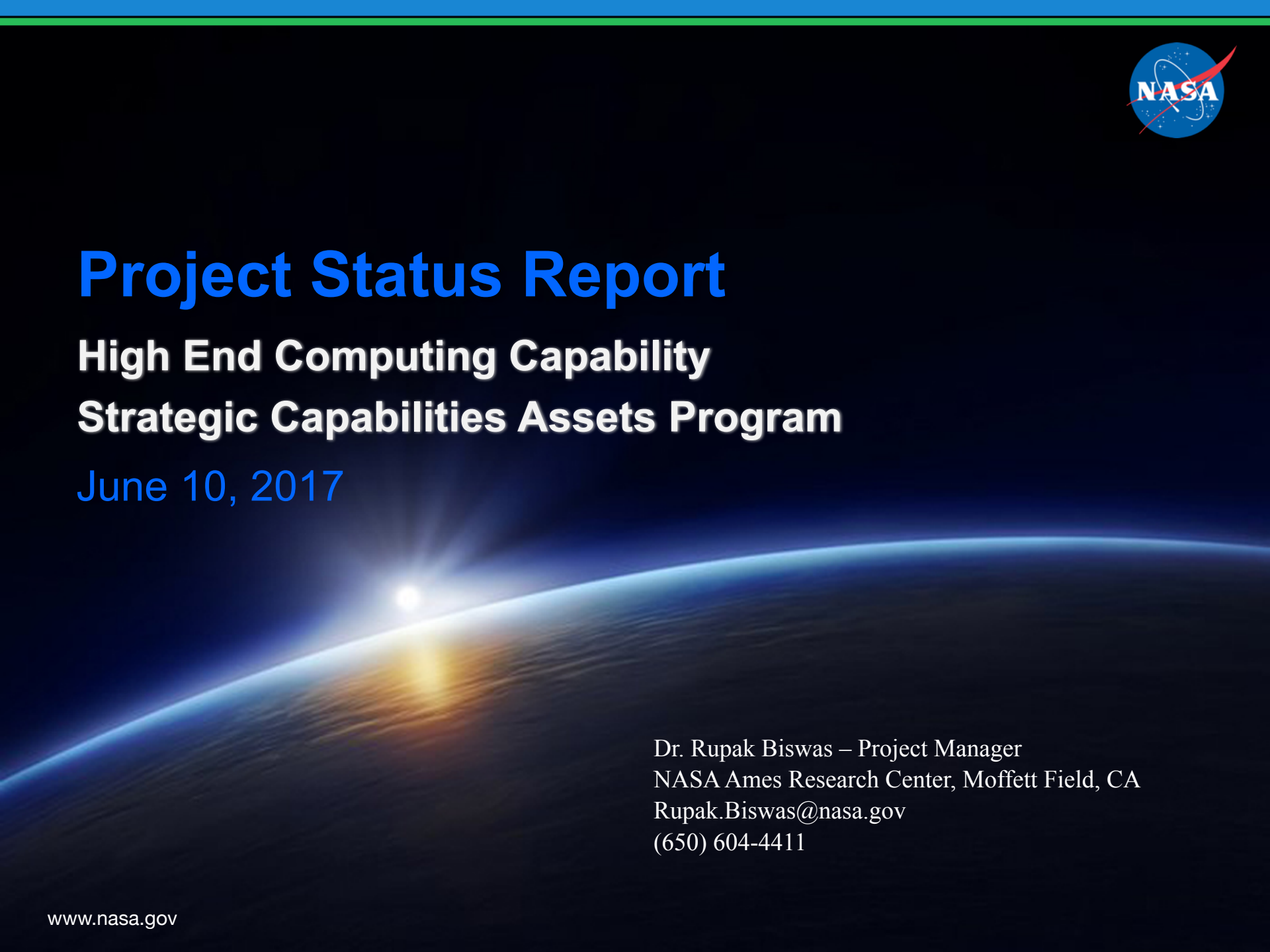


Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

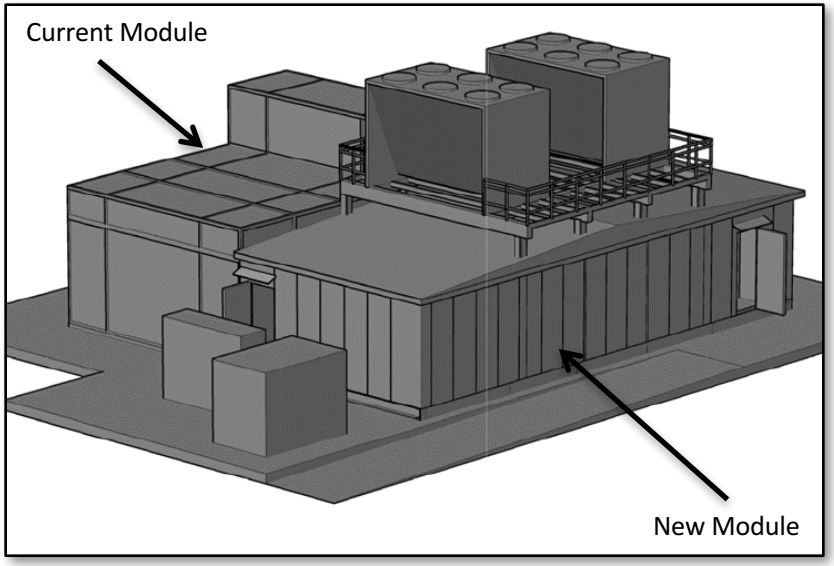
June 10, 2017

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

HECC Completes Final Design Review of Module 2 of the Modular Supercomputing Facility

- HECC engineers authorized vendor partners Hewlett Packard Enterprise (HPE), AZZ, and ePod Solutions to proceed with assembling the second module of the Modular Supercomputing Facility (MSF), following a presentation of the final design review.
- The HECC Facilities team is working with NASA Ames facility engineers to prepare the MSF site for the new module, which is significantly more powerful than the first module, and requires a modification of the power distribution system.
  - Module 2 will also incorporate an adiabatic dry cooler on the roof to provide cooling water to the HPE E-Cell compute racks.
- Module 2 is scheduled to be delivered in August, and the team will then begin the process of assembly, computer hardware installation, and integration with the existing Electra system.

Mission Impact: To meet NASA's rapidly increasing high-end computing requirements, HECC engineers are studying alternative technologies for maximizing productivity of the agency's supercomputing resources.



Computer model of the Modular Supercomputing Facility (MSF) Module 2 with adiabatic coolers on the roof, and showing its position next to MSF existing module containing the Electra supercomputer.

POCs: William Thigpen, william.w.thigpen@nasa.gov, (650) 604-1061, NASA Advanced Supercomputing (NAS) Division; Chris Tanner, christopher.tanner@nasa.gov, (650) 604-6754, NAS Division, CSRA, LLC

New PBSPro Feature Enables More Efficient Use of Pleiades, Electra, and Merope

- PBSPro now offers a feature for users to release nodes from a running job, shrinking the job and releasing the nodes for other jobs.
- PBSPro vendor Altair implemented the feature at the request of HECC staff, who worked closely with Altair to test and validate the feature before making it available to users.
- Many jobs make use of tens or hundreds of nodes to process data in parallel, but then finish with post-processing on just one node that may take hours. During this post-processing the unused nodes are idle.
- Users can now release idle compute nodes from a job, reducing their job accounting charges and allowing more efficient use of computing resources. Altair is working toward making this new feature available to all customers running PBSPro.

Mission Impact: HECC users are now able to release idle nodes from their jobs, making those nodes available to other users and improving the efficiency of HECC computational resources.

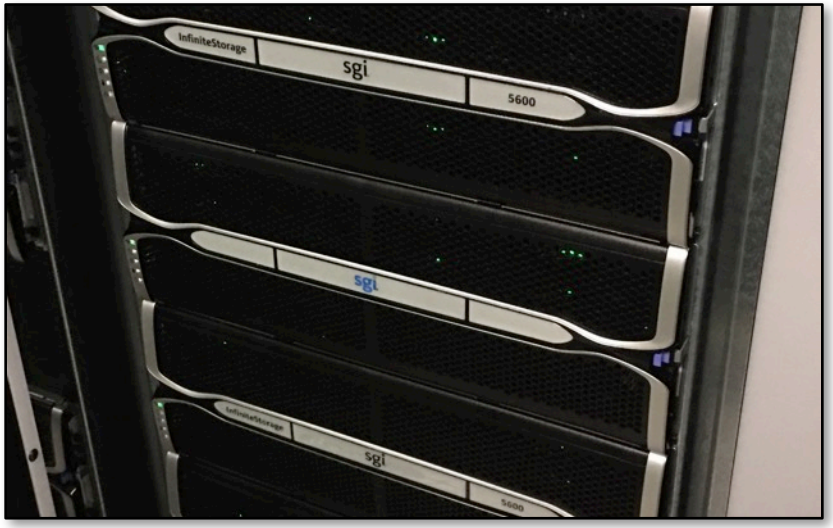
A new job management feature available on HECC supercomputers, including Pleiades (shown), Electra, and Merope, allows idle computational resources to be made available to the general user population.

POC: Greg Matthews, gregory.a.matthews@nasa.gov, (650) 604-1321, NASA Advanced Supercomputing Division, CSRA LLC

Lustre nobackupp2 Filesystem Capacity Increased by 81 Percent

- HECC augmented the nobackupp2 Lustre filesystem with increased capacity to support the rising demand for temporary (scratch) space.
- The filesystem grew by an additional 12 petabytes (PB) of raw storage and added 8.35 PB of usable space—over 81% increase in capacity.
- The installation required two days of downtime on the filesystem to reconfigure the existing hardware and install the additional disks. The dedicated time was completed ahead of schedule and the filesystem was returned to production while the new disks were initialized in the background.
- The rest of the activity, including configuration and integration of the new equipment into the filesystem, was transparent to the users.

Mission Impact: HECC's increased storage capacity will enable users to more fully utilize the computing resources and run more data-intensive applications for NASA research projects.



To optimize performance on the filesystem, 2,840 out of the 3,600 disk drives in the filesystem had to be moved during the two-day dedicated time.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division;
Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, CSRA LLC

HECC Enables Seamless Testing of Knights Landing Cluster Configurable Memory

- HECC staff developed and released a job scheduling capability to reconfigure the Multi-Channel DRAM (MCDRAM) memory available on the 20-node SGI cluster with Intel Xeon Phi 2730 “Knights Landing” (KNL) processors.
- MCDRAM is a new memory technology introduced with KNL processors that offers higher bandwidth than standard DDR4 memory. Each node has 192 gigabytes (GB) of DDR4 memory, and 16 GB of MCDRAM memory.
- MCDRAM can be configured to function as either an additional memory cache layer, standard system memory, or a hybrid of cache and system memory. This configuration occurs at boot time and requires changing each node’s Basic Input Output System (BIOS) settings.
- This new job scheduling capability allows users to specify their desired MCDRAM configuration. BIOS changes and node reboots are performed as needed by the job scheduler.

Mission Impact: This new job scheduling capability enables comprehensive testing of new memory technology, and positions NASA for use of reconfigurable hardware in next-generation processors.

Birds-eye view of the SGI test system, consisting of 20 nodes containing Intel Xeon Phi 7230 “Knights Landing” processors and an administrative management system. The system is a self-contained cluster, but has the capability to interconnect with the Lustre filesystem for testing.

POCs: Greg Matthews, gregory.a.matthews@nasa.gov (650) 604-1321, Bill Arasin, william.f.arasin@nasa.gov, (650) 604-2036, NASA Advanced Supercomputing Division, CSRA LLC

Facility Engineers Complete Cooling System Check Valve Upgrade

- HECC facility engineers coordinated with their counterparts in Code J and their vendors to diagnose and fix a problem of water overflowing out of the cooling tower basin.
  - Water exiting the cooling loop caused the chillers that transfer heat away from Pleiades to shut down temporarily.
- HECC and Code J staff determined that the problem was caused by check valves with an oil-filled dashpot damper, which kept the check valves from sealing.
- The wide temperature range of the exterior environment and the low operating pressure of the water loop made these check valves a poor choice for our particular application.
- With the cause identified, the check valve manufacturer selected a more appropriate valve type for the application, and the valves were installed by Code J contractors.
- The new check valves reduce the risk of another cooling system shutdown and allow Pleiades to stay online.

Mission Impact: Maintaining a robust cooling system is crucial to the continuous operation of supercomputing capabilities for HECC users.

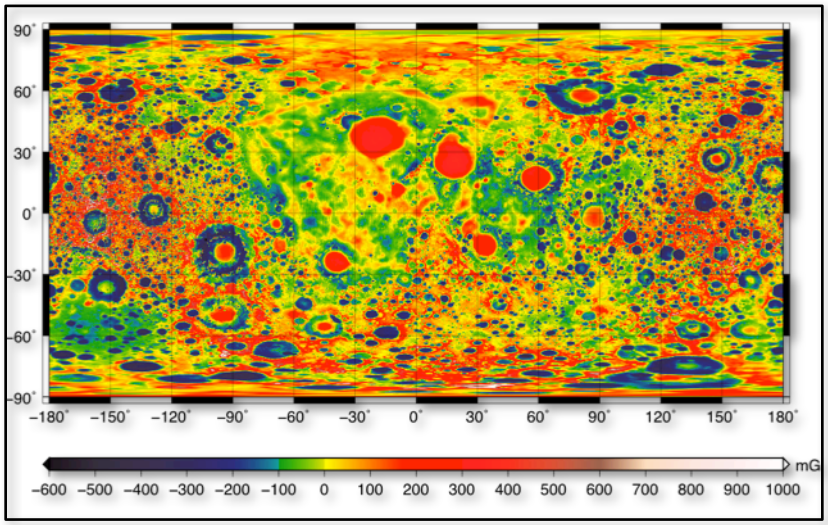
One of four new check valves (blue) installed between the NASA Advanced Supercomputing (NAS) facility's cooling water pump (red) and the cooling water supply pipe (gray).

POC: Chris Tanner, christopher.tanner@nasa.gov, (650) 604-6754, NASA Advanced Supercomputing Division, CSRA, LLC

Help from HECC Applications Team Critical to Successful Completion of GRAIL Runs

- HECC's Application Performance and Productivity (APP) team helped NASA's Gravity Recovery and Interior Laboratory (GRAIL) mission complete a multi-year effort of computational runs on Pleiades.
- The APP team has worked with the GRAIL mission since 2012, providing significant help along the way, including:
  - Spent thousands of hours analyzing job failures to find causes and workarounds to get the GRAIL workload running again.
  - Provided two large performance wins for the code: the first changed I/O and process binding, resulting in a 10% improvement in run time; the second win involved a switch to newer nodes and a newer compiler that provided wider vector instructions. The latter reduced the cost of a single run from 218,000 SBUs to 53,000 SBUs and improved reliability because fewer nodes were required.
  - Overcame setbacks from newer operating system kernels' inability to effectively reclaim memory from page cache on multiple occasions.
- One lesson that APP staff learned, in retrospect: They should have more strongly encouraged the GRAIL team to implement a checkpoint-restart capability in their code. This would have allowed them to finish their work as much as a year earlier and would have saved millions of SBUs. Going forward, all users running long jobs on hundreds of nodes will be required to have this capability in their codes.

Mission Impact: HECC expertise in addressing application issues regularly results in performance boosts and much faster turnaround time for scientists and engineers across all mission directorates.



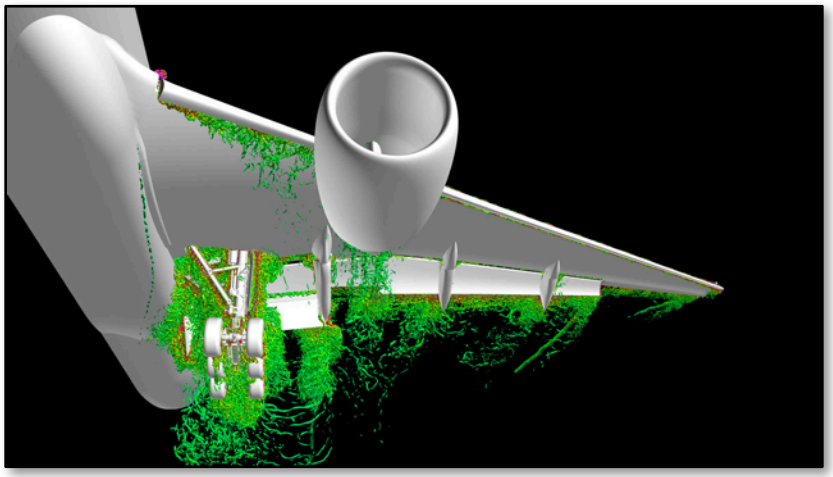
This map shows the gravity field of the moon as measured by NASA's GRAIL mission. Units are milliGalileos, where 1 Galileo is 1 centimeter per second squared. Reds correspond to mass excesses, which create areas of higher local gravity; blues correspond to mass deficits, which create areas of lower local gravity.

POCs: Johnny Chang, johnny.chang@nasa.gov, (650) 604-4356, Dan Kokron, daniel.s.kokron@nasa.gov, NASA Advanced Supercomputing Division, CSRA LLC

May 2017 Usage on HECC Systems Sets New Record of 25.7 Million SBUs

- For the third month in a row, usage on the HECC supercomputer systems set a new record.
- The combined usage for May by NASA's science and engineering groups was 25,690,988 Standard Billing Units (SBUs*), exceeding the previous month's record of 24,856,653 SBUs.
- Usage of all HECC Systems (Pleiades, Electra, Merope, and Endeavour) contributed to this record; Pleiades provided users with 21,813,979 SBUs and Electra provided 2,896,355 SBUs.
- This increase was enabled by high demand, system stability, and efficient operations that delivered system utilization of over 90% (where 75% utilization is the target).
- Additional resources are being procured to address continually growing requirements.

Mission Impact: The HECC facility continues to provide mission directorates with more resources for the accomplishment of their goals and objectives.



This image of an isosurface of the lambda-2 criterion, with vorticity magnitude color-mapped on the surface, represents a sample of the many simulations run on HECC systems. The visualization based on a simulation of a large civil aircraft in landing configuration, including the main landing gear. *Benedikt Koenig, Exa Corporation*; *Patrick Moran, NASA/Ames*

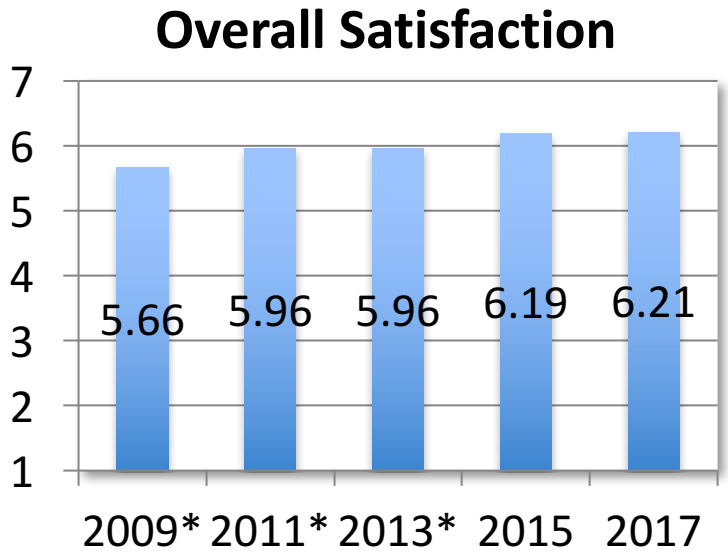
POC: Leigh Ann Tanner, leighann.tanner@nasa.gov, (650) 604-4468, NASA Advanced Supercomputing Division, CSRA LLC

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

2017 NAS User Survey Results Will Help Improve Services to Our Users

- The User Services Team completed the 2017 NAS User Survey on May 5. Users from all NASA mission directorates, as well as academia and industry, participated in the survey.
- The survey received a response rate of about 21%, or 346 users. These users assessed and provided feedback on 12 HECC service areas.
- Survey scores were very similar to previous years, with Overall Satisfaction scoring 6.21 out of 7.
  - The overall score has risen steadily since the survey began (5.66 in 2009, 6.19 in 2015).
- In addition to quantitative results, users provided many comments, which reveal areas of both satisfaction and frustration.
- The HECC teams will use these comments to continue to improve services.
- Two representative quotes from our users:
  - "The reliability of the NAS systems is superb! This is a professionally run organization that actually pays attention to the reliability of the system, and the quality of the software support. This is the best organization I have used (and I have used many computer centers over the years)."
  - "The wait times of jobs in the queues could be shorter or managed better. It would be great if there was some way to estimate when a queued up job was going to start running."

