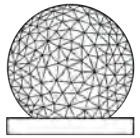
Haystack AeroVista REU

Hirani Sattenapalli, Aparna Rajesh, T. Lucas Briggs



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“Aurora Touching Sunrise” from NASA archives

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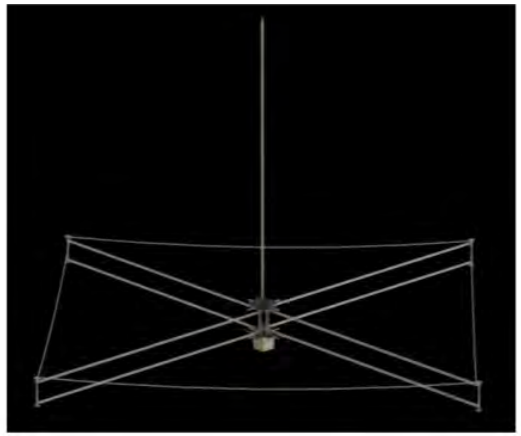
AERO VISTA Mission Introduction

AERO VISTA Payload ←



Antenna after Deployment →

- AERO & VISTA satellites will collect radio frequency (RF) data from the auroral regions
- Data will be used to accomplish science and tech goals
  - Study emissions such as Auroral Kilometric Radiation (AKR), Medium Frequency Burst (MFB), Auroral Roar, and Auroral Hiss
  - Validate usage of Vector Sensor Interferometry and RFI survey

