SSERVI: A Virtual Institute

Yvonne Pendleton, Director
Solar System Exploration Research Virtual Institute (SSERVI)
Planetary Science Subcommittee Presentation
Sept. 4, 2014
• What is a Virtual Institute?
• Virtual Institute Model complements R&A
• SSERVI Role and Mission
• SSERVI Science and Exploration Research
• Shared Facilities & Cross-Team Collaborations
• Next Generation Support
• SSERVI Central Office Responsibilities
• Community Opportunities
What is a Virtual Institute?

• A virtual, distributed organization effectively integrates interdisciplinary research efforts using the expertise of research institutions and universities across the country and around the world.

• Eliminates geographical constraints, enabling selection of the best investigations, teams and resources to address NASA’s current goals, regardless of where team members or infrastructure are located.

• Cooperative agreement notices (issued every 2-3 years) provide continuity and overlap between generations of institute teams.

• Virtual technology and communication tools enhance team research.

• Responsive to Presidential executive orders issued as part of the Green Initiative.

• By sharing students, facilities and resources, and by reducing travel, the virtual institute model reduces cost, providing more bang for the buck.
A strong R&A grant program and strategic use of the virtual Institute (VI) model are complementary ways to advance science.

Virtual Institutes address complex, multi-faceted questions and have these advantages:

- Cooperative Agreement (as opposed to a Grant) leverages NASA’s investment in a way the R&A does not. It is a contractual obligation that requires in-kind contributions from the PI institution (facilities, faculty hires, non-NASA funded labor, etc.).
- Rapid integration of multi-disciplinary topics enhances productivity
- Cross-team sharing of students unites teams (increases collaborations)
- Long-term funding alleviates the need to write many individual proposals, and allows more time for research (just as a block grant would do).
- Teams that were competitive now collaborate to reveal new knowledge at intersections between fields of expertise which otherwise would not have crossed.
- Real-time science discussions foster sharing of data and facilities between teams (domestic and int’l) prior to results being published.
- Funded by NASA HEOMD and SMD
- SSERVI created in 2013
- Expanded Scope from NASA Lunar Science Institute
“SSERVI is a virtual institute established to advance basic and applied lunar and planetary science research and to advance human exploration of the solar system through scientific discovery.”

• Advance basic and applied research fundamental to lunar and planetary science, and advance human exploration of the solar system through scientific discovery and advancement

• Conduct and catalyze collaborative research in lunar and planetary science, enabling cross-disciplinary partnerships throughout the science and exploration communities

• Provide scientific, technical, and mission-relevant analyses for appropriate NASA programs, planning and space missions as requested by NASA

• Explore innovative ways of using information technology for scientific collaboration and information dissemination across geographic boundaries

• Train the next generation of scientific explorers through research opportunities, and encourage global public engagement through informal programs, and participatory public events
SSERVI Role in Solar System Exploration

- SSERVI provides flexible support by using cooperative agreements to redirect efforts in response to new knowledge and/or changing NASA requirements.

- Data and facilities sharing hastens scientific discovery, while creating cross-disciplinary exchanges and teaming arrangements that otherwise would not have existed.

- SSERVI acts as a conduit between NASA and community:
  - Distribution of knowledge through reports, peer reviewed publications, Exploration Science Forum, Workshops without Walls, Focus groups, etc.
  - NASA's research investments and scientific breakthroughs from team research are well disseminated throughout the international and national communities
The role of the Moon, NEAs, Phobos & Deimos in revealing the origin and evolution of the inner Solar System

Moon, NEA, and Martian moon investigations as windows into planetary differentiation processes

Near-Earth asteroid characterization (including NEAs that are potential human destinations)

Lunar structure and composition

Regolith of Target Body(s)

Dust and plasma interactions on Target Body(s)

Volatile (in its broad sense) and other potential resources on Target Body(s)

Innovative observations that will advance our understanding of the fundamental physical laws, composition, and origins of the Universe
U.S. Teams Competitively Selected in 2013

