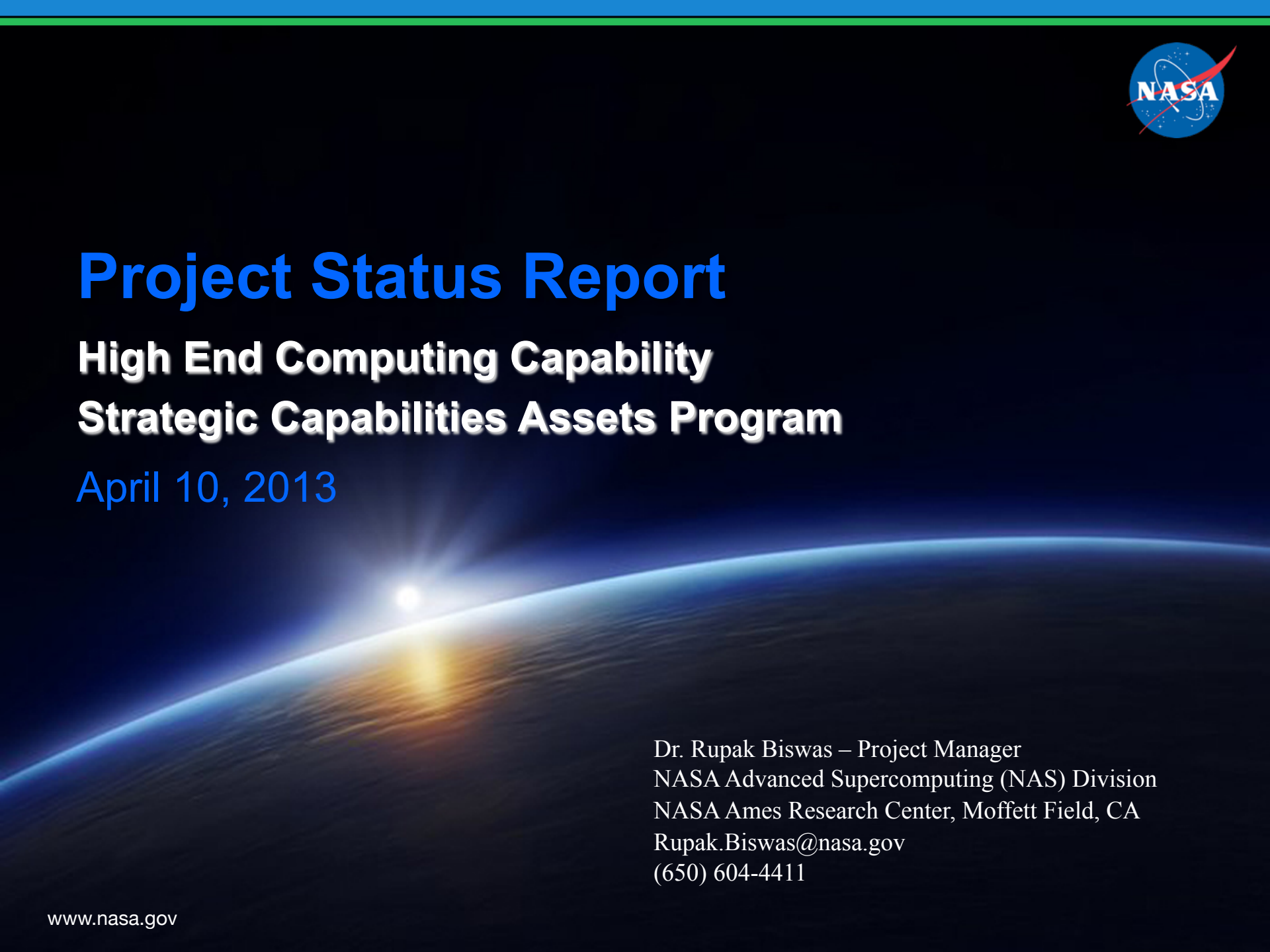


# Project Status Report

## High End Computing Capability
## Strategic Capabilities Assets Program

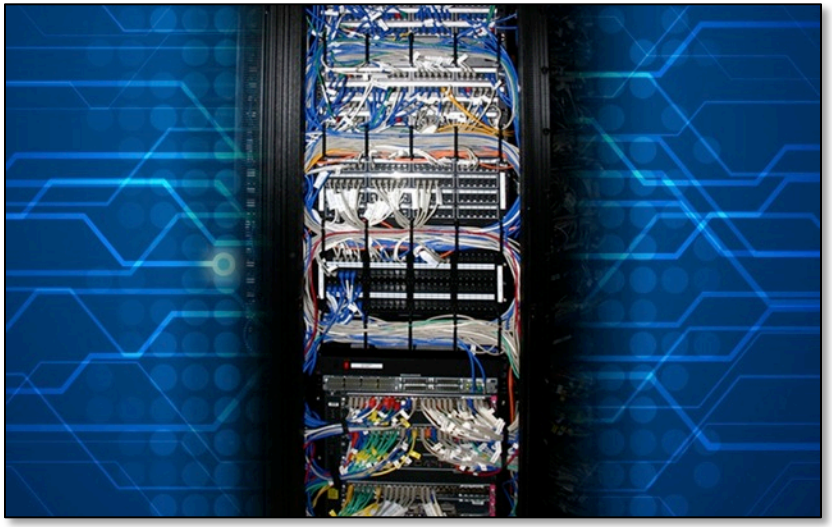
April 10, 2013

Dr. Rupak Biswas – Project Manager
NASA Advanced Supercomputing (NAS) Division
NASA Ames Research Center, Moffett Field, CA
Rupak.Biswas@nasa.gov
(650) 604-4411

# New Utility Identifies Most Active Data Transfers, Aids in Optimization

- The HECC Networks team developed a new utility that provides daily email reports listing the 20 largest data transfers between the NASA Advanced Supercomputing facility's local area network (NASLAN) and remote systems.
- This capability allows the team to ensure that large data transfers are optimized, minimizing the time taken to move data between sites.
- The utility also reports on the applications used for large data transfers so that HECC code optimization experts can make sure the applications are properly tuned and supported.
- In addition, the utility provides engineers with more granular data for monthly network reports.
- This additional capability enhances the ability of the HECC team to take a proactive approach that often addresses issues before the user sees the problem.

**Mission Impact:** By optimizing the largest storage transfers, HECC reduces congestion and improves data transfers for all users.



Engineers responsible for the NASA Advanced Supercomputing facility's local area network (NASLAN) continually improve the efficiency of end-to-end management of the HECC networking environment.

***POCs:*** Nichole Boscia, nichole.boscia@nasa.gov, (650)-604-0891, Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, NASA Advanced Supercomputing Division, Computer Sciences Corp.

# New Data Analysis Nodes Available for Memory-Intensive Post-Processing Work

- HECC systems engineers deployed 10 data analysis nodes for the Parallel Data Migration Facility (pDMF) virtual storage manager that runs on the mass storage system, Lou2.
- Each of these 10 Intel Sandy Bridge-based nodes has either 96 or 256 gigabytes (GB) of memory; the standard Sandy Bridge compute node has 32 GB. This provides nearly 13x the memory and more than 2.5x cores compared to the previous system. In addition, the Sandy Bridge processors provide a 10x performance improvement over the Itanium processors.
- The new system allows users that need an x86 computing environment to more efficiently post-process their data by eliminating the need to move data to other compute resources.
- When Lou1 users are migrated to the pDMF system in mid-2013, they will be able to use this same functionality; until then, the memory on the Lou1 system has been augmented with memory from the retired Columbia compute nodes.

**Mission Impact:** The archive data analysis nodes save scientists and engineers valuable time by eliminating the need to move large amounts of data for post-processing activities.

The new HECC data analysis nodes contain Intel Xeon E5-2670 (Sandy Bridge) processors (2.6 GHz). Five nodes are equipped with 96 GB of memory; the other five nodes have 256 GB of memory.

***POCs:*** Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

# Filesystem Expansion Will Increase Storage Capacity and File Transfer Performance

- The HECC Supercomputing Systems team recently procured additional Lustre and Network FileSystem (NFS) storage hardware for the Pleiades and Endeavour supercomputers.
- The Lustre filesystem will be augmented with 10.8 petabytes (PB) of storage that will nearly double the storage capacity on the compute systems (to 19 PB raw data). The expansion will increase the random read performance to 70 gigabytes per second (GB/s), and the random write performance to 50 GB/s. The expansion will provide a 1.7x improvement on write and a 1.4x improvement on read performance compared to the current storage system.
- For user applications that do not perform well on Lustre, a 1-PB NFS storage solution was procured to complement the Lustre storage; this will replace an existing NFS solution and increase the storage capacity in NFS by 15x.
- The team also procured a dedicated, 400-terabyte NFS storage system to improve workflow between the NASA Earth Exchange (NEX) project's prototyping sandbox resources and Pleiades.

**Mission Impact:** An increase in storage capacity and filesystem performance will enable NASA researchers to better utilize HECC computing resources and run more data-intensive applications.

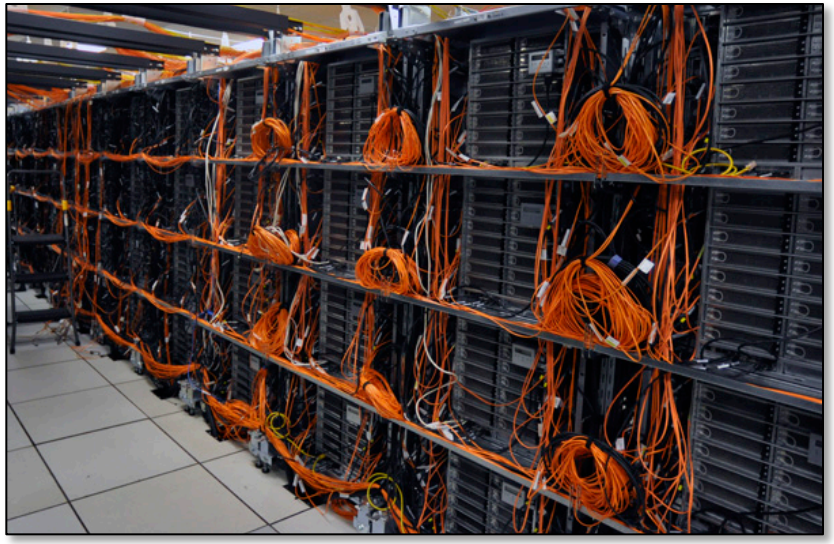
New storage hardware provides the HECC environment with the ability to maximize storage density, reduce operational costs through efficiencies, and increase productivity for users.

***POCs:*** Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

# InfiniBand And Lustre Maintenance Activities Help Ensure Stable Environment

- Recently, the HECC Supercomputing Systems team completed maintenance activities on the InfiniBand network and Lustre servers, with minimal impact to user jobs running on Pleiades and Endeavour.
- The team suspended batch jobs running on the systems—effectively freezing running jobs in place while hardware was replaced and Lustre server software was updated.
- Once maintenance activities were completed, the suspended jobs resumed and continued to run normally; using this method results in significant savings—about 7 million hours—of computing time.
- Of the 485 jobs running on the system, 430 resumed successfully. The majority of unsuccessful restarts were caused by the jobs not registering with PBSPro to handle the suspend signal; this issue is being addressed.

**Mission Impact:** Performing regular system maintenance on HECC supercomputers provides a more stable, reliable computational environment for NASA's scientific and engineering users.



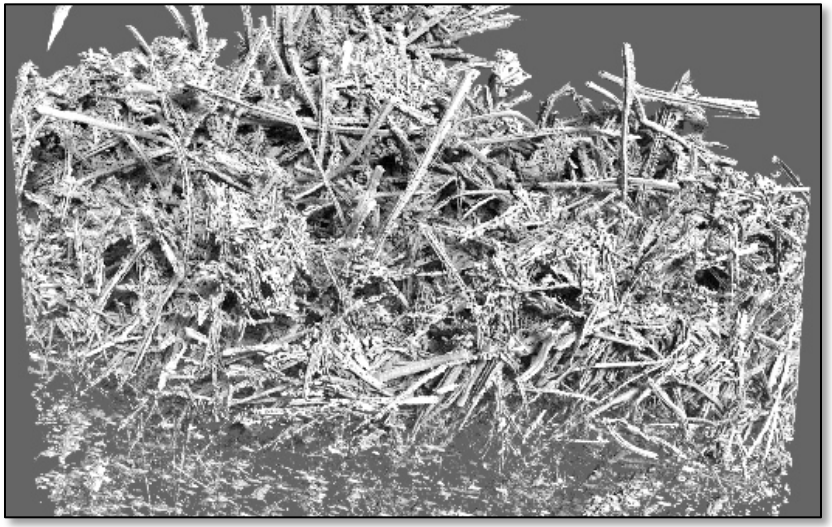
The Pleiades supercomputer (above), along with the new Endeavour system, are connected through the world's largest InfiniBand network, with more than 65 miles of cabling.

***POCs:*** Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

# Visualization Team Helps Scientists Unravel the Secrets of Heatshield Ablation

- The HECC Data Analysis & Visualization team extended the capabilities of an open-source ray tracer (Embree) and used it to reveal complicated structures in tomography scans of Carbon Fiberform used in thermal protection systems (TPS).
- Ray tracing provides ambient occlusion and shadows for better perception of depth and shape.
- The work extended the software by:
  - Adding advanced view/animation capabilities;
  - Adding binary reads for an order-of-magnitude speedup over XML, which enables rendering of isosurfaces with over 100 million triangles—a task that was infeasible prior to this work.
- In-depth oxidation is clearly detected by the new capability, leading to improved understanding and refinement of models for the ablation process.
- The visualization work supports fundamental research under the agency's Hypersonic Entry, Descent, and Landing (HEDL) project. Fiberform is the material used on both the Stardust capsule and Mars Science Lab TPS.

**Mission Impact:** HECC's customized visualization support is enabling scientists to understand how carbon fibers oxidize, and helps to reduce uncertainties and margins in the design of thermal protection systems.



An X-ray micro-tomography scan of Carbon Fiberform (the base substrate for phenolic impregnated carbon ablator, or PICA), shows the micro-structure of the fibers after ablation, or oxidation from below. Ray tracing (shown above) elucidates a level of detail in the complicated structures that has never been seen before. *Tim Sandstrom, NASA/Ames*

***POC:*** Tim Sandstrom, timothy.a.sandstrom@nasa.gov, (650) 604-1429, NASA Advanced Supercomputing Division, Computer Sciences Corp.

