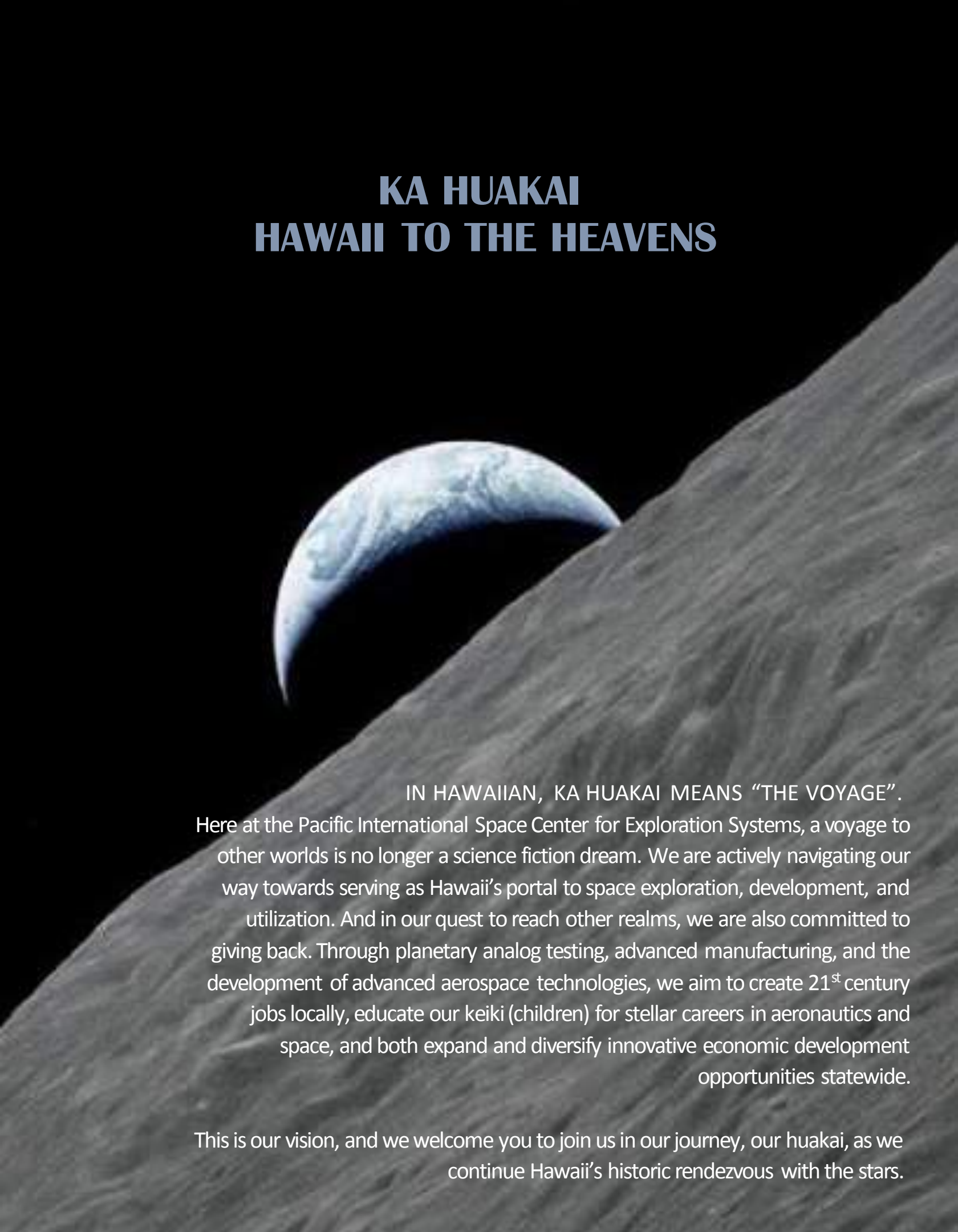
PISCES ANNUAL REPORT

2014

PACIFIC INTERNATIONAL SPACE CENTER FOR EXPLORATION SYSTEMS | HILO, HAWAII

PISCES
Pacific International Space Center for Exploration Systems

KA HUAKAI
HAWAII TO THE HEAVENS



IN HAWAIIAN, KA HUAKAI MEANS "THE VOYAGE".
Here at the Pacific International Space Center for Exploration Systems, a voyage to other worlds is no longer a science fiction dream. We are actively navigating our way towards serving as Hawaii's portal to space exploration, development, and utilization. And in our quest to reach other realms, we are also committed to giving back. Through planetary analog testing, advanced manufacturing, and the development of advanced aerospace technologies, we aim to create 21st century jobs locally, educate our keiki (children) for stellar careers in aeronautics and space, and both expand and diversify innovative economic development opportunities statewide.

This is our vision, and we welcome you to join us in our journey, our huakai, as we continue Hawaii's historic rendezvous with the stars.

ABOUT PISCES

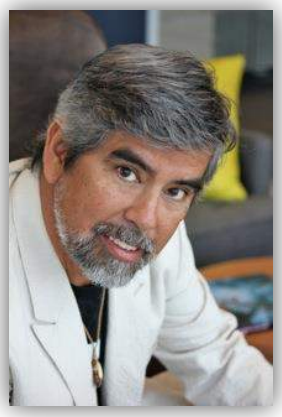
The PISCES Staff outside the Hilo office.

The Pacific International Space Center for Exploration Systems, or PISCES for short, is a Hawaii State Government Aerospace Agency located in Hilo, Hawaii. The Center is part of the State Department of Business, Economic Development, and Tourism (DBEDT) and conducts environmentally-safe field tests on Hawaii's volcanic terrain to test and validate advanced space technologies under the jurisdiction of the Hawaii State Department of Land and Natural Resources (DLNR). These include robotics, advanced manufacturing, and advanced communications - all with dual purposes: for use in space as well as here on Earth.

"These space technologies include robotics, advanced manufacturing, and advanced communications – all with dual purposes: for use in space as well as here on Earth..."

LETTER FROM THE BOARD CHAIR

HENK ROGERS



DEAR PISCES SUPPORTERS,

It has been a challenging year for PISCES. Washington/NASA, other space faring nations (India, China, Russia), and visionary entrepreneurs from the commercial space sector are talking about going to the Moon or to Mars. This should be the year when PISCES begins to seriously attract some of the companies involved in this upcoming business to base some of their research and development activities in Hawaii - especially in light of our State's major geographical/geological advantages (e.g., Moon and Mars-like soils/terrain, mid-Pacific/near-equatorial location).

Unfortunately, PISCES was caught in Hawaii's projected budget crunch. We did not receive the money we had been allocated in Fiscal Year 2014 to break ground on our proposed Hilo facilities. We had selected a location on the Big Island that would have included development of a world-class aerospace tech park, but this opportunity has now been put on hold. Hopefully we can recover this lost ground next year when our budget situation improves.

Despite PISCES' budgetary shortfall, however, much has been accomplished! Programs that were launched in temporary PISCES facilities are now moving "full steam ahead". Our intrepid Executive Director, Rob Kelso, has been inspiring aerospace leaders and companies on the mainland to look to Hawaii as the ideal place to deploy their off-planet efforts. And the opportunities here are truly legion!

For example, our State is making excellent progress toward developing a commercial space launch facility that will bring space tourism to Hawaii. Our second four-month crew will leave the Mars HI-SEAS (Hawaii Space Exploration Analog and Simulation) Habitat (simulating a long duration Mars mission on the Big Island) this August. NASA has selected Hawaii as the premier site for our nation's first laser communications ground terminal that will soon link with next-generation orbiting satellites and interplanetary probes. And PISCES is working with various companies to help pioneer innovative applications of 3D manufacturing technologies that will use basaltic materials to construct facilities on other planetary bodies (as well as on Earth!).

All in all, the future of Hawaii-based space exploration still looks as bright and promising as ever. As the world gears up to explore and colonize off-planet, Hawaii can play a prominent role as both a major contributor to and beneficiary of global space enterprise, and PISCES can help realize this potential by encouraging a significant portion of the aerospace industry to operate in the islands - creating high paying science and engineering jobs for future generations of scientists, engineers, and entrepreneurs who ultimately will lead us to the frontiers of space. Let's keep our eye on this ball and make sure these opportunities don't slip away.

PISCES is doing its part to bring the business of space exploration to Hawaii. Let's all do our part!

Aloha,
Henk B. Rogers
Chairman
PISCES Board of Directors

LETTER FROM THE EXECUTIVE DIRECTOR

ROB KELSO

ALOHA!

Fiscal year (FY) 2014 (July 1, 2013 – June 30, 2014) was a period of unprecedented accomplishments for the Pacific International Space Center for Exploration Systems (PISCES), and expansion into new areas of research and development within planetary surface systems technologies. PISCES received its 726 lb. planetary rover during the spring - a rover that will be a centerpiece for integrated robotic operations within PISCES for years to come, and one that is expected to play a key role as a platform for planetary basalt construction. PISCES also acquired a high-end 400-watt laser to begin research in laser sintering of planetary basalt materials for 3D fabrication. PISCES added key personnel to its staff in the areas of robotics systems engineering and 3D laser printing to maximize these project initiatives. Additionally, PISCES saw remarkable strategic partnerships form with NASA Kennedy Space Center and NASA Headquarters in Washington DC for joint research in planetary construction and innovative laser optical communications technology within the State of Hawaii.

