



Status of the TWiLiTE Direct Detection Doppler Lidar

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HS3 Science Team Meeting
NASA Wallops
May 7-8, 2012

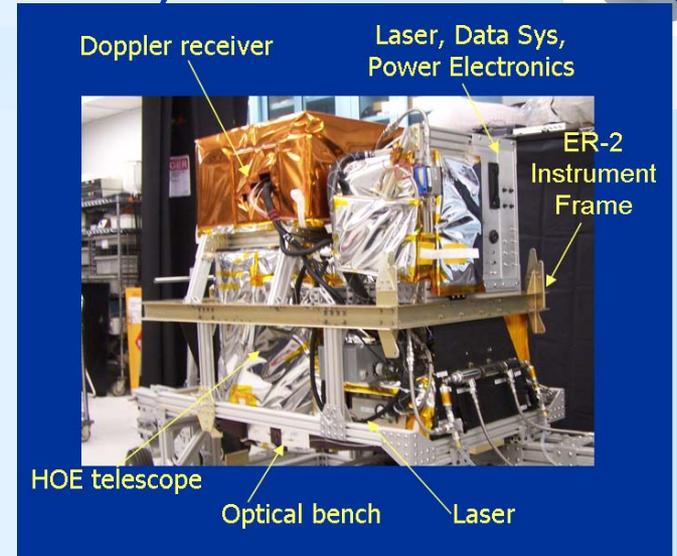




Tropospheric Wind Lidar Technology Experiment (TWiLiTE)



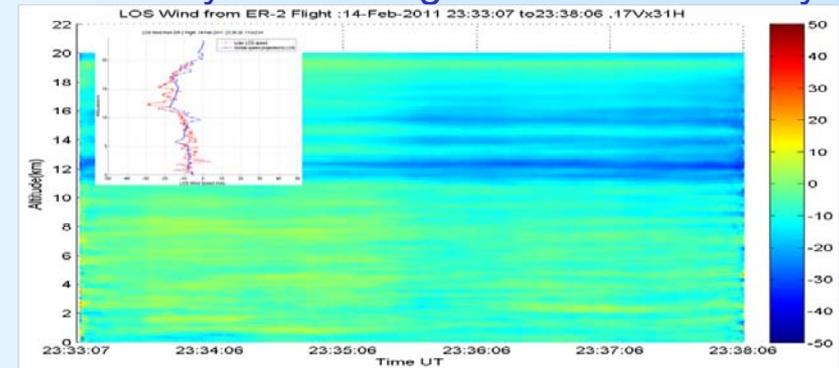
- TWiLiTE is a compact, rugged direct detection scanning Doppler lidar designed to measure wind profiles in clear air from 20 km to the surface.
- TWiLiTE operates autonomously on NASA research aircraft (ER-2, DC-8, WB-57, Global Hawk).
- Engineering flight tests on the NASA ER-2 in 2009 and 2011 demonstrated autonomous operation of all major systems.
- TWiLiTE is being reconfigured to fly on the environmental Global Hawk during the 2013 HS3 deployment.



TWiLiTE system configured for ER-2 QBay

TWiLiTE Instrument Parameters

Wavelength	354.7 nm
Telescope/Scanner Area	0.08 m ²
Laser Linewidth (FWHH)	150 MHz
Laser Energy/Pulse (8 W)	40 mJ @ 200 pps
Etalon FSR	16.65 GHz
Etalon FWHH	2.84 GHz
Edge Channel Separation	6.64 GHz
Locking Channel Separation	4.74 GHz
Interference filter BW (FWHH)	120 pm
PMT Quantum Efficiency	25%



TWiLiTE LOS wind profiles from Feb 14, 2011 ER2 test flight. A 10 minute segment taken over Fresno, CA is shown. Inset is a single TWiLiTE profile compared with wind profile data from the 00Z, Feb 15 NWS radiosonde launched from Oakland, CA.





TWiLiTE Performance Summary

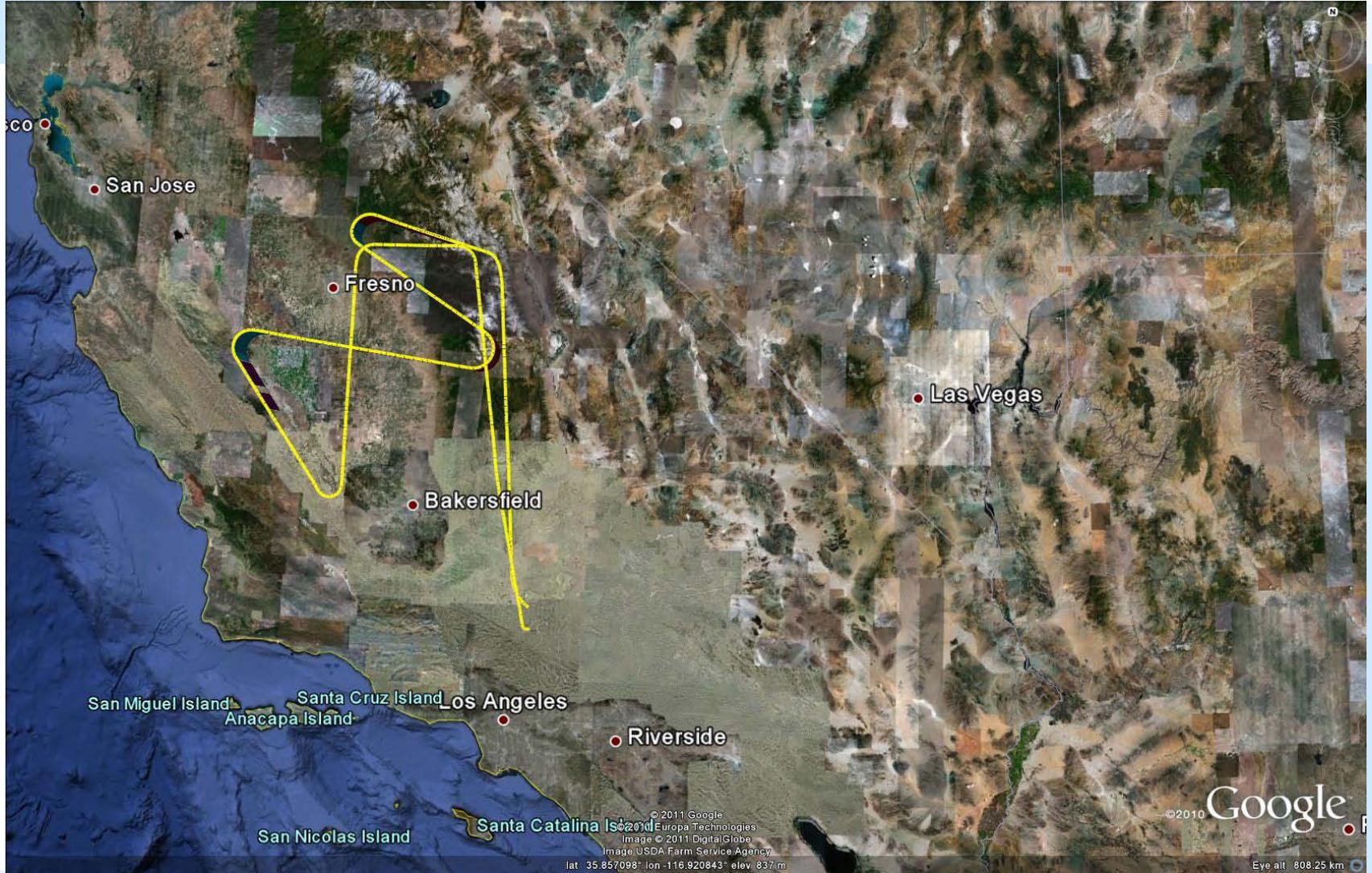


Data products	Vertical profiles of u,v wind field from aircraft to surface, clouds permitting
Velocity accuracy (m/s)	< 2.0
Range of regard (km)	0 -18 (ER-2,WB57); 0-12 km (DC-8)
Vertical resolution (km)	0.250 (programmable)
Horizontal integration per LOS (s)	10 s (programmable)
Nadir angle (deg)	45
Scan pattern	8 position conical step-stare (programmable)





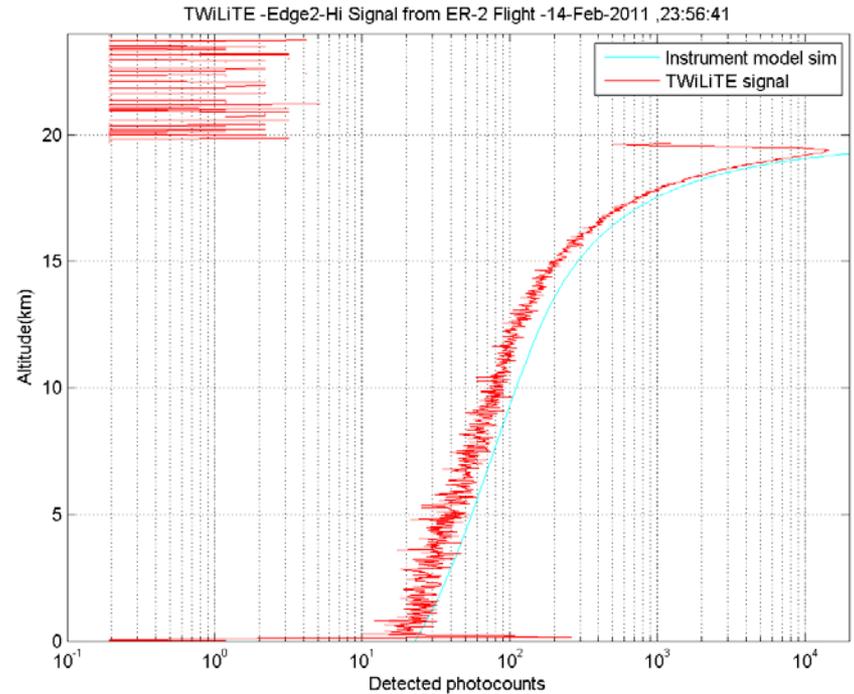
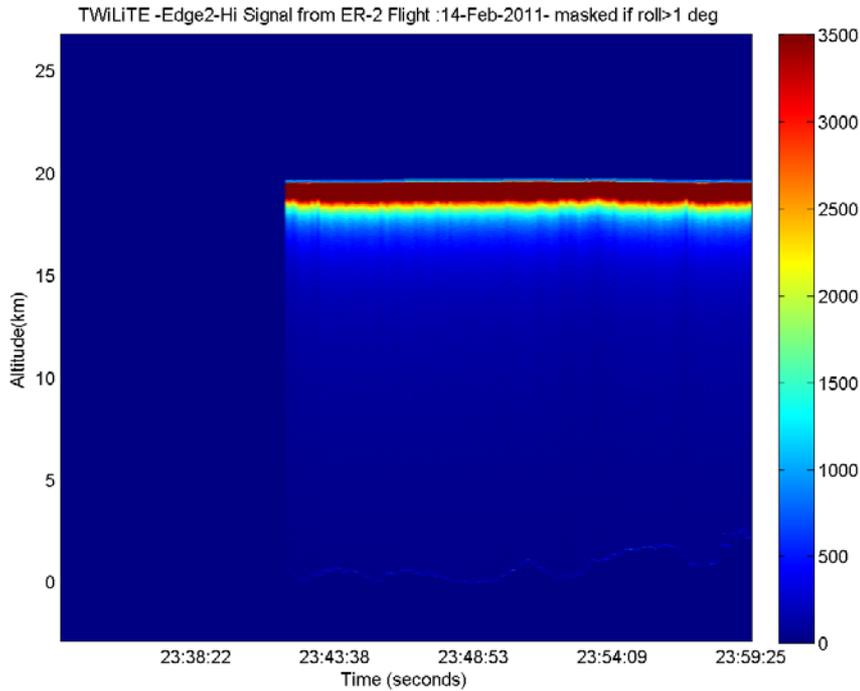
February 14, 2011 flight over California Central Valley