Mission Impact: The valuable feedback provided by this survey helps the HECC support teams improve services to aid users in achieving their mission goals. Periodically surveying users also helps teams understand which services our users consider most important.



Comparison of Overall Satisfaction scores on a 7-point scale over the past 5 surveys. *Calibrated from 5-point scale.

POC: Emily Kuhse, emily.kuhse@nasa.gov, (650) 604-1687, NASA Advanced Supercomputing Division, CRSA LLC

ESS Team Provides Support for Agency System Requirements and HECC Infrastructure Operations

- HECC's Engineering Servers and Services (ESS) team continues its ongoing support of 520 servers and user systems, and implemented numerous agency updates while working on infrastructure projects. Some of the work completed in the past six months includes:
  - Updated and tracked systems to be in compliance with: the BigFix installation requirement; removal of 3DES ciphers from all systems; addition of hostnames into certificates to meet DHS OMB M-15-13 requirements; and PIV authentication on Macs.
  - Upgraded 65 of 179 Macs to macOS 10.12 Sierra (36% complete).
  - Upgraded 93 of 339 Linux servers and workstations to Red Hat 7 (27% complete).
  - Built and configured 30 new Linux servers (16 of them are Virtual Machines).
  - Applied 37 Mac, 55 Linux, and 10 Windows patch sets (total of 102 unique patch sets) to the supported systems.

Mission Impact: System security and compliance with new agency requirements are critical to successful operations of HECC systems, and the ongoing patches and upgrades provided by ESS are key components of ensuring system security.

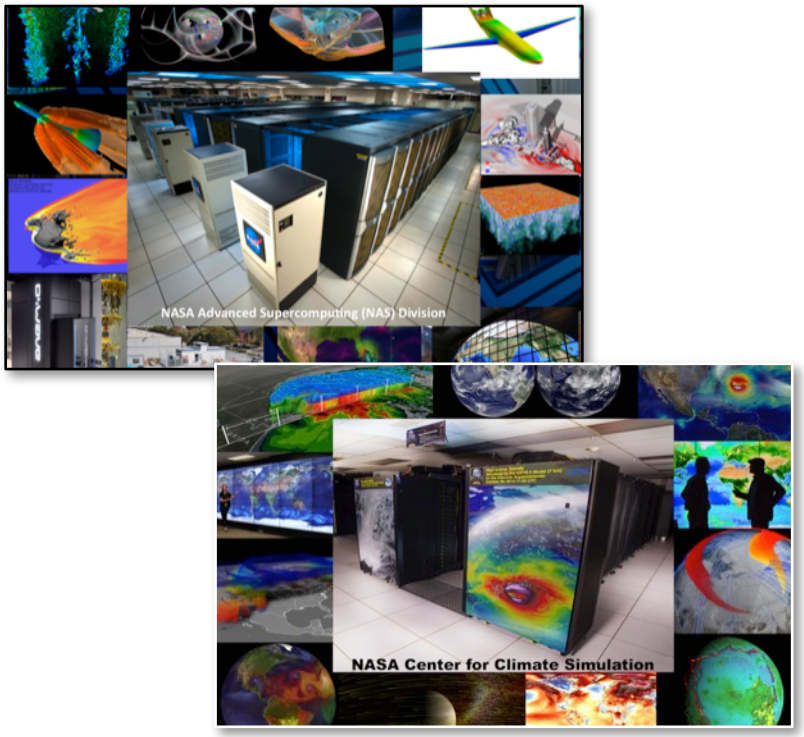
HECC's upgrade of 223 Linux servers to Red Hat Enterprise Linux version 7 is underway.

POC: Robert Shaw, robert.c.shaw@nasa.gov, (650) 604-4354, NASA Advanced Supercomputing Division, CSRA LLC

Agency Releases NASA Advanced Computing Services (NACS) Request for Proposals

- On May 24, NASA released the final Request for Proposals (RFP) to provide support services for the HEC Program's NASA Advanced Computing Services (NACS) contract. The NACS procurement will support high-end, advanced, and supercomputing capability for the NAS facility at Ames and for the NCCS at Goddard. NACS could also provide support at other NASA centers and at the Jet Propulsion Laboratory, as required by NASA advanced computing mission requirements.
- The NACS procurement is a consolidation of the two current support services contracts at NAS and NCCS. The NACS Statement of Work outlines the requirements that contractors have historically performed at the two centers.
- The extensive RFP was announced via the Federal Business Opportunities and consists of a 10-year total period of performance, if all options are exercised. The total estimated value of NACS procurement is about $1.1 billion. The statement of work to be performed was composed by technical teams from Ames and Goddard.
- The consolidation of the two contracts at NAS and NCCS will provide best-value to NASA by reducing transaction costs, ensure streamlined acquisition, and improve the overall effectiveness of NACS services through consolidated management and shared practices.
- NACS will provide HECC users with an integrated computing environment, including high-end computational, storage, and networking resources. NACS also includes services for high-end applications, data-intensive computing and visualization, collaborative computing, and emerging computing paradigms.

Mission Impact: NACS will provide world-class high performance computing to all NASA missions in support of mission-driven science and engineering.



Representative NASA science and engineering results enabled by the Pleiades and Discover supercomputers at the NAS and NCCS.

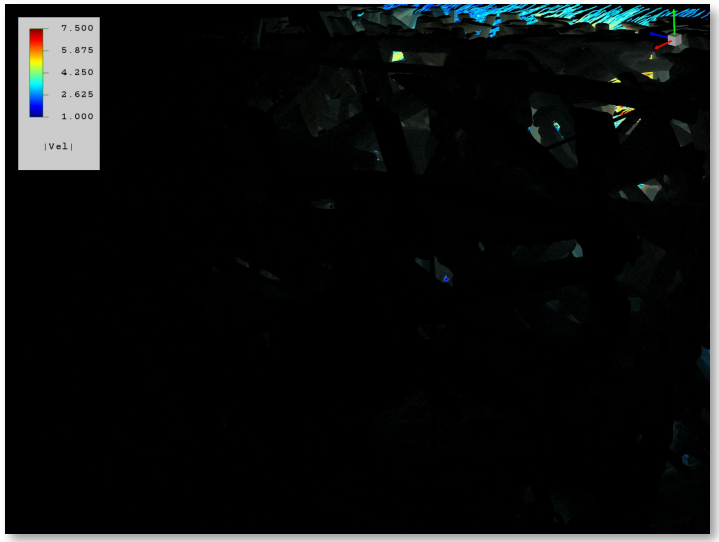
POC: Arsi Vaziri, arsi.vaziri@nasa.gov, (650) 604-4523, NASA Advanced Supercomputing Division

Tomography, Modeling & Simulation Enable Rapid TPS Materials Development *

- As part of NASA Ames' effort to develop new thermal protection system (TPS) materials for future space missions, research scientists in the NAS Division are developing modeling and simulation tools that enable characterization of material properties and response to hot plasma.
- The NAS team ran Direct Simulation Monte Carlo (DSMC) computations on the Pleiades supercomputer; this method computes the response of low-density carbon fiber materials based on realistic digital representations of a built substrate, acquired using X-ray microtomography.
  - Comparison of numerical computations of permeability with experimental results for FiberForm TPS material used on several missions showed excellent agreement.
  - The validated method enabled the team to compute the permeability of other substrates, including those used on the SpaceX Dragon vehicle; and a new NASA carbon felt substrate in development.
- The team's goal over the next 3-plus years is to develop a material design framework that will enable rapid development of mission-tailored TPS materials.

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

Mission Impact: New modeling & simulation tools, combined with simulations and visualizations produced using HECC supercomputing resources, will lead to better thermal protection material designs, accelerate the design process, and reduce the need for extensive testing.



Streaklines of scattered argon particles in a sample of virgin FiberForm that was acquired using X-ray microtomography. The video was generated over a 2-millisecond timespan using the SPARTA Direct Simulation Monte Carlo code. *Arnaud Borner, Tim Sandstrom, NASA/Ames*

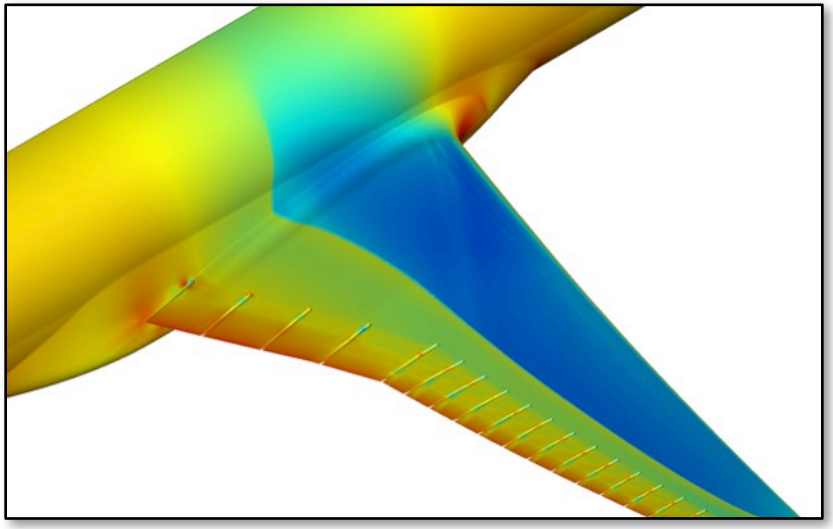
POCs: Nagi N. Mansour, nagi.n.mansour@nasa.gov, (650) 604-6420; Arnaud Borner, arnaud.p.borner@nasa.gov, (650) 604-5986, NASA Advanced Supercomputing Division

High-Fidelity Aeroelastic Simulations of New Flexible Aircraft Wing Concepts *

- Aerospace engineers at NASA Ames are studying new aeroelastic modeling and simulation capabilities that can help optimize aircraft designs with newer, lightweight materials and flexible wings.
- The team ran simulations on Pleiades to study the drag performance of NASA's Generic Transport Model aircraft with an adaptive aeroelastic wing shaping control technology, the Variable Camber Continuous Trailing Edge Flap (VCCTEF) system.
  - Two main types of simulations were run: viscous simulations using the Launch Ascent and Vehicle Aerodynamics (LAVA) Reynolds-Averaged Navier-Stokes (RANS) code, and inviscid simulations using the Cart3D Euler solver.
  - The former showed the effect of viscosity on the system's drag performance, and how the effect varies with wing shape deformations and flap deflections.
  - Results also showed that flow separation between gaps in the flaps of one configuration (without elastomer between the flaps) degrades both aerodynamic performance and the validity of inviscid methods.
  - A comparison of the LAVA and Cart3D results showed that the inviscid approach works for design optimization if the viscous drag effects do not vary by much, as in the case of the VCCTEF with elastomer.

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

Mission Impact: HECC resources help researchers develop high-fidelity computational tools to evaluate new aircraft design concepts and modeling approaches. This work was supported by the Advanced Air Transport Technology (AATT) project under NASA's Advanced Air Vehicles Program (AAVP).



Pressure coefficient contour over an aircraft wing with the "piano finger" configuration of the Variable Camber Continuous Trailing Edge Flap (VCCTEF) system (without elastomer between the flaps). The simulation was computed with the Cart3D CFD code. *Marie Denison, NASA/Ames*

POCs: Marie Denison, marie.f.denison@nasa.gov, (650) 604-5588, NASA Advanced Supercomputing Division;
Nhan Nguyen, nhan.t.nguyen@nasa.gov, (650) 604-4063, NASA Ames Research Center

HECC Facility Hosts Several Visitors and Tours in May 2017

- HECC hosted 11 tour groups in May; guests learned about the agency-wide missions being supported by HECC assets, and some groups also viewed the D-Wave 2X quantum computer system. Visitors this month included:
  - Scott Robinson and Edison Carlos from NASA Headquarters visited to discuss the building infrastructure of the Modular Supercomputer Facility.
  - Barak Fishbain, Assistant Professor in the Environmental, Water and Agricultural Engineering Division at Technion – Israel Institute of Technology.
  - Helene Hellmark Knutsson, Swedish Minister for Higher Education and Research.
  - Irfan Azeem, National Science Foundation and Jeff Morrill, NASA Headquarters were briefed and given a tour of the NAS facility while attending the 4th Living With a Star Technical Interchange Meeting.
  - Students from the National Society of Black Engineers at the Santa Clara University.
  - Members of the American Institute of Aeronautics and Astronautics student branch, San Jose State University chapter.

Chris Buchanan, HECC networking and security lead, gives students a tour of the NAS facility's quantum computing room.

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

Papers

- "**Impacts of Solar-Absorbing Aerosol Layers on the Transition of Stratocumulus to Trade Cumulus Clouds**," X. Zhou, et al., Atmospheric Chemistry and Physics (EGU), May 1, 2017. *
  http://www.atmos-chem-phys-discuss.net/acp-2017-255/
- "**Performance of the Widely-Used CFD Code OVERFLOW on the Pleiades Supercomputer**," G. Guruswamy, NASA Technical Report (NTRS), May 1, 2017. *
  https://ntrs.nasa.gov/search.jsp?R=20170004382
- "**Exploring the SDSS Dataset with Linked Scatter Plots: I. EMP, CEMP and CV Stars**," D. Carbon, C. Henze, B. Nelson, arXiv:1705.01233 [astro-ph.SR], May 3, 2017. *
  https://arxiv.org/abs/1705.01233
- "**Dynamical Properties of Eccentric Nuclear Disks: Stability, Longevity, and Implications for Tidal Disruption Rates in Post-Merger Galaxies**," A.-M. Madigan, et al., arXiv:1705.03462 [astro-ph.GA], May 9, 2017. *
  https://arxiv.org/abs/1705.03462
- "**Numerical Investigation of Shock-Train Response to Inflow Boundary-Layer Variations**," R. Fievet, et al., AIAA Journal, vol. 55, issue 6, May 12, 2017. *
  https://arc.aiaa.org/doi/full/10.2514/1.J055333
- "**Three-Dimensional GRMHD Simulations of the Remnant Accretion Disks from Neutron Star Mergers: Outflows and R-Process Nucleosynthesis**," D. Siegel, B. Metzger, arXiv:1705.05473 [astro-ph.HE], May 15, 2017. *
  https://arxiv.org/abs/1705.05473

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

Papers (cont.)

- "**Nonthermal Particle Accelerationin3D Relativistic Magnetic Reconnection in Pair Plasma**," G. Werner, D. Uzdensky, arXiv:1705.05507 [astro-ph.HE], May 16, 2017. * *https://arxiv.org/abs/1705.05507*
- "**Atmospheric Escape from the TRAPPIST-1 Planets and Implications for Habitability**," C. Dong, et al., arXiv:1705.05535 [astro-ph.EP], May 16, 2017. * *https://arxiv.org/abs/1705.05535*
- "**Electron Diffusion Region During Magnetopause Reconnection with an Intermediate Guide Field: Magnetospheric Multiscale Observations**," L.-J. Chen, et al., Journal of Geophysical Research: Space Physics, May 17, 2017. * *http://onlinelibrary.wiley.com/doi/10.1002/2017JA024004/full*
- "**Blunt-Body Paradox and Transient Growth on a Hypersonic Spherical Forebody**," P. Paredes, M. Choudhari, F. Li, Physical Review Fluids, vol. 2, May 24, 2017. * *https://journals.aps.org/prfluids/abstract/10.1103/PhysRevFluids.2.053903*
- "**Helioseismic Holography of Simulated Sunspots: Dependence of the Travel Time on Magnetic Field Strength and Wilson Depression**," T. Felipe, D. Braun, A. Birch, arXiv:1705.09135 [astro-ph.SR], May 25, 2017. * *https://arxiv.org/abs/1705.09135*
- "**The Demographics of Rocky Free-Floating Planets and their Detectability by WFIRST**," T. Barclay, et al., The Astrophysical Journal, vol. 841, no. 2, May 26, 2017. * *http://iopscience.iop.org/article/10.3847/1538-4357/aa705b*

