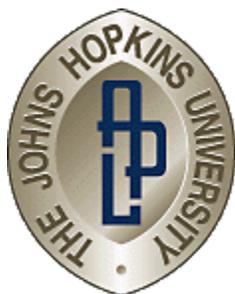

The Johns Hopkins University Applied Physics Laboratory

Cassini/MIMI Data Analysis Center IDL Analysis Users Guide

Revision 12

M. B. Kusterer



The Johns Hopkins University
Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723-6099

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<u>Revision</u>	<u>Date</u>	<u>Author</u>	<u>Description of change</u>
2		Kusterer	Added more information to data volume program description
4		Kusterer	Changed keyword on most routines from apply_rf to int_flux and dif_flux
5		Kusterer	Added examples of new options of standard plots, like converted numbers and new plot types. Some image unit labels were corrected.
6		Kusterer	Added examples of some new standard plot formats.
7		Kusterer	Added keyword IONMODE to some of the plotting tools
8		Kusterer	Added new menus description and figures. Removed GIF output as an option as it is no longer offered in IDL5.4. Corrected the number of sectors data available in the INCA Image menu from 4 to 16 for ION mode data.
9			Added section for flat image program. Added minimum and maximum options on some menus.

11	Kusterer	Version 11: Update to include new programs and menu options. Expanded the section on using get_data and get_imagaes to access images and data inside IDL programs. Included examples.
12	Kusterer	Split out the XINCA user's guide to another document. Updated options available and added many new program descriptions.

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Cassini/MIMI Data Analysis Center IDL Analysis Software Users Guide

1. Objectives

This document presents the IDL Analysis Software Users Guide. The guide describes how to use the majority of the IDL analysis software that displays and accesses data from the MIMI instrument on the Cassini spacecraft. The primary objective of this guide is to describe the menu functions. Some key data access programs descriptions are included to aid a user in calling the software from within IDL, but for a more detailed explanation of the program parameters and keywords see the program headers. The calling sequence for the program called from the menu is included when it is an easy program to run from the command line.

2. Scope

The programs described in this document are all IDL programs or the scripts that call other programs. They are accessed from the MIMI main menu or from the IDL command prompt. The XINCA program is described in the Cassini/MIMI Data Analysis Center XINCA Users Guide and the operations programs are described in the Cassini/MIMI Data Analysis Center Operations Users Guide.

3. References

The references listed below provide additional information about the instrument, data files, and the plotting software. Reference 1, the Instrument Data User Guide, is the official guide to the MIMI instrument. It contains a great deal of information on the instrument, calibration of the data as well as example plots.

The file naming convention document, reference 2, describes the naming conventions for the Level 1A and 1B files. The software described in this document reads the L1A files. The MIMI L1A data file layout document, reference 3, covers the contents and structure of the L1A files. Knowledge of the structure of the L1A files is not necessary to run this software but the document lists the sensor file channel names and descriptions, which might be helpful in some cases.

For further assistance in working with the processing system, the C++ input/output code that the IDL code uses and the software directory structure refer to reference 4, the processing software guide. The processing guide has a detailed description of the scripts that set up the users environmental variables needed by the IDL software and propel the user into IDL. Currently, the software runs on the Linux and Mac systems using GNU make, C++, C, and IDL. The option to run entirely in IDL has been added to the software.

The user guide for the XINCA software has been removed to it's own document, reference 5 and the operations program descriptions have been removed to reference 6.

Document Title
1. J. Vandegriff, R. DiFabio, D. Hamilton, M. Kusterer, J. Manweiler, D. Mitchell, C. Paranicas, E. Roussos, Cassini/MIMI Instrument Data User Guide , February 8, 2013.
2. M. Kusterer. Cassini/MIMI Data Analysis Center File Naming Convention , revision 10, May

22, 2014.

3. M. Kusterer, L. Burke, Cassini/MIMI Data Analysis Center Level 1A File Layouts, revision 21, May 22, 2014.
4. M. Kusterer. Cassini/MIMI Data Analysis Center Processing Software Guide, revision 10, January 17, 2014
5. M. Kusterer, Cassini/MIMI Data Analysis Center XINCA User Guide, revision 1, May 22, 2014
6. M. Kusterer, Cassini/MIMI Data Analysis Center Operations User Guide, revision 1, May 22, 2014

4. Document Overview

This document covers the IDL analysis software for the MIMI team. For all the IDL software applications the interactive menus are called from the main menu. Each menu makes a command line call to the software to perform the plots. This division of the menu code from the underlying plotting software allows the same command line programs to be called in a batch mode from the IDL menus, processing system and the web application menus.

The menu is called in a non-blocking mode so that the IDL command line is active during the menu operation. Compiled changes to programs that are called by the menu during the menu operation will be used in the next call.

For more information on using all the program parameters, see the program file headers where the parameters are explained in detail. The program names are shown in all caps since that was the IDL syntax at the time that this project was started and matches the syntax in the programs.

5. How to Access MIMI Software

The MIMI IDL analysis software can be accessed by using the csh scripts in the /project/cassini/decomsoft/arch_`uname`/scripts directory on the Linux systems. These scripts set up environmental variables and then start up the IDL software. The `uname` Linux call will select the proper version based on the user's platform type. Currently we support Linux (arch_Linux) and Mac (arch_Darwin). The Mac users would use the path set up for their systems.

In the processing software guide, listed in the previous related documents section, section 2.4.1 described how to set up the USER_DAC_DEFINES script which resides in the /project/cassini/decomsoft/arch_`uname`/scripts directory. **Only Mac users need to edit this file. All users do need to source this file before using the scripts to enter IDL described in this section.**

```
source /project/cassini/decomsoft/arch_`uname`/scripts/USER_DAC_DEFINES
```

Most of the scripts to launch IDL take one parameter that is the software version to use. The parameter can be "dev" for development version, or "prod" for production version. The parameter is not required for all scripts will default to use the production software. The main MIMI menu script is called as follows (the first defaults to production, the second explicitly uses production and the third uses the development version):

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu prod
```

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu dev
```

The scripts to launch into IDL or create the IDL save sets of routines are shown in the following table.

mimi_menu	The MIMI menu script brings up a menu that can access most of the IDL programs. In each of the following sections, the script to access the program from Unix or Linux, will be described as well as how to run the program from inside IDL at the command prompt. The scripts access the production software by setting the IDL_STARTUP environmental variable to point to the Decom_IDLstartup file. The startup file accesses the proper version of the IDL software, sets up some display parameters for the PC displays. The script then runs the version of IDL that currently works with the MIMI software.
get_mimi_data	The get_mimi_data script brings up the MIMI data ASCII dump program menu.
get_mimi_images	The get_mimi_images script brings up the MIMI INCA image ASCII dump menu.
mimi_idl	The mimi_idl script just puts the user into IDL at the command prompt.
mimi_batch “command “	The mimi_batch script is used by the processing software to run the non-interactive IDL plotting from the Unix prompt. Put a non-interactive non-window producing IDL call inside the quotes.
mimi_makevm	The mimi_makevm script creates the IDL save set of the version of analysis software for use by the IDL virtual machine. The save set is placed in the vm_save subdirectory in the scripts directory. ./mimi_makevm would make the production version. ./mimi_makevm dev would make the development version.
mimi_runvm	The mimi_runvm script uses the IDL save set with the IDL virtual machine which does not require an IDL license

6. MIMI Main Menu

A main menu has been designed to access many of the MIMI IDL graphics and data dumping programs. To access the main MIMI menu, the script is called from Linux or Unix as follows:

/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu

To access the main menu from inside IDL type the following:

IDL>S = mimi()

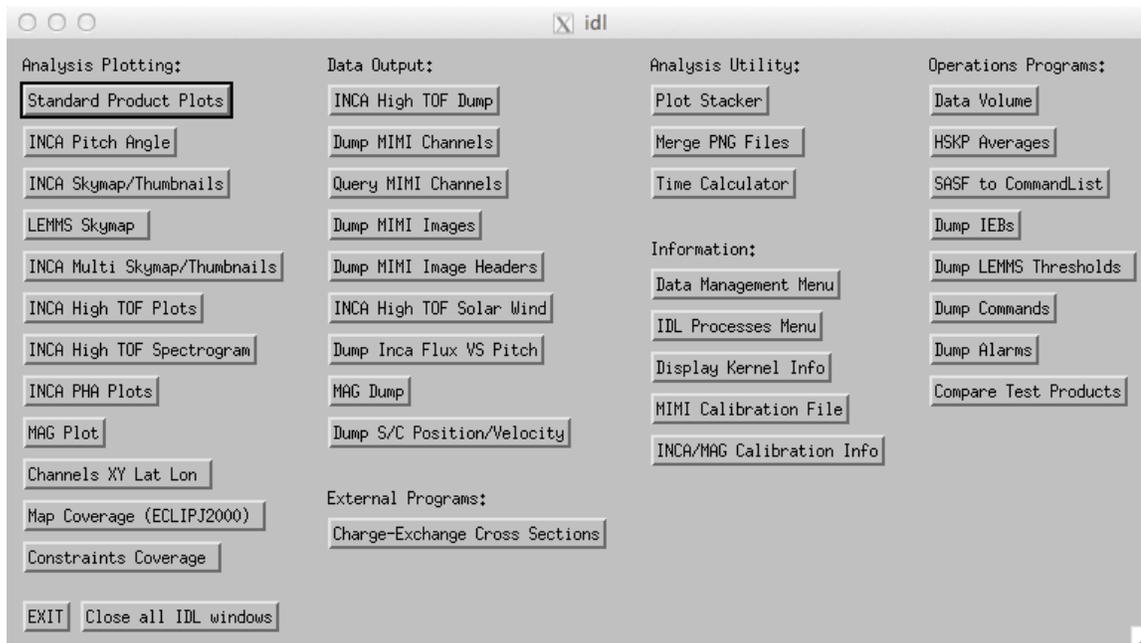


Figure 1: The MIMI main menu. It allows the user to access many of the MIMI IDL analysis and operations programs.

The main menu shown in Figure 1 is divided into functional sections, analysis plotting, data output, external programs, analysis utilities, information and operations programs. Here is a short description of the analysis plotting programs.

- The Standard Product Plots will access the Standard_prod program menu and is used to display a variety of browse products.
- The INCA Pitch Angle program plots the image intensity versus the pitch angle in a histogram or scatter plot.
- The INCA Skymap/Thumbnail and INCA Multi Skymap/Thumbnail will plot the image warped into a Azimuthal map projection and are both described in the XINCA User Guide (reference 5).
- The INCA High TOF Channel Plots option will plot the INCA images averaged or summed to a single point and plotted in a line plot.
- The INCA High TOF Spectrogram program will plot the INCA images averaged or summed into a single point and plotted as a spectrogram.
- The INCA PHA Plots button will plot the CHEMS and INCA PHA data in a scatter or color histogram format.
- The Mag Plot option will plot the magnetometer data in various formats and dump the data to an ASCII file.
- The Channels XY Lat Lon program will plot any channel's value with the X and Y value being time, distance, X-distance, Y-distance, Z-distance, local time, latitude, SKR longitude or L value.
- The Constraints coverage program allows the user to select spacecraft or instrument pointing constraints and display the data matching the constraints.

The following programs are available in the data output programs column.

- The INCA High TOF Channel Dump option will dump the INCA TOF data and positional information to an ASCII file.
- The Dump MIMI Channels menu and the use of the GET_DATA program from the command line are described with a few examples.
- The Query MIMI Channels program allows the user to query the data using header data values to locate instances that match certain data states.
- The Dump MIMI Images menu and the use of the GET_IMAGES, GET_IMAGE_POS and GET_IMAGE_NOPOS programs from the command line are described with a few examples.
- The Dump MIMI Image Headers program will dump the image headers to an ASCII file. This is primarily used for debugging purposes.
- The Mag Plot and Dump option will plot the magnetometer data in various formats or dump the data to an ASCII file. It is described in the analysis plotting section.
- The INCA High TOF Solar Wind option is a menu that outputs INCA high TOF image data to ASCII files and then calls a FORTRAN program to dump solar wind information.

The External program section only contains the Charge-Exchange program, which was written by MIMI science team member. The charge exchange program displays the charge-exchange cross sections. This program will not be described in this document.

The following programs are available in the analysis utility column.

- The Plot Stacker program allows the user to select individual plots from the browse product standard formats and combine them into a single plot. The user can save the format for reuse.
- The Merge PNG files program allows the user to select portions of PNG files to put together on another PNG file.
- The Time Calculator program allows the user to add or subtract to a UTC in day of year or month-day, SCLK or ephemeris time.

The following programs are available in the information column.

- On user Mac and personal Linux systems, the Data Management Menu will appear. It allows the user to administer the data set that is available on their computer. It can be used to install and update any auxiliary files that the system uses.
- The IDL processes menu will display any currently running IDL jobs on the system that the user is on. This is intended to be of assistance to those trying to find and delete any spurious IDL jobs that crash or are interrupted.
- The Display Kernel Information option allows the user to examine the spice kernels that are automatically loaded by the program and those that in a user entered directory. The program uses the SPICE kernel information programs and reflects the output into a window.
- The MIMI Calibration Info option brings up the current calibration numbers for the sensors based on time.
- The INCA/MAG Calibration Info program will display the INCA and Magnetometer out of calibration time periods.
-

At the bottom of the main menu are the following functions.

- The Exit button exits the main menu and put the user into IDL at the command line.

- The Close all IDL windows command will close all open IDL windows. If the user is using the XINCA program, this function will close the embedded IDL window in the XINCA menu so should not be used when that program is open.

7. Analysis Plotting Programs

The analysis plotting programs include all of the analysis programs that can produce graphic output except the XINCA and multi-XINCA skymap/thumbnail programs which are covered in a separate user guide.

7.1 Commonly Used Output Types and Keyword Parameters

The commonly used graphic output plot types operate the same in all plot types so they are described here to eliminate repeating them in each application description.

On most menus, the PNG, JPEG and the other output types will have a text box with a small button beside it. To select an output other than the screen, either type the full path and name of the output file or select the button to the left of the text field, to bring up a file selector menu.

Each file name must have a file extension. When an application with the option for multiple file outputs is used, the software will append _nnn before the file extension so it is important to include a file extension.

The file extension also is used by the file selector menu. Here are the expected extensions. If the user uses a different extension, change the filter text in the file selection menu shown in Figure 2.

PNG = *.png

JPG = *.jpeg

PS = *.ps

PDF = *.pdf

GIF = *.gif

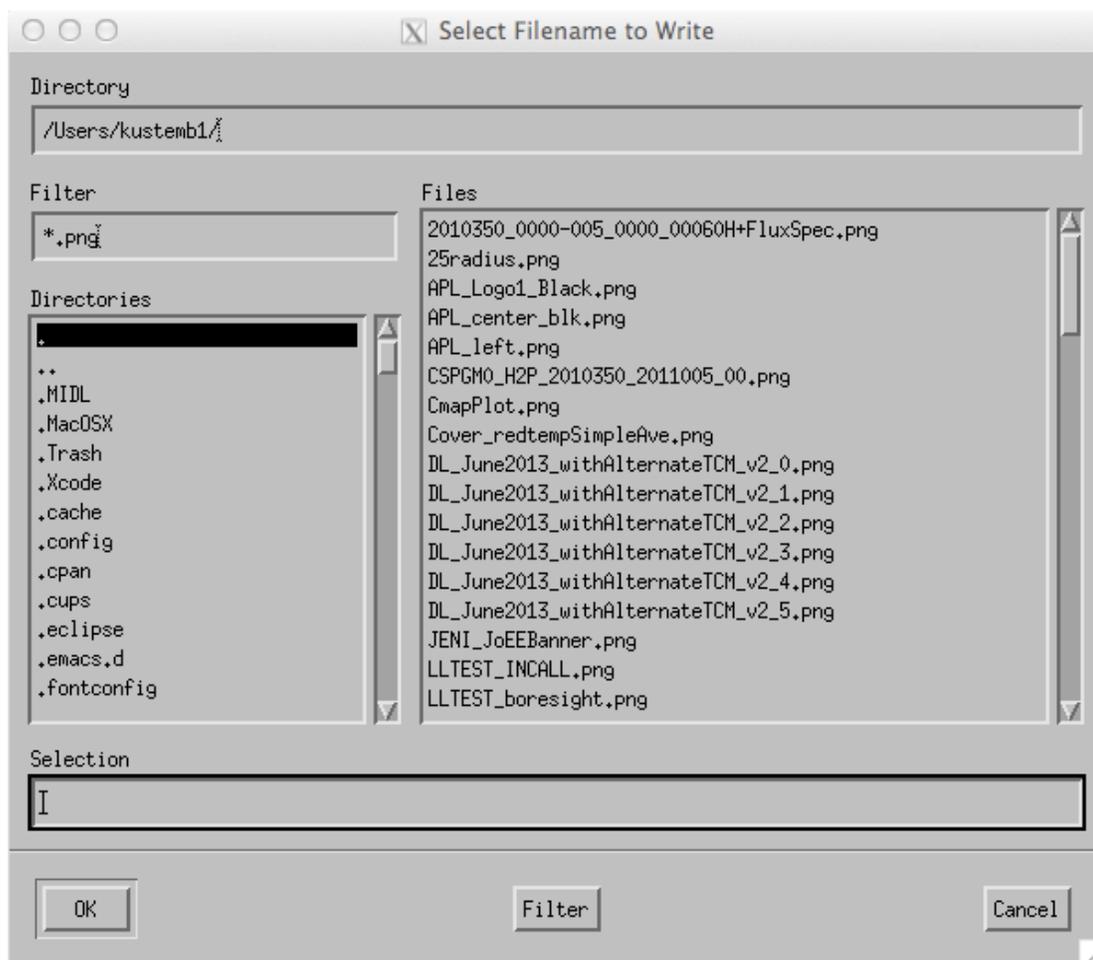


Figure 2: File Selector Menu. Select the file directory and the entire filename including extension.

The following table contains some commonly used keywords when running the programs from the IDL command line. **When creating a graphic output file, be sure to use the “,/NOWIN” keyword with PS, PNG, JPEG, PDF and GIF keyword options.**

Commonly Used Keywords

COLORMAP	Index of IDL colormap to use. Default is set using the MIMI_DEFAULT_COLORMAP in the USER_DAC_DEFINES script. Example colormap=32
WIN	Index of the specific window to open. Example win=10. The default action is to allow IDL to select the window index.
NOWIN	If set then do not open a window in IDL. To use this option, the user must have a PS, PDF, JPEG or GIF selected. This is used when producing many files in a batch mode. Example: /nowin. It will improve the resolution of the output file. If it is not used then the program will plot to the screen and then copy that to the output file. This always

	results in a smaller resolution for the output file.
PS	Path and filename of the postscript file. If no output field is used, the output defaults to a window. “ps” is the expected file extension. Example ps=’/homes/user/file.ps’,/nowin
PDF	Path and filename of the PDF file. “pdf” is the expected file extension. Example pdf=’/homes/user/file.pdf’,/nowin. This only works on linux. If no output field is used, the output defaults to a window.
PNG	Path and filename of the PNG file. “png” is the expected file extension. Example png=’/homes/user/file.png’,/nowin. If no output field is used, the output defaults to a window.
JPEG	Path and filename of the JPEG output file. “jpeg” is the expected file extension Example jpeg=’/homes/user/file.jpeg’,/nowin. If no output field is used, the output defaults to a window.
GIF	Path and filename of the GIF output file. “gif” is the expected file extension Example gif=’/homes/user/file.gif’,/nowin. The GIF output option only works on the linux system. The output is first made into a PNG file and converted into a GIF. If no output field is used, the output defaults to a window.
WHITEBACK	If set then the window will have a white background. If a JPEG, PNG, or GIF are selected then 2 files will be created. One will have a black background and one will have the white background with an extra _wht appended to the filename before the file extension.
ASCII Filename	Name of the ASCII output file. Enter the entire path and filename. The file selector button on the left side will bring up a file selector window in which the filename can be entered.

7.2 Standard Browse Products

The standard browse products are a set of browse product types that are used to monitor instrument mode, health and safety. They are also used to display data validity, and spacecraft orientation.

The STANDARD_PROD.PRO line-plotting program creates many of the browse products. It uses a set of product files that specify the exact data type including sensor and channel to be plotted per graph, line types, and additional items such as logarithmic versus linear lines. Product files are very easy to set up and make it easier to create plots that are used repetitively. The product files contain an IDL structure type that conforms to the format expected by the STANDARD_PROD program.

The standard prod menu offers the standard time range, and product type selection separated into sensor related types and plots the selected data using the settings contained in the product type file.

To access the standard product menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Standard Product Plots button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=standard_prod_menu()
```

The standard_prod routine can be run two ways. One can use the menu, which allows users to select the time range, control file and output option, and is shown in Figure 3.

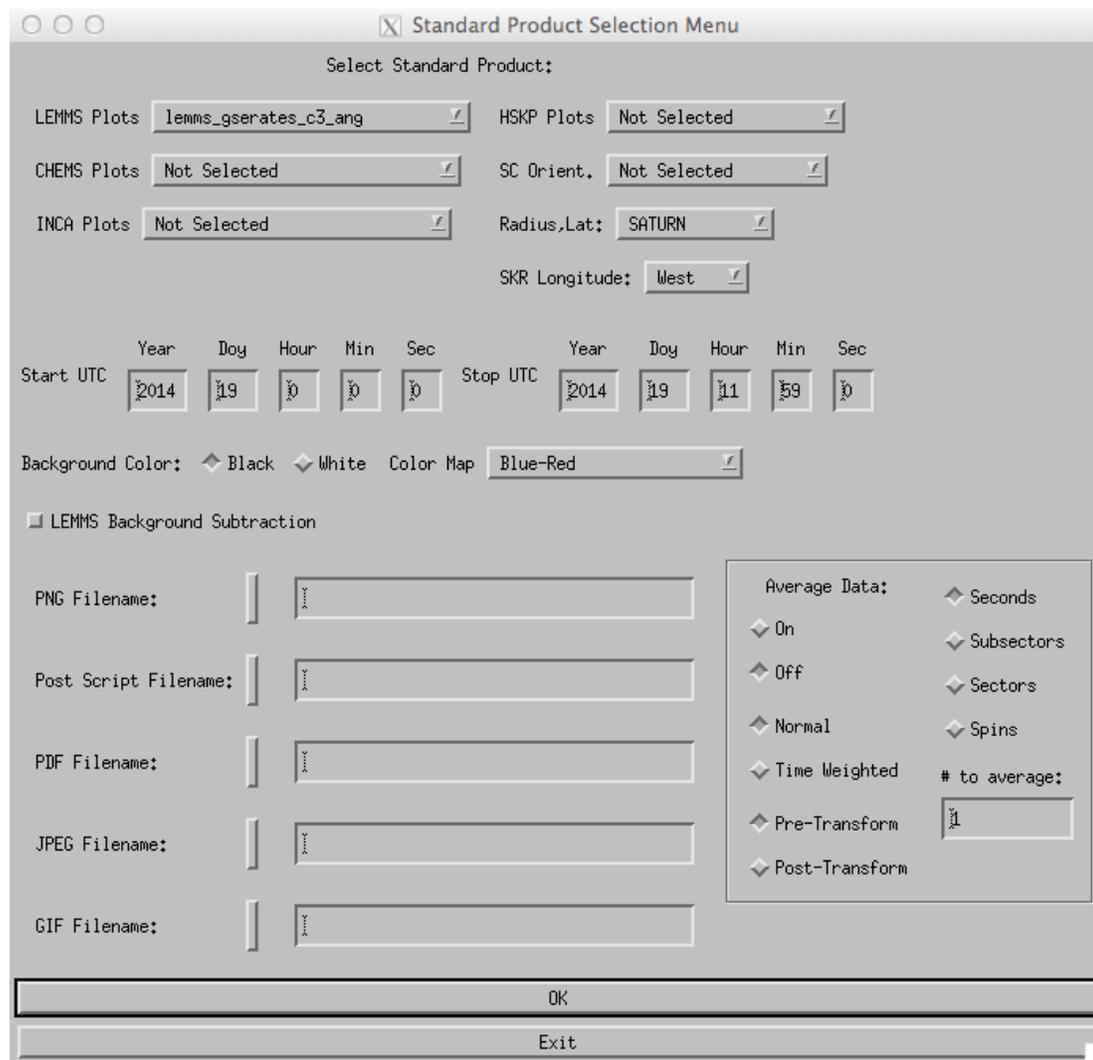


Figure 3: The standard product program menu allows users to select the browse product types interactively. To plot the data to an output file like PNG, PS or JPEG, type in a full path or use the button to the left of the output file text box to enter the name.

The second way to plot the channels is to use the STANDARD_PROD.PRO program that is called from the idl command line prompt.

Calling Sequence