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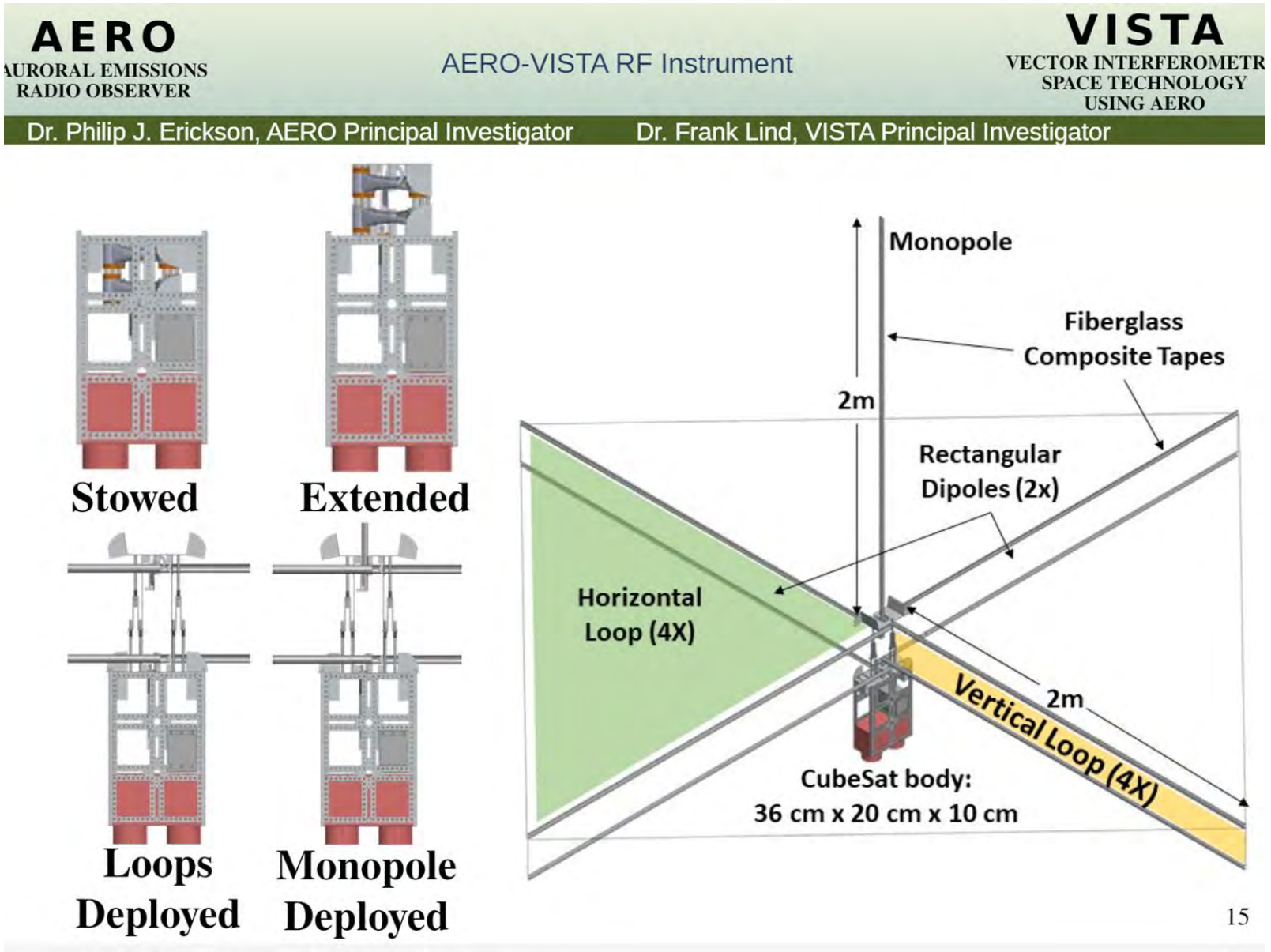
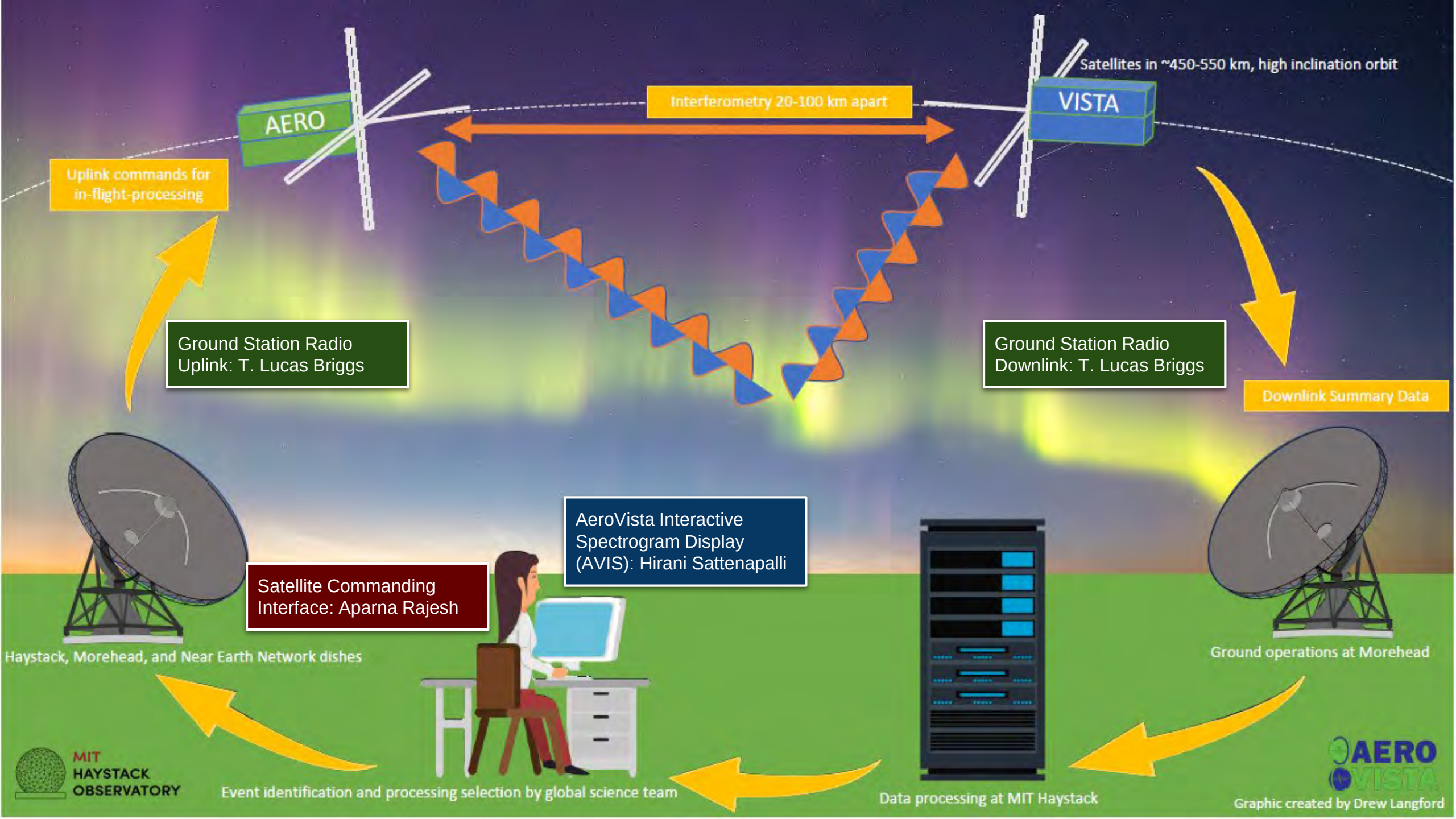