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

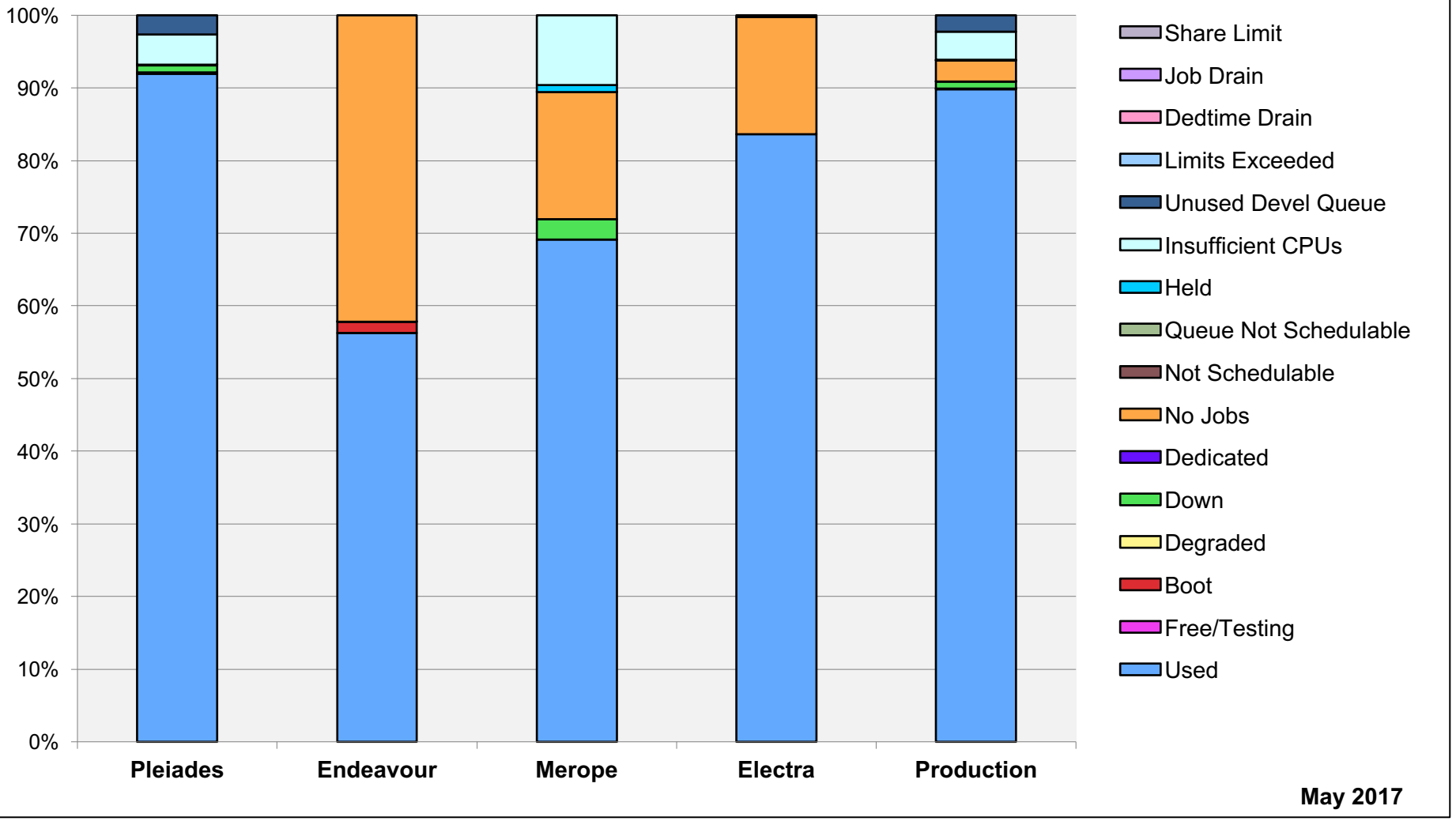
News & Events

- **Scientists Find Giant Wave Rolling Through the Perseus Galaxy Cluster**, *NASA Feature*, May 2, 2017—Combining data from NASA's Chandra X-ray Observatory with radio observations and computer simulations run on the Pleiades supercomputer, an international team of scientists has discovered a vast wave of hot gas in the nearby Perseus galaxy cluster.
  https://www.nasa.gov/feature/goddard/2017/scientists-find-giant-wave-rolling-through-the-perseus-galaxy-cluster
  - **Astronomers Discovered a Wave of Hot Gas Larger than the Milky Way**, Popular Mechanics, May 3, 2017.
    http://www.popularmechanics.com/space/deep-space/a26356/nasa-gigantic-hot-gas-wave/
  - **Scientists Find Giant Wave Rolling Through Perseus Galaxy Cluster**, Phys.Org, May 2, 2017.
    https://phys.org/news/2017-05-scientists-giant-perseus-galaxy-cluster.html
- **NASA Issues a Challenge to Speed Up Its Supercomputer Code**, *NASA Press Release*, May 2, 2017—NASA's aeronautical innovators are sponsoring a competition to reward qualified contenders who can manipulate the agency's FUN3D design software so it runs ten to 10,000 times faster on the Pleiades supercomputer without any decrease in accuracy.
  https://www.nasa.gov/aero/nasa-issues-a-challenge-to-speed-up-its-supercomputer-code
  - **Geniuses Wanted: NASA Challenges Coders to Speed Up Its Supercomputer**, *The New York Times*, May 8, 2017.
    https://www.nytimes.com/2017/05/08/science/nasa-supercomputer-pleiades.html
  - **NASA Needs Your Help to Speed Up its Supercomputer Code,** *Mashable*, May 8, 2017.
    http://mashable.com/2017/05/08/nasa-supercomputer-code-challenge/#yccu3XaB4Oq7
  - **NASA's Coding Contest Draws Geniuses***, Paste Magazine,* May 24, 2017.
    https://www.pastemagazine.com/articles/2017/05/nasa-coding-contest.html

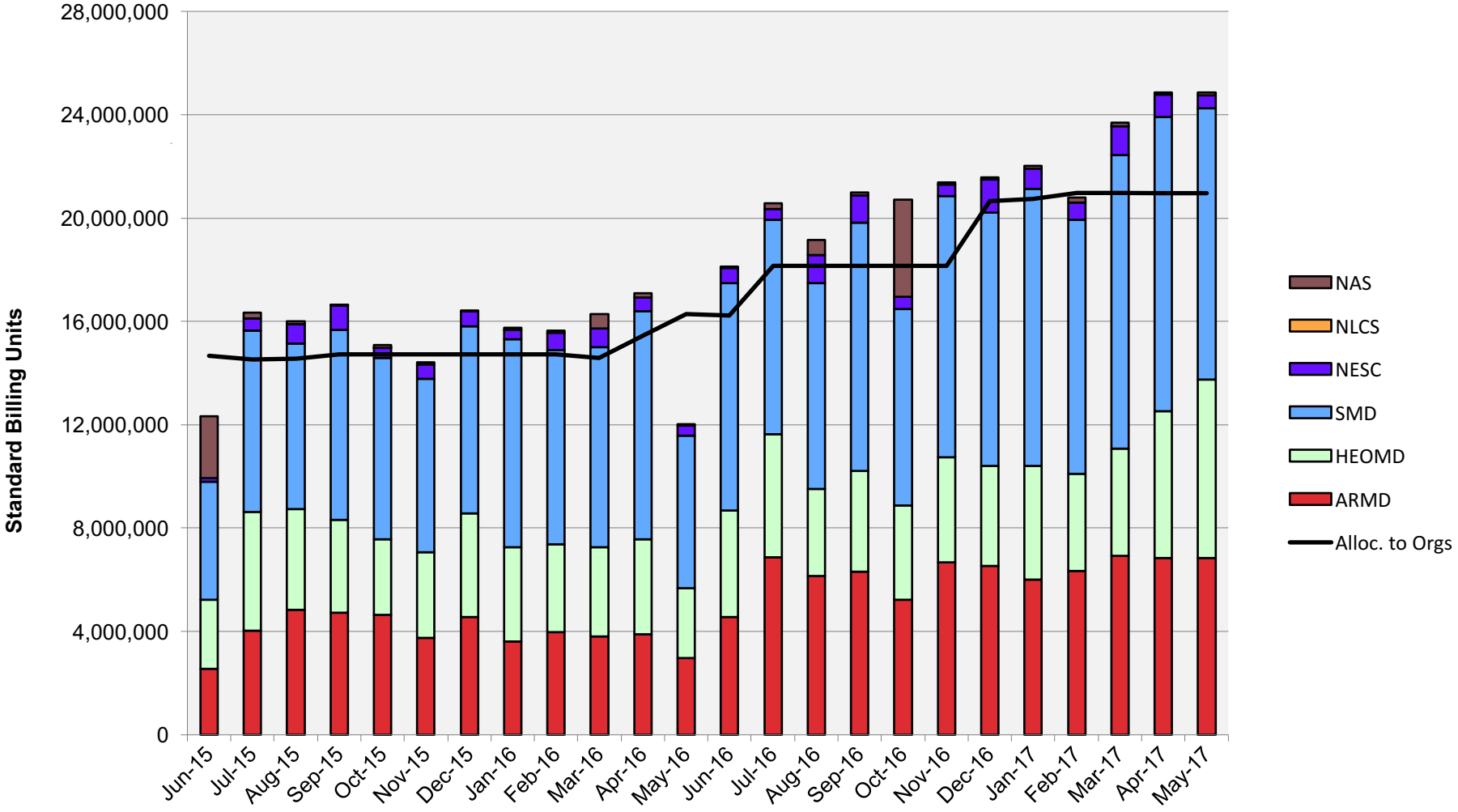
News & Events (cont.)

- **New Study Shows How Even Small Asteroids Can Make A Big Impact**, *Now Space*, May 10, 2017—A team of researchers at the NASA Advanced Supercomputing Division are utilizing the Pleiades supercomputer to run asteroid impact scenarios of varying sizes, density, entry angle, impact speed, and impact locations, in order to better predict the possible damage of an asteroid strike, and assess the probability and risk of these unlikely, yet potentially dangerous, events. *http://now.space/posts/small-asteroids-big-impact/*

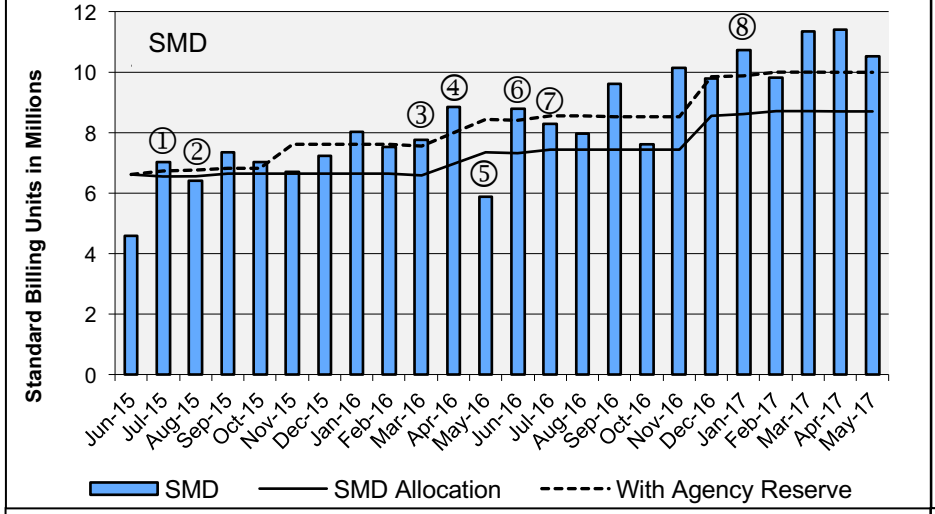
HECC Utilization

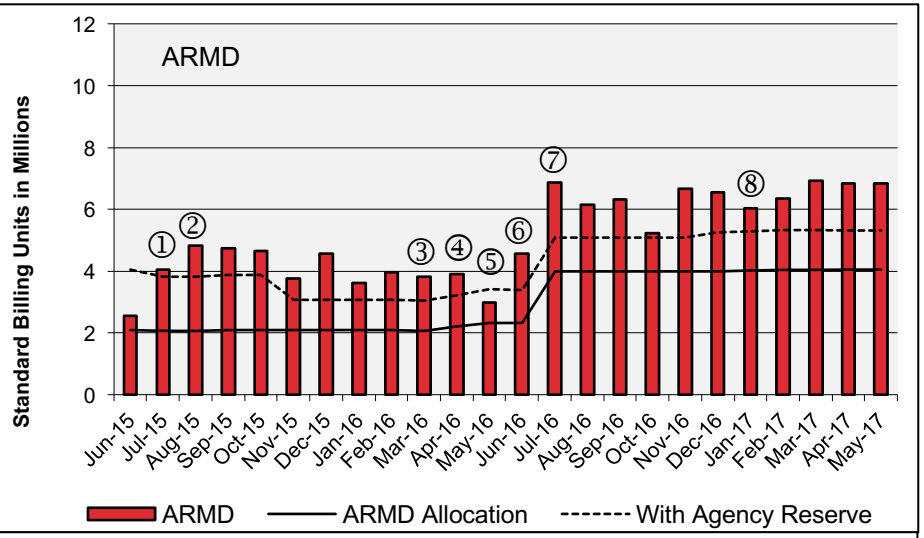


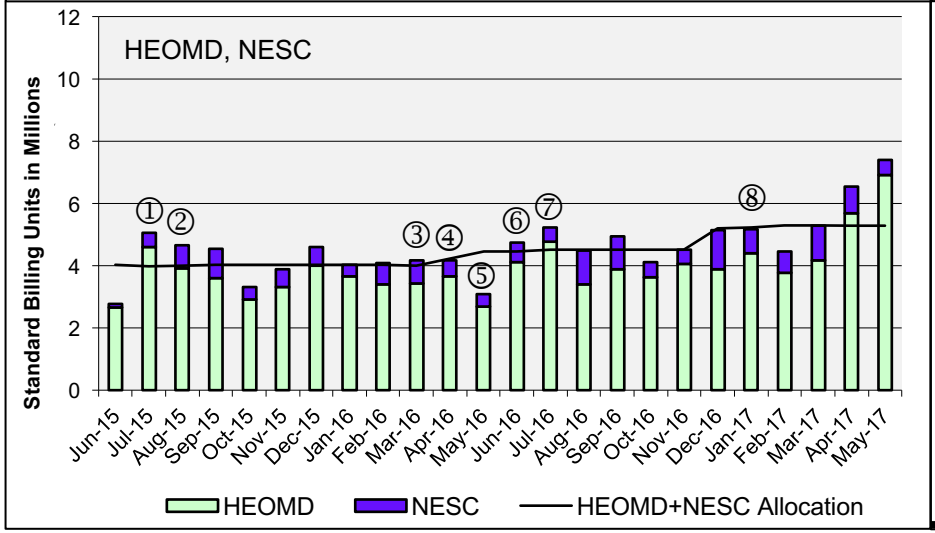
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month

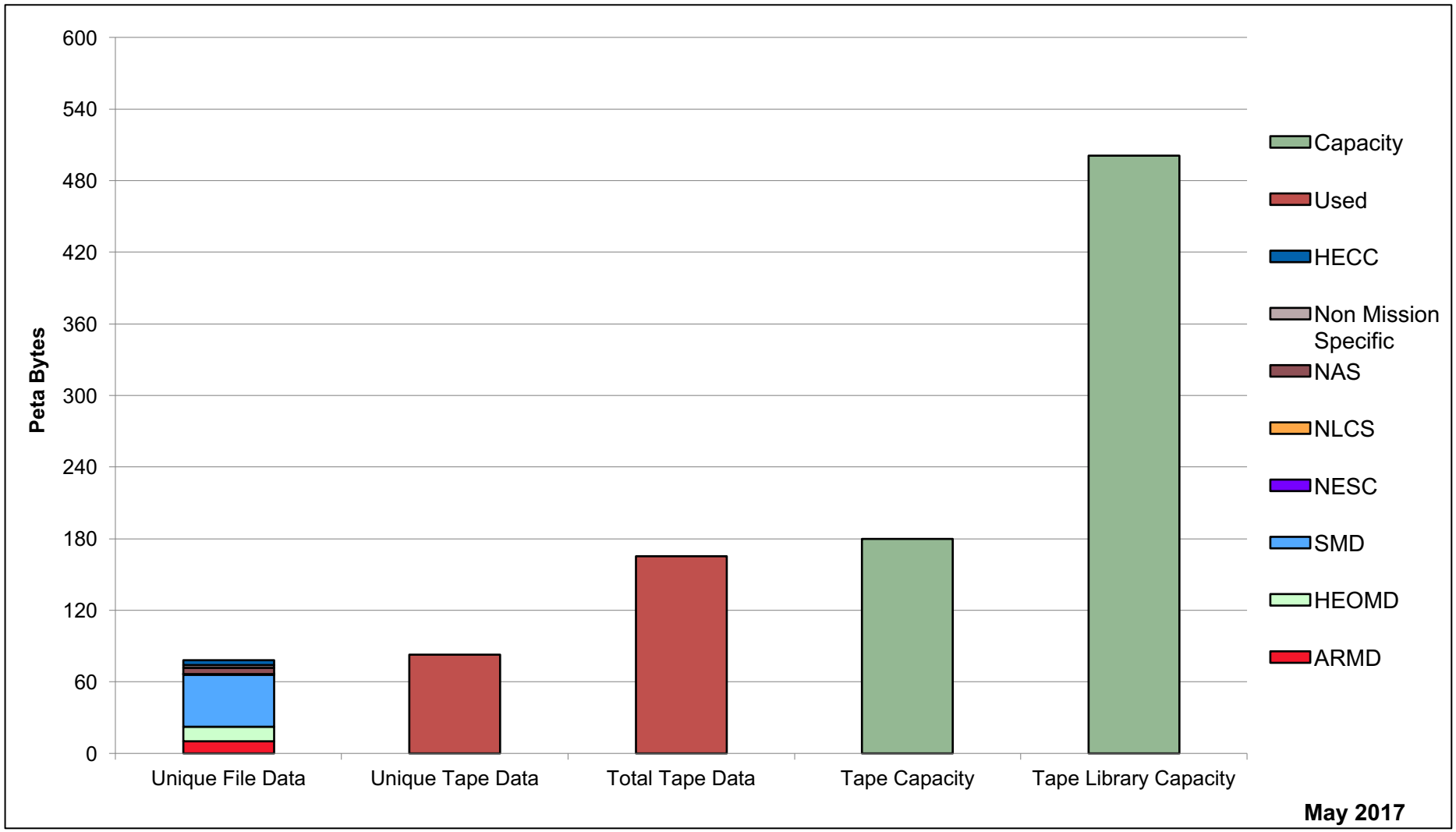




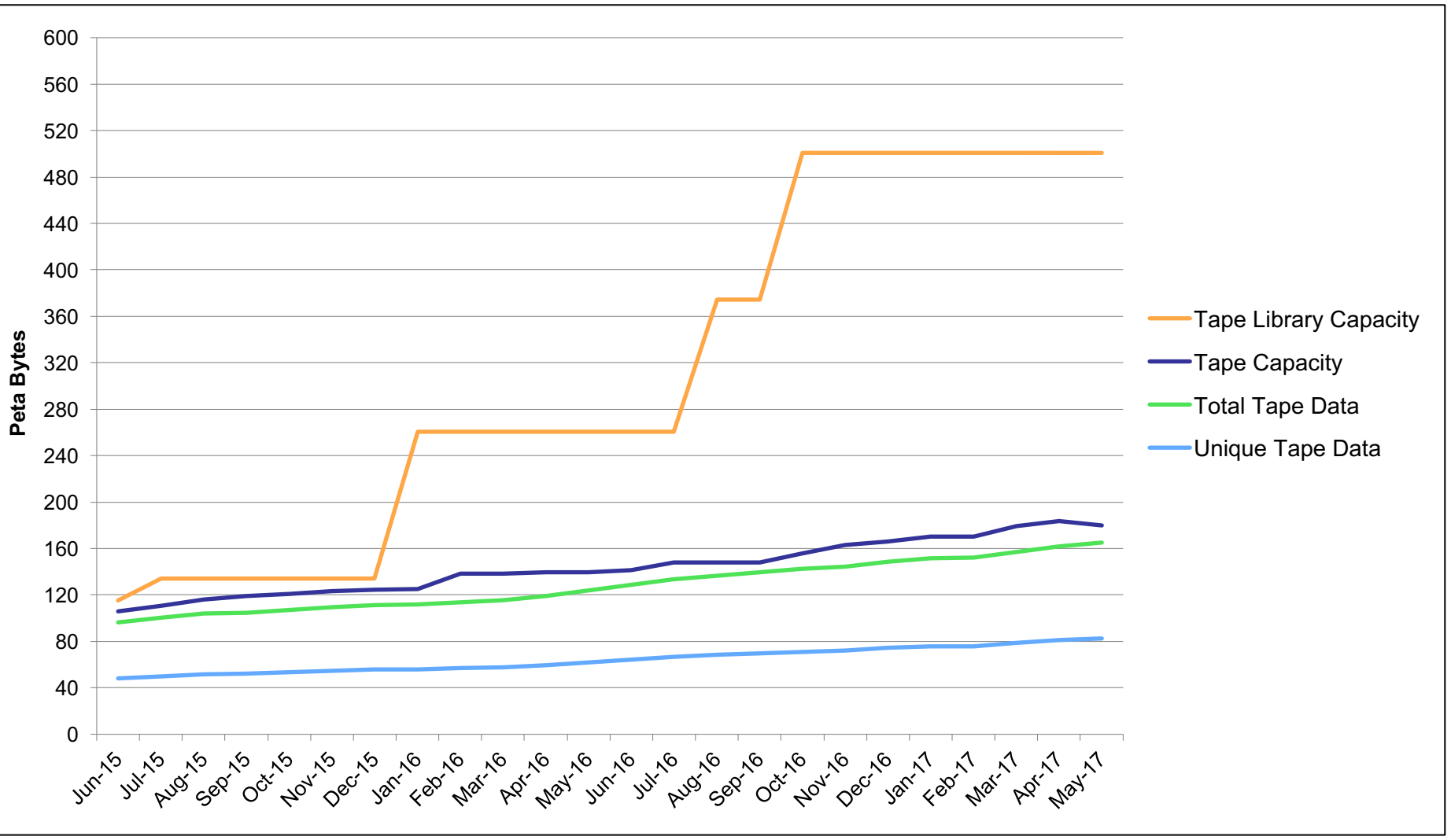


① 7 Nehalem ½ racks retired from Merope
② 7 Westmere ½ racks added to Merope
③ 16 Westmere racks retired from Pleiades
④ 10 Broadwell racks added to Pleiades
⑤ 4 Broadwell racks added to Pleiades
⑥ 14 (All) Westmere racks retired from Pleiades
⑦ 14 Broadwell Racks added to Pleiades
⑧ 16 Electra Broadwell Racks in Production, 20 Westmere 1/2 racks added to Merope

