Introducing GV: A Geometry Visualizer for Planning Spacecraft and Ground-Based Observations

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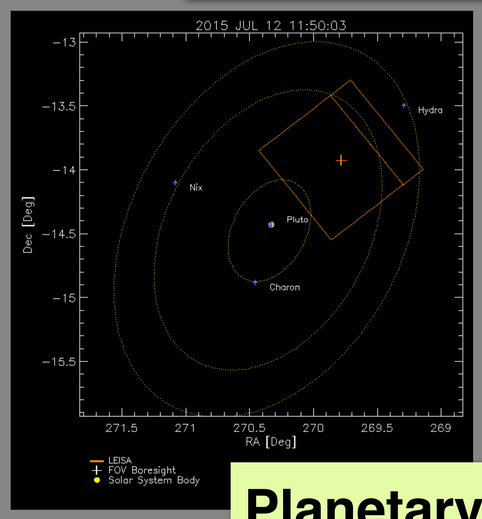


Planetary Positions

GV uses SPICE to calculate planet, satellite, and spacecraft positions accurately. New bodies such as comets and asteroids are readily added.

Abstract: GV (Geometry Visualizer) is a web-based program for planning spacecraft observations. GV is the primary planning tool used by the New Horizons science team to plan the encounter with Pluto.

GV creates accurate 3D images and movies showing the position of planets, satellites, and stars as seen from a observer on a spacecraft or other body. NAIF SPICE routines are used throughout for accurate calculations of all geometry. GV includes 3D rendering of all planetary bodies, lon/lat grids, ground tracks, albedo maps, stellar types and positions from HD and Tycho-2 catalogs, and spacecraft FOVs. It generates still images, movies, and geometric data tables.

GV is accessed through an easy-to-use and flexible web interface. The interface allows for uniform use from any computer and assures that all users are accessing up-to-date versions of the code and kernel libraries. Compared with existing planning tools, GV is often simpler, faster, lower-cost, and more flexible.

GV was developed at SwRI to support the New Horizons mission to Pluto. It has been subsequently expanded to support multiple other missions in flight or under development, including Cassini, Messenger, Rosetta, LRO, and Juno. The system can be used to plan Earth-based observations such as occultations to high precision, and was used by the public to help plan 'Kodak Moment' observations of the Pluto system from New Horizons.

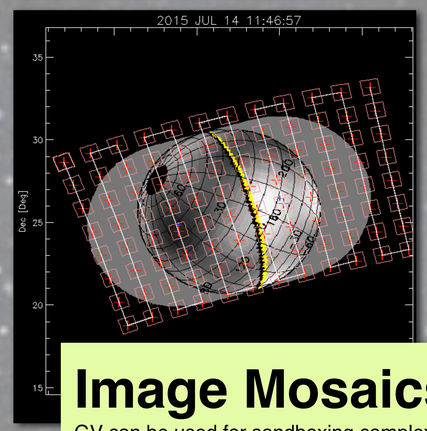
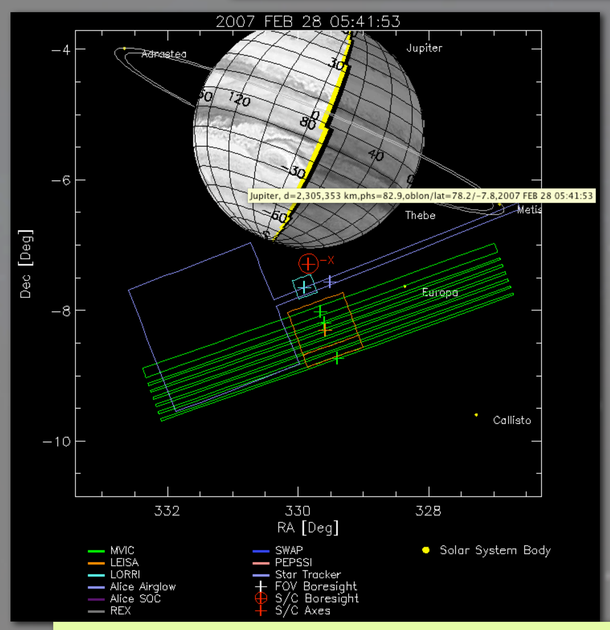


