MONTANA RESEARCH AND ECONOMIC DEVELOPMENT INITIATIVE (MREDI)

Overall Return on Investment:

- **Additional funds received: $57,567,717**
- **Grants in progress: $46,412,849**
- **Montana companies formed: 12**
- **Private Sector Partnerships: 77**
- **Public Partnerships: 34**
- **Patents: 18**
- **Jobs: 353**
    - **Private Sector jobs: 66**
    - **University jobs: 287**

Optics & Photonics, MSU: $2.5M

Outcomes: Researchers completed work on ten subprojects ranging from the development of ultra-compact spectral imagers to map weeds during grain harvest to new methods to detect organic contaminants that accumulate on the surface of water. These efforts led to new collaborative relationships between Montana academic organizations and companies, especially in the field of precision agriculture. The project forged stronger partnerships between academic researchers and Montana companies through the creation of new commercial products, and intensified the long-term impact of training students in research with commercialization in mind.

Additional funds received: $20,830,000

Grants in progress: $24,800,000

Jobs: 58, including 10 private sector engineering and commercialization positions

Three Montana businesses created: Revibro Optics (Bozeman), Advanced Microcavity Sensors (Bozeman), Beartooth Scientific (Bozeman)

Eight commercial products developed: Method of mapping weeds in grain fields using low-cost cameras; FPGA smart-camera system; airborne hyperspectral imaging systems; LCAM hyperspectral sensing technology; hyperspectral imagining microscope with integrated microfluidic cell nutrient dosing system; adjustable-focus mirrors; spectroscopic testing of new laser materials channel waveguides in $LiNbO_3$; lithium niobate crystal incorporating thulium ions for photonic signal processing; lithium niobate and lithium tantalite crystals; major progress toward commercially viable sub-micron nano-photonic devices; nondestructive method of testing optical waveguides using frequency-chirped lasers; major progress toward new lasers for methane gas sensing

Partnerships (13 private sector and 1 public sector): NWB Sensors, Freeman Farms, Nugent Farms, Meridian Flying Services, Resonon, Flat Earth, Advanced Microcavity Sensors, Revibro, S2 Corporation, AdvR, Scientific Materials, Montana Instruments, Altos Photonics

Patents: 4 patents and one provisional patent filed

More information: http://mus.edu/research/Funded/OpticsAndPhotonics.asp

Agricultural Profitability, MSU: $2.3M

Outcomes: Significant outreach took place within the 15 subprojects and ag efficiency data and results were presented to over 700 industry professionals, NGOs and producers around the state. Light activated sensor controlled (LASC) WeedSeeker sprayer technology was developed and found to reduce herbicide usage by 55-70% of the amounts used with a conventional broadcast sprayer (also resulting in a reduction of up to 70% in herbicide costs). The On-Farm Precision Experiment subproject concluded that the use of site-specific nitrogen application would increase net returns to producers and often will reduce nitrogen fertilizer use.

Additional funds received: $4,525,000

Grants in progress: $562,500

Jobs: 41, including 6 private sector positions

Commercial products developed: Several new varieties of durum are in development; WeedSeeker technology is likely to be commercialized for use in chemical fallow and for postharvest weed control; new pulse herbicide products are likely to be commercialized following IR-4, EPA approvals; hyperspectral imaging sensors on hand-held devices and UAVs for detection of herbicide-resistant weeds will be commercialized in the near future in partnership with local Montana drone and optics based companies.

Patents: One provisional patent filed

Partnerships (8 private): Northern Seed, NWB Sensors, S&K Electronics, Triangle Ag Services, Resonon, BASF, Bayer Crop Science, FMC Corporation; many new partnerships with producers around the state

Future plans: Research on direct-fed microbials to reduce rumen nitrate and nitrite levels will continue as part of a USDA-NIFA funded SBIR grant. The cover crop/grazing research team is preparing a $2.5M proposal to the USDA Agriculture and Food Research Initiative competitive grants program for ongoing research. MSU is continuing to partner with Northern Seed to extend efforts to create improved durum varieties for Montana growers. A potential market for newly released drone-capable hyperspectral imaging systems sold by Resonon and drones sold by a variety of Montana companies was created.

