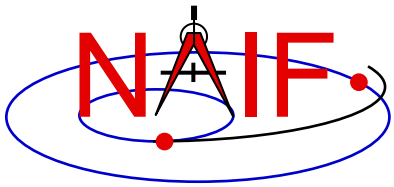


Navigation and Ancillary Information Facility

WebGeocalc (WGC)

<http://wgc.jpl.nasa.gov:8080/webgeocalc>

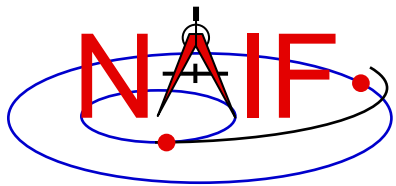
January 2017



Overview

Navigation and Ancillary Information Facility

- **WebGeocalc (WGC) provides a graphical user interface (GUI) to a SPICE server running a geometry computation engine**
 - Using WGC is easier than having to write your own program that incorporates some SPICE Toolkit software
 - But WGC computations are limited in scope: the tool cannot do near as much as an own-built program that uses SPICE Toolkit APIs
- **WGC is useful in making space geometry computations using SPICE ancillary data**
 - See the next page for a graphic depicting “ancillary data”
 - For a description of SPICE, look here:
<http://naif.jpl.nasa.gov/naif/aboutspice.html>



What are Ancillary Data?

Navigation and Ancillary Information Facility

and
size/shape
of Earth

J2000 reference frame
(EME 2000)

Sun

Solar System Barycenter

Earth

Spacecraft

Antenna
reference
frame

Instrument
reference frame

Relative positions
of spacecraft and
solar system bodies

and
size/shape
of planet

Planet

Pointing of
Instrument
field-of-view

Reference frames

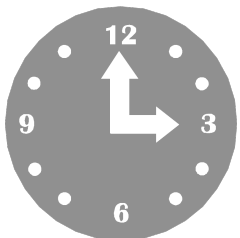
Positions

Orientations

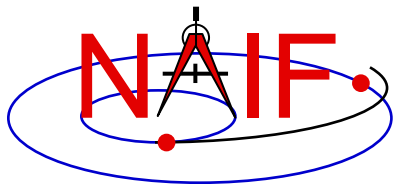
Sizes/shapes

Instrument Pointing

Time Conversions



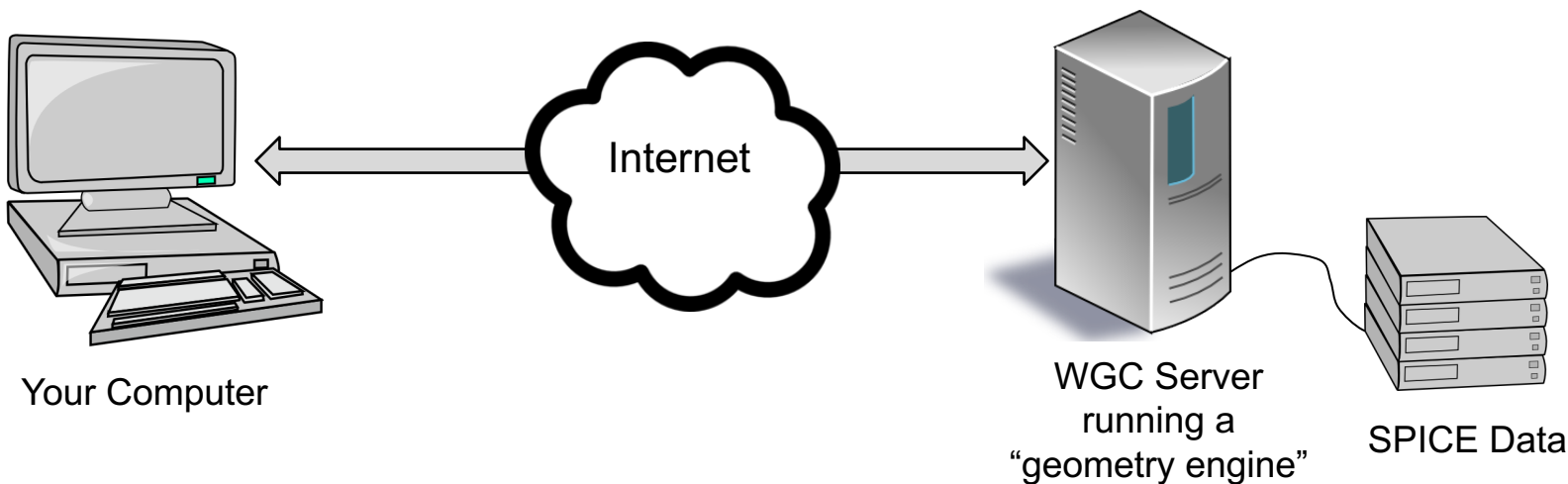
Time Conversion
Calculations

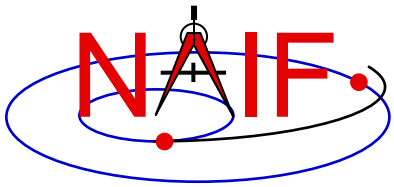


Architecture

Navigation and Ancillary Information Facility

- **WGC uses a client-server architecture**
 - The user only needs a computer running a web browser
 - The browser connects via Internet to a WGC “computation engine” running on a server
 - » The WGC server has access to a variety of SPICE kernel files

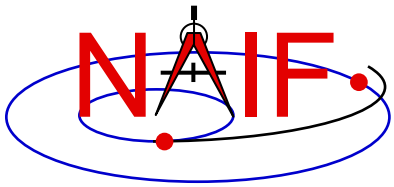




Using WebGeocalc

Navigation and Ancillary Information Facility

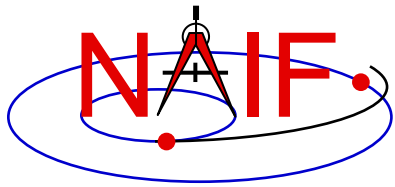
- **WGC makes it “easy” to do many kinds of SPICE computations**
 - You need not write a program using SPICE Toolkit software
 - Instead, open a web browser and use standard GUI widgets to:
 - » read a variety of HELP statements (if just learning to use WGC)
 - » select the computation desired
 - » select the data to be used in your computation
 - » specify the computation details
 - » press the “CALCULATE” button
 - Your results, possibly including some plots, appear in your browser window
- **There are a number of conditions under which WGC will not be able to fulfill your request**
 - See the Limitations and Errors pages at the end of this tutorial for some examples



Purpose

Navigation and Ancillary Information Facility

- **WGC can support planetary science in several ways**
 - Help a user check his/her own SPICE-based program under development
 - Help a user check the validity of a SPICE data file (a “kernel”)
 - Help a user quickly solve a one-time space geometry problem
 - Allow those unable to write a SPICE-based program to nevertheless make some kinds of space geometry computations
 - Help a science data peer reviewer do spot checks of geometry parameters contained in an archive about to be submitted to an archive center



