SIMPLEX User's Guide

Build 7 – September 2016

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Introduction

SIMPLEX is an interactive simulation tool that enables users to define instrument configuration and operational modes, simulate observing scenarios, and determine the quality and extent of science coverage for a given trajectory.

SIMPLEX Web Pages

- SIMPLEX software downloads: http://simplex.jhuapl.edu
- JIRA issue tracking: https://sdsci-jira.jhuapl.edu:8443/browse/SIMPLEX

Help and User Accounts

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Installation

SIMPLEX is a Java application and can be run on any system with a Java 8 (recently upgraded from Java 7) runtime environment (jre8) installed. This includes Mac, Windows, and Linux. Follow these steps to install SIMPLEX:

1. Verify that the Java 8 runtime environment is installed on your computer.
    a. Type: `java –showversion` in a terminal window.
    b. You must also have the Java Developer Kit (JDK 8) to run Java on the command line in a terminal window.
    c. Download Java 8 here: http://www.oracle.com/technetwork/java/javase/downloads/jdk8-downloads-2133151.html
    d. Contact your local IT Help Desk for Java help.
2. Request a download of SIMPLEX on the SIMPLEX page: http://simplex.jhuapl.edu. Click on the green email icon in the upper right corner of the web page that looks like this:
3. Within 24 hours, you will receive an email from an email account called "SD-Dropbox" (bitbucket@jhuapl.edu). The email will contain a link where you can download the software.
    a. You might want to add this email address to your address book so that the email doesn't go to the Junk mail folder.
    b. Do not reply or send emails to this account, as they will not be answered.
4. Click on the link in the email to take you to a web page to download the SIMPLEX zip archive (e.g., "**SIMPLEXBuild7Package.zip**").
5. Unzip the zip archive to a convenient location on your file system, which creates a folder called **SIMPLEX-Build7.** The following files and directories are included in this directory:
    a. SIMPLEX-<Instrument>.LBL files: These are label files that contain the instrument-specific parameters and observing modes.
    b. Trajectory kernel files will be in sub directories appropriately named for their respective trajectory files (e.g. .\15-F10\). The sub directories contain the following information:
        i. Leap Seconds kernel (.tls)
        ii. Planetary Constants Kernel (.tpc)
        iii. Spacecraft Kernel (.bsp)
        iv. KnownSolarSystem.lbl (a listing of known bodies in the solar system)
        v. <Trajectory-name>_ENCOUNTERS.txt – Mission Design file listing all flybys, their designated number, and other details.
        vi. <Trajectory-name>_MANEUVERS.txt – Mission Design file listing all maneuver burns.
        vii. Dsn_allpasses.csv – SIMPLEX created this file listing the science data downlink segments for the trajectory.
        viii. Top9096Stars.csv
        ix. Map images of Europa, Io, Callisto, Ganymede (.jpg files) and Jupiter (.png)
    c. Command line executable files (see descriptions below)

d. Mission files (which specify instrument and simulation parameters), e.g.,
    i. **E-15-F10.mission**
    ii. **E-16-F11.mission (newest trajectory)**
e. **SIMPLEX.JAR** – the SIMPLEX Java program
f. **SIMPLEXGuide-Build-7.docx** (this document) – user's guide in Word format
g. **SIMPLEXGuide.html** – user's guide in HTML format

Input Files

Spice Files

The following SPICE files (which are included in the software delivery) are required for a run:

- Leap Seconds kernel (LS)
- Planetary Constants Kernel (PCK)
- Spacecraft Kernel (SPK)
- Dss_35_36_prelim_itrf93_140620 (SPK and frame kernel (FK))
- Earth_topo_050714.tf
- Earthstns_itrf93_050714.bsp (SPK for DSN stations)
- Earth_070425_370426_predict.bpc (Earth planetary kernel)

The leap seconds and planetary constants kernels are always needed. The spacecraft kernel is generally a project-specific kernel. Often the ephemeris kernel for our solar system is combined with the spacecraft kernel. If this is the case, it will be obvious when you run the ***brief*** program described below (from the JPL/NAIF SPICE toolkit). If the solar system ephemeris information is not already combined with the spacecraft kernel then it needs to be included in the kernel list. The de431.bsp planetary ephemeris file can be downloaded here:
http://naif.jpl.nasa.gov/pub/naif/generic_kernels/spk/planets/

NAIF website where generic kernels are available for download:
http://naif.jpl.nasa.gov/pub/naif/generic_kernels/

Notes:

- **Processing of SPICE files:** All related calculations are done on the fly with a native Java library called Crucible, developed at APL.
- **Partial trajectories:** SIMPLEX supports working with partial trajectory files. You need to create a new mission file with the partial SPK, then add a body. The software will discover the flybys that are present in the SPK. If you don't combine your trajectory with the de431 SPK (or whichever DE SPK you use), then you just need to add it to the kernels list.

SIMPLEX Build 7 also includes the ability to predict times and data volumes for the science downlinks. For the spacecraft kernels provided in the SIMPLEX package there will be a spreadsheet provided that lists the details of each science data downlink segment.

To add a trajectory file into SIMPLEX that was not part of the package, you will need the following additional NAIF kernels before you run the DSN analysis:

- dss_35_36_prelim_itrf93_140620.bsp
- dss_35_36_prelim_itrf93_140620.tf
- earth_topo_050714.tf
- earthstns_itrf93_050714.bsp
- earth_070425_370426_predict.bsp.

These files are included with the Build 7 package under the directory 16F11/. To run the DSN analysis and create a new science downlink spreadsheet click the *DSN* button next to the kernel list on the *Mission* page of the user interface.

