Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

December 10, 2016

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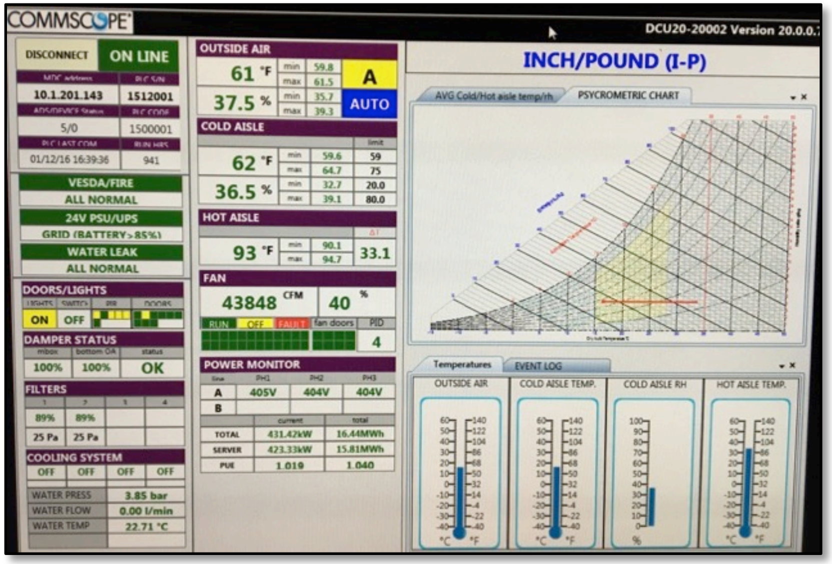
Modular Supercomputing Facility on Schedule to Go Into Production in December

- HECC facilities engineers continued efforts in November to prepare the Modular Supercomputing Facility (MSF) for production. Accomplishments include:
  - Characterized the MSF HVAC system for temperature, pressure, and power draw to work toward the optimal performance parameters.
  - Improved hot aisle/cold aisle air flow containment beyond the as-delivered design from SGI/ CommScope, eliminating compute rack hot exhaust air leaks into the cold aisle. The improvement reduced power required for cooling the MSF compute racks by 45% over the initial system setup — from 15 kilowatts (kW) to 8 kW.
  - Reduced the power usage effectiveness (PUE) to 1.02 (with a typical 360 kW compute load).
- The Facilities team will continue working with SGI/CommScope, along with HECC systems engineers and applications performance specialists to bring the MSF into full production in late December. In addition, we have begun preparations for adding a second DCU-20 module to the MSF.

Mission Impact: The MSF provides a more efficient way of providing supercomputing resources to NASA scientists, paving the way for reduced power/cooling overhead to run future HECC supercomputers and associated hardware.



Screenshot of the Modular Supercomputing Facility operations display under a typical load. By engineering and tuning the module, HECC has reduced the power usage effectiveness (PUE) to 1.02 (bottom of the middle section of the display).

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

HECC Staff Steer Agency's 29th Exhibit at Annual Supercomputing Conference

- A team from the HECC Project coordinated NASA's presence at SC16, the 29th annual Supercomputing Conference, held November 14–18 in Salt Lake City, Utah.
- Users from 5 NASA locations, along with university and corporate collaborators, presented results of 40 science and engineering projects enabled by Pleiades and Discover and supported by HECC & NCCS visualization, optimization, and network experts.
- Featured demos highlighted for media and attendees included:
  - Complex CFD simulations to study the causes of dynamic stall during rotorcraft flight to improve efficiency and safety.
  - A global simulation of meteorology and atmospheric chemistry that captures shifting patterns of ozone and other chemical compounds.
  - Revolutionary modeling and simulation techniques for design of complex planetary entry missions for next-generation spacecraft.
  - Global 3D models and high-resolution scientific visualization of the sun's magnetic field to predict the effects of space weather.
- A wide array of intricate images and movies of science and engineering simulations, many created by HECC visualization experts (see slide 4), were shown on the HECC 10- x 6-foot hyperwall.
- Pleiades now ranks 9th worldwide (5th in the US) on the High Performance Conjugate Gradient (HPCG) Benchmark list. On the TOP500 list Pleiades ranks 13th worldwide (6th in the US), Electra ranks 96th worldwide (39th in the US), and Discover ranks 117th worldwide (47th in the US).

Visit the NASA@SC16 website at: www.nas.nasa.gov/SC16

Mission Impact: SC16 provided a platform to share technical accomplishments with the public directly. The information produced here also provides material for other outreach activities throughout the year.

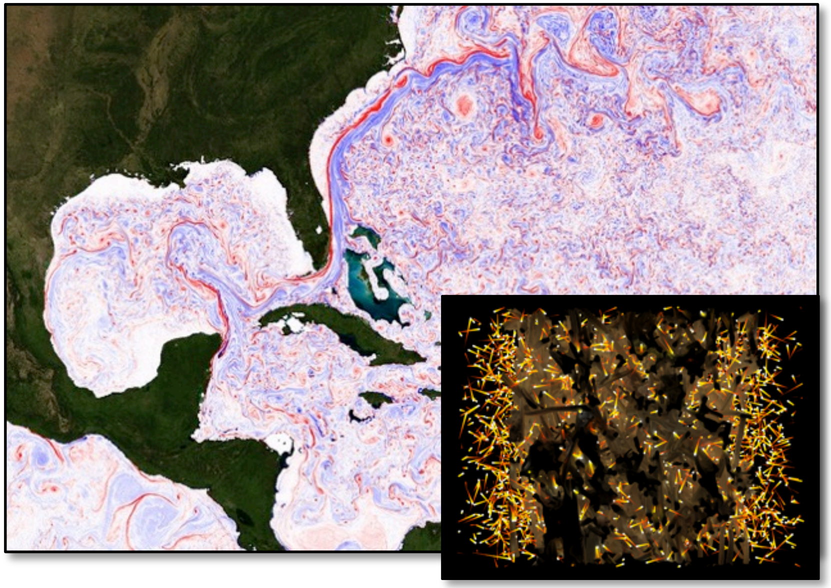
A group of students posing for one of many photo ops taken in the 30-ft. x 40-ft. NASA booth at the SC16 conference in Salt Lake City. The booth was designed and supported by HECC staff to highlight the critical role of supercomputing in science and engineering projects across the agency. Inset: HECC user Andrey Stejko explains details in his simulations of solar magnetic fields.

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

HECC Visualization Team Showcases NASA Science, Engineering at SC16

- The HECC Visualization team produced and showed detailed animations on the mini-hyperwall at SC16 (see slide 3) to support all NASA mission directorates. Example animations included rotorcraft blade vortex interaction, SLS/SRB booster separation, global ocean circulation, stellar magnetic fields, and heatshield material properties.
- The SLS/SRB animation was made from a 200-terabyte dataset involving a time-accurate, moving-grid simulation of the SRB boosters moving away from the SLS over 1.5 seconds of real time. Seeding and advecting particles through the complex moving grid system required advances to the Vis group's codebase and required hundreds of hours of computational time.
- At 245 million cells, a single layer of Estimating the Circulation and Climate of the Ocean (ECCO) project data is too large for any conventional animation. However, HECC visualization specialists provided a moving window at roughly 9 times high-definition resolution (the full size of the mini-hyperwall) to show surface vorticity across a diverse set of interesting locales across the globe (see larger image).
- The Vis team also provided an intuitive feel to the motion of argon gas molecules through carbon-fiber heat shield material by using the particle histories as light sources in the darkened material (see inset). These molecular collisions are one method of heat transfer, and although the number of particles shown is quite modest, the scientists liked the way both individual reflections and overall activity could be seen.

Mission Impact: Bringing NASA research scientists' complex results achieved to the public serves NASA's outreach goals, foments partnerships, and helps to inspire the next generation of scientists.



Detail of ocean surface vorticity in the Gulf of Mexico and surrounding regions from a global 1-kilometer MITgcm simulation, from the Estimating the Circulation and Climate of the Ocean (ECCO) project; *Christopher Henze, NASA/Ames.* Inset: Pathways of argon through a sample rendering of virgin FiberForm heatshield material acquired using X-ray microtomography; *Tim Sandstrom, Arnaud Borner, NASA/Ames*.

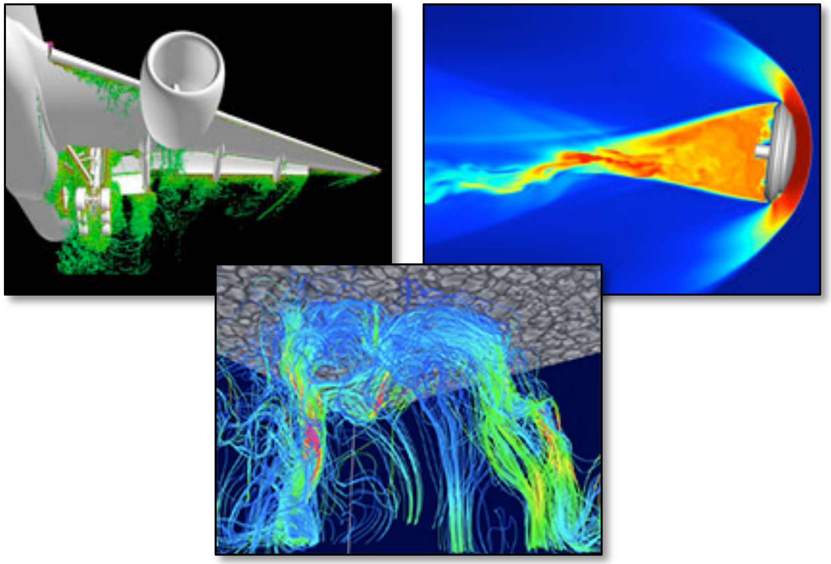
***POC**:* Tim Sandstrom, tim.sandstrom@nasa.gov, (650) 604-1429, NASA Advanced Supercomputing Division, CSRA LLC

November 2016 Usage on Pleiades Sets New 30-Day Record of 20.669 Million SBUs

- November usage on the Pleiades supercomputer set a new normalized (30-day-month) record.
- Just under 20.669 million Standard Billing Units (SBUs*) were used by NASA's science and engineering organizations, exceeding the previous normalized record of 20.3 million SBUs set in September 2016.
- This increase was enabled by high demand, system stability, and efficient operations that delivered system utilization of almost 90% (where 75% utilization is the target).
- About 345 projects from all across NASA used time on Pleiades during November.
- The top 10 projects used from 405,149 to 2,592,604 SBUs each and together accounted for over 47% 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.



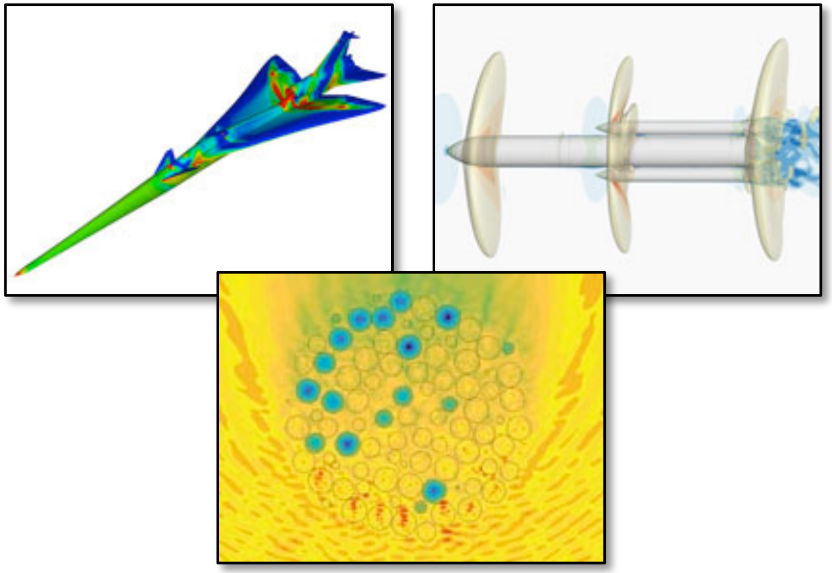
Images representing projects on Pleiades from different Mission Directorates. Clockwise from top left: Simulation of a large civil aircraft in landing configuration, including the main landing gear, *B. Koenig, Exa Corporation.* A visualization of the temperature around a free-flying model tested in the NASA Ames Ballistic Range, *M. Wright, NASA/Ames.* Simulation of a magnetic loop emerging through the solar surface, *R. Stein, Michigan State University, A. Nordlund, Niels Bohr Institute.*

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

New Allocation Period for Supercomputer Time Begins for NASA Mission Directorates

- The new allocation period for all of NASA's mission directorates began November 1.
- The mission directorates awarded about 310 million SBUs* of supercomputer time on HECC systems to over 600 projects.
- The Science Mission Directorate led the way and awarded almost 155 million SBUs to about 425 projects.
- The Aeronautics Research Mission Directorate awarded over 80 million SBUs to 120 projects.
- The Human Exploration and Operations Mission Directorate awarded about 75 million SBUs to 58 projects.
- Recent expansions to Pleiades (including the ARMD purchase) enabled the mission directorates to award 23% more time than for FY2016.

Mission Impact: NASA programs and projects periodically review the distribution of supercomputer time to assess the demand for resources and assure consistency with mission-specific goals and objectives.



Images of ARMD, HEOMD, and SMD projects supported by HECC resources. Clockwise from top left: Visualization of the pressure field over the Low Boom Flight Demonstrator, *James Jensen, NASA/Ames.* Mach contours on the symmetry plane of the Space Launch System cargo configuration, *Craig Streett, NASA/Langley*. Visualization of the magnitude of the modeled electric field within a cluster of silica glass and iron particles, *Carey Legett, Stony Brook University*.

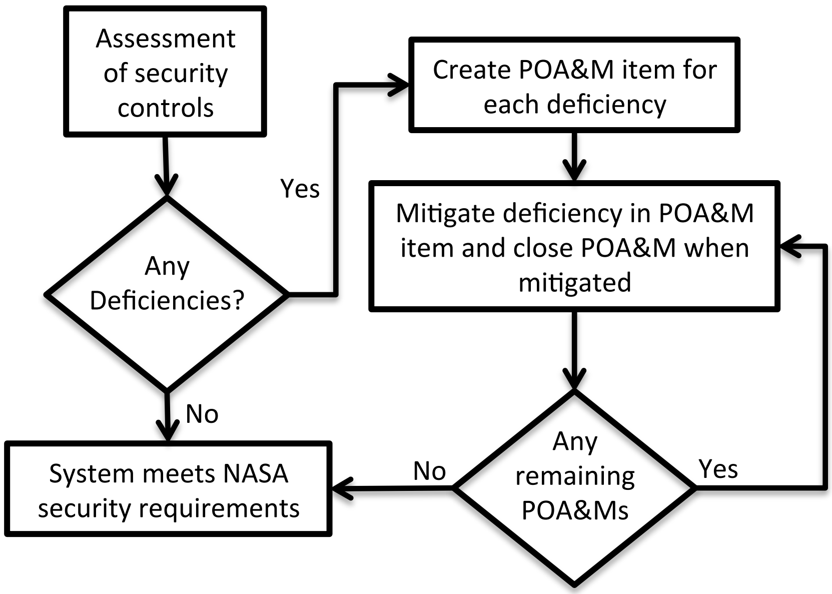
POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

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

Security Team Resolves All Plan of Action & Milestone Items from Last Security Assessment

- Plan of Action & Milestones (POA&Ms) are deficiencies identified during the annual security assessment of HECC/NAS systems.
- The last NASA Ames security assessment that resulted in a signed authorization to operate (ATO) on 1/22/2016, resulted in 9 POA&Ms.
- The following summarizes actions taken to fix the deficiencies identified in the POA&Ms:
  - Updated documents, including a memo of agreement, the NAS Acceptable Use Statement to address social networking, and the group account policy.
  - Added missing implementation detail to the security plan for one NIST SP 800-53 Rev 4 control, as well as some missing projects with unique requirements for two other controls.
  - Developed a system patching schedule and applied an improved patch management system to ensure that patches are expeditiously installed.
  - Clarified the account management approach on a small demo system.
- Fixing these POA&M items ensures that the NAS facility maintains its ATO.

