

National Aeronautics and Space Administration

HIGH-END COMPUTING CAPABILITY PORTFOLIO

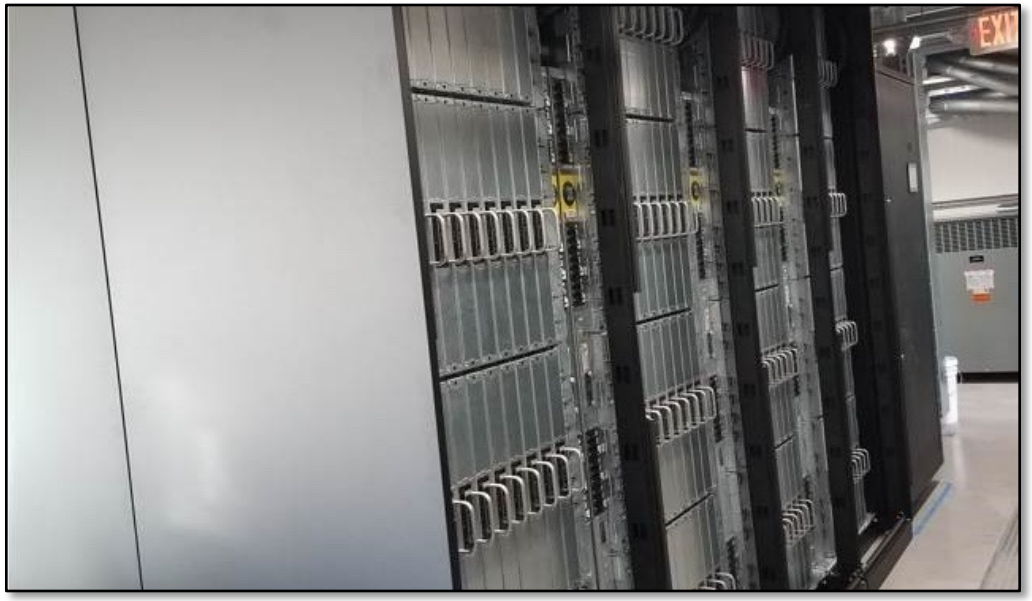
William Thigpen
NASA Advanced Supercomputing Division

December 10, 2021

Latest Aitken Expansion Goes Into Production

- HECC's Supercomputing Systems group completed the latest Aitken expansion and placed the new nodes into production—further increasing HECC's compute capability.
- The expansion increases Aitken's theoretical peak performance by 32%, from 8.41 petaflops to 10.76 petaflops.
- The expansion comprises four HPE Apollo 9000 "Badger" racks containing 512 AMD EPYC 7742 "Rome" compute nodes. The HPE Performance Cluster Manager (HPCM) will be used for managing the cluster configuration.
  - Each node has two 64-core AMD second-generation System-on-Chip (SoC) EPYC (pronounced "epic") 7742 Rome processors.
  - Adds 65,536 cores.
  - Adds 262 terabytes memory.
- The Aitken Rome nodes use the PBS scheduler and use the same InfiniBand fabric as the existing Aitken E-Cells and HPE racks.
- Another 512 Rome nodes are scheduled to be added to Aitken in early 2022.

IMPACT: The latest Aitken expansion, with 512 new AMD Rome nodes, provides more computational capacity and resources to support engineers and scientists for NASA mission projects.



The four new racks added with the Aitken expansion provide 512 AMD EPYC 7742 "Rome" nodes with 128 cores per node.
Jason Inoue, NASA/Ames

Request Management System (RMS) Transitions to HECC

RMS development team transitioned RMS from Goddard Private Cloud to HECC-supported servers to allow RMS to gain direct access to supercomputing resource utilization databases in future versions.

- The transition included:
  - Creating three virtual machines at HECC on in-house supported hypervisors.
  - Migrating an automated build system and other development and staging environments.
  - Migrating from CentOS 7 to Red Hat 8.
  - Significant testing of each environment.
- The RMS development team successfully completed the transition with minimal code changes.
- The downtime transition period was less than four hours, minimal impact to the user community.
- The transition to HECC hardware was completed 53 days ahead of the original schedule deadline.

IMPACT: The transition to HECC allows developers to utilize databases that were not accessible in the Goddard Private Cloud (GPC). It provdes NASA's High End Computing Program more ownership of the data and integration with additional databases that will enhance the user experience.



Slide from a High End Computing Board of Advisors presentation for the Resource Management System. *NASA*

HECC Teams Develop, Lead NASA's Virtual SC21 Exhibit

- The HECC Tools team, in collaboration with the Publications and Media team, planned and produced NASA's virtual exhibit for SC21, the International Conference for High Performance Computing, Networking, Storage, and Analysis, held November 14–19.
- The NASA@SC21 website features 39 science and engineering projects enabled by HECC and NCCS supercomputers and supported by visualization, optimization, and machine learning experts. The projects represent teams from five NASA centers, plus university collaborators.
- Highlights this year included several videos and recorded presentations:
  - NAS Division Chief Piyush Mehrotra provided a warm welcome to SC21 attendees.
  - An eye-catching introduction on the landing page invited visitors to link to each research project.
  - Four researchers presented their projects.
  - An SC21-produced interview engaged three Ames researchers working on Artemis-related projects.
- Additional highlights included:
  - A special sidebar featuring "6 Things to Know About NASA Supercomputing" that provided summary information about 10 featured projects—matching the "listicle" format of the press release that announced NASA's participation in the conference.
  - Digital swag—ringtones, desktop and mobile wallpapers, and virtual backgrounds.
  - A carefully curated social media campaign to draw the public to the virtual exhibit via Twitter and Facebook.

IMPACT: Participating in the annual supercomputing conference provides a public platform to showcase NASA science and engineering projects supported by the agency's high-performance computing (HPC) resources, as well as NASA's latest advances in HPC technologies.



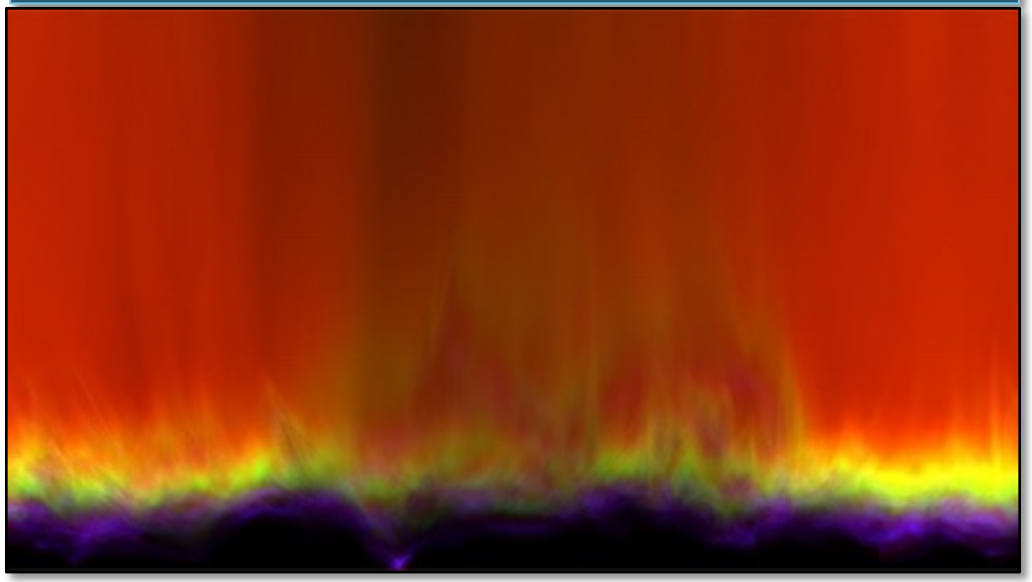
An introductory video prominently featured on the landing page of the NASA@SC21 website invites visitors to explore more than 70 images and 30 videos from 39 research projects, along with a page for each project to explain the research details, results, and impact. *John Hardman, NASA Ames*

Modeling Observations of Heliophysics Missions from Realistic 3D Solar Simulations*

- Researchers at NASA Ames ran realistic simulations on Pleiades of the solar atmosphere and synthesized the plasma emission and spectra observed by NASA spacecraft.
  - The goal is to understand how physical properties of the solar atmosphere (such as temperature and energy flows) can be obtained from spectral lines and broadband emissions observations.
- Using simulation data, the team computed various spectral lines and emissions, including: bright spectral lines observed by IRIS; extreme ultraviolet (EUV) emission observed by the Solar Dynamics Observatory's (SDO) Atmospheric Imaging Assembly using temperature response functions; and Fe I 6137 Å Stokes profiles (widely used in the measurements of vector magnetic fields) observed by SDO's Helioseismic and Magnetic Imager.
- The team discovered a connection between the properties of shock waves spreading into the solar corona and those of spectral lines formed in the transition region and EUV originating from hot plasma.
- This work confirms the capability to estimate energy transport by shock waves into the solar corona, and other properties of shock, from currently operating NASA missions.

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

IMPACT: Spectral line and emission analyses performed on results of realistic 3D solar simulations allow us to better understand the observations from NASA missions and to learn more about the hot dynamic plasma in the solar atmosphere.



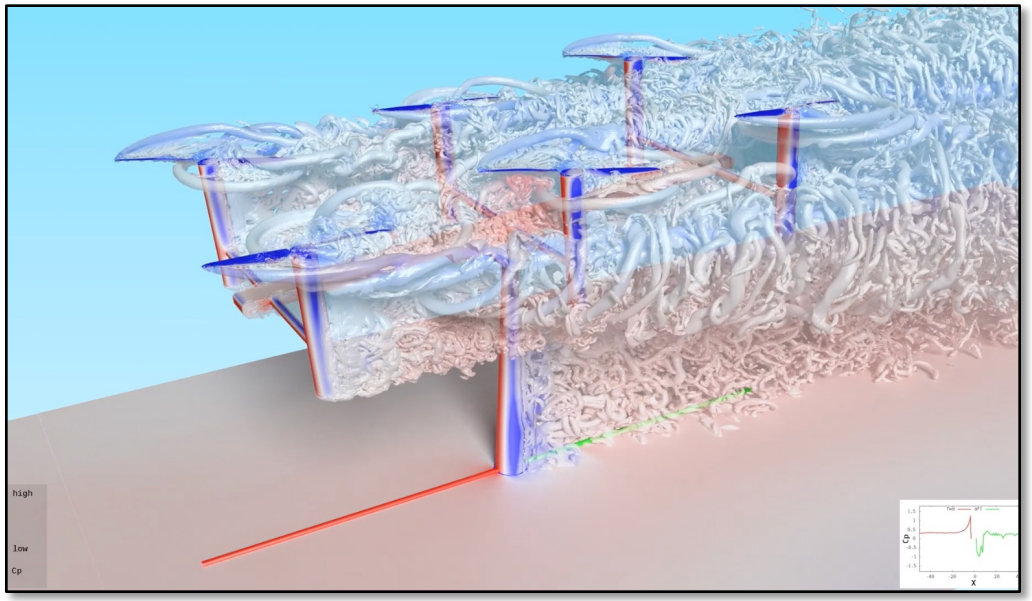
Visualization of the Solar Dynamics Observatory Atmospheric Imaging Assembly (SDO/AIA) synthetic emission for the side view of the simulated quiet Sun region. Sporadic heating events in the solar transition region and a self-organized magnetic structure are seen in the center of the region. *Viacheslav Sadykov, Georgia State University; Irina Kitiashvili, NASA/Ames*

Simulations of the Complex Multirotor Test Bed Experiment*

- As part of NASA's Revolutionary Vertical Lift Technology (RVLT) Project, the agency developed the Multirotor Test Bed (MTB) system to facilitate wind tunnel testing for new and existing multirotor aircraft configurations.
- To improve the design of the system, researchers at NASA Ames are using computational fluid dynamics (CFD) methods to validate and analyze the system as a whole. They coupled NASA's OVERFLOW code with CAMRADII to produce full, unsteady flows with moving grids for the rotors, as well as the steady-state algorithm of the rotor disk model.
- Detailed comparison and validation were performed for both higher-fidelity full rotor unsteady flows and reduced-order rotor-disk methods. To reduce the complexity of simulating unsteady flows of the rotating blades with moving overset grids, researchers used an option in OVERFLOW to model rotors and propellers as infinitely thin disks. This will allow MTB engineers to adjust the rotor parameters more precisely and in new ways.
- The CFD simulations maintained rotor lateral symmetry in the flowfield, as opposed to the measured asymmetry in wind tunnel tests. Hopefully, the MTB system will eventually explain why lateral symmetry is not maintained.
- In future work, the rotor disk model used in the MTB tests will be utilized to accelerate the design for the next generation of rotor-based concept vehicles.

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

IMPACT: This work is part of a wider effort to analyze results and improve the design of the Multirotor Test Bed system, which undergoes testing in the 7- by 10-foot wind tunnel at NASA Ames Research Center.



A flow visualization of a forward fight experiment of the Multirotor Test Bed system with six rotors at a 5-degree rotor tilt. The flow field is colored by the pressure coefficient. *Jasim Ahmad, Tim Sandstrom, NASA/Ames.*

Papers

- "**TOI-2257 b: A Highly Eccentric Long-Period Sub-Neptune Transiting a Nearby M Dwarf**," N. Schanche, et al., arXiv:2111.01749 [astro-ph.EP], November 2, 2021. *
  https://arxiv.org/abs/2111.01749
- "**The THESAN Project: Predictions For Multi-Tracer Line Intensity Mapping in the Epoch of Reionization**," R. Kannan, et al., arXiv:2111.02411 [astro-ph.CO], November 3, 2021. *
  https://arxiv.org/abs/2111.02411
- "**TOI-712: A System of Adolescent Mini-Neptunes Extending to the Habitable Zone**," S. Vach, et al., arXiv:2111.02416 [astro-ph.EP], November 3, 2021. *
  https://arxiv.org/abs/2111.02416
- "**Mars Methane Sources in Northwestern Gale Crater Inferred From Back Trajectory Modeling**," Y. Luo, et al., Earth and Space Science, vol. 8, issue 11, November 4, 2021. *
  https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021EA001915
- "**Ion Acceleration and the Development of a Power-Law Energy Spectrum in Magnetic Reconnection**," H. Che, G. Zank, A. Benz, The Astrophysical Journal, vol. 921, no. 2, November 9, 2021. *
  https://iopscience.iop.org/article/10.3847/1538-4357/ac1fe7/meta
- "**HybridQ: A Hybrid Simulator for Quantum Circuits**," A. Mandra, J. Marshall, E. Rieffel, R. Biswas, arXiv:2111.06868 [quant-ph], November 12, 2021. *
  https://arxiv.org/abs/2111.06868

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

Papers (cont.)

- **2021 Supercomputing Conference, St. Louis, MO/Virtual, November 15-20, 2021**
  - "**Active Controls for a Smooth Ride on Air Taxis in Urban Environments**," G. Guruswamy *
    https://www.nas.nasa.gov/SC21/research/project1.html
  - "**Simulations of the Complex Multirotor Test Bed Experiment**," J. Ahmad. *
    https://www.nas.nasa.gov/SC21/research/project2.html
  - "**CFD Analysis of Integrated Propulsion Systems for the SUSAN Aircraft**," T. Chau, J. Duensing, L. Machado, C. Kiris, R. Jansen. *
    https://www.nas.nasa.gov/SC21/research/project3.html
  - "**Turbulence Resolving Simulations for Aircraft Certification by Analysis**," A. Ghate, G. Kenway, G.-D. Stich, C. Kiris. *
    https://www.nas.nasa.gov/SC21/research/project4.html
  - "**Predicting Jet Noise NASA's Low Boom Flight Demonstrator**," G.-D. Stich, A. Ghate, J. Housman, C. Kiris.*
    https://www.nas.nasa.gov/SC21/research/project5.html
  - "**CFD Analysis of the Transonic Truss-Braced Wing Aircraft**," D. Maldonado, J. Housman, M. Piotrowski, C. Kiris.
    https://www.nas.nasa.gov/SC21/research/project6.html
  - "**Increasing Aircraft Fuel Efficiency with Boundary-Layer-Ingesting Tail-Cone Thrusters**," J. Duensing, L. Machado, L. Fernandes, C. Kiris. *
    https://www.nas.nasa.gov/SC21/research/project7.html
  - *"***Preparing the X-59 Quiet Supersonic Transport Aircraft for Flight***," J. Jensen, J. Housman, M. Nemec, M. Aftosmis, C. Kiris. **
    https://www.nas.nasa.gov/SC21/research/project8.html

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Papers (cont.)

- **2021 Supercomputing Conference, St. Louis, MO/Virtual, November 15-20, 2021 (Cont.)**
  - "**Flight Readiness Simulations for Artemis**," D. Dalle, S. Rogers, G. Schauerhamer, J. Meeroff.* *https://www.nas.nasa.gov/SC21/research/project11.html*
  - "**Predicting Orion Ascent Abort Acoustic Environment Enhance Astronaut Safety**," F. Cadieux, M. Barad, J. Jensen, C. Kiris. * *https://www.nas.nasa.gov/SC21/research/project12.html*
  - "**Simulating a Mars Supersonic Retropropulsion Concept Vehicle**," F. Cadieux, S. Neuhoff, M. Barad, C. Kiris. * https://www.nas.nasa.gov/SC21/research/project13.html
  - "**Simulating Supersonic Parachute Inflation for Mars Landing**," J. Boustani, F. Cadieux, M. Barad, C. Kiris. * *https://www.nas.nasa.gov/SC21/research/project14.html*
  - "**How Many Galaxies Do You Need to Make One Milky Way**," M. Peeples, A. Wright, J. Tumlinson. * *https://www.nas.nasa.gov/SC21/research/project15.html*
  - "**A Global, Coupled Ocean-Atmosphere Simulation with Kilometer-Scale Resolution**," D. Menemenlis, A. Molod, C. Henze, C. Hill. * *https://www.nas.nasa.gov/SC21/research/project16.html*
  - "**Modeling a Young Sun's Role in Lunar Ice and Hematite**," C. Dong, L. Wang, J. Green, D. Draper. * *https://www.nas.nasa.gov/SC21/research/project17.html*
  - "**Protoplanetary Disk Simulations from Large to Small Scales**," S. Zhang, I. Rabago, S. Baronett, C.-C. Yang.* *https://www.nas.nasa.gov/SC21/research/project18.html*

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Papers (cont.)

