

Navigation and Ancillary Information Facility

**COSPAR 2018
S.2-0006-18**

International Support for Space Mission Geometry Calculations

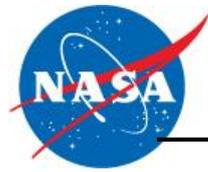
16 July 2018

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on behalf of the NAIF Team**

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Jet Propulsion Laboratory/California Institute of Technology

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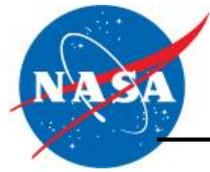


Geometry is Important

Navigation and Ancillary Information Facility

- **Having correct space mission geometry is an important contributor to mission success in:**
 - observation planning,
 - data analysis, and
 - mission engineering.

- **Obtaining this geometry with ease and confidence:**
 - reduces risk and cost
 - facilitates the obtaining of excellent science results, and
 - makes for happy scientists!

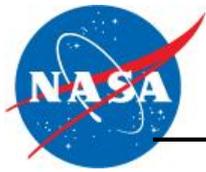


“SPICE” is an Available Approach

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- **The SPICE* system is used world-wide to provide scientists and engineers with a wide assortment of observation geometry.**
- **Maybe SPICE would work for you?**

* **S**pacecraft **P**lanet **I**nstrument **C**amera-matrix **E**vents



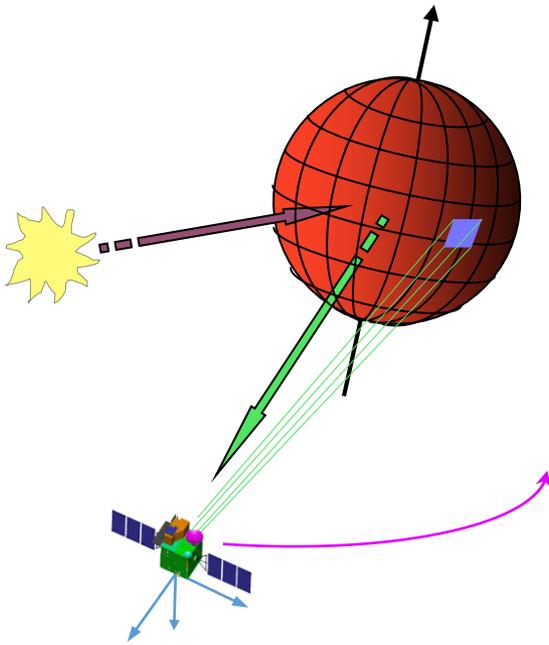
What Can One Do With SPICE?

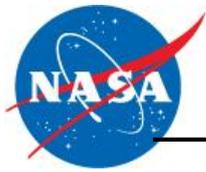
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Compute many kinds of “**observation geometry**” parameters

Examples

- Positions and velocities of planets, satellites, comets, asteroids and spacecraft
- Size, shape and orientation of planets, satellites, comets and asteroids
- Orientation of a spacecraft and its various moving structures
- Instrument field-of-view location on a planet's surface



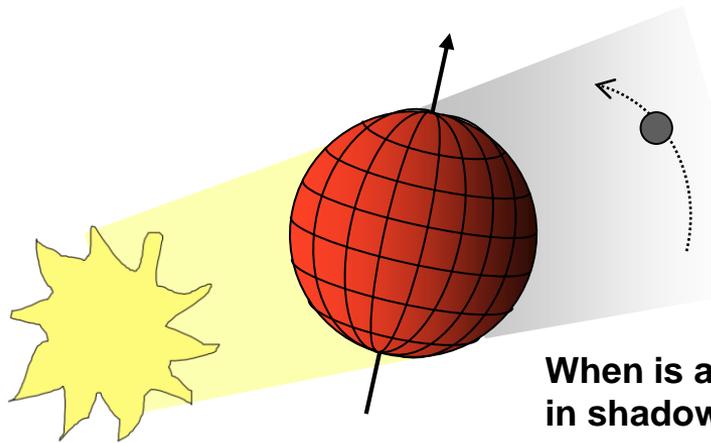


What Can One Do With SPICE?

