EXECUTIVE SUMMARY

Item Name: **Request to Amend TRIF 3-Year Plan for the University of Arizona**

☒ Action Item

Requested Action: The University of Arizona asks the board to approve its Amendment to the institution's TRIF 3-year plan.

Background/History of Previous Board Action

Arizona law established TRIF from Proposition 301 state sales tax revenue and gives ABOR the authority to administer the fund on the universities' behalf.

To comply with the TRIF statute, the board approves a TRIF 3-year plan which provides a narrative and budget for university research and workforce development programs funded by TRIF money. The 3-year plan summarizes the program investments and predicted outcomes for FY 2022-2024. Each program within the plan targets one of the five strategic research areas:

- Improving Health;
- Water, Environment and Energy Solutions;
- National Security Systems;
- Space Exploration and Optical Solutions, and
- Workforce Development.

Based on the approved university's 3-year plans, the board distributes an annual base amount of TRIF revenues to the universities under the following allocations:

- ASU: $32 million per year
- NAU: $16 million per year
- UA: $32 million per year

The universities use this base allocation to fund the research and work force programs summarized in the plans.

Discussion

In FY 2021, the board received more TRIF revenue than originally budgeted. The board is distributing some of the additional revenue received as a 6 percent inflationary adjustment to the base amount already allocated to each university. For UArizona this represents $1.9 million in additional revenue resulting in a base TRIF funding awarded

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of $33.9 million**.** This inflationary adjustment will be ongoing for the duration of the 3-year plan.

UArizona revised its 3-year plan to allocate the additional $1.9 million to establish the Institute for the Future of Data and Computing (IFDC). The amended plan is provided

Committee Review and Recommendation

The Research and Health Sciences Committee reviewed this item at its January 27, 2022 meeting and recommended forwarding the item to the full board for review and consideration. The committee may receive additional information at a future meeting.

Statutory/Policy Requirements

A.R.S. §15-1648 “Technology and Research Initiative Fund”

ABOR Policy 3-412 “Administration of Technology and Research Initiative Fund”

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Improving Health
Program Name: Aging and Resilience

Problem Statement:

With more and more individuals living longer, an aging Arizona population will bring unique challenges and opportunities in health care. Critical research and development still needs to be done to understand the processes of normal and healthy aging; determine the causes of age-related diseases; develop and test drugs, devices, and behavioral interventions to minimize handicap and disease; and maximize functionality and independence for a higher quality of life.

Program Description:

We expect to gain a better understanding of common initiating mechanisms across four age-associated neurodegenerative diseases (Alzheimer's, Parkinson's, multiple sclerosis, and ALS). We also will continue trials into potential therapeutics and interventions to reverse cognitive decline. Technology developments will be leveraged into advances in home health, mobile health (mHealth), and telemedicine applications that bring safety, security, and medical care to all corners of the state and beyond. Working with the resources of the University of Arizona's NCI-designated Comprehensive Cancer Center, we will embark on programs to prevent cancer through precision lifestyle modifications and early detection, and cure cancer with greater understanding of its biological underpinnings and new treatments, such as immunotherapy.

What is the University's Advantage and/or Anticipated Funding Opportunities?

We are uniquely poised to conduct both basic and clinical research into the biology of aging and age-related brain diseases such as Alzheimer's, Parkinson's, and other neurological conditions. We have expertise in many areas related to aging and age-related disease, particularly in psychosocial, cognitive, immune, inflammation, neurodegenerative, metabolic, and geriatric care. Our studies range from brain imaging to looking at molecular and genomic changes during aging to dietary and exercise interventions. Together with our health and community partners, we have the expertise and support to translate basic studies into effective treatments and life-enhancing strategies for humankind, which ultimately will reduce health care costs and increase the chance for a long, healthy, productive, disease-free life.

Is there an Arizona Specific Benefit or Impact?

Arizonans will benefit from this initiative in many ways, including:
•New discoveries into the interactions between aging brain and aging body in health and diseases
•Development of therapeutics, together with the Arizona Center for Drug Discovery, to target age-related diseases
•Development of innovations in brain science that lead to precision therapeutic treatments for neurodegenerative diseases
•The ability to create a customized plan for optimized physical and cognitive aging utilizing big data and meta-omics
•Increased number of, and enrollment in, cancer prevention and treatment trials

Investment Detail

	2022	2023	2024	Total
Infrastructure	508,989	508,989	508,989	1,526,967
Basic Research	220,048	220,048	220,048	660,144
Applied Research	385,084	385,084	385,084	1,155,252
Development	55,012	55,012	55,012	165,036
Technology Transfer	129,193	129,193	129,193	387,579
Total	1,298,326	1,298,326	1,298,326	3,894,978

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	275,060	385,084	495,108	1,155,252
Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	20,000,000	20,000,000	20,000,000	60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
License and Options Income	50,000	50,000	50,000	150,000
Startups	0	1	0	1
Startup Investments	0	0	0	0
Startup FTEs	0	3	0	3

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Improving Health
Program Name: Infectious Disease and Microbiome Sciences

Problem Statement:

Infectious disease is the major cause of death in low-income countries, and emerging infectious diseases threaten countries worldwide, as the COVID-19 pandemic has shown. Researchers learn more every day about the role the human microbiome (both bacteria and viruses) plays in health and behavior. An example includes respiratory diseases that are considered to result from a combination of genes, environment, and lifestyle. The role of microbes in health and disease through interconnected human-animal-plant-earth reservoirs presents a complexity which is of vast importance and not yet completely understood.

Program Description:

We will leverage the considerable infrastructure we have developed for testing and serology of COVID-19 into a broader infrastructure for understanding, preventing, and treating infectious disease and possible future pandemics, as well as understanding the long-term effects of these diseases. We will also develop models of vector-born infections such as Zika. Understanding the variables affecting mosquito spread in Arizona may inform strategies to stop the transmission of Zika and keep Arizona free of this disease. Finally, we will look inside the human body to understand the healthy microbiome in niches throughout the body, as well as dysbiosis and its effect on diseases such as gastrointestinal cancers and infertility.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona's interdisciplinary researchers are pushing the boundaries of knowledge. Our outstanding investigators across immunobiology, public health, medicine, animal and comparative biomedical sciences, and others work together with complemented expertise to solve complex problems. TRIF-supported facilities such as the genetically engineered mouse models and biosafety level 3 and omics capabilities support cutting-edge research to enable new discoveries related to the role of microbes in human health and disease.

Is there an Arizona Specific Benefit or Impact?

•Development of more accurate, rapid, and inexpensive tests for COVID-19 and future infectious diseases
•Better understanding of demographic and health history effects on immunoprotection gained with vaccination against COVID-19 and other diseases
•New clinical trials to show the effect of potential therapies for respiratory illnesses
•Better understanding of the healthy biome in various human organs, and development of therapies for dysbiosis

Investment Detail

	2022	2023	2024	Total
Infrastructure	508,989	508,989	508,989	1,526,967
Basic Research	220,048	220,048	220,048	660,144
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Publications in Academic Peer-Reviewed Journals	92	92	92	276
License and Options Income	50,000	50,000	50,000	150,000
Startups	0	1	0	1
Startup Investments	0	0	0	0
Startup FTEs	0	3	0	3

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Improving Health
Program Name: Precision Medicine and Omics

Problem Statement:

Omics refers to collective technologies that explore the role of different molecules and how they interact with various bodily systems. Proteins, lipids/fats, and their metabolic products are all important and accessible indicators of human health. The study of omics is critical to developing personalized, targeted therapies to boost efficacy, improve health, lessen adverse exposures, and reduce health care costs. To analyze the vast amounts of omics data and turn it into actionable precision medicine, the science of bioinformatics needs not only to be used, but be further developed, using the combination of computer science, statistics, mathematics, and engineering.

Program Description:

We expect to make major strides in four general areas. First, we will create a comprehensive approach in the nascent field of pharmacogenomics. Rather than a one-size-fits-all approach to therapy or dosage based on gross factors such as body surface area, drug prescriptions—and in particular polypharmacy—we need to take into account an individual's genomic factors. Second, with gene interactions, we are beginning to understand not just the impact of single genes on health but also the interplay of many, or even hundreds, of genes on complex conditions such as diabetes and heart disease. Extracting this information using conventional naive biostatistical models may require numbers of participants exceeding the world's population. We will develop new models to enable extraction of complex data. Third, we will develop models of the transcriptome, which is the initial product of gene expression.We will determine the difference between "nature and nurture," or the effect of the environment (internal and external) on gene expression. Finally, to address the unsustainable cost of drug development, we will advance an adaptable clinical trials model to improve outcomes and reduce costs.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has a strong infrastructure in both expertise and instrumentation to develop omics and precision medicine. Investments in sequencing and mass spectroscopy facilities have occurred with past TRIF investments, with a particular emphasis on metabolomics and precision nutrition. The National Science Foundation-sponsored CyVerse and the UArizona Center for Biomedical Informatics and Biostatistics bring strengths in extracting actionable knowledge from large data sets. In addition, UArizona's partnership with Banner Health, including the All of Us program, means that enormous amounts of health data are available for researchers to analyze and drive subsequent experiments and therapy development.

Is there an Arizona Specific Benefit or Impact?

The benefit to Arizona will include:

- UArizona is successful in obtaining a Clinical and Translational Science Award with partners across Arizona to move promising science to translation
- An increase in Banner Health and other clinical partner collaborative grants and contracts, bringing research dollars to Arizona and increasing research and clinical staff jobs
- More clinical trials in Arizona because of the expertise in adaptive clinical trial design, which will provide cutting-edge treatment options for Arizonans and more rapid development of cures

Investment Detail

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Infrastructure	508,989	508,989	508,989	1,526,967
Basic Research	220,048	220,048	220,048	660,144
Applied Research	385,084	385,084	385,084	1,155,252
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Technology Transfer	129,193	129,193	129,193	387,579
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Performance Measures

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Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	20,000,000	20,000,000	20,000,000	60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
License and Options Income	50,000	50,000	50,000	150,000
Startups	1	0	1	2
Startup Investments	0	0	0	0
Startup FTEs	3	0	3	6

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Improving Health
Program Name: Technology for Health

Problem Statement:

Advances in technology always have been quickly adopted to aid human health and well-being. For example, the rise of computer technology in the 1950's enabled computational tomography (CT) scans that allowed clear visualization of the human brain for the first time. More recently, strong, flexible, and inert materials have made long-term implantable vascular shunts possible. Improving Health depends upon continual adoption of technology and innovation to solve problems identified by scientists and physicians.

