Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

January 10, 2015

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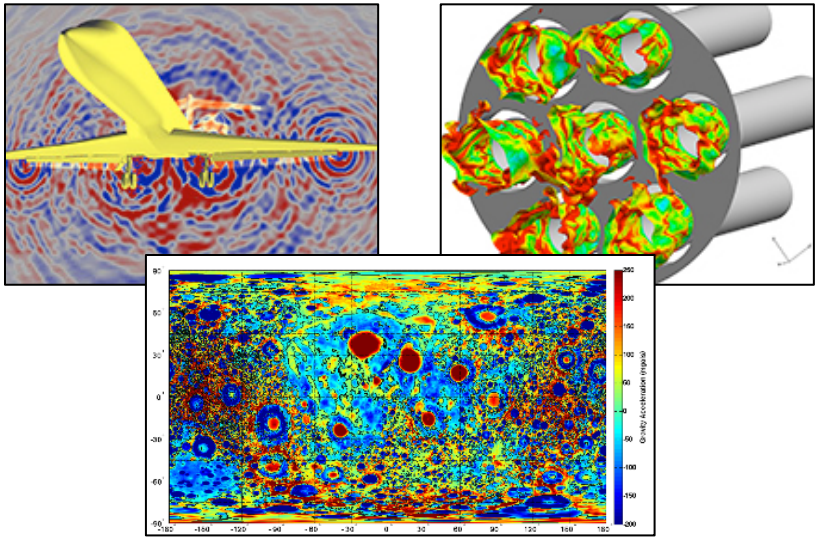
December Usage on Pleiades Exceeds 14.09 Million SBUs and Sets New Monthly Record

- December usage on the Pleiades supercomputer set a new monthly record.
- Over 14.09 million Standard Billing Units (SBUs*) were used by NASA's science and engineering organizations, exceeding the previous record of 13.31 million SBUs (set in November 2014) by almost 6%.
- This increase was enabled by high demand and by efficient operations that delivered over 80% system utilization (75% utilization is target).
- Over 300 projects from ARMD, HEOMD, SMD, NESC, and NAS used time on Pleiades during December.
- Usage for the top 10 projects ranged between 267,962 and 1.07 million SBUs, and accounted for over 45% of total usage.
- The HECC Project continues to plan and evaluate ways to address the future requirements of NASA's users.

*1 SBU equals 1 hour of a Pleiades Westmere 12-core node.

Mission Impact: Increasing Pleiades' system capacity provides mission directorates with more resources for the accomplishment of their goals and objectives.



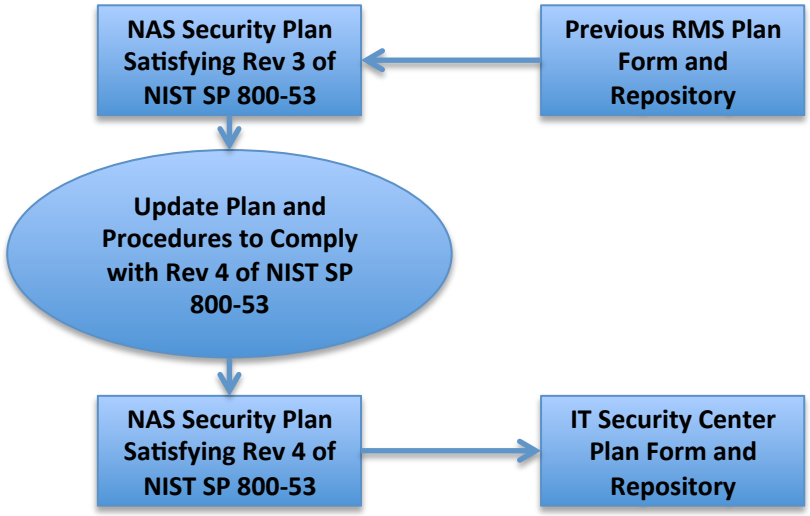
Images from projects that were among the top users in their respective mission directorates. Clockwise from top: Simulated radiated sound field produced by a full-scale Gulfstream aircraft during landing. *E. Fares, Exa Corporation; P. Moran, NASA/Ames.* Snapshot of temperature contours during the combustion process in the rocket engine's combustor. *B. Richardson, D. Westra, NASA/Marshall.* High-resolution lunar gravity field from the Gravity Recovery and Interior Laboratory (GRAIL) primary and extended missions. A. *Konopliv, NASA/JPL.*

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov,
(650) 604-3180, NASA Advanced Supercomputing Division

Security Plan Updated and Uploaded to the New NASA Repository

- The NAS Division security plan was updated to satisfy Revision 4, the latest version of the National Institute of Standards and Technology (NIST) SP 800-53, Security and Privacy Controls for Federal Information Systems and Organizations.
- HECC/NAS security staff are required to use the recently adopted IT Security Center (ITSC), the new system for creating and managing NASA security plans.
  - Significant work was accomplished to transform the plan into the new ITSC-required template.
  - This work was made even more challenging since ITSC has not yet been upgraded to support the Revision 4 controls.
  - The ITSC assigned a new security plan number to the NAS plan: CD-ARC-TNE-Sys-3232.
  - This update effort ensures that the NAS plan complies with the latest NASA/NIST security requirements, and that the Security team is following the latest security guidance.

Mission Impact: Keeping current with the latest National Institute of Standards and Technology and NASA security requirements helps ensure mission success through a strong, secure HECC system.



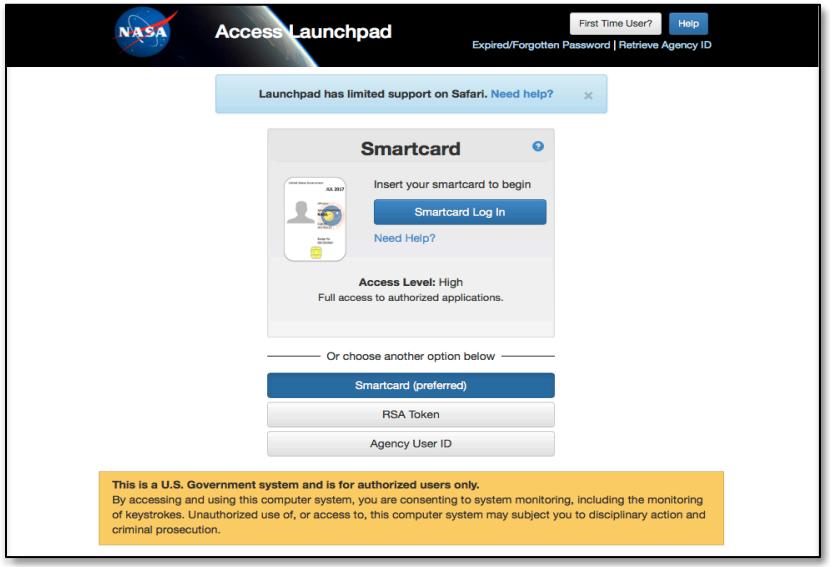
The process used by HECC security experts to update and transform the NASA Advanced Supercomputing (NAS) Division security plan into a new form and to a new NASA security plan repository.

POC: Thomas Hinke, thomas.h.hinke@nasa.gov, (650) 604-3662, NASA Advanced Supercomputing Division

Authentication Platform for HECC and PRACA Websites Upgraded to SiteMinder

- The Engineering Servers and Services (ESS) team completed the agency-directed upgrade from Launchpad to CA SiteMinder on all HECC and Problem Reporting, Analysis and Corrective Action (PRACA) websites. Twenty-nine Red Hat Linux servers were upgraded.
- Since the NASA Enterprise Applications Competency Center (NEACC) documentation covered only Windows systems, not Linux, additional research and training was required for the team to prepare for this upgrade.
- The ESS work on the upgrades included:
  - SATERN and CA SiteMinder training.
  - Development and documentation of the Linux installation process and settings.
  - Creation of 29 agents, 3 agent groups, 27 configuration objects, and 10 applications in SiteMinder to prepare for deployment.
  - Installation and configuration of the agent on each server during dedicated time.
- SiteMinder offers users the capability to authenticate to web services, such as the NAS account request form, using their NASA Smartcard (badge), RSA SecurID token, or Agency User ID.

Mission Impact: Implementation of SiteMinder's centralized platform for secure website authentication provides users the capability to authenticate with their NASA Smartcard and standardizes website authentication for developers.



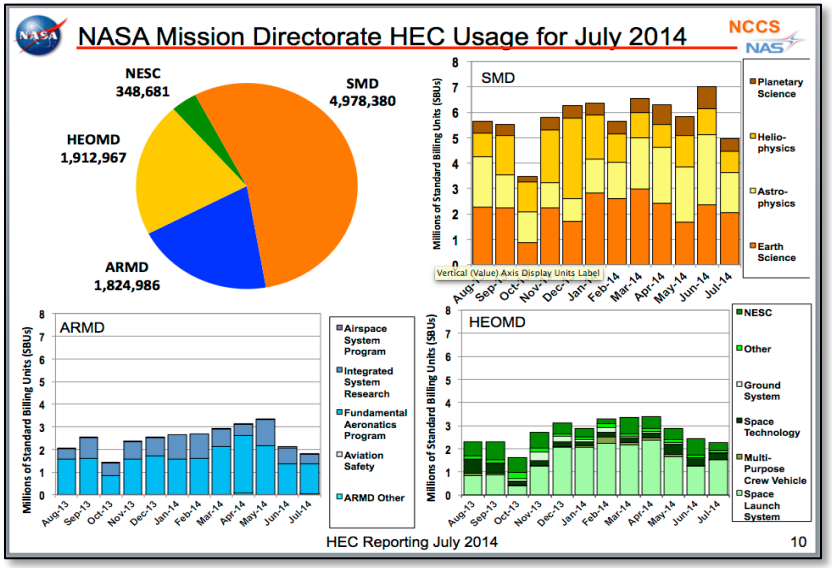
The SiteMinder authentication platform provides NASA users with an option to authenticate with their NASA Smartcard, in addition to the previously available options of using an RSA SecurID token or Agency User ID.

POCs: Jeff Melin, jeffrey.melin@nasa.gov, (650) 604-0715; Frank Cianci, frank.cianci@nasa.gov, (650) 604-2559, NASA Advanced Supercomputing Division, ADNET Systems

Upgrade to MicroStrategy Version 9.4 Speeds HECC Monthly Report Processing

- The HECC Tools team completed the upgrade of its MicroStrategy data analytics platform from version 9.2 to version 9.4, providing a 30-45% performance improvement for processing lengthy HEC and HECC monthly reports.
- The new release provides the following enhancements and capabilities:
  - Significantly speeds the movement of reports from development to production by allowing reports and objects to be packaged and relocated instead of having to be re-created.
  - New "Data Blending" functionality allows multiple data sources to be inserted into a single grid, simplifying the production of reports.
  - Dashboard support enables the development of daily, weekly, and monthly dashboards of usage accounting data.
- The team thoroughly tested the new MicroStrategy version, including development testing, report checkout, and report adjustments, in order to ensure accuracy of the 42 reports and charts that are generated each month.

Mission Impact: Improved MicroStrategy reporting capabilities allow continued streamlining of the lengthy and complex usage accounting process required to create the HEC and HECC monthly reports.



The HECC Tools team utilizes MicroStrategy to gather and integrate supercomputer usage data into easily understood charts and slides for the monthly HEC and HECC reports.

POCs: Ryan Spaulding, ryan.c.spaulding@nasa.gov, (408) 772-6567, NASA Advanced Supercomputing Division, ADNET Systems; Blaise Hartman, blaise.hartman@nasa.gov, (650) 604-2539, NASA Advanced Supercomputing Division, Bay Systems

Forest Dynamics Scientists Use hyperwall to Explore TB-sized Forest Disturbance Dataset

- The HECC Visualization group hosted North American Forest Dynamics (NAFD) scientists in December to help explore the results of a terabyte-sized forest disturbance dataset on the hyperwall.
  - The NAFD team used Pleiades to process ~57,000 Landsat scenes taken over a 25-year period and to produce a series of national map products, including disturbance history, forest recovery trajectories, and spatio-temporal patterns of forest disturbance causal factors.
  - The Visualization group used their bigview tool, which allows zooming and panning of large images on the 128-screen hyperwall. Stepping through the time series of images had the effect of animating the changes to forests.
- During two extensive visits, the scientists gained understanding of the extent and patterns of forest harvest, mountain top mining, waves of insect damage, and other phenomena. They found “slices” of data that will be used to help convey NAFD results.

Mission Impact: The hyperwall, used in conjunction with HECC visualization expertise, gives users a powerful way to explore terabyte- and petabyte-scale datasets, and can facilitate discovery of features in the data that would go unseen on desktop displays.

Chengquan Huang (University of Maryland), Gretchen Moisen (US Forest Service), and Warren Cohen (US Forest Service), visited the NAS facility on December 12, to study the results of their North American forest disturbance study on the 128-screen hyperwall.

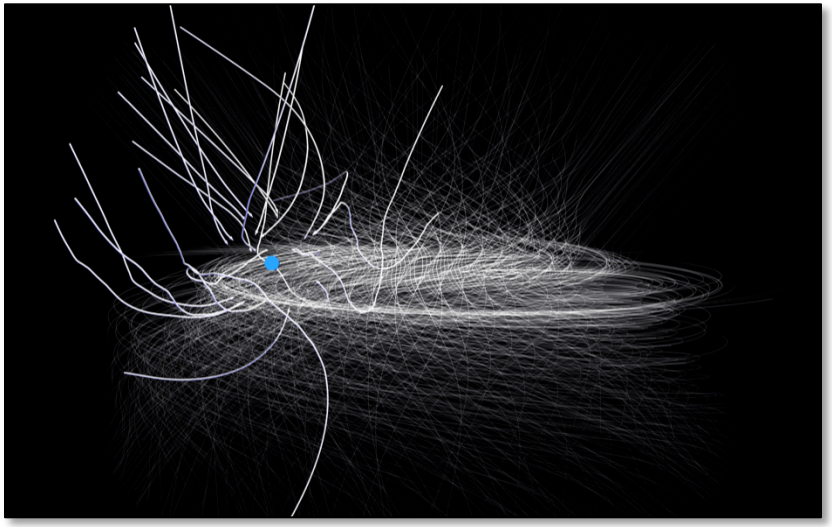
POCs: Tim Sandstrom, tim.sandstrom@nasa.gov, (650) 604-1429, NASA Advanced Supercomputing Division, Computer Sciences Corp.; Jennifer Dungan, jennifer.l.dungan@nasa.gov, (650) 604-3618, NASA Ames Research Center

Simulations Trace Ultra-High-Energy Cosmic Rays Through the Galactic Magnetic Field *

- Using the most sophisticated galactic magnetic field (GMF) model to date, scientists have run the first high-resolution simulations ever conducted of ultra-high-energy cosmic ray (UHECR) trajectories through the Milky Way.
- The simulations, run on Pleiades, backtrack the particle trajectories from Earth through the GMF. Results are helping to reveal the origin and composition of the UHECRs, while simultaneously improving our understanding of the GMF itself.
- The simulations show that the impact of the GMF on the UHECR trajectories is much more profound than previously understood, and that galactic magnetic turbulence strongly affects their Earth arrival distributions.
- Each simulation was comprised of over 51 million events and required an average of 250,000 Pleiades processor-hours to complete.
- Future simulations incorporating astronomical observations will help to further refine the model and help scientists better understand the GMF, its origins, and its role in the history of the Milky Way.

