GUTS (Global High Accuracy Trajectory System) – A New SLR System for Japan
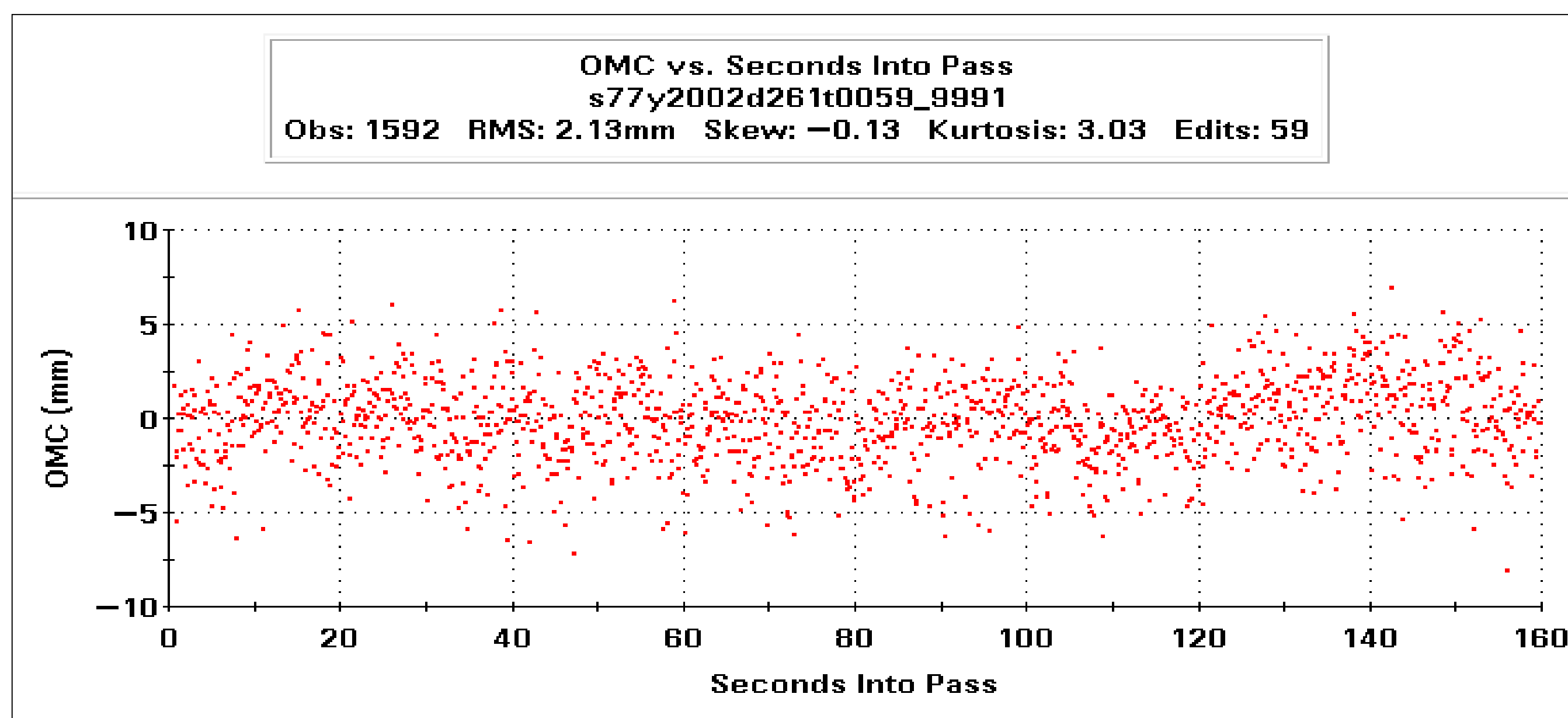
Thomas Oldham, David McClure, Ray Stringfellow, Michael Heinick, Charles Steggerda,
Matthew Bieneman, Seth Gordon, Jerome Cho, Mary Hakim, Om Sharma
Global High Accuracy Trajectory System (GUTS) Project
Honeywell Technology Solutions, Inc.
7515 Mission Drive
Lanham, MD 20716 USA
E-mail: thomas.oldham@honeywell-tsi.com

