

2018

CONFERENCE ON ADVANCED
POWER SYSTEMS FOR

DEEP SPACE EXPLORATION



CONFERENCE AGENDA



A satellite with solar panels is shown in space, orbiting a planet. The background is a starry field.

Table of Contents

Welcome	1
Technical Advisory Committee	2
Conference Agenda	3
Side Meeting Rooms	3
Notes Page	11

Detailed Agenda

Monday, 22 October 2018

Registration	4
VIP Welcome & Announcements	4
Goals for Deep Space Exploration	4
System Perspectives on Deep Space Power I.....	4
Networking Lunch	5
System Perspectives on Deep Space Power II.....	5
Powering Ocean Worlds Exploration.....	5

Tuesday, 23 October 2018

Registration	6
NASA and DOE Power Systems Perspectives.....	6
Powering Spacecraft in Extreme Environments I.....	6
Lunch Break (On Your Own).....	7
Powering Spacecraft in Extreme Environments II.....	7

Wednesday, 24 October 2018

Registration	8
Powering Small Deep Space Missions	8
Powering Mars Exploration and Connections to Lunar Exploration	9
Networking Lunch	9
Emerging and Advanced Deep Space Power Concepts	9

Welcome

We are pleased to welcome you to the 2018 Conference on Advanced Power Systems for Deep Space Exploration! As we approach the 6th decade of interplanetary exploration, this conference will provide an excellent platform to discuss where we have been and the challenges ahead. Space power technologies have advanced significantly from the first United States satellite (Explorer 1) launched with primary batteries alone in 1958, to the sophisticated multi-mission radioisotope thermoelectric generator (RTG) and high reliability lithium-ion batteries powering the Mars Science Laboratory today.

As we look to the future, the technical challenges, as well as the opportunities for exploration and discovery are no less significant. These include the proposed exploration of caverns and lava tubes beneath the planets and moons of our Solar System, the return to Earth of an extraterrestrial sample from Mars, and science probes landing on the surface of Europa and one day melting through its icy shell to access and investigate the liquid water below for bio-signatures. In the works are concepts for our first interstellar missions.

The innovations in power systems continue. The recent Juno mission to Jupiter challenged the conventional wisdom that solar arrays could not be used at these extreme distances. This power system was enabled by advances in low-intensity and lightweight solar arrays combined with high energy and long-life lithium-ion batteries. In 2017, humankind passed the unimaginable milestone of the Voyager 1 spacecraft surviving 40 years in space supported by its long lived RTG. A host of other spacecraft such as the 20 year Cassini mission to Saturn, the New Horizons mission to Pluto, as well as the comet and asteroid missions Dawn, Rosetta and Hayabusa have all executed their voyages of discovery supported by a reliable power source. Continued advances in RTG technology are on-going at the National Aeronautics and Space Administration and the European Space Agency, and are complemented by similar enhancements in energy storage technologies, solar arrays, power

electronics, and new power system architectures. What advances are on the horizon to enable the next generation of deep space exploration? That is the focus of this conference.

We have planned a comprehensive agenda of talks covering the full gamut of deep space power topics, including mission design, systems engineering, power electronics, power generation, and energy storage geared for the challenging and scientifically intriguing destinations within the Solar System and beyond. This includes speakers from space agencies and organizations around the world, who will provide an international perspective. The intent of this conference is to share information, to build new relationships, and to pave the way for new approaches to deep space power systems. Enjoy your time in Pasadena!

Technical Advisory Committee
2018 Conference on Advanced Deep Space Power Systems

Technical Advisory Committee

Lead Technical Advisor

Erik Brandon, Jet Propulsion Laboratory

Technical Advisory Committee

Andreea Boca, Jet Propulsion Laboratory
Gary Bolotin, Jet Propulsion Laboratory
Ratnakumar Bugga, Jet Propulsion Laboratory
Richard Ewell, Jet Propulsion Laboratory
Jean-Pierre Fleurial, Jet Propulsion Laboratory
Jonathan Grandidier, Jet Propulsion Laboratory
Terry Hendricks, Jet Propulsion Laboratory
Chris Matthes, Jet Propulsion Laboratory
Will West, Jet Propulsion Laboratory
David Woerner, Jet Propulsion Laboratory

Monday	Tuesday	Wednesday
VIP Welcome and Conference Announcements	NASA and DOE Power System Perspectives	Powering Small Deep Space Missions
Goals for Deep Space Exploration		
Break	Break	Break
System Perspectives on Deep Space Power I	Powering Spacecraft in Extreme Environments I	Powering Mars Exploration and Connections to Lunar Exploration
Conference Networking Lunch	Lunch Break (On Your Own)	Conference Networking Lunch
System Perspectives on Deep Space Power II	Powering Spacecraft in Extreme Environments II	Emerging and Advanced Deep Space Power Concepts
Break	Break	Break
Powering Ocean Worlds Exploration	Powering Spacecraft in Extreme Environments II, cont.	Emerging and Advanced Deep Space Power Concepts, cont.