- **2021 Supercomputing Conference, St. Louis, MO/Virtual, November 15-20, 2021 (Cont.)**
  - "**3D Radiative Hydrodynamics Model to Capture the Effects of Solar Rotation**," I. Kitiashvili, A. Wray, A. Kosovichev, V. Sadykov. *
    https://www.nas.nasa.gov/SC21/research/project19.html
  - "**CFD Analysis of Mars Retrorocket Wind Tunnel Models**," K. Edquist. *
    https://www.nas.nasa.gov/SC21/research/project21.html
  - "**CFD Aerodynamic Database for the NASA X-57 Maxwell Airplane**," K. Deere, J. Viken. *
    https://www.nas.nasa.gov/SC21/research/project22.html
  - "**Simulating the Many Personalities of Our Sun**," L. Matilsky, J. Toomre. *
    https://www.nas.nasa.gov/SC21/research/project23.html
  - "**Identifying Stellar Flare Progenitors Before They Breach the Surface**," Connor Bice, Juri Toomre. *
    https://www.nas.nasa.gov/SC21/research/project24.html
  - "**Simulating the SLS Solid Rocket Booster Plume-Water Induced Environment**," T. Rivord, B. Williams. *
    https://www.nas.nasa.gov/SC21/research/project25.html
  - "**Preparing to Map the World in Living Color with the Surface Biology and Geology Mission**," J. Jenkins, A. Michaelis, Y. Shinozuka, W. Wang. *
    https://www.nas.nasa.gov/SC21/research/project26.html
  - "**Visualizing the Flow Physics of Human-Scale Mars Entry**," P. Moran, G. Nastac, P. Kolono, E. Nielsen. *
    https://www.nas.nasa.gov/SC21/research/project27.html

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Papers (cont.)

- **2021 Supercomputing Conference, St. Louis, MO/Virtual, November 15-20, 2021 (Cont.)**
  - "**Neural Network Training at Scale with Deep Learning Frameworks**," S. Ranjan, T. Norman, J. Gee. * *https://www.nas.nasa.gov/SC21/research/project28.html*
  - "**Convection in High-Resolution Global Solar Simulations**," A. Stejko, G. Guerrero, A. Kosovichev. * *https://www.nas.nasa.gov/SC21/research/project29.html*
  - "**Galactic Center VR: Bringing Your Neighborhood Supermassive Black Hole into Your Living Room**," C. Russell, J. Cuadra, B. Luco, M. Sepulveda.* *https://www.nas.nasa.gov/SC21/research/project30.html*
  - "**HECC: Changing to Meet NASA's Challenges**," W. Thigpen. * *https://www.nas.nasa.gov/SC21/research/project43.html*

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Papers (cont.)

- "**Performance of Wall-Modeled LES with Boundary-Layer-Conforming Grids for External Aerodynamics**," A. Lozano-Duran, S. Bose, P. Moin, AIAA Journal, published online November 15, 2021. *
  https://arc.aiaa.org/doi/abs/10.2514/1.J061041
- "**The Dynamical State of Massive Clumps**,; Z.-J. Lu, et al., arXiv:2111.08887 [astro-ph.GA], November 17, 2021. *
  https://arxiv.org/abs/2111.08887
- "**A Highly Mutually-Inclined, Compact Warm-Jupiter System KOI-984?**" L. Sun, et al., arXiv:2111.09668 [astro-ph.EP], November 18, 2021. *
  https://arxiv.org/abs/2111.09668
- "**Particle-in-Cell Simulations of Astrophysical Relativistic Jets**," A. Meli, K. Nishikawa, Universe, vol.7, issue 11, November 19, 2021. *
  https://www.mdpi.com/2218-1997/7/11/450
- "**Excitation and Damping of Slow Magnetosonic Waves in Flaring Hot Coronal Loops: Effects of Compressive Viscosity**," L. Ofman, T. Wang, arXiv:2111.10696 [astro-ph.SR], November 20, 2021. *
  https://arxiv.org/abs/2111.10696

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Papers (cont.)

- "**Linear Stability-Based Smooth Reynolds-Averaged Navier-Stokes Transition Model for Aerodynamic Flows**," G. Halia, et al., AIAA Journal, published online November 22, 2021. *"**The TESS-Keck Survey. VI. Two Eccentric Sub-Neptunes Orbiting HIP-97166**," M. MacDougall, et al., The Astronomical Journal, vol. 162, no. 6, November 26, 2021. *
https://iopscience.iop.org/article/10.3847/1538-3881/ac295e
- "**Mapping the Magnetic Field in the Taurus/B211 Filamentary Cloud with SOFIA HAWC+ and Comparing with Simulation**," P. S. Li, et al., Monthly Notices of the Royal Astronomical Society, published online November 27, 2021. *
https://academic.oup.com/mnras/advance-article-abstract/doi/10.1093/mnras/stab3448/6445062

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Presentations

- "**Effects of Rotation on Subsurface structure and Dynamics of Main-Sequence Stars with Shallow Convection Zones**," I. Kitiashvili, A. Wray, A. Kosovichev, presented at the International Astronomical Symposium, November 2021. *
- "**3D Realistic Modeling of Solar-Type Stars to Characterize the Stellar Jitter**," I. Kitiashvili, S. Granovsky, A. Wray, presented at the International Astronomical Symposium, November 2021. *
- **2021 Supercomputing Conference, St. Louis, MO/Virtual, November 15-20, 2021**
  Video presentations on the NASA@SC21 website, November 2021. *
  https://www.nas.nasa.gov/SC21/presentations.html
  - "**Simulating the SLS Solid Rocket Booster Plume-Water Induced Environment**," B. Williams
  - "**A Global, Coupled Ocean-Atmosphere Simulation with Kilometer-Scale Resolution**," D. Menemenlis
  - "**Galactic Center VR: Bringing Your Neighborhood Supermassive Black Hole into Your Living Room**," C. Russell, J. Cuadra

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News and Events

- **NASA, Supercomputing, and the Artemis Moon Mission**, *SC21 Blog*, November 8, 2021—NASA supercomputers are helping the agency prepare for Artemis, the program that will return humans to the Moon. Learn more in this SC21 TV interview with NAS Division research scientists Jordan Angel, Derek Dalle and Francois Cadieux.
  https://sc21.supercomputing.org/2021/11/08/nasa-supercomputing-and-the-artemis-moon-mission/
- **6 Things to Know about Supercomputing at NASA**, *NASA Ames*, November 12, 2021—From exploring the solar system and outer space to improving life here on Earth, supercomputing is vital to NASA missions.
  https://www.nasa.gov/press-release/ames/6-things-to-know-about-supercomputing-at-nasa
- **NASA@SC21 Virtual Exhibit**, November 14-19, 2021—The NASA@SC21 virtual exhibit highlights 39 projects from across the agency and academia, all of which utilized the computing, storage, networking, and/or visualization services from the NASA Advanced Supercomputing (NAS) Division at Ames Research Center and the NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center.
  https://www.nas.nasa.gov/SC21/
- **Supercomputing Reveals "Fossil Record" of Galaxy Collisions and Mergers**, *NASA Ames*, November 17, 2021—Using the Pleiades supercomputer and data from the Hubble Space Telescope, researchers simulated a Milky Way-like galaxy in the early stages of a collision with another smaller galaxy—revealing a detailed "fossil record" of information about the simulated galaxy's history.
  https://www.nasa.gov/feature/ames/supercomputing-reveals-fossil-record-of-galaxy-collisions-and-mergers

News and Events (cont.)

- **NASA's Newest Supercomputer Gets a Power Boost**, *NAS News*, November 18, 2021—NASA's Aitken supercomputer is being expanded with 512 new nodes that bring its theoretical peak performance to 10.76 petaflops—a 28% increase in performance. *https://www.nas.nasa.gov/pubs/stories/2021/feature_Aitken_Nov_21_expansion.html*
- **NASA Simulates a Smooth Ride to Stabilize Air Taxis**, *NASA Ames*, November 18, 2021—Utilizing the supercomputers at NAS, researchers are using complex computer simulations to assess air vehicles to improve safety and performance. *https://www.nasa.gov/image-feature/ames/nasa-simulates-a-smooth-ride-to-stabilize-air-taxis*
- **NASA Supercomputers Predict How Vibrations Vary with Altitude for Orion Abort Scenarios**, *NASA Ames*, November 22, 2021—NAS Division researchers are using their LAVA software to simulate Orion's launch abort system, to predict how different abort scenarios will affect vibrations generated by exhaust plume pressure waves. *https://www.nasa.gov/image-feature/ames/nasa-supercomputers-predict-how-vibrations-vary-for-orion-abort-scenarios*
- **New Deep Learning Method Adds 301 Planets to Kepler's Total Count**, *NASA Ames*, November 22, 2021—By using a new deep neural network called ExoMiner and NASA's Pleiades supercomputer, NAS researcher Jon Jenkins and his colleagues recently added a whopping 301 newly validated exoplanets to the total exoplanet tally. *https://www.nasa.gov/feature/ames/new-deep-learning-method-adds-301-planets-to-keplers-total-count*
- **Coronal Prediction for the December 4, 2021 Total Solar Eclipse**, *Predictive Science Inc.*, November 2021—The final prediction of the solar corona for the December 4, 2021 total solar eclipse, which will be visible over Antarctica and parts of the South Pacific. *https://shadow2.predsci.com/corona/dec2021eclipse/home.php*

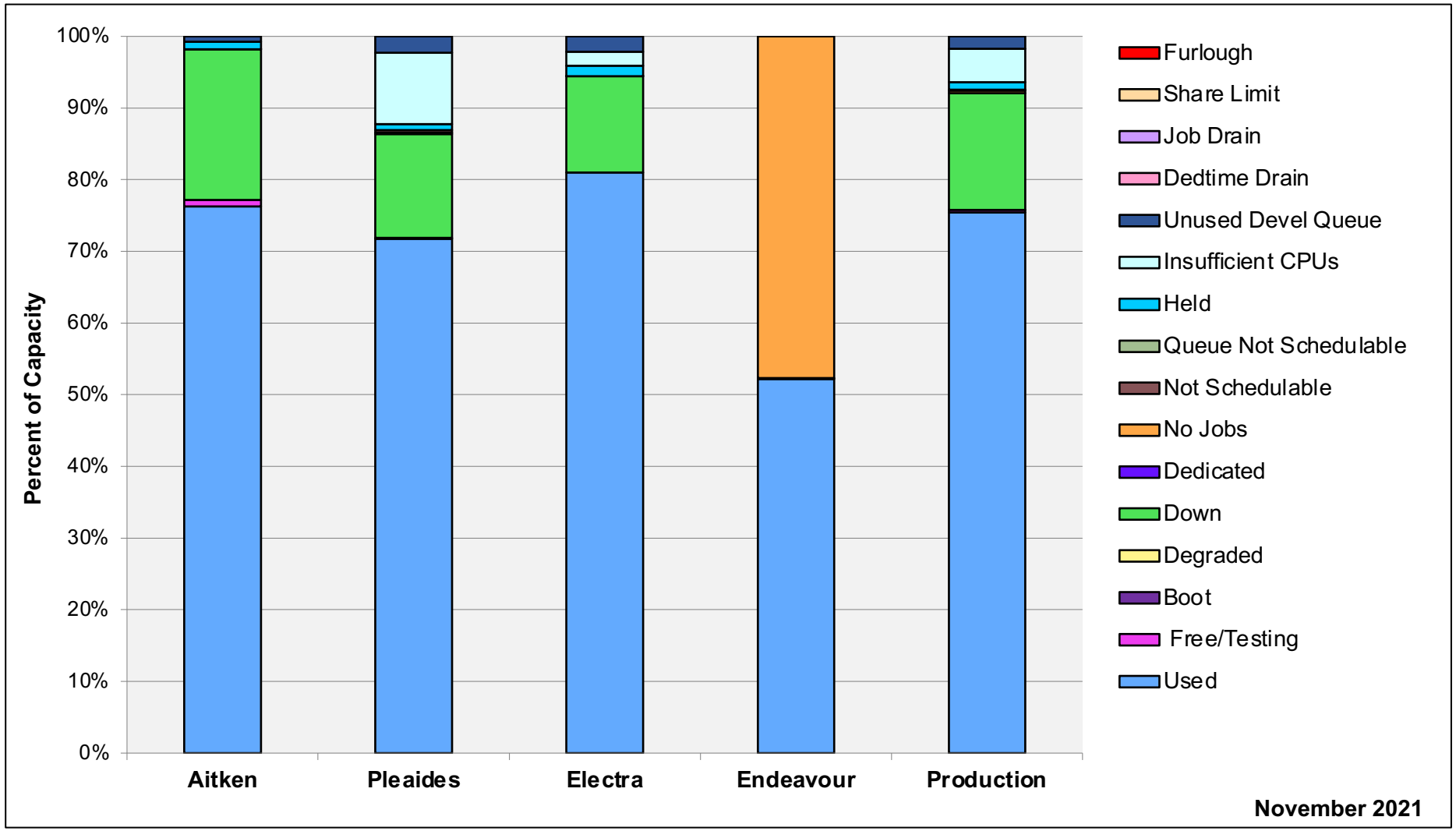
News and Events: Social Media

- **Coverage of NAS Stories**
  - NASA@SC21: Twitter Collection (45 tweets), Facebook (11 posts)
    - Orion LAS Simulation:
      - NASA Ames: Facebook 112 likes, 2 comments, 36 shares; Twitter 288 retweets, 367 quote tweets, 1,816 likes.
      - NASA Supercomputing: Twitter 4 retweets, 1 quote tweet, 31 likes.
    - Air Taxi Simulations:
      - NASA Ames: Facebook 79 likes, 4 comments, 20 shares; Twitter 25 retweets, 1 quote tweet, 91 likes.
      - NASA Langley: Twitter 19 retweets, 87 likes.
    - Colliding Galaxies:
      - NASA Ames: Facebook 44 likes, 16 shares; Twitter 56 retweets, 3 quote tweets, 335 likes.
    - 6 Things to Know about Supercomputers Feature:
      - NASA Ames: Facebook 106 likes, 3 comments, 28 shares; Twitter 23 retweets, 123 likes.
  - Scientist Feature, Patricia Ventura Diaz:
    - NASA Supercomputing: Facebook 553 users reached, 27 engagements, 2 shares.
    - NASA Ames: Facebook 110 likes, 2 comments, 25 shares; Twitter 18 retweets, 68 likes.
  - Exoplanet Validation Pipeline:
    - NASA Supercomputing: Facebook 728 users reached, 22 engagements, 9 likes, 1 share.
    - NASA Ames: Facebook 69 likes, 16 shares; Twitter 135 retweets, 20 quote tweets, 63 likes.
    - NASA: Twitter 854 retweets, 50 quote tweets, 6,623 likes.

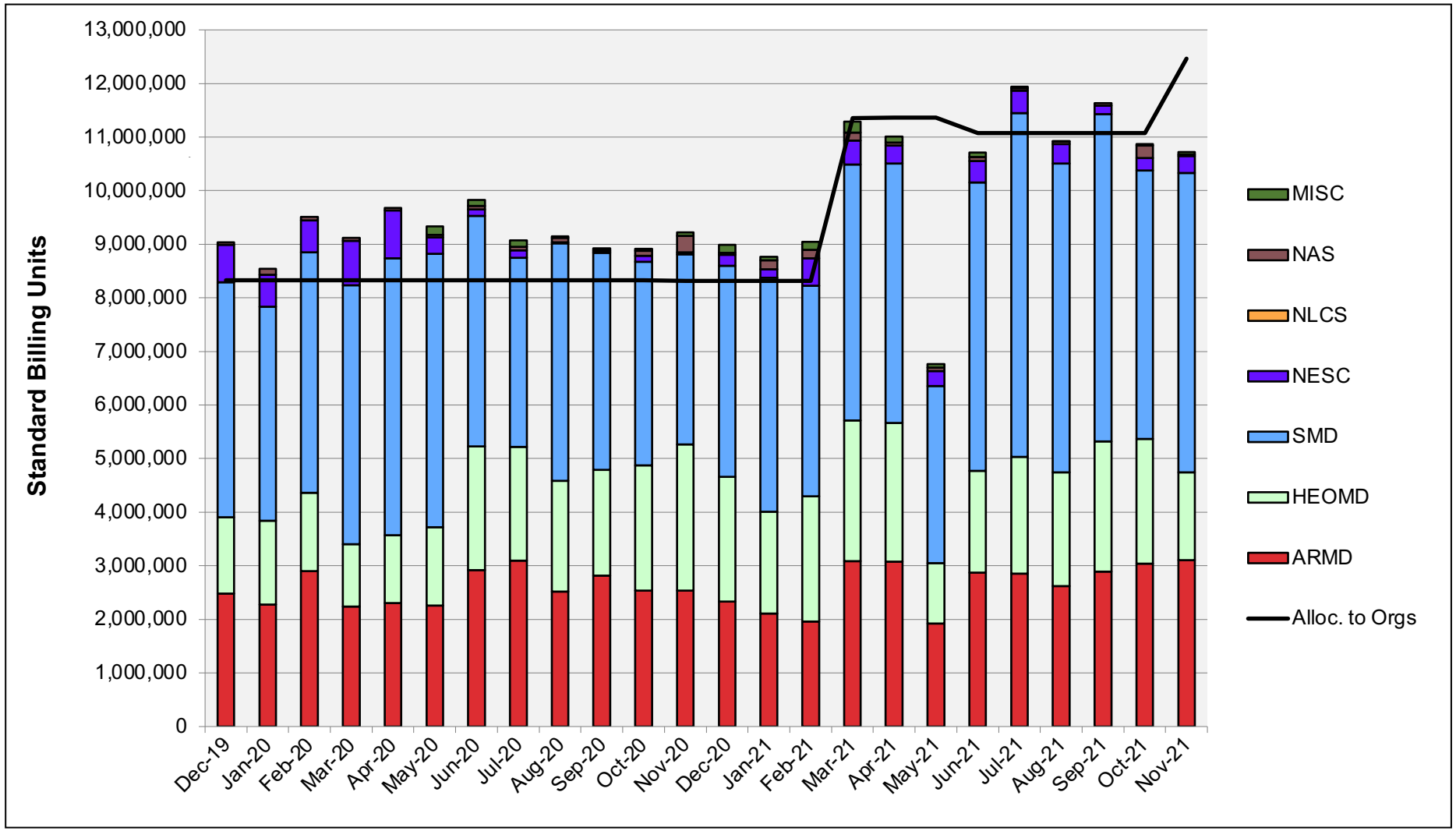
News and Events: Social Media

- **Coverage of NAS Stories (cont.)**
  - DART/Asteroid Impact Prediction:
    - NASA Supercomputing: Facebook 128 users reached, 5 engagements, 2 likes, 1 share.
    - NASA Ames: Facebook 39 likes, 1 comment, 15 shares; Twitter 16 retweets, 2 quote tweets, 69 likes.
  - Black Hole Friday:
    - NASA Supercomputing: Facebook 168 users reached, 8 engagements, 5 likes; Twitter 13 retweets, 36 likes.
    - NASA Ames: Facebook 27 likes; Twitter 66 retweets, 7 quote tweets, 261 likes.
  - Monday Motivation Poster:
    - NASA Ames: Facebook 132 likes, 4 comments, 30 shares; Twitter 8 retweets, 76 likes.