Within the pages of this final report, the reader will note a marked growth in the level of strategic participation from many elements in Hawaii, as well as from NASA, educational institutions and the private sector outside the State and in other countries. The inclusion of the private sector, federal agencies, and international entities has allowed research collaborations to greatly grow and deepen. Furthermore, our partnership with Hawaii's Department of Business, Economic Development, and Tourism (DBEDT) has become a vital and important link to the State's aerospace initiative. We look forward to continuing this partnership as PISCES' efforts within the State continue to expand.

Within the federal, state, private/commercial, and academic sectors, PISCES has also achieved significant success in its advocacy of planetary robotic development and basalt construction research. PISCES is extremely proud of its continued and growing relationship with the University of Hawaii system.

Looking to the future, we see PISCES being tapped in entirely new ways by NASA and the emerging commercial space/planetary resources sector, bringing innovation and new thinking to advanced technology development and supporting its respective mission needs.

I am especially pleased to introduce the final report for PISCES for fiscal year 2014. As Executive Director of this important state-funded program, it has been my pleasure to direct this new and growing organization during its first full year of operation. I want to extend my congratulations to the excellent PISCES staff who made this first full year a success in Hawaii. I also extend my sincere thanks to the many legislators, board members, academic advisors, cultural committee members and members of the business sector for their input, contributions, guidance and interest. I look forward with great anticipation to my continued role as Director as PISCES enters its second full year of operations in FY15. The enthusiastic and widespread support for PISCES will ensure continued success during the exciting years ahead. We have only just begun to reach for new heights in continuing Hawaii's historic rendezvous with the stars.

With much Aloha,

Robert M. Kelso

Executive Director, PISCES

2014 PISCES ANNUAL REPORT

EXECUTIVE SUMMARY

MOVING FORWARD | Return on Innovation

The Pacific International Space Center for Exploration Systems (PISCES) completed its first full year of operations, building on achievements of the last half of fiscal year 2013. PISCES is moving forward from a position of strength. We made solid progress in our mission to advance planetary surface systems technology and to improve economic returns to Hawaii by focusing on our three primary strategic initiatives: robotics, planetary basalt construction, and infrastructure (communication relay towers and backbone).

In Fiscal Year (FY) 2014, PISCES operated on-budget and on-schedule for new strategic initiatives planned for FY14. We were able to increase from 4.5 Full-Time Employees (FTE) at the end of FY13 to 6.25 FTE, adding individuals with engineering, project management, and robotics skills critical to our success. Furthermore, PISCES became increasingly recognized within the world-wide space community for its emerging research in planetary construction and robotics.

"We made solid progress in our mission to advance planetary surface systems technology and to improve economic returns to Hawaii . . ."

KEY FINDINGS

PISCES' planetary rover shown shortly after arriving in the Islands.

- **Planetary Surface Systems Technology Development.** PISCES made significant advancements in planetary surface systems research and development:
  - PISCES acquired a 726 lb. planetary rover from Canada and began instrumenting the robotic platform with camera systems, flight communication packages, new avionics/software, and attitude determination technology.
  - In-Situ Resource Utilization (ISRU) – PISCES developed an integrated build-out plan for a systems-of-systems architecture for demonstration and evaluation at the PISCES test site. The PISCES rover will be the key/central piece for the PISCES Robotic Village. Other ISRU technology will be introduced from NASA field centers and academic institutions.
  - Planetary Basalt Research
    - PISCES made great progress with developing a high-power laser/sintering laboratory for research in 3D printing/fabrication using planetary basalt fines.
    - Under joint funding between PISCES and the County of Hawaii-R&D Department, PISCES led a collaborative research effort with several NASA field centers and the University of Hawaii at Manoa in the world's first additive-construction "lunar sidewalk" using basalt material in the city of Hilo.
- **Federal / NASA Partnerships.** Formal working agreements between PISCES and NASA were completed, including a reimbursable space act agreement (SAA) in the spring of 2013 and a non-reimbursable agreement in late summer 2014. Further, PISCES entered into two major program agreements with NASA Headquarters:
  - 3D construction using volcanic basalt/regolith – PISCES was sought by NASA Headquarters as a key strategic partner in joint research involving 3D construction of regolith. Project definition and formulation was completed in FY14, with Phase 1 (construction of a launch/landing pad in Hawaii) scheduled to begin in early FY15. This further positions Hawaii to be the leading State in developing volcanic material processing techniques for construction (for both terrestrial and planetary surfaces).
  - NASA Advanced Laser Optical Communication Ground Station – NASA Headquarters/Space Communications and Navigation (SCaN) sought out PISCES to partner in the creation of the world's first laser optical ground station to be located on the Big Island in Hawaii.
    - PISCES is currently working with NASA on possible site locations, interfacing with the University of Hawaii System on curricula for laser optics and communications.

International Strategic Partners. PISCES is reaching out to the international community relative to joint research and testing opportunities.

- Japan – discussing rover robotic testing and 3D printing research in Hawaii
- Germany – loaned a high-power laser to PISCES for 3D printing research with basalt material
- Canada – provided long-term loan of a large planetary rover for research/testing in Hawaii
- Hungary – performed robotics testing for Team Puli (Budapest) on Mauna Kea in preparation for a Google Lunar XPRIZE (GLXP) lunar mission.

- **Public Information Outreach**. PISCES made significant progress in implementing critical outreach tools that enhanced the dissemination of information about PISCES progress and achievements:
  - PISCES website – a new website (Pisces.hawaii.gov) went "live" along with a monthly newsletter including a distribution list of over 700 participants.
  - A PISCES banner was placed at the Hilo Airport to introduce visitors to PISCES' strategic initiatives.
  - Major outreach events were planned and executed including presentations at the Pacific Aviation Museum in Honolulu, the State Capitol, schools, malls and planetariums statewide.

Rover debut at Pacific Aviation Museum.

- **Planetary Analog Test Sites** - PISCES improved its planetary test site with the addition of several new pieces of infrastructure:
  - Advanced communications-links for interfacing remote control centers with robotic systems at the PISCES field test site.
  - A new power mast and solar array.
  - Generation of the PISCES Facility User Guide.
  - Surveying new planetary test sites including high-quality lava tubes and skylights.
  - Development of a database for field-site data for PISCES analog test sites.

PISCES' rover outfitted with aluminum wheels shown at an analog test site.

PISCES also facilitated and conducted test site operations for the GLXP Team Puli robotic rover as well as interface command/control testing with their control center in Budapest, Hungary.

Workforce Development / University Involvement

- PISCES supported 13 interns during the summer of 2014 in various PISCES projects and initiatives. Students represented the University of Hawaii-Hilo (UHH), University of Hawaii-Maui College (UHMC), University of Hawaii-Manoa (UHM), Western Washington University, and University of Rochester, New York.
- One former PISCES intern supported a joint NASA/PISCES geologic investigation on Mauna Kea, which led to her selection as one of the first recipients of the NASA Sally Ride Fellowship and a 2014 summer internship at the NASA-Johnson Space Center.

State Legislative Resolutions

- PISCES led efforts for the successful passage of two Resolutions in the 2014 session of the Hawaii State Legislature supporting:
  - Recognition of the Apollo 11 Tranquility Base as a UNESCO Historic Site
  - NASA-sponsored research in basalt construction

Artist rendering of construction-scale 3D printing on the moon. Image Credit: Behnaz Farahi and Connor Wingfield.

As prudent financial stewards, the PISCES staff have invested in strategic programs that deliver value. We controlled expenses and carefully managed our state-funding, allowing us to further advance Hawaii's support for planetary surface/space technology development, as well as to provide our customer with high quality technical, educational, and professional resources (in spite of challenging economic conditions). Our achievements in FY14 have positioned us well for even greater advances in our strategic initiatives. Thank you to the PISCES staff, volunteers, and strategic partners for your roles in making these successes happen.

Robert M. Kelso
Executive Director, PISCES

PISCES
Pacific International Space Center for Exploration Systems

PLANETARY SURFACE SYSTEMS TECHNOLOGY AND DEVELOPMENT

One of PISCES' main areas of development this year included the creation from the ground up of a Robotic Village. The long-term goal will be to establish a site where different technologies in Planetary Surface Exploration can be tested, validated, and integrated prior to deployment.

The analog test sites on the Big Island have been used in the past by PISCES and other agencies, and new sites are currently being evaluated and characterized to provide an ideal set of conditions to test newly-emerging technologies.

PISCES will not only be involved as a facilitator but also as an active participant in Research and Development.

The Robotic Village will be a multiphase project covering different areas of space exploration systems development (explained below). This project was launched with the long-term loan of a planetary Alpha-Argo rover manufactured by Ontario Drive and Gear

[1] (ODG).

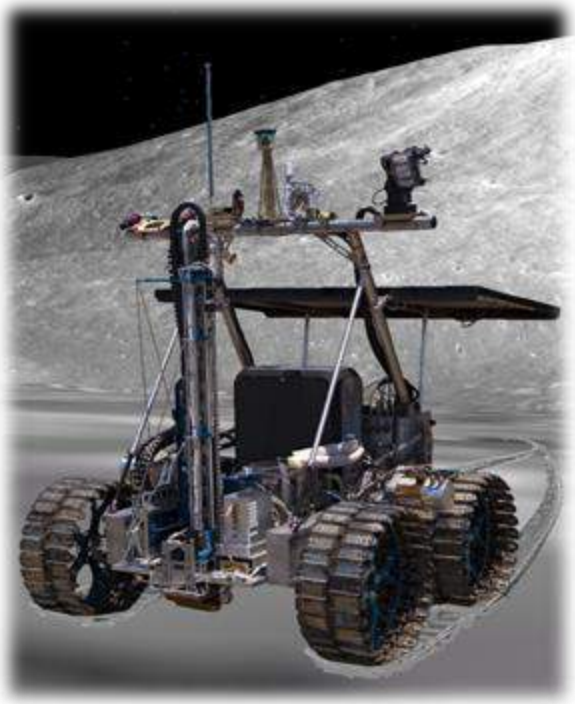
Upcoming phases will include the evaluation of renewable power sources for the rover such as solar panels for battery recharging, the use of a Hydrogen Fuel cell as a power source, and the integration of a Mating Umbilical Plate (MUP) for fuel transfer to the cell's tanks.

