MMS-FPI Visualization Portal

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IHDEA Meeting
October 16-18, 2019

MMS-FPI Background

- Magnetospheric Multiscale Mission (MMS)
  - Primary focus to investigate magnetic reconnection in earth's magnetosphere
  - Launched 13 March 2015
  - Four identically instrumented observatories travelling in a tetrahedral formation
- Fast Plasma Investigation (FPI)
  - Primary goal to measure electron and positive ion phase space densities within earth's magnetosphere
  - 64 spectrometers (32 pairs) evenly distributed among the four observatories. Each observatory contains:
    - 4 Dual Electron Spectrometers (DES)
    - 4 Dual Ion Spectrometers (DIS)

FPI Science Data

- Full sky-maps (16 zenith x 32 azimuths) at 32 energies
- Fast Survey (FS) mode
  - 4.5 sec resolution for all regions of interest (ROI)
  - Two hour files
- Burst mode
  - Segments of interest selected by Scientist in the Loop (SITL)
  - Resolution
    - DES: 30 ms
    - DIS: 150 ms
  - File durations are length of selected burst interval (usually 1-5 minutes)
- Data stored in CDF format
- Variables
  - Distributions
  - Moments
  - Energy spectrograms
  - Partial moments

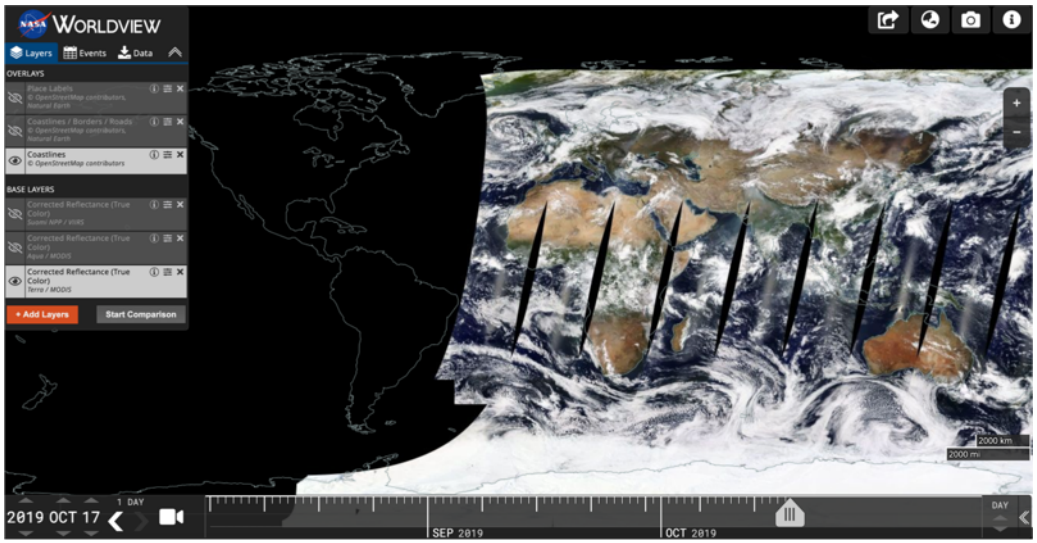
FPI Science Data

- L2 Data Holdings (as of 2019-10-15)
  - Burst: 770,262 files / 33.2 TB
  - Fast survey: 204,708 files / 8.7 TB
- Data archive
  - Science Data Center (SDC): https://lasp.colorado.edu/mms/sdc/public
  - Space Physics Data Facility (SPDF): https://spdf.gsfc.nasa.gov
- Data information and product guide
  - https://lasp.colorado.edu/mms/sdc/public/datasets/fpi
- Portal and visualizer (currently in prototype phase)
  - https://fpi.gsfc.nasa.gov

