TRIF 3-YEAR PLAN

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About This Plan

The Technology and Research Initiative Fund (TRIF) Plan summarizes the program investments and predicted outcomes for FY2022-2024. This plan incorporates a few modifications from past years. The plan has been shortened from 5- to 3-years in duration. Each proposed TRIF investment has a 1-page program proposal including a problem statement, program description, university's advantage and benefit to Arizona. Each program proposal focuses on one of the five strategic research areas:

1. Improving Health;
2. Water, Environment and Energy Solutions;
3. National Security Systems;
4. Space Exploration and Optical Solutions and
5. Workforce Development.

In addition, each program's funding proposal is subdivided into how much of the program funding is directed toward fundamental research stages:

- Basic Research,
- Applied Research,
- Development and
- Research Infrastructure.

Where Basic Research is defined are 10+ years to a potential commercial product, Applied Research is defined as 2-5 years to a commercial product and Development is defined as less that 2-years to a commercial product. Additionally, Research Infrastructure investment is defined as resources and related services that are used to conduct research. Research Infrastructure is critical to the advancement of the research enterprise and crosses all research investment stages.

Executive Summary

This report summarizes Arizona's three State Universities plans to invest TRIF funds, over the next three years. This plan represents a diverse portfolio of research and workforce development programs that promises a significant benefit to the State of Arizona. The program investments are classified in terms of one of the five research areas:

1. Improving Health;
2. Water, Environment and Energy Solutions;
3. National Security Systems;
4. Space Exploration and Optical Solutions and
5. Workforce Development.

Each program's funding is further categorized from a research stage or pipeline perspective:

- Basic Research,
- Applied Research,
- Development and
- Research Infrastructure.

- The largest TRIF investment by the University Enterprise is in Improving Health, see Figure 1. In total 31% of funding is directed toward Improving Health.

- From a research stage perspective, the largest TRIF investment by the University Enterprise is in Research Infrastructure, see Figure 2. In total 38% of funding is directed toward maintaining and enhancing Research Infrastructure.

- ASU's largest TRIF investment area, 45%, is in Improving Health, UArizona's largest investment area, 39%, is in National Security Systems, and NAU's largest investment area, 55%, is in Workforce Development, Figure 3.

- From a research stage perspective: ASU's largest investment, 37%, is in Applied Research, UArizona's, 49%, is in Research Infrastructure and NAU's, 72%, is in Research Infrastructure, see Figure 4.

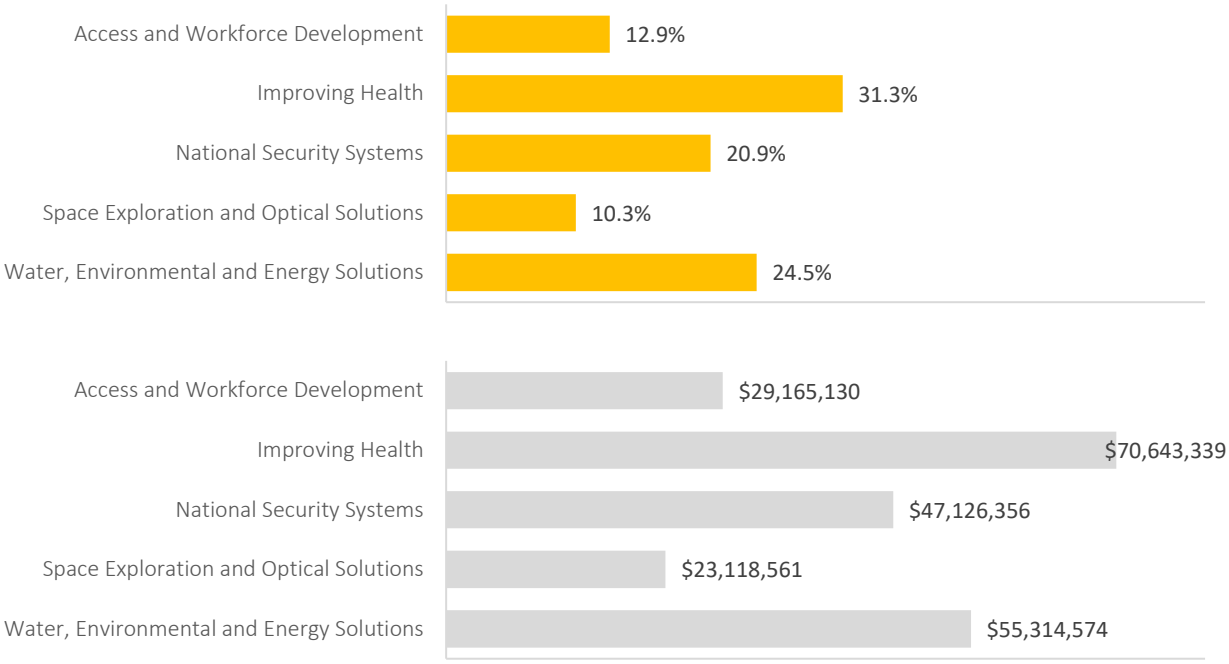


Figure 1. The University Enterprise Proposed 3-Year TRIF Spending by Program Area

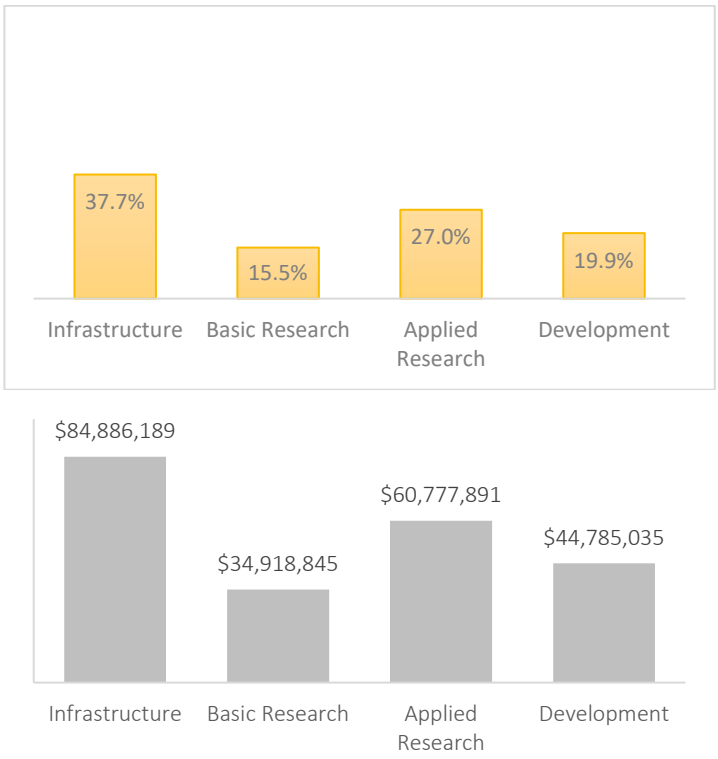
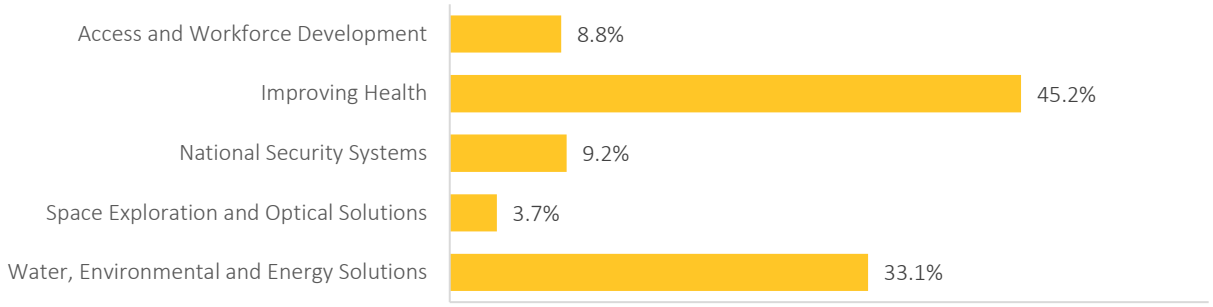
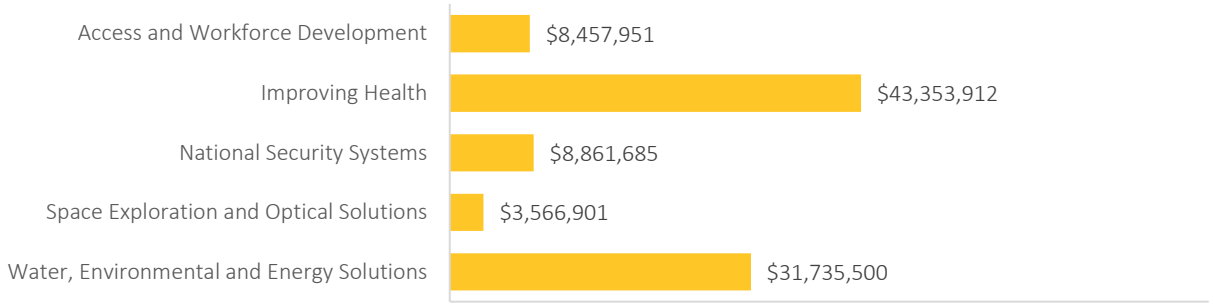


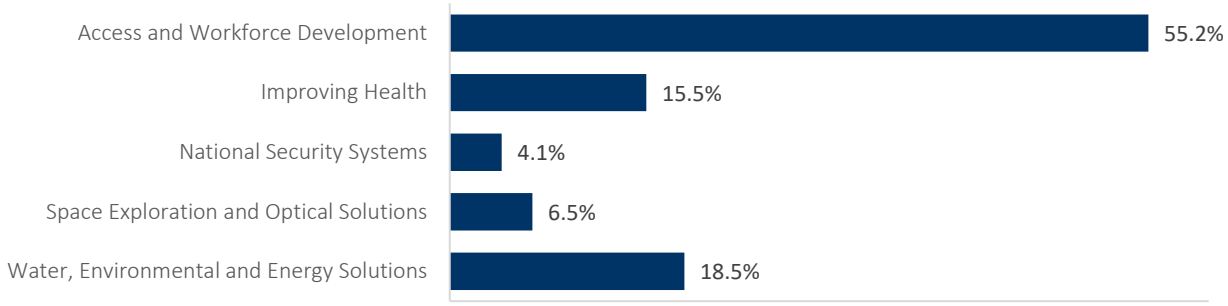
Figure 2. The University Enterprise Proposed 3-Year TRIF Spending by Research Stage

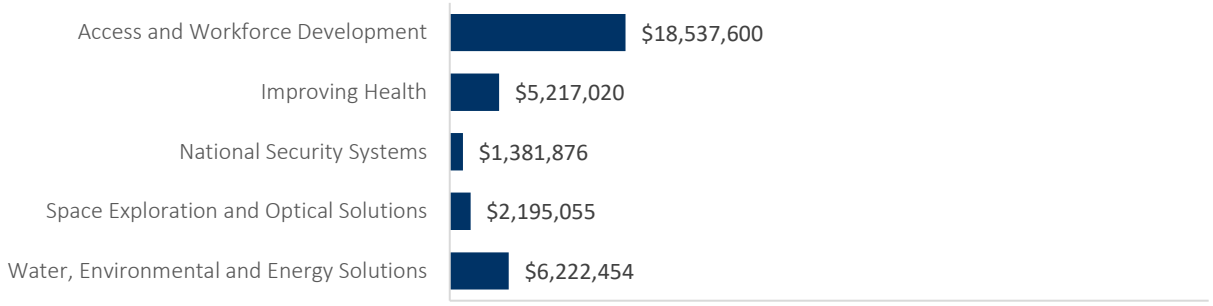
Arizona State University Proposed 3-Year TRIF Spending by Program Area





Northern Arizona University Proposed 3-Year TRIF Spending by Program Area by Program Area





University of Arizona Proposed 3-Year TRIF Spending by Program Area

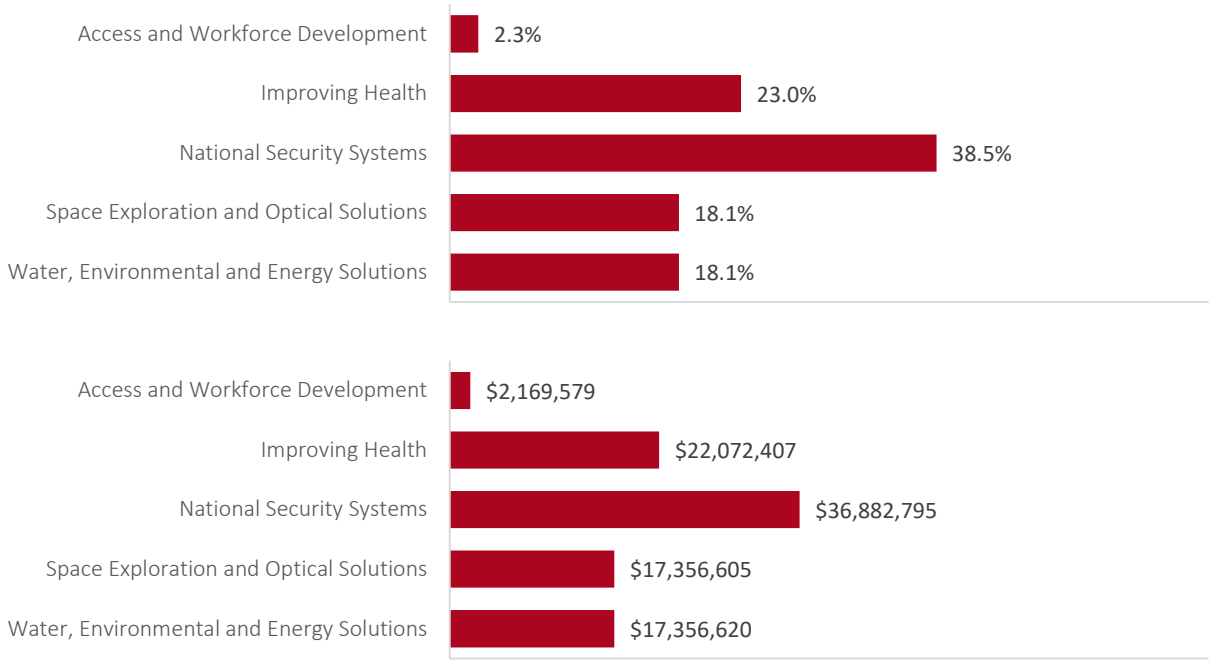
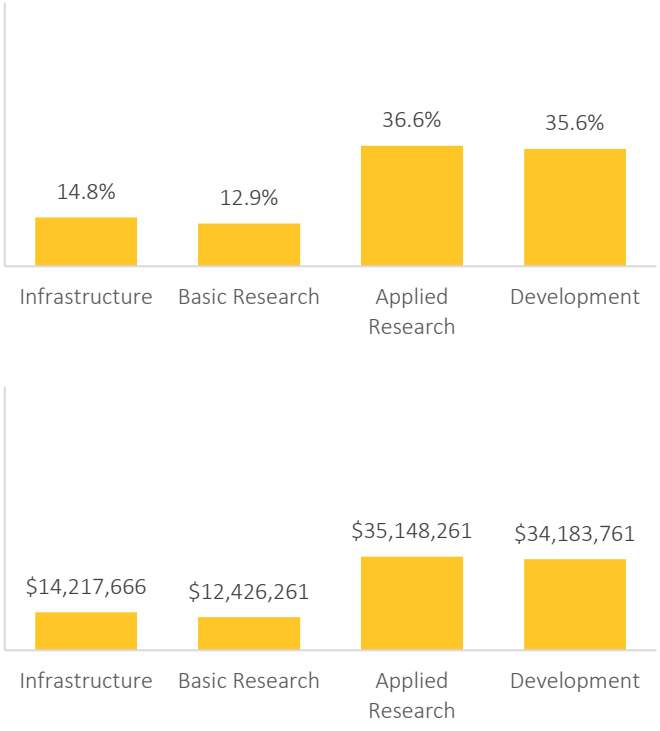
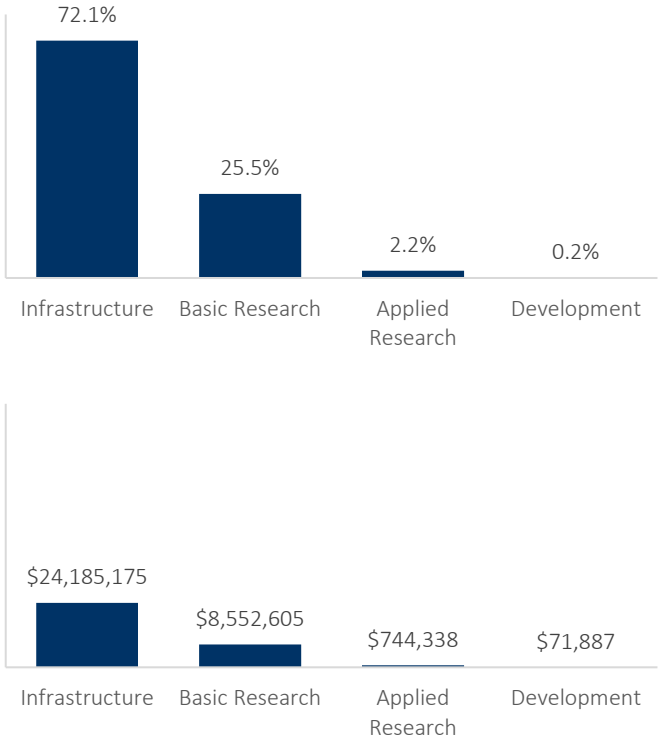


Figure 3. Institutional Research Area Investment

Arizona State University Proposed 3-Year TRIF Spending by Research Stage



Northern Arizona University Proposed 3-Year TRIF Spending by Research Stage



University of Arizona Proposed 3-Year TRIF Spending by Research Stage

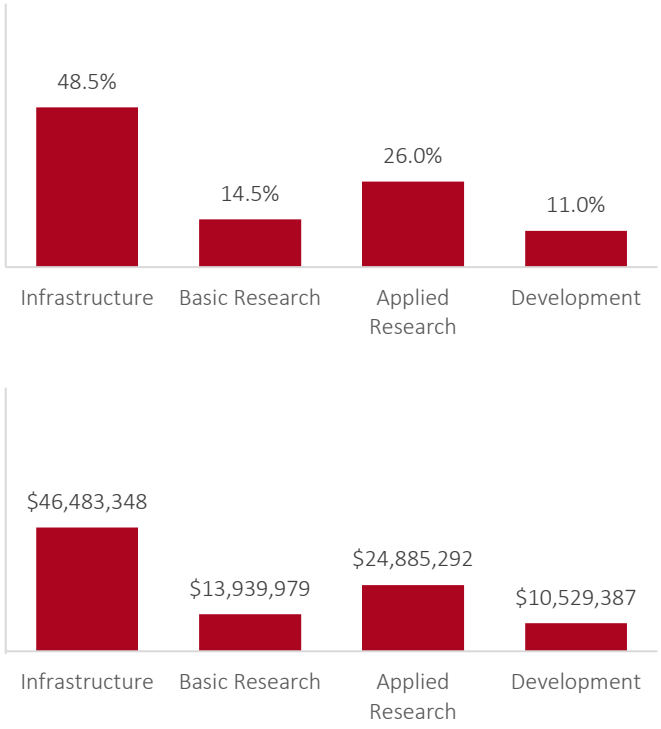


Figure 4. Institutional Research Stage Investment Breakout.