Program Description:

The Fourth Industrial Revolution envisions a convergence of biological, physical, and data sciences. This collaborative approach has long been a hallmark of BIO5. Specifically, we will do the following: Point-of-care imaging: We will create new, noninvasive imaging tools for earlier diagnosis and treatment of disease -enabling point-of-care imaging that can even be done by an individual with a smartphone; Closed-Loop Sensors Lab: Sensors/detectors/cameras and closed-loop "sensors/data -> analysis -> intervention -> measure impact" experiments will measure the effect of environmental perturbations on workplace performance, analyze reaction to social interactions, negotiation, team building exercises, etc., and develop/monitor the effects of "electroceuticals" or wearable therapeutics; Wearable technology: Develop new materials and electronic technologies further enabling battery-less, wireless, conformable wearables; Shared resources: Modern biology requires ever more complex instrumentation, to expedite large-scale, team science grants. These grants in turn will boost federal research funding, serve as a resource for local industry, and create new services and companies in Arizona.

What is the University's Advantage and/or Anticipated Funding Opportunities?

With co-located engineering, optical sciences, and medical disciplines, UArizona is poised to make technology advances and rapidly apply them to human health. The culture of interdisciplinary research and strong translational sciences, together with a supportive intellectual property environment with Tech Launch Arizona and the Eller College of Management's McGuire Entrepreneurship Program, mean that innovations are rapidly turned into products to improve the health and wellness of Arizonans and beyond.

Is there an Arizona Specific Benefit or Impact?

•Increased industry engagement with faculty and students through facilities and services, including analytical chemistry, imaging, bioinformatics, and sensors, leading to synergies in research and development, and accelerating Arizona bioindustry
•An increase in technology transfer activities related to sensors and imaging technology with more patents and licenses
•Additional external funding in wearable technology, home health, and telemedicine related to expertise in cutting-edge technology and resources such as the Sensors Lab

Investment Detail

	2022	2023	2024	Total
Infrastructure	1,469,413	1,469,413	1,469,413	4,408,239
Basic Research	381,158	381,158	381,158	1,143,474
Applied Research	762,315	762,315	762,315	2,286,945
Development	127,052	127,052	127,052	381,156
Technology Transfer	298,376	298,376	298,376	895,128
Total	3,038,314	3,038,314	3,038,314	9,114,942

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	635,263	635,263	635,263	1,905,789
Postdocs Supported	25	25	25	75
Graduate Students	65	65	65	195
Undergraduate Students	70	70	70	210
Sponsored Project Funding	20,000,000	20,000,000	20,000,000	60,000,000
Publications in Academic Peer-Reviewed Journals	92	92	92	276
License and Options Income	50,000	50,000	50,000	150,000
Startups	1	0	1	2
Startup Investments	0	0	0	0
Startup FTEs	3	0	3	6

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Improving Health
Program Name: KEYS and Engaged Training

Problem Statement:

As one of the core tenets of our mission, we are committed to training and inspiring our next generation of scientists. Many students interested in the biosciences are never able to practice and contribute to hands-on research in actual laboratories. Through BIO5's KEYS Research Internship Program, we provide real-world application of classroom learning to spark intellectual and creative curiosity and connect Arizona's excelling students with UArizona while still in high school. These real-world laboratory experiences with BIO5 build a pipeline of talent into our state universities, prepare students for success in college and career, and help strengthen our state's future knowledge-based workforce.

Program Description:

BIO5 engages and trains our future generations of scientists through innovative internship programs and an interactive learning environment that promotes experiential learning and STEM proficiency in Arizona. Undergraduates, graduates, postdocs, and even high school interns experience practical application of what they learn in the classroom by working side by side with world-class researchers in BIO5 labs. Forty percent of those working in BIO5 are students. We will continue to engage the pipeline of trainees from the high school through postdoc levels through programs like KEYS and active learning research opportunities for UArizona students. We will also demonstrate how student success and experiential research are integrally linked. Our KEYS Research Internship Program binds talented high school students to UArizona early, which often provides the foundation to keep them in Arizona for, and after, college.

What is the University's Advantage and/or Anticipated Funding Opportunities?

The seven-week KEYS Research Internship Program offers a unique opportunity to talented high school students who have a strong interest in science, health, or the environment. The internship provides students with laboratory experience and the ability to work with world-class scientists on real research projects. Since 2007, 526 students have completed the KEYS internship. Of those, 71 percent have chosen to stay in Arizona for college, with the majority of those attending UArizona. KEYS alumni are automatically accepted into UArizona's Honors College, and most pursue STEM-related degrees and careers. BIO5 also engages students at post-secondary levels through initiatives including the Student-Industry Networking Event, Post-Doctoral Fellowship program, and the BIO5 Ambassadors program.

Is there an Arizona Specific Benefit or Impact?

•Increased student participation in KEYS statewide through both a computational, remote version and an in-person laboratory-based version, boosting the interest in STEM careers among Arizona high school students
•Increased number of companies and external entities who participate in activities such as the student-industry networking event leading to connections and internships
•Increased number of well-trained personnel from bachelors to doctoral levels available to work with and/or be hired by our Arizona biosciences industry

Investment Detail

	2022	2023	2024	Total
Infrastructure	687,029	687,029	687,029	2,061,087
Basic Research	74,255	74,255	74,255	222,765
Applied Research	74,255	74,255	74,255	222,765
Development	0	0	0	0
Technology Transfer	87,196	87,196	87,196	261,588
Total	922,735	922,735	922,735	2,768,205

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	0	0	0	0
Graduate Students	0	0	0	0
Undergraduate Students	50	50	50	150
Sponsored Project Funding	0	0	0	0
Publications in Academic Peer-Reviewed Journals	12	12	12	36
License and Options Income	0	0	0	0
Startups	0	0	0	0
Startup Investments	0	0	0	0
Startup FTEs	0	0	0	0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Water, Environmental and Energy Solutions
Program Name: Observation Systems for Resilience Monitoring and Modeling

Problem Statement:

We can better prepare for change if we are able to monitor it in real time. Data related to weather, water resources, soil and vegetation conditions, air quality, greenhouse gases, wind and solar energy, and other conditions allow us to predict what we might expect in the future and plan accordingly. Monitoring parameters on the ground, while critically important, is time and labor intensive, and each monitoring point has only a limited radius of relevance. Monitoring from above ground using instruments on airplanes, balloons, and satellites permits greater spatial coverage and sampling frequency. Combined, these methods produce higher-resolution results and improved predictions.

Program Description:

Leveraging our existing strengths and programs, we will launch a regional-scale climate forecasting center and produce energy forecasting products codeveloped with utilities. We will contribute to science, policy, economic, and technology solutions to help monitor and manage greenhouse gas emissions and develop more refined local and regional-scale climate, weather, and other models. We also will grow partnerships with communities to codevelop data and information products that allow them to make decisions based on greater understanding of probable conditions.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has long-established expertise in space exploration and remote sensing, the study of Earth processes, and climate-related modeling, which, when combined, yield the potential for powerful new observation-based products and physical and economic forecasts. While efforts are distributed in colleges and institutes across the university, the globally recognized Arizona Remote Sensing Center aggregates experts and programs specifically dedicated to supporting decisions informed by its products and services. New programs are designed for identifying ways for communities to identify large methane emitters and other major carbon producers, anticipate growing conditions, help the military prepare for changing conditions and mitigate hazards, and evaluate the economic costs of environmental impacts.

Is there an Arizona Specific Benefit or Impact?

- New partnerships with Arizona and other industries and communities
- Development of new water and energy management and forecasting tools for Arizona resource managers, industry, and utilities
- Establishment of a new regional-scale climate forecasting center
- Development of new means to monitor and help manage greenhouse gas emissions
- Creatation of new energy forecasting products codeveloped with utilities

Investment Detail

	2022	2023	2024	Total
Infrastructure	548,908	349,305	349,305	1,247,518
Basic Research	43,146	129,439	129,439	302,024
Applied Research	302,025	302,025	302,025	906,075
Development	43,146	129,439	129,439	302,024
Technology Transfer	101,328	101,328	101,328	303,984
Total	1,038,553	1,011,536	1,011,536	3,061,625

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	431,465	215,732	215,732	862,929
Postdocs Supported	4	4	4	12
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	5,666,667	5,666,667	5,666,667	17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
License and Options Income	0	0	0	0
Startups	0	0	1	1
Startup Investments	0	33,000	66,000	99,000
Startup FTEs	0	1	1	2

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Water, Environmental and Energy Solutions
Program Name: Building Resilience from Environmental to Human Health

Problem Statement:

Arizona's changing climate, population, demographics, and land use patterns, as well as sudden shocks to the system from pandemics, heat waves, wildfires, and other natural phenomena, bring a continuous stream of health challenges to our communities. People are moving closer to the urban/wild interface, and changing climate brings new or more intense natural hazards and new vectors for disease transmission into our region. Communities need reliable information about the nature and extent of threats, the economic costs of threats and possible counter actions, where the greatest vulnerabilities lie, and scenarios for building resiliency to their effects. Resource use and extraction industries are critical to the Arizona economy but have an impact to our environment that needs to be addressed.

Program Description:

New research will advance our understanding of the impacts of heat, drought, and other climate impacts as well as of sources of contaminants to water, air, and food systems in order to help develop early warning systems that preempt environment-human crises. Researchers will collaborate with communities to develop mitigation strategies, produce scenario evaluation tools, and build community education programs. New approaches to mining and reclamation will enable these industries to prosper while preserving our environment.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona researchers study major public health issues such as those due to vector-, air-, and water-borne diseases; heat waves; and water and food contamination as they relate to a changing climate. In addition, UArizona is helping to develop a worldwide early warning system for monitoring other emerging zoonotic mutations with human crossover potential. A newly formed collaborative for global adaptive pandemic solutions led by UArizona places us at the forefront of research dedicated to identifying and filling knowledge gaps to better prepare for pandemic impacts by dedicating attention to prophylactics and treatments that are ready for deployment when needed.

Is there an Arizona Specific Benefit or Impact?

- Establishment of new partnerships with Arizona communities, governments, and tribes to help them prepare for heat, drought, and disease-related impacts associated with climate change and to build resilience to future threats
- Development of new threat-warning and evaluation tools for resource managers, utilities, and industry
- Creatation of solutions aimed at combating pandemics and addressing their social and economic impacts
- Support for the sustainability of the Arizona mining industry through new partnerships and approaches

Investment Detail

	2022	2023	2024	Total
Infrastructure	548,908	349,305	349,305	1,247,518
Basic Research	43,146	129,439	129,439	302,024
Applied Research	302,025	302,025	302,025	906,075
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Technology Transfer	101,328	101,328	101,328	303,984
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Performance Measures

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Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	5,666,667	5,666,667	5,666,667	17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
License and Options Income	0	0	0	0
Startups	0	1	0	1
Startup Investments	0	34,000	68,000	102,000
Startup FTEs	0	1	1	2

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Water, Environmental and Energy Solutions

Program Name: Future-Proofing Arizona Water

Problem Statement:

From farmers and ranchers to tourists, developers, miners, and legislators, Arizonans are concerned about the state's water supply. We seek reliable supplies of clean water for our municipalities, industries, and ecosystems. We seek new technologies to treat contaminated water and new means to use it more efficiently and distribute it equitably. The science and technology of clean and reliable water is extremely important, as is having people understand the options and trade-offs associated with alternative paths forward and encouraging the exploration of creative new ways to manage water in the state.