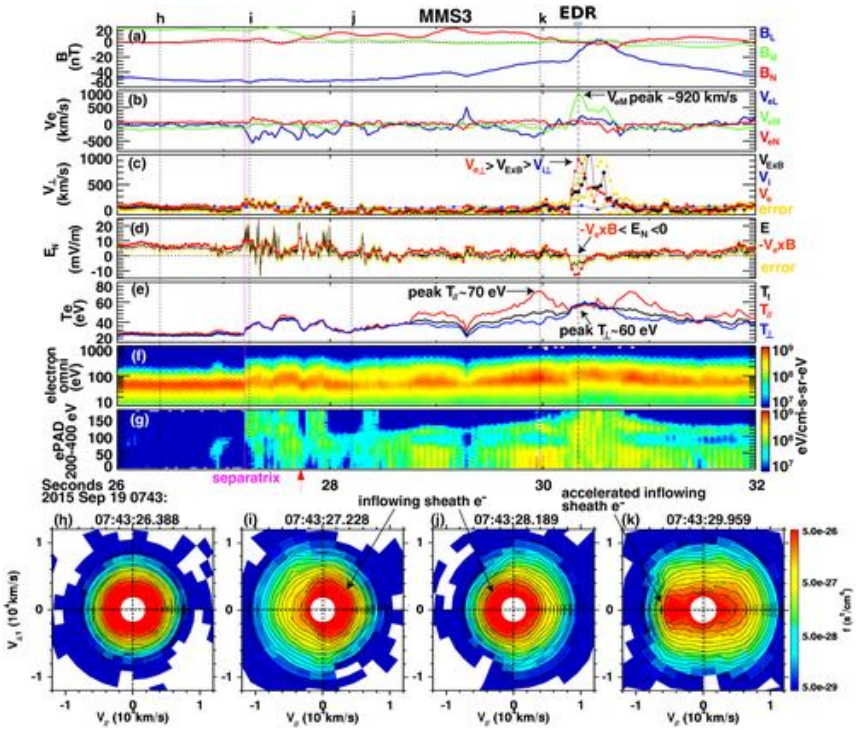
Inspiration

- Worldview
  - https://worldview.earthdata.nasa.gov
  - Interactively browse global, full-resolution satellite imagery
- Giovanni
  - https://giovanni.gsfc.nasa.gov/giovanni
  - Provides way to visualize, analyze, and access Earth science remote sensing data
- Aquarius L3 image browser
  - https://podaac.jpl.nasa.gov/aquarius/gallery
  - Animation by flipping through images
- Van Allen Probes Science Gateway
  - http://rbspgway.jhuapl.edu
  - Data, models, software and tools in support of the Van Allen Probes mission

Earth Science vs Heliophysics



VS



Earth Science vs Heliophysics

- Earth science
  - Easily relatable
  - Accessible
  - More tools / apps
  - Large community of non-scientist users: farmers, fishermen, rapid response, resource management, et al.
- Helio
  - Higher learning curve
  - Few immediate applications
  - User community mostly scientists
  - Mostly DOY tools
  - Same old IDL plots

