From pucks to ampules to bobs: development of instrumented telemetered small payloads for multipoint arrays

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CEDAR, rockets, June 2018, Santa Fe

history

- Auroral Turbulence2 (Lynch GRL 1999)
- Pucks: FFM with JPL (Zheng JGR 2003)
- Darts: multiple small rockets (Lynch, Gelinas JGR 2005)
- FADs: ROPA (Jones JASTP 08)
- PFFs: Cascades2 (Lynch JGR 2012)
- Balloons and Ducks: Arduino arrays (Slagle 2012)
- Small Rockets (Conde, Rosanova, Hesh) (Roberts RSI, JSR, 2017)
- Isinglass
- SubTec8 ERPA-Bobs addendum
- Delamere
- ARCS….

2 ISINGLASS rockets

Ionospheric **S**tructuring: **IN** situ and **G**roundbased **L**ow **A**ltitude **S**tudie**S**

P.I. Kristina Lynch, Dartmouth

**Aurora over Venetie optical site,
photo by Jason Ahrns (UAF student)**

Motivation/Objective: Determining which spatial forcing scales cause observable differences in ionospheric parameters -- critical knowledge needed for merging magnetospheric and ionospheric models for M-I coupling studies.

Mission: Multi-sensor, multi-scale, multi-site, multi-scientist campaign:
Two sounding rockets with 6 payloads each; Imagery, radars, spacecraft, modelling, assimilation…

ISINGLASS Rockets -- each with 6 Payloads!

Includes 4 3U-size subpayloads (Bobs) which send telemetry to main payload

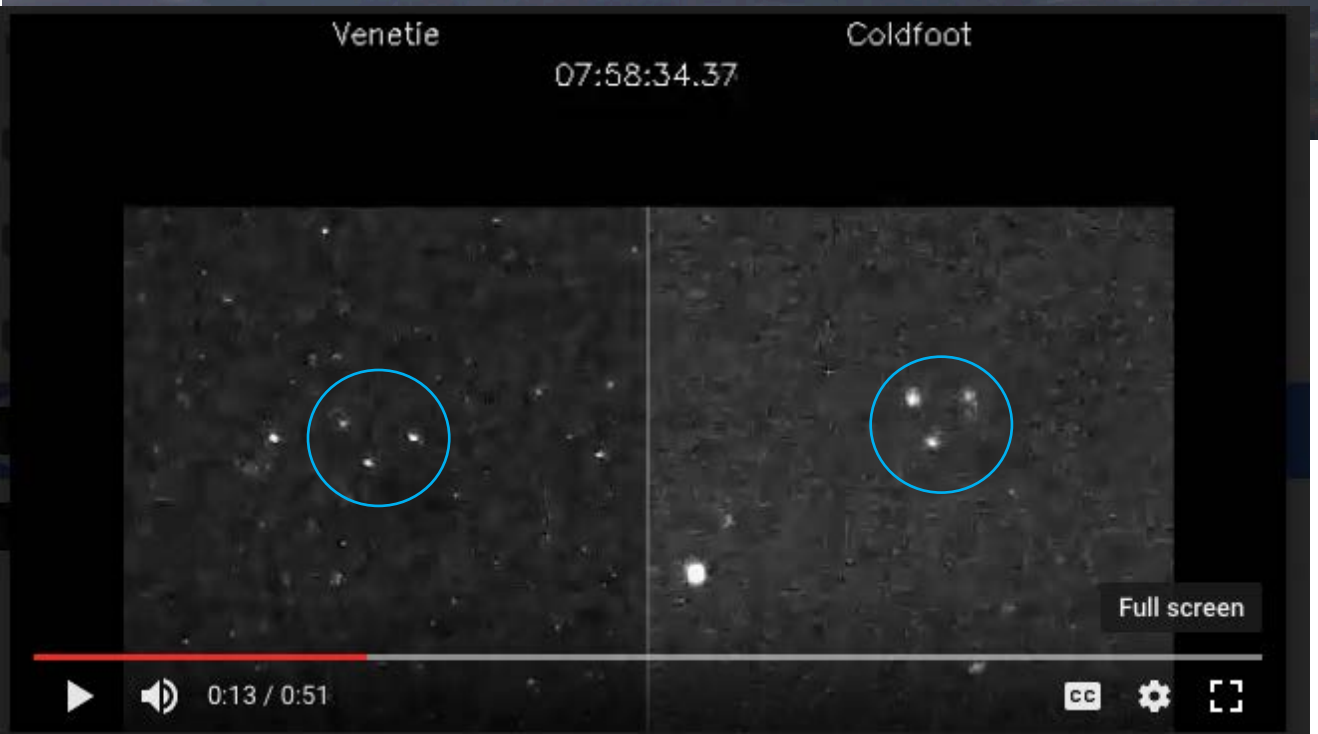
Video: T Max Roberts

Science instruments flown in situ:

Main Payload -- Auroral precipitation sensor; magnetometer, thermal electron sensor, ion RPAs

Large Sub-Payload along the main payload axis -- Electric fields, magnetometer, thermal e-