Computations

Navigation and Ancillary Information Facility

- **Three categories of SPICE computations are possible**

1. Geometry Calculator

- » **Compute a parameter value at a given time, or over a time range**

- Example: Compute the angular size of Phobos as seen from the SPIRIT Mars rover from 2009 March 10 12:00:00 to 2009 March 10 14:00:00

2. Geometric Event Finder

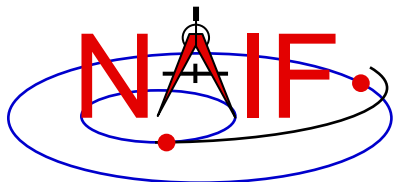
- » **Within a specified time bounds (the confinement window)...**

- Find time intervals when a particular geometric condition exists
 - Example: Find time intervals when Phobos is occulted by Mars as seen from Mars Odyssey within the period 2010 June 01 to 2010 June 02
- Find time intervals when a parameter is within a given range
 - Example: Find time intervals when the spacecraft altitude is between 300 and 400 km
- Find time intervals when a parameter has reached a local or global maximum or minimum
 - Example: Find time intervals when the angular separation of a satellite from a planet, as seen from a spacecraft, has reached its minimum value

3. Time conversion calculator

- » **Convert between various time systems and time formats**

- **See the WGC “menu” on the next page for some details**



Computation Menu*

Navigation and Ancillary Information Facility

Geometry Calculator

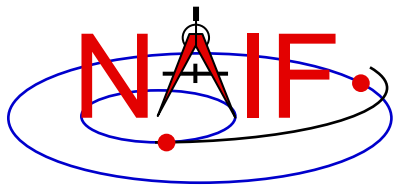
State Vector	Position and velocity of target relative to observer.
Angular Separation	Angle between 2 targets as seen from an observer.
Angular Size	Apparent size of a target as seen from an observer, as an angle.
Frame Transformation	Transformation between 2 reference frames.
Illumination Angles	Sunlight incidence, emission, and phase angles at a point on a target body as seen from an observer.
Sub-solar Point	Sub-solar point on a target body as seen from an observer.
Sub-observer Point	Closest point on a target body to an observer.
Surface Intercept Point	Coordinates of the intercept point of a ray in a reference frame, as seen from an observer.
Orbital Elements	Orbital parameters of a target body relative to a central observing body.

Geometric Event Finder

Position Finder	Find time intervals when target coordinate satisfies a condition.
Angular Separation Finder	Find time intervals when the angle between 2 bodies, as seen by an observer, satisfies a condition.
Distance Finder	Find time intervals when the distance between a target and observer satisfies a condition.
Sub-Point Finder	Find time intervals when the sub-observer point on a target satisfies a condition.
Occultation Finder	Find time intervals when a target is occulted by, or is in transit across, another body.
Surface Intercept Finder	Find time intervals when the surface intercept of a ray in a reference frame satisfies a coordinate condition.
Target in Field of View	Find time intervals when a target is within the field of view of an instrument.
Ray in Field of View	Find time intervals when a specified ray is within the field of view of an instrument.

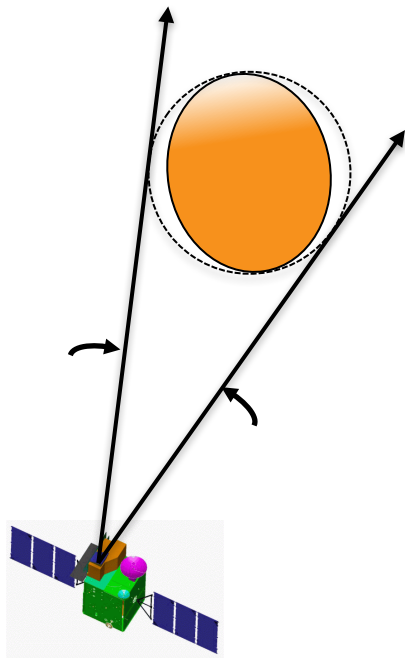
Time Calculator

Time Conversion	Convert time values from one time system to another.
---------------------------------	--

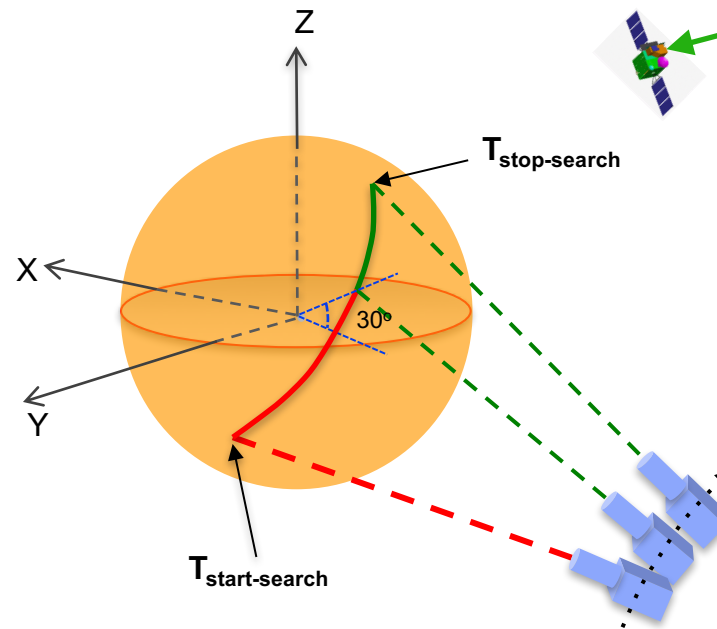


Illustrations of Three Available Computations

Navigation and Ancillary Information Facility

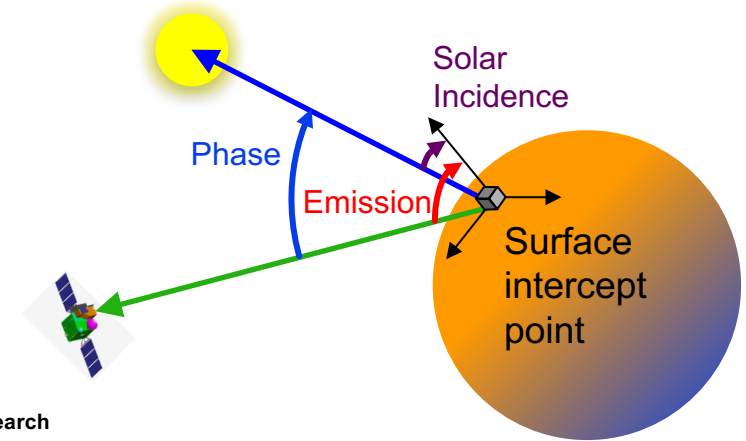


Angular Size



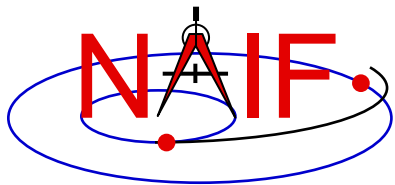
The **GREEN** trace shows when the latitude of the instrument boresight surface intercept is greater than 30 degrees, within the time range $T_{\text{start-search}}$ to $T_{\text{stop-search}}$.