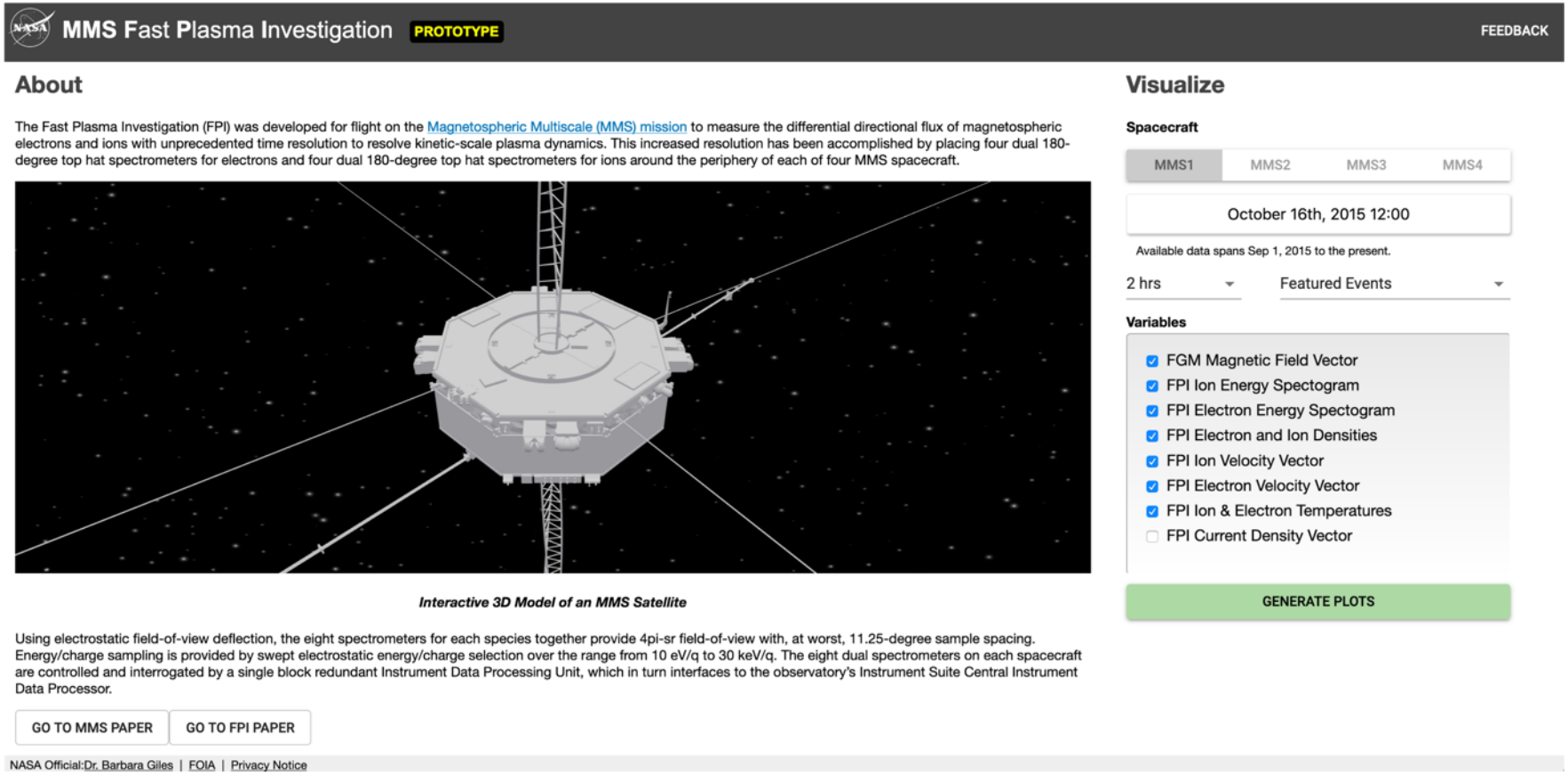
FPI Visualizer Initial Goals

- Fast, easy to use, and accessible (online) visualizer
- Science users
  - Interactive data browse and quicklook
  - More intensive data discovery and manipulation
  - Provide publication quality plots
  - Provide broader context for the data, e.g., where were the observatories during a time period, etc.
- Non-science users
  - Understanding of the mission's objectives
  - Outreach

FPI Visualizer (prototype) Features

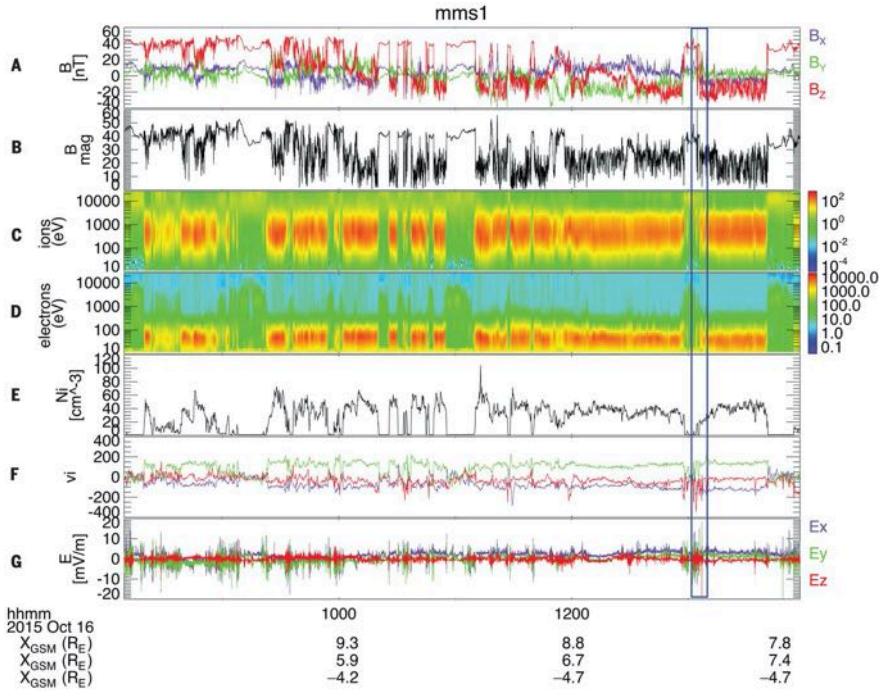
- URL: https://fpi.gsfc.nasa.gov
- Selection criteria
  - Observatory
  - Date
  - Featured dayside electron diffusion region (EDR) encounters identified by J. Webster (https://doi.org/10.1029/2018JA025245, 2018)
- Plots
  - 2, 4, and 6 hour plots of FPI and magnetic field (FGM) data on demand
  - Plots of burst data; fast survey if burst not available
- Interactivity
  - Hover over variable to show time and measurement
  - Zoom in for finer temporal view
- Download and permalink