Mission Impact: Closing out Plan Of Action and Milestone items ensures that HECC computer systems continue to maintain current security and privacy controls required for federal information systems and organizations.



This diagram shows the process by which a Plan of Action and Milestone items are created and closed.

POC: Thomas Hinke, thomas.h.hinke@nasa.gov, (650) 279-4053, NASA Advanced Supercomputing Division

ESS Team Continues Ongoing Support for HECC Infrastructure Operations

- HECC's Engineering Servers and Services (ESS) team continued its ongoing support of over 500 servers and user systems and is making strides in the following areas:
  - Patches and Vulnerability Scans: ESS recently resolved the last overdue vulnerability identified in the weekly Nessus scans from the HECC/ NAS Security team. No overdue patches or vulnerabilities exist at this time.
  - Red Hat 7 Upgrades: ESS finalized the Red Hat 7 workstation build, received an approved scan of the build, and will be starting the upgrade of the 100-plus user Linux workstations. The upgrade of ~200 servers is already underway.
  - MacOS 10.12 Sierra: The team is developing the NAS image for Sierra. This work includes verification of scientific, administration, and user applications on Sierra; lockdown of the system based on the recently released 10.12 CIS benchmarks; approval of security scans; definition of the upgrade process; and approvals for the deployment of MacOS 10.12 to ~200 Macs at the NAS facility.

Mission Impact: System security is critical to successful operations of the HECC systems, and ongoing patching and upgrades provided by the Engineering Servers and Services team are key components of ensuring system security.

The HECC upgrade of 200 Red Hat servers is underway. Monthly and critical patching keeps all systems secured and up to date.

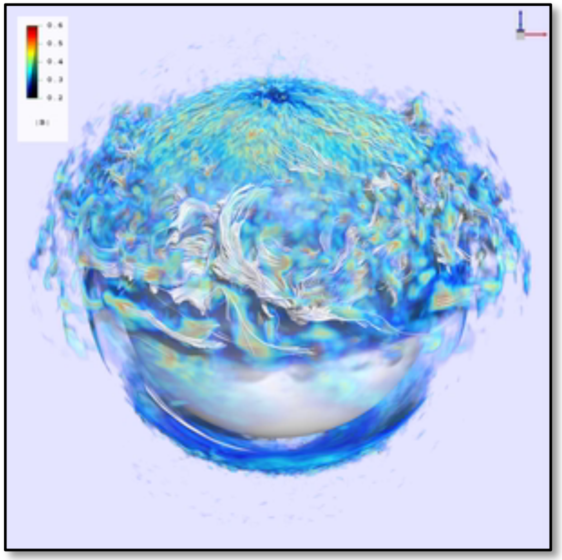
POC: Robert Shaw, robert.c.shaw@nasa.gov, (650) 604-4354, NASA Supercomputing Division, CSRA LLC

Exploring the Sun Through High-Resolution Modeling *

- Physicists at the New Jersey Institute of Technology (NJIT), working with HECC data analysis and visualization experts, are gaining new insight into solar phenomena.
- The NJIT team uses cutting-edge, global 3D models to solve computations for the mass flows of plasma in and around the sun's convection zone, where most of the turbulent motion and flow occurs.
  - Models employ an ideal magnetohydrodynamic theory algorithm with dynamo action to create a naturally developing magnetic field that interacts with charged plasma and sustains a global magnetic field with dynamo action.
  - The team tracks the evolution of their models and compares the cyclical patterns of solar activity with data collected from NASA's Solar Dynamics Observatory.
  - Current models can accurately simulate the natural development of a solar cycle that corresponds to real-time periods of solar activity, as well as patterns of magnetic field distribution.
- The HECC Visualization team uses simulation results to create striking, high-resolution videos and images that give a more detailed look at how turbulence inside the sun can create magnetic structures at the bottom of the convection zone.
- To simulate the motion of plasma on the sun, the NJIT team ran their complex fluid advection algorithm and simulations on 128–512 processor-cores on Pleiades, which would take years on regular computers.

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

Mission Impact: The Pleiades supercomputer and HECC's data analysis and visualization experts are helping scientists visualize complicated solar phenomena, gain insight of the underlying physics and help improve the understanding of solar phenomena.



Video of the magnitude of the magnetic field on the sun, with magnetic field lines drawn in based on continuous magnetic field strength. The evolution is over the course of five months and shows how a large portion of the magnetic field is stored at the transition layer between zones on the sun at about 70% of the solar radius, and how it emerges in twisted wreath structures onto the surface. *Timothy Sandstrom/NASA Ames.*

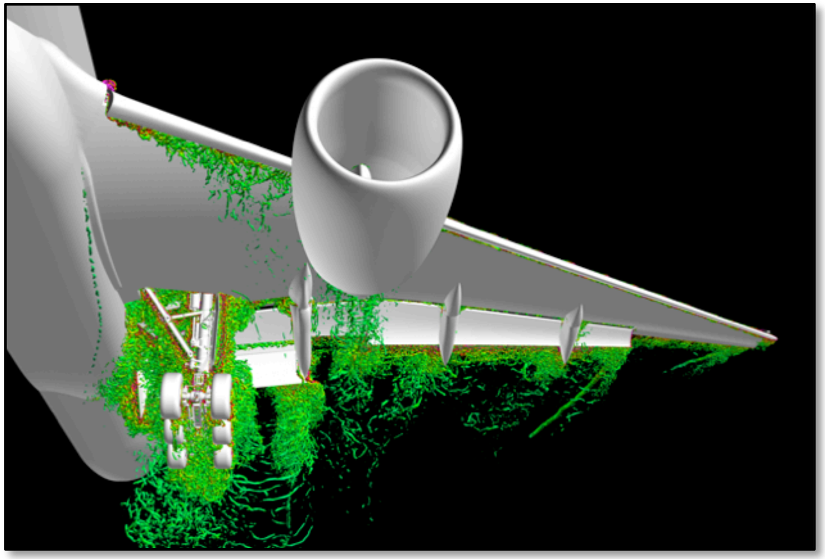
POC: Andrey Stejko, astejko1@ithaca.edu, New Jersey Institute of Technology

Toward Quieter Skies: New Tools to Predict and Mitigate Airframe Noise *

- Researchers at NASA Langley are performing simulations on Pleiades to study airframe-generated noise, a primary source of aircraft noise during approach and landing.
- The team simulated airflow over a high-fidelity, 26%-scale model of the Boeing 777 aircraft main landing gear, both in isolation and as installed on a semi-span model of the airplane in landing configuration.
  - The simulations accurately predicted, for the first time, the noise generated by the main landing gear of a large civil transport with all of its extreme geometrical complexities included.
  - After capturing the noise sources associated with the main gear components, the researchers evaluated the effectiveness of a toboggan-shaped noise reduction device installed on the gear model.
- Results showed that adding the toboggan device to the main landing gear reduced farfield sound pressure levels by 3–4 decibels over most of the frequency range.
- Further simulations of the 26%-scale, semi-span model will pave the way for simulating a full-scale, complete large civil aircraft in landing configuration.

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

Mission Impact: In support of the NASA Flight Demonstrations and Capabilities Project, these simulations performed on the Pleiades supercomputer will help the agency develop and mature technologies that will reduce civil aircraft noise footprints.



Visualization of an isosurface of the lambda-2 criterion, with vorticity magnitude color-mapped on the surface, based on a simulation of a large civil aircraft in landing configuration, including the main landing gear. *Patrick Moran, NASA/Ames.*

POC: Mehdi Khorrami, mehdi.r.khorrami@nasa.gov, (757) 864-3630, NASA Langley Research Center

HECC Facility Hosts Several Visitors and Tours in November 2016

- HECC hosted 8 tour groups in November; 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:
  - NASA Administrator Charles Bolden, visited Ames and held a Centerwide All Hands; as part of his center tour he requested a visit to the HECC Modular Supercomputer Facility.
  - A large group from: the California Air Resources Board’s Research Division leadership team; the U.S. Environmental Protection Agency (EPA) Region 9 (Pacific Southwest); and the EPA Office of Research and Development visited Ames and toured NAS to hear about the extensive atmospheric modeling done here.
  - The Ames Transiting Exoplanet Survey Satellite (TESS) team, TESS Manager Jeff Volosin from NASA Goddard, and Principal Investigator George Ricker from the Massachusetts Institute of Technology, met with HECC/NAS staff to discuss our capabilities.
  - Members of the California Science Center board of directors visited NAS as part of their Ames tour.

HECC Deputy Project Manager William Thigpen hosted a tour and briefing of the new Modular Supercomputing Facility for NASA Administrator Charles Bolden on November 28, 2016.

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

Papers

- "**FIRE in the Field: Simulating the Threshold of Galaxy Formation**," A. Fitts, et al., arXiv:1611.02281 [astro-ph.GA], November 7, 2016. *
  https://arxiv.org/abs/1611.02281
- "**Direct Numerical Simulation of a High-Pressure Turbulent Reacting Temporal Mixing Layer**," J. Bellan, Combustion and Flame, vol. 176, November 12, 2016. *
  http://www.sciencedirect.com/science/article/pii/S0010218016302966
- "**Investigating Seasonal Methane Emissions in Northern California Using Airborne Measurements and Inverse Modeling**," M. Johnson, et al., Journal of Geophysical Research: Atmospheres, November 18, 2016. *
  http://onlinelibrary.wiley.com/doi/10.1002/2016JD025157/full

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

Presentations

- **2016 Supercomputing Conference**, November 13–18, 2016, Salt Lake City, UT.
  - “**The Rewards of HPC: Experiments in Turbulence**,” G. Coleman. *
    https://www.nas.nasa.gov/SC16/demos/demo1.html
  - “**An Optimized Multicolor Point-Implicit Solver for Unstructured Grid Applications on GPUs**,” M. Zubair, E. Nielsen. *
    https://www.nas.nasa.gov/SC16/demos/demo2.html
  - “**Toward Quieter Skies: New Tools to Predict and Mitigate Airframe Noise**,” M. Khorrami. *
    https://www.nas.nasa.gov/SC16/demos/demo3.html
  - “**Advancing the Development of Hypersonic Transportation**,” R. Fièvet. *
    https://www.nas.nasa.gov/SC16/demos/demo4.html
  - “**Numerical Simulation of Aircraft Noise**,” C. Kiris. *
    https://www.nas.nasa.gov/SC16/demos/demo5.html
  - “**High-Fidelity Aeroelastic Simulations of Future Airplane Concepts**,” M. Denison. *
    https://www.nas.nasa.gov/SC16/demos/demo6.html
  - “**New Insights into Dynamic Stall for High Performance Helicopters**,” N. Chaderjian. *
    https://www.nas.nasa.gov/SC16/demos/demo7.html
  - “**Computational Aeroacoustics for Green Aviation Propulsion Technology**,” M. Barad. *
    https://www.nas.nasa.gov/SC16/demos/demo8.html
  - “**CFD Support for Quiet Supersonic Aircraft Design**,” J. Jensen. *
    https://www.nas.nasa.gov/SC16/demos/demo10.html
  - “**The Tempestuous Global Ocean Circulation**,” C. Hill. *
    https://www.nas.nasa.gov/SC16/demos/demo11.html

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

Presentations (cont.)

- **2016 Supercomputing Conference (cont.)**
  - "**Exploring the Sun through High-Resolution Modeling**," A. Stejko. *
    https://www.nas.nasa.gov/SC16/demos/demo12.html
  - "**From Tomography to Material Properties of Thermal Protection Systems**," F. Panerai, N. Mansour. *
    https://www.nas.nasa.gov/SC16/demos/demo13.html
  - "**Data-Constrained Simulation of Coronal Mass Ejection Propagation**," A. Savcheva. *
    https://www.nas.nasa.gov/SC16/demos/demo14.html
  - "**Simulating Solar Activity to Predict the Impact on Earth's Space Weather**," R. Stein. *
    https://www.nas.nasa.gov/SC16/demos/demo15.html
  - "**Modeling Nanoscale Light Scattering by the Lunar Regolith**," C. Legett. *
    https://www.nas.nasa.gov/SC16/demos/demo16.html
  - "**Improving Fidelity of Launch Vehicle Liftoff Acoustic Simulations**," P. Liever. *
    https://www.nas.nasa.gov/SC16/demos/demo17.html
  - "**Building CFD-Based Aerodynamic Databases for the Space Launch System**," H. Lee. *
    https://www.nas.nasa.gov/SC16/demos/demo18.html
  - "**Predictive Modeling for NASA Entry, Descent, and Landing Missions**," M. Wright. *
    https://www.nas.nasa.gov/SC16/demos/demo19.html
  - "**How NASA's Astronauts will Survive Earth Re-Entry from Deep Space**," R. McDaniel. *
    https://www.nas.nasa.gov/SC16/demos/demo20.html
  - "**NASA's High End Computing Capability: It's Electra-fying!**" W. Thigpen.
    https://www.nas.nasa.gov/SC16/demos/demo21.html

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

Presentations (cont.)

- **2016 Supercomputing Conference (cont.)**
  - “**Improving Productivity at NASA’s Largest Supercomputing Center**,” H. Jin. *https://www.nas.nasa.gov/SC16/demos/demo22.html*
  - “**Explorations at the Frontier of Quantum Computing**,” B. O’Gorman. * *https://www.nas.nasa.gov/SC16/demos/demo23.html*
  - “**Supporting Petabyte-Scale Science on the NASA Earth Exchange**,” S. Ganguly. * *https://www.nas.nasa.gov/SC16/demos/demo24.html*
  - “**Improving Prediction of Buffet Forces for Design of the Space Launch System**,” W. Jones. * *https://www.nas.nasa.gov/SC16/demos/demo25.html*
  - “**Highly Parallel Radiative Transfer in Stellar Simulations**,” A. Wray. * *https://www.nas.nasa.gov/SC16/demos/demo26.html*
- “**Methodology and Application of HPC I/O Characterization with MPIProf and IOT**,” S. Chang, H. Jin, J. Bauer, presented at the 5th Workshop on Extreme-Scale Programming Tools, Salt Lake City, UT, November 13–18, 2016. * *http://dl.acm.org/citation.cfm?id=3018824*
- “**Self-Healing Independent File Transfer**,” P. Kolano, presented at the SGI User Group Luncheon, Salt Lake City, UT, November 14, 2016.

