

Time and Frequency Activities at the JHU Applied Physics Laboratory

Civil GPS Signals Interface Committee

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The Johns Hopkins University Applied Physics Laboratory



The largest University Affiliated Research Center in the United States

Located between Baltimore, MD and Washington, DC in Laurel MD on 400 acres with 20 major buildings + satellite campuses

Staff of about 8000 employees (~2/3s are engineers & scientists)

Major sponsors are the DoD, NASA, DHS, IC

Time & Frequency Lab Mission

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

Time & Frequency Laboratory



Clock Vault



Time and Frequency Lab Hardware

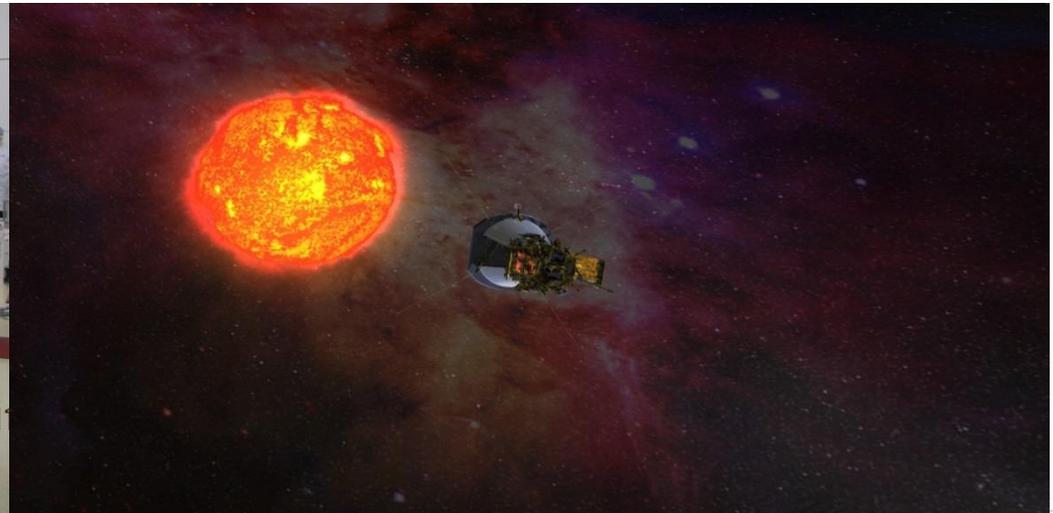
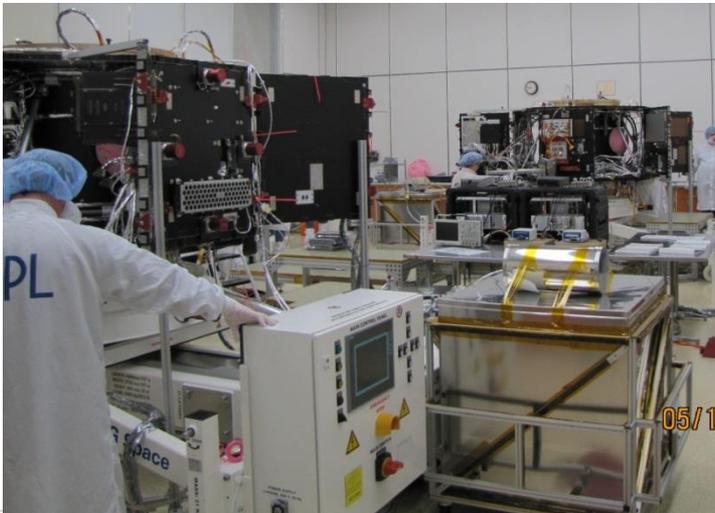
- 4 High Performance Cesiums & 1 Standard Performance Cesium
- 3 Hydrogen Masers
- 2 5MHz clock measurement systems
- 1 1pps clock monitor system
- 2 High Resolution Offset Generators
- 3 GPS Time Transfer Receivers

Mission Support

- Integration and testing of flight hardware
- Frequency reference for spacecraft ranging and communications
- Time-stamping of ground receipt telemetry packets
- R & D of time and frequency devices and distribution systems

Support of APL Space Science Missions

- Continued mission operations support for:
 - TIMED – **T**hermosphere **I**onosphere **M**esosphere **E**nergetics and **D**ynamics
 - STEREO – **S**olar **T**errestrial **R**elations **O**bservatory
 - New Horizons - mission to Pluto and Kuiper Belt Objects
 - Van Allen Probes - (formally Radiation Belt Storm Probes), launched Aug 2012
 - Parker Solar Probe
- Integration support for the Europa Clipper mission



