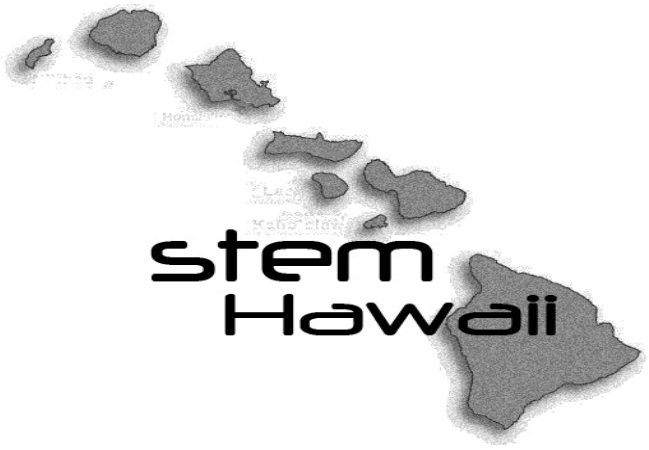
AKAMAI

Maui Internship Symposium

August 6, 2010
Wailea Marriott Resort
Lokelani Ballroom



Program Information
&
Intern Abstracts

2010 Maui Akamai Internship Program

Akamai Workforce Initiative
Institute for Scientist & Engineer Educators
Institute for Astronomy
UH Maui College

Akamai – smart, clever

The Maui Akamai Internship Program is a unique program that combines re-search experiences, coursework, communication skill building, and mentoring. Through the Akamai Program, 10-15 college students from Hawai'i are placed in the Maui high-tech industry for the summer, and then are provided with guid-ance and mentoring as they advance in their education and careers. The Akamai program is based on an internship model designed by the Center for Adaptive Optics (CfAO) using National Science Foundation (NSF) Science and Technology Center funding, with the specific aim of developing and piloting a program to address the workforce needs related to astronomical research and technology in Hawai'i.

The Akamai Internship Program includes:

- 40-hour optics and workforce preparation short course
- 7-week research experience at a Maui technical facility
- Science & Engineering Communication course in which all interns prepare:
  - Oral presentation
  - Poster presentation
  - Technical abstract
  - Personal statement
  - Résumé
- Symposium and many other opportunities for students to present their work
- Ongoing educational and career support
- 3 units credit from UH Maui College

2010 Host Organizations

- Akimeka
- Hnu Photonics
- Institute for Astronomy
- Maui High Performance Computing Center
- Pacific Defense Solutions
- Pacific Disaster Center
- Textron
- Trex Enterprises

Akamai Workforce Initiative

Institute for Astronomy
Jeff Kuhn, Lisa Hunter, Lani LeBron, Samara Phillips, Cindy Giebink, David Harrington

UH Maui College
Mark Hoffman, Elisabeth Reader

Air Force Maui Optical and Supercomputing Site
Joseph Janni

2010 Akamai Short Course Instructors

Dave Harrington - Lead Instructor
UH Institute for Astronomy

Garrett Elliot
UH Institute for Astronomy

Cindy Giebink
UH Institute for Astronomy

Bill Giebink
UH Institute for Astronomy

Michael Jacox
UC Santa Cruz

Ryan Montgomery
UC Santa Cruz

Jerome Shaw
UC Santa Cruz

Ryan Swindle
UH Institute for Astronomy

Claire Walton
UC Santa Cruz

2010 Communication Instructors

Michael Nassir - Lead Instructor
University of Hawaii at Manoa, Institute for Astronomy

Gabriel Roybal - Instructor
UC Santa Cruz

Special Thanks . . .

The Akamai Workforce Initiative would like to thank the following individuals for their commitment and support of the 2010 Maui Akamai Internship Program:

Jason Addison – Textron Systems
Arthur Agdeppa – UH Maui College
Dave Archambeault – Pacific Defense Solutions
J.D. Armstrong – UH Institute for Astronomy
Bryan Berkowitz – Akimeka
Chauncey Brown – HNu Photonics
Suzanne Burns – UH Maui
Bob Calder – UH Institute for Astronomy
Ken Chambers – UH Institute for Astronomy
Paul Coleman – UH Institute for Astronomy
Keiki-Pua Dancil – Hawai'i Science & Technology Council
Ned Davis – Trex Enterprises
Sandra Dawson – Thirty Meter Telescope
Dennis Douglas – Pacific Defense Solutions
Mike Engelmann – Trex Enterprises
Christina Finch – Pacific Disaster Center
Deanna Garcia – Akimeka
Jim Gaines - UH Manoa
Gregory Gates – UH Institute for Astronomy
Dean George – MHPCC
Cindy Giebink – UH Institute for Astronomy
Randy Goebbert – Textron Systems
Errol Jay Gorospe – Akimeka
Les Hieda – UH Institute for Astronomy
Mark Hoffman – UH Maui College
David Kim – HNu Photonics
Peter Konohia – Textron Systems
Rolf Kudritzki – UH Institute for Astronomy
Jeff Kuhn – UH Institute for Astronomy
Kawai Kuluhiwa – Pacific Defense Solutions
Jarrod Latoya – HNu Photonics
Dennis Liang – Boeing/PDS
Ron Magarin – UH Maui College
Ross Matoi – Textron Systems
Robert McLaren IfA Manoa
Tom Melsheimer – UH Institute for Astronomy
Sharon Mielbrecht – Pacific Disaster Center
Maria Nieves – Pacific Disaster Center
Daron Nishimoto – Pacific Defense Solutions
Garry Nitta – UH Institute for Astronomy
Chris Paris – Akimeka
Jung Park – UH Maui College
Richard Puga – HNu Photonics
Elisabeth Reader – UH Maui College
Michael Reiley – HNu Photonics
Jeff Schmidt – MHPCC
Dee Symonds – Trex Enterprises
Lance Terada – MHPCC
John Valliant – UH Institute for Astronomy

