Montana Board of Research & Commercialization Technology

Business Resources Division
Montana Department of Commerce

"The bottom line is that over the past 10 years MBRCT support has helped leverage more than $30,000,000 in federal research grants and contracts for Montana researchers affiliated with the CSFN! Clearly, the investment by the MBRCT has yielded an exceptional return."

Richard Bridges
Professor of Pharmacology and Toxicology
University of Montana, Missoula

$38 million in Awards

$301 million in Follow-On Funds

50 Products Commercialized

As of January 2013

MONTANA
DEPARTMENT OF COMMERCE

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Executive Summary

Since it began operations in 2000, the Montana Board of Research and Commercialization Technology (MBRCT) has played an important role in the development and support of technology-based Montana companies. This support has assisted Montana companies to complete research projects, resulting in the commercialization of products and services. In many cases, these research projects have strengthened cooperation between the private sector and the Montana University System.

MBRCT has also supported many university-based projects. These efforts generally fall into two broad categories: 1) projects that increase the research infrastructure in the Montana University System by supporting basic research and facilitating the hire of researchers who have the ability to attract dollars and additional research expertise to their respective institutions, and 2) projects that involve the collaboration with Montana technology companies, resulting in the transfer of intellectual property that can be commercialized.

MBRCT will continue to play an important role in the expansion of research capabilities and the commercialization of technologies developed with MBRCT funds.

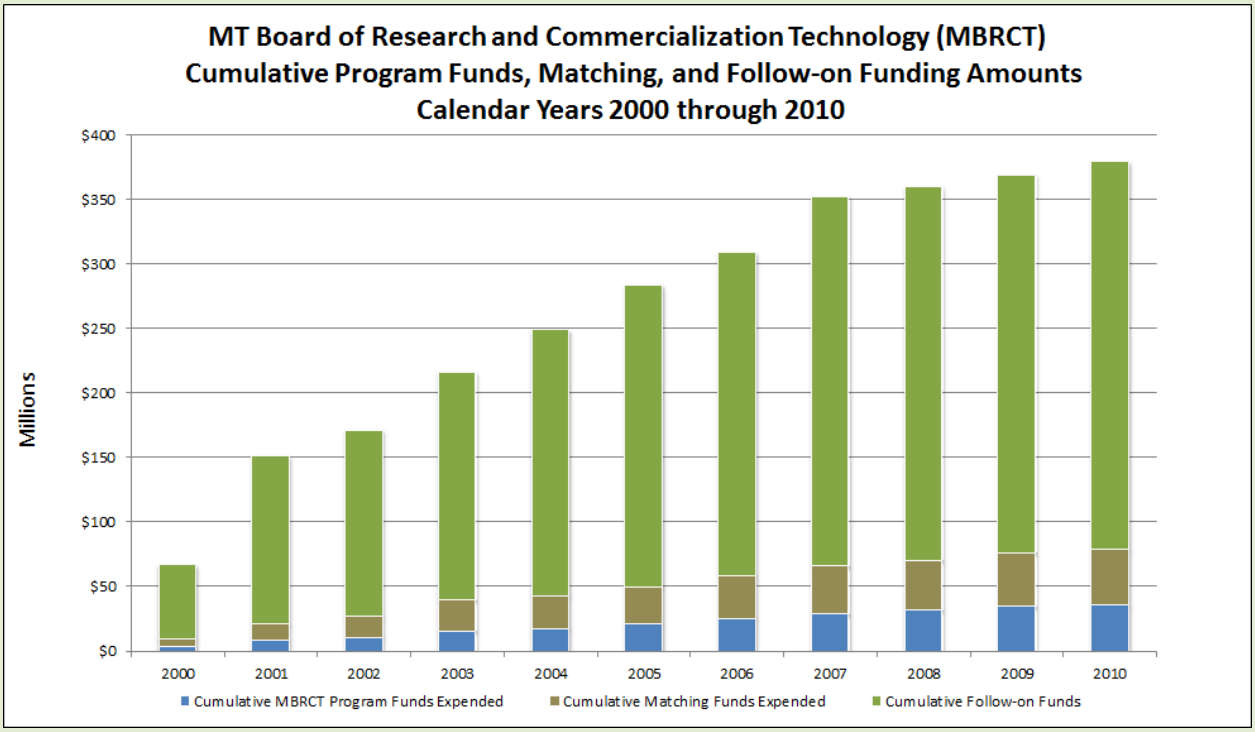
Impact of MBRCT Funds

- 185 projects have been funded with a total of $38 million in grants.
- $301 million in follow-on funding has been funneled into Montana from such sources as federal agencies, educational institutions, private businesses, non-profit associations and other state governments. This has resulted in $7.92 in follow-on funding for every dollar granted by the program.
- The program has generated $1.16 in matching funds for every grant dollar awarded. Matching funds total $44 million.
- 50 projects have been commercialized, ranging from new wheat varieties to sensors and lasers to biofilm reactors.
- 153 of the projects have student participation, providing financial support and training in science and technology academic fields and some of these students have been hired by companies funded by the program. Faculty members are principal investigators for 117 of the research projects conducted at their respective universities.
- 12 start-up companies have resulted from program research projects.
- In addition to 12 start-up companies, 36 company expansions have resulted from program research projects.
- 225 scientific publications and professional presentations have resulted from program research projects.

