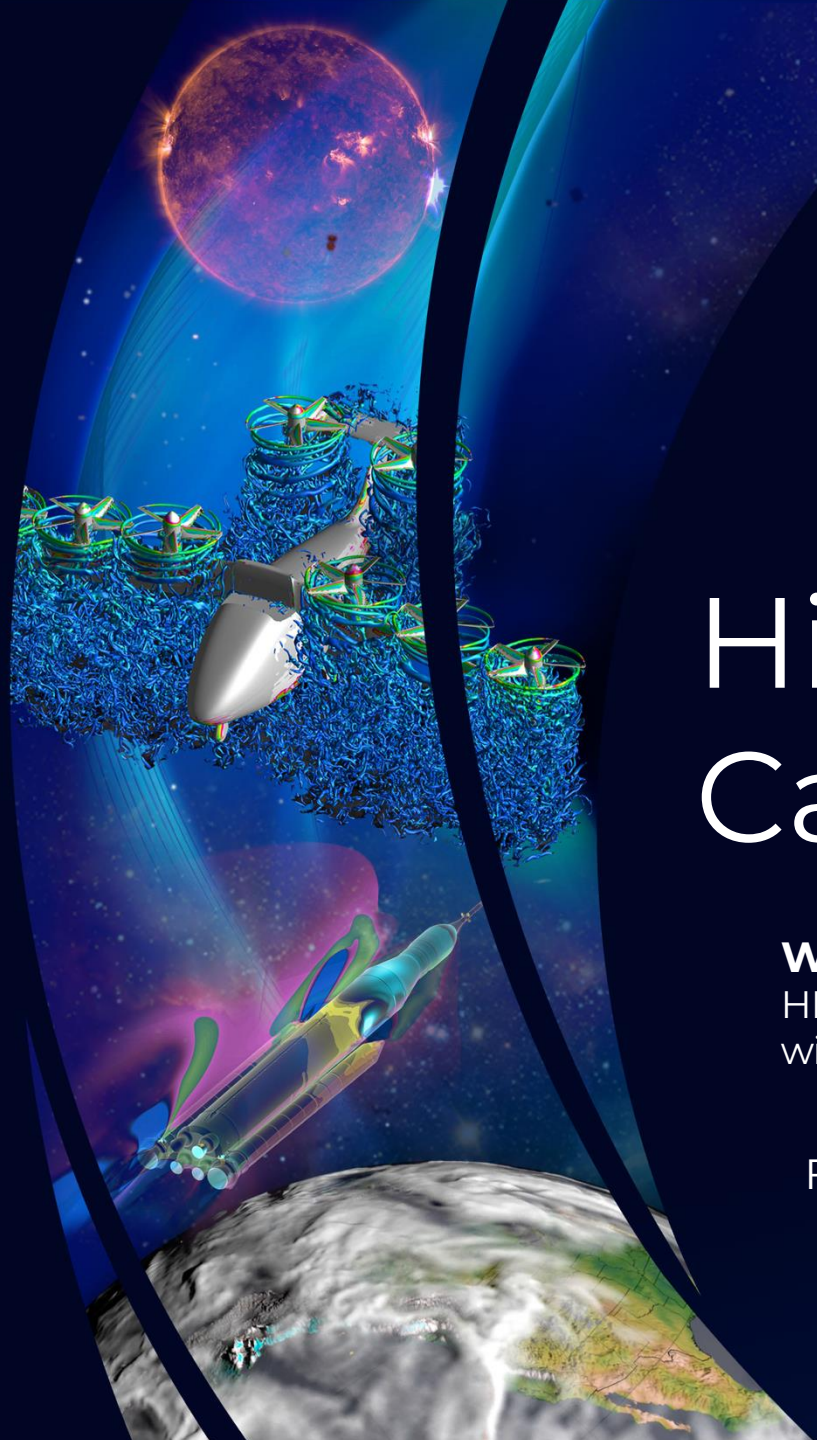


National Aeronautics and Space Administration

High-End Computing Capability

William Thigpen
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February 10, 2025

Significant Accomplishments: Current & Future

Current

- Selected Monthly Accomplishments
- HECC Enables SoCal Fire Simulations
- NASA Foundation Models Trained on Cabeus
- HECC Teams Develop and Integrate RMS Launchpad
- HECC Completes Annual Building Maintenance
- HECC Selects Next-Generation CPU System
- Simulations and AI Insights into Neutron Stars
- Analyzing the Artemis Launch Environment

Future

- Open GH200 Expansion to General User Community
- Install Temporary Transformer for 2nd Compute Module

Selected Monthly Accomplishments

- **Improving Efficiency**
  - The Tools team completed updating all (47 scripts) documentation URLs in their scripts from old Redmine to the new locations in Confluence. This will save time when errors are sent out or when updates are made to the code since developers can go directly to the current documentation in Confluence. This will allow ESS to shut down both redmine.nas.nasa.gov and redminedev.nas.nasa.gov and get back resources for the HCI infrastructure.
  - The Tools team also completed rewriting PBS scripts used for backlog and devel queue reporting to Python. The previous architecture had five different versions of the TCL (originally Tool Command Language pronounced “tickle”) script running on the different PBS systems. By moving to a single code base in a modern language, updates are more streamlined and simpler to make.
- **Improving System Stability and Security**
  - The Engineering Systems and Services (ESS) team completed a Mail Server Logging project and submitted to security for closure. This will close out a POA&M and improve security compliance.
  - The ESS team also assisted CPIDS Ops staff with the setup of new Dell database servers to increase compliance with Data at Rest (DAR) Information Technology Security requirements. This effort involved a hardware refresh to replace existing non-DAR systems with DAR encrypted.
- **Improving Access to Leading-Edge Systems**
  - The Big Data team deployed a new dataset named GeoNEX Coincident Ground Observations (GeCGO) for Hirofumi Hashimoto. The GeCGO is the subset of GeoNEX data at Terrestrial Observational Network Sites to facilitate the use of data from geostationary satellites.
- **Improving User Experience**
  - The Publications and Application Performance and Productivity teams completed updates to seven Knowledge Base articles to support the new Grace Hopper nodes. They also updated several more articles to support incorporating the V100 GPUs into the Cabeus supercomputer.

Selected Monthly Accomplishments (cont.)

- **Outreach and Collaboration**
  - Visualizations featured in the Oak Ridge National Laboratory (ORNL) 2024 Year in Review were produced on the hyperwall system by Pat Moran, HECC Visualization and Data Analysis team. The visualizations were part of simulations performed by the NASA Langley FUN3D team on the ORNL Frontier supercomputer and prominently featured in the review article: ORNL supercomputers aid NASA's Mars missions.
  - HECC teams powered up all the University of California, Berkeley racks in Building N233A/190, as part of the agreement for NASA to host supercomputing resources for UC Berkeley. The agreement includes support the development of novel computing algorithms and software for a wide variety of scientific and technology areas.
  - Jon Jenkins attended the 245th American Astronomical Society (AAS) Winter meeting January 11-16 in National Harbor, MD, where he presented "Comparing the Efficiencies of the SPOC and QLP Transit Search Pipelines."

HECC Enables Southern California Fire Simulations

- HECC received an urgent project request from the Jet Propulsion Laboratory (JPL) for resources to simulate the the extreme wind and fire events in Southern California that started January 7, 2025.
  - The simulation will be used for extremely high-resolution mesoscale simulations of the weather during the extreme wind and fire events.
  - These simulations will help provide insight into what happened (in terms of atmospheric physics and dynamics, and potentially fire spread) that night/morning in the Altadena-Pasadena area and will pave the way for future real-time coupled mesoscale/fire forecasting.
- HECC User Services was able to coordinate with the requestor despite the requestor not having access to electricity and communications coming through email coordination by cell phone while the fires were active.
  - User Services coordinated with the requestor to find an active user to be the PI.
  - The user submitted a request and User Services was able to allocate it immediately.
  - The Control Room updated the allocation, and the users were able to start preparing their simulations within an hour of allocation.
- The fast response by User Services allowed users access to critical supercomputing systems to simulate extreme weather and paves the way for better wildfire forecasting in the future.

IMPACT: HECC experts' flexibility and fast response make access to critical computing resources possible within hours.

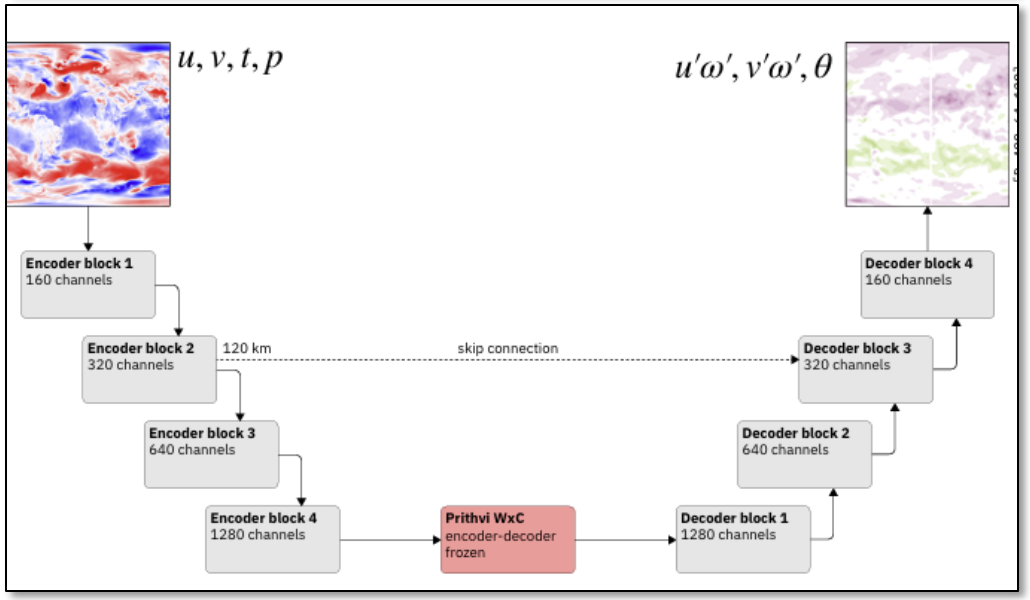


Image of a wildfire. *NASA*

NASA Foundation Model Trained on Cabeus

- The HECC Data Science team assisted the Prithvi Foundation Model for Weather and Climate (Prithvi WxC) trained at NAS on the Cabeus supercomputer with up to 128 A100 GPUs.
- While traditional numerical weather prediction (NWP) models have made significant strides, they require substantial computational resources. The emergence of deep learning with foundation models pretrained on vast datasets offers a promising alternative for weather and climate modeling.
- Prithvi WxC is a 2.3 billion-parameter foundation model developed using 160 variables from the Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2).
- The model employs an encoder-decoder-based architecture, incorporating concepts from various recent transformer models to effectively capture regional and global dependencies in the input data.
- Use cases covered by Prithvi include autoregressive rollout forecasting, downscaling, gravity wave flux parameterization, and extreme events estimation.
- The pretrained model, along with the associated fine-tuning workflows, were publicly released as an open-source contribution via the Hugging Face platform.

IMPACT: Foundation models for development of accurate and efficient weather and climate models are crucial for understanding and predicting outcomes and trends in Earth's complex atmospheric-oceanic system.

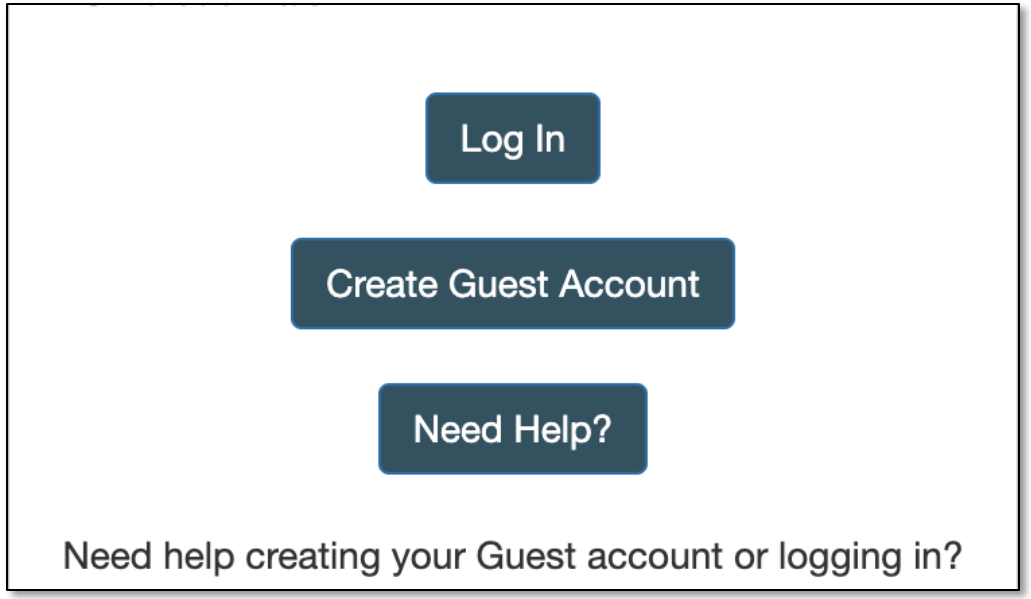


This chart depicts the fine-tuning architecture of the Prithvi Foundation Model for Weather and Climate for parameterization of gravity wave flux. *NASA IMPACT Foundation Models Team*

HECC Teams Develop, Integrate RMS Launchpad

- HECC teams developed Request Management System (RMS) versions 4.0 and 4.0.1, brought the application behind NASA's Launchpad PIV-enabled multifactor authentication system, and enabled NASA Guest Account Service for non-NASA users.
- This version release brings the application in line with NASA security requirements for web authentication and reduces the burden of account management on the RMS team.
  - Users with Launchpad credentials will experience a streamlined login and no longer need to maintain a separate password for RMS.
  - Users without existing Launchpad credentials, such as non-NASA affiliated researchers seeking NASA High-End Computing (HEC) resources as part of a ROSES proposal, will access the system by registering for a NASA Guest Account.
- Integration required a collaborative effort between RMS, Security, and ICAM teams.
- Launchpad integration provides a higher level of confidence in the degree of certainty that a person is who they claim to be and their suitability/fitness for their position or access level, increasing security to the RMS application.

IMPACT: Developing in-house software to manage supercomputer resource allocation requests allows the NASA High-End Computing Program more ownership of the data and simplifies the process for reviewing allocations and mission directorate targets.



Screen capture from the Request Management System landing page.

HECC Completes Annual Building Maintenance

- HECC facilities engineers, in collaboration with Code J, Amentum, and HPE, planned, coordinated, and conducted the annual building maintenance for N258, R&D088, and R&D099. The work included numerous repairs and maintenance of key components of the facilities.
- Building N258 and the Modular Supercomputing Facility (MSF) sites require annual electrical and cooling system maintenance to reduce the risk of unplanned outages. Pleiades, Electra, Aitken, Endeavour, the hyperwall, and storage systems were all powered off for the maintenance.
- Maintenance activities completed:
  - Cleaned the N258 cooling tower, chiller condenser tubes, and computer room subfloor. Replaced the refrigerant metering float on one of N258's three chillers.
  - Cleaned the high-voltage switchgear and adiabatic coolers for the R&D088 and R&D099 support infrastructure.
  - Cleaned and tested the N258 computer room 480V circuit breakers. Replaced 2 breakers that would not close after maintenance.
  - Completed testing and returned the Rotary Uninterruptible Power Supply (RUPS) to service. The RUPS had been out of service for a DC-bus failure since August 2024.
  - Tested all N258 fire suppression systems.
- HECC engineers express their appreciation to the HECC user community for their patience during the Annual Maintenance.

IMPACT: Preventative maintenance on the HECC facilities' cooling systems and electrical distribution is essential to eliminate downtime caused by aging infrastructure, yielding more computer uptime for NASA science and engineering users.



A Code J electrical engineer programs a new power meter in the RUPS High Voltage Switchgear Enclosure during the 2025 Annual Maintenance.
Chris Tanner, NASA/Ames

HECC Selects Next-Generation CPU System

- HECC selected Hewlett Packard Enterprise (HPE) to provide the next-generation CPU system.
  - The selected system is an HPE Cray EX supercomputer consisting of four EX4000 cabinets containing a total of 1,024 compute nodes.
  - The system will replace the current aging Pleiades supercomputer and the Intel "Broadwell" portion of Electra, with a significant increase in compute capacity.
  - HECC staff members selected the system based on the best value, including price-performance, for NASA applications after a thorough review of five proposals received from the Request-For-Proposal (RFP).
  - HECC will install the system in Compute Module 2.
- Other details of the Cray EX system include:
  - Each EX4000 cabinet consists of 256 compute nodes, each node containing:
    - Two 128-core AMD EPYC 9745 processors.
    - 768 GB DDR5 memory.
    - Two 200 Gb/s Cray Slingshot network connections.
  - The system's peak performance is 20.13 petaflops (quadrillion floating-point operations per second). The system will provide an estimated 13,445 SBUs per hour, which is about 1.8 times Pleiades' capability and 1.1 times Aitken's capability.
  - The procurement also included 4 login nodes, 10 service nodes, 28 routers, and a Test-Development-System (TDS) for testing and development.

IMPACT: The next-generation CPU system will provide additional computing capability allowing the decommissioning of much larger and inefficient legacy systems.

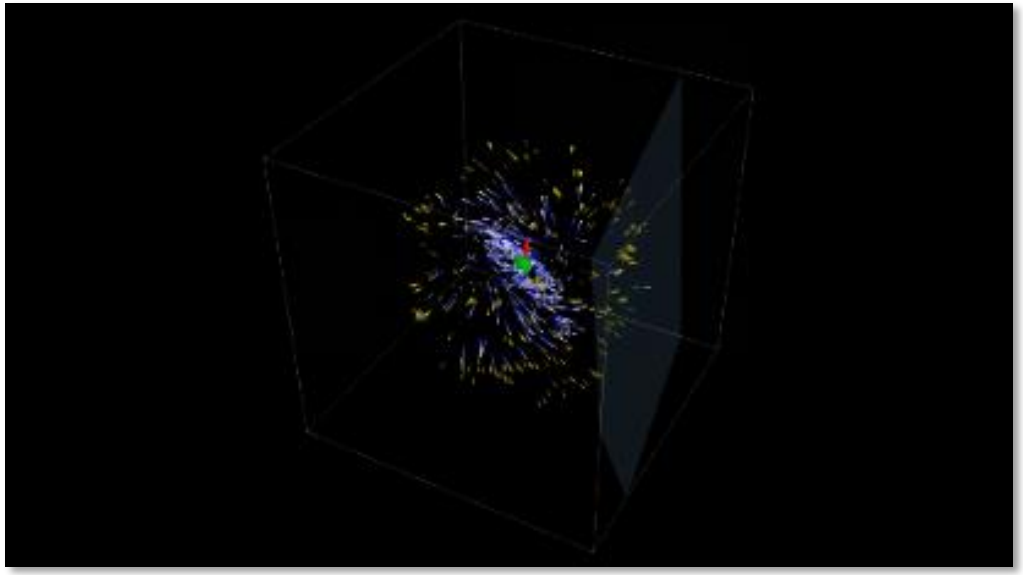


The next-generation CPU system will be installed in Compute Module 2 at the Modular Supercomputing Facility at NASA's Ames Research Center. *Chris Tanner/NASA Ames*

Simulations and AI Insights into Neutron Stars *

- Researchers at NASA's Goddard Space Flight Center used Aitken, Pleiades, Electra, and Cabeus to explore neutron stars—some of the densest objects in the universe—by using cutting-edge simulations and advanced machine learning techniques.
  - The scientists ran magnetohydrodynamic (MHD) and particle-in-cell (PIC) simulations to study the magnetic environments, or magnetospheres, of single and binary neutron stars. By examining their emission patterns, they aimed to understand the high-energy radiation detected by NASA's Fermi Gamma-ray Space Telescope.
  - By applying deep neural networks, the researchers were able to quickly infer crucial properties of neutron stars, such as their magnetic field structure, mass, and radius, from data obtained by Fermi and by NASA's Neutron star Interior Composition Explorer (NICER), an X-ray observatory aboard the International Space Station.
  - The simulations explained gamma-ray pulsars observed by the Fermi satellite and uncovered hidden correlations. Machine learning sped up neutron star parameter inference, revealing multipolar magnetic fields in millisecond pulsars, with better constraints on the equation of state from NICER and Fermi data.
- This work will help astrophysicists better understand the extreme conditions inside neutron stars and provide new insights into their equation of state—a fundamental aspect of astrophysics that describes the state of matter under a given set of physical conditions.

IMPACT: This work advances understanding of pulsar emissions, offers key insights into magnetic fields and dense matter properties, and guides similar studies of black holes; and plays a pivotal role in shaping future space missions and mission concepts, including AMEGO-X, GammaTPC, and STROBE-X.



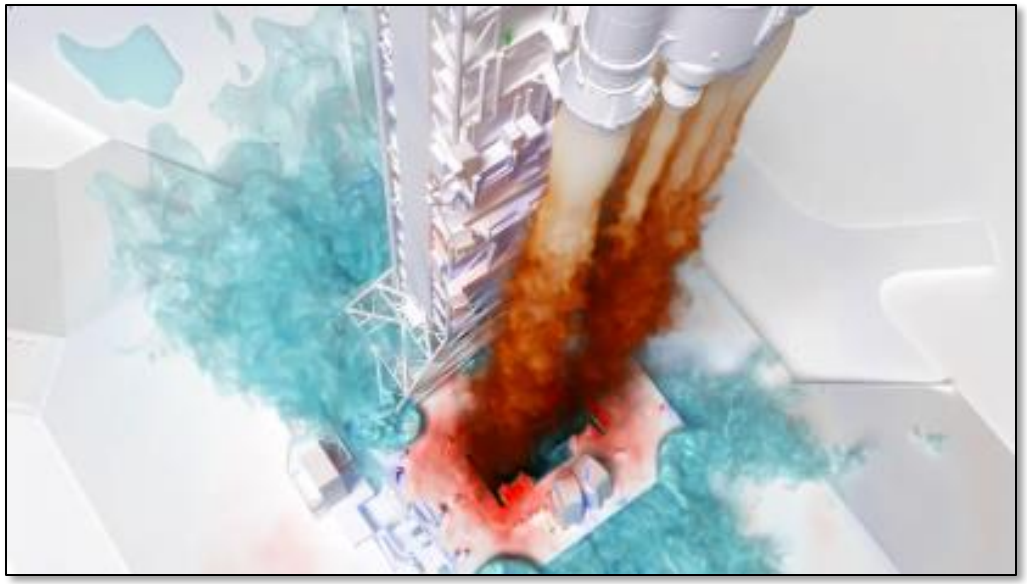
This video showcases 3D relativistic particle-in-cell simulations of pulsar magnetospheres over eight rotations. *Constantinos Kalapotharakos, NASA/Goddard*

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

Analyzing the Artemis Launch Environment *

- The Launch, Ascent, and Vehicle Aerodynamics (LAVA) team at NASA Ames is advancing prediction capabilities to simulate the Artemis mission launch environment, in particular exhaust plume impingement, which can create hazardous forces and vibrations that may damage critical infrastructure or the vehicle payload during launch.
- Using the LAVA software's multiphase capabilities, the team simulated the Artemis I launch environment, where some of the mobile structure was damaged during the 2022 launch. In this model, the rocket is held lofted in space at seven seconds after liftoff with all water-based suppression systems turned on.
- The team was able to show that the suppression system generally dampens pressure and acoustic signals, but the exhaust flow from the plume can redirect the water in a way that significantly increases maximum pressure forces.
- This simulation was run on 180 AMD Rome nodes of the Aitken supercomputer at the NASA Advanced Supercomputing facility, taking roughly 25 days and generating over 400 terabytes of data.
- HECC staff provided significant help and support to keep the simulation running steadily for such a long period over so many nodes.

