

Empire State Development
Division of Science, Technology & Innovation
(NYSTAR)



2022 Program Report
Centers for Advanced Technology

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Introduction

Empire State Development (ESD) is New York's chief economic development agency. The mission of ESD is to promote a vigorous and growing economy, encourage the creation of new job and economic opportunities, increase revenues to the State and its municipalities, and achieve stable and diversified local economies. Through the use of loans, grants, tax credits and other forms of financial assistance, ESD strives to enhance private business investment and growth to spur job creation and support prosperous communities across New York State.

ESD's Division of Small Business & Technology Development (SBTD) supports the growth of small businesses, defined as firms with 100 or fewer employees, providing and implementing programs and services that facilitate access to capital, technical assistance, technology assistance, and venture funding.

ESD's SBTD includes the Division of Science, Technology & Innovation (NYSTAR) which manages the Centers for Advanced Technology (CAT) Program. The CAT program, created in 1983, supports applied research, development and technology transfer in multiple technological areas in collaboration with private industry. CATs play a critical role in spurring technology-based applied research and economic development in the state, promoting national and international research collaboration and innovation, and leveraging New York's research expertise and funding with investments from the federal government, foundations, businesses, venture capital firms and other entities.

Through a competitive process, NYSTAR awards 10-year designations in technology fields of strategic importance to New York's economic competitiveness. Eligible applicants are New York universities and affiliated research institutes.

Below are individual summaries for each of the 15 CATs covering the July 1, 2020 through June 30, 2021 reporting period with information as reported by the Center that includes:

- Importance to NYS
- Impacts
- Federal or Other Grants Awarded
- Education and Technology Commercialization Activities
- Commercialization
- Start-up Companies Formed
- Licensing Agreements
- Level of Matching Funds Provided

During this reporting period, the CATs reported 664 jobs created and retained and over \$284 million in economic impact. Generated impacts for the program are broken down below and included in the summary section for each CAT.

Center	New Jobs	Retained Jobs	Total jobs	Economic Impact
Center for Advanced Ceramic Technology at Alfred University	6.0	3.0	9.0	\$9,006,655
Center for Flexible Hybrid Medical Device Manufacturing at Binghamton University	1.0	42.0	43.0	\$13,924,580
Integrated Electronic Engineering Center at Binghamton University	41.0	3.0	44.0	\$34,471,435
Center for Advanced Materials Processing at Clarkson University	38.0	98.0	136.0	\$9,560,470
Center for Life Science Enterprise at Cornell University	0.0	0.0	0.0	\$1,187,000
Advanced Science Research Center Sensor CAT at City University of New York	3.0	0.0	3.0	\$1,809,519
CAT in Telecommunications at New York University Polytechnic University	6.0	1.0	7.0	\$5,900,700
CAT in Future Energy Systems at Rensselaer Polytechnic Institute	1.0	7.0	8.0	\$11,354,018
Additive Manufacturing and Multifunctional Printing CAT at Rochester Institute of Technology	22.0	9.0	31.0	\$2,799,000
Center for Biotechnology at Stony Brook University	37.0	29.0	66.0	\$70,418,125
Center for Integrated Electric Energy Systems at Stony Brook University	32.0	15.0	47.0	\$7,488,933
CAT in Nanomaterials and Nanoelectronics at SUNY Polytechnic Institute	24.0	40.0	64.0	\$23,370,972
CAT in Computer Applications and Systems Engineering at Syracuse University	29.0	35.0	64.0	\$21,923,419
CAT in Big Data and Health Sciences at University of Buffalo	103.0	9.0	112.0	\$27,674,223
CAT in Emerging and Innovative Sciences at University of Rochester	12.0	18.0	30.0	\$44,099,894
Totals	355.0	309.0	664.0	\$284,988,942

Requests for Proposals

There were no Center for Advanced Technology Requests for Proposals released during this period. The next CAT competition is expected to be held in early to middle 2024 as 10 current CAT designations are set to expire on June 30, 2025.

Individual CAT Reports

Individual CAT reports continue for the remainder of this document.

Center for Advanced Ceramic Technology (CACT)

Alfred University

Dr. John Simmins, Director

Technology Focus

Ceramics

Importance to NYS

Alfred University is the only institution in the country to offer a glass science PhD and one of only two dedicated to ceramic engineering. CACT links NYS firms to unique expertise aimed at solving a wide range of analytical and applied research needs for technical ceramics and glass materials science.

Description of Achievements

Following the lifting of major restrictions limiting on-campus activity during the pandemic, CACT saw strong demand for analytical and service agreements, and increased interest in internships. CACT worked with 21 NYS-based firms, three companies from outside NYS, one Canadian firm, and multiple projects with Johns Hopkins University, on 47 projects at the University. New York State companies included ASK Chemicals, AirFlow Catalyst Systems, Belvac, Boston Valley Terra Cotta, Cerion, Corelle, Corning, Eastman Kodak, Foster-Rush, Momentive, Refractron, Replacement Tiles Solutions, SRS Holdings, Unifrax, Washington Mills, and Xylon Technical Ceramics. Additional consulting support, in preparation for future projects, was conducted with NYS-based firms Armoured One, Himed, and ThermoFisher Scientific.

CACT played a lead role in regional entrepreneurship through the first “Tri-Collegiate Think Tank” held in November 2020, introducing students at Alfred State College, Alfred University and Houghton College to challenges brought upon by the COVID pandemic, faced by Allegany County firms. This was followed by the Startup Allegany Collegiate Competition held in April 2021. Winning teams receive mentorship from IncubatorWorks and pre-seed support from CACT and other private sector sponsors.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
6	3	\$3,951,532	\$1,631,101	\$215,685	\$2,600,000	\$608,337	\$9,006,655

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
32	16	32	12

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Co-Investigator	Source	Amount	Duration (yrs)	Summary
235741	Dr. S. Misture		NSF	\$953,000	1	Development of modeling approaches for fitting synchrotron X-ray scattering data to describe nanoscale-disordered bimetallic nanoparticles for nuclear waste immobilization.
244529	Dr. S. Misture		SF	\$495,254	1	Purchase of Focused Ion Beam Scanning Electron Microscope
235742	Dr. S. Misturee		DOE through U. of Connecticut	\$70,000	1	Multi-Constituent airborne contaminants capture with low cost oxide getters and mitigation of cathode poisoning in solid oxide fuel cell.

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

CACT sponsored internships at Filtros, GBC Materials, Washington Mills, Integrity Metal Fabrication & Repair, ASK Chemicals, Sigma Advanced Materials, and Replacement Tiles Solutions. CACT sponsored the Tri-Collegiate Think Tank and Startup Allegany Collegiate Competition, both focused on entrepreneurship training.

CACT employed three internal interns to develop marketing materials and survey Allegany County-based companies to understand their needs. CACT employed two engineering interns in capturing as-built drawings of the IncubatorWorks facility for a ceramics pilot plant to be located in the building. CACT sponsored five (5) mechanical engineering interns for a glass recycling project looking at grinding and extrusion of glass-polymer composites.

Commercialization

CACT continued industrial outreach at major international industrial glass/ceramic conferences, including the Material Science & Technology (MS&T) show in Columbus, OH and Ceramics Expo in Cleveland, OH. CACT participated in several local/regional programs, including Fuzehub Virtual Solutions Forum on 8/6/20, United States Advanced Ceramics Association virtual conference on 9/24/20, Fuzehub Virtual Solutions Forum on 9/30/20, virtual MedTech Conference on 10/21/20, virtual NYSTAR Connect session on 2/16/21, virtual Fuzehub North Country Solutions Forum on 4/14/21, and virtual NYSTAR Connect session on 4/20/21.

Applied research via analytical projects, service agreements, equipment lending agreements, and sponsored research continued in spite of restricted access to University facilities.

Invention Disclosures /Patents

None

Start-up Companies Formed

Company Name	City	Product/Service	Sector
Replacement Tiles Solutions	Alfred, NY	3D printed molds for producing replacement terra cotta and concrete roofing tiles	Architectural materials fabrication

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

CACT worked with 21 NYS-based firms.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	NYSTAR Funding	Matching Funds		Total
		Company Cost Share	Other Sources	
Salaries & Fringe	\$472,394	\$72,331	\$216,560	\$761,285
Indirect Costs	\$70,858	\$18,082	\$36,240	\$125,180
Equipment	\$76,329	\$7,170	\$748,587	\$832,086
Materials & Supplies	\$287	\$17,953	\$23,254	\$41,494
Tuition	\$0	\$0	\$0	\$0
Travel	\$705	\$0	\$0	\$705
Subcontractors	\$0	\$0	\$15,502	\$15,502
Other	\$118,118	\$10,026	\$2,943,593	\$3,071,737
Total	\$738,691	\$125,562	\$3,983,736	\$4,847,989

Total Federal: \$430,764**Total In-kind: \$325,587**

Center for Flexible Hybrid Medical Device Manufacturing (FlexMed)

Binghamton University

Mark Poliks, Director

Technology Focus

Medical Manufacturing/Biomedical & Devices

Importance to NYS

The FlexMed CAT provides economic growth for New York State by serving as a “synergy center” focusing on cost-effective product development and pilot manufacturing activities. FlexMed works with industry partners of all sizes – from large integrators and manufacturers to small start-ups – across New York State to design, develop and manufacture tools, processes, materials and products in the health device space, based on flexible-hybrid electronics technologies.

Description of Achievements

During the 2020-2021 program year, staff made good progress toward a number of project and contract activities. Staff conducted work on 17 flexible hybrid electronics projects with value in excess of \$18.6M comprised of a combination of federal funding, NYS matching contributions, and industrial partner funding. Staff also worked on several COVID-related initiatives, including a collaborative project with the University of Rochester School of Medicine to develop methods to test for the SARS-CoV-2 and other biological agents. The FlexMed CAT also undertook several workforce development initiatives, including the expansion of FlexPro Workshop offerings in New York State. The FlexPro program, developed by NextFlex team, is hands-on technical training designed to immerse professionals into the design and manufacturing processes associated with flexible hybrid electronics (FHE). The FlexMed CAT also conducted a Workforce Training Workshop co-sponsored with the Cornell NanoScale Facility which brought together NYS industry, government and universities to discuss needs for workforce training and how academia can help. Finally, FlexMed CAT continued to actively interact with industry participants via the MedTech and Fuzehub organizations in an effort to identify and understand the needs of and connect with NYS product developers.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
1	42	\$2,250,000	\$1,120,000	\$6,337,880	\$3,350,000	\$866,700	\$13,924,580

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
15	14	3	15

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
FlexMed graduate student awarded 2 nd place in the Innovators of the Future competition.	February 2021	The competition was part of the 20 th Annual FLEX Conference in February 2021.	https://www.semi.org/en/blogs/technology-trends/university-students-help-shape-flexible-electronics-innovation-at-flex-conference-2021
FlexMed team won first place in an Additive Manufacturing competition.	December 2020	This competition was sponsored by the Department of Defense.	https://discovere.binghamton.edu/news/additive-7910.html
Two FlexMed-affiliated industry researchers were named as 2020 NextFlex Fellow Award winners.	July 2020	NextFlex	https://www.businesswire.com/news/home/20200228005108/en/NextFlex-Presents-Four-Flexible-Hybrid-Heroes-With-the-2020-Fellow-Award

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Co-Investigator	Source	Amount	Duration (yrs)	Summary
Application-Responsive Encapsulation Processes for FHE Devices	Mark Poliks, Binghamton University	Stephen Gonya, Lockheed Martin	NextFlex	\$85,000	1	To identify design rules to guide future FHE encapsulation solutions.
Prediction of Infectious Disease Evolution in Ambulatory Patients through Continuous Health Assessment	Mark Poliks, Binghamton University	Azar Alizadeh, GE	NextFlex	\$135,000	1	Development of a wearable, single-use, clinical grade, multi-sensor device for continuous tracking of respiratory infectious illness progression.
Circuit Fabrication and Development on Novel Thin-Film Crystalline Silicon on Flexible Molybdenum Foil	Graeme Houser, Lux Semiconductors	Mark Poliks, Binghamton University	NSF	\$145,000	1.5	Development and fabrication of peel-and-stick wireless sensors for use in medical devices.

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

The FlexMed CAT partnered with NextFlex to expand their FlexPro Workshop offerings in New York State. The FlexPro program is hands-on technical training designed to immerse professionals into the design and manufacturing processes associated with flexible hybrid electronics (FHE), as well as familiarize participants with applications and benefits of FHE technology. The program is customizable in terms of focus and length, ranging from four hours to two days depending on desired outcomes. FlexMed will begin offering the FlexPro Workshops at Binghamton University once the COVID restrictions are fully lifted in labs. These workshops will

leverage FlexMed’s advanced microelectronics manufacturing research center, allowing participants to explore the application of roll-to-roll processing methods, including large-area photolithography, to flexible electronics and displays.

Commercialization

During the 2020-2021 program year, FlexMed CAT worked with several industry-sponsored projects addressing company interests: GE Global Research, Corning, Inc., Lockheed Martin Owego, Universal Instruments, 2M Technology, and TTM Technologies. Forthcoming partners include Lux Semiconductors, CathBuddy, Inc., Advanced Fetal Monitoring, and TapeCon, Inc. Second, FlexMed CAT staff and students were closely engaged with the NextFlex Manufacturing USA consortium and its participating New York State companies who are interested in flexible electronic medical device manufacturing. Third, the team actively participated in both MedTech and Fuzehub meetings and events in an effort to identify and understand the needs of and connect with NYS product developers. Finally, the team worked closely with Binghamton’s S3IP and IEEC to develop new opportunities for interested companies.

Invention Disclosures /Patents

None

Start-up Companies Formed

Company Name	City	Product/Service	Sector
Advanced Fetal Monitoring, LLC	Manlius, NY	This start-up company has developed and patented a wearable, wireless ultrasound device that is able to collect time-sensitive imaging data which can be fed into computer vision based artificial intelligence to predict deadly uterine ruptures and unexpected mass hemorrhages before they happen. FlexMed provided STTR application assistance for NSF funding to further R&D of the device design and will work with the company to provide prototype manufacturing and safety testing.	Medical device manufacturing

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

During the 2020-2021 program year, FlexMed worked with several start-up companies to help them address design review and new product introduction evaluation. **CathBuddy, Inc.**, (Woodbury, NY), which is developing a catheter system comprised of a reusable, RFID-tagged catheter system, to develop a proposal for submission to the Department of Defense Spinal Cord Injury Research Program. Staff also provided evaluation and testing services to **Lux Semiconductors** (Albany, NY) which has developed a new class of electronics called System-on-Foil, designed to overcome current limitations of printed circuit boards and semiconductor packaging technologies. FlexMed has been working closely with **Tapecon, Inc.** (Buffalo, NY) to assist them in the fabrication of an FHE wearable temperature sensing device which will utilize screen-printed circuits and benefit the company as both a learning tool and a technology demonstrator. Staff also provided pilot manufacturing, testing and evaluation services to **Heat Inverse** (Ithaca, NY), which has developed a photonic metamaterial that gets cold with none of the energy input or waste heat associated with conventional cooling; and **SunDensity** (Rochester,

NY) which has developed an innovative Photonic Smart Coating (PSC) technology that improves the efficiency of solar panels. Furthermore, FlexMed staff provided proposal development assistance to **Organic Robotics Corporation** (Rochester, NY), a start-up company which has developed sensors that can bend and twist with the human form for motion capture, muscle activity and respiration measurements. Staff also provided proposal development support to **Assistance in Motion** (Ithaca, NY), **Advanced Fetal Monitoring, LLC** (Manlius, NY), and **Triton Biodevices** (Syracuse, NY).

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	NYSTAR Funding	Matching Funds		Total
		Company Cost Share	Other Sources	
Salaries & Fringe	\$275,637	\$30,856	\$120,330	\$426,823
Indirect Costs	\$41,346	\$7,714	\$23,427	\$72,487
Equipment	\$0	\$0	\$0	\$0
Materials & Supplies	\$847	\$434,246	\$0	\$435,093
Tuition	\$0	\$1,601	\$0	\$1,601
Travel	\$0	\$0	\$0	\$0
Subcontractors	\$0	\$0	\$0	\$0
Other	\$233,097	\$0	\$0	\$233,097
Total	\$550,927	\$474,417	\$143,757	\$1,169,101

Total Federal: \$0

Total In-kind: \$0

Integrated Electronic Engineering Center (IEEC)

Binghamton University

S.B. Park, Director

Technology Focus

Electronics Reliability and Testing.

Importance to NYS

The IEEC performs research to better understand the materials used, components, interconnect technologies, substrates and assembly performance and reliability through the range of uses from wearable / flexible assemblies, power electronics, server platforms, consumer devices and other market sectors. The IEEC has also extended the research into smart manufacturing of these devices through the use of the Smart Electronics Manufacturing Laboratory where research is conducted to use AI and machine learning to allow automatic adjustment and optimization of manufacturing parameters to product a better end product.

The IEEC works with large and small companies to improve products. It also sponsors an industry consortium to perform research that is applied to their products. These efforts result in economic impact to NYS in terms of new and retained jobs as well as increased revenues to these companies.

Description of Achievements

The IEEC continued its work with industry in 2020-21. The faculty and staff continued to use the university's laboratories to assist companies in product development and improvement.

Due to COVID-19, physical interactions with member companies have been limited. Contact with IEEC members and other New York State companies was maintained on-line. The IEEC joined the battle against COVID-19 by using our laboratory equipment and expertise. Benson Chen, the associate director, volunteered for many projects.