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

Mission Impact: Enabled by NASA's Pleiades supercomputer, new simulations help scientists improve their understanding of the galactic magnetic field—crucial for interpreting diverse astrophysical phenomena such as dark matter and cosmic rays.



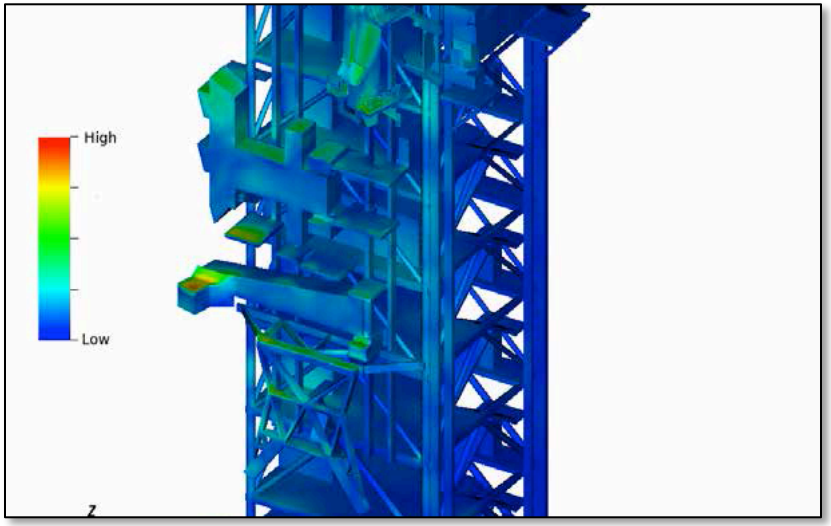
Visualization of a galactic magnetic field model with 3D ultra-high-energy cosmic ray (UHECR) trajectories. The UHECRs shown (thick lines) are about to reach Earth (blue dot). Those from the opposite side of the Milky Way are typically deflected by the galactic magnetic field (thin lines) and cannot reach Earth, except at the highest energies. *Chris Henze, Tim Sandstrom, NASA/Ames*

POCs: Michael Sutherland, sutherland.54@osu.edu, (614) 292-5713, Ohio State University; Glennys Farrar, gf25@nyu.edu, (212) 992-8787, New York University

Pleiades Enables Efficient Computational Modeling of Launch Environments *

- Researchers at NASA Ames are utilizing Pleiades to perform intensive computational fluid dynamics (CFD) simulations required analyze the redesign of the Space Launch System (SLS) launch site infrastructure at NASA Kennedy.
- Simulations produced are used to characterize the plume-induced pressure loads on the site's mobile launcher (ML) and tower, and leverage lower-fidelity analytical approaches to efficiently provide predictions for ~10,000 possible launch trajectories.
  - Unsteady simulations of the launch vehicle plume in free-air were performed to obtain time-averaged flow statistics.
  - Subsequently, this time-averaged plume data was swept past the ML/tower structure, following the path of each trajectory variation and accounting for the corresponding vehicle orientation.
  - Total pressure of the plume was projected on the ML/ tower structure while employing analytical corrections for supersonic impingement on the surfaces.
- Pleiades parallel computing capability was critical to performing the intensive, high-fidelity plume simulations and subsequent engineering analyses.

Mission Impact: Enabled by the Pleiades supercomputer, high-fidelity computational fluid dynamics simulations, combined with engineering analyses, will significantly improve the safety and operational cost of NASA Kennedy's redesigned launch complex for future space missions.



Computed maximum surface pressures on the NASA Kennedy launch tower structure over a time period during a heavy-lift launch scenario.
Christoph Brehm, NASA/Ames

POCs: Emre Sozre, emre.sozer@nasa.gov, (650) 604-0594, Cetin Kiris, cetin.c.kiris@nasa.gov, (650) 604-4485, NASA Advanced Supercomputing Division

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

HECC Facility Visitors and Tours in December 2014

- HECC hosted 12 tour groups in December; guests learned about the agency-wide missions being supported by HECC assets, and some of the groups also viewed the D-Wave Two quantum computer system. Visitors this month included:
  - Dr. Bjorn Ottersten, Center for Security, Reliability and Trust, Luxembourg.
  - An Ames media press event for the Exploration Flight Test-1 launch was held at the NAS facility. Code T staff presented Orion graphics on hyperwall.
  - James Schultz, staff writer for the Aeronautics Research Mission Directorate, NASA Headquarters.
  - A group of scientists visiting from Massachusetts Institute of Technology who are working with Ames Kepler staff on the upcoming Transiting Exoplanet Survey Satellite (TESS) project.
  - Manuel Pinto de Abreu, the Secretary of State of the Sea, Portugal.
  - Arthur Payton, Counterintelligence Division Operations Manager, NASA Headquarters, talked with NAS Division management regarding possible collaboration and gaining time on Pleiades.
  - Dr. Reinhard Schulte-Braucks, head of the European Space Agency's Global Monitoring for Environment and Security Unit, which also oversees the Copernicus Program.

Reinhard Schulte-Braucks (left), who heads the Global Monitoring for Environment and Security Unit at the European Space Agency (ESA), visited the NAS facility as part of his tour of NASA Ames. The tour was requested by the European Commission (EC) for potential collaborations with both the EC and the ESA.

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

Papers and Presentations

- "**High-Temperature Miscibility of Iron and Rock During Terrestrial Planet Formation**," S. M. Wahl, M. Militzer, Earth and Planetary Science Letters, vol. 410, December 1, 2014. * *http://www.sciencedirect.com/science/article/pii/S0012821X14007067*
- "**Martian Atmospheric Collapse: Idealized GCM Studies**," A. Soto, M. Mischna, T. Schneider, C. Lee, M. Richardson, Icarus, December 4, 2014. * *http://www.sciencedirect.com/science/article/pii/S0019103514006575*
- "**Galaxy and Mass Assembly (GAMA): The Galaxy Luminosity Functions within the Cosmic Web**," E. Eardley, et al., arXiv:1412.2141 [astro-ph.CO], December 5, 2014. * *http://arxiv.org/abs/1412.2141*
- "**Shallow Cavities in Multiple-Planet Systems**," P. C. Duffell, R. Dong, arXiv:1412.3560 [astro-ph.EP], December 11, 2014. * *http://arxiv.org/abs/1412.3560*
- "**Global Simulations of Axisymmetric Radiative Black Hole Accretion Discs in General Relativity with a Mean-Field Magnetic Dynamo**," A. Sadowski, et al., Monthly Notices of the Royal Astronomical Society, vol. 447, issue 1, December 12, 2014. * *http://mnras.oxfordjournals.org/content/447/1/49.full*
- **2014 American Geophysical Union Fall Meeting**, December 15–19, 2014, San Francisco,
  - "**Realistic Modeling of Multi-Scale MHD Dynamics of the Solar Atmosphere**," I. Kitiashvili. *
  - "**Advances in Realistic MHD Simulations**," I. Kitiashvili. *

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Papers and Presentations (cont.)

- **2014 American Geophysical Union Fall Meeting** (cont.)
  - "**Improving NASA GPM Data Exploitation Through Cloud-Resolving Model Empowered with Parallel AsyncIO Management**," D. Kokron, T. Clune, W.-K. Tao.
  - "**Three-Dimensional Magnetic Reconnection Under Low Chromospheric Conditions Using a Two-Fluid Weakly Ionized Reactive Plasma Model**," N. Mansour. *
  - "**Open NASA Earth Exchange: A Public-Private Partnership for Climate Change Research**," R. Nemani, et al. *
  - "**Linking the Solar Interior with the Corona: Observations, Models, and Data Assimilation**," I. Kitiashvili, N. Mansour (Chairs), A. Wray.
  - "**Open NASA Earth Exchange (OpenNEX): Strategies for Enabling Cross Organization Collaboration in the Earth Sciences**," S. Ganguly, R. Nemani, et al. *
  - "**Using NASA Earth Exchange (NEX) to Develop Annual US Forest Disturbance Products**," R. Nemani, et al. *
  - "**The Sun's Meridional Flow and Its Role in Magnetic Flux Transport and the Sunspot Cycle**," D. Hathaway, L. Upton. *
  - "**Revised Sunspot Numbers and the Effects on Understanding the Sunspot Cycle**," D. Hathaway. *
  - "**Improving Synchronic Maps with Far-Side Active Region Emergence**," D. Hathaway, L. Upton.*
  - "**A Spatio-Temporal Data Mining Approach to Global Scale Burned Area Modeling**," R. Nemani, N. Oza, et al. *

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

Papers and Presentations (cont.)

- **2014 American Geophysical Union Fall Meeting** (cont.)
  - "**High-Resolution Climate Data Over Conterminous US Using Random Forest Algorithm**," R. Nemani, et al. *
  - "**Preliminary Vegetation Index Products from Suomi NPP VIIRS Illuminate the California Drought**," R. Nemani, et al. *
  - "**Advancing Analytics Using Big Data Climate Information System**," R. Nemani (Chair).
  - "**Large-Scale Image Analytics Using Deep Learning**," R. Nemani, S. Ganguly, A. Michaelis, et al. *
  - "**Impact of Cumulated CO_2 Emission on Air Temperature: Millennial-Scale Prediction**," R. Nemani, et al. *
  - "**Variability of Global Atmospheric CO_2 Concentrations Over Interannual to Multi-Decadal Timescales: A Linear Approximation**," R. Nemani, et al. *
  - "**Using Analytics to Support Petabyte-Scale Science on the NASA Earth Exchange (NEX)**," R. Nemani, S. Ganguly, A. Michaelis, P. Votava. *
  - "**A Semi-Automated Machine Learning Algorithm for Tree Cover Delineation from 1-m Naip Imagery Using a High Performance Computing Architecture**," S. Ganguly, et al. *
  - "**Reducing Uncertainties in Satellite-derived Forest Aboveground Biomass Estimates Using a High Resolution Forest Cover Map**," G. Zhang, et al. *
  - "**Mapping Urban Expansion Across North America Using Multi-Temporal Landsat and Nighttime Lights Data**," A. Michaelis, G. Zhang, S. Ganguly, R. Nemani, et al. *
  - **"On the Use of FOSS4G in Land Cover Fraction Estimation with Unmixing Algorithms**," U. Kumar, S. Ganguly, G. Zhang, R. Nemani, et al. *

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Papers and Presentations (cont.)

- **2014 American Geophysical Union Fall Meeting** (cont.)
  - **"Long-Term Data Records of Biophysical Parameters from Multiple Satellite Systems**," S. Ganguly, R. Nemani, G. Zhang, et al. *
  - **"A Quarter-Century U.S. Forest Disturbance History Mapped from Landsat**," J. Dungan, et al. *
  - "**Quantum Boosting and Fast Classical Metrics for Tree Cover Detection in Remote Sensing Data**," S. Ganguly, R. Nemani, et al. *
  - "**Cost Optimal Elastic Auto-Scaling in Cloud Infrastructure**," S. Ganguly, R. Nemani, et al. *
  - "**Geography of Global Forest Carbon Stocks & Dynamics**," S. Ganguly, R. Nemani, et al. *
  - "**Mapping Drought Impacts on Agricultural Production in California's Central Valley**," F. Melton, A. Guzman, et al. *
  - "**Integrating Parallel Distributed Data Mining Algorithms into the NASA Earth Exchange (NEX)**," N. Oza, R. Nemani, A. Michaelis, et al. *
- "**Electron and Ion Heating by Whistler Turbulence: Three-Dimensional Particle-in-Cell Simulations**," R. S. Hughes, S. P. Gary, J. Wang, Geophysical Research Letters, December 17, 2014. *
  http://onlinelibrary.wiley.com/doi/10.1002/2014GL062070/full
- "**Asynchronous Amazon Forest Canopy Phenology Indicates Adaption to Both Water and Light Availability**," M. Jones, J. Kimball, R. Nemani, Environmental Research Letters, December 18, 2014. *
  http://iopscience.iop.org/1748-9326/9/12/124021/pdf/1748-9326_9_12_124021.pdf

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Papers and Presentations (cont.)