GUTS Station Overview

Honeywell Technology Solutions, Inc. (HTSI) is currently integrating the Global High Accuracy Trajectory System (GUTS) SLR system for the National Space Development Agency of Japan (NASDA) in the STALAS facility at the Goddard Geophysical and Astronomical Observatory (Greenbelt, Maryland, USA). This system will ultimately be installed at the NASDA facility on Tanegashima Island in Japan. HTSI is manufacturing the SLR control system, electronics, optics, and aircraft warning radar system; producing and implementing the control, scheduling, and data processing software; integrating the NEC-manufactured laser and the Brashear-manufactured 1-meter telescope with our items; and preparing for collocation with the HTSI-operated NASA MOBLAS-7. The HTSI provided optics, electronics, and control system are derived from those developed by HTSI for the Matera Laser Ranging Observatory (MLRO) located in Matera, Italy.

The GUTS SLR system will have the capability to range to satellites in orbits ranging from Low Earth to Geosynchronous. In addition, special modifications to the HTSI control software will allow the system to be operated remotely from the NASDA facility in Tsukuba via a low bandwidth data link as well as by a local operator at Tanegashima.

Initial integration testing of the system has produced outstanding results. Ranging to the calibration cube located on the system's optical table produces ranges with an RMS of ~2 mm. This is expected to be degraded to no worse than 2.5 mm when ranging is performed to the external calibration pier following the installation of the telescope.

OMC vs. Seconds Into Pass
s77y2002d261t0059_9991
Obs: 1592 RMS: 2.13mm Skew: −0.13 Kurtosis: 3.03 Edits: 59

Producing World Class Data During Initial Integration Testing

GUTS Station Specifications

- Ranging from Low-Orbit to Geo-synchronous Orbit
- <5mm Normal Point RMS to LAGEOS-1 or LAGEOS-2 (<15mm RMS to Geo-stationary)
- Nd:YAG laser provided by NEC with 10Hz laser fire rate, 30mJ output @ 532nm (300mJ for Geo-stationary)
- 1 Meter Telescope (provided by Brashear)
- MCP-PMT detector
- Supports satellites including ETS-VIII, ADEOS-II, ALOS, LRE, LAGEOS, etc.

- Can generate prediction / tracking information, produce station schedules, and process satellite full-rate data into normal points
- Can be controlled locally or from a remote facility over a 256Kbps LAN connection.
- Station controlled by HTSI Satellite Laser Ranging Real-Time Software and X-Window based GUI suite
- HTSI Laser Hazard Reduction System Radar for Aircraft Detection

GUTS Laser Range Timing Electronics

The GUTS Laser Range Timing Electronics support the overall GUTS system goal of 10mm RMS for LAGEOS-1 or LAGEOS-2 satellites (5mm normal point RMS) and 3mm RMS for external ground targets. The Honeywell manufactured timing electronics include a Range Gate Generator for precision PMT or streak camera gating, an Event Timer for precise epoch timing of fire and return events, a Time Synchronization Module for generating low-jitter system clock signals that are synchronized to an external time reference, and a Peak Detector for amplitude measurement and modeling of amplitude dependent systematic timing errors.

HTSI Event Timer Specifications

- Event epochs recorded with a precision of less than 5 picoseconds RMS with a single vernier
- Can have up to 3 verniers improving jitter to less than 3.0 picoseconds RMS
- Maximum of 12 inputs, each with an individual ID flag
- High Speed: records up to 10 million events per second
- Unlike time interval counter, can measure multiple overlapping time intervals measuring large ranges (i.e. Lunar, Geosynchronous)

### HTSI Range Gate Generator Specifications

- Provides up to 8 independent synchronized high-precision delay (range gate) signals for precisely timed and rapidly updated control applications
- Delay and Pulse Width Range for each channel is 20ns to infinity (under computer control)
- Each channel delay time programmable to 20ps resolution with less than 50ps RMS jitter
- Each channel can be reprogrammed in real-time at a 1MHz rate
- Multiple outputs for each channel with 50 ohm drive capability. TTL, NIM, and ECL output levels.
- Allows use of near real-time data filtering and trigger updating to enhance precise gating.