Executive Summary – page 2

Impact of MBRCT Funds (Continued)

- 135 patents have been applied for and/or received.
- 22 licensing agreements have been completed or are under negotiation.
- 87 Montana companies are program collaborators. These companies are grant recipients, have sold products resulting from program research projects or have otherwise been directly involved in program projects.



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Mission Statement

Montana Board of Research & Commercialization Technology

The mission of the Montana Board of Research & Commercialization Technology is to support the development of research and technology that has commercial potential within Montana by providing leadership and funding resources for those activities.

The objective is to award funds to research and commercialization projects with significant potential to improve the state's economy by:

- *Supporting clean coal research and development projects, and renewable resource research and development projects;*
- *Supporting production agriculture projects that improve production capability, value-added opportunity and alternative crop options;*
- *Supporting projects that have the involvement of private companies;*
- *Supporting projects that enhance the state's research infrastructure;*
- *Supporting projects that show a clear path to commercialization in Montana; and,*
- *Providing oversight management of awarded grants.*

MBRCT Program & Funding Decision Process

The Montana Board of Research and Commercialization Technology was created by the Montana Legislature to provide a predictable and stable source of funding for research and commercialization projects to be conducted at research and commercialization centers in Montana. The purpose of the program is to encourage economic development through investment in research projects that have a clear path to commercialization.

Eligible Applicant

Montana-based research and commercialization centers defined as:

- Campuses of the University of Montana or Montana State University
- Tribal Colleges
- Colleges of Technology and Community Colleges
- Agricultural Research Centers
- Private Laboratories and/or Research Centers

Award Criteria

The six-member Board takes the following criteria into account when making funding decisions:

- Has potential to diversify or add value to a traditional basic industry of the state's economy
- Shows promise for enhancing technology-based sectors or commercial development of discoveries
- Employs or takes advantage of existing research and commercialization strengths
- Has a realistic and achievable project design
- Employs an innovative technology
- Has a qualified research team
- Has scientific merit based on peer review
- Includes research opportunities for students

Board Members

Marty Connell, Billings
Jim Davison, Anaconda
Erik Somerfeld, Power
Tom Tanner, Arlee
John Youngberg, Bozeman

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Montana Scientific Research & Development Industry Sector

Montana's Research and Development Industry Sector is a vibrant part of the state's economy and its on-going growth.

A recent US Chamber of Commerce report (June 2012) ranked Montana fourth in the nation in entrepreneurship and innovation. Since 2002, the state has added 3,200 STEM (science, technology, engineering and mathematics) jobs to its economy, led by growth in engineering services, computer systems design, information technology, and energy industries.

As shown in the tables below, Montana's rate of increase in employment and payroll in the Scientific Research & Development Industry Sector outpaced the growth in the U.S. as a whole. MBRCT will continue to play an important role in the development of Montana's research and development sector.

Montana Scientific Research & Development Industry Sector

Key Statistics	2001	2011	% Change 2001 to 2011
Total Number of Establishments with Employees	129	147	14% increase
Total Employment of all Establishments with Employees	662 workers	1,028 workers	55.3% increase
Total Annual Payroll paid to all employees	$24.4 Million	$61.9 Million	153.7% increase
Avg. Annual Wage per employee	$36,881	$60,256	63.4% increase

Source: Bureau of Labor Statistics, Quarterly Census of Employment & Wages (QCEW)

US Scientific Research & Development Industry Sector

Key Statistics	2001	2011	% Change 2001 to 2011
Total Number of Establishments with Employees	19,606	24,186	23.4% increase
Total Employment of all Establishments with Employees	530,832 workers	630,378 workers	18.8% increase
Total Annual Payroll paid to all employees	$36.0 Million	$64.8 Million	79.6% increase
Avg. Annual Wage per employee	$67,934	$102,761	51.3% increase

Source: Bureau of Labor Statistics, Quarterly Census of Employment & Wages (QCEW)