Surface Intercept Event Finder



Illumination Angles

Camera scanning across the planet's surface



Typical Geometry Calculator Input

Navigation and Ancillary Information Facility

Angular Size

Calculate the angular size of a target as seen from an observer. ?

Kernel selection: MER2 Rover (Spirit) ?

Target: PHOBOS ?

Observer: SPIRIT ?

Aberration Correction

Light propagation: ☒ None ☐ To observer ☐ From observer ?

Light-time algorithm: Converged Newtonian ?

Stellar aberration: ☒ Include stellar aberration correction ?

Input Time

Time system: UTC ?

Time format: Calendar date and time ?

Input times: ☐ Single time ☒ Single interval ☐ List of times ☐ List of intervals

Start time: 2009 MAR 10 12:00:00 ?

Stop time: 2009 MAR 10 14:00:00 ?

Time step: 1 minutes ?

Plots

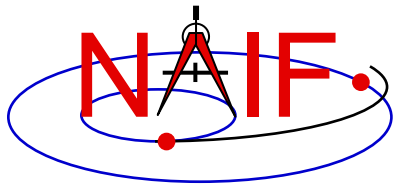
Time series plots: ☒ Angular Size ?

X-Y plots: X: Angular Size vs. Y: Angular Size Add Plot

Error handling: Stop on error ?

Calculate

- Compute the angular size of Phobos as seen from the Mars rover “SPIRIT” over a two hour period on 2009 March 10
- Use typical GUI drop-down menus, fill-in boxes, radio buttons and check boxes to specify the details of the computation you wish to make



Typical Geometry Calculator Output

Navigation and Ancillary Information Facility

Input Values

Calculation type	Angular Size
Target	PHOBOS
Observer	SPIRIT
Light propagation	No correction
Time system	UTC
Time format	Calendar date and time
Time range	2009 MAR 10 12:00:00 to 2009 MAR 10 14:00:00, step 1 minutes

Summary of your input

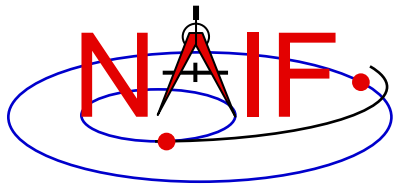
*Angular size of
Phobos as seen
from the Mars
rover "SPIRIT"*

Tabular Results

Click a value to save it for a subsequent calculation.

	UTC calendar date	Angular Size (deg)
1	2009-03-10 12:00:00.000000 UTC	0.20212256
2	2009-03-10 12:01:00.000000 UTC	0.20294481
3	2009-03-10 12:02:00.000000 UTC	0.20377024
4	2009-03-10 12:03:00.000000 UTC	0.20459871
5	2009-03-10 12:04:00.000000 UTC	0.20543007
6	2009-03-10 12:05:00.000000 UTC	0.20626418
7	2009-03-10 12:06:00.000000 UTC	0.20710088
8	2009-03-10 12:07:00.000000 UTC	0.20794000
9	2009-03-10 12:08:00.000000 UTC	0.20878138
10	2009-03-10 12:09:00.000000 UTC	0.20962484
11	2009-03-10 12:10:00.000000 UTC	0.21047019
12	2009-03-10 12:11:00.000000 UTC	0.21131725
13	2009-03-10 12:12:00.000000 UTC	0.21216581
14	2009-03-10 12:13:00.000000 UTC	0.21301567

