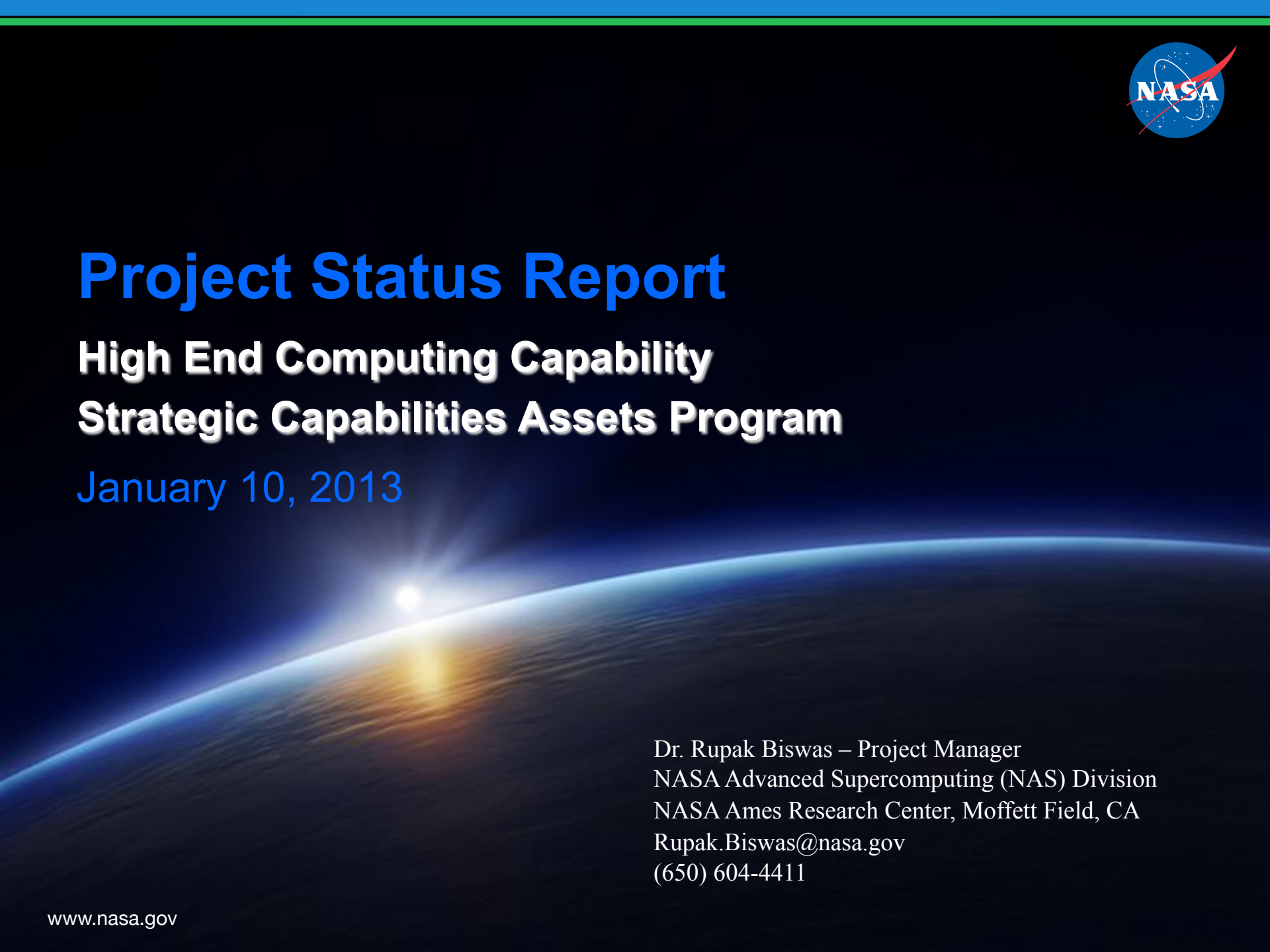


Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

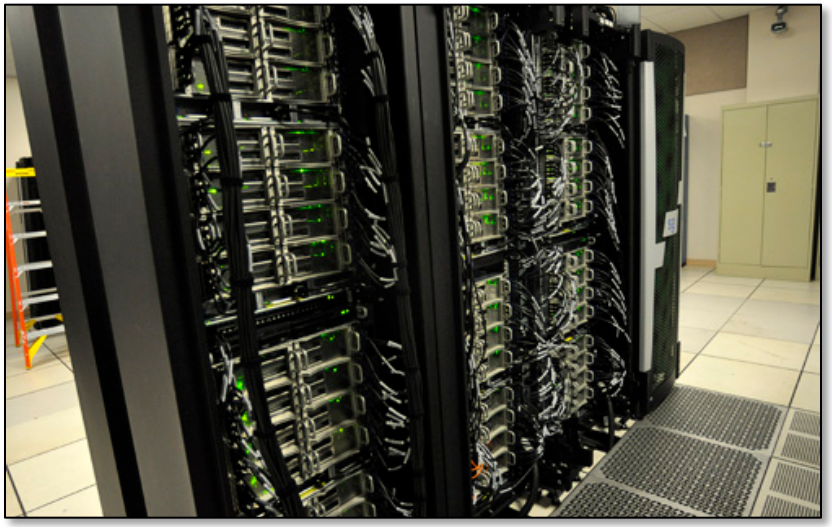
January 10, 2013

Dr. Rupak Biswas – Project Manager
NASA Advanced Supercomputing (NAS) Division
NASA Ames Research Center, Moffett Field, CA
Rupak.Biswas@nasa.gov
(650) 604-4411

New Shared-Memory Supercomputer Installed to Replace Columbia System

- The HECC Supercomputing Systems team installed a new SGI UltraViolet 2 (UV-2) system; when put into production, this system will replace the Columbia supercomputer.
- UV-2 retains the unique, shared-memory capabilities that Columbia provided to users, allowing all processes to access up to all of the memory on the system.
- The new system is composed of two nodes – a 1,024-core node with 4 terabytes (TB) of memory, and a 512-core node with 2 TB of memory. With a peak performance of 32 teraflops (TF), this system will be able to do all of the work that currently needs Columbia's unique capabilities.
- Columbia, which has been serving as a reliable production system since 2004, originally contained twenty 512-core nodes, and ranked second on the November 2004 TOP500 list with a performance of 51 TF.

Mission Impact: The new SGI UltraViolet 2 supercomputer, with its shared-memory architecture and binary compatibility with Pleiades, improves the large shared-memory environment necessary to a portion of the NASA user community.



The newly installed SGI UltraViolet system replaces Columbia with faster processors that are binary compatible with the Pleiades system—an advantage because users won't have to recompile their codes.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

Pleiades Computing Capacity Augmented to Support Mission Requirements

- Pleiades was augmented with two additional Sandy Bridge racks, increasing the system's peak performance to 1.79 petaflops (PF).
- The two new racks add 2,304 cores (for a total of 128,256 cores and 11,920 compute nodes). These racks add 48 teraflops to Pleiades' total computing capacity.
- The 144 nodes were integrated seamlessly into Pleiades' InfiniBand fabric using HECC's live integration techniques, without interruption to users' production workload.
- This unique capability to add computing resources "live" enables HECC to quickly and transparently deliver more production cycles to users to meet NASA's demanding computing requirements.

Mission Impact: Continued augmentation of the HECC supercomputer environment provides an increased computational capability to support the demanding requirements of NASA's mission directorates.

The new Sandy Bridge racks take the Pleiades supercomputer's peak performance to 1.79 petaflops.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

Archive System Upgraded to Provide Enhanced Storage Capability

- The "Lou2" archive system was recently upgraded to a Sandy Bridge-based cluster supporting the high-availability parallel Data Migration Facility (pDMF) environment.
- The upgrade accomplishes several goals:
  - Refreshes the system hardware;
  - Improves the scalability of the archive system;
  - Improves user workflow.
- Prior to the upgrade, Lou2 utilized a single SGI Altix 4700 system that was approaching HECC's system scalability limitations.
- To simplify user workflow, the Pleiades scratch filesystem is now available on the archive system.
- The Science Mission Directorate user community were the first that were able to use this capability, but other users will be transitioned from the Lou1 system to the upgraded system over the next few months.

Mission Impact: The upgrade of the archive system provides a high-availability, scalable archive environment for HECC users.

The new "Lou2" parallel Data Migration Facility hardware. The HECC archive systems write a combined 1.5 petabytes of data each month.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, Computer Science Corp.

Rotary Uninterruptible Power Supply Arrives and Installation Begins

- Facilities staff are preparing for operation of a new Rotary Uninterruptible Power Supply (RUPS), delivered to the NASA Advanced Supercomputing (NAS) facility in November.
- Units were set on their pads and integration work (wiring all equipment) is underway to bring backup power to HECC computing, storage, and network systems.
- Three units, totaling 6 megawatts of power, will be brought online in Spring 2013; priority will be placed on backing up storage systems and communications equipment.
- Once available, utility power will be routed through these units and a diesel-powered generator will provide backup power should utility power fail; when required, the cutover will happen seamlessly.

Mission Impact: The availability of uninterrupted power will provide NASA's scientific and engineering users with continuous access to data storage and HECC computing resources.

Rotary Uninterruptible Power Supply (RUPS) units are now in place on the north side of the NASA Advanced Supercomputing (NAS) facility. Three RUPS units and one switching enclosure comprise the system that will be used to deliver uninterrupted power to the computing complex.

POC: John Parks, john.w.parks@nasa.gov, (650) 604-4225, NASA Advanced Supercomputing Division

Support Team Completes Data at Rest Encryption on HECC-Supported Laptops

- HECC continued its six-year usage of FileVault to meet the agency's Data at Rest (DAR) requirements for OS X 10.7 (Lion) laptops, completing full disk encryption on laptops at the NAS facility on Nov. 26, 2012.
- Custom features of HECC's FileVault 2 usage that allow us to meet agency DAR requirements include:
  - Laptops are built from a single security-certified image and use a single escrow key;
  - FileVault Escrow Key is stored by Code IS and HECC for decryption capability;
  - Casper application scans Macs and can report on systems with/without encrypted partitions.
- FileVault, a standard part of OS X, has been successfully used at the NAS facility since 2006 to provide laptop encryption, works with all Apple updates, has no additional cost, and provides full disk encryption on OS X versions since 10.7.

Mission Impact: Sensitive data is protected on HECC-supported laptops by full disk encryption.

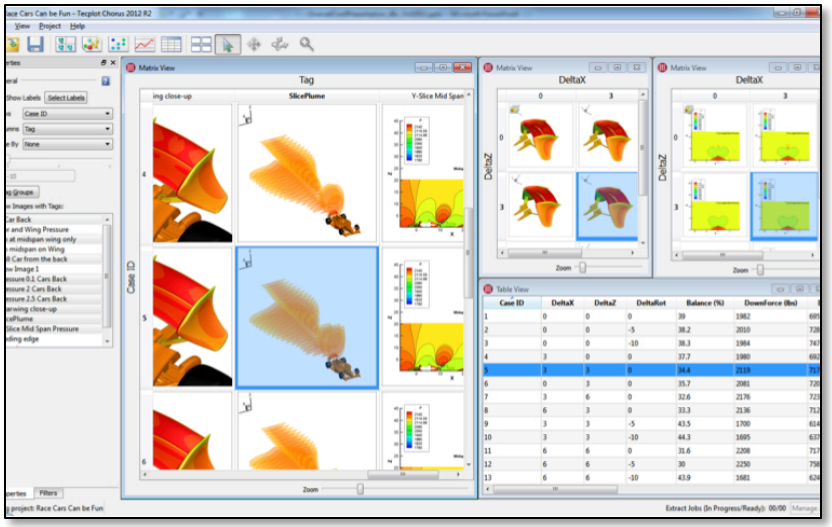
Data at Rest (DAR) Full Disk Encryption is a requirement for all NASA laptops. Due to the risk of critical data loss in the event of lost or stolen computers, NASA is in the process of implementing DAR encryption on all laptop computers.