ROBOTICS

The Alpha-Argo rover provides a mobile platform for payload experimentation. The rover is powered by two independent electric motors and can be controlled by a Radio Frequency (RF) remote control, or through a series of commands that can be sent remotely via a CAN (Controller Area Network) Bus integrated into the unit's avionics.

The Alpha-Argo rover has an open payload deck design which allows for extreme flexibility in design. Currently, PISCES is working on the development and integration of the command and control systems which will include remote navigation systems, navigation cameras, and different types of sensors. The remote command and control capabilities will be designed so that control of the rover can be transferred to any location where Internet is available through a secure server. This will allow agencies to operate the rover and their payloads from distant locations.

[1] Ontario Drive and Gear Limited. 220 Bergey Court, New Hamburg, Ontario. Canada, N3A 1J5.



Artemis Jr. rover outfitted with NASA's RESOLVE (Regolith and Environment Science & Oxygen and Lunar Volatiles Extraction) payload that was tested at a PISCES analog site.

ISRU

In-Situ Resource Utilization, or ISRU, is a primary area of interest in space exploration. ISRU relates to the ability to "live off the land" - or to use local available resources for construction materials, life support resources, and fuel and energy supplies. Different fuel extraction technologies have been successfully tested at the PISCES analog sites. PISCES is considering bringing some of these systems back to integrate into the Robotic Village project.

FLIGHT HARDWARE DEVELOPMENT

PISCES has been working closely with NASA Engineers to build a Flight Delay Emulator (FDE) which will allow users to simulate the same time delay in communications that exists between Earth and other planets or moons. This will allow the testing of payloads on the rover to take place under the same conditions (communications wise) they would encounter if they were operating on Mars, the Moon, or another planetary body.

DATA MANAGEMENT

Working in collaboration with students from the University of Hawai'i in Hilo, and the University of Hawai'i Maui College, PISCES is currently developing a data management and telemetry system to be integrated with the rover.

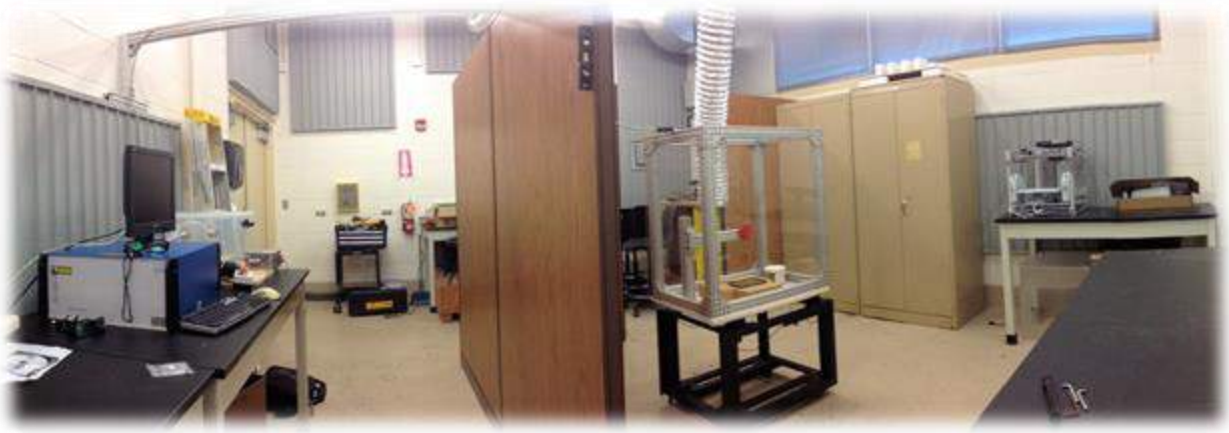
UNMANNED AERIAL SYSTEMS

During the past year, PISCES investigated numerous uses for unmanned aerial systems (UAS) that bring satellite sensor technology closer to earth, resulting in higher resolution capability. Applications in precision agriculture (fertilizer, water resource, pest management), land use management (hunting, species population census, invasive species), search & rescue (hiking, coastal, disaster management) and commercial applications (power-line inspections) were identified, socialized with community leaders and end-users. This sector of the aerospace industry was seen as a future growth sector, especially for small companies providing data-collection and interpretation services to customers.

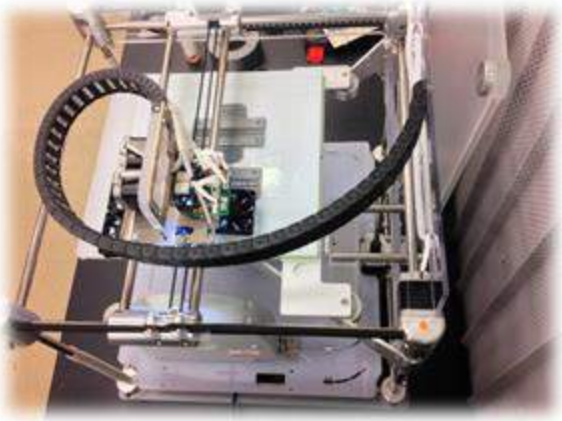
PLANETARY BASALT RESEARCH

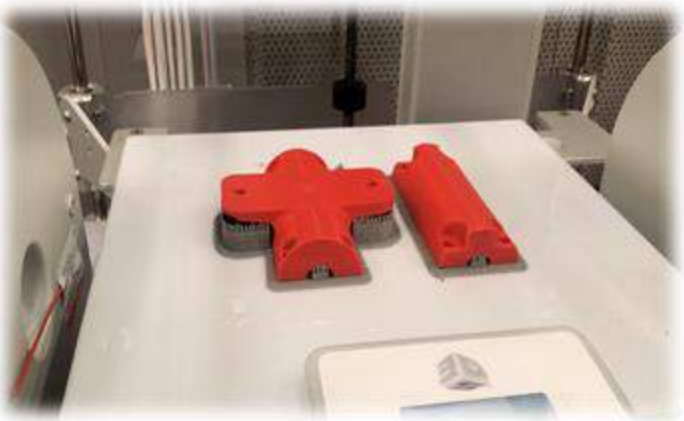
BASALT FABRICATION

In November of 2013, Jenoptik, GmBh offered PISCES a long-term loan of one of their 400-watt fiber optic lasers for use in PISCES' basalt additive manufacturing project. In January 2014, PISCES gained access to an empty machine shop in UH Hilo's Science and Technology Building for use as a laser and 3D printing lab and began work outfitting it for class IV laser work in April, 2014. PISCES built an anti-vibration worktable and enclosure, modified the ventilation, setup laser partitions, workspaces, and much more (see the panoramic picture below).



PISCES also designed and printed (on PISCES' Cubex 3D printer) the laser mounting bracket (see pictures below).





In June of 2014, the laser was installed and PISCES has now begun beam and basalt melt characterizations.

BASALT CONSTRUCTION

Lunar Sidewalk with County of Hawaii

PISCES has received $25,000 in funds from the County of Hawaii Department of Research and Development to place three demonstration sidewalk sections made with cement alternative concretes. UH Manoa will provide a fly ash composite concrete for one section and NASA Kennedy Space Center will provide a sintered basalt section and a polymer-based basalt concrete section (captioned as 'interlocking bricks' and 'class "B" concrete' shown in the image below). The County of Hawaii Department of Public Works has selected a well-trafficked sidewalk section in downtown Hilo for the test sections. Emplacement of the test sections will start in August, 2014.

NASA's 3D Additive Construction Using Regolith

PISCES, along with NASA Kennedy, NASA Marshall, the Jet Propulsion Laboratory, and USC (University of Southern California) have responded to a request from NASA Headquarters for a three-year, approximately $8,000,000 proposal using basalt regolith and additive manufacturing (3D printing) for construction of 2D structures (i.e. roads and landing pads) and a 3D-printed building. NASA Headquarters expects to select an awardee by the end of Summer 2014.

PLANETARY COMMUNICATION

NASA LASER OPTICAL GROUND STATION

OVERVIEW- LASER LUNAR RELAY DEMONSTRATION

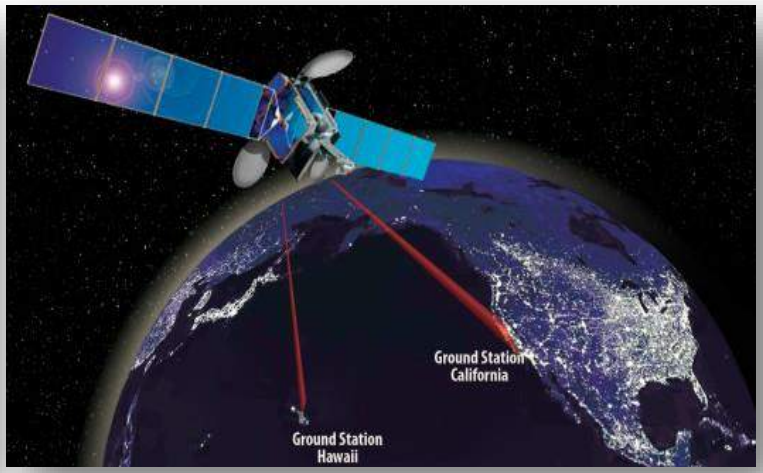
The Lunar Communication Relay Demonstration (LCRD) was a technology demonstrator flown on the Lunar Atmosphere and Dust Environment Explorer (LADEE), which launched in September 2013 from Wallops Island Launch Facility in Virginia. This launch was attended by John Hamilton and UHH student intern Krystal Schlechter as a result of their work with ground-based lunar impact observations in support of the main science mission.

