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Development of an Earth Horizon Sensor for Small Satellite Course Pointing Control

University of Colorado AES Senior Design Project
2014

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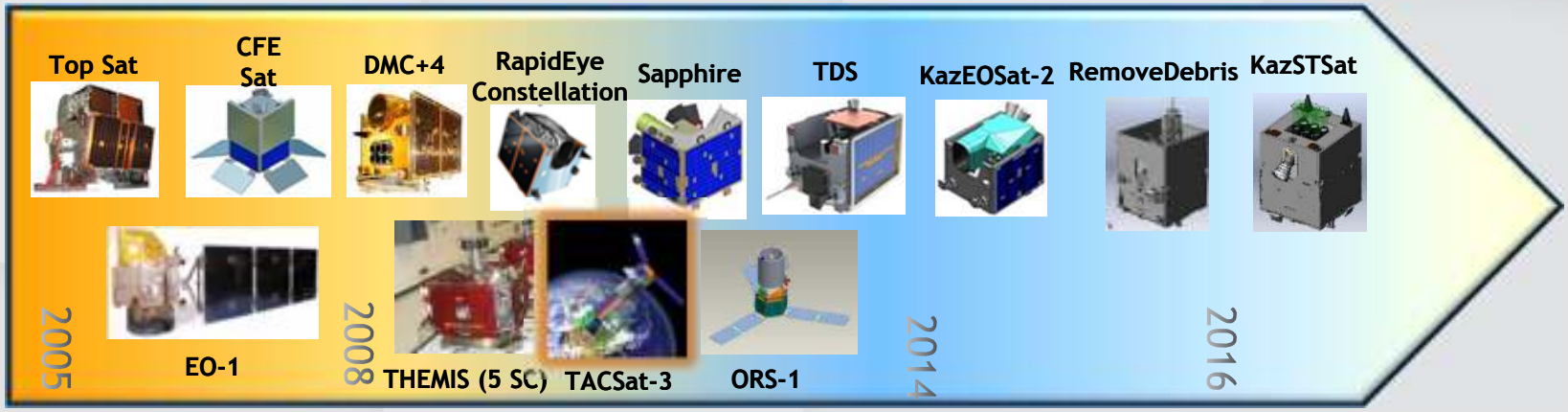
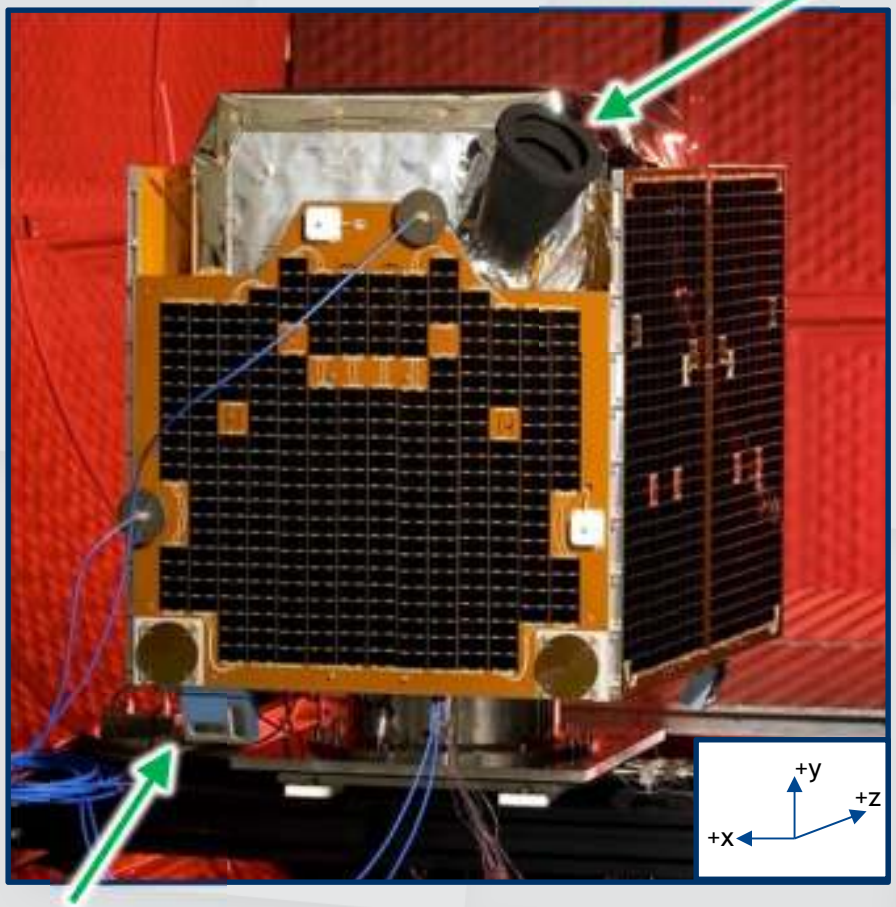
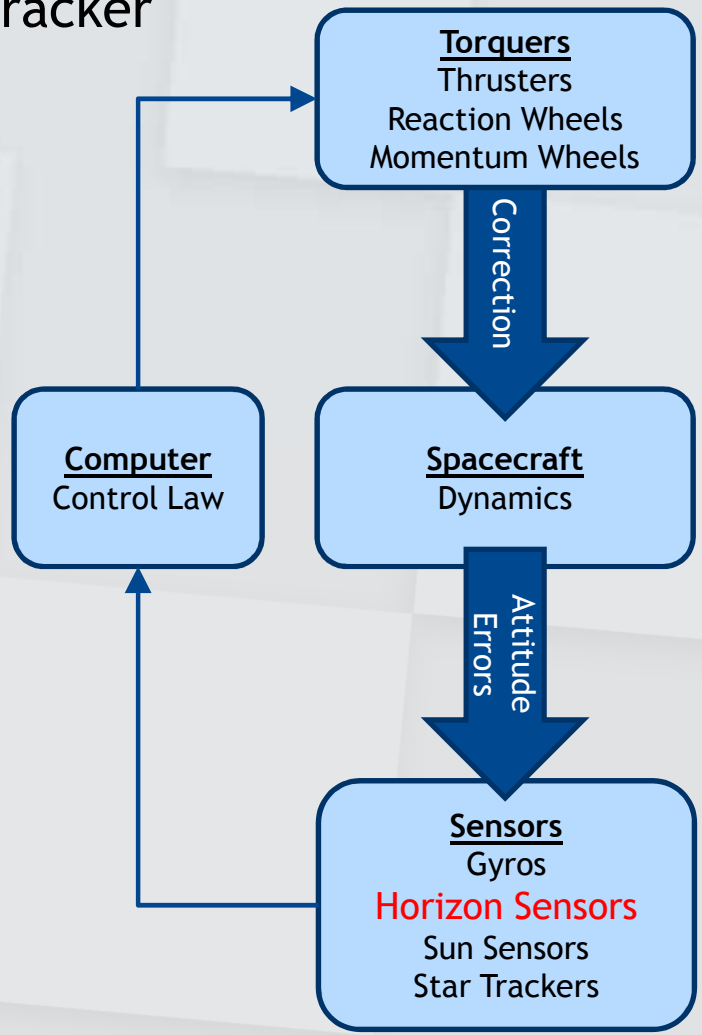
Surrey Satellite Technology US Intro

