Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

April 10, 2016

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Upgrade Doubles Tape Library Performance for Users

- The Systems team recently updated one of HECC's six tape libraries and increased the tape mount rate to nearly twice the previous rate, enabling faster access to user data on the archive system.
- The team worked closely with Spectra Logic engineers to evaluate and test the performance of the Spectra High Performance Transporter (HPT) robot technology within the tape library.
- Two HPTs were installed to replace a single older-generation tape library transport. In addition to reducing users' access time to archived data, having a redundant tape transport improves the reliability of the tape library, as a single HPT can continue to service data requests.

Mission Impact: Improved performance of the HECC archival tape library enables NASA users to get faster access to mission data for simulation and analysis.

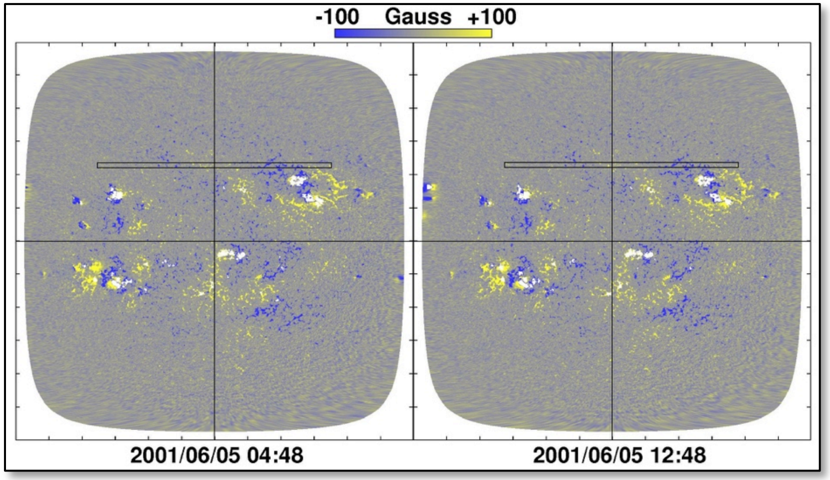
In addition to two new Spectra Logic High Performance Transport robots that double tape mount performance, the upgraded HECC tape library has a new skin with NASA-related images provided by the vendor as part of the upgrade.

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, CSC Government Solutions, LLC

HECC Team Achieves 93-Fold Speedup in Image Code for Solar Dynamics Observatory

- HECC's Application Performance and Productivity (APP) team parallelized an image comparison code used to analyze data from the Helioseismic and Magnetic Imager (HMI) instrument on the Solar Dynamics Observatory (SDO).
- The code compares 4096 x 4096 pixel images to determine the Sun's differential rotation and meridional flow. Each image comparison is done independently from other image comparisons; a message-passing regime was used for this embarrassingly parallelization.
- APP experts achieved a 93-fold speedup and a ~73% efficiency in resource usage when running the code on 128 Haswell processors on Pleiades. This performance increase allows the SDO team to reprocess the previous six years of data (as new information is obtained concerning image geometry, such as image center, size, and orientation) and to process the continuing data stream in real time.

Mission Impact: The ability to analyze images more quickly will allow scientists to perform real-time analysis and reanalysis of the flows that determine the evolution of the Sun's magnetic field.



A pair of masked solar magnetic maps from June 5, 2001, obtained 8 hours apart from the Helioseismic and Magnetic Imager. Blue represents negative magnetic polarity, yellow represents positive magnetic polarity. Tick marks around the borders are at 15-degree intervals in latitude and longitude from the central meridian. The strongest correlation for the outlined strip of pixels in the earlier map (left) is calculated to occur for a shift of 23.7 pixels in longitude and 0.4 pixels in latitude for a similar strip in the later map (right).

POC: Samson Cheung, samson.h.cheung@nasa.gov, (650) 604-0923, NASA Advanced Supercomputing Division, CSC Government Solutions LLC

APP Team Parallelizes Application Used in Design of Orion Heat Shield

- HECC's Application Performance and Productivity (APP) team parallelized a Monte Carlo version of the Charring Ablator Response code (CHAR), a thermal protection system (TPS) prediction code that is used by the Orion Spacecraft team to model heat shield material response to planetary entry.
- This new version, called mcCHAR, speeds up simulations to determine the thickness needed for the Orion heat shield, and provides correlation studies of the many parameters that go into a planetary entry.
- The APP team developed a set of scripts to launch 20,000 simultaneous CHAR runs to investigate heat shield sizings.
- Initially, the Lustre filesystem could not handle the I/O from 20,000 simultaneous runs. The team corrected the issue by "throttling" file creations and adjusting filesystem parameters.
- Currently, the mcCHAR analysis is done one point location at a time. In the future, the APP team will expand the parallelization to investigate all the body points (~300) at the same time.

Mission Impact: The capability to parallelize an analysis application using a Monte Carlo approach allows faster design turnaround times and an improved thermal protection system to support the NASA Orion spacecraft's journey to Mars.

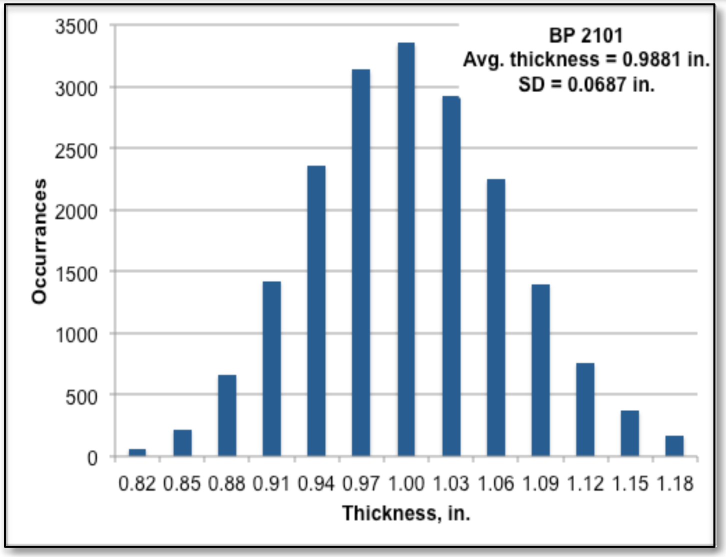


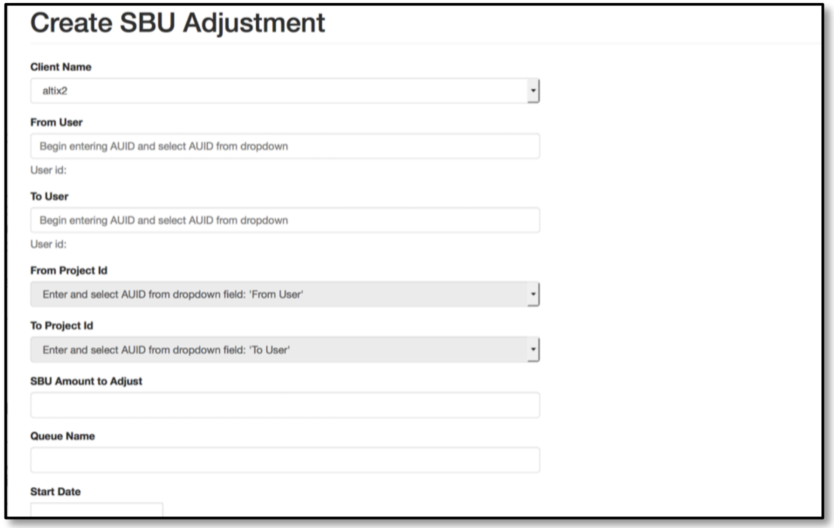
Chart showing a Gaussian-shaped TPS sizing of the Orion heat shield at a particular body point location, after 20,000 sizings (CHAR runs). The nominal thickness is shown in the middle. The thickness value serves as a confidence guideline that the heat shield design will not go over a certain maximum temperature at the bond line, where the adhesive is applied between two heat shield panels.

POC: Samson Cheung, samson.h.cheung@nasa.gov, (650) 604-0923, NASA Advanced Supercomputing Division, CSC Government Solutions LLC

Tools Team Develops Web Interface for HECC Accounting Database

- The Tools team developed a web interface to improve the management of the accounting data for HECC systems. The interface allows HECC database administrators to create, modify, and display data such as queue information, conversion and resource charging factors, and fiscal year information for the Pleiades, Endeavour and Merope supercomputers.
- Improvements introduced with the accounting web interface include:
  - Ease in making Standard Billing Unit (SBU) adjustments between specified users and groups.
  - Ability to perform the create, retrieve, update, and delete operations for client and cluster attributes used for managing accounting data.
  - Enhanced security for the database.
  - Removal of obsolete GUI interface and library.
- Future updates to the web interface will include features to manage administrative tasks related to resource usage accounting.

Mission Impact: Even as the complexity of the accounting on the HECC systems increases, this new web interface allows easy management of the client and cluster data.



Screenshot of the interface showing updates to the HECC accounting database, such as the automation of standard billing unit (SBU) adjustments through the web interface.

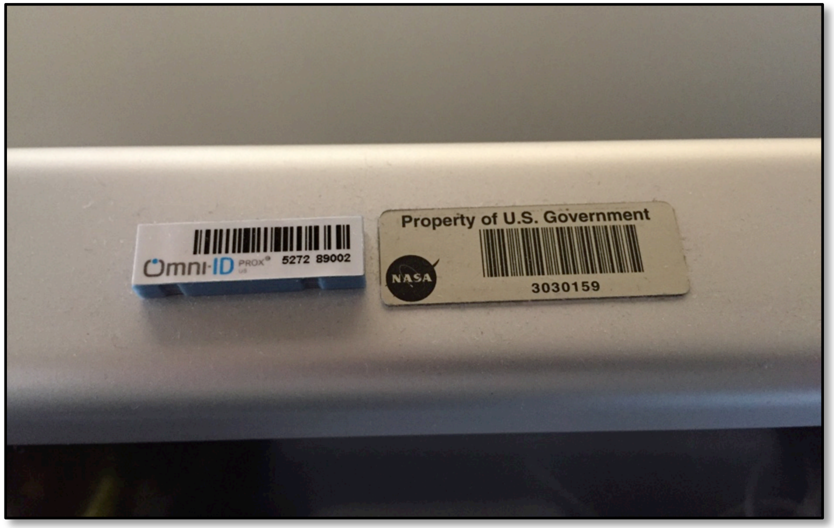
POC: Mi Young Koo, mi.y.koo@nasa.gov, (650) 604-4528, NASA Supercomputing Division, CSC Government Solutions LLC

RFID Tags Are Applied to HECC Assets and Tracked in Remedy Assets

- The HECC Property team applied Radio-Frequency IDentification (RFID) tags to current HECC and NAS Division assets, now applying both Equipment Control Number (ECN) and RFID asset tags to newly acquired assets. RFID tags aid the staff in scanning assets for annual inventories by eliminating the need to physically locate hard-to-find ECN tags. The pairing of RFID tags to ECN tags is accomplished with an RFID scanner checked out when needed from the Logistics.
- An RFID field was added to the NAS Remedy asset records used to track HECC and NAS assets. Nightly syncs of the NASA Property database and the NAS Remedy asset records keep the Remedy database up to date.
- Remedy Smart Reports are used to report on the status of the assets and these reports can be used to easily identify any assets in need of RFID tags.

** N-PROP is the agency's automated property management system.*

Mission Impact: RFID tags enable easy scanning of assets to better manage property movement and to quickly complete inventory scans.



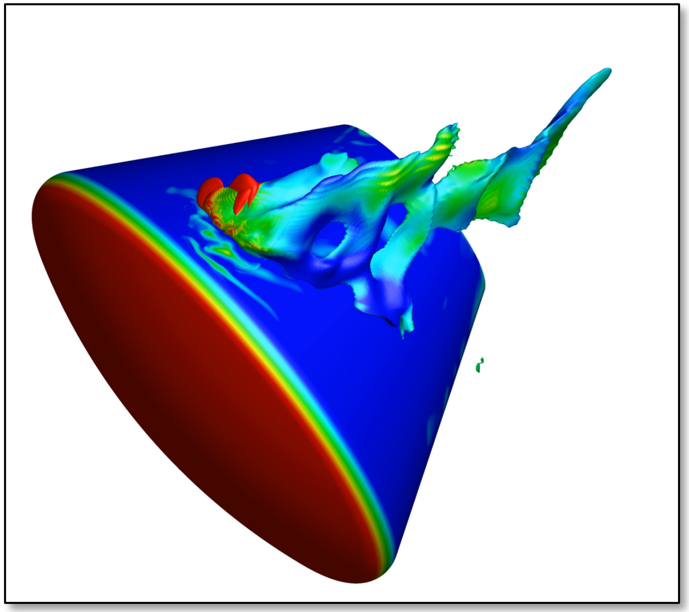
RFID tags come in a variety of sizes to fit any NASA asset and are currently paired with the NASA Equipment Control Number (ENC) tag to provide additional identification of the asset.

POCs: Judy Kohler, judy.j.kohler@nasa.gov, (650) 604-4303, NASA Advanced Supercomputing (NAS) Division, CSC Government Solutions LLC, Mi Young Koo, mi.y.koo@nasa.gov, (650) 604-4528, NAS Division, CSC Government Solutions LLC

Pleiades Simulations Help Design NASA's Orion Spacecraft for Deep Space Exploration

- Researchers at NASA Ames performed high-fidelity simulations on Pleiades to assist engineers in the design of Orion's Thermal Protection System (TPS) and other key components. The simulations were used to:
  - Estimate the energy exchange between the spacecraft and its environment at different flight conditions, such as entry speed, altitude, and vehicle orientation.
  - Model scenarios where high heating can occur during entry, such as the interaction of Orion's reaction control system jets with incoming flow, or enhanced heating downstream of a compression pad.
- The simulations were computed at both flight and wind tunnel conditions, and computational results are being compared with experimental data.
  - Designers used the computational results and the test data to select and size the TPS materials for Orion.
  - The comparisons will also help engineers validate and refine their aerothermal models and reduce error margins in their designs.
- Further simulations will help engineers optimize the spacecraft design for NASA's upcoming Exploration Missions, EM-1 and EM-2.