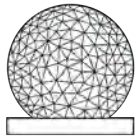
Monopole, Horizontal Loop, and Rectangular Dipoles correspond to channels on spectrogram

Slide from Mary Knapp AERO-VISTA presentation 2021


AERO
VISTA
Satellites in ~450-550 km, high inclination orbit
Interferometry 20-100 km apart
Uplink commands for in-flight-processing
Ground Station Radio Uplink: T. Lucas Briggs
Ground Station Radio Downlink: T. Lucas Briggs
Downlink Summary Data
AeroVista Interactive Spectrogram Display (AVIS): Hirani Sattenapalli
Satellite Commanding Interface: Aparna Rajesh
Haystack, Morehead, and Near Earth Network dishes
Ground operations at Morehead
MIT HAYSTACK OBSERVATORY
Event identification and processing selection by global science team
Data processing at MIT Haystack
AERO VISTA
Graphic created by Drew Langford

AERO-VISTA Interactive Spectrogram Display

Hirani Sattenapalli



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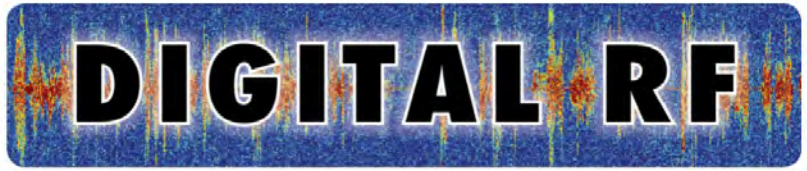
AVIS Display & Objectives

- Provide a tool for the science team to visualize metadata
- Present spectrogram data in plotly graphs
- Allow science team to perform computation on channel data and send commands for in-flight processing