February 14 flight over California Central Valley-Track S4

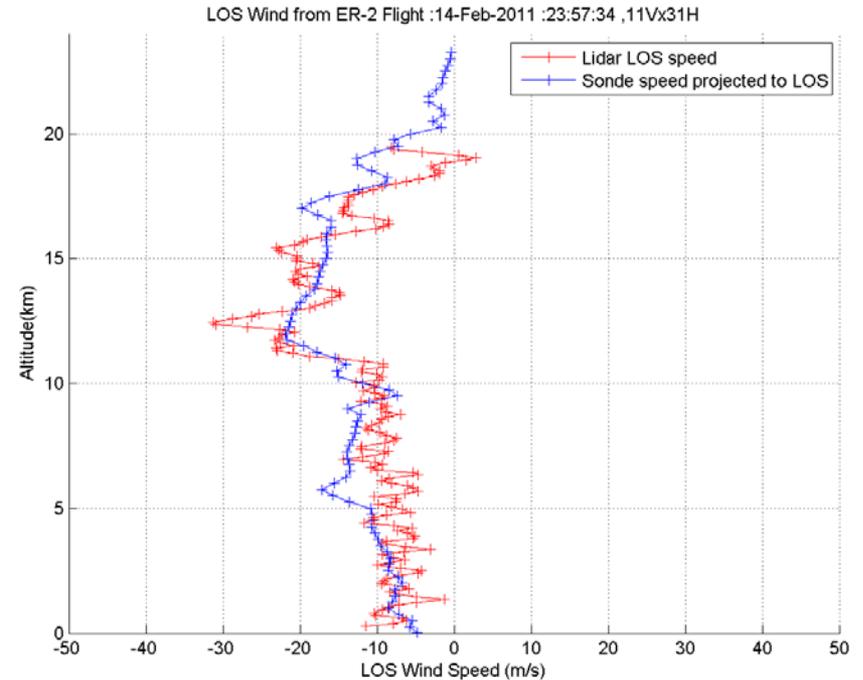
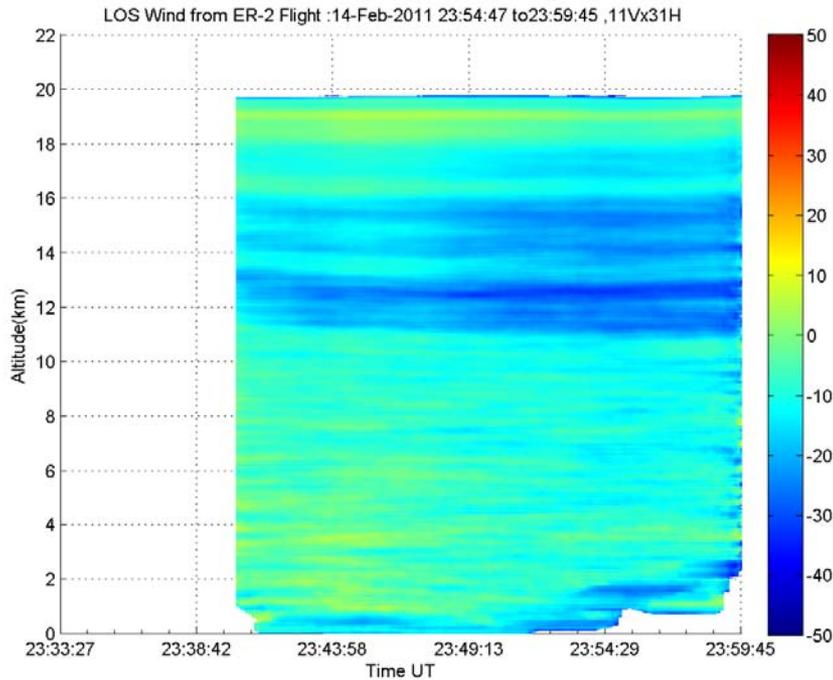
$\Delta t_{\text{avg}}=1$ second, $\Delta R=30$ m, $\Delta z=21$ m





February 14 flight over California Central Valley

$\Delta t_{avg} = 11$ second $\Delta z = 253$ m



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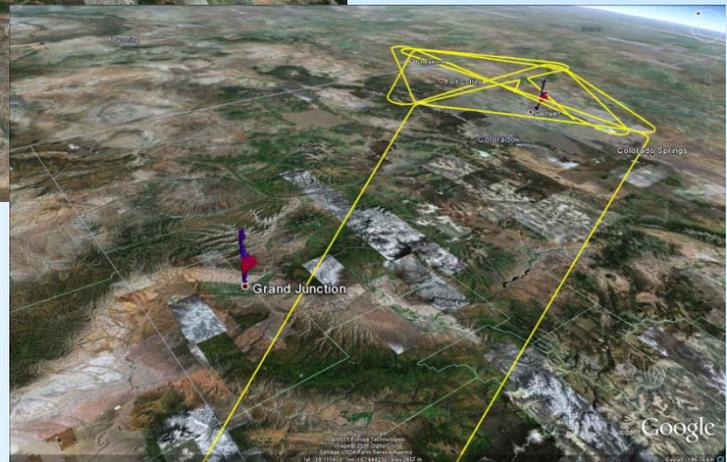
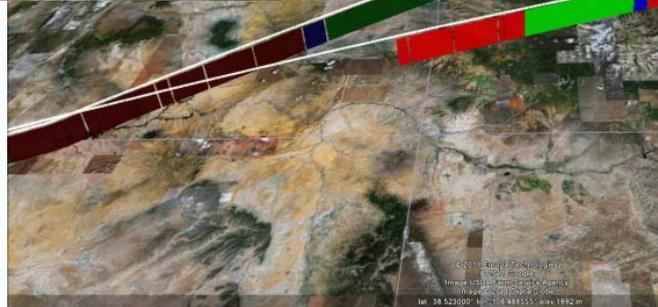
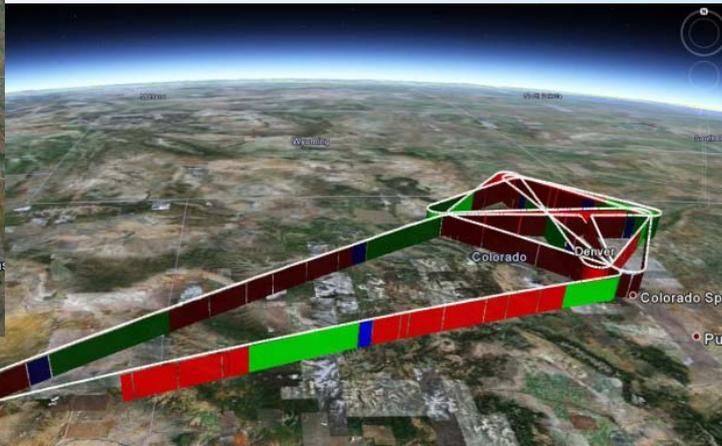
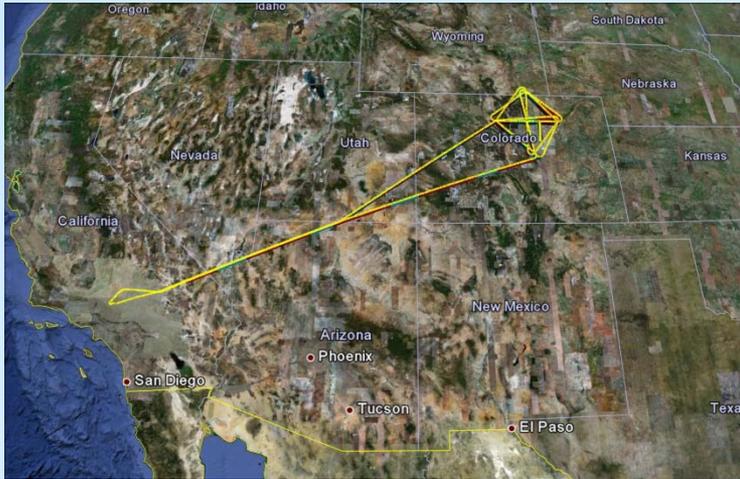


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Earth Science Technology Office



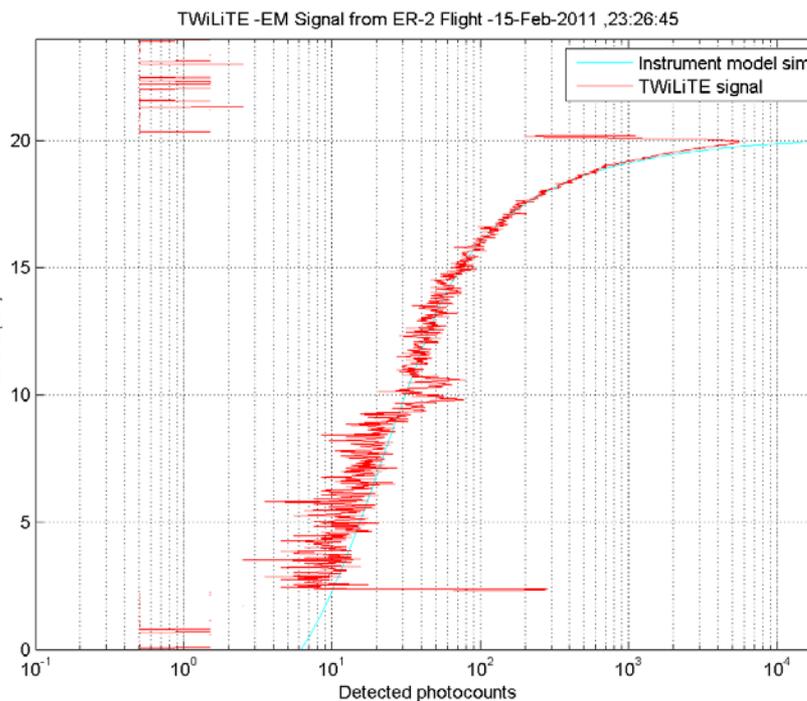
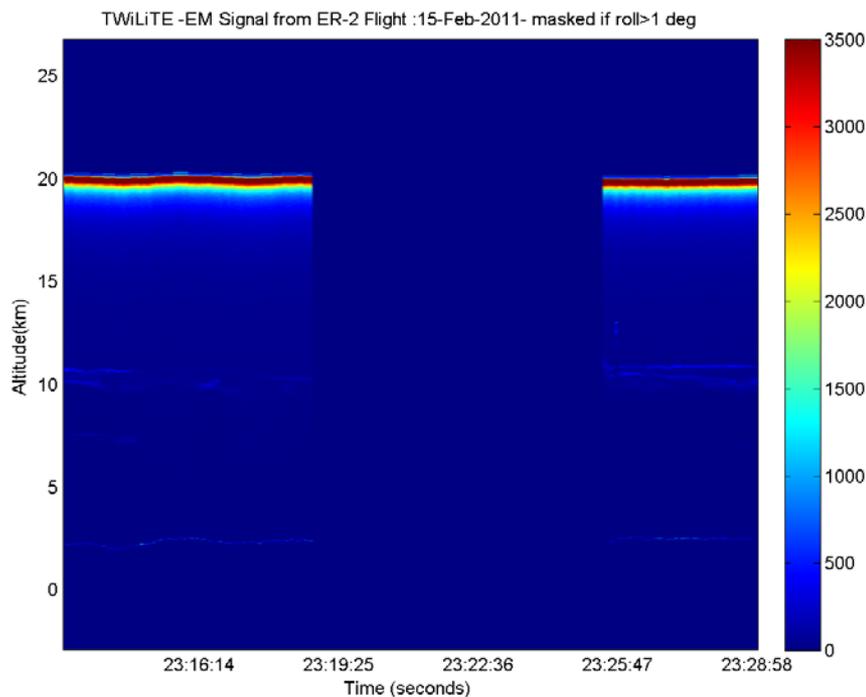
February 15, 2011 flight Palmdale, CA to Denver, CO