IMPACT: Results from this simulation give insight into the environment that caused the mobile launcher damages during the Artemis I launch and is helping in the redesign of the launch pad and mobile launcher for future Artemis missions.



Lofted Artemis I launch simulation using the LAVA Cartesian CFD solver. The water mass fraction is shown using nested isocontours in teal, and the plume gas mass fraction is shown, where white is large and dark orange is small. *Chris DeGrendele, Timothy Sandstrom, NASA/Ames*

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

Papers

- "**The Role of Electric Dominance for Particle Injection in Relativistic Reconnection**," S. Gupta, N. Sridhar, L. Sironi, arXiv:2501.00979 [astro-ph.HE], January 1, 2025. *
  https://arxiv.org/abs/2501.00979
- **AIAA SciTech 2025 Forum**, Orlando, FL, January 6-10, 2025.
  - "**Fluidic Fence Flow Control on a 30° Swept Wing in Compressible Freestreams**," E. McFadden, J. Bons. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-0481
  - "**Dynamically Dominant Flow Features During Wave Mode Transition in a Rotating Detonation Engine Combustor**," V. Raju Hasti, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-0402
  - "**Invited: Spectral Proper Orthogonal Decomposition of uPSP Measurements in Recent NASA Ames Wind Tunnel Test**," J. Li, et al. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-0234
  - "**Computational Optimization of a Rotary Valved Pulse Combustor Concept**," D. Paxson, H. Perkins, S. Yungster. *
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-1593
  - "**Evaluating Ground Reflection Effects on eVTOL Rotor Noise**," M. Marques Goncalves, et al. *
    https://arc.aiaa.org/doi/10.2514/6.2025-1242
- "**MPhys: A Modular Multiphysics Library for Coupled Simulation and Adjoint Derivative Computation**," A. Yildirim, et al., *Structural and Multidisciplinary Optimization*, vol. 68, no. 15, published online January 8, 2025. *
  https://link.springer.com/article/10.1007/s00158-024-03900-0
- "**FOGGIE X: Characterizing the Small-Scale Structure of the CGM and its Imprint on Observables**," R. Augustin, et al., arXiv:2501.06551 [astro-ph.GA], January 11, 2025. *
  https://arxiv.org/abs/2501.06551

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

Papers (cont.)

- "**BATSRUS GPU: Faster-than-Real-Time Magnetospheric Simulations with a Block-Adaptive Grid Code**," Y. An, et al., arXiv:2501.06717 [astro-ph.IM], January 12, 2025. *
  https://arxiv.org/abs/2501.06717
- "**On the Origin of Compressive Turbulence in Protoclumps in High Redshift Disks**," O. Ginzburg, et al., arXiv:2501.07097 [astro-ph.GA], January 13, 2025. *
  https://arxiv.org/abs/2501.07097
- "**A New Look at Earth's Water and Energy with SWOT**," N. Vinogradova, et al., *Nature Water*, vol. 3, published online January 13, 2025. *
  https://www.nature.com/articles/s44221-024-00372-w
- "**Discovery of a Cold Giant Planet and Mass Measurement of a Hot Super-Earth in the Multi-Planetary System WASP-132**," N. Grieves, et al., *Astronomy & Astrophysics*, vol. 693, published online January 15, 2025. *
  https://www.aanda.org/articles/aa/abs/2025/01/aa48177-23/aa48177-23.html
- "**Simulations of Eccentricity Growth in Compact Binary Accretion Disks with Magnetohydrodynamic Turbulence**," M. Ohana, et al., *The Astrophysical Journal*, vol. 979, no. 2, published online January 22, 2025. *
  https://iopscience.iop.org/article/10.3847/1538-4357/ad9ddb/meta
- "**Fine Structures in Interlaced Magnetic Flux Ropes via Hall-MHD Simulations**," Y.-D. Jia, et al., *AIP Advances*, vol. 15, issue 1, published online January 22, 2025. *
  https://pubs.aip.org/aip/adv/article/15/1/015325/3331966

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Papers (cont.)

- "**The NCORES Program: Precise Planetary Masses, Null Results, and Insight into the Planet Mass Distribution Near the Radius Gap**," D. Armstrong, et al., arXiv:2501.14355 [astro-ph.EP], January 24, 2025. *
  https://arxiv.org/abs/2501.14355
- "**A MARVEL-ous Study of How Well Galaxy Shapes Reflect Dark Matter Halo Shapes in Cold Dark Matter Simulations**," B. Keith, et al., arXiv:2501.16317 [astro-ph.GA], January 27, 2025. *
  https://arxiv.org/abs/2501.16317
- "**Pinpointing the CN Stretch Frequency of Neutral Cyano-Polycyclic Aromatic Hydrocarbons: A Laboratory and Quantum Chemical Spectroscopic Study of 9-Cyanoathracene**," V. Esposito, et al., *Journal of Physical Chemistry Letters* (Physical Insights into Chemistry, Catalysis, and Interfaces), published online January 27, 2025. *
  https://pubs.acs.org/doi/abs/10.1021/acs.jpclett.4c03396
- "**Unstable Accretion in TW Hya: 3D Simulations and Comparisons with Observations**," M. Romanova, et al., *Monthly Notices of the Royal Astronomical Society*, published online January 28, 2025. *
  https://academic.oup.com/mnras/advance-article/doi/10.1093/mnras/staf148/7985761
- "**Central Densities of Dark Matter Halos in FIRE-2 Simulations of Low-Mass Galaxies with Cold Dark Matter and Self-Interacting Dark Matter**," M. Straight, et al., arXiv:2501.16602 [astro-ph.GA], January 28, 2025. *
  https://arxiv.org/abs/2501.16602
- "**Generating Hard Ising Instances with Planted Solutions Using Post-Quantum Cryptographic Protocols**," S. Mandrà, et al., *Future Generation Computer Systems*, vol. 166, published online January 28, 2025. *
  https://www.sciencedirect.com/science/article/abs/pii/S0167739X25000160

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Papers (cont.)

- "**Ocean Submesoscale Fronts Induce Diabatic Heating and Convective Precipitation within Storms**," F. Vivant, et al., *Communications: Earth & Environment* (Nature), vol. 6, published online January 30, 2025. https://www.nature.com/articles/s43247-025-02002-z
- "**Characterization of the Σ9(114)[110] Symmetric Tilt Grain Boundary in NiTi and Its Relationship to the Martensitic Transformation**," G. Plummer, et al., *Diffusionless Phase Transformations in Engineering Alloys*, published online January 31, 2025. * https://link.springer.com/article/10.1007/s11837-025-07141-4

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Presentations

- **AIAA SciTech 2025 Forum**, Orlando, FL, January 6-10, 2025.
  - "**High-Fidelity Aeropropulsive Optimization of a Mail-Slot Distributed Electric Propulsion System for the SUSAN Electrofan**," J. Anibal, J. Duensing.*
    https://arc.aiaa.org/doi/10.2514/6.2025-1276
  - "**LAVA WMLES Results for the 5th High-Lift Prediction Workshop**," E. Sozer, M. Barad, J. Housman, F. Cadieux, V. Sousa, E. Dumlupinar, K. Saurabh, K. Ravikumar, J. Duensing.*
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-0887
  - "**Copula-Based Method to Generate Consistent Surface Pressures Under Uncertainty**," A. Burkhead, D. Dalle.*
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-1203
  - "**Wall-Modeled LES of a Swept Wing with Leading-Edge Ice Using LAVA Curvilinear, Unstructured, and Cartesian Solvers**," D. Craig Penner, V. Sousa, K. Ravikumar, K. Saurabh, F. Cadieux, G.-D. Stich, M. Barad, J. Housman, J. Duensing.*
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-0059
  - "**Sonic Boom Ground Noise Minimization via the Adjoint Method**," D. Rodriguez, M. Aftosmis, M. Nemec, S. Rallabhandi.*
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-0772
  - "**High-Fidelity Aeropropulsive Assessment of Distributed Electric Propulsion and Boundary Layer Ingestion for the SUSAN Electrofan**," T. Chau, J. Anibal, B. Lowe, L. Machado, J. Duensing.*
    https://arc.aiaa.org/doi/abs/10.2514/6.2025-1275

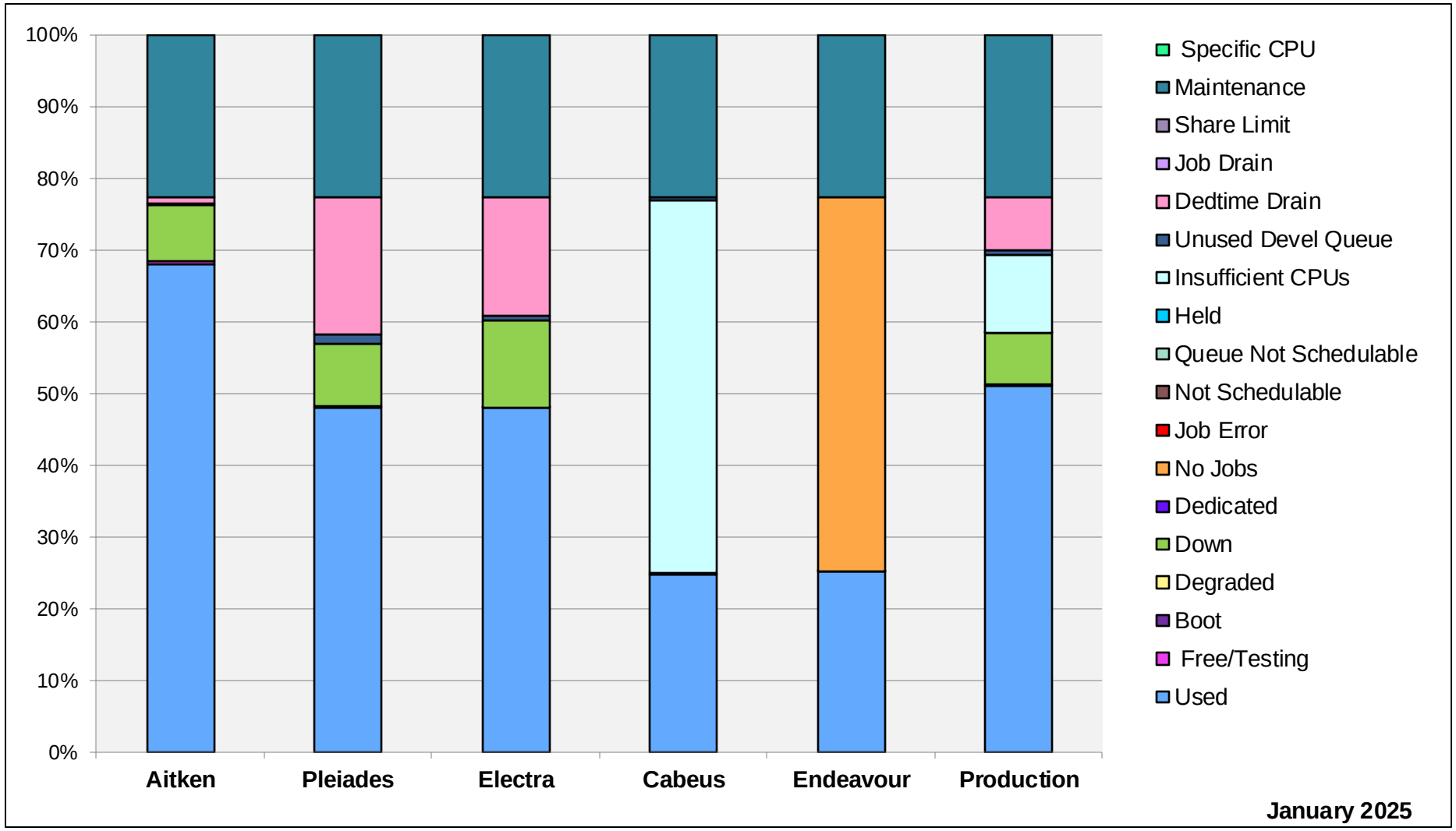
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News & Events

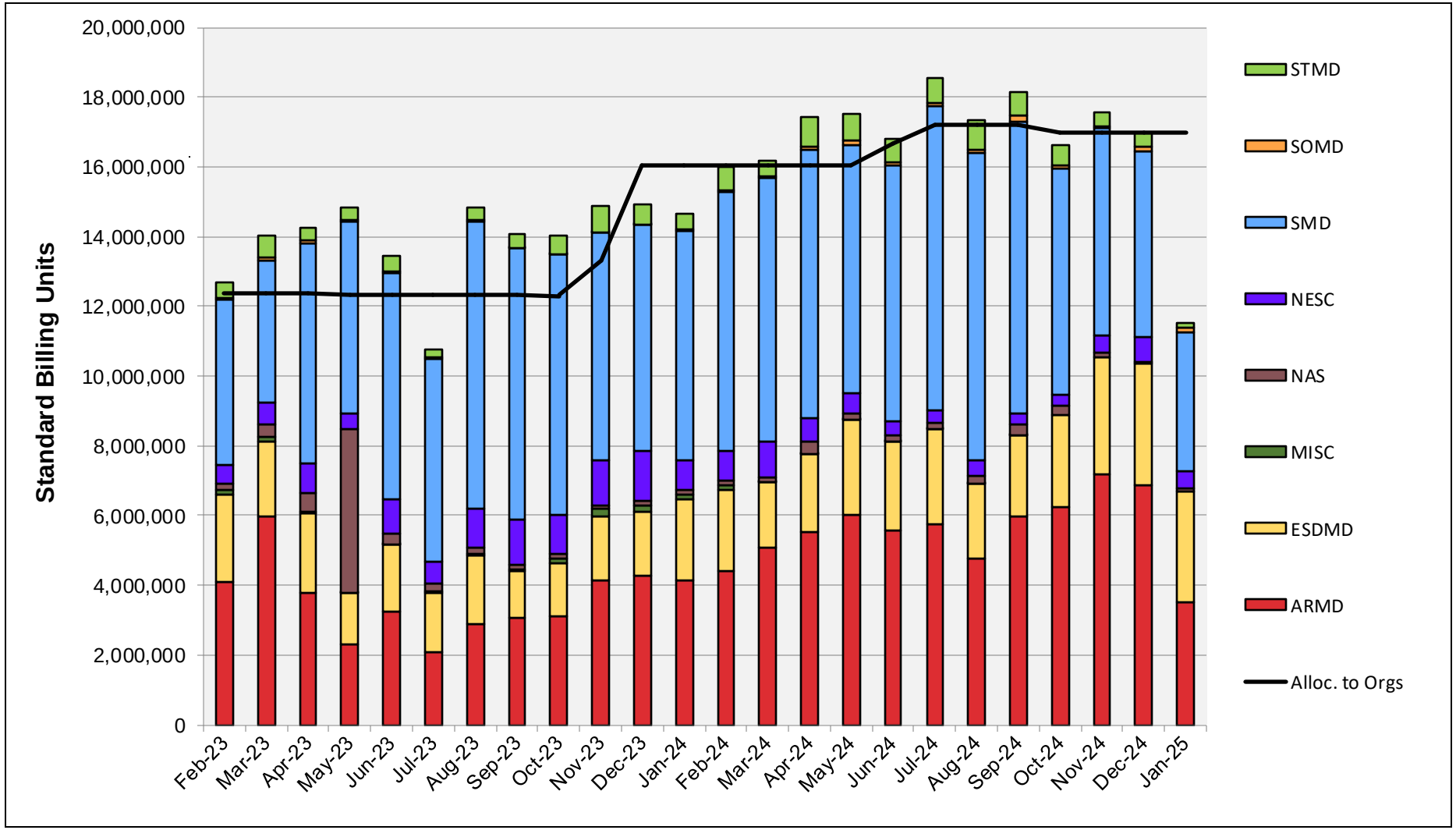
- **4 Ways NASA is Using AI FOR Space Exploration**, *SlashGear*, January 27, 2025—Using NASA's Pleiades supercomputer, ExoMiner can identify real planets among other celestial bodies by examining decades of collected data and running a variety of tests based on properties scientists use to identify exoplanets.
  https://www.slashgear.com/1768440/nasa-space-exploration-how-ai-changing-methods-tools-used/

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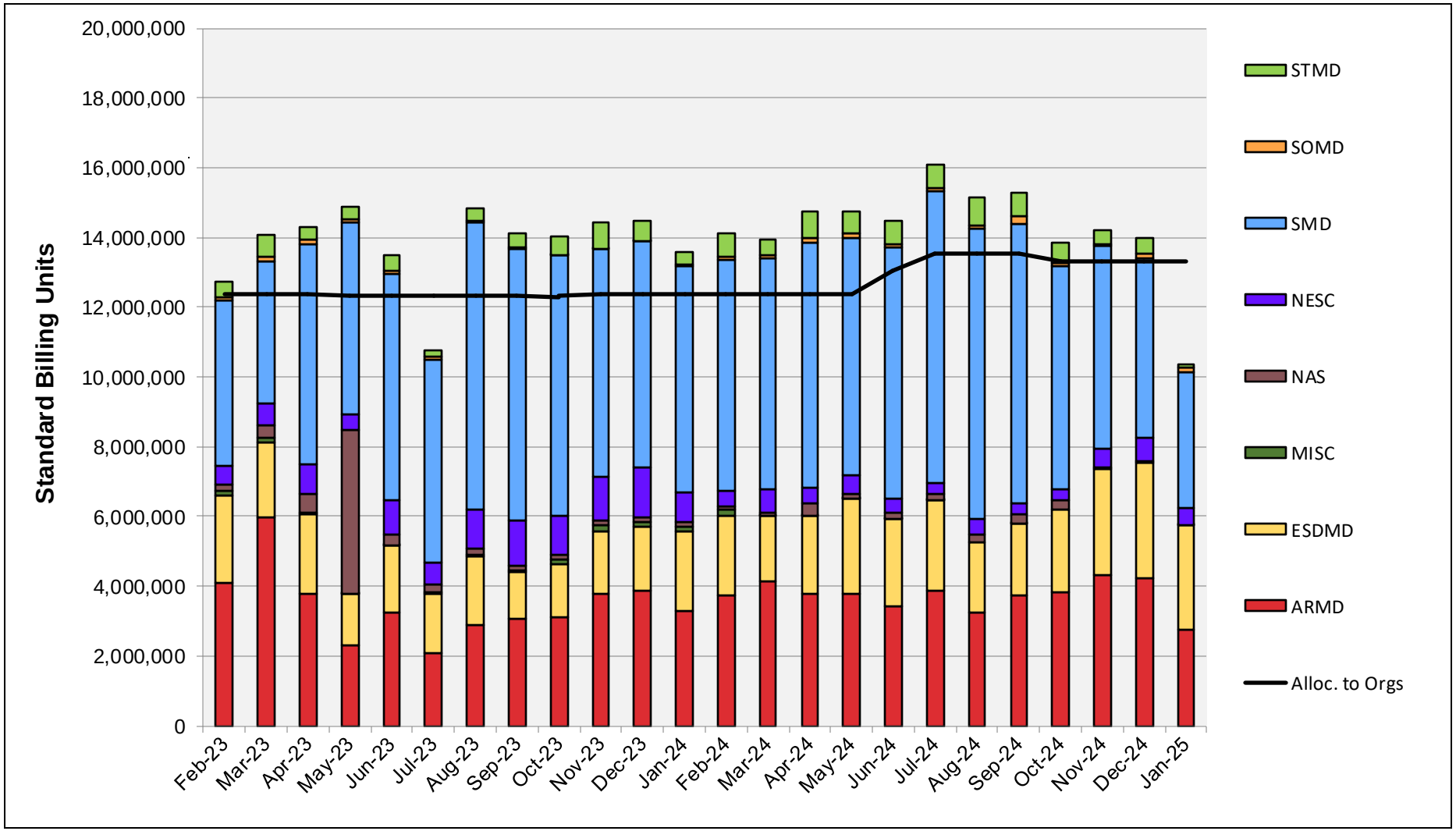
HECC Utilization



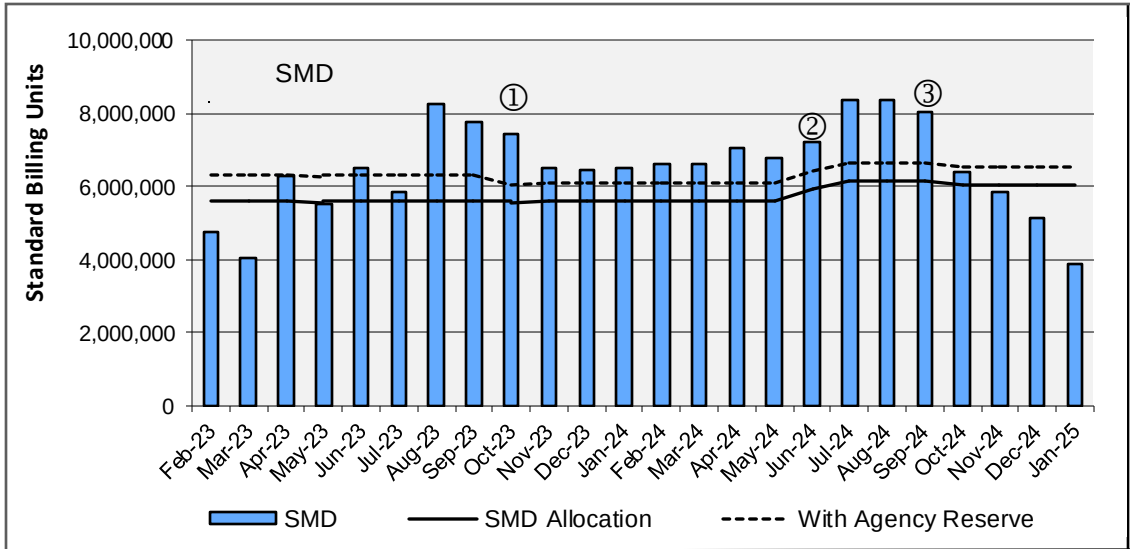
HECC Utilization Normalized to 30-Day Month