```
STANDARD_PROD, '1999-230T18:00.000', '1999-230T18:20.000', 'inca_rates',  
png='~/homes/user/inca_rates.png', ps='~/homes/user/inca_rates.ps', /nowin
```

Start and Stop UTC	
Year	Input 4-character year. Hit return to load the same value into the stop year.
Doy	Input 3-character day of year that starts with 1. Hit return to load the same value into the stop doy.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
SKR Longitude	The SKR longitude can be plotted in east or west longitude.
Background Color	The plots can be produced with either black or white background.
LEMMS Background Subtraction	Subtract the background values from the LEMMS channels if a LEMMS browse product is selected.
Average On/Off	This option turns on the averaging option. Not all data can be averaged at this time but a notice will be printed out if the data cannot be averaged.
Normal	The normal method of averaging the data is summed over the time range and divided by the number of samples.
Time Weighted	The time weighted method; sums the data times its accumulation time over the time range and divides by the total accumulation time.
Pre-Transform	The averaging can be done pre-transform which means the data is read in day long sections, averaged and concatenated together. This method allows us to display very large amounts of data that previously caused out of memory errors in IDL.
Post-Transform	The averaging option is usually performed after any operations (Post-Transform) to get the data in its final format.
Seconds, Subsectors, Sectors or Spins	The time frame for averaging is specified by selecting seconds, subsectors, sectors or spins and the number to average.
# to average	Selects the number of Seconds, Subsectors, Sectors or Spins to average
Browse Product Types	
Input: Control filename in ascii text, the file must be resident in a path present in the users IDL !path variable. The menu options are the actual product file names.	
LEMMS Product Styles	
lemms_gserates_c_ang	Line plot of LEMMS accumulator rates.
lemms_gserates_c3_ang	X-axis is time, Y-axis is count rates.
lemms_gserates_c3_ang _yrange	Ang indicates that below the plots is a spacecraft location plot.

lemms_gserates_c	<p>C indicates they are plotted in counts/accumulator.</p> <p>C3 indicates they are plotted in log Intensity/(cm² ster Kev sec).</p> <p>The _yrange version is used on long time ranges like over a month.</p>
Lemmschemsinca_spectro Lemmschemsinca_spectro_mag	Plots a stacked set of spectrograms of LEMMS, CHEMS and INCA.
Lemms_<channel>_c3 Lemms_a_c3 Lemms_b_c3 Lemms_c_c3 Lemms_d_c3 Lemms_e_c3 Lemms_p_c3 Lemms_z_c3	<p>Line plot of all <channel> channels like A would include A0-A8.</p> <p>Ang indicates that below the plots is a spacecraft location plot.</p> <p>C indicates they are plotted in counts/accumulator.</p> <p>C3 indicates they are plotted in log Intensity/(cm² ster Kev sec)</p>
Lemms_priorsum_c3 Lemms_prior_line_c	Line plot of priority channels. Sum indicates that they are the summed channels. C3 indicates they are plotted in log Intensity/(cm ² ster Kev sec)
Lemms_motor_c	Plot of various motor flags, voltages and currents.
lemms_priority Lemms_priority_ang	<p>Dot plot of LEMMS priority channels,</p> <p>X-axis is time, Y-axis is angle. Color is count rates. This code was written by Stefano Livi.</p>
CHEMS Product Styles	
chems_rates_ang	<p>Line plot of CHEMS accumulator rates.</p> <p>X-axis is time, Y-axis is number of counts.</p> <p>Below the plots is a spacecraft location plot.</p>
chems_rates	<p>Line plot of CHEMS accumulator rates.</p> <p>X-axis is time, Y-axis is number of counts.</p>
INCA Plot Styles	
inca_rates_ang	<p>Line plot of INCA accumulator rates.</p> <p>X-axis is time, Y-axis is number of counts.</p> <p>Below the plots is a spacecraft location plot.</p>
Tof_channels_axis	Plots an INCA TOF channels line plot. Use the separate High TOF Channel plotting program described later in the document for more options with this type of plot.
Inca_discharge_c_ang	Line plot of INCA discharges with INCA voltages and

	currents
Housekeeping Product Styles	
Volts_coinc_ang	Line plot of INCA coincidence rates and the high voltage on the collimator. Ang indicates that a spacecraft location plot is included.
Phitheta_ang	Line plot of inca image phi and theta values for each of the image types with mag Bx, By, Bz and B total data and spacecraft angle plot.
analog_v1_c	Line plot of MIMI analog voltages, where X-axis is time and Y-axis is voltage. Ang indicates that a spacecraft location plot is included below the voltage plots.
Analog_v2_c	Line plot of MIMI analog currents where X-axis is time and Y-axis is current. A plot of the valid and invalid command count, alarm id and the current active IEB number is included. Ang indicates that a spacecraft location plot is included below the other plots.
analog_t1_c	Line plot of MIMI analog temperatures where X-axis is time and Y-axis is current. Ang indicates that a spacecraft location plot is included.
Valid_onoff	The validity plot is a bar plot of all L1a data validity with respect to time. Validity indicates if the data is present. It includes the top plot of Ion/Neutral mode as well as an indication of calibration status on INCA.
Spacecraft Orientation Product Styles	
Sc_angle	A spacecraft location plot. It includes the axis to Saturn, Sun and NEP as well as the sun angle to the LEMMS LET and HET.
quaternions_c	Line plot of decoded and decommutated quaternions where X-axis is time and Y-axis is quaternion value.

The following figures show some output examples of frequently used product types.

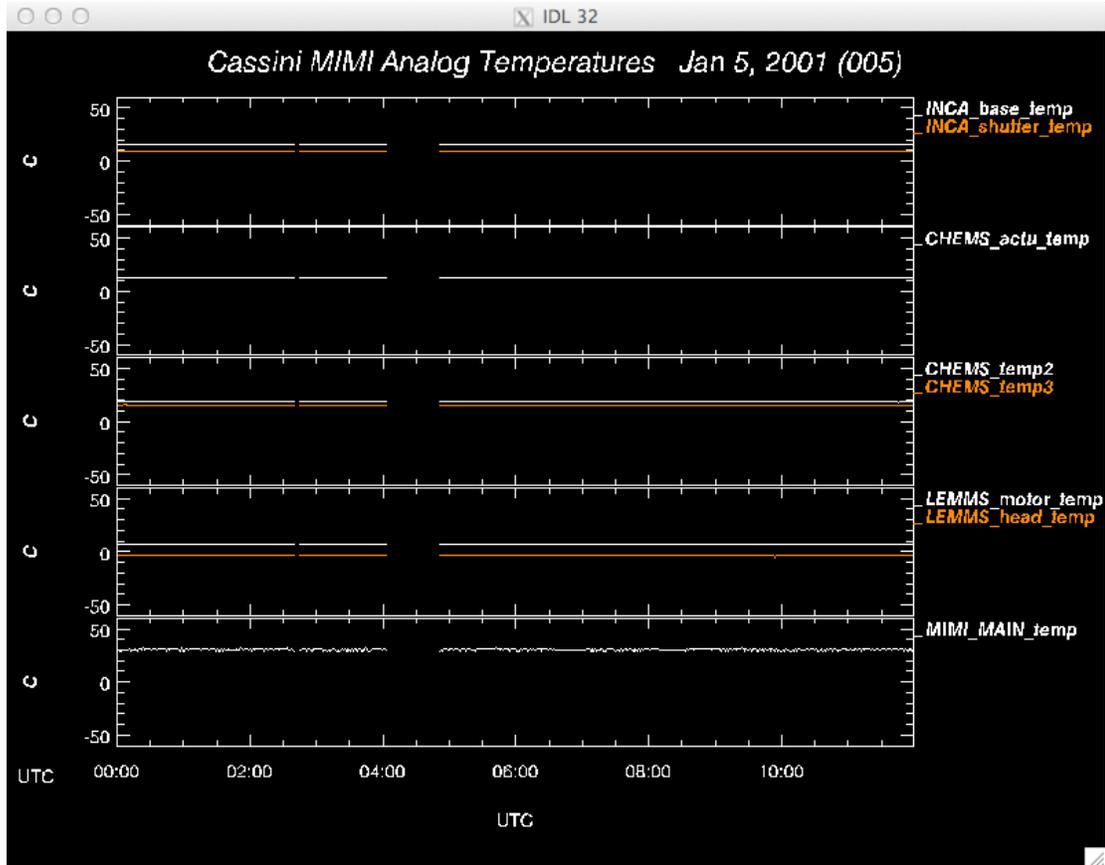


Figure 4: The analog_t1_c product style plots the converted analog temperatures for the LEMMS, INCA and CEMS sensors. Calling sequence for this image was STANDARD_PROD, '2001-005T00:00.000', '2001-005T12:00.000', 'analog_t1_c', png='/homes/user/analog_t.png', /NOWIN

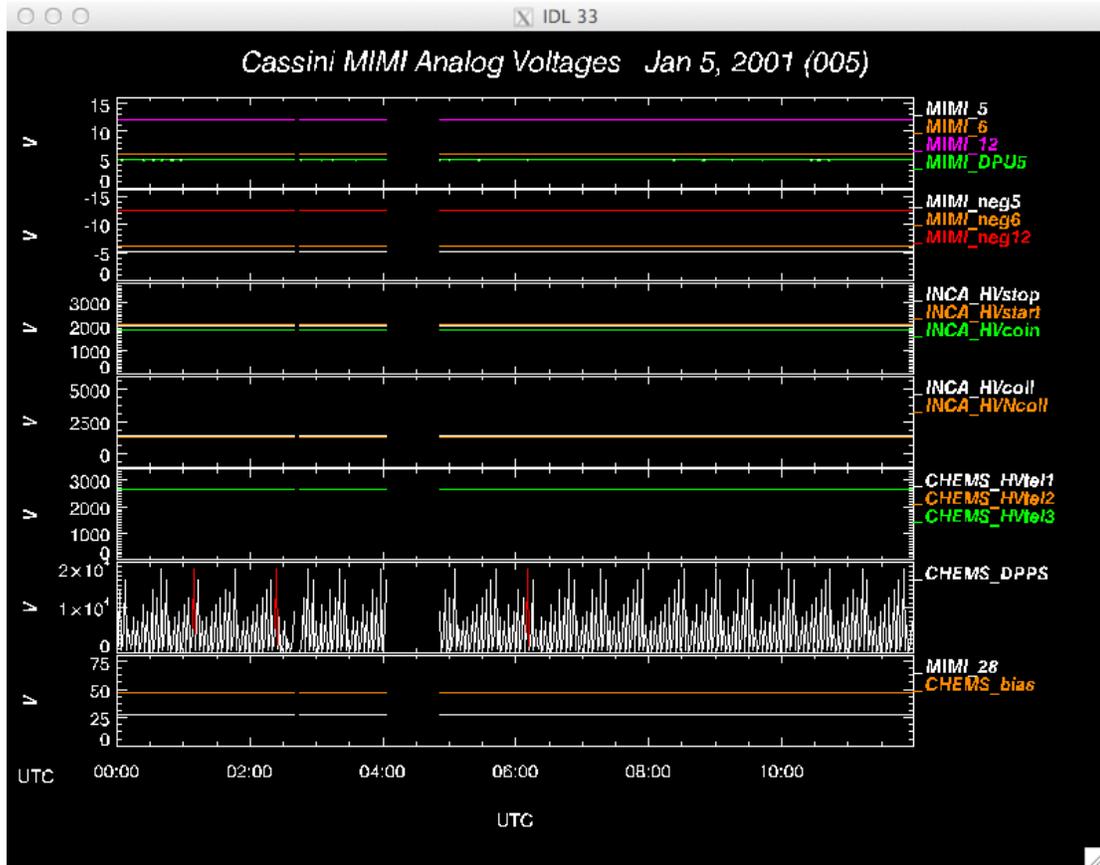


Figure 5: The analog_v1_c product style plots the converted analog voltages for the LEMMS, INCA and CHEMS sensors. Calling sequence for this image was STANDARD_PROD, '2001-005T00:00.000', '2001-005T12:00.000', 'analog_v1_c', png='/homes/user/analog_v.png', /NOWIN.

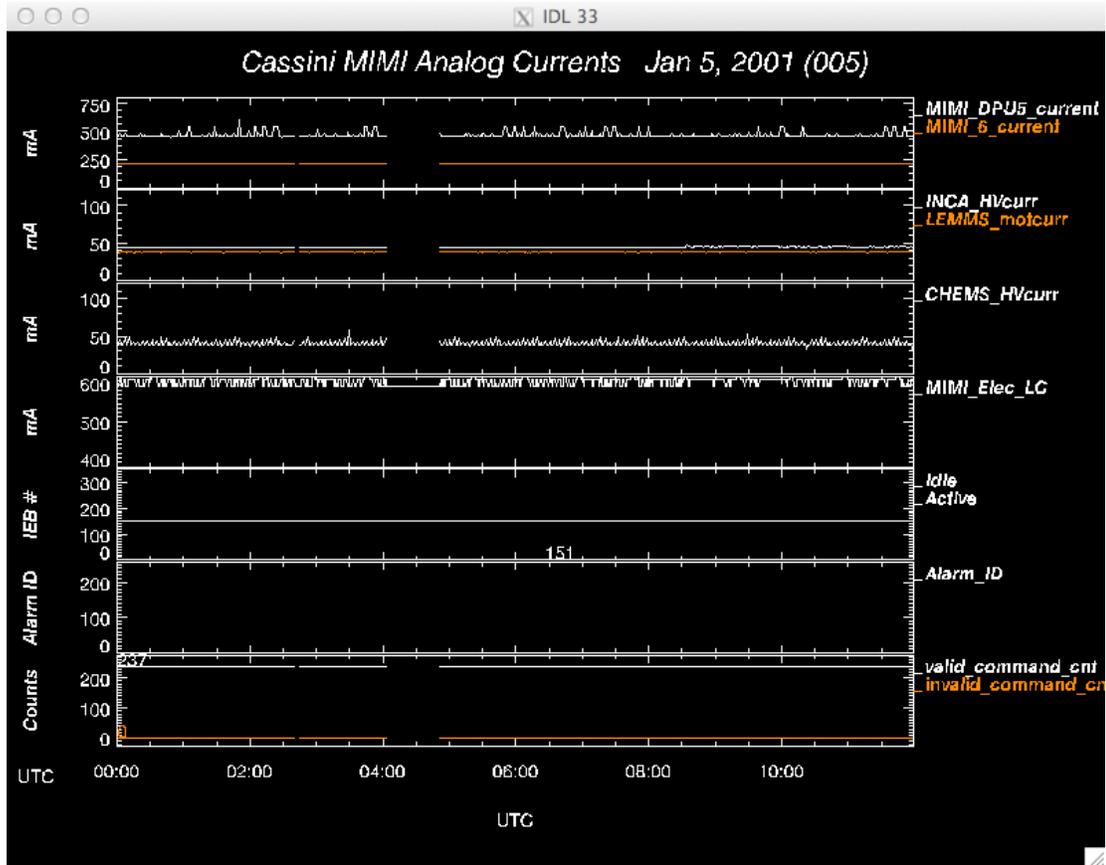


Figure 6: The analog_v2 product style displays the analog currents, current IEB, Alarms and the valid and invalid command counts. Calling sequence for this image was STANDARD_PROD, '2001-005T00:00.000','2001-005T12:00.000','analog_v2_c', png='/homes/user/analog_v2.png',/NOWIN.

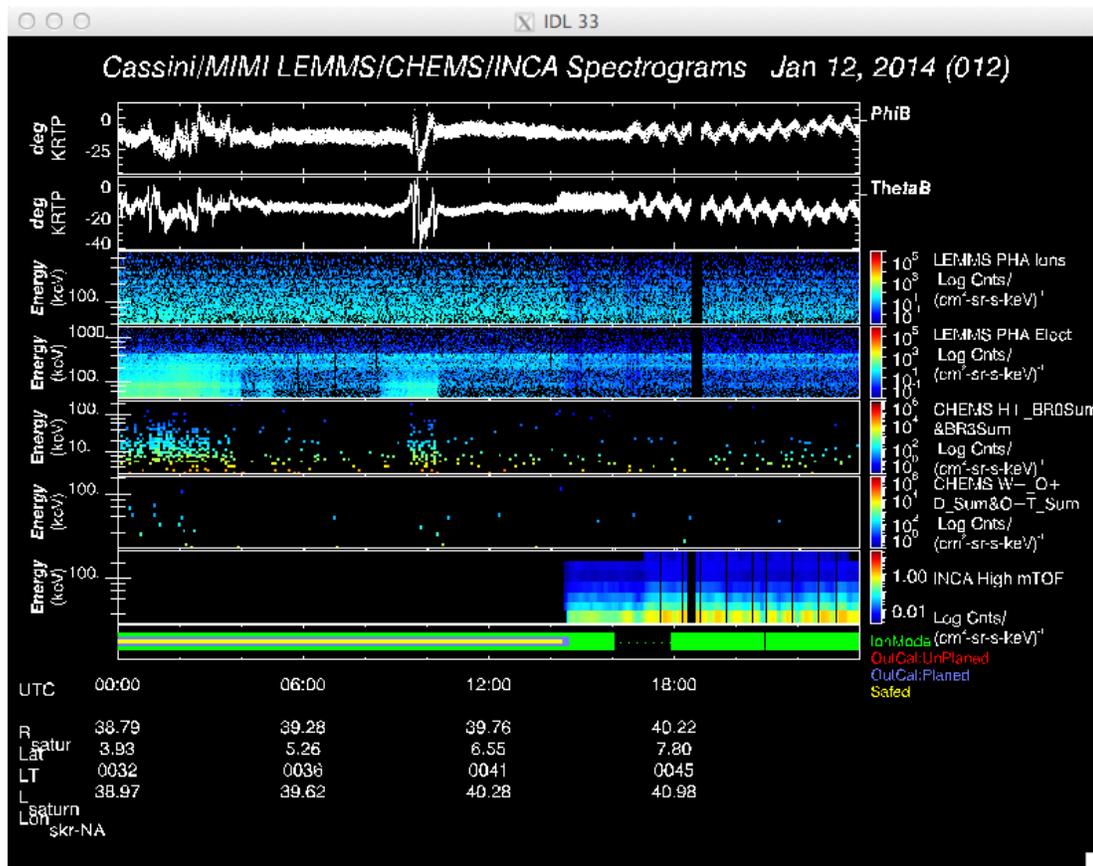


Figure 7: The lemmschemsinca_spectro_wmag product style plots a stacked set of spectrograms of LEMMS, CHEMS and INCA. For the option to include a plot of Phi and Theta for the mag field use the file that ends with _wmag. Calling sequence for this image was STANDARD_PROD, '2014-012T00:00.000', '2014-012T23:59.000', 'lemmschemsinca_spectro_wmag, png='/homes/user/spectro.png', /NOWIN.

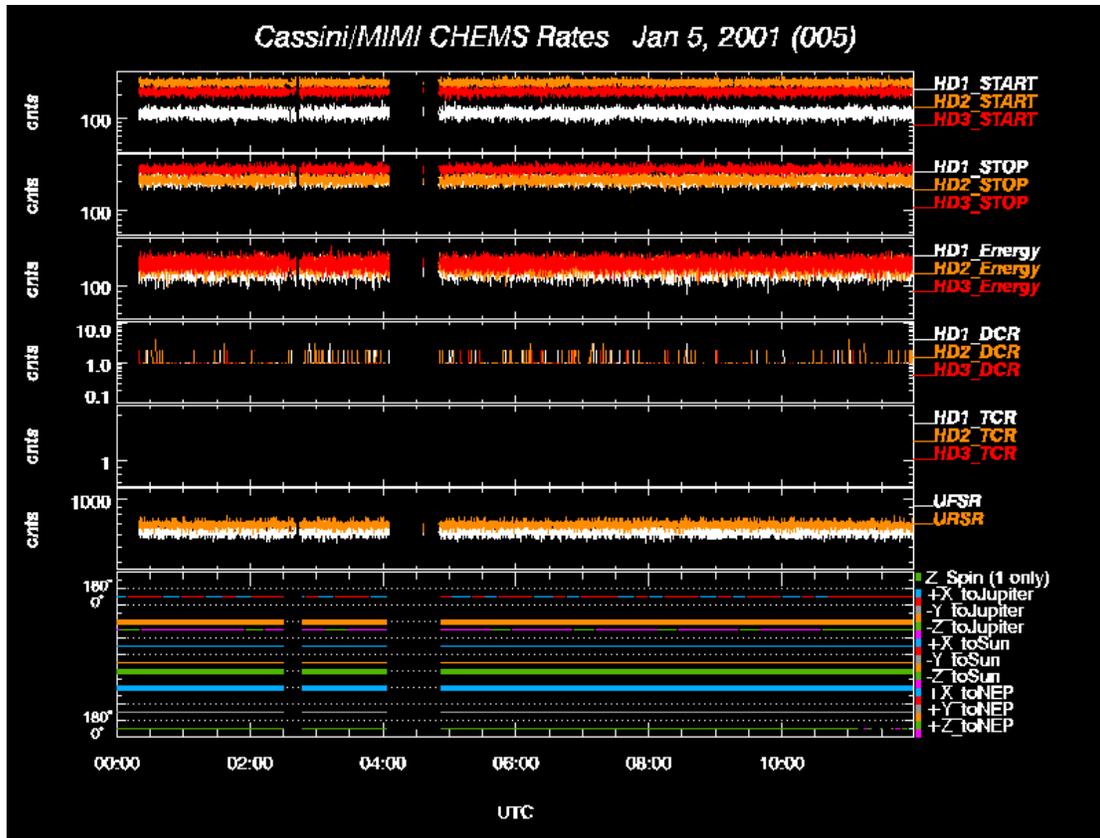


Figure 8: The chems_rates_ang product style plots the accumulator rates channels for the CHEMS sensor. The addition of the _ang at the end of the control file plots both the CHEMS rates and the S/C location plot at the bottom. Calling sequence for this image was STANDARD_PROD, '2001-005T00:00.000','2001-005T12:00.000','chems_rates_ang', png='/homes/user/chems_rates.png', /NOWIN

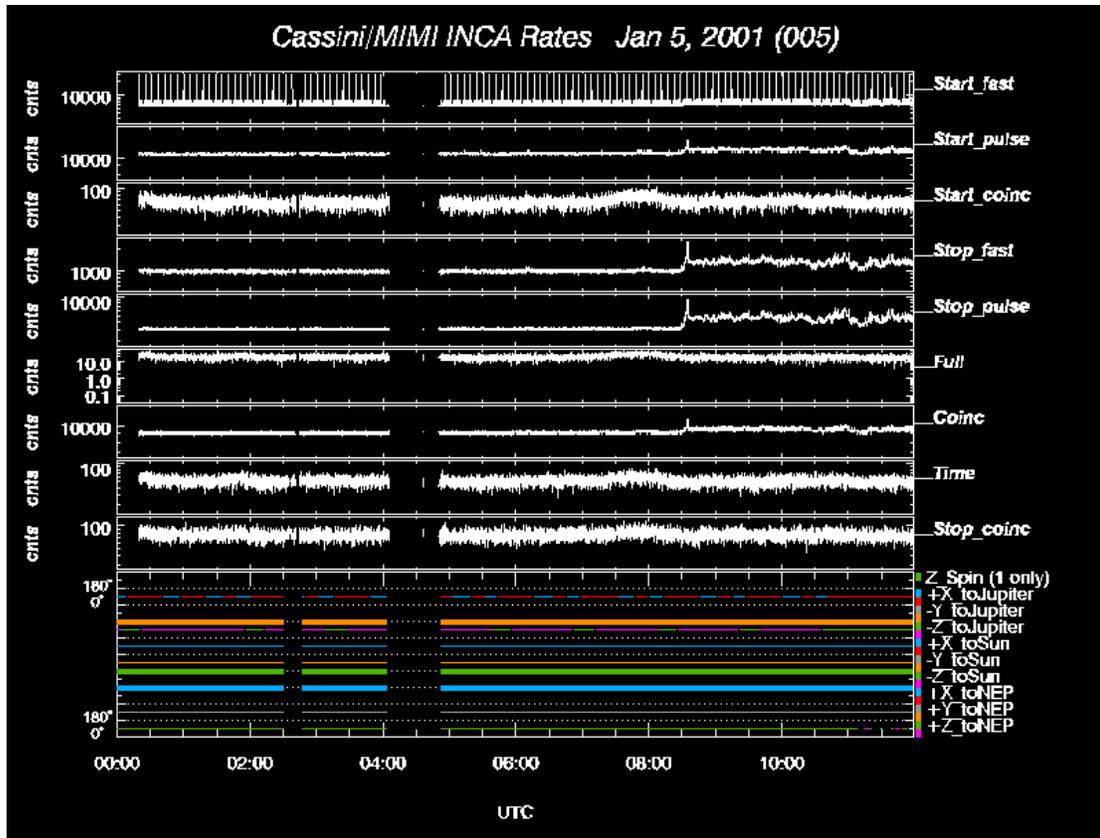


Figure 9: The inca_rate_ang product style plots the accumulator rates channels of the INCA sensor. The addition of the _ang at the end of the control file plots both the INCA rates and the S/C location plot at the bottom. Calling sequence for this image was STANDARD_PROD, '2001-005T00:00.000','2001-005T12:00.000', 'inca_rates_ang', png='/homes/user/inca_rates.png', /NOWIN

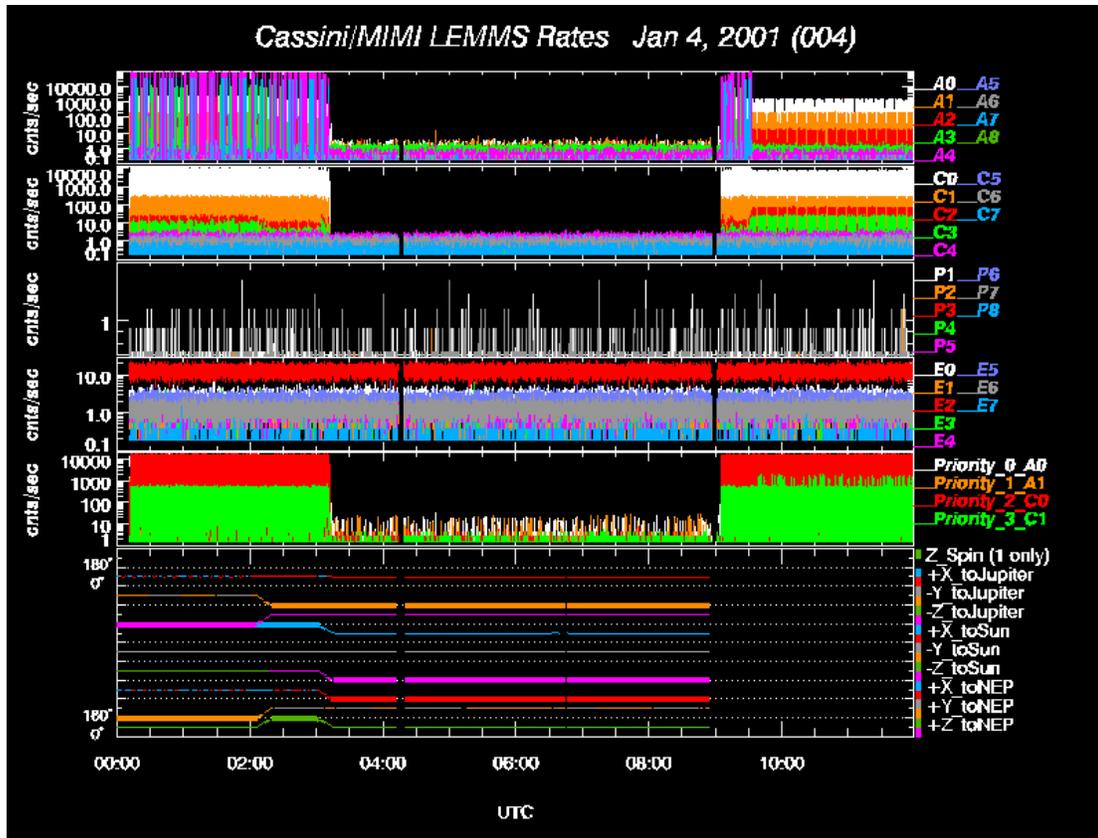


Figure 10: The lemms_gserates_c_ang product style plots the accumulator rates channels of the LEMMS sensor. The addition of the _ang at the end of the control file plots both the LEMMS rates and the S/C location plot at the bottom. Calling sequence for this image was STANDARD_PROD, '2001-004T00:00.000','2001-004T12:00.000', 'lemms_gserates_c_ang', png='/homes/user/lemms_rates.png', /NOWIN

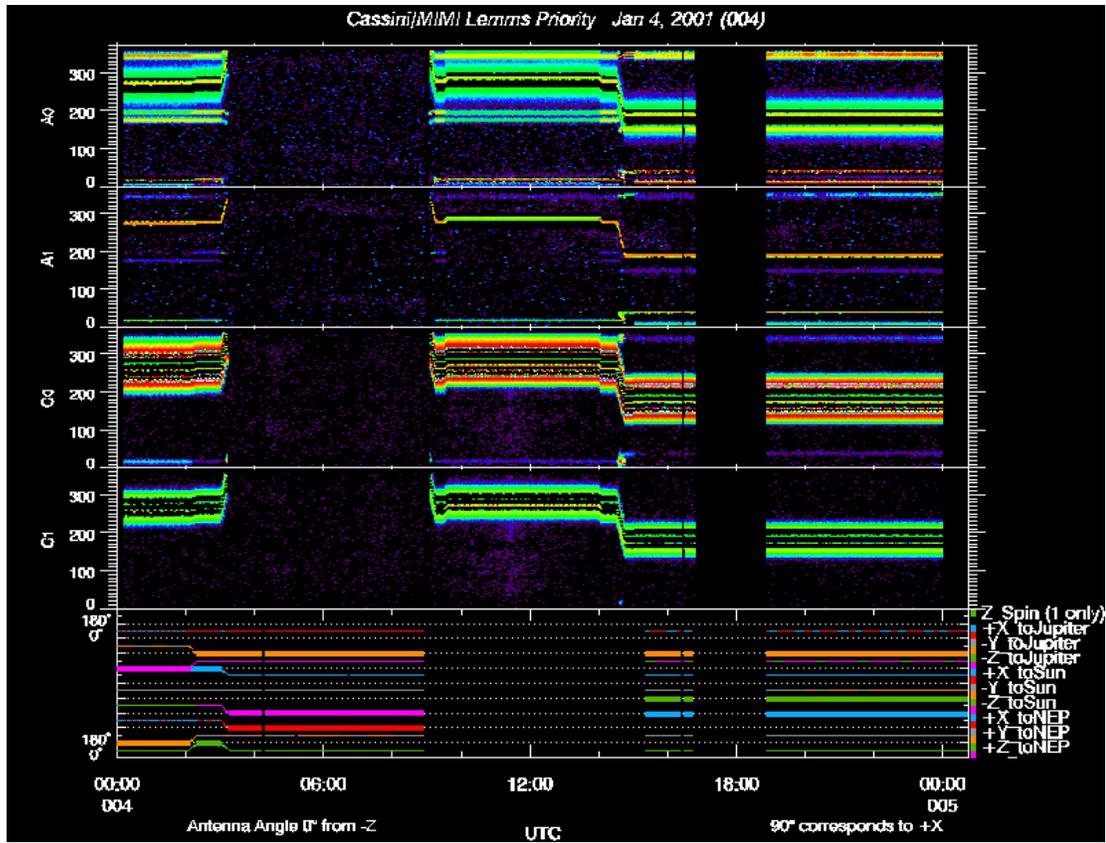


Figure 11: The lemms_priority_ang product file plots the priority channels of the LEMMS sensor. The addition of the _ang at the end of the control file plots both the LEMMS rates and the S/C location plot at the bottom. Calling sequence for this image was STANDARD_PROD, '2001-004T00:00.000','2001-004T23:59.000', 'lemms_priority_ang', png='/homes/user/lemmspriority.png', /NOWIN

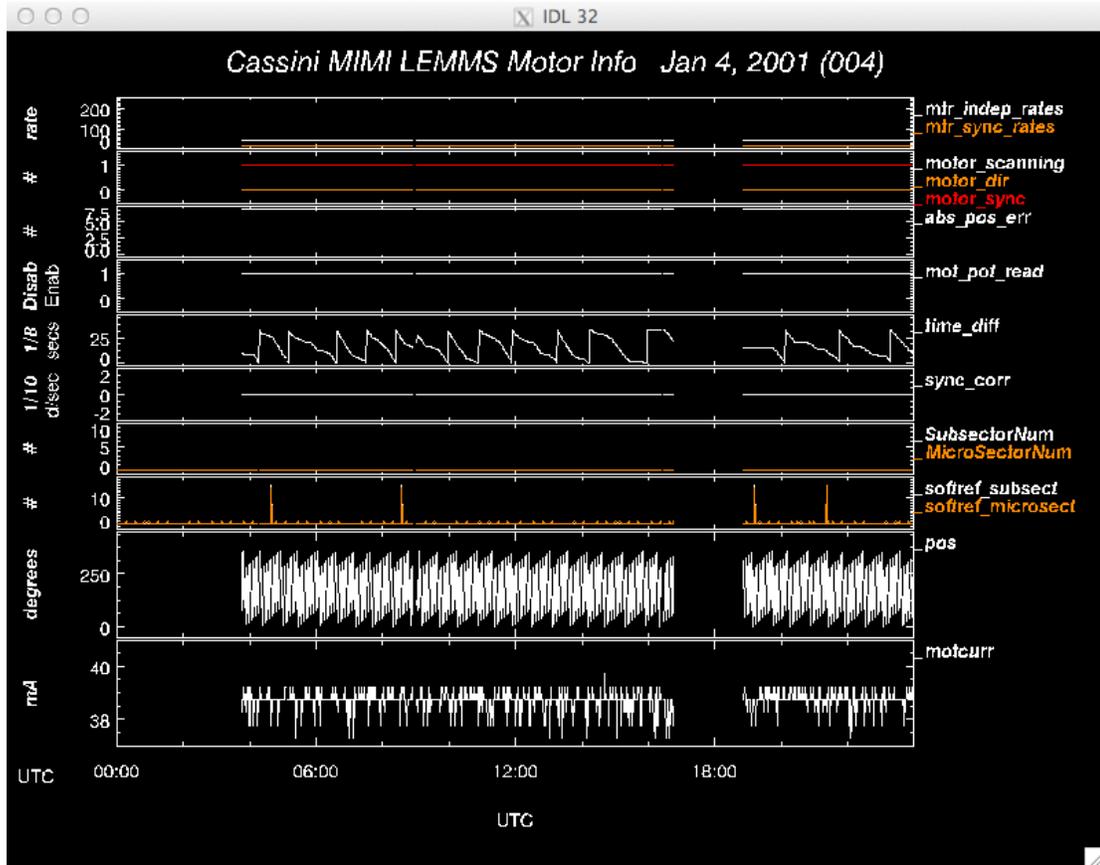


Figure 12: The lemms_motor_c product type plots LEMMS motor parameters. Calling sequence for this image was STANDARD_PROD, '2001-004T00:00.000', '2001-004T12:00.000', 'lemms_motor_C, png=/homes/user/lemms_motor.png', /NOWIN

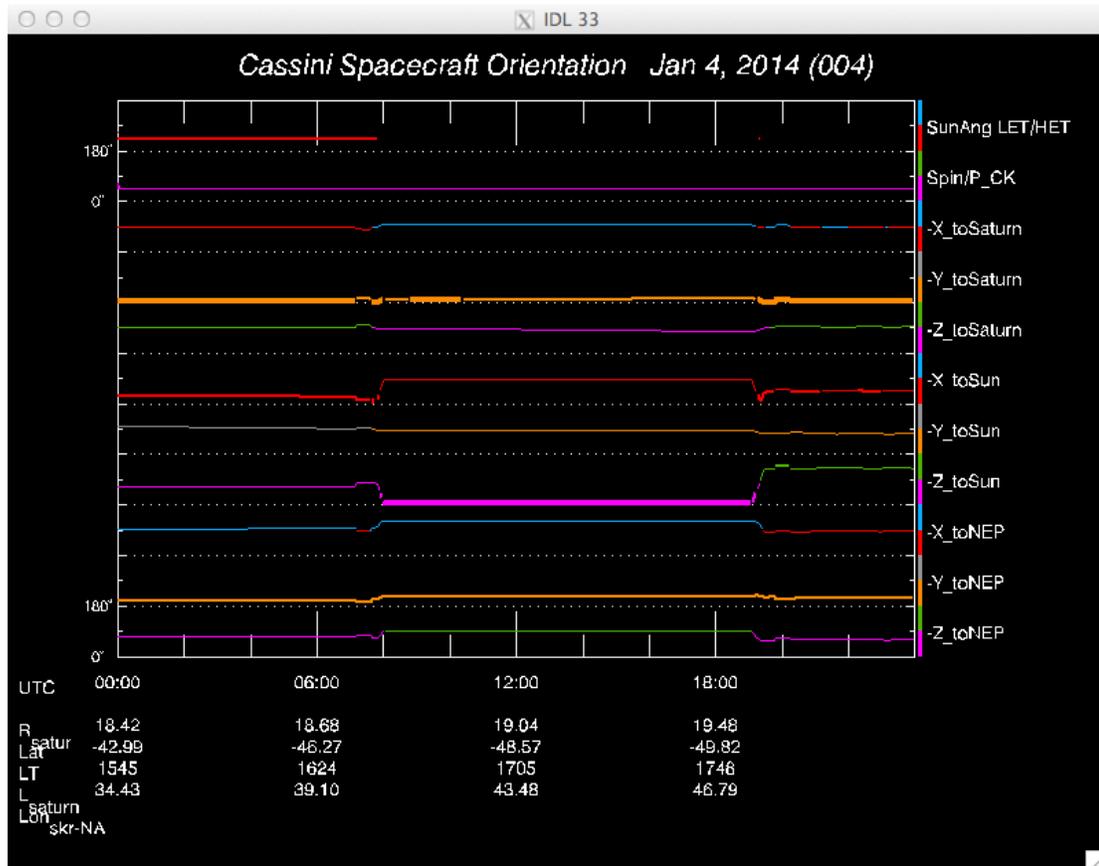


Figure 13: The `sc_angle` product type plots the spacecraft location plot style. Calling sequence for this image was `STANDARD_PROD, '2014---4T00:00.000','2014-004T23:59.000', 'sc_angle', /nowin, png='/homes/user/sc.png'`. The plots go from 0 to 180 degrees. The line gets thicker as it approaches the edges of the plots, either 0 or 180 degrees. The color of the plots change according to whether the line is in the 0-89.9 or 90-180 section. NEP stands for North Ecliptic Plane. The green line in the second plot from the top is only plotted if the Z spin is equal to 1 when the spacecraft is spinning about the Z-axis. The pink line in the first plot at the top is only plotted if a predicted C kernel was use. In the top plot, the red bar indicates sun is within +/- 20 degrees of the LEMMS high-energy telescope and the blue bar is for the LEMMS low-energy telescope.

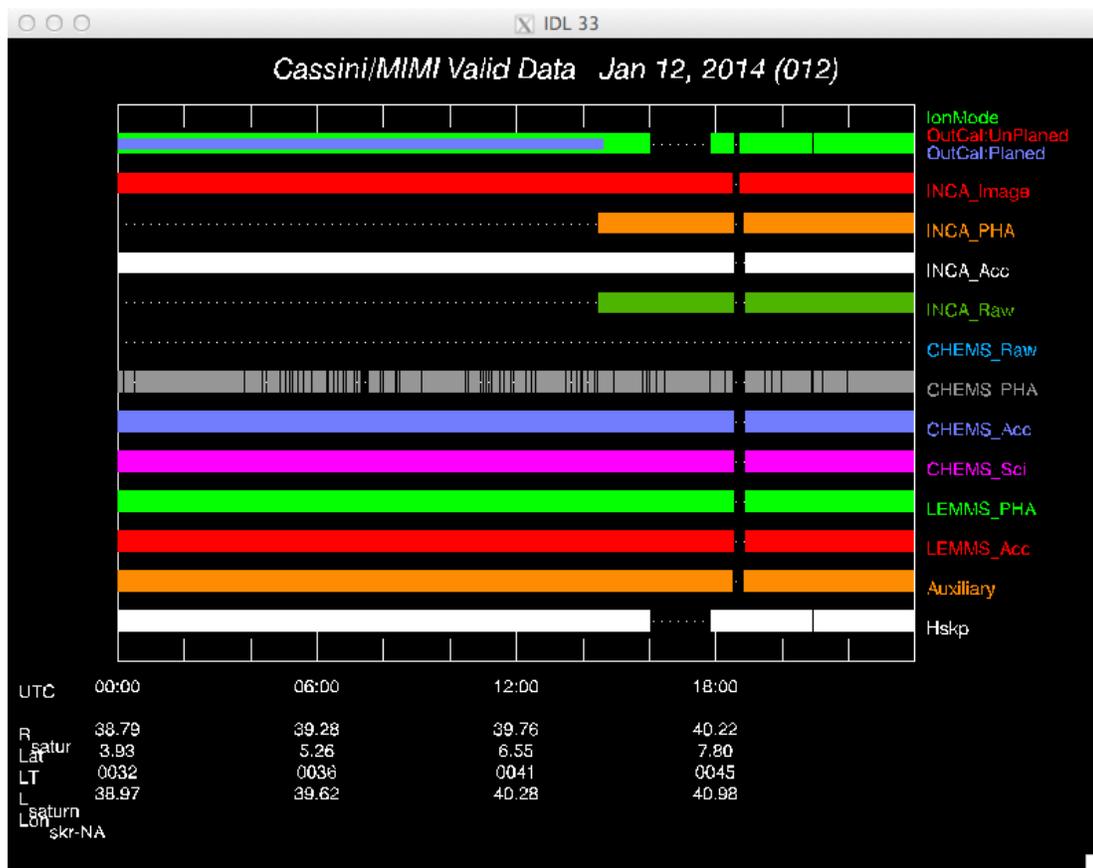


Figure 14: The valid_onoff product style plots a bar plot of all L1a data availability with respect to time. It includes the top plot of INCA’s ion and neutral mode as well as an indication of INCA’s calibration status. The blue line on top of the green line indicates that INCA was out of calibration at this time but it was an intentional period with the INCA voltages turned down. Calling sequence for this image was STANDARD_PROD, '2014-012T00:00.000','2014-012T23:59.000', 'valid_onoff, /nowin, png='/homes/user/valid.png'.

7.3 INCA Pitch Angle Plots

The INCA sensor image Pitch Angle program plots the image intensity versus the pitch angle in a histogram or scatter plot. It also can plot an image of the pitch angle over the image pixels. The menu is shown in Figure 15.

To access the INCA Pitch Angle Plot menu from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the INCA Pitch Angle Plots button or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=PITCH_FLUX_MENU()
```

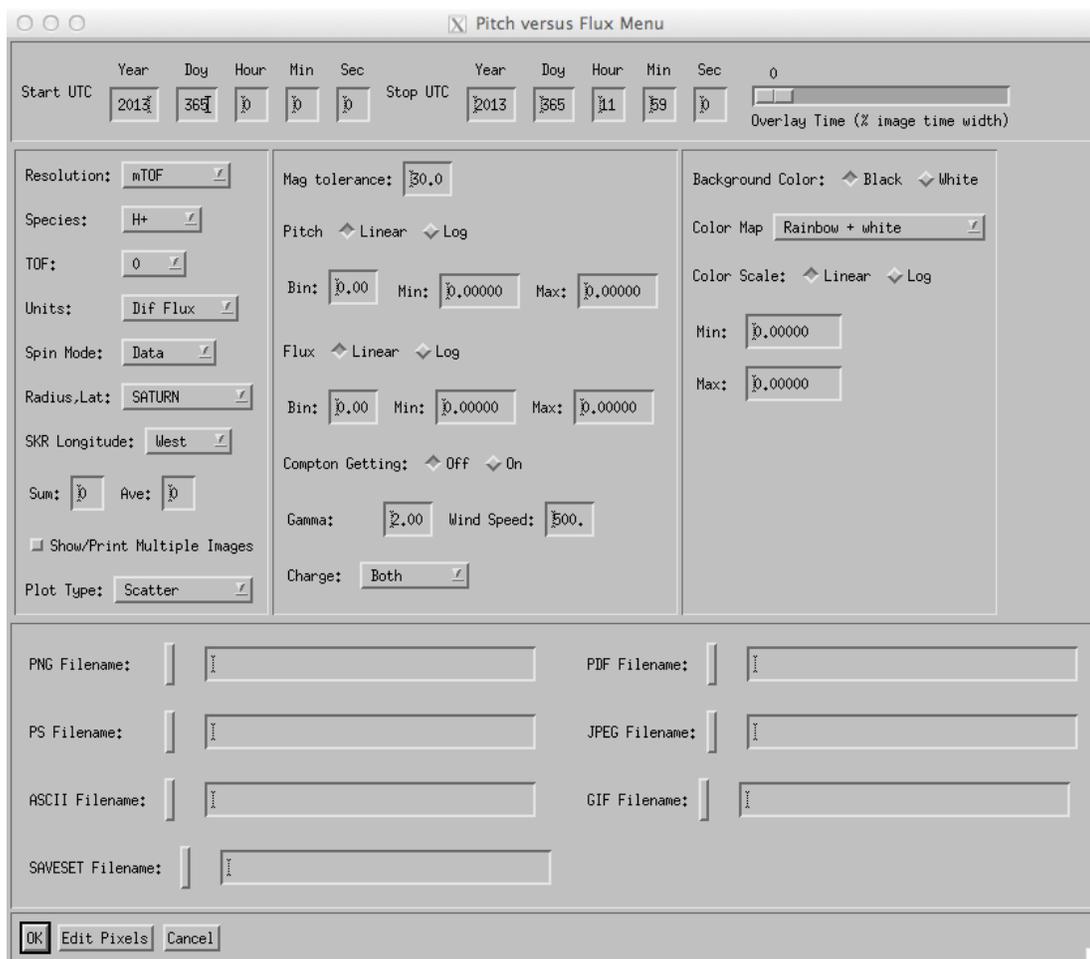


Figure 15: Pitch versus Flux Menu.

Calling Sequence:

PITCH_FLUX,2013,365,0,2013,365,1159,2,0,0, /SUPPLEM_AXIS, /WESTLON,
 MAGTOL=30.0000, BODY="SATURN", /DIF_FLUX, /SCATTER, /NOMULTI
 PITCH_FLUX,startyear,startdoy,starthourmin,stopyear,stopdoy,stophourmin,\$
 type, species, tof

Start and Stop UTC	
Year	Input 4-character year. Hit return to load the same value into the stop year.
Doy	Input 3-character day of year that starts with 1. Hit return to load the same value into the stop doy.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.

Sec	Input 2-character seconds with a range of 0 to 59.
Data Source	The default data source is to use the LIA binary files. However, the option to use the PDS ASCII data files is available.
Resolution	The program allows the user to display high mass time-of-flight (TOF), high spatial or high time resolution images For the command line call: type 0:highspatial 1:high time 2:high TOF.
Species	Both hydrogen and oxygen data can be plotted. For the command line call: species 0:H, 1:He, 2:CNO, 3:Heavy, 4: other, 5:all (hightime).
TOF	The menu allows the user to select individual TOF values. High time and spatial resolution may use 0-low, 7-high TOF. High TOF may use 0-7 TOF values.
Units	Unit options are differential intensity, integral intensity, counts per second and counts. Keywords: Counts are the default. DIF_FLUX will select differential intensity INT_FLUX will select integral intensity CNTSEC will select counts per second units
Spin Mode	The data can be forced to be in either spin or stare mode instead of using the parameter reported in the data header. This is not usually used but is included for debugging purposes.
Radius, Lat	Select the body to be used for the supplementary labels (radius, latitude, local time)
SKR Longitude	The SKR longitude can be plotted in east or west longitude.
Sum or average	The number of images that will be summed (counts) or averaged after the data is converted. If not selected, then the data is plotted over the accumulation time of the image.
Show/Print Multiple	If no averaging is selected, then the data is plotted over the accumulation time of the image. If a larger time period is selected, and the multiple button is selected then multiple windows or output plots will be created, one for each image accumulation time or averaged image accumulation time.
Plot Type	The plot type offers histogram or scatter plots. It also can plot an image of the pitch angle over the image pixels. Examples of the plot types are included in the following figures.
Mag	The mag tolerance is the maximum variance of the mag mean angle over the

Tolerance	image accumulation time that will be acceptable.
Pitch Linear/Log	Plot the pitch angle in either linear or log in the scatter or histogram.
Pitch Bin	This is the smallest bin size for the pitch (X) axis in the histogram. The default value is 50.
Pitch Min/Max	Enter the minimum or maximum linear value to bound the plot X limits (even when in log mode).
Flux Linear/Log	Plot the flux in either linear or log in the scatter or histogram. The default value is 50.
Flux Bin	This is the smallest bin size for the flux (Y) axis in the histogram.
Flux Min/Max	Enter the minimum or maximum linear value to bound the plot Y limits (even when in log mode).
Compton Getting	Apply a correction for the Compton–Getting effect. See the routine GET_COMPTONGETTING for more information on how this is being implemented.
Gamma	Compton-Getting Gamma parameter. It is usually close to 2.0 in the solar wind frame.
Wind Speed	This is the convective speed of the plasma for the Compton-Getting correction. The default value is 500.
Charge	The INCA instrument is considered to be in ion mode when the voltage applied to the collimator is less than a threshold (1000 volts currently). When the collimator voltage is above that threshold, the instrument is considered to be in neutral mode. The data from just ion or neutral or both mode(s) may be plotted.
Background color	The background of the plot can be either black or white.
Color Scale	The data can be displayed in either linear or log for the histogram or image format.
Min and Max	Enter the minimum or maximum linear value to bound the plot y limits (even when in log mode).
Edit Pixels Button	At the bottom of the menu is an Edit Pixels button. It accesses a menu that allows the user to turn off pixels in the image. The Edit Pixels Menu included in Figure 16 where the user selects the type of image to edit the pixels for and Figure 17 which shows an example of the 16x16 pixel editing menu.