Mission Configuration Files (.mission files)

Mission configuration files are text based with a hierarchy of objects similar to PDS label files. Default mission configuration files for each trajectory are included with the software delivery. These files can be edited with any text editor. One of the main functions of the SIMPLEX user interface is to produce an error-free mission configuration file.

Whenever the ***Save*** button is clicked in the GUI, the .mission file is updated and saved in the main SIMPLEX directory.

When the ***Run*** button is clicked in the GUI, the program places a copy of the mission configuration file to a user defined output folder and saves a copy into the location where the program runs so that subsequent runs of the program have the information that the user entered. If multiple flybys are selected for one run, Simplex will automatically create folders for each flyby within the user defined output folder.

A list outlining all the data products that are saved to the user defined output folder is included under List 1 on page 14.

Running SIMPLEX

SIMPLEX can be run via a Graphical User Interface (GUI) or in a non-interactive, command-line mode (useful for batch runs).

Using the SIMPLEX GUI

On Windows: Navigate to folder that contains the SIMPLEX.JAR file and double click to open the Mission List GUI.

On Mac or Linux systems: Navigate to folder that contains the SIMPLEX.JAR file and double click on runGUI to open the Mission List GUI.

If you prefer to run from the command line:

1. Open a command or terminal window.
2. Change directory to the location of the jar file.
3. Type: **`java -Xmx8G -classpath SIMPLEX.JAR sp.gui.SIMPLEX`**

- In command line notation this is equivalent to: `java <virtual machine options> -classpath <jar file> <main class = sp.gui.SP> -f <mission file>`

- **Note:** The directory containing the jar file also contains 2 scripts (runGUI and runGUI.bat) that contain the above default Java commands. The .bat version is used on Windows.
    - To use a command script, type the following:

      command line prompt> **`runGUI ./E-16-F11.mission`**

- The "NoGUI" scripts run the simulation in batch mode. NOTE: Remember the batch mode uses the corresponding mission file and all of its settings. If the mission file does not specify run options for Analysis or Maps or Web Pages the batch mode will not produce the corresponding products.

Running via command-line, non-interactive mode:

1) Open a command or terminal window.
2) Change directory to the location of the jar file.
3) Type: **`java –Xmx12G -classpath SIMPLEX.JAR sp.gui.SIMPLEX -f ./E-15-F10.mission -s`**
    - In command line notation: `java <virtual machine options> -classpath <jar file> sp.gui.SIMPLEX -f <mission file> -s`
    - The SIMPLEX package includes several "run" scripts for convenience.

-f option: If the mission file is not part of the command line input (after the –f), then the mission list dialog shown in the upper left of Figure 1 will pop up. If a configuration file is provided but no other options are commanded, the software will do some basic checking on the configuration file. If all is well the progress window will appear.

-s option: suppresses any windows from appearing.

Memory: The virtual machine command line argument -Xmx8G instructs the runtime environment to set aside 8 GigaBytes of memory for the Java Virtual Machine. If your machine has more memory, it is recommended that you use it by setting aside more memory for the virtual machine (-Xmx10G = 10 GigaBytes, -Xmx16G = 16 GigaBytes, and so on). Some aspects of the simulation are memory intensive and others are CPU intensive.

The simulation will query your system to find out how many processing cores are available and it will run roughly an equal number of parallel tasks. This means your computer may be slow while running the simulator.

Known Issues

1. The "Framing" image type is not yet supported for the EIS NAC.
2. Instruments cannot be added or removed in the ***Instruments*** tab of the GUI (figure 4).
3. *Coverage Analysis* is currently the only working analysis.
4. In the *Coverage Analysis* web page the fourth link from the top of the page, with the title: *Panel coverage by resolution*, is not working correctly and the results should not be trusted.
5. The Plume observations won't show up in the output files. Some instrument specific logic is still needed for plume observations.

See http://simplex.jhuapl.edu for the latest, complete list of known issues.

See the JIRA page https://sdsci-jira.jhuapl.edu:8443/browse/SIMPLEX for the list of open enhancement requests, bug fixes. Access to this page requires a username/password. Contact Alice Berman for access.

Assumptions and Conventions Used

In this version of SIMPLEX, the following assumptions and conventions are used:

- Europa is modeled as a uniform sphere (latitudes are planetocentric).

SIMPLEX User Interface Workflow

The following sections provide information how to use the SIMPLEX GUI to set up a simulation. For quick reference, here are the main steps, each described in more detail below.

1. Open a mission configuration file (.mission) from the mission list
    - Build 7 contains mission files for both 15F10 and 16F11 trajectories.
2. Tab through the configuration pages to make adjustments as needed.
3. At any point, click ***Save*** to save your changes in the .mission file.
4. When the configuration is set click the ***Run*** button.
5. Select a location for the output of the simulator (Note: About 2,000 files are generated for each flyby).
6. Wait until the simulator is finished running.

