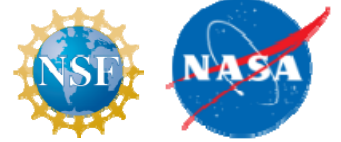




**30<sup>TH</sup> ANNUAL SMALL  
SATELLITE CONFERENCE**



**ELFIN**  
**Electron Losses and Fields  
Investigation**

Lydia Bingley, Project Manager  
Vassilis Angelopoulos, Principal Investigator  
Ryan Caron, Chief Engineer

August 07, 2016  
Logan, Utah



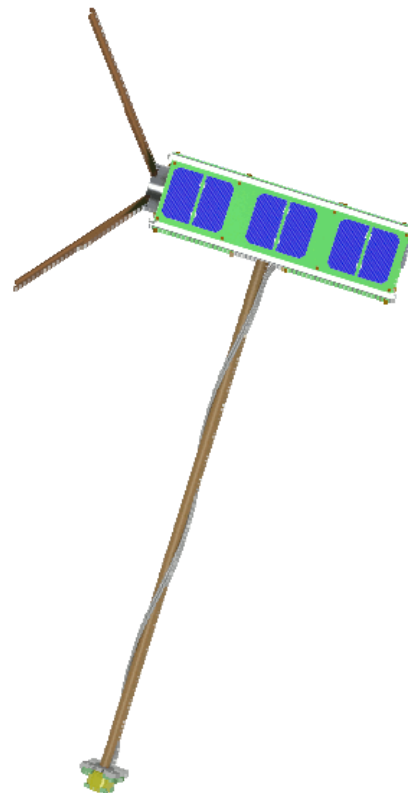
**Introduction**

**Science Mission**

**Primary Payload**

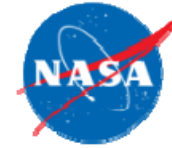
**Additional Instruments**

**Summary**





# INTRODUCTION



What is ELFIN?

3U+ CubeSat

Space Weather Mission

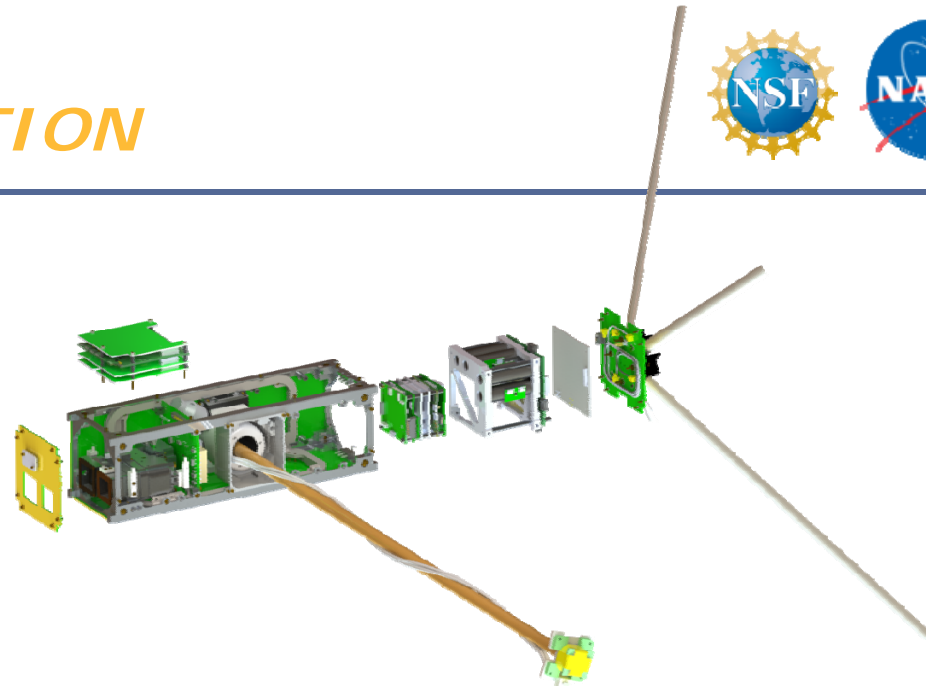
Developed at UCLA in  
collaboration with the

Aerospace Corporation

Sponsored jointly by  
NASA/NSF

Team of UCLA staff and  
students from all  
disciplines

Builds upon experience  
from past space weather  
missions (ELFIN-L,  
THEMIS)





## SCIENCE MISSION



**Problem:** Space weather is not well understood and current models lack accurate storm prediction.

**Goal:** Increase understanding of relativistic electron loss from the radiation belts to the Earth's atmosphere.

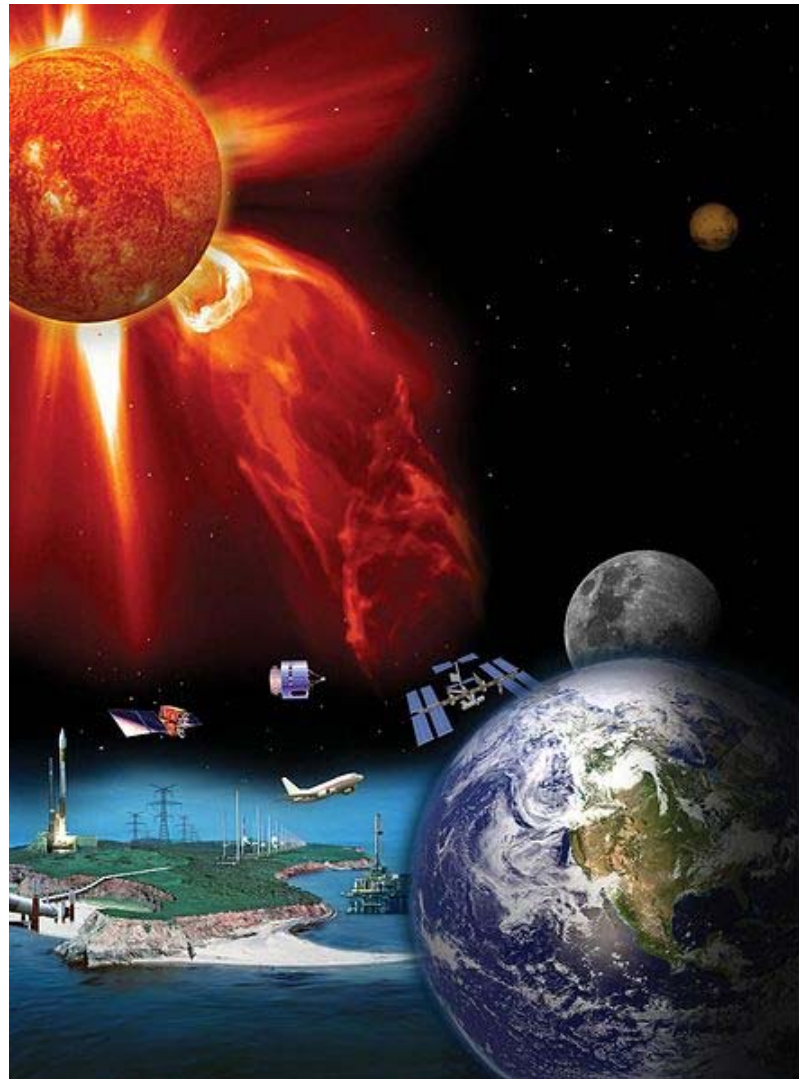
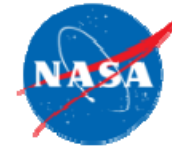