TRIF 3-YEAR PLAN

ARIZONA STATE UNIVERSITY

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Executive Summary

TRIF investment at Arizona State University has been fundamental to elevating ASU as a leading research and educational powerhouse. ASU leverages TRIF to attract growing external investment to our state, providing a threefold return on investment to date. Since TRIF began, ASU has more than quintupled its research expenditures, rising to #6 in the nation for research expenditures among institutions without a medical school.

The university's solutions-focused approach to grand challenges led U.S. News & World Report to name ASU "#1 in innovation" for six consecutive years. Currently, ASU is educating nearly 120,000 students, providing the knowledge, skills and hands-on experience that 21st century employer's demand.

For the next funding cycle of FY 2022-2024, ASU will build on its foundation of TRIF-enabled expertise and infrastructure, developing novel solutions to challenges in our state and the skilled workforce needed to implement them. The university has strategically selected programs and projects that are poised to bring the greatest return on investment to Arizona.

ASU will accelerate the impact of these programs by allocating a portion of TRIF to infrastructure that supports and scales their success. These cross-cutting resources are available to all of the focus areas to help secure external funding, accelerate discoveries and bring innovative solutions to market.

TRIF investment creates an ecosystem that empowers businesses to succeed in our state. Arizona's long-term commitment to research attracts and generates companies that advance new technologies and helps them stay ahead of disruptive trends. Our universities provide the talent, knowledge and infrastructure companies need to be competitive. In turn, they create stable, high-wage jobs and invest in their communities — a virtuous cycle of economic growth and human well-being for generations to come.

University Vision and Philosophy

The goals of TRIF align with ASU's mission as spelled out in its charter:

> ASU is a comprehensive public research university, measured not by whom it excludes, but by whom it includes and how they succeed; advancing research and discovery of public value; and assuming fundamental responsibility for the economic, social, cultural and overall health of the communities it serves.

The charter provides the vision that guides ASU in advancing the following goals:

- **Demonstrate leadership in academic excellence and accessibility.** This includes matching Arizona's socioeconomic diversity with regard to both access and measurable outcomes for success.
- **Establish national standing in academic quality and impact of colleges and schools in every field.** ASU provides Arizona learners with the highest quality education at an affordable cost.
- **Establish ASU as a leading global center for interdisciplinary research, discovery and development by 2025.** The university is on a path toward bringing more than $1 billion in annual research funding into the state. The outcomes of this research are transforming Arizona's economic competitiveness.

- **Enhance our local impact and social embeddedness.** ASU is empowering 21st century learners to co-develop solutions to the social, technical, cultural and environmental issues facing 21st century Arizona.

Expected Outcomes

ASU leverages TRIF investment to achieve the following outcomes:

- **Return on investment.** New externally funded grant awards are a result of strategic alignment of research with challenges that need to be solved and of strong partnerships with leading national and global organizations. This brings additional revenue to the state and creates jobs at the university and with our local partners.
- **Technology transfer.** Patents, licenses and options, and new startup companies represent the translation of research and innovation to the marketplace where they can benefit society.
- **Industry engagement.** By partnering with industry leaders, we leverage our knowledge enterprise for maximal marketplace impact.
- **Workforce contributions.** University students who receive research training understand problem solving and are prepared for the high-tech industries driving our economy.
- **Educational outreach.** ASU leads numerous outreach efforts to spark discovery, learning and entrepreneurship among K-12 students and community members.
- **Government agency/community engagement.** Collaborations with government and community agencies connect our subject matter experts and innovative solutions with organizations working directly with populations in need.

Marketing/Communication Overview

The Strategic Marketing and Communications Team within ASU's Knowledge Enterprise conveys the value and impact of research and innovation through engaging multimedia storytelling. These communications also create their own impact by sharing new knowledge generated through research with the public.

The team strategically disseminates this content through university websites, mass media, social media, print collaterals, newsletters, presentations and events.

ASU communications on TRIF-enabled programs and projects will include the following key messages:

- TRIF investments are strategically leveraged to support programs with a track record of success as well as emerging high-potential research areas.
- The research and economic development enabled by TRIF has a significant, positive impact on our state and beyond.
- TRIF investments support the training and education of students, contributing to a highly skilled workforce that can fulfill the high-tech jobs being created in Arizona and attract new business and industry to the state.

TRIF-related deliverables for this funding cycle will include:

- Annual TRIF report that outlines accomplishments and return on investment.
- Stories of TRIF-enabled discoveries and impact, told through news articles, feature articles, graphics and videos posted to ASU websites and social media accounts.
- Media pitches on TRIF-enabled discoveries and impact to local, national and international news outlets.

- Marketing collaterals that publicize TRIF-enabled programs and achievements to key stakeholders and potential partners.

University Administration of TRIF

TRIF is administered through the ASU Knowledge Enterprise under the following leadership:

- Sally C. Morton, executive vice president
- Neal Woodbury, vice president for research and chief science and technology officer

Over the next three years, ASU will invest in the following programs under the five TRIF focus areas:

- Improving health
    - Biodesign Institute, led by Joshua LaBaer
    - Institute for the Future of Health, led by George Poste
    - Arizona Wellbeing Commons, led by Joshua LaBaer
- Water, energy and environmental systems
    - Global Futures Laboratory, led by Peter Schlosser
    - LightWorks, led by Gary Dirks
    - Future H20, led by Dave White
    - Engineering Research Centers, led by Kyle Squires
- National Security Systems
    - Global Security Initiative, led by Nadya Bliss
- Space exploration and optical sciences
    - NewSpace, led by Jim Bell
    - Interplanetary Initiative, led by Lindy Elkins-Tanton
- Access and workforce development
    - Luminosity Lab, led by Mark Naufel
    - J. Orin Edson Entrepreneurship + Innovation Institute, led by Ji Mi Choi
    - MacroTechnology Works/Advanced Electronics and Photonics, led by Kevin Reinhart
    - Advanced Materials Initiative, led by William Petuskey

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Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Access and Workforce Development
Program Name:	Corporate Engagement and Strategic Partnerships

Problem Statement:

ASU is an institution that prioritizes use-inspired research, student experiential learning, student success and community embeddedness. This requires a deep understanding of the needs of the external community and the agility, commitment and will to mobilize university resources to match and problem-solve in real time. ASU's Corporate Engagement and Strategic Partnerships team builds long-term, mutually beneficial partnerships that help Arizona's constituents and the entire U.S. economic ecosystem.

Program Description:

Corporate Engagement and Strategic Partnerships advances university-wide research and education efforts in key sectors such as semiconductors, sustainability, health futures and workforce development. The program facilitates complex engagements to leverage the abilities of the community, the university and our business collaborators while supporting all stakeholders. Our work is individualized, transformative and impactful to best support all involved, especially Arizona. By expanding and diversifying the workforce, developing novel solutions to complex challenges, and finding innovative approaches to advancing research and development initiatives, Corporate Engagement and Strategic Partnerships infuses ASU's productivity and innovation into the economy through intentional engagement and partnership.

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

ASU's advantage is the university's vast resources and networks across Arizona. Through one-of-a-kind academic-corporate partnerships, corporate collaborators can access ASU's world-class faculty and student talent, cutting-edge research and development, and state-of-the-art facilities. Corporate Engagement and Strategic Partnerships provides partners with an institutional commitment to collaboration, growth and impact on a global scale, coupled with a response time that is required for industry engagement.

Anticipated funding opportunities are broad given the different assets and clients we serve. Funding will come in the form of direct industry-sponsored research projects, consortium fees, corporate philanthropy, leases paid in Innovation Zones at ASU, fees for custom academic or non-credit programs and/or federally sponsored research, with corporate partners as supporters or subcontractors.

Is there an Arizona Specific Benefit or Impact?

There are significant impacts and benefits to Arizona. The work performed by the Corporate Engagement and Strategic Partnerships team supports economic and community development groups to recruit companies to relocate or expand their business in Arizona. Recent examples include the $20 billion Intel expansion, $8 million investment by Applied Materials and the $32 billion TSMC location to Arizona, creating over 3,000 jobs in the state. We will also create opportunities to increase technological access throughout the state through public-private partnerships with industry giants such as Dell and Verizon, organizations that have prioritized closing the digital divide and providing access to remote and rural areas.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	500,000	500,000	500,000	1,500,000
Development	500,000	500,000	500,000	1,500,000
Total	1,000,000	1,000,000	1,000,000	3,000,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	1	1	1	3
Graduate Students	5	6	8	19
Undergraduate Students	2	2	2	6
Sponsored Project Funding	107,000	112,000	118,000	337,000
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Access and Workforce Development
Program Name:	J. Orin Edson Entrepreneurship + Innovation Institute

Problem Statement:

Funding is needed to stimulate new collaborations with academic units, provide entrepreneurial training and development opportunities, and to supply the related material resources needed to continue to strengthen Arizona's entrepreneurial community and ecosystem.

Program Description:

The J. Orin Edson Entrepreneurship + Innovation Institute (Edson E+I) stimulates new collaborations with academic units to add dimension to both the student and faculty experience and development that lead to both personal and professional positive outcomes as well as economic and community development outcomes. Through TRIF funding, we have supported collaborations in business, creative arts enterprises, engineering, health innovation, and sustainability and piloted a number of new initiatives that have since led to additional funding.

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

Edson E+I believes in ASU's charter of excellence with inclusion and impact at scale and its design aspirations including valuing entrepreneurship. Edson E+I supports over 50,000 square feet of place-based innovation spaces across five locations. These spaces provide co-working, events and exhibitions, and amenities spaces for emerging ventures and community-based partners including entrepreneur support organizations to convene, network, and strengthen the entrepreneurial community and ecosystem. With academic collaborations, entrepreneurial training and development, and a place-based innovation spaces network as continued resources, Edson E+I has raised $40.4 million in additional funding including two endowed funds of $11.5 million over the last five years.

Is there an Arizona Specific Benefit or Impact?

Edson E+I's mission is to serve as the connecting and collaborating resource across ASU and the greater Phoenix community, providing support and material resources for entrepreneurship. Leadership from Edson E+I serve on the boards of StartupAZ, Co+Hoots Foundation, Phoenix Startup Week, AZ Bioscience and others including national organizations such as the Global Consortium of Entrepreneurship Centers (GCEC). We are recognized as a critical community leader by the Greater Phoenix Economic Council, the Arizona Commerce Authority and multiple offices of economic and community development across Greater Phoenix. Edson E+I is a leader in inclusive entrepreneurship and has championed many community-based programs including the externally-funded and mobile food entrepreneurship program, Prepped and the Kauffman Foundation's Inclusion Challenge.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	400,000	400,000	400,000	1,200,000
Development	400,000	400,000	400,000	1,200,000
Total	800,000	800,000	800,000	2,400,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	0	0	0	0
Graduate Students	2	2	2	6
Undergraduate Students	6	7	7	20
Sponsored Project Funding	3,508,580	3,684,009	3,868,209	11,060,798
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Access and Workforce Development
Program Name:	The Luminosity Lab

Problem Statement:

The current university systems within the United States lack effective student engagement models that provide undergraduate students with meaningful applied research and development opportunities. Opportunities, when they do exist for undergraduates, are often not relevant to the technical and real challenges of the 21st century. As a result, the United States stands to lose its position as the world leader in innovation and R&D.

Program Description:

Having designed and successfully launched The Luminosity Lab, a novel model of student-led research and development, Luminosity now aspires to launch a consortium, in which ASU-powered Luminosity labs will be chartered at academic institutions around the country. These labs, powered by ASU, will engage exceptional talent at each hosting institution within our unique model of student-led R&D to focus on moonshot projects and impacting society. These labs will scale ASU's access to student talent, corporate partners and academic institutions across the globe.

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

ASU will retain the IP generated throughout the network and serve as the prime recipient of all sponsored research that is executed within the consortium. This model, which is the first of its kind, will scale ASU's patent numbers and sponsored research dollars exponentially. This embedded model is net revenue generating and funded pilots are underway. Each new lab will bring in resources to offset its costs. However, the program will require initial investment to get established and support staffing requirements.

Is there an Arizona Specific Benefit or Impact?

This nationwide program will be powered by ASU and its home base will be established within Arizona. Arizona and ASU will benefit tremendously from the expansion of the brand, as well as the resulting IP, talent and corporate partnerships. Our hope is to make Arizona the home for all spinout companies that are generated from this national innovation network.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	166,667	166,667	166,667	500,000
Applied Research	166,667	166,667	166,667	500,000
Development	166,667	166,667	166,667	500,000
Total	500,000	500,000	500,000	1,500,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	0	0	0	0
Graduate Students	1	1	2	4
Undergraduate Students	12	13	14	39
Sponsored Project Funding	139,851	146,844	154,186	440,881
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Access and Workforce Development
Program Name:	Vice President for Research

Problem Statement:

When faculty are developing proposals, evaluation plans are often required, yet many faculty do not have the expertise to create a comprehensive and competitive evaluation component. However, having a well-developed evaluation plan aligned with educational and broader impact goals is an essential component needed to secure funding for sponsored projects.

Program Description:

CREST (College Research and Evaluation Services Team) within the ASU Knowledge Enterprise provides technical assistance and evaluation planning at the pre-award stage at no cost to faculty members and staff. CREST includes three full-time evaluation professionals with advanced degrees, graduate level training in evaluation and global experiences in evaluation methods. Expertise includes quantitative and qualitative analysis data collection for needs assessments, implementation and impact evaluations. CREST currently supports the evaluation of 29 projects totaling over $50 million in funding from the National Science Foundation, U.S. Department of Education, National Institutes of Health, the ASU Foundation, and state and national philanthropic organizations.

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

CREST completed evaluation sections of 59 grant proposals over FY21. This same level of work is expected in FY22. The total potential revenue generated through funding if all grants were awarded would be over $25 million.

Is there an Arizona Specific Benefit or Impact?

With the grant funding on projects, the overwhelming majority need to provide educational services to K-16 students. These students primarily reside within Arizona and receive free, high-quality educational outreach they may otherwise not have had available. K-12 teachers from Arizona also have opportunities to participate in paid professional development to increase their pedagogical skills and technical knowledge to bring back to their classrooms.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	140,000	140,000	140,000	420,000
Development	140,000	140,000	140,000	420,000
Total	280,000	280,000	280,000	840,000

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	100	105	110	315
Sponsored Project Funding	362,414	380,535	399,562	1,142,511
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Access & Workforce Development
Program Name:	Research Development

Problem Statement:

Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.

Program Description:

Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.

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

Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.

Is there an Arizona Specific Benefit or Impact?

ASU's research portfolio directly impacts the regional economy and contributes to ASU's national ranking among institutions of higher education.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	60,306	60,306	60,306	180,917
Applied Research	60,306	60,306	60,306	180,917
Development	60,306	60,306	60,306	180,917
Total	180,917	180,917	180,917	542,751

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	3	3	3	9
Sponsored Project Funding	40,000,000	42,000,000	44,100,000	126,100,000
Startups	0	0	0	0

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Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Access & Workforce Development
Program Name:	Skysong Innovations

Problem Statement:

ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.

Program Description:

SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). In 2020, ASU was issued 140 U.S. patents, tied with the University of Florida, up from 137 the previous year, and just one spot behind Harvard. Tsinghua University in Beijing was the only non-U.S. university to surpass ASU on the global list. In FY20, ASU researchers working with SI continued to set new benchmarks, submitting 306 invention disclosures and launching 19 new startups. ASU startups also raised more than $120 million in external funding in FY20.

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

SI has worked for years to help ASU startups connect with investors. In that regard, SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly $1 billion in venture capital and other funding. Because many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill which connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and – in some cases – even take positions running these startups. SI is also the ASU lead behind the ASU-Mayo MedTech Accelerator, which brings together the recognized world leader in patient care, education, and research, with the nation's #1 ranked university for innovation.

Is there an Arizona Specific Benefit or Impact?

SI annually commissions the Seidman Research Institute to perform an economic impact analysis of ASU's tech transfer activities. The most recent report found that from 2016-2020, as a result of the operations of SI and the Arizona-based, ASU-linked companies, Arizona's economy gained a cumulative $717.8 million in gross state product, $477.9 million in labor income, 7,059 job years and $64 million in state and local tax revenues. By 2025, Seidman projects the economic impact of SI and these ASU-linked companies will exceed $2.3 billion, with the vast majority of that impact in Arizona.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	19,466	19,466	19,466	58,397
Applied Research	19,466	19,466	19,466	58,397
Development	19,466	19,466	19,466	58,397
Total	58,397	58,397	58,397	175,192

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	0	0	0	0
Sponsored Project Funding	0	0	0	0
Startups	5	5	5	15

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Improving Health
Program Name:	Biodesign Institute

Problem Statement:

Emergent global challenges in medicine, environmental sustainability and national security continue to threaten the health of our communities and our planet. The Biodesign Institute at Arizona State University is committed to solving such challenges by developing rigorous, collaborative, nature-inspired science for the benefit of all life on Earth. By leveraging TRIF investment, Biodesign improves health, ensures security, sustains the planet and provides access and workforce development opportunities.

