MMS Data Access

A tutorial

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B21/Rm 183A
1-2 pm
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NASA Goddard Space Flight Center

MMS Data Access

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- Data Display/Analysis Tools
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  - Autoplot
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  - Reading data and making plots
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MMS Data Access

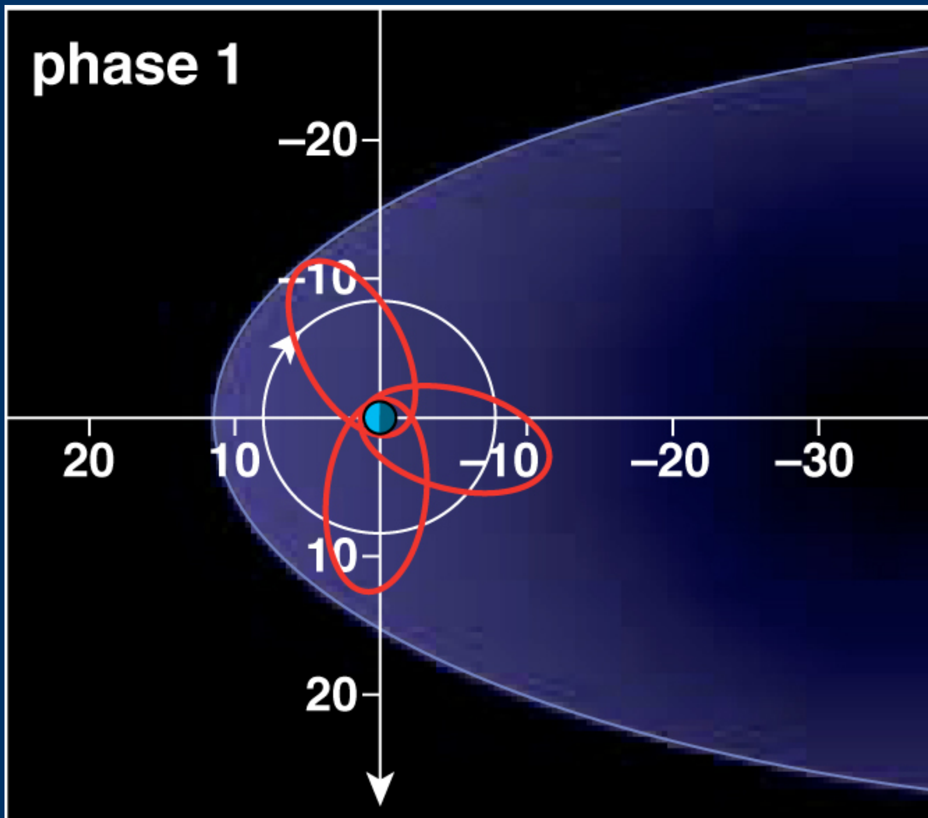
All slides and support material for this presentation will be posted on the public SDC page

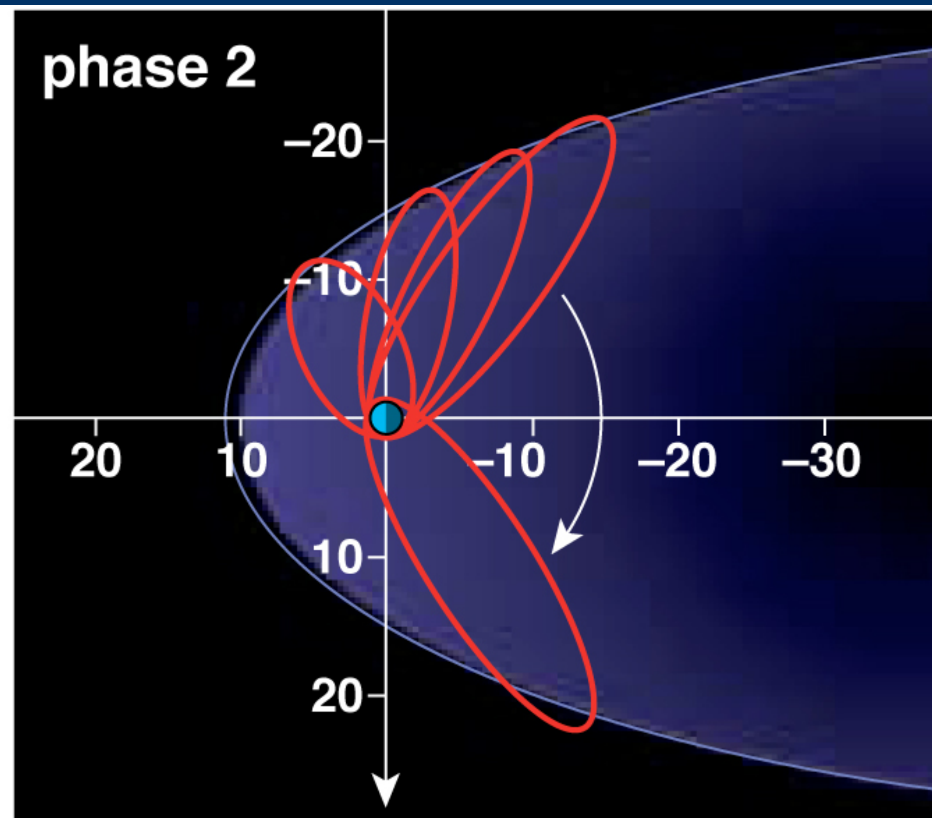
and the internal-NASA/Goddard SEDwiki

Future tutorials will be arranged based on interests.
Please send feedback and comments to:
Guan.Le@nasa.gov

Orbital Phases

- The overall objective of MMS is to investigate magnetic reconnection on the electron and ion scales.
- MMS employs two mission phases with inclination of 28 deg. to optimize encounters with both dayside and nightside reconnection regions.

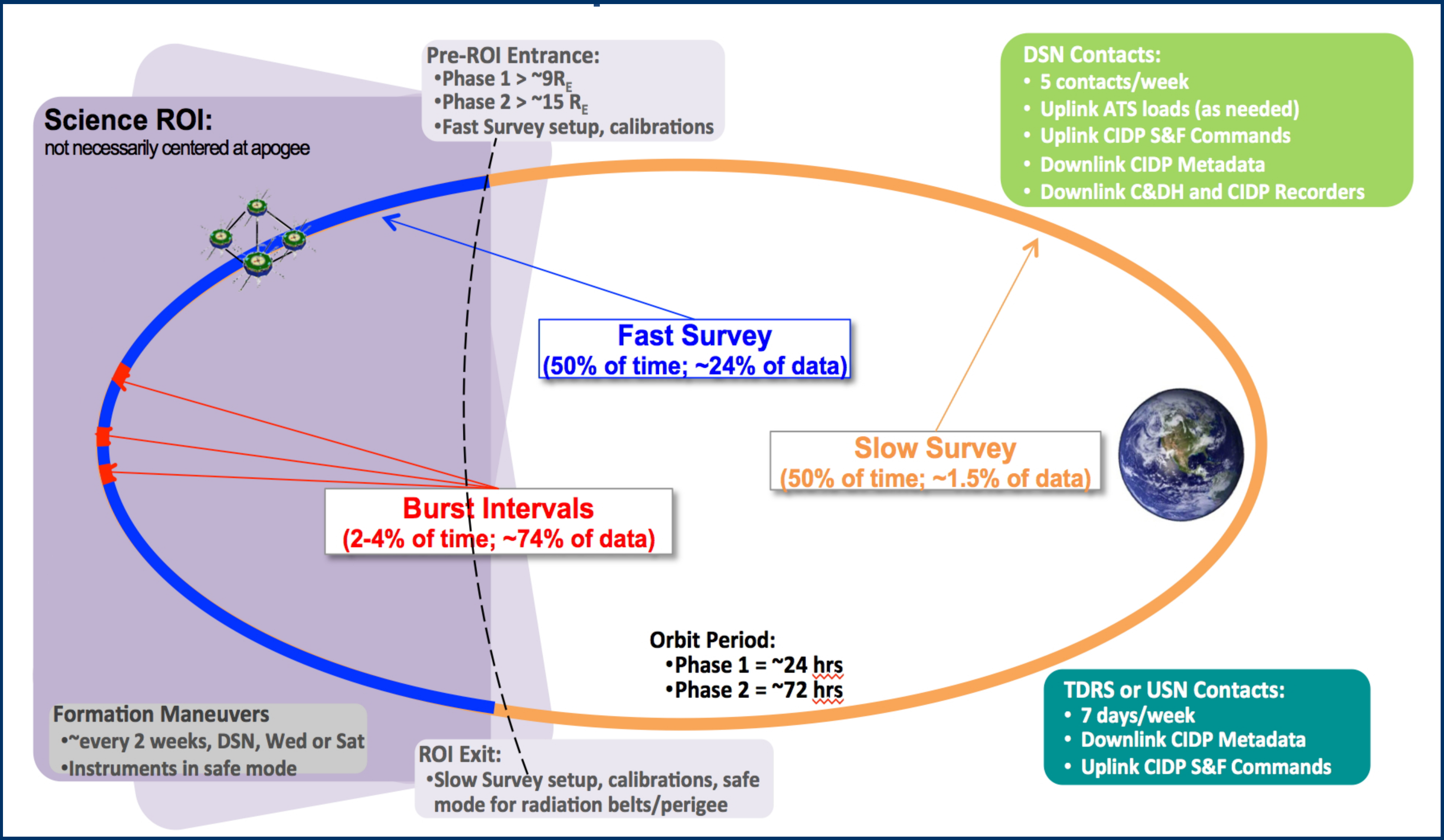




Dayside Magnetopause:
Phase 1a – September 1, 2015
Phase 1x – March 8, 2016
Phase 1b – September 26, 2016

Dayside Magnetopause and Nightside Neutral Sheet:
Phase 2a – January 31, 2017
Phase 2b – May 1, 2017

Region of Interest (ROI) and Data Types



Public Data

Quick Look	Scientific data products generated using simplified science processing algorithms and/or provisional calibrations and intended to provide only basic scientific insight. Generation will occur as quickly as possible.	24-hr latency
Level-2	Data processed to physical units and/or derived geophysical parameters by combining calibration, ancillary, and other data. These represent the lowest level of research grade scientific data.	30-day latency starting NLT 6 months after commissioning
Level-3	Mission Level Data Products (MLDP). These have been resampled spatially and/or temporally and may be measurements from multiple instruments to produce a merged data set.	Event-based

Rules of Data Use

https://lasp.colorado.edu/mms/sdc/public/about/

lasp.colorado.edu

Home | About the Data | Quicklook | Search | Datasets | Software | Links | Team Site

Data Rights and Rules

The terms for distribution and use of the MMS data products are specified in the NASA Heliophysics Science Data Management Policy document, and are summarized here in terms of the MMS mission. These guidelines govern both the production and distribution of scientific data sets by the MMS program, and also use of the MMS data by the science community and general public, and are summarized below.

