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## TLRS-4 Deployment to Maui, Hawaii

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### Abstract

*With the completion of the TLRS-4 Operational Readiness Review in the fall of 2005, Honeywell Technology Solutions Inc (HTSI) working with the University of Hawaii Institute for Astronomy (IfA), deployed the NASA TLRS-4 system to the 10,000 foot summit of the Haleakala volcano on September 7th, 2006. TLRS-4 is returning a critical data point to the ILRS Global solution following the closure of the HOLLAS SLR station in 2004. This paper describes the planning, deployment, current status and future at the Haleakala Observatory.*

### Background

The NASA Transportable Laser Ranging System (TLRS) number 4, TLRS-4, was returned to operations during spring and summer of 2005, following approximately 10 years of inactivity as an operational station in the NASA SLR Network. A highly



successful inter-comparison test with Moblas 7 validated that TLRS-4 was ready for deployment. Following the Operational Readiness Review on September 15, 2005, TLRS-4 was readied for deployment to the 10,000 ft summit of the Haleakala volcano on Maui, Hawaii. The system was to be operated by the University of Hawaii (UH), Institute for Astronomy (IfA) under contract to NASA, returning a critical data point in the Pacific Ocean. As the Hollas system had been

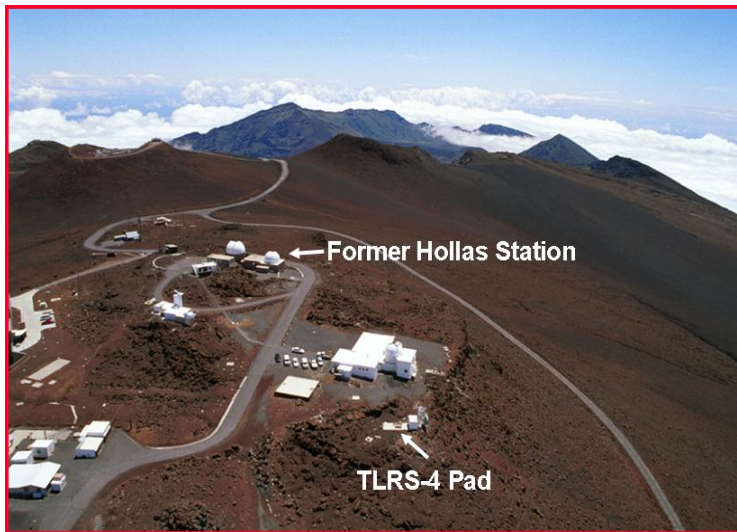
decommissioned in 2004 following budget reductions at NASA, the site was converted to the new PanStarrs Observatory. To return SLR to the Haleakala Observatory, the TLRS-4 system was provided and would be moved to a pad within approximately 100 meters of the Hollas station. The figure below shows the location of the former Hollas system and the location of where TLRS-4 system would be deployed.



### Haleakala Observatory Site Preparations

As the Hollas site was no longer available for SLR, a suitable location for TLRS-4 was required. One was found near the Mees Solar Observatory, however there was inadequate infrastructure to support SLR operations. Improved infrastructure to be considered included: pad, power, grounding voice and data communications, calibrations piers, site safety and site and system survey. Even though the IfA had no

formal contract in place with NASA, they provided excellent coordination for all efforts of site preparations that would be required to locate TLRs-4 at the observatory.



During this period when no contract existed with the IfA, the system remained in a semi-operational mode at the Goddard Geophysical and Astronomical Observatory (GGAO) in Greenbelt, Maryland at NASA SLR Headquarters.

Also, during this time, a dome safety retrofit project occurred in Maryland to provide a remotely operated and

weather hardened dome and shutter to meet with the sometimes harsh wind and rain conditions at the summit of the Haleakala volcano. Additionally, an upgrade to provide for 4 Hz tracking for high orbital satellites occurred and the TLRs systems were not originally designed to high satellite tracking.

