Montana Space Grant Consortium
Student Research Symposium
Monday April 7, 2014

Student Presentation Abstracts

Session: Environmental and Earth Sciences
Undergraduate from a Research Institution
Reed Hovenkotter
University of Montana – Missoula – Physics

Predicting Terrain-Influenced Winds with WindNinja

WindNinja is a program designed to predict the winds that would occur across complex terrain at a higher resolution and produced in a time frame faster than previously capable. This project was to validate WindNinja against standard weather models and established surface weather stations.

Session: Environmental and Earth Sciences
Undergraduate from a Small Institution
Cory Lovec
Montana State University – Billings – Science

Analysis of Ozone Chemistry Utilizing Cavity Ringdown Spectroscopy

Cavity ringdown spectroscopy (CRDS) is an exceptionally sensitive technique that can be used to measure the concentrations of trace gases in the environment. This can be particularly useful when looking at extremely low concentrations, as parts-per-trillion limits have been published with certain elements. Optimization of the technique included empty cavity readings, and a maximization of the decay time from the cavity ringdown. Once the CRDS cell was determined to be optimized and stable, initial testing to determine the half-life of ozone began; published values for the half-life of ozone vary, so another published value is of great use. The ultimate goal is to study chemical reactions of ozone with other chemicals, so determination of ozone's natural half-life is necessary to decouple this from the rate of decay of ozone due to a reaction. The fact that this experiment uses visible light to determine the ozone concentrations allows one to not worry about the light inducing a higher rate of decay of the ozone (as would be the case if this were done using ultraviolet light).

Session: Environmental and Earth Sciences
Graduate Student

Caleb Pan
University of Montana – Missoula – Geography
Pan, Caleb and Kamp, Ulrich

First inventory of glaciers in Mongolia, derived from Landsat imagery from 1989 to 2011

Glaciers in the Altai Mountains of Mongolia provide an estimated 10% of the total water resources within the country. Yet, the number and area of glaciers within the Altai Mountains is inconsistent and conflicting. Glacier mapping attempts by previous author groups often did not mention their mapping methods, data source, and/or date of analysis, therefore, making it difficult to analyze and compare glacier base data. Implementing data acquired from Landsat 4, 5, and 7; this glacier inventory developed an intuitive, robust, and inexpensive methodology to map glaciers in the Altai Mountains during 1990, 2000, and 2010. Along with the developed methodology, this study also presents a definition for 'glacier', glaciated extents, and date of acquisition to ensure consistency for the future of glacier monitoring in the Altai Mountains. Furthermore, this study parameterized the glacier outlines using SRTM data, including equilibrium line altitude, mean slope, mean glacier terminus elevation, and aspect. The inventory found a total glacierized area of 541 km2 in 1990, 428 km2 in 2000, and 372 km2 in 2010. The glacierized area decreased by -21% from 1990-2000, -13% from 2000-2010, and -31% for the entire period 1990-2010. When analyzing a sub-sample of 260 glaciers, 6% advanced, 11% stagnated, and 83% receded from 1990-2010. By comparing SRTM and ASTER GDEM data, we found that mean surface lowering of -12 m occurred at 82% of all glaciers from 2000-2008. All glacier datasets are available to the public free of charge that Global Land Ice Measurements from Space (GLIMS) website.

Session: Environmental and Earth Sciences
Graduate Student
Ruben Behnke
University of Montana – Missoula – Forestry

Progress and challenges in the development of an update to the MTCLIM humidity algorithm

Over the past two decades, the MTCLIM algorithm has been the primary method by which daily humidity (dew point and/or vapor pressure deficit) has been calculated in many interpolated climate products such as Daymet, as well as in many numerical models, such as VIC and Rhessys. Here, I present ongoing work in the Numerical Terradynamic and Simulation Group at the University of Montana to update and improve this method. Sophisticated statistical data mining and modeling methods, meteorological reanalysis data, as well as the much greater number of humidity observations being taking over the past two decades form the basis of this new effort. The goal of this work is to produce a data set of average daily dew point from 1948 to the current time period at a resolution of 800 meters over the contiguous United States.

Session: Environmental and Earth Sciences
Graduate Student
Alyssa Peck
Montana State University – Bozeman - Mathematical Sciences
Peck, Alyssa; Manlove, Kezia; Stanley, Laura

Evaluating the Effectiveness of Occupant Protection Programs

Vehicle occupant protection, and especially seat restraint use, are widely accepted as critical to public health. Recently, transportation agencies have confronted stagnation in seat belt compliance rates with a suite of programs designed to increase use. It is of interest to these agencies to evaluate the effectiveness of their programs across jurisdictions, but the required analytical methods are typically beyond their scope. This project attempted to bridge that gap by working in collaboration with Montana Department of Transportation to analyze a set of metrics corresponding to occupant protection program efficacy. Information was leveraged from existing, but previously unpaired data streams (state-level program activity maps and budgets, and nationally standardized seatbelt survey data) to estimate the impacts of occupant protection programs in Montana on seat belt compliance rates. Data were assembled in a GIS, and analyzed via a logistic regression model with mixed effects. The findings provide quantitative estimates of specific programs' contribution to seat restraint use with critical insights for future resource allocation.

Session: Engineering and Remote Sensing
Undergraduate from a Research Institution
Scott Miller
Montana State University – Bozeman – Electrical and Computer Engineering

Communicating with a balloon payload floating 20 miles straight up utilizing an Iridium network satellite modem

A presentation on a MSGC BOREALIS student project to track high-altitude balloon payloads using an Iridium network satellite modem to send and receive data from a payload at up to 90,000 ft. Ground station software was created to facilitate two-way communication with a webserver and database system set up to receive and store data. This information was then plotted on a Google Maps overlay and updated dynamically allowing anyone to view the location of the balloon via a website on the internet. This presentation will detail challenges, methods, and results of the project. Come learn how we sent emails to near-space!

An ancillary project utilizing ultrasonic sound waves to measure temperature during a high-altitude balloon flight will also be presented. Temperature measurement at altitude is a challenging task with several environmental factors influencing the measurement. The measurement device utilizes a microprocessor and ultrasonic transducer to measure the speed of sound. This measurement is then used to calculate ambient temperature. Project goals, challenges, methods, results, and future work will be detailed.

Session: Engineering and Remote Sensing
Undergraduate from a Research Institution
Lincoln Gulley
Montana State University – Bozeman – Mechanical Engineering

Development of Remote Controlled Camera Platform for BOREALIS Blimp

An overview of the design considerations, construction, and troubleshooting of a remote controlled, live-view camera platform that was suspended below the BOREALIS blimp. A glance at future goals to incorporate the system as a tool to study wildland fire dynamics.