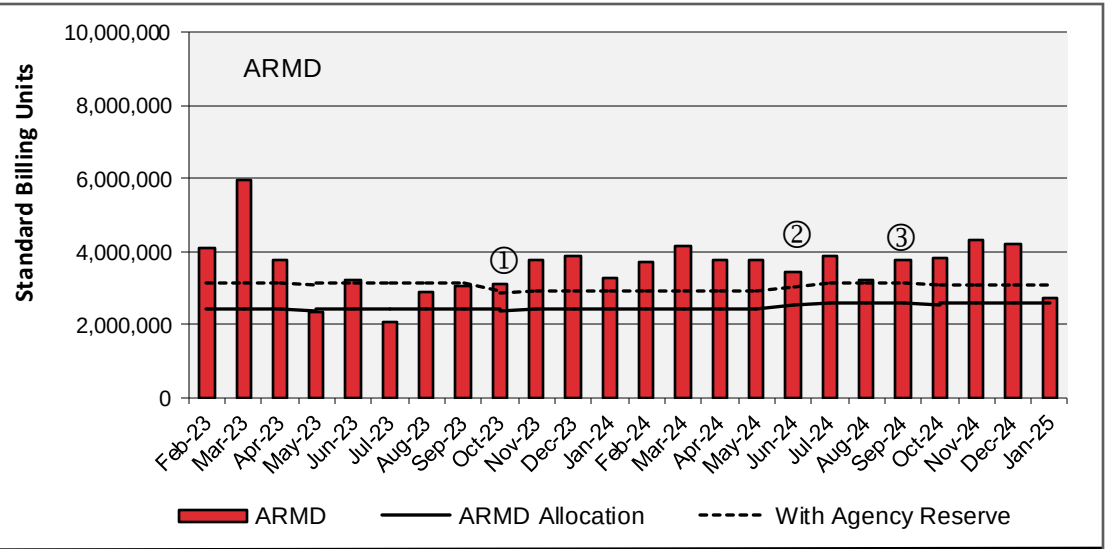


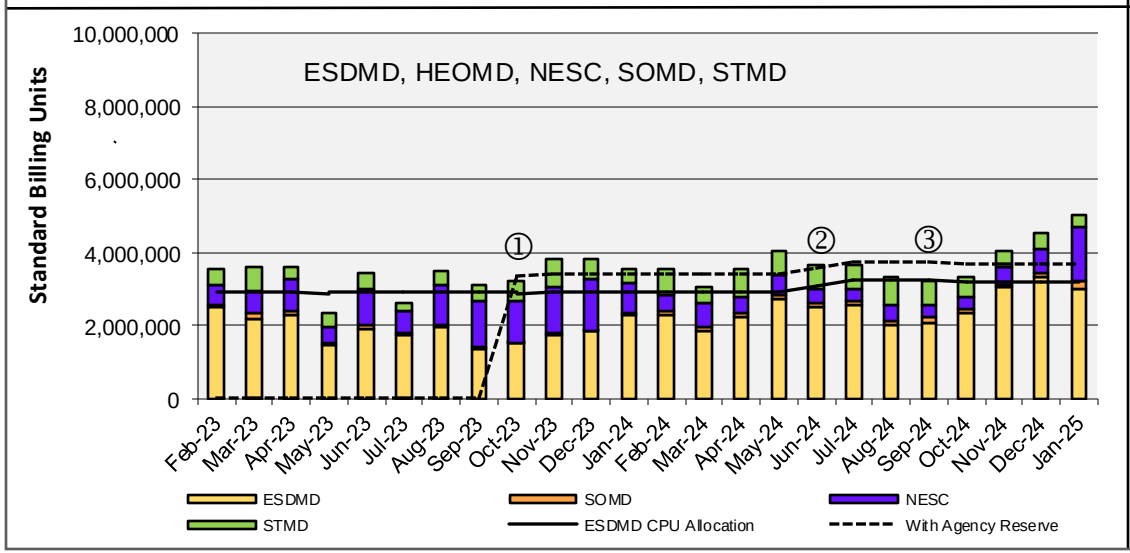
CPU Only Normalized Data



CPU Only by Mission Directorate





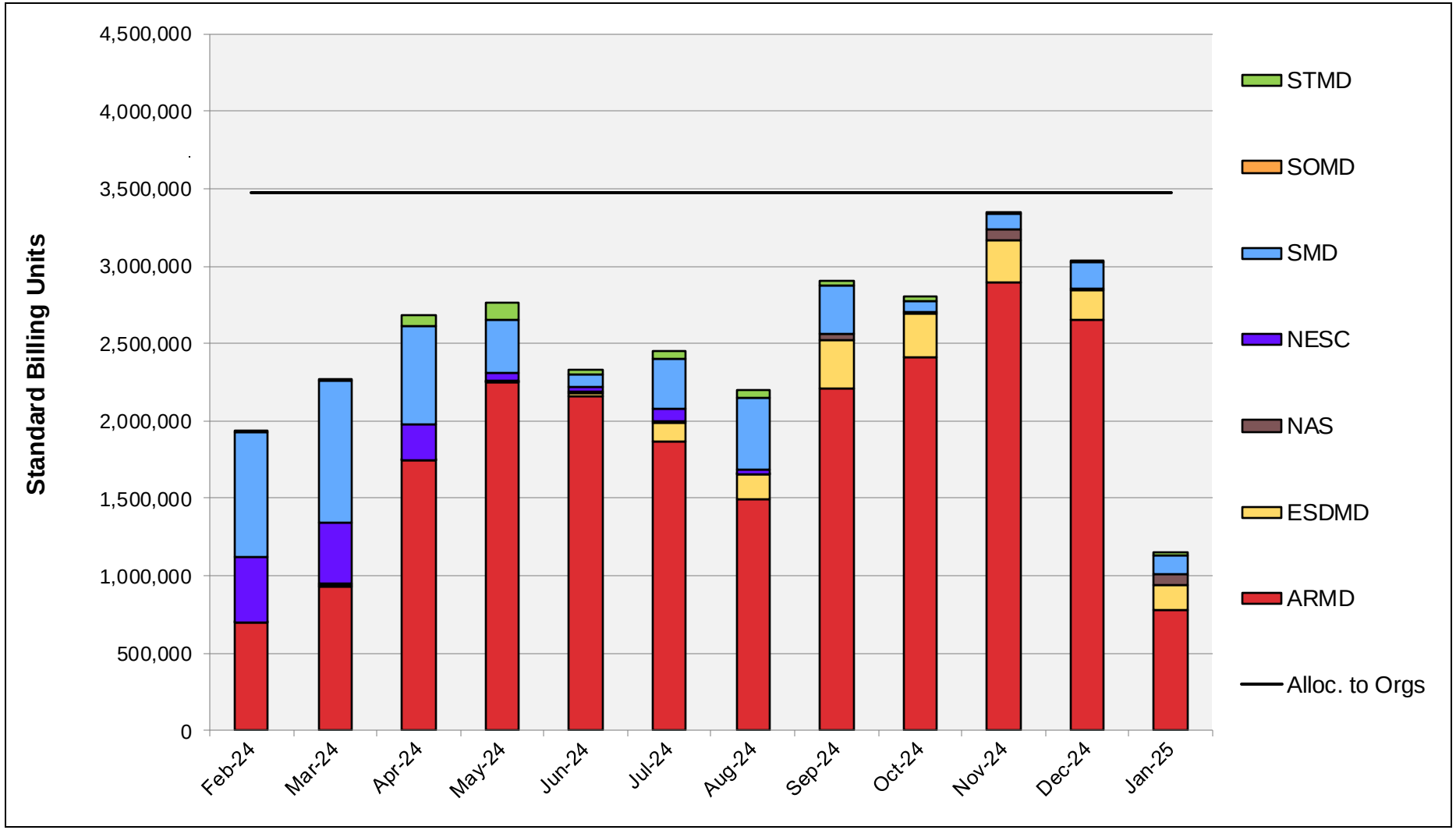


① 4 Rome Apollo Racks added to Aitken

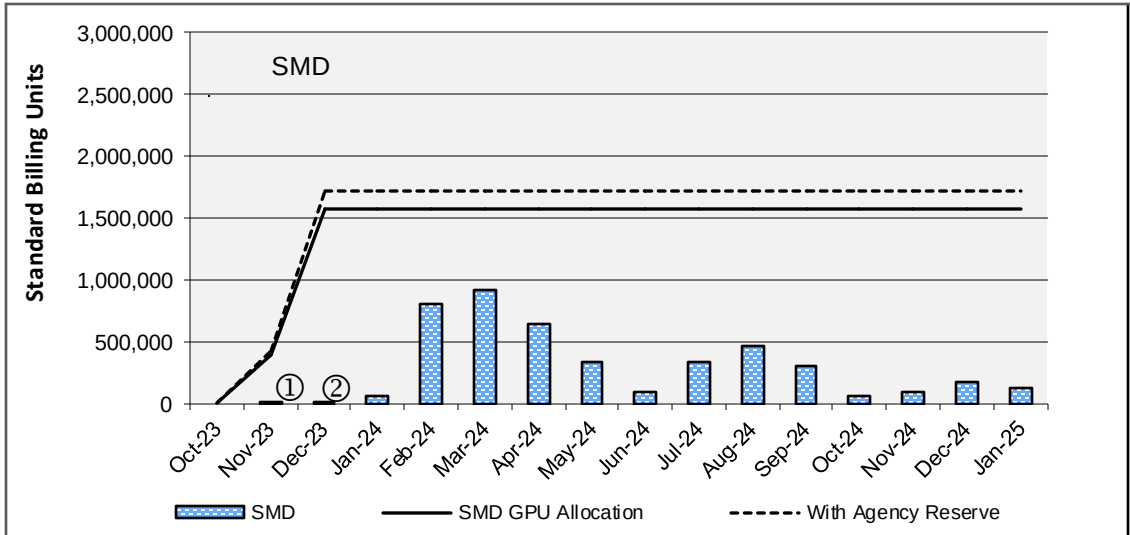
② Aitken Milan nodes added

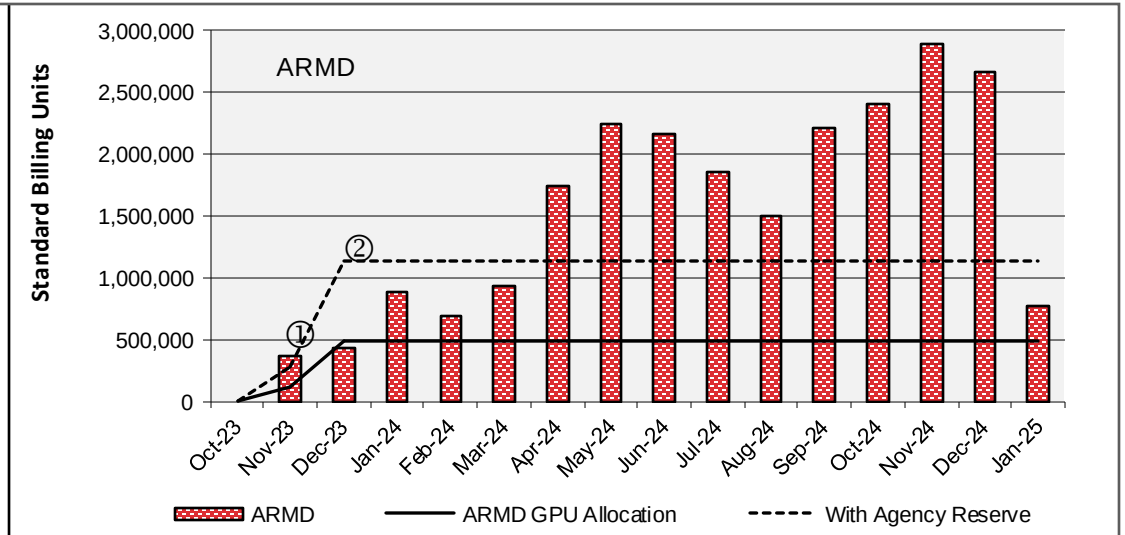
③ Sandy Bridge temporarily removed

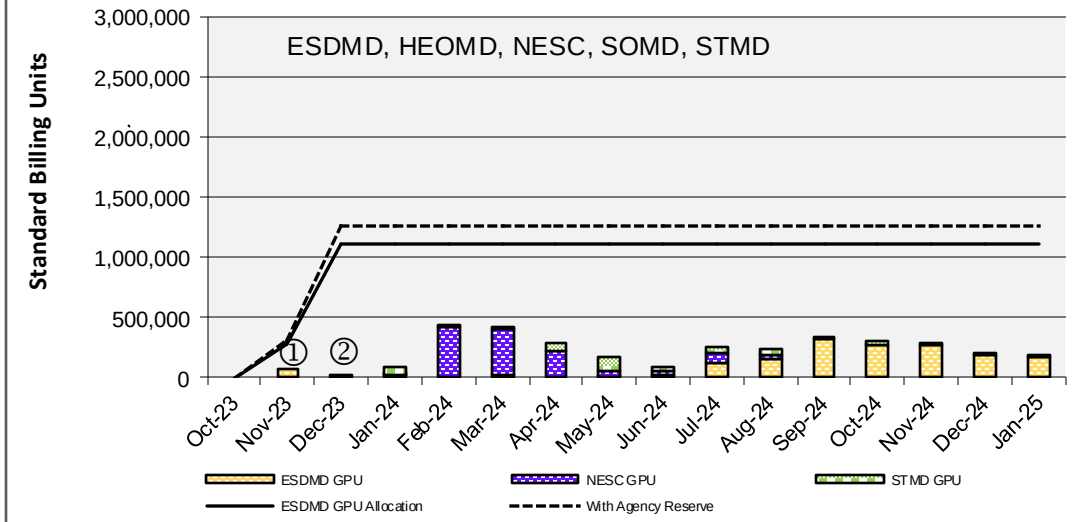
GPU Only Normalized Data



GPU Only Normalized Data



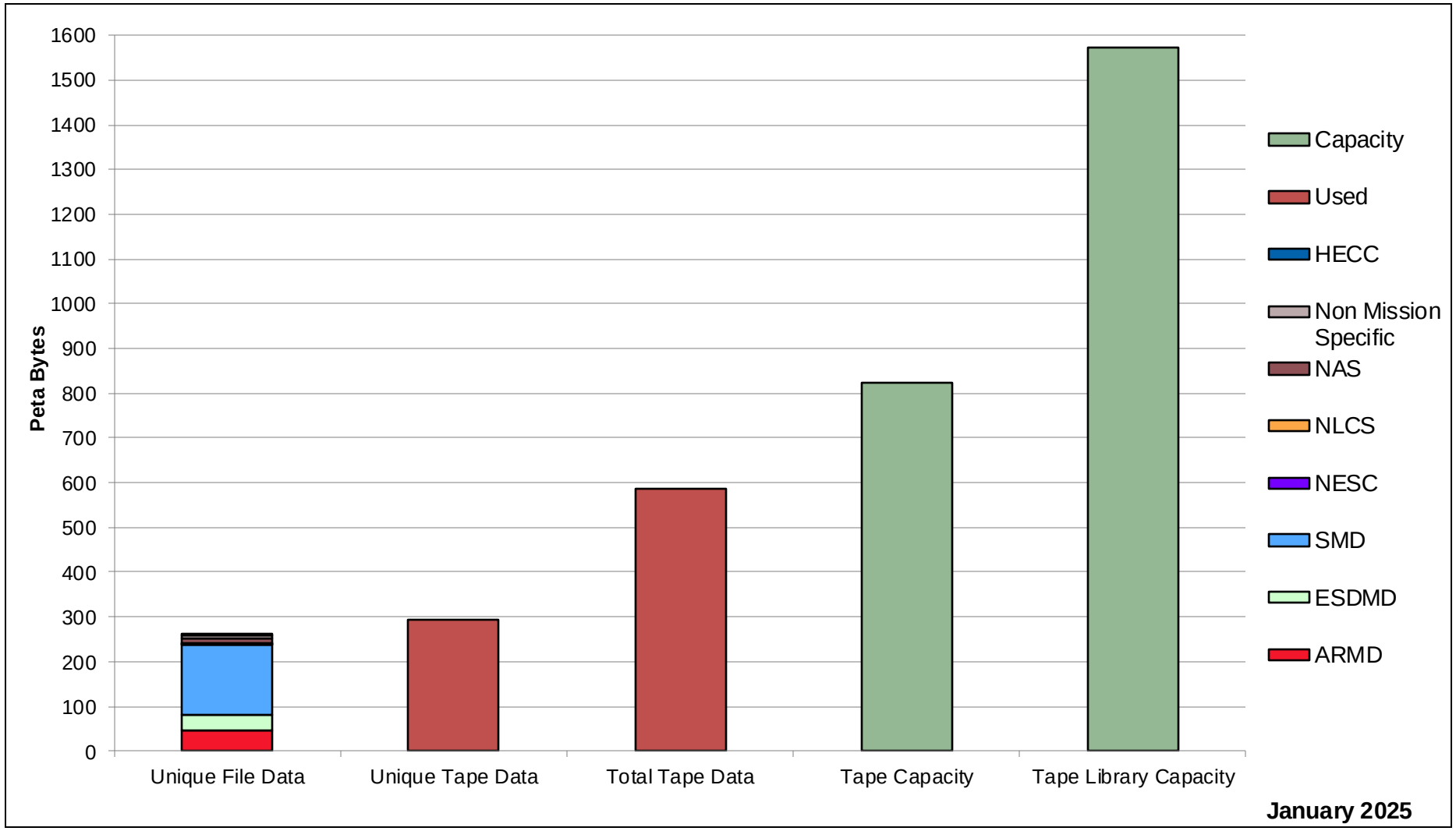




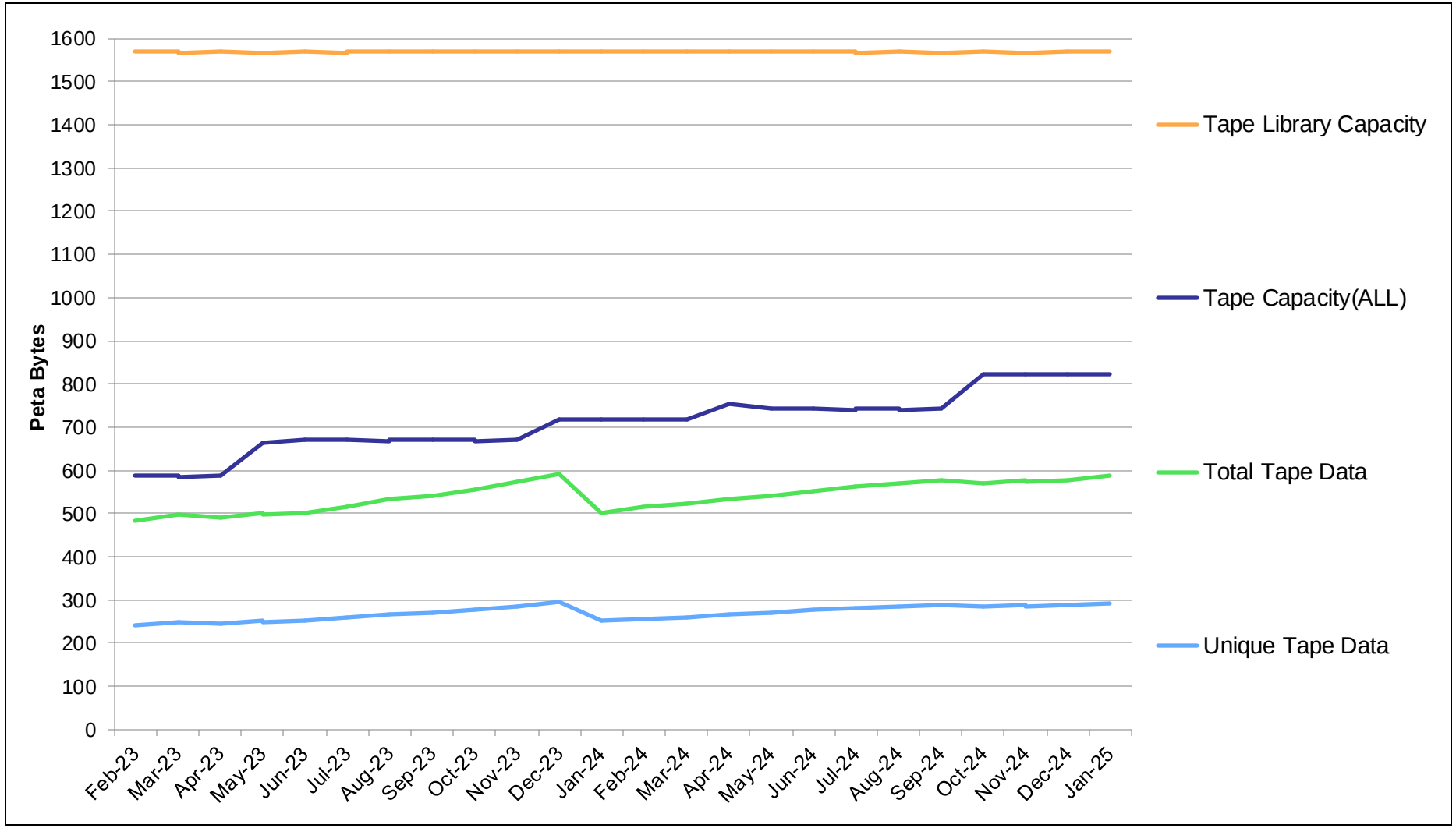
① Cabeus v100 nodes added