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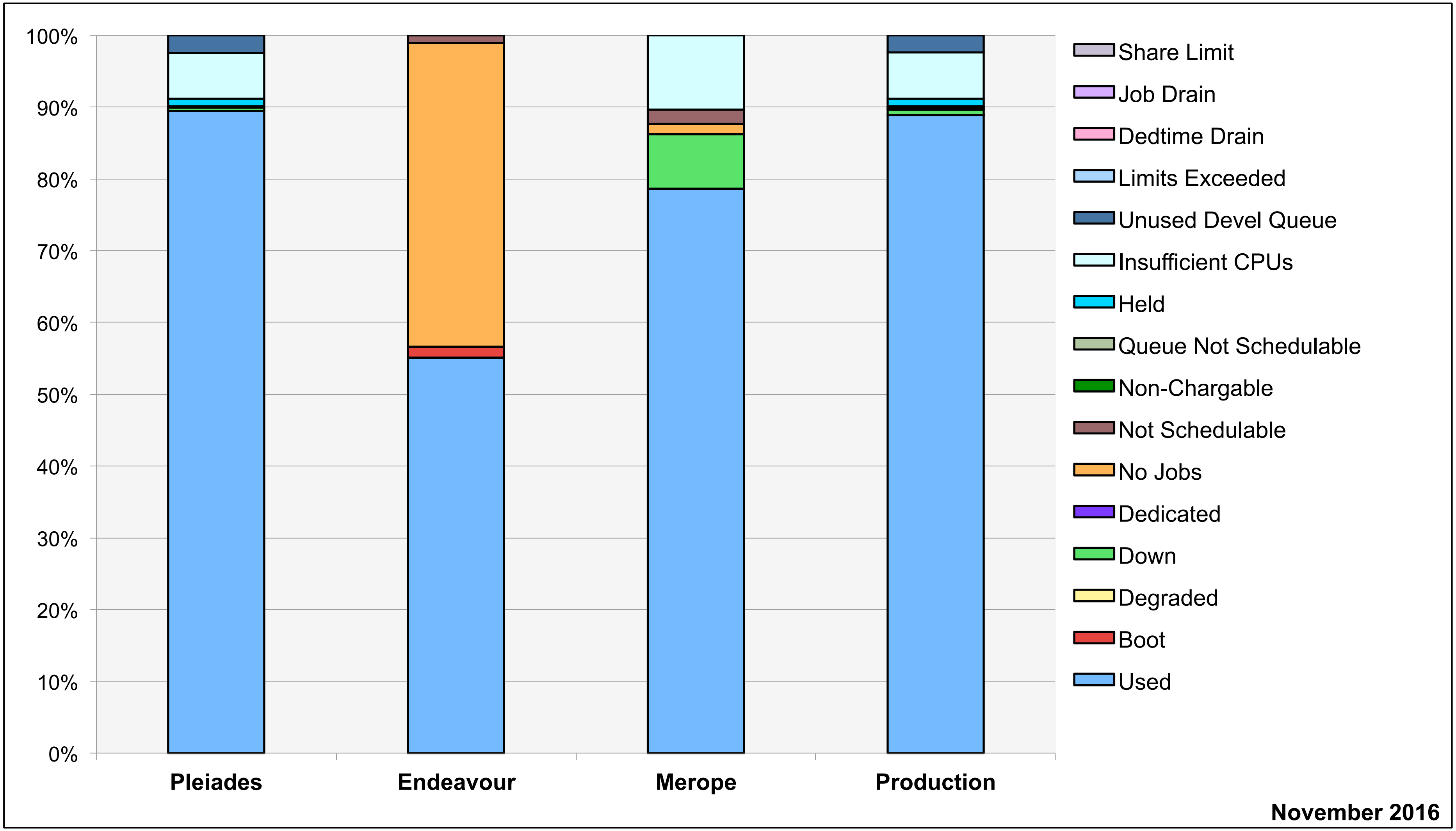
News & Events

- **Stuart Rogers: NASA In Silicon Valley Podcast**, *NASA Ames Podcast*, November 2, 2016—NASA Advanced Supercomputing Division aerospace engineer Stuart Rogers talks about the critical role in computational fluid dynamics and supercomputers in the agency's aeronautics and space exploration missions.
https://soundcloud.com/nasa/stuart-rogers-advanced-supercomputing?in=nasa/sets/nasa-in-silicon-valley
  - **Pegasus5 – NASA Software of the Year**, *NASA Ames YouTube Feature*, November 4, 2016.
  https://www.youtube.com/watch?v=vklMRx_T2BY
- **NASA Science and Technology Advancements Demonstrated at Supercomputing Conference**, *NASA Ames Feature Story*, November 10, 2016—Experts from NASA and across the U.S. presented their latest research results and supercomputing achievements at SC16, the international high-performance computing conference in Salt Lake City, Utah.
https://www.nasa.gov/ames/feature/NASA-Science-and-Technology-Advancements-Demonstrated-at-Supercomputing-Conference
  - **NASA Takes a Byte Out of Annual Supercomputing Conference**, *NASA Ames Press Release*, November 10, 2016.
  https://www.nasa.gov/ames/press-release/nasa-takes-byte-out-of-annual-supercomputing-conference
- **NASA Ames Research Center, "Pleiades," Supercomputer from SGI Ranks #13 on TOP500**, *SGI Blog*, November 14, 2016—At the 2016 International Conference for High Performance Computing, Networking, Storage, and Analysis (SC16) in Salt Lake City, UT, it was announced that Pleiades, housed by NASA, was ranked #13 on the TOP500 list.
http://blog.sgi.com/nasatop500/

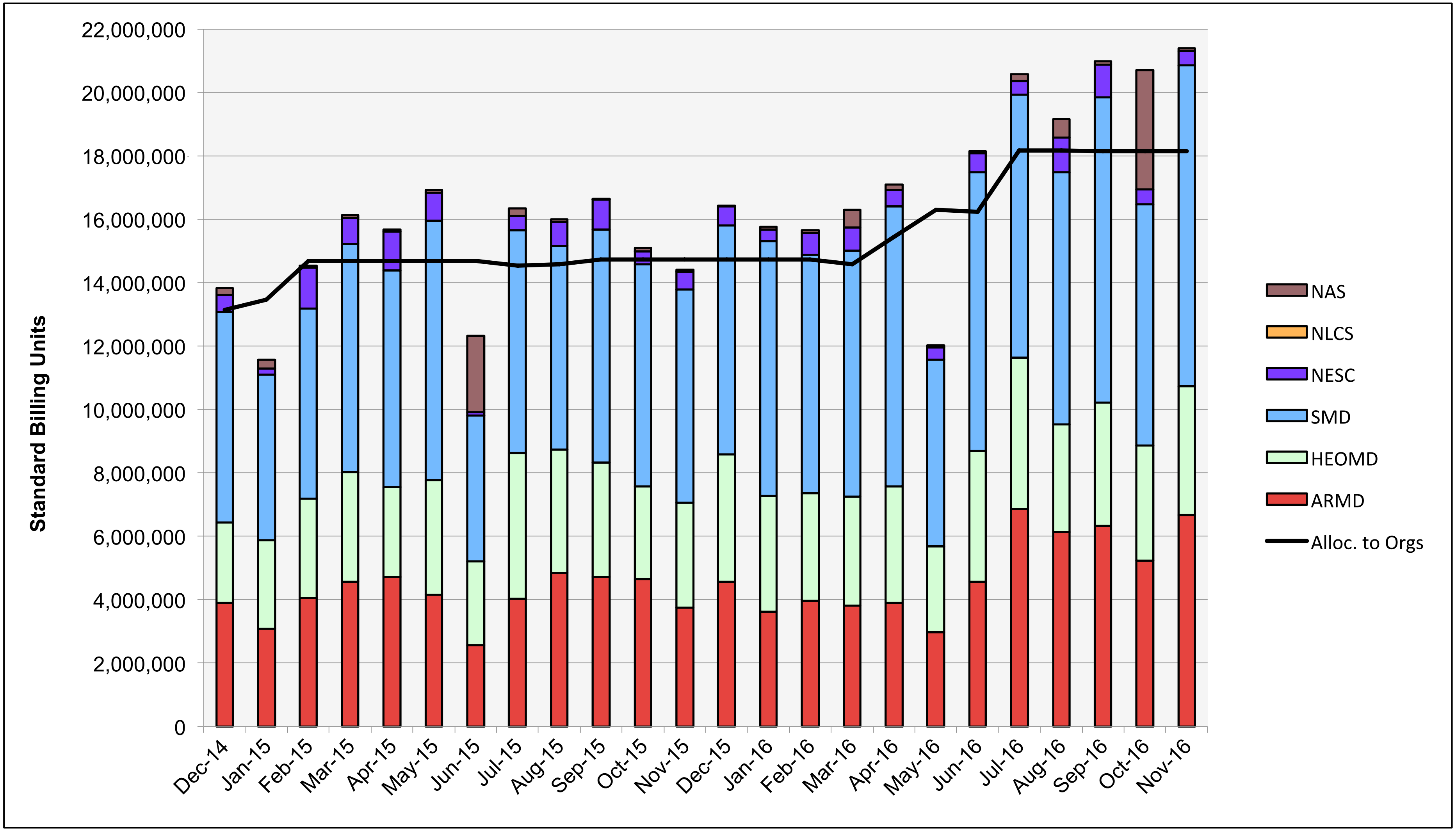
News & Events (cont.)

- **Predictive Modeling for NASA's Entry, Descent, and Landing Missions**, *NASA Ames Image Feature*, November 16, 2016—This visualization shows the temperature around a free-flying model that was tested in a ballistic range facility at NASA's Ames Research Center. The simulation was run on the Pleiades supercomputer. *https://www.nasa.gov/ames/image-feature/predictive-modeling-for-nasa-s-entry-descent-and-landing-missions*
  - **Predictive Modeling for NASA's Entry, Descent, and Landing Missions**, *Space Daily*, November 21, 2016. *http://www.spacedaily.com/reports/Predictive_Modeling_for_NASAs_Entry_Descent_and_Landing_Missions_999.html*
- **Taking a High-Res 3D Look at the Sun**, *New Jersey Institute of Technology Press Release,* November 16, 2016—Among the NJIT researchers at the forefront of studying the star closest to Earth is Andrey Stejko, a Ph.D. candidate in physics. His research, supported by NASA, is focused on using a combination of high-resolution 3D models, scientific visualization, and supercomputers to gain a deeper understanding of the Sun's magnetic field and the effects of space weather on our home planet. *http://www.njit.edu/news/2016/2016-354.php*
- **Meet Pleiades, NASA's Most Powerful Supercomputer**, *NASA Ames YouTube Feature*, November 23, 2016—The Pleiades supercomputer at NASA's Ames Research Center, recently named the 13th fastest computer in the world, provides scientists and researchers high-fidelity numerical modeling of complex systems and processes. *https://www.youtube.com/watch?v=YSiXrQKTNm4*

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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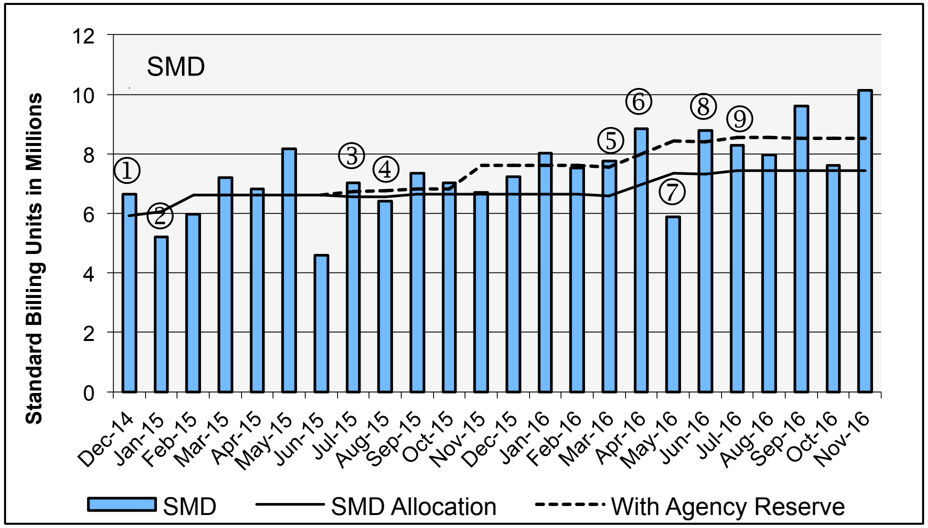
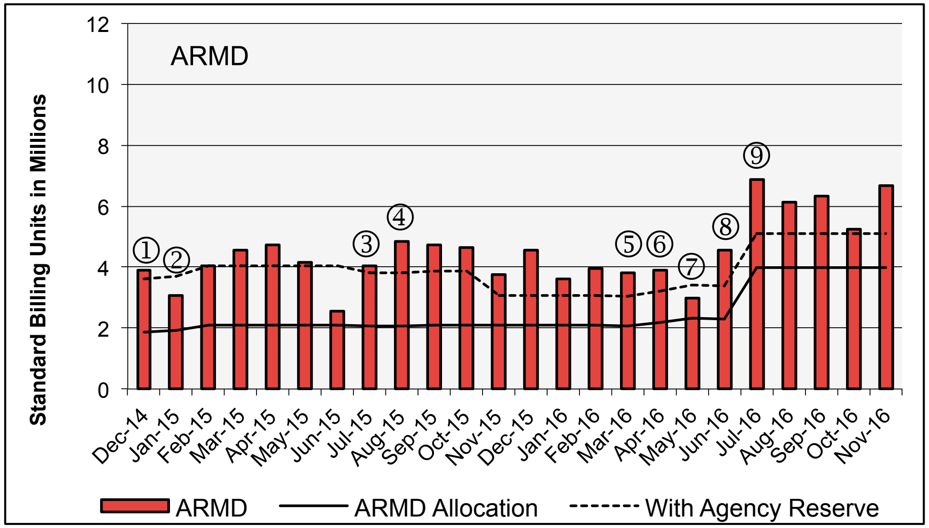
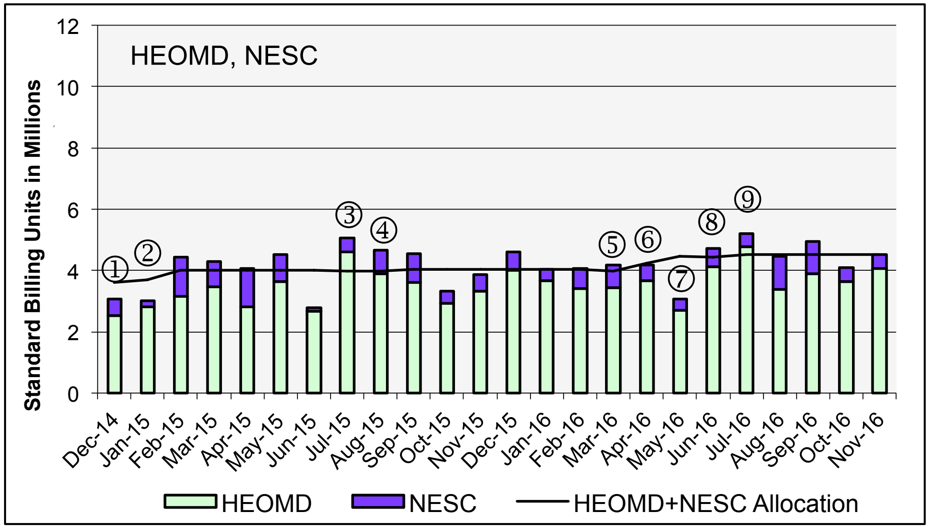
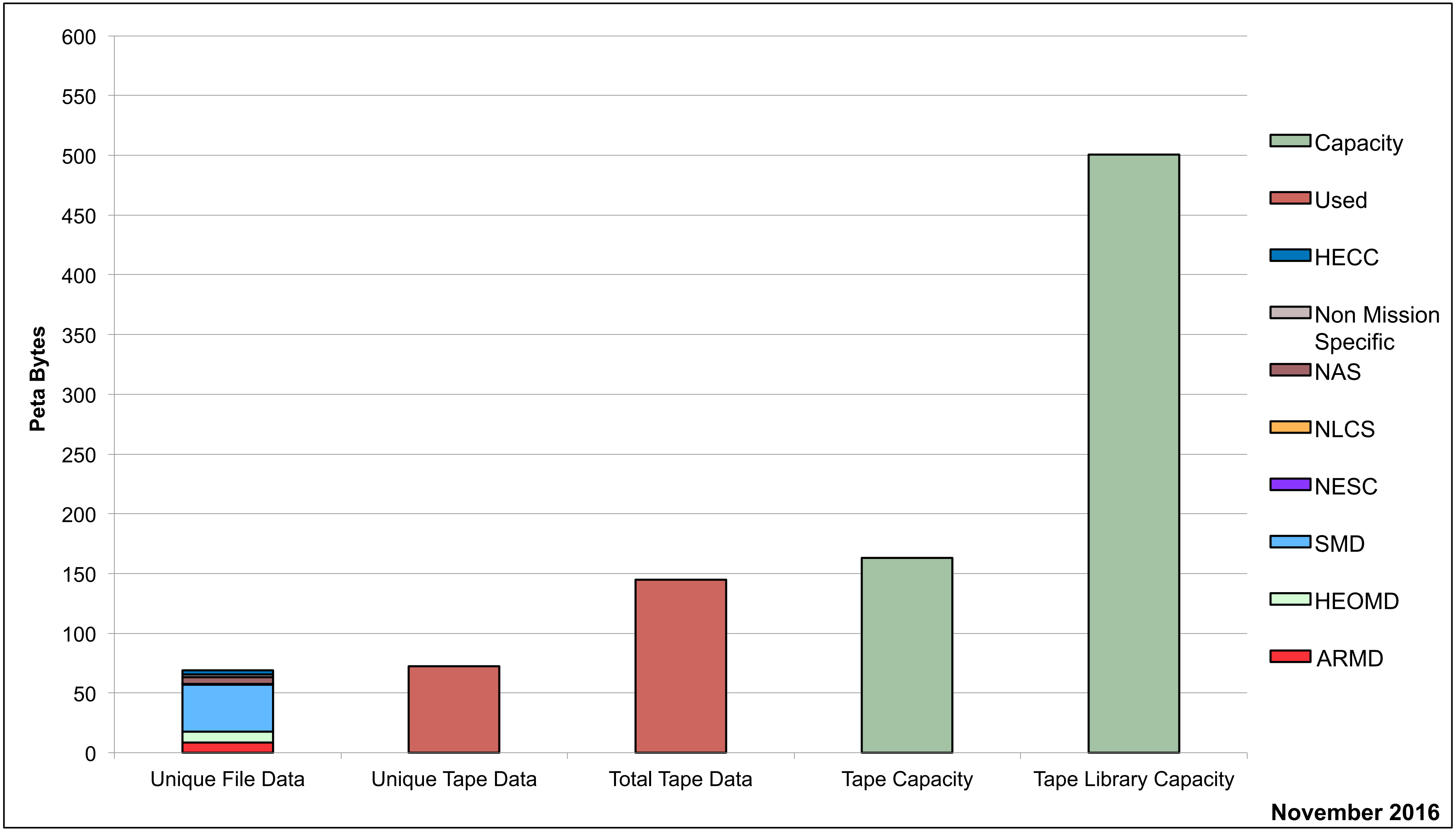