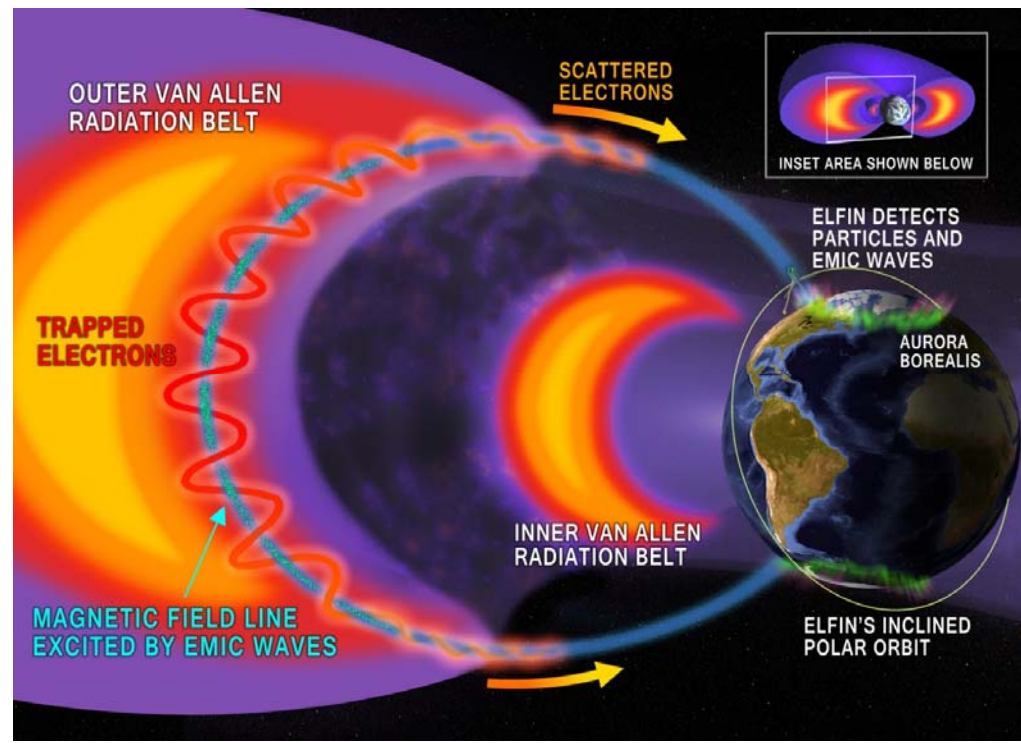
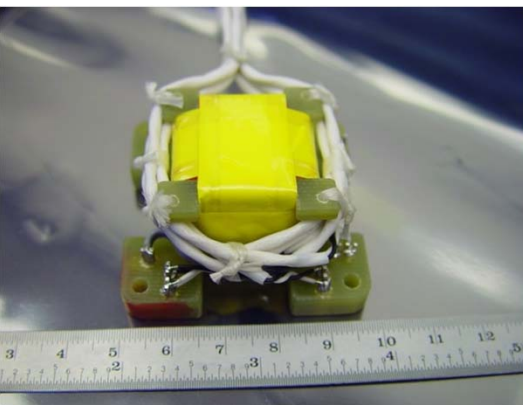
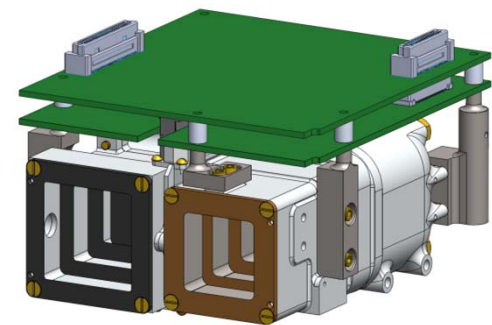
Image Credit: <http://www.nasa.gov/topics/solarsystem/>



## SCIENCE MISSION



**Approach:** ELFIN will measure, for the first time, if the angle and energy distribution of precipitating electrons bear the characteristic signature of scattering by Electromagnetic Ion Cyclotron (EMIC) waves







# PRIMARY PAYLOAD - FGM



## Substantial Flight Heritage:

Space Technology 5 (ST5)



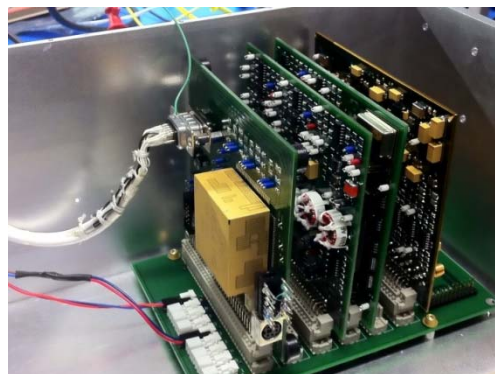
Demonstration and Science Experiments (DSX)



InSight

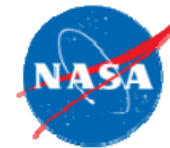


ELFIN – Lomonosov (ELFIN-L)