- Nine teams funded March of 2014, each for 5 years:
  - **Dan Britt**, University of Central Florida. “Center for Lunar and Asteroid Surface Science” (CLASS)
  - **Bill Farrell**, Goddard Space Flight Center. “Dynamic Response of Environments at Asteroids, the Moon, and moons of Mars (DREAM2)”
  - **Tim Glotch**, Stony Brook University. “Remote, In Situ and Synchrotron Studies for Science and Exploration”
  - **Mihaly Horanyi**, University of Colorado. “Institute for Modeling Plasma, Atmospheres and Cosmic Dust (IMPACT)”

“More than the sum of its parts, SSERVI’s distributed network of US Teams leverage gov’t, academia, and industry capabilities and investments to advance science and engineering technologies for multiple target bodies and communities.”
## Science and Exploration Balance

<table>
<thead>
<tr>
<th>Role of Target Body(s) in revealing the origin and evolution of the inner Solar System</th>
<th>Target Body structure and composition</th>
<th>Innovative observations that will enhance our understanding of the fundamental physical laws, composition, and origins of the Universe</th>
<th>Near-Earth asteroid characterization (including NEAs that are potential human destinations)</th>
<th>Dust and plasma interactions on Target Body(s)</th>
<th>Geo-technical properties (Moon, NEAs, Mars)</th>
<th>Regolith of Target Bodies</th>
<th>Radiation</th>
<th>Volatiles (in its broad sense) and other potential resources on Target Body(s)</th>
<th>In-Situ Resource Utilization (ISRU)/Prospecting (Moon, NEAs, Mars)</th>
<th>Propulsion-induced ejecta (Moon, NEAs, Mars)</th>
<th>Operations/Operability (all destinations, including transit)</th>
<th>Human health and performance (all destinations, including transit)</th>
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### Science emphasis

**Science emphasis**

- **Heldmann**
- **Brit**
- **Pieters**
- **Bussey**
- **Farrell**
- **Horanyi**
- **Glotch**
- **Kring**
- **Britt**
- **Farrell**
- **Pieters**
- **Bussey**
- **Glotch**
- **Horanyi**
- **Kring**
- **Britt**
- **Glotch**
- **Horanyi**
- **Kring**
- **Bottke**
- **Heldmann**
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- **Horanyi**

### Exploration emphasis (SKGs)

**Exploration emphasis (SKGs)**

- **Heldmann**
- **Brit**
- **Pieters**
- **Bussey**
- **Farrell**
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- **Glotch**
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- **Heldmann**
- **Horanyi**

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The table above illustrates the balance between science and exploration efforts, highlighting the roles of various target bodies and the emphasis on different aspects such as structure, composition, characterization, and resource utilization.
International Partners

- Seven international partnerships
- additional partnerships in development

**Canada** (14 institutions)
PI: Gordon Osinski,
University of Western Ontario

**Germany** (29 institutions)
PI: Ralf Jaumann
DLR

**Israel** (1 institution)
PI: Shlomi Arnon
Ben-Gurion University at the Negev

**Kingdom of Saudi Arabia** (1 institution)
PI: Abdulaziz Alothman
King Abdulaziz City for Science & Technology (KACST)

**Korea** (1 institution)
PI: Gwangyeok Ju
Korean Aerospace Research Institute (KARI)

**Netherlands** (8 institutions)
PI: Wim van Westrenen
VU University Amsterdam

**United Kingdom** (14 institutions)
PI: Mahesh Anand,
Open University

SSERVI’s International partnerships engage the global science community on a no-exchange-of-funds basis.
Collaborations between
**Mihaly Horanyi** at
University of Colorado,
**Carle Pieters** at Brown
University, **Tim Glotch** at
Stony Brook University,
**Jennifer Heldmann** at NASA
Ames Research Center, and
**David Kring** at the Lunar
and Planetary Institute (LPI)

**Sample Repository @
Natural History Museum**
Collaborations between, David Kring at the Lunar and Planetary Institute (LPI), William Bottke at Southwest Research Institute (SwRI), and Mihaly Horanyi at University of Colorado

Asteroid Modeling/ Nice Model
Collaborations between Mihaly Horanyi at University of Colorado, Carle Pieters at Brown University and Tim Glotch at SUNY

Facilities sharing and sample analysis
Jennifer Heldmann (FINESSE) at Ames Research Center, **Tim Glotch** (RIS⁴E) at Stony Brook University and Canadian partner.

