

**Arizona University System
Technology and Research Initiative Fund (TRIF)**

TRIF Proposal

The University of Arizona

Optical Sciences and Technology Program
(OST)

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EXECUTIVE SUMMARY

The University of Arizona has the best optics program in the world. The program has at its core the College of Optical Sciences and important contributions from the College of Science, College of Engineering, and the College of Medicine. The impact of optics on the economy of the state of Arizona, and the country as a whole in the coming years is staggering. The market for optics in communication, medical care, heavy industry, sensing and security and military exceeds \$200 billion per year. Optics is clearly in a revolutionary stage of development and this has been recognized by the US government and a number of leading states. For example, in New York, California, Washington, Georgia, Florida and North Carolina alone, there have been state and private initiatives that have resulted in creation of Centers of Excellence in Optics and Photonics. There is a serious concern that not only the ongoing initiatives in these states compete for new faculty, students and federal funds, but also in addition they have been attempting to attract our leading faculty from the UA. It is only through continuing and increasing support from the State and the University and through cooperative and coordinated efforts across campus that UA's leadership role in optics will not be rapidly eroded. The TRIF Optical Sciences and Technology Program provides the type of financial and leadership support needed to engage in novel optics initiatives which will continue to secure the University's position as the best optics program in the world. The lack of such an effort can have devastating consequences on one of the UA flagship programs.

This proposal is designed to help the UA keep its leadership position in optics and requests support funding for the second five year period for broad multidisciplinary and novel initiatives in optics and photonics that will from this point forward be designated as the Optical Sciences and Technology Plan (OST). OST has profound implications for the New Economy of the State of Arizona. This plan builds on the opportunities and successes the University of Arizona has had during the first five years of funding in the area of Optical Sciences and Technology. The following section will discuss those accomplishments and successes in more detail.

OST is seeking continued funding to support new initiatives in (1) research and technology development, (2) workforce development, (3) technology transfer and technology support for the optics industry in the state of Arizona and (4) educational outreach. These four areas are integrally related and pertinent to the proposal's New Economy emphasis.

Research and Technology Development

The research and technology development portion of the proposal focuses on three areas: (a) photonics component concerned with novel materials and optical systems including nanomaterials and photonic crystal structures, (b) novel imaging and sensor components that will meet the higher demand for precision optics with a wide array of practical implications, and (c) development of state of the art astronomical optics.

Workforce Development

The workforce development portion of the proposal offers realistic and attainable solutions to the severe shortage of trained personnel in optical sciences and technology. Strategies developed will improve two-year technical training, undergraduate and graduate curricula in optical sciences, recruit students to optics career choices, and reach-out to optics companies through courses that include web-based, learning-centered technology. A special focus of workforce development has brought about a new two-year optics technician training program at Pima Community College (PCC) to facilitate the training of technicians for employment in the local optics market. This program will fill a critical need for trained technicians locally.

Technology Transfer and Industry Outreach

The support of the optics industry in Arizona to encourage new technologies and technology transfer is important to the growth of the optics industry. Thus far, OST has been a means for identifying and pursuing commercial opportunities and for ensuring that The University of Arizona and State of Arizona reap the maximum possible economic benefit.

OST calls for close collaboration between the University of Arizona and the optics industry. Special visiting scholars programs have brought and will continue to bring personnel from corresponding industrial affiliates to the campus for collaboration on mutually beneficial research projects and related initiatives. This will continue to further enhance application opportunities and commercialization potential.

Educational Outreach

Outreach efforts designed to attract students to the study of optics are also an important part of OST's emphasis. Strategies include the planning of outreach activities with the teachers and faculty of K-12 schools and community colleges and technical schools to interest students in optics careers. A special focus of this area has been to support outreach activities to attract potential optics students from the Native American communities of the State.

OST is viewed against measurable performance objectives that speak strongly to research-economy interface. It is designed with budget assumptions that entail a leveraging of state funding with government and industrial funding. It is expected that the return on investment to the state from OST will be substantial.

1. CORE VISION/PROJECT DESCRIPTION

1.1 Overview

Optics, the science and engineering of light, addresses the development and implementation of new technologies. Its applications range from the mundane: televisions, copy machines, computer screens, and bar code scanners -- to the fantastic: lifesaving medical techniques and instruments, NASA's space program, and world-wide communication systems. Its promise for the future includes the promise of preventing and curing disease, overcoming the pain and limitation of injury, renewing and sustaining our environment, securing a safer world, and improving the quality of life for all.

