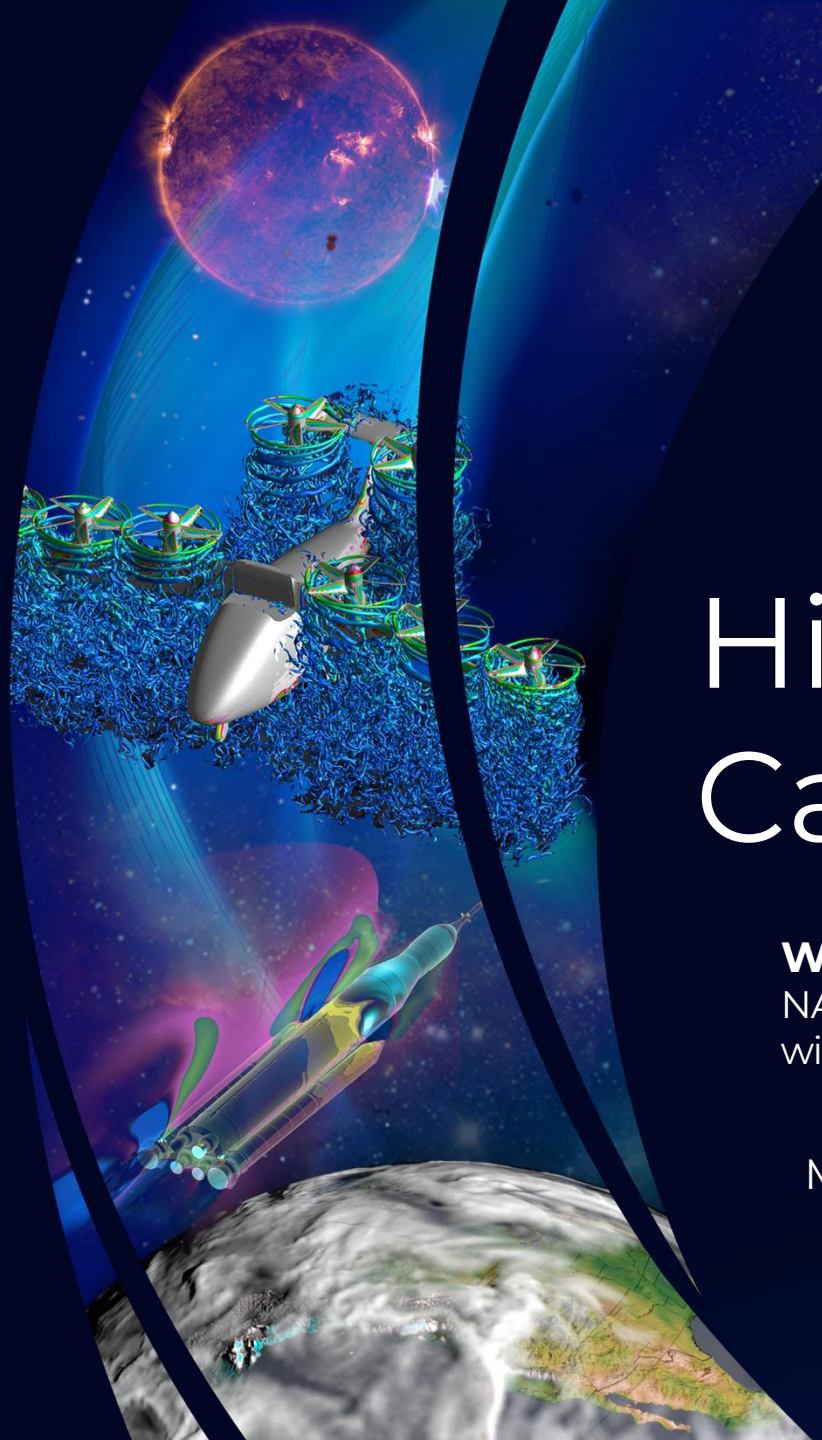


National Aeronautics and Space Administration

High-End Computing Capability

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March 10, 2025

Significant Accomplishments: Current & Future

Current

- Selected Accomplishments
- Grace Hopper Nodes Released to Users
- Alpha User Testing Helps Prepare Grace Hopper Nodes for Production
- New Theater Seating Installed in hyperwall Room
- Predicting the 2024 Eclipse in Real Time
- Using Scale-Resolving Methods to Accurately Predict the Aerodynamics of In-Flight Icing

Future

- Control Room Project
- Enclave Scripts
- Allocation ACL enforcer script)
- Nagios Patching

Selected Monthly Accomplishments

- **Improving Efficiency**
  - Completed several projects to improve efficiency, including a new Jenkins pipeline for deploying web application codes. Thisdevelopment host is for an upcoming dashboard website hosted by the team. The dashboard will feature three applications: Mission Quotas, Shift Us age, and Remedy Stars Report. The pipeline allows developers to deploy changes quickly and consistently to the host, saving time and redu cing mistakes when doing such work by hand.
  - Completed updates to the myNAS Data Status web page. The new status page is available to administrators in each myNAS environment (dev, stage, and production). It lists every data file used, along with its expected interval and last modification time. The site changes a filename to red when the last modification is outside the expected interval, which allows the team to see at-a-glance which files are not updating correctly so they can investigate the correct myNAS pipeline. This saves hours of time look at timestamps when an issue is found.
- **Improving System Stability and Security**
  - The team continues to increase IT Security compliance across all managed devices. Activities include: completed initial deployment of the Corero distributed denial of services (DDoS) appliance with Networks staff; deploying a test RHEL9 system for the MODIS Airborne Simulator (MAS) team to test; meeting with the vendor Code42 to discuss data exfiltration mitigation capabilities; and deploying new database servers to replace older systems that cannot easily be data-at-rest encrypted. The overall effort will improve the NAS/HECC security posture and potentially reduce the risk of data exfiltration from the enclave.
  - The team installed ECL Splunk forwarders on several dev, stage, and lab servers for the MAS Calibration Parameter Input Dataset (CPIDS) group. This will enable Security to more easily detect ant trace any failures in our security posture.
- **Improving Access to Leading-Edge Systems**
  - The Application Performance and Productivity team successfully built GAMER on theCabeus Grace Hopper nodes, per a user request. GAMER is a GPU-accelerated Adaptive-MEsh-Refinement (AMR) code for astrophysics. The team is running a merging cluster simulation to determine whether the code could possibly be leveraged as a GPU benchmark in the future.

Selected Monthly Accomplishments (cont.)

- **Improving User Experience**
  - The Big Data team delivered the annual market research report to the Big Data Lead. The report summarizes technologies or changes to improve the NAS Data Portal for the users and NASA. Previous reports resulted in, for example, high availability of the servers and custom local file system failovers for the Visualization team.
- **Outreach and Collaboration**
  - The Visualization and Data Analysis team collaborated with user David Perez on tilt-wing urban air mobility vehicle visualizations. The generated animations show surface flow mapped with the surface friction coefficient. The team continues to provide users like Perez deep insights into NASA modeling and simulation, enhancing overall productivity and study results. See a sample frame from the animation at: https://data.nas.nasa.gov/viz/vizdata/tsandstr/pventura/sc24/img/v00.56160.4k.png.

Grace Hopper Nodes Released to Users

- The Grace Hopper nodes, part of the Cabeus supercomputer, were released to general users on March 3. These nodes provides additional graphics processing unit (GPU) capacity for HECC users.
- The system provides 350 NVIDIA Grace Hopper nodes on an HDR InfiniBand network and is connected to the HECC shared storage filesystems.
- The nodes are available to all HECC users without charge for a two-week period to test and port their codes over to the new GPU resources. After the two-week period, users will be billed standard billing units (SBU) hours for time used.
- Prior to the production release of the nodes, a small set of early access “alpha” users were added to the system in December, with another set of early access users added in January to provide feedback on issues, improvements, or changes on the system (see slide 6.)
- To ensure users have the information needed to run jobs on these nodes, multiple Knowledge Base articles were updated, and several new articles were published, including:
  - Preparing to Run on Grace Hopper GPU Nodes
  - Cabeus GPU Nodes
  - Requesting Cabeus GPU Resources
  - Programming for NVIDIA GPUs

IMPACT: The new Grace Hopper nodes will provide more computational capacity to support HECC users' requirements for graphics processing units.

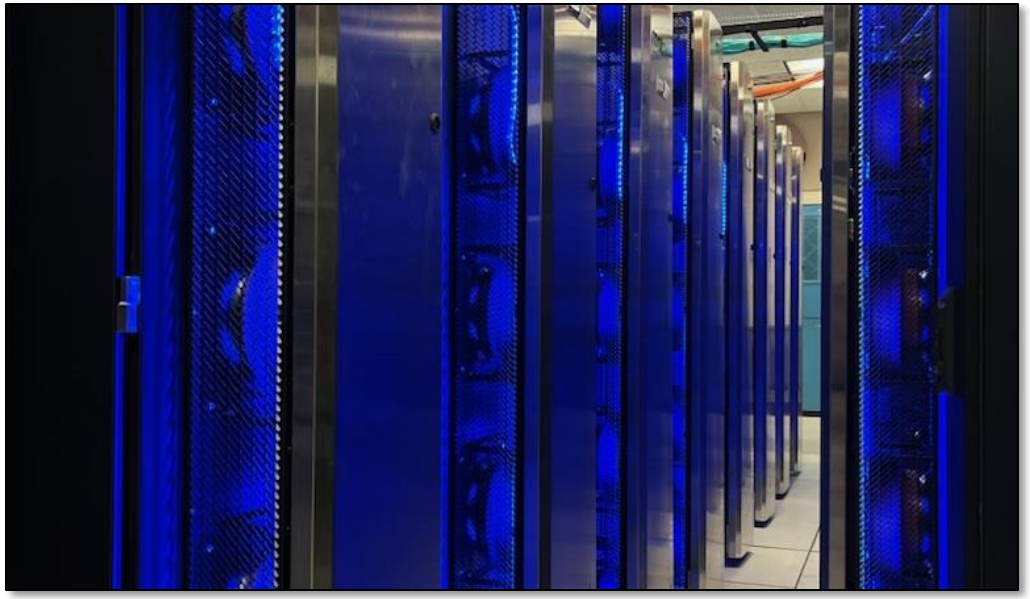


View of the water-cooled doors on the racks housing the Grace Hopper nodes installed as part of the Cabeus supercomputer at the NASA Advanced Supercomputing facility. *Davin Chan, NASA/Ames*

Alpha User Testing Helps Prepare Grace Hopper Nodes for Production

- To get real user testing and workflow results on the Cabeus Grace Hopper nodes as early as possible, alpha users were invited to test the system. This allowed HECC systems and applications experts to identify and resolve user issues before general early user testing began.
- Alpha users were invited to use the Grace Hopper nodes in December 2024 and January 2025.
- Alpha users discovered several issues, which were quickly resolved by the Systems and Application Performance and Productivity (APP) teams throughout the Grace Hopper testing period. Milestones included:
  - FUN3D and LAVA executables were built on Advanced RISC Machine (ARM) architecture using provided compilers and MPI Libraries. This will enable the wider NAS user base to use FUN3D and LAVA on Grace Hopper much more expeditiously.
- An Alpha User reports "The Alpha User experience was incredibly valuable for us. It gave us a head start in setting up LAVA dependencies on the ARM CPUs and optimizing the code for better performance before wider onboarding. We identified best practices for running LAVA on the new nodes, fine-tuned MPI launch configurations, tested different MPI software variants, and validated LAVA at nearly 70% of the full system. This also enabled us to run production cases and make quick progress on key applications like simulations of high-lift CRM in NTF tunnel and transonic buffet on the OAT15A airfoil for the 8th AIAA Drag Prediction Workshop."

IMPACT: Alpha user testing enables early identification and resolution of system and software issues, providing a more stable environment for follow-on testing and production.

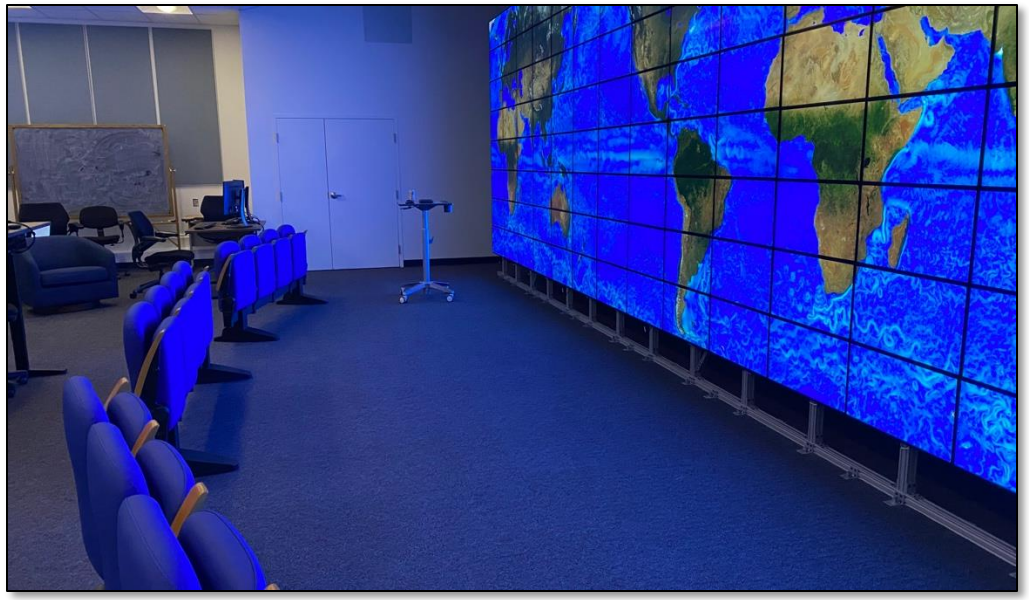


View of the water-cooled doors on the racks housing the Grace Hopper nodes installed as part of the Cabeus supercomputer at the NASA Advanced Supercomputing facility. *Larry Tran, NASA/Ames*

hyperwall Room Modernization Completed

- HECC procured and installed new theater seats for viewing scientific visualizations on NASA's recently installed billion-pixel hyperwall, as the final step in modernizing the Visualization Lab at the NASA Advanced Supercomputing facility.
  - Access to the hyperwall enables researchers to display and analyze their high-dimensional datasets, using HECC-developed software to simultaneously display portions or aspects of one or many datasets.
- The new theater seating replaces outdated rolling or folding office chairs and creates an easily modifiable professional environment for visitors and teams of scientists who work with the Visualization and Data Analysis-team to view new and unique aspects of their scientific data.
  - The seats feature a fully configurable design using the Figueras Mutawheel system, with multidirectional built-in wheels, suited for quick and easy adaptation to multiple activities.
  - Seats can be easily changed from four to 24 depending on the number of visitors and reconfigured to optimize functionality.
- HECC and the NAS Division staff have already hosted scientific teams and external visitors in the remodeled Visualization Lab, including NASA's Surface Water Ocean Topography (SWOT) mission team, the Prime Minister of New Zealand, and local media representatives.

IMPACT: The new theater seating system in the Visualization Lab at Ames provides a comfortable and professional environment for people viewing the new hyperwall—one of the most powerful visualization systems in the world.



Flexible seating arrangement for 4 to 24 scientists and visitors to view important science data on the hyperwall in the NAS Visualization Lab at NASA Ames. *Leigh Ann Tanner, NASA/Ames*

Predicting the 2024 Eclipse in Real Time *

- In early 2024, the team at Predictive Science Inc. used near real-time magnetohydrodynamic simulations to predict the appearance of the Sun's atmosphere leading up to the April 8, 2024 total solar eclipse.
- For the first time, they provided a continuously updated prediction based on a data-driven time-evolving model with measurements of the Sun's surface used to update conditions, as well as dedicated computing resources and support from HECC—using over 200 nodes continuously over a full three weeks.
- The team ran their Magnetohydrodynamic Algorithm outside a Sphere (MAS) code in real time on the Electra supercomputer's Cascade Lake nodes, which allowed them to explore inherently time-dependent phenomena that cannot be studied with a steady-state model, such as mass ejections, prominences, and streamer evolution.
- The resources and flexibility provided by HECC allowed for a unique data assimilative predictive model that was able to incorporate solar surface magnetic field data almost as quickly as it was taken—keeping the predictive model within 10 hours of real time.
- The Predictive Science team will be using the methods and experience from this project to create a 24/7 continuously running, real-time model of the solar corona.

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

IMPACT: This model was used by scientists and the public to plan observational efforts for the day of the eclipse and is now being used by groups across the heliophysics and astrophysics communities.

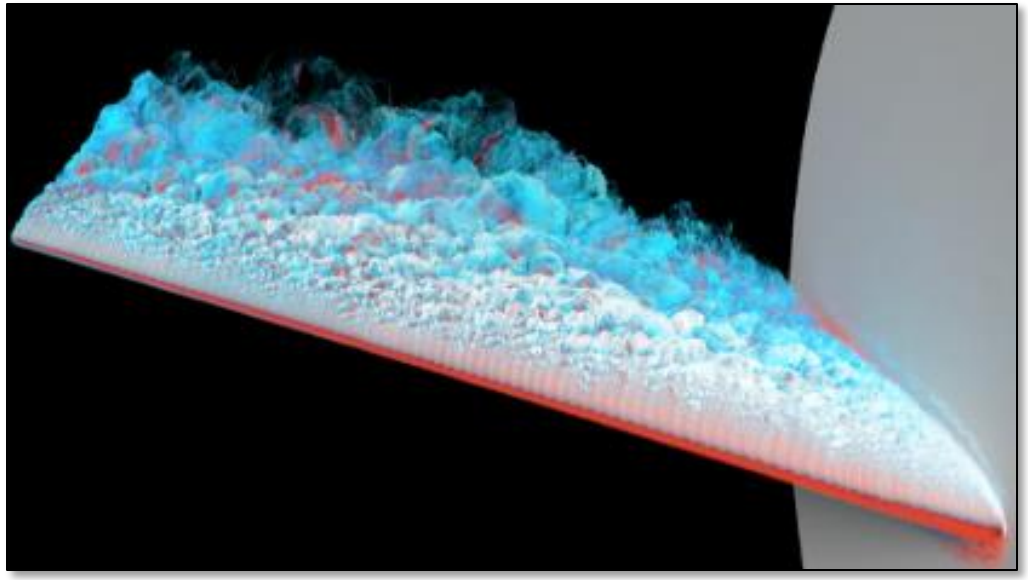


Wavelet-processed white light emissions from the time-dependent magnetohydrodynamic model, as seen from Earth's position on eclipse day. *Predictive Science Inc.*

Using Scale-Resolving Methods to Accurately Predict the Aerodynamics of In-Flight Icing *

- To support NASA's Advanced Air Transport Technology and Transformational Tools and Technologies projects, researchers at NASA Ames assessed the ability of scale-resolving numerical methods to accurately and efficiently predict the aerodynamics of in-flight icing—the buildup of ice on aircraft surfaces during flight.
- The team used the Launch, Ascent, and Vehicle Aerodynamics (LAVA) framework to evaluate the aerodynamic performance of a swept wing with high-fidelity and smooth leading-edge ice shapes using wall-modeled large-eddy simulations with structured hybrid curvilinear body-fitted/immersed-boundary and unstructured Voronoi grids.
- They compared their aerodynamic results, including integrated loads, surface pressure profiles, and skin-friction streamlines, against experimental results from the Wichita State University wind tunnel.
- The simulations showed excellent agreement with both ice shapes, but the high-fidelity ice shape was easier to simulate than the smooth ice shape, likely due to simpler flow physics near the leading edge.
- These advancements enable computationally efficient exploration of aerodynamic performance under icing conditions, guiding future numerical modeling choices for next-generation aircraft designs.

IMPACT: Leveraging HECC's new GPU-based Cabeus supercomputer and LAVA's Voronoi meshing tool, researchers greatly reduced the turnaround time for simulating complex icing configurations.



Video of a wall-modeled large-eddy simulation of the flow over a scaled Common Research Model wing with high-fidelity leading-edge ice at an angle of attack of 8.423 degrees. *David Craig Penner and Timothy A. Sandstrom, NASA/Ames*

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

Papers

- "**Revisiting Turbulent Properties of Solar Convection with 3D Radiative Hydrodynamic Modeling**," I. Kitiashvili, A. Wray, arXiv:2502.00974 [astro-ph.SR], February 3, 2025. *
  https://arxiv.org/abs/2502.00974
- "**Infrared Cooling in an Anharmonic Cascade Framework: 2-Cyanoindene, the Smallest Cyano-PAH Identified in Taurus Molecular Cloud-1**," M. Stockett, et al., *ACS Earth and Space Chemistry*, vol. 9 issue 2, published online February 4, 2025. *
  https://pubs.acs.org/doi/full/10.1021/acsearthspacechem.4c00381#
- "**Feedbacks Between Fjord Circulation, Mélange Melt, and the Subglacial Discharge Plume at Kangerlussuaq Glacier, East Greenland**," M. Wood, et al., *Journal of Geophysical Research: Oceans*, vol. 130, issue 2, February 5, 2025. *
  https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2024JC021639
- "**Reconnection Signatures in Kelvin-Helmholtz Instability Evolution in 2D PIC Simulations**," N. Ahmadi, et al., *Physics of Plasmas*, vol. 32, issue 2, February 7, 2025. *
  https://pubs.aip.org/aip/pop/article/32/2/022104/3334507
- "**Development of Interatomic Potential Suitable for Molecular Dynamics Simulation of Ni Oxidation and Ni-NiO Interface**," G. Plummer, et al., *Journal of Chemical Physics*, vol. 162, issue 5, February 7, 2025. *
  https://pubs.aip.org/aip/jcp/article/162/5/054709/3333334
- "**Properties of Turbulent Convection and Large-Scale Flows in a Rotating F-Type Star Revealed by 3D Realistic Radiative Hydrodynamic Simulations**," I. Kitiashvili, A. Kosovichev, A. Wray, arXiv:2502.07006 [astro-ph.SR], February 10, 2025. *
  https://arxiv.org/abs/2502.07006

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

Papers (cont.)