LCRD was an unqualified success proving that laser communication with broad bandwidth capabilities could work at lunar distances. This technology demonstrator enabled subsequent development of several laser communication projects.

The first of these initiatives was to build the first long-term laser communication ground station (LCGS). For the LADEE mission, two temporary ground stations (Lunar Laser Ground Terminal - LLGT) at White Sands, NM and Table Mountain, CA were used, along with a European Space Agency (ESA) facility in the Canary Islands.

After extensive site comparisons, Mauna Loa was selected as the best possible location for the LCGS.

LLCD – Lunar Laser Communications Demonstration ((LADEE Mission 2013)



LCRD - Laser Communication Relay Demonstration 2016

From left to right: Marc Seibert (NASA), Kimberly Cashin (Hamilton Booze Allen), and Randy Aliss (Northrop Grumman) discuss with MLO staff and PISCES Logistics Manager John Hamilton the potential location for the weather monitoring station for the LASER Comm. project on Mauna Loa.

PHASE 1 | Advanced Weather Ground Station

Phase 1 of the LCGS is an advanced weather and sky monitoring station designed by Northrop Grumman. This would consist of standard meteorological instrumentation (temperature, wind velocity, atmospheric pressure, etc.), as well as ceilometers and infrared all-sky cloud monitors to access real-time, line-of-sight atmospheric transparency for the near infrared laser communication beam from the LCGS. In addition, turbulence measurements would be collected via a Differential Image Measuring Monitor.

PHASE 2 | Laser Communications Relay Demonstration

Phase 2 involves a semi-portable laser communications ground station designed to work to geostationary earth orbit (GEO), where an upgraded Tracking and Data Relay Satellite (TDRS) with a laser terminal will be launched in 2016 and put on station. This will allow ground laser communication to be relayed to either other earth stations, or to other assets in low earth orbit (LEO) such as the International Space Station (ISS), the Orion manned space capsule, or to other satellites. This facility will remain in operation and will overlap the planned Phase 3 facility.

PHASE 3 | Long-Term Laser Optical Ground Station

Phase 3 is the long-term laser communication ground station that will supplant Phase 2 once it is fully operational. This facility is planned to be the first of many laser ground stations spread around the world. It is expected to have an operations crew of 4 with 3 eight-hour shifts to cover 24-hour operations. PISCES will bid to be selected as the contract organization for operations. Common and joint use of the PISCES control room at the PISCES headquarters will enable rapid implementation of Phases 2 and 3.

PLANETARY ANALOG TEST SITES IN HAWAII

Development of a world-class analog test site and PISCES Facilities

i. Addition of Communications link

In 2013, PISCES upgraded the NASA node SNRF router at the Ellison S. Onizuka Center for International Astronomy (aka Hale Pohaku).

ii. Powermast and solar array

A solar powered WI-FI relay unit was constructed to enable the Internet communication link between Hale Pohaku and the PISCES analog test site in Haiwahine Valley. This is a portable unit that is deployed when operations are conducted at the test site (pictured at right).

Solar-powered WI-FI relay.

iii. Modifications to Hale Pohaku

New WI-FI antennae were installed at Hale Pohaku to replace the existing HI-SEAS antenna that was window mounted. A mast was installed on the corner of the second story of the dining building. This mast holds the antenna for HI-SEAS pointing south towards Mauna Loa and the Haiwahine Valley WI-FI relay location to the northwest. This upgrade resulted in superior signal gain due to a larger antenna and outside mounting where the signal is not degraded by passing through a glass window.

iv. Addition of skylight/lava tubes

Due to the recent discovery of surface features on the moon and Mars that resemble geologic skylights to subterranean voids or perhaps lava tubes, PISCES has embarked on surveys of lava tubes suitable as analogs for testing equipment and exploration technologies. These vary from recent tubes on Mauna Loa, Kilauea, and Pu'u O'o, to older (and wetter) tubes in Puna and South Kohala.

v. PISCES Facility User's Guide

The PISCES Planetary Analog Test Sites (PPATS) facility user's guide was developed to market and advertise the various test sites and their unique capabilities. This document, along with a customer questionnaire for test requirements (Form 100), was distributed to past and future potential customers such as the Google Lunar XPRIZE (GLXP) teams and foundation.

vi. Development of a Database of PISCES Analog Test Sites

Summer interns were tasked in 2013 and 2014 to survey existing and potential analog test sites around the island of Hawai'i. The data has been ported to a searchable GIS database for future use. Plans are to eventually have the database accessible via a web interface.

Analog Test Operations

Team Puli

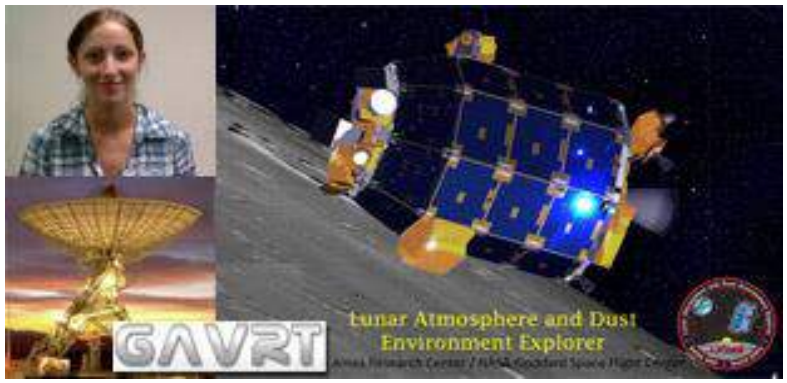
The Hungarian GLXP team Puli, performed a week-long series of exercises at our lunar analog test site at Haiwahine Valley in December 2013. Significant results included the completion of a 600 meter traverse under remote control from their Mission Control facility in Budapest, successful imaging of the end goal and transmittal of this image to Hungary and back, and simultaneous control of two mini-rovers via remote use from Budapest mission control.

GLXP Team Puli's lunar rover that successfully traversed 600 meters at a PISCES analog test site in Dec. 2013.

PISCES has contacted the other GLXP teams and GLXP Foundation to offer them utilization of the analogue test site.

WORKFORCE DEVELOPMENT

Internships



UHH Astronomy major Krystal Schlecter was selected as the Akamai Summer Intern for PISCES during 2013. Her project was to lead a group of student observers to monitor the unilluminated portion of the lunar disk for rapid and faint light flashes indicative of meteoritic impacts on the lunar surface. This baseline data was crucial for the Lunar Atmosphere and Dust Environment Explorer (LADEE) space mission which was to orbit the Moon and measure *in-situ* the lunar exosphere and lofted dust.

LADEE was launched in September 2013 from Wallops Island Launch Facility in Virginia. This launch was attended by John Hamilton and Ms. Schlecter after a successful crowd funding campaign. Official NASA launch invitations were received and outreach work at the NASA Wallops Island Visitors Center was performed with the LADEE team of scientists and engineers.

Melissa Adams at NASA Johnson Space Center with PISCES Executive Director Rob Kelso and her NASA mentor Trevor Graf.

UHH Geology major Melissa Adams was selected for a field geology expedition to one of the cinder cones near the summit of Mauna Kea as part of a Mars geochemistry analog for the Curiosity rover and Mars Science Laboratory. Satellite imagery indicated similarities between the current destination of Curiosity at Gale crater and Mauna Kea with respect to hydro-altered basalts. Samples were located and collected during the expedition with NASA Johnson Space Center (JSC) geologist Trevor Graff of the Astromaterials Research Experiment section (ARES).

The team was honored by NASA with official Certificates of Appreciation and Melissa was selected as one of 11 possible recipients of the newly established Sally Ride Internship. This summer, Melissa is assisting in the investigation of the Mauna Kea samples at the Johnson Space Center in Houston, Texas.

UHH Astronomy and Earth & Space Science major Ian Seely was selected as the recipient of the Space Resources Roundtable 2014 Undergraduate Scholarship for his research on detecting and measuring lava tubes from ground level using geophones. His work complements the internal measurements and characterizations of lava tubes and provides a means to map the extent and surface depth of these hidden features. Ian presented his work at the Planetary and Terrestrial Mining Sciences Symposium (PTMSS) at the Colorado School of Mines in Golden, Colorado.

Visiting Scientists

During FY14, PISCES hosted a visiting scientist for 4 months from the NASA-Kennedy Space Center (KSC), Marc Seibert. A reimbursable space act agreement (SAA) was developed and signed between PISCES and NASA KSC Director Bob Cabana. This agreement served as a contract mechanism for funding Mr. Seibert through PISCES. During his first tour, Mr. Seibert conducted two major activities:

1. Developed and installed a communications 'backbone' within the PISCES planetary analog test site on Mauna Kea to enable remote operation control centers to communicate with their operational robotic systems. This equipment and new capability was successfully used in support of the Google Lunar XPrize (GLXP) analog test for Team Puli from Budapest, Hungary.
2. Mr. Seibert also provided technical/communications expertise for the initial 4 month crew test of the Hi-SEAS activity in a habitat on Mauna Loa.

Mr. Seibert returned in FY14 for a second tour of duty in Hawaii under funding from NASA Headquarters. Mr. Seibert worked directly with PISCES staff to investigate possible test site locations on the Big Island for NASA's lunar optical laser communications ground station.