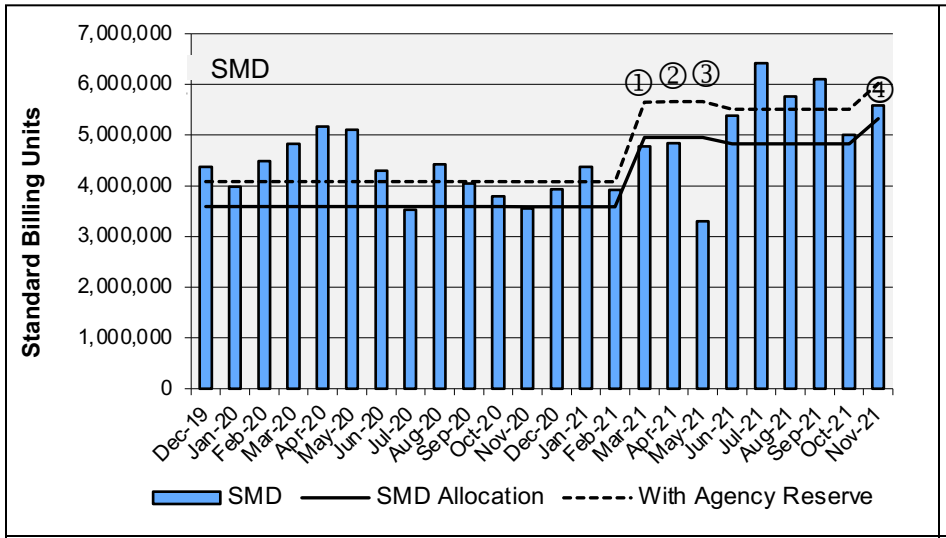
HECC Utilization

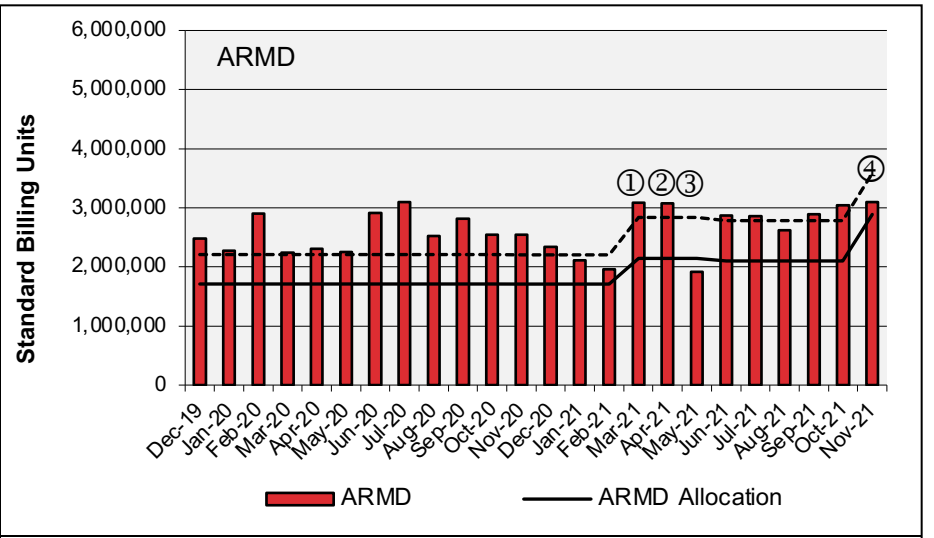


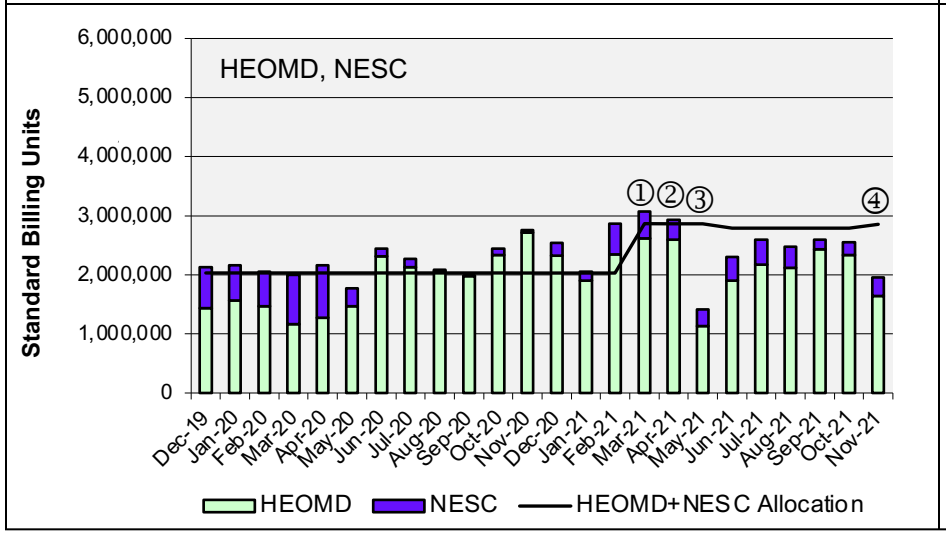
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







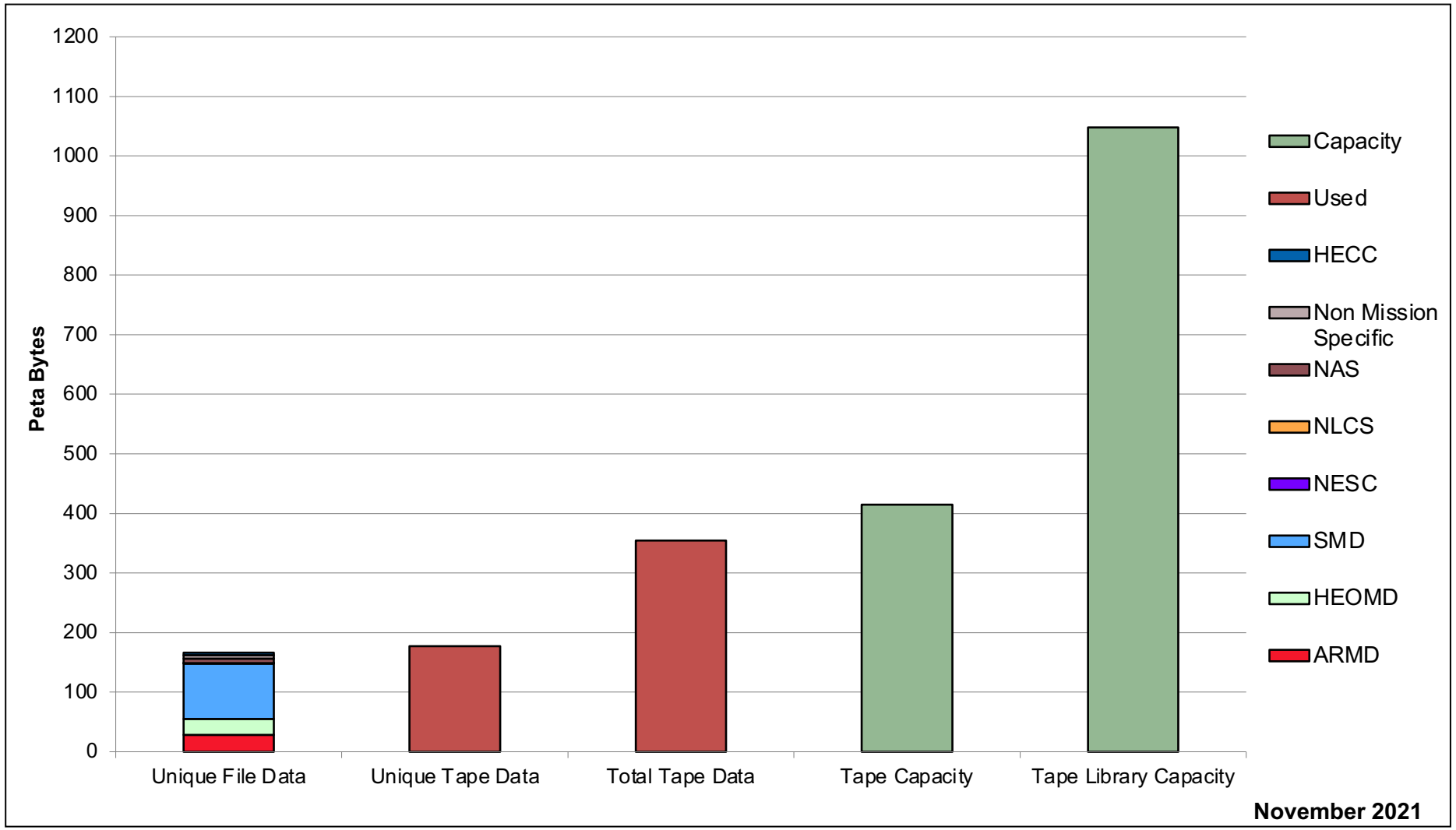
① 8 Rome Apollo racks introduced into Aitken