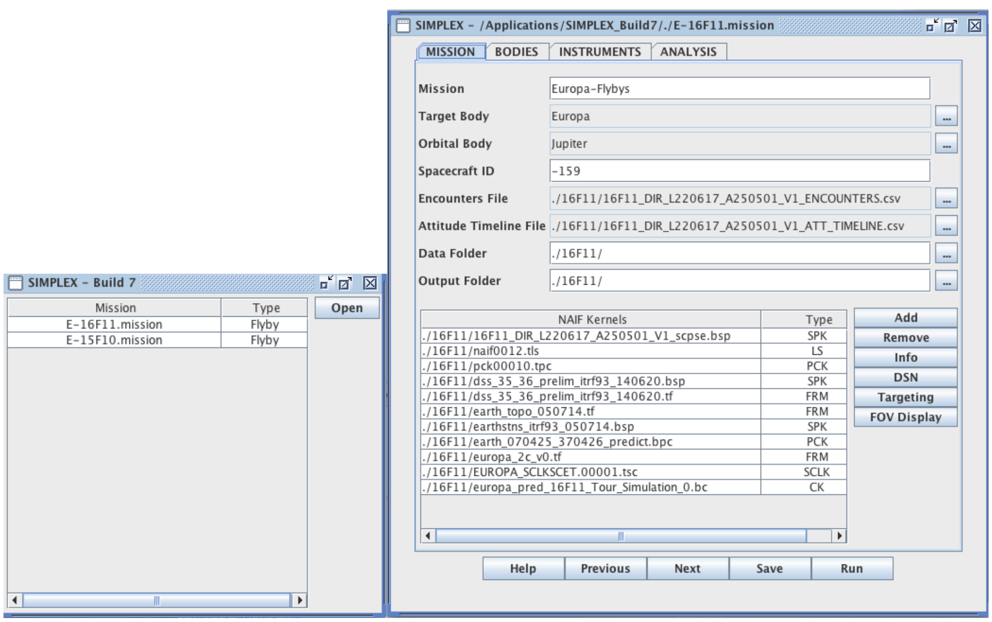

Figure 1. The Mission List GUI and the Mission page: select a predefined mission, create a new mission, and edit mission level parameters. The Mission page has general information about the mission: name, target body, orbital body, type of mission, file system location of input data, the target location of the simulator output, and a list of NAIF kernel files.

MISSION page

The mission page (right side of Figure 1) holds several key pieces of information:

- **Spacecraft ID field** (-650 for Europa Clipper, -159 for Europa Mission). In a future release of SIMPLEX you will be able to discover the spacecraft ID by selecting the spacecraft kernel file. Until then it is possible to run the program within the ***cspice*** library provided by NAIF (http://naif.jpl.nasa.gov).
- **Data Folder:** Enter the path for the appropriate input folder in this box. This is the folder containing the trajectory-specific input files (e.g., 15-10).
- **Output Folder:** Enter the location of your desired output folder in this box.

BODIES page

Once the kernels and spacecraft ID are configured correctly, it is possible to move on to the Bodies tab (Figure 2) and add a target body to the configuration. You will need to select a planetary body from the tree dialog, as in Figure 3, and provide an encounter radius and a global map image file. If the spacecraft never gets within the encounter radius of a target body then the software will notify you and a larger radius can be provided.

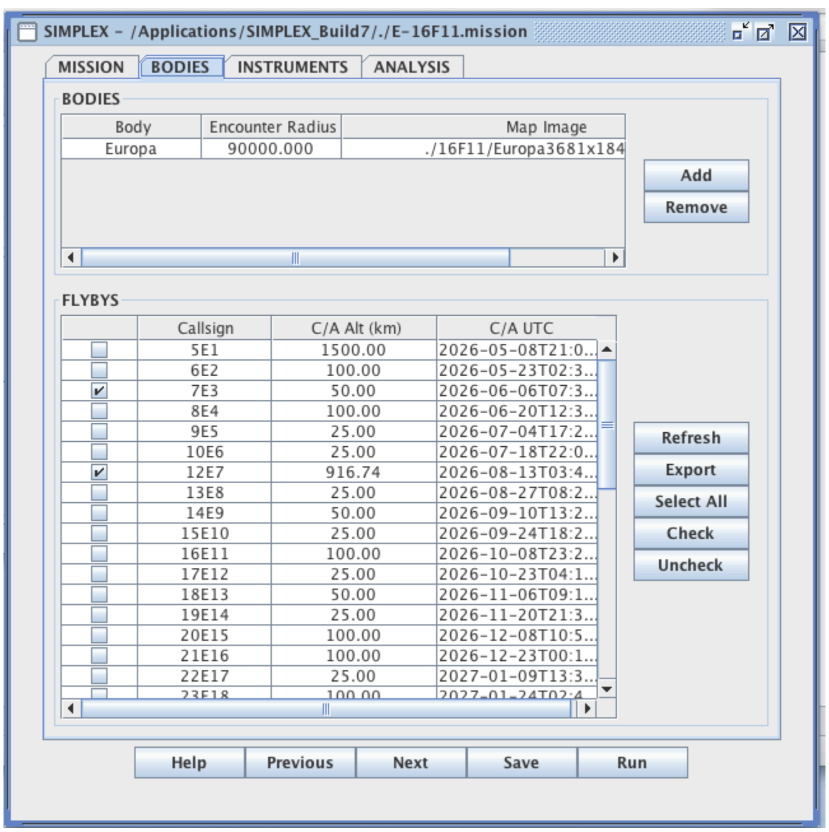

Figure 2. Bodies page is a listing of target body name, encounter radius, and a global map image file for the body.