Program Description:

As the premiere scientific research institute in one of the nation's fastest-growing research universities, the Biodesign Institute addresses an expansive array of global challenges by creating nature-inspired solutions to address society's greatest challenges in biomedical health, environmental sustainability and national security. Biodesign is poised to promote workforce and leadership development with academic and hands-on, laboratory enrichment experiences and education to advance research, technology and thought leadership in the state of Arizona, and to elevate and expand Arizona's highly skilled workforce. Voter-supported investment in university research pioneered at Biodesign allocates resources to promote access to highly skilled experts and technologies in state-of-the-art laboratories for high-impact research of societal value. In this way TRIF funding is a powerful driver of scientific excellence and enables multiple pathways to enrich the economy through higher education access for workforce development, with ASU Biodesign-specific programs in impactful areas.

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

The ASU advantage for additional funding opportunities are many, including: 1. Expansion of COVID-19 testing success to a more generalized platform for developing new ways to rapidly diagnose and detect disease. 2. Expansion of the Neurodegenerative Disease Research Center (NDRC) under the leadership of Jeff Kordower. 3. In partnership with the ASU School for Complex Adaptive Systems, expand efforts in cybersecurity, artificial intelligence, deep learning and computational biology to reduce internet security threats and measure the impact of censorship on internet architecture. 4. Leverage TRIF funding to enable the formation of spinout companies. 5. Established the Biodesign Center for Sustainable Macromolecular Materials and Manufacturing (BCSM3) to focus on sustainable manufacturing and polymer chemistry, with goals of generation of sustainable, environmentally friendly materials.

Is there an Arizona Specific Benefit or Impact?

Biodesign is committed to impactful programs to improve human health and economic opportunity in Arizona. TRIF funding to the Biodesign Institute would enhance the workforce and impact health in many areas, including: 1. Through Compact X-ray free electron laser/compact X-ray light source student internships, train the next generation of X-ray machinists, technologists and physicists. 2. Through internships and fellowships in the ASU Biodesign Clinical Testing Laboratory (ABCTL), train and educate workers to seek new technologies and solutions to respond to potential infectious viruses such as COVID-19 and its various strains. 3. Develop Biodesign workforce training opportunities in semiconductor science and sustainable manufacturing as well as other key areas of economic value.

Investment Detail

	2022	2023	2024	Total
Infrastructure	3,304,222	3,304,222	3,304,222	9,912,666
Basic Research	0	0	0	0
Applied Research	2,138,000	2,138,000	2,138,000	6,414,000
Development	2,138,000	2,138,000	2,138,000	6,414,000
Total	7,580,222	7,580,222	7,580,222	22,740,666

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	95	100	105	300
Graduate Students	415	436	458	1,309
Undergraduate Students	159	167	176	502
Sponsored Project Funding	56,867,053	59,710,405	62,695,925	179,273,383
Startups	4	4	5	13

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investvest Area:	Improving Health
Program Name:	ACCEL (Arizona Coalition for Comprehensive Evaluation of Long-COVID)

Problem Statement:

There is growing recognition that survivors of COVID-19 infection are vulnerable to developing a wide range of post-infection problems (known as long-COVID) of unknown duration with implications for long-term care costs and disabilities affecting capacity to work. Long-COVID affects the cardiovascular system, lungs, joints, skin, GI tract and brain with widely differing effects in different individuals. There is an urgent need for new diagnostic tests and clinical assessment tools to predict which patients will develop Long-COVID and their prognosis.

Program Description:

The Arizona Coalition for Comprehensive Evaluation of Long-COVID (ACCEL) is a multi-institution consortium led by ASU's Complex Adaptive Systems Initiative (CASI), in partnership with Abrazo Health, Dignity Health, Honor Health, Mayo Clinic, Valleywise Health, Veterans Administration, Arizona Department of Health Services, HealthCurrent, NAU, TGen-North and multiple units at ASU (Biodesign Institute, College of Health Solutions, Southwest Interdisciplinary Center (SIRC), College of Public Service and Community Solutions). Its goal is to establish collaborative research on COVID-19 immune responses to predict individuals at risk of severe COVID-19, death or development of long-COVID. CASI's role as founding sponsor of National Biomarker Development Alliance established protocols for biobanking of samples for multiOmics and standardized data formats for multi-institution data exchange that have been adopted by the ACCEL project

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

The scale of the patient populatoin suffering from long-COVID and its statewide impact will benefit from mobilizing tri-unviersity resources to generate the spectrum of clinical, research and computing skills required.
Long-COVID is attracting major federal funding. ASU and and the Institute for Future Health (a joint program of ASU and the University of Arizona) have strong competitive assts to pursue these fundign sources and provide a robust return on investment.

Is there an Arizona Specific Benefit or Impact?

Over 1 million Arizonans have been infected with COVID-19. Over 70,000 have been hospitalized and 18,000 have died. Based on the incidence of long-COVID across the U.S. and undected infections, the nation is potentially facing a formidable public health challenge of up to 1 million chronically ill individuals. Arizona will face a proportional burden and will need to mobilize new speciality clincis to meet the needs of these patients. Discovery of new diagnostic biomarkers as part of this project offers opportunities to develop intellectual property to promote collaborations with industry for commercialization and royalty revenues.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	712,323	712,323	712,323	2,136,970
Applied Research	712,323	712,323	712,323	2,136,970
Development	712,323	712,323	712,323	2,136,970
Total	2,136,970	2,136,970	2,136,970	6,410,910

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	54	56	59	169
Graduate Students	254	266	280	800
Undergraduate Students	110	116	121	347
Sponsored Project Funding	253,962	266,660	279,993	800,615
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Improving Health
Program Name:	Skysong Innovations

Problem Statement:

ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.

Program Description:

SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO).In FY20, ASU researchers working with SI continued to set new benchmarks, submitting 306 invention disclosures and launching 19 new startups. ASU startups also raised more than $120 million in external funding in FY20. Moreover, when the COVID-19 pandemic first emerged, SI began fast-tracking innovations to prevent, diagnose or treat the disease. To date, SI has licensed eight ASU-developed COVID technologies to companies.

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

SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly $1 billion in venture capital and other funding. SI is also the ASU lead behind the ASU-Mayo MedTech Accelerator, which brings together the recognized world leader in patient care, education, and research, with the nation's #1 ranked university for innovation. Emerging companies selected for strong potential for next-generation medical technologies/services undergo an immersive curriculum, followed by 12 months of close collaboration, guidance, and tracking. Participants can access fast-track product development collaborations, research, and clinical validation studies with Mayo Clinic and/or medical education and research through ASU.

Is there an Arizona Specific Benefit or Impact?

SI annually commissions the Seidman Research Institute to perform an economic impact analysis of ASU's tech transfer activities. The most recent report found that from 2016-2020, as a result of the operations of SI and the Arizona-based, ASU-linked companies, Arizona's economy gained a cumulative $717.8 million in gross state product, $477.9 million in labor income, 7,059 job years and $64 million in state and local tax revenues. By 2025, Seidman projects the economic impact of SI and these ASU-linked companies will exceed $2.3 billion, with the vast majority of that impact in Arizona.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	490,538	490,538	490,538	1,471,613
Applied Research	490,538	490,538	490,538	1,471,613
Development	490,538	490,538	490,538	1,471,613
Total	1,471,613	1,471,613	1,471,613	4,414,840

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	0	0	0	0
Sponsored Project Funding	0	0	0	0
Startups	5	5	5	15

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Improving Health
Program Name:	Office of Government and Community Engagement

Problem Statement:

Decisions to pursue solutions to most pressing human health challenges are often informed by select organizations and committees with limited access by the broader research community. Moreover, securing federal research funding is highly competitive and becoming more and more challenging. To participate meaningfully in relevant discussions and secure funding to support research, ASU must conduct creative, coordinated efforts to establish the university as a thought leader in policy setting areas and increase federal support for research and research-related activities.

Program Description:

The Office of Government & Community Engagement serves as the liaison to officials and agencies of the U.S. government, state of Arizona, Maricopa County, surrounding municipalities and communities, tribal nations, Mexico and cultural leaders. Our office establishes and maintains communication channels with policy-makers, sponsor agency officials and program staff to effectively represent our research capabilities, infrastructure and organizational strenths. We facilitate participation in priority-setting venues and recognition as a thought leader and valuable contributor to advances in science and technology in the national interest, enabling sustained growth in our research and development pursuits.

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

ASU is developing new, cross-disciplinary teams and partnerships that position it well to participate in high-level discussions around use of novel technologies and analytical tools to address more complex health challenges than have been resolved to date. We are already seeing early evidence of realization of the need for such innovative approaches in recent funding opportunities, for which we are getting recognition. With appropriate outreach, ASU's Health Futures Center will provide facilities needed to increase our competitiveness in obtaining funding from the U.S. Department of health and Human Services, including NIH, CDC, HRSA and PCORI. In addition, coupling our broad biomedical expertise with artificial intelligence and machine learning is already enhancing our ability to compete for large, new funding opportunities that require this interdisciplinarity.

Is there an Arizona Specific Benefit or Impact?

Growth of the microelectronics industry in Arizona and other advanced technologies will be the beneficiaries of increased research efforts that depend on access to these tools, with corresponding positive economic impacts. ASU will also be a source for a highly skilled workforce in these areas, thereby providing a magnet for future industry growth. Arizona is also home to rural and urban communities experiencing disproportionate health disparities based on multiple factors, many of which may be identified using advanced analytical tools such as artificial intelligence, which requires increased federal funding.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	304,000	304,000	304,000	912,000
Development	304,000	304,000	304,000	912,000
Total	608,000	608,000	608,000	1,824,000

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	0	0	0	0
Sponsored Project Funding	7,000,000	7,350,000	7,717,500	22,067,500
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Improving Health
Program Name:	Research Computing

Problem Statement:

The process of discovery is directly driven by the scale and pace of available simulation and analysis capacity on campuses. Research projects within Arizona increasingly rely on foundational and advanced research computing. Over 80% of the top-funded researchers at each of the state institutions are currently supported through research computing infrastructure and services. This percentage continues to increase as more research funding opportunities require not only research computing but also systematic support for data controls and regulations. Positioning our researchers for success in health, medical, defense and next-generation technologies research requires a scale of support only available at the statewide level, providing enhanced collaborative capability across all three universities.

Program Description:

ASU Research Computing provides cutting-edge technology to support research and education while advancing the knowledge and understanding of deploying 21st-century cyberinfrastructure in a large public research university. Specifically, this program supports multidisciplinary research and education in science, technology, engineering and mathematics domains, including computational genomics, molecular dynamics, computational materials science, robotics and imaging. The program increases ASU's capacity for computationally enabled discovery and provides a federated access mechanism for extramural resource sharing across Arizona. Partnering with Dell Technologies, the ASU Research Computing Core Facility has established the ASU Center of Excellence in High Performance Computing and Artificial Intelligence. One of only three such centers in the United States, Research Computing currently enables nearly $1 billion in proposals and nearly $300 million in awards.

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

Investment in Research Computing will unify, broaden and overarchingly lift all advanced computing capabilities across the state. Notably, investment of TRIF funds in this program will:

- Directly enable ASU proposals totaling $2 million per year.
- Precipitate large-scale federal infrastructure awards.
- Increase percent conversion of faculty who have consumed research computing resources.
- Increase engagement via training events reaching over 1,000 participants per year.
- Shorten the time to achieving transformational research and scientific discovery.

Is there an Arizona Specific Benefit or Impact?

Research Computing has developed capacities in advanced computing and data for initiatives in health, sustainability, space exploration, national security and workforce development that benefit Arizona. Examples include:

- Federally regulated secure computing environment for the Global Security Initiative.
- Advanced data movement network for the Lunar Reconnaissance Orbiter Camera.
- Developing the Health Futures Computational Facility in partnership with Mayo Clinic.
- Exploring workforce development opportunities in our tribal communities and identifying solutions to accessing technological resources.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	765,000	765,000	765,000	2,295,000
Applied Research	765,000	765,000	765,000	2,295,000
Development	765,000	765,000	765,000	2,295,000
Total	2,295,000	2,295,000	2,295,000	6,885,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	110	116	121	347
Graduate Students	633	665	698	1,996
Undergraduate Students	217	228	239	684
Sponsored Project Funding	47,441,365	49,813,433	52,304,105	149,558,903
Startups	3	3	3	9

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	National Security Systems
Program Name:	Global Security Initiative

Problem Statement:

Today's national and global security challenges are highly complex and interconnected, including protecting information networks (such as those found in critical infrastructure), optimizing human-robot teams, combatting mis- and disinformation, leveraging massive amounts of complex data for effective decision making, and developing transition pathways to application. These challenges require both developing advanced mission-focused research capabilities and creating novel training environments.

Program Description:

ASU's Global Security Initiative (GSI) brings together unique ASU research, education, and programming capabilities to address national and global security challenges. GSI has three pillars of activity: research, education and engagement. The research pillar establishes interdisciplinary teams to work on the most challenging problems in security. Currently, GSI has four centers: Center for Cybersecurity and Digital Forensics (CDF), Center for Human, AI, and Robot Teaming (CHART), Center on Narrative, Disinformation, and Strategic Influence (NDSI), and Center for Accelerating Operational Efficiency (CAOE), a U.S. Department of Homeland Security (DHS) Center of Excellence (COE). GSI also manages the Cybersecurity Education Consortium (CEC), an interface between industry and academia to facilitate a robust talent pipeline for cybersecurity jobs in Arizona and across the nation. In addition, GSI supports ASU's Center for Wireless Information Systems and Computational Architectures (WISCA), which builds novel computational architectures that require significantly less power while improving computational ability.

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

GSI has strategically aligned ASU capabilities with national security needs in cybersecurity, human/AI teaming, analytics and narrative analysis, which has resulted in large-scale externally funded awards and recognition by government and academic partners of ASU's unique strengths in these areas. GSI is also creating a unique role for ASU in the education domain, addressing the need to expand STEM education to ensure our future national security. In the last five years, largely through strategic investment in GSI focus areas, ASU's DoD HERD expenditures grew by more than 50%. Assuming the current investment level and other complimentary university activities, we expect the DoD HERD expenditures to continue to grow another approximately 20% by 2024, leading to $50-55 million in annual DoD expenditures and projected rise in (DoD HERD) ranking to place ASU near the top 20.

Is there an Arizona Specific Benefit or Impact?

GSI is improving state and national cyber-readiness in multiple ways. We provide hands-on learning activities for all skill levels and age groups, including free resources for Arizona’s middle school and high school teachers, and a free educational platform that guides emerging members of the cybersecurity community through increasingly sophisticated learning modules. GSI's cybersecurity research is informed by connections with Arizona-based industries, and helps protect the intellectual property of Arizona-based companies and the personal information of citizens of Arizona from cyber-threats. A dedicated university security entity helps establish Arizona as a forward-thinking, security-conscious state that can serve as a model for others as the threats to our nation continue to evolve.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	1,249,000	1,249,000	1,249,000	3,747,000
Development	1,249,000	1,249,000	1,249,000	3,747,000
Total	2,498,000	2,498,000	2,498,000	7,494,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	42	45	47	134
Graduate Students	383	402	422	1,207
Undergraduate Students	140	147	154	441
Sponsored Project Funding	39,723,704	41,709,889	43,795,383	125,228,976
Startups	2	2	2	6

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	National Security Systems
Program Name:	Skysong Innovations

Problem Statement:

ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.

Program Description:

SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities, and 11th worldwide, according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). In addition, ASU researchers working with SI were No. 4 in patents granted, No. 4 in startup companies launched, and No. 3 in inventions disclosed among universities without medical schools, according to a recently released report by the Association of University Technology Managers (AUTM) on FY19 outputs. As a result, ASU was just one of five universities without a medical school ranking in the top 10 for issued patents, startups launched, inventions disclosed, and deal flow (along with Carnegie Mellon, MIT, NC State and Purdue).

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

SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly $1 billion in venture capital and other funding. Because experience has taught us that many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill. The ASU Startup Mill connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and – in some cases – even take positions running these startups. In FY21, SI advanced sponsored research providing over $30 million in funding for ASU, resolving IP and other substantive issues as part of the agreements.

Is there an Arizona Specific Benefit or Impact?

SI annually commissions the Seidman Research Institute to perform an economic impact analysis of ASU's tech transfer activities. The most recent report found that from 2016-2020, as a result of the operations of SI and the Arizona-based, ASU-linked companies, Arizona's economy gained a cumulative $717.8 million in gross state product, $477.9 million in labor income, 7,059 job years and $64 million in state and local tax revenues. By 2025, Seidman projects the economic impact of SI and these ASU-linked companies will exceed $2.3 billion, with the vast majority of that impact in Arizona.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	110,955	110,955	110,955	332,865
Applied Research	110,955	110,955	110,955	332,865
Development	110,955	110,955	110,955	332,865
Total	332,865	332,865	332,865	998,595

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	0	0	0	0
Sponsored Project Funding	0	0	0	0
Startups	5	5	5	15

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	National Security Systems
Program Name:	Research Development

Problem Statement:

Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.

Program Description:

Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.

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

Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.

Is there an Arizona Specific Benefit or Impact?

ASU's research portfolio directly impacts the regional economy and contributes to ASU's national ranking among institutions of higher education.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	41,010	41,010	41,010	123,030
Applied Research	41,010	41,010	41,010	123,030
Development	41,010	41,010	41,010	123,030
Total	123,030	123,030	123,030	369,089

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	3	3	3	9
Sponsored Project Funding	40,000,000	42,000,000	44,100,000	126,100,000
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	Global Futures Laboratory Programming

Problem Statement:

The Emergence of the Julie Ann Wrigley Global Futures Laboratory at ASU is rooted in the conviction that we can and must make a meaningful contribution to ensuring a habitable planet and a future in which well-being is attainable for all mankind.
This laboratory draws from ASU's deep commitment to use-inspired research, our ongoing work in sustainability and service to the global community in which we live. We are running out of time on many fronts, and need to address problems with urgency, sometimes within only a few years or decades. Water, Energy and Environmental Systems are key drivers to a more sustainable future.