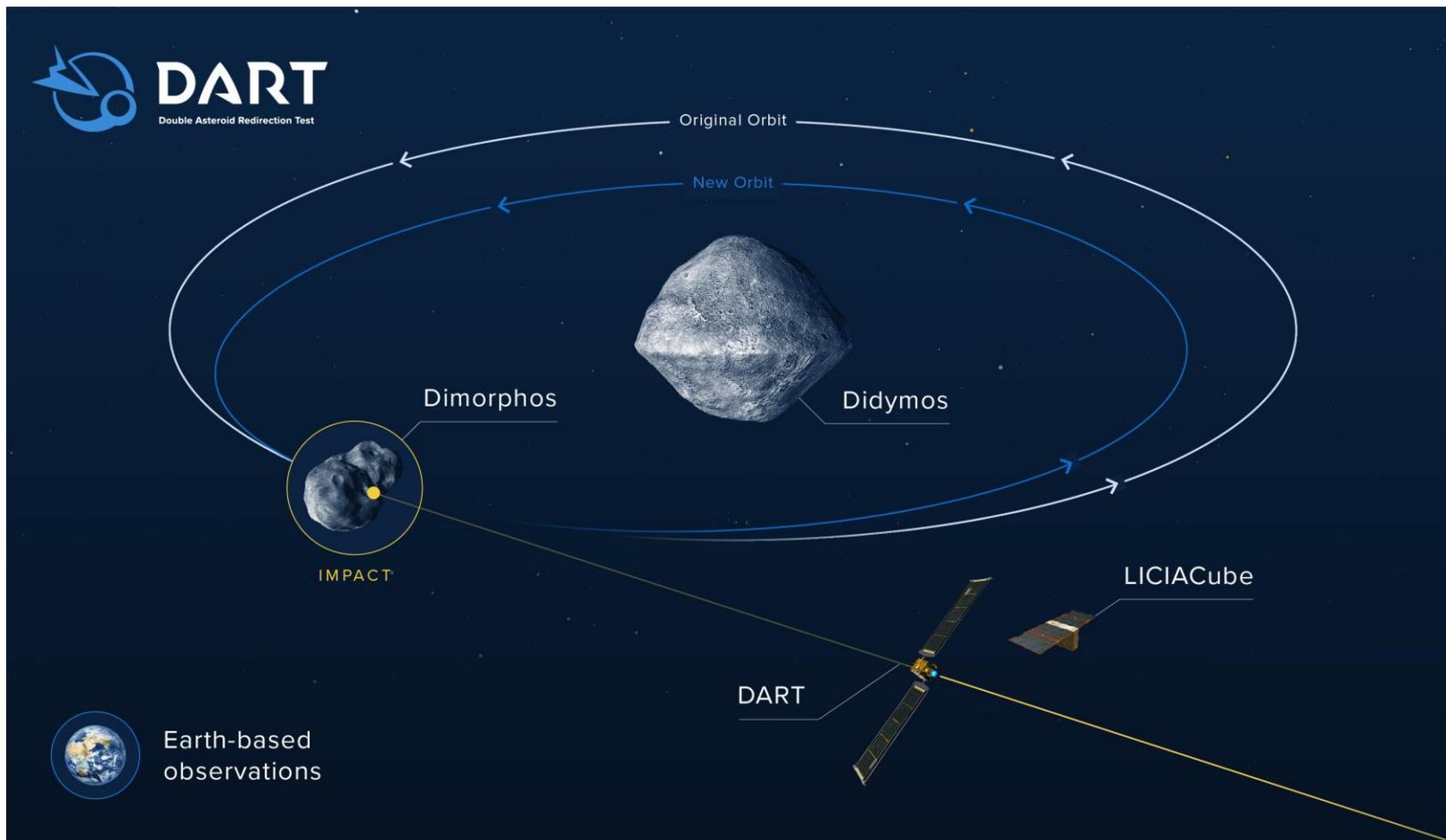
DART



DART



DART



DART

- Impact date is next week, September 26th at 23:14 UTC!!
- APL Contribution: Frontier RF Radio

DART X-band Frontier Radio

- PC, EX, RX: PSP Flight Spare (assembled)
- **DSP slice** (Clipper) QPSK
- **Spacer** (DART) No Ka-Band