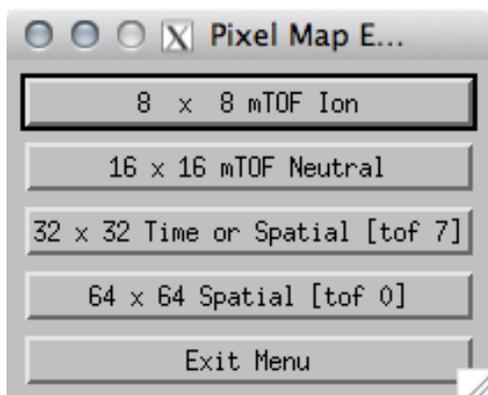


Figure 16: Edit Pixels Menu. Select an image size to match the data being viewed.

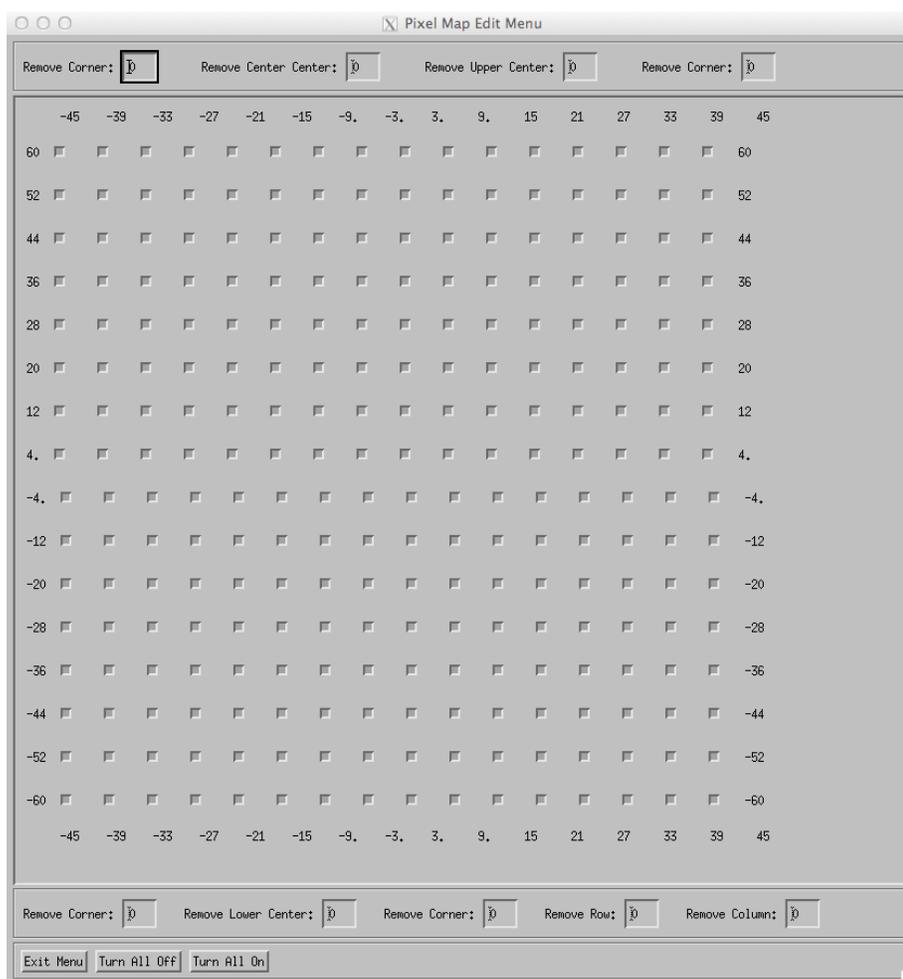


Figure 17: 16 x 16 Pixel Map Menu. It is used to mask pixels in the image. The user selects the pixels to exclude. In any field, hit return to make the change. The remove corners fields removes N pixels from the nearest corner. The Remove Center Center removes N pixels from the center. The Remove Upper Center removes N pixels from the center of the top of the image. The Remove Lower Center removes N pixels from the center of the bottom of the image. The Remove Row removes pixels from the row ordered from the top = 0. The Remove Column removes pixels from the column left = 0.

The following figures show the scatter, histogram and pitch angle image options.

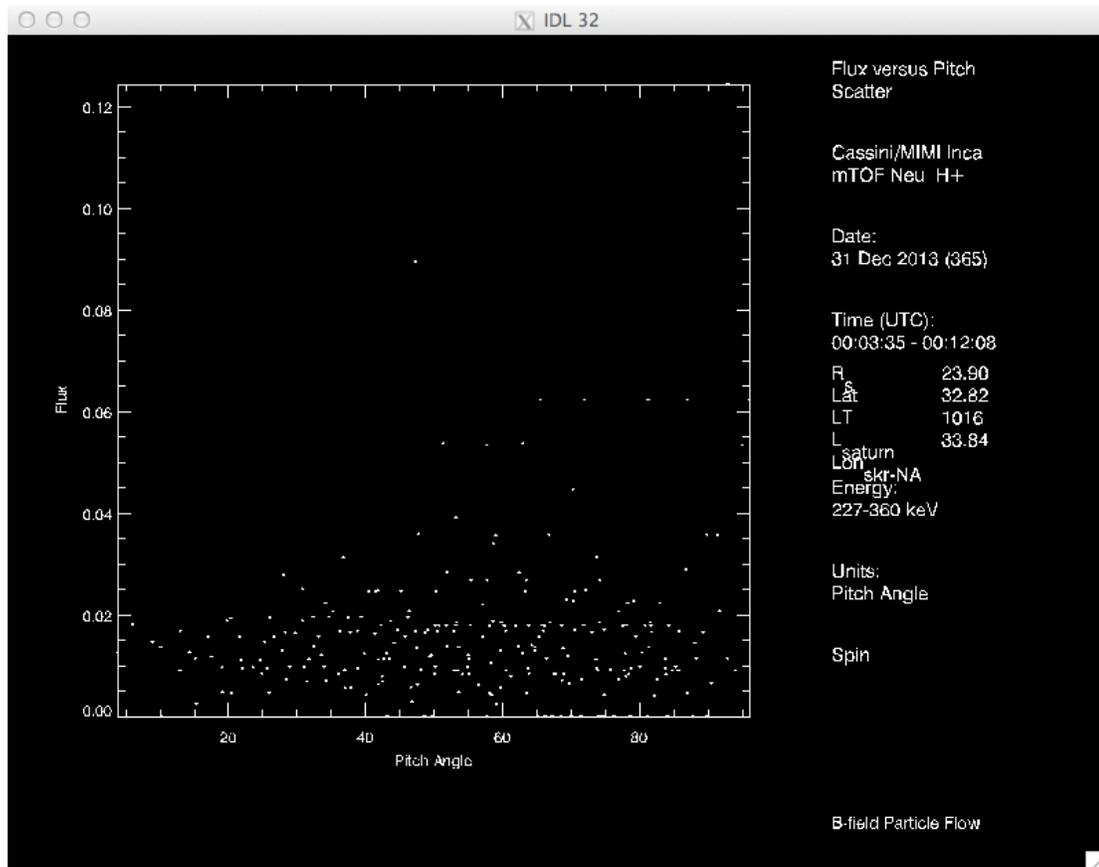


Figure 18: Pitch vs Flux Scatter Output Option. Pixel intensity in the selected units is on the Y-axis and pixel pitch angle is on the X-axis.

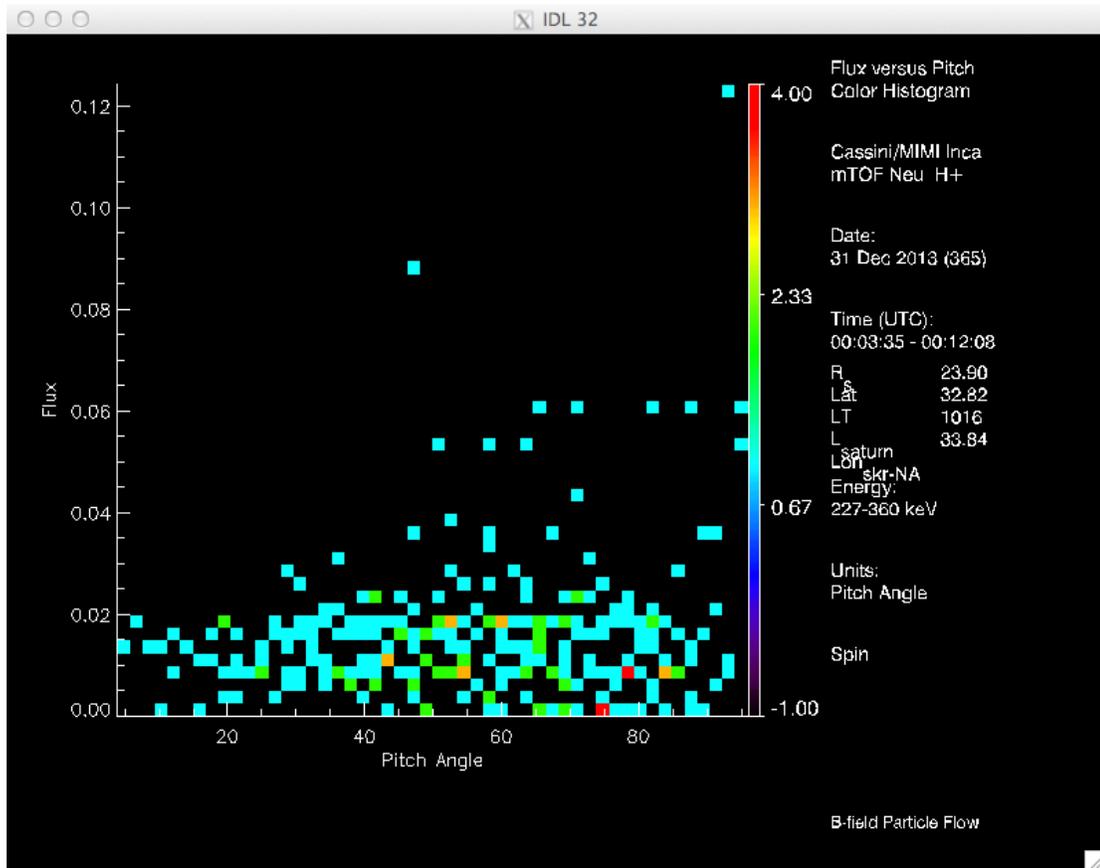


Figure 19: Pitch vs Flux Histogram Output Option. Pixel intensity in the selected units is on the Y-axis and pixel pitch angle is on the X-axis.

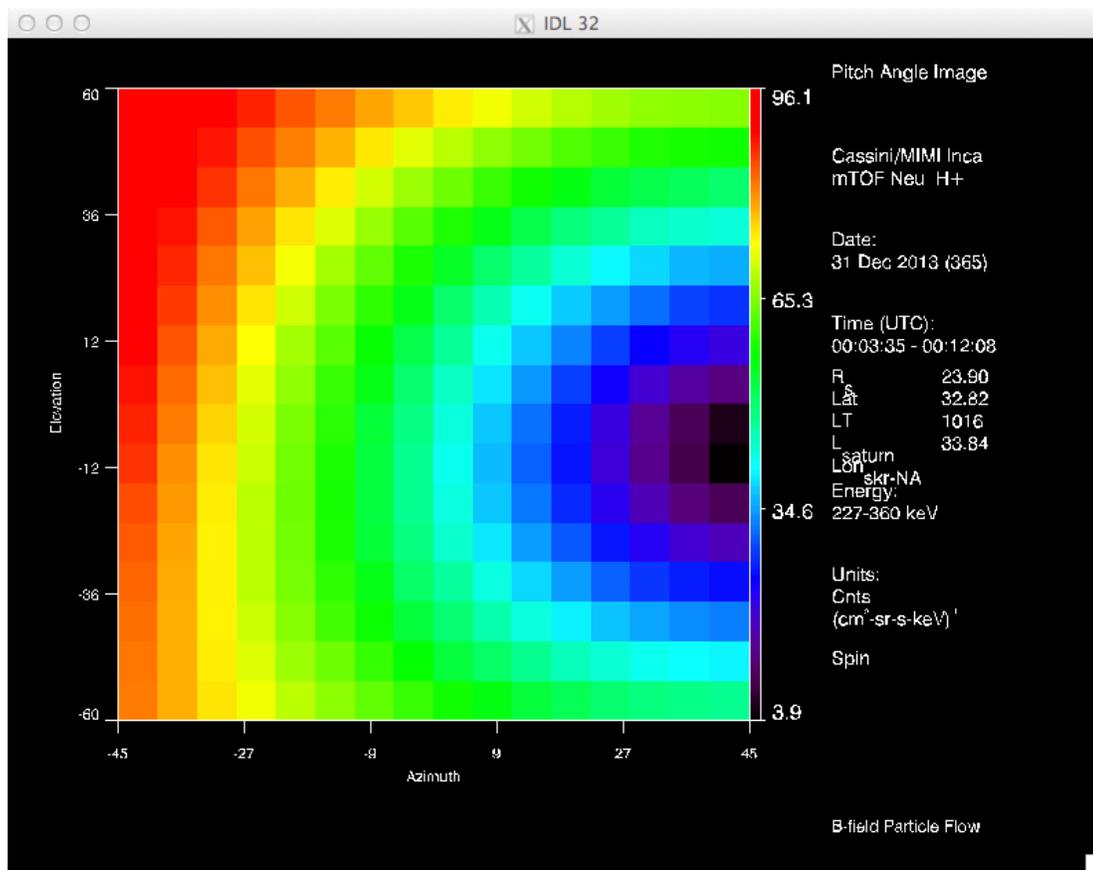


Figure 20: Pitch Angle Over the Image Pixels Output Option.

7.4 INCA High TOF Channel Plots

The INCA High TOF Channel Plots option will plot the INCA images averaged or summed to a single point and plotted in a line plot.

To access the TOF Channel Plot menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the INCA High TOF Channel Plots button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=TOFCHANNELS_MENU()
```

The TOF channel-plotting program takes a time range, image type, species type and reads in all matching INCA sensor image data. Then each image is summed or averaged down to one value. The data is plotted in one line plot per TOF bin. The y-axis is the summed or averaged value and the x-axis is time. The user can average or sum the image data before it is summed or averaged down to one pixel. The user can also generate the output in counts, integral or differential intensity. Figure 21 shows the TOF channel plot menu.

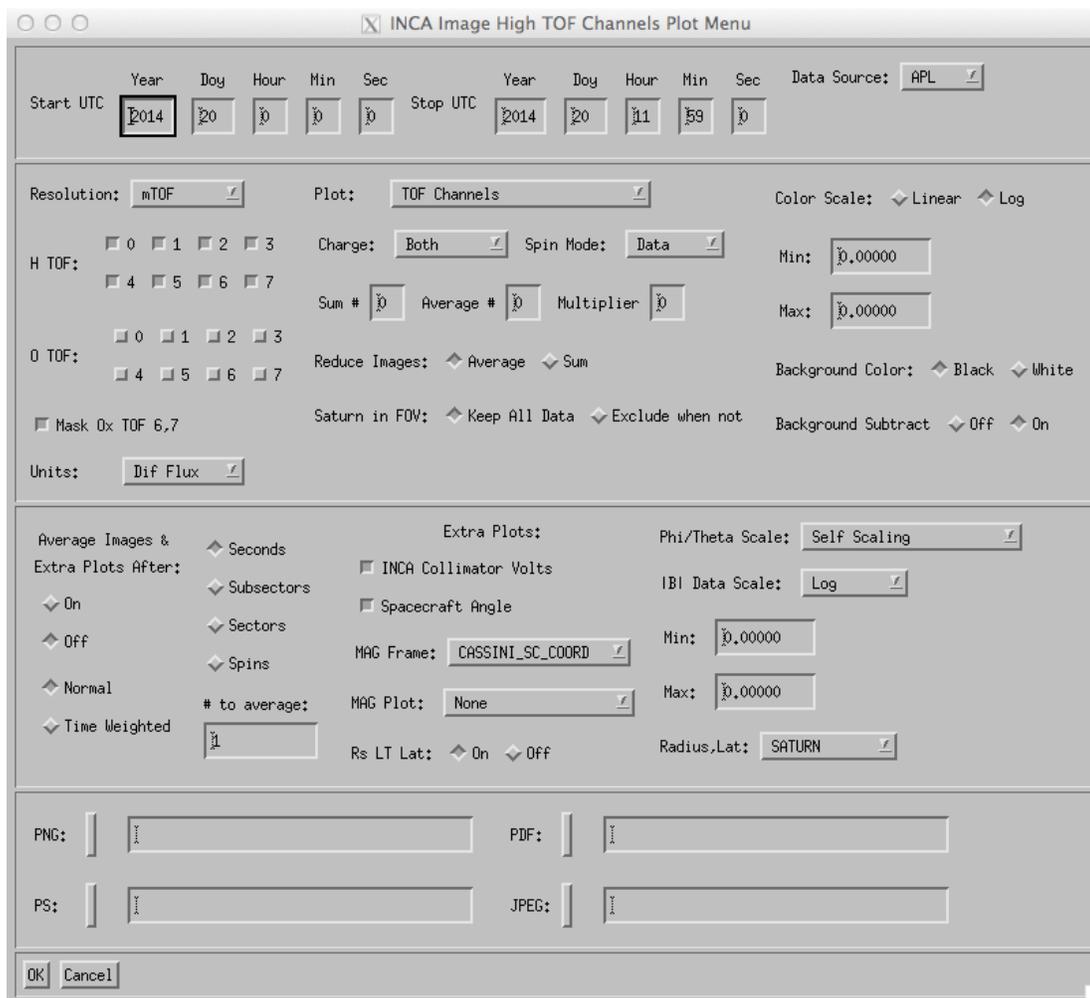


Figure 21: INCA High TOF Channels Plot Menu.

Calling Sequence

TOFCHANNELS_PLOT, 1999, 175, 2027, 1999, 175, 2200, 2, 0, 1, AVERAGE=4, /DIF_FLUX

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Data Source	The default data source is to use the L1a binary files. However, the option to use the PDS ASCII data files is available.
Resolution	The program allows the user to display high mass time-of-flight , high spatial or high time resolution images

	For the command line call: type 0:highspatial 1:high time 2:high tof.
Species	Both hydrogen and oxygen data can be plotted. For the command line call: species 0:H, 1:He, 2:CNO, 3:Heavy, 4: other, 5:all (hightime).
TOF	The menu allows the user to select individual time of flight values for both hydrogen and oxygen. To do this using the command line, see the OTOF and HTOF keyword options.
Mask Ox	The TOF 6 and 7 images have known high pixel values and the affected pixels. This option allows the user to mask those pixels.
Units	Unit options are differential intensity, integral intensity, counts per second and counts.
Plot Type	The plot type offers normal high time-of-flight and partial pressure plots. The partial pressure plots can be with the separate time-of-flights or combined into the geometric mean of the original partial pressures.
Charge	The INCA instrument is considered to be in ion mode when there is less than a threshold (1000 volts currently) volts applied to the collimator. When the collimator voltage is above that threshold, the instrument is considered to be in neutral mode. The data from just ion or neutral mode may be plotted.
Spin Mode	The data can be forced to be in either spin or stare mode instead of using the parameter reported in the data header. This is included for debugging purposes.
Sum or average	The images can be summed (counts) or averaged before the data is calculated
Multiplier	The multiplier is a parameter to multiply by any data in spin mode.
Reduce Images	All the data from one image is averaged or summed (counts) to produce the data. For the command line call, ave_or_sum = 1 then average data to obtain image point ave_or_sum = 0 then sum data to obtain image point
Saturn in FOV	Select this option to exclude data when Saturn is in the FOV.
Color Scale	The data can be displayed in either linear or log mode.
Min and Max	Enter the minimum or maximum linear value for the plot y limits (even when in log mode).
Background color	The background of the plot can be either black or white.
Background Subtract	A few INCA time-of-flight images have background values that can be subtracted from the images before use.

INCA collimator Volts	Include a plot of the INCA collimator voltage.
Spacecraft Angle	Include the spacecraft location plot.
Mag frame	This option allows the user to select a frame for the magnetometer data if it is selected to plot.
Mag Plot	Include a plot of the mag data in either Bx, By and Bz, Phi/Theta or partial pressure plot styles.
Display Rs LT Lat	The radius to Saturn, light time and latitude can be displayed at the bottom of the plots along with the time.
Radius, Lat	Select the Axis body to determine the body used for the supplementary labels (radius, latitude, local time)
Phi/Theta Scale	The phi and theta data can be allowed to self-scale or set to a standard set of minimum and maximum.
Min and Max in Mag area	The minimum and maximum limits linear value for the Bx,By and Bz plot can be set.
Data Scale	The mag data can be displayed in log or linear.

The following figures show examples of the TOF channel plotting options.

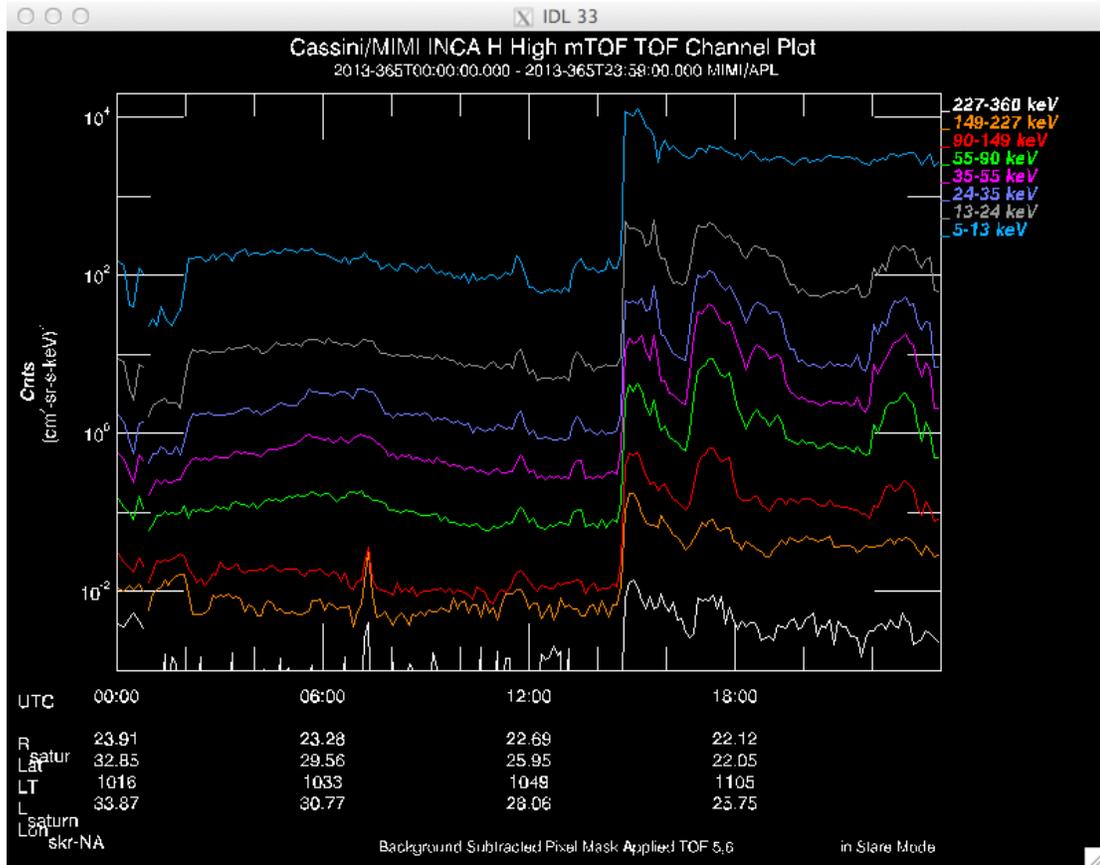


Figure 22: TOF Channel plot of INCA TOF images. The Calling sequence to produce this plot is TOFCHANNELS_PLOT, 2013,365,0000,2013,365,2359,2,0,1, /LOG_PLOT, /DIF_FLUX, png='/homes/user/tof.png', /NOWIN

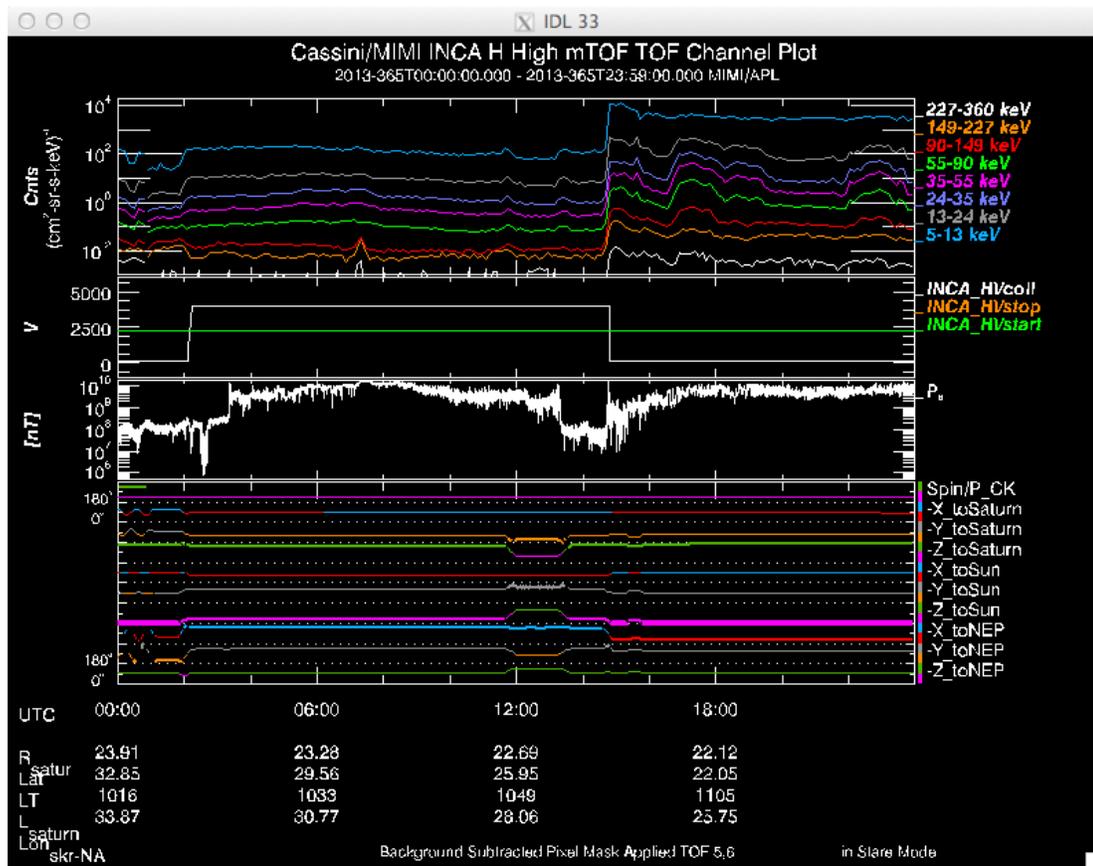


Figure 23: Line plot of INCA TOF data with the magnetometer data in Partial Pressure, INCA High Voltage and the spacecraft location plots. The command used was TOFCHANNEL_PLOT,2013,365,0,2013,365,2359,2,0,1,/SUBTRACT_BACK,TOF=[0,1,2,3,4,5,6,7],/DIF_FLUX,/MAGPARTPRESS,MAGLOGVAL=1,/SC_LOC,/COLLV. Notice how the plot contains both ion and neutral data that can be detected by viewing the voltage on the INCA_HVcoil parameter in the INCA voltage plot. The charge command could be used to display just ion or neutral mode data.

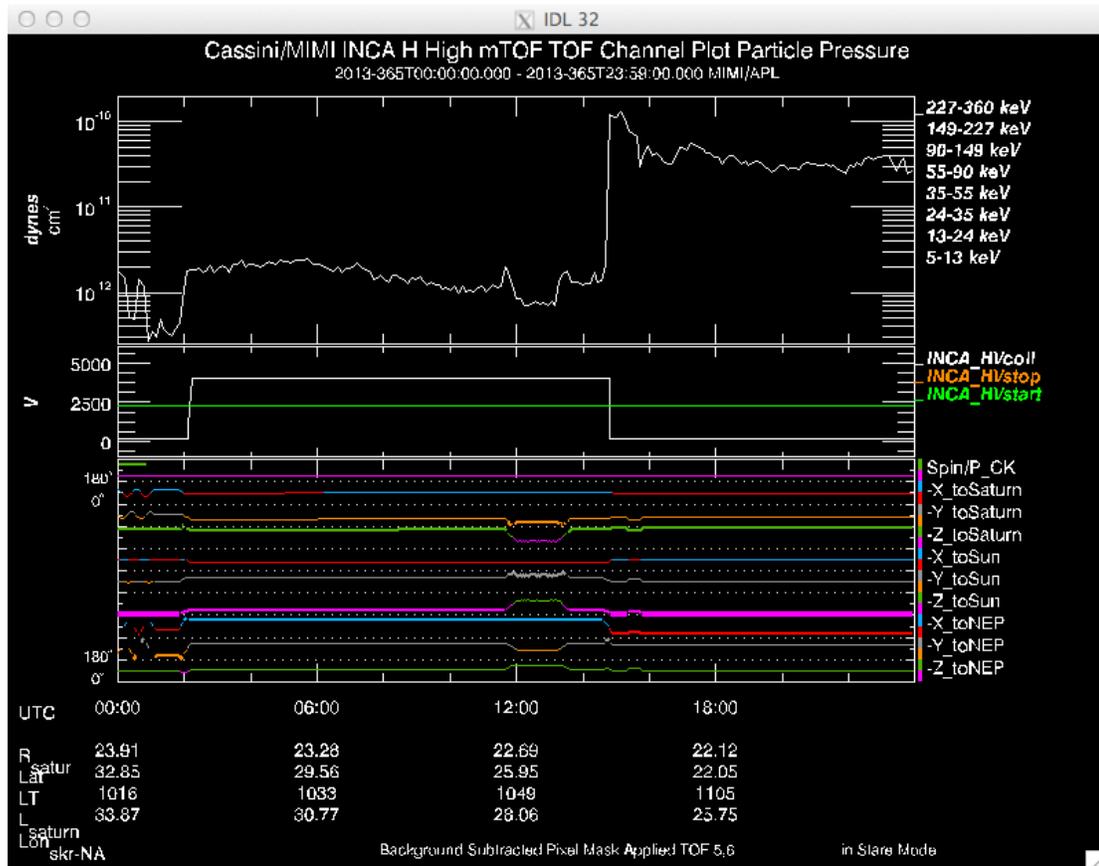


Figure 24: INCA TOF Channels in Partial Pressure. The geometric mean of the separate time-of-flights partial pressures is displayed. The command used was `TOFCHANNELS_PLOT,2013,365,0,2013,365,2359,2,[0],1,/SUPPLEM_AXIS,/SUBTRACT_BACKGROUND,/MASKOX,HTOF=[0,1,2,3,4,5,6,7],/DIF_FLUX,/TOG_PART_PRESS,/LOG_PLOT,/SC_LOC,/COLLV.`

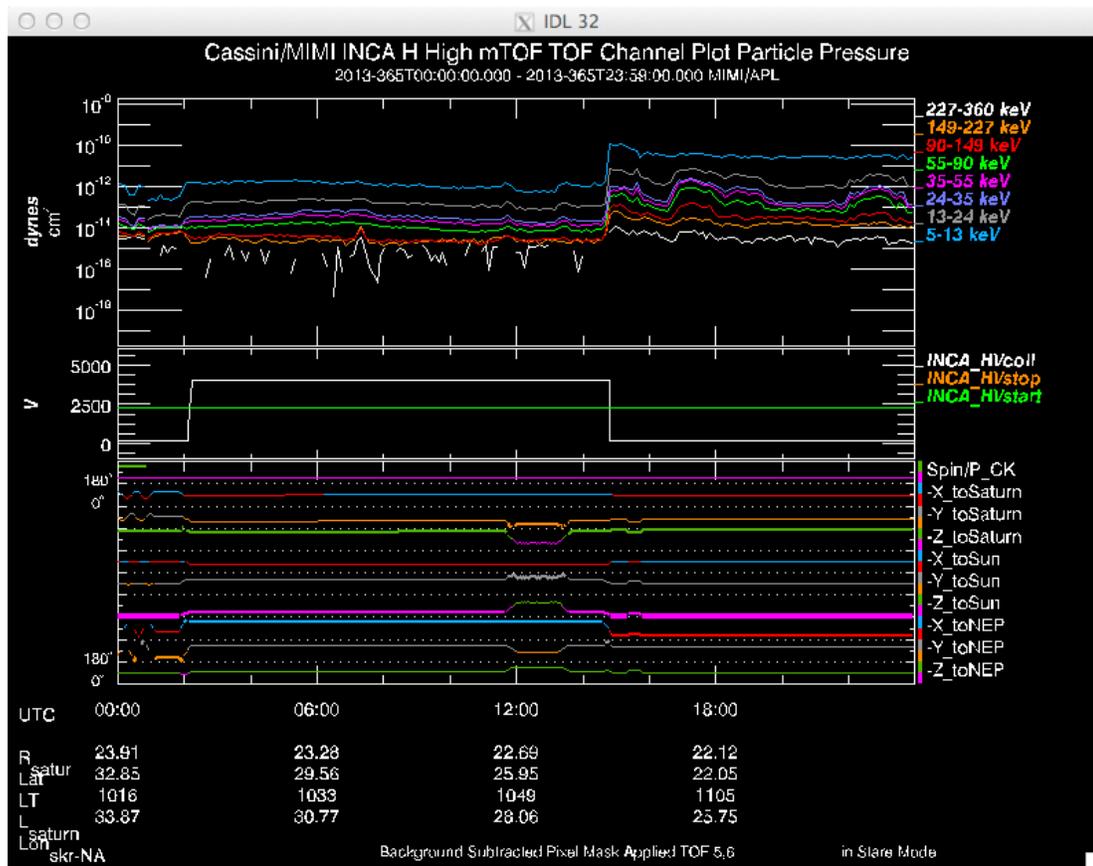


Figure 25: INCA TOF Channel in Separate Particle Pressure. The command used was `TOFCHANNELS_PLOT,2013,365,0,2013,365,2359,2,[0],1,/SUPPLEM_AXIS,/SUBTRACT_BA CK,/MASKOX,HTOF=[0,1,2,3,4,5,6,7],/DIF_FLUX,/DIF_PART_PRESS,/LOG_PLOT,/SC_LOC,/COLLV`

7.5 INCA High TOF Spectrograms

The `IMAGE_SPECTRO.PRO` program reads in all matching H+ High TOF data for one species, sums or averages each image into one number and plots a spectrogram of the data.

To access the Image Spectro menu from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the INCA High TOF Spectro button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts /mimi_idl
```

```
IDL>s = SPECTRO_MENU()
```

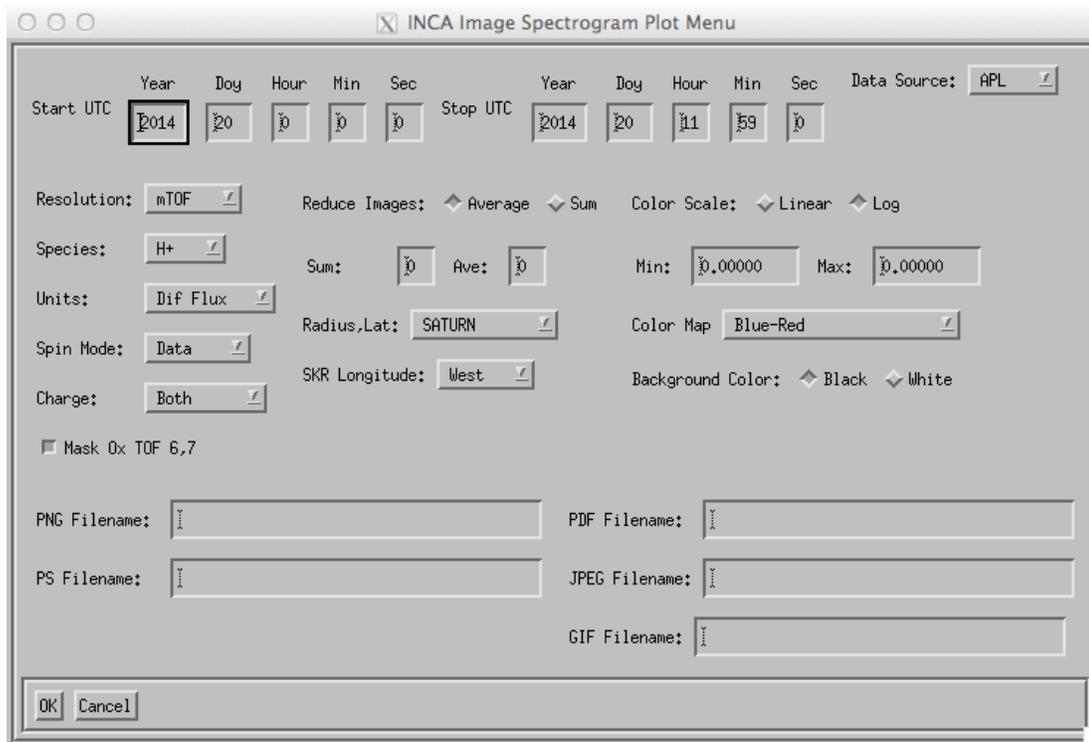


Figure 26: INCA TOF Channel Spectrogram Menu.