Program Description:

This laboratory draws from ASU's deep commitment to use-inspired research, our ongoing work in sustainability and service to the global community in which we live. TRIF funding supports multiple programs focused on new energy systems, decisions systems and water related research.

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

The Julie Ann Wrigley Global Futures Laboratory leverages the tools and expertise of transdisciplinary research institutes, centers and facilities across ASU to generate new ideas and solve problems. We work in networks and in close exchange with the people affected by problems to combine knowledge and develop solutions on multiple scales. Our New Energy Systems efforts — carbon capture, synthetic fuels, energy transition — have funding opportunities from the Department of Energy (DOE), Carbon Collect and National Science Foundation (NSF). Our Decisions Systems project — complex systems thinking, convergence research, data visualization and modeling — may attract funding from State Department/USGS, Helios Foundation, Rockefeller Foundation and DOE. Our Water research — building on the Action for Water Equity (AWE) NSF award to create a center-level effort — may draw additional investment from the NSF.

Is there an Arizona Specific Benefit or Impact?

1. Transforming Arizona into a hub of carbon capture and synthetic fuel creation, forging partnerships that include the Navajo Nation, APS, SRP, and local NGOs support the economic transition from coal to alternative energy sources including support to affected communities. 2. Partnering with cognizant national topic leaders and integrate the perspectives and data of faculty, State, County, and industry leaders, with the goal to attract approximately $10 million in funding and establish Arizona as a leader in developing economic resilience and continuity in the face of major disruptions. 3. Significantly expand ASU water initiatives including western water resilience and innovation ecosystem by attracting $25 million in external funding to improve water sustainability and bring jobs, greater water access and equity to urban and rural communities.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	2,643,000	2,643,000	2,643,000	7,929,000
Development	1,321,500	1,321,500	1,321,500	3,964,500
Total	3,964,500	3,964,500	3,964,500	11,893,500

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	44	46	49	139
Graduate Students	217	228	239	684
Undergraduate Students	148	156	163	467
Sponsored Project Funding	25,819,327	27,110,293	28,465,808	81,395,428
Startups	2	2	2	6

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	Skysong Innovations

Problem Statement:

ASU researchers are tackling some of the world's biggest challenges, from sustainable resources and carbon capture to cancer detection and treatment. Their post-research challenge comes in finding the right partners, strategic investments and experienced entrepreneurial leaders needed to move those innovations into successful commercial application. Skysong Innovations (SI) identifies those technologies with broad potential and coordinates with the right partners to bring these innovations into the marketplace. From pulling water out of thin air to re-engineering a virus to attack cancer, ASU researchers have worked with Skysong Innovations to spin out dozens of companies that have the potential to revolutionize the way we navigate the global challenges of the 21st century.

Program Description:

SI is ASU's exclusive intellectual property management and technology transfer organization (TTO). Since 2003, SI has provided the ASU research community with the support and expertise needed to turn their research discoveries into commercial opportunities. SI has long been one of the top-performing university TTOs in terms of researcher inventions disclosed, licensing deals signed and startups launched per research dollar. For the third consecutive year, ASU is in the top 10 for U.S. patents issued to U.S. universities — and 11th worldwide — according to an annual ranking of the top universities by the National Academy of Inventors (NAI) and the Intellectual Property Owners Association (IPO). In 2020, ASU was issued 140 U.S. patents, tied with the University of Florida, up from 137 the previous year, and just one spot behind Harvard. Other U.S. universities in the top 10 include MIT, Stanford, and Caltech. Tsinghua University in Beijing was the only non-U.S. university to surpass ASU on the global list.

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

SI regularly interacts with venture-capital firms, angel-investment groups, and other potential investors around the globe to showcase ASU startups and technologies. All told, ASU researchers working with SI have launched more than 170 startups, which in turn have attracted nearly $1 billion in venture capital and other funding. Because experience has taught us that many investors are wary of giving money to companies led by inexperienced founders, we created a special program called the ASU Startup Mill. The ASU Startup Mill connects ASU companies with successful entrepreneurs and experienced corporate executives who can provide advice, support and – in some cases – even take positions running these startups. In FY21, SI advanced sponsored research providing over $30 million in funding for ASU, resolving IP and other substantive issues as part of the agreements.

Is there an Arizona Specific Benefit or Impact?

SI annually commissions the Seidman Research Institute to perform an economic impact analysis of ASU's tech transfer activities. The most recent report found that from 2016-2020, as a result of the operations of SI and the Arizona-based, ASU-linked companies, Arizona's economy gained a cumulative $717.8 million in gross state product, $477.9 million in labor income, 7,059 job years and $64 million in state and local tax revenues. By 2025, Seidman projects the economic impact of SI and these ASU-linked companies will exceed $2.3 billion, with the vast majority of that impact in Arizona.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	521,683	521,683	521,683	1,565,049
Applied Research	521,683	521,683	521,683	1,565,049
Development	521,683	521,683	521,683	1,565,049
Total	1,565,049	1,565,049	1,565,049	4,695,148

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	0	0	0	0
Sponsored Project Funding	0	0	0	0
Startups	5	5	5	15

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	MacroTechnology Works Site Development

Problem Statement:

MacroTechnology Works (MTW) mission is "To become the engine of semiconductor and energy materials and device research in the US and a national resource for advancing new technologies to pilot scale." Over the past 2 years ASU has started to develop a model to realize this mission, leveraging the MTW site and the unique facilities and equipment available there to enable a collaborative university/startup/industry research model. Defining elements for this model include: strong core facilities (available to all) for democratized research; small “proprietary” faculty and industry labs for unique toolsets; key corporate partners that enhance our capabilities and engage in joint research; a lease + user fees + research collaboration model that provides options that fit the scale of the partner; and undergraduate, graduate, and employee training.

Program Description:

1. Strong core facilities provide users with access to capital equipment within the core. This allows industry partners to access non-proprietary toolsets on a fee for service basis, and allows startups and smaller companies access to industry-scale tools. 2. The MTW site has highly configurable space within cleanroom environments that allow small proprietary lab spaces to operate on site. These labs are available as leased spaces for industry partners. Industry partners executing a lease are required to also commit to funding research activities. 3. Key corporate partners provide opportunities to enhance access to state of the art tools for materials deposition, etch, and characterization and provide opportunities for industry relevant research activities. 4. Engaging with companies at various scales is enabled via a scalable model that engages partners in leased space, core facilities usage, and research collaboration that provides a win-win opportunity for ASU researchers to participate in value added research that aligns with industry needs. 5. Undergraduate, grad student, and post doc participation in research projects and training on industry relevant tools helps to prepare the next generation semiconductor workforce.

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

With recent announcements of new semiconductor fabs being built in the valley, Arizona has an opportunity to become the hub of semiconductor research and innovation in the U.S. ASU has a robust pipeline of semiconductor research and has key partnerships in place to expand the ecosystem in Arizona. ASU researchers engaged in programs at MTW are currently funded at ~$25 million per year, and we expect federal and industry funding for semiconductors to grow. Our projections are amplified by the federal requests for funding via the CHIPS act which addresses supply chain shortages in the wake of the COVID pandemic. ASU is expecting to participate in a number of large scale opportunities related to manufacturing and supply chain working with Arizona industry partners including a NIST-sponsored Manufacturing USA Institute and a DOD-sponsored National Network for Microelectronics Research and Development.

Is there an Arizona Specific Benefit or Impact?

There are several impacts to Arizona. Research activities at ASU can be tied directly in intellectual property (IP) generation and oftentimes to startup companies, jobs and wealth creation. ASU is engaged with eight Arizona-based startups at MTW already. Student engagement in research opportunities provides experiential learning and results in better trained employees. With recent announcements of new fab facility construction in the state there is a heavy demand for employees in the semiconductor industry, well beyond the needs within the fabs as suppliers across the supply chain also increase staffing.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	0	0	0	0
Development	1,000,000	1,000,000	1,000,000	3,000,000
Total	1,000,000	1,000,000	1,000,000	3,000,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	5	5	5	15
Graduate Students	20	20	20	60
Undergraduate Students	0	0	0	0
Sponsored Project Funding	30,000,000	33,000,000	37,000,000	100,000,000
Startups	9	11	12	32

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	Research Development

Problem Statement:

Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.

Program Description:

Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.

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

Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.

Is there an Arizona Specific Benefit or Impact?

ASU's research portfolio directly impacts the regional economy and contributes to ASU's national ranking among institutions of higher education.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	201,189	201,189	201,189	603,566
Applied Research	201,189	201,189	201,189	603,566
Development	201,189	201,189	201,189	603,566
Total	603,566	603,566	603,566	1,810,698

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	3	3	3	9
Sponsored Project Funding	40,000,000	42,000,000	44,100,000	126,100,000
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	Center for Bio-mediated and Bio-Inspired Geotechnics (CBBG)

Problem Statement:

Through the Center for Bio-mediated and Bio-Inspired Geotechnics (CBBG), Arizona State University is the international leader in appling the emerging field of biogeotechnics to develop sustainable and resilient geotechnical solutions for civil infrastructure systems. Through direct application of and by mimicking biological processes abiotically, CBBG seeks to reduce the life cycle costs and environmental and social impacts of construction, operation, and maintenance of infrastructure systems that build on, in, and with earthen materials.

Program Description:

Led by ASU, CBBG is a National Science Foundation Gen-3 Engineering Research Center and includes three other leading public Universities: Georgia Institute of Technology, New Mexico State University and the University of California at Davis. CBBG has four technological thrusts: Geological Hazard Mitigation; Environmental Protection and Ecological Restoration; Infrastructure Construction Methods and Materials; and Subsurface Exploration and Excavation. CBBG also has a focus on Innovation, Diversity and Inclusion, and Education that includes a robust K-12 outreach program and a Research Experience for Teachers (K-14) program that has a strong emphasis on participants from underrepresented groups.

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

ASU is uniquely suited to lead CBBG because of its emphasis on transdisciplinary and use-inspired research, sustainable development, local impact and social embeddedness, and global outreach. With its focus on bio-mediatation, bio-inspiration and earthen (geologic) materials, CBBG research is by nature a transdisciplinary endeavor. Its progress is facilitated by ASU's ability to foster and support interdisciplinary work. All CBBG projects must be targeted towards sustainable development of civil infrastructure, i.e., must be use-inspired, whether it be focused on fundamental knowledge development or integration of a new technology into civil infrastructure systems. And all CBBG projects must be supported by a life cycle sustainability assessment (LCSA) that documents potential contributions of the project to the triple bottom line of social, environmental and financial benefit.

Is there an Arizona Specific Benefit or Impact?

TRIF support for CBBG has many direct and indirect benefits for Arizona. Direct benefits include research on problems of major importance to the health and well-being of Arizona citizens such as fugitive dust control and remediation of groundwater impacted by chlorinated solvents, education and training for Arizona's engineering workforce, training and curriculum development for local K-14 schools, and entrepreneurial opportunities for startup businesses. Indirect benefits for Arizona not only include contributions to sustainability and resilience of civil infrastructure systems across the U.S. and worldwide but also research on global problems of concern to major Arizona-based industries such as mitigation of the impacts of mining on groundwater and enhanced management of methane emissions at landfills.

Investment Detail

	2022	2023	2024	Total
Infrastructure	400,000	400,000	400,000	1,200,000
Basic Research				0
Applied Research				0
Development				0
Total	400,000	400,000	400,000	1,200,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	4	4	4	12
Graduate Students	19	20	21	60
Undergraduate Students	12	12	13	37
Sponsored Project Funding	2,205,548	2,315,826	2,431,617	6,952,991
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	NSF Nanosystems Engineering Research Center for Off-Grid Nanotechnology Enabled Water Treatment (NEWT

Problem Statement:

The vision of the Nanosystems Engineering Research Center for Nanotechnology-Enabled Water Treatment Systems (NEWT) is to enable access to water of suitable quality almost anywhere in the world by developing next-generation, easy-to-deploy modular treatment systems enabled by nanotechnology. These efforts both protect human lives and support sustainable economic development.

Program Description:

NEWT aims to develop new technologies to purify drinking and industrial waters. Initially funded in 2015, we are renewed through 2025. As NEWT approaches self-sufficiency, we are request funding to continue discovery of new treatment technologies that will stimulate the many industrial partners with breakthrough science. This compliments our strong success in industrial members then funding associated projects. Personnel time and material funds will be used to support multiple NEWT faculty on high-risk science that will collect preliminary data for new extramural funding proposals, and funds to demonstrate technology translation using our mobile testbed. The NEWT faculty and student team has been amazingly successful with new patents, start-ups and STTR awards – and having the ability to translate to the testbed has proven essential in these higher TRL endeavors. The NEWT team leads and participates in a broad range of outreach, education and diversity activities.

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

ASU has lead recruitment and collaboration with over 25 industrial members of NEWT. Annually these industrial members fund an additional $1 million at ASU in research through NEWT. The NEWT research has been leveraged to be part of a recent NIH MEMCARE Center with Harvard and Yale, and a new NSF Science and Technology Center to be launched in October 2021.

Within NEWT we are on the verge of a new project with the Gates Foundation for reuse of greywater inside homes, and use of the reused water for sanitation. This is considered a high-risk, high-tech solution that Gates is providing to NEWT and considerable follow-on funding and industrial spinouts are expected.

Is there an Arizona Specific Benefit or Impact?

NEWT is recruiting more Arizona-based industry partners struggling with on-site water reuse challenges that they must address to meet corporate sustainability goals. This both improves water conservation efforts in our desert state and increases the visibility of ASU researchers to the private sector as experts who can rapidly solve real-world problems and provide actionable information for companies. Two start-up companies in Arizona related to NEWT technology have advanced funding from NASA and hire employees in Arizona. Our technologies are being integrated into water solutions for rural communities to provide clean drinking water. Annually we bring undergraduates from Arizona Community colleges and high school teachers from Arizona into our research labs for organized, paid, summer research experiences.

Investment Detail

	2022	2023	2024	Total
Infrastructure	35,000	35,000	35,000	105,000
Basic Research				0
Applied Research				0
Development				0
Total	35,000	35,000	35,000	105,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	4	4	4	12
Graduate Students	19	20	21	60
Undergraduate Students	12	12	13	37
Sponsored Project Funding	2,205,548	2,315,826	2,431,617	6,952,991
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Water, Energy and Environmental Systems
Program Name:	Collaborative Research Infrastructure and Core Facilities

Problem Statement:

As the state of Arizona positions itself to be a leader in the research areas targeted by TRIF, it is imperative that we maintain and enhance our core infrastructure that supports these initiatives. We have taken steps toward developing a statewide network to promote awareness of shared resources across the state. We have leveraged federal funding to the extent possible to secure advanced and highly specialized technologies. Just as important are our fundamental capabilities and personnel that form the backbone of our core infrastructure. TRIF funding is an essential component of our overall funding strategy to maintain an appropriate refresh rate of these broadly-impactful fundamental capabilities.

Program Description:

Core Facilities mission:

To facilitate the expansion and enhancement of ASU's research enterprise by providing technical and scientific services to support faculty research objectives and enable success.

Strategy:

1. Maintain state-of-the-art facilities and expert staff to support technologies and applications aligned with ASU's strategic research goals.
2. Provide effective access (physical, financial, training, workflows) and maintain customer-focused orientation.
3. Increase awareness of capabilities through marketing, communications and promotional efforts.
4. Engage industry and non-profit partners to fully leverage resources and maintain fiscal sustainability.

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

ASU is uniquely poised to advance research and secure external funding in key areas that are enabled largely by core facilities. Given federal funding initiatives, our geographical location, and strength in advanced materials, solar, power electronics and other related areas, there is significant opportunity for expanding partnerships within the semiconductor industry as companies establish a presence in the Phoenix metro area. These will be supported by our NanoFab, Eyring Materials Center, Advanced Electronics and Photonics, and Solar Fab facilities. In addition to funding in the semiconductor space, ASU's clinical partnerships with multiple health care organizations provides a unique opportunity to competitively pursue National Institutes of Health funding through the Clinical and Translational Science Award program. Funding of infrastructure with which we provide shared clinical support services will be instrumental to advancing this effort.

Is there an Arizona Specific Benefit or Impact?

By nature, core facilities train a high volume of university students, staff and faculty, as well as industry partners, and thereby contribute significantly to hands-on workforce development. Many of our student trainees move on to work in local industry as scientists and engineers, utilizing the skill sets they develop under our training programs.

Investment Detail

	2022	2023	2024	Total
Infrastructure	1,000,000	1,000,000	1,000,000	3,000,000
Basic Research	670,128	670,128	670,128	2,010,383
Applied Research	670,128	670,128	670,128	2,010,383
Development	670,128	670,128	670,128	2,010,383
Total	3,010,383	3,010,383	3,010,383	9,031,149

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	159	167	175	501
Graduate Students	696	731	768	2,195
Undergraduate Students	332	349	366	1,047
Sponsored Project Funding	61,072,281	64,125,895	67,332,189	192,530,365
Startups	5	6	6	17

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Space Exploration and Optical Sciences
Program Name:	Interplanetary Initiative

Problem Statement:

Humankind is compelled to explore space and will have a space future. Most efforts to prepare for this space future are aimed toward incremental science in narrow disciplines. They struggle to cope with the larger picture or, alternatively, only look at the larger societal impacts without being connected to real scientific endeavors. However, humankind's space future requires fusing disciplines together for these efforts to succeed.

Program Description:

The interplanetary Initiative is transforming both how we educate the next generation and how we fundamentally conduct research while finding common cause in an essential challenge for humanity: our space future. Space exploration is a compelling, freeing vehicle for ideation about the future of society and education. To build a positive space future, people will need to embrace and know how to tackle unsolved problems. ASU is uniquely prepared to create thoughtful, communicative, transdisciplinary teams including scientists, engineers, psychologists, sociologists, artists, public relations experts, historians and beyond.