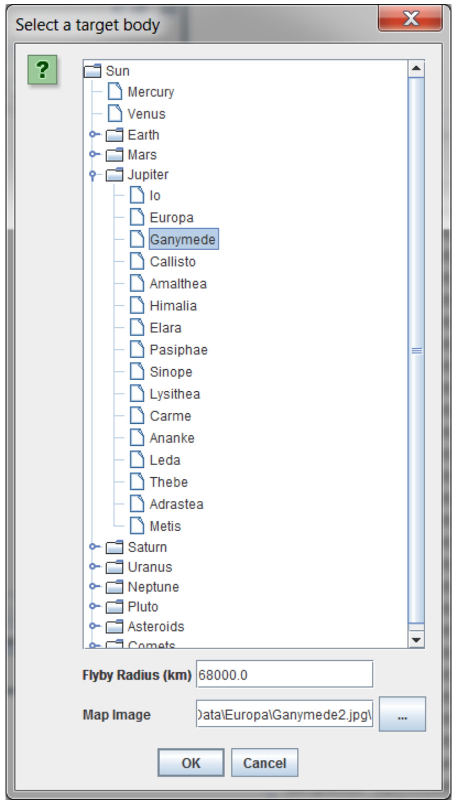

Figure 3. The target body selection tree opens when you select *Add* on the Bodies page.

INSTRUMENTS page

The following selected instruments are currently included in the Instruments page:

- EIS - Camera
- MISE – Spectrometer
- REASON - Radar
- EuropaUVS – Ultraviolet Spectrograph
- ETHEMIS – Thermal Imager
- PIMS – Plasma Cups
- MASPEX – Mass Spectrometer
- ICEMAG - Magnetometer
- SUDA – Dust Collector

You can select an instrument from the instruments list and click *Edit* to view or change several instrument parameters and add, edit, or remove observing modes. **Figure 4** shows the instrument page in action. For now the *Add* and *Remove* buttons are disabled.

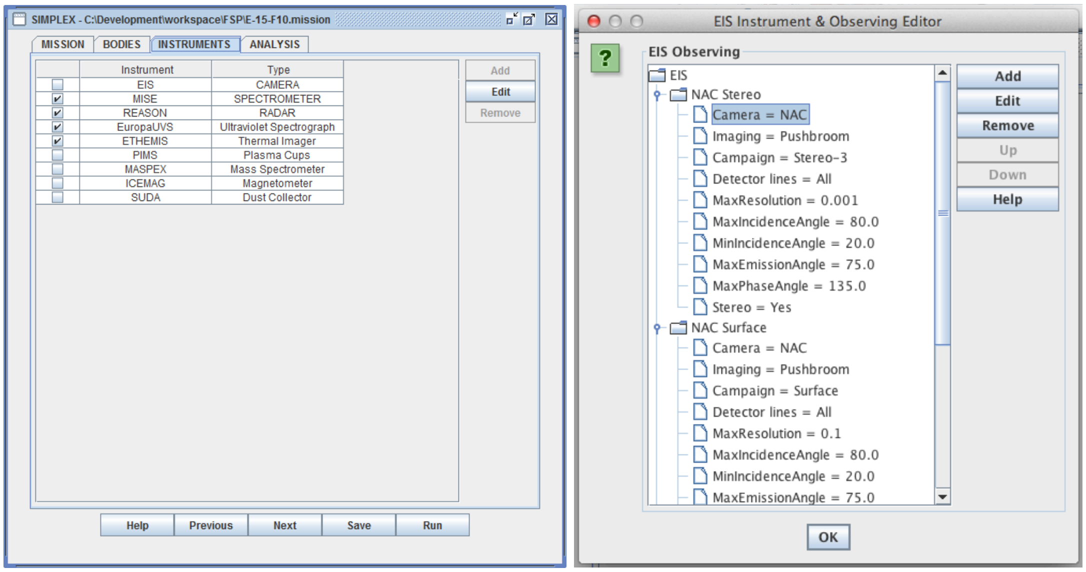

Figure 4. The Instruments page enables viewing of existing instrument parameters, editing of parameters, and definition of observing modes. Selecting the *EIS* entry at the top of the list and clicking *Edit* opens the screen on the right which shows the observing modes for EIS. Selecting the root node and clicking *Edit* launches the EIS camera editor (left) in figure 5. Selecting an observing mode (a branch) and clicking *Edit* launches the observation editor (right) in figure 5.

Note:

- **The edit dialogs for each instrument are slightly different and based on a limited understanding of the important parameters for each instrument. Some instrument's editors are more mature than others.**

The drop down boxes, text fields, and check boxes in the top part of the observation editor (right in figure 5) informs the SIMPLEX logic on how to simulate a particular observation. The fields (bottom portion of the same panel) tell the SIMPLEX logic which observations to keep and which to discard. If any portion of the observation passes the user defined filter parameters then the observation is kept.