Presentation Schedule

Opening Remarks

Jeffrey Kuhn
Assoc. Director for Maui Operations, UH Institute for Astronomy

Lisa Hunter
Director, Akamai Workforce Initiative

Concurrent Session I

HNu Photonics

Melting Borosilicate Glass for Mirror Substrates
Lake Casco (Univ. of Pennsylvania)

An Off-Grid Solar Photovoltaic System for a Macadamia Nut Farm
Kiah Imai (Michigan Tech)

Maui High Performance Computing Center

Keeping Your Information Safe: Linux System Administration and System Security
Jennifer Razo (Honolulu CC)

Akimeka

Construction of a Safe Lab Environment for Computer System Upgrades and Testing
Danielle Prince (Univ. of Arkansas at Little Rock)

Creating an Enterprise-Level Dashboard for Cross-Domain Solution (CDS) Systems
Kai Warman (Drexel Univ.)

- Break -

Pacific Disaster Center

Mapping Climate-Change Indicators Using Geographic Information Systems
Kaitlin Madriaga (Univ. of Washington)

A Tsunami of Information: Organizing and Enhancing the PDC's Natural Hazard Web Content
Leslee Mahoney (Gustavus Adolphus College)

Trex Enterprises

Designing a Deep-Water Sea Anchor System for a Wave Energy Capture Device
Kekoa Roback (UH Mānoa)

Designing a Hybrid Retraction System for a Wave Energy Capture Device
Masafumi Inoue (UH Mānoa)

Concurrent Session II

UH Institute for Astronomy

Developing a Standardized Telescope Instrument Interface for Pan-STARRS
Daniel Hong (UH Mānoa)

Improving Smoothness and Adhesion of Physical Vapor-Deposition Mirror Coatings
Robert Grimmett (UH Mānoa)

Controlling an Electron Beam to Polish Mirrors
Bryan Baello (UH Maui College)

A Configuration GUI for Blind Deconvolution of Astronomical Images
Brian Behnia (UH Hilo)

Mechanical System Design for an Off-Axis Telescope
Matthew Parilla (Cal Poly San Luis Obispo)

- Break -

Textron

A Database Framework for Indexing Skyglow Meta-Data
Andrew Wessels (UH Hilo)

Synthetic Scene Generation for the MSSS Digital Video System
Sarah Souza (Rochester Inst. of Tech.)

Pacific Defense Solutions

Building a Daytime Satellite-Tracking Telescope System — Camera System Integration
Laurie Hozaki (UH Maui College)

Tracking a Rogue Satellite for Photometric and Positional Information
Chad Nagata (UH Maui College)

ABSTRACTS

Melting Borosilicate Glass for Mirror Substrates

Lake Casco
University of Pennsylvania

HNu Photonics
Mentors: David Kim, Jarrod Latoya & Richard Puga
Advisor: Michael Reiley

Borosilicate glasses, because of their superior thermal properties, are used in numerous applications. One of the most common is their utilization as the substrate for mirrors in many telescopes. To assess the possibility of molding large chucks of borosilicate for mirrors in-house at HNu Photonics, the reconstruction of an old kiln was commissioned. Borosilicate glass has a working point of approx. 2300 ˚F, but the temperature specifications of this particular kiln were unknown. The broken firebrick interior was repaired using refractory mortar, and a new programmable temperature controller and thermocouple were installed on the kiln. Since detailed information on borosilicate heat treatments is not widely available due to its proprietary nature, a rough treatment based on available information was devised and performed. First, borosilicate frit was created in-house using scrap borosilicate and a variety of methods. This frit was placed into a simple graphite mold, and the temperature was slowly ramped up to the glass's working point, then held constant until all air bubbles had escaped. Next, the glass was very slowly cooled to its annealing temperature, 1050 ˚F, and soaked at that temperature for a few hours to allow any stresses developed from cooling to dissipate. Finally, the glass was cooled very slowly to its strain point at 800 ˚F, after which the cooling rate was increased until the kiln returned to room temperature. Based the on the quality of the glass in the first run, different cooling rates and more complex molds will be attempted.

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Lake Casco, was born and raised in Lahaina, and is a 2008 Lahainaluna graduate. Lake is currently attending the University of Pennsylvania and majoring in Materials Science and Engineering, with a minor in Energy and Sustainability. He is set to graduate in spring of 2012. In his free time he enjoys going to the beach, surfing, hanging out with friends, playing guitar and working out. After graduating from Penn, Lake is interested in pursuing a job in renewable energy or sustainability.

An Off-Grid Solar Photovoltaic System for a Macadamia Nut Farm

Kiah Imai
Michigan Technological University
HNu Photonics
Mentors: Chauncey Brown, David Kim & Richard Puga
Advisor: Michael Reiley

A client's macadamia nut farm is located in a remote location where power is not supplied by the electric utility. Currently, two diesel generators are used to power the farm's machinery at a cost of $350 per month for fuel. The goal of this project is to design and install a self-sustaining "off-grid" photovoltaic system that provides clean, renewable energy to the farm. The system must be designed to provide power to run the farm's processing equipment for a full eight-hour workday. The cost of the system is not a major constraint, although valid reasoning behind the design must be presented to the client. A data acquisition system was used to measure power consumption of the machines during normal working conditions over the period of a day. The maximum load, including overhead, was found to be 12 kW, so this was used to estimate the size of the solar array and battery bank. The size of the proposed solar array was also determined by the DC-to-AC derate factor, the anticipated hours of direct sunlight, the size of the battery bank, and the expected daily power consumption. Likewise, the necessary battery bank capacity was determined using the DC-to-AC derate factor, the daily power consumption, the depth of discharge of the battery bank, and the number of days of autonomy. Taking all of this into account, it was concluded that the array should be large enough to generate 38.67 kW, and the battery bank size should be 240 kW·h. The overall system will supply 12 kW of power for a full 8 hours per day and would provide one day of autonomy. In the case of continuously bad weather, a backup generator will be used to charge the batteries and/or provide direct power to the equipment. Due to the system's large size and commercial environment, only a preliminary design and layout of the solar array and battery bank could be determined.