② Endeavour replaced with new hardware

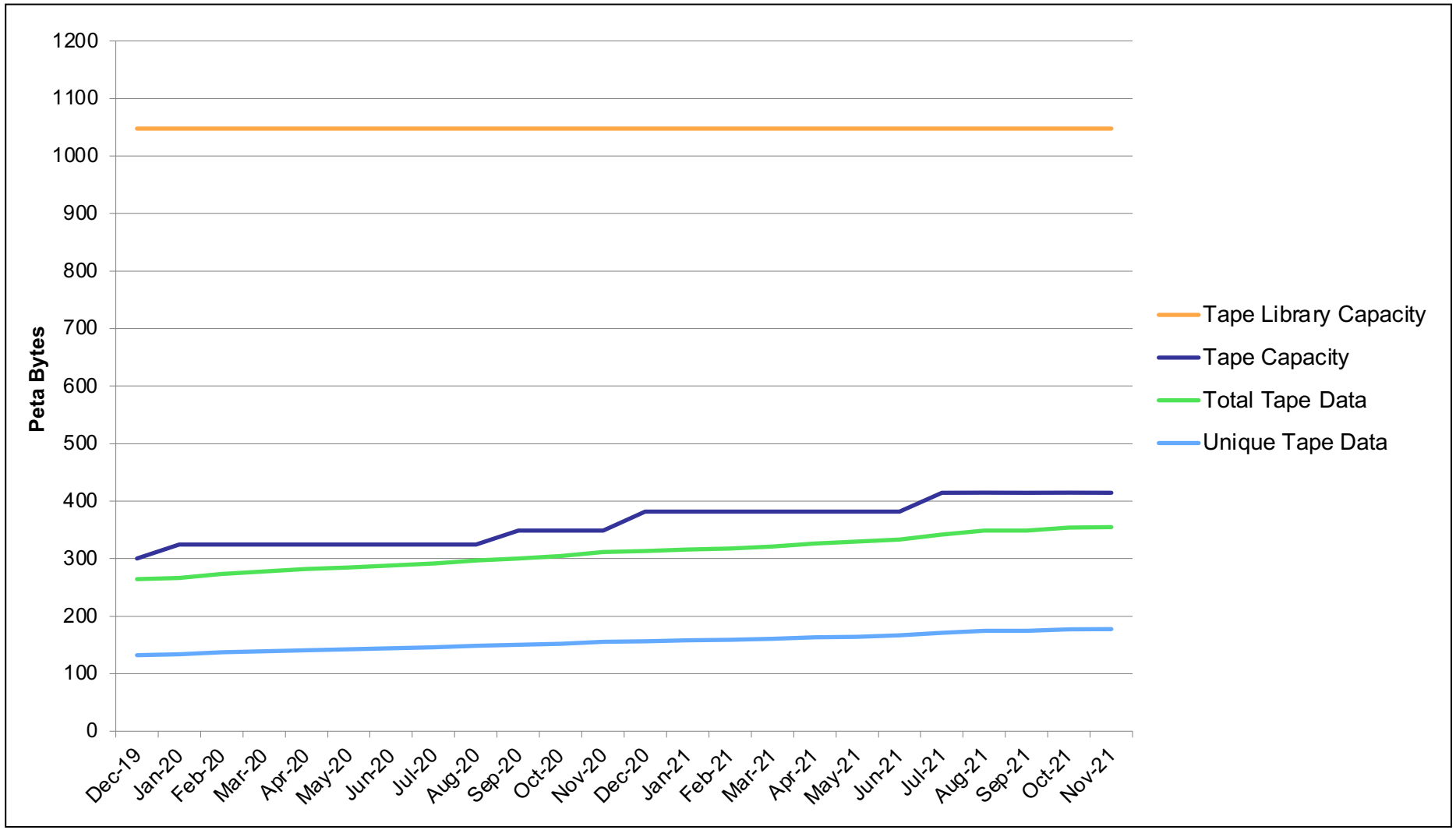
③ Merope retired

④ 4 Rome Apollo Racks added to Aitken

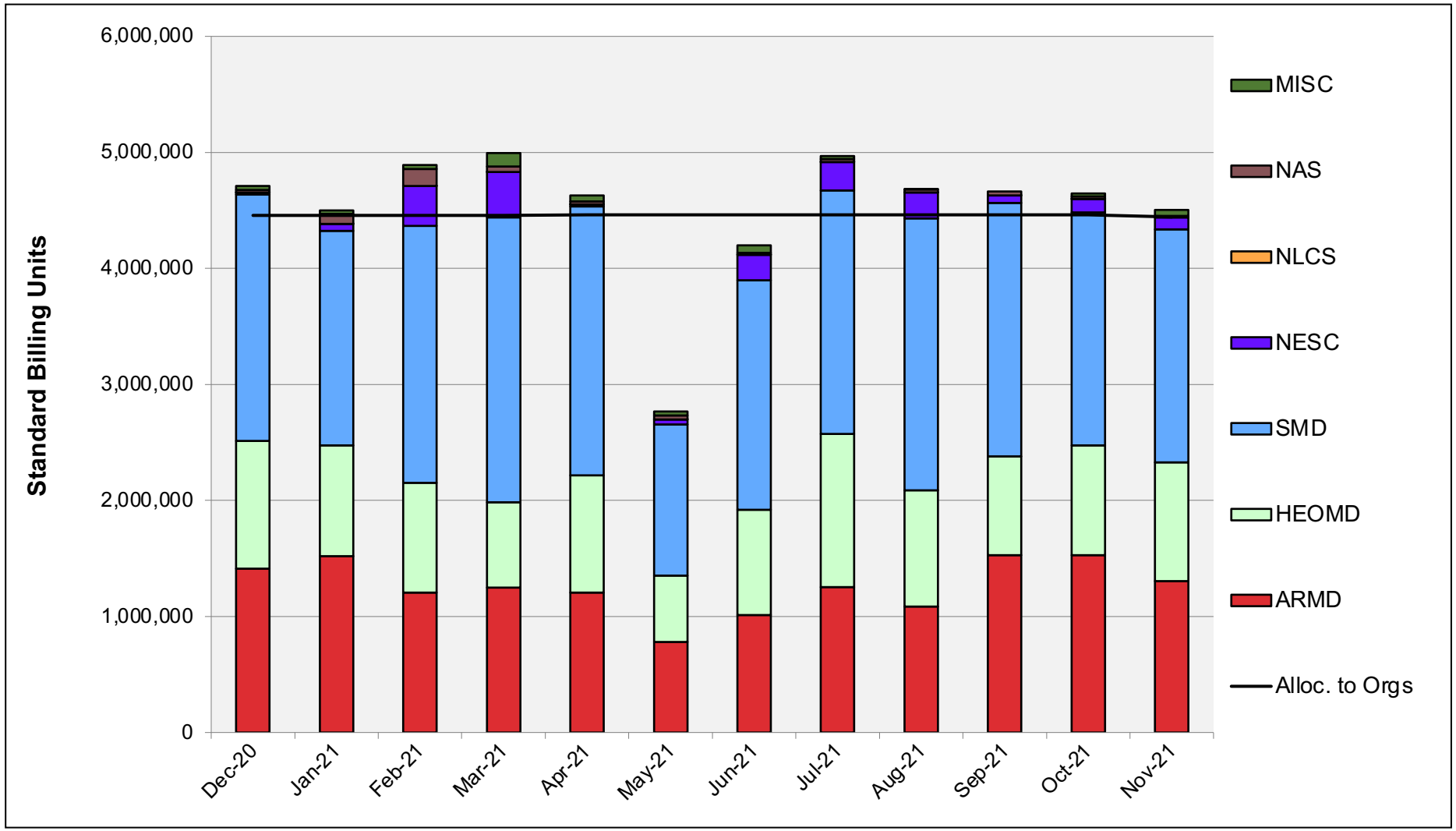
Tape Archive Status



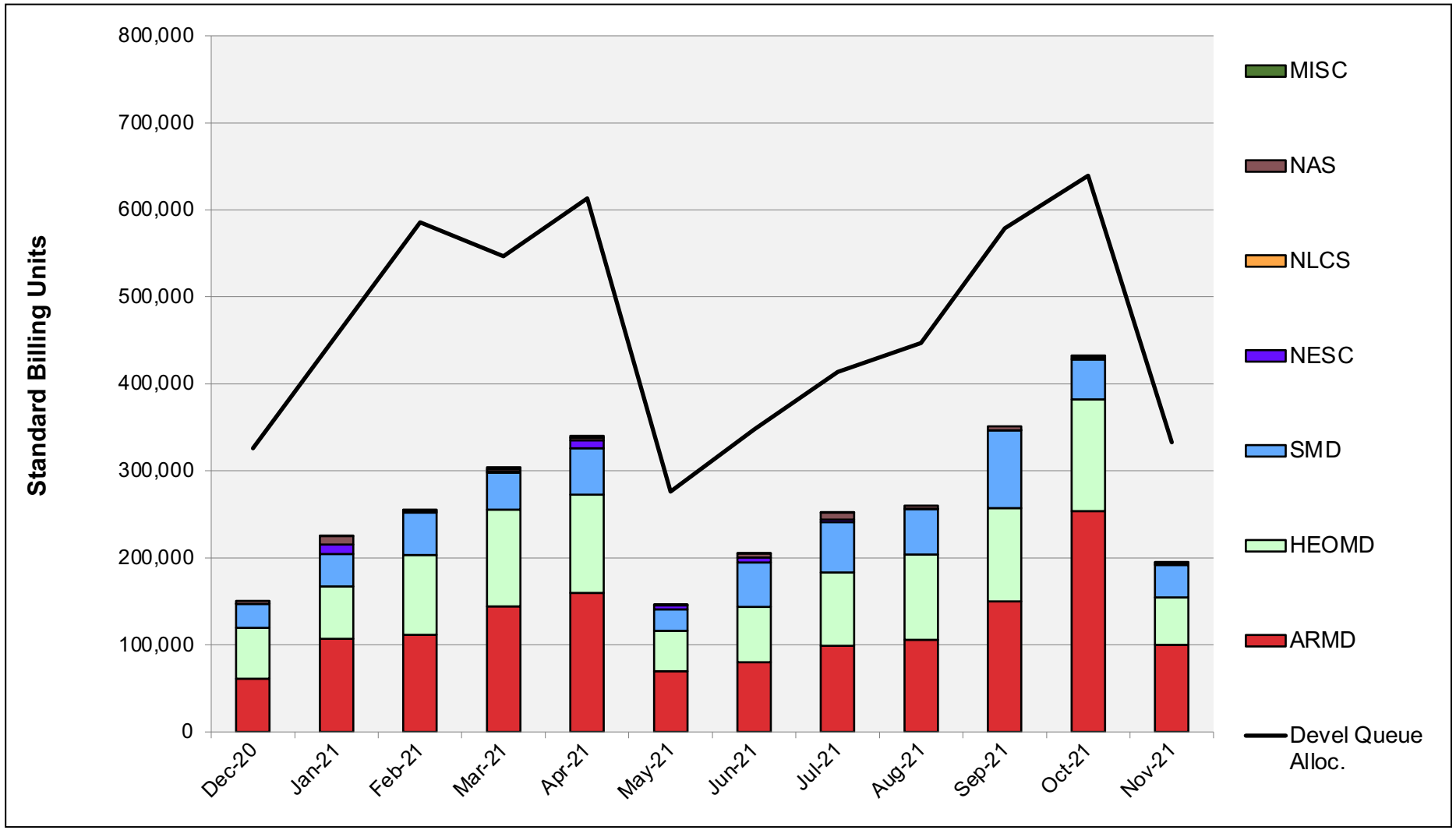
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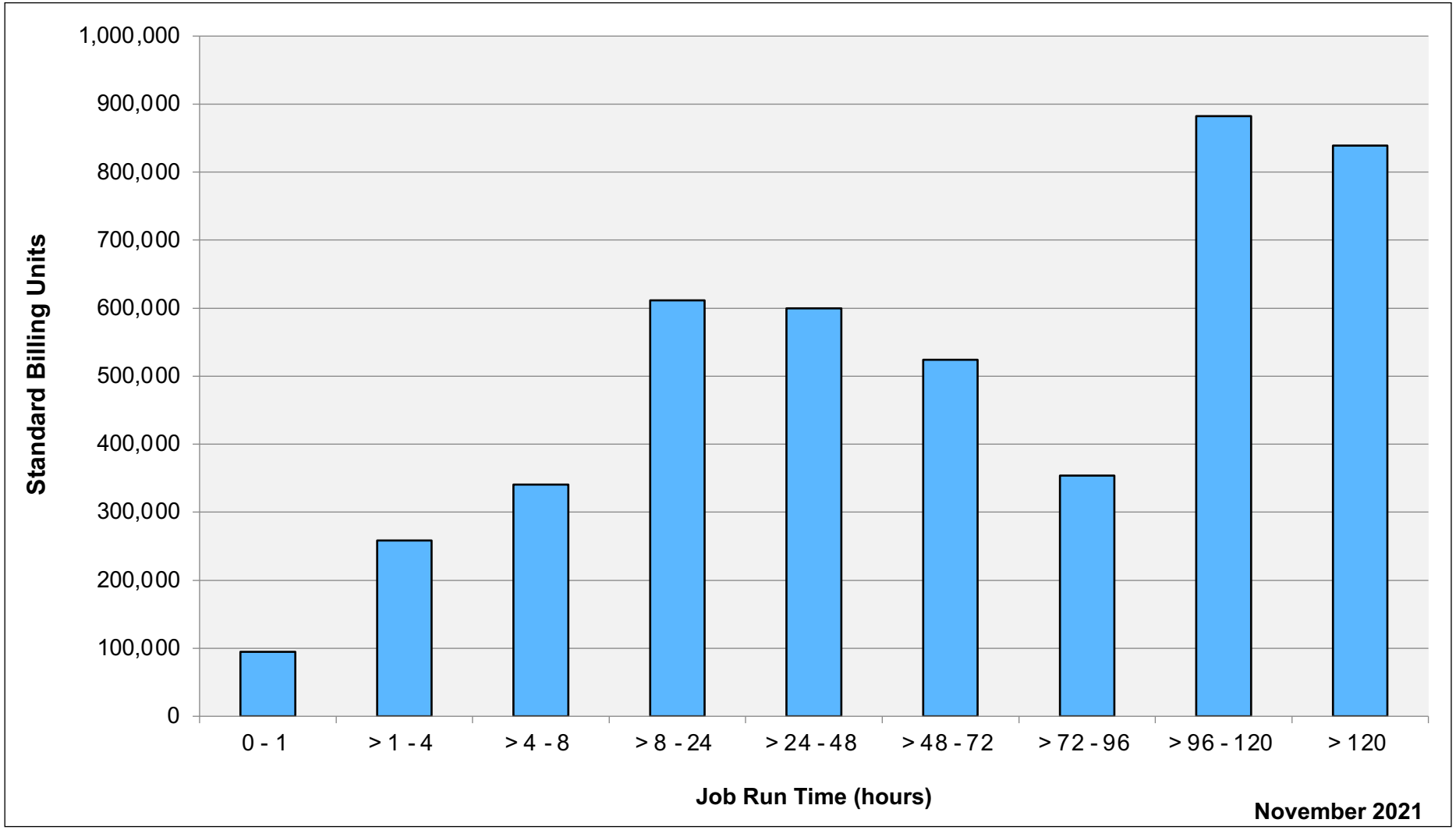
Pleiades: SBUs Reported, Normalized to 30-Day Month



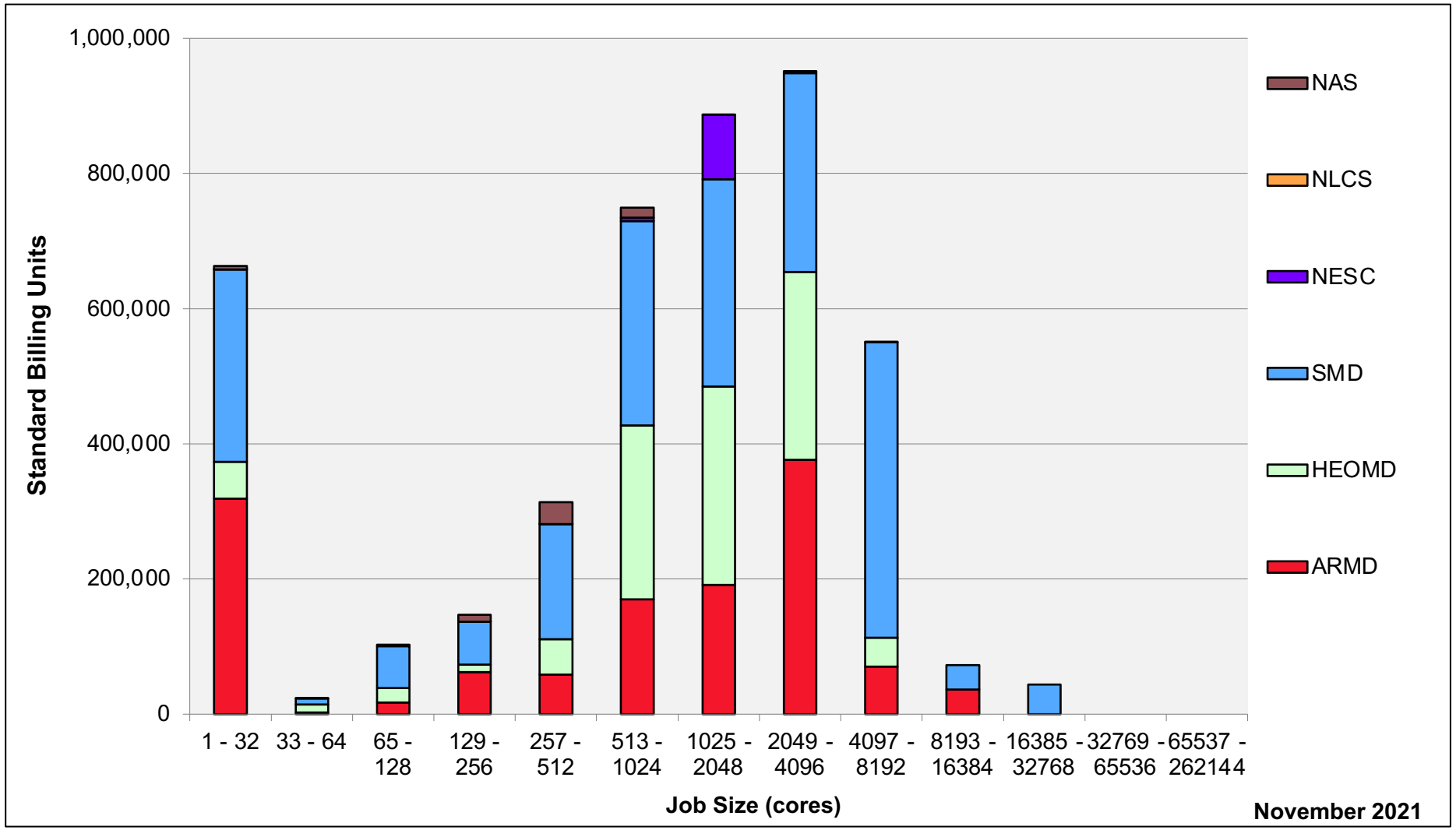
Pleiades: Devel Queue Utilization



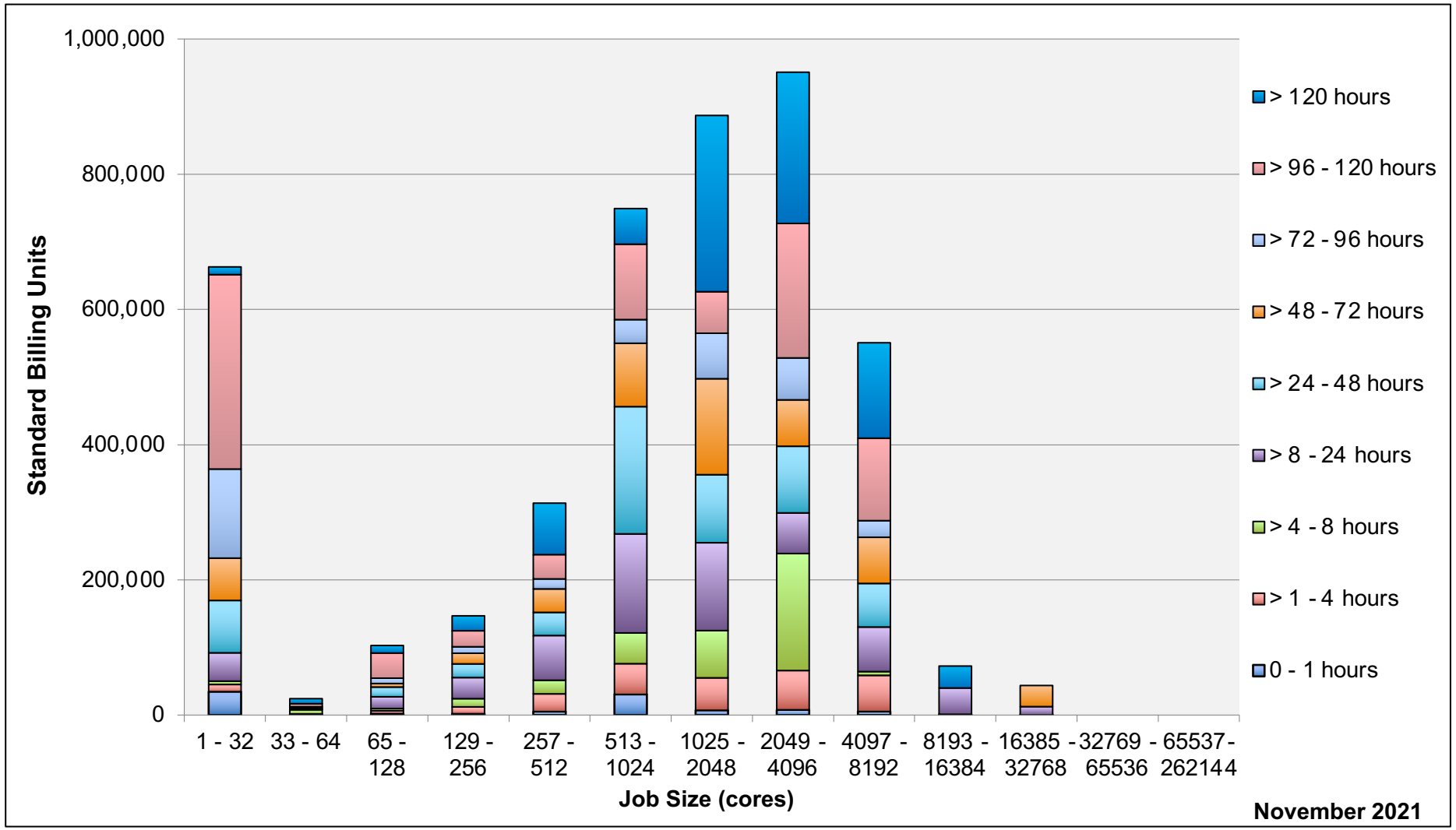
Pleiades: Monthly Utilization by Job Length



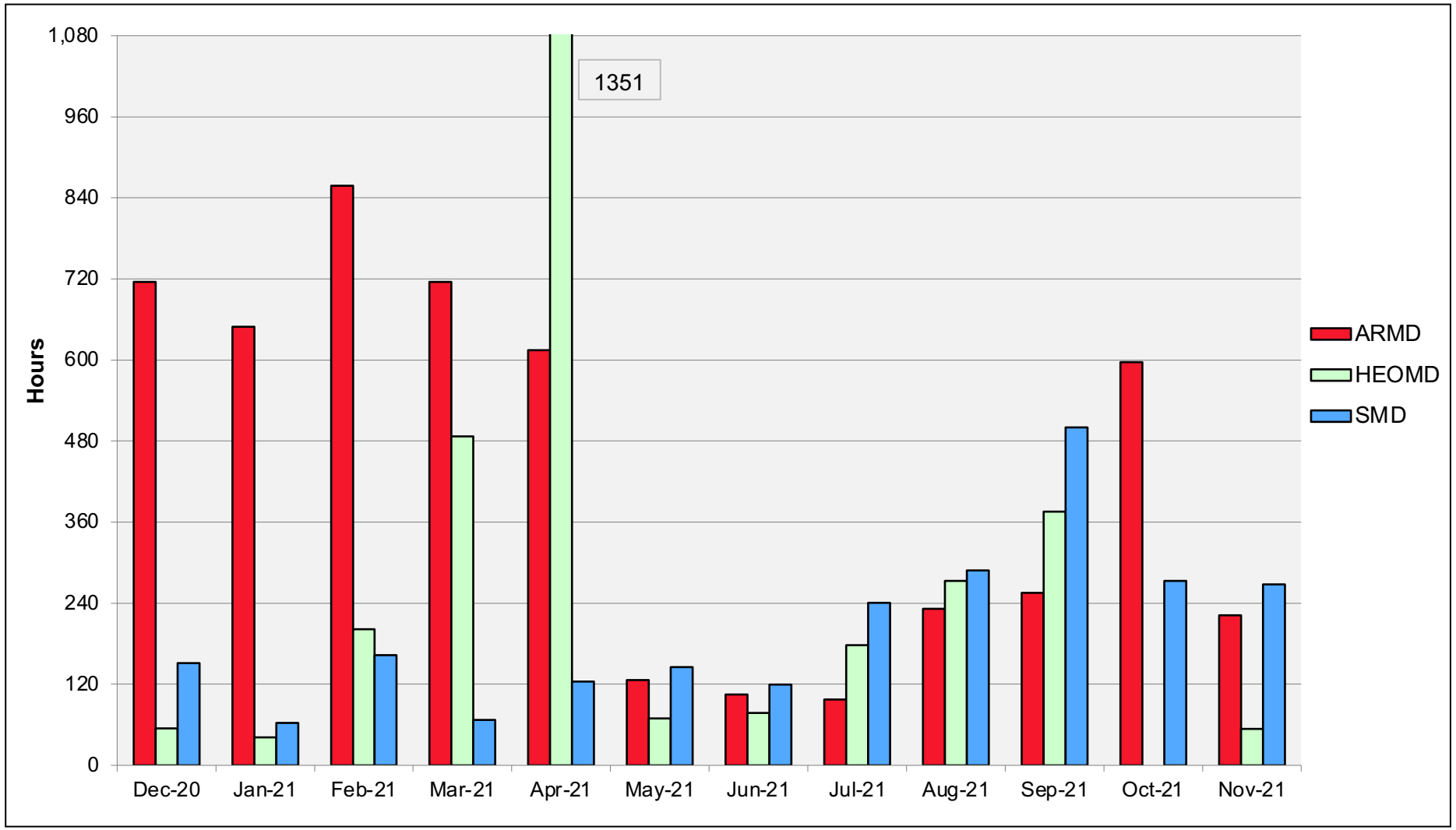
Pleiades: Monthly Utilization by Job Size