IEEC won a SAMRI (SUNY-Applied Materials Research Initiative) award. This is a collaborative research initiative between SUNY and Applied Materials for multi-year projects. IEEC submitted two white papers and won a three-year long "Real 3D Packaging Solution and Enablement" project.

The IEEC is constantly improving the course content on electronics packaging courses offered by Watson College. The introductory course was offered online in Fall 2020. Five graduate students took the course, and we received a number of inquiries from industry interested in offering the course to their new engineers.

IEEC partnered with Purdue, Georgia Tech, Arizona, and Vanderbilt University to win a 3-year, \$460,000, project from the Department of Defense for domestic microelectronics workforce development. The goal is to develop an educational module on microelectronics packaging for undergraduate students. In the Spring of 2021, the developed course was offered in all five institutions and students who took the class were given the opportunity for summer internships at National Labs. In Binghamton, six students participated.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
41	3	\$32,029,623	\$1,274,000	\$57,022	\$145,790	\$965,000	\$34,471,435

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
35	27	22	70

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
SB Park, Regional Contributions Award	Fall 2020	2020, IEEE Electronic Packaging Society, Region 1-7 & 9	https://eps.ieee.org/awards/regional-contributions-award.html
Daryl Santos, Paul A. Robert Award	Fall 2020	American Society for Quality, Section 205	
Benson Chan, IEEE Senior Member Grade	November 23, 2020	IEEE	

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (yrs)	Summary
Develop and Demonstrate a True 3D Packaging	Dr. Bahgat Sammakia, Mechanical Engineering	SUNY Applied Materials Research Institute	\$50,000	1	This project will develop methodology and understanding for a true 3D package development

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

The IEEC has offered industry-oriented courses for over two decades. The newly renovated courses on Electronic Packaging, WTSN582 and WTSN583, are offered in the Fall and Spring semesters respectively. Engineers from member companies were taking these courses remotely from even before the COVID-19 pandemic. The IEEC's mini modular courses on topics such as failure analysis, have developed from these Watson School courses.

Member companies receive custom education, training, and technical support. A funded project provided finite element modeling training. In conjunction with the S3IP's Analytic and Diagnostics Lab, the IEEC offers classes in tool operation.

Commercialization

Companies come to the IEEC to test potential products. A New York company worked with the IEEC to develop products to address the limitations of current electromechanical and solid-state switches. The IEEC staff

evaluated the composition and structure of their product’s switch anchors. Product improvement resulted in cost avoidance totaling \$2,500,000.

The IEEC and its industry consortium (including IBM, GE, Lockheed, Corning and BAE) funded 10 research projects in 2020-21. These projects were chosen by the member companies to complement their own research. Research projects sponsored by IEEC full member companies lead to savings and product developments within the company.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Research Sponsor	Description
Low temperature, Nanostructured Ceramic Coatings (Patent # 10,828,499)	Prof. Junghyun Cho, Mechanical engineering	Not attributable to a specific project. Developed from several projects	Development of a substrate coating, that can be treated to generate free radicals, to assist in degradation of surface deposits
Multilevel Bridge Tapped Resonant Converter	Prof. Pritam Das, Dept. of Electrical & Computer Engineering	Not attributable to a specific project. Developed from several projects	Development of an integrated single stage AC-DC converter with reduced number of semiconductors
Tunable Adsorption and Wetting	Sunil Dube	Not attributable to a specific project. Developed from several projects	This disclosure relates to the field of controlling the surface properties of a material particularly relating to wetting and adsorption.

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

The IEEC continued aiding small businesses in their electronics needs. Smart Electronics Manufacturing Lab (SEML) is available to small companies in need of assembly services for their prototyping and can assist companies looking to build 5-10 prototypes. It is not affordable for many of these companies to get this service done with other companies or organizations. IEEC uses this opportunity to train students in SMT skills which can help them get jobs in the electronics manufacturing field. The IEEC also offers Associate Membership to small companies, Associate Membership gives members \$500 credit in the IEEC labs. IEEC staff regularly attend FuzeHub events and have been a major supporter of their manufacturing forums. This introduces the IEEC to smaller companies that may not know how we can help them. The IEEC is also a supporter to other NY State assets when it comes to electronics, we provide mentorships to companies out of the CNY Biotech Accelerator to help these startups with guidance in electronics packaging designs, supplier sources and testing.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$528,902	\$374,007	\$652,261	\$1,555,170
Indirect Costs	\$79,335	\$82,613	\$156,351	\$318,299
Equipment	\$0	\$0	\$7,759	\$7,759
Materials & Supplies	\$20,574	\$22,651	\$65,475	\$108,700
Tuition	\$0	\$48,768	\$32,181	\$80,949
Travel	\$9,065	\$0	\$3,909	\$12,974
Subcontractors	\$6,817	\$0	\$0	\$6,817
Other	\$9,434	\$68,402	\$70,610	\$148,446
Total	\$654,127	\$596,441	\$988,546	\$2,239,114

Total Federal: \$163,563**Total In-kind: \$0**

Center for Advanced Materials Processing (CAMP)

Clarkson University

Devon Shipp, Director

Technology Focus

Advanced Materials & Materials Processing

Importance to NYS

The mission of the CAMP at Clarkson University is to achieve excellence in applied research and technology development in advanced materials through collaborations with companies, industries, and entrepreneurs. Such alliances will advance innovation, assist in developing new products, and solve manufacturing challenges, and thus promote economic development in New York State and promote the growth of North Country and New York State industries.

Description of Achievements

CAMP achieved a number of accomplishments during the period July 1, 2020 – June 30, 2021, even though the pandemic was still restricting aspects of operations. Some notable items are:

- Worked with NY companies to develop novel materials and processes to enhance their competitiveness. For example:
 - Continued enhancement of CAMP’s international reputation in *chemical-mechanical planarization* (CMP), which is a process that typically involves using a highly dispersed particle slurry to polish semiconductor wafers during electronic chip manufacturing. Clarkson has expanded its investment in CMP through a cluster hire of multiple faculties across campus that have expertise in CMP and supporting technologies.
 - Supported DMAX Plasma, a start-up based in Potsdam NY, in the development of technologies to remove PFAS (per- and polyfluoroalkyl substances) compounds from the environment.
 - Corning Incorporated worked with CAMP faculty to develop electrically activated molecular assemblies which are original chemicals that can be used to make smart windows.
- Completed a strategic planning process.
- Instituted a new “CAMP Graduate Fellowship” award, which provides initial funding for projects that are of demonstrated interest to industry.
- Held a two-day Technical Symposium on October 19 – 20 for university and industrial partners. The program included access to on-line research presentations that highlighted CAMP faculty and student’s expertise and capabilities. The highly successful symposium featured a keynote lecture by world-renowned materials scientist/engineer Joseph DeSimone, Stanford University professor and founder of Carbon 3D, a leading company in 3D printing innovation.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
38	98	\$267,030	\$1,179,499	\$1,657,039	\$5,702,219	\$754,683	\$9,560,470

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
13	14	3	10

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
Çetin Çetinkaya Appointed Michael E. '78 and Janet Jesanis Endowed Chair at Clarkson University	10/14/2020	Clarkson University	https://www.clarkson.edu/news/cetin-cetinkaya-appointed-michael-e-78-and-janet-jesanis-endowed-chair-clarkson-university
Selma Mededovic Thagard Appointed March Professor at Clarkson University	10/14/2020	Clarkson University	https://www.clarkson.edu/news/selma-mededovic-thagard-appointed-march-professor-clarkson-university
Clarkson Mechanical Engineering Professors, Students Win American Welding Society Award	11/4/2020	American Welding Society	https://www.clarkson.edu/news/clarkson-mechanical-engineering-professors-students-win-american-welding-society-award
Stanford Ranks Clarkson Researchers as Top Scientists in the World	12/31/2020	Stanford University	https://www.clarkson.edu/news/stanford-ranks-clarkson-researchers-top-scientists-world
Clarkson Graduate Student Receives American Chemical Society Award	2/25/2021	American Chemical Society	https://www.clarkson.edu/news/clarkson-graduate-student-receives-american-chemical-society-award
Clarkson Professor Named Associate Editor of Chemical Engineering Journal	2/19/2021	Chemical Engineering Journal	https://www.clarkson.edu/news/clarkson-professor-named-associate-editor-chemical-engineering-journal
Clarkson Professor Recognized for Career Contributions in Polymer Chemistry	3/24/2021	Royal Society of Chemistry (U.K.)	https://www.clarkson.edu/news/clarkson-professor-recognized-career-contributions-polymer-chemistry
Clarkson Students Awarded National Science Foundation Graduate Research Fellowships	4/2/2021	National Science Foundation	https://www.clarkson.edu/news/clarkson-students-awarded-national-science-foundation-graduate-research-fellowships
Clarkson University Junior Named 2021 Goldwater Scholar	4/6/2021	Goldwater Scholarship and Excellence in Education Foundation	https://www.clarkson.edu/news/clarkson-university-junior-named-2021-goldwater-scholar
Clarkson Professor Named Fellow of the American Society of Mechanical Engineers & Fellow of the American Welding Society	4/13/2021	American Welding Society	https://www.clarkson.edu/news/clarkson-professor-named-fellow-american-society-mechanical-engineers-fellow-american-welding

Clarkson Professor Receives Excellence in Research & Scholarship Award	5/12/2021	Clarkson University	https://www.clarkson.edu/news/clarkson-professor-receives-excellence-research-scholarship-award
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Federal or Not-for-Profit Grants Awarded

Project	PI	Co-Investigator	Source	Amount	Duration	Summary
102016	Ajit Achuthan	Sean Banerjee Natasha Banerjee	NSF	\$16K of \$278K total	1 year	This project proposes the development and commercialization of a new mechanical testing system building on some of the technical innovations derived from a previous NSF funded research
102187	Marcias Martinez	Craig Merrett Sumona Mondal	ONR	\$172,837 of \$803,272 total	5 yrs	The vision to this project is the development of a static strength prediction model that combines in-situ NDI and SHM techniques with physics-based modelling as a means of developing a digital twin framework for static strength prediction.

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

CAMP offers user training for all shared user instrumentation, many of which are used for CAMP-industry projects. Frequently requested instruments include scanning electron microscopy, transmission electron microscopy, atomic force microscopy, dynamic mechanical analysis, and X-ray diffraction. CAMP's instrument workshop, which is open to graduate students, faculty, and industrialists, was temporarily suspended during 2020-2021 due to COVID. A highly successful technical symposium was hosted October 19–20, 2020, for university and industrial partners, and included access to on-line research presentations that highlighted CAMP expertise and capabilities, and keynote lecture by world-renowned materials scientist/engineer Joseph DeSimone of Stanford University.

Commercialization

None

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Research Sponsor	Description
IP21-02	Artem Melman	Evgeny Katz, Paolo Bollella	N/A	Chemical and biochemical reactions catalyzed by enzymes, DNAzymes, Nanozymes, and other catalytic species with the catalytic activity dependent on pH value of solutions and proceeding at a solid/liquid interface are switched ON/OFF or tuned to a desirable reaction rate by changing a local (interfacial) pH value.
Patent 10,934,827	Fiona Laramay	Michelle Crimi	SERDP	Ex-situ remediation technology has been the primary method for treating groundwater contaminated with poly- and perfluoroalkyl substances. These pump and treat systems are expensive and energy intensive. To address the need for effective in situ remediation technology, a reactor to be used within a subsurface well has been developed. The reactor allows for contaminant destruction methods such as ultrasound to be used in situ. This invention eliminates the need for pumps and aboveground treatment. In addition, it produces no waste products that must be treated further.
Patent 11,027,990	Selma Mededovic	Thomas Holsen	U.S. Air Force	An electrical discharge plasma reactor system for treating liquid, the reactor system including: a reactor chamber configured to hold the liquid and a gas; a discharge electrode disposed within the reactor chamber, wherein the discharge electrode is disposed within the gas; an opposing electrode disposed within the gas within the reactor chamber; one or more gas diffusers disposed within the liquid, wherein the one or more gas diffusers is configured to induce the generation of a layer of foam on a surface of the liquid in a plasma-contact region; and a power supply connected to the discharge electrode and/or the opposing electrode, the power supply configured to induce the discharge electrode and the opposing electrode to generate plasma in the plasma-contact region.
IP21-09	Selma Mededovic	Tom Holsen	N/A	Removal of dissolved organic compounds from drinking water, wastewater, and contaminated groundwater is a standard process in water treatment. Conventionally, methods for the removal of these organics include physical removal or the addition of chemical oxidants. These physical processes can be energy intensive, and the addition of chemicals can lead to undesirable byproducts. Gas-phase electrical discharge plasmas generated upon the surface of water have been shown to degrade dissolved surfactant-like organic compounds with high energy efficiency and no chemical additives because they can be transported by bubbles to the liquid

				<p>surface where the plasma generated radicals are produced. However, degradation of non-surfactant compounds is slow as these chemicals tend to remain in the bulk liquid phase and are not exposed to the plasma generated radicals.</p> <p>A plasma spinning disc reactor (PSDR) has the ability to create a thin film of liquid across the surface of a disc. When liquid is supplied to the center of a rotating surface, the liquid flows to the surface's edge as a film. Initially, the liquid is accelerated tangentially by the shear stress at the liquid/disc interface. As the liquid reaches its angular velocity, it moves outward as a thinning film under centrifugal force. This thinning will allow the plasma-generated radicals to penetrate the entirety of the liquid layer. Furthermore, the stresses imposed on the liquid layer as it spreads across the disc lead to mixing of the contaminant and the radicals</p>
IP21-10	Artem Melman	Evgeny Katz, Daniel Massana Roquero, Paolo Bollella	N/A	<p>The high porosity of calcium alginate hydrogel was controlled by its treatment with polyvinyl alcohol followed by cross-linking with diboronic acids which blocks larger pores in calcium alginate. Low molecular weight (11-31 kDa) polyvinyl alcohol selectively diffuses into larger pores of calcium alginate hydrogel and the subsequent cross-linking with 1,3-benzenediboronic acid is highly efficient providing stoichiometry of one 1,3-benzenediboronic acid per four OH groups of polyvinyl alcohol. The cross-linking blocks larger pores in calcium alginate hydrogel decreasing leaching of model bovine serum albumin, insulin, and myoglobin proteins physically entrapped in calcium alginate hydrogel by 20-30 fold. Internal pore blockage was confirmed by scanning electron microscopy (SEM) and surface pore closure by liquid atomic force microscopy (AFM).</p>

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

In FY 20-21, CAMP helped Ducted Wind Turbines with funding their second SOW under the contract, helping the company to increase their competitiveness in the wind energy market. CAMP also continued facilitating between Tapecon and Clarkson faculty to develop printed sensor technology. Discussions are still ongoing in FY22 in an attempt to fine-tune the areas of collaborations. CAMP began frequent and lengthy discussions with GCLIProw, a company that wants to move from thermomolding to 3D printing athletic shoes and helped them understand the properties of their current material and guided them on how to develop the technology.

Potters Industries began a number of consultation meetings to discuss how CAMP expertise can help with understanding fracture mechanics of their glass source material, ultimately defining a project that is going on at present. Polaris Renewables started working towards defining a collaboration with CAMP resulting in Polaris Renewables becoming a member of CAMP. Atlantic Testing Labs consulted with CAMP on the feasibility to develop their own vibracore machine as the commercially available one is phased out. A solution was defined, and funding of the project is pending. CAMP also assisted the local IDA in attracting Illumisoft Lighting, a Canadian Company, to St. Lawrence County with expertise they required to get certification of their product. CAMP offered an array of solutions, and a project was approved but funding could not be secured.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$480,818	\$331,384	\$333,331	\$1,145,533
Indirect Costs	\$72,123	\$49,707	\$49,037	\$170,867
Equipment	\$10,774	\$9,215	\$0	\$19,989
Materials & Supplies	\$65,711	\$103,040	\$51,231	\$219,982
Tuition	\$456	\$41,589	\$31,520	\$73,565
Travel	\$103	\$796	\$1,091	\$1,990
Subcontractors	\$0	\$0	\$0	\$0
Other	\$12,719	\$13,274	\$345,806	\$371,799
Total	\$642,704	\$549,005	\$812,016	\$2,003,725

Total Federal: \$0

Total In-kind: \$0

Center for Life Science Enterprise

Cornell University

Matt DeLisa, Director

Technology Focus

Life Sciences

Importance to NYS

In alignment with Cornell University's land grant mission, the Center for Life Sciences Enterprise (CLSE) provides transformative opportunities in New York's agricultural, veterinary, medical and engineering sectors. The CLSE offers business services for all stages of the company start-up life cycle, from initial concept to securing venture capital funding.

Description of Achievements

The CLSE supported development of promising biotechnologies through matching grants to Cornell researchers who partnered with life sciences companies in human medicine and agriculture, in the areas of human and animal health, agriculture, and nutrition.

The CLSE also provided industry education and support through the Entrepreneurship@Cornell summer internship program, which connects Cornell students with NYS life sciences companies for hands-on internships in all areas of product and business development. Eight interns worked with five biotechnology companies and received matching funds from the CAT program for their internship support.

The Kevin M. McGovern Family Center for Venture Development in the Life Sciences provided intensive business incubation for 14 NYS life sciences companies, including Ascribe Biosciences, Dimensional Energy, Ecolectro, Esper Biosciences, Inso Biosciences, Ionica, Kanvas, mPOD, ORLink, Renerva, Repairogen, Sonder, VitaScan, and Zymtronix. The companies were awarded over \$3.6 million in grant funding to their organizations and employed 71 people in professional and technical positions.