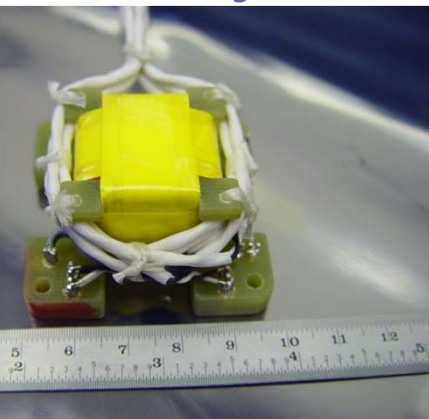
## PRIMARY PAYLOAD - FGM



### FGM Electronics

Dimensions: 90mm x 90mm x 25 mm

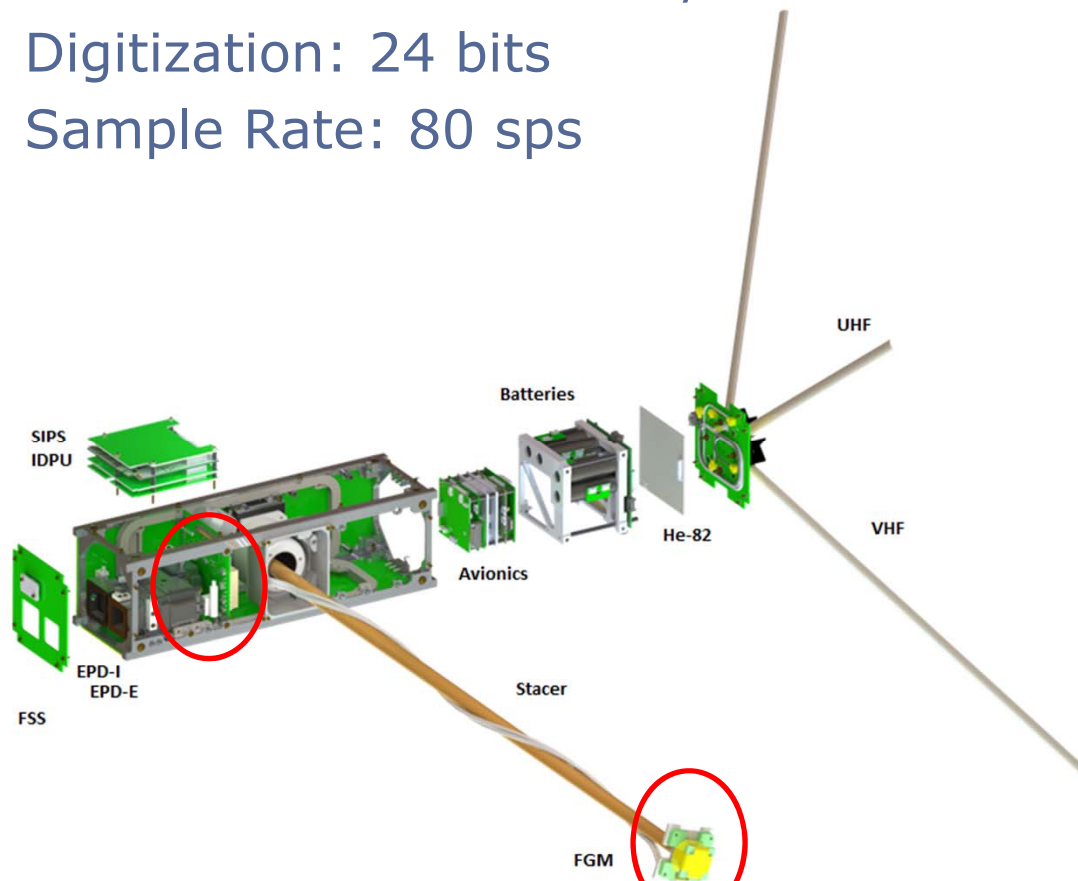
Mass: 100 g



### FGM Sensor

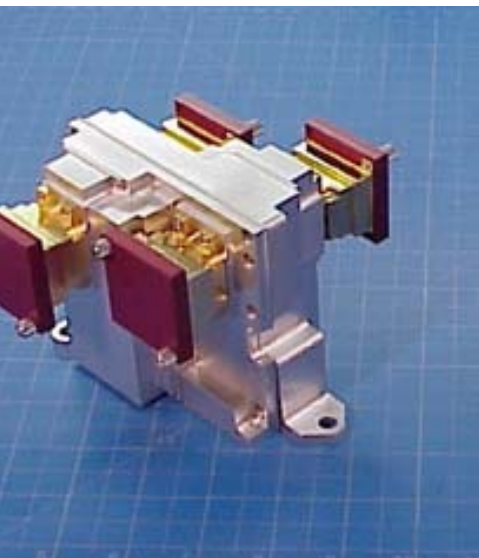
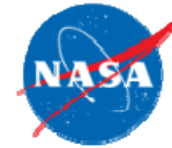
Dimensions: 48mm x 48mm x 25mm

- Dynamic Range:  $\pm 55,000$  nT
- Resolution: 6.5 pT
- Noise Resolution: 0.2 nT/ $\sqrt{\text{Hz}}$
- Digitization: 24 bits
- Sample Rate: 80 sps