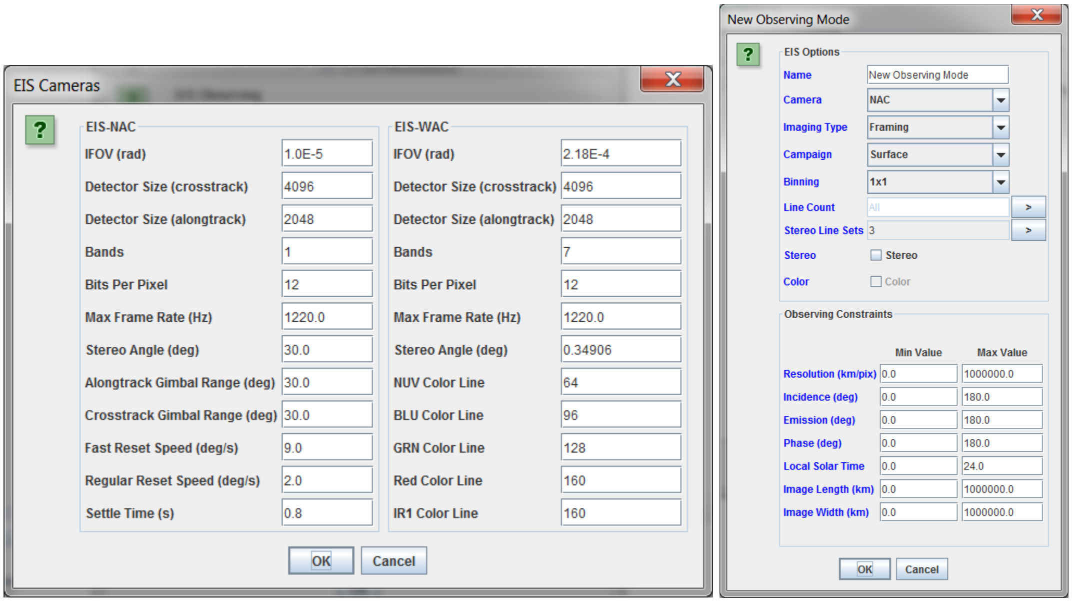

Figure 5. Instrument Settings editor for the Europa Imaging System (EIS). The above left panel is for editing camera parameters and the above right enables definition of observing modes.

ANALYSIS page

On the analysis page the user can add one of several types of analysis to any of the instruments. All the types of analysis are run together as a (multithreaded) job and represented on the progress window by the *Analysis* donut graph.

The Analysis Editor (shown on the right in figure 6) is used for adding or editing analyses. Every new analysis object is coupled with a name and an image filter. During the analysis process this user-defined filter determines which of the instrument's images are counted and which are rejected.

The analysis types currently implemented are:

- **Coverage**: a detailed accounting of area covered on each flyby, panel, and hemisphere.
- **Image Count**: an accounting of the images that pass thru the image filter.
- **Crossovers**: a ground track analysis detailing ground track crossovers.

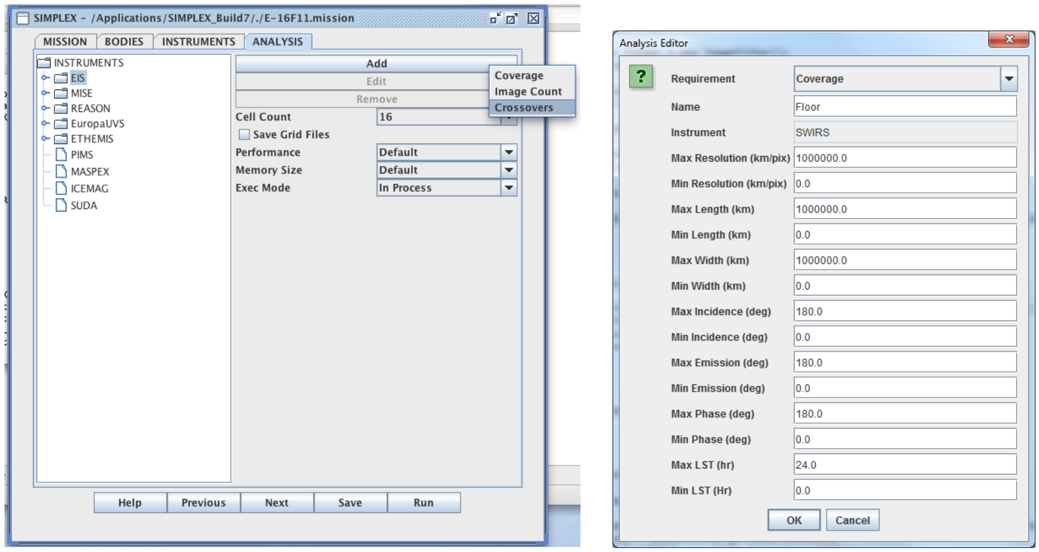

Figure 6. Analysis page and editor. When the user selects an instrument the *Add* button becomes active and a new analysis type can be added. To edit or delete an analyses use the *Edit* and *Remove* buttons after selecting one of the analyses under an instrument node on the tree. Clicking on the *Add* or *Edit* buttons brings up the *Analysis Editor* dialog (right).

Bottom row buttons

Help: Brings up the SIMPLEX help images. The help image series show screen shots with descriptive text and pointers for users. Clicking on the left hand side of each Help image takes the user back to the previous image in the series, while clicking on the right hand side of the image moves the screen to the next image in the series.

Previous: Go back to previous page

Next: Go to next page

Save: After making changes, hit the **Save** button at the bottom of the GUI. The .mission file is updated.

Run: Click this button to begin the simulation.

Select an output folder: The GUI depicted in Figure 7 will request an output folder and provide a suggested name for the run. The suggested name is the name of a folder that does not yet exist – so there is no chance of mixing the results from two runs (with potentially different parameters) together. If you are choosing to run multiple flybys within one simulation, Simplex will automatically create a folder for the output files of each flyby in the folder you choose. Files that summarize the entire simulation will be saved to the top level of this folder.

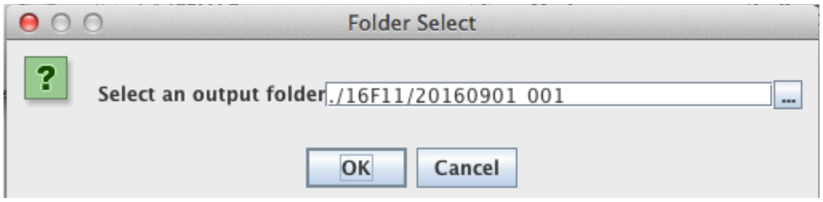

Figure 7. Select a file system directory to receive the output from the simulation. If the folder doesn't exist the user is prompted to create the folder.