- "**TOI-5108 b and TOI 5786 b: Two Transiting Sub-Saturns Detected and Characterized with TESS, MaHPS, and SOPHIE**," L. Thomas, et al., *Astronomy & Astrophysics*, vol. 694, published online February 7, 2025. * https://www.aanda.org/articles/aa/full_html/2025/02/aa51676-24/aa51676-24.html
- "**TOI-2015b: A Sub-Neptune in Strong Gravitational Interaction with an Outer Non-Transiting Planet**," K. Barkaoui, et al., arXiv:2502.07074 [astro-ph.EP], February 10, 2025. * https://arxiv.org/abs/2502.07074
- "**Exploring the Complex Heliotail Boundary by an Extended Level Set Approach**," C. Onubogu, et al., *The Astrophysical Journal Letters*, vol. 980, no. 2, published online February 11, 2025. * https://iopscience.iop.org/article/10.3847/2041-8213/ada68e/meta
- "**Spectral Extension of the CPF-Measured Earth-Reflected Solar Radiances for CPF-CERES Intercalibration**," Q. Yang, et al., *Journal of Geophysical Research: Atmospheres*, vol. 130, issue 4, February 12, 2025. * https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2024JD041054
- "**ExoMiner++ on TESS with Transfer Learning from Kepler: Transit Classification and Vetting Catalog for 2-min Data**," H. Valizadegan, et al., arXiv:2502.09790 [astro-ph.EP], February 13, 2025. * https://arxiv.org/abs/2502.09790
- "**A Spiral Structure in the Inner Oort Cloud**," D. Nesvorny, et al., arXiv:2502.11252 [astro-ph.EP], February 16, 2025. * https://arxiv.org/abs/2502.11252

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Papers (cont.)

- "**Adaptive Mesh Refinement in Semi-Implicit Particle-in-Cell Method**," T. Arshad, et al., *ESS Open Archive*, published online February 18, 2025. *
  https://essopenarchive.org/doi/full/10.22541/essoar.173991375.59823810
- "**Asymmetric Temperature Variations in Protoplanetary Disks. I. Linear Theory, Corotating Spirals, and Ring Formation**," Z. Zhu, et al., *The Astronomical Journal*, vol. 980, no. 2, published online February 20, 2025. *
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- "**Short-Period Small Planets with High Mutual Inclinations are More Common around Metal-rich Stars**," X. Hua, et al., *The Astrophysical Journal Letters*, vol. 980, no. 2, published online February 20, 2025. *
  https://iopscience.iop.org/article/10.3847/2041-8213/adb1dc/meta
- "**A Fully Kinetic Perspective on Weakly Active Comets: Asymmetric Outgassing**," J. Deca, et al., *Planetary and Space Science*, vol. 258, February 21, 2025. *
  https://www.sciencedirect.com/science/article/pii/S0032063325000315
- "**TOI-6324b: An Earth-Mass Ultra-Short-Period Planet Transiting a Nearby M Dwarf**," R. Lee, et al., arXiv:2502.16087 [astro-ph.EP], February 22, 2025. *
  https://arxiv.org/abs/2502.16087
- "**Applying Gaussian Process Machine Learning and Modern Probabilistic Programming to Satellite Data to Infer CO_2 Emissions**," S. Jeong, et al., *Environmental Science & Technology*, published online February 24, 2025. *
  https://pubs.acs.org/doi/full/10.1021/acs.est.4c09395

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

Papers (cont.)

- "**Fully Compressible Magnetohydrodynamic Simulations of Solar Convection Zones with CHORUS++**," A. Paoli, C. Liang, arXiv:2502.17805 [astro-ph.SR], February 25, 2025. *
  https://arxiv.org/abs/2502.17805
- "**Radiation Magnetohydrodynamic Simulation of Sub-Eddington Circumbinary Disk around an Equal-Mass Massive Black Hole Binary**," V. Tiwari, et al., arXiv:2502.18584 [astro-ph.HE], February 25, 2025. *
  https://arxiv.org/abs/2502.18584
- "**TESS Hunt for Young and Maturing Exoplanets (THYME). XII. A Young Mini-Neptune on the Upper Edge of the Radius Valley in the Hyades Cluster**," A. Distler, et al., *The Astronomical Journal*, vol. 169, no. 3, published online February 25, 2025. *
  https://iopscience.iop.org/article/10.3847/1538-3881/ada26a
- "**TOI-6508b: A Massive Transiting Brown Dwarf Orbiting a Low-Mass Star**," K. Barkaoui, et al., arXiv:2502.19940 [astro-ph.EP], February 27, 2025. *
  https://arxiv.org/abs/2502.19940

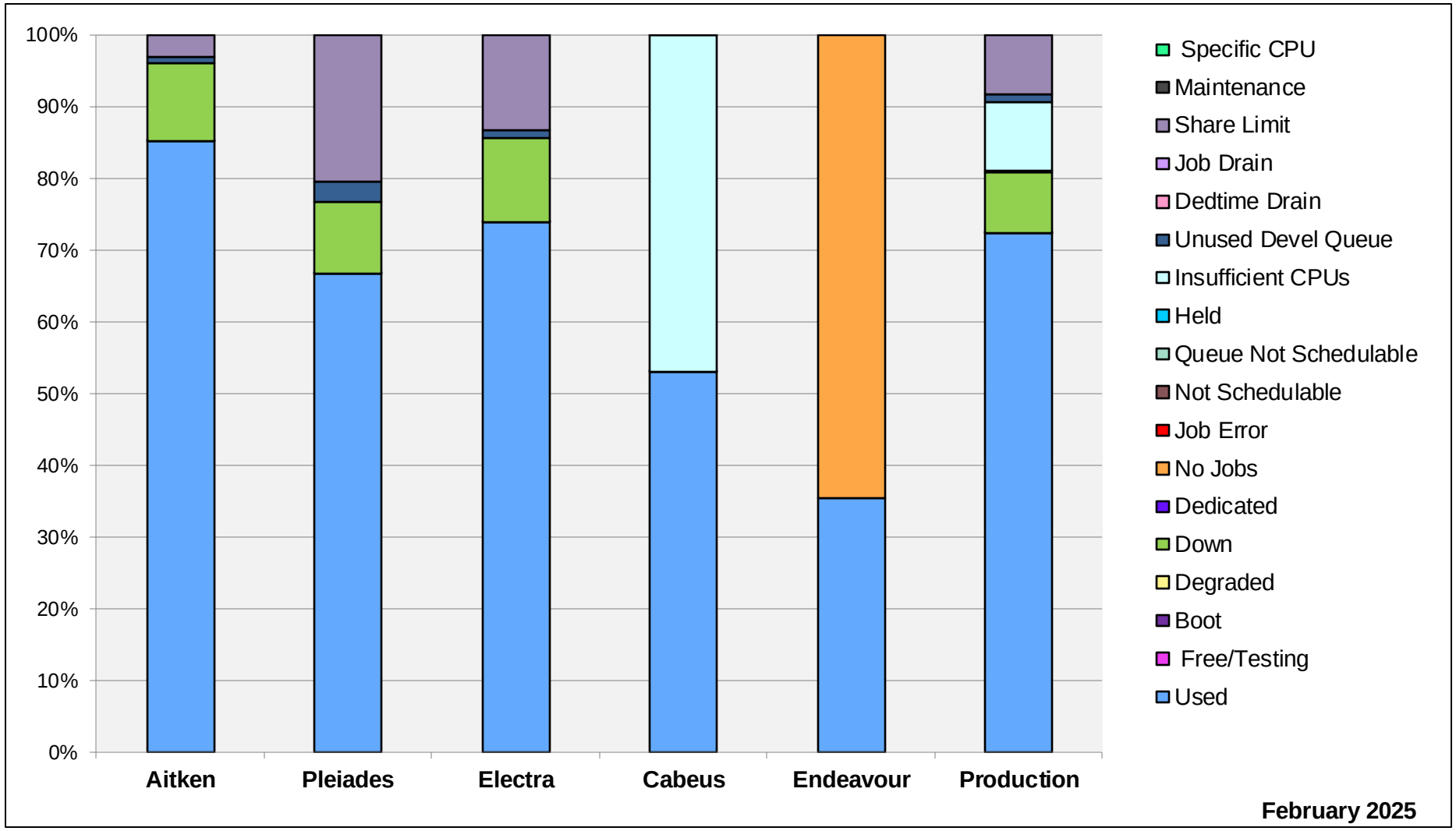
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News & Events

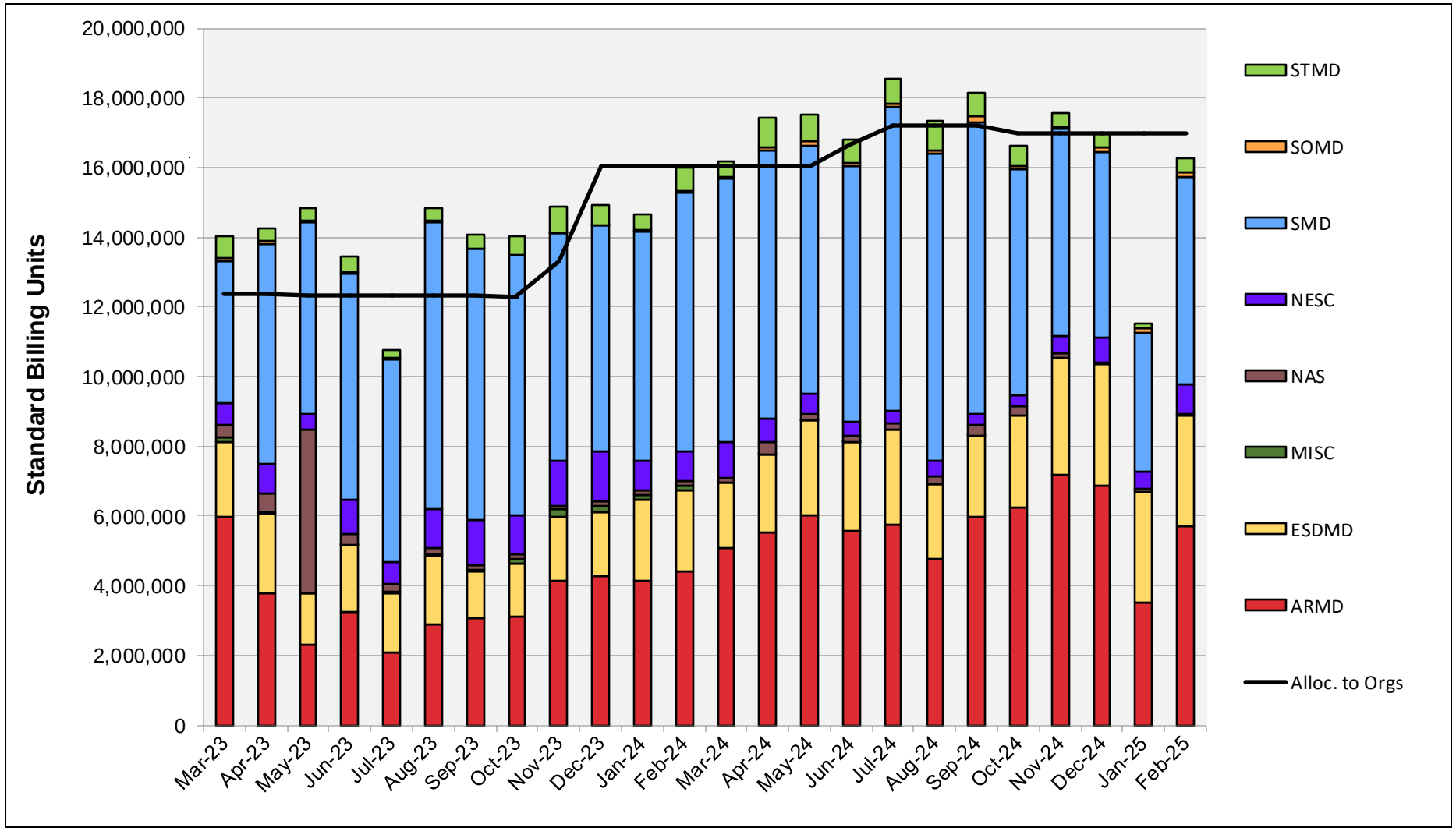
- **NASA Supercomputer Finds Billions of Comets Mimicking the Milky Way's Shape: 'The Universe Seems to like Spirals!'**, *Space.com*, February 27, 2025—Using the Pleiades supercomputer, scientists have discovered another spiral structure on the edge of our solar system composed of billions of icy bodies surrounded by a shell of comets called the Oort cloud. https://www.space.com/the-universe/solar-system/nasa-supercomputer-finds-billions-of-comets-mimicking-the-milky-ways-shape-the-universe-seems-to-like-spirals*
  - **NASA Supercomputer Reveals Strange Spiral Structure at the Edge of our Solar System**, *LiveScience*, February 23, 2025. https://www.livescience.com/space/nasa-supercomputer-reveals-strange-spiral-structure-at-the-edge-of-our-solar-system
  - **NASA Supercomputer Finds Milky Way-like Spiral at Solar System's Edge**," *Interesting Engineering*, February 24, 2025. https://interestingengineering.com/space/nasa-supercomputer-oort-clouds
  - **The Oort Cloud Forms a Spiral at the Outskirts of Our Solar System**, *Discover Magazine*, February 24, 2025. https://www.discovermagazine.com/the-sciences/the-oort-cloud-forms-a-spiral-at-the-outskirts-of-our-solar-system
  - **Mysterious Cloud at Solar System's Edge Found to Host Strange 'Mini Galaxy'**, *The Independent*, February 24, 2025. https://www.the-independent.com/space/solar-system-edge-mini-galaxy-b2703478.html
  - See slide 11 for the paper "A Spiral Structure in the Inner Oort Cloud," which garnered additional extensive national and international coverage of the Oort cloud discovery enabled by Pleaides, including MSN and Times of India.

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

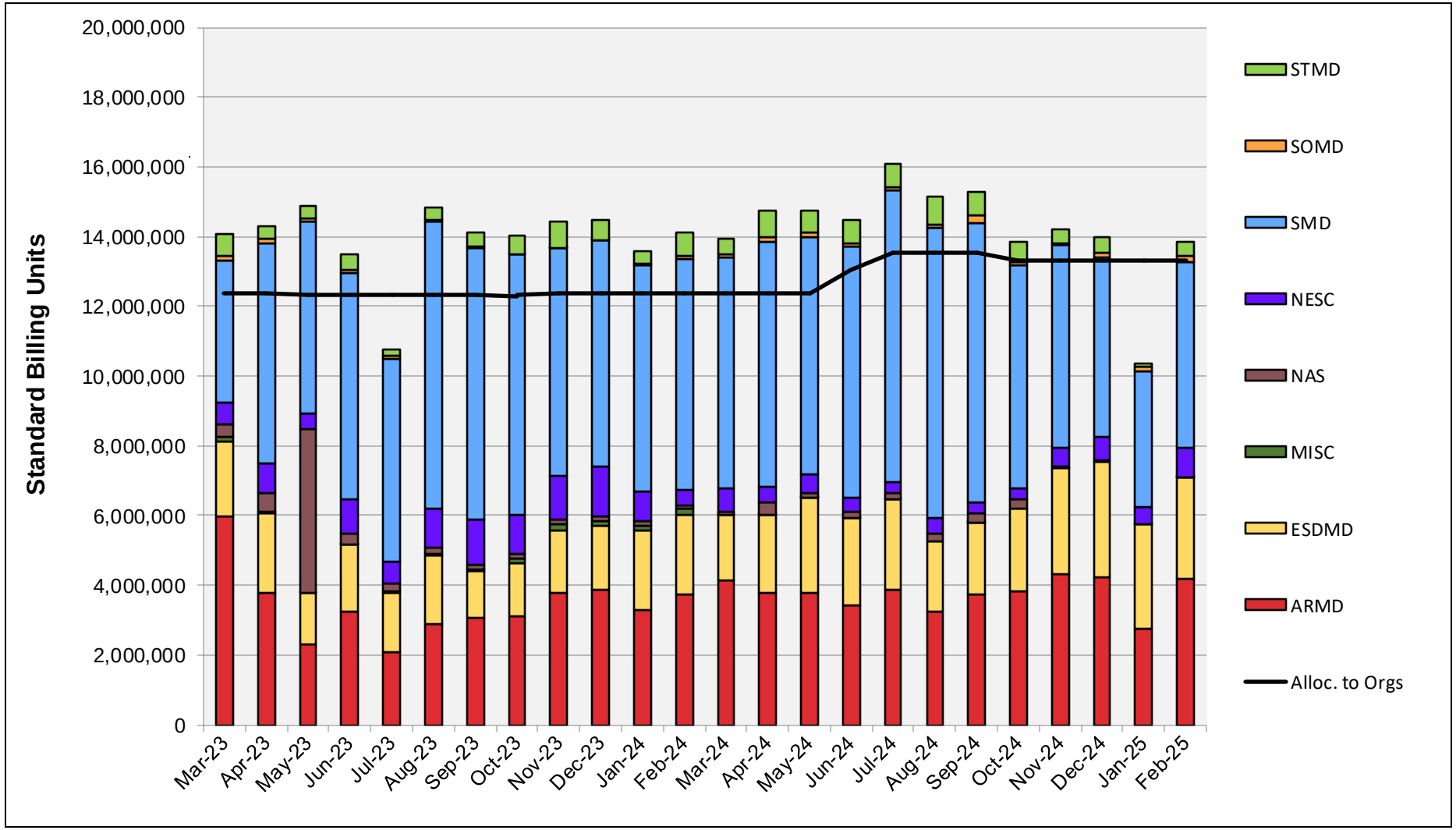
HECC Utilization



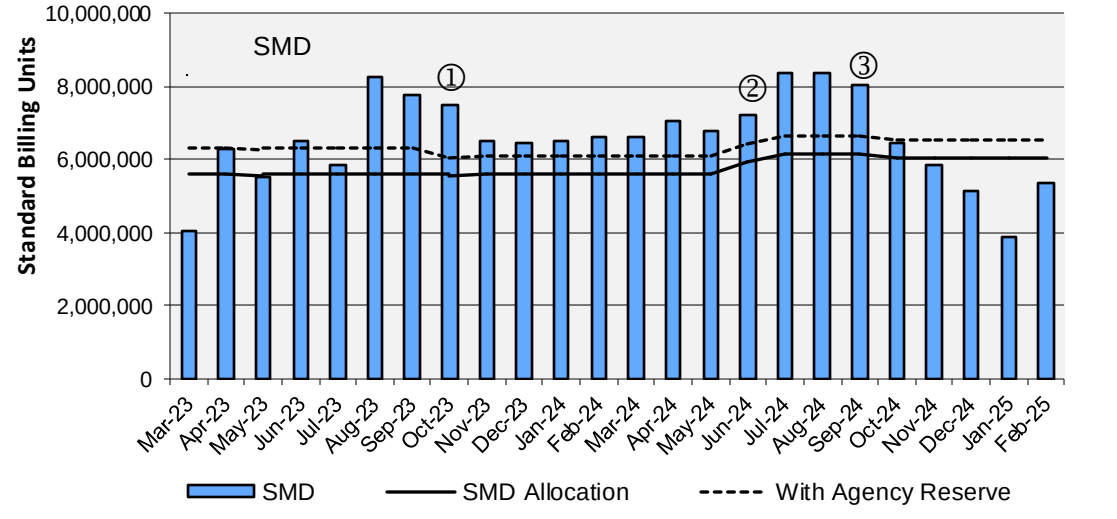
HECC Utilization Normalized to 30-Day Month

