2024 ANNUAL REPORT

PennState
Applied Research Laboratory

ALLAN SONSTEBY
Executive Director
Applied Research Laboratory

A Message from the Executive Director

REMAINING RELEVANT

In 2018, former U.S. Secretary of Defense James Mattis challenged the U.S. Department of Defense (DoD) to create a "...culture of performance and affordability that operates at the speed of relevance." As ARL continues to expand and evolve, we remain committed to harnessing next-generation scientific and technological advances. With almost 80 years of innovating, we have amassed a wealth of institutional and technical knowledge that our sponsors rely on to solve unique and critical problems. ARL recognizes that without investing in science and technology and continuing to push the frontiers of technological advancement, our nation will lag behind our competitors.

THE FINAL FRONTIER

In 1945, the year of ARL's founding, man had not yet walked on the moon. The first U.S.-launched satellite was more than 10 years in the future. The possibilities of space were only beginning to be harnessed. Now, nearly eight decades later, we have glimpsed the surface of Mars and sent U.S. citizens into orbit with commercial shuttles. With thousands of satellites in orbit, intra-space collisions remain a very real threat to national security. At this year's SXSW Conference, ARL researchers from the Communications, Information, and Navigation Office demonstrated space situational awareness technology which can help to avert these costly collisions. You can learn more about their work in our *Project Spotlight* on page 12.

A BRILLIANT LEGACY

This year marks the 75th Anniversary of the Garfield Thomas Water Tunnel (GTWT), an official American Society of Mechanical Engineers-designated landmark. In the years since construction, the GTWT has provided crucial support in the areas of marine propulsor and torpedo design, biomedical research, hydrodynamic and acoustic research, and renewable energy. The GTWT will continue to expand upon its brilliant legacy under the direction of Benjamin Beck, Ph.D., who was appointed deputy director and head of the Fluid Dynamics and Acoustics Office (FDAO) in September 2023. I welcome Dr. Beck to ARL's senior leadership team and am confident that FDAO will flourish under his direction.

As always, I am grateful to our research sponsors, the Penn State community, and the extraordinary people of ARL who have helped us deliver excellence in research, discovery, and innovation for almost 80 years.

It is with great pleasure that I present this year's annual report.

Be well,

Allan

OUR RESEARCH

Reporting to Penn State's Office of the Senior Vice President for Research (OSVPR), ARL plays a critical role advancing Penn State's mission of teaching, research, and service. As part of that mission, we strive to exemplify Penn State's core values, including:

- Discovery: We seek and create new knowledge and understanding, and foster creativity and innovation, for the benefit of our communities, society, and the environment.
- Excellence: We strive for excellence in all our endeavors as individuals, an institution, and a leader in higher education.

In our role as a Department of Defense University Affiliated Research Center (UARC), we ensure that essential engineering and technology capabilities are maintained. ARL's research teams perform basic scientific exploration, proof of principal/proof of concept experimentation, applied research and development, rapid prototyping, and technology transition.

To accomplish our mission, ARL teams with government laboratories and universities on many of our programs, speeding technology maturation and driving new capabilities to the field. ARL also serves as an integral part of Penn State's educational mission by advising students, teaching classes, and collaborating with faculty to advance the University's larger academic goals. We serve as subject matter experts in our areas of competency and we offer world-class research capabilities to attract the next generation of students, researchers, scientists, and industry professionals.

OUR PEOPLE

The cutting-edge research and innovative technologies that ARL produces would not be possible without our talented team. People ultimately drive the success of any endeavor that our Laboratory pursues. Our workforce at ARL is comprised of highly skilled, highly specialized researchers, scientists, and enterprise professionals. In 2020, U.S. Secretary of Defense Mark T. Esper stated, "A diverse and inclusive DoD draws out and builds upon the best in each of us; it builds esprit de corps, forges teamwork, and brings out the best between us."

That remains true today. ARL embraces diversity, equity, inclusion, and belonging as business imperatives in the best interests of our sponsors. By championing diverse viewpoints and unique perspectives, we actively seek to learn and grow from our workforce. We do not tolerate discrimination in any form.

