

# GPS Time and Frequency Transfer Activities at NIST

Victor Zhang

National Institute of Standards and Technology  
Time and Frequency Division



# Code-Based Common-View

- Secondary method for contributing NIST time scale to the computation of TAI and UTC
- Time and frequency comparison network in the Inter-American Metrology System (SIM)
- Synchronization of clocks in radio stations WWV/WWVB, and WWVH to UTC(NIST)
- Global Time Service
- Time Measurement and Analysis Service (TMAS)

# Code-Based One-Way

- Frequency Measurement and Analysis Service (FMAS)
- GPS Disciplined Oscillator and GPS One-Way Receiver Calibration Service
- NIST GPS Data Archive

# Carrier-Phase

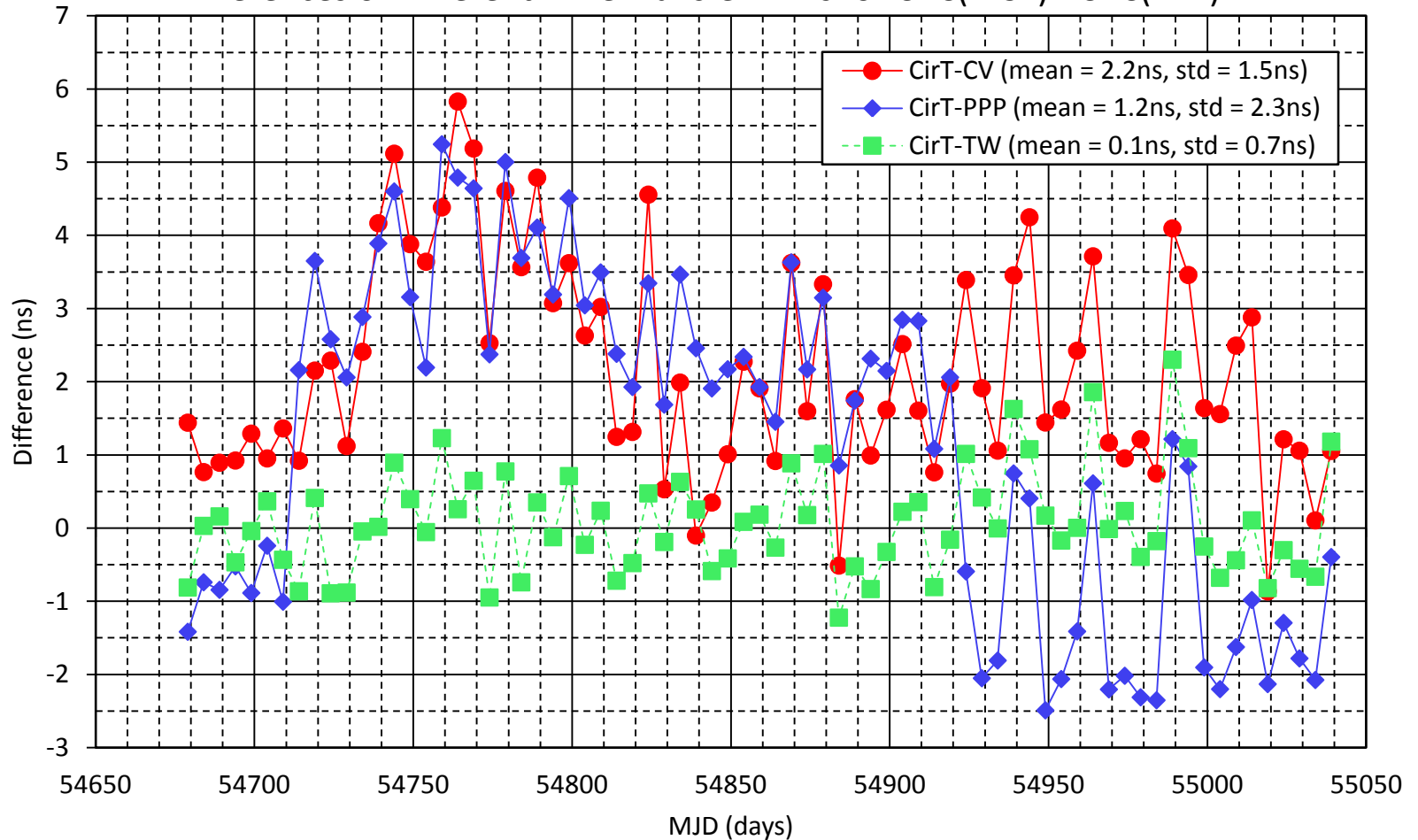
- Two stations, *NISU* and *NIST*, in the IGS tracking network (*NISU* was decommissioned on August 25, 2009. *NIST* is the primary IGS station at NIST)
- Remote clock comparison with the IGS clock products
- Remote clock comparison with the BIPM TAI PPP results