Session: Engineering and Remote Sensing
Undergraduate from a Research Institution
Andrew Crawford
Montana State University – Bozeman – Mechanical Engineering

Replacing X-Plane's Flight Dynamics Engine

The United States Army and NASA need an immediate solution to quickly go from a mission description to flying a prototype design in simulation to gain a pilot's first-order analysis on the aircraft's performance and handling capabilities. NASA and the Army currently use the Vertical Motion Simulator (VMS), the worlds largest high fidelity simulator, for pilot analysis of rotorcraft, however it involves a high degree of manpower and pre-existing flight models. X-Plane is an advanced flight simulation software, Federal Aviation Administration (FAA) approved, paralleling the Army's current system, that can be employed for use as an acceptable simulation platform, before a VMS model is produced. X-Plane will allow rapid implementation of pilot's first order response analysis of aircraft's handling in simulation. The top-level task will be replacing X-Plane's flight dynamics engine, which currently uses Blade Element Theory, with accurate state-space models created in Simulink/MATLAB using linear interpolation. This will be achieved by creating an interface "plug-in" between X-Plane and Simulink, yet still using X-Planes visual graphics and flight control hardware inputs. A detailed procedural document will be written showing the step-by-step process of creating the interface for the Army and NASA for future applications.

Session: Engineering and Remote Sensing
Undergraduate from a Research Institution
Tim Basta
Montana State University – Bozeman – Mechanical Engineering

High Altitude Ballooning: Developing a Zero-Pressure Flight System

This presentation details the ongoing research into developing a device that allows for neutral buoyancy ballooning at the university level. Due to the cost of traditional zero-pressure balloons, it is not realistic for many programs to fly their experiments at neutral buoyancy. The Zero-Pressure Valve is used in conjunction with a latex burst balloon, and autonomously vents Helium from inside the balloon at programmed intervals until the preset altitude has been reached. The control system for the valve also allows users to override the program from the ground, placing the vent in either the fixed open or fixed closed position. The vent system itself is comprised of a rotating polycarbonate gate that is actuated by a servo-motor. The vent system is also equipped with a projectile flight termination system, to allow for emergency flight termination without cutting away the valve system. This valve system will provide ballooning groups with the ability to fly at preset altitudes for extended periods of time, and to control the descent of the balloon real-time during flight.

Session: Engineering and Remote Sensing
Undergraduate from a Research Institution
Cameron Kauffman
Montana Tech of the University of Montana - General Engineering

A Study of Rivet Holes in Composite Materials

Holes are major deformations in composite materials because continuous fibers give the material its strength. Anything that disrupts this continuity severely reduces the strength of the material. This experiment tests whether a unidirectional fiber (layed up using 0°/90° alternating sheets) or a woven fiber (layed up using 0°/90° plain weave fabric) is stronger in tension when a hole is drilled in the middle of the material. Both carbon fiber and fiberglass were used, with one type of unidirectional fiber being compared to the same type of woven fiber. Two different drill bits (diamond and carbide tip) were used to determine whether any significant strength difference existed between using a diamond tip bit or a carbide bit.

Session: Engineering and Remote Sensing
Undergraduate from a Research Institution
Tyler Cook
Montana Tech of the University of Montana - Metallurgical & Materials Engineering

Oxidation Kinetics of Nicrofer-6025HT for use in Elevated Temperature Electrochemical Devices

Recent advances in the use of high temperature electrochemical devices have prompted considerable research into potential materials for fabrication for these devices. For these applications, a manifold material must be bonded to the ceramic interconnect components. These systems operate efficiently at elevated temperatures and thus require that an effective manifold material be utilized that maintains an effective long-term structural stability at the designated operating temperature, has a coefficient of thermal expansion that closely matches that of the ceramic, and produces an oxide surface that allows reactive air brazing between dissimilar materials. Nicrofer-6025HT is a nickel based alloy that is being investigated for use as a manifold material because it meets the above requirements. In the current study, the oxidation kinetics for polished Nicrofer-6025HT was evaluated at 800-900°C for extended time periods. The oxidation behavior was characterized using weight gain measurements and scanning electron microscopy-energy dispersive x-ray (SEM-EDX) analysis, and exhibited a rate constant, kp, of between 7.81x10-13 and 9.81x10-12 g2 cm-4 s-1. The activation energy was determined to be approximately 265.2 kJ/mol. The microstructure exhibited Type II oxidation behavior consisting of a chromia (Cr2O3) outer layer with an inner alumina (Al2O3) acicular layer growing into the nickel matrix.

Session: CubeSat
Graduate Student
Raymond Weber
Montana State University – Bozeman – Electrical and Computer Engineering
Raymond J. Weber, Justin A. Hogan, Brock J. LaMeres

CubeSat Reconfigurable Computing Platform: Performance and Power Analysis

A custom 1U CubeSat form factor platform was designed and built to test the performance of a Xilinx Virtex-6 field programmable gate array (FPGA) for spaceflight missions. This system is designed to utilize triple modular redundant processing elements, active partial reconfiguration, and configuration memory scrubbing to mitigate the effects of space-based radiation allowing for reliable operation in orbit. To enhance performance and leverage the capabilities of FPGAs, both soft-core microprocessors and commonly utilized computational functions were instantiated as specialized hardware cores, called tiles. Using partial reconfiguration these tiles are configured as needed in the normal course of operation, or to repair radiation-induced damage in active tiles. By using hardware accelerators to complete tasks more rapidly and spend more time in a low power idle mode, average system power consumption is minimized. In this presentation, the performance and power consumption of our system is compared to processors commonly used in CubeSat missions and common radiation hardened spaceflight computers. Both integer performance (MIPS) and floating point math performance (MFLOPS) were studied using theoretical peak values and benchmark results.

Session: CubeSat
Undergraduate from a Research Institution
Patrick Moholt
Montana State University – Bozeman

Cost Reduction of Machining by Design

With each mission in aerospace being different, there is a high degree of customization to each project. Satellite design is done to ensure a successful mission but is often times neglected when it comes to ease of assembly and manufacturing. This presentation will be about designing parts with the machinist and cost of the part in mind. This will provide details about how most tools in the machine shop operate and what key areas of design can reduce cost and time in the machine shop.

Session: CubeSat
Undergraduate from a Small Institution
Noel Stewart
Salish Kootenai College – Hydrology

Bison-Sat : A small satellite mission at Salish Kootenai College

In order to make scientific observations of the earth, we rely on earth observing satellites that are often cost prohibitive. Launching a satellite weighing several tonnes into orbit can cost around $400 million. In 1999, a low cost satellite in the form of a cube , with a dimension of 10cm on a side and weight of about 1kg, was developed at Stanford and California Polytechnic State Universities. Following the successful launch of this “Cube-Sat”, opportunities were granted to other education institutions from NASA to build, launch and use similar small satellites to execute Science related and educational missions. Salish Kootenai College was the first Tribal college to be awarded such an opportunity. “Bison Sat” is being designed for educational purposes as well as developing cost efficient and relevant scientific observations using visible narrow bandwidths, from a custom designed payload. We will test the ability to monitor changes in vegetation cover, obtain cloud and snow cover observations, and compare the Bison Sat imagery with other earth observing satellite images. The Bison Sat's payload's resolution is far greater than most earth observing satellites in use today. The project will allow students to test new hardware, acquire cost efficient scientific observations from images, and to ultimately share the observations with the public and the younger generation of our reservation. A major goal is to increase students interest towards pursuing a career in one of the Science, Technology, Engineering and Mathematics (STEM) fields on our reservation, where resources are so limited.