② Cabeus a100 nodes added

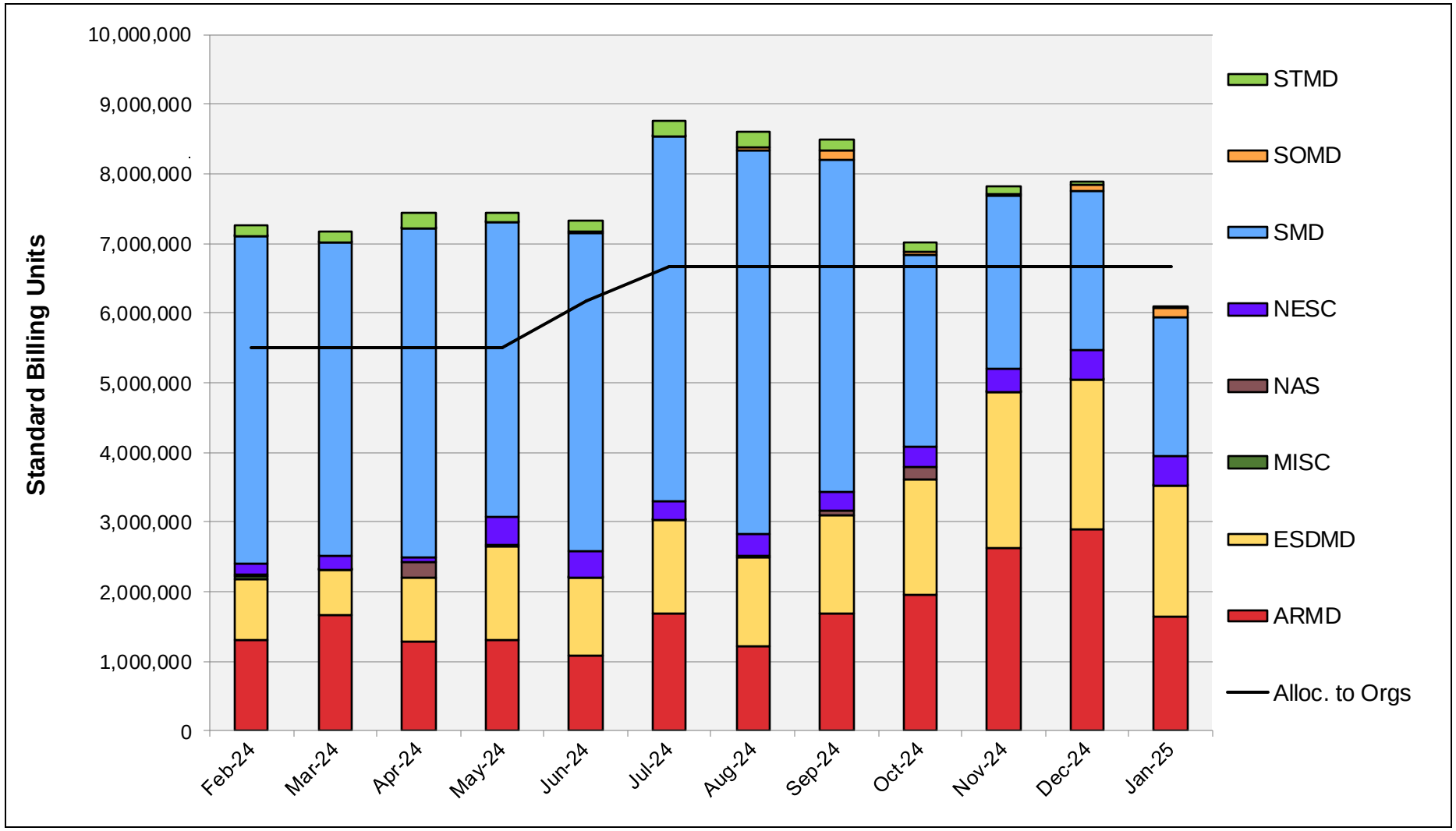
Tape Archive Status



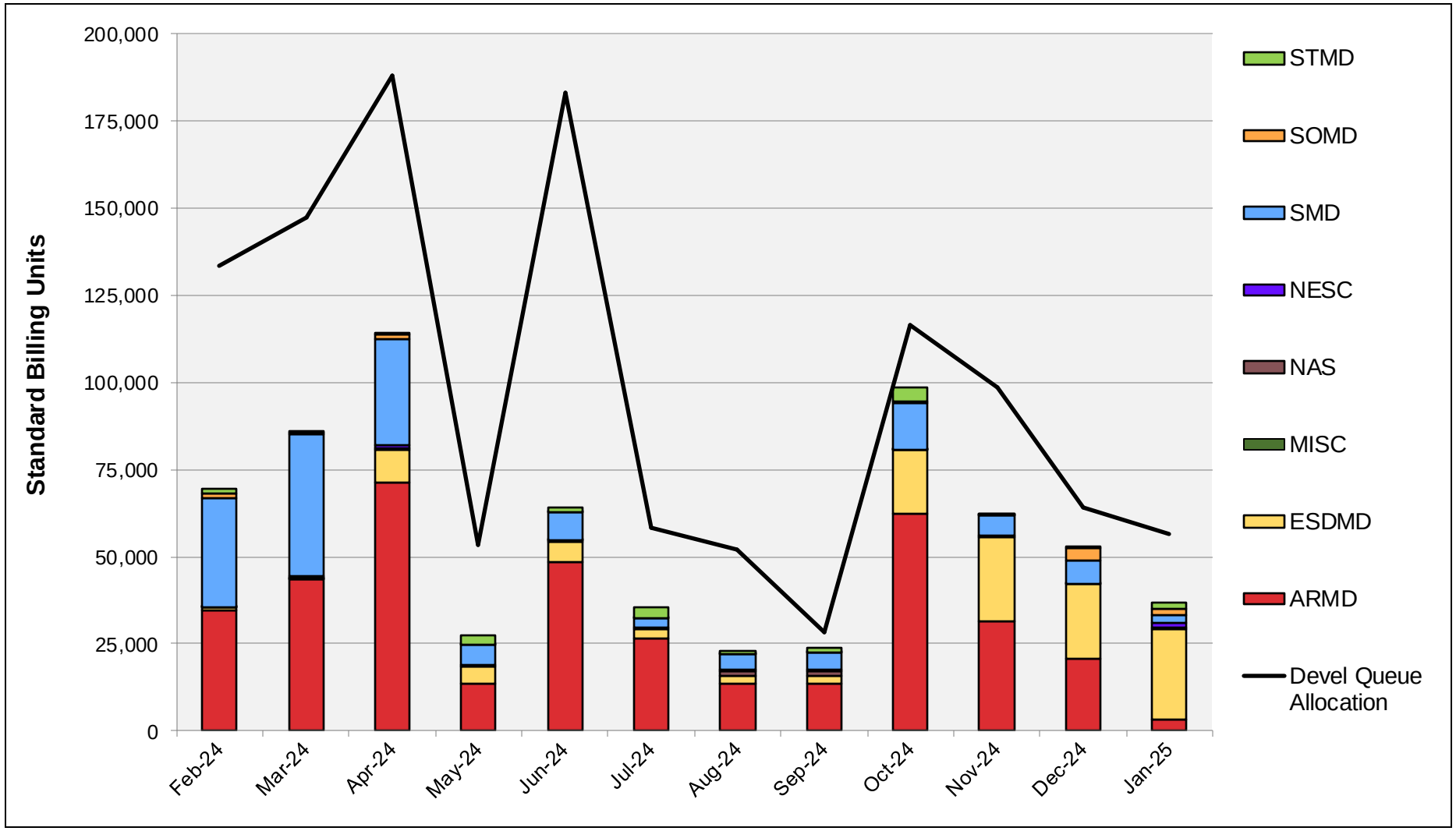
Tape Archive Status



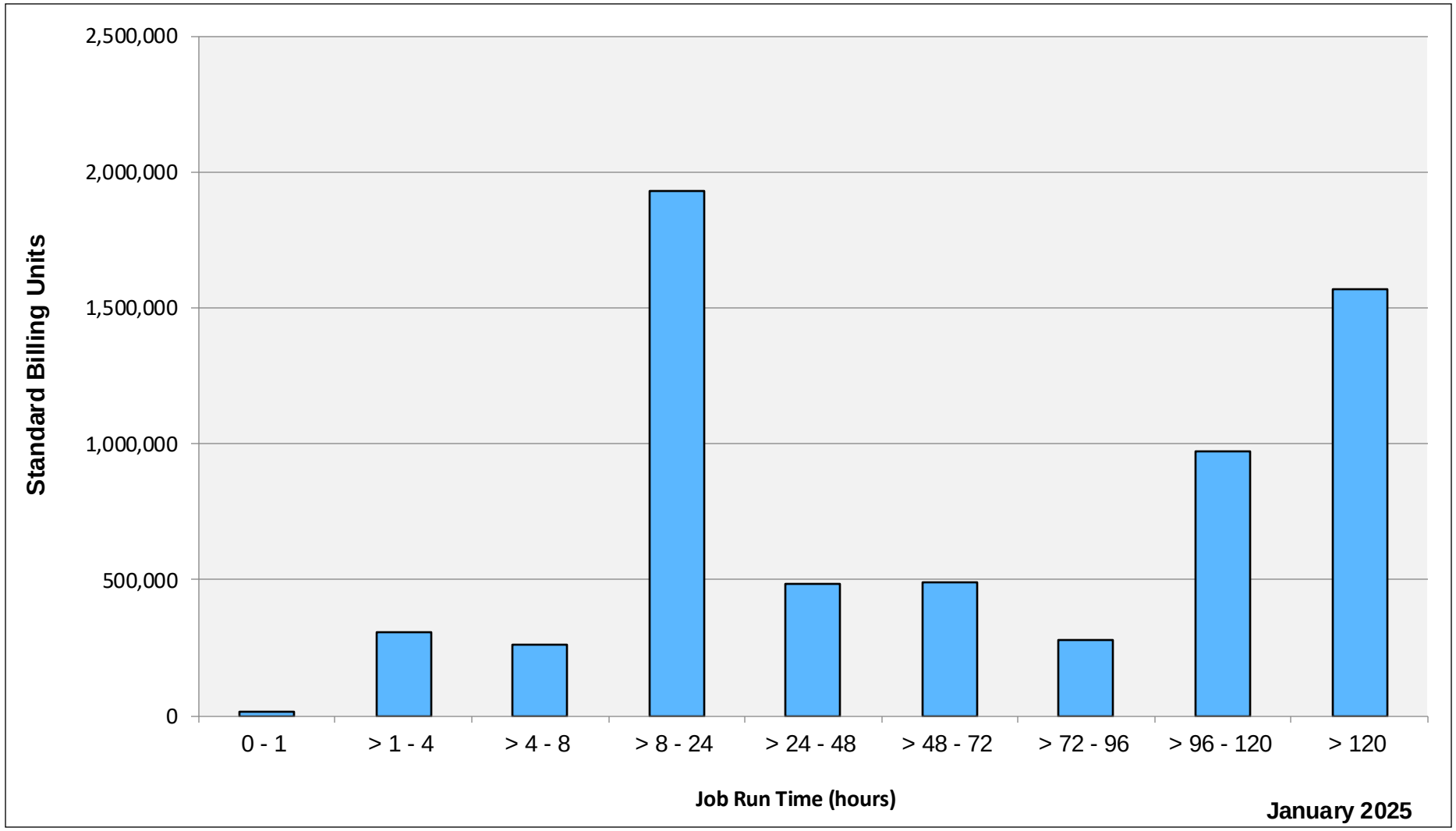
Aitken: SBUs Reported, Normalized to 30-Day Month



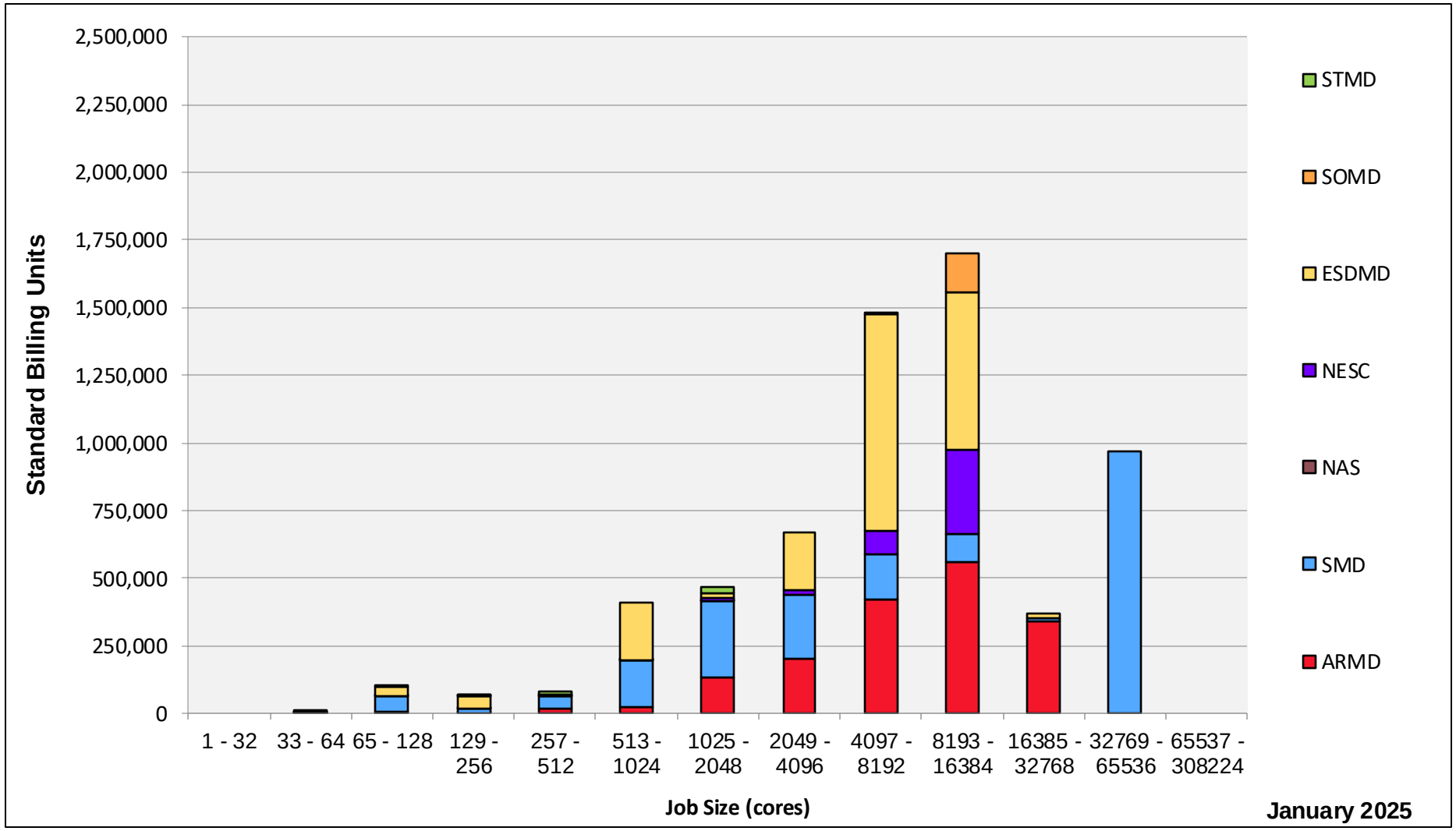
Aitken: Devel Queue Utilization



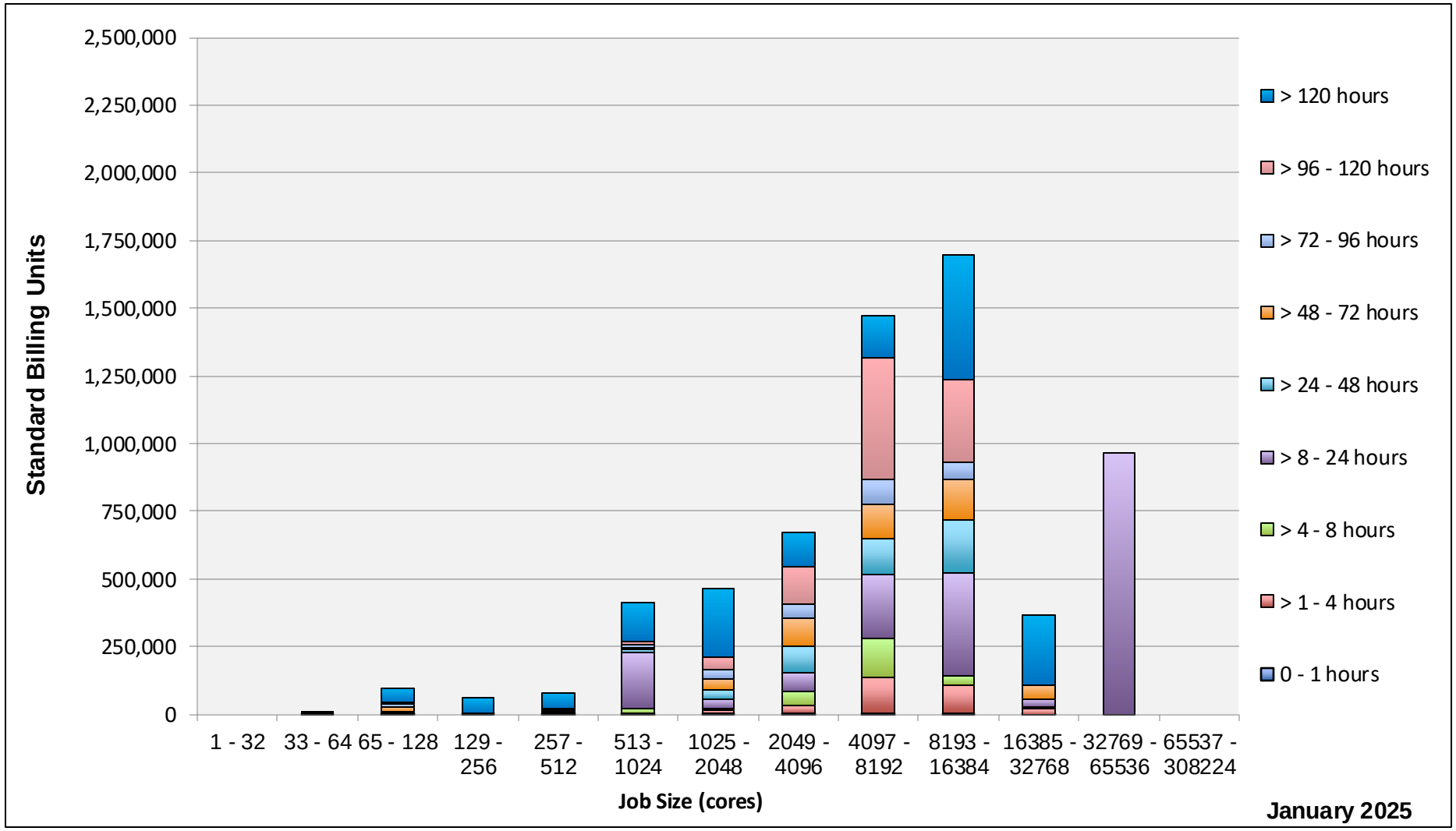
Aitken: Monthly Utilization by Job Length



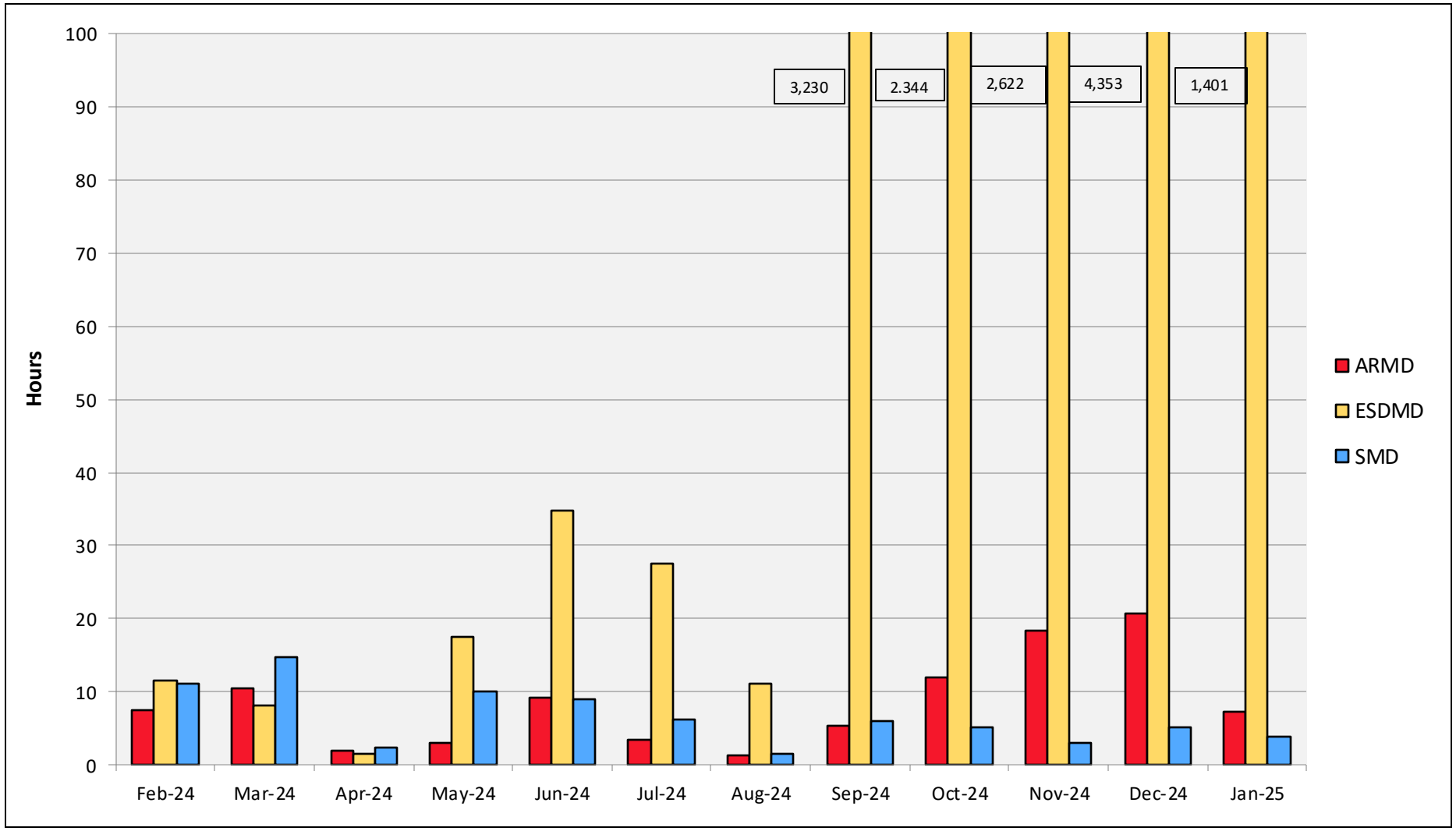
Aitken: Monthly Utilization by Job Size



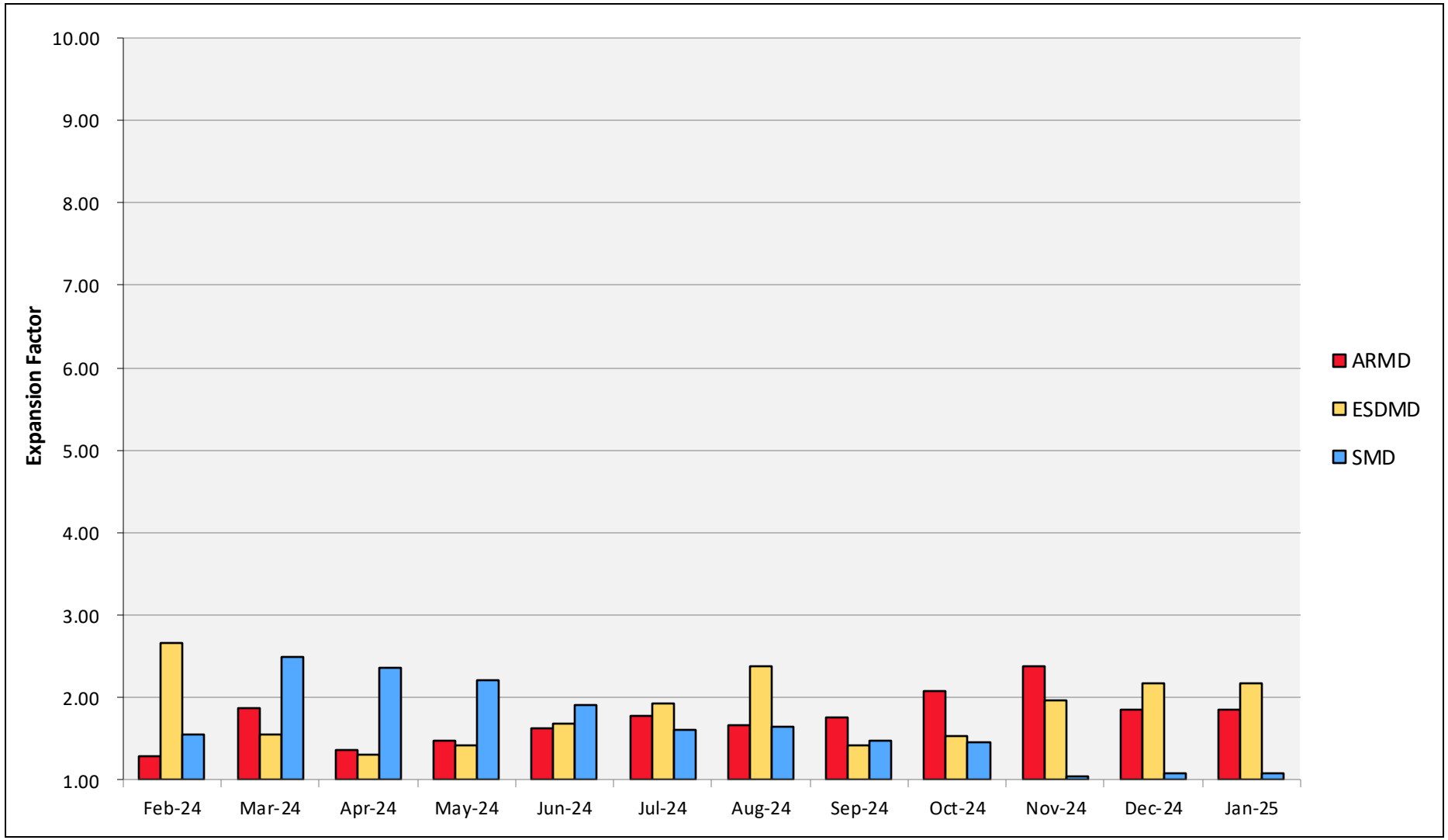
Aitken: Monthly Utilization by Size and Length