Mission Impact: The ability to rapidly turn around solutions is critical to maintaining NASA's ambitious schedule for the Orion and SLS programs. Enabled by HECC resources, engineers were able to complete hundreds of simulations in just one month.



Visualization of flow interaction between Orion's reaction control system (RCS) jets with incoming flow, showing temperature contours on the surface of the capsule and the RCS plumes.

POC: Chun Tang, chun.y.tang@nasa.gov, (650) 604-3480, NASA Ames Research Center

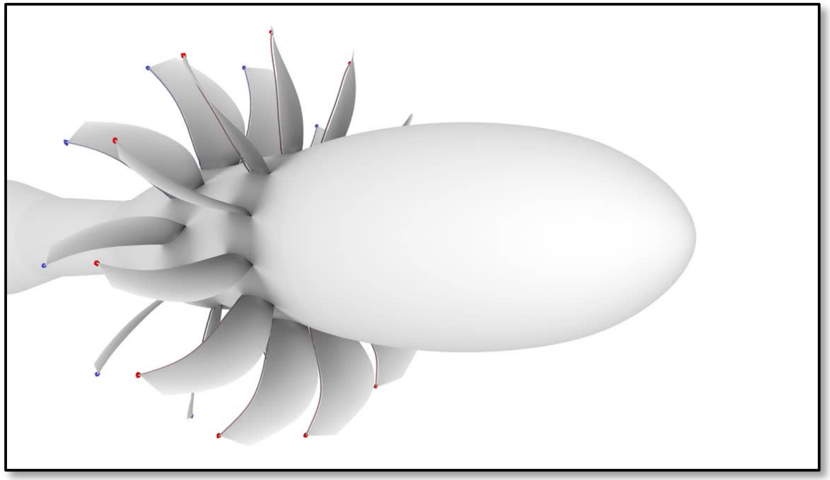
** HECC provided supercomputing resources and services in support of this work*

Pleiades Enables First-of-A-Kind Aeroacoustic Open-Rotor Simulations for Green Aviation

- CFD researchers at NASA Ames produced unique simulations that reliably predict noise sources for a contra-rotating open rotor propulsion system.
- The team ran their in-house Launch Ascent and Vehicle Aerodynamics (LAVA) framework on Pleiades to:
  - Simulate the open rotor with a novel higher-order immersed boundary method.
  - Simulate the open rotor with a boundary layer resolving, body-fitted structured curvilinear approach.
  - Analyze the main noise-generation mechanisms of the open-rotor system.
- This work demonstrated that LAVA's higher-order methods provide the ability to perform accurate aeroacoustic analysis of wake-dominated flow fields.
- HECC visualization experts helped generate ultra-high-quality renderings of the open-rotor flow physics.

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

Mission Impact: The Pleiades supercomputer enables researchers to simulate and analyze noise-generation processes for open-rotor designs in order to advance the state-of-the-art in computational fluid dynamics simulations for green aviation.



Visualization of a contra-rotating, open-rotor simulation created using the Launch Ascent and Vehicle Aerodynamics (LAVA) code's Cartesian higher-order accurate computational fluid dynamics solver. Red particles are seeded on the upstream blades, blue on the aft blades. Solid colors are seeded on the tips, while faded colors are on the blade trailing edges. *Tim Sandstrom, NASA/Ames*

POC: Cetin Kiris, cetin.c.kiris@nasa.gov, (650) 604-4485, NASA Advanced Supercomputing Division

HECC Facility Hosts Several Visitors and Tours in March 2016

- HECC hosted 12 tour groups in March; 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:
  - Renee Wynn, NASA Chief Information Officer, and Robert Powell, Sr. Advisor for Cyber Security were briefed by NAS management on the HECC services.
  - NASA Associate Administrator for Aeronautics, Dr. Jaiwon Shin was briefed by NAS Division managers as part of his Ames Center visit.
  - Congressman Mike Thompson, representing California's 5th Congressional District, along with the Digital Fabrication (dFAB) Leadership Group. The 60 guests were high-level executives and internationally recognized leaders from the digital fabrication industry and advanced manufacturing industry, including CEOs and university professors.
  - Vernon Gibson, Chief Scientific Adviser for the United Kingdom Ministry of Defense; Kate Gill, 1st Secretary Science & Technology with the British Embassy, Washington DC; and Rhona McDonald, Deputy Director and West Coast Regional Director at UK Science & Innovation Network, visited NAS as part of their center visit.
  - A group from students for the Exploration and Development of Space, University of Arizona, visited Ames as part of their spring break tour of Silicon Valley.

Bryan Biegel, NAS deputy division chief, presented computational results obtained from HECC resources on the NASA hyperwall to Congressman Mike Thompson and guests from the Digital Fabrication Leadership Group.

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

Papers

- “**Impacts of Interactive Stratospheric Chemistry on Antarctic and Southern Ocean Climate Change in the Goddard Earth Observing System – Version 5 (GEOS-5)**,” F. Li, et al., Journal of Climate (American Meteorological Society), February 29, 2016. *
http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-15-0572.1
- “**Numerical Modeling of Orbit-Spin Coupling Accelerations in a Mars General Circulation Model: Implications for Global Dust Storm Activity**,” M. Mischna, J.Shirley, arXiv:1602.09137 [astro-ph.EP], February 29, 2016. *
http://arxiv.org/abs/1602.09137
- “**A Transiting Jupiter Analog**,” D. Kipping, et al., arXiv:1602.00042 [astro-ph.EP], February 29, 2016. *
http://arxiv.org/abs/1603.00042
- “**Evaluation of Wetland Methane Emissions Across North America Using Atmospheric Data and Inverse Modeling**,” S. Miller, et al., Biogeosciences, vol. 13, March 2, 2016. *
http://www.biogeosciences.net/13/1329/2016/
- “**Common Origin of Kinetic Scale Turbulence and the Electron Halo in the Solar Wind —Connection to Nanoflares**,” H. Che, arXiv:1603.00549 [astro-ph.SR], March 2, 2016. *
http://arxiv.org/abs/1603.00549

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

Papers (cont.)

- "**A Four-Fluid MHD Model of the Solar Wind/Interstellar Medium Interaction with Turbulence Transport and Pickup Protons as Separate Fluid**," A. Usmanov, M. Goldstein, and W. Mattheaus, The Astrophysical Journal, vol. 820, March 10, 2016. *
http://iopscience.iop.org/article/10.3847/0004-637X/820/1/17
- "**Magnetized Jets Driven by the Sun: The Structure of the Heliosphere Revisited—Updates**," M. Opher, et al., Physics of Plasmas, vol. 23, March 10, 2016. *
http://scitation.aip.org/content/aip/journal/pop/23/5/10.1063/1.4943526
- "**Magnetohydrodynamical Simulations of a Deep Tidal Disruption in General Relativity**," A. Sadowski, et al., Monthly Notices of the Royal Astronomical Society, vol. 458, issue 1, March 11, 2016. *
http://mnras.oxfordjournals.org/content/early/2016/03/11/mnras.stw589.abstract
- "**Triggering and Delivery Algorithms for AGN Feedback**," G. Meece, G. M. Voit, B. O'Shea, arXiv:1603.03674 [astro-ph.GA], March 11, 2016. *
http://arxiv.org/abs/1603.03674
- "**What Physics Determine the Peak of the IMF? Insights from the Structure of Cores in Radiation-Magnetohydrodynamic Simulations**," M. Krumholz, et al., arXiv: 1603.04557 [astro-ph.GA], March 15, 2016. *
http://arxiv.org/abs/1603.04557

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

Papers (cont.)

- "**Velocity Amplitudes in Global Convection Simulations: The Role of the Prandtl Number and Near-Surface Driving**," B. O'Mara, et al., arXiv:1603.06107 [astro-ph.SR], March 19, 2016. *
http://arxiv.org/abs/1603.06107
- "**Search for Gamma-Ray Emission from Dark Matter Annihilation in the Small Magellanic Cloud with the Fermi Large Area Telescope**," R. Caputo, et al., Physical Review D, March 22, 2016. *
http://journals.aps.org/prd/abstract/10.1103/PhysRevD.93.062004
- "**An Automated, Open-Source Pipeline for Mass Production of Digital Elevation Models (DEMs) from Very-High-Resolution Commercial Stereo Satellite Imagery**," D. Shean, et al., ISPRS Journal of Photogrammetry and Remote Sensing, vol. 116, March 25, 2016. *
http://www.sciencedirect.com/science/article/pii/S0924271616300107

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

Presentations

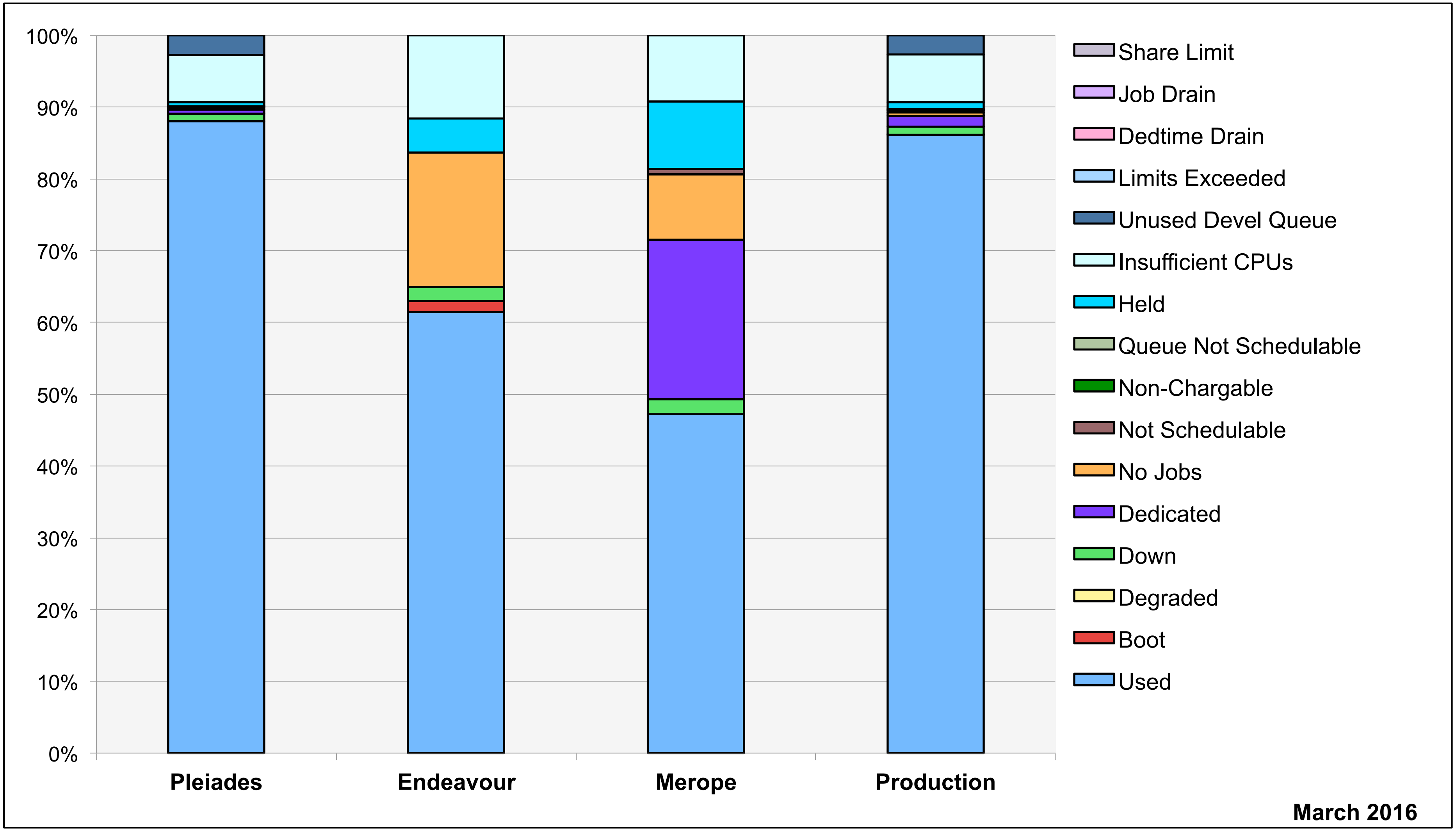
- "**Predicting the Amplitude and Hemispheric Asymmetry of Solar Cycle 25 with Surface Flux Transport**," D. Hathaway, presented at the International Space Science Institute, Bern, Switzerland, March 2, 2016.*
- "**Engineering Risk Assessment of Launch Vehicle Failure**," T. Manning, presented at the JAXA/University of Tokyo Symposium on Advances in Rocket and Spacecraft Modeling and Simulation, Tsukuba, Japan, March 23, 2016.*

