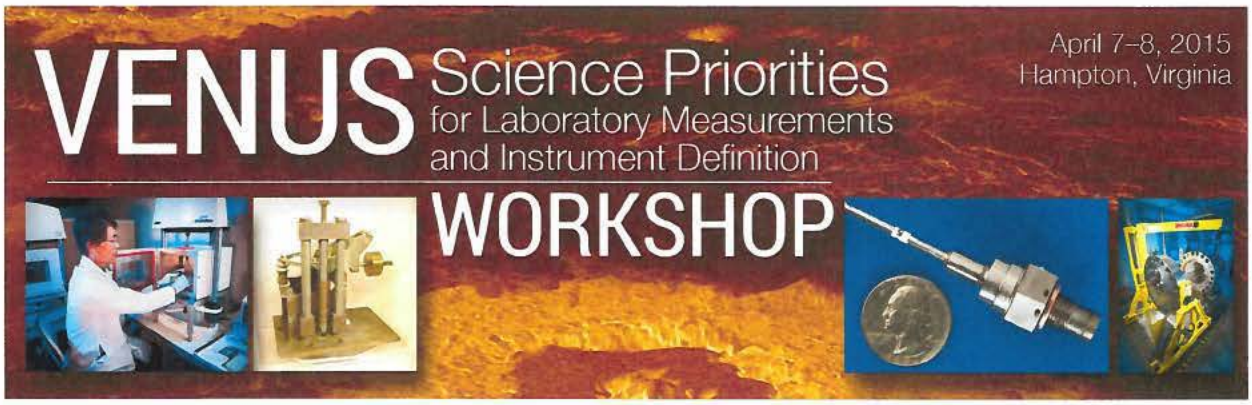

Program

LUNAR AND PLANETARY INSTITUTE

USRA

Venus Science Priorities

for Laboratory Measurements and Instrument Definition Workshop

April 7–8, 2015 • Hampton, Virginia

Sponsor

Universities Space Research Association
Lunar and Planetary Institute
National Aeronautics and Space Administration
National Institute for Aerospace
Northrop Grumman Aerospace Systems

Conveners

Tibor Kremic
NASA Glenn Research Center
Upendra Singh
NASA Langley Research Center

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Abstracts for this workshop are available in electronic format via the workshop website at **www.hou.usra.edu/meetings/venustech2015/** and can be cited as Author A. B. and Author C. D. (2015) Title of abstract. In *Venus Science Priorities for Laboratory Measurements and Instrument Definition Workshop,* Abstract #XXXX. LPI Contribution No. 1838, Lunar and Planetary Institute, Houston.