- Beginning no later than 6-months after instrument commissioning, MMS instrument teams will generate definitive, scientifically useful data products and deliver to the SOC within 30 days of downlink from each spacecraft.
- Users should use QuickLook data plots for event browsing, and not for scientific analysis or publication without express consent of the PI and relevant Lead Co-Investigators.

1. MMS-SMART data products are open to all scientists and the public (Users).
2. There are no proprietary periods associated with any of the MMS-SMART data products.
3. Users shall have timely access to the scientifically useful data and analysis tools that are equivalent to the level that the MMS-SMART science working team uses.
4. Users should contact the MMS-SMART Principal Investigator (PI) and the relevant lead co-investigators of the instrument or modeling group early in an analysis project to consult on the appropriate use of instrument data or model results.
5. Users who wish to publish results derived from MMS data should directly involve the MMS-SMART PI and/or Instrument Leads and team members as appropriate in the analysis and to offer co-authorship. Co-authorship may be declined.
6. Users should heed the caveats of investigators as to the interpretation and limitations of data or model results. All important caveats should be included in the publication, even if co-authorship is declined. Data and model version numbers should also be specified.
7. Users should acknowledge the sources of data used in all publications, presentations, and reports. Appropriate acknowledgement to institutions, personnel, and funding agencies should be given.
8. Users should provide the MMS-SMART PI and/or instrument Lead CoIs a copy of each manuscript that uses MMS-SMART data upon submission of that manuscript for consideration of publication. Upon publication, the citation should be transmitted to the PI and any other providers of data.
9. Users should widely distribute, to interested parties, their conference abstracts, presentations, and publications.
10. Users should make tools of general utility and/or value-added data products widely available to the community, and to notify the MMS-SMART PI of such utilities or products, having clearly labeled the product as being different from an original MMS-SMART produced data product.

MMS Instrument Team Contact

https://lasp.colorado.edu/galaxy/display/mms/MMS+Instrument+Team+Members+for+Scientific+Collaborations

MMS Science / MMS Science Working Team Home

MMS Instrument Team Members for Scientific Collaborations

Created by Guan Le, last modified on Mar 07, 2016

The following is a list of scientists who can answer MMS project and data questions and are available for scientific collaborations.

Mission Leads:

- Jim Burch, PI, SwRI (jburch @ swri.edu)
- Roy Torbert, Deputy PI, UNH, (Roy.Torbert @ unh.edu)
- Tom Moore, Project Scientist, GSFC (Thomas.E.Moore @ nasa.gov)

EDP – Electric Field Double Probes – Axial Double Probes (ADP)

- Robert Ergun, lead, LASP (ree @ lasp.colorado.edu)

EDP – Electric Field Double Probes – Spin-plane Double Probes (SDP)

- Per-Arne Lindqvist, lead, KTH Stockholm (lindqvist @ plasma.kth.se)
- Yuri Khotyaintsev, IRF Uppsala (yuri @ irfu.se)
- Göran Marklund, KTH Stockholm (goran.marklund @ ee.kth.se)
- Tomas Karlsson, KTH Stockholm (tomask @ kth.se)
- Daniel Graham, IRF Uppsala (dgraham @ irfu.se)
- Andris Vaivads, IRF Uppsala (andris @ irfu.se)

FGM - Flux Gate Magnetometers (AFG and DFG)

- Chris Russell, lead, UCLA (ctrussel @ igpp.ucla.edu)
  Bob Strangeway, UCLA (strange @ igpp.ucla.edu)
- Rumi Nakamura, IWF Graz (rumi.nakamura @ oeaw.ac.at)
- Ferdinand Plaschke, IWF Graz (Ferdinand.Plaschke @ oeaw.ac.at)
- Guan Le, GSFC (Guan.Le @ nasa.gov)
- Jim Slavin, U. Michigan (jaslavin @ umich.edu)
- Brian Anderson, JHU/APL (Brian.Anderson @ jhuapl.edu)

SCM – Search Coil Magnetometer

- Olivier Le Contel, lead, LPP (olivier.lecontel @ lpp.polytechnique.fr)
- Matthieu Berthomier, LPP (matthieu.berthomier @ lpp.polytechnique.fr)
- Alessandro Retinò, LPP (alessandro.retino @ lpp.polytechnique.fr)
- Fouad Sahraoui, LPP (fouad.sahraoui @ lpp.polytechnique.fr)
- Hugo Breuillard, LPP (hugo.breuillard @ lpp.polytechnique.fr)

EDI – Electron Drift Instrument

- Roy Torbert, lead, UHN (Roy.Torbert @ unh.edu)
- Hans Vaith, UNH (hans.vaith @ unh.edu)
- Ivan Dors, UNH (ivan.dors @ unh.edu)
- Hiroshi Matsui, UHN (hiroshi.matsui @ unh.edu)
- Matt Argall, UNH (matthew.argall @ unh.edu)
- Craig Kletzing, U. Iowa (craig-kletzing @ uiowa.edu)
- Scott Bounds, U. Iowa (scott-bounds @ uiowa.edu)
- Rumi Nakamura, IWF Graz (rumi.nakamura @ oeaw.ac.at)

FPI – Fast Plasma Instrument

- Barbara Giles, lead, NASA GSFC, (barbara.giles @ nasa.gov)
- Craig Pollock, lead emeritus (craig @ denaliscientific.org)
- John Dorelli, NASA GSFC (john.dorelli @ nasa.gov)
- William Paterson, NASA GSFC (william.r.paterson @ nasa.gov)
- Dan Gershman, NASA GSFC (daniel.j.gershman @ nasa.gov)
- Levon Avanov, NASA GSFC (levon.a.avanov @ nasa.gov)
- Michael Chandler, NASA MSFC (michael.chandler@nasa.gov)
- Victoria Coffey, NASA MSFC (victoria.coffey@nasa.gov)
- Benoit Lavraud IRAP/CNRS (blavraud @ irap.omp.eu)
- Yoshifumi Saito, ISAS/JAXA (saito @ stp.isas.jaxa.jp)
- Conrad Schiff, NASA GSFC (conrad.schiff-1 @ nasa.gov)

HPCA – Hot Plasma Composition Analyzer

- Stephen Fuselier, lead, SwRI (sfuselier @ swri.edu)
- Roman Gomez , SwRI (rgomez @ srwi.edu)
- Karlheinz Trattner, LASP (Karlheinz.Trattner @ lasp.colorado.edu)
- Steve Petrinec, LMATC (steven.m.petrinec @ lmco.com)

EPD – Energetic Particle Detector - Fly's Eye Energetic Particle Sensor (FEEPS) and Energetic Ion Spectrometer (EIS)

- Barry Mauk, lead, JHU/APL (Barry.Mauk @ jhuapl.edu)
- J. Bernard Blake, Aerospace (FEEPS) (JBernard.Blake @ aero.org)
- Joseph Fennell, Aerospace (FEEPS) (joseph.fennell @ aero.org)
- James Clemmons, Aerospace (James.H.Clemmons @ aero.org)
- Dan Baker, LASP (Daniel.Baker @ lasp.colorado.edu)
- Geoff Reeves, LANL (reeves @ lanl.gov)
- Harlan Spence, UNH (harlan.spence @ unh.edu)
- Ian Cohen, APL (ian.cohen @ jhuapl.edu)
- Joseph Westlake, APL (EIS) (Joseph.Westlake @ jhuapl.edu)
- Allison Jaynes, LASP (FEEPS) (allison.jaynes @ lasp.colorado.edu)

ASPOC - Active Spacecraft Potential Control Devices

- Rumi Nakamura, lead, IWF Graz (rumi.nakamura @ oeaw.ac.at)
- Harald Jeszenszky, IWF Graz (harald.jeszenszk @ oeaw.ac.at)
- Maria Andriopoulou, IWF Graz (maria.andriopoulou @ oeaw.ac.at)
- Philippe Escoubet, ESA ESTEC (Philippe.Escoubet @ esa.int)

MMS Data Portal

Coordinate Data Analysis Web- CDAWeb (NASA/Goddard)

- Online as of March 1, 2016
- Level 2 data products only (9/1/2015 to ~30 days from present)
- Data format: CDF (http://cdf.gsfc.nasa.gov), but ASCII as well
- Landing Page http://cdaweb.gsfc.nasa.gov
- Directory browse http://cdaweb.sci.gsfc.nasa.gov/pub/data/mms/
- Current Instruments available (as of March, 2016):

  FPI = Fast Plasma Investigation
  DSP = Spectra (electric/magnetic fields)
  EDP = Electric field double probe
  EDI = Electron Drift Instrument
  FEEPS = Energetic Particle sensor
  FGM = Flux gate magnetometer
  SCM = Search coil magnetometer
  ASPOC = Active S/C Potential
  MEC = Magnetic Ephemeris and support data