Side Meeting Rooms

We encourage you to meet with your colleagues throughout the week. See the registration desk for availability on side meeting rooms. Space will be scheduled on a first-come-first-served basis.

Monday, 22 October 2018

- 0715 - 0745 Speaker Meeting for Monday's Presenters**
Conference Center Lower Level, Room 107
- 0700 - 1730 Registration Open**
Conference Center Lower Level Foyer

VIP Welcome & Announcements

Conference Center Lower Level, Room 107

- 0800 - 0815 Jet Propulsion Laboratory VIP Welcome**
Larry James, Jet Propulsion Laboratory
- 0815 - 0825 Conference Introduction and Review of Conference Logistics**
Erik Brandon, Jet Propulsion Laboratory

Goals for Deep Space Exploration

Session Chair: Erik Brandon, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 0825 - 0855 NASA Planetary Science Division Overview**
Leonard Dudzinski, NASA Headquarters
- 0855 - 0925 Overview of Decadal Survey and OPAG Findings for Deep Space Exploration**
Pat Beauchamp, Jet Propulsion Laboratory
- 0925 - 0955 Science Perspective: The Big Questions for Deep Space Exploration**
Michael Mischna, Jet Propulsion Laboratory
- 0955 - 1025 Break**

System Perspectives on Deep Space Power I

Session Chair: Gary Bolotin, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1025 - 1050 Overview of Deep Space Power System Challenges**
Greg Carr, Jet Propulsion Laboratory
- 1050 - 1115 Formulation of New Architectures for Deep Space Exploration**
Brent Sherwood, Jet Propulsion Laboratory

- 1115 - 1140 The Role of Power in Deep Space Communications**
Stephen Townes, Jet Propulsion Laboratory
- 1140 - 1250 Networking Lunch - Provided Onsite**
Conference Center Lower Level, Room 106

System Perspectives on Deep Space Power II
Session Chair: Richard Ewell, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1250 - 1320 Designing Spacecraft Power Systems to Solve Planetary Protection Challenges**
Lisa Pratt, NASA Headquarters
- 1320 - 1350 Overview of NASA Radioisotope Power Systems Program**
Leonard Dudzinski, NASA Headquarters
- 1350 - 1420 Overview of the European Space Nuclear Power Systems Programme**
Richard Ambrosi, University of Leicester
- 1420 - 1445 Power Systems for Avionics and Motor Control in Deep Space Missions**
Gary Bolotin, Jet Propulsion Laboratory
- 1445 - 1515 Break**

Powering Ocean Worlds Exploration
Session Chair: Jean-Pierre Fleurial, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1515 - 1545 Enabling Technologies for Ocean Worlds Exploration**
Andrew Gray, Jet Propulsion Laboratory
- 1545 - 1610 Solar/Battery Power Architectures for Missions to Jupiter and Beyond**
Greg Carr, Jet Propulsion Laboratory
- 1610 - 1635 Commercial Li-Ion Battery Risk Reduction for Applications to Ocean Worlds Exploration**
Kumar Bugga, Jet Propulsion Laboratory

- 1635 - 1700 Saturn Solar Cells: State of Art and Development**
Andreea Boca, Jet Propulsion Laboratory
- 1700 - 1725 eMMRTG Development and Infusion**
Joe Giglio, DOE Idaho National Laboratory
- 1725 Adjourn**

Tuesday, 23 October 2018

- 0715 - 0745 Speaker Meeting for Tuesday's Presenters**
Conference Center Lower Level, Room 107
- 0700 - 1800 Registration Open**
Conference Center Lower Level Foyer