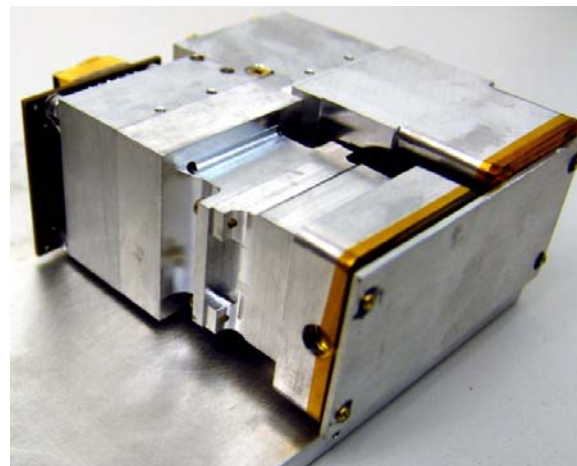




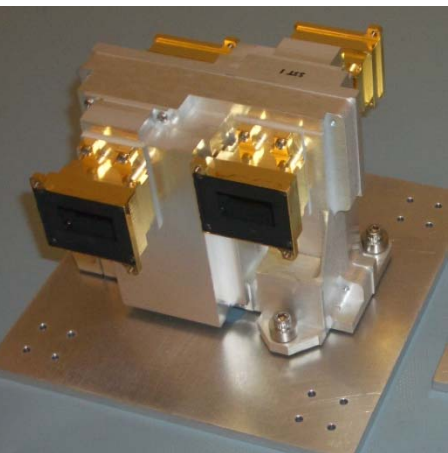
# PRIMARY PAYLOAD - EPD



SST - Solid State Telescope



ELFIN - L Energetic Particle Detector



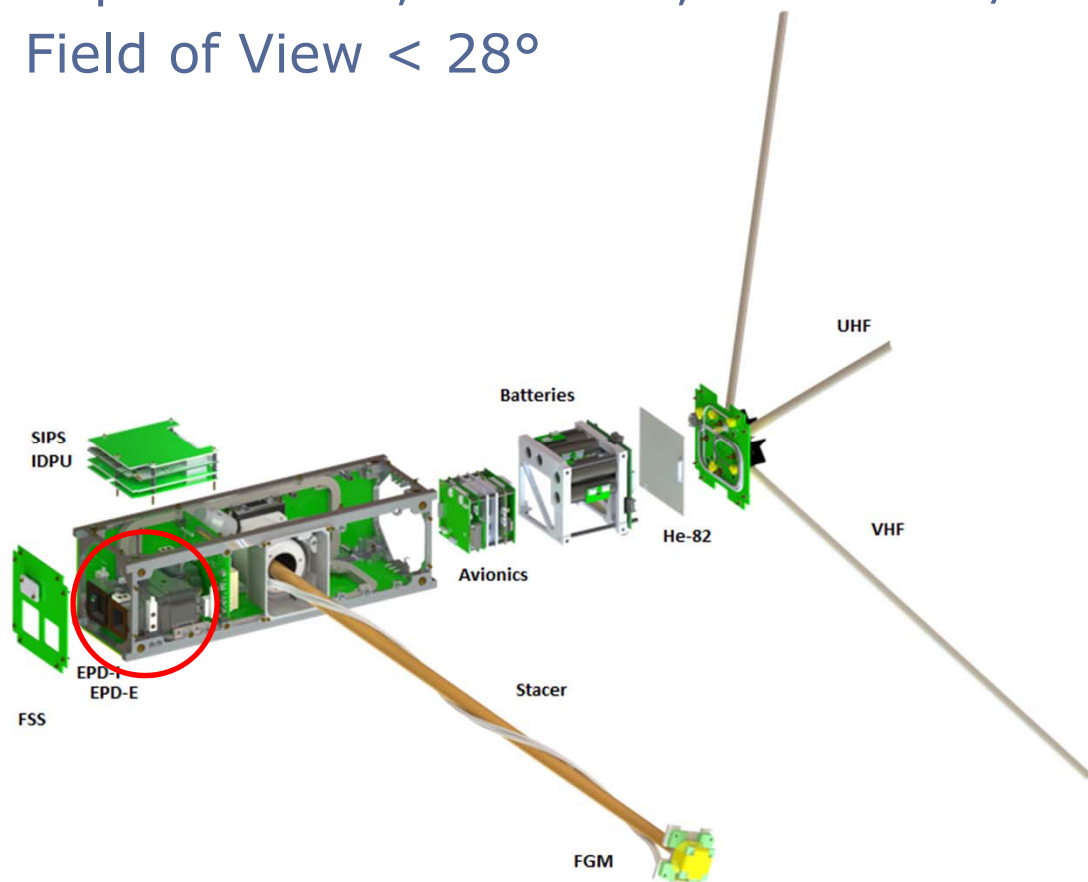
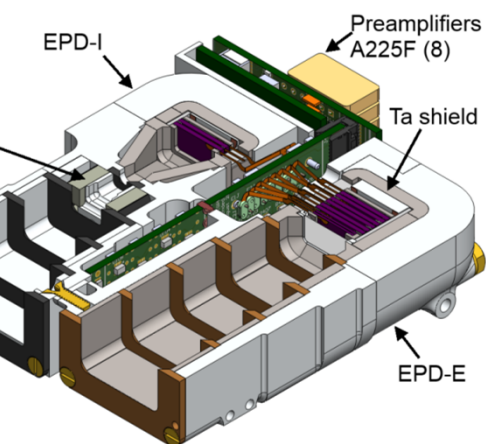
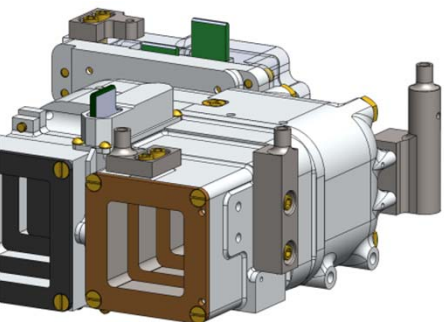




## PRIMARY PAYLOAD - EPD

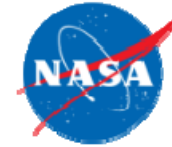


- EPD-E: 50 keV – 4 MeV
- EPD-I: 50 keV – 300 keV
- Capable of 10,000 to 50,000 counts/s
- Field of View  $< 28^\circ$

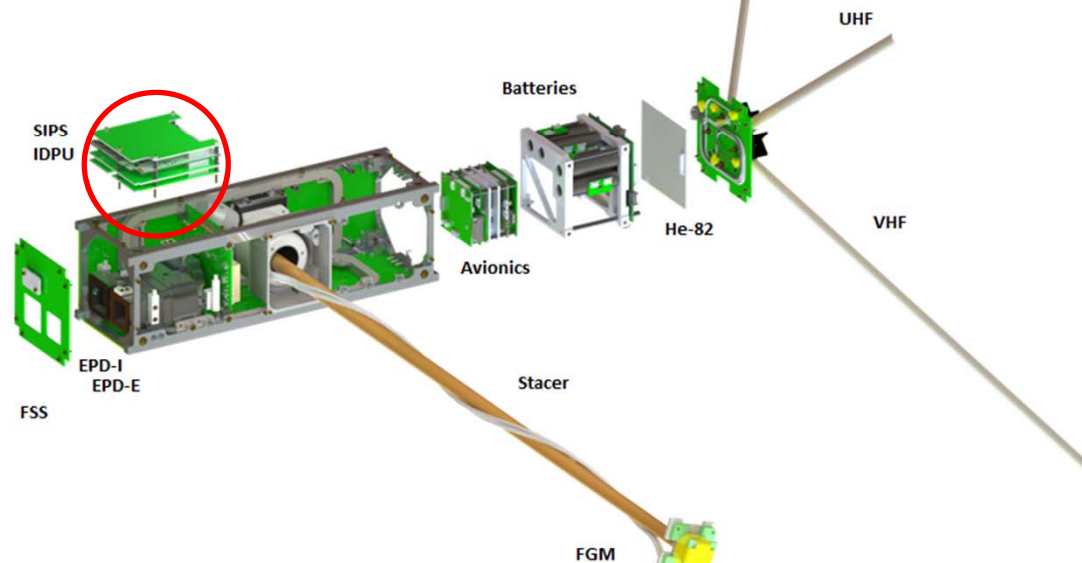
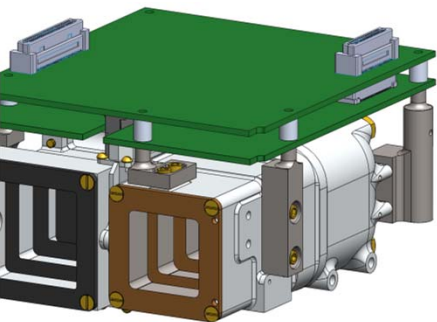