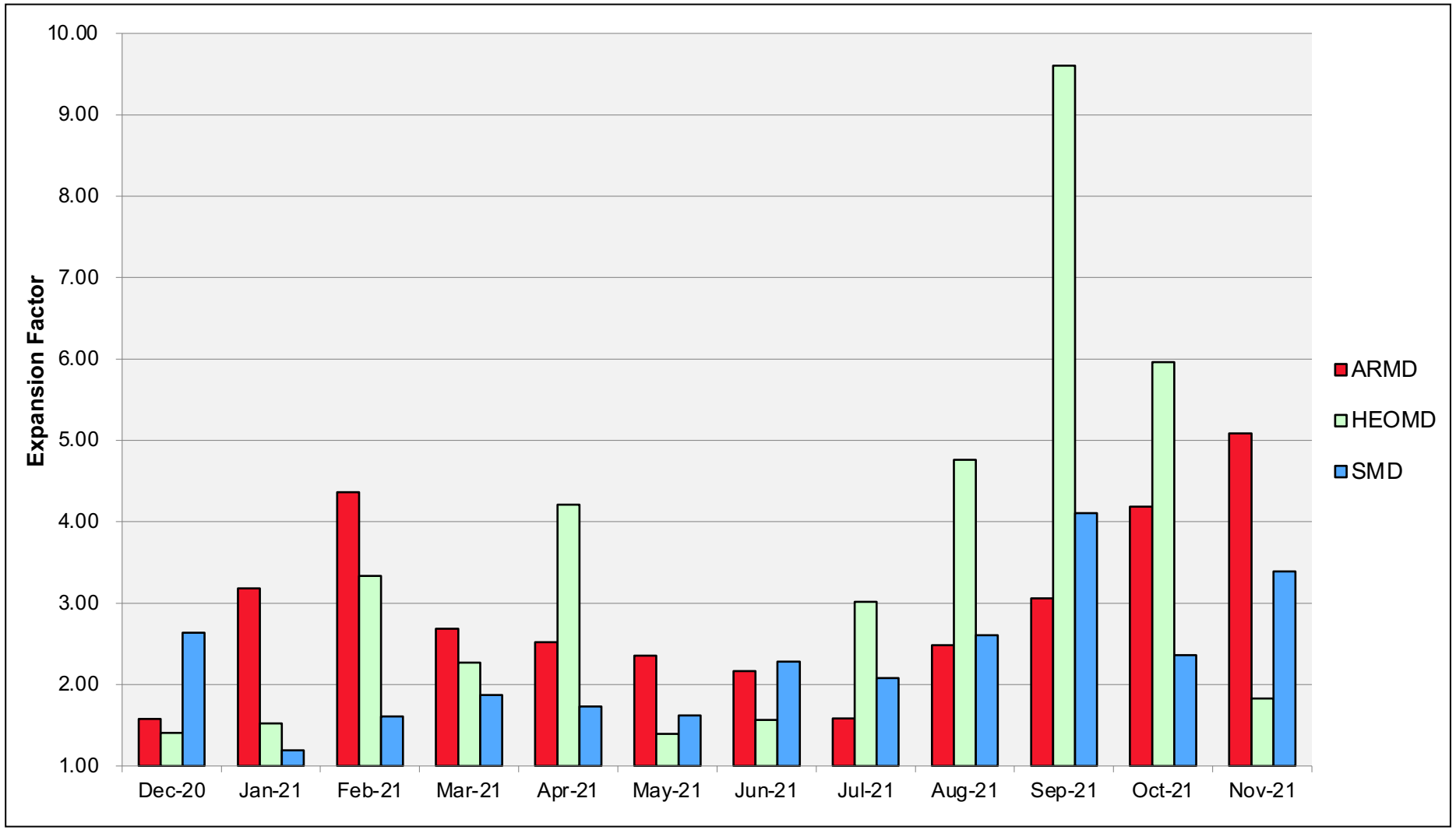
Pleiades: Monthly Utilization by Size and Length



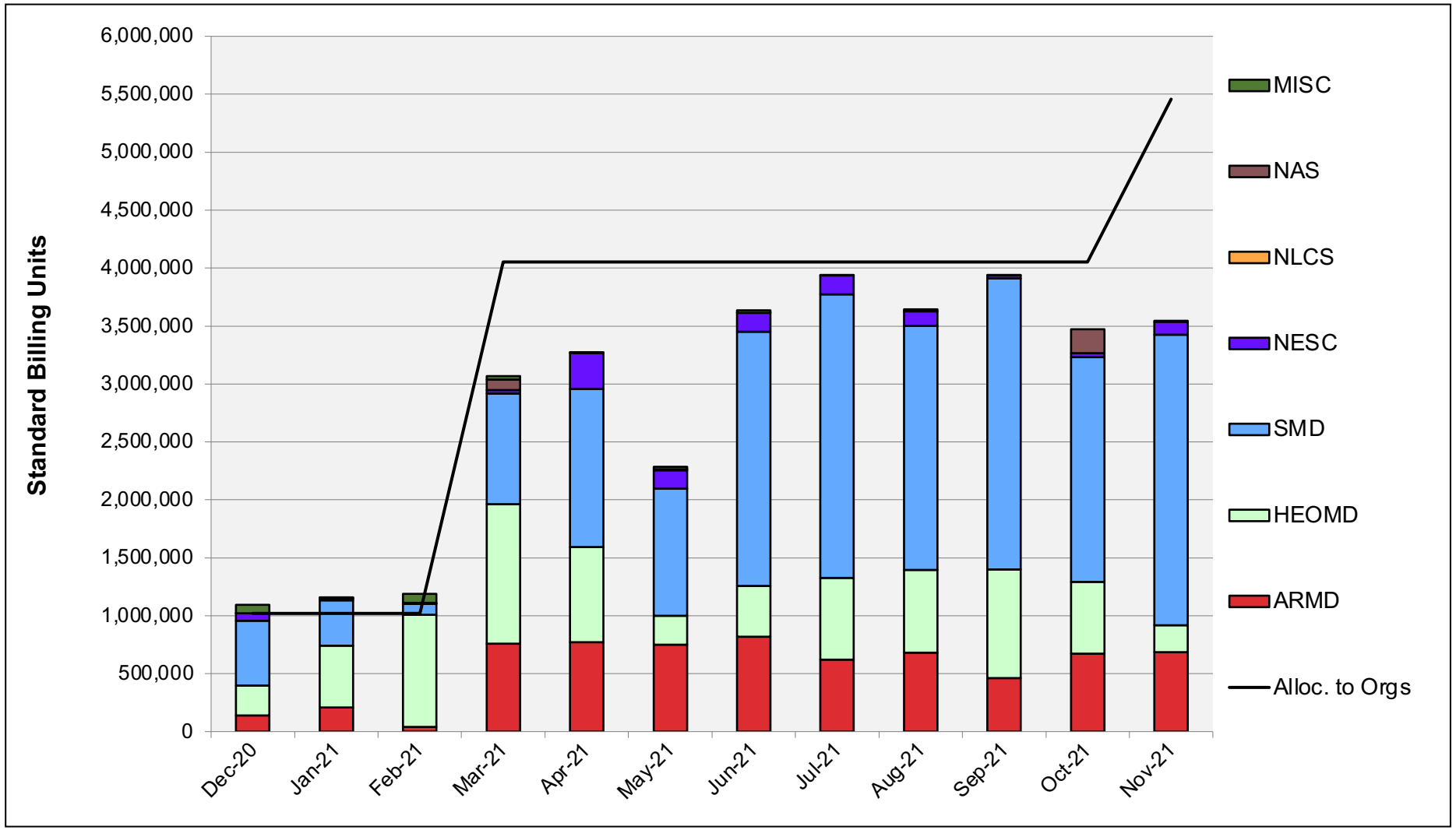
Pleiades: Average Time to Clear All Jobs



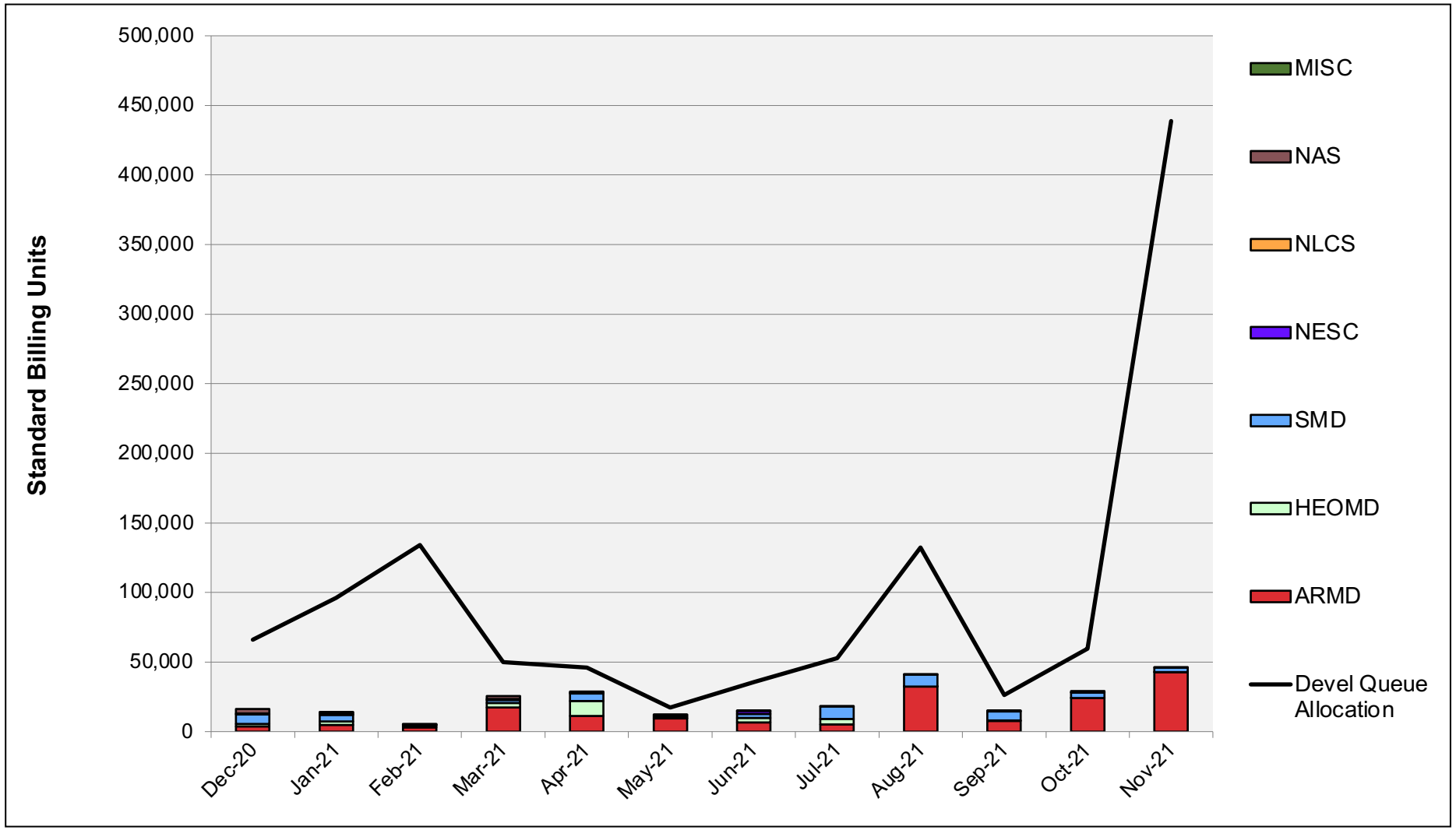
Pleiades: Average Expansion Factor



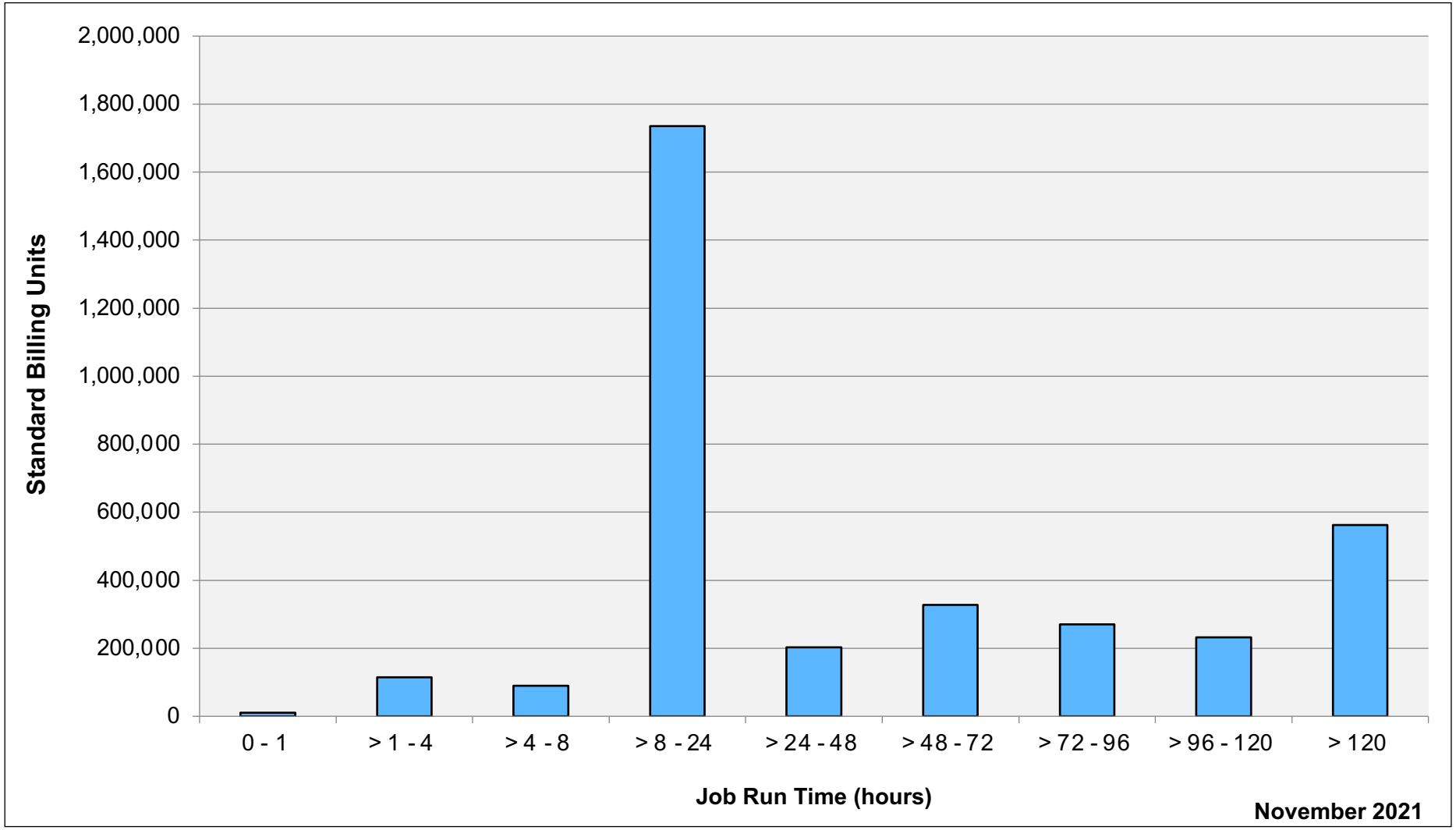
Aitken: SBUs Reported, Normalized to 30-Day Month



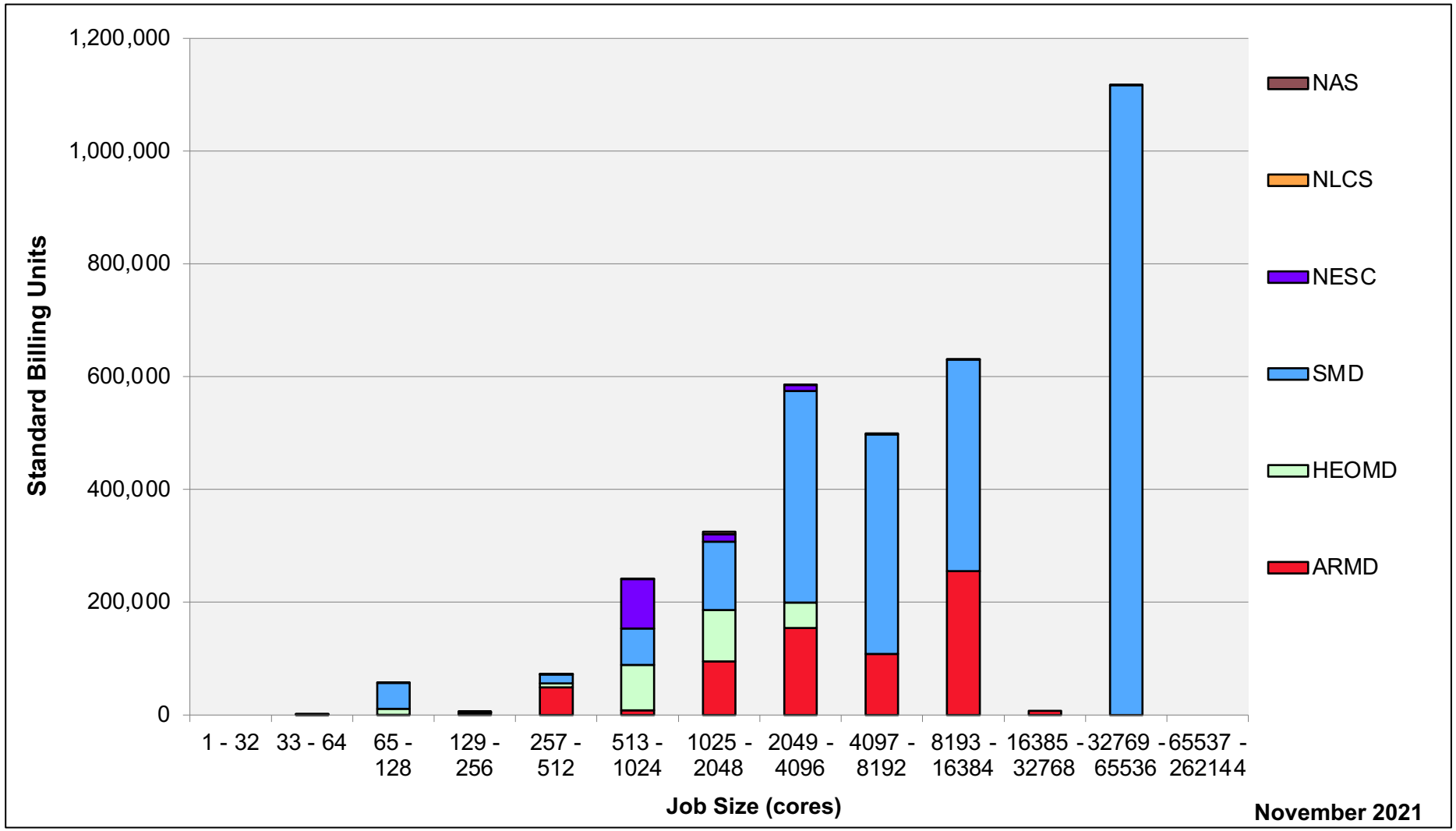
Aitken: Devel Queue Utilization



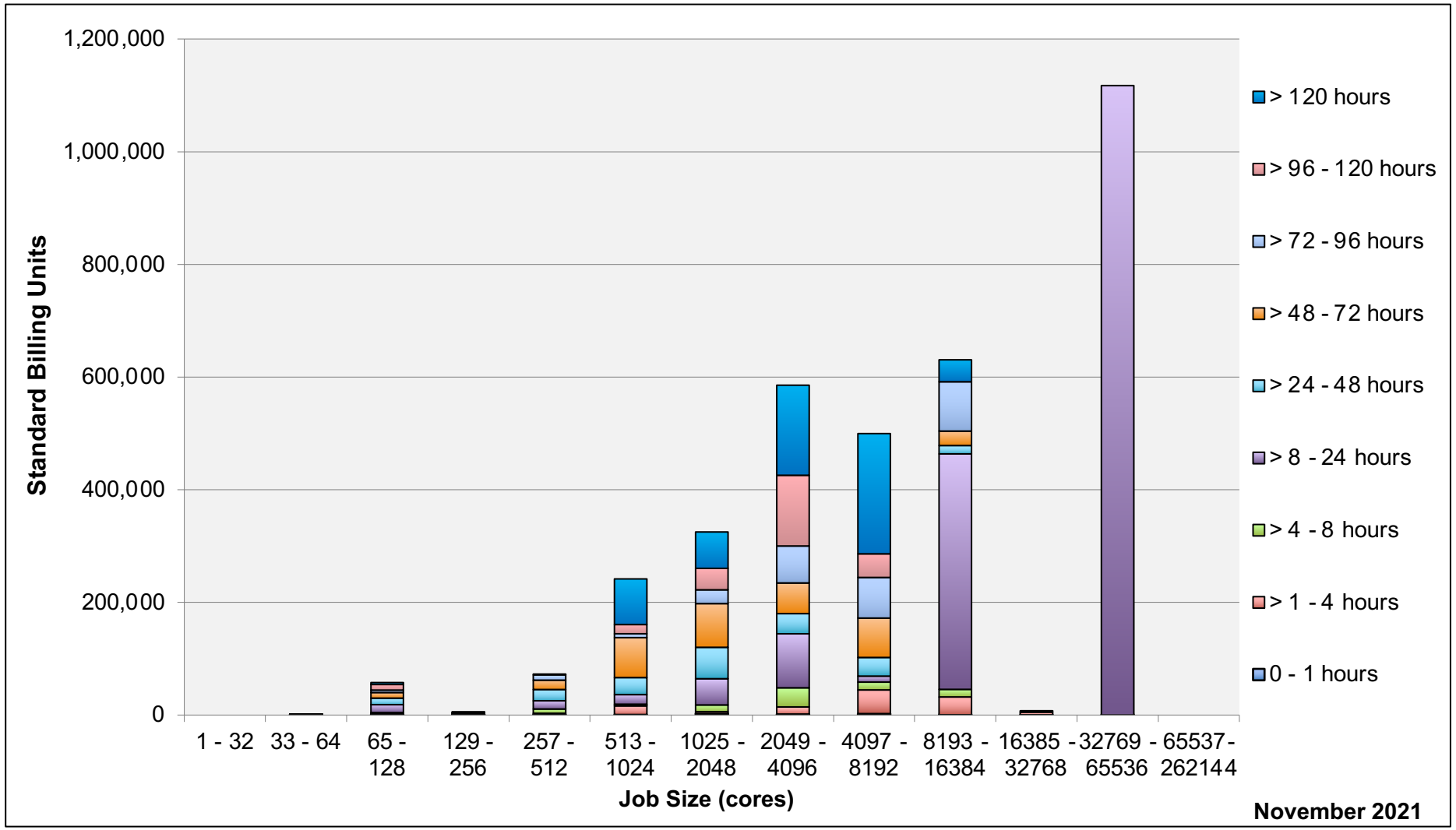
Aitken: Monthly Utilization by Job Length