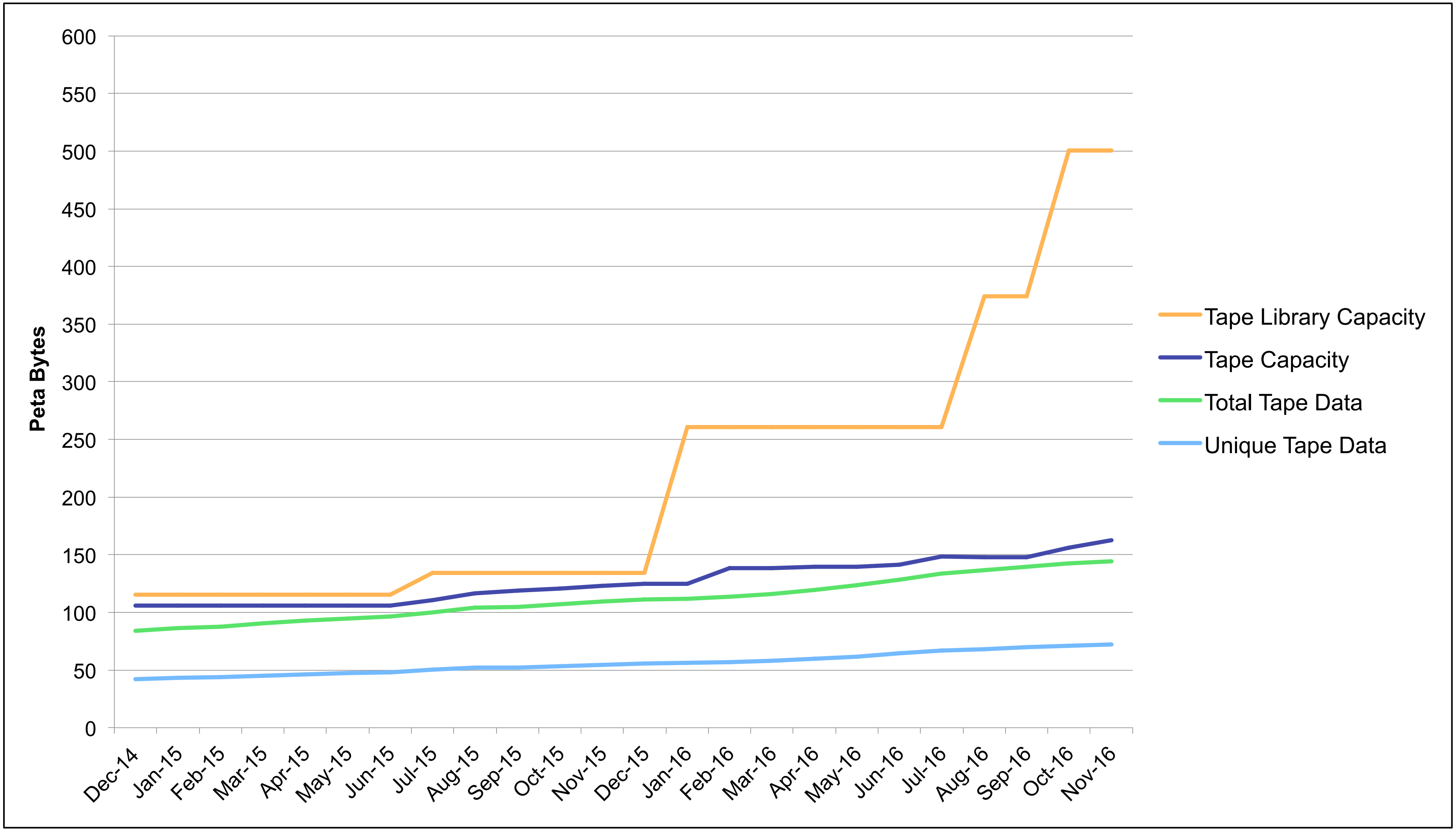


① 16 Westmere racks retired from Pleiades
② 14 Haswell racks added to Pleiades
③ 7 Nehalem ½ racks retired from Merope
④ 7 Westmere ½ racks added to Merope
⑤ 16 Westmere racks retired from Pleiades
⑥ 10 Broadwell racks added to Pleiades
⑦ 4 Broadwell racks added to Pleiades
⑧ 14 (all) Westmere racks retired from Pleiades
⑨ 14 Broadwell racks added to Pleiades (10.5 Dedicated to ARMD)