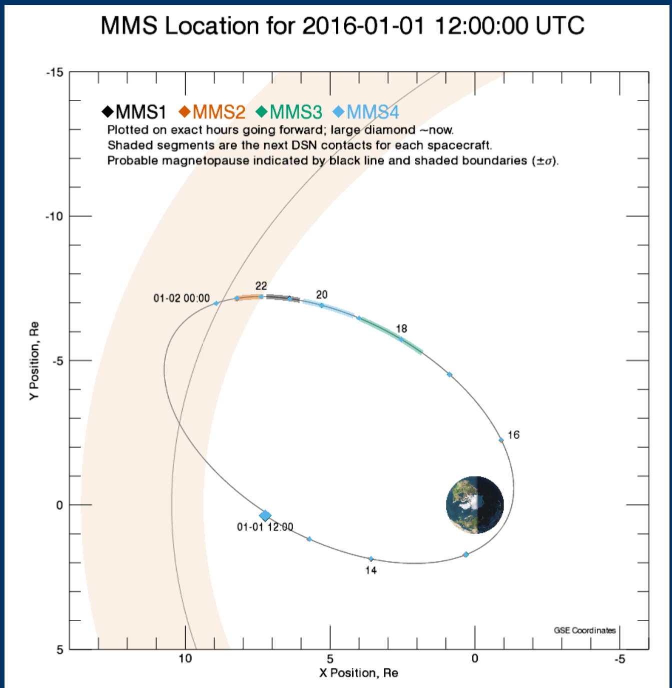
CDAWeb MMS Current Inventory

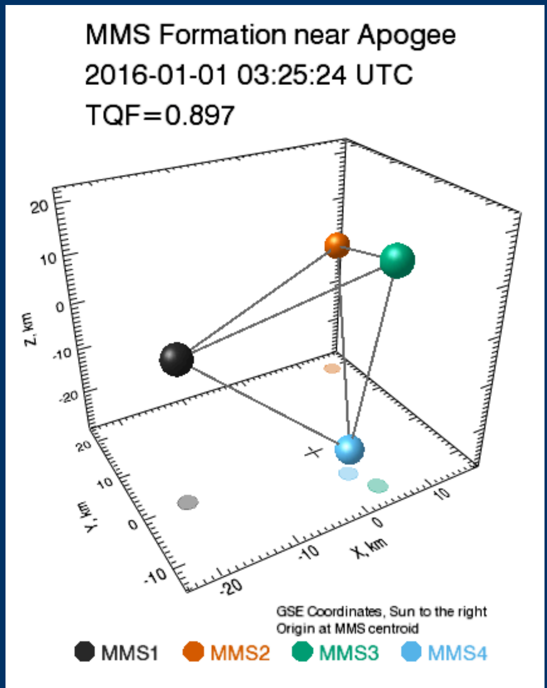
http://cdaweb.gsfc.nasa.gov/sc_inventory_plots/MMS_Public_Inventory.gif

MMS Data Portal

SDC (Science Data Center, LASP)

- Landing Page https://lasp.colorado.edu/mms/sdc/public/
- Online as of March 1, 2016
- Public Level 2 data products only (9/1/2015 to ~30 days from present)
- Data format: CDF
- Current Instruments available: Similar to CDAWeb





MMS Data Portal

SDC (Science Data Center)

- Data access options
  - Web (RESTful HTTPS API via wget)
    https://lasp.colorado.edu/mms/sdc/public/about/how-to/
  - Directory browsing (grab specific CDF data files)
    https://lasp.colorado.edu/mms/sdc/public/about/browse-wrapper/
  - Data Search (ZIP archive download, SDC dir structure)
    https://lasp.colorado.edu/mms/sdc/public/search/
- Data Availability
  https://lasp.colorado.edu/mms/sdc/public/about/processing/
- About data sets and most recent files
  https://lasp.colorado.edu/mms/sdc/public/datasets/

Data Display and Analysis Tools

CDAWeb

- Data Explorer (web based plotting)
  - Option to download CDFs

http://cdaweb.gsfc.nasa.gov/istp_public/

ISTP Skeleton Editor (for examining CDF file metadata)

http://sscweb.gsfc.nasa.gov/skteditor/

Satellite Situation Center (SSCWeb), MMS ephemeris data & conjunctions

http://sscweb.gsfc.nasa.gov/

4-D orbit viewer (Java based tool)

http://sscweb.gsfc.nasa.gov/tipsod/

Orbit plots (GIF walk) useful for MMS and other satellites

http://cdaweb.gsfc.nasa.gov/cgi-bin/gif_walk/

Data Display and Analysis Tools

CDAWeb: SPDF Get Data Routine

- A standalone IDL routine is available for loading data directly from SPDF: `spdfgetdata`

  http://cdaweb.gsfc.nasa.gov/WebServices/REST/CdasIdlLibrary.html

  http://cdaweb.gsfc.nasa.gov/WebServices/REST/idl/api/spdfgetdata.html#SpdfGetData

- Download `spdfcdas.sav` from the above link and then restore.
- Example to load MMS1 FGM data:

```
IDL>d=spdfgetdata('MMS1_FGM_SRVY_L2', 'ALL-VARIABLES',['2015-10-30','2015-10-31'], $
/verbose, /keep)

IDL>help, d,/struc

IDL>d2=read_mycdf('',/all,'filename.cdf')
```

  http://spdf.gsfc.nasa.gov/CDAWlib.html#read_mycdf

- Data quantities accessible through the structure via: `d.variablename.dat`
- `/keep` will keep the downloaded CDF file, else the `spdfgetdata` routine will erase it (leaving only the d structure)
- Variable names can be found through the list compiled on CDAWeb:

http://cdaweb.gsfc.nasa.gov/pub/software/cdaweb_idl_clients/cdaweb_get_bin/List_of_valid_CDAWEB_dataset_IDs_and_variable_names.txt

- The spdfcdas.sav package also contains a GUI broswer, spdfcdawebchooser:

```
IDL>spdfcdawebchooser
```

Data Display and Analysis Tools

Autoplot

- JAVA based interactive display tool (one of the very few JAVA apps that I use!)
- Reasonably fast for data display
- Can load a variety of data formats, including CDF
- Some programming functionality through Jython (Python on a JAVA platform)
- Examples of data loading: single CDF file, built-in CDAWeb browser.

Landing Page: http://autoplot.org

Download: http://autoplot.org/jnlp/latest/autoplot.jar

Help: http://autoplot.org/help

Data Display and Analysis Tools

SPEDAS (Space Physics Environment Data Analysis Software)

- IDL based (legacy TPlot) software suite for data display and analysis
- Used by a variety of missions (e.g., THEMIS, WIND, GOES)
- Actively being extended for the MMS mission
- Efficient front-end for loading MMS data via `mms_load_*` routines
- Can access both CDAWeb and SDC data repositories
- Software package updated daily!

Wiki:

http://spedas.org/wiki/index.php?title=Main_Page

Bleeding Edge software:

http://themis.ssl.berkeley.edu/socware/bleeding_edge/

Log of updates:

http://spedas.org/changelog/

Data Display and Analysis Tools

SPEDAS Install

1. Grab the latest bleeding edge package (spdsw_latest.zip)
   `http://themis.ssl.berkeley.edu/socware/bleeding_edge/`
2. Unzip spdsw_latest.zip
3. Set IDL !PATH to point to bleeding edge release
   Command line Example (or put in .idl_startup.pro):
   `!PATH = !PATH + ":"+expand_path('+/path/to/spdsw_r20346_2016-03-07')`
   IDLde: Preferences/IDL/Paths

   *** Special Note: Make sure any other SPEDAS/Tplot packages are not in the !PATH prior to the bleeding edge version, since different versions of SPEDAS are NOT compatible.

4. Install later version of CDF in IDL (prior to 8.5) if necessary (need at least ver. 3.6.0: `IDL>help, /DLM, 'CDF'`
   `http://cdf.gsfc.nasa.gov/html/cdf_patch_for_idl.html`

5. Generate Help docs (routine is available as part of this presentation package):
   `IDL>mms_spdsw_help`

   Output are two files (view with browser):
   spdsw_rxxxxx_YYYY-MM-DD_mms_help.html
   spdsw_rxxxxx_YYYY-MM-DD_tplot_help.html

Data Display and Analysis Tools

SPEDAS mms_load_* routines

- **Most important keywords:**

```
trange=['YYYY-MM-DD/hh:mm:ss', 'YYYY-MM-DD/hh:mm:ss']
Probes=['1', '2', '3', '4']
level='l2'
data_rate='srvy'
/spdf
varformat
```

- **Example (quickly create time series plots of some data):**

```
IDL>mms_load_fgm, trange=['2015-09-30/10:00:00',
'2015-09-30/13:00:00'],probes=['1'], level='l2',
data_rate='srvy', /spdf
IDL>tplot_names
IDL>tplot, ['mms1_fgm_b_gsm_srvy_l2']
IDL>get_data, 'mms1_fgm_b_gsm_srvy_l2', time, data
```

- Use /spdf to load data from SPDF, leave off to load from SDC (but check save and ok on username/password dialog to suppress pop-up in the future)
- Ephemeris data from: `mms_load_mec`
- Data downloaded to home dir: `/data/mms`
- Many more examples (cribs) can be found in the spdsw package:

  `idl/projects/mms/examples`

- MMS_LOAD_AFG
- MMS_LOAD_ASPOC
- MMS_LOAD_ASPOC_CRIB
- MMS_LOAD_ATT_TPLOT
- MMS_LOAD_DATA
- MMS_LOAD_DATA_SPDF
- MMS_LOAD_DATA_UT__DEFINE
- MMS_LOAD_DFG
- MMS_LOAD_DSP
- MMS_LOAD_DSP_CRIB
- MMS_LOAD_EDI
- MMS_LOAD_EDI_CRIB
- MMS_LOAD_EDP
- MMS_LOAD_EDP_CRIB
- MMS_LOAD_EIS
- MMS_LOAD_EIS_BURST_CRIB
- MMS_LOAD_EIS_CRIB
- MMS_LOAD_EIS_CRIB_QLPLOTS
- MMS_LOAD_EPH_TPLOT
- MMS_LOAD_FEEPS
- MMS_LOAD_FEEPS-EIS_CRIB_QLPLOTS
- MMS_LOAD_FEEPS_CRIB
- MMS_LOAD_FEEPS_CRIB_QLPLOTS
- MMS_LOAD_FGM
- MMS_LOAD_FGM_BURST_CRIB
- MMS_LOAD_FGM_CRIB
- MMS_LOAD_FPI
- MMS_LOAD_FPI_BURST_CRIB
- MMS_LOAD_FPI_CALC_OMNI
- MMS_LOAD_FPI_CALC_PAD
- MMS_LOAD_FPI_CRIB
- MMS_LOAD_FPI_CRIB_QLPLOTS
- MMS_LOAD_FPI_CRIB_QLPLOTS_L2
- MMS_LOAD_FPI_FIX_ANGLES
- MMS_LOAD_FPI_FIX_DIST
- MMS_LOAD_FPI_FIX_SPECTRA
- MMS_LOAD_HPCA
- MMS_LOAD_HPCA_BURST_CRIB
- MMS_LOAD_HPCA_CRIB
- MMS_LOAD_HPCA_CRIB_QLPLOTS
- MMS_LOAD_MEC

Magnetic Field Data Access

Magnetometers on each spacecraft

AFG=Analog Fluxgate Magnetometer

DFG=Digital Fluxgate Magnetometer

SCM=Search Coil Magnetometer

- Combined AFG+DFG=FGM, used for L2 CDF files.