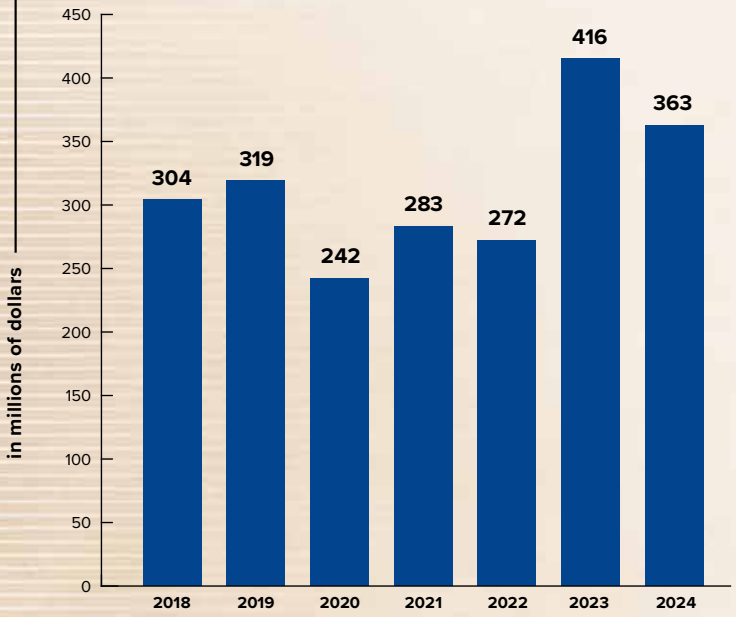
We demand accountability for our actions at all levels of the organization. We empower our leaders to achieve success through training opportunities, mentoring, and active coaching. Our leaders embody ARL's values and instill them in the employees they manage.

By encouraging collaboration, candor, and compassion, we cultivate an environment where our community can thrive.

Our Year at a Glance

NET FUNDED SPONSOR AWARDS

2018	**$304,000,000**
2019	**$319,000,000**
2020	**$242,000,000**
2021	**$283,000,000**
2022	**$272,000,000**
2023	**$416,000,000**
2024	**$363,000,000**



SPONSORS UFY 24

1 NAVSEA **45%**

2 ONR **13%**

3 USG **11%**

4 OTHER DOD **7%**

5 DARPA **6%**

6 DTRA **6%**

7 OTHER NAVY **5%**

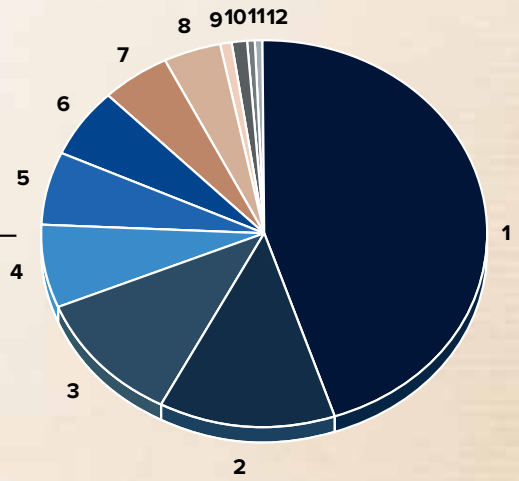
8 OTHER ARMED SERVICES **4%**

9 OTHER USG **1%**

10 USMC **1%**

11 JIATF-S **.5%**

12 NAVAIR **.5%**



UFY 2024

$772M
TOTAL AMOUNT OF PROPOSALS

$363M
TOTAL AMOUNT OF NET FUNDED AWARDS

334
PROPOSALS SUBMITTED

209
AWARDS RECEIVED

118
SPONSORS

48
INVENTION DISCLOSURES

$388M
TOTAL AMOUNT OF OPERATING REVENUE

ARL operates under the Penn State's fiscal year, which runs from July 1 through June 30.

Significant Accomplishments

- The renovation of the Garfield Thomas Water Tunnel building and experimental facilities has been completed which will empower the next generation of ARL researchers in fluid dynamics and acoustics.
- FDAO hosted the Frontiers in Acoustics Metamaterials Symposium, an ARL co-sponsored two-day forum which brought together academia and Navy partners. Speakers presented state-of-the-art research in acoustic metamaterials for naval applications in the areas of active acoustic metamaterials, elastic/underwater metamaterials, computational methods, and implementation.
- ARL continues to receive funding from multiple sponsors for development and execution of advanced computation fluid dynamics (CFD) software for analysis of complex hydrodynamic problems.
- ARL achieved significant endurance and performance milestones for the MK48 MOD9 Advanced Capability Heavyweight torpedo program. ARL is under a multiyear contract to support transition from prototyping to production with a Navy-selected industry partner.
- ARL, under the Office of Naval Research Future Naval Capability program, successfully demonstrated anti-submarine warfare baseline software for the MK58 Compact Rapid Attack Weapon. ARL also successfully exercised the prototype launcher assembly that will be integral to incorporation on VIRGINIA class submarines. ARL is under a multiyear contract to support transition from prototyping to production with a Navy-selected industry partner.