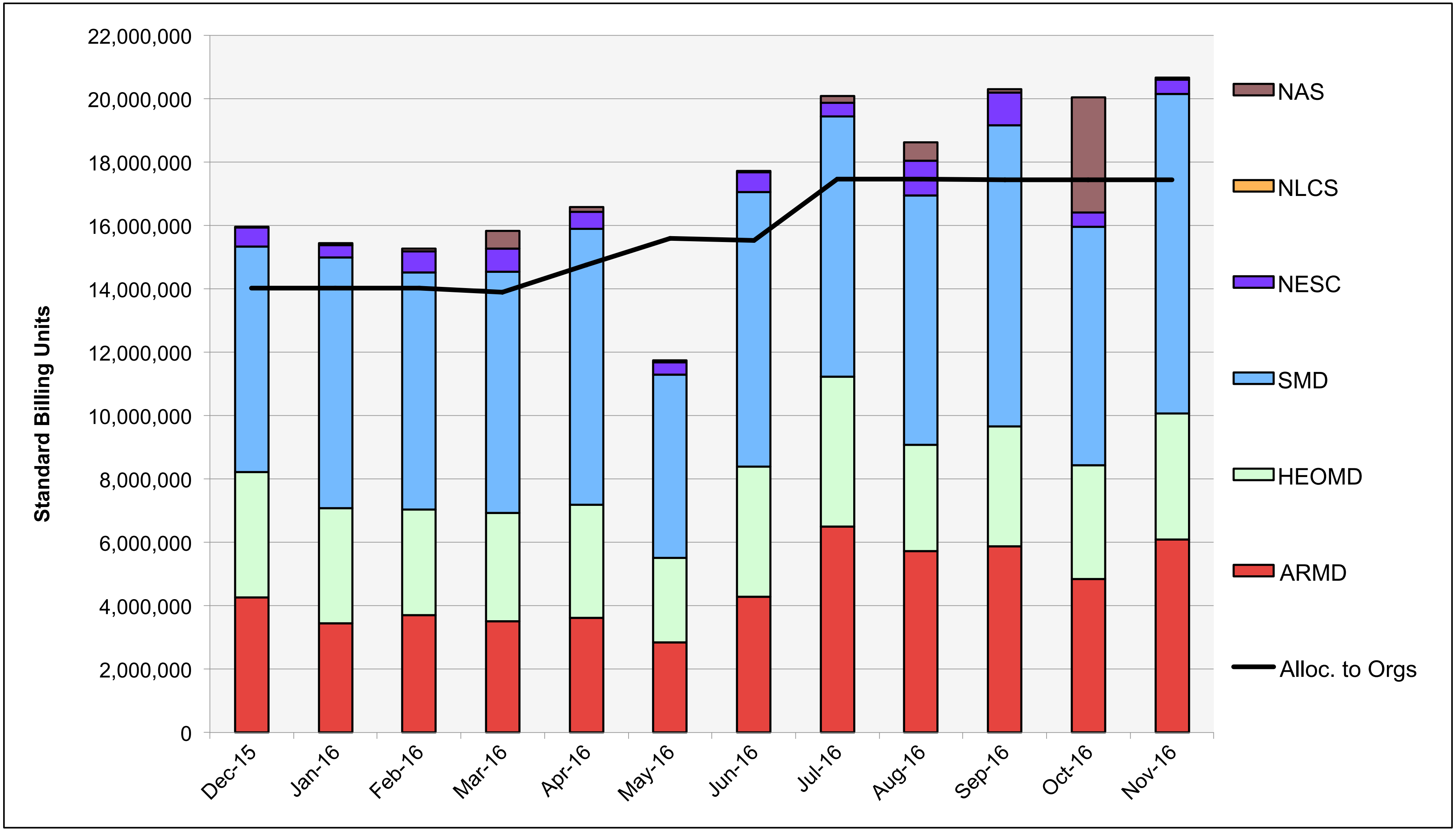
Tape Archive Status



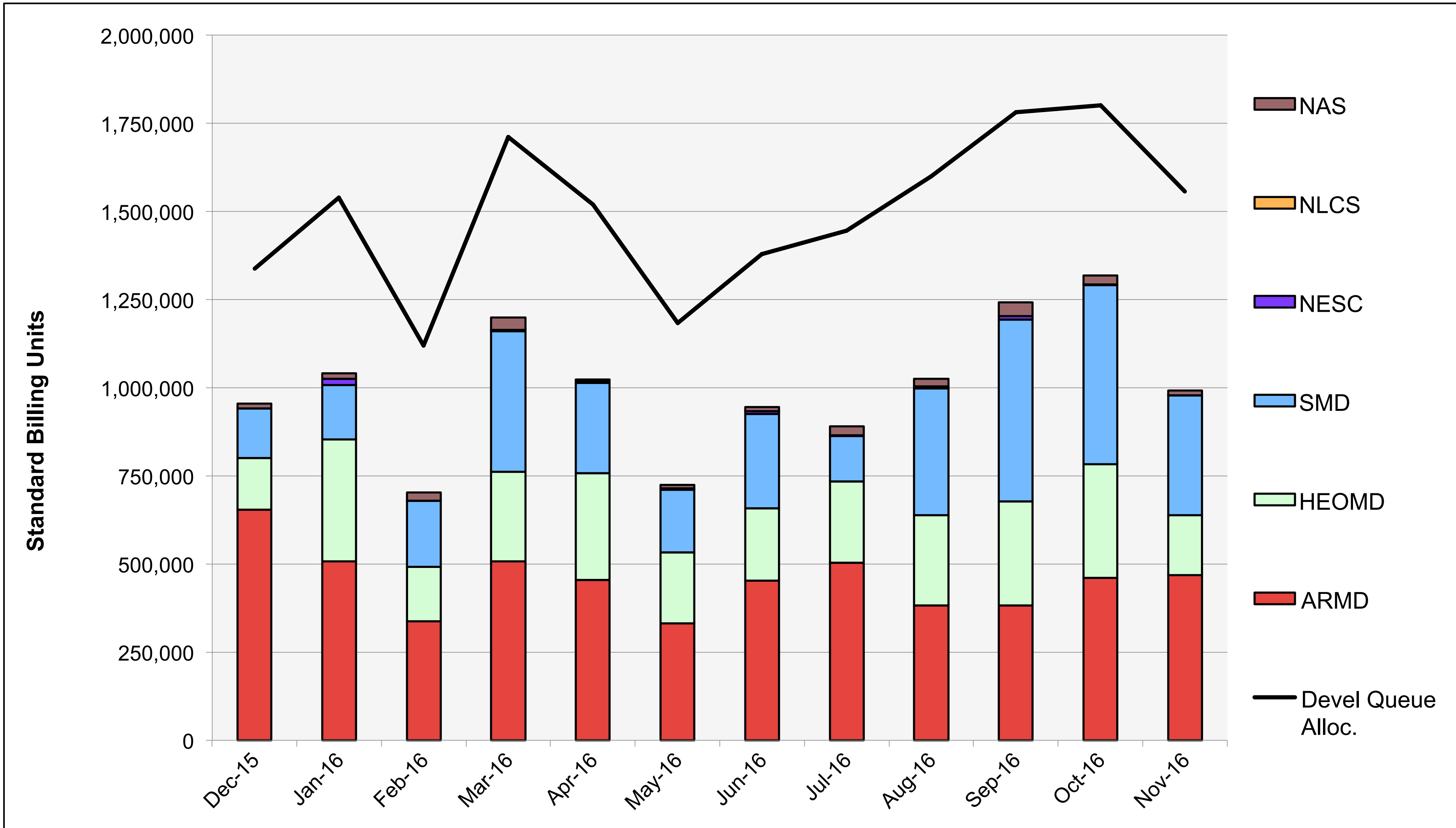
Tape Archive Status



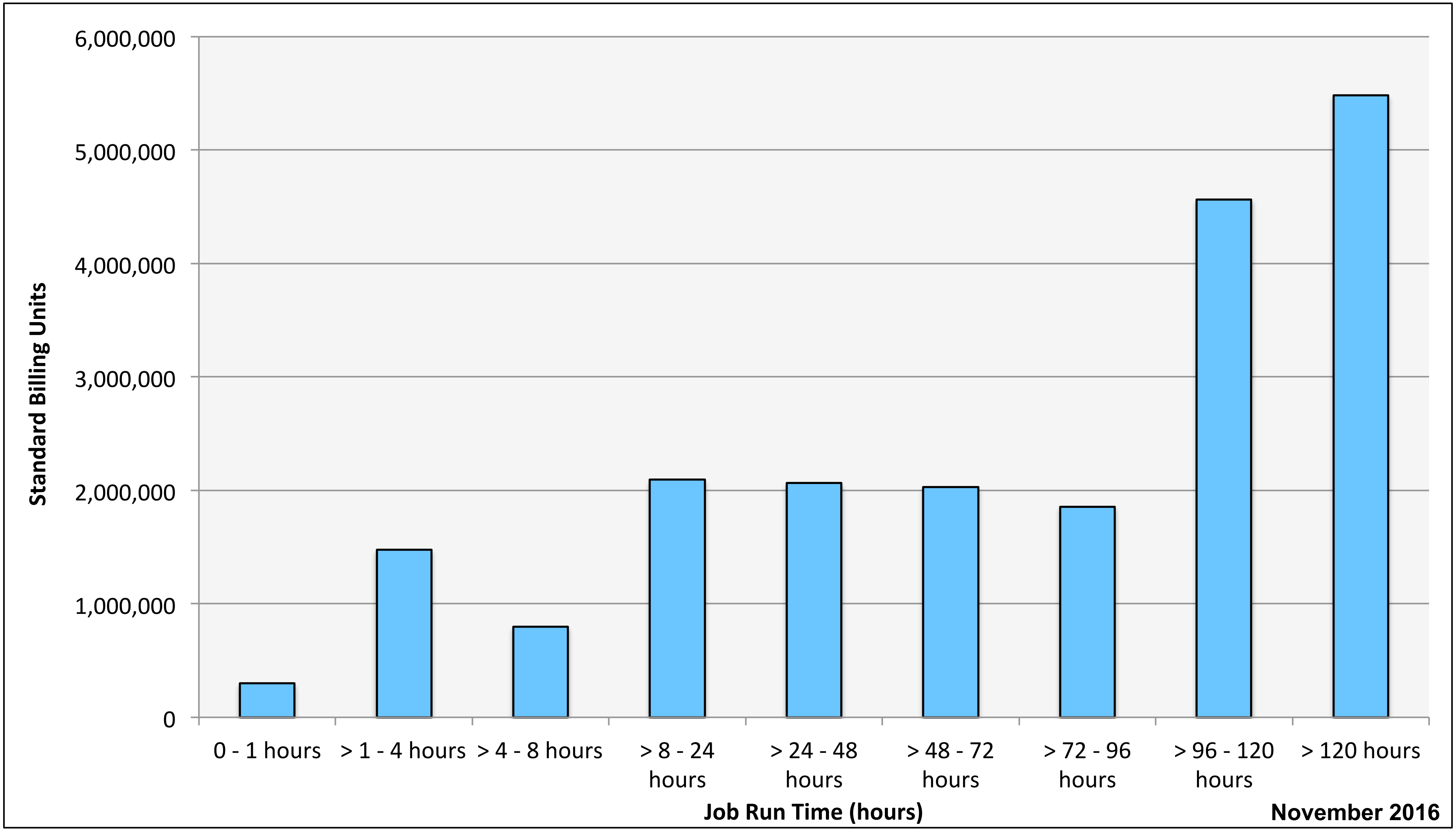
Pleiades:
SBUs Reported, Normalized to 30-Day Month



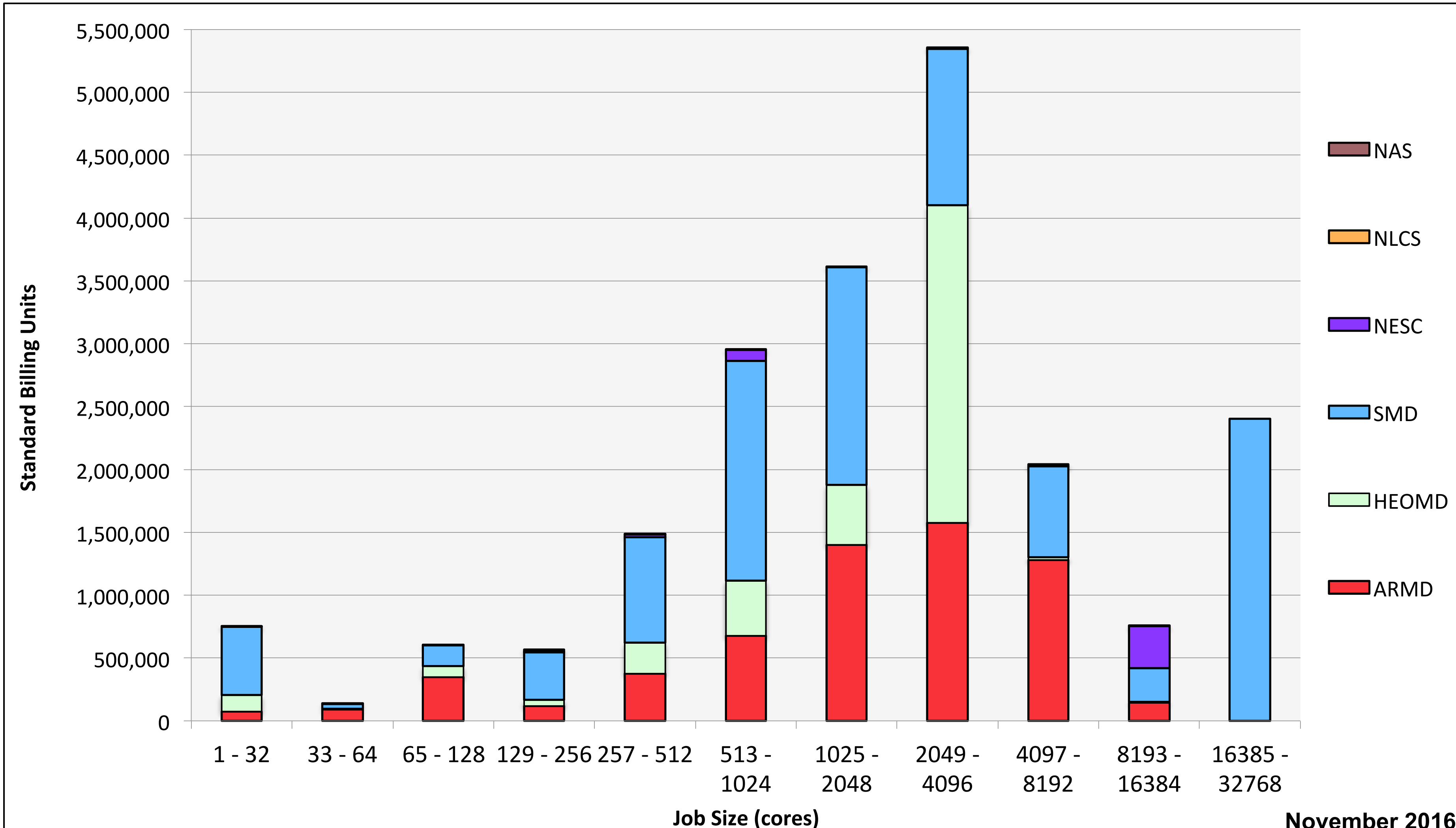
Pleiades: Devel Queue Utilization



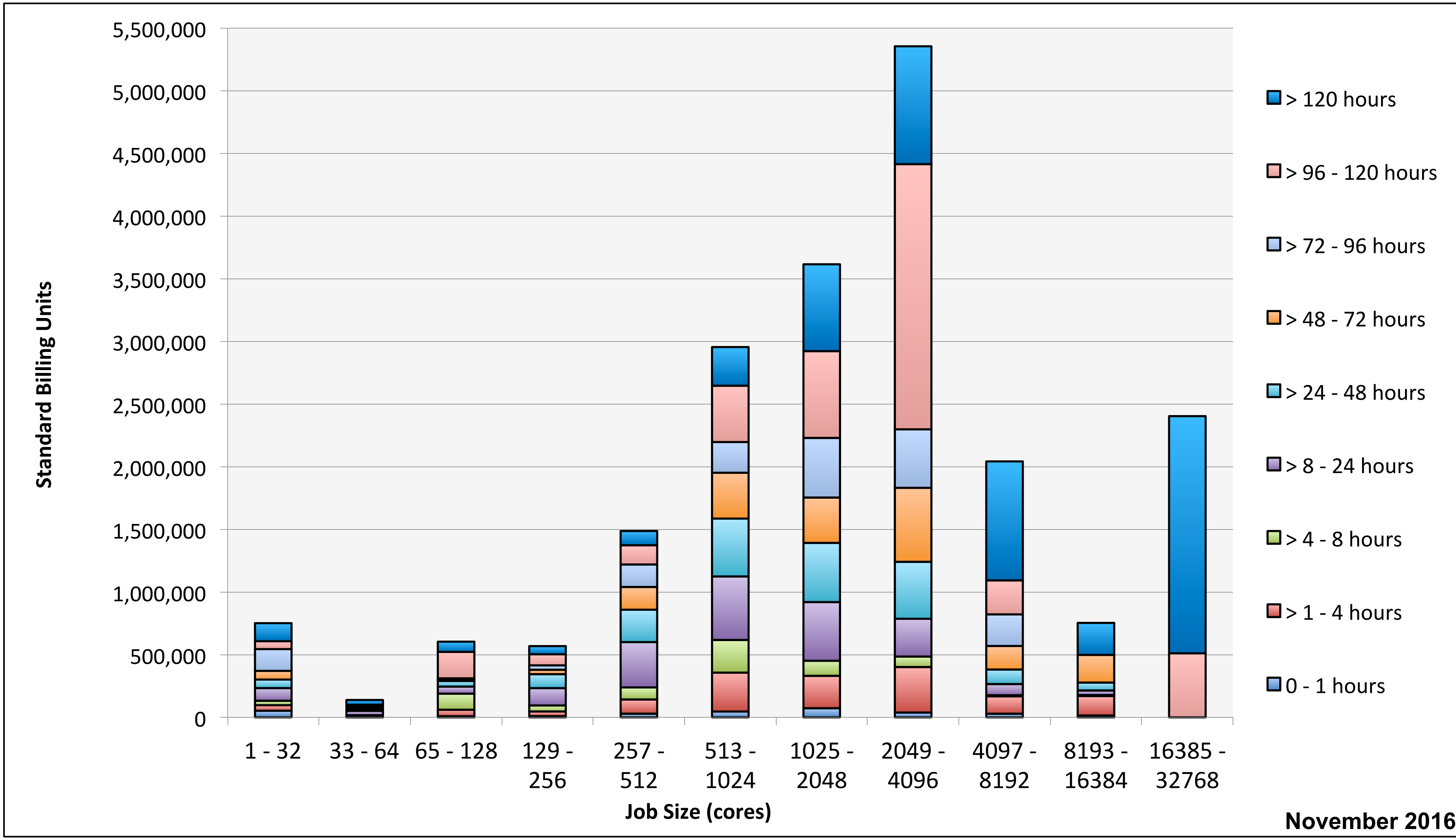
Pleiades:
Monthly Utilization by Job Length



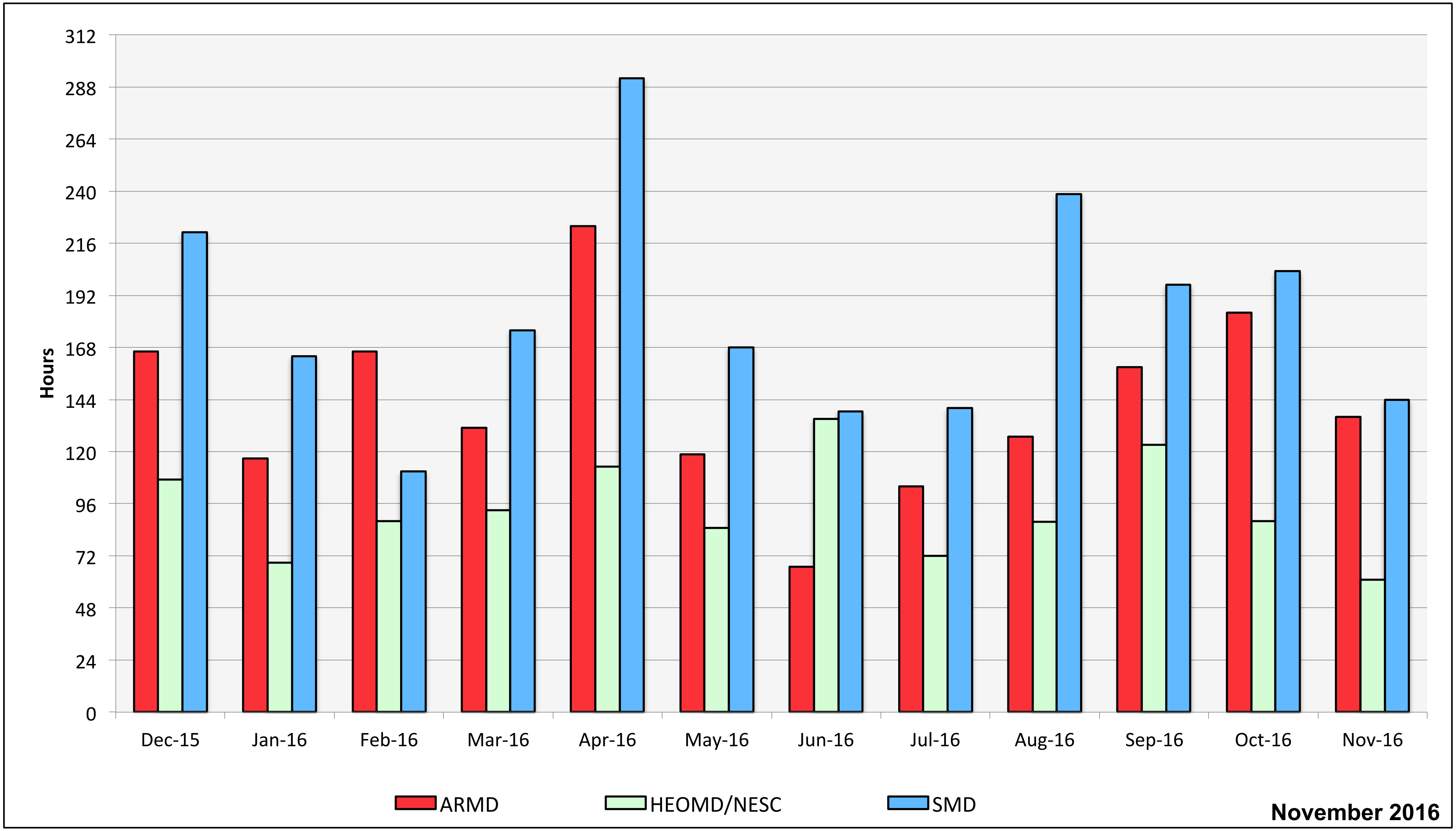
Pleiades: Monthly Utilization by Size and Mission