February 15, 2011 Flight - Track 28

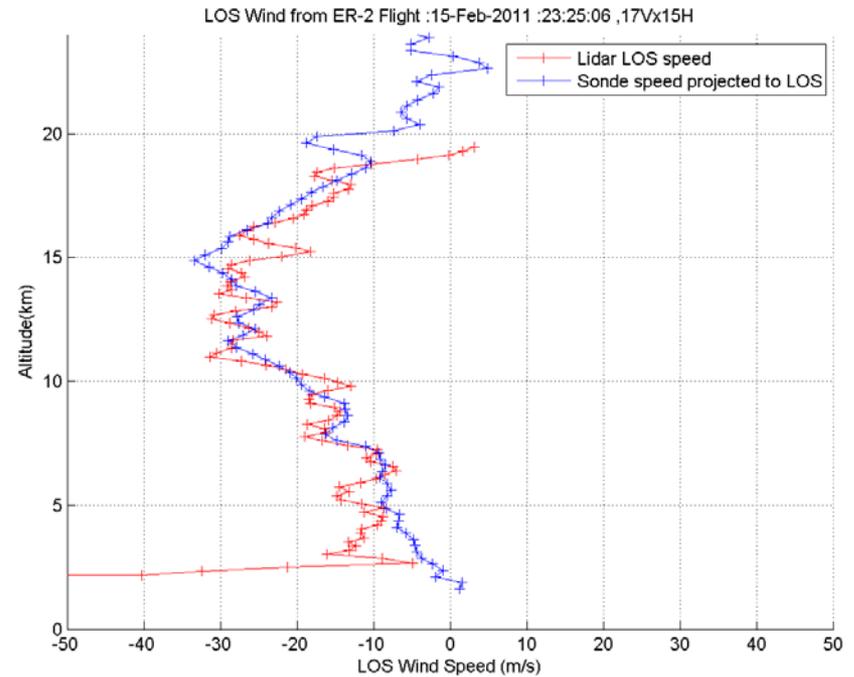
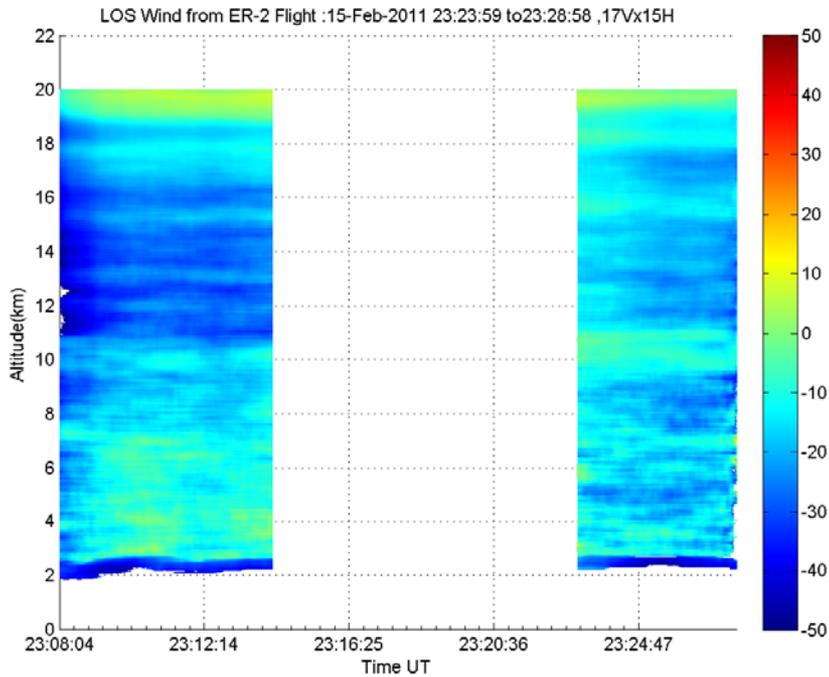
$\Delta t_{avg} = 1$ second, $\Delta R = 30$ m, $\Delta z = 21$ m





February 15, 2011 flight Palmdale, CA to Denver, CO - 28

$\Delta t_{avg} = 11$ seconds, $\Delta z = 253$ m



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TWiLiTE-GH Repackaging

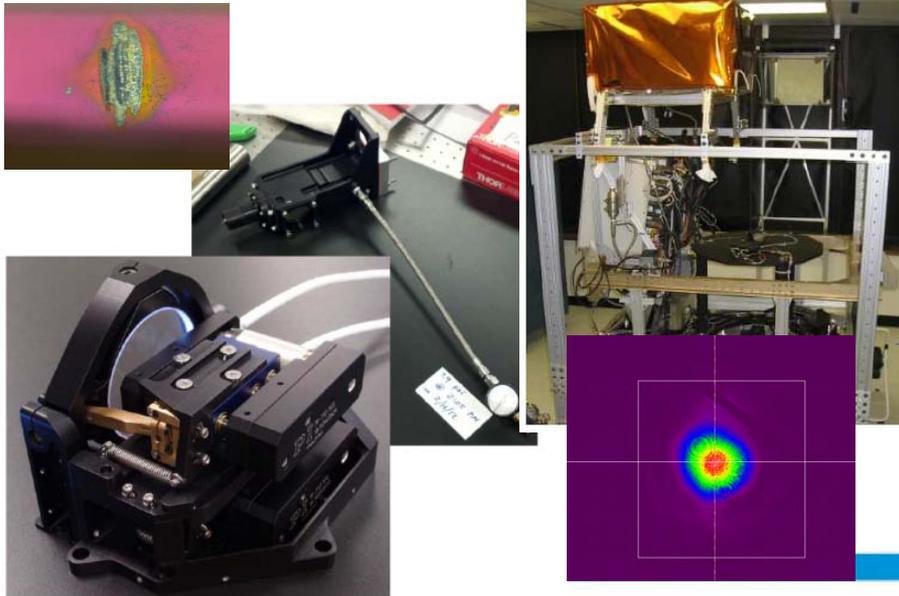


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EXCELLENCE IN AEROSPACE TECHNOLOGY

- The objectives of this effort are to:
 - Reconfigure TWiLiTE to fly onboard the Global Hawk (AV-6) in support of the 2013 HS3 deployment
 - Utilize the AESA 360 zone 25 deep fairing
 - Maintain compatibility with the ER-2
 - Deploy current HOE telescope, maintaining compatibility with new ACT telescope

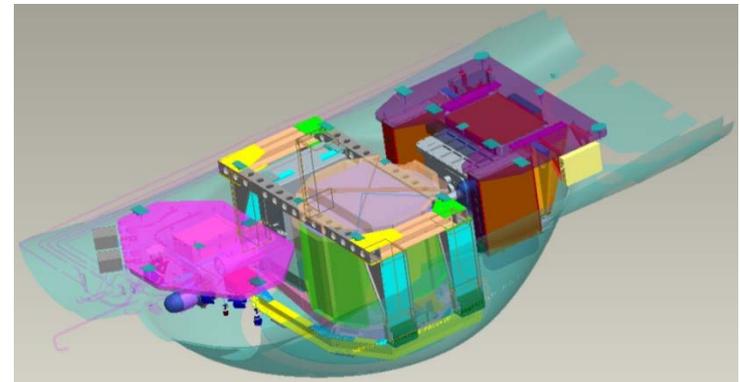
TWiLiTE Mods and Maintenance

- Laser repair by Fibertek completed.
- Beam Expander leak identified; Modifications completed
- Laser/beam expander optical alignment and collimation completed
- New Beam Steering Mirror (BSM) fabricated, assembled and tested.
- Laser, beam expander and new BSM reassembled on TWiLiTE optical bench.
- Modifications to flight electronics boxes completed. Operational testing in progress

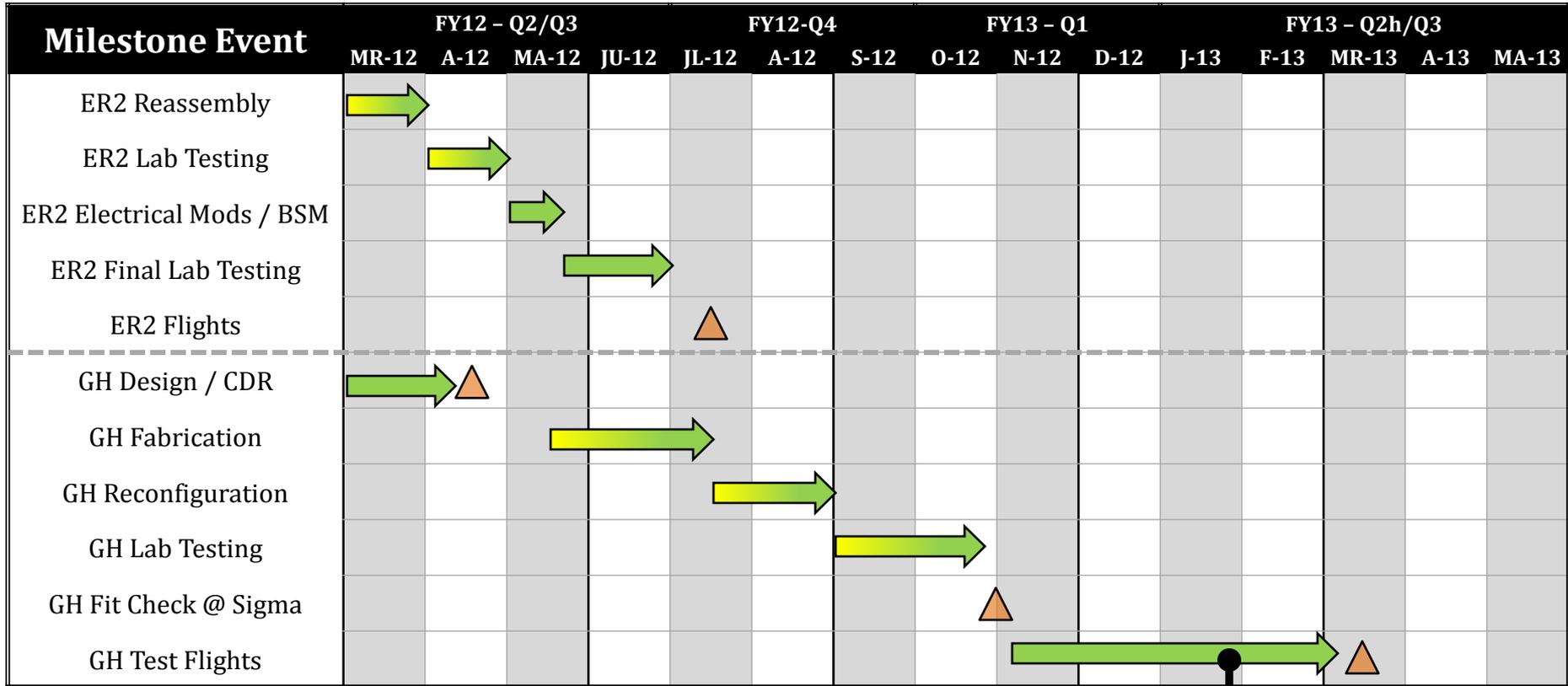


Global Hawk Design

- GH “CDR” schedule moved forward to 4/5/12 due to significant progress
- Solid models for instrument pallets sent to DFRC for fabrication
- Drawing packages for Opt Bench structure, Electrical Pallet, Thermal Loop and GH Window Mount all reviewed and complete. Awaiting final approval (DFRC/NG).
- Battery Back-Up environmental test discussions ongoing with DFRC

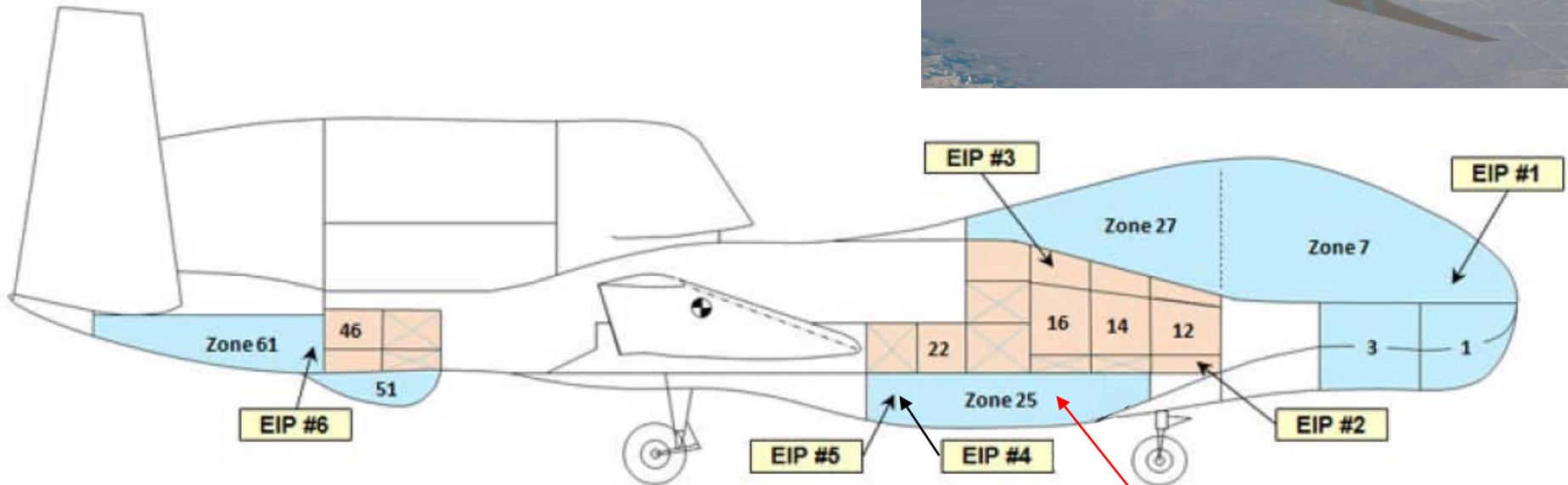


Schedule Overview / Program Milestones



Downtime for instrument testing in lab & final mods / tweaking after GH fit check (Schedule Contingency)

- X / X Event Complete: On Schedule / Late
- / → / → Event Progress: On Schedule / Delayed Start / Behind Schedule
- ▲ Existing Milestone