4 Bob subpayloads ejected radially -- 2 ion RPAs, IMU, and optical beacon

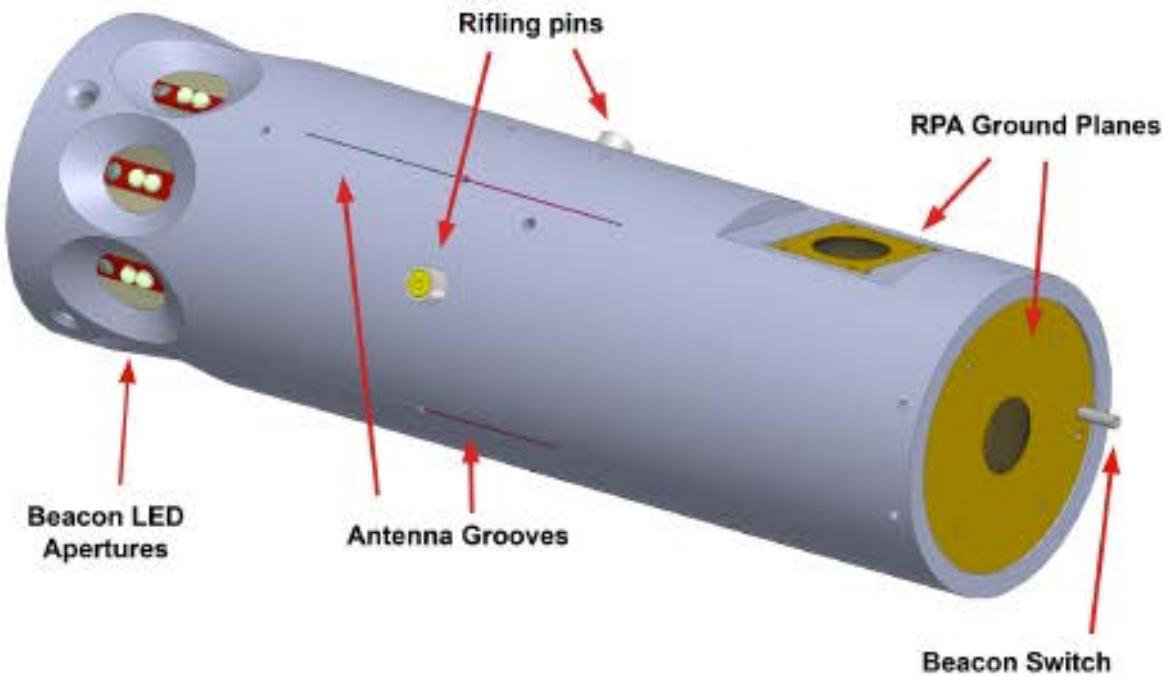


Beacons seen from Venetie, and from Coldfoot

Video: T Max Roberts
Beacon image: D Hampton

ISINGLASS

Ionospheric Structuring:
In Situ and Groundbased Low Altitude StudieS



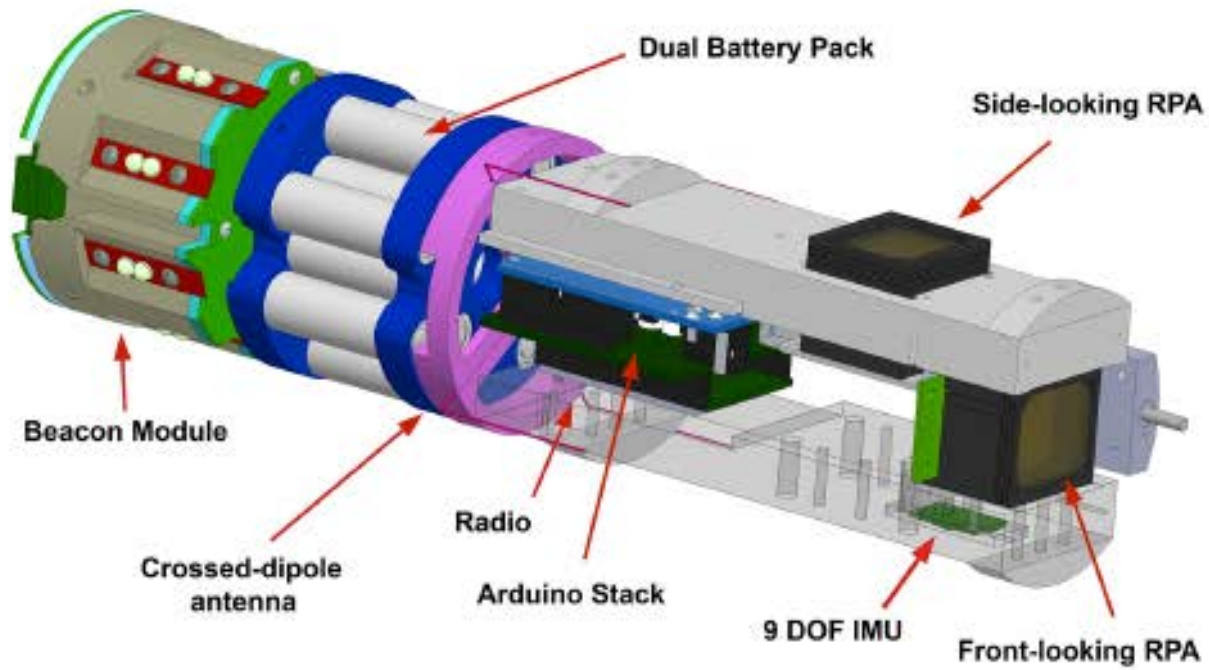
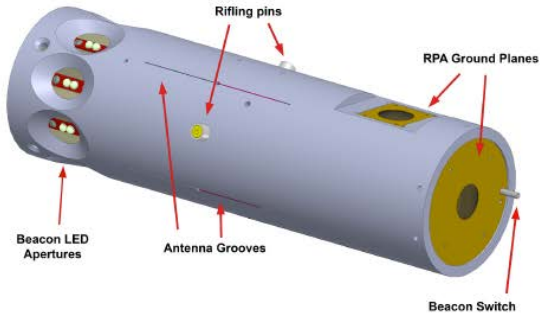
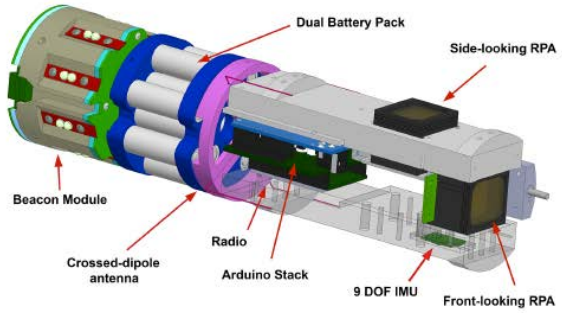


