutrinos, Neff. The latter could provide evidence for sterile neutrinos. POLARBEAR is part of a sequence of experiments that will within the next ~10 years probe the theory of cosmic inflation and reach the sensitivity required to measure the sum of neutrino masses as predicted from mass differences measured via neutrino oscillations. The results submitted for publication in late 2013 are a major milestone in this direction.

In addition, a collaboration of theoretical and experimental particle physicists from ATLAS and CMS worked together on supersymmetry phenomenology using the UCSD/SDSC infrastructure. This project was formed at the Les Houches Workshop 2013 [3] and is using our infrastructure to produce a wide scan of “Natural Supersymmetry” models that the data from ATLAS and CMS can probe.

Infrastructure:
UCSD/SDSC host the glideinWMS metascheduler that is used for all the science on OSG other than ATLAS. This includes XSEDE allocations on OSG. The infrastructure is deployed in Mayer Hall and SDSC for redundancy. At SDSC, OSG benefits from generator backup power. In addition to serving the broader national scientific community, we also offer the service via a login node to scientists locally. UCSD operates a CMS Tier-2 center, and UCSD/SDSC interfaced the Gordon Supercomputer to analyze 125 TB of CMS data. CMS processed roughly 400 million collisions recorded with the Vector Boson Fusion and Multi-jet and missing H_T triggers during the 2012 data taking period of CMS at the LHC.

Value of OSG to Science at UCSD/SDSC:
The key value of OSG is large spikes of resources with little lead time, and when needed. Individual researchers have spiked at 35k hours per day. For example, the phenomenology project consumed more than 300k hours, almost all in one month, concentrated on a few days of 10-35k hours per day.

2.2.5 OSG VO

The OSG VO does not "own" any resources and exists only to harvest opportunistic cycles and make them available to researchers who need access to DHTC resources. These cycles are made available to researchers by the OSG User Support team, which is part of the funded effort in the project. They provide: 1) integration and operations of the job submission systems that provide OSG access for researchers; and 2) consulting that accelerates the time-to-production for those who need assistance in adapting their computation to run on OSG. The User Support team is presently comprised of staff from USC-ISI, FNAL and BNL.

Two segments of researchers are enabled for access to OSG DHTC resources:

1. **OSG-XD:** OSG serves as a Level 2 Service Provider in XSEDE and enables access to those users who are granted allocation with that process; this community is referred to as OSG-XD users.
2. **OSG-Direct:** Many research groups and PIs directly approach OSG for access to DHTC resources; this community of users is referred to as OSG-Direct users.

In the preceding year, we provided ~26M wall hours to 23 OSG-XD users; and we provided ~21M hours to 14 OSG-Direct users.

XSEDE Allocation	PI	University	Science Domain	Hours
TG-ATM130009	Phillip Anderson	University of Texas at Dallas	Atmospheric Sciences	46,028
TG-ATM130015	Phillip Anderson	University of Texas at Dallas	Atmospheric Sciences	77,168
TG-OCE130029	Yvonne Chan	University of Hawaii, Manoa	Ocean Sciences	21,493
TG-IRI130016	Joseph Cohen	University of Massachusetts, Boston	Information, Robotics, and Intelligent Systems	70,536
TG-MCB100109	Lillian Chong	University of Pittsburgh	Molecular Biosciences	264,362
TG-CCR120041	Luca Clementi	San Diego Supercomputer Center	Computer and Computation Research	12
TG-DMR130036	Emanuel Gull	University of Michigan	Materials Research	212,059
TG-DMR120085	Emanuel Gull	University of Michigan	Condensed Matter Physics	60,624
TG-MCB090163	Michael Hagan	Brandeis University	Biophysics	33,785

TG-MCB120070	Joseph Hargitai	Albert Einstein College of Medicine	Molecular Biosciences	39
TG-MCB090174	Shantenu Jha	Rutgers, the State University of New Jersey	Molecular Biosciences	127
TG-IBN130001	Donald Krieger	University of Pittsburgh	Integrative Biology and Neuroscience	24,338,299
TG-CHE130103	Jeremy Moix	Massachusetts Institute of Technology	Chemistry	48,768
TG-PHY110015	Pran Nath	Northeastern University	Physics	303,931
TG-DMS120024	Benjamin Ong	Michigan State University	Mathematical Sciences	68,907
TG-MCB130072	Robert Quick	Indiana University	Molecular Biosciences	15
TG-TRA100004	Andrew Ruether	Swarthmore College	Training	444,374
TG-IBN130008	Jorden Schossau	Michigan State University	Integrative Biology and Neuroscience	9,042
TG-PHY120014	Qaisar Shafi	University of Delaware	Physics	525,616
TG-CHE130091	Paul Siders	University of Minnesota, Duluth	Chemistry	80,325
TG-STA110014S	Nancy Wilkins-Diehr	University of California-San Diego	Center Systems Staff	5
TG-STA120004	XD Staff	Various	Testing & Integration	14
TG-TRA120041	Hanning Chen	George Washington University	Computer and Information Science and Engineering	230
OSG-XD		23 Users	Total Hours	26,605,759

Table 5: OSG-XD Allocations usage for 12 months ending January 31, 2014

OSG ProjectName	PI	University	Science Domain	Wall Hours
Duke-QGP	Steffen A. Bass	Duke University	Nuclear Physics	2,399,539
SPLINTER	Robert Quick	Indiana University School of Medicine	Medicine	3,979,535
IU-GALAXY	Robert Quick	Indiana University	Bioinformatics	200,377
RIT	Alexander Arlange	Rochester Institute of Technology	Ramsey Numbers R(C4,Km)	764,216
Snowmass	Meenakshi Narain	Brown University	Particle Physics	9,972,492
ECFA	Meenakshi Narain	Brown University/LPC group	Particle Physics	1,744,646
SNOplus	Joshua R Klein	University of Pennsylvania	Neutrino Physics	488
DetectorDesign	John Strologas	University of New Mexico	Medical Imaging	444,403
BNLPET	Martin Purschke	Brookhaven National Lab	Biomedical Imaging	22,453
UMich	Paul Wolberg	University of Michigan	Microbiology	1,056,952
EIC	Thomas Ullrich	Brookhaven National Lab	Particle Physics	410,593
UPRRP-MR	Steven Massey	Universidad de Puerto Rico, Rio Piedras Campus (UPRRP)	Bioinformatics	609,433

DeerDisease	Lene Jung Kjaer	Southern Illinois University	Biological Sciences	11,692
Pheno	Stefan Hoeche	SLAC	High Energy Physics	367,660
OSG-Direct		14 Users	Total Hours	21,984,479

Table 6: OSG-Direct Usage for 12 months ending January 31, 2014

3. The OSG Fabric of Services

The OSG project provides the fabric of software and services that enable production by the science stakeholders. This includes operational capabilities, security, software integration and packaging, testing, and documentation as well as user support. Scientists who use the OSG production fabric demand stability and reliable facility, and we are continuing our operational focus on providing stable and dependable production level capabilities. At the same time, we look to provide new capabilities that make is easier to adopt and use OSG. The stakeholders continued to perform record amounts of processing. The two largest experiments, ATLAS and CMS, continued to use OSG at record levels, and the OSG infrastructure has demonstrated that it is up to the challenge and continues to meet the needs of the stakeholders.

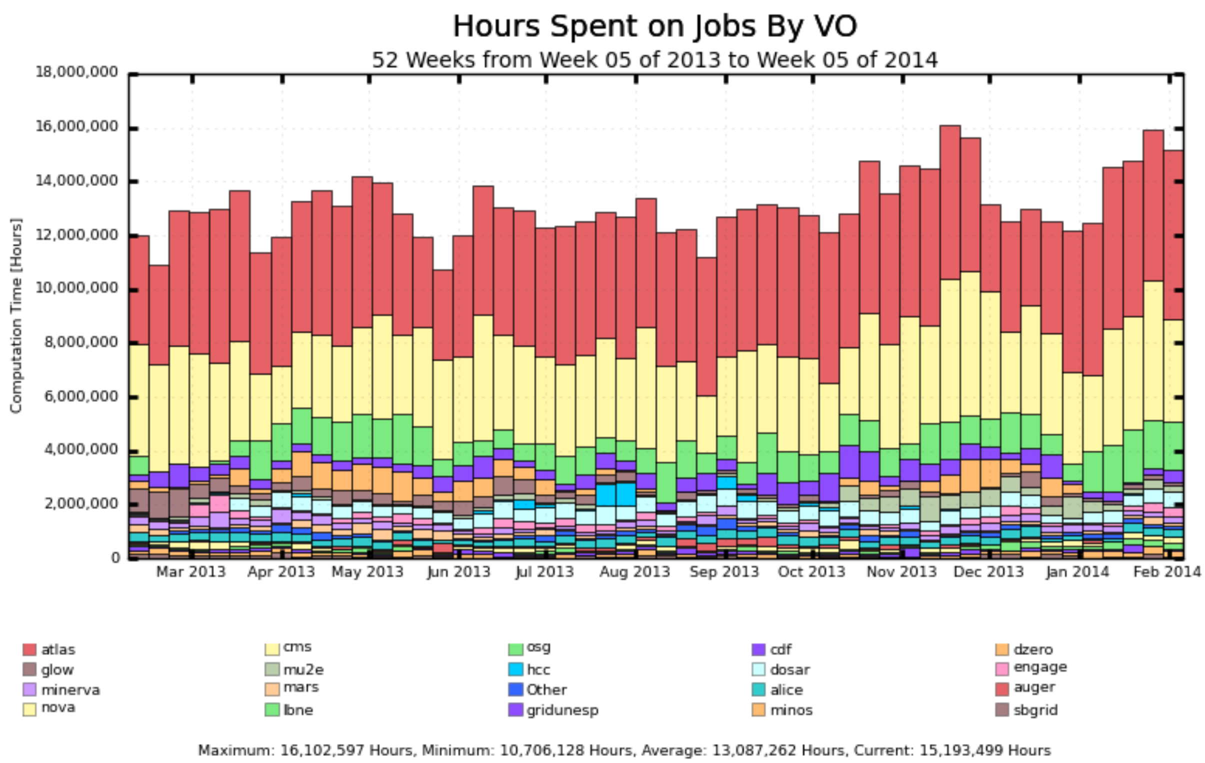

Figure 17: OSG facility usage vs. time for the past 12 months, broken down by VO

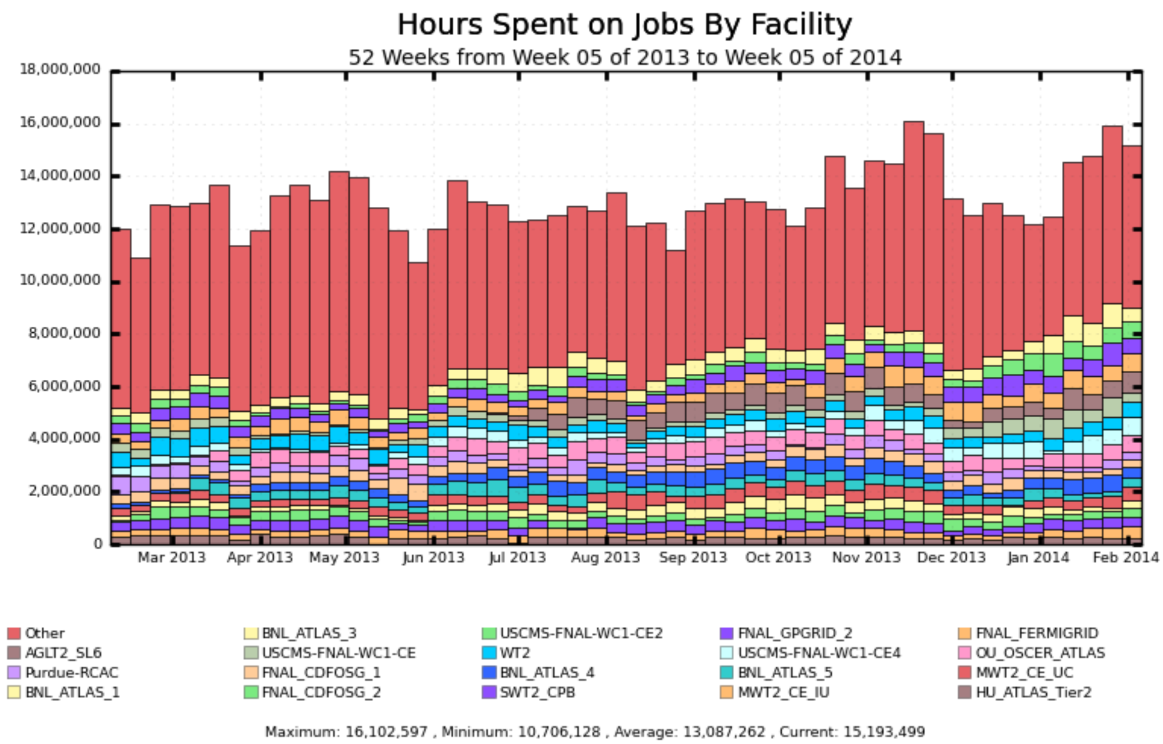

Figure 18: OSG facility usage vs. time for the past 12 months, broken down by Site.
("Other" represents the summation of all other "smaller" sites)

During the last year, the usage of OSG resources by VOs has averaged ~13M hours per week. Peak weeks have grown from about 14M hours to recent usage of 16M hours in a single week. The OSG ecosystem comprises over 120 sites; the largest sites are mostly owned by the LHC but other sites taken together represent a very large percentage of available production.

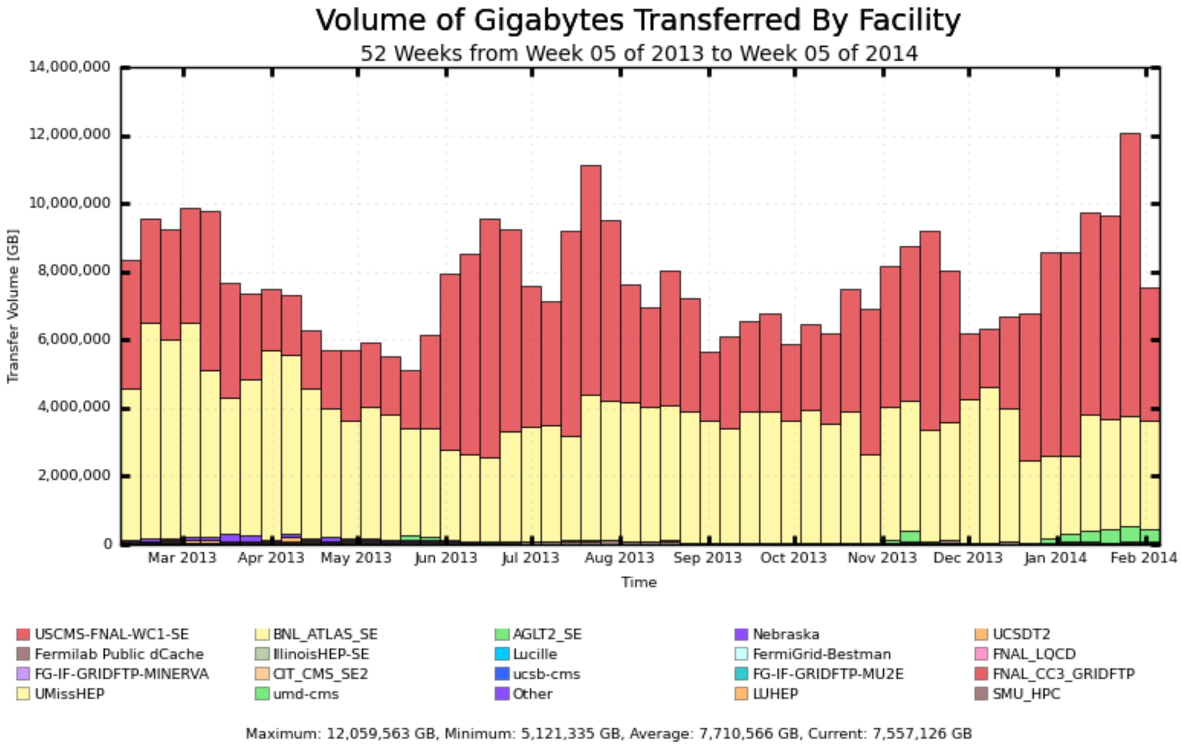

Figure 19: OSG facility data transfer by LHC site for the past 12 months

Data transfer to/from the CMS and ATLAS Tier-1 sites has averaged over 7 PetaBytes per week with peaks approaching 10 PetaBytes per week.

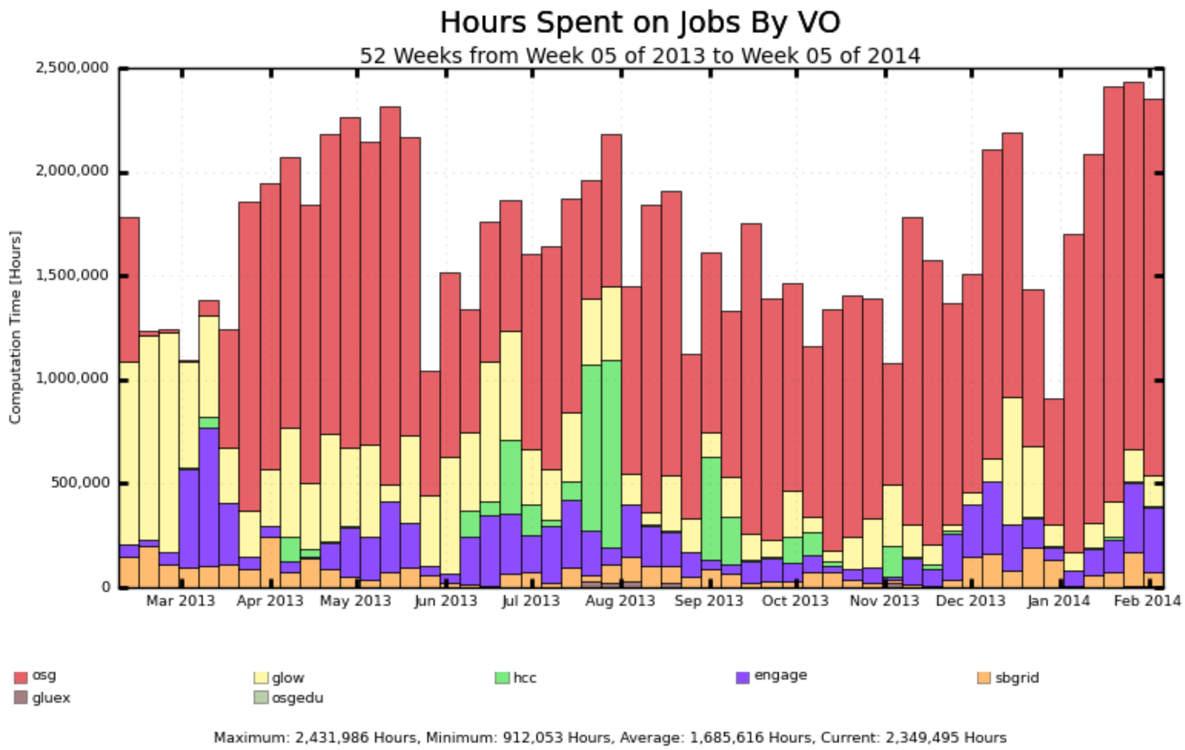

Figure 20: Opportunistic usage in OSG for the past 12 months

Approximately 1.7M hours per week (approximately 12% of total) are used in opportunistic mode by VOs to enable science by researchers who do not have their own compute clusters or are in need of compute resources that exceed what is available to them locally at their campus. Opportunistic use in OSG has grown to 87M hours from the previous 12-month total of 51.6M hours.

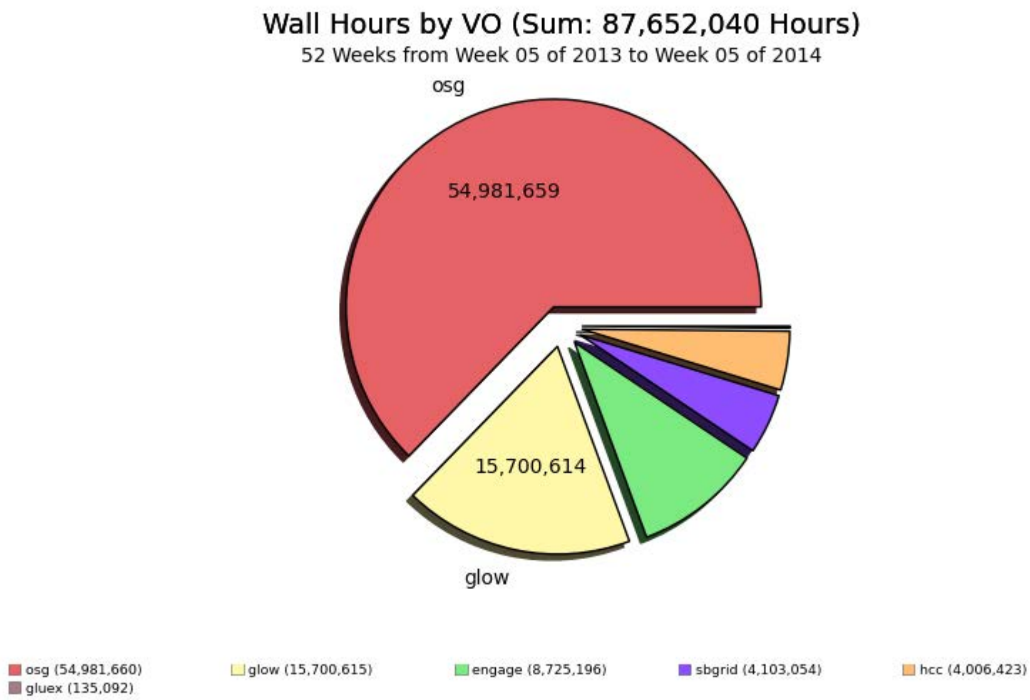

Figure 21: Opportunistic usage by VO for the past 12 months

In order to achieve the above throughput, OSG actively supports its stakeholders in the broad deployment of a flexible set of software tools and services for efficient, scalable and secure distribution of workload among OSG sites. Both major workload management systems supported by OSG – glideinWMS and PanDA – are based on use of pilot jobs and these have become the preferred mechanism for OSG usage. Nearly all of the VOs are now utilizing this mechanism for submitting jobs to the OSG. At the request of our stakeholders, OSG continues to operate two glideinWMS pilot factories to support this technology.

In summary, OSG continues to demonstrate that it is meeting the needs of U.S. CMS and U.S. ATLAS stakeholders at all Tier-1s, Tier-2s and Tier-3s. And OSG continues to actively support and meet the needs of a growing community of non-LHC science groups that are increasing their reliance on OSG.

3.1 Technology

The OSG Technology Area provides the OSG with a mechanism for medium- to long-term technology planning. This is accomplished via two sub-groups, the Blueprint and Investigations groups.

Blueprint: The Blueprint sub-group records the conceptual principles of the OSG and focuses on the long-term evolution of the OSG. The Blueprint group meets approximately quarterly (during 2013, there were three meetings) and produces knowledge (in the form of documents or meeting notes) which aims to reflect our understandings of the basic principles, definitions, and the broad outlines of how the elements of OSG fit together. The primary topics discussed this year include integrating cloud resources, resource provisioning, using SSH for accessing non-OSG clusters and the authorization infrastructure. The resource provisioning work has resulted in an "OSG resource provisioning" blueprint which will be refined throughout 2014.

Investigations: To manage the influx of new external technologies—while keeping to the OSG principles—this sub-group does investigations to understand the concepts, functionality and impact of external technologies. The goal is to identify technologies that are potentially disruptive in the mediumterm of 12-24 months and give the OSG recommendations on whether and how to adopt them. Based on these recommendations, a temporary team may be formed from technology staff and other areas to help guide the technology into the OSG. The selection of investigation topics are driven by the outcomes of the blueprint meetings, stakeholder requests and the OSG executive team.

We consider the following work highlights of the past year:

- **HTCondor-CE evolution**: After last year's "next-gen CE" investigation, the HTCondor-CE was selected as the base of the next OSG-CE. We worked to "hand off" the distribution aspects of HTCondor-CE to the software team. However, work to refine default settings, improve the HTCondor integration with blahp[8] and implement bug fixes continued for the Technology Investigation team. By the end of the year, we had our first two production deployments of the HTCondor-CE (short of our internal goal of three). This work will continue next year; the goal is to transition 20% of delivered OSG Production Grid CPU hours to the HTCondor-CE.
- **OASIS v2**: The **O**SG **A**pplication **S**oftware **I**nstallation **S**ervice, based on the CERN CVMFS software, began this year as a mechanism to improve software distribution across the OSG for small groups. The version of OASIS deployed by Production in Year 1 sacrificed a few scalability goals in order to be released in a timely fashion. We have made a prioritized list of improvements to the existing service, CVMFS upgrades and a new implementation for version 2.
- **Resource Isolation**: The resource isolation work done during 2012 was not explored further in 2013. Instead, the security team focused on traceability and auditing techniques on the VO submit host (as opposed to a technology solution such as an improved *glexec*). Some minor work is expected in 2014 on using Parrot as a sandboxing tool for OSG user support.
- **Data Management**: A modest number of improvements were made in data management. We made progress in having HTTP proxies be a required service at all OSG sites (which improves the stagein of common files). With the HTCondor team, we worked on designing improvements to how the schedd manages file transfers. We helped the OSG user support team configure Parrot integration into the OSG-XSEDE submit host (allowing seamless CVMFS integration).

Communications: Another important aspect of the team is to communicate our knowledge outside the OSG. All investigation results are uploaded to the OSG DocDB. We participate in and present at the WLCG's Grid Deployment Board. Also, the WLCG interoperability group reports to the Technology Area.

3.2 Software

The OSG Software team produces a software distribution that helps organizations perform DHTC and helps sites participate in the OSG Production Grid. This software underpins the technical platform of the OSG Production Grids; it builds upon operating systems (OS) and other software distributions, and it supports the operation of the production facility as well as end-user scientific applications. Other developers provide most of the software, in which cases the Software team provides packaging, builds and automated testing. In a few select cases, the Software team creates and maintains software tools that support the community and that would not exist otherwise. Further, the Software team integrates the myriad of components, and supports and troubleshoots the integrated software in production.

Ultimately, the mission of the Software team is to minimize the effort needed to manage the software that underlies DHTC. Thus, the team works closely with the OSG Technology, Release, Production, Operations, and Security teams, plus key stakeholders in the scientific community.

[8] http://research.cs.wisc.edu/htcondor/gahp/

Following a major transition of the software stack to RPM packaging and distribution technology over the past few years, this year the Software team focused on delivering new technologies and significant updates to existing ones. Also, the release cycle was slowed to a monthly cadence to improve overall quality now that the RPM distribution is the production standard. An example of a major new technology was the introduction of HTCondor-CE, software that manages the flow of jobs coming into a site from remote sites. Until now, the Globus GRAM Gatekeeper has been the only OSG-supported software to perform this role. As the number and rate of jobs continuously increases, the OSG sought a resource management system that is best prepared to handle demands well into the future. The Software team packaged HTCondor-CE and contributed to its end-user documentation.

A significant software update was the transition of all OSG software components that use the Java platform from Java version 6 to 7. Support for Java 6 implementations ceased early in 2013, and due to the frequency and urgency of Java platform security and bug updates, it was critical for the well-being of the OSG infrastructure to move to a supported Java implementation. The Software team updated Java components as needed, helped test all Java software in OSG, planned the deployment process for the transition and wrote a monitoring tool for Java installations. In particular, a great deal of effort went into updating the BeStMan and jGlobus software components to work in Java 7.

To help sites deal with change management issues surrounding major software updates, the Software team introduced a new capability for the OSG software stack: parallel, independent release series. Previously, all software updates went into a single repository, so sites found it difficult to separate major updates from minor fixes. With the addition of a new release series, sites can — for a time — stick with the older (3.1) series and receive more conservative updates, then plan their switch to the newer (3.2) series to receive larger updates. We will support both series for a while, then deprecate and discontinue the older one. When enough major updates warrant it, we will start another new release series (3.3 or 4.0). This new capability required significant work on the OSG software infrastructure, which was designed to handle only one release series, but now can handle new release series with minimal further investment.

In addition to major projects, the Software team continues to deliver new and updated software for OSG sites. The team contributed to 20 releases of the software stack across both release series. Additions include a collection of tools from the Cooperative Computing Lab at Notre Dame, a production release of a replacement for the venerable CE-Monitor tool, full support for the LSF and SLURM batch systems, and a new means for installing client tools. Major updates included the new HTCondor 8.0 stable series, the Hadoop Distributed Filesystem (HDFS) 2.0, and Globus Toolkit 5.2.5. In addition to major projects and minor updates, the team demonstrated its agility by dealing with several emergency updates caused by surprise, undocumented OS updates. For example, a significant upgrade to OpenSSL changed minimum requirements on the size of certain security objects, a change which had consequences throughout the OSG software stack.

In sum, the Software team continued in its role of supporting site administrators, science end users, and the DHTC and software packaging communities through timely and effective updates of the OSG Software stack.

In the coming year, the Software team continues to face the central challenge of providing new and updated software without disrupting (much) the ability of the production facility to help researchers complete their work. A selection of key initiatives follows.

- HTCondor-CE: Although the Software team delivered initial support for the new CE technology this year, much remains to be done before a majority of sites will adopt it. It does not support all back-end batch systems that the OSG supports (e.g., PBS), it lacks strong support for configuration and the existing documentation is not adequate for all uses. The Software team will address these issues this coming year to support broad adoption of the technology.

- Enterprise Linux 7: The next major version of the Red Hat Enterprise Linux (EL) OS and its derivatives is due very soon. The Software team plans to support EL 7 systems shortly after release, and doing so entails changes to the infrastructure used to build and distribute the software stack. At the same time, the Software team will work with other OSG areas to plan for the eventual removal of support for EL 5 systems.

- New client bundle: As usage evolves, the technical platform of the OSG evolves too. In particular, the way in which science end users interact with the OSG has shifted over the past couple of years, but some of our end-user-facing tools have changed little in the same period. The Software team will work with User Support to identify leading-edge research lab configurations and hence will design and implement a new bundle of end-user tools.

- Contributing packages: It has long been the goal of the Software team to contribute packages and patches to broader software repositories, especially Extra Packages for Enterprise Linux (EPEL). Doing so would make our work available to even more users, and in return, would benefit us through increased scrutiny and contributions. The goal is to contribute initial work this year.

- Expanded testing: The Software team maintains over 200 tests of the integrated OSG software stack, and runs the tests daily. Coverage of software components is good, but coverage of the high-level use cases that we document, support and recommend to sites is still light. The goal is to expand coverage of our test suite and better align it with documented use cases. Beyond adding individual tests, the test framework must be enhanced to support a wider range of test cases than can be expressed today.

In addition, the Software team will continue to provide routine updates to software and packaging, and to respond with agility to user support requests, security updates and critical bug fixes.

3.3 Release Management

The OSG Release team tests and releases the software produced by the OSG Software team. The Release team assures the quality of the software by testing it in typical use cases as well as testing that the changes introduced by the Software team have their desired effect. The Release team works very closely with the Software and Technology teams. Most of the time, the software is tested directly by the Release team. On occasion, the software is tested by technically savvy members of the OSG. External testing is used when specialized environments or circumstances are not available to the Release team. Also, external testing is employed when the software changes are far reaching and coverage with additional use cases is desired. The Release team manages this testing effort and collects the testing results before a software release.

This year the Release team has established a fixed release schedule. This release schedule benefits the system administrators, Release team and Software team. It allows everyone to plan when a release will happen. This fixed release schedule lets the Software and Release team accurately plan and release the new OSG Software stack series on time.

Another benefit of the fixed release schedule is that there are periods of time with less testing. During this time, the team has been collecting a library of test cases for the various software components. This library of test cases assures good coverage of features and repeatability of testing. A new team member can execute a test case and be confident that the major features will be tested. Also, he can quickly acquire experience with that component.

Despite having a fixed release schedule, we have had to do an emergency release, due to upstream OS vendor changes that had a negative effect on OSG Software components. For this release, many components needed to be tested in a very short amount of time. The Software team lent personnel to the Release team to do this testing in short order. The cooperation and ability to shift work between the

Release and Software teams is a big advantage when unusual situations present themselves.

This year the Release team has released approximately 20 software versions. Currently, two software series are being produced concurrently. Each month, both versions are tested and released. Many of the bug fixes go into both versions. So, it is more efficient to test and release them together.

Clear communication with the system administrators and end users is an important function of the Release team. Every release announcement has a clear summary of the changes in the release and any known issues. It also has links to further documentation of changes. Any interested party can drill down to details of any change in the release.

In cooperation with the Software team, we are creating an resource on the Integration Test Bed (ITB) grid in Madison. The ITB instance will allow both the Software and Release teams to deploy software in an environment that is close to the production environment. This gives both the Release and Software teams insight into the system administrators' and end users' experience. Also, we will be able to employ a much wider set of test cases in an environment that mirrors what is in the field.

3.4 Operations

The OSG Operations team provides the central point for operational support for the OSG and provides the coordination for various distributed OSG services. OSG Operations publishes real-time monitoring information about OSG resources; supports users, developers and system administrators; maintains critical grid infrastructure services; provides incident response; and acts as a communication hub. The goals of the OSG Operations group are many: supporting and strengthening the autonomous OSG resources, building operational relationships with peer grids, providing reliable grid infrastructure services, ensuring timely action and tracking of operational issues, and assuring quick response to security incidents. During the last year, OSG Operations continued to provide the OSG with a reliable facility infrastructure and community support while at the same time improving services to offer more robust tools to the OSG stakeholders.

OSG Operations actively supports U.S. LHC activities and will continue to refine and improve our capabilities for these stakeholders. As OSG Operations supports the LHC data-taking phase, we continue to meet the high expectations for service reliability and stability of existing and new services.

A major transition to new user identification management procedures continued to heavily impact operations effort during the past year. OSG has completed the move from credentials being provided by DOEGrids to OSG PKI (based on DigiCert). Approximately 7,000 certificates were issued during this reporting period. The certificates of early adopters are expiring and effort to improve the user experience associated with certificate renewal is being actively investigated.

During the last year, OSG Operations continued to provide and improve tools and services for the OSG. These include

- Operating the OSG PKI Front-End service allowing users to request certificates via the OSG Information Management (OIM) service. Its administrative interface issues and tracks all certificate-related activities. All OSG members and 13 other organizations previously served by DOEGrids used these services.

- Exceeded expectations for service availability and reliability as defined by Service Level Agreements with the single exception of the MyOSG portal in July. The downtime causing this exception was a single, nine-hour, outage associated with problems with a shared library after an OS update.

- Operated the Information (BDII) service, critical to the LHC community, at an availability of 99.9% during the reporting year.

Figure 22 shows the downtime fraction for critical Operations services; downtime fraction is defined as (1-Availability). Shown here is the average for the two instances of each service. Oasis-replica is a single instance, for the other services actual aggregated availability is higher than indicated by this plot. From a user perspective these services are unavailable only if both instances are unavailable.

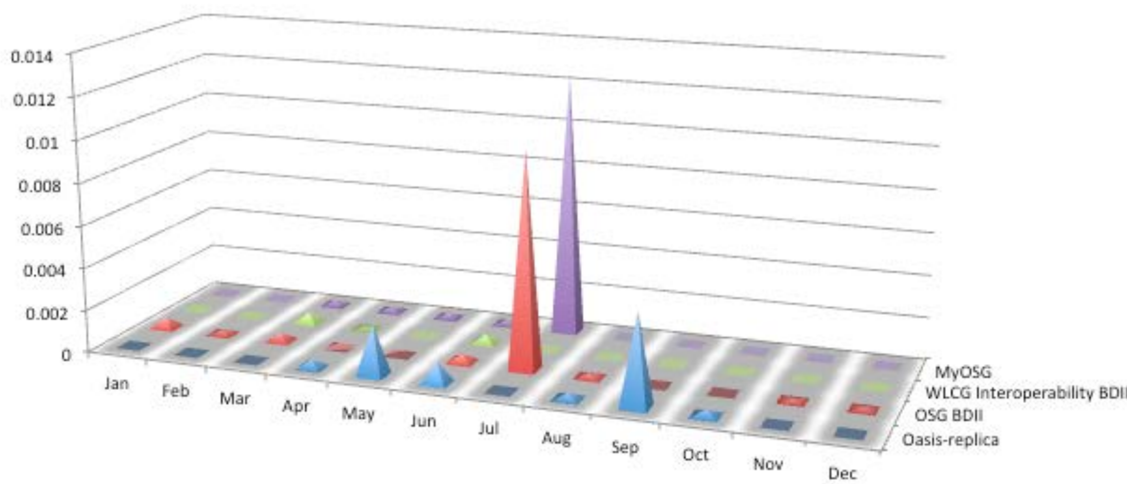

Figure 22: The downtime fraction for critical Operations services.

- Operations Support experienced an almost 300% increase in opened tickets. This is almost entirely due to the influx of certificate requests associated with the CA transition. Ticket response quality with the increased load was maintained at the same levels as the previous reporting period. Figure 23 shows ticket activity for the last 10 months of this period.

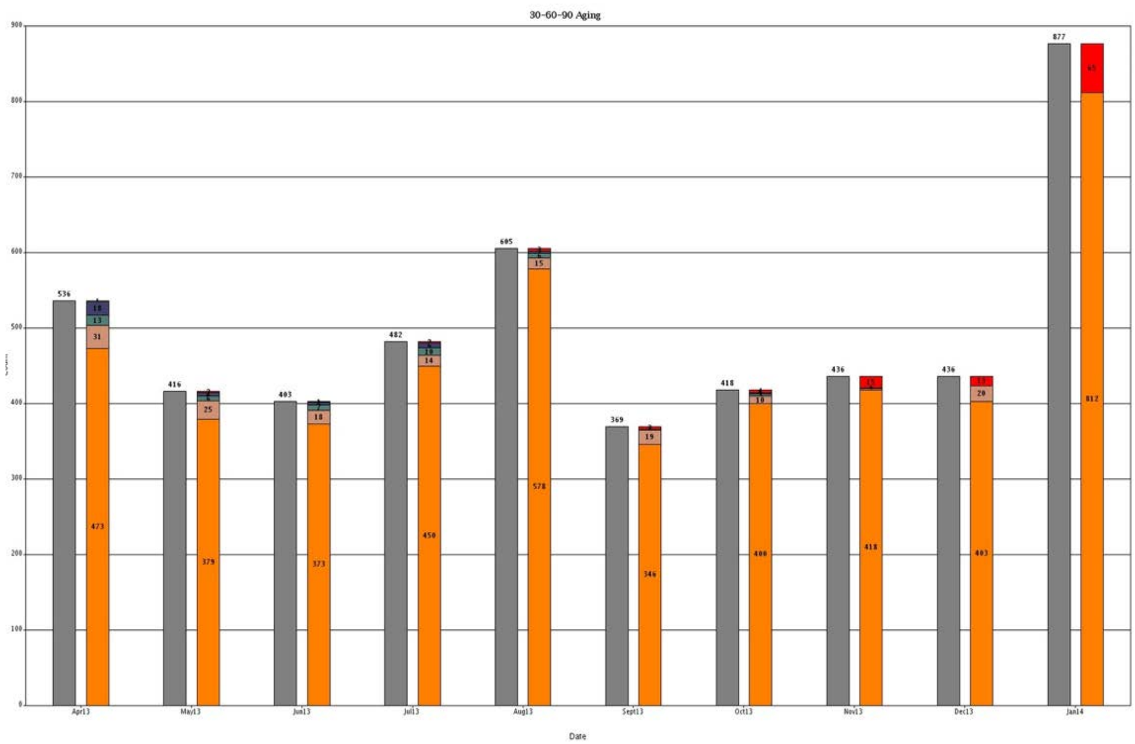

Figure 23: Monthly Ticketing Activity from April 2013 to January 2014. Gray bars are opened tickets, orange bars are resolved tickets, and red bars are tickets not resolved.

- We continued our partnership with WLCG and EGI operations groups. This included working on change management for our shared services (Ticketing, Monitoring and Accounting) and attendance and presentations at major peering partner events.

- We operated OASIS. Since the on-time release of this service in April 2013 it has achieved +99% availability. Mechanisms to replicate other similar repositories have been developed. In particular, repositories of several VOs common to OSG and EGI are replicated on OASIS. Operations works with its European counterparts to implement replication from OASIS to EGI repositories.

- We operated a real-time event monitoring service to display a variety of Operational activities as they occur.

- We continued efforts to improve service availability via the completion of hardware and service upgrades:

  - Completed the move of all production services to the state-of-the-art Data Center located on the Indiana University (IU) Bloomington campus. Previously services were located on multiple IU campus.
  - Updated the operating systems to latest RHEL versions and virtual machine host software to assure consistency of service environment.
  - Continued to maintain high availability for the OSG-XSEDE submission node. Currently this service has over 1,100 registered users and operates at +99% availability.

- Added and operated OSG-flock, an auxiliary server to OSG-XSEDE to improve scalability under high user demand.

3.5 Network Monitoring

Networks are fundamental to the use and operation of grid systems, yet, to date, they have been treated as an external "black box," with no awareness of the network state and no possibility to manage or prioritize traffic to optimize the performance and efficiency of the overall grid system. During this second year, we continue to integrate "networking" into OSG (in much the same way as storage systems and clusters have been) to deliver an ensemble system capable of robustly serving scientists using OSG.

Goals: The long-term goal of this OSG network activity is to define a set of services and functionality which transform the current best-effort networks into a managed component of the OSG. Our intent is to enable OSG to become the source of needed network metrics for OSG sites as well as for our partners (like WLCG). Over time, we intend to augment the OSG software stack with a monitored, managed network component, building upon the tools and framework already existing or planned in OSG wherever appropriate and extending those capabilities as required. The work for this second year focused on the required network monitoring needed to be able to understand the network's behavior and impact within OSG, as well as the needed planning and coordination to prepare for the longer-term goal. Year 3 primary goals:

1) **Deploying and Integrating Network Monitoring for OSG and Partners**
   a. Completing the deployment of perfSONAR-PS for all OSG sites.
   b. Integrating network monitoring and metric gathering into OSG infrastructure.
   c. Delivering a production service that provides users and sites with visibility into their network performance and allows them to quickly identify network problems.
   d. Providing access to network metrics for higher-level decision support in applications.
   e. Documentation.
2) **Coordinating network-related efforts within OSG to ensure network-related developments are properly considered as OSG progresses**
   a. This includes planning for the incorporation of evolving methods for controlling networks end-to-end (both internal and external to the OSG footprint).
   b. Raising awareness within OSG about networking to make sure relevant stakeholders are positioned to take advantage of networking capabilities as they are available.
   c. Helping to organize new efforts to develop, prototype and deploy networking capabilities within OSG as deemed useful by OSG management.

Progress: In conjunction with the WLCG, we are pushing to instrument all WLCG (including OSG sites) with perfSONAR-PS installations to provide the needed network metrics and diagnostic capabilities. As of the end of January 2014, we had 80% of WLCG sites deployed. For goal **1a** above, OSG sites can refer to the wiki[9] for deployment details, and non-WLCG OSG sites not yet deployed will be contacted to encourage them to deploy and offer any help they require. In addition, OSG Operations has augmented OIM with the ability to track perfSONAR-PS installations, and detailed instructions are in the OSG wiki[10]. Regarding **1b,** OSG Networking and Operations have deployed initial code from the Modular Dashboard project integrating perfSONAR-PS monitoring into MyOSG[11]. Unfortunately, the Modular Dashboard is now orphaned (See Challenges below). The components of an appropriate service (goal **1c**) are under very active discussion amongst the OSG Networking, Technology and Operations areas and the WLCG perfSONAR-PS Deployment taskforce. This is closely related to providing a suitable API to access needed metrics (goal **1d**), which is also under discussion and will be clearer once an updated

---

[9] https://twiki.opensciencegrid.org/bin/view/Documentation/PerfSONARToolKit
[10] https://www.opensciencegrid.org/bin/view/Documentation/RegisterPSinOIM
[11] https://myosg.grid.iu.edu/about (See "Resource Group" -> "Perfsonar Status")

service is in place. Documentation (goal **1e**) about OSG Networking is being updated as we progress and is available on the OSG wiki[12].

Goal 2 is ongoing and is being reached by a combination of activities. The OSG Area Coordinators meeting keeps all the other OSG areas informed about network-area progress (topics are rotated through each week). In addition, OSG activities are advertised at relevant meetings (ESnet/Internet2 Joint Techs, LHCONE/LHCOPN meetings and similar venues) and useful information is fed back to OSG. Likewise, efforts from various network-research projects (DYNES, ANSE, PANDA Big-Data, etc.) are being used to preview possible future technologies relevant for OSG and guide our planning and deployment goals.

Challenges: Many of the tools and technologies we wish to deploy "in production" for OSG are under active development. This creates a challenge to get them deployed in a timely way. The perfSONAR-PS Toolkit is what we are targeting for deployment at all OSG sites, but we want to ensure it is simple to deploy and maintain. The 3.3.x series of the toolkit include significant improvements in configuration, ease-of-use and resiliency, but were slow in arriving (fall 2013). Of greater concern is the "orphaning" of the Modular Dashboard (in GitHub) with the departure of Tom Wlodek/BNL. To address this we are partnering with ESnet on using their MaDDash Dashboard as a replacement, augmented with OMD (Open Monitoring Distribution built on the popular Nagios system) which was prototyped over December 2013 and is being evaluated for integration into MyOSG.[13] Currently the focus is on **1) producing an OSG network service** capable of appropriately monitoring our perfSONAR Toolkits and **2) completing the perfSONAR-PS Toolkit deployment at our sites**.

3.6 Security

The Security team leads the OSG effort to provide operational security, identity management, security policies; to adopt useful security software; and to disseminate security knowledge and awareness. The work can broadly be classified into two main areas: 1) maintaining operational security; and 2) improving the identity management capabilities for OSG stakeholders.

In the area of identity management, OSG already offers a robust, secure PKI, as described in Section 3.9. We continue our effort to offer alternatives that provide improved usability and efficiency and interoperability with other cyberinfrastructures. To these ends, we had several important projects in the identity management area over the past year.

One of the key projects was the traceability project. This project was an integral part of our long-term strategy of enabling secure access by middleware such as pilot job factories, and allowing them to authenticate users via means a community may have in place other than user certificates. To achieve this, we evaluated the user traceability – identifying the user who has submitted a grid job – in the glideinWMS system. Our goal was to prove that in the glideinWMS system we could select a random job at a worker node and trace it back to the user who had originally submitted the job. The project was a major success; we found out that the glideinWMS system had sufficient capability to trace users. Armed with this result, we evaluated the OSG VO, which uses glideinWMS for job submission, and allowed their users to send jobs without end-user certificates. The project has so far received very positive responses from the users, and we have other VOs that also want to switch to certificate-free job submissions. Currently, we are close to allowing GLOW VO to switch to this mode of operation, and afterwards we will work with other VOs.

[12] https://www.opensciencegrid.org/bin/view/Documentation/NetworkingInOSG
[13] https://maddash.aglt2.org/maddash-webui and https://maddash.aglt2.org/WLCGperfSONAR

Another important alternative in the identity management area was to enhance our ability to support federated identities from university campuses and DOE laboratories by increasing the number of sites which accept CILogon Basic CA certificates for user access. This was important for our users who needed certificates for variety of reasons. The CILogon Basic CA provided a simple user interface that could issue certificates very quickly. Unfortunately, due to lack of IGTF accreditation, CILogon Basic CA was not accepted universally in OSG sites. We have worked with our sites to understand their risk model regarding this CA and explained the pros and cons of accepting this CA. We have currently six sites that accept certificates from this CA and these sites represent 40% of the total wall clock time in OSG.

Finally, to increase interoperability, we have started working on developing an OSG Identity Provider (IdP) service. This service will allow OSG users to authenticate with third-party services easily. The IdP service will release some of our users' identity attributes to third-party services, per our users' permission, so that our users would not have to establish their identities with these services. Our initial goal is to use the IdP service to enable the OSG users to get onboard with the OSG Connect project. Eventually, this service will be used to authenticate our users to other external services.

Under the operational security, we prepared for an important transition this year. Our certificates are transitioning to using the SHA-2 algorithms. To have a seamless transition, security and software teams have tested our infrastructure and worked on a transition plan. We have also evaluated the security risk of using user proxy certificates that still uses SHA-1 hashing algorithm.

We have enhanced our VO registration process with a security training session. After joining OSG, the security team holds a training meeting with each new VO. During the training, we cover the basics of operational security such as incident response, vulnerabilities and also our PKI infrastructure.

We have conducted a security evaluation of our OASIS/CVMFS service at Grid Operations Center (GOC). We are currently in the process of conducting an announced security drill with the service. Similar to a fire drill, our personnel exercise the actions that should be performed during a security incident. We believe due to the nature of data stored in OASIS service, such a drill will be extremely useful for OSG.

3.7 Campus Grids

Accomplishment: Creation of a job submission and data service for campus researchers

OSG Connect was created to provide an efficient pathway for engaging campus researchers with science workloads suitable for DHTC resources. Leveraging HTCondor, Globus Online, CILogon, and auto-provisioning tools created at UChicago, we deployed a service capable of quickly on-boarding new science research groups. OSG Connect appears in the OSG as a "campus grid" with 16 associated science projects registered in the OIM and leverages the glideinWMS overlay workload system deployed by OSG. A user-job storage service,

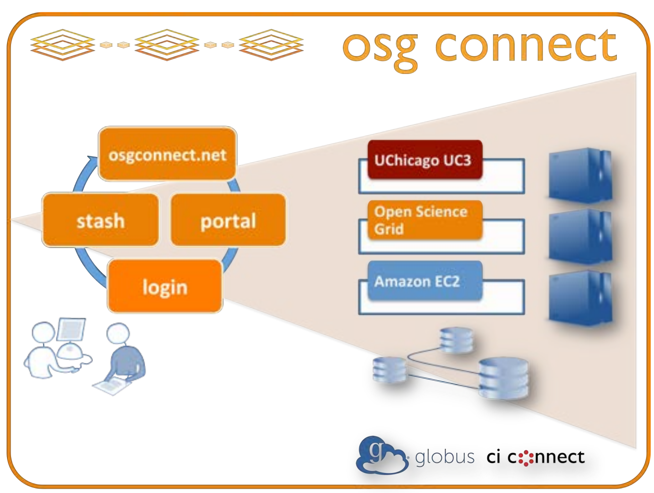

Figure 24 Architecture of the OSG Connect Service

Stash, was deployed providing a Globus campus data service for OSG.

Most projects were set up at the OSG Campus Infrastructures Community (CIC) workshop held at Duke University. The workshop, locally organized by Professor Steffen Bass (Duke Physics), Professor Jeff Chase (Duke Computer Science), John McGee (RENCI) and John Pormann (Duke Office of Information Technology), took place August 27-28, 2013, and was fully funded by the Information Initiative at Duke University (iiD). The workshop was designed to share OSG expertise in DHTC with researchers interested in learning how to utilize grid computing for their ongoing research and had 65 participants, among them about 45 from Duke University. The event featured overview talks on scientific computing at Duke and introduced the participants to the OSG Connect service. Practical demonstrations with BOSCO, Pegasus and Swift with a number of practical tutorial-like examples in the "ConnectBook" enabled workshop participants to get a hands-on experience with DHTC at a scale of thousands of jobs.

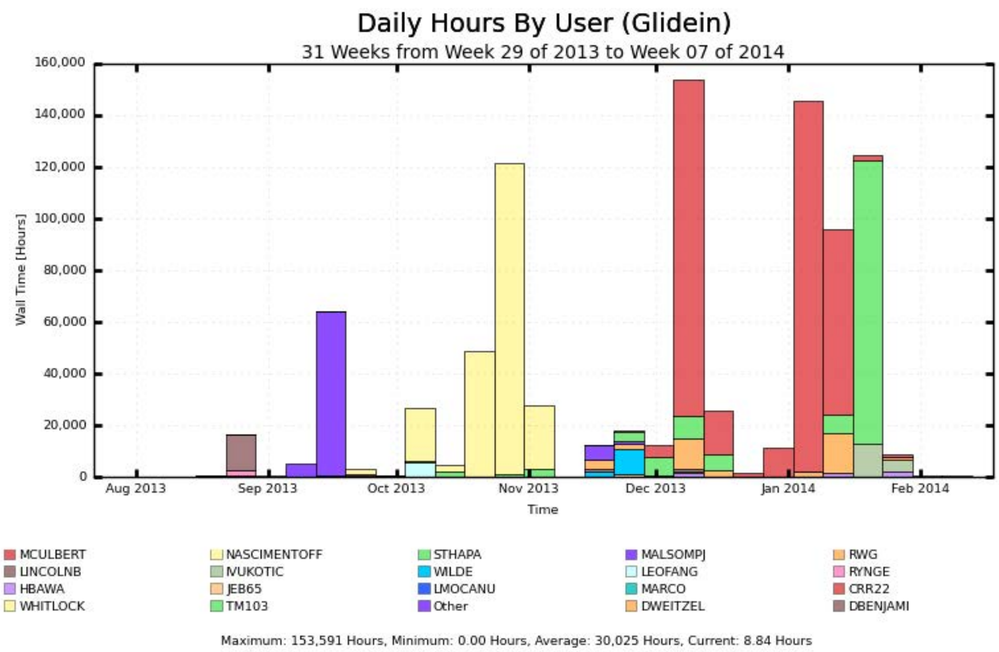

Figure 25: OSG Connect usage by user since deployment in August 2013.

To date, most usage has come from a small number of projects: Knowledge Systems in Educational Assessment (Dept. of Psychology, University of Illinois at Urbana-Champaign); National Evolutionary Synthesis Center (Evolutionary Biology, Duke University); and Path Space Hybrid Monte Carlo (Theoretical Chemistry, University of Cincinnati).

Accomplishment: A Model for Bridging Campuses to National Scale Cyber Resources

Following the Duke workshop, we began work on "connecting" the Duke HTCondor grid to the OSG in a way that transparently added resources to the local pool when needed. A milestone of having the system functional in time for Supercomputing 2013 (SC13) was identified. The service, which implements an OSG Campus Grid "Duke CI Connect," was a joint initiative of the OSG Campus Grids team, the Scalable Computing Support Center (SCSC) at Duke University led by Tom Millege and the University of Chicago CI Connect team. Following the pattern established by OSG Connect, the Duke CI Connect service offers a campus grid hybrid: a platform joining the Duke Grid (a campus HTCondor pool), the opportunistic cycles of the OSG, and, through a campus bridging partnership, the University of Chicago's campus grid, UC3. Access to the service is controlled locally by the SCSC support center and allows Duke researchers to use local campus resources as before, but adds DHTC resources from the OSG and UC3 within the same (local) job environment. Preliminary testing during the SC13 conference demonstrated the ability to quickly and repeatedly process 10,000 15-minute jobs spread over the two campus grids and the distributed sites of OSG infrastructure using the OSG VO, thus realizing the benefit of shared distributed resources. A number of Duke researchers have established projects in OIM for their work.

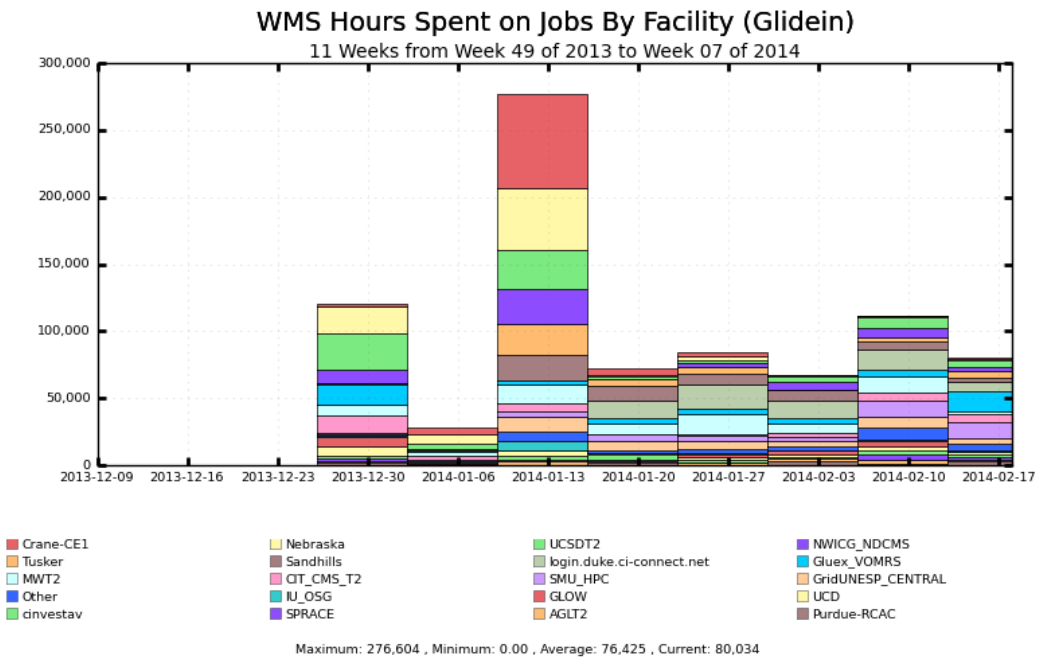

Figure 26: Accounting summary for Duke CI-Connect campus grid.

While the usage comes from a single project (theoretical particle physics), the additional resources beyond the Duke campus grid are sizable and distributed.

Impacts for Stakeholders: The communities targeted in the OSG Campus area are not from the traditional group of OSG stakeholders (e.g. the large VOs, HEP, etc.). However, OSG Connect provides an engagement tool to reach diverse research communities whether or not the campus has an OSG presence.

Challenges Ahead: The leading challenge is maintaining meaningful engagements with campus-based researchers, and helping them port their code and data for a distributed environment.

3.8 User Support

The goal of the User Support area is to enable science and research communities from their initial introduction to the OSG to production usage of the DHTC services and to provide ongoing support for existing communities' evolving needs. The focus in the last year has been to increase the access of U.S. researchers to OSG computing resources to accomplish their science. In addition, we continue to provide support for new communities who want to join OSG and integrate their compute resources into the OSG sharing ecosystem.

The OSG is a sharing ecosystem and does not "own" any computing resources. Members of the OSG consortium connect their resources to perform computing for their experiments and also make available resources not currently in use by other OSG members; these shared compute cycles are referred to as opportunistic cycles. We operate a VO called "osg" that does not own any computing resources (sites), and its primary purpose is to harvest opportunistic cycles. This VO serves as the primary vehicle for providing access to opportunistic cycles in OSG for U.S. researchers.

Expanding access to OSG DHTC computing resources for U.S. researchers is being addressed on three distinct fronts:

1. OSG-XD: The OSG continues to be a service provider to XD/XSEDE; in the last year, 22 OSG-XSEDE allocations used ~26M wall hours. We provide the first line of support for these users and provide tutorials on structuring work for high-throughput computing (HTC) environments. The OSG-XD system can access the >100 sites in OSG by using the glideinWMS job management system; we provide a virtualized interface for XSEDE users who can view the OSG as one pool of compute resources. We continue to collaborate with XSEDE staff in refining the system and providing documentation and support to users.[14]

2. OSG-Direct: We continue to provide access to DHTC resources to researchers who contact OSG directly; in the last year, 14 OSG-Direct users used ~22M wall hours. These researchers learn about us via referrals from other OSG users, andthey usually connect with us via a web-form on our website or via email. We are working to develop plans to share more broadly information about the OSG DHTC facility with campus researchers in the US.

3. OSG-Flocking: We have become aware of campus communities who need access to more HTC computing resources than are locally available but for a variety of reasons (e.g., effort, expertize, focus, etc.) are not able to form and operate their own VO. Thus, we now provide a "bulk" connection method for these communities; they can set up a local submit host and overflow their jobs to the OSG via a flocking connection. Some of the communities that are already trying out this capability are the following: 1) BakerLab; 2) SAGA; 3) iPlant. In addition, this mechanism is enabling our Campus Grids effort by providing the backbone for sending jobs into the OSG production fabric (see section 3.7).

Due to the growth in U.S. researchers using OSG and the science they have accomplished, we have seen a major increase in usage of opportunistic OSG resources in the last year, as shown in Figure 27.

[14] https://www.xsede.org/web/guest/OSG-User-Guide

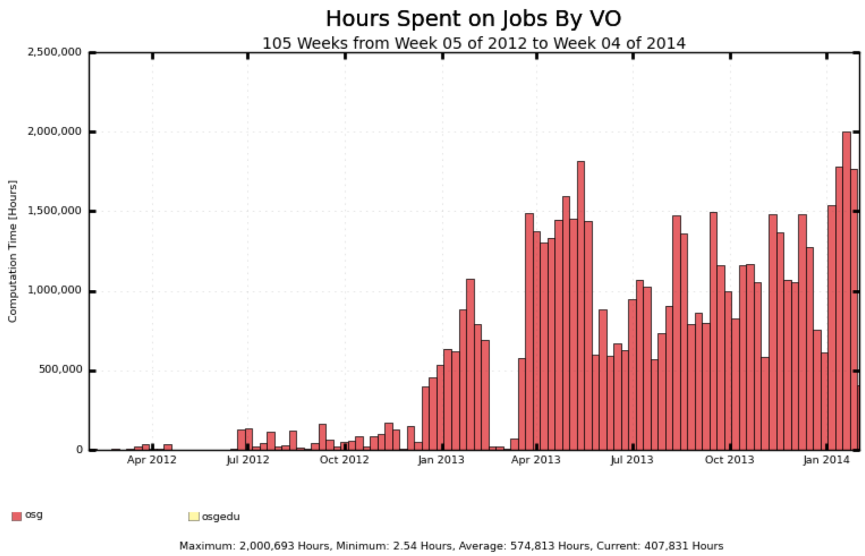

Figure 27: Weekly Hours for osg VO from Feb 2012 to Jan 2014

In the 12-month-period ending February 1, 2014, we have harvested 54M opportunistic hours for U.S. researchers; this compares with 6.7M hours for the previous 12 months.

An interesting example of OSG-Direct usage was the Snowmass LPC group led by Dr. Meenakshi Narain. This group consists of 5-10 researchers who needed to accomplish their simulations by August 2013, and they did not own significant computing resources. Over six months, this project used ~11M hours and produced ~70 TB of simulation results. This sharing of opportunistic cycles makes it possible for researchers to get their work done on compressed intervals that would be impossible without access to such a resource. Thehe number of cores that can be made available to a small group via OSG often far exceeds what they might be able to afford on their own.

And an interesting example of OSG-XD usage is the work on "Very High Resolution Functional Brain Mapping" by Don Krieger, Department of Neurological Surgery at the University of Pittsburgh. They processed human magnetoencephalographic (MEG) recordings to extract neuroelectric waveforms from localized regions with the brain. These are conceived as virtual recordings from small brain volumes (< 2 mm cubes) as if from indwelling wire electrodes. The method, referee consensus processing, enables solution of large systems of nonlinear equations for one or a few variables at a time. It represents a significant discovery in applied mathematics. When applied to MEG, this yields ~100,000 times the statistical power and ~1,000 times the information compared with any other functional brain mapping method, including functional magnetic resonance imaging (MRI). In 2013, this work used ~19M hours and enabled processing of ~100 experimental sessions representing ~35 hours of MEG recordings.

In the last year, we have assisted various teams in connecting their resources to OSG as new sites, including PNNL and University of MarylanD-IGS. And we are currently working with Saint Louis University to establish their site on OSG.

In a distributed system where jobs can "land" on any of the ~120 sites, we face the challenge of making large data sets accessible "anywhere" for those analysis jobs. We continue to support a capability (based on the integrated rule-oriented data-management software, iRODS) to allow easier movement of large data sets to and from OSG sites, and this has included the needed integration with OSG storage elements. This solution is in limited deployment for OSG-Direct users.

In a large grid, there is a good chance that there will be unused capacity at some sites at any point in time. The challenge is detecting this availability in a timely fashion and matching it with the needs of researchers. We continue to investigate methods to improve our ability to identify and harvest these opportunistic resources in an appropriate timeframe..

In addition, we are exploring ways to reach out to more U.S. campuses to identify additional researchers who can benefit from access to OSG DHTC resources; one possible avenue is by establishing a partnership with XSEDE Campus Champions.

3.9 OSG PKI CA

A key identity management component of OSG's technical fabric is a PKI to allow for authentication of users and services. Since February 2013, we have seen the effective operation of the OSG PKI, successfully taking over service from the DOE Grids PKI, which ceased issuing new certificates on March 23, 2013. All activities which were indicated as pending in last year's annual report have been completed, including reporting on lessons learned at the OSG all-hands meeting, finishing support for certificate renewal, and finalizing the transfer ownership of the PKI to the OSG Operations and Software teams.

The OSG PKI has issued 1,175 total user and 5,857 total host certificates. Table 7 shows these certificates broken down by VO. Issued by the DOE Grids PKI and still to expire are 244 user certificates and 2,748 host certificates, which may potentially still be requested of the OSG PKI.

In comparison, the DOE Grids PKI issued 3,129 user certificates and 9,285 host certificates in 2011. The difference is attributable to efforts to reduce certificates usage by directing users to other means of accessing resources, e.g., OSG Connect (http://osgconnect.net/), directing user to CERN and their national PKIs when more appropriate, and technical efforts to reduce certificate usage.

Virtual Organization	User Certificates	Host Certificates
ALIC	32	0
ANL	28	7
ATLAS	449	871
Belle	20	12
CIGI	0	2
CMS	43	2644
CSIU	4	8
DES	6	0
DOSAR	7	41
DREAM	3	0

DZero	7	0
ESGF	11	8
Engage	26	17
Fermilab	117	1328
FusionGrid	65	4
glast.org	1	0
GLOW	20	103
GPN	6	0
Gluex	15	42
HCC	23	79
IceCube	22	3
LBNE	4	0
LBNL	8	17
LQCD	7	0
LSST	3	57
MIS	7	0
nanoHUB	0	8
NEBioGrid	1	0
NEES	1	4
NERSC	17	73
NYSGRID	6	11
Nova	0	1
ORNL	56	14
OSG	35	426
OSGEDU	25	0
SBGrid	28	8

SLAC	14	9
snoplu.snolab.ca	13	0
STAR	9	0
SURAgrid	18	56
SeaQuest	2	0
T2K	7	0
UC3	5	4
XENON	4	0
Total	1175	5857

Table 7: OSG PKI certificate by virtual organization.

A survey of OSG PKI users was undertaken with regards to their satisfaction with the service. Responses were received from 57 users of the service. Summarized results from the survey follow. These results indicate that while most of the respondents are finding the service usable, there clearly is some room for improvement, both in terms of the implementation and its documentation. (Having 35% of responding users not know where to turn for help is clearly a problem.)

Question	Difficult	Somewhat Difficult	Somewhat Easy	Easy	N/A
How easy was it to find the necessary documentation to use the OSG PKI?	9%	32%	39%	21%	-
If you used the OIM Web interface, how easy was it to perform necessary actions?	7%	25%	25%	36%	7%
If you used the command line tool, how easy was it to perform the necessary actions?	7%	5%	7%	18%	63%
Considering only the renewal process, can you tell us how easy it was for you to complete that process?	2%	19%	13%	22%	44%

Table 8: First set of responses from OSG PKI User Survey

Question	Yes	No
Did you receive the right amounts of notification/communication while processing your	82%	18%

requests?		
If you needed assistance, did you know who to contact for help?	65%	35%
Did you receive enough information about how to install and maintain your certificates?	77%	23%

Table 9: Second set of responses from OSG PKI User Survey

Plans for the upcoming year include authoring a paper to appear in IGSC, (http://event.twgrid.org/isgc2014/) describing the transition and lessons learned to provide guidance for OSG and other projects in future identity management transitions; negotiating a new contract with DigiCert (http://www.digicert.com/), who is contracted by OSG to provide the CA service on which the PKI is based; and developing a roadmap for migration to a PKI fully based on InCommon and identity federation.

4. Project, Consortium and Partners

4.1 Project Institutions

The OSG Project is jointly enabled by the following institutions:

Institution	Key Functions
University of Wisconsin - Madison	PI, Software
BNL	Co-PI, Technology Investigation, Software, User Support
FNAL	Co-PI, Executive Director, Security, User Support, Project Management
Indiana University	Operations, Communications, OSG PKI
Morgridge Institute	Campus Grids, Network Monitoring
UCSD	Co-PI, Operations (gWMS Factory), Software
University of Chicago	Campus Grids, Software
University of Illinois & NCSA	Security
University of Michigan	Network Monitoring
University of Nebraska - Lincoln	Technology Investigation, Software, User Support
University of Southern California-Information Sciences Institute	User Support

Table 10: OSG Project Funded Institutions

4.2 OSG Council & Consortium

During 2013 the OSG Council moved to quarterly meetings – with two of the meetings being face-to-face allowing more time for in-depth discussion and presentation of Consortium issues. Two new members of the Council have been added representing significant resource provider organizations: Jarek Nabrzyski, from the Center for Research Computing University of Notre Dame, and Michael Norman, director of the San Diego SuperComputing Center. This met our goal this year to make progress in ensuring the Council better represents the diversity of our community.

- October 2nd- 3rd, 2013 Semi-Annual Face-to-Face Meeting
- June 13th, 2013 Agenda/Minutes
- March 14-15th, 2013 Semi-Annual Face-to-Face Meeting

- February 12th, 2013 Agenda/Minutes
- January 8th, 2013 Agenda/Minutes

The three subcommittees presented their draft reports to the Council and initial comments and action items were identified and completed:

- The Council structure – clarification of roles through edits to the by-laws and management plan.
- OSG's Relations with Industry – meetings with six potential industry collaborators held before the October Council meeting.
- Sustaining the OSG – the scope decided upon was regarded as premature and we will revisit this topic later in 2014.

4.3 OSG Partners

4.3.1 Notre Dame

Since joining the OSG in a more formal way, the University of Notre Dame (ND) has been working on two major tasks: (1) enabling the bioinformatics community on OSG resources and (2) integrating OpenStack with the ND OSG resources. Short reports for each of the tasks follow.

Enabling the bioinformatics community on OSG
Our efforts focused on enabling the Galaxy workflow system on OSG. Our need was driven by the VectorBase Project community (www.vectorbase.org), an international bioinformatics resource center funded by NIH/NIAID. Galaxy workflows can be created in an intuitive way by drag-and-drop mechanisms connecting tools via their input and output data. Galaxy has been added as additional analysis framework to VectorBase, currently still as beta version with selected tools, databases and workflows. The existing authentication in Galaxy is being enhanced for single sign-on to improve the user experience. If users are already logged in to the VectorBase portal, they can seamlessly utilize Galaxy without the need for a further authentication. If a user is not logged in to the VectorBase portal, the VectorBase credentials stored in a database are the basis for the security features. Users authenticate themselves via the same login and password as if they were logging in to the VectorBase portal. The next step is to create the same workflows with varying tools considering preferences in the user community. While the underlying infrastructure consists at the moment of a powerful single machine, a further step includes the integration of supplementary resources managed via Condor. Thus, the resource needs of the large VectorBase community will be met.

In early 2013 ND's Nabrzyski initiated Galaxy discussions within the OSG Council. ND has been looking for partners to deploy and test Galaxy on OSG resources. We have been focusing on enabling Galaxy on OSG on specific workflows using BLAST and large databases in Galaxy. The first prototype of a tool splits the data automatically and dynamically in a way that the chunks of data are suitable for each of the OSG resources. The technical specifications of OSG resources are quite different dependent on the site the jobs are submitted to. This is not controllable by a user. The next step is to integrate the tool in Galaxy and to integrate OSG resources. The latter includes several working tasks: from automatically creating user credentials for granting access to OSG resources, through enhancing Galaxy for these credentials, to extending Galaxy for the job submission to OSG resources. We have been working with the Indiana University team on this effort, and more details can be found in their report.

The aforementioned work on VectorBase and the OSG project can benefit from each other and, thus, deliver an enhanced and user-friendly analysis framework especially tailored to the specific community.

Integrating OpenStack with ND's OSG resource
ND's CMS infrastructure is fully integrated with OSG. Currently, all OSG VOs can run at ND except for GLOW, which was regularly filling /tmp and crashing servers. We will look to find a way to better sandbox such jobs and provide GLOW access.

We have been in discussion with OSG regarding OpenStack integration for about nine months. ND runs a prototype OpenStack infrastructure in collaboration with Rackspace. ND and Rackspace engineers have been working to streamline each OpenStack release with RedHat OS upgrades. OpenStack is predominantly built and tested on Ubuntu, which does not match ND/OSG RHEL/CENTOS/SELinux builds. Two key libraries are conflicting with the Dec. 2013 release. We have a fix in testing and should be ready for ND user testing by March 2014.

One key limit of the OSG+OpenStack integration was that OSG only supported Amazon's API. There is limited/deprecated Amazon API support in OpenStack. It was determined worth the time/effort to focus on OSG+Condor+OpenStack native API support. The respective teams at UWisc, UTSA and OSG/FNAL are working on this.

There are two large biology-focused research projects at ND (Vectorbase and VecNet) which will both be exploring utilization of subsets of the Condor/OSG/OpenStack platforms, some of which was presented in the first section above. We are currently working to identify the appropriate resource allocation based on variant funding sources and user groups. The analysis and initial platform selection should be completed by end of the spring semester, i.e., by May 2014.

4.3.2 Indiana University

Indiana University (IU) has extensive computer resources, including the first petaFLOPS system owned and operated by a university. However, the needs of IU researchers exceed even what these systems can provide and so IU has made extensive use of OSG resources. IU physicists are collaborators on the ATLAS experiment, but the use of OSG by that organization has been described elsewhere. Currently, biological sciences users constitute the remainder of the IU researchers using OSG. In addition, the OSG GOC is based at IU, and they are actively searching for additional researchers that would benefit from access to OSG resources.

The largest user (by CPU hours) is currently the SPLINTER[15] (Structural Protein-Ligand Interactome) project led by Prof. Samy Meroueh. This project seeks to identify drug candidates by calculating the affinity of a small molecule (the ligand) to a target protein. Potential treatments for diseases could be identified by finding compounds that interfere with the function of proteins associated with a disease. A collection of ligands (up to 5.6 million at this writing) is tested against a set of target proteins to evaluate which ligands bind to the target protein. Approximately 7,000 proteins have been examined to date against a subset of ligands. Plans to extend the ligand catalog to 26 million compounds are being pursued. The protein catalog is expected to grow continuously as new targets are identified and characterized. The project has used nearly 4 million CPU hours to date and is currently actively using OSG resources.

The OSG Galaxy project is designed to allow researchers using the Galaxy web-based genomics analysis workflow composition tool to execute HTC jobs, such as BLAST, on the OSG. This project is initially

[15] http://compbio.iupui.edu/group/7/pages/about_us

being tested on the IU-Galaxy portal. The IU-Galaxy[16] portal allows its users to run bioinformatics applications using their data as input. The portal allows access to a full suite of genome assembly, annotation, alignment and other applications, as well as file transfer and transformation utilities necessary to build genome science workflows. Potential users of this portal have been identified and are working with the developers to bring this service into general availability. So far we have successfully run over 300,000 CPU hours of BLAST jobs, and results are under evaluation by the researchers. Potential use of this system is enormous; a user wishing to execute more than 50 billion BLAST[17] queries has been identified.

4.3.3 ESNet

ESnet provides the high-bandwidth, reliable connections that link scientists at national laboratories, universities and other research institutions, enabling them to collaborate on some of the world's most important scientific challenges, including energy, climate science and the origins of the universe. Funded by the DOE Office of Science and managed and operated by the ESnet team at Lawrence Berkeley National Laboratory, ESnet provides scientists with access to unique DOE research facilities and HPC resources.

ESnet has collaborated with OSG for over a decade in helping to support the LHC and HEP community and other VOs that OSG supports. In particular, ESnet has been actively engaged with OSG on developing and improving the perfSONAR software suite to best serve the research community. perfSONAR provides active network monitoring and performance testing to ensure scientists' network connections are always operating at peak performance. In addition, ESnet and OSG worked together for many years in providing the DOE Grids Certificate service. In 2012 and 2013, the organizations worked together to transition to a new PKI service operated by OSG. Overall, the transition was performed relatively seamlessly, and all DOE Grid customers are now utilizing the OSG service or other similar services.

Looking ahead, OSG and ESnet are exploring ways to work together to build an engagement program reaching out to new science communities that have not traditionally leveraged HTC and high-performance networks as part of their workflow. The groups hope this effort will improve science outcomes for many research collaborations.

4.4 Satellite Projects

The OSG coordinates with, and leverages the work of, many other projects that collaborate with OSG in different ways. Projects are classified as satellites if they expect to collaborate closely with OSG and impact members of the OSG Consortium.

Satellite projects are independent projects with their own project management, reporting, and accountability to their program sponsors; the OSG core project does not provide oversight for the execution of the satellite project's work program. Current and recent OSG satellite projects where there is significant interaction are enumerated below.

1. ExTENCI – This satellite finished with a final report detailing the science outcomes. Further collaboration between XSEDE and OSG is occurring through the participation of OSG as an XD resource provider.

[16] http://rt.uits.iu.edu/sct/projects/galaxy.php
[17] http://www.bioinformatics.org/wiki/BLAST

2. AAA - Any Data, Anytime, Anywhere. (OSG Interface: Ken Bloom). The outcomes of this project are being deployed into production by CMS. There is a request from ATLAS and CMS to do some support of XROOTD services in OSG, and this is under discussion by the project.

3. dV/DT - Accelerating the Rate of Progress towards Extreme Scale Collaborative Science. (OSG Interface: Brian Bockelman). The OSG Council has received two reports of the work being done by the dV/DT project and regards the work being done in monitoring and interpretation of performance as potentially useful for the community.

4. CC-NIE Integration: Bringing DHTC to the Network with LARK. (OSG Interface: Brian Bockelman). LARK is providing results being tested by US CMS.

5. DASPOS - Data and Software Preservation for Open Science. (OSG Interface: Michael Ernst). The DASPOS project is continuing to work locally and in the international context of the Data Preservation for High Energy Physics (DPHEP) initiative to deliver the prototype end-to-end systems. It is working closely with other activities in the physics community, such as the Tevatron Analysis Preservation supported by the DOE.

6. XSIM - Extreme Scale Identity Management. (OSG Interface: Ruth Pordes). The outcomes of this project, in the form of guidance to VOs and Resource Providers in how to assess their joint identity management needs and architect their system to fulfill those needs, will be tested in OSG in the coming year. XSIM will provide written guidance to all VOs and one-on-one consulting to one to two VOs to be identified based on their interest.

5. Education & Communications

5.1 Education

The OSG Education area provides training opportunities for existing staff and for domain science users. In the latter case, training events are also a type of outreach activity; they reach out to the science community, helping to engage new students, faculty and researchers in the OSG infrastructure with the aim of transforming their research through the use of HTC. Last year, the main activity of OSG Education area was the 2013 OSG User School at the end of June in Madison, Wisconsin.

The school was the fourth annual offering of our training program for domain science students. The goal of the school is to help students learn to use DHTC, locally or across the grid, as a tool for doing their research. In 2013, we hosted 26 students from 21 institutions and diverse fields, including physics, chemistry, biology, engineering, geography and radiology. Through lectures, many hands-on exercises and even live-action role-play, students learned how to run science applications on distributed resources (locally and on OSG), build complex workflows, manage large and distributed data, and turn scientific computing challenges into appropriately sized and scaled workflows that are ready for real-world use. Five OSG staff served as the instructors, and as a special and highly motivating event, four UW–Madison researchers came and talked about how using HTC has transformed their own research. Again this year, students rated the school very highly, and they seemed eager to apply what they learned to their own research.

OSG continues to evolve the school, both in terms of matching curriculum to the current technical systems in use and in terms of pedagogy and materials. The 2013 school featured several refinements, including improved exercises in the basics of HTC, better use of role-play exercises to illustrate key concepts (and get participants moving), and a new and highly effective final capstone exercise to integrate the concepts and techniques presented throughout the week. The Education team and instructors will continue to make such improvements for the 2014 school, based on feedback from students and from the team's own knowledge and experiences.

After the school concludes, we continue to follow up with the participants throughout the year to see how they are applying what they learned and to support them as we can. If students lack resources locally to run large computations, we provide direct access to OSG resources. In this manner, we have provided hundreds or thousands of computing hours to students who otherwise would have only their own lab resources.

5.2 Communications

OSG Communications activities include a monthly newsletter, several blogs used by the technical and product contributors and staff, as well as contributions to, and membership in, the advisory board of the "International Science Grid this Week" (iSGTW). The newsletter is sent to a broad list and its focus is communication to the members of the Consortium. Recently, new newsletter archives have been moved to a publicly accessible archive, and for 2014 thus are archived acrosshttp://www.opensciencegrid.org/news/subscribe/ and https://twiki.grid.iu.edu/bin/view/Management/NewsLetters.

The OSG Planet Blog has a few committed contributors. iSGTW publications have continued with continued increase in Twitter followers.

OSG Communications activities also include publication of research highlights describing science accomplished through the use of OSG. These are published as part of the monthly newsletter and also are often re-published by iSGTW.

OSG research highlights are archived at https://www.opensciencegrid.org/bin/view/Management/OSGResearchHighlights and on the new publicly accessible web site at the urls below.

- BLAST on OSG provides a timesaving alternative for large-scale analysis Jan. 2014
- The Power of Sharing Dec. 2013
- Using the OSG to simulate DNA-protein interaction Nov. 2013
- Using the OSG to investigate the human immune response to infection with M. tuberculosis Oct. 2013
- Snowmass update with Dr. Meenakshi Narain Aug. 2013
- Using the OSG to diagnose, treat, and eventually prevent disease June 30, 2013
- Predicting Agricultural Impacts of Large-scale Drought May 21, 2013
- Following the long tail of economics: Amit Gandhi uses the OSG to outdo parallel computing March 29, 2013
- GlueX team nears needed throughput on OSG March 5, 2013

Appendix 1

Science Publications enabled by OSG

2013

Contents

ATLAS

1) Search for charginos nearly mass-degenerate with the lightest neutralino based on a disappearing-track signature in pp collisions at $\sqrt{s}$ = 8 TeV with the ATLAS detector
By ATLAS Collaboration (Georges Aad et al.). arXiv:1310.3675 [hep-ex].
10.1103/PhysRevD.88.112006. Phys.Rev. D88 (2013) 112006.

2) A fast hardware tracker for the ATLAS trigger system
By J. Anderson, A. Andreani, A. Andreazza, A. Annovi, M. Atkinson, B. Auerbach, M. Beretta, V. Bevacqua et al.. 10.1016/j.nima.2012.11.133. Nucl.Instrum.Meth. A718 (2013) 258-259.

3) Search for microscopic black holes in a like-sign dimuon final state using large track multiplicity with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1308.4075 [hep-ex]. 10.1103/PhysRevD.88.072001. Phys.Rev. D88 (2013) 072001.

4) Production of kshort, kstar(892)and phi(1020) in minimum bias events and kshort and lambda in jets in pbar p collisions at sqrt(s)=1.96 TeV, By CDF Collaboration (T. Aaltonen et al.). arXiv:1308.3371 [hep-ex]. 10.1103/PhysRevD.88.092005. Phys.Rev. D88 (2013) 092005.

5) Search for direct third-generation squark pair production in final states with missing transverse momentum and two b-jets in $\sqrt{s} =$ 8 TeV pp collisions with the ATLAS detector
By ATLAS Collaboration (Georges Aad et al.). arXiv:1308.2631 [hep-ex].
10.1007/JHEP10(2013)189. JHEP 1310 (2013) 189.

6) Search for new phenomena in final states with large jet multiplicities and missing transverse momentum at sqrt(s)=8 TeV proton-proton collisions using the ATLAS experiment
By ATLAS Collaboration (Georges Aad et al.). arXiv:1308.1841 [hep-ex].
10.1007/JHEP10(2013)130. JHEP 1310 (2013) 130.

7) Search for excited electrons and muons in $\sqrt{s}$=8 TeV proton-proton collisions with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1308.1364 [hep-ex]. 10.1088/1367-2630/15/9/093011. New J.Phys. 15 (2013) 093011.

8) Dynamics of isolated-photon plus jet production in pp collisions at $\sqrt(s)=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.6795 [hep-ex]. 10.1016/j.nuclphysb.2013.07.025. Nucl.Phys. B875 (2013) 483-535.

9) Measurement of top quark polarization in top-antitop events from proton-proton collisions at $\sqrt{s}$ = 7 TeV using the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.6511 [hep-ex]. 10.1103/PhysRevLett.111.232002. Phys.Rev.Lett. 111 (2013) 232002.

10) Measurement of jet shapes in top-quark pair events at $\sqrt{s}$ = 7 TeV using the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.5749 [hep-ex]. 10.1140/epjc/s10052-013-2676-3. Eur.Phys.J. C73 (2013) 2676.

11) Measurement of the top quark charge in pp collisions at $\sqrt{s} =$ 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.4568 [hep-ex]. 10.1007/JHEP11(2013)031. JHEP 1311 (2013) 031.

12) Evidence for the spin-0 nature of the Higgs boson using ATLAS data
By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.1432 [hep-ex].
10.1016/j.physletb.2013.08.026. Phys.Lett. B726 (2013) 120-144.

13) Measurements of Higgs boson production and couplings in diboson final states with the ATLAS detector at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.1427 [hep-ex]. 10.1016/j.physletb.2013.08.010. Phys.Lett. B726 (2013) 88-119.

14) Measurement of the differential cross-section of B^{+} meson production in pp collisions at $\sqrt{s}$ = 7 TeV at ATLAS, By ATLAS Collaboration (Georges Aad et al.). arXiv:1307.0126 [hep-ex]. 10.1007/JHEP10(2013)042. JHEP 1310 (2013) 042.

15) Measurement of the Azimuthal Angle Dependence of Inclusive Jet Yields in Pb+Pb Collisions at $\sqrt{s_{NN}}$= 2.76 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1306.6469 [hep-ex]. 10.1103/PhysRevLett.111.152301. Phys.Rev.Lett. 111 (2013) 152301.

16) Performance of jet substructure techniques for large-R jets in proton-proton collisions at $\sqrt{s}$ = 7 TeV using the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1306.4945 [hep-ex]. 10.1007/JHEP09(2013)076. JHEP 1309 (2013) 076.

17) Searches for the Higgs boson decaying to $W^{+} W^{-} \to \ell^{+}\nu \ell^{-}\bar{\nu}$ with the CDF II detector, By CDF Collaboration (T. Aaltonen et al.). arXiv:1306.0023 [hep-ex]. 10.1103/PhysRevD.88.052012. Phys.Rev. D88 (2013) 052012.

18) Measurement of the high-mass Drell--Yan differential cross-section in pp collisions at $\sqrt{s}$=7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1305.4192 [hep-ex].
10.1016/j.physletb.2013.07.049. Phys.Lett. B725 (2013) 223-242.

19) Measurement of the distributions of event-by-event flow harmonics in lead-lead collisions at = 2.76 TeV with the ATLAS detector at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1305.2942 [hep-ex]. 10.1007/JHEP11(2013)183. JHEP 1311 (2013) 183.

20) A search for $t\bar t$ resonances in the lepton plus jets final state with ATLAS using 4.7 fb^{-1} of pp collisions at $\sqrt{s} = 7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1305.2756 [hep-ex]. 10.1103/PhysRevD.88.012004. Phys.Rev. D88 (2013) 012004.

21) Triggers for displaced decays of long-lived neutral particles in the ATLAS detector
By ATLAS Collaboration (Georges Aad et al.). arXiv:1305.2284 [hep-ex].
10.1088/1748-0221/8/07/P07015. JINST 8 (2013) P07015.

22) Search for resonant diboson production in the lvjj decay channels with the ATLAS detector at 7 TeV By ATLAS Collaboration (Georges Aad et al.). arXiv:1305.0125 [hep-ex]. 10.1103/PhysRevD.87.112006. Phys.Rev. D87 (2013) 112006.

23) Measurement of the production cross section of jets in association with a Z boson in pp collisions at $\sqrt{s}$ = 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1304.7098 [hep-ex]. 10.1007/JHEP07(2013)032. JHEP 1307 (2013) 032.

24) Search for nonpointing photons in the diphoton and E^{miss}_T final state in $\sqrt{s}$=7 TeV proton-proton collisions using the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1304.6310 [hep-ex]. 10.1103/PhysRevD.88.012001. Phys.Rev. D88 (2013) 1, 012001.

25) Measurement of the inclusive jet cross section in pp collisions at sqrt(s)=2.76 TeV and comparison to the inclusive jet cross section at sqrt(s)=7 TeV using the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1304.4739 [hep-ex]. 10.1140/epjc/s10052-013-2509-4. Eur.Phys.J. C73 (2013) 2509.

26) Measurement with the ATLAS detector of multi-particle azimuthal correlations in p+Pb collisions at $\sqrt{s_{NN}}$=5.02 TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1303.2084 [hep-ex]. 10.1016/j.physletb.2013.06.057. Phys.Lett. B725 (2013) 60-78.

27) Search for third generation scalar leptoquarks in pp collisions at $\sqrt{s}$ = 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1303.0526 [hep-ex]. 10.1007/JHEP06(2013)033. JHEP 1306 (2013) 033.

28) Characterisation and mitigation of beam-induced backgrounds observed in the ATLAS detector during the 2011 proton-proton run, By ATLAS Collaboration (Georges Aad et al.). arXiv:1303.0223 [hep-ex]. 10.1088/1748-0221/8/07/P07004. JINST 8 (2013) P07004.

29) Search for WH production with a light Higgs boson decaying to prompt electron-jets in proton-proton collisions at $\sqrt{s}$=7 TeV with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1302.4403 [hep-ex]. 10.1088/1367-2630/15/4/043009. New J.Phys. 15 (2013) 043009.

30) Improved luminosity determination in pp collisions at $\sqrt{s}$ = 7 TeV using the ATLAS detector at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1302.4393 [hep-ex]. 10.1140/epjc/s10052-013-2518-3. Eur.Phys.J. C73 (2013) 2518.

31) Search for a light charged Higgs boson in the decay channel $H^+ \to c\bar{s}$ in $t\bar{t}$ events using pp collisions at $\sqrt{s}$ = 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1302.3694 [hep-ex]. 10.1140/epjc/s10052-013-2465-z. Eur.Phys.J. C73 (2013) 2465.

32) Measurement of the cross-section for W boson production in association with b-jets in pp collisions at $\sqrt{s}$ = 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1302.2929 [hep-ex]. 10.1007/JHEP06(2013)084. JHEP 1306 (2013) 084.

33) Measurement of kT splitting scales in W->lv events at sqrt(s)=7 TeV with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1302.1415 [hep-ex]. 10.1140/epjc/s10052-013-2432-8. Eur.Phys.J. C73 (2013) 2432.

34) Measurements of $W\gamma$ and $Z\gamma$ production in pp collisions at $\sqrt{s}$= 7 TeV with the ATLAS detector at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1302.1283 [hep-ex]. 10.1103/PhysRevD.87.112003. Phys.Rev. D87 (2013) 112003.

35) Measurement of hard double-parton interactions in $W(\to l\nu)$+ 2 jet events at $\sqrt{s}$=7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1301.6872 [hep-ex]. 10.1088/1367-2630/15/3/033038. New J.Phys. 15 (2013) 033038.

36) Search for long-lived, multi-charged particles in pp collisions at $\sqrt{s}$=7 TeV using the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1301.5272 [hep-ex]. 10.1016/j.physletb.2013.04.036. Phys.Lett. B722 (2013) 305-323.

37) Search for single b^*-quark production with the ATLAS detector at $\sqrt{s}=7$ TeV By ATLAS Collaboration (Georges Aad et al.). arXiv:1301.1583 [hep-ex]. 10.1016/j.physletb.2013.03.016. Phys.Lett. B721 (2013) 171-189.

38) Multi-channel search for squarks and gluinos in $\sqrt{s}=7$ TeV pp collisions with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1212.6149 [hep-ex]. 10.1140/epjc/s10052-013-2362-5. Eur.Phys.J. C73 (2013) 2362.

39) A search for prompt lepton-jets in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1212.5409. 10.1016/j.physletb.2013.01.034. Phys.Lett. B719 (2013) 299-317.

40) Observation of Associated Near-side and Away-side Long-range Correlations in $\sqrt{s_{NN}}$=5.02 TeV Proton-lead Collisions with the ATLAS Detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1212.5198 [hep-ex]. 10.1103/PhysRevLett.110.182302. Phys.Rev.Lett. 110 (2013) 182302.

41) Search for a two-Higgs-boson doublet using a simplified model in $p\bar{p}$ collisions at $\sqrt{s}=1.96$ TeV, By CDF Collaboration (T. Aaltonen et al.). arXiv:1212.3837 [hep-ex]. 10.1103/PhysRevLett.110.121801. Phys.Rev.Lett. 110 (2013) 12, 121801.

42) Search for charged Higgs bosons through the violation of lepton universality in $t\bar{t}$ events using pp collision data at $\sqrt{s}=7$ TeV with the ATLAS experiment By ATLAS Collaboration (Georges Aad et al.). arXiv:1212.3572 [hep-ex]. 10.1007/JHEP03(2013)076. JHEP 1303 (2013) 076.

43) Search for a heavy narrow resonance decaying to $e \mu$, $e \tau$, or $\mu \tau$ with the ATLAS detector in $\sqrt{s}=7$ TeV pp collisions at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1212.1272. 10.1016/j.physletb.2013.04.035. Phys.Lett. B723 (2013) 15-32.

44) Measurement of Upsilon production in 7 TeV pp collisions at ATLAS, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.7255 [hep-ex]. 10.1103/PhysRevD.87.052004. Phys.Rev. D87 (2013) 5, 052004.

45) Measurement of the ttbar production cross section in the tau+jets channel using the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.7205 [hep-ex]. 10.1140/epjc/s10052-013-2328-7. Eur.Phys.J. C73 (2013) 2328.

46) Search for the neutral Higgs bosons of the Minimal Supersymmetric Standard Model in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.6956 [hep-ex]. 10.1007/JHEP02(2013)095. JHEP 1302 (2013) 095.

47) Measurement of angular correlations in Drell-Yan lepton pairs to probe Z/gamma* boson transverse momentum at sqrt(s)=7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.6899 [hep-ex]. 10.1016/j.physletb.2013.01.054. Phys.Lett. B720 (2013) 32-51.

48) Search for new phenomena in events with three charged leptons at $/sqrt{s}$ = 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.6312 [hep-ex]. 10.1103/PhysRevD.87.052002. Phys.Rev. D87 (2013) 5, 052002.

49) Measurement of ZZ production in pp collisions at $\sqrt{s}=7$ TeV and limits on anomalous ZZZ and $ZZ\gamma$ couplings with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.6096 [hep-ex]. 10.1007/JHEP03(2013)128. JHEP 1303 (2013) 128.

50) Search for resonances decaying into top-quark pairs using fully hadronic decays in pp collisions with ATLAS at $\sqrt{s}=7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.2202 [hep-ex]. 10.1007/JHEP01(2013)116. JHEP 1301 (2013) 116.

51) Measurement of isolated-photon pair production in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.1913 [hep-ex]. 10.1007/JHEP01(2013)086. JHEP 1301 (2013) 086.

52) Searches for heavy long-lived sleptons and R-Hadrons with the ATLAS detector in pp collisions at $\sqrt{s}=7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.1597 [hep-ex]. 10.1016/j.physletb.2013.02.015. Phys.Lett. B720 (2013) 277-308.

53) Search for supersymmetry in events with photons, bottom quarks, and missing transverse momentum in proton-proton collisions at a centre-of-mass energy of 7 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.1167 [hep-ex]. 10.1016/j.physletb.2013.01.041. Phys.Lett. B719 (2013) 261-279.

54) Search for contact interactions and large extra dimensions in dilepton events from pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1211.1150 [hep-ex]. 10.1103/PhysRevD.87.015010. Phys.Rev. D87 (2013) 015010.

55) Search for Extra Dimensions in diphoton events using proton-proton collisions recorded at $\sqrt{s}=7$ TeV with the ATLAS detector at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.8389 [hep-ex]. 10.1088/1367-2630/15/4/043007. New J.Phys. 15 (2013) 043007.

56) Search for long-lived, heavy particles in final states with a muon and multi-track displaced vertex in proton-proton collisions at $\sqrt{s}=7$ TeV with the ATLAS detector
By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.7451 [hep-ex]. 10.1016/j.physletb.2013.01.042. Phys.Lett. B719 (2013) 280-298.

57) A search for high-mass resonances decaying to $\tau^+\tau^-$ in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.6604 [hep-ex]. 10.1016/j.physletb.2013.01.040. Phys.Lett. B719 (2013) 242-260.

58) Measurement of Z boson Production in Pb+Pb Collisions at $\sqrt{s_{NN}}=2.76$ TeV with the ATLAS Detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.6486 [hep-ex]. 10.1103/PhysRevLett.110.022301. Phys.Rev.Lett. 110 (2013) 022301.

59) Jet energy resolution in proton-proton collisions at $\sqrt{s}=7$ TeV recorded in 2010 with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.6210 [hep-ex]. 10.1140/epjc/s10052-013-2306-0. Eur.Phys.J. C73 (2013) 2306.

60) Measurement of the mass difference between top and antitop quarks, By CDF Collaboration (T. Aaltonen et al.). arXiv:1210.6131 [hep-ex]. 10.1103/PhysRevD.87.052013. Phys.Rev. D87 (2013) 5, 052013.

61) Search for pair production of heavy top-like quarks decaying to a high-pT W boson and a b quark in the lepton plus jets final state at $\sqrt{s}$=7 TeV with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.5468 [hep-ex]. 10.1016/j.physletb.2012.11.071. Phys.Lett. B718 (2013) 1284-1302.

62) Search for pair-produced massive coloured scalars in four-jet final states with the ATLAS detector in proton-proton collisions at $\sqrt{s}=7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.4826 [hep-ex]. 10.1140/epjc/s10052-012-2263-z. Eur.Phys.J. C73 (2013) 2263.

63) Search for dark matter candidates and large extra dimensions in events with a jet and missing transverse momentum with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.4491 [hep-ex]. 10.1007/JHEP04(2013)075. JHEP 1304 (2013) 075.

64) Measurement of W^+W^- production in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector and limits on anomalous WWZ and $WW\gamma$ couplings By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.2979 [hep-ex]. 10.1103/PhysRevD.87.112001. Phys.Rev. D87 (2013) 112001.

65) Search for direct chargino production in anomaly-mediated supersymmetry breaking models based on a disappearing-track signature in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.2852 [hep-ex]. 10.1007/JHEP01(2013)131. JHEP 1301 (2013) 131.

66) Measurement of the B_c^{-} meson lifetime in the decay $B_{c}^{-} \rightarrow J/\psi~\pi^{-}$ By CDF Collaboration (T. Aaltonen et al.). arXiv:1210.2366 [hep-ex]. 10.1103/PhysRevD.87.011101. Phys.Rev. D87 (2013) 011101.

67) ATLAS search for new phenomena in dijet mass and angular distributions using pp collisions at $\sqrt{s}=7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.1718 [hep-ex]. 10.1007/JHEP01(2013)029. JHEP 1301 (2013) 029.

68) Measurement of the flavour composition of dijet events in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1210.0441 [hep-ex]. 10.1140/epjc/s10052-013-2301-5. Eur.Phys.J. C73 (2013) 2301.

69) Search for displaced muonic lepton jets from light Higgs boson decay in proton-proton collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.).

arXiv:1210.0435 [hep-ex]. 10.1016/j.physletb.2013.02.058. Phys.Lett. B721 (2013) 32-50.

70) Search for dark matter candidates and large extra dimensions in events with a photon and missing transverse momentum in pp collision data at $\sqrt{s}=7$ TeV with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1209.4625 [hep-ex]. 10.1103/PhysRevLett.110.011802. Phys.Rev.Lett. 110 (2013) 011802.

71) Search for light top squark pair production in final states with leptons and b^- jets with the ATLAS detector in $\sqrt{s}=7$ TeV proton-proton collisions, By ATLAS Collaboration (Georges Aad et al.). arXiv:1209.2102 [hep-ex]. 10.1016/j.physletb.2013.01.049. Phys.Lett. B720 (2013) 13-31.

72) Observation of the Production of a W Boson in Association with a Single Charm Quark By CDF Collaboration (T. Aaltonen et al.). arXiv:1209.1921 [hep-ex]. 10.1103/PhysRevLett.110.071801. Phys.Rev.Lett. 110 (2013) 7, 071801.

73) Search for the Higgs boson in the all-hadronic final state using the full CDF data set By CDF Collaboration (T. Aaltonen et al.). arXiv:1208.6445 [hep-ex]. 10.1007/JHEP02(2013)004. JHEP 1302 (2013) 004.

74) Search for direct production of charginos and neutralinos in events with three leptons and missing transverse momentum in $\sqrt{s}=7$ TeV pp collisions with the ATLAS detector By ATLAS Collaboration (Georges Aad et al.). arXiv:1208.3144 [hep-ex]. 10.1016/j.physletb.2012.11.039. Phys.Lett. B718 (2013) 841-859.

75) Search for direct slepton and gaugino production in final states with two leptons and missing transverse momentum with the ATLAS detector in pp collisions at $\sqrt{s}=7$ TeV By ATLAS Collaboration (Georges Aad et al.). arXiv:1208.2884 [hep-ex]. 10.1016/j.physletb.2012.11.058. Phys.Lett. B718 (2013) 879-901.

76) Search for new phenomena in the $W W$ to $\ell \nu \ell$' ν' final state in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1208.2880 [hep-ex]. 10.1016/j.physletb.2012.11.040. Phys.Lett. B718 (2013) 860-878.

77) Measurement of the jet radius and transverse momentum dependence of inclusive jet suppression in lead-lead collisions at $\sqrt{s_{NN}}$= 2.76 TeV with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1208.1967 [hep-ex]. 10.1016/j.physletb.2013.01.024. Phys.Lett. B719 (2013) 220-241.

78) Search for squarks and gluinos with the ATLAS detector in final states with jets and missing transverse momentum using 4.7 fb^{-1} of $\sqrt{s}=7$ TeV proton-proton collision data By ATLAS Collaboration (Georges Aad et al.). arXiv:1208.0949 [hep-ex]. 10.1103/PhysRevD.87.012008. Phys.Rev. D87 (2013) 012008.

79) Measurement of charged-particle event shape variables in $\sqrt{s}=7$ TeV proton-proton interactions with the ATLAS detector, By ATLAS Collaboration (Georges Aad et al.). arXiv:1207.6915 [hep-ex]. 10.1103/PhysRevD.88.032004. Phys.Rev. D88 (2013) 032004.

80) Measurements of top quark pair relative differential cross-sections with ATLAS in pp collisions at $\sqrt{s}=7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1207.5644

[hep-ex]. 10.1140/epjc/s10052-012-2261-1. Eur.Phys.J. C73 (2013) 2261.

81) Measurement of the Λ_b lifetime and mass in the ATLAS experiment By ATLAS Collaboration (Georges Aad et al.). arXiv:1207.2284 [hep-ex]. 10.1103/PhysRevD.87.032002. Phys.Rev. D87 (2013) 3, 032002.

82) W boson polarization measurement in the $t\bar{t}$ dilepton channel using the CDF II Detector By CDF Collaboration (T. Aaltonen et al.). arXiv:1205.0354 [hep-ex]. 10.1016/j.physletb.2013.03.032. Phys.Lett. B722 (2013) 48-54.

83) Single hadron response measurement and calorimeter jet energy scale uncertainty with the ATLAS detector at the LHC, By ATLAS Collaboration (Georges Aad et al.). arXiv:1203.1302 [hep-ex]. 10.1140/epjc/s10052-013-2305-1. Eur.Phys.J. C73 (2013) 2305.

84) Jet energy measurement with the ATLAS detector in proton-proton collisions at $\sqrt{s}=7$ TeV, By ATLAS Collaboration (Georges Aad et al.). arXiv:1112.6426 [hep-ex]. 10.1140/epjc/s10052-013-2304-2. Eur.Phys.J. C73 (2013) 2304.

CMS

1) Measurement of the di_erential and double-di_erential Drell-Yan cross sections in proton-proton collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.7291 [hep-ex] 10.1007/JHEP12(2013)030 JHEP 1312, 030 (2013)

2) Jet and underlying event properties as a function of charged-particle multiplicity in protonproton collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.4554 [hep-ex] 10.1140/epjc/s10052-013-2674-5 Eur. Phys. J. C 73, 2674 (2013)

3) Search for R-Parity Violating Supersymmetry at the CMS Experiment" A. Cakir [on behalf of the CMS Collaboration]. arXiv:1310.3598 [hep-ph] PoS EPS -HEP2013, 264 (2013)

4) Rapidity distributions in exclusive Z + jet and + jet events in pp collisions at p s=7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.3082 [hep-ex] 10.1103/PhysRevD.88.112009 Phys. Rev. D 88, 112009 (2013)

5) Measurement of the cross section and angular correlations for associated production of a Z boson with b hadrons in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.1349 [hep-ex] 10.1007/JHEP12(2013)039 JHEP 1312, 039 (2013)

6) Electroweak bosons in heavy-ion collisions with the CMS detector at p sNN = 2.76 TeV" Florent et al. [CMS Collaboration]. 10.1088/1742-6596/446/1/012046, J. Phys. Conf. Ser. 446, 012046 (2013).

7) Measurement of the di_erential and double-di_erential Drell-Yan cross sections in proton-proton collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.7291 [hep-ex] 10.1007/JHEP12(2013)030 JHEP 1312, 030 (2013)

8) Jet and underlying event properties as a function of charged-particle multiplicity in protonproton collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.4554 [hep-ex] 10.1140/epjc/s10052-013-2674-5
Eur. Phys. J. C 73, 2674 (2013)

9) Search for R-Parity Violating Supersymmetry at the CMS Experiment" A. Cakir [on behalf of the CMS Collaboration]. arXiv:1310.3598 [hep-ph] PoS EPS -HEP2013, 264 (2013)

10) Rapidity distributions in exclusive Z + jet and + jet events in pp collisions at p s=7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.3082 [hep-ex] 10.1103/PhysRevD.88.112009 Phys. Rev. D 88, 112009 (2013)

11) Measurement of the cross section and angular correlations for associated production of a Z boson with b hadrons in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.1349 [hep-ex] 10.1007/JHEP12(2013)039 JHEP 1312, 039 (2013)

12) Modi_cation of jet shapes in PbPb collisions at sqrt(s[NN]) = 2.76 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1310.0878 [nucl-ex] 10.1016/j.physletb.2014.01.042, Phys. Lett. B 730, 243 (2014)

13) Electroweak bosons in heavy-ion collisions with the CMS detector at p sNN = 2.76 TeV" Florent et al. [CMS Collaboration]. 10.1088/1742-6596/446/1/012046
J. Phys. Conf. Ser. 446, 012046 (2013).

14) Observation of sequential _ suppression in PbPb collisions" Z. Hu et al. [CMS Collaboration]. 10.1088/1742-6596/446/1/012043, J. Phys. Conf. Ser. 446, 012043 (2013).

15) Searches for new physics using the t_ p t invariant mass distribution in pp collisions at s=8??TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1309.2030 [hep-ex] 10.1103/PhysRevLett.111.211804 Phys. Rev. Lett. 111, 211804 (2013)

16) Measurement of the production cross section for Z ! ___ in pp collisions at p s = 7 TeV and limits on ZZ and Z triple gauge boson couplings" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1309.1117 [hep-ex] 10.1007/JHEP10(2013)164 JHEP 1310, 164 (2013)

17) Search for a new bottomonium state decaying to _(1S)_+_ in pp collisions at p s = 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1309.0250 [hep-ex] 10.1016/j.physletb.2013.10.016 Phys. Lett. B 727, 57 (2013)

18) Measurement of the top-quark mass with all-jets _nal states in pp collisions at 7 TeV" E. Schlieckau [CMS Collaboration]. 10.1088/1742-6596/452/1/012022
J. Phys. Conf. Ser. 452, 012022 (2013).

19) Very High-pT Triggered Dihadron Correlations in PbPb Collisions at 2.76 TeV with CMS" R. Conway [CMS Collaboration]. 10.1088/1742-6596/458/1/012006
J. Phys. Conf. Ser. 458, 012006 (2013).

20) Measurement of the W-boson helicity in top-quark decays from t_t production in lepton+jets events in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1308.3879 [hep-ex] 10.1007/JHEP10(2013)167 JHEP 1310, 167 (2013)

21) Angular analysis and branching fraction measurement of the decay B0 ! K_0_+_□" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1308.3409 [hep-ex] 10.1016/j.physletb.2013.10.017 Phys. Lett. B 727, 77 (2013)

22) Studies on B hadron production, spectroscopy and decays at CMS" X. Shi [CMS Collaboration]. 10.1088/1742-6596/455/1/012033 J. Phys. Conf. Ser. 455, 012033 (2013).

23) Latest results on the search for D0 ? ?? and B0 s:d ? ?? decays from CMS" F. Palla [CMS Collaboration]. 10.1088/1742-6596/455/1/012032 J. Phys. Conf. Ser. 455, 012032 (2013).

24) Studies of exotic quarkonium states at CMS" A. Fanfani [CMS Collaboration]. 10.1088/1742-6596/455/1/012031, J. Phys. Conf. Ser. 455, 012031 (2013).

25) Search for Higgs decaying to WW at CMS" L. Di Matteo [CMS Collaboration]. 10.1088/1742-6596/455/1/012030 J. Phys. Conf. Ser. 455, 012030 (2013).

26) Search for exotic resonances in diboson _nal states with the CMS detector at the LHC" F. A. Dias [CMS Collaboration]. 10.1088/1742-6596/455/1/012029 J. Phys. Conf. Ser. 455, 012029 (2013).

27) Performance of the CMS electromagnetic calorimeter and its role in the hunt for the Higgs boson in the two-photon channel" F. De Guio [CMS Collaboration]. 10.1088/1742-6596/455/1/012028 J. Phys. Conf. Ser. 455, 012028 (2013).

28) Search for the Standard Model Higgs in H ? ZZ ? 4l channel with the CMS experiment" N. D. Filippis [CMS Collaboration]. 10.1088/1742-6596/455/1/012027 J. Phys. Conf. Ser. 455, 012027 (2013).

29) Vector boson plus jet physics at CMS" T. Cornelis [CMS Collaboration]. 10.1088/1742-6596/455/1/012026 J. Phys. Conf. Ser. 455, 012026 (2013).

30) Electroweak results from CMS" V. Ciulli [CMS Collaboration]. 10.1088/1742-6596/455/1/012025 J. Phys. Conf. Ser. 455, 012025 (2013).

31) Search for the neutral Supersymmetric Higgs boson with the CMS experiment at LHC" Branca [CMS Collaboration]. 10.1088/1742-6596/455/1/012024, J. Phys. Conf. Ser. 455, 012024 (2013).

32) Heavy ion physics from the CMS collaboration" P. Sarin [CMS Collaboration]. 10.1088/1742-6596/455/1/012023 J. Phys. Conf. Ser. 455, 012023 (2013).

33) Search for top-squark pair production in the single-lepton _nal state in pp collisions at s = 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1308.1586 [hep-ex] 10.1140/epjc/s10052-013-2677-2 Eur. Phys. J. C 73, 2677 (2013)

34) Combined measurement of the t_t cross section and the b-tagging e_ciency using l+jet events with CMS" M. Maes [CMS Collaboration]. 10.1088/1742-6596/452/1/012053 J. Phys. Conf. Ser. 452, 012053 (2013).

35) Measurement of the single-top-quark t-channel cross section in pp collisions at p s = 7 TeV using a multivariate analysis" D. Klingebiel [CMS Collaboration]. 10.1088/1742-6596/452/1/012052 J. Phys. Conf. Ser. 452, 012052 (2013).

36) Measurement of Spin Correlations in Top Pair Events in the Dilepton Channels in pp Collisions at 7 TeV" F. Hhle [CMS Collaboration]. 10.1088/1742-6596/452/1/012049 J. Phys. Conf. Ser. 452, 012049 (2013).

37) Search for production of SUSY partners of the top quark with the CMS detector" G. g. Hammad [CMS Collaboration]. 10.1088/1742-6596/452/1/012048 J. Phys. Conf. Ser. 452, 012048 (2013).

38) Measurement of the mass di_erence between top and antitop quarks" S. Blyweert [CMS Collaboration]. 10.1088/1742-6596/452/1/012044 J. Phys. Conf. Ser. 452, 012044 (2013).

39) Measurement of Missing Transverse Energy in Top Pair Events" P. Symonds [CMS Collaboration]. 10.1088/1742-6596/452/1/012032 J. Phys. Conf. Ser. 452, 012032 (2013).

40) Measurement of the t_t production cross section in the dilepton channel in proton-proton collisions at p s = 8 TeV with the CMS experiment" J. Kieseler [CMS Collaboration]. 10.1088/1742-6596/452/1/012029 J. Phys. Conf. Ser. 452, 012029 (2013).

41) Measurement of Di_erential t_t Cross Sections at 7 TeV" M. Grner [CMS Collaboration]. 10.1088/1742-6596/452/1/012027 J. Phys. Conf. Ser. 452, 012027 (2013).

42) Measurement of the single top quark t-channel cross section with a template _t analysis" M. Merola [CMS Collaboration]. 10.1088/1742-6596/452/1/012018 J. Phys. Conf. Ser. 452, 012018 (2013).

43) Object de_nition and performance at CMS" C. Diez Pardos [CMS Collaboration]. 10.1088/1742-6596/452/1/012015 J. Phys. Conf. Ser. 452, 012015 (2013).

44) Search for Higgs boson production in association with a top quark pair in pp collisions" Brinkerho_ [CMS Collaboration]. 10.1088/1742-6596/452/1/012006 J. Phys. Conf. Ser. 452, 012006 (2013).

45) Precision measurements in the top quark sector with the CMS experiment at the LHC" P. Ferreira da Silva [CMS Collaboration]. 10.1088/1742-6596/447/1/012033 J. Phys. Conf. Ser. 447, 012033 (2013).

46) Measurement of the properties of the 125 GeV Higgs boson with the CMS detector" J. oVarela [CMS Collaboration]. 10.1088/1742-6596/447/1/012010 J. Phys. Conf. Ser. 447, 012010 (2013).

47) Search for R-parity violating Supersymmetry using the CMS detector" F. Ratnikov [CMS Collaboration]. arXiv:1307.7609 [hep-ex] 10.1051/epjconf/20136018012 EPJ Web Conf. 60, 18012 (2013)

48) Measurement of the prompt J= and (2S) polarizations in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1307.6070 [hep-ex] 10.1016/j.physletb.2013.10.055, Phys. Lett. B 727, 381 (2013)

49) Study of Higgs Production in Fermionic Decay Channels at CMS" N. Mohr [CMS Collaboration]. arXiv:1307.5745 [hep-ex] 10.1051/epjconf/20136012007 EPJ Web Conf. 60, 12007 (2013)

50) Search for a Higgs boson decaying into a Z and a photon in pp collisions at p s = 7 and 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1307.5515 [hep-ex] 10.1016/j.physletb.2013.09.057 Phys. Lett. B 726, 587 (2013)

51) Measurement of the B(s) to mu+ mu- branching fraction and search for B0 to mu+ mu- with the CMS Experiment" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1307.5025 [hep-ex] 10.1103/PhysRevLett.111.101804 Phys. Rev. Lett. 111, 101804 (2013)

52) Searches for New Physics in Multijet Final States" C. Vuosalo [CMS Collaboration]. arXiv:1307.2518 10.1051/epjconf/20136017001 EPJ Web Conf. 60, 17001 (2013)

53) Searches for new physics with leptons and/or jets at CMS" C. Vuosalo [CMS Collaboration]. arXiv:1307.2168 PoS DIS 2013, 122 (2013)

54) ? suppression in PbPb collisions at the LHC" T. Dahms [CMS Collaboration]. arXiv:1307.1795 PoS Beauty 2013, 021 (2013)

55) Search for Single and Pair-Production of Dijet Resonances with the CMS Detector" K. Yi [CMS Collaboration]. arXiv:1307.1400 [hep-ex] 10.1088/1742-6596/455/1/012034 J. Phys. Conf. Ser. 455, 012034 (2013)

56) The performance of the CMS muon detector in proton-proton collisions at sqrt(s) = 7 TeV at the LHC" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1306.6905 [physics.ins-det] 10.1088/1748-0221/8/11/P11002 JINST 8, P11002 (2013)

57) Search for top squarks in R-parity-violating supersymmetry using three or more leptons and b-tagged jets" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1306.6643 [hep-ex] 10.1103/PhysRevLett.111.221801 Phys. Rev. Lett. 111, 221801 (2013)

58) Jet Cross-Section Measurements In CMS" S. Ganguly et al. [CMS Collaboration]. arXiv:1306.6604 [hep-ph] 10.1142/S0217751X13300305 Int. J. Mod. Phys. A 28, 1330030 (2013)

59) Energy calibration and resolution of the CMS electromagnetic calorimeter in pp collisions at s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1306.2016 [hep-ex] 10.1088/1748-0221/8/09/P09009 JINST 8, P09009 (2013)

60) Measurement of the W+W□ Cross section in pp Collisions at p s = 7 TeV and Limits on Anomalous WW and WWZ couplings" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1306.1126 [hep-ex] 10.1140/epjc/s10052-013-2610-8 Eur. Phys. J. C 73, 2610 (2013)

61) Measurement of the hadronic activity in events with a Z and two jets and extraction of the cross section p for the electroweak production of a Z with two jets in pp collisions at s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1305.7389 [hep-ex] 10.1007/JHEP10(2013)062 JHEP 1310, 101 (2013)

62) Measurement of neutral strange particle production in the underlying event in proton-proton collisions at sqrt(s) = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1305.6016 [hep-ex] 10.1103/PhysRevD.88.052001 Phys. Rev. D 88, 052001 (2013)

63) Quarkonium Results in PbPb Collisions at CMS" M. Caldern de la Barca Snchez [CMS Collaboration]. arXiv:1305.5560 [nucl-ex] 10.1088/1742-6596/458/1/012011 J. Phys. Conf. Ser. 458, 012011 (2013)

64) Study of exclusive two-photon production of W+W□ in pp collisions at p s = 7 TeV and constraints on anomalous quartic gauge couplings" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1305.5596 [hep-ex] 10.1007/JHEP07(2013)116 JHEP 1307, 116 (2013)

65) Search for gluino mediated bottom- and top-squark production in multijet _nal states in pp collisions at 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1305.2390 [hep-ex] 10.1016/j.physletb.2013.06.058 Phys. Lett. B 725, 243 (2013)

66) Multiplicity and transverse momentum dependence of two- and four-particle correlations in pPb and PbPb collisions" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1305.0609 [nucl-ex] 10.1016/j.physletb.2013.06.028 Phys. Lett. B 724, 213 (2013)

67) Searches for long-lived charged particles in pp collisions at p s=7 and 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1305.0491 [hep-ex] 10.1007/JHEP07(2013)122 JHEP 1307, 122 (2013)

68) Measurement of the ratio of the inclusive 3-jet cross section to the inclusive 2-jet cross section in pp collisions at p s = 7 TeV and _rst determination of the strong coupling constant in the TeV range" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1304.7498 [hep-ex] 10.1140/epjc/s10052-013-2604-6 Eur. Phys. J. C 73, 2604 (2013)

69) Measurement of the _0b lifetime in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1304.7495 [hep-ex] 10.1007/JHEP07(2013)163, JHEP 07, 163 (2013)

70) Measurement of masses in the t_t system by kinematic endpoints in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1304.5783 [hep-ex] 10.1140/epjc/s10052-013-2494-7 Eur. Phys. J. C 73, 2494 (2013)

71) Search for a standard-model-like Higgs boson with a mass in the range 145 to 1000 GeV at the LHC" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1304.0213 [hep-ex] 10.1140/epjc/s10052-013-2469-8, Eur. Phys. J. C 73, 2469 (2013)

72) Measurement of the _(1S); _(2S), and _(3S) cross sections in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1303.5900 [hep-ex] 10.1016/j.physletb.2013.10.033 Phys. Lett. B 727, 101 (2013)

73) Search for microscopic black holes in pp collisions at p s = 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1303.5338 [hep-ex] 10.1007/JHEP07(2013)178 JHEP 1307, 178 (2013)

74) Studies of jet mass in dijet and W/Z + jet events" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1303.4811 [hep-ex] 10.1007/JHEP05(2013)090, JHEP 1305, 090 (2013)

75) Observation of a new boson with mass near 125 GeV in pp collisions at p s = 7 and 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1303.4571 [hep-ex] 10.1007/JHEP06(2013)08, JHEP 1306, 081 (2013)

76) Measuring the Top Quark Mass using Kinematic Endpoints" B. Nachman [CMS Collaboration]. arXiv:1303.3988 [hep-ex] 10.1088/1742-6596/452/1/012056, J. Phys. Conf. Ser. 452, 012056 (2013)

77) Measurement of associated production of vector bosons and top quark-antiquark pairs at sqrt(s) = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1303.3239 [hep-ex] 10.1103/PhysRevLett.110.172002, Phys. Rev. Lett. 110, 172002 (2013)

78) Search for supersymmetry in hadronic _nal states with missing transverse energy using the variables AlphaT and b-quark multiplicity in pp collisions at 8 TeV" S. Chatrchyan et al.[CMS Collaboration]. arXiv:1303.2985 [hep-ex] 10.1140/epjc/s10052-013-2568-6 Eur. Phys. J. C 73, 2568 (2013)

79) Search for the standard model Higgs boson produced in association with a top-quark pair in pp collisions at the LHC" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1303.0763 [hep-ex] 10.1007/JHEP05(2013)145, JHEP 1305, 145 (2013)

80) Search for narrow resonances using the dijet mass spectrum in pp collisions at sqrt(s) = 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.4794 [hep-ex] 10.1103/PhysRevD.87.114015 Phys. Rev. D 87, 114015 (2013)

81) Measurement of the X(3872) production cross section via decays to J/psi pi pi in pp collisions at sqrt(s) = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.3968 [hep-ex] 10.1007/JHEP04(2013)154, JHEP 1304, 154 (2013)

82) Top Quark Mass Combination Techniques and Treatment of Uncertainties at the Tevatron and LHC" E. Shabalina [CDF and D0 and ATLAS and CMS Collaborations]. 10.1088/1742-6596/452/1/01202 J. Phys. Conf. Ser. 452, 012023 (2013).

83) Search for a Higgs boson decaying into a b-quark pair and produced in association with quarks in proton-proton collisions at 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.2892 [hep-ex] 10.1016/j.physletb.2013.04.017, Phys. Lett. B 722, 207 (2013)

84) Top properties in t_t events at CMS (includes mass)" V. Adler [on behalf of the CMS Collaboration]. arXiv:1302.2885 10.1051/epjconf/20134917009, EPJ Web Conf. 49, 17009 (2013)

85) Search for new physics in _nal states with a lepton and missing transverse energy in pp collisions at the LHC" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.2812 [hep-ex] 10.1103/PhysRevD.87.072005, Phys. Rev. D 87, no. 7, 072005 (2013)

86) Performance of the CMS Level-1 Trigger" J. Brooke [CMS Collaboration]. arXiv:1302.2469 [hep-ex] PoS ICHEP 2012, 508 (2013)

87) Study of the underlying event at forward rapidity in pp collisions at p s = 0.9, 2.76, and 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.2394 [hep-ex] 10.1007/JHEP04(2013)072 JHEP 1304, 072 (2013)

88) Searches for Higgs bosons in pp collisions at sqrt(s) = 7 and 8 TeV in the context of four-generation and fermiophobic models" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.1764 [hep-ex] 10.1016/j.physletb.2013.06.043, Phys. Lett. B 725, 36 (2013)

89) Search for pair-produced dijet resonances in four-jet _nal states in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.0531 [hep-ex] 10.1103/PhysRevLett.110.141802, Phys. Rev. Lett. 110, 141802 (2013)

90) Measurement of the t_t production cross section in the all-jet _nal state in pp collisions at P s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1302.0508 [hep-ex] 10.1007/JHEP05(2013)06, JHEP 1305, 065 (2013)

91) Search p for contact interactions using the inclusive jet pT spectrum in pp collisions at s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1301.5023 [hep-ex] 10.1103/PhysRevD.87.052017, Phys. Rev. D 87, 052017 (2013)

92) Search for physics beyond the standard model in events with _ leptons, jets, and large transverse momentum imbalance in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1301.3792 [hep-ex] 10.1140/epjc/s10052-013-2493-8 Eur. Phys. J. C 73, 2493 (2013)

93) Interpretation of Searches for Supersymmetry with simpli_ed Models" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1301.2175 [hep-ex] 10.1103/PhysRevD.88.052017 Phys. Rev. D 88, 052017 (2013)

94) Event shapes and azimuthal correlations in Z + jets events in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1301.1646 [hep-ex] 10.1016/j.physletb.2013.04.025. Phys. Lett. B 722, 238 (2013)

95) Study of the Mass and Spin-Parity of the Higgs Boson Candidate Via Its Decays to Z Boson Pairs" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1212.6639 [hep-ex] 10.1103/PhysRevLett.110.081803, Phys. Rev. Lett. 110, 081803 (2013)

96) Inclusive search for supersymmetry using the razor variables in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1212.6961 [hep-ex] 10.1103/PhysRevLett.111.081802, Phys. Rev. Lett. 111, 081802 (2013)

97) pSearch for new physics in events with same-sign dileptons and b jets in pp collisions at s = 8 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1212.6194 [hep-ex] 10.1007/JHEP03(2013)037, 10.1007/JHEP07(2013)041, JHEP 1303, 037 (2013), [Erratum-ibid. 1307, 041 (2013)]

98) Search for contact interactions in _+_□ events in pp collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1212.4563 [hep-ex] 10.1103/PhysRevD.87.032001, Phys. Rev. D 87, no. 3, 032001 (2013)

99) Search for long-lived particles decaying to photons and missing energy in proton-proton collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1212.1838 [hep-ex] 10.1016/j.physletb.2013.04.027, Phys. Lett. B 722, 273 (2013)

100) \pSearch for Z ' resonances decaying to tt_ in dilepton+jets _nal states in pp collisions at s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1211.3338 [hep-ex] 10.1103/PhysRevD.87.072002, Phys. Rev. D 87, 072002 (2013)

101) Search for supersymmetry in _nal states with a single lepton, b-quark jets, and missingtransverse energy in proton-proton collisions at p s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1211.3143 [hep-ex] 10.1103/PhysRevD.87.052006, Phys. Rev. D 87, no. 5, 052006 (2013)

102) Search for a non-standard-model Higgs boson decaying to a pair of new light bosons in four-muon _nal states" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1210.7619 [hep- ex] 10.1016/j.physletb.2013.09.009, Phys. Lett. B 726, 564 (2013)

Search for pair production of third-generation leptoquarks and top squarks in pp colli-sions at P s = 7 TeV" S. Chatrchyan et al. [CMS Collaboration]. arXiv:1210.5629 [hep-ex] 10.1103/PhysRevLett.110.081801, Phys. Rev. Lett. 110, 081801 (2013)

CDF

Published:

1) Measurement of the Leptonic Asymmetry in t anti-t Events Produced in ppbar Collisions at Sqrt(s) - 1.96 TeV   T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 072003 (2013). ArXiv: 1308.1120

2) Search for a Dijet Resonance in Events with Jets and Missing Transverse Energy in p anti-p Collisions at sqrt(s) = 1.96 TeV   T. Aaltonen et al, The CDF Collaboration, Phys. Rev. D. 88, 092004 (2013). arXiv: 1310.7267.

3) Indirect Measurement of sin2theta W (M W) Using e+e- Pairs in the Z-Boson Region with p anti-p Collisions at a Center-of-Momentum Energy of 1.96 TeV   T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 072002. arXiv: 1307-0770.

4) Evidence for a Bottom Baryon Resonance Lambda_b* in CDF Data   T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 071101. ArXiv: 1308.1760.

5) Observation of D0-D0 bar Mixing Using the CDF II Detector   T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 111, 231802. arXiv: 1309.4078.

6) Combination of CDF and D0 W-Boson Mass Measurements   T. Aaltonen et al., The CDF and D0 Collaborations, Phys. Rev. D 88, 052018. arXiv: 1307.7627.

7) Search for the Production of ZW and ZZ Boson Pairs Decaying into Charged Leptons and Jets in Proton-Antiproton Collisions at Sqrt(s) = 1.96 TeV T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 092002 (2013). arXiv: 1310.0086.

8) Searches for the Higgs Boson Decaying to W+ W- --> l+nul-nubar with the CDF II Detector T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D. 88, 052012 (2013). arXiv: 1306.0023.

9) Higgs Boson Studies at the Tevatron T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 052014 (2013). arXiv: 1303.6346.

10) Combination of Searches for the Higgs Boson using the Full CDF Data Set T. Aaltonen et al, The CDF Collaboration, Phys. Rev. D. 88, 052013 (2013). arXiv: 1301.6668.

11) A Direct Measurement of the Total Decay Width of the Top Quark T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 111, 202001 (2013). arXiv: 1308.4050.

12) Exclusion of Exotic Top-Like Quarks with -4/3 Electric Charge Using Jet-Charge Tagging in Single-Lepton t anti-t Events at CDF T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 032003. arXiv: 1304.4141.

13) Production of kshort, kstar(892) and phi (1020) in Minimum Bias Events and kshort and lambda in Jets in p anti-p Collisions at sqrt(s) = 1.96 TeV T. Aaltonen et al, The CDF Collaboration, Phys. Rev. D 88, 092005 (2013). arXiv: 1308.3371.

14) Signature-Based Search for Delayed Photons in Exclusive Photon Plus Missing Transverse Energy Events from p anti-p Collisions with sqrt(s) = 1.96 TeV T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 031103 (2013). arXiv: 1307.0474.

15) Search for Pair Production of Strongly Interacting Particles Decaying to Pairs of Jets in p pbar Collisions at sqrt (s) = 1.96 TeV T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 111, 031802 (2013). arXiv: 1303.2699.

16) Top-Quark Mass Measurement in Events with Jets and Missing Transverse Energy Using the Full CDF Data Set T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 88, 011101. ArXiv: 1305.3339.

17) Measurement of the Cross Section for Direct-Photon Production in Association with a Heavy Quark in p pbar Collisions at sqrt (s) = 1.96 TeV T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 111, 042003. arXiv: 1303.6136.

18) Differential Cross Section dsigma/d(cos theta_t) for Top-Quark-Pair-Production in p anti-p

Collisions at Sqrt(s) = 1.96 TeV T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 111, 182002 (2013). arXiv: 1306.2357.

19) Measurement of R = B(t_$B"*_(BWb)/B(t_$B"*_(BWq) in Top-Quark-Pair Decays using the Lepton+Jets Events and the Full CDF Run II Data Set T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D. 87, 11101(R) (2013). arXiv: 1303.6142.

20) Search for Supersymmetry with Like-Sign Lepton-Tau Events at CDF T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 110, 201802 (2013). arXiv: 1302.4491.

21) Measurement of the top quark forward-backward production asymmetry and its dependence on event kinematic properties T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 87, 092002 (2013).arXiv: 1211.1003.

22) Measurement of the Top-Quark Pair Production Cross-Section in Events with Two Leptons and Bottom-Quark Jets Using the Full CDF Data Set T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 88, 091103 (2013). arXiv: 1304.7961.

23) Search for B(s)-->mu+mu- and Bd-->mu+mu- Decays Using the Full CDF Run II Data Set T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 87, 072003 (2013). arXiv: 1301.7048.

24) Measurement of the cross section for prompt isolated diphoton production using the full CDF Run II data sample T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 110, 101801 (2013). arXiv: 1212.4204.

25) Search for a Two-Higgs-Boson Doublet Using a Simplified Model in ppbar Collisions at sqrt (s) = 1.96 TeV T Aaltonen et al, The CDF Collaboration, Phys. Rev. Lett. 110, 121801. arXiv: 1212.3837.

26) Search for Resonant Top-Antitop Production in the Lepton Plus Jets Decay Mode Using the Full CDF Data Set T. Aaltonen et al, The CDF Collaboration, Phys. Rev. Lett. 110, 121802 (2013). arXiv: 1211.5363

27) Updated Search for the Standard Model Higgs Boson in Events with Jets and Missing Transverse Energy Using the Full CDF Data Set T. Aaltonen et al, The CDF Collaboration, Phys. Rev. D 87, 052008 (2013). arXiv: 1301.4440.

28) Measurement of the Mass Difference Between Top and Anti-Top Quarks T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 87, 052013 (2013). arXiv: 1210.6131.

29) Measurement of W-Boson Polarization in Top-Quark Decay Using the Full CDF Run II Data Set T. Aaltonen et al., The CDF Collaboration, Phys. Rev. D 87, 031104(R) (2013). arXiv:

1211.4523.

30) Search for the Higgs Boson in the All-Hadronic Final State Using the Full CDF Data Set T. Aaltonen et al., The CDF Collaboration, JHEP 02 (2013) 004. arXiv: 1208.6445.

31) Observation of the Production of a W Boson in Association with a Single Charm Quark T. Aaltonen et al., The CDF Collaboration, Phys. Rev. Lett. 110, 071801 (2013). arXiv: 1209.1921

32) Measurement of the Bc meson lifetime in the decay Bc --> J/mu+mu- pi+ T. Aaltonen et al, The CDF Collaboration, Phys. Rev. D 87, 011101(R) (2013). Fermilab-Pub-12-565-E. arXiv: 1210-2366.

Submitted:

33) A Precise Measurement of the W-Boson Mass with the Collider Detector at Fermilab T. Aaltonen et al, The CDF Collaboration, submitted to Phys. Rev. D. November 4, 2013. Fermilab-Pub-13-515-E. arXiv: 1311.0894.

34) First Search for Exotic Z Boson Decays into Photons and Neutral Pions in Hadrons Collisions T. Aaltonen et al, The CDF Collaboration, submitted to Phys. Rev. Lett. November 13, 2013. Fermilab-Pub-13-509-E. arXiv: 1311.3282.

35) Study of Orbitally Excited B Mesons and Evidence for a New B pi+ Resonance T. Aaltonen et al, The CDF Collaboration, submitted to Phys. Rev. D. September 23, 2013. Fermilab-Pub-13-393-E. arXiv: 1309.5961.

36) Search for Trilepton New Physics and Chargino-Neutralino Production at CDF T. Aaltonen et al, The CDF Collaboration, submitted to Phys. Rev. Lett. September 28, 2013. Fermilab-Pub-13-446.

37) Combination of Measurements of the Top-Quark Pair Production Cross Section from the Tevatron Collider T. Aaltonen et al, The CDF Collaboration, submitted to Phys. Rev. D. September 29, 2013. Fermilab-Pub-13-432-E. arXiv: 1309.7570.

DZero

1) Measurement of the asymmetry in angular distributions of leptons produced in dilepton tt final states in pp collisions at $\sqrt{s}$ = 1.96 TeV Published 12/02/13: Phys. Rev. D 88, 112002 (2013), arXiv:1308.6690 plots 9.7 fb^{-1}

2) Measurement of the muon charge asymmetry in pp → W + X → μν +X events at $\sqrt{s}$ = 1.96 TeV Published 11/15/13: Phys. Rev. D 88, 091102(R) (2013), arXiv:1309.2591 plots 7.3 fb^{-1}

3) Studies of *W* boson plus jets production in pp collisions at √s =1.96TeV Published 11/05/13: Phys. Rev. D 88, 092001 (2013), arXiv:1302.6508 plots 3.7 fb^{-1}

4) Evidence for *s*-channel single top quark production in pp collisions at √s=1.96 TeV Published 11/04/13: Phys. Lett. B 726, 656 (2013), arXiv:1307.0731 plots 9.7 fb^{-1}

5) Measurement of the differential cross section of photon plus jet production in pp collisions at √s = 1.96 TeV Published 10/21/13: Phys. Rev. D 88, 072008 (2013), arXiv:1308.2708 plots 8.7 fb^{-1}

6) Combination of CDF and D0 W-Boson Mass Measurements Published 09/24/13: Phys. Rev. D 88, 052018 (2013), arXiv:1307.7627 plots 5.3 fb^{-1}

7) Higgs Boson Studies at the Tevatron Published 09/17/13: Phys. Rev. D 88, 052014 (2013), arXiv:1303.6346 plots 10 fb^{-1}

8) Combined search for the Higgs boson with the D0 experiment Published 09/17/13: Phys. Rev. D 88, 052011 (2013), arXiv:1303.0823 plots 9.7 fb^{-1}

9) Search for $ZH \to \ell^+\ell^- bb$ production in 9.7 fb^{-1} of pp collisions with the D0 detector Published 09/17/13: Phys. Rev. D 88, 052010 (2013), arXiv:1303.3276 plots 9.7 fb^{-1}

10) Search Search for Higgs boson production in trilepton and like-charge electron-muon final states with the D0 detector Published 09/17/13: Phys. Rev. D 88, 052009 (2013), arXiv:1302.5723 plots 9.7 fb^{-1}

11) Search for the standard model Higgs boson in ℓν+jets final states in 9.7 fb^{-1} of pp collisions with the D0 detector Published 09/17/13: Phys. Rev. D 88, 052008 (2013), arXiv:1301.6122 plots 9.7 fb^{-1}

12) Search for a Higgs boson in diphoton final states with the D0 detector in 9.6 fb^{-1} of pp Collisions at √s = 1.96 TeV Published 09/17/13: Phys. Rev. D 88, 052007, (2013), arXiv:1301.5358 plots 9.6 fb^{-1}

13) Search for Higgs boson production in oppositely charged dilepton and missing energy final states in pp collisions at √s = 1.96 TeV, Published 09/17/13: Phys. Rev. D 88, 052006 (2013), arXiv:1301.1243 plots 9.7 fb^{-1}

14) Search for the Higgs boson in lepton, tau and jets final states, Published 09/17/13: Phys. Rev. D 88, 052005 (2013), arXiv:1211.6993 plots 9.7 fb^{-1}

15) Measurement of the ZZ production cross section and search for the standard model Higgs boson in the four lepton final state in pp collisions , Published 08/15/13: Phys. Rev. D 88, 032008 (2013), arXiv:1304.5422 plots 9.8 fb^{-1}

16) Search for anomalous quartic WWγγ couplings in dielectron and missing energy final states in pp collision s at √s=1.96 TeV, Published 07/29/13: Phys. Rev. D 88, 012005 (2013), arXiv:1305.1258 plots 9.7 fb^{-1}

17) Measurement of the differential cross sections for isolated direct photon pair production in pp collisions at √s = 1.96 TeV, Published 07/10/13: Phys. Lett. B 725, 6 (2013), arXiv:1301.4536 plots 8.5 fb^{-1}

18) Measurement of direct CP violation parameters in $B^{\pm}\to J/\psi K^{\pm}$ and $B^{\pm}\to J/\psi\pi^{\pm}$ decays in 10.4 fb^{-1} of Tevatron data, Published 06/12/13: Phys. Rev. Lett. 110, 241801 (2013), arXiv:1304.1655 plots 10.4 fb^{-1}

19) Measurement of the ratio of differential cross sections $\sigma(pp \to Z + b\ jet)/\sigma(pp \to Z + jet)$ in pp collisions at $\sqrt{s}$ = 1.96 TeV, Published 05/28/13: Phys. Rev. D 87, 092010 (2013), arXiv:1301.2233 plots 9.7 fb^{-1}

20) Search for the Rare Decay $B_s^0\to\mu^+\mu^-$, Published 04/11/13: Phys. Rev. D 87, 072006 (2013), arXiv:1301.4507 plots 10.4 fb^{-1}

21) Measurement of the combined rapidity and p_T dependence of dijet azimuthal decorrelations in pp collisions at $\sqrt{s}$=1.96 TeV
Published 04/08/13: Phys. Lett. B 721, 212(2013), arXiv:1212.1842 plots 0.7 fb^{-1}

22) Search for Charged Massive Long-lived Particles at $\sqrt{s}$=1.96 TeV
Published 03/14/13: Phys. Rev. D 87, 052011 (2013), arXiv:1211.2466 plots 6.3 fb^{-1}

23) Measurement of the ratio of three-jet to two-jet cross sections in pp Collisions at $\sqrt{s}$ = 1.96 TeV
Published 03/13/13: Phys. Lett. B 720, 6 (2013), arXiv:1209.1140 plots 0.7 fb^{-1}

24) Measurement of the γ+c-jet cross section and the ratio γ+c and γ+b cross sections in pp collisions at $\sqrt{s}$=1.96 TeV
Published 02/26/13: Phys. Lett. B 719, 354 (2013), arXiv:1210.5033 plots 8.7 fb^{-1}

25) Measurement of Leptonic Asymmetries and Top Quark Polarization in tt Production
Published 01/24/13: Phys. Rev. D 87, 011103(R) (2013), arXiv:1207.0364 plots 5.4 fb^{-1}

26) Measurement of the pp to W + b + X production cross section at $\sqrt{s}$ = 1.96 TeV
Published 01/29/13: Phys. Lett. B 718, 1314 (2013), arXiv:1210.0627 plots 6.1 fb^{-1}

NEES

1) Tricia Clayton, P.M. (2013) Self-Centering Steel Plate Shear Walls: Subassembly and Full-Scale Experimental Investigation. PhD dissertation, Dept. of Civil and Environmental Engineering, University of Washington, Seattle, WA.

STAR

1) **“**Anomalous centrality evolution of two-particle angular correlations from Au-Au collisions at $\sqrt{s_{NN}}$ = 62 and 200 GeV**”,** STAR Collaboration, Phys. Rev. C **86** (2012) 64902.

2) **“**Measurements of D^0 and D^* Production in p + p Collisions at $\sqrt{s_{NN}}$ = 200 GeV**”,** STAR Collaboration, Phys. Rev. D **86** (2012) 72013.

3) **“**Inclusive charged hadron elliptic flow in Au + Au collisions at $\sqrt{s_{NN}}$ = 7.7 - 39 GeV**”,** STAR Collaboration, Phys. Rev. C **86** (2012) 54908

4) **“**System Size Dependence of Transverse Momentum Correlations at RHIC**”,** STAR Collaboration, Phys. Rev. C **87** (2013) 64902.

5) **“**Third Harmonic Flow of Charged Particles in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV**”,** STAR Collaboration, Phys. Rev. C **88** (2013) 14904.

6) **“**Observation of an energy-dependent difference in elliptic flow between particles and antiparticles in relativistic heavy ion collisions**”,** STAR Collaboration, Phys. Rev. Lett. **110** (2013) 142301.

7) **“**Elliptic flow of identified hadrons in Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7--62.4 GeV**”,** STAR Collaboration, Phys. Rev. C **88** (2013) 14902.

8) **“**Measurement of J/ψ Azimuthal Anisotropy in Au+Au Collisions at $\sqrt{s_{NN}}$ = 200 GeV**”,** STAR Collaboration, Phys. Rev. Lett. **111** (2013) 52301.

9) **“**Studies of di-jets in Au+Au collisions using angular correlations with respect to back-to-back leading hadrons**”,** STAR Collaboration, Phys. Rev. C **87** (2013) 44903.

10) **“**J/ψ production at high transverse momenta in p+p and Au+Au collisions at $\sqrt{s_{NN}}$ = = 200 GeV**”,** STAR Collaboration, Phys. Lett. B **722** (2013) 55.

11) “Single Spin Asymmetry A_N in Polarized Proton-Proton Elastic Scattering at $\sqrt{s}$ = 200 GeV**”,** STAR Collaboration, Phys. Lett. B **719** (2013) 62.

12) “Freeze-out Dynamics via Charged Kaon Femtoscopy in sqrt(sNN)=200 GeV Central Au+Au Collisions”, STAR Collaboration, Phys. Rev. C **88** (2013) 34906

13) “Fluctuations of charge separation perpendicular to the event plane and local parity violation in sqrt(s_NN)=200 GeV Au+Au collisions at RHIC”, STAR Collaboration, Phys. Rev. C **88** (2013) 64911

14) “Energy dependence of moments of net-proton multiplicity distributions at RHIC”, STAR Collaboration, Phys. Rev. Lett. **112** (2014) 32302

15) “Neutral pion cross section and spin asymmetries at intermediate pseudorapidity in polarized proton collisions at sqrt{s}=200 GeV”, STAR Collaboration, Phys. Rev. D **89** (2014) 12001

GridUNESP

1) D. F. Tavares, A.D. Araujo, E. D. Leonel, R.N. Costa Filho, *Dynamical properties for a mixed Fermi accelerator model* , Physica A: Statistical Mechanics and its Applications, Available online 24 May 2013,,doi: http://dx.doi.org/10.1016/j.physa.2013.05.027

2) D. R. da Costa, I.L. Caldas, E. D. Leonel, *Dynamical properties for an ensemble of classical particles moving in a driven potential well with different time perturbation* , Physics Letters A, Volume 377, Issues 31–33, 30 October 2013, Pages 1814–1821, doi:http://dx.doi.org/10.1016/j.physleta.2013.05.050

3) E.F. Oliveira, F.C. Lavarda, *Structure of P3HT in the solid state* , Journal of Polymer Science Part B: Polymer Physics, 2013 doi:http://dx.doi.org/10.1002/polb.23338|

4) J. A. de Oliveira, E. D. Leonel, *A rescaling of the phase space for Hamiltonian map: Applications on the Kepler map and mappings with diverging angles in the limit of vanishing action* ,Applied Mathematics and Computation,Volume 221, 15 September 2013, Pages 32–39 doi:http://dx.doi.org/10.1016/j.amc.2013.06.045

5) F.J. Caires, A.C. Gigante, D.J.C. Gomes, O. Treu-Filho, M. Ionashiro, *Synthesis, thermal behaviour and spectroscopic study of trivalent lanthanide and yttrium(III) α-hydroxyisobutyrates, in solid state* ,Thermochimica Acta, Available online 11 July 2013, In Press, Accepted Manuscript doi:http://dx.doi.org/10.1016/j.tca.2013.06.034

6) D.A. Gálico, G.L. Perpétuo, R.A.E. Castro, O. Treu-Filho,A. O. Legendre, M. S. Galhiane, G. Bannach, *Thermoanalytical study of nimesulide and their recrystallization products obtained from solutions of several alcohols* ,Received: 7 March 2013 / Accepted: 10 June 2013, Journal of Thermal Analysis and Calorimetry, doi: http://dx.doi.org/10.1007/s10973-013-3294-x

7) A.C. Gigante, F.J. Caires, D.J.C. Gomes, L.S. Lima, O. Treu-Filho, M. Pivatto, M. Ionashiro, *Spectroscopic study and thermal behavior of trivalent lanthanides and yttrium (III) chelates of EDTA using TG-DSC, FTIR, and TG-DSC coupled to FTIR* ,Received: 21 February 2013 / Accepted: 6 June 2013, Journal of Thermal Analysis and Calorimetry, doi: http://dx.doi.org/10.1007/s10973-013-3284-z

8) Diego Z. Carvalho, Günther J.L. Gerhardt, Guilherme Dellagustin, Emerson L. de Santa-Helena, Ney Lemke, Alan Z. Segal, Suzana V. Schönwald, Loss of sleep spindle frequency deceleration in Obstructive Sleep Apnea, Clinical Neurophysiology, Available online 27 July 2013, ISSN 1388-2457, doi:http://dx.doi.org/10.1016/j.clinph.2013.07.005.
9) de Mendonça MR, Rizzi LG, Contessoto V, Leite VB, Alves NA, Inferring a Weighted Elastic Network from Partial Unfolding with Coarse-grained Simulations, Proteins: Structure, Function, and Bioinformatics, Accepted Article, doi: http://dx.doi.org/10.1002/prot.24381

10) da Costa, D. R., C. P. Dettmann, and E. D. Leonel. "Circular, Elliptic and Oval Billiards in a Gravitational Field." arXiv preprint arXiv:1308.0362 (2013).http://arxiv.org/pdf/1308.0362.pdf

11) da Costa, Diogo Ricardo, Mário R. Silva, and Edson D. Leonel. "Escape Beam Statistics and dynamical Properties for a Periodically Corrugated Waveguide." Communications in Nonlinear Science and Numerical Simulation (2013). doi: http://dx.doi.org/10.1016/j.cnsns.2013.08.009

12) Barra, Carolina V., et al. "Synthesis, Cytotoxic Activity and DNA Interaction of Pd (II) Complexes Bearing N'-methyl-3, 5-dimethyl-1-thiocarbamoylpyrazole." Polyhedron (2013). doi: http://dx.doi.org/10.1016/j.poly.2013.08.040

13) C.P. Dettmann, E.D. Leonel, *Periodic Compression of an Adiabatic Gas: Intermittency-enhanced Fermi acceleration*, EPL (Europhysics Letters), 2013, 103 40003, doi: http://dx.doi.org/10.1209/0295-5075/103/40003

14) R.S. Borges, J. Batista Jr, R.B. Viana, A.C. Baetas, E. Orestes,M. A. Andrade, K. M. Honório and A. B. F. da Silva, *Understanding the Molecular Aspects of Tetrahydrocannabinol and Cannabidiol as Antioxidants* , Molecules 2013, 18, 12663-12674; doi: http://dx.doi.org/10.3390/molecules181012663

15) L. P. Livorati, Matheus S. Palmero, Carl P. Dettmann, I. L. Caldas and E. D. Leonel, *Separation of particles leading to decay and unlimited growth of energy in a driven stadium-like billiard*, Submitted on 14 Oct, 2013, http://arxiv.org/abs/1310.3615v1

16) D.A. Gálico, B.B.C. Holanda, R.B. Guerra, A.O. Legendre, D. Rinaldo, O. Treu-Filho, G. Bannach, *Thermal and Spectroscopic Studies on Solid Ibuprofen Complexes of Lighter Trivalent Lanthanides* , Accepted Manuscript 05 Nov, 2013, doi: http://dx.doi.org/doi:10.1016/j.tca.2013.11.005

17) Batagin-Neto, Augusto; S. Bronze-Uhle, Erika; V. G. Vismara, Marcus; P. Assis, Andrei; A. Castro, Fernando; Geiger, Thomas; C. Lavarda, Francisco; F. O. Graeff, Carlos, *Gamma-Ray Dosimetric Properties of Conjugated Polymers in Solution*, Current Physical Chemistry, Volume 3, Number 4, December 2013 , pp. 431-440(10)

18) L. P. Livorati, O. Georgiou, C. P. Dettmann and E. D. Leonel, *Escape through a Time-dependent Hole in the Doubling Map* , 25 December, 2013http://arxiv.org/abs/1312.7030v1

GLOW

1) Aartsen, MG, et al. (IceCube Collaboration), Search for a Diffuse Flux of Astrophysical Muon Neutrinos with the IceCube 59-string Configuration, *J Phys Rev*, submitted.

2) Aartsen, MG, et al. (IceCube Collaboration), Search for Neutrino-Induced Particle Showers with IceCube-40, *J Phys Rev*, submitted.

3) Aartsen, MG, et al. (IceCube Collaboration), Observation of the Cosmic-Ray Shadow of the Moon with IceCube, *J Phys Rev*, submitted.

4) Aartsen, MG, et al. (IceCube Collaboration), Improvement in Fast Particle Track Reconstruction with Robust Statistics, *Nucl Instrum Methods*, in press.

5) Aartsen, MG, et al. (IceCube Collaboration), An IceCube Search for Dark Matter Annihilation in Nearby Galaxies and Galaxy Clusters, *J Phys Rev*, 2013, D88, 122001.

6) Aartsen, MG, et al. (IceCube Collaboration), Probing the Origin of Cosmic-Rays with Extremely High Energy Neutrinos Using the IceCube Observatory, *J Phys Rev*, 2013, D88, 112008.

7) Aartsen, MG, et al. (IceCube Collaboration), Search for Time-Independent Neutrino Emission from Astrophysical Sources with 3 years of IceCube Data, *Astrophys J*, 2013, 799, 132.

8) Aartsen, MG, et al. (IceCube Collaboration), Evidence for High-Energy Extraterrestrial Neutrinos at the IceCube Detector, *Science*, 2013, 59, 1117-1128.

9) Aartsen, MG, et al. (IceCube Collaboration), South Pole Glacial Climate Reconstruction from Multi-Borehole Laser Particulate Stratigraphy, *J Glaciology*, 2013, 122001.

10) Aartsen, MG, et al. (IceCube Collaboration), Measurement of Atmospheric Neutrino Oscillations with IceCube, *Phys Rev Lett*, 2013, 111, 081801.

11) Aartsen, MG, et al. (IceCube Collaboration), Measurement of the Cosmic Ray Energy Spectrum with IceTop-73, *J Phys Rev*, 2013, D88, 042004.

12) Aartsen, MG, et al. (IceCube Collaboration), First Observation of PeV-energy Neutrinos with IceCube, *Phys Rev Lett*, 2013, 111, 021103.

13) Aartsen, MG, et al. (IceCube Collaboration), Measurement of South Pole Ice Transparency with the IceCube LED Calibration System, *Nucl Instrum Methods*, 2013, A711, 73-89.

14) Aartsen, MG, et al. (IceCube Collaboration), All-Particle Cosmic Ray Energy Spectrum Measured with 26 IceTop Stations, *Astropart Phys*, 2013, 44, 40-58.

15) Aartsen, MG, et al. (IceCube Collaboration), Measurement of the Atmospheric v_e Flux in IceCube, *Phys Rev Lett*, 2013, 110, 151105.

16) Aartsen, MG, et al. (IceCube Collaboration), An Improved Method for Measuring Muon Energy Using the Truncated Mean of dE/dx, *Nucl Instrum Methods*, 2013, A703, 190-198.

17) Aartsen, MG, et al. (IceCube Collaboration), Observation of Cosmic Ray Anisotropy with the IceTop Air Shower Array, *Astrophys J*, 2013, 765, 55.

18) Aartsen, MG, et al. (IceCube Collaboration), Search for Dark Matter Annihilations in the Sun with the 79-string IceCube Detector, *Phys Rev Lett*, 2013, 110, 131302.

19) Aartsen, MG, et al. (IceCube Collaboration), Search for Galactic PeV Gamma Rays with the IceCube Neutrino Observatory, *J Phys Rev*, 2013, D87, 062002.

20) Aartsen, MG, et al. (IceCube Collaboration), Cosmic Ray Composition and Energy Spectrum from 1-30 PeV Using the 40-String Configuration of IceTop and IceCube, *Astropart Phys*, 2013, 42, 15-32.

21) Aartsen, MG, et al. (IceCube Collaboration), IceTop: The Surface Component of IceCube, *Nucl Instrum Methods*, 2013, A700, 188-220.

22) Aartsen, MG, et al. (IceCube Collaboration), Lateral Distribution of Muons in IceCube Cosmic Ray Events, *J Phys Rev*, 2013, D87, 022001.

23) Aartsen, MG, et al. (IceCube Collaboration), Search for Relativistic Magnetic Monopoles with IceCube, *J Phys Rev*, 2013, D87, 012005.

24) Aartsen, MG, et al. (IceCube Collaboration), Searches for High-Energy Neutrino Emission in the Galaxy with the Combined IceCube-AMANDA Detector, *Astrophys J*, 2013, 763, 33.

25) Frees, A, et al., Power law scaling for the adiabatic algorithm for search engine ranking, *Phys Rev* A, in press.

26) Rudinger, K, et al., Comparing algorithms for graph isomorphism using discrete- and continuous-time quantum random walks, *J Comp Theory Nanosci*, 2013, 10, 1653-1661.

27) Chua, Y, et al., Incommensurate phases of a supported nanoparticle film subjected to uniaxial compression, *PNAS*, 2013, 110, 824—831.

28) Dentico, D, et al., Reversal of cortical information flow during visual imagery as compared to visual perception, *NeuroImage,* in review.

29) Piantoni, G, et al., Disrupted directed connectivity along the cingulate cortex determines vigilance after sleep deprivation, *NeuroImage*, 2013, 79, 213-222.

30) Chang, JY, et al., Sparse multivariate autoregressive models with exogenous inputs for modeling intracerebral responses to direct electrical stimulation of the human brain, *Asilomar Conference on Signals, Systems, and Computers*, 2013.

31) Hinckley, DM, et al., Coarse-grained Modeling of DNA Oligomer Hybridization: Length, Sequence, and Salt Effects, *J Chem Phys*, in review.

32) Freeman, GS, et al., DNA shape dominates sequence affinity in nucleosome formation, *Phys Rev Lett*, in review.

33) Hinckley, DM, et al., An experimentally-informed coarse-grained 3-site-per-nucleotide model of DNA: Structure, thermodynamics, and dynamics of hybridization, *J Chem Phys*, 2013, 139, 144903.

34) Whitmer, JK, et al., Nematic-Field-Driven Positioning of Particles in Liquid Crystal Droplets, *Phys Rev Lett*, 2013, 111, 227801.

35) Qin, K, et al., Evolutionary pattern design for copolymer directed self-assembly, *Soft Matter*, 2013, 9, 11467-11472.

36) Kwak, I-Y, et al., Mapping quantitative trait loci underlying function-valued phenotypes, in preparation.

37) Moore CR, et al., High-throughput computer vision introduces the time axis to a quantitative trait map of a plant growth response, *Genetics,* 2013, 195, 1077-086.

38) Wellons, M, et al., Improvement in Fast Particle Track Reconstruction with Robust Statistics. *Nuclear Inst and Methods*, in print.

39) Wellons, M, et al., Robust Statistics in IceCube Initial Muon Reconstruction, *International Cosmic Ray Conference*, 2013.

40) Govindaraju, V, et al., Understanding Tables in Context Using Standard NLP Toolkits, *ACL*, 2013, short paper.

41) Zhang, C, et al., GeoDeepDive: Statistical Inference using Familiar Data-Processing Languages, *SIGMOD 13*, demo.

42) Frank, JR, et al., Building an Entity-Centric Stream Filtering Test Collection for TREC 2102, *TREC 2013*.

43) Zhang, C, and Ré, C, Towards High-Throughput Gibbs Sampling at Scale: A Study across Storage Managers, *SIGMOD 2013*.

44) Hall, G, et al., Simultaneous determination of the Second Harmonic Generation emission directionality and reduced scattering coefficient from 3D imaging of thick tissues, *J Biomed Optics*, 2013, 18, 116008.

45) Price, C, and Perkins, NB, Finite temperature phase diagram of the classical Kitaev-Heisenberg model, *Phys Rev B*, 2013, 88, 024410.

46) Churchill, TH, et al., Speech perception in noise with a harmonic complex excited vocoder, *JARO*, in press.

47) Geng, Z, and Wahba, G. Group variable selection via convex Log-Exp-Sum penalty with application to a breast cancer survivor study, *Biometrics*, in revision.

(repeat from PI: VanVeen; collaboration)

48) Dentico, D, et al., Reversal of cortical information flow during visual imagery as compared to visual perception, *NeuroImage,* in review.

49) Mondal, J, et al., Self-Assembly of Gemini Surfactants: A Computer Simulation Study, *J Phys Chem B*, 2013, 117, 4254-4262.

50) Chakraborty, B, et al., Inference for Optimal Dynamic Treatment Regimes using an Adaptive m-out-of-n Bootstrap Scheme, *Biometrics*, 2013, 69, 714-723.

51) Moore CR, et al., High-throughput computer vision introduces the time axis to a quantitative trait map of a plant growth response, *Genetics,* 2013, 195, 1077-086.

(repeat from PI: Edgar Spalding; collaboration)

52) Moore CR, et al., Mapping quantitative trait loci affecting *Arabidopsis thaliana* seed morphology features extracted computationally from images, *G3: Genes, Genomes, Genetics*, 2013, 3, 109-118, cover feature.

53) McDaniel, JG and Schmidt, JR, Physically-Motivated Force Fields from Symmetry-Adapted Perturbation Theory, *J Phys Chem A*, 2013, 117, 2053-2066.

54) McDaniel, JG, et al., Microscopic Origins of Enhanced Gas Adsorption and Selectivity in Mixed-Linker Metal-Organic Frameworks, *J Phys Chem C*, 2013, 117, 17131-17142.

55) Christianson, J, et al., Mechanism of N_2 Reduction to NH_3 by Aqueous Solvated Electrons, *Phys Chem B*, 2014, 118, 195-203.

56) Gandhi, A, and Serrano-Padial, R, Belief Heterogeneity Explain Asset Prices: The Case of the Longshot Bias, *Rev Econ Stud*, in press.

57) Wang, X, et al., Correlation of Cognitive Function with Ultrasound Strain Indices in Carotid Plaque, *Ultrasound Med Biol*, 2014, 40, 78-89.

58) Ma, C, and Varghese, T, Analysis of Two-Dimensional Ultrasound Cardiac Strain Imaging using Joint Probability Density Functions, *Ultrasound Med Biol*, in press.

59) Rao, N, et al., Sparse Overlapping Sets Lasso for Multitask Learning and its Application to fMRI Analysis, *Adv Neur In*, 2013, 26.

60) Wright, ES, et al., Exploiting Extension Bias in PCR to Improve Primer Specificity in Ensembles of Nearly Identical DNA Templates, *Environ Microbiol,* 2013, 12259.

61) Lauck, M, et al., Discovery and full genome characterization of two highly divergent simian immunodeficiency viruses infecting black-and-white colobus monkeys (Colobus guereza) in Kibale National Park, Uganda, *Retrovirology*, 2013, 10, 107.

UCSDGrid

1) "Evidence for Gravitational Lensing of the Cosmic Microwave Background Polarization from Cross-correlation with the Cosmic Infrared Background"
POLARBEAR Collaboration, P.A.R. Ade *et al.*
arXiv:1312.6645

2) "Gravitations Lensing of Cosmic Microwave Background Polarization"
POLARBEAR Collaboration, P.A.R. Ade *et al.*
arXiv:1312.6646 (submitted for publication)

3) Les Houches Workshop on "Physics at TeV Colliders", Proceedings 2013. (in preparation)

4) Press release about collaboration between UCSD/SDSC/OSG to make Gordon accessible to CMS.
http://ucsdnews.ucsd.edu/pressrelease/sdscs_gordon_supercomputer_assists_in_crunching_large_hadron_collider_data

University of Notre Dame

1) P. Brenner, D. Thain, K. Lannon and D. Skeehan, Opportunistic High Energy Physics Computing in User Space with Parrot, accepted for CCGrid 2014;

Holland Computing Center

1) Huang, Xin, Huang, Lin, Peng, Hong, Guru, Ashu, Xue, Weihua, Hong, Sang Yong, Liu, Miao, Sharma, Seema, Fu, Kai, Caprez, Adam P., Swanson, David R., Zhang, Zhixing and Ding, Shi-Jian, ""ISPTM: an Iterative Search Algorithm for Systematic Identification of Post-translational Modifications from Complex Proteome Mixtures," *Journal of Proteome Research ,* vol. 12 , no. 9, 2013, pp. 3831-3842, doi:10.1021/pr4003883.http://pubs.acs.org/doi/abs/10.1021/pr4003883

OSG VO - User Support

BNL-PET

1) Vaska P, Schulz D: The challenges and rewards of behavioral neuroimaging. Neurotoxicology and Teratology 2013; 37: 82-83.

2) Vaska P, Cao T: The State of Instrumentation for Combined Positron Emission Tomography and Magnetic Resonance Imaging. Seminars in Nuclear Medicine 2013; 43(1): 11-18.

3) Purschke ML, Babst B, Budassi M, Cao T, Fried J, Schlyer D, Stoll S, Vaska P, Woody C: The PET Scanner for Plants at the Brookhaven National Laboratory. IEEE Nuclear Science Symposium and Medical Imaging Conference, vol N33-6. Seoul, Korea, 2013.

4) Cao T, Mitra S, Vaska P: A Time-of-Flight Neutron Activation Method for Measuring Trace Element Concentrations in vivo. IEEE Nuclear Science Symposium and Medical Imaging Conference, vol M21-58. Seoul, Korea, 2013.

5) Cao T, Azmoun B, Stoll S, Purschke ML, Babst B, Vaska P, Woody CL: A Study of a GEM Tracking Detector for Imaging Positrons from PET Radioisotopes in Plants. IEEE Nuclear Science Symposium and Medical Imaging Conference, vol M21-52. Seoul, Korea, 2013.

6) Budassi M, Stoll SP, Purschke ML, Fried J, Babst BA, Ferrieri RA, Woody CL, Vaska P, Schlyer DJ: Imaging Performance of the BNL PET Imaging System for Plant Science. IEEE Nuclear Science Symposium and Medical Imaging Conference, vol M16-22. Seoul, Korea, 2013.

detectorDesign

1) J. Strologas, S. Metzler, X. Zheng, W. Chang, "Optimizing Collimator Resolution/Sensitivity in SPECT Iterative Reconstruction", 2013 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC).

2) J. Strologas, S. Metzler, X. Zheng, W. Chang, "Image-Quality Effects of System-Matrix-Formation Statistics in SPECT Iterative Reconstruction", 2013 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC).

Duke-QGP

1) Dissecting galaxy formation models with Sensitivity Analysis -- A new approach to constrain the Milky Way formation history - Gómez, Facundo A. *et al.* arXiv:1311.2587 [astro-ph.GA]

2) Systematic Monte-Carlo studies of dijets at RHIC using the VNI/BMS parton cascade - Coleman-Smith, C.E. *et al.* Nucl.Phys. A904-905 (2013) 759c-762c

3) A 'Helium Atom' of Space: Dynamical Instability of the Isochoric Pentahedron - Coleman-Smith, C.E. *et al.* Phys.Rev. D87 (2013) 044047 arXiv:1212.1930

EIC

1) The dipole model Monte Carlo generator Sartre 1 Tobias Toll, Thomas Ullrich. Jul 30, 2013. 20 pp. e-Print: arXiv:1307.8059 [hep-ph]

Pheno@SLAC

1) M. Cahill-Rowley, J. Hewett, S. Hoeche, A. Ismail, T. Rizzo, The New Look pMSSM with Neutralino and Gravitino LSPs", Eur.Phys.J. C72 (2012) 2156, DOI: 10.1140/epjc/s10052-012-2156-1, SLAC-PUB-14922, http://inspirehep.net/record/1118828

2) S. Hoeche, F. Krauss, M. Schonherr, F. Siegert, "QCD matrix elements + parton showers: The NLO case", SLAC-PUB-15191, IPPP-12-52, DCPT-12-104, LPN12-081, FR-PHENO-2012-017, MCNET-12-09, http://inspirehep.net/record/1123387 (in review)

Snowmass/ECFA

1) Avetisyan, J. Campbell, T. Cohen et al., "Methods and Results for Standard Model Event Generation at $\sqrt{s}$ = 14 TeV, 33 TeV and 100 TeV Proton Colliders (A Snowmass Whitepaper)", arXiv:1308.1636v2 [hep-ex]

2) Avetisyan, T. Bose, "Search for top partners with charge 5e/3", arXiv:1309.2234v1 [hep-ex] M. Berggren, T. Han, J. List et al., "Electroweakino Searches: A Comparative Study for LHC and ILC (A Snowmass White Paper)", arXiv:1309.7342v1 [hep-ph]

3) E. Brownson, N. Craig, U. Heintz et al., "Heavy Higgs Scalars at Future Hadron Colliders (A Snowmass Whitepaper)", arXiv:1308.6334v2 [hep-ex]

4) The CMS Collaboration, "Performance studies on the search for 2HDM neutral Higgs bosons with the CMS Phase-II detector upgrades", CMS PAS FTR-13-024, 2013, http://cds.cern.ch/record/1607086

5) The CMS Collaboration, "Projections for Top FCNC Searches in 3000/fb at the LHC", CMS PAS FTR-13-016, 2013, http://cds.cern.ch/record/1605885

6) The CMS Collaboration, "Sensitivity study of the prospects for searching for heavy vector-like charge 2/3 quarks at p s = 14 TeV with the upgraded CMS detector", CMS PAS FTR-13-026, 2013, http://cds.cern.ch/record/1605864

7) The CMS Collaboration, "Studies of the performances of the H -> ZZ 4 m analysis with the CMS Phase II detector upgrade", CMS PAS FTR-13-003, 2013, http://cds.cern.ch/record/1607076

8) The CMS Collaboration, "Study of the Discovery Reach in Searches for Supersymmetry at CMS with 3000/fb", CMS-PAS-FTR-13-014, 2013, http://cds.cern.ch/record/1607141

9) T. Cohen, T. Golling, M. Hance et al., "A Comparison of Future Proton Colliders Using SUSY Simplified Models: A Snowmass Whitepaper", arXiv:1310.0077v2 [hep-ph]

10) T. Cohen, T. Golling, M. Hance et al., "SUSY Simplified Models at 14, 33, and 100 TeV Proton Colliders", arXiv:1311.6480v1 [hep-ph]

11) Drueke, B. Schoenrock, B. Alvarez Gonzalez, R. Schwienhorst, "Searches for resonances in the tb and tc final states at the high-luminosity LHC", arXiv:1309.7043v2 [hep-ex]

12) D. Duggan, J. A. Evans, J. Hirschauer et al., "Sensitivity of an Upgraded LHC to R-Parity Violating Signatures of the MSSM", arXiv:1308.3903v1 [hep-ph]

13) T. Han, S. Padhi, S. Su, "Electroweakinos in the Light of the Higgs Boson", arXiv:1309.5966v1 [hep-ph]

14) Iashvili, S. Jain, A. Kharchilava, H. B. Prosper, "Discovery potential for heavy t-tbar resonances in dilepton+jets final states", arXiv:1309.7684v1 [hep-ex]

15) Okawa, J. Kunkle, E. Lipeles, "Prospects on the search for invisible Higgs decays in the ZH channel at the LHC and HL-LHC: A Snowmass White Paper", arXiv:1309.7925v1 [hep-ex]

16) P. Onyisi, R. Kehoe, V. Rodriguez, Y. Ilchenko, "Analysis of t tbar H Events at sqrt(s)=14 TeV with H -> WW", arXiv:1307.7280v2 [hep-ex]

17) E. W. Varnes, "Vector-like B pair production at future pp colliders", arXiv:1309.0788v2 [hep-ex]

18) J. Vasquez, J. Adelman, A. Loginov, P. Tipton, "Study of ttH (H mu mu) in the three lepton channel at sqrt(s) = 14 TeV; A Snowmass white paper", arXiv:1310.1132v1 [hep-ex]

UMich

1) Marino S, Fallahi-Sichani M, Linderman JJ, Kirschner DE. "Mathematical models of anti-TNF therapies and their correlation with tuberculosis", in Antibody-mediated Drug Delivery Systems: Concepts, Technology and Applications, Y. Pathak and S. Benita, eds. John Wiley and Sons, 2012. Published Online: 23 APR 2012, DOI: 10.1002/9781118229019.ch5.
2) Gong C, Mattilla JT, Miller M, Flynn J, Linderman JJ, Kirschner DE. Predicting lymph node output efficiency through systems biology. *J Theoretical Biology 335*: 169-184, 2013.

3) Myers AJ, Marino S, Kirschner DE, Flynn JL, Inoculation Dose of Mycobacterium tuberculosis Does Not Influence Priming of T Cell Responses in Lymph Nodes, J Immunol. 2013 Apr 1 [Epub ahead of print], PMID: 23547119, PMCID: n/a

4) Gong C, Linderman JJ, Kirschner DE, "Harnessing the heterogeneity of T cell differentiation fate to fine-tune generation of effector and memory T cells", submitted.

5) Kirschner DE, Hunt CA, Marino S, Fallahi-Sichani M, Linderman JJ. "Tuneable resolution as a systems biology method for multi-scale, multi-compartment computational models, submitted.

6) Linderman JJ, Kirschner DE. "In silico models of *M. tuberculosis* infection provide a route to new therapies", submitted.

In preparation:

7) Pienaar, E et al "Failed treatment in TB results from pre-treatment granuloma bacterial levels and sub-optimal abx concentrations within granulomas"

8) Marino, S et al "Macrophage polarization drives granulomaoutcome during *Mycobacterium tuberculosis* infection"

9) Marino, S et al "Limited frequency of cytokine-producing T cells in tuberculosis lung granulomas"

10) Marino, S et al "A two-pronged data-mining approach to biomarker discovery in Tuberculosis using both NHP and computational model"

UPRRP-MR – Preparation

1) The neutral emergence of phenotypic robustness is unaccompanied by coding robustness in single domain proteins, Pagan, R.F., Medina-Cruz, A., Orozco, E., Velev, J., Massey, S.E.