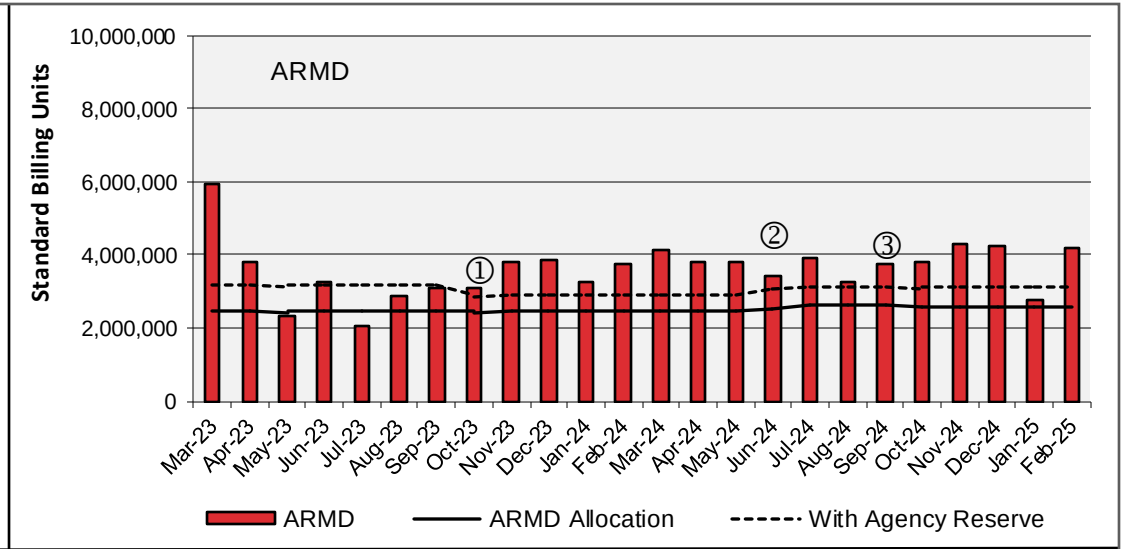


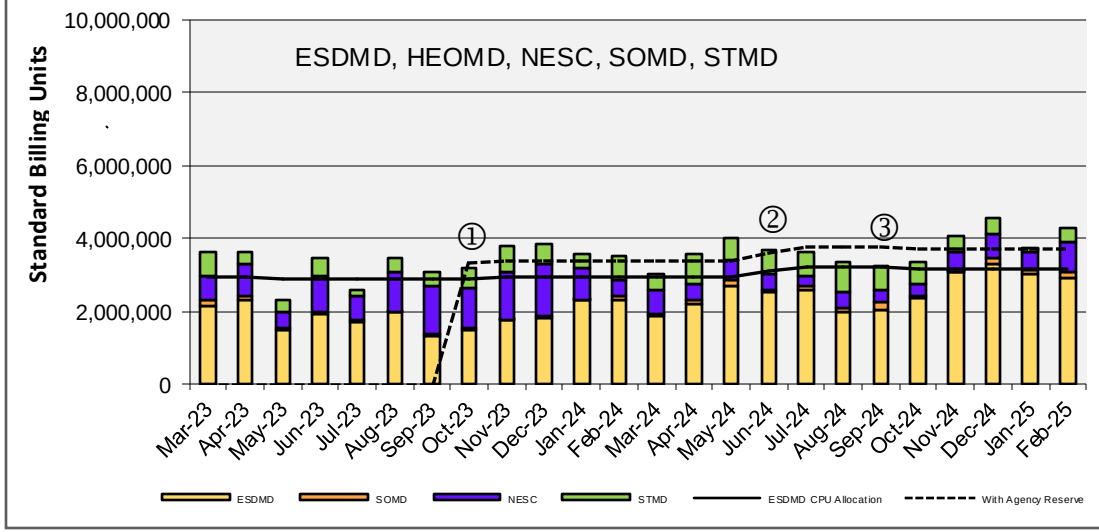
CPU Only Normalized Data



CPU Only by Mission Directorate





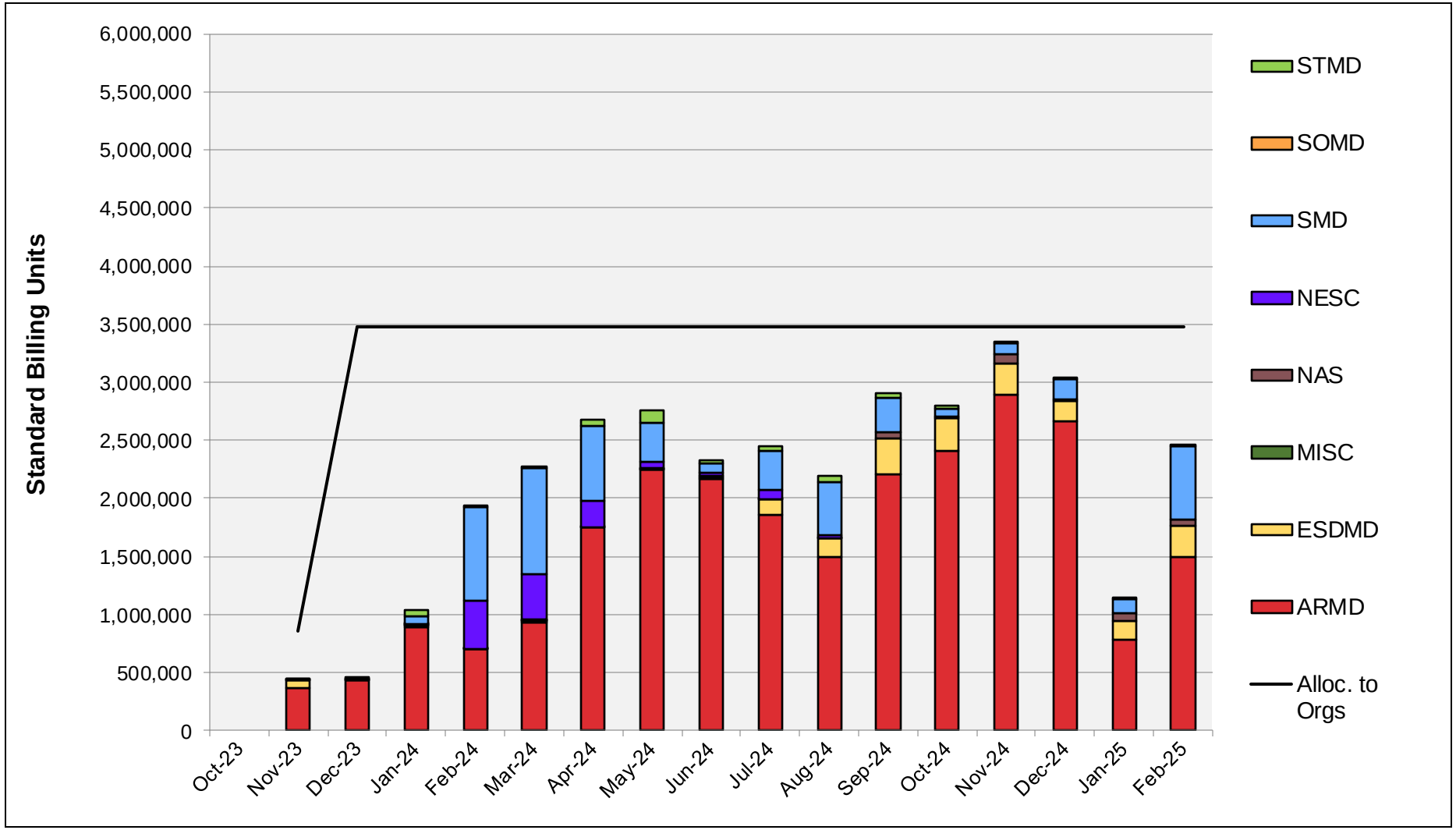


① 4 Rome Apollo Racks added to Aitken

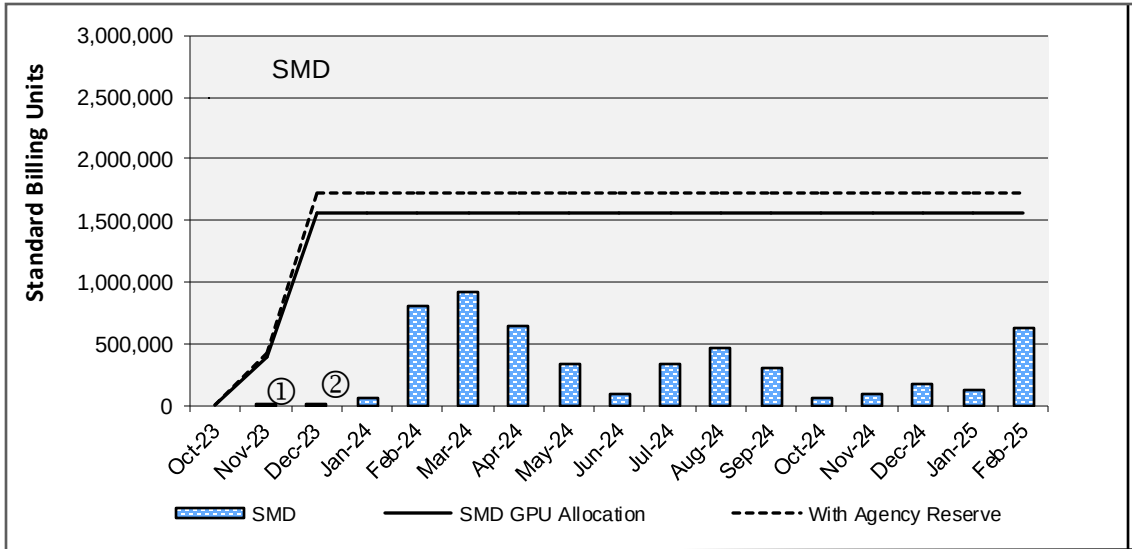
② Aitken Milan nodes added

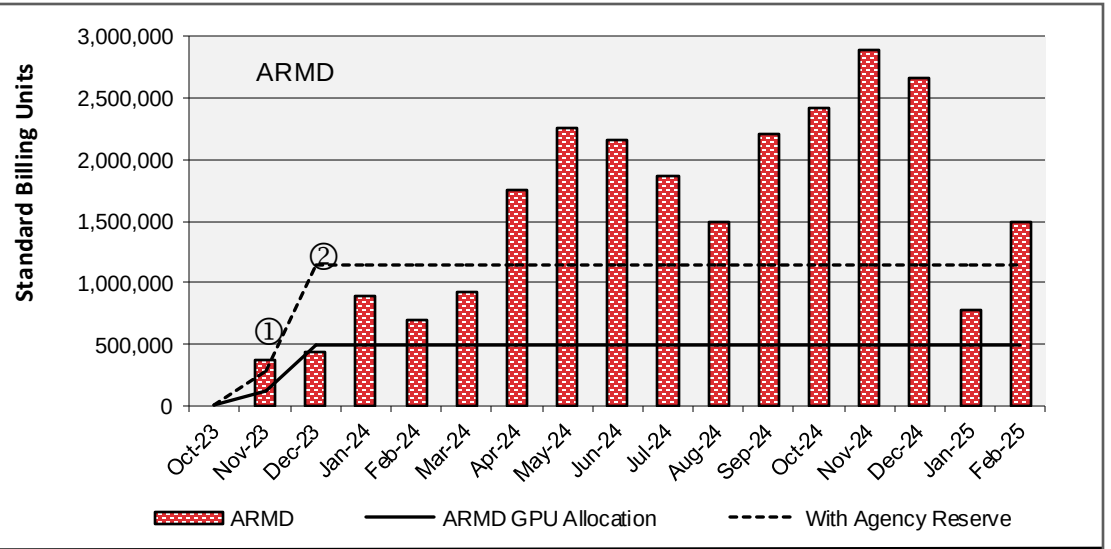
③ Sandy Bridge temporarily removed

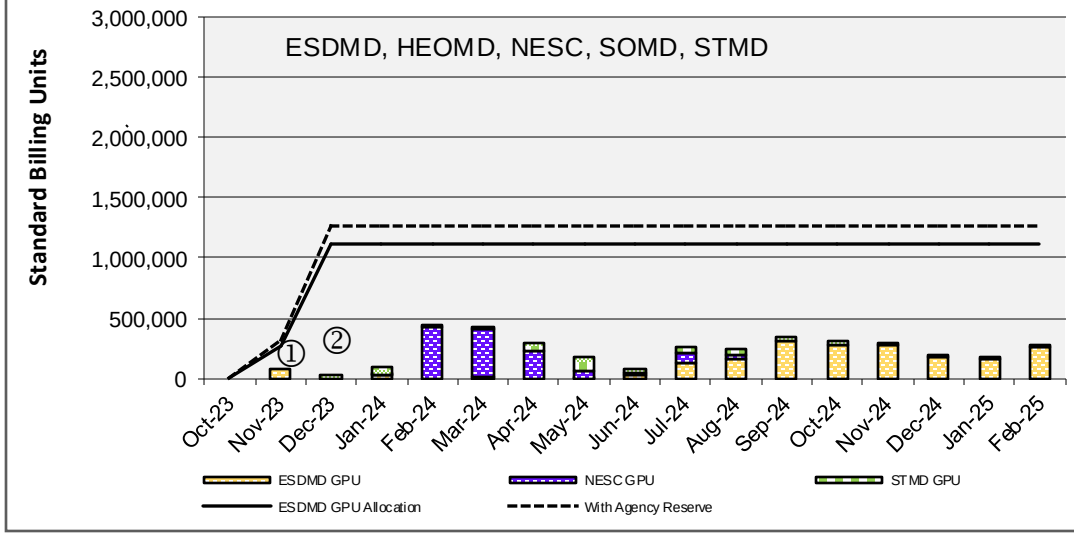
GPU Only Normalized Data



GPU Only Normalized Data



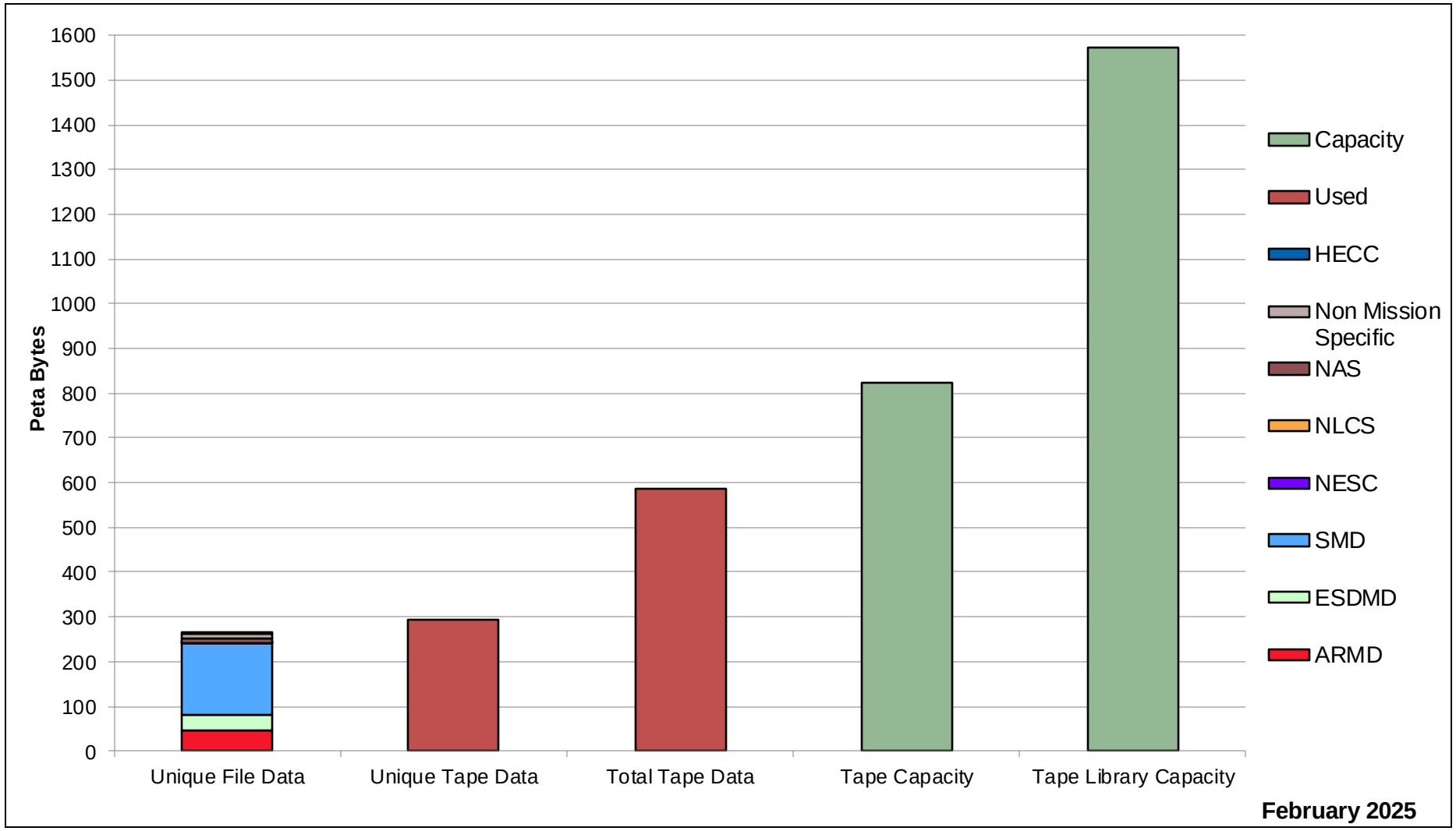




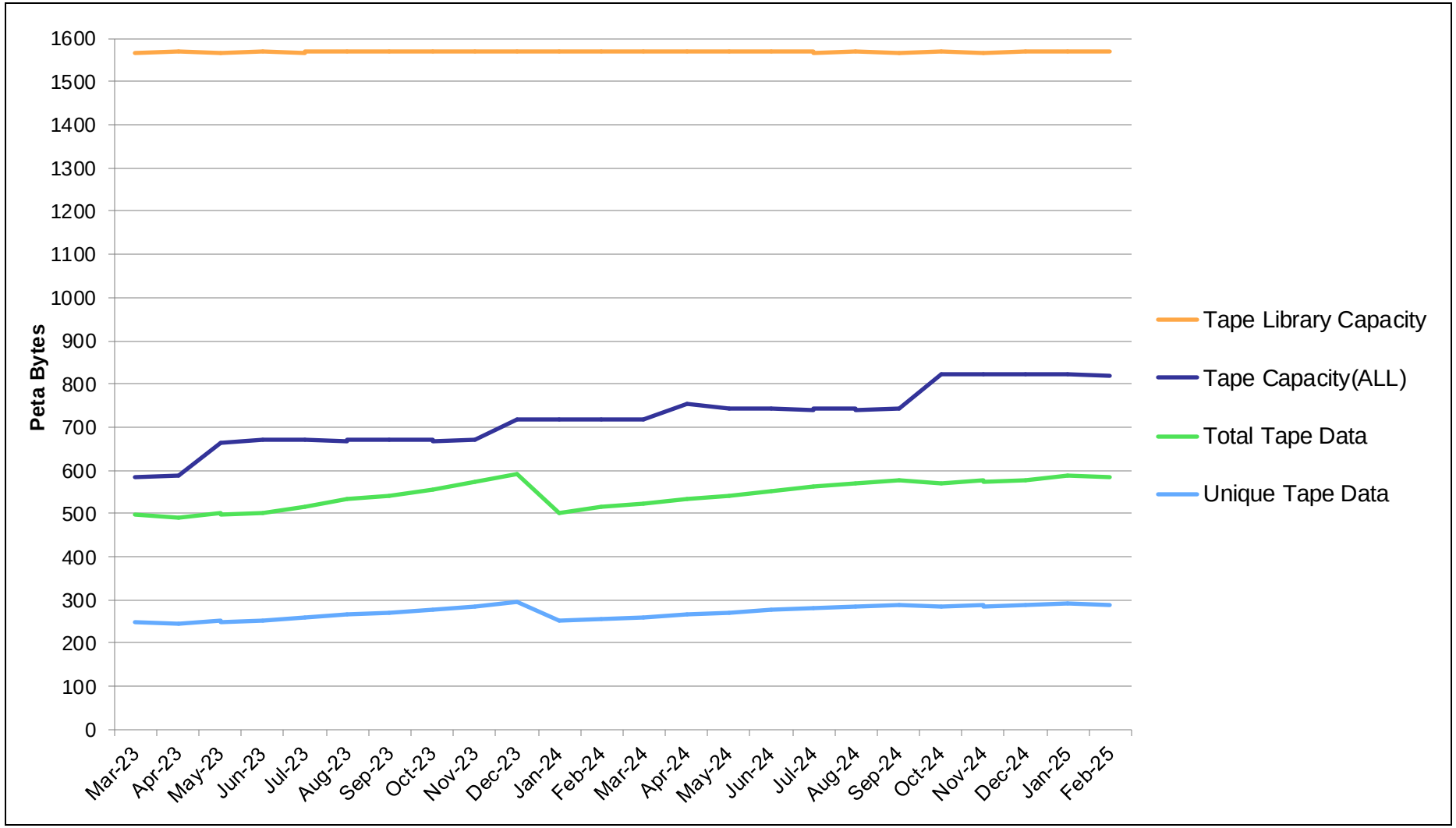
① Cabeus v100 nodes added