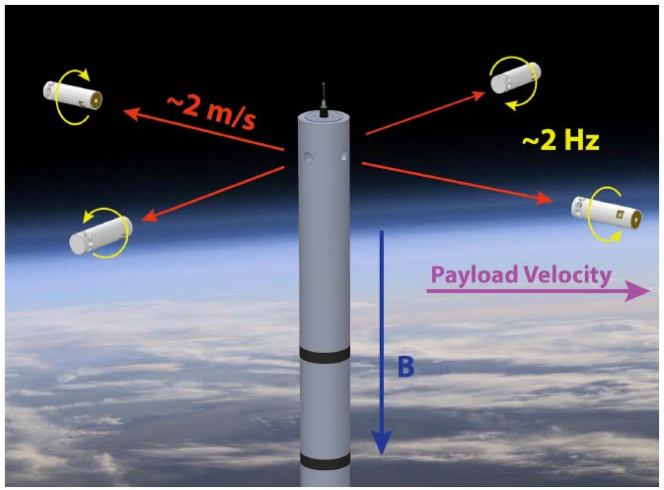
Figure: T Max Roberts

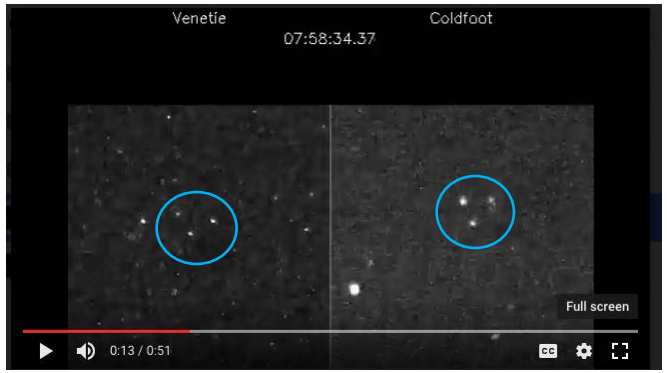
Bob Payload Instrumentation: Cylindrical 3U Ampule envelope