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

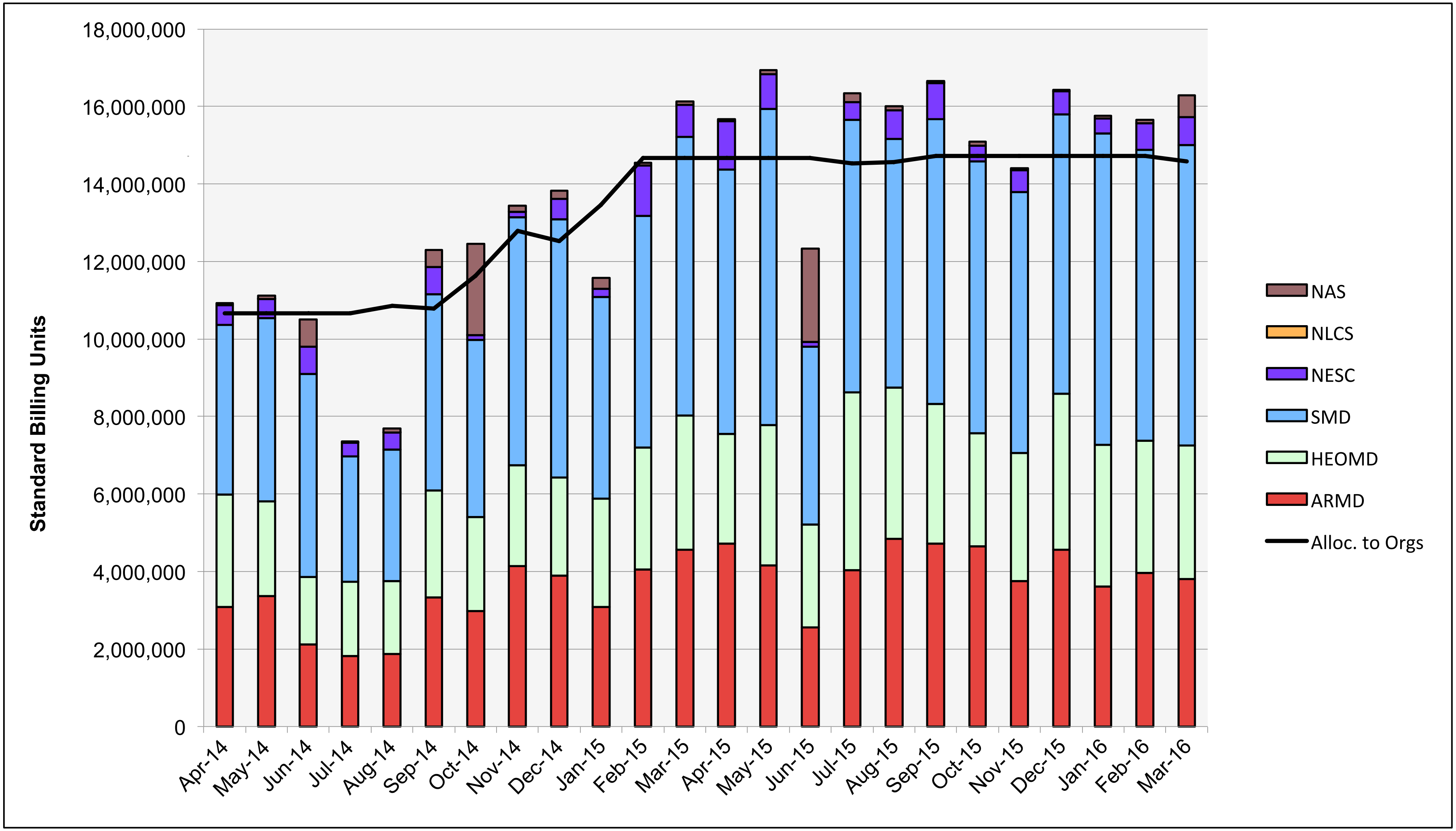
News and Events

- **Masters with Masters "What's the Big Deal with Big Data?" (Second in Series) Interview Event,** *Image of hyperwall,* March 23,2016 - *http://km.nasa.gov/masters-with-masters-whats-the-big-deal-with-big-data-second-in-series-interview-event/?utm_medium=email&utm_source=govdelivery*

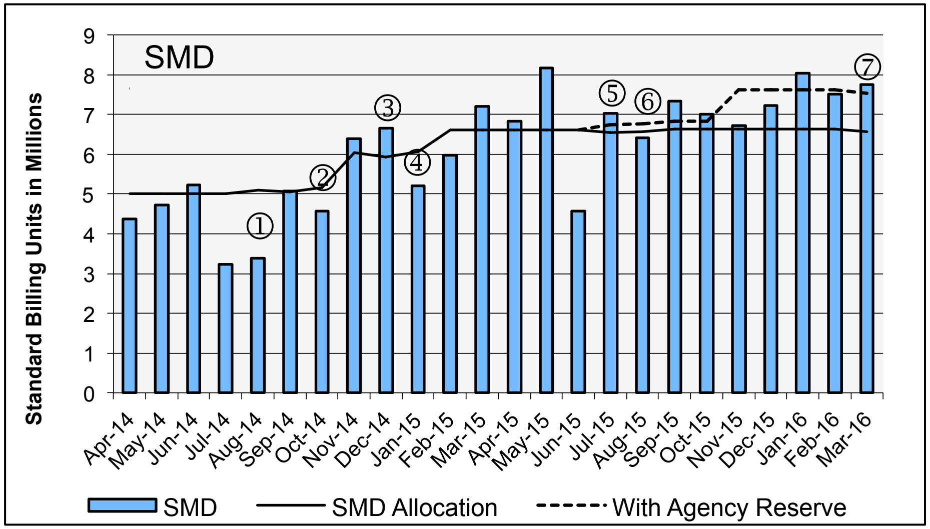
HECC Utilization

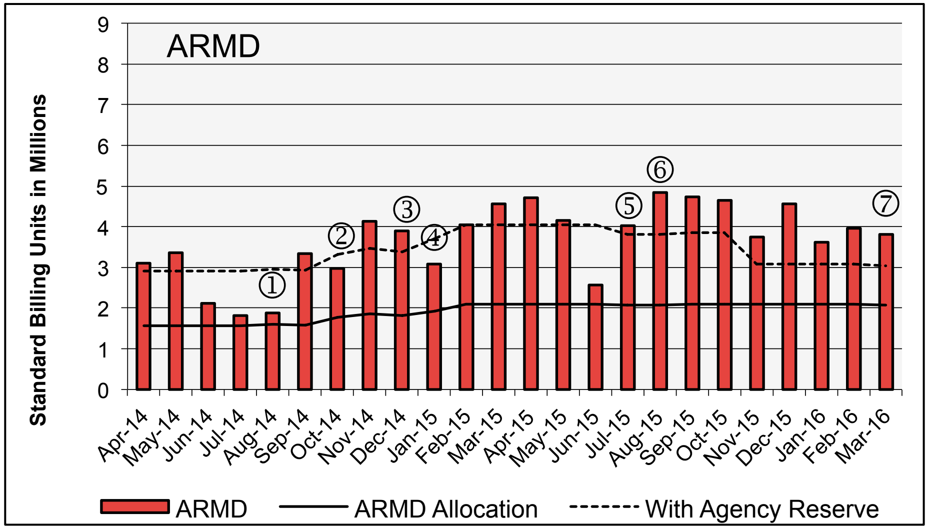


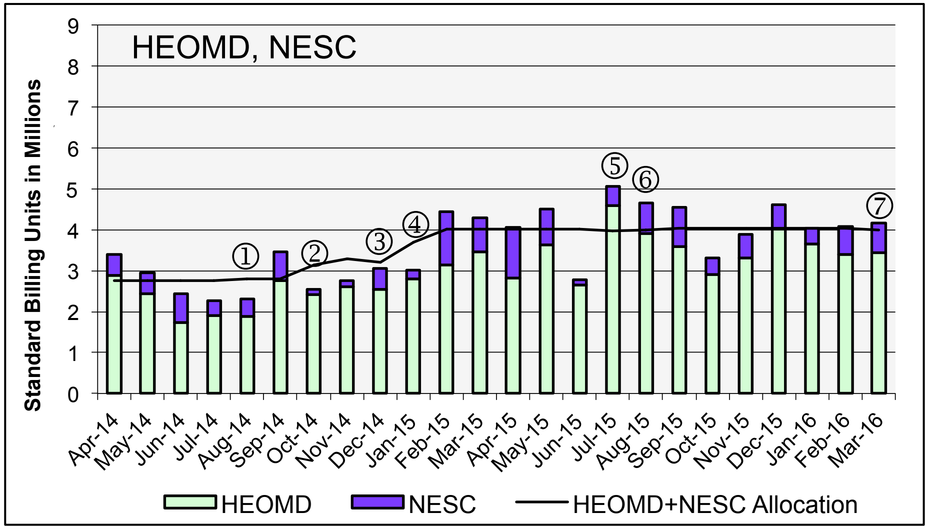
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







① 6 Westmere Racks added to Merope, Merope Harpertown retired

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

③ 16 Westmere Racks retired from Pleiades

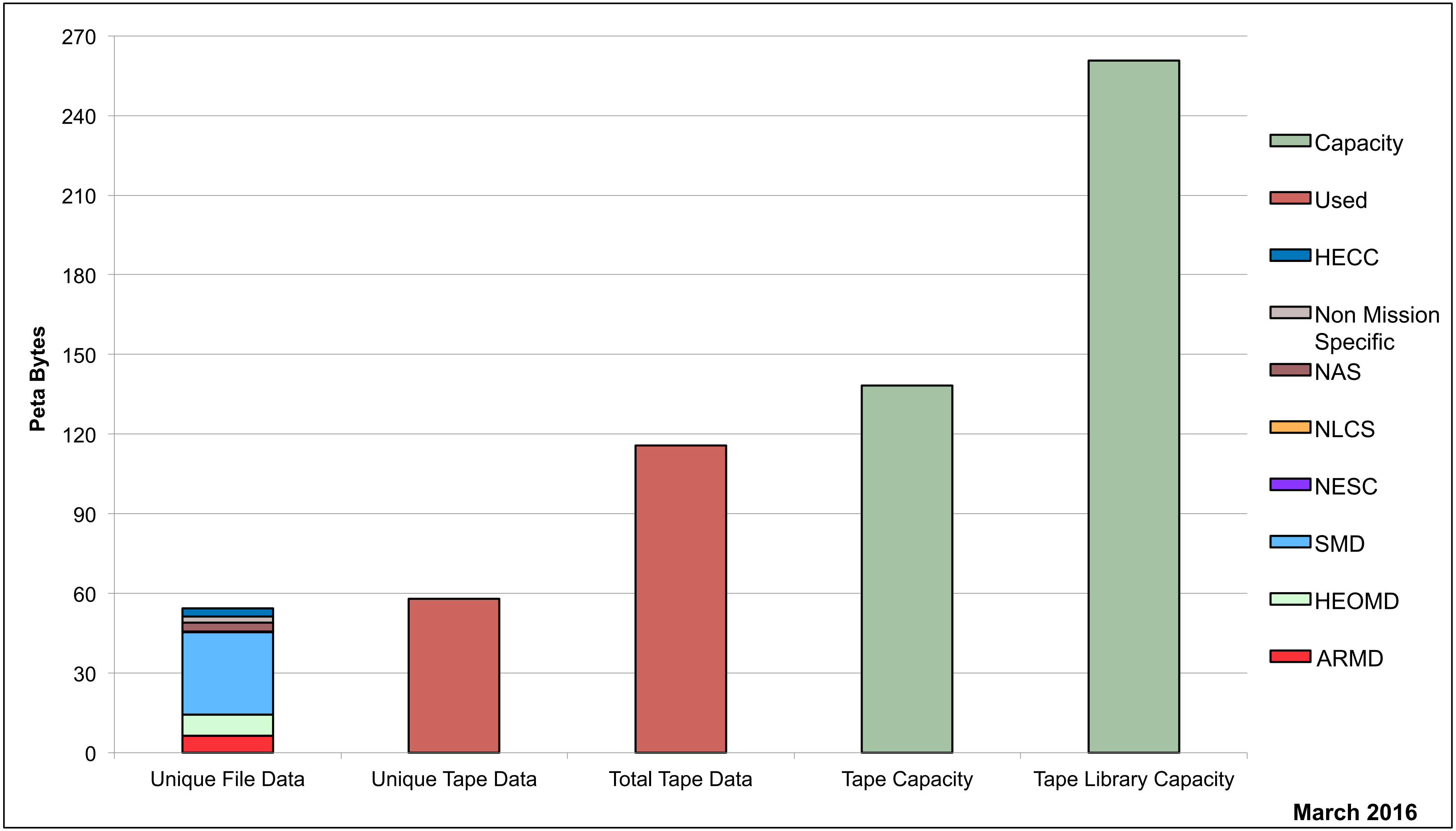
④ 14 Haswell racks added to Pleiades

⑤ 7 Merope Nehalem Racks removed from Merope

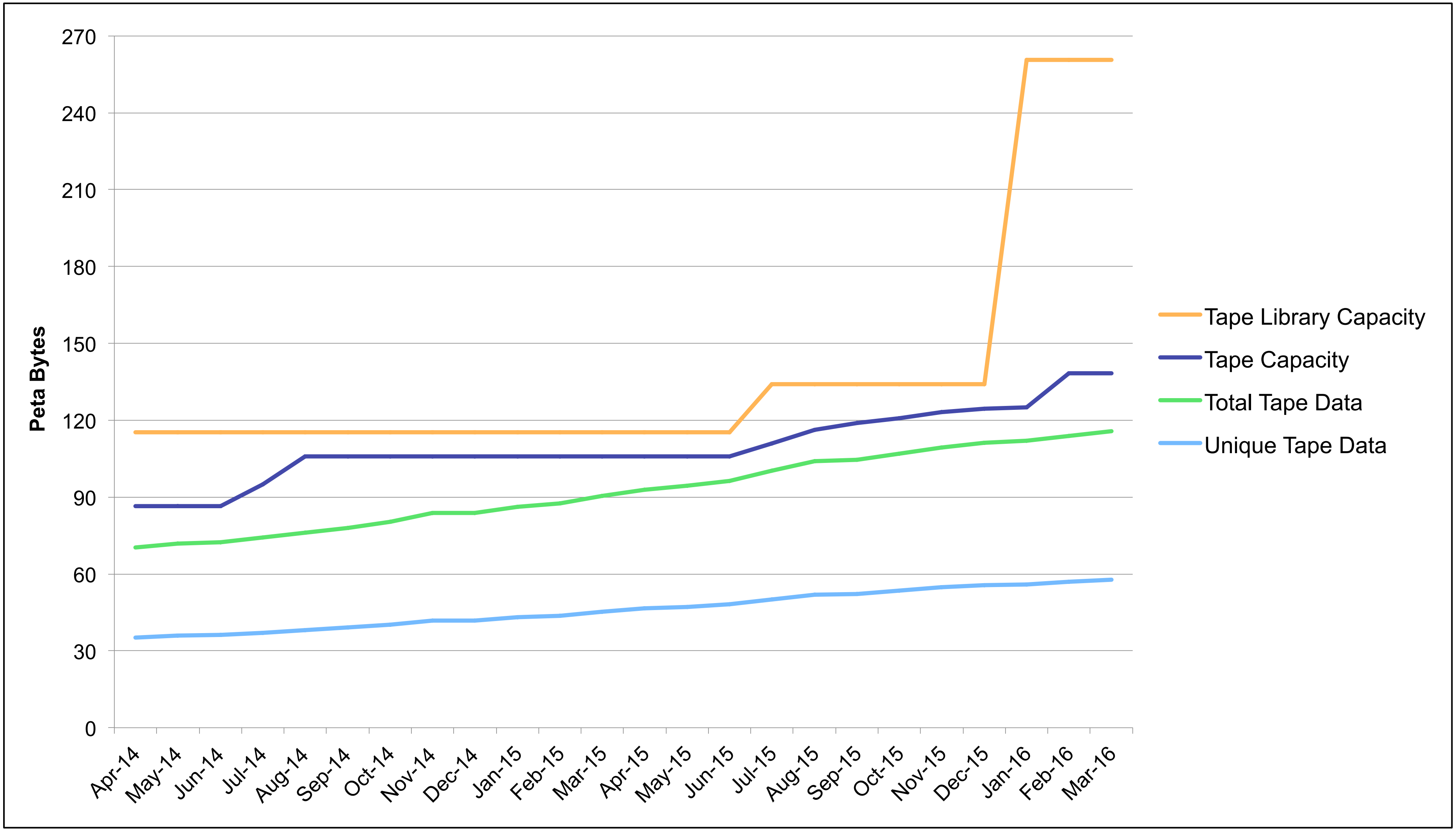
⑥ 7 Merope Westmere Racks added to Merope