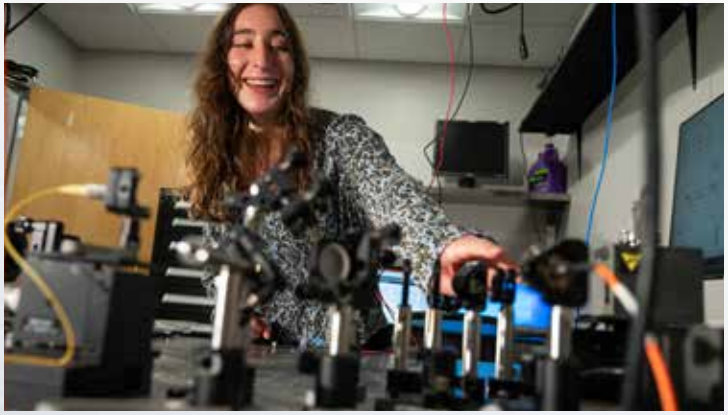
- ARL began a multiyear contract to design and integrate low-band and mid-band synthetic aperture SONAR capability into the Navy's planned Integrated Search and Survey sensor suite. ARL is working with the Navy's industry partners to deliver this capability for future VIRGINIA platforms.

LANDING HELICOPTER DOCK (LHD-2) RUDDER STOCK REPAIRS

The Multifunctional Automated Repair System (MARS) repaired corrosion damage on both port and starboard rudder stocks of LHD-2 (USS Essex) at BAE Systems in San Diego, California. The use of MARS realized a time savings of more than 24 days in dry dock and approximately $2.5M in associated costs to the U.S. Navy. The rudder stock repair was the largest Navy cold spray repair to date.

During the repair, more than 220 pounds of powder flowed in more than 24 hours of spray time. Cold spray offers a significant time savings and risk reduction when compared to traditional weld repair.

ARL leveraged lessons learned from MARS demonstrations and in-situ repair aboard SSN-795 when working on the LHD-2. This iterative fielding approach was critical to enabling the project's success.



CINO

The **Communications, Information, and Navigation Office (CINO)** develops solutions and champions the transfer of advanced technologies to the DoD, Intelligence Community (IC), and other government and industrial sponsors.

Our portfolio encompasses the research, development, prototyping, and delivery of advanced sensing, communications, cyber, geospatial, analytic, and visualization capabilities. In the past year, we built upon our efforts to expand and enhance the capabilities sought by our sponsors. Some of these efforts include delivering advanced artificial intelligence and machine learning capabilities to operational systems; deploying big data infrastructure prototypes for large-scale data sets on government systems; developing new passive navigation techniques; and demonstrating space situational awareness tools and applications.

Finally, our teams delivered a software defined radio communication solution for the Fleet and completed an operational acceptance test for a second software-defined radio that specialized in counter-unmanned aerial system defeat.

FDAO

The **Fluid Dynamics and Acoustics Office (FDAO)** performs basic and applied research in experimental and computational fluid dynamics and acoustics, propulsor and pump design and testing, and engineering education.

In the past year, we provided leading edge science and technology for the U.S. Navy's current and future submarine fleet, including contributions to the VIRGINIA, COLUMBIA, and future SSN(X) class submarines. Working closely with the Office of Naval Research, our project areas include computational structural acoustics, acoustic materials, vibration and noise reduction, and computational fluid dynamics codes. Additionally, we have supported DARPA on high-risk, high-reward advanced propulsion concepts and novel drag assessment programs.

As part of our partnership with Penn State's College of Engineering (CoE), FDAO faculty and staff worked with CoE faculty on multiple joint research projects, taught classes, and participated in collaborative forums such as the Fluid Dynamics Research Consortium and the Center for Acoustics and Vibration. CoE and ARL STEM education programs continue to support graduate and undergraduate-level students.