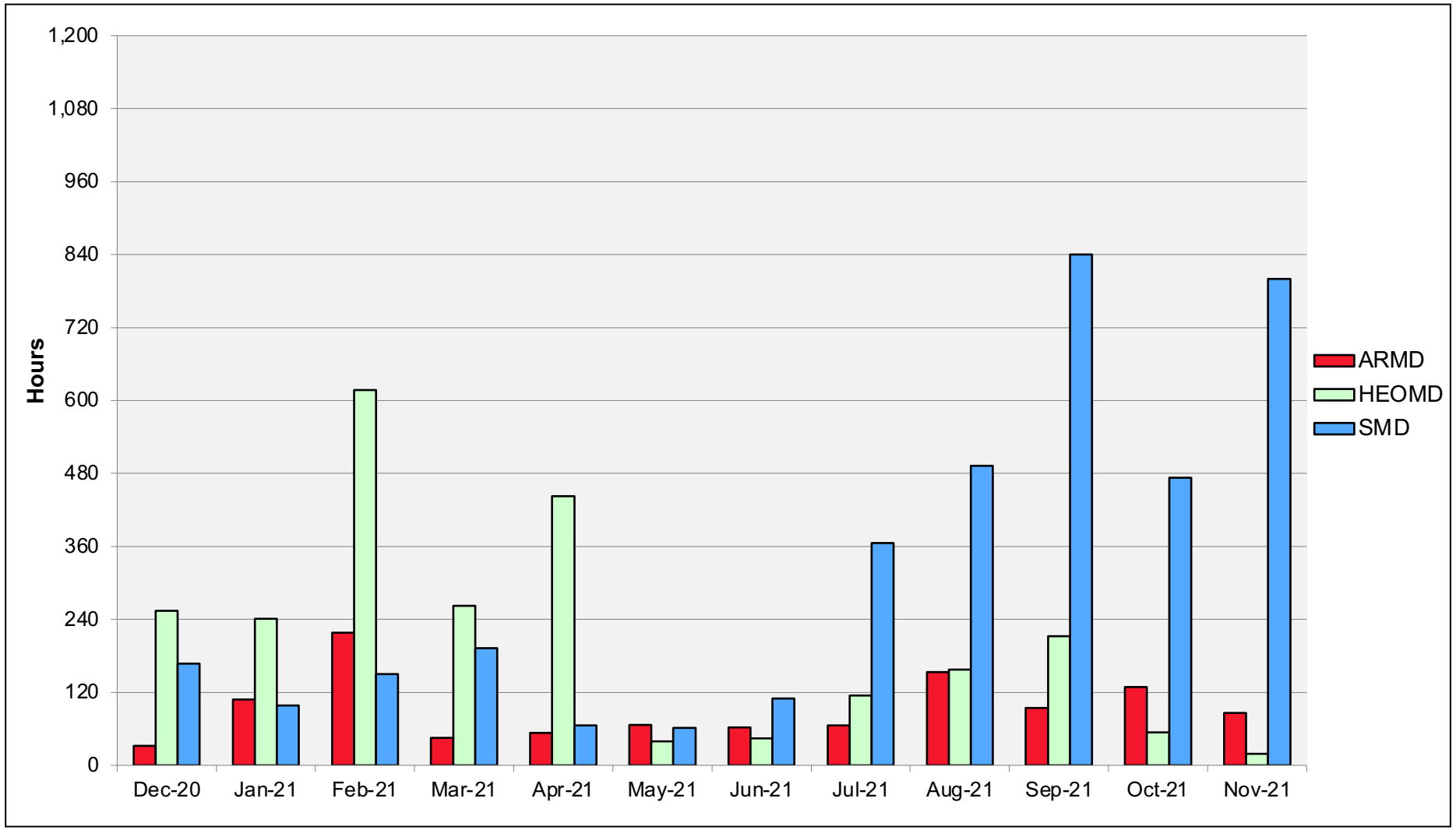
Aitken: Monthly Utilization by Job Size



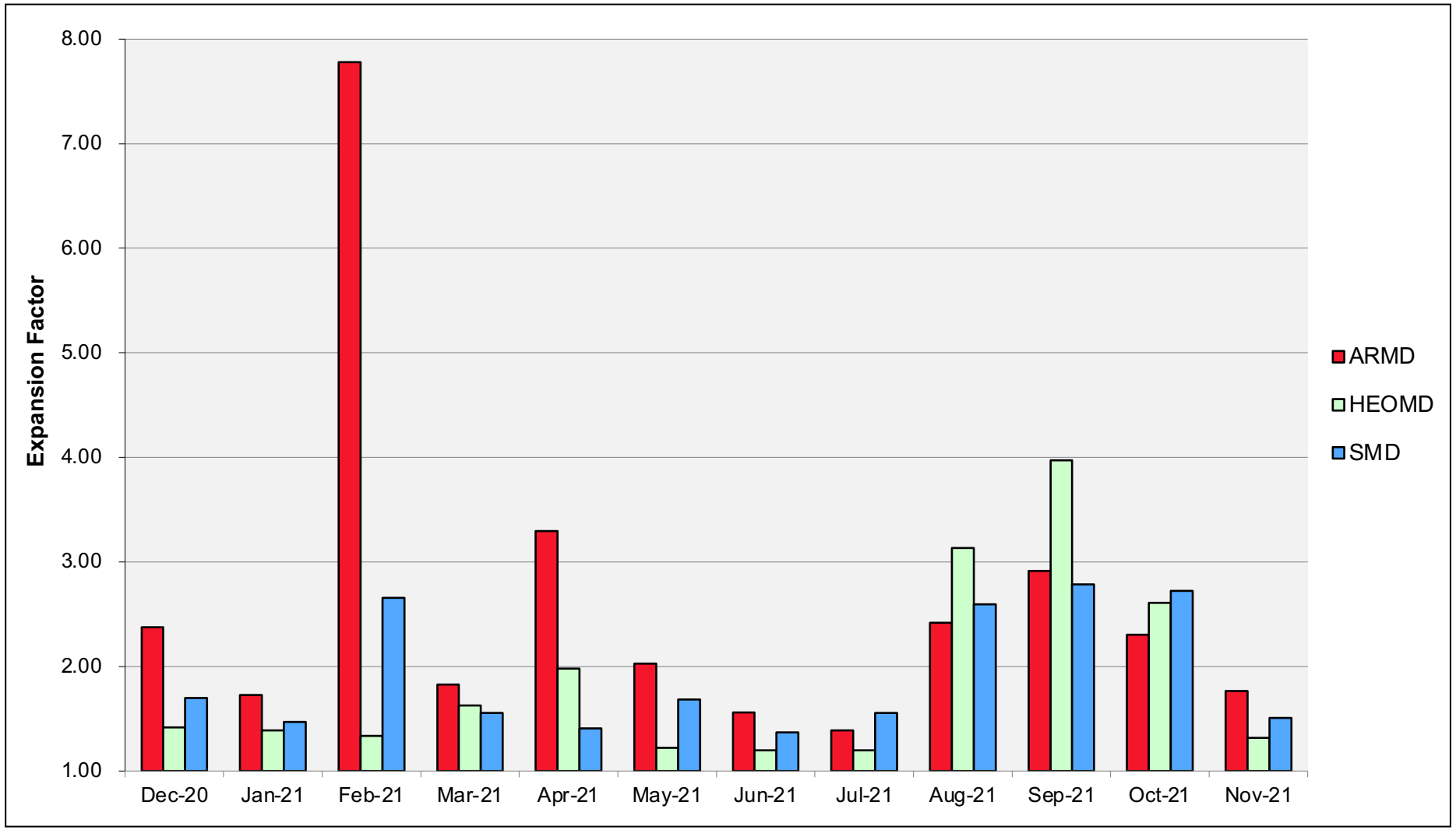
Aitken: Monthly Utilization by Size and Length