⑦ 16 Westmere Racks retired from Pleiades

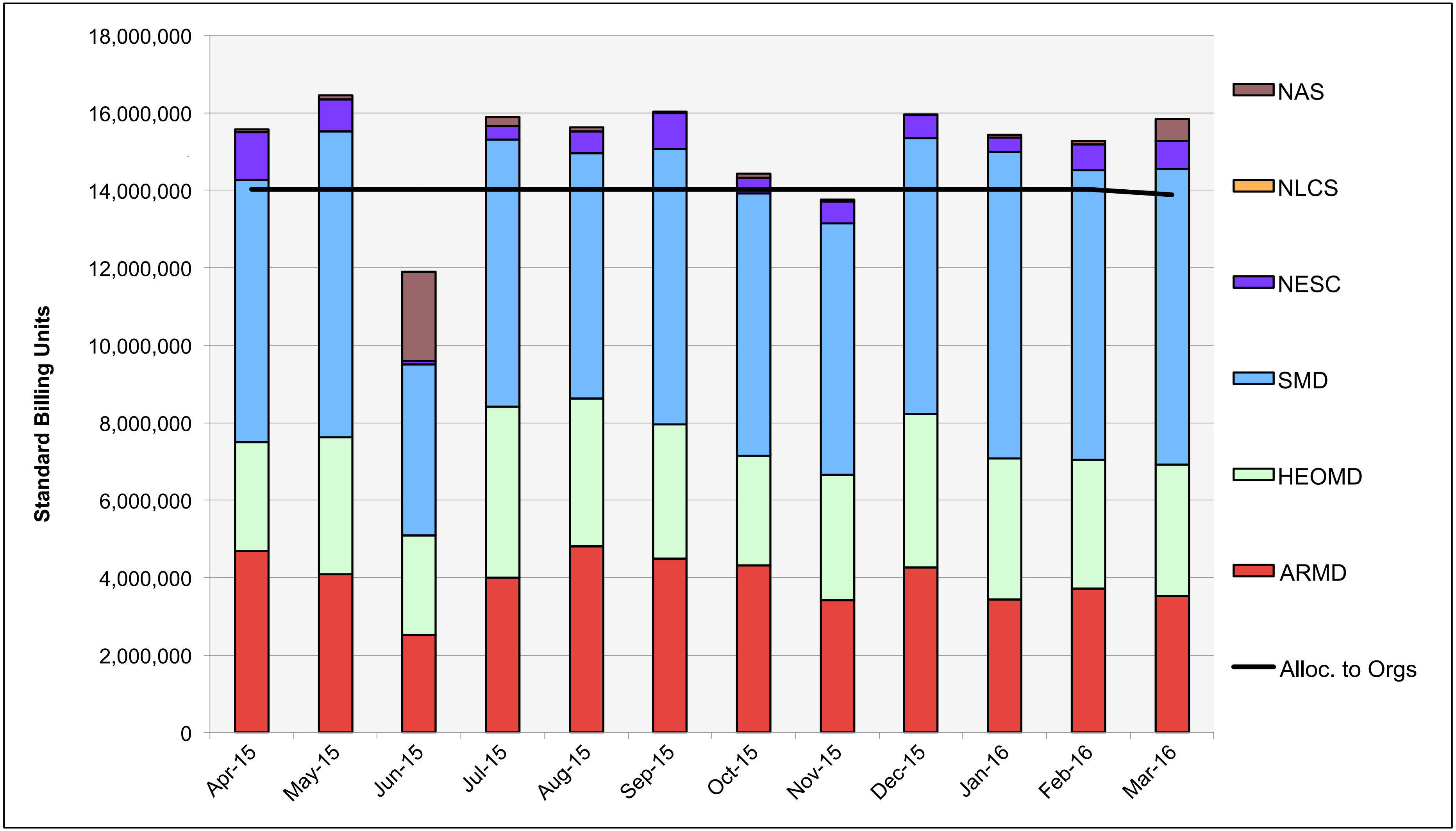
Tape Archive Status



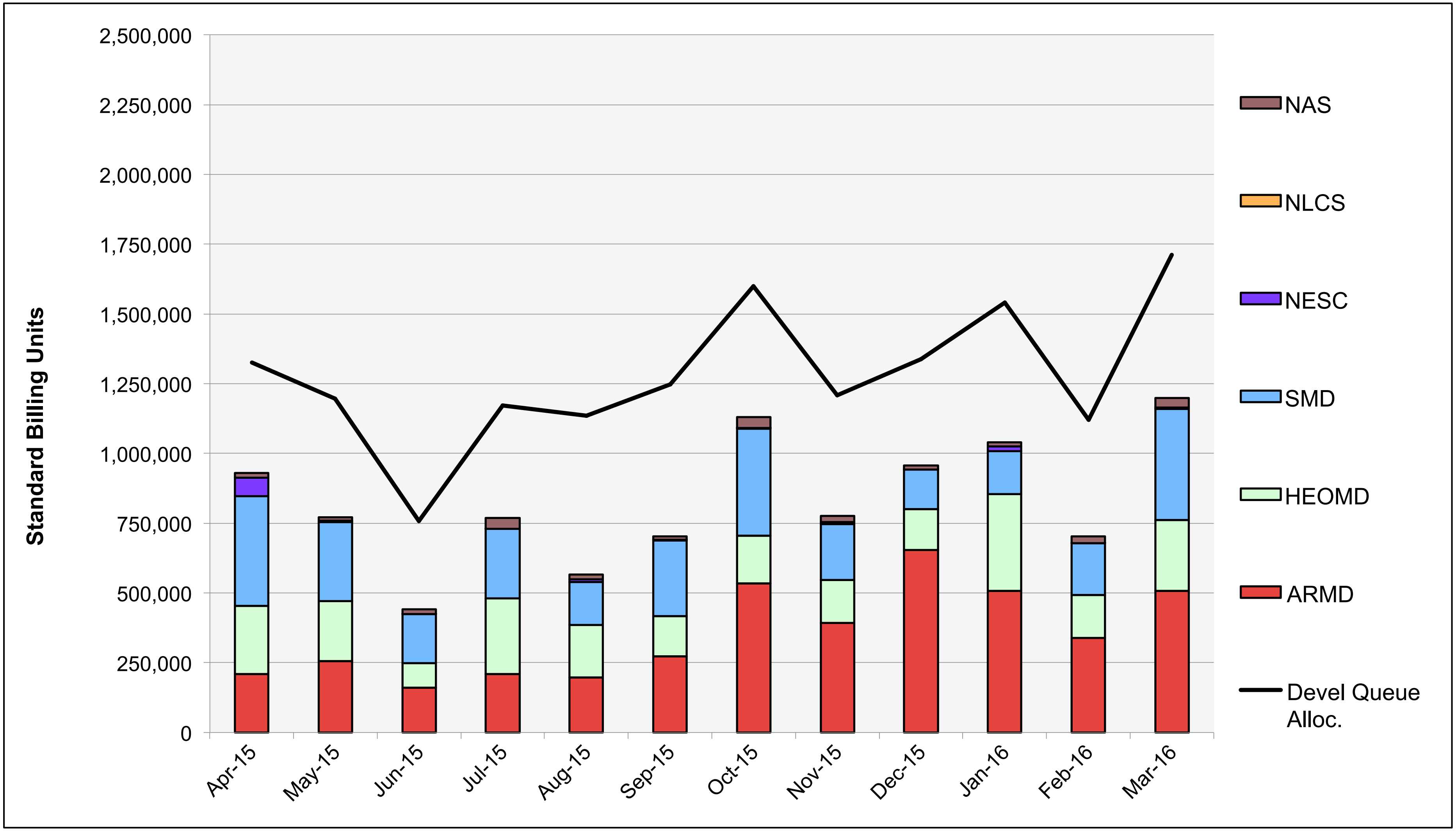
Tape Archive Status



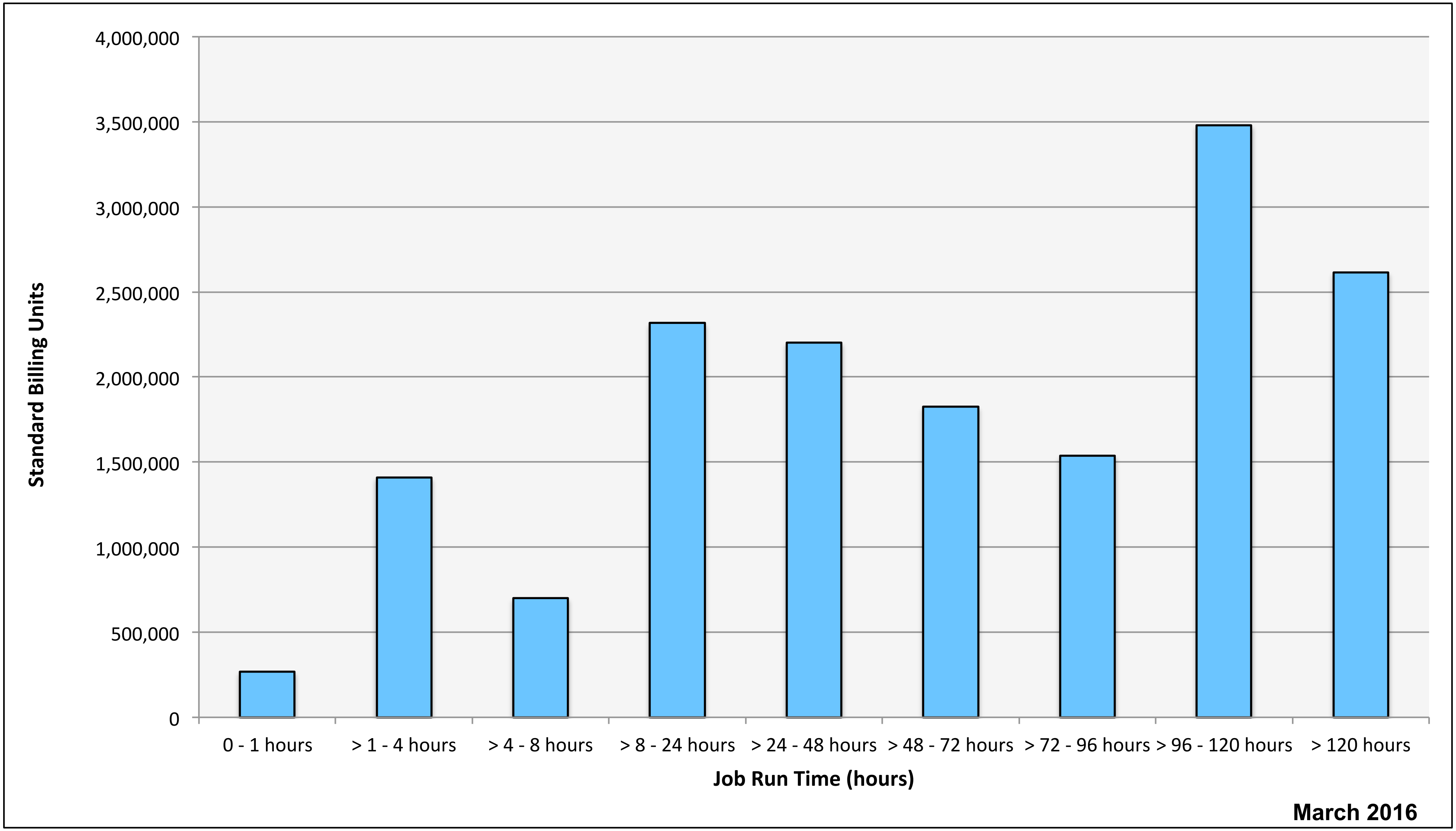
Pleiades: SBUs Reported, Normalized to 30-Day Month