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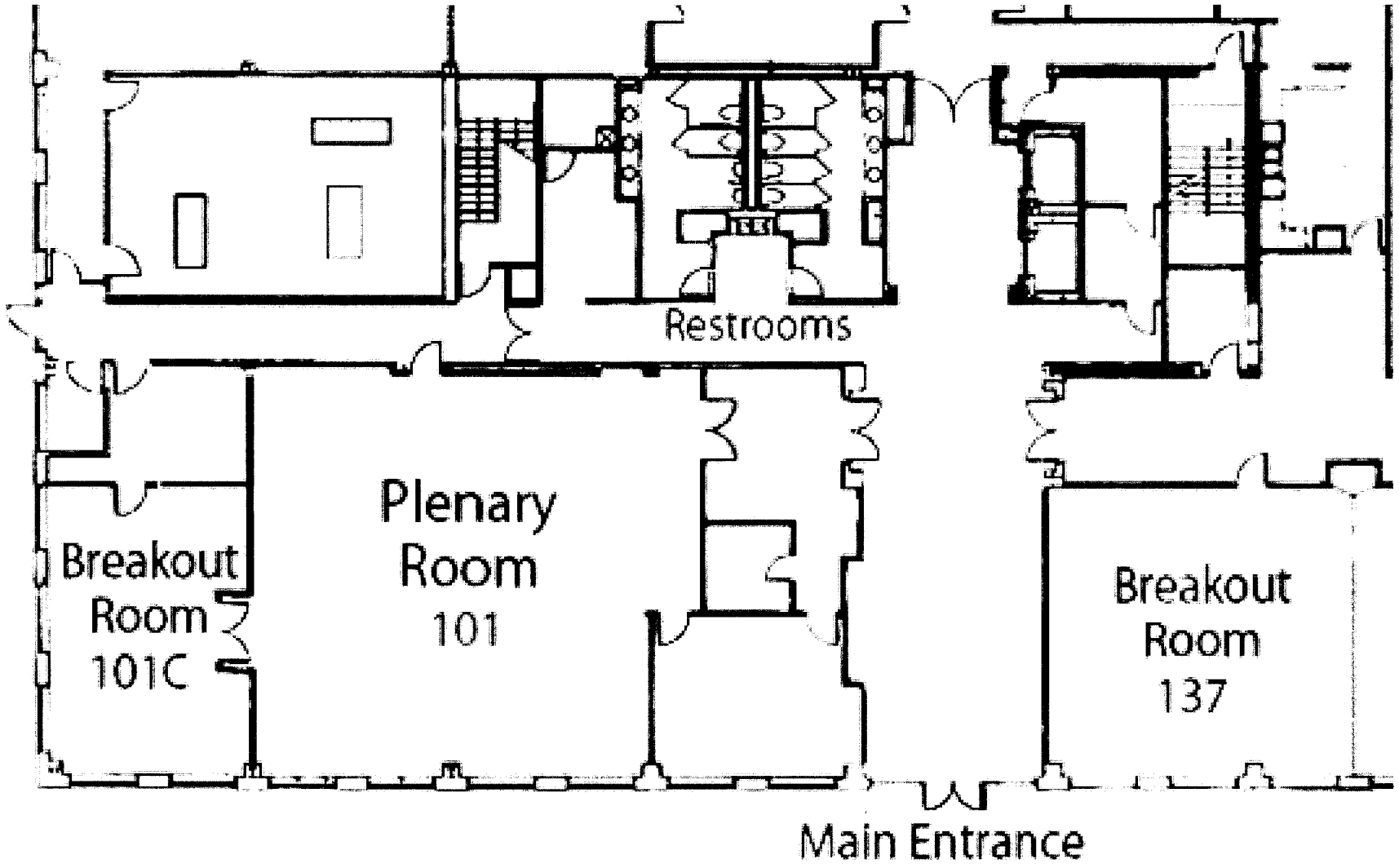

National Institute for Aerospace

Technical Guide to Sessions

Tuesday, April 7, 2015

8:00 a.m.	Room 101	Plenary: Workshop Overview and Introductions
9:45 a.m.	Room 101	Pre-Poster Session: Community Comments/ Plugs/One-Minute Presentations
10:30 a.m.	Room 101	Poster Session ***Atmosphere*** *Lab Measurements* *Multiscale — Power — Electronics — Platform — Other* *Orbit* *Surface*
1:00 p.m.	Room 101	Plenary: Announcement for Breakouts and Breakout Sessions

Wednesday, April 8, 2015

8:30 a.m.	Room 101	Plenary: Day 1 Summary of Group Progress/Results
9:30 a.m.	Breakout Rooms	Breakout Sessions
1:00 p.m.	Breakout Rooms	Breakout Sessions
4:00 p.m.	Room 101	Plenary: Day 2 Summary of Group Progress/Results
7:30 p.m.	Virginia Air and Space Museum	Public Lecture

Program

Tuesday, April 7, 2015
PLENARY: WORKSHOP OVERVIEW AND INTRODUCTION
8:00 a.m. Room 101

Chairs: **Tibor Kremic**
Upendra Singh

8:00 a.m. Kremic T. *
Welcome, Introductions, and Logistics

8:15 a.m. Glaze L. S. *
VEXAG Goals and Objectives Summary

8:30 a.m. Beauchamp P. M. *
General Technology Summary

8:45 a.m. Seablom M. *
Synergies with Space Technology Mission Directorate

9:00 a.m. Sharpton V. L. *
Targets Workshop Results and Next Steps

9:25 a.m. Beaty D.W. *
Instrument and Lab Work: Lessons Learned from Mars

9:35 a.m. *Break*

PRE-POSTER SESSION:
COMMUNITY COMMENTS/PLUGS/ONE-MINUTE PRESENTATIONS
9:45 a.m. Room 101

Chairs: **Noam Izenberg**

Each poster presenter will have an opportunity to give a one-minute oral presentation summarizing highlights to focus discussion during the poster session.

