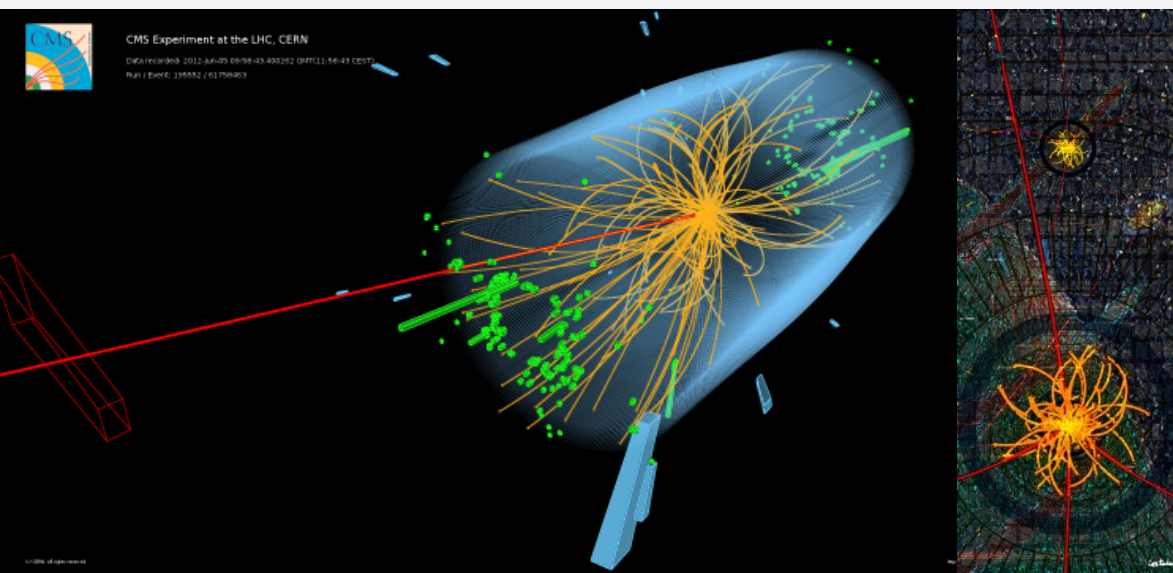




The next five years: U.S. CMS

Ken Bloom

8 October 2015





CMS science needs computing

- The scientific problems of particle physics are naturally addressed through high-throughput computing
 - Has been true since long before we knew what “high-throughput computing” actually was!
 - Individual particle interactions (“events”) are statistically independent, and can thus be analyzed in an embarrassingly parallel fashion
- The scale of the data naturally lends itself to HTC
 - CMS expects to record 9.2 PB of raw data in 2015-17
 - Data are then reconstructed, secondary datasets created
 - Simulations data have similar size and processing needs
 - Overall CMS computing needs by 2017: 1692 kHS06 \approx 155,000 batch slots, 115 PB disk, 193 PB archival storage



On the grid

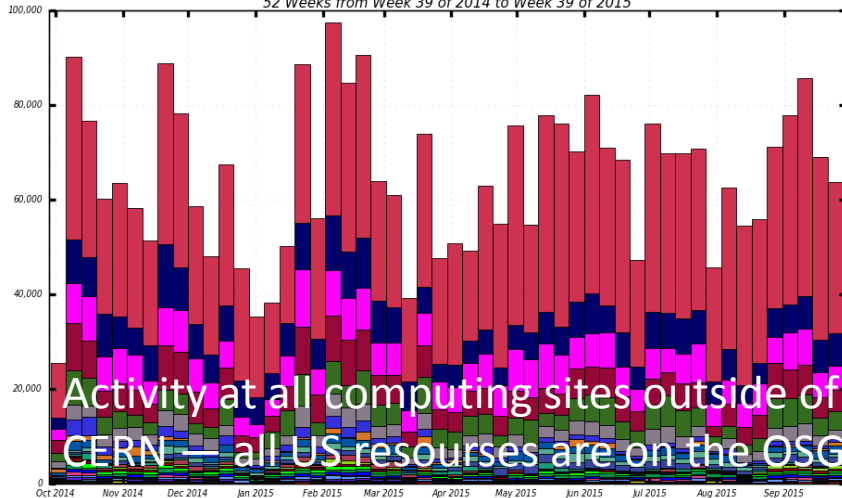
- The political nature of the LHC collaborations lends itself to *distributed* HTC
- 78% of the processing and 85% of the storage live outside of CERN, the host lab for the experiment.
 - 7 “Tier-1” sites in 7 countries
 - 24x7 support, archival tape
 - Fermilab T1 on the OSG, largest single CMS computing site
 - ~50 “Tier-2” sites in 24 countries
 - Business hour support
 - 8 U.S. and 2 Brazil sites on OSG
 - And numerous “Tier-3” sites at universities
- The U.S. sites comprise ~40% of the CMS computing resources outside of CERN
- And U.S. sites provide (28+10)% of OSG computing hours
- U.S. CMS is a very important customer, and OSG provides critical support to fulfilling CMS science goals