***POC**:* Cathy Parks, cathy.b.parks@nasa.gov, (650) 604-4314, NASA Advanced Supercomputing Division, Computer Sciences Corp.

HECC Collaborates with Tecplot Developers to Host User Training Webinar

- HECC's monthly webinar series featured a session for 40 users on utilizing Tecplot 360 and Tecplot Chorus, two widely employed computational fluid dynamics (CFD) visualization and analysis tools.
- Tecplot's Durrell Rittenberg and Scott Imlay were onsite at the NAS facility to demonstrate use of Tecplot tools to reduce post-processing time and improve understanding of complex physical phenomena.
- Although the webinar was designed for beginning users, one engineer commented later that some of the techniques demonstrated were also beneficial to experienced users.
- As the first of this type in our webinar series, this model of collaboration between vendors and HECC staff to provide first-hand user training was very successful.

Mission Impact: Training provided directly by software developers allows agency users to gain first-hand experience in reducing their time-to-solution using HECC resources.



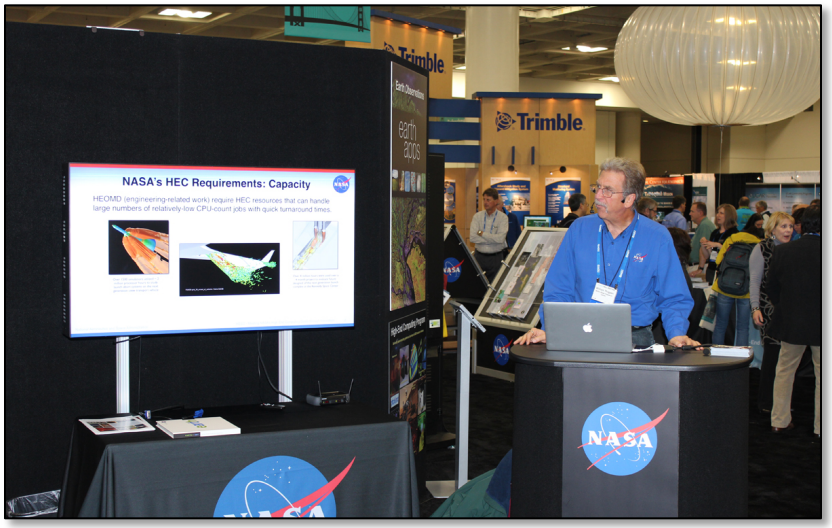
A slide from the webinar, "Reduce Post-Processing Time and Improve Understanding of Complex Physical Phenomena with Tecplot 360." Presenters demonstrated use of the Tecplot Chorus tool to analyze collections of CFD simulations and quickly compare results.

POCs: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division; Sherry Chang, sherry.chang@nasa.gov, (650) 604-1272, NASA Advanced Supercomputing Division, Computer Sciences Corp.

HECC Participates in Annual AGU Conference

- HECC staff supported and participated in the annual American Geophysical Union (AGU) conference held in San Francisco, December 3–7, 2012.
- Joining scientists and technologists from NASA Headquarters (HQ) and other NASA centers, staff presented two technical talks in the theater area of the agency's 40- x 50-ft. booth, delivered a paper at the conference, and gave two poster session presentations (see slide 13).
- Taking advantage of the presence of NASA HQ attendees, the NASA Earth Exchange (NEX) Steering Committee met to review the current status of NEX activities.
- Staff also supported NASA outreach goals by distributing brochures and datasheets highlighting NASA's key Earth and space science projects and capabilities, and a NEX-HPC Summer School 2013 announcement.
- HECC contributions were well received by AGU attendees and NASA colleagues alike.

Mission Impact: Participation in science conferences highlights the scientific value of NASA data and provides a valuable opportunity to meet HECC users to discuss computational resource and service needs.



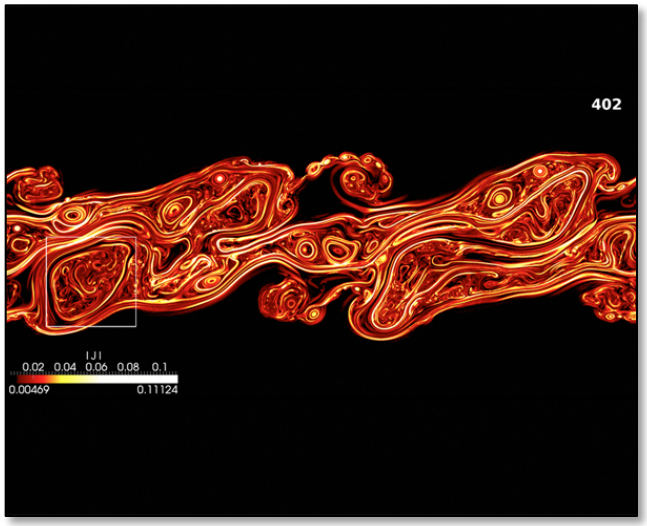
Bill Thigpen, HECC deputy program manager, delivers a technical talk at the NASA booth at AGU. Thigpen highlighted some of the agency's many scientific and engineering achievements made possible by HECC's supercomputing capabilities.

***POC**:* Harper Pryor, harper.pryor@nasa.gov, (650) 604-0468, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Simulations Reveal Causes, Consequences of Turbulence in the Earth's Protective Shield*

- Running petascale, kinetic simulations on Pleiades' massively parallel architecture has allowed researchers at the University of California, San Diego to leapfrog existing state-of-the-art magnetospheric models.
- Spacecraft observations have revealed that many regions in the magnetosphere exhibit turbulence, which can amplify the effects of space weather on Earth. During this project the research team has:
  - For the first time, been able to follow the development of this turbulence and its consequences;
  - Discovered mechanisms for the generation of the turbulence;
  - Confirmed several predictions through comparison with spacecraft observations.
- The team has also provided input to the design and planning of NASA's upcoming Magnetospheric Multiscale Mission.

Mission Impact: These kinetic simulations, enabled by HECC resources, have been crucial to breakthrough studies and are enabling closure on critical issues in magnetospheric physics.



Formation of turbulence driven by the presence of velocity shear. This turbulence gives rise to structures at the smallest, electron-level scales, and mixes solar wind plasma and fields with those in the Earth's magnetosphere. Homa Karimabadi, University of California, San Diego; Burlen Loring, Lawrence Berkeley National Laboratory

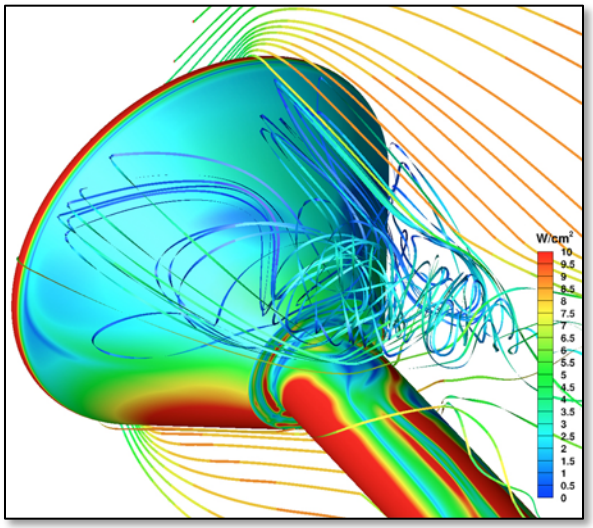
POC: Homa Karimabadi, homa@ece.ucsd.edu; Ari Lie, ariyle@gmail.com, University of California at San Diego

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

Pleiades Supports Simulations of Planetary Environments for Space Exploration Vehicles*

- Computational Fluid Dynamics (CFD) experts at NASA Ames are running simulations on Pleiades to accurately predict the aerodynamic heating on a spacecraft's surface during planetary atmospheric entry.
- Inaccurate prediction of heating may lead to mission failure, so vehicle designers must have accurate aerothermal environment estimates to select appropriate thermal protection system (TPS) materials.
- Research revealed that even on a smooth body vehicle, it is difficult to accurately predict heating on the backshell TPS with flow separation; and a two-equation shear stress transport turbulence model did not perform better than the simpler algebraic turbulence models for hypersonic separated flows.
- As part of this work, Pleiades played a critical role in producing aerothermal databases for the Mars Science Laboratory and Orion Multi-Purpose Crew Vehicle.

Mission Impact: HECC resources are critical to providing vehicle designers accurate aerothermal environment estimates needed to select appropriate thermal protection system materials that protect spacecraft during high-speed entry into a planet's atmosphere.



Simulation of an Orion Multi-Purpose Crew Vehicle model tested in a wind tunnel at Mach 8. Surface contours indicate heat flux and the lines represent stream traces colored by the local velocity magnitude. David Saunders, NASA/Ames.

POCs: Chun Tang, chun,y.tang@nasa.gov, (650) 604-3480; David Saunders, david.a.saunders@nasa.gov, (650) 604-1480, NASA Ames Research Center

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

HECC Facility Hosts Several Visitors and Tours in December 2012

- HECC hosted 10 tour groups in December; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - John Grunsfeld, Associate Administrator for the Science Mission Directorate, as part of his visit to Ames Research Center (ARC);
  - Paul Giangarra, Distinguished Engineer at IBM, who met with HECC management regarding possible collaborations;
  - Addison Snell, CEO, Intersect360 Research who was a guest of HECC management;
  - 52 members of the agency's NASA FIRST leadership development program, who toured the facility during their ARC module of the program;
  - 21 Masters students from a Carnegie Mellon Silicon Valley class enjoyed the hyperwall overview and tour of computer room.

Associate Administrator for the Science Mission Directorate John Grunsfeld, met with HECC Project Manager Rupak Biswas and Ramakrishna Nemani, NASA Earth Exchange principal scientist, along with other Ames staff. As part of the visit, Grunsfeld viewed a global climate simulation on the hyperwall visualization system.

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

Presentations and Papers

- "**Angular Momentum Transport by Acoustic Modes Generated in the Boundary Layer I: Hydrodynamical Theory and Simulations**," M. A. Bylaev, R. R. Rafikov, J. M. Stone, arXiv:1212.0508 [astro-ph.SR], December 3, 2012. *
  http://arxiv.org/abs/1212.0580

- **AGU 2012,** December 3–7, 2012, San Francisco, CA.
  http://fallmeeting.agu.org/2012/
  - "**Development of NASA Earth Observing System Simulation Suite (NEOS3)**," N. Niamsuwan, S. Tanelli, M. P. Johnson, J. C. Jacob. *
  - "**Weakly Rotating Convective Dynamos: Application to Uranus and Neptune**," K. Soderlund, M. Heimpel, E. King, J. Aurnou. *
  - "**HECC Project: Meeting High-End Computing Goals through Innovation**," William Thigpen
  - "**NASA Earth Exchange: A Collaborative Supercomputing Platform**," Ramakrishna Nemani – presented by Petr Votava
  - "**Data Impact of Pre-GCM Constellation Microwave Radiances in Goddard WRF Ensemble Data Assimilation System**," S. Zhang, P. Chambon, X. Lin, A. Hou, S. Cheung *
  - "**Analysis of Tropical Cyclones and Tropical Wave using the Parallel Ensemble Empirical Model Decomposition (EEMD) Method**," B. Shen, Z. Wu, S. Cheung (poster) *
  - "**Performance of NASA Earth Science Applications using Modern Computer Accelerator Technologies**," P. Mehrotra, S. Cheung, R. Hood, H. Jin, D. Kokron, R. Biswas, M. Thompson (poster)

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

Presentations and Papers (cont.)

