Report from APL

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APL in Brief

What Are We?
- Division of Johns Hopkins University
- University Affiliated Research Center

Who Are We?
- Technically skilled and operationally oriented
- Objective and independent

Who Are Our Sponsors?
- DoD
- NASA
- DHS
- IC

What Is Our Goal?
- Critical Contributions to Critical Challenges

Laboratory Statistics
- 400 acre campus in Laurel, MD
- Employees: ~5,000 Staff
- Revenues: ~$1.0B
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.
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 – **Thermosphere Ionosphere Mesosphere Energetics and Dynamics**
  - STEREO – **Solar TErrestrial Relations Observatory**
  - New Horizons, mission to Pluto and Kuiper Belt Objects
  - MESSENGER – **MErcury Surface, Space ENvironment, GEochemistry, and Ranging**

- **New mission launched Aug 2012, Van Allen Probes (formally Radiation Belt Storm Probes)**
Time and Frequency Laboratory

- Located in new building on south campus
- Separate environmental chamber for clocks
- Fiber-optic signal distribution system to all APL laboratories beyond the new Space Dept. building
- Novatel PROPAK6 receiver tracks GPS, GLONASS and GALILEO
  - Enables Precise Point Positioning (PPP) time transfer
Time & Frequency Laboratory
Clock Vault
Lab Facilities

- Dedicated entirely to Time & Frequency operations with restricted access

- Clock vault temperature maintained at 68 degrees ± 0.5 degrees Fahrenheit and humidity maintained at 50% ± 1%

- AC power is on building UPS plus back-up local UPS for critical systems

- Isolated network for sharing GPS and clock data
Time and Frequency Lab Hardware

- 3 High Performance Cesiums & 1 Standard Performance Cesium
- 3 Hydrogen Masers
- 1 5MHz measurement system
- 1 1PPS clock monitor system
- 2 High Resolution Offset Generators
- 3 GPS Time Transfer Receivers
Time and Frequency Dissemination

- 5 MHz, 10 MHz, 1PPS via copper wire to internal labs and via fiber optic to other buildings on APL campus
- IRIG-B APL local time
- IRIG-B UTC
- IRIG-B input to APL NTP server
- GPS signal via distribution amp
GPS Time Transfer

- Receiver operations
  - Precise Point Positioning (PPP)
  - Multi-Channel Common-View
- Common-View with NIST & USNO
- GPSPPP with BIPM
APL Timescale

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

Launched: January 19, 2006
Pluto Closest Approach: July 14, 2015

Ten Years and Three Billion Miles . . .

2007-2014
For most of the eight-year trek from Jupiter to Pluto, the craft will spin slowly in a state of “hibernation,” signaling once a week to ensure it’s “sleeping peacefully.” But for about 50 days each year, it will be awakened to conduct an intensive set of calibration and science observations.

February-March 2007:
If the spacecraft launches during the first three weeks of its launch window, it can fly by Jupiter and save up to three years of flight time with the slingshot-like gravity boost provided by this giant planet. (The timeline shown in this figure assumes a launch during the first 17 days of the window.)

January-February 2006:
New Horizons spacecraft due to launch from Cape Canaveral, Florida, during a 35-day “launch window.”

2017-2020
With NASA approval, the spacecraft will be directed toward one or more Kuiper Belt Objects, beyond Pluto.

2014
Regular monitoring begins about 200 days before the spacecraft’s closest approach to Pluto.

Fall 2014
During the fly-by of Pluto, scientists expect 24 hours of data gathering. At its closest, New Horizons will pass within 6,000 miles of the frozen dwarf.

July 2015
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PEPSSI: Particle detection instrument used to detect molecules and atoms escaping from Pluto’s atmosphere.

SWAP: Particle instrument used to measure the properties of the solar wind around Pluto.

REX: Radio experiment to study Pluto’s atmosphere by observing the bending of radio waves beam up to the craft by giant antennas on Earth.

Student Dust Counter: Devised by undergrads at University of Colorado; will count dust particle impacts from Earth all the way into the Kuiper Belt.
Pluto-Charon Flyby: Closest Approach (July 2015)

- Position and lighting at Pluto Closest Approach (C/A)
- Spacecraft trajectory time ticks: 10 minutes
- Closest approach distances are to body centers
- The New Horizons team will develop plans to observe Pluto's two smaller moons after additional observations to refine each moon's orbit

Charon Closest Approach
Planned Distance: 27,000 kilometers (16,800 miles)
Speed: About 14 km/s (31,300 mph)
14 minutes after Pluto C/A

Pluto Closest Approach
Planned Distance: 10,000 kilometers (6,200 miles)
Speed: About 14 km/s (31,300 mph)
New Horizons Weekly Operations Status Report
August 13, 2014 – August 19, 2014
DOY 225 – 231

Mission Statistics (at 231:11:00:00 UTC)

- Round trip light time (RTLT) is 29363 seconds (8hrs 9min 23secs) (↑)
- Sun distance is 30.16 AU (↑)
- Earth distance is 29.43 AU (↑)
- Pluto distance is 2.62 (↓) AU
- Sun Probe Earth angle is ~1.35° (↑)
- Sun Earth Probe angle is ~135.42° (↓)

New Horizons news is posted on the Pluto website:

http://pluto.jhuapl.edu/