FGM Modes

slow/fast survey (8 or 16 Hz)

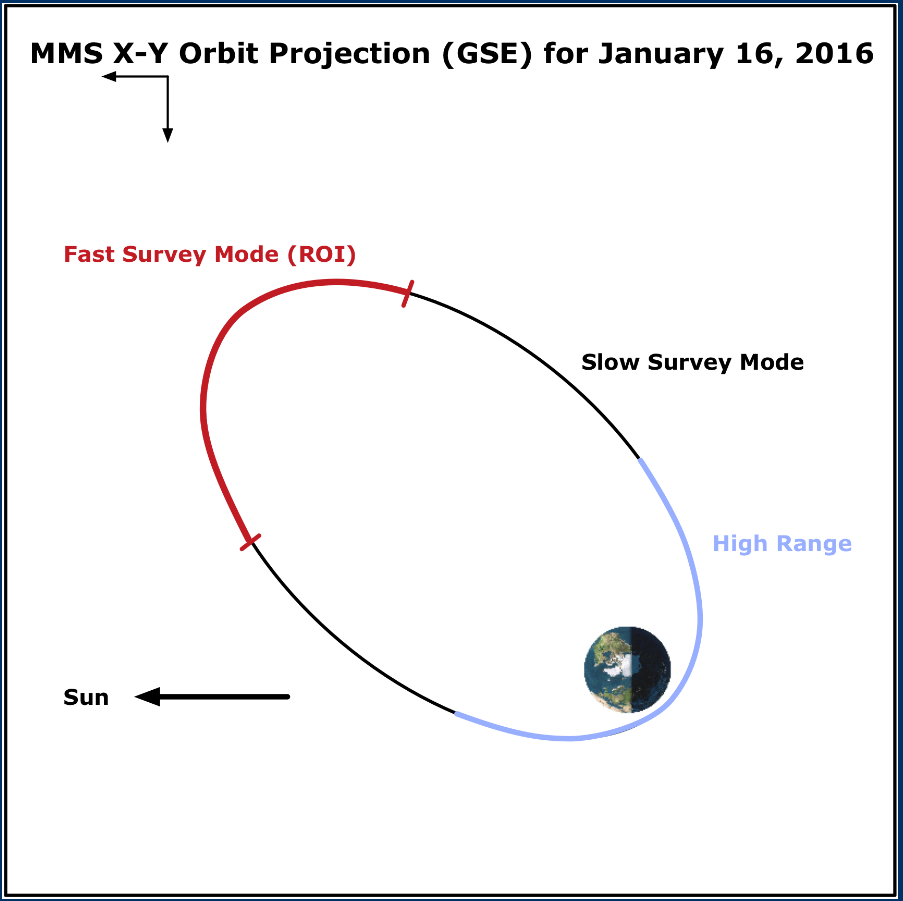
burst (128 Hz)

FGM dynamic ranges

low (near apogee): ±650 nT

High(near perigee): ±10,500 nT

(>8,000 nT mag saturated)



Magnetic Field Data Access

How to read Fluxgate Magnetometer (FGM) data

SPEDAS Package load routine: `mms_load_fgm`

First load data:

```
IDL> mms_load_fgm, trange=['2015-09-30/10:00:00', '2015-09-30/13:00'], $
        probes=['1'],level='l2',data_rate='srvy',/spdf, varformat='*gsm*'
```

`varformat='*gse*'` ← Load data in GSE coordinates
`varformat='*gsm*'` ← Load data in GSM coordinates
Leave varformat off to load all data quantities

(Check html help for more details on keyword options)

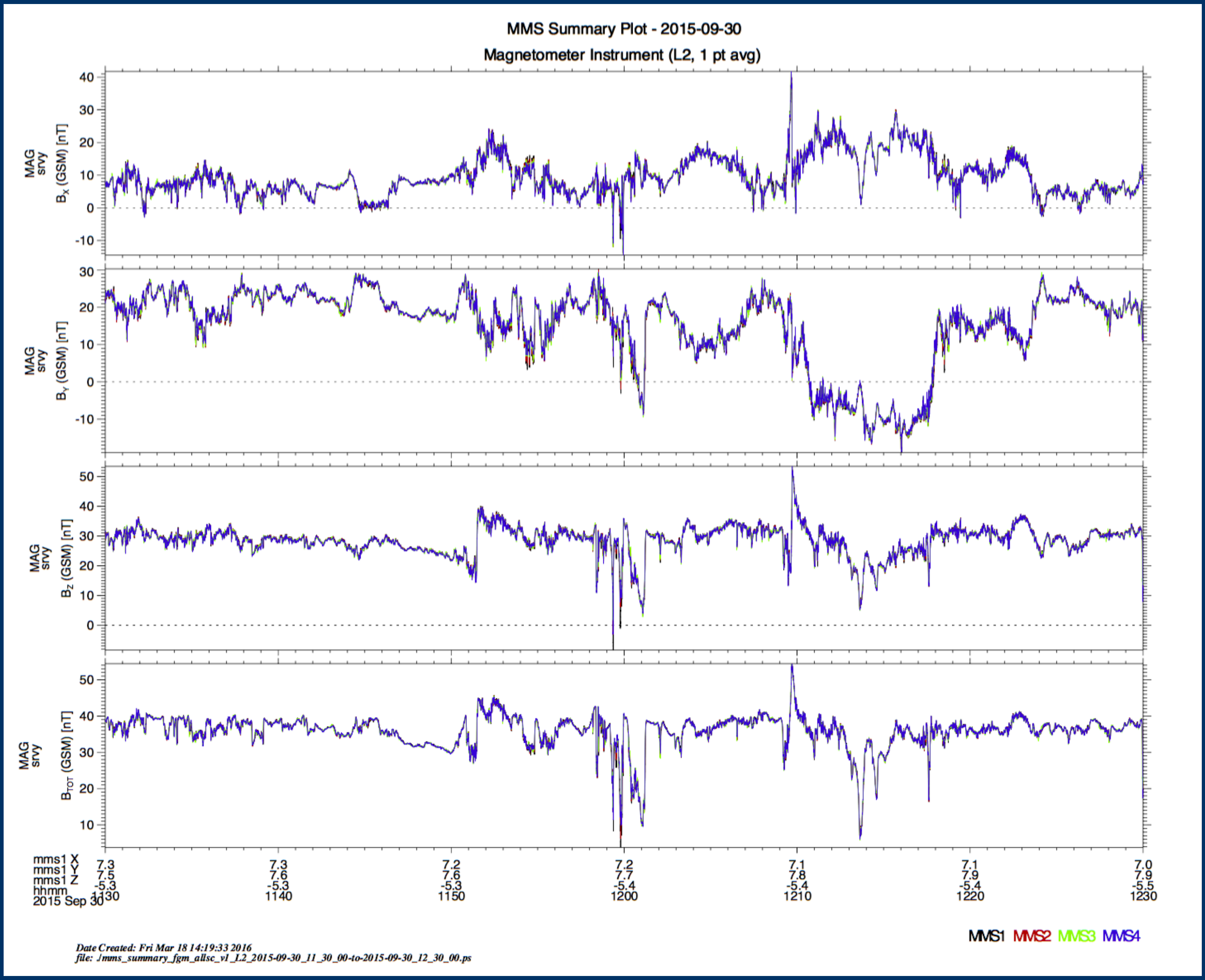
How about ephemeris data?

```
IDL> mms_load_mec, trange=['2015-09-30/10:00:00', '2015-09-30/13:00'],$
        probe=['1'], varformat='*mec_r_gsm*'
```

See code `mms_plot_fgm_example.pro` which includes the above two lines , code to convert ephemeris to earth radii, and plot Bx, By, Bz, Btot for all 4 spacecraft.