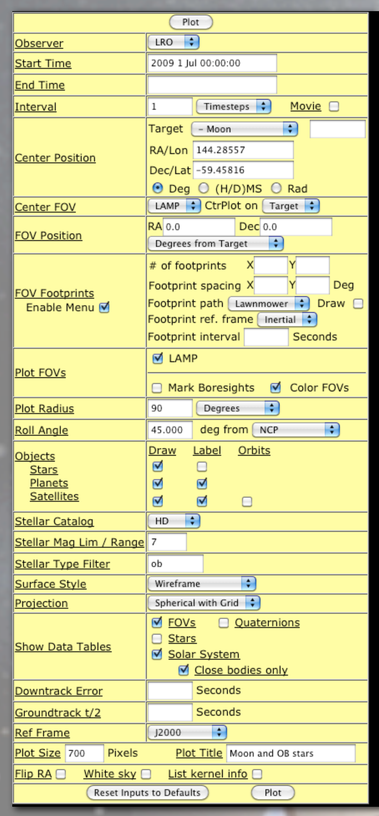
Image Mosaics

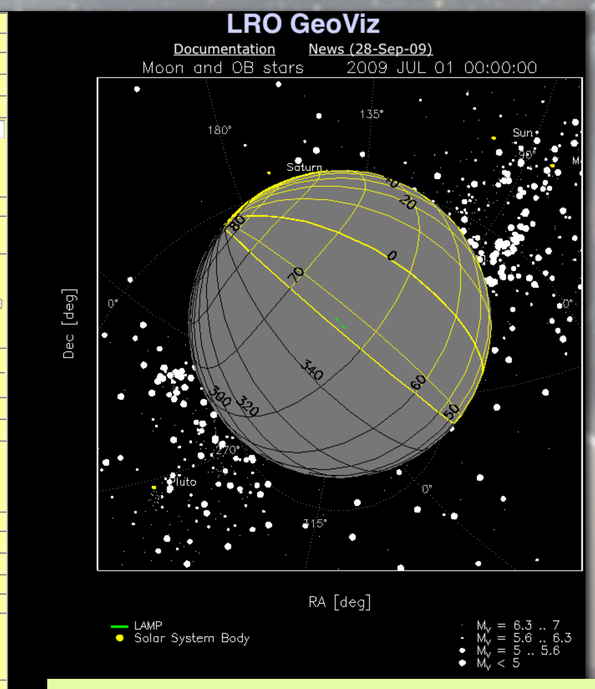
GV can be used for sandboxing complex imaging mosaics, such as planned at the Pluto encounter. The grey region shows the uncertainty in Pluto's observed position.



Instrument FOVs

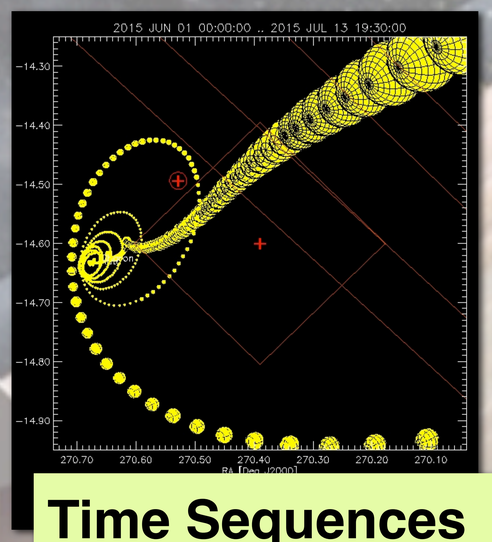
GV plots the FOVs for any selected remote sensing instruments, such as the New Horizons instruments shown here. The FOV definitions are read directly from their SPICE kernel files for accuracy.





Simple Web Interface

All of the GV input parameters are controlled by the panel on the left. Here the Moon is plotted, as seen from LRO, along with all HD O/B stars with $M_V < 7$.



Time Sequences

This plot shows the Pluto-Charon system from the viewpoint of the inbound New Horizons spacecraft. Over the course of 1 month, both objects increase in size and orbit the Pluto barycenter.

