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CYGNSS Mission Update

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CYGNSS Objectives and Mission Design

- CYGNSS Objectives
 - Measure ocean surface wind speed in all precipitating conditions, including in tropical cyclones (TC)
 - Measure ocean surface wind speed in the TC inner core with sufficient frequency to resolve genesis and rapid intensification
- CYGNSS Mission Design
 - Eight satellites in a single 510 km circular orbit plane at 35° inclination, each carrying a GPS bistatic radar receiver
 - Four simultaneous real time measurements of surface σ_o and scattering waveform by each receiver using GPS L1 signal at 1.575 GHz





Spaceborne Empirical Demonstration of Ocean Wind Speed Retrievals by GNSS-R

DDMs measured by GNSS-R instrument (early version of CYGNSS science payload) deployed on UK-DMC-1 mission (launch 2003) with co-located NDBC buoys for wind speed ground truth

Software-based generation of DDMs in ground processing with <<1% duty cycle





DDMs measured by GNSS-R instrument (nearly identical to CYGNSS DDMI science payload) deployed on TDS-1 mission (launch 2014). Ground truth co-location and intercomparison analysis in progress

Firmware-based generation of DDMs in real time with 100% duty cycle







TDS-1 Real Time DDM Generation (September 2014)





TechDemoSat-1 GNSS-R Measurements (slide by Zorana et al., see their poster)

- First data set released by SSTL on March 5th, 2015
 - Cover period September 2014 – February 2015
 - Preliminary TDS-1 SGR-ReSI wind speed retrievals developed by UK National Oceanography Center (NOC)
- Data collocated and evaluated vs GDAS winds and Wave Watch 3 model

SGR-ReSI Wind Speed







CYGNSS Specular Point Contacts and Spatial Sampling







CYGNSS Earth Coverage

- 90 min (one orbit) coverage showing all specular reflection contacts by each of 8 s/c
- 24 hr coverage provides nearly gap free spatial sampling within +/- 35 deg orbit inclination





DDM Observables: DDMA and LES

- DDM Average (DDMA) is the average value of the forward scattering cross-section over a delay-Doppler window
 - The size of the window is equivalent to ~25 km spatial resolution

- Leading Edge Slope (LES) is the slope of the leading edge off the Integrated Delay Waveform, obtained by integrating the DDM along the Doppler dimension
 - The delay-Doppler window of the linear regression that gives the slope is equivalent to ~25 km spatial resolution

DDMA









RMS Error for different RCG thresholds (25 km spatial resolution)



RCG = Range Corrected Gain





Mission Flight Segments



Launch Vehicle: Government Furnished Pegasus XL





Engineering Models Reduce Flight Hardware Risk

- Engineering Model (EM) has completed initial AI&T efforts
 - Verified mechanical, electrical, and software performance and interfaces
 - Verified Ground Support Equipment (GSE) interfaces
 - Provided personnel training and procedure development
- Structural Thermal Model (STM) has completed low level vibration testing and thermal balance testing
 - Results from vibration testing and thermal vacuum testing used to calibrate Structural and Thermal analysis models
 - Demonstration of thermal and structural design and performance
- Radio Frequency Model (RFM) testing inside anechoic chamber completed
 - Accomplished performance characterization of the RF systems and validated the RF analytical models of the antenna performance
 - Used for both L-band and S-band system testing



Engineering Model in AI&T High Bay



STM on Vibe Table





STM in Thermal/Vacuum Chambe

Radio Frequency Model in Anechoic Chambe







Mission Ground Segments







Ground Network <u>USN</u>

Mission Operations Center (MOC) <u>SwRI</u> Science Operations Center (SOC) <u>Univ. of Michigan</u>





Project Schedule

Date	Milestone
Dec 2012	Project start
Jun 2013	System Requirements Review (SRR)
Jan 2014	Preliminary Design Review (PDR)
Jan 2015	Critical Design Review (CDR)
Jun 2015	System Integration Review (SIR)
Jun 2015 – Jun 2016	Assemble Integrate & Test the Observatories
Jul-Aug 2016	Integrate Obs., Deployment Module, Launch Vehicle
Oct 17, 2016	LAUNCH
Oct 2016 – Mar 2017	Spacecraft commissioning, Science payload and algorithm calibration and validation
Oct 2016 – Sep 2018	On-orbit Mission Lifetime





Thank You

for more information visit http://cygnss-michigan.org

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