

TIME AND FREQUENCY ACTIVITIES AT THE JHU APPLIED PHYSICS LABORATORY

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Abstract

The Time and Frequency Laboratory (TFL) at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) provides support to multiple NASA/JPL missions that span our solar system from the study of the Sun's coronal mass ejections (STEREO) to the examination of the outer planets and the Kuiper Belt objects (New Horizons). This support includes providing precise time and frequency to the integration and testing of flight hardware, frequency reference for spacecraft ranging and communications via the APL communications facility, and the time-stamping of ground receipt telemetry packets from various spacecraft. The TFL's ensemble of three high-performance cesium standards and three hydrogen masers are integrated to form the APL timescale that is the basis for estimating UTC – UTC (APL) and for evaluating the performance of the individual clocks. Traceability to the USNO, NIST, and UTC is maintained via GPS common-view and all-in-view time transfer. The TFL's clocks are also incorporated into the formulation of International Atomic Time (TAI). Recently, the TFL Master Clock was transitioned from a cesium-beam frequency standard to a hydrogen maser, and the frequency adjustments of UTC (APL) are now performed with a high-resolution offset generator. These changes have greatly improved the stability of UTC (APL) and have also improved our ability to steer to UTC.

APL Time and Frequency Lab



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14. ABSTRACT The Time and Frequency Laboratory (TFL) at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) provides support to multiple NASA/JPL missions that span our solar system from the study of the Sun's coronal mass ejections (STEREO) to the examination of the outer planets and the Kuiper Belt objects (New Horizons). This support includes providing precise time and frequency to the integration and testing of flight hardware, frequency reference for spacecraft ranging and communications via the APL communications facility, and the time-stamping of ground receipt telemetry packets from various spacecraft. The TFL's ensemble of three high-performance cesium standards and three hydrogen masers are integrated to form the APL timescale that is the basis for estimating UTC to UTC (APL) and for evaluating the performance of the individual clocks. Traceability to the USNO, NIST, and UTC is maintained via GPS common-view and all-in-view time transfer. The TFL's clocks are also incorporated into the formulation of International Atomic Time (TAI). Recently, the TFL Master Clock was transitioned from a cesium-beam frequency standard to a hydrogen maser, and the frequency adjustments of UTC (APL) are now performed with a high-resolution offset generator. These changes have greatly improved the stability of UTC (APL) and have also improved our ability to steer to UTC.					
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Mission

Provide precise time and frequency in support of critical APL projects and maintain traceability to U.S. and international timing laboratories.

APL Space Science Missions

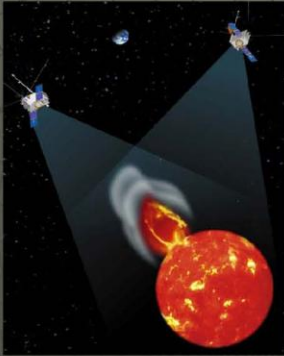


- ◆ **TIMED** – **T**hermosphere
Ionosphere **M**esosphere
Energetics and **D**ynamics



- ◆ **MESSENGER** – **M**ercury
Surface, **S**pace
Environment,
Geochemistry, and **R**anging

APL Space Science Missions (continued)



- ◆ STEREO – **S**olar
Terrestrial **R**elations
Observatory



- ◆ New Horizons

Lab Facilities

- ◆ Located in standard laboratory room
- ◆ Temperature maintained at 68 degrees
+/-3 degrees Fahrenheit
- ◆ Humidity maintained at 60% maximum
- ◆ AC power is on building UPS plus local UPS
for critical systems

Time and Frequency Lab Hardware

- ◆ 3 High Performance Cesium Standards
- ◆ 3 Hydrogen Masers
- ◆ 5 MHz measurement system
- ◆ 1 PPS clock monitor system
- ◆ 1 High Resolution Offset Generator
- ◆ 2 GPS Time Transfer Receivers