Calling Sequence

IMAGE_SPECTRO,2001,004,0000,2001,004,2359,0,1

Spectro Menu Options

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Data Source	The default data source is to use the L1a binary files. However, the option to use the PDS ASCII data files is available.
Resolution	The program allows the user to display high mass time-of-flight , high spatial or high time resolution images For the command line call: type 0:highspatial 1:high time 2:high tof.
Species	Both hydrogen and oxygen data can be plotted.

	For the command line call: species 0:H, 1:He, 2:CNO, 3:Heavy, 4: other, 5:all (hightime).
Mask Ox	The TOF 6 and 7 images have known high pixel values and the affected pixels. This option allows the user to mask those pixels.
Units	Unit options are differential intensity, integral intensity, counts per second and counts.
Charge	The INCA instrument is considered to be in ion mode when the voltage applied to the collimator is less than a threshold (1000 volts currently). When the collimator voltage is above that threshold, the instrument is considered to be in neutral mode. The data from just ion or neutral mode may be plotted.
Spin Mode	The data can be forced to be in either spin or stare mode instead of using the parameter reported in the data header. This is not usually used but is included for debugging purposes.
Sum or average	The images can be summed (counts) or averaged before the data is calculated
Reduce Images	All the data from one image is averaged or summed (counts) to produce the data. For the command line call, ave_or_sum = 1 then average data to obtain image point ave_or_sum = 0 then sum data to obtain image point
Color Scale	The data can be displayed in either linear or log.
Min and Max	Enter the minimum or maximum linear value to bound the plot y limits (even when in log mode).
Background color	The background of the plot can be either black or white.
Radius, Lat	Select the Axis body to determine the body used for the supplementary labels (radius, latitude, local time)
SKR Longitude	The SKR longitude can be displayed as East or West longitude.

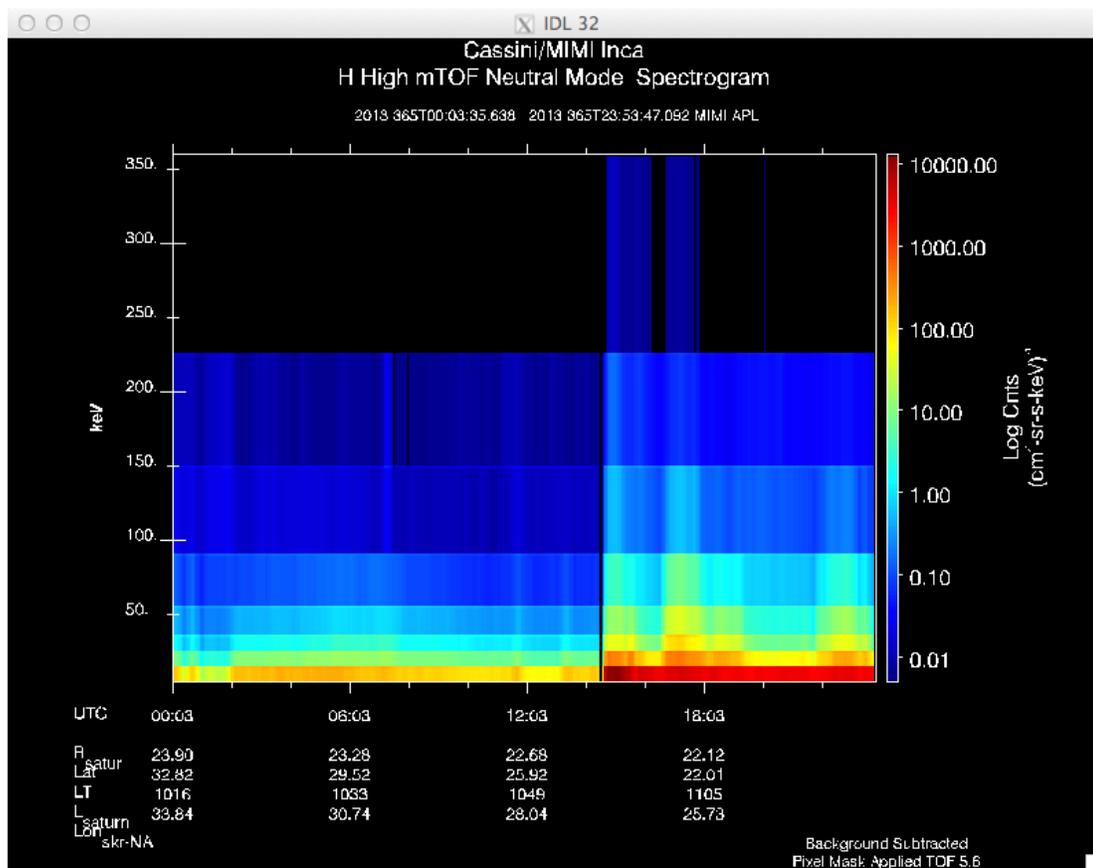


Figure 27: INCA TOF Spectrogram plot. This is a spectrogram created from the INCA images. The Calling sequence is `IMAGE_SPECTRO,2013,365,0,2013,365,2359,0,ave_or_sum,/SUPPLEM_AXIS,/WESTLON,/MASKOX,/DIF_FLUX,/LOG_COLORMAP.`

7.6 INCA and CHEMS PHA Plots

The `plot_pha` program reads in CHEMS or INCA data selected by user using a menu. The X and Y channels are selected interactively using a menu based on the sensor selection. Most combinations of parameters require some manipulation of the bin sizes and minimum and maximum data values. Figure 28 shows the INCA and CHEMS PHA plots menu.

Calling Sequence

```
PLOT_PHA, '1999-230T21:56:00','1999-230T22:19:00','INCA','PHA
Events','Pulse_Height_Rear','ENUC'
```

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.

Sec	Input 2-character seconds with a range of 0 to 59.
Sensor	'INCA','CHEMS'. Either INCA or CHEMS PHA data can be plotted. This parameter will load the X and Y variable fields with the appropriate channels.
INCA X or Y variable	<p>Coinc is the coincidence bit from the event ID.</p> <p>Start_Stop is the "TAC present" bit from the event ID.</p> <p>Pulse_Height_Front is the pulse height from the front.</p> <p>Pulse_Height_Rear is the pulse height from the rear.</p> <p>TOF is the ten msbs of the corrected time-of-flight</p> <p>ENUC is a calculated value from TOF.</p> <p>Azimuth ranges from 0-63 (-90° ... +90°) and elevation ranges from 0-47 (-90° ... +90°)</p> <p>Elevation = 48 indicates that azimuth and elevation are out of range. Both angles are in the high-time resolution coordinate system.</p> <p>Mass_Range</p> <p>000 Invalid</p> <p>001 H</p> <p>010 He</p> <p>011 CNO</p> <p>100 Heavy</p> <p>101, 110, 111 Invalid</p>
CHEMS X or Y variable	<p>DPSS_Level The value of the DPSS step.</p> <p>Energy range is in keV</p> <p>TOF is time-of-flight in ms.</p> <p>SSD_ID is the ID of the SSD.</p> <p>Strt_MCP_ID is the start MCP ID.</p> <p>Range</p>
OH separator line	We can plot the line that separates the Oxygen from the Hydrogen if Pulse Height Rear is plotted versus ENUC. Figure 29 shows this line.
Colormap Linear or Log Scale	The scale for the color map can be plotted in either linear or log.
X and Y Linear and Log Scale	The scale for the X and Y variables can be plotted in either linear or log mode.
Bin Width	For the default plot, Pulse_Height_Rear versus ENUC, the X bin width is 1.0 and the default value is used for the Y bin width. The default value for bin width is data range/50.
Data Min and	The minimum and maximum data range for the X and Y parameters can be

Max	entered in linear mode.
-----	-------------------------

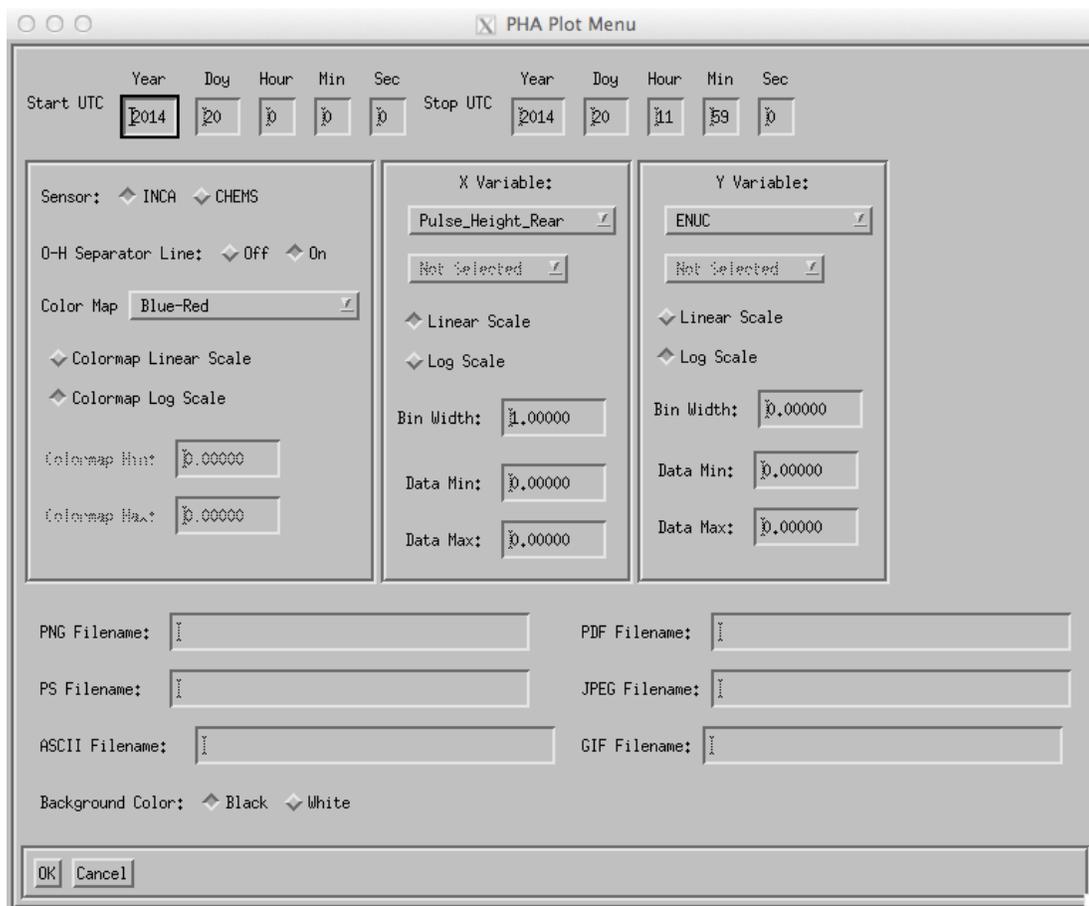


Figure 28: INCA and CHEMS PHA Plot Menu. The sensor button will load the variables shown under X and Y variable.

Figure 29 shows the INCA Pulse Height Rear plotted versus ENUC (a calculated value from TOF) with the line that separates the Oxygen from the Hydrogen.

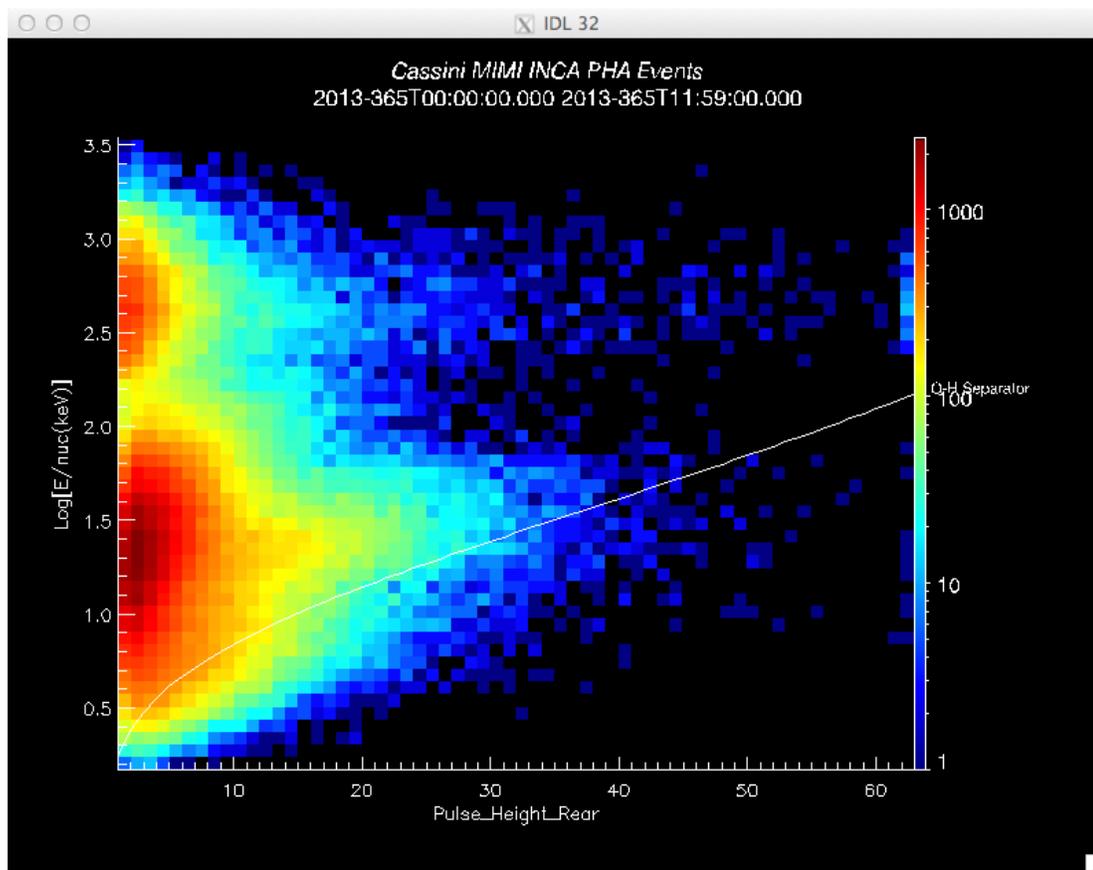


Figure 29: INCA PHA Events Plot. The calling sequence is `PLOT_PHA,'2013-365T00:00:00.000','2013-365T11:59:00.000','INCA','PHA Events','Pulse_Height_Rear','ENUC',/LOG_COLORMAP,/LOGY,BIN_X_SIZE=1.00000,/PLOT_OHLIN E,COLORMAP=33`

7.7 Magnetometer Line Plots

The mag plotting program takes a time range, a coordinate frame and a plot type and reads in all matching magnetometer data (provided courtesy of the Cassini MAG Investigation). It has the option to plot the data in Bx, By, Bz and Btotal, partial pressure or in phi theta mode. The mag plotting program is part of the standard prod plotting program but was moved to it's own menu because it has many parameters. The mag plotting menu also allows the user to dump the magnetometer data in the transformed format, enter an ASCII filename into the menu.

To access Mag Plot menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the MAG Plot Dump button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=MAG_MENU()
```

The second way to plot the channels is to call the `standard_prod` program described in section 7.2 Standard Products, from the idl command line prompt with one of the following product types.

Mag Plot Product Types

Collv_mag_field_c	INCA High Voltage collimator with mag field
Collv_mag_part_pressure collv_mag_part_pressure_ang	INCA High Voltage collimator with mag field in partial pressure format, add _ang to get the spacecraft angle plot at the bottom.
Collv_mag_phitheta_c Collv_mag_phitheta_c_ang	INCA High Voltage collimator with mag field in phi theta format, add _ang to get the spacecraft angle plot at the bottom.
Mag_field_c	Mag field with Bx, By, Bz and B magnitude
Mag_part_pressure Mag_part_pressure_ang	Mag field in partial pressure format add _ang to get the spacecraft angle plot at the bottom.
Mag_phitheta_c Mag_phitheta_c_ang	Mag field in phi theta format, add _ang to get the spacecraft angle plot at the bottom.

Calling Sequence

STANDARD_PROD, '1999-230T18:00.000', '1999-230T18:20.000', 'mag_field_c,
png="/homes/user/mag.png"/,nowin

The magnetometer has periods where the instrument data is all equal to zero or the instrument was in calibration mode. These data periods will appear as if there is no data. See the following section on the View Out of Calibration Menu, section 10.5 to see how to list the periods of time that are affected. Figure 30 shows the Mag Plot/Dump Menu.

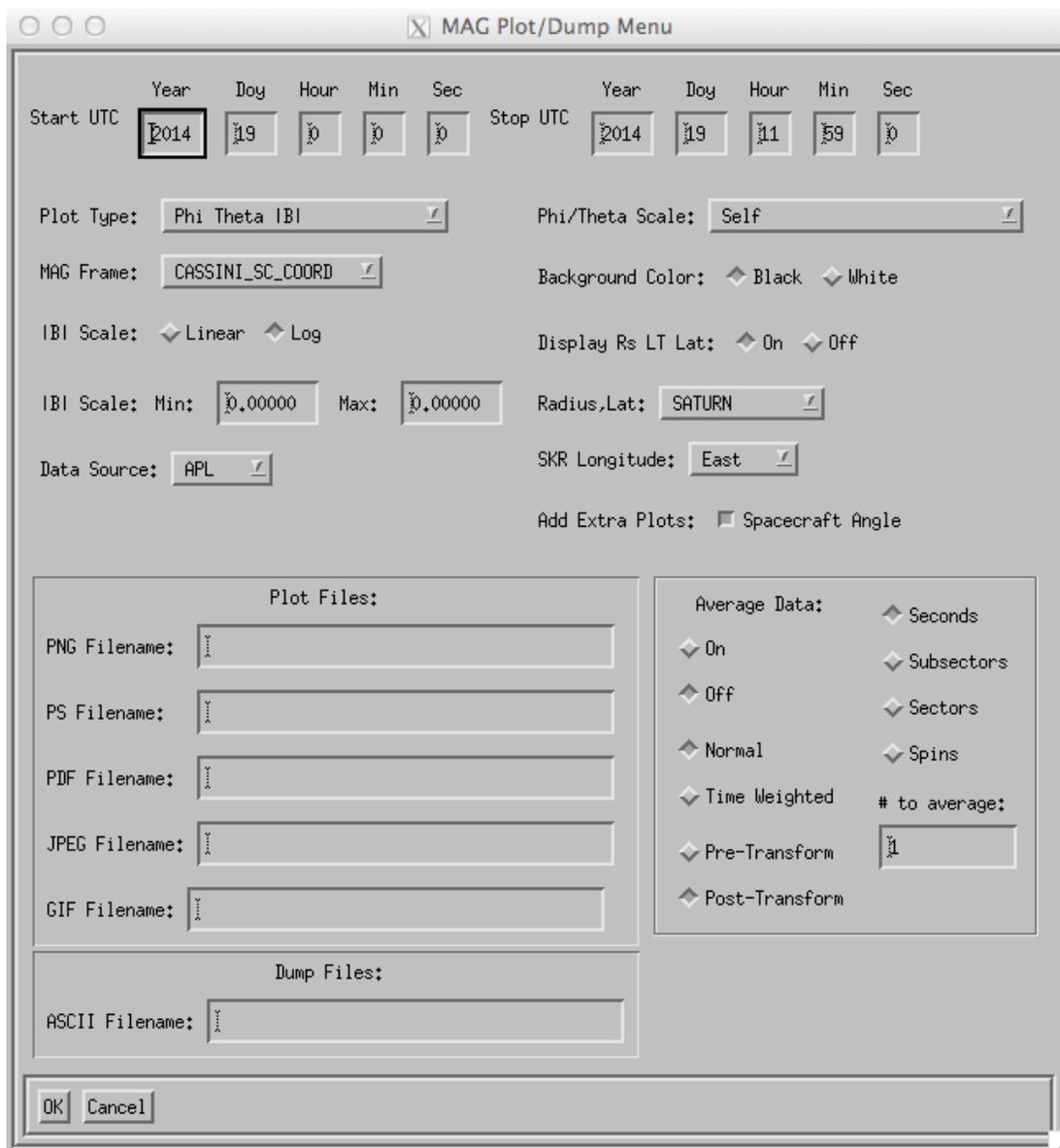


Figure 30: The magnetometer data menu allows users to plot the magnetometer data as Bx By Bz, phi theta or as partial pressure. To plot the data to an output file like PNG, PS or JPEG, type in a full path or use the button to the left of the output file text box to enter the name.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.

Sec	Input 2-character seconds with a range of 0 to 59.
Plot Type	The magnetometer data can be plotted in Bx, By, Bz and B magnitude which is shown in Figure 31, phi theta which is shown in Figure 32 or as partial pressure which is shown in Figure 33.
Mag Frame	Only used for Mag Plots. Enter the coordinate system to plot the data in.
Linear or Log	The data can be plotted in a linear or log format
Min/Max	The minimum and maximum range for the data can be selected
Data Source	Both the L1a binary and PDS data files can be used as data for this plot.
Phi/Theta Scale	The scale for the phi theta plots can default to the minimum and maximum data value or be set to the range specified.
Background Color	The Output plots can be produced with either black or white background.
Display Rs LT Lat	The radius to Saturn, light time and latitude can be displayed at the bottom of the plots along with the time.
Radius, Lat	Select the Axis body to determine the body used for the supplementary labels (radius, latitude, local time)
SKR Longitude	The SKR longitude can be plotted in east or west longitude.
Spacecraft Angle Plot	If the button is selected the spacecraft angle plot will be appended at the bottom of the other plots.
Average On/Off	This option turns on the averaging option. Not all data can be averaged at this time but a notice will be printed out if the data can not be averaged.
Normal	The normal method of averaging the data is summed over the time range and divided by the number of samples.
Time Weighted	The time weighted method, sums the data times its accumulation time over the time range and divides by the total accumulation time.
Pre-Transform	There is an option to do the averaging pre-transform which means the data is read in day long sections, averaged and concatenated together. This method allows us to display very large amounts of data which previously caused out of memory errors in IDL.
Post-Transform	The averaging option is usually performed after any operations (Post-Transform) to get the data in its final format.
Seconds, Subsectors, Sectors or Spins	The time frame for averaging is specified by selecting seconds, subsectors, sectors or spins and the number to average.
# to average	Selects the number of Seconds, Subsectors, Sectors or Spins to average
Plot Files	

The following figures show some magnetometer plot examples.

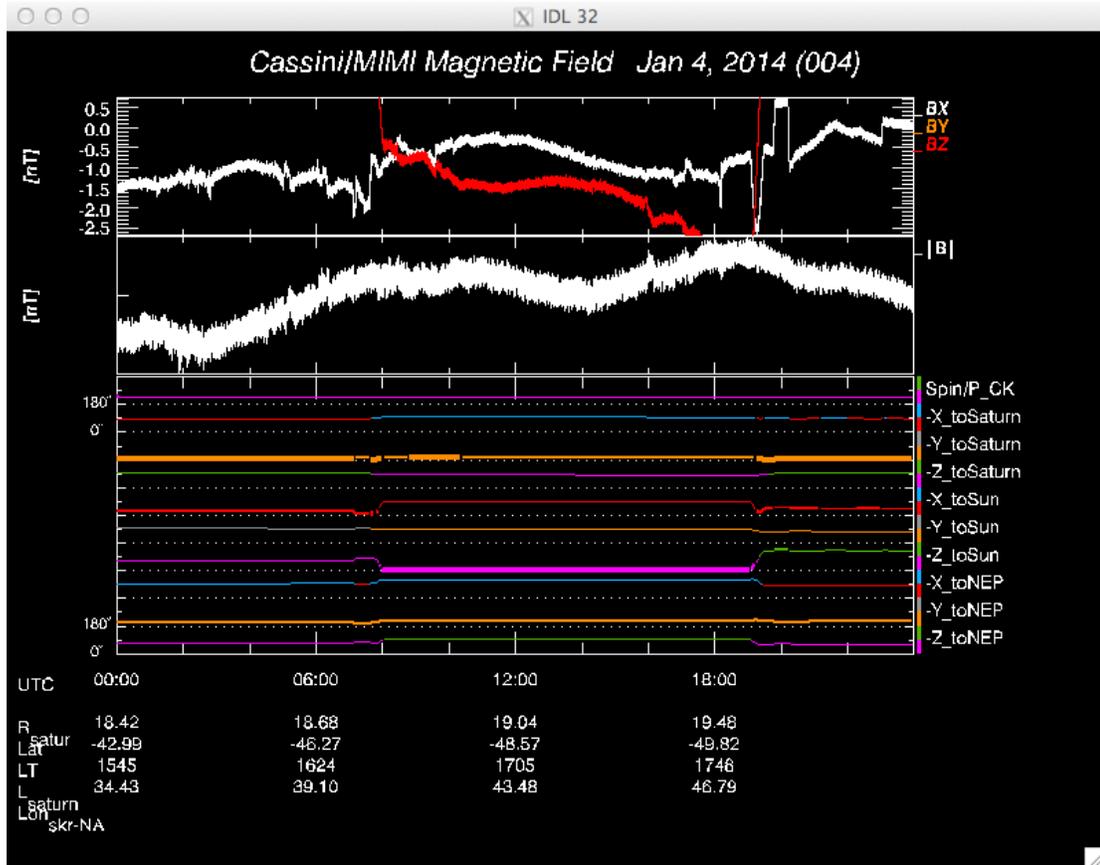


Figure 31: This is the magnetometer data displayed in the Bx, By and Bz format with the spacecraft angle plot. Calling sequence for this image was STANDARD_PROD, '2014-004T00:00.000','2014-004T23:59.000', 'mag_field_c, ADDRALA=1, /nowin, png='/homes/user/mag.png'.

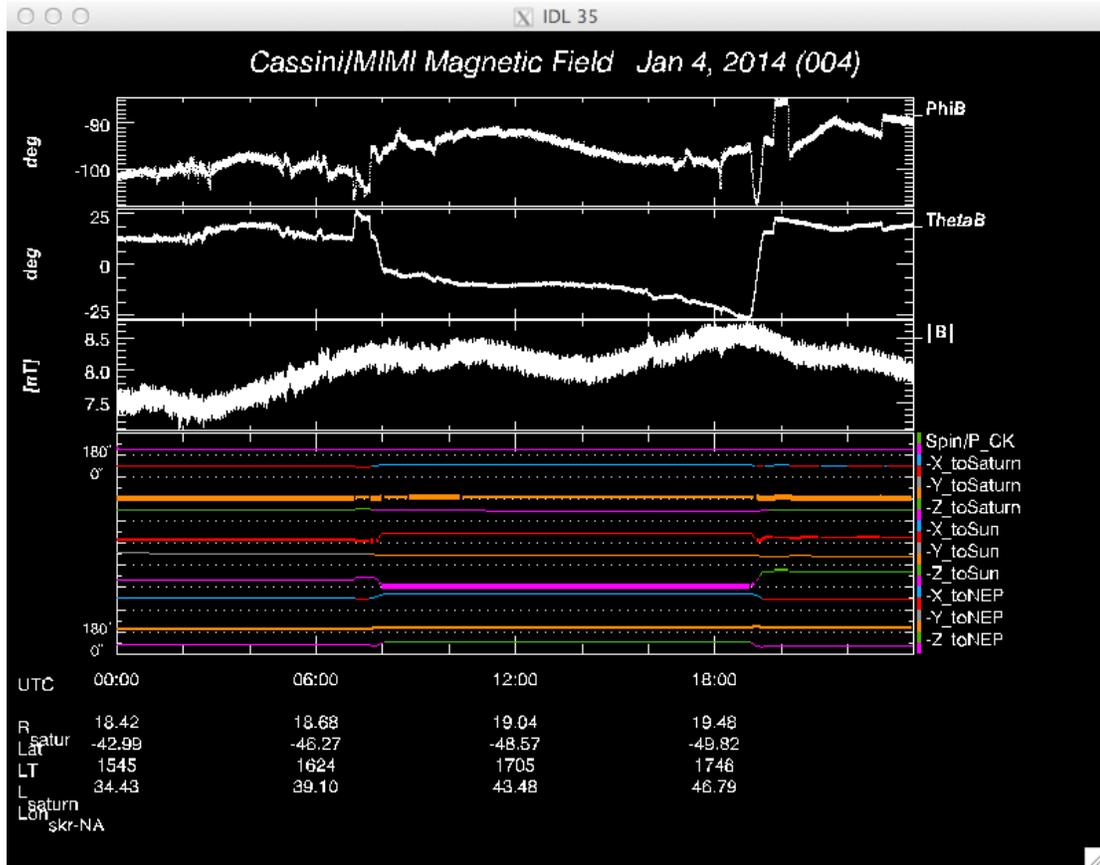


Figure 32: This is the magnetometer data displayed in the phi theta format with the spacecraft angle plot. Calling sequence for this image was STANDARD_PROD, '2014-004T00:00.000','2014-004T23:59.000', 'mag_phitheta_c_ang, /nowin, png='/homes/user/mag.png'.

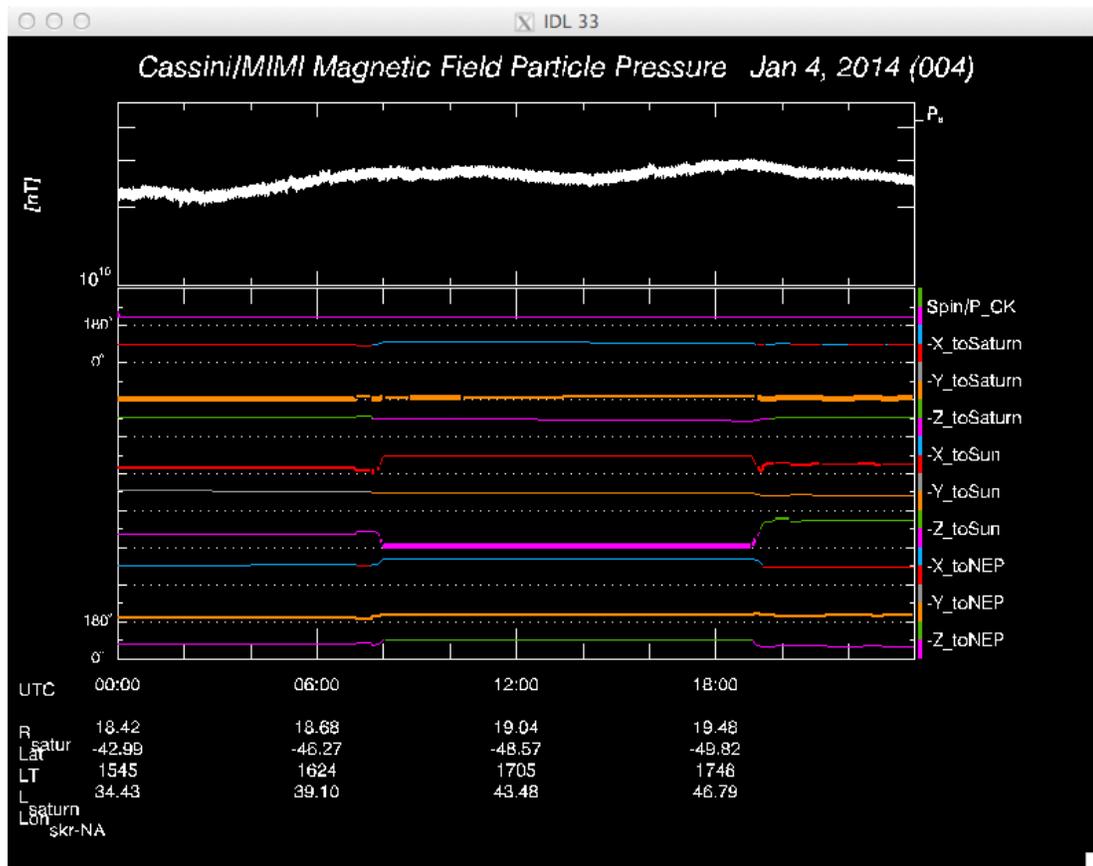


Figure 33: This is the magnetometer data displayed in the partial pressure format with the spacecraft angle plot. Calling sequence for this was STANDARD_PROD, '2014-004T00:00.000','2014-004T23:59.000', 'mag_part_pressure_ang, /nowin, png='/homes/user/mag.png'.

7.8 Channels XY Latitude and Longitude Plots

The Channels XY Lat Lon program will plot any channel's value as the Z or intensity with the X and Y value being time, distance, X-distance, Y-distance, Z-distance, local time, latitude, SKR longitude or L value. The menu is shown in Figure 35.

To access Mag Plot menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the MAG Plot Dump button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=XY_SUPP_MENU()
```

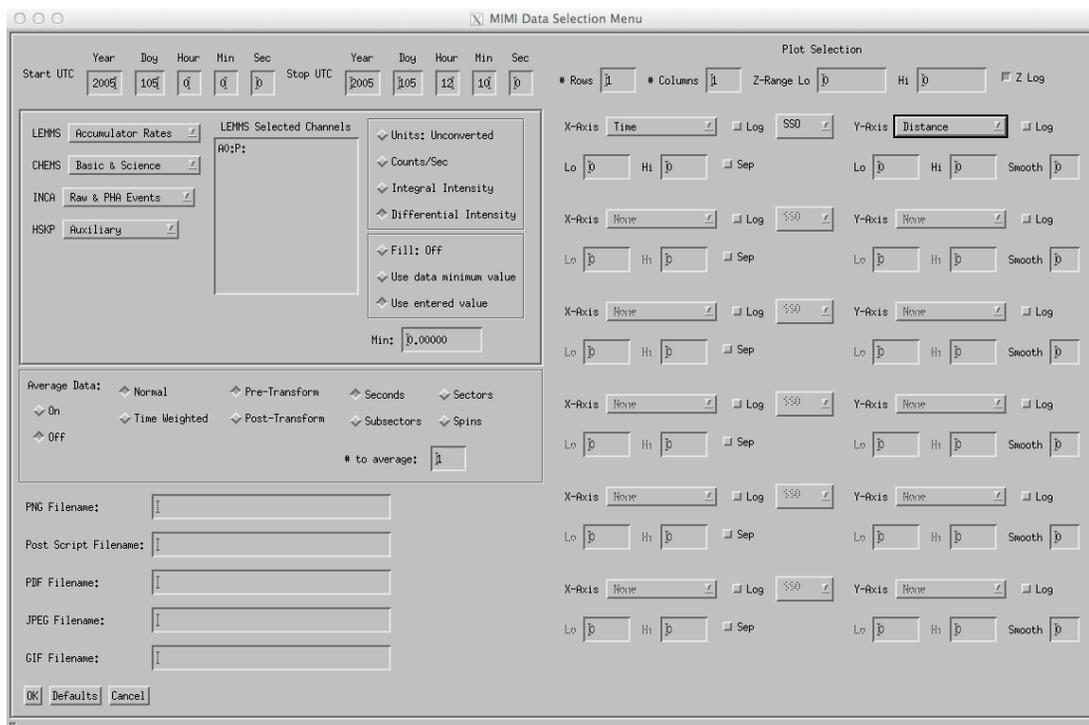


Figure 34: Plot Channels in XY or Latitude and Longitude Menu. Selection of the data type, LEMMS, CHEMS, INCA or HSKP will bring up the Select Channel menu shown in Figure 35. The selected channels will appear in the Selected Channels List. NOTE: Select the units before selecting the channels because it will change the channels available.

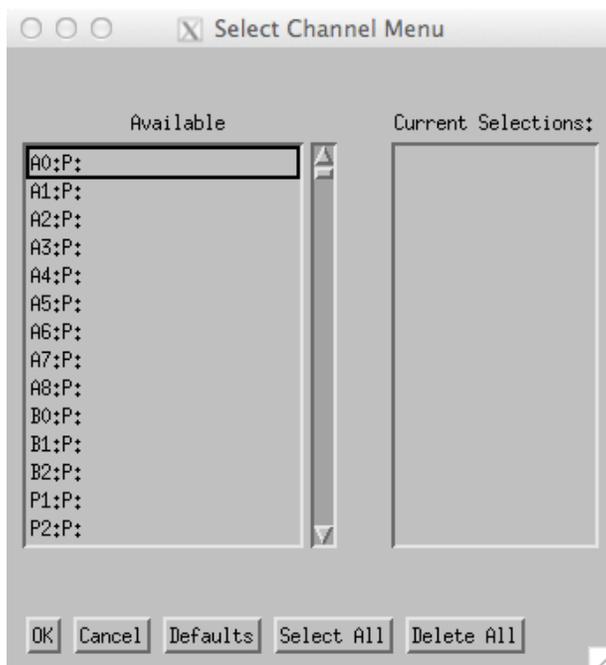


Figure 35: Channel Selection Menu. This menu will appear when one of the sensor buttons is selected. Select the units before selecting the channels because in some cases the units will change the type of channels available to the user. To select a channel, click on the channel and it will appear in the Current Selection list. To un-select a channel, click on

it in the Current Selection list and it will disappear. When the user selects OK, they will return to the XY menu and the selected channels will be displayed in the Selected Channels list. Cancel will return the user to the XY menu without changing the selected channels list.