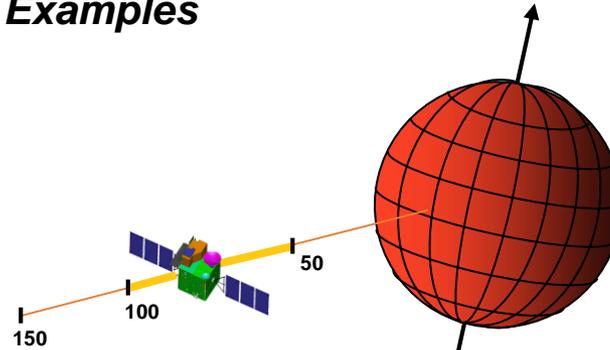
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Find times when a specified “geometric event” occurs

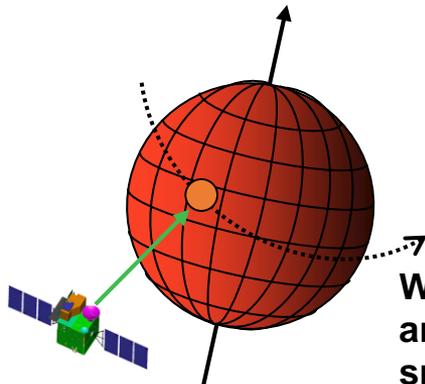
Examples



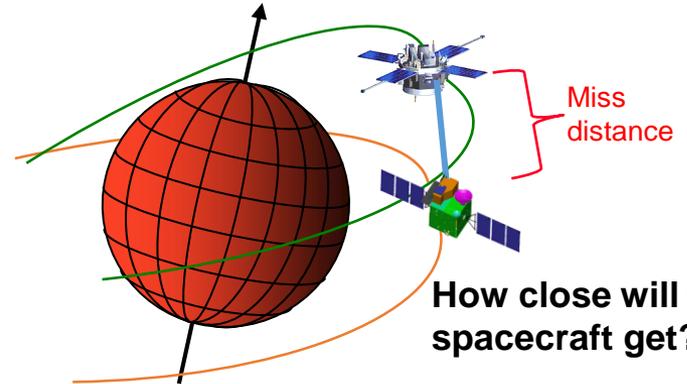
When is an object in shadow (occultation)?



When is the spacecraft's altitude within a given range? (Example: 50 to 100 km)



When is an object in front of another, as seen from a spacecraft (transit)?