In April 2006, in anticipation of the IfA, NASA contract being finalized and due to the time required to transport the system from Maryland to Hawaii, it was determined to ship the system to Maui. The system arrived in Maui in late May 2006. As the contract had not been finalized, the shipment consisting of the Ranging Van, the Support Trailer and the radar platform and tracking dome, were placed at the Waiakoa, IfA office property located at 3,000 feet for holding until the system could be sent to the summit. A key milestone to be completed once the contract was in place was a site occupancy permit and permit to perform infrastructure modifications at the observatory.



When the contract was approved in late spring a occupation and building permit was applied for by the IfA. The permit was received in mid-August 2006 and site preparations were begun.

The Haleakala volcano is rich in native Hawaiian history, culture and religion. A cultural observer was required to approve and oversee all work performed on the site



where any disturbance may occur to native soils. Special requirements and permissions for excavation, removal and replacement of ground were followed and it was required that any person working on the project to be provided with a training and a cultural introduction to the religious and historical significance and understanding of working in Hawaii.

Following this training and receipt of the permitting, both HTSI and IfA worked aggressively to ready the site for occupation of the TLRs-4 system. Major components of site infrastructure included the calibration piers and site power. The previous figures show the unoccupied pad and the construction of the calibration piers. Temporary site power was provided from the Mees Observatory.

On September 6, 2006, the TLRs-4 was readied for transport from the IfA offices in Waiakoa to the summit. The newly fabricated dome and radar platform were installed at the Waiakoa office prior to loading the tracking van on the flatbed for the trip to the summit.



The Operations Van and the Support Trailer were delivered and installed on a rainy September 7<sup>th</sup> and placed on the pad shown above. Since that time, connection to the temporary site power, setup of the two vans and the reenergizing of the system began with the IfA and HTSI team.



An interesting point of working at the Haleakala Observatory is that the crew is required to drive from either sea level or near sea level to the 10,000 foot summit daily. Working conditions with such a daily change in altitude affect how the workers exert effort both mentally and physically. As one never completely adapts to the high altitude, greater concentration in routine physical and mental tasks, are required.



Transition of the TLRS-4 from the HTSI team to the IfA was seamless due to the extensive background in SLR that was retained by the University of Hawaii with key people such as Dan O’Gara and Jake Kamibayashi, the close similarities between the TLRS-4 software architecture and the Hollas system. More significantly, the new TLRS-4 Station Manager, Craig Foreman, spent months in Maryland in the restart effort of the TLRS-4 system and was responsible for many of the modifications of the system to operate in the Haleakala summit environment. Craig’s

success was ensured by working with the HTSI team especially Maceo Blount who lead the installation team to Maui for the installation and training of the other IfA personal.



**HTSI TLRS-4 Installation Team  
Maceo Blount Craig Foreman**





### **Current Status**

At the time of this report, the TLRS-4 station setup is completed. During the startup of the system, there was a laser failure that was being troubleshot. Also, during this time, optical alignments were being completed and the other components and subsystems were being verified. Site power to the system was being used on a temporary basis from the Mees Observatory while a permanent source was being developed.

Remaining efforts and future plans for TLRS-4 include completing the System Operational Verification Tests (SOVT), ground calibration testing, satellite tracking and validation of data acquired. Also required actions include completing the site survey analysis and report generation, updating of the Site Log, and completion of the training aspect of TLRS-4 to the IfA crew.

Power switchover to a more permanent solution will require further effort, approval by the cultural observer and contracting with local contractors and the local power company. During this period, the ground field will be enhanced to reduce ground currents on station. Locating an SLR station located at the top of a dormant volcano produce unique grounding opportunities that must be resolved in unique ways.



## **Conclusion**

In conclusion, acknowledgements of the many extra efforts and the dedicated team that worked to reach a successful conclusion to the project that restores an important piece of the global puzzle for the reference frame and for SLR go to NASA with the leadership provided by David Carter. Also to the HTSI Team led by Howard Donovan and his the team of professionals including Don Patterson, Dennis McCollums, Tony Mann, Michael Heinick, Julie Horvath, Bart Clarke, Oscar Brogdon, Maceo Blount, and Craig Foreman. And finally, the team from the University of Hawaii, Institute for Astronomy and the extra efforts provided by Dan O’Gara, Mike Maberry, Jeff Kuhn, Jake Kamibayashi and Les Hieda.