- "**Radiation from Particles Accelerated in Relativistic Jet Shocks and Shear-flows**," K.-I. Nishikawa, et al., arXiv:1412.7064v1 [astro-ph.HE] December 22, 2014. *http://arxiv.org/abs/1412.7064* *
- "**A Steady-State Picture of Solar Wind Acceleration and Charge State Composition Derived from a Global Wave-Driven MHD Model**," R. Oran, et al., arXiv: 1412.8288v1 [astro-ph.SR] December 29, 2014. *http://arxiv.org/abs/1412.8288* *

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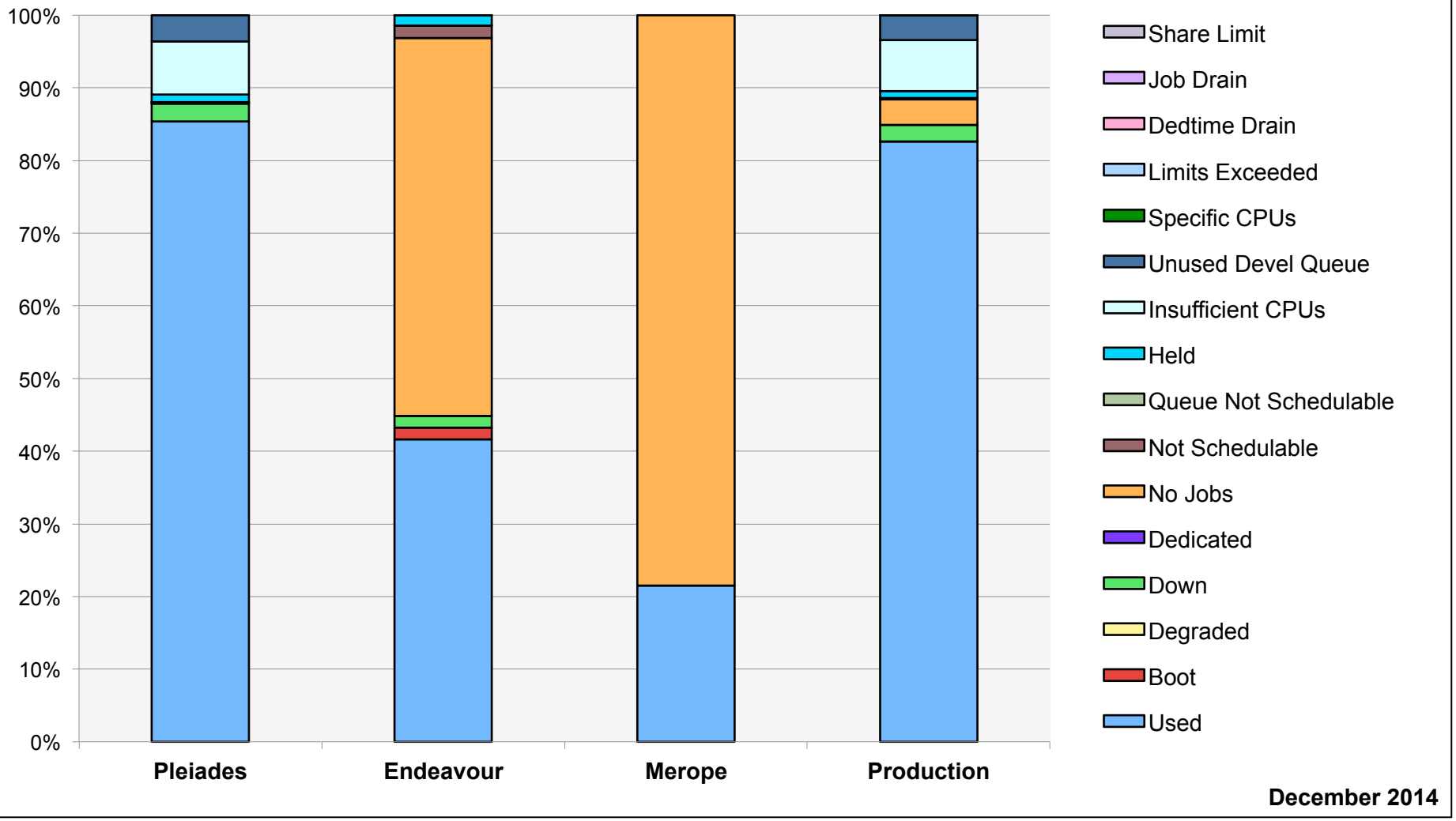
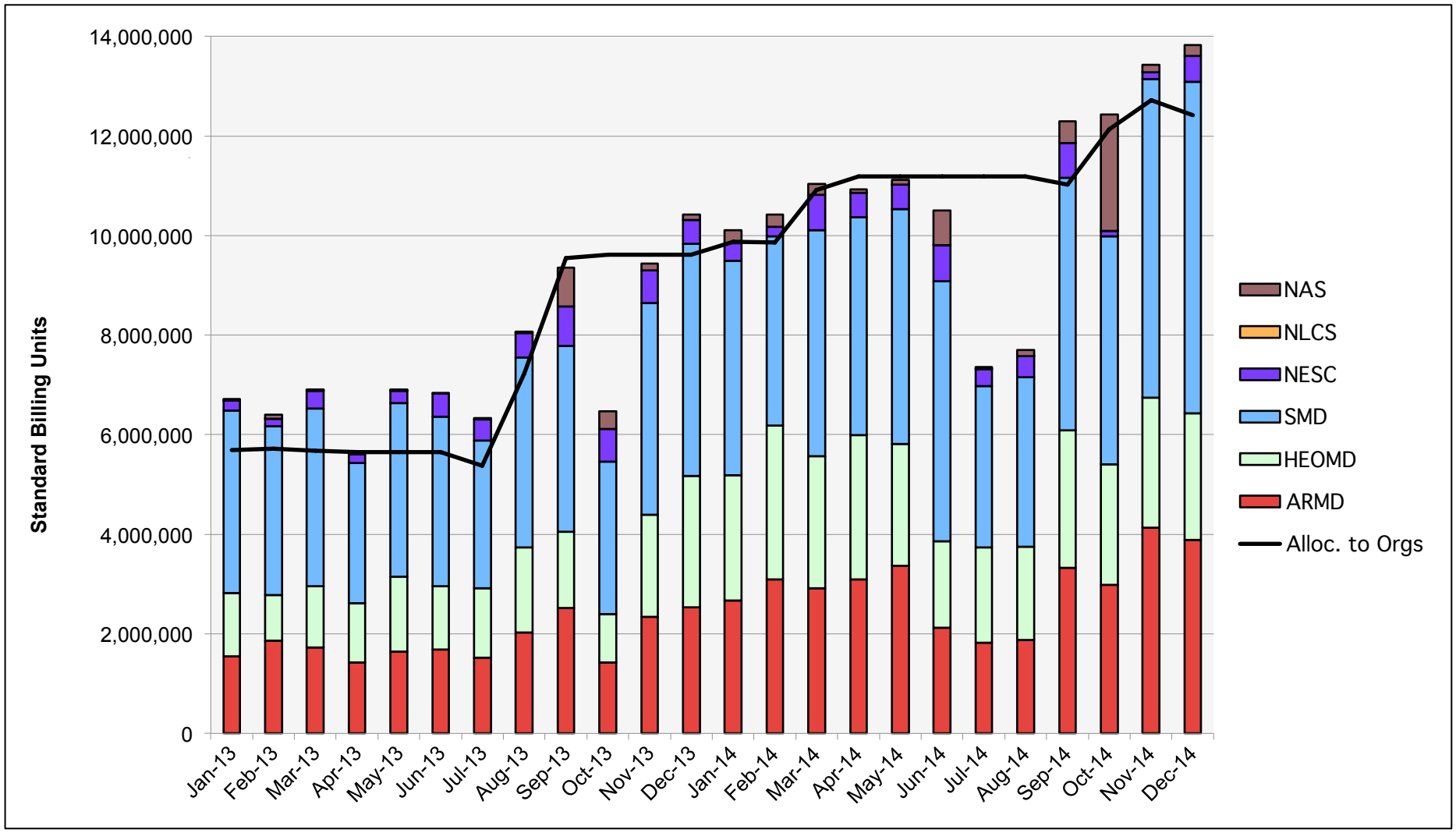
News and Events

- **NASA at the AGU Fall Meeting**, December 15-19, 2014, San Francisco—NAS Division staff attended the American Geophysical Union's fall meeting, one of the largest Earth and space science conferences in the world. They presented their work to the public at the NASA booth's hyperwall on the exhibit floor, chaired paper sessions, and displayed posters of some of the year's accomplishments in the poster hall.
- **Northern California NASA Scientists Bring Drought Research Home**, *NASA Ames press release*, December 15, 2014—Researchers at NASA Ames Research Center utilized the NASA Earth Exchange (NEX) platform and HECC systems at the NAS facility to study satellite data, in order to analyze and project the effects of California's record drought. *http://www.nasa.gov/ames/northern-california-nasa-scientists-bring-drought-research-home*
- **The Greenland Ice Sheet: Now in HD**, *Ohio State University press release,* December 18, 2014—Researchers at OSU hope to expand their project to turn satellite images into publicly available elevation maps to the Pleiades supercomputer starting in 2015. *http://news.osu.edu/news/2014/12/18/the-greenland-ice-sheet-now-in-hd/*

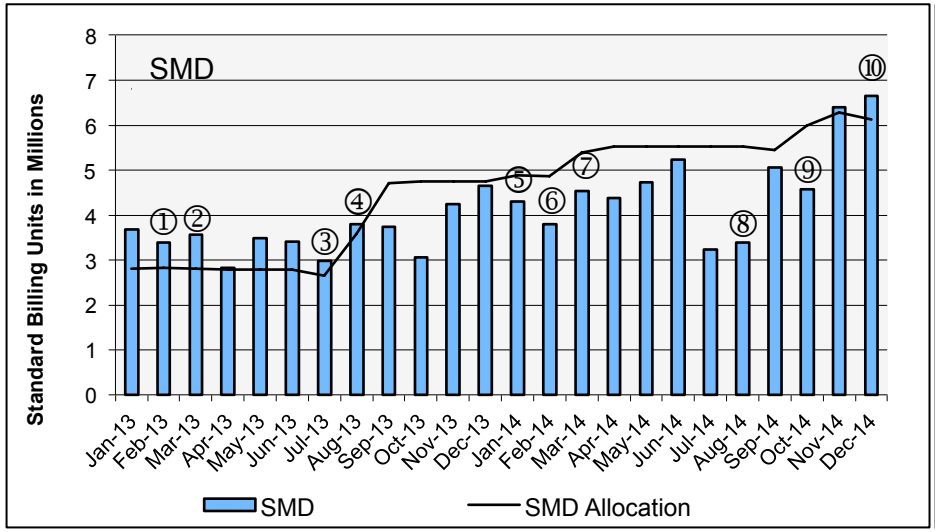
HECC Utilization

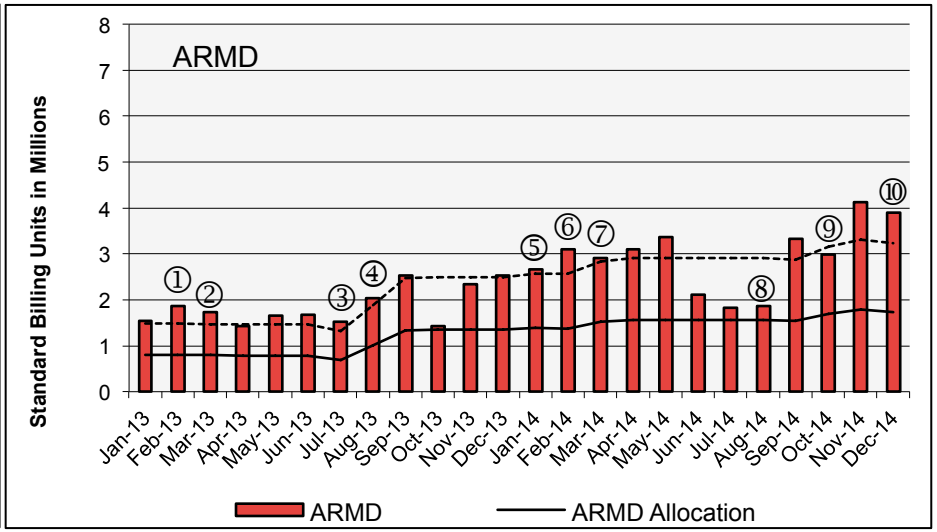


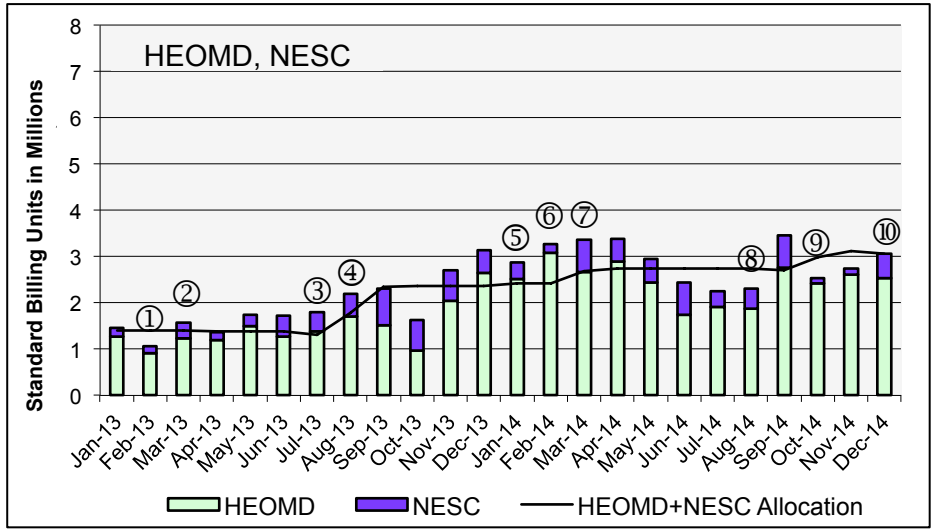
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







① Columbia 21, 23, and 24 retired, Endeavour 2 added

② Columbia 22 retired; Endeavour 1 added

③ 32 Harpertown Racks retired

④ 32 Harpertown Racks retired; 46 Ivy Bridge Racks added

⑤ 6 Ivy Bridge Racks added; 20 Nehalem, 12 Westmere Racks Retired

⑥ 8 Ivy Bridge Racks added mid-Feb; 8 Ivy Bridge Racks added late Feb.

