



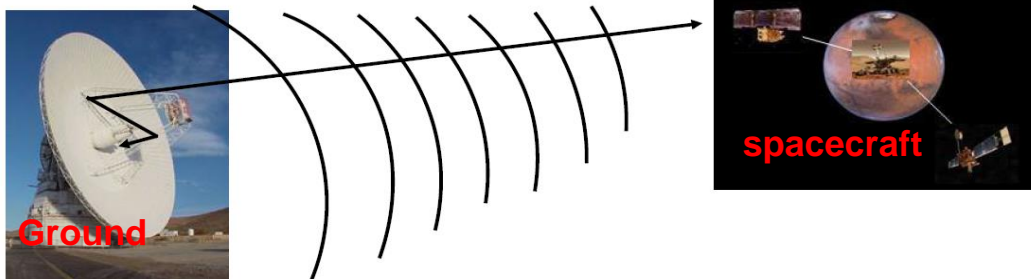
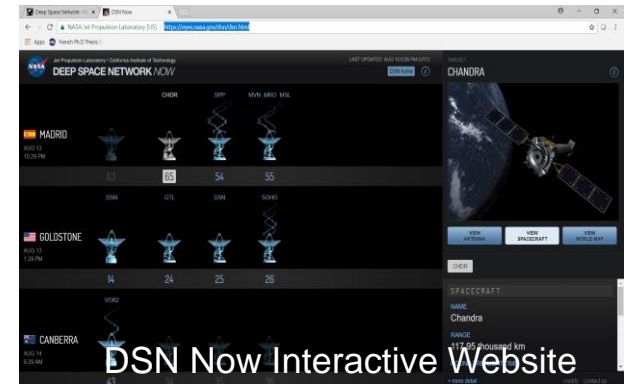
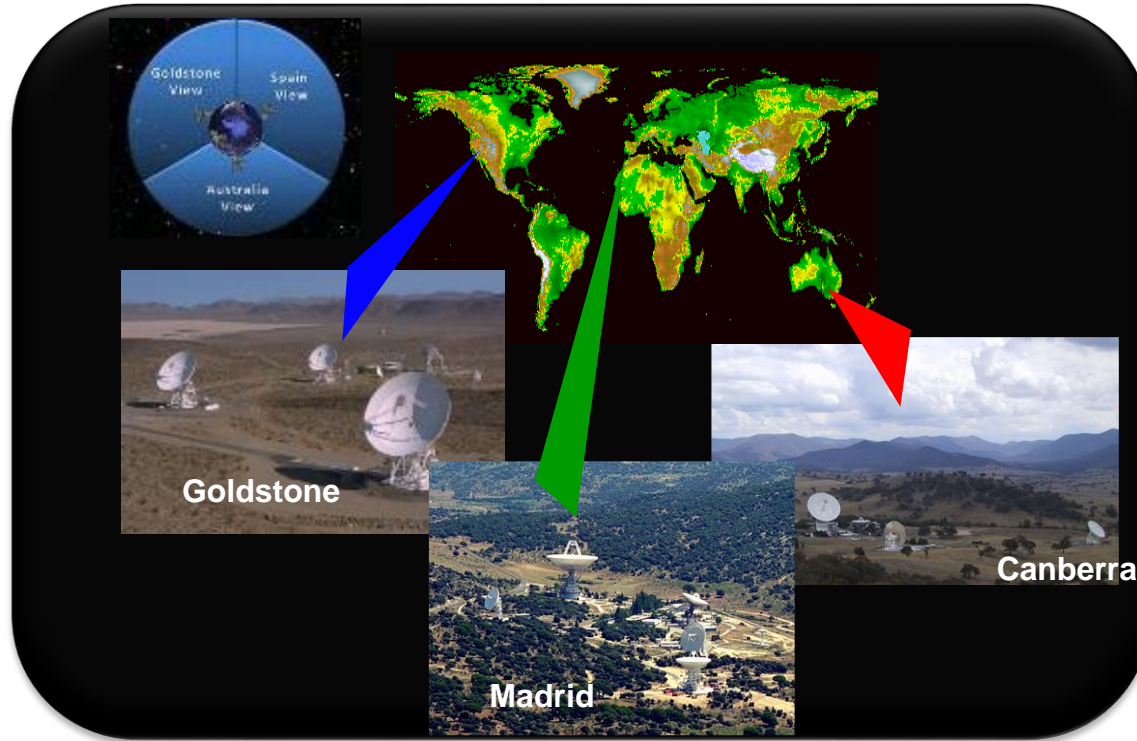
# Report from JPL Frequency Standards Test Laboratory

Dr. Lin Yi, Technologist, Sept. 21, 2020  
Frequency And Timing Advanced Instrument Development Group