Magnetic Field Data Access

Default execute of `mms_plot_fgm_example.pro:`



FPI Data Products

Sensors on each spacecraft

DES=Dual Electron Spectrometer

DIS=Dual Ion Spectrometer

FPI Modes

slow/fast survey (1 min or 4.5s)

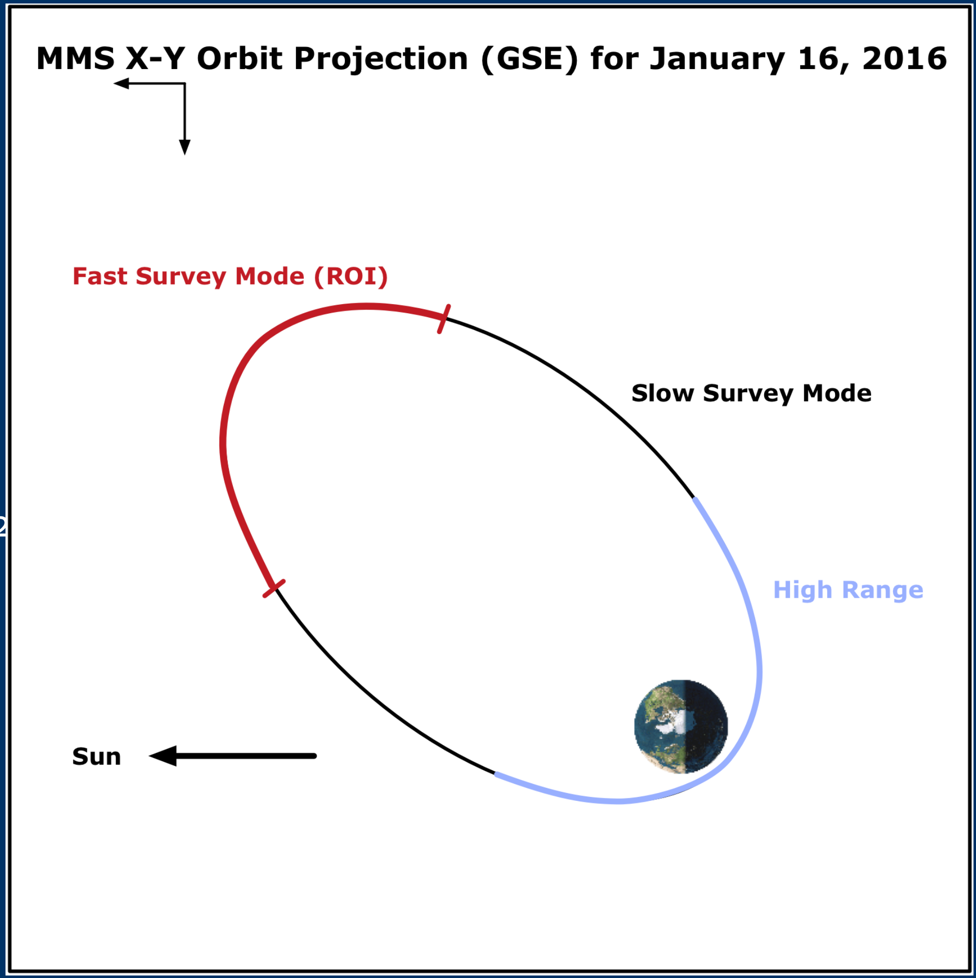
burst (30ms e-, 150ms i+)

FPI Data

FPI data is ordered into 11.25°x11.25° angular bins

FPI steps through 10eV-30keV in 2 sets of interleaved 32 energy steps (parity 0 and parity 1)*. After 60ms/300ms, FPI provides 64 unique energy steps

* This may produce plotting artifacts in burst data



Fast survey data is averaged over several seconds of burst data so the geometric mean energies of the stepping tables are used.

FPI Skymaps have:

32 azimuth angles x 16 polar angles x 32 energies

FPI CDFs

- OBS_SENSOR_QUANTITY_COORD_MODE

- OBS = mms1,mms2,mms3,mms4
- SENSOR = des,dis
- QUANTITY= dist, numberdensity, bulkx,bulky,bulkz,etc…
- COORD = dbcs (despun body coordinate system),gse*
  *GSE data not yet populated but DBCS is within ~2° of GSE
- MODE = fast,brst

*FPI times are START times of the accumulation interval

Release notes:

https://lasp.colorado.edu/mms/sdc/public/datasets/fpi/mms-FPIReleaseNotes-290216-1820-98.pdf

FPI Skymaps

- Key fields:
  - Epoch – start time of skymap accumulation
  - dist – 3D 32x16x32 phase space density
  - disterr – 1 sig statistical errors for phase space densities
  - steptable_parity = stepper table (0 or 1) used for this burst
  - energy0,energy1 – burst energy targets for parity 0 and parity 1
  - energy – fast survey energy targets
  - theta – polar angle look directions (DBCS)
  - phi – azimuthal angle look directions (DBCS)
  - errorflags – automatically populated quality flags

- Caveats:
  - Photoelectrons (internal and external) not removed from skymaps - check spacecraft potential and look out for a ~0.5 cm^{-3} population of electrons <100eV traveling anti-sunward.
  - Compression of skymaps can distort low signal areas of image – be wary of summing maps and interpreting data with high statistical error

FPI Moments

- Key fields:
  - Epoch – start time of skymap accumulation
  - steptable_parity = stepper table (0 or 1) used for this burst
  - energy0, energy1 – burst energy targets for parity 0 and parity 1
  - numberdensity = density
  - bulkx, bulky, bulkz = flow speed
  - pressxx, etc. = pressure tensor components
  - energyspectr = directional (DBCS and B-field) energy spectrograms
  - *_err = 1 sig statistical errors (take absolute value for now…)
  - errorflags – automatically populated quality flags

- Caveats:
  - Imperfect correction factors and compression loss result in spin periodicities (~20s) in Vex-Vey and offsets in Vez
  - Effect of photoelectrons (internal and spacecraft) are removed using spacecraft potential measurements and a model fit
  - Cold plasma (<10eV) and hot plasma (>30keV) are not measured.

  - <u>Crosscheck with other instruments! –vxB & E, curlB & J, HPCA & FPI</u>

  _Each sensor has its own systematic uncertainties that are environment dependent

SPEDAS MMS FPI L2 example IDL code

- mms_fpi_dist_slice_comparison_crib_l2.pro

  creates various 2D slices of the either the ion or electron distribution function.

- mms_load_fpi_crib_qlplots_l2.pro

  creates multiple plots of dynamic spectra and moments.

mms_fpi_dist_slice_comparison_crib_l2.pro

IDL>.run mms_fpi_dist_slice_comparison_crib_l2.pro

IDL>*for FPI data rate input 0 for brst, 1 for fast:* 1

IDL>*input probe #:*3

IDL>*input 0 for FPI electrons, 1 for FPI ions:* 1

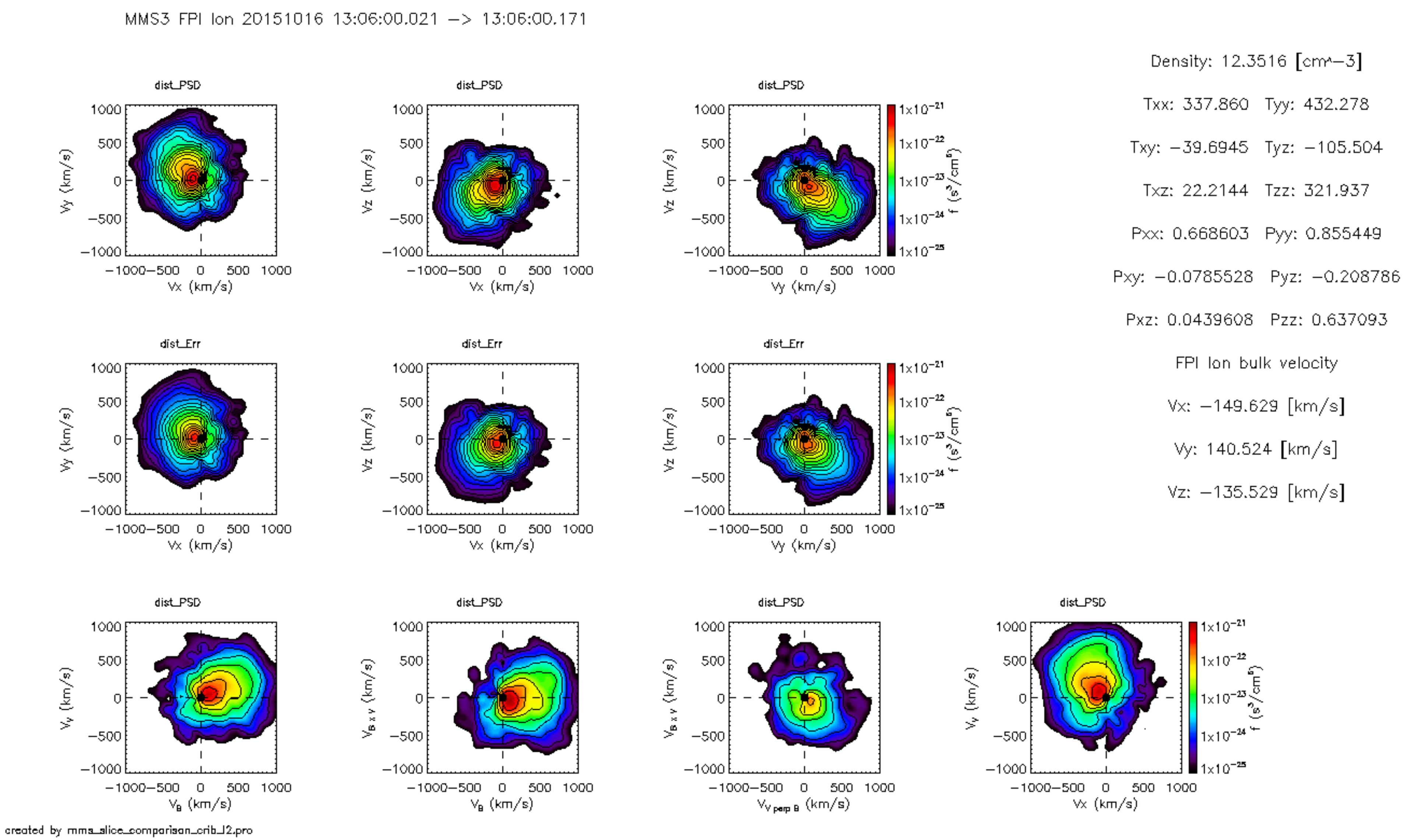
IDL>*input 1 for geometric scaling or 0:* 0

IDL>*input integer resolution (defaults: 2D/3D interpolation: 150, geometric: 500)* 150