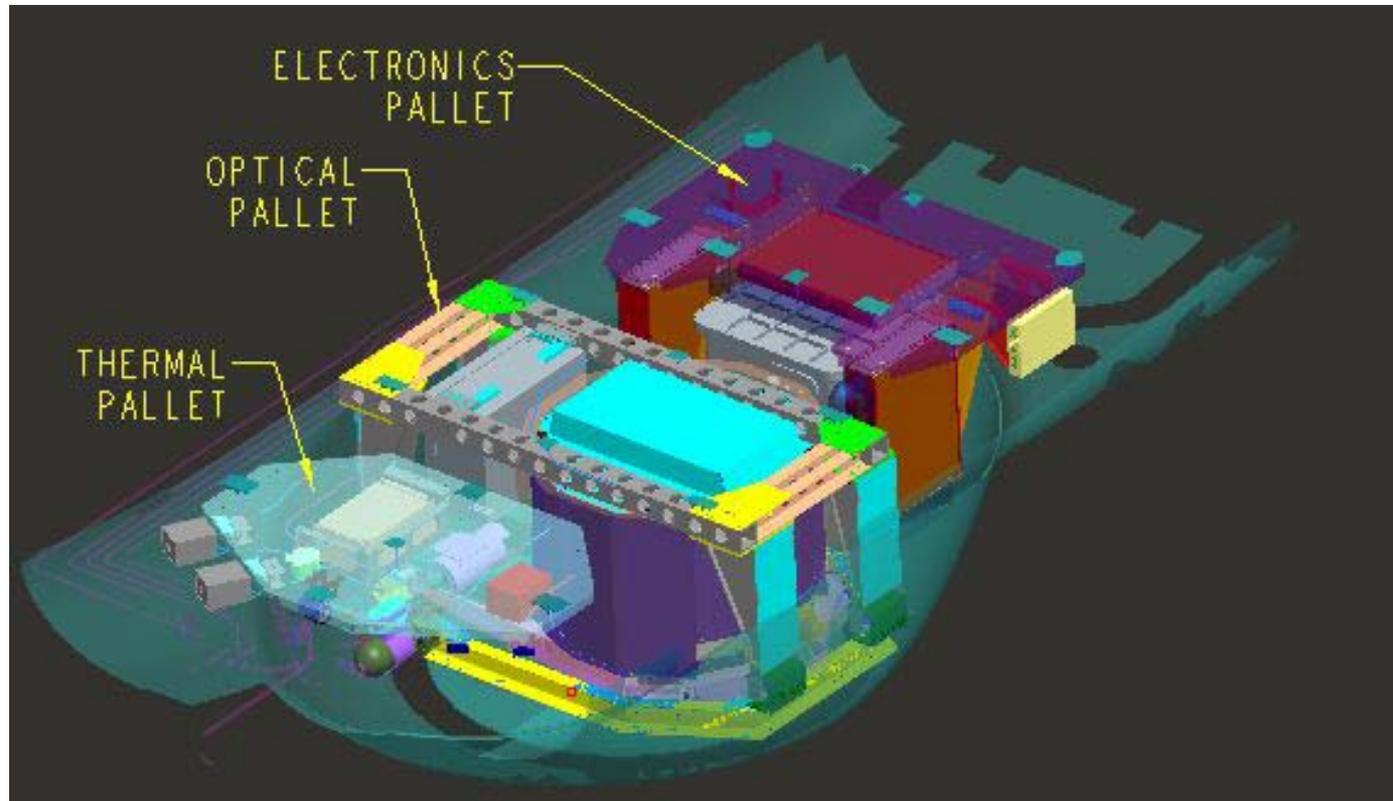
**TWiLiTE mounted
in zone 25**



TWiLiTE-GH Overview



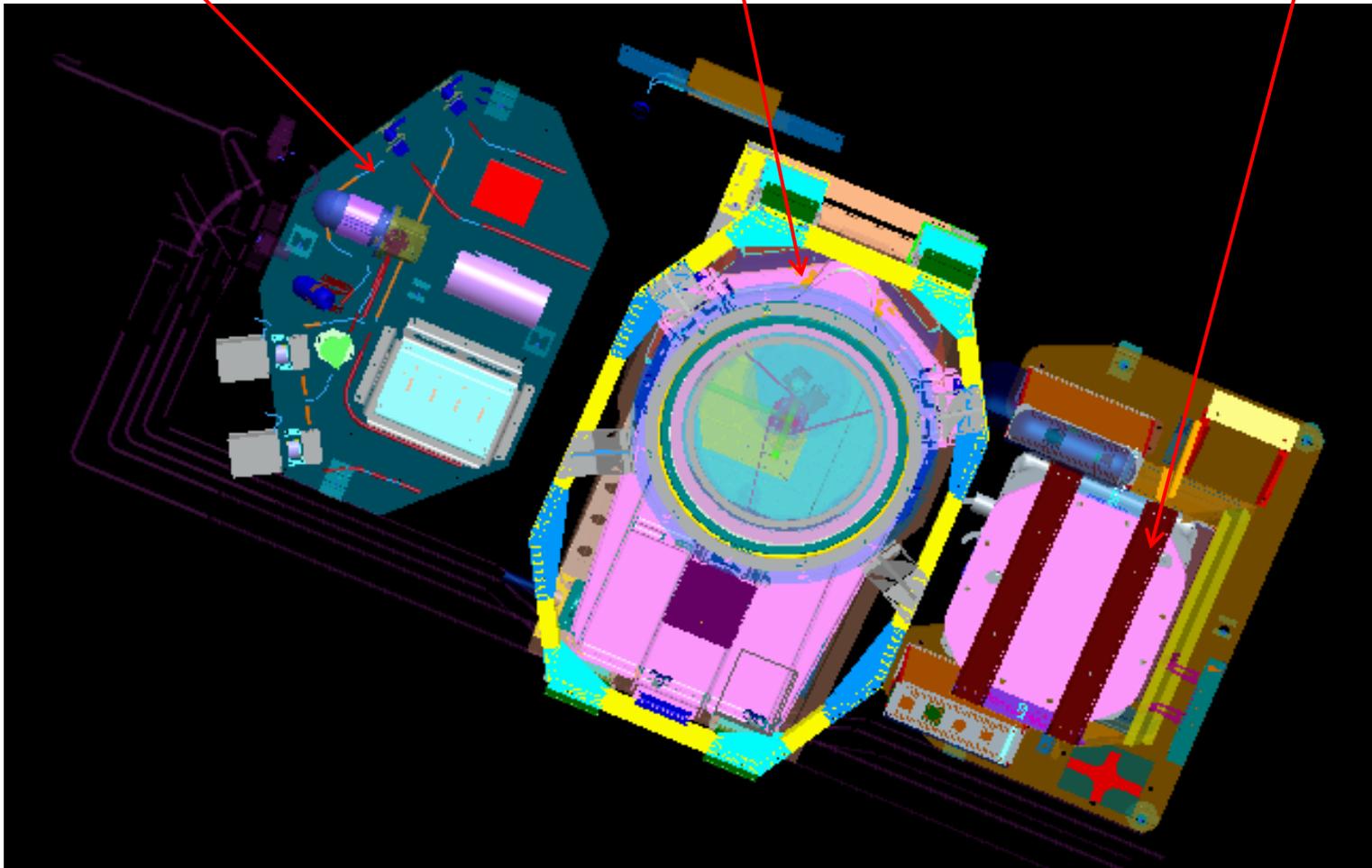
- Instrument mounted on 3 pallets
 - Electronics
 - Optics
 - Thermal



Thermal pallet

Optics pallet

Electronics pallet



Outer dimensions: 41" x 27" x 20"

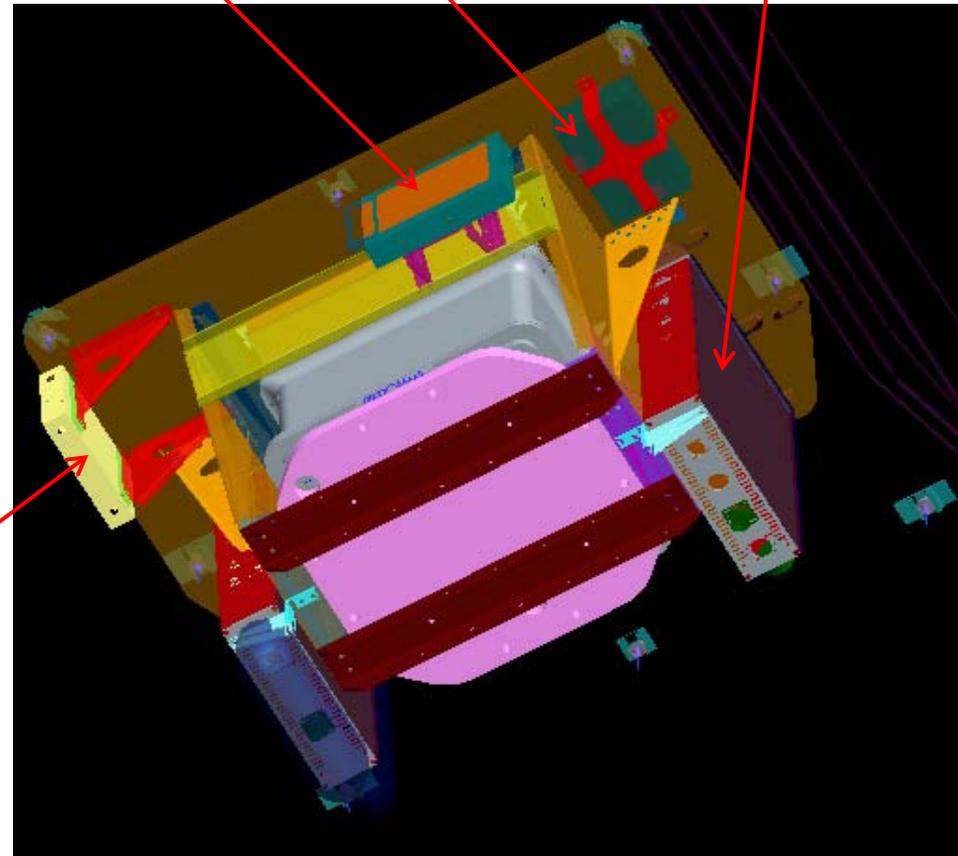
Hard drive

Backup battery

Data, power boxes (3X)

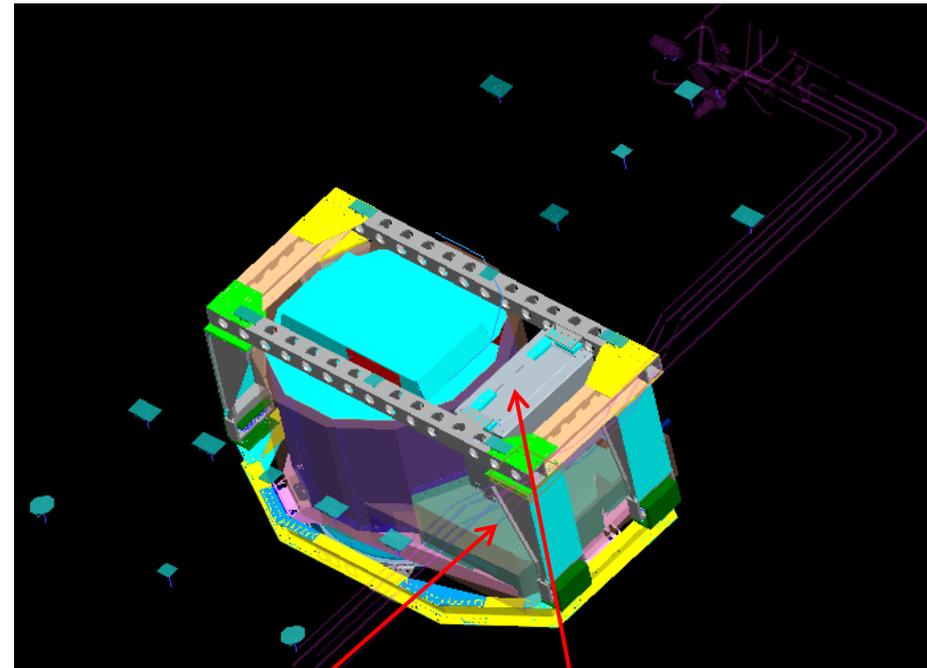
Receiver

Heater block



Optics Pallet

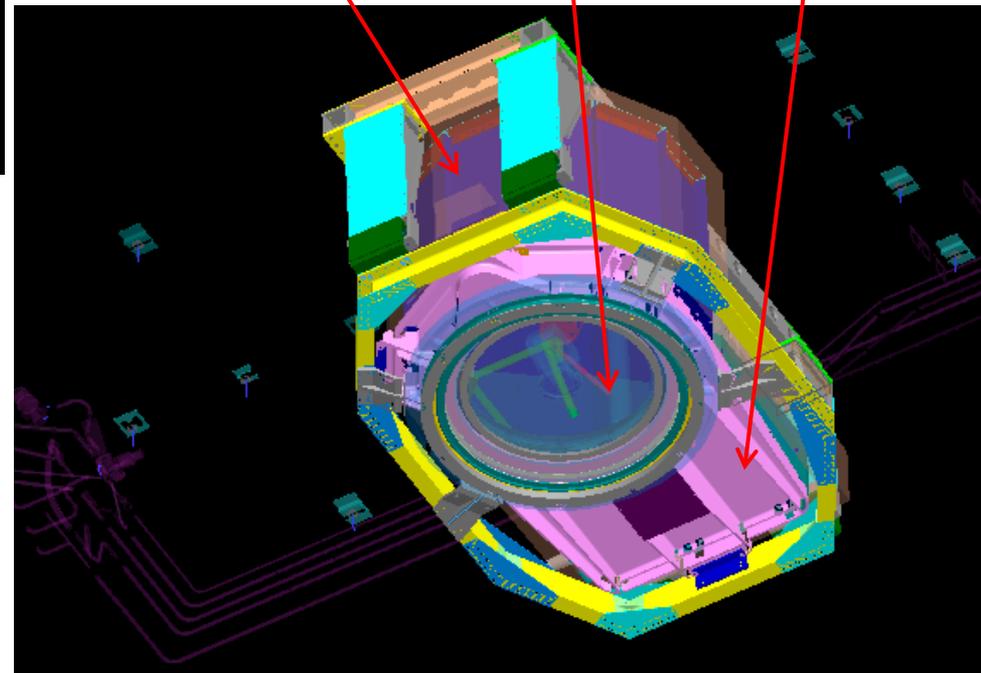
Outer dimensions: 48" x 34" x 28"