**Jet Propulsion Laboratory**  
California Institute of Technology

# NASA/JPL Deep Space Network and Exploration



<https://www.nasa.gov/>  
<https://www.jpl.nasa.gov/>  
<https://deepspace.jpl.nasa.gov/>



# DSN Frequency & Timing System (FTS)

Frequency Standards Test Lab (FSTL) @ JPL

State-of-Art Clock Technologies and Characterization

Stability  
Measurements



GPS  
Antennas



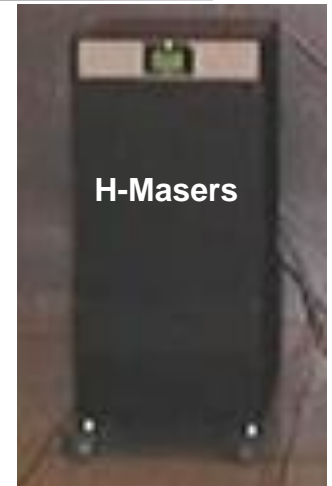
Environmental Tests



DSN Clocks



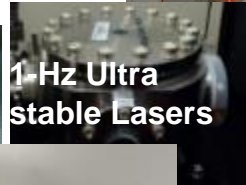
Atomic  
Standards



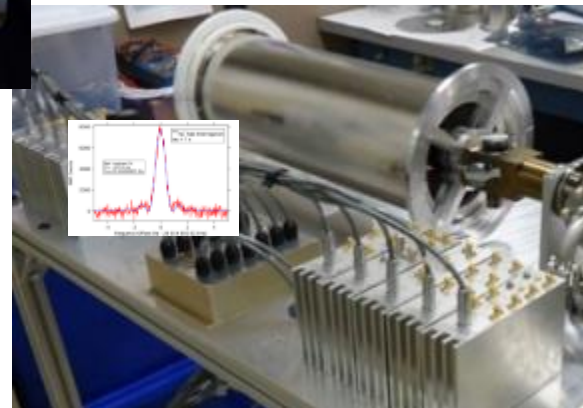
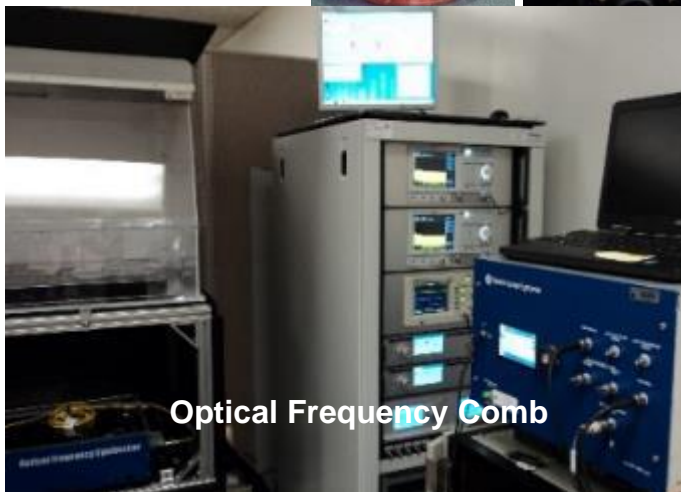
Low Noise Oscillators



1-Hz Ultra  
stable Lasers



Optical Frequency Comb



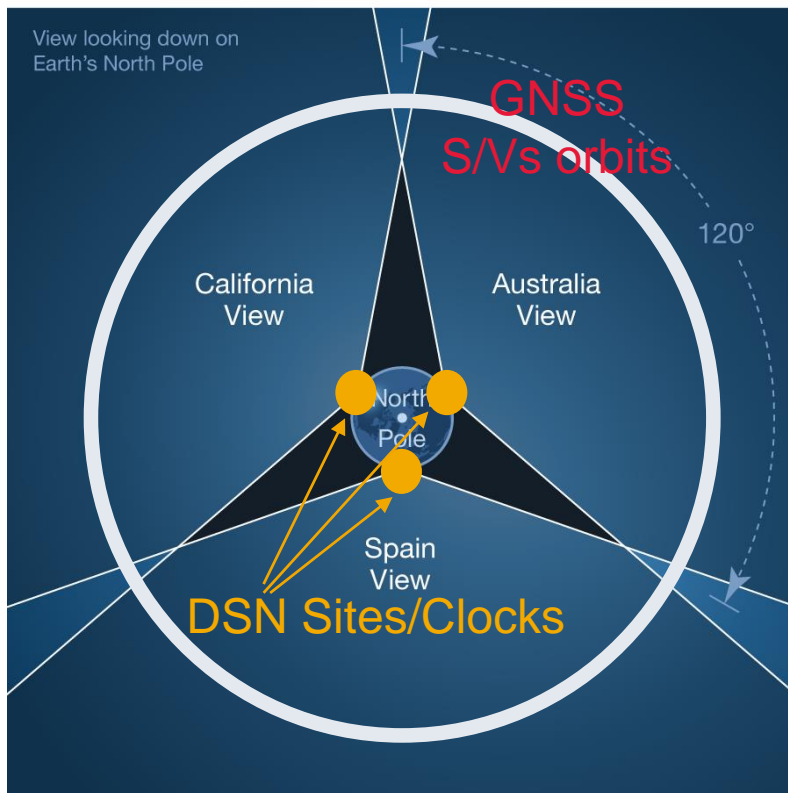
Ultra-Stable Hg<sup>+</sup> Clocks (LITS-10-12)  
(NASA, DOD, ESA, Commercial)