Tuesday, April 7, 2015
POSTER SESSION: ATMOSPHERE
10:30 a.m. Room 101

Wilzewski J. S. Gordon I. E. Rothman L. S.
CO_2, H_2 and He Line Broadening Coefficients and Pressure Shifts for the HITRAN Database **[#4001]**
In order to aid studies of the Venusian atmosphere the spectral lines of selected molecules in the HITRAN database were supplemented with broadening coefficients (and their temperature exponents) and line shifts due to the pressure of CO_2.

Trainer M. G. Mahaffy P. R. Brinckerhoff W. B. Johnson N. M. Glaze L. S.
Investigating the Origin and Evolution of Venus with In Situ Mass Spectrometry **[#4003]**
Measurement of noble gas abundances on Venus remain a high priority for planetary science. This can be accomplished as part of an atmospheric investigation using flight-proven mass spectrometer technology and demonstrated enrichment techniques.

Majid W. Duncan C. Kuiper T. Russell C. Lightsey E.
A Cubesat Mission to Venus: A Low-Cost Approach to the Investigation of Venus Lightning **[#4004]**
We will describe a CubeSat mission concept to study lightning at Venus.

Lee G. Polidan R. Sokol D. Bolisay L. Barnes N.
Venus Atmospheric Maneuverable Platform (VAMP) Science Vehicle Concept **[#4007]**
We will update the VAMP design and discuss plans for future trade studies, analyses, and prototyping to advance the concept and we will discuss how VAMP will enable opportunities for novel long duration scientific studies of the Venus atmosphere.

Izenberg N. R. Papadakis S. J. Monica A. H. Deglau D. M.
FirefOx — An Oxygen Fugacity Sensor for Venus **[#4008]**
FirefOx is a small, simple primary sensor for the quantitative assessment of partial pressure of oxygen in the lower atmosphere of Venus, to help quantify the surface's oxidation state and stable mineralogy.

Webster C. R. Blacksberg J. Christensen L. E. Flesch G. J. Forouhar S. Briggs R.
Keymeulen D. Mahaffy P. R.
Digital Tunable Laser Spectrometer for Venus Atmospheric Isotope Ratios **[#4012]**
A Venus Tunable Laser Spectrometer (VTLS) can provide high science return for Venus atmospheric and planetary evolution through high-precision measurements of a variety of isotope ratios in C, H, O and S-containing gases, including triple isotopes.

Mimoun D. Cutts J. Stevenson D. Garcia R. F.
Exploring Venus Interior Structure by Detection of Infrasonic Waves **[#4013]**
Knowledge of the interior structure of Venus is currently impeded by the limited time that a seismometer can survive in the atmosphere of Venus. We propose to remotely detect quakes by infrasonic measurements at the top of the cloud layer.

Vento D. M. Kremic T. Nakley L. M.
Using the Glenn Extreme Environments Rig (GEER) for Venus Research **[#4014]**
The Glenn Extreme Environments Rig (GEER) has the capability to simulate the Venus atmosphere chemistry, temperature and pressure anywhere from the surface to about 70 km. GEER can provide a CO_2/N_2 with six trace gasses plus water.

Dutt A. Limaye S. S.
Adiabatic Lapse Rate and Static Stability in the Venus Atmosphere **[#4023]**
We calculate the adiabatic lapse rate and static stability by considering the real gas effects of the binary mixture of carbon dioxide and nitrogen that largely make up the Venus atmosphere through a thermodynamic model explicit in Helmholtz energy.