Kiah Imai was born in California but raised on the island of Kaua'i. He is currently pursuing a B.S. degree in Electrical Engineering Technology at Michigan Technological University and will be graduating December 2010. He enjoys the outdoors, hiking, going to the beach, and hanging out with friends.

Keeping Your Information Safe:
Linux System Administration and System Security

Jennifer Razo
Honolulu Community College
Maui High Performance Computing Center
Mentors: Dean George & Lance Terada

In every company or organization, people worry about their data getting into the wrong hands. In order to protect this information, large amounts of time, money and manpower are spent on system administration and security. This ensures that private information remains secure from outside parties, such as hackers intent on stealing social security or bank account numbers.
To protect sensitive information at the Maui High Performance Computing Center, we compared the security features of three operating systems: Windows Vista, Windows XP, and CentOS. In order to evaluate their relative effectiveness at protecting data, we compared firewalls, administration tools, and overall security between the three systems. We discovered that the Linux operating system is more secure than the others because Linux users are not given administrator rights by default. Once the operating systems' differences had been investigated, we configured two servers with Raid 10 disk formatting: four hard drives are used, and each pair is mirrored and striped with information. CentOS and RedHat Linux were each installed on one of the two servers. Afterward, both systems were patched with security updates. Currently, Linux System Administration is being investigated as a means to protect the information systems. In addition, we are investigating which services are necessary to run the system, which services are non-critical, and which changes in practices would better secure the system. Once the appropriate operating system has been identified to protect our servers, we can begin accurately securing our information.

Jennifer Razo was born and raised in Makawao on the island of Maui. She graduated from Kamehameha Schools Maui Campus in 2006 with a double endorsement in the Information Technology and the Arts & Communication Academies. Jennifer is currently a junior enrolled in the Computing, Electronics, and Networking Technology (CENT) program, where her interest lies in Networking and Computer Security. Her goal is to graduate with a BS from the CENT program through UH West Oahu, complete her CCNA and A+ certifications, and go on to secure a position in industry.

Construction of a Safe Lab Environment for Computer System Upgrades and Testing

Danielle Prince
University of Arkansas at Little Rock
Akimeka, LLC
Mentor: Errol Gorospe

Many of today's businesses maintain their own internal computer networks and e-mail servers. In order to maintain optimal system performance, both must be kept up-to-date as new technology becomes available and new software versions are released. Akimeka is preparing to perform a pair of upgrades to their corporate computer network: (1) update Active Directory (which sets up the network infrastructure) from Windows Server 2003 to Windows Server 2008, and (2) update their e-mail server from Exchange Server 2003 to Exchange Server 2010. Upgrades of this magnitude are first planned out and tested in a safe, isolated computing environment, or "lab," where accidents or mistakes will not pose a problem to the actual system. Hence, we started by creating a lab similar to Akimeka's current network structure and e-mail system, but on a much smaller scale, to use for simulating and testing the planned upgrades. Two servers were employed to set up the network, add users, and provide IP addresses for Internet access, and one server was used to house Exchange and allow e-mail to be sent back and forth. Research was conducted on strategies to upgrade the network and e-mail configurations without losing or negatively affecting the current setup. As the test upgrade progresses in the lab environment, problems that arise and their solutions are being documented, so that they might be later avoided or worked around. Finally, a documented plan for the upgrade will be prepared, based on the upgrade and tests performed in the lab environment. If the upgrades in the lab environment are successful, the documented plan will be used during the upgrade of the company's actual system later this year.

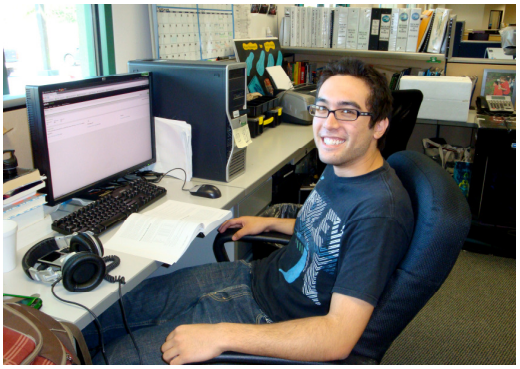
Danielle Prince is a senior studying Information Science at the University of Arkansas at Little Rock. She grew up on Maui and graduated from Kekaulike High School in 2007 before heading to the mainland for college. She hopes to find a job involving Web design or database development, possibly following graduate school. When she is home on Maui, Danielle enjoys going to the beach (or reading books and seeing friends, when the beach is not an option).