More information: http://mus.edu/research/Funded/AgriculturalProfitability.asp

Traumatic Brain Injury, UM: $2.2M

Outcomes: The Neural Injury Center exceeded its goals of addressing traumatic brain injury (TBI) in Montana by evaluating and aiding 57 student veterans with mild TBI. Over half of these veterans also received neuropsychological testing at no cost to them. Researchers developed a comprehensive panel of oculomotor, balance, cognitive, and blood based microRNA diagnostic tests by working with 170 subjects, and these tests are now included in daily operations at the Neural Injury Center and moving towards commercialization. The team utilized their newly-developed rodent model of repetitive mTBI to repurpose a previously FDA-approved drug which produces a significant neuroprotective effect when delivered eight hours after injury. This work significantly enhances the value of an existing patent owned by UM. VAST: Next Generation Learning completed a computer-based cognitive training system for TBI subjects and developed a virtual reality diagnostic system to assess and manage TBI and concussions. N-SITE validated a software system designed to help find patterns and signals in EEGA data to accurately predict TBI-induced adult epilepsy; the software is now in use at UM and collaborations are in place for prospective large scale clinical trials.

Additional funds received: $1,269,775

Grants in progress: $4,115,000

Jobs: 32, including 12 private sector positions

Patents: 7

Six commercial products developed: Blood-based miRNA for use as *in vitro* diagnostics; BalanceLab; Lucius vs. 1.0 System; VirtualMind VR Cognitive Assessment Platform; VastAbility Cognitive Training System; CogFit Frontal Lobe Testing Software

Five Montana businesses created: FYR Diagnostics (Missoula), Synergy Applied Medical & Research (Missoula), VirtualMind (Missoula), PatientOne (Missoula), C.A. Laukes LLC (Missoula)

Partnerships (13 private and 10 public): VAST, N-Site, Glia Diagnostics, Synergy Applied Medical and Research, HitIQ, Senso-Motoric Instruments, Tobii Technology, Boston University, N-SITE, EMG Systems, Cortical Metrics, Tetra Discovery Partners, Impact Technologies Australia, Tonix Pharmaceutical

Future plans: Newly-formed companies VirtualMind and PatientOne have created one private sector project manager position and two private sector programming positions in Missoula, with projections for 6-8 additional positions in the next 12-24 months. Synergy Applied Medical and Research just opened a position for a sales representative, and the three students and post-doctoral fellows supported through the MREDI grant are now partners and employees of the company. FYR Diagnostics currently has three employees and are in discussion with an angel group for seed funding of $500,000 - $1M. The Neural Injury Center has served or continues to support 102 individuals and has moved toward financial self-sustainability through billing insurance for services provided by clinicians.

More information: http://mus.edu/research/Funded/TraumaticBrainInjury.asp

One Medicine, MSU: $1.5M

Outcomes: The research team moved four projects from basic science into the small business market through collaboration with three private sector companies in Montana. The return on investment was ~2.7 to 1 on projects focusing on developing new therapeutics to reduce the impacts of inflammatory and infectious diseases on animal and human health.

Additional funds received: $4,078,924

Grants in progress: $8,000,000

Jobs: 70, including 2 private sector hires

One new Montana business created: SurGene (Bozeman)

Partnerships (2 private sector): Totem BioSciences (Victor) & SAJE Pharma (Kalispell)

Future plans: SurGene is in the final stages of negotiating a contract that will employ 2-3 scientists to continue the development new molecular tools that enhance the surgical repair of defective genes. Scours research will continue with the submission of an SBIR grant with Totem BioSciences, and two additional SBIR applications are in progress with Totem investigating inflammatory mediators and immunomodulation to combat *Staphylococcus auereus.* Further studies on anti-inflammatory treatments of rheumatoid arthritis are planned with SAJE Pharma and an STTR proposal submission is set for September 2017.

More information: http://mus.edu/research/Funded/OneMedicine.asp

Mental Health, MSU: $1.4M

Outcomes: New technology that uses brain measures to make the diagnosis of mental illness more objective (fNIRS) is now in place in Montana and 48 young adult participants have taken part in the study. SiteOne Therapeutics and MSU successfully demonstrated the efficacy and initial safety of two clinical candidates for non-opiod therapeutic agents for acute and chronic pain, an advancement that secured an additional $15M in financing. The Youth Aware of Mental Health (YAM) subproject partnered with eight Montana schools to deliver pilot suicide prevention curriculum to 1,387 freshmen students.