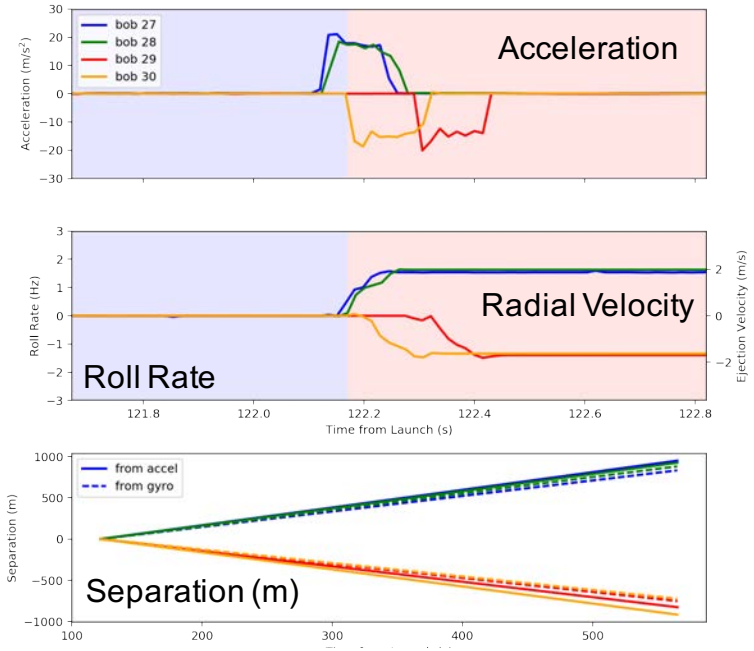




Figures: T Max Roberts



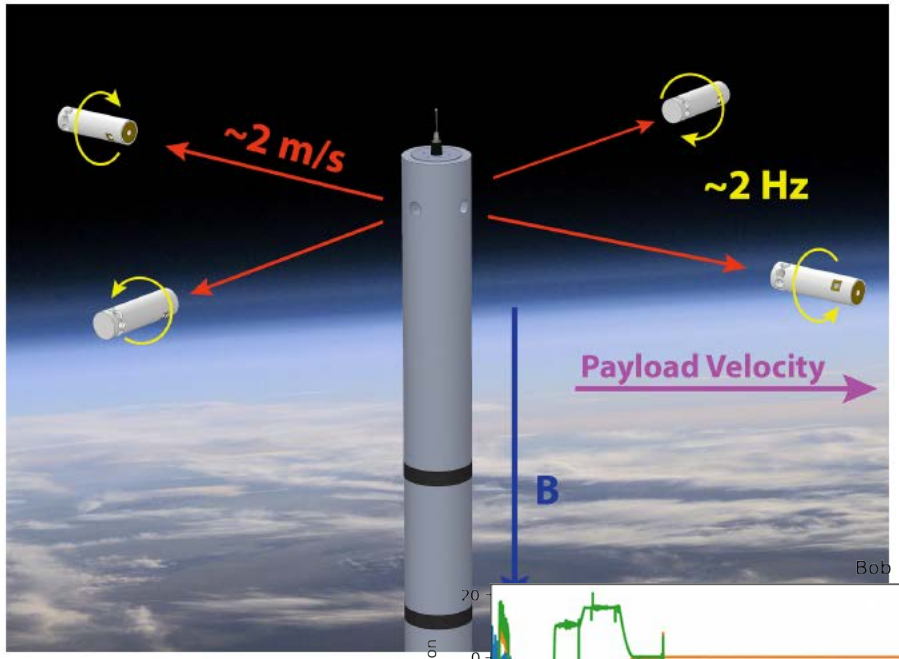


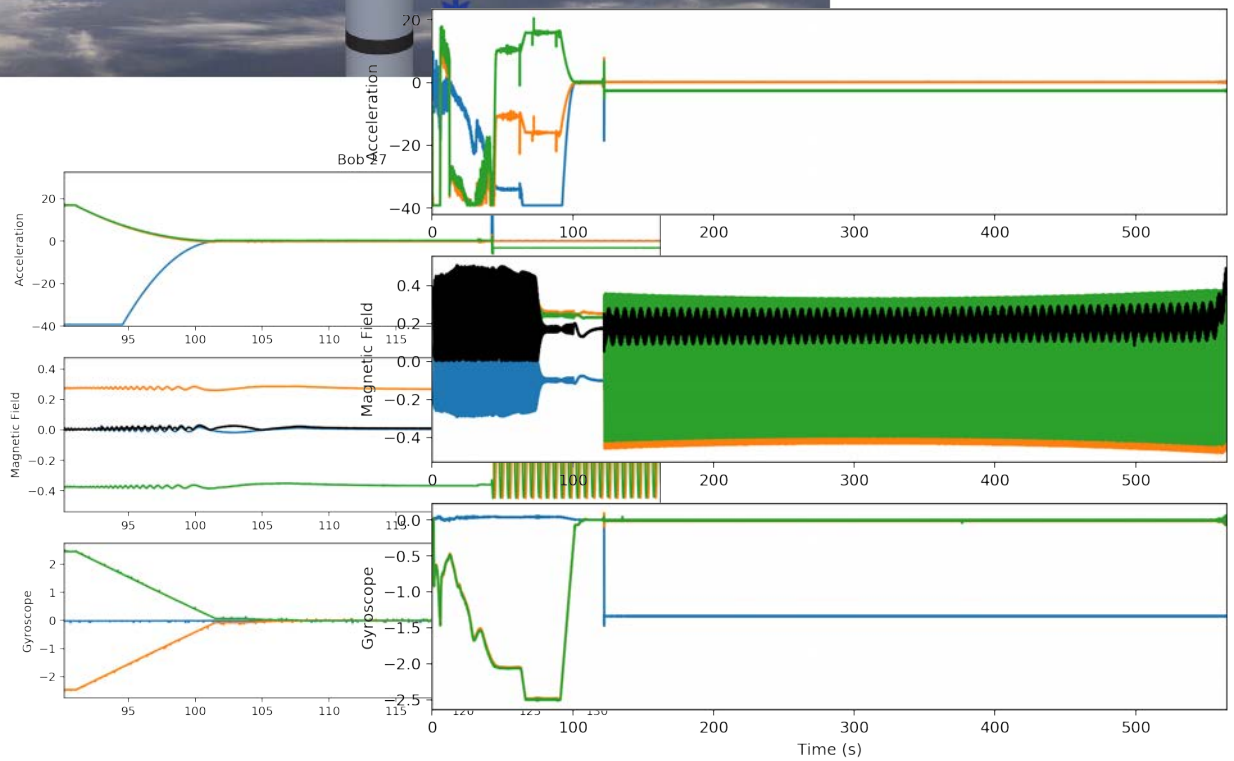


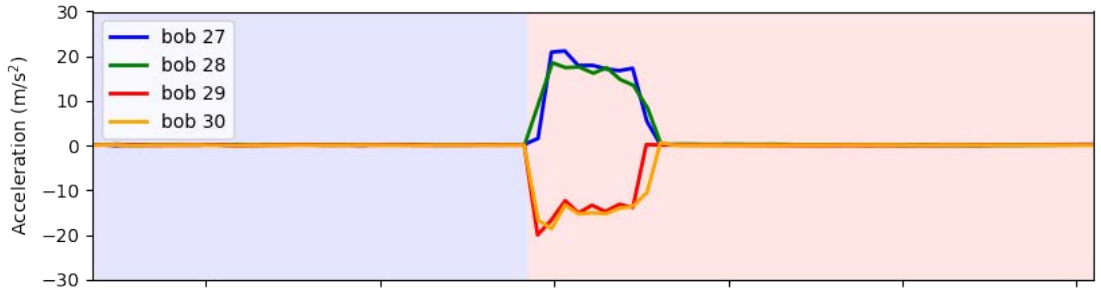
Time (sec since launch)