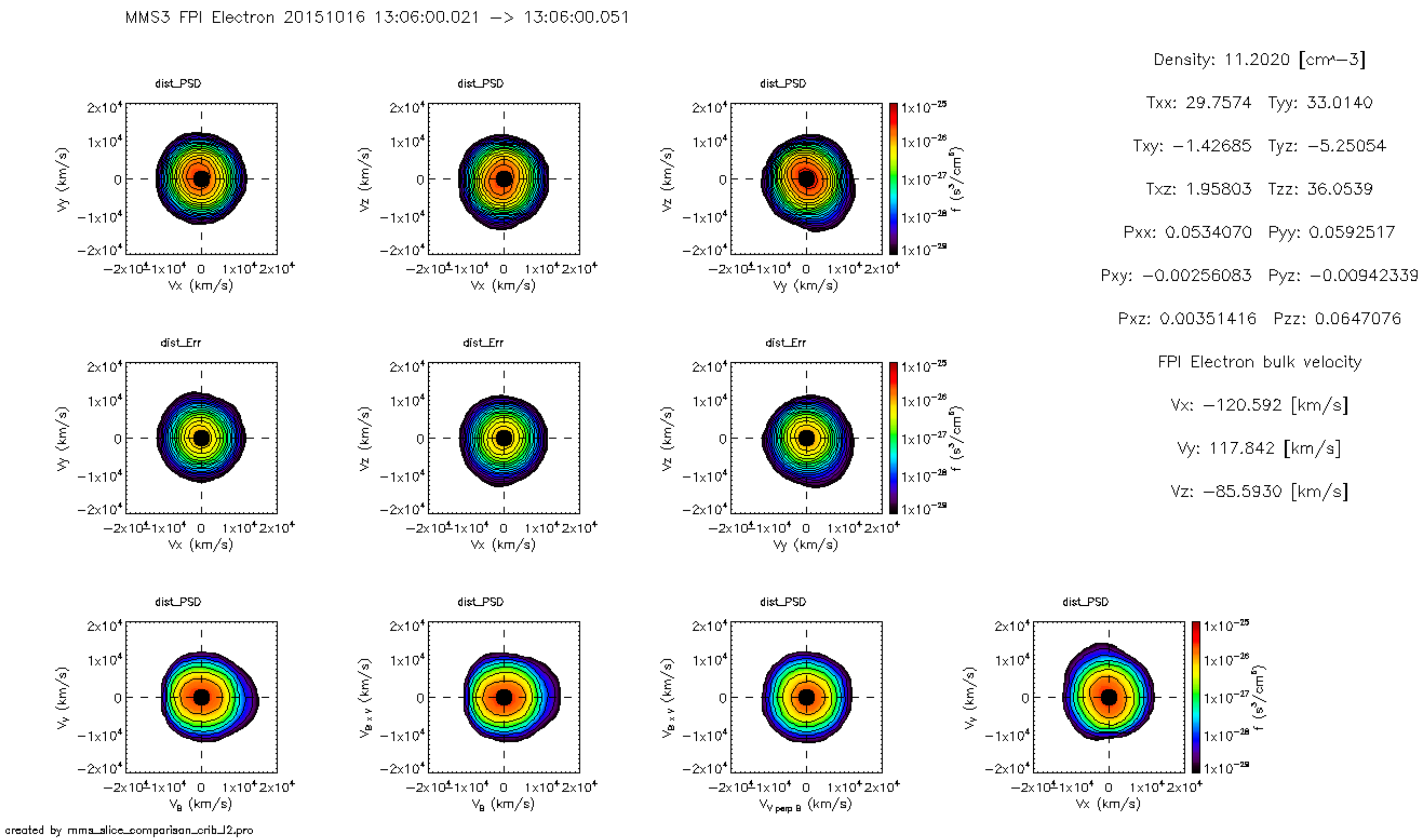
IDL>*input max |velocity| in km/s to plot, input 0. for autoscaling:*
1000

Example plot output next 2 slides.

mms_fpi_dist_slice_comparison_crib_l2.pro: ion example



mms_fpi_dist_slice_comparison_crib_l2.pro: electron example



mms_load_fpi_crib_qlplots_l2.pro

IDL>.run mms_load_fpi_crib_qlplots_l2.pro

IDL>*for FPI data rate input 0 for brst, 1 for fast:* 1

Example plot output next 4 slides.

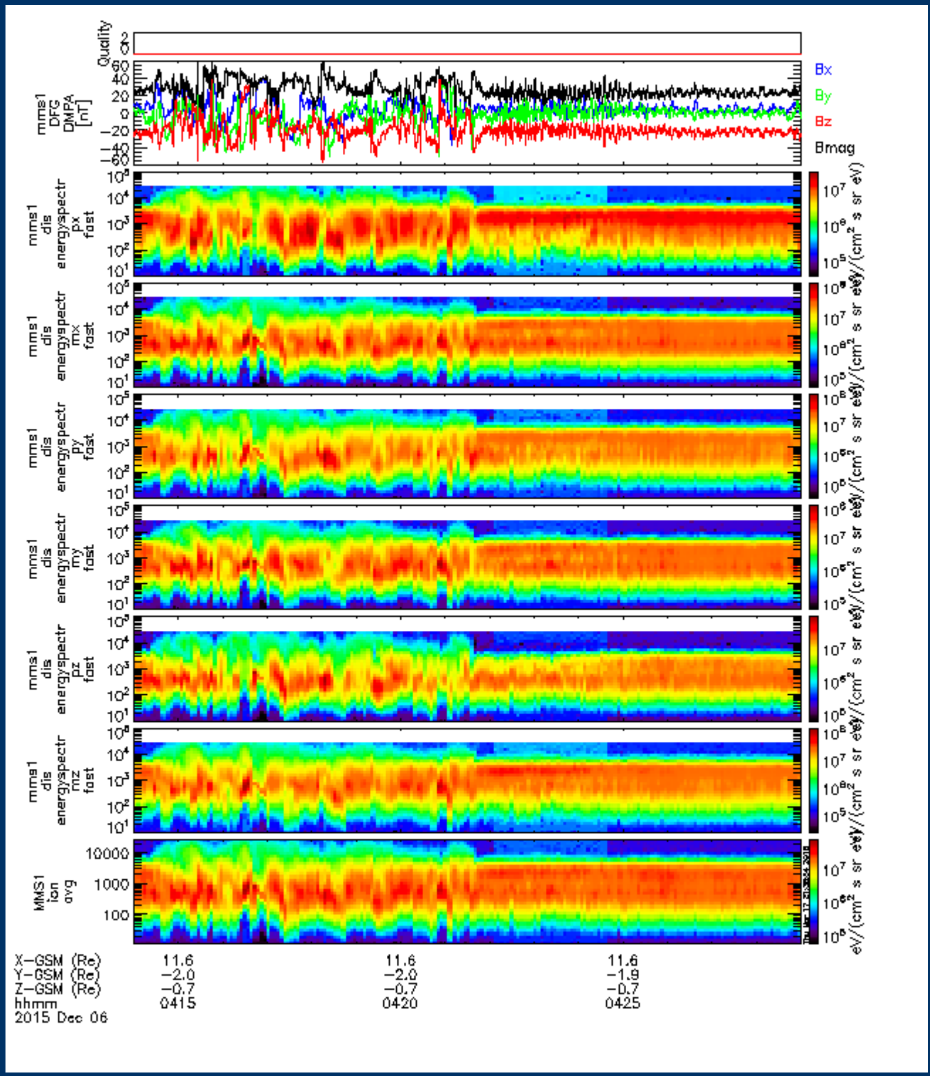
mms_load_fpi_crib_qlplots_l2.pro: output

- mms_load_fpi_crib_qlplots_l2.pro

- Example plot top to bottom

- Quality flag (0 - good)
- Magnetic field
- FPI ion dynamic spectra: energy vs time
- +x direction
- -x direction
- +y direction
- -y direction
- +z direction
- -z direction
- All directions

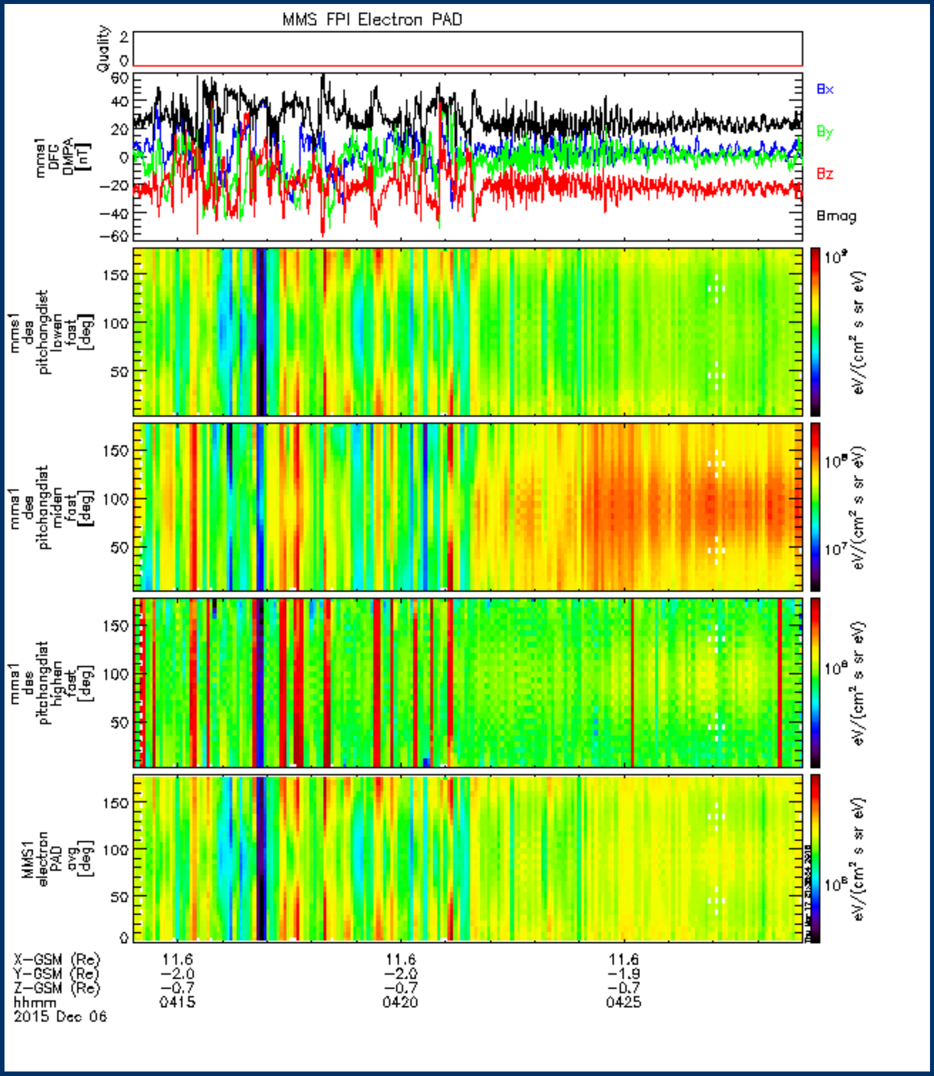
- X -spin plane towards the Sun
- Z -spin axis
- Y -completes the coordinate system