Program Description:

Water resources are arguably among the most—if not the most—pressing environmental issue facing Arizona. To ensure a reliable and safe water supply for all Arizonans, we will form new types of partnerships between scientists, engineers, and policymakers; produce concept papers that connect science to policy and bring science to bear on addressing and resolving water management challenges; commercialize new water treatment technologies; promote a greater diversity of voices influencing water resources management; and engage in innovative partnerships with the private sector.

What is the University's Advantage and/or Anticipated Funding Opportunities?

Ranked No. 1 in the nation in water resources, the UArizona has more than 280 faculty and researchers in 48 departments and programs that specialize in topics related to water. Expertise ranges from the physical and social sciences, economics, and public policy to civil engineering, biology, and environmental chemistry, addressing drought and climate, environmental systems, management and policy, society and culture, and technology and industry. UArizona works with numerous stakeholder communities at federal, tribal, regional, state, and local scales to develop water management plans and policies, and runs the Arizona Laboratory for Emerging Contaminants. Additionally, the Water and Energy Sustainable Technology (WEST) Center develops new methods to detect, quantify, and treat contaminants in water.

Is there an Arizona Specific Benefit or Impact?

- Establishment of new partnerships with water managers and policymakers in Arizona and the Southwest, ranging from small communities to large municipalities and state/regional scale
- New water policies and management decisions informed with science
- Creation of new water quality and water management tools and technologies codeveloped with users

Investment Detail

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Infrastructure	548,908	349,305	349,305	1,247,518
Basic Research	43,146	129,439	129,439	302,024
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Publications in Academic Peer-Reviewed Journals	14	14	14	42
License and Options Income	0	0	0	0
Startups	0	0	0	0
Startup Investments	0	0	0	0
Startup FTEs	0	0	0	0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Water, Environmental and Energy Solutions
Program Name: Adaptable Desert Communities, Culture, and Ecosystems

Problem Statement:

For humans to continue to live in arid lands, we must understand how we can be resilient to impacts associated with climate change and other stresses affecting the linked human and natural systems of the desert. Southern Arizona and northwest Mexico are in the crosshairs of global climate change. Many changes that will eventually affect the rest of the world are starting here in the arid Sonoran Desert; our experiences can inform communities across the globe. Integrated research, education, and outreach grounded in community needs is necessary to guide actions, policies, and decisions that preserve and enhance these linked cultural and ecological systems.

Program Description:

With our history and living-laboratory location in the Sonoran Desert, we will draw upon our geographic heritage, experience, skills, expertise, and relationships with Southern Arizona communities to provide resilience solutions for arid lands in other parts of the world. Additionally, we will establish a program of science, culture, and art; form transdisciplinary university/stakeholder working groups to accelerate innovative solutions to the challenges of future life in the desert; and launch undergraduate, graduate, and community experiential courses that train the next generation of researchers in resilience thinking and science.

What is the University's Advantage and/or Anticipated Funding Opportunities?

In April 2020, the UArizona established the Arizona Institutes for Resilience (AIR) to aggregate its unique resources and programs under one administrative unit, which will strengthen this initiative. More than a century of research at the Desert Laboratory at Tumamoc Hill has revealed how life has adapted to an arid and unpredictable environment. Building on data from long-term plots, knowledge of ecosystem responses to prior climate changes, and an understanding of the persistence of humans in this region, we can transform how we address future ecological challenges. The potential and opportunities of the Desert Lab are significant and range from place-based research to field courses and programs for students and the community in culture, arts, and sciences. In addition to Tumamoc Hill, activities at Biosphere 2 likewise blend ecosystem science with arts and culture at a world-renowned, unique, controlled-environment research facility.

Is there an Arizona Specific Benefit or Impact?

- Production of science-based information products that use our unique research laboratories
- Increased education of communities about the impacts of climate change and how to build resiliency to change through science, culture, and the arts by taking advantage of the public interest in Tumamoc Hill and Biopshere 2
- Recognition as a world leader in developing and implementing resilience solutions for arid lands elsewhere
- Establishment of new university-community partnerships working together to develop new approaches to resiliency
- Increased number of students learning about resilience science through hands-on experiences and experimental courses

Investment Detail

	2022	2023	2024	Total
Infrastructure	548,907	349,304	309,304	1,207,515
Basic Research	43,146	129,439	129,439	302,024
Applied Research	302,025	302,025	302,025	906,075
Development	43,146	129,439	129,439	302,024
Technology Transfer	101,328	101,328	101,328	303,984
Total	1,038,552	1,011,535	971,535	3,021,622

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	431,464	215,732	215,732	862,928
Postdocs Supported	4	4	4	12
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	5,666,667	5,666,667	5,666,667	17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
License and Options Income	0	0	0	0
Startups	0	0	0	0
Startup Investments	0	0	0	0
Startup FTEs	0	0	0	0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Water, Environmental and Energy Solutions
Program Name: Fostering Leaders in Resilience

Problem Statement:

Arizona is home to a diverse population with varying strengths, interests, and vulnerabilities. Preparing for a resilient future requires our next generation of leaders and decision makers to reflect that diversity and be able to communicate across sectors and disciplines. STEM training is necessary, particularly for the initiatives described in this planning document, but with fluency that goes beyond just STEM. New cross-disciplinary fields are emerging that mix science with technology or policy, for example, and we need to draw students into them. Students, in turn, seek opportunities to make a difference in their communities even before they graduate.

Program Description:

To prepare the next generation for the future workplace and guide students on a career path related to resilience, we will increase diversity in existing scholarship and internship programs; design and implement experiential learning curricula; expand internship programs to include more opportunities, especially with underserved populations and for less advantaged students; offer more leadership training and mentoring for junior faculty via TRIF-funded programs; grow programs to reach K-12 students in STEM and attract them to the university; and create and offer new environment-focused courses that allow high school students to gain UArizona credit.

What is the University's Advantage and/or Anticipated Funding Opportunities?

The university has established programs in science communications training for graduate students and faculty, experiential learning, and cross-disciplinary collaboration, with strong ties and programs supporting Hispanic and Indigenous communities. This program will be expanded and adapted to undergraduate students. New internship programs will place students in paid positions in the community where they can test potential careers while providing valuable service to local organizations. UArizona also supports several programs that train teachers to bring STEM into K-12 classrooms and is developing a series of environment-focused dual enrollment classes that will allow high school students to gain UArizona credit and familiarity with the many paths an environmental degree can follow.

Is there an Arizona Specific Benefit or Impact?

- Provide increased opportunities for resilience-focused experiential learning through courses and internships
- Increase the number of students engaging in resilience-related training
- Increase the number of students from underserved populations engaged in environmental and resilience-focused programs
- Increase involvement by junior faculty in applied resilience-focused research that engages with communities, strengthening ties between the university and Arizona communities
- Increase the scientific and technical knowledge of Arizona communities through greater engagement with university students and faculty

Investment Detail

	2022	2023	2024	Total
Infrastructure	548,907	349,304	349,304	1,247,515
Basic Research	43,146	129,439	129,439	302,024
Applied Research	302,025	302,025	302,025	906,075
Development	43,146	129,439	129,439	302,024
Technology Transfer	######	######	######	303,984
Total	1,038,552	1,011,535	1,011,535	3,061,622

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	431,464	215,732	215,732	862,928
Postdocs Supported	5	5	5	15
Graduate Students	30	30	30	90
Undergraduate Students	25	25	25	75
Sponsored Project Funding	5,666,667	5,666,667	5,666,667	17,000,001
Publications in Academic Peer-Reviewed Journals	5	5	5	15
License and Options Income	0	0	0	0
Startups	0	0	0	0
Startup Investments	0	0	0	0
Startup FTEs	0	0	0	0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Water, Environmental and Energy Solutions
Program Name: Resilient Systems Integration

Problem Statement:

Transformational changes in our production of secure and sustainable energy, food, and water sources, and in the efficient use of energy, are among the most significant global challenges of the 21st century. As energy demands, food scarcity, and climate variability increase, the means to create and maintain reliable and resilient energy delivery systems, food production systems, and water supplies sufficient to sustain and enhance our society, our economy, and our ecosystems are of paramount importance, especially in regions like Arizona and the Southwest. An integrated and aggressive approach that incorporates economic considerations is required to solve these problems, especially as these regions are home to many communities that are particularly vulnerable to such changes.

Program Description:

We will develop new materials, technologies, and operations targeted to energy-efficient water reuse and purification for all sectors as well as smarter data and decision-making platforms with robust links to policy and decision-making processes for water and energy production and use. We also will integrate new science and technology with policy development, decision making, support, and education; produce new designs of the future for a more resilient and efficient urban and rural environment; and create regional test beds and new public-private partnerships.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona researchers are at the forefront of the food-energy-water nexus, exploring ways to address our scientific, technological, economic, and societal challenges. UArizona partnerships with Indigenous communities, particularly the Navajo Nation, are developing technical solutions to build reliable, affordable access to energy, water, and food while training the next generation of food-energy-water systems professionals to tackle these challenges. The university has been a pioneer in the development of agrivoltaics, with the flagship project at Biosphere 2 named a 2018 World Changing Idea, subsequent experiments initiated at local area schools, and discussions expanded to large-scale Arizona growers. UArizona researchers work closely with government officials in Yuma to enhance agriculture in the region, where food, energy, and water are of great socioeconomic importance, but would be scarce if not for thoughtful, informed resource management. Further, UArizona's new RESTRUCT program harnesses expertise from across the university to address the complex design, engineering, social, economic, and environmental challenge of envisioning, defining, and advancing the future built infrastructure. Various organizations such as the British Standards Institution, the Marriott Corporation, and the Campbell Gray Hotel group, as well as universities across the US, acknowledge our expertise and leadership.

Is there an Arizona Specific Benefit or Impact?