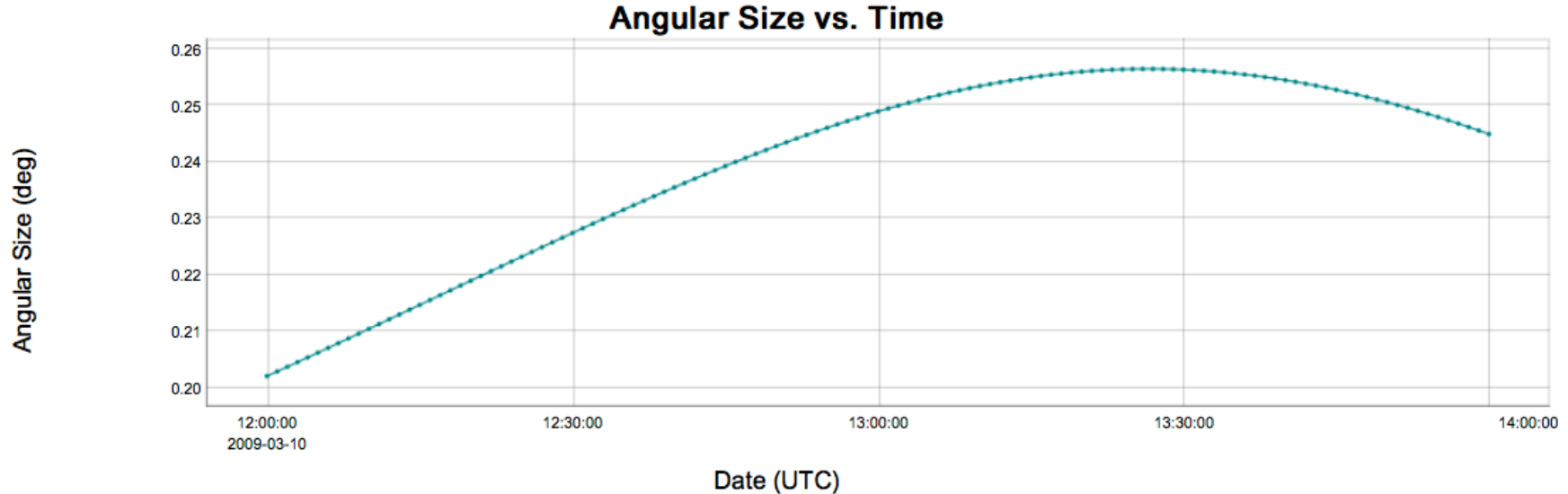
Tabular results



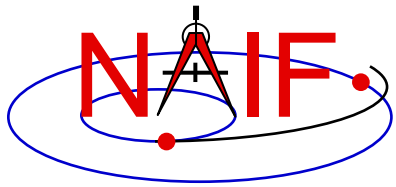
Typical Geometry Calculator Plot

Navigation and Ancillary Information Facility

- **Some Geometry Calculator computations offer optional plots**



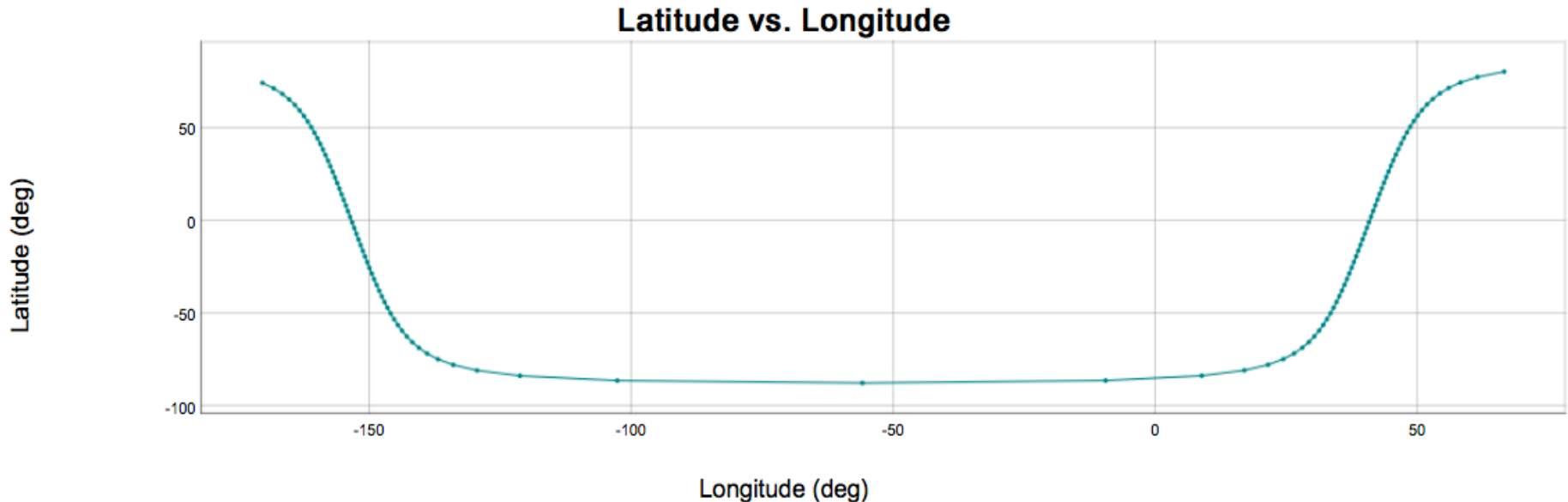
Angular size of Phobos as seen from the Mars rover “SPIRIT”



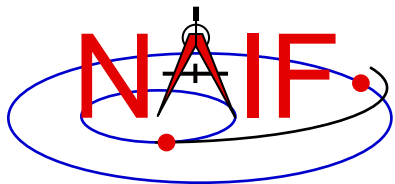
Another Geometry Calculator Plot

Navigation and Ancillary Information Facility

- **Some Geometry Calculator computations offer plots using other than time on the X axis**



***Mars Global Surveyor sub-point on Mars
from 2008 JAN 1 00:10:00 to 2008 JAN 1 02:00:00***



Typical Geometric Event Finder Input

Navigation and Ancillary Information Facility

Occultation Event Finder

Find time intervals when an observer sees one target occulted by, or in transit across, another. [?](#)

Kernel selection: Mars Odyssey [?](#)

Occultation type: ☒ Any ☐ Full ☐ Annular ☐ Partial [?](#)

Front body: MARS [?](#)

Front body shape: ☐ Point ☒ Ellipsoid [?](#)

Front body frame: IAU_MARS [?](#)

Back body: PHOBOS [?](#)

Back body shape: ☐ Point ☒ Ellipsoid [?](#)

Back body frame: IAU_PHOBOS [?](#)

Observer: MARS ODYSSEY [?](#)

Aberration Correction

Light propagation: ☒ None ☐ To observer ☐ From observer [?](#)

Light-time algorithm: Converged Newtonian [?](#)

Input Time

Time system: UTC [?](#)

Time format: Calendar date and time [?](#)

Input times: ☒ Single interval ☐ List of intervals

Start time: 2010 JUN 01 [?](#)

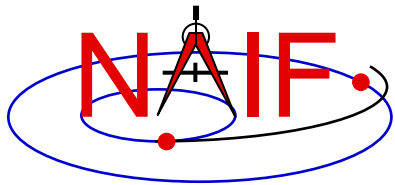
Stop time: 2010 JUN 02 [?](#)

Time step: 1 minutes [?](#)

Output time units: ☐ seconds ☒ minutes ☐ hours ☐ days [?](#)

Calculate

- Find the times when Phobos is occulted by Mars as viewed from the Mars Odyssey spacecraft, during the period 2010 JUN 01 to 2010 JUN 02
- Use typical GUI drop-down menus, fill-in boxes, radio buttons and check boxes to specify the details of the computation you wish to make



Typical Geometric Event Finder Output

Navigation and Ancillary Information Facility

Input Values

Calculation type	Occultation Event Finder
Occultation type	Any
Front body	MARS
Front body shape	Ellipsoid
Front body frame	IAU_MARS
Back body	PHOBOS
Back body shape	Ellipsoid
Back body frame	IAU_PHOBOS
Observer	MARS ODYSSEY
Light propagation	No correction
Time system	UTC
Time format	Calendar date and time
Time range	2010 JUN 01 to 2010 JUN 02, step 1 minutes
Output time units	minutes

Summary of your input

When is Phobos occulted by Mars as seen from Mars Odyssey?

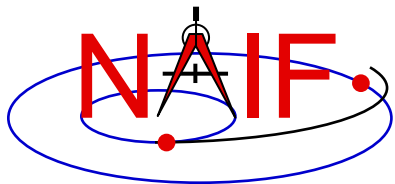
Tabular Results

Click a value to save it for a subsequent calculation.

Save All Intervals

	Start Time	Stop Time	Duration (mins)
1	2010-06-01 00:04:26.021732 UTC	2010-06-01 00:51:10.264641 UTC	46.737381
2	2010-06-01 01:24:29.613301 UTC	2010-06-01 02:00:24.470706 UTC	35.914290
3	2010-06-01 03:03:10.407364 UTC	2010-06-01 03:57:18.126849 UTC	54.128658
4	2010-06-01 06:01:49.736199 UTC	2010-06-01 06:55:34.722424 UTC	53.749770
5	2010-06-01 07:58:43.095947 UTC	2010-06-01 08:39:21.182114 UTC	40.634769
6	2010-06-01 09:10:48.846727 UTC	2010-06-01 09:54:44.492005 UTC	43.927421
7	2010-06-01 10:57:18.630420 UTC	2010-06-01 11:50:49.343214 UTC	53.511879
8	2010-06-01 13:55:36.186600 UTC	2010-06-01 14:49:37.827064 UTC	54.027341
9	2010-06-01 15:53:04.642891 UTC	2010-06-01 16:24:27.068718 UTC	31.373763
10	2010-06-01 17:00:06.149085 UTC	2010-06-01 17:48:55.474342 UTC	48.822087
11	2010-06-01 18:51:22.462322 UTC	2010-06-01 19:43:35.637833 UTC	52.219591
12	2010-06-01 20:25:04.806659 UTC	2010-06-01 20:44:18.076413 UTC	19.221162
13	2010-06-01 21:49:30.099608 UTC	2010-06-01 22:43:34.010176 UTC	54.065176