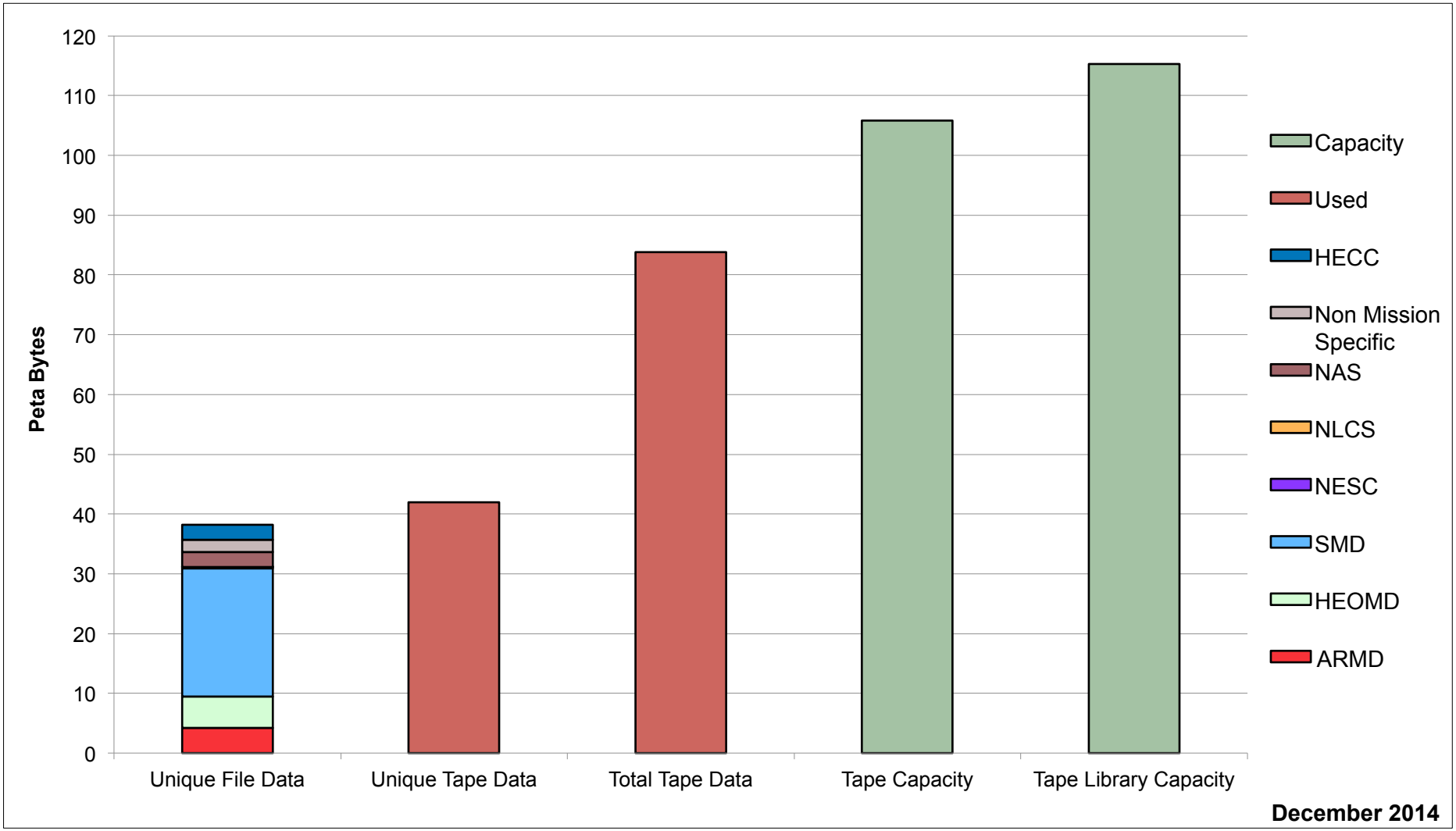
⑦ 4 Ivy Bridge Racks added mid-March

⑧ 6 Westmere Racks added to Merope, Merope Harpertown retired

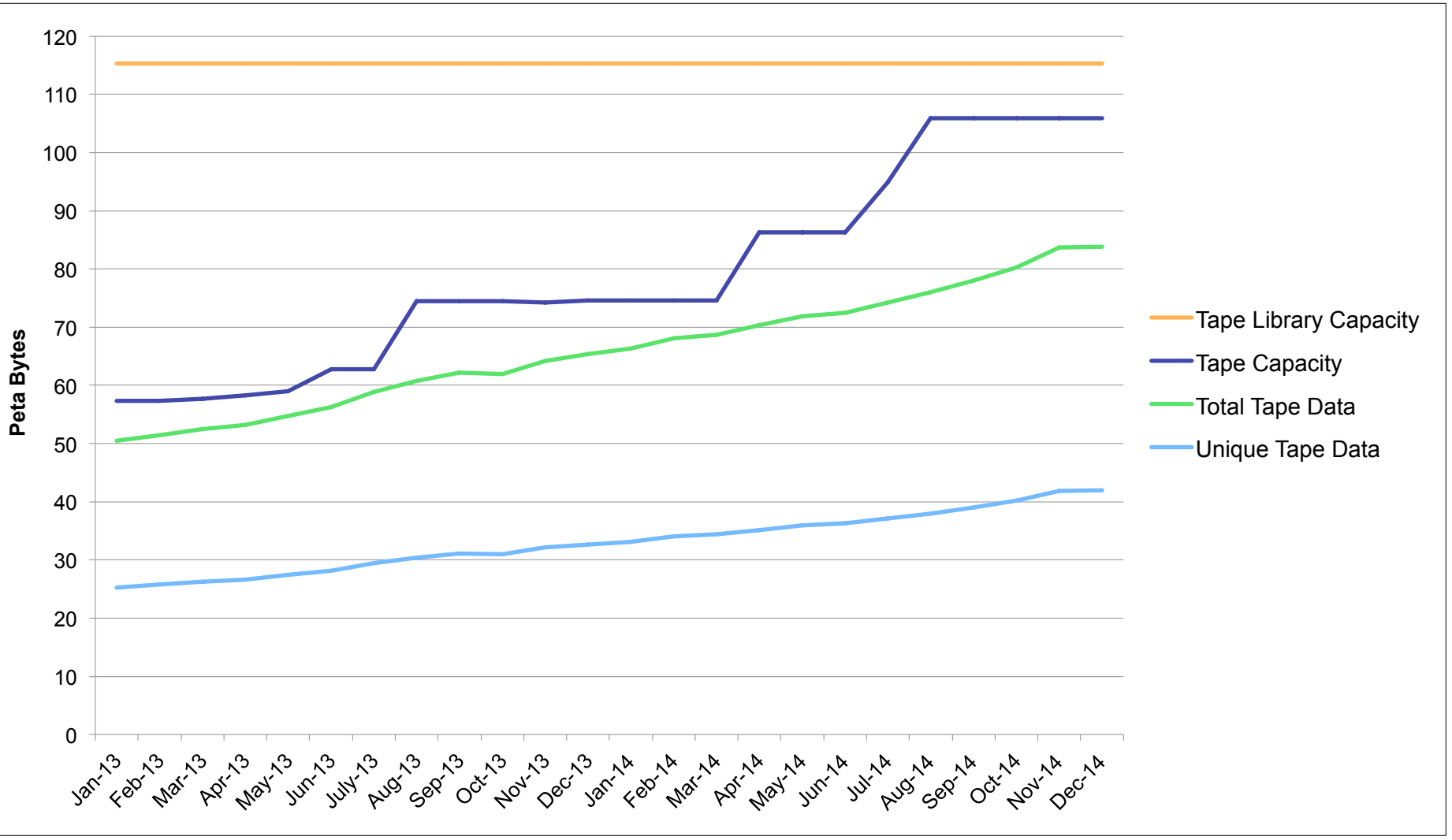
⑨ 16 Westmere Racks retired; 10 Nehalem Racks and 2 Westmere Racks added to Merope; 3 Ivy Bridge Racks added; 15 Haswell Racks added

