Electrojet Zeeman Imaging Explorer (EZIE): A NASA Mission of Opportunity to Study the Ionospheric Electrojets

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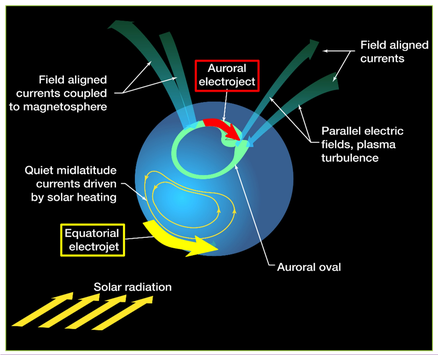
What is EZIE?

EZIE is a cost-effective three- CubeSat mission flying in a pearls-on-a-string configuration that uses a single compact four-beam spectro-polarimeter on each spacecraft and innovative Zeeman remote sensing technique to image, for the first time, the magnetic footprints of electrojets that flow at altitudes of ~100–130 km. EZIE provides measurements of the mesoscale structure (~150-500 km) and the temporal evolution (2-20 min) of the electrojets with a goal to resolve mysteries of these electrojets and paves the way for better space-weather predictions.



Mission Characteristics:
No. of spacecraft: 3
Payload: 4-beam Full-Stokes Radiometers

Orbit:
Circular: 325-675 km
Inclination: Sun-Sync
LTAN: 08:00-12:30 or 22:00 to 02:00

Mission Lifetime:
Commissioning: 2 months
Operations: 16 months

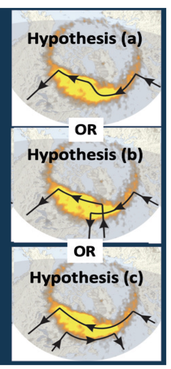
Launch Date: No earlier than Fall 2024

Launch: Secondary Payload on Falcon-9

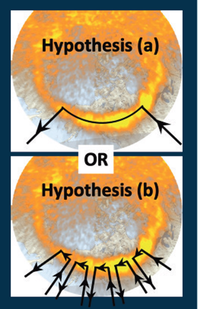
EZIE Mission Primary Science Objectives

EZIE Primary science goals are to resolves 45 year-old hot debates on the structures of the high-latitude current system.

TSQ 1:
EZIE will resolve the decade old debate about the substorm current wedge (SCW) configuration. Figure shows three published SCW scenarios as wire models superposed onto auroral images from the NASA Polar VIS Earth Camera.

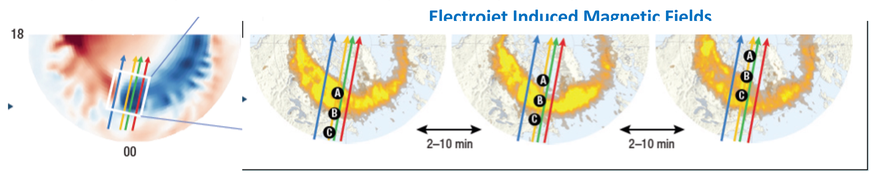


TSQ 2:
EZIE will determine to what extend the electrojet consist of small current wedgelets. Figure shows (a) the classical auroral electrojet configuration and (b) the recently much promoted wedgelet scenario.



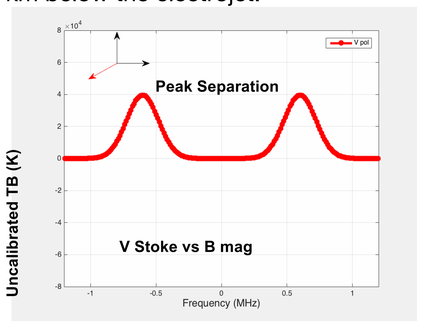
Mission Science Measurement Requirements

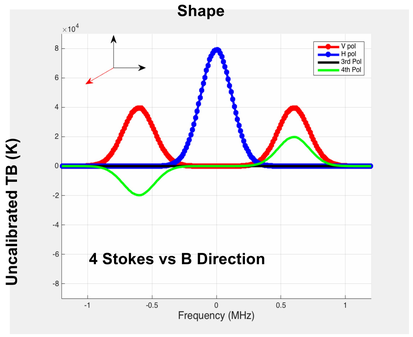
EZIE focuses on a new frontier of near-earth magnetic field measurements. EZIE shall obtain measurements of the aurora electrojet induced magnetic fields to reveal their “mesoscale” (~150–500 km) spatial structure and temporal evolution (~2-20 min) near the midnight sector at auroral latitudes (poleward of 55° Mlat) with a precision of 200 nT (~75 nT expected).



Innovative Current-Magnetic Field Sensing Technique

EZIE utilizes the Zeeman property of the O_2 118 GHz emission line to obtain the strength and direction of the magnetic field near ~80 km, about 20- 30 km below the electrojet.