XY Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Data Type	<p>If the user wishes to use units of integral or differential intensity, they should select the units first because they affect which particles are available for LEMMS and CHEMS.</p> <p>The user selects a sensor and data type button and the pull down menu of data types for that sensor will appear. When the user selects a data type, the Channel Selection Menu will pop up.</p>
Channel Selection Menu	<p>Figure 35: Channel Selection Menu. This menu will appear when one of the sensor buttons is selected. Select the units before selecting the channels because in some cases the units will change the type of channels available to the user. To select a channel, click on the channel and it will appear in the Current Selection list. To un-select a channel, click on it in the Current Selection list and it will disappear.</p>
Selected Channel List	<p>Channels that were selected by the user. Note that the label on the list shows the sensor name. This list is not editable by the user. To change the selection here the user must select the data type pulldown menu again to get the channels popup menu and change the list in that menu.</p>
Units	<p>Some data types are available in units other than data numbers. Housekeeping, Quaternions, LEMMS channel values are available in counts/accumulation. LEMMS and CHEMS channel values are available in integral and differential intensity. This should be selected before the channel list is entered since for LEMMS it will affect which particles are available.</p>
Fill	<p>The fill data can be replaced by the data minimum or an entered value.</p>
Data Source	<p>Both the L1a binary and PDS data files can be used as data for this plot.</p>
Background Color	<p>The Output plots can be produced with either black or white background.</p>
Average On/Off	<p>On selects to use averaging on the data. Not all data can be averaged at this time but a notice will be printed out if the data can not be averaged.</p>
Normal	<p>The normal method of averaging the data is summed over the time range and divided by the number of samples.</p>

Time Weighted	The time weighted method, sums the data times its accumulation time over the time range and divides by the total accumulation time.
Pre-Transform	There is an option to do the averaging pre-transform which means the data is read in day long sections, averaged and concatenated together. This method allows us to display very large amounts of data which previously caused out of memory errors in IDL.
Post-Transform	The averaging option is usually performed after any operations (Post-Transform) to get the data in its final format.
Seconds, Subsectors, Sectors or Spins	The time frame for averaging is specified by selecting seconds, subsectors, sectors or spins and the number to average.
# to average	Selects the number of Seconds, Subsectors, Sectors or Spins to average
# Rows and # Columns	Select the number of rows and columns in the plot. This determines how many sets of the X and Y axis values need to be entered.
Z-Range Lo and Hi	Set a minimum or maximum for the channel value color map.
Z Log or Linear	Plot the channel value color map in linear or log.
X-Axis, Y-Axis Variable	Select the variable to plot on the X and Y axis.
X-Axis or Y-Axis Log or Linear	Select to plot the X and Y axis variables in linear or log mode.
X-Axis or Y-Axis Frame	Select the frame in which to plot the X and Y axis variables.

Figure 36 shows a channel XY plot example.

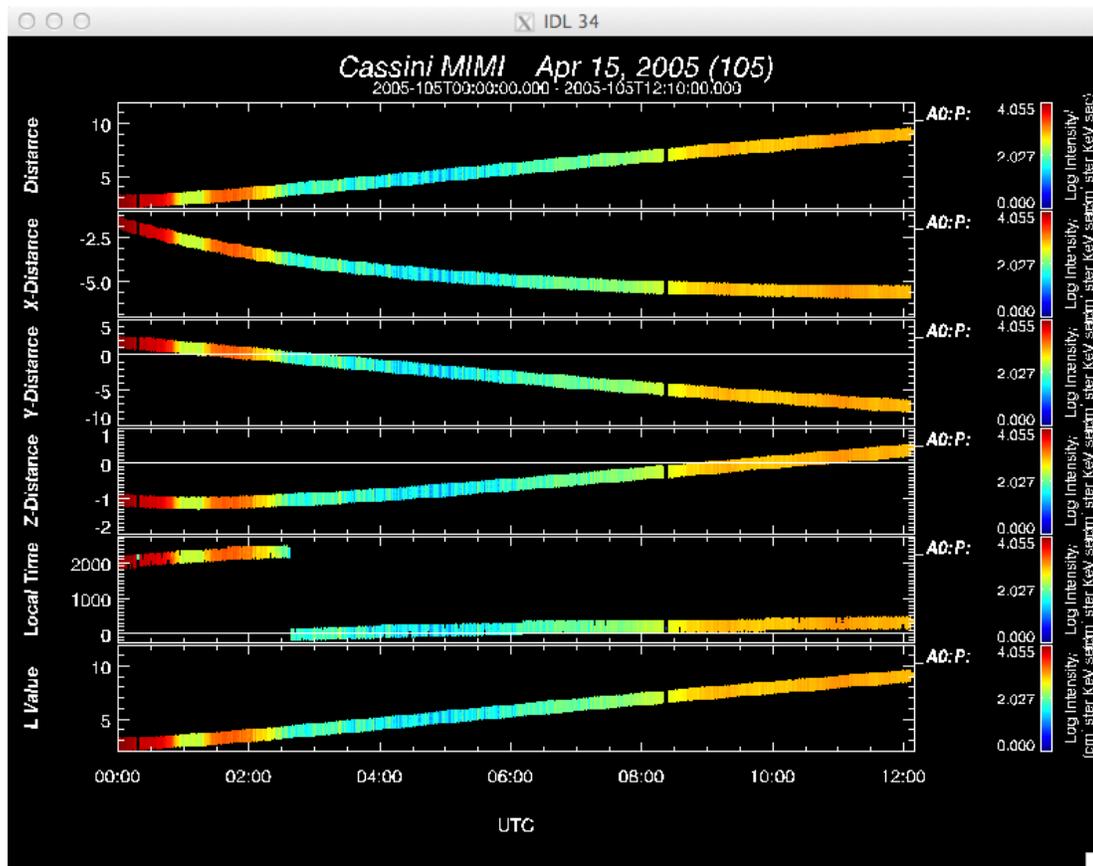


Figure 36: XY Channel Plot Example. The LEMMS A0 channel protons intensity is plotted with the Y-axis as distance, X,Y,Z-distance, local time and L value with time on the X-axis.

7.9 Constraints Coverage Plots

The Constraints coverage program allows the user to select spacecraft or instrument pointing constraints and display the INCA image data that matches the constraints. The menu is shown in Figure 37.

To access Constraint Coverage Plot menu from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Constraints Coverage button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=CMAP_MENU()
```

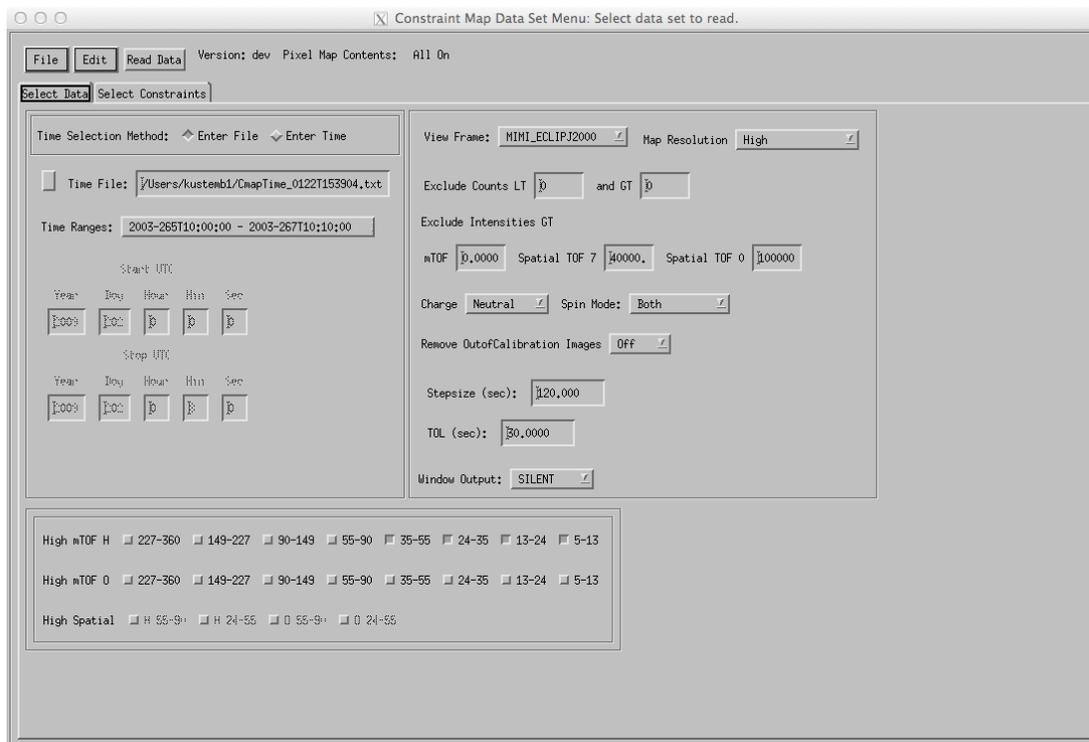


Figure 37: Constraints Coverage Menu - Select Data Tab.

The map resolution, the number of time-of-flights selected and the time ranges determine the program run time. So it is recommended that the user start with a short time range, one TOF, and low map resolution to make sure the output is acceptable before starting a long run.

The following tables describe the menu pull-down button and tab menu options.

FILE Pull-down Options	
Save to IDL Saveset	This option will run the program and save the output to an IDL saveset file that can be read back into the program. It saves the data selection, constraints and results. This option saves the user from entering the data selection and constraints multiple times.
Load from IDL Saveset	This option will read in an IDL saveset that contains the data selection, constraints and results and will launch into the second tier Constraint Map Menu shown in Figure 39.
Save to IDL Saveset in background	The IDL save set can be saved to a file in a background process. This function has not be well tested.
Save Constraints to File	The constraints can be saved to a text file.
Load Constraints from File	The constraints can be loaded from a text file.
Save Pixel Map to File	The pixel mask map can be saved to a file. NOTE: There is a pixel mask that is recommended for use by the instrument team and it is

	applied by default.
Load Pixel Map to File	The pixel mask map can be loaded from a file.
Save SC Constraint Times	The times for each image that contributes to the final output can be saved to a file.
Exit	Exit the program.
EDIT Pull-down Options	
Edit Pixel Map	Bring up the pixel map menu that allows the user to mask individual pixels in the image. See Figure 16 and Figure 17 for examples of the pixel map menus.
Load Defaults to Pixel Map	Bring back the pixel map to the default pixel map. NOTE: There is a pixel mask that is recommended for use by the instrument team and it is applied by default.
Edit CASSINI_ISMF Frame	The ISMF frame parameters can be edited if that frame is selected.
Return CASSINI_ISMF frame to Defaults	Returns the ISMF frame to default values.
Turn All Pixels On	Turn on all the pixels in the image.
Insert Test Image	Insert a test image into each image. This is a debugging option.
Read Data	The read data option will start the program CMAP evaluating the constraints for the time ranges and TOF selected. The command window will print out an indication where the program is in execution. When the program is finished and there was data that matched the constraints, the user will be directed to the second tier Constraint Map Menu shown in Figure 39.

Select Data Tab Menu Parameters

Time	<p>The time can be entered two ways, the user can select the Enter Time button and use the standard Start and Stop time fields. The user can also use the Enter File option to select a time file which contains multiple UTC time ranges in the following format:</p> <p>2004-251T10:10, 2004-251T14:30 2004-252T10:10, 2004-252T19:00 2004-254T10:10, 2004-254T18:30 2004-256T06:00, 2004-256T11:15</p> <p>The multiple time range format allows the user to skip periods of data easily. When this mode is selected, the Time Range becomes a pull-down display of the time ranges selected.</p>
Start and Stop UTC	

Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
View Frame	The view frame is a shortened spice frame name for the image data to be projected into.
Map Resolution	The map resolution can be low, medium and high and developer test which is very low. The map resolution is a factor in program run time. It is recommended to start with a small time range and a low map resolution to make sure the output is what the user desires before running the entire time set and higher map resolution since the program run time can be very long.
Exclude Counts	The user can select to exclude pixels with counts values less than or greater than a value.
Exclude Intensities	The user can exclude pixels with intensity values greater than a value.
Charge	The user can use both ion and neutral data or just one. The ion data is image data collected when the voltage on the INCA collimator is below a threshold voltage and the neutral mode data is collected when the voltage is above that threshold.
Spin Mode	The user can use both spin and stare mode data or just one.
Remove Out of Calibration Images	The user can remove images collected when the instrument was out of calibration. Periods when the INCA instrument is out of calibration can be viewed using the menu in section 10.5.
Stepsize	The step size is the step used to evaluate the constraints. The default value is 120 seconds.
TOL	The time-of-light is used in the constraint evaluation. The default value is 30 seconds.
Window Output	The window output is normally set to silent. The verbose setting will print more messages.
TOF Selections	<p>The time-of-flight selections are available for both hydrogen and oxygen for the high mass time-of-flight resolution images. The high spatial and time resolution image types are not currently supported in this program.</p> <p>The number of TOF selected will directly affect the program run time. When setting up a run, test with just one TOF and a short time range and when the settings are correct, then add all the TOF's and longer time ranges that are desired.</p>

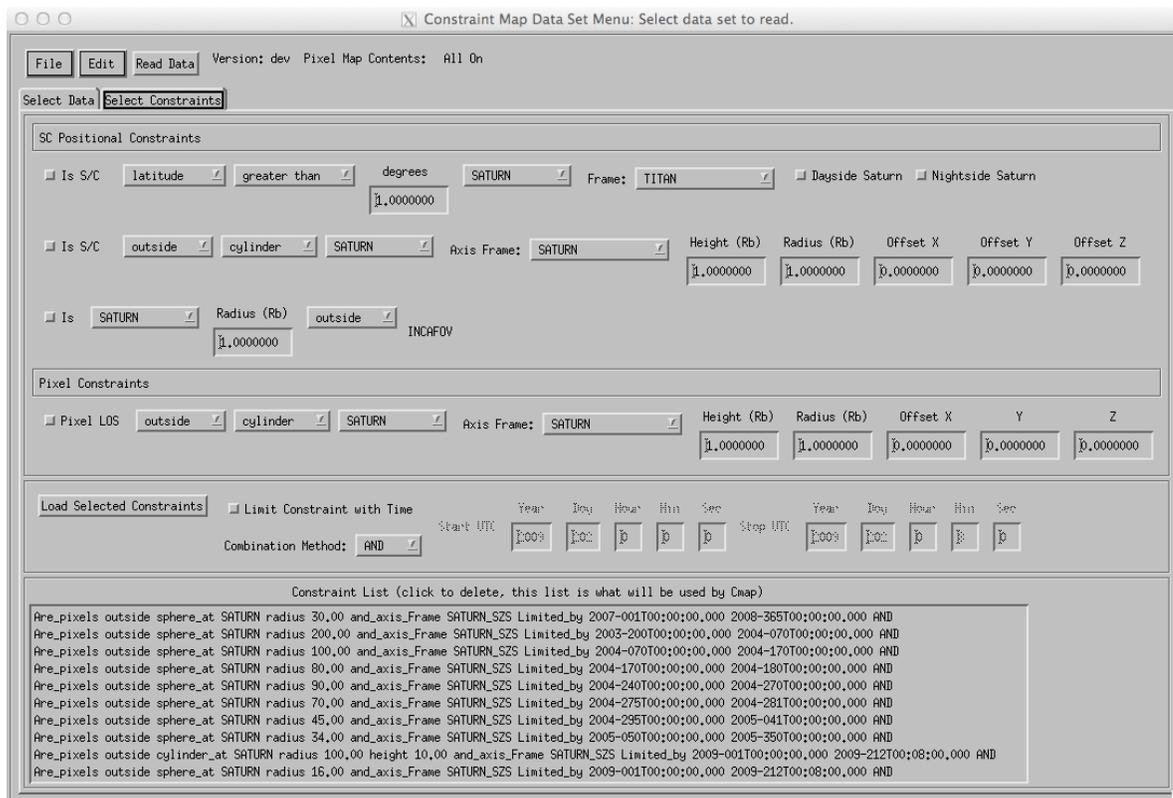


Figure 38: Constraints Coverage Select Constraints Menu Tab.

The constraints menu shown in Figure 38 allows the user to stack up constraints for the program to evaluate which it uses to decide whether or not to keep either images or pixels within the images for the final display. The spacecraft (S/C) Positional Constraints will affect the inclusion of entire images and the Pixel Constraints will affect the inclusion of individual pixels.

Select Constraints Menu Parameters Tab

<p>S/C Positional Constraints</p>	<p>The constraints in the S/C positional constraints determine when entire images pass or fail. The constraints are evaluated over each image accumulation time and must pass for the entire time for the image to be accepted.</p> <p>To set up a constraint for selection, turn on the button on the left, set each pull down variable and enter any text field values in that line. The constraint will not be added to the list until the Load Selected Constraints button is selected. Note: Every constraint that is turned on will be loaded each time the Load Selected Constraints button is pushed. So turn off the constraint when not needed.</p>
<p>Pixel Constraints</p>	<p>The constraints in the pixel constraints section operate a little differently than the S/C positional constraints. Each pixel in the image is evaluated for the constraint using the pixel look direction vector over the image accumulation time. So images may have sections of pixels that do not pass.</p>

	To set up a constraint for selection, turn on the button on the left, set each pull down menu and enter any text field values. The constraint will not be added to the list until the Load Selected Constraints button is selected.
Load Selected Constraints	The load button will read every constraint that is turned on in the menu in order from the top down and load them into the Constraint List window at the bottom of the menu.
Combination Method	The constraints can be combined using AND or OR. The combination method appears at the far right of each constraint in the constraint list.
Limit Constraint with Time	Individual constraints can be limited over a time range. Select the button and enter the time range. It will be applied to every constraint turned on when the Load Selected Constraint button is selected.
Constraint List	A text version of all constraints selected with the Load Selected Constraints button will be displayed in the list in the order they are selected. Each constraint can be removed by clicking on it.

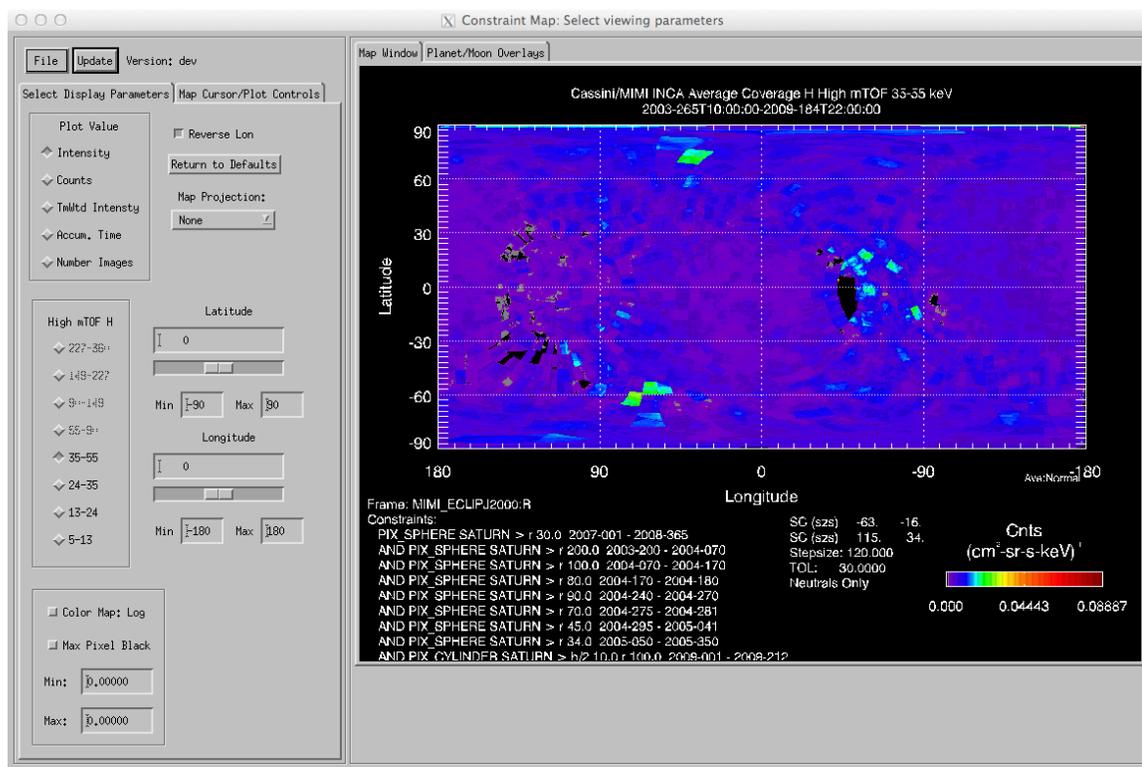


Figure 39: Constraints Coverage Map Menu. This menu appears after the Read Data button is pushed and the data is calculated. It also will appear when an IDL saveset is read in.

Select Display Parameters Tab:

Plot Value	The data sets that are created include the data in intensity, counts and time-weighted intensity. A map of the accumulated time in
------------	--

	each pixel and the number of images that contributed to each pixel is included. Figure 39 displays the map with differential intensity selected.
Reverse Lon	The map can be displayed with the longitude axis reversed as Figure 39 shows.
Return To Defaults	The original default display parameters can be reloaded and the display updated to return to the original settings.
Map Projection	The map can be plotted using an IDL map projection Azimuthal, Cylindrical, Hammer, Mercator or Mollweide. Figure 39 does not use a map projection for the display.
TOF Selection	A single time-of-flight selection in the data set can be displayed.
Latitude Slider and Limits	Sliders can be used to move the center of the map in latitude. When the slider is moved, the Min and Max fields will update.
Longitude Slider and Limits	Sliders can be used to move the center of the map in longitude. When the slider is moved, the Min and Max fields will update.
Colormap Log	Select the color map: log button to change the color map from linear to log scale.
Colormap Max Pixel Black	The highest value pixel value can be turned black. This is an aid for noisy pixels in the image.
Colormap Limits	The limits for the colormap may be entered in linear values. Use Update to update the display.

Map Window Tab:

The map window displays the coverage map for the selected display parameter. The Y-axis is latitude and the X-axis is longitude. Both the longitude and latitude may be adjusted by using the sliders or by typing in the minimum and maximum axis values and updating the display.

The main title displays the INCA image type and time-of-flight value as well as the minimum and maximum time range displayed.

Below the coverage map is the list of constraints used to create the map. There is a limited space to show the constraints so if there are many, not all will show on the screen.

The following figure displays the button available on the Map Cursor/Plot Controls tab. When the Cursor On/Open window button is selected, an additional window will open. The user can then select a portion of the map with the mouse button, and the values contained within that area would be plotted on the window with as an average coverage spectrum.

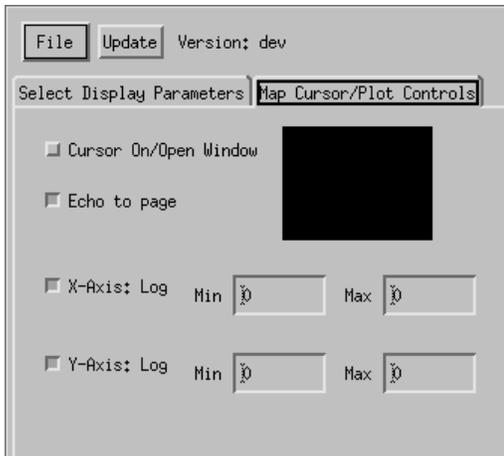


Figure 40: Map Cursor/Plot Controls Tab.

Map Cursor/Plot Tab Controls:

Cursor On/Open Window	This button opens or closes the cursor profile window.
Echo To Page	If this button is selected, the information will be written to the text output in the cursor profile window.
X-Axis: Log	If the button is selected, the plot will display the X-axis in log scale. If it is not selected, it will display the data in linear scale.
X-Axis: Range	To limit the scale plotted on the X-axis, type a minimum and maximum linear value in the text fields. Then reselect the data to display.
Y-Axis: Log	If the button is selected, the plot will display the Y-axis in log scale. If it is not selected, it will display the data in linear scale.
Y-Axis: Range	To limit the scale plotted on the Y-axis, type a minimum and maximum linear value in the text fields. Then reselect the data to display.

Figure 41 shows the cursor window with the Constraints Map Menu. The small rectangle on the Map Cursor/Plot Controls menu shows the area selected in the rectangle image. The cursor window shows the values plotted as an average coverage spectrum in the text window on top and the actual plot below.

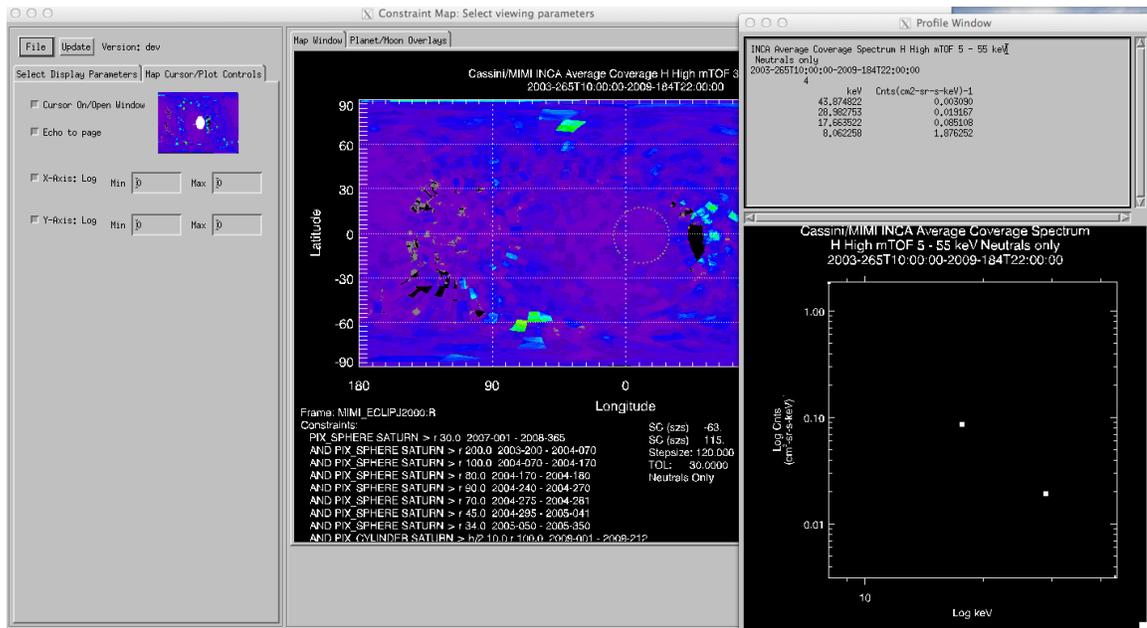


Figure 41: Cursor Window on Constraints Map Menu. The user has selected an area on the map with the cursor and the values present in that area are plotted as an average coverage spectrum on the plot and shown in the text window.

Figure 42 shows the options available on the Planet/Moon Overlays menu. The Sun, Saturn and Voyager overlay options are available along with a user entered option.

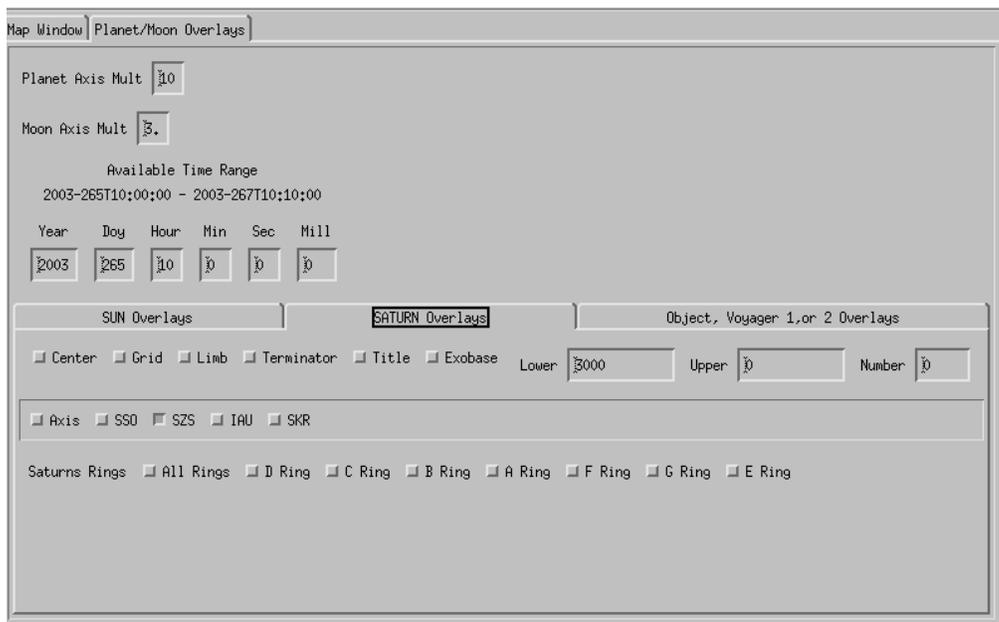


Figure 42: Planet/Moon Overlay Tab.

Planet/Moon Overlays:

Planet Axis Multiplier Moon Axis Multiplier	Sometimes the default length of the planet and moon axis selection is not acceptable depending on the size of the plot. Enter a new value and selection update to re-plot the data.
Available Time Range	The time range is that of the entered time. The time shown in the field below is the time when the plotted overlays will be calculated.
Center	The center option will plot a dot at the center of a body.
Grid	The grid option is a grid plotted at the body radius about the center of the selected body.
Limb	The limb option plots a limb of the selected body.
Terminator	The terminator option plots a terminator of the selected body.
Title and Title Field	The title is a short text field plotted near the center of the body. In the case of the Object and Voyager, the user can type in the field name
Axis	The axis option will plot the X,Y and Z axis for the selected body in the selected frame of reference.
Exobase button and limits	To display Exobase rings about the body, turn on the option and enter a low and high limit and the number of exobase rings desired for the body.
Saturn Rings	Either all of Saturn's rings or the individual rings can be displayed.
Voyager Object Location Frame Longitude and Latitude	If the location of Voyager or an object is known in one of the selected frames, the object can be plotted on the map. Select the latitude, longitude and frame for the measurements, center and/or title and update.

FILE Pull-down Options	
Plot to PNG, JPEG, PS, PDF	The map can be output to multiple formats, simply select the output mode and enter a file path and name in the file selection window.
Print map data from IDL saveset	The value, in doubles, of each pixel in the displayed map, (whatever plot value is selected, counts, intensity ...), can be written to a file. This function is mostly used for debugging purposes. The file format is X = columns Y = rows.
Print bytescale map data from IDL saveset	The bytescaled value of each pixel in the displayed map, (whatever plot value is selected, counts, intensity ...), can be written to a file. This function is mostly used for debugging purposes. The file format is X = columns Y = rows.
Print position data from IDL saveset	The position in latitude and longitude of each pixel in the map can be written to a file. The file format is first longitude X = columns Y = rows followed by latitude in the same format.
Colorbar	Select from the available IDL color bars and select update to use the new colorbar.

Background Color	The user can select from black and white backgrounds on the map as well as the output types.
Plot Cursor Profile Window to PNG, JPEG, PS, PDF	Plot the cursor profile average coverage spectrum to an output file. The user will be prompted to enter a filename in the file selection menu.
Save Cursor Profile to IDL saveset	Save the cursor profile average coverage spectrum values to an IDL saveset. The user will be prompted to enter a filename in the file selection menu.
Save Cursor Profile to ASCII	Save the cursor profile average coverage spectrum values to an ASCII file. The user will be prompted to enter a filename in the file selection menu.
Exit	Exit the constraint map menu. Control will return to the Constraint Map Data Set Menu.
Update	Update will re-plot the constraint map with any edited display parameters.

8. Data Output Programs

The data output program section describes the analysis programs with data output capabilities. The menus are described and for the more important IDL programs that the menus call, details on how to run and access the data variables are included for users interested in writing code.

8.1 Output MIMI Channel Data

The Dump MIMI Channels, Query MIMI Channels menus and the use of the GET_DATA program from the command line are described with a few examples.

8.1.1 Dump MIMI Channels Menu

The Dump MIMI Channels menu can be accessed from the main MIMI menu. It is an interactive menu that calls the get_data program. It allows the user to write out selected time ranges and channels from the L1A files in an ASCII or IDL saveset format. The menu is shown in Figure 44.

To access the Dump MIMI Channels menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

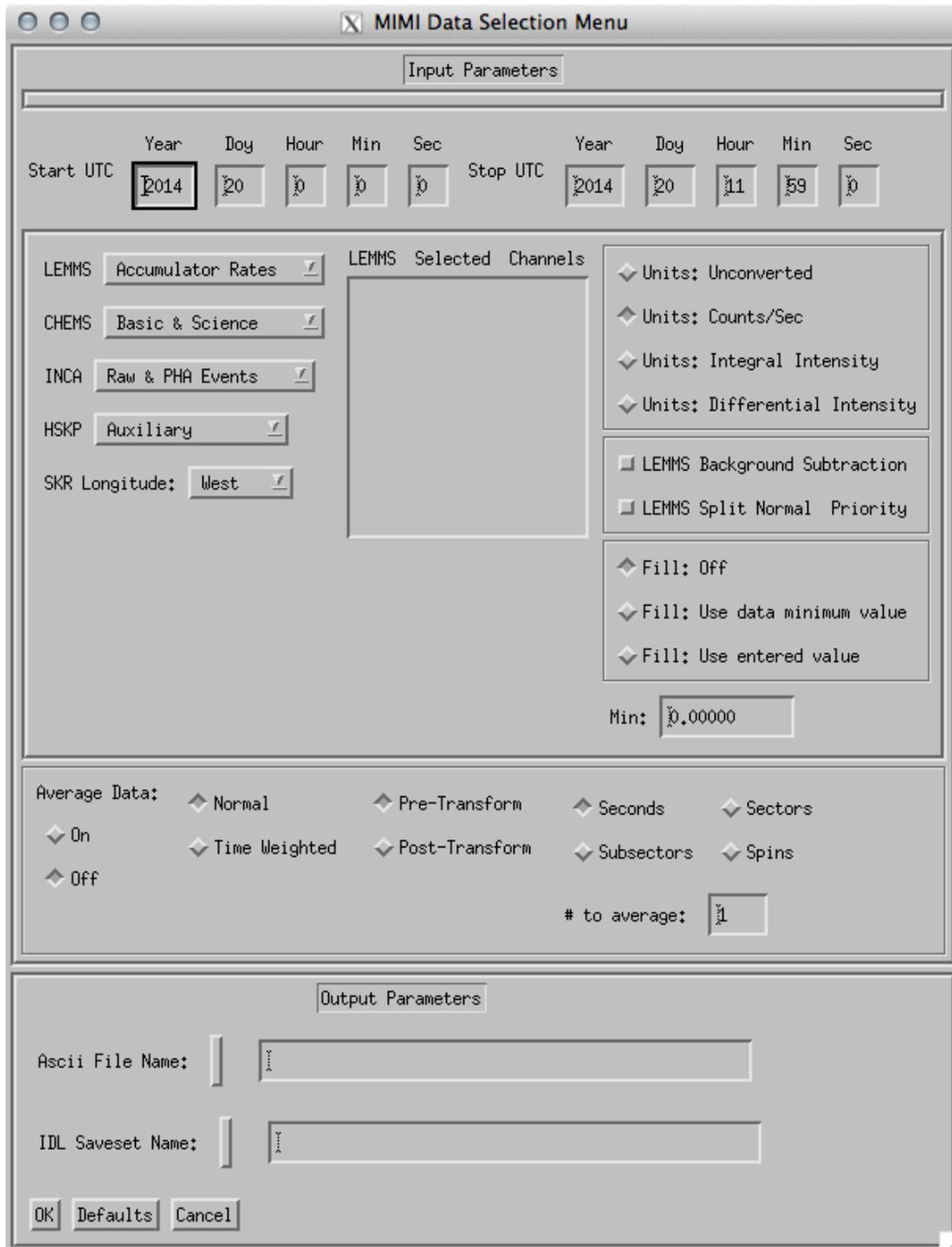


Figure 43: Dump MIMI Channels Menu.

When a user selects a sensor, the Channels Menu shown in Figure 44 will appear. The user should make sure they select units before selecting channels since for some data types, the units affect the channel list available for that sensor.

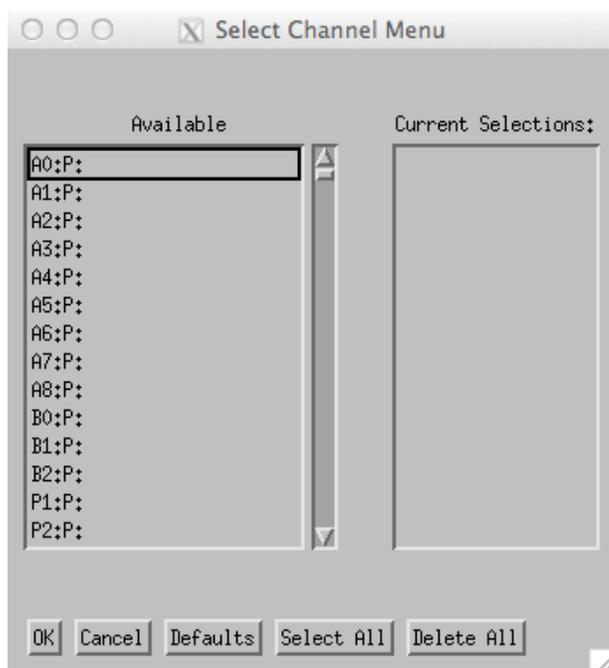


Figure 44: Channels Menu. This shows the channel menu for differential intensity for LEMMS accumulator rates. The units must be selected before selecting the channel in case the particles have to be added to the selections.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Data Type	<p>If the user wishes to use units of integral or differential intensity, they should select the units first because they affect which particles are available for LEMMS and CHEMS.</p> <p>The user selects a sensor and data type button and the pull down menu of data types for that sensor will appear. Just click on the pull down option and a pop up menu containing the channels available for that data type will appear. Figure 44 shows the select channel menu for differential intensity for LEMMS accumulator rates.</p>
Channel List Menu	<p>In the menu in Figure 44, the user clicks on a channel in the list on the left of the popup menu and it will show up on the right. If a channel has been selected in error, select it on the list on the right to deselect it. The select all button will select all channels and the delete all button will remove all selections from the list. When the list of channels has been selected then hit the OK button and the selected list of channels will appear in the get_data_menu selected channels list.</p>

Selected Channel List	The Selected Channel List shows the channels that were selected by the user. Note that the label on the list shows the sensor name. This list is not editable by the user. To change the selection here the user must select the data type pull-down menu again to get the select channels popup menu and change the list in that menu.
Units	Some data types are available in units other than data numbers. Housekeeping, Quaternions, LEMMS channel values are available in counts/accumulation. LEMMS and CHEMS channel values are available in integral and differential intensity. This should be selected before the channel list is entered since for LEMMS it will affect which particles are available.
LEMMS Background Subtraction	Subtract the background values from the LEMMS channels if a LEMMS browse product is selected.
LEMMS Split Normal and Priority	The LEMMS accumulator rates include both normal and fine rates channels. There is the option to split the normal and fine rates out into separate files. If this option is selected and an ASCII file is selected then 2 files will be created. One will have the _normal and one will have _priority appended onto the filename.
Fill	The fill data can be replaced by the data minimum or an entered MIN value.
Average On/Off	This option turns on the averaging option. Not all data can be averaged at this time but a notice will be printed out if the data can not be averaged.
Normal	The normal method of averaging the data is summed over the time range and divided by the number of samples.
Time Weighted	The time weighted method, sums the data times its accumulation time over the time range and divides by the total accumulation time.
Pre-Transform	There is an option to do the averaging pre-transform that means the data is read in day long sections, averaged and concatenated together. This method allows us to display very large amounts of data that previously caused out of memory errors in IDL.
Post-Transform	The averaging option is usually performed after any operations (Post-Transform) to get the data in its final format.
Seconds, Subsectors, Sectors or Spins	The time frame for averaging is specified by selecting seconds, subsectors, sectors or spins and the number to average.

8.1.2 GET_DATA Program

8.1.2.1 Using the GET_DATA Program

The GET_DATA program is the main read routine for the L1a binary and ascii files.

The user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

See explanation of variables in the next section. To run the program interactively type:

```
GET_DATA,TIMESTRUCT=timestruct,SENSOR="LEMMS",
```

'DATATYPE="Accumulator Rates",CHANNELS=["A0","A1"],\$
numcols, numrows, maximagesize, data, images, labels, spinchar_sct, datachar_sct

KEYWORDS

NOGUI	If = 1 then the input data values are sent directly to read routine
INPUTDIR	Just set this to "". It is an old field that is no longer used.
TIMESTRUCT	Structure of the form following, required if NOGUI mode is selected <pre>{STARTYEAR:'1999',\$ STARTDOY:'003',\$ STARTTIME:'0800',\$ STOPYEAR:'1999',\$ STOPDOY:'003',\$ STOPTIME:'0805'}</pre> <p>To make a time structure from an ASCII string, use the following code: Timestruct = STR2TIME(['2005-313T00:00:00','2005-313T23:59:59'])</p> <p>To make an ASCII string from a time structure, use the following code: Utcstr = TIME2STR(timestruct)</p>
SENSOR	One of the following strings, required if NOGUI mode is selected ['LEMMS','CHEMS','INCA','Housekeeping'] Don't use GET_DATA to read Inca Images, use GET_IMAGES! Get_data used to be used to read images but isn't anymore.
DATATYPE	One of the following strings, matched to selected sensor, required if NOGUI mode is selected and sensor Not equal to Inca Images <ul style="list-style-type: none"> • LEMMS: ['Accumulator Rates','PHA Data'] • CHEMS: ['Basic & Science','Accumulator Rates','PHA Events','Raw Data'] • INCA: ['Raw & PHA Events','Accumulator Rates','PHA Events'] • HSKP: ['Auxiliary','SFDU']
CHANNELS	A string array of channels matching sensor, data type, required if NOGUI mode is selected.
ASCIINAME	Set to ascii file name if the user wants to write out ascii file. Not required.
SAVESETNAME	Set to name of IDL save set file or pass a null string. Not required.
USE_BINARY	1 if you want to always use binary. (this is the default), a 0 will select ascii files. Example: use_binary=0 to get ascii files. Reading ASCII files is SLOW!

IDL Output Variables

The IDL variables will be available in IDL after you read the data using the non-interactive menu. They are described in the following table.

numcols	Equals total number of columns, including header values. Equals number of header variables plus number of channels.
numrows	Long total number of rows, over estimated, initially and then corrected. Equals number of time samples during your time range.
Maximagesize	Not used in this routine
numimages	Included but not used in get_data.
data	Array size [all_numrows,all_numcols], overestimated initially and then corrected
Images	Not used in this routine.
labels	Text array of column labels, size numcols+2, includes 2 SCET following character labels at beginning.
spinchar_scet	Text array of start of spin spacecraft ephemeris time, size all_numrows
datachar_scet	Text array of data time spacecraft ephemeris time, size all_numrows

8.1.2.2 Accessing Data from GET_DATA Using Channel Data Column Values

This section explains how to access the data and header values when it is read in using GET_DATA program or from a restored IDL saveset.

The data_hdr_h.pro file contains the indexes into the data and image arrays in which the various parameters are located like ET time. To use the parameters in your IDL code just put @data_hdr_h in your code. The table called Data Header IDL Variable Name describes the variables in that file.

To get all the ephemeris time for the data read in, array = data[* ,DATA_ET_SECS].

To find the channel values in the data array, see the following code.

The following code converts the timestruct structure described in the previous section (keyword TIMESTRUCT) into a set of UTC strings starttime.

```
starttime = TIME2STR(timestruct)
```

The following code converts the UTC string arrays to ephemeris time

```
s=SPICE.UTC2ET(starttime,et)
```

The following code obtains a string array, channellist, of all LEMMS accumulator rates channel names using the same sensor and data type values used in the call

```
path = GETENV('DECOM_CONFIG_DIR')  
sensor = 'LEMMS'  
datatype = 'Accumulator Rates'  
channellist = GET_LISTOFCHANS(et, path, sensor, datatype)
```

The output data array contains both the data header values and the requested channels. The channels will be in the same positions that you passed them in as channel names. So the data[* , 0:N] equal the data header values and data[* ,n+1 : *] equal the channel values.

To find the column that contains your channel data in the output data array, use the following code.

```
colpos = WHERE(labels[*] EQ 'A0')
colpos = colpos(0)-2 ;subtract 2 because 0 and 1 are string labels of string array
timepos = WHERE(data[* ,DATA_ET_SECS_C] GE et[0] AND [* ,DATA_ET_SECS_C] LE et[1])

your_channel = data[timepos, colpos]
your_et_times = data[timepos, DATA_ET_SECS_C]
your_channels_subsector = data[timepos, SECTOR_NUMBER_C]
your_channels_utc_strings = datachar_scet [timepos]
```

The user can use the variables in the data_header_c file to access other data header values with data[* , <header variable name>]

Data Header IDL Variable Name	Description
SPINSTART SCET CHAR C	Start of Spin Time in ASCII UTC string
DATA SCET CHAR C	Data Time in ASCII UTC string
SPIN_COUNTER_C	Spin counter index
SECTOR_NUMBER_C	Sector
SUBSECTOR_NUMBER_C	Subsector
SPINSTART_SCLK_SECS_C	Start of Spin Time in Spacecraft clock
SPINSTRT_SCLK_FINE_C	Start of Spin S/C Clock fine word
SPINSTRT_ET_SECS_C	Start of Spin Time in Ephemeris Time
CDS_ERROR_C	CDS Error Flag, passed from s/c
SPINSTAR_MODE_C	Spin or starring mode flag. 0=stare, 1=spin
SPIN_PERIOD_C_C	Spin Period $spin_rate \text{ (minutes)} = \text{Spin Period} * 64. * 16. * 16. * 16. / 6. * 1000000. * 60.$
DATA_SCLK_SECS_C	Data Time in Spacecraft clock
DATA_SCLK_FINE_C	Data Time S/C Clock fine word
DATA_ET_SECS_C	Data Time in in Ephemeris Time
SENSOR_BITRATE_C	Bit rate for sensor

8.1.3 Query MIMI Channels

The query data program allows the user to locate data matching a particular state of header and data values. It can write this information to a file or to the command window.

To access the query_data menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Query MIMI Channels button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts//mimi_idl
IDL>s = QUERY_DATA_MENU()
```

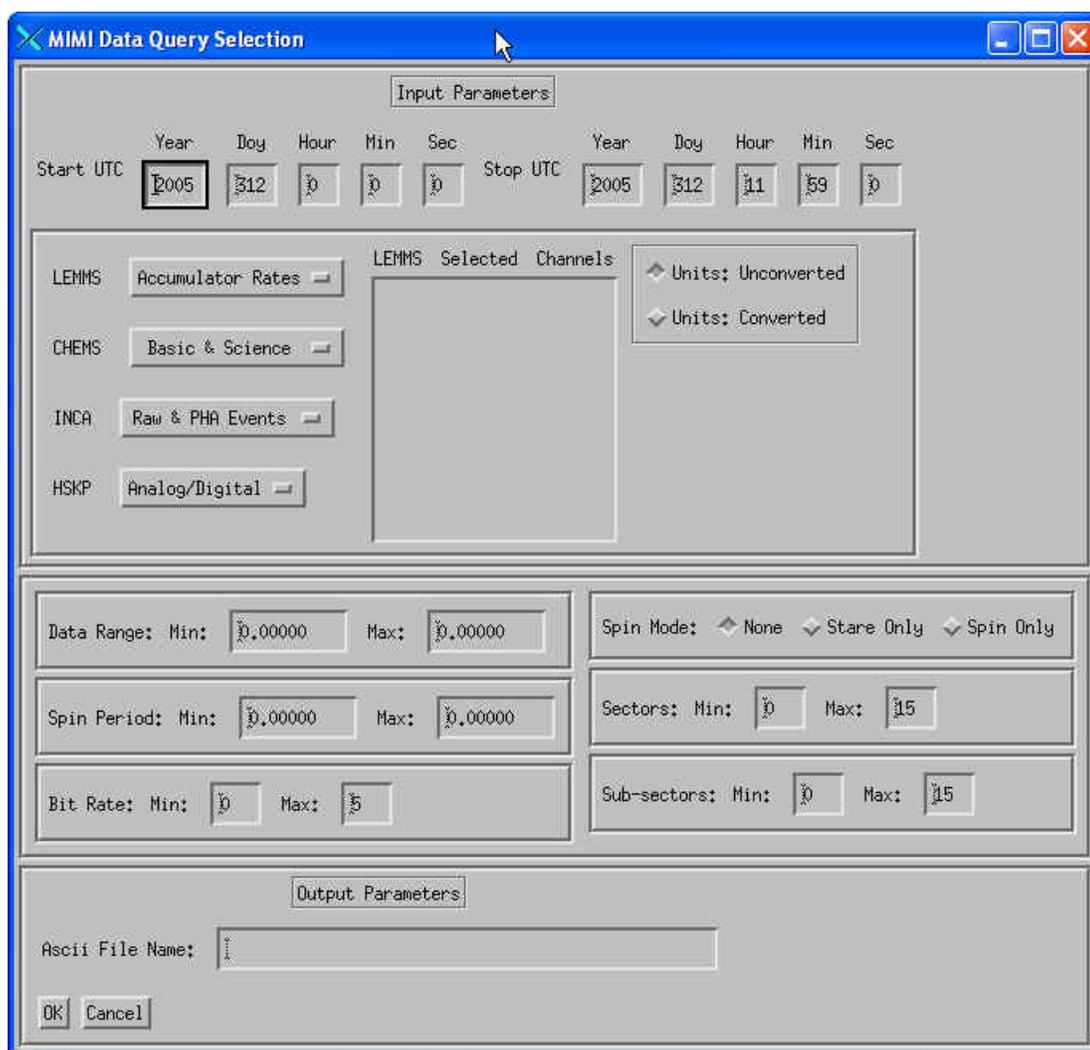


Figure 45: Query Data Menu.

The Figure 45 shows the Query Data Menu. The data will be written out in the same format as if the user used the Dump MIMI Channels menu in the section 8.1.1. It is useful to locate times of specific instrument modes or values. See section 8.1.2.2 for a more in depth description of the data array that it produces.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.

Sec	Input 2-character seconds with a range of 0 to 59.
Data Type	<p>If the user wishes to use units of integral or differential intensity, they should select the units first because they affect which particles are available for LEMMS and CHEMS.</p> <p>The user selects a sensor and data type button and the pull down menu of data types for that sensor will appear. Just click on the pull down option and a pop up menu containing the channels available for that data type will appear. Figure 44 shows the select channel menu for differential intensity for LEMMS accumulator rates.</p>
Channel List Menu	<p>In the menu in Figure 44, the user clicks on a channel in the list on the left of the popup menu and it will show up on the right. If a channel has been selected in error, select it on the list on the right to deselect it. The select all button will select all channels and the delete all button will remove all selections from the list. When the list of channels has been selected then hit the OK button and the selected list of channels will appear in the get_data_menu selected channels list.</p>
Selected Channel List	<p>The Selected Channel List shows the channels that were selected by the user. Note that the label on the list shows the sensor name. This list is not editable by the user. To change the selection here the user must select the data type pull-down menu again to get the select channels popup menu and change the list in that menu.</p>
Units	<p>Some data types are available in units other than data numbers. Housekeeping, Quaternions, LEMMS channel values are available in counts/accumulation. LEMMS and CHEMS channel values are available in integral and differential intensity. This should be selected before the channel list is entered since for LEMMS it will affect which particles are available.</p>
Data Range	<p>The data range for the selected channel can be limited. The QDATA_LO and QDATA_HI keywords would be used for the command line version.</p>
Spin Period	<p>The data can be queried when the spin period is within a range in minutes. The command line uses SPINPER_LO and SPINPER_HI keywords.</p>
Bit Rate	<p>The data can be limited to periods when the bit rate is within a range of 1-Very Low to 5-Very High. The BITRATE_HI and BITRATE_LO keywords would be used for the command line call.</p>
Spin Mode	<p>The data can be queried for that taken during spin or stare mode. The command line call would use SPINSTARE=0 for stare and 1 for spin mode. By not including the keyword then both types of data would be included.</p>
Sectors	<p>The data can be queried during a specific sector. The command line would include SECT_HI and SECT_LO keywords.</p>
Sub-sectors	<p>The data can be queried during a specific sub-sector. The command line would include SUBSECT_HI and SUBSECT_LO keywords.</p>
ASCII File	<p>This text field path and the filename of the ASCII file that will contain the output data if entered. If the field is not filled in the output will only go to the command window.</p>

An example call would be `s=QUERY_DATA(2013,365,0,2013,365,1159, "LEMMS", "Accumulator Rates","A0:P", units=3, QDATA_LO=0.00000, QDATA_HI=100.000)`

8.2 Output MIMI Image Data

The Dump MIMI Images, Dump MIMI Image Headers menu and the use of the GET_IMAGES, GET_IMAGE_POS and GET_IMAGE_NOPOS programs from the command line are described in this section and a few examples are included.

8.2.1 Dump INCA Images Menu

To access the menu from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Dump MIMI Images button.

The Dump INCA Images Menu calls the GET_IMAGES program to read and save the INCA image data to a file or IDL saveset. The MIMI Image Dump Menu is shown in Figure 46.

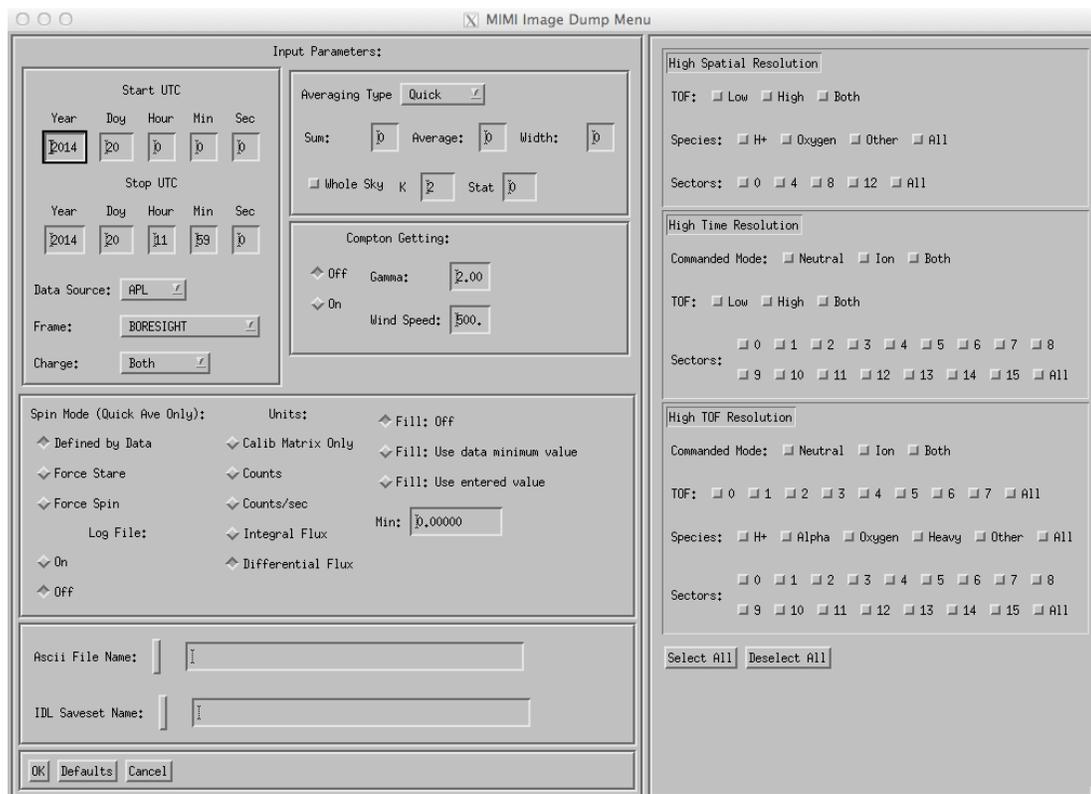


Figure 46: Dump INCA Images Menu

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.

Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Spin Mode	If a long time range is selected, the images will be averaged or summed in chunks of like spin mode. If the user wants to force the sum or average to only be in spin or stare they can select these buttons.
Summing or Averaging	The images can be summed or averaged in like spin mode chunks. They are stacked right on top of each other regardless of positioning. It is best not to mix image resolution types when averaging and summing, although they have been tested.
Units	The image pixel values may be written out in counts, counts/second, integral flux, differential flux or just the calibration matrix.
Fill	Pixels or whole images without values in the images can be present due to gaps in the data. A fill value can be selected to represent those absent values other than the default NAN value, with the data minimum or an entered value.
Image Selection Menu	The images can be selected by resolution type, TOF, Species and Sector values. The user should notice that the high mTOF images have all 16 sectors listed but in neutral mode only 4 images will be sent. The 16-sector option is left over from no longer used image mode. If the user is using neutral mode just select ALL sectors but only 4 images will be displayed. The ION mode will have all 16 images if selected.

8.2.2 GET_IMAGES Program

8.2.2.1 Using the GET_IMAGES Program

The user can run the following script and command to access the GET_IMAGES program from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

See explanation of the variables in the next section. To run the program type:

```
GET_IMAGES,TIMESTRUCT=timestruct,SENSOR="INCA  

Images",IMAGETYPE=defaultimages,$
```

```
numcols, numimages, maximagesize, data, images, labels, spinchar_sct, datachar_sct,/NOGUI
```

Keyword Input Variables

NOGUI	If = 1 then the input data values are sent directly to read routine. If set to 0 then the Dump INCA Images menu will come up.
INPUTDIR	Just set this to "". It is an old field that is no longer used.

TIMESTRUCT	<p>Structure of the form following, required if NOGUI mode is selected</p> <pre>{STARTYEAR:'1999',\$ STARTDOY:'003',\$ STARTTIME:'0800',\$ STOPYEAR:'1999',\$ STOPDOY:'003',\$ STOPTIME:'0805'}</pre> <p>To make a time structure from an ASCII string, use the following code: Timestruct = STR2TIME(['2005-313T00:00:00','2005-313T23:59:59'])</p> <p>To make an ASCII string from a time structure, use the following code: Utcstr = TIME2STR(timestruct)</p>
SENSOR	The Sensor should always be 'INCA'.
DATATYPE	The Data type should always be 'INCA Images'.
IMAGETYPE	<p>Structure of following form, required if NOGUI mode is selected and if sensor Inca Images is selected, array index represents a type of image, a set value turns it on. For example, spat_TOF(0)=1 - selects low TOF, spat_TOF(1)=1 - selects high TOF</p> <pre>Imagestruct = {spat_TOF:lonarr(2),high spatial TOF spat_spec:lonarr(3), high spatial species spat_sec:lonarr(4), high spatial sector time_mode:lonarr(2), high time resolution ion, neutral mode time_TOF:lonarr(2), high time resolution TOF time_sec:lonarr(16), high time resolution sector tof_mode:lonarr(2), high TOF resolution ion, neutral mode tof_tof:lonarr(8), high TOF resolution TOF tof_spec:lonarr(5), high TOF resolution species tof_sec:lonarr(16)} high TOF resolution sector</pre> <p>To read the high spatial images with tof = 0, species = H and all sectors.</p> <pre>Imagestruct.spat_spec[0] = 1 Imagestruct.spat_spec[1] = 0 Imagestruct.spat_spec[2] = 0 Imagestruct.spat_TOF [0] = 1 Imagestruct.spat_TOF [1] = 0 FOR n=0,15 DO Imagestruct.spat_sec[n] = 1</pre>
ASCIINAME	Set to ascii file name if the user wants to write out ascii file. Not required.
SAVESETNAME	Set to name of IDL save set file or pass a null string. Not required.
USE_BINARY	1 if you want to always use binary. (this is the default), a 0 will select ascii files. Example: use_binary=0 to get ascii files. Reading ASCII files is SLOW!

IDL Output Variables

The IDL variables will be available in IDL after you read in the IDL save set or run the GET_IMAGES program. They are described in the following table.

numcols	Equals total number of columns, including header values. Equals
---------	---

	number of header variables plus number of channels.
numrows	Long total number of rows, over estimated, initially and then corrected. Equals number of time samples during your time range.
numimages	Number of images
images	Images is an array size of [all_numimages,maximagesize,maximagesize] (set by get_image_size)
Maximagesize	Maximum image size. The image size of an individual image should always be found by using data[<imageindex>, NUMCOLS_C]. High spatial images vary in image size based on TOF value. If the user mixes image types, then the image array returned will be the size of the biggest image type with the smaller types included. The following code will access the image no matter what size it is. <pre> imagesize = data[0,NUMCOLS_C] myimage = images[0, 0:imagesize-1, 0:imagesize-1] </pre>
data	Array size [all_numimages,all_numcols], overestimated initially and then corrected. In the case of reading images, the data array just has the data header and image header to match the images. The first index into the data array matches the first index into the images array. In the row above, the 0 index access all the data and image header information for the 0th image in the images array.
labels	Text array of column labels, size numcols+2, includes 2 SCET following character labels at beginning. To match the data array, use labels[2:*].
spinchar_sct	Text array of start of spin spacecraft ephemeris time, size all_numrows
datachar_sct	Text array of data time spacecraft ephemeris time, size all_numrows

8.2.2.2 Accessing Image Data Using Image and Header Data Column Values

The data_hdr_h.pro file contains the indexes into the data arrays in which the various parameters are located like ET time. A table follows the code examples describing the data header values contained in the data_hdr_h.pro file. The image_hdr_h.pro file contains the indexes into the image header arrays in which the various parameters are located in the data array as well as some IDL variables that equal header values. A table follows the code examples describing the image header values contained in the image_hdr_h.pro file.

To use the parameters in your IDL code just put

```

@data_hdr_h
@image_hdr_h

```

To get all the ephemeris time for the data read in, array = data[* , DATA_ET_SECS].

The following code converts the timestruct structure described in the previous section (keyword TIMESTRUCT) into a set of UTC strings starttime.

```

starttime = TIME2STR(timestruct)

```

The following code converts the UTC string arrays to ephemeris time
s=SPICE.UTC2ET(starttime,et)

The following code locates the image indexes that have ephemeris times within the selected range.
timepos = WHERE(data[*],DATA_ET_SECS_C] GE et[0] AND \$
data[*],DATA_ET_SECS_C] LE et[1])

The following variables contain the ephemeris time, sector number and UTC strings for the images that have ephemeris times within the selected range.

```
image_et_times = data[timepos, DATA_ET_SECS_C]
image_subsectors = data[timepos, SECTOR_NUMBER_C]
image_utc_strings = datachar_scet [timepos]
```

The following code locates the position of the first image that matches high spatial, tof = 0 and species ;= Hydrogen. Some of the fields used to identify the image types, species and tof values are from the image_hdr_c.pro file.

```
img_pos = WHERE(data[timepos,TYPE_C] EQ DOUBLE(IMAGETYPE_HIGHSPATIAL) AND $
data[timepos,SPECIE_C] EQ DOUBLE(IMAGESPECIE_H) AND $
data[timepos,TOF_C] EQ DOUBLE(IMAGETOF_LOW)
```

```
IF img_pos[0] NE -1 THEN BEGIN
    imagesize = data[timepos[img_pos[0]],NUMCOLS_C]
    myimages = images[timepos[img_pos[0]], 0:imagesize-1, 0:imagesize-1]
ENDIF
```

Data Header Index	Description
SPINSTART_SCET_CHAR_C	Start of Spin Time in ASCII UTC string
DATA_SCET_CHAR_C	Data Time in ASCII UTC string
SPIN_COUNTER_C	Spin counter index
SECTOR_NUMBER_C	Sector
SUBSECTOR_NUMBER_C	Subsector
SPINSTART_SCLK_SECS_C	Start of Spin Time in Spacecraft clock
SPINSTRT_SCLK_FINE_C	Start of Spin S/C Clock fine word
SPINSTRT_ET_SECS_C	Start of Spin Time in Ephemeris Time
CDS_ERROR_C	CDS Error Flag, passed from s/c
SPINSTAR_MODE_C	Spin or starring mode flag. 0=stare, 1=spin
SPIN_PERIOD_C_C	Spin Period spin_rate (minutes) = Spin Period*64.*16.*16.*16. / 6. * 1000000. * 60.)
DATA_SCLK_SECS_C	Data Time in Spacecraft clock
DATA_SCLK_FINE_C	Data Time S/C Clock fine word
DATA_ET_SECS_C	Data Time in in Ephemeris Time
SENSOR_BITRATE_C	Bit rate for sensor

Image Header Index or header value	Description
NUMCOLS_C	Index: Number of columns in image. Is same as rows.
NUMROWS_C	Index: Number of rows in image. Is same as columns.
COMPRESSIONINFO_C	Index: Compression type.
LOSSCOMP_C	Index: Lossless Compression
LOG16TO8_C	Index: Set if image pixels have been log compressed
THETAOFFSET_C	Index: Theta offset of 90 x 120 image
PHIOFFSET_C	Index: Phi offset of 90 x 120 image

IMAGETYPEID_C	Index: Image type not split out into fields
TYPE_C	Index: Type image, 0:spatial, 1:time, 2:mTOF. You can use the IDL parameters IMAGETYPE_HIGHSPATIAL, IMAGETYPE_HIGHTIME and IMAGETYPE_HIGHMTOF
CHARGE_C	Index: Charge of image, 0:neutral, 1:ion. This is the commanded mode of the instrument, in which different image sets are sent down. This is not due to a voltage change on the collimator!!! You can use the IDL parameters IMAGECHARGE_NEUTRAL and IMAGECHARGE_ION
SPECIE_C	Index: Species 0:H, 2: 0, 5: All (high time only) You can use the IDL parameters IMAGESPECIE_H, IMAGESPECIE_CNO, IMAGESPECIE_ALL.
TOF_C	Index: ToF value: 0-7. You can use the IDL parameters IMAGETOLOW and IMAGETOHIGH which are indexes 0 and 7 respectively.
IMAGETYPE_HIGHSPATIAL	Header Value: High Spatial Image resolution type
IMAGETYPE_HIGHTIME	Header Value: High Time Image resolution type
IMAGETYPE_HIGHMTOF	Header Value: High mTOF Image resolution type
IMAGECHARGE_NEUTRAL	Header Value: Neutral Charge
IMAGECHARGE_ION	Header Value: Ion Charge
IMAGESPECIE_H	Header Value: Species Hydrogen
IMAGESPECIE_CNO	Header Value: Species Oxygen
IMAGESPECIE_ALL	Header Value: All species, used for high time resolution species
IMAGETOLOW	Header Value: Low TOF
IMAGETOHIGH	Header Value: High TOF
SUBPACKHDR_VERYLOW	Header Value: Very low bit rate
SUBPACKHDR_LOW	Header Value: Low bit rate
SUBPACKHDR_MEDIUM	Header Value: Medium bit rate
SUBPACKHDR_HIGH	Header Value: high bit rate
SUBPACKHDR_VERYHIGH	Header Value: Very high low bit rate

8.2.3 GET_IMAGE_POS Program

The GET_IMAGE_POS program allows the user to access the INCA images with the accompanying attitude for each pixel from within IDL. The data is returned in a structure in IDL or saved to an IDL saveset. The routine contains a test routine at the top that shows an example of calling GET_IMAGE_POS and working with the data. The calling sequence is:

Starttime = '2014-025T00:00:00'

Stoptime = '2014-025T01:00:00'

Type = 0

Tof = 7

Spec = 0

Frame = 'SATURN_EQUATORIAL_SYSTEM'

Data = GET_IMAGE_POS(starttime, stoptime, type, tof, spec, frame, status, /DIF_FLUX)

Parameters

Starttime and stoptime	The starttime and stoptime variables are UTC strings with the following format: yyyy-doyThh:mm:ss.msc
Type	The type parameter is the image resolution type. 0 = high spatial resolution 1 = high time resolution 2 = high mass TOF resolution
Tof	The TOF parameter is the time-of-flight. High spatial and high time resolution image have the following TOF: 0 = lo 7 = hi High mass TOF resolution images have the following TOF 0 = lo, 1, 2, 3, 4, 5, 6, 7 = hi
Spec	The spec parameter is the image species. The high spatial and high mass TOF resolution images have 0 = Hydrogen, 2 = Oxygen. The high time resolution images only have 5 = all.
Frame	The frame is the full string name of a spice frame to calculate the position in. Some typical frame names are CASSINI_MIMI_INCA_LL, SATURN_SOLAR_ORBIT, SATURN_EQUATORIAL_SYSTEM, CASSINI_KRTP
Status	The status if 0 indicates that the read of the selected data worked. If the status is -1 then the read did not work.

Keywords

INTERP_MISS	If the INTERP_MISS keyword is set, then the spice software will use the last know position for missing attitude, position and velocity. WARNING: This can be VERY inaccurate and should only be used by the advanced user in the cruise phase where there are gaps in the attitude and the spacecraft motion was well understood.
CNTSEC, INT_FLUX, DIF_FLUX, FLUX_CALIB	The units of the image data default to counts. CNTSEC = counts/seconds INT_FLUX = counts/(cm ² sr s) DIF_FLUX = counts/(cm ² sr s keV) The FLUX_CALIB option will return the calibration matrix consisting of the efficiencies and geometric factors for the pixels. This option is used for debugging purposes.
SHIFT_PIXEL	The shift_pixel keyword is used to apply a known correction factor in units for the 64x64 image to the image. Currently the value recommended by the instrument team is :

	Shift_pixel = [-1.5, 0.5] [Theta, Phi]
AVERAGE and SAMPLE_SUM	If AVERAGE or SAMPLE_SUM is the number of images to be combined. The value should be greater than one to take effect. SAMPLE_SUM should only be used on counts. The method of combination defaults to a quick method if the MOTION_AVE or SIMPLE_AVE options are not used. The quick method will stack the images on top of one another in stare mode, take the sum and apply the average if selected. If the instrument is in spin mode, then the quick method will stack the matching sector images on top of one another to get the sum.
MOTION_AVE	The motion average option is a C program that assigns the relevant value (sum, average, integral flux or differential flux) to each pixel in the output frame of reference. This is accomplished pixel by pixel and there are $4^{(k-1)}$ sample points computed for each pixel. For each image pixel sample point, the latitudes and longitudes in the original image frame are converted to the latitude and longitude of the output frame. Then the pixel of the final image that corresponds to this latitude and longitude is calculated. Finally, the relevant quantity is obtained from the original pixel based on the units selected. The next step is to combine all of the quantities from the sample points for the given image and the results are combined for the sum or average. It can take a long time but is very accurate. This C program has been added to the SPICE icy library so is available in IDL. It does require the MOTION_STAT and MOTION_K keywords to be included.
MOTION_STAT	The motion stat field sets the statistically significant counts value for a pixel to be included in the calculation.
MOTION_K	The k value determines the accuracy of the calculation. There are $4^{(k - 1)}$ sample points computed for each pixel. K must be ≤ 4 .
SIMPLE_AVE	The simple average method was created since the motion average method is slow. It is less accurate but is much better than the quick method discussed in the AVERAGE and SUM field above. The simple method takes the latitude and longitude of the pixel in the initial image frame and calculates the resultant value and location in the final output frame of reference. The resultant images in the output frame are summed and averaged if selected.
WIDTH_AVESUM	This is the step size between the output averaged or summed images. The field value must be greater than 1.
EXCLUDE_LOW and EXCLUDE_HIGH	The exclude low and high keywords allow the user to exclude pixels from the images with count values lower than EXCLUDE_LOW or higher than EXCLUDE_HIGH.
COMPTON_GETTING	This option applies a correction for the Compton-Getting effect to the images. See the routine GET_COMPTONGETTING for more information on how this is being implemented. The COMPTON_GETTING is a structure with the following format:

	<p>Cg = {on:1, pvel:wind_speed, gamma:gamma}</p> <p>On = 1, filter is applied, 0 = not applied</p> <p>Wind_speed: This is the convective speed of the plasma for the Compton-Getting correction. The default value is 500.</p> <p>Gamma: Compton-Getting Gamma parameter. It is usually close to 2.0 in the solar wind frame.</p>
SAVESET	The saveset keyword should equal the string path and full filename of the intended IDL saveset.

Output:

The program returns a data structure with the following format:

time: Time in [year,doy,secondsofday]
et: Ephemeris time in [numrows]
utc: UTC time [numrows]
accum_time: Accumulation time of image in seconds [numrows]
images: Images in units specified in units [numrows, maximagesize, maximagesize]
x: [numrows, maximagesize, maximagesize),\$;Position of each image pixel in rectangular coordinates
y: [numrows, maximagesize, maximagesize),\$
z: [numrows, maximagesize, maximagesize),\$
xsc: [numrows],\$;sc position in Rbody
ysc: [numrows],\$
zsc: [numrows],\$
ck_coverage: [numrows],\$;If set to 1 then had CK coverage, otherwise is interpolation
type: string title for image type
tof: string title for tof
spec: string title for species
frame: long exact name of SPICE frame
units: string units to write out in file
unitsforplot: string units to write on plot, has 2 lines
spin_period: [numrows] spin period in original unitless number
spin_period_min: [numrows] spin period in minutes
spinstare_mode: [numrows], spin stare mode 0 = stare, 1 = spin
pt_apply: flag [numrows] if = 1, then attitude produced phi/theta offsets have been applied
phi_offset: [numrows] attitude produced phi offset in degrees

theta_offset: [numrows] attitude produced theta offset in degrees
align_theta_offset: [numrows] instrument alignment theta offset in pixels
align_phi_offset: [numrows] instrument alignment phi offset in pixels
neutralionmode: [numrows] image neutral or ion mode, neutral = 0, ion=1

Numrows is the number of images returned.