- New partnerships with Arizona industry and government
- Creation of better data and decision-making platforms for resource managers, utilities, and others users
- Creation of knowledge for policymakers and decision makers arising from university-community partnerships
- Development of new materials, technologies, and operations targeted to energy-efficient water reuse and purification
- Integration of new science and technology with policy development, decision making, and education

Investment Detail

	2022	2023	2024	Total
Infrastructure	548,908	349,305	349,305	1,247,518
Basic Research	43,146	129,439	129,439	302,024
Applied Research	302,025	302,025	302,025	906,075
Development	43,146	129,439	129,439	302,024
Technology Transfer	101,328	101,328	101,328	303,984
Total	1,038,553	1,011,536	1,011,536	3,061,625

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	$ 431,465	$ 215,732	$ 215,732	862,929
Postdocs Supported	4	4	4	12
Graduate Students	20	20	20	60
Undergraduate Students	15	15	15	45
Sponsored Project Funding	5,666,667	5,666,667	5,666,667	17,000,001
Publications in Academic Peer-Reviewed Journals	14	14	14	42
License and Options Income	0	0	0	0
Startups	0	0	1	1
Startup Investments	0	33,000	66,000	99,000
Startup FTEs	0	1	1	2

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Cyber Defense

Problem Statement:

Our hyper-digital world, where anything that can be referred to as a "device" is probably connected or connectable to the internet, creates a vast attack surface for bad behavior, whether from script-kiddies, criminals, or nation states. This is true for commercial, government, consumer systems, and a wide swath of America's defense systems. Preventing attacks that deny or degrade the confidentiality, integrity, or availability of the data or systems is critical to a well-functioning military, economy, and society.

Program Description:

TRIF investments in cyber defense activities are intended to develop countermeasures and solutions to phishing, ransomware, advanced persistent threat, and more subtle attack mechanisms.

What is the University's Advantage and/or Anticipated Funding Opportunities?

The university is home to talented and innovative electrical and computer engineers and scientists and draws globally competitive students to Arizona. They are backed by top physicists and mathematicians, and they have access to some of the most advanced modeling and research platforms in the world. Our College of Applied Science and Technology (CAST) in Sierra Vista offers degree and certificate programs to train personnel in machine learning, artificial intelligence, and cybersecurity. We have achieved the highest level of recognition from defense agencies for our ability to contribute to solutions in this area.

Is there an Arizona Specific Benefit or Impact?

- Open-source solutions
- Increased industrial-sponsored research in cyber defense
- Increased federal, defense, and intelligence agency sponsored projects
- Increased recruiting of top faculty and students
- Increased licensing and tech transfer impacts

Investment Detail

	2022	2023	2024	Total
Infrastructure	395,213	494,016	494,016	1,383,245
Basic Research	176,037	220,047	220,047	616,131
Applied Research	258,879	323,598	323,598	906,075
Development	258,879	323,598	323,598	906,075
Technology Transfer	121,593	151,991	151,991	425,575
Total	1,210,601	1,513,250	1,513,250	4,237,101

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	207,103	258,879	258,879	724,861
Postdocs Supported	1	1	1	3
Graduate Students	3	3	3	9
Undergraduate Students	2	2	2	6
Sponsored Project Funding	1,666,667	1,666,667	1,666,667	5,000,001
Publications in Academic Peer-Reviewed Journals	17	22	22	61
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Cyber Exploitation

Problem Statement:

Understanding how our digital systems can be adversely impacted by bad actors starts with the initiative on cyber defense, outlined above. The cyber exploitation initiative focuses on the second and third order effects when a breach occurs: How we delay, deny, and defeat attempts to cause our digital systems to mislead us, perform in unintended and dangerous ways, or slow down or confuse the integrated or cyber-physical systems with which they are associated.

Program Description:

TRIF investments in cyber exploitation technologies will deliver techniques, software, and improved instruction in methods to ensure the safe and continuous operation of systems that have been challenged or threatened.

What is the University's Advantage and/or Anticipated Funding Opportunities?

We are fortunate to have faculty and staff with real-world experience dealing with these threats for the Department of Defense and in industrial settings. Again, in this area, we have achieved the highest level of recognition from defense agencies for the quality of our faculty, infrastructure, and instruction.

Is there an Arizona Specific Benefit or Impact?

- Open-source solutions
- Increased industrial-sponsored research in cyber exploitation
- Increased federal, defense, and intelligence agency sponsored projects
- Increased recruiting of top faculty and students
- Increased Licensing and tech transfer impacts

Investment Detail

	2022	2023	2024	Total
Infrastructure	203,594	152,696	152,696	508,986
Basic Research	176,037	132,028	132,028	440,093
Applied Research	424,561	318,421	318,421	1,061,403
Development	258,879	194,159	194,159	647,197
Technology Transfer	121,593	91,195	91,195	303,983
Total	1,184,664	888,499	888,499	2,961,662

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	207,103	155,327	155,327	517,757
Postdocs Supported	1	1	1	3
Graduate Students	4	4	4	12
Undergraduate Students	3	3	3	9
Sponsored Project Funding	1,666,667	1,666,667	1,666,667	5,000,001
Publications in Academic Peer-Reviewed Journals	17	13	13	43
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Human-Computer Interactions

Problem Statement:

Computer systems used to be designed to respond to human input efficiently and consistently. With wearables, digital assistants, ubiquitous data, and artificial intelligence-infused and connected objects, we now require approachable, accessible, efficient interactions for compute-capable platforms to interact with humans. In many critical applications and systems, we also have moved from a time of a human operator in the control loop, to a human supervisor on the control loop. Safety, ergonomics, multi-sensory interactions, and intuitive interfaces are critical.

Program Description:

Research in the area of human-computer interaction should reduce errors in the use of our defense systems, reduce the training burden as users transition to new systems, and reduce human stress in the use of these systems.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has strong electrical and computer engineering faculty as well as depth in artificial intelligence and mathematics. We have strong language centers; psychology, physiology, and social sciences faculty; and design themes around strengthening the built environment. These multidisciplinary talents will help us shape the interface between the real world and digital terrain, building efficiency and removing impediments to national security system interfaces and practices.

Is there an Arizona Specific Benefit or Impact?

- Increased industrial-sponsored research in human-computer interactions
- Increased federal, defense, and intelligence agency sponsored projects
- Increased recruiting of top faculty and students
- Increased licensing and tech transfer impacts

Investment Detail

	2022	2023	2024	Total
Infrastructure	101,798	101,798	101,798	305,394
Basic Research	129,439	129,439	129,439	388,317
Applied Research	212,280	212,280	212,280	636,840
Development	88,019	88,019	88,019	264,057
Technology Transfer	60,796	60,796	60,796	182,388
Total	592,332	592,332	592,332	1,776,996

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	103,551	103,551	103,551	310,653
Postdocs Supported	0	0	0	0
Graduate Students	3	3	3	9
Undergraduate Students	3	3	3	9
Sponsored Project Funding	1,666,667	1,666,667	1,666,667	5,000,001
Publications in Academic Peer-Reviewed Journals	9	9	9	27
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Advanced Energy Systems

Problem Statement:

Energy systems are required everywhere from deep sea to space, and from miniature applications to electrical grid storage devices. Meeting these demands requires a broad range of energy systems with discrete size, weight, power density, capacity, and cost targets. New approaches to providing these solutions are slow to emerge in the commercial market and must rely on fundamental and applied research that can rapidly scale and transition to commercial production.

Program Description:

We anticipate making advances in fundamental science, prototype systems, and teaching and learning that ensure Arizona serves the needs of commerce and the military, and that the state is an attractive destination for these industries.

What is the University's Advantage and/or Anticipated Funding Opportunities?

These solutions require the combined creativity of electrical, mechanical, and systems engineers, materials scientists, and application space expertise. The close-knit activities between the UArizona Colleges of Engineering and Science faculty are ideal for attacking these problems.

Is there an Arizona Specific Benefit or Impact?

•Increased industrial-sponsored research in energy systems
•Increased federal, defense, and intelligence agency sponsored projects
•Increased recruiting of top faculty and students
•Increased licensing and tech transfer impacts

Investment Detail

	2022	2023	2024	Total
Infrastructure	368,267	368,267	368,267	1,104,801
Basic Research	132,028	132,028	132,028	396,084
Applied Research	194,159	194,159	194,159	582,477
Development	132,028	132,028	132,028	396,084
Technology Transfer	91,195	91,195	91,195	273,585
Total	917,677	917,677	917,677	2,753,031

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	155,327	155,327	155,327	465,981
Postdocs Supported	1	1	1	3
Graduate Students	3	3	3	9
Undergraduate Students	2	2	2	6
Sponsored Project Funding	1,666,667	1,666,667	1,666,667	5,000,001
Publications in Academic Peer-Reviewed Journals	13	13	13	39
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Advanced Manufacturing

Problem Statement:

Advanced manufacturing (AM) includes concepts in rapid prototyping and parts-on-demand, additive manufacturing (e.g., 3D printing), sustainable and environmentally sound processes, and advanced robotics and other forms of automation. Enabling technologies can include materials, equipment, processes, software, and computation. AM has the potential to shorten product development timelines, improve worker safety, increase production, reduce waste, and preserve the natural environment. Significant challenges remain for widespread implementation of many AM technologies and include materials research, robotics, in-process quality control, and product inspection.

Program Description:

Presently there are several elements of AM that are coalescing around areas such as aerospace research. These elements include advanced materials and additive manufacturing. TRIF funding will help accelerate and expand these efforts, fostering maturation toward larger extramural funding mechanisms. Opportunities exist for novel application of AM to new domains, and TRIF resources will be devoted to supporting projects that will target these opportunities with unique ideas. Over the next five years, we expect continued aggregation of related areas of research (e.g. AR/VR, advanced materials, robotics) around AM, facilitated by TRIF support.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has many research programs and experienced investigators active in new materials development, additive manufacturing equipment and processes, artificial intelligence for process improvement, environmental engineering, and advanced robotics. In one particular area of AM, additive manufacturing, faculty across several units have collaborated to form the Additive Manufacturing Initiative. This group seeks to leverage faculty expertise and resources to further research and training in the application of 3D printing to challenges in manufacturing in extreme conditions, next-generation manufacturing, and adaptive process control. The team also has initiatives in workforce development, including using virtual and augmented reality technology to teach advanced manufacturing practices.

Is there an Arizona Specific Benefit or Impact?

- Maturation of at least one program area into a research center focused on AM
- Increased coordination of related research and technologies around AM
- Development of new application areas for AM and the number of potential sponsors of extramurally funded research
- Cultivatation of a larger number of partnerships with a growing AM industry base, particularly those in Arizona

Investment Detail

	2022	2023	2024	Total
Infrastructure	497,159	497,159	497,159	1,491,477
Basic Research	178,238	178,238	178,238	534,714
Applied Research	262,115	262,115	262,115	786,345
Development	178,238	178,238	178,238	534,714
Technology Transfer	123,113	123,113	123,113	369,339
Total	1,238,863	1,238,863	1,238,863	3,716,589

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	209,692	209,692	209,692	629,076
Postdocs Supported	1	1	1	3
Graduate Students	3	3	3	9
Undergraduate Students	2	2	2	6
Sponsored Project Funding	2,083,333	2,083,333	2,083,333	6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Novel Materials

Problem Statement:

Military systems operate in extreme environments that pose challenges to structural and packaging materials. Their energy systems require lightweight and high-electrical discharge capabilities. The structures require materials systems with unique fastening and joining methods. Increasingly, those materials must accommodate additional functionality and embedded systems than previous systems.