② Cabeus a100 nodes added

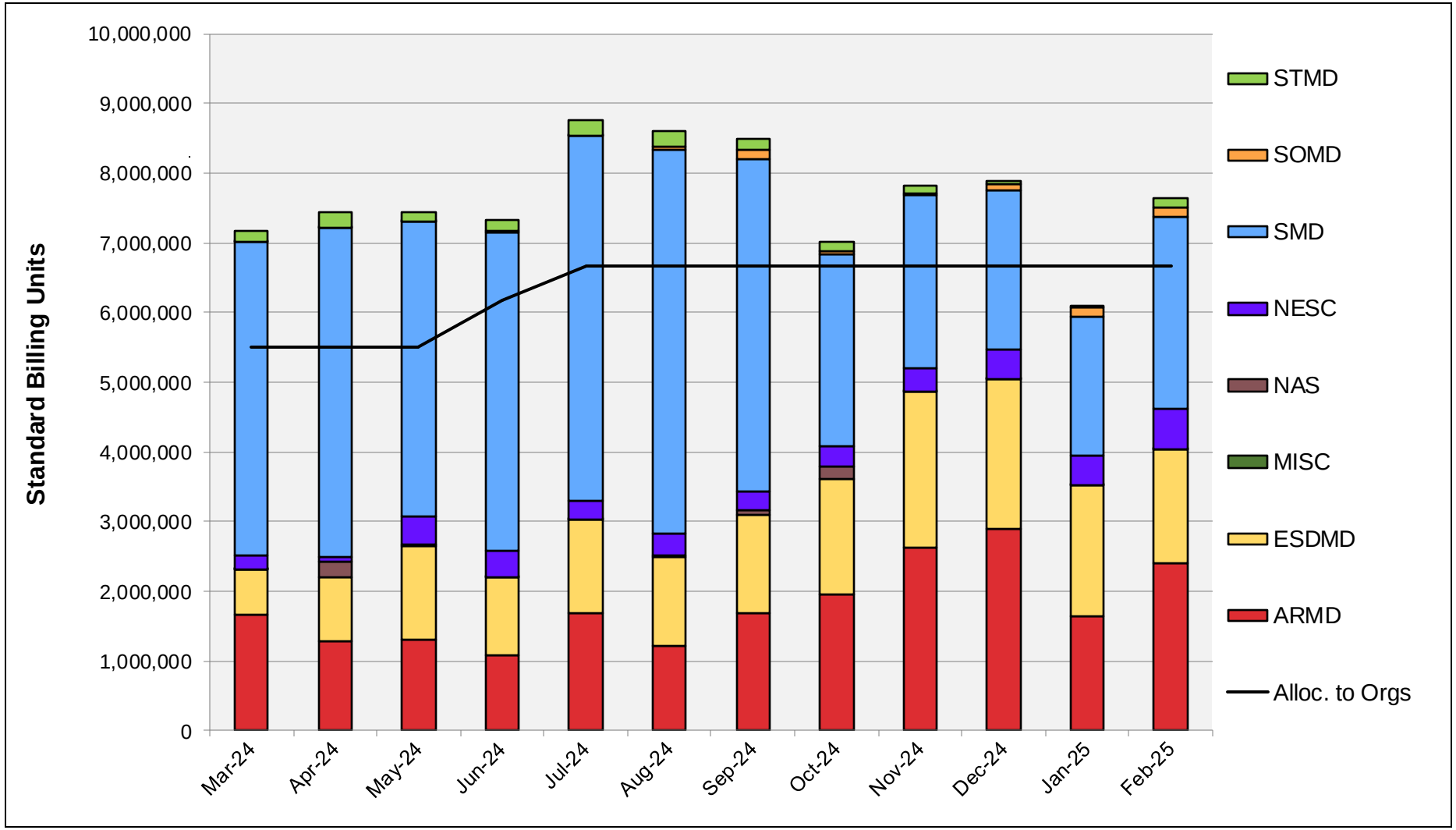
Tape Archive Status



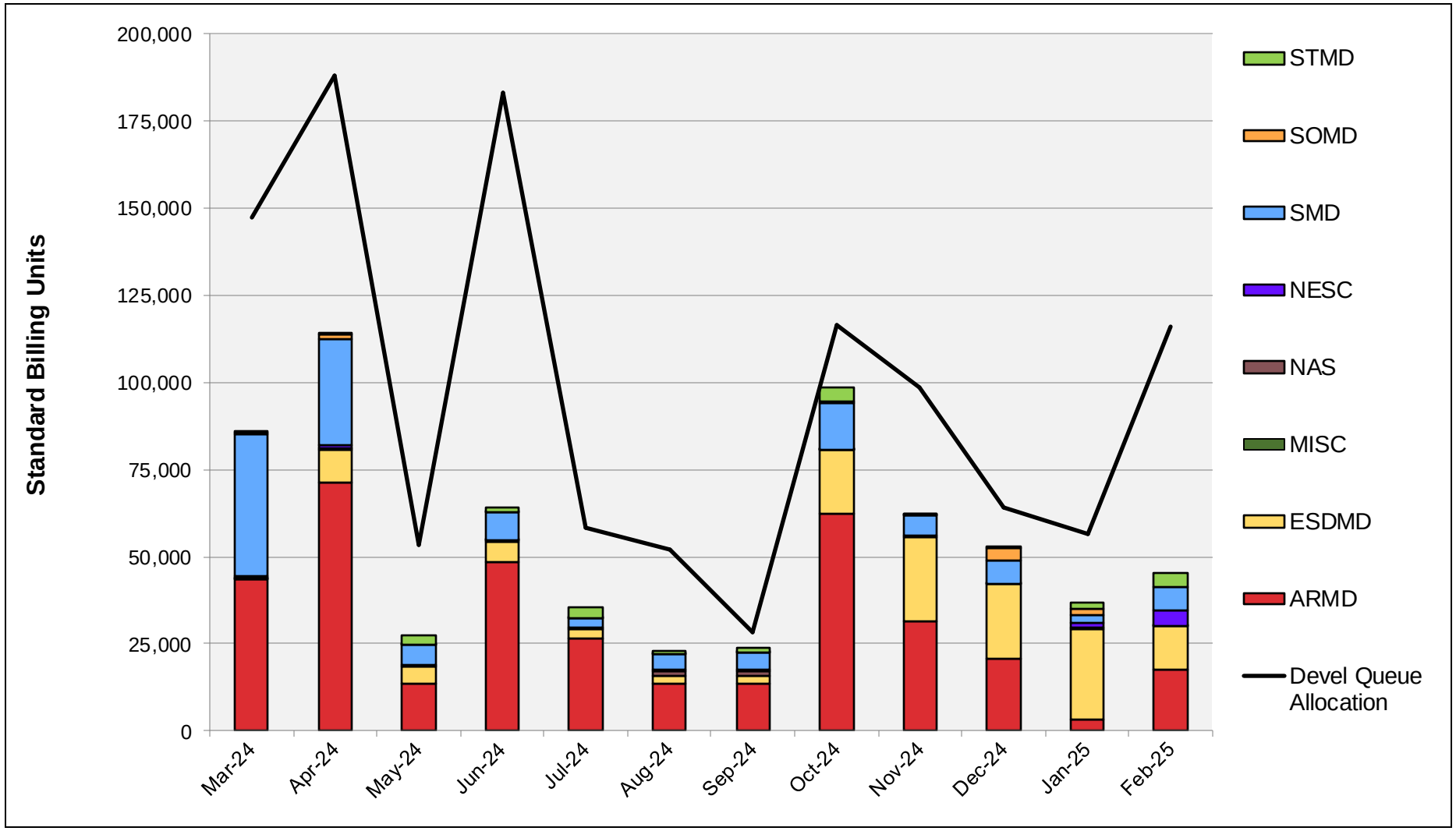
Tape Archive Status



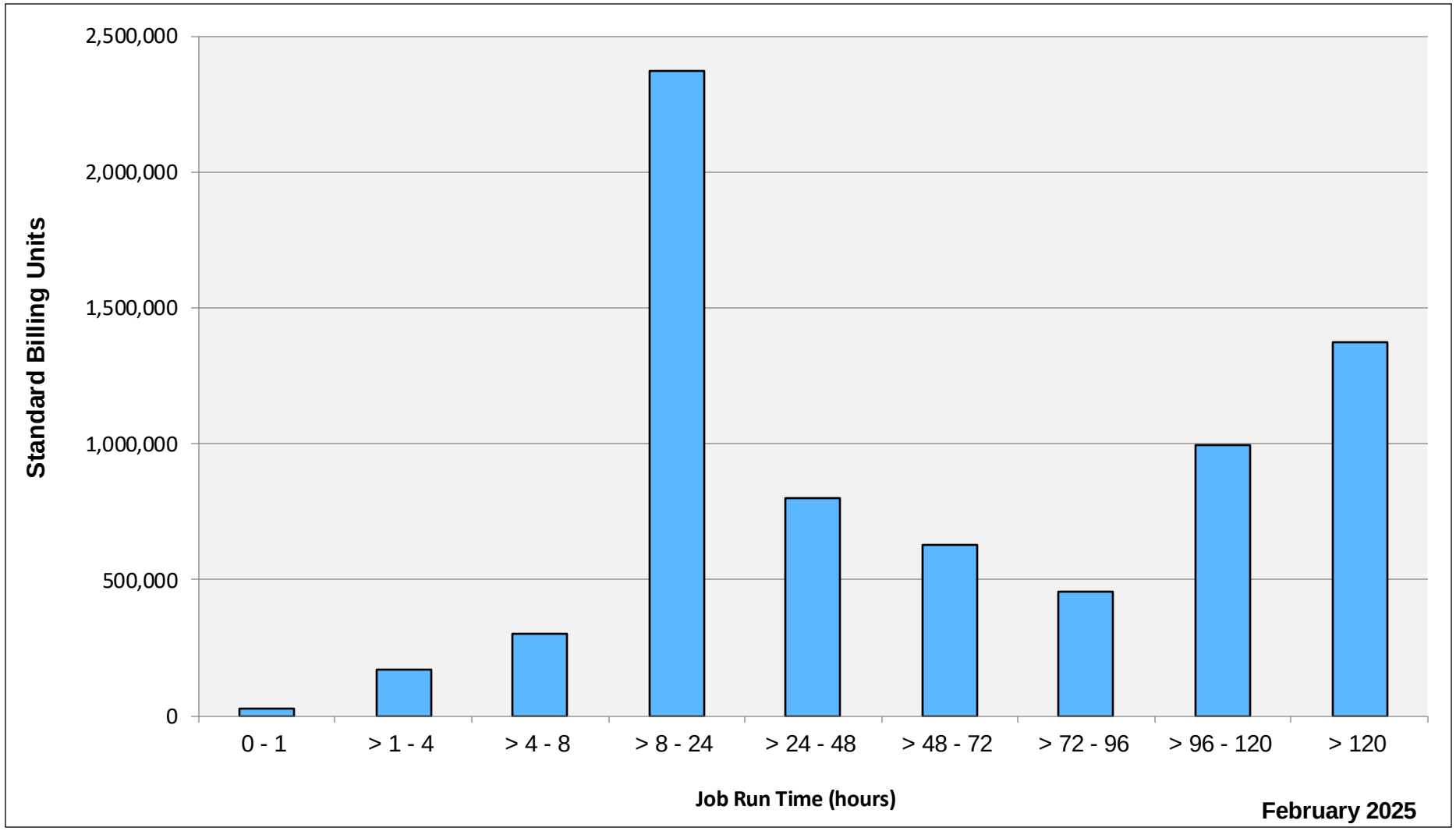
Aitken: SBUs Reported, Normalized to 30-Day Month



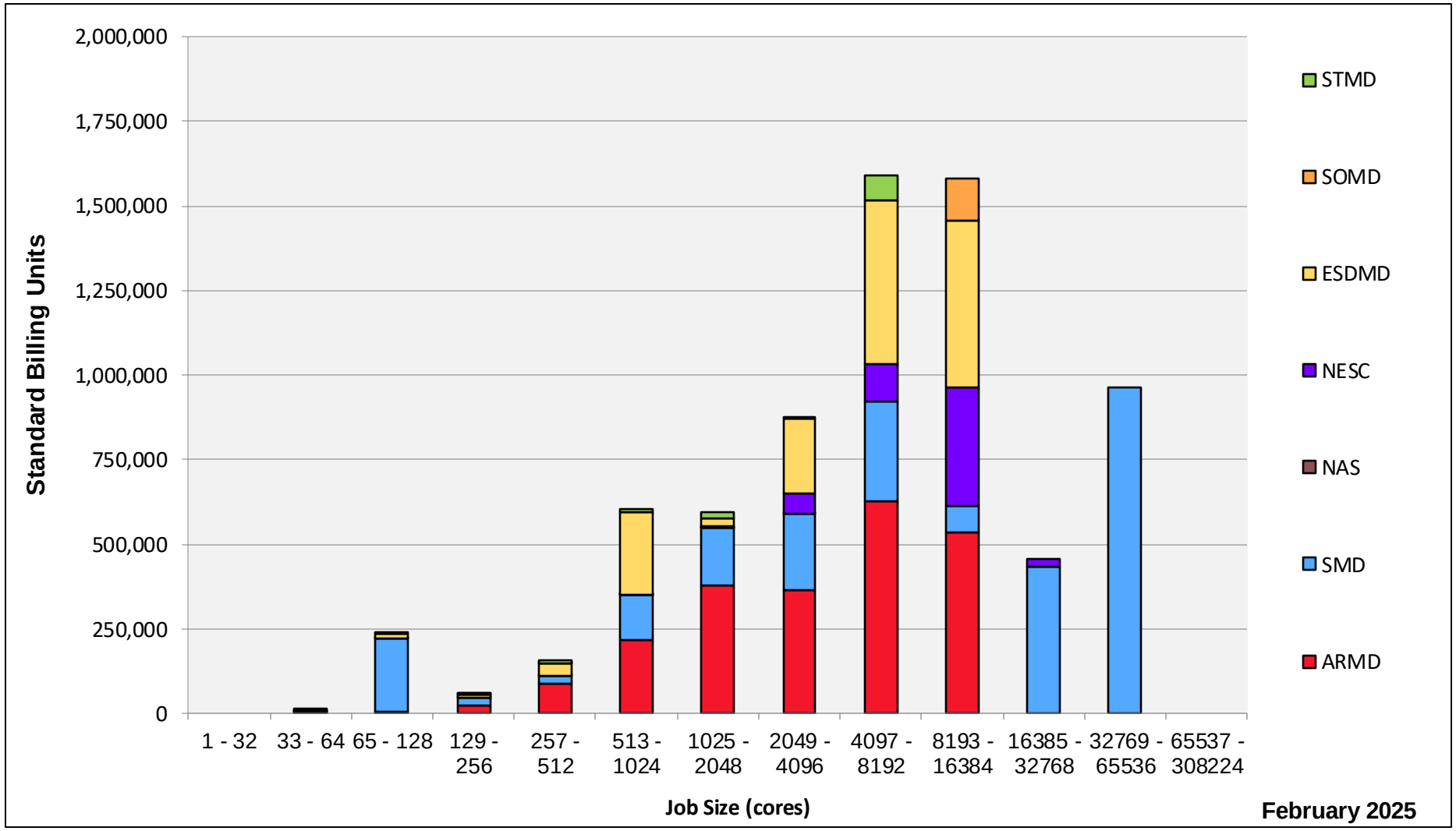
Aitken: Devel Queue Utilization



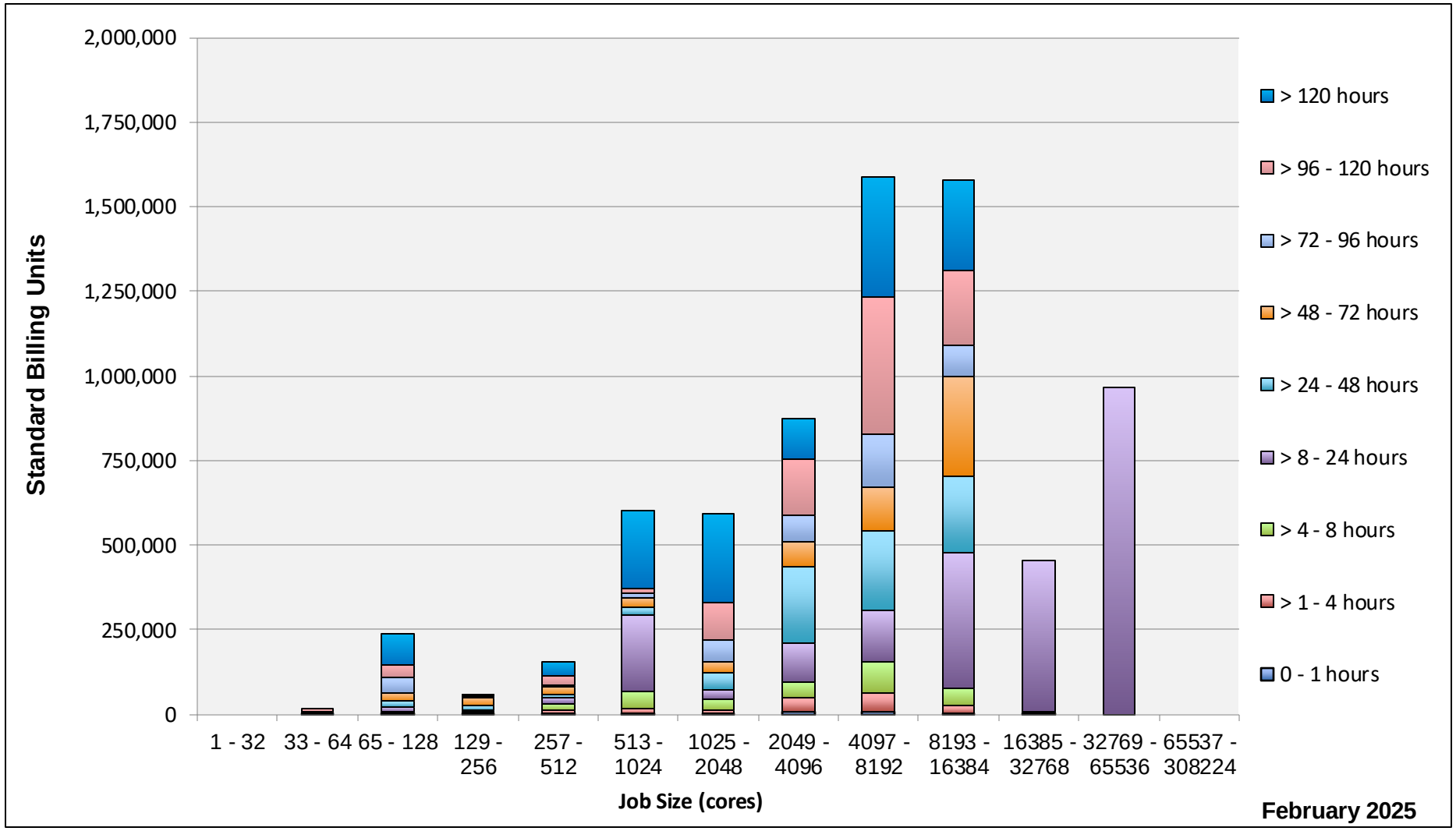
Aitken: Monthly Utilization by Job Length



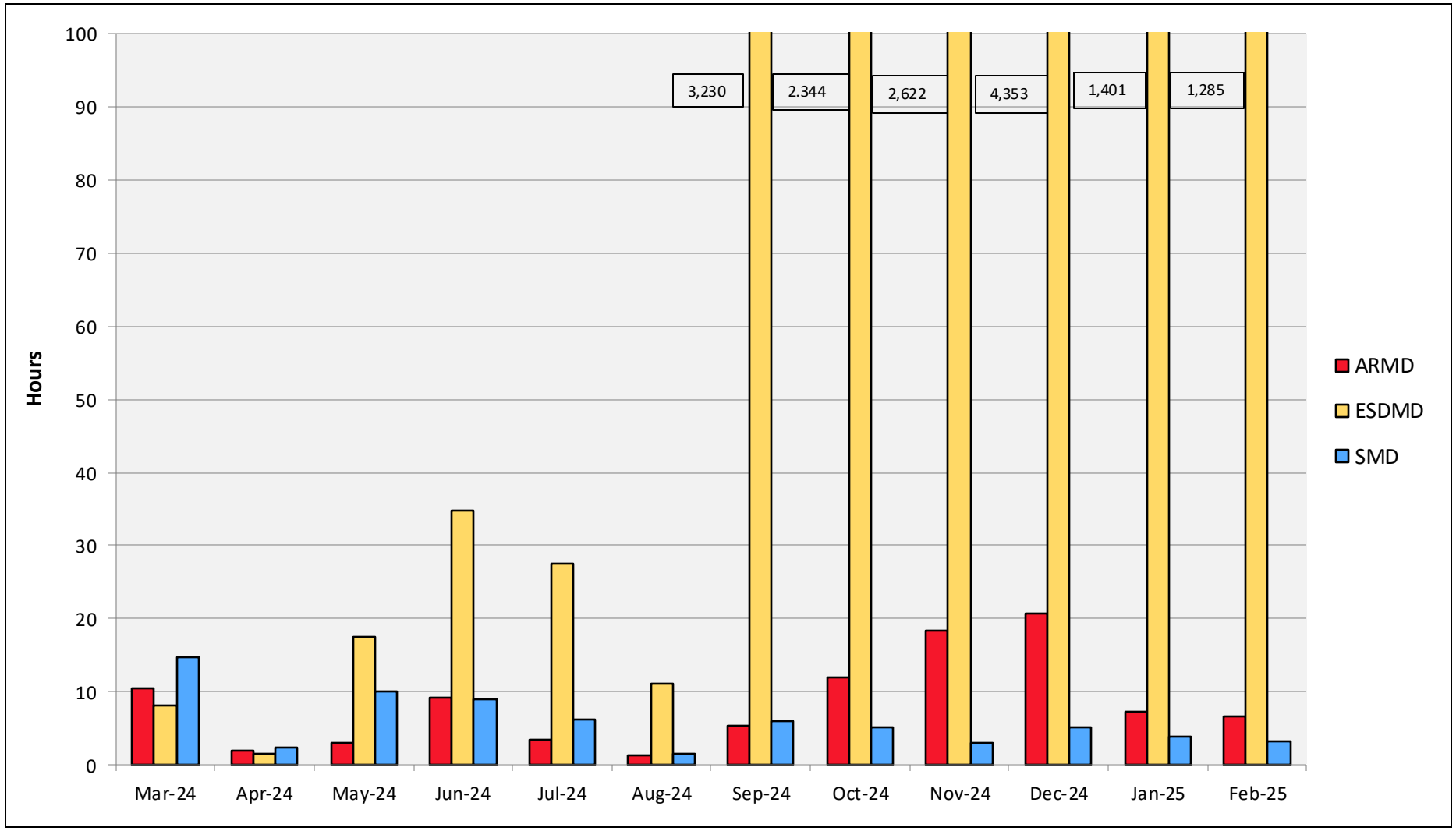
Aitken: Monthly Utilization by Job Size



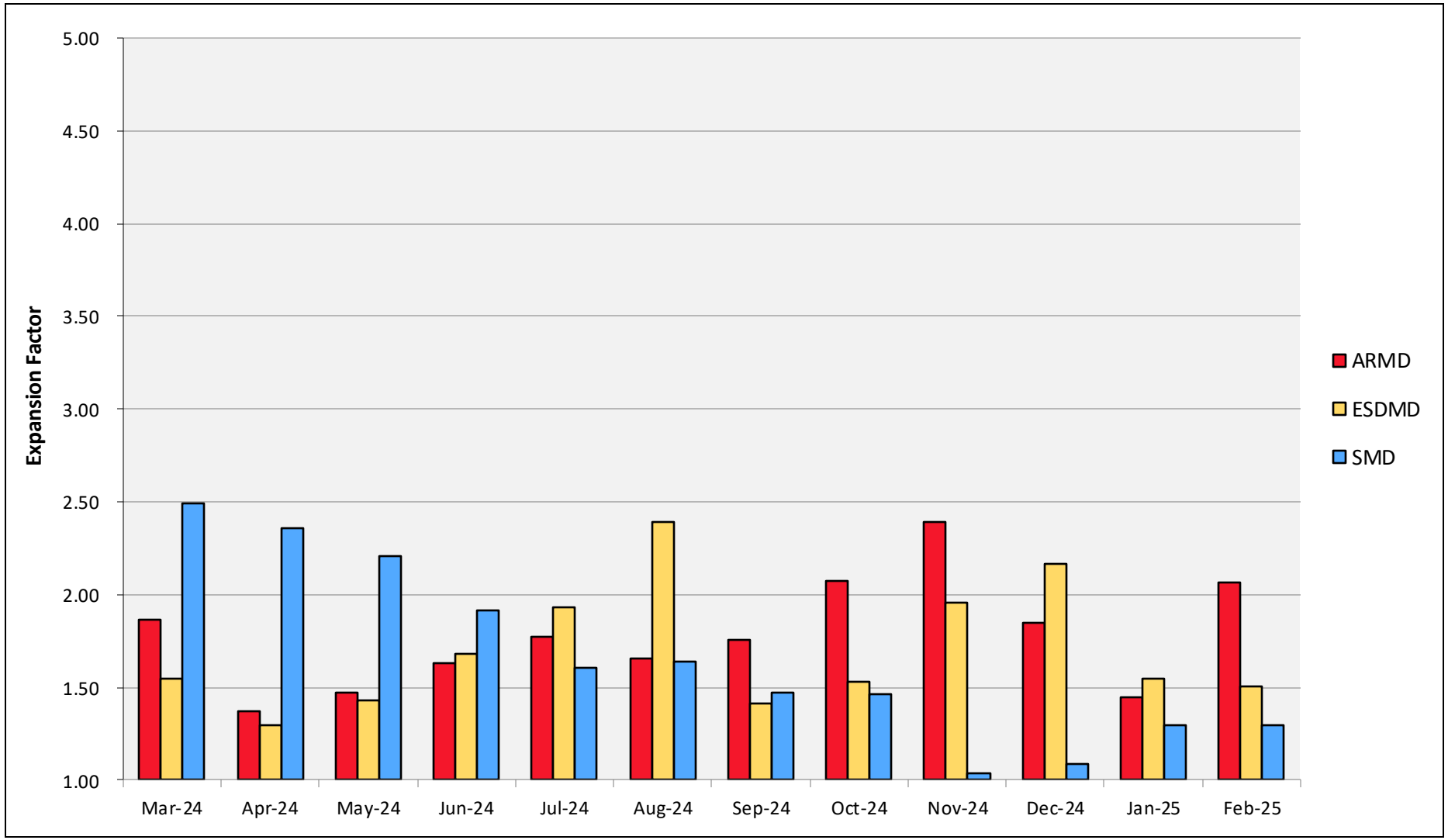
Aitken: Monthly Utilization by Size and Length