# HECC Knowledge Base Updated to Reflect Supercomputing Transition

- The HECC Publications & Media team recently completed a significant revision of the HECC Knowledge Base.
  - The team removed or modified more than 80 articles as part of the effort to decommission the Columbia supercomputer, which was retired in March 2013 after nine years of service.
  - Modifications involved thorough research to identify required changes and rewrites to existing information.
  - The HECC Application Performance and Productivity (APP) team provided inputs and reviewed the updates to ensure technical accuracy.
  - This effort represents the broadest revision to the Knowledge Base since its inception in 2011.
- The team also revised the NAS and HECC websites. Changes included numerous news updates, removal of Columbia usage and system status indicators, and archiving the Columbia resource page.
- The team is currently working with APP to complete another set of additions to the Knowledge Base to provide information for effectively using the newest HECC supercomputer, Endeavour.

**Mission Impact:** Researchers across all NASA Mission Directorates depend on the HECC Knowledge Base for accurate, high-quality user documentation that enables them to access and efficiently utilize HECC supercomputing resources.

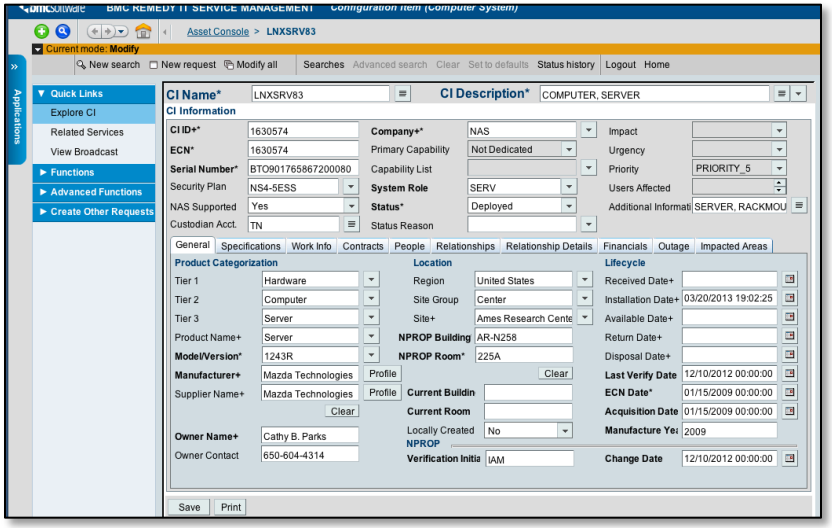

The HECC Knowledge Base provides comprehensive user documentation for all of the supercomputing resources managed by the HECC Project.

***POCs:*** Jill Dunbar, jill.a.dunbar@nasa.gov, (650) 604-3534; Sherry Chang, sherry.chang@nasa.gov, (650) 604-1272, NASA Advanced Supercomputing Division, Computer Sciences Corp.

# Property Data Merged into Remedy Asset Management Tool

- HECC asset data is now downloaded daily from the N-PROP database into the NAS facility's Remedy database to enable association of asset data with trouble tickets and administration of computer systems.
- Enhanced functions enabled by this and other computer data in Remedy include the ability to:
  - Create and relate computer assets to trouble tickets, and track failures and outages of computer assets;
  - Associate racks and components with NASA Equipment Control Numbers (ECNs), and track and view components of computer assets;
  - Link property data with operating systems, IP addresses, host names, software, and additional information stored in Remedy;
  - Report on computer assets based on users, security plan, age, etc.
- The HECC Tools team enhanced the Remedy Asset Management module to include additional fields (e.g., Security Plan, N-PROP location, Custodian) and provided a console for data entry, updates of assets, and to easily generate common reports that had been obtained from the previous stand-alone property database.

**Mission Impact:** Merging property data and system software information into the NASA Advanced Supercomputing facility's Remedy database provides a total view of HECC computer assets and allows the establishment of relationships useful in administering systems and reporting on the assets.




This screen capture shows some of the data fields pulled from N-PROP and made available for a HECC computer asset in the NASA Advanced Supercomputing (NAS) facility's Remedy database.

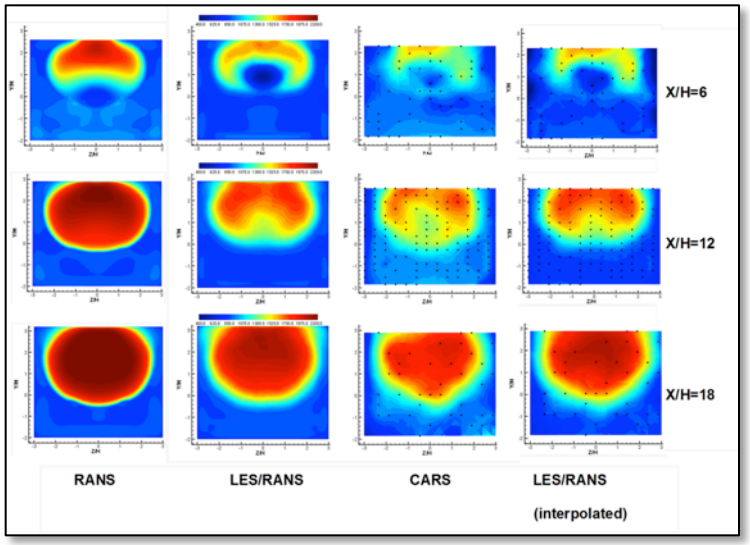
***POCs:*** Mi Young Koo, mi.y.koo@nasa.gov, (650) 604-4528, NASA Advanced Supercomputing Division, Computer Sciences Corp.; Aqeel Rehman, mohammad.a.rehman@nasa.gov, (650) 604-4566, NASA Advanced Supercomputing Division, Intrinsyx.

# Pleiades Enables Simulation of Hypersonic Turbulent Combustion for Future Aircraft

- Researchers at North Carolina State University (NCSU) are running large-eddy simulations (LES) on Pleiades to support more accurate analysis, design, and optimization of scramjets for NASA's Hypersonics project.
- A scramjet engine can fly five times faster than the speed of sound while operating much more efficiently than a conventional rocket.
- The LES strategy was combined with REACTMB, a parallelized reactive flow solver developed at NCSU that solves the compressible Navier-Stokes equations governing a chemically reactive mixture of gases.
- The solution required tens of thousands of iterations and completed in just a few days on Pleiades—a task that would have been impossible in this timeframe, even on high-end desktop systems.

** HECC provided supercomputing resources and services in support of this work.*

**Mission Impact:** Using HECC's highly parallel compute resources allows researchers to simulate hypersonic flight conditions, paving the way for the use of LES as a predictive tool for analyzing more complex scramjet combustor designs, and reducing costly wind tunnel tests.




Comparison of predicted temperature contours with experimental Coherent Absorption Raman Scattering (CARS) measurements at three cross-flow planes downstream of the injector. From left: Reynolds-averaged Navier-Stokes predictions; large-eddy simulation (LES) predictions; CARS measurements; LES predictions interpolated to CARS measurement points.

***POC:*** Jack Edwards, jredward@ncsu.edu, (919) 515-5264, North Carolina State University

# Interactive Exhibit Highlights Impact of Supercomputing on Science & Engineering

- The HECC Publications & Media team designed, produced, and installed an interactive educational display highlighting the critical role of supercomputers in NASA missions.
- The display, installed at the NASA Ames Exploration Center, which hosts about 55,000 visitors each year, is aimed at middle- and high-school audience and comprises the following elements:
  - Two display cases of supercomputer hardware and network components, labeled with engaging, public-friendly facts;
  - A touch-screen display featuring a fun and challenging supercomputing-related quiz, with answers based on the facts from the display cases;
  - Another touch-screen display offering several short videos, including an introduction by HECC Project Manager Rupak Biswas, scientific visualizations that highlight the real-world benefits of supercomputing, and a 3D flythrough animation of the NAS facility and computer room.
- Exploration Center docents have received very positive feedback about the display from visitors, particularly from students in the target age range.

**Mission Impact:** Engaging students and the public in learning how NASA supercomputing resources and capabilities enable important missions contributes to the agency's education goals, and may inspire the next-generation of technologists, scientists, and engineers.


The 8-ft. by 8-ft. supercomputing display also features large photos depicting HECC hardware and service offerings, and includes convenient document racks where visitors can take home additional information for reference and use in school projects.

***POCs:*** John Hardman, john.p.hardman@nasa.gov, (650) 604-0417; Marco Librero, marco.t.librero@nasa.gov, (650) 604-0434, NASA Advanced Supercomputing Division, Computer Sciences Corp.

# HECC Facility Hosts Several Visitors and Tours in March 2013

- HECC hosted 8 tour groups in March; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - A group of 20 researchers from the U.S. Geological Survey (USGS); NASA Ames is exploring the possibility of having USGS move their Menlo Park offices to the Ames campus, and researchers are interested in possible collaborations involving modeling and simulation on supercomputers;
  - A group involved in a potential Ames-Lawrence Livermore National Laboratory (LLNL) collaboration; LLNL is interested in partnering with Ames in the areas of wind energy modeling and climate modeling with a focus on satellite imaging;
  - A large group of elected officials and staff members from the Second Annual California Aerospace Week event were briefed by HECC staff;
  - Rick Ambrose, Executive Vice President of Lockheed Martin Space Systems Company, and Wanda Sigur, Vice President of Lockheed Martin Civil Space, were briefed on HECC systems.

HECC visualization team lead Chris Henze (far right) shows the results of a climate modeling simulation on the hyperwall to researchers visiting from the U..S Geological Survey, Menlo Park, California.

***POC:*** Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputer Division

# Papers and Presentations

- "**Analysis of present day and future OH and methane lifetime in the ACCMIP simulations**," A. Vouldarakis, V. Naik, J.-F. Lamarque, et al., Atmospheric Chemistry and Physics, vol. 13, pp. 2563-2587, March 5, 2013. *
  *http://www.atmos-chem-phys.net/13/2563/2013/acp-13-2563-2013.html*
- "**Magnetic energy production by turbulence in binary neutron star mergers**," J. Zrake, A. I. MacFadyen, arXiv:1303.1450 [astro-ph.HE], March 6, 2013. *
  *http://arxiv.org/abs/1303.1450*
- "**Propagation into the heliosheath of a large-scale solar wind disturbance bounded by a pair of shocks**," E. Provornikova, M. Opher, V. Izmodenov, G. Toth, Astronomy and Astrophysics, March 6, 2013. *
  *http://www.aanda.org/articles/aa/pdf/forth/aa20892-12.pdf*
- "**Tropospheric ozone changes, radiative forcing and attribution to emissions in the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP)**,"
  D. S. Stevenson, P. J. Young, V. Naik, J.-F. Lamarque, et al., Atmospheric Chemistry and Physics, vol. 13, pp. 3063-3085, March 5, 2013. *
  *http://www.atmos-chem-phys.net/13/3063/2013/*
- "**High-velocity collisions from the lunar cataclysm recorded in asteroidal meteorites**,"
  S. Marchi, et al., Nature Geoscience, vol. 6, pp. 303-307, March 24, 2013. *
  *http://www.nature.com/ngeo/journal/v6/n4/full/ngeo1769.html*

** HECC provided supercomputing resources and services in support of this work*

# Papers and Presentations (Continued)


- "**Temperature and vegetation seasonality diminishment over northern lands**," L. Xu, R. B. Myneni, R. R. Nemani, et al., Nature Climate Change, vol. 3, issue 3, March 10, 2013 *
  *http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate1836.html*
- "**Kepler-68: Three Planets, One with a Density Between that of Earth and Ice Giants,**" R. Gilliand, G. Marcy, …, C. Henze, et al., The Astrophysical Journal, vol. 766, issue 1, March 20, 2013
  *http://iopscience.iop.org/0004-637X/766/1/40/*
- "**The kinematics of the Local Group in a cosmological context**," J. E. Ferero-Romero, Y. Hoffman, et al., arXiv:1303.2690 [astro-ph.CO], March 11, 2012. *
  *http://arxiv.org/abs/1303.2690*
- "**The VIMOS Public Extragalactic Redshift Survey (VIPERS). Galaxy clustering and redshift-space distortions at z=0.8 in the first data release**," S. de la Torre, et al., arXiv:1303.2622 [astro-ph.CO] March 11, 2013. *
  *http://arxiv.org/abs/1303.2622*
- **"Detection of the large scale alignment of massive galaxies at z~0.6**," C. Li, Y. P. Jing, A. Faltenbacher, J. Wang, arXiv:1303.1965 [astro-ph.CO], March 8, 2013. *
  *http://arxiv.org/abs/1303.1965*

** HECC provided supercomputing resources and services in support of this work*

# Papers and Presentations (Continued)

- "**Orbital anisotropy in the cosmological haloes revisited**," R. Wojtak, S. Gottloeber, A. Klypin, arXiv:1303.2056 [astro-ph.CO], March 8, 2013. * *http://arxiv.org/abs/1303.2056*
- "**Three-Dimensional Atmospheric Circulation of Hot Jupiters on Highly Eccentric Orbits,**" T. Kataria, et al., The Astrophysical Journal, vol. 767, no. 1, March 26, 2013. * *http://iopscience.iop.org/0004-637X/767/1/76*
- "**Saturation of the MRI in Strongly Radiation Dominated Accretion Disks**," Y.-F. Jiang, J. M. Stone, S. W. Davis, arXiv:1303.1823 [astro-ph.HE], March 7, 2013. * *http://arxiv.org/abs/1303.1823*
- "**Location of the bow shock ahead of cloud G2 at the Galactic Center**," A. Sadowski, R. Narayan, L. Sironi, F. Ozel, arXiv:1303.3893 [astro-ph.HE], March 15, 2013. * *http://arxiv.org/abs/1303.3893*
- "**The Acceleration of Thermal Protons at Parallel Collisionless Shocks: Three-dimensional Hybrid Simulations**," F. Guo, J. Giacalone, arXiv:1303.5174 [astro-ph.HE], March 21, 2013. * *http://arxiv.org/abs/1303.5174*
- "**Detection of Carbon Monoxide and Water Absorption Lines in an Exoplanet Atmosphere**," Q. M. Konopacky, et al., arXiv:1303.3280 [astro-ph.EP], March 13, 2013. * *http://arxiv.org/abs/1303.3280*