Usage in the last year

dashboards

Running jobs
52 Weeks from Week 39 of 2014 to Week 39 of 2015



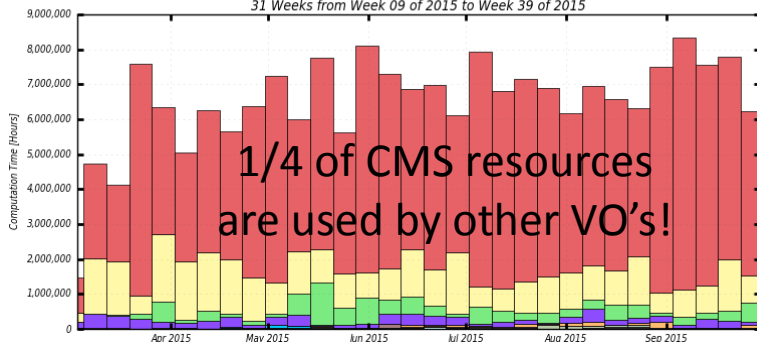
Activity at all computing sites outside of CERN — all US resources are on the OSG



- USA
- SPAIN
- GERMANY
- RUSSIA
- TAIWAN
- BRAZIL
- UKRAINE
- MEXICO
- ESTONIA
- AUSTRIA
- HUNGARY
- INDIA
- BELARUS
- UNITED KINGDOM
- BELGIUM
- POLAND
- PORTUGAL
- None
- NEW ZEALAND
- FRANCE
- SWITZERLAND
- FINLAND
- CHINA
- PAKISTAN

Maximum: 97,443, Minimum: 0.00, Average: 61,181, Current: 11,159

Hours Spent on Jobs By VO
31 Weeks from Week 09 of 2015 to Week 39 of 2015



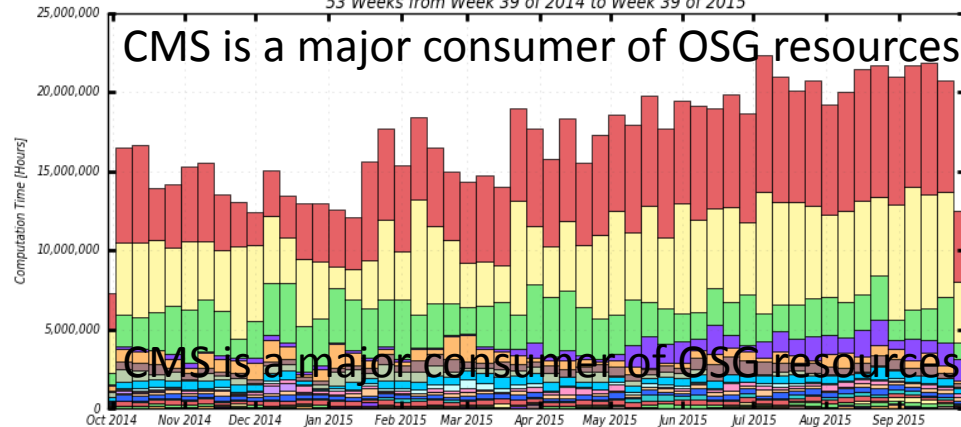
1/4 of CMS resources are used by other VO's!