The Biotechnology Resource Center (BRC), in partnership with the CLSE as part of the Cornell Institute of Biotechnology, provided scientific services and expertise to four NYS companies through the BRC Genomics, Imaging, and Proteomics core facilities.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
0	0	\$101,000	\$0	\$500,000	\$586,000	\$0	\$1,187,000

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged w/ companies
20	4	0	8

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (yrs)	Summary
Research PGR: Enhancer Discovery and Design in Agriculturally Important Crop Plants	Edward Buckler	National Science Foundation	\$90,941	3	Integrating crop plan data across platforms and developing machine learning models
Instrumentation for Application Ionlyme, A Sers-based Lyme disease assay	Louis Walcer	NYS – FuzeHub	\$35,000	3	Support instrumentation purchase for Ionica Sciences
Top-Down Proteomics in Support of Proteogenomics of Bacterial Plant Pathogens	Sheng Zhang	USDA-ARS	\$49,509	3	Develop protocols and methods for the application of top-down proteomics to bacteria
Improving Maize and Sorghum Efficiency Using Grass Diversity and Computational Modeling	Cinta Romay	USDA-ARS	\$2,461,650	2	Increase knowledge of crop diversity and applications for plant breeding
Developing Automatable Platforms for Sample Prep in Genomic Analysis	Louis Walcer	NYS – FuzeHub	\$50,000	1	Inso Sciences’ development of automatable platforms for genomic analyses sample preparation

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

In partnership with the Entrepreneurship@Cornell program, conducted a summer internship program with NYS startup companies in the life sciences fields, including agriculture and biofuels, industrial safety, and laboratory product and service technology development. The interns gain invaluable industry experience and training, while the small company gains Cornell students’ expertise and staffing support they could not otherwise receive. The following companies participated in 2021 - Capro-X, Harrick Plasma, Iterate Labs Inc., MiTiGen, and Nova Sterilis.

Commercialization

The CLSE awarded matching grants to Cornell faculty and researchers, who partnered with NYS companies in medicine and agriculture to develop novel diagnostics and treatment. Walter De Jong and Neil Mattson worked with Ascribe Bioscience to develop a novel agricultural sustainability product. Diego Diel partnered with Natural Biologics to prevent viral disease in pigs and promote food security. Jere Haas and Joanna Fiddler, along with Vitascan, developed a diagnostic test for iron deficiency. Joe McFadden worked with Balchem on improving choline bioavailability and health.

Invention Disclosures /Patents

None

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

Reported in aggregate for confidentiality

Project	Principle Investigator	Co-Investigator	Company Partner	Royalty Income
				\$820,513

Small Business Assistance Provided

The McGovern Center, Cornell's business incubator for life sciences companies, focuses on accelerating research and development of client companies' technology and products, by assisting companies with developing business plans, securing investment, and strengthening management teams. The following small NYS-based businesses participated in the incubation program.

Ascribe Biosciences - <https://ascribescience.wordpress.com>

Develops agribiotech products to combat major crop pathogens without negative impacts on human health and the environment.

Dimensional Energy - <https://www.dimensionalenergy.net>

Converting waste carbon dioxide from industrial emissions into solar fuels and feedstocks.

Ecoelectro - <http://www.ecoelectro.com/>

Improving fuel cell performance, at lower cost thresholds.

Esper BioSciences, Inc. - <http://www.smallbizdev.cornell.edu/companies/esper-biosciences-inc>

Enabling improved, faster, and more portable DNA sequencing technologies.

Ionica Sciences - <http://www.ionicasci.com>

Rapid use diagnostic testing platform to detect Lyme disease, mosquito-borne diseases, and STIs.

MPod - <https://www.mpod.io/>

Provides diagnostic tools for infectious diseases, including COVID-19.

ORLink - <https://myorlink.com>

Cloud-based software that reduces surgical supply waste, makes operating rooms more efficient, and improves patient safety.

Renerva - <https://www.renerva.com>

Developing implantable technologies to improve nerve repair procedures.

Repaigen – <http://www.repaigen.com/>

Enhancing efficiency of skin's natural DNA repair process through protein inhibition technology.

Sonder Research X - <https://www.aufbauholdings.com/portfolio/sonder-research-x>

Developing diagnostics and therapeutics in ophthalmology and oncology.

VitaScan Technologies - <http://vitascan.me>

Smartphone enabled point-of-use diagnostic platform for micronutrients.

ZYMtronix - <http://www.zymtronix.com>

Nanoparticle delivery system for enzymes, with multiple commercial applications

In addition, the Biotechnology Resource Center (BRC) provided Imaging core facility services to small NYS businesses Ichor Therapeutics and SeeQC. The small NYS companies receiving assistance through the internship program include Capro-X, Harrick Plasma, Invictus BCI, Iterate Labs, MiTiGen, and Nova Sterilis.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	NYSTAR Funding	Matching Funds		Total
		Company Cost Share	Other Sources	
Salaries & Fringe	\$368,757	\$60,652	\$397,808	\$827,217
Indirect Costs	\$55,313	\$15,163	\$59,671	\$130,148
Equipment	\$0	\$0	\$0	\$0
Materials & Supplies	\$71,721	\$39,477	\$0	\$111,198
Tuition	\$17,858	\$14,750	\$0	\$32,608
Travel	\$1,305	\$0	\$0	\$1,305
Subcontractors	\$68,542	\$0	\$0	\$68,542
Other	\$136,476	\$41,475	\$418	\$178,368
Total	\$719,972	\$171,517	\$457,897	\$1,349,386

Total Federal: \$0

Total In-kind: \$0

Advanced Science Research Center Sensor CAT

City University of New York

Dr. Rein Ulijn, Director

Technology Focus

Sensor Technology

Importance to NYS

The [ASRC Sensor CAT](#) program leverages the high-tech instrumentation and scientific research expertise which compose CUNY’s Advanced Science Research Center (ASRC) in NYC, a state-funded facility with focus areas in: Nanoscience, Structural Biology, Neuroscience, Photonics, and Environmental Science. The program plays a vital role in funding early-stage, successful startups in serious need of continued academic support as they develop their tech (working prototypes). The CAT program is unique as it helps incentivize new startups to locate in NYC and bridge-the-gap between initial funding (private, SBIR/STTR, etc.) and further investment.

Description of Achievements

The new CAT’s achievements include of a range of new supported research collaborations together with the culmination of efforts to develop partnerships (internal and external to CUNY) to support founding its workforce development efforts. With the COVID-19 pandemic a major impedance to normal lab/research efforts, the CAT has continued to work developing stakeholder relationships and building a modern foundation within CUNY in the innovation and entrepreneurship space where the program can naturally exist to support its successful NSF iCorp program which develops early-stage ideas into new startups.

Currently, CAT has funded company projects (four in total) that have already made significant progress with their projects, marked be prototype deliverables, provisional patents, and successful outside funding awards. Direct hand-holding from the CAT supporting these companies as they do work in various labs, submit grant proposals, and pitch to investors has not only enabled the build of strong relationships with these companies with goals to expand their projects and student inclusion, but allowed the CAT to explore its value proposition and areas of expertise for future program marketing purposes. The goal, like other successful long-running CAT programs in the state, is to define what our program specifically excels at and build a team of our experts within our center/organization with proven examples that they can successfully collaborate with industry.

Additionally, in order to increase awareness and lower the cost-bar to entry to ASRC, the CAT has also created a new two-step funding mechanism, called *Jump Start*, which supports startups proof-of-concept studies with ASRC core facilities, with the goal of leading to longer-term funded collaborations.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
3	0	\$17,000	\$83,442	\$1,639,077	\$70,000	\$0	\$1,809,519

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
10	4	1	10

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

None

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

Partnerships of note have been built during this period with CUNY's Baruch College where the Zicklin School of Business together with Field Center for Entrepreneurship, Small Business Development Center, and CUNY Startup organizations reside. Together with the CAT, leaders from these entities are slated to co-teach a first-of-its kind course in the Fall '21 focused on STEM Entrepreneurship – providing CUNY STEM graduate students a focused course where they can learn and explore taking Intellectual Property from the Lab to the Marketplace (creating a pipeline synergistic to CUNY iCorp program).

The CAT formed a partnership with NYC EDC's *LifeSciNYC* program to co-fund summer internships. Successful pilot of this partnership led to the CAT co-funding CUNY student (nine total) internships in the summer of '21.

The CAT began an approach of two major corporations in NYS (Estee Lauder and Global Foundries) to discuss establishing a relationship focused around support of their interests in developing CUNY-student relationships and pipeline and career skills development. Discussions will continue in the areas of creation of Graduate-Level Fellowships and potential for core curriculum modification.

Commercialization

The CAT finds at CUNY a strong opportunity for impact in supporting startups in NYC early-stage commercialization of hard tech. The initial companies supported by the new CAT are in the early-stages of developing bio-related sensing platforms. Three of four startups are spin-outs of CUNY from a range of a campuses (City College, College of Staten Island, and Hunter College) involve the creation of new patents for their technology to be shared by the company and CUNY. CUNY currently has limited support in its Technology Commercialization Office (TCO) and the CAT looks to navigate leadership support for modernizing and expanding its capabilities to support scale-up of the innovation ecosystem.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Licensing Partner	Research Sponsor	Description
Serial No. 17/708,327	James Sholtz	N/A		VYIR, INC (co-sponsor ASRC Sensor CAT)	Design of ultra-low cost infrared camera for various applications from self-driving cars to military weapons deployment
Serial No. 16/519,652	Dr. Adam Braunschweig	K,Palanichamy; M.F. Bravo	CUNY	Dultech, LLC (co-sponsor ASRC Sensor CAT)	Biorecognition element called 'synthetic carbohydrate receptors' (SCRs) that bind carbohydrates.

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

The CAT provides small-business support by internally searching for and building partnerships within CUNY to solve tech-related problems. The CAT business development director has been working with FuzeHub to manage requests for such support. The CAT has already worked with such companies to submit two grant proposals for FuzeHub Manufacturing Grants (50K) to support the foundation of an industry-partnership. Additionally, the CAT supports small businesses not only in tech development, but potential to work with CUNY student interns. The program sees a strong need and value for such workforce development and looks to develop its own mechanisms for co-funding such support, in similar form to LifeSciNYC, but with focus of graduate-level STEM students.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	NYSTAR Funding	Matching Funds		Total
		Company Cost Share	Other Sources	
Salaries & Fringe	\$318,822	\$104,046	\$164,766	\$587,634
Indirect Costs	\$47,823	\$26,011	\$19,045	\$92,879
Equipment	\$0	\$0	\$0	\$0
Materials & Supplies	\$13,691	\$32,653	\$0	\$46,344
Tuition	\$0	\$0	\$0	\$0
Travel	\$0	\$5,000	\$0	\$5,000
Subcontractors	\$0	\$0	\$0	\$0
Other	\$0	\$0	\$0	\$0
Total	\$380,336	\$167,710	\$183,811	\$731,857

Total Federal: \$0

Total In-kind: \$0

Center for Advanced Technology in Telecommunications

New York University, Polytechnic University

Shivendra Panwar, Director

Technology Focus

Telecommunications and Information Technology

Importance to NYS

The Center for Advanced Technology in Telecommunications (CATT) at New York University; with support from Columbia University, focuses on information technology and telecommunications. The CATT conducts applied research with industry as well as industry-oriented education and training, in three main areas: wireless networks, network security and network applications.

Description of Achievements

The New York Tech economy continues to grow with Google, Facebook, Apple and Amazon continuing to expand their footprint in New York City, even in the middle of the pandemic. The availability of deep pools of potential employees, convenient public transport and last, but not the least, the research and training available at area universities like NYU and Columbia University, have facilitated this trend.

NYU Wireless has established itself as the leading center for fifth generation (5G) cellular wireless research in the US. There is no US company in this area: Nokia and Ericsson, the two major players in the US, are headquartered in Finland and Sweden, respectively. The CATT is well placed to lead this effort when funding is in place for a national effort. Investing in the continued success of CATT and NYU Wireless, NYU Tandon will be hiring a new tenure track faculty member in this area during the next academic year.

CATT's cybersecurity faculty have pioneered a graduate-level online cybersecurity program. The NYU Cyber Fellows program offers scholarships that result in one of the lowest-cost online master's degrees in the country, at \$18,000, and develops highly skilled technical graduates ready to step into the growing cybersecurity gap. The starting salary of graduates is expected to be about \$120,000. CATT is working to get Federal government employees from a national security agency into this program.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
6	1	\$1,371,204	\$850,000	\$3,297,414	\$382,082	\$0	\$5,900,700

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
21	21	5	25

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Co-Investigator	Source	Amount	Duration (yrs)	Summary
Transportation Gaps and Disability-Related Unemployment: Smarter Cities and Wearables combating Commuting Challenges for the Visually Impaired	John Ross Rizzo	Yao Wang, Maurizio Porfiri, Sundeep Rangan, Yi Fang Lorna Thorpe	National Science Foundation	\$1,499,038	October 1, 2020- September 30, 2023	Study low-vision behavior and develop more powerful wearables that can handle data-intensive processing, enabling parallel functionality. The project will afford VIS4ION, a revolutionary wearable platform
Algorithmic Tools for Proximity Problems among Curves	Boris Aronov		National Science Foundation	\$399,082	April 1, 2021- March 31, 2024	Designing effective algorithms and data structures with provable performance guarantees for fundamental problems
MLWiNS: Resource Constrained Mobile Data Analytics Assisted by the Wireless Edge	Siddharth Garg	Yao Wang, Elza Erkip	National Science Foundation	\$350,000	July 1, 2020- June 30, 2023	Learn “analytics-aware” compression schemes from data by training low-complexity compressor deep neural networks (DNNs) that execute on mobile devices and achieve a range of transmission rate and analytics accuracy targets
RAPID: Visualizing Epidemical Uncertainty for Personal Risk Assessment	Enrico Bertini	Rumi Chunara, Lace Padilla	National Science Foundation	\$191,696	August 1, 2020- July 31, 2021	Test people understand currently available COVID-19 data visualizations and create communication guidelines based on these findings
Student Travel to for 2020 Conference on Decision and (GameSec)	Quanyan Zhu		National Science Foundation	\$8,000	July 1, 2020- June 30, 2022 (Estimated)	Supports student travel for 10 students to attend the 2020 Conference on Decision and Game Theory for Security (GameSec)
Secure and Trustworthy Cyberphysical Microfluidic System	Ramesh Karri		National Science Foundation	\$542,431	May 1, 2021- April 30, 2024 (Estimated)	Ensure the security and trustworthiness of cyber-physical microfluidic systems

Interdisciplinary and Cross-Layer Research Agenda for the National Wireless Spectrum Center	Dipankar Raychaudhuri	Theodore Rappaport, Marwan Krunz, Henning Schulzrinne, Gil Zussman	National Science Foundation	\$300,000	August 15, 2020- July 31, 2021 (Estimated)	Focus of a spectrum research SII-Center goes beyond 5G, IoT, and other existing or forthcoming systems and technologies to chart out a trajectory to ensure US leadership in future wireless tech
AI-based modeling and control for traffic flow systems	Zhong-Ping Jiang		UT-Battelle, LLC c/o Oak Ridge National Laboratory	\$40,000	May 10, 2021– March 31, 2022	Aims to apply AI-based modeling and control using real-time data to construct an AI-based closed-loop coordinated signal control systems for multiple intersections together with routing strategies for even distribution of traffic flows
Chip Fabrication and Instrumentation for Hardware Trojan Detection	Farshad Khorrami		Office of Naval Research (ONR)	\$359,486	May 1, 2021- April 30, 2022	Build on an on-going ONR-funded research project to detect hardware Trojans based on the physical phenomenon of short-term aging
NeTS: Small: Multi-path Multi-tier Dynamic Streaming of 360 Degree Video	Yong Liu		National Science Foundation	\$16,000	April 23, 2021- September 30, 2021	Supports two undergraduate students to work on our 360 degree video streaming project in summer 2021. The project is on the development, deployment, and evaluation of the proposed 360-degree streaming system
DNN for Radar perception	Anna Choromanska		NXP USA, Inc	\$215,000	April 12, 2021- July 31, 2022	Engagement between NXP and NYU is to investigate applications of Deep Neural Networks (DNN) for Radar perception. The goal of the project is to enable low SWaP AI hardware design for Radar perception in autonomous driving
CAREER: From Analysis to Practice: Landscape-driven Optimization Algorithms for Deep Learning	Anna Choromanska		National Science Foundation (NSF)	\$101,516	March 15, 2021- February 28, 2026	Aims at overcoming this limitation by describing universal properties of Deep learning (DL) systems that hold across a variety of DL models and data sets
Advanced Dissolution-based Monolayer	Davood Shahrjerdi		Brookhaven National Laboratory	\$104,347	March 15, 2021- May 31, 2022	The Center for Functional Nanomaterials (CFN) at Brookhaven National Laboratory