** HECC provided supercomputing resources and services in support of this work*

# Papers and Presentations (Continued)

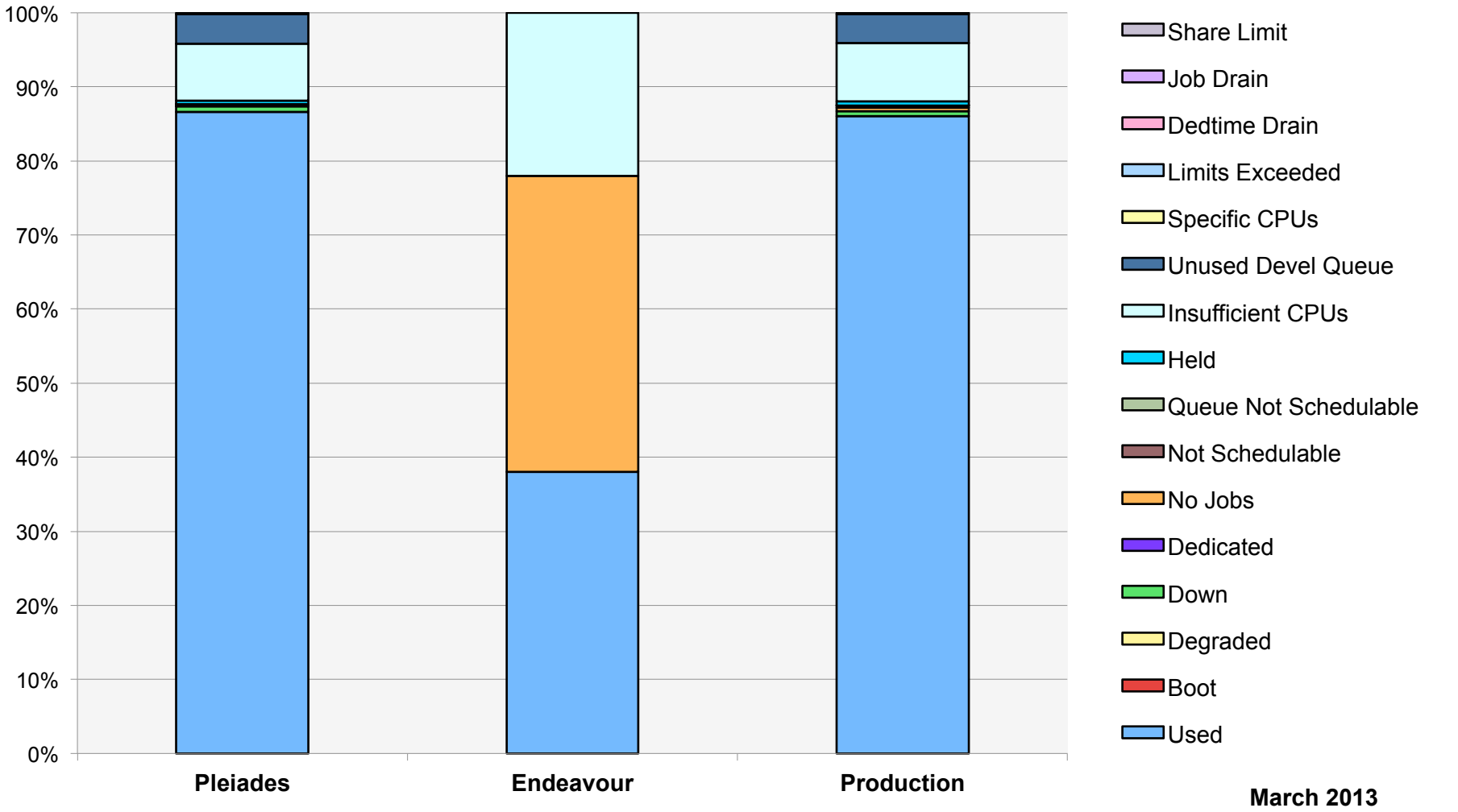
- "**Multi-species turbulent mixing under supercritical-pressure conditions: modeling, direct numerical simulation and analysis revealing species spinodal decomposition**," E. Masi, J. Bellan, K. G. Harstad, N. A. Okong'o, Journal of Fluid Mechanics, vol. 721, pp. 578-626, March 19, 2013. * *http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=8869499*

** HECC provided supercomputing resources and services in support of this work*

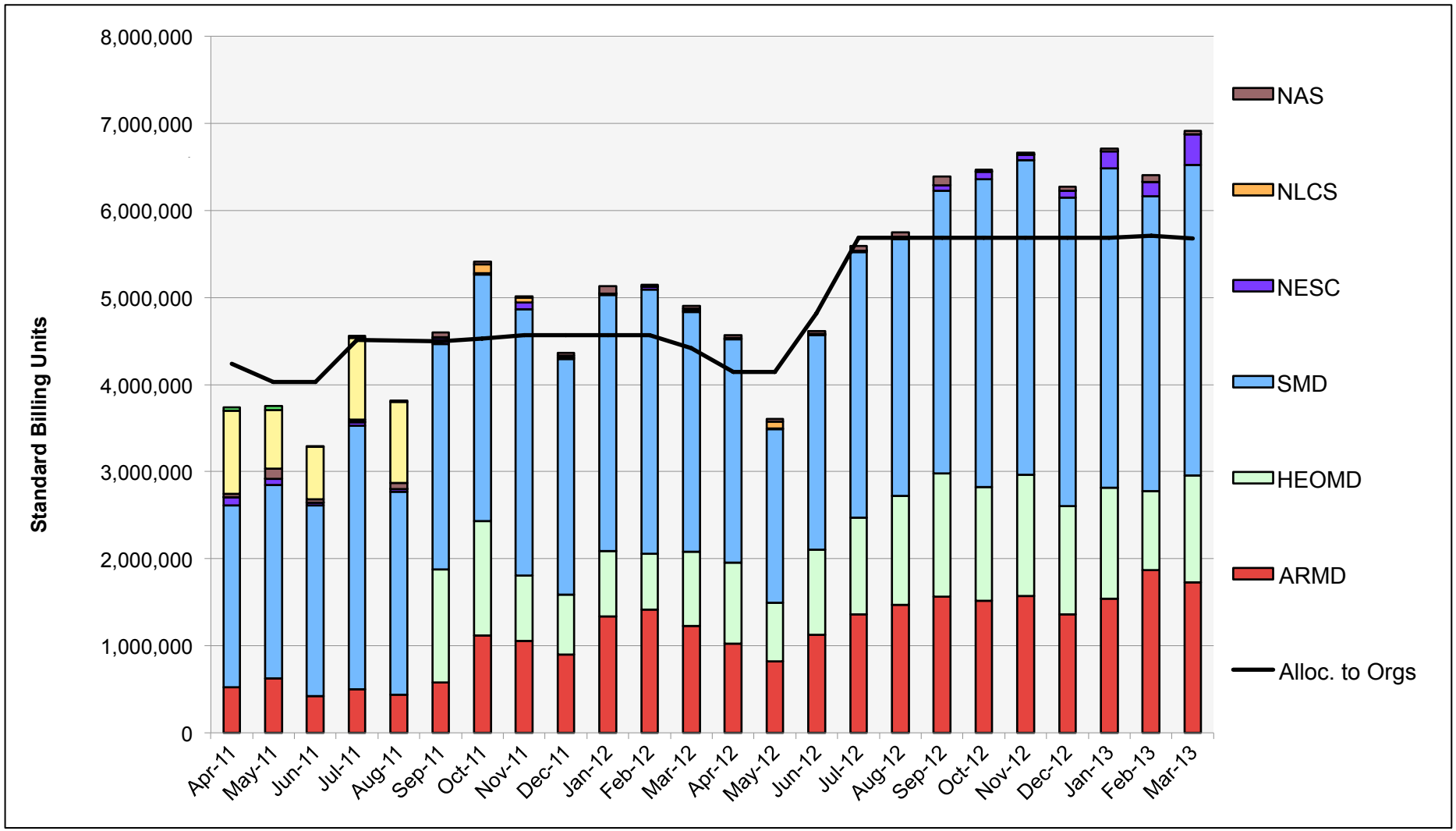
# News and Events

- **Pleiades Models Ocean and Sea Ice System,** *International Science Grid This Week,* March 13, 2013—Dimitris Menemenlis, climate scientist at NASA JPL, talks about the ECCO-IcES project and how the Pleiades supercomputer provides the balanced, high-end computing environment needed to combine the MITgcm and ISSM models used to help understand the forces that create and affect sea-ice at Earth's poles. *http://www.isgtw.org/feature/pleiades-models-ocean-and-sea-ice-system*

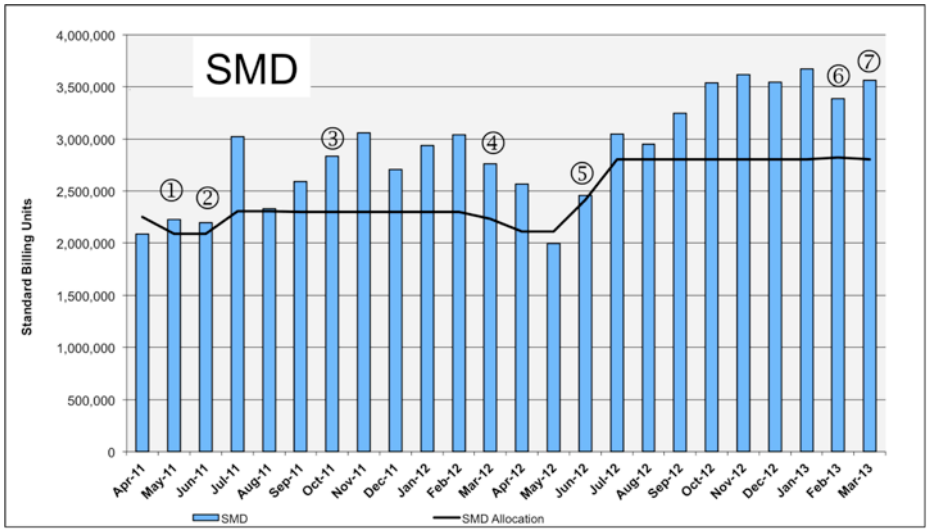
# HECC Utilization

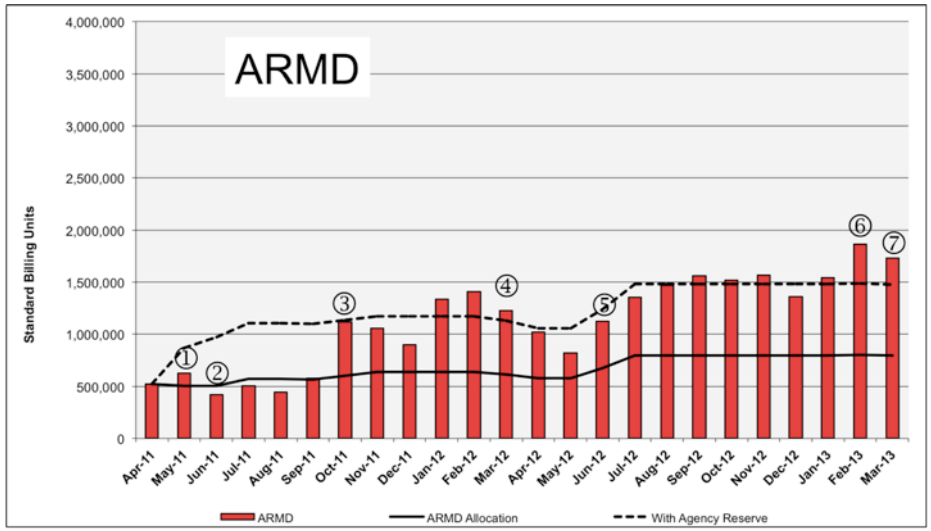


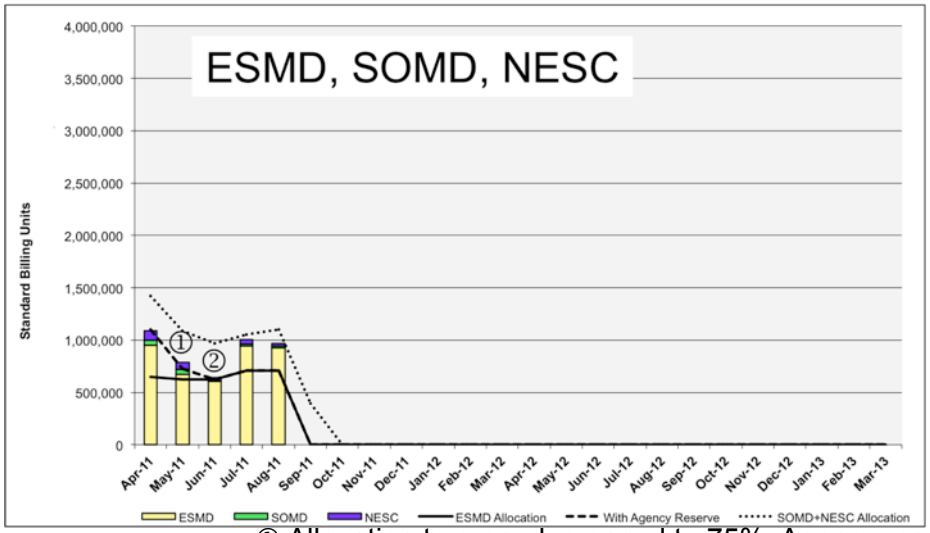
# HECC Utilization
# (Normalized to 30-Day Months)