Program Description:

We expect substantial progress in fundamental materials development, testing, and evaluation of coupon (small materials samples) and larger scale-up materials models, technical artifacts, and prototypes.

What is the University's Advantage and/or Anticipated Funding Opportunities?

Through growing collaborations with Arizona's resident military and intelligence components, our scientists are increasingly familiar with the operational and design issues that these systems must accommodate.

Is there an Arizona Specific Benefit or Impact?

- Increased industrial-sponsored research in novel materials
- Increased federal, defense, and intelligence agency sponsored projects
- Increased recruiting of top faculty and students
- Increased licensing and tech transfer impacts

Investment Detail

	2022	2023	2024	Total
Infrastructure	299,404	299,404	299,404	898,212
Basic Research	129,439	129,439	129,439	388,317
Applied Research	103,551	103,551	103,551	310,653
Development	25,888	25,888	25,888	77,664
Technology Transfer	60,796	60,796	60,796	182,388
Total	619,078	619,078	619,078	1,857,234

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	258,879	258,879	258,879	776,637
Postdocs Supported	0	0	0	0
Graduate Students	3	3	3	9
Undergraduate Students	3	3	3	9
Sponsored Project Funding	1,666,667	1,666,667	1,666,667	5,000,001
Publications in Academic Peer-Reviewed Journals	9	9	9	27
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Internet of Things (IoT)

Problem Statement:

The Internet of Things (IoT) is represented by devices with a multitude of capabilities, including self-identification, localization, diagnostic status, data acquisition, processing, and device-to-device and device-to-network communication. Devices function under the umbrella of the internet, which serves as a means of data transfer and communication. Application areas can be broadly categorized in terms of consumer, organizational, industrial, infrastructure, and military sectors. Technologies that support the IoT include wireless, low-power consumption electronics, energy storage, miniaturization, cloud computing, and data analytics. While deployment of IoT systems began in the early 2000's, barriers such as compatibility and lack of a clear value-proposition have hampered adoption. Security and privacy concerns with respect to data usage also have tempered enthusiasm.

Program Description:

We anticipate this initiative will focus resources around current areas of demonstrable leadership in IoT technologies (e.g., transportation, agriculture, mining), as well as emerging areas (e.g., health monitoring), to deepen expertise and solidify critical mass. Over the next five years, one or more of these programs will be capable of maturation to national research center status, with commensurate federal funding support (e.g., ERC, MURI, NIH P01 or P50). TRIF funding also would support smaller programs in a "seed and feed" approach. The nature of IoT research involves a wide application space, and new discoveries can potentially be directed toward a myriad of applications and/or combined with related technologies to address ever-larger challenges. TRIF seed grants in the IoT initiative will be used to ensure that a pipeline of discoveries emerges over the five-year timeframe, and that this culture persists in the future.

What is the University's Advantage and/or Anticipated Funding Opportunities?

As a large land-grant university, UArizona is positioned to address complex system problems in a variety of application domains. Current research in wireless communications, low-energy consumption sensors, agricultural automation, data analytics, machine learning, wearables, advanced manufacturing, robotics, and transportation provide broad capabilities and expertise that can be directed toward important research questions that currently limit the effective application of IoT technologies. The university's ability to form strong academic-industry partnerships can help focus research and accelerate translation through proof-of-concept, technology transfer, and commercialization.

Is there an Arizona Specific Benefit or Impact?

•Development of a community around IoT technologies that includes multiple investigators, a convergence research approach, education and training programs directed toward workforce development, and increased technology transfer activity
•Increased synergy between currently diffuse areas of IoT research and improved competitiveness for large, center-type funding awards
•Development of a robust pipeline of seed projects that address emerging challenges and new application spaces

Investment Detail

	2022	2023	2024	Total
Infrastructure	400,151	400,151	400,151	1,200,453
Basic Research	178,238	178,238	178,238	534,714
Applied Research	262,115	262,115	262,115	786,345
Development	262,115	262,115	262,115	786,345
Technology Transfer	123,113	123,113	123,113	369,339
Total	1,225,732	1,225,732	1,225,732	3,677,196

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	209,692	209,692	209,692	629,076
Postdocs Supported	2	2	2	6
Graduate Students	5	5	5	15
Undergraduate Students	3	3	3	9
Sponsored Project Funding	2,083,333	2,083,333	2,083,333	6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Data Sciences

Problem Statement:

Many areas of the Fourth Industrial Revolution (4IR) produce and/or can benefit from large pools of data. However, data in and of itself is not useful unless properly interpreted. Analytics provides for the systematic computational analysis of data using techniques such as text-to-data (e.g., natural language processing), machine learning, data visualization, and image informatics. Current challenges such as analysis of unstructured data, computation time, predictive accuracy, and complex event processing provide opportunities for additional academic research.

Program Description:

Data sciences is at the core of many research activities at UArizona, and establishment of the Data Science Institute (DSI) has been instrumental in creating an array of capabilities available to many investigators and teams. Over the next five years, this initiative will use TRIF funds to expand the application of data science techniques, in particular the use of DSI, among a broader base of users. We will take concepts, practices, and capabilities from tools like CyVerse and support their expansion beyond life science research so that they can be utilized more broadly. We will support projects that apply data science to more application domains and demonstrate utility in a wider array of problems solving endeavors. TRIF support will also be directed toward the application of data sciences at different size scales. This initiative will support projects that seek to implement the use of data science techniques, especially those that enable data analysis and interpretation in new and novel ways.

What is the University's Advantage and/or Anticipated Funding Opportunities?

Through DSI, numerous faculty across the university have access to core capabilities in many facets of data processing and analysis, visualization, and interpretation. DSI fills the gap between research software and domain science by working with research teams at the cutting edge of data-driven discovery. Currently, DSI offers support in four applied focus areas, including natural language processing, machine learning, large-scale data visualization, and image informatics. Individual investigators working in various 4IR fields can leverage the DSI for their own investigations that require data analytics, as well as collaborate on research that aims to answer important questions and broaden the application of data analytics itself.

Is there an Arizona Specific Benefit or Impact?

•Increased awareness and utilization of data sciences as a research tool, particularly DSI and CyVerse, across all 4IR- related initiatives
•Growth of CyVerse beyond life sciences
•Implementation of data science techniques at a range of dataset size scales

Investment Detail

	2022	2023	2024	Total
Infrastructure	206,139	206,139	206,139	618,417
Basic Research	178,238	178,238	178,238	534,714
Applied Research	429,868	429,868	429,868	1,289,604
Development	262,114	262,114	262,114	786,342
Techonology Transfer	123,113	123,113	123,113	369,339
Total	1,199,472	1,199,472	1,199,472	3,598,416

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	209,692	209,692	209,692	629,076
Postdocs Supported	2	2	2	6
Graduate Students	5	5	5	15
Undergraduate Students	3	3	3	9
Sponsored Project Funding	2,083,333	2,083,333	2,083,333	6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Cyber-Physical Systems

Problem Statement:

Industry has traditionally relied on highly linear data and communications for decision making. Cyber-physical systems (CPS) enables real-time access to data and intelligence from a myriad of sources and locations simultaneously, with the potential to fundamentally change the way businesses operate. Challenges in CPS include many fundamental questions regarding system integration, safety, accuracy, data processing, and reliability.

Program Description:

At present there are several active programs that focus on CPS problems and technologies. TRIF funding would support further growth and expansion. Over the next five years, we expect that the number of competitive grants submissions from these programs will grow and the number of research sponsors will increase beyond past experience, which recently has been limited mostly to NSF. In particular, current opportunities exist with the Department of Defense, NASA, and industry that we can and should pursue. TRIF funding will also make investments to increase UArizona's activities in this domain by bringing current groups together for larger projects, as well as introducing new investigators to the field through seed grants. One area that may be particularly fruitful is CPS application to health care. With the growth of telemedicine, which is largely focused on video-enabled patient interactions (especially during the SARS-CoV-2 pandemic), innovators are turning to the next frontier. This will undoubtably involve CPS-enabled platforms such as remote surgery.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has a history of involvement in CPS research since at least 2014. We held a workshop for faculty interested in CPS funded by the NSF and most recently were awarded another NSF grant in "Computationally Aware Cyber-Physical Systems." UArizona has many units and individual investigators across the university conducting research and student training in the broad field of CPS. The Compositional Systems Labs, housed within Systems and Industrial Engineering and aligned with the UArizona Transportation Research Institute, works in the fields of transportation and autonomous vehicles. The College of Science (Applied Math), Electrical and Computer Engineering, and the Center for Applied Genetics and Genomic Medicine also are engaged in CPS activities.

Is there an Arizona Specific Benefit or Impact?

•Growth of existing CPS activities and an increase in the number of submitted proposals, particularly beyond NSF
•Increased participation of faculty in CPS-related research, especially from related areas (e.g., mechanical engineers that work on the physical systems side)
•Expanded application space for CPS-related technologies in all relevant areas, but importantly in health care

Investment Detail

	2022	2023	2024	Total
Infrastructure	206,139	206,139	206,139	618,417
Basic Research	262,114	262,114	262,114	786,342
Applied Research	429,868	429,868	429,868	1,289,604
Development	178,238	178,238	178,238	534,714
Technology Transfer	123,113	123,113	123,113	369,339
Total	1,199,472	1,199,472	1,199,472	3,598,416

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	209,692	209,692	209,692	629,076
Postdocs Supported	2	2	2	6
Graduate Students	5	5	5	15
Undergraduate Students	3	3	3	9
Sponsored Project Funding	2,083,333	2,083,333	2,083,333	6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Advanced Communications Systems

Problem Statement:

The requirement for assured, secure, and ad hoc communications with independent, remote, and other systems operating under attack requires creative, innovative, and breakthrough approaches to consistently establish connections and deliver that data in a timely way. Quantum communications, optical communications, new approaches to encryption, and other approaches to sound and radio-frequency devices are desperately needed by the military and may add value to the methods of the Fourth Industrial Revolution.

Program Description:

We anticipate the development of fundamental science and prototype systems that, with additional federal or industrial engagement, can lead to effective commercial and military solutions. We would expect to see even greater collaboration among the colleges and such sites as Ft. Huachuca, providing students with multidisciplinary research experiences ready to compete for top jobs in these industries and fields.