Libraries Used

redis

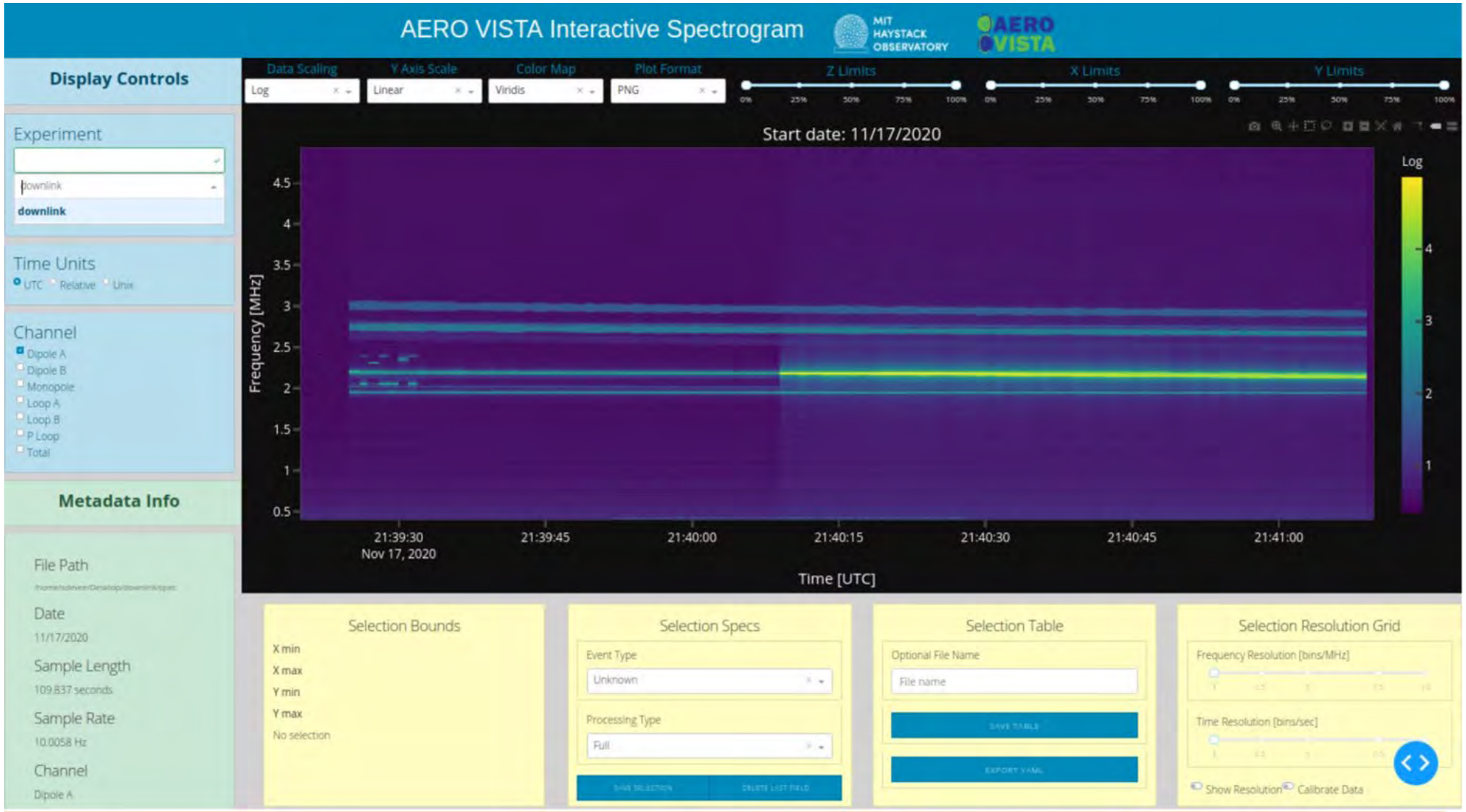


- Plotly
  - Graphing utility used for telemetry maps and spectrogram plots
- Redis
  - In-memory data structure used to store metadata
- Digital RF
  - Software used for reading and writing spectrogram metadata into digital RF format

Libraries Used

- Dash
  - Python framework to build web pages
  - Used to build and style layout and components of the dashboard
- Numpy
  - python library to work with arrays and matrices
- Xarray
  - python package that adds dimensions and coordinates to numpy arrays
  - used to organize metadata to place into redis