Creating an Enterprise-Level Dashboard for Cross-Domain Solution (CDS) Systems

Kai Warman
Drexel University
Akimeka, LLC
Mentors: Bryan Berkowitz & Chris Paris

Currently there is no centralized way to monitor or administrate the proprietary government systems used for controlling the flow of highly classified information to low-security-level contacts, such as squad commanders or unclassified employees. These systems vary widely in hardware and operating systems, making it difficult to compile load and usage data from the different machines — each system has a different set of display commands and event-log formats. This incompatibility across systems limits an administrator's ability to troubleshoot or to take preventative measures. The objective of this project is to create an all-in-one dashboard that displays system statistics gathered from hardware metrics and network traffic, compiling them into an enterprise-level dashboard display. A commercially available program, Splunk, was chosen for the base for the dashboard. Then, using data generated from Bash (Bourne-Again SHell) scripts, I created and customized displays for critical information on several demonstration dashboards. The dashboards were further enhanced using Splunk's built-in Flash tools, as well as by direct editing of XML and configuration files. The final dashboard displays include top-down views and drill-downs to specific systems. System variables are displayed as 24-hour time-dependent graphs, as well as real-time values that update every second. The result is a powerful utilization-monitoring system that allows system administrators to have enterprise-level awareness of all critical operations in their data center. They can track usage trends and analyze statistics. This allows administrators to better identify problems, reduce response time, and ultimately form a detailed idea of hardware usage and needs, enabling them to upgrade their system accordingly.

Kai Warman was born and raised on Maui and is a King Kekaulike graduate. He is currently attending Drexel University in Philadelphia and is moving into his 3rd year in the Software Engineering program. In his spare time, Kai enjoys building computers, listening to music, and being outdoors.



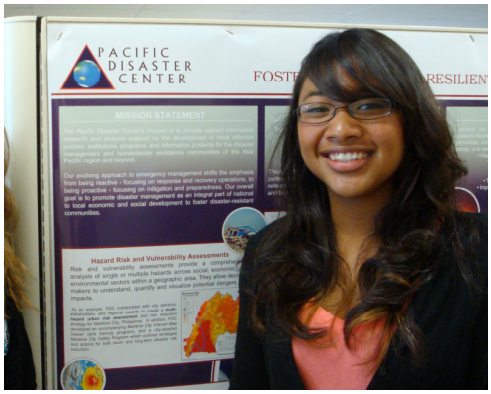
Mapping Climate-Change Indicators Using Geographic Information Systems

Kaitlin Madriaga
University of Washington

Pacific Disaster Center
Mentor: Maria Nieves

Scientists can identify possible climate trends by tracking local weather data. This project acts as a first step in creating a reliable source of such information. We generated a global map that can define, establish, and monitor Global Climate-Change Indicator Sites. A set of climate-indicator sites were selected whose meteorological data span the past 40 years with information including frequency of hazards, population, and types of land cover. A total of 99 sites were chosen, each of which has a mixed type of land cover (no one type exceeding 75% of the whole area) and mixed human activity (~50% either urban or agriculture). A subsample of 25 sites was selected to display more detailed information on land cover and Normalized Derived Vegetation Index (NDVI) classifications. All sites also included data on temperature, precipitation, drought, and frequency of hazards. In order to collect proper spatial data, information was collected from existing networks such as the National Geospatial-Intelligence Agency and USGS. Using our Geographic Information System, downloaded satellite images were clipped down to 42 km ´ 42 km images. The clipped images were used for further land-cover analysis such as NDVI, which shows the amount of vegetation growing in a specific area. Meteorological data for these sites was measured and recorded once a month for 40 years, providing us with long-term, regularly sampled data. The map provides scientists and the public with a common database to monitor population, infrastructure, socioeconomic conditions, and natural hazards. The ultimate goal is to have an organized, interactive map that would be updated throughout future years.

Kaitlin Madriaga is from the island of Maui. She is currently attending the University of Washington in Seattle, where she is studying in the biological science field. She is interested in medicine and new upcoming technology. She loves to travel, shopping, and playing any sport in the water. After graduating college, she hopes to travel abroad and someday come back to Maui and work in the science/tech field.



A Tsunami of Information: Organizing and Enhancing the PDC's Natural Hazard Web Content

Leslee Mahoney
Gustavus Adolphus College

Pacific Disaster Center
Mentor: Christina Finch

When the state of Hawai'i issued a tsunami warning in February 2010, the Pacific Disaster Center's (PDC) website (www.pdc.org) received more than 20,000 hits—far more than expected. The high level of traffic ultimately crashed the site, and a subsequent assessment of the existing website identified problem areas across the site. The "Resources" tab, which links to detailed information about natural hazards, had multiple problems such as old content, inconsistent organization, and difficult navigation. The goal of this project is to improve the "Resources" section in three ways: (1) develop the "More Information" links for each hazard type; (2) research and gather information on Hawaii's natural hazard history; and (3) create sample webpages that organize the new content effectively. After familiarization with the current PDC site, research for the "History" and "More Information" sections was compiled from professional organizations such as FEMA, USGS, and NOAA. Adobe Dreamweaver was used in combination with cascading style sheets (CSS, a Web-design language) to develop a set of eight interactive sample webpages. Since CSS-styled webpages require less code and load faster than HTML tables, CSS was used to build a model of the proposed PDC website redesign. This simplified version contains new organizational ideas for the "History" content, such as using interactive timelines that display links and enlarged pictures. The webpages also include a short summary of each historic event and source all content, so that users and educators can obtain more information. The sample site's design and/or content may be used in the final PDC website redesign.

Leslee Mahoney was born and raised on the island of Maui. She graduated from King Kekaulike High School in June 2009 with valedictorian honors. She is currently finishing up her first year of college at Gustavus Adolphus College in St. Peter, Minnesota. While Leslee is planning on majoring in management, she also intends to focus on the fields of environmental science and web design. During her free time Leslee enjoys creating websites, riding her bike, and spending time with family and friends at the beach. .