Update on Aerospace Technology Research and Development Park

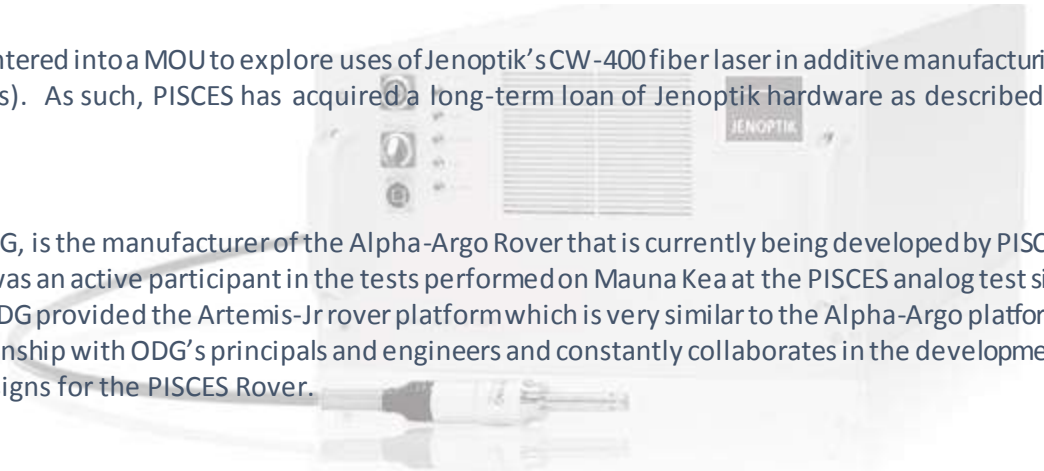
PISCES and DAGS completed a site selection in Spring 2014 for the PISCES headquarters, test and checkout lab, and regolith arena buildings. The site selected was at the W.H. Shipman Business Park in Kea`au. This site was selected over other private and public lands due to: its existing infrastructure (roads, water, power, and broadband); the availability of fee-simple lands for spin-offs and industry partners; its ability to conform to PISCES' customer-based timetable; and its proximity to the University of Hawaii, Hilo International Airport, and Hilo Harbor.

PISCES' legislative request for FY2015 CIP funds for design and land purchase was not approved. PISCES is now considering other options.

Level of Private Sector Investment in Aerospace and Related Partnerships for PISCES Development Initiatives

i. Jenoptik

PISCES and Jenoptik, GmBh entered into a MOU to explore uses of Jenoptik's CW-400 fiber laser in additive manufacturing using novel materials (basalts). As such, PISCES has acquired a long-term loan of Jenoptik hardware as described in section 8.



ii. ODG

Ontario Drive and Gear, or ODG, is the manufacturer of the Alpha-Argo Rover that is currently being developed by PISCES for the Robotic Village. ODG was an active participant in the tests performed on Mauna Kea at the PISCES analog test site in 2012. During those tests, ODG provided the Artemis-Jr rover platform which is very similar to the Alpha-Argo platform. PISCES has an ongoing relationship with ODG's principals and engineers and constantly collaborates in the development of test specifications and designs for the PISCES Rover.

iii. PPI

Planetary Power, Inc. (PPI) has approached PISCES to test their SUNSparq solar concentrator power head's efficiency using biodigestor-produced methane. As of June 2014, PISCES and PPI are working out details regarding funding and a timeline.

STRATEGIC PARTNERSHIPS

Update on Space Act Agreement (SAA) between PISCES and NASA

PISCES has submitted an annex to their existing reimbursable space act agreement with NASA Kennedy Space Center to enable cooperation on PISCES' Sustainable Concrete Project. The annex is presently being reviewed by NASA's legal team for final approval by NASA HQ.

Memoranda of Understanding

i. Jenoptik

PISCES and Jenoptik, GmBh entered into an MOU to explore uses of Jenoptik's CW-400 fiber laser in additive manufacturing using novel materials (basalts).

ii. Honeybee Robotics

PISCES and Honeybee Robotics entered into an MOU to investigate and develop: additive manufacturing methods and technologies for printing with in-situ resources; integrated drilling and mobility hardware; and other technologies.

iii. Made in Space

PISCES and Made In Space (a 3D printing company with printers on the International Space Station) entered into an MOU to investigate and develop: additive manufacturing methods and technologies for printing with in-situ resources.

iv. NOAA

PISCES and NOAA enacted an MOU with the intent to collaborate in establishing the NASA Laser Communication Ground Station at the Mauna Loa Observatory (MLO) site on Hawaii Island.
NOAA and PISCES agreed to ensure that this project is compatible with existing projects at MLO and will not adversely affect the ongoing climate measurements via air quality changes.

NASA Centers: HQ, Ames, Johnson, Kennedy

This past year, PISCES substantially increased its presence at, and participation with, various NASA centers. PISCES and NASA HQ have been working closely to bring NASA's first permanent laser communication ground station to the State of Hawaii and, in conjunction with the University of Hawaii, to develop the needed coursework to ensure local workforce development. PISCES is also working with NASA KSC on: the PISCES Sustainable Concrete Project; flight communications control and command for the PISCES rover; additive manufacturing; and the PISCES student flight experiment. PISCES is working with NASA AMES Research Center on the PISCES Sustainable Concrete Project. With NASA JSC, PISCES is working to acquire various resource extraction, navigation, and fuel transfer hardware.

University Involvement

PISCES continues to actively engage the University of Hawai'i by mentoring students on projects relevant to both their education and PISCES' mission. The UH-Hilo Astrophysics Club, led by Krystal Schlecter, continued to support the LADEE mission with lunar impact monitoring using telescopes, cameras, and software supplied by PISCES, as well as logistical support with transportation.

Melissa Adams (a geology student at UH-Hilo) interned with PISCES for 10 weeks and was an invaluable asset to PISCES and NASA Johnson Space Center. Melissa's leadership and expertise as a PISCES intern, and subsequent follow-up work, earned her a Certificate of Appreciation from NASA JSC and a NASA Sally Ride Internship at the Center for the summer of 2014.

Nicolas Turner, Saya Baker, and Kevin Edward worked with Melissa Adams as student interns to characterize (and collect data on) potential planetary analog sites and create a PISCES database of analog field sites. In collaboration with the UH-Hilo Spatial Data and Visualization (SDAV) lab, these interns incorporated their collected data into GIS and created accessible Google Earth files.

Max Kerr (a freshman at UH-Hilo) was hired as a PISCES Robotics Technician in April of this year. Max is a Hilo High School graduate. His programming experience with the Hilo High Robotics team made him an ideal candidate for the position. Max is working with Rodrigo Romo and has been tasked to develop the programming and select the hardware for the command and control systems for the PISCES Rover.

Casey Pearring (a sophomore at UH-Hilo) is joining PISCES this summer as a replacement for Max Kerr who will be leaving next fall to attend Vanderbilt University on a full scholarship. Casey is also a Hilo High School graduate and collaborated with Max in building the Robotic team for the school. Casey also has programming experience and will work with Max over the summer to ensure a smooth transition until the fall when he will take over the position.

Chris Yoakum was hired as a Communications Specialist for PISCES. He is a University of Hawaii at Hilo graduate who came to PISCES highly recommended by UH-Hilo's Communications Department. He was brought on board in May as an intermittent hire and assists the PISCES Public Information Officer with the website, monthly newsletter, social media, and news blasts.

Dr. Elliot Sanders was hired as the PISCES Senior Technologist in February of 2014. Dr. Sanders has extensive engineering experience and is primarily working on the PISCES additive manufacturing projects. Dr. Sanders is also Affiliate Faculty at UH-Hilo.

PISCES Operation Manager, Christian Andersen, is an affiliate faculty member of the Physics and Astronomy Department at UH-Hilo.

PISCES Logistics Manager, John Hamilton, is an Instructor in the Physics and Astronomy Department at UH-Hilo.

Ontario Drive Gear
Ontario, Canada
International Society for Terrain-Vehicle Systems
Hanover, New Hampshire
Planetary Power
Seattle, Washington
Made In Space & NASA Ames Research Center
Mountain View, California
Honeybee Robotics
New York, New York
Nasa Headquarters
Washington, D.C.
Center for Rapid Automated Fabrication Technologies
University of Southern California
National Oceanic & Atmospheric Administration
Washington, D.C.
Russ Ogi, Hawaii 3D Printing Expert
Honolulu, Hawaii
Nasa Kennedy Space Center
Florida
University of Hawaii
Manoa & Hilo
NASA Johnson Space Center
Houston, Texas
Hawaii TechWorks
Hilo, Hawaii
Na Pua No`eau
Hilo, Hawaii

Strategic Partners

ANNUAL REPORT | 2013-2014

PACIFIC INTERNATIONAL SPACE CENTER FOR EXPLORATION SYSTEMS

STATE LEGISLATION FOR SPACE AND PLANTARY SURFACE TECHNOLOGY

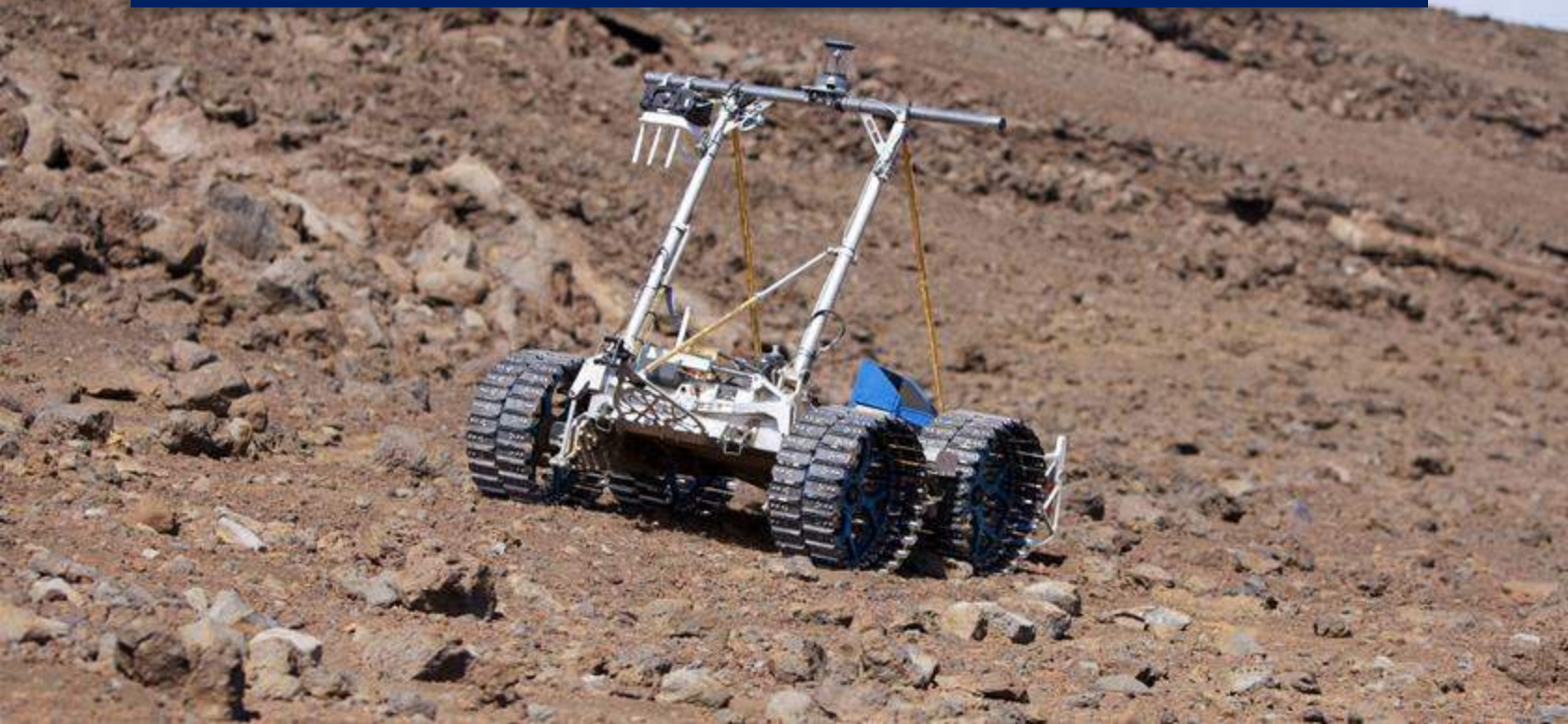
FY15 FUNDING BILLS AND APPROVAL

For the FY15 Budget cycle, PISCES had submitted a total supplemental budget request of $1.376M (to augment the $400K appropriated for FY15 during the 2013 Session through Act 134) to support test site operations, basalt research and planetary robotics testing/development. However, the State elected to provide only $500K for this purpose (through HB2152/Act 169). Furthermore, the State provided no building funds (capital improvement/CIP) to PISCES for FY15 (PISCES had requested $1.5M in CIP for FY15 for 3-acres of land acquisition toward building a new research/test facility plus administration offices). However, the State did appropriate an additional $250K (through SB2583/Act 171) to support preliminary studies for PISCES' Laser Communication Ground Station initiative.

Bill #	Description	Request	Appropriation
SB2583/HB2151	Laser Communications Ground Station Initiative	$500K	$250K
SB2584/HB2150	Sustainable Technologies	$250K (Subject to match with State of California)	$0
SB2585/HB2152	PISCES Operations & CIP	$1.376M * $1.5M	$500K ** $0

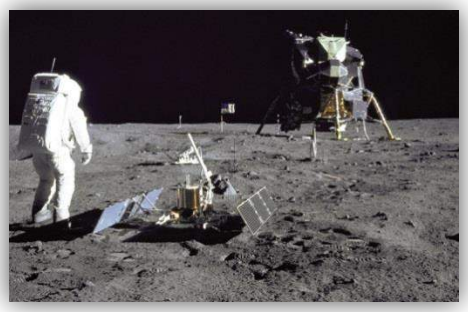
* The total original budget for FY15 was $1.776M, of which $400K was already appropriated in the first year of the biennium.

** Since $400K was appropriated in the first year of the biennium, the total appropriation for PISCES operations in FY15 is $900K.



Senate Concurrent Resolutions

SCR 82: Recognition of the Apollo 11 Tranquility Base as a Historic Site



Apollo 11 astronaut 'Buzz' Aldrin on the Moon at Tranquility Base with the Eagle Lunar Module in 1969 (photo courtesy of NASA).

Hawaii joined three other states in the movement to push for world recognition of the historic site where humans first set foot on the moon. Lawmakers approved SCR 82, a PISCES Senate Concurrent Resolution urging the United Nations Educational, Scientific Cultural Organization (UNESCO) to preserve "Tranquility Base" by placing it on the World Heritage List alongside other renowned landmarks such as the Pyramids at Giza and the Great Wall of China.

Efforts to protect the first ever human landing site are under way amid a flurry of anticipated moon-missions spurred by the Google Lunar XPRIZE competition. Several launches are planned in 2015, and China already made the first lunar surface contact in 37 years when its Chang'e 3 spacecraft touched down and deployed a robotic rover last December.

The Tranquility Base Day Resolution, which was drafted with assistance from the Hawaii Office of Aerospace Development, also recognizes the indispensable role the Aloha State played during the Apollo era. The Big Island's volcanic terrain, which is nearly a carbon copy of our moon's, provided essential training grounds for Apollo astronauts between 1965 and 1972.

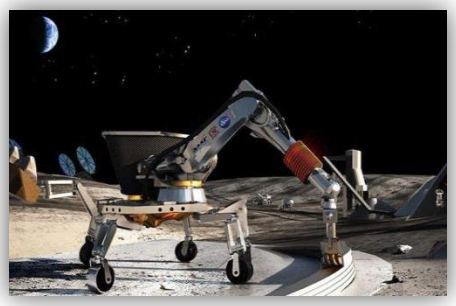
Hawaii also provided communication relays during the Apollo 11 spaceflight, and supported the recovery of the returning astronauts after their spacecraft splashed down in the Pacific Ocean about 800 miles from the Islands.

The Apollo 11 crew's re-entry capsule splashing down in the Pacific Ocean about 800 miles from Hawaii on July 24, 1969 (photo courtesy of Milt Putnam).

The State of Hawaii will commemorate the 45th anniversary of the epic lunar landing on July 20th, 2014.

Apollo 15 Commander Dave Scott and Lunar Module Pilot Jim Irwin on the Big Island conducting pre-launch training in December, 1970

SCR 83: Support for NASA-Sponsored Research in Basalt Construction



Artist rendering of a construction-scale 3-D printer building lunar infrastructure (Image credit: Behnaz Farahi and Connor Wingfield).

Lawmakers approved SCR 83, backing a PISCES-NASA initiative that could help Hawaii produce its own construction materials instead of importing them. Senate Concurrent Resolution 83 calls for State support in the development of "lunar concrete" - concrete made out of lava rock (basalt) that could be used both at home and in outer space. The project could potentially create jobs in manufacturing and technology in Hawaii, while making the Islands' economies more sustainable. The Hawaii County Department of Research and Development is helping fund this project, and NASA Ames, NASA's KSC, and UH-Manoa are partnering with PISCES to develop a prototype sidewalk made out of lunar concrete.

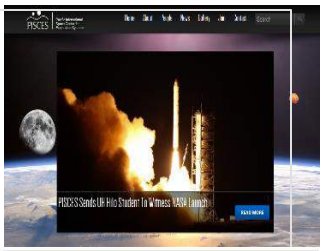
This initiative also involves building structures in Hawaii using 3-D printers and volcanic basalt. The project aims to build infrastructure in space using robotics and regolith to avoid the costly effort of sending construction materials into space. 3-D printers are already building houses on Earth using recycled materials.

PISCES is one of four partners chosen by NASA to develop 3-D printing technology for construction in space. The proposed project calls for building a landing pad, curved wall, and dome-shaped habitat in Hawaii.

SPOTLIGHT

Surfing the Mars-like Terrain

PUBLIC INFORMATION AND OUTREACH



PISCES NEWSLETTER: INAUGURAL ISSUE

MESSAGE FROM THE EXECUTIVE DIRECTOR

Website

After PISCES was legislatively transferred from the University of Hawaii at Hilo to the State Dept. of Business, Economic Development, and Tourism (in 2012), the top priority in terms of public information and outreach was to develop a new, updated website reflecting the changes within the agency. Procurement for a web developer began in June of 2013, and led to the selection of Infinity Consulting, a local firm, in August. In September, PISCES launched a separate website, http://pisces.hawaii.gov, through the Hawaii State Information and Communication Services Division. This served as a temporary solution to the immediate need for an online presence until Infinity Consulting finished constructing the new website. By February, www.pacificspacecenter.com was live and linked to pisces.hawaii.gov to minimize confusion as well as to provide the credibility associated with a .gov website.