The interplanetary Initiative is creating and implementing novel pan-university learning programs centered on open inquiry and launching new research driven by interdisciplinary teams tackling some of the biggest questions about space exploration. The implementation and scaling of our unique teaming and learning processes will make problem-solving and knowledge creation accessible to all of society.

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

The Interplanetary Initiative helps ASU drive forward (and ultimately scale) new models of learning and research that support an inclusive and sustainable space future. The program also explores new organizational models for advancing ASU's mission.

The initiative's experimental processes and programs, in addition to the interdisciplinary and cross-sector community of thought leaders which it has nurtured and grown, puts ASU in a competitive position for high-impact partnerships and funding opportunities in the space sector, such as its partnership with XPRIZE.

Is there an Arizona Specific Benefit or Impact?

The initiative's novel learning programs will directly benefit learners and businesses based in Arizona. For example, OpenCitizen meets learners wherever they are — in the home or the workplace — and connects their learning experience to what matters most to them in their communities. OpenCitizen's local problem solving focus benefits Arizona by empowering its citizens to make positive changes in their community while gaining new skills. The Technological Leadership B.S., which has just completed its first year and offers a radically different learning experience in which students direct their own learning through research processes, enrolled 18 students living in Arizona. Moreover, the Interplanetary Initiative strengthens ASU's relationships with the robust aerospace industry in Arizona though workforce development and research partnerships.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	133,333	133,333	133,333	400,000
Applied Research	133,333	133,333	133,333	400,000
Development	133,333	133,333	133,333	400,000
Total	400,000	400,000	400,000	1,200,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	2	2	2	6
Graduate Students	6	6	6	18
Undergraduate Students	64	67	71	202
Sponsored Project Funding	5,089,714	5,344,200	5,611,410	16,045,324
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Space Exploration and Optical Systems
Program Name:	Materials of the Universe

Problem Statement:

Space exploration is now pursued actively in both the private and government sectors. The discovery of complexities in our solar system and of thousands of remarkably diverse exoplanets raises both fundamental and practical questions. To understand planets, we need to combine knowledge from fields ranging from astrophysics to geochemistry to materials science. We need to answer materials-based questions, such as determining the detailed structure, composition and evolution of distant planets based on a few observed properties. At the same time, we need better materials for space exploration — solving problems like finding more sensitive spectroscopic detectors, building more robust space vehicles, and extracting and utilizing extraterrestrial resources. These problems are closely related and form a new field, which we call materials of the universe.

Program Description:

The Navrotsky Eyring Center for Materials of the Universe (MotU) addresses the two challenges above — understanding planets and improving materials for space exploration — by an interdisciplinary program involving about 20 faculty from the School of Molecular Sciences (SMS), the School of Earth and Space Exploration (SESE) the Department of Physics, and the School for Engineering of Matter, Transport, and Energy (SEMTE). A major thermodynamics and high-temperature materials laboratory has been established by the MotU director, Alexandra Navrotsky, who joined ASU in 2019, and further strengthened by the hire of Professor Hongwu Xu, arriving this fall. Four additional MotU faculty positions are planned in the College of Arts and Sciences, with two searches commencing imminently. A major NSF proposal for a high-pressure center has been submitted, thus adding emphasis to materials under extreme conditions relevant to planetary systems — high temperature, high pressure, radiation fields, etc. Faculty in different fields are co-supervising graduate students. Seminars, courses and workshops have been held and are being developed.

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

ASU has unique strengths in astrophysics, planetary exploration (both orbiters and landers), experimental geochemistry and thermodynamics, electron microscopy and fundamental theory, with a distinguished history of collaboration in solid state science. There are funding opportunities from NSF, DOE, NASA and DOD, and a number of proposals have already been submitted and some funded. A large private gift to support MotU, partly now and partly as a bequest, has been finalized.

Is there an Arizona Specific Benefit or Impact?

With growing high tech and space related industries in Arizona, MotU will have increasing opportunities for collaboration with industry. The growing industrial sector will have access to ASU facilities and uniquely trained students who will function at the interface of space science, physical science and engineering.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	106,667	106,667	106,667	320,000
Applied Research	106,667	106,667	106,667	320,000
Development	106,667	106,667	106,667	320,000
Total	320,000	320,000	320,000	960,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	2	2	2	6
Graduate Students	2	2	2	6
Undergraduate Students	0	0	0	0
Sponsored Project Funding	381,034	400,085	420,090	1,201,209
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Space Exploration and Optical Systems
Program Name:	Space Technology and Science Initiative (NewSpace)

Problem Statement:

The exponential growth in the commercial space industry provides an enormous opportunity for universities to partner with commercial space companies to seek funding from federal agencies for education, science and technology, workforce development and national security. ASU's expertise in space science and technology and a growing commercial space industry presence provide multiple entry points for partners to engage and see mutual benefits. The ASU Space Technology and Science (NewSpace) Initiative works across the university on numerous commercial space projects, including satellite communication and ground stations, DOD space opportunities, continued growth in NASA funding, development of a spaceport in Arizona, space industry presence on campus, commercial remote sensing projects for Arizona, and ASU exposure at industry events.

Program Description:

The ASU Space Technology and Science ("NewSpace") Initiative was established in 2013. The Initiative was designed to develop and integrate the commercial space industry with the space science and technology community at ASU. Leveraging heritage experts from ASU for space and space relevant science and technology growth, we have been successful in securing a number of new space-related projects on campus, including a NASA-funded deep space satellite mission to orbit the Moon for mapping of lunar polar hydrogen and other programs focused on space-related sensors, instruments and spacecraft systems. ASU NewSpace is supporting the growth of the Arizona space industry through ASU student capstone programs, the establishment of a space business entrepreneurship course for students, and partnerships with industry to enable access to the unique space-relevant facilities available on campus. We also focus on developing an ASU-led satellite communication and tracking ground station, smallsat instrument development and technology advancement, industry sponsored senior design/capstone course growth, and Arizona NASA Space Grant mentorship.

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

Morgan Stanley predicts that by 2040, the space economy will be over $1 trillion. ASU has over 300 investigators that submit proposals to NASA and other space-related funding sources. Leveraging and growing this space researcher cohort has been a focus at ASU NewSpace. Incorporating our 400+ industry partners into funding proposal development, we directly enabled the submission of over $60 million in proposals to federally sponsored opportunities in FY21, leading to over $1.5 million in awards last year. We forecast that through ASU NewSpace there will continue to be growth in proposals annually of $40-$75 million, along with an increase in our win rate on awards.

Is there an Arizona Specific Benefit or Impact?

Yes. ASU NewSpace has cultivated relationships with more than 60 Arizona-based companies or institutions in the space industry. These industry relationships have resulted in multiple sub-contracts to NASA-funded projects, multiple ASU senior design/capstone projects and multiple public-facing events through organizations like AZ Commerce Authority, the City of Tempe, the Greater Phoenix Economic Council, AZ Tech Council and others. These benefits and impact will continue to grow as ASU NewSpace expands its ability to assemble ASU experts and commercial space industry partners to pursue new funding opportunities. These efforts will enable deep relationships to benefit the students, faculty and facilities at ASU along with the growing Arizona space industry.

Investment Detail (in tens of thousands of dollars)

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	0	0	0	0
Applied Research	200,000	200,000	200,000	600,000
Development	200,000	200,000	200,000	600,000
Total	400,000	400,000	400,000	1,200,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	0	0	1	1
Graduate Students	6	9	12	27
Undergraduate Students	40	42	44	126
Sponsored Project Funding	1,500,000	2,500,000	4,000,000	8,000,000
Startups	0	0	1	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Arizona State University
TRIF Investment Area:	Space Exploration and Optical Sciences
Program Name:	Research Development

Problem Statement:

Increasing the diversity, reach, quality and impact of ASU's faculty, staff and student research activities contributes to the strength of our regional economy and improves our national standing in higher education.

Program Description:

Research Development is responsible for increasing the size of ASU's research enterprise through a community of practice around early positioning and competitiveness of proposals for funding from federal agencies. This is accomplished through strategic intelligence of funding opportunities and improved teaming, outreach and training during research-related events, transparent and equitable management of limited funding opportunities and internal seed grants programs, and professional proposal management for large and complex funding proposals.

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

Research Development is responsible for dissemination of hundreds of limited funding opportunities to the university, providing hundreds of documents in support of strategic decision-making for leaders, bringing together hundreds of researchers to discuss competitive funding solicitations, and supporting millions of dollars' worth of proposals from ASU. This work increases the overall ability of ASU to reach aggressive goals for research expenditures.

Is there an Arizona Specific Benefit or Impact?

ASU's research portfolio directly impacts the regional economy and contributes to ASU's national ranking among institutions of higher education.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	22,989	22,989	22,989	68,967
Applied Research	22,989	22,989	22,989	68,967
Development	22,989	22,989	22,989	68,967
Total	68,967	68,967	68,967	206,902

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	3	3	3	9
Sponsored Project Funding	40,000,000	42,000,000	44,100,000	126,100,000
Startups	0	0	0	0

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TRIF 3-YEAR PLAN

NORTHERN ARIZONA UNIVERSITY

ARIZONA BOARD OF REGENTS

ASU ◆ NAU ◆ UA

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This plan positions NAU as a national leader in supporting equity and delivering educational value to students and Arizona communities through workforce-driven programming throughout AZ and transformative learning opportunities in impactful research programs.

Executive Summary

Northern Arizona University (NAU) will use TRIF funds to foster integrated and complementary educational and research activities that create exceptional impact and value for our diverse students, leading to the betterment of Arizona's communities. Building on past investments, allocations of TRIF funds in this three-year plan will be distributed across three primary efforts; **Access and Workforce Development (A/WD, ~40%), targeted areas of research excellence (~30%), and a competitive process for seed funding (~30%)** to support and incentivize the development of new and expanded workforce development programs that enable access, as well as, research projects that support the intersections between research and experiential learning opportunities for our diverse student population.

The plan presented here provides continuing support for our A/WD initiative to serve the needs of Arizona residents, particularly the underserved, unemployed and underemployed. Arizona workers, especially those displaced by the Covid-19 disruptions, are urgently seeking flexible and stackable learning pathways that provide new career and advancement opportunities through upskilling and furthering their educations. NAU's action team charged to examine and revise our current portfolio of statewide academic programs, delivery models, and student support services will **ensure that we are meeting the unique labor demand needs of the individual communities surrounding each statewide site and providing support to ensure student success.** NAU's implementation of related actions will be data-driven and well-informed through the collective voices and work of the action team. The commitment of A/WD funding is critical for the success of this effort.

This plan provides ongoing support for our core **Areas of Distinctive Excellence in research** – Pathogen Genomics, Community and Health Equity Research, Forest Health and Environmental Sciences, and Astronomy & Planetary Sciences – by funding research and learning opportunities that are closely connected with our undergraduate and graduate educational programming. Further, targeted investments for **Developing Areas of Research Strength** will complement established programs at partner institutions within the state to address areas of critical need for the future knowledge-based economy such as informatics, cybersecurity, materials and bioengineering. The expected outcome of our investments in Developing Areas of Strength will be growth in research productivity that prioritizes student learning outcomes and connectivity with our academic programs. Past TRIF investments have seeded many outstanding student-focused educational outcomes, as detailed in the individual Program Descriptions, and an explicit focus of this plan is to invest directly in opportunities for students to participate in research and to enroll in research-training programs, with a particular focus on broadening these opportunities for first-generation and students from underserved groups.

A significant component of our plan includes dedicated seed funding, through a competitive basis, for **strategic investments to incentivize innovative workforce development programming and support developing research areas that promote student engagement and learning** through the Seed, Equipment and Infrastructure Investment process. This component of the 3-year TRIF plan is designed to ensure NAU remains nimble and responsive to areas of need in the state as they emerge. Impact on student success, ability to grow and broaden student participation, and capacity to equip students with

skills in demand from priority industries in the state will be the metrics in which this program, as well as all TRIF investments at NAU, will be evaluated.

These investments will improve the health and well-being of Arizonans, help solve regional problems of global relevance, increase regional and statewide economic opportunities, as well as, serve as an essential enabler of workforce development.

University Vision and Philosophy

NAU's goal is to equip students with knowledge and career-ready skills to meet AZ workforce needs and to find innovative scientific and technical solutions to problems facing our community, while providing direct economic benefit to the state through scientific advances, workforce training, and access to higher education for all Arizonans.

NAU is well positioned to expand the delivery of high-quality programming that reaches place-bound students, particularly underserved adult learners, while meeting the evolving workforce demands in Flagstaff and across the State of Arizona. We have developed a workforce and curriculum planning process to ensure program relevance and alignment with the workforce through the data-driven identification of high-growth and emerging academic programs. **By developing and delivering a variety of credentials informed by the real-time labor demand and workforce analysis tied to each of the unique statewide communities that we serve,** this key initiative will significantly increase the number of students with skillsets that meet the evolving workforce needs of existing and emerging employers. A proposed expansion of programs and services will offer a wider range of credentials and new ways of operating in collaboration with community colleges, including transfer pathways and adjunct faculty appointments, building stackable program pathways, and employing universal design practices across programs in 90/30 programs. To meet non-traditional student needs, NAU **will provide personalized student support services** through a University Advising Access Connected Care Team (ACCT) devoted to increasing access and student success.

The impact of NAU research on the education of students is a critically important outcome for our TRIF investments. NAU's mission has always been centered in education, and the **research investments have expanded opportunities for undergraduate and graduate participation in research and** development (undergraduate participation in research has grown nearly 25%, and graduate by more than 100% since 2015). This plan will help us achieve our goal of being a leading minority- and Hispanic Serving Institution by investing directly in opportunities for students to participate in research and to enroll in research-training programs, with a particular focus on broadening these opportunities for first-generation and students from underserved groups.

Central to NAU's three-year plan is the pursuit of grand challenges facing the State of Arizona and the world today that the core strengths of NAU's complimentary research and educational activities are uniquely positioned to address. The Office of the Vice President for Research and Office of the Provost have jointly identified key interdisciplinary programs within each initiative that align our expertise with these grand challenges and position the university effectively with external funding opportunities and industrial needs, summarized below.

- **Access and Workforce Development.** Northern Arizona University has a focused commitment to provide the residents of Arizona with access to high-quality educational pathways that provide career-ready knowledge and skills. **The programs identified below will attract and serve all**

interested learners through the diminishment of enrollment, retention, and completion barriers. Specifically, the deliberate design and alignment of real-time labor demand within the programs and support services will be a critical element to improve our support of historically underserved populations of adult learners and transfer students across the state.

- Workforce Training, Lifelong Learning, and Professional Development
  - The demand for workforce development, lifelong learning, and professional development offerings remains strong across Arizona. In response, **we have identified data-driven demand for launching workforce offerings and development centers, including the Mesa Workforce Development Center.** This specific effort will provide affordable and accessible education and training where people work and live. Additionally, we will **expand our professional development offerings successfully provided by the NAU College of Education and the K12 Center** in support of new and continuing teachers.
- New and Expanded Programming
  - NAU's action team is **charged to examine and revise our current portfolio of statewide academic programs, delivery models, and student support services**. These efforts will provide alignment between the unique labor demand and support needs of the communities and regions surrounding each statewide site. NAU's implementation of related actions will be data-driven and well-informed through the collective voices and work of the action team. Dedicated A/WD funding is critical for the success of this effort.
- Student Service and Support
  - The **creation of the University Advising Access Connected Care Team (ACCT) will build new institutional services devoted to increasing access and student success.** The student service and support efforts provided within ACCT will attract and serve adult learners and transfer students, particularly historically underserved populations with barrier-free educational pathways.
- Instructional and Graphic Design Support for High-quality Programming
  - NAU's instructional and graphic design strategies will continue to be supported through the A/WD funding. This professional design team is a **university-wide coordinated effort supporting faculty development of transformative and equitable educational opportunities** for all learners, including the growing diverse population of adult learners and working professionals.
- Continuing Support for Existing Access and Workforce Development Programs
  - NAU offers more than 60 flexible pathways of undergraduate and graduate programs at statewide sites and online. The continued use of A/WD funds to deliver these cross-disciplinary academic programs is **essential for the sustainability and growth of programs that align with current and projected workforce trends.**

- **Improving Health.** Northern Arizona University's efforts under the *Improving Health* initiative expands Arizona's biosciences economy by building increased research capacity in the biosciences/bioengineering and health research areas. Our research programs in health and the biosciences directly affect Arizonans through hospitals and healthcare institutions, medical technology industries, the identification and tracking of infectious disease in the community and by addressing healthcare disparities for underserved populations (Native American, Hispanic, and rural poor).

Improving Health investments will directly benefit from NAU's Areas of Distinctive Excellence in Pathogen Genomics and Community Health Research. Further, Improving Health will also benefit from more limited investment into NAU's Developing Area of Strength in Bioengineering/Biotechnology.

- **Water, Energy and Environmental Systems.** Northern Arizona University's programs under the *Water, Energy and Environmental Systems* initiative are based on the understanding that Arizona's natural resource base drives the viability of key economic activities of tourism, farming, ranching, and recreation. *Water, Energy and Environmental Systems* supports rigorous scientific research, sound scientific and technical assistance, and information transfer to landowners, managers, and stakeholders.

  This initative focuses on NAU's Areas of Distinctive Excellence in Forest Health and Land Management and Adapting to a Changing Environment.

- **National Security Systems.** Banking, healthcare, energy, travel, and manufacturing are just some of the industries that require (a) increasingly more secure means of protecting data and thwarting deliberate attempts to disrupt computer networks, (b) ever more sophisticated approaches to safeguarding computing systems operations, and (c) a more cyber-savvy workforce. Further, the precise management of foundational supply chains of energy, food, and water will be a requirement for communities for the foreseeable future. Development of novel purpose-driven functional materials will also deeply influence society of the future as well as burgeoning needs of the industry within the state.

  NAU has made recent hires of prominent researchers in these fields and is positioned to address these challenges with limited investment into the Developing Areas of Strength in Cybersecurity and Innovative Materials, and Supply Chain Management.