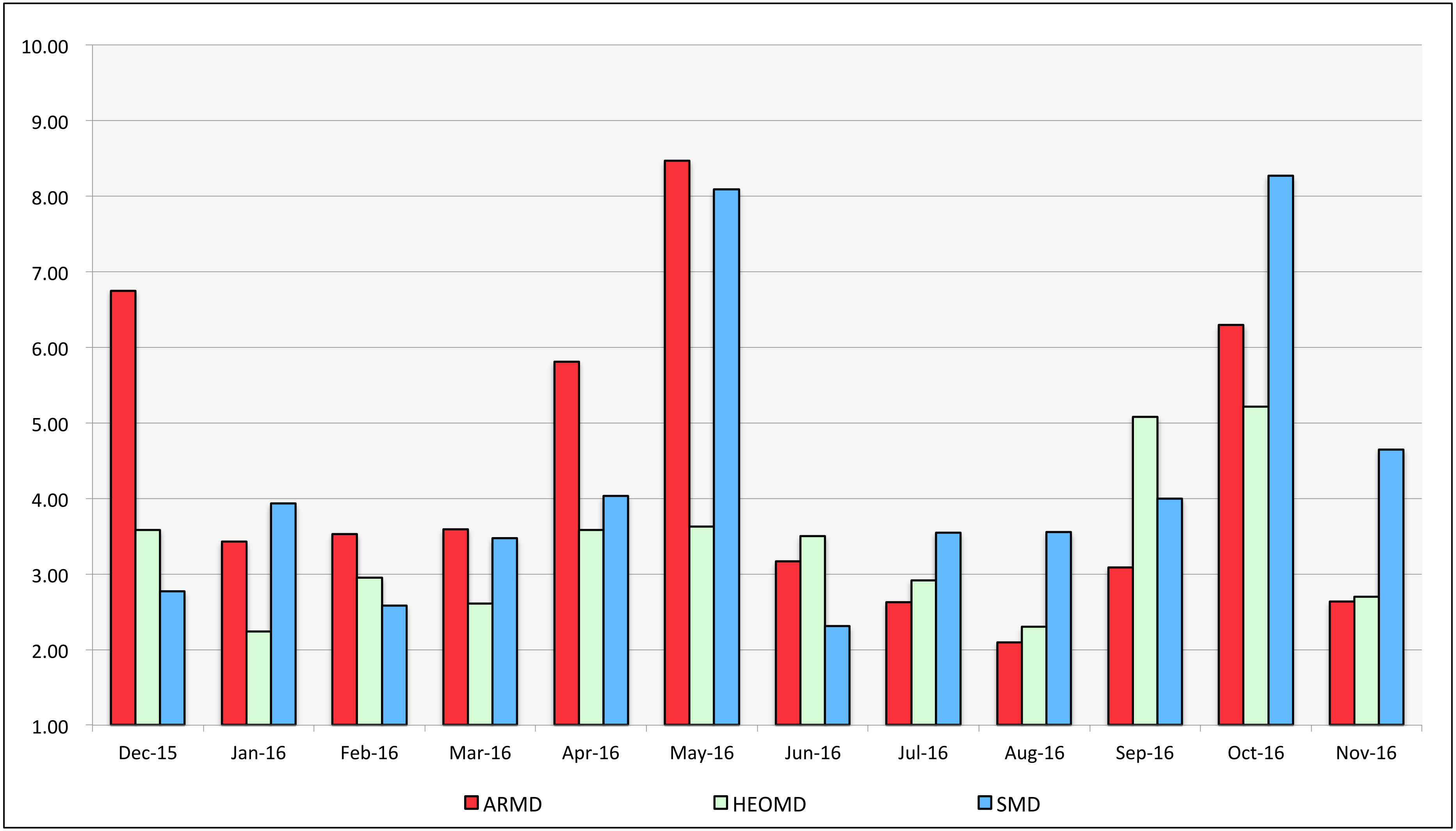
Pleiades: Monthly Utilization by Size and Length



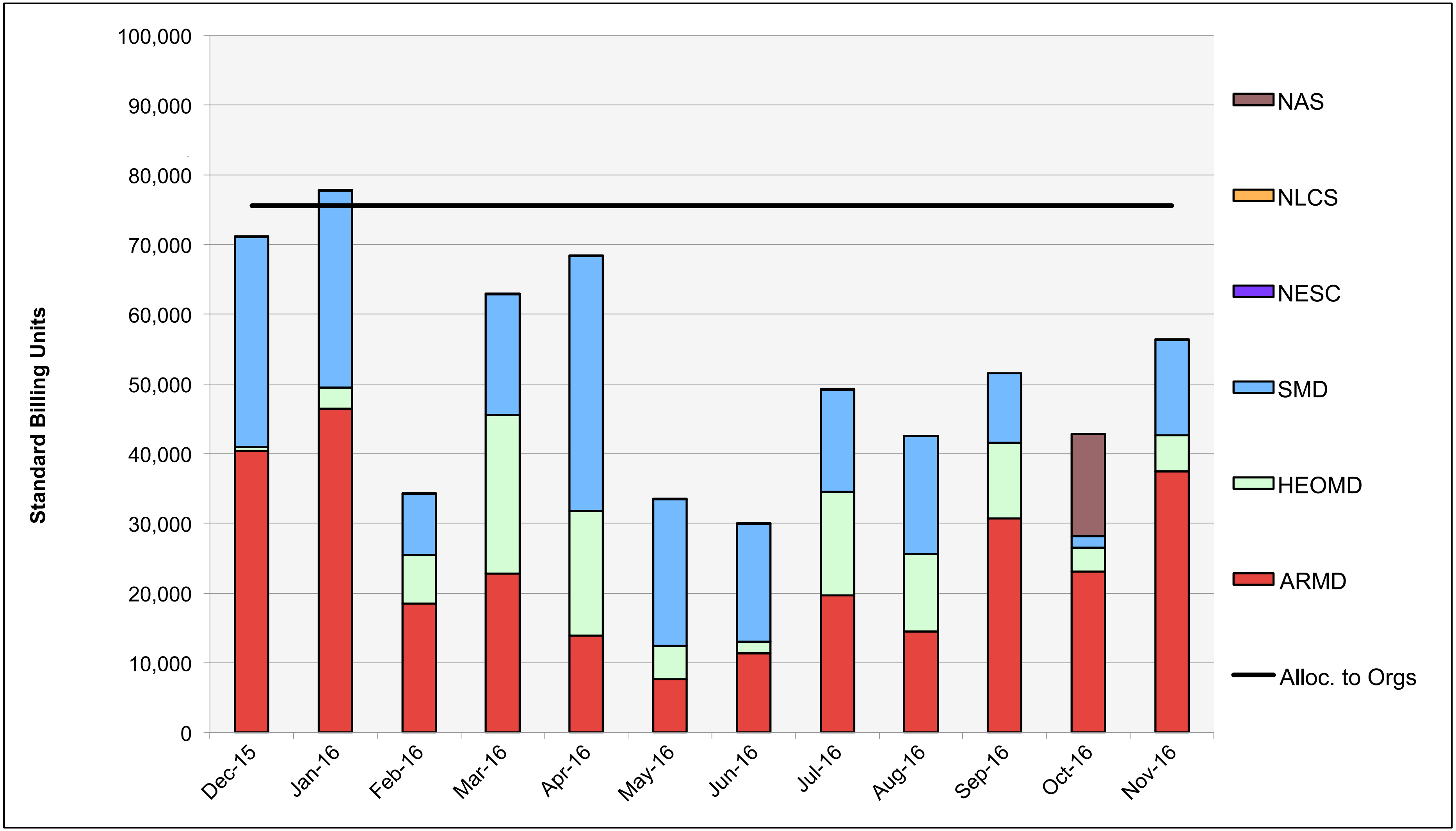
Pleiades:
Average Time to Clear All Jobs



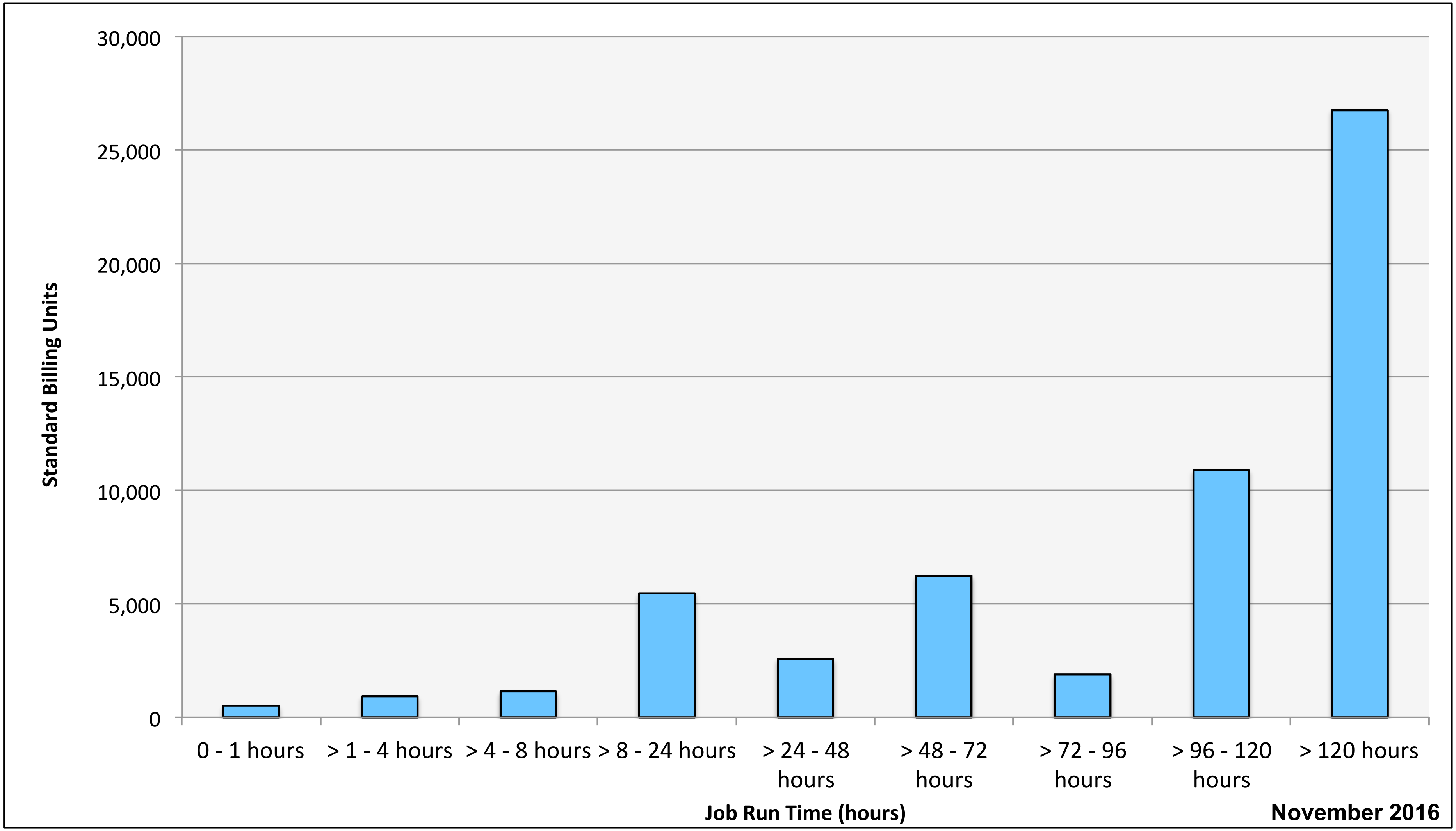
Pleiades: Average Expansion Factor



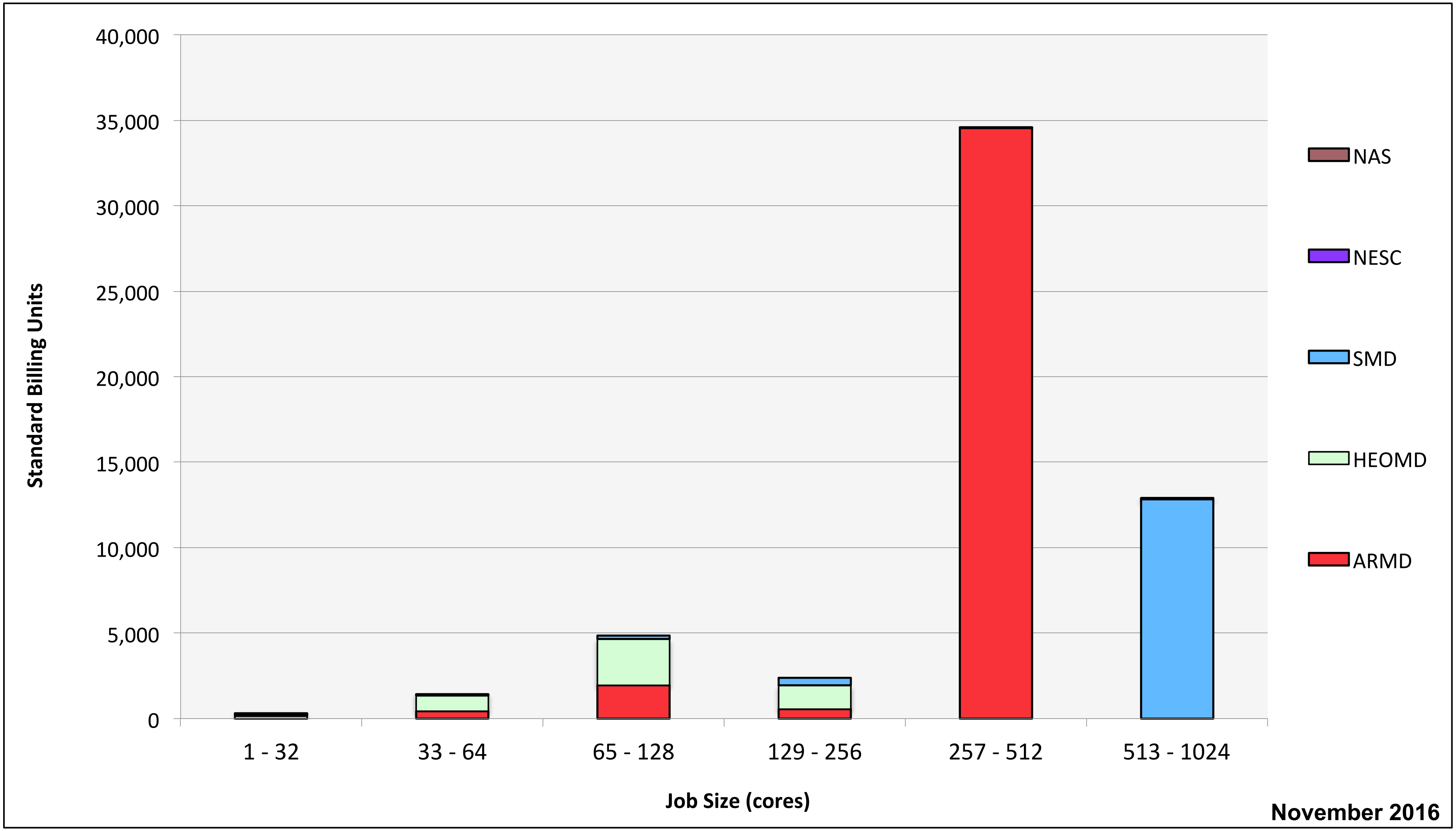
Endeavour: SBUs Reported, Normalized to 30-Day Month