Tabular results



Typical Geometric Event Finder Plot

Navigation and Ancillary Information Facility

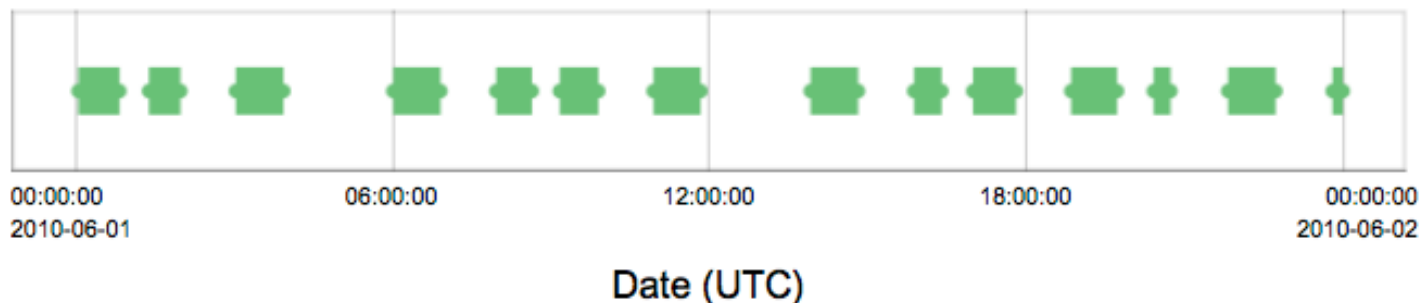
- **Geometric Event Finder computations all produce “plots” of the time intervals that satisfy your search computations**

Click and drag to zoom, shift-click and drag to pan. Double-click or use button to reset zoom level.

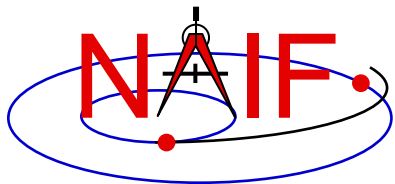
Download Plot

Reset Zoom

Occultation Finder Time Interval Plot



Between June 1, 2010 and June 2, 2010, find times when Phobos is occulted by Mars, as viewed from the Mars Odyssey spacecraft



First Example of Time Conversion

Navigation and Ancillary Information Facility

Time Conversion

Convert times from one time system or format to another. ?▶

Kernel selection:

Cassini Huygens

Input Time

Time system:

UTC

Time format:

Calendar date and time

Input times:

☒ Single time

☐ Single interval

☐ List of times

☐ List of intervals

Time:

2011 MAR 10

Output Time

Time system:

UTC

Time format:

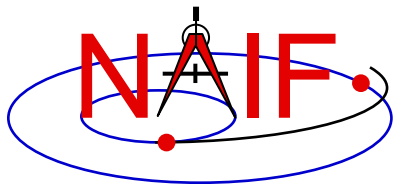
Julian date

Custom format:

UTC
TDB
TDT
Spacecraft clock

Calendar (year/month/day)
Calendar (year/day-of-year)
Julian date
Seconds past J2000

The output is:
2455630.500000000 JD UTC



Second Example of Time Conversion

Navigation and Ancillary Information Facility

Time Conversion

Convert times from one time system or format to another. ? ▶

Kernel selection: Mars Reconnaissance Orbiter ? ▶

Input Time

Time system: UTC ? ▶

Time format: Calendar date and time ? ▶

Input times: ☐ Single time ☒ Single interval ☐ List of times ☐ List of intervals

Start time: 2011 MAR 10 ? ▶

Stop time: 2011 MAR 11 ? ▶

Time step: 20 minutes ? ▶

UTC
TDB
TDT
Spacecraft clock

Calendar (year/month/day)
Calendar (year/day-of-year)
Julian date
Seconds past J2000

Output Time

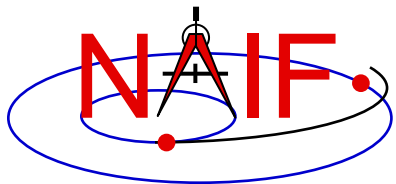
Time system: UTC ? ▶

Time format: Julian date ? ▶

Custom format: ? ▶

The output is:

2011-03-10 00:00:00.000000 UTC	2455630.500000000 JD UTC
2011-03-10 00:20:00.000000 UTC	2455630.513888900 JD UTC
2011-03-10 00:40:00.000000 UTC	2455630.527777800 JD UTC
2011-03-10 01:00:00.000000 UTC	2455630.541666700 JD UTC
etc.	etc.



Third Example of Time Conversion

Navigation and Ancillary Information Facility

Time Conversion

Convert times from one time system or format to another. ?▶

Kernel selection:

Lunar Reconnaissance Orbiter ?▶

Input Time

Time system:

Spacecraft clock ?▶

Spacecraft clock ID: -85 ?▶

Time format:

Spacecraft clock string ?▶

Input times:

☒ Single time ☐ Single interval ☐ List of times ☐ List of intervals

Time:

1/0330220800.000 ?▶

Spacecraft clock string
Spacecraft clock ticks

Calendar (year/month/day)
Calendar (year/day-of-year)
Julian date
Seconds past J2000
Custom format

Output Time

Time system:

UTC ?▶

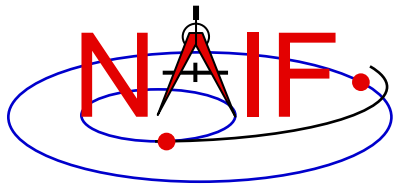
Time format:

Calendar (year-month-day) ?▶

Custom format:

The output is:

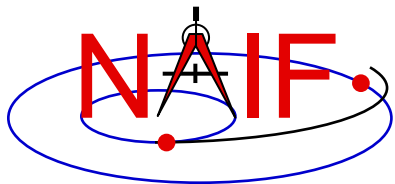
2011-06-20 00:00:00.044032 UTC



Categories of Available Data

Navigation and Ancillary Information Facility

- **The JPL/NAIF Group is operating a WGC server**
 - This server provides access to three categories of SPICE data (kernels)
 - » **Generic** SPICE data, not specifically tied to a single planetary mission
 - » **Archived** SPICE data, from planetary missions that have been formally ingested into NASA's Planetary Data System
 - This includes a few non-NASA missions for which NAIF provides a shadow archive
 - » **Operations** SPICE data, for JPL-operated planetary missions, for three ESA planetary missions, and for a few past missions for which an archive does not exist
 - This category often includes some predictive data
 - This category is the most difficult to use because...
 - there are no meta-kernels for these collections
 - there is sometimes a large number of kernels from which you must choose the ones needed
 - there is little readily available information to help you make your kernel choices
 - **VERY IMPORTANT:** Read the “**About the data**” webpage provided within the tool for details



Kernel Selection

Navigation and Ancillary Information Facility

Angular Size

Calculate the angular size of a target as seen from an observer. ? ▶

Kernel selection: ? ▶

Target:

Observer:

Aberration Correction

Light propagation:

Light-time algorithm:

Stellar aberration:

Input Time

Time system:

Time format:

Input times:

Start time:

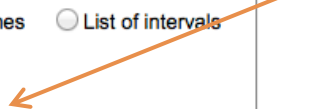
Stop time:

Time step:

Solar System Kernels
Latest Leapseconds Kernel
Latest Planetary Constants Kernel
Ground Stations Kernels

Cassini Huygens
Clementine
Dawn
Deep Impact (Primary mission)
Deep Impact (EPOXI mission)
Deep Space 1
GRAIL
Hayabusa
Lunar Reconnaissance Orbiter
MER1 Rover (Opportunity)
MER2 Rover (Spirit)
MESSENGER
Mars Express
Mars Global Surveyor
Mars Odyssey

Manual



A scrollable drop-down menu is used to select the kernel set(s) to be used in your calculation.