Session: CubeSat
Undergraduate from a Research Institution
Jerry Johnson
Montana State University – Bozeman – Physics/Mechanical Engineering

FIREBIRD Thermal Modeling

The operating environment experienced by spacecraft in low earth orbit presents many unique design challenges due to its harsh and unforgiving nature. One major area of study in the aerospace industry is thermal design and management. Large spacecraft often employ entire subsystems, both active and passive, to cool and/or heat various sensitive components. However, CubeSat developers typically have not taken thermal considerations into account because of the relatively low power consumption and therefore, heat generation of these small satellites. As CubeSat technology has advanced, CubeSats are generating more power from larger and more efficient solar panels, and they are beginning to use more "power-hungry" components which generate significant heat loads within the spacecraft. Specifically, this presentation will focus on thermal design, modeling, and testing techniques used to analyze the four spacecraft of the FIREBIRD missions.

Session: CubeSat
Undergraduate from a Research Institution
Jordan Maxwell
Montana State University – Bozeman – Physics
Johnson, Sam; Remington, Jackson; Creveling, Josh; Logan, Riley

Testing Inter-Satellite Link Capabilities for Cube-Satellites

The CPOD (Cubesat Proximity Operations Demonstration) mission is a NASA project consisting of two 3U (10cm x 10cm x 33cm) cube-satellites aimed at testing several small-scale avionics technologies. One of the goals of this mission is for the two spacecraft to be able to find one another and dock in orbit. This will be accomplished using a variety of technologies, one of which is the Inter-Satellite Link (ISL). The ISL system consists of two identical modules which use RF to communicate and, by sending time-stamped data, to calculate ranging between them. Several challenges arose during characterization of these modules, including significant noise from the RF background, but a series of controlled tests will allow for a complete understanding of the ISL and for the opportunity to correct any inherent failures of the system before launch in 2015.

Session: Astrophysics
Graduate Student
Nathan Boll
University of Michigan - AOSS
Bentley, Anthony; Boll, Nathan; Fortier, Kier ; Garg, Nikhil; Pickering, Elizabeth; Riesland, David; Salazar, Denise; Stelter, Christopher

NASA Space Academy: Advanced Concept Mission Design for Extreme Environment Surface Exploration of Venus and Titan

The atmospheric composition and geologic structure of Venus and Titan have been identified as priority targets for scientific exploration by the Planetary Science Decadal Survey, however the extreme environments of these bodies present significant obstacles to spacecraft design that have severely limited past and proposed landed missions. This project included two conceptual studies for Discovery-class landers capable of long-duration missions at ambient temperature on Venus and Titan, incorporating emerging technologies within the field of electronics in combination with novel configurations of proven systems. Radioisotope Thermal Power systems and silicon carbide communications and data handling are examined in detail, and key scientific instruments are proposed, including a seismometer and an advanced photodiode imager.

Session: Astrophysics
Graduate Student
Michael Freed
Montana State University – Bozeman – Physics
Freed, Michael; Longcope, Dana; McKenzie, David

Findings from a Three Year Survey of Coronal Null Points

We report the findings from a comprehensive coronal magnetic null point survey created by Potential Field Source Surface (PFSS) modeling & Solar Dynamic Observatory/Atmospheric Imaging Assembly (SDO/AIA) observations. Locations of magnetic null points in the corona were predicted from the PFSS model from Carrington Rotation 2098 to 2139 and manually compared to contrast enhanced SDO/AIA images in 171 angstroms. Statistical results will be presented that illustrate the characteristics associated with the observed and predicted null points. These characteristics include there radial & latitudinal distribution; eigenvalues associated with null point structure; and the effect spine orientation has on observability.

Session: Astrophysics
Undergraduate from a Research Institution
Chantanelle Nava
University of Montana – Missoula – Physics

Predicting Exoplanet Yield of MINERVA from Simulated Observations

In the search for Earth analogues, astronomers are using technology designed to detect small rocky planets in the habitable zone, the annulus around a star in which temperatures could support liquid water. Small rocky planets induce RV signals easily missed in the presence of stellar noise sources of comparable or larger amplitudes. Over the next decade, the introduction of new technology such as the James Webb Space Telescope (JWST) and the Thirty Meter Telescope (TMT) will allow astronomers to search small rocky planets' atmospheres for biomarkers indicating the existence of past or present life. Before these telescopes take to the sky, however, it is essential that their operators know the most promising locations to investigate. MINERVA (MINiature Exoplanet Radial Velocity Array) is a dedicated exoplanet observatory with 1 meter per second precision to detect these low-mass Earth-like planets orbiting in the habitable zone of bright, nearby stars. We can determine how many planets we can expect to detect around these targets and optimize our observing strategy through the use of statistics from the NASA Kepler mission. I have produced computer-simulated MINERVA observations to quantify the observatory's expected exoplanet yield and develop an observing strategy that will maximize the number of detections. In preliminary results, MINERVA's expected yield is 15±4 new exoplanets with 2.2±1.5 in the habitable zone based on an average over 1000 simulations.

Session: Astrophysics
Undergraduate from a Research Institution
Allison Mueller
University of Montana – Missoula – Physics

Absolute Single Photoionization of Xe1+ and Xe2+ for the Determination of Elemental Abundances in Astrophysical Nebulae

Absolute single photoionization cross-section measurements of Xe1+ and Xe2+ ions were performed using synchrotron radiation and the ion-photon merged-beams technique. For Xe1+, measurements were made at a photon energy resolution of 9.0 meV from 19.4 to 31.0 eV, spanning the 2P3/2 ground state ionization threshold and the 2P1/2 metastable state threshold. For Xe2+, measurements were made at a photon energy resolution of 30 meV from 24.5 to 41.0 eV, spanning the 3P2 ground state ionization threshold and the 3P0, 3P1, 1D2, and 1S0 metastable state thresholds. Numerous autoionizing resonances arising from the ground and metastable states of both ions are identified using quantum defect theory.