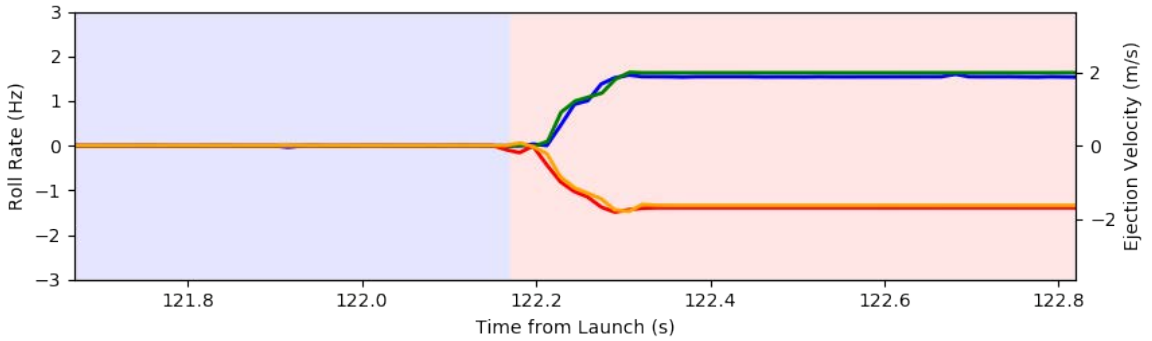
← Optical beacons observed by multiple ground cameras provide triangulated Bob locations