MBRCT Investment in Agricultural Research

MBRCT Award	Matching Funds	Follow-On Funding	Leverage Ratio
$6,528,445	$6,030,829	$30,408,400	4.7 to 1

Figures reflect actual funds expended

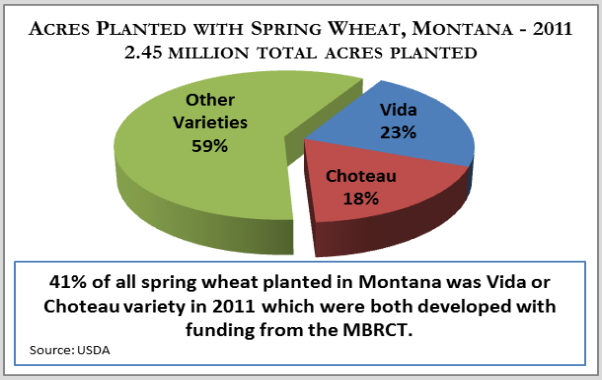
The importance of the agricultural industry in Montana is well known and the program has supported many projects that have generated impressive results.

Sample of Funded Projects

- MSU identified durum wheat lines with the low cadmium-accumulation gene then crossed them onto high quality lines that are adapted to Montana. Cadmium is a nonessential heavy metal that causes health problems for some people. New durum varieties low in cadmium open up international markets, including the European Union.
- Bee Alert Technology, Inc. conducted research leading to a patented Colony Health Scanner, which is a fully integrated, remote hive health monitoring system for bee colonies. This device can scan a honeybee colony and quickly indicate the health of that colony. With honeybee colony devastation resulting from Colony Collapse Disorder, the crucial role of bee pollination has been brought to the attention of the general public.

Montana's Agricultural Industry

In 2010, agriculture generated $2.6 billion in income on 29,400 farms and ranches – making it the largest industry sector in Montana.
Source: Montana Department of Agriculture Web Site



- According to Dr. Jerald Bergman, Superintendent at MSU Eastern Agricultural Research Center, MBRCT grant activity had a very positive influence on Anheuser-Busch's decision to locate a $6.8 million malt barley handling and storage facility in Sidney.

MBRCT Investment in Agricultural Research - page 2

Sample of Funded Projects

- A funded project at the Eastern Agricultural Research Center (EARC) resulted in the development of "Silver" durum wheat which was released by Montana State University in January 2012. This durum variety is early-maturing and day-length insensitive in contrast to all other varieties in Montana. Because of its day-length insensitive characteristic, "Silver" durum can be grown in any part of Montana and matures at the desired time.

- Other high value crop research at EARC allowed sugar beet producers to produce the same high quality crop with less water and greatly improved weed control. With research dollars from MBRCT, the Center also developed the *Mondak Gold* potato which now has yearly commercial production of over 1,200 acres.

> ***…"it is very rewarding to have the grant resources to conduct this pertinent research to support irrigation development and the commercialization of high-value and value-added crops including the malt barley industry."***
>
> Dr. Jerald Bergman
> Superintendent
> MSU Eastern Agricultural Research *Center*

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MBRCT Investment in Energy & Mining Research

MBRCT Award	Matching Funds	Follow-On Funding	Leverage Ratio
$3,998,377	$4,164,348	$32,816,569	8.2 to 1

Figures reflect actual funds expended

Starting in 2009, the program has directed 30% of its annual funds to energy technologies either through clean coal or renewable resources.

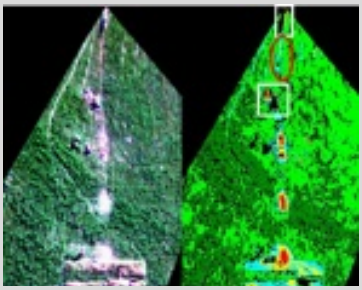
Sample of Funded Projects

- Montana Tech has successfully developed, tested and patented a metallic mercury filter that can remove mercury from flue gas, such as is emitted from coal-fired plants. Coal and coal-fired power generators are major contributors to Montana's economy and industrial growth. In Montana 45% of all electricity is generated from coal.
- Another project is conducting the assessment of in-situ gasification of deep coal beds in Eastern Montana. In-situ gasification is a method of controlled burning of deep coal beds; the resulting gases are captured, processed into a useable synthetic gas, and fed into pipelines or converted to liquids.
- Many different companies are conducting research to develop renewable and alternative energy resources. Biofuels are being tested along the Hi-Line, Montana Tech is developing cost -effective methodologies for developing geothermal resources, and the Montana Aerospace Development Association (MADA) in Butte is developing and testing Ammonia as an alternative "green fuel" for electric power generation applications.