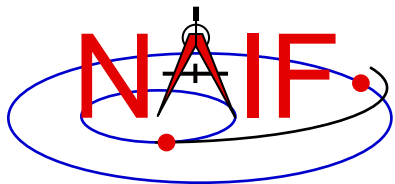
Use the menu to select:

- **generic kernel sets**
- **archived mission kernel sets (includes relevant generic kernels)**
- **manual selection of individual kernels from operations collections**

Plots: ☒ Angular Size ? ▶

Error handling: Stop on error ? ▶

Calculate



“Tooltip” Feature

Navigation and Ancillary Information Facility

Angular Size

Calculate the angular size of a target as seen from an observer. ? ▶

Kernel selection:

MER2 Rover (Spirit) ? ▶

Target:

Observer:

Aberration Correction

Light propagation:

Light-time algorithm:

Stellar aberration:

Input Time

Time system:

Time format:

Input times:

Start time:

2009 MAR 10 12:00:00 ? ▶

Stop time:

2009 MAR 10 14:00:00 ? ▶

Time step:

1

minutes ? ▶

Solar System Kernels
Latest Leapseconds Kernel
Latest Planetary Constants Kernel
Ground Stations Kernels
Cassini Huygens
Clementine
Dawn
Deep Impact (Primary mission)
Deep Impact (EPOXI mission)
Deep Space 1
GRAIL
Hayabusa
Lunar Reconnaissance Orbiter
MER1 Rover (Opportunity)
MER2 Rover (Spirit)
MESSENGER
Mars Express
Mars Global Surveyor
Mars Odyssey

If you hover your **cursor** over a kernel set name, some information about the kernel set will appear—for example, dates covered by the data.

Archived MER2 kernels covering from 2003-06-10 to 2010-05-03

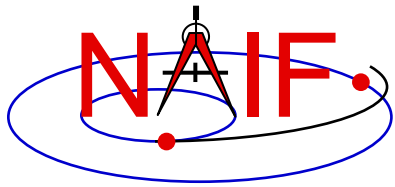
You can hover over the kernel set name in the “Kernel selection” menu, or in the “Kernels Selected” panel.

Unfortunately this feature is **not** available for “Manual” kernel selection.

Plots: ☒ Angular Size ? ▶

Error handling: Stop on error ? ▶

Calculate



Auto-complete Feature

Navigation and Ancillary Information Facility

- If you select any kernel set(s) other than “Manual”, many of the input widgets will be supplied with the names of all available selections
 - Just start typing the name you want and all items matching what you typed will appear in a drop down menu
 - Alternatively, simply type a “blank” and all items available within the kernel set(s) you selected will appear
- In the example below, using the Cassini Huygens archive, the user has typed “mi” in the “Target” selection box. The names of the three objects containing those letters are displayed for the user’s selection. (All three are satellites of Saturn.)

Kernel selection:

Cassini Huygens

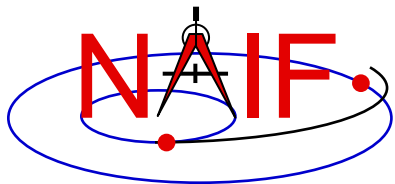


Target:

mi

BERGELMIR
MIMAS
YMIR

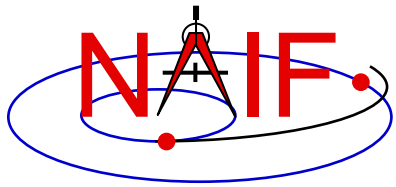




Downloading Results

Navigation and Ancillary Information Facility

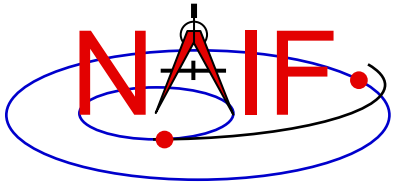
- **You can download tabular results to your computer by clicking the “Download Results” button, then selecting the format desired:**
 - Excel
 - Comma separated values
 - Plain text
- **You can download any plots by clicking on the “Download Plot” button**
 - Plots are saved in PNG format with a transparent background
 - » Easily pasted into a document or presentation



Saving Results for Use as New Inputs

Navigation and Ancillary Information Facility

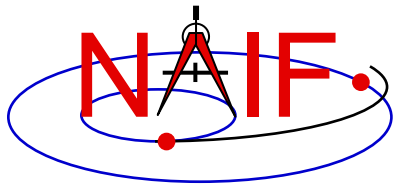
- **You can save a numeric output, or an event finder interval start or stop time, by clicking on the value**
 - The saved value will appear in a “Saved Values” panel on the right side of your browser window
 - This value can then be dragged to an input widget in a subsequent calculation
- **You can save a complete set of event finder output interval start and stop times by clicking the “Save All Intervals” button**
 - These can then be used as part of the input for a subsequent geometric event finder computation if you select “List of intervals” for the “Input times” selection



Programmatic Interface


Navigation and Ancillary Information Facility

- **For major space research institutions NAIF can offer WGC having a programmatic (RESTful) interface**
- **Talk to the NAIF manager for details**



Getting Help

Navigation and Ancillary Information Facility

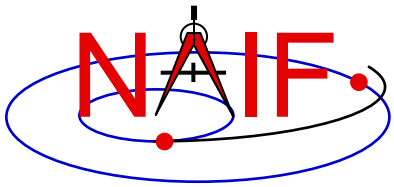
- **WGC users must read the “*About the Data*” web page to understand the kinds of SPICE kernels (data) available to the WGC tool**
- **Most GUI controls have associated HELP text, available by clicking the  icon**
- **Most computation descriptions have an associated graphic depicting one or more examples of what may be computed**
- **Some GUI controls have a second-level, more extensive help description, available by clicking the “Read more...” text displayed in the first level help**
- **The NAIF Team has limited ability and authorization to provide individual help**
 - **Make good use of the HELP panels and other documentation included in WGC**
 - **Look at the SPICE tutorials and documentation available on the NAIF website**
 - » **<http://naif.jpl.nasa.gov>**



Usage Rules

Navigation and Ancillary Information Facility

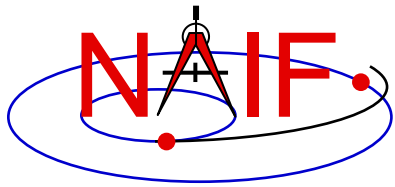
- The WGC program has a link entitled “*Rules of Use*”
 - WGC users must read and abide by these rules
- Using WGC requires some knowledge of space geometry and of NASA’s SPICE system
 - The NAIF website provides much SPICE information:
 - » <http://naif.jpl.nasa.gov>
 - Casual surfers, educators and public outreach entities may find more useable space geometry information and tools elsewhere on the web