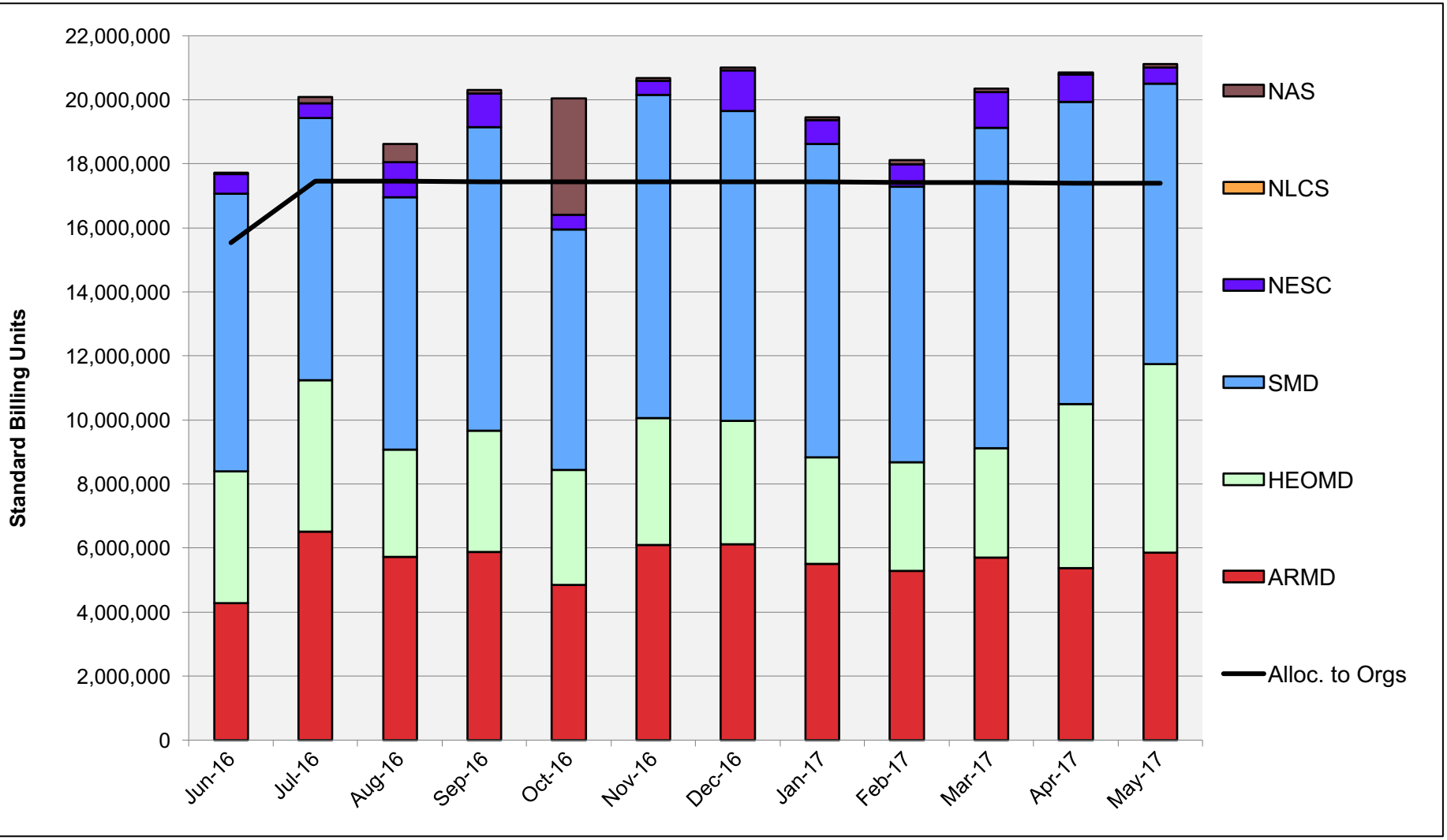
Tape Archive Status



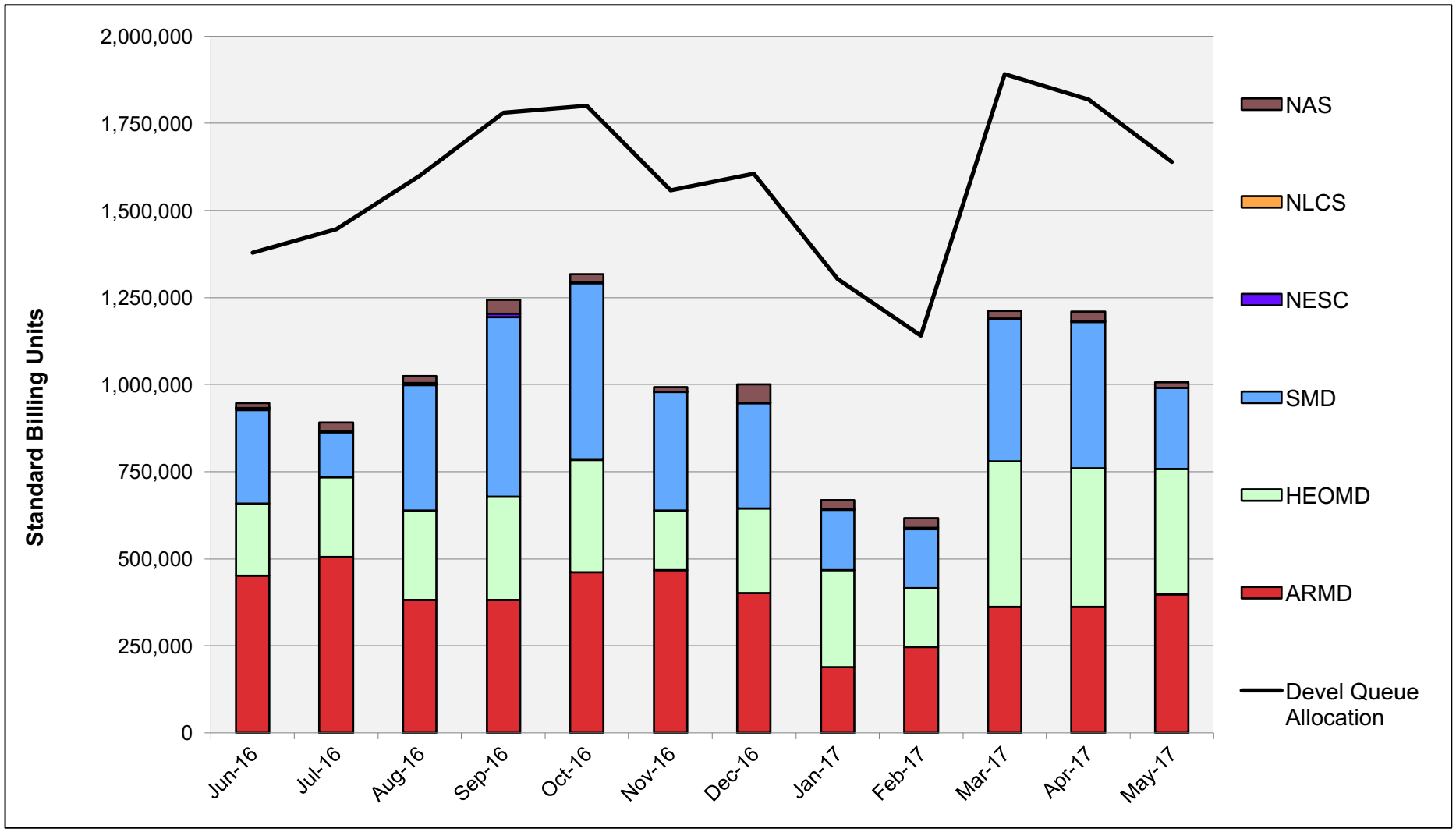
Tape Archive Status



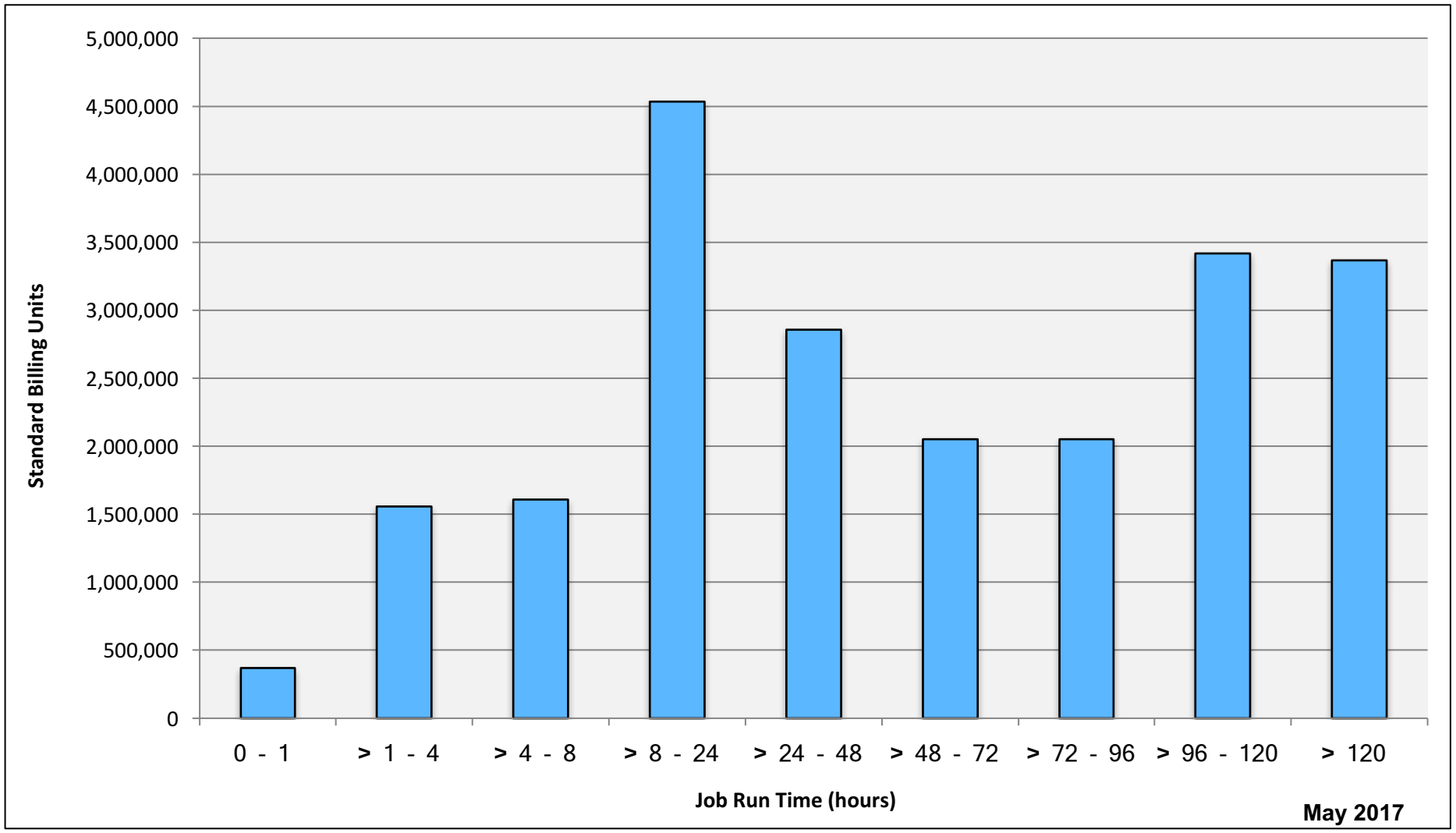
Pleiades:
SBUs Reported, Normalized to 30-Day Month



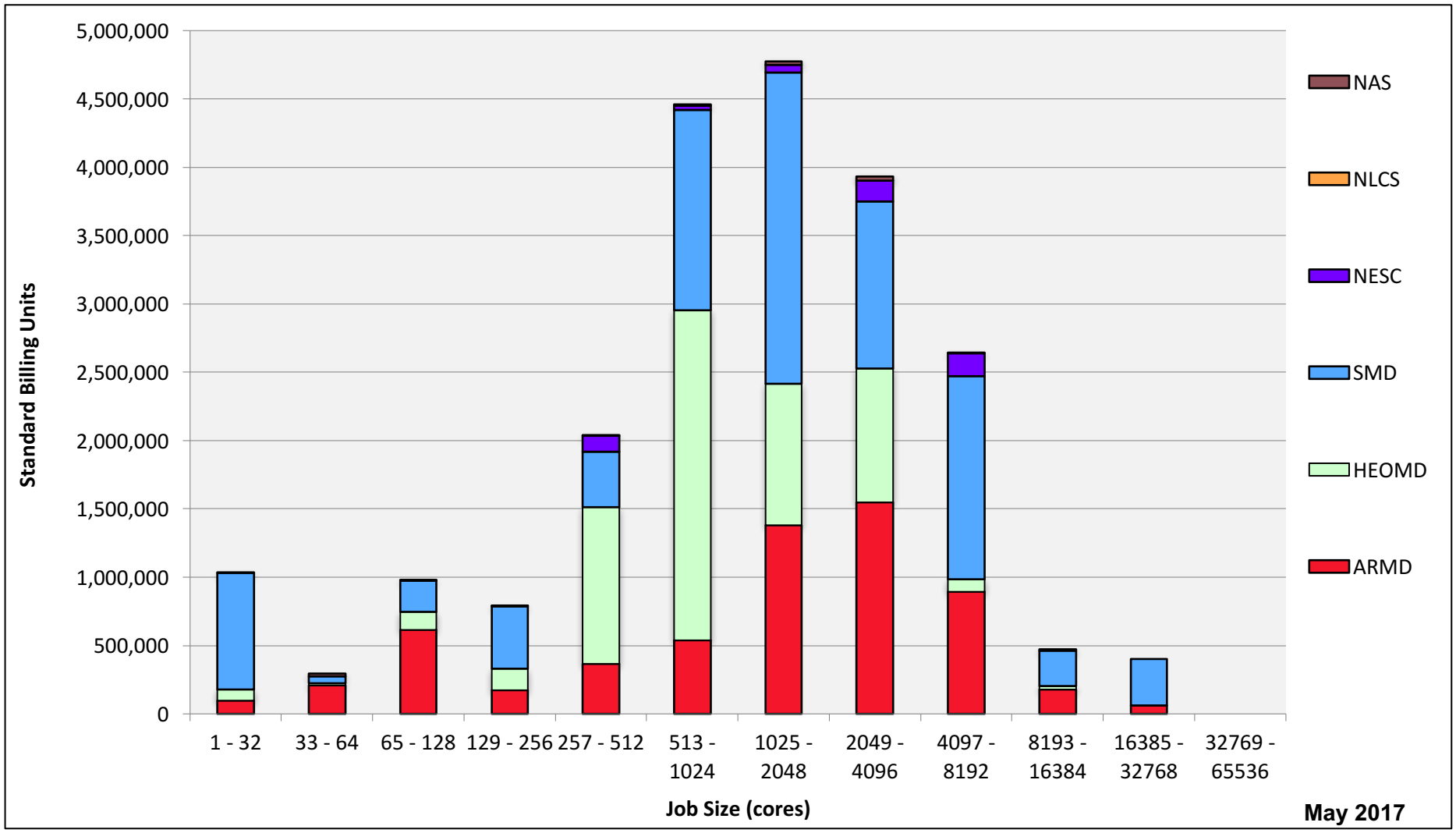
Pleiades:
Devel Queue Utilization



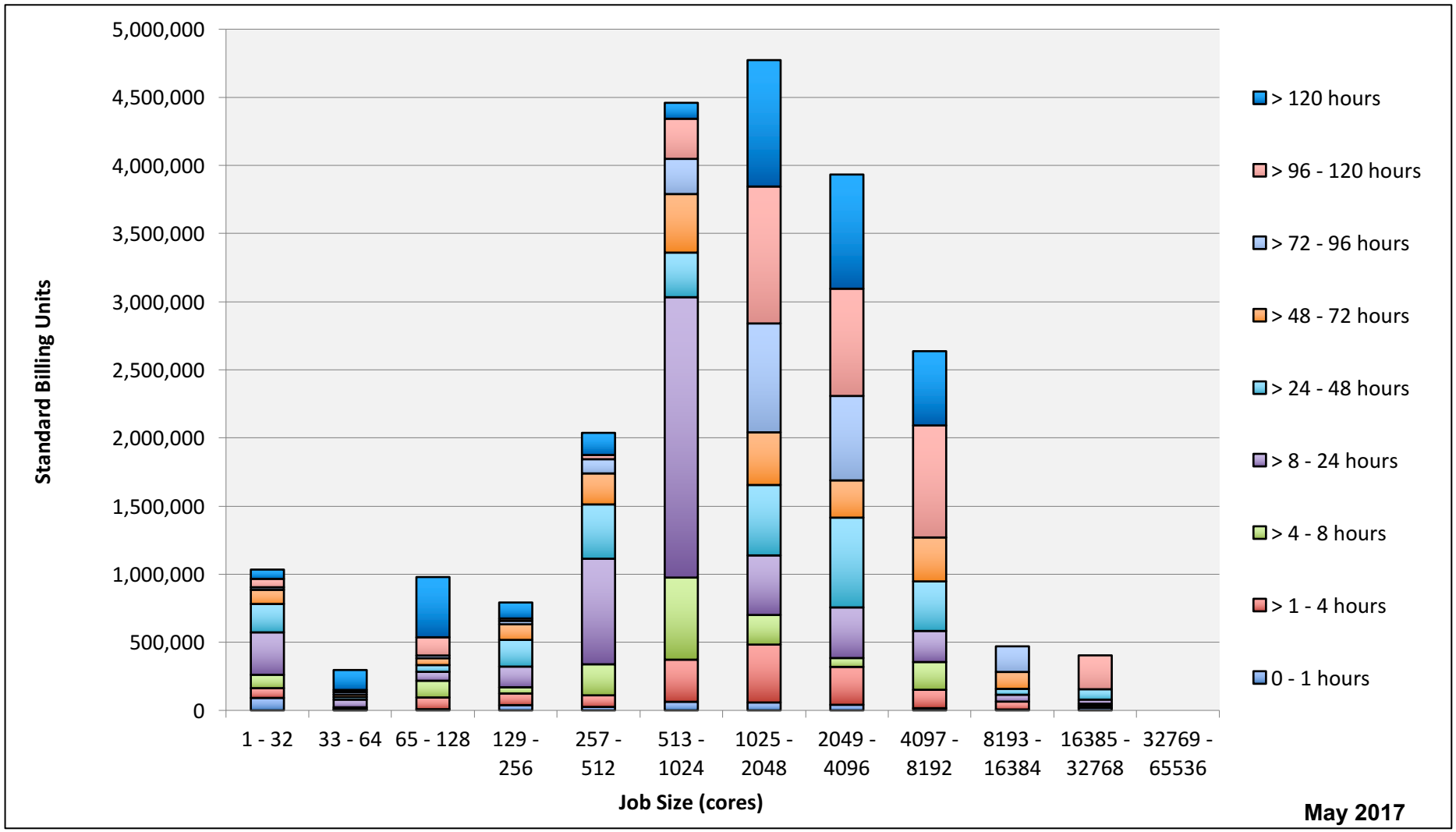
Pleiades:
Monthly Utilization by Job Length