- **"Assessing the Impact of pre-GPM Constellation Microwave Precipitation Radiance Data in the Goddard WRF Ensemble Data Assimilation System,"** P. Chambon, S. Q. Zhang, A. Y. Hou, M. Zupanski, S. Cheung, NASA.gov, December 7, 2012. *
  ftp://rsd.gsfc.nasa.gov/betsy/chambon/Draft_EDAS_ExpFrance_V0-8.doc
- **"Reconstructing the Distribution of Haloes and Mock Galaxies Below the Resolution Limit in Cosmological Simulations,"** S. de la Torre, J. A. Peacock, arXiv: 1212.3615 [astro-ph.CO], December 14, 2012. *
  http://arxiv.org/abs/1212.3615
- **"The Rockstar Phase-space Temporal Halo Finder and the Velocity Offsets of Cluster Cores,"** P. S. Behroozi, R. H. Wechsler, H-Y. Wu, *The Astrophysical Journal*, Volume 762, Number 2, December 20, 2012. *
  http://iopscience.iop.org/0004-637X/762/2/109
- **"Semi-implicit Scheme for Treating Radiation Under M1 Closure in General Relativistic Conservative Fluid Dynamics Codes,"** A. Sdowski, R. Narayan, A. Tchekhovskoy, Y. Zhu, arXiv:1212.5050 [astro-ph.HE], December 20, 2012. *
  http://arxiv.org/abs/1212.5050
- **"Adiabatic Acceleration of Suprathermal Electrons Associated with Dipolarization Fronts,"** Q. Pan, et al., *Journal of Geophysical Research: Space Physics*, Volume 117, Issue A12, December 19, 2012. *
  http://onlinelibrary.wiley.com/doi/10.1029/2012JA018156/full

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

News and Events

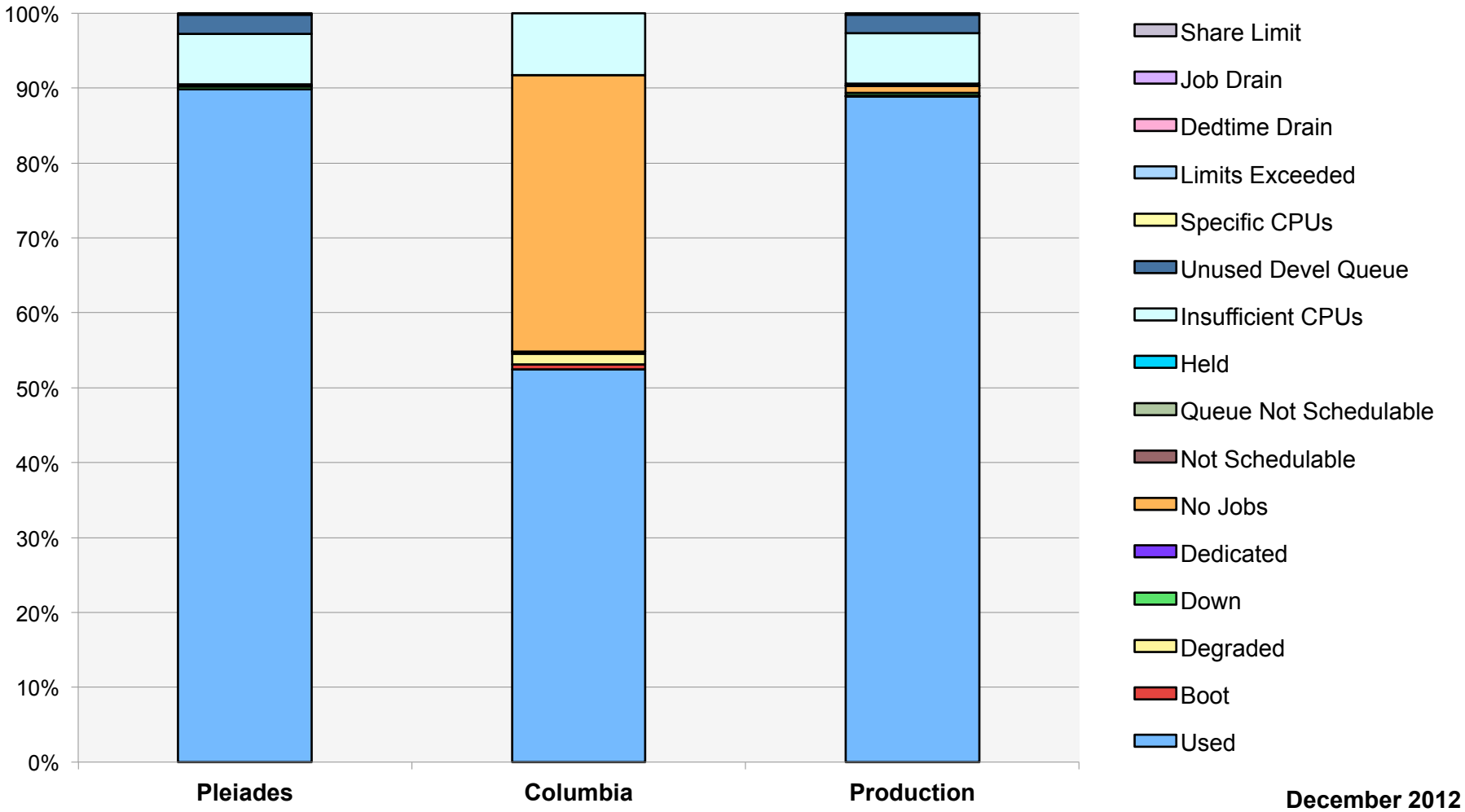
- **Revolutionizing Rotorcraft Design with CFD,** *International Grid Science This Week (iSGTW),* December 5, 2012 – The NAS Division's Neal Chaderjian talks to iSGTW about the recent advancements in rotorcraft simulation using CFD, and the importance of HECC's supercomputing resources for processing such large data sets.

  http://www.isgtw.org/feature/revolutionizing-rotorcraft-design-cfd

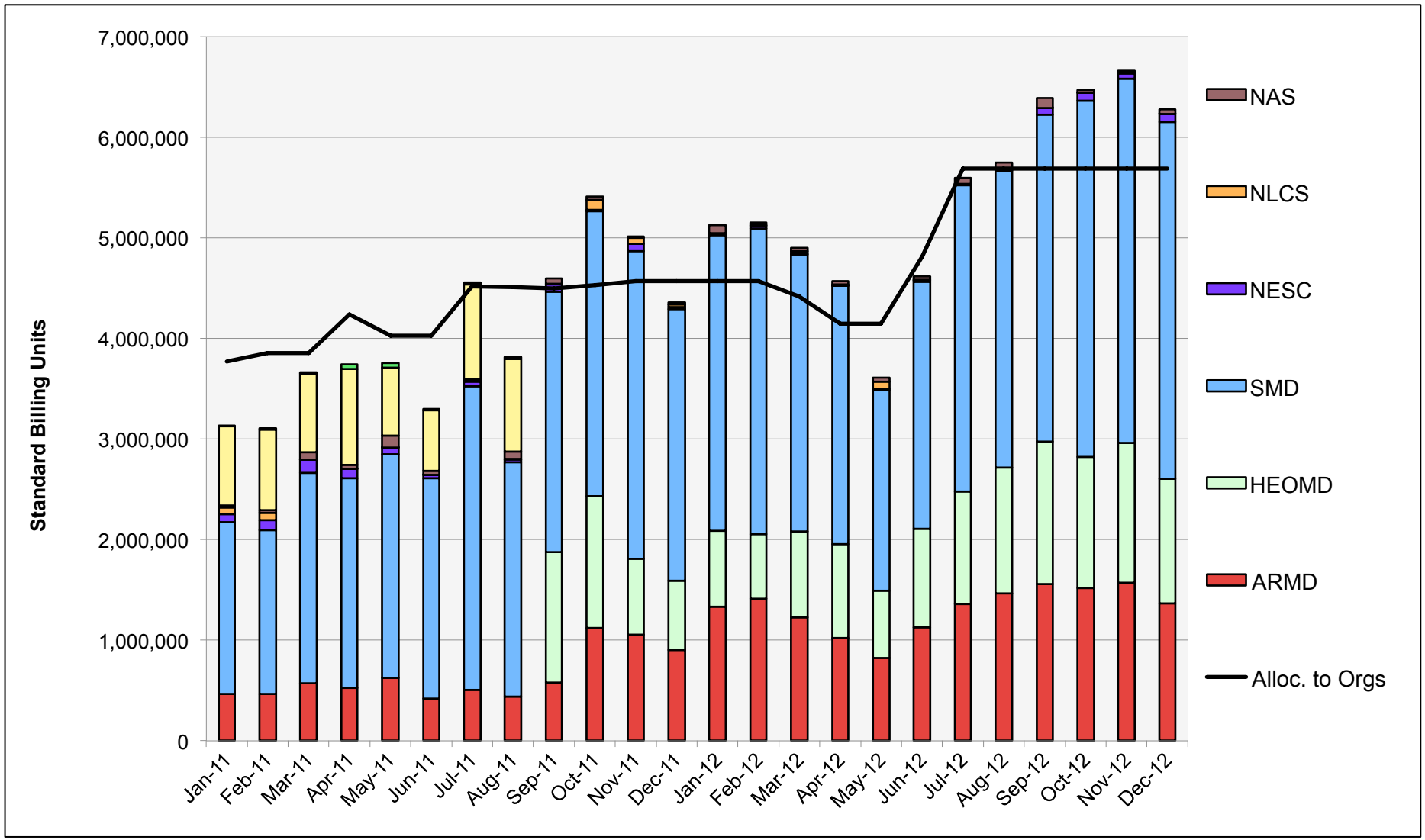
- **Discoveries - The Researchers: Bruno Giacomazzo,** *Wyoming Business Report,* December 7, 2012 – The University of Colorado's Bruno Giacomazzo and his recent work simulating merging black holes on the Pleiades supercomputer are featured in the annual scientific publication highlighting innovative work being done at Wyoming and Colorado universities.