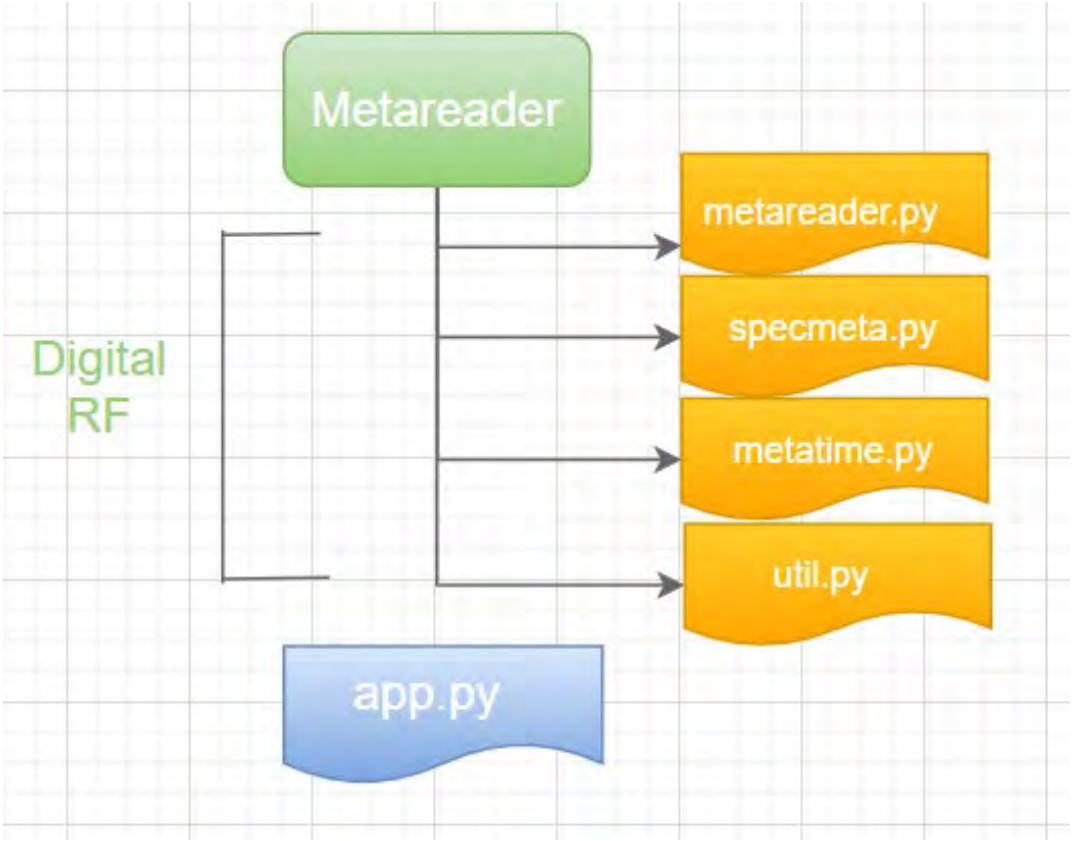
Existing AVIS Display



Goals for Dashboard Version 2.0

- Faster Loading of Data
  - Updating the spectrogram by retrieving and processing the summary data files presents a high computational load
- Display of Telemetry Data
  - Spacecraft speed, location, and altitude
  - Used to provide context for science team
- Generation of Subplots to do computation between channels
- Overall Design Changes to increase visual & user interactibility

File Structure



AVIS Version 1

- Metareader used to read summary data file
- Metatime provides timestamp data
- Specmeta creates spectrogram plot
- Util - creates dash components for the display