Exfoliation/Transfer Methods						(BNL) has ongoing funded work to develop the Quantum Materials Press (QPress), a first-of-its-kind cluster tool that aims to streamline and automate the workflow associated with forming two-dimensional (2D) materials via exfoliation, transferring these to new substrates, and forming layered heterostructures of these ultrathin materials
CAREER: A Peer-to-Peer Approach to Electricity Supply	Yury Dvorkin		National Science Foundation	\$104,733	February 16, 2021- February 29, 2024	Fundamentally re-think and re-engineer the current US power grid architecture to accommodate a massive penetration level of customer-end distributed energy resources (DERs) while improving the overall reliability, resiliency, and energy efficiency of the power sector
Air Interface Design for Terahertz (THz) Wireless Communication	Elza Erkip		InterDigital Communications, Inc.	\$110,000	January 1, 2021- December 31, 2021	Pioneer in measuring and modeling propagation characteristics of the channel above 140 GHz in downtown Brooklyn, NY, and comparing its characteristics with lower millimeter wave frequencies of 28 and 73 GHz
Verizon 5G EdTech Challenge	Thanasis Korakis		Verizon Corporate Resources Group, LLC	\$425,000	December 2, 2020- April 1, 2022	Design and development of new education labs based on the "Space Base" environment. The labs are again based on the "escape rooms concept" of the COVET framework
PDRD: Trust Consortium - Board-Level Security for Embedded Systems - NDA A21-0136	Farshad Khorrami		Honeywell Federal Manufacturing & Technologies	\$220,000	November 30, 2020- August 31, 2021	Design and fabrication of PCBs with multiple Trojans. The project is design for the evaluation of accuracy, precision, and recall of anomaly detection and information leakage for a wide range of settings

Quantification of Contingency Reserve Requirements Considering Risk	Yury Dvorkin		Electric Power Research Institute	\$38,000	October 28, 2020- January 31, 2021	Development of simulation-driven analyses of contingency risks on power grid operations, including increased cycling, reserve deliverability and extreme weather conditions, which will be carried out using representative power grid instances
Multi-Resolution Utility Discovery and Maximization	Farshad Khorrami		BAE Systems	\$160,000	September 29, 2020- June 25, 2022	Develop methods (feature extraction and clustering algorithms) to process and ingest multiple types of input data streams and feed into the machine learning systems
New Methods for Non-Convex Optimization in Deep Learning	Anna Choromanska		Alfred P. Sloan Foundation	\$75,000	September 15, 2020- September 14, 2022	Perform the analysis of the influence of the network's architecture and data selection and augmentation schemes on the flatness of the optimization landscape around the solutions found by different optimizers and at the decision boundaries
MR Imaging Biomarkers of Microstructure Relating to Cognitive Performance after Mild Traumatic Brain Injury	Yao Wang		New York University School of Medicine (NYU SOM)	\$90,439	September 1, 2020- August 31, 2021	Develop and validate machine learning algorithms for predicting the outcomes in cognitive function tests of MTBI and control subjects from their imaging features and demographic data
Perception and Control for Autonomous Agile Perching and Grasping with Micro Aerial Vehicles - DCIST Collaborative Research Alliance - Contract No. W911NF-17-2-0181	Giuseppe Loianno		University of Pennsylvania	\$110,056	September 1, 2020- August 31, 2021	Detect and estimate target of interests with on board sensors such as cameras and IMUs. We are particularly interested to reliably detect tree branches, or planar piecewise areas such as roofs or moving vehicles
Advanced Automotive Radar DSP Research	I-Tai Lu		NXP USA, Inc	\$86,000	September 1, 2020- June 30, 2021	Develop and analyze the performance of interference mitigation signal processing techniques and target parameter estimation techniques based on

						computationally efficient sparse representation framework for automotive radar applications
Cooperative Secure Learning	Farshad Khorrami		BAE Systems	\$450,000	August 17, 2020- January 31, 2022	BAE's Privacy-preserving Arithmetic Computation for Encrypted Learning (PARCEL) solution is designed to mitigate common privacy challenges by combining recent research in cooperative learning on encrypted feature embeddings with new network log sanitization techniques
SII Planning Grant: National Center for Radio Spectrum Innovations (NCRSI)	Thomas Marzetta		University of Notre Dame	\$16,475	August 15, 2020- July 31, 2021	Development of a comprehensive plan for an SII-Center which would help maintain and extend US leadership in future wireless technologies, systems, and applications in science and engineering through the efficient use and sharing of radio spectrum
Autonomous Robotics Research Center	Giuseppe Loianno		Technology Innovation Institute (Foreign)	\$1,081,805	August 1, 2020- August 1, 2023	Develop a state-of-the-art Autonomous Vehicles Platform (AVP), consisting of a complete framework to enable advanced research in the field of autonomous vehicles
Collaborative Research: Designs and Theory for Event-Triggered Control with Marine Robotic Applications	Zhong-Ping Jiang		National Science Foundation	\$60,000	August 1, 2020- July 31, 2023	Devise mathematical methods to control the behavior of dynamical systems that arise in the field of marine robotics and other engineering applications
Random Matrix Theory-Based Noise Removal in MRI	Yao Wang		New York University School of Medicine (NYU SOM)	\$73,905	August 1, 2020- July 31, 2021	Establish an objective framework to quantify the information content of different MRI modalities, by separating between the signal and the noise

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

CATT continues to work with NYU Tandon’s enterprise learning team to develop tailored programs for leading Industry partners’ more than 12,000 eligible employees for economic development. Certificates and Master’s level programs in mobility, network security, offensive security, and power engineering have been developed for working professionals. This workforce development initiative with CATT develops highly-skilled technical graduates to fill the growing cybersecurity gap. CATT is also instrumental in raising awareness of the NYU Tandon growing enrollment to nearly double the size from last year with more than 400 employees from industry partners participating in our cybersecurity workforce development education programs.

Among CATT’s Educational and Training activities initiated on a yearly basis is an educational summer program where STEM NYC teachers are trained to enhance their professional development and to collaboratively create hands-on educational material for thousands of NYC students.

Commercialization

CATT works closely with companies to translate research into know-how for the companies. A typical project involves faculty and students working with companies to identify engineering problems and their solution. These solutions often tap into the cumulative know-how and experience of CATT. This is of immense help to our corporate clients.

NYU also helps in the patent and commercialization process. There is an active effort to market and license patents. Additionally, through the Future Labs incubators and NSF’s I-Corp, entrepreneurs are encouraged to turn intellectual property into startup companies.

Invention Disclosures /Patents

Disclosure /Patent Number	Inventor	Research Sponsor	Description
US10841026B2	Aditya Dhananjay, Sundeep Rangan, Dennis Shasha	NYU	System, Method And Computer-Accessible Medium For Simulation And Emulation Of Wireless Cluster And/Or Tapped Delay Line Models
US10707367B2	Bahman Hekmatshoar-Tabari, Devendra K. Sadana, Ghavam G. Shahidi, Davood Shahrjerdi	IBM	Contact For Silicon Heterojunction Solar Cells
US10011920B2	Bahman Hekmatshoar-Tabari, Ali Khakifirooz, Alexander Reznicek, Devendra K. Sadana, Ghavam G. Shahidi, Davood Shahrjerdi	IBM	Selective Epitaxial Growth Of Silicon At Low Temperature For Device
US10763386B2	Keith E. Fogel, Bahman Hekmatshoartabari, Devendra K. Sadana, Ghavam G. Shahidi, Davood Shahrjerdi	IBM	Heterostructure Germanium Tandem Junction Solar Cell

US10790336B2	Ali Afzali-Ardakani, Bahman Hekmatshoartabari, Devendra K. Sadana, Ghavam G. Shahidi, Davood Shahrjerdi	IBM	Hybrid High Electron Mobility Transistor And Active Matrix Structure
US10756230B2	Tze-Chiang Chen, Bahman Hekmatshoartabari, Devendra K. Sadana, Davood Shahrjerdi	IBM	Methods For Forming An Interdigitated Back Contact Heterojunction Photovoltaic Device With A Floating Junction Front Surface Field
US10772720B2	Bahman Hekmatshoartabari, Ghavam G. Shahidi, Davood Shahrjerdi	IBM	Method Of Assembling Artificial Electronic Skin
US10862692B2	Davood Shahrjerdi, Abdullah ALHARBI	New York University	Systems And Methods For Optical Physical Unclonable Parameters
US10957659B2	Kenneth Rodbell, Davood Shahrjerdi	IBM	Monolithic Integration Of III-V Cells For Powering Memory Erasure Devices
US20200383250A1	Michael Knox, Andrew IPPOLITI, Georgios Kyriakou, Carlos OSPINA, Nicolas VANSNICK	Botfactory Inc	Method For Producing A Printed Wiring Board

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

None

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$540,028	\$403,326	\$558,301	\$1,501,655
Indirect Costs	\$78,514	\$86,348	\$77,372	\$242,234
Equipment	\$5,503	\$2,721	\$6,347	\$14,571
Materials & Supplies	\$3,084	\$57,157	\$58,219	\$118,460
Tuition	\$4,870	\$0	\$115,060	\$119,930
Travel	\$1,115	\$0	\$1,345	\$2,460
Subcontractors	\$60,100	\$0	\$0	\$60,100
Other	\$100	\$0	\$0	\$100
Total	\$693,314	\$549,552	\$816,644	\$2,059,510

Total Federal: \$244,065

Total In-kind: \$0

Center for Advanced Technology Future Energy Systems (CFES)

Rensselaer Polytechnic Institute

Dr. Jian Sun, Director

Technology Focus

Energy

Importance to NYS

First designated in 2004 as a CAT, CFES supports New York State energy initiatives and the energy industry through applied research, technology transfer, education, and outreach. CFES research focuses on renewable energy, energy storage, energy efficiency, green hydrogen and smart grid technologies to enable a future energy system that is sustainable, resilient, and economical.

Description of Achievements

Fiscal 2021 was a productive and successful year for CFES despite the challenges of navigating COVID-19 protocols. The fiscal year culminated with our most robust economic impact report since 2016.

During this reporting period, CFES had 14 faculty members engaged in collaborative research with NYS companies across 20 projects. The companies included Enermat Technologies, IBM, SelfArray, StorEn Technology, Orion Polymer, GE Global Research Center, New York Power Authority, Smarter Grid Solutions, JEM Consulting Services, Corning, Green Power Tower, and MIMiC. Research focus areas included: energy storage; hydrogen generation; solid-state super-capacitor development; wind turbine modeling, development and testing; smart grid and distributed energy resources management; glass composites; high voltage SiC power devices; and micro-climate HVAC.

Additionally, in this fiscal year, seven new federal grants were awarded a total of \$2.8MM. The projects scopes include fuel cells, offshore wind, machine learning, and radiative heat transfer.

There was abundant networking and outreach activity this fiscal year including eight virtual conferences and one-on-one outreach to current and recent past industry collaborators. The result of this activity included over 30 meetings with New York State companies and over 50 new industry contacts.

Finally, CFES is happy to report the strongest economic impact in five years. Eleven companies reported a combined total of \$11,354,018 in economic impact. Additionally, seven jobs were created, and another 25 jobs were retained as a result of industry collaboration with our Center.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
1	7	\$1,226,273	\$50,000	\$1,285,763	\$8,791,982	\$0	\$11,354,018

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
13	15	3	35

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Co-Investigator	Source	Amount	Duration (yrs)	Summary
Small Signal-Stability of Inverter-based Power Systems	Jian Sun		ERCOT	\$345,394	3	Develop the theory, core algorithms and supporting tools for small-signal stability analysis of inverter-based power systems
Cyber-resilient High-dimensional Data Analytics with Analytical Guarantees	Meng Wang		Airforce Research Lab	\$150,000	2	Enhance information extraction from networked data and resilience to cyber attacks in Air Force Systems
Optimal Co-design of Integrated Thermal Electrical Networks and Control Systems for GED Energy Systems	Luigi Vanfretti		University of Colorado	\$243,539	2	Combined heat and power (CHP) model for district energy will be significantly enhanced to enable the interaction between a microgrid and a district energy system
Risk Segmentation and Portfolio Analysis for Pareto Dominance in High Renewable Penetration and Storage Reserves	Aparna Gupta	Koushik Kar, Joe Chow, Kristen Schell, Lynette Remillard	Department of Energy	\$1,914,000	3	Develop market mechanism and risk assessment techniques to support a cost-effective and risk-informed integration of renewable energy resources
Methods and Tools for Continuous Model Development, Testing, and Verification	Luigi Vanfretti		Department of Energy	\$50,000		Identify requirements from model developers that can help develop a process for model testing and verification that can be modularized and deployed in heterogenous compute environments
Radiative Heat Transfer and Control using Photonic Crystal	Shawn Yu Lin		DARPA	\$113,450	1	To achieve fast, dynamic thermal switching times, we postulate the use of a Photonic Crystal (PC) filament operating at 1=1-2mm
Fast and Reliable Information Extraction from Guaranteed Learning of Neural Networks	Meng Wang		Army Research Office	\$99,436	1	Develop computationally efficient algorithms for training neural networks and establish the theoretical foundation of the required number of training samples to learn a powerful neural network

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

During fiscal 20-21, our center helped support eight postdocs (\$76,551), 29 graduate students (\$299,926 in stipends and tuition), and six undergrads (\$17,564 in tuition).

Commercialization

Of the 13 NYS companies we worked with this year, six were small companies and four were start-ups with new technology. Partnership with CFES is an integral part of the development of technology and commercialization strategy for each of these new companies. CFES' work with SelfArray's new LED display technology validated their technology and the company is pursuing commercialization opportunities. Our work with MIMiC's solid-state HVAC technology led to their NYSERDA award of \$330,000 and they are exploring relationships with potential manufacturers.

Invention Disclosures /Patents

Disclosure /Patent Name	Co-inventor	Licensing Partner	Research Sponsor	Description
Proton Exchange Membrane Material and Methods of Making Same. Patent #: US2020/0091535A1	Chulsung Bae Eun Joo Park Junyoung Han		StorEn Technologies	This invention is a new type of polymer that has qualities that are desirable for acting as a proton or cation exchange membrane

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

CFES collaborated with six NYS small businesses. This work included advancing technology (all companies); proof of concept (SelfArray); testing of new materials (StorEn Technologies); characterization studies (Orion Polymer); design, build, and test HVAC prototype (MIMiC); validation of hypothesis (JEM Consulting Services); and design, build and test wind turbine performance in the wind tunnel testing lab (for Green Power Tower in partnership with RIT's P2i center).

Additional collaborations have led to third party funding awards for our small business partners. These include \$330,000 from NYSERDA for MIMiC, \$225,000 from NYSERDA to JEM Consulting, \$90,000 across two projects from NYSERDA to Orion Polymer, and \$74,000 from NYSERDA to SelfArray.

CFES frequently refer partners to new funding opportunities when announced by DOE, NYSERDA, and NSF. CFES, as part of the CAT, COE, NYSTAR, and MEP ecosystem frequently refers small businesses to other helpful resources and encourage company participation in relevant events including FuzeHub's Commercialization

Competition and the NYSTAR Innovation Showcase, where several company contacts were personally invited and exhibited.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	NYSTAR Funding	Matching Funds		Total
		Company Cost Share	Other Sources	
Salaries & Fringe	\$434,269	\$695,861	\$878,429	\$2,008,559
Indirect Costs	\$65,140	\$120,428	\$193,405	\$378,973
Equipment	\$1,144	\$23,776	\$35,954	\$60,874
Materials & Supplies	\$31,946	\$44,258	\$96,388	\$172,592
Tuition	\$39,754	\$73,080	\$162,011	\$274,845
Travel	\$1,230	\$0	\$850	\$2,080
Subcontractors	\$0	\$0	\$322,305	\$322,305
Other	\$269	\$0	\$0	\$269
Total	\$573,752	\$957,403	\$1,689,342	\$3,220,497

Total Federal: \$771,441

Total In-kind: \$0

Additive Manufacturing and Multifunctional Printing (AMPrint) Center for Advanced Technology

Rochester Institute of Technology

Denis Cormier, Director

Technology Focus

Additive Manufacturing and 3D Printing

Importance to NYS

New York document printing companies have shed tens of thousands of jobs in recent years. 3D printing is closely related to document printing though, and this represents a unique opportunity for NYS. The AMPrint Center is helping OEM's, material providers, and end users tap into the rapidly growing 3DP market.

Description of Achievements

The COVID-19 pandemic severely affected AMPrint Center operations during the reporting period. Three AMPrint Center staff members were unfortunately laid off without a CAT contract in place. Despite the reduction in staffing, the AMPrint Center successfully balanced extensive efforts to design and produce COVID-related PPE with the need to continue 3D printing R&D activities. PPE activities largely focused on face masks, face shields, nebulizers, and ventilators. Relatively few new R&D projects were initiated during the peak of lockdowns; however, numerous industry and government projects were initiated in the latter half of the reporting period as lockdown measures began to ease up. The economic impact reports indicate that at least 20 new jobs were created or retained in addition to significant new funding received and cost savings realized. Five new patent applications were submitted jointly between the AMPrint Center and industry partners, and one new patent was awarded. In order to support the growth of additive manufacturing in New York State, the AMPrint Center added several significant pieces of equipment to its world-class facility. Chief among these additions were an Impossible Objects CBAM composite 3D printer, and a micro/nano CT scanning machine from Pinnacle Microsystems. The composite 3D printer is supporting collaborative research with several NYS based manufacturers. The x-ray CT scanning machine is one of only a handful of machines of its type in NYS and is already being extensively used by numerous companies.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
22	9	\$608,000	\$1,155,000	\$1,036,000	\$0	\$0	\$2,799,000

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
5	8	0 (all are continuing)	10

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (yrs)	Summary
Effect of Additive Manufacturing Methodology on Material Properties	Mark Olles	U.S. Army Materiel Command	\$100,000	1	The objective of this project is to investigate the effects of additive manufacturing on material properties.
Development of Additive Manufacturing Reactive Printers, Charges and Testing Methods	Mark Olles	U.S. Army Materiel Command	\$416,000	2	This project deals with additive manufacturing of reactive materials.