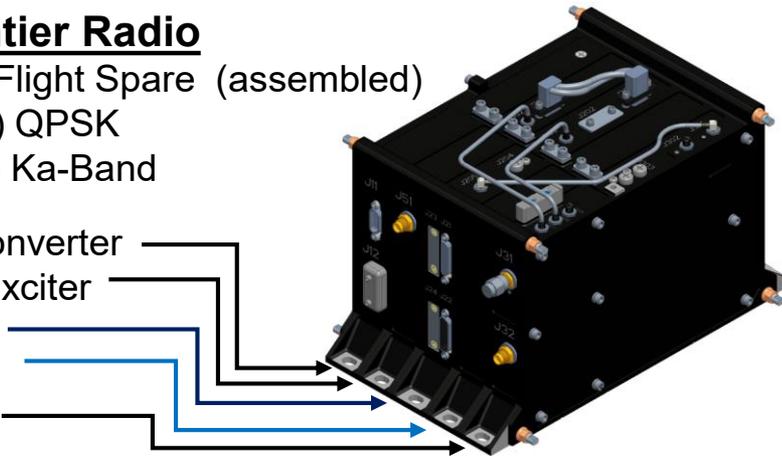
7434-6700-09 Power Converter

7443-6500-39 X-Band Exciter

7443-6600-49 DSP

7482-6500-09 Spacer

7443-6400-19 Receiver



Methods of Time Transfer Between Labs

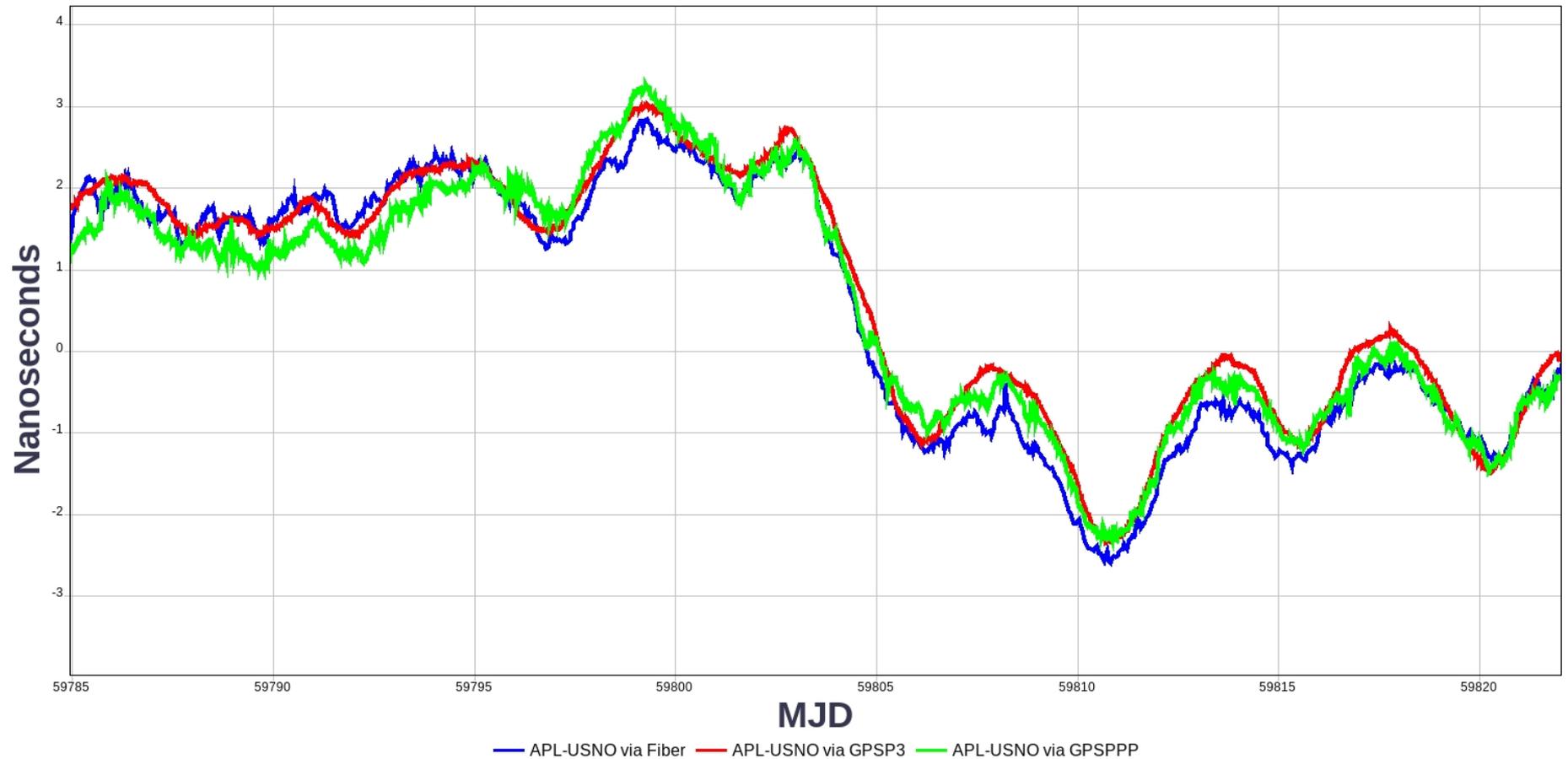
- GPS Common-View using the Measured Ionosphere (GPSP3)
- GPS Carrier Phase Time Transfer (GPSPPP)
- Two-Way Time and Frequency Transfer
- Portable Atomic Clock
- Fiber optic