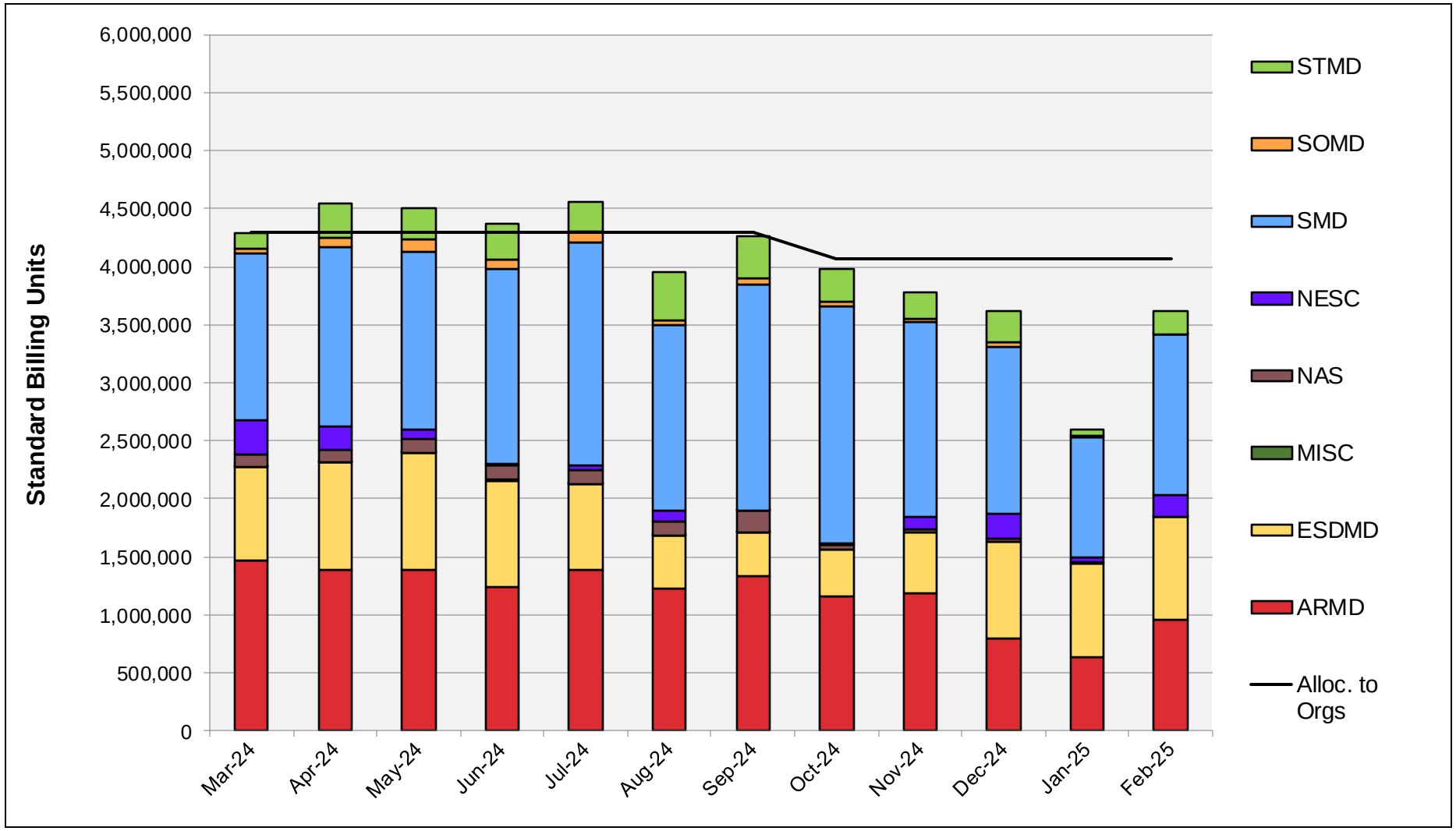
Aitken: Average Time to Clear All Jobs



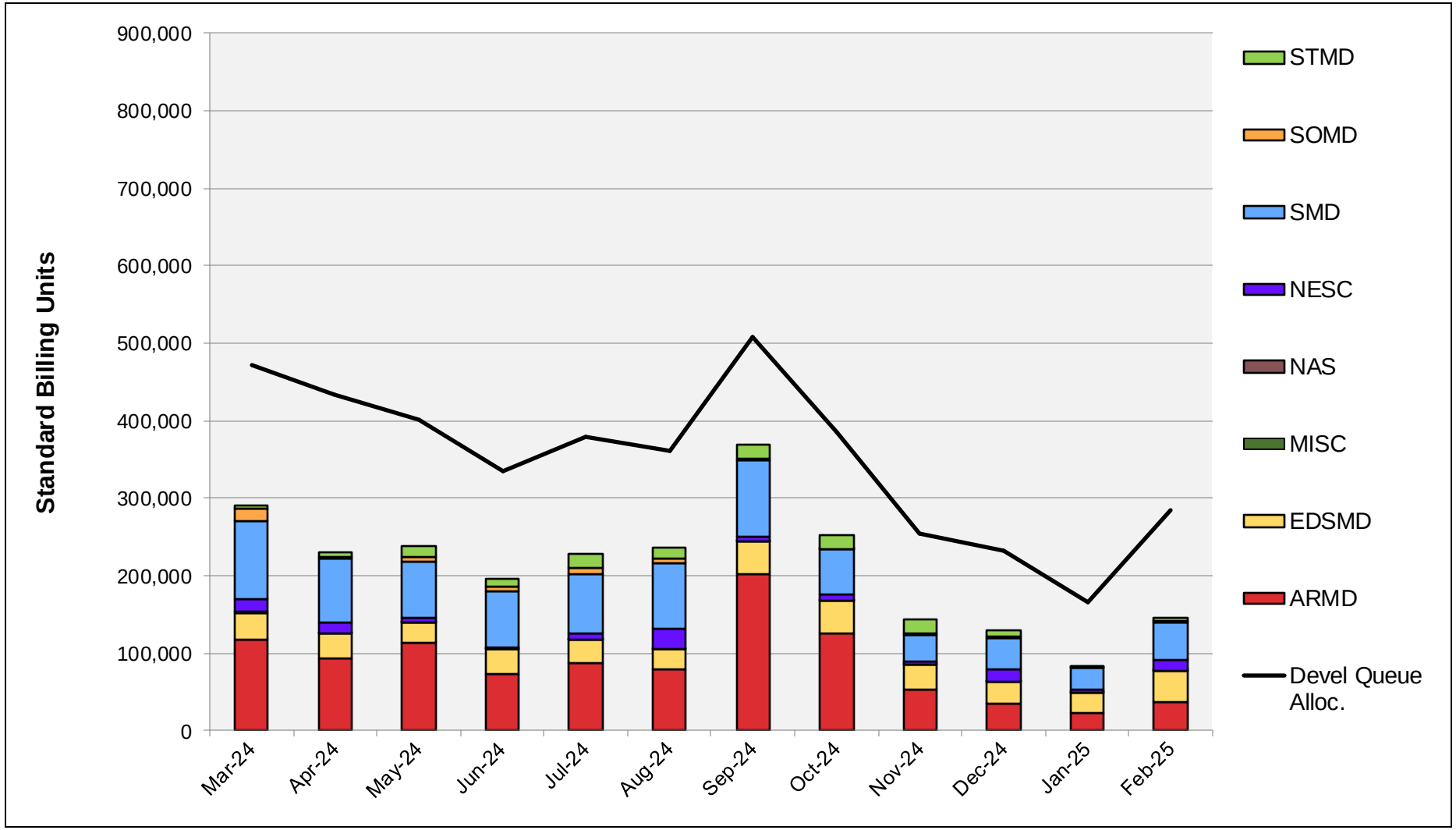
Aitken: Average Expansion Factor



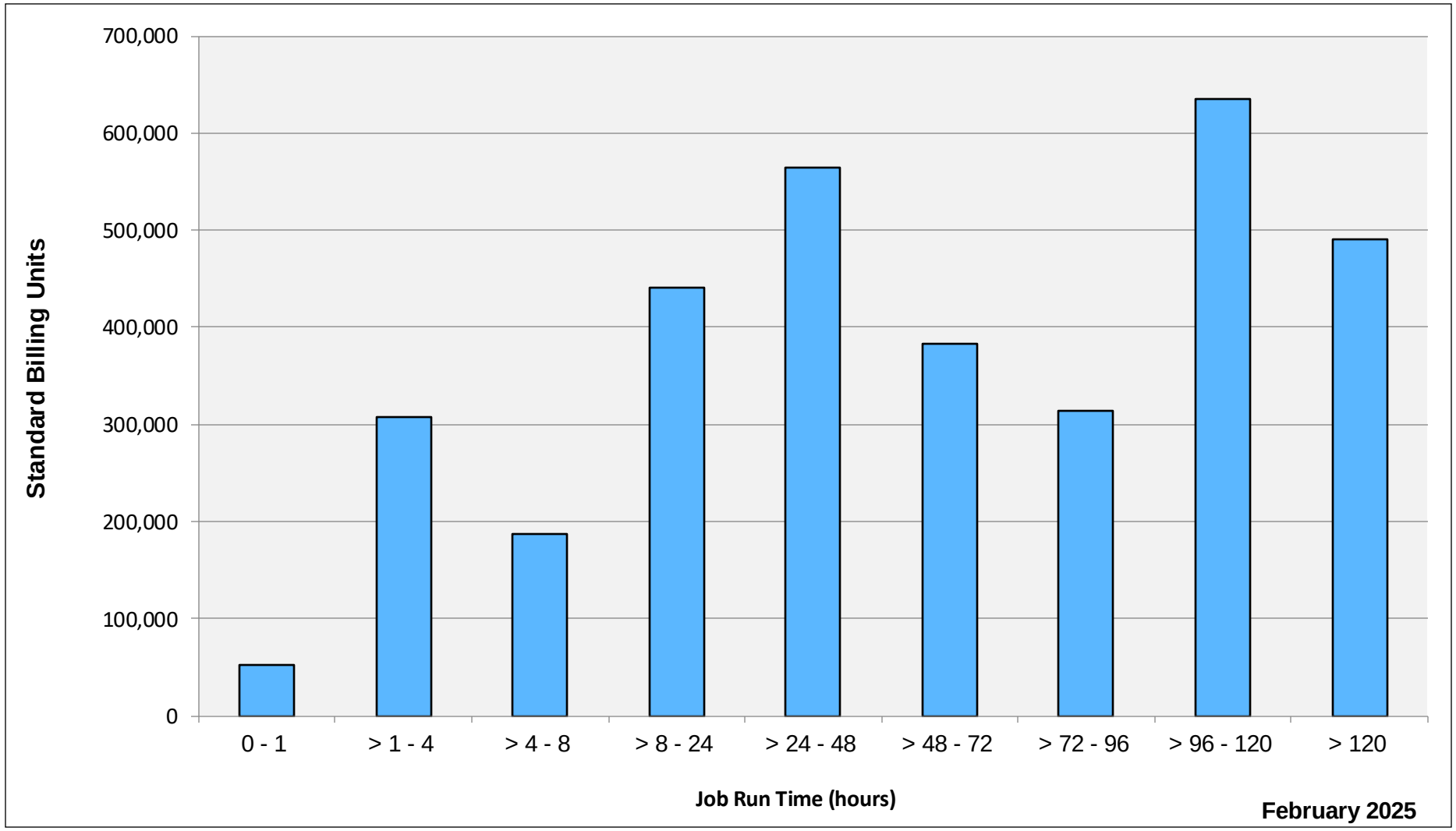
Pleiades: SBUs Reported, Normalized to 30-Day Month



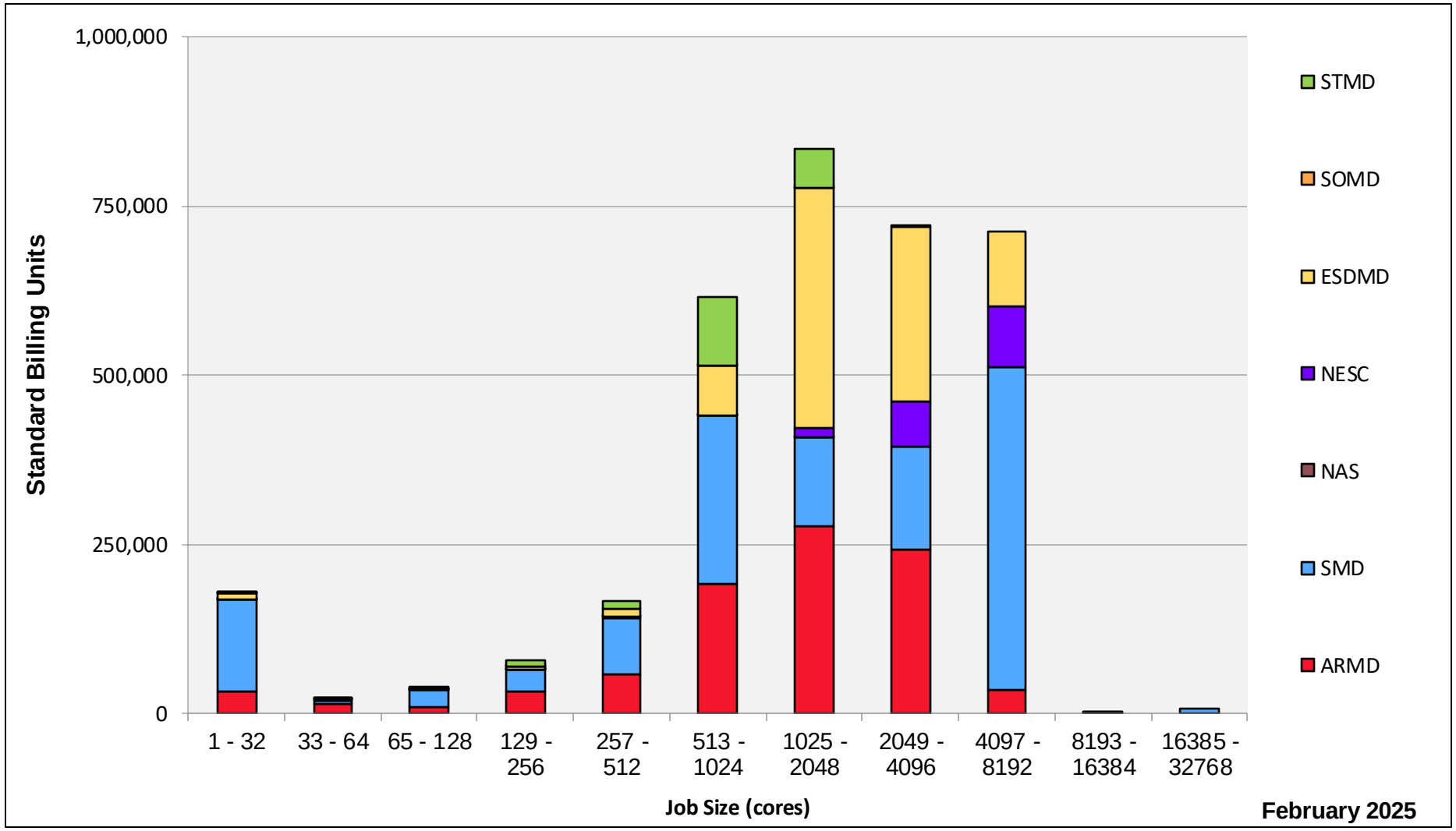
Pleiades: Devel Queue Utilization



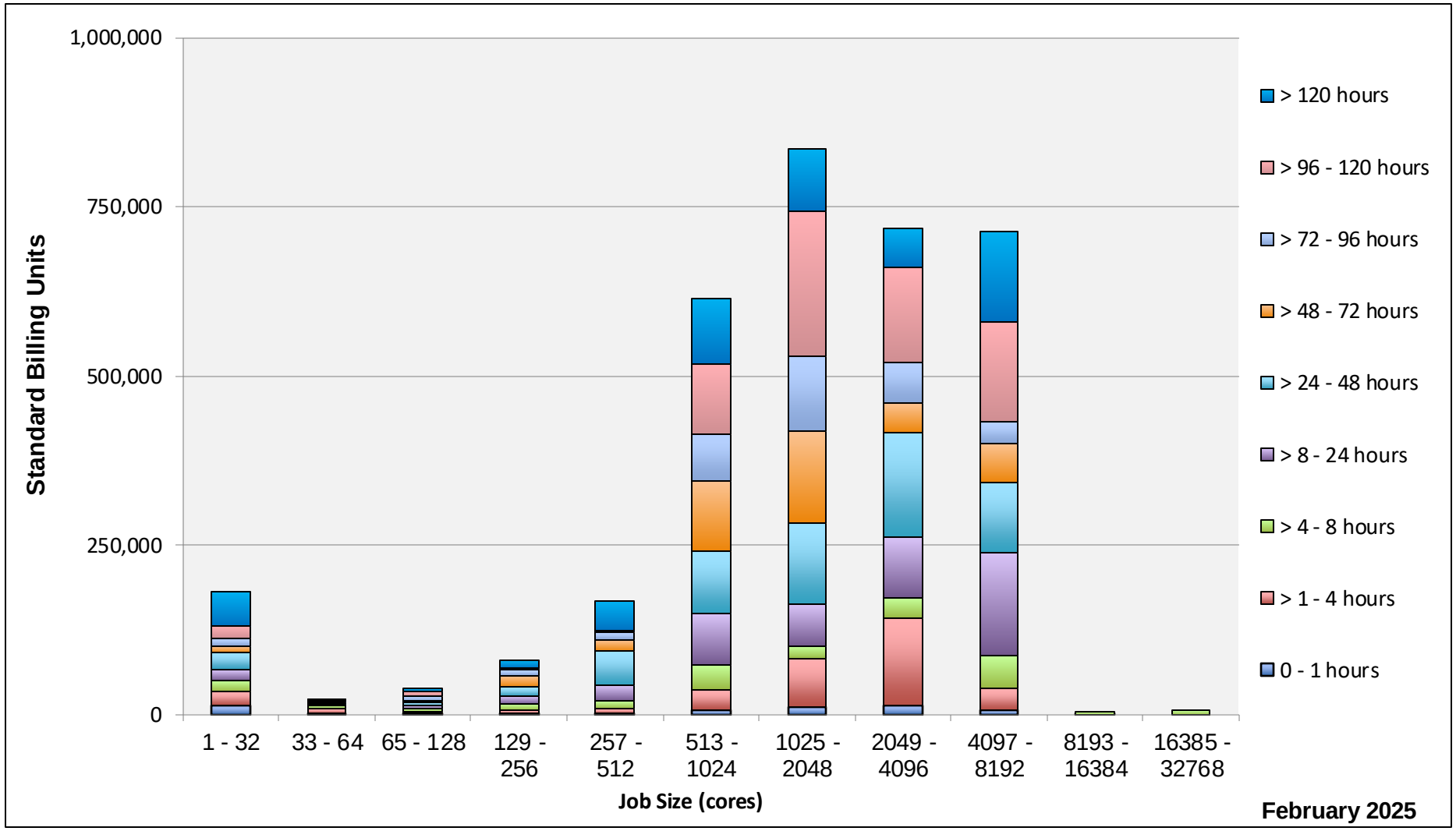
Pleiades: Monthly Utilization by Job Length



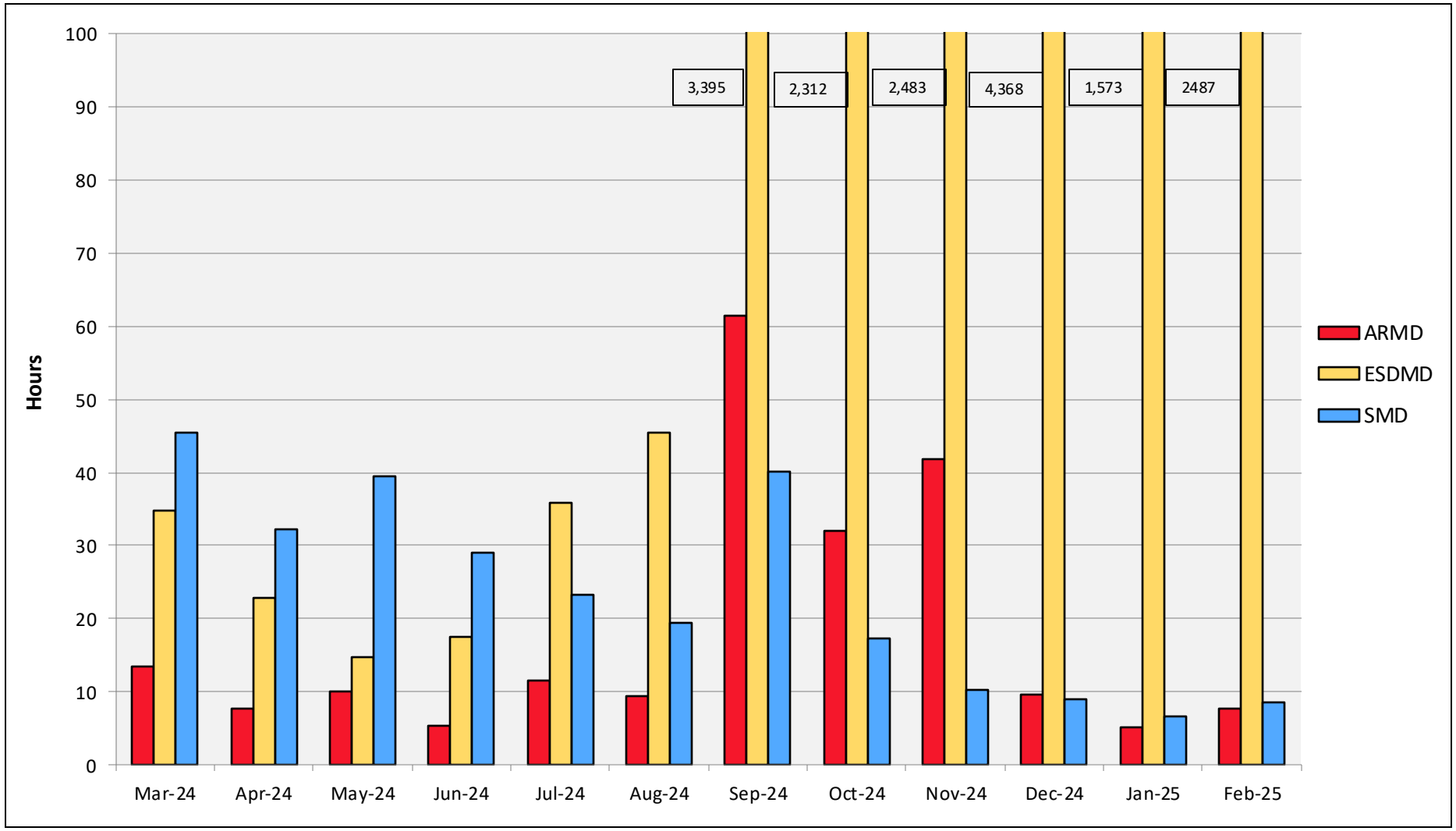
Pleiades: Monthly Utilization by Job Size