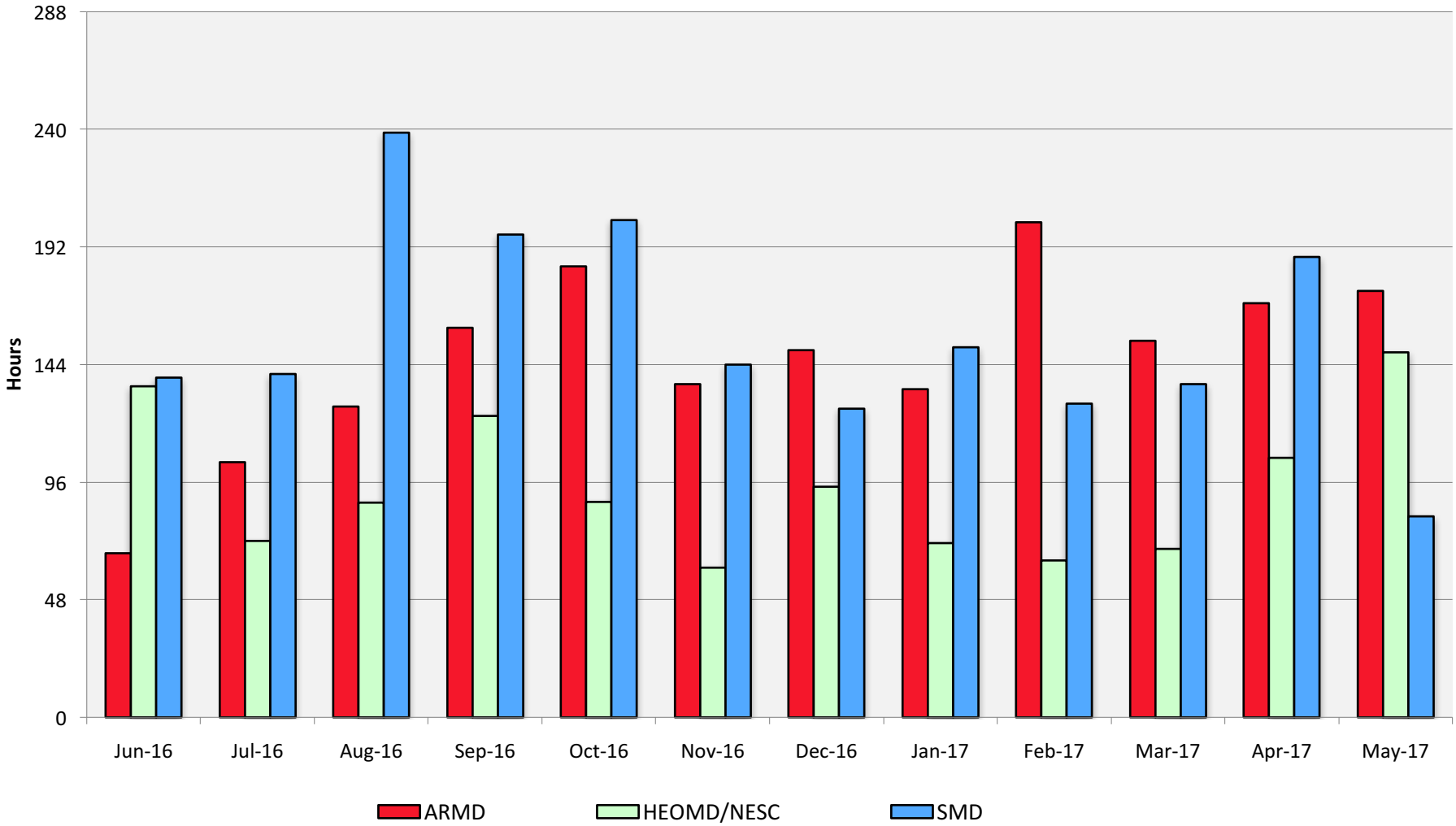
Pleiades:
Monthly Utilization by Size and Mission



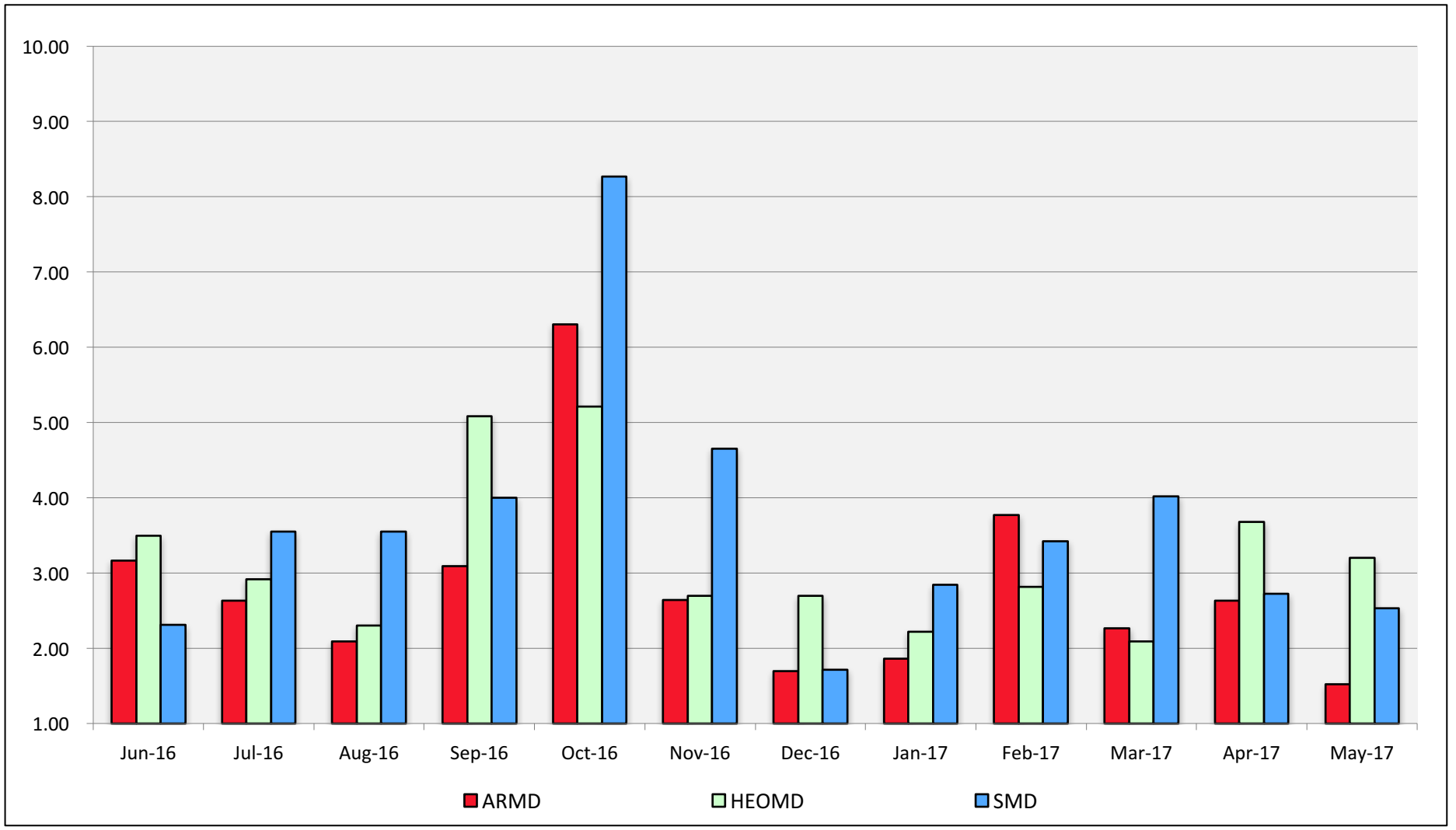
Pleiades:
Monthly Utilization by Size and Length



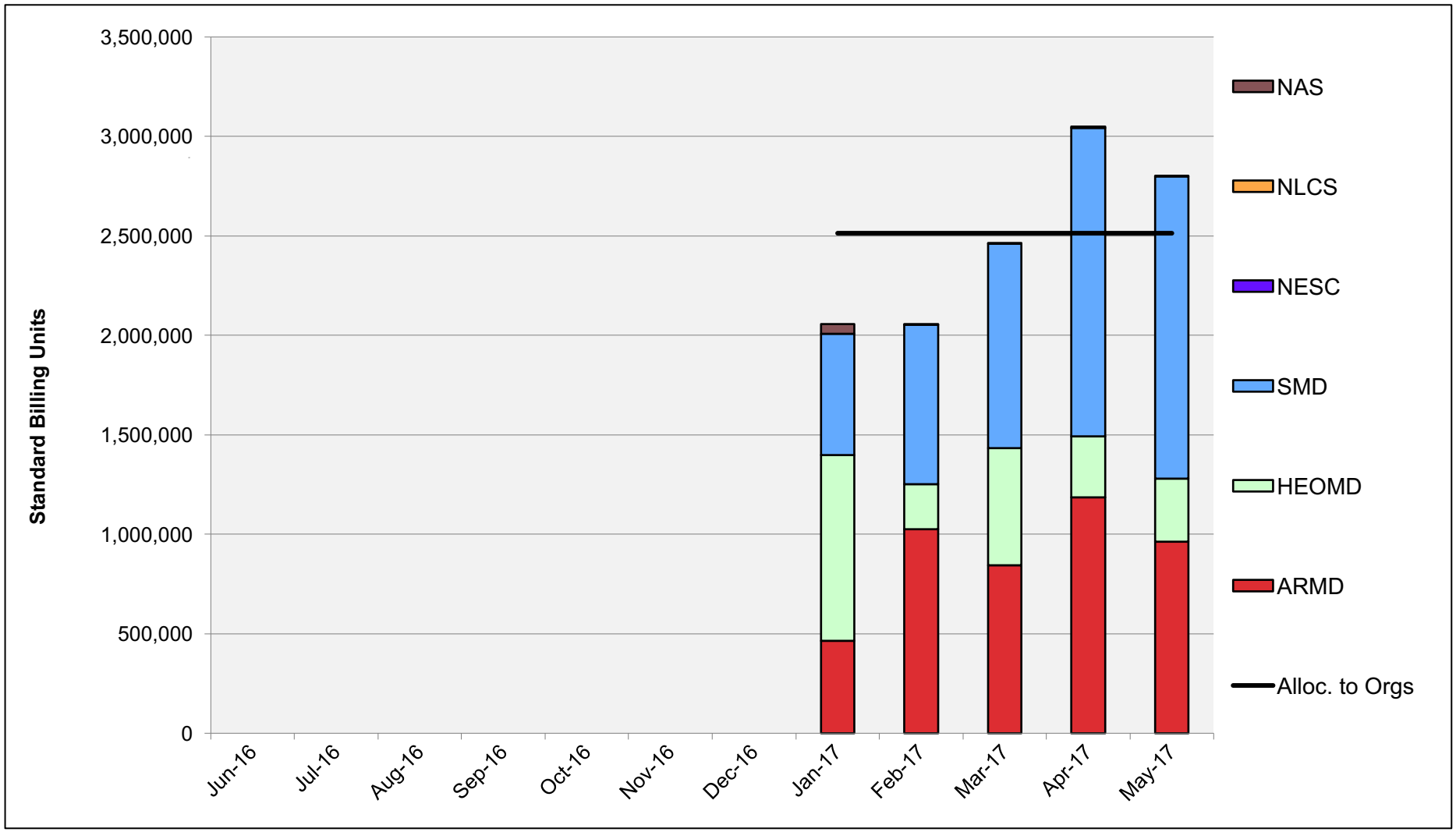
Pleiades:
Average Time to Clear All Jobs



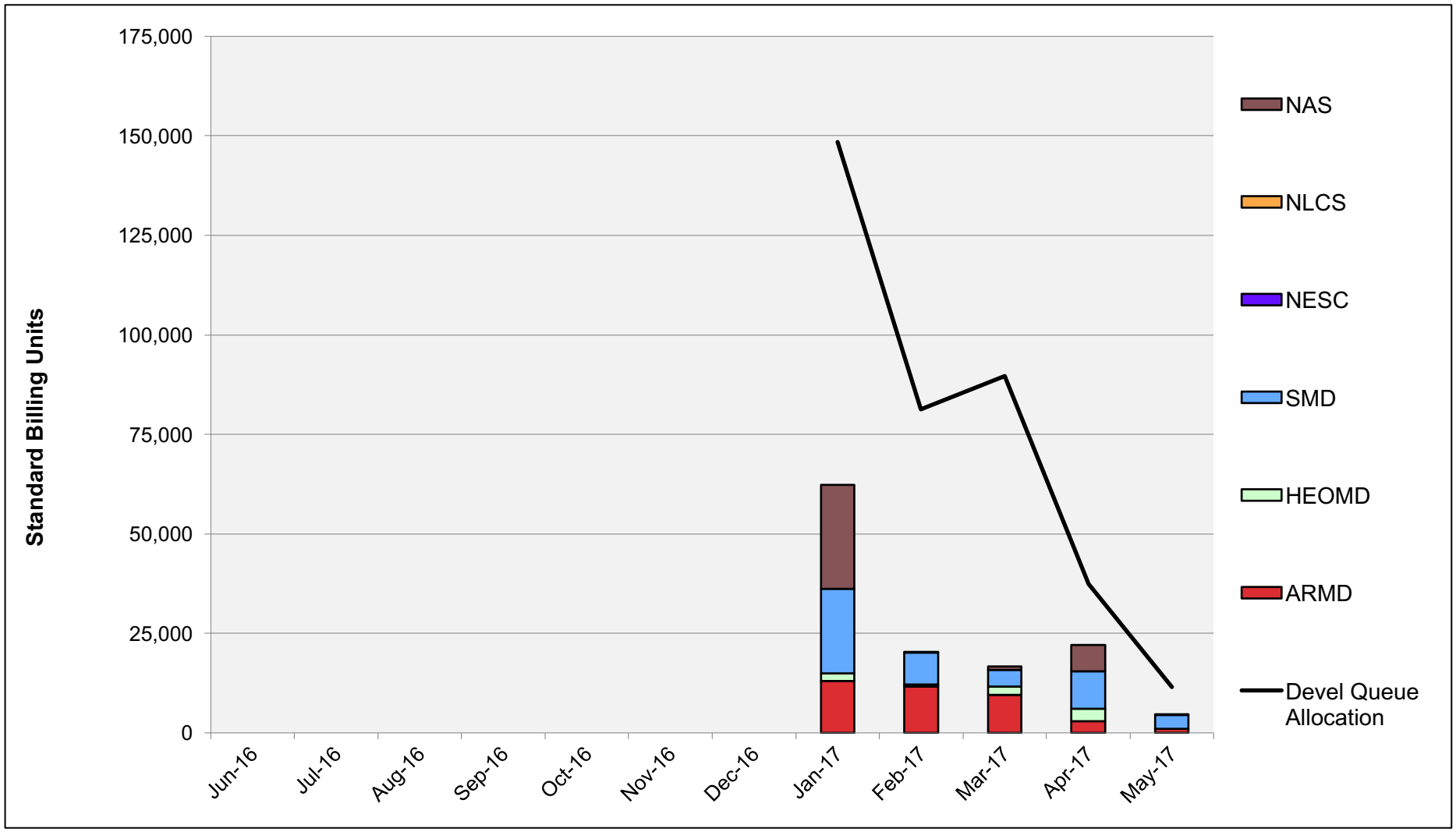
Pleiades:
Average Expansion Factor



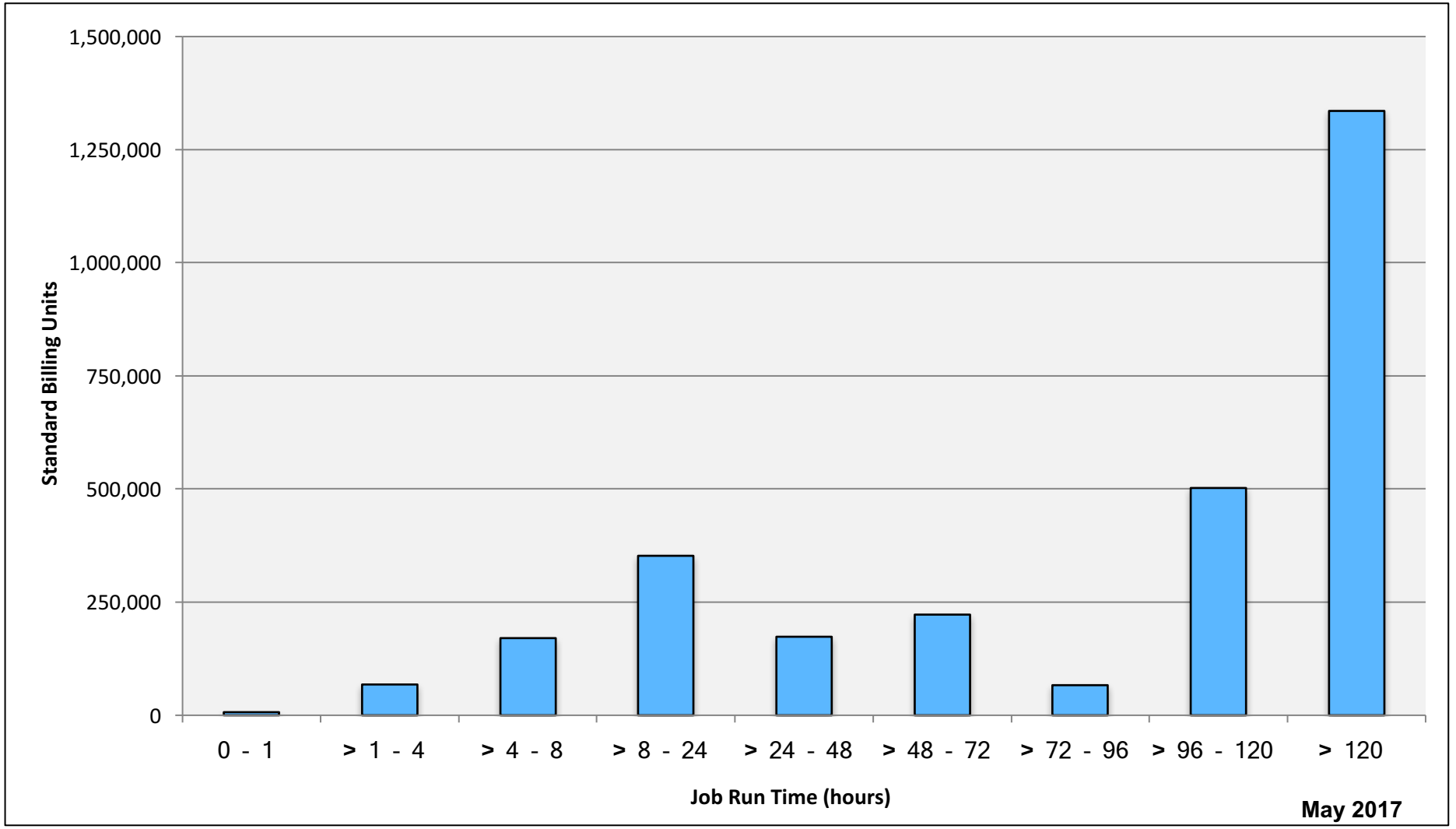
Electra:
SBUs Reported, Normalized to 30-Day Month