Progress Meter: The progress meter (Figure 8) will display the status of the run. The steps are:

- **Flyby Simulation**: For each selected pass that was selected in the Flybys tab and for every instrument mode chosen, the Flyby Simulator runs through the instrument-specific pointing logic and determines what each instrument actually sees on the ground (the ground intercept points). Three .csv files are generated in this step:
  - **Pass files** – filename structure - (one file per instrument mode per flyby): spreadsheet containing a frame-by-frame accounting of the instrument operations for each instrument.
  - **Image file** – filename structure - (one file per instrument mode per flyby): spreadsheet containing one line per image, giving summary information like image center point, resolution, etc.
  - **Articulation file** – filename structure**:** only produced for instruments that have some kind of articulation (EIS & MISE).
  - **Simulation summary** – filename structure**:** a single file listing with columns identical to the image file listing (table 2) but including all the instruments and flybys for a simulation. This is a good source of information on science data volume for the entire mission.
- **Analysis**: Each analysis type (*Coverage*, *Image Count*, and *Crossovers*) generates products based on the analysis.
- **Maps**: Also uses the pass information from the flyby simulation to make maps. Currently no constraints are applied to these maps – every image simulated gets drawn on the appropriate maps in the color defined on the operations page.

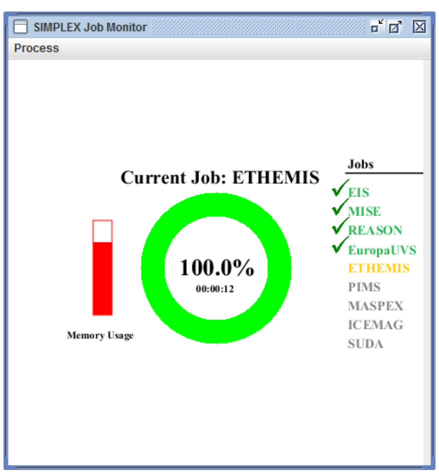

Figure 8. The progress window shows what percentage of the current job is complete. The job list on the right of the donut graph shows the jobs. Jobs listed with a green check are complete, the current job is listed in yellow, and jobs that haven't been started are listed in grey.

Products and Output Files:

SIMPLEX produces files describing virtually every activity the science instruments undertake during the flyby. The flyby callsign is used by many of the output files. The default callsign is simply the body name then a dash then the zero based flyby number (e.g. Europa-0). If the trajectory was delivered with an encounter file, or if the user makes an encounter file, the callsign is taken from the "ENC" column. The correct row in the encounters file is identified by matching the closest approach time of the flyby with the DCA and TCA columns (date closest approach and time closest approach, respectively).

The flyby simulator outputs are generated for every run of SIMPLEX regardless of the run options selected by the user.

At the end of each run SIMPLEX produces web pages to make for easy navigation through the data products. Figure 9 shows an example web page for a full run of all the instrument simulators.

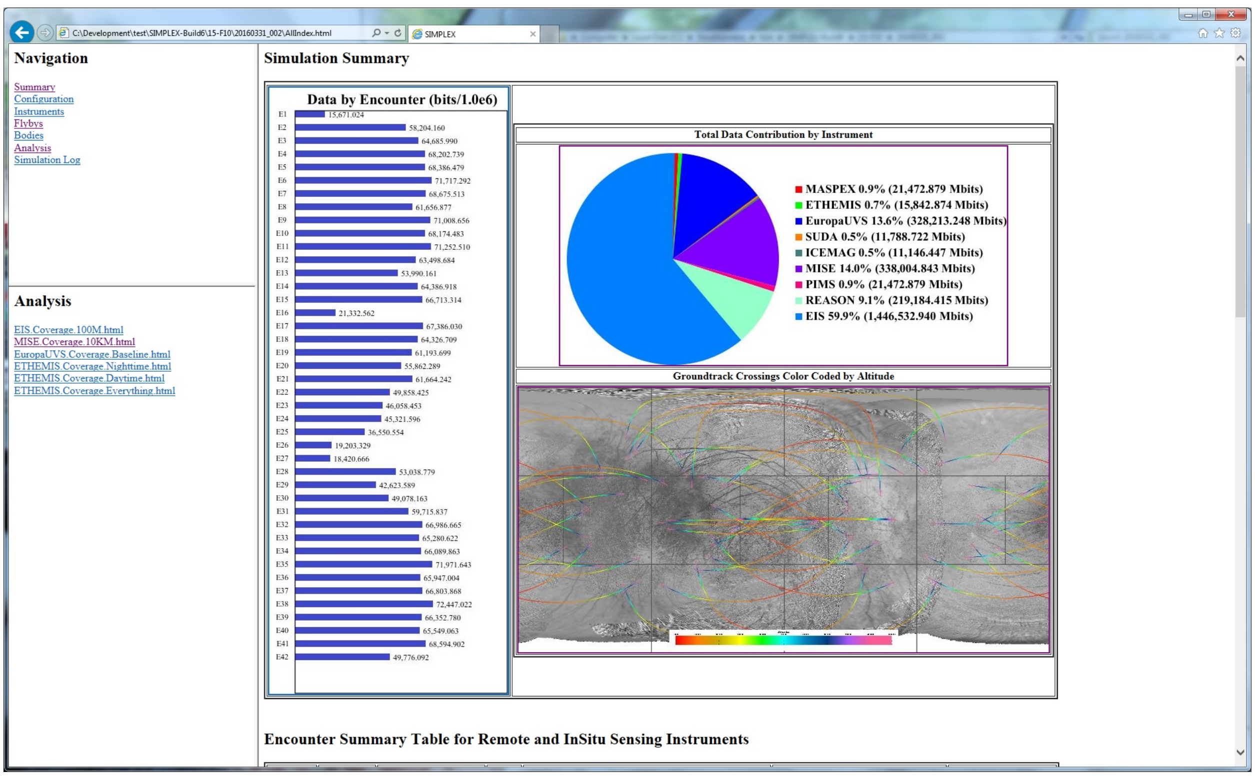

Figure 9. The summary web page for a full run of SIMPLEX.