Session: Astrophysics
Undergraduate from a Research Institution
Kenny Harwood
University of Montana – Missoula – Physics

Improved Neutron-Capture Element Abundances in Planetary Nebulae

Spectroscopy of planetary nebulae (PNe) provides the means to investigate the synthesis of neutron(n)-capture elements which cannot be detected in stars. However, accurate abundance determinations of these elements present a challenge because the required atomic data for these species are not well-known. We present initial results of a program that addresses these challenges. Deep high resolution optical spectroscopy of _20 PNe has been performed to detect emission lines from trans-iron species including Se, Br, Kr, Rb, and Xe. The optical spectral region provides access to multiple ions of these elements, which reduces the magnitude and importance of uncertainties in the ionization corrections. In addition, experimental and theoretical efforts are providing determinations of the photoionization cross-sections and recombination rate coefficients of Se, Kr, and Xe ions. These new atomic data make it possible to derive robust ionization corrections for these elements. Together, our observational and atomic data results enable n-capture element abundances to be determined with unprecedented accuracy in ionized nebulae. of _20 PNe has been performed to detect emission lines from trans-iron species including Se, Br, Kr, Rb, and Xe. The optical spectral region provides access to multiple ions of these elements, which reduces the magnitude and importance of uncertainties in the ionization corrections. In addition, experimental and theoretical efforts are providing determinations of the photoionization cross-sections and recombination rate coefficients of Se, Kr, and Xe ions. These new atomic data make it possible to derive robust ionization corrections for these elements. Together, our observational and atomic data results enable n-capture element abundances to be determined with unprecedented accuracy in ionized nebulae.

Session: Education and Outreach
Undergraduate from a Research Institution
David Riesland
Montana State University – Bozeman – Electrical and Computer Engineering

Prototypes and Outreach: Developing a low-cost aquatic probe

During the summer of 2013, NASA Space Academy at Glenn Research Center developed an outreach tool as an analogue to their proposed Titan probe. This talk will cover the design constraints and methods used to build and test a low cost aquatic rover suitable for outreach.

Session: Education and Outreach
Undergraduate from a Research Institution
Jacob Kuschner
Montana State University – Bozeman – Mechanical Engineering

Hiscock Engineering and Astronomy Education Outreach Project

With the aid of the William A Hiscock Space Grant, a 6'' reflector telescope is currently being built by a group of four local high school students in order to provide them a tactile learning experience within the field of astronomy. These students have been selected in an application process aimed to gage their curiosity and knowledge of the night sky, as well as their ability to work with others and learn in a new environment. Through this project they are learning about design and engineering related concepts by being faced with challenging problems during the the telescope's construction. Once the telescope is complete, the students will be able to use it to explore and learn more about the night sky through additional observational challenges and exercises. The success of this project is being measured by the level of engagement and feedback from the students, and how willing they are to explore new ideas their own. At the moment, a lot of positive feedback has been received from all four students, although the project is not complete.

Session: Education and Outreach
Graduate Students
Laurence Alexander and Brett Kuxhausen
Montana State University – Bozeman – Science and Natural History Film Making

Space Public Outreach Team

Session: High School Talks
Danelle Toren
Simms High School – Simms, MT

Temperature Lapse Rate of the Troposphere in Montana

Global Warming is occurring. This is the gradual heating of the Earth's lower atmosphere. The purpose of this research is to determine the Temperature Lapse Rate in Central Montana and to determine if the Temperature Lapse Rate is changing. A GRAW DFM-06 Radiosonde was launched on November 7th, 2013 from Simms, MT. Temperature, humidity, altitude, wind, and location were collected. The Temperature Lapse Rate was measured and compared to the ten year Temperature Lapse Rate average from Great Falls and Glasgow. The estimate of uncertainty of the means was determined using the Root Mean Squared Error. The Earth's average Temperature Lapse Rate fell outside the estimate of uncertainty. Although one data point the Simms mean Temperature Lapse Rate fell outside of the estimate of uncertainty when compared to the Great Falls and Glasgow data. Therefore, the Null Hypothesis is rejected; the means are not the same and the Temperature Lapse Rate has changed.

Session: High School Talks
Sam Miller
North Toole County High School – Sunburst, MT
Sam Miller and Andy Ryan

Assessing the Antimicrobial Properties of Selected Local Homeopathic Plants

The purpose of this experiment was to determine if selected local trees (Sage brush (Artemisia tridentate), Balsam poplar (Populus balsamifera), and Trembling Aspen (Populus tremuloides)) contain antimicrobial properties as tested on the bacteria species Eschrichia coli, Staphylococcus epidermidis, and Bacillus cereus. We hypothesized that all of our selected local plants will have antimicrobial properties and we believe that the trembling aspen will yield the best results because it has historically been used to treat infections, fevers, and parasitic worms. We prepared six extracts from the three trees, one water-based and one alcohol-based for each species. To test our hypothesis, we soaked sterile disks in the extracts and placed them in bacteria coated petri dishes. Using a ruler, we measured the diameter of the zones of inhibition at twelve hour increments for 72 hours. After analysis, we accepted our hypothesis because all of our extracts possessed antimicrobial properties. However, Sage was statistically the most effective extract.

Session: High School Talks
Conner Overcast
North Toole County High School – Sunburst, MT

The Economic and Environmental Benefits of Submerged Computers - Phase II

The purpose of my experiment is to further explore the potential of submersion cooling of computers. I hypothesized that having a different liquid to submerse the computer into and having a different pump will increase the efficiency and effectiveness of submersion cooling. The new liquid I used was transformer oil. My new pump had a greater flow rate than last years. I implemented by changes and compared the results to those of last year. In addition to the added variables, I included a server to conduct my tests on. After my analysis, I accepted my expected hypothesis. The pump was able to circulate the fluid through my radiator at a rate which increased its cooling effectiveness. And while water-cooling and AC cooling are still more effective, the submersion is less costly.

Session: High School Talks
Dylan Rossbach
Hellgate High School – Missoula, MT

Constructing an Alternative MIPS Football Helmet Model to Limit Rotational Acceleration from Angular Impact

This research study designed and tested an alternative prototype helmet based upon the sliding-layers concepts presented in MIPS technology. Instead of simple sliding layers, this prototype used flexible closed cell foam supports to connect the outer layer of the helmet to an inner layer that surrounds the head. It was hypothesized that this would allow the outer layer to move independently from the inner layer but still provide cushioning from linear impact and be more resilient to the repeated impacts of the football game than other MIPS models. This prototype was designed using variable widths of the supports between the two layers to vary elasticity. Then these models were tested for their ability to reduce rotational acceleration on angular impact compared to a standard football helmet.