News Blasts

To keep those within the PISCES network updated on agency programs, news blasts are issued to the agency's distribution list, which has grown to more than 700 people. These blasts average about two to three per month. Many of these blasts resulted in positive media coverage, with three of the blasts generating front-page news coverage: Team Puli's testing in Hawaii, PISCES rover debut, and the NASA pictures that PISCES Executive Director Rob Kelso obtained showing Apollo astronauts training on the Big Island of Hawaii. PISCES has been featured in the Honolulu Star-Advertiser, Hawaii's ABC, NBC, and CBS stations, SpaceNews, New York Times, and Huffington Post, among other news journals.

Newsletter

In July, PISCES began producing a monthly e-newsletter, which is e-mailed to the agency's distribution list, as well as posted on social media, and on the PISCES website.

Social Media

- Facebook: PISCES Hawaii
- Twitter: @PISCES_Hawaii
- YouTube: Pacific International Space Center for Exploration Systems

Events

The Aerospace Summit and the official Hawaii debut of the rover were the two major press/outreach events for PISCES in FY14:

Aerospace Summit

- OCT 6: Hawaii Children & Youth Day - PISCES joined other aerospace companies in transforming the bottom floor of the State Capitol into a space wonderland for kids (and kids at heart!)
- OCT 7: PISCES organized a press conference about the Summit
- OCT 8 & 9: Aerospace Summit (coordinated by the State Office of Aerospace Development)

PISCES Rover Debut

- MAR 27: Surprise visit to students at Stevenson Middle School in Honolulu; private reception at the Pacific Aviation Museum at Pearl Harbor giving invited guests a sneak preview of the rover
- MAR 28: LIVE on KHON & KITV's morning shows featuring the rover at the Museum; Rover demo at the Hawai i State Capitol
- MAR 29: Official public Hawaii debut of rover at the Museum's "Discover Your Future in Aviation" event
- APR 18: PISCES Mauna Kea Skies talk at `Imiloa on "Living Off the Land", featuring the rover

Conferences Participated in by PISCES

In order to establish connections and build partnerships with the global space exploration community and industry, it is vital that PISCES staff actively participate in professional aerospace meetings and conferences around the world. During this past year, PISCES staff attended the following events:

- American Astronomical Society Division for Planetary Sciences (AAS DPS) Annual Meeting. Denver, CO. Oct 6-11, 2013 (Christian Andersen - attended)
- International Society of Terrain Vehicle Systems (ISTVS) Conference. Tampa, FL. Nov 4-7, 2013. (John Hamilton - attended)
- 4th International Workshop on Lunar and Planetary Compact and Cryogenic Science and Technology Applications (LSA4), Cocoa Beach, FL. Apr 8-11, 2014 (Rodrigo Romo - Online streaming presentation: “PISCES Robotic Village, a Multiphase Project for the Development and Testing of Vertically Integrated ISRU Technologies”.)
- Space Symposium, Colorado Springs, CO. May 18-23, 2014. (Christian Andersen - attended)
- Planetary & Terrestrial Mining Sciences Symposium (PTMSS), Golden, CO. June 10-11, 2014 (Rodrigo Romo – attended. Presentation: “PISCES Robotic Village: Developing a World Class Test Site for ISRU System and Technology Integration”. John Hamilton – attended. Presentations: “2013 - Analog Field tests – 2012 Summer Test review and future prospects; 2014 - PRISM: PISCES Robotic International Space Mining Competition; PISCES Planetary Analog Site: Current and Future Uses.”

EDUCATIONAL OUTREACH PROGRAMS & SUPPORT

AstroDay at Prince Kuhio Plaza.

GLXP Team Puli demonstrating their rover at the Imiloa Center.

As with all analog testing efforts, PISCES coordinated public outreach activities with the GLXP Team Puli at diverse venues island-wide, such as `Imiloa Astronomy Center, Kealakehe High School, and Galaxy Garden in Hilo.

PISCES began this year's EPO efforts in January with the Onizuka Science Day at UH-Hilo. In addition to a display booth, PISCES presented workshops using the GLXP Moonbots' remotely controlled LEGO rovers to recreate a lunar mission. In February, PISCES supported the Hawaii Island Science and Engineering Fair, where the PISCES award in Astronautics went to High School student Sage Durest for Lunar Impact Observations (mentored by UH-Hilo student Krystal Schlecter). PISCES staff supported the week-long 'Journey Through the Universe' with classroom visits throughout the East Hawaii School District. Community outreach continued the following month with participation in the Merrie Monarch Parade, with the PISCES rover "marching" with the staff to a very positive public reception.

PISCES' rover pictured with Miss Hawaii.

PISCES Staff and rover marching in Merrie Monarch parade.

STARS

PISCES is launching a brand new summer educational program for young women in high school called "STARS": STEM Aerospace Research Scholars. It's designed to encourage and inspire young women to pursue a career in space or other related field in STEM (Science Technology Education and Mathematics). STARS is intended for sophomore and junior girls in high school, which is when students typically begin looking at colleges and preparing their transcripts and resumes for the college application process.

The program consists of a one-week workshop held July 7-11 in Hilo. Students will get hands-on experience with the PISCES robotic rover and learn how to design a mock robotic mission to the Moon (with a focus on *in-situ* resource utilization (ISRU)). Classes will consist of space lectures, hands-on activities, guest speakers, video presentations, and team tests/challenges, with the last day spent at the summit of Mauna Kea, teaching students how the Hawaiian culture ties in with space exploration.

AstroDay

Closely following the hula festival was the premier science outreach event on the island - AstroDay. PISCES held this event in the center of the mall behind the main stage and exhibited our rover, along with the Moonbots activity for the keiki. Furthermore, judicious use of the loan from the Heinlein Foundation of 3 astronaut suits for display in the Prince Kuhio Mall AstroDay window, in the `Imiloa exhibit and keiki program, and in the Merrie Monarch parade (with interactive use during AstroDay) provided wide public exposure for PISCES. PISCES also participated in the Kona STEM camp at Kealakehe High School in June.

Robotic Technician Max Kerr at the AstroDay event.

Lunabotics and PRISM

PISCES participated in judging the first NASA Robotic Mining Competition (RMC) at Kennedy Space Center. The RMC (known for the past five years as Lunabotics) is a college-level engineering challenge for US teams to design, build, and dig with a robot that can navigate, collect, and deposit regolith. Evolving from this competition is PRISM, our *international* competition that takes the RMC robots out of the controlled confines of the laboratory and places them in the more realistic and challenging setting of our PISCES Planetary Analog Site.

Competition Arena for NASA RMC

Lunabotics Robot at PISCES Test Site

OPERATIONS & MANAGEMENT

OVERVIEW OF FY14 FUNDING

- Operations: Act 169, SLH2012 appropriated $500K to PISCES operations in FY13. All funds were encumbered in an agreement between DBEDT and the Research Corporation of the University of Hawaii (RCUH) for the operation of PISCES. At the end of FY13, $289K of the FY13 appropriation was available for use in FY14 and carried PISCES through until the FY14 appropriation was available for expenditure in November 2013. Act 273, SLH2013 and Act 134, SLH2013 each appropriated $400K to PISCES for a total of $800K in newly appropriated funds for PISCES operations in FY14. These funds were also encumbered in an agreement between DBEDT and RCUH. See the chart below for a summary of FY14 operations funding and expenditures.

Source of Funds	Total Funds Available	Funds Expended in FY14	Outstanding POs as of 6/30/2014	Total Expended & Committed	Available Balance
FY13 Ops Appropriation carried into FY14	$ 288,610	$ 288,610	$ -	$ 288,610	$ -
FY14 Ops Appropriation	$ 800,000	$ 379,362	$ 18,445	$ 397,807	$ 402,193
Totals	$ 1,088,610	$ 667,972	$ 18,445	$ 686,417	$ 402,193

The available balance of FY14 funds shown in the table above will be used to cover early FY15 operations until FY15 funds are available for use.

- Capital improvement: Act 106, SLH2012 appropriated $1.84M to PISCES for capital improvement. These funds had to be spent and/or encumbered by June 30, 2014. In FY13, $275K was allocated from PISCES to the Department of Accounting and General Services (DAGS) for the planning and site survey study for locating a new PISCES facility. The DAGS site survey study was delivered and presented to the PISCES Board of Directors in March 2014. The PISCES Board identified a site from among those presented as their first choice and decided to begin the administrative and competitive processes required to acquire a building site. A process to encumber the remaining $1.565M for design work prior to 6/30/2014 was initiated, but the process was not successfully completed by June 30th.

DETAILED STATEMENT OF ASSETS, LIABILITIES, REVENUES, AND EXPENSES FOR FY14

The only capital asset (value of $5K or more) owned by PISCES is a 2006 Chevrolet Silverado K1500 pick-up truck. For practical reasons, this truck remains assigned to the University of Hawaii for use by PISCES. PISCES pays for the operation, maintenance and care of this truck.

Non-labor liabilities as of June 30, 2014 are low, totaling less than $500. June 30, 2014 payroll expenses outstanding were $27.4K and were paid on July 7, 2014. PISCES has an unpaid lease obligation through December 31, 2014 of $12.1K, and this amount is committed by purchase order as of June 30, 2014. PISCES was not able to access FY14 funds until November of 2013. The balance of FY13 funds carried into to FY14 paid for operations until the FY14 funds were available. The FY13 funds were fully expended by mid-December 2013. Likewise, PISCES will carry FY14 funds into FY15, and they will pay for operations expenditures until FY15 funds are available for expenditure.

The following table shows the total funds available for FY14, expenditures, outstanding purchase orders and the balance of funds remaining as of June 30, 2014.