FOV Positions
Download as CSV

FOV	RA Center [deg]	Dec Center [deg]	RA Center [hms]	Dec Center [dms]	Sol Elon [deg]	Pluto Res per Pix [km]
MVIC	91.21595	14.81942	6 4 51.827	14 49 9.92	14.47917	27.760
MVIC Framing	91.21595	14.81942	6 4 51.827	14 49 9.92	14.47917	27.760
MVIC P2	91.37915	14.72346	6 5 30.995	14 43 24.46	14.38117	27.760
MVIC NIR	91.88522	14.42177	6 7 32.453	14 25 18.39	14.08896	27.760
LEISA	91.49562	14.69050	6 5 58.948	14 41 25.80	14.29586	85.419
LORRI	90.89021	15.13064	6 3 33.651	15 7 50.31	14.62846	6.940
Alice Airglow	90.73046	14.77039	6 2 55.310	14 46 13.39	14.92223	-999
Alice SOC	171.62434	-30.49479	11 26 29.843	-30 29 41.25	81.92312	-999
REX	171.73836	-30.41789	11 26 57.206	-30 25 4.40	81.96990	-999
SWAP	171.17510	-30.39948	11 24 42.024	-30 23 58.12	81.54026	-999
PEPSSI	204.72339	-9.63881	13 38 53.614	-9 38 19.73	102.34668	-999
Star Tracker 1	125.98257	49.89693	8 23 55.818	49 53 48.95	33.47682	-999
Star Tracker 2	66.99888	-23.37089	4 27 59.730	-23 22 15.19	57.67824	-999
FSS	171.64243	-30.41406	11 26 34.184	-30 24 50.62	81.89630	-999
+X	270.52114	-15.14547	18 2 5.075	-15 8 43.71	165.05375	-999
+Y	171.40562	-30.34061	11 25 37.349	-30 20 26.18	81.68266	-999
+Z	23.56790	-55.33986	1 34 16.295	-55 20 23.49	102.32912	-999
-X	90.52114	15.14547	6 2 5.075	15 8 43.71	14.94625	-999
-Y	351.40562	30.34061	23 25 37.349	30 20 26.18	98.31734	-999
-Z	203.56790	55.33986	13 34 16.295	55 20 23.49	77.67088	-999
S/C	90.52114	15.14547	6 2 5.075	15 8 43.71	14.94625	-999

Planetary & Stellar Data Tables

GV can generate extensive data tables which can be exported for use in other applications. Here shown are tables for the FOV positions, nearby stars, and planetary angles and positions.

Solar System Bodies
Download as CSV

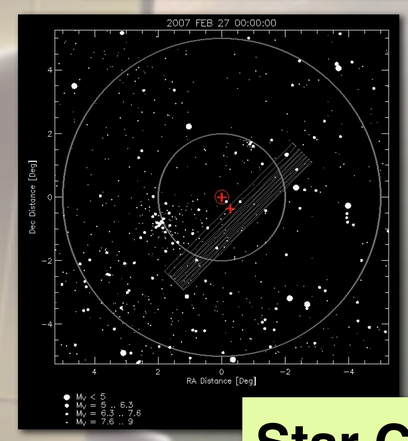
Name	UTC	Julian	RA [deg]	Dec [deg]	RA [hms]	Dec [dms]	Eclip Lon [deg]	Eclip Lat [deg]	Dist [AU]	Dist [km]	Ang Diam [urad]	Phase [deg]	Sol Elon [deg]	SubSol Lon [deg]	SubSol Lat [deg]	SubObs Lon [deg]	SubObs Lat [deg]	Lon on Primary [deg]	Lat on Primary [deg]	Pole Ang [deg]	AngVel [urad/sec]
Sun	2015 JUL 15 15:46:57	2457219.15760	105.08043	20.79311	7 0 19.304	20 47 35.19	104.08521	-1.91183	32.91808	4,924,474,830	282.7	0.00	0.00	0.00	0.00	343.08	5.33	-999.00	-999.00	359.54	0.0004
Earth	2015 JUL 15 15:46:57	2457219.15760	104.79091	20.76055	6 59 9.817	20 45 37.98	103.81913	-1.97199	31.91336	4,774,170,024	2.7	171.14	0.27	11.18	21.53	181.71	-20.87	-999.00	-999.00	360.00	0.0056
Pluto	2015 JUL 15 15:46:57	2457219.15760	91.21595	14.81942	6 4 51.827	14 49 9.92	91.18891	-8.61485	0.00928	1,388,019	1721.9	165.52	14.48	299.64	-49.42	101.58	42.16	-999.00	-999.00	297.39	0.0902
Charon	2015 JUL 15 15:46:57	2457219.15760	91.44635	15.58734	6 5 47.125	15 35 14.41	91.40631	-7.84489	0.00930	1,390,900	852.7	166.04	13.95	119.64	-49.42	282.63	42.00	358.04	2.83	298.15	0.2799
Nix	2015 JUL 15 15:46:57	2457219.15760	89.75632	14.03261	5 59 1.517	14 1 57.39	89.76037	-9.40648	0.00945	1,413,949	42.4	163.90	16.10	117.33	-49.42	317.18	41.25	236.97	-0.74	295.83	0.1629
Hydra	2015 JUL 15 15:46:57	2457219.15760	92.38370	17.34281	6 9 32.087	17 20 34.11	92.28814	-6.07755	0.00929	1,389,771	43.2	167.52	12.48	110.55	-49.42	276.19	41.93	9.09	2.57	300.19	0.5652