Designing a Deep-Water Sea Anchor System for a Wave Energy Capture Device

Kekoa Roback
University of Hawai'i at Mānoa

Trex Enterprises
Mentors: Ned Davis, Dee Symonds & Michael Engelmann
Collaborator: Masafumi Inoue

Instruments and sensors used in oceanographic research require a source of energy in order to collect their data. This requires a portable, self-contained, sustainable power-generation system that can operate in the open ocean. Wave-generated power meets these needs, and when used in conjunction with photovoltaic cells, can provide an efficient means of sustainable energy. The Wave Energy Capture (WEC) device designed by Trex uses the repetitive vertical motion of a buoy on open-ocean waves to harvest power: the cable connecting the buoy to an anchoring device drives an internal rotary generator. The goal of this project is to design and test a sea anchor system for deep-water applications where a traditional anchor cannot be secured to the sea floor. Vertical alignment of the sea anchor and buoy needs to be maintained to maximize the energy harvested. This will be accomplished using a sensor package to determine relative position, and a thruster assembly to reposition the sea anchor as necessary. I began the design using a commercially available sea drogue, originally intended for boats, which was in the shape of a conical frustum. Initial calculations, supported by in-water measurements, indicated that the size required for sufficient vertical drag would also result in excessive horizontal drag that would need to be overcome by the thruster system. Initial thruster designs were considered and a prototype built. Tests of the prototype showed that the power requirements for the thruster assembly would far exceed the amount of available power. Several alternate sea anchor designs were considered, drag calculations were performed, and scale models were built and tested. Pursuant to this analysis, an optimal design will be chosen and scaled up to provide the desired amount of drag for the second-generation WEC device. This design will be tested at the Kilo Nalu test facility on O'ahu in late August, and the results will be used to refine the design of future sea anchors.

Kekoa Roback was born and raised on the island of Maui. He graduated from Lahainaluna High School in 2004 and Honolulu Community College in 2006. Currently, he is a senior at the University of Hawai`i at Mānoa in pursuit of a degree in Mechanical Engineering and plans to graduate in spring 2012. He enjoys the beach and hanging out with friends and family.

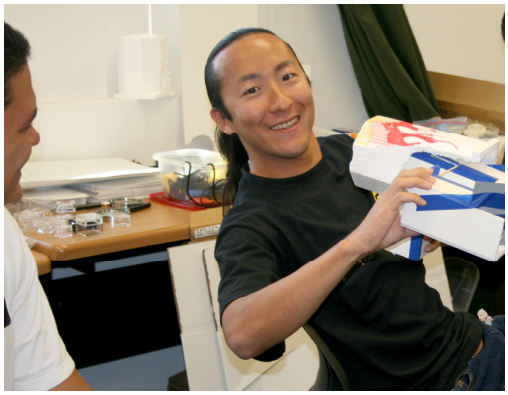
Designing a Hybrid Retraction System for Wave Energy Capture Device

Masafumi Inoue
University of Hawai'i at Mānoa

Trex Enterprises
Mentors: Ned Davis, Dee Symonds & Michael Engelmann
Collaborator: Kekoa Roback

Ocean waves contain significant energy, and they can provide a more reliable and continuous source of renewable energy than the sun or wind. A wave energy capture (WEC) device has been developed by Trex Enterprises to power ocean-based instruments and sensors. A generator is housed in the WEC device that is suspended just below a buoy and connected by a long cable to an anchor. Upward wave motion actuates the generator by extending the cable between the WEC device and the anchor, but the cable must be retracted during downward wave motion. The original design relied on a passive mechanical spring system, but it could not adjust its response to specific wave periods or heights, and it was also prone to fatigue failure. We have designed an active motorized retraction system that provides a more reliable mechanism and that can respond electronically to a variety of wave heights and periods. A Hall Effect sensor detects the rotation of the main shaft, and a comparator observes the overload on the motor, indicating upward wave motion. Microcontrollers process signals from the sensor and comparator to initiate and stop the retraction motor. A passive spring has been retained in our design to reduce the load on the active retraction motor; the shared load also reduces spring fatigue and improves reliability. We anticipate that testing will reveal a substantial increase in performance and life span of the WEC device when this hybrid retraction system is used, compared to the spring-only design.

Masafumi Inoue was born in Japan and moved to the island of Oahu in 2002. He is currently a junior majoring in Mechanical Engineering at University of Hawaii at Manoa and plans to graduate in May 2011. In his spare time, he enjoys spending time with his wife, watching movies, and fixing things around house .



Developing a Standardized Telescope Instrument Interface for Pan-STARRS

Daniel Hong
University of Hawai'i at Mānoa
Institute for Astronomy
Mentors: Robert Calder, Thomas Melsheimer & Gregory Gates
Advisor: Kenneth Chambers

The Panoramic-Survey Telescope and Rapid Response System (Pan-STARRS) has several instruments used for observing that will need to be mounted on the telescope. Therefore, I was given the task of creating a universal instrument interface for the third-party instruments associated with Pan-STARRS. To solve this, I designed the Auxiliary Mounting Interface (AMI). When I started, there were no clear definitions for the limiting parameters (dimensions, power, weight, etc.) of the instruments. I interviewed numerous sources and presented a preliminary design review to determine all requirements and constraints for the mounting system. My design worked within these specifications to standardize the telescope-instrument connections and a mounting plate to house them. I used SolidWorks software to create models and used its finite element analysis to optimize the design. A weight limitation of either 40 or 100 lbs was imposed on instruments, due to the limited manpower at the telescope. The final design is a dovetail wall-mount that allows any instrument to be easily installed, removed, and realigned consistently to its original position. A critical design review, needed before approving construction, is scheduled shortly before the end of my Akamai internship.

Born and raised in Oahu, Daniel Hong is going into his fourth year at University of Hawaii at Manoa majoring in mechanical engineering. His passion for the S.T.E.M fields stemmed from the three years he had participated in FIRST robotics at McKinley High School. He still goes back to mentor the robotics team ever since he graduated. Daniel's main goal after receiving his degree is to help his community to become a better a place for now and future generations.