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

COVID significantly curtailed classes, short courses, and webinars during this year. However, AMPrint Center faculty and staff still contributed more than 10 invited talks/webinars/panels to industry-focused audiences. Examples include presentations to industry audiences at NextFlex, an Emerging Materials workshop put on by Los Alamos National Labs, the Fuzehub Innovation Showcase, an IISE webinar, and a NYS Semiconductor Industry Workforce Development workshop. A new course was also developed entitled *Personalized 3D Printing*. The training materials developed for this course rely heavily on software packages from nTopology and Autodesk, both of which have employees in New York State.

Commercialization

The majority of the AMPrint Center's commercialization activity is covered under non-disclosure agreements. However, the licensing agreement details listed below indicate significant industry activity. One AMPrint Center spin-out company (PrisAM LLC) has successfully obtained its first federal contracts to commercialize technology developed in the AMPrint Center.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Research Sponsor	Description
Peristaltic Micropumps and Fluid Delivery Devices That Incorporate Them	Borkholder, D.	Forouzandeh, F., Carter, R., Cormier, D., Walton, J., Frisina, R.	NIH	This patent deals with implantable micropumps used to treat hearing loss.
Metal Drop Ejecting Three-Dimensional (3D) Object Printer Having An Increased Material Deposition Rate	Cormier, D.	Badesha, S., and Sambhy, V.	Xerox	This disclosure describes a high throughput liquid metal jetting 3D printing technique.
Method and System for Operating a Metal Drop Ejecting Three-Dimensional (3D) Object Printing To Form Vias In Printed Circuit Boards With Conductive Metal	Cormier, D.	Badesha, S., and Sambhy, V.	Xerox	This disclosure describes a metal droplet jetting technique used in printed electronic circuit boards.

Building An Object With A Three-Dimensional Printer Using Vibrational Energy	Cormier, D.	Badesha, S., and Sambhy, V.	Xerox	This disclosure describes a method of improving material properties in a liquid metal jetting process.
Fabrication of Lattice Structures With A Three-Dimensional Printer	Cormier, D.	Jayabal, D., Badesha, S., and Sambhy, V.	Xerox	This disclosure describes a method of printing light weight metal lattice structures.
Building An Object With A Three-Dimensional Printer Using Burst Mode Jetting	Cormier, D.	Rifat, U., and Mehta, P.	Xerox	This disclosure describes a method of enhancing mechanical properties in engineered lattice structures.
Heating System for Additive Manufacturing Processes	Cormier, D.	Poddar, P., Tarr, X., Kon, J., Foster, A., and Greeley, A.	RIT	This disclosure describes an improved method for heating nozzles in 3D printers.
Planetary Extrusion System for Additive Manufacturing of Engineered Lattice Structures	Cormier, D.	Poddar, P., Tarr, X., Kon, J., and Foster, A.	National Science Foundation	This disclosure describes a new high speed multi-nozzle 3D printer technology.

Start-up Companies Formed

None

Licensing Agreements

Project	Inventor	Licensing Partner
Development of a Freeze-Extrusion Test Fixture for Medical Simulator 3D Printing	Denis Cormier	Xerox
Vibration-Assisted Liquid Metal Droplet Jetting	Denis Cormier	Xerox
Inkjet 3D Printing of Dentures	Denis Cormier	Myerson
Additive Manufacturing Research and Testing - 3D Liquid Metal Jetting	Denis Cormier	Xerox
Printed Conductors	Denis Cormier	Corning

Royalties

None

Small Business Assistance Provided

Although COVID reduced the AMPrint Center's ability to interact with industry partners, there were several significant small business interactions. An AMPrint Center startup company (PrisAM LLC) successfully received its first federal research contracts. The AMPrint Center provided grant writing assistance for that award as well as help building the initial prototype machine. Another significant interaction involved a company that cannot be named due to a non-disclosure agreement. The AMPrint Center helped this company develop a novel 3D printing material for use in a medical device application. It then helped develop a new inkjet based 3D printer that will be manufactured by one NY State company and sold/distributed by another NYS company. The AMPrint Center also had countless email and phone call interactions with small businesses looking for information or advice on 3D printing technologies.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$171,686	\$47,336	\$148,812	\$367,834
Indirect Costs	\$25,753	\$11,834	\$37,203	\$74,790
Equipment	\$52,477	\$139,285	\$107,408	\$299,170
Materials & Supplies	\$5,081	\$9,193	\$8,573	\$22,847
Tuition	\$0	\$0	\$3,133	\$3,133
Travel	\$0	\$0	\$293	\$293
Subcontractors	\$12,264	\$0	\$0	\$12,264
Other	\$115,610	\$66,203	\$121,814	\$303,627
Total	\$382,871	\$273,851	\$427,236	\$1,083,958

Total Federal: \$142,958

Total In-kind: \$0

Center for Biotechnology Stony Brook University

Dr. Clinton Rubin, Director

Technology Focus

Life Sciences, enabling sciences & agricultural sciences

Importance to NYS

The Center for Advanced Technology in Biotechnology at Stony Brook University will capitalize upon the intellectual and physical resources of Stony Brook University to catalyze, accelerate, and enhance commercial opportunities to fuel the growth and economic impact of New York’s life sciences industry.

Description of Achievements

During the reporting period July 1, 2020 - June 30, 2021, the Center for Biotechnology’s (CFB) programs contributed to the generation of \$15.5M in new corporate revenues, \$40.1M in non-government funds acquired, \$13.6M in federal funds acquired, \$280K in cost savings, and \$3.5M in capital expenditure impacts. Total economic impact for the period was \$73.3M. Sixty-five and a half new jobs were created and 109.5 retained.

The [Life Sciences Summit 2021](#) took place virtually on November 9-10, 2021 and attracted over 250 attendees. The Life Sciences Summit is an early stage investor and business development conference that highlights innovation with the objective of connecting emerging biotech companies and academic innovators with the capital and strategic partners they will need to move new discoveries through clinical development. Participants included: emerging companies developing next generation therapeutics, devices, diagnostics and research tools; key opinion leaders covering all aspects of discovery, development, and commercialization; strategic industry partners (Pfizer, Merck, Eli Lilly, Boehringer Ingelheim, Fox Rothschild, etc.); and early-stage investors (MPM Capital, SVB Capital, H.I.G. Capital, Pappas Ventures, etc). More than 60 of the most promising emerging companies participated on the formal program and dozens more attended. Companies invited to present in the Emerging Company Showcase at the Summit are professionally managed, with preclinical through Phase 2A, and have raised less than \$15M. Several are now in discussion with partners for financing or strategic investment.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
37	29	\$12,627,104	\$279,712	\$13,595,085	\$40,418,436	\$3,497,788	\$70,418,125

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
85	85		16

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
2021 Henri Termeer Fellowship	4/2021	The Termeer Foundation	https://www.businesswire.com/news/home/20210421005171/en/The-Termeer-Foundation-Announces-Recipients-of-2021-Henri-Termeer-Fellowship
Rapid COVID Testing Competition	3/2021	XPrize	https://www.businesswire.com/news/home/20210316005410/en/Grand-Prize-Winners-Selected-in-6M-XPRIZE-Rapid-Covid-Testing-Competition-to-Create-Fast-Frequent-Cheap-and-Easy-to-Use-Solutions

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (yrs)	Summary
Optimizing the immune response by targeting the STS Enzymes	Carpino, Nicholas A	NIAID	\$576,427	1	New clinical protocols that will reduce the morbidity and mortality attributed to systemic pathogen infections, by enhancing host immune responses
MELD: Accelerating Modeling of Proteins using Bayesian Inference	Dill, Kenneth A	NIGMS	\$317,007	1	Develop MELD, a computational Bayesian accelerator that “melds” together molecular dynamics simulations with external knowledge
Molecular Functions of Cilia-Planar Polarity Effectors (CPLANES) in Skin Morphogenesis and Homeostasis	Chen, Jiang	NIAMS	\$340,373	1	Provide insight into how the CPLANE proteins orchestrate or segregate PCP and ciliogenesis in the mammalian skin.
Novel PET Radiotracers for Imaging Infection	Tonge, Peter	NIBIB	\$343,139	1	To develop radiotracers that can be used for non-invasive PET imaging to detect and localize bacterial pathogens in humans.
Biomechanical Approaches and Technologies for Enhancing TAVR Outcomes	Bluestein, Danny	NIBIB	\$748,628	1	To develop next generation TAVR technology.
Prism-PET: A Tof-Doi-Compton Pet Detector Technology for Total-Body PET Imaging	Del Poeta, Maurizio	NIBIB	\$647,165		To improve geometric coverage using large axial FOV for total-body imaging.
Mechanism of Slow Onset Enzyme Inhibition and	Tonge, Peter	NIGMS	\$326,975	1	Elucidate the molecular factors that dictate the impact of drug- target

Translation to Time – Dependent Drug Activity					residence time on in vivo drug activity.
Sphingosine-1-Phosphate and Cryptococcosis	Del Poeta, Maurizio	NIAID	\$498,277	1	To study the role of the host SK1-S1P pathway in controlling the infection by Cryptococcus neoformans (Cn).

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

The Fundamentals of the Bioscience Industry is an 84-hour seminars and workshops program, led by industry executives. Thirteen students participated in the 18th offering of the program; two graduate students pursuing an MS, five graduate students pursuing a PhD, two postdoctoral fellows, two scientists, and a PhD.

Multiple SBIR/STTR Intensive Workshops and 1:1 Proposal Preparation Counseling attracted over 175 company participants. Early-stage entrepreneurs are turning to organizations like the CFB to access our established network of industry professionals and investors, people they are unlikely to connect with on their own given the current business restrictions related to the pandemic.

Commercialization

Long Island BioMentor Initiative provides intensive team mentoring to first-time entrepreneurs. Seven new mentees (entrepreneurs) and 16 new mentors were added to the program. Four Quarterly Mentor Meetings, 13 Mentor Team Meetings, five Pre-BioStrategy Sessions, and 12 BioStrategy Sessions were held. Mentee consideration is based upon stage of development, identified needs of the entrepreneur, and the intake assessment conducted by the program's Entrepreneur Liaison.

Commercialization Fellows work directly with clients to conduct market assessments and IP due diligence, analyze regulatory pathways, develop financial models, connect entrepreneurs to the CFB network of industry professionals, and they help hone the client's investor presentation.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Description
Multi-diameter drill bit	Marcus Abboud	Sihana Rugova	Tooth drilling or cutting instruments; Instruments acting like a sandblast machine; e.g., for cleaning, polishing or cutting teeth.
Methods and compounds to inhibit enveloped virus release	Carol Carter	Susan Watanabe	A compound having an antiviral activity for inhibiting release of an enveloped virus from a cell is disclosed.
Method for fabrication a multi-well amorphous selenium detector	Amirhossein Goldan	Wei Zhao	Provides a field shaping multi-well detector and method of fabrication thereof.
Radiation therapy with orthovoltage x-ray minibeam	Avraham Dilmanian		A method for delivering therapeutic radiation to a target.
Azasteroids for Treatment of Tuberculosis	Nicole Sampson	Xinxin Yang, Tianoa Yuan	Provides a compound for use in combination with an anti-tuberculosis drug for treating a subject infected with M. tuberculosis.

Dynamic Phantom for Functional Magnetic Resonance Imaging	Lilianne Strey (Mujica-Parodi)	Helmut Strey, Daniel DeDora	A dynamic phantom for use with a functional magnetic resonance imaging (fMRI) device.
Multi-Well Selenium Device and Method for Fabrication Thereof	Amirhossein Goldan	Wei Zhao	Provides a field shaping multi-well detector and method of fabrication thereof.
Selenium Photomultiplier and Method for Fabrication Thereof	Amirhossein Goldan	Wei Zhao	The photomultiplier includes a field-shaping multi-well avalanche detector, including a lower insulator, an a-Se photoconductive layer and an upper insulator.
Systems And Methods for Promoting Cellular Activities for Tissue Maintenance, Repair, and Regeneration	Yi-Xian Qin		Systems And Methods for Promoting Cellular Activities for Tissue Maintenance, Repair, and Regeneration
Adeno-associated-virus Rep sequences, vectors and viruses	Wadie Bahou	Patrick Hearing, Varsha Sitaraman	The invention provides adeno-associated virus (AAV) replication (Rep) sequences.
Compositions and Methods for Enhancing the Biological Response to Chemical Agents and Physical Stimuli	Clinton Rubin		Compositions/methods configured to deliver a stimulus (therapeutic agent or therapeutically beneficial signal) to a cell, tissue, organ, or organism.

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

Project	Principle Investigator	Co-Investigator	Company Partner	Royalty Income
				\$15,96,584**

**Terms and financial payments to the institution are inter-agency material agreements through The Research Foundation of SUNY's Office of Technology Licensing and Industry Relations (OTLIR). Royalty income associated with the CAT is distributed under proprietary conditions through OTLIR as well; therefore, an aggregate figure is provided above.

Small Business Assistance Provided

None

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$959,055	\$1,406,072	\$4,833,363	\$7,198,490
Indirect Costs	\$120,996	\$351,518	\$1,208,341	\$1,680,855
Equipment	\$0	\$102,029	\$861,223	\$963,252
Materials & Supplies	\$54,438	\$311,517	\$1,202,502	\$1,568,457
Tuition	\$0	\$19,234	\$121,949	\$141,183
Travel	\$24	\$6,002	\$53,497	\$59,523
Subcontractors	\$37,099	\$0	\$2,007,310	\$2,044,409
Other	-\$4,635	\$91,298	\$473,384	\$560,047
Total	\$1,166,977	\$2,287,670	\$10,761,569	\$14,216,216

Report was for period 7/1/20 – 12/31/21

Total Federal: \$9,871,964**Total In-kind: \$0**

Center for Integrated Electric Energy Systems (CIEES)

Stony Brook University

Prof. Benjamin Hsiao, Director

Technology Focus

Energy storage and the integration of renewable energy sources into New York's electric grid systems

Importance to NYS

The mission of CIEES is to support the Climate Leadership and Community Protection Act, by enabling the transformation of the electricity grid to reach 70% renewable energy generation by 2030, and zero-emission electricity by 2040. CIEES' location on Long Island is key in facilitating the utilization of 9 GW offshore wind power.

Description of Achievements

CIEES and its clients quickly adapted to the new reality caused by the pandemic. During the reporting period, CIEES client companies reported the generation of 32 new jobs, the retention of 14 jobs in NY, and approximately \$7,500,000 of economic impact in the form of increased revenues, cost savings, Federal funding, private investment and capital expenditures between July 1, 2020 and June 30, 2021.

In addition, CIEES research programs generated eight new technology disclosures, which were filed with Stony Brook University (SBU) University's Intellectual Property Partners. Four new patent applications were filed by SBU on CIEES research program technologies.

In 2020, CIEES began collaboration with the Energy Resilience Consortium, the collaboration resulted in a joint proposal to ONRL, with CIEES and Bren-Tronics Inc., as partners. CIEES continued to work with the SBU's I-GIT by participating in a consortium of national labs to submit a proposal to the Department of Energy under the H2@Scale 2020 program.

As part of CIEES' workforce development mission, CIEES continued to work with the Department of Electrical & Computer Engineering during the reporting period. This effort is committed to serve students in high needs schools and underrepresented groups and helping them meet the requirements of the Next Generation Science Standards/New York State Science Learning Standards. In addition, in August 2020, CIEES offered a virtual summer camp 'Online Robotics Camp' for over 70 middle school students.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
32	15	\$727,000	\$350,000	\$24,823	\$5,887,110	\$500,000	\$7,488,933

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
19	6	2	15

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
R&D 100 Award	09.30.2020	SuperClean Glass	https://www.rdworltonline.com/rd-100-award-winners-announced-in-mechanical-materials-category/
American Academy of Arts and Sciences	06.30.2021	Prof. Esther Takeuchi	https://www.amacad.org/news/members-elected-2021-class-section

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Co-Investigator	Source	Amount	Duration (yrs)	Summary
AI-Enabled Provably Resilient Networked Microgrids	Dr. Peng Zhang	Scott Smolka Scott Stoller Xin Wang	NSF	\$887,707	2	Programmable platform with continuous-depth deep neural networks, reachability analysis, to enable scalable, self-protecting, autonomic and ultra-resilient microgrids
Asynchronous Distributed and Adaptive Parameter Tuning (ADAPT) for Hybrid PV Plants	Dr. Peng Zhang		DOE	\$2,600,000	2	Help communities maintain power during man-made or natural disasters, restore power after, and improve system cybersecurity
AI-Grid: AI-Enabled, Provably Resilient, Programmable Networked Microgrids	Dr. Peng Zhang	Scott Smolka, Xin Wang, Scott Stoller	NSF	\$73,129	2	AI-enabled, provably resilient NMs. Key innovations are a programmable platform integrating reliable modeling under uncertainty, reachability analysis, and formal control
Enabling Self-Protecting, Ultra-Cyber-Physical-Resilient Microgrids	Dr. Peng Zhang	Zefan Tang, Yifan Zhou	U.S. Navy	\$265,000	1.5	Develops a deployable Three Lines of Defense model to enable unprecedentedly self-protecting, ultra-cyber -resilient cognitive microgrids
Intelligent Power Stages (IPS)	Dr. Fang Luo		UT Battelle	\$212,976	2	Develop novel intelligent power stages on the same chip, with benefits of compactness, system reliability, and cost effectiveness
Development of the Cryogenic Hydrogen-Energy Electric Transport Aircraft (CHEETA) Design Concept	Dr. Fang Luo		NSF subcontract with University of Illinois	\$124,361	2	The project will develop a cryogenic hydrogen fuel cell system for powering all-electric aircraft

Robust and Intelligent Integration of Micro-Grids to Improve Isolated Site Resilience	Dr. Benjamin Hsiao	Vyacheslav Solovyov, Kyle Roelofs Fang Luo	US Navy	\$259,311	2	The project will use the latest advances in the internet of things (IoT) communication to demonstrate predictive energy dispatch of Mil-spec energy storage
Learning for Faster Computations to Enhance Efficiency and Security of Power System Operations	Dr. Yue Zhao		NSF	\$249,096		This project will develop new machine learning algorithms to improve the computational efficiency of solving challenging power system operation problems
Machine Learning Algorithms for High fidelity Modeling, Monitoring, and Forecasting	Dr. Yue Zhao		NYSERDA	\$1,000,000	2	The project will develop a suite of grid modernization metrics that leverage current industry practice, and develop new metrics for emerging grid attributes and architectures
Software-Defined Urban Distribution Network for Smart Cities	Dr. Peng Zhang		NSF	\$210,908	2	The innovation of this project lies in integrating IoT technologies, software-defined networking and real-time computing to establish a scalable SD2N architecture

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

CIEES continued to work with the Department of Electrical & Computer Engineering during the academic year and the summer of 2021. This effort is committed to serve students in high needs schools and from underrepresented groups and to meet the requirements of the Next Generation Science Standards /New York State Science Learning Standards. In addition, CIEES offered a virtual summer camp “Online Robotics Camp” for over 70 middle school students that had an unprecedented success in attendance. In addition, CIEES set up a microgrid prototype for training students, which was used train students on the latest advances in IoT communication.