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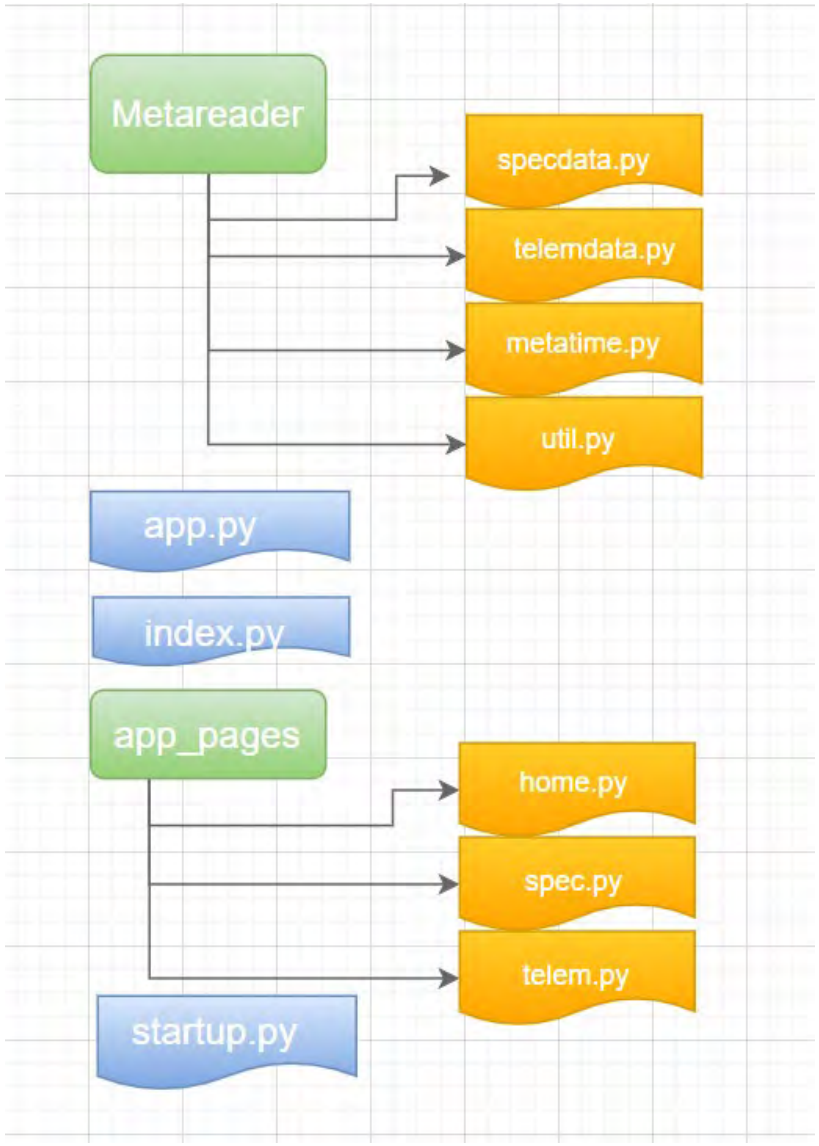
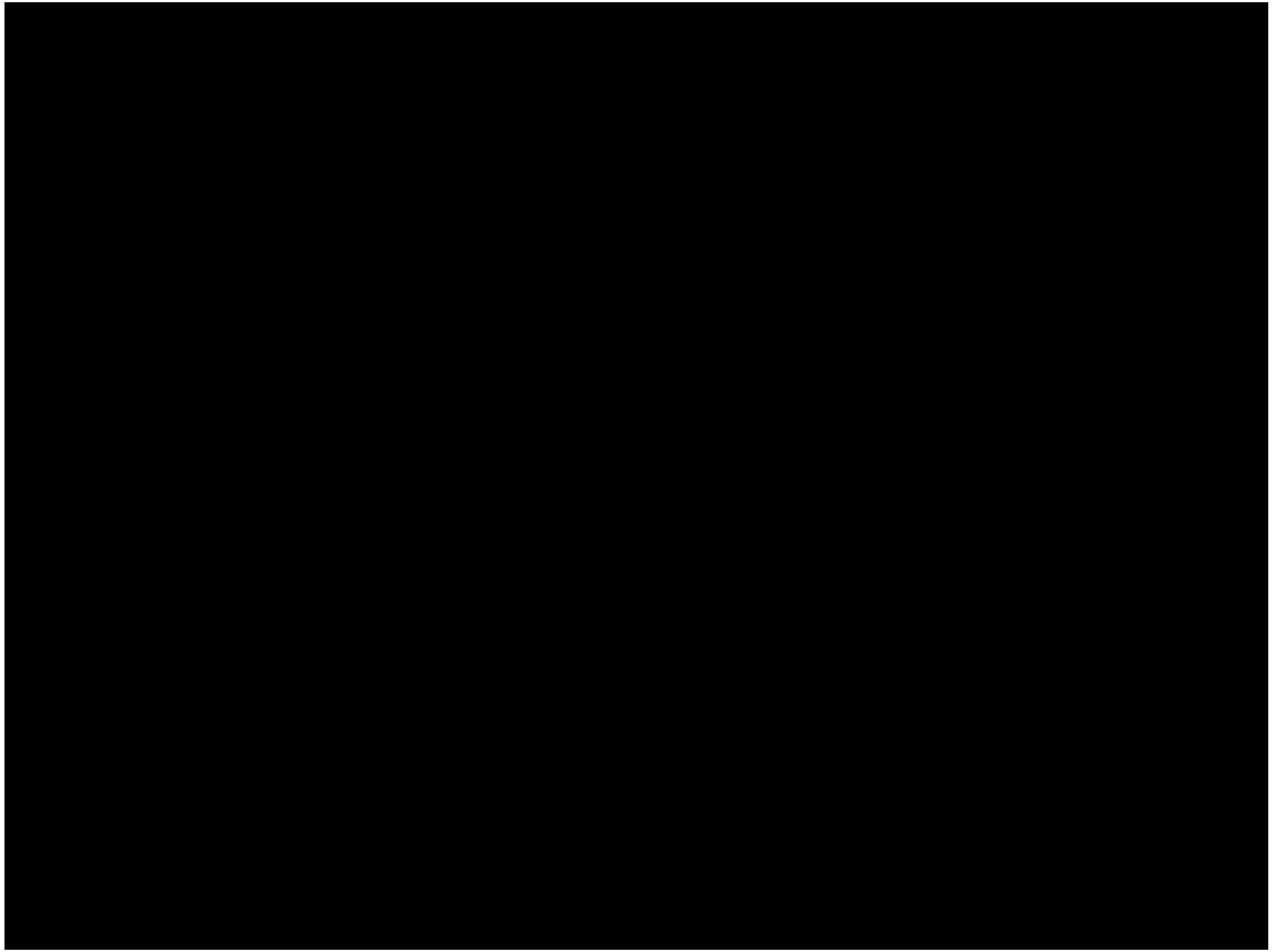
File Structure