- **Space Exploration and Optical Systems.** Northern Arizona University's investment in *Space Exploration and Optical Systems* will leverage the state-of-the-art astronomical resources found in Northern Arizona to prepare a workforce with unique skills that will strengthen Arizona's stature as a worldwide leader in astronomy and planetary science research. Institutions in Arizona employ approximately 2,000 people in this field, with a payroll exceeding $84 million. Under this initiative, NAU post-docs and graduate students will develop cutting-edge skills that will prepare them for high-paying positions in Arizona.

  NAU's Area of Distinctive Excellence within this initiative is Solar System Science and Exoplanets.

The **Seed, Equipment and Infrastructure Investment process** is designed to ensure NAU remains nimble and responsive to areas of need as they emerge. For example, seed funding will be available on a competitive basis to develop workforce training experiences to reach new markets of AZ residents, to facilitate the development of new externally sponsored programs, to purchase and support of specialized instrumentation or for laboratory renovations, and for undergraduate and graduate student research experiences. This intramural process will be jointly administered by the Office of the Vice President for Research and the Office of the Provost. Impact on student success, ability to grow and broaden student participation, and capacity to equip students with skills in demand from priority

industries in the state will be the primary metrics in which this program, as well as all TRIF investments at NAU, will be evaluated.

Expected Outcomes

As a university with a significant focus on undergraduate education, NAU will use TRIF to **increase research participation across our student populations**, particularly among groups that have been historically underrepresented in the STEM disciplines, as well as to tangibly **integrate research and scholarly activity into our educational offerings**. The university's research portfolio, including areas of distinctive excellence and developing areas of strengths, will **strategically increase research expenditures, make significant contributions to knowledge creation, and support meaningful solutions** for regional problems of global relevance. Additionally, NAU will **increase access quality programs for rural and urban communities** resulting in a highly skilled workforce to address the industrial needs across the state.

Marketing/Communication Overview

Sharing the impacts of NAU's workforce-driven programming and transformative educational opportunities in cutting-edge research on students and AZ communities will be a vital part of informing NAU's stakeholders, including the public, state legislature, and ABOR, about the benefits of TRIF and its role in improving quality of life for all Arizonans.

Videos and featured stories in our re-branded marketing efforts will showcase NAU scientists and scholars—and their students— working together to solve regional problems of global relevance. Impacts of our revitalized portfolio of educational programming and student support services will be highlighted to demonstrate that NAU is meeting the unique labor demand needs of the individual communities surrounding each statewide site. Additionally, by creating news stories, press releases, and related marketing content that demonstrate how researchers develop solutions to the grand challenges facing us, NAU will show its audiences how NAU is using TRIF investments to generate tangible benefits that have a positive impact on Arizona's economic viability and make this state a better place to live.

The NAU University Marketing team, led by its Research Communications division, will deliver a consistent message by highlighting research impact, economic drivers, and student and public benefit through stories that showcase the positive impact of TRIF investments, including workforce development through student research opportunities, and projects that raise the reputation of Arizona's researchers in a way that attracts national and international investment to the state. NAU will also join a coordinated effort among the three Arizona universities to develop a strategic marketing plan that focuses on demonstrating the collective value of the TRIF program in research approach reaching its external stakeholders.

University Administration of TRIF

The Office of the Vice President for Research and the Office of the Provost are jointly responsible for implementing the 3-year plan, including disbursement of funds for each initiative. More specifically, the Vice President for Research and the Vice Provost for Online and Innovative Educational Initiatives engage with campus leaders and faculty to guide the achievement of the stated goals for each initiative, and to encourage the development of novel ideas and new interdisciplinary collaborations. These regular engagements also assist with limitations as they are identified and facilitate the annual reporting process on behalf of the university.

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Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Access and Workforce Development
Program Name:	Continuing Support for Existing Access and Workforce Development Programs

Problem Statement:

NAU offers a legacy of strong programs that align with the workforce demand across the State of Arizona. The programs serve transfer students, including adult learners, through statewide and online delivery modes. Additionally, the support for the development of real-time labor demand and workforce analysis is aligned with the programming offered. The continuation of these program investments is critical to continue the delivery and support of flexible high-quality programming that meets the needs of the Arizona workforce.

Program Description:

The existing academic programs supported through A/WD TRIF funding cross many disciplines. They are intentionally designed in flexible manners, including but not limited to 90/30-degree completion programs, certificates, and graduate degrees. For the 90/30-degree completion programs, NAU faculty collaborate with our community college partners to design and design programs in Arizona that include well-articulated progression plans for students to follow from entry point through graduation. The following academic discipline areas deliver more than sixty certificate, undergraduate and graduate programs online and at statewide sites through the TRIF A/WD initiative. These programs will continue to be supported with this important funding: Communication Sciences & Disorders Programs, Educational Leadership Programs, Educational Psychology Programs, Educational Specialties Programs, Teaching & Learning Programs, Health Sciences Programs, Nursing Programs

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

NAU has a significant advantage for serving Arizona transfer students and adult learners through the delivery of workforce-driven programs at our statewide sites. These locations provide place-bound students the much-needed access to high-quality educational pathways, while empower them to maintain their life commitments, particularly jobs, family, and community responsibilities.

Is there an Arizona Specific Benefit or Impact?

High-growth labor trends are commonly described as above-average student and labor market demand growth and volume. According to Hanover Research, Arizona student degree completion trends and employment projections indicate there are 11 high-growth fields projected at the bachelor's level. Additionally, there are 14 high-growth fields projected at the master's level. All projected high-growth fields are captured within the existing academic programs supported through A/WD TRIF funding. The continued delivery of these programs is essential for the sustainability and growth of programs that align with current and projected workforce trends.

Investment Detail

	2022	2023	2024	Total
Infrastructure	2,758,788	2,539,588	2,539,588	7,837,964
Basic Research				0
Applied Research				0
Development				0
Total	2,758,788	2,539,588	2,539,588	7,837,964

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students	1,235	1,321	1,454	4,010
Undergraduate Students	2,749	2,941	3,235	8,925
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Access and Workforce Development
Program Name:	Student Service and Support

Problem Statement:

As US society has increasingly created a narrative of questioning the value of higher education, students and their families have had greater interest in assurances that the university experience and achieving a college degree will lead to social mobility through expanded employment opportunities. This specific population will benefit from a prescriptive degree completion plan that increases access through barrier-free support. Now more than ever, it is critical that all students, including adult learners, receive holistic services and support throughout the student lifecycle, particularly in the areas of purposeful academic and career alignment, participation in internship and externships, transferable career skill development, and strong job seeking skills.

Program Description:

Example of proposed programming:

• University Advising Access Connected Care Team: The creation of the University Advising Access Connected Care Team (ACCT) will build new institutional services devoted to increasing access and student success, with a particular emphasis on non-traditional transfer students and academic programs supporting workforce development. We will directly address the distinct needs of non-traditional and adult learners through a case-management approach, which guides students through institutional policies and processes, serves students outside traditional business hours, and integrates an infrastructure that utilizes data and technology for data-driven decision-making and efficient operations.

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

ACCT will substantially improve our ability to open access pathways and build capacity in workforce development programs. The North Valley site provides an ideal location convenient for place-bound students within Phoenix, Statewide Sites, and surrounding communities. We will provide on-site services at the North Valley site with a focus on degree attainment in a timely and cost-effective manner. The student support will collaborate across university and community college partners to attract and serve students with barrier-free educational pathways, including the development of a comprehensive structure for accessing prior learning for credit.

Is there an Arizona Specific Benefit or Impact?

In July 2021, Arizona ranked 39th amongst US states in unemployment rates at 6.6% (national average is 5.4%) and 33rd in college attainment rates (30% compared to the national average of 33%). College degrees can result in greater access to higher paying jobs and provide protection against unemployment. But college degrees alone do not provide access to higher paying job opportunities; students also need experiences that build transferable job skills and access to social networks that provide access to such jobs. NAU will advance its commitment to equitable postsecondary value by embedding career development in academic programs, and providing direct support to students to build a strong professional portfolio of transferrable career skills enhanced with internship experiences.

Investment Detail

	2022	2023	2024	Total
Infrastructure	1,277,146	1,219,979	1,082,361	3,579,486
Basic Research				0
Applied Research				0
Development				0
Total	1,277,146	1,219,979	1,082,361	3,579,486

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students	481	713	977	2,171
Undergraduate Students	1,070	1,587	2,174	4,831
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investment Area:	Access and Workforce Development
Program Name:	Instructional and Graphic Design Support for High-quality Programming

Problem Statement:

Providing well-developed faculty professional development programs increases overall organizational satisfaction. Professional instructional design drives engaging learning experiences within faculty coursework. A focus on instructional design is necessary to develop and deliver high-quality, accessbile programs for all learners. Course enrichments for adult learners will provide classroom design that create effective learning experiences. Busy working professionals will be more engaged and retained through professional design practices. Ongoing TRIF funding will support innovative development of new and existing programs, including alternative credentials, learning modules, stackable programming, as well as prior learning assessments and portfolios.

Program Description:

The following instructional and graphic design strategies will be supported through the TRIF A/WD initiative.

• Coordination of a university-wide instructional and graphic design team to develop transformative and equitable educational opportunities for all learners, including the growing diverse population of adult learners and working professionals

• Intentional universal design practices for the creation of instructional materials and utilization of educational technology that enables student success

• Ensuring that workforce training, lifelong learning, and professional development programs are developed with competency-based focus design that articulate to learning outcomes

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

Designing classroom instruction that utilizes emerging educational technologies to engage and satisfy adult learners will lead to high-quality learning experiences. The ongoing support of the coordinated team of instructional and graphic designers aligns with NAU's vision to create access to high-quality programming by delivering the highest course quality through the professional development of NAU faculty.

Is there an Arizona Specific Benefit or Impact?

NAU serves a diverse population of students through the statewide and online programs. The instructional and graphic designers provide expert learning design, educational graphics and creative design, educational technology services, and training support for all NAU faculty, including online and statewide faculty members. Instructional design principles will support the faculty to deliver engaging content that will lead to effective connections between students, faculty, as well as more involvement from students in their learning.

Investment Detail

	2022	2023	2024	Total
Infrastructure	1,123,554	1,123,553	1,123,553	3,370,660
Basic Research				0
Applied Research				0
Development				0
Total	1,123,554	1,123,553	1,123,553	3,370,660

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students	50	100	200	350
Undergraduate Students	100	200	300	600
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investment Area:	Access and Workforce Development
Program Name:	Workforce Training, Lifelong Learning, and Professional Development

Problem Statement:

Arizona is facing a worker shortage across several sectors, including the service industry, high-skilled technical talent, and manufacturing environments. Arizona sectors with high job losses due to the pandemic include education, sales, and social services, with the current job market privileging bachelor's and master's degree recipients. Arizona's Hispanic or LatinX populations are reported at 31.7%, a significantly higher percentage than the rest of the country. Hispanic, first-generation, non-traditional, and low-income students often seek formal education and/or workforce training to enhance their opportunities. The demand for workforce training, lifelong learning, professional development will remain strong as community members seek alternative educational pathways toward sustainable employment.

Program Description:

Mesa Workforce Development Center: The NAU School of Hotel and Restaurant Management (SHRM) is working with Intermestics Partners and Kind Hospitality to develop a facility that will serve as an education and training hub located at Skybridge Arizona in Mesa, AZ. The leaders of SkyBridge estimate 10,000-12,000 new jobs will be created within the next decade on site, based on the mixed use of the 3.5 million square feet slated for development, and that is just within Phoenix-Mesa Gateway Airport. The Center will prepare students and workers for jobs by providing the necessary skills and credentials through apprenticeships and employer required occupational training in addition to their regular academic instruction. Other proposed workforce training, lifelong learning, and professional development programs include a Microelectronics Workforce Training Program, Industry 4.0 Workforce Training Lab, Financial Planning Certificate, Risk Management and Insurance Certificate, Hospitality Innovative Technology (HIT) Certificate, Organizational Leadership Series, Customer Service Institute, and K-12 Center.

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

The Mesa Workforce Development Center Skybridge partner, Swift, is already a corporate partner for the W.A. Franke College of Business (FCB) Risk Management and Insurance (RMI) program. The corporation has made a significant donation to the RMI program.

The state of Arizona has been home to many semiconductor and electronics manufacturing companies since 1950's. Recently, TSMC and Intel both announced their investment to build additional semiconductor fabs in Chandler, AZ. The Microelectronics Workforce Training Program will provide the industry with a talented and intelligent university-educated workforce that will innovate, build new products, and adapt to new technologies.

Is there an Arizona Specific Benefit or Impact?

Providing affordable, accessible, and flexible workforce education and training where people work and live is critical to Arizona future. NAU will help develop the talent that employers need to accommodate present and future demand for their products and services.

Investment Detail

	2022	2023	2024	Total
Infrastructure	800,600	740,456	761,350	2,302,406
Basic Research				0
Applied Research				0
Development				0
Total	800,600	740,456	761,350	2,302,406

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students	100	200	300	600
Undergraduate Students	165	300	475	940
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investment Area:	Access and Workforce Development
Program Name:	New and Expanded Programming

Problem Statement:

The Covid-19 pandemic has disrupted the labor market in unprecedented manners across the State of Arizona, including the closings of nonessential businesses, significant demands in healthcare, and sudden shifts to remote work. These disruptions have resulted in displacements of much of the workforce, including but not limited to, service workers, education providers, sales, and social service fields. A significant number of affected workers represent socioeconomically vulnerable diverse populations. Workers are urgently seeking flexible and stackable pathways of education that provide new career and advancement opportunities through upskilling and furthering their educations.

Program Description:

We have organized an action team to provide an inclusive and collaborative review of our current portfolio of academic programs, delivery models, and student services for each of the statewide sites. This action team is further charged to identify the unique labor demand needs of the individual communities surrounding each statewide site and provide recommendations for new and expanded programming in collaboration with the community college partners. Programming recommendations will include workforce development strategies and student services to best serve our current and future students across the State of Arizona. NAU's implementation of related actions will be data-driven and well-informed through the collective voices and work of the action team. The commitment of A/WD funding is critical for the success of this effort. Examples of potential programming: Grow Your Own Program – Teacher Education: The Grow Your Own program will prepare future teachers to make a difference in their communities. CS4ALL Teaching Certificate – Teacher Education: NAU's strong expertise in computer science pedagogy and teacher training make it a natural partner in the state's Computer Science vision.

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

We are well-positioned to reach urban and rural communities through our established statewide sites. The delivery of new and expanded programs will represent high workforce demand and will also provide much needed access to local communities. Proposed expansion of programs will offer a wider range of credentials and new ways of operating in collaboration with community colleges, including opportunities to partner across staff and faculty, building stackable program pathways, and employing universal design practices across programs in 90/30 programs.

Is there an Arizona Specific Benefit or Impact?

As reported in the 2020 College Completion Report, most of the state public universities' graduates stay in Arizona, find jobs, and contribute to the state's workforce. Providing access to degree attainment in high demand fields for place-bound adult learners will continue to support who would otherwise face undue challenges in pursuing a baccalaureate or graduate degree. Additionally, we will provide upskilling of the workforce communities surrounding our individual statewide sites that will provide pathways for securing a job near their homes and result in the retention of our working residents of Arizona.

Investment Detail

	2022	2023	2024	Total
Infrastructure	219,112	555,624	672,348	1,447,084
Basic Research				0
Applied Research				0
Development				0
Total	219,112	555,624	672,348	1,447,084

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students	20	60	120	200
Undergraduate Students	30	60	120	210
Sponsored Project Funding				0
Publications in Academic Peer-Reviewed Journals				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Improving Health
Program Name:	Pathogen Genomics

Problem Statement:

The Challenge: Rapidly characterize outbreaks of pathogens to inform and enable community response. The COVID-19 pandemic illustrated that rapid detection of microbial pathogens is critical to an informed community response. Although the pandemic illuminated the need for screening in the eyes of many Americans, rapid and reliable detection strategies are also crucial for doctors to prescribe appropriate antibiotic regimens and to identify emerging biothreats. In Arizona, environmental monitoring of pathogens found in soil or animal hosts (e.g. Valley fever, West Nile virus) is necessary to inform appropriate community responses. New detection and mitigation strategies will be a national priority and the need for skilled professionals to collect and interpret this data has never been more important.

Program Description:

Northern Arizona University's program in Pathogen Genomics research is primarily carried out through the world-renowned Pathogen and Microbiome Institute (PMI), with complementary research in this area in the Department of Biological Sciences and School of Informatics, Computing & Cyber Systems. Major focus areas include the evolution, ecology, and epidemiology of human and animal pathogens spanning those involved in hospital-acquired infections, to anthrax, plague, biological warfare agents, to virulent viral pathogens such as COVID-19. Research strengths encompass microbiology, high throughput genetics and genomics analysis, bioinformatics and drug development. Cutting-edge research efforts are also contributing to our understanding of the human microbiome through identification and characterization of the communities of microorganisms of the human gut, sinuses, and skin, for example, which are associated with human health and disease.

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

NAU is uniquely equipped to address this challenge due to its core strength in microbial genetics, genomics and microbiome sciences, and its history of training undergraduate researchers to support the health-care and biotechnology industries. Anchored by PMI, which includes a state of the art BSL3 laboratory and vivarium, NAU will continue to maintain robust relationships with external clients at the DHS and DoD. Recent investment into PMI has enabled it to grow its portfolio to include expertise in virology and computational sciences. On average, Pathogen Genomics researchers have trained over forty undergraduate researchers annually over the previous five-year period and continue to provide exemplary training in the fundamentals of genomic research. These students go on to outstanding next steps after NAU, including medical school and top graduate programs.

Is there an Arizona Specific Benefit or Impact?

Pathogen Genomics researchers specialize in infectious disease that affect Arizona and the Southwest. Their expertise was instrumental to the community response to COVID-19 and they play important roles in continued monitoring efforts. The program has proven to be effective in training students for jobs in translational genetics and medicine. In addition to researching pathogens with a significant presence in the state, NAU launched the COVID-19 Testing Service Center to grow the SARS-CoV-2 virus and test new drugs against it, giving Arizona an edge in responding to the crisis. NAU's TRIF investments will ensure researchers continue to make discoveries and invent new technologies that have an immediate and long-lasting impact on the health and well-being of the population of Arizona.