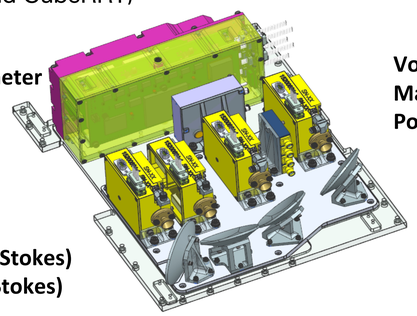




Heritage, Low Size, Weight, and Power Instrument

EZIE utilizes miniaturized room-temperature spectro-polarimeters with technologies develop and demonstrated for NASA Earth Sciences missions (e.g, TEMPEST-D and CubeRRT)

Heterodyne Spectrometer

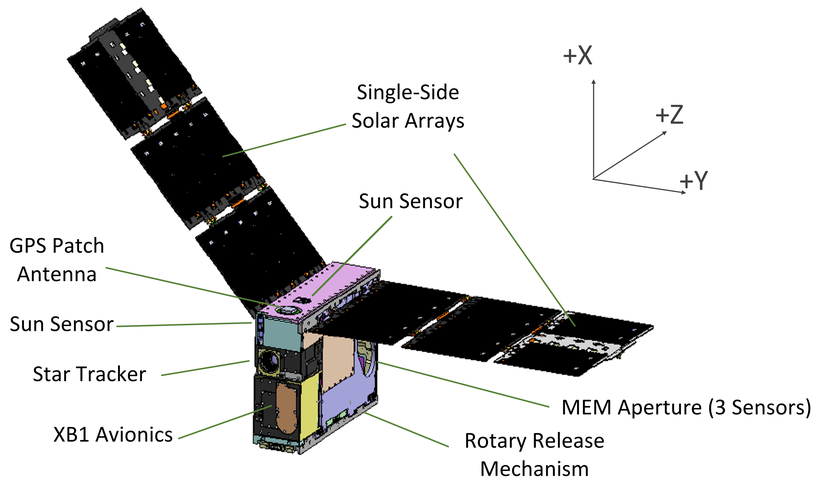


Band Width: 12 MHz
Resolution: 98 kHz
Field-of-view: ~4°
Int. Timet: 3 seconds
Noise: ~2.1 K (1st /2nd Stokes)
~2.9 K (3rd/4th Stokes)

Vol:~4 U
Mass: 4 kg
Powe: 17.8 W

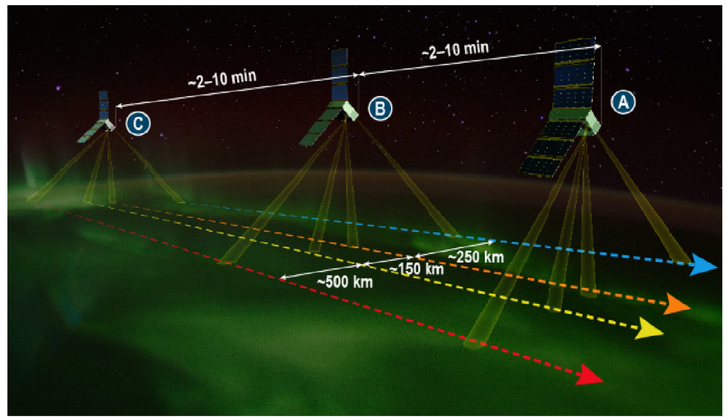
Heritage 6 U CubeSat

EZIE utilizes three 6U spacecraft flying in a pearls-on-a-string configuration to obtain the magnetic field perturbations induced by the electrojets simultaneously at different times.



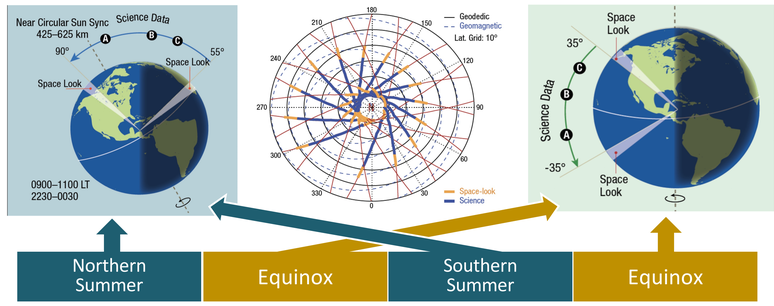
2D Imaging Mesoscale Spatial Structure of Electrojets

EZIE utilizes a 4-beam MEM spectro-polarimeter on each spacecraft to image the electrojets. It also utilizes differential drag technique to adjust the separations of the three pearls-in-a-string spacecraft to obtain temporal variation of the electrojets



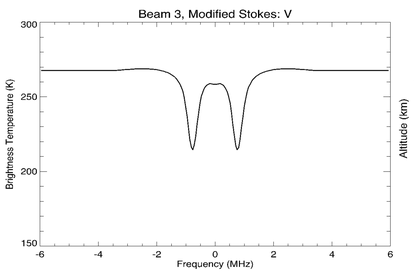
Optimized Observation Plan

EZIE utilizes an observation plan that optimizes measurement and resource needs.

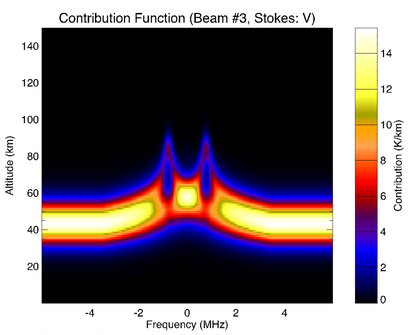


Secondary Science Products of Interests (winds and temperature)

EZIE also obtains line-of-sight winds and temperatures every 3 seconds from the Doppler shifts and brightness temperature of the O2 118 GHz spectral radiances .



Doppler Shift => 3 sec Line of Sight Winds around ~80 km with at ~2 m/sec precision



Spectral Radiances (brightness temperature) => temperature profile from ~40 km to 80 km with a precision of < 1K at 45 km.

Acknowledgment: NASA contracts to JHUAPL, JPL and GSFC for the development of the EZIE mission concept and design