Session: High School Talks

Jacob Alborano
North Toole County High School – Sunburst, MT

Evaluating Petroleum-Contaminated Soil Remediation Methods

The purpose of my project is to determine which petroleum contaminated soil remediation method is the most effective when is dealing with contaminated soil. For this experiment, I tested one type of bacteria (Pseudomonas fluorescens) and one fungi (Penicillium notatum) that are known for their ability to degrade hydrocarbons in oil. I also used one other type of fungi, Aspergillus niger, which has shown some preliminary indications of an ability to degrade hydrocarbons. In addition to these types of fungi and bacteria, I used a microorganism fertilizer called S-200. The S-200 fertilizer is a biodegradable fertilizer that promotes and increases bacterial and fungal growth during bioremediation. In order to test these microorganisms and S-200 fertilizer, I started by placing contaminated soil into 24 paint cans. Second, I thoroughly mixed the soil in each can to disperse the hydrocarbons and sent 100 mL samples to Energy Labs in Billings, Montana to test for initial hydrocarbon content in each. Next, I applied each microorganism to three individual paint cans each and each microorganism combined with the S-200 fertilizer to three individual paint cans and thoroughly mixed. For the controls, I applied just the S-200 fertilizer to three paint cans and left the last three paint cans with just the contaminated soil. I watered and thoroughly mixed the soil every three days to promote further bacterial and fungal growth and to allow the microorganisms to have access to oxygen. Finally, I sent 100 mL samples at two weeks and four weeks to Energy Labs in Billings, Montana to test for hydrocarbon content. After statistically analyzing my results I came to the conclusion that the Aspergillus niger combined with the S-200 Fertilizer allowed for the quickest and most effective remediation method.

Session: Middle School Talks
Samuel Bosio
Hamilton Middle School – Hamilton, MT

Can Silver Nanoparticles Prevent Nosocomial Infections

The aim of this study was to test the antimicrobial effects of silver nanoparticles, specifically on a catheter. Nosocomial infections (infections that occur in hospitals) are extremely common and dangerous, as well as hard to treat. Antibiotics are the current treatment, but they notably ineffective. Thus, novel treatments are necessary to prevent costly nosocomial infections.

I originally hypothesized silver would create a large zone of inhibition around anything it was on, but silver nanoparticles actually only prevent growth where they are concentrated.

This experiment tests silver against Lysol and Neosporin in MMH and Mueller Hinton agar (the latter being better for growing bacteria and rich in iron) for antibacterial properties. The silver was tested in different concentrations, at different temperatures, and with a different surface area exposed to bacteria. The bacteria in use was S. epidermidis, and the experiment was done in duplicates. The experiment was done this way because S. epidermidis is the most frequent culprit to blame for nosocomial infections, most likely due to the biofilms it forms.
This testing reveals that the silver is an effective antibacterial, and even does better than antibiotics in certain environments and on catheters.

Session: Middle School Talks
First Lego League - Synergy
Billings Middle School – Billings, MT

Tornado Safe Shelters in Elementary Schools in Moore, Oklahoma

The presentation will be based on the 2013 FIRST Lego League Challenge - Nature's Fury. The presentation will recount the First Lego League Team Synergy research and findings.

Session: Middle School Talks

Natasha Johnson and Kasey Sands
West Valley School – Kalispell, MT

Breaking the Barriers

“Can you stop a tsunami?” Many people asked themselves this question after a massive tsunami hit Japan in 2011. We came up with this project because we are both very interested in natural disasters and we wanted to see if there was any way to stop a tsunami. If there isn’t a way to completely stop a tsunami, even slowing one down would have a positive effect on coasts and coastal cities. If an effective tsunami barrier was to be created, it could save lives and millions of dollars worth of damage. We tested to see which angle of barrier will be most successful in reducing or stopping a tsunami wave. To test this we built a tsunami tank with the help of Rod Sands which we used to simulate a tsunami. Building this tank helped us to control many variables, such as how much force was applied to the wave and the distance it traveled. We tested four different barrier angles: 45 degrees, 90 degrees, 135 degrees, and 0 degrees or no barrier to see which one would be most effective. The 45 degree barrier, which we hypothesised to do the best, did the worst out of all the barriers but better than no barrier. The results of the 45 degree barrier was closely followed by the 90 degree barrier, then 135 degree barrier which did the best. Overall, this project was very successful in determining which barrier did the best in reducing the effects of a tsunami.

Session: Poster
Undergraduate from a Research Institution
Angelita Bearquiver
Chief Dull Knife College – Science
Bearquiver, Angelita , Gibbisons, Sean , Madsen, Robert, Jones, Edwin , Roundstone, Wayne, Noel , Mary

Metagenomic Tongue River Sediment Survey

Water-saturated sediments that underlie a stream channel (benthic and hyporheic zones), often harbor the majority of biomass in a riverine system, primarily in the form of microbial biofilms . These sediment microbial communities dominate riverine biogeochemical cycling and can be responsible for 76-96% of total respiration. Despite their importance, these microbial communities are poorly characterized. Mapping the spatial and temporal distribution of taxonomic and functional diversity in different lotic (river and stream) biomes, and understanding how this diversity is modulated by environmental and anthropogenic drivers, is vital for integrating microbes into predictive biogeochemical models

Session: Poster
Undergraduate from a Research Institution
Orrin Boese
Montana State University – Bozeman – Electrical and Computer Engineering

Characterization and Analysis of Nanostructured Polymer Optical Waveguides and Grating Couplers

A new optical characterization system was designed in order to examine the grating coupling through nanostructured polymers. Functionality was included in the system to measure the index of refraction of the polymers in question. The designed optical system integrates the ability to observe grating coupling and to measure refractive index with ease of transition between these functions. The index of refraction was measured by a prism method which implements physical laws to create a system of equations that can be readily solved by a written script in MATLAB. The characterization system was given fine control over a wide range of incident angles by using a periscope assembly with adjustability in both mirror angles and the spacing between the mirrors. Grating coupler devices were fabricated in-house both to verify the system and to analyze fabrication results.

Session: Poster
Undergraduate from a Research Institution
Kyren Bogolub
University of Montana – Missoula – Physics

Absolute Single Photoionization of Se2+ for the Determination of Elemental Abundances in Astrophysical Nebulae

Absolute single photoionization cross-section measurements of Se2+ ions were performed using synchrotron radiation and the ion-photon merged-beams technique. Measurements were made at a photon energy resolution of 24 meV from 24.0 to 42.5 eV, spanning the 3P0 ground state ionization threshold and the 3P1, 3P2, and 1D2 metastable state thresholds. Numerous autoionizing resonances arising from the ground and metastable states are identified using quantum defect theory. To better identify the resonant structure near the individual state thresholds, additional measurements were made at a photon energy resolution of 6.7 meV from 30.0 to 31.9 eV. As a result of these high-resolution measurements, a significant shift of approximately 800 meV in the historically accepted value of the ionization potential of Se2+ is reported.