Investment Detail

	2022			Total
Infrastructure	180,000	180,000	180,000	540,000
Basic Research	359,788	385,467	459,800	1,205,055
Applied Research	185,000	185,000	185,000	555,000
Development	0	0	0	0
Total	724,788	750,467	824,800	2,300,055

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	4	5	6	15
Graduate Students	17	22	24	63
Undergraduate Students	50	52	55	157
Sponsored Project Funding	6,000,300	6,493,946	6,890,261	19,384,507
Publications in Academic Peer-Reviewed Journals	52	57	62	171
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Improving Health
Program Name:	Biotechnology and Bioengineering

Problem Statement:

The Challenge: Developing new technologies to address critical medical needs of Arizona and the nation. The need for innovative solutions to medical problems is ever-present in society. Arizona has significant areas of medical need common to our civilian and veteran populations. As a single example, the NIH has dedicated programs to spur the development of tools and rehabilitation strategies to prevent ambulatory decline in aging populations, and the DoD has a need for similar technologies to aid human performance of service members and recovery of injured veterans. Technologies that respond to current and emergent needs of civilians that are also positioned to serve the needs of deployed military and injured veterans represent highly attractive investment areas for the state.

Program Description:

The Bioengineering and Biotechnology initiative is supported by a recently established PhD program in Bioengineering and by researchers in diverse departments, including Biological Sciences, Applied Physics & Materials Sciences, Chemistry, Health Sciences, Athletic Training, and Mechanical Engineering, which form collaborative interdisciplinary groups to carry out basic and applied research in areas including personal bionics and wearable robotics, rehabilitation, hearing improvement, development of materials and devices for biocompatible implants, sensors, wound healing agents, and other medical devices. NAU researchers are positioned well to partner with faculty at other in-state institutions to further develop research programs and provide experiential learning opportunities for our students in this broader area.

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

As the home of the medical devices division of industry pioneer W.L. Gore, Flagstaff is a center of innovation within the state for bioengineering and medical devices. Previous program investment enabled NAU to contribute to these fields while concurrently training students to meet the workforce needs of these industries. NAU will draw from expertise in the departments of Biological Sciences, Chemistry, Mechanical Engineering, and Applied Physics & Materials Sciences to pursue external funding opportunities in Defense as well as NIH. Skills of NAU researchers participating in this program complement larger programs at our partner institutions in the state, and collaborative projects among universities are likely to yield further positive outcomes and expanded research opportunities for our students, in turn providing graduates strong fundamental skills for employment in the biotechnology or medical devices industries.

Is there an Arizona Specific Benefit or Impact?

Wearable technology, sensors, precision medicine, and medical device development are a focus of the Bioengineering and Biotechnology program, and NAU will continue to develop intellectual property and licensable technology in these areas. Ongoing work has fostered SBIR/STTR grants and start-up companies based on NAU technology, and further investment will expand these opportunities. Arizona in general and Flagstaff in particular is home to many industries that require skilled workers in medical devices and translational biotechnology research. Investments in bioengineering and biotechnology are catalyzing discoveries that improve lives, foster economic growth and provide cutting-edge training for a diverse population of students who will join Arizona's workforce.

Investment Detail

	2022	2023	2024	Total
Infrastructure	416,500	512,500	0	929,000
Basic Research	263,704	128,489	153,267	545,460
Applied Research	117,450	0	0	117,450
Development	0	0	0	0
Total	797,654	640,989	153,267	1,591,910

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	416,500	512,500	0	929,000
Postdocs Supported	3	4	6	13
Graduate Students	18	19	22	59
Undergraduate Students	30	35	40	105
Sponsored Project Funding	1,502,864	1,552,940	1,587,303	4,643,107
Publications in Academic Peer-Reviewed Journals	22	24	26	72
Startups	0	0	1	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Improving Health
Program Name:	Community Health Research

Problem Statement:

The Challenge: Reducing health disparities in rural and underserved populations. Many prevalent diseases in America disproportionately affect minority and underserved/rural populations, and this trend is often magnified in the southwest. In Arizona, the mortality rates associated with diabetes are nearly eight-fold higher than the state average for Native American communities and two-fold higher for Hispanic/Latino populations. A 2020 CDC report also found that Native Americans have higher incident rates of many cancers compared to non-Hispanic White people (www.cdc.gov/cancer/dcpc/ research/articles/cancer-AIAN-US.htm). The factors that contribute to health inequity are multifaceted and require a coordinated and interdisciplinary response.

Program Description:

The Community Health Research program will further develop NAU's nationally recognized capacity to produce translational health research and discoveries in community-based healthcare research, precision and personalized medicine, infectious disease control, and partnership-based clinical research for the diverse populations of Arizona and beyond. The program supports a wide range of research into chronic health conditions such as cardiac disease, obesity, dental health, communicative disabilities, , cancer, health informatics, and wellness training research, among others. Faculty across departments in the College of Health & Human Services, the College of Engineering, Informatics & Applied Sciences, the College of the Environment, Forestry & Natural Sciences, and the College of Social & Behavioral Sciences work in collaborative, interdisciplinary groups to transform evidence-based bioscience and health care applications to improve lives and foster economic growth in Arizona and beyond.

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

Previous investment into this program has paid dividends via the establishment of the Center for Health Equity Research (CHER) and the Southwest Heath Equity Research Collaborative (SHERC); moreover, NAU has a longstanding focus on basic science impacting cancer health disparities, community health and student training through the Partnership for Native American Cancer Prevention (NACP), which is a partnership with the University of Arizona Cancer Center (UACC) funded by the National Cancer Institute. Achieving health equity, eliminating disparities, and improving population health is a of the goal of the Health People 2030 initiative set forth by the Department of Health and Human Services. Together, Community Health researchers equip Native American, Hispanic and other diverse students with high impact multidisciplinary training that prepares them for a wide variety of solutions-oriented jobs in critical areas of need.

Is there an Arizona Specific Benefit or Impact?

Investment into the Community Health Research program serves address health disparities in underserved populations throughout the state and trains diverse students for careers in health-related occupations. Program researchers and their mentees are spearheading interdisciplinary and culturally informed efforts to find community-driven solutions to address health inequities wherever they exist. By building valuable partnerships with local and regional healthcare providers, research institutions and tribal communities, program researchers are making important developments in community and behavioral health sciences, which are particularly valuable for rural Arizona communities that do not have the same access to public health resources as do individuals in Phoenix or Tucson.

Investment Detail

	2022	2023	2024	Total
Infrastructure	60,000	60,000	0	120,000
Basic Research	359,788	385,467	459,800	1,205,055
Applied Research	0	0	0	0
Development	0	0	0	0
Total	419,788	445,467	459,800	1,325,055

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	4	5	7	16
Graduate Students	22	27	28	77
Undergraduate Students	15	18	22	55
Sponsored Project Funding	3,539,802	3,381,061	3,217,860	10,138,723
Publications in Academic Peer-Reviewed Journals	40	44	48	132
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	National Security Systems
Program Name:	Cybersecurity and Innovative Materials

Problem Statement:

The Challenge: Preventing cybercrime through the development of hacker-resistant security measures and novel materials. As of December 2020, global economic losses from cybercrime were estimated to be over a trillion dollars, and over half of companies that experienced a cyberincident admitted to having no plan to respond to or prevent a future incident. The most pressing challenge is the need for cybersecurity that cannot be easily defeated. Novel approaches include embedded encryption in hardware, innovation in secure quantum computing, nanotechnology and robust microelectronics. The development of innovative materials to address these concerns also has practical applications spanning national security, the production of clean energy and water, and microelectronics.

Program Description:

The Cybersecurity and Innovative Materials program addresses key challenges for secure computing and the development of microelectronics. Cybersecurity for information and communications systems, reconfigurable computing, remote sensing, and the internet are areas of major concern for industry operations, institutional protection of data, computer-to-computer communications, and other related applications. Every technology-oriented industry requires increasingly sophisticated approaches to computing systems operations, computing applications, and data protection. In addition to the need for cybersecure materials, the society of tomorrow will increasingly rely on bioelectronics and biosensors, quantum computing, nanotechnology, and those for novel energy storage. All of these will require fundamental research and translatable discoveries to forge these foundations for society. We see this growing need as a core national security priority in the coming decade, as is the effective training of participants in the computing systems and microelectronic industry workforce.

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

The university will leverage expertise in the School of Informatics, Computing & Cyber Systems, Mechanical Engineering and Applied Physics & Material Science to develop technology modules that will enable new forms of protection across the landscape of cybersecurity needs. Furthermore, NAU researchers will leverage strengths in materials science across multiple academic units as well as the Center for Materials Interfaces in Research and Applications (¡MIRA!), to develop and combine several new technologies, including innovations in microelectronics and the design of computer hardware, to improve the ability of computers to fend off cyberattacks. ¡MIRA! is a materials science center with research foci on quantum materials, active matter and nanoclusters, materials for national security and maintains a mission for expanding opportunities for students from underserved groups in applied materials research.

Is there an Arizona Specific Benefit or Impact?

National security and the economic vitality of the United States depends on a stable, safe and resilient cyberspace. The cybersecurity and defense industries have long been one of the most important employers for the state, and coupled with the rapid expansion of job opportunities in semiconductors and microelectronic materials there is expected to be an immediate and pervasive need for skilled workers across these fields in the state of Arizona. Program researchers will provide important experiential opportunities for undergraduate and graduate students, thus in these disciplines to help meet the growing need for these important and rapidly growing Arizona industries.

Investment Detail

	2022	2023	2024	Total
Infrastructure	309,731	125,000	0	434,731
Basic Research	119,929	128,489	153,267	401,685
Applied Research	71,888	0	0	71,888
Development	71,887	0	0	71,887
Total	573,435	253,489	153,267	980,191

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	309,731	125,000	0	434,731
Postdocs Supported	6	8	8	22
Graduate Students	25	30	35	90
Undergraduate Students	30	35	40	105
Sponsored Project Funding	1,992,141	2,227,355	2,389,619	6,609,115
Publications in Academic Peer-Reviewed Journals	20	22	25	67
Startups	0	0	2	2

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	National Security Systems
Program Name:	Supply Chain Management

Problem Statement:

The Challenge: Empower communities with tools to enable adaptation to unexpected events. Communities thrive when they have ready access to food, energy and water, but when disruptions to their supply occurs (through natural disasters, wildfires, extreme weather events, or even a global pandemic) the lives and livelihood of its citizens may be jeopardized. The ability to accurately model and visualize the supply chain and commodity transit pathways in real-time can provide powerful information for decision-makers and emergency managers in the resilient management of their food, energy and water systems for disaster relief and recovery. Knowledge of potential limitations to commodity distribution can help communities and states plan for and effectuate recovery as rapidly as possible.

Program Description:

The Supply Chain Management program researchers work with very large datasets in partnership with economic forecasting data and analysis of social and behavioral trends in affected communities, to enable construction of models to develop effective responses to unexpected events. Effective community responses to catastrophic events is a priority global need that serves to protect people's lives and livelihoods. Supply chain analysis will aid development of intelligently planned and sustainable smart cities, smart buildings and smart cars. Implementation of the program relies on interdisciplinary expertise from a suite of academic units, including the School of Informatics, Computing & Cyber Systems, School of Earth & Sustainability, College of Health & Human Services, College of Social & Behavioral Sciences, and the W.E. Franke College of Business. The strong focus on interdisciplinarity fosters technical innovations, economic development, and workforce training.

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

NAU researchers are developing a nationally scalable protocol for public participation in research that leverages data science and visualization tools, and we anticipate this program will effectively complement work at our partner institutions in the state. FEWSION, which uses comprehensive data sets to map out domestic supply chains and resources, aims to develop a framework for deploying adaptation strategies for interdependent power, water, and transportation systems. The tool analyzes and extracts new information from public datasets describing the production, consumption, and flow of food, energy, and water. This program represents an attractive path for students seeking careers in data analytics or information sciences. We anticipate opportunities for student engagement to increase as the program develops, and collaboration with researchers at programs in other statewide institutions will be pursued.

Is there an Arizona Specific Benefit or Impact?

The pandemic has shown that effective management of supply chains is essential. When disruptions to the supply of food, energy or water occurs, people's lives and livelihood are at risk. Investment into the Supply Chain Management program will enable NAU researchers to develop unique algorithms from publicly-available datasets to describe the production, consumption, and flow of food, energy, and water. These tools will provide invaluable information to city planners, economic planners and emergency managers inside and outside of Arizona. Further, training of undergraduate, graduate and postdoctoral scientists in advanced data analytics will provide effective workers to meet the need of industry in the state.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	119,929	128,489	153,267	401,685
Applied Research	0	0	0	0
Development	0	0	0	0
Total	119,929	128,489	153,267	401,685

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	0	2	3	5
Graduate Students	2	6	9	17
Undergraduate Students	3	10	13	26
Sponsored Project Funding	1,559,548	1,456,649	1,355,663	4,371,860
Publications in Academic Peer-Reviewed Journals	18	20	22	60
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Space Exploration and Optical Sciences
Program Name:	Solar System Science and Exoplanets

Problem Statement:

The Challenge: To understand the composition of objects in our solar system, and to pursue a spacecraft mission to explore an asteroid. The origins of the Solar system and its unexplored bodies remain among the most significant questions for space scientists. Research is performed through high-powered telescopy, in which signatures are assessed through measurement and analysis of large data sets. Data obtained from instrumentation delivered to the site of observation via a planned spaceflight is also necessary. Cutting-edge equipment must be made that is limited in size and weight, is robust and resilient, and is constructed in an economical fashion. Deployed instrumentation can acquire data inaccessible through telescope images and is critical to understand the composition of these bodies.

Program Description:

TRIF funding has enabled recruitment of leading-edge faculty to NAU's Department of Astronomy and Planetary Sciences with experience on collaborative spacecraft missions, and program researchers aim to lead a spacecraft mission to an asteroid through the NASA SIMPLEx program. Currently, researchers and their students direct the daily tasks of the NASA Curiosity Rover on the surface of Mars from campus and have developed deployable instruments for other missions to the red planet. Researchers specializing in exoplanets have access to powerful telescopes, as well as unique equipment capable of replicating and measuring phenomena in the environments of these distant planets. NAU researchers will engage with our partner institutions in the state, and with the aerospace industry in Arizona. In addition to yielding valuable scientific information, this project will also provide industry contacts and unique training opportunities for undergraduate and graduate researchers, strongly serving current needs of this cornerstone industry in Arizona.

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

Northern Arizona was the site of a transformative finding in planetary science when Pluto was discovered at Lowell Observatory, and NAU is positioned to build on this rich tradition. Previous investment grew the department of Astronomy & Planetary Science, created a top-tier doctoral program, and enabled important discoveries, such as the evidence of Farfarout, which was recently confirmed as the most distant object in the Solar System by the International Astronomical Union. NAU researchers access important telescopes and have developed valuable collaborations (Lowell Observatory, USGS) to pursue new funding opportunities at NASA, the DoD, and ithe NSF. Finally, program researchers are collaborating with other areas of university strength to understand seasonal variations of biosignatures using remote sensing, both on Earth and potentially those detectable on astrobiological targets of interest.

Is there an Arizona Specific Benefit or Impact?

According to the Arizona Commerce Authority, the state is home to over 1300 manufacturers and suppliers of the aerospace industry and employs over 58,000 workers. Astronomy and planetary sciences is also an important employer for the state, which houses numerous internationally recognized research facilities and observatories. Investment into the Solar Systems Sciences and Exoplanets program will allow researchers and students to engage with our partner institutions in the state, and with the aerospace industry in Arizona. In addition to the scientific information this program is poised to provide, it will also facilitate industry contacts and unique learning opportunities for undergraduate and graduate researchers, strongly serving current needs of this industry in Arizona.

Investment Detail

	2022	2023	2024	Total
Infrastructure	0	0	0	0
Basic Research	689,788	715,467	789,800	2,195,055
Applied Research	0	0	0	0
Development	0	0	0	0
Total	689,788	715,467	789,800	2,195,055

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	0	0	0
Postdocs Supported	0	1	1	2
Graduate Students	7	8	10	25
Undergraduate Students	10	13	16	39
Sponsored Project Funding	3,465,529	3,919,541	4,297,490	11,682,560
Publications in Academic Peer-Reviewed Journals	40	44	48	132
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Water, Energy and Environmental Systems
Program Name:	Forest Health and Land Management

Problem Statement:

The Challenge: Development of a sustainable management strategy to improve forest health and lessen the risk of catastrophic wildfire. Forests in the western U.S. provide invaluable resources and services to the nation. In addition to the financial benefit they provide, healthy forests also contribute to people's quality of life. Forests provide clean air and water, contribute to biodiversity, recreational opportunities, and scenic landscapes. Unmanaged forests, on the other hand, are at risk of catastrophic wildfires and post-fire flooding that damage landscapes and livelihoods. An interdisciplinary and coordinated approach to develop and promote the best science to inform management is required to accomplish forest restoration and watershed protection is needed inside and outside of Arizona.

Program Description:

Under the Forest Health and Land Management initiative, NAU invests in researchers in the Ecological Restoration Institute (ERI), along with faculty in the School of Forestry, School of Earth & Sustainability, and School of Informatics, Computing & Cyber Systems. ERI seeks solutions to the costly environmental problems of degraded forest health and unnatural wildfire. Losses of city and county revenue from decreased tourism, short-term job losses, damage to water supplies, and the devastation experienced by those who live through catastrophic wildfire are just some of the economic impacts that ERI's work seeks to alleviate. Additionally, investments in the program support the development and use of remote sensing technology to monitor forest health, wildfire recovery, and the effect of environmental change on wildlife populations. Past TRIF investments in these units have enabled NAU to provide training in restoration science, including fieldwork experiences, to hundreds of graduate and undergraduate students.