mms_load_fpi_crib_qlplots_l2.pro: plot output

Top to bottom

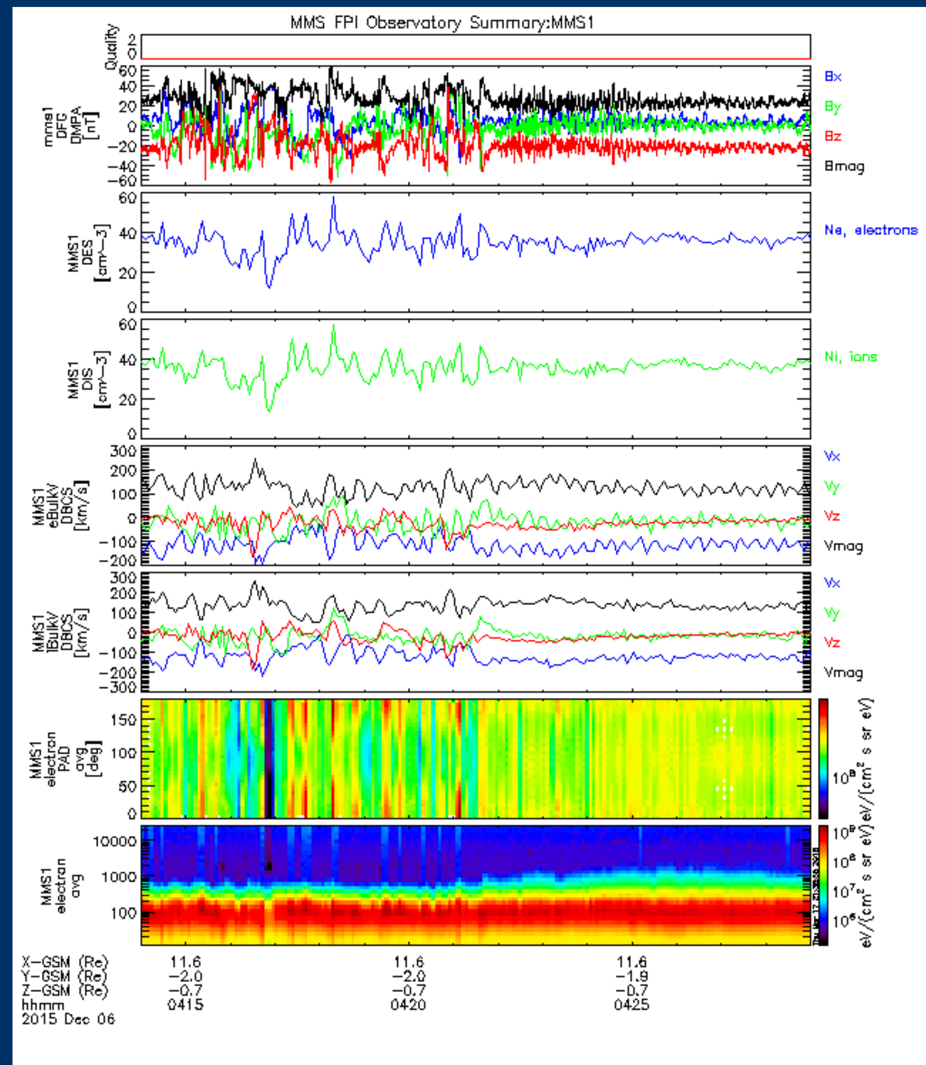
- Quality flag
- Magnetic field
- Electron dynamic spectra: pitch angle vs time, averaged over
  - Low energy: 0-200 eV
  - Mid energy: 200-2000 eV
  - High energy: 2-30 keV
  - All energies



mms_load_fpi_crib_qlplots_l2.pro: plot output

top to bottom

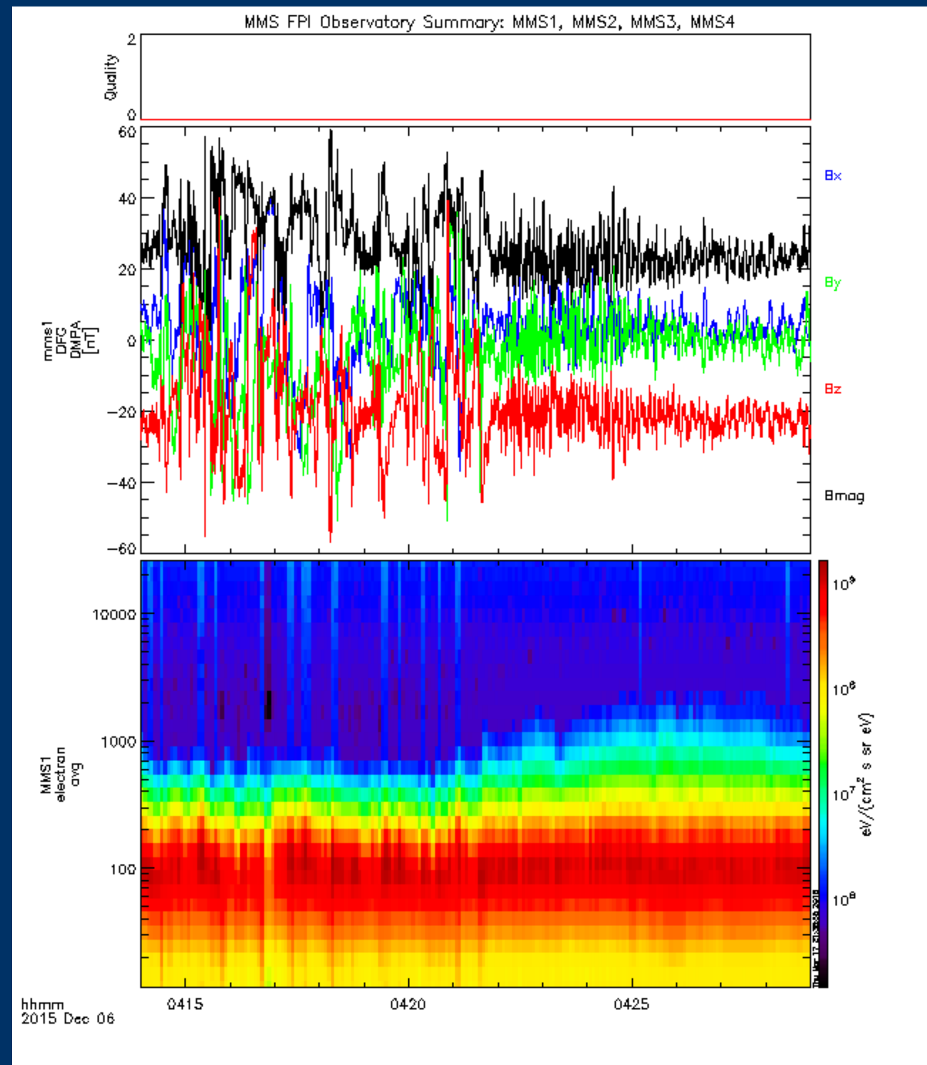
- Quality flag
- Magnetic field
- MMS1 Ion density
- MMS1 Electron density
- Bulk Ion Velocity
- Bulk Electron Velocity
- MMS2 ave electron flux dynamic spectra: energy vs time
- MMS2 ave electron flux dynamic spectra: energy energy vs time



mms_load_fpi_crib_qlplots_l2.pro: plot output

top to bottom

- Quality flag
- Magnetic field
- Electron OMIN flux dynamic spectra: energy vs time



Binning CDAWEB data into common time bins

- Another way to load data into an IDL session other than using SPEDAS
  - Note: epoch_minus_delta and epoch_plus_delta not yet incorporated
  - Note: binning is made in Julian Day
- Binning multiple CDAWEB data sets into common time bins
- MMS FPI example
- Main website is at `http://hpde.gsfc.nasa.gov/hpde_software_tools.html`
- Source code is at `http://hpde.gsfc.nasa.gov/cdaweb_get_bin.sav`
- Quick start guide at