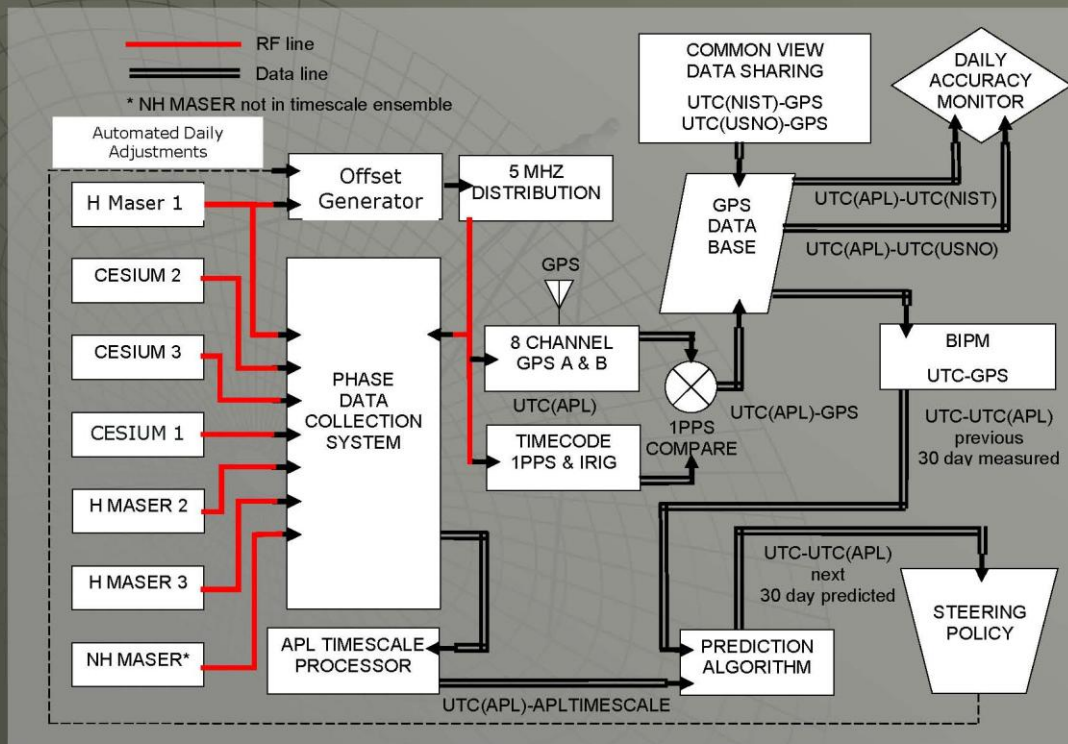
Time and Frequency Dissemination

- ◆ 1 MHz, 5 MHz, 10 MHz, 100 MHz
- ◆ 1 PPS
- ◆ IRIG-B APL Local Time
- ◆ IRIG-B UTC
- ◆ Common View GPS Time Transfer
 - NIST, USNO, BIPM

APL Timescale

- ◆ 3 Hydrogen Masers
- ◆ 3 High Performance Cesiums
- ◆ Clocks are selectively weighted
- ◆ Referenced to UTC(APL)

