

# 21<sup>st</sup> International Planetary Probe Workshop

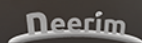
Williamsburg, Virginia

June 8-14, 2024

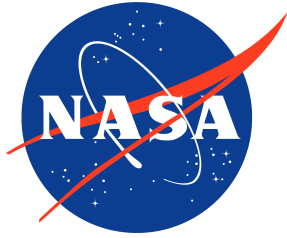


**Short Course:**  
Historical Highlights  
of Planetary Probe  
Missions  
June 8-9, 2024

[www.ippw2024.org](http://www.ippw2024.org)



# IPPW-2024 Sponsors & Patrons



# IPPW-2024 Welcome

Each year, the International Planetary Probe Workshop brings together a diverse group of scientists, engineers, technologists, and policy makers from around the world. We welcome you to Williamsburg, Virginia, USA and the 21st IPPW, hosted by Analytical Mechanics Associates and NASA Langley Research Center. IPPW-2024 is being held in coastal Virginia, home of NASA's oldest field center. NASA Langley has been central to Entry, Descent, and Landing (EDL) missions and technology development since the earliest days of spaceflight for both crewed and robotic exploration. Today, the center is the home of Hypersonic Inflatable Aerodynamic Decelerator (HIAD) technology, as well as many other advanced EDL technologies in development, and mission support for Earth-return, and exploration of the Moon, Venus, Mars, Titan, Uranus, and beyond.

IPPW-2024 offers a varied program, with keynote addresses, technical presentations, posters, and many opportunities for networking. Per IPPW tradition, the Workshop was preceded by a two-day Short Course, "Historical Highlights of Planetary Probe Missions". Additionally, we solicited and evaluated nominees for the Al Seiff Memorial Award, an annual award recognizing and honoring an individual for their outstanding career contributions to IPPW disciplines and commitment to mentoring the next generation of solar system explorers. We are pleased to present the 2024 Al Seiff Award to Pat Beauchamp, recently retired from the Jet Propulsion Laboratory.

We received a total of 130 abstracts, with 70 oral and 52 poster presentations planned for this year's workshop. We encourage you to engage with the presenters throughout the week. The Program Organizing Committee worked hard to develop and coordinate the outstanding technical program over the five days of this year's IPPW. To accommodate a large number of presenters and posters in a workshop format, we have scheduled shorter oral presentations within each technical session, followed by a brief Q&A with each speaker. All posters will be highlighted with brief, pitch-style short talks by the poster presenter prior to two separate Poster Sessions on Tuesday and Thursday evenings. There are no parallel sessions at IPPW-2024, allowing you to attend all sessions of interest. After two and a half days of presentations and poster discussions, Wednesday afternoon, June 12th, has been set aside to participate in a tour of facilities at NASA Langley Research Center, followed by a banquet at the Virginia Air and Space Museum, home of Apollo 12.

Since IPPW-2024 is a workshop, we invite you to take advantage of the many opportunities during coffee breaks, lunches, and open evenings to pursue collaborations and partnerships and to exchange ideas with other workshop participants. We thank our generous IPPW-2024 sponsors, as listed in this program, for supporting our 21st workshop and for providing funding to support both European and US students participating in the workshop. This year, we awarded 20 student scholarships and have scheduled events with a student focus, including the Student Social on Sunday evening and the Student-Professional Development Luncheon on Tuesday.

On Friday afternoon, June 14th, the plans will be presented for our 22nd workshop (IPPW-2025), to be hosted by the High Enthalpy Flow Diagnostics Group (HEFDiG) of the Institute of Space Systems at the University of Stuttgart in Germany. With so many exciting missions, emerging technologies, new collaborations, and planning for future exploration opportunities at space agencies around the world, we encourage you to actively participate, expand your knowledge, and enjoy our 21st International Planetary Probe Workshop this year. IPPW is entirely run by volunteers serving on numerous committees throughout the year, and we would like to thank the Local Organizing Committee, Program Organizing Committee, Student Organizing Committee, Al Seiff Award Committee, and the entire International Organizing Committee for the planning and execution of this year's workshop.

Welcome to IPPW-2024! *Ad astra.*

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# AI Seiff Memorial Award

## About the Award

The young researchers today will stand on the shoulders of the giants from the past to discover great things in the future.

An important element of the International Planetary Probe Workshops is to introduce, motivate, and educate young people in the scientific studies of planetary atmospheres. Only by placing today's research activities in the proper historical context through recognizing the contributions of our predecessors can we define a framework for future explorations.