Montana's Energy Sector

Since 2005, projects utilizing coal, natural gas, wind, hydro, landfill gas, and process heat have added **more than a gigawatt (1169.3 MW)** of new generation capacity across Montana.

Source: Energy Promotion Division MT Department of Commerce



- Montana Tech has completed a study examining the use of alkaline sulfide solution as a method to recover gold from ore and ore concentrates. The advantage of this approach is the ability to effectively leach and recover gold without the use of toxic alternatives such as cyanide.

MBRCT Investment in Energy & Mining Research - page 2

Sample of Funded Projects

- Several projects are also exploring ways to transform Montana's coal into hydrogen or gas, use CO_2 sequestration for clean coal production and enhance the methodology for removing sodium from coal.

- Resonon, Inc. in Bozeman is working with MSU to develop a system for indirectly detecting carbon-dioxide leaks from underground pipelines and reservoirs that may occur from carbon sequestration activities. This is part of a line of imaging spectrometers products from Resonon which have multiple applications in the agricultural, mining, biomedical and environmental monitoring sectors.

- Purity Systems Incorporated (PSI) of Missoula and the University of Montana collaborated on Immobilized Metal Polyamine Composites (*IMPAC*) which is successfully used in arsenic and selenium remediation and removal. Initial commercialization of earlier work funded by MBRCT has occurred at the Redbank Mines copper recovery project in Australia.

…"I hope the MBRCT is supported by this state for the next decade. Keep up the good work!"

Michael Utter CEO - Rural Community Innovations - Bozeman

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MBRCT Investment in Biotech & Medical Research

MBRCT Award	Matching Funds	Follow-On Funding	Leverage Ratio
$8,909,421	$7,791,938	$70,537,762	7.9 to 1

Figures reflect actual funds expended

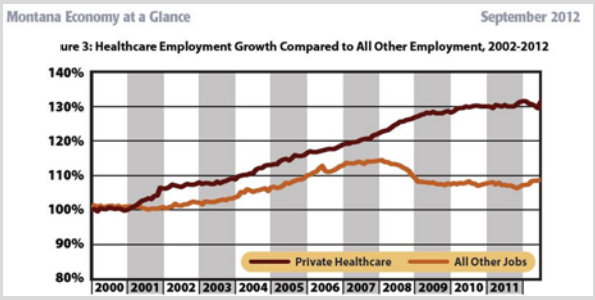
Thirteen different companies along with four branches of the Montana University System have received funding from the MBRCT program for biotech and medical research.

Sample of Funded Projects

- At the University of Montana in Missoula, funds have been committed to a multi-year project which leverages a National Institutes of Health (NIH) Center of Biomedical Research Excellence (COBRE) award. This effort has established the Center for Structural and Functional Neuroscience (CSFN) for the purpose of providing needed infrastructure to increase the competiveness of biomedical research efforts in Montana. The project has created an environment at the CSFN where products and technologies are being developed and collaborating Montana companies are commercializing them. Four start-up companies have resulted from these efforts, and $37 million in additional funding has been brought into Montana by researchers affiliated with the CSFN.

Montana's Health Care Industry

The healthcare industry is the second largest private employer in Montana, with more than 59,000 jobs. This means that 1 in 6 jobs in Montana's private sector are in the health care industry.



Source: Montana Department of Labor & Industry, Research and Analysis Bureau

- Bacterin International, Inc. in Belgrade has developed and commercialized an allograft based bone void filler for surgical bone grafting applications. MBRCT funding was essential to the concept development and preclinical studies of this Class II medical device.

MBRCT Investment in Biotech & Medical Research – page 2

Sample of Funded Projects

- WaveSource, Inc., in Whitefish, is developing multifocal soft contact lenses to improve non-surgical vision for people who require vision correction. Through advanced lens design and fitting software, WaveSource takes highly accurate optical measurements of the eye and generates a lens that is personalized for every individual. When combined with the WaveSource simplified fitting and design software, patients can be corrected to a high level of accuracy, greatly improving visual clarity.
- Montana Tech and Montana State University collaborated on a project to employ novel, recently discovered viruses to combat serious bacterial infections that are otherwise untreatable using existing antibiotics. The idea is that combining nanoparticles and bacteriophages that infect the same bacterial species will result in extremely effective treatments with potential for low-cost clinical translation.

…"sales for the OsteoSelect product generated $4.7 million in revenue for 2011 and $2.9 million for the first six months of 2012… and projected total sales for 2012 of approximately $6.7 million…thanks again for your support in making this product a reality."