Additional funds received: $15,480,149

Jobs: 38, including 30 private sector YAM facilitators and assistants

Partnerships (3 private sector and 3 public sector): Western Montana Mental Health Center, Neuralynx, SiteOne Therapeutics, MT Office of Public Instruction, MSU Extension, pilot schools

Future plans: The current fNIRS study will be expanded to include a focus on the substance abuse behaviors with a special emphasis on Native American communities. Young children will also be included in the sample pool to determine how early neural markers may contribute to the development of depression and anxiety in early life. SiteOne is developing plans to bring additional animal models to the

MSU Animal Resource Center and to hire support staff to manage future research activities. The YAM program has expanded to 17 additional schools across the state and will apply for federal funding to conduct a large scale randomized control trial of YAM in both Montana and Texas. YAM will be adapted to make it appropriate for testing in college-aged students and young adults.

More information: http://mus.edu/research/Funded/MentalHealth.asp

Water Quality Monitoring, UM: $1.3M

Outcomes: Research focused on collecting larger quantities of environmental DNA (eDNA) to improve the detection of aquatic invasive species, which resulted in a technique that detected an average of 2 – 10 times more DNA per sample than previous methods. The team focused on zebra and quagga mussels after their recent discovery in the Tiber Reservoir, and the myxozoan parasite which was found in the Yellowstone River in 2016 and caused Proliferative Kidney Disease resulting in massive fish kills. These new sampling techniques are now used by the US Forest Service, US Geological Survey, Glacier National Park, the Blackfeet and Salish Kootenay tribes, Missoula County Weed District, Flathead Basin Commission, Clearwater Resource Council, and the Whitefish Lake Institute to prevent the spread of aquatic invasive species. Additionally, the team created a final prototype of a small portable capillary electrophoresis system capable of field analysis of surface or ground water for issues associated with fracking return water.

Additional funds received: $1,415,807

Grants in progress: $600,000

Jobs: 19

Patents awarded or in progress: 1 patent and 1 provisional patent filed

Commercial products: The autonomous alkalinity system is significantly closer to commercialization and one system has been sold to NOAA for testing purposes

Partnerships (7 private sector): Supramolecular Research Institute, Vintage Lab Tech, Sunburst Sensors, SensorSpace, JDM Enterprises, S&K Electronics, Big Sky Machining

Future plans: The eDNA group is continuing to test new techniques to make invasive species testing more sensitive and easily operated in the field, and are collaborating with the only other zebra mussel eDNA lab in the U.S. to develop a technique which would allow non-specialists to do rapid field testing for invasive mussels. Research on halogen bonding anion separation has strong patent prospects that will be pursued.

More information: http://mus.edu/research/Funded/WaterQuality.asp

Energy Technology, MSU: $1.2M

Outcomes: Researchers created mineral seals for leaky oil and gas wells at greater depths and higher temperatures and obtained federal funds in partnership with a Montana company to initiate a mineral precipitation well sealing field test. Fly ash storage remediation tests were carried out using material from Colstrip's storage ponds and a CO_2 – Enhanced Oil Recovery assessment was completed to provide industry stakeholders with an understanding of the scale and effort needed to reduce CO_2 emissions at the Colstrip plant. A strain of microalgae was isolated from coal bed methane ponds and was determined to have great potential as a biofertilizer for wheat.

Additional funds received: $9,424,930

Grants in progress: $1,690,000

Jobs: 39, including 2 private sector positions

Patents: 1

3 commercial products developed: Mineralization sealing technologies in the subsurface; mobile biomineralization technology; computer program for feature extraction from true color images

One Montana business formed: CALX (Butte)

Partnerships (13 private sector and 3 public sector): MET, Shell Canada, Star of Texas, Gallagher Drilling, Warner Oil and Gas, Schlumberger, Southern Company, Talen Energy, Tetra Tech, Northern Seed, Summit Energy, Shell Global, Summit Gas Resources, U.S. Geological Survey, Environmental Protection Agency, MSU Potato Lab

Future plans: Through a partnership with MET, the researchers are expanding the biomineralization technology's range for commercialization by developing a mobile mineralization unit and field laboratory to advance the technology readiness level. Two field demonstrations of fly ash remediation at Colstrip are planned and researchers will continue investigating biofilms, microalgae, biofertilizers, and crop plants.

More information: http://mus.edu/research/Funded/EnergyTechnology.asp

DroneFire, UM: $900,000

Outcomes: The DroneFire team flew 150+ missions for ten natural resource partners and deployed UAS on three active wildfires. UAS were also deployed on 32 missions on prescribed fire operations. The project contracted with five Montana companies and one Idaho company to collect data from six platforms and nine sensors to advance research in thermal infrared mapping of fires, fire weather modeling, wildlife habitat characterization, multispectral remote sensing, and water quality assessment. DroneFire acquired two Certificates of Authorization from the FAA to test drones, which are difficult to acquire and provide valuable R&D opportunities for project partners. Eleven remote pilots were trained and twelve UM researchers are now using drones in research areas ranging from watershed assessment to weather forecasting.

Additional funds received: $453,000

Grants in progress: $3,500,000

Jobs: 12, including 4 private sector positions

Three Montana businesses created: DoubleC (Miles City), Aerial Solutions (Missoula), Commander Navigation (Hamilton)

Partnerships (16 private sector and 9 public sector): Sands Unmanned Aircraft Training, Skyefish, Birds Eye of the Big Sky, RDO Equipment Company, Chilton Skis, ADVASO, Trout Unlimited, The Nature Conservancy (MT & GA), Tall Timbers Research Station and Land Conservancy, TESLA Foundation, Quantum Weather, Resonon, Bitterroot and Lolo National Forests, Missoula Fire Sciences Laboratory, Bandy Ranch, Burnt Fork Ranch, Lubrecht Experimental Forest, Saint Luis University, USFS National Technology Development Program, US Fish and Wildlife Service

Future plans: Future research is in two primary areas – fire and fuel characterization and fire weather forecasting – with upcoming projects focused on firefighter safety zones, imaging of active fire fronts, and developing instruments to collect atmospheric weather data from drones to develop site-specific wildfire forecasts. The team is also developing contracts to facilitate long-term UM UAS engagement with USFS Region One and has ongoing projects monitoring aspen restoration and water use efficiencies in center pivot irrigation practices.

More information: http://mus.edu/research/Funded/DroneFire.asp

Bio-Based Fuels, MSU-Northern: $800k

Outcomes: Researchers developed an effective method of synthesizing unleaded aviation gasoline from camelina, established that a biorefinery processing camelina can be profitable and competitive against other processes, and successfully demonstrated pilot-scale pelletizing methods of camelina meal for animal feed and heat sources.

Grants in progress: $3,145,349

Jobs: 26

Partnerships (4 private sector and 11 public sector): Calumet Refining, Elevance Renewable Sciences, Omega Grains, Story Mills Oils, Opportunity Link, Old Dominion University, Texas A&M University, University of Idaho, Wayne State University, South Dakota State University, Virginia Commonwealth University, University of Minnesota, Montana State University, Montana State University Billings, USDA

Patents: One provisional patent filed and one patent application in progress

Future plans: The team is continuing to work in partnership with MSUB City College to study further pellet production techniques and are publishing a book titled “Design Study for Fuel Pellet Production from Underutilized Biomass” to serve as a resource for farmers, landfill operators, engineers, and financial institutions.

More information: http://mus.edu/research/Funded/Bio-BasedFuels.asp

Metal Recovery, MT Tech: $495,000

Outcomes: Two pilot-scale continuous flow reactors systems were constructed and operated to further develop the metal recovery process. Magnetic nanocomposite particles were successfully developed that proved effective in laboratory and pilot plant evaluations. Montana wastewater streams have been identified for further testing in the pipeline reactor and include large-volume samples from the Berkeley Pit, the Parrot Tailings, and the Travona, Ophir, and Kelley mines.

Grants in progress: Multiple SBIR and STTR grant applications are planned

Jobs: 14

Partnerships (1 private sector): Water and Environmental Technologies

Patents: Research has led to the development of intellectual property (in the form of the in-line electromagnet module) and patent applications will be filed.

Future plans: Research is shifting from using surrogate solutions to real wastewater samples in the pipeline reactor and experimentation with mine-affected waters is currently underway at MT Tech using samples from local mines, wells, and the Berkeley Pit. Alternative applications of the technology are being explored, including the treatment of wastewater for anions, nutrients, and petroleum contamination.

More information: http://mus.edu/research/Funded/MetalRecovery.asp

Remediation Technology, MSU-Billings: $263,000

Outcomes: Researchers investigated the use of PDTC, a natural product discovered by the project's principal investigator, to clean up contaminated groundwater without the expense of removal. The research yielded limitations for the use of PDTC in remediation but opened up new methodologies for future testing.

Additional funds received: $90,132

Jobs: 4

Future Plans: Advanced materials research utilizing x-ray spectroscopy will be conducted at the Stanford Synchrotron Radiational facility and a patent application is planned. The team will also continue to test different synthetic chemistry approaches and reaction rates under simulated groundwater conditions.

More information: http://mus.edu/research/Funded/RemediationTechnology.asp