A webpage is also produced for each instrument, each encounter, each body, each Analysis, and the configuration and log file. Comma separated value (csv) spreadsheets are also produced to the all the instruments. The logic for each imaging instrument produces a frames file in the format of Table 1, and an images file in the format of Table 2.

List 1 – A listing of all the output files.

Product	Description	Module/Option
Pass files (Table 1) <Filename structure>	One pass file is created for every checked instrument mode on every checked flyby. The contents are an exposure-by-exposure accounting of the activities of the instrument mode on a particular flyby.	Flyby Simulator
Image files (Table 2)	One image file is created for each checked instrument mode on each flyby. The image file contains a summary of the images taken on a flyby by an instrument mode.	Flyby Simulator
Simulation Summary (Table 2)	The summary file is a listing of all the images collected throughout the entire mission for all the instruments. It has the same format as the image files (item 2 in this list). The name of the summary file matches the mission file used to run the simulation, except the ending is .csv instead of .mission	Flyby Simulator
Coverage (Table 4)	Coverage analysis generates a web page showing a detailed breakdown of the area covered by flyby, panel, hemisphere for a single instrument such as MISE . File names are: <Instrument>.Coverage.<Analysis Name>.html	Analysis
Summary Page	A web page summarizing all the flybys	Web
Flyby Page	A web page summarizing all the activities on a single flyby	Web
Instrument Page	A web page summarizing all the activities of a single instrument	Web

Table 1. Pass files: <flyby encounter>.<instrument>.csv (e.g. E5.MISE.csv)

The simulator produces a frame by frame accounting for the instrument operations. The items in this table appear as columns in the simulator spreadsheet and one spreadsheet is produced for each instrument mode for each flyby.

	Field	Description	Type
1	Image	Each flyby starts with image number 0 and increments as images are added to a flyby	Integer
2	Frame	A frame is a single exposure of the detector. The frame number in this column starts from 0 on the	Integer
3	Ephemeris Time	The ephemeris start time of the frame	Number
4	UTC Time	The UTC start time of the frame	String
5	Viewing Angle (deg)	The pitch angle of the instrument at the start time of the frame	Number
6	Roll Angle (deg)	The roll angle of the spacecraft at the start time of the frame	Number

7	Altitude (km)	The altitude of the spacecraft at the start of the frame	Number
8	Intercept Lat (deg)	The latitude surface point intercepted by a ray emanating from the center pixel of the camera	Number
9	Intercept Lon (deg)	The longitude surface point intercepted by a ray emanating from the center pixel of the camera	Number
10	Cross Track Spacing (km)	The width of an IFOV projected onto the surface at the boresight of the camera at the start of the frame	Number
11	Along Track Spacing (km)	Along track distance in kilometer from between the boresight surface pixel intercept and the last frame's boresight surface pixel intercept	Number
12	Solar Incidence Angle (deg)	The solar incidence angle at the surface intercept point for the boresight pixel	Number
13	Emission Angle (deg)	The solar emission angle at the surface intercept point for the boresight pixel	Number
14	Local Solar Time	The local solar time at the surface intercept point for the boresight pixel	Time
15	Spacecraft-X (km)	X-component of the spacecraft location in IAU body coordinate system at the start of the frame	Number
16	Spacecraft-Y (km)	Y-component of the spacecraft location in IAU body coordinate system at the start of the frame	Number
17	Spacecraft-Z (km)	Z-component of the spacecraft location in IAU body coordinate system at the start of the frame	Number
18	Velocity-X (km/s)	X-component of the spacecraft velocity vector in IAU body coordinate system at the start of the frame	Number
19	Velocity-Y (km/s)	Y-component of the spacecraft velocity vector in IAU body coordinate system at the start of the frame	Number
20	Velocity-Z (km/s)	Z-component of the spacecraft velocity vector in IAU body coordinate system at the start of the frame	Number
21	Sun-X (km)	X-component of the Sun location in IAU body coordinate system at the start of the frame	Number
22	Sun-Y (km)	Y-component of the Sun location in IAU body coordinate system at the start of the frame	Number
23	Sun-Z (km)	Z-component of the Sun location in IAU body coordinate system at the start of the frame	Number
24	Sub-Solar Lat. (deg)	Latitude of the surface point closest to the Sun	Number
25	Sub-Solar Lon. (deg)	Longitude of the surface point closest to the Sun	Number
26	Frame Score	A weighted priority score for the entire frame.	Number
27	SC X axis-X	The X-component of a vector representing the X-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number

28	SC X axis-Y	The Y-component of a vector representing the X-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
29	SC X axis-Z	The Z-component of a vector representing the X-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
30	SC Y axis-X	The X-component of a vector representing the Y-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
31	SC Y axis-Y	The Y-component of a vector representing the Y-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
32	SC Y axis-Z	The Z-component of a vector representing the Y-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
33	SC Z axis-X	The X-component of a vector representing the Z-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
34	SC Z axis-Y	The Y-component of a vector representing the Z-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number
35	SC Z axis-Z	The Z-component of a vector representing the Z-axis of the spacecraft at the start time of the frame in the IAU body coordinate system	Number

Table 2. Image file: <flyby callsign>.<instrument mode>Images.csv (e.g. E5.MISEImages.csv)

The image summary table is a spreadsheet with columns matching what is shown in this table that lists a single row for each image created for each instrument mode on each flyby.