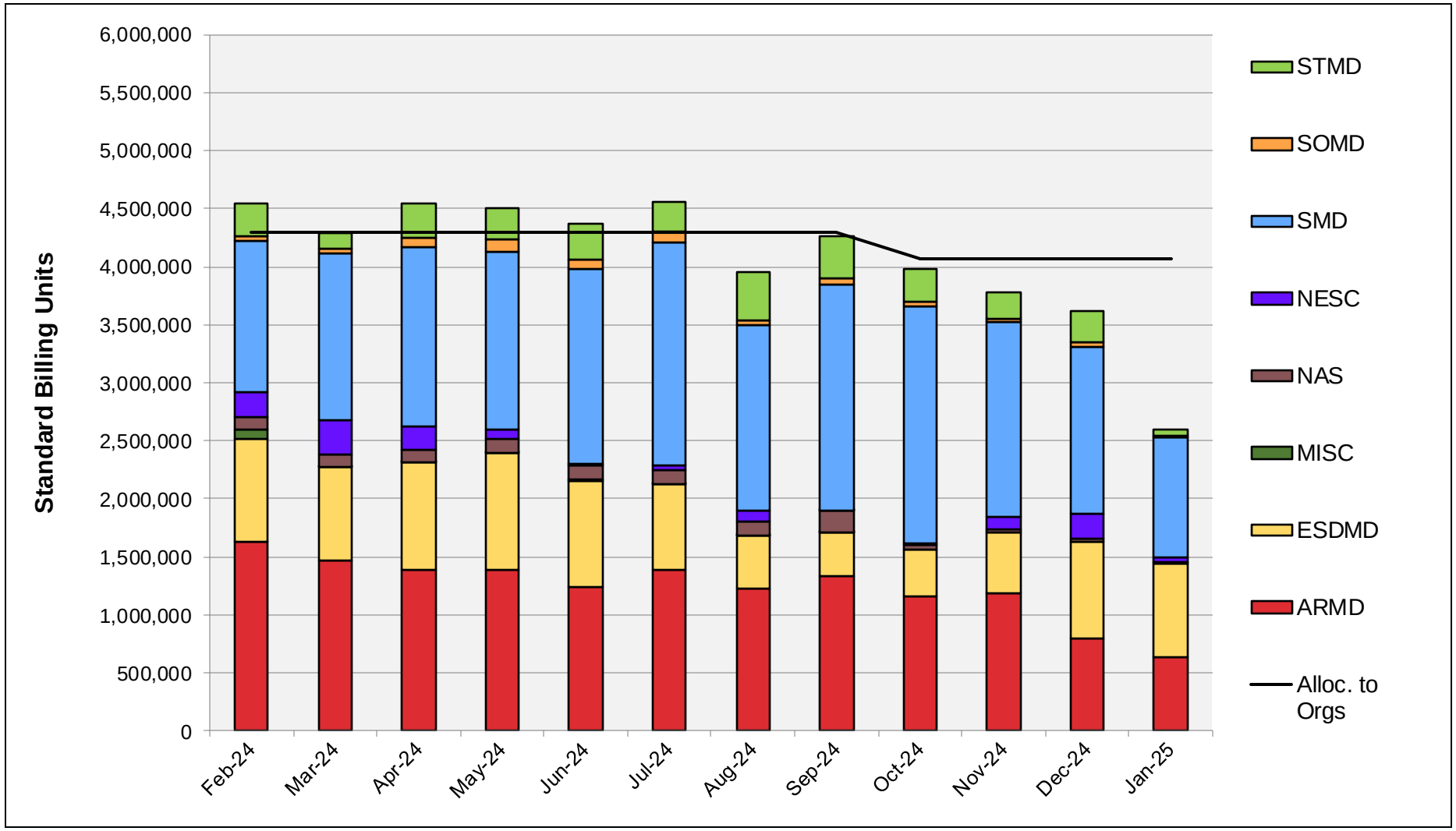
Aitken: Average Time to Clear All Jobs



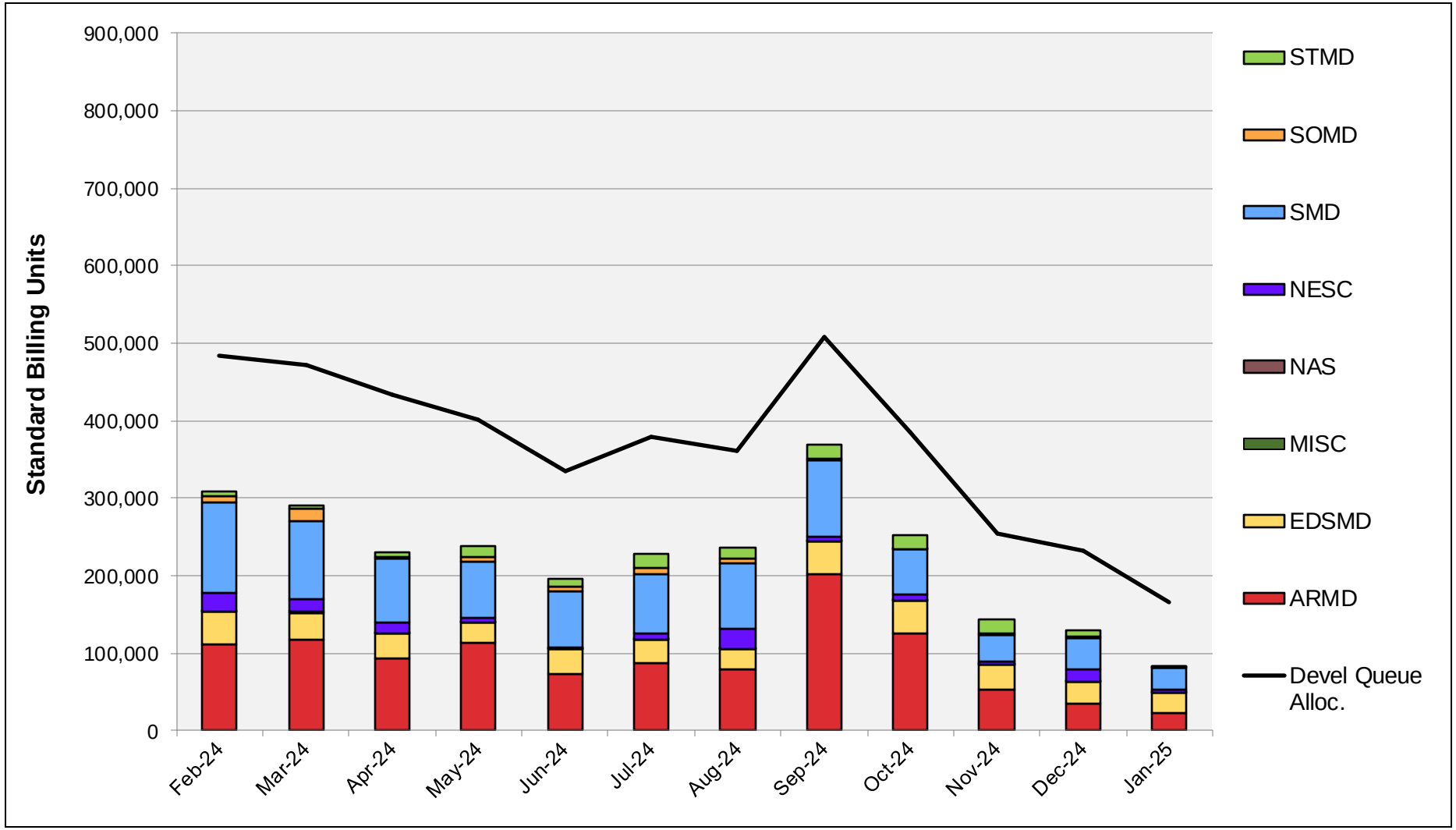
Aitken: Average Expansion Factor



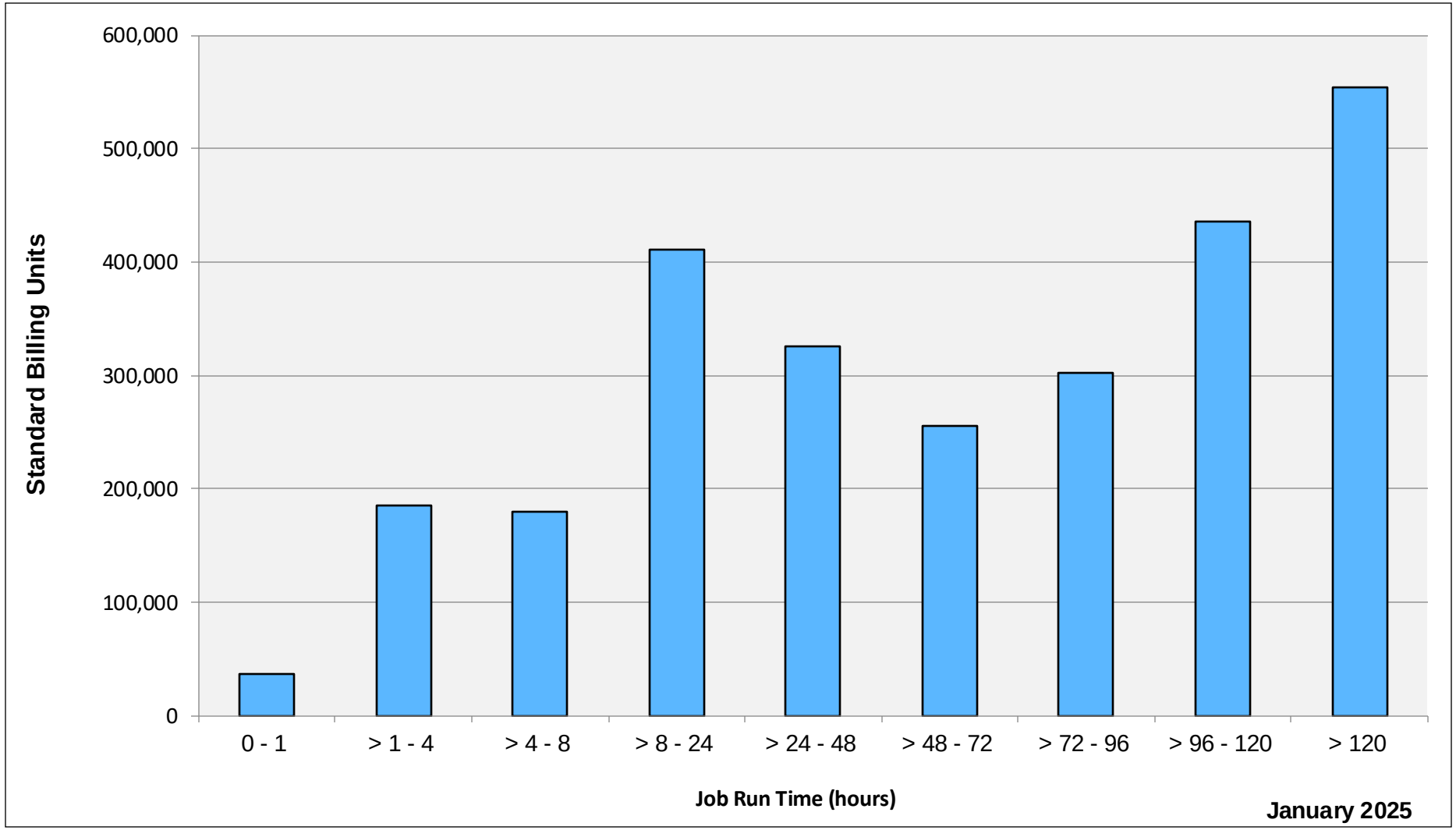
Pleiades: SBUs Reported, Normalized to 30-Day Month



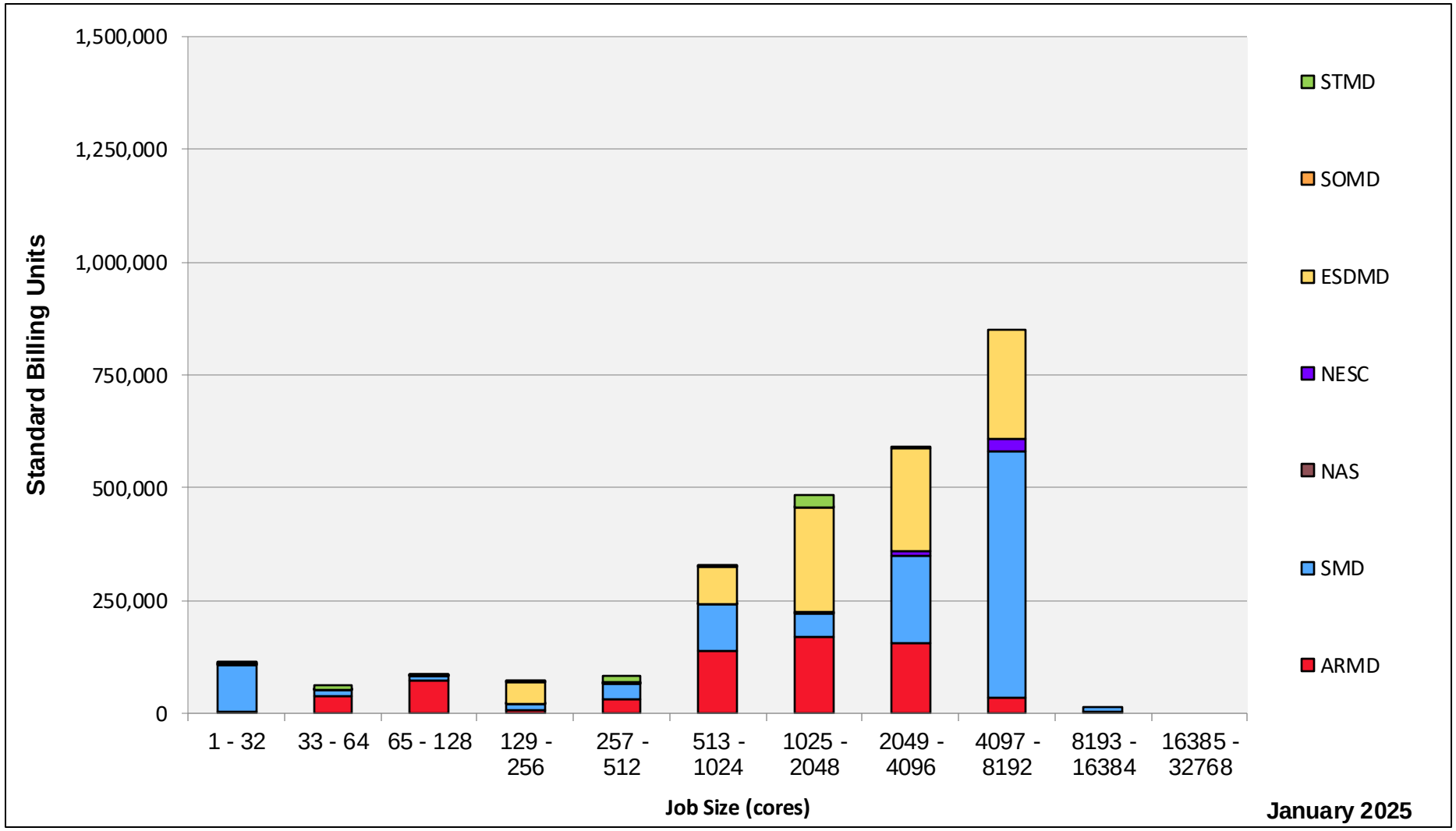
Pleiades: Devel Queue Utilization



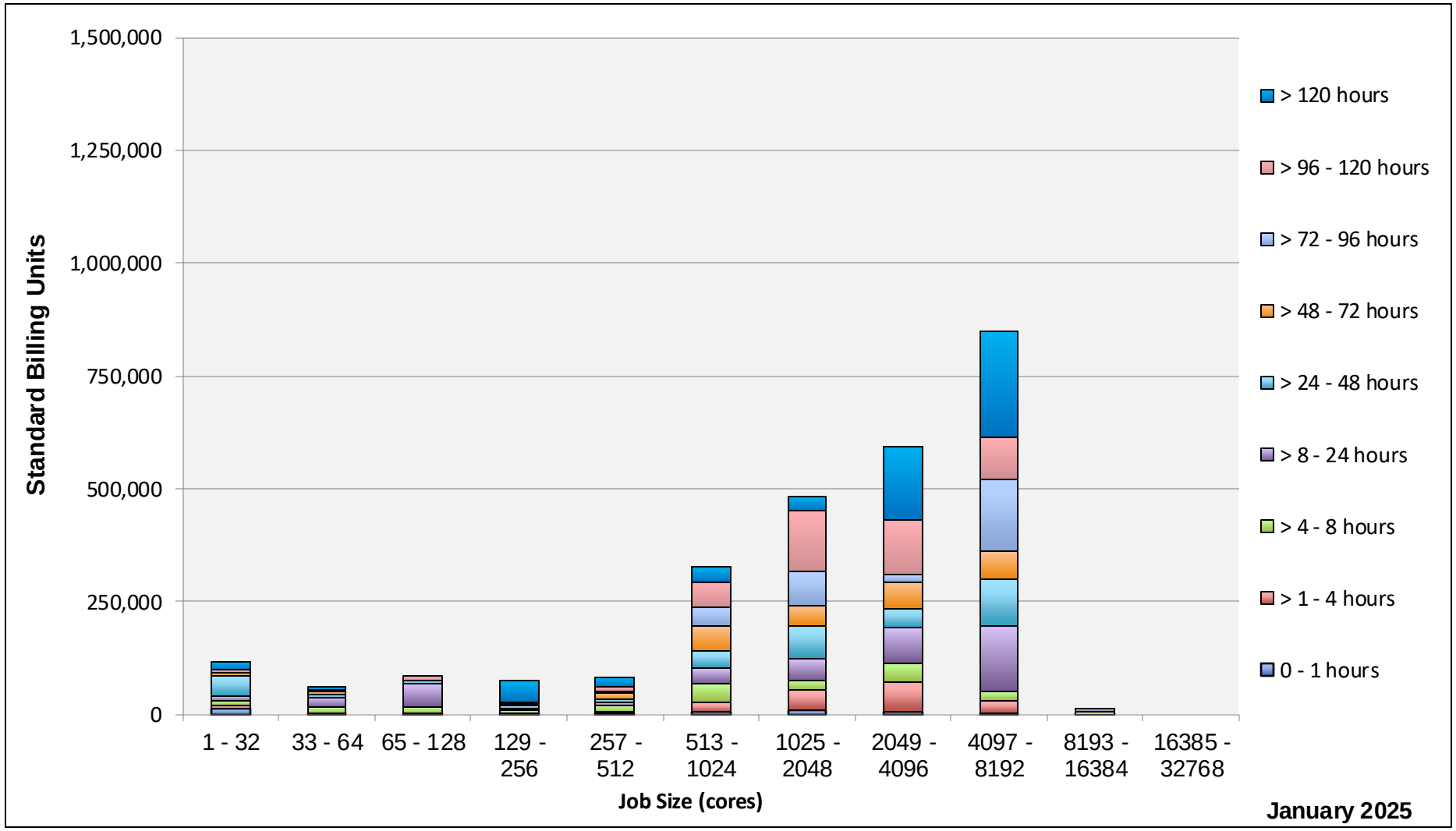
Pleiades: Monthly Utilization by Job Length



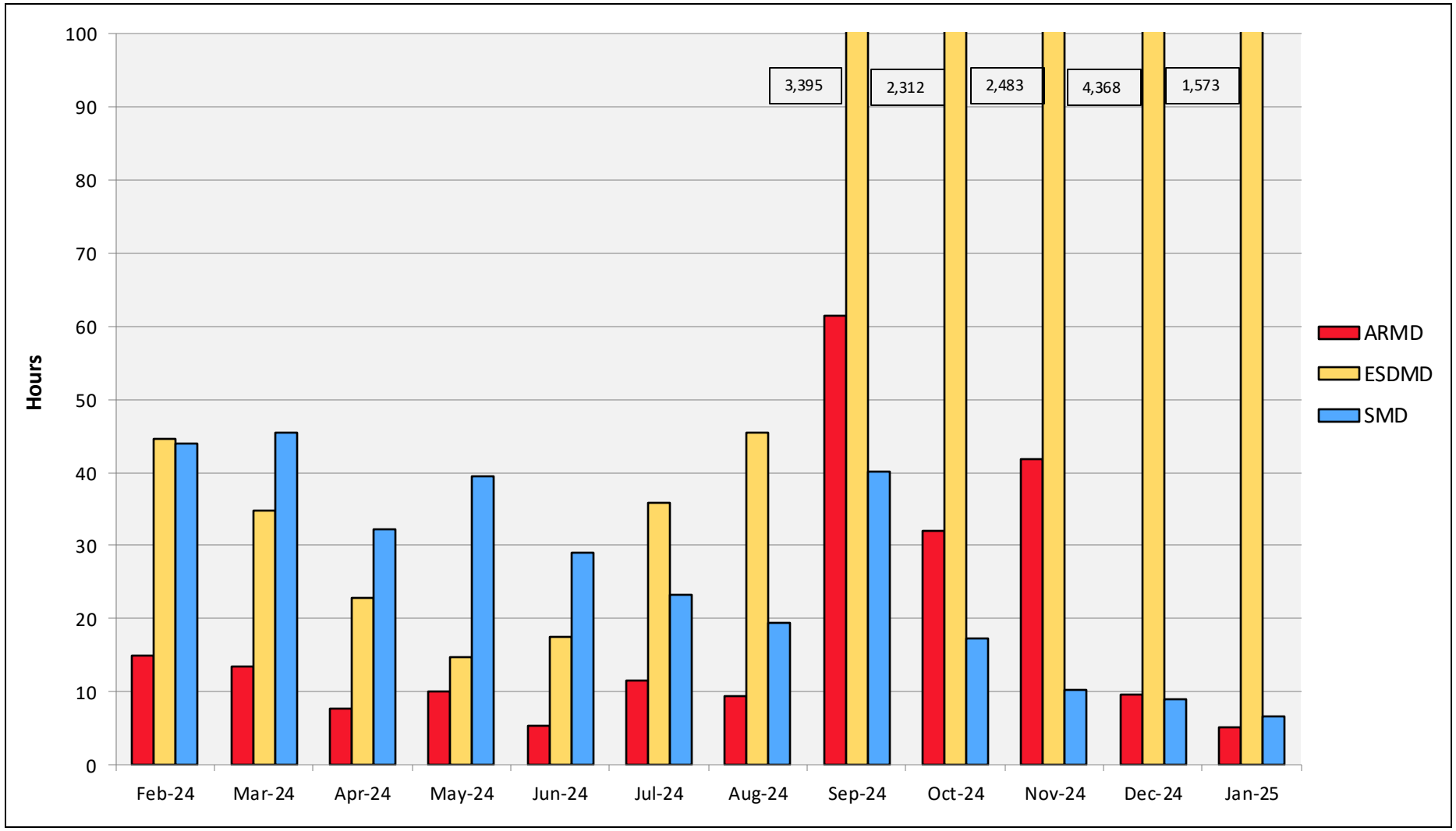
Pleiades: Monthly Utilization by Job Size