# Primary GPS Timing Receiver – *NIST*

- Dual frequency, multi-channel receiver
- Receiver calibrated with respect to the previous primary receiver (*NBS10*, last calibrated by the BIPM travel receiver in December 2003)
- Receiver produces
  - Code-based common-view data (in GGTTTS format)
  - RINEX files
    - Ionosphere-free (P3) code-based common-view data
    - Carrier-phase (IGS Clock Products and TAIPPP) data
    - IGS products

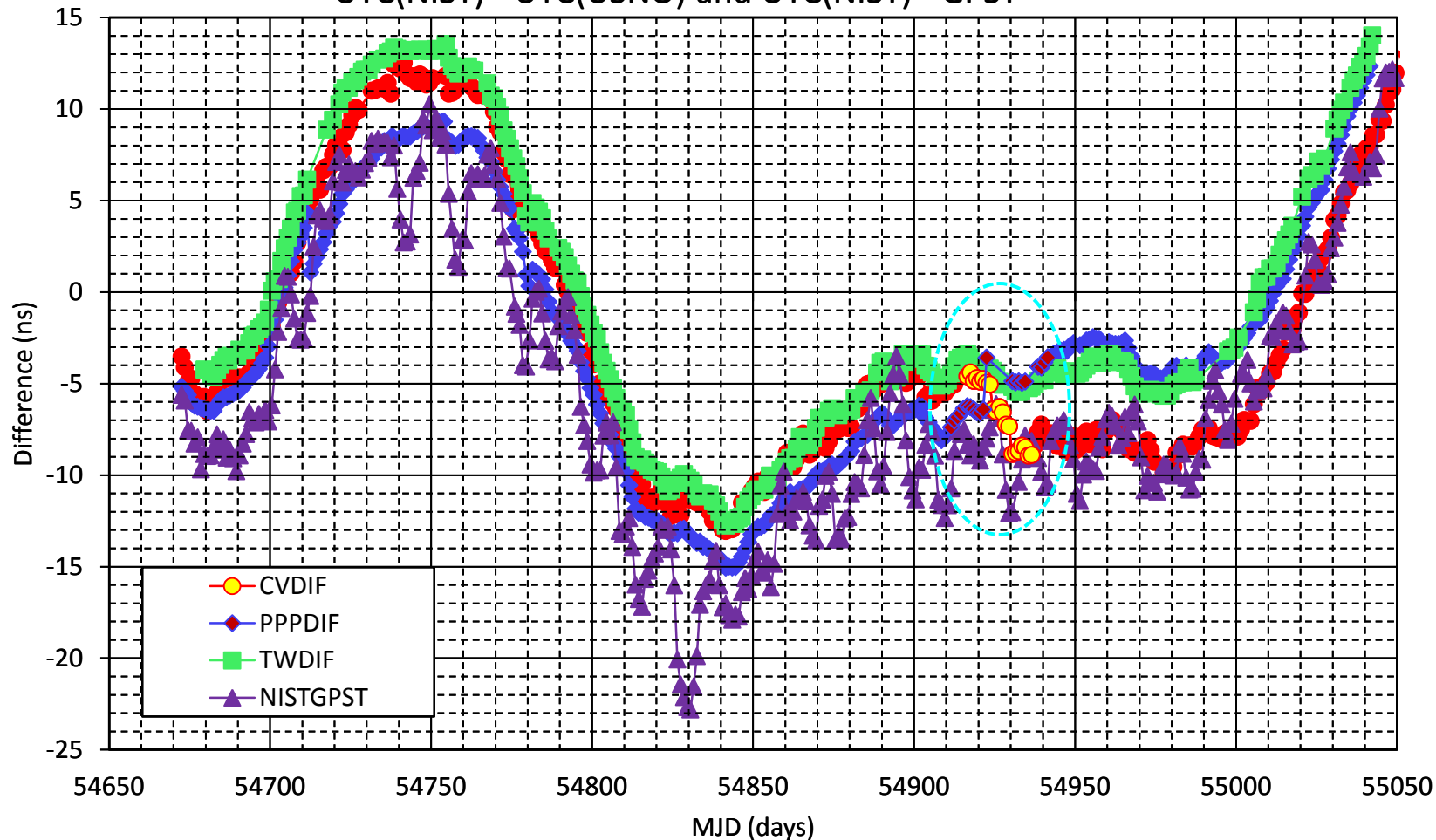
# Primary Receiver Performance

Differences of Different Time Transfer Links for UTC(NIST) - UTC(PTB)