AVIS Version 2.0

- Specmeta and Metareader files replaced with Specdata file
- Specdata:
  - used to enter summary data into redis for in-memory storage
- App.py files
  - Split into index.py, app.py, & app pages to accommodate multi-page dash app
  - Easier for future additions

Demo



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Summary of New Layout & Results

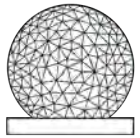
- App.py structure & index.py
  - Allows for easy addition of future improvements
- Redis interface & backend structure
  - Enters all spectrogram and time data into redis
  - Meant for future collaboration between Lucas and Aparna's work
  - Access files in redis and send uplink files into redis
- Speed
  - In memory storage of data did not speed up spectrogram plot generation as desired
  - Data input to redis makes it easier for data to be accessed and exported in the future

Summary of New Layout & Results Cont.

- Telemetry data page
  - Provides a data table of satellite speed, position/ location, & altitude
  - Provides context for science team when analyzing spectrogram data
- Subplots page
  - Continuous regeneration of spectrogram plots to use for computation between different channels (ex. sum(loops), mult(dipoles), division, linear combinations)
  - Used to classify if data is showing electrostatic or electromagnetic phenomena & type of emission

Future Work

- Computation between channels
  - Currently there is subplot generation; computation for channel math needs to be developed
- Improvements on redis structure
  - Data organization in redis and improvements on file access
- Satellite video/ display in home page
  - Future satellite data to be presented on the home page



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Citations

Erickson, et al. “AERO: Auroral Emissions Radio Observer”. *In: Conference on Small Satellites*. Aug. 2018. url: https : / / digitalcommons . usu . edu / smallsat/2018/all2018/453

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Volz, R., Rideout, W. C., Swoboda, J., Vierinen, J. P., & Lind, F. D. (2021). Digital RF (Version 2.6.6). MIT Haystack Observatory. Retrieved from https://github.com/MITHaystack/digital_rf

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