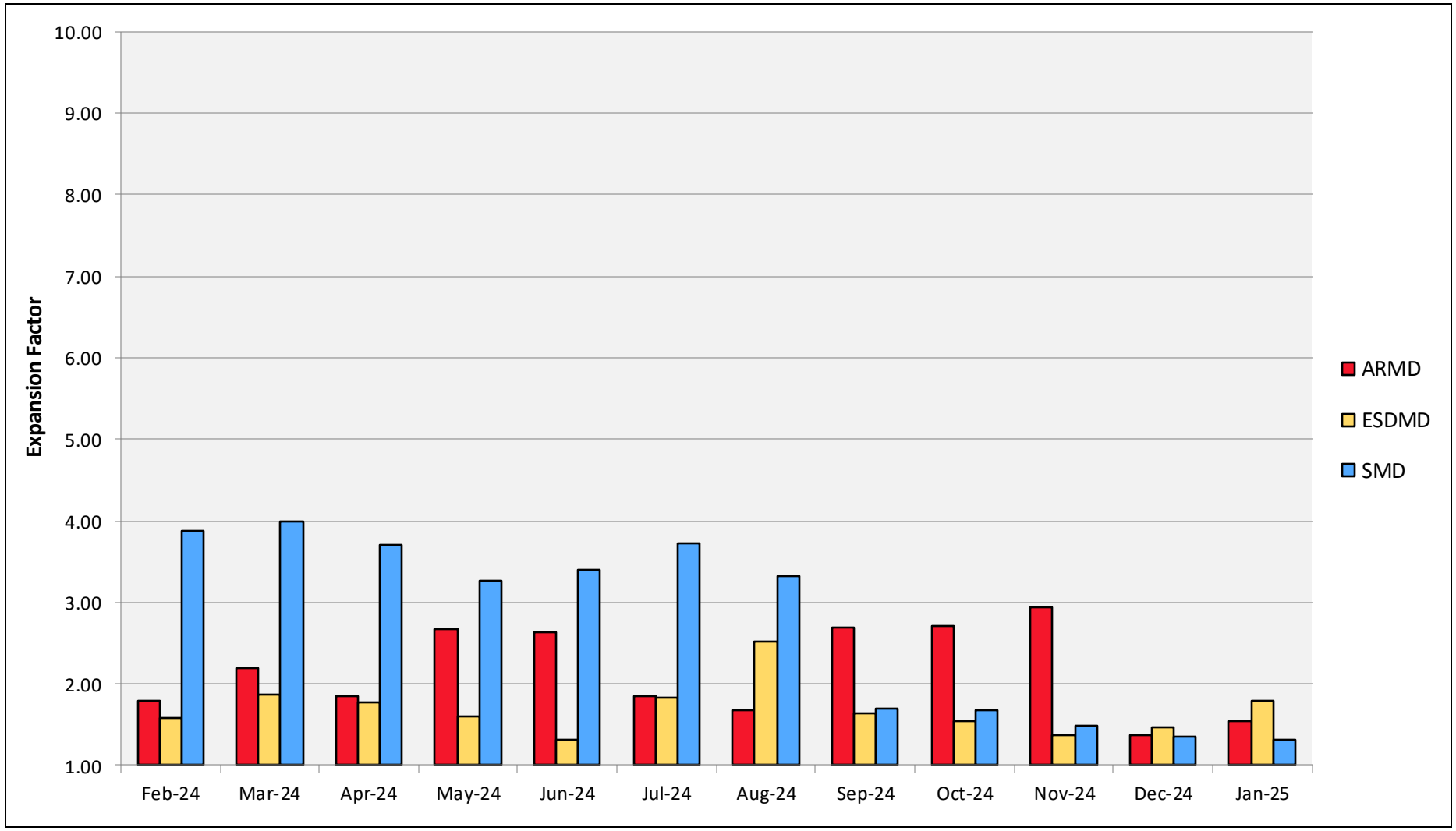
Pleiades: Monthly Utilization by Size and Length



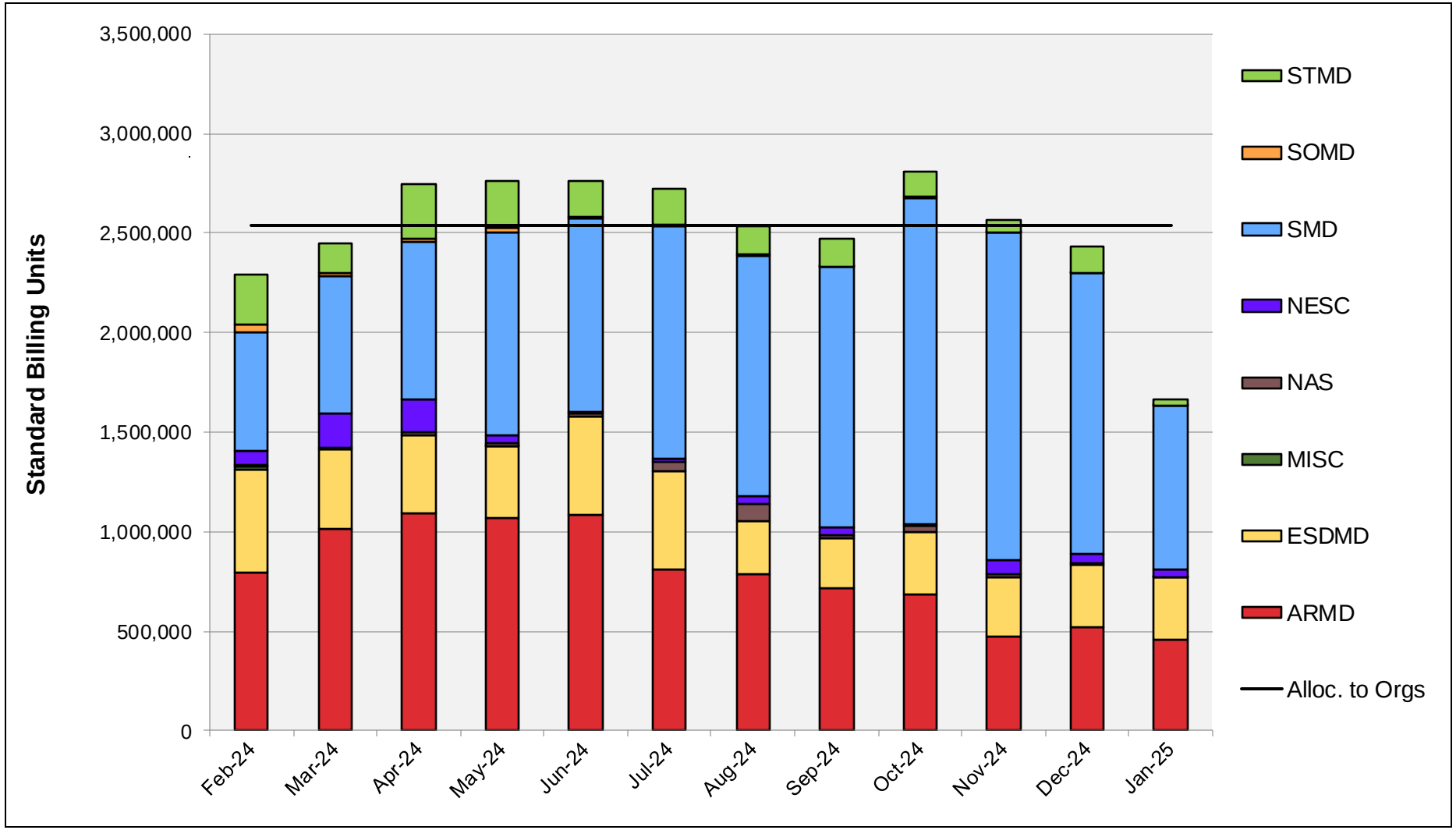
Pleiades: Average Time to Clear All Jobs



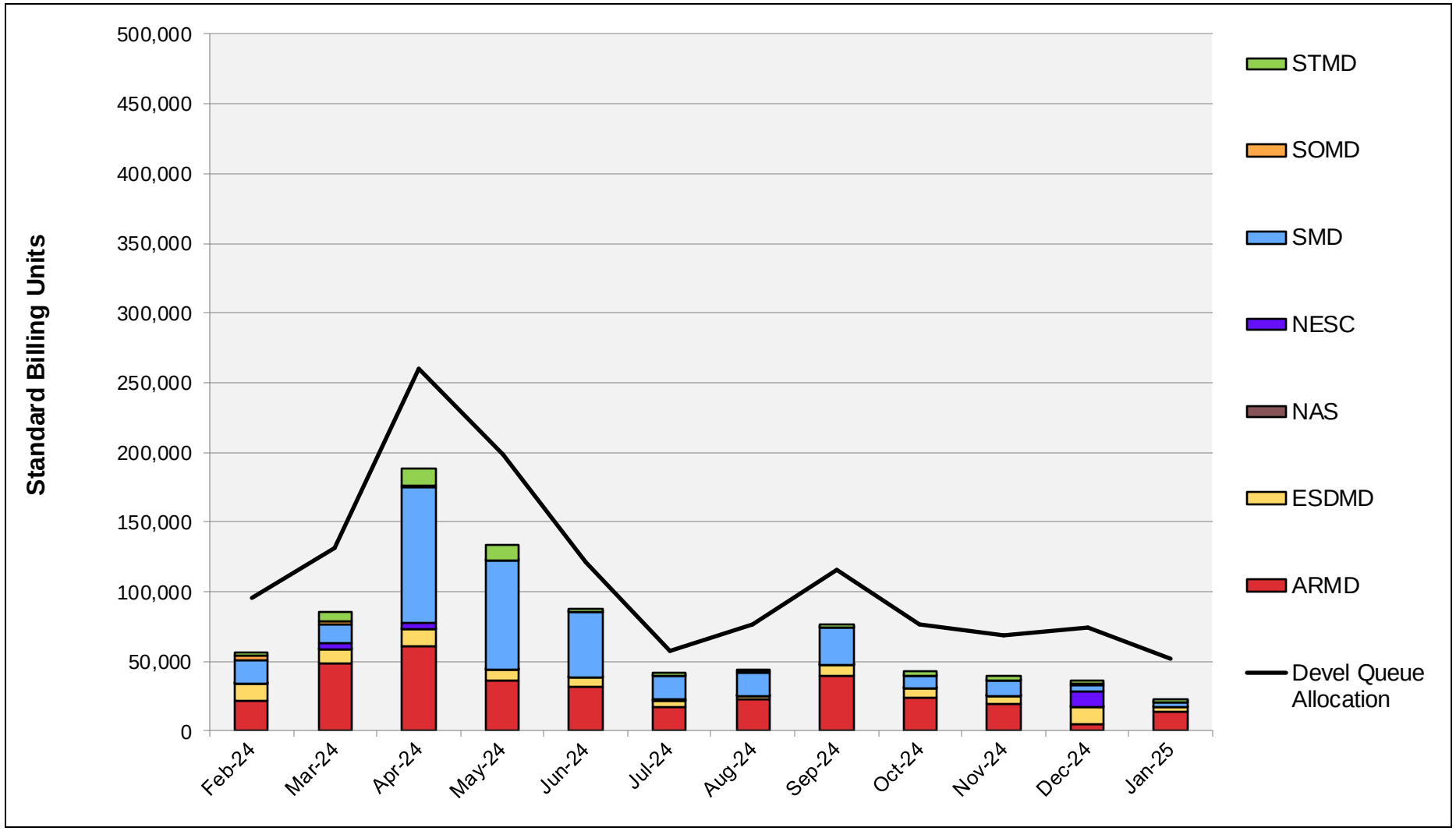
Pleiades: Average Expansion Factor



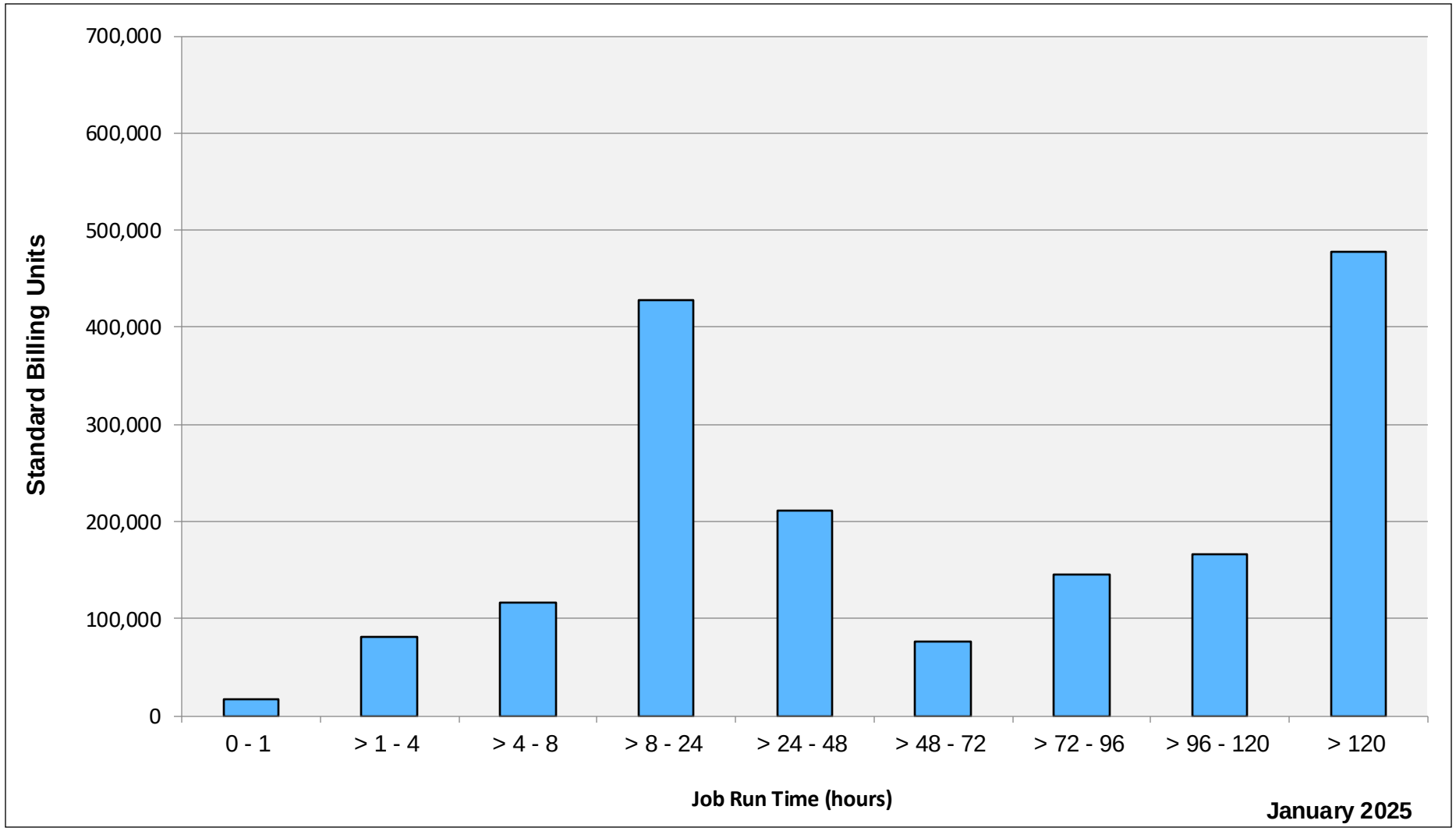
Electra: SBUs Reported, Normalized to 30-Day Month



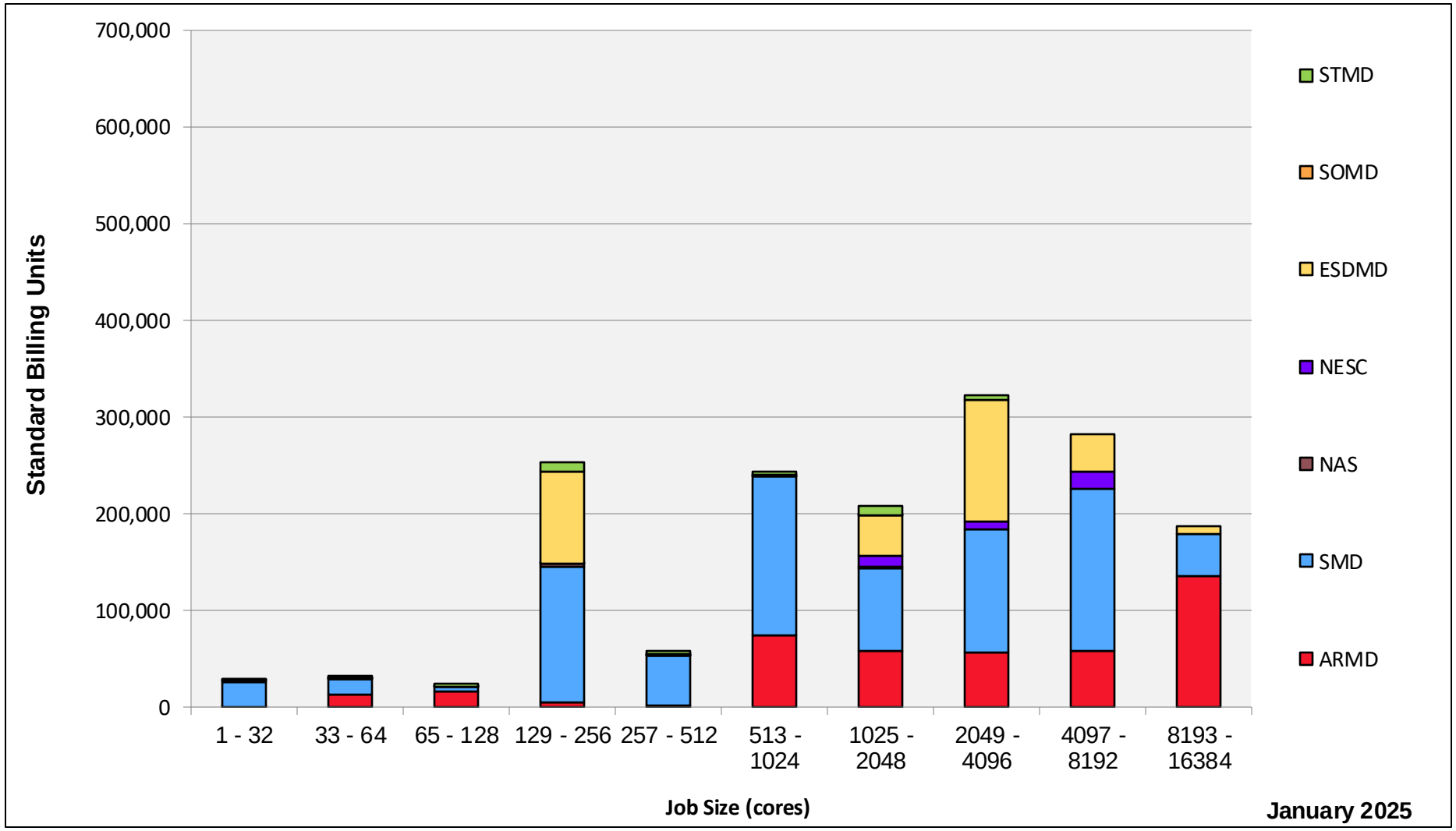
Electra: Devel Queue Utilization



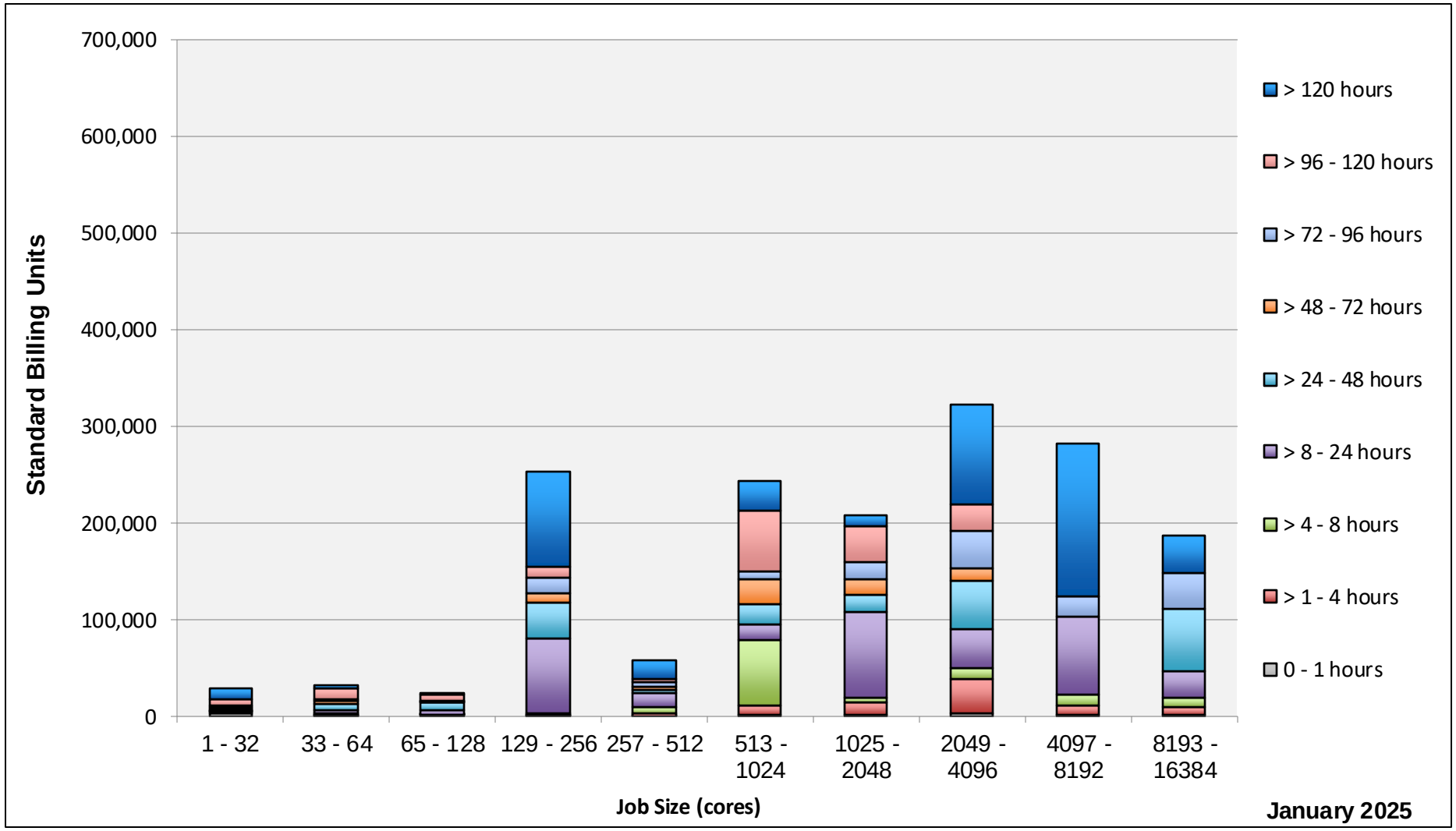
Electra: Monthly Utilization by Job Length



