

THE SPACECRAFT PLANETARY IMAGING FACILITY (SPIF) AT CORNELL UNIVERSITY. R.D.

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Introduction: The Cornell/NASA Spacecraft Planetary Imaging Facility (SPIF) is one of the nine domestic and eight foreign facilities that compose the Regional Planetary Image Facilities Network (RPIFN). As one of NASA'S RPIFs, SPIF serves three basic functions:

1. *To provide support for research activities in the planetary sciences at Cornell and the surrounding areas of New York State and Pennsylvania.*
2. *To provide information and data from both past and present planetary missions to the media, educational groups and general public.*
3. *To organize and catalog an archival image collection, including prints, negatives, maps, digital media, and supporting documentation. [1,2]*

SPIF has successfully carried out these functions for the past 35 years, adapting its services to fit the current needs of the community as necessary.

Objectives: SPIF has just completed its 35th year of successful operation as a joint venture between NASA and Cornell [3]. SPIF has operated as a repository of spacecraft data, a facilitator of research, and as a hub for innumerable education and public outreach activities. Part of the facility's success lies in the fact that Cornell scientists and staff participate in many of the ongoing and upcoming NASA Solar System exploration missions. Both individual investigators and their students make use of SPIF resources and contribute their expertise to various programs designed for researchers, students and the general public.

In addition to the successful programs that SPIF has been conducting since its inception, which now foster an average of over 3500 visitors per year, we have recently expanded the facility's activities in all three of its basic functions, increasing the scope and depth of currently offered programs, and expanding into the local community by partnering with local education and outreach centers in upstate NY. The Education Directors at both the Ithaca Sciencenter and the Paleontological Research Institute (PRI, Museum of the Earth) partner with SPIF on a variety of activities that communicate planetary science to the public, as described below.

Research Support: In order to bring SPIF's support of planetary research into the digital age, we have set up a Planetary Photogrammetry and GIS Laboratory that incorporates hardware and software to support the following activities:

1. ArcGIS – SPIF has installed three workstations dedicated to ArcGIS planetary mapping. The Data Manager has completed ESRI levels I through III training and will run open GIS workshops.
2. SOCET SET – SPIF has installed two SOCET SET workstations, each with a standard flat screen display and a dedicated stereo display to allow users to create digital elevation models (DEM's) of planetary surfaces from stereo image pairs.
3. ISIS – Processing pipelines often involve the use of routines from Integrated Software for Imaging and Spectrometers (ISIS). To make these pipelines more streamlined, dedicated ISIS workstations has been installed in the Photogrammetry Lab. The SPIF Data Manager and Director are both versed in ISIS processing and routinely help students and other researchers develop their processing pipelines.
4. SPIF also provides meeting space for planetary research groups within the Cornell Center for Astrophysics and Planetary Science (CCAPS), who make use of our wireless internet, large screen display for video-conferencing, and conference room facility with projector, which provides additional meeting capabilities.

Communicating Science to the Public: SPIF is on the curriculum of a number of regional school districts and, as such, provides planetary image tours of the solar system and hand-on activities (e.g., edible RAT) to classes on a yearly basis (**Figure 1**). Classes range from second grade through college undergraduate courses. Other groups include summer space camps at the Ithaca Sciencenter, planetarium talks, visits to regional astronomical societies, senior centers, and youth groups.

SPIF Visitation Statistics for Jan-Dec. 2014: [4]

Number of groups: 116

K-12 students: 1,354 (Fig. 1)

K-12 teachers: 91

College students: 322

College teachers: 84

Adults accompanying youth visitors: 35

Adults in groups not listed above: 989

Walk-in visitors: 702

Total number of visitors: 3,577

A tour of the solar system includes PowerPoint, three-dimensional stacked projectors (for stereo display), and our two Magic Planet displays. SPIF's Magic Planet solar system image set includes the

Sun, all eight planets, the asteroids Vesta and Ceres, the Galilean satellites, Earth's moon, Pluto and representations of various types of Exoplanets, in our close association with the Carl Sagan Institute for solar system and exoplanet exploration.

Archiving activities: SPIF's book and periodical collection is in the process of being ingested into the Cornell University Library system's online database, increasing exposure across the Cornell campus and greater community.

The hardcopy image collection contains over 200,000 print images from Mariner 9, Mariner 10, Viking Orbiters and Landers, Voyagers, Magellan and Galileo, as well as prints from the handheld collections of Gemini and Apollo missions. These large datasets are indexed so they can be searched quickly.

There is also a developing digital image collection consisting of global and regional processed mosaics of various planetary bodies that are ready for viewing on the GIS workstations.

We are constantly adding to our physical collection, expanding our meteorite collection, the bulk of which was donated by Ithaca meteorite collector Michael Casper. Additional pieces are purchased for research and lecture purposes at modest cost.

Extraterrestrial Virtual Field Experience (EVFE): The EVFE is a team-based, game-like educational activity that places student-players in the role of a NASA science team, tasked with commanding a landed spacecraft to address specific scientific questions. EVFE builds upon the Virtual Field Experience (VFE) program successfully pioneered by our partner organization, PRI, which uses remote sensing data (e.g. images) of real terrestrial locations of geologic interest to create virtual environments that can be explored by teacher-led groups of students in an inquiry based manner.

In the first of several planned EVFE modules, students must direct the use of the instrument suite on the Mars Exploration Rover (MER) Opportunity to explore and understand the origin of hematite at the Meridiani Planum landing site. As with real mission teams, players must balance the desire to make observations of many targets as quickly as possible against the limited resources and capabilities of the spacecraft. All of the images and other observational data presented to the players within the activity derive from actual mission data, and the overall story arc and in-game commentary (on, e.g., possible scientific interpretations of the data) are provided by MER science team members. **(Figure 2)**

Multiple rounds of playtesting have taken place in a college classroom setting, and a number of workshops have taken place for professional high school educators who wish to incorporate EVFE into their

classrooms. Formal evaluation of EVFE is planned for the first half of 2016. An earlier web-based prototype system has recently been ported to Unity; EVFE is now available on mobile devices. A second module is planned for release in summer of 2016, which will comprise a alternative presentation of the story of hematite at Meridiani Planum that is refined for use in high school science classroom settings, incorporating significant feedback received from educators.

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References: [1] Muller and Grindrod (2010) *European Planetary Science Congress 2010*, 883; [2] Holdren, J.P. (2014), Improving the Management of and Access to Scientific Collections, *Memorandum for the Heads of Executive Departments and Agencies*, Executive Office of the President, Office of Science Technology and Policy; [3] Shirley and Fairbridge, eds. (1997) *Encyclopedia of Planetary Sciences*, Chapman and Hall, London, 686; [4] The most recent year for which complete statistics are available.



Figure 1. Lansing, NY 2nd graders visit SPIF yearly

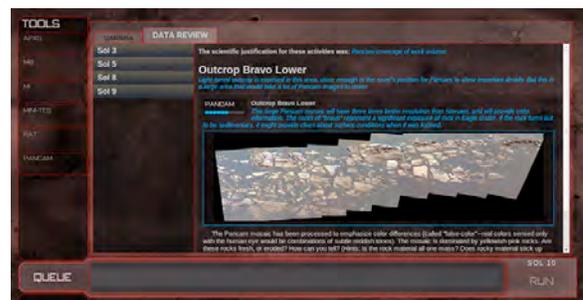


Figure 2. EVFE SOL 9 Data Review