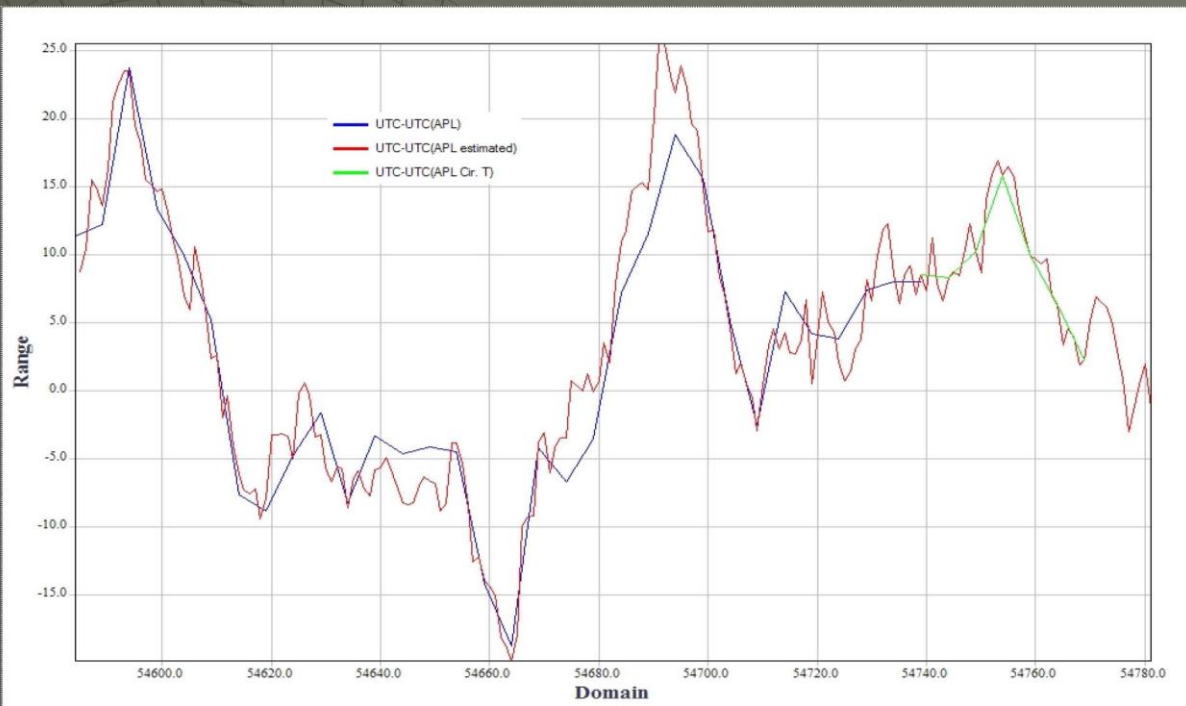
APL Timekeeping System



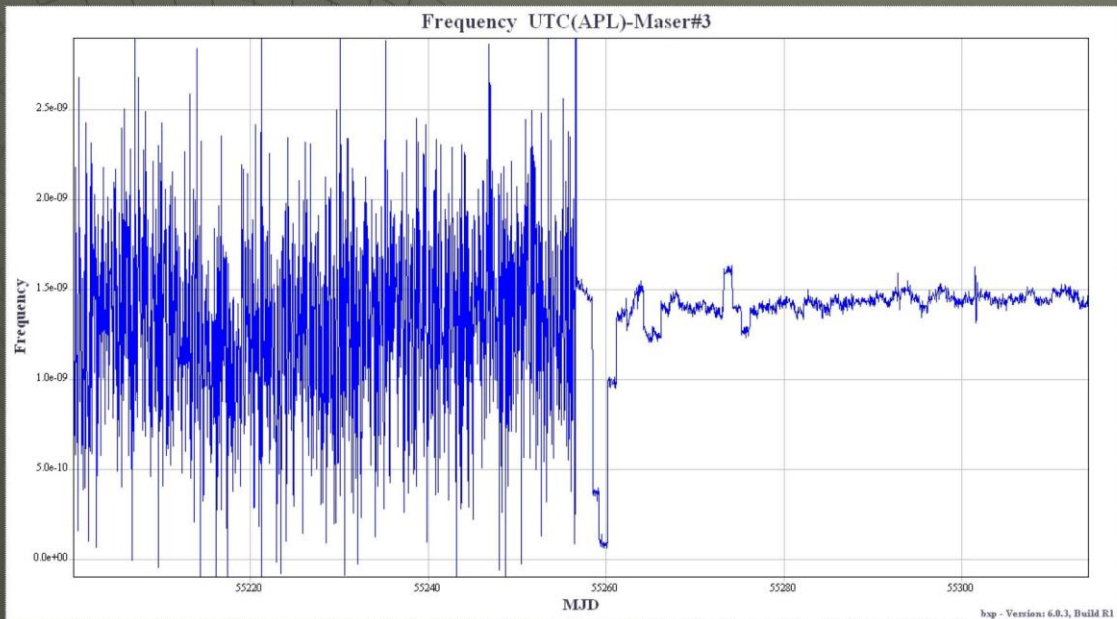
UTC(APL)

- ◆ Output of Offset Generator
- ◆ Offset Generator driven by a Hydrogen Maser
- ◆ Offset Generator adjustments are based on estimation of UTC-UTC(APL)
- ◆ Adjustments are made daily

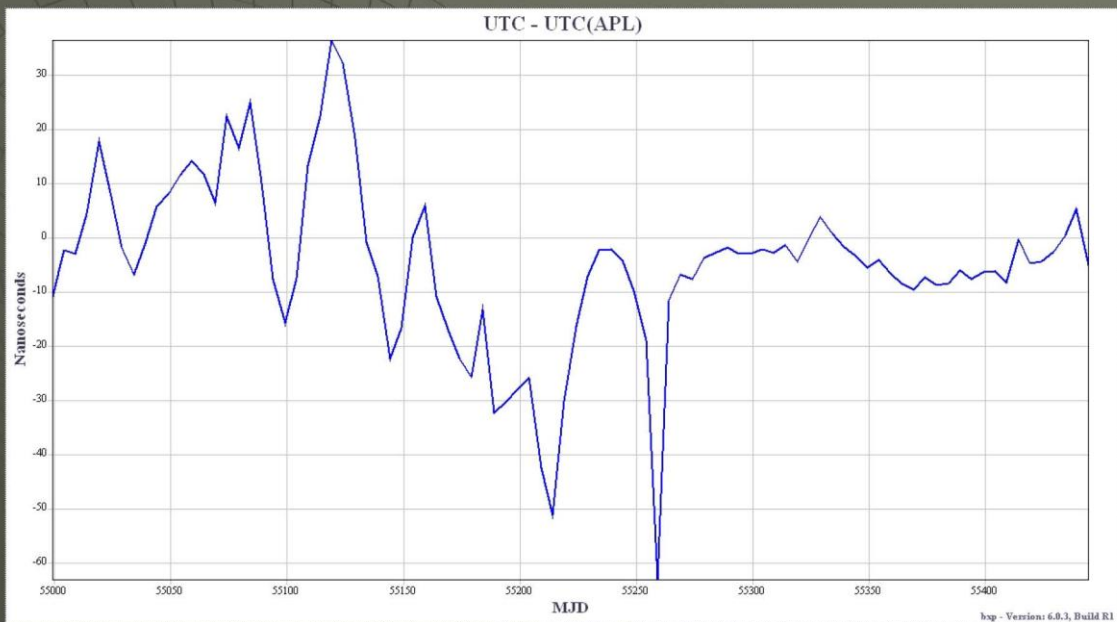
UTC – UTC(APL) & UTC – UTC(APL estimated)



Switch from Cesium & Microstepper to Maser & Offset Generator



Automated Daily Adjustments Using Offset Generator Beginning MJD 55259



Summary of Improvements 2003 - 2010

- ◆ GPS Antenna Survey
- ◆ Reporting GPS & Clock Data to the BIPM
- ◆ GPS Common-View Time Transfer with the USNO & NIST
- ◆ APL Autonomous Time Scale Algorithm
- ◆ UTC – UTC(APL) Estimation Algorithm
- ◆ Automated Daily Offset Generator Frequency Adjustments