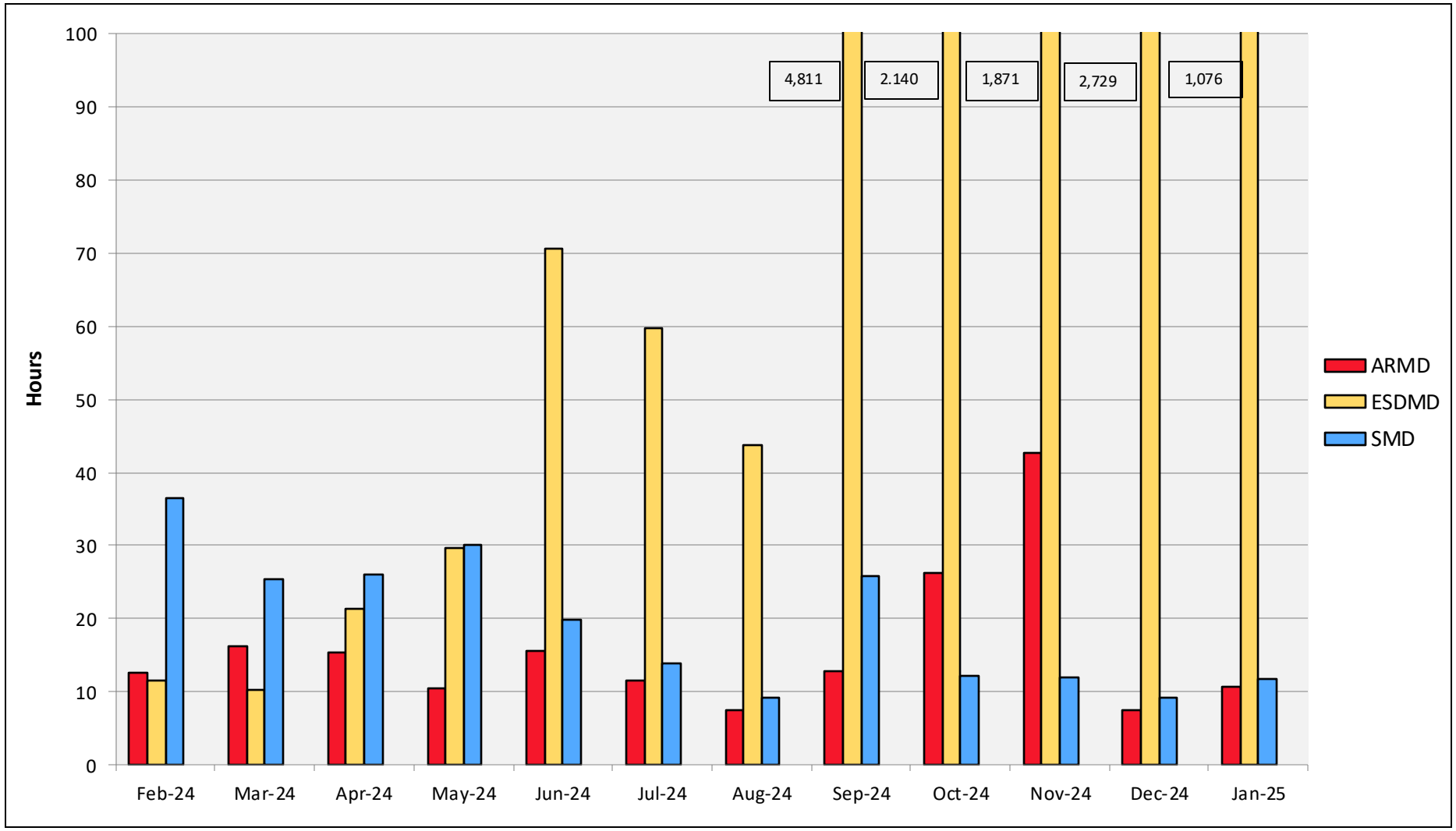
Electra: Monthly Utilization by Job Size



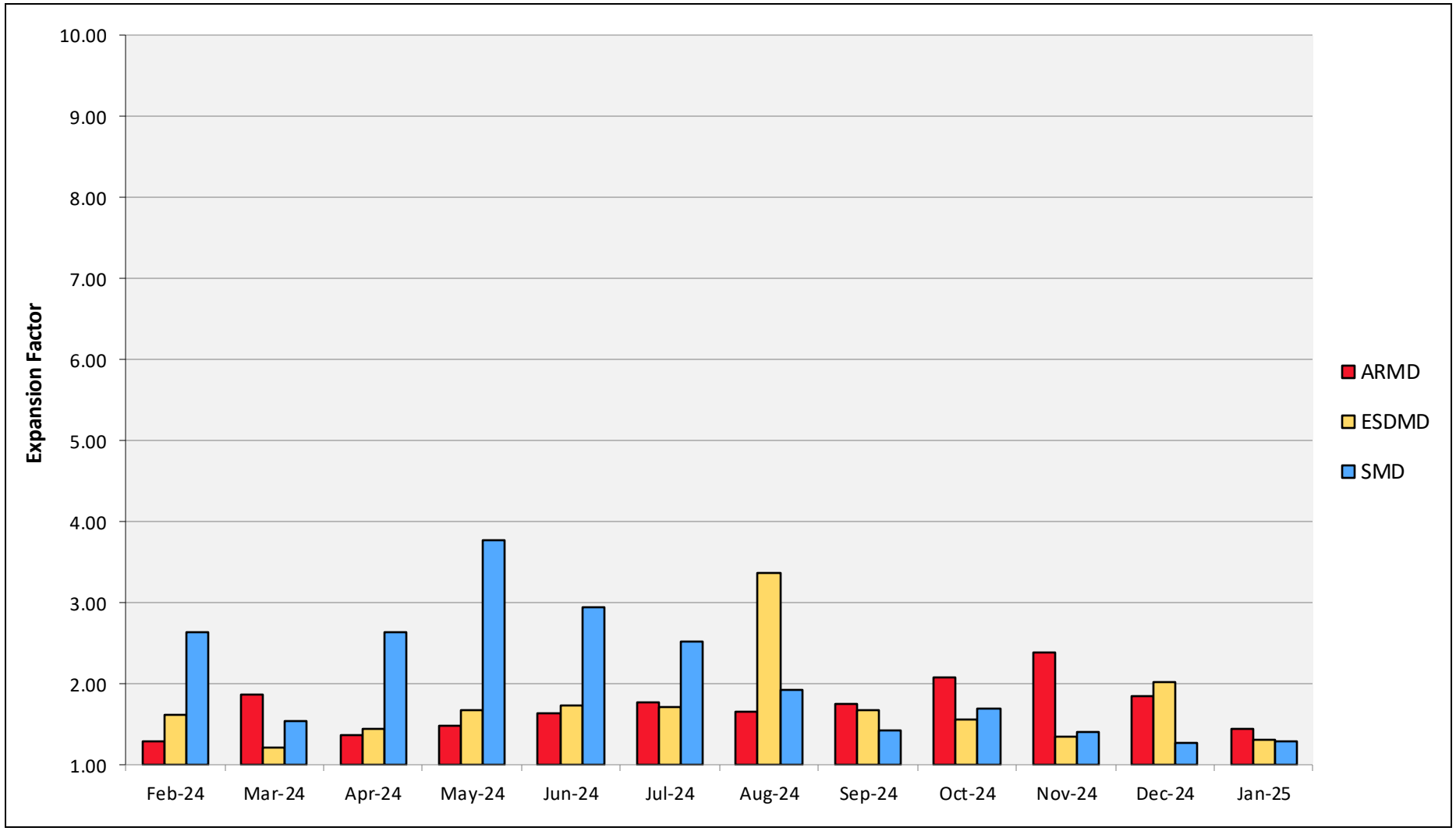
Electra: Monthly Utilization by Size and Length



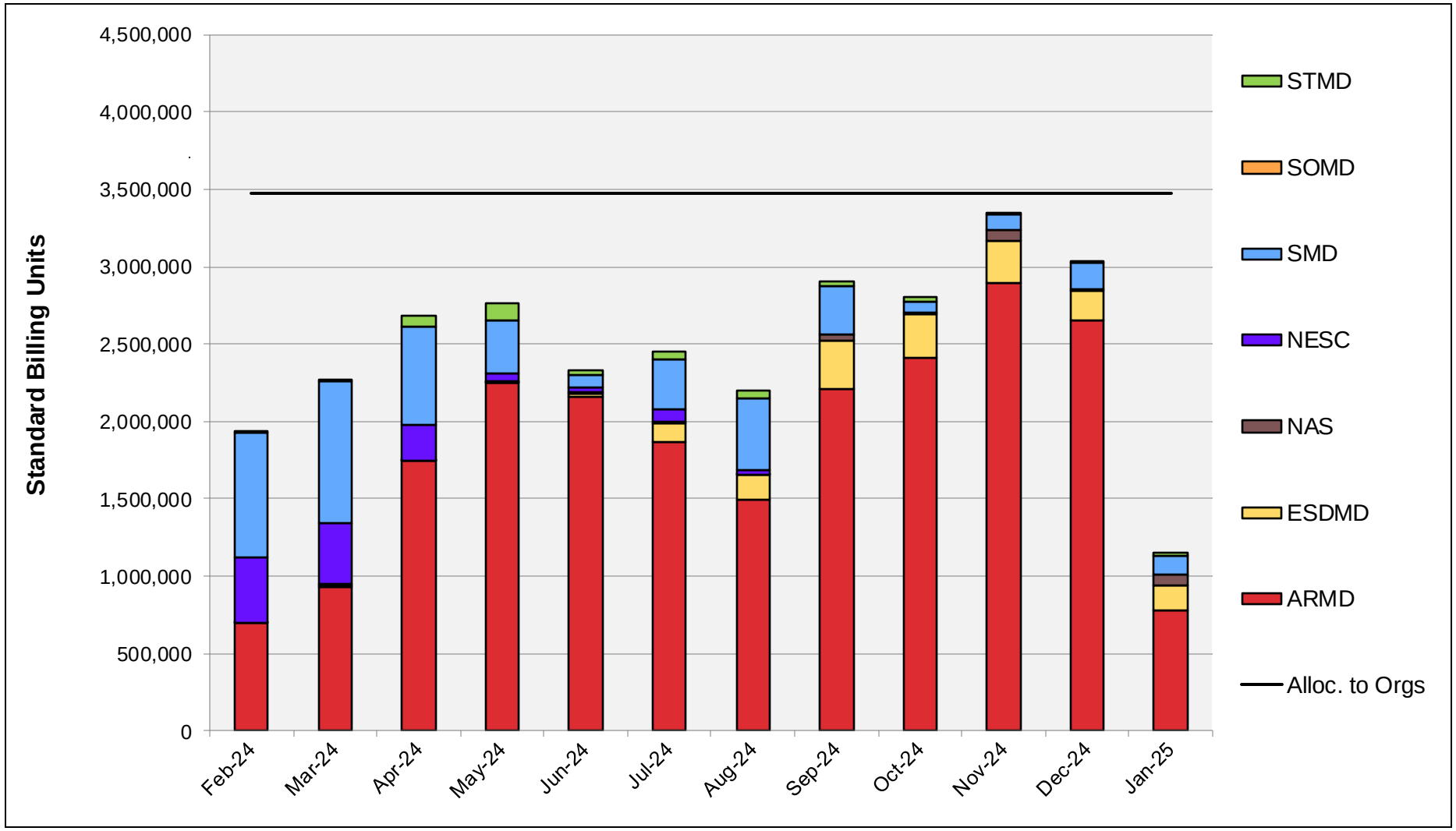
Electra: Average Time to Clear All Jobs



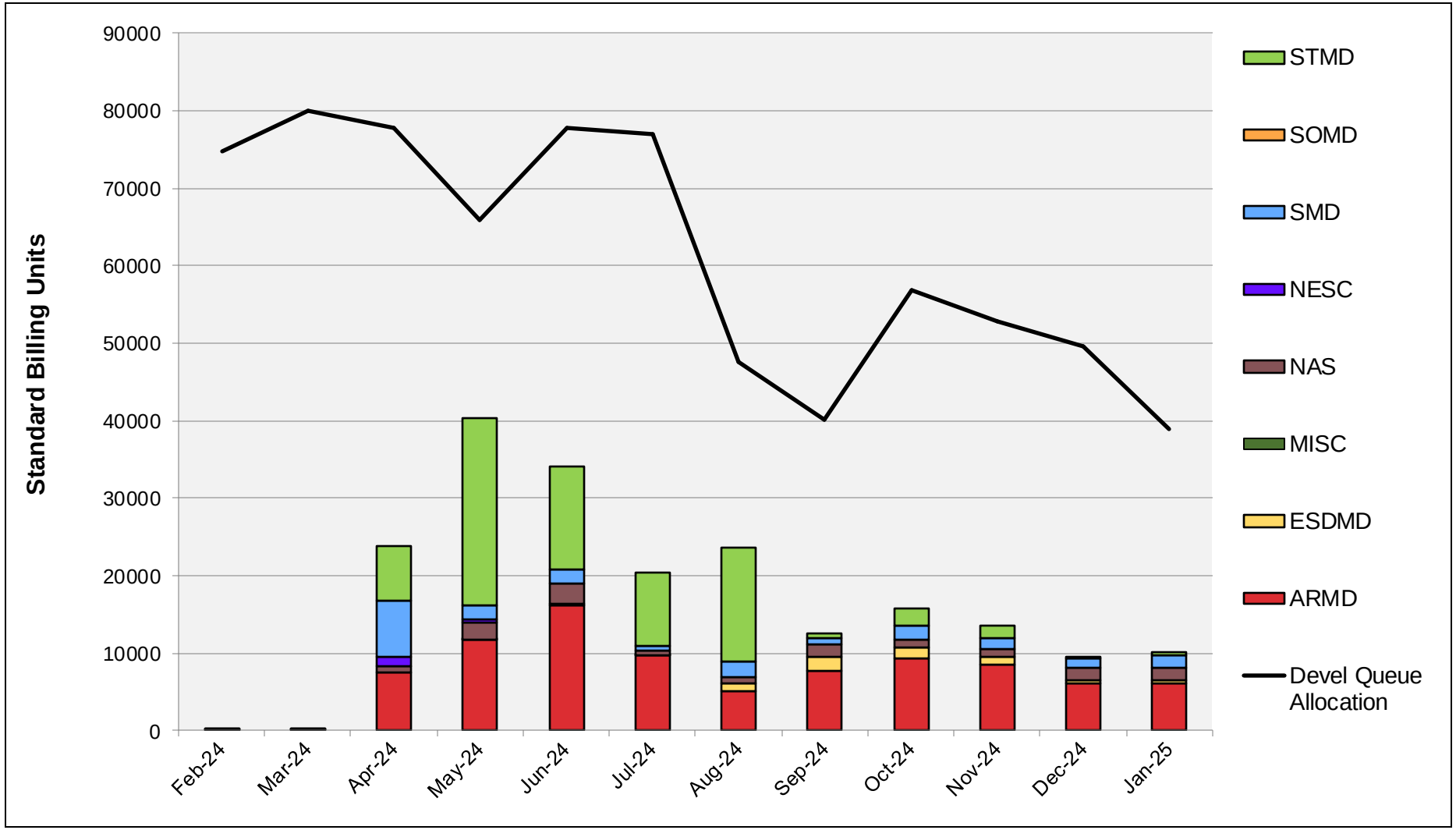
Electra: Average Expansion Factor



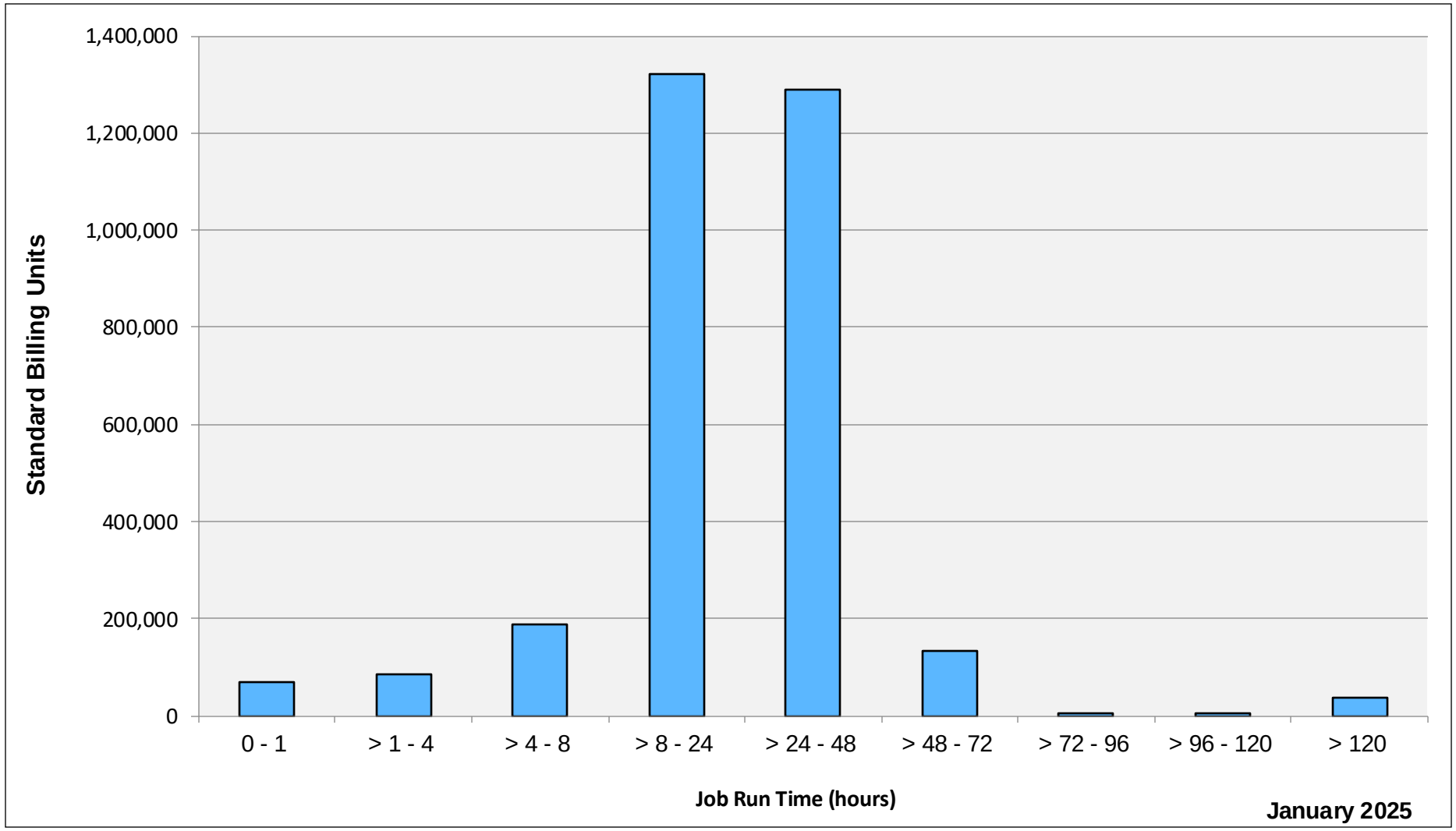
Cabeus: SBUs Reported, Normalized to 30-Day Month