HTSI Time Synchronization Module

- Outputs multiple system clock rates (1, 10, and 100PPS) that are tightly synchronized to each other
- Low jitter (50ps RMS) TTL and NIM outputs
- 50 ohm drive capability for clean extended signal transmission
- Output rates can be easily customized
- Used with RGG to synchronize all system triggers to external 1PPS reference.

HTSI Peak Detector Specifications

- Measures the amplitude of high-speed (up to a few GHz) electronic pulses
- Up to 8 input channels with customized amplitude input ranges (normal range 100mV to 2V)
- 8 bit amplitude resolution
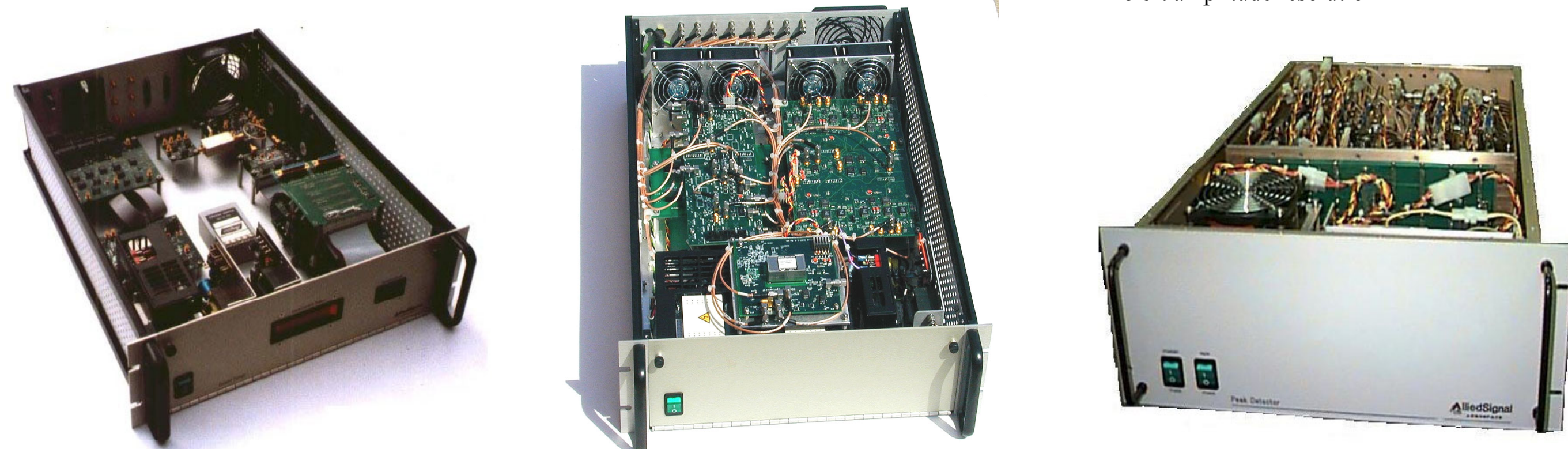
GUTS Station Locations

The GUTS SLR station is currently being integrated by Honeywell Technology Solutions, Inc. (HTSI) in the Stalas facility at the Goddard Geophysical and Astronomical Observatory in Greenbelt, Maryland, USA. After collocation testing with the NASA MOBLAS-7 station, the GUTS SLR equipment will be installed on Tanegashima Island, Japan. The remote station control facility will be located in Tsukuba, Japan. Construction of the SLR building at Tanegashima is complete.