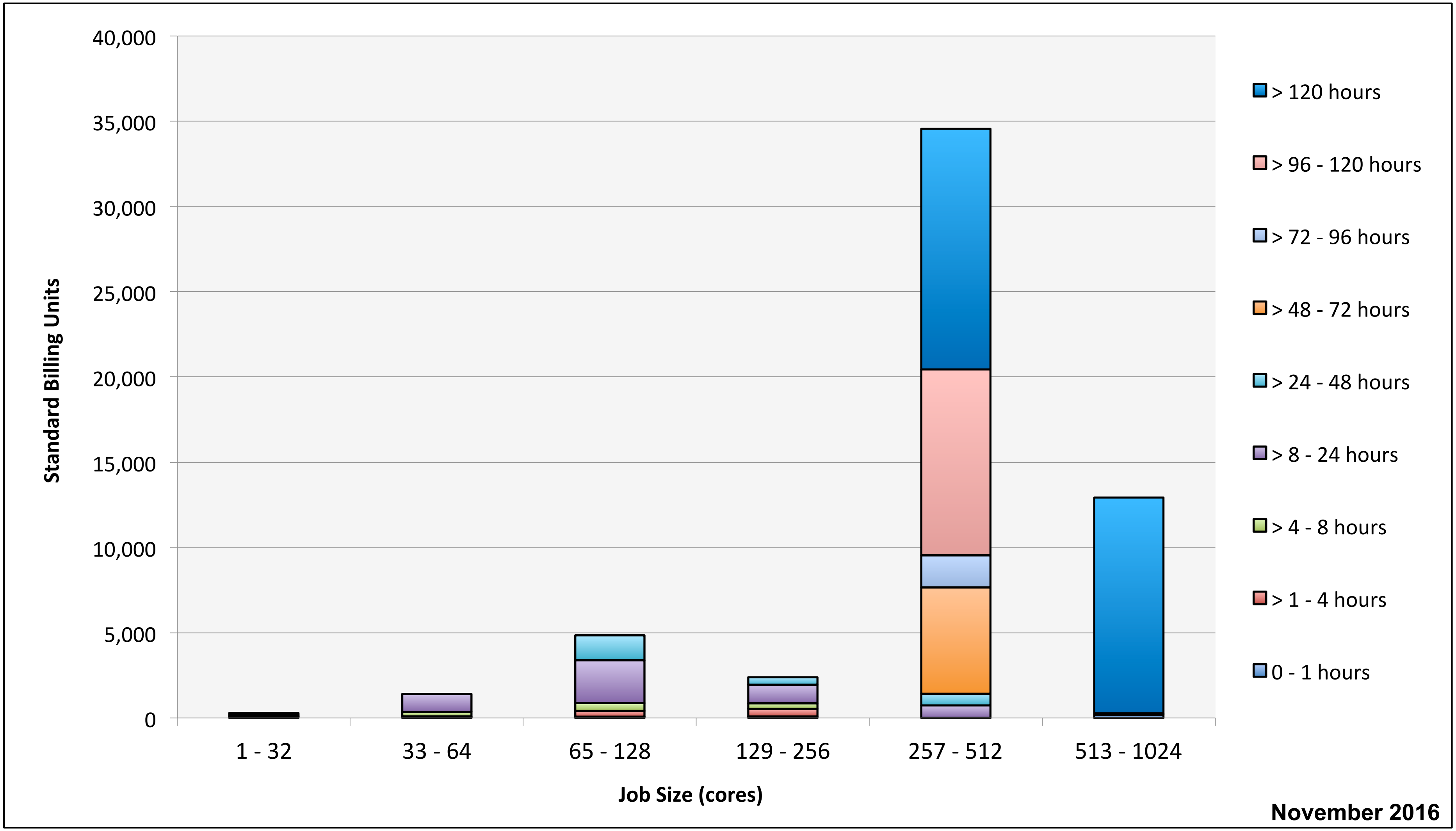
Endeavour: Monthly Utilization by Job Length



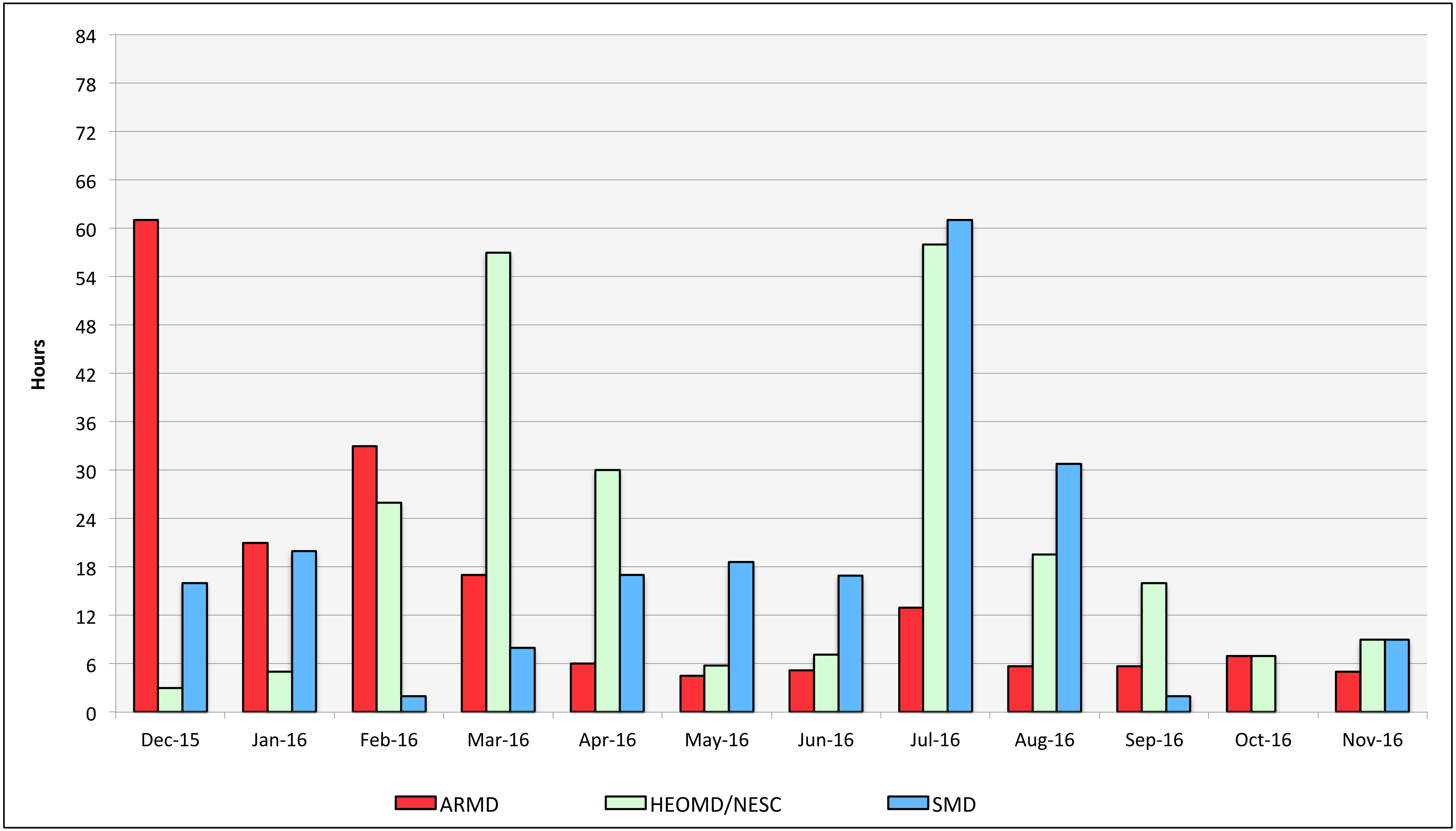
Endeavour: Monthly Utilization by Size and Mission



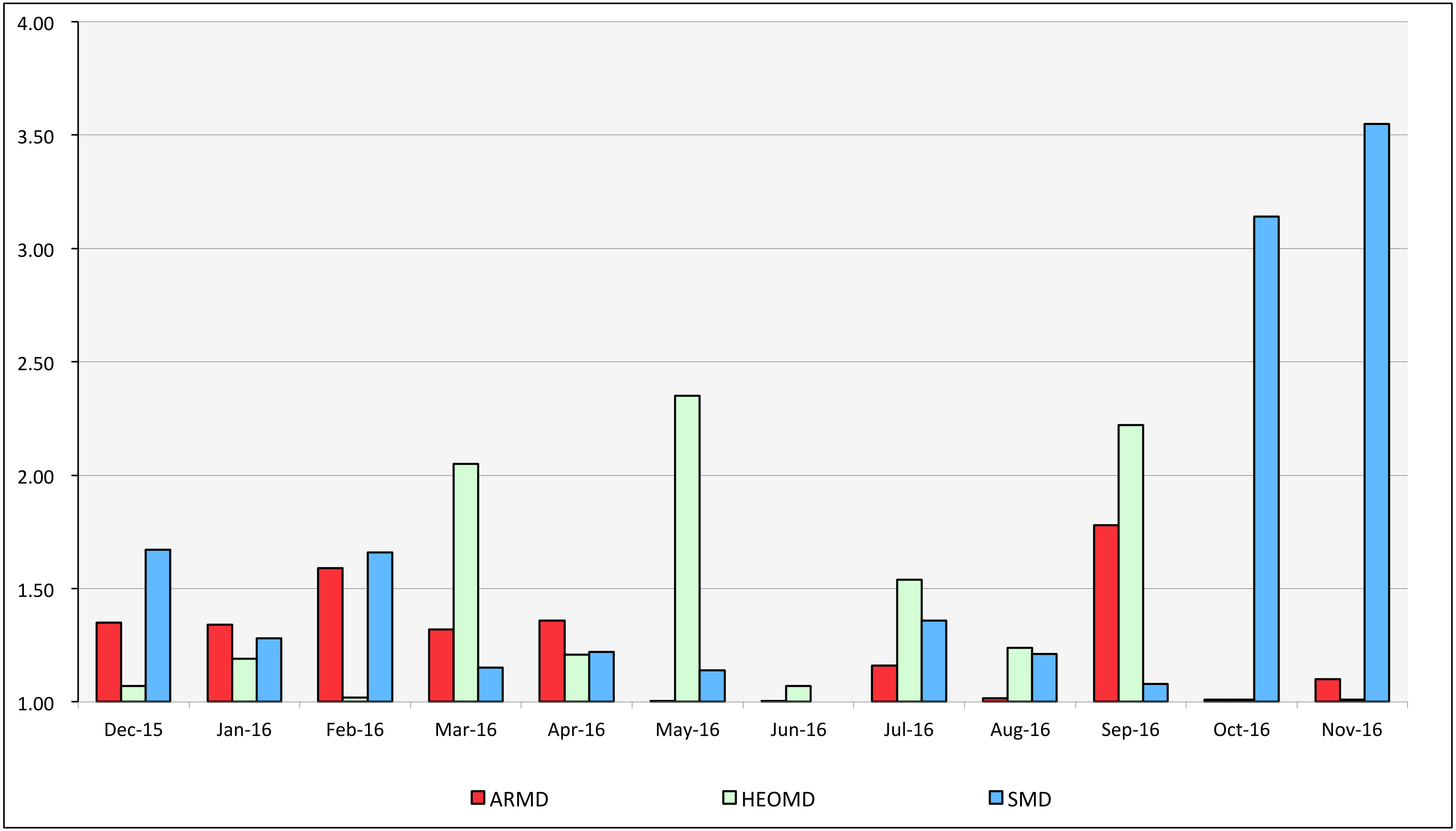
Endeavour:
Monthly Utilization by Size and Length



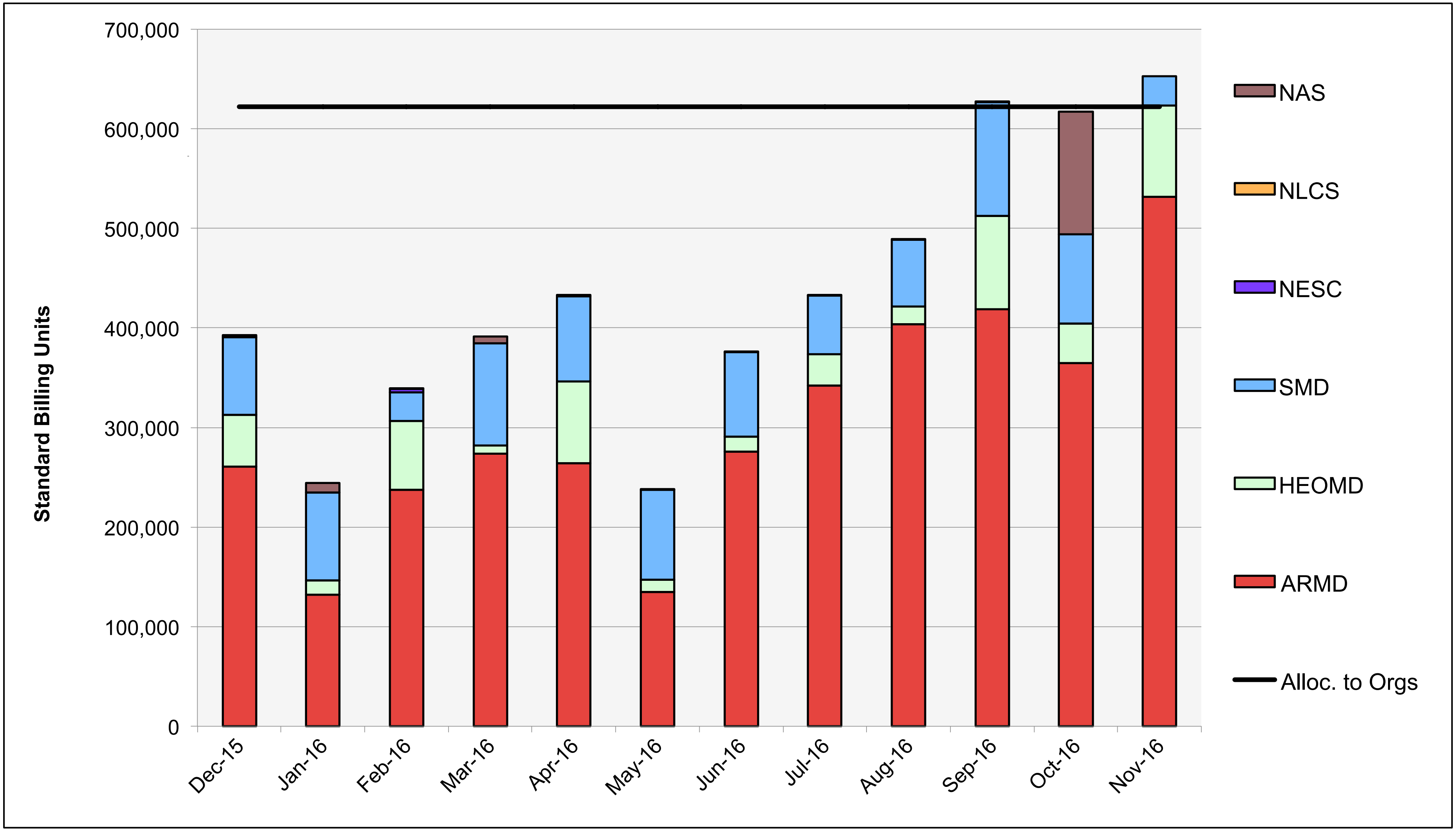
Endeavour:
Average Time to Clear All Jobs