MMO

The **Materials and Manufacturing Office (MMO)** develops integrated solutions that combine optimized material properties with advanced processing and manufacturing techniques. Our robust expertise allows us to address supply chain challenges and enable rapid, cost effective system development and sustainment.

Our researchers also provide critical support to the Navy and other federal sponsors in the areas of directed energy, electro-optic, and electronics manufacturing technologies. In the past year, MMO performed fundamental material development, process development, and technology transition for our sponsors. We developed innovative processes in additive manufacturing and cold spray, qualified processes for use in repairing Naval components, and transitioned them to U.S. Navy shipyards.

As we expand our research portfolio, we have served as a test and integration partner for new DoD enterprise information systems and have developed health monitoring solutions for critical Navy platforms. We are proud to contribute to the affordability and speed of acquisition of major weapons systems through our three Office of Naval Research ManTech Centers of Excellence: the Institute for Manufacturing and Sustainment Technologies, the Electronics Manufacturing Center, and the Electro-Optics Center.

USO

The **Undersea Systems Office (USO)** continues to serve as a trusted resource and system developer in critical undersea technology areas including undersea weapons, Unmanned Undersea Vehicles (UUVs), and advanced sonars. Over the past year, we conducted crucial system testing, fleet exercises, and design reviews to support the Navy's three undersea weapons programs.

The MK48 Mod 9 Heavyweight torpedo completed three highly successful integrated system tests and supported the program office as it begins the proposal solicitation process. The MK54 Mod 2 Advanced Lightweight torpedo underwent a significant program realignment, now representing two increments to better phase in required capabilities. The Compact Rapid Attack Weapon, now MK58, transitioned to a Program of Record. ARL is working hand-in-hand with the Navy's industry partner to ensure a smooth transition to production.

Our Large Test Vehicles continue to find utility for the Navy, serving as submarine surrogate platforms for a variety of payload and sensor assessments and providing significant design and programmatic risk reduction for Navy programs. Our SONAR research division continued advancements in a variety of SONAR sensor applications, particularly in support of Subsea/Seabed Warfare and Mine Countermeasures mission areas.

ENTERPRISE OPERATIONS

Ensuring seamless operation of a multifaceted research organization presents unique challenges, and the ten ARL Enterprise teams offer a wealth of experience to deliver solutions. From amplifying and coordinating ARL's messaging (**Corporate Communications)**; to building, certifying, and protecting ARL's cutting-edge intelligence platforms (**Information Technology Services**); to monitoring the Laboratory's policies and processes (**Compliance**), Enterprise Operations worked in concert with our research offices to enable ARL's research mission.

As the Laboratory continues to grow, we've built a solid foundation for the next generation of scientists, engineers, and industry professionals. The collaborative efforts of the **Leadership, Culture, and Student Programs** office and the **Human Resources** team ensures that ARL continues to attract the brightest minds for our next-generation workforce.