As solar system explorers, we are bound by our colleagues' achievements and are obligated to further this chain of scientific discovery to the next generation. The award also provides young researchers, who never had the chance to know him, with the opportunity to learn how AI Seiff's work truly influences virtually every aspect of planetary exploration.

### **IPPW-2024 AI Seiff Award Winner: Dr. Patricia (Pat) Beauchamp, Caltech/JPL, Retired**

Pat's contributions to science and engineering have been extensive, and have been achieved through a series of challenging assignments. After joining JPL in 1992, she was appointed to lead JPL's Center of Excellence for In Situ Exploration and Sample Return (CISSR). Her participation in OPAG and VEXAG has enhanced the work of both assessment groups. Pat went on to serve as Chief Technologist for JPL's Engineering and Science Directorate. In that role, Pat led the effort to develop NASA's Technology Readiness Assessment (TRA) best practice. She took part in significant collaborations with international colleagues on numerous studies. These ultimately resulted in ESA's Jupiter Icy Moons Explorer (JUICE) mission, now on its way to Jupiter, and NASA's Europa Clipper mission, scheduled for launch this year. In addition, Pat has played a key role in attracting and mentoring young scientists and engineers, including guiding many young women in their science and technology careers at JPL and NASA. For these achievements in science, technology, and mentoring in the tradition of AI Seiff, IPPW has selected Pat as the 2024 recipient of the AI Seiff Award.



# Short Course: Historical Highlights of Planetary Probe Missions

It is almost 60 years since the first successful landings on other planetary bodies (Luna 9) and almost 50 since images came back from other worlds (Venera 9, Viking). The short course has a compilation of a series of presentations featuring scholars of these endeavors, and including some of the protagonists themselves to share their direct experience of international planetary mission developments, to highlight the challenges and triumphs, and to offer lessons learned for future efforts. In addition to the successful projects, the course will also touch on planetary missions that were lost, and review the counterfactual history of how planetary exploration might have been very different had they succeeded.

In the spirit of IPPW itself, the topics cover scientific, engineering and programmatic aspects.

Topics covered will include:

- Key planetary entry probe demonstrators (e.g. PAET)
- First close-up investigation of Mars and preparation for Viking
- Into the hellish depths of Venus with the Venera probes
- Galileo and Pioneer Venus probes
- Radio science highlights
- Parachute development
- Thermal Protection Systems
- Huygens
- Beagle 2
- Small bodies landers
- Information sources on historical probe missions
- Trivia quiz!

# Short Course Agenda

21st International Planetary Probe Workshop, Williamsburg, Virginia, USA. June 8-14, 2024.

Short Course : "Historical Highlights of Planetary Probe Missions"

Organizers : Andrew Ball (ESA) and Ralph Lorenz (Johns Hopkins APL)

	Start	Duration	End	Activity / Talk Title	Speaker(s)	
Saturday 8th June	9:00	0:20	9:20	Register		
	9:20	0:30	9:50	Welcome / Introduction	Ball/Lorenz	
	9:50	0:40	10:30	Planetary Atmospheric Entry Test (PAET)	Jim Arnold	
	10:30	0:20	10:50	Coffee Break		
	10:50	0:40	11:30	Beyond the Internet - Information Sources on Planetary Missions	Andrew Ball	
	11:30	0:40	12:10	Heritage in Planetary Missions, A Double-edged Sword	Peter Gage	
	12:10	0:40	12:50	Lunch		
	12:50	0:40	13:30	From Mariner 9 Orbiter to Viking Lander: A Bridge too Far?	Jim Cutts	
	13:30	0:40	14:10	First into the Hellish Depths: the Venera/VeGa Landers	Lorenz/Ball	
	14:10	0:40	14:50	Pioneer Venus and Galileo Probes	Bernie Bienstock	
	14:50	0:15	15:05	Coffee Break		
	15:05	0:40	15:45	Radio Highlights	Sami Asmar	
	15:45	0:40	16:25	Aerodynamic Decelerator Systems: Advances in the Last Two Decades	Clara O'Farrell/Katie Siegler	
	16:25	0:30	16:55	Trivia Quiz	all (Lorenz/Ball facilitation)	
	Sunday 9th June	9:30	0:20	9:50	Welcome / Coffee / Quiz recap	
		9:50	0:40	10:30	History of Ablative TPS used in NASA Missions	Raj Venkatapathy/Matt Gasch
10:30		0:40	11:10	Historical highlights of European Thermal Protection System development	Thierry Pichon	
11:10		0:20	11:30	Coffee Break		
11:30		0:40	12:10	Japanese Sample Return Missions from Asteroids: Hayabusa and Hayabusa 2	Kazuhiko Yamada	
12:10		0:40	12:50	Beagle 2 20 Years Later: What It Was, Was Supposed To Do, and What It Did	Ed Chester	
12:50		1:00	13:50	Lunch		
13:50		0:40	14:30	Small Bodies Landers	Lars Witte	
14:30		0:40	15:10	Huygens	Ralph Lorenz	
15:10		0:20	15:30	Coffee Break		
15:30		0:45	16:15	Beyond the Agencies: Commercial and other paradigms	Lorenz/Chester/Ball	
16:15	0:45	17:00	Counterfactual History Discussion - What If.....?	all (Lorenz/Ball facilitation)		