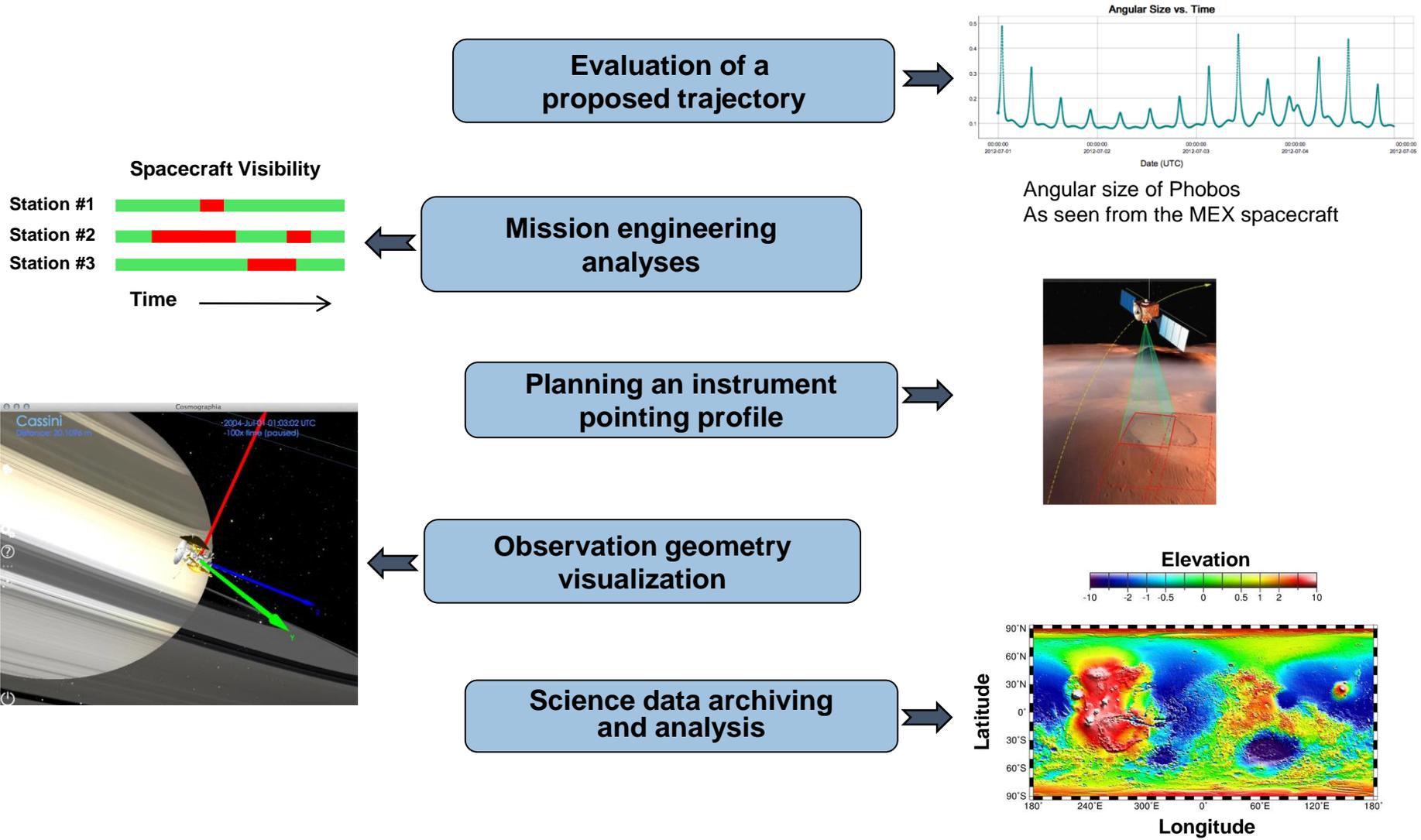


How close will two spacecraft get?



Examples of How SPICE Is Used

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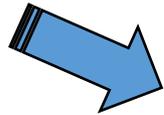


SPICE Pictorial Summary

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From assorted sources

Planet ephemeris
S/C trajectory
S/C orientation



**SPICE
Utility
Programs**



**SPICE
Kernels**

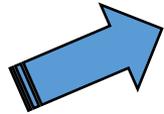


Your Program

**Your
Software
Modules**

**SPICE
Software
Modules**

Distances
Velocities
Altitudes
Latitudes
Longitudes
Lighting Angles
etc., etc.



Text editor



**Ancillary
Data Files**



**Observation
Geometry
Parameters**

From assorted sources

Spacecraft geometry
Instrument geometry
Planet size, shape, orientation



SPICE System Components

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1100
1010
0101

Ancillary data files (“kernels”).....