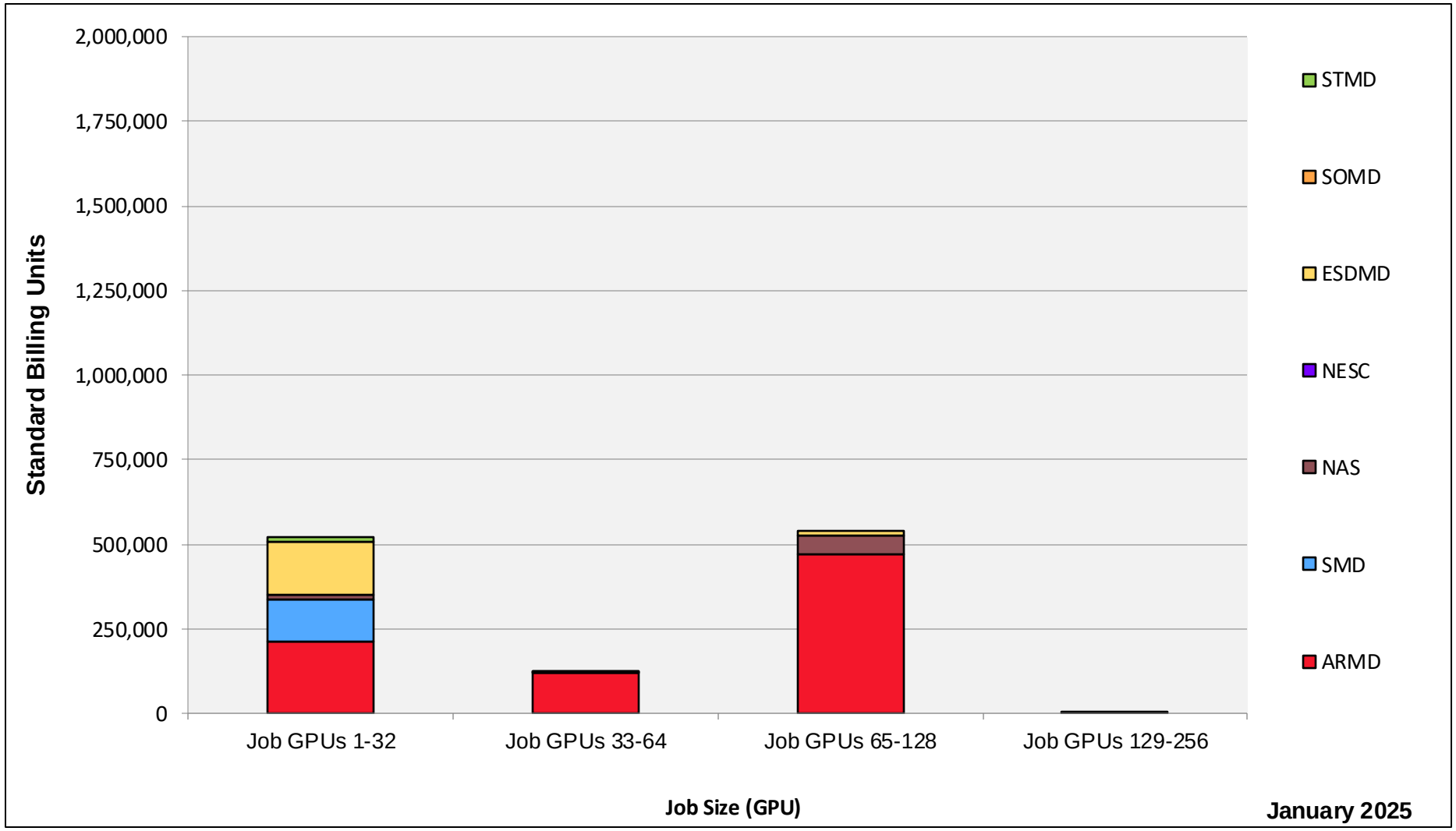
Cabeus: Devel Queue Utilization



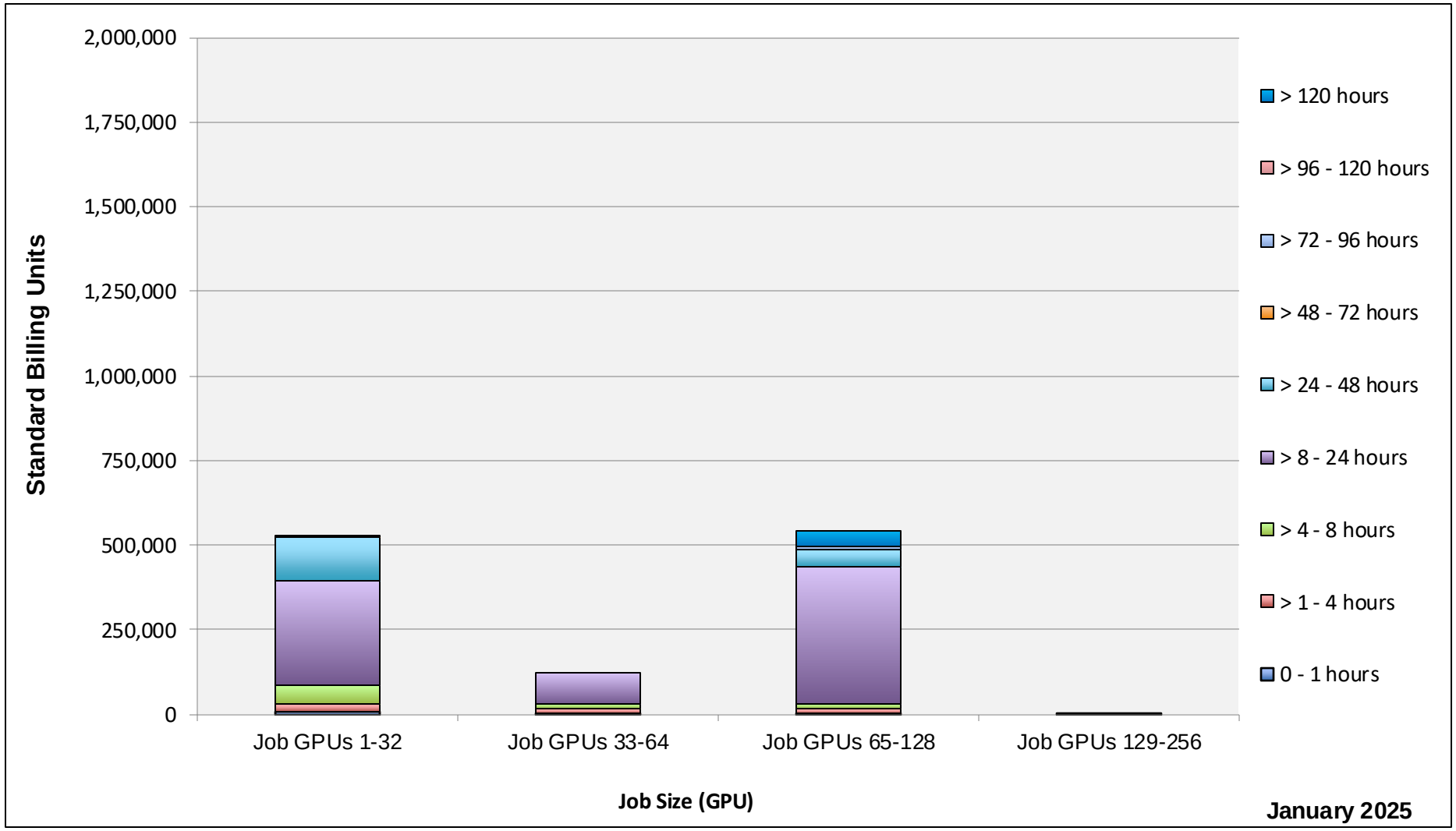
Cabeus: Monthly Utilization by Job Length



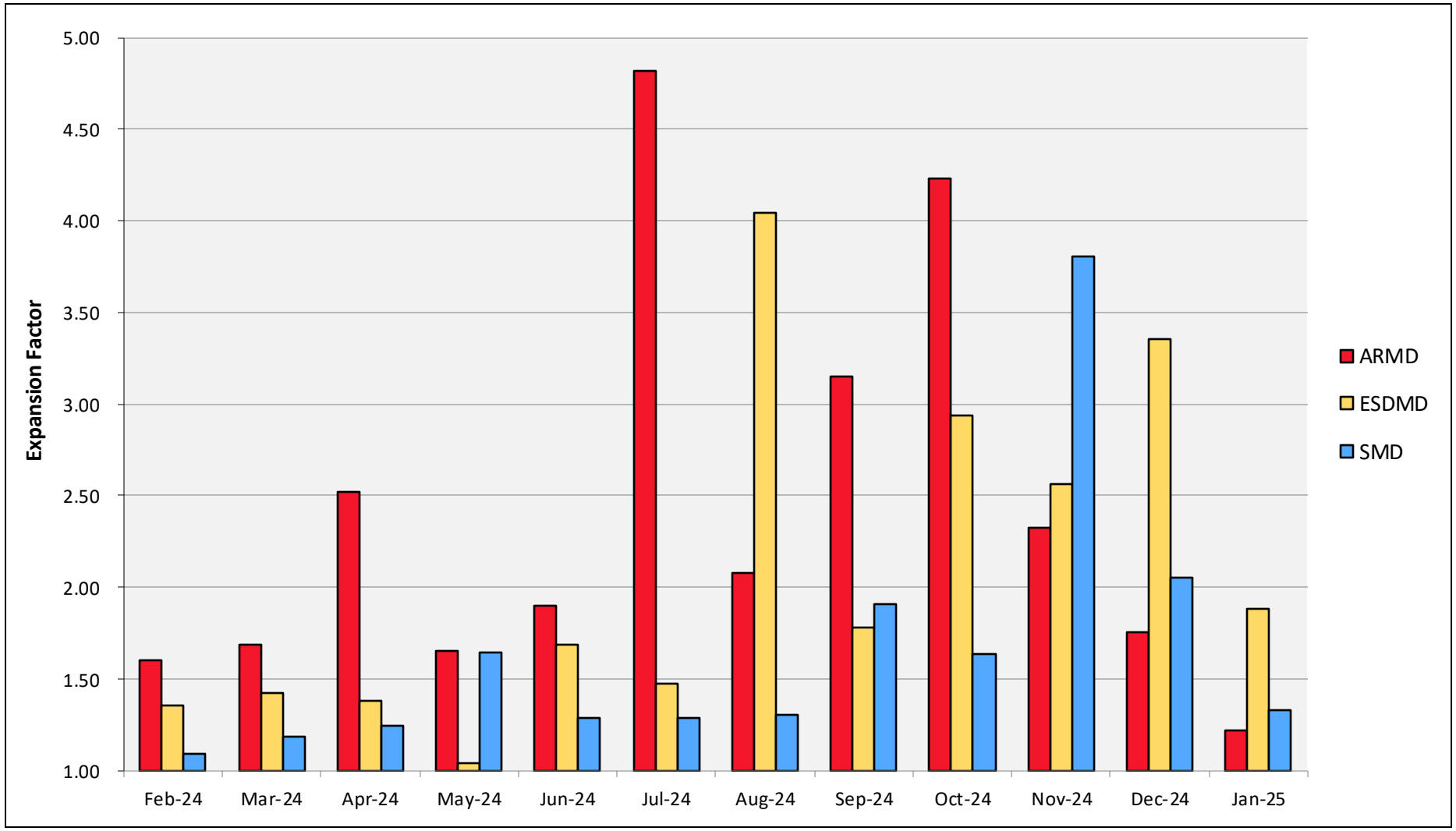
Cabeus: Monthly Utilization by Job Size



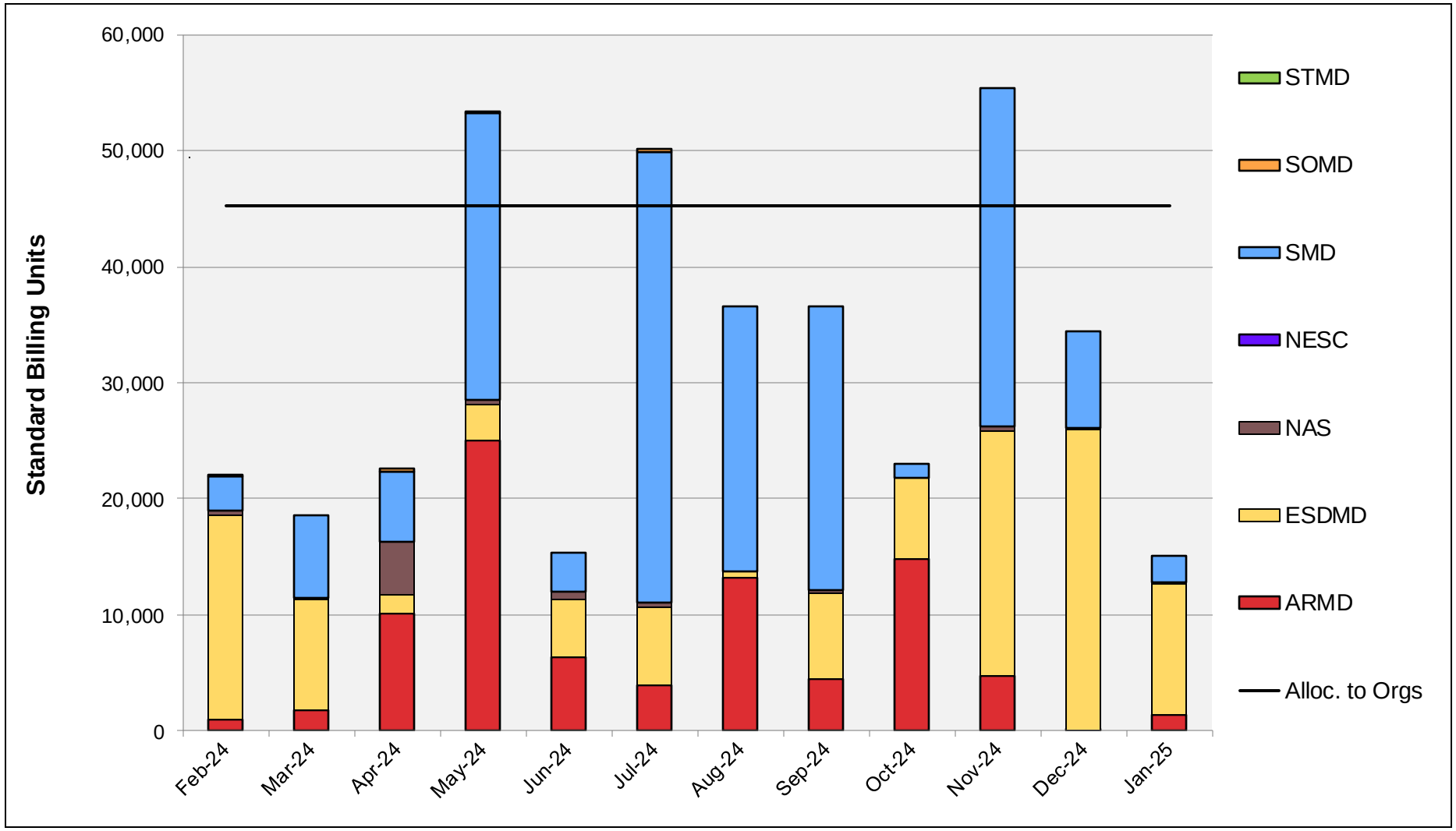
Cabeus: Monthly Utilization by Size and Length



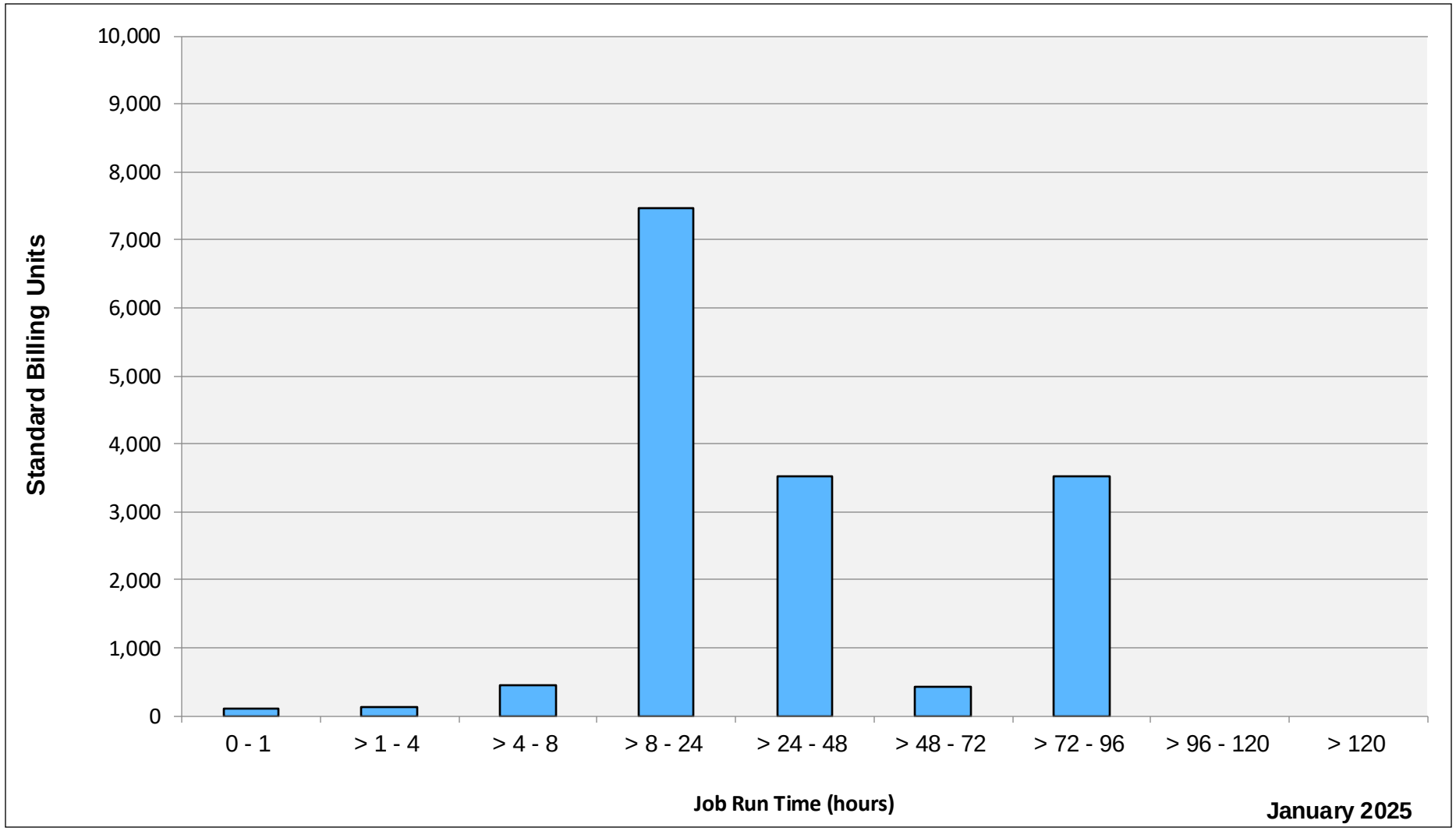
Cabeus: Average Expansion Factor



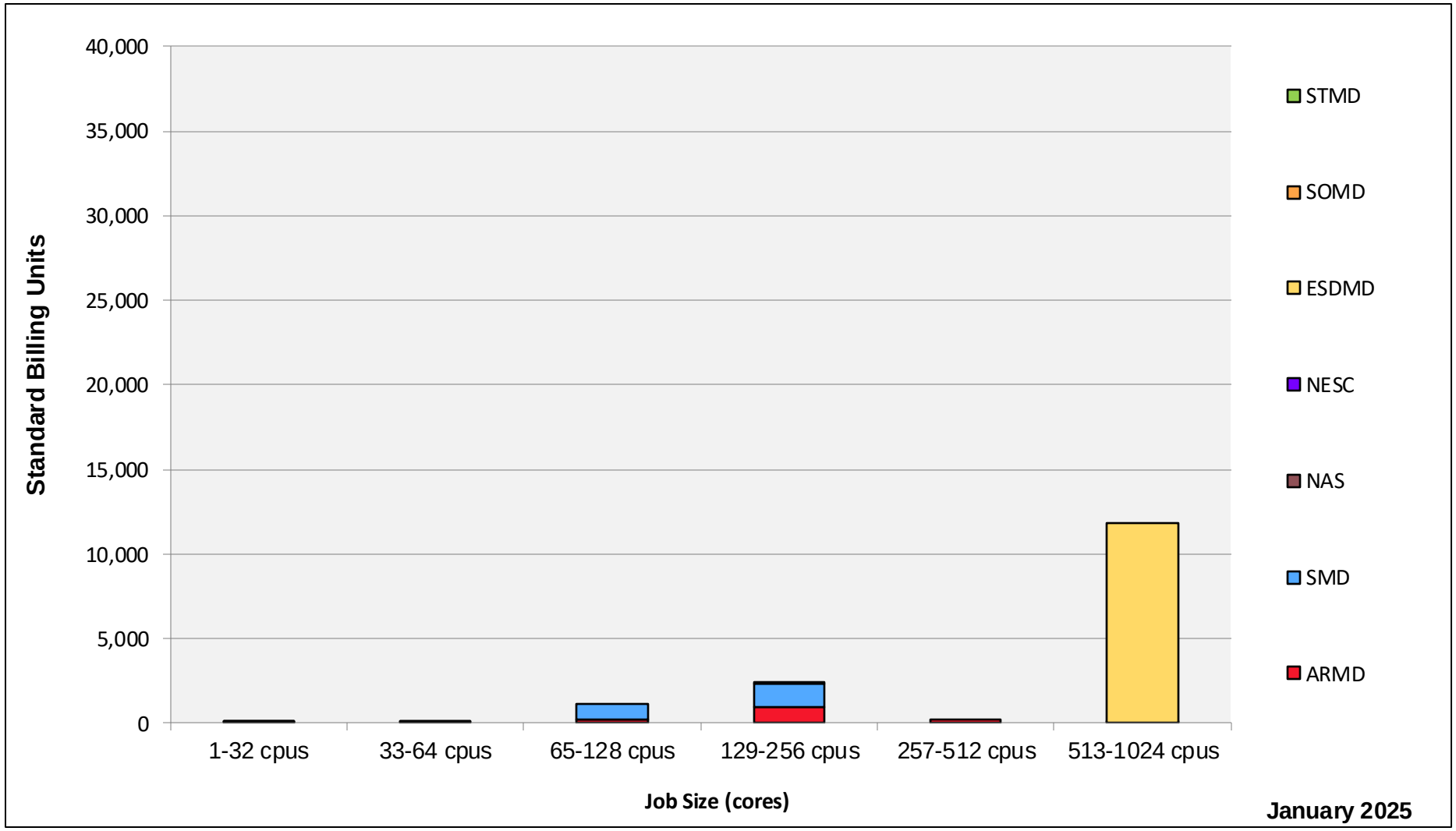
Endeavour: SBUs Reported, Normalized to 30-Day Month



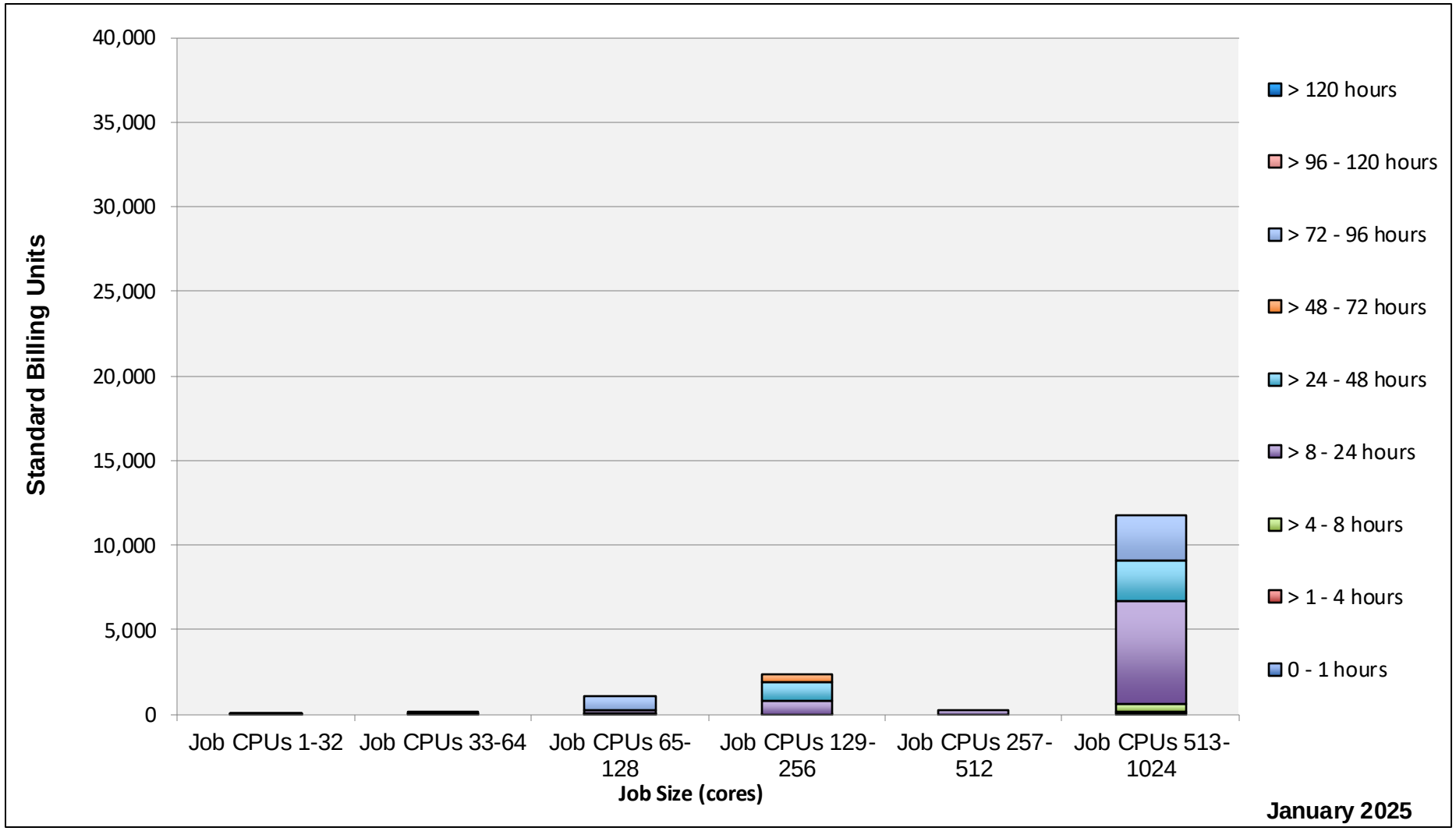
Endeavour: Monthly Utilization by Job Length



Endeavour: Monthly Utilization by Job Size



Endeavour: Monthly Utilization by Size and Length



Endeavour: Average Expansion Factor