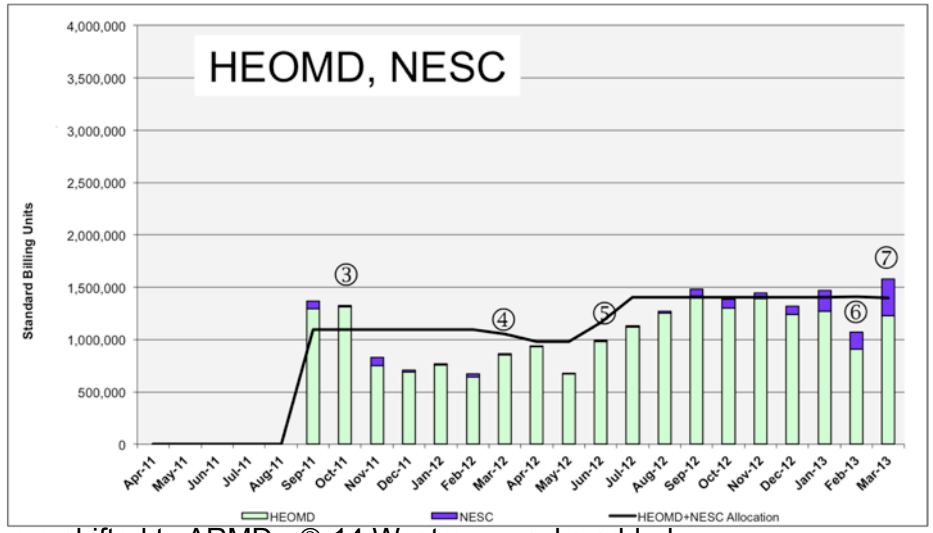


# HECC Utilization by MD (Normalized to 30-Day Months)



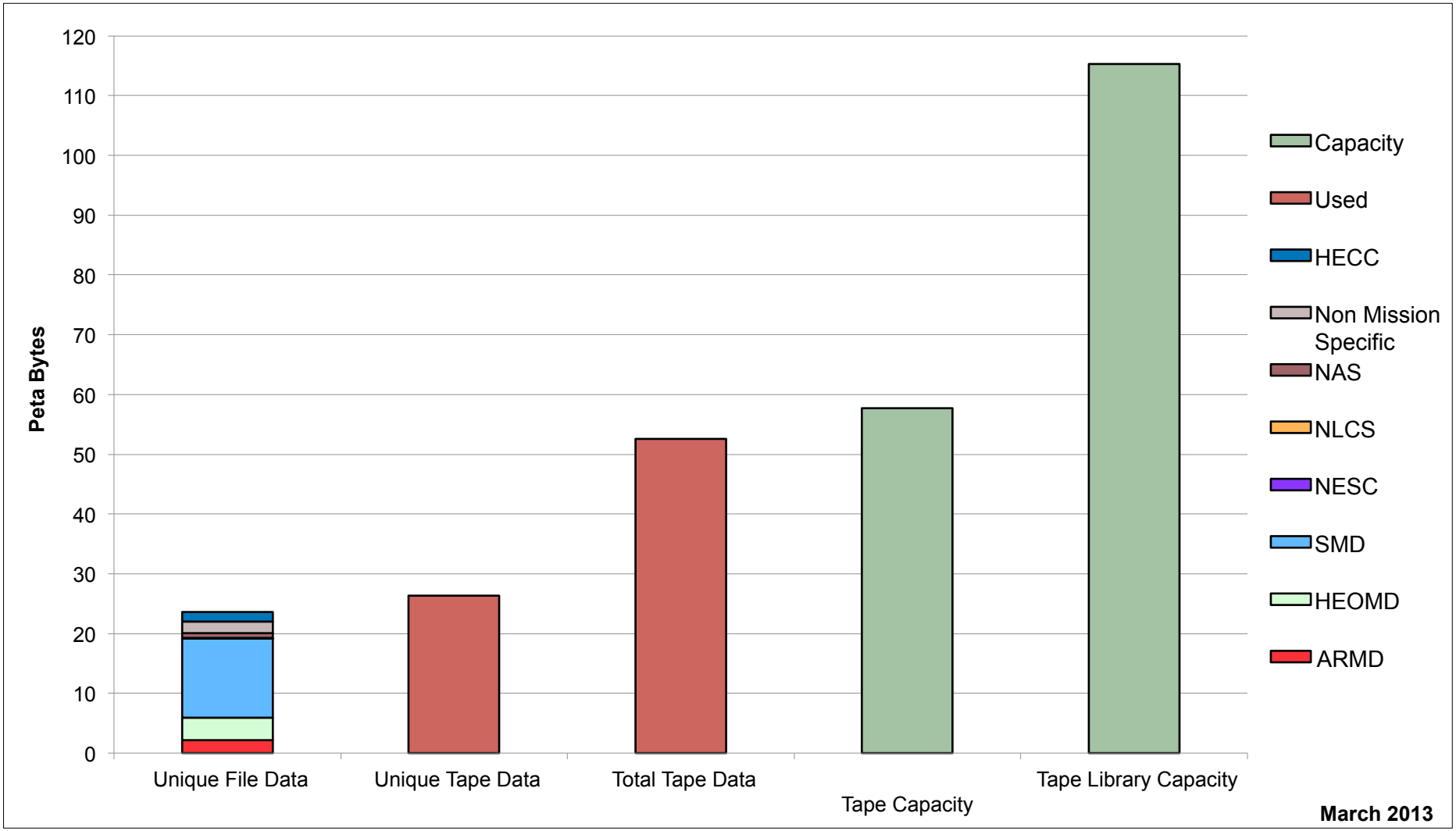




① Allocation to orgs. decreased to 75%, Agency reserve shifted to ARMD ② 14 Westmere racks added
③ 2 ARMD Westmere racks added ④ 28 Harpertown racks removed ⑤ 24 Sandy Bridge racks added

# Tape Archive Status



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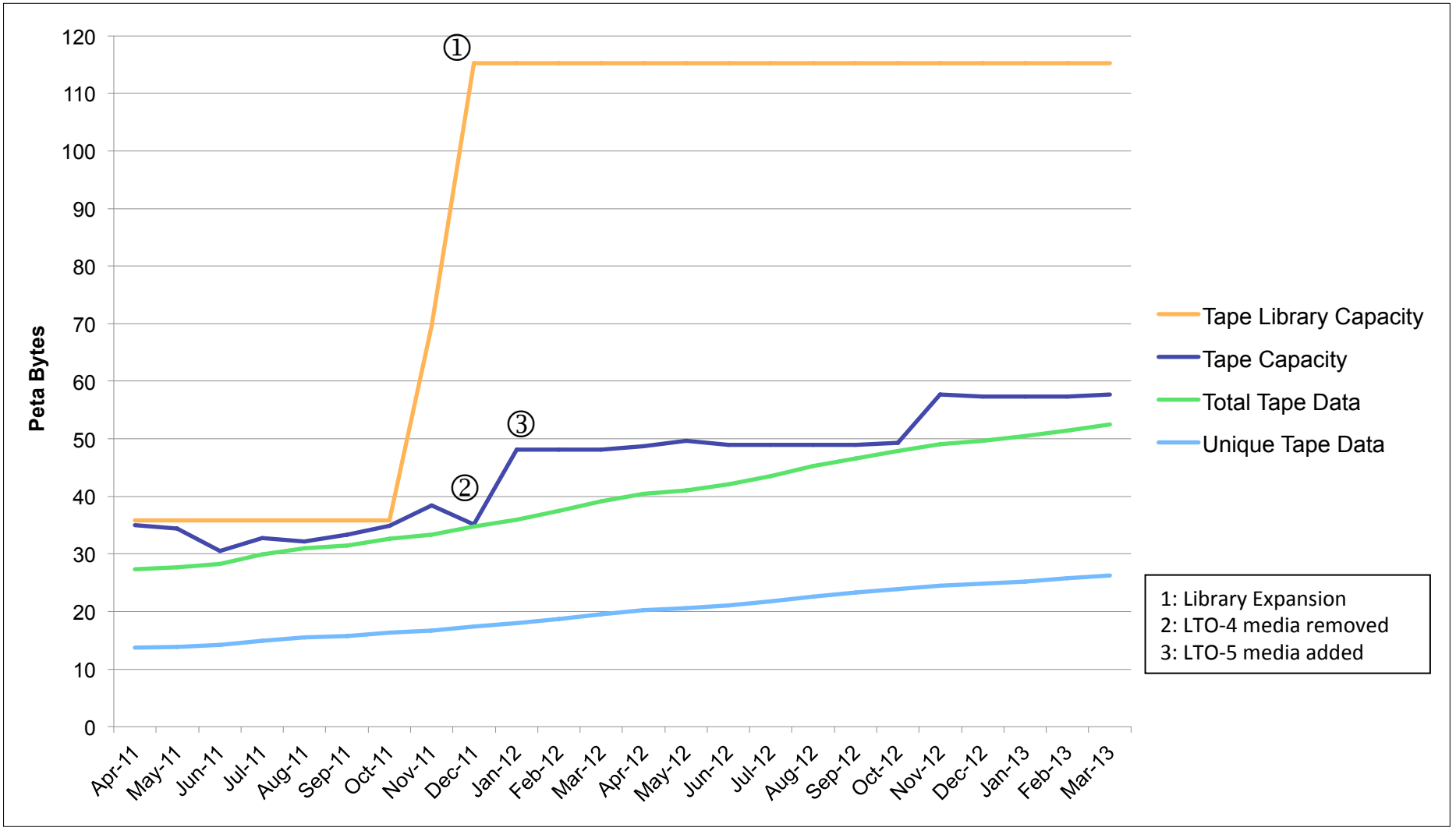
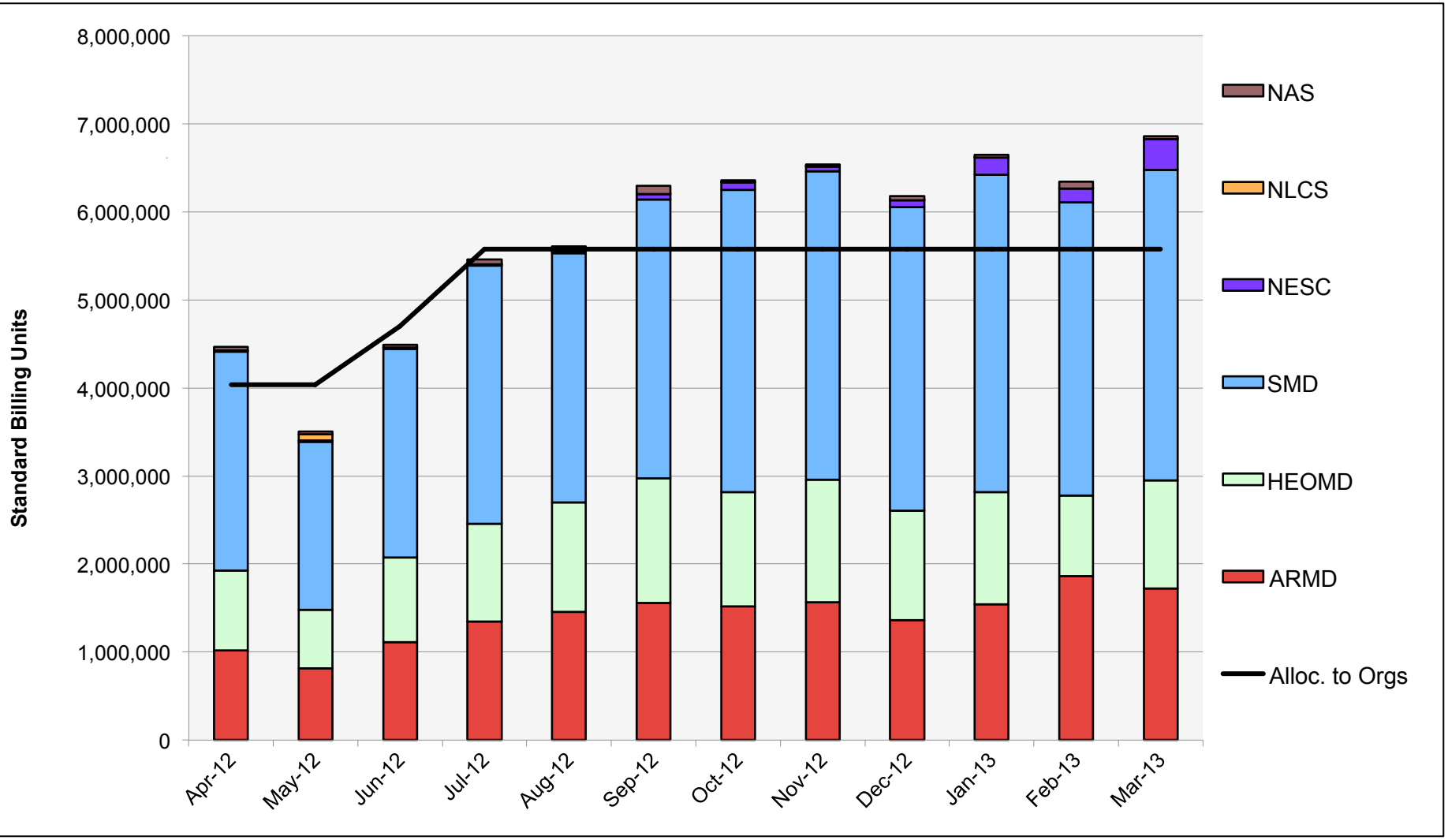
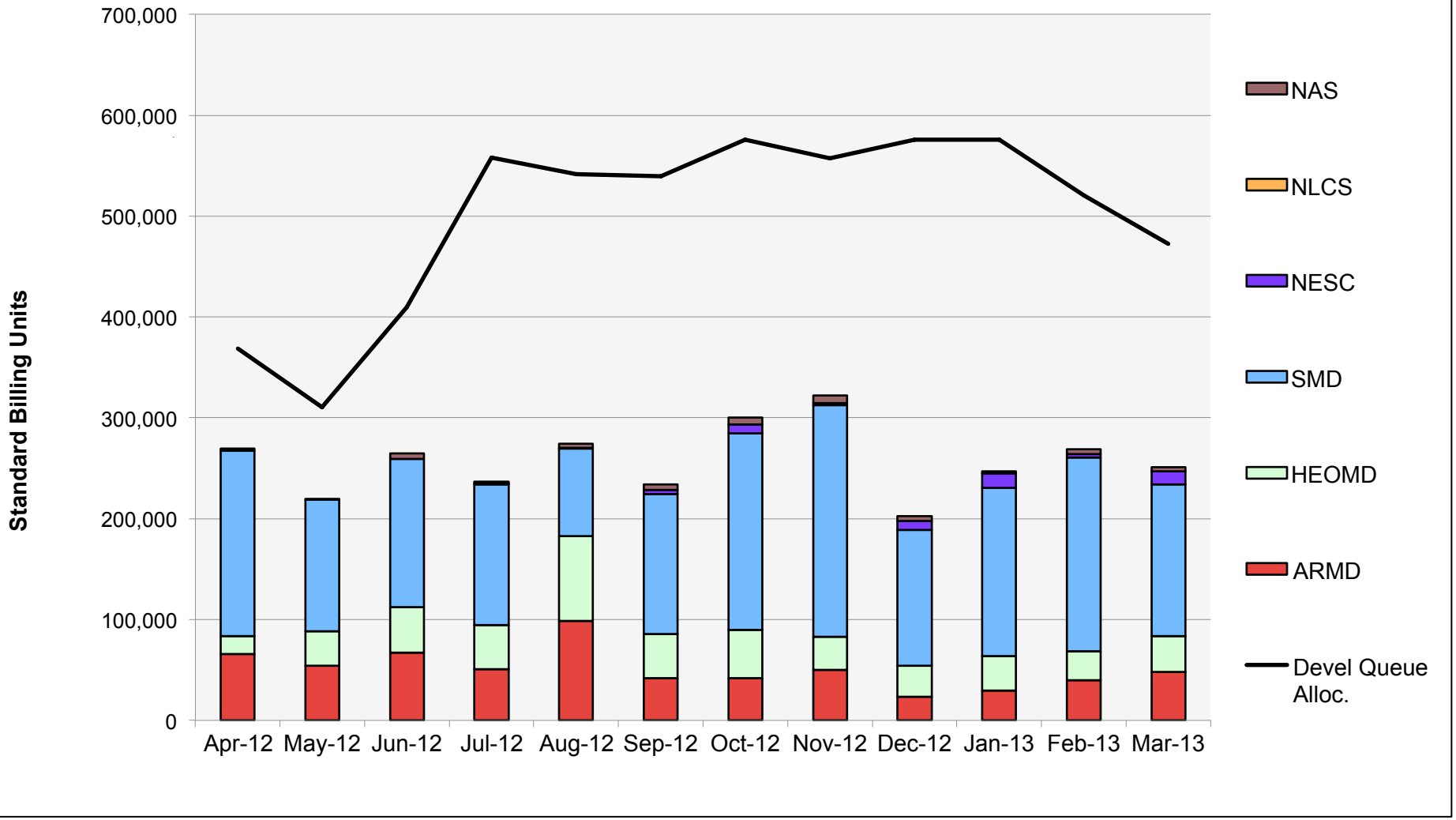