	Field	Description	Type
1	Flyby	Flyby callsign constructed as: <body name>-<0 based flyby number> (e.g. Europa-5)	String
2	ET	Ephemeris time for the center frame of the image	Number
3	Start Time (UTC-cal)	UTC time for the center frame of the image in day of year format	Time
4	Center Time (UTC-cal)	UTC time for the center frame of the image in calendar format	Time
5	Stop Time (UTC-cal)		
6	Duration (sec)	The duration in seconds of the image collection	Number
7	Instrument	Name and mode of the instrument	String
8	Solar Incidence Angle (deg)	The solar incidence angle of the boresight pixel in the center frame of the image at the time of	Number

		collection	
9	Solar Phase Angle (deg)	The solar phase angle of the boresight pixel in the center of the image	Number
10	Emission Angle (deg)	The emission angle at the center pixel of the image	Number
11	Local Solar Time (hh:mm)	The local solar time of the center pixel of the image	Number
12	Altitude (km)	Altitude of the spacecraft at the instant the center frame is collected	Number
13	Center Latitude (deg)	Latitude of the boresight pixel in the center frame of the image	Number
14	Center Longitude (deg)	East longitude of the boresight pixel in the center frame of the image	Number
15	S/C Radius (km)	Distance from the center of the body to the spacecraft	Number
16	Image Length (km)	Length of the image in the along track direction	Number
17	Image Width (km)	Width of the image in the cross track sense	Number
18	Image Number	Image number, each instrument's flyby starts with image number 0	Number
19	Frame Count	Count of the number of frames in the image	Number
20	Frame Rate (frames per sec)	The number of frames that is taken each second	Number
21	Uncompressed Data (Mbits)	The data collected for this image. The value is: (Frame Count) x (Samples) x (Lines) x (Bits Per Pixel) x (Band Count) / 1024^2	Number
22	Lines	The number of lines in the image	Number
23	Samples	The number of samples in each frame	Number
24	Bands	The number of bands in the image	Number
25	Crosstrack Pixel Spacing (km)	The pixel to pixel spacing at the center of the image	Number
26	Area (km^2)	The area covered by this image	Number

Table 3. Coverage file: <Instrument>Coverage.<Analysis Name>.csv (e.g. MISE.Coverage.Baseline.html)

The coverage table lists the coverage of an instrument by flyby. At the bottom of the table the totals by panel, hemisphere, and globally are tallied. Above the table the image filter parameters are listed.

	Field	Description	Type
1	Flyby	Flyby callsign constructed as: <body name>-<0 based flyby number> (e.g. Europa-5)	String

2	Altitude	Altitude in km at closest approach	Number
3	Panel 1	The area in sq. km covered in this panel by this flyby	Number
4	Panel 2	The area in sq. km covered in this panel by this flyby	Number
5	Panel 3	The area in sq. km covered in this panel by this flyby	Number
6	Panel 4	The area in sq. km covered in this panel by this flyby	Number
7	Panel 5	The area in sq. km covered in this panel by this flyby	Number
8	Panel 6	The area in sq. km covered in this panel by this flyby	Number
9	Panel 7	The area in sq. km covered in this panel by this flyby	Number
10	Panel 8	The area in sq. km covered in this panel by this flyby	Number
11	Panel 9	The area in sq. km covered in this panel by this flyby	Number
12	Panel 10	The area in sq. km covered in this panel by this flyby	Number
13	Panel 11	The area in sq. km covered in this panel by this flyby	Number
14	Panel 12	The area in sq. km covered in this panel by this flyby	Number
15	Panel 13	The area in sq. km covered in this panel by this flyby	Number
16	Panel 14	The area in sq. km covered in this panel by this flyby	Number
17	Sub-Jovian	The area in sq. km covered in this hemisphere by on this flyby	Number
18	Anti-Jovian	The area in sq. km covered in this hemisphere by on this flyby	Number
19	Leading Hemisphere	The area in sq. km covered in this hemisphere by on this flyby	Number
20	Trailing Hemisphere	The area in sq. km covered in this hemisphere by on this flyby	Number
21	Northern Hemisphere	The area in sq. km covered in this hemisphere by on this flyby	Number
22	Southern Hemisphere	The area in sq. km covered in this hemisphere by on this flyby	Number
23	Flyby Area	Total surface area covered on this flyby	Number
24	Flyby Coverage	Total percentage of surface area covered on this flyby	Number
25	New Area	Total surface area covered on this flyby that is new (covered for the first time)	Number
26	Total Coverage	The total surface area covered by this and all previous flybys	Number

27	Flyby Panels	The number of panels with some coverage by this flyby	Number
28	Total Panels	The total number of panels with coverage by this and all previous flybys	Number

Table 4. Outline file: <flyby encounter>.<Instrument Name>.Image<image number>.Outline.csv (e.g. Europa-6.MISE.Image2.Outline.csv)

The outline table lists the fields in the outline spreadsheets. There will be 1 outline spreadsheet for each image.

	Field	Description	Type
1	Latitude	Latitude in degrees of this vertex	Number
2	Longitude	Longitude in degrees of this vertex	Number