New Time Transfer Receiver Advantages

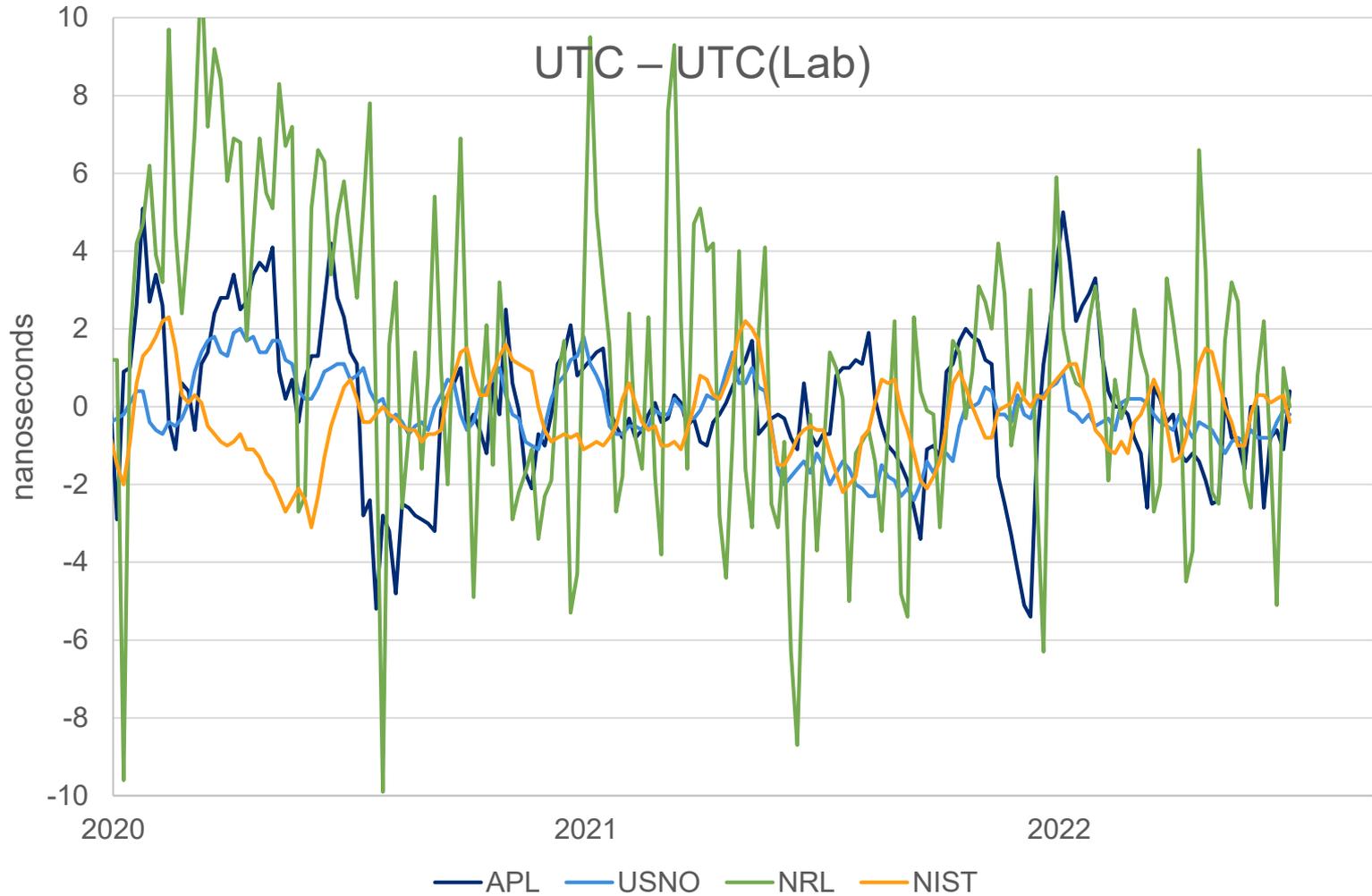
- Receiver purpose-built with support for precise time transfer requirements
- Built-in 1PPS in/out support
- Built-in tick-to-phase compensation
- On-board memory storage
- Full codeless tracking on P1 and P2
- Multi-GNSS and modern GPS signals tracking

Fiber Time Transfer with USNO

UTC(APL)-UTC(USNO) via Fiber, GPSP3, GPSPPP



Performance of UTC(APL) vs Other US Labs





JOHNS HOPKINS
APPLIED PHYSICS LABORATORY