# PRIMARY PAYLOAD - EPD



- Old analog circuitry replaced to save acreage
- EPD – Digital 1: 5 ADCs, 1 FPGA
- EPD – Digital 2: 3 ADCs, 1 FPGA

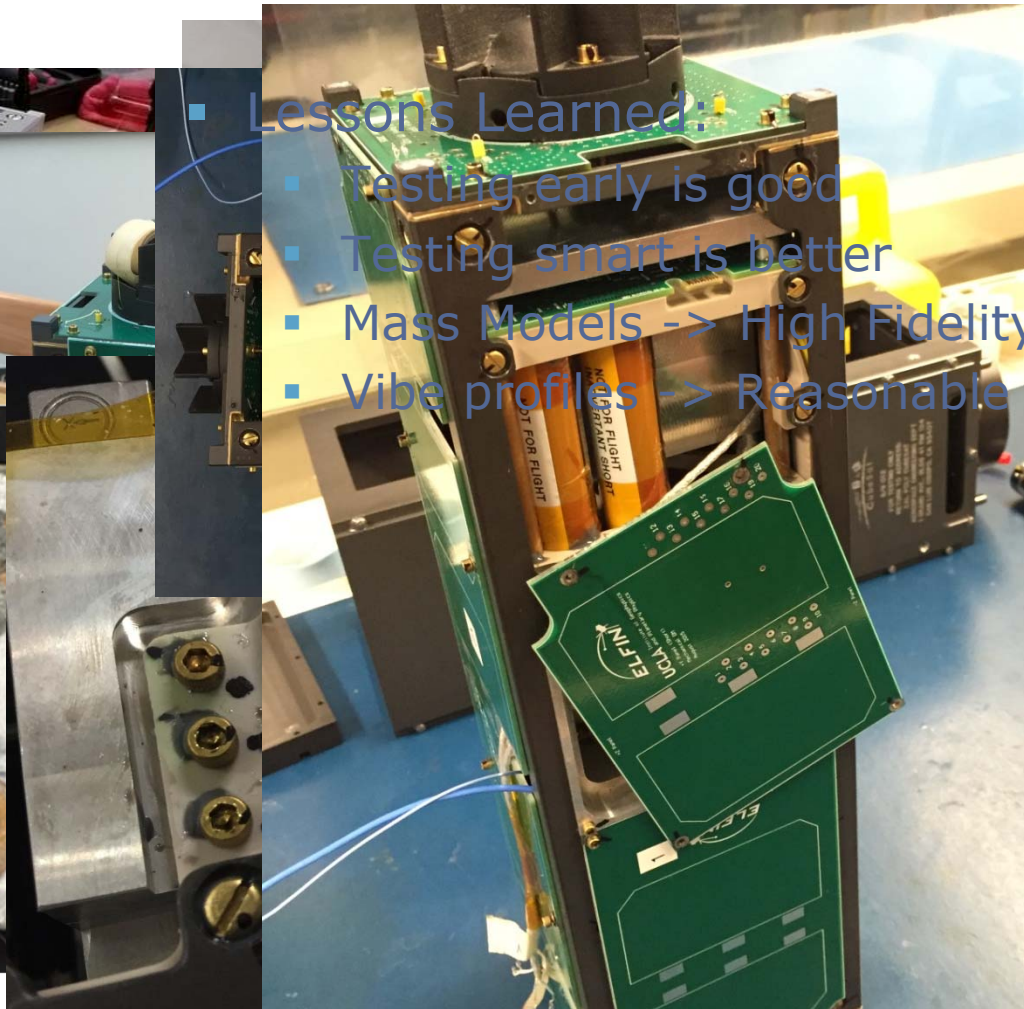
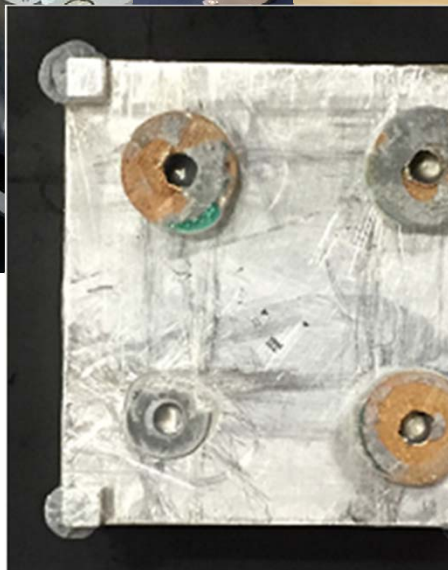




# PRIMARY PAYLOAD - EPD



- Vibration Testing

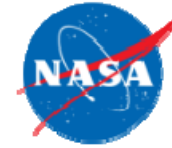


- Lessons Learned:
  - Testing early is good
  - Testing smart is better
  - Mass Models -> High Fidelity
  - Vibe profiles -> Reasonable