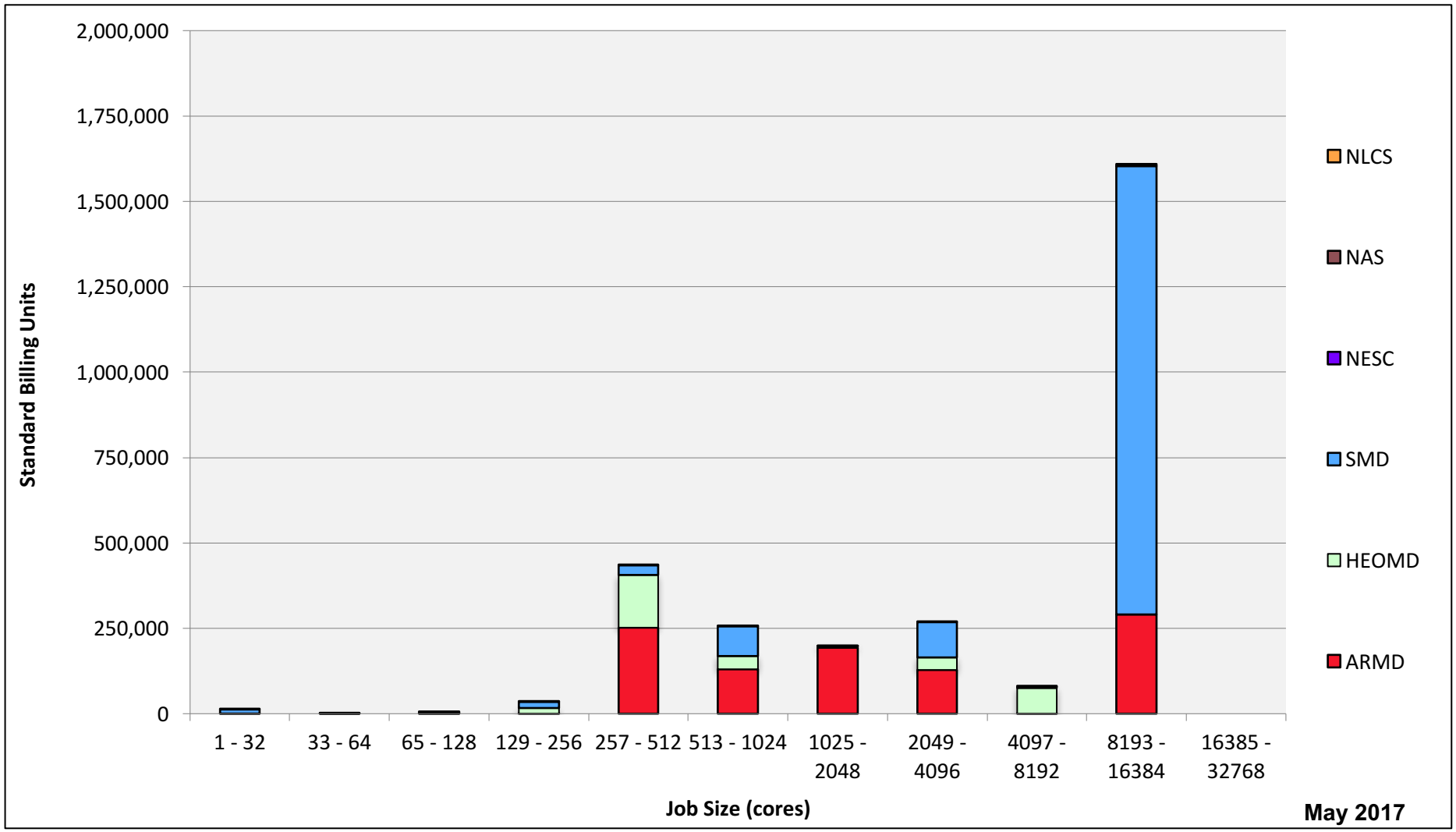
Electra:
Devel Queue Utilization



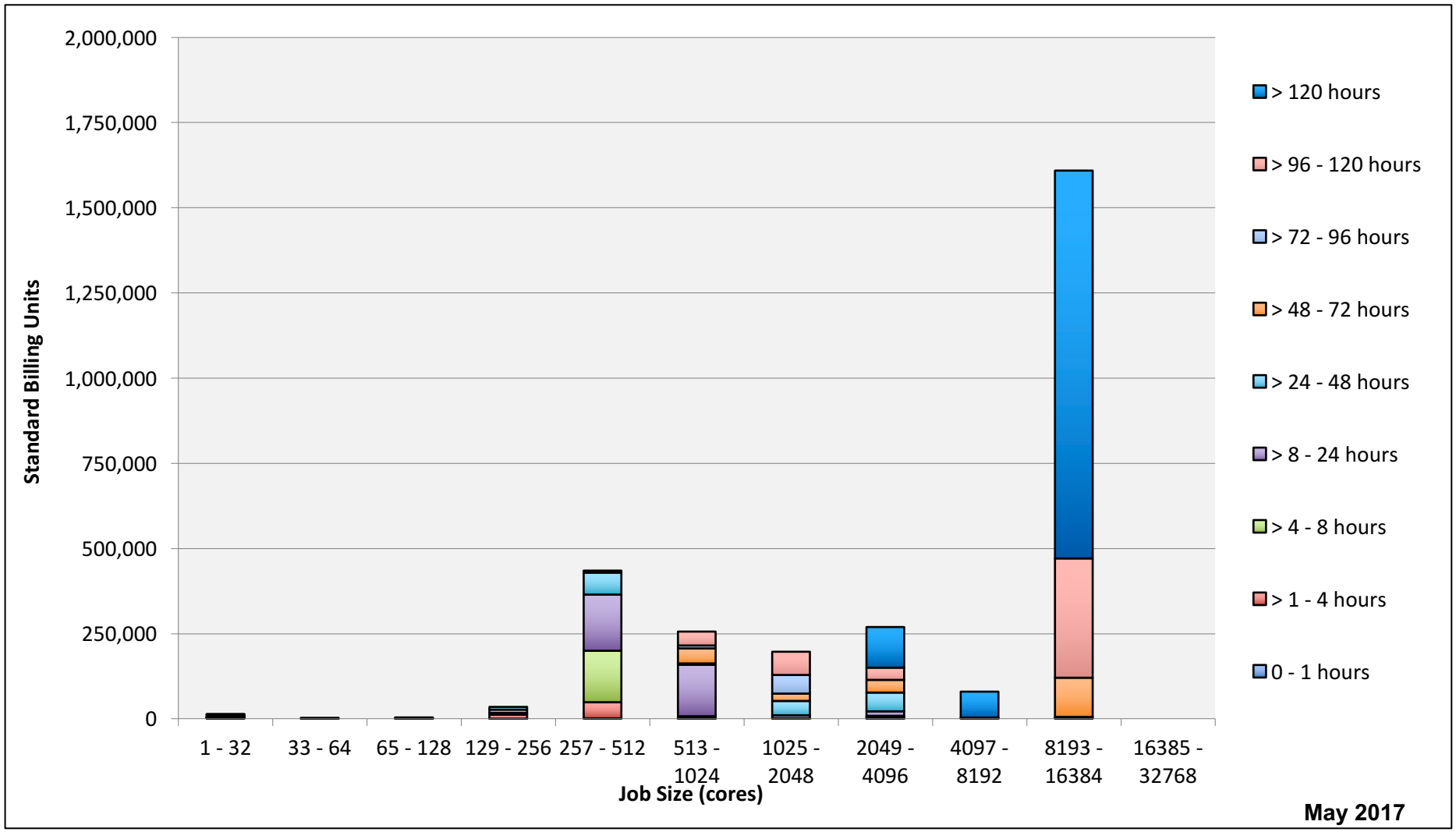
Electra:
Monthly Utilization by Job Length



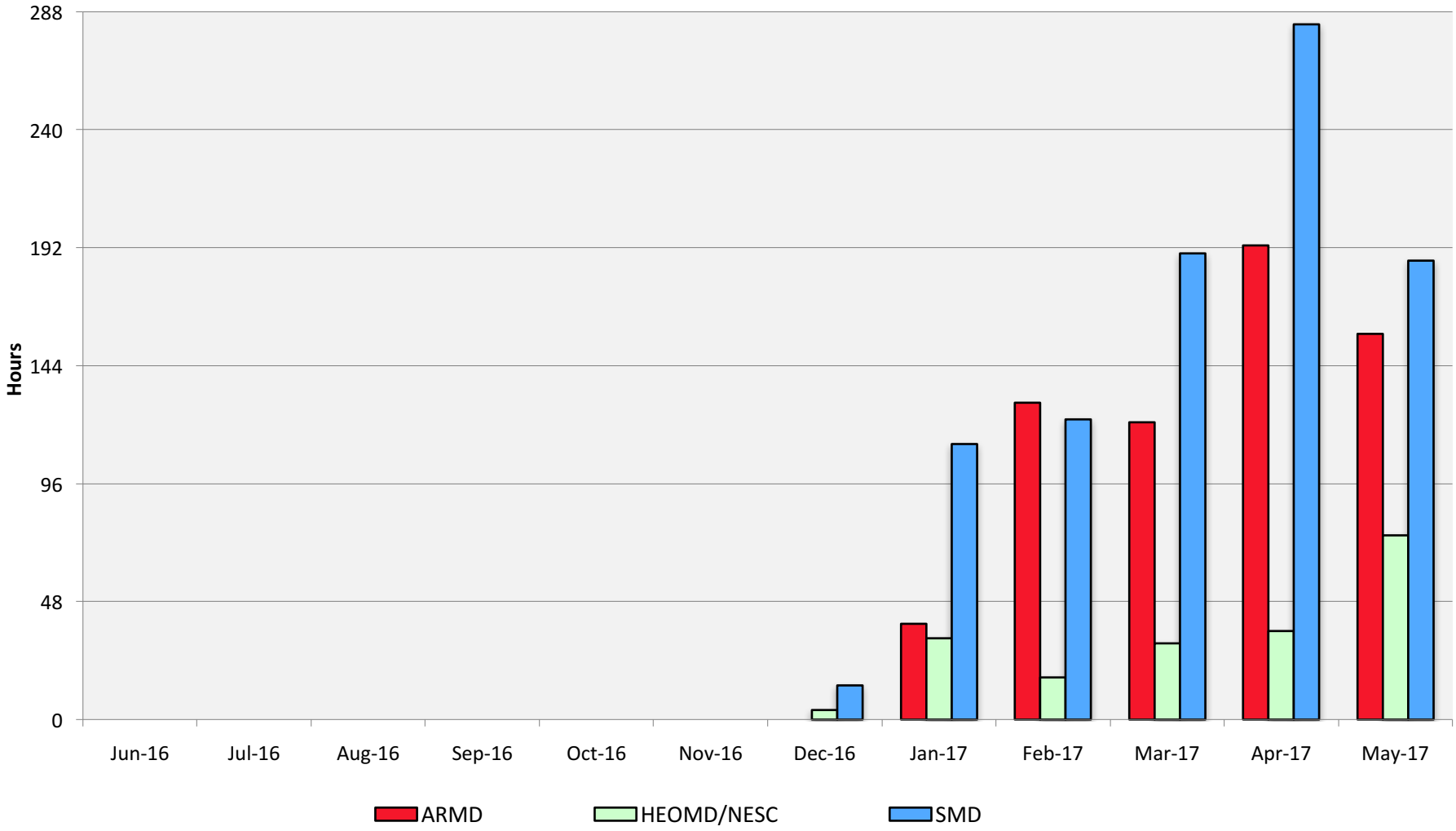
Electra:
Monthly Utilization by Size and Mission



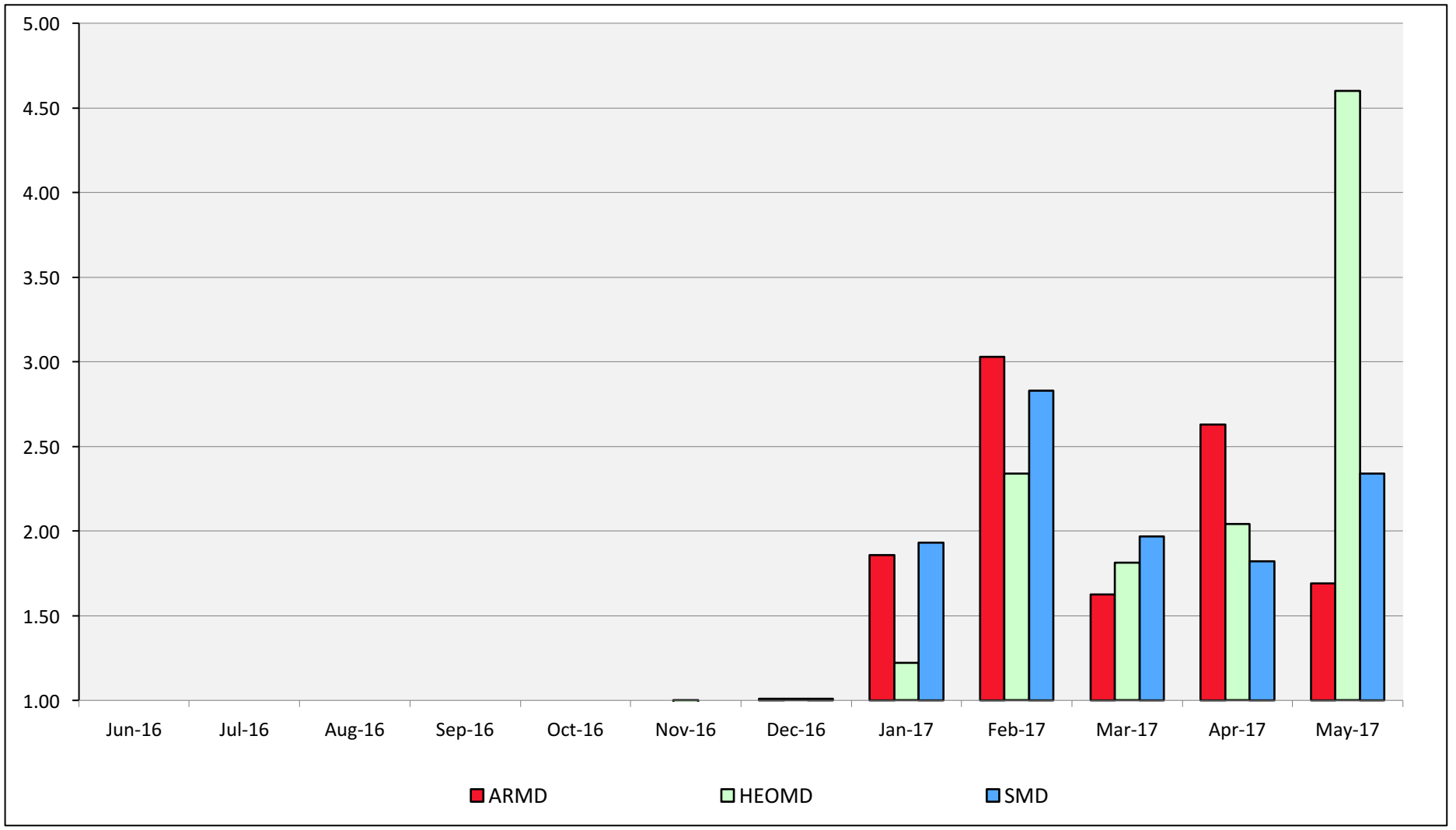
Electra:
Monthly Utilization by Size and Length