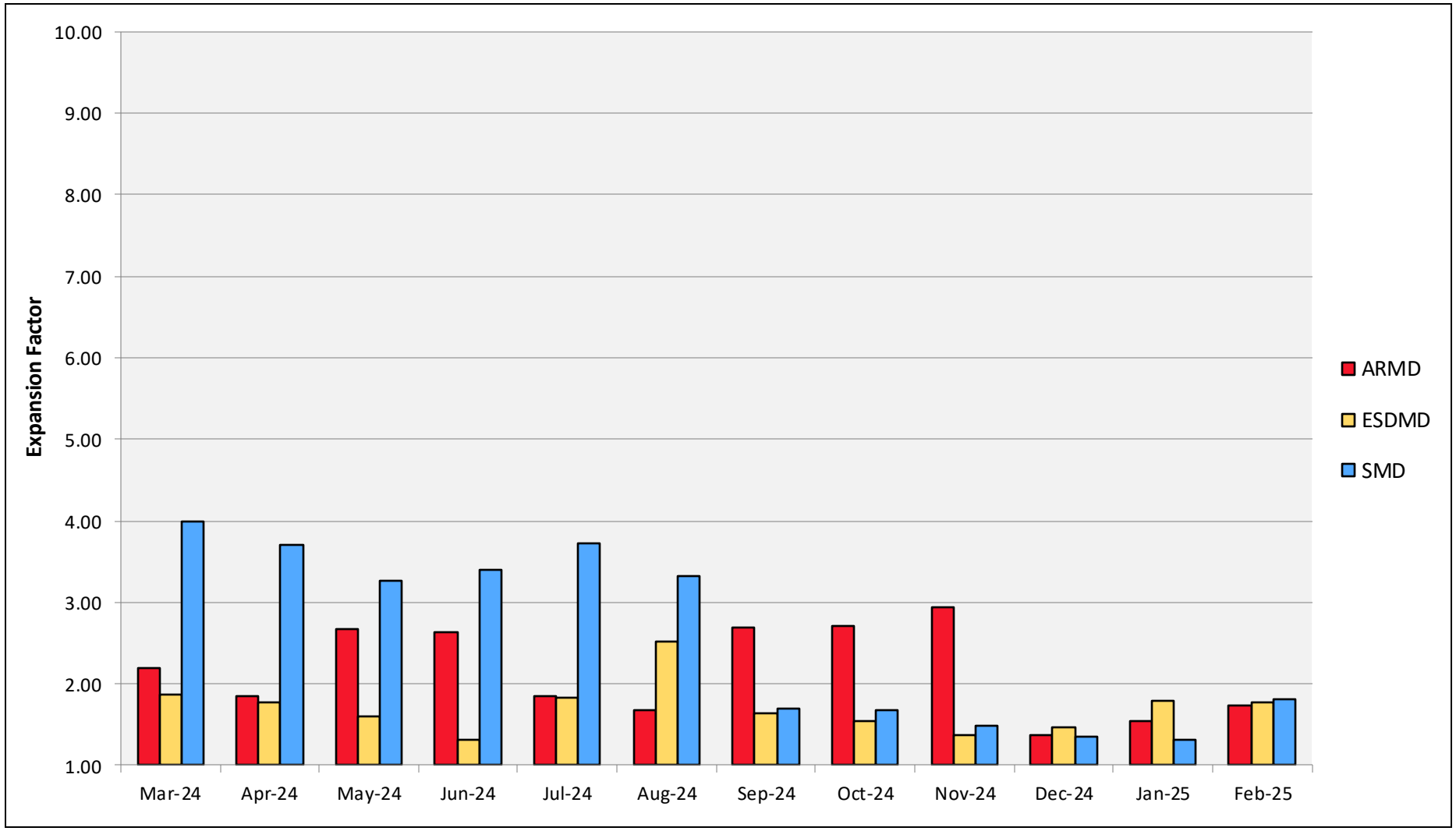
Pleiades: Monthly Utilization by Size and Length



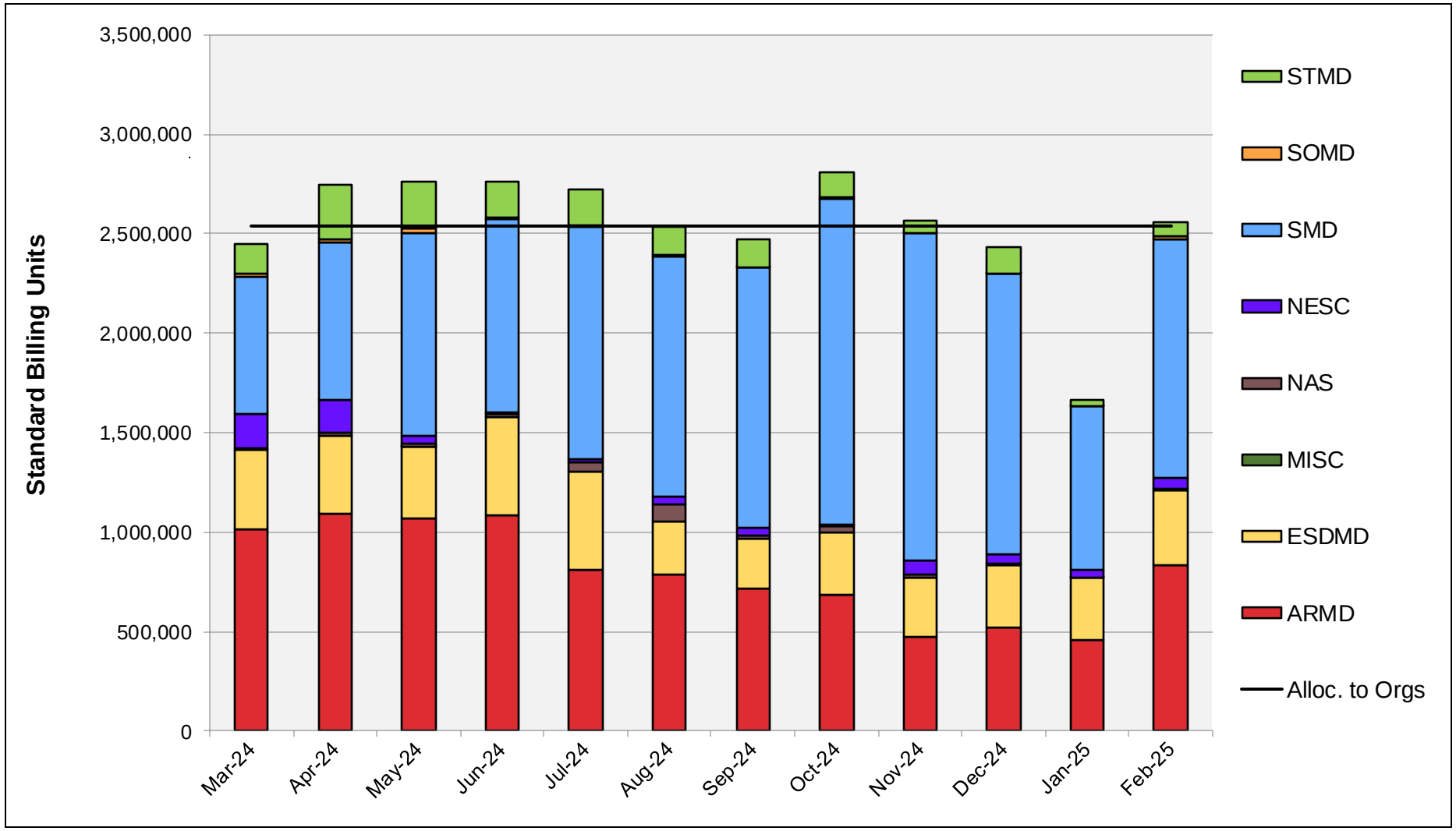
Pleiades: Average Time to Clear All Jobs



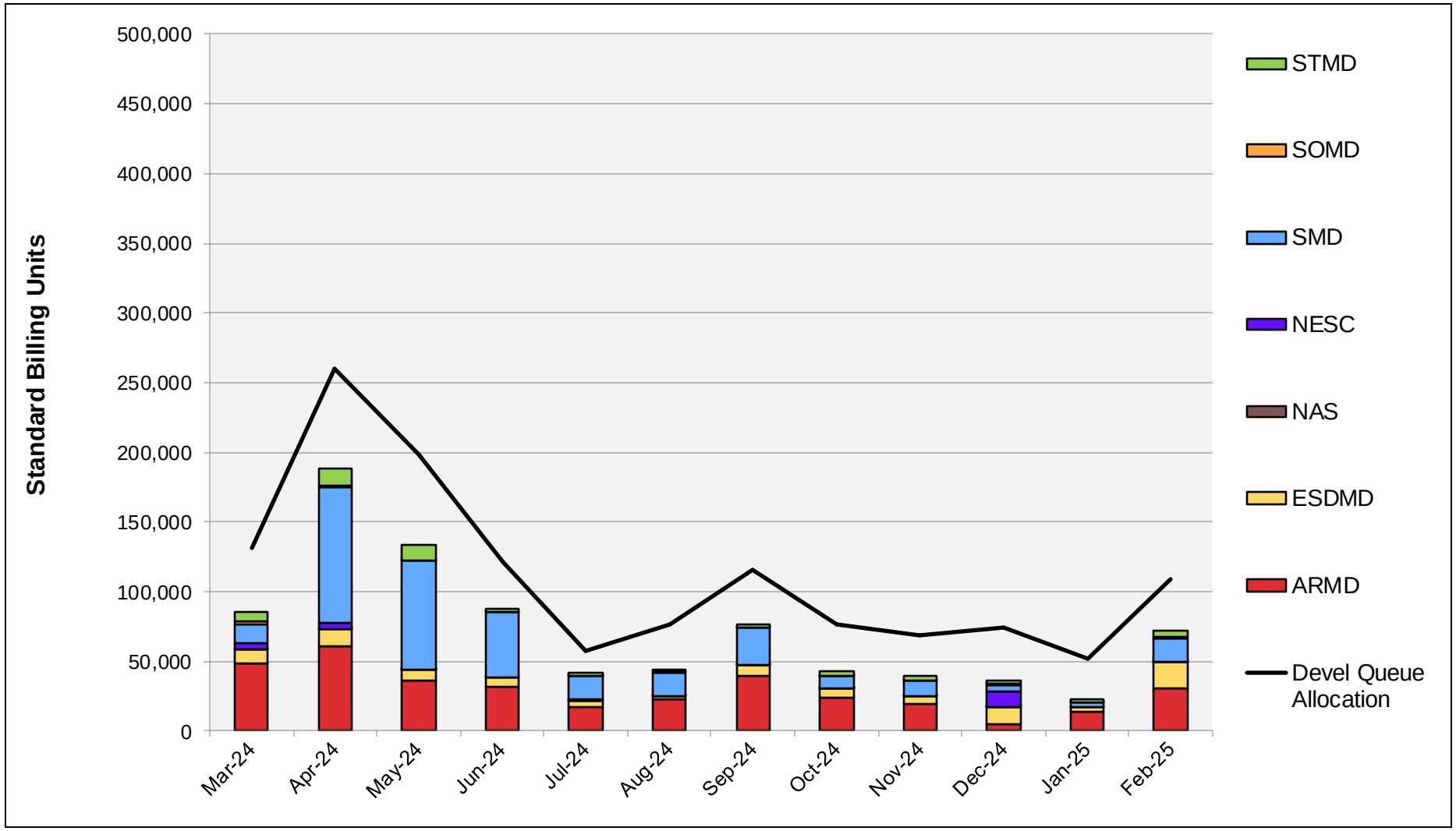
Pleiades: Average Expansion Factor



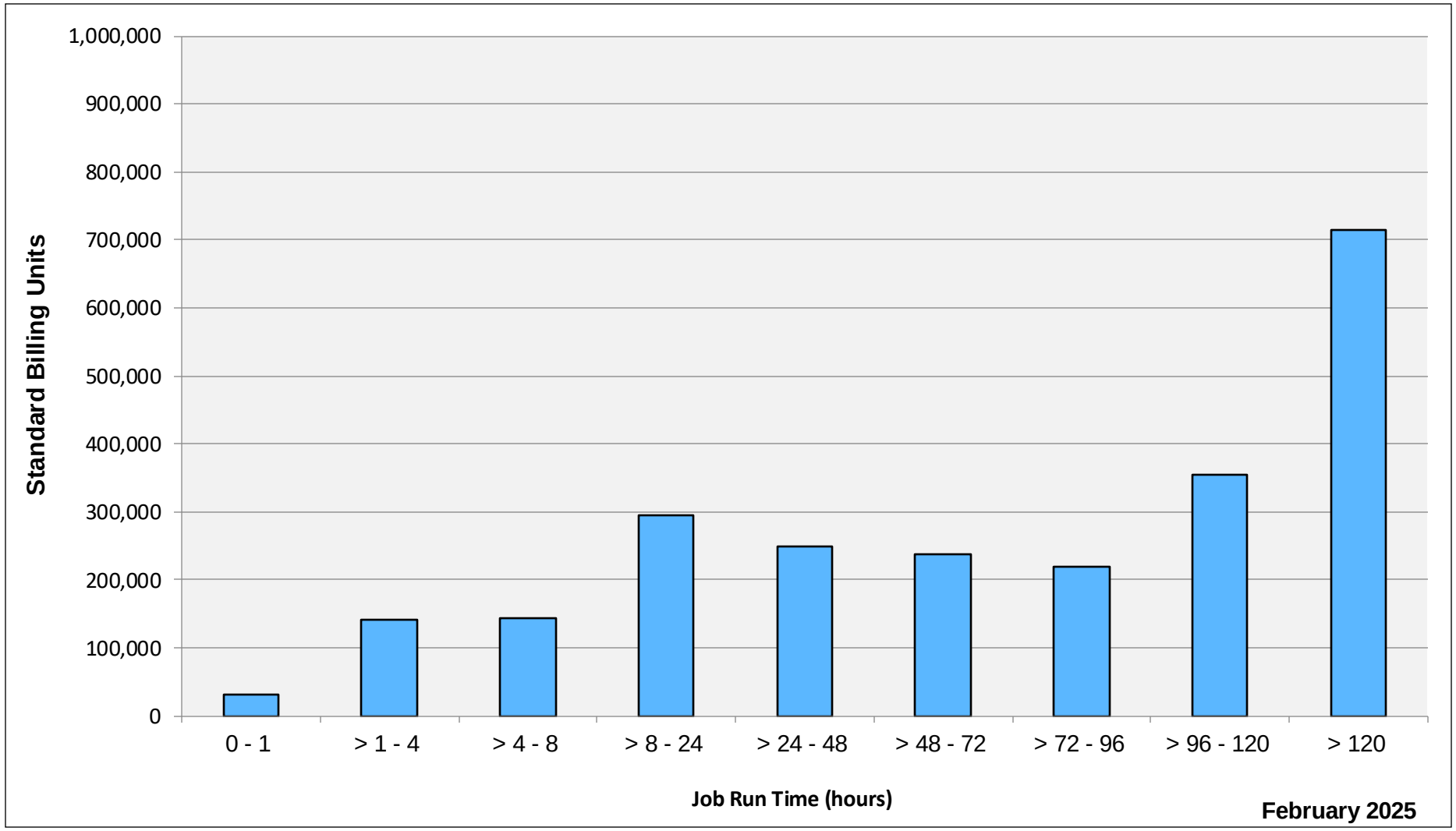
Electra: SBUs Reported, Normalized to 30-Day Month



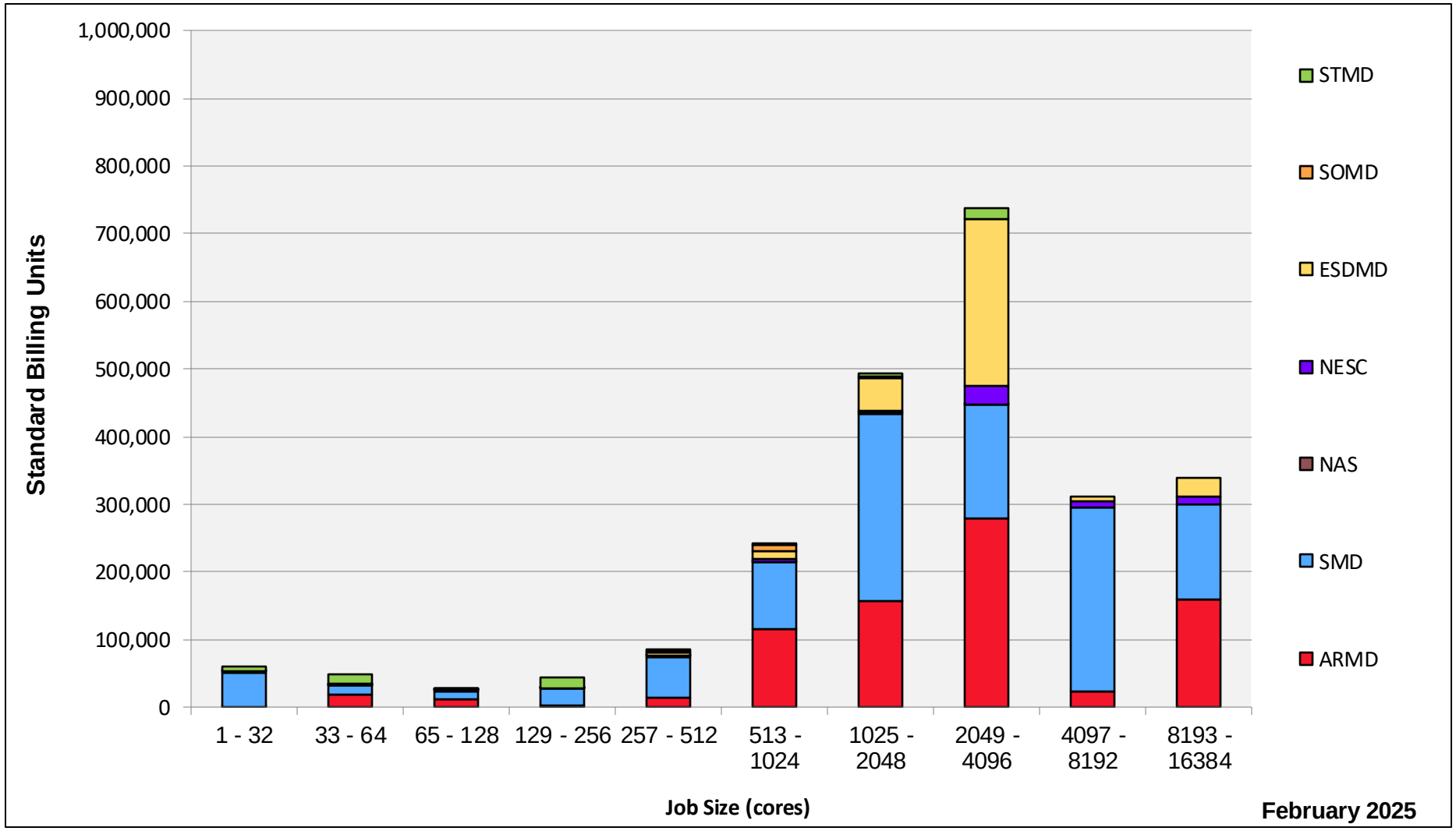
Electra: Devel Queue Utilization



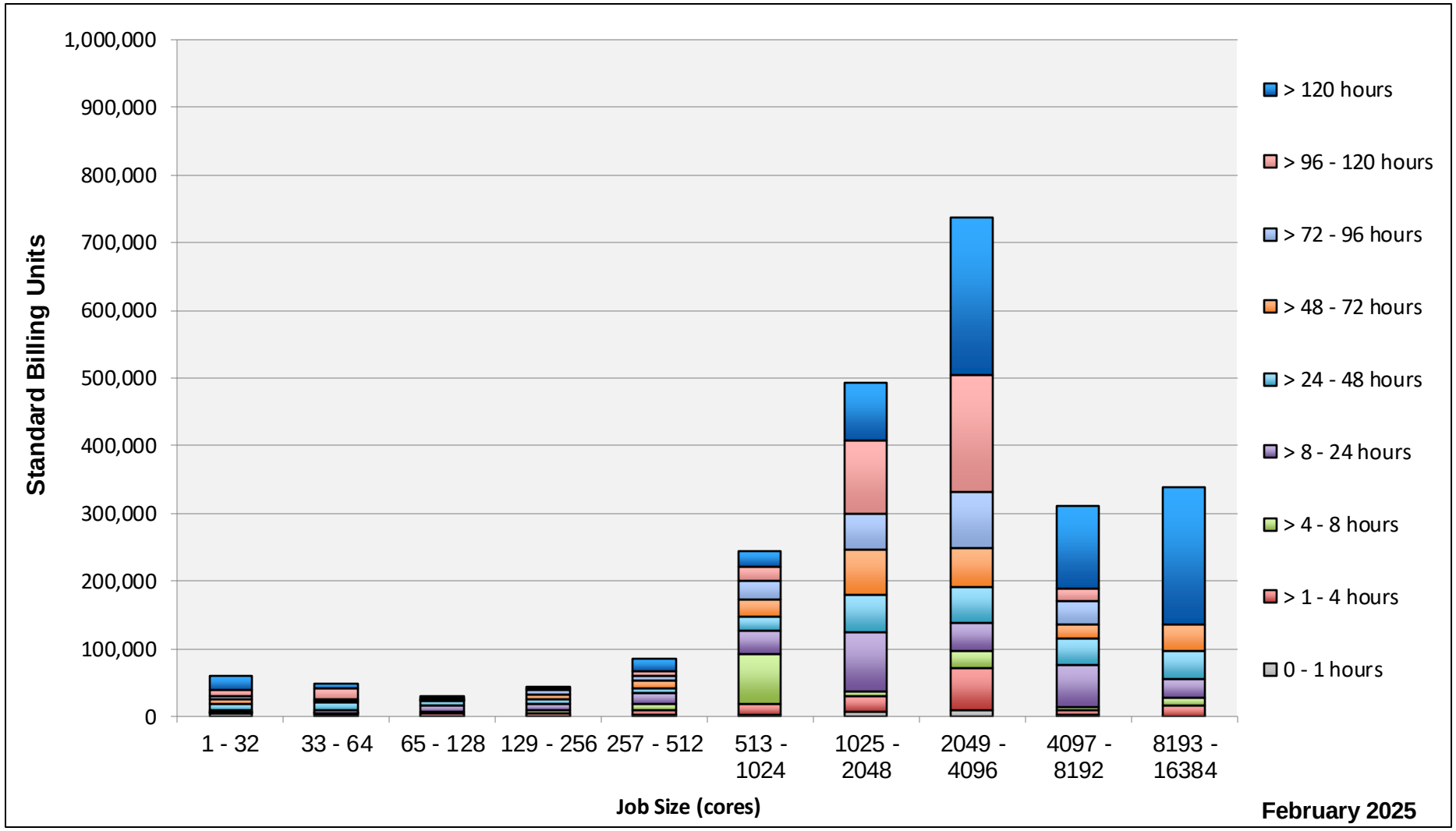
Electra: Monthly Utilization by Job Length