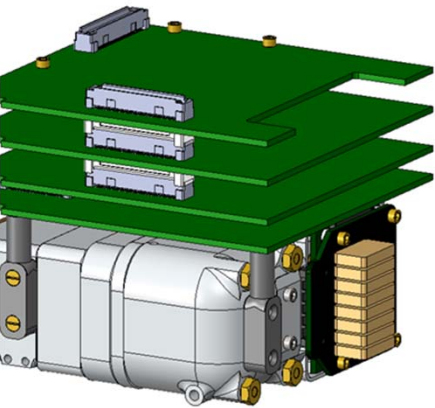




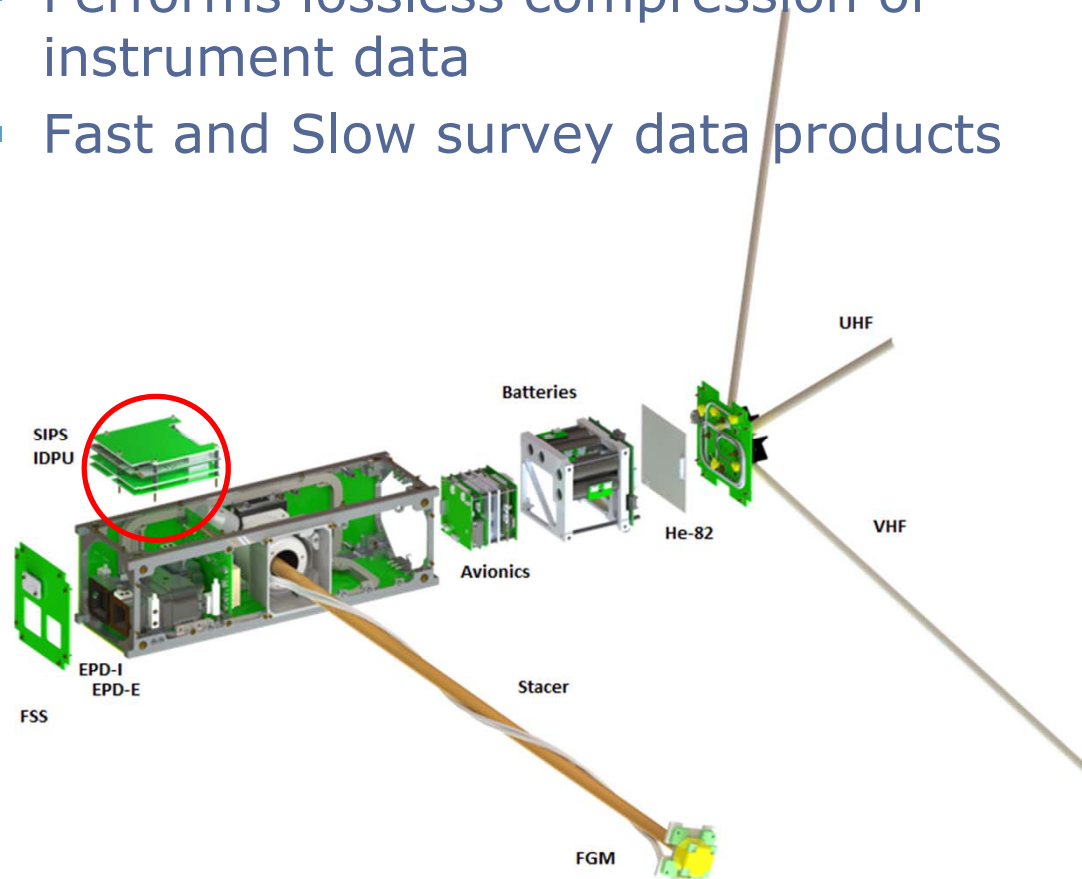
# ADDITIONAL INSTRUMENTS



## Instrument Data Processing Unit



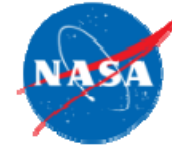
- Generates magnetic sectoring
- Performs lossless compression of instrument data
- Fast and Slow survey data products



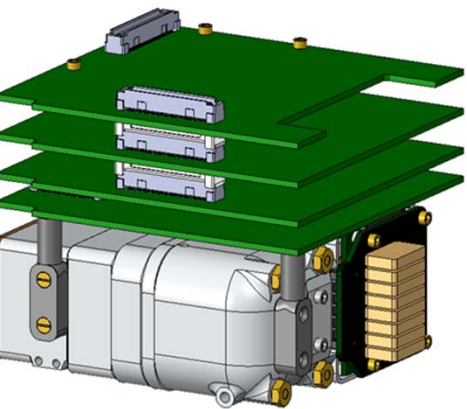




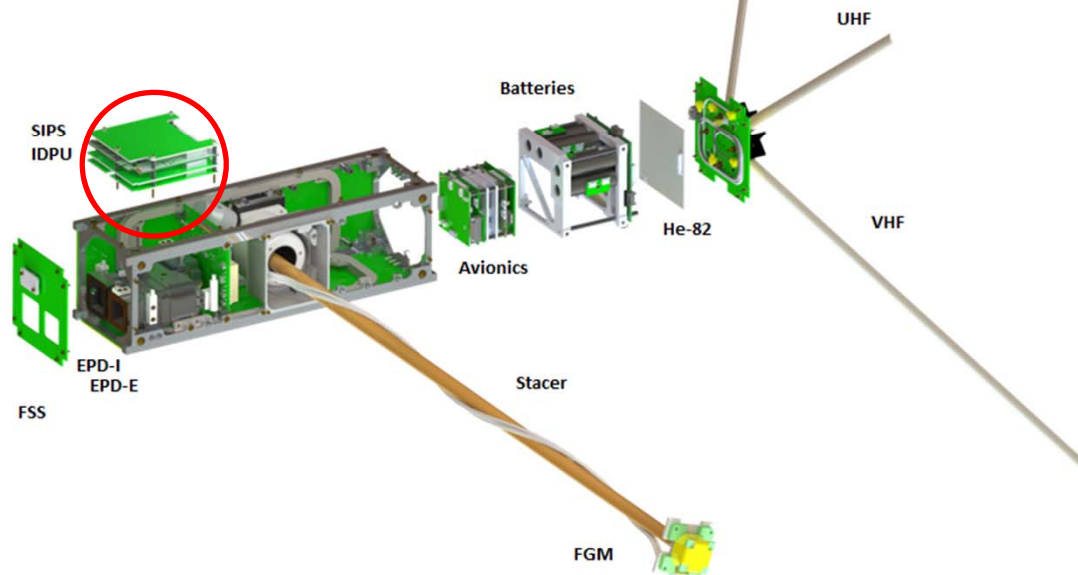
# ADDITIONAL INSTRUMENTS



## Switching Instrument Power Supply



- Provides regulated, switched, monitored power to EPD and FGM
- Provides regulated, unswitched power to IDPU
- Provides latch up protection to EPD ADCs