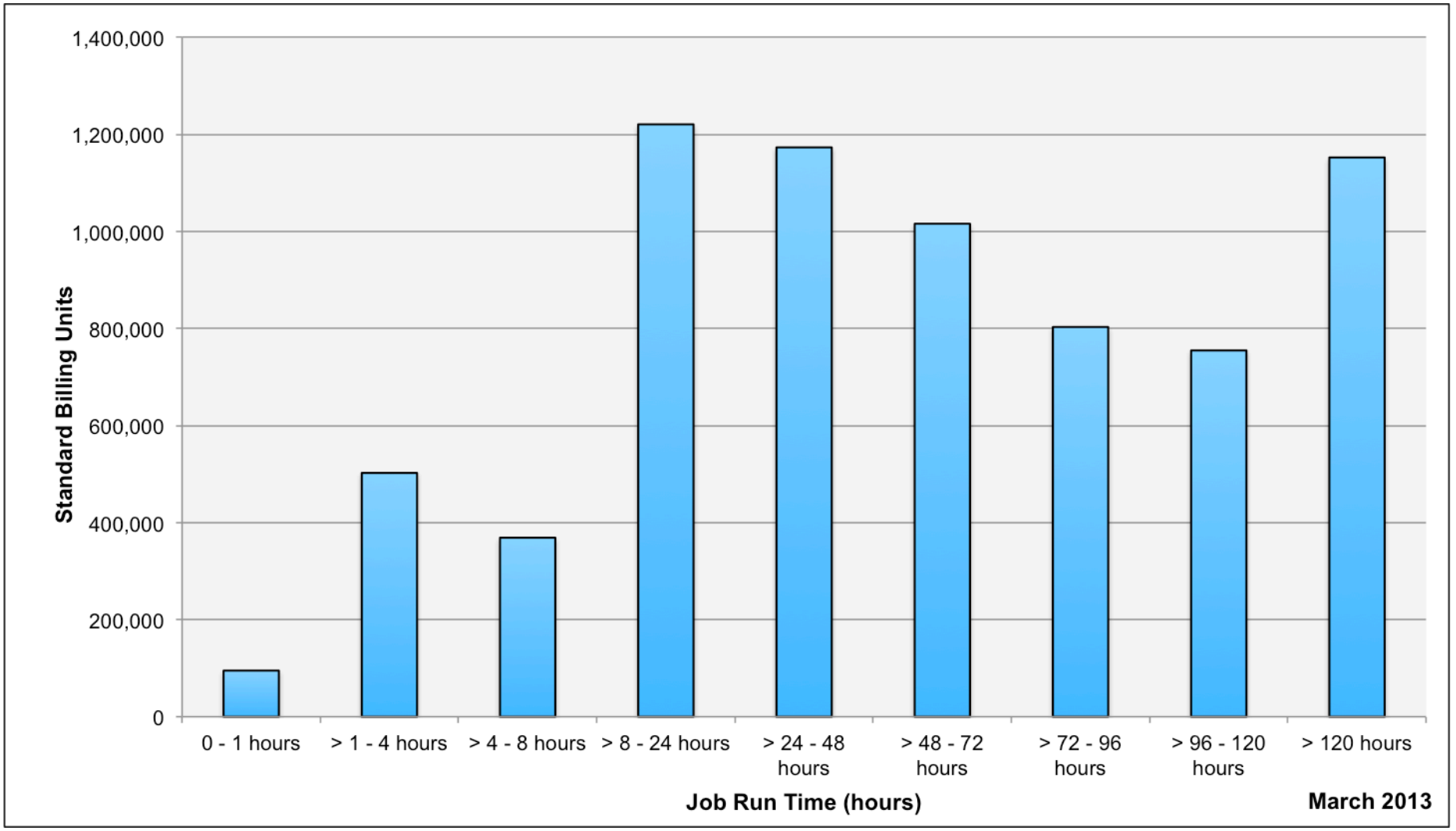
# Pleiades:
# SBUs Reported, Normalized to 30-Day Month



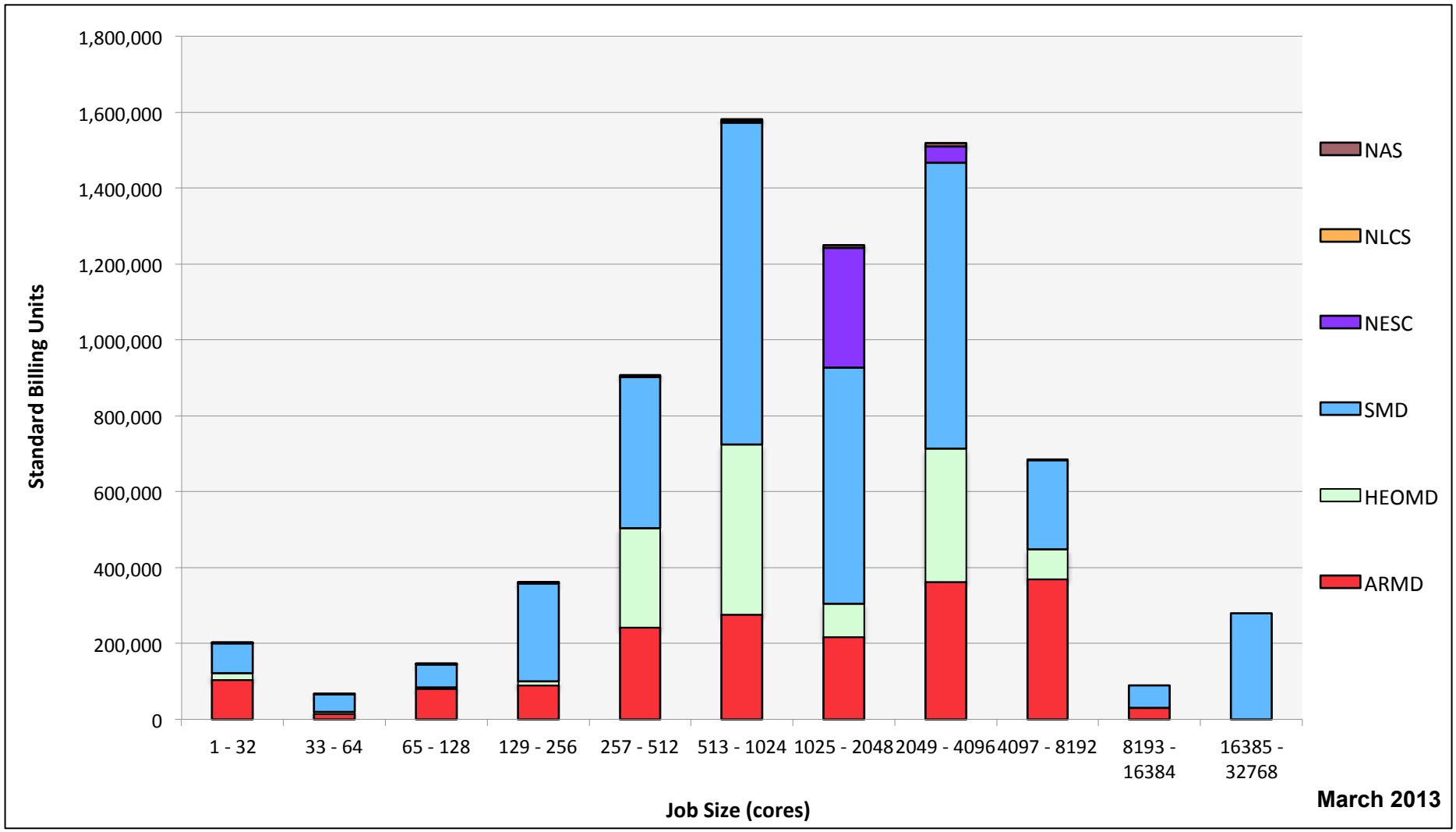
# Pleiades:
# Devel Queue Utilization



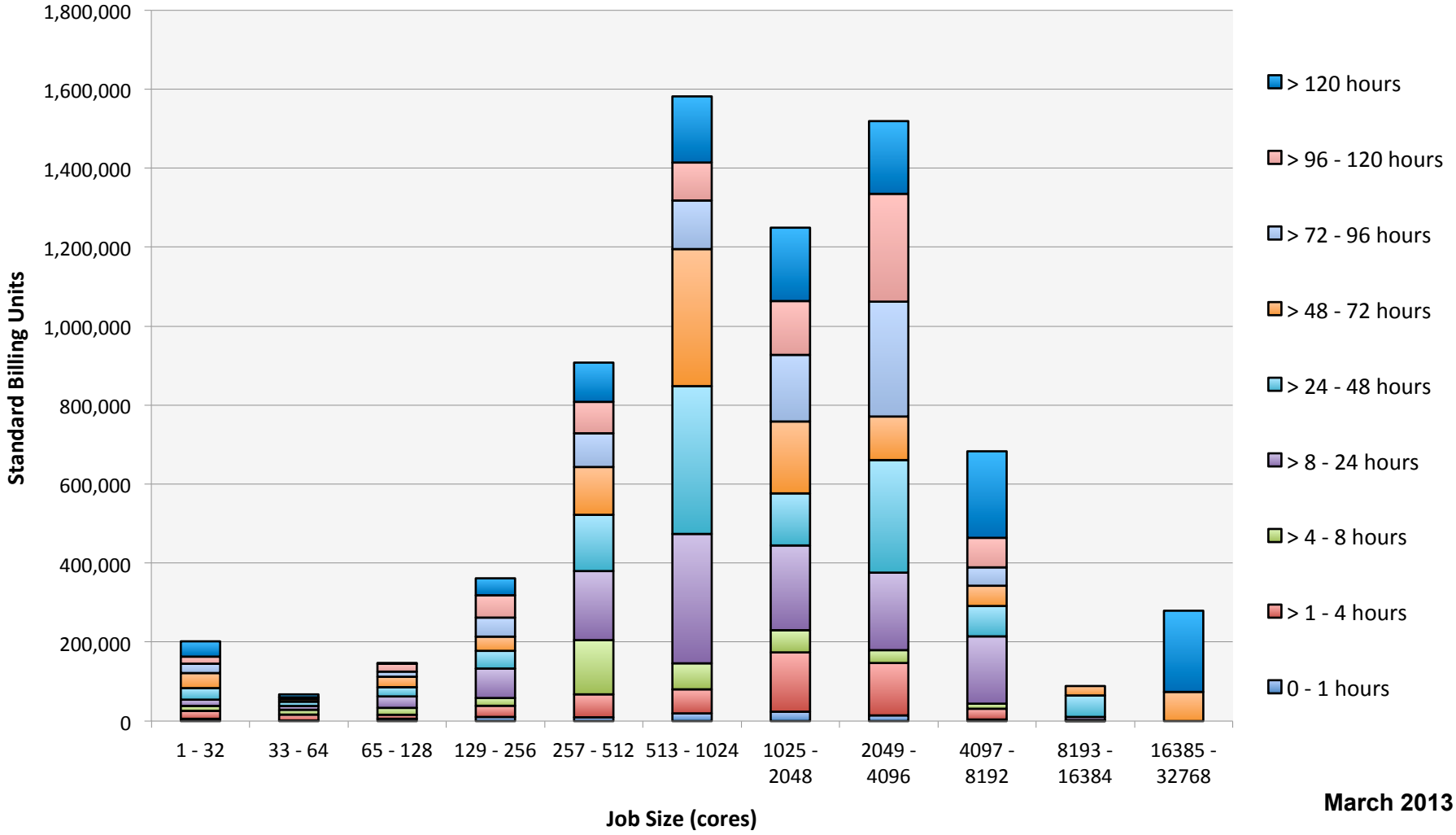
# Pleiades:
# SBUs Reported, Normalized to 30-Day Month