What is the University's Advantage and/or Anticipated Funding Opportunities?

The UArizona Colleges of Science, Optical Sciences, and Engineering are perfect sources of these types of solutions. From the $26M NSF-funded Center for Quantum Networks, an engineering research center, to our efforts in the Frontiers of Sound, acoustic waves research for next-generation information processing, we have the skill and the scientific and technical collaborations in place to answer these challenges.

Is there an Arizona Specific Benefit or Impact?

- Increased industrial-sponsored research in advanced communications systems
- Increased federal, defense, and intelligence agency sponsored projects
- Increased recruiting of top faculty and students
- Increased licensing and tech transfer impacts

Investment Detail

	2022	2023	2024	Total
Infrastructure	748,509	748,509	748,509	2,245,527
Basic Research	323,598	323,598	323,598	970,794
Applied Research	258,879	258,879	258,879	776,637
Development	64,720	64,720	64,720	194,160
Technology Transfer	######	######	######	455,973
Total	1,547,697	1,547,697	1,547,697	4,643,091

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	258,879	258,879	258,879	776,637
Postdocs Supported	2	2	2	6
Graduate Students	3	3	3	9
Undergraduate Students	3	3	3	9
Sponsored Project Funding	1,666,667	1,666,667	1,666,667	5,000,001
Publications in Academic Peer-Reviewed Journals	22	22	22	66
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: Artificial Intelligence

Problem Statement:

The field of artificial intelligence (AI) can encompass research in machine learning, computer visioning, and natural language processing. Application of such research can create computational approaches to human-like reasoning that can augment decision making. A laudable goal of AI is to replace human decision making, particularly where the task is extremely complex and/or large amounts of data are involved. The quality of any AI system is dependent on the data used to develop and support it. Major challenges are data quality, bias, structure, labeling, and methods to curate large datasets.

Program Description:

An important objective for TRIF support in the AI initiative is to bring existing research and application capabilities together in new ways to create synergies and increase opportunities for both funding and impact. We expect there are step-function gains that can be realized by connecting investigators and seeding new projects that will expand the development and application of AI. At present, there is fervent excitement around AI that is making it challenging to understand what represents true opportunity for UArizona. TRIF funding will be employed to bring together AI investigators from across campus to sort through potential strategies for expansion of AI research and technologies and determine the best path. We expect at least one outcome to be a cogent roadmap that will help UArizona establish itself as a leader in AI in one or more research and/or application domains.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona currently deploys AI approaches across several research domains, including AI research itself. Recent and current programs include applications of AI in cybersecurity, space exploration, health care, education, sustainability, transportation, and border security. UArizona investigators are developing new approaches to AI itself, such as machine learning algorithms that adapt over time. Current efforts span multiple departments and colleges and provide the potential to pull teams of AI specialists together to address even larger challenges.

Is there an Arizona Specific Benefit or Impact?

•Development of an AI roadmap that details a strategy for UArizona to follow toward a position of national prominence
•Determination of AI-related areas where UArizona can be competitive and establish world-class programs
•Demonstration of UArizona leadership in one or more research or application domains related to AI (e.g., major grant award, center of excellence)

Investment Detail

	2022	2023	2024	Total
Infrastructure	606,292	606,292	606,292	1,818,876
Basic Research	262,115	262,115	262,115	786,345
Applied Research	209,692	209,692	209,692	629,076
Development	52,422	52,422	52,422	157,266
Technology Transfer	123,113	123,113	123,113	369,339
Total	1,253,634	1,253,634	1,253,634	3,760,902

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	209,692	209,692	209,692	629,076
Postdocs Supported	0	0	0	0
Graduate Students	1	1	1	3
Undergraduate Students	3	3	3	9
Sponsored Project Funding	2,083,333	2,083,333	2,083,333	6,249,999
Publications in Academic Peer-Reviewed Journals	17	17	17	51
License and Options Income	0	0	0	0
Startups	0	1	2	3
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	3	4

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: National Security Systems
Program Name: 4th Industrial Revolution Workforce Development

Problem Statement:

The Fourth Industrial Revolution is characterized by a period of an unprecedented rapid change. Concepts are advancing so quickly to implementation, led mostly by large companies, that the existing workforce struggles to keep pace. Moreover, academic programs that would train the pool of new workers are falling behind the demand for skills in new employees. Particularly in STEM fields, the imperative for a focus on fundamentals and connection of theory to practice leaves little room for additional training in areas required for the 4IR. Development of new programs that can address the training of both existing workers and current students is necessary to feed the needs of the 4IR workforce.

Program Description:

TRIF funding will support the expansion of STEM education programs at UArizona, especially in those that target growth in enrollment from groups underrepresented in fields of study related to 4IR. We will seek out and fund initiatives that bring faculty and staff together to address an urgent need for the 4IR workforce of the future. Several funding agencies, particularly those in the Department of Defense, are launching new programs related to STEM education and workforce development to fill a current pipeline that has been diminishing over time in the US. We will employ TRIF funding strategically to strengthen programs so that they are competitive on a national level.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona already has institutional strengths in STEM fundaments education, as well as ongoing emphasis in connecting theory to practice with curricula, such as our four-year Craig M. Berge Engineering Design Program. Faculty with expertise in pedagogical, social, and behavioral research can complement ongoing program development to help implement new teaching modalities (e.g., online learning), and we can expand industry partnerships not only to serve workers interested in continuing education, but also to provide internship and co-op opportunities to traditional students. Current programs such as the Catapult Engineering Program seek to support and mentor underrepresented groups to help students persist in their degrees and graduate.

Is there an Arizona Specific Benefit or Impact?

- Development of innovative STEM-based workforce development programs, particularlyfor the pipeline shortages for government and industry
- Success in competing for at least one major STEM training grant
- Growth in partnerships with stakeholders such as government labs and industry to better align workforce development programs with their needs and expand experiential learning for students
- Launch of at least one workforce development program that partners with K-12 and community colleges, across a spectrum of institutions but especially in areas with disadvantaged and/or underserved populations

Investment Detail

	2022	2023	2024	Total
Infrastructure	336,830	336,830	336,830	1,010,490
Basic Research	145,619	145,619	145,619	436,857
Applied Research	116,495	116,495	116,495	349,485
Development	29,124	29,124	29,124	87,372
Technology Transfer	68,396	68,396	68,396	205,188
Total	696,464	696,464	696,464	2,089,392

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	116,495	116,495	116,945	349,935
Postdocs Supported	0	0	0	0
Graduate Students	1	1	1	3
Undergraduate Students	3	4	5	12
Sponsored Project Funding	2,083,333	2,083,334	2,083,335	6,250,002
Publications in Academic Peer-Reviewed Journals	10	11	12	33
License and Options Income	0	0	0	0
Startups	0	1	1	2
Startup Investments	0	500,000	750,000	1,250,000
Startup FTEs	0	1	1	2

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Space Exploration and Optical Sciences
Program Name: University of Arizona Space Institute

Problem Statement:

UArizona has an unparalleled history of involvement and leadership of major space science facilities and missions, both space-based and ground-based. Competition within academia, industry, and the federal government, however, has developed strong infrastructures for proposal development and project management, while UArizona has simply maintained its previously successful approach. The competitive landscape has changed, and UArizona must develop common infrastructure among space exploration and optical sciences to more effectively compete for research support in the future.

Program Description:

The University of Arizona Space Institute (UASI) will provide a structure to aid in the development, proposal, and operation of large spacecraft missions and space- and ground-based instruments. By increasing both the number of operational projects and the support to develop them, UASI will help supply and retain the necessary workforce, providing the engineering and scientific expertise to develop, advance, propose, and operate the next generation of large projects funded by NASA, NSF, NOAA, and other government agencies. Successful proposal of such major missions and projects takes years of work, which is usually beyond the means of individual investigators or departments to support. The integrated UASI enables such long-term, higher-profile investments.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona was the first university to manage a planetary lander mission (Phoenix Mars Lander) and to lead a New Frontiers mission (OSIRIS-REx). Our scientists and engineers have developed, supplied, and operated a significant number of instruments to NASA planetary flagship missions (Pioneer 10, Voyager, Cassini, and numerous Mars missions) and NASA astrophysics flagship missions (NICMOS for the Hubble Space Telescope, MIPS for the Spitzer Space Telescope, and NIRCam for the James Webb Space Telescope), as well as ground-based telescopes that have significantly expanded our understanding of the universe (Multiple Mirror Telescope, the two 6.5m Magellan Telescopes, Large Binocular Telescope, the 24.5 Giant Magellan Telescope under construction, Spacewatch, and the Catalina Sky Survey).

Is there an Arizona Specific Benefit or Impact?

This TRIF initiative will produce more than a 20x ROI, including:
•Growth in the number of multi-million dollar spacecraft mission and instrument contracts
•Increased number of positions in a highly skilled workforce capable of designing, building, and operating spacecraft hardware and missions
•Increased number of students involved in spacecraft missions and projects
•Increased opportunities for Arizona companies to participate in spacecraft missions and projects

Investment Detail

	2022	2023	2024	Total
Infrastructure	359,284	359,284	359,284	1,077,852
Basic Research	103,551	103,551	103,551	310,653
Applied Research	258,879	258,879	258,879	776,637
Development	362,430	362,430	362,430	1,087,290
Technology Transfer	121,593	121,593	121,593	364,779
Total	1,205,737	1,205,737	1,205,737	3,617,211

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding	2,000,000	4,000,000	6,000,000	12,000,000
Publications in Academic Peer-Reviewed Journals		5	15	20
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Space Exploration and Optical Sciences
Program Name: Quantum Technology & Systems Engineering

Problem Statement:

UArizona has successfully launched a vital program in quantum information science and engineering (QISE), including its recent leadership role in the NSF Center for Quantum Networks. Quantum technologies also are positioned to benefit a host of additional applications and markets that harness advanced sensor systems in physical sciences, life sciences, and defense. To lead the emerging quantum economy, UArizona must galvanize a high-impact, integrative, university-wide QISE effort.

Program Description:

This TRIF initiative will focus resources on developing explicit systems-scale solutions and demonstrators with unambiguous quantum performance advantage, ideally in sensor spaces that will strongly complement other UArizona investment areas, such as those in space sciences, National Security Systems, and Improving Health. To support CQN and other emerging systems QISE applications, and to bring experience in deployable quantum systems, the College of Optical Sciences has committed an Endowed Chair faculty position to lead in quantum systems engineering. It will also support committed Research, Innovation and Impact matching funds for CQN and additional infrastructure required for the QISE effort, such as advanced e-beam lithography tools.

What is the University's Advantage and/or Anticipated Funding Opportunities?