Session: Poster
Graduate Student
Douglas Brugger
University of Montana – Missoula – Geosciences

CHARACTERIZING STREAMFLOW RESPONSE TO IRRIGATION USING COUPLED HYDROLOGIC AND AGROECONOMIC MODELS

The reservoirs, diversions, and wells used for irrigation in a watershed form a network that substantially alters the timing and magnitude of surface water flows. If the irrigation network in a watershed is not adequately represented in a computational hydrologic model, the model might not accurately forecast surface water response to climate forcing. This is notably important during periods of drought, when irrigation demand is high and water availability is low. The behavior of irrigators depends on more than just water availability; other factors include market prices of inputs and commodities, policies & regulations, and the feasibility of alternative crops. We address this by coupling a rainfall-runoff and water distribution model (HEC-HMS) to an economic model of agricultural production, which both simulates irrigator behavior (namely allocation of inputs such as land, water, and labor) and quantifies yields and revenues. The coupled model simulates the impact of farming decisions in the hydrologic network, such as reduced water availability for downstream irrigators due to upstream water use. The result is a spatial depiction of both streamflow response and irrigation network response to climate forcing. We present a case study of drought conditions for the Bitterroot River watershed in Montana that quantifies 1) the economic effects on irrigators, 2) the effect of irrigation on the water budget, and 3) the sensitivity of the system to variations in climate forcing. The case study shows that reductions in agricultural productivity do not scale proportionally with reductions of available water.

Session: Poster
Undergraduate from a Research Institution
Conner Dack
Montana State University – Bozeman – Electrical and Computer Engineering

Designing and Benchmarking Space Imagining Algorithms through the use of the Montana High Performance Computing Cluster

The research in this document was completed by Connor A. Dack and covers the design of an image compression algorithm that is optimized for the use on a Field Programmable Gate Array (FPGA). The algorithm uses the input of a bit map created by the camera that is attached to the stack of circuit boards which also house the FPGA and the power supply. The bit map is converted into an array of red, green, and blue codes that create the JPG image. The conversion of the bit map was completed through a series of loops and calculations within the algorithm. The algorithm was then tested on the Montana High Performance Computing Cluster at Montana Tech in Butte, Montana. The results will be used as the baseline for the testing the algorithm on the FPGA. The final application of both the FPGA and the image compression algorithm will be space imaging.

Session: Poster
Undergraduate from a Small Institution
Tucker Downs and Kobi Hudson
Rocky Mountain College – Computer Science

Monitoring Algae Growth in the Nanoracks Enclosure on the International Space Station

The first design had a sensor package which included a photoresistor, CO2 sensor, and low resolution camera. These were all placed around a 3D printed growth chamber and used to monitor the algae. This design had three major flaws. The first: the 3D printed container was too difficult to seal without using a sealant that would outgas (one of the constraints). The second: even minimal condensation caused the sensors to fail. The third: the CO2 sensors were very unreliable and hard to calibrate. These three flaws prompted a change in the design. This change was to loose the photoresistor and the CO2 sensor but keep the camera. With only the camera there the translucency of the 3D printed material. In this revision of the design, lexan was the material of choice for constructing the growth chamber. However, Lexan was too dangerous to melt and fuse into a box resembling the 3D printed container in some of the first rough drafts. This lead to two big ideas. The first being three lexan bottles “sandwiched” between two thin pieces of lexan. Which would allow for grow lights and the camera to look directly down on a flat surface and see how much algae is growing. The second, is again, two pieces of lexan “sandwiching” four 1½” diameter lexan tubes perpendicular to the flat lexan “bread” pieces. This again allows for the grow lights and camera to rest above and receive a clear image.

Session: Poster
Graduate Student
Zach Gill
Montana State University – Bozeman – Chemical Engineering
Zach Gill, Lik Ming Aw, McLain Leonard, Chinomso Onuoha, Roberta Amendola, Paul Gannon

A FUNDAMENTAL STUDY OF THE HIGH TEMPATURE CORROSION AND INTERDIFFUSION OF CHROMIUM, ALUMINUM, AND SILICON COATINGS ON A NICKEL-201 SUBSTRATE

Advanced turbine engines require higher thrust-to weight ratios, increased fuel efficiency and durability as well as reduced emissions. To achieve these goals, new high-temperature materials with high-strength, low-cost and non-strategic compositions are needed. In advanced turbine applications, combustor liners, turbine blades and vanes are exposed to corrosive combustion products at temperatures up to ~1700°C, with high gas velocities, entrained particulates and other foreign objects at pressures up to 3 MPa (30 atm). These extreme conditions can drive a dangerous phenomenon known as "hot corrosion", an accelerated form of oxidation that occurs when metals and metal alloys are heated in the temperature range 700–900°C in the presence of salt deposits. An increased understanding of the fundamental behaviors of common high temperature alloys and their degradation mechanism is therefore critical for the production of reliable components. A model substrate, Nickel 201, was coated on one side with Cr, Al, or Si thin films (~1 um) via magnetron sputtering physical vapor deposition (PVD). Uncoated and coated samples were then exposed to laboratory air at 700°C and 900°C and to air/SO2 gas mixture at 700°C over different time periods to observe coating-substrate interactions and oxide formation. Identical samples were subjected to the same exposures with the addition of a deposit of sodium sulfate (Na2SO4), in imitation of environments conducive to "hot corrosion". Sample mass gains were recorded and resulting oxide compositions assessed using FE-SEM/EDS and XRD as a function of exposure time. At 700°C, coated and uncoated samples displayed different oxidation behaviors. Under laboratory atmosphere at 700°C, no evidence for hot-corrosion was observed. While in air/SO2 exposure evidence for hot corrosion was observed. When sodium sulfate was introduced at 900°C, coated and uncoated samples displayed rapid corrosion consistent with the effects of hot corrosion. The oxidation process and coating/substrate inter-diffusion phenomena are presented and discussed in the context of establishing basic approaches to improve the fundamental understanding of hot corrosion, testing methodology, and protection mechanisms.

Session: Poster
Graduate Student
Jacob Downs
University of Montana – Missoula – Computer Science

algorithm development to perform metagenomic analysis on a large set of microbial genomes

Session: Poster
Undergraduate from a Research Institution
Nathan Hyatt
Montana State University – Bozeman – Physics

Relativistic Electron Microbursts

I will be presenting on the research i have done for FIREBIRD involving electron microbursts. this will include descriptions of other missions that have collected data, and the approach the FIREBIRD mission is taking to detect electron microbursts.

Session: Poster
Undergraduate from a Research Institution
Ryan Johnson
University of Montana – Missoula – Physics

Using Montana's Own Satellites to Inspire Middle School Students

This project attempts to inspire middle school students by introducing them to local science resources as a means to motivate a deeper interest in the sciences. The particular data used is from the Space Science and Engineering Lab's HRBE satellite. The objectives are to teach young students how to connect to the SSEL server using MySQL workbench, load data, determine what each column of data means, and accurately graph the data using Excel. Then students will interpret the graph to determine when the satellite is charging and discharging its batteries so they may correlate the battery data to HRBE's orbit and track HRBE using the Gpredict software.