  http://www.wyomingbusinessreport.com/article.asp?id=64237

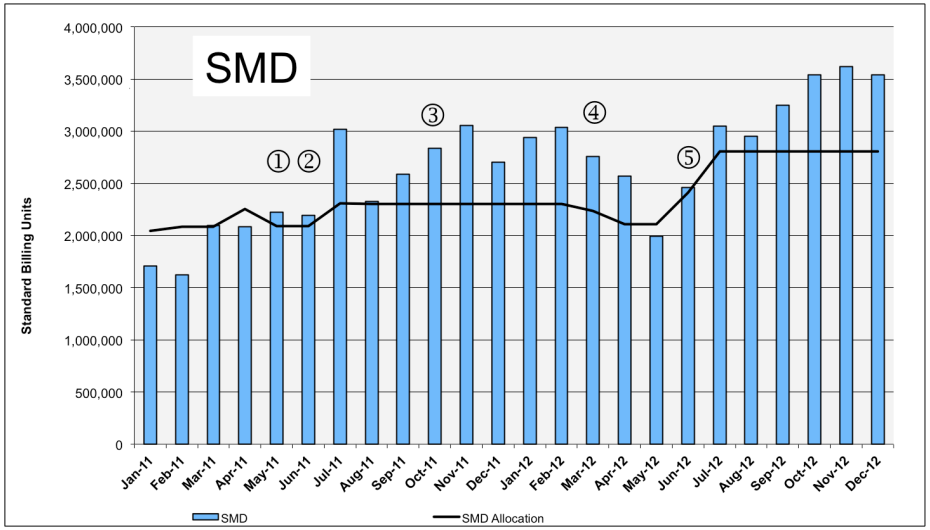
HECC Utilization

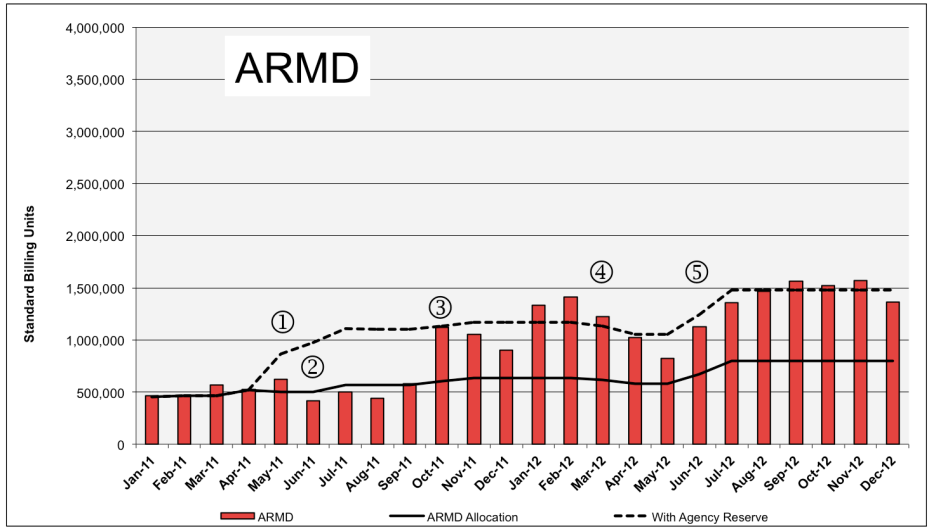


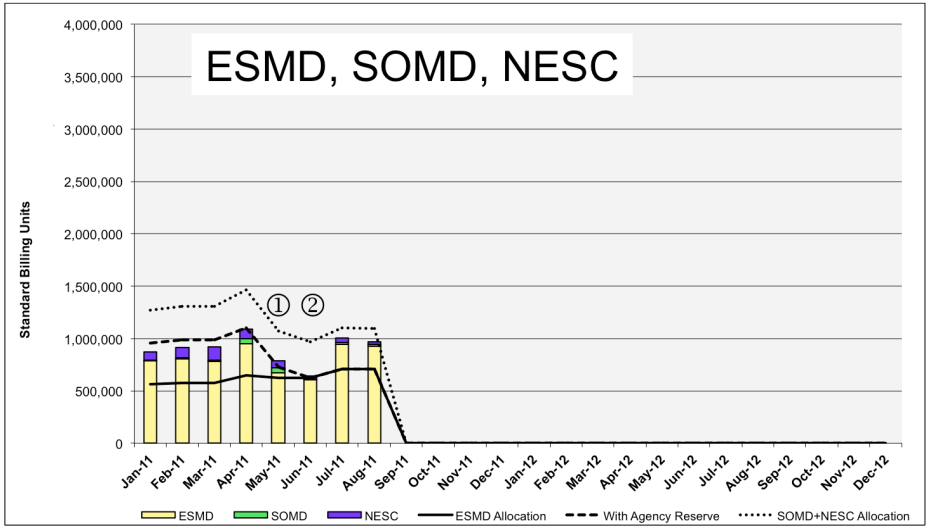
HECC Utilization Normalized to 30-Day Month

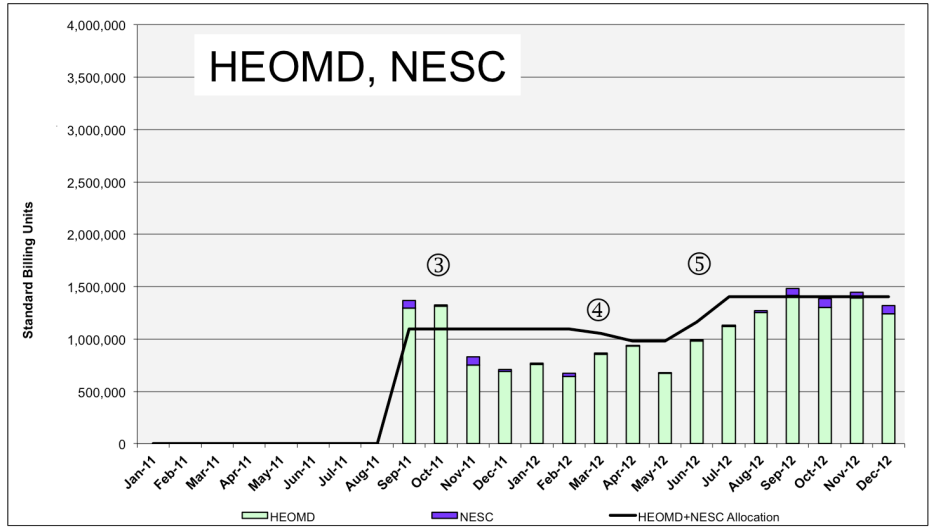


HECC Utilization Normalized to 30-Day Month



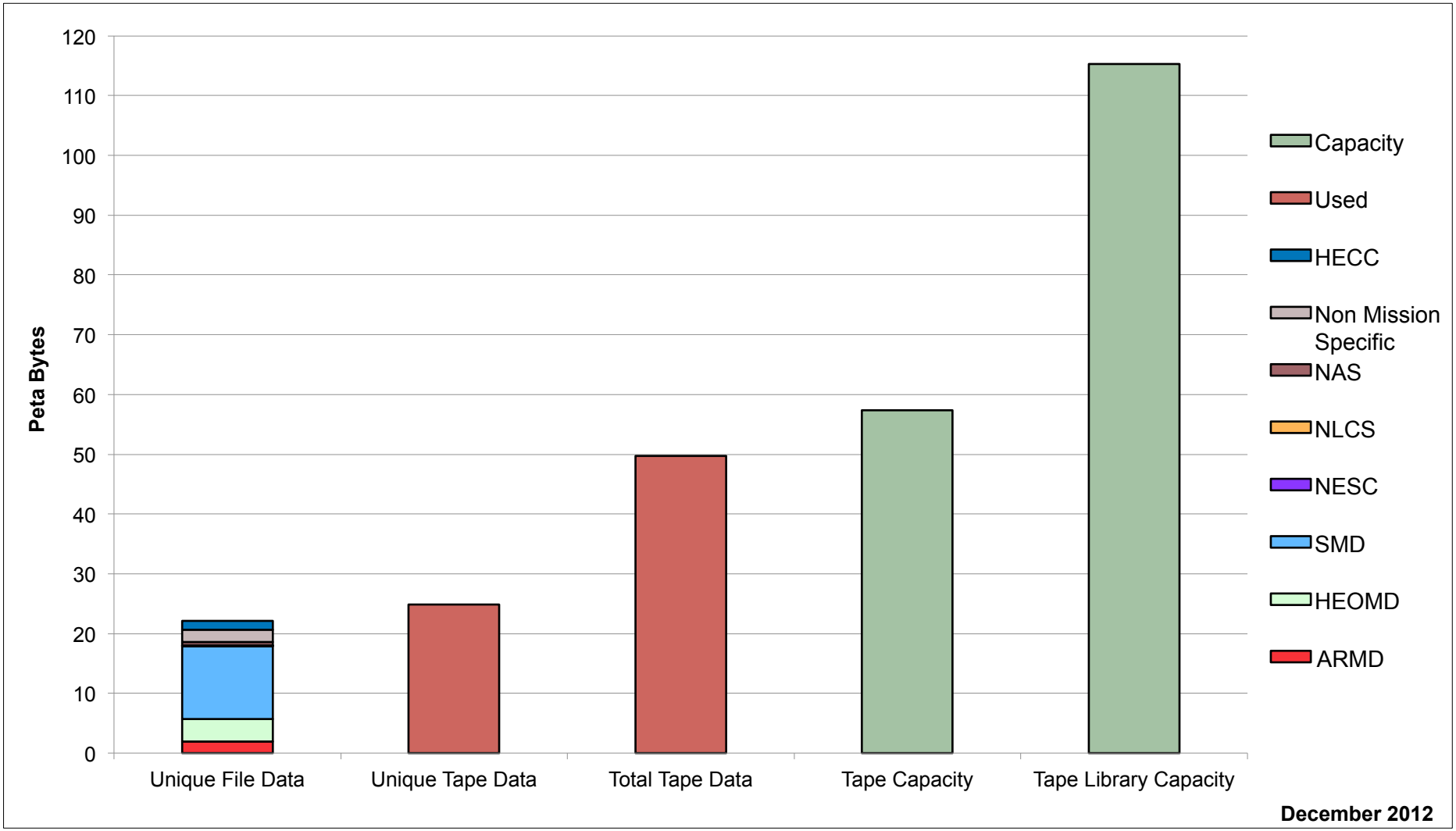




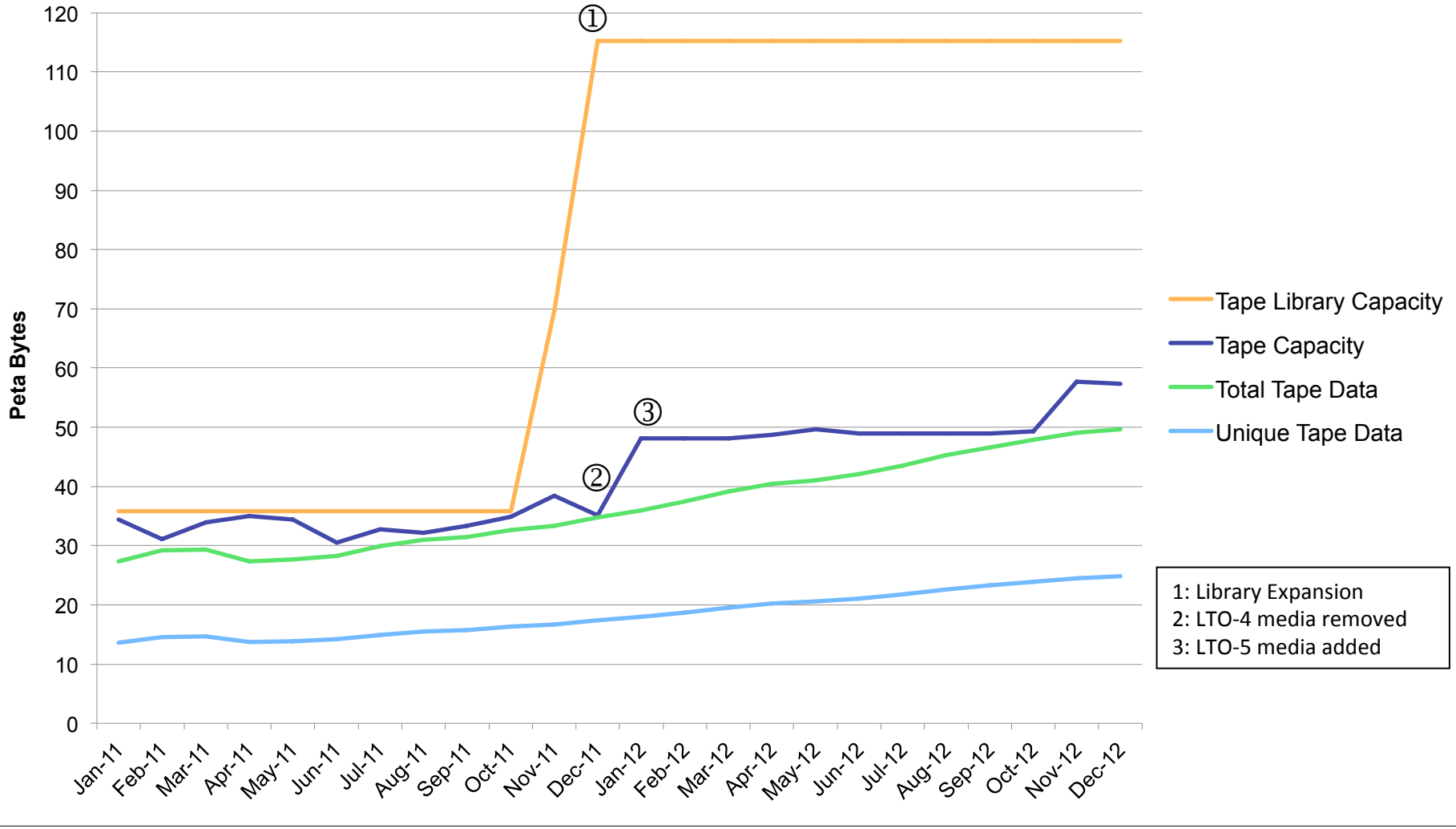


① Allocation to orgs. decreased to 75%, Agency reserve shifted to ARMD ② 14 Westmere racks added
③ 2 ARMD Westmere racks added ④ 28 Harpertown racks removed ⑤ 24 Sandy Bridge racks added

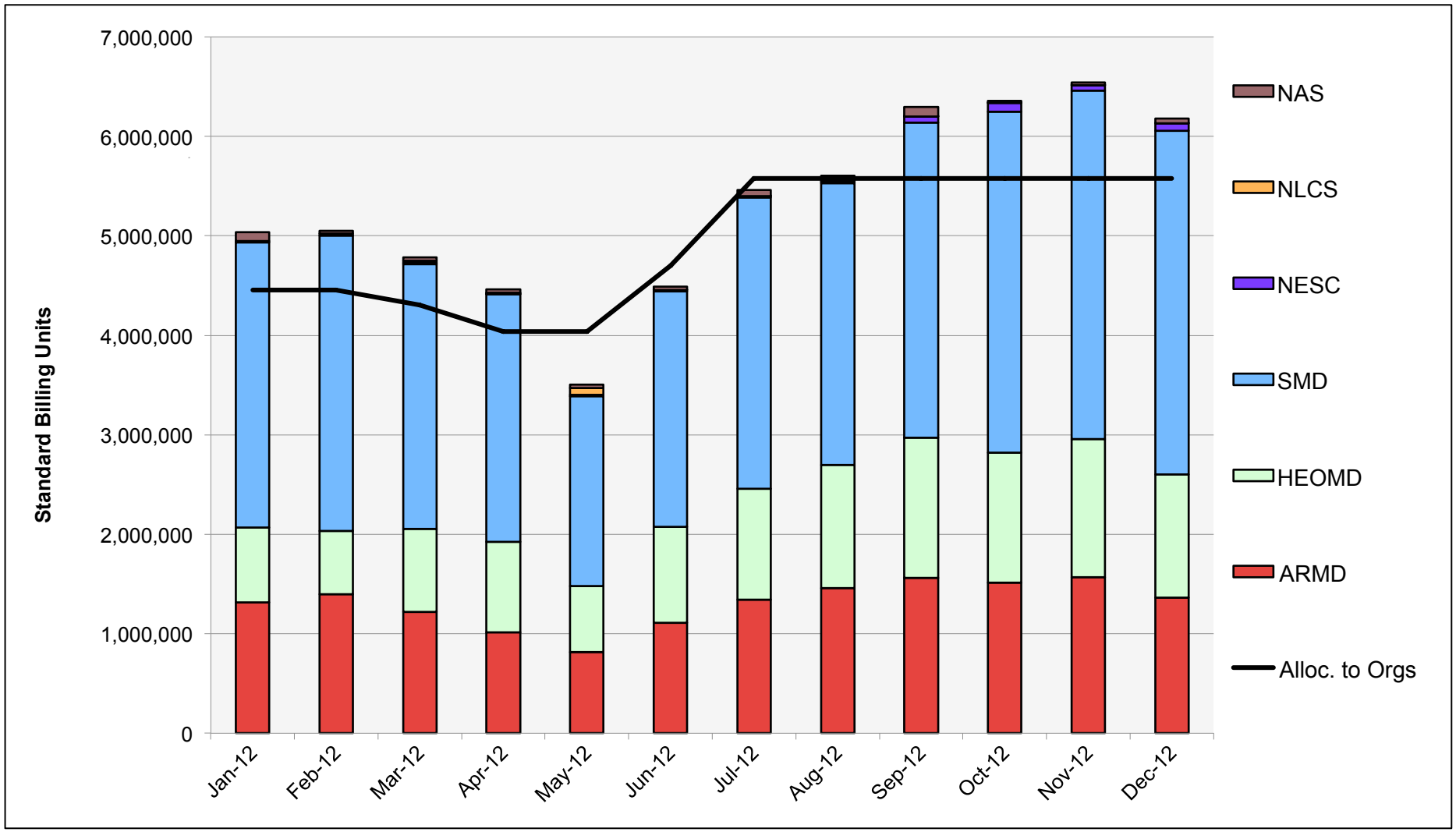
Tape Archive Status



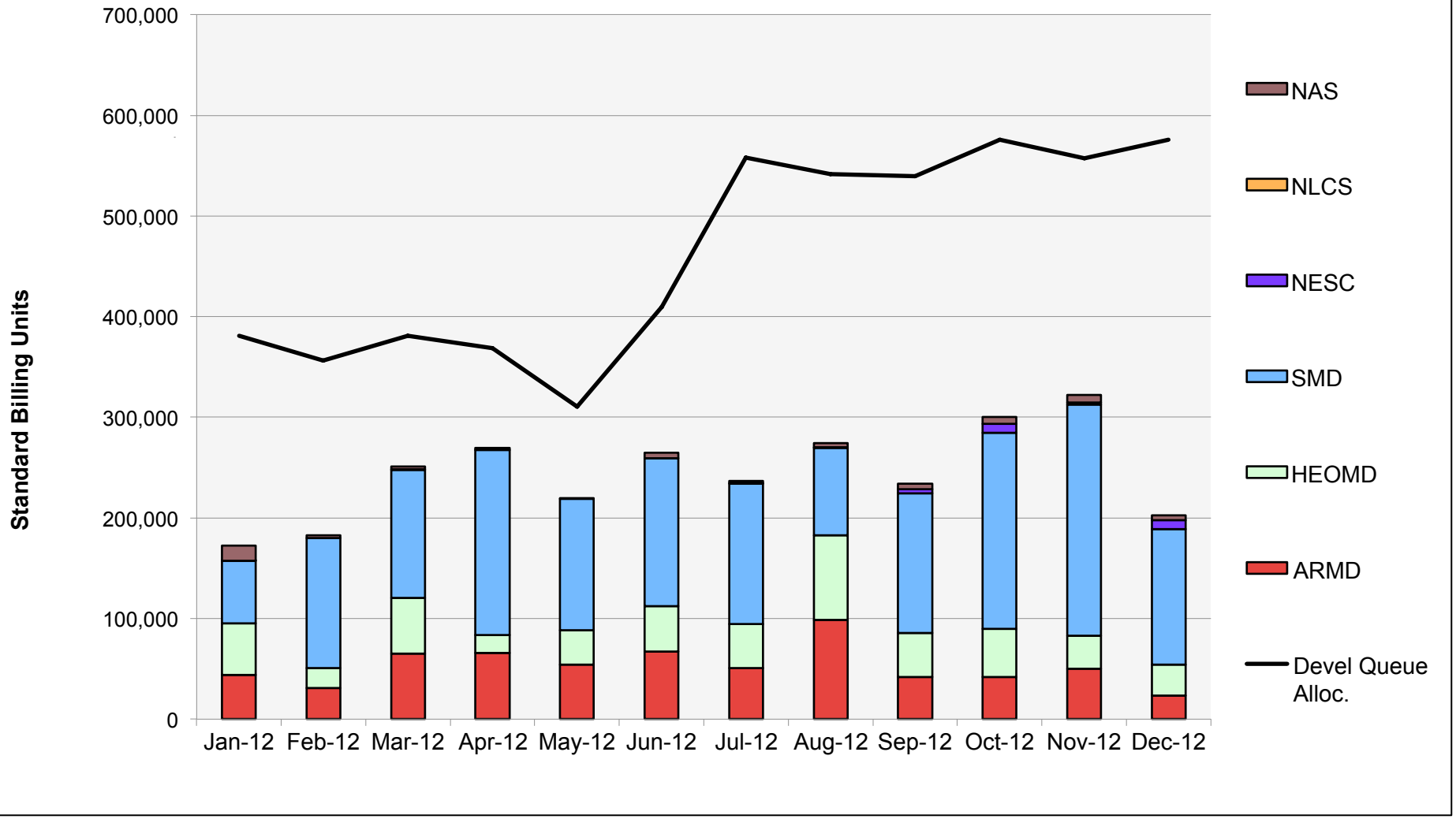
Tape Archive Status



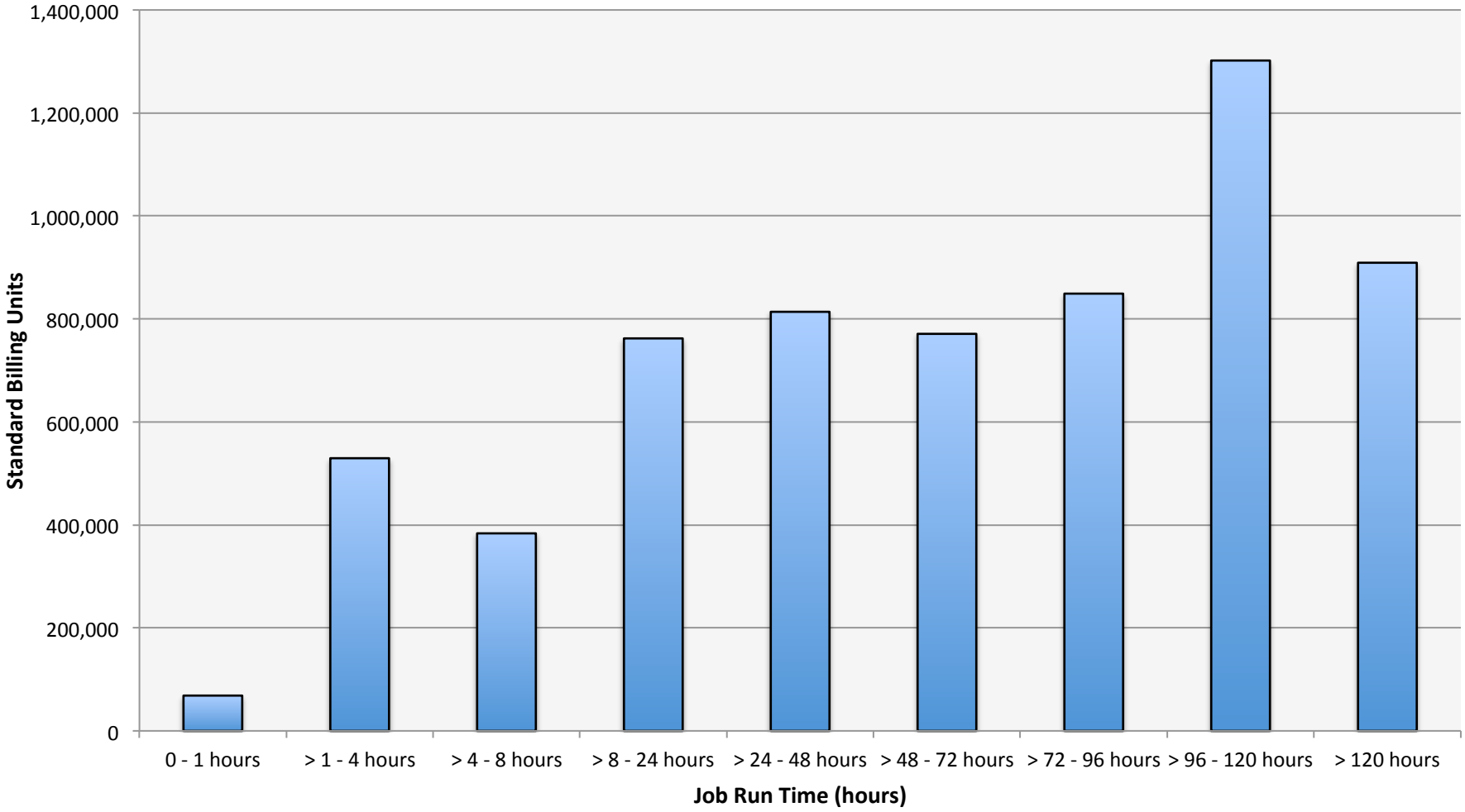
Pleiades:
SBUs Reported, Normalized to 30-Day Month