COST CATEGORY	Total Funds Available	Expended Thru 6/30/2014	Outstanding Purchase Orders	Total Expended & Committed	Available Balance
Salaries & Fringe	$768,946	$505,483	$0	$505,483	$263,462
Controlled Property	$79,680	$15,309	$0	$15,309	$64,371
Materials & Supplies	$15,541	$22,675	$1,309	$23,983	($8,442)
Travel	$59,576	$43,563	$72	$43,635	$15,941
Consultant/Fee for Service	$46,725	$6,777	$0	$6,777	$39,948
Printing/Publication	$650	$56	$0	$56	$594
Communication	$7,603	$5,922	$0	$5,922	$1,682
Equipment	$0	$0	$0	$0	$0
Repairs & Maintenance	$3,709	$1,295	$242	$1,537	$2,172
Rental-Space	$45,054	$32,785	$16,822	$49,607	($4,553)
Other Current Expenditures	$24,314	$11,520	$0	$11,520	$12,794
Direct Costs Total	$1,051,797	$645,384	$18,445	$663,828	$387,969
Indirect Costs	$36,813	$22,588	$0	$22,588	$14,225
Grand Total	$1,088,610	$667,972	$18,445	$686,417	$402,193

The apparent over-expenditure in the materials and supplies category results from a difference in categorization between budgeted amounts and expenditures. For example, budget for controlled property included buying shop tools and supplies for the basalt concrete and robotic rover projects. When these items were purchased, they were classified in the materials and supplies category. The apparent over-expenditure in rental space occurs because the budgeted expenses were planned to cover the project through October 2014. However, rental space is committed through December 2014. The positive available balance in the other cost categories will cover anticipated expenses as planned through October 31, 2014. Labor and non-labor expenditures overall are within the planned parameters.

OFFICE AND RESEARCH LOCATIONS

Office/Staff:

PISCES leases 1,012 square feet of office space at 99 Aupuni Street in Hilo that serves as our agency headquarters. The space contains a conference room and six work stations for nine PISCES staff (6.25 FTE) to use when they are not working in off-site labs or elsewhere in the field.

Laser Lab:

In January 2014, PISCES gained use of an empty machine shop in UH Hilo's Science and Technology Building for use as a laser and 3D printing lab and began outfitting it for class IV laser work in April, 2014.

Robotics Test & Checkout Lab:

Test & Check Out Lab facilities are required for any robotics program. Prior to the arrival of the PISCES Rover, two sites were evaluated as potential locations for the PISCES Test & Check Out Lab. The first location was at the Blue Planet Foundation's Pu'u Wa'awa'a ranch in Kona and the second facility was the Engineering Lab at the University of Hawai'i in Hilo. Due to its proximity to PISCES offices and access to UHH students, the UHH facility was chosen as the initial location to house the rover. Tools were acquired to properly equip the shop/lab, and on April 16, 2014 the rover was delivered.

While the UHH facility provided a convenient location for the Rover, the size of the facility was not adequate, so on May 14 the Robotic Test & Check Out lab was relocated to a 40' x 20' High Bay at Shipman Business Center. This new location provides adequate space to perform the work required on the Rover and will also house the microwave and inductive coil basalt sintering operations.

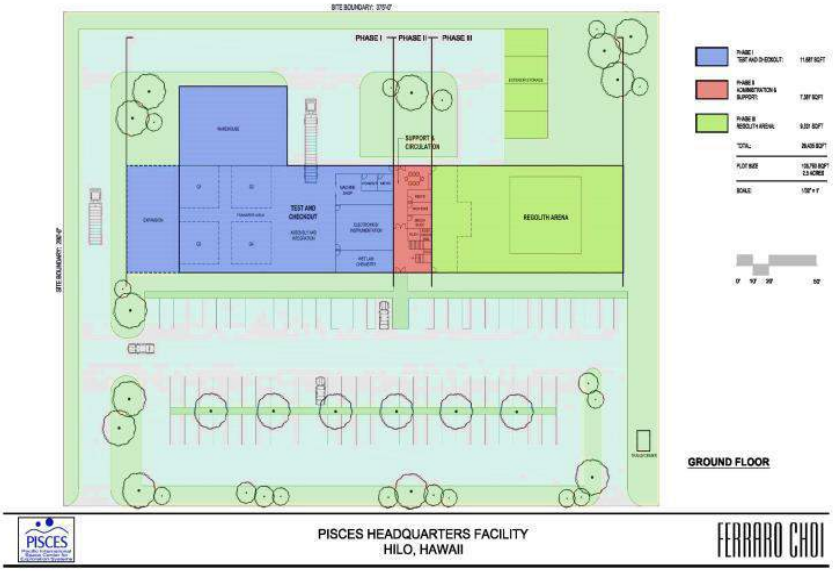
ADMIN BUILDING; OPERATIONS AND CHECKOUT (O&C) FACILITY PLANNING/DESIGN

Update on PISCES build-out plans

To address the legislature's mandate for PISCES to establish a world-class research and technology park, PISCES, in concert with DAGS and Ferraro-Choi Associates, evaluated multiple sites during FY14 for building the PISCES research center. The concept developed by Ferraro-Choi included three main focal areas:

1. The first priority was to build an air-conditioned, high-bay facility for test & checkout operations supporting robotics, planetary rovers, and planetary test hardware. The facility would also include an operations control center to interface with the planetary systems under-going testing and checkout in the high-bay. No such facility exists in Hawaii to-date to attract and support users from the federal government, commercial space sector, international organizations, and academic communities.

    a. The Control Center in the planned PISCES building will need to be completed by the summer of 2017 in order to support testing and operations of the NASA laser communications ground station currently scheduled for 2018.



Blueprint of the planned PISCES building.

2. The second phase would be to construct an administrative wing to support the PISCES staff, visiting scientists, and engineers travelling with their planetary hardware.

3. The third phase would include an open-air arena for preliminary testing of robotics systems prior to transport to PISCES' high-altitude test sites.

Based on analysis by DAGS and Ferraro-Choi, the PISCES Board of Directors assessed three finalist sites. Three (3) acres within the Shipman Technology Part in Keaau were chosen as the "site-of-choice" for the build-out.

MANAGEMENT AND GOVERNANCE

a. PISCES Board of Directors – In November 2012, the PISCES Board of Directors was formed following the guidelines set forth in Act 169 SLH2012. The Board members are:

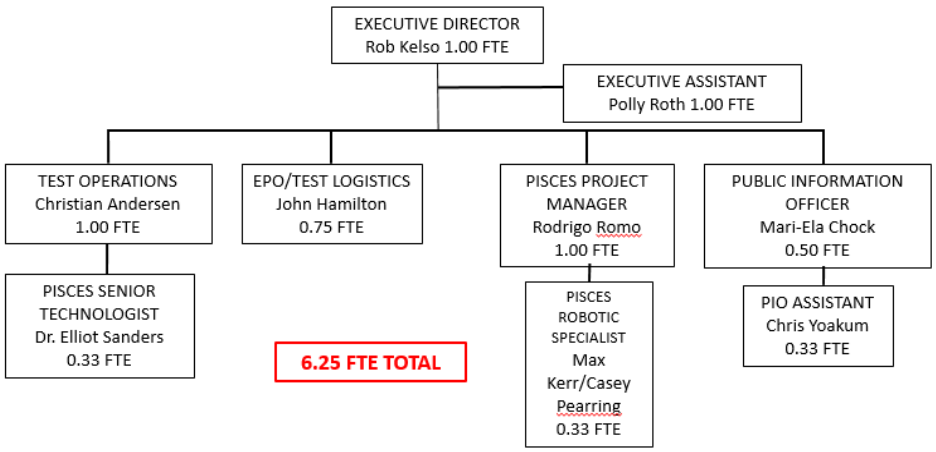
- Henk B. Rogers, PISCES Board Chairman
- Rob Kelso, PISCES Executive Director & Board Vice Chair
- Lewis L. Peach, Jr., Board Secretary
- The Honorable George R. Ariyoshi
- Hoyt Davidson, Near-Earth LLC
- Galen Ho, President Galen Enterprise
- Mary Alice Evans (representing the Director of DBEDT)
- Jim Keravala, Shackleton Energy
- Chancellor Donald Straney (representing the President of the University of Hawaii)
- Dr. Daniel J. Rasky, NASA-Ames, Ex-Officio, Non-Voting

The Board met six times in fiscal 2014: July 18, 2013; October 7, 2013; January 29, 2014; March 12, 2014; March 21, 2014 and May 20, 2014.

b. PISCES Cultural Advisory Committee – The Cultural Advisory Committee (Papa A'oa'o) was originally formed in 2007. This committee is composed principally of Native Hawaiian professionals and cultural practitioners and its role is to provide advice to PISCES Management and staff on conducting operations in a culturally sensitive manner. The members of the Cultural Advisory Committee are:

- Kalepa (Chad) Baybayan
- Nathan Chang
- Greg Chun
- Kamaka Gunderson
- Robert K. Lindsey, Jr.
- Kimo Pihana
- Koa Rice
- Dr. David Sing
- Frank Trusdell

c. PISCES Staff – The PISCES staff has increased from 4.5 FTE at the end of FY13 to 6.25 FTE at the end of FY14, adding individuals with engineering, project management and robotics skills critical to our success. The organizational chart below illustrates current PISCES positions.



PISCES

Pacific International
Space Center for
Exploration Systems

99 Aupuni Street Suite 212-213
Hilo, HI 96720
Tel: 808-935-8270
PISCES.HAWAII.GOV
E: pisces@dbedt.hawaii.gov

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