Session: Poster
Undergraduate from a Research Institution
Sam Johnson, Riley Logan, Jackson Remmington, Josh Creveling
Montana State University – Bozeman – Electrical Engineering and Physics

Inter-Satellite Linking

The ability for small satellites to dock with other objects and satellites in orbit is incredibly useful. Perhaps the most immediate application for such capabilities is the deorbiting of space junk that is slowly crowding earth's vicinity. Deorbiting space trash can be accomplished by docking with it and slowing it down. But before small satellites can attempt to clean up the space around our planet--making it safer for equipment and humans alike--they have to be able to dock to each other. To find one another in orbit, two satellites need to be able to "see" and "talk" to one another. The students of the Space Science and Engineering lab are addressing this need by designing and characterizing flight-candidate antennas for the purpose of inter-satellite linking. Dipole antennas and patch antennas of various types were tested and characterized with and without amplifiers in the field using long, straight stretches of road as test sites. Ranging data and communication data were used to evaluate each antenna's behavior and performance. After field testing the flight-candidate antennas, a 2.4GHz patch antenna with an amplifier in-line emerged as best performing inter-satellite linking setup so far. This research has shown the promise of this configuration, but there is much more characterization that must be done before it is selected for flight.

Session: Poster
Undergraduate from a Small Institution
Ksenia Lynch
Rocky Mountain College – Biology

Allelochemicals and invasion success in Russian olives (Elaeagnus angustifolia)

Non-native species are of great concern because of their impacts on the ecosystems they invade (decreased biodiversity, hybridization with natives, altered ecosystem function,…). Throughout the western US, Russian olive is a non-native species of special concern and is credited both with causing the decline in native cottonwoods (Populus spp.) and altering plant and animal communities. When considering non-native species, one area of interest is how they invade and become established so quickly. Russian olive may be a successful invader because possesses allelochemicals (substances which are produced by one plant that inhibit native plants and/or herbivores). Allelochemicals can provide an advantage for non-natives by diminishing germination success and growth rates in competing plant species or by repelling herbivores. We are using two model bioassays to test the hypothesis that Russian olive is a successful invader because it produces chemicals that inhibit competitors and/or deter herbivores. Our preliminary results suggest that Russian olive possess anti-plant allelochemicals and allelochemicals deterring herbivores. We also have data from one trial that suggests that the native cottonwood species cause greater negative impact on the two model bioassays. Thus Russian olive may be a successful because it can tolerate the allelochemicals produced by other species.

Session: Poster
Undergraduate from a Small Institution
Floyd McMillian
Fort Peck Community College – Science

Water quality of the Poplar River and its tributaries

The water quality of the Poplar River and two tributaries are subject to fluctuations due to a number of factors. To help understand these fluctuations, three methodologies were used to draw possible conclusions over the course of this project. Chemical analysis, biotic index, and habitat assessments were the three methodologies used. This study is important because watersheds in Montana are still un-characterized. For chemical analysis the water was analyzed for turbidty, pH, dissolved oxygen, temperature, total dissolved solids, chloride ions, water hardness, nitrate, & conductivity. Biotic analysis was anyalzed using benthic macorinvertebrates. Results showed that due to the Brine water plume and the Coal fired generator upstream the Poplar River has high turbidity, high pH, and a high chloride load. In conclusion, the further downstream closer to residential areas and the brine water plume the poorer the water quality.

Session: Poster
Undergraduate from a Research Institution
Nichole Murray
Montana State University – Bozeman – Mechanical Engineering

The Daring Story of Taking High Altitude Balloons To New Horizons

Researching at the edge of space is an area that intrigues human minds. Two types of high altitude balloons can accomplish this: the traditional, latex sounding balloon which expands until it bursts, and the fixed volume zero pressure balloon, which expands to the capacity of the fixed volume and then vents out excess helium. The zero pressure balloon and its payload become neutrally buoyant and float at a nearly constant altitude until the flight is terminated. My project was to create a valve system to vent helium that would allow us to transform the traditional latex balloons into the rare and coveted zero pressure balloons. Several initial valve systems were created and tested. These valves worked well on smaller prototype balloons but lacked the capacity to vent our standard balloons. A modified valve with greater conductance was constructed and demonstrated the capability of venting sufficient helium to keep the balloon from bursting. When this valve and it control system is completed it will open countless doors for more scientific research at high altitudes, allowing experiments sent up on the balloons to float about 90,000 feet for extended periods of time, collecting more data and allowing for improved research results.

Session: Poster
Undergraduate from a Research Institution

Mary Peterson
Montana State University – Bozeman – Mechanical and Industrial Engineering
Manning, Kathryn; Miller, Kassandra; Peterson, Mary; Suwara, Genevieve; Tevary, Tesha; Walsh, Allison

High Altitude Payload Design Project Summer 2013

In this project, 6 female engineering students worked as part of an interdisciplinary project team to design a high altitude balloon payload. The payload carried electronics capable of monitoring radiation at different altitude levels. It was also required to fly in conjunction with a radiation tolerant computer that our advisor (Brock LaMeres) and his graduate students were working on (this is an ongoing research effort at MSU to develop reliable space computers for NASA). The payload was designed over the course of an 8-week summer program at MSU during June and July of 2013. At the end of July the payload was launched on a BOREALIS balloon flight from the Harlowton Airport (in MT). Once recovered, the data that the payload collected was reviewed and compared to the data collected by the research computer. The requirements that were developed in order to design the payload are shown below.

Functional Requirements: log radiation and corresponding altitude for duration of flight (up to 100,000 feet an back), store data on non-volatile memory, provide power for duration of flight plus 1 hour set up and 1 hour for recovery, indicate the unit is powered on, indicate system is running properly, ensure system is both water-resistant and buoyant, provide internal fire resistance, provide internal temperature regulation, ensure system will operate within temperature range of flight, ensure system will withstand forces of launch, ascent, balloon pop, descent and landing, ensure system can attach to research computer payload, and ensure combined system can attach to Borealis balloon.

Performance Requirements: log radiation and altitude data each second, provide 5 watts per hour over 4 hour flight, provide sound and/or light to indicate power is on, provide sound and/or light to indicate system is operating properly, ensure water cannot leak into system and payload floats, enable system to shut down if internal temperature exceeds 100 C, ensure system can withstand vertical force of 10Gs and horizontal force of 5Gs, ensure payload temperature will operate between -60 and 60C (external), ensure payload temperature stays within and will operate between -20 and 40C (internal), and ensure pressure sensor can withstand 0-90kPa.

Physical Requirements: Ensure system does not exceed maximum dimensions of a 6in cube, ensure system does not exceed maximum weight of 3lbs, and mechanically interface with the Research Computer and the BOREALIS balloon system.