Gregory Juda, Chief Scientific Officer, Bacterin International, Inc., Bozeman

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MBRCT Investment in Photonics & Optics Research

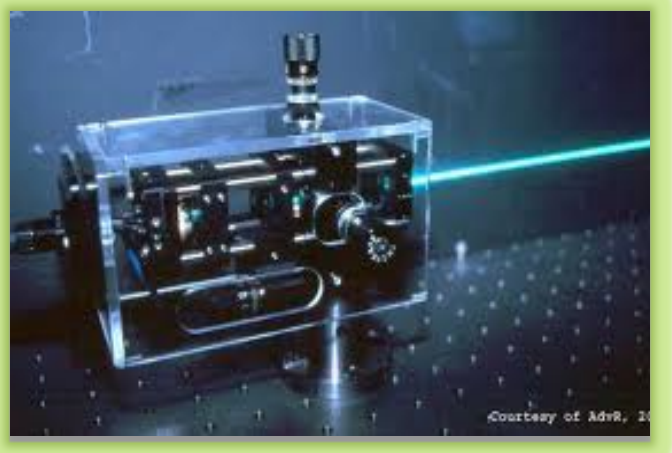
MBRCT Award	Matching Funds	Follow-On Funding	Leverage Ratio
$5,909,871	$7,747,125	$76,842,404	13.0 to 1

Figures reflect actual funds expended

The MBRCT program has provided, on average, a little over $500,000 per year since 2000 to various photonic and optic research recipients. As an industry group, this research has resulted in the highest amounts of follow-on funding. Follow-on funding is defined as funding obtained by the project after MBRCT participation.

Sample of Funded Projects

- Lasers, sensors, optical imaging devices, spectrometers and waveform generation are all being researched, tested, developed, and commercialized by Montana universities and private sector businesses.
- Bridger Photonics, Inc. and MSU have developed a novel mirror that, with the use of voltage, can be deformed into a curved shape to focus light without mechanical motion. Bridger Photonics in Bozeman plans to use this technology to make compact zoom lenses with no moving parts for cell phone cameras.
- AdvR Inc. of Bozeman develops, manufactures, and sells engineered optical crystals and forward integrated photonic products. Early funding from MBRCT grants allowed the company to develop its engineered crystals for use in industrial, university, and government laboratories. Continued funding has allowed the development of the packaging of these materials for ease of use and to create a wider customer base.



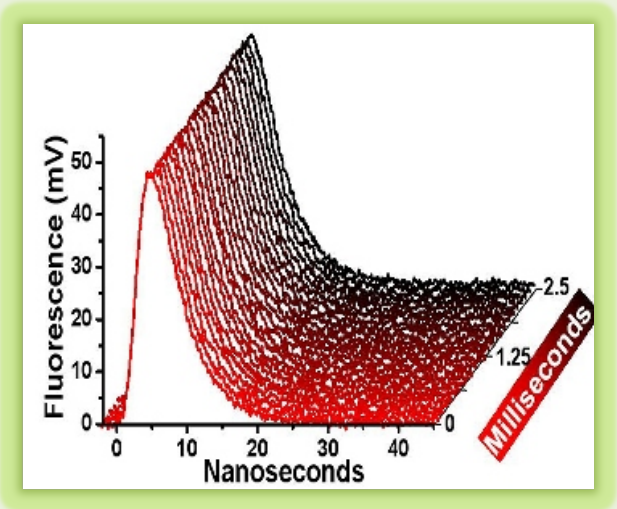
MBRCT Investment in Photonics & Optics Research – page 2

Sample of Funded Projects

- S2 Corporation in Bozeman was contracted by Northrop Grumman as the sole-source provider of a turnkey stable laser system. Applications for ultra-stable lasers include: compact stable continuous wave lasers; compact stable mode locked lasers that can provide periodic trains of optical pulses; and, mode locked lasers which have new uses in material characterization and system development.

- ILX Lightwave Corporation in Bozeman utilized MBRCT funding to develop a next generation fiber optic power meter that offers the photonic industry's lowest polarization dependent response (PDR). This meter is used by leading fiber optic component manufacturers throughout the world to manufacture and test high performance components such as fiber optic couplers, splitters, and amplifiers. Technology developed with MBRCT funding led to the development of a unique optical integration sphere configuration that exhibits ultra-low PDR while reducing manufacturing cost compared to prior designs.

> ..*"a small number of investments led directly to...the creation and growth of at least two strong Montana companies, and indirectly to the start of at least two other Montana companies."*
>
> Wm. Randall Babbitt - Spectrum Lab - Montana State University, Bozeman



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MBRCT Investment in Other Research

MBRCT Award	Matching Funds	Follow-On Funding	Leverage Ratio
$3,164,269	$2,614,248	$15,655,397	4.9 to 1

Figures reflect actual funds expended

Other research projects cover a wide variety of industries and products including software, bioreactors, carbon dioxide sensors, and biomimetic floating islands.