8.2.4 GET_IMAGE_NOPOS Program

The GET_IMAGE_NOPOS program allows the user to access the INCA images without the accompanying attitude for each pixel from within IDL. The data is returned in a similar structure to that returned by GET_IMAGE_POS minus the attitude fields in IDL or saved to an IDL saveset. The routine contains a test routine at the top that shows an example of calling GET_IMAGE_POS and working with the data. The calling sequence is:

Starttime = '2014-025T00:00:00'

Stoptime = '2014-025T01:00:00'

Type = 0

Tof = 7

Spec = 0

Frame = 'SATURN_EQUATORIAL_SYSTEM'

Data = GET_IMAGE_POS(starttime, stoptime, type, tof, spec, status, /DIF_FLUX)

Parameters

Starttime and stoptime	The starttime and stoptime variables are UTC strings with the following format: yyyy-doyThh:mm:ss.msc
Type	The type parameter is the image resolution type. 0 = high spatial resolution 1 = high time resolution 2 = high mass TOF resolution
Tof	The TOF parameter is the time-of-flight. High spatial and high time resolution image have the following TOF: 0 = lo 7 = hi High mass TOF resolution images have the following TOF 0 = lo, 1, 2, 3, 4, 5, 6, 7 = hi
Spec	The spec parameter is the image species. The high spatial and high mass TOF resolution images have 0 = Hydrogen, 2 = Oxygen. The high time resolution images only have 5 = all.

Status	The status if 0 indicates that the read of the selected data worked. If the status is -1 then the read did not work.
--------	--

Keywords

CNTSEC, INT_FLUX, DIF_FLUX, FLUX_CALIB	<p>The units of the image data default to counts.</p> <p>CNTSEC = counts/seconds</p> <p>INT_FLUX = counts/(cm² sr s)</p> <p>DIF_FLUX = counts/(cm² sr s keV)</p> <p>The FLUX_CALIB option will return the calibration matrix consisting of the efficiencies and geometric factors for the pixels. This option is used for debugging purposes.</p>
SHIFT_PIXEL	<p>The shift_pixel keyword is used to apply a known correction factor in units for the 64x64 image to the image. Currently the recommended value is :</p> <p>Shift_pixel = [-1.5, 0.5] [Theta, Phi]</p>
AVERAGE and SAMPLE_SUM	<p>If AVERAGE or SAMPLE_SUM is the number of images to be combined. The value should be greater than one to take effect. SAMPLE_SUM should only be used on counts. The method of combination defaults to a quick method if the MOTION_AVE or SIMPLE_AVE options are not used. The quick method will stack the images on top of one another in stare mode, take the sum and apply the average if selected. If the instrument is in spin mode, then the quick method will stack the matching sector images on top of one another to get the sum.</p>
MOTION_AVE	<p>The motion average option is a C program that assigns the relevant value (sum, average, integral flux or differential flux) to each pixel in the output frame of reference. This is accomplished pixel by pixel and there are 4^(k-1) sample points computed for each pixel. For each image pixel sample point, the latitudes and longitudes in the original image frame are converted to the latitude and longitude of the output frame. Then the pixel of the final image that corresponds to this latitude and longitude is calculated. Finally, the relevant quantity is obtained from the original pixel based on the units selected. The next step is to combine all of the quantities from the sample points for the given image and the results are combined for the sum or average. It can take a long time but is very accurate.</p> <p>This C program has been added to the SPICE icy library so is available in IDL. It does require the MOTION_STAT and MOTION_K keywords to be included.</p>
MOTION_STAT	<p>The motion stat field sets the statistically significant counts value for a pixel to be included in the calculation.</p>
MOTION_K	<p>The k value determines the accuracy of the calculation. There are 4^(k - 1) sample points computed for each pixel. K must be <= 4.</p>

SIMPLE_AVE	<p>The simple average method was created since the motion average method is slow. It is less accurate but is much better than the quick method discussed in the AVERAGE and SUM field above.</p> <p>The simple method takes the latitude and longitude of the pixel in the initial image frame and calculates the resultant value and location in the final output frame of reference. The resultant images in the output frame are summed and averaged if selected.</p>
WIDTH_AVESUM	<p>This is the step size between the output averaged or summed images. The field value must be greater than 1.</p>
EXCLUDE_LOW and EXCLUDE_HIGH	<p>The exclude low and high keywords allow the user to exclude pixels from the images with count values lower than EXCLUDE_LOW or higher than EXCLUDE_HIGH.</p>
COMPTON_GETTING	<p>Apply a correction for the Compton-Getting effect. See the routine GET_COMPTONGETTING for more information on how this is being implemented. The COMPTON_GETTING is a structure with the following format:</p> <p>Cg = {on:1, pvel:wind_speed, gamma:gamma}</p> <p>On = 1, filter is applied, 0 = not applied</p> <p>Wind_speed: This is the convective speed of the plasma for the Compton-Getting correction. The default value is 500.</p> <p>Gamma: Compton-Getting Gamma parameter. It is usually close to 2.0 in the solar wind frame.</p>
SAVESET	<p>The saveset keyword should equal the string path and full filename of the intended IDL saveset.</p>

Output:

The program returns a data structure with the following format:

- time: Time in [year,doy,secondsofday]
- et: Ephemeris time in [numrows]
- utc: UTC time [numrows]
- accum_time: Accumulation time of image in seconds [numrows]
- images: Images in units specified in units [numrows, maximagesize, maximagesize]
- type: string title for image type
- tof: string title for tof
- spec: string title for species
- frame: long exact name of SPICE frame
- units: string units to write out in file
- unitsforplot: string units to write on plot, has 2 lines
- spin_period: [numrows] spin period in original unitless number

spin_period_min: [numrows] spin period in minutes
spinstare_mode: [numrows], spin stare mode 0 = stare, 1 = spin
pt_apply: flag [numrows] if = 1, then attitude produced phi/theta offsets have been applied
phi_offset: [numrows] attitude produced phi offset in degrees
theta_offset: [numrows] attitude produced theta offset in degrees
align_theta_offset: [numrows] instrument alignment theta offset in pixels
align_phi_offset: [numrows] instrument alignment phi offset in pixels
neutralionmode: [numrows] image neutral or ion mode, neutral = 0, ion=1

Numrows is the number of images returned.

8.2.5 Dump MIMI Image Headers

The Dump MIMI Image Headers program will dump the image headers to an ASCII file. This is primarily used for debugging purposes. Figure 47 shows the Dump Image Headers Menu.



Figure 47: Dump INCA Image Headers Menu.

The Dump Image Headers Menu will dump the contents of the image headers to an ASCII file. This program is mainly used for debugging purposes.

To access the Dump Image Headers menu from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Dump Image Headers button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s= DUMP_IMAGEHDR_MENU()
```

The menu calls the DUMP_IMAGE_HEADERS program to dump the image header contents from one day to a file. The top row of the file contains the column titles. Sections for each image type follow that, with one row of data header and image header contents for each image after an

image type text label. Each section covers the whole day and is followed by the next image type section.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year. Hit return to load the same value into the stop year.
Doy	Input 3-character day of year that starts with 1. Hit return to load the same value into the stop doy.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Dump To File	Use the file selector button to select the path and filename of the output file or enter the entire path and filename in the text field.

8.3 INCA High TOF Channel Dump

The INCA High TOF Channel Dump option will dump the INCA TOF data and positional information to an ASCII file. Figure 48 shows the INCA High TOF Channel Dump menu.

To access the TOF Channel Dump menu from Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the INCA High TOF Channel Dump button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl  
IDL>s=TOFCHANNELS_DUMP_MENU()
```

The TOF channel dump program takes a time range, image type, species type and reads in all matching image data. Then each image is summed or averaged down to one value. The data is written out to an ASCII file or IDL saveset. The user can average or sum the image data before it is summed or averaged down to one pixel. The user can also generate the output in counts, integral or differential flux.

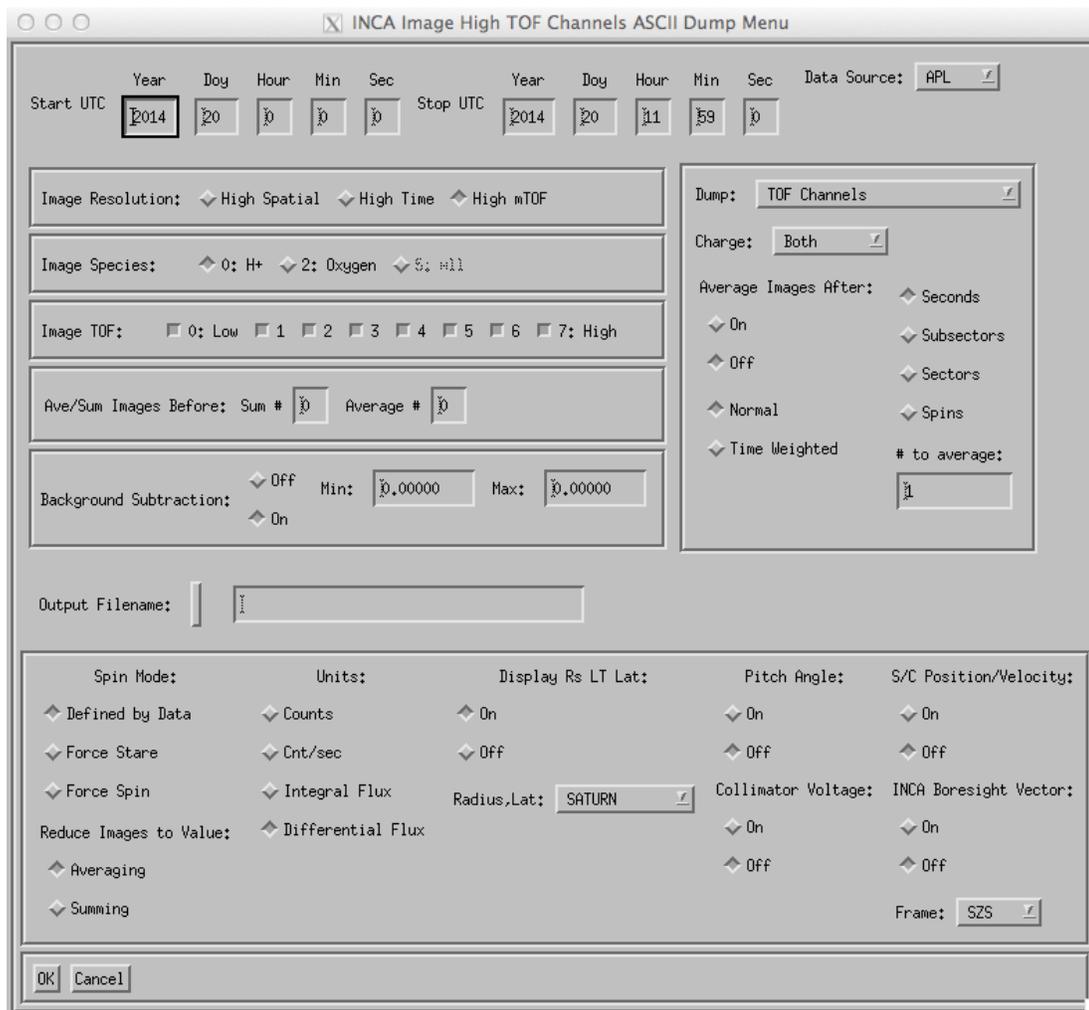


Figure 48: INCA High TOF Channels Dump Menu.

Calling Sequence

TOFCHANNELS_DUMP,2013,365,0,2013,365,1159,2,0,ave_or_sum,/homes/user/tofdump.txt/
 SUPPLEM_AXIS,/ADDMAG,/ADDCOLLV,/ADDSCPOS,/ADDINCABS,DUMPFrames="S
 ATURN_EQUATORIAL_SYSTEM"/SUBTRACT_BACK,TOF=[0,1,2,3,4,5,6,7]/DIF_FLUX

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.

Data Source	The default data source is to use the L1a binary files. However, the option to use the PDS ASCII data files is available.
Resolution	The program allows the user to display high mass time-of-flight , high spatial or high time resolution images For the command line call: type 0:highspatial 1:high time 2:high tof.
Species	Both hydrogen and oxygen data can be plotted. For the command line call: species 0:H, 1:He, 2:CNO, 3:Heavy, 4: other, 5:all (hightime).
TOF	The menu allows the user to select individual time of flight values. To do this using the command line, see the TOF keyword options.
Mask Ox	The TOF 6 and 7 images have known high pixel values and the affected pixels. This option allows the user to mask those pixels.
Units	Unit options are differential intensity, integral intensity, counts per second and counts.
Dump	The data dumped can be normal high time-of-flight and partial pressure plots. The partial pressure plots can be with the separate time-of-flights or combined into the geometric mean of the original partial pressures.
Charge	The INCA instrument is considered to be in ion mode when the collimator is set to less than a threshold of 1000 volts. When the collimator voltage is above that threshold, the instrument is considered to be in neutral mode. The data set can contain just ion or neutral mode data or both types.
Spin Mode	The data can be forced to be in either spin or stare mode instead of using the parameter reported in the data header. This is included for debugging purposes.
Sum or average	The images can be summed (counts) or averaged before the data is calculated
Multiplier	The multiplier is a parameter to multiply by any data in spin mode.
Reduce Images	All the data from one image is averaged or summed (counts) to produce the data. For the command line call, ave_or_sum = 1 then average data to obtain image point ave_or_sum = 0 then sum data to obtain image point
Saturn in FOV	The option to exclude data when Saturn is in the FOV is available
Min and Max	Enter the minimum or maximum linear value to bound the plot y limits (even when in log mode).
Background Subtract	A few INCA time-of-flight images have background values that can be subtracted from the images before use.

INCA collimator Volts	This option includes a column of the INCA collimator voltage.
Spacecraft Position and Velocity	This option includes a column of spacecraft position and velocity. POS = Spacecraft position in kilometers relative to the observer body VEL = Spacecraft velocity in kilometers per second
Pitch Angle	This option includes a column of magnetometer Bx, By, Bz and Btotal.
INCA Boresight Vector	This option includes a set of the INCA boresight vectors in rectangular coordinates.
Frame	This option is the frame in which to dump the INCA boresight vector and the S/C position and velocity.
Display Rs LT Lat	Additional values can be displayed with the time on the X-axis such as radius to Saturn, light time and latitude.
Radius, Lat	Select the Axis body to determine the body used for the supplementary labels (radius, latitude, local time)

8.4 INCA High TOF Solar Wind

The INCA High TOF Solar Wind option is a menu that outputs INCA high TOF image data to ASCII files and then calls a FORTRAN program to dump solar wind information. Figure 49 shows the INCA High TOF Solar Wind Menu.

The menu allows the user to select and read in the INCA high MTOF images using the SOLARWIND6.PRO and write them to ASCII files that are read in by the FORTRAN solar wind program. SOLARWIND6 calls TOFIMAGE_DUMP6 to read the images and write them to a file. The fortran programs that are called from SOLARWIND6 are listed below:

`/project/cassini/solarsoft/arch_`uname`/<version>/inca3_v3/f/incaswv` for the Kappa method

`/project/cassini/solarsoft/arch_`uname`/<version>/inca5_v3/f/incaswv` for the Power Law method

To access the Solar Wind menu from Unix or Linux:

`/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu`

and select the INCA High TOF Solar Wind button. Or the user can run the following script and command:

`/project/cassini/decomsoft/arch_`uname`/scripts /mimi_idl`

`IDL>s=SOLARWIND_MENU()`

Calling Sequence

`SOLARWIND6, 1999, 175, 2027, 1999, 175, 2200, 'KAPPA', 0, xdeg, AVERAGE=8, $`

`TOF=[1,2,3,4,5,6,7],$ '/homes/user/incatof.txt', '/homes/user/solout.txt', '/homes/user/solplot.txt'`

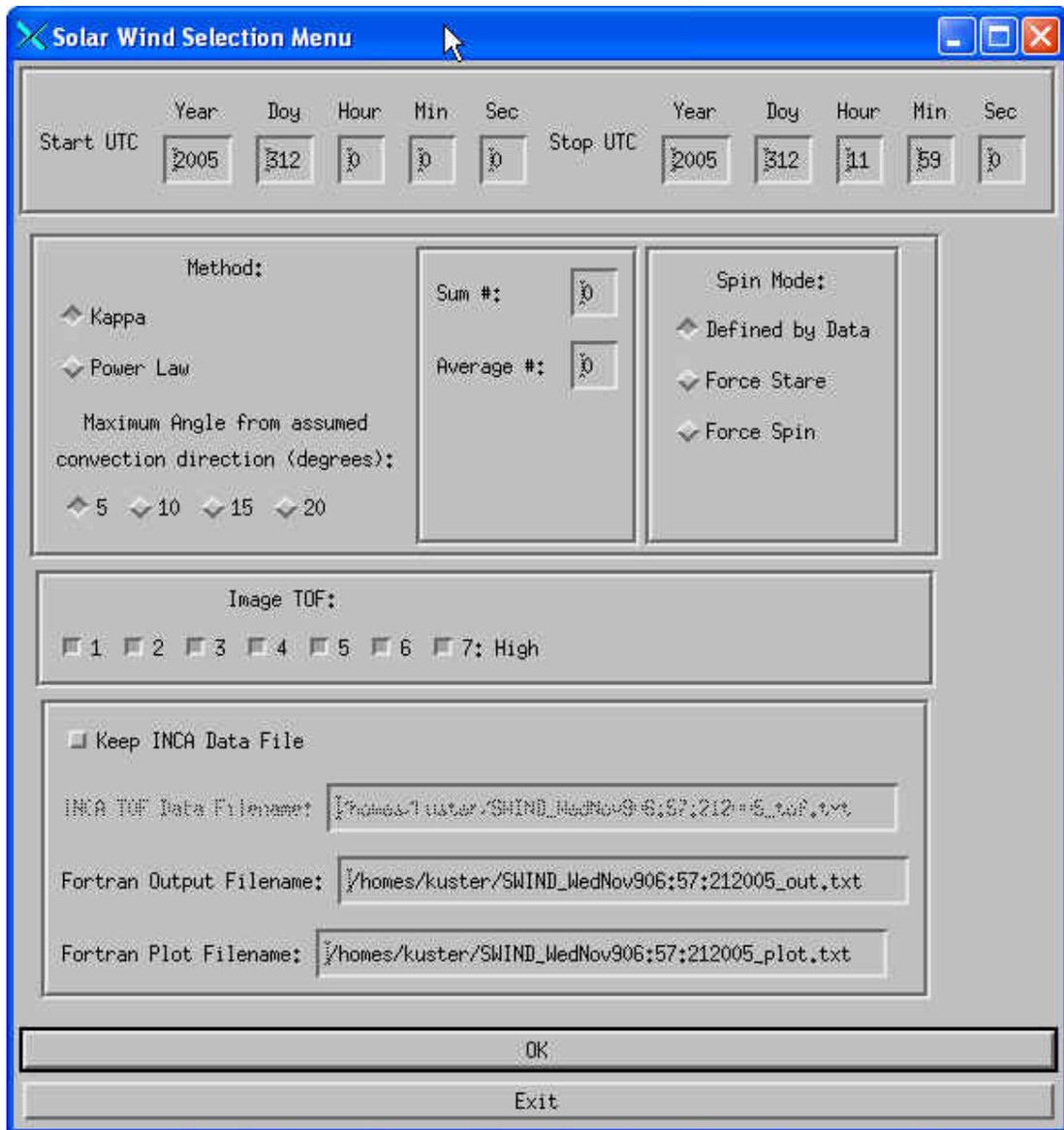


Figure 49: Solar Wind Selection Menu

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.

Sec	Input 2-character seconds with a range of 0 to 59.
method	Select either the Kappa or Power Law method.
Maximum Angle	Maximum angle from assumed convection direction in degrees.
Sum #	If greater than 1 then sum data for the number of samples equal to the value of SAMPLE_SUM. A sample is a 4 sector image for high spatial and high mTOF and is a sector image for high time. If the s/c is in spin mode, each 4 sector image will be averaged with the individual 4 sector image of the next spin. If the s/c is in stare mode, each 4 sector image inside a spin will be averaged together. Example: ,sample_sum=4.
Average #	If greater than 1 then average data for the number of samples equal to the value of AVERAGE. DO NOT USE BOTH SAMPLE_SUM and AVERAGE together. It assumes AVERAGE if this occurs. A sample is a 4 sector image for high spatial and high mTOF and is a sector image for high time. Example: ,average=4.
FORCE_SPIN_MODE	Act as if always in spin mode. Example: ,/force_spin_mode.
FORCE_STARE_MODE	Act as if always in staring mode. Example: ,/force_stare_mode.
Image TOF	This allows the user to leave out specific TOF images
Keep Inca Data File	The default action is to delete the INCA data file after the fortran program has finished. Select this button to keep the file.
INCA TOF Data File	Name of the INCA TOF Data File. This is a specific format file which also contains the quaternions to match each image.
Fortran Output File	Name of the Fortran output file.
Fortran plot File	Name of the Fortran plot file.

8.5 Dump INCA Flux vs Pitch Angle

The user can write out the intensity or normalized intensity for all the high mTOF images in selectable pitch bin ranges to an ASCII file. Figure 50 shows the Dump INCA Flux vs Pitch Angle Menu.

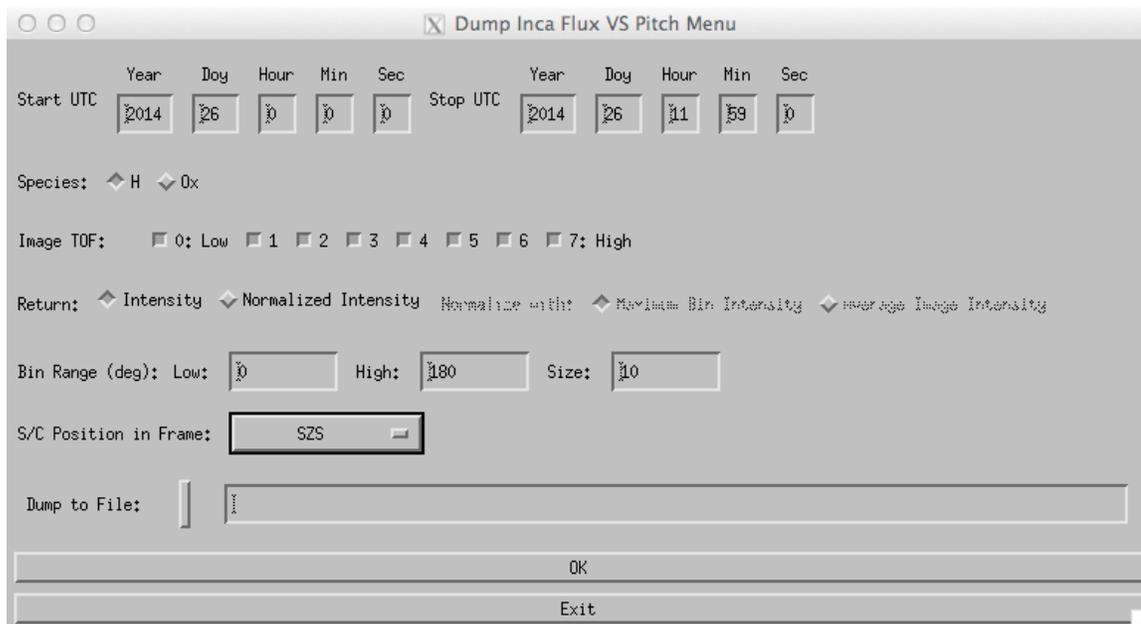


Figure 50: Dump INCA Flux vs Pitch Menu.

To access the Dump INCA Flux vs Pitch menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Dump INCA Flux vs Pitch button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts /mimi_idl
```

```
IDL>s=DUMP_PITCHBINS_MENU()
```

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
species	The species for the high mTOF images. H for hydrogen or Ox for oxygen
Image TOF	Select the individual TOF's to be included in the output.
Return	Select to output either intensity or normalized intensity.
Normalize with	If normalized intensity is selected, then the buttons for normalization method will be made active. Select to normalize with maximum bin intensity or the

	average image intensity.
Bin range Low and High	The bin range low and high set the range in degrees for the entire set.
Bn Range Size	The bin range size is the bin size in degrees for each calculation.
S/C Position in Frame	The spacecraft position and velocity will be output in the frame selected.
Dump to File	Select the path and filename for the output file.

Output:

The file columns are described in the following table:

Startutc – stoputc	
Species: <species>	
Return: <return value>	
Frame for S/C Position: <framename>	
Year	4 digit year
DOY	3 digit day of year
HH:MM:SS.SSS	HH = hours, MM = minutes, SS = seconds, SSS = milliseconds
ET	Ephemeris time
Spin Mode	Spin mode , 0 = stare, 1 = spin
Collimator	Indicates if collimator voltage is above the threshold, 1 = Neutral Mode 1 = Ion Mode
Pitch:<bin 0>_Ave:<TOF 0>	The pitch angle bins vary first with the beginning TOF
Pitch:<bin 1>_Ave:<TOF 0 >	
...	
Pitch:<bin 0>_Ave:<TOF 1>	Once the first TOF has been output for all bins, we start with the second TOF.
...	
Pitch:<bin n>_Ave:<TOF n>	
SCPos_X(km)	Spacecraft X position in km
SCPos_Y(km)	Spacecraft Y position in km
SCPos_Z(km)	Spacecraft Z position in km
SCVel_X(km)	Spacecraft X velocity in km
SCVel_Y(km)	Spacecraft Y velocity in km

SCVel_Z(km)	Spacecraft Z velocity in km
Pitch Inca	Pitch angle for inca in degrees

8.6 Magnetometer Data Dump

The magnetometer dump menu is the same menu and calls the same program as the magnetometer plot menu. See section 7.7 for a description of the menu.

8.7 Dump S/C Position and Velocity

The dump s/c position and velocity menu allows the user to output the spacecraft state, position and velocity in a selected frame. Figure 51 shows the S/C Position Menu.

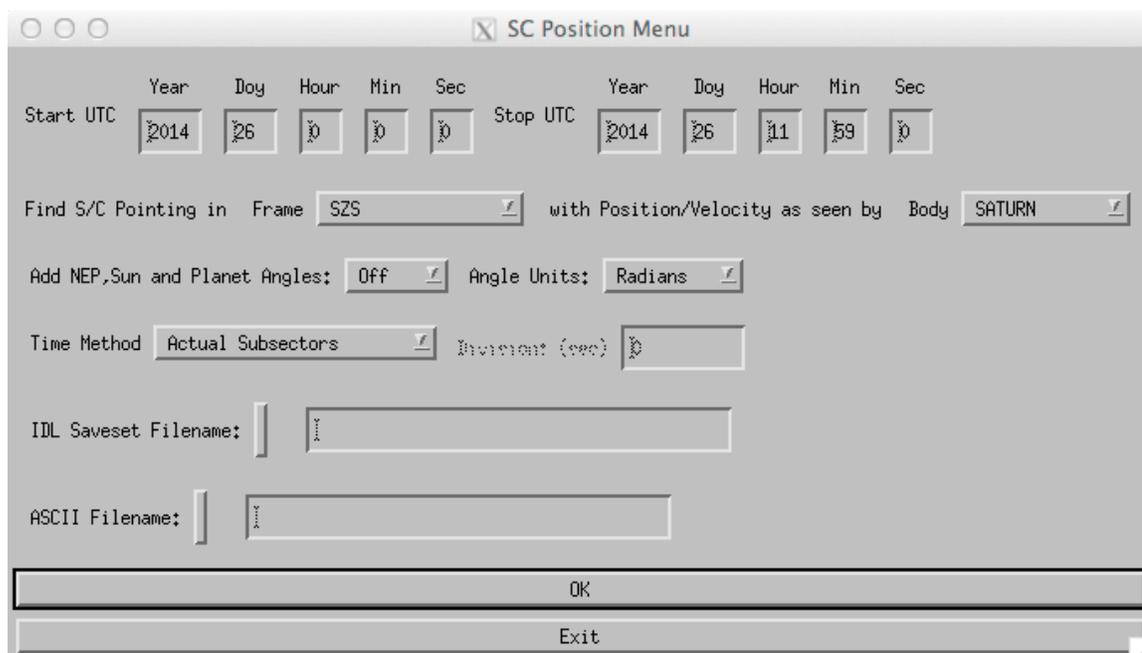


Figure 51: Dump SC Position Menu.

To access the S/C Position Menu menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Dump S/C Position Menu button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts /mimi_idl
```

```
IDL>s=SCPOS_MENU()
```

The calling sequence in IDL is

```
Posvel = GET_SC_POS('2014-028T00:00:00.000','2014-028T11:59:00.000',  
SATURN_EQUATORIAL_SYSTEM,'SATURN',ASCII_NAME="/user/scpos.txt")
```

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Frame	The frame to output the data in.
Body	Output the data as seen by this body
Add NEP, Sun and Planet Angles	<p>The north ecliptic plane (NEP), sun and planet angles can be added</p> <p>NEP = the angles in degrees between the three spacecraft axes (and negative) and the normal to the mean ecliptic plane of J2000.</p> <p>Sun = the angles in degrees between the three spacecraft axes (and negative) and the S/C to sun vector</p> <p>Planet = the angles in degrees between the three spacecraft axes (and negative) and the S/C to planet vector</p>
Angle Units	The angles can be calculated in either radians or degrees
Time Method	<p>There are 2 methods to determine the time resolution in which to output the data. The Actual Subsectors method matches the sector times of the data. If the user is comparing these values to MIMI data, they would want to use this option since the times would match those of the channel or image data.</p> <p>The Start, stop and division method uses the start and stop and the division field to determine the time resolution. The division field will be activated if this method is selected</p>
Division	The division is used with the Start, stop and division time method. It is in seconds.
IDL Saveset	<p>The data structure can be written to an IDL saveset in the following format:</p> <p>frame: string spice frame name</p> <p>planet: string planet name</p> <p>UTC: string array of UTC time strings</p> <p>ET: double array of ephemeris time</p> <p>SCX: {x: double, y: double, z: double}</p> <p>SCY: {x: double, y: double, z: double}</p> <p>SCZ: {x: double, y: double, z: double}</p> <p>POS: {x: double, y: double, z: double}</p> <p>VEL: {x: double, y: double, z: double}</p>

	SCX, Y, Z = Unit vector of the spacecraft X, Y, Z axis attitude in radians POS = Spacecraft position in kilometers relative to the observer body VEL = Spacecraft velocity in kilometers per second
ASCII File	The fields in the file are written out as follows: Frame name Planet name Number rows columns Column Labels (space delimited) UTC, ET, SCX (x,y,z), SCY (x,y,z), SCZ (x,y,z), POS (x,y,z), VEL (x,y,z)

9. Analysis Utility Programs

9.1 Plot Stacker

The Plot Stacker program allows the user to select individual plots from the browse product standard formats and combine them into a single plot. The user can save the format for reuse. Figure 52 shows the Plot Stacker Menu.

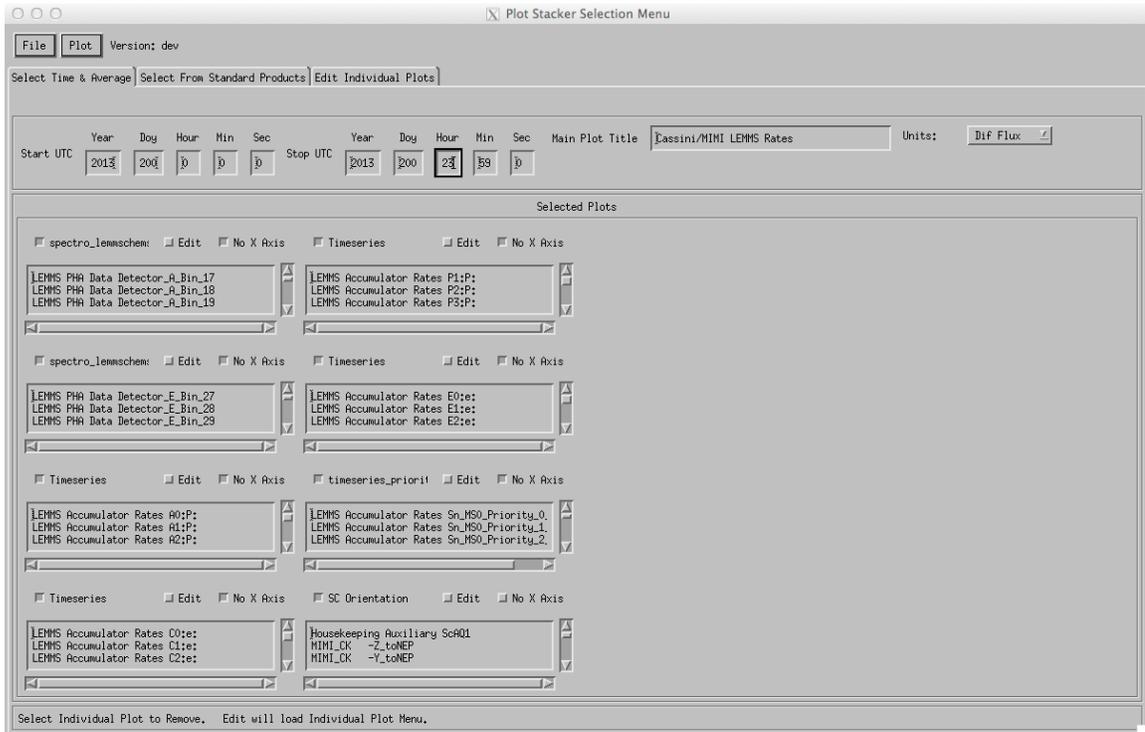


Figure 52: Plot Stacker Menu Select Time & Average Tab. Normally, the plot stacker menu Select time and average selected plots window is blank until the user selects some plots or reads in a saved plot product file.