Commercialization

During the reporting period, CIEES developed a proposal, which was funded by the Office of Naval Research entitled “Robust and Intelligent Integration of Micro-Grids to Improve Isolated Site Resilience”. The project will apply advanced energy storage control algorithms developed with CIEES and SBU faculty teams on microgrid platforms. The energy storage units used for this project are manufactured by NYS small businesses, Bren-Tronics LLC and IOXUS Corp. The successful demonstration will result in licensing of the energy control technology to industrial partners.

In addition, CIEES assisted StorEn Technologies LLC, a NY-based small business, in evaluating and testing their vanadium flow battery prototype.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Licensing Partner	Research Sponsor	Description
63/007,077 CoreVent 050-9181 CoreVent	Dimitris Assanis	John Brittelli, Jon Longtin, Christopher Page	N/A	Stony Brook Foundation	CoreVent uses readily available parts from multiple vendors and standard ventilator connections, intentionally made to be both flexible and broad in scope
63/114,281 A Dynamic Intrasaccular Biodegradable Polymer. 050-9187 A smart LEA for dynamic adjustments	Daniel Cohn	Juyi Li, Miriam Rafailovich, Chandramouli Sadasivan, Aaron Sloutski		Morin Foundation and Hebrew University	A smart LEA for dynamic adjustments and remodeling
63/140,318 Molybdenum Oxide Composition for Use in Zinc-ion Battery 050-9211 Stable Molybdenum Oxide Cathodes for Aqueous Zinc-ion Batteries	Amy Marschilok	Esther Takeuchi, Kenneth Takeuchi, Lei Wang		Department of Energy	A zinc and chlorine-based water-in-salt electrolyte (WISE) is introduced to a MoO ₃ nanobelt cathode for the first time, significantly increasing the stability of MoO ₃ cathodes
63/173,642 Electrolyte Compositions 050-9226 New Electrolyte Enabling Stable Extended Cycling under Extreme Conditions	David Bock	Amy Marschilok, Esther Takeuchi, Kenneth Takeuchi		Department of Energy	This invention relates to the field of energy storage devices including new classes of electrolytes base on the concept of localized high concentration electrolytes (LHCEs) for operation of Li-ion batteries
050-9208 Real-time mood identification by quantitative facial motion analysis	Matthew Jacobs	Charles Mikell, Sima Mofakham, Selma Mohammad, Miriam Rafailovich, Jordan Saadon, Fan Yang		Stony Brook Foundation	A system and method for real-time mood identification by quantitative facial motion analysis providing a quantitative facial analysis diagnostic platform for quantitative analysis disorders

050-9240 Zinc/Manganese Oxide Flow Cell Battery	Lisa Housel	Amy Marschilok, Esther Takeuchi, Kenneth Takeuchi		Department of Energy	The construction of a cathode, which incorporates MnOx into a three- dimensional carbon architecture
050-9250 Gaseous Nitro-Oxidation Process (G-NOP) for Upcycling the Biomass Waste Using the NOx Gases	Dr. Ben Hsiao	Priynaka Sharma		NSF	This invention includes the utilization of the NOx gas pollutant to upcycle biomass waste feedstocks
050-9244 Development of All-Cellulose Ultrafiltration Membranes for High- performance Wastewater Treatment	Dr. Ben Hsiao	Mengying Yang		NSF	Wastewater treatment with low membrane fouling using 100% sustainable cellulose membrane by a simple and energy-saving preparation method

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

CIEES assisted StorEn Technologies LLC, a NY-based small business, in evaluating a vanadium flow battery prototype. Due to a unique combination of environmental, power and expertise requirements, StorEn could not locate a suitable facility that would perform the tests in the short timescale. The CIEES team successfully completed its tasks, safely installed the battery and provided power wiring and interfacial electronics. The successful test results allowed StorEn to secure additional funding to develop a new large-scale battery. Launched in September 2020, the campaign, which is to remain open for three full years, has already generated \$6.4 million. This will fund development of the pre-production prototype which is currently undergoing thorough testing at the Queensborough-based National Battery Testing Centre in Australia. Specifically, the CIEES team coordinated safe delivery of 1 ton of Vanadium Sulfate electrolyte, assisted in safe filling of the flow battery container, and installation of the high-current wiring and the battery management system. In tests, the battery demonstrated >90% roundtrip efficiency and over 95% charge retention.

In addition, during the reporting period, the CIEES team employed expertise of their team in developing methane sensing light-emitting diodes and receivers for compact natural gas sensors with an industry partner. Currently, the company is undergoing a pilot trial at Consolidated Edison facility in Bronx, NY.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$793,001	\$922,926	\$1,273,397	\$2,989,325
Indirect Costs	\$118,950	\$230,731	\$318,349	\$668,030
Equipment	\$0	\$28,994	\$20,650	\$49,644
Materials & Supplies	\$23,713	\$55,085	\$95,054	\$173,851
Tuition	\$0	\$2,826	\$135,255	\$138,081
Travel	\$0	\$194	\$9,033	\$9,227
Subcontractors	\$0	\$0	\$212,209	\$212,209
Other	\$6,977	\$254,169	\$68,005	\$329,151

Report was for period 7/1/20 – 12/31/21

Total Federal: \$1,716,801**Total In-kind: \$0**

Center for Advanced Technology in Nanomaterials and Nanoelectronics State University of New York Polytechnic Institute (SUNY Poly)

Michael Fancher, Director

Technology Focus

Nanomaterials and nanoelectronics, semiconductor and related technologies

Importance to NYS

As NYS has made significant investments to become a leader in high tech fields and attract companies to the State, CATN2 has supported many advancements in the semiconductor and related fields driving and supporting NYS’s leadership position. Several current efforts are focused on attracting significant funding to New York from the CHIPS Act.

Description of Achievements

The CATN2 successfully issued and funded the fourth and fifth rounds of competitive funding under the Center’s Matching Investment Program (MIP). The MIP was developed to address the research, development, and deployment needs of NY based companies to work with the CATN2 and collaborate with SUNY Poly faculty and to successfully leverage and build upon the capabilities available at SUNY Poly. The fourth round focused entirely on COVID-19 response and research. These two rounds leveraged \$403K of ESD/NYSTAR funding to enable \$1.05M in Matching Commitments from and in support of eight NY industry partners in COVID-19 response and research, MEMS, biopharmaceutical and tissue engineering, and semiconductor manufacturing.

Other highlights during this reporting period included: continuing the expansion of the silicon carbide power electronics ecosystem in the Mohawk Valley with the construction of Cree’s (Wolfspeed’s) \$1 billion chip fab; deepening the relationship with SUNY Poly housed start-up Menlo Micro to further develop their groundbreaking MEMS switch technology with facility access, intern support, and an MIP funded project; continued support of AIM Photonics and their workforce development programs; and growth of the Advanced Manufacturing Performance Center (AMP Center) with continued development of the Career Alignment Platform for advanced manufacturing focused exploration and training as well as an expansion of component/system test-beds for training of Pumps/Vacuum Systems, Sensors/Toxic Gas Monitoring Systems (TGMS), Valves & Seals/Multiple Systems, RF Products/Plasma Systems, and several others.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
24	40	\$1,160,500	\$1,348,169	\$17,614,103	\$7,500	\$3,240,700	\$23,370,972

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
32	44	9	36

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (Yrs)
Inhibiting SARS-CpV-2 replication in cardiomyocytes using functionalized nanoparticles	Boivin	American Heart Association	\$100,000	1
Energy Storage Technology Workforce Training Program	Efstathiadis	NYSERDA	\$246,421	2
Solar blind UV III-Nitride Photocathode array	Shahedipour-Sandvik	Banpil / NASA	\$41,000	1
Solar blind UV AlGaIn APD photodetector array	Shahedipour-Sandvik	Banpil / NASA	\$41,000	1
Bioengineering Recombinant Anticoagulant Heparin	Sharfstein	Tega Therapeutics / NSF	\$250,000	2
The Vertical Microelectronics via Interface Sciences (VERMIS) Institute	Lee	Department of Energy	\$14,548,027	4
A Roadmap for Future Pandemic Readiness	Harame	National Institute of Science and Technology	\$356,408	1
Viral Optical Resonance Test Express	Harame	NIST	\$3,117,734	1.5
Development of an sRNA Therapeutic Prototype for Senescence Abatement	Melendez	SXRNA Technologies, LLC / NIH	\$108,817	1
NSF Convergence Accelerator Track C: Quantum Information Processor Scaling with Optimized Fabrication Technologies	Papa Rao	National Science Foundation	\$999,740	0.75
Wearable sensor for opioids detection based on electrochemical sensor array integrated with Bluetooth device	Cady	NIG / NIDA / Emitech, Inc.	\$30,000	1
Co-design Center for Quantum Advantage (C2QA)	Papa Rao	Brookhaven National Laboratory / Department of Energy	\$750,000	5
Fabrication of an Adaptable Neuromorphic System for Exploring Nanoelectronic Options	Cady	Air Force Research Laboratory	\$4,220,308	3
Manufacture of an Amperage Leak Detector prototype using a modified Beacon (CYALKIT-E02 Solar-Powered BLE Sensor)	Cady	United Aircraft Technologies (UAT) / Air Force Research Laboratory	\$45,000	0.5
Computational Cell Design for Next Generation EV Batteries	Efstathiadis	ARMA International / Department of Defense	\$35,332	0.583
Distributed Optical Sensing System Development for Hypersonic Applications	Huang	OptoXense, Inc. / DARPA	\$134,980	1
RECODE: Identification and manipulation of mesenchymal signaling pathways that promote secretory acinar cell maturation	Xie	UAlbany / National Science Foundation	\$152,660	4
NNL-SUNY Poly Capstone Project on Nickel Ferrite	Dunn	Fluor Marine Propulsion, LLC	\$65,545	0.667
FMSG: Manufacturing of hybrid tissue-electronic and photonic devices	Sharfstein	National Science Foundation	\$500,000	2
Wearable Toxic Gas Scanner	Cady	AFRL / Sensory Biotech, Inc.	\$15,000	0.25
Development of a Cortical Optogenetic Stimulation System for Visual and Cognitive Prosthetics	Galis	SUNY Downstate / NIH	\$1,167,937	5
Redox Control of SASP	Melendez	National Institutes of Health	\$445,381	3
High Temperature Implanted SiC JBS Diodes	Sung	Nissin Ion Equipment Company Ltd.	\$30,000	2

Salivary Organoids for the Study of Salivary Mucins in SARS-CoV-2 Viral-Host Interactions	Xie	UAlbany / National Institutes of Health	\$591,235	5
Long Life High Efficient Photocathodes	Shahedipour-Sandvik	SMI / Department of Energy	\$175,987	2
Integrated Photonic Devices for Application-Specific Design	Harame	Department of Defense	\$150,000	0.67
REU Site: Innovation and Commercialization of Emerging Technologies	Dunn	National Science Foundation	\$333,511	3
MITE-ARG (Massachusetts Integrated photonics Technology Engagement - Alternate Reality Game)	Harame	Department of Defense	\$124,889	1
SHIELD (Sustainable Heavy Ion Environment enabled by Lateral Devices) on SiC	Sung	National Aeronautics and Space Administration (NASA)	\$1,217,574	2
Manufacturing Platform for High-Temperature CMOS ICs on SiC	Sung	NoMIS Power Group, LLC / Department of Defense	\$20,000	0.583
Resistive Random Access Memory (RRAM) for AI Applications	Cady	SUNY-IBM	\$100,000	1
Group II-Sb Alloys for Multivalve Phase Change Memory	Oktyabrsky	SUNY-IBM	\$100,000	1
Novel (Al)GaIn-based Beta (Photo) Voltaic Devices with Enhanced Performance: A Fundamental Study into Opportunities and Challenges	Shahedipour-Sandvik	Army Research Office	\$7,500	0.167
Fabrication of an Adaptable Neuromorphic System for Exploring Nanoelectronic Options	Cady	US Airforce Research Laboratory	\$5,570,307	3
Sensitized Solar Cell Performance	Efstathiadis	University of Hafr Al-Batin, KSA	\$138,209	1.5
Artificial Intelligence Driven Adaptive Sensors for Autonomous Object Recognition	Oktyabrsky	The University of Buffalo / Army Research Office	\$200,000	2
Transplantable report of activity and connectivity kinetics (TRACK) in the acutely injured spinal cord	Paluh	New York State Department of Health	\$926,763	3
iPSCs to Simulate Glaucoma	Xie	New York State Department of Health	\$330,000	2
Hydrogen Fueling Station with Cryo-compressed Storage	Efstathiadis	Minas Scientific LLC / DOE	\$34,043	1
Near zero Boil-off Design of Liquid Hydrogen Tanks	Efstathiadis	Minas Scientific LLC / DOE	\$35,578	1
High Pressure nanomaterial particulate Filter for Heavy Duty Hydrogen Fueling Stations	Efstathiadis	Minas Scientific LLC / DOE	\$28,974	1

Summaries not provided

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

CATN2 has successfully implemented a comprehensive Engage, Enrich, and Educate approach to preparing the high-tech workforce focusing on: 1) Engagement, to attract potential workers; 2) Enrichment, to build a workforce pipeline; and 3) Education and training that is industry-oriented. Engagement efforts have emphasized exposure to nanotechnology careers. Enrichment efforts have targeted HS students through internships and HS classwork. Education and training efforts have focused on degree and certificate granting programs; certificates and badges under the NSF NEATEC program; and collaborative programs with all levels of local, state, and national universities under the federally funded AIM Photonics.

Commercialization

To generate broad commercialization impacts the CATN2 established and supports ongoing outreach and networking through referral networks in: 1) RD&D Industry Alignment Frameworks (American Institute for Manufacturing Integrated Photonics (AIM Photonics), Statewide Silicon Carbide Power Electronics RD&D Initiative, and Advanced Manufacturing Performance (AMP) Center); 2) RD&D Shared-Use Facilities (SUNY Poly's 200 and 300mm pilot lines and Zero Energy Net Facility Test-bed); 3) Strategic Economic Development Initiative Partnerships (Advanced Regenerative Manufacturing Institute (ARMI), The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), and Albany College of Pharmacy and Health Sciences Center for Biopharmaceutical Education and Training (CBET); and 4) Entrepreneurial Programs (iClean/Tech Valley Business Incubator and Corporate Venture Exchange).