Limited Capability

Navigation and Ancillary Information Facility

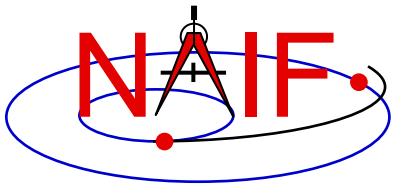
- **WGC does not provide all of the space geometry computational capability offered by the SPICE Toolkits**
 - But WGC nevertheless provides substantial capability—likely more than is obvious at first glance
- **More capability might be added if the user community finds this tool useful**



Feedback

Navigation and Ancillary Information Facility

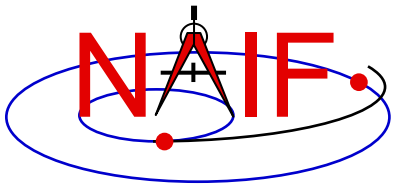
- **WGC includes a “*Feedback*” button, making it rather easy to provide the NAIF team with any sort of useful feedback...**
 - What you like or don’t like about WGC
 - What seems incorrect, incomplete or unclear
 - What features you would like to see added
 - » **Caution: NAIF already has a long list of improvements we’d like to make, so we make no promises to act on any specific feedback.**



Problems Using WGC

Navigation and Ancillary Information Facility

- **There are several limitations and errors you might encounter in using WebGeocalc**
 - See the next several pages for examples
 - Some of these conditions could be unique to the WGC installation at NAIF, and not exist with some other installation
- **One browser does not interact well with WGC**
 - Internet Explorer 8.0.7601.17514 on a Windows 7 PC
 - » May not properly handle “Manual” kernel loading
 - Many popular browsers/versions have been checked, but it’s possible that problems exist with some others



Missing Input

Navigation and Ancillary Information Facility

- **WGC will alert you to missing inputs.**

Angular Separation

Calculate the angular separation between two targets as seen from an observer. ?▶

A body name or code is required.

Kernel selection: Mars Express ?▶

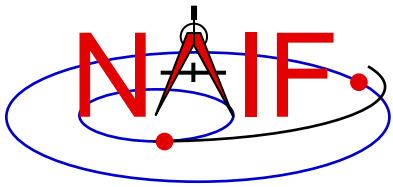
Target 1: Mars ?▶

Target 1 shape: ☒ Point ☐ Sphere ?▶

Target 2: PHOBOS ?▶

Target 2 shape: ☒ Point ☐ Sphere ?▶

Observer: ?▶ * Required



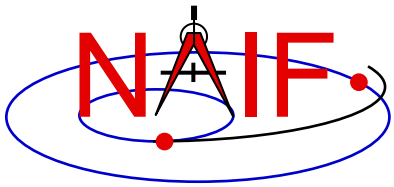
Request is Too Large

Navigation and Ancillary Information Facility

- **WGC has limits set on computational resources.**
 - No more than 25,000 “Geometry Calculator” computations
 - No more than 1 million “Geometric Event Finder” time steps
 - No more than 3 minutes of wall clock time
- **If any of these limits will be (or have been) exceeded, you’ll see a message saying so and your computation request will be terminated.**
- **Some examples:**

Too many data points. This version of WebGeocalc can only calculate 25000 data points in a single calculation, and the requested time inputs specify 631152010 data points. Either use a smaller time range or a larger time step. NAIF plans to remove this restriction in a future version of WebGeocalc.

Time step is too small. This version of WebGeocalc requires the time step to be at least $1.0\text{E-}6$ times the size of the time window. The requested time step is only $9.506426208650559\text{E-}8$ times the size of the window. Either specify a smaller time range or a larger time step.



SPICE Error Messages


Navigation and Ancillary Information Facility

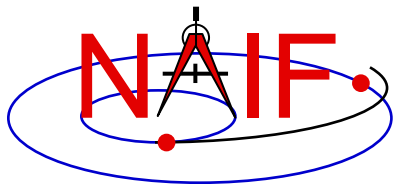
- **WGC will display a SPICE Toolkit error message when an underlying SPICE API is able to detect a problem.**
- **These SPICE error messages all begin with:**
 “CSPICE_N00xx:” followed by some text
- **See the remaining pages for some examples.**



Unusable Time Tag(s) - 1

Navigation and Ancillary Information Facility

- Time tag processing within WGC makes use of SPICE Toolkit modules.
- These Toolkit modules offer a great deal of capability. But not every conceivable style of time tag, and not every time system, are acceptable.
- What to do?
 - Use the help icons  next to any Time system or Time format input.
 - See Appendix 2 of the [Chronos User's Guide](http://naif.jpl.nasa.gov/misc/chronos_ug.html) for some details and many examples.
 - » http://naif.jpl.nasa.gov/misc/chronos_ug.html
 - See the [Time Required Reading](http://naif.jpl.nasa.gov/pub/naif/toolkit_docs/FORTRAN/req/time.html) document for a full explanation of time treatment within SPICE.
 - » http://naif.jpl.nasa.gov/pub/naif/toolkit_docs/FORTRAN/req/time.html



Unusable Time Tag(s) - 2

Navigation and Ancillary Information Facility

- **A few examples of bad time tags and resultant error messages.**

- Using UTC and Calendar format, and inputting: **2010:10:03 05:44:12**

CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the integer <03> could not be determined: ' 2010:10:<03> 05:44:12'

- » Would have worked using: **2010-10-03 05:44:12** or **2010/10/03 05:44:12**

- Using UTC and Calendar format, and inputting: **2455160.098304**

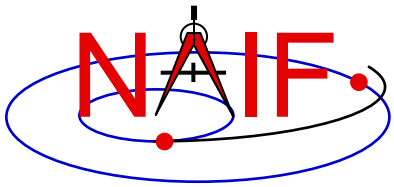
CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the decimal number <2455160.098304> could not be determined: <2455160.098304>

- » Needed to specify “Julian date” format

- Using UTC and Calendar format, and inputting: **2010:10:03T05:44:12**

CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The input string uses the ISO “T” date/time delimiter but does not match any of the accepted ISO formats.

- » Instead, use an ISO-defined format such as: **2010-10-03T05:44:12**
 - (Dashes before the “T” and colons after the “T”)



Unusable Time Tag(s) - 3

Navigation and Ancillary Information Facility

- **A few more examples of bad time tags and resultant error messages.**

- Using UTC and Calendar format, and inputting: 2010-10-03 05:44:12 JD

CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the integer <12> could not be determined: ' 2010-10-03 05:44:<12> JD'

» 2010-10-03 05:44:12 is not a Julian date format: remove the trailing JD

- Using TDB and Julian date format, and inputting: 2.4404005000000000 D+06

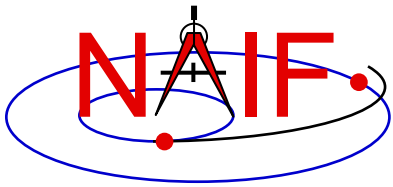
CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the integer <06> could not be determined: ' 2.4404005000000000 D+<06> JD TDB'

» “E” and “D” notation are not allowed

- Using Spacecraft clock and Spacecraft clock string format, and inputting: 81138762:563

CSPICE_N0065: CSPICE.scencd: SPICE(KERNELVARNOTFOUND): [scencd_c --> SCENCD --> SCTIKS --> SCTYPE --> SCL01] SCLK_DATA_TYPE_0 not found. Did you load the SCLK kernel?