Software (SPICE Toolkit)



Documentation



Tutorials



Programming lessons



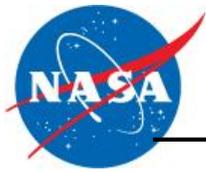
Training classes



User consultation

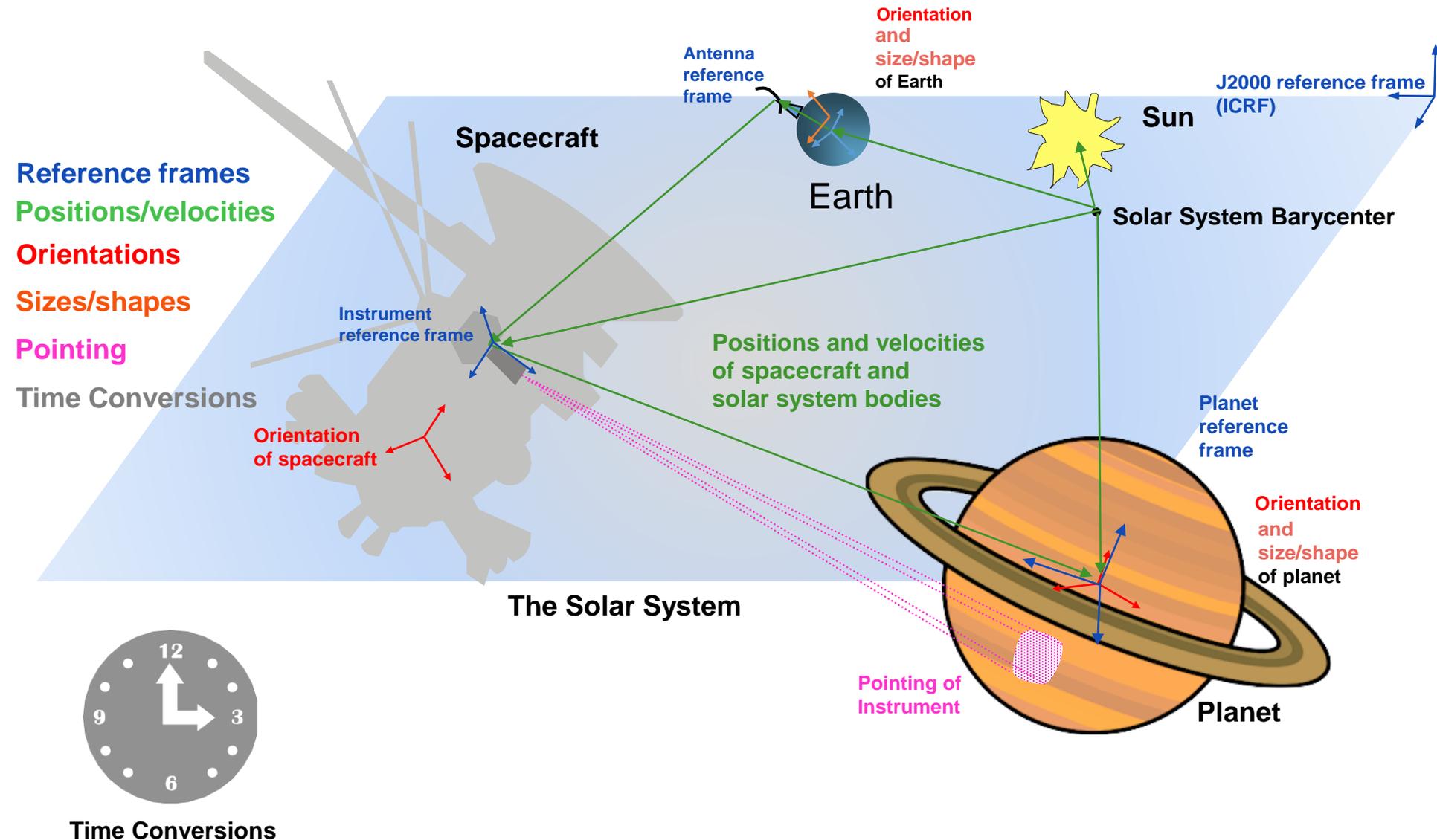


But wait!



What are “Ancillary Data?”