⑩ 16 Westmere Racks retired

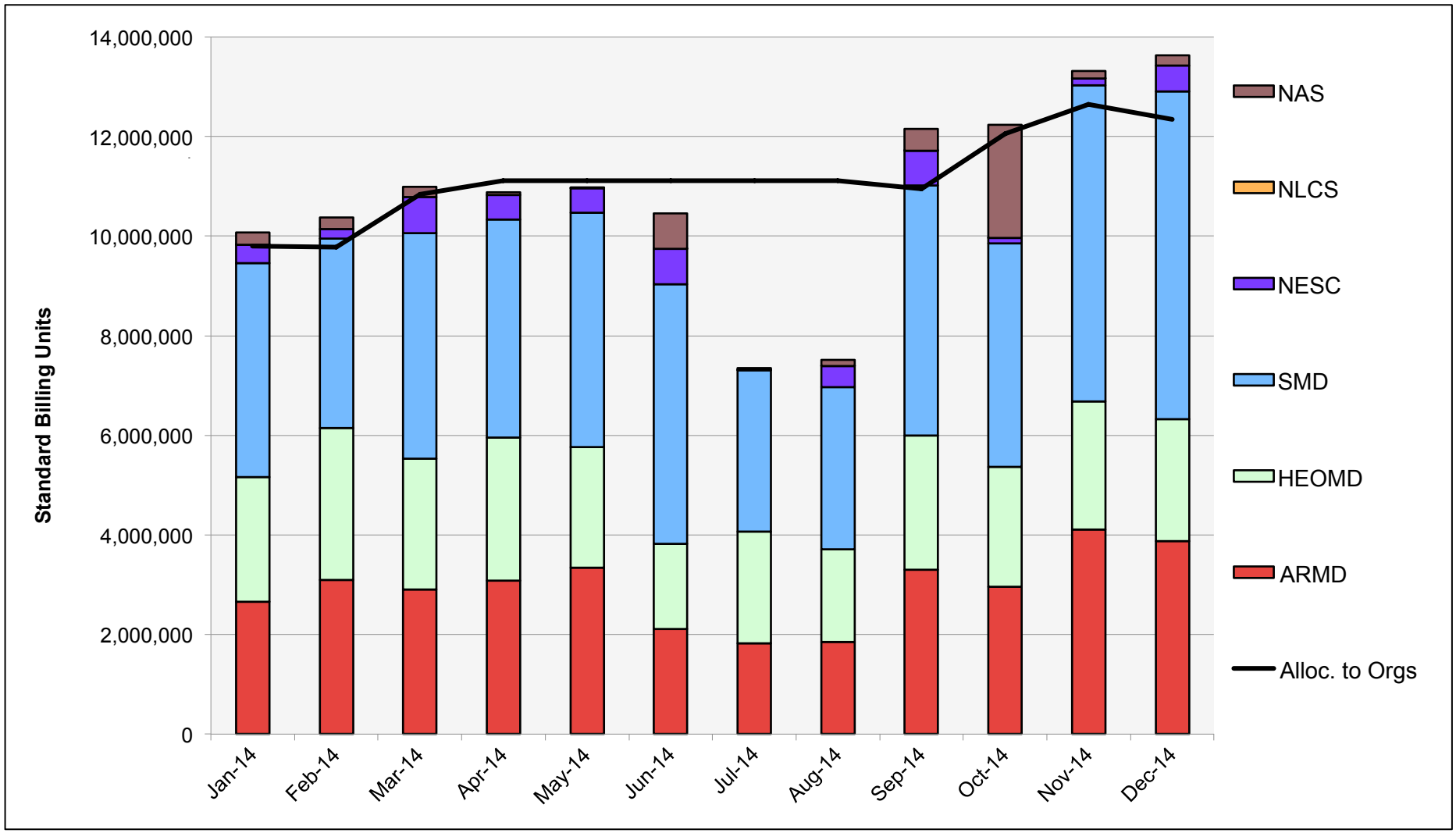
Tape Archive Status



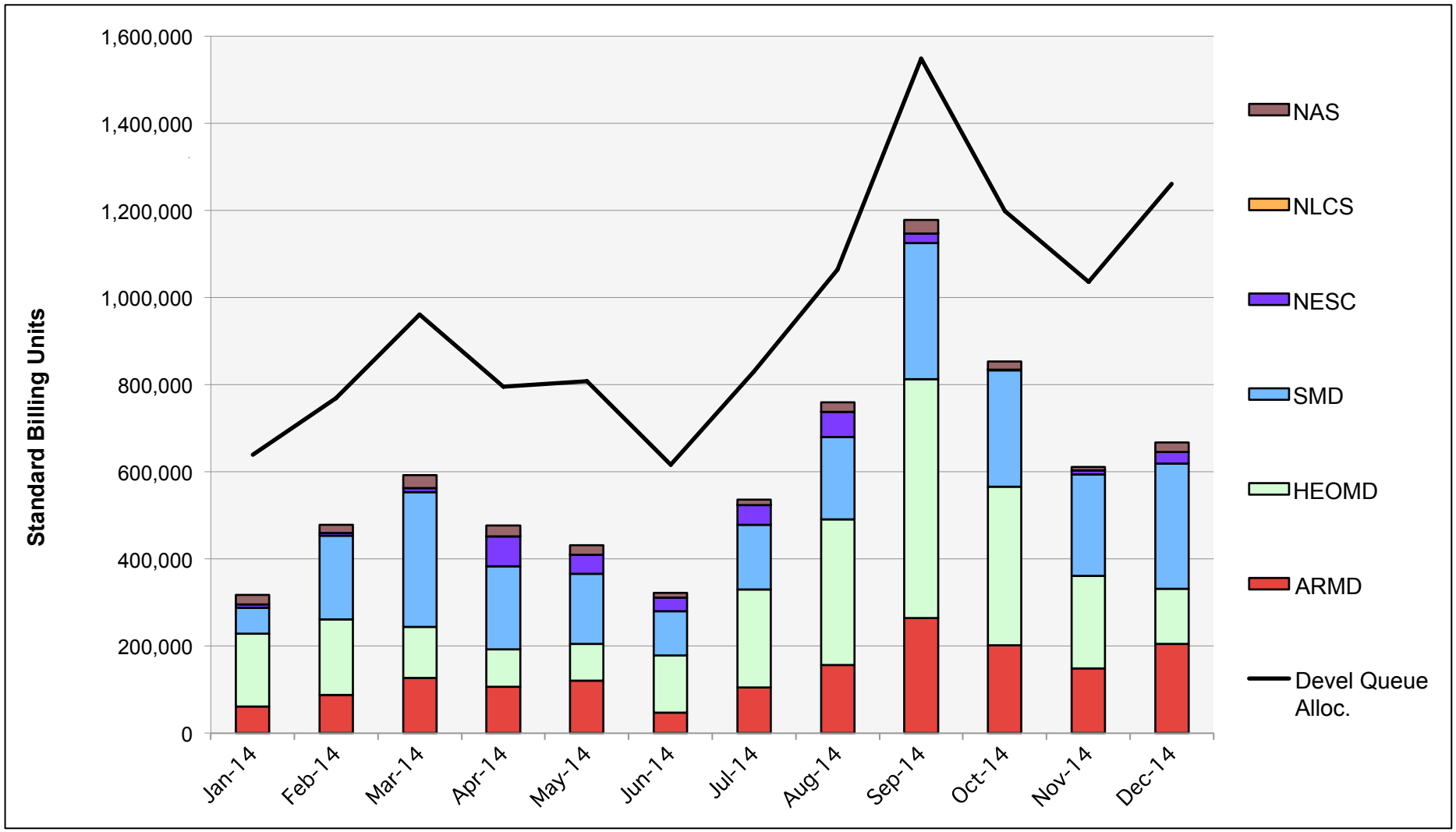
Tape Archive Status



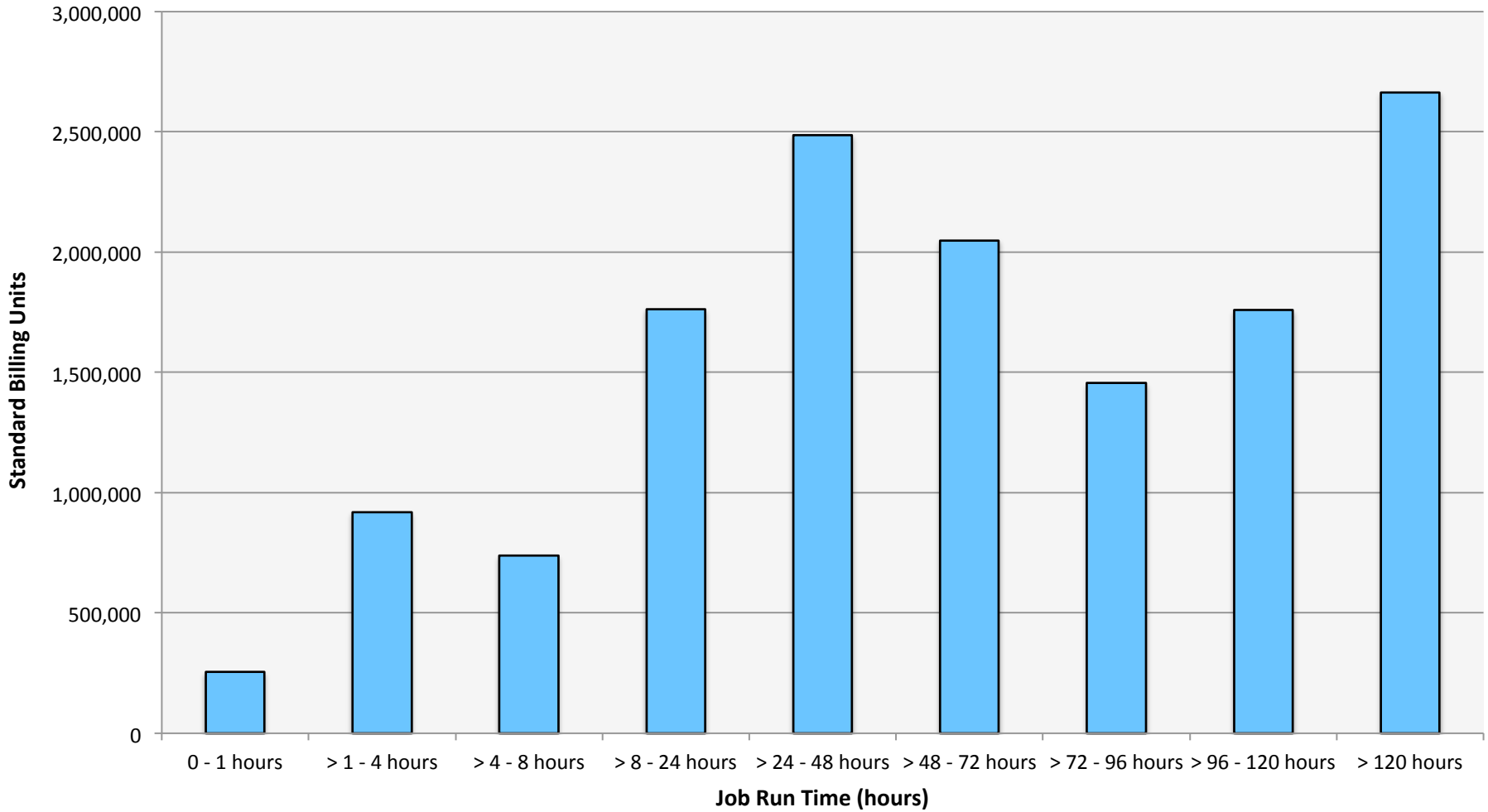
Pleiades:
SBUs Reported, Normalized to 30-Day Month



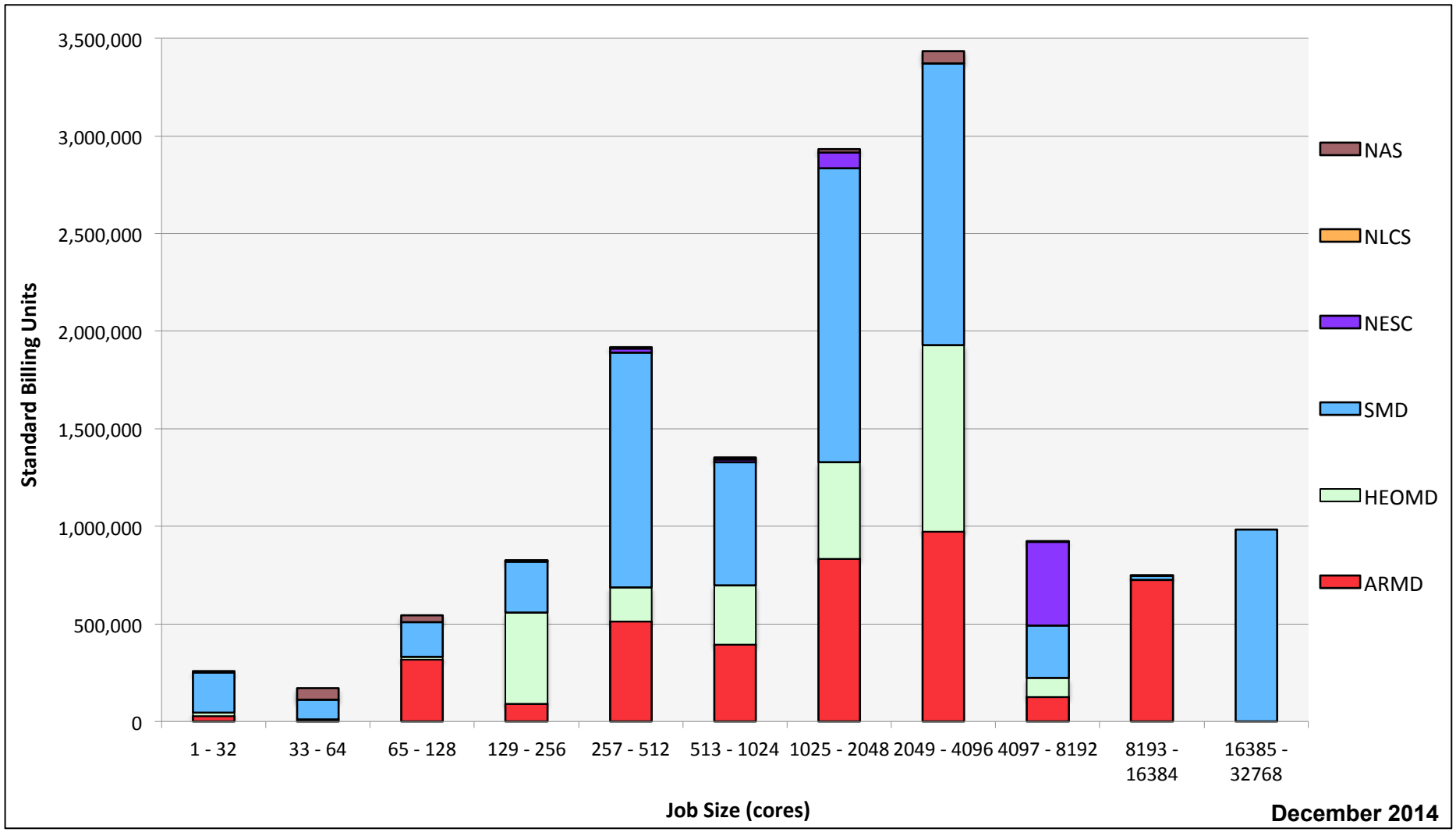
Pleiades:
Devel Queue Utilization



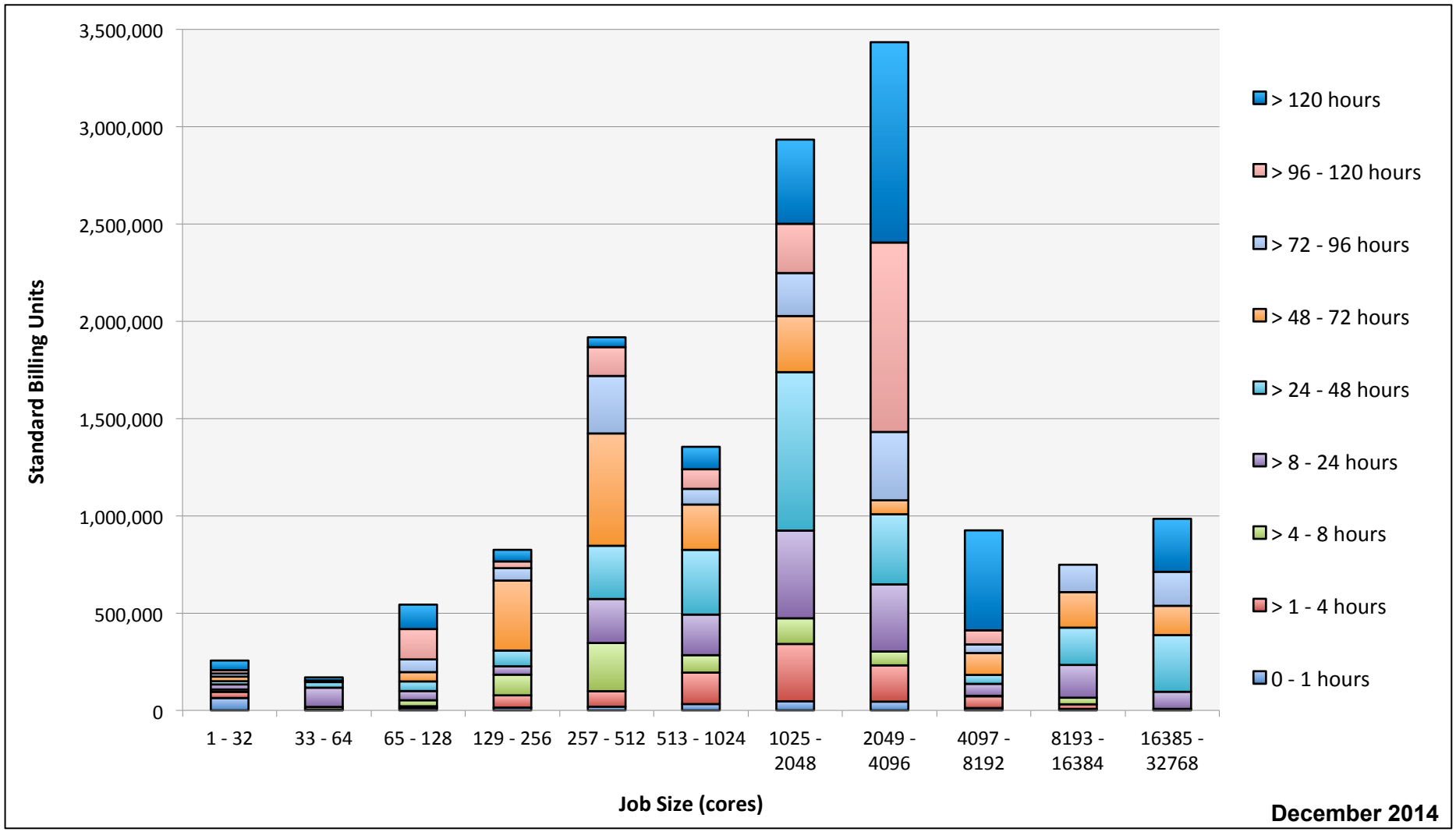
Pleiades:
Monthly Utilization by Job Length



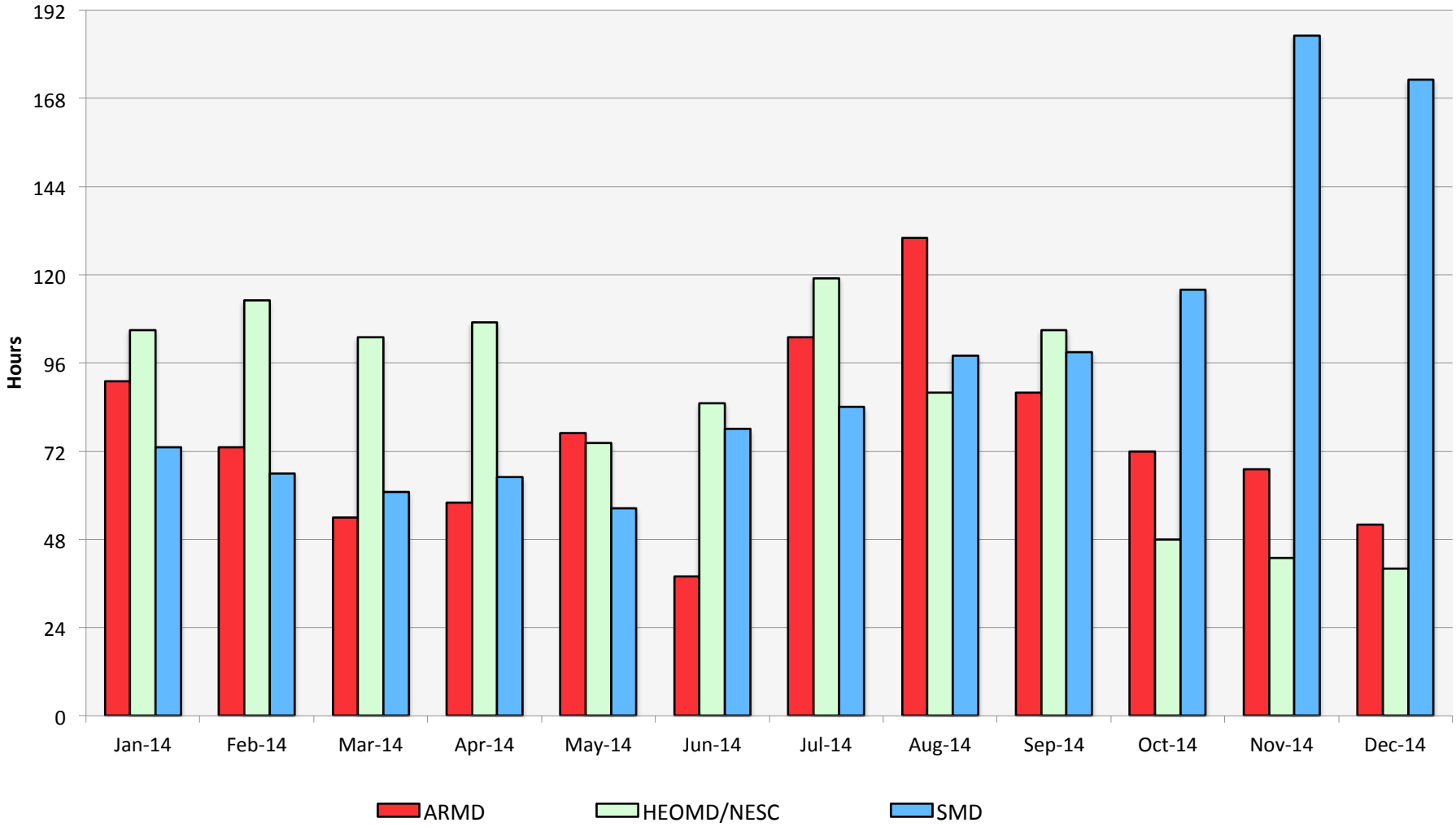
Pleiades:
Monthly Utilization by Size and Mission



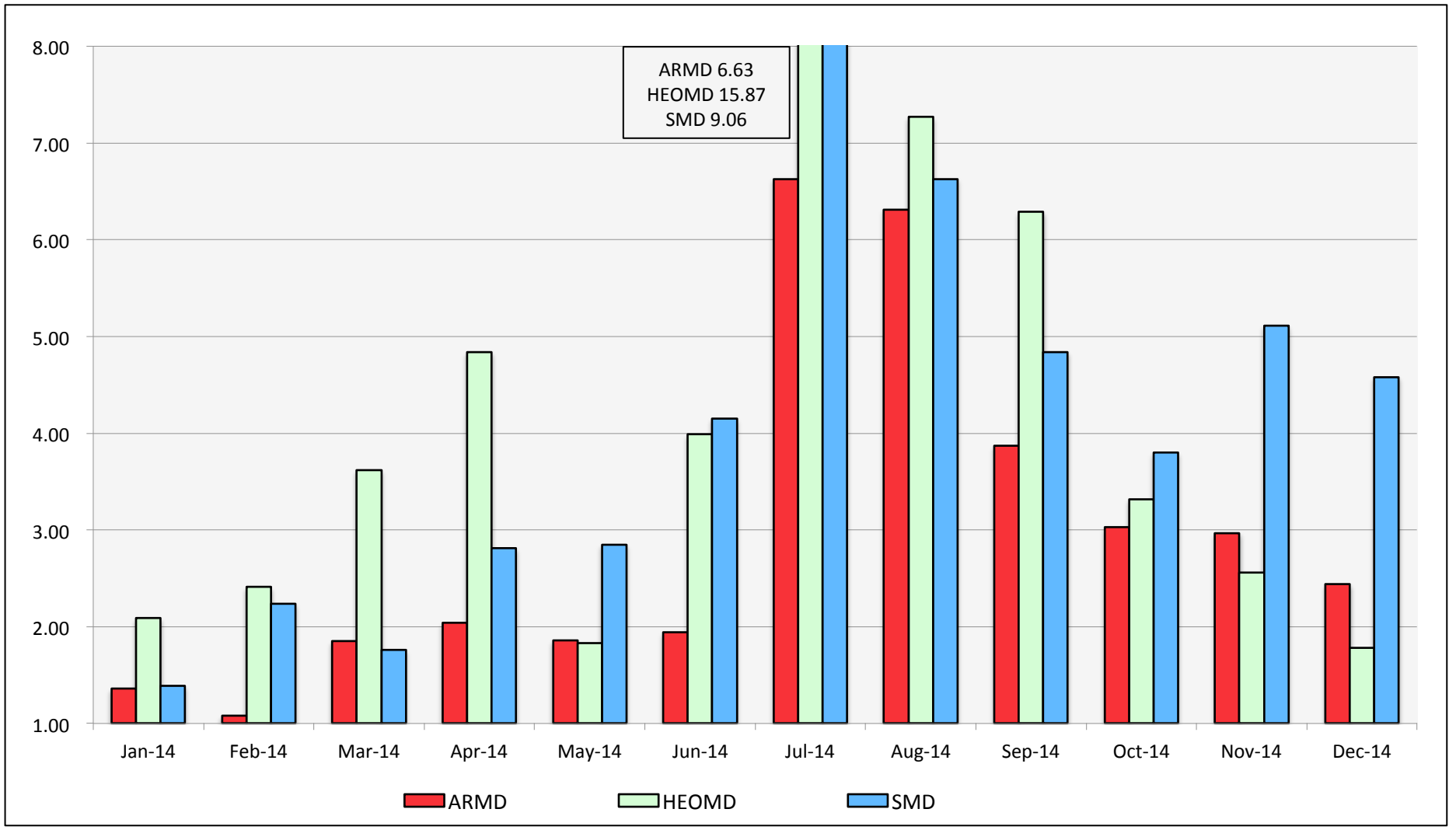
Pleiades:
Monthly Utilization by Size and Length



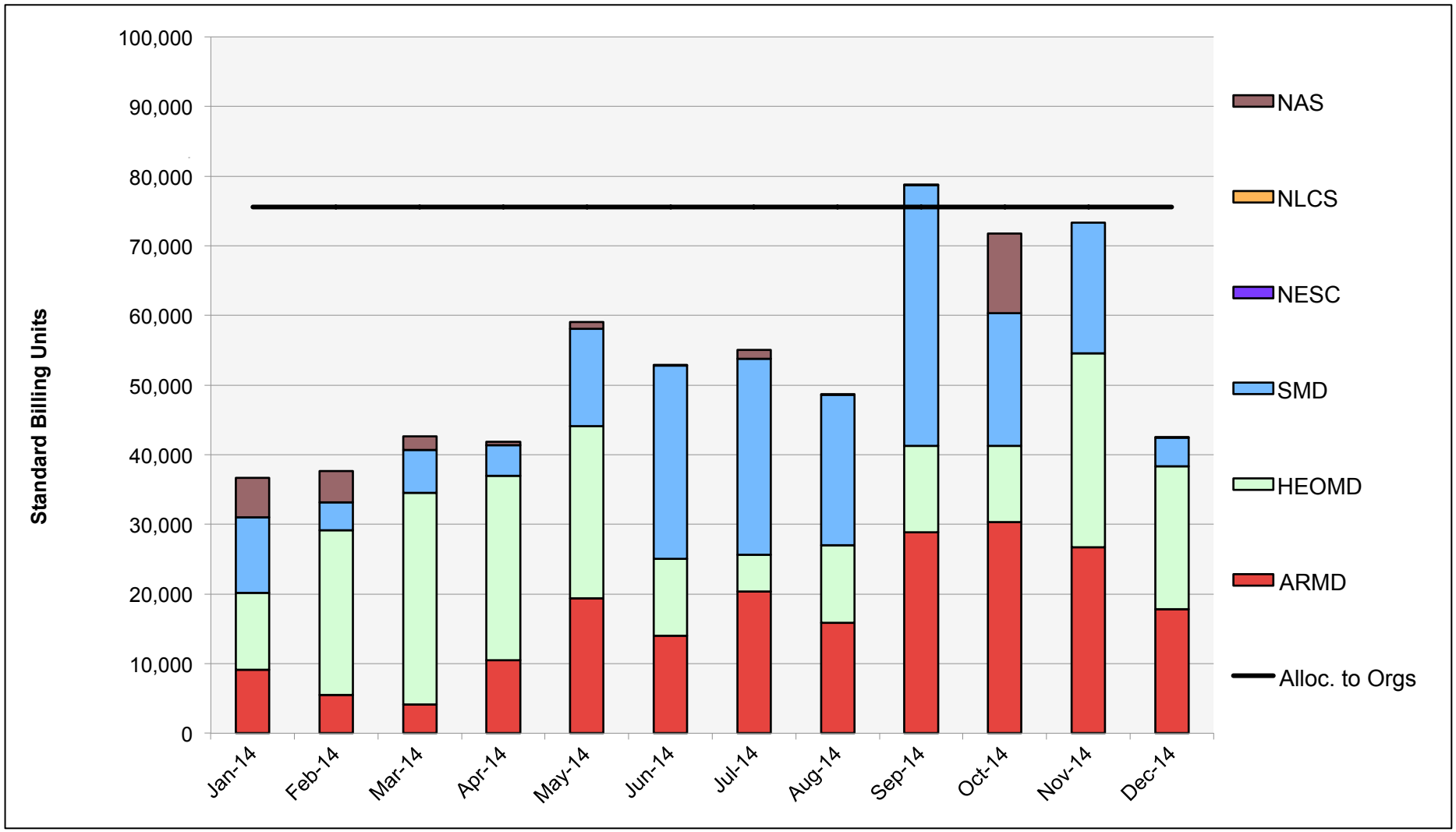
Pleiades:
Average Time to Clear All Jobs



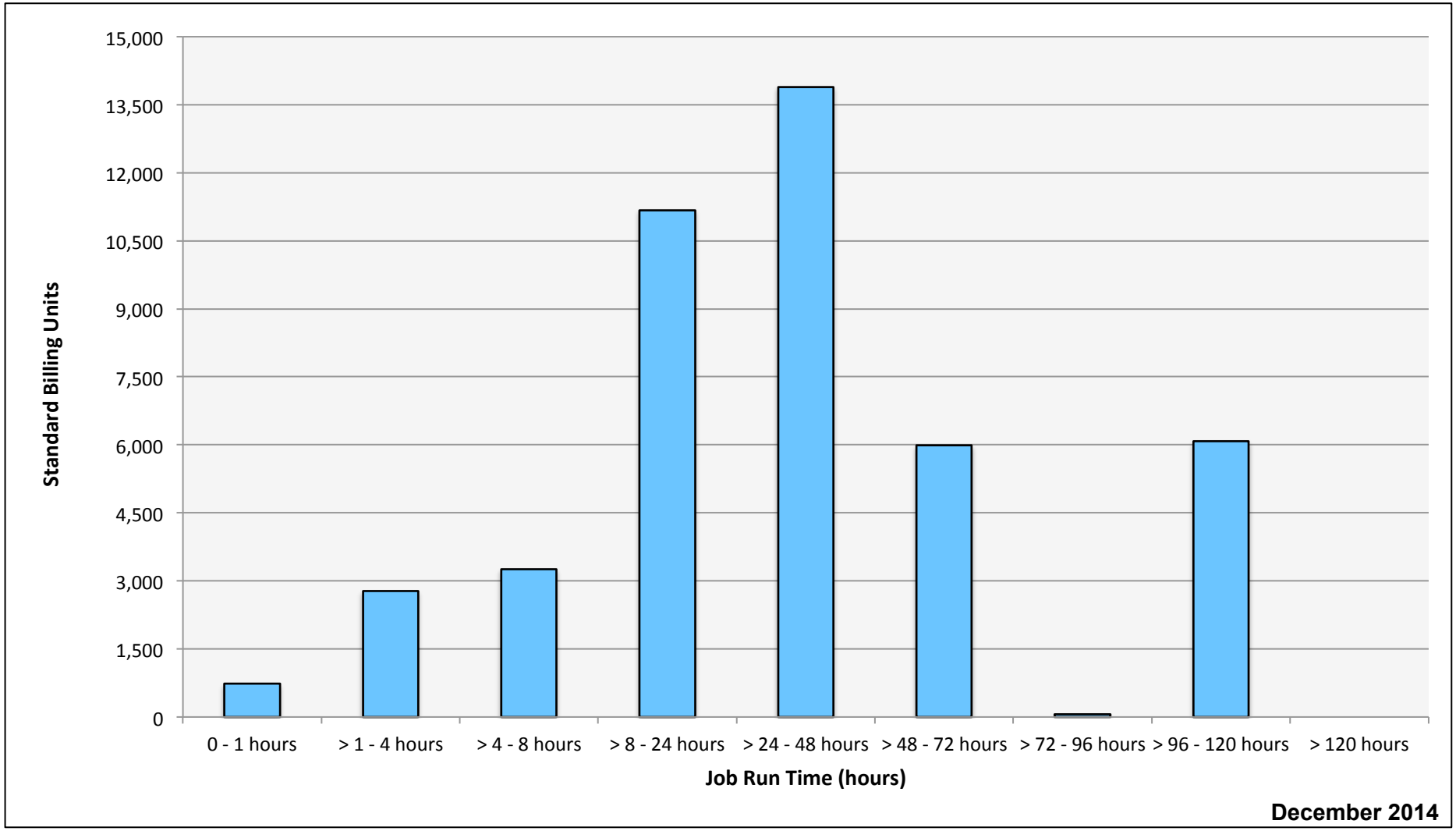
Pleiades:
Average Expansion Factor



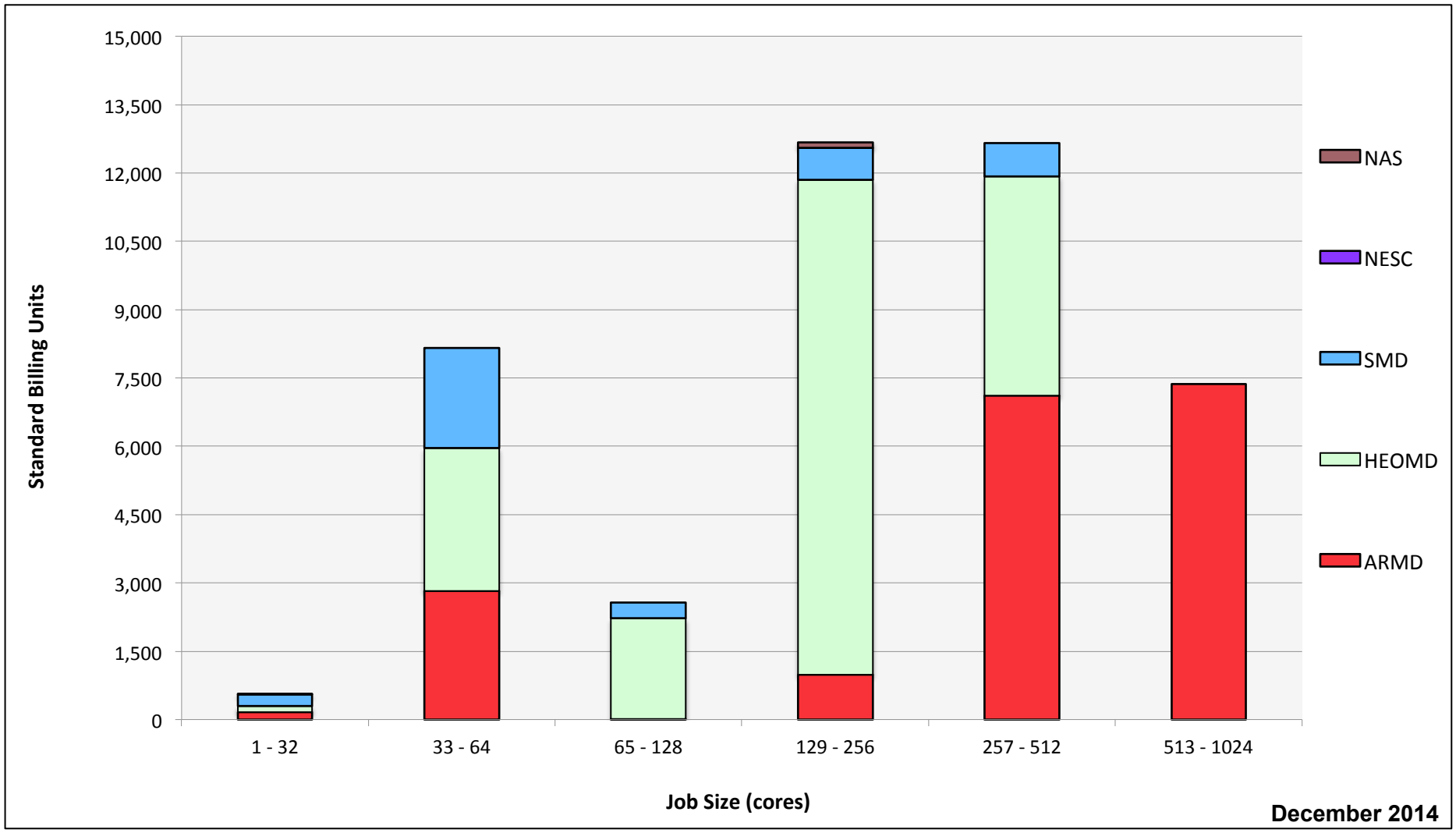
Endeavour:
SBUs Reported, Normalized to 30-Day Month