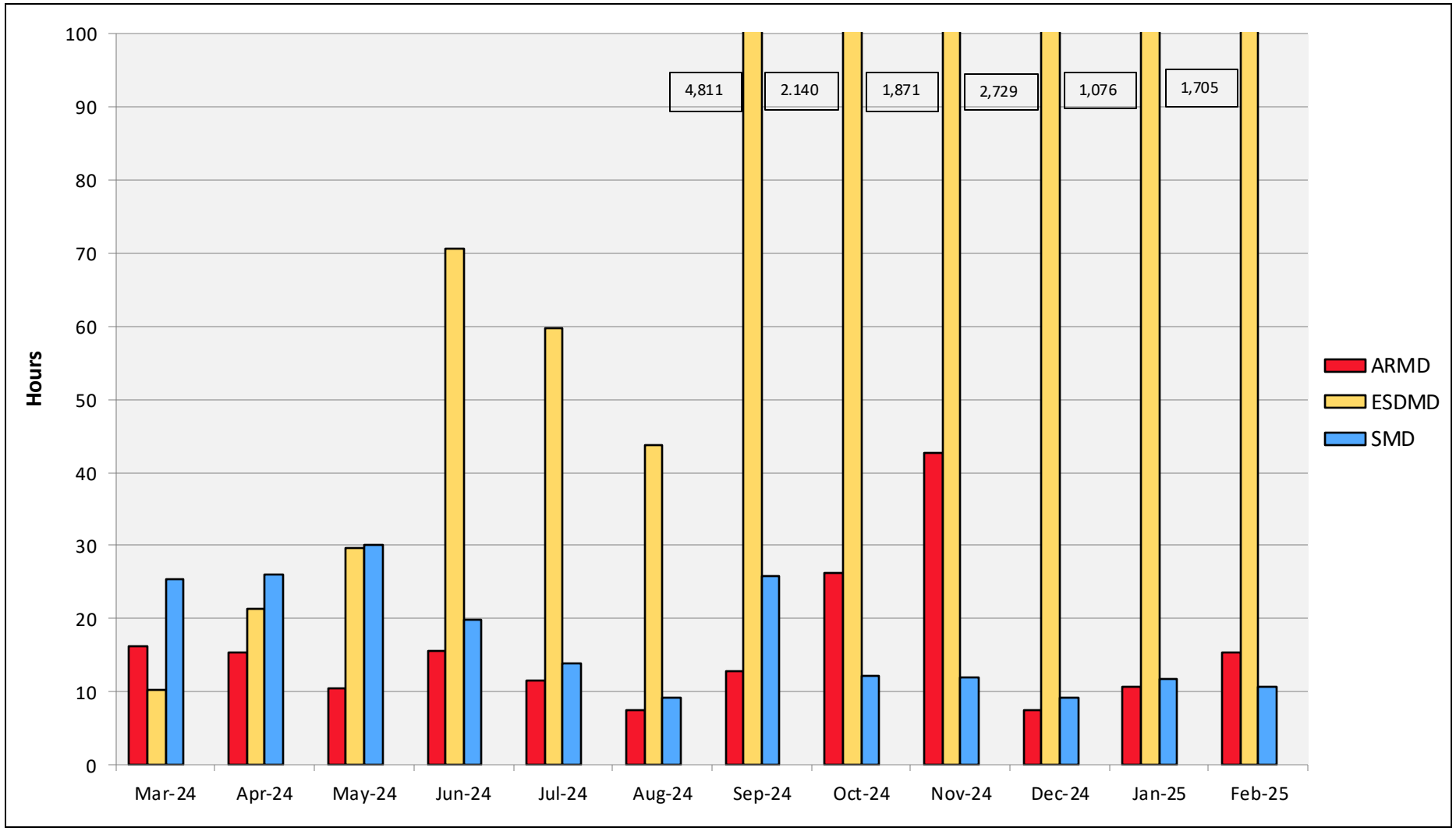
Electra: Monthly Utilization by Job Size



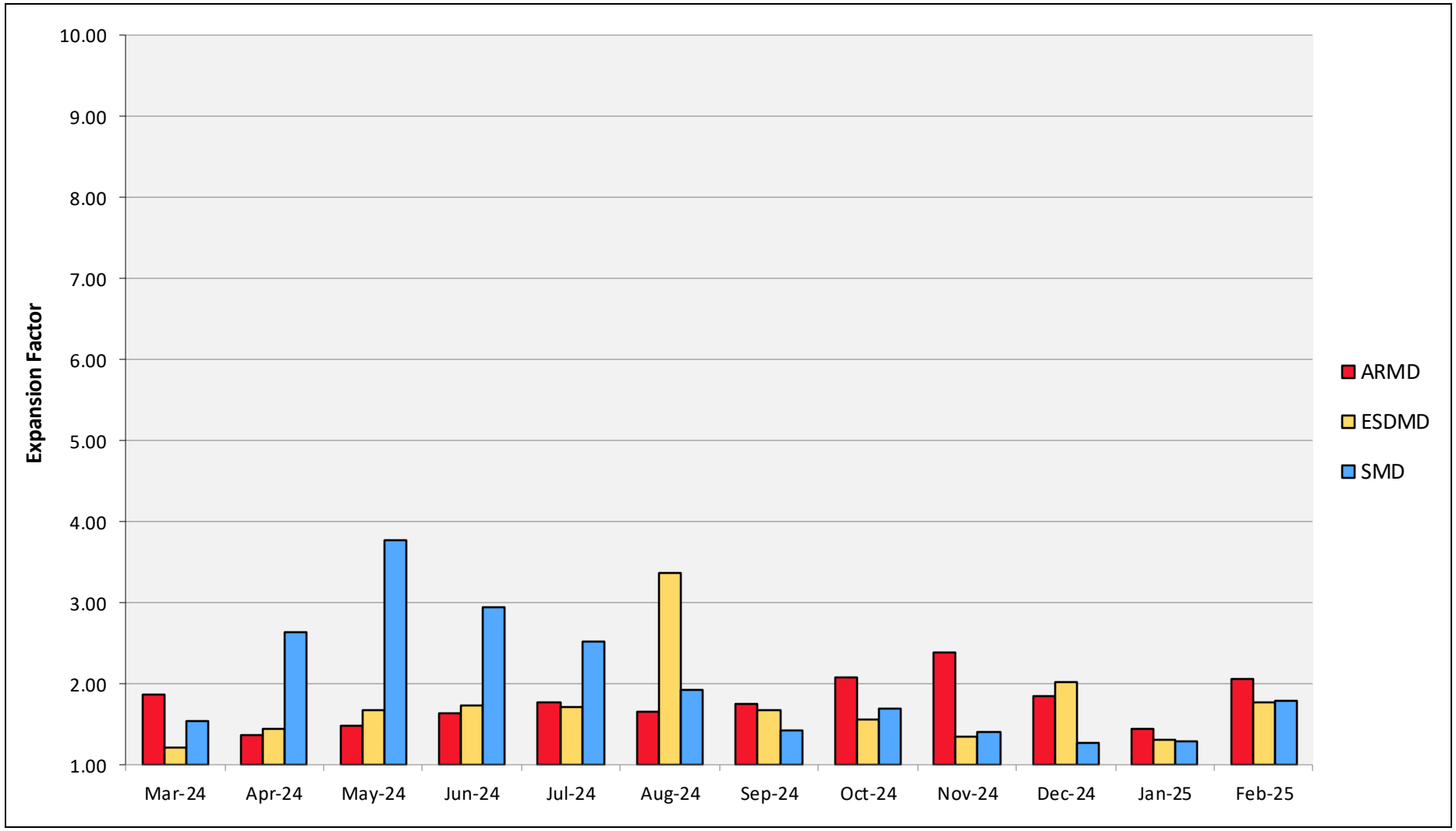
Electra: Monthly Utilization by Size and Length



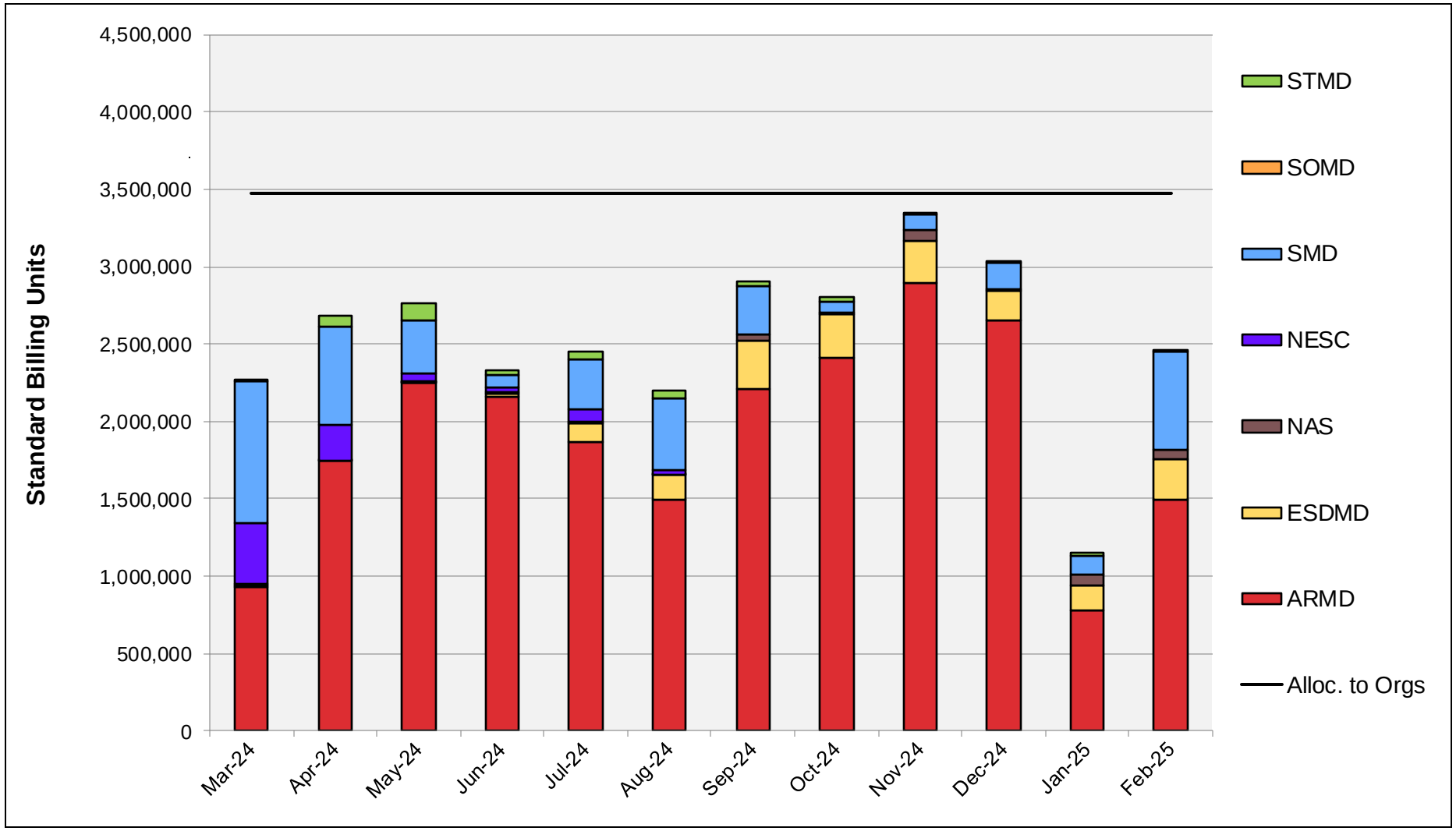
Electra: Average Time to Clear All Jobs



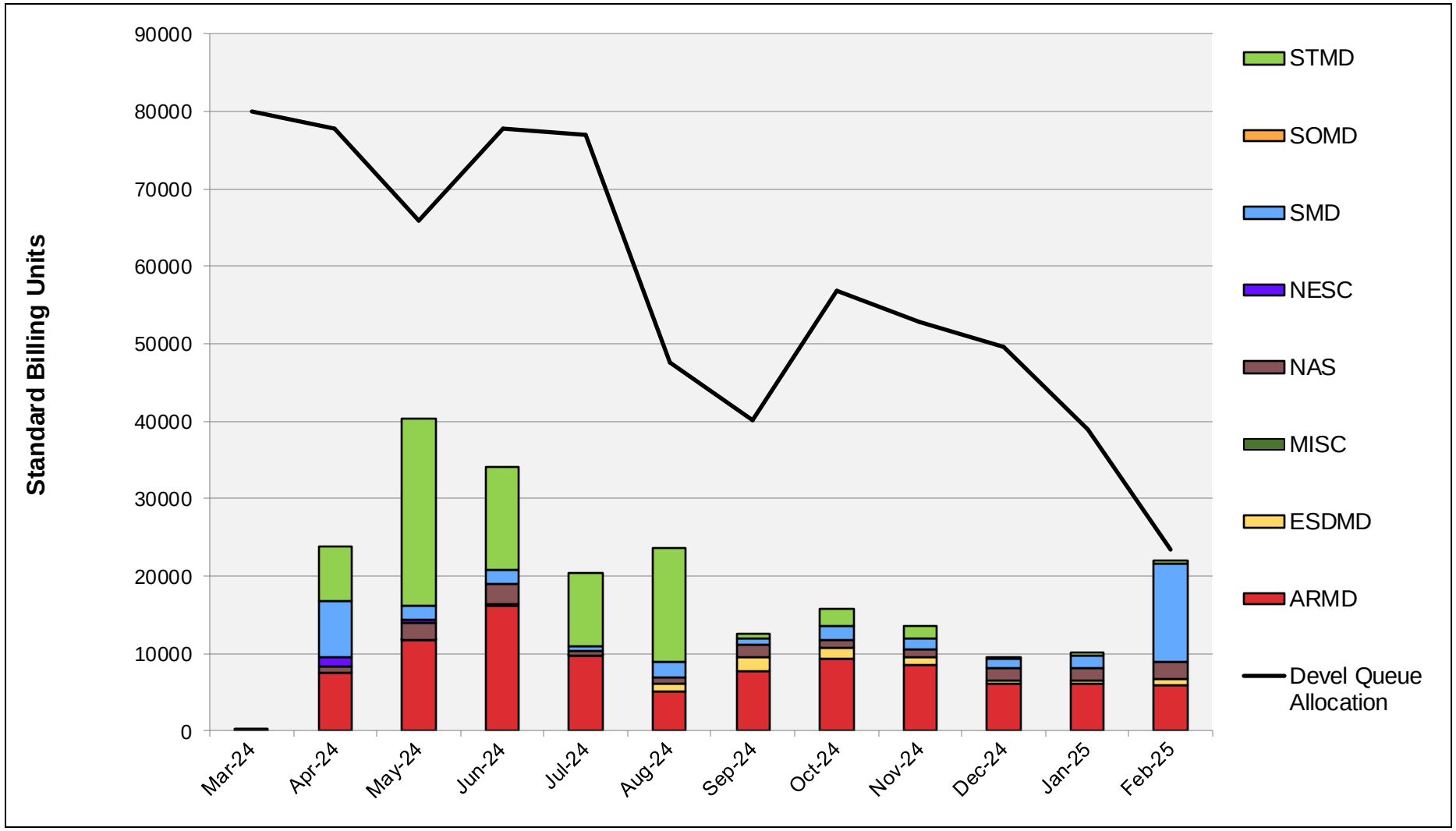
Electra: Average Expansion Factor



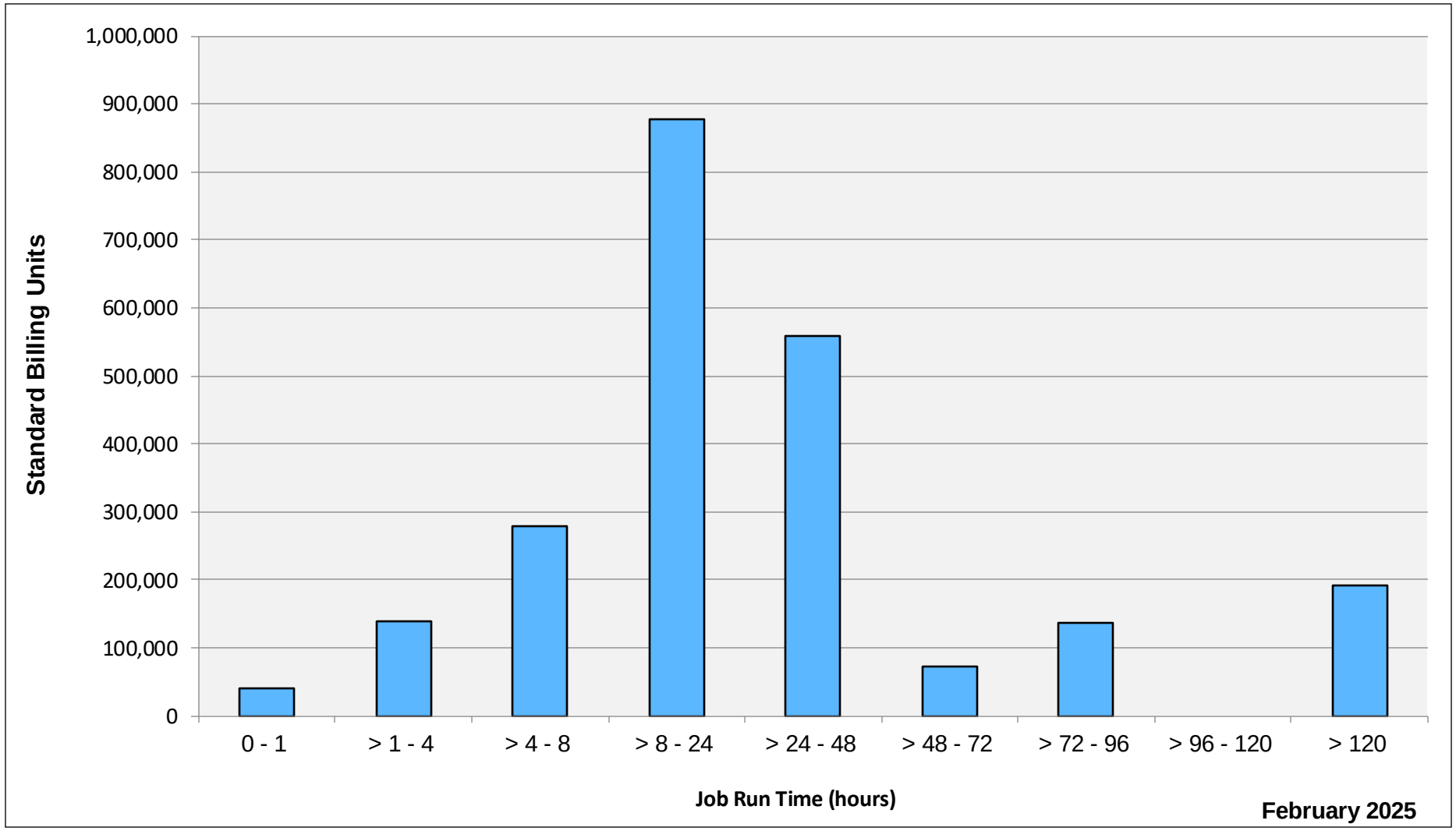
Cabeus: SBUs Reported, Normalized to 30-Day Month