FPI Visualizer Home Page

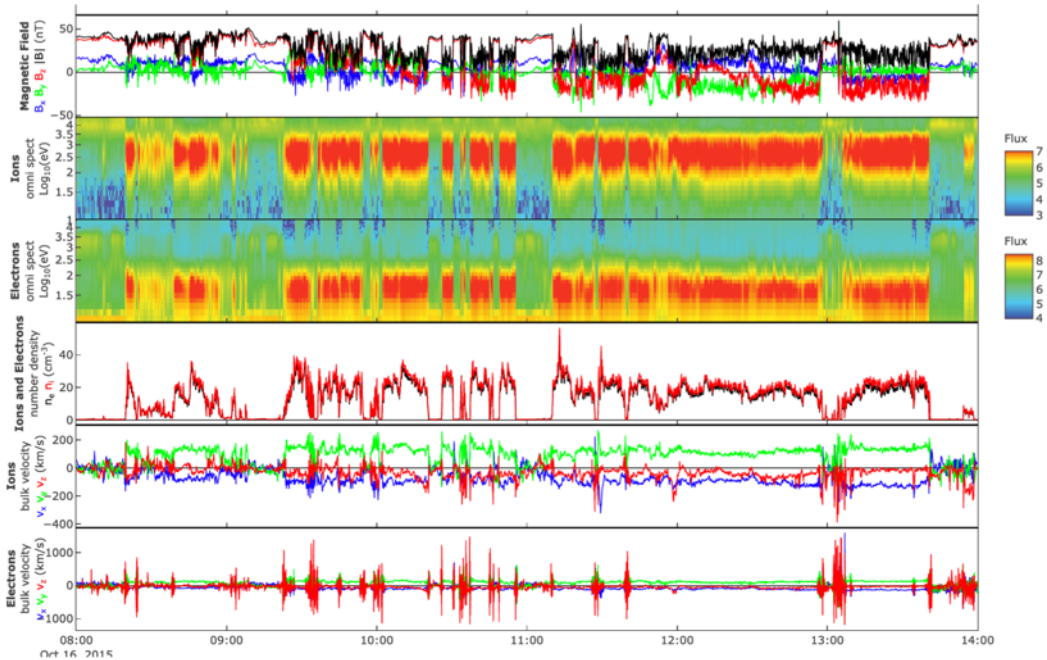


J. Burch plot vs FPI Visualizer

https://science.sciencemag.org/content/352/6290/aaf2939



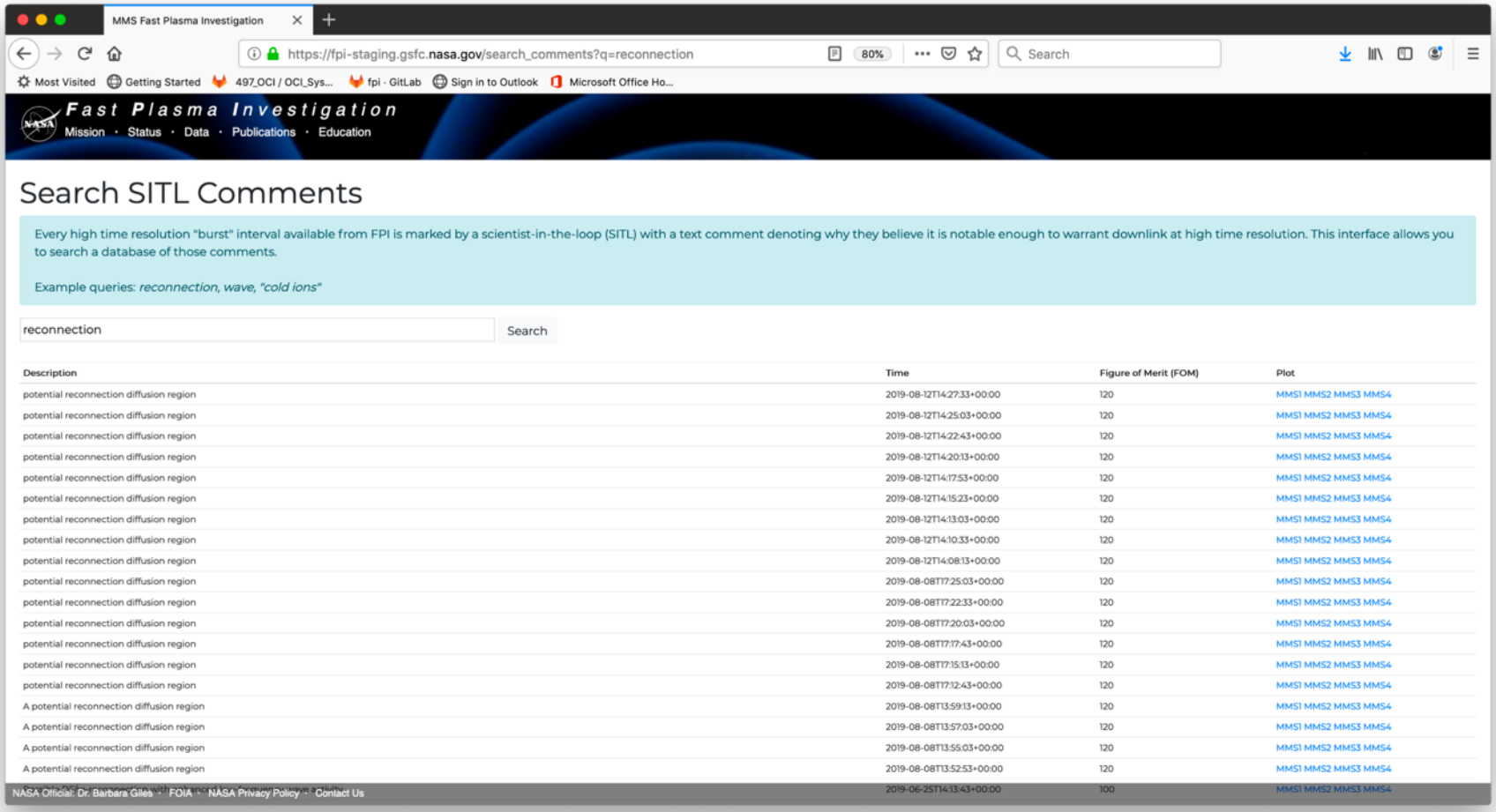
FPI Visualizer (dev version)



FPI Visualizer (prototype) Development

- Frontend
  - React: JavaScript library for building user interfaces
  - Plotly: plotting library
- Backend
  - Django: Python web framework
  - CDAS RESTful Web services: access data from the SPDF
- Initial release: December 2018 for AGU fall meeting
- New release: Late fall 2019
- More frequent releases to follow

Search SITL Comments



Path Forward

- Emulate “IDL-like” plots seen in publications
- Allow plot downloads in format that can be manipulated; e.g., PDF, etc.
- Data download links
- Arrange order of plots
- More variables, including distributions
- Multi-spacecraft plots
- Subset energies
- Search on SITL burst comments
- Plots by observatory position
- Tagging of intervals
- Animation
- Incorporation in upcoming FPI Portal

Feedback

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