Greenbelt, MD
Tsukuba
Tanegashima
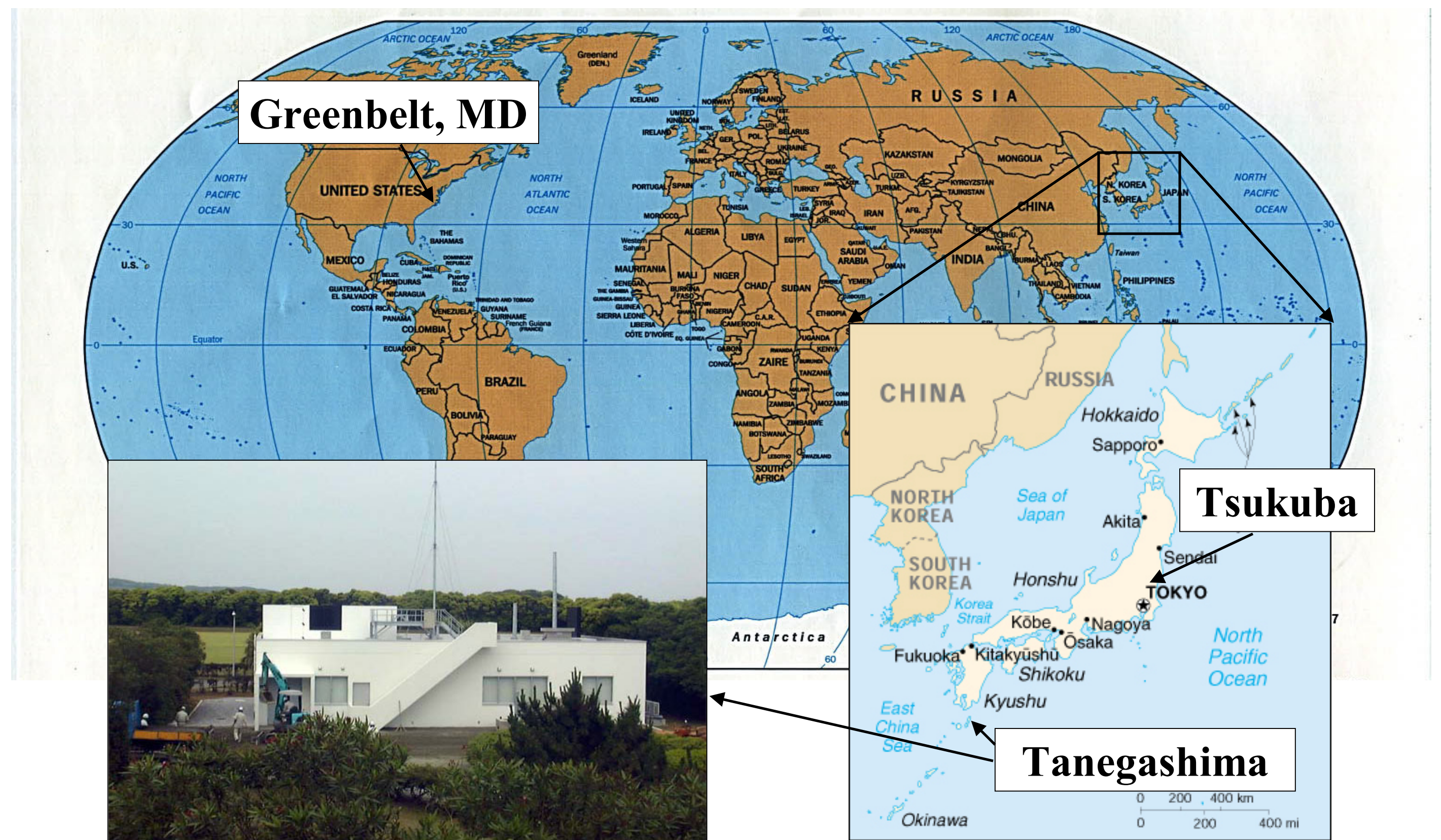
GUTS Station Status