Improving Smoothness and Adhesion of Physical Vapor-Deposition Mirror Coatings

Robert Grimmett
University of Hawai'i at Mānoa
Institute for Astronomy
Mentor: J.D. Armstrong
Advisor: Jeffrey Kuhn

Most high-performance telescope mirrors are created by coating a glass substrate with a reflective substance using the process of physical vapor deposition: aluminum (or other metallic substance) is vaporized from a high-current filament inside an evacuated chamber, and aluminum atoms deposit into a solid coating on all objects within the chamber. The Institute for Astronomy (IfA) on Maui is currently capable of aluminizing 30-cm-diameter mirrors with a peak-to-valley variation of 100 nm. This project seeks to improve mirror-coating techniques in three areas: smoothness, durability, and reflectivity. Smooth mirrors are needed to reduce scattered light within the telescope's optical path, and the best way to make a smooth mirror is to start with a clean, smooth substrate. We found that an ultrasonic bath and nitrogen air gun are best for removing debris during substrate preparation. A durable coating is necessary for mirrors to withstand long-term exposure and use. To create a durable, long-lasting coating, good adherence of the aluminum to the glass substrate must occur. Our study showed that the cleaning technique used during substrate preparation is key for durability, as well. Finally, reflectivity is most important because it is the essential function that makes a mirror, a mirror. Aluminum coatings reflect a greater range of visible wavelengths at a higher reflectivity than other metals. The IfA is now able to implement these improved techniques when coating mirrors using their existing vapor-deposition equipment.

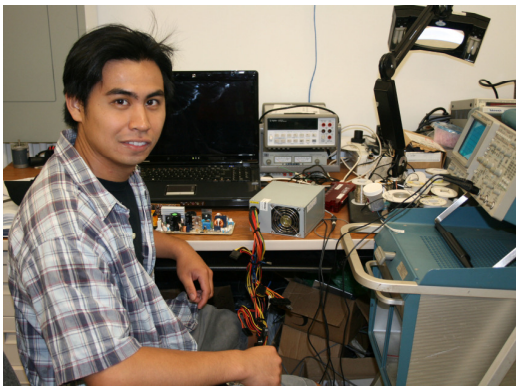
Robert Grimmett grew up in a military family and graduated from Radford High School in Honolulu. He is currently pursuing a B.S. in Mechanical Engineering at the University of Hawai'i at Mānoa. Robert is a member of the Native Hawaiian Science and Engineering Mentorship Program, Kahue Wai Ola STEM scholars, and the Renewable Energy for Island Sustainability program. In his free time he likes to surf, hike, and camp.

Controlling an Electron Beam to Polish Mirrors

Bryan Baello
University of Hawai'i Maui College
Institute for Astronomy
Mentors: Lester Hieda & John Valliant

Vacuum electron-beam ("e-beam") coating chambers are typically used for coating substrates. Substrates such as lenses and mirrors have an inherent level of "microroughness." A smoother and flatter substrate scatters less light, which makes for a better optical element. The goal of this project is to polish substrates at sub-nanometer levels. This polishing involves taking an optical element such as a mirror, positioning it over the crucible area of the vacuum chamber, then using the e-beam to selectively erode or ablate the surface of the substrate. In order to complete this task, a variable-waveform sweep generator with fine control must be created to position and control the e-beam. A graphical programming language, LabView, was used to create a simulated function-generator. A LabJack data-acquisition device was installed as an interface with the LabView software: the LabJack converts the digital signal created by the LabView function generator into a real-world output voltage, which is then fed to the e-beam controller of the vacuum chamber. Two separate voltage signals are generated by the simulated function generator, and these signals drive the e-beam in the *x* and *y*-dimensions. This allows the e-beam to be steered and swept back and forth across the mirror surface that is being micro-polished.

Bryan Baello was born in the Philippines and lived there until the age of eight, when he immigrated to the U.S. and lived in Minnesota. He moved to Maui by himself and is attending UH Maui College in the Electrical and Computer Engineering Technology (ECET) program. After completing his Associate of Science degree, he plans to earn a Bachelor's of Applied Science at UH Maui. He likes to read, go hiking, fishing, and body boarding, watch movies, and do all the enjoyable things that there are to do on Maui.



A Configuration GUI for Blind Deconvolution of Astronomical Images

Brian Behnia
University of Hawaii at Hilo
Institute for Astronomy
Mentor: Cindy Giebink

Blind deconvolution is an iterative mathematical process used to increase the sharpness of images that have been blurred by atmospheric distortion. It can be applied to any image, but it is particularly useful in astronomical image post-processing to improve image clarity. Before this project, a configuration file containing a large number of mathematical parameters and input files was passed to a supercomputer; these parameters were all assigned manually, line-by-line, in text files. This process was not only cumbersome for the end-user, it also created a potential to produce errors in variable assignment, and it allowed the user to initialize sets of variables that should not be used concurrently. Hence, this process had the potential of sending jobs to the supercomputer that were not configured properly, wasting valuable processing time. We are producing a graphical user interface (GUI), using the Qt framework and C++ language, to generate this configuration file. The GUI helps the user produce a configuration file with correct parameters, passes the file to a supercomputer job queue, and visualizes images as they are processed. Ultimately, this will reduce the frequency of user error and will make the process of blind deconvolution of astronomical images much more user-friendly.