Sample of Funded Projects

- Floating Island International, with offices in Livingston, Bozeman and Billings, produced and marketed biomimetic, self-sustaining floating islands for remediation of degraded fisheries, wildlife habitats, and human water resources. Funding for this project came from as far away as Beijing Tongzhong Forest Park, Singapore Public Utilities Board and South Africa Wastewater Treatment Experiment.

Bioscience Subsector Industries in Montana

Key Statistics	2001	2011	% Change 2001 to 2011
Total Number of Establishments with Employees	221	272	23.1% increase
Total Employment of all Establishments with Employees	1,533 workers	2,247 workers	46.6% increase
Total Annual Payroll paid to all employees	$58.6 Million	$117.5 Million	100.5% increase
Avg. Annual Wage per employee	$38,277	$52,279	36.6% increase

Source: Bureau of Labor Statistics, Quarterly Census of Employment & Wages (QCEW)

- Developed by Sunburst Sensors, LLC of Missoula, with the assistance of the MBRCT and the National Oceanic and Atmospheric Administration, the autonomous flow through instrument allows researchers to perform shipboard or bench-top analysis of CO_2 and/or pH of a sample stream.

- Developed in part with MBRCT funding, Fluorescence Innovations, Inc. (FI2) in Bozeman has successfully commercialized an innovative fluorescence lifetime spectrometer. The University of Minnesota-Duluth and the University of Kansas were among the first customers for this instrument because of its superior performance. Compared to other instruments in the market place, the FI2 approach produces lifetime data - 100 times faster and with 10 times better repeatability.

MBRCT Investment in Other Research - page 2

Sample of Funded Projects

- S2 Corporation in Bozeman is producing a novel vibration dampening module for cryo-coolers. This unique product has performance specifications which far exceed those of commercial cryo-cooler vendors. Markets include industry and research in spectroscopy, signal processing, quantum computing, academic institutions and other research or scientific studies.

- Resodyn Acoustic Mixers, Inc., an affiliate of Resodyn Corporation, has developed an innovative patented technology called Resonant-Acoustic. This technology utilizes low-frequency, high-intensity acoustic energy to process difficult-to-mix compounds found in many industries such as cosmetics, pharmaceuticals, ceramics, coatings and plastics.

…"on behalf of the team of Floating Island International, I would like to express our sincere appreciation for the funding that the MBRCT has provided for research and commercialization of our products. I believe that this funding has had a very large impact on our chances of long-term commercial success."

Frank Stewart – Stewart Engineering - Bozeman

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MBRCT National Science Foundation and EPSCOR

MBRCT Award	Matching Funds	Follow-On Funding	Leverage Ratio
$7,495,782	$14,897,627	$74,630,984	9.9 to 1

Figures reflect actual funds expended

The National Science Foundation (NSF) is the only federal agency whose mission includes support for all fields of fundamental science and engineering, except for medical sciences.

The NSF EPSCoR (Experimental Program to Stimulate Competitive Research) mission is to assist the National Science Foundation in its statutory function "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education".

Twenty-eight states (including Montana), the Commonwealth of Puerto Rico, Guam, and the U.S. Virgin Islands are currently eligible to compete in the NSF EPSCoR program opportunities.

MBRCT funding has been a critical part of the match requirements with the University of Montana and Montana State University. MBRCT awarded $7.5 million in grant funding over a period of seven years in this successful partnership between the National Science Foundation and the State of Montana. The governing strategy of the grants was to identify and enhance the science and technology capacity of Montana State University and the University of Montana and directly stimulate Montana's economic development. The effort successfully achieved the overall goals, including:

1) Developing target areas to serve as a science and technology foundation to economic development
2) Providing a highly skilled science and technology workforce involved in each of the target areas
3) Establishing new initiatives in education outreach with a significant regional and national impact

The Montana NSF EPSCoR program developed research focus areas by enabling faculty hires, graduate and undergraduate student support, technician hires, equipment for core support facilities, information technologies upgrades, web development and information dissemination, seminars, conferences, and support for visiting scholars at University of Montana, Montana State University, Montana Tech and Tribal colleges. The program joined together past, current and future scientists into Centers of Excellence to build and sustain specific scientific expertise in Montana.

