**Exhibit A: Project Description**
**(Scope of Work, Special Requirements)**

**Project Title:** Optics and Photonics Research for Montana Economic Development

**Subproject 1: Ultra-compact spectral imagers for precision agriculture, wild fire mapping, and natural resources** (Shaw with NWB Sensors, Inc.). Ultra-compact imaging systems will be developed and calibrated to enable discrimination of crops and weeds for precision agriculture, UAV mapping of wildfires, and a wide variety of ground-based and UAS-based remote sensing for natural resource monitoring. The sensor systems will be commercialized through NWB Sensors, Inc. and tested for precision agriculture at Montana farms in Fairfield, MT and Sidney, MT with Meridian Flying Services from Sidney, MT.

**Subproject 2: Hyperspectral imaging for monitoring cell growth and high-performance, real-time image processing** (Dratz, Snider, and Shaw with Swanson at Resonon, Inc.). A hyperspectral imaging system will be developed for real-time monitoring of live cell growth in disease studies, drug testing, and ultimately personal nutritional optimization. The new system will be coupled to a high-speed electronic module to enable real-time image processing. This will produce a new product for Resonon, Inc., which will be much less expensive and more rugged than high-powered microscopes and will provide new capabilities in real-time hyperspectral imaging for food and product sorting and object-identification applications.

**Subproject 3: Microcavity sensors for hyperspectral imaging** (Barber with Barbour at newly established Advanced Microcavity Sensors LLC). Micron-scale optical structures will be used as high-resolution color filters to enable hyperspectral and ultra-spectral imaging. Initial applications are in skin cancer detection, counterfeit drug detection, precision agriculture, and natural resources.

**Subproject 4: Translational research to commercialize micro-mirror technology** (Dickensheets with Arrasmith at newly established Revibro). Microfabricated optical mirrors using Micro-Electro-Mechanical-Systems (MEMS) technology will be transitioned into commercial products for markets in microscopy, medical imaging, astronomy, and other advanced imaging markets. The primary challenge to be overcome in this research effort is to improve device yields to enable sustainable production.

**Subproject 5: Active waveguides and integrated optical circuits** (Cone, Babbitt, Nakagawa, Barber, Himmer, Avci, and Thiel with S2 Corp., AdvR, FLIR/Scientific Materials, and Montana Instruments). Optical crystals designed by MSU and produced by FLIR/Scientific Materials Corp. will be combined with waveguide design and fabrication capabilities of AdvR and MSU and integrated with Montana Instruments cryogenic systems to enable new research and commercial applications of Spatial-Spectral Holography (S2) by MSU and S2 Corp., leading to new technologies that allow MSU and the companies to enter the multi-billion-dollar telecommunications and defense markets of optical waveguides and integrated photonic circuits.

**Subproject 6: Optical Parametric Oscillator for Tunable Lasers** (Repasky with AdvR, Inc.). Nonlinear optical crystals will be used to develop optical parametric oscillator (OPO) technology

that will become a new product line for AdvR, Inc. and position MSU and the company to compete for grants and sales in the rapidly growing markets involving tunable lasers for chemical gas detection.

**Subproject 7: Nonlinear Optical Detection of Surface Contaminants** (Walker with Altos Photonics). A simple, fast, and accurate method for detecting molecules adsorbed to surfaces will be developed. This will be based on nonlinear optical overtone spectroscopy. The result will be a proof-of-principle demonstration using commercially available subsystems that can be integrated into a portable device for assessing drinking water contamination, pesticide usage, etc., and sold commercially by Altos Photonics.