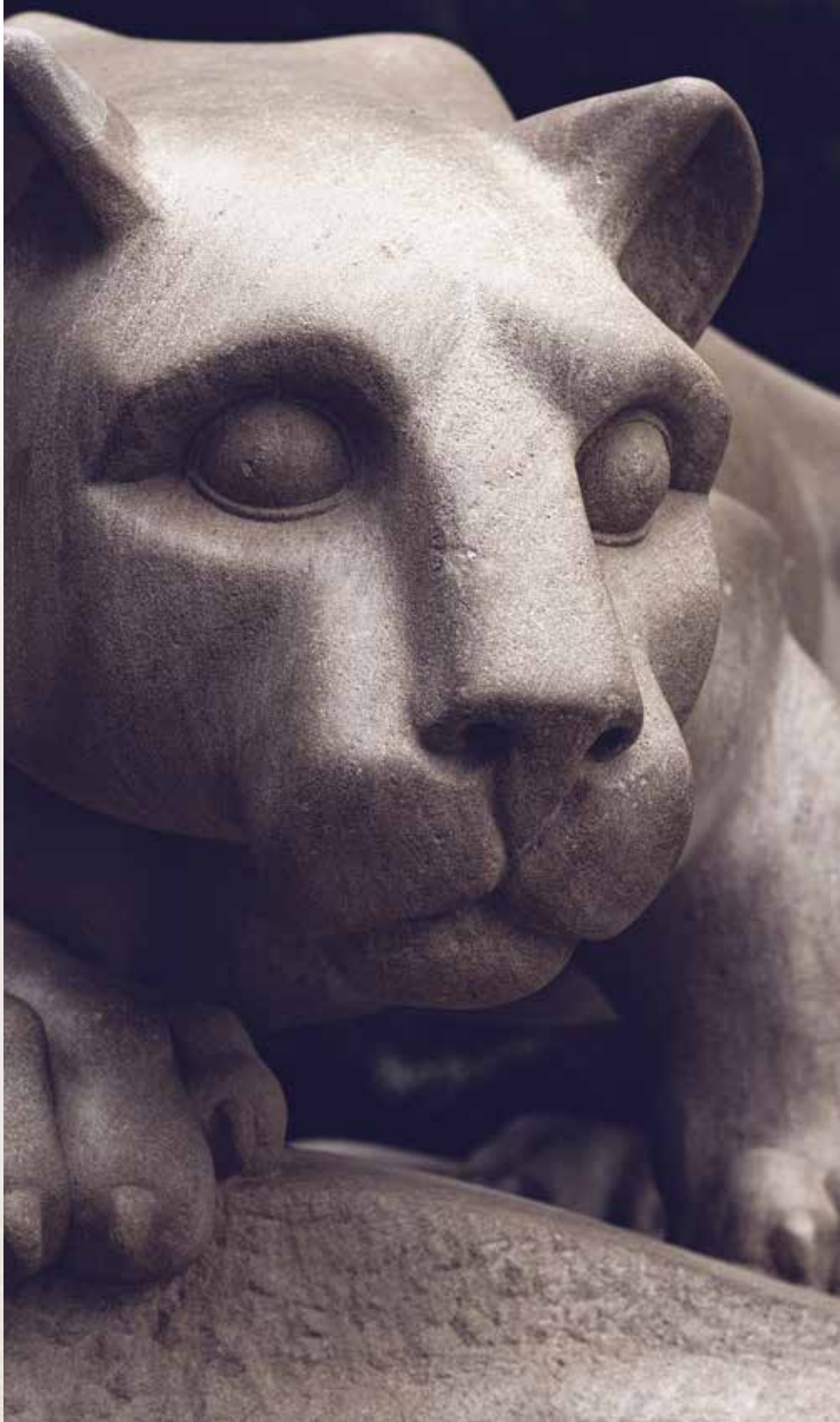
With more than 1,500 ARL employees occupying more than 860,274 square feet of building space, our **Engineering Services** team leads the mammoth task of ensuring safe, secure facilities for our employees to thrive. Our **Security Services** team, in collaboration with the **Special Program Security** team, employs a sophisticated, multi-pronged approach to protect ARL's valuable research.

As researchers embark on their projects, the **Business Services** team ensures that the resources, process, and services required to achieve success are readily available**.**

As the Laboratory makes significant strides in research, innovation, and discovery, the **Process Excellence** and **Enterprise Program Management** teams provide assistance in executing and optimizing internal ARL processes, leveraging industry best practices, implementing LEAN methodologies, and facilitating collaboration across the Laboratory.

All of ARL—including leadership, research offices, and enterprise operations—remains committed to strengthening our capabilities, exploring new technologies, driving organizational efficiency, and anticipating our sponsors' emerging needs.

Enterprise Operations works in concert with our research offices in support of ARL's mission.