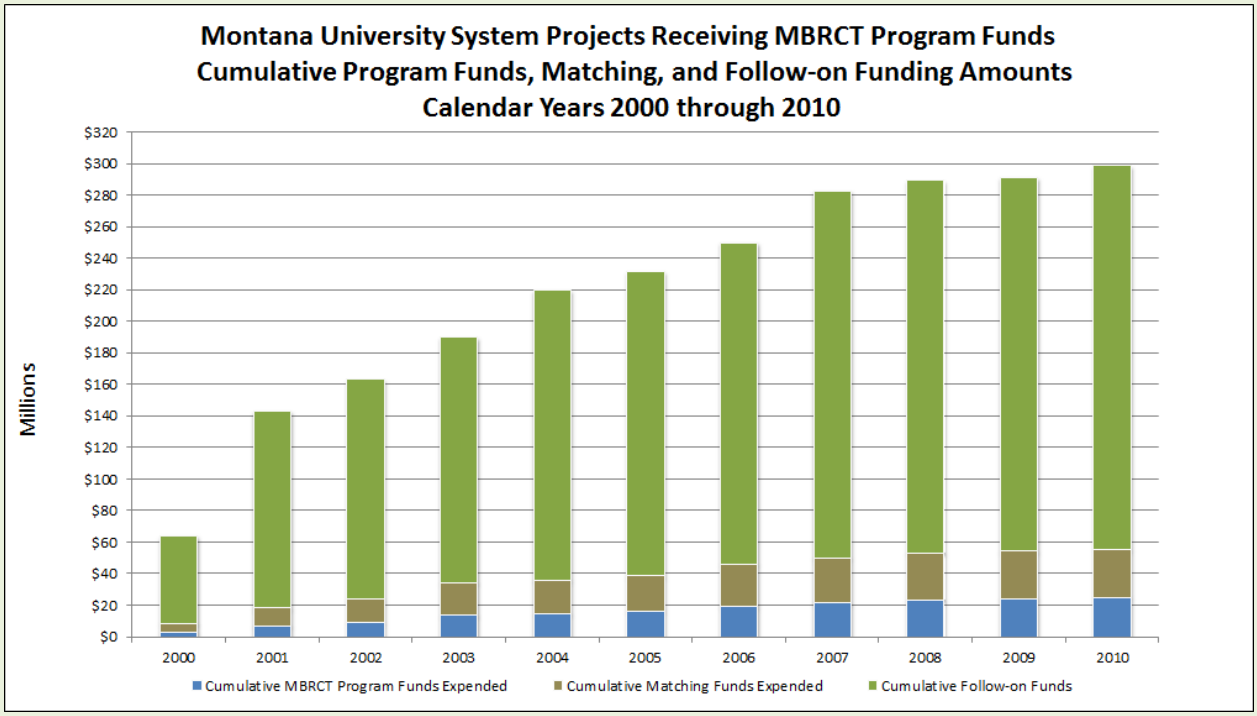
Montana Universities

Montana University System Campuses and Research Facilities

MBRCT has been an important partner in assisting the Montana University System to obtain additional research funding for technology projects. The projects typically involve direct involvement of Montana private sector companies to facilitate commercialization. For every project, there is an emphasis on development that leads to licensing the technology.

Student researchers also benefit from MBRCT research funding. The funding provides stipends and offsets some of the costs of tuition and other college expenses. Of the 185 projects funded by MBRCT, 153 involved students working on the projects themselves, earning wages and/or college credits. In addition, the students learn new skills in different academic fields.

For the ten-year period from 2000 through 2010, the MBRCT program has provided $25.2 million to the Montana University System in technology project funding. This funding has allowed for $30.5 million in matching funds and $243.2 million in follow-on-funding, representing a ratio of 9.6 to 1.