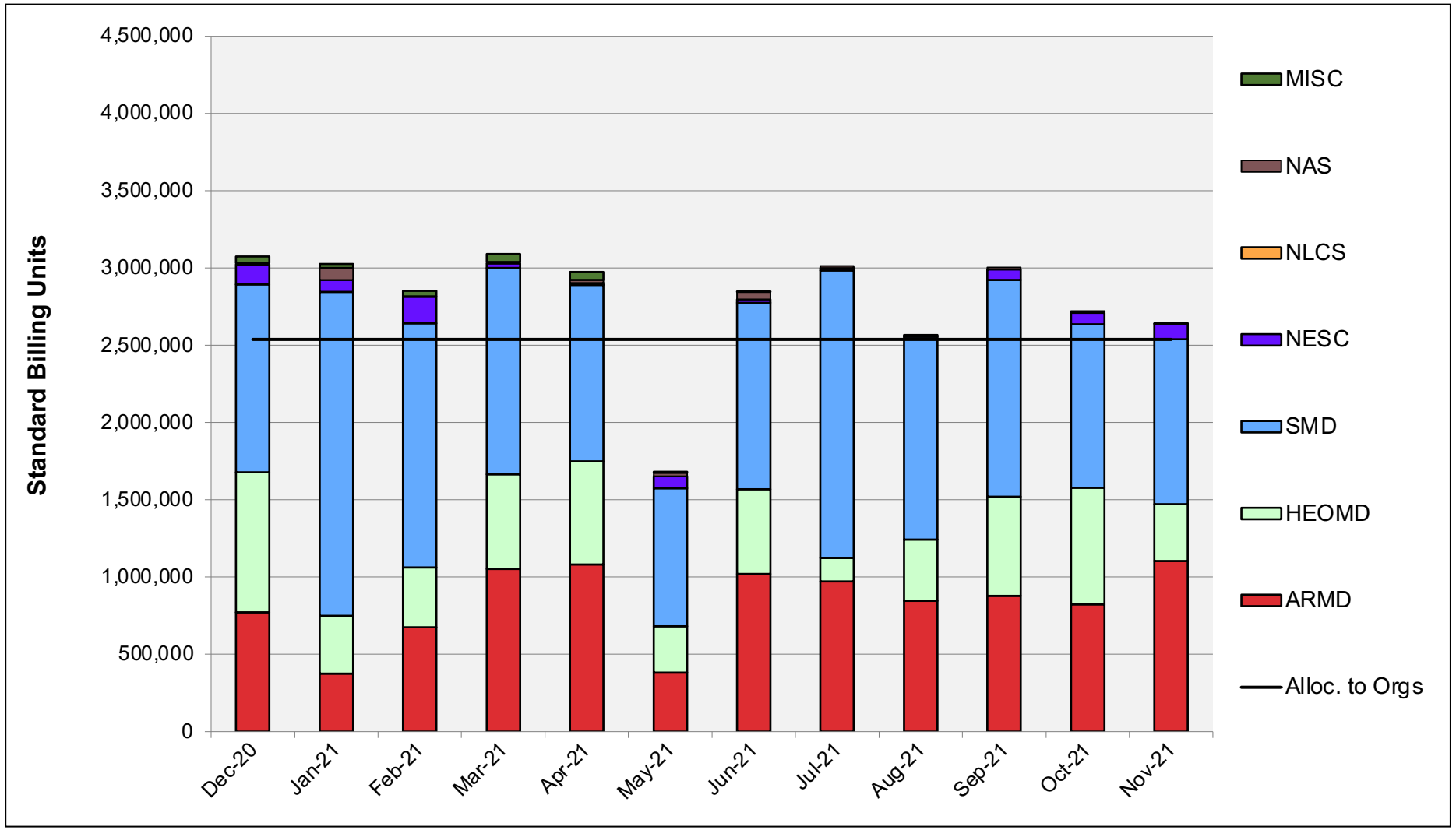
Aitken: Average Time to Clear All Jobs



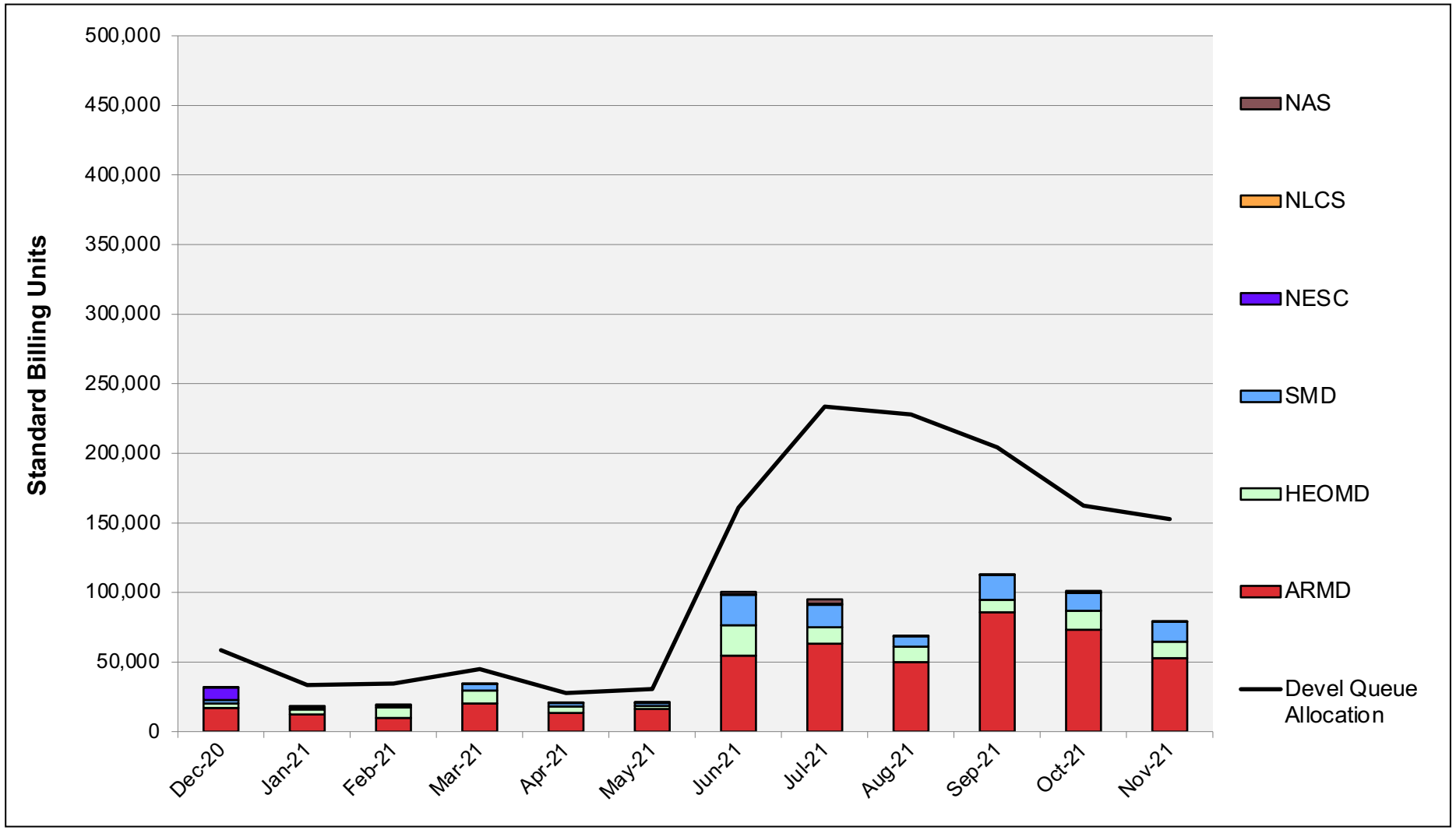
Aitken: Average Expansion Factor



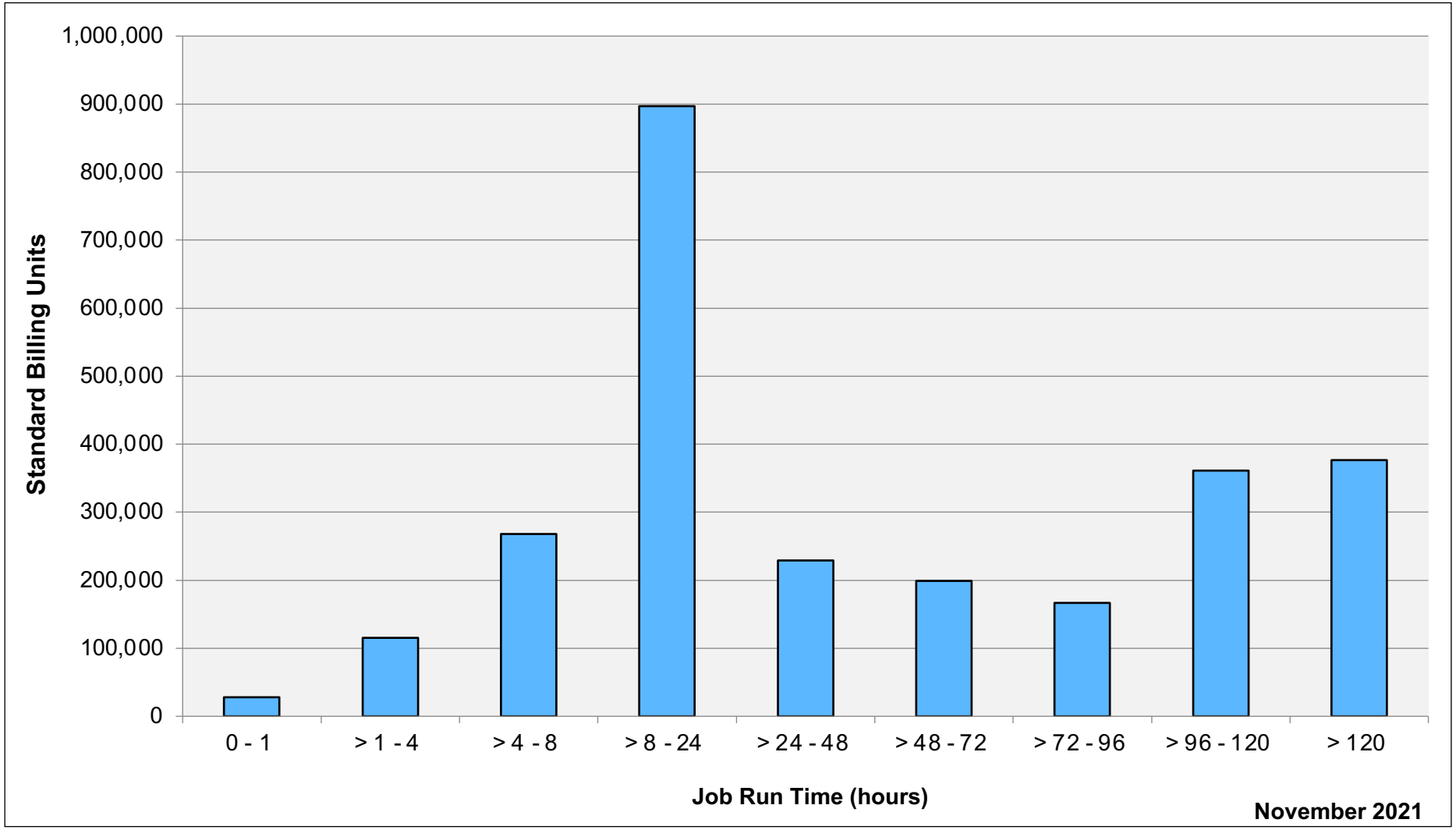
Electra: SBUs Reported, Normalized to 30-Day Month



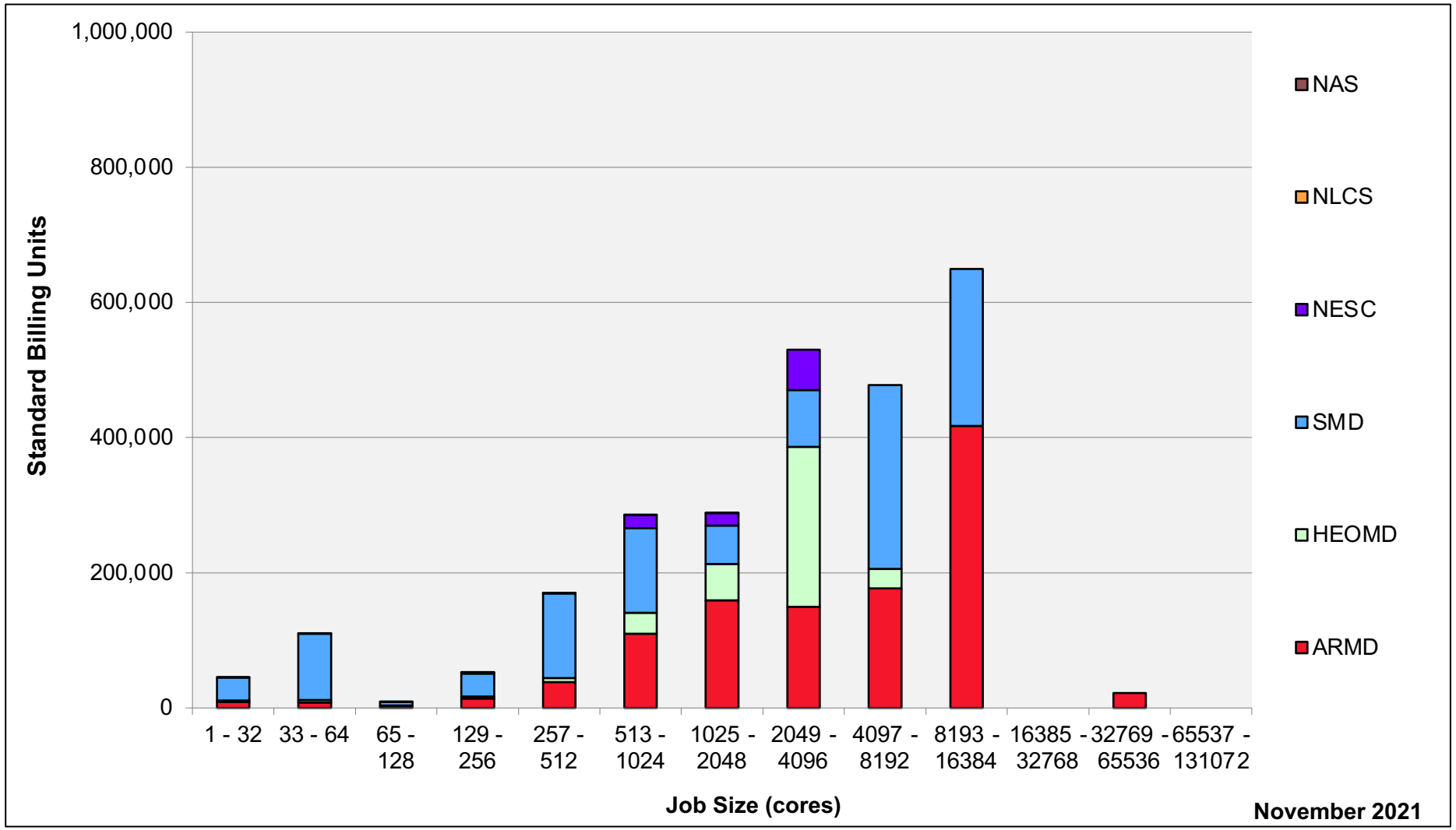
Electra: Devel Queue Utilization



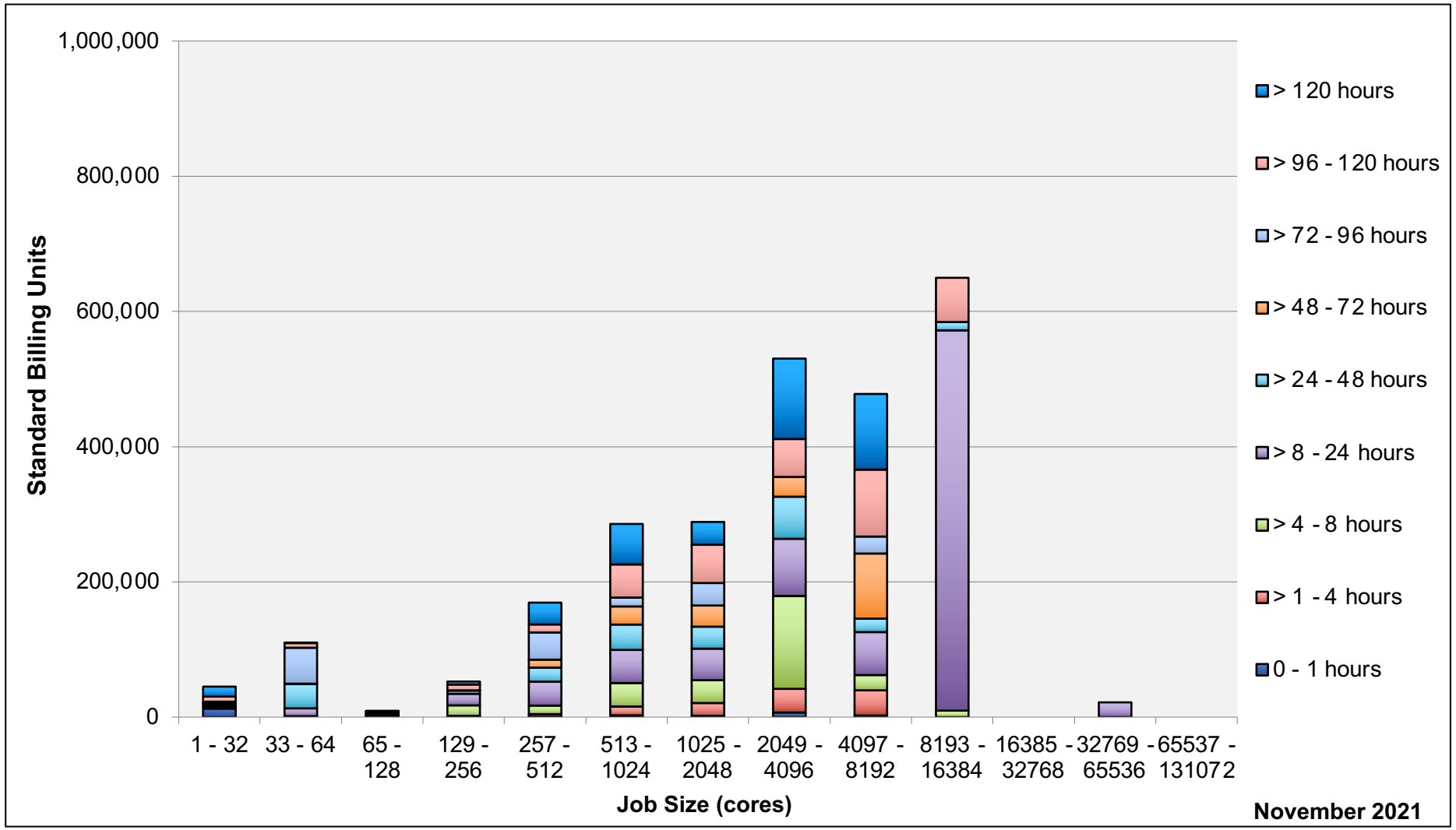
Electra: Monthly Utilization by Job Length



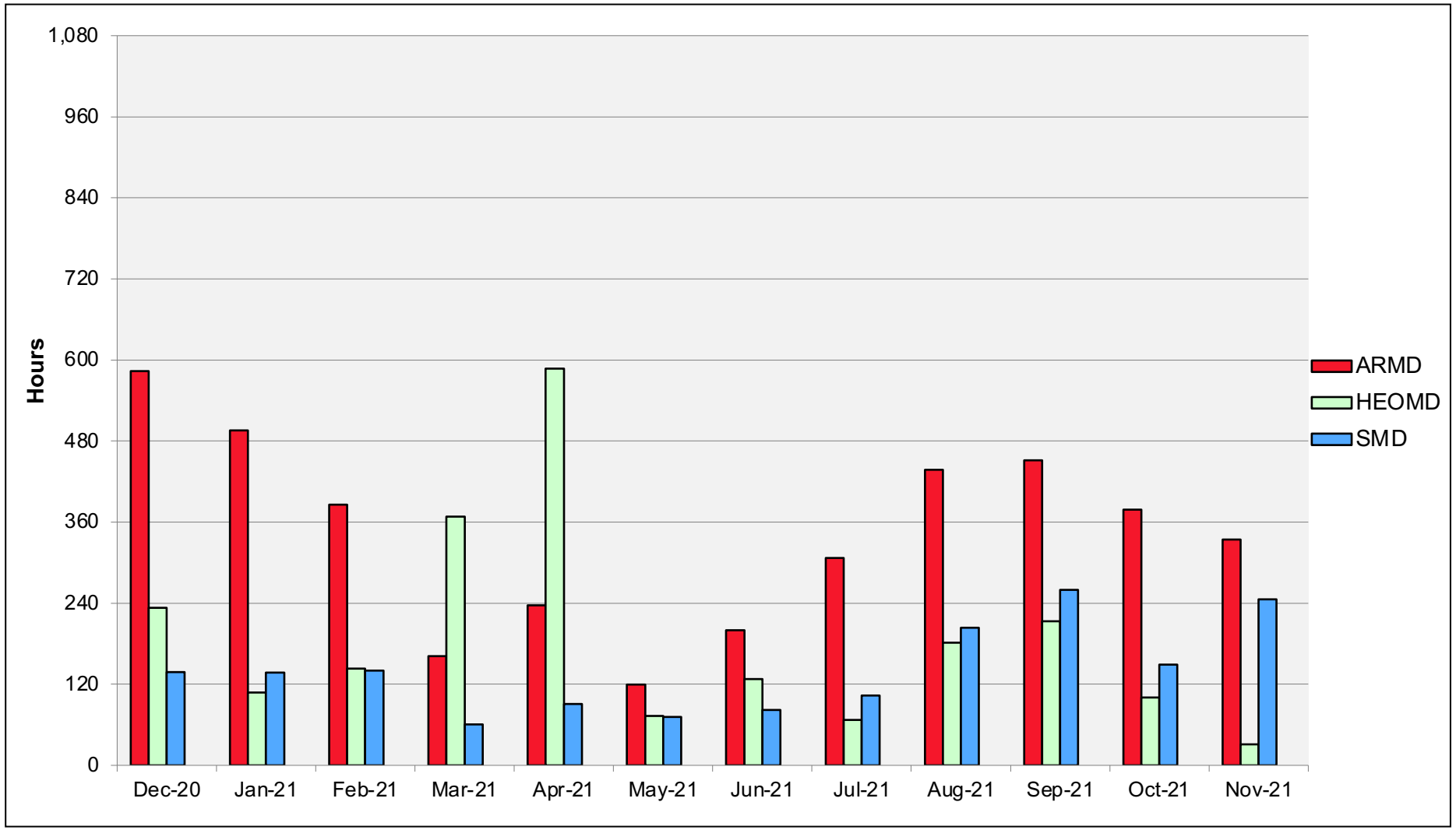
Electra: Monthly Utilization by Job Size



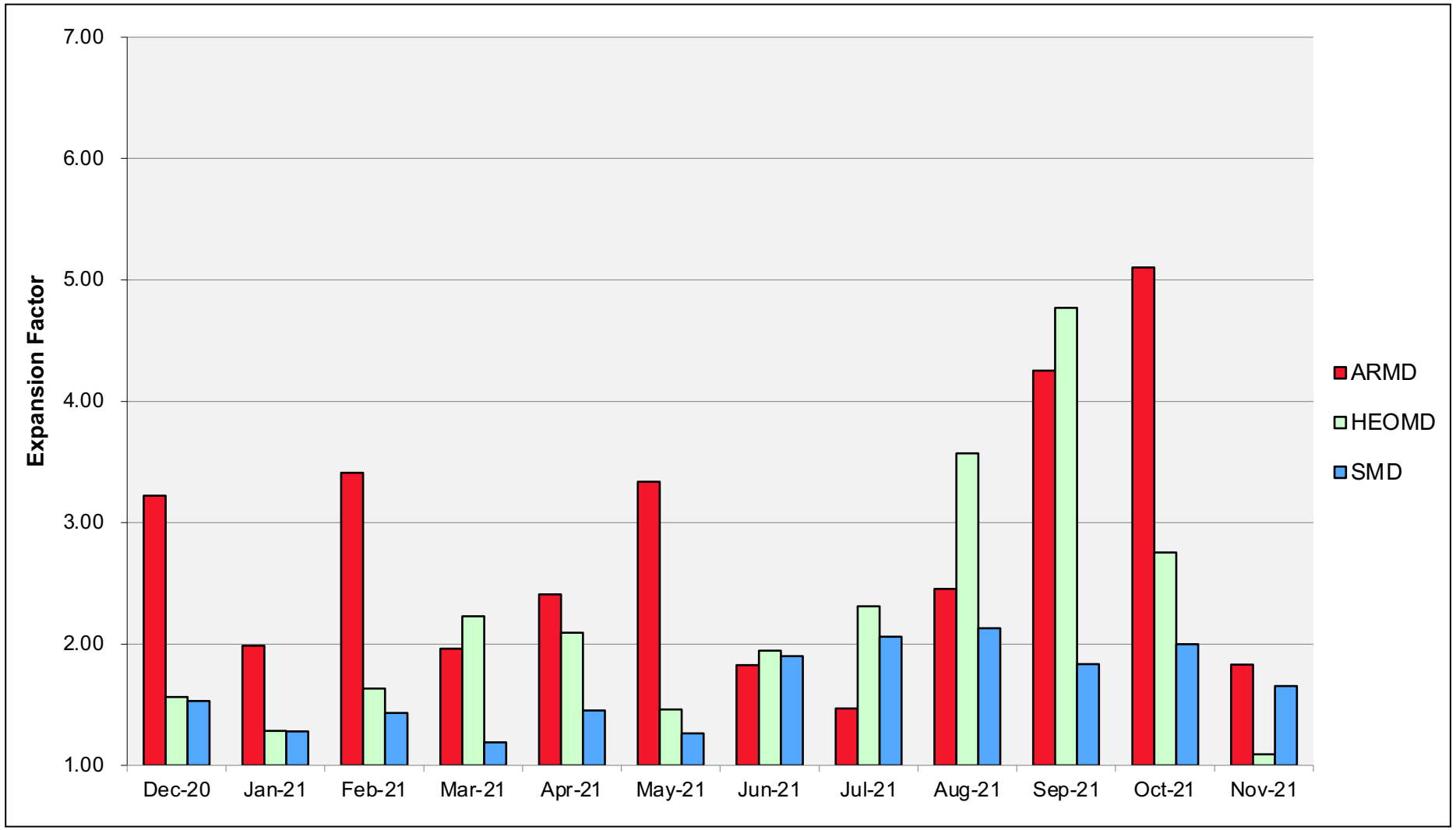
Electra: Monthly Utilization by Size and Length