- cms
- atlas
- hcc
- nees
- osg
- lc
- seaqwest
- nanohub
- mu2e
- cdf
- gluex
- ligo
- glow
- nova
- genie
- fermilab
- sbgrid
- UCSD
- dune

Maximum: 8,344,933 Hours, Minimum: 1,467,601 Hours, Average: 6,510,247 Hours, Current: 6,217,299 Hours

Computation Hours Per Week

53 Weeks from Week 39 of 2014 to Week 39 of 2015



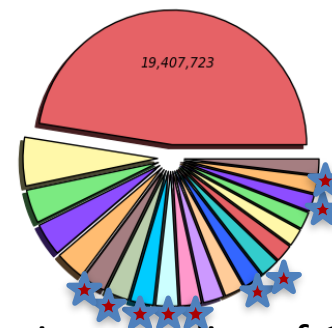
CMS is a major consumer of OSG resources

CMS is a major consumer of OSG resources

- atlas
- nova
- dzero
- seaquest
- cms
- minerva
- Other
- osg
- dosar
- gridunesp
- darkside
- mu2e
- cdf
- mars
- sbgrid
- glow
- dune
- alice
- microboone

Maximum: 22,324,949 Hours, Minimum: 7,270,103 Hours, Average: 16,938,974 Hours, Current: 12,538,763 Hours

Wall hours by facility (Total: 40,005,120 hours)
14 Days from 2015-09-15 to 2015-09-29