» The Spacecraft clock ID value is 0, which is not a valid clock ID. Either you did not load an archival kernel set (containing the mission SCLK kernel) or you did not manually load a SCLK kernel.



Time out of Bounds - 1

Navigation and Ancillary Information Facility

- WGC will display a SPICE error message when SPICE is able to detect a problem.

Angular Size

Calculate the angular size of a target as seen from an observer. ? ▶

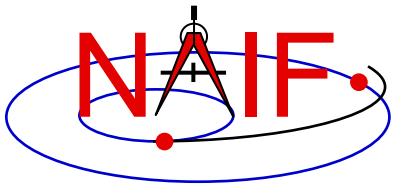
CSPICE_N0064: CSPICE.spkezr: SPICE(SPKINSUFFDATA): [spkezr_c --> SPKEZR --> SPKEZ --> SPKGEO] Insufficient ephemeris data has been loaded to compute the state of 199 (MERCURY) relative to -236 (MESSENGER) at the ephemeris epoch 1995 MAY 03 00:01:01.185.

Kernel selection: MESSENGER ? ▶

Target: MERCURY ? ▶

Observer: MESSENGER ? ▶

- In this example the user requested the position of Mercury relative to the MESSENGER spacecraft at a time before MESSENGER was launched.

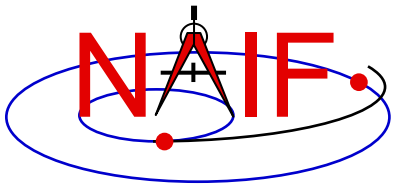


Time out of Bounds - 2

Navigation and Ancillary Information Facility

- **Users involved with mission planning often ask to make a computation for a future time that is not within the bounds of loaded time-dependent kernels (most usually SPKs and CKs).**
 - **Kernels available in SPICE archives usually cover only up to a date in the past, seen using the Tool Tip displayed when you hover your cursor over the name of the archived kernel set.**
 - » **Example for the Cassini archive as of April 2015:**

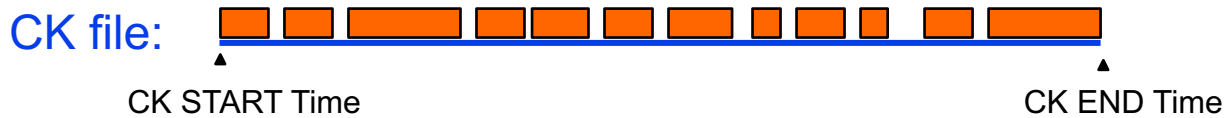
Archived Cassini kernels covering from 1997-10-15 to 2014-06-30
 - **Some kernels available via MANUAL loading from NAIF's operations collections might contain “predict” data, but there is no guarantee, and it can be difficult for a person not familiar with the mission of interest to determine which kernel to load.**



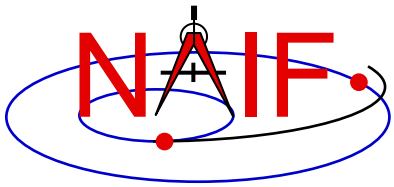
Missing Data - 1

Navigation and Ancillary Information Facility

- If you try to make a series of calculations (e.g. over a time interval, or at each of a set of times) it could be that some of the calculations can be made while others can not due to data gaps or otherwise missing data.
 - A gap in a CK is the most likely culprit. This is usually caused by sparse or missing downlinked spacecraft attitude telemetry.
 - The graphic below represents a CK file.
 - » The orange bars are called “**interpolation intervals**” during which orientation can be determined.
 - » The white spaces between the orange bars are gaps during which orientation cannot be determined.



- » See the next page for some options to deal with this.

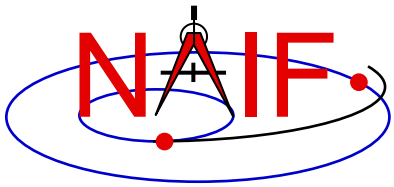


Missing Data - 2

Navigation and Ancillary Information Facility

- When making “**Geometry Calculator**” computations you can control the action taken by WGC using the “Error handling” control found at the bottom of each “Geometry Calculator” web page.
 - The options are:
 - » Stop on error (the default setting)
 - » Report errors and continue (a more friendly but still safe option)
 - » Silently omit errors (dangerous; not recommended)
- However, when making “**Geometric Event Finder**” calculations you haven’t any options: WGC will issue an error message and discontinue the computation, showing no interval results at all. ☹

CSPICE_N0064: CSPICE.gftfov: SPICE(NOFAMECONNECT): [gftfov_c --> GFTFOV --> GFFOVE --> ZZGFSOLV --> ZZGFFVST --> PXFORM --> REFCHG] At epoch 3.1753086618393E+08 TDB (2010 JAN 23 15:01:06.183 TDB), there is insufficient information available to transform from reference frame 1 (J2000) to reference frame -82360 (CASSINI_ISS_NAC). Frame CASSINI_ISS_NAC could be transformed to frame -82000 (CASSINI_SC_COORD). The latter is a CK frame; a CK file containing data for instrument or structure -82000 at the epoch shown above, as well as a corresponding SCLK kernel, must be loaded in order to use this frame. Failure to find required CK data could be due to one or more CK files not having been loaded, or to the epoch shown above lying within a coverage gap or beyond the coverage bounds of the loaded CK files. You can use CKBRIEF with the -dump option to display coverage intervals of a CK file.



Incomplete Data

Navigation and Ancillary Information Facility

- **Computations involving ephemerides (trajectories) or orientations often require the chaining—the stringing together—of multiple “chunks” of data to obtain needed positional information.**
- **Kernels containing ALL the needed “chunks” of data to complete the chain must be loaded into WGC.**
 - This is rarely a problem when using a mission’s archive since much care is taken to make the archive complete.
 - But incomplete data is often a problem when **MANUALLY** loading individual kernels from a mission operations collection. The user may not understand what are the needed components of an ephemeris chain (SPK, FK) or an orientation chain (some of CK, FK, PCK).



Mixed Up Target and Observer

Navigation and Ancillary Information Facility

- A user wants to find the sub-observer point on the moon using the Lunar Reconnaissance Orbiter (LRO) spacecraft as the observer.
- S/he selects the “Sub-Observer Point” calculation, loads the LRO kernel set, and specifies the Target as “LRO,” the reference frame as “IAU_MOON” and the observer as the “MOON.”

CSPICE_N0065: CSPICE.subpnt: SPICE(INVALIDFRAME): [subpnt_c --> SUBPNT] Reference frame IAU_MOON is not centered at the the target body LUNAR RECONNAISSANCE ORBITER. The ID code of the frame center is 301.

- S/he mixed up what should be the observer and the target. Interchange these two items and the calculation will work.



Limitation – One at a Time

Navigation and Ancillary Information Facility

- **WebGeocalc executes only one computation at a time.**
 - **Any computation requests received while one computation is in progress will be queued in the order received.**
 - » **A “queued” message will be displayed in your browser’s window.**
 - » **Each request will automatically execute once having reached the top of the queue.**