# IPPW-2024 Technical Program Overview

## Venus

A renaissance in Venus exploration is underway with ESA's EnVision orbiter mission and NASA's VERITAS orbiter and the DAVINCI in-situ probe missions all going to Venus by the early 2030s. Several other missions, both commercial and government-funded, are also targeting Venus exploration in the next decade. The subsequent steps in Venus exploration may include aerial platforms, short duration landers, and long-lived lander concepts for which technologies are still under development. Our dedicated Venus IPPW session invites submissions on both scientific platform technologies and the experiments that will be conducted from them. Of particular interest are innovative techniques for exploring Venus that employ methods for coping with and/or exploiting its severe environment. We especially welcome Venus science contributions, both surface and atmospheric, from selected missions or from missions in development.

## Mars

This session will focus on recent, current, in development, and proposed Mars missions. Topics may include science, technology, and systems dealing with the in-situ exploration of Mars, including aerobraking, entry, descent, and landing segments, and sample return. Contributions to this session can address aspects such as (but not limited to) climate, atmospheric science, astrobiology, geology, in-situ resource utilization, and human exploration through the use of local, regional, or global landed networks. This session will focus on recent, current, in development, and proposed Mars missions. Topics may include science, technology, and systems dealing with the in-situ exploration of Mars, including aerobraking, entry, descent, and landing segments, and sample return. Contributions to this session can address aspects such as (but not limited to) climate, atmospheric science, astrobiology, geology, in-situ resource utilization, and human exploration through the use of local, regional, or global landed networks.

## Ice Giants & Gas Giants

The gas giants (Jupiter & Saturn) and ice giants (Uranus & Neptune) each offer unique opportunities for improving our understanding of planetary science and astrobiology. This is reflected in the recent planetary science decadal survey, which identifies the Uranus orbiter and probe as the highest priority new flagship mission and includes a Saturn probe as a prioritized theme for medium-class missions. This session will bring together contributions related to scientific investigation, entry descent and landing systems, cross-cutting technologies, and mission concepts relevant to in-situ exploration of the outer planets. Discussions of lessons learned from relevant previous missions or ongoing efforts are also welcome.

## **Titan & Airless Bodies**

This session combines contributions on all aspects of the exploration of two types of targets: water worlds (Europa, Enceladus, Titan) and airless bodies (Mercury, Earth's moon, other airless planetary satellites, and small solar system bodies including asteroids and comets). Content may include related science and science goals/drivers, mission concepts, (entry,) descent and landing technologies, ocean access methods for the water worlds, architectures for and development of landers/rovers/vehicles, instrumentation, and field testing of technologies/equipment. Abstracts on current and future mission proposals, operational strategies, impact of lessons learned from previous missions, as well as results of current projects are equally invited.

## **Modeling, Simulation, Testing, & Validation**

This session will focus on advancements in entry, descent, and landing (EDL) mission phases, either in the form of experiments or modeling & simulation. Such relevant topics include: flight dynamics/stability; computational fluid dynamics (CFD); shock layer radiation and kinetics, guidance, navigation, and control (GNC); materials and thermal protection systems (TPS); decelerator systems; plume surface interaction (PSI); integrated/optimized capabilities; and related disciplines. Current work in testing and demonstration techniques, model validation, and diagnostics are also a major component of this session. Work that advances the state-of-the-art, broadens the capabilities of EDL technologies, or compares/leverages both testing and computational models including data-driven modeling, is especially relevant. Preference is given to discussion of models, simulations, ground testing, flight tests, and validation applied directly to specific EDL missions and proposals, rather than general model development.