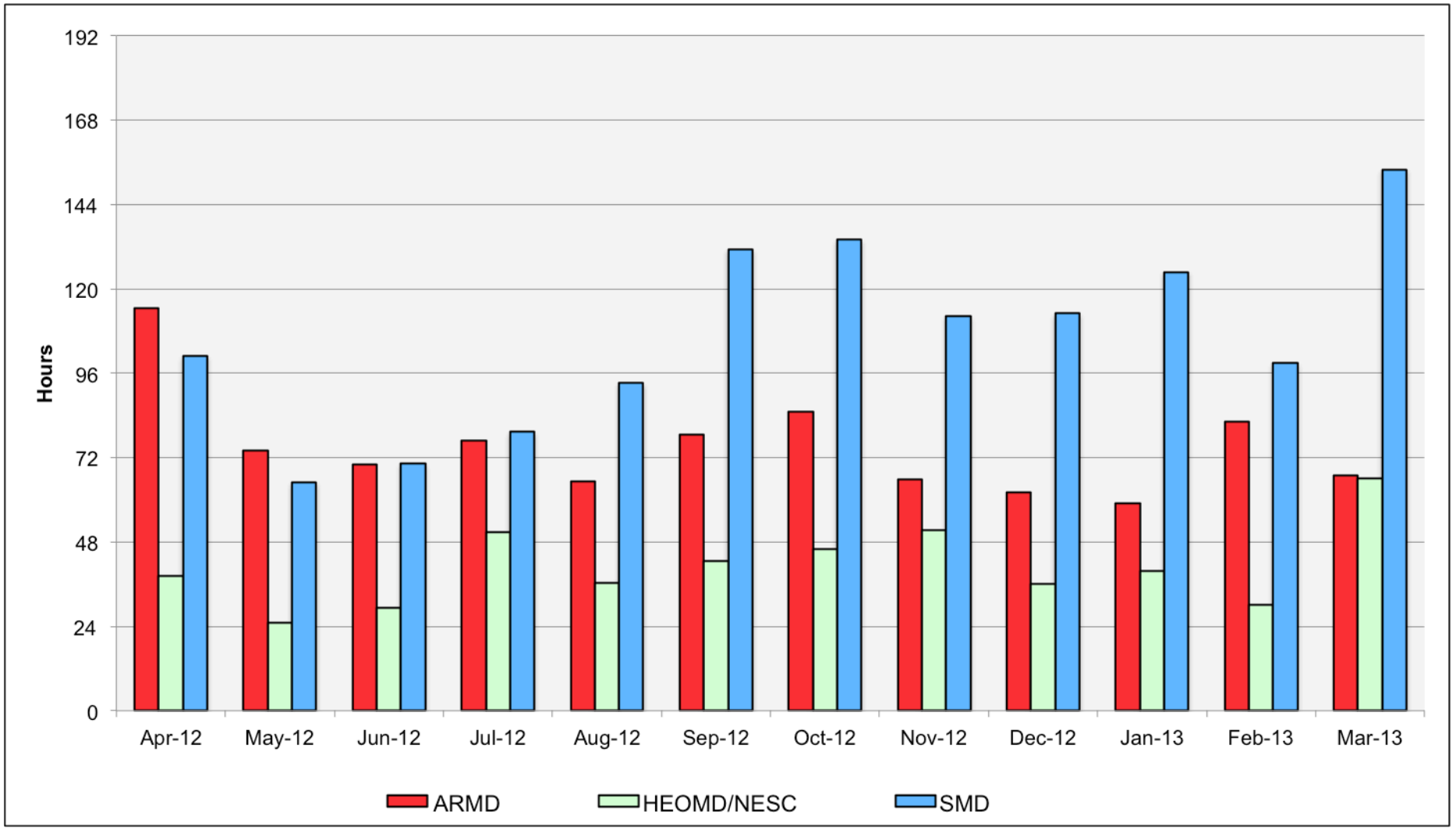
# Pleiades:
# Monthly Utilization by Size and Mission



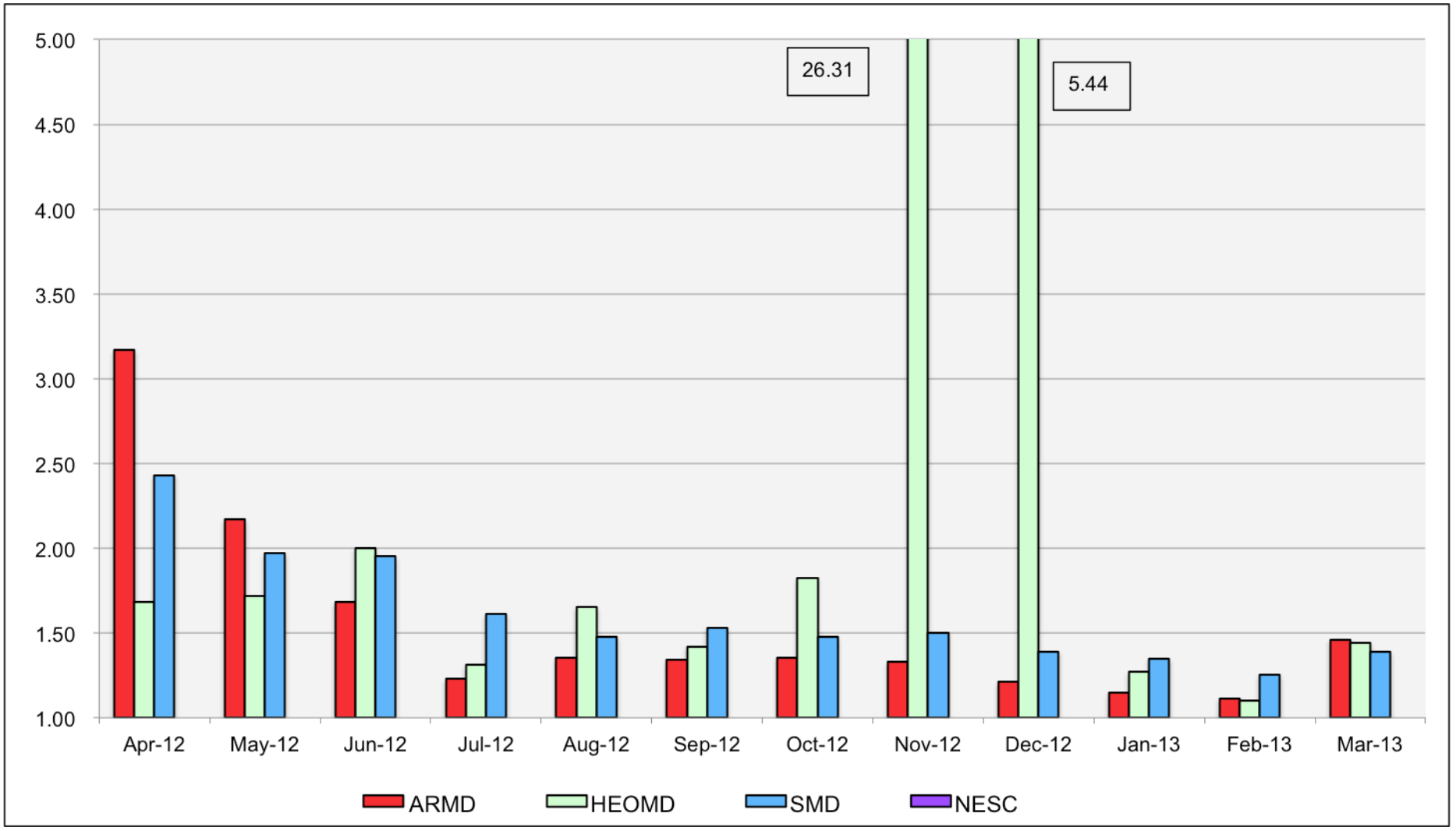
# Pleiades:
# Monthly Utilization by Size and Length



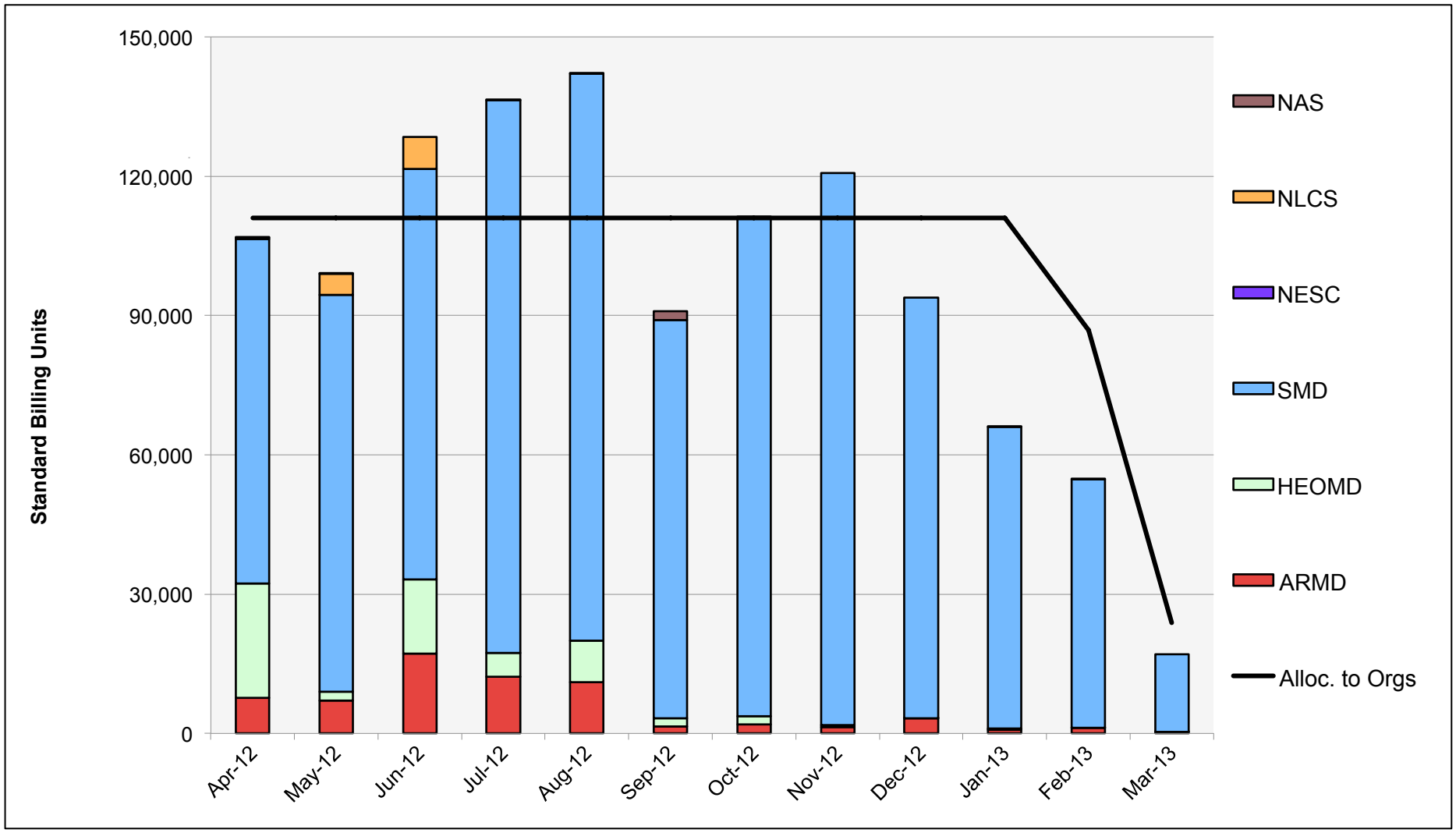
# Pleiades:
# Average Time to Clear All Jobs