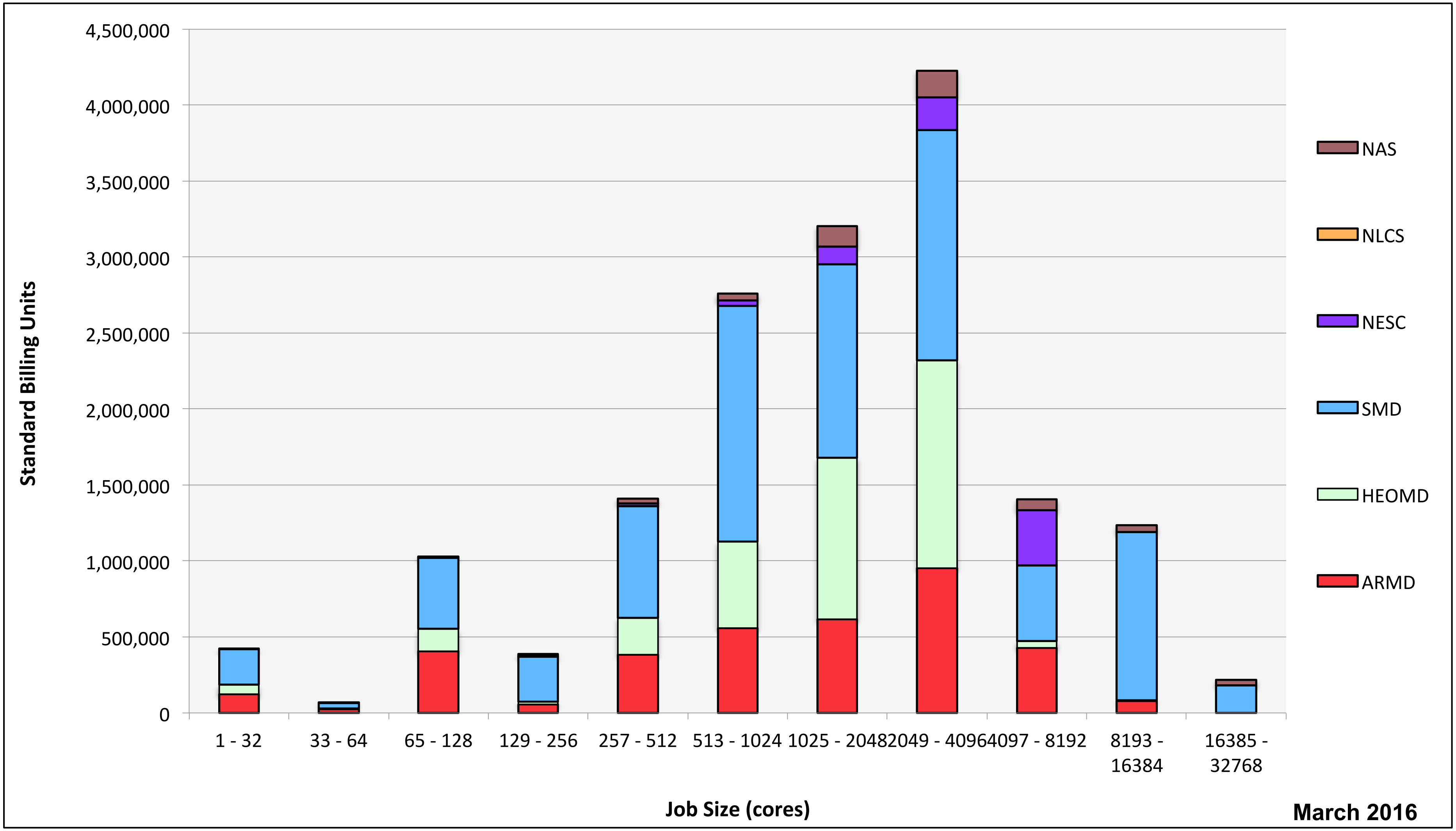
Pleiades:
Devel Queue Utilization



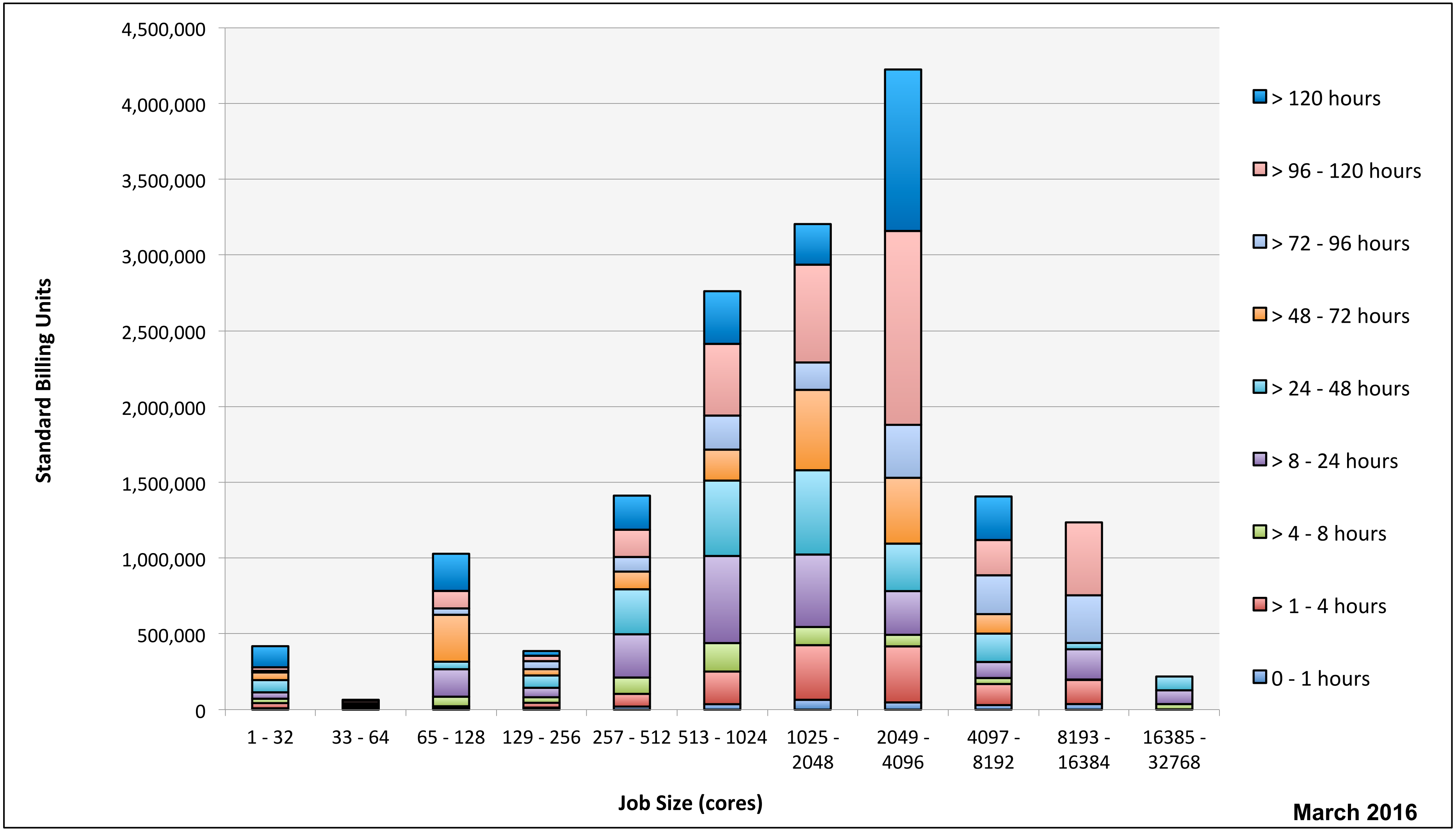
Pleiades: Monthly Utilization by Job Length



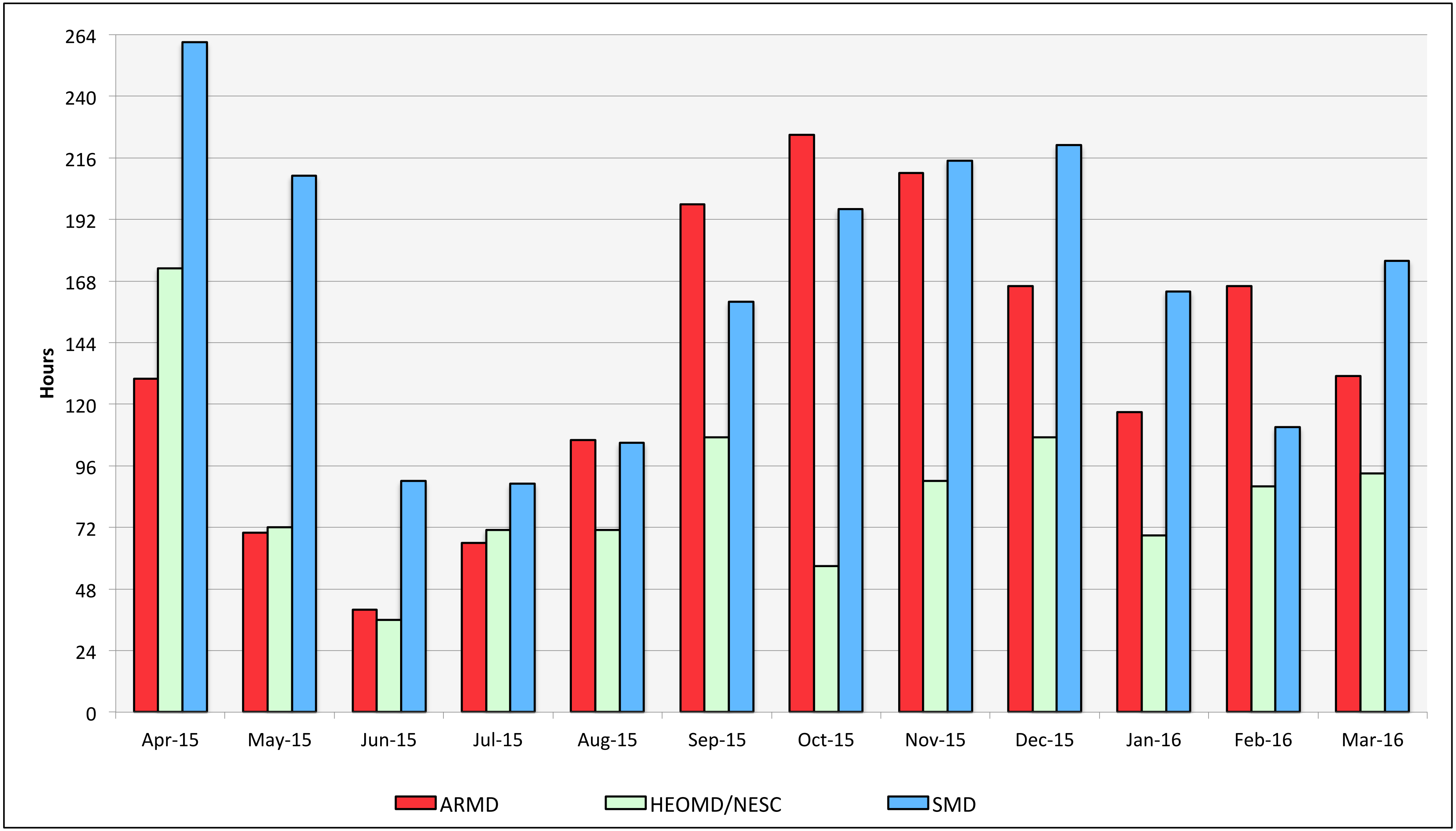
Pleiades: Monthly Utilization by Size and Mission



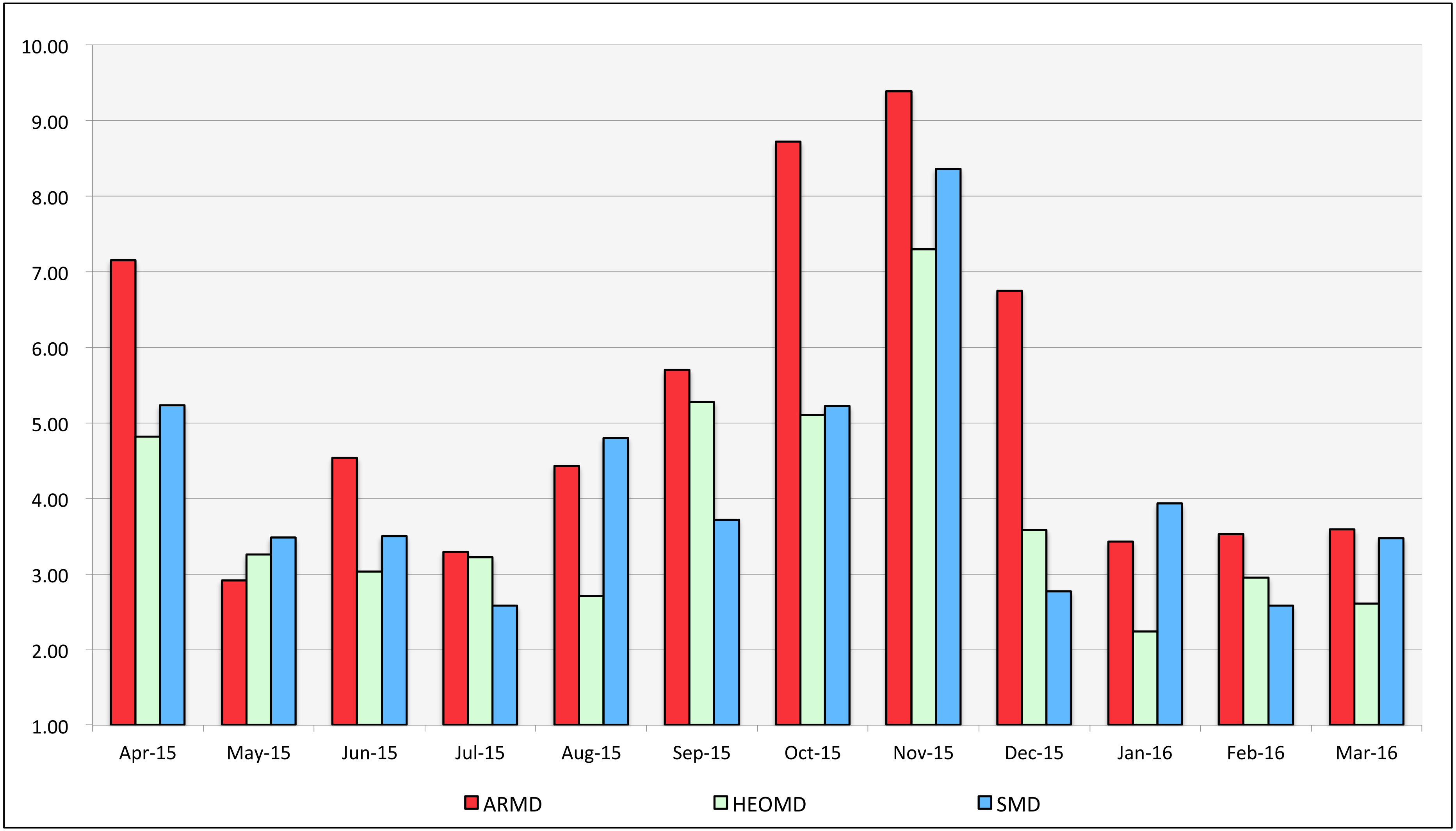
Pleiades:
Monthly Utilization by Size and Length