9/21/2020, CGSIC Timing Subcommittee, ION-GNSS+ 2020

# GNSS roles in DSN – FTS/FSTL



## GNSS All-in-View Time transfer for clocks synchronization between JPL, Goldstone, Madrid and Canberra



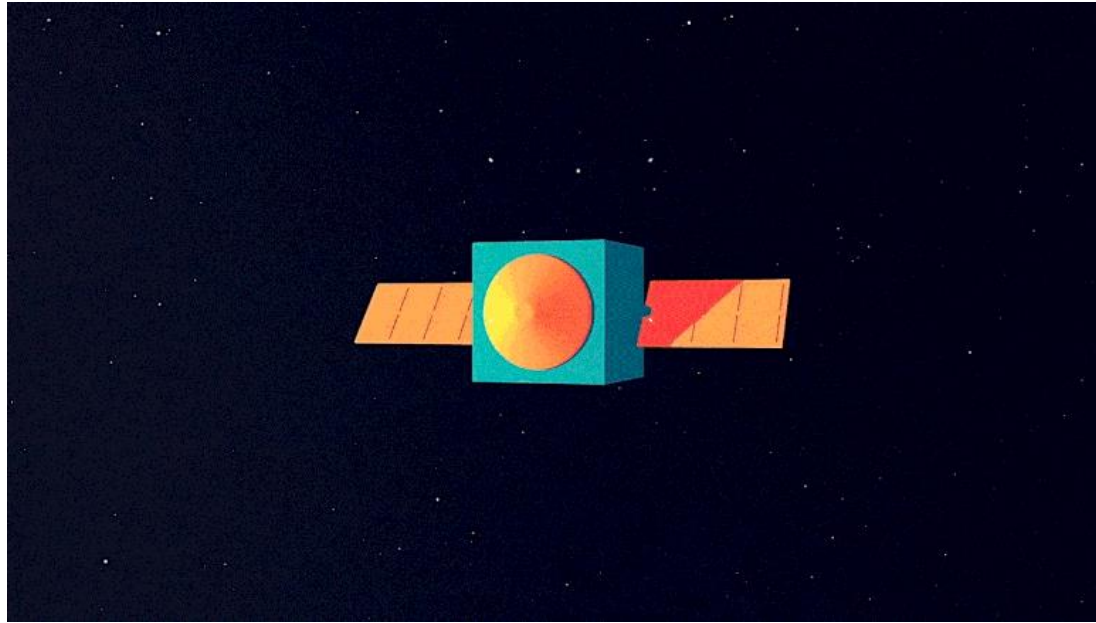
### Short baseline time transfer

- JPL-Goldstone ~100miles

### Long baseline time transfer

- Goldstone-Madrid ~ 5800 miles
- Madrid-Canberra ~11000 miles
- Goldstone-Canberra ~ 7700 miles

# Deep Space Atomic Clock --Launched in June 2019



Credit: NASA/JPL-Caltech

- Expected 10 times more stable than atomic clocks flown on GPS satellites.
- NASA has extended the mission through August 2021



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<https://www.jpl.nasa.gov/news/news.php?feature=7687>

# Other Precision Timing Related Activities at FSTL


- Lin Yi et al., “A Molecular Clock Architecture for Deep Space Inter-SmallSat Radio Occultation”, invited talk, Precise Time and Time Interval Meeting, January 25-28, 2021, San Diego, CA

 Technology development for microwave molecular clocks of low size, weight and power

- Lin Yi et al., “Space-Very Long Baseline Interferometry Mission Requirements Analysis on Space Borne Frequency Standards and Optical Frequency Combs”, Conference on Lasers and Electro-Optics, virtual, 2020

 Quantitative analysis for applying advanced frequency standards to space-VLBI missions

- Andrey Matsko et al., “On mechanical motion damping of a magnetically trapped diamagnetic particle”, Physics Letters A. 384, 126643 (2020)

 Feasibility study for acceleration sensing mechanical system  $Q \sim 10^8 - 10^9$



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