Advances in the field of optics influences our lives in ways that could not have been imagined a generation or two ago and we are just now beginning to see the fruits of the scientific discoveries of the last three or four decades. The development of the laser -- a mere 40 years ago -- has given us fiber optic-communications, compact disks, laser surgery, and has led to other developments in optical lithography systems for patterning computer chips, high-resolution microscopes, adaptive optics for Earth-based astronomy, infrared sensors for remote controls and night-vision equipment, high-efficiency lighting sources and a host of other applications in a multitrillion-dollar world market.

Optics is one of the world's fastest growing industries and also one of the most lucrative. In the United States, there are several internationally known optics centers in Georgia, Texas, New Mexico, Colorado, Florida, New York, and these states are aggressive in competitively pursuing funding.

Arizona is considered to be a major center for the optics industry and Tucson's optics industry is widely considered to be among the best in the nation, with a vibrant company base, enviable business-to-business cooperation, and top educational opportunities. The driving force behind Arizona's thriving optics industry is the research capabilities and education programs at UA's College of Optical Sciences, where the knowledge gained in the classrooms and research laboratories is being brought to development in the commercial marketplace.

1.2 Mission, goals, values and vision

The mission of the TRIF Optical Sciences and Technology Program is to create a university industry alliance that supports the growth of Optics. The TRIF Optical Sciences and Technology Program creates a broad multidisciplinary research and education program dealing with optical sciences and technology. It has profound and wide-ranging implications for the continued growth and development of optical sciences and technology in the New Economy of the State.

The goal of the TRIF Optical Sciences and Technology Program is to support the development of the New Economy in Arizona through an integration of academic and technical leadership in one of the important industries targeted for growth in Arizona. This Program includes components of research and technology development, workforce development, and the provision

of technology transfer and technology support for the Arizona optics companies. Between 1996 and 2006 the size of the optics industry in Arizona has increased by more than a factor of 10 and the University of Arizona has become the leading university in the country in optical research and education. Our vision for the next 10 years is that we will maintain our leadership in optics education and research, and Arizona will become the leading state in the country in optics industry.

2. OPERATIONAL STRATEGIES

2.1 Development and Production

Development and production are long-term, ongoing processes, encompassing multiple endeavors by Arizona optics groups and a consortium of industrial partners, including but not limited to 4D Technology, Corning, Inc., BAE Systems, DMetrix, E-Systems, Gigabit Optics, Nitto Denko, NP Photonics, Inc., Samsung, Sony, Terapixel-Finland, Thermo Electron, TRW and Veeco. TRIF Optical Sciences and Technology funded initiatives are positioning the University optics program to take a leadership role in new endeavors with federal and industrial partners.

2.1.1 Development status

Long range research is currently being carried out with several industrial and government partners.

2.1.2 Production process

Team efforts encompass all areas of endeavor.

2.1.3 Cost of development

Currently being met by the College of Optical Sciences with funds received from the Technology and Research Program, the National Science Foundation Science and Technology Center, the Air Force Office of Scientific Research through the Multidisciplinary Research Initiative, the Keck Foundation, the National Science Foundation Division of Materials Research, and other funding sources.

2.1.4 Labor requirements

Optical Sciences faculty members as well as faculty members from other colleges who are working in optics.

2.2 Marketing and Promotion

Marketing focuses on novel areas critical to information technology and is multi-disciplinary: fiber optics technology, high power fiber lasers, photonic materials development, optoelectronic devices, biophotonics and nanopore-based technology, display information,

information storage, processing information, transmission of information, simulation and modeling, materials development, quantum information technology and adaptive eyewear.

2.2.1 Strategy

Strategic plans encompass enhancement of partnerships already established within the educational and business communities supplemented by outreach efforts to support the recruitment of underrepresented groups.

2.2.2 Method of promotion

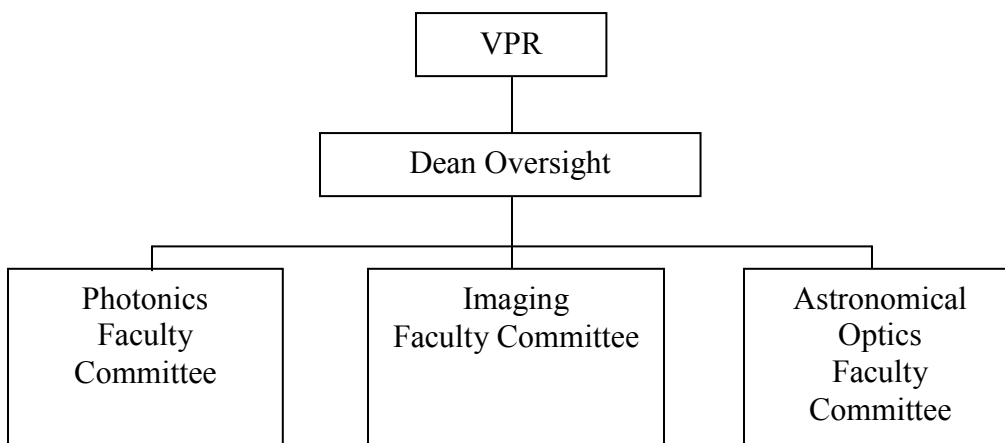
Department Web site, Workshops and tutorials targeted to practicing professionals in critical technologies and active outreach initiatives to reach Native American representatives, University representatives and collaboration with the Mathematics, Engineering and Science Achievement program for early outreach to K-12, underrepresented minorities, and first-generation college bound students.

2.2.3 Advertising and promotion plans

Same as above.

2.3 Project Management

2.3.1 Description of the organizational setup



The organizational management structure behind OST is constructed of three faculty committees (photonics, imaging, and astronomical optics) who report directly to a dean oversight committee, who in turn report to the UA Vice President for Research and Graduate Studies.

2.3.2 Advisory boards

External Review Committee

- Bruce Wright (Chair), UA Associate Vice President, Economic Development
- Bob Breault –Chairman of the Board, Breault Research Organization
- Richard Juergens – Senior Engineering Fellow, Raytheon Missile Systems
- Glenn Sincerbox – Professor Emeritus, Optical Sciences

TRIF Optics Committee

- James C. Wyant (Chair), Dean College of Optical Sciences, Professor Optical Sciences, Professor Electrical & Computer Engineering
- Arthur Gmitro, Professor of Radiology and Optical Sciences
- Thomas Peterson, Dean College of Engineering, Professor Chemical and Environmental Engineering
- Nasser Peyghambarian, Professor Optical Sciences, Professor, Materials Science & Engineering and Chair, Lasers & Photonics
- Joaquin Ruiz, Dean College of Science, Professor Geosciences

TRIF Optics/Imaging Faculty Advisory Committee

- Arthur F. Gmitro (Chair), Professor of Radiology and Optical Sciences.
- J. Roger P. Angel, Regents Professor of Astronomy and Optical Sciences.
- Jennifer K. Barton, Associate Professor of Biomedical Engineering, Electrical and Computer Engineering, and Optical Sciences.
- Robert H. Brown, Professor of Planetary Sciences.
- Eustace L. Dereniak, Professor of Optical Sciences
- Michael R. Descour, Associate Professor of Optical Sciences
- James T. Schwiegerling, Associate Professor of Ophthalmology and Optical Sciences.

The TRIF Optics/Photonics Faculty Advisory Committee

- Nasser Peyghambarian (Chair), Professor Optical Sciences, Professor, Materials Science & Engineering, and Chair, Lasers & Photonics.
- Neal R. Armstrong, Professor Chemistry, Professor Optical Sciences.
- Jerome V. Moloney, Professor Applied Mathematics, Professor Optical Sciences.
- Joseph H. Simmons, Department Head, Material Sciences & Engineering, Professor Materials Science & Engr., Professor Optical Sciences.
- Masud Mansuripur, Professor Optical Sciences, Chair Optical Data Storage Center.