Steffes P. G.
Laboratory Measurements of the 2–4 mm Opacity of Sulfuric Acid Vapor Under Simulated Venus Conditions **[#4026]**
For over 30 years sulfuric acid vapor has been recognized as a major source of the microwave and millimeter-wave absorption in the atmosphere of Venus. This paper describes a new laboratory measurement campaign to characterize the 2–4 mm opacity.

Makel D. B. Carranza S.
Development of a Harsh Environment Gas Sensor Array for Venus Atmospheric Measurements **[#4033]**
Progress on the development of a compact chemical microsensor array for profiling the chemical composition of the Venus atmosphere and providing gas composition measurements as part of the long lived lander is described.

Ashish Mr. Alam Mr. Limaye Mr.
Blimplane a Conceptual Hybrid UAV for Venus Exploration **[#4034]**
A Semi-Buoyant Aerial Platform is proposed. High fidelity CFD simulation are done to get the vehicle aerodynamic performance.The vehicle can perform surveillance and station keeping missions for altitude range 60–80km. It can take a payload of 100 kg.

Alam Mr. Saroha Mr. Priyadarshi Mr. Limaye Mr.
Hybrid Entry Ship: A Conceptual Entry-Descent and Surveillance Platform for Venus Atmosphere **[#4035]**
A hybrid entry ship concept which will enter from low Venus orbit. It will undergo series of changes in its configuration to meet an optimal entry-descent and surveillance sequence. It houses payloads upto 300 kg. Available power to payload is 250W.

Tuesday, April 7, 2015
POSTER SESSION: LAB MEASUREMENTS
10:30 a.m. Room 101

Kohler E. Johnson N. M.
Current Laboratory Research and Venus In-Situ Chamber Investigations **[#4019]**
We present current laboratory experiments conducted in the Venus simulation chamber at NASA Goddard Space Flight Center.

Smith M. A. H. Sung K. Brown L. R. Malathy Devi V.
Measurements of CO_2 Spectroscopic Parameters in the Near-Infrared **[#4022]**
High-resolution near-IR laboratory spectra of CO_2 at room temperature and below have been recorded using Fourier transform spectrometers (FTS) together with specialized sample cells. Spectroscopic parameters have been retrieved from these data.

Tuesday, April 7, 2015
POSTER SESSION: MULTISCALE — POWER — ELECTRONICS — PLATFORM — OTHER
10:30 a.m. Room 101

Lawrence D. J. Peplowski P. N.
Addressing High-Priority Venus Science Objectives with Orbital and Surface-Based Nuclear Spectroscopy **[#4005]**
We explore the use of gamma-ray and neutron measurements at Venus to address important Venus science questions. Low-resource instrumentation provides high heritage solutions for addressing questions related to Venus' atmosphere and surface.

Miura Y. Tanosaki T.
Local and Global Waters on Venus and Earth: Poor Planetary Supply on Venus **[#4006]**
Global materials of rock, air and water can found in the inner solar system. Local water can be formed by mixing to the rocks, whereas global water found only Earth is required huge supply from two planets. Venus has no mixed source of global water.

Kott T. M. Izenberg N. R. Papadakis S. J. Gold R. E.
Unspooling Generators for Venus Power Applications **[#4009]**
Unspooling generators provide a novel, potentially low cost and risk long duration power source for future Venus missions.

Walker A. R. Haberbusch M. S. Sasson J.
Thermoacoustic Duplex Technology for Cooling and Powering a Venus Lander **[#4018]**
A Thermoacoustic Stirling Heat Engine (TASHE) is directly coupled to a Pulse Tube Refrigerator (PTR) in a duplex configuration, providing simultaneous cooling and electrical power, thereby suiting the needs of a long-lived Venus lander.

Newman J. M.
Development of a Lightweight Radiometer for In-Situ Measurements in Extreme Environments **[#4028]**
NASA has identified the need for technology to explore extreme environments. A robust radiometer can meet this need and make flexible measurements through selection of optical band-pass filters. As such, development of a radiometer has been proposed.