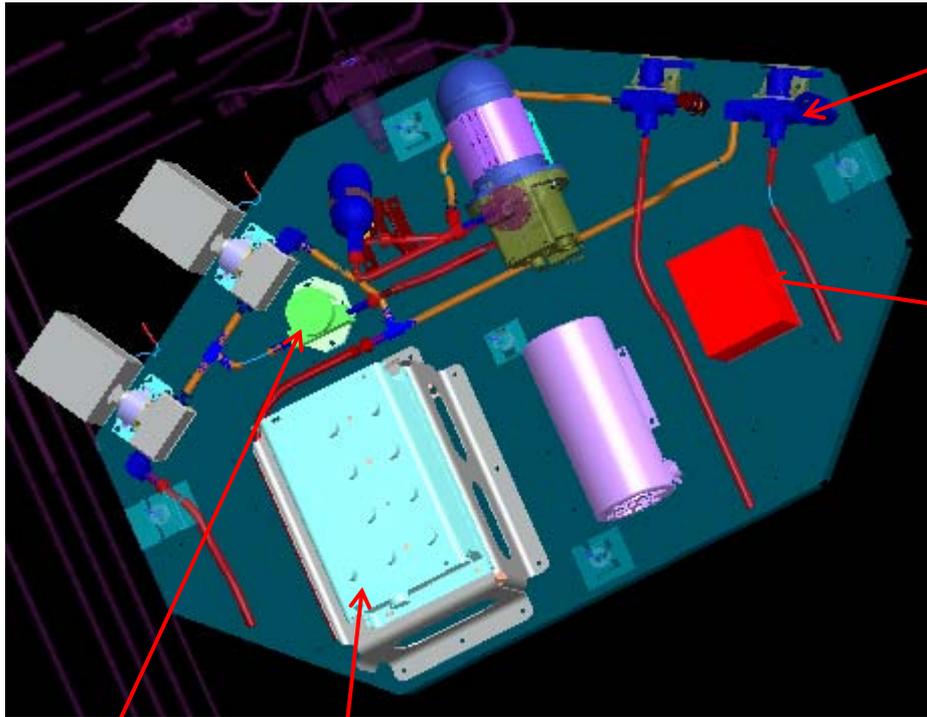
LOM

LEM

Window
HOE telescope Optical bench



Thermal Pallet



GSE valves (2X)

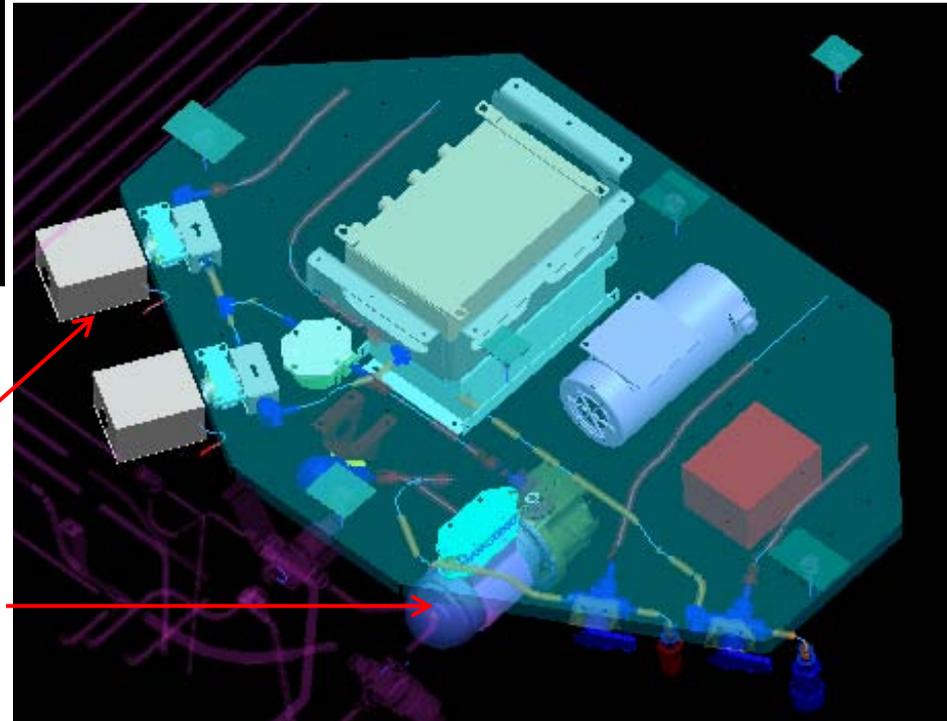
PID enclosure

Flow meter

EIP assembly

Proportional valves (2X)

Pump



Outer dimensions: 40" x 27" x 11"



Status Summary



- April 2012 completed a series of instrument modifications and maintenance activities to improve performance and stability: laser repair; Beam Steering Mechanism replaced; beam expander redesigned.
- Completed design and analysis of layout of TWiLiTE to fit Zone 25 on Global Hawk. Reviewed design with DFRC on April 5, 2012.
 - Awaiting final review by NG before fabricating structure
- Preparing for test flights on ER-2 scheduled July 9-20.
- GH fit check and flight planned for March 2013



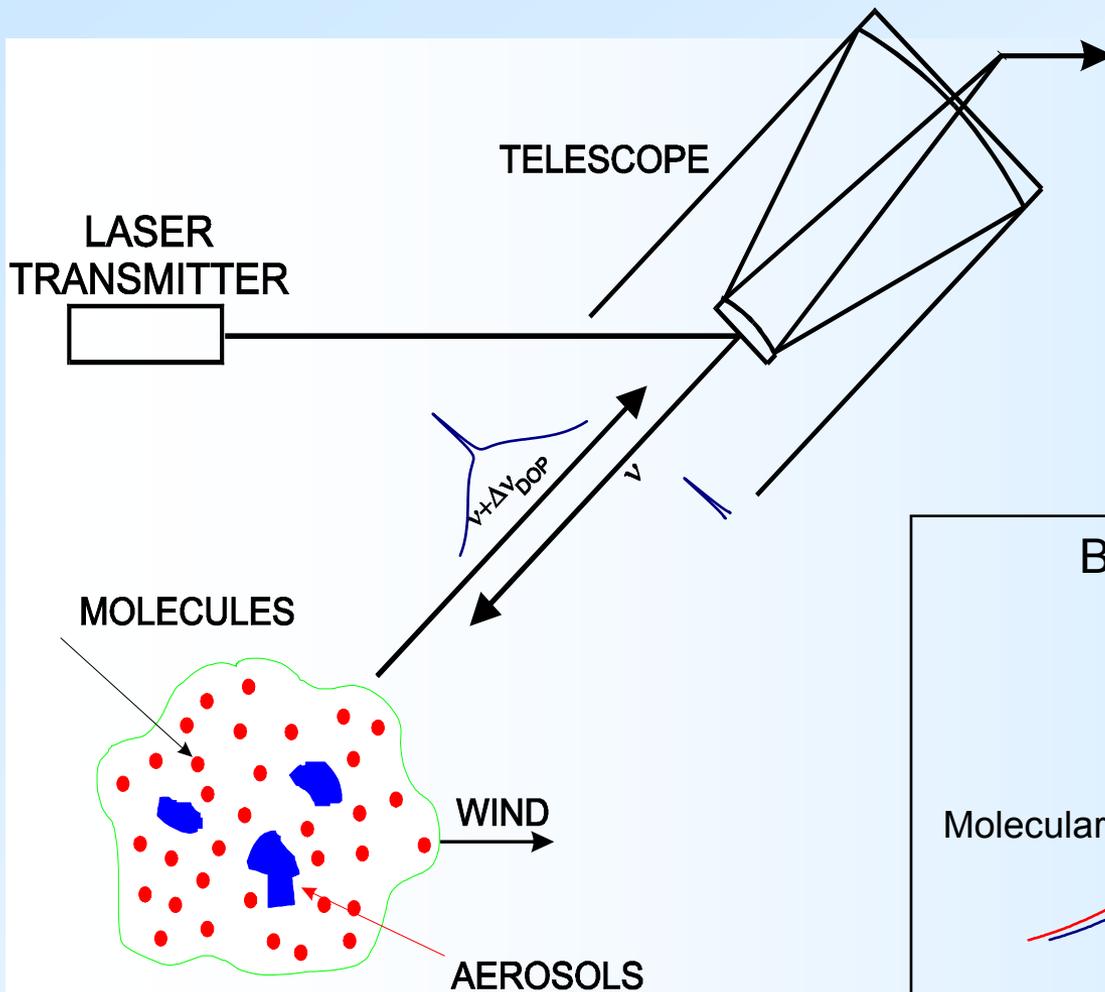


Backups



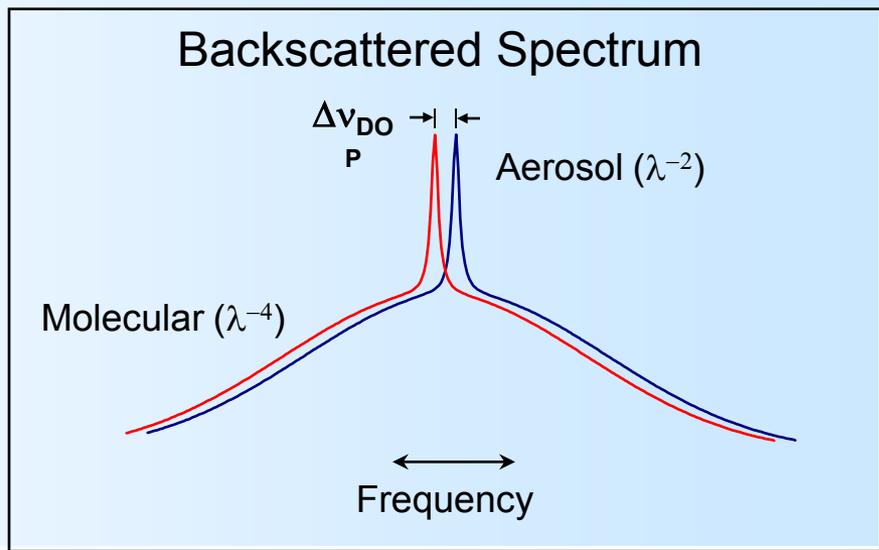


Doppler Lidar Measurement Concept



DOPPLER RECEIVER -
Multiple flavors dependent on scattering target -

- Aerosol return gives high accuracy and high spatial and temporal resolution **when aerosols present**
- Molecular return gives lower accuracy and resolution but **signal is always there**





TWiLiTE Instrument Parameters



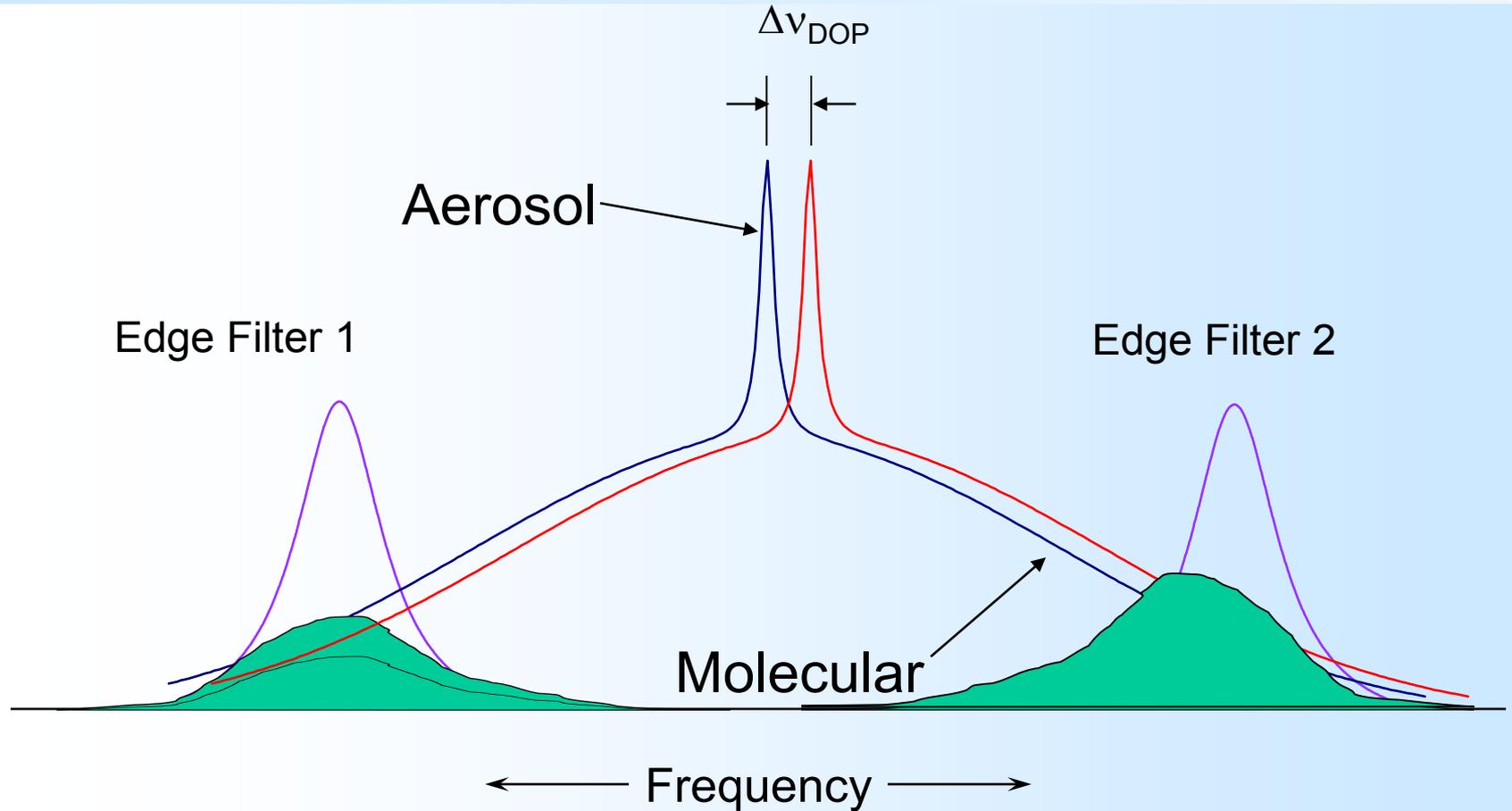
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Etalon FSR	16.65 GHz
Etalon FWHH	2.84 GHz
Edge Channel Separation	6.64 GHz
Locking Channel Separation	4.74 GHz
Interference filter BW (FWHH)	120 pm
PMT Quantum Efficiency	25%





Double Edge Measurement Principle

Molecular Channel at 355 nm

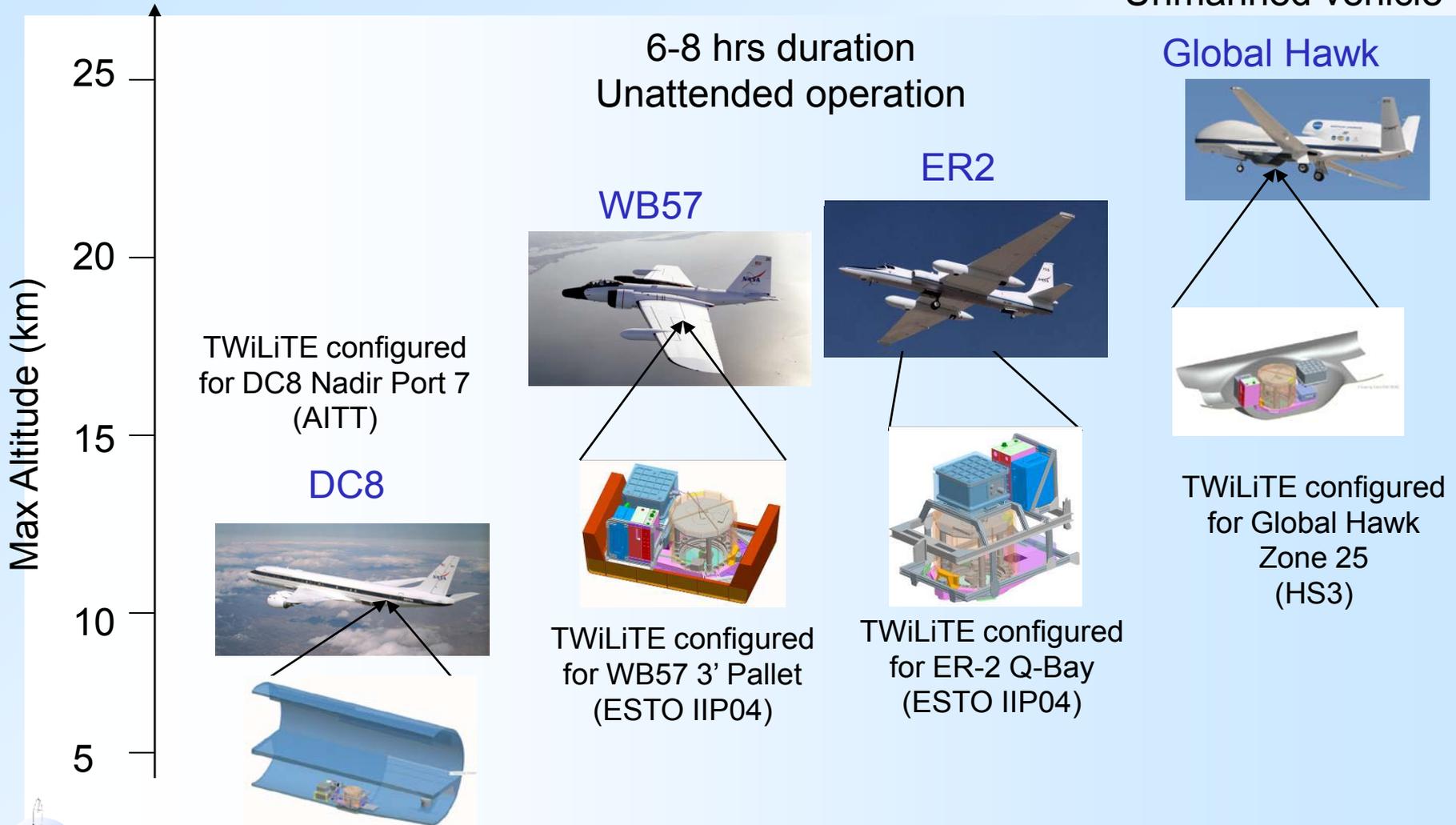




TWiLiTE Compatible NASA Airborne Science Platforms

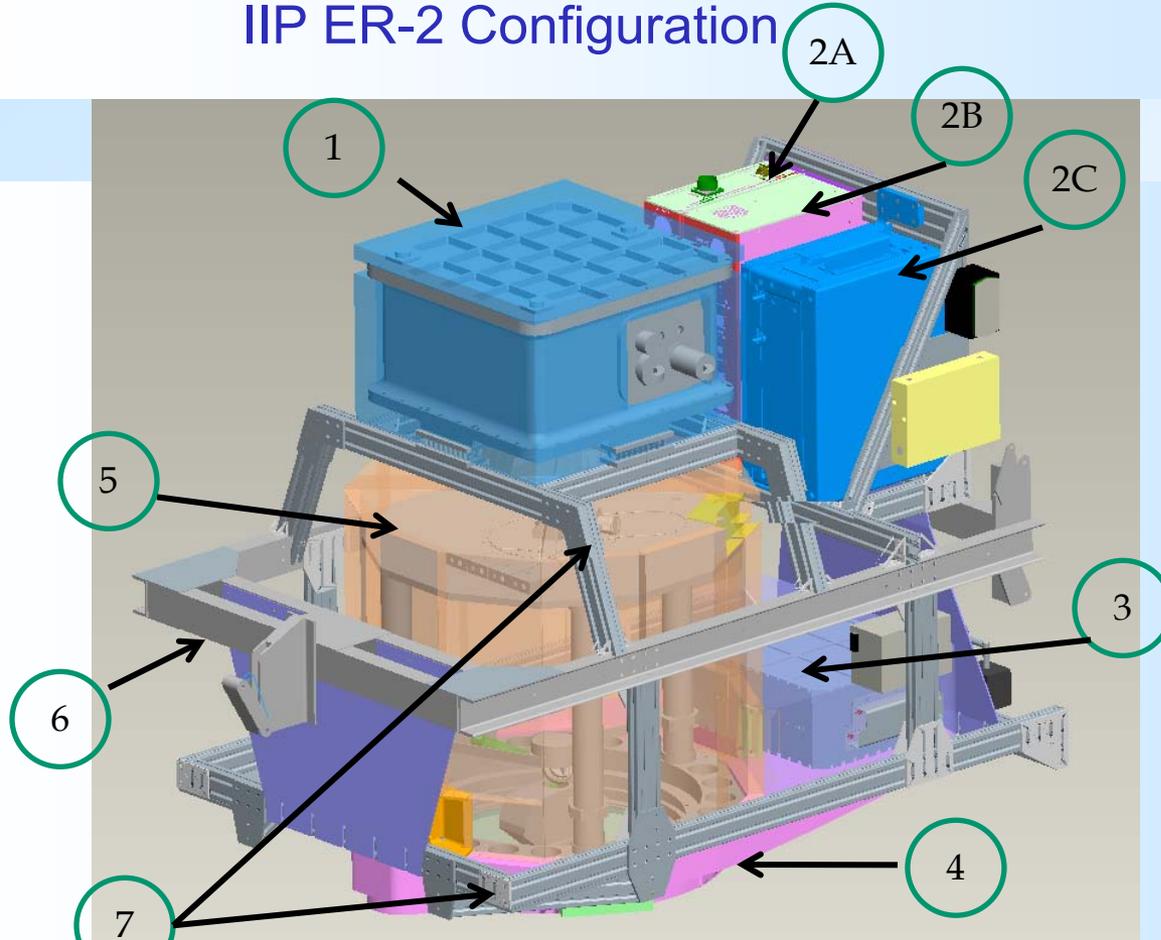


36 hrs duration
Unmanned vehicle





TWiLiTE Modular Assembly- IIP ER-2 Configuration



1. Doppler receiver (Notes: insulated pressurized box; vibration isolated from frame; on liquid cooling loop; weighs about 100 lbs)
2. A) Data system electronic box; B) power distribution box; C) laser electronics module (LEM)
3. Laser Optical Module (LOM) (Notes: insulated pressurized box; on liquid cooling loop; 3 pt titanium flex mounts to opt bench)
4. Optical Bench
5. HOE telescope
6. ER-2 Qbay instrument pallet (mechanical interface defined by aircraft.)
7. 80-20 structure (modular framework can be easily redesigned for different aircraft)





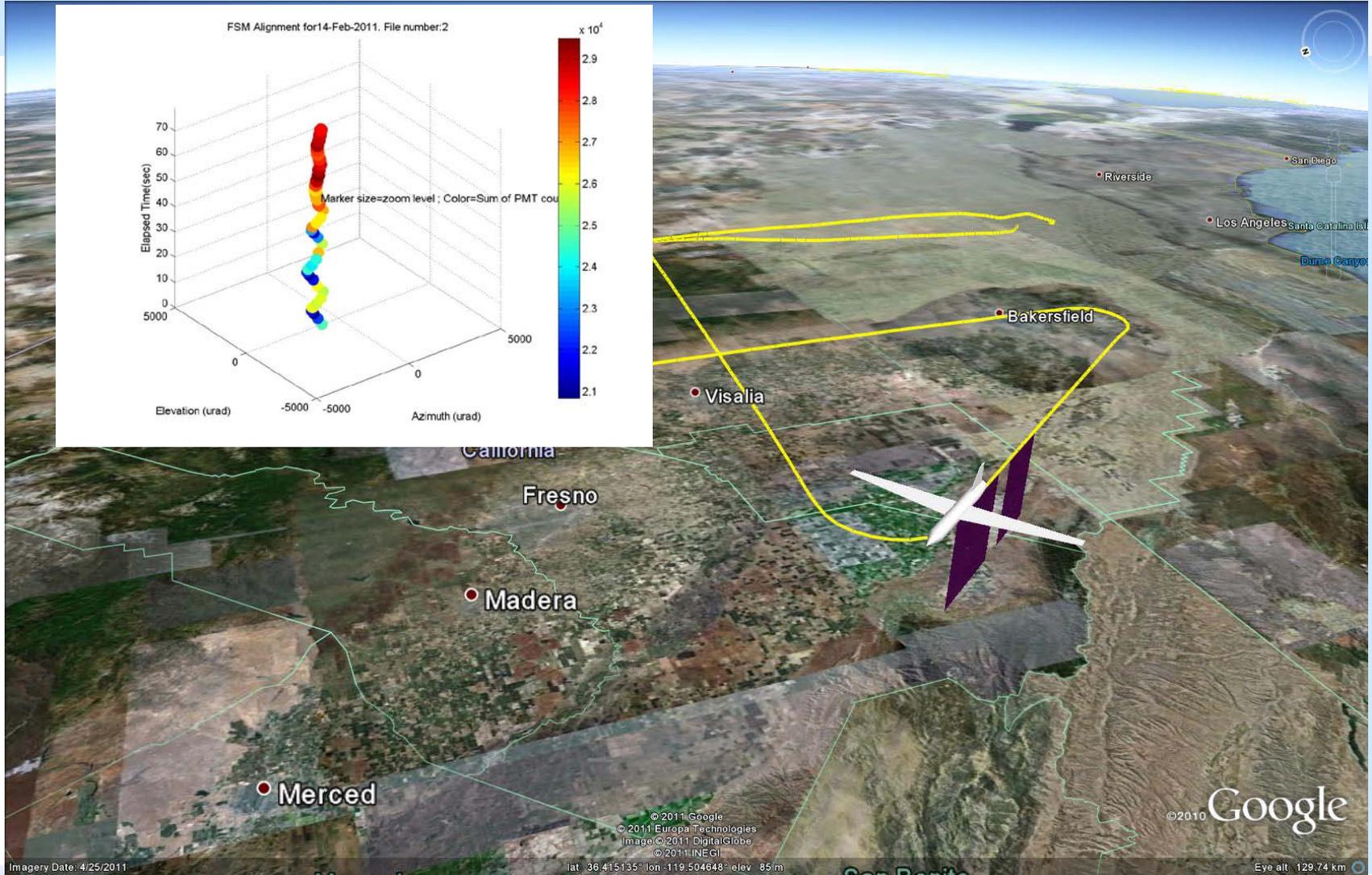
ER-2 Engineering Flights October, 2009 & February, 2011





TWiLiTE Flight Test Modes

Fast Steering Mirror Alignment



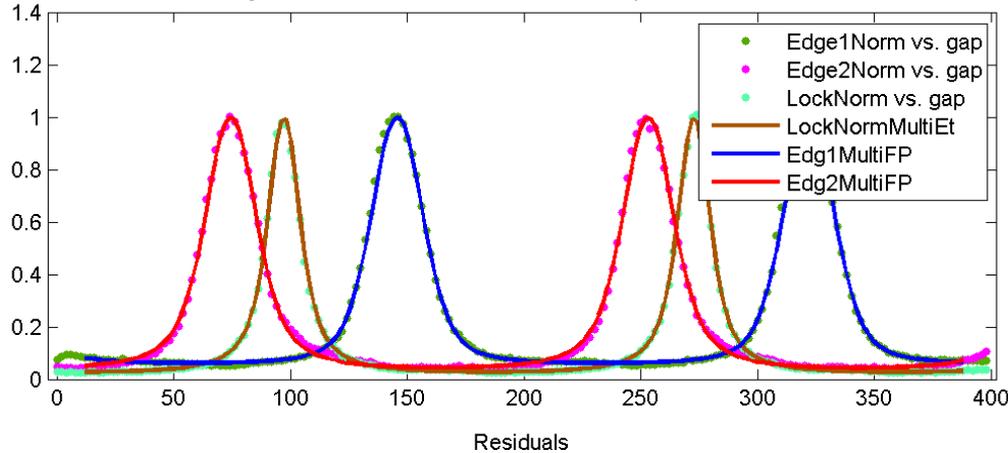


TWiLiTE Flight Test Modes

Etalon Calibration



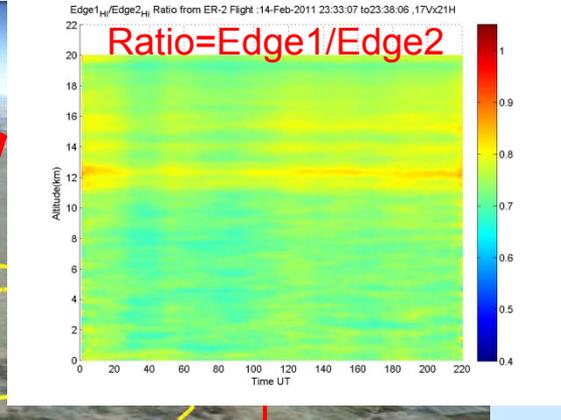
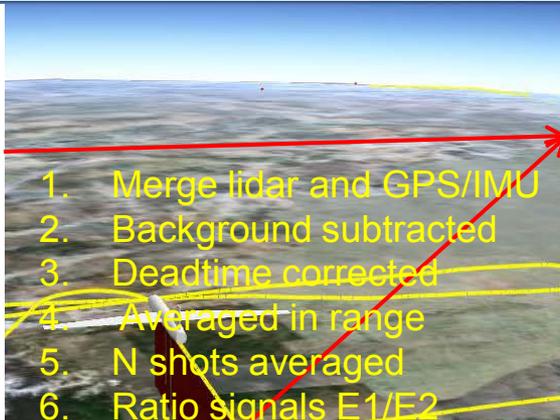
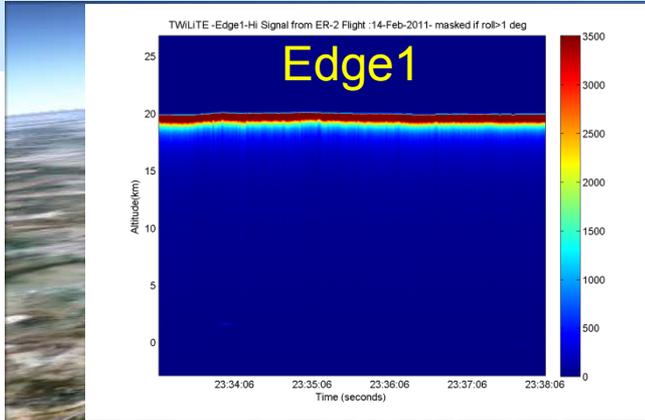
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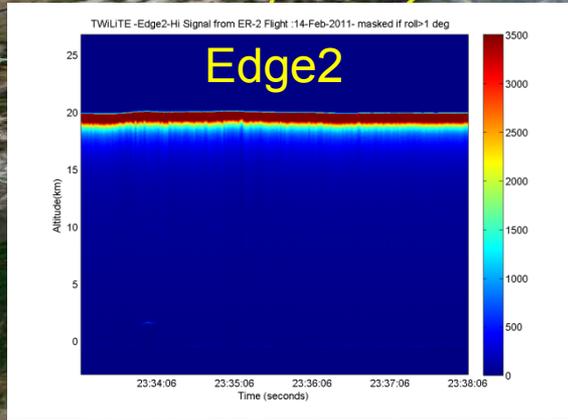


TWiLiTE Flight Test Modes

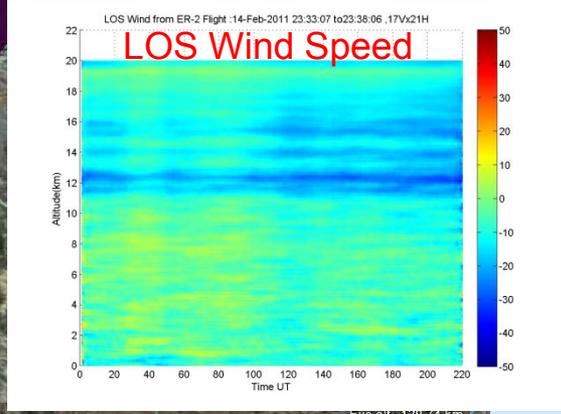
Science Data Acquisition



1. Merge lidar and GPS/IMU
2. Background subtracted
3. Deadtime corrected
4. Averaged in range
5. N shots averaged
6. Ratio signals E1/E2



1. Utilize etalon scan with simulated Rayleigh Brillouin spectral lineshape to generate calibration curve .
2. Calculate LOS wind speed
3. Apply correction for aircraft motion*



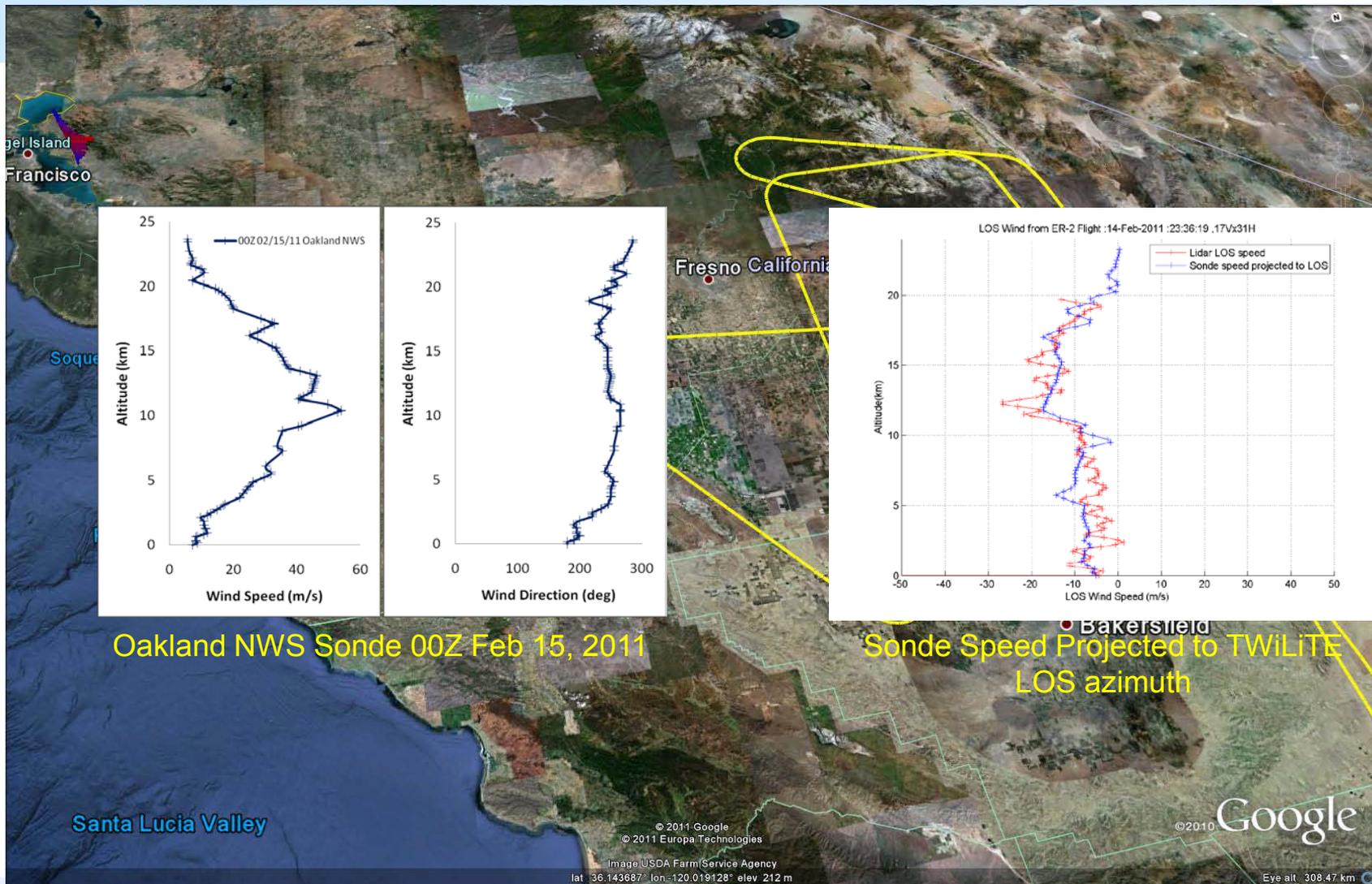
Imagery Date: 4/25/2011

© 2011 Google
 © 2011 Europa Technologies
 Image © 2011 DigitalGlobe
 © 2011 INEGI
 lat 36.415135° lon -119.504648° elev 85 m