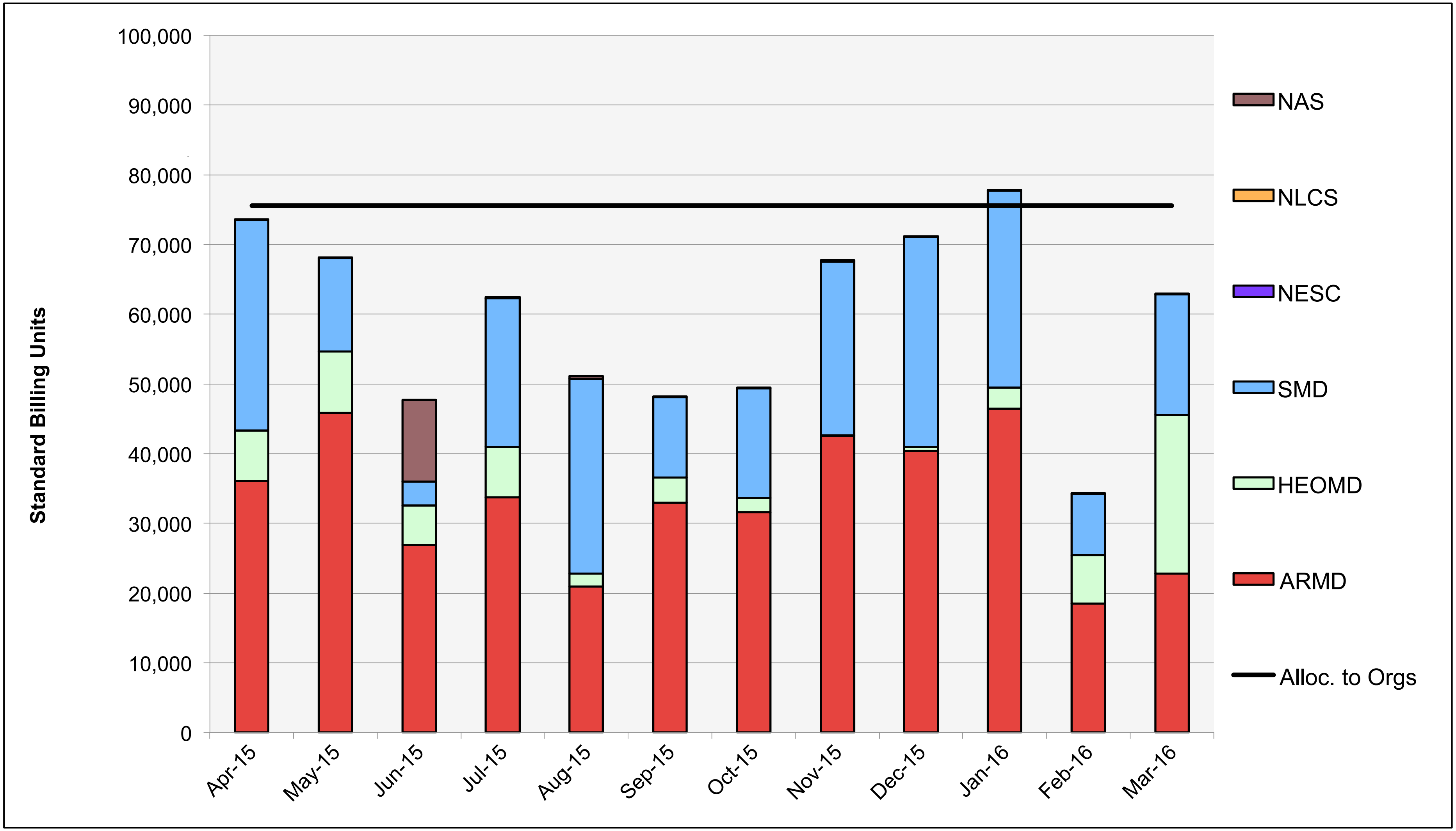
Pleiades: Average Time to Clear All Jobs



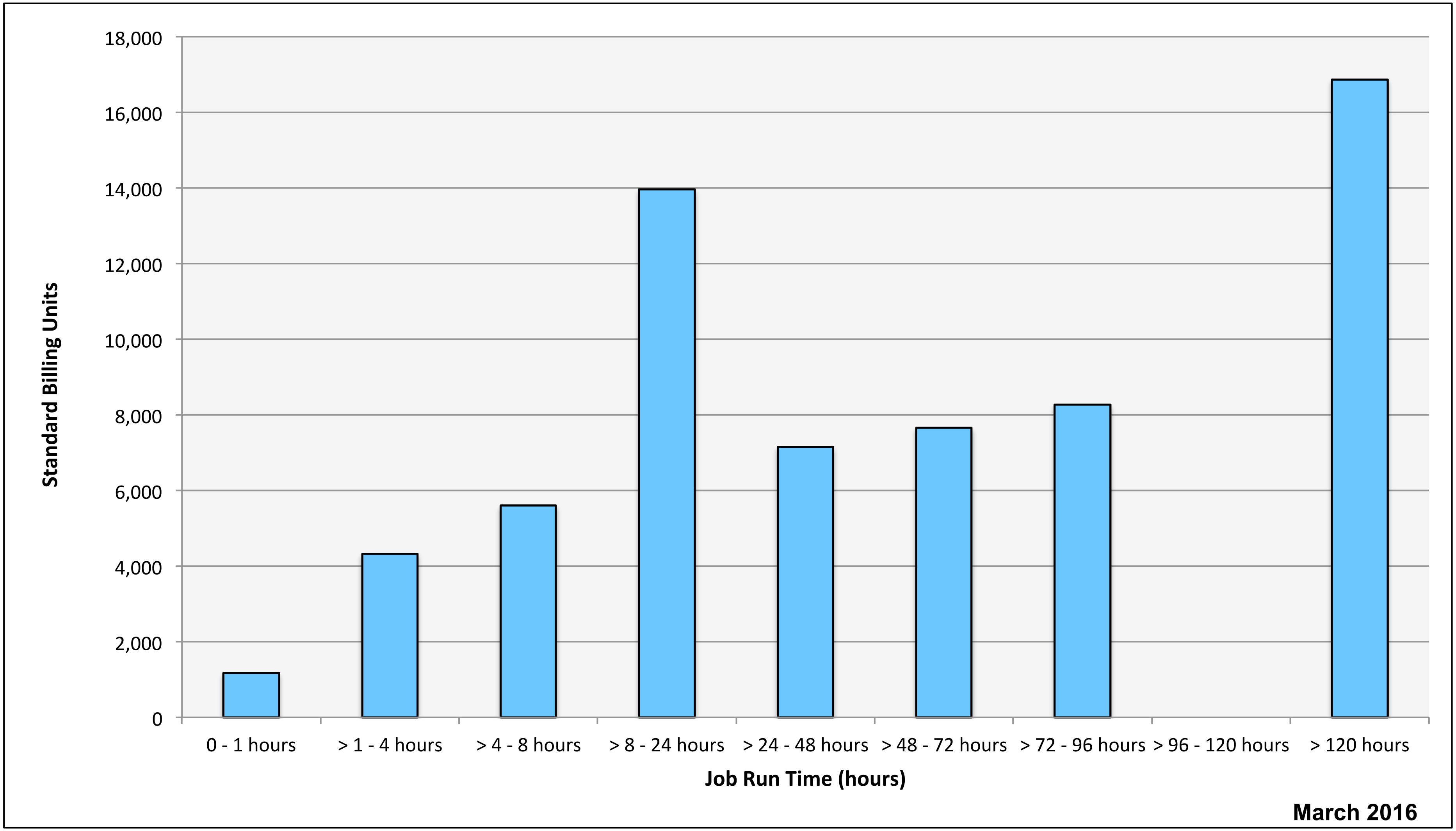
Pleiades:
Average Expansion Factor



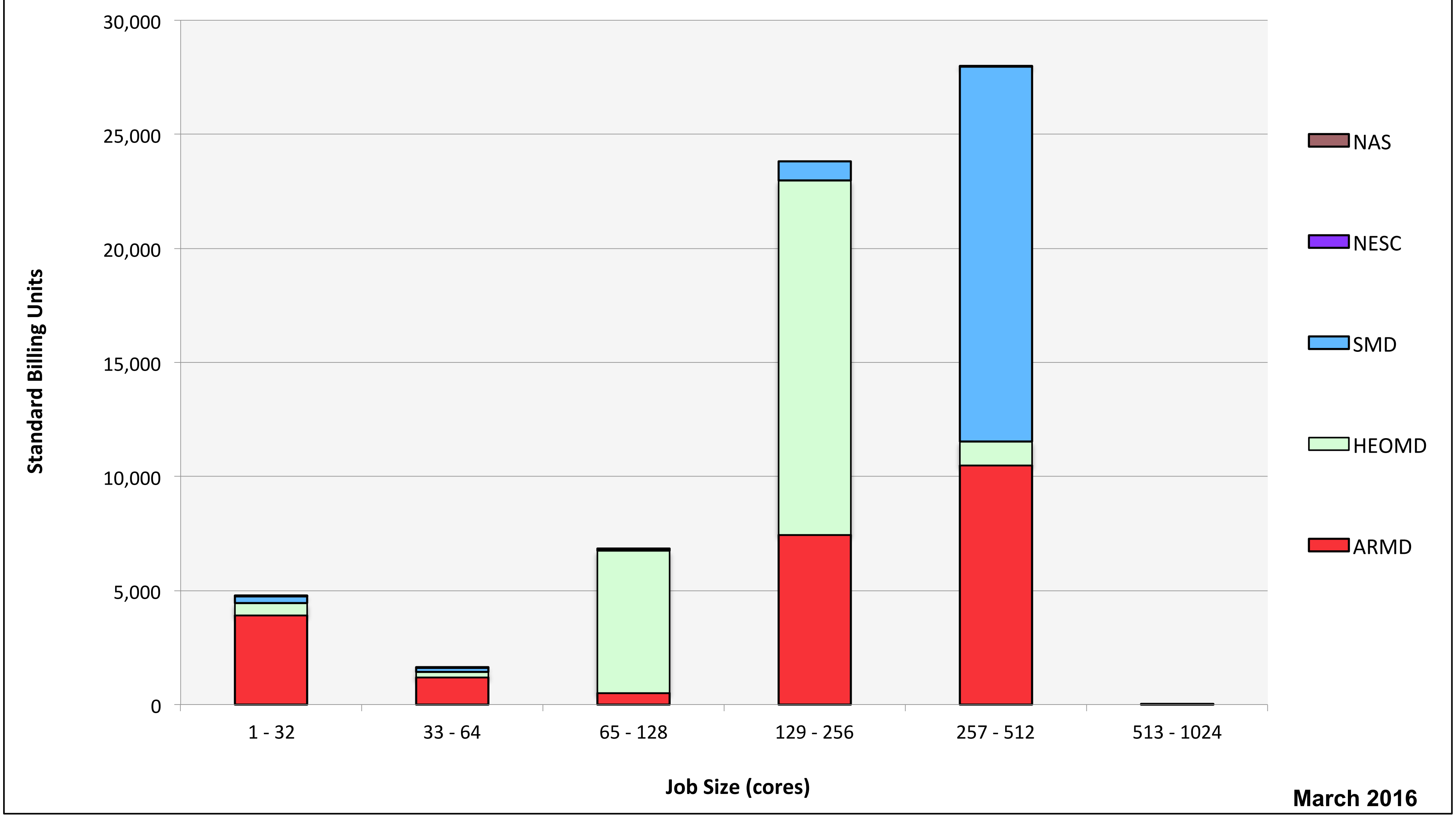
Endeavour:
SBUs Reported, Normalized to 30-Day Month



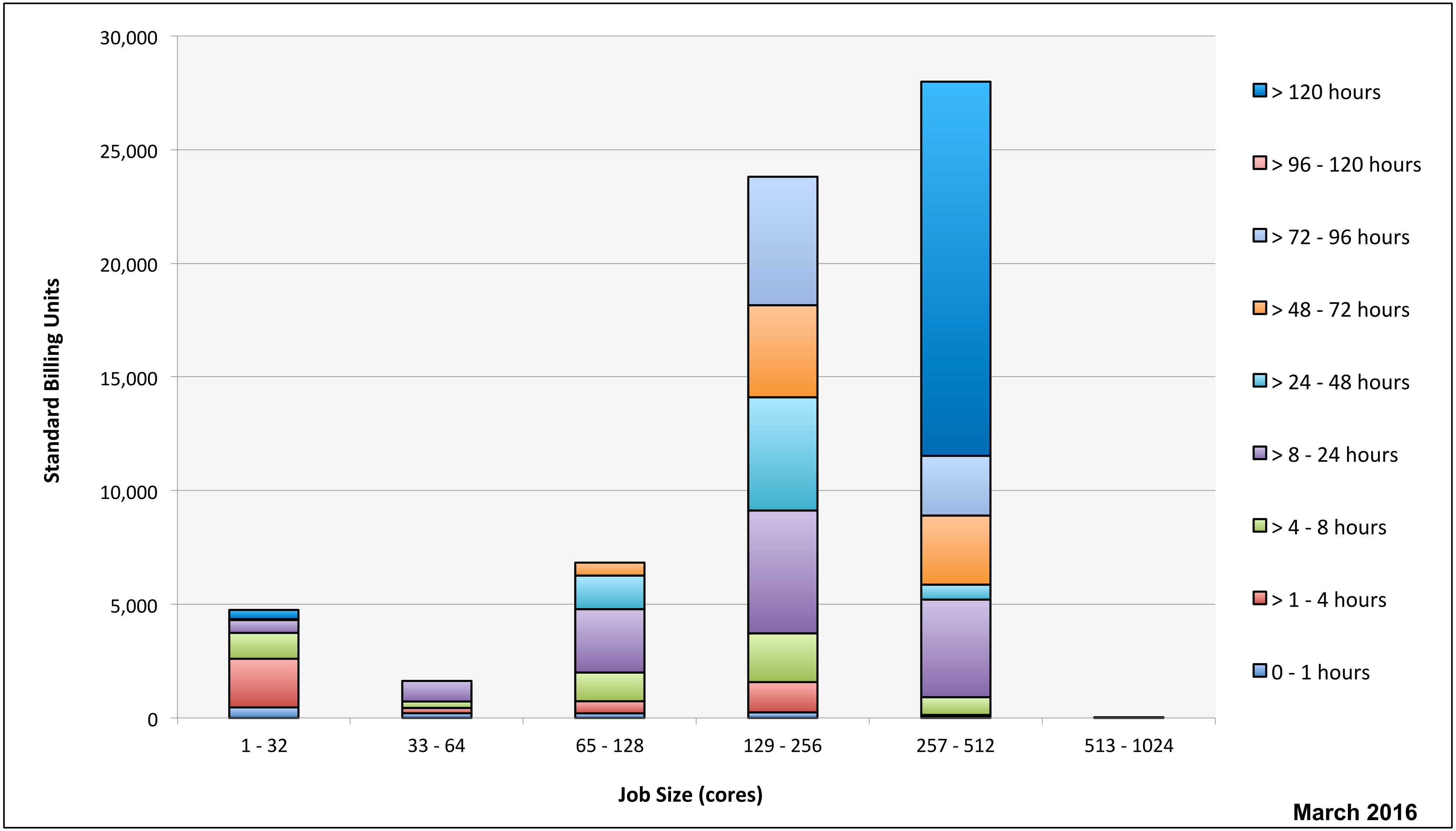
Endeavour:
Monthly Utilization by Job Length