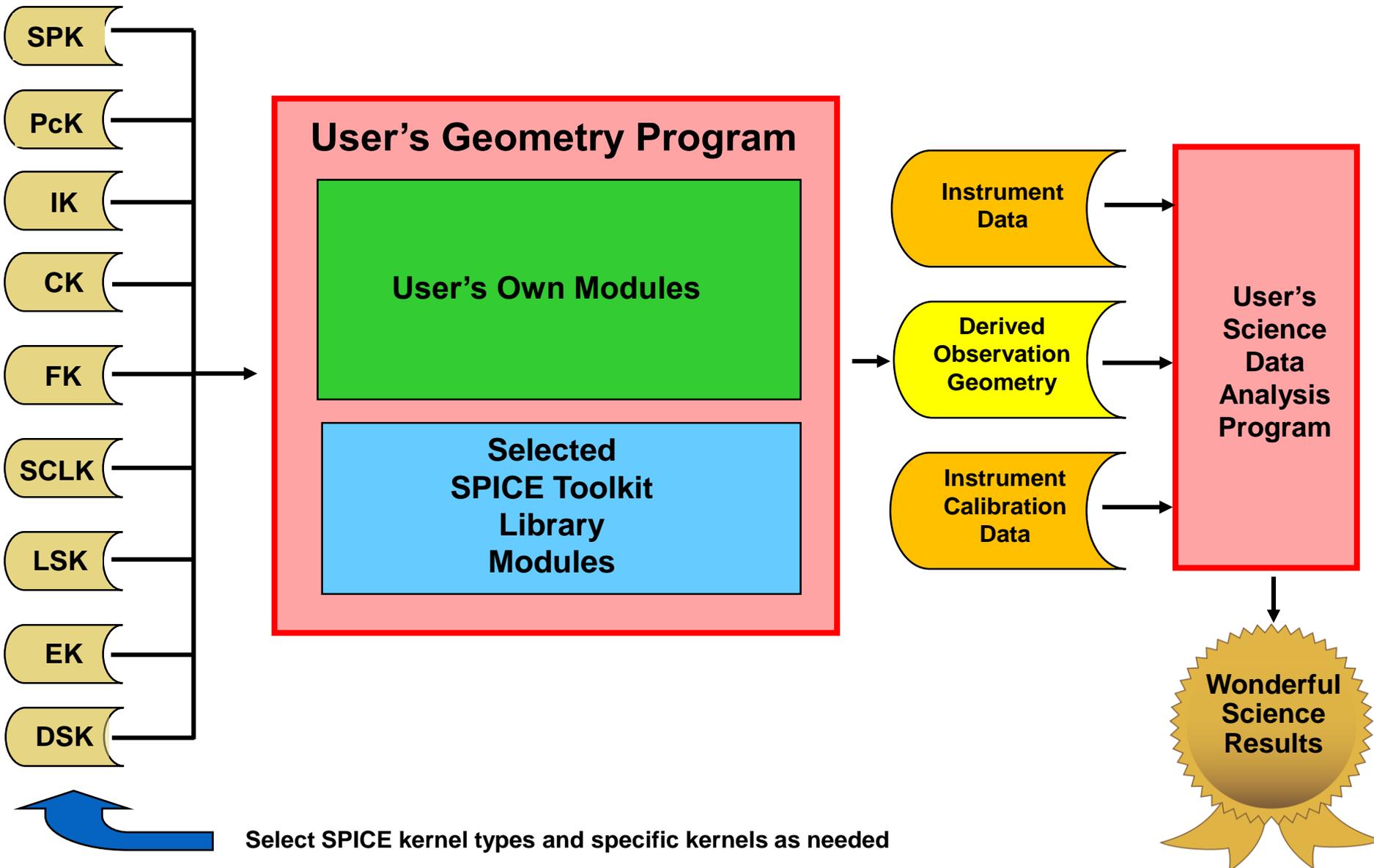
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Using SPICE Data and Software