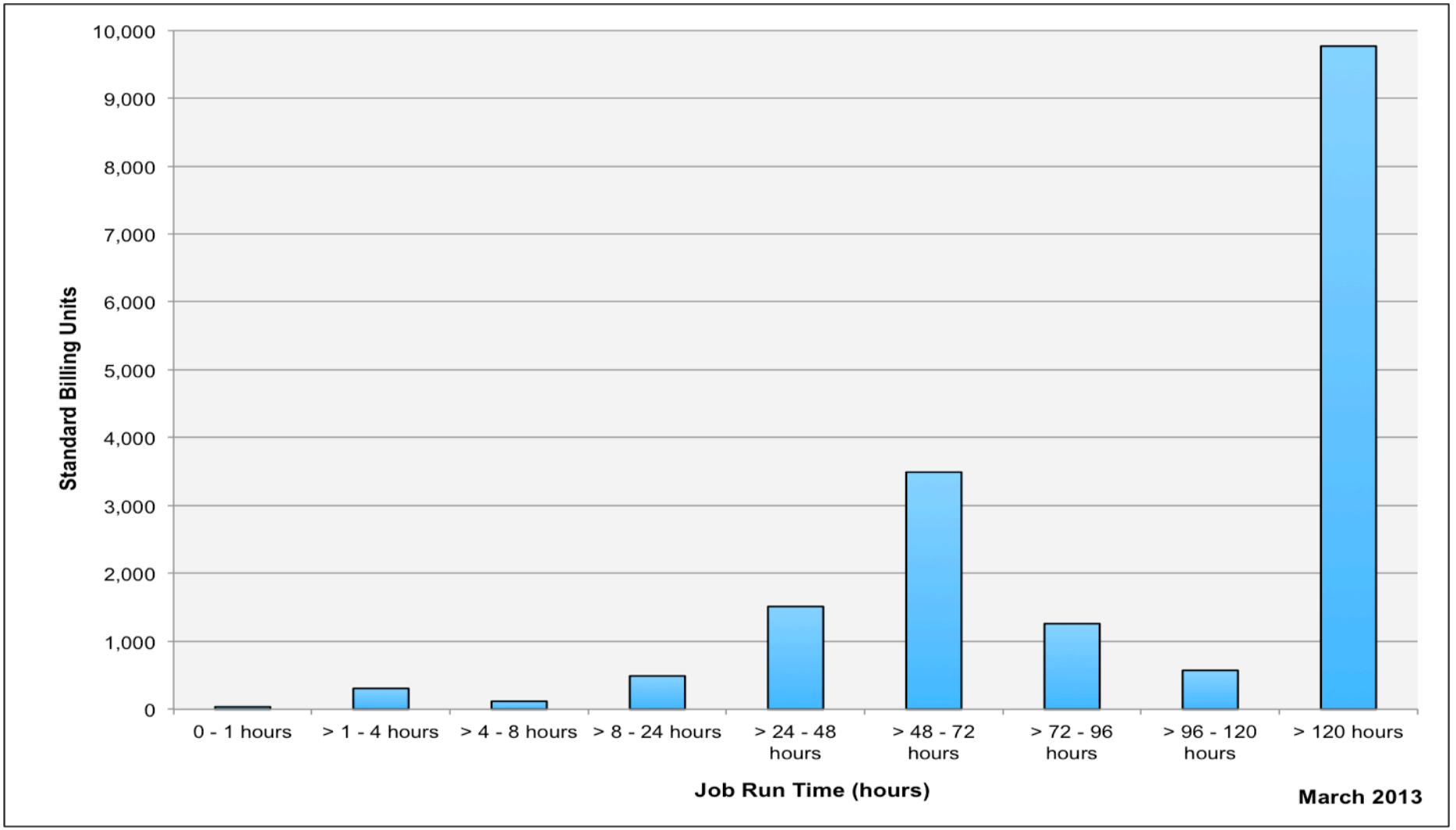
# Pleiades:
# Average Expansion Factor



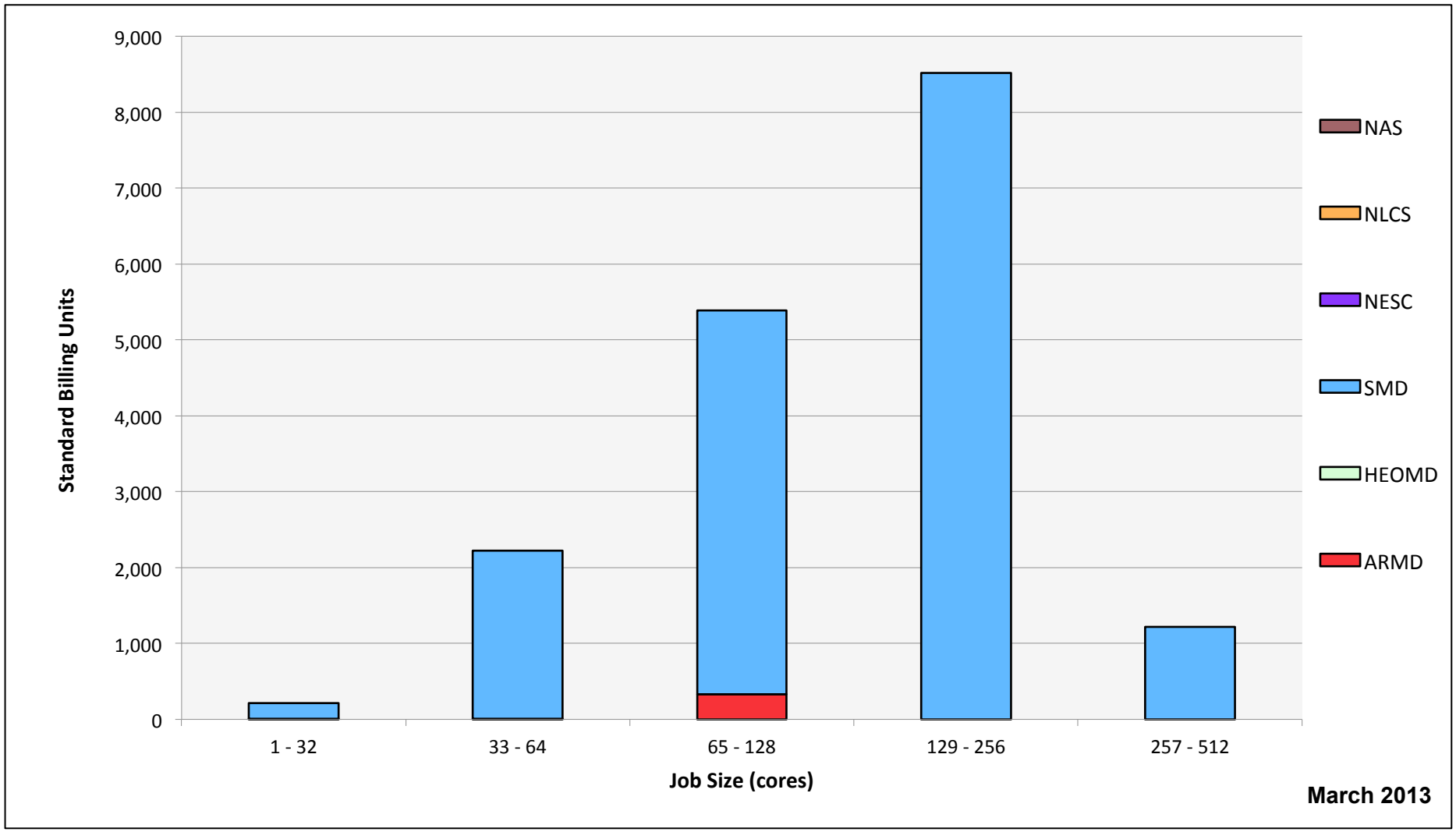
# Columbia:
# SBUs Reported, Normalized to 30-Day Month



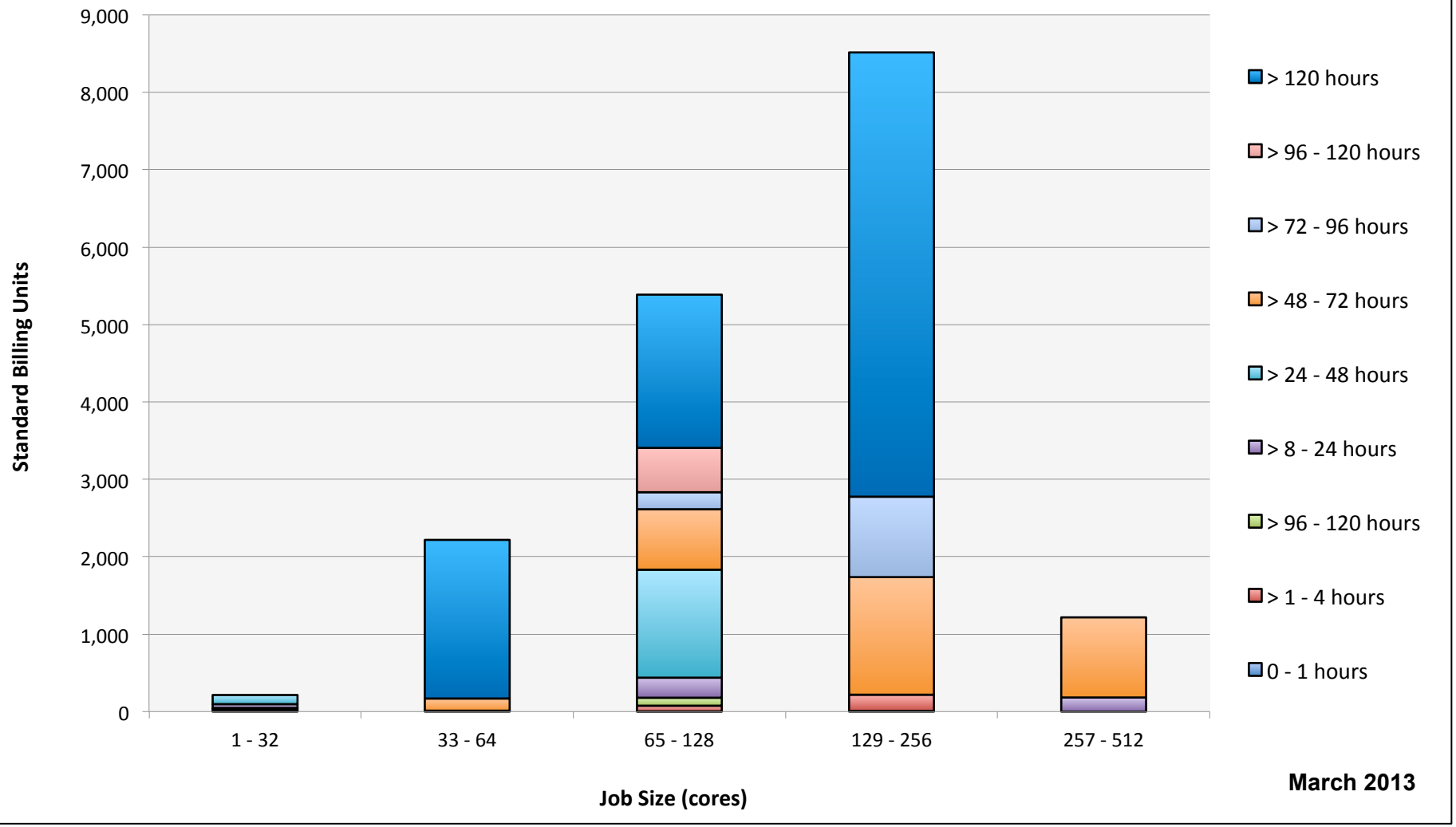
# Columbia:
# SBUs Reported, Normalized to 30-Day Month



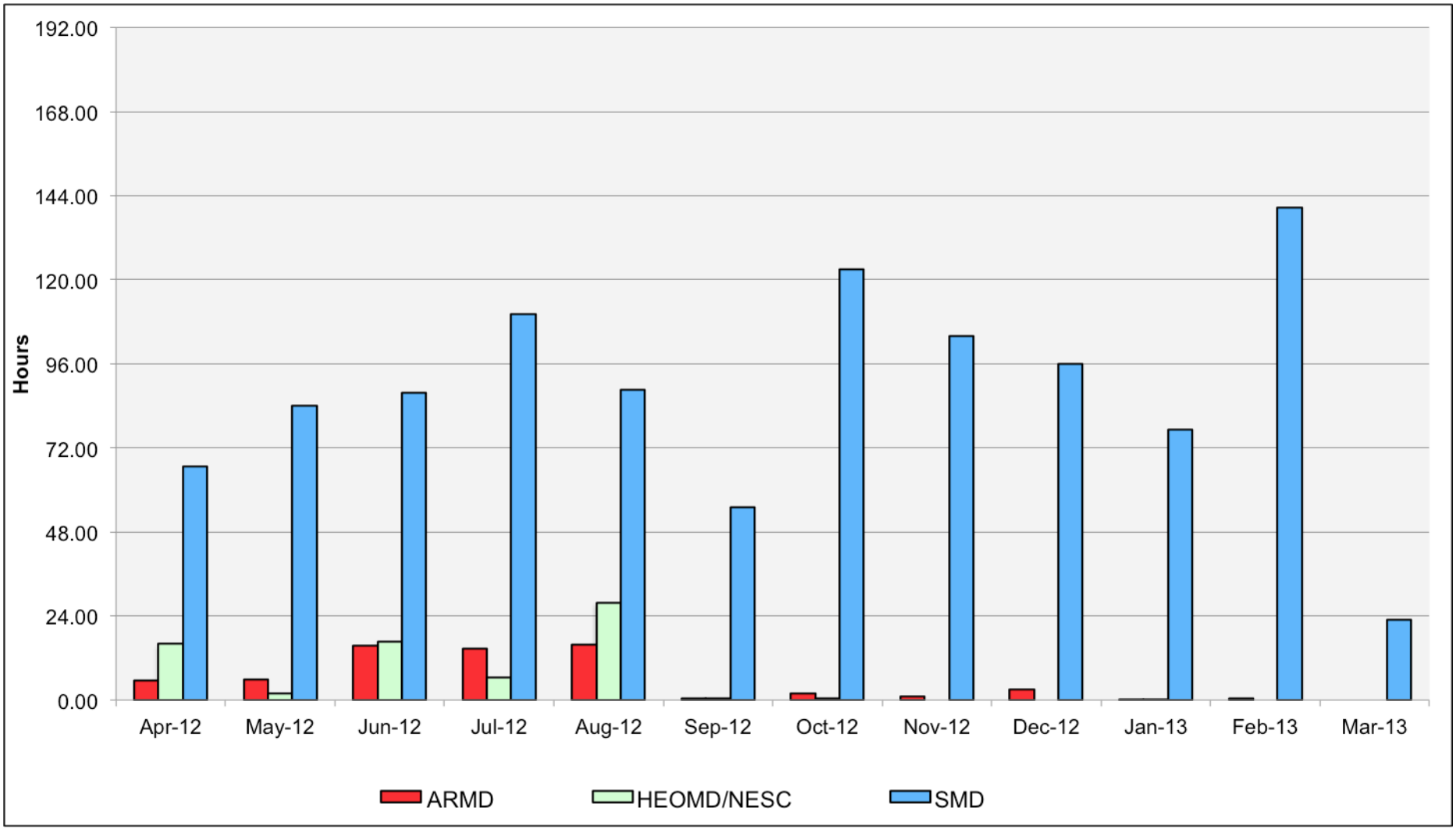
# Columbia:
# Monthly Utilization by Size and Mission