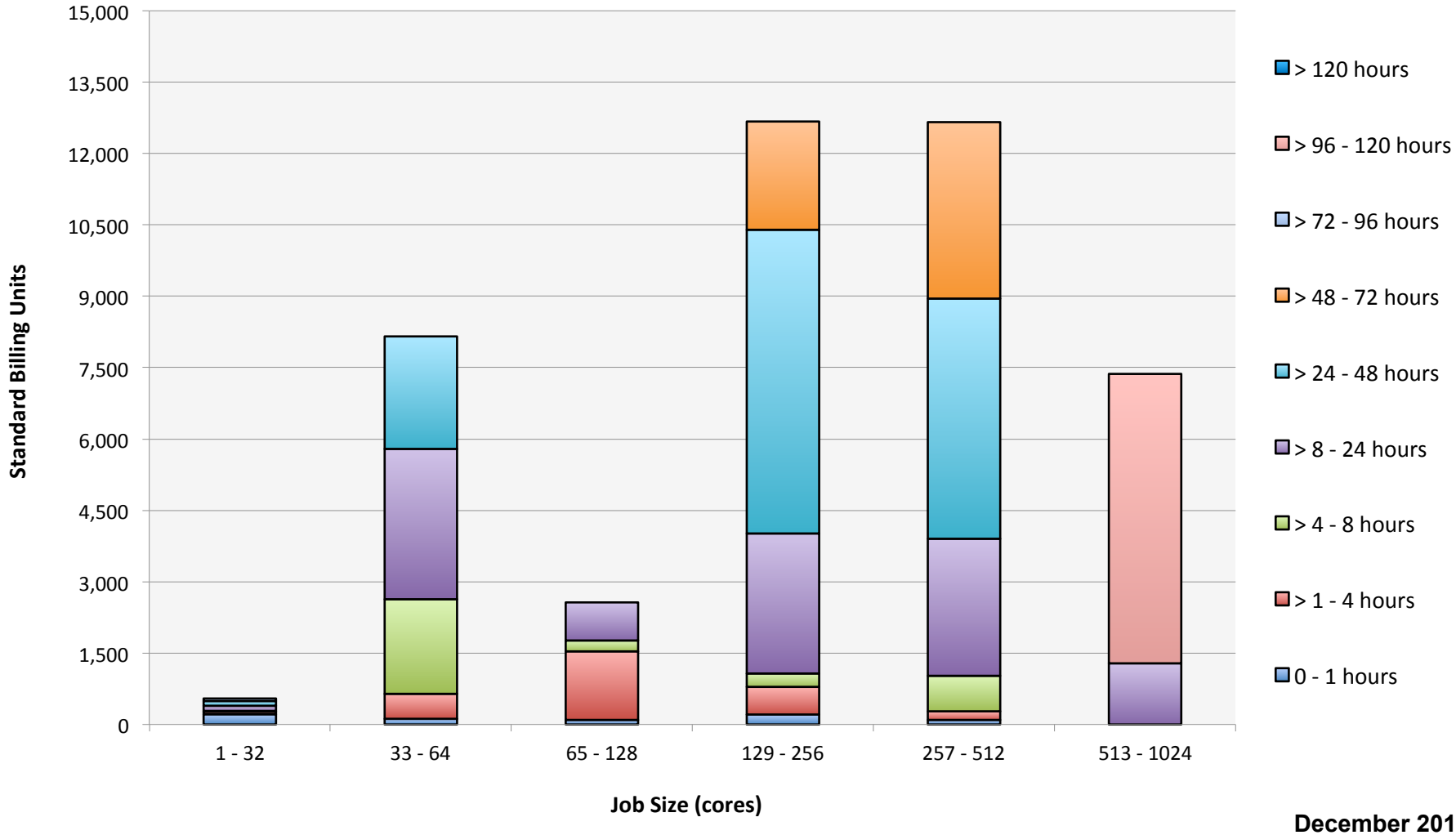
Endeavour:
Monthly Utilization by Job Length



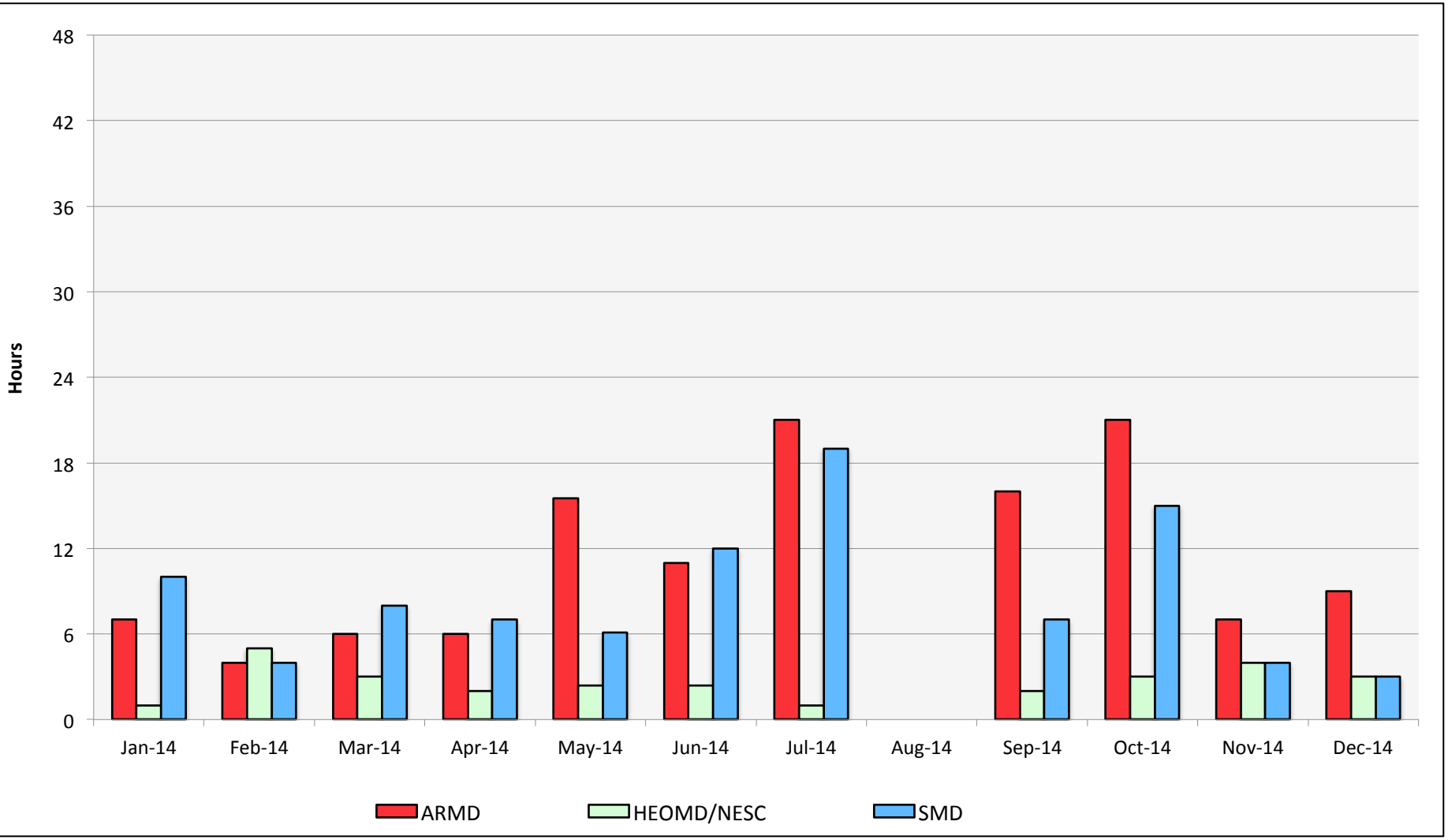
Endeavour:
Monthly Utilization by Size and Mission



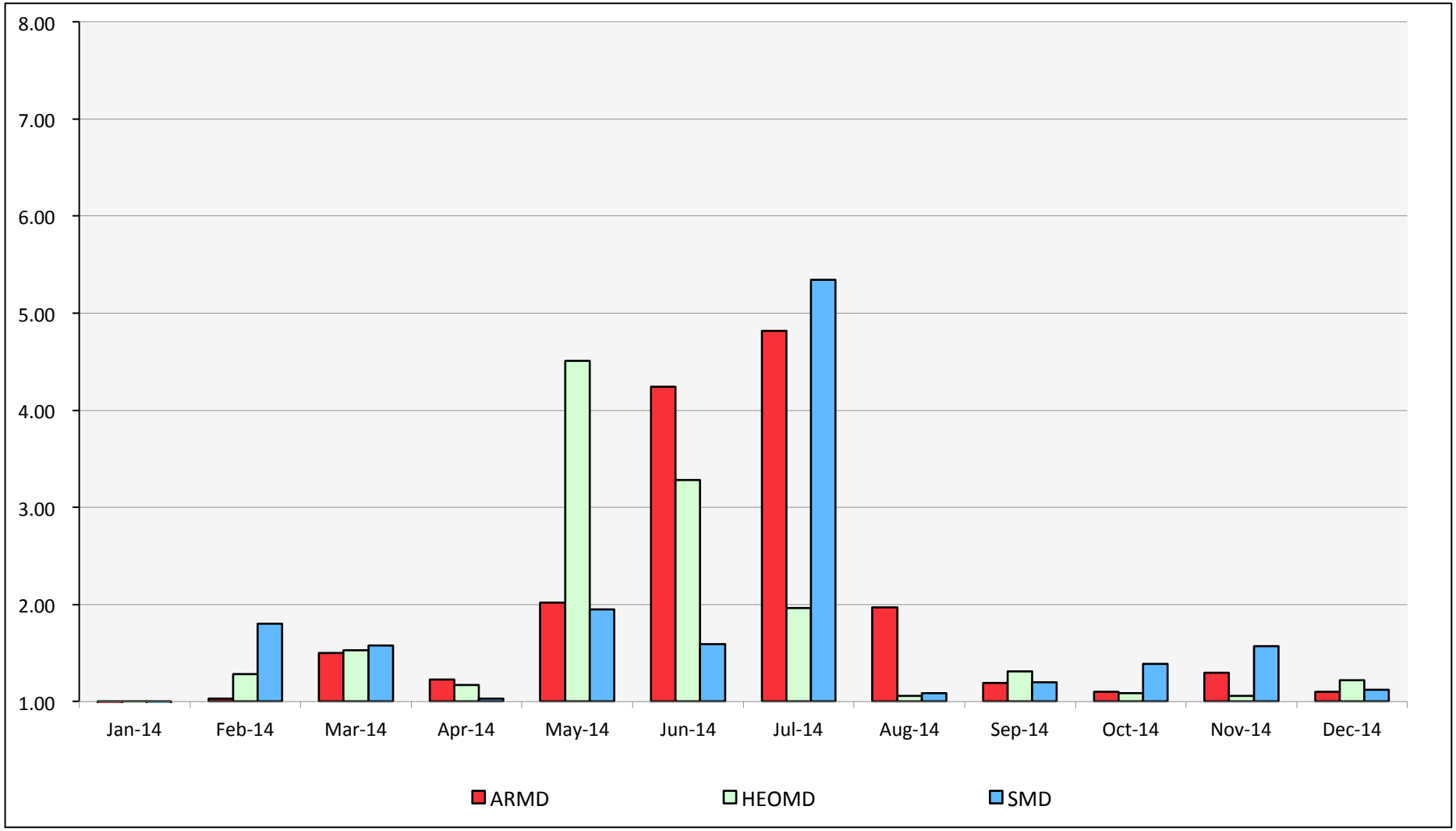
Endeavour:
Monthly Utilization by Size and Length