Invention Disclosures /Patents

Patent Application Name	Inventor	Co-inventor
Methods for Qualitative and Quantitative Analysis of a Plurality of Biomarkers	Nathaniel Cady	
Semiconducting Devices, Back End of line portions for Devices, and Dielectric Materials Incorporating Deuterium	Patrick Lenahan	James Lloyd, Niaz Mahmud
Methods for Resistive RAM (ReRAM) Performance Stabilization via Dry Etch Clean Treatment	Karsten Beckmann	Nathaniel Cady, Martin Rodgers, Shyam Sridhar, Sergey Voronin, Qi Wang
Solid-State Field-Effect Air Filtration Systems, Masks Including Same, and Methods of Forming Same	Haralabos Efstathiadis	Michael Fasullo, Iulian GherasoIU
Polishing Slurries including Ceria Nanoparticles and Methods for Polishing Materials	Kathleen Dunn	Christopher Netzband
Metal Oxide Semiconductor Field Effect Transistors (MOSFET)	Woongje Sung	
Additive Manufacturing Systems	Bridget Boland	Gregory Denbeaux
Compositions, Apparatuses, and methods for Making and Using Bioscaffolds	James Castracane	Melinda Larsen, Pujhitha Ramesh, Susan Sharfstein, Yubing Xie
Novel cryoelectrospun scaffolds for tissue engineering and methods for manufacturing	James Castracane	Melinda Larsen, Pujhitha Ramesh, Susan Sharfstein, Yubing Xie
Chip-scale Photonic Processing Neuroprosthetic Emitter	Olivya Caballero	John Carter, Spyridon Galis, Stephen Macknik, Susana Martinez-Conde, Satyavolu Papa Rao, Edward White
Chip-scale Photonic Processing Neuroprosthetic Detector	Olivya Caballero	John Carter, Spyridon Galis, Stephen Macknik, Susana Martinez-Conde, Satyavolu Papa Rao, Edward White
Extended P-well with a gradient doping profile for SiC MOSFETs	Dongyoung Kim	Adam Morgan, Woongje Sung
Defect Density Manipulation in HfO2 for ReRAM Application via Angular Velocity Adjustments in a Semi-batch ALD Chamber	Karsten Beckmann	Nathaniel Cady, Jubin Hazra
Humanized yeast deletion collection expressing cytochrome p450 1A2	Michael Fasullo	
Suspended Graphene Energy Harvesting Solid State Structure	Christopher Hobbs	Vincent LaBella, Nicholas Pieniazek

Summaries not provided

Start-up Companies Formed

Company Name	City	Product/Service	Sector
NoMIS Power Group	Albany, NY	Custom design & fabrication of power semiconductor devices made at a low-cost, pure-play U.S. foundry. Discrete and module power packaging from qualified U.S. providers for device characterization and converter applications.	Semiconductor / clean energy

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

Throughout this reporting period the CATN2 provided various services and assistance to NY based small businesses including the following:

- Access to state-of-the-art process and metrology equipment and expertise
- Proof-of-concept support
- Pilot-prototyping services
- Manufacturing Scale-up
- Technology demonstration and test including metrology, characterization, and reliability
- Business development support, including making introductions and identifying grant, partnership, and sales opportunities
- Funding for collaborative research projects
- Create and maintain a pipeline of new employees
- Develop and provide a wide range of specifically tailored workforce development programs
- Entrepreneurship support – including business plan drafting, company introductions, guidance, pitch preparation, supporting business plan competitions and corporate venture exchange, etc.

Some of the NY based small business that were provided these services during this reporting period included:

- BESS Tech
- Cytocybernetics
- Eonix Energy
- Free Form Fibers
- Glauconix Biosciences
- Hocus Locus
- Lux Semiconductors
- Magnolia Optical Technologies
- Marktech Optoelectronics
- Menlo Microsystems
- Midux Technologies
- NoMIS Power Group
- SeeQC
- sxRNA Technologies
- Xallent, Inc.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$302,314	\$465,166	\$0	\$767,480
Indirect Costs	\$45,257	\$44,368	\$0	\$89,625
Equipment	\$60,253	\$0	\$0	\$60,253
Materials & Supplies	\$134,203	\$32,524	\$0	\$166,727
Tuition	\$8,151	\$26,761	\$0	\$34,912
Travel	\$25	\$1,265	\$0	\$1,290
Subcontractors	\$0	\$0	\$0	\$
Other	\$139,144	\$80,499	\$0	\$219,643
Total	\$689,347	\$650,583	\$0	\$1,339,930

Total Federal: \$0**Total In-kind: \$0**

**Center for Advanced Technology in Computer Applications and Systems
Engineering (CASE)
Syracuse University
Pramod Varshney, Director**

Technology Focus

Information technology and telecommunications

Importance to NYS

CASE conducts research in cutting edge technology areas that involve large quantities of information about the environment (physical, biological, cyber) or human behavior (marketing, financial, social networks), for improved situational awareness and to determine an appropriate action or response. Application domains include unmanned air systems, health, defense, and security that will lead to significant job creation and economic growth in NYS.

Description of Achievements

CASE continued to realize outlined goals and objectives, focusing activities to increase measurable economic impact and position CASE for continued success. CASE continued to be instrumental in delivering on the commitments of the URI, providing support to Genius NY finalist companies, access to UAVs and FAA licensed pilot for faculty and industry partners, technical support for UAVs and data security activities, assisting Centerstate CEO with attraction activities, and working with key industry partners from start-ups to multinationals on related projects. Center leadership and staff continue to engage the Industry Advisory Board, faculty researchers, industry partners, and key university and community constituents in serving the New York State industry and scientific communities. CASE remains an active member of NUAIR, facilitating faculty and industry use of the FAA-designated UAS Test Bed. In addition, CASE continues to play a key role in the CNY Defense Alliance and support of the Cyber Research Institute. During the ongoing COVID-19 pandemic, nearly all business development activities continued via video conference.

Due to COVID-19, we continued a “pause” for our “2021 NEXT” annual innovation conference in partnership with CNY TDO, NYSSTLC and SUNY Upstate’s Biotech Accelerator (CNYBAC). Syracuse University had the opportunity on two occasions, to present its Waste Water Surveillance Project to NY lawmakers, as well as the Governor’s administration.

CASE’s incubator is currently at 80% capacity, with 12 companies. We continue to see a steady flow of interested parties despite the pandemic. New companies continue to appreciate the CASE/SU affiliation, including our office space, closeness to faculty, and talent.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
29	35	\$17,614,270	\$970,117	\$1,646,032	\$1,117,500	\$575,500	\$21,923,419

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
37	6	0	76

Designations and Recognitions

None

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (yrs)	Summary
Electric Fence Alarm System (EFAS)	Qiao, Quinn	Insulights	\$94,900	2 years	Develop an innovative version of the electric fence insulator, advancing agricultural-related manufacturing in the United States. The Proposed Phase II research goal is to commercialize and bring the Electric Fence Alarm System (EF AS) to market as the Phase II project completes

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

The CASE Industry Co-op program, our signature workforce development program continues to be successful, placing students in a variety of short- and long-term positions within local companies to gain direct work experience and provide opportunities and encouragement to remain in the region after graduation. The Co-op program, despite the pandemic continued without interruption as students worked remotely. CASE, in partnership with the Department of Electrical Engineering and Computer Science (EECS), continues to support an annual colloquium series on industry-relevant technical topics. CASE continues to work with the New York State Science and Technology Law Center to deliver commercialization and intellectual property training.

Commercialization

CASE helps to promote CEO's NY Genius and Grants for Growth Programs, working together with CEO, The Technology Garden, CNY TDO, other universities, and range of representatives from industry to refer companies seeking funding to enable university-industry collaboration with significant commercial potential. CASE is working with winners of the Genius awards to assist them in achieving their business goals, especially prototype design and hiring students to assist with research and development. CASE facilitated meetings between a number of local small businesses and potential partners on campus and within larger corporations for potential commercialization opportunities. CASE's other commercialization partners include Central NY Defense Alliance, NYSSTLC and NUAIR.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Description
Compositions and Methods for Enhancing Peptide Stability Against Protease Digestion	Robert Doyle	David Hermelin Jonathan Bortz	https://patents.google.com/patent/US10716827B2/en?q=10%2c716827 This invention allows for the creation of oral delivery of drugs that currently are only effective by being administered parenterally. This technology would increase patient adaptability to drugs taken daily for chronic disease
Tryptamine-Based SHIP Inhibitors for the Treatment of Cancer	John Chisholm	William Kerr Sandra Fernandes	https://patents.google.com/patent/US10736877B2/en?q=10%2c736%2c877 SHIP2 is an important factor to tumor initiation and have suggested SHIP inhibition as a potential methodology to

			treat breast and colorectal cancer. This invention employs the use of a tryptamine based SHIP2 inhibitor that can be utilized as a new methodology of treating these conditions
Micro Environmental Control System	H. Ezzat Khalifa	NA	https://patents.google.com/patent/US10782052B2/en?q=10%2c782%2c052 This technology allows for an effective added micro environment temperature control system to improve heating and cooling of already existing large-scale systems in offices and/or other spaces, to reduce energy consumption
Efficient Channel Estimation and Symbol Detection for Massive MIMO-OFDM	Biao Chen	Michael J. Gans John Matyjas	https://patents.google.com/patent/US10785060B2/en?q=10%2c785%2c060 The system may be used to improve broadband wireless communications, satellite to ground communications, and air to ground communications
Use of Lipids for Preventing Fretting Corrosion in the Modular Tapers of Orthopedic Implants	Jeremy Gilbert	David Pierre	https://patents.google.com/patent/US10806822B2/en?q=10%2c806%2c822 The invention comprises the use of a layer of lipids within the taper junction of a modular orthopedic implant, such as a hip or knee replacement, to protect against fretting corrosion (the corrosive reaction that occurs when two metallic components rub together)
Saposin B Binds the Lipofuscin Bisretinoid A2E and Prevents its Enzymatic and Photo Degradation	Robert Doyle	NA	https://patents.google.com/patent/US10813981B2/en?q=10%2c813%2c981 Invention is useful in the treatment and/or prevention of a disease or indication associated with accumulation of a bisretinoid, for example A2E. In many embodiments, the disclosed methods and compositions are useful in treating an eye disease such as macular degeneration
Method for Predication of a DNA Profile Mixture Ratio	Michael Marciano	Jonathan Adelman Laura Haarer	https://patents.google.com/patent/US10854316B2/en?q=10%2c854%2c316 This invention combines statistical and biological approaches processed by using a combinational algorithm to enumerate all potential DNA mixture scenarios within a single DNA marker. Provides a deeper understanding of the DNA mixture beyond the capacity of human computation.
Shape Memory Assisted Self-Healing Polymers Having Load Bearing Structure	Patrick Mather	Wenyang Pan	https://patents.google.com/patent/US10875282B2/en?q=10%2c875%2c282 The invention is a new self-healing shape memory polymer to be used for sensors, actuators and smart devices with a potential for a variety of applications.
Passive Nano-Heat-Pipes for Cooling and Thermal Management of Electronics and Power Conversion Devices	Shalabh Maroo	An Zou Manish Gupta	https://patents.google.com/patent/US10881034B2/en?q=10%2c881%2c034 The invention is a cooling system for an electronic device that can be added to devices after market or incorporated during manufacturing. Capable of cooling electronics and power

			conversion devices and maintaining the optimal operating temperature.
Single-Molecule Pore-Based Sensor for Proteins and Transient Protein-Protein Interactions	Liviu Movileanu	Avinash Thankur	https://patents.google.com/patent/US10921309B2/en?q=10%2c921%2c309 The invention is a modification of a protein based nanopore that in combination with other technology will allow it to detect protein interactions, which can help in the diagnosis of diseases, including cancer.
Shape Memory Assisted Self-Healing Polymeric Amorphous Coatings	Patrick Mather	Sabrina Crandall Xiaofan Luo Erika Rodriguez	https://patents.google.com/patent/US10935699B2/en?q=10%2c935%2c699 The invention is a blend of polymers that can repair coatings for optical lenses, windows, and paint topcoats on motor vehicles.
Dried Attractive Lure and Kill Stations for the Control of Aedes Aegypti	David Larsen	Anna Stewart Marco Neira	https://patents.google.com/patent/US10954358B2/en?q=10%2c954%2c358 The invention is for a dried attractive toxic bait station that would lure and kill <i>Ae. Aegypti</i> and other mosquitoes.
System and Method for Inter-Species DNA Mixture Interpretation	Michael Marciano	Jonathan Adelman	https://patents.google.com/patent/US10957421B2/en?q=10%2c957%2c421 The invention is a method of providing a hybrid machine learning approach that enables rapid and automated deconvolution of DNA mixtures of multiple contributors.
Cooling Charge Determination for a Local Thermal Management System	H. Ezzat Khalifa	NA	https://patents.google.com/patent/US10955151B2/en?q=10%2c955%2c151 The invention is a system and method for estimating the amount of cooling remaining in a latent heat thermal storage module of a local environmental control system.
System and Method for Automated Detection of Figure Element Reuse	Daniel Acuna	Konrad Kording	https://patents.google.com/patent/US10997232B2/en?q=10%2c997%2c232 The invention is a system and method to detect the reuse of images in articles or other publications.
Synthesis of Superhydrophobic Microporous Surfaces Via Light-Directed Phytopolymerization and Phase Separation	Ian Dean Hosein	NA	https://patents.google.com/patent/US11022888B2/en?q=11%2c022%2c888 The invention is the formation of microporous surfaces through polymer induced phase separation in a photopolymer solvent mixture. Allows for the manufacture of polymer membranes using inexpensive and safe light sources with the ability to control pore size and spacing.

Start-up Companies Formed

None

Licensing Agreements

Project	Inventor	Licensing Partner
100917, 100951	Jeongmin Ahn	Delaware based energy tech start-up (name of partner is confidential)
100667, 100754	Rebecca Bader	Massachusetts based biotech company (name of partner is confidential)

Royalties

None

Small Business Assistance Provided

From July 1, 2020, to December 31, 2020, we supported 25 small businesses with a total of \$220,274.97 in support. From January 1, 2021, to June 30, 2021, we were able to support 32 small businesses with a total of \$259,950.44 in support. Our CASE team was able to provide our small businesses with a cumulative total of \$480,225.41 in support during the 2020-2021 project year, allowing small businesses to continue production, growth, and employment.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$272,740	\$694,495	\$68,614	\$1,035,849
Indirect Costs	\$18,074	\$32,140	\$10,292	\$60,506
Equipment	\$0	\$20,000	\$0	\$20,000
Materials & Supplies	\$0	\$8,426	\$0	\$8,426
Tuition	\$0	\$0	\$7,574	\$7,574
Travel	\$0	\$1,638	\$0	\$1,638
Subcontractors	\$0	\$79,581	\$29,746	\$109,327
Other	-\$67,121	\$47,584	\$0	-\$19,537
Total	\$223,693	\$883,864	\$116,226	\$1,223,783

Total Federal: \$0**Total In-kind: \$0**

Center for Advanced Technology in Big Data and Health Sciences University at Buffalo

Dr. Norma Nowak & Jeffrey Dunbar, Co-Directors

Technology Focus

Life Sciences, Enabling Sciences and Agricultural Sciences

Importance to NYS

The University at Buffalo Center for Advanced Technology in Big Data and Health Sciences (UB CAT) engages NYS companies in collaborative projects with University experts and infrastructure to advance innovations in life sciences through funding applied research projects. These activities result in company growth through job creation, increased ability to raise investment funds, and increased revenues positively impacting the economy of NYS.

Description of Achievements

Fifteen collaborative projects with companies including Concarlo Holdings, Garwood Medical, EVQLV, Manhattan Biosolutions, POP Biotechnologies, You First Services, and Rheonix were supported by the UB CAT. These UB CAT industry partners made significant progress towards achieving their company goals despite the COVID-19 pandemic. Several addressed the COVID-19 healthcare crisis such as You First Services with a device that eliminates airborne pathogens, Rheonix leveraged their microfluidics technology platform for COVID-19 diagnostic lab testing, and a joint project between Manhattan Biosolutions and EVQLV focused on the discovery and development of next generation immunotherapies for cancer through leveraging artificial intelligence algorithms to generate drug/antibody candidates. Infections developed as a result of joint replacement are a costly healthcare problem. Garwood Medical’s BioPrax™ is a minimally invasive device designed to prevent and potentially treat biofilm infections in prosthetic joint and osseo-integrative limb replacements through effective electrical stimulation treatments. These infections have devastating results for patients, and result in a costly healthcare problem. POP BIO, a UB startup, is leveraging their CoPoP technology to generate more long lasting highly effective vaccines for major healthcare concerns including infectious diseases such as COVID-19, RSV (Respiratory Syncytial Virus), cancer and Alzheimer’s Disease. POP BIO entered into a collaboration with EuBiologics to generate a SARS-CoV-2 vaccine resulting in the technology being approved and advanced for human trials. Concarlo Holdings is developing a therapeutic toolkit for difficult to treat metastatic breast cancer, utilized their CAT funding to generate data that led to an NIH Phase I SBIR grant.