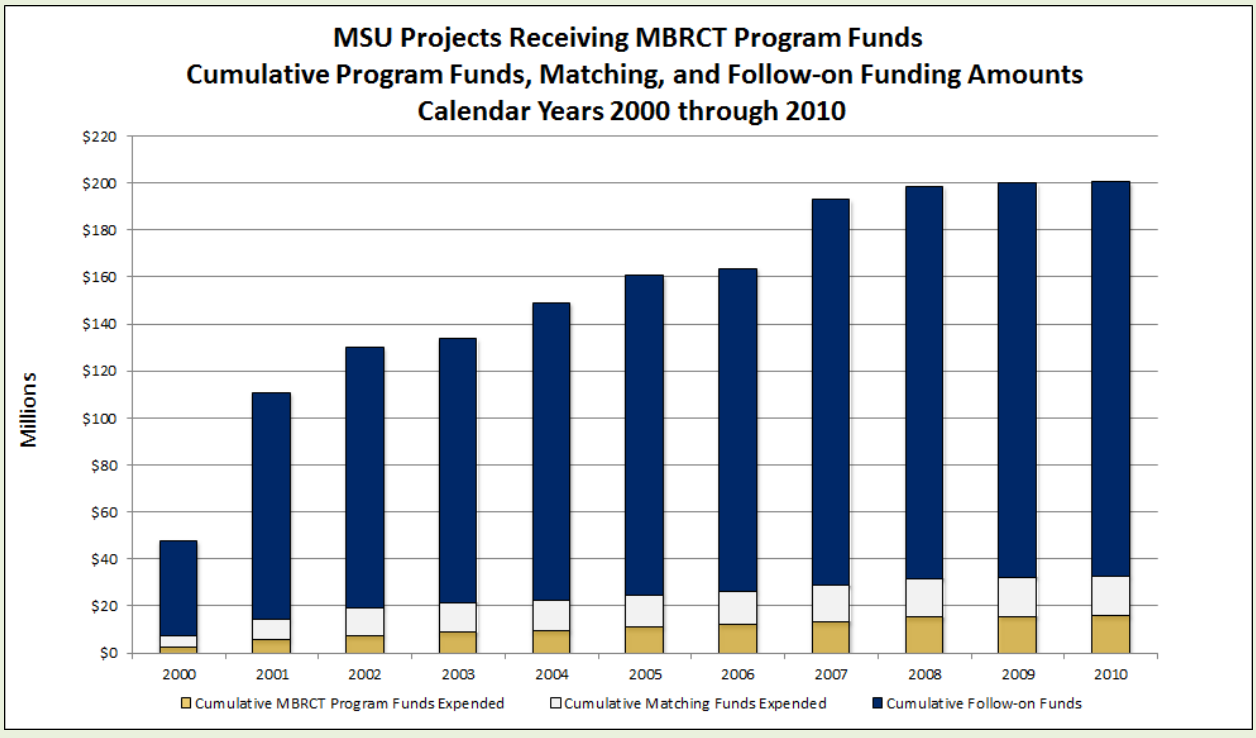
Montana Universities - continued

Montana State University (MSU) Campuses and Research Facilities

For the ten-year period from 2000 through 2010, the MBRCT program has provided $16 million to Montana State University in technology project funding. This funding has allowed for $16.8 million in matching funds and $167.7 million in follow-on-funding, representing a ratio of 10.4 to 1.

Funded MSU campus projects include:

- Lasers Stabilized to Spectral Holes in Rare Earth Doped Crystals
- Spatial Spectral Coherent Holographic Integrating Processor-S2-CHIP
- Optical Coherent Transient RF Signals Processors for Pulse Shaping and Arbitrary Waveform
- Accelerated Development of Two Gene-Imidazolinone-Tolerant Wheat Varieties in Montana
- Commercialization of BmJ as a Broad Spectrum Microbial Plant Disease Control Agent
- Functional Analysis of Genes Controlling Malting Barley
- New Red Laser-Excited Fluorescent Dyes for Ultrasensitive Multiplex Detection in Proteomics
- Broadband Direct Digital Conversion with Spatial Spectral Holograph Technology
- Durum Wheat with Low-Cadmium Uptake for Production in Montana
- Genetically Engineered Biophotonic Nanoprobes for Two-Photon Microscopy
- Image-Guided Photodynamic Therapy to Sanitize Breast Cancer Draining Lymph Nodes
- Development of Bismuth-Thiol Based Therapeutic Agents for Treating Chronic Wounds
- Hard White Wheat: Jump-Starting a New Industry for Montana Agriculture



Montana Universities - continued

University of Montana (UM) Campuses and Research Facilities

For the ten-year period from 2000 through 2010, the MBRCT program has provided $9.2 million to the University of Montana in technology project funding. This funding has allowed for $13.7 million in matching funds and $75.4 million in follow-on-funding, representing a ratio of 8.2 to 1.

Funded UM campus projects include:

- Commercialization of Instruments for Autonomous Measurements of Carbon Dioxide and pH for Research and Industrial Applications
- Advanced Materials for Metal Processing Recovery and Remediation
- Investigation of Electron Transfer Based Photonic and Electro-Optic Materials and Devices
- Immobilized Metal Polyamine Composites (IMPACS) for Removal and Recovery of Negatively Charged Species from Contaminated Waters and Mine Leaches
- Enhancement of Applied Translational Research in Biomedicine
- Neuroprotective Treatment for Traumatic Brain Injury

Funded Montana Tech projects include:

- Nontoxic Alkaline Sulfide Lixiviants for Recovering Gold from Montana Ore Bodies
- Enhancement of Montana Coal to Support Future Expansion Sodium Removal Technology
- Nanoparticle-Bacteriophage Cocktails to Combat Infectious Disease
- Development of a Commercially Viable Metallic Nanoparticle Filter to Remove Mercury from Coal Fired Power Plant Flue Gas