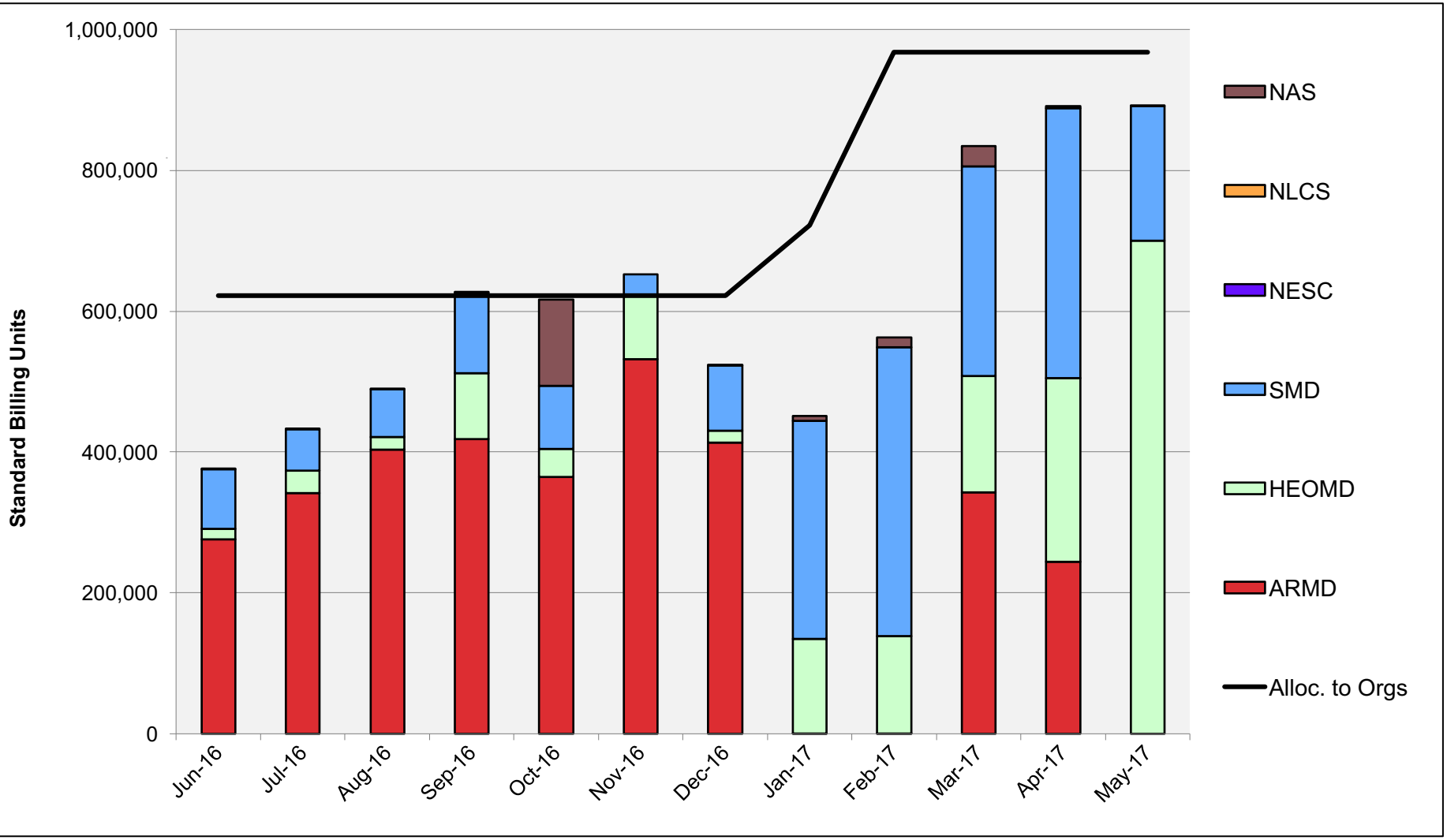
Electra:
Average Time to Clear All Jobs



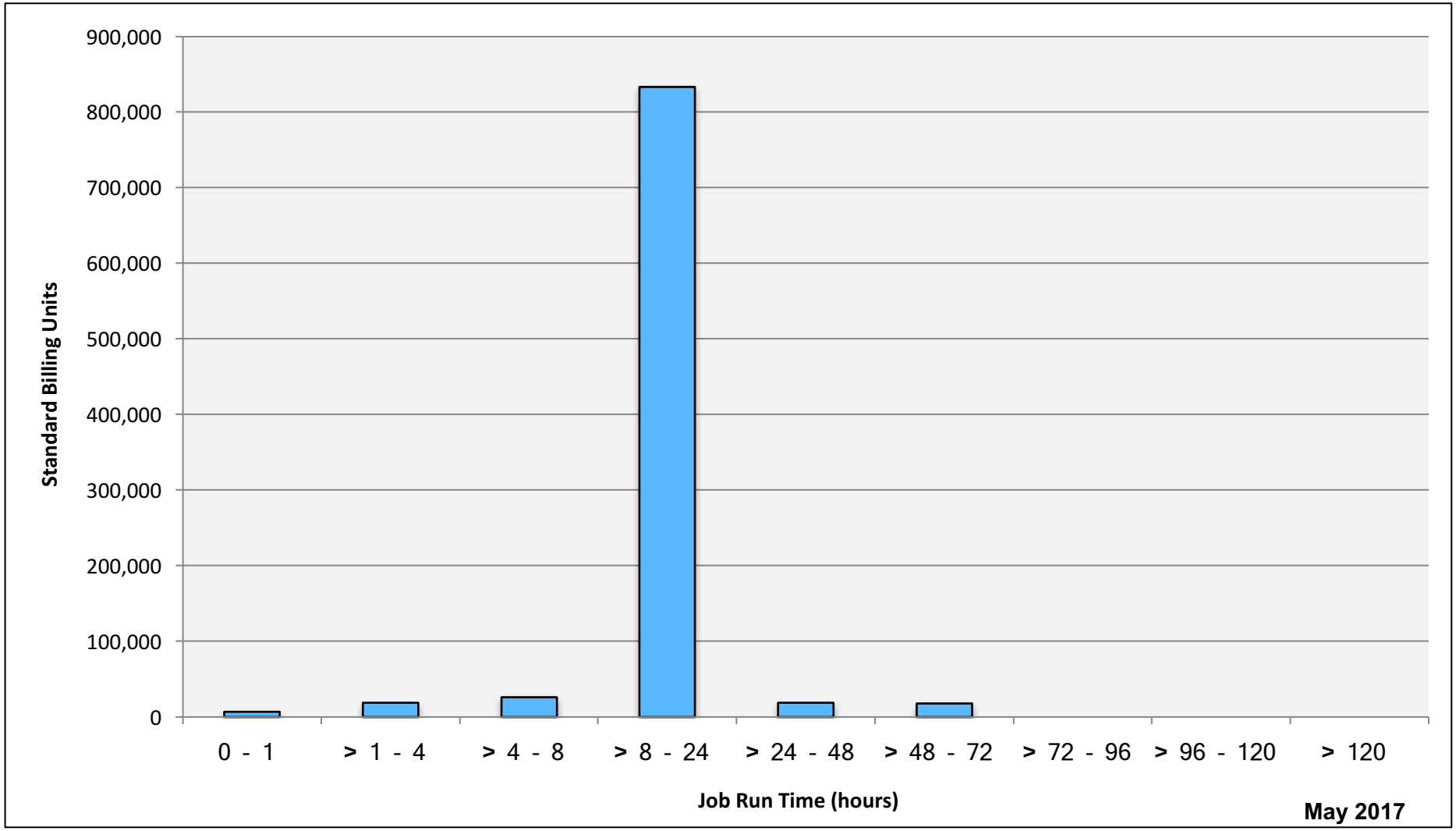
Electra:
Average Expansion Factor



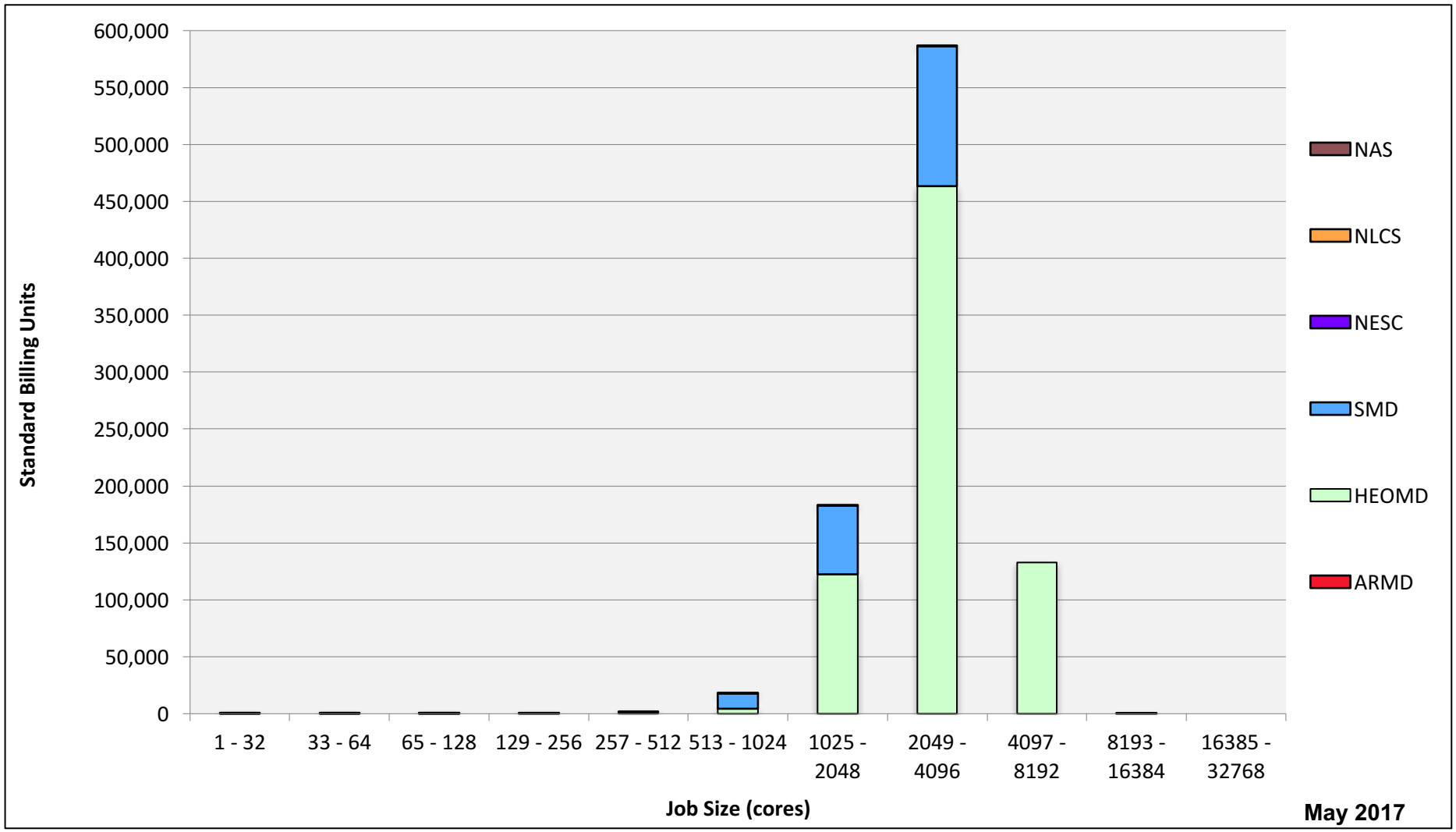
Merope:
SBUs Reported, Normalized to 30-Day Month



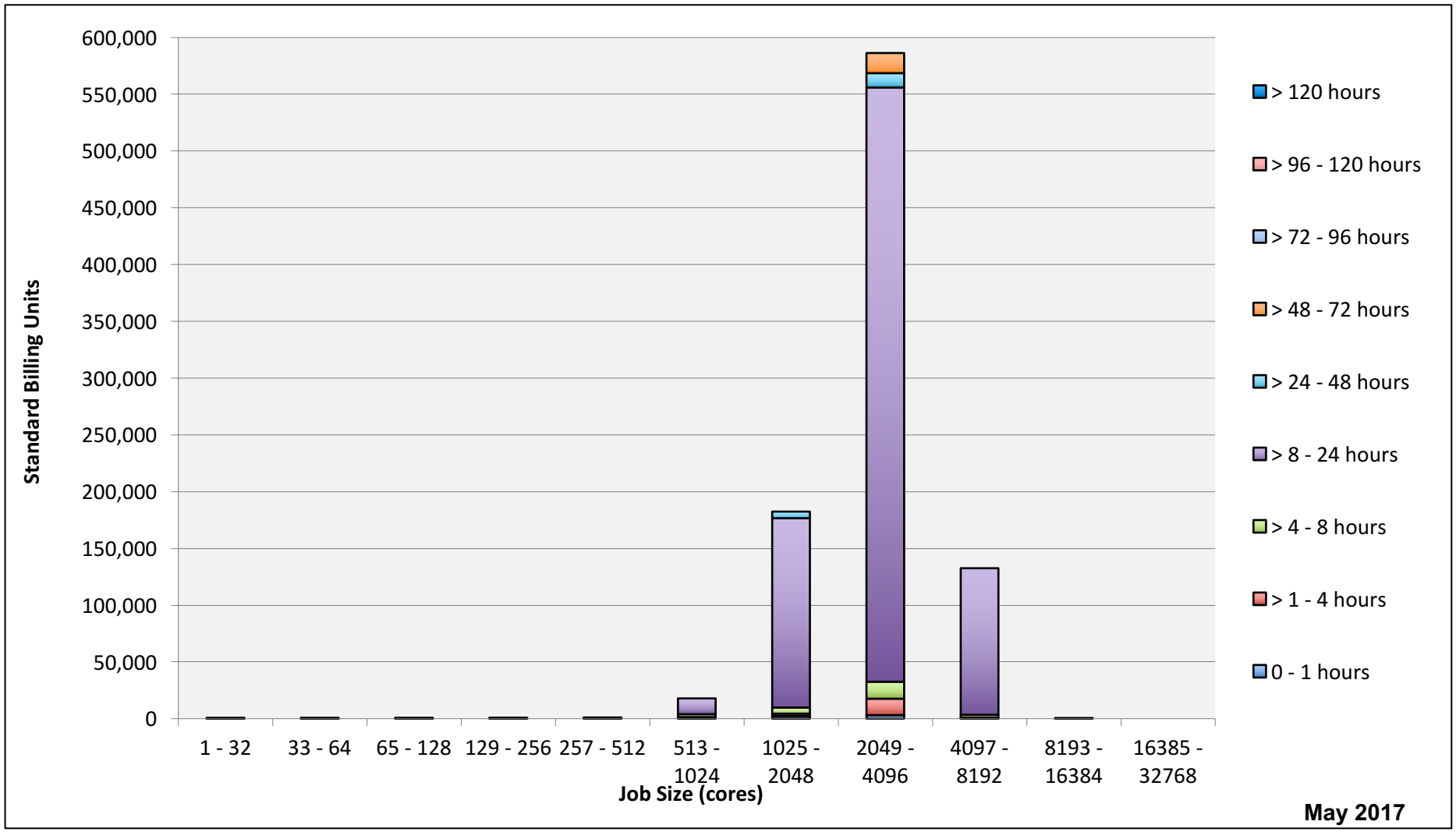
Merope:
Monthly Utilization by Job Length



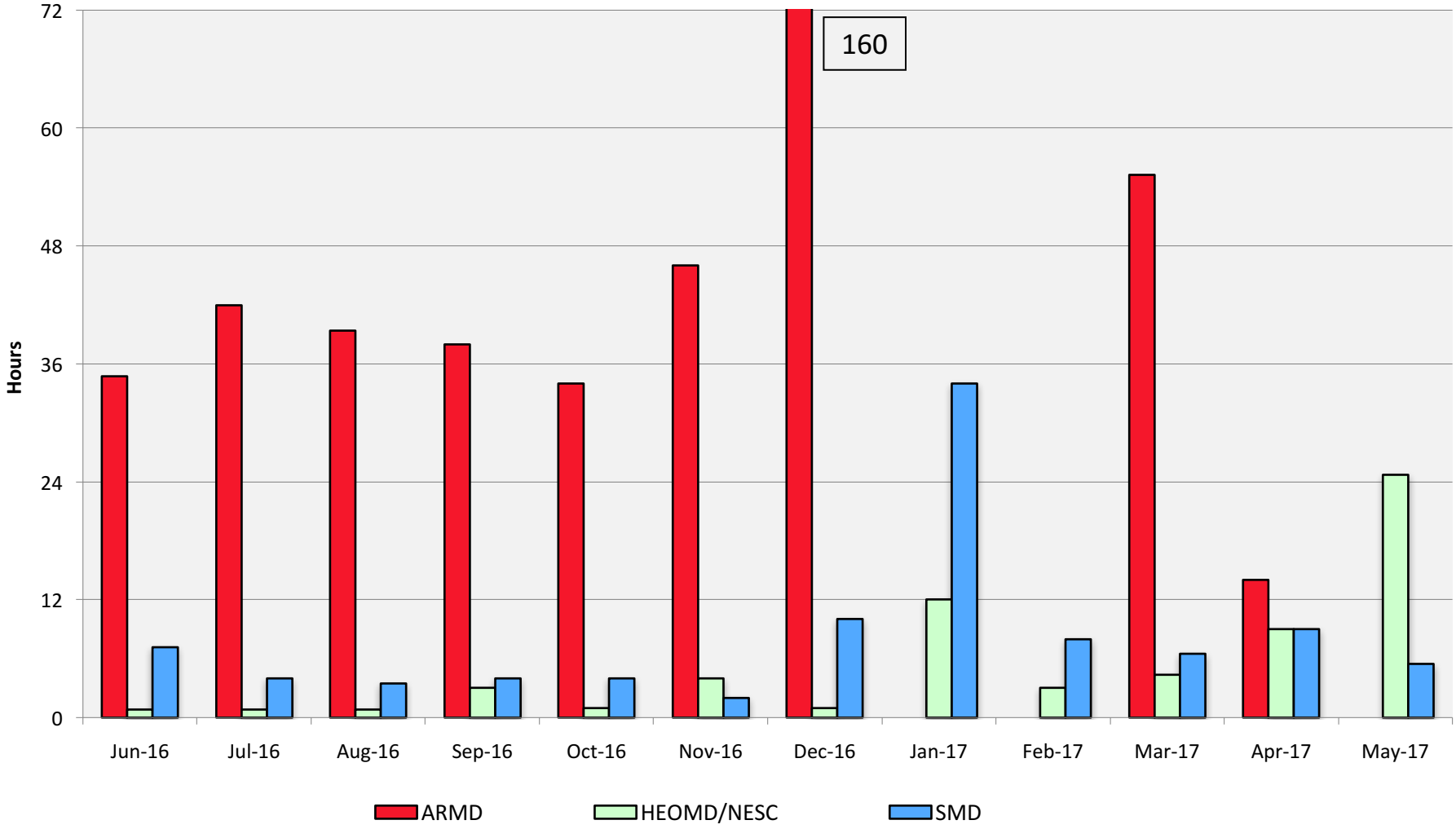
Merope:
Monthly Utilization by Size and Mission



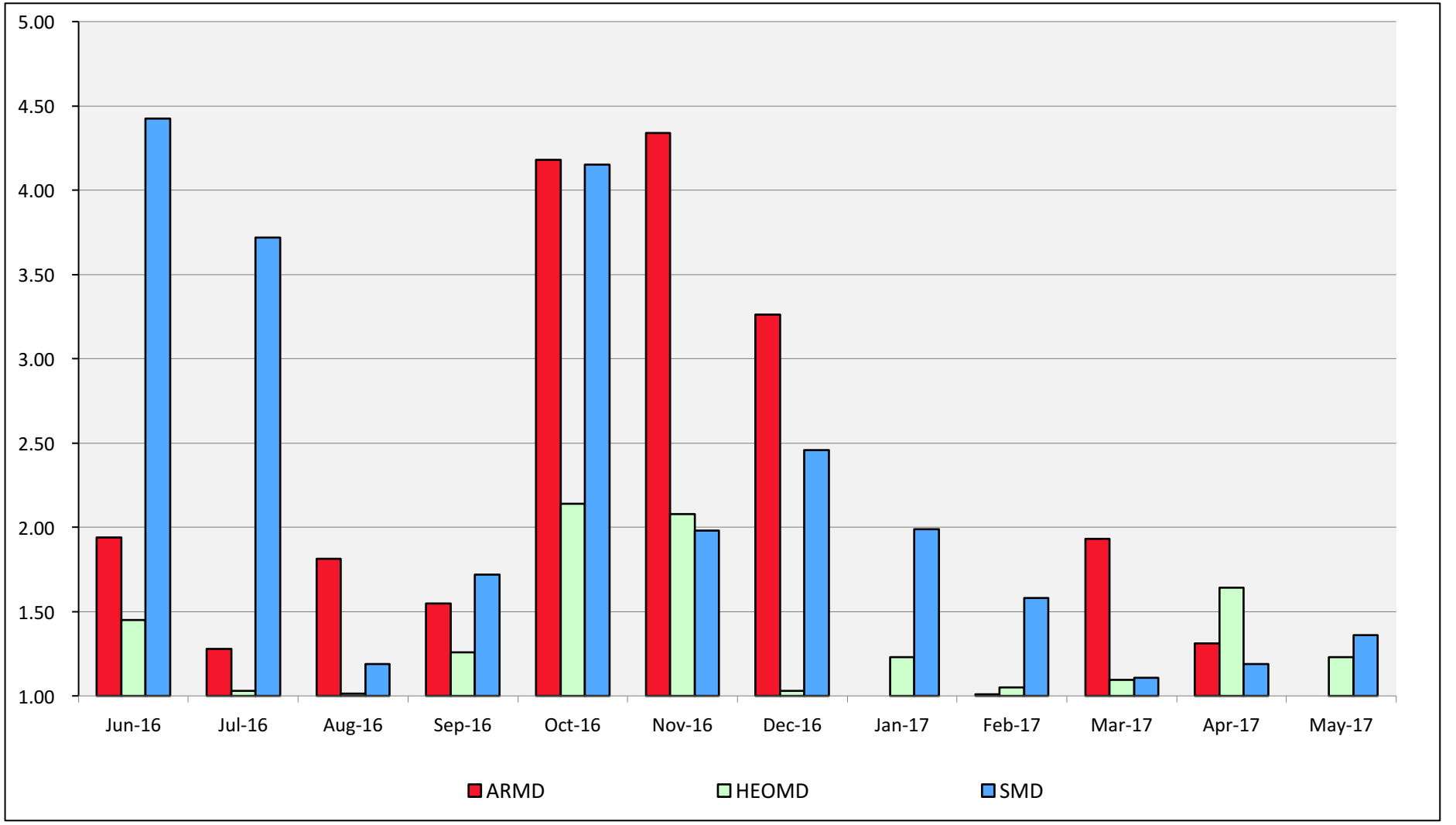
Merope:
Monthly Utilization by Size and Length