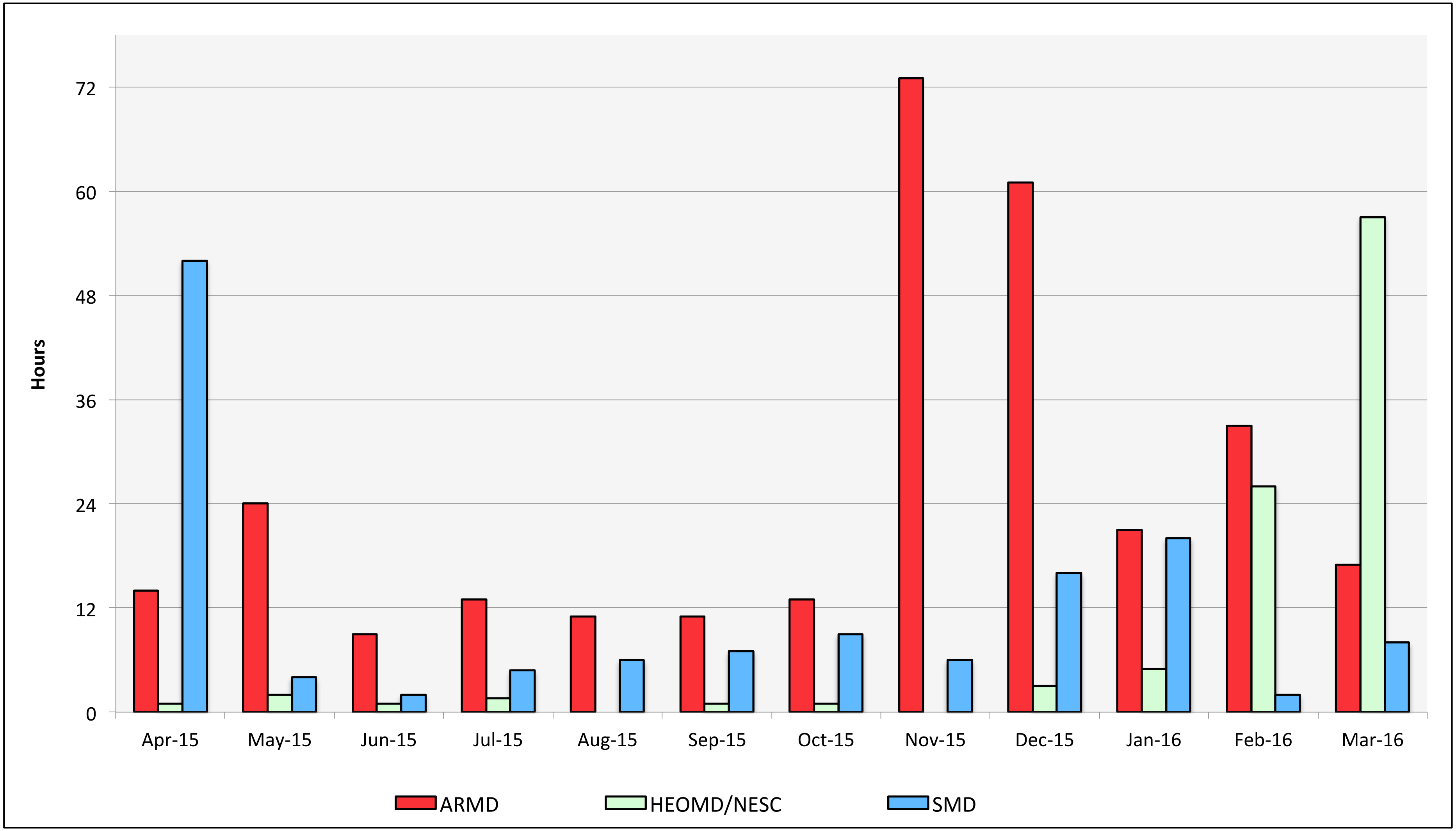
Endeavour: Monthly Utilization by Size and Mission



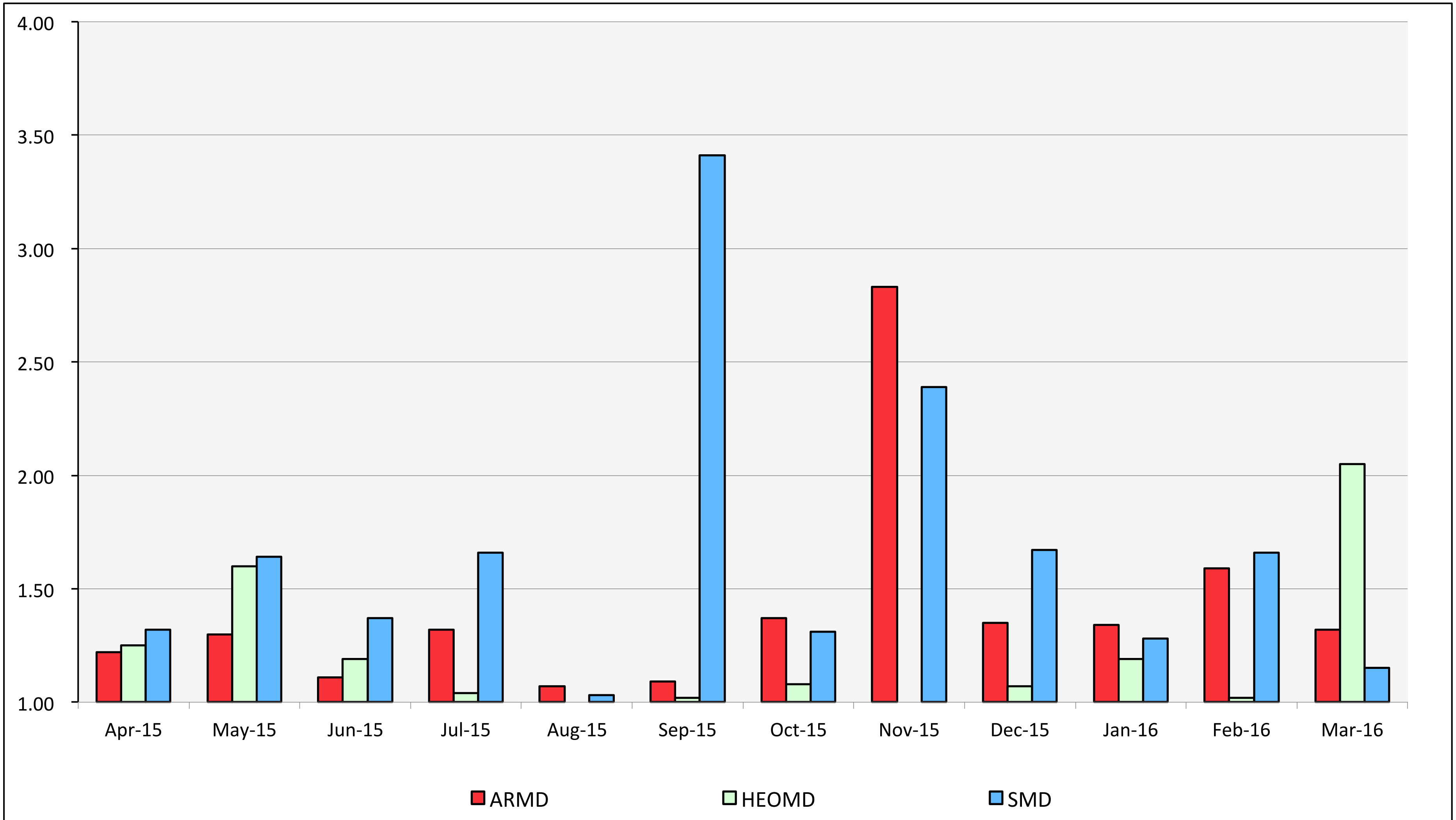
Endeavour: Monthly Utilization by Size and Length



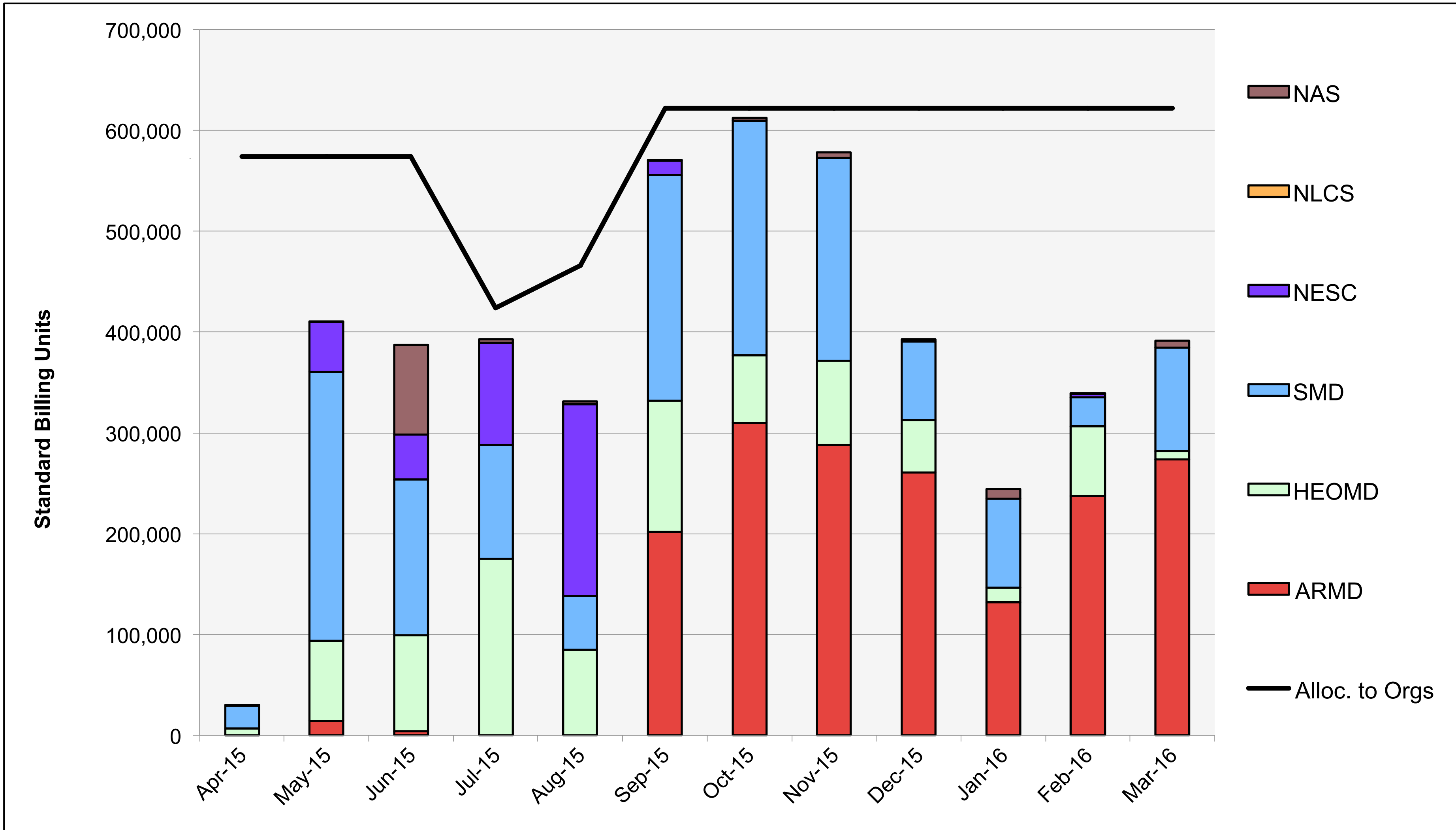
Endeavour: Average Time to Clear All Jobs