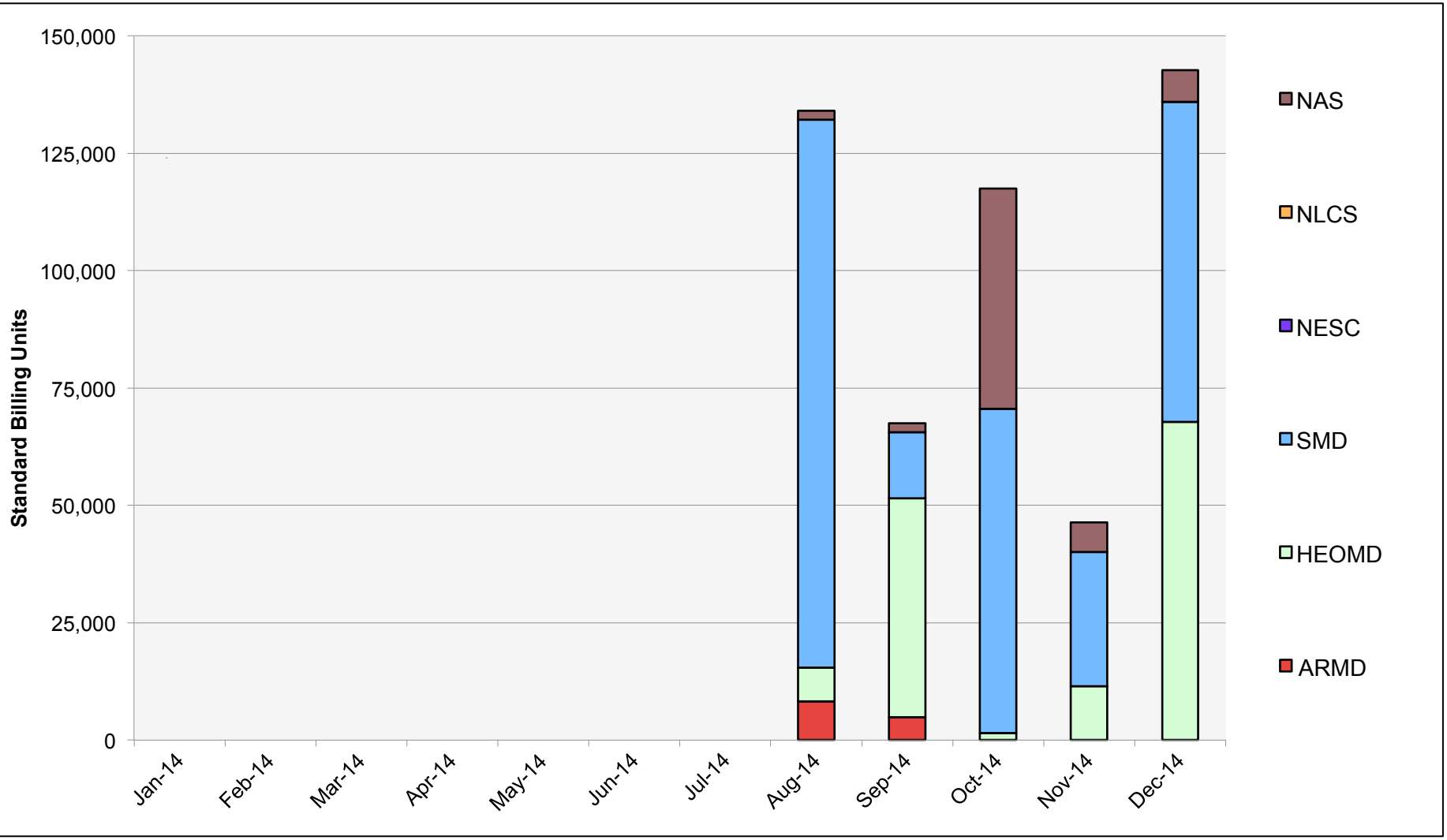
Endeavour:
Average Time to Clear All Jobs



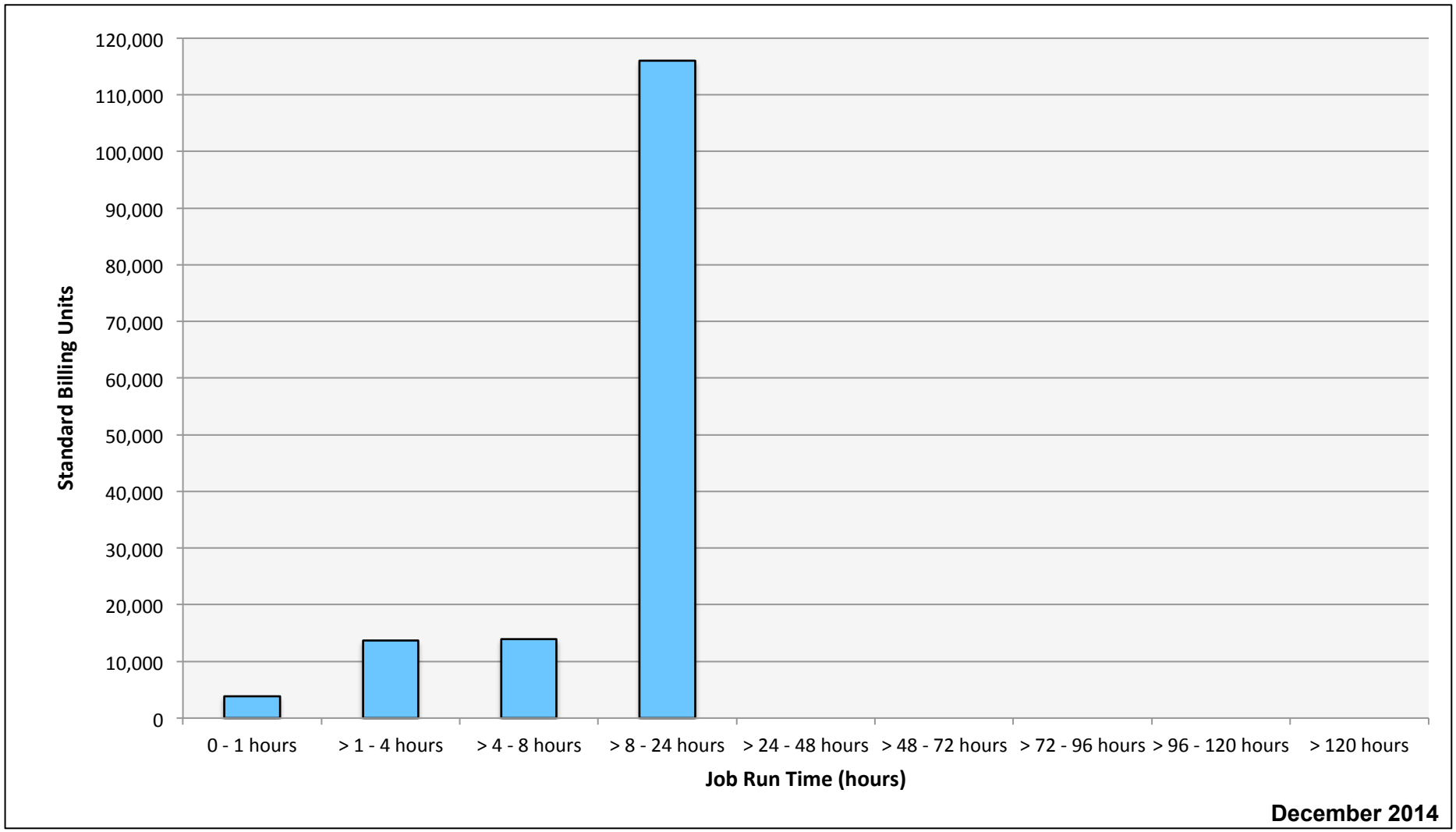
Endeavour:
Average Expansion Factor



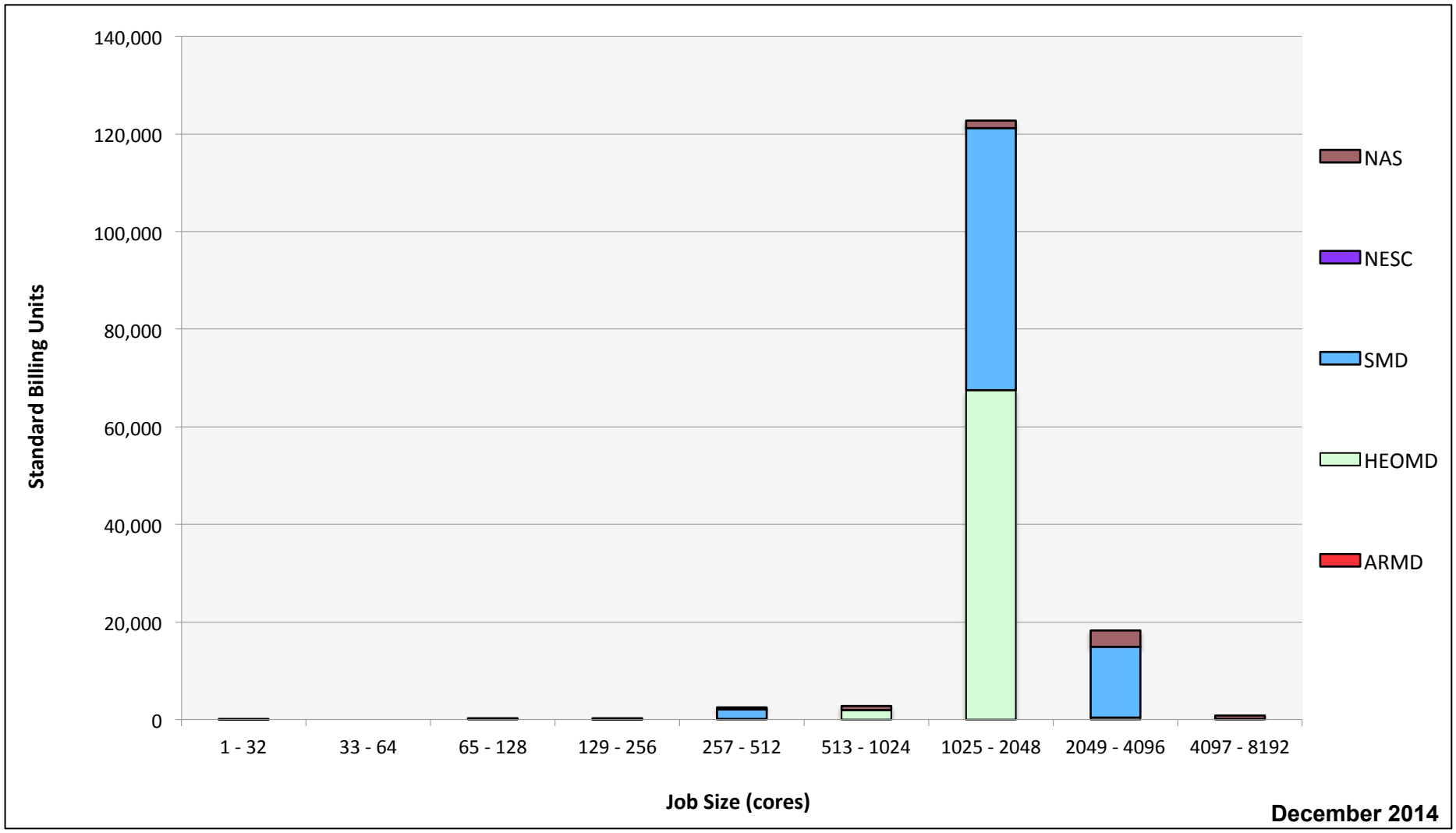
Merope:
SBUs Reported, Normalized to 30-Day Month



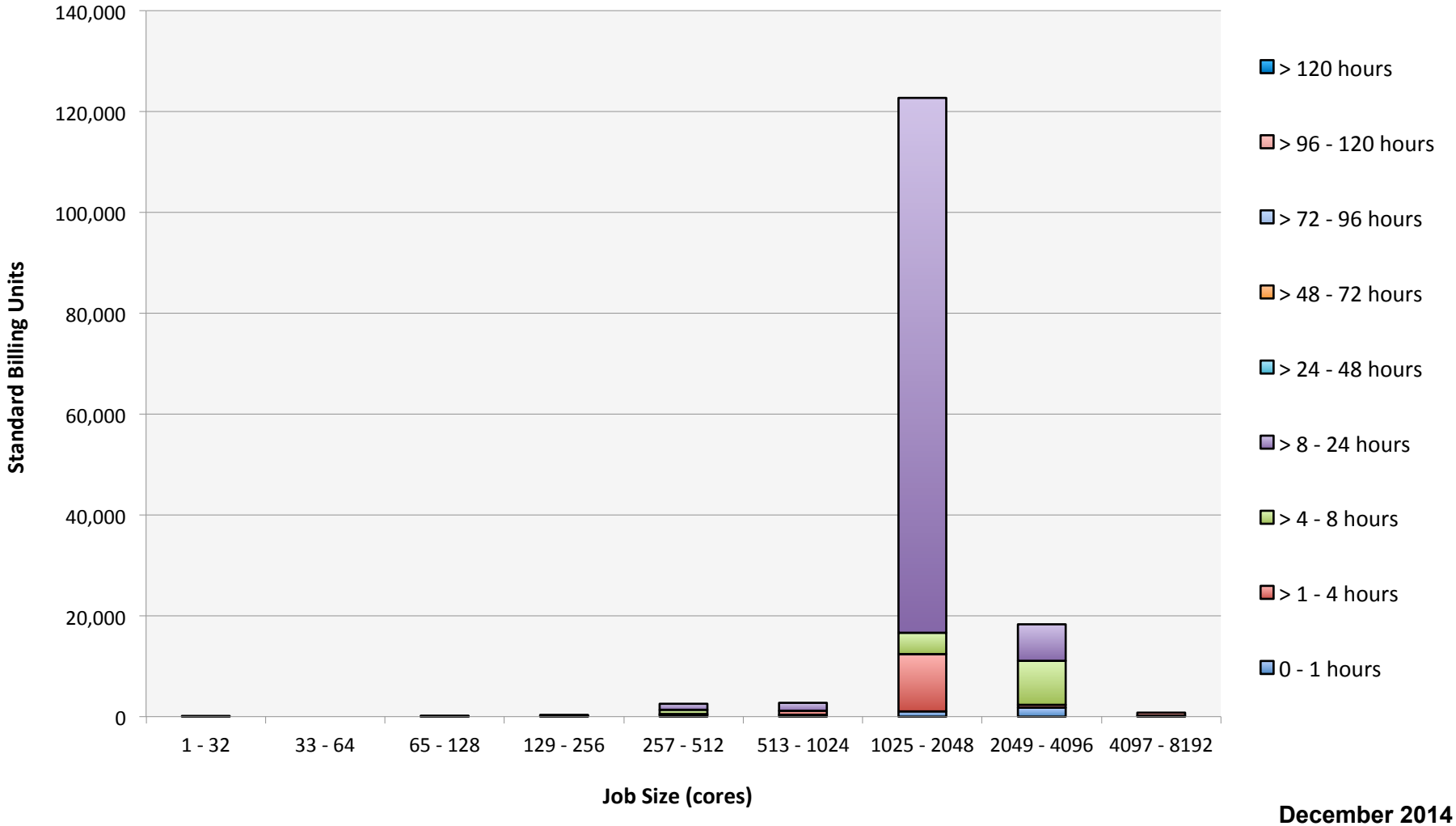
Merope:
Monthly Utilization by Job Length



Merope:
Monthly Utilization by Size and Mission



Merope:
Monthly Utilization by Size and Length



Merope:
Average Expansion Factor