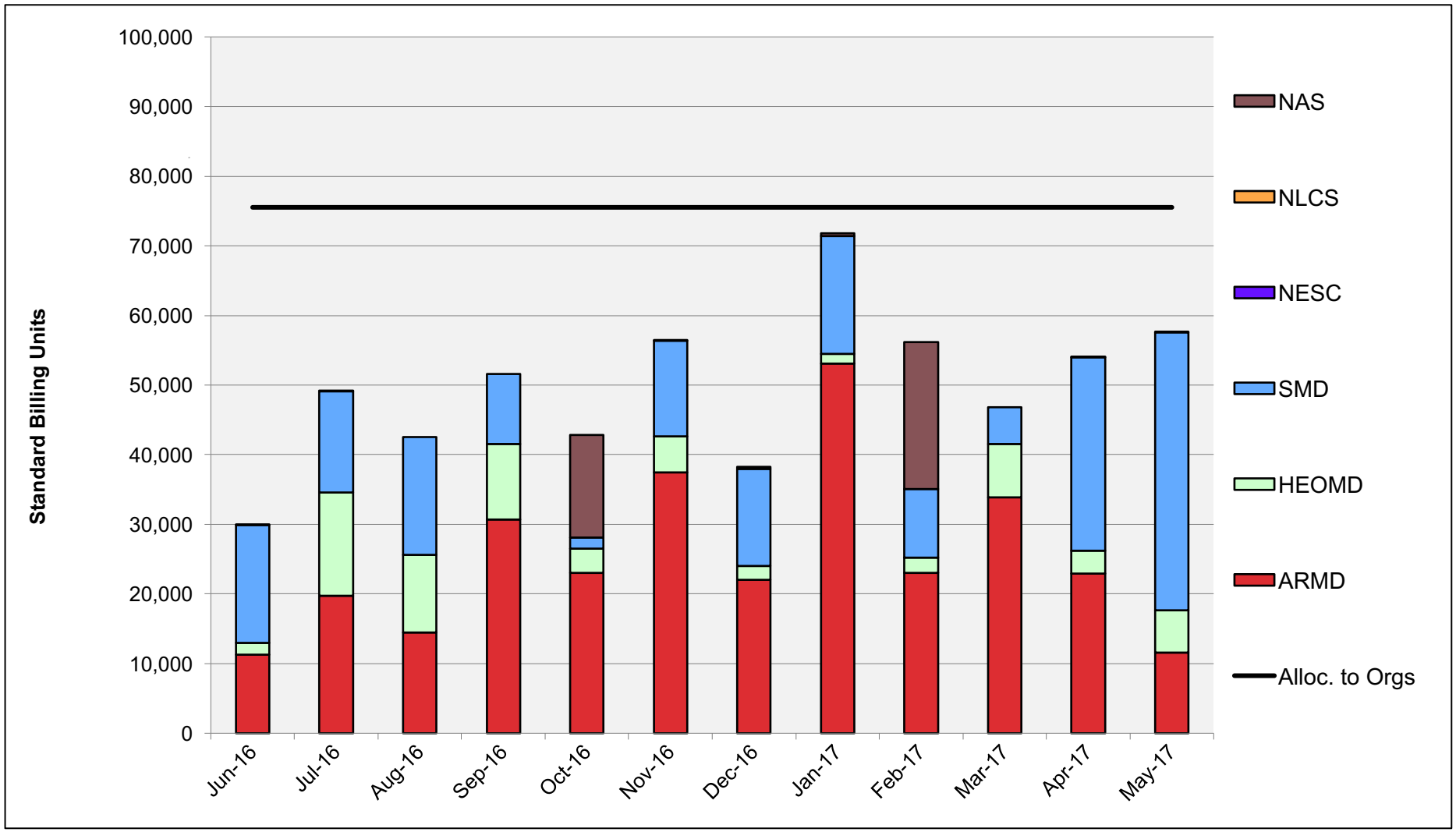
Merope:
Average Time to Clear All Jobs



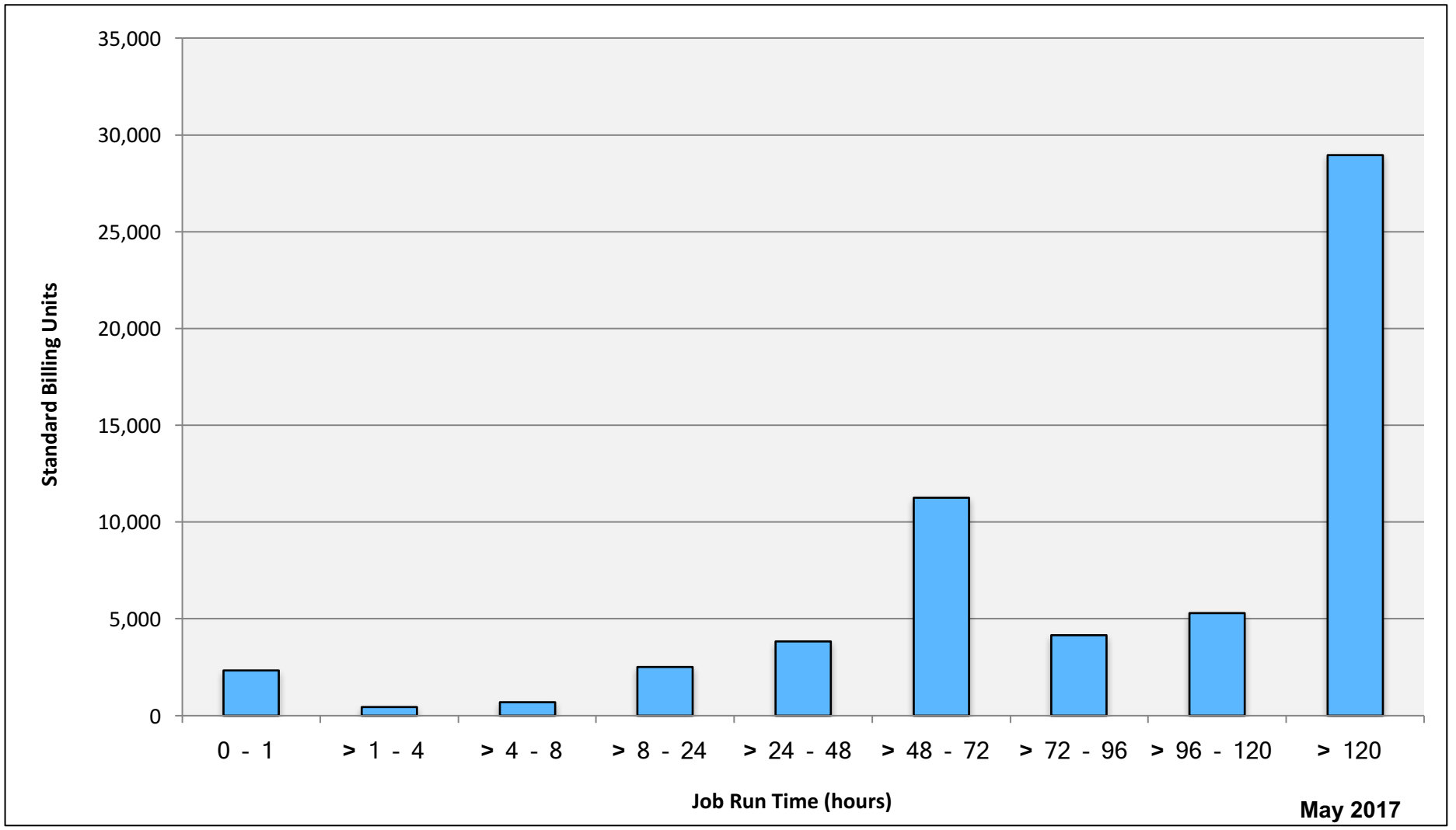
Merope:
Average Expansion Factor



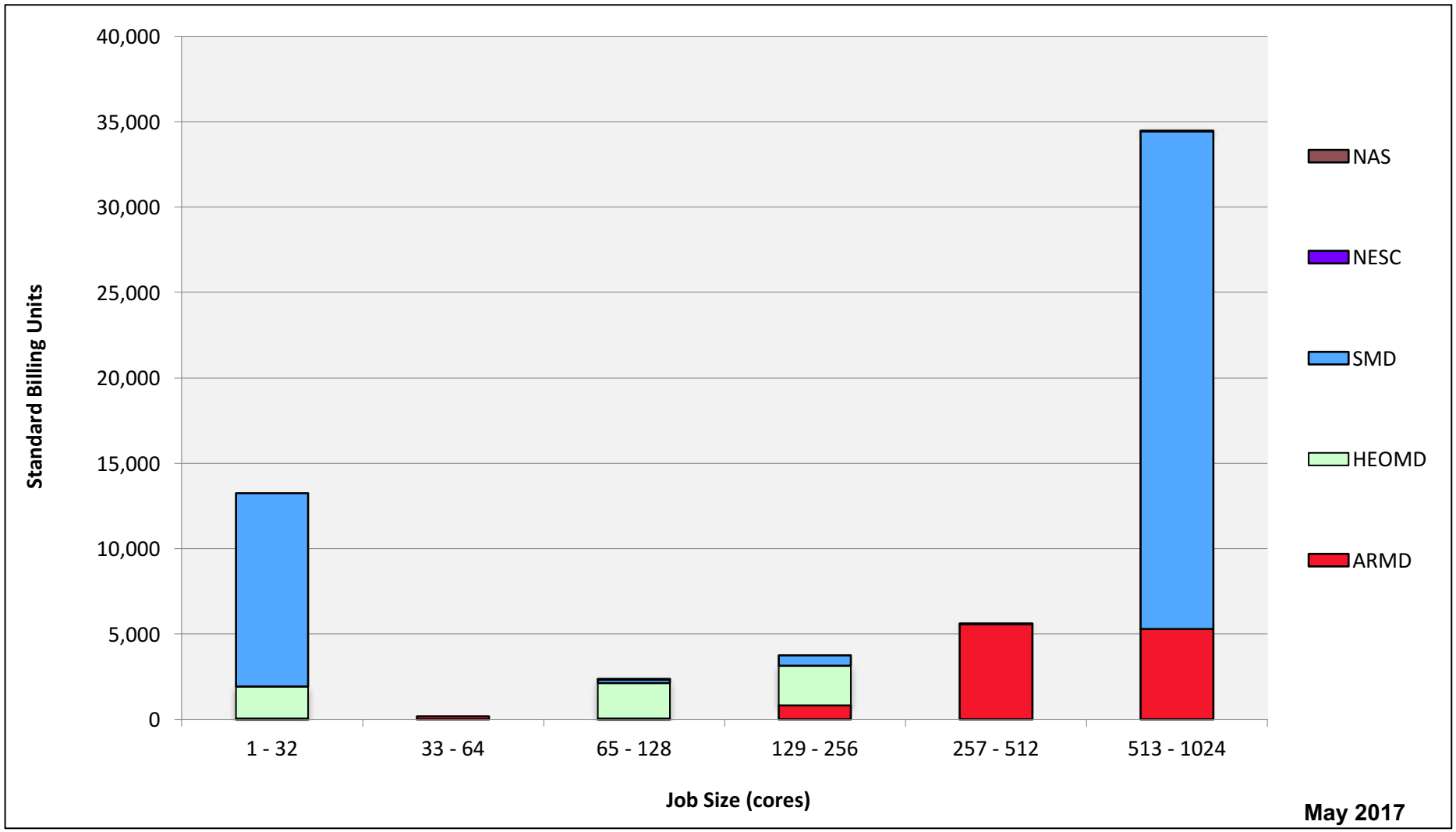
Endeavour:
SBUs Reported, Normalized to 30-Day Month



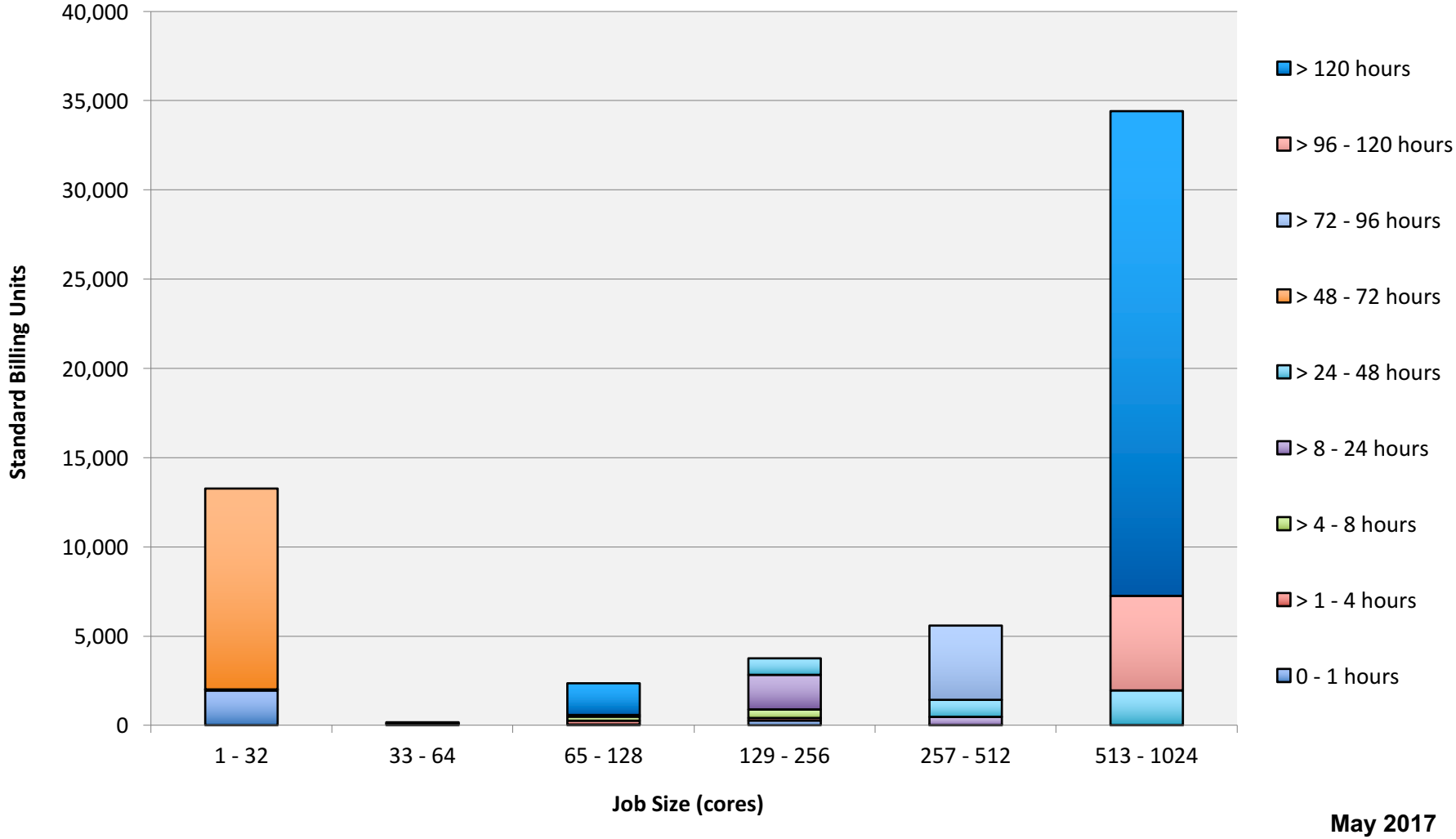
Endeavour:
Monthly Utilization by Job Length



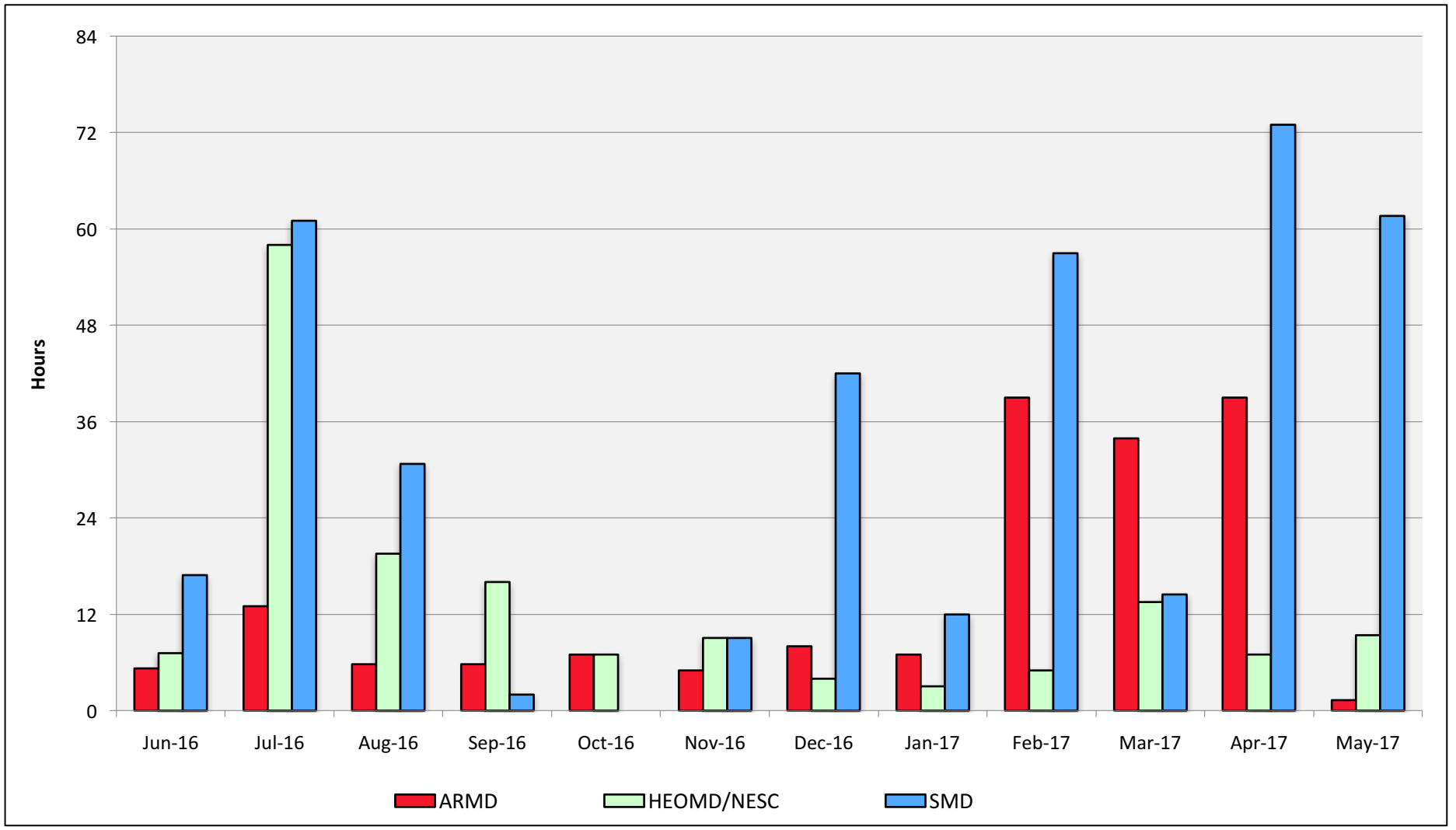
Endeavour:
Monthly Utilization by Size and Mission



Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Average Time to Clear All Jobs



Endeavour:
Average Expansion Factor