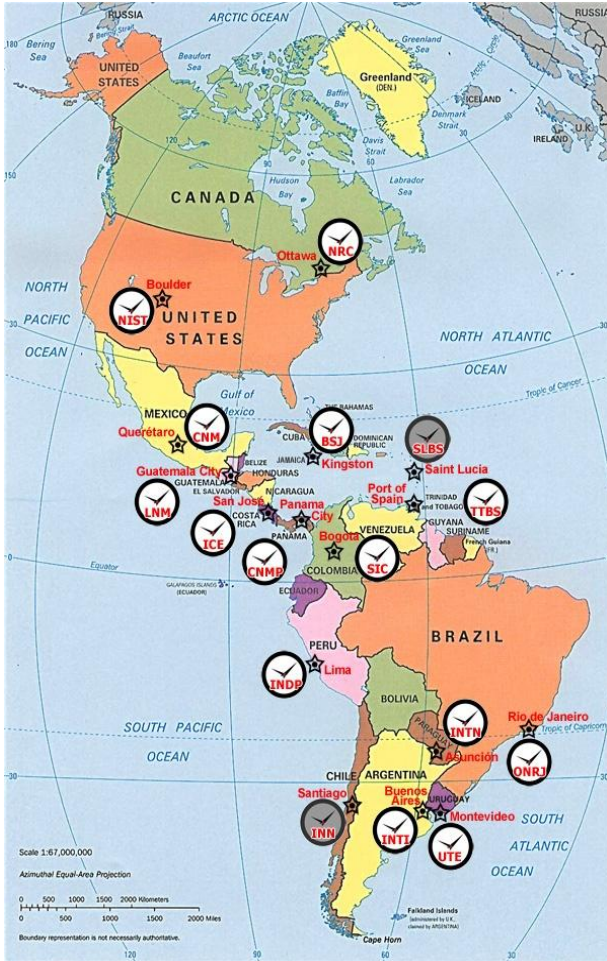


# Primary Receiver Performance

UTC(NIST) - UTC(USNO) and UTC(NIST) - GPST



# Time and Frequency Comparison Network in the Inter-American Metrology System (SIM)



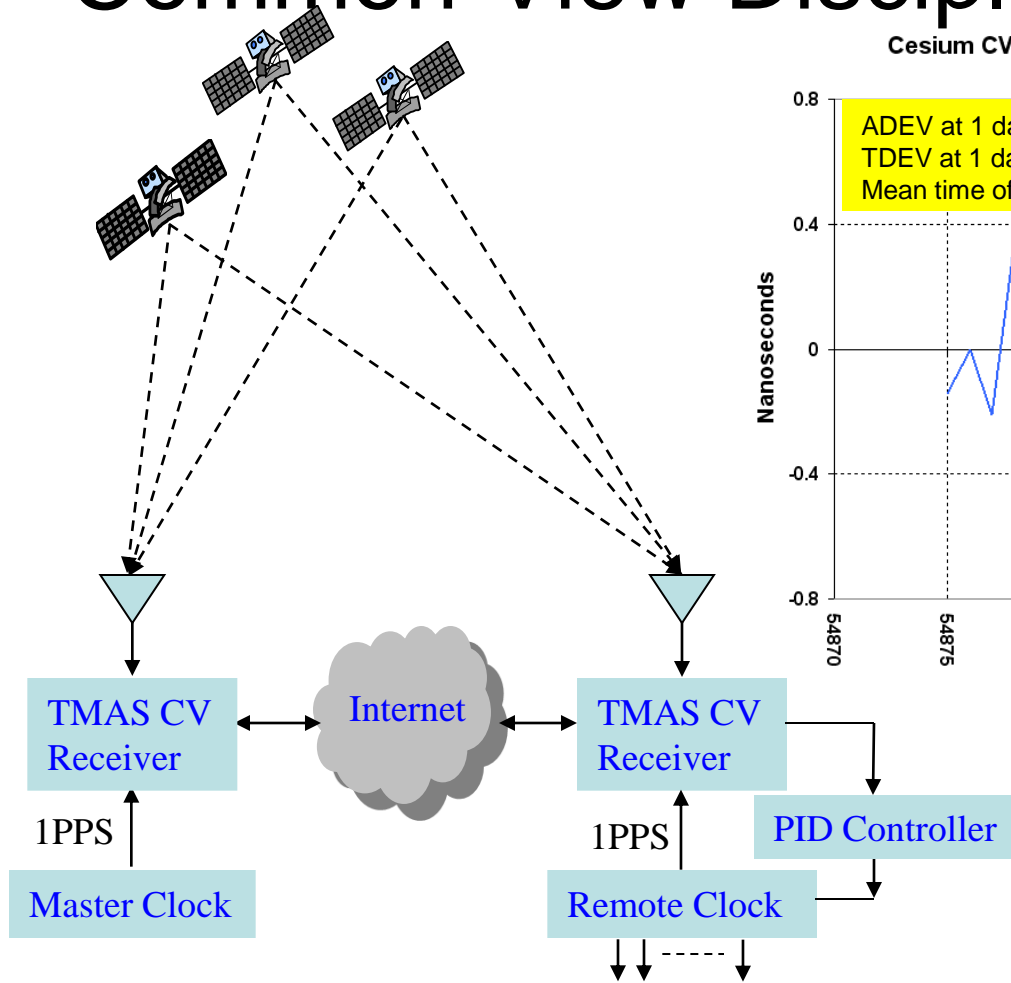
Laboratory and Country	Date of Operation	Reference Clock
NIST (U.S.A)	2005	UTC(NIST)
CNM (Mexico)	April 2005	UTC(CNM)
NRC (Canada)	May 2005	UTC(NRC)
CNMP (Panama)	October 2005	UTC(CNMP)
ONRJ (Brazil)	September 2006	UTC(ONRJ)
ICE (Costa Rica)	January 2007	Cesium
SIC (Colombia)	February 2007	Cesium
INTI (Argentina)	July 2007	Cesium
LNM (Guatemala)	August 2007	Rubidium
BSJ (Jamaica)	January 2008	Cesium
UTE (Uruguay)	September 2008	Cesium
INTN (Paraguay)	September 2008	Rubidium
INDECOPI (Peru)	August 2009	Rubidium
TTBS (Trinidad & Tobago)	August 2009	Rubidium