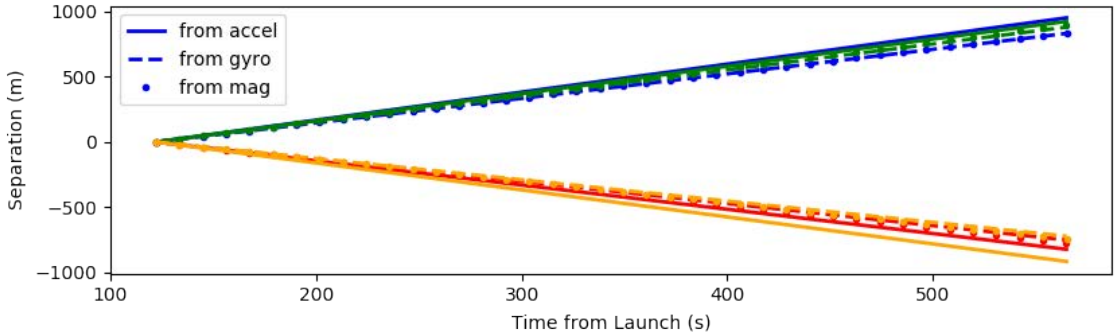
Beacon image: D Hampton



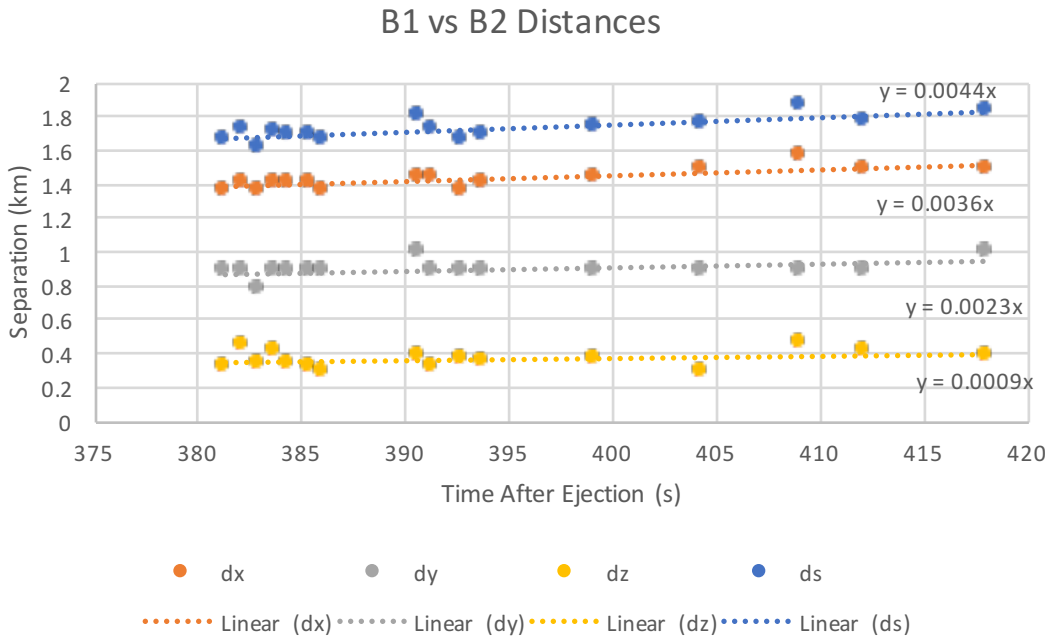




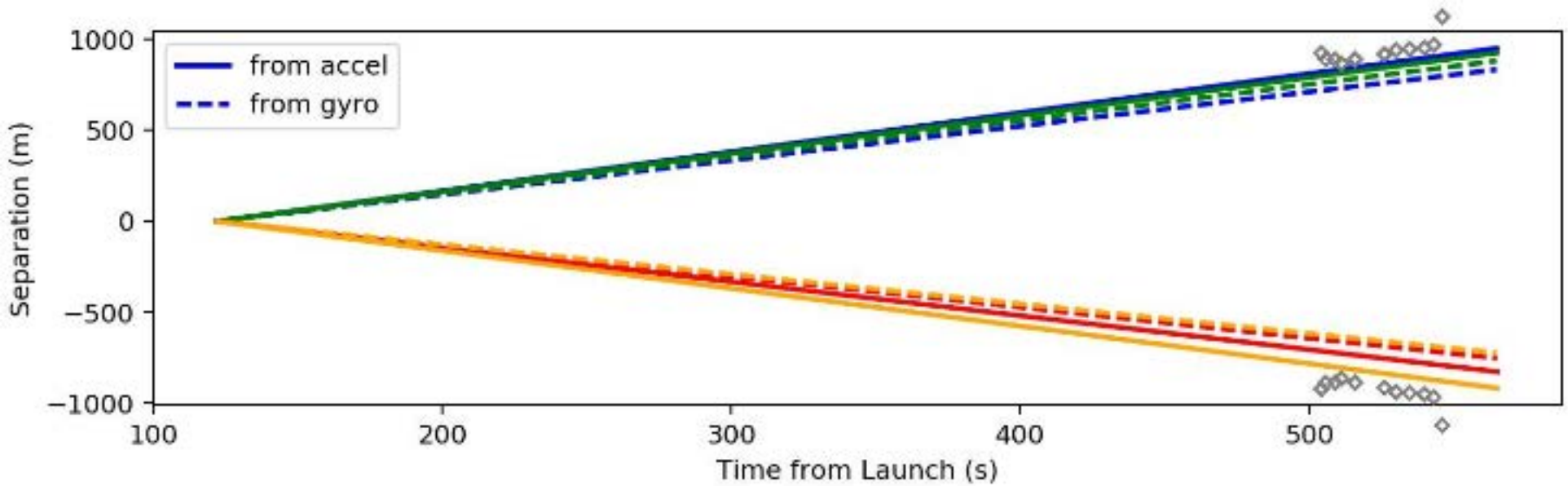




Figures: T Max Roberts



Figures: J Vann (UAF thesis); M Conde; H Stenbaek-Nielsen, TMRoberts

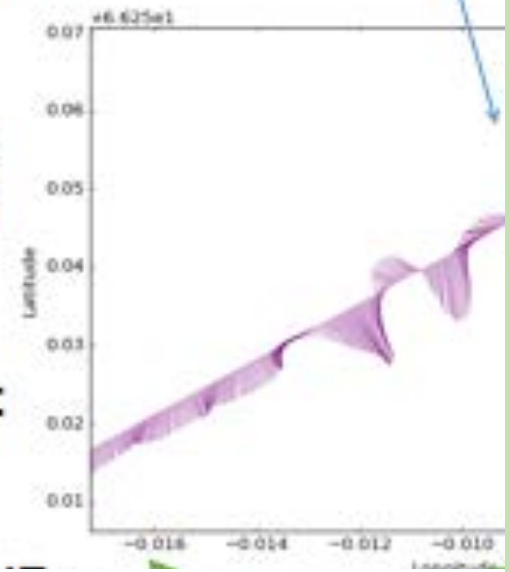


Alfven wave signature at edge of arc

Alfvenic signature:

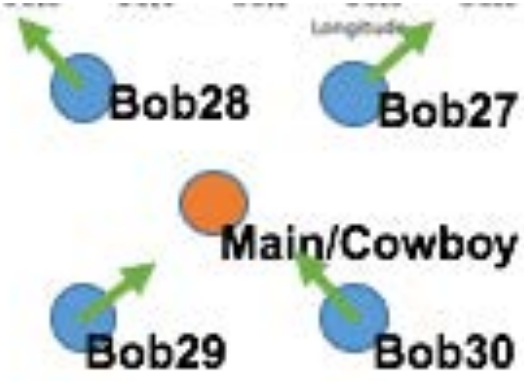
Alfvenic signature at poleward edge of discrete arc.

Seen by Cowboys:

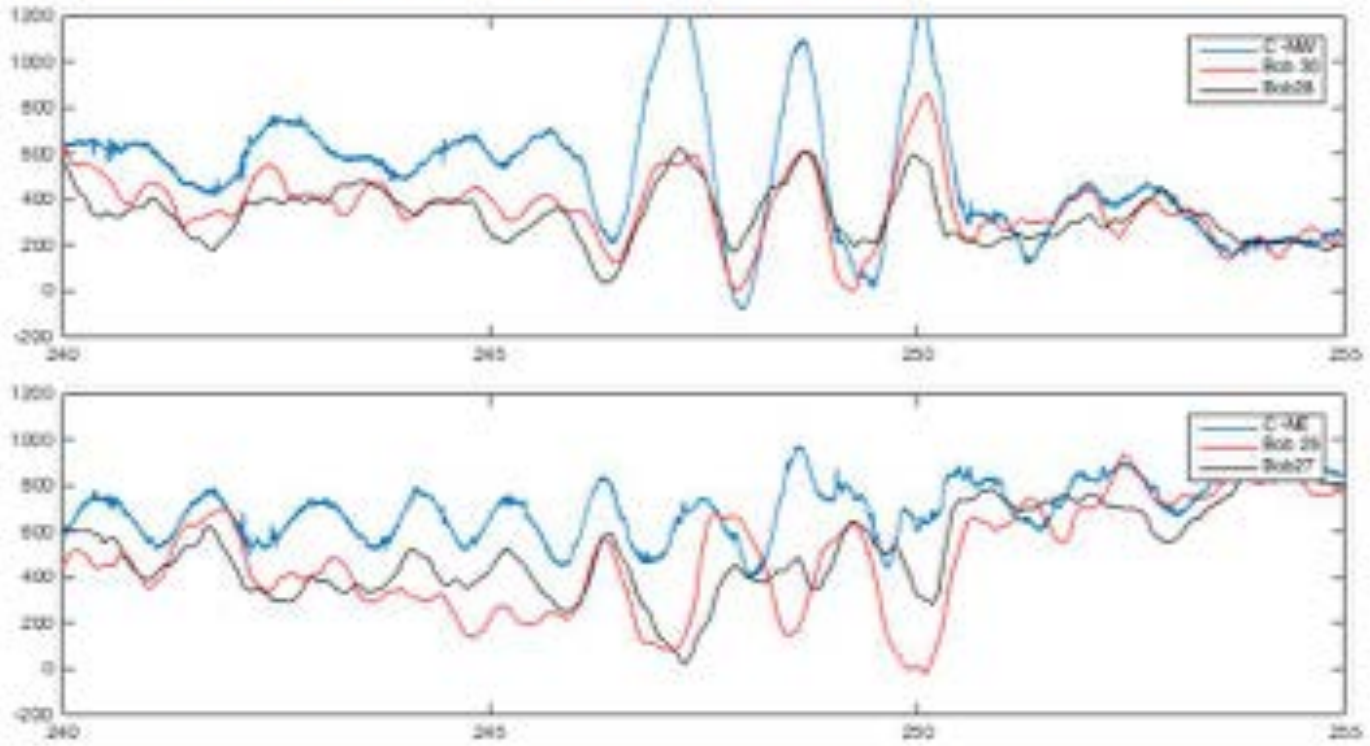


And also by Bob PIPs: (800 m cross at this time)

Green arrows: look directions of FWD PIPs.



Compare to Cowboy NE and NW:



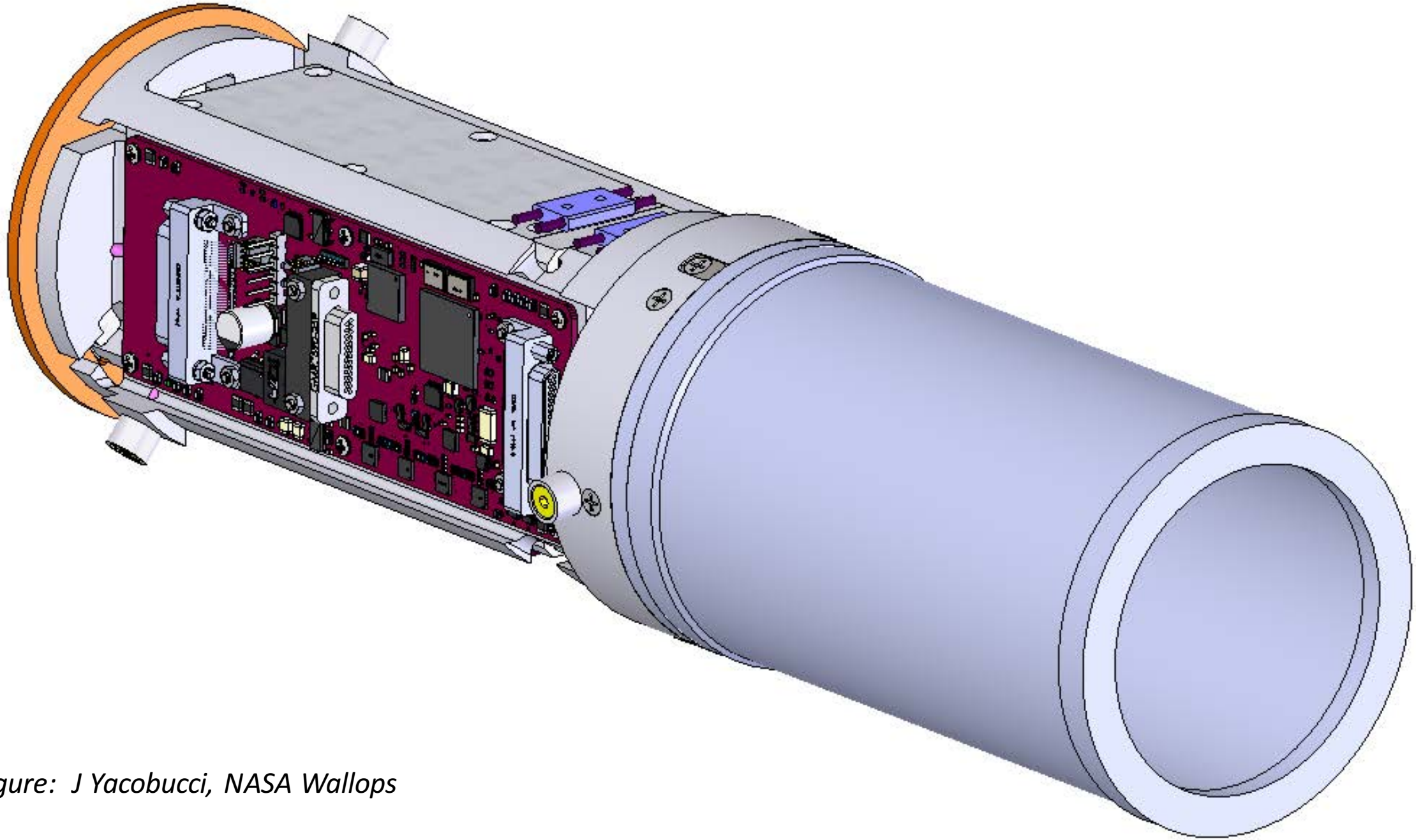


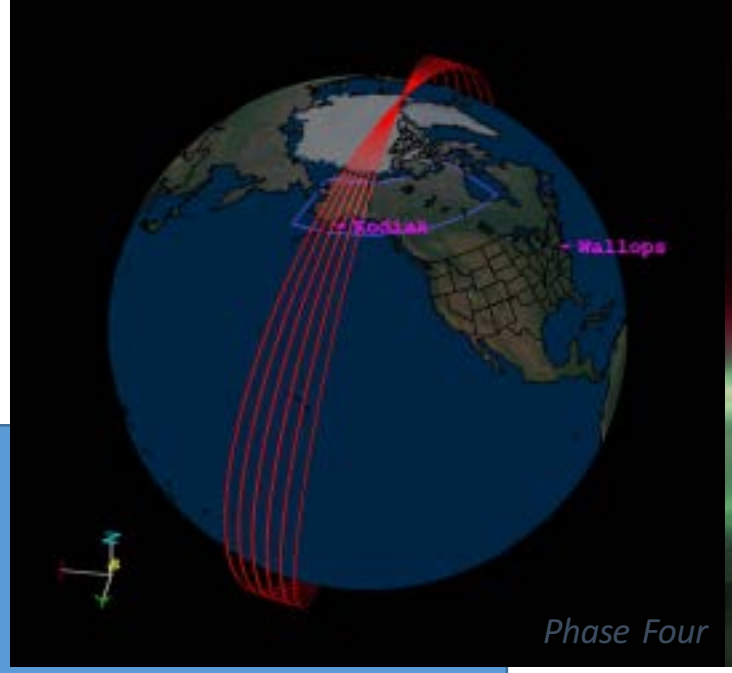
Figure: J Yacobucci, NASA Wallops

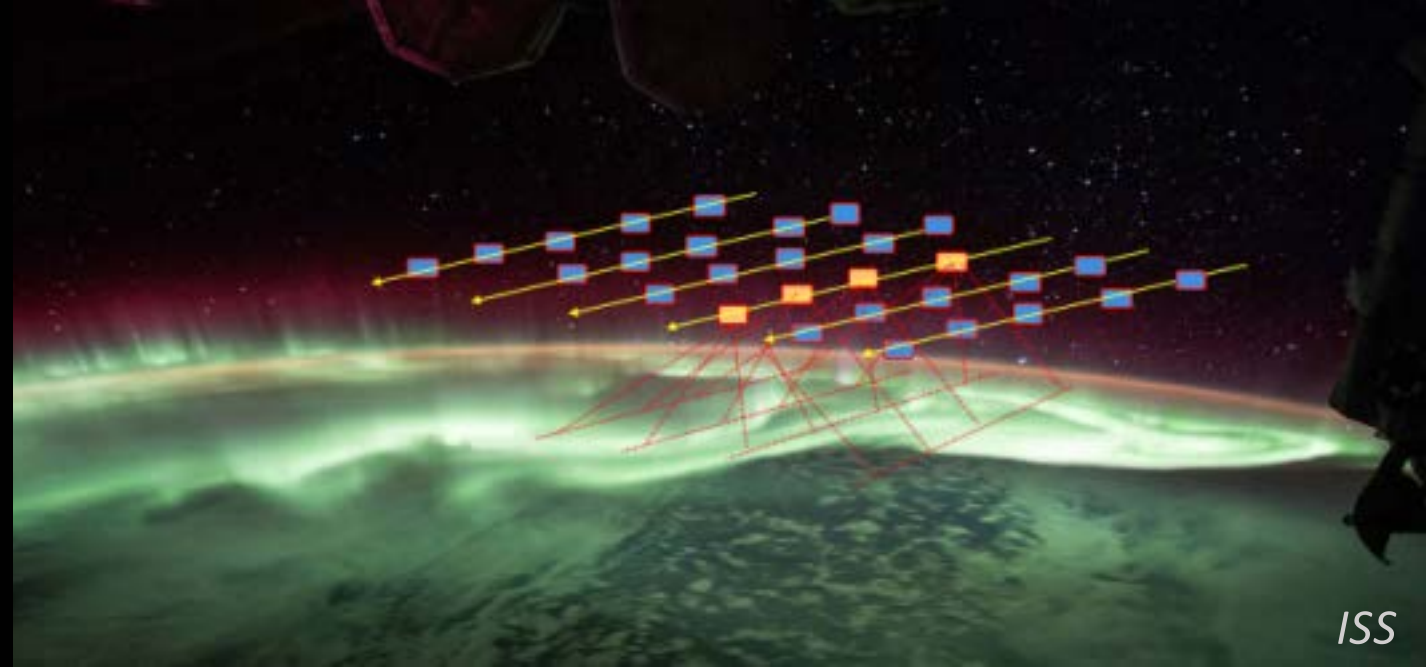
upcoming

- Sub-tec-8 – Fall 2019
  - 4 deployables
  - 2 with springs (2-5 m/s separation); 2 with rockets (10s m/s separation)
  - Springs: PIPs
  - Rockets: ERPAs

- Delamere Kinet-X – Fall 2020
  - Flight from Wallops for Io-like Alfven wings
  - Four spring-deployed PIP ejectables
  - Somewhere between Hesh-like and Bob-like

Mission Concept





ARCS
AURORAL RECONSTRUCTION CUBESWARM

- What is the role of the ionosphere in the creation of auroral arcs?
  - What causes the aurora? How do the magnetosphere and ionosphere work together to control the dynamics and structure of auroral arcs across scales?
  - How do ionospheric flows and current structures work together to regulate/create auroral arcs?
  - What magnetospheric generator theories are consistent with the observed 2d current, flow, and conductivity patterns in the ionosphere?