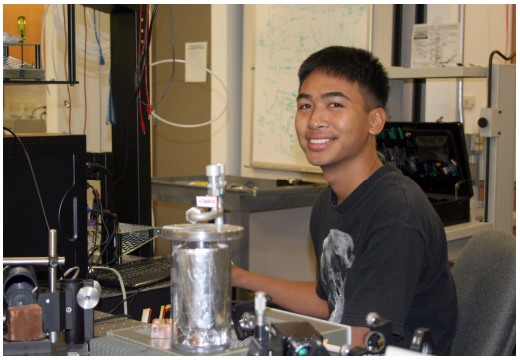
Brian Behnia is a Computer Science major attending the University of Hawaii at Hilo. In his spare time he enjoys bodyboarding, tennis, basketball, reading, and spending time with his family and friends. He is also fascinated with astronomy and physics, and would love to fulfill his dream of helping to increase our understanding of the universe.

Mechanical System Design for an Off-Axis Telescope

Matthew Parilla
California Polytechnic State University, San Luis Obispo
Institute for Astronomy
Mentors: Jeffrey Kuhn & Garry Nitta

Maximizing the structural rigidity of a telescope is essential for allowing astronomers to optimize image quality and to better resolve distant objects. PLANETS, a 1.85-meter, off-axis equatorial telescope to be located atop Haleakala, will focus on optimizing image quality. To accomplish this, microscopic gravitational and thermal deflections within the telescope system must be minimized. With this goal in mind, I designed and analyzed several components of the PLANETS system using Autodesk Inventor and Algor software, including the observatory building, the polar axis and fork, the mirror and its supports, and the telescope mount. Using the software's finite element analysis package, I analyzed various parts of the telescope for deflections experienced by the system. Using 61 points of support arranged in concentric circles, the maximum deflection in the mirror due to gravity and thermal effects was reduced to 35.4 nanometers. A lightweight and rigid frame was needed for mounting the mirrors and optical equipment with a target maximum deflection of 50 microns when in the upright position. A steel truss system constructed using hollow cross-sections weighed only 2150 kg and experienced a maximum deflection of 43.2 microns, meeting the design criteria. Additionally, magnetostrictive materials that change in length when subjected to a magnetic field may be used to further minimize the deflection in the system. A solid design base has now been established with this project; further optimization of the components within the PLANETS telescope system will produce better quality images.

Matthew Parilla, a 2007 graduate of Maui High School, will enter his fourth year at the California Polytechnic State University, San Luis Obispo in the fall. He plans to graduate in 2011 with a B.S. in Mechanical Engineering and a concentration in Mechatronics. After graduation, Matthew plans to work in the field of robotics or aerospace. He looks forward to making important contributions to the technology of the future. He enjoys playing basketball, snowboarding, spending time with family and friends, and playing the guitar.



A Database Framework for Indexing Skyglow Meta-Data

Andrew Wessels
University of Hawai'i at Hilo
Textron Systems
Mentors: Jason Addison & Peter Konohia

Atmospheric light known as "skyglow" can hinder the ability of ground-based sensors to detect faint objects in the night sky. In order to help researchers monitor skyglow, we receive large amounts of data from a camera dedicated to recording images of the night sky. In its raw form, this data is relatively inaccessible. Python code has been written to process the raw data by extracting useful meta-information and preparing it for subsequent processing, by removing errors and storing it in a usable format. The meta-information describes the context of individual data segments and allows us to extract desired information. In place of the existing system, we have employed an SQLite database that provides a faster, more efficient interface — it reduces redundancies and enables the user to extract relevant statistics from any subset of the data. Once stored, the meta-data must undergo a data-cleanup algorithm that we developed to correct inconsistencies. We also created software to produce various data products using this database, such as images, video, graphs, and statistics, with plans for more products in the future. The code has been packaged into a general library that can be used to streamline the data acquisition, cleanup, and production processes. This will be an important tool for researchers interested in accessing this skyglow data, and hopefully this framework can be adapted for use with other datasets in the future.

Andrew Wessels was born in Salem Massachusetts, but moved to Hawaii at the age of two. He graduated from Hilo High School in 2006, and is currently pursuing his Bachelor's Degree in Computer Science at the University of Hawaii at Hilo. Andrew enjoys reading about new technology, writing code for websites, playing games, and collecting music. His dream is that someday his efforts will help change the world.

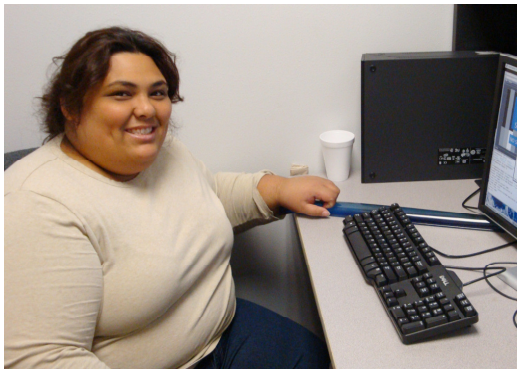
Synthetic Scene Generation for the MSSS Digital Video System

Sarah Souza
Rochester Institute of Technology

Textron Systems
Mentor: Randy Goebbert
Advisor: Ross Matoi

This project involves learning about the digital video system, known as SpOCK Video Kit (SVK), at the Maui Space Surveillance Site (MSSS) and creating synthetic images for the SVK to use. The goal of this project is to create an external program that creates synthetic images to be displayed in the SVK. The project also involves modifying the SVK so that it is able to accept images created by the external program. The external program uses Simple DirectMedia Layer (SDL), an open-source cross-platform multimedia library designed to provide fast access to the graphics frame buffer. We used SDL to create a program that outputs fixed and/or simple animated scenes. We also used Qt to allow the SVK and the external program to communicate. Qt is a cross-platform application development framework that contains a shared memory component. The external program sends out data to shared memory, and the SVK reads in data from shared memory. The image is then placed into the SVK video pipeline. Once there, the generated image can be used to validate SVK image-processing algorithms such as background subtraction and object tracking. If time permits, the project will expand to include playback of digital video into the SVK pipeline.