# FIN SUMMARY



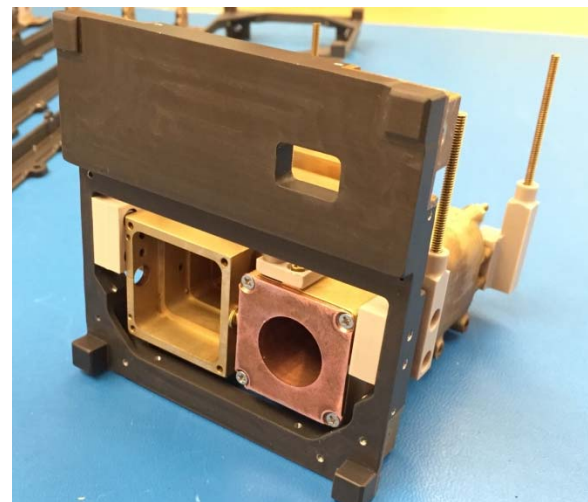
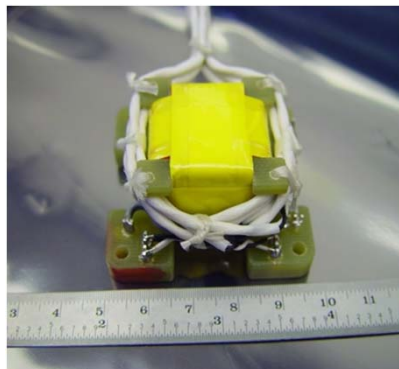
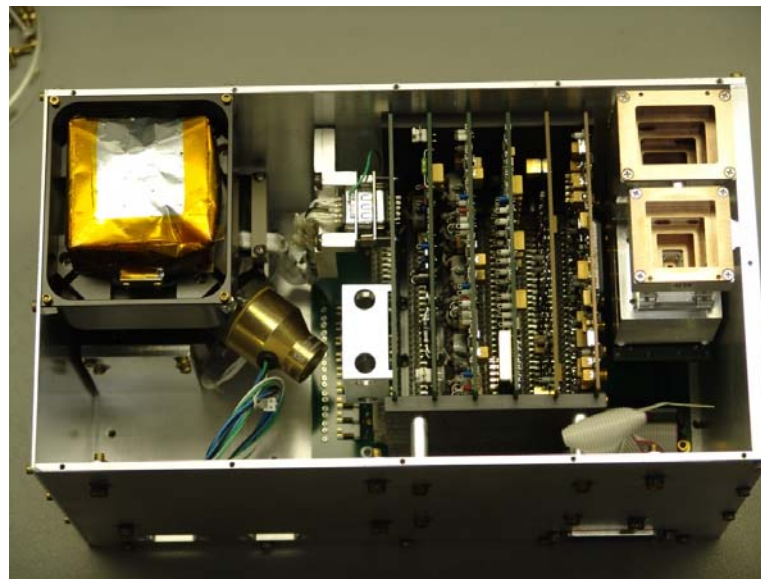
FIN is developing two instruments capable of performing large scale science on a CubeSat platform

FIN-L on orbit now, starting to receive results

FIN-M – significant flight heritage

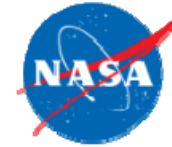
FIN-D – newer design and implementation

FIN-E ready for launch in late 2017





# ACKNOWLEDGEMENTS



Thank you to all of our sponsors, stakeholders,  
and contributors



UCLA



Jet Propulsion Laboratory  
California Institute of Technology



Shaun Murphy @ Northrop Grumman

Katharine Gamble @ UT Austin

Jim White WDOE @ Colorado Satellite Services

Mark Spencer WA8SME @ ARRL

Tony Monteiro AA2TX & Bob Davis KF4KSS @ AMSAT-NA





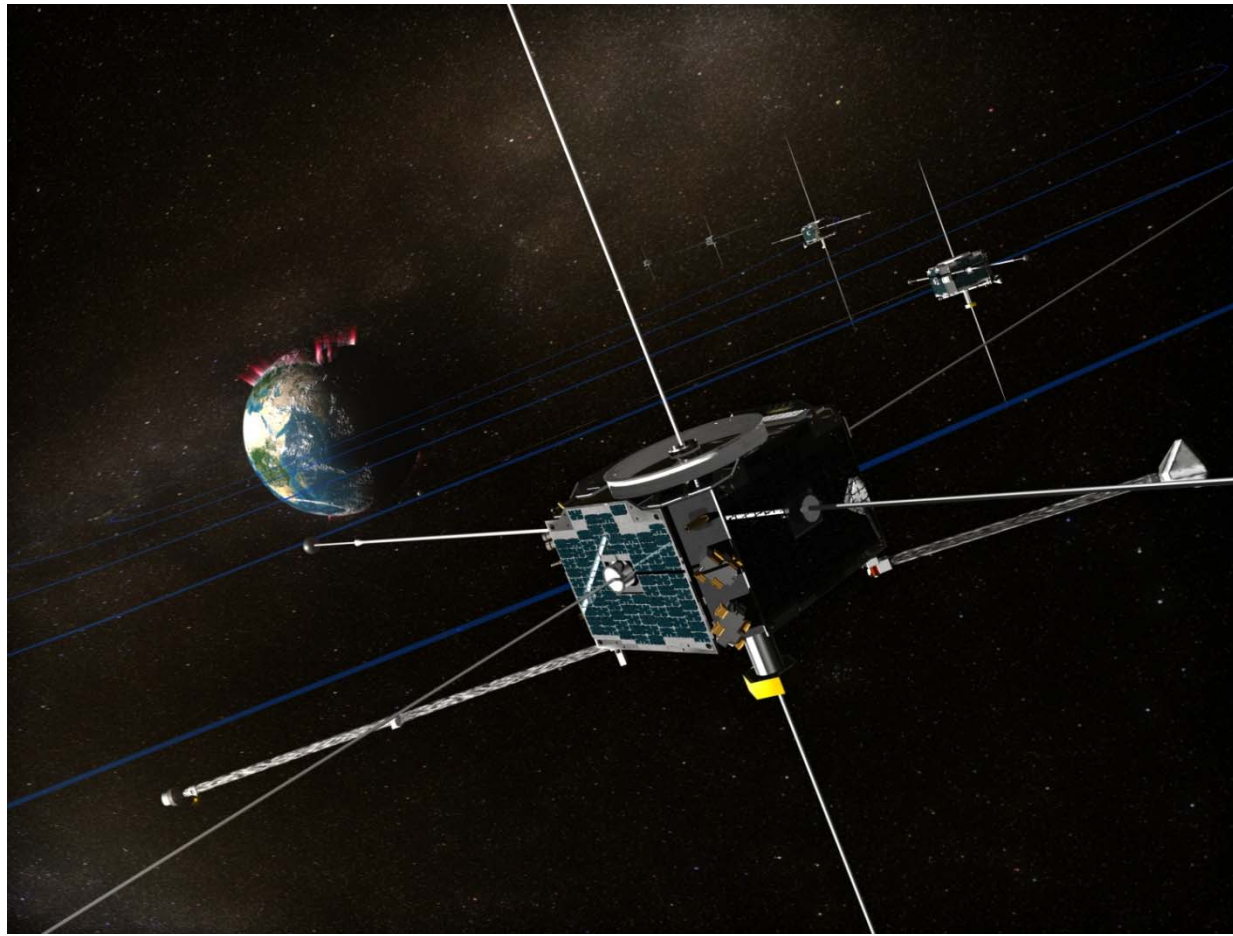


## SCIENCE MISSION



FINs science mission is complementary to larger NASA missions (THEMIS, MMS, DSX, etc)