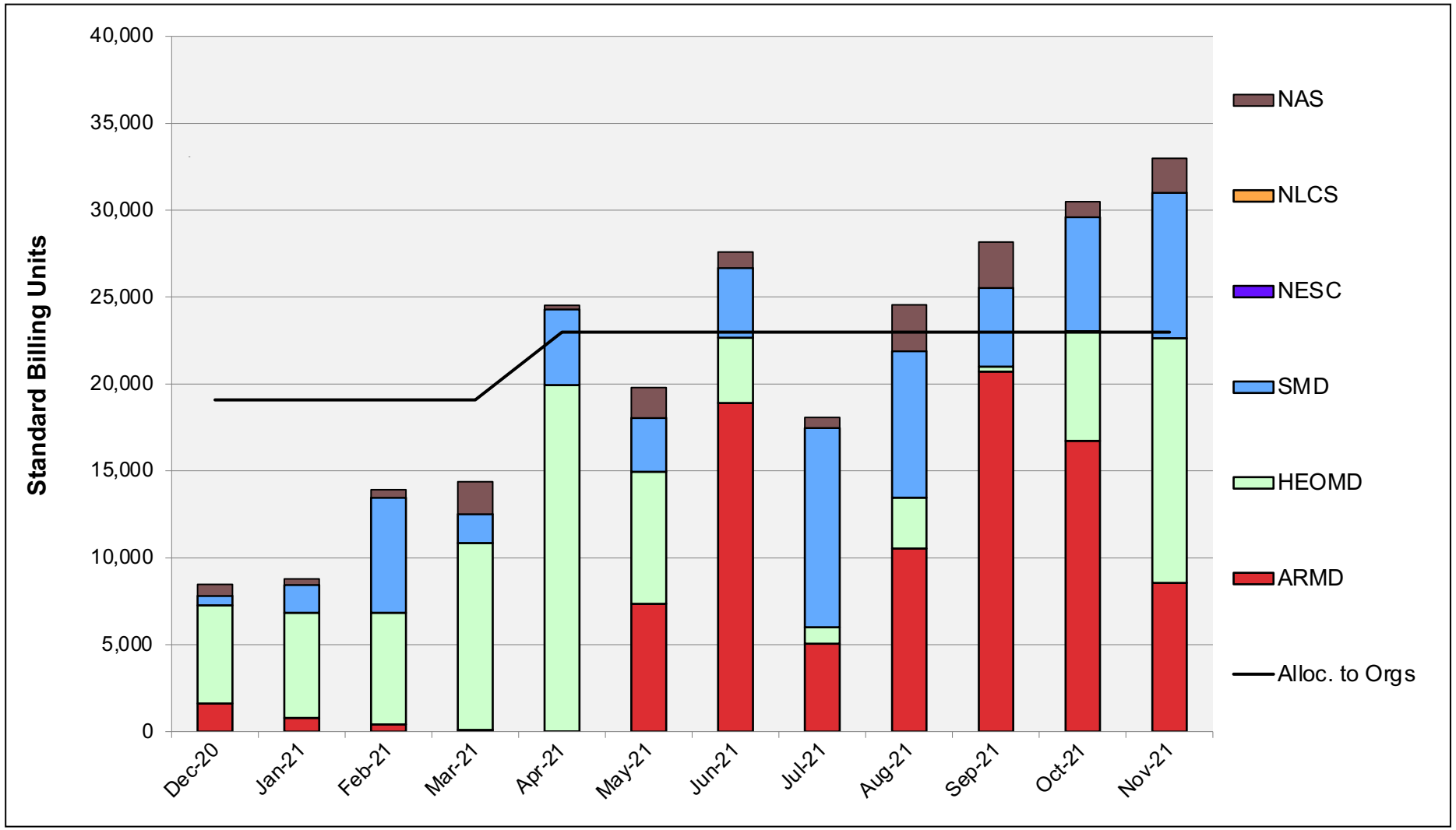
Electra: Average Time to Clear All Jobs



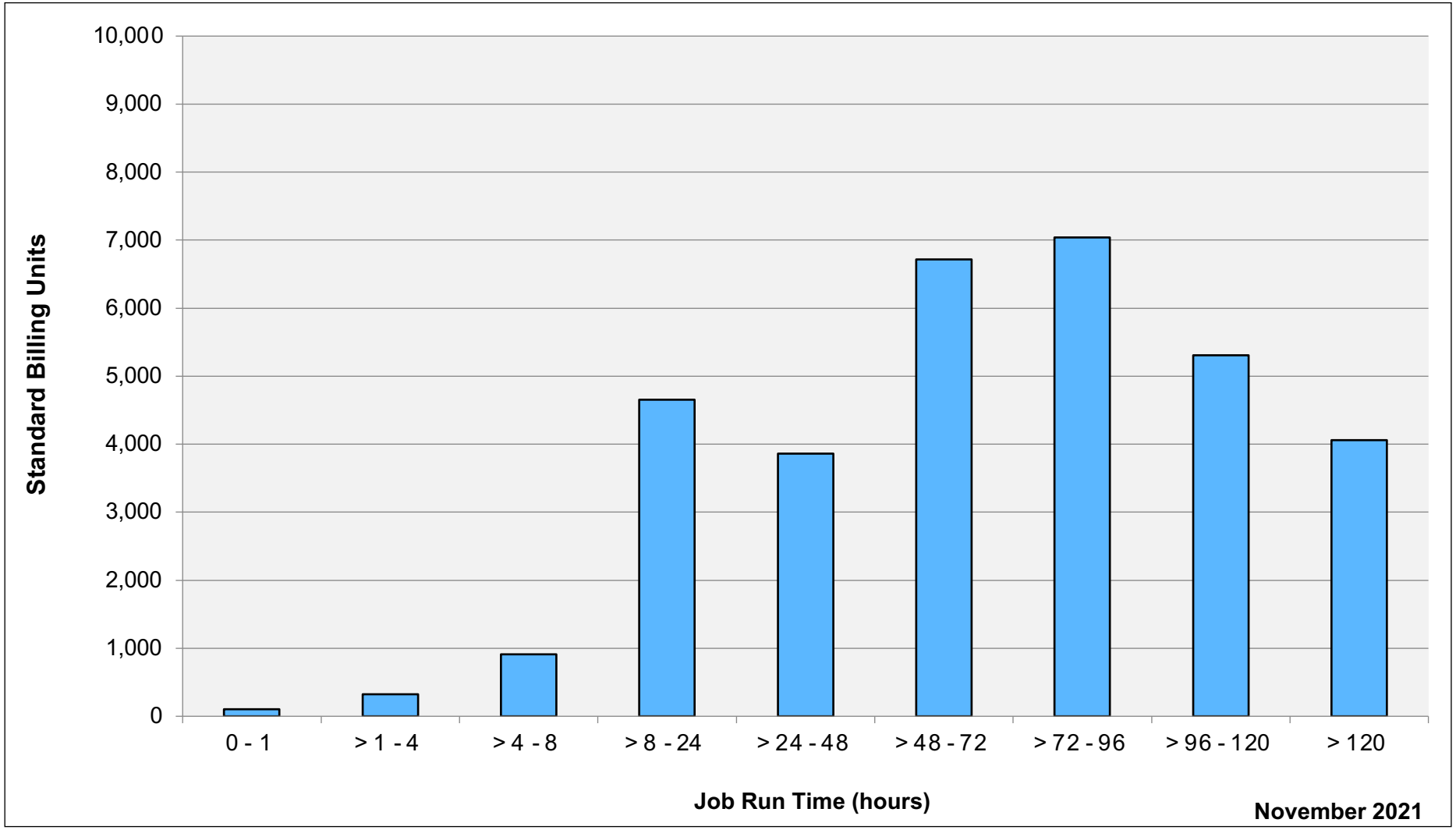
Electra: Average Expansion Factor



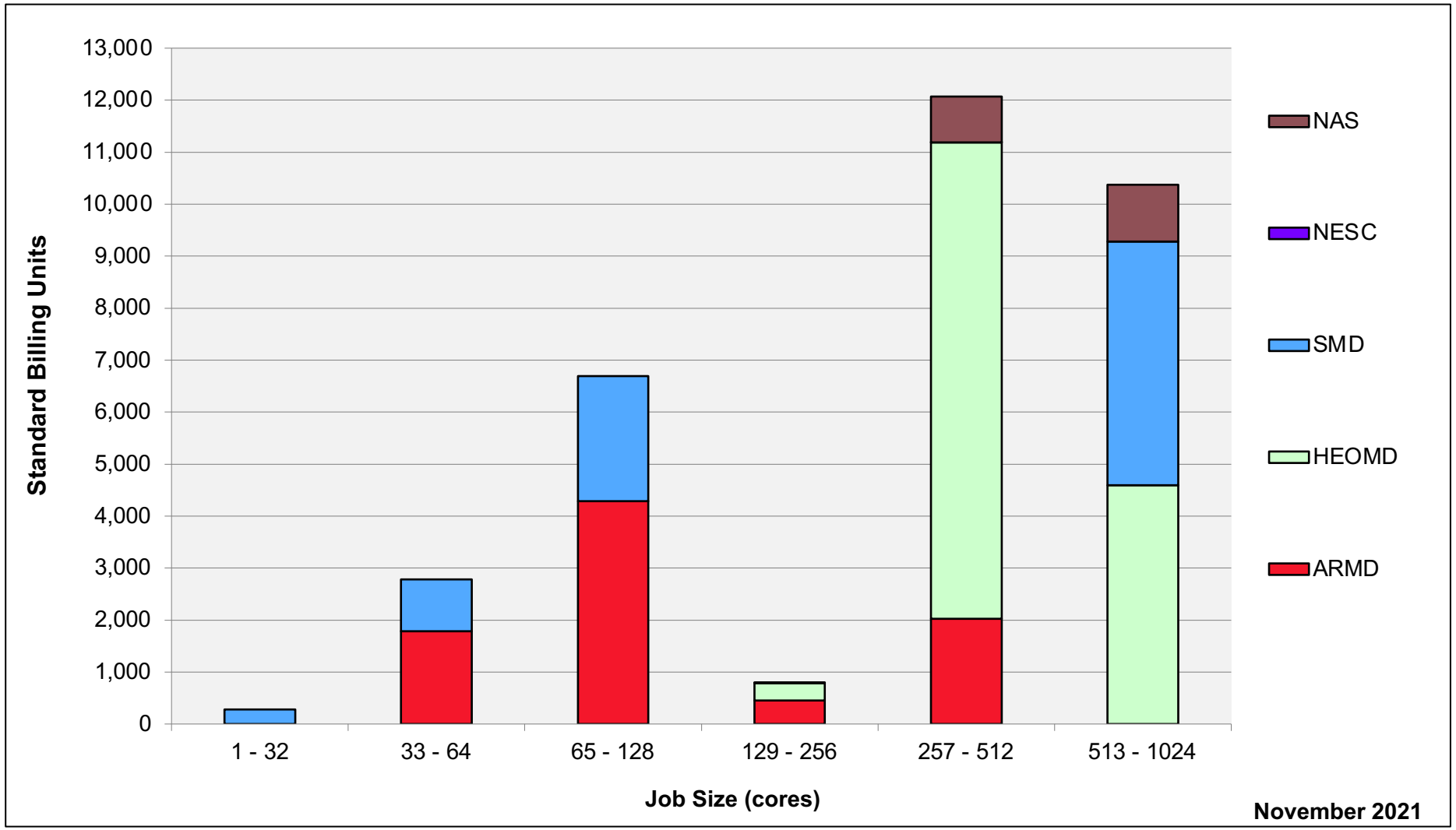
Endeavour: SBUs Reported, Normalized to 30-Day Month



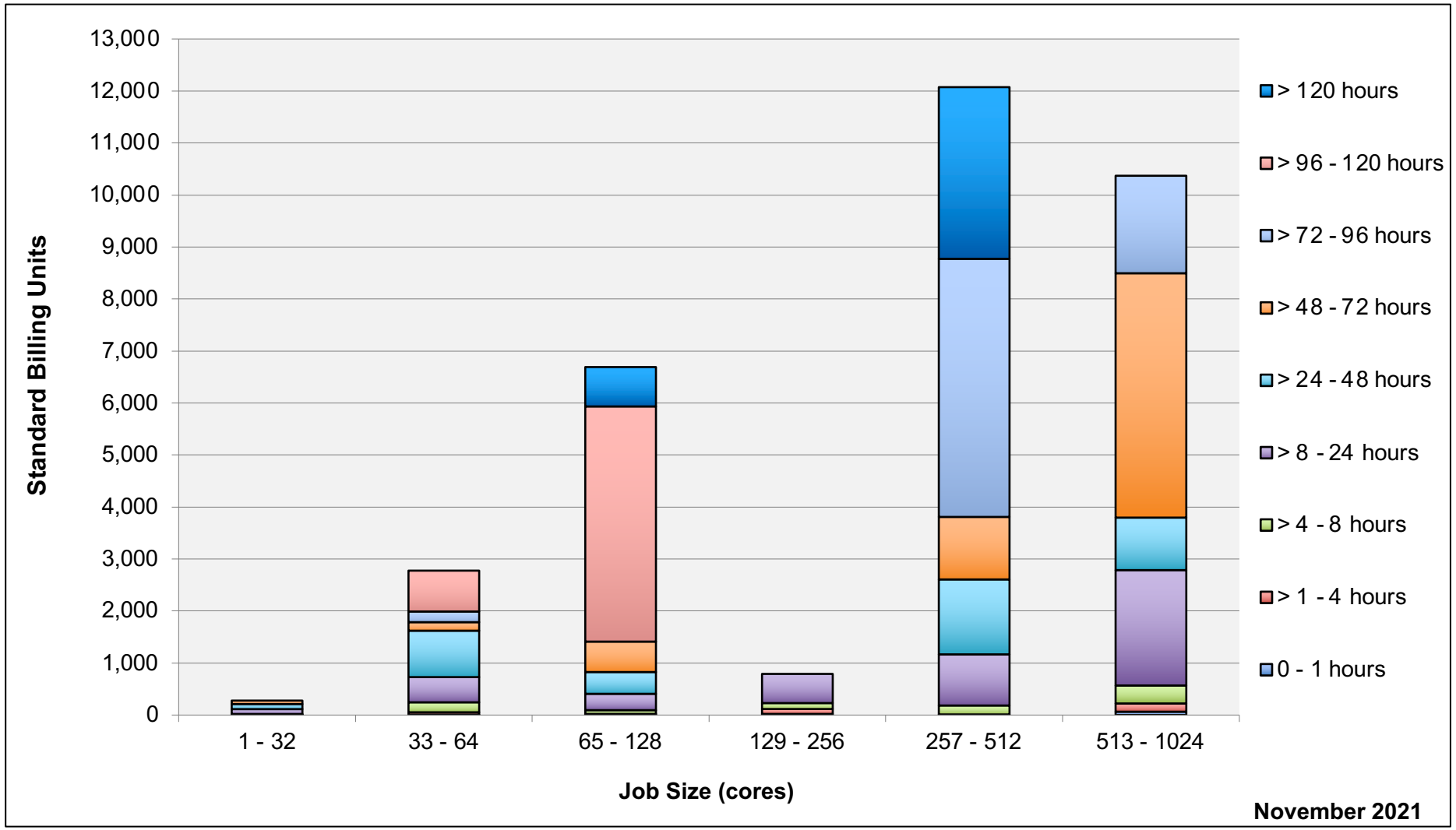
Endeavour: Monthly Utilization by Job Length



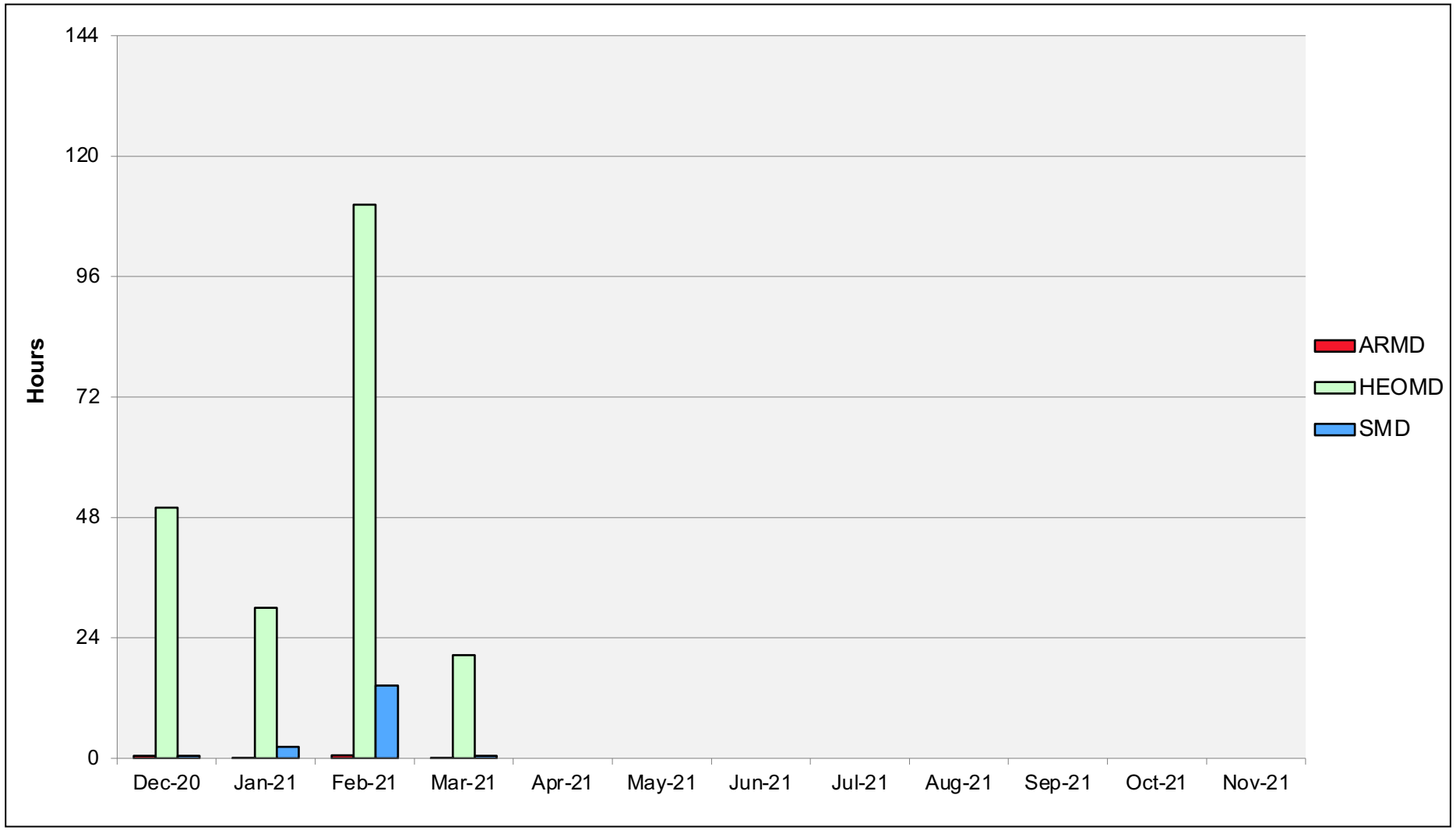
Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Time to Clear All Jobs



Endeavour: Average Expansion Factor