Holsclaw G. M. Esposito L. W. McClintock W. M.
The Balloon Infrared Spectrograph for Surface Thermal Emission (BIRSTE) of Venus **[#4029]**
To address fundamental questions regarding geologic processes on Venus, we propose a near-infrared spectrograph with low resource requirements mounted on a balloon gondola platform to measure thermal emission from the surface.

de Jong M. L.
Venus Altitude Cycling Balloon **[#4030]**
A novel balloon concept is demonstrated that uses mechanical compression as altitude control mechanism to sustain long duration balloon probe flight in the cloud level region of Venus' atmosphere between 45 and 58 km altitude.

Monica A. H. Deglau D. M. Maier D. Kohn E. Izenberg N. R. Papadakis S. J.
High Temperature Electronics for Future Venus Exploration **[#4032]**
We discuss two different high temperature electronics paradigms for use in future missions to Venus.

Tuesday, April 7, 2015
POSTER SESSION: ORBIT
10:30 a.m. Room 101

Hensley S. Smrekar S. Shaffer S. Paller M. Figueroa H. Freeman A. Hodges R. Walkemayer P.
VISAR: A Next Generation Inteferometric Radar for Venus Exploration **[#4010]**
The VERITAS Mission is a proposed mission to Venus designed to obtain high resolution imagery and topography of the surface using an X-band radar configured as a single pass radar interferometer coupled with a multispectral NIR mapping capability.

Jessup K. L. Woodruff R. A. Davis M. Beebe C. Finley T. Marcq E. Mills F. Bertaux J. L.
High-Spectral Resolution Mid-UV Spectrograph for Venus Observing **[#4024]**
We are developing a high-spectral resolution (1.5 Å) mid-UV spectrograph that can map the spatial distribution of Venus' SO_2 and SO gases when observing from orbit around Venus as well as from a highly elliptical (perigee ~ 75000 km) Earth orbit.

Gilmore M. S.
Elevating Venus Observations (of the Solid Planet) from Orbit **[#4025]**
Future orbital missions require enhanced communication rates, and extensive laboratory work on the spectroscopy of minerals and high temperature and the rates and composition of Venus weathering reactions.

Singh U. N. Limaye S. Emmitt G. Refaat T. F. Kavaya M. J. Yu J. Petros M.
Lidar Measurements of Wind and Cloud Around Venus from an Orbiting or Floating/Flying Platform **[#4036]**
Given the presence of clouds and haze in the upper portion of the Venus atmosphere, it is reasonable to consider a Doppler Wind Lidar (DWL) for making remote measurements of the 3D winds within the tops of clouds and the overlying haze layer.

Gronoff G. P. Gray C. Mertens C. J. Slanger T.
A UV-Visible Instrument for Limb Based Venus Observations **[#4037]**
The objective of this presentation is to show the need of a UV-visible instrument for limb observation of the upper atmosphere.

Imamura T. Ando H. Iwata T. Yamazaki A. Kasai Y. Sagawa H.
Venus Orbiter Concept with Satellite-to-Satellite Radio Occultation and Submillimeter Sounder **[#4038]**
JAXA's Venus orbiter Akatsuki aims to explore the atmospheric dynamics of Venus by multi-wavelength imaging observations.

Tuesday, April 7, 2015
POSTER SESSION: SURFACE
10:30 a.m. Room 101

Pandey S. Zacny K.
Impeller Flow Characterisation for a High Temperature Venus Drill and Sample Delivery System **[#4002]**
Venus Drill and Sample Delivery System is being designed to conduct surface operations during future missions. The impact of ambient atmosphere on the performance of pneumatically driven components is investigated using finite volume model approach.

Sharma S. K. Misra A. K. Acosta-Maeda T. E. Dyer M. D. Clegg S. M. Wiens R. C.
Time-Resolved Remote Raman Spectroscopy for Venus Exploration **[#4011]**
We describe a compact gatable planetary Raman spectrograph developed at the University of Hawaii that is suitable for detecting low concentrations of relevant minerals in a basaltic glass matrix on the Venus surface from a lander.

DeMarines J. Abedin M. N. Moore W. Bradley A. T.
From Clouds to Life Detection: The Past, Present, and Future of LIDAR **[#4015]**
LIDAR holds promise for Venus exploration with its application to remote sensing of mineralogy, atmospheric chemistry, and biosignatures. We present new developments in LIDAR instrumentation, and discuss potential applications to Venus science.