Project Spotlight

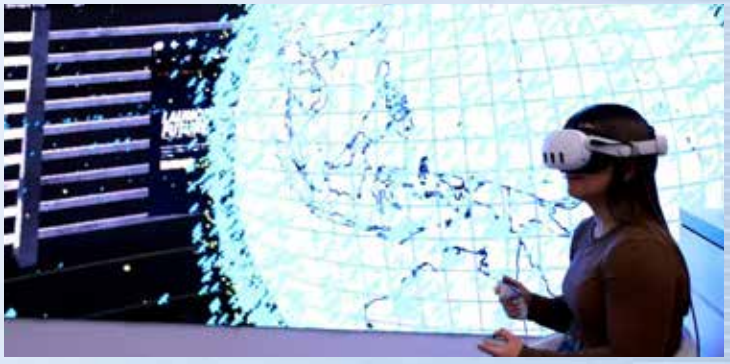
STARDUST AT SOUTH BY SOUTHWEST

ARL worked with the National Reconnaissance Office's Office of Public Affairs (NRO OPA) to deliver an unclassified, publicly-releasable version of the STARDUST Space Situational Awareness (SSA) application to demonstrate at their booth at the South by Southwest Creative Technology Expo in Austin, Texas, in March of 2024. The ARL team delivered approximately 200 briefings on the importance of the space domain during the three-day event. Integrating commercial-off-the-shelf Virtual Reality (VR) hardware and an ARL-developed immersive application, the team presented various orbits, constellations, real-world use-cases, and more. The demonstration received kudos from the NRO OPA team as well as expo attendees. The demonstration was featured in posts from the NRO's official social media accounts.

STARDUST is a virtual reality application that has been in development for a number of years. The application presents users with a scaled-down globe surrounded by thousands of space objects classified by type, owner, and size. In the immersive environment, users can view real time positions of the space objects and interact with the objects to view satellite characteristics. Further interactions allow users to investigate relationships between the objects in orbit. A timeline gives the user full control over the playback of historical events as well as forecasts of future events. The user can load additional layers on the globe to view a multi-domain environment.

Virtual reality provides the opportunity to do many things that are difficult or impossible in the real world. When the user dons the headset, STARDUST provides a number of environments where they can explore the three-dimensional space data including a large watch floor, a small room, and space environment. The application enables users to explore spatial relationships in three dimensions, asking questions such as "What's on the other side of the globe right now?" and "Where is that satellite going?" The STARDUST environment allows users to experience what it would be like to be in orbit from the safety of an office.

Under the hood, STARDUST is powered by a game engine, which simplifies the integration with many different virtual reality platforms. The application has been developed to prototype multi-user, multi-site collaboration within virtual environments, meaning all users see each other's selected objects, while menus and analytical results can be shared among the users in a session. The development team has been working to better understand methodologies to improve data access and sharing between users. Finally, the application has been used to demonstrate various application deployment strategies including standalone, enclave, and cloud. STARDUST development and deployment continues as new extended reality display systems come online, and the development team seeks to remain at the forefront of this rapidly-developing space.



Photos Courtesy of the National Reconnaissance Office Public Affairs Office


CURRENT TIME
03/10/2024
03:13 PM
UTC Standard Time
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HST
SIMULATION TIME
3/7/2024 20:35:04
JOB LISTINGS
IRIDIUM 33 DEB
33777
FENGYUN 1C DEB
30562
ROTATE

Our Future Outlook

As we approach the halfway mark of a decade that saw a global pandemic, rapid advances in artificial intelligence and machine learning, and a new generation entering the workforce, ARL's focus on innovation and agility has served us well in navigating this era of seismic change.

Adapting to a constantly-evolving world demands creativity, perseverance, and a willingness to remain open to the art of the possible. It also requires investment in the core competencies and capabilities that have been the hallmark of ARL's success. As we look to programs like the Internal Science and Technology Program (ISTP), which fosters and capitalizes on ideas that align with our mission; expands our science and technology capabilities; strengthens our competencies; enables strategic opportunities; and addresses our sponsors' present and future needs, we continue to evolve our portfolio of capabilities.

2024 marks the first year where "Generation Z" (those born between 1997–2012) makes up a larger portion of the workforce than "Baby Boomers" (those born between 1946–1964). Our SOAR (Student Opportunities in Applied Research) program, the Walker Graduate Assistantship, and other ARL programs provide promising students the opportunity to engage with hands-on research and receive valuable mentorship. As we build the next-generation workforce, we remain committed to an inclusive, belonging environment where all individuals can thrive together.

The pursuit of excellence often demands sacrifice, and we are grateful to our colleagues, friends, and loved ones for their steadfast support. Serving our nation through our sponsors is a profound honor we do not take for granted. As we look forward to another successful year, we remain confident that the Laboratory will continue to thrive.

Adapting to a constantly-evolving world demands creativity, perseverance, and a willingness to remain open to the art of the possible.

1,593 TOTAL EMPLOYEES

203 STUDENT EMPLOYEES

32% / 25% / 13%

BACHELOR'S DEGREE | MASTER'S DEGREE | DOCTORAL DEGREE

178 DISCIPLINES REPRESENTED

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