## **Innovative Concepts for Exploration**

This session invites submission of abstracts that propose novel and highly innovative future mission concepts, scientific measurement instruments, technologies, and programmatic approaches for solar system exploration. This includes, but is not limited to, non-traditional entry, descent, and landing concepts and technologies, innovative in-situ exploration of solar system bodies including multi-sensor/multi-probe and swarm approaches, small spacecraft exploration missions and technologies, and innovative solutions for reducing mission risk and/or life cycle costs to enable a greater number of mission opportunities or facilitate synergies between missions. Preference will be given to innovative and visionary ideas that have the potential to significantly advance the state of the art in current exploration approaches, capabilities or technologies.

## **Aerocapture, Entry, Descent, & Landing**

This session focuses on the development and advancement of EDL technologies to enable future planetary missions involving probes, landers, and deployable flight vehicles. Areas of interest include but are not limited to aeroassist maneuvers, thermal protection systems, deployable heat shields, aerothermodynamics, parachutes, GN&C, retro-propulsion, landing systems, and associated instrumentation. Discussion of new concepts and flight demonstrations is encouraged.

## **Science, Instrumentation, Experiments, & In-Situ Measurements**

Science instruments are a key component of planetary exploration missions. Scientific experiments in space exploration typically involve the development of instrument concepts and ideas through experiments and field campaigns. This session invites abstracts discussing instrument concepts, hardware, and field experiments aimed at demonstrating and developing scientific investigations for planetary exploration. Abstracts may include topics such as innovative concepts for previously infeasible measurements or report on progress made in developing instrumentation hardware or measurement techniques through experiments. Priority will be given to experiments or instrumentation geared towards in-situ measurements such as landers, probes, or aerial platforms. A combined scientific/technical approach, addressing both the scientific objectives and measurement principles are encouraged.

## **Earth Return**

The Earth Return session will provide a discussion space for mission concepts, science objectives, and engineering related to Sample Return to Earth. Also welcome are submissions regarding sample acquisition, characterization, containment assurance, and planetary protection related to safely returning samples to Earth. The goal of this session is to present the state-of-the-art within the community for sample return to Earth missions as well as concepts to enable and enhance future Earth return missions.



Full Program QR Code

# Workshop Program Schedule

Time	Monday	Tuesday	Wednesday	Thursday	Friday	
7:30	Coffee and Snacks	Coffee and Snacks	Coffee and Snacks	Coffee and Snacks	Coffee and Snacks	
7:45						
8:00						
8:15						
8:30	Opening Session 1/2	Venus Keynote  Venus (5 talks)	Modelling Keynote  Modelling (5 talks)	Giants Keynote  Giants (5 talks)	Titan & Airless Keynote  Titan & Airless (5 talks)	
8:45						
9:00						
9:15		Coffee Break	Coffee Break	Coffee Break	Coffee Break	
9:30						
9:45						
10:00	Opening Session 2/2	Science Keynote  Science (6 talks)	Innov. Explor. Keynote  Innov. Explor. (6 talks)	Modelling Posters  Modelling (7 talks)	Earth Return Keynote  Earth Return (6 talks)	
10:15						
10:30						
10:45		Boxed Lunch (TBC)	Lunch	Lunch	Closing Session	
11:00						
11:15						
11:30	Lunch & Dignitaries Lunch	Lunch & Professional Development Lunch	Posters: Giants, Innov. Keynote  Venus (5 talks)	AEDL Keynote  Mars, Sci, Venus Posters		
11:45						
12:00						
12:15	Mars Keynote  Mars (4 talks)	AEDL Posters  AEDL (5 talks)	NASA Langley Tour	AEDL (5 slots)	Adjourn	
12:30						
12:45-14:15						
14:15	Coffee Break	Coffee Break	Coffee Break	Break		
14:30						
14:45						
15:00	AEDL I (3 talks)	Mars (4 talks)	Break	Break		
15:15						
15:30						
15:45	Break		Break			
16:00	Reception	Poster Session (1.5h): AEDL, Mars, Venus & Science (30 posters)	Banquet	Poster Session (1.5h): Modellingm, Innov Expl, Giants, Titan & Earth Return		
16:15						
16:30						
16:45	Break	Break	Break	Break		
17:00						
17:15						
17:30	Break	Break	Break	Break		
17:45						
18:00						
18:15	Break	Break	Break	Break		
18:30						
18:45						
19:00	Break	Break	Break	Break		
19:15						
19:30						
19:45	IOC Dinner					
20:00						