- Who we are
  - U.S. Delaware-registered company, under U.S. control and operation
  - U.S.-focused satellite, satellite subsystems manufacturing, and mission operations provider
  - Wholly-owned subsidiary of Surrey Satellite Technology Limited (SSTL) in the U.K., collectively referred to as Surrey
  - 100% mission success record over 15 years. 200+ years on orbit
  - More than 40 satellites in over 30 years



Attitude Control Systems Overview

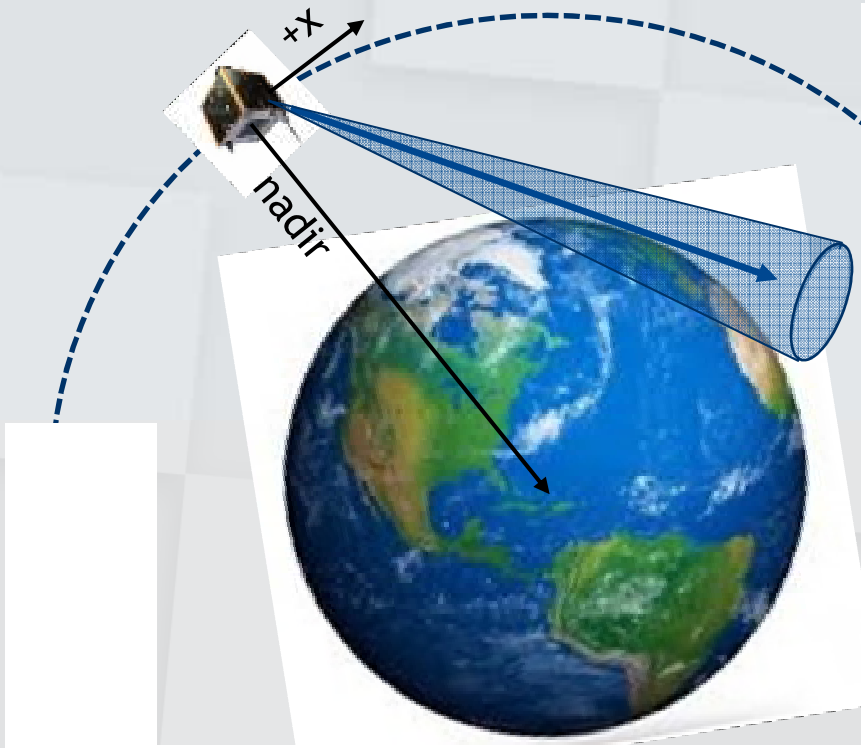


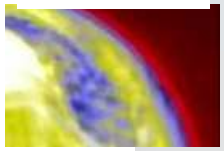


Objective

- Design an inexpensive, lightweight, and easy to integrate sensor that detects (or derives) the Earth limb vector to within 0.5 degree of accuracy
- Sensor is intended to be used for missions that do not require “fine” pointing control and so do not require star trackers
  - Star trackers provide accuracies on the order of arcseconds (1 arcsec = 1/3600th of a degree), but they can be expensive and complex
  - Sun sensors (course) are relatively simple, inexpensive and provide accuracies on the order of a few degrees or less; can only be used for part of an orbit
  - Earth sensors sit somewhere between these two; come with the added benefit that they can be designed for use at all or any part of an orbit
  - Sensed Earth horizon can change according to orbit inclination, seasons, etc. depending on the detection method chosen and so accuracy is often traded against hardware/software complexity

Background





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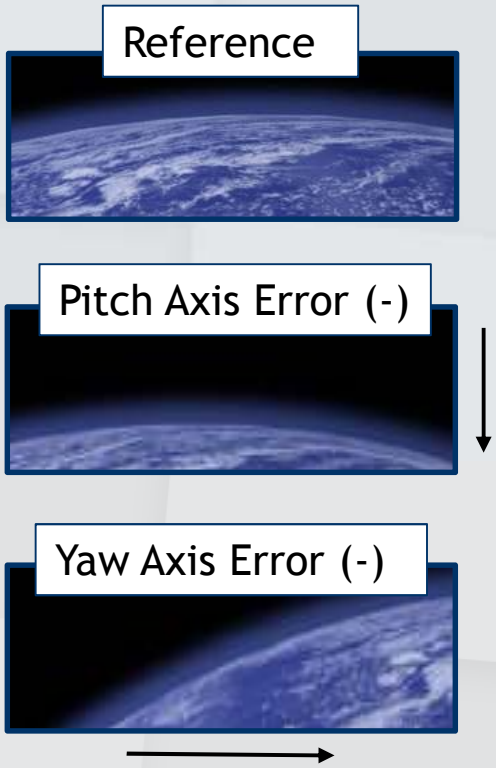

- Earth exhibits different radiation signatures across different bands of the electromagnetic spectrum; detector technologies are fast evolving
- Earth limb vector alone only 2DOF; Roll axis error needs another reference
- Hardware trending towards Micro Electro Mechanical Systems (MEMS)

Challenges

- Mechanical Engineering
  - Small hardware; new hardware options; FOV; volume
    - Mounting angle, form fitting, fastening
- Electrical Engineering
  - Small sensor electronics; detector sensitivity; filtering
    - DC-to-DC, noise characterization
- Aerospace Engineering
  - Reference data may vary with orbital environment
    - Understanding how these variables affect what is considered “truth”
- Software Engineering
  - Algorithm design; simulation; EGSE/display interfaces
    - Passing and storing data in electronics

TDS-1 Movie

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