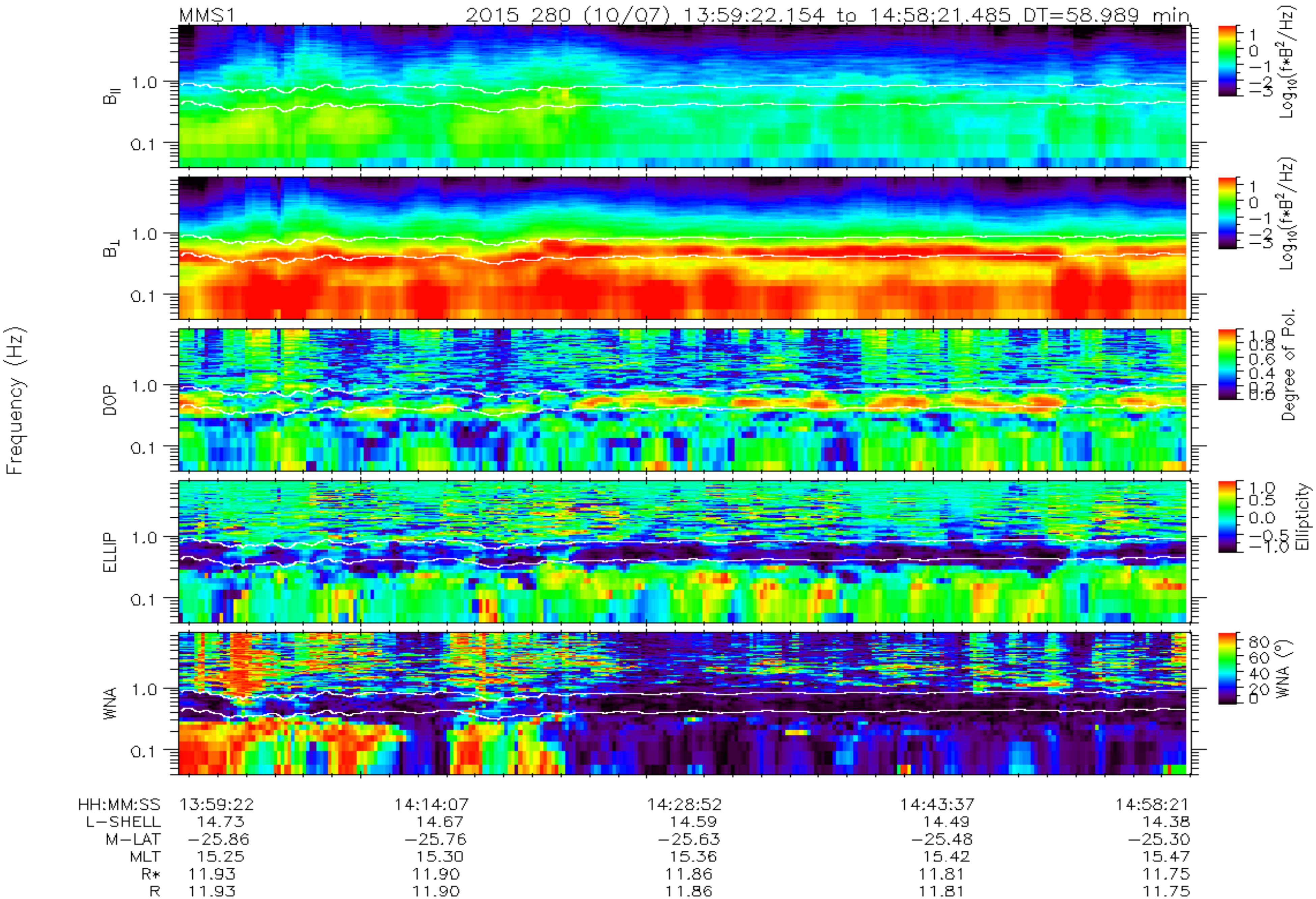
`http://cdaweb.gsfc.nasa.gov/pub/software/cdaweb_idl_clients/cdaweb_get_bin/cdaweb_get_bin_quick_start_guide.pdf`

- Example code including a MMS routine at

  `http://hpde.gsfc.nasa.gov/creader_demos.zip`

- MMS example code: `cread_mms4_example.pro`
  - Binning magnetic & electric field to FPI survey cadence.

Binning CDAWEB data MMS example

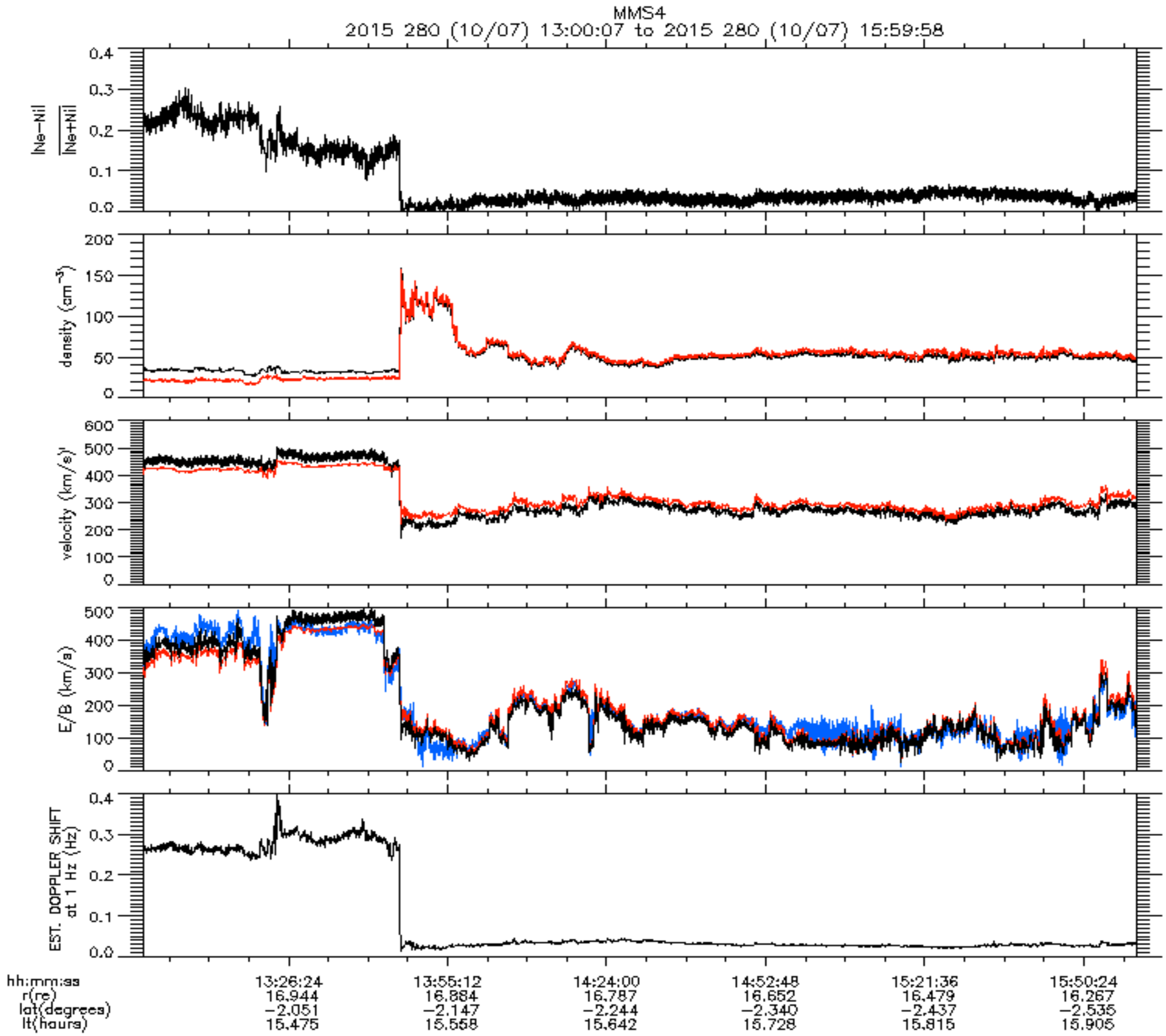


Binning CDAWEB data

IDL input

```
Restore,' cdaweb_get_bin.sav'
timename='jd'
dt_sec= 4.5d0
start_time = '2015-10-07T13:00:05.000Z'
stop_time = '2015-10-07T15:59:59.999Z'
dataset_id = 'MMS4_FPI_FAST_L2_DIS-MOMS'
vars = [ 'mms4_dis_numberdensity_dbcs_fast=deni4',
'mms4_dis_bulkspeed_dbcs_fast=vi4',
'mms4_dis_bulkazimuth_dbcs_fast=azi4',
'mms4_dis_bulkzenith_dbcs_fast=thi4']
cdaweb_get_bin,dataset_id,vars,start_time,
stop_time,dt_sec,time_name=timename
```

cread_mms4_example.pro



Appendix

Glossary of Instrument Acronyms

Instrument Suite	Acronym	Definition
Fields	AFG	Analog flux Gate Magnetometer
	DFG	Digital flux Gate Magnetometer
	FGM	Flux Gate Magnetometer (combined AFG/DFG)
	SCM	Search Coil Magnetometer
	EDI	Electron Drift Instrument
	ADP	Axial Double Probe (electric field)
	SDP	Spin-plane Double Probe (electric field)
	BPSD	Magnetometer Power Spectral Density (from SCM)
	EPSD	Electric Power Spectral Density (from SCM)
Energetic Particle Detector (EPD)	EIS	Energetic Ion Spectrometer
	FEEPS	Fly's Eye Energetic Particle Sensor
Fast Plasma Investigation (FPI)	DES	Dual Electron Spectrometer
	DIS	Dual Ion Spectrometer
Hot Plasma Composition Analyzer	HPCA	Ion velocity space distributions
Active Spacecraft Potential Control	ASPOC	Indium ion beam to control S/C potential
Ephemeris	MEC	Magnetic Ephemeris and support data

More details can be found in “Magnetospheric Multiscale Instrument Suite Operations and Data System”, Baker, D.N., et al., Space Sci Rev, 2015

Article References

Select MMS related articles

"Magnetospheric Multiscale Overview and Science Objectives", Burch, J.L., et al., Space Science Reviews, 2015.
"Magnetospheric Multiscale Science Mission Profile and Operations", Fuselier, S.A., et al., Space Science Reviews, 2015.
"Theory and Modeling for the Magnetospheric Multiscale Mission", Hesse, M., et al., Space Science Reviews, 2015.
"The Magnetospheric Multiscale Magnetometers", Russell, C.T., et al., Space Science Reviews, 2015.
"Magnetospheric Multiscale Instrument Suite Operations and Data System", Baker, D.N., et al., Space Science Reviews, 2015.
"The FIELDS Instrument Suite on MMS: Science Objectives, Measurements, and Data Products", Torbert, R.B., et al., Space Science Reviews, 2014.

Full list of articles describing the MMS operations, data, and instruments can be found in Space Science Reviews (2014 through the present):
http://link.springer.com/search?query=%22Magnetospheric+Multiscale%22&date-facet-mode=between&facet-start-year=2014&previous-start-year=2014&facet-end-year=2016&previous-end-year=2015

Code Examples

The following code is available along with this presentation:
mms_data_access_tutorial_code.zip

Program Name	Description
mms_spdsw_help.pro	Generate HTML help files from inline SPEDAS documentation
mms_plot_fgm_example.pro	Generate a multi-panel plot (Bx, By, Bz, Btot) for FGM data
mms_fpi_dist_slice_comparison_crib_l2.pro	Creates 2D slices of ion or electron distribution function
mms_load_fpi_crib_qlplots_l2.pro	Creates multiple plots of dynamic spectra and moments
creader_demos.zip	Example code showing how to bin to common time bins

Many more examples (cribs) can be found in the spdsw package:
`idl/projects/mms/examples`

Contact Information

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MMS FPI Team