Eye alt 129.74 km



Feb 14, 2011 ER-2 Flight Track- Oakland NWS sonde comparison



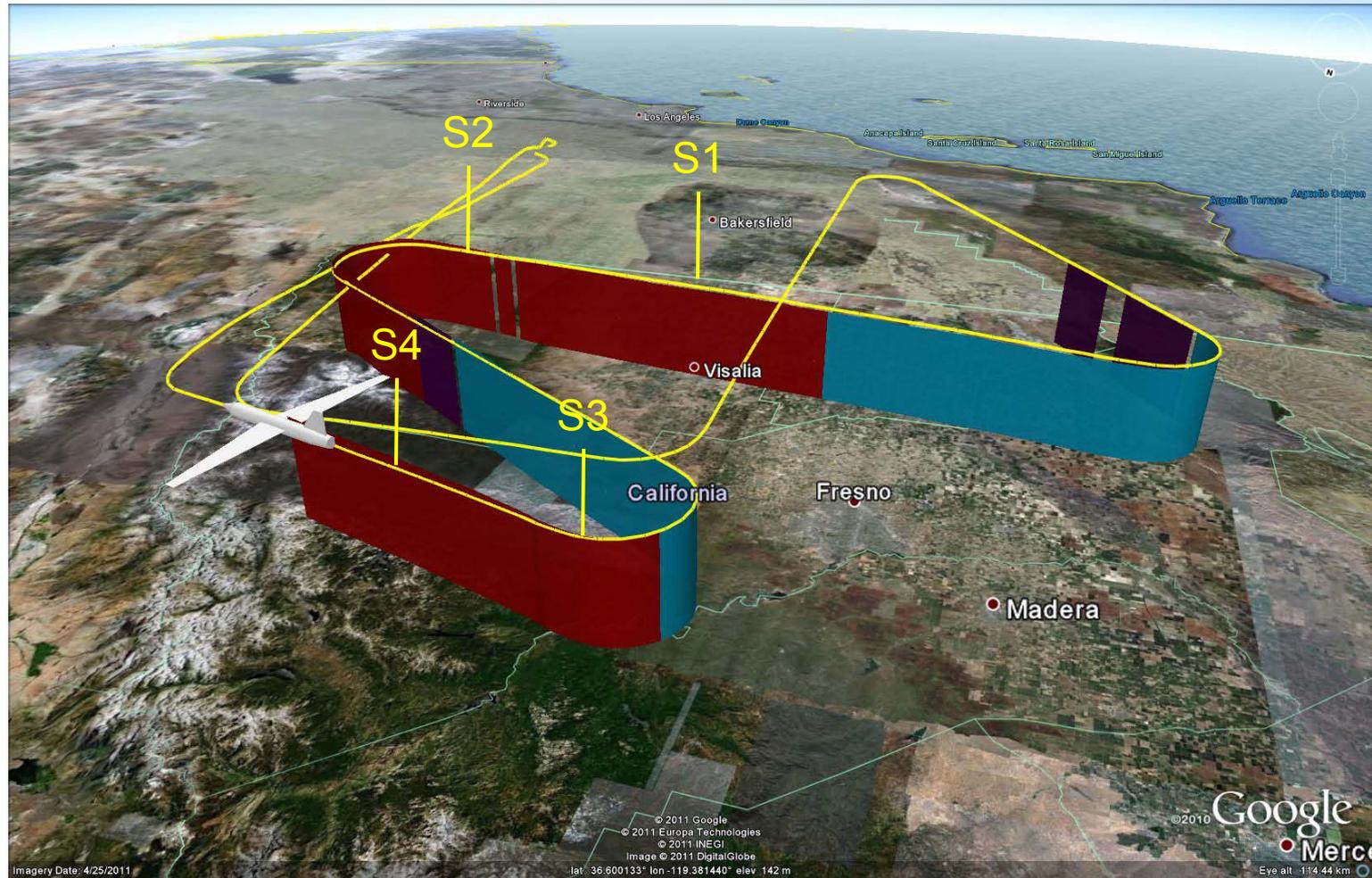
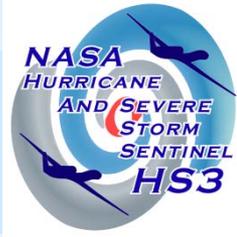
Oakland NWS Sonde 00Z Feb 15, 2011

Sonde Speed Projected to TWILITE
LOS azimuth





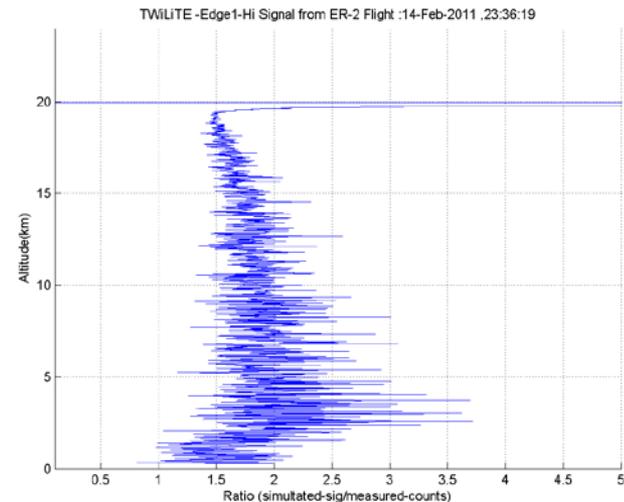
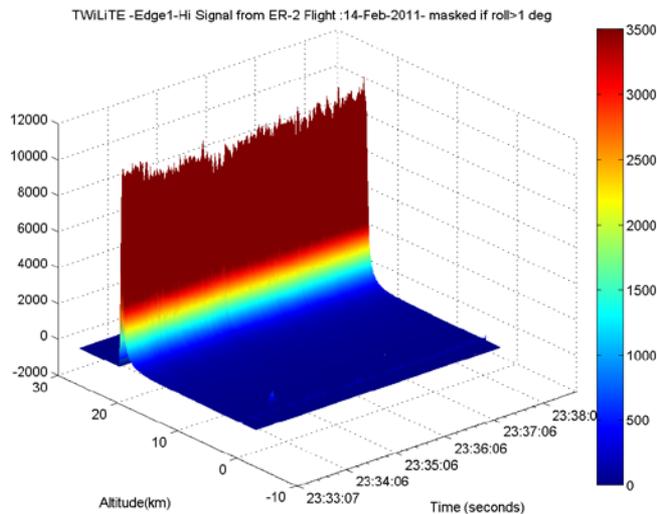
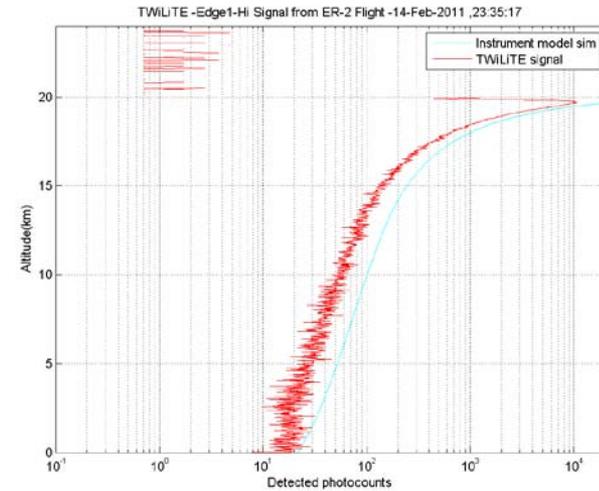
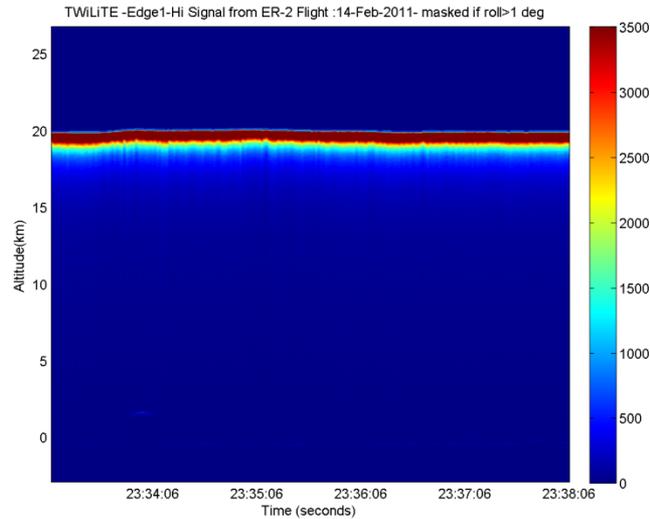
Feb 14, 2011 ER-2 Flight Track





February 14 flight over California Central Valley-Track S1

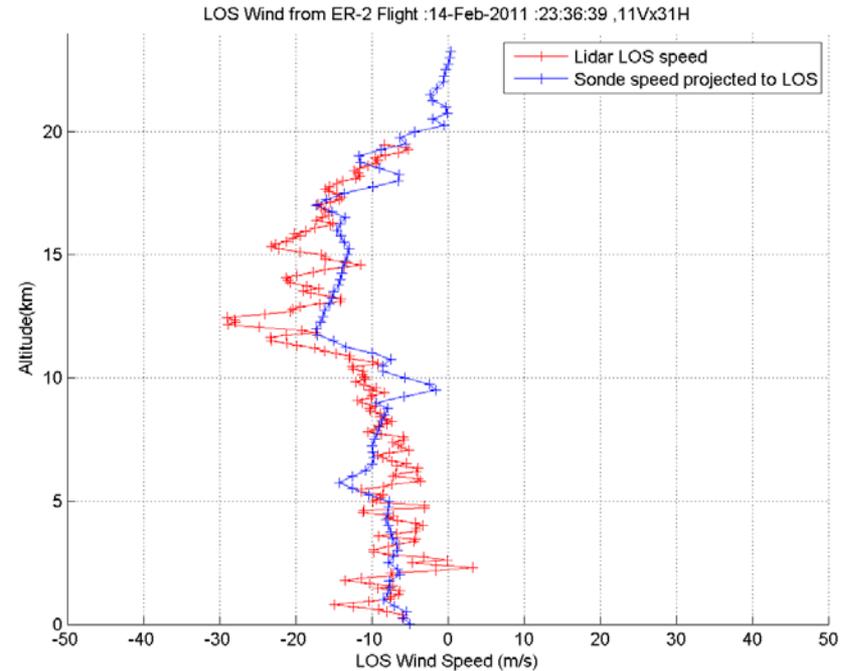
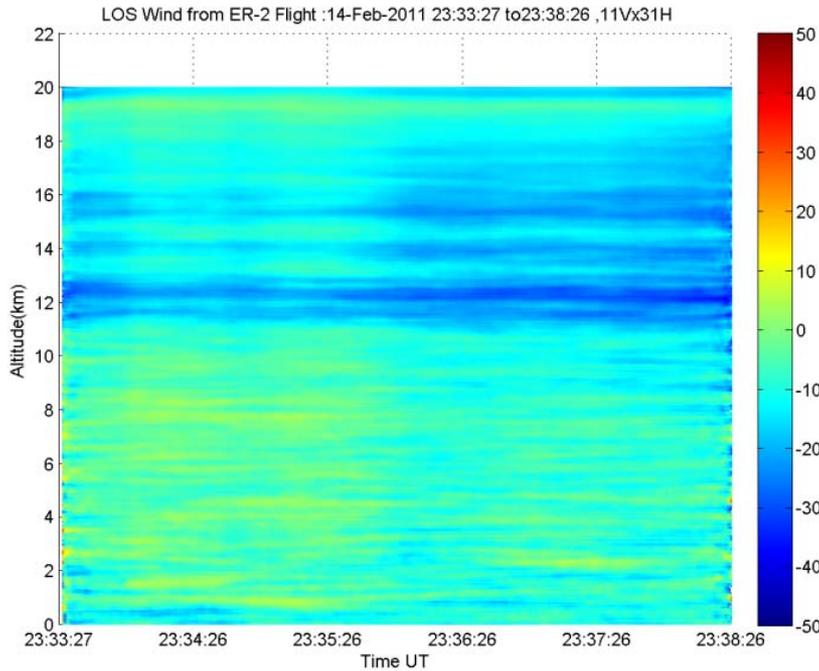
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February 14 flight over California Central Valley

$\Delta t_{\text{avg}}=11$ second, $\Delta z=253$ m



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