NASA and DOE Power System Perspectives
Session Chair: David Woerner, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 0800 - 0805 Announcements**
- 0805 - 0835 NASA's Power Capability Leadership Team's Strategic Priorities in Power**
Chris Iannello, NASA Office of Chief Engineer
- 0835 - 0905 Department of Energy Plutonium Production Updates**
Steven Sherman, Oak Ridge National Laboratory
- 0905 - 0930 Improvements to the Nuclear Launch Approval Process**
Peter McCallum, NASA Glenn Research Center
- 0930 - 1000 Break**

Powering Spacecraft in Extreme Environments I
Session Chair: Will West, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1000 - 1025 Ultra-Low Temperature Primary Battery Development**
Cyrus Rustomji, South 8 Technologies

- 1025 - 1050 New Approaches for Primary Battery Power System Design**
Brandon Burns, Jet Propulsion Laboratory
- 1050 - 1115 High Efficiency Multi-Junction Solar Cells for LILT Applications**
Clay McPheeters, SolAero Technologies Corporation
- 1115 - 1140 LILT Optimized Triple Junction Solar Cells**
Philip Chiu, Spectrolab
- 1140 - 1205 Low Temperature Characterization of Space Photovoltaics**
Don Walker, The Aerospace Corporation
- 1205 - 1330 Lunch Break - On Your Own**
See registration desk for walkable restaurant ideas

Powering Spacecraft in Extreme Environments II
Session Chair: Jonathan Granddier and Andreea Boca, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1330 - 1355 Power Needs for Ocean Worlds Sub-Surface Access**
Wayne Zimmerman, Jet Propulsion Laboratory
- 1355 - 1420 Extreme Environments Solar Power Project: Enabling Solar Array Power to the Outer Planets**
Jeremiah McNatt, NASA Glenn Research Center
- 1420 - 1445 Design of Solar Arrays for Deep Space Application**
Ed Gaddy, Johns Hopkins University, Applied Physics Laboratory
- 1445 - 1510 Lithium-Ion Batteries for the Juno Mission**
Rob Gitzendanner, EaglePicher Technologies
- 1510 - 1535 Sub-Surface RTG Systems and New Heat Sources**
Terry Hendricks, Jet Propulsion Laboratory
- 1535 - 1555 Break**

- 1555 - 1620 Understanding Batteries under Extreme Conditions using Advanced Modeling and Simulation Techniques**
Simon Hein, German Aerospace Center/DLR and Helmholtz Institute Ulm (HIU)
- 1620 - 1645 Safety and Reliability of Batteries in Deep Space Missions**
Tom Barrera, LIB-X Consulting
- 1645 - 1710 Approaches to Fault Tolerance in Deep Space Batteries**
Joseph Troutman, Enersys/ABSL
- 1710 - 1735 Primary/Rechargeable Batteries for High Reliability Deep-Space Exploration Applications**
Chengsong Ma, SAFT
- 1735 - 1800 Ultralight Radiation-Tolerant Perovskite Solar Cells for Deep Space Applications**
Michael Kelzenberg, Caltech
- 1800 Adjourn**

Wednesday, 24 October 2018

- 0715 - 0745 Speaker Meeting for Wednesday's Presenters**
Conference Center Lower Level, Room 107
- 0700 - 1730 Registration Open**
Conference Center Lower Level Foyer

Powering Small Deep Space Missions
Session Chair: Terry Hendricks, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 0800 - 0805 Announcements**
- 0805 - 0830 Power Systems for Future Deep Space CubeSat Missions**
Jonathan Baker, Jet Propulsion Laboratory

- 0830 - 0855 Power Systems for Drones in Deep Space Exploration**
Florence Fusalba, CEA-Grenoble FRANCE and Bruno Samaniego Lopez, Airbus
- 0855 - 0920 Development and Testing of Batteries for Asteroid Sample Return Missions**
Yoshitsugu Sone, JAXA
- 0920 - 0945 Small RPS (<40 W_e) Mission Architectures**
Young Lee, Jet Propulsion Laboratory
- 0945 - 1010 1-Watt Radioisotope Power System for Small Spacecraft**
Scott Wilson, NASA Glenn Research Center
- 1010 - 1040 Break**

Powering Mars Exploration and Connections to Lunar Exploration

Session Chair: Kumar Bugga, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1040 - 1110 Common Power Options for Crewed Surface Missions and Deep Space Science Probes**
Lee Mason, NASA Glenn Research Center
- 1110 - 1135 Mars Optimized Solar Cells**
Paul Stