2014

Accelerometer measurements to characterize drag profiles in the mesosphere

B. Burkholder

G. Lehmacher

CI Project #837

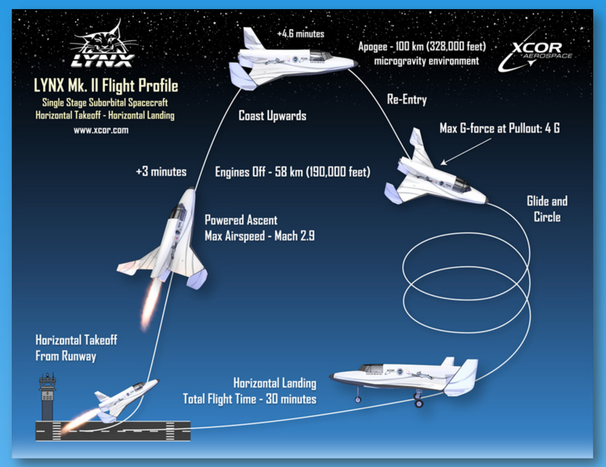
Accelerometer Measurements to Characterize Drag Profiles in the Mesosphere

Join us in Fall 2014

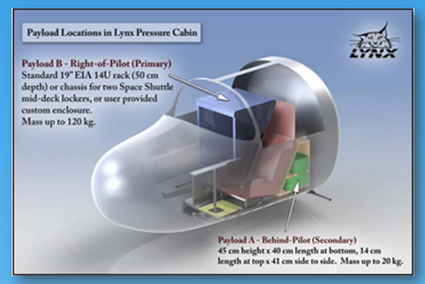
Brandon Burkholder, Herbert Behlow, & Dr. Gerald Lehmacher
Department of Physics and Astronomy, Clemson University
Contact: bburkho@g.clemson.edu

Project Goal: To assemble a CubeSat payload for launch aboard a suborbital vehicle which provides accelerometer data during the free-fall portion of the flight. This data can then be used to model the atmosphere as well as how drag profiles on a vehicle falling in the mesosphere effect reentry.

XCOR Lynx



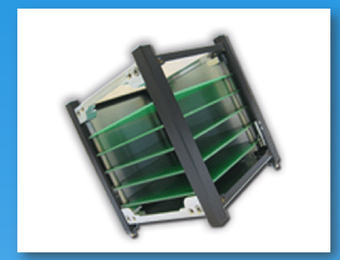
The XCOR Lynx reusable suborbital space plane is ideal for this experiment because of the low cost per flight. It can be flown up to 4 times in a single day bringing payloads to 100 km above Earth's surface. It is our goal to fly this payload on the Lynx.



Internal payload bays of the Lynx are designed to carry CubeSats

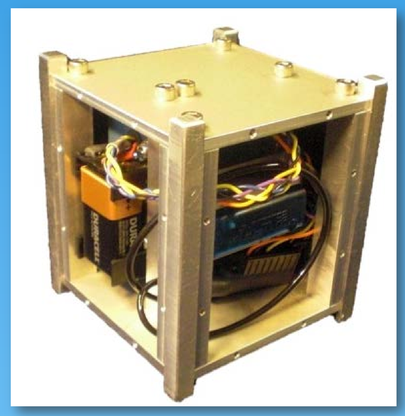
Design & Apparatus

Data Logger MSR 160
- 1000 Hz sampling rate
- 12 bit resolution
- 4 input channels
- Remote start ability



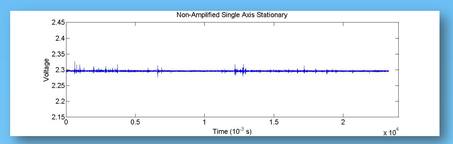
The full set up shows the data logger mounted atop a housing for the accelerometer and associated circuitry. We have tested 3-axis MEMS accelerometers from Kionix and STM. Power is supplied to the accelerometer via a 9 V battery while an internal battery powers the logger. This current proof of concept can easily be scaled down in size and weight for optimized launch simplicity.

The CubeSat: Ideal platform for simple, compact science instruments. Can be built and launched at a low cost. Standard size and weight allows for payloads of many CubeSats which can all be deployed in the same manner.

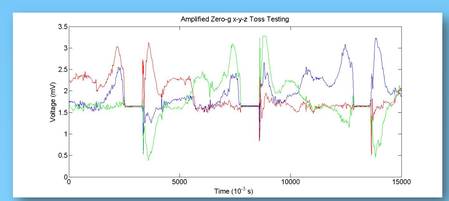


Data & Testing

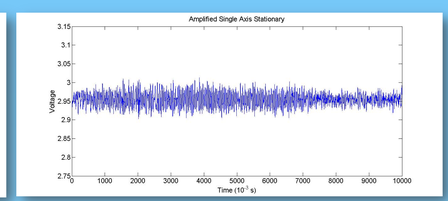
(A) : Non-amplified, the device simply sits on the table and records
(B) : Amplified, the device sits on the table and records
(C) : Noise spectra from .5 seconds of data in zero-g & while at rest
(D) : Non-amplified, the device is tossed in the air with each axis parallel to the ground once to achieve short periods of zero-g
(E) : Amplified, the same zero-g test is applied



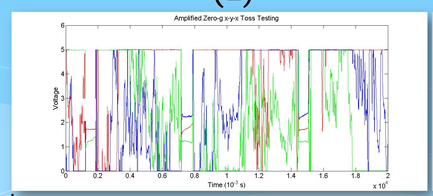
(A)



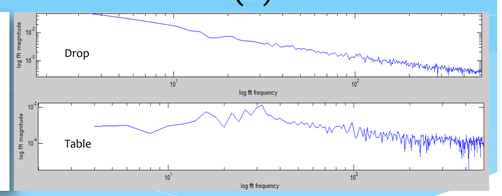
(E)



(B)

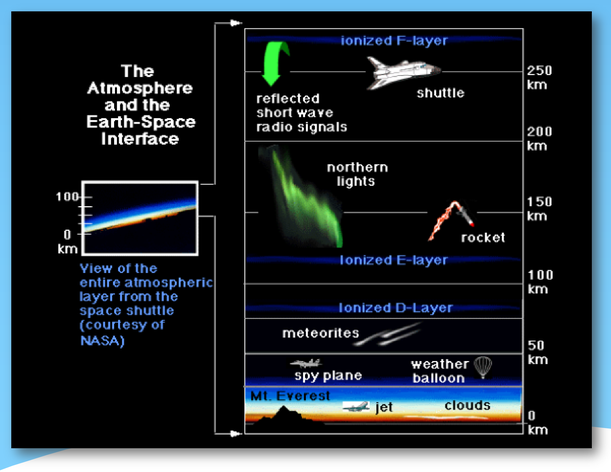


(D)

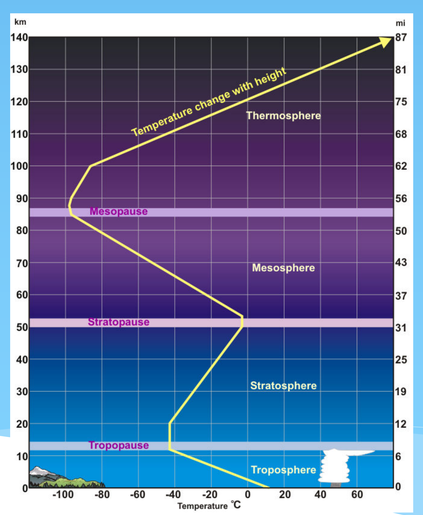


(C)

The Mesosphere



The mesosphere lies in the region between 50-100 km above the Earth's surface. Studying the dynamics of this region is difficult due to its inaccessibility. The information provided by this simple device can be used to extrapolate the density, temperature, and wind structure of the atmosphere in this region.



CLEMSON UNDERGRADUATE RESEARCH

Conclusions: With our current prototype, we have been able to understand the voltage outputs that the accelerometer gives in a variety of different situations and characterize the noise present in the set up. We now look to improve upon the design by decreasing the size and weight and eventually fly the device on a suborbital vehicle. We also will try to use data to calculate how drag affects our design and compare this to models so that eventual flight data can be best utilized.

Acknowledgements: Materials and labor supported by NASA Low Cost Access to Space Program Project NNX13AE26G

Resources: www.xcor.com, Payload User Guide
www.kionix.com, Noise Measurements
flightopportunities.nasa.gov, www.citizensinspace.org