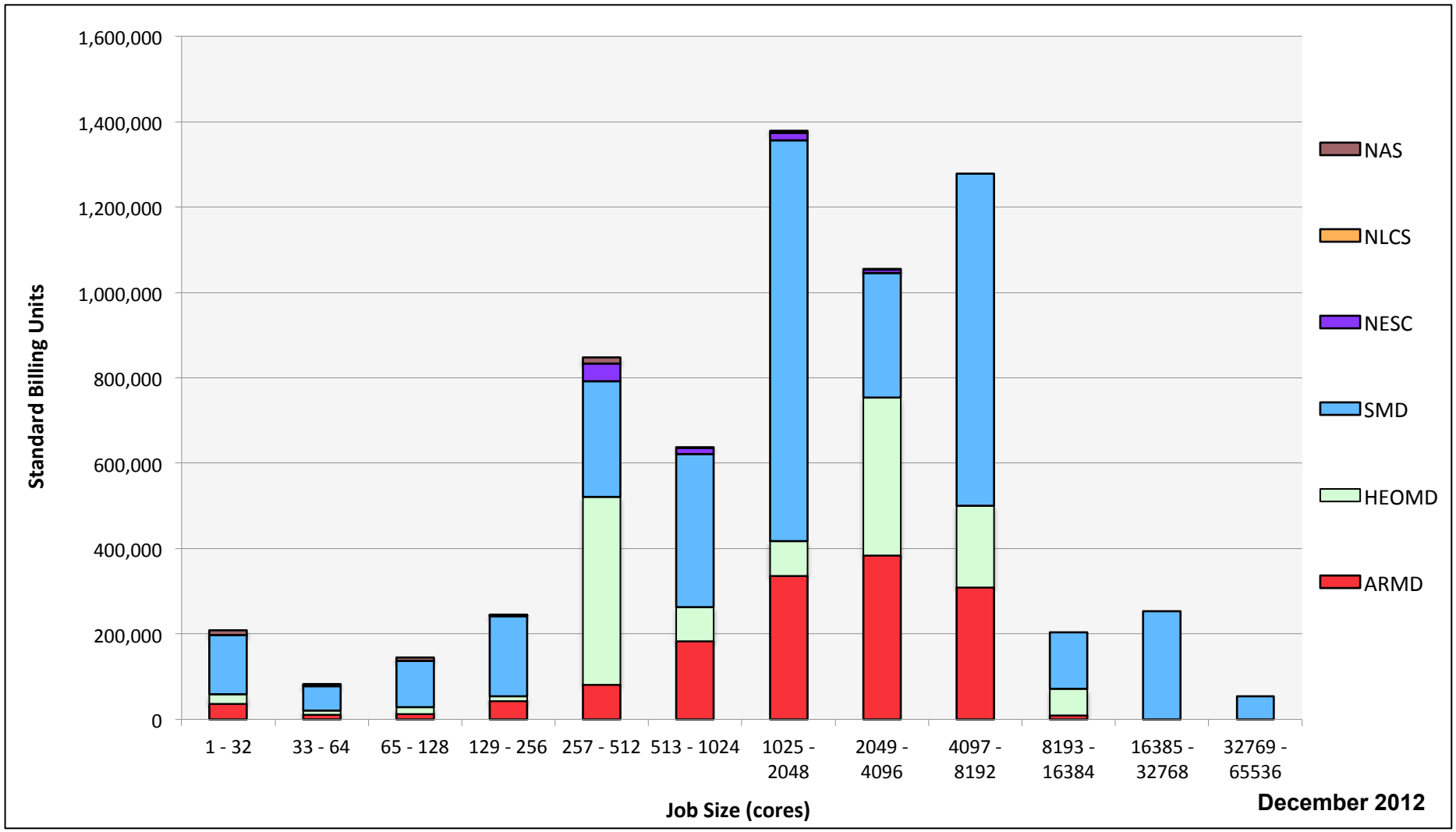
Pleiades:
Devel Queue Utilization



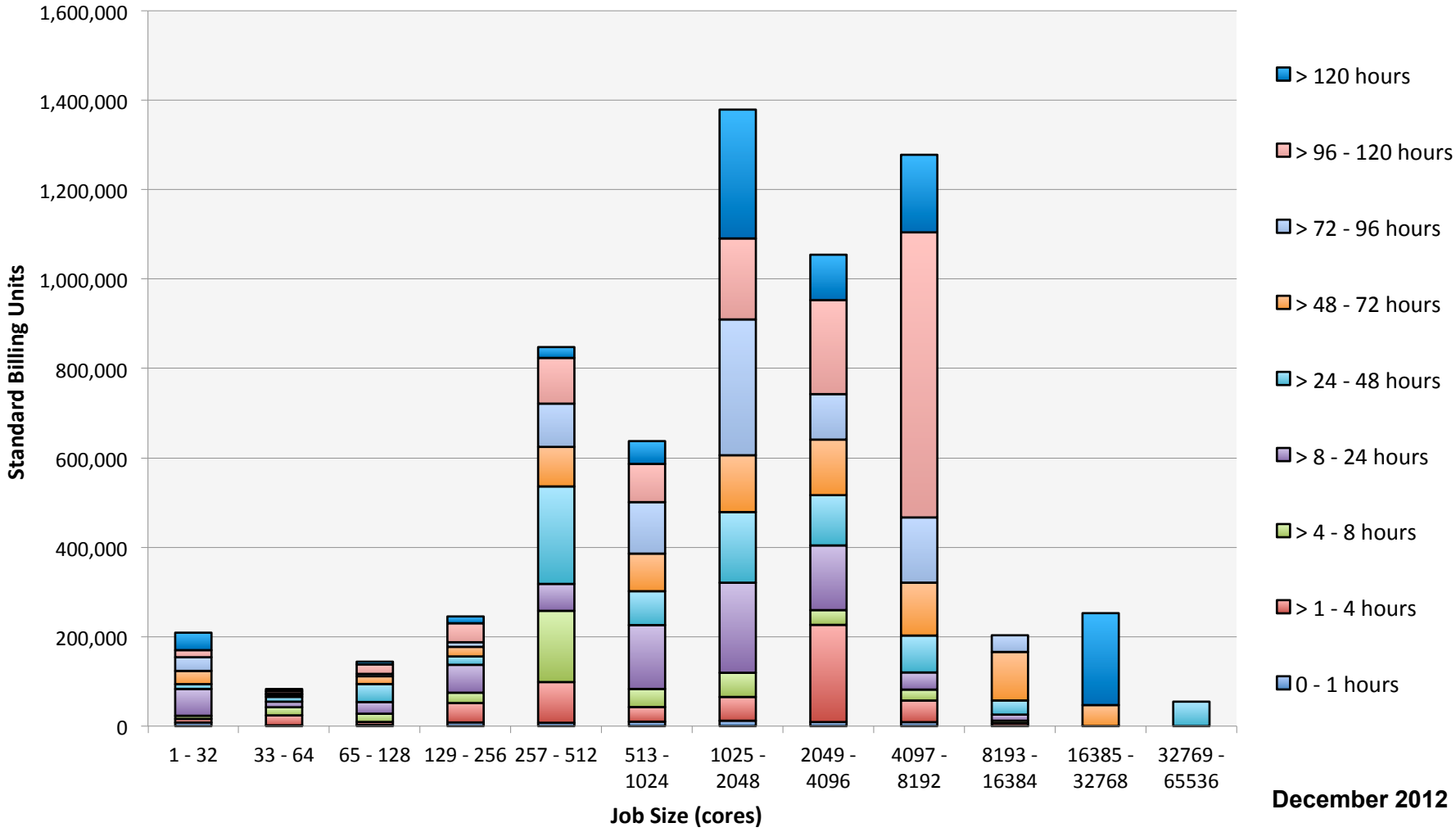
Pleiades:
Monthly Utilization by Length



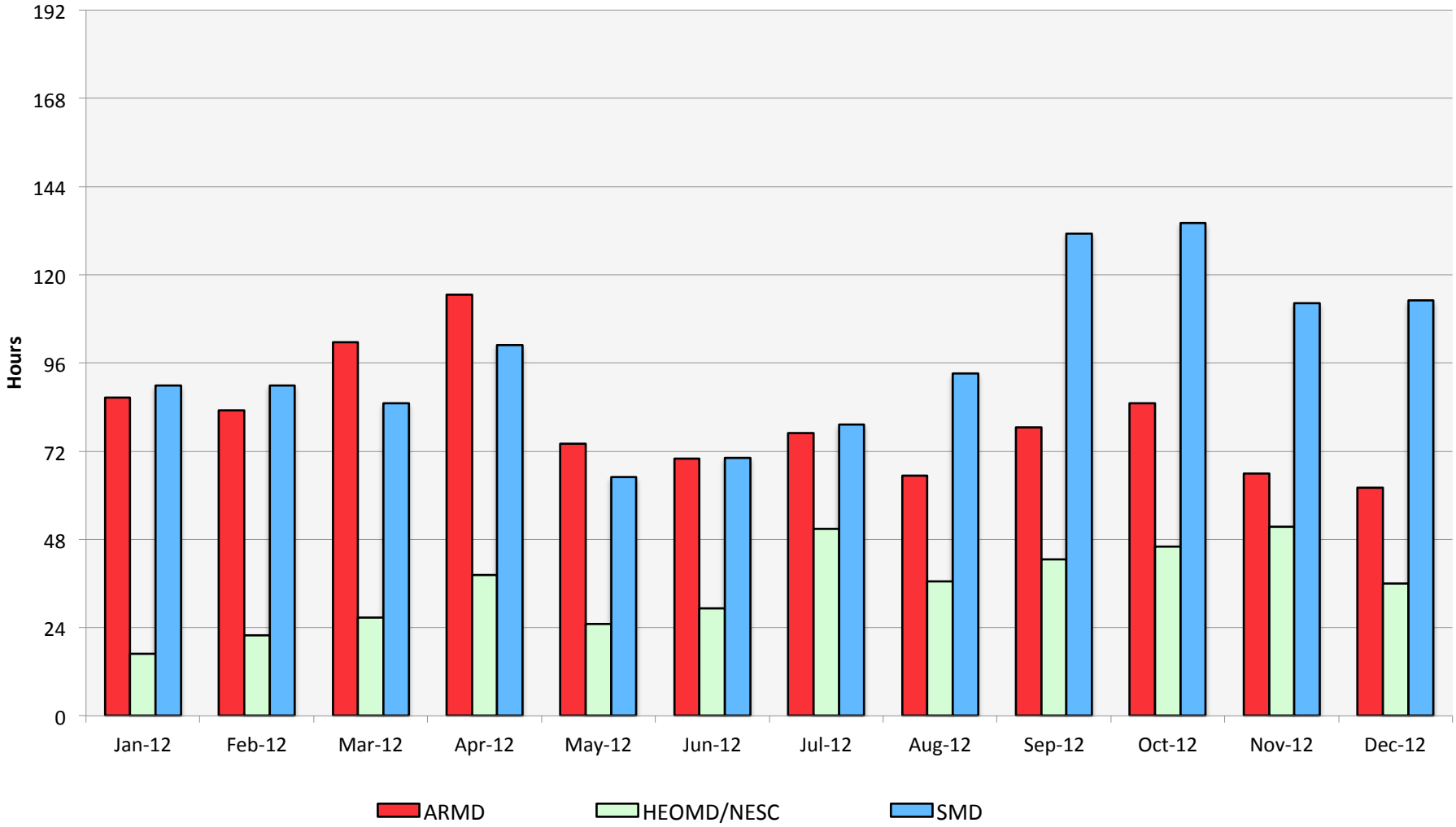
Pleiades:
Monthly Utilization by Size and Mission



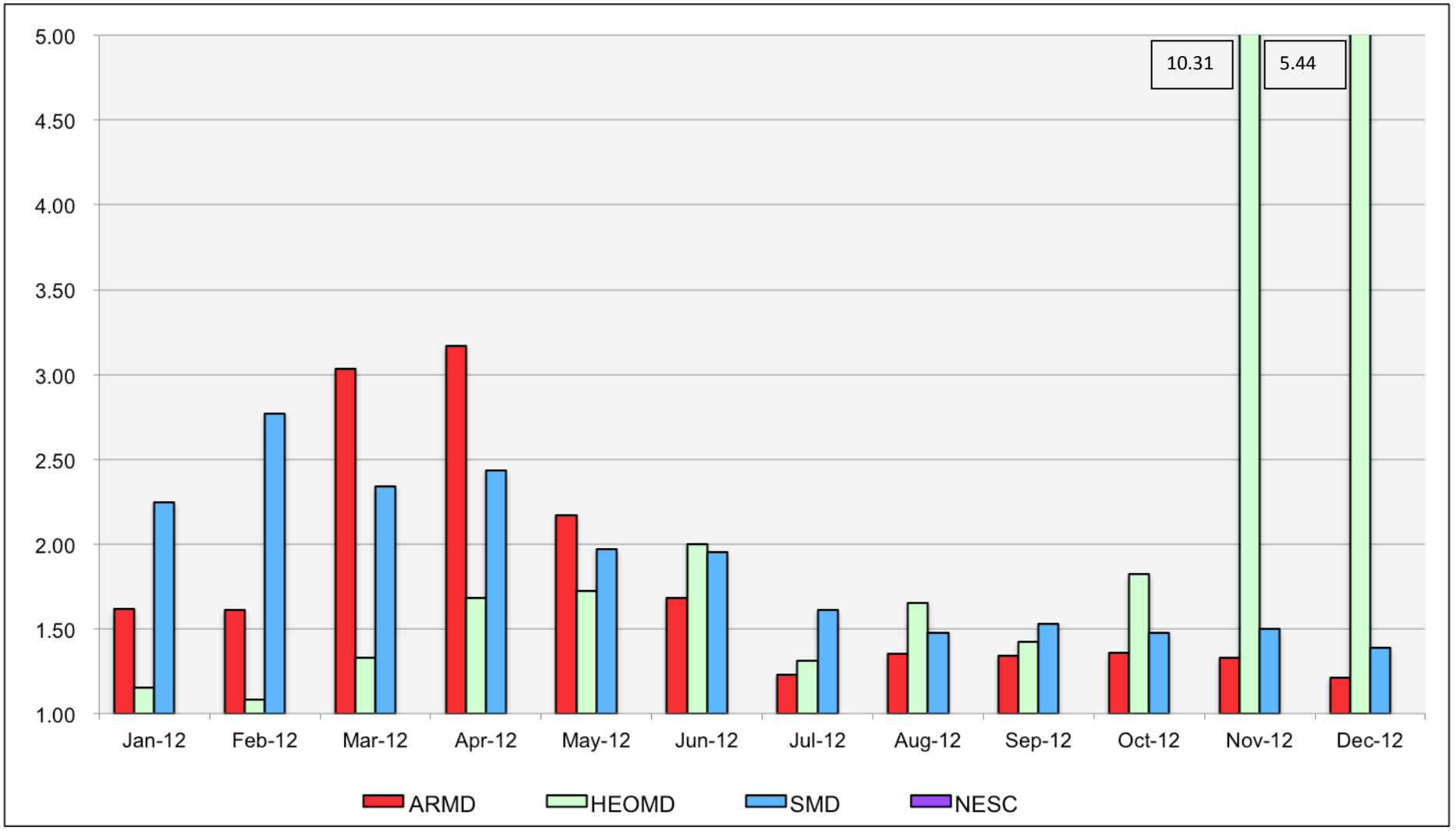
Pleiades:
Monthly Utilization by Size and Length



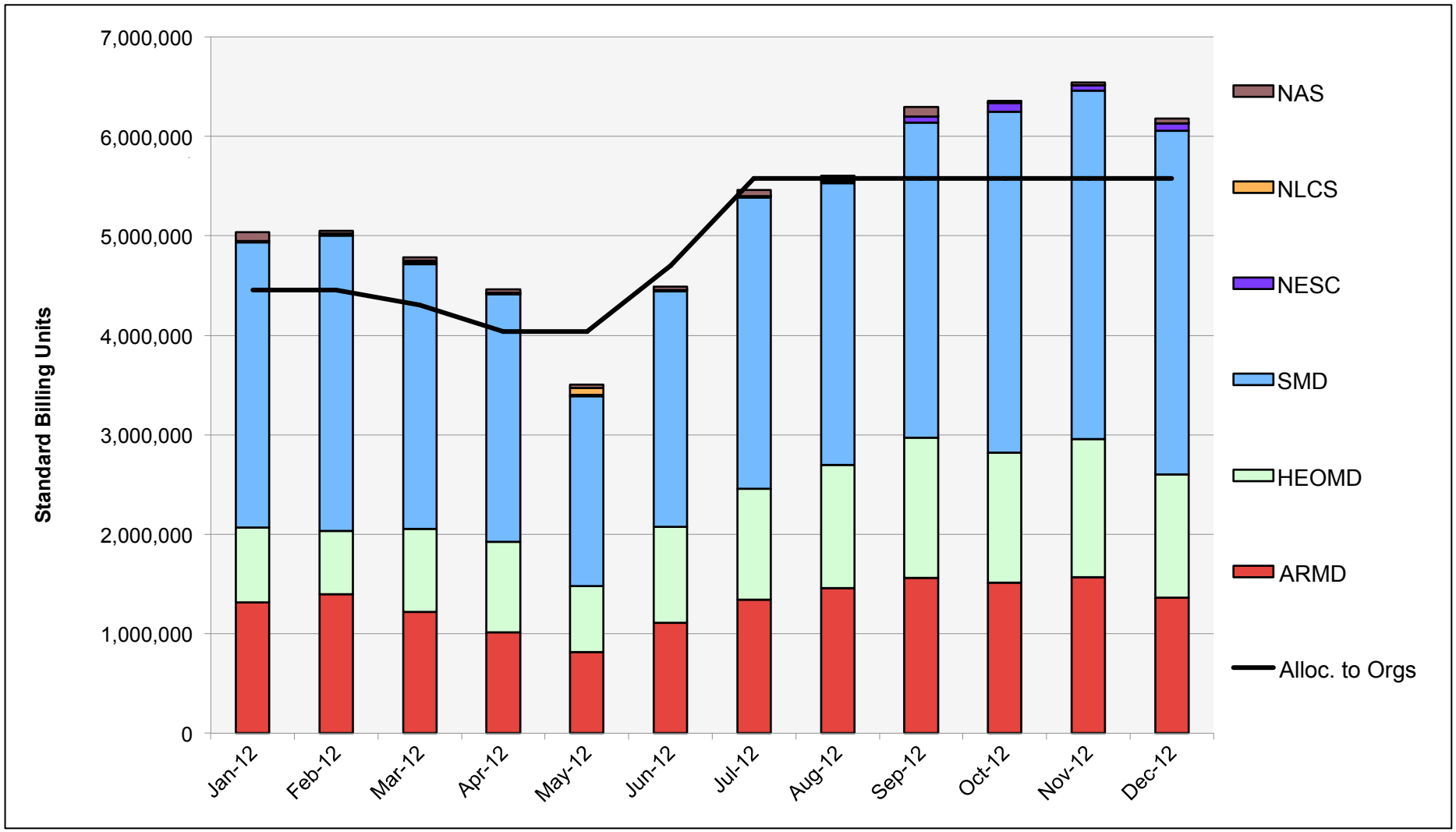
Pleiades:
Average Time to Clear All Jobs



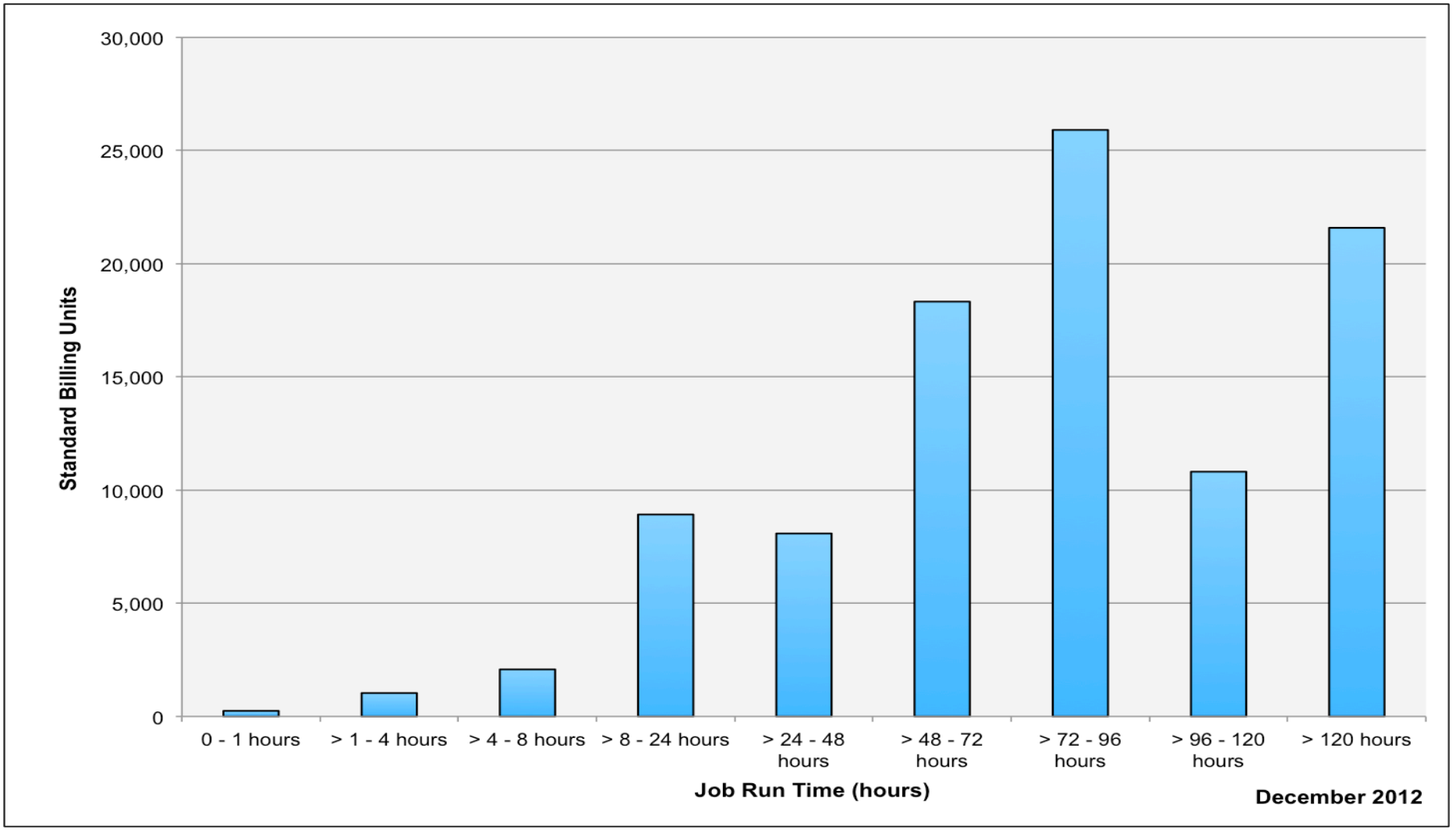
Pleiades:
Average Expansion Factor



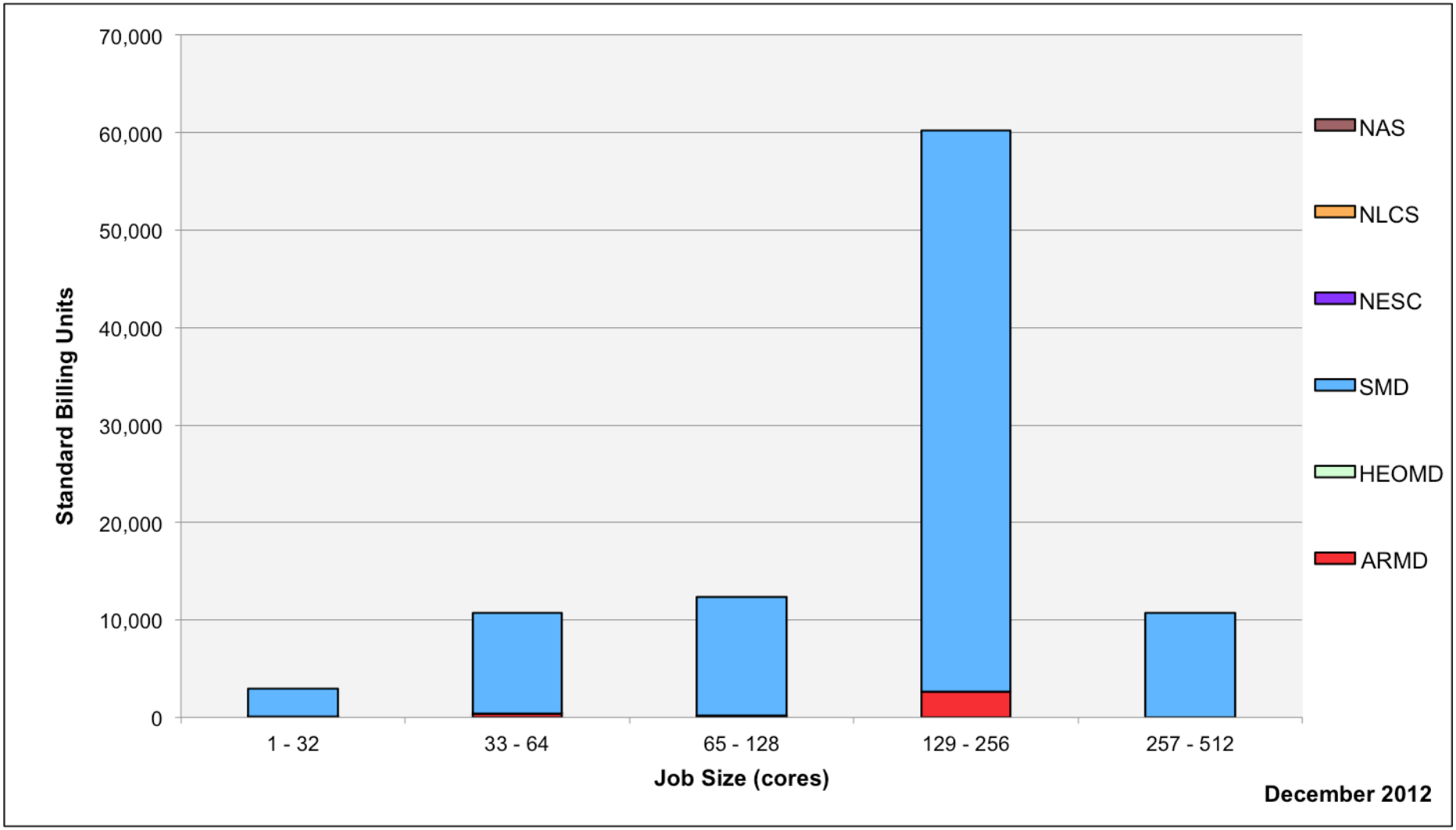
Columbia:
SBUs Reported, Normalized to 30-Day Month



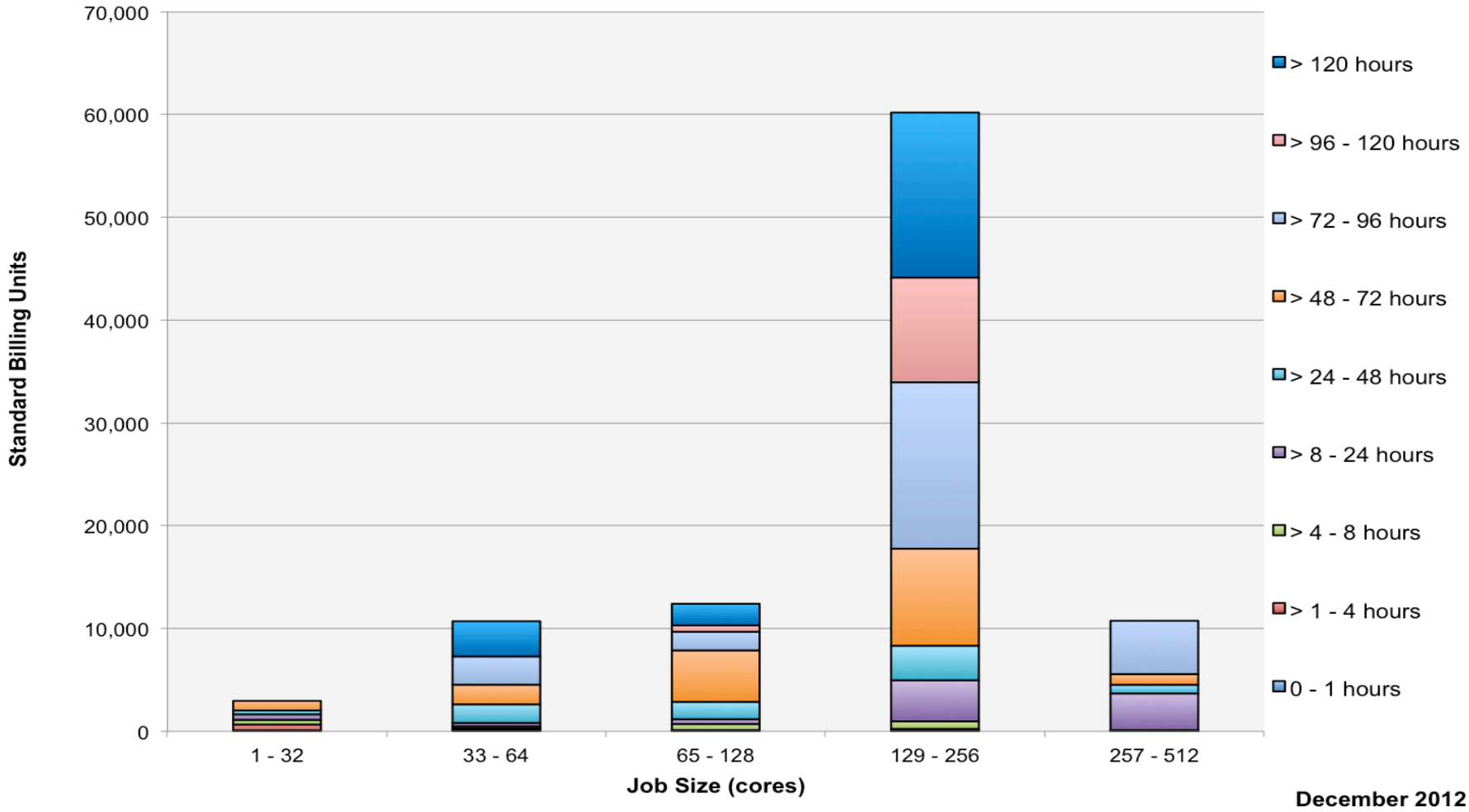
Columbia:
SBUs Reported, Normalized to 30-Day Month



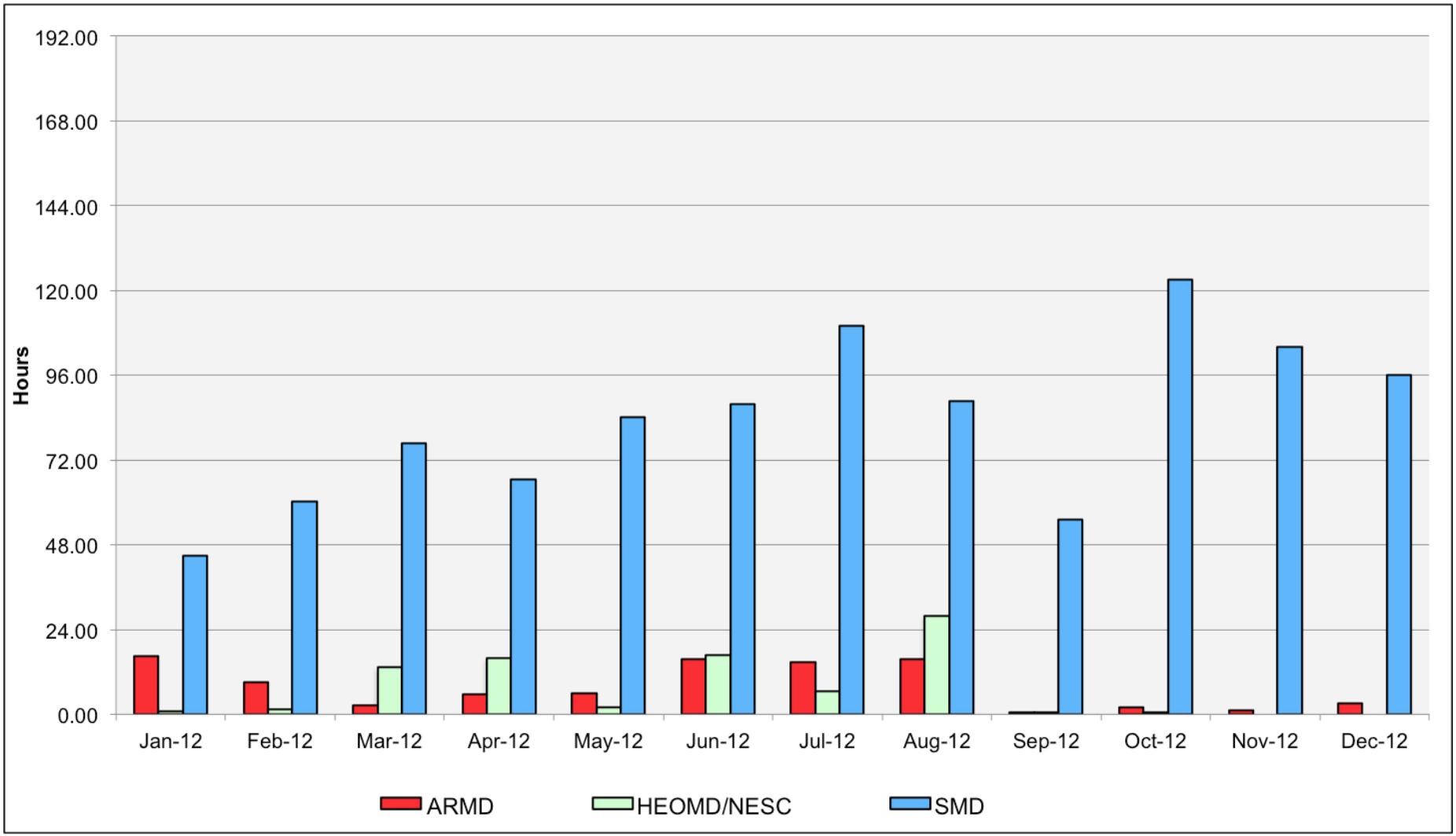
Columbia:
Monthly Utilization by Size and Mission



Columbia:
Monthly Utilization by Size and Length



Columbia:
Average Time to Clear All Jobs



Columbia:
Average Expansion Factor