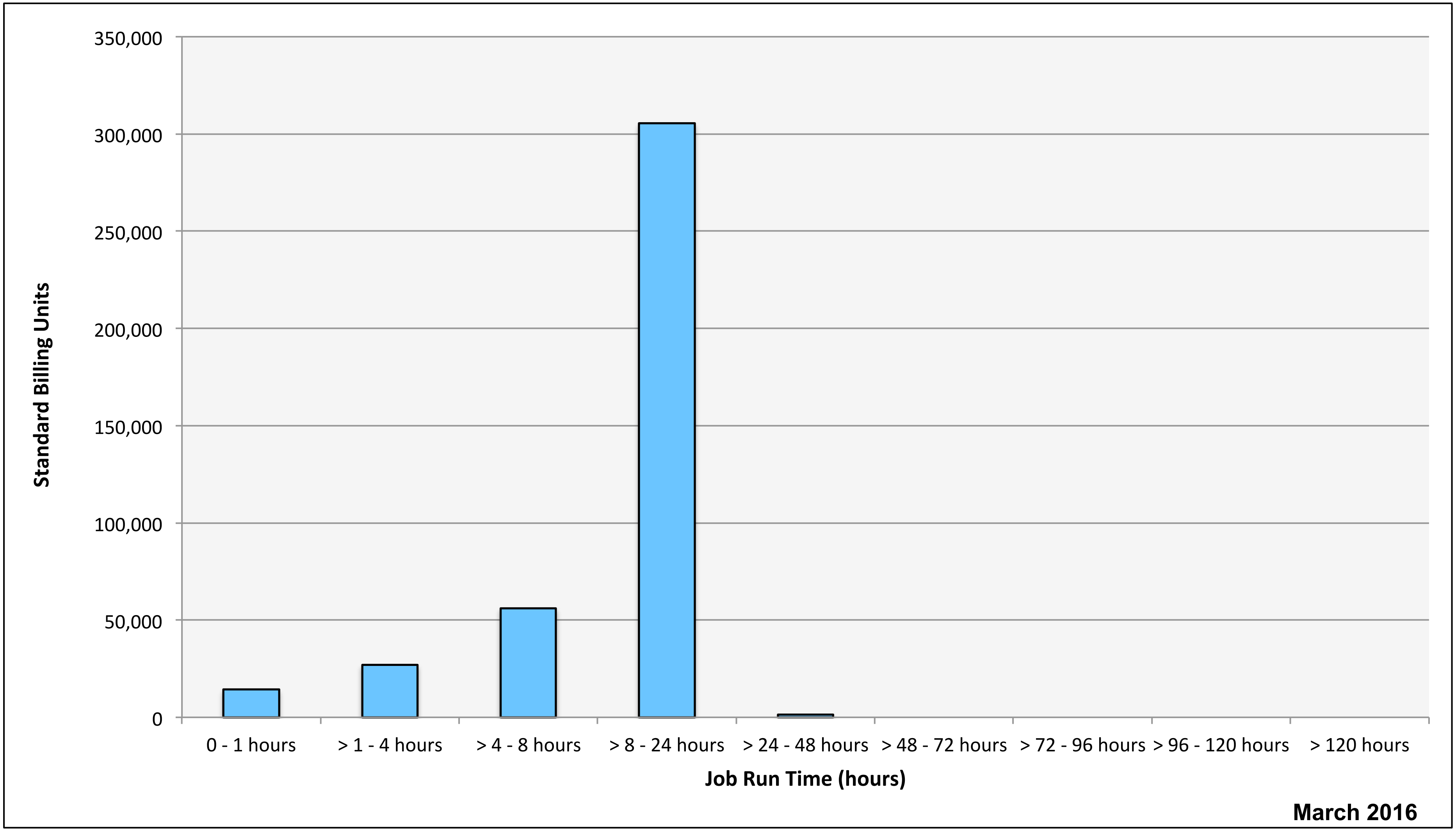
Endeavour:
Average Expansion Factor



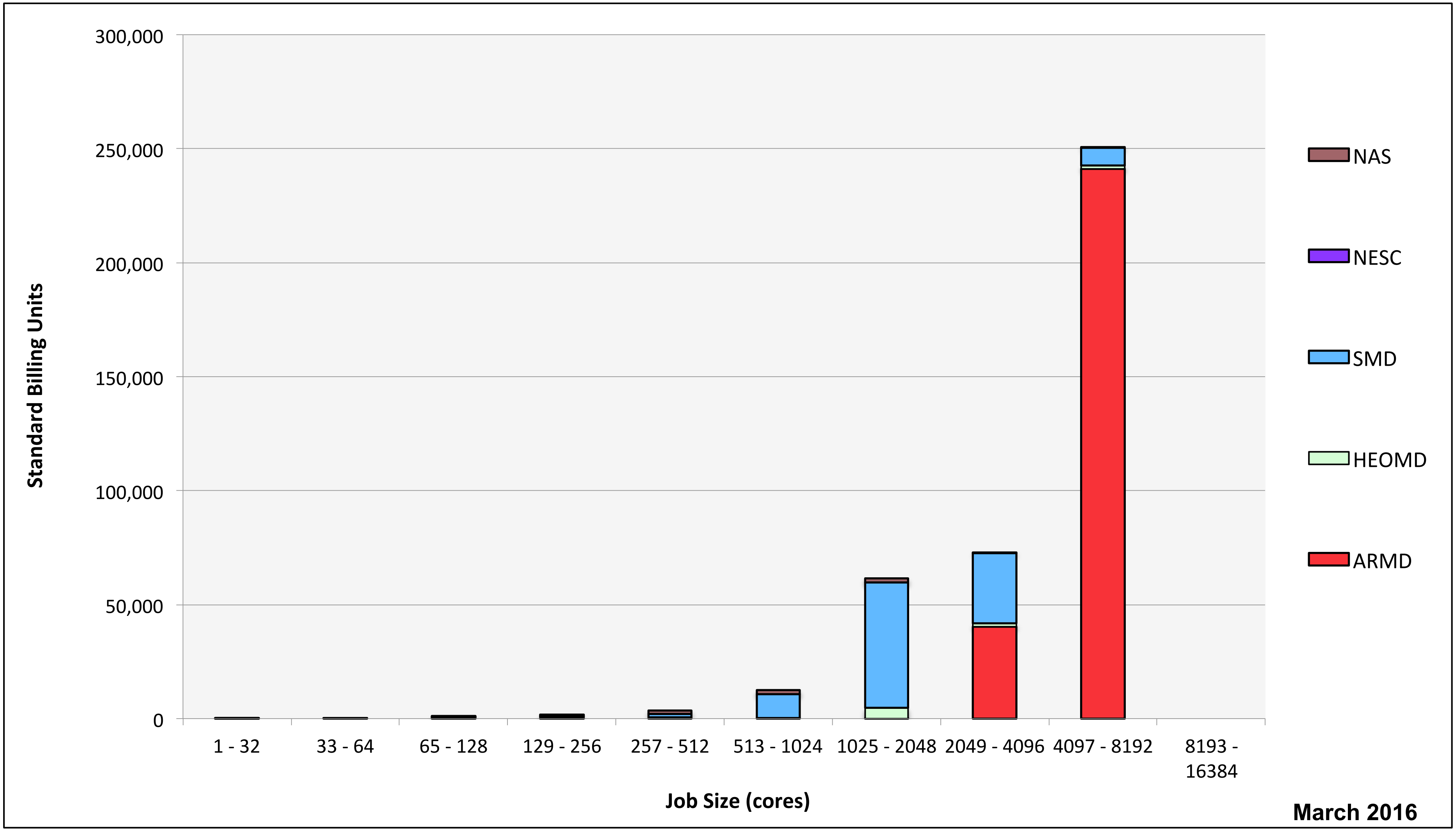
Merope:
SBUs Reported, Normalized to 30-Day Month



Merope:
Monthly Utilization by Job Length



Merope:
Monthly Utilization by Size and Mission



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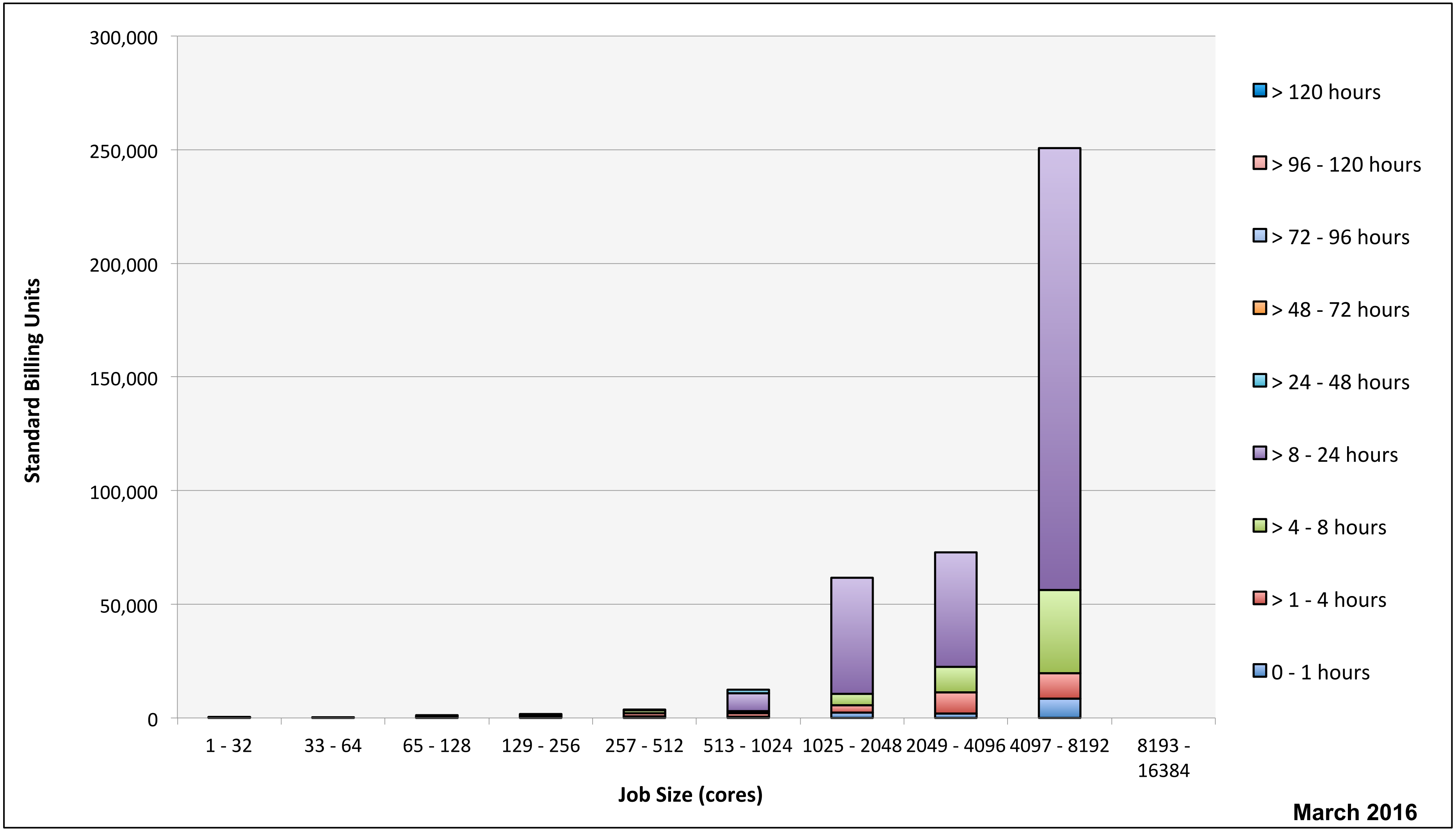

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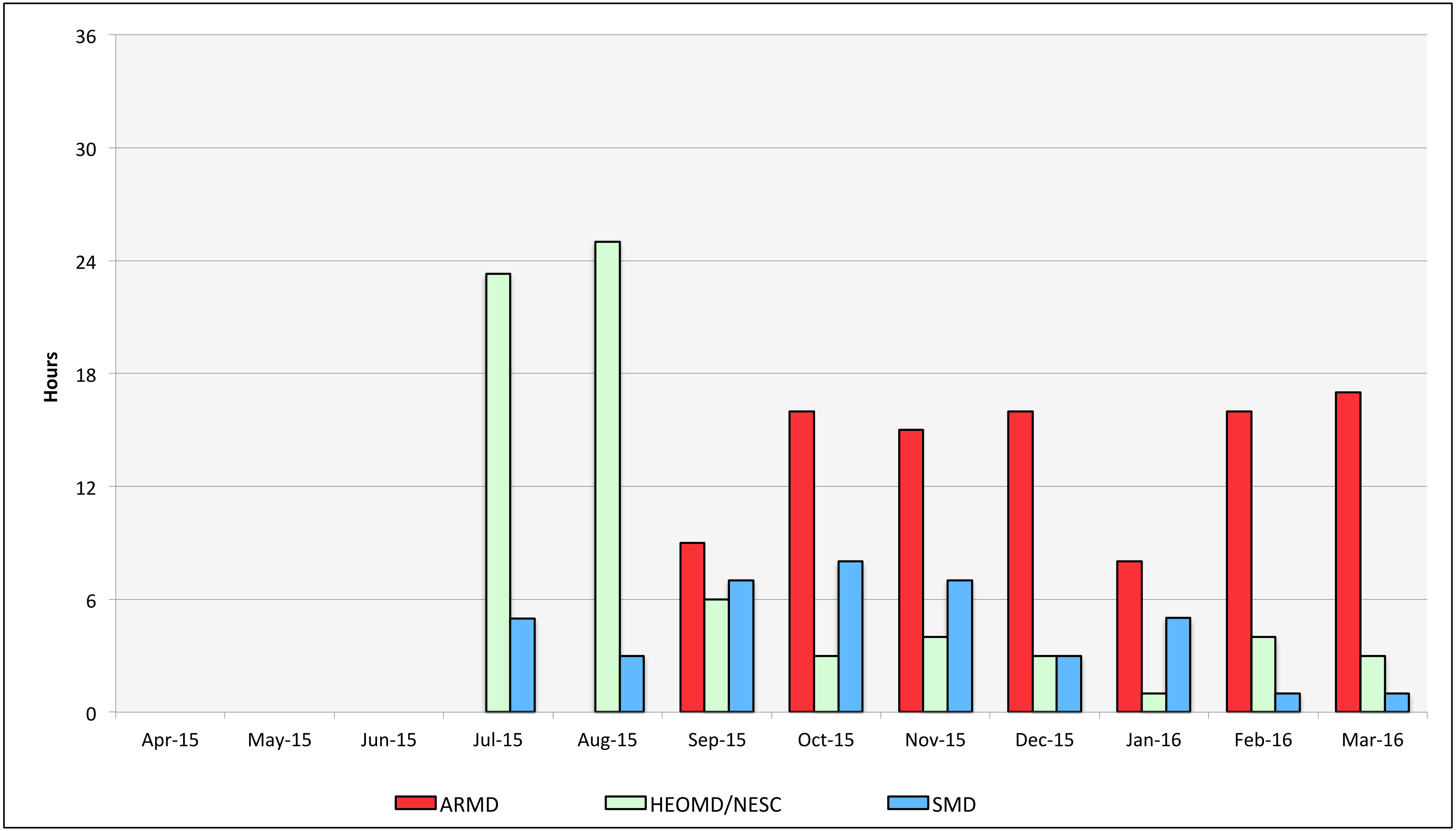

Merope:
Average Expansion Factor