With its prior substantial faculty investments in QISE, combined with its high-visibility national leadership with CQN, UArizona is exceptionally well positioned. Potential quantum systems applications include sensors systems for defense and scientific discovery and communications solutions beyond the scope and budget of CQN. This TRIF initiative will harness resources in the Colleges of Optical Sciences, Engineering, Science, and Medicine, and CQN has additionally broken new ground by funding societal impacts research in the Colleges of Law and Social and Behavioral Sciences.

Is there an Arizona Specific Benefit or Impact?

This TRIF initiative will produce more than a 10x ROI, including:

- Growth in quantum research proposals, grants, and contracts
- Intellectual property generation with an excellent record of licensing potential
- Regional workforce development, producing increased BS, MS, PhD, postdoc, and research scientist talent with experience in applications-driven teams
- QISE start-up companies and strengthened relationships with local tech companies

Investment Detail

	2022	2023	2024	Total
Infrastructure	1,040,886	867,405	867,405	2,775,696
Basic Research	0	0	0	0
Applied Research	135,514	135,514	135,514	406,542
Development	0	150,000	150,000	300,000
Technology Transfer	121,593	121,593	121,593	364,779
Total	1,297,993	1,274,512	1,274,512	3,847,017

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	800,000	600,000	600,000	2,000,000
Postdocs Supported	3	8	12	23
Graduate Students	8	14	20	42
Undergraduate Students				0
Sponsored Project Funding	600,000	2,400,000	3,500,000	6,500,000
Publications in Academic Peer-Reviewed Journals	4	8	12	24
License and Options Income			100,000	100,000
Startups			1	1
Startup Investments			250,000	250,000
Startup FTEs			3	3

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Space Exploration and Optical Sciences
Program Name: World Leading Facilities for Astronomical Research

Problem Statement:

Over 280 UArizona researchers (and additional students and faculty at ASU and NAU) depend on our world-renowned astronomical research facilities to produce transformative scholarship and return to Arizona, through external funding, 10x the currently provided state funding. We need $2.4M per year of additional funding to maintain our current level of observatory operations and protect and grow our external funding.

Program Description:

UArizona will continue to use our facilities to make further ground-breaking discoveries. We anticipate progress in the characterization of planets around other stars, including the search for signs of life in the atmospheres of these planets. The Event Horizon Telescope will perform further tests of Einstein's theory of gravity by studying the nearest massive black holes. Our well-equipped telescopes will identify the sources of gravity wave-producing events and provide new insights into the formation and evolution of stars and galaxies. We will use our facilities to train the next generation of astronomers and industry innovators.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has been a leader in space sciences for over a century. Our five mountaintop observatories in the desert Southwest, under clear, dark skies, have brought the world's most talented students, engineers, and faculty to Arizona. These exceptional people have produced the innovations leading to our leadership in both space- and ground-based research facilities, not only in Arizona, but around the world. With our federal (e.g., NASA, Department of Energy (DOE), NSF) and foreign partners, we have developed the observatories and space missions that enable our past transformative discoveries, from proving the existence of dark matter to the first image of a massive black hole.

Is there an Arizona Specific Benefit or Impact?

- Greater than a 700 percent ROI, through external funding, on the funds provided to support and upgrade our facilities.
- Completion of the next five observing campaigns of the Event Horizon Telescope (which uses our radio telescopes on Mount Graham and Kitt Peak) to complete our studies of the massive black holes in the nearest galaxies.

Investment Detail

	2022	2023	2024	Total
Infrastructure	778,449	778,449	778,449	2,335,347
Basic Research	155,327	155,327	155,327	465,981
Applied Research	103,551	103,551	103,551	310,653
Development	103,551	103,551	103,551	310,653
Technology Transfer	121,593	121,593	121,593	364,779
Total	1,262,471	1,262,471	1,262,471	3,787,413

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported	20	20	20	60
Graduate Students	40	40	40	120
Undergraduate Students				0
Sponsored Project Funding	14,000,000	14,000,000	14,000,000	42,000,000
Publications in Academic Peer-Reviewed Journals	20	20	20	60
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Space Exploration and Optical Sciences
Program Name: Optical Sensing and Display for Human-Centered Intelligent and Autonomous Systems

Problem Statement:

Since the dawn of computing, the interface between computers and humans has become progressively more personal, from computer room to desktop to mobile phone. The next revolution, wherein people will live and work in ubiquitous digital spaces, is just starting, and it will spawn entirely new economies and improvements in quality of life. Optical sensing is a critical enabling technology in this revolution, and we already are witnessing the increasing proliferation of sophisticated 3D optical sensing and imaging in consumer mobile platforms, autonomous vehicles, entertainment, smart spaces for enterprise business, remote medicine, and remote sensing for scientific discovery, defense, environment, and agriculture.

Program Description:

This initiative will advance UArizona's scientific/engineering leadership in a very high-impact area. We will establish applications-driven collaborative research teams to accelerate the development of underlying optical technologies, ranging from breakthrough chip-scale 3D imagers with integrated neural processors, to smart displays and interfaces that enable ubiquitous information access, to new free-form optics that enable 100x reductions in size, weight, power, and cost (SWaP-C). In addition to the discovery engendered by cutting-edge applications research, this applications-driven approach lays the groundwork for increased private-sector partnerships, commercial transitions, and economic development.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona is exceptionally well positioned to take on this challenge. The College of Optical Sciences has eight faculty members strongly engaged in this area of optical sensing and display, including a new Endowed Chair and three additional new hires, spanning the core technologies and application domains mentioned above. These faculty are pursuing innovations that offer exciting promise in providing game-changing technical capabilities and cost reduction. They are also leaders in their field and have exceptionally strong industry engagement, with more than $10M in private-sector research support and IP revenue over the past four years. By linking with engineering, medicine, and data science, this effort will leverage synergies from university-wide investments.

Is there an Arizona Specific Benefit or Impact?

This TRIF initiative will produce compelling ROI, including:
•Growth in optical sensor research grants/contracts, including a major center proposal
•Workforce development, producing BS, MS, PhD, and postdoc/research scientist talent with application team experience to support regional economic development
•Intellectual property generation with an excellent record of licensing potential
•New start-up companies and strengthened relationships with local tech companies

Investment Detail

	2022	2023	2024	Total
Infrastructure	763,317	370,093	370,093	1,503,503
Basic Research	0	0	0	0
Applied Research	375,514	575,514	575,514	1,526,542
Development	0	140,000	140,000	280,000
Technology Transfer	######	######	######	364,779
Total	1,260,424	1,207,200	1,207,200	3,674,824

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	500,000	200,000	200,000	900,000
Postdocs Supported	6	10	14	30
Graduate Students	8	15	20	43
Undergraduate Students				0
Sponsored Project Funding	800,000	2,000,000	3,500,000	6,300,000
Publications in Academic Peer-Reviewed Journals	8	12	20	40
License and Options Income			100,000	100,000
Startups			1	1
Startup Investments			150,000	150,000
Startup FTEs			2	2

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Space Exploration and Optical Sciences
Program Name: Frontiers in Space Exploration and Optical Sciences

Problem Statement:

To achieve any of our objectives in Space Exploration and Optical Sciences, we need to be able to recruit the talent and establish the new programs necessary to respond to the latest developments in—and actively create the future of—those fields. This means hiring the scientists and engineers who are developing those fields and providing them with the resources necessary to succeed. These resources can include students, technical support, and equipment. This investment in the future is crucial to sustaining our current successes and building the new success stories.

Program Description:

UArizona has world leaders in many fields and subfields within the Space Exploration and Optical Sciences focus area. However, to remain a leader as an institution, we need to continue to add future leaders in burgeoning fields and replace the expertise we inevitably lose as the current leaders age and retire. In particular, UArizona has a history of developing sensors and instruments that leverage emerging technologies to make revolutionary measurements, but we need to continue to hire the scientists who are able to make this happen.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona is home to internationally recognized faculty, staff, and students in Steward Observatory, the Lunar and Planetary Laboratory, and the College of Optical Sciences. This reputation makes the university a destination of choice for the very best talent in space exploration and optical sciences. Securing resources to recruit that talent, however, remains a major challenge.

Is there an Arizona Specific Benefit or Impact?

The primary measure of success is adding faculty who:
•generate new streams of funding
•attract high-quality new students
•build programs that integrate with the existing strengths of the university's Space Exploration and Optical Sciences areas

Investment Detail

	2022	2023	2024	Total
Infrastructure	598,807	598,807	598,807	1,796,421
Basic Research	258,879	258,879	258,879	776,637
Applied Research	207,103	207,103	207,103	621,309
Development	51,776	51,776	51,776	155,328
Technology Transfer	######	######	######	364,779
Total	1,238,158	1,238,158	1,238,158	3,714,474

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	415,000	415,000	415,000	1,245,000
Postdocs Supported	1	1	1	3
Graduate Students	2	2	2	6
Undergraduate Students				0
Sponsored Project Funding	500,000	500,000	500,000	1,500,000
Publications in Academic Peer-Reviewed Journals	15	15	15	45
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Access and Workforce Development
Program Name: Building Pre-College Interest in Research and Technical Careers

Problem Statement:

One of the pre-college barriers to early development of Arizona's technically skilled workforce is an overall lack of awareness and interest among K-12 students about the requirements for the desirable Arizona jobs they ultimately will want to pursue. This is particularly true within communities with less access to research and fewer technically skilled role models with whom to engage. Early exposure to research and technology, and the career possibilities that go with those skillsets, through a variety of targeted outreach activities, will help inspire the future workforce.

Another challenge to address is successful completion of the demanding courses that support many science, technology, engineering, and math-empowered careers. For example, Arizona's Hispanic high school students graduate at a rate of 72%. Of those graduates, only 33% are eligible for admission to any of the three Arizona universities. Additionally, 59% of Arizona Hispanic high school students have deficiencies in mathematics, preventing them from being viewed as university ready. They often are "discounted" as candidates for a technically challenging degree pathway and choose a non-research path.

Program Description:

By building and supporting broader pre-college awareness of, and interest in, research opportunities and highly skilled careers among Arizona's students, UArizona can help influence the next generation of diverse leaders taking Arizona's industries to new heights of productivity and growth. These future leaders will develop new perspectives on the variety of research and technical careers available to them, how those career paths will positively impact their communities and the state, and the skills needed to join the workforce. As UArizona works to overcome the barriers that historically have limited participation in such careers, we will develop more meaningful partnerships with community stakeholders, engaging them to participate in building these talent pipelines for the betterment of our state.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona has a long history of supporting pre-college students through a multitude of programs and structures designed for K-12 audiences to advance Arizona's future workforce. Many of our programs provide expertise in skill building and mentoring in key areas that are typically barriers to STEM and technical career preparation readiness. TRIF funds can leverage these existing programs and structures, which have resulted in trusted relationships with Southern Arizona's young learners, their teachers, and their families. While not a comprehensive list, examples of programs that work directly with youth include the Upward Bound program, Early Academic Outreach, Engineering 102, Native Student Outreach and Resiliency (Native SOAR), Mentoring and Education for SCIence in Tucson (MESCIT), Keep Engaging Youth in Science (KEYS, discussed in the Improving Health section of this plan), Girls Who Code, and Imagine Your STEM Future.