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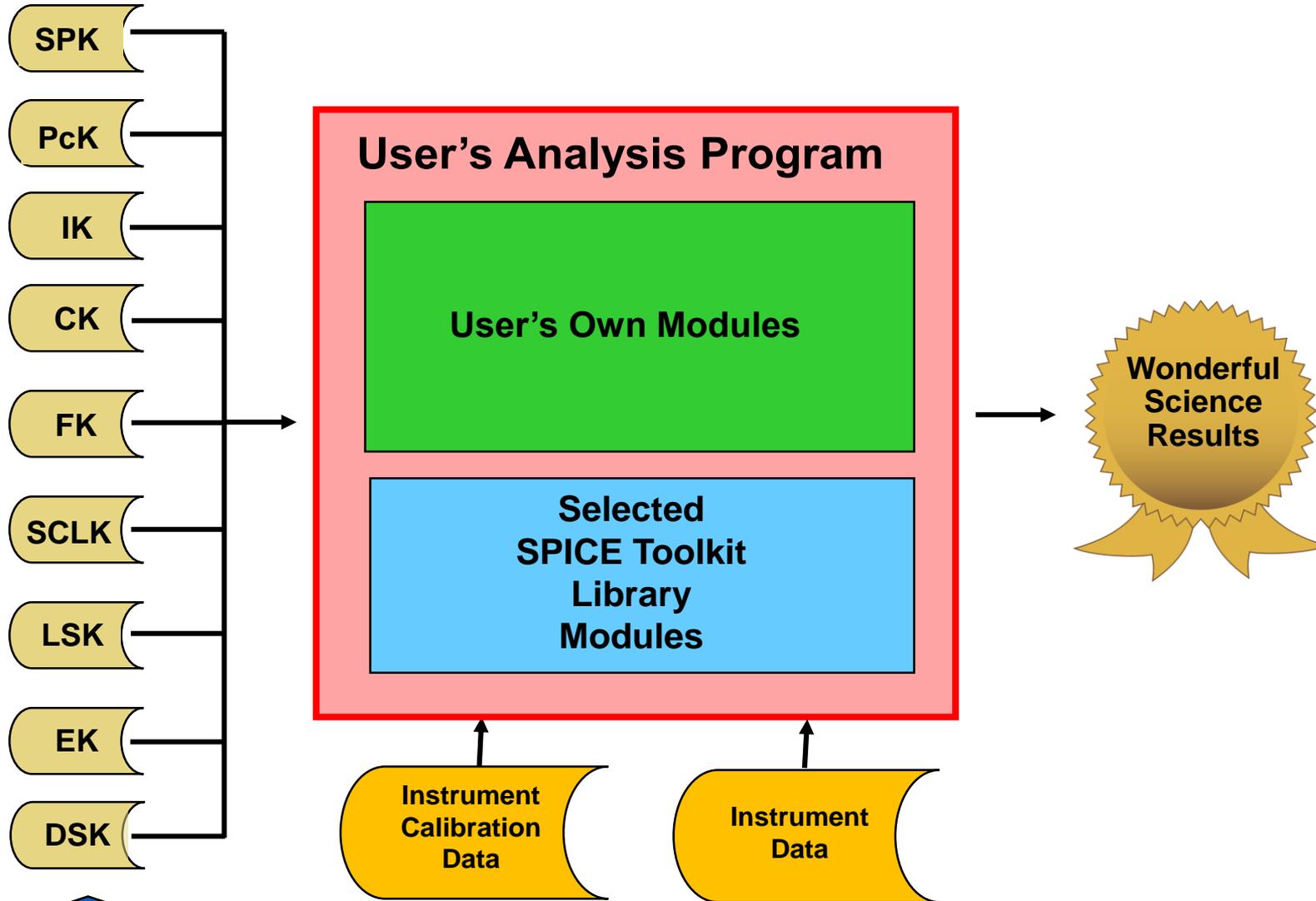