HD Stars
Download as CSV

ID	RA [deg]	Dec [deg]	RA [hms]	Dec [dms]	Eclip Lon [deg]	Eclip Lat [deg]	Mag [Ptm]	Mag [Ptg]	Type
HD 42560	92.99676	14.21113	6 11 59.223	14 12 40.08	92.94290	-9.20404	4.30	4.20	B3
HD 41753	91.90262	14.77179	6 7 36.629	14 46 18.44	91.86095	-8.66171	4.40	4.20	B2
HD 38899	87.38037	12.64894	5 49 31.289	12 38 56.17	87.39810	-10.77319	4.90	4.90	B9
HD 42545	92.99175	16.12795	6 11 58.020	16 7 40.61	92.89733	-7.28775	4.90	4.80	B3
HD 43386	94.10179	12.26698	6 16 24.430	12 16 1.13	94.08481	-11.12065	5.10	5.50	F5
HD 43153	93.84195	16.15303	6 15 22.069	16 9 10.90	93.71979	-7.24315	5.30	5.30	B9
HD 43247	93.92971	12.55200	6 15 43.131	12 33 7.19	93.90544	-10.84052	5.40	5.30	B9
HD 39317	88.09612	14.17540	5 52 23.069	14 10 31.44	88.12974	-9.25802	5.60	5.50	B9
HD 39019	87.59730	14.29691	5 50 23.352	14 17 48.88	87.64187	-9.12921	5.70	6.70	K0
HD 42954	93.61077	17.92203	6 14 26.585	17 55 19.31	93.45114	-5.48050	5.70	5.90	A5

Features of GV

- Built on SPICE framework allowing for accurate positions and geometry for planets, satellites, and spacecraft
- Integration with HD and Tycho-2 star catalogs, including positions, magnitudes, and stellar types
- Simple web interface
- Accurate FOVs for remote sensing instruments
- Wireframe images showing position grids and surface lighting
- Albedo and surface composition maps
- Easy generation of both images and movies
- Lookup of actual spacecraft orientation and pointing from SPICE C-Kernels
- Output of all data in graphical and table format
- Flexible input and output coordinates, including both J2000 celestial and ecliptic systems
- Cartesian or spherical projection of sky coordinates.
- Light-time corrections for all computations
- Rapid generation of tables of geometric parameters (distance, phase angle, etc.) over a time interval
- Display of Jovian aurora and satellite flux footprints



Star Catalogs

GV includes the complete HD and Tycho-2 star catalogs. Stellar types, magnitudes, and precessed positions are available.

You can use GV now!

GV is available for use by the community at http://soc.boulder.swri.edu/nhgv . Please contact Henry Throop (throop@boulder.swri.edu) about using GV for new or additional missions.

Who is using GV?

- **New Horizons Science Team**
  - GV is being used by the NH Science Team as the main planning tool for the Pluto encounter.
- **New Horizons EPO**
  - GV was used by the public to help plan 'Kodak Moment' observations of the Pluto system.
- **Lunar Reconaissance Orbiter**
- **Rosetta**
- **MESSENGER**
- **Juno**
- **Ground-based observers**