The GUTS laser, optics, electronics, meteorology, and control system are currently integrated within the Stalas building awaiting installation of the 1 meter Brashear telescope. The station currently ranges to an internal calibration corner cube located on the optical table with ~2mm RMS.
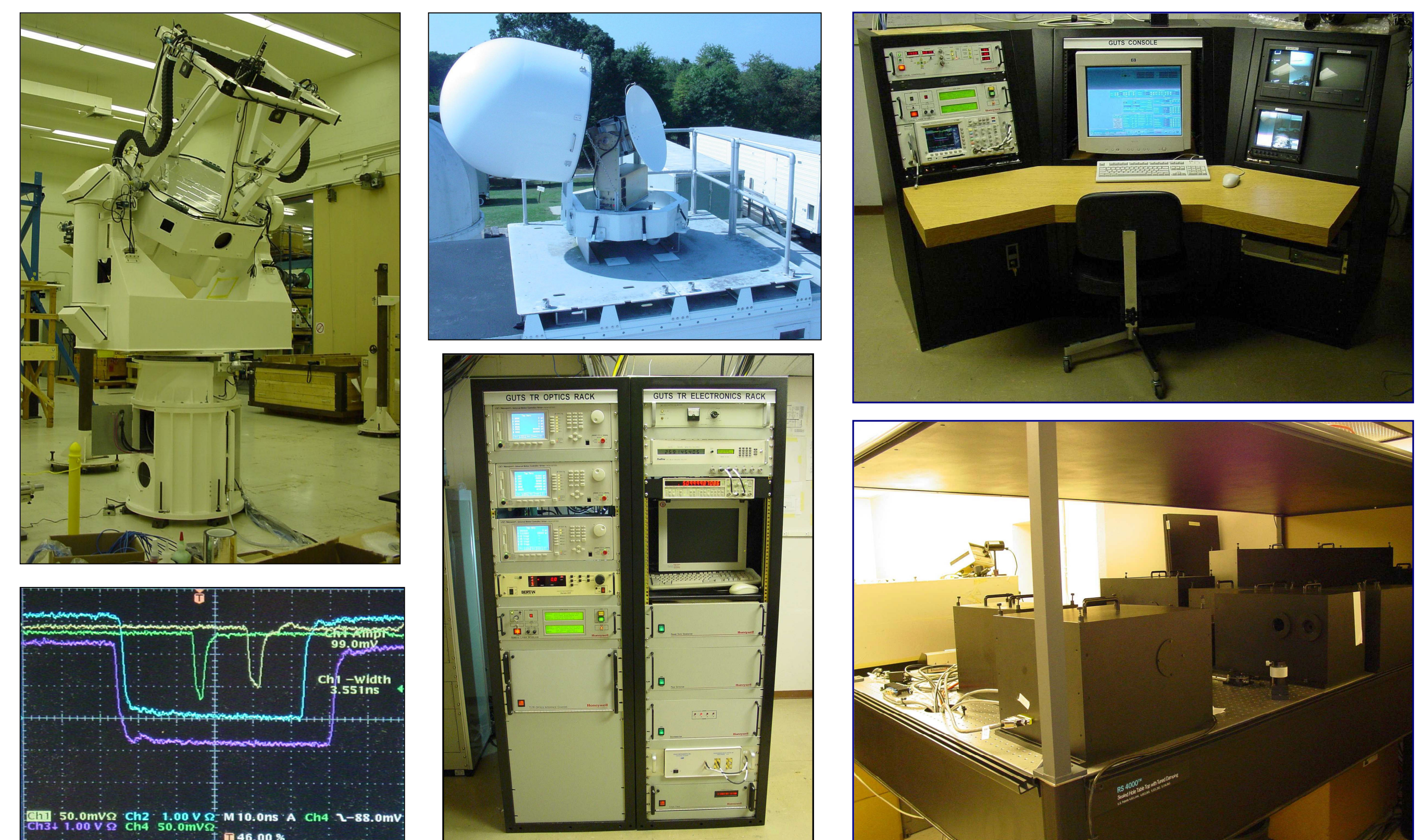
GUTS Station Software

HTSI has created a very full featured set of Real-Time Control, Numerical Computation, and Graphical User Interface software customized to the task of Satellite Laser Ranging. All GUIs are written in X-Windows to allow display on multiple graphical terminals located locally or remotely and provide an integrated HTML Documentation System displayed using the Netscape Web Browser. High-speed multiple processor computing platforms are utilized for fast concurrent operations.