Session: Poster
Undergraduate from a Research Institution
Brian Redman
Montana State University – Bozeman – Electrical and Computer Engineering

Testing a Low-cost All-Sky Infrared Cloud Imager

Information about cloud patterns is useful for Earth-space optical communications research. Thermal infrared sky imaging is a technique that records cloud patterns by measuring the heat radiation emitted by the clouds. This method is particularly well suited for continuous ground-based measurements of cloud cover statistics because it functions equally well during day and night. Sophisticated infrared cloud imagers have been developed previously at Montana State University, but there is an interest in exploring the capabilities of lower-cost systems. A low-cost infrared cloud imager capable of imaging the entire sky dome has been developed. The system uses a metal dome to reflect the whole sky to an off-axis infrared camera. This poster describes the design of this all-sky infrared cloud imager and the algorithms created to remove the thermal infrared radiation emitted by the dome and correct for the angular and radiometric distortion introduced by the dome. Data from the all-sky infrared cloud imager will be compared to the data from lidar and two different infrared cloud imagers that were deployed at Montana State University over a period between 2012 and spring 2014.

Session: Poster
Undergraduate from a Research Institution
Aaron Reynolds
Montana State University – Bozeman – Electrical and Computer Engineering

Producing and Testing Infrared Cloud Imaging Systems

Optical communications offer far greater bandwidth and data rate compared to radio waves, the current method for most satellite to ground data transfer. The foremost issue with Earth-space optical communications is obstructions between the ground station and satellite, of which clouds are the most common. Thus, ground stations need accurate spatial and temporal data of local clouds. The Infrared Cloud Imager (ICI) thermally images the sky and processes the sky radiance data to identify the cloud attenuation to an optical communication signal. From cloud attenuation the viability of an optical communication link can be studied. I assisted in the construction and testing of four ICI systems for the NASA Jet Propulsion Laboratory (JPL) and the NASA Glenn Research Center. My role was primarily concerned with housing and interface fabrication as well as running the ICIs. In addition, I ported the Beaglebone microcontrollers from Angstrom Linux to Debian Linux. This device runs a server inside the instruments which operates as a data logger and system management service. Debian was found to support the necessary functions, as well being more stable than the Angstrom system. I also assisted in system validation. This involved running the MSU LIDAR, collecting data, and processing these data to compare cloud attenuation retrievals between the ICI instruments and the LIDAR system. Two of these systems have been shipped out for installation at the NASA JPL Table Mountain Facility.

Session: Poster
Undergraduate from a Research Institution
David Riesland
Montana State University – Bozeman – Electrical and Computer Engineering
Bentley, Anthony; Riesland, David

Secure Autonomous Data Mule for Disruption Tolerant Networking
Terrestrial networking and routing protocols are inadequate for space where long distances and disconnection make communications difficult.. Space networks need a robust protocol to operate within these constraints. DTN is a protocol being developed largely in part by NASA to meet these challenges while providing a common language for all space assets. The goal of our project is to develop a simulated planetary network suitable for testing and implementation of DTN-based systems.

Session: Poster
Undergraduate from a Research Institution
David Riesland
Montana State University – Bozeman – Electrical and Computer Engineering
Bentley, Anthony; Boll, Nathan;Fortier, Kier;Garg, Nikhil;Pickering, Elizabeth; Riesland, David; Salazar, Denise;Stelter, Christopher

Titanic: Titan Terrestrial and Nautical Investigation Craft

A NASA mission plan was developed and analyzed to investigate Titan's hydrocarbon lakes. A prototype analogue of this probe was then constructed to splash down successfully, perform experiments, and collect data. This prototype has been developed with open source software, and was built with the purpose of inspiring younger students to make prototypes of their own.

Session: Poster
Undergraduate from a Small Institution
Brittany Robbins
University of Great Falls – Biology
Robbins, Brittney, Bickford, Nate, Carpenter, Chrissie, Hoffman, Katie

Natural Protein: Your Health and Your Energy

There are many different components that combine in order to create the optimum athletic performance. According to nutritionists, individuals must portion their intake of calories, watch the amount of carbohydrates and maximize the amount of protein they consume on a daily basis (protein). One thing that is rarely asked in new age diets is to limit the amount of protein an athlete is consuming. A common problem with the intake of protein in the new age of working out and training is which protein to take, a supplement, a powder, or consuming more protein. There are hundreds of choices in the protein world, but which protein is truly best to provide the highest possible performance from an athlete? Synthesized proteins are said to include everything a body wants and needs in order to produce the highest results but natural protein has better effects on health and energy levels than the synthesized protein chemicals (Protein). For this experiment mice will be used and separated based upon gender and protein source to be tested. Each protein source will have a male and female test group, giving six groups, three female groups containing a control, a synthetic protein, and the natural protein groups, the males will be divided the same way. We will use the Control-Pause (CP) test, a CP test would help to measure the amount of energy through breathing and body oxygen levels (Exercise). Each mouse tested individually, will be placed in the CP test unit for half an hour and the CO2 produced in that time will be recorded and analyzed.

Session: Poster
Graduate Student
Stacie Smith
Montana State University – Bozeman – Electrical and Computer Engineering
Smith, Stacie; Himmer, Phil; Nakagawa, Wataru

Investigation of Nanoscale Etching and Poling of Lithium Niobate

The capabilities of some nonlinear optical devices can be improved through approaches such as nano-optics. Two methods, in particular, that can enhance the wavelength conversion efficiency and versatility of current second harmonic generation (SHG) devices made out of lithium niobate are creating nanoscale domain inversions (to make for efficient quasi-phase matched SHG devices at various wavelengths) and gratings (to potentially achieve exact-phase matching). Lithium niobate is the material of interest as it is a commonly used material for SHG processes.

This research explores these options, creating nanoscale domain inversions and nanostructuring lithium niobate, in order to enhance current SHG devices. After completing a comprehensive literature survey on current lithium niobate structuring techniques, lithium niobate is structured with an inductively coupled plasma reactive ion etch (ICP-RIE) and poled using an all optical poling technique. The research results in nanostructured gratings in lithium niobate via ICP-RIE but no optical poling was achieved. This project is a foundation towards the long-term goal of building more efficient nonlinear optical devices.

Session: Poster
Undergraduate from a Research Institution
Eric Wissenbach and Reed Hovenkotter
University of Montana – Missoula – Physics

WindNinja

WindNinja is a program designed to predict the winds that would occur across complex terrain at a higher resolution and produced in a time frame faster than previously capable. This project was to validate WindNinja against standard weather models and established surface weather stations.

Session: Poster
Undergraduate from a Research Institution
David Riesland
Montana State University – Bozeman – Electrical and Computer Engineering

Multi-Wavelength Aurora Detector