The TRIF Astronomical Faculty Advisory Committee

- Peter Strittmatter (Chair), Department Head; Astronomy, Regents Professor; Astronomy, Director; Steward Observatory
- Roger P. Angel, Regents Professor; Astronomy and Optical Sciences
- James H. Burge, Associate Professor; Optical Sciences and Astronomy
- Jose Sasian, Professor; Optical Sciences

2.4 Sustainability

2.4.1 Anticipated funding sources for ongoing support

Since the beginning, the faculty members and staff of Optical Sciences have actively pursued opportunities for research collaboration with industry and governmental agencies. Typically Optical Sciences manages over 100 new contracts or contract modifications annually and submits more than 200 new proposals each year. Technology developed on TRIF will help us gain more support from our industry and government partners.

2.4.2 Timeline for transitioning away from TRIF support

Transition timeline for TRIF supported projects will vary from less than one year to not normally more than 3 years.

Optical Sciences and Technology in the New Economy

3. GOALS/METRICS/OUTCOMES

3.1 Specific and realistic goals that are clearly measurable

3.1.1 Return on investment, ROI

Performance Measures

	FY02 Proj	FY02 Actual	FY03 Proj	FY03 Actual	FY04 Proj	FY04 Actual	FY05 Proj	FY05 Actual	FY06 Proj	FY06 Actual	FY07 Proj	FY07 Actual	FY08 Proj	FY09 Proj	FY10 Proj	FY11 Proj
RETURN ON INVESTMENT (\$ in millions)																
Sponsored Awards		11.325		3.398		19.94		2.428	2.50	9.677	\$16.000	\$21.749	\$16.350	\$16.700	\$17.050	\$17.400
Patent Royalty Income											\$0.055	\$0.050	\$0.060	\$0.065	\$0.070	\$0.075
Gifts & Other Sources											\$0.017	\$0.041	\$0.034	\$0.034	\$0.051	\$0.051
WORKFORCE CONTRIBUTIONS																
New Faculty Hires	4	3	4	6	2	0	2	1	2	1	2	3	2	2	2	2
Growth in optics-related undergraduate enrollment	10	12	15	25	15	44	0	25	0	-12	4	-40	6	4	6	4
Growth in optics-related graduate enrollment	10	30	10	15	10	21	0	0	0	23	3	15	4	3	4	4
Growth in optics-related distance learning	5	3	10	48	10	32	10	32	5	23	5	-8	8	8	10	10
TECHNOLOGY TRANSFER & COLLABORATIONS																
New Start-up Companies	2	2	1	1	0	0	0	0	1	1	0	0	1	0	1	1
Patent Applications	2	15	2	15	2	10	2	17	7	23	7	21	8	10	10	12
Invention Disclosures											25	27	27	29	31	33
OUTREACH & EDUCATION																
Workshops, seminars and conferences supported	0	7	0	5	0	6	0	6	5	15	5	17	5	5	6	6

Explanation of ROI Calculations:

ROI calculation for FY02 through FY06: Annual New federally funded major optics projects plus New industrial funded major optics projects plus New affiliate sponsors obtained (in \$'s) divided by annual TRIF Optical Sciences and Technology Program Total Expenditures

ROI calculation for FY07 to FY11: Annual Sponsored Awards plus Patent Royal income plus Gifts & Other Sources divided by annual TRIF Optical Sciences and Technology Program Total Expenditures. Sponsored Awards, Patent Royalty income and Gifts & Other Sources (i.e. Affiliates funding) included for university personnel receiving TRIF Optical Sciences and Technology Program funding as defined in the ABOR approved ROI Formula

Note: Undergraduate enrollment decline is due to increased college admission requirements and large undergraduate graduating classes in FY06 and FY07

3.1.2 Technology transfer

Technology transfer is an important area of measuring the goals and economic outcomes of OST because information is readily available through the Office of Technology Transfer and this information is naturally a good measure of the viability of the relationship between university research and local industry. Number of start-up companies, number of patents applications filed and invention disclosures submitted to the University Office of Technology Transfer are the key technology transfer measures that will be used.

3.1.3 Industry outreach

We will seek out optics companies that are interested in moving to Arizona and we will work with them to help provide the workforce, training, and research they need to be successful. We will also work with existing companies to help them solve technical and staffing problems.

3.1.4 Work force contributions

We will increase the number of graduates and we will continue keeping our curriculum current to be producing graduates with the skills needed by industry. We will also seek to hire new faculty with the credentials and experience to initiate new optics initiatives at the university.