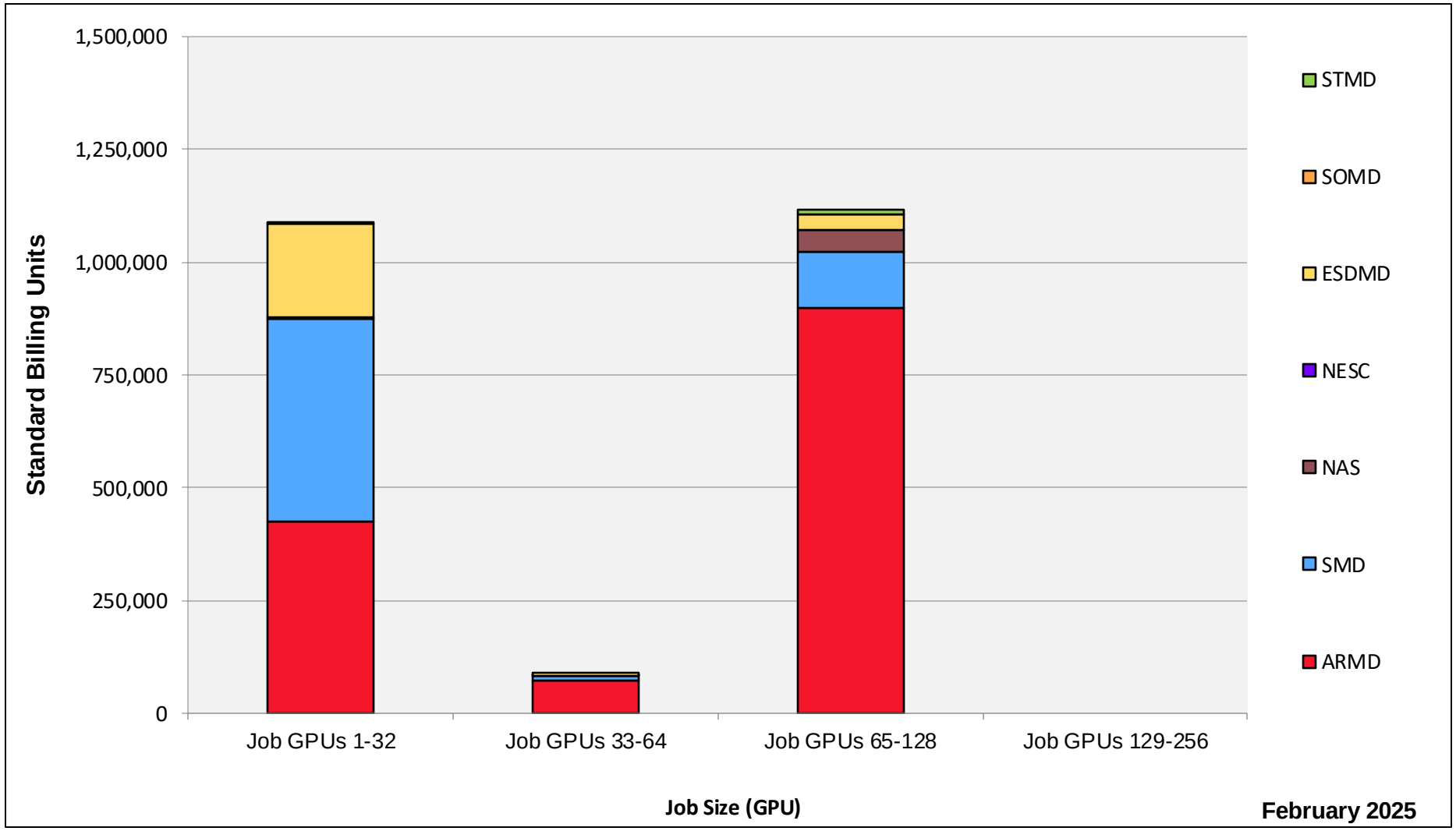
Cabeus: Devel Queue Utilization



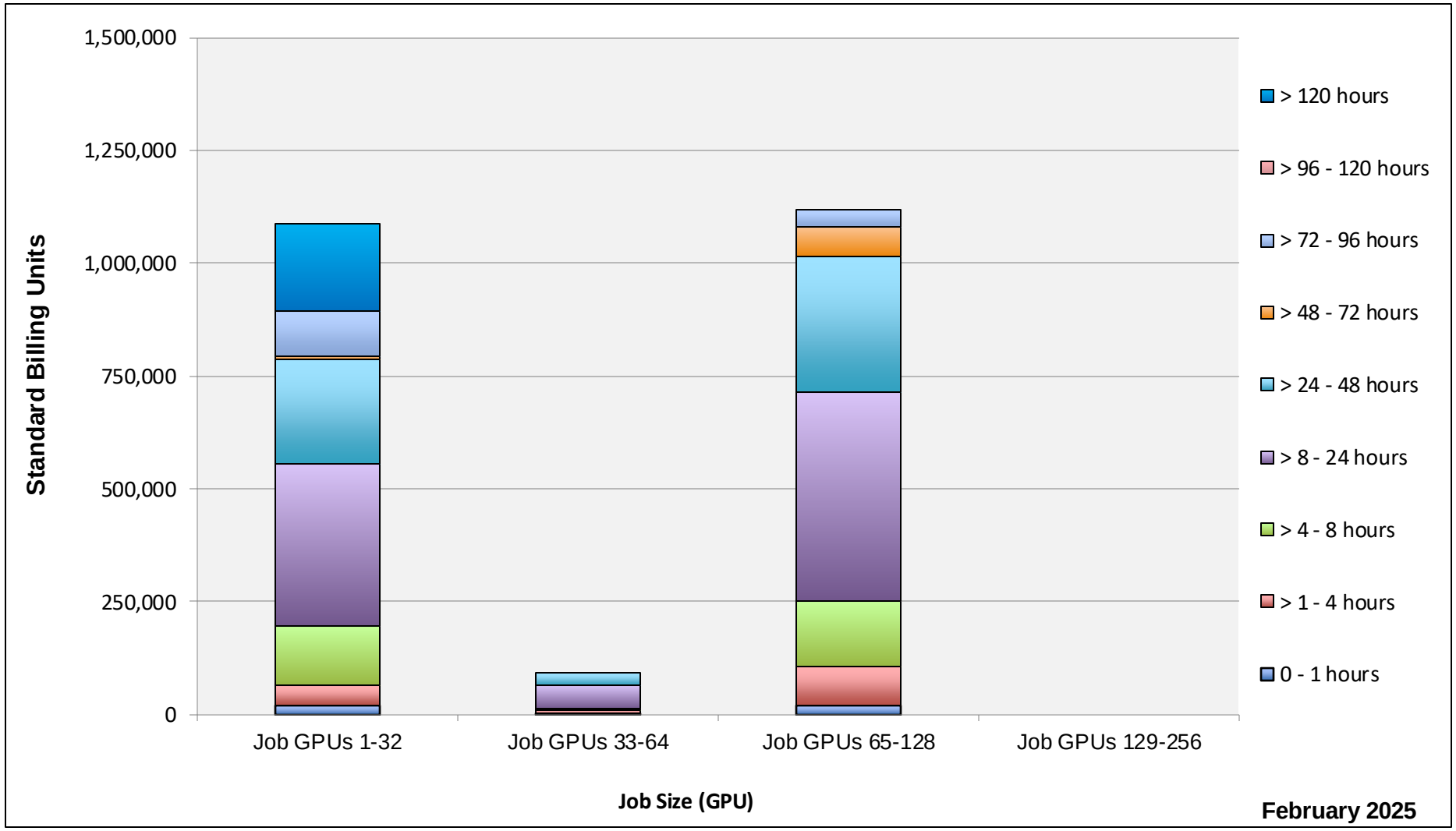
Cabeus: Monthly Utilization by Job Length



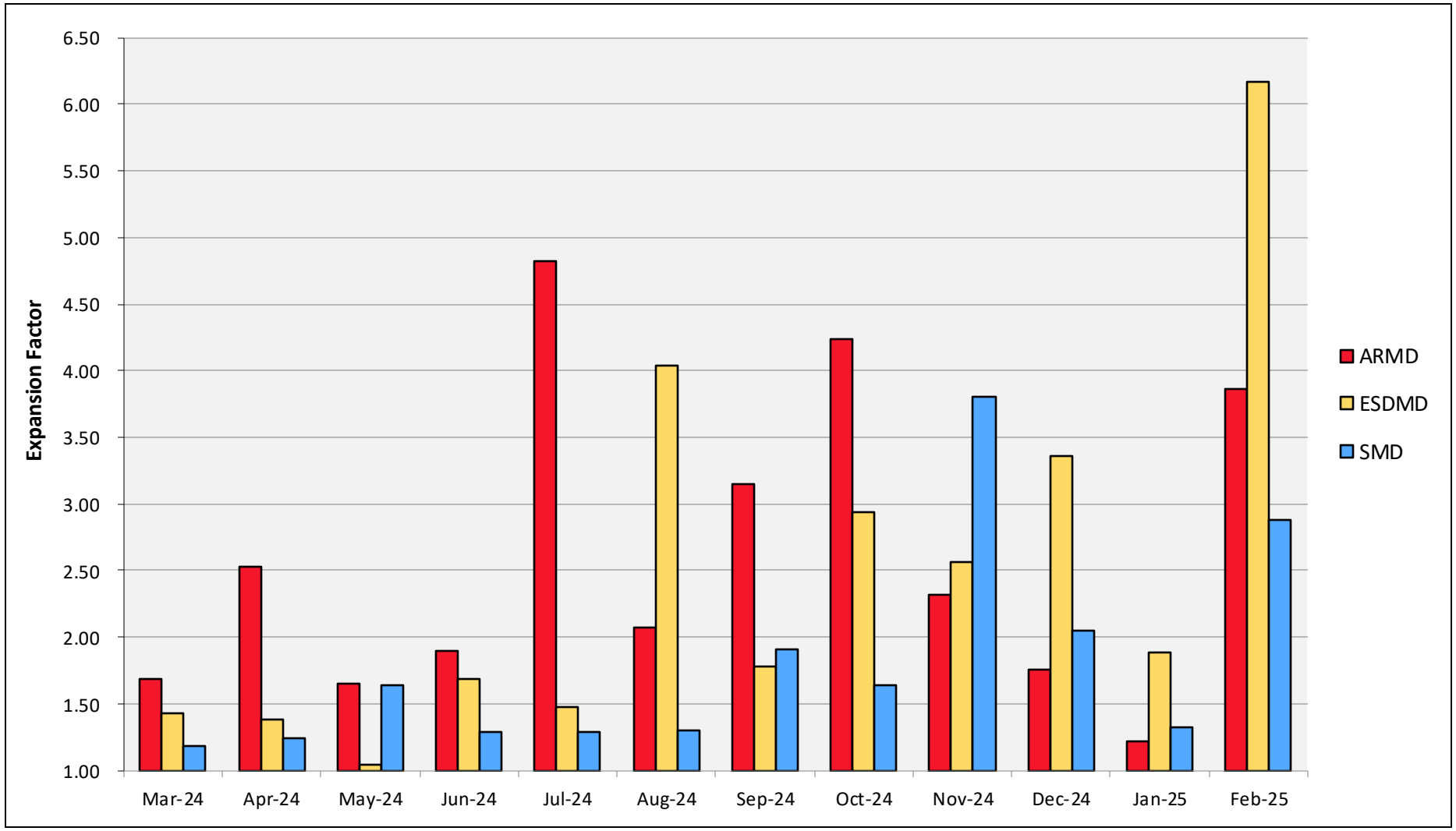
Cabeus: Monthly Utilization by Job Size



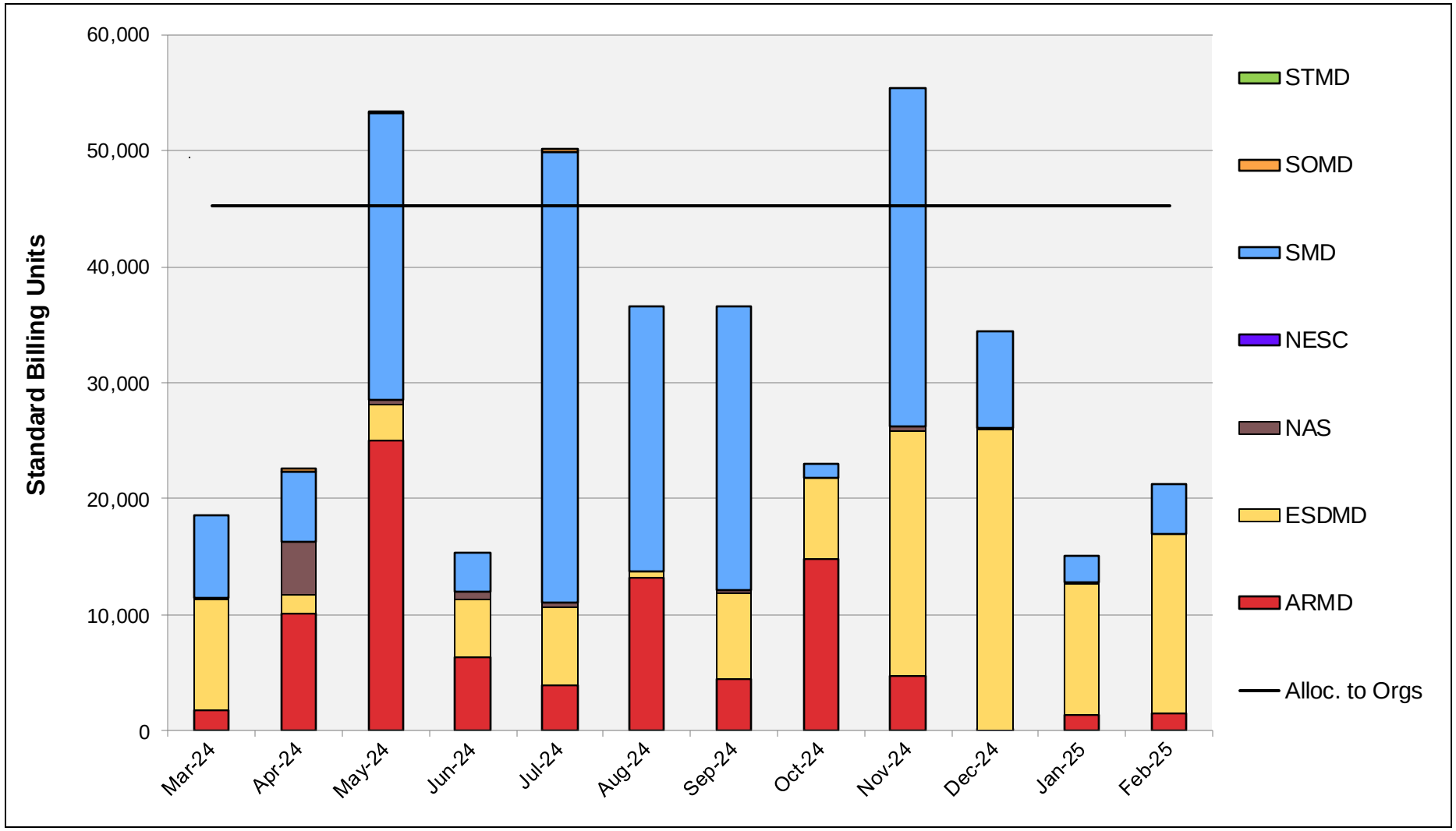
Cabeus: Monthly Utilization by Size and Length



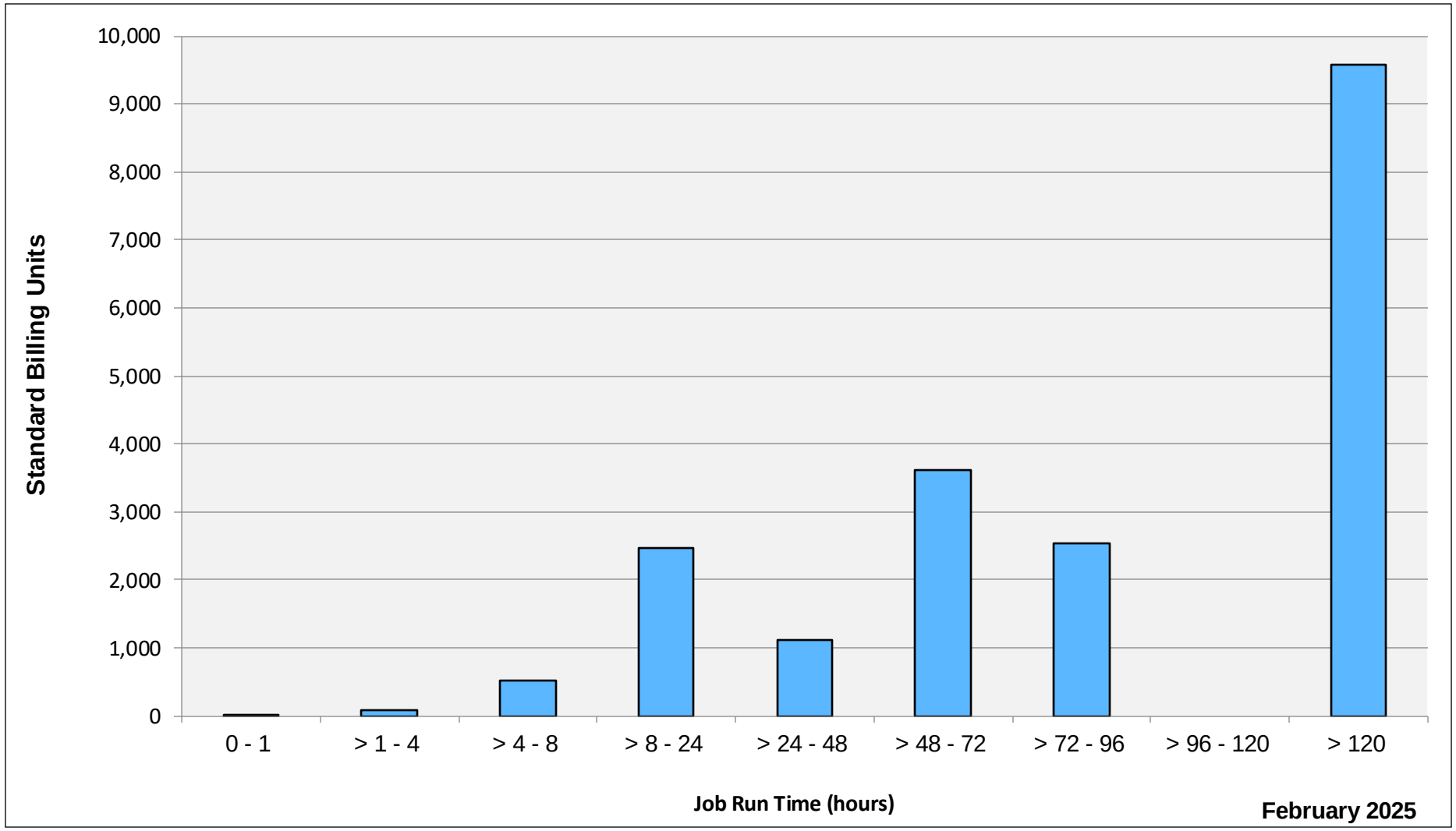
Cabeus: Average Expansion Factor



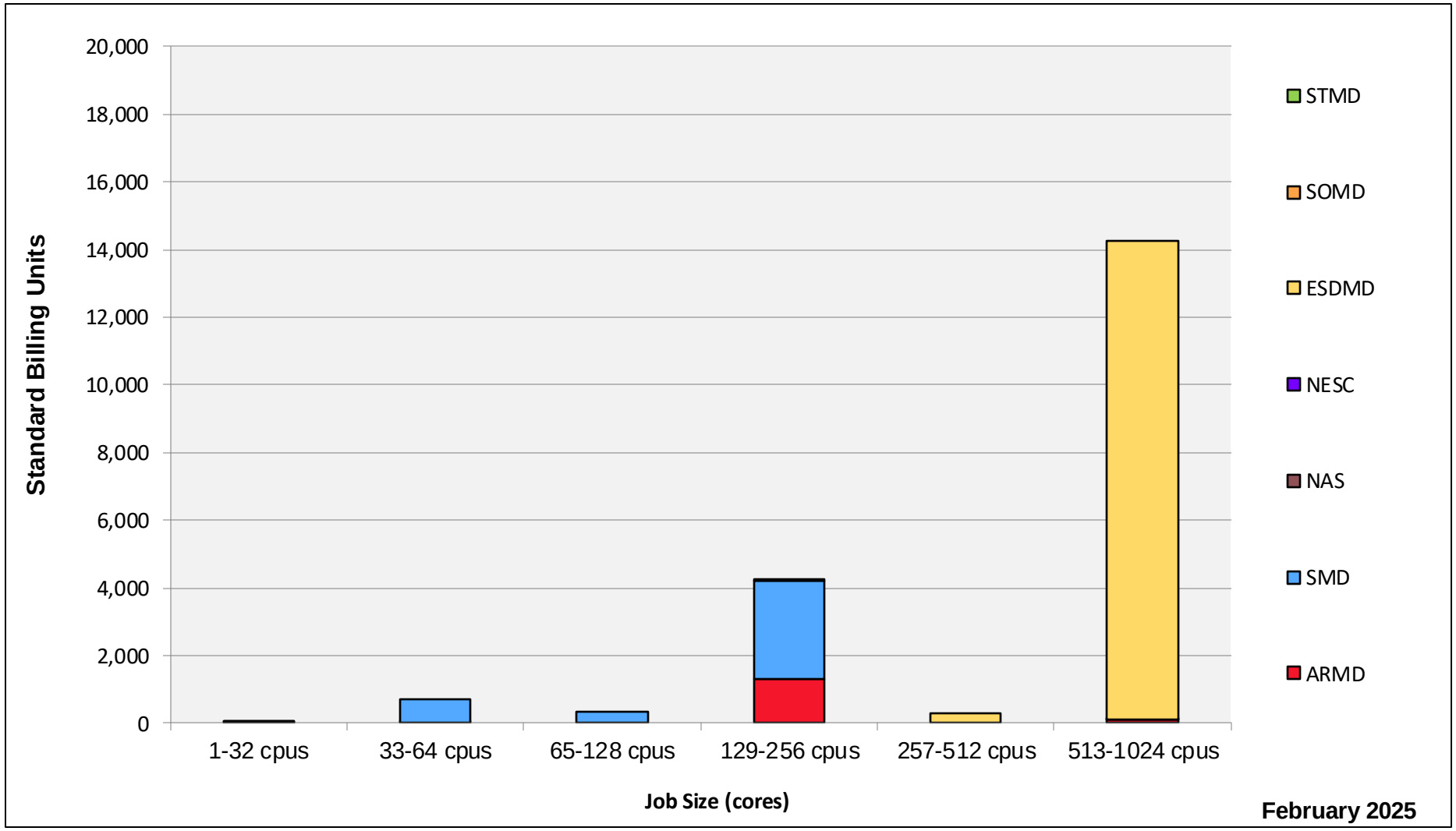
Endeavour: SBUs Reported, Normalized to 30-Day Month



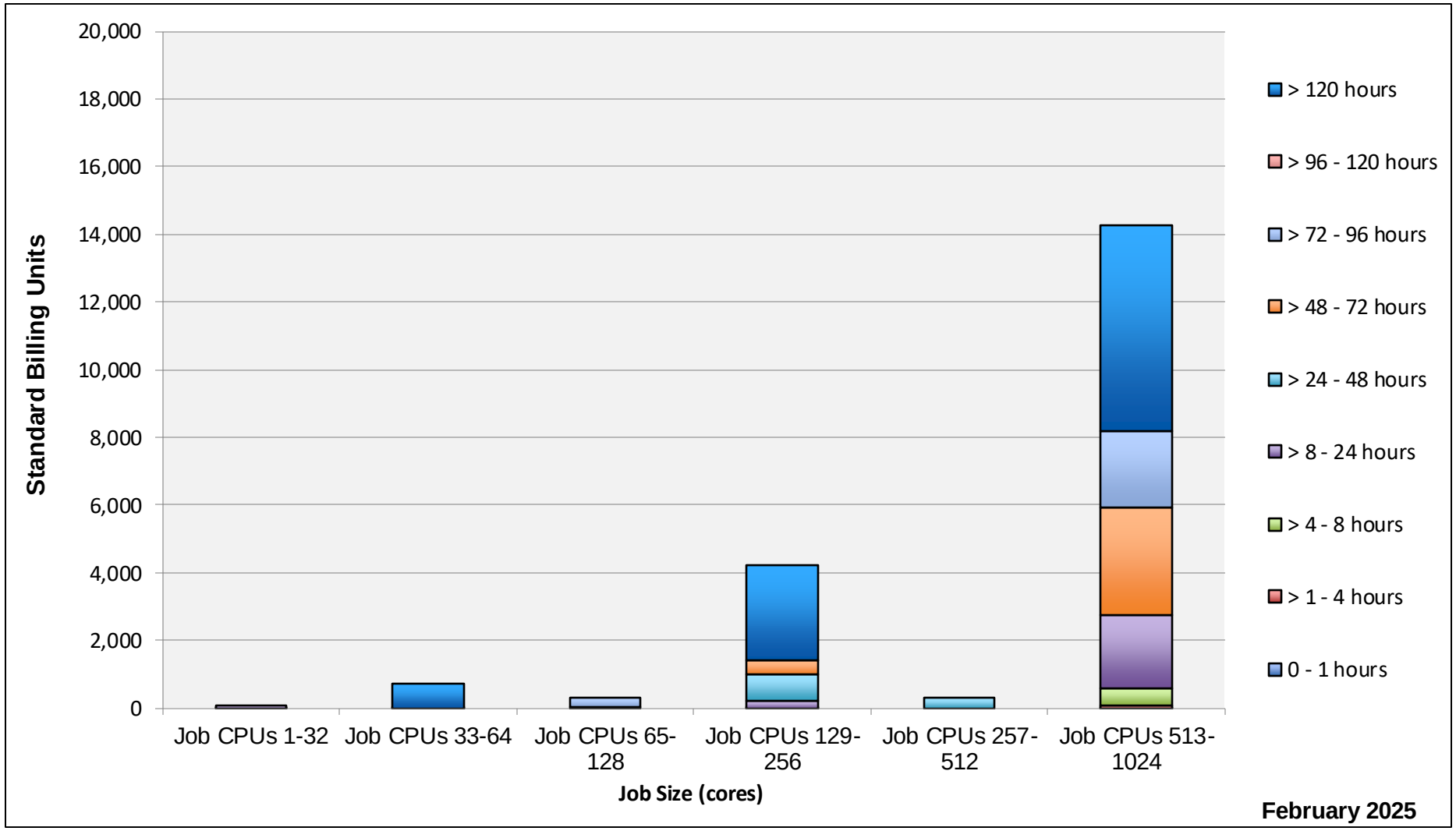
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor