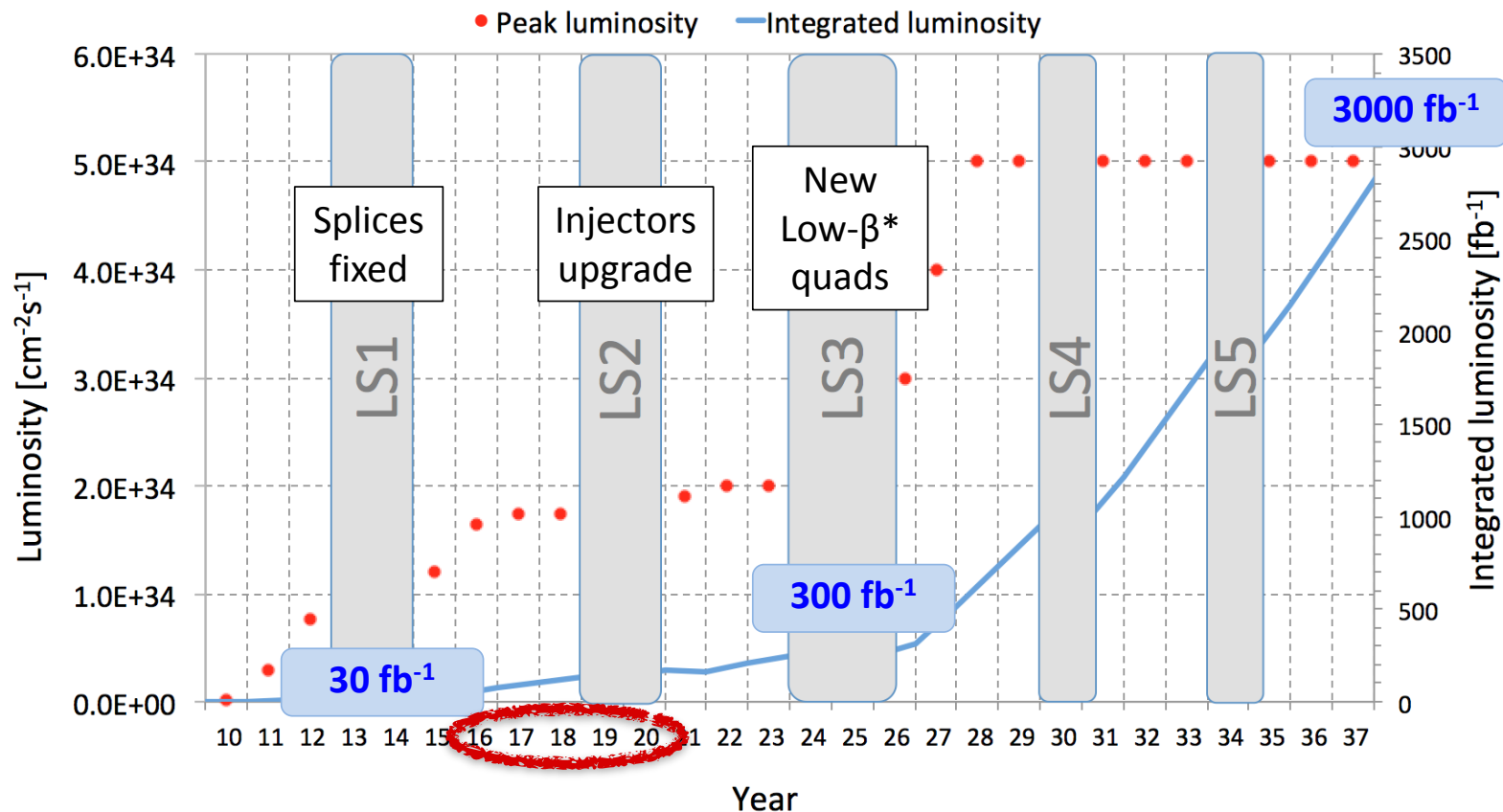


CMS is a major supplier of OSG resources

- Other (19,407,723)
- SU-OG-CE (2,381,444)
- USCMS-FNAL-WC1-CE2 (1,173,027)
- Purdue-Hadoop-CE (1,099,349)
- CIT_CMS_T2 (937,748)
- NET2 (837,819)
- MW2T_CE_UC (1,643,103)
- USCMS-FNAL-WC1-CE (1,137,351)
- OU_OSCER_ATLAS (1,015,678)
- MW2T_CE_UiUC (864,122)
- UFlorida-HPC (822,198)
- AGLT2_SL6 (1,609,133)
- USCMS-FNAL-WC1-CE4 (1,133,614)
- BNL_ATLAS_6 (960,610)
- FNAL_GPGRID_QUOTA_3 (859,739)
- NET2_HU (773,738)



Only the beginning



- The LHC will operate for at least 20 more years, with ever-growing datasets of ever-growing complexity, requiring growing computing resources and calling for continuous improvements in computing ingenuity!



Evolution on the horizon

- Original LHC computing models were very static
 - Known resource providers with well-understood computing tasks
 - Fixed amount of computing resources “pledged” to experiment
 - Resources themselves were very standardized
 - Activity of a given job largely contained within a given site
- Changing to a much more dynamic model
 - Much more fluidity in the tasks performed at a given site, so site capabilities must be more generic
 - Resources owned by the experiment might not be sufficient to support the physics needs, so need to explore other providers
 - Those “other providers” might run a greater diversity of computing architectures
 - Growing use of data federations will lead to greater activity across wide-area networks — the many distributed computing sites will act more and more like one single facility?



Where can U.S. CMS work with OSG?

- Access to a greater variety of resources outside the WLCG system
 - Resources where we may get a special allocation, like SDSC
 - Cloud-like resources, be they opportunistic or for rent
 - HPC architectures, such as those being made available to us by DOE ASCR (e.g. NERSC/ANL/ORNL)
- Elastic resources
 - Sites that are “ours” may want to provision resources differently
 - Fermilab HEPCloud project seeks to straightforwardly expand their resources by adding in e.g. cloud resources when it is favorable to do so to meet demand
 - ◎ Will be testing it this fall with expansion into AWS
 - Gives the T1 site more flexibility for how they provide resources
- Pilot job systems such as glideinWMS will enable CMS to take advantage of both of these cases
 - CMS relies on glideinWMS in many places and I expect that we will continue to do so; we invest some of our own effort in development



Where can U.S. CMS work with OSG?

- Individual universities are important players for U.S. CMS and have resources to use and perhaps share
 - The “Tier-3 sites”, resources controlled by and/or made available to individual small research groups for their own benefit
 - Can range from small clusters maintained by physicists, to portions of massive campus-wide centers
 - Could be guaranteed share, or opportunistic
- Want to enable campus physicists to take advantage of any resources made available to them
- CMS usage of campus resources can be a beachhead for OSG — a way to introduce university IT organizations to the power of DHTC and then add them to the OSG community



Outlook

- CMS remains an example of what the OSG was built to serve, and OSG has served it extremely well
 - Provides the underlying computing fabric that has enabled physics discoveries
- CMS has also made great contributions to OSG in the form of resources, expertise and innovation
- The next five years will probably see much greater fluidity and diversity in available computing resources and how they might be used by CMS
- Perhaps this presents a challenge to OSG, but the opportunities presented are surely even greater!