Is there an Arizona Specific Benefit or Impact?

- Increased awareness of and interest in research and technical careers among Arizona pre-college students and their larger community, particularly among populations who have historically had less access to such careers
- Increased opportunities for exposure to state-of-the-art scientific and technical infrastructure and research faculty
- Knowledge of or participation in research projects that are co-created between researchers and community stakeholders
- Increased awareness of important Arizona economic development and research initiatives, and the associated future career opportunities
- Development of formal and informal educators that have the skills to support student research and technical career-related experiences

Investment Detail

	2022	2023	2024	Total
Infrastructure	84,208	84,208	84,208	252,624
Basic Research	0	0	0	0
Applied Research	0	0	0	0
Development	24,270	24,270	24,270	72,810
Technology Transfer	11,399	11,399	11,399	34,197
Total	119,877	119,877	119,877	359,631

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Access and Workforce Development
Program Name: The Community College to Four-year University Transition

Problem Statement:

Many Arizona students begin their postsecondary study at a two-year community college, due to financial resources or because they lack the academic qualifications and competitiveness to begin at one of the state's four-year universities. Students who seek to transfer to UArizona and have an interest in STEM majors often face several barriers. Research opportunities and other experiential learning experiences are scarce at community colleges, so transfer students struggle to compete for such experiences when they arrive at UArizona. Additionally, a difference exists in the academic cultures between community colleges and four-year universities, especially in the research-intensive STEM and pre-health fields.

Program Description:

TRIF funding will support UArizona programs that assist students through the transfer process into technical and research-intensive majors, provide paid research opportunities to transfer students to work on TRIF-funded research initiatives, and involve foundational research that will help us understand and overcome barriers for community college transfer students into research-rich degree programs and careers.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona houses the nationally known Center for the Study of Higher Education, with leading scholars whose research on the following topics can inform initiatives relevant to strengthening workforce development programs with community colleges:

- The challenges Latinx, African American, and low socioeconomic status (SES) students face transitioning into four-year college, research-intensive degree programs
- College planning strategies and trajectories of diverse community college transfer students
- Recruitment and access issues for community college students into research-rich majors and careers

Is there an Arizona Specific Benefit or Impact?

- Increased number of students accessing communication tools or events
- Increased transfer overall from Arizona community colleges into research-intensive majors at UArizona
- Increased number of students selecting STEM or other research-rich majors upon transferring
- Increased faculty partnerships between community colleges and UArizona researchers
- Increased indicators for participation in undergraduate research before transferring
- Increased retention of community college transfer students in STEM to graduation

Investment Detail

	2022	2023	2024	Total
Infrastructure	48,881	48,881	48,881	146,643
Basic Research	8,453	8,453	8,453	25,359
Applied Research	12,679	12,679	12,679	38,037
Development	21,132	21,132	21,132	63,396
Technology Transfer	9,879	9,879	9,879	29,637
Total	101,024	101,024	101,024	303,072

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Access and Workforce Development
Program Name: Expanding Undergraduate Research Opportunities

Problem Statement:

Undergraduate research is well known as a high-impact educational practice that leads to increased retention and a stronger workforce. An early undergraduate research experience (URE) in social sciences and humanities leads to significant gains in analytical and critical thinking skills for first- and second-year students, especially for first-generation students. UREs, particularly during the academic year, lead to increased interest and persistence in STEM, especially for underrepresented minorities. However, the traditional one-on-one apprenticeship model prevalent at UArizona limits the number of students with these experiences to a select few.

Program Description:

TRIF funds will support the expansion of undergraduate research opportunities to provide equitable access to research experiences for students who historically have had less access to research early in their academic careers. The funds will also be used to support student's direct participation in TRIF-funded research projects and the dissemination of best practices in the various models of undergraduate research engagement.

What is the University's Advantage and/or Anticipated Funding Opportunities?

UArizona offers numerous long-running undergraduate research programs supported by the institution that address societal needs. As a Hispanic-Serving Institution and an American Indian and Alaska Native-Serving Institution, the university is now more intently focused on the "servingness" aspect of these designations. The culture within science departments has been shifting to recognize the value of offering research opportunities to a wide majority of students and not to just the top, most academically talented.

Is there an Arizona Specific Benefit or Impact?

- Increased diversity and representation among UArizona students who have access to research experiences and research-rich curriculum
- Increased number of research-rich courses and other research opportunities targeted to first- and second-year students, and vertically integrated projects (VIPs)
- Increased number of awarded proposals that incorporate scaled-up research experiences in their education plans
- Overall increased retention in STEM of underserved and underrepresented students
- Overall increased enrollment in graduate research programs among historically underserved and underrepresented students necessary to realize Arizona's workforce challenges

Investment Detail

	2022	2023	2024	Total
Infrastructure	69,202	69,202	69,202	207,606
Basic Research	49,862	49,862	49,862	149,586
Applied Research	49,862	49,862	49,862	149,586
Development	39,890	39,890	39,890	119,670
Technology Transfer	23,559	23,559	23,559	70,677
Total	232,375	232,375	232,375	697,125

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Access and Workforce Development
Program Name: Supporting Diverse Graduate Student Researchers

Problem Statement:

Graduate students are the backbone of the research workforce at UArizona and frequently transition to high-tech industries in their careers. They generally outnumber other staff researchers, and prospective students are actively recruited by research-intensive graduate programs. Upon graduation, they are highly sought by industry. However, diverse graduate students pursuing these programs often face barriers, at both the recruitment and acceptance stages. Even if accepted into a program, they can face a lonely and unwelcoming environment. UArizona seeks a highly representative group of passionate graduate students who have the training to succeed in research-intensive careers after they leave graduate school.

Program Description:

TRIF funding will prioritize research projects that include graduate student researchers from across Arizona's complex demographics; connect research efforts and lived experiences to address issues of importance to Arizona's communities; are open to recruiting graduate students from within UArizona's existing undergraduate community; require inclusive mentor training for their research teams; and provide professional development opportunities so students can master technical skills and those that promote collaboration, creativity, and critical thinking. These are exactly the skills that Arizona's high-tech industries are seeking.

What is the University's Advantage and/or Anticipated Funding Opportunities?

With TRIF investment, UArizona can leverage and support a number of existing programs and structures to address the challenges described above. The Graduate College oversees the McNair Program, funded by the U.S. Department of Education, and the Undergraduate Research Opportunities Consortium, both of which serve diverse undergraduates and prepare them for graduate school. A number of graduate training programs and Graduate Interdisciplinary Degree Programs exist on campus in disciplinary areas that TRIF funds, and we will work with these programs to advance efforts towards growing Arizona's research and technical workforce and a vibrant economy.

Is there an Arizona Specific Benefit or Impact?

•TRIF-funded research teams representing the breadth of Arizona society
•TRIF-funded research teams are more likely to tackle Arizona's grand challenges that directly impact Arizona's communities and industries
•Among TRIF-funded research projects, higher numbers of underrepresented students persist year-to-year in research-intensive fields, developing the skills to succeed in the high-tech workforce
•Among TRIF-funded research projects, graduate students report feeling welcome in their research-intensive environment

Investment Detail

	2022	2023	2024	Total
Infrastructure	51,784	51,784	51,784	155,352
Basic Research	44,775	44,775	44,775	134,325
Applied Research	44,775	44,775	44,775	134,325
Development	14,925	14,925	14,925	44,775
Technology Transfer	17,479	17,479	17,479	52,437
Total	173,738	173,738	173,738	521,214

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0

Technology and Research Innovation Fund (TRIF) Program Proposal

TRIF Investvest Area: Access and Workforce Development
Program Name: Inclusive Mentoring for a Diverse Research Workforce

Problem Statement:

Many of us need the support of high-quality mentors to succeed and advance in our professions. This is especially true for those who are pursuing careers in research and high-tech fields. Mentoring often is most impactful when the mentor and mentee share the same gender, cultural background, or life experience. UArizona must be able to ensure that future and early-career researchers receive high quality, culturally inclusive mentoring through a robust training landscape and increase the pool of diverse mentors to serve the needs of our students and our future workforce.

Program Description:

Through TRIF funding, we will leverage these efforts and provide support to establish a mentoring community focused on innovating, increasing awareness, and disseminating best practices; develop higher-quality mentoring across TRIF-funded research projects and participants; create a centralized infrastructure to support culturally responsive and asset-based mentoring workshops; and implement a system for follow-up support to research mentors, particularly those participating in TRIF-funded research initiatives and projects. Additionally, we anticipate supporting an increased campus-wide understanding of how to overcome insensitivities in the mentor-mentee relationship; a series of events convening research thought leaders from community colleges and UArizona to identify barriers and solutions to mentoring challenges; and increased rewards and recognition for faculty who engage in high-quality mentoring practices and who carry higher-than-normal mentoring loads to provide mentoring to students who are from similar backgrounds.

What is the University's Advantage and/or Anticipated Funding Opportunities?

A number of early-stage efforts exist on campus around research mentor training, mentoring in STEM and health science, peer mentoring, and inclusive mentoring. The Office of Societal Impact has developed workshops for faculty, staff, and peer mentors on culturally responsive and asset-based, inclusive mentoring. An interactive training series is under development, supported by the Provost's Office of Diversity & Inclusion, in which Black, Indigenous, and People of Color (BIPOC) faculty will mentor other faculty as they undergo training to mentor BIPOC students. The UAHS Office of Diversity & Inclusion offers a series of training and support for mentoring students specifically in the health sciences.

Is there an Arizona Specific Benefit or Impact?

•Development of a comprehensive database of training opportunities and mechanisms to track trainings offered and taken
•Among TRIF-funded research projects, an increased number of faculty and staff who have completed research mentor trainings
•Among TRIF-funded research projects, an increased number of students with high-quality, inclusive research mentors

Investment Detail

	2022	2023	2024	Total
Infrastructure	40,556	40,556	40,556	121,668
Basic Research	35,067	35,067	35,067	105,201
Applied Research	35,067	35,067	35,067	105,201
Development	11,689	11,689	11,689	35,067
Technology Transfer	13,679	13,679	13,679	41,037
Total	136,058	136,058	136,058	408,174

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
License and Options Income				0
Startups				0
Startup Investments				0
Startup FTEs				0