3.1.5 Educational outreach

Curriculum innovation involves the expansion of existing degree programs through both attraction of faculty to support the expansion and the growth in undergraduate, graduate, and distance learning enrollment. We will visit many schools to let students know about careers in optics.

3.1.6 Government agency/community outreach

We will give tours and talks to keep the community informed about new developments in optics. We will serve as proposal reviewers and advisors for several government agencies.

3.1.7 Partnerships/collaborations

Partnerships and collaborations in this case represent collaborations in the form of financial or measurable strategic support. Partnerships and collaborations will be measured using increase in affiliate memberships and increases in government and industry funded research awards.

3.2 Timeline for Achievement of Goals

Included in Section 2.4.2 above.

Optical Sciences and Technology in the New Economy

3.3 Early Proof of Performance

The accomplishments of the TRIF Optical Sciences and Technology Program will have a direct impact on the Optics Initiatives FY2007-11 goals as detailed below.

The TRIF funding was leveraged and generated more than \$60 million of outside funding, which resulted in the creation of 2 new research centers and a major equipment grant. In addition to facilitating additional sponsored research funding, the creation of the new research centers will have a positive impact on all the elements of the FY2008-11 OST.

Fourteen first class faculty members were hired. These new faculty members broadened the scope of research and education at the University by providing expertise in optical materials, optoelectronic devices and photonic and imaging systems. By broadening the scope of research and education capabilities in the University optics program, the University will be in a stronger position to compete for major federal and industrial funded research awards. In addition, the broadened scope will allow the university to expand our workforce development efforts, educational programs, increase the development of new intellectual property, and attract new members to the Industrial Affiliates Program.

More than 100 graduate students were supported by TRIF. The TRIF funding was leveraged 100% by other support that the faculty provided (through federal and private sector funds). The students participated in cutting edge research and thus enhanced the quality of research at the University.

4. PRO FORMA FINANCIALS

4.1 Funding Request

FINANCIAL INFORMATION

	FY02 Actual	FY03 Actual	FY04 Actual	FY05 Actual	FY06 Actual	FY07 Revised Budget	FY07 Actual	FY08 Revised Budget	FY09 Revised Budget	FY10 Revised Budget	FY11 Revised Budget
REVENUE											
Carry Forward	\$ -	\$ 1,535,952	\$ 324,825	\$ 366,298	\$ 1,230,225	\$ 135,586	\$ 135,586	\$ 594,471	\$ -	\$ -	\$ -
New TRIF Revenue	\$ 4,395,646	\$ 4,803,518	\$ 4,521,523	\$ 4,491,847	\$ 4,047,769	\$ 3,646,492	\$ 3,646,492	\$ 3,755,667	\$ 3,536,694	\$ 3,678,161	\$ 3,825,288
TOTAL REVENUE	\$ 4,395,646	\$ 6,339,470	\$ 4,846,348	\$ 4,858,145	\$ 5,277,994	\$ 3,782,078	\$ 3,782,078	\$ 4,350,138	\$ 3,536,694	\$ 3,678,161	\$ 3,825,288
EXPENDITURES											
Personal Services	\$ 1,004,904	\$ 1,781,270	\$ 2,688,414	\$ 2,209,066	\$ 2,575,898	\$ 3,086,138	\$ 2,143,214	\$ 3,764,271	\$ 3,050,577	\$ 3,266,294	\$ 3,491,346
All Other Operating Expenses	\$ 854,790	\$ 3,233,375	\$ 791,636	\$ 418,854	\$ 1,566,510	\$ 695,940	\$ 1,044,393	\$ 585,867	\$ 486,117	\$ 411,867	\$ 333,942
Capital	\$ 1,000,000	\$ 1,000,000	\$ 1,000,000	\$ 1,000,000	\$ 1,000,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL EXPENDITURES	\$ 2,859,694	\$ 6,014,645	\$ 4,480,050	\$ 3,627,920	\$ 5,142,408	\$ 3,782,078	\$ 3,187,607	\$ 4,350,138	\$ 3,536,694	\$ 3,678,161	\$ 3,825,288
Return on Investment	4.0:1	0.6:1	4.5:1	0.7:1	1.9:1	4.3:1	6.8:1	3.8:1	4.8:1	4.7:1	4.6:1