Sarah Souza is from Kaneohe, Oʻahu. She is currently a fifth-year Computer Engineering Technology student at Rochester Institute of Technology. Sarah is a “gadget junkie” and likes learning about new devices. She also enjoys video games and tennis in her free time.



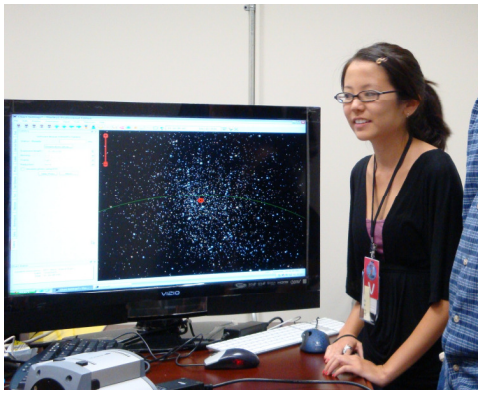
Building a Daytime Satellite-Tracking Telescope System — Camera System Integration

Laurie Hozaki
University of Hawai'i Maui College

Pacific Defense Solutions
Mentors: Kawai Kuluhiwa, Dennis Liang & Dave Archambeault
Advisor: Daron Nishimoto
Collaborator: Chad Nagata

The Iridium and Cosmos satellites that collided in 2009 produced 1700 pieces of new space debris. Therefore, it is important to track this debris cloud to protect operational satellites. Persistent observations of this debris cloud are needed to meet the space surveillance objectives of the U.S. Air Force. Optical satellite tracking systems usually operate during the night. Since satellites orbit the earth during both day and night, it is also important to track satellites during the day. The challenge of tracking satellites during daytime is to select a charge-coupled device (CCD) that will maximize its signal-to-noise ratio (SNR) by optimizing the integration time and read noise, while suppressing the sky background. A CCD with a fast frame-readout is needed to maximize the temporal resolution of each pass and to prevent saturation from the sky background. To maximize the SNR, we also need a CCD that has low read noise. Finally, to suppress the sky background, we need to select an optimal filter stack combination using *I*-band and neutral-density filters. Three CCDs were selected for testing: Apogee, Fairchild, and Andor. We selected the electron-multiplying charge-coupled device (EMCCD) frame-transfer Andor iXon 897 camera. One of its limitations is that it runs on a Linux-based computer, which is not compatible with the rest of the telescope system. We are researching commercial off-the-shelf (COTS) Windows-based software, such as CCDSoft or MaxImDL, that will be able to control the camera while also being compatible with the tele-scope-control system.

Laurie Hozaki was born and raised on the island of Maui and has lived there most of her life. She is currently attending UH Maui College and is pursuing an A.S. degree in the Electronics and Computer Engineering Technology (ECET) program. After graduating, she hopes to further her education by getting a bachelor's degree, and then to find a job in the tech industry. Apart from academics, she likes to play video games, read books, and go hiking.



Tracking a Rogue Satellite for Photometric and Positional Information

Chad Nagata
University of Hawai'i Maui College

Pacific Defense Solutions
Mentors: Kawai Kuluhiwa, Dennis Liang & Dave Archambeault
Advisor: Daron Nishimoto
Collaborator: Laurie Hozaki

Galaxy 15, a television communications satellite, lost contact with its owner Intelsat in early April 2010. A malfunction believed to be prompted by a solar flare knocked the satellite out of its geostationary orbit, sending it on a drifting path in space. Now observations of this object are necessary to understand the threat that it poses to other operational satellites. We will be using two similarly configured optical systems to track and image *Galaxy 15* for photometric and positional measurements. Each system is equipped with a 1024´1024 back-illuminated charge-coupled device (CCD), a focal reducer, and an eight-position filter wheel with Johnson *BVRI* and clear filters. One optical system is on Maui, and the other is in Albuquerque, NM. Both systems are capable of tracking *Galaxy 15* autonomously through a network-tasking GUI. Calibrated satellite data will be automatically collected from these two systems and processed using software called Astrograph, which provides accurate positional and photometric information on the object. This data will help analysts understand how the uncontrolled drift of the *Galaxy 15* satellite will affect other operational satellites.

Chad Nagata is a junior at UH Maui College majoring in Electronics and Computer Engineering Technology. He plans to enter the new bachelor's degree program in Engineering Technology in Fall 2011. He hopes to continue working for Pacific Defense Solutions on the project begun during his Akamai internship. Chad enjoys being outdoors and doing all types of sports, including tennis, basketball, volleyball, and bowling.

Akamai Workforce Initiative

University of Hawai‘i Institute for Astronomy (IfA)
Institute for Scientist & Engineer Educators (ISEE)
UH Maui College

The Akamai Workforce Initiative (AWI) partners industry, observatories, educational institutions, and community to meet needs in astronomy, remote sensing, and other technology industries in Hawai‘i. The AWI includes internships, the Teaching and Curriculum Collaborative, development of engineering technology courses, and outreach to high schools.

The AWI will advance Akamai – smart, clever, expert – students into the technology workforce on Maui, and more broadly in Hawai‘i.

AWI includes internships on Maui and the Big Island

Maui Akamai Internship

Akimeka, hν Photonics, Institute for Astronomy, Maui High Performance Computing Center, Pacific Defense Solutions, Pacific Disaster Center, Textron Systems, Trex Hawaii

Hawai‘i Akamai Internship

Canada-France-Hawaii Telescope, Gemini Observatory, Institute for Astronomy, W.M. Keck Observatory, Smithsonian Submillimeter Array, Subaru Telescope

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