Hunter G. W. Ponchak G. E. Beheim G. M. Neudeck P. G. Spry D. J. Scardelletti M. C. Meredith R. D. Taylor B. Beard S. Kiefer W. S.
High Temperature Seismometer, Electronics, and Sensor Development for Venus Applications **[#4016]**
This poster describes work to develop long-lived seismometry, high temperature electronics, and sensor technologies operational in Venus conditions with the potential to enable new Venus surface missions.

Pauken M. Smrekar S.
A Heat Flux Instrument for Measuring Venus Surface Heat Flow **[#4017]**
An instrument has been developed to measure the surface heat flow on Venus. Heat flow measurement would provide a better understanding of the evolutionary development of Venus. The instrument uses a semiconductor thermopile to measure heat flow.

Treiman A. H. Dyar M. D.
Instrument Requirements for Geochemistry (Elemental Abundances): An Approach **[#4020]**
An approach for geochemists to generate science-based requirements for elemental analyses on planetary surfaces such as Venus is described.

Landis G. A. Oleson S. R.
Venus Rover Design Studies **[#4021]**
This paper summarizes studies of rover and lander systems to operate on the surface of Venus analyzed by the NASA Glenn COMPASS team.

Wang A. Wei J. Lambert J. L. Hutchinson I.
A Compact Integrated Raman Spectrometer, CIRS, for Fine-Scale Definitive Mineralogy in Venus Explorations **[#4027]**
A flight Raman system requires carefully crafted optical configurations with high efficiency optical and opto-electronic components. CIRS and MMRS represent two flexible configurations to be selected by various types of Venus missions.

Tuesday, April 7, 2015
PLENARY: ANNOUNCEMENTS FOR BREAKOUTS
1:00 p.m. Room 101

1:00 p.m. Announcements and dispersal for breakouts

BREAKOUT SESSIONS
1:15 p.m.

Orbit	**Atmosphere**	**Surface**
Room: 137	Room: 101C	Room: 101
Marty Gilmore and Joern Helbert	Kevin Baines	Allan Trieman

1:15 p.m. Moderators
Introductions

1:30 p.m. Groups
Breakout Discussions

Wednesday, April 8, 2015
PLENARY: DAY 1 SUMMARY OF GROUP PROGRESS/RESULTS
8:30 a.m. Room 101

Chairs: **Tibor Kremic**
Upendra Singh

8:30 a.m. Orbit Group Progress

8:40 a.m. Atmosphere Group Progress

8:50 a.m. Surface Group Progress

BREAKOUT SESSIONS
9:30 a.m.

Orbit	**Atmosphere**	**Surface**
Room: 137	Room: 101C	Room: 101
Marty Gilmore and Joern Helbert	Kevin Baines	Allan Trieman

9:30 a.m. Moderators
Announcements

9:45 a.m. Groups
Breakout Discussions

Wednesday, April 8, 2015
BREAKOUT SESSIONS
1:00 p.m.

Orbit	**Atmosphere**	**Surface**
Room: 137	Room: 101C	Room: 101
Marty Gilmore and Joern Helbert	Kevin Baines	Allan Trieman

1:00 p.m. Moderators
Announcements

1:15 p.m. Groups
Breakout Discussions

PLENARY: DAY 2 SUMMARY OF GROUP PROGRESS/RESULTS
4:00 p.m. Room 101

Chairs: **Tibor Kremic**
Upendra Singh

4:00 p.m. Orbit Group Summary

4:10 p.m. Atmosphere Group Summary

4:20 p.m. Surface Group Summary

4:30 p.m. Discussion/Comments, Follow-up Work, Communicating Findings/Results, Next Steps

5:30 p.m. *Meeting Adjourns*

PUBLIC LECTURE
7:30 p.m. Virginia Air and Space Museum

Invited Speakers:

Dr. Hakan Svedham, *European Space Agency*

James Green, *NASA Headquarters*

Notes

Notes