Select SPICE kernel types and specific kernels as needed

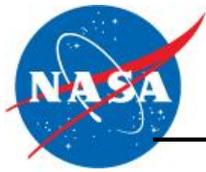


Using SPICE Data and Software

Navigation and Ancillary Information Facility

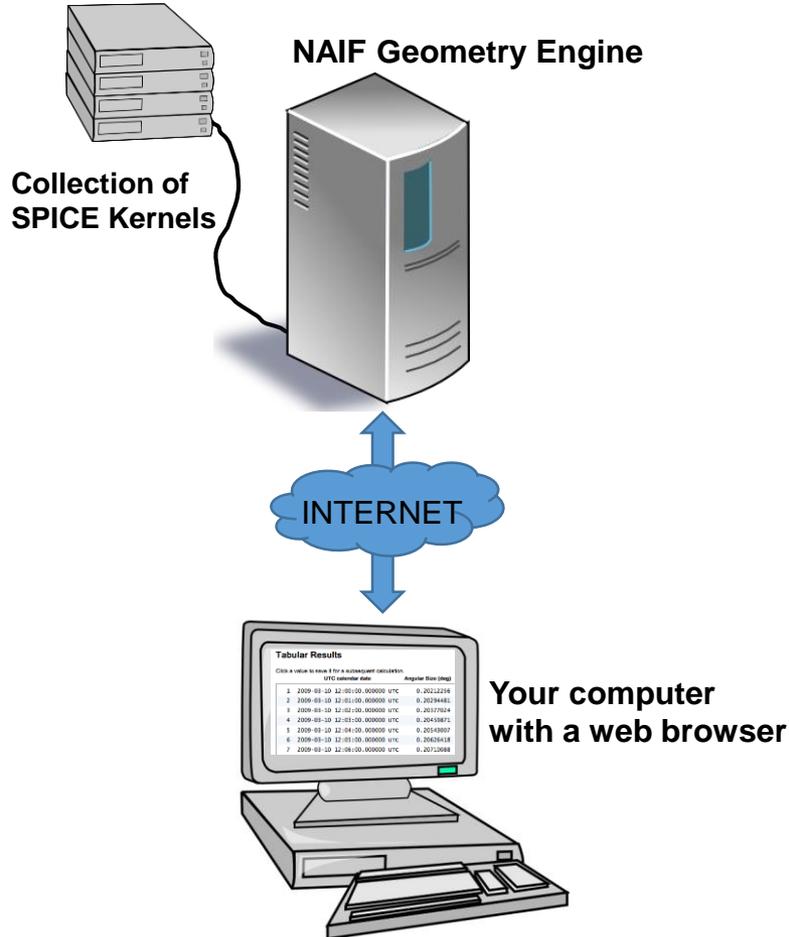


Select SPICE kernel types and specific kernels as needed



Other Ways to Use SPICE

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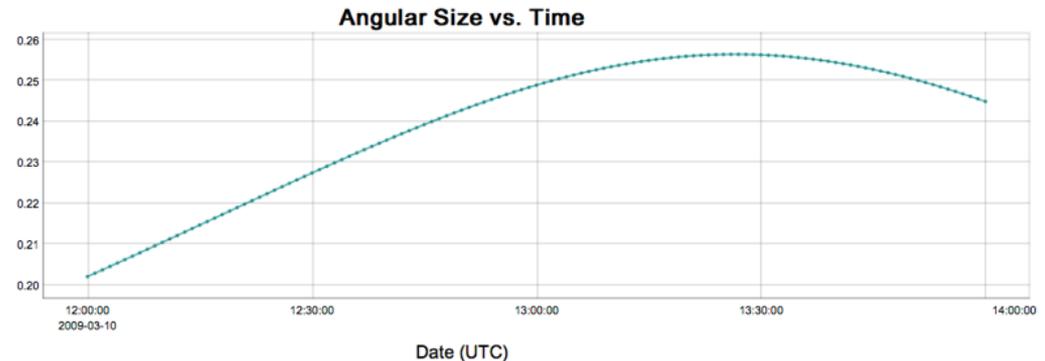


Tabular Results

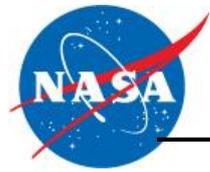
Click a value to save it for a subsequent calculation.