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

Centered in the largest ponderosa pine forest in North America, and with the only School of Forestry in the state, NAU is uniquely positioned to pursue this challenge. NAU's ERI plays a primary role in forest restoration initiatives across the west and is the lead member of the multi-university Southwest Ecological Restoration Institute (SWERI). Ongoing research and restoration work performed in NAU's highly regarded School of Forestry supports active management and conservation of our natural resources in concurrence with the revival of the forest products industry in Arizona. In the 1950's, the Arizona State Land Department dedicated 4000 acres of forest in Northern Arizona as an "outdoor laboratory" for NAU. Building on this history, the 50,000 acre Centennial Forest was established in 2000, offering a premier location for research and workforce training for students in Forestry undergraduate and graduate programs.

Is there an Arizona Specific Benefit or Impact?

Arizona has over 18 million acres of forested land within its boundaries, and unmaintained and unhealthy forests are at risk of catastrophic wildfire and flooding. The development of land restoration practices minimizes the risk of wildfires, and lessens the economic impact of these natural disasters. In addition to the introduction of responsible land management and resource conservation practices that protect residents throughout the west, researchers are collaborating with governmental stakeholders and developing industry partnerships to revive the forest products industry, thus improving the economic outlook for rural communities statewide. Finally, this program will provide training in restoration science, including fieldwork experiences, to many graduate and undergraduate students.

Investment Detail

	2022	2023	2024	Total
Infrastructure	1,205,000	625,000	500,000	2,330,000
Basic Research	359,788	385,467	459,800	1,205,055
Applied Research	0	0	0	0
Development	0	0	0	0
Total	1,564,788	1,010,467	959,800	3,535,055

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	100,000	0	0	100,000
Postdocs Supported	2	2	2	6
Graduate Students	8	10	12	30
Undergraduate Students	15	18	22	55
Sponsored Project Funding	3,626,718	3,817,599	3,962,319	11,406,636
Publications in Academic Peer-Reviewed Journals	40	44	48	132
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	Water, Energy and Environmental Systems
Program Name:	Adapting to a Changing Environment

Problem Statement:

The Challenge: Predict the impact of a changing environment on soils, the atmosphere, ecosystems, and natural populations. Changes in our environment and climate have resulted in alteration of many aspects of the world today, including the strength and duration of weather events and changes in the average temperature and precipitation relative to historical patterns. As the environment changes, life on Earth changes with it. A deep understanding of how the flora and fauna on Earth are impacted by these changes (including wildlife ecosystems, forests, and even soils) will be required for society to effectively adapt as our environment changes around us.

Program Description:

Under the Adapting to a Changing Environment program, NAU makes investments in two Research Centers: The Center for Ecosystem Science and Society (Ecoss) and the Center for Advancing Western Landscapes (CAWL). Researchers in Ecoss investigate the interactions of biological communities—from single cells to the entire globe—with the environment, with a particular eye for how they both respond to and influence environmental change. Ecoss provides opportunities for the training of future scientists and actively engages the public in the discoveries made by the center. CAWL has advanced cross-disciplinary environmental research and training at NAU with a focus on the Colorado Plateau. The center has taken the initiative to provide science-based leadership to address conservation and environmental challenges in the West. Additional complementary research in the Adapting to a Changing Environment program occurs through faculty-led initiatives from the School of Earth & Sustainability, Department of Biological Sciences, School of Forestry, School of Informatics, Computing, & Cyber Systems and the Sustainable Communities program.

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

With recognized leaders in environmental science and ecology, and with synergy from skills in remote sensing and computational modeling, NAU is uniquely positioned to train the next generation of scientists to tackle problems in these areas. NAU has multidimensional strength in this program, including faculty who incorporate field-based, molecular genetic and bioinformatic approaches to understanding how changing climate impacts life on earth. The integration of sensor technology with informatics allows researchers to conduct longitudinal studies to assess ecosystem and forest health. Together with research in forestry and ecology, this work informs sustainable development goals and management practices. Program researchers mentor students across degree programs that take full advantage of NAU's unique place-based strength of being situated in the natural laboratory of the Colorado Plateau.

Is there an Arizona Specific Benefit or Impact?

Changing land management practices and climate variation are altering Earth's landscapes, but scientists don't have a complete picture of their impact on ecosystems. Program researchers use unique instruments, facilities, and field-based experiences to study the interactions of biological communities and determine how they respond to and influence environmental change. This information helps forge solutions to environmental challenges and aids land-management efforts across the globe. The program provides outstanding educational opportunities and research engagement for undergraduate and graduate students, preparing them for careers with natural resource management agencies, research laboratories, and environmental consulting firms, among other in-demand career pathways.

Investment Detail

	2022	2023	2024	Total
Infrastructure	593,844	350,000	350,000	1,293,844
Basic Research	359,788	573,967	459,800	1,393,555
Applied Research	0	0	0	0
Development	0	0	0	0
Total	953,632	923,967	809,800	2,687,399

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	270,000	270,000	540,000
Postdocs Supported	8	9	10	27
Graduate Students	44	47	50	141
Undergraduate Students	35	38	40	113
Sponsored Project Funding	4,237,633	4,164,990	4,073,196	12,475,819
Publications in Academic Peer-Reviewed Journals	80	88	96	264
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	Northern Arizona University
TRIF Investvest Area:	TBD
Program Name:	Seed, Equipment and Infrastructure Investment

Problem Statement:

The Challenge: Provide resources to departments/centers, faculty and students to ensure the University remains responsive to current needs of the state. The ability of an institution to succeed in research, student training and workforce development requires support in a variety of ways. Students benefit from the mentorship of expert researchers through paid fellowships or project grants. Early/Mid-career faculty require support to host students and seed funding to help acquire key data to help find external funding. Departments can develop through strategic planning funds to support faculty working in areas that benefit the university's mission. Investment into research infrastructure ensures the university pursues cutting edge-work and effectively trains students to meet the evolving needs of employers.

Program Description:

The Seed, Equipment and Infrastructure Investments (SEII) program provides a competitive mechanism for NAU researchers, students and/or interdisciplinary teams to request internal support for equipment, infrastructure, seed funding, or strategic planning for new programs to train students in emerging areas of workforce need. Requests will be solicited from eligible investigators doing research in a TRIF-supported initiative, and will be evaluated by internal and external referees on their scientific excellence, impact on student training and workforce development, and alignment with broader strategic goals of the university. We anticipate that researchers participating in programs recognized as Areas of Distinctive Excellence for NAU will be very competitive for support through the SEII program, as will researchers who, in collaboration with others, aim to explore how their own research can integrate with and benefit from these recognized areas of expertise. Improving student outcomes and expanding access to research traineeships or research workforce development are a major focus of the request.

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

NAU prides itself as an institution that is dedicated to student access and success, and empowers our students to succeed both in the classroom and the research laboratory. Through this novel program, the university will be able to foster new research opportunities in a manner that is inclusive of the diverse research strengths of research on campus, as well as to help ensure the robustness of our research enterprise and its ability to remain responsive to the evolving workforce needs in our community. Providing exceptional student training and experiential learning opportunities has always been a core mission of NAU and this program will allow us to significantly expand the number of students we serve, and broaden the demographic of students who participate in research.

Is there an Arizona Specific Benefit or Impact?

The Seed, Equipment and Infrastructure Investments program serves to help the research enterprise at NAU operate optimally, which in turn continues to aid the state's economic growth through providing rigorously trained individuals to support workforce needs in high-demand areas throughout Arizona in all TRIF supported initiatives.

Investment Detail

	2022	2023	2024	Total
Infrastructure	TBD	TBD	TBD	TBD
Basic Research	TBD	TBD	TBD	TBD
Applied Research	TBD	TBD	TBD	TBD
Development	TBD	TBD	TBD	TBD
Total	3,950,000	4,925,000	5,490,000	14,365,000

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses	0	125,000	525,000	650,000
Postdocs Supported	0	2	3	5
Graduate Students	8	10	12	30
Undergraduate Students	50	60	70	180
Sponsored Project Funding	0	0	0	0
Publications in Academic Peer-Reviewed Journals	0	0	0	0
Startups	0	0	0	0

TRIF 3-YEAR PLAN

UNIVERSITY OF ARIZONA

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Executive Summary

Positioning Arizona and its citizens for success in the coming decades is the fundamental goal of TRIF investments at Arizona's public universities. These investments are strategic and valuable. The projects that are funded serve as a leading indicator of future innovation to the emerging industries in Arizona; they prepare the universities' talented students for opportunities in these emerging industries and enhance the innovation culture in our state to attract ever more external investment and industry. The initiatives conducted through the TRIF program for the coming three years include:

- Improving Health
- Water, Environmental and Energy Solutions
- National Security Systems
- Space Exploration and Optical Sciences
- Access and Workforce Development

These initiatives will leverage previous investments, draw more focus on the nexus between these fundamentals and Arizona's resilience, and pursue capabilities that will extend Arizona's national prominence in delivering value from such innovations. We will use the next three-year planning horizon for TRIF to focus our efforts on not only meeting the original goals of the legislature, but in positioning Arizona as The Resilient State, capable of dealing with any threat and successfully operating through any challenge. Our goal through TRIF investment is to help create an agile state economy; produce a workforce that stays in Arizona and adapts and acclimatizes to change; support a healthy entrepreneurial ecosystem; and continue to develop the technical prowess, innovation, and discovery contained within the University.

University Vision and Philosophy

At the University of Arizona, we are working together to expand human potential, explore new horizons, and enrich life for all of us. Our mission is to continuously improve how we educate and innovate so we can lead the way in developing disruptive problem-solvers capable of tackling our greatest challenges. We aim to create a world where human potential is realized and we're all working together to create solutions to big problems so that life in our communities, in Arizona, and on our planet can thrive.

We strive to live our core values every day, seeking to demonstrate in all of our activities:

- Integrity – To be honest, respectful and just
- Compassion – Choose to care
- Exploration – Be insatiably curious
- Adaptation – Stay open-minded and eager for what's next
- Inclusion – Know we are better together
- Determination – Always Bear Down

Expected Outcomes

We measure TRIF impact and outcomes in a number of ways, including return on investment, technology transfer, workforce contributions, educational outreach, and engagement with government agencies, the community, and industry. UArizona will not only manage TRIF investments to make Arizona the Resilient State, but we also will leverage those investments wherever possible to expand TRIF impact and influence in our overall research programs. We will use our communications and leadership engagement to influence others to adopt the benchmark resilient methods and technologies

that will form these valuable TRIF investments. UArizona will work closely with the Arizona Board of Regents across this three-year planning horizon to make these plans effective and impactful for all residents of the state.

From FY2017 to FY21, UArizona advanced viral disease research before the arrival of COVID-19. We led the way in agrivoltaics and wastewater epidemiology and created the foundation for the Arizona Institutes for Resilience (AIR), a powerhouse research and outreach enterprise capable of leveraging our top-ranked global research position in water to a critical mass of integrated solution-oriented disciplines and technologies. TRIF was essential as the University reached $760M in annual research activity, and in bringing its resulting breakthroughs to bear on the Arizona economy, and our TRIF investment areas will continue to align with areas of state and national need and where UArizona faculty can provide significant expertise and value. This strategy accelerates the capacity to expand impact, economic opportunity, and external funding opportunities to benefit the well-being of the people of Arizona and beyond.

Marketing / Communication Overview

The primary marketing and communications goals include highlighting the many ways TRIF outcomes and successes benefit Arizona and promoting the initiative's short- and long-term importance in improving the lives of Arizonans. Central to these goals is a marketing plan that delivers real, data-driven stories about tangible benefits that resonate strongly with stakeholders. This strategy includes aligning external communications with the TRIF initiatives outlined in this plan and includes internal engagement, designed to raise awareness of TRIF among faculty and the University community as a whole.

A unified and coordinated effort among the three Arizona universities is critical to sending a clear, positive message to external stakeholders about the value of TRIF. In this collaborative context, the Research Communications division of the Office for Research, Innovation and Impact will work with the University's central Marketing and Communications staff to promote UArizona's TRIF initiative in a variety of ways, with a focus on research impact, economic drivers, and public benefit. The focus will be on stories that showcase impact of TRIF investments on Arizona—bringing outside resources into Arizona that are spent locally—as well as technology and company creation, workforce development, and the impact of the ensuing technologies, products, patents, and public benefits that improve the quality of life for citizens of the state.

University Administration of TRIF

TRIF is administered through the Office of Research, Innovation and Impact with the following leadership:

- Elizabeth "Betsy" Cantwell, Senior Vice President, Research and Innovation
- John O'Neil, Vice President, Research Development
- Sangita Pawar, Vice President, Research Operations
- Brooks Jeffery, Associate Director, Infrastructure
- Lori Schultz, Assistant Vice President, Research Intelligence
- Kim Patten, Assistant Vice President, Research Development
- Doug Hockstad, Assistant Vice President, Tech Launch Arizona
- Anh Le, Senior Director, Business Services
- Stephanie Doster, Director, Research Communications

During the proposed 2021-24 cycle, UArizona will invest TRIF funds in the following five strategic initiatives, which are described in detail throughout the plan:

- **Improving Health**
  - Led by Jennifer Barton, Director, BIO5 Institute
- **Water, Environmental and Energy Solutions**
  - Led by James Buizer, Interim Director, Arizona Institutes for Resilience
- **National Security Systems**
  - Led by John O'Neil, Vice President, Research Development
- **Space Exploration and Optical Sciences**
  - Led by Tim Swindle, Director, UArizona Space Institute
- **Access and Workforce Development**
  - Led by Jennifer Fields, Director, Office of Social Impacts

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Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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 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	83,394	83,394	83,394	250,182
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
Total	223,008	223,008	223,008	669,024

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	62,254	62,254	62,254	186,762
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
Total	166,729	166,729	166,729	500,187

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	48,746	48,746	48,746	146,238
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
Total	130,569	130,569	130,569	391,707

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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.

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	84,209	84,209	84,209	252,627
Basic Research	0	0	0	0
Applied Research	0	0	0	0
Development	24,270	24,270	24,270	72,810
Total	108,479	108,479	108,479	325,437

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	52,144	52,144	52,144	156,432
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
Total	94,408	94,408	94,408	283,224

Performance Measures

	2022	2023	2024	Total
Faculty Startup Package Expenses				0
Postdocs Supported				0
Graduate Students				0
Undergraduate Students				0
Sponsored Project Funding				0
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	1,568,901	1,568,901	1,568,901	4,706,703
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
Total	2,839,426	2,839,426	2,839,426	8,518,278

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
Startups	1	0	1	2

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	569,289	569,289	569,289	1,707,867
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
Total	1,229,433	1,229,433	1,229,433	3,688,299

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
Startups	0	1	0	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	569,289	569,289	569,289	1,707,867
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
Total	1,229,433	1,229,433	1,229,433	3,688,299

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
Startups	0	1	0	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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?

- 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

	2022	2023	2024	Total
Infrastructure	569,289	569,289	569,289	1,707,867
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
Total	1,229,433	1,229,433	1,229,433	3,688,299

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
Startups	1	0	1	2

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	681,234	681,234	681,234	2,043,702
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
Total	829,744	829,744	829,744	2,489,232

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
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	799,188	799,188	799,188	2,397,564
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
Total	1,446,385	1,446,385	1,446,385	4,339,155

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	463,313	579,141	579,141	1,621,595
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
Total	1,157,108	1,446,384	1,446,384	4,049,876

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	552,980	552,980	552,980	1,658,940
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
Total	1,171,571	1,171,571	1,171,571	3,514,713

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	647,342	647,342	647,342	1,942,026
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
Total	1,171,571	1,171,571	1,171,571	3,514,713

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	301,351	301,351	301,351	904,053
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
Total	1,171,571	1,171,571	1,171,571	3,514,713

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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. 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	469,103	469,103	469,103	1,407,309
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
Total	1,171,571	1,171,571	1,171,571	3,514,713

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	301,351	301,351	301,351	904,053
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
Total	1,171,571	1,171,571	1,171,571	3,514,713

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	297,630	223,223	223,223	744,076
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
Total	1,157,107	867,831	867,831	2,892,769

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	409,616	409,616	409,616	1,228,848
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
Total	867,831	867,831	867,831	2,603,493

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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 for the pipeline shortages in 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	359,635	359,635	359,635	1,078,905
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
Total	650,873	650,873	650,873	1,952,619

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
Startups	0	1	1	2

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	148,815	148,815	148,815	446,445
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
Total	578,553	578,553	578,553	1,735,659

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	319,675	319,675	319,675	959,025
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
Total	578,553	578,553	578,553	1,735,659

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
Startups	0	1	2	3

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	639,350	639,350	639,350	1,918,050
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
Total	1,157,108	1,157,108	1,157,108	3,471,324

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
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	781,593	441,593	441,593	1,664,779
Basic Research				0
Applied Research	375,514	575,514	575,514	1,526,542
Development		140,000	140,000	280,000
Total	1,157,107	1,157,107	1,157,107	3,471,321

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
Startups			1	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	1,021,593	871,593	871,593	2,764,779
Basic Research				0
Applied Research	135,514	135,514	135,514	406,542
Development		150,000	150,000	300,000
Total	1,157,107	1,157,107	1,157,107	3,471,321

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
Startups			1	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	432,247	432,247	432,247	1,296,741
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
Total	1,157,107	1,157,107	1,157,107	3,471,321

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
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	794,677	794,677	794,677	2,384,031
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
Total	1,157,106	1,157,106	1,157,106	3,471,318

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
Startups				0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	575,940	403,354	403,354	1,382,648
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
Total	964,257	964,257	964,257	2,892,771

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
Startups	0	1	0	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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

	2022	2023	2024	Total
Infrastructure	575,940	403,354	403,354	1,382,648
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
Total	964,257	964,257	964,257	2,892,771

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
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	575,940	403,354	403,354	1,382,648
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
Total	964,257	964,257	964,257	2,892,771

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
Startups	0	0	1	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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

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	575,940	403,354	403,354	1,382,648
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
Total	964,257	964,257	964,257	2,892,771

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
Startups	0	0	1	1

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	575,939	403,353	403,353	1,382,645
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
Total	964,256	964,256	964,256	2,892,768

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
Startups	0	0	0	0

Arizona Board of Regents

Technology and Research Innovation Fund (TRIF) Program Proposal

University:	University of Arizona
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	575,939	403,353	403,353	1,382,645
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
Total	964,256	964,256	964,256	2,892,768

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
Startups	0	0	0	0