For the 2020-21 FY, the program yielded \$ 28.7 million in non-job impacts and 103 new jobs across New York State.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
103	9	\$6,221,459	\$775,895	\$2,961,869	\$17,690,000	\$25,000	\$27,674,223

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
14	15	9	6

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
Dhaval Shah, PhD, named 2020 North American New Investigator Award Winner	November 2020	International Society for the Study of Xenobiotics	https://www.issx.org/news/538157/Dhaval-K.-Shah-Named-ISSX-2020-North-American-New-Investigator-Award-Winner.htm
Albert Titus, PhD, named to National Academy of Inventors	June 2021	National Academy of Inventors	https://www.buffalo.edu/campaign/priorities-and-goals/new-themes-parent-page/future-leaders.host.html/content/shared/smb/news/2020/12/titus-nai-fellow-12478.detail.html
Yun Wu, Ph.D., received the Technology Impact Award	2020	Cancer Research Institute	Yun Wu, Ph.D. - Technology Impact Award - Cancer Research Institute (CRI)

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Co-Investigator	Source	Amount	Duration (yrs)	Summary
Electrical Stimulation for Infection Control of the Skin-Implant Interface of Osseointegrated Prostheses	Mark Ehrensberger, PhD	Garwood Medical	US Army Medical Research Acquisition Activity	\$744,188	2	Optimization of a novel electrical stimulation technology to prevent and/or eradicate infections at the skin-implant interface for osseointegrated prosthetic limbs
Integrated pH Sensor for Smart Wound Care	Albert Titus, PhD	Garwood Medical	Strategic Partnership for Industrial Resurgence (SPIR) Grant	\$13,456	1	For wound healing, pH can be used as a measure of the status of the healing process. It is clearly beneficial to have pH measurement devices that can be implanted or worn on the surface of the body
Early Detection and Immunomodulation of PD-1 Inhibitor Induced Cardiotoxicity	Jonathan Lovell, PhD		Health Research Inc	\$17,398	1	Brings together a combined expertise of a cardiac/thoracic pathologist, a cardiac MRI expert and a biomedical engineer to study the early detection and immunomodulation of ICI-induced cardiotoxicity
Optimization of sustainable double emulsion microsphere manufacturing	Praveen Arany	Optimed	Fuzehub	\$50,000	1	Streamline the downstream manufacturing process to achieve a cost-effective, sustainable, environment friendly technology
Novel Inhibitor for the treatment of ER+ metastatic breast cancer	Yun Wu	Concarlo Holdings LLC	NIH SBIR	\$15,000	1	Develop a novel drug, IpY, to improve advanced ER/PR+, Her2-breast cancer outcomes

Pathophysiology of Left Ventricular Stiffening in Heart Failure	Brian Weil		National Heart Lung and Blood Institute	\$397,476	1	Reduce the high morbidity and mortality associated with Heart failure with preserved ejection fraction (HFpEF), an increasingly prevalent disease
Quantitative Fluorescence Imaging-Guided Detection and Targeted Therapy Monitoring Platform for Ovarian Cancer Micrometastases	Jonathan Lovell		Wright State University	\$91,049	1	Implement a quantitative laparoscopic imaging and treatment approach for advanced detection of micromets and optimization of CPT for targeted destruction of ovarian micromets and reduced toxic side effects
Tolerance Inducing Phosphatidylserine (TIPS): a nanoparticle based platform for immunotherapy	Sathy Balu Iyer		Empire Discovery Institute	\$102,480	1	The project also aims to identify mechanism-based biomarkers to support future translational studies in Immunotherapy.
A System to Optically Determine the Absolute Membrane Potential in Human iPSCD Cardiac Myocytes	Randall Rasmusson	Cytcybernetics	NSF SBIR	\$51,300	1	Develop and optimize a validated, reliable, robust, and easy to use turn-key kit for optical analysis of h-iPSC cardiac myocyte electrical activity with the unique feature of measuring absolute membrane potential
Companion biomarker development of TF-antigen assay	Yun Wu		Health Research Inc	\$28,000	1	The goal is to test a newly developed liquid biopsy for precision cancer immunotherapy

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

UB CAT provides a wide range of workforce development opportunities for a variety of ages and education levels to build the workforce for meeting the demand of new and growing companies in life sciences. Highlights include an NIH Science Education Partnership Award (SEPA) to UB professors Dr. Steve Koury, with Dr. Nowak as Co-PI and Dr. Small as key contributor. This grant provides training for high school teachers and students in metagenomics, bioinformatics and scientific laboratory techniques. Dr. Small developed educational materials on vaccine development and safety, hosted community “Vaccine Chats,” and continues to support The Research Laboratory High School. UB CAT provides various experiential learning opportunities to UB students by way of CAT funded projects, internships with our data analytics group and placement of UB student assistants in companies we support.

Commercialization

UB CAT takes an integrated view of commercialization efforts: for example, all outreach on behalf of UB life science technologies first considers whether a technology can be targeted to a NYS company to promote both successful licensing and CAT-sponsored research interactions. New UB startups developing life science technologies are informed of and referred to the UB CAT. The presence of the UB CAT, and the knowledge that

resources are available specifically to support and advance Life Sciences startups, has in turn helped drive commercialization, encouraging entrepreneurial researchers to found their own companies and engage with commercial partners.

Invention Disclosures /Patents

Confidential

Start-up Companies Formed

Company Name	City	Product/Service	Sector
AmritX, Inc.	Buffalo, New York	Pharmaceuticals	Pharmaceuticals

Licensing Agreements

Confidential

Royalties

Confidential

Small Business Assistance Provided

The primary type of assistance provided to young companies supported through the UB CAT was to enable no cost extensions on funded projects. The majority of our company partners were impacted by supply chain issues as a result of the pandemic. The UB CAT facilitated sourcing of certain lab supplies needed for critical projects from other vendors or UB labs. UB CAT companies located in the UB Center of Excellence in Bioinformatics and Life Sciences benefited from remaining open as essential healthcare and research businesses. This environment provided PPE, and disinfectant products to keep the company staff safe and healthy.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	NYSTAR Funding	Matching Funds		Total
		Company Cost Share	Other Sources	
Salaries & Fringe	\$324,979	\$111,653	\$367,001	\$803,633
Indirect Costs	\$48,747	\$16,748	\$53,074	\$118,569
Equipment	\$0	\$9,750	\$0	\$9,750
Materials & Supplies	\$95,431	\$137,976	\$82,576	\$315,983
Tuition	\$7,175	\$6,164	\$0	\$13,339
Travel	\$0	\$0	\$0	\$0
Subcontractors	\$0	\$0	\$0	\$0
Other	\$115,940	\$110,321	\$195,930	\$422,191
Total	\$592,272	\$392,612	\$698,581	\$1,683,465

Total Federal: \$214,754

Total In-kind: \$0

Center for Advanced Technology in Emerging and Innovative Sciences (CEIS)

University of Rochester

Mark Bocko, Director

Technology Focus

Photonics and Imaging Science Systems

Importance to NYS

Photonics, Optics and Imaging constitutes a major industry cluster centered in the Rochester and Finger Lake region of New York State. Global revenues for photonics enabled products from displays to telecommunications exceeds \$2 trillion dollars annually and New York State is a major source of the goods and technologies that serve and drive these global markets. Cooperative innovation and technology transfer between our region's Universities and the NY photonics industry cluster has been the priority of CEIS from its founding close to 30 years ago, and we continue to drive innovation and investment in regional resources like AIM Photonics, to provide technology support for major industry partners like L3Harris, Corning, and Carestream, and to support the growth of startup companies like Clerio Vision, LighTopTech, SiMPore and many others.

Description of Achievements

The period July 2020 – June 2021 was challenging for the UR CAT. OSC had a moratorium on many contracts due to the State's financial difficulties related to the pandemic. With a delayed contract, the Center had to delay funding proposals that had been submitted to our call for proposals. Once the CEIS contract was finalized, our team awarded 18 projects with 20 faculty and 13 company partners. The collaborations with industry partners allowed 17 UR and RIT students the opportunity to receive training through their engagement in collaborative University/industry research.

In 2021, CEIS staff decided it would be beneficial to co-host the spring showcase event with the University of Rochester Data Science CoE. FuzeHub support was enlisted for this virtual event. The FuzeHub team was invaluable as they managed the logistics of the online meeting platform and the 4/29 event was very well received. Nevertheless, the team is pleased to return to an in-person Showcase event in 2022.

CEIS was very fortunate to have the full support of the University of Rochester in the most financially challenging period during the early stages of the pandemic. The University's uninterrupted financial support of the Center enabled us to retain all of the CEIS staff without the need for furloughs. This enabled us to carry on the CEIS mission without interruption and ultimately to achieve continued significant economic impact for the year. New CEIS initiatives in two areas also were commenced in the latter part of this reporting period. These include efforts to consolidate and build the emerging regional industry cluster in audio and music related technologies and an initiative to build upon the success of the Testing and Packaging (TAP) facility of AIM Photonics to expand its activities into semiconductor packaging. CEIS continues to work with regional economic development entities to advance these two initiatives.

Impacts

New Jobs	Retained Jobs	Increased Revenues	Cost Savings	Govt Funds	Non-Govt Funds	Capital Improvements	Total Impacts
12	18	\$1,600,507	\$5,143,669	\$18,090,718	\$18,545,000	\$720,000	\$44,099,894

Companies Served and Projects

# of Companies Served	# of projects on-going	# of projects completed	# of students engaged with companies
11	10	7	17

Designations and Recognitions

Awards / Recognition	Date Received	Recognizing Organization	Link
Jannick Rolland - Fellow of the National Academy of Inventors (NAI)	December 8, 2020	National Academy of Inventors (NAI)	https://www.prnewswire.com/news-releases/national-academy-of-inventors-announces-2020-fellows-301187629.html ; http://www.hajim.rochester.edu/optics/news-events/na-faculty.html
Mark Bocko - Edmund A. Hajim Outstanding Faculty Award	May 25, 2021	University of Rochester at 171 st commencement	https://www.hajim.rochester.edu/bravo/2021-05-25-bocko-faculty.html
Thomas Brown - Mercer Brugler Distinguished Teaching Professorship	June 17, 2021	University of Rochester	https://www.rochester.edu/newscenter/2021-merc-er-brugler-professorships-honor-outstanding-educators-484472/

Federal or Not-for-Profit Grants Awarded

Project	Principle Investigator	Source	Amount	Duration (yrs)	Summary
Femtosecond-Laser-Based Welding System prototype	Jie Qiao – RIT Chester F. Carlson Center for Imaging Science	FuzeHub award to partner Aktiwave, LLC	\$49,898	1 year	This collaboration aims to open the path for flexible, high-precision, and autogenous fabrication and integration of photonic/medical devices and sensors with improved instrument lifetime and reliability.

Education and Technology Commercialization Activities

Industry-Oriented Education and Training

The UR research team has routine, biweekly project meetings with Clerio Vision, Inc. to share results obtained and to strategize about scientific questions, technological issues, manufacturing and commercialization goals of this project. Prof. Huxlin guest-lectured in a Clerio Vision seminar series in July, presenting a synopsis of her work in corneal biology, wound healing and corneal nerve physiology and pathology – key aspects of the work being funded by CEIS. The PI has trained several Clerio employees in giving outreach presentations. Prof. Knox presents four optics demonstrations at a local YMCA.

RIT team has had two quarterly meetings with the Bausch +Lomb team to present our research findings, and to collect information and insight from the team. The team has added another member to the contact lens research and development team—Dr. Lucia Carichino—who has begun to work on the problem of deformation of the eye in response to suction pressure produced by the contact lens.

The PI presented “Benchmarking Domain Adaptation Methods for Aerial Images,” via an online meeting with Kitware and the Air Force in May 2021.

Internal Workforce Development

- **Clerio Vision, Inc.** - The broad project team spans PhD, MS, and UG levels. At the PhD level, trainees are currently pursuing PhDs in Optics, Mechanical Engineering, or Materials Science on topics related to this project. Two students successfully defended their PhD theses. Because of the multi-disciplinary nature of the research, the students are well trained in optical systems, instrumentation, and data analysis. The team regularly works with two research engineers at Clerio. It is an excellent model for interactions with Clerio wherein students can get an excellent education and experience with the corporate ('startup') environment. Professor Lerner leads the BME Senior Design program, in which students develop designs in response to problems proposed from external partners in the medical center or industrial partners. This course models an engineering workplace approach and is excellent training for students pursuing careers in industry.
- **Corning, Inc.** – Two MS students graduated; one in summer term (continuing at RIT in Ph.D. program) and one in Fall semester 2020 (hired into a position at Qualcomm). There was a direct hire of a dedicated process technician for project supported by CEIS funds (position maintained).
- **RAM Photonics** - This research project supported the training of one MS student and one PhD student.
- **Thermo Fisher Scientific** – A graduate student spends substantial time using the testing facility at Thermo Fisher in Syracuse. He has collaborated with staff at Thermo Fisher involved in detector testing. He has also been instrumental in cross calibrating the NIST and Thermo facilities. An undergraduate RIT student has also received training on this project as well.
- **LC Orthopedics** - Two MS students worked on this project, one graduated May 2020, the other will graduate Dec. 2020.
- **Aktiwave, LLC** – One PhD student has worked on this project.
- **Kitware** – Students trained on this project were selected for 2021 summer internships at Qualcomm, Tesla, and Amazon.
- **L3Harris Technologies**– two PhD students, one MS student, and one undergraduate student were involved in this project.

Commercialization

- **Project # 1830C001: James McGrath - Computational Models of Nanomembrane Fouling | Industry Sponsor: SiMPore, Inc.** This project developed a predictive model of fouling on microslit membranes and published this in a supplement to a recent manuscript: Lucas, K., S.D. Ahmad, M. Deghani, T. Gaborski, and J. McGrath, *Critical flux behavior of ultrathin membranes in protein-rich solutions*. Separation and Purification Technology, 2020. 251. The work has been translated to SiMPore, Inc. and they now use our predictions of capacity in numerous projects and product development efforts. We have also presented to the Environmental Health and Science Center Community Advisory Board.
- **Project # STAR RIT 11: Ray Ptucha - Physio-Algorithms for LCOI's Physio Science Products | Industry Sponsor: LC Orthopedics** The technology developed from this grant is being used in products by LC Orthopedics. Customers perform exercises or stretch poses and the camera records progress from week to week. For example, as flexibility increases over time, the new tools can reflect this with increased pitch/roll/yaw.

- **Project # 1930C001: Jie Qiao - Femtosecond laser-based fabrication of photonic waveguides toward waveguide lasers Industry Sponsor: Aktiwave, LLC** The success of this research, jointly developed by Aktiwave and RIT through this CAT project, led to Aktiwave winning an STTR Phase II award from NASA on commercializing the waveguide laser technology enabled by femtosecond laser direct writing of 3D waveguides.

Invention Disclosures /Patents

Disclosure /Patent Name	Inventor	Co-inventor	Research Sponsor	Description
Ophthalmic Lens with Depth-Modulated Optical Structures and Methods of Forming	Wayne Knox	Clerio Vision, Inc. co-inventors	Clerio Vision, Inc. and CEIS (NYSTAR CAT)	High power femtosecond Ytterbium-doped fiber laser-based system for optimization of femtosecond micromachining ophthalmic devices
System and method for ultrasound imaging of tissue through bone PCT/US21/29188, 04/26/2021	Zeljko Ignjatovic	Jovan Mitrovic, William J. Sehnert	Carestream Health and CEIS (NYSTAR CAT)	Ultrasound imaging at high spatial resolution utilizing unique excitation waveform matched to the acoustical response of skull structures and accounts for magnitude and phase of echoes in an image reconstruction process
Pseudo-Random Sparse Arrays for Cost, Area, and Power Savings in Ultrasound Imaging Provisional application 63/260,091	Zeljko Ignjatovic	Jovan Mitrovic, William J. Sehnert	Carestream Health and CEIS (NYSTAR CAT)	Method of separating transducer elements of ultrasound transducer array into two disjoint subsets to reduce hardware complexity, cost, and power consumption in portable medical ultrasound systems while maintaining image quality
Method for Modifying the Refractive Index of Ocular Tissues and Applications Thereof US Patent No.10,813,791 and WIPO 20210042950 Int. Class A61F 9/008 Appl. No 17072286	Wayne Knox	Krystal Huxlin	Clerio Vision, Inc. and CEIS (NYSTAR CAT)	Method for modifying a refractive property of ocular tissue by creating at least one optically modified gradient-index tissue layer in the corneal stroma and/or the crystalline
Optical Device and Method for Modifying the Refractive Index of Optical Material US Patent No. 10,893,936	Wayne Knox	Li Ding and Dharmendra Jani	Clerio Vision, Inc. and CEIS (NYSTAR CAT)	

Start-up Companies Formed

None

Licensing Agreements

None

Royalties

None

Small Business Assistance Provided

Clerio Vision was able to secure a joint development agreement with a leading global ophthalmic company to develop a next generation Silicon Hydrogel-based multifocal contact lens using Clerio’s LIRIC driven optics. The collection of CEIS projects created critical data to assure Clerio’s partner to move forward with the first phase of the development efforts. Savings realized by several years of partnering with CEIS/UR faculty were redirected to refine the treatment nomogram for non-invasive LASIK and is currently generating enhanced results that feed directly into product commercialization.

CEIS support for Prof. Rashedi’s and **DinamicOR** helped solidify the design of the company’s surgical back-table. With that, the company was able to place inventory purchases for new tables, and the corresponding surgical drapes to cover those tables in the operating room. With the COVID-19 pandemic, this collaboration became even more important for DinamicOR from an R&D perspective. They used the business 'downtime' to improve their products; this study played a key role.

The collaboration with CEIS, Prof. Dalecki, and **Imaginant** allowed improvements to the company’s Ultrasound Transducer Technology that led to them creating a new product family which in turn enabled Imaginant to become vertically integrated and to produce Ultrasound Transducers for use with our other products.

Kitware’s partnership with CEIS funded researchers resulted in \$161,000 in cost savings; the estimated cost to replicate the unique and valuable DIRSIG image simulator operations and customizations performed by RIT as well as their research contribution into simulating image characteristics.

The theoretical modeling developed by the Carney group for **SunDensity** (“Company of the Year” in NextCorps’ 2020 Luminate competition) is of critical need for the design of a highly scalable manufacturing process for production of Photonic Smart Coatings (PSC™). Preliminary calculations already served as a tool for guiding the manufacturing process at SunDensity by eliminating inefficient designs, which saved a considerable amount of the company’s resources.

Level of Matching Funds Provided and uses

Expenses (include Federal State, local funds & in-kind)

Operating Expenses	Matching Funds			Total
	NYSTAR Funding	Company Cost Share	Other Sources	
Salaries & Fringe	\$487,131	\$279,272	\$0	\$766,403
Indirect Costs	\$69,101	\$42,891	\$0	\$111,992
Equipment	-\$2,401	\$3,374	\$0	\$973
Materials & Supplies	\$2,428	\$47,327	\$0	\$49,755
Tuition	\$0	\$0	\$0	\$0
Travel	-\$878	\$0	\$0	-\$878
Subcontractors	\$5,561	\$0	\$0	\$5,561
Other	\$4,071	\$65,736	\$0	\$69,807
Total	\$565,013	\$438,600	\$0	\$1,003,613

Total Federal: \$0

Total In-kind: \$0