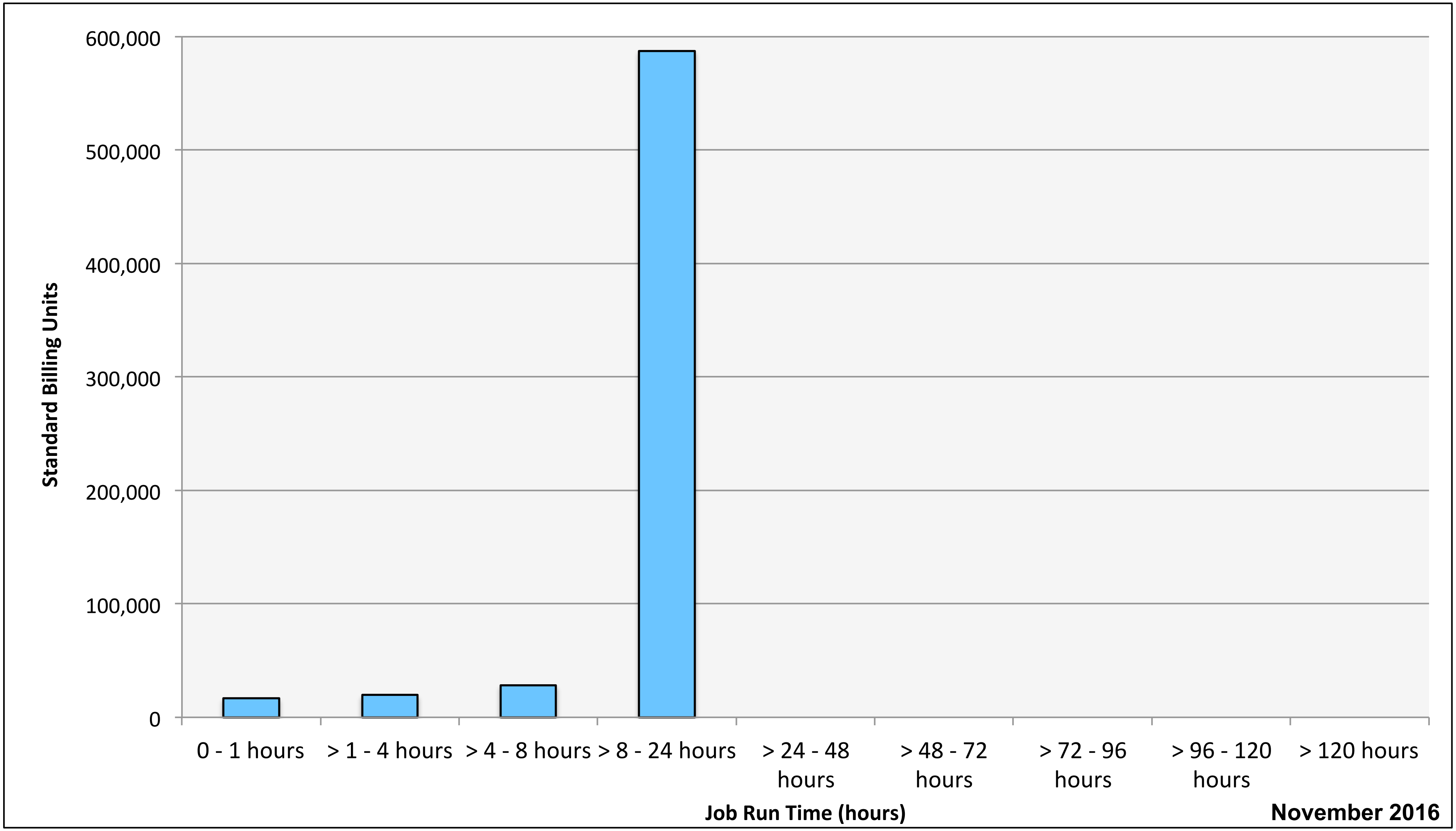
Endeavour:
Average Expansion Factor



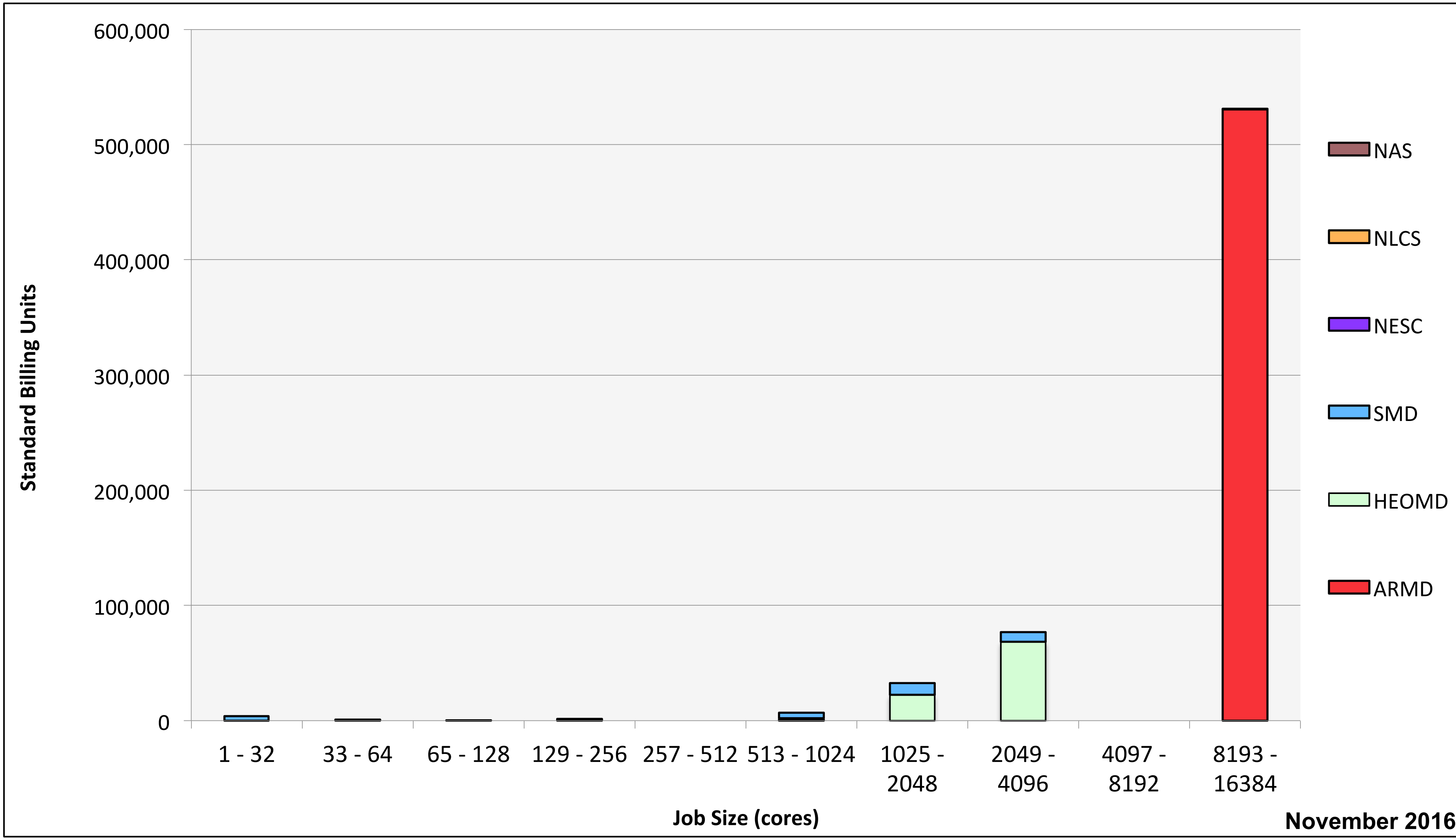
Merope: SBUs Reported, Normalized to 30-Day Month



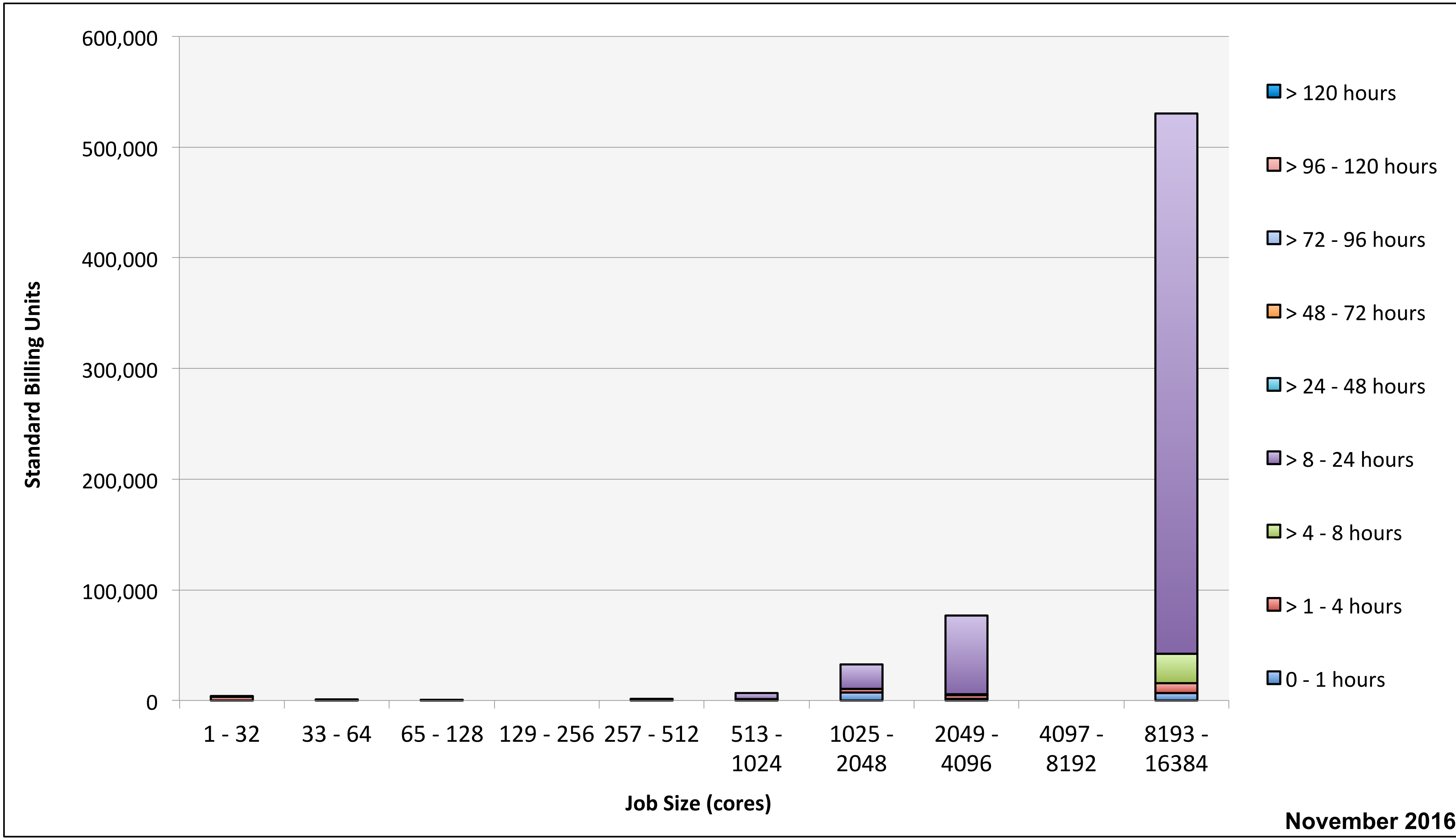
Merope:
Monthly Utilization by Job Length



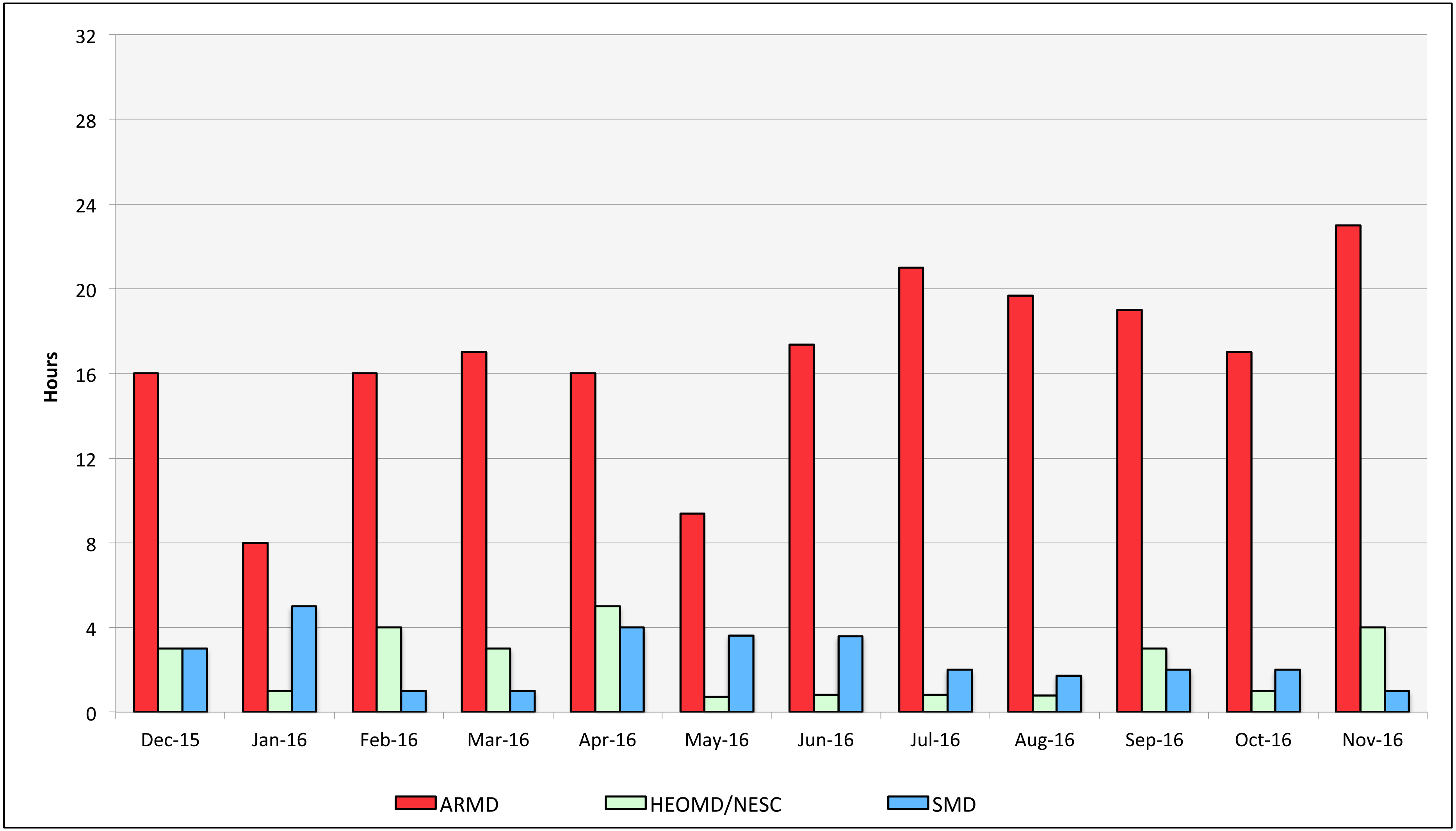
Merope: Monthly Utilization by Size and Mission



Merope:
Monthly Utilization by Size and Length



Merope:
Average Time to Clear All Jobs



Merope:
Average Expansion Factor