To access the Plot Stacker Menu menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Plot Stacker Menu button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts /mimi_idl
```

```
IDL>s=PLOT_STACK_MENU()
```

Select Time & Average Tab Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Main Plot Title	The title of the plot. This field will be written over if the user selects plots from the standard product with the standard product name, so enter this title at the end of the selection process.
Units	These are the output units for the data. The units are also written over if the user selects plots from the standard product with the standard product units, so enter the units at the end of the selection process. The unit selection on this tab affects the channels that can be selected on the Edit Individual Plots Tab.
Selected Plots	This area in the menu will store the final selected plot types. When the user starts up the menu, this area will be blank. Plot Type: The plot type label shows the type of plot that has been selected. Each plot type can be unselected from the final set by clicking the leftmost button labeled with the plot type. Edit: The selected plot types can be edited by selecting the Edit button. No X Axis: The user can select to eliminate the X-axis labels on all but the last plot to save space. This field should be checked after all plots have been selected but before hitting the Plot button.



Figure 53: Plot Stacker Selection Select From Standard Products Tab.

The select from standard products tab allows the user to select individual plots from the MIMI standard browse products. One of the sensor, housekeeping (HSKP) or spacecraft orientation pull down menus is used to select a browse product and the window will display the individual plots in that product, see Figure 53. To remove an individual plot from the window, turn off the selection button at the left of the plot style. When the set of plots to be used is selected, hit the Save Standard Plots button. The plots will be written to the Select Time and Average tab.

The user can then switch back to the Select From Standard Products tab to continue selecting plots from other browse products. Figure 52 displays the individual plots selected and Figure 54 shows the plot that results.

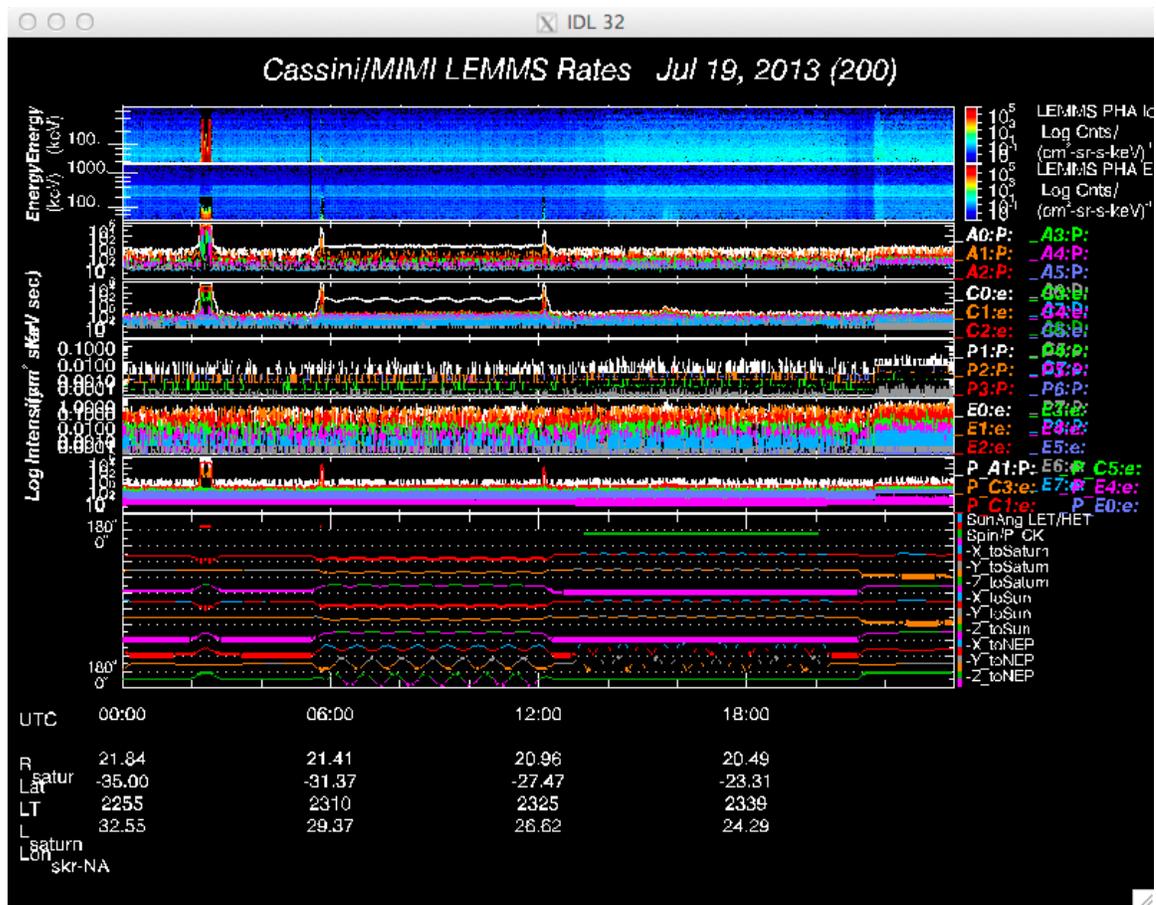


Figure 54: Plot Stacker Combination of LEMMS, CHEMS, INCA Spectrogram with LEMMS Rates Plot.

Menu Parameters

File Pull-down Options	
Colorbar	The colorbar option brings up a color bar menu with the IDL color bar options.
Background	The background option brings up a background color menu where the user can select to use a black or white background.
Save Menu Values	The individual selected plots can be saved to a product file which can be used with the restore menu values option to read back in those selected plots. The product file can also be used with the standard_prod program to make the plot.
Restore Menu Values	Any product file can be read back into the menu. Use the save menu values option to save the file. The standard browse product files can also be read into the menu.
Exit	Exit the program.
Plot Pulldown Options	

Plot to Window	The plot can be created using an IDL window.
Plot to PNG, JPEG, GIF, PS, PDF	This option will bring up the file selection menu and prompt the user to enter an output file path and name. The plot can be plotted to an output file format in PNG, JPEG, GIF (linux only), PS and PDF (linux only).
Clear All Selected Plots	This option will remove any selected plots from the Select Time and Average window.

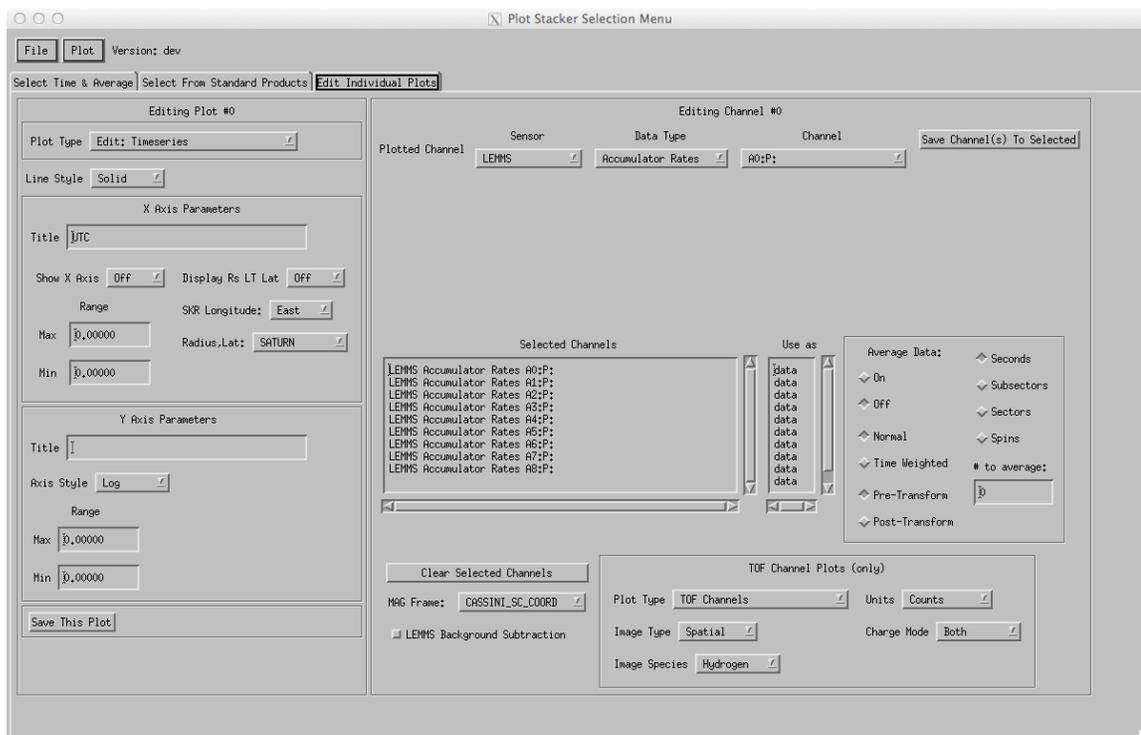


Figure 55: Plot Stacker Selection Edit Individual Plots Tab.

The user can create or edit a plot using the existing plot types. The Edit Individual Plots tab shown in Figure 55 has two sections. The Editing Plot #N section is used to select the plot style parameters. The Edit Channel #N section is used to select the channels displayed in the plot.

Menu Parameters

Editing Plot #N Section	
Plot Type	The plot types that allow the channels to be edited are the time series, time series data range and the INCA TOF channels. An example of the time series plots is in Figure 10, the lemms_gserates_c_ang browse product. The time series data range allows the user to enter channels that are the limits expected for a channel type and the plot will plot any data outside the limits as a red line. An example of the time series data range plot type is found in Figure 5, the analog_v1_c browse product. The

	<p>TOF channel plot style is found in Figure 22.</p> <p>The following plot types are not editable. An example of the SC Orientation plot is found in Figure 13. The data validity plot style is shown in Figure 14. The mag plot types are shown in section 7.7 Magnetometer Plots. The INCA HV collimator plot is shown in Figure 5 the analog voltage browse product. The valid and invalid command counts, alarm id and IEB # plots are shown in Figure 6, the analog current plot.</p>
Line Style	The line style can be solid or dotted
X,Y Axis Title	The title for the X or Y-axis.
Show X Axis	The labels for the X-axis (time) can be hidden or included. This affects the size of the plots. For multiple plots using the same time range, it is recommended to hide the X-axis labels until the bottom plot to maximize plot size.
Display Rs LT Lat	The radius to Saturn, light time and latitude can be displayed at the bottom of the plots along with the time.
SKR Longitude	The SKR longitude can be plotted in east or west longitude.
Radius, Lat	Select the Axis body to determine the body used for the supplementary labels (radius, latitude, local time)
X,Y Axis Range	The X or Y-axis limits are always linear values even if the plot is in log mode.
Y Axis Style	The data can be plotted in log or linear mode.
Save This Plot	Once all the data on both the Editing Plot #N and Editing Channel #N sections are finalized, the plot type can be saved by selecting the Save This Plot button. The newly created or the update to an existing plot type, will be added to the Select Time and Average window.
Editing Channel #N	
Plotted Channel	To select a channel, the user selects the sensor, the sensor data type, and then the channel. The channels available depend on the sensor, data type and the units selected in the Select Time and Average Tab in the top far right corner.
Save Channels to selected	Once a channel has been selected then hit the save channel button and the channel will show up in the Selected channels window.
Selected Channels	This window is a list of the selected channels.
Use as	Each channel can be either used as data or as a limit for other channels.
Average On/Off	This option turns on the averaging option. Not all data can be averaged at this time but a notice will be printed out if the data can not be averaged.
Normal	The normal method of averaging the data is summed over the time range and divided by the number of samples.
Time Weighted	The time weighted method, sums the data times its accumulation time

	over the time range and divides by the total accumulation time.
Pre-Transform	There is an option to do the averaging pre-transform which means the data is read in day long sections, averaged and concatenated together. This method allows us to display very large amounts of data which previously caused out of memory errors in IDL.
Post-Transform	The averaging option is usually performed after any operations (Post-Transform) to get the data in its final format.
Seconds, Subsectors, Sectors or Spins	The time frame for averaging is specified by selecting seconds, subsectors, sectors or spins and the number to average.
# to average	Selects the number of Seconds, Subsectors, Sectors or Spins to average
Clear Selected Channels	This button will clear any channels out of the Selected Channels window.
Magnetometer Frame	If magnetometer data is selected (from the housekeeping sensor), the frame of reference in which to report the data can be selected.
LEMMS background subtraction	Select this background to subtract the LEMMS background from the rates or PHA data.
TOF Channel Plots (only)	
Plot Type	The TOF channels plot style can plot the individual images averaged to one point. The partial pressure plots can be with the separate time-of-flights or combined into the geometric mean of the original partial pressures.
Image Resolution	The high mTOF, time or spatial times-of-flight images can be plotted.
Image Species	Either the hydrogen or oxygen species can be plotted.
Units	The data can be plotted in counts, counts/sec, integral intensity or differential intensity.
Charge	Both the ion and neutral mode data or just ion or neutral mode data can be displayed.

9.2 Merge PNG Files

The Merge PNG files program allows the user to select portions of PNG files to put together on another PNG file. Figure 56 shows the Merge PNG Menu.

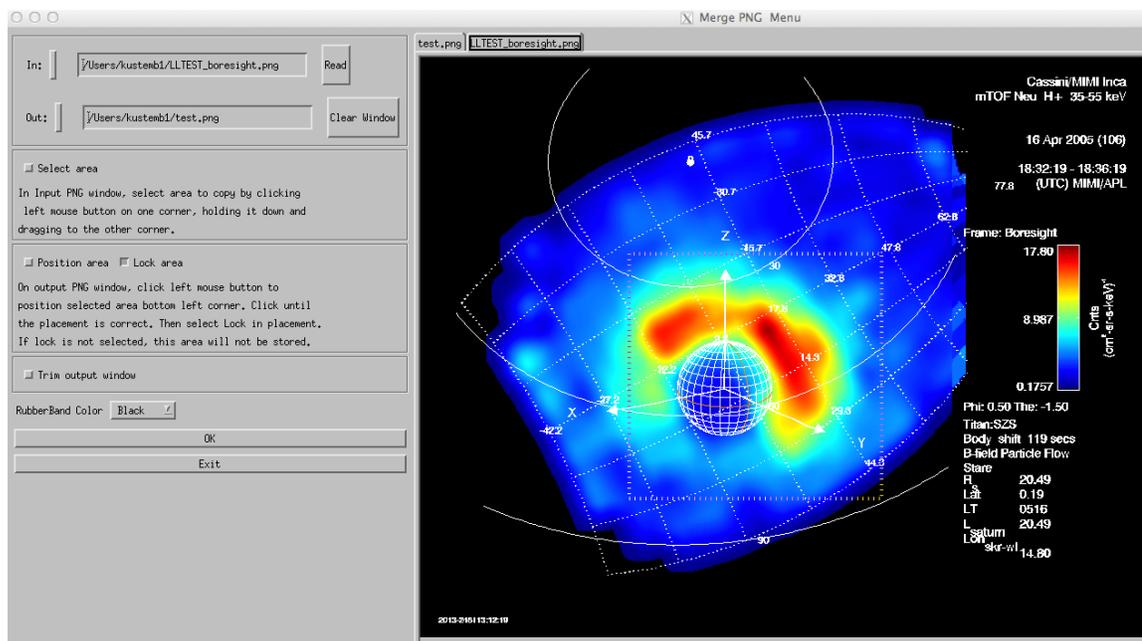


Figure 56: Merge PNG Files Menu. This figure shows the image with a cursor box that the user has selected.

The Merge PNG files program was created to allow users to cut and paste portions of PNG files into another PNG file.

Menu Parameters

In	The user selects the button on the far left of the file text field to bring up the file selector window or they can enter the filename in the field. After the file is selected, then the user selects the Read button and the PNG will be displayed in the Input Tab Window to the right. The title of the tab will change to the name of the file displayed.
Out	The output text file is the name of the final PNG file that will be written from the portions of the input PNG files. Selecting the button on the far right will bring up the file selector button.
Clear Window	This option will clear the output window.
Select Area	Once an input file is selected and read in, The select area button is selected and then the user copies an area in the PNG by holding the left button on the mouse down on the first corner of the area and dragging the mouse to the other corner. A cursor box will show the area that the user has selected. This is shown in Figure 56. Depending on the color of the image, the user may need to change the rubber band color so the cursor box shows.
Position Area	Once an area on the input PNG image has been selected, select the Position Area button and the output PNG draw area will appear. Use the mouse to select the left bottom most position of the selected area and the image will appear. Clicks again in a different position to move the area around the output draw area. Figure 57 shows the output draw area with

	two areas put together.
Lock Area	After the final position for the selected area has been selected on the output draw area, select the Lock Area button. Now, more areas from new input PNG files can be selected and placed on the output draw area.
Trim Output Window	The final output PNG file can be trimmed and Figure 57 shows the output draw area with the selected area to be included defined by a cursor box.
Rubber Band Color	The cursor box is set to plot in XOR mode to draw the cursor box. Sometimes the color doesn't show up well on certain plots so the user can set different colors to improve seeing the cursor box on top of the image.
Ok	This option will write out the selected output in the output tab to a PNG file.
Exit	This option exits the menu.

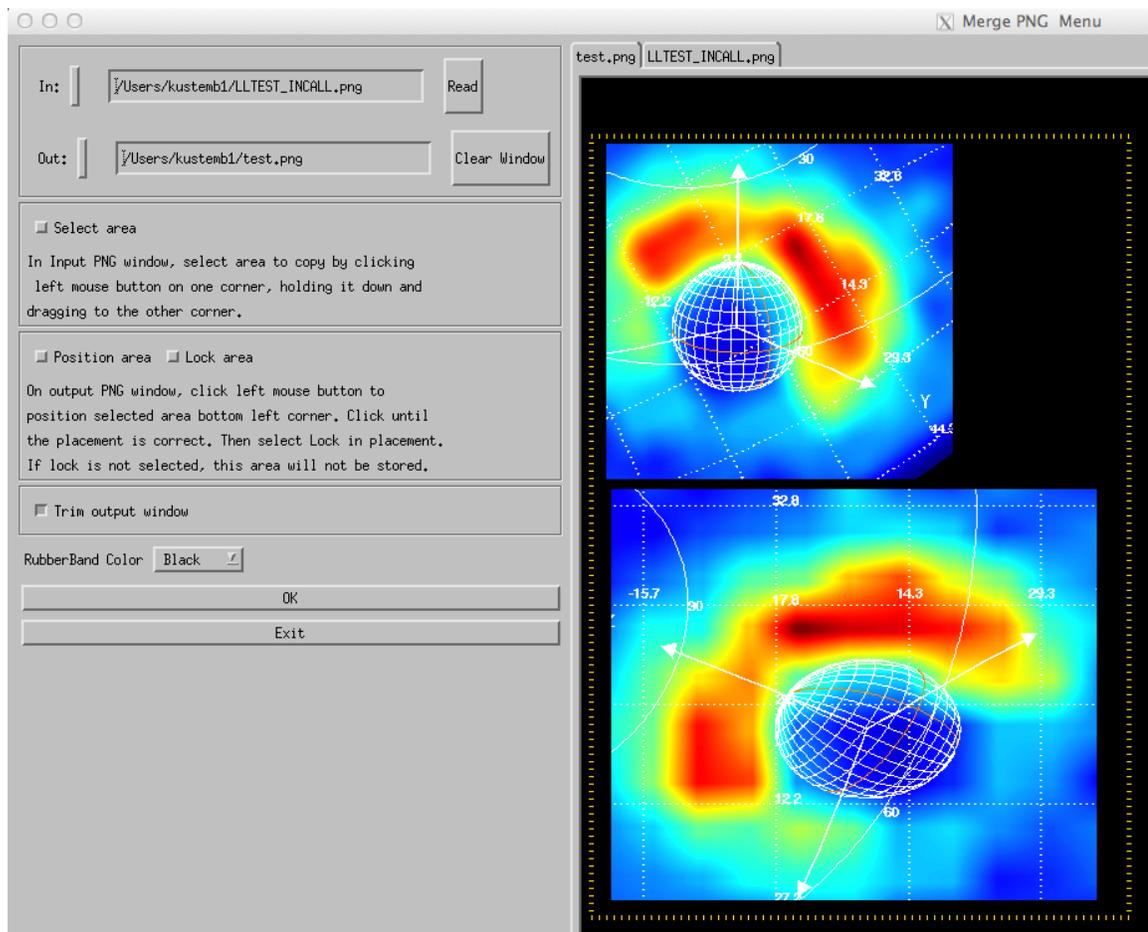


Figure 57: Merge PNG Menu Output PNG Draw Window. This figure shows the output draw area with two areas put together.

9.3 Time Calculator

The Time Calculator program allows the user to add or subtract time to a time in the day of year or month-day, SCLK or ephemeris time format. Figure 58 shows the Time Calculator Menu.

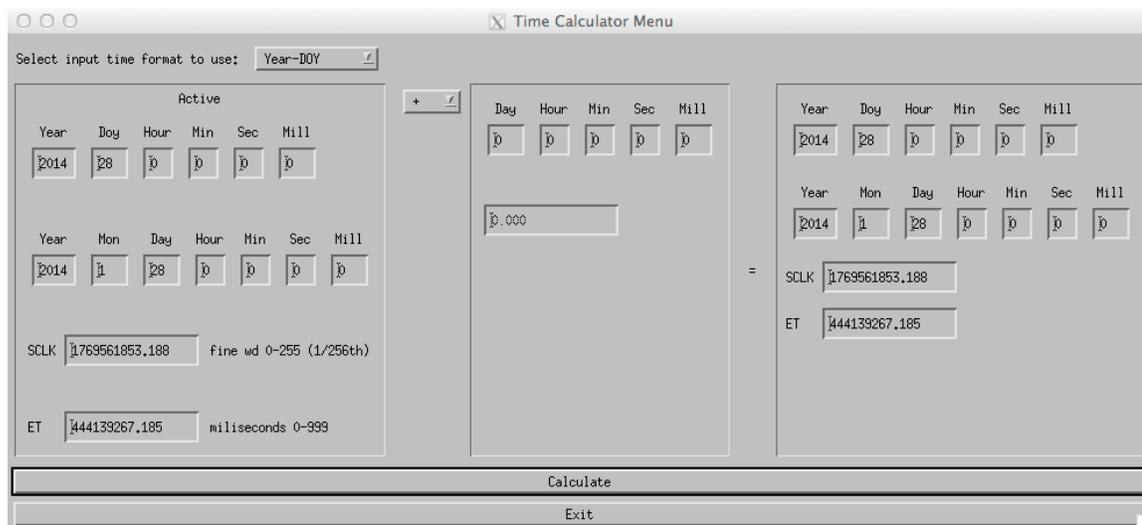


Figure 58: Time Calculator Menu.

Menu Parameters

Select input time format	The menu can start with time in a year-day-of-year, year-month-day, spacecraft clock or ephemeris time format.
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Month	Input 2-character month, starts with 1.
Day	Input 2-character day of month, starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Mill	Input 3 character milliseconds with a range of 0 to 999.
SCLK	Spacecraft clock field. Its is made up of the <clock value>.<fine word>. The fine word is 0-255.
ET	Ephemeris time in <seconds>.<milliseconds>. Milliseconds go from 0-999.

The user selects the time format, enters the active time, the value to add or subtract, the add or subtract method and selects calculate. All the fields in the far right section will be filled in. If spacecraft clock is the input time format, then the SLCK field in the middle will be used to enter the value.

10. Information Programs

10.1 Data Management Menu

On Mac systems and personal Linux systems, the Data Management Menu will appear as an option. It allows the user to administer the data set that is available on their computer. It can be used to install and update any auxiliary files that the system uses. Figure 59 shows the Data Management Menu.

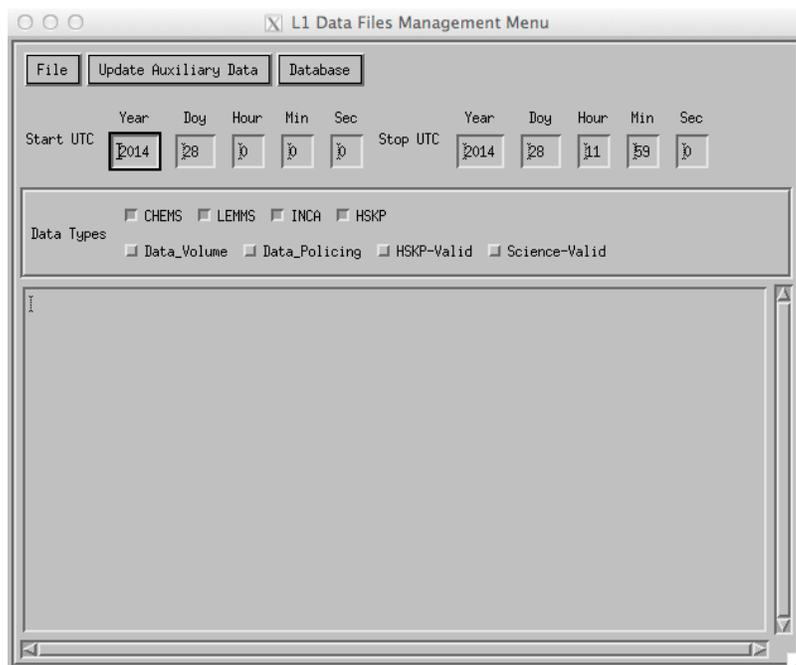


Figure 59: Data Management Menu.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Data Types	The L1a files from the three sensors, CHEMS, LEMMS and INCA and the housekeeping data files can be managed from the menu. Some auxiliary files such as the data volume, data policing, housekeeping and science validity files can also be managed from the menu. Select all file types to be operated on by the pull-down menu options and set the start and stop time for the data set desired.
File Pull-down Menu	

Get L1a Files	Download the L1a files for the selected data types if not already present in the database.
Get L1a Files, Remove Before	Remove the matching L1a files if present in the database and then download them for the selected data types. This is needed if the data file was transferred to the user's machine before the L0 data was completely downloaded from the spacecraft and processed to L1a data.
Gzip L1a Files	Perform gzip on all selected files.
Gunzip L1a Files	Perform gunzip on all selected files.
List L1a Files	List the matching L1a and auxiliary files in the window.
Remove L1a Files	Remove the matching L1a and auxiliary files.
Exit	Exit the menu.
Update Auxiliary Data Pull-down Menu	
INCA Out of Calibration	Download an updated copy of the INCA out of calibration file.
MAG Out of Calibration	Download an updated copy of the MAG out of calibration file.
Obtain SPICE Analysis Kernels	Download the analysis SPICE kernel set. It will also change the directory names in the meta kernels to match the user's directory. After this is done, be sure to exit IDL and reenter to load the new analysis kernel set.
Change Directories in SPICE Kernels	Just perform the change to the analysis kernel set. This can be used if the user obtains the analysis kernel set and places it in the directory specified by the YOUR_METAKERNEL_DIR environmental variable set in the USER_DAC_DEFINES script.
Database Pull-down Menu	
Make Database	This option will create the L1a database with all it's directories at the location specified by the MIMI_DATA environmental variable set in the USER_DAC_DEFINES script.
Remove Database	This option will remove the L1a database with all it's directories at the location specified by the MIMI_DATA environmental variable set in the USER_DAC_DEFINES script. It will remove all files.

10.2 IDL Processes Menu

On the Mac and on Linux, when a user uses control-C to exit IDL or crashes out of IDL, a zombie IDL job is usually created. These processes tend to ramp up the CPU usage and slow down the machines affected. The IDL processes menu uses the ps Linux command to display any currently running IDL jobs on the system that the user is on. This is intended to be of assistance to those trying to find and delete any spurious IDL jobs created by using control-C to exit IDL. The user will always show the current IDL job. The Mac version will not show the IDL help as a job but

the Linux version does show the IDL help as a process. Figure 60 shows the IDL Processes Menu.

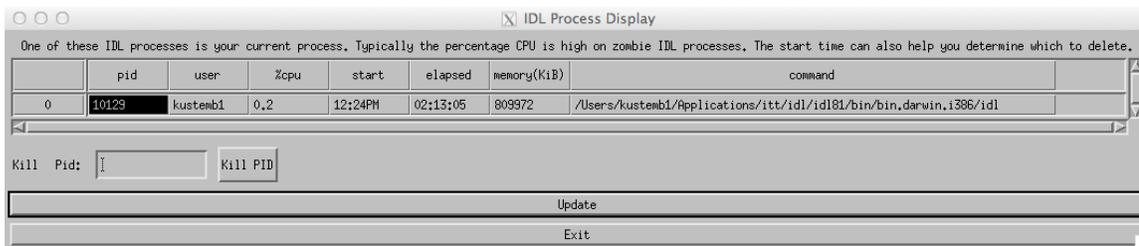


Figure 60: IDL Processes Menu.

Menu Display Values and Parameters

Pid	Process ID
User	Owner of the process
%cpu	CPU utilization. Typically the percentage of the CPU will be high on a zombie IDL process.
Start	The time the command started
Elapsed	How long the command has been running
Memory	The memory used in (KiB)
Command	The path of the command
Kill PID #	Enter the process ID to be killed. Make sure this is not the IDL session you are currently running.
Kill PID	Select the button to kill the process ID.
Update	This button reloads the menu with the current processes with IDL in the name.
Exit	Exit the menu.

10.3 Display Kernel Information

The Display kernel program has been created to make it easy for the user to look up which kernels are currently being selected by the automated software or to investigate the contents of a kernel file without having to do a command line call to the spice software. Figure 61 shows the Kernel Menu.

To access the kernel menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the Display Kernel Info button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts//mimi_idl
```

```
IDL>s=KERNEL_MENU()
```

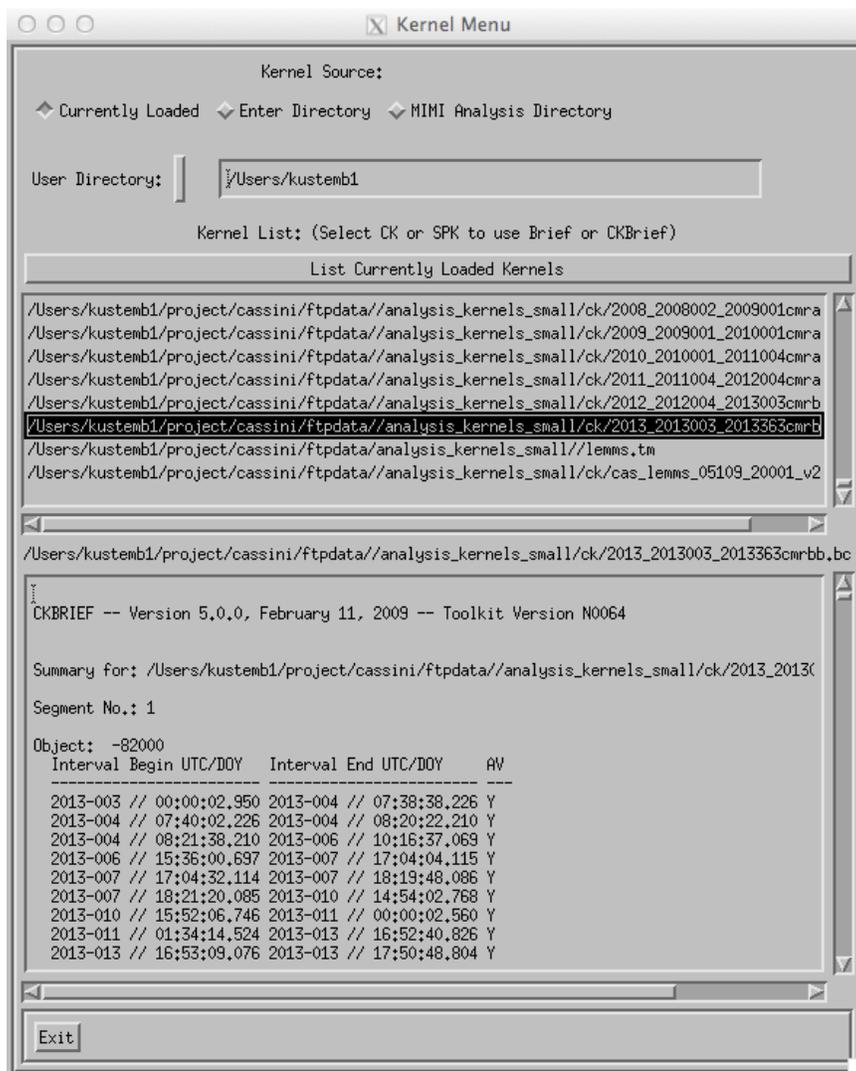


Figure 61: Kernel Menu.

Menu Parameters

<p>Kernel Source</p>	<p>The Currently Loaded option will display the kernels currently loaded in the IDL session in the kernel list window when the List Currently Loaded Kernels button is selected.</p> <p>The Enter Directory option will display all the kernels in the User Directory. This option requires the user to select a directory from the ftp mirror site or from the analysis site or to hand enter a directory.</p> <p>The MIMI Analysis Directory will always go to the directory specified by the environmental variable YOUR_METAKERNEL_DIR set in the USER_DAC_DEFINES.</p>
<p>User directory</p>	<p>This directory field can be hand edited or use the file selector button to bring up the file selector menu. The program expects the</p>

	directory to contain spice kernels.
List Current Kernels	This button will refresh the list of kernels in the Kernel list based on the selections in the above buttons
Kernel List Window	This is a list of the kernels. Each kernel can be selected and the contents will be displayed in the bottom window. The program uses the SPICE applications to dump the information from the kernels.
Kernel Contents Window	This is window that displays the contents of the selected kernel from the Kernel List window.

There is a useful routine available at the IDL prompt called `what_kernels` that will list all the currently loaded kernels. The calling sequence is

```
IDL>what_kernels
```

10.4 MIMI Calibration File

The MIMI calibration menu will display the calibration factors from the most recent MIMI calibration file that match a specified time. Figure 62 shows the MIMI Calibration Menu.

To access the Calibration menu from Unix or Linux:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_menu
```

and select the MIMI Calibration Info button. Or the user can run the following script and command:

```
/project/cassini/decomsoft/arch_`uname`/scripts/mimi_idl
```

```
IDL>s=LEMMS_CALIB_MENU()
```

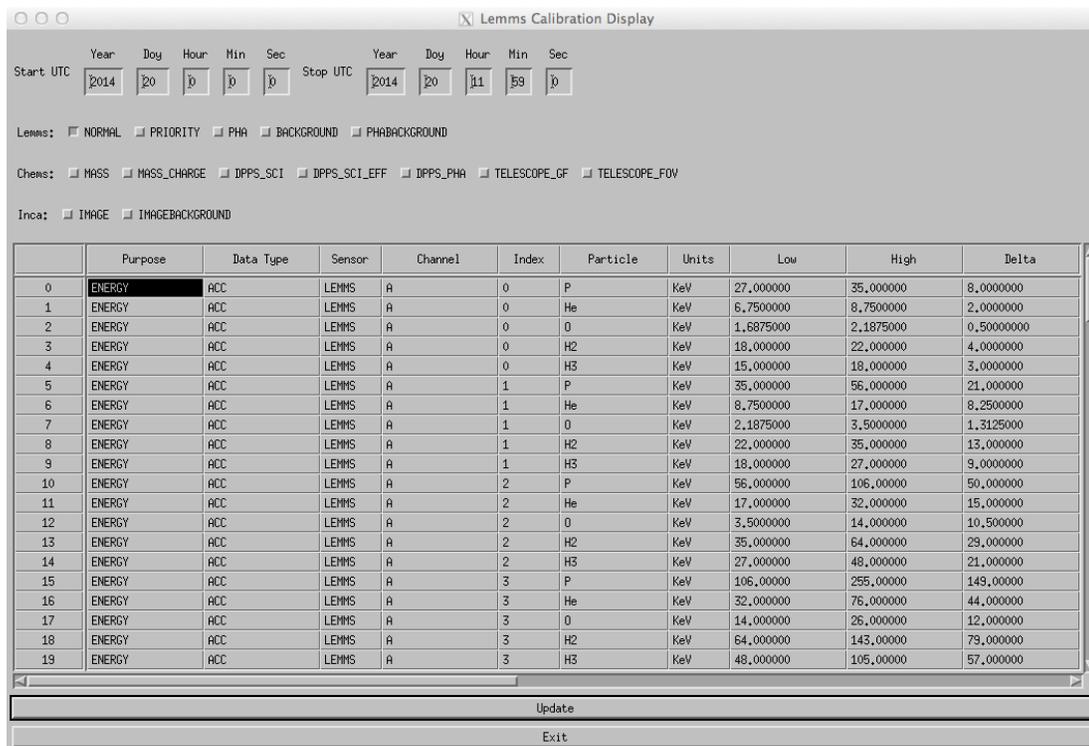


Figure 62: MIMI Calibration Menu.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Doy	Input 3-character day of year that starts with 1.
Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
Select just one data type to display	
LEMMS	Lemms calibration data types to display Normal: Low and high energy range for the normal accumulator rates Priority: Low and high energy range for the priority accumulator rates PHA: Low and high energy range for the PHA counters Backgrounds: These are the background values for the accumulator rates from the midpoint value in the calibration file. PHA Backgrounds: These are the background values for the PHA from the midpoint value in the calibration file.
CHEMS	Mass: Low and high mass range of a basic rate or species rate. Mass charge: Low and high mass/charge range for a basic rate or species rate

	channel. DPPS_SCI: Low and high energy/charge range for a channel. DPPS_SCI_EFF: Efficiency for channel from the midpoint of the calibration file. DPPS_PHA: Low and high energy/charge range for a PHA channel. TELESCOPE_GF: Telescope geometry factor. TELESCOPE_FOV: Telescope field-of-view.
INCA	IMAGE: Low and high energy range for an image type, species and time-of-flight. IMAGE Background: Background values for an image type, species and time-of-flight.
Calibration Table	This table displays the calibration information.
Update	Select update to refresh the calibration information for a new time and sensor type.

10.5 INCA/MAG Calibration Info

The INCA/MAG Calibration Info program will display the INCA and Magnetometer out of calibration time periods. Figure 63 shows the Out of Calibration Menu.

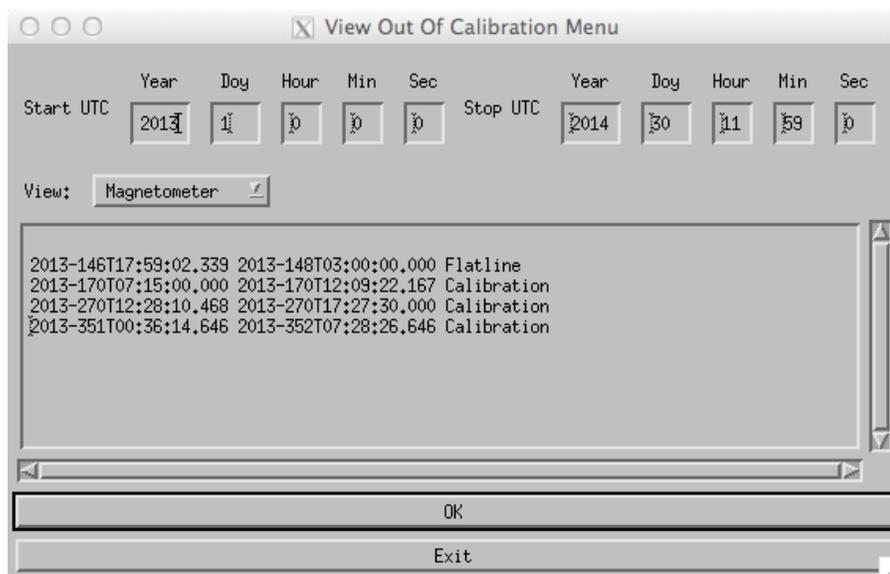


Figure 63: View Out of Calibration Menu.

Menu Parameters

Start and Stop UTC	
Year	Input 4-character year.
Day	Input 3-character day of year that starts with 1.

Hour	Input 2-character hour with a range of 0 to 23.
Min	Input 2-character minute with a range of 0 to 59.
Sec	Input 2-character seconds with a range of 0 to 59.
View	The out of calibration time periods for either INCA or the magnetometer can be displayed in the window
Ok	Select ok to display the matching data.
Exit	Exit the menu.