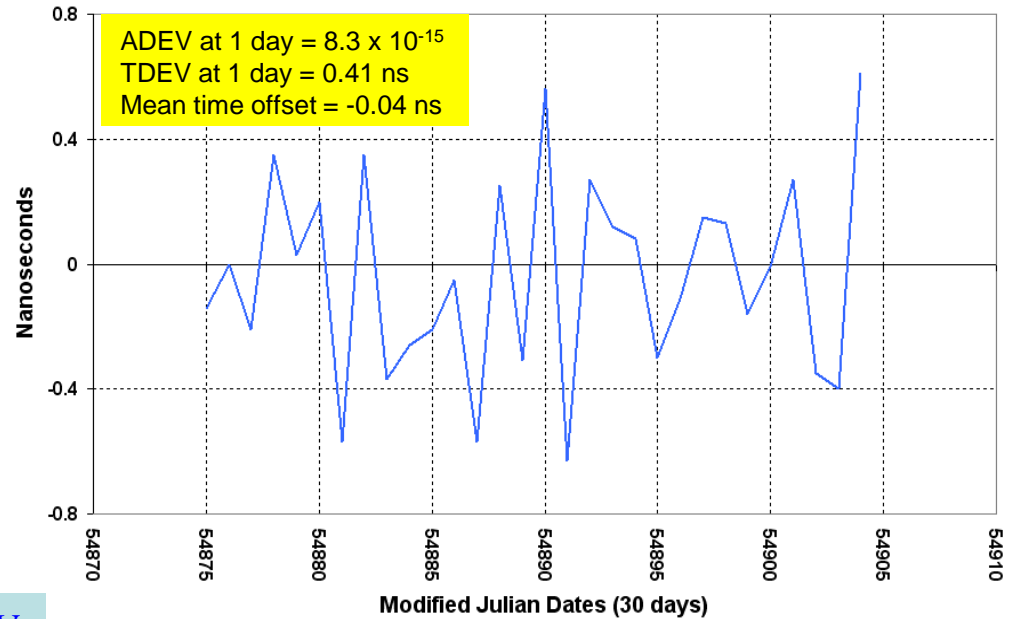


# Common-View Disciplined Oscillator

Cesium CVDO locked to UTC(NIST) from LSU, 2587 km baseline

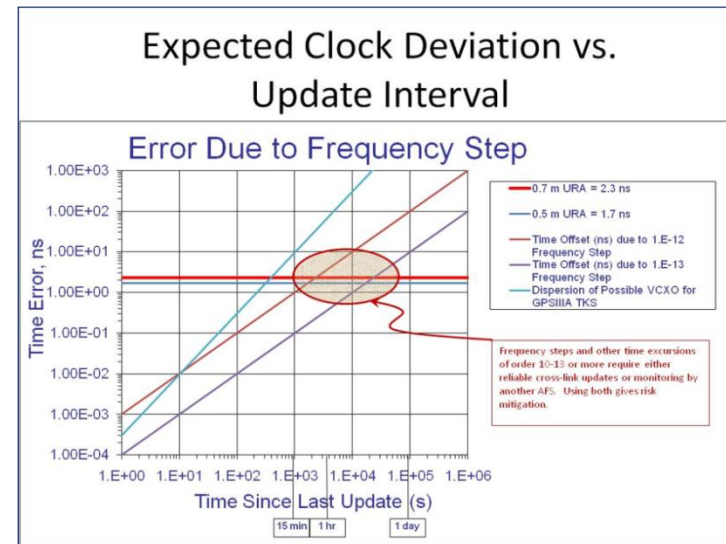
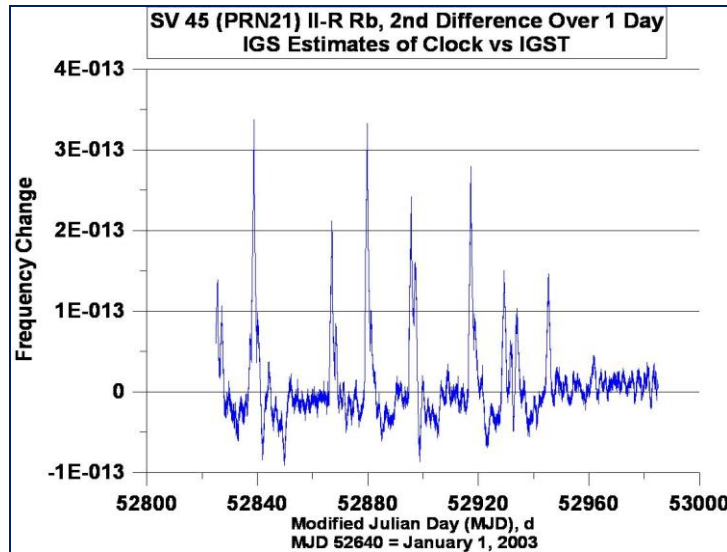


Outputs locked to the master clock



*NIST/USCG joint project of steering a rubidium or a cesium clock to agree with a remote time scale. Initial study was published at 2008 PTTI meeting by Lombardi of NIST and Dahlen of USCG and work is ongoing.*

# Study on Space-based Clock Monitoring for Integrity Alerting



- Un-alerted satellite clock error degrades the integrity of GPS signal.
- On-board monitoring allows for new options, e.g. Fail-Operational
- Need on-board Atomic Frequency Standard (AFS) and measurement system for space-based AFS integrity monitoring.

Please contact Dr. Marc Weiss, [mweiss@boulder.nist.gov](mailto:mweiss@boulder.nist.gov) for more information

# NIST GPS Time and Frequency Transfer Service

- Frequency Measurement and Analysis Service (FMAS)  
(*Service ID#76100S*)
- Time Measurement and Analysis Service (TMAS)  
(*Service ID#76101S*)
- Global Time Service (*Service ID#76110S*)
- Characterization of Global Positioning System (GPS) Satellite Receivers (*Service ID#76120S*)

[http://ts.nist.gov/ts/htdocs/230/233/calibrations/time\\_freq/broadcast.htm](http://ts.nist.gov/ts/htdocs/230/233/calibrations/time_freq/broadcast.htm)

GPS Data Archive [GPS - UTC(NIST) all-in-view]

<http://tf.nist.gov/service/gpstrace.htm>