	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

WebGeocalc
An on-line geometry calculator



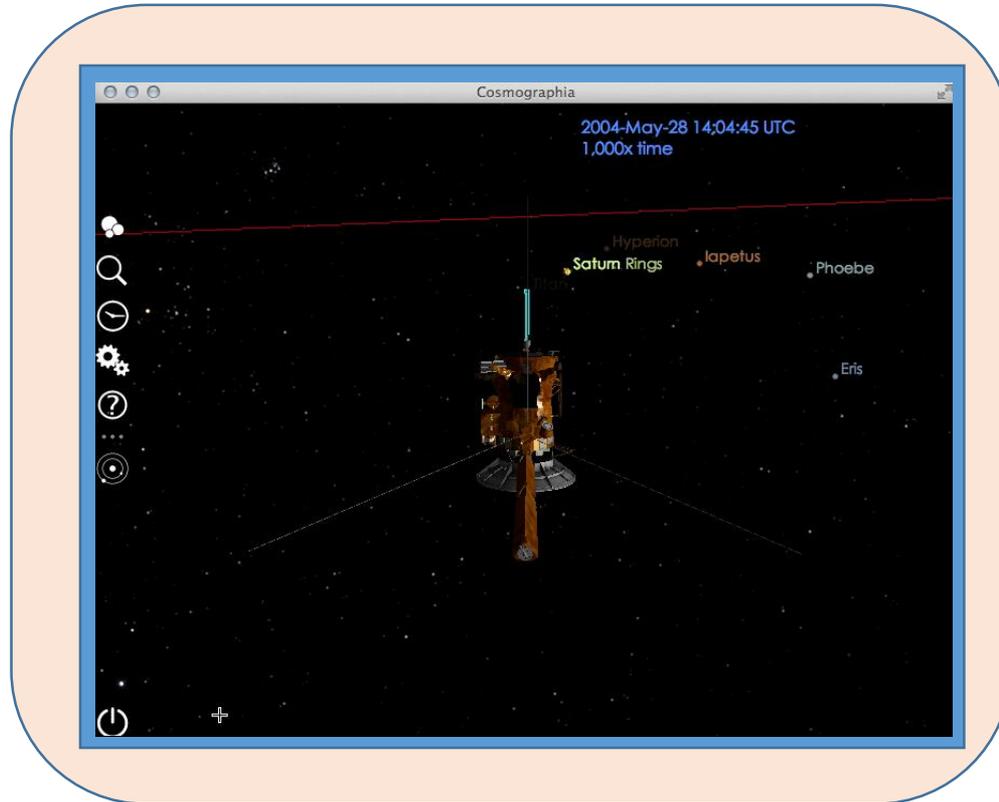
Angular size of Phobos as seen from the Mars rover "SPIRIT"



Other Ways to Use SPICE

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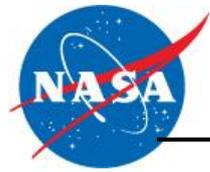
Your Computer



Obtain highly accurate visualizations of observation geometry that did or will transpire during a mission.

In this example the Cassini camera is taking images of Saturn and some of its moons.

Cosmographia
A 3D Mission Visualization Tool



Important Details About SPICE

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- Works on most popular platforms
- SPICE Toolkit source code is available in several languages
 - Fortran 77, C, IDL, MATLAB, JNI, Python
- Code is very well tested
- Code is highly documented
- Tutorials and programming lessons are available
- Training classes are offered about every 18 months
- No registration, licensing or export restrictions
- Thanks to NASA, it's all **Free!**

Stop by the PDS booth for further information