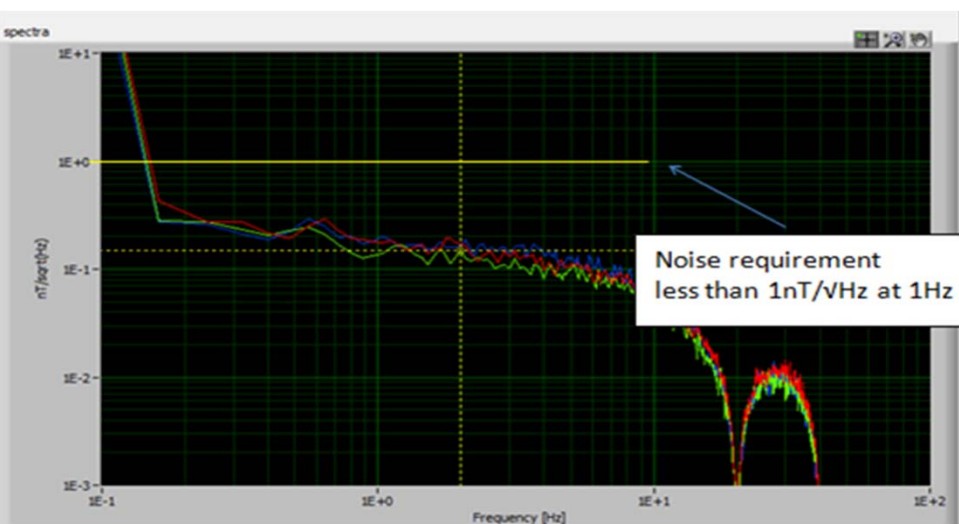
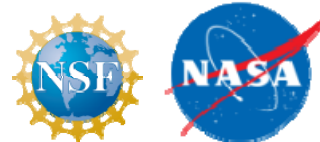
Conjunctions  
with equatorial  
spacecraft will  
reveal the full  
significance of  
wave-particle  
dynamics in the  
magnetosphere



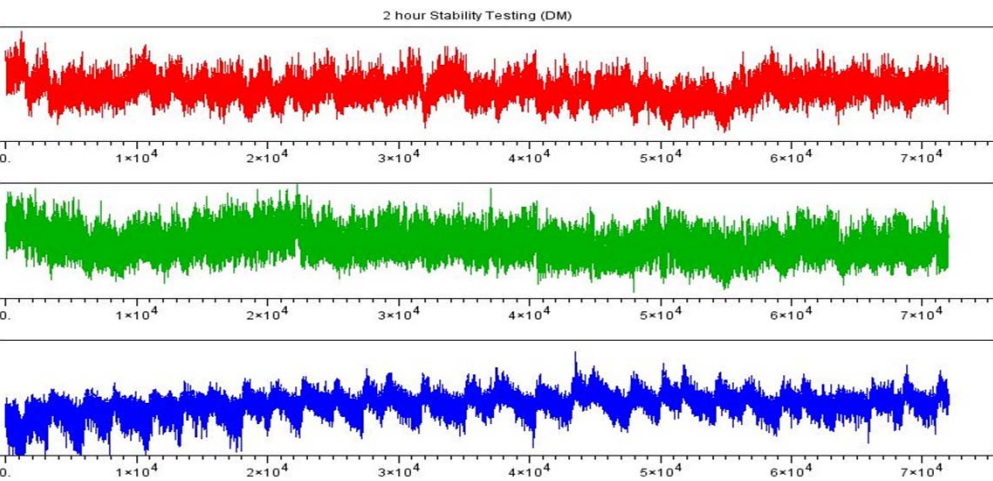




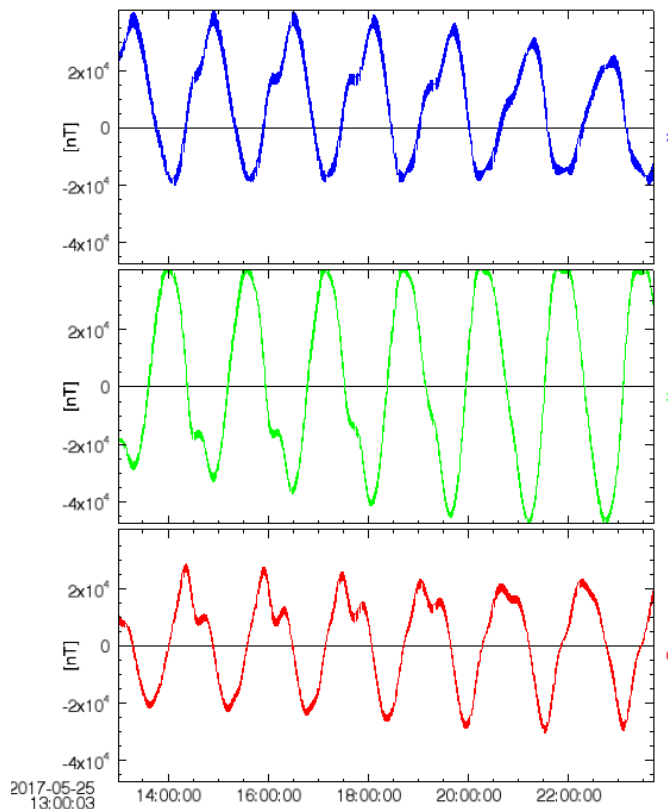
# PRIMARY PAYLOAD - FGM



## ELFIN FGM Noise Results



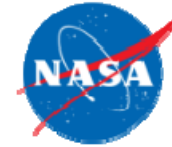
## ELFIN FGM Stability Test Results



## ELFIN-L FGM Results



# PRIMARY SCIENCE OBJECTIVE



Determine the dominant loss mechanism of relativistic electrons precipitation, namely if electromagnetic ion cyclotron (EMIC) or other processes are the dominant scattering mechanism.