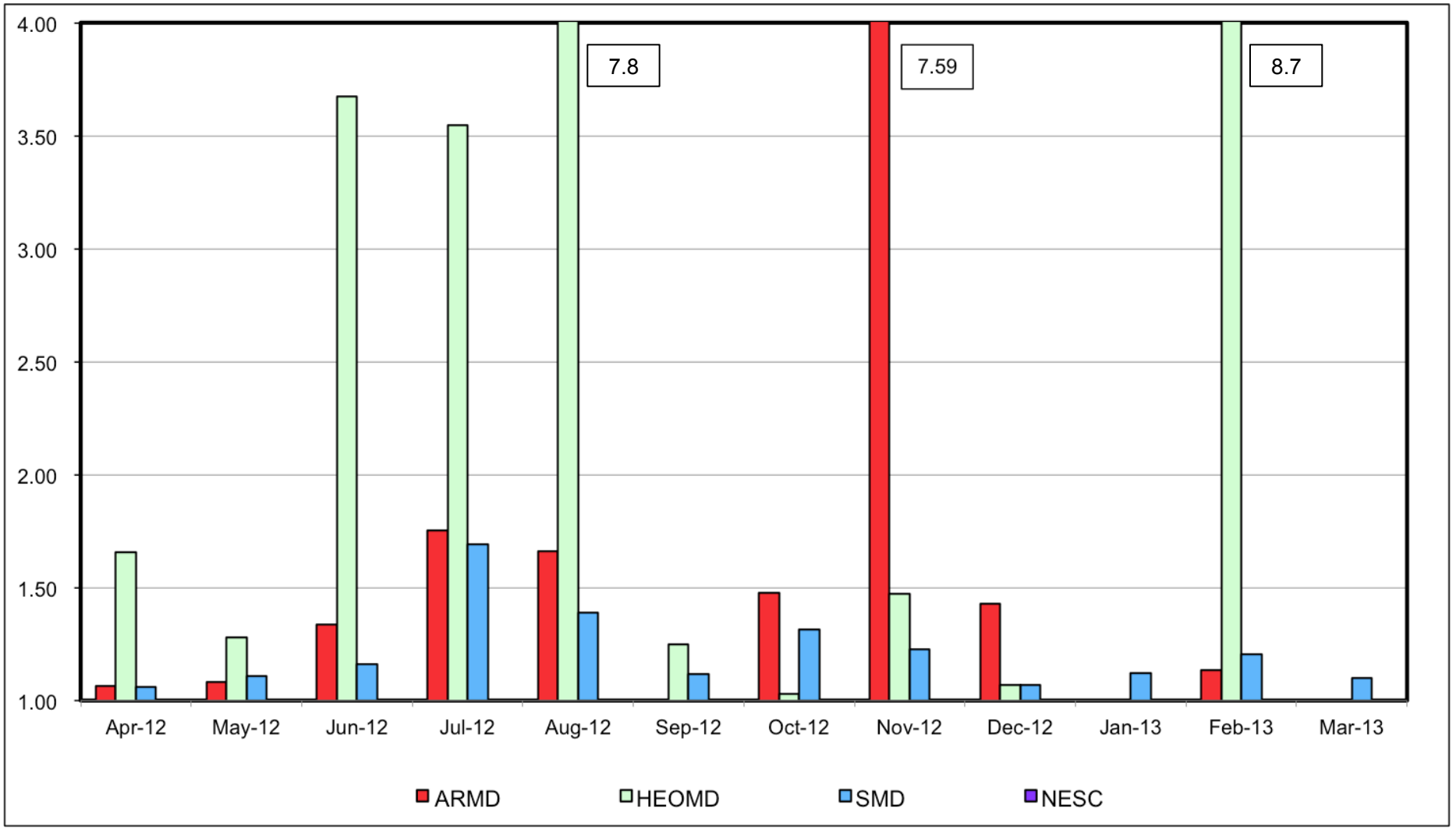
# Columbia:
# Monthly Utilization by Size and Length



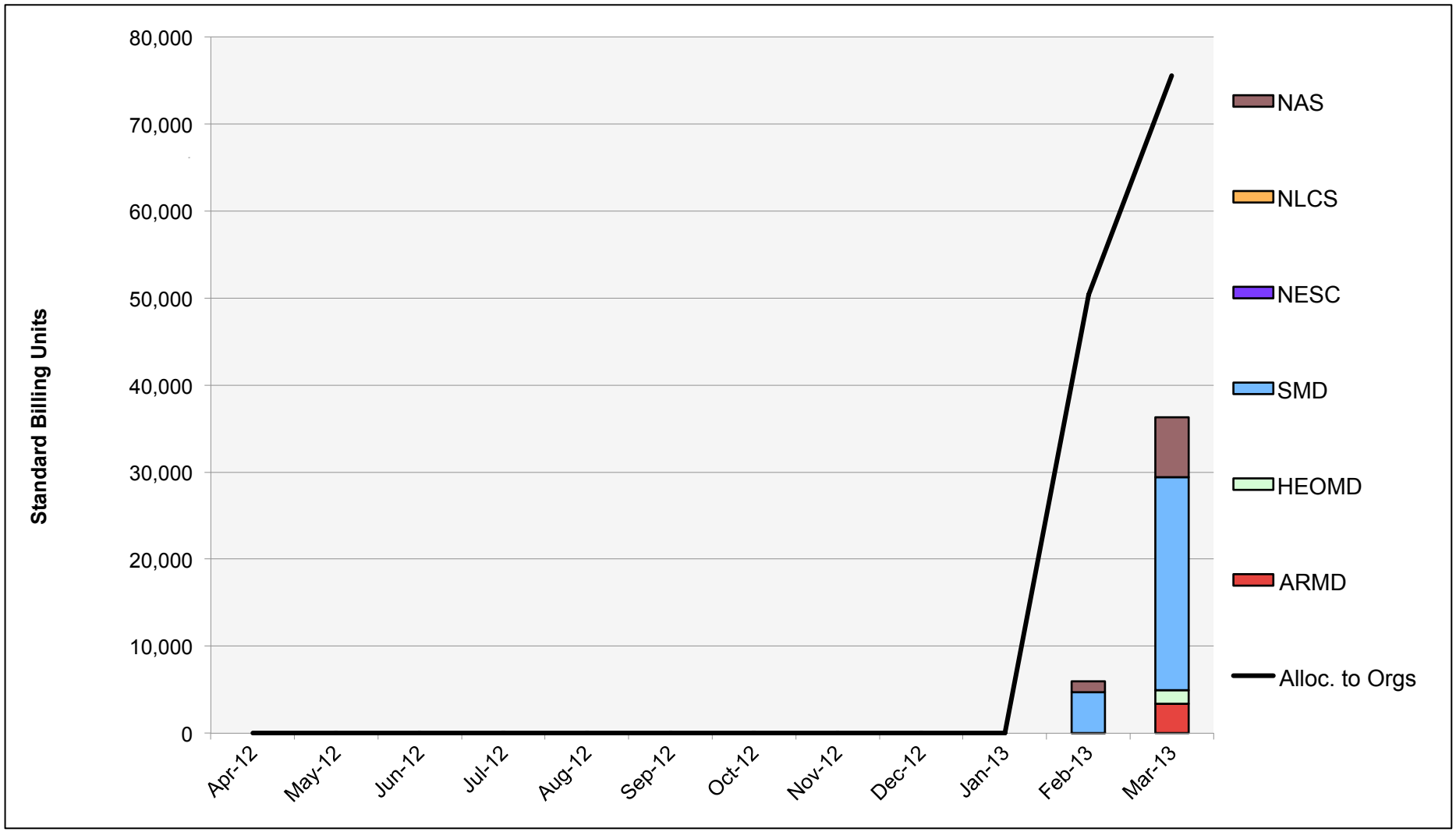
# Columbia:
# Average Time to Clear All Jobs



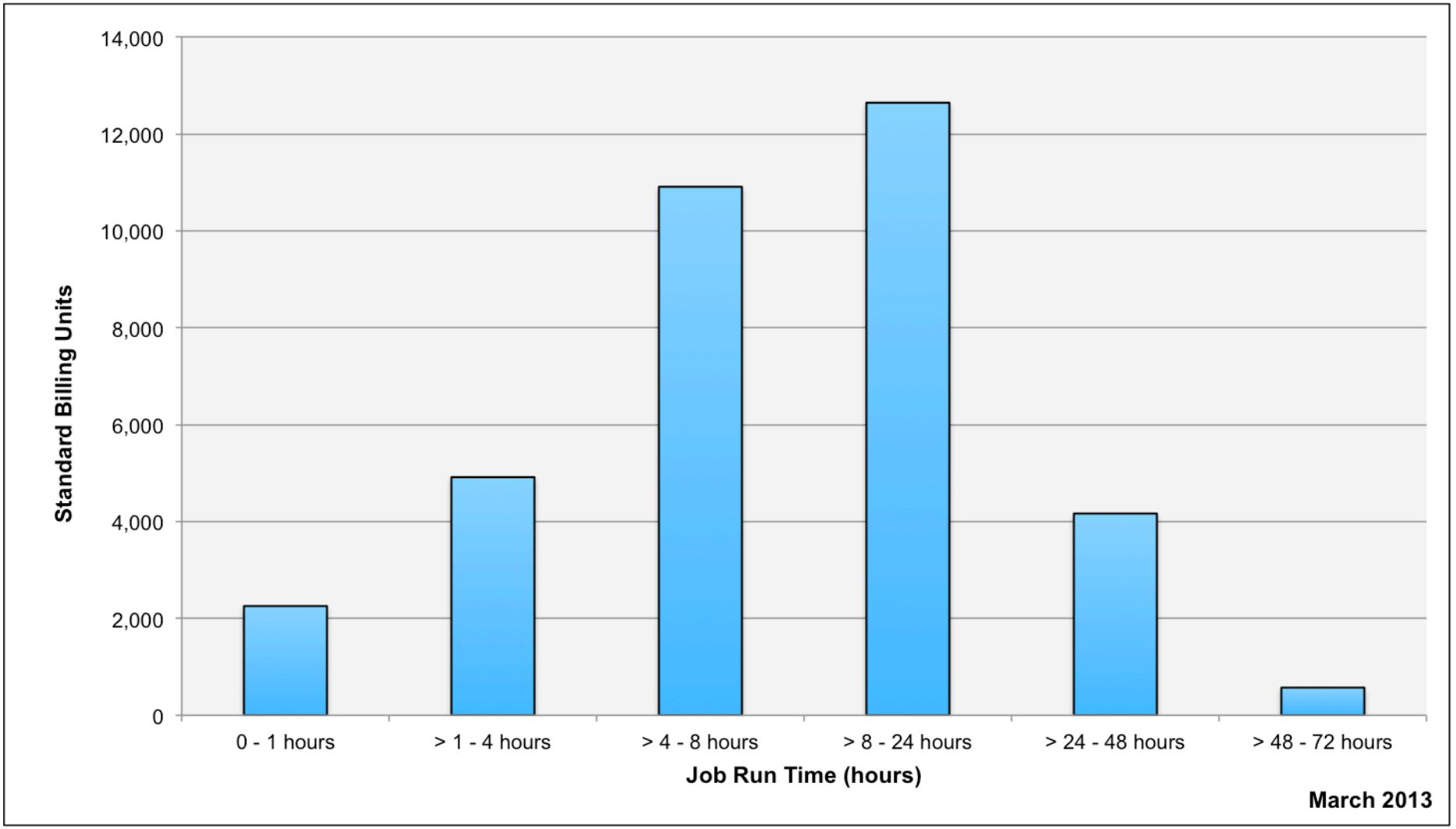
# Columbia:
# Average Expansion Factor



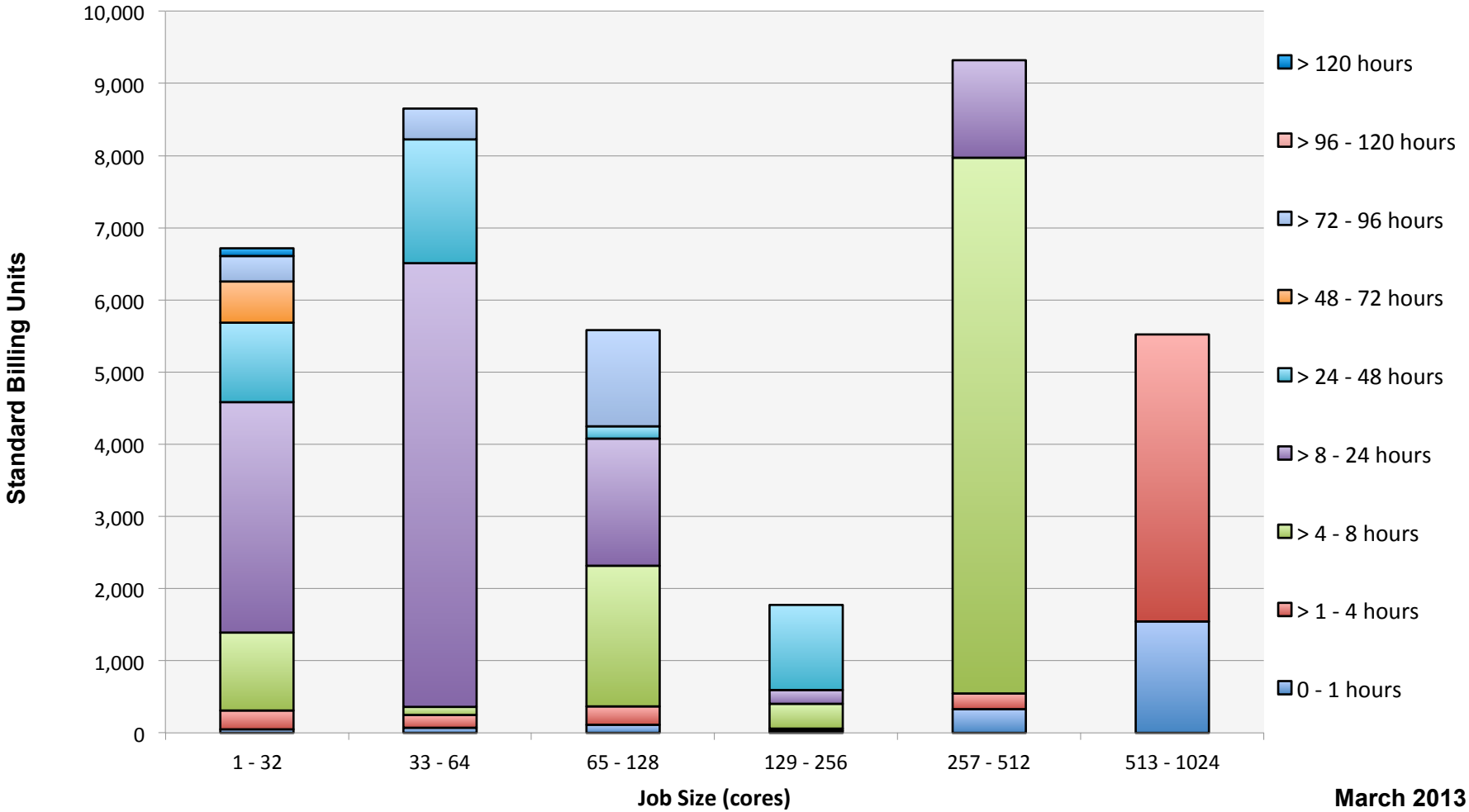
# Endeavour:
# SBUs Reported, Normalized to 30-Day Month



# Endeavour:
# SBUs Reported, Normalized to 30-Day Month



# Endeavour:
# Monthly Utilization by Size and Length



# Endeavour:
# Monthly Utilization by Size and Mission