**Field campaign at Craters of the Moon** National Monument and Preserve, Idaho.
David Kring at Lunar and Planetary Institute (LPI) and Canadian international partner

Field School at the Sudbury Impact Structure
Mihaly Horanyi at University of Colorado
Collaborated with German/DLR international partners

Dust Accelerator: ice target and gas chamber instrument development
Science & Exploration Collaborations

Examples of linkages between Science and Exploration:

Bussey – Soil Work
- Mapped the geology of the south pole and characterizes polar deposits, volatiles and environment (lighting)
- Tests wheel designs for more efficient rovers and excavation/civil engineering

Pieters – Lunar Resources
- Models of lunar magma ocean and evolution
- Laboratory experiments to model lithologies & volatiles on the lunar surface

Horanyi – Dust Accelerator
- Used for instrument calibrations
- Dust experiments (energies up to 3 MV; particle sizes: 0.2 – 2.5 microns; particle velocities: 1 – 100 km/s)
SSERVI (and NLSI):

- Trained ~200 graduates who are now employed in academic and other positions;
- Established new programs and promoted faculty positions at several universities
- Established annual LunaGradCon; an in-person graduate student conference (2009-present)
- Student exchange programs between teams (domestic and international)
- NASA Postdoctoral Program (NPP), with postdocs shared between teams to facilitate inter-team collaborations
- Supports NextGen Lunar Scientists and Engineers (NGLSE) 2009-present; SSERVI considering new group with expanded scope
- Works to develop consistent educational and training opportunities
- Ensures long duration support of graduate students and postdocs
• Operates out of NASA Ames Research Center (10 WYE/ 3 FTE)
• Transitioned in 2013 from NASA Lunar Science Institute (NLSI) with same staff
• **Tracks team science activities, budgets, and publications**
• Develops Cooperative Agreement Notices (CANs) with HQ guidance
• Runs panel review and recommends team selections to HQ
• Administers funds for competitively selected teams (~$1.2M/team/year)
• Reports Institute activities to NASA HQ, community and general public
• Interfaces with Lunar Exploration & Analysis Group (LEAG), Small Bodies Analysis Group (SBAG), the commercial space sector,
• Facilitates commercial partnerships to further Solar System science
• Implements collaborative technologies and training for collaborative research
• Convenes an Executive Council to share team research
• Enables Community collaborative science and fosters community development
• Organizes, develops and coordinates SSERVI public engagement activities
• Fosters formal International partnerships at no-cost to NASA
Science & Exploration Community Engagement

• 2014 Exploration Science Forum (ESF); ~450 attendees
• SSERVI Central is a co-organizer of the European Lunar Symposium (ELS); several SSERVI teams actively involved
• Strong annual SSERVI participation and leadership at European Planetary Science Conference (EPSC), Lunar Planetary Science Conference (LPSC), and American Geophysical Union (AGU) fall meeting (with special SSERVI AGU sessions)
• Provide scientific input and virtual meeting support for Global Exploration Roadmap (GER)
• SSERVI staff serve active roles in LEAG & SBAG (Executive and Steering Committees)
• SSERVI continues Focus Groups to bring together communities to share science and exploration strategies
• SSERVI acts as liaison to Planetary Science Community for NASA Human Architecture Team (HAT)
• ~1000 virtual meetings facilitated 2008-2014
SSERVI was instrumental in supporting more than 160 virtual events in 2013.
• Three days (**21 hours**) of virtual, interactive activities
• Over 450 unique log-ins
• **Parallel sessions** were held throughout the forum with ~200 concurrent attendees
• More than **100 speakers** presented from locations around the country and as far away as India
• **68 virtual posters** with synchronous and asynchronous chat and commenting
• Student "Lightning Talks"
• Participants and presenters joined from desktops, mobile devices and/or "virtual hubs", high quality videoconferencing rooms located at NASA Centers, universities and labs around the world.
• Social media platforms such as Twitter, Facebook and YouTube were used to increase reach and engagement.
• No travel required
• While successful, a survey of 153 people revealed significant shortcomings in comparison to in-person forum (virtual not ideal for all situations)
• NASA decided to reinstate the in-person component to the 2014 Exploration Science Forum (240 in-person/220 virtual attendees)
Cutting-Edge Virtual Technologies

Silicon Valley offers:
• unique “Early Adopter” and “Developer” roles
• “Hot spot” for new technology development
• Tech partnership opportunities

SSERVI:
• Virtual Institutes keep NASA on the cutting-edge of collaborative technology
• Ensures new communications tools enhance effectiveness of interdisciplinary and collaborative research and training
• Acts as a conduit between new tech and the scientific community
  • 10% of 2014 ESF participants attended using Telepresence Robot

Telepresence Robot by Double Robotics Inc., Sunnyvale CA
NASA transitioned Lunar Mapping and Modeling Portal (LMMP) Management to SSERVI in 2014:

- LMMP is a multi-user collaborative tool useful for mission planning and analyzing multiple datasets
- Enhanced LMMP lighting analysis performance
- Android & IOS “Moon Tours” mobile app released
- High resolution lunar surface maps and models upgraded
- Developed ability to bookmark layered visualizations for later retrieval and for sharing with other users
- Developed the ability to add user layers
- Improved system robustness and reliability
- Adapted to Vesta, Mars and other bodies included in PDS database
Google Lunar X-Prize (GLXP)
Hosted meetings, facilitated web series on infusing science into GLXP teams, coordinated payload opportunities

Lunar Orbiter Image Recovery Project (LOIRP)
SSERVI/NLSI facilitated Space Act, hosting high-res images, and website development
Community Opportunities

• Team selections staggered every 2.5-3 years, with award periods of five years per team, provides continuity across generations of Institute teams and responding to changing needs of NASA.

• New Focus Groups centered around the expanded Institute scope bring together previously disparate scientific and exploration communities (e.g., Analogs, Volatiles, Mission Instrumentation, and Dust Atmosphere and Plasma focus groups).

• Several new international partnerships are currently in review which will provide new collaborative opportunities for international and domestic team members.
Virtual Institute model (with longer periods of performance and higher funding levels in a Cooperative Agreement structure) applied to cross-disciplinary problems allows for:

• Ability to assemble the best possible team, regardless of geographic location
• Cost savings (travel, leveraging existing facilities, time)
• Rapid response to changing environments (political, technological, scientific)
• Long term stability for students (future workforce)
• Unexpected discoveries from interdisciplinary and inter-team research (i.e., the whole is more than sum of the parts) and significant productivity from each team
Back Up Slides
Virtual Organizations and Collaborative Technologies

What are they?
“Geographically, organizationally and/or time dispersed workers brought together by IT to accomplish one or more organizational goals”

Why are they important?
Science and engineering challenges are increasingly complex. Solving them requires the expertise and resources of many organizations. Strategic partnerships around the world allow the government to respond to rapidly changing environments.

“Organizational structure promotes an optimal interaction between centralization and autonomy”

Organization of technologies, people and communities creates “Participative Centralization”
Harvard Business Review
David Kring at Lunar and Planetary Institute (LPI)
Collaborated with Carle Pieters at Brown University

William Bottke at Southwest Research Institute (SwRI)

*Collaborated with David Kring* at Lunar and Planetary Institute (LPI)

**Sample Analysis & Modeling**
Carle Pieters at Brown University collaborated with Ben Bussey at Applied Physics Lab (APL)

Remote Sensing
Mihaly Horanyi at University of Colorado collaborated with William Farrell at Goddard Space Flight Center (GSFC)

Dust/Plasma Modeling & Experimentation
Benefits and Value *

- Ability to share and leverage expensive equipment and facilities
- Cost savings
- Skill Sharing
- Enhance technical competencies
- Increased insight and discovery across disciplines
- Remote mentoring and training
- Development of new products
- Increased competitiveness
- Improved information and knowledge sharing across disciplines and between organizations
- Decreased duplication of effort
- Better understanding of complex global issues resulting in improvement of public policies
- Rapid response for decision making
- Shorter development time of products
- Higher publication rates
- Unite experts across the globe
- Teams and organizations can reconfigure and adapt quickly to meet dynamic requirements and opportunities
- Increased visibility of STEM disciplines
- Broader access to datasets and instrumentation and field sites
- Increased group and organizational learning across distances
- Group and organizational learning can accelerate progress on goals and sustainability of the community

“Leaders today must be able to harness ideas, people and resources across boundaries of all kinds. That requires reinventing their talent strategies and building strong connections both inside and outside their organizations.” –Harvard Business Review
Virtual Collaboration: Then and Now

Collaborative technologies have come a long way...
- When SSERVI (SSERVI’s predecessor) first started the iPad had not yet been invented!
- Virtual conferences were high-end and expensive, and (mostly) required dedicated rooms

Now tablets and smart phones are widely available
- Requires smaller investment in infrastructure
- Individuals can connect wherever an internet connection is available
- New visualization tools can help researchers analyze data and models more effectively, less expensively and in a collaborative and interactive environment

Where is the frontier?
- New technologies (3D, 4K, hyperwalls, etc.) are pointing the way toward further high-fidelity, high data rate collaboration
- Higher bandwidth, new data visualization, multiple geographically dispersed teams, etc. (e.g. 10G data pipes now becoming standard in academia)
Big data, cloud computing and high data rates are enabling new connections, interactions and insights between disciplines

- Scientific and engineering visualization
- Mobile devices and augmented reality combined with large display systems

Leveraging communication technologies can enhance science and education activities related to fieldwork, analogues and planetary exploration

- Application to data sharing and archiving, virtual science participation at field sites and geo-location of data
- Big data, low bandwidth for use in exploration environments
- Many science data sets and models are of a size and complexity that warrant the development of new research and analysis techniques.

Where is Virtual Technology Going?
SSERVI advances our understanding of Earth, of our Solar System, and the cosmos, through virtual collaboration.

**Virtual Forum & Hyperwall**

**Research:** SSERVI demonstrated a custom Adobe Connect experience at the 2013 Lunar Science Forum. The SSERVI Hyperwall is a collaborative technology to share scientific results through meetings in virtual space. Exploration Uplink, is an education-focused web-operated rover, recently demonstrated in S. Africa.

**Description:** Previously used in universities and laboratories across the country as well as international locations, this live, web enabled connection and a very simple interface, allows scientists, students and the general public to collaborate from thousands of miles away, in real time.

**Application:** Users are introduced to key elements of participatory exploration: Lunar and asteroid analog sites; Tele-operation and mission planning challenges (through communication delays and limited mobility); Strategies for achieving maximum science and exploration goals.

**Learn more:**

[http://sservi.nasa.gov](http://sservi.nasa.gov)
“I took a virtual tour of the SSERVI office by beaming into a small robot. I was sitting at my computer in the living room of my apartment in the Netherlands, and was immediately connected to SSERVI Central in California. In just a few minutes, they taught me the basics of how to control the robot - and then we were off on the tour. We stopped by a few offices, we looked at all the great technology used for collaboration, and I even had my first official “virtual water cooler” conversation.

Being in a robot is a unique experience because while it’s not like being there in person, there is still a component of having a physical presence. For example, when someone walks away from the robot, the sound gets quieter - and you can hear when someone is speaking behind you. In addition, the engagement level of the user is higher because it’s not just a monitor we are sitting behind and passively watching.

It will be interesting to experiment with how remote technologies can help us bridge the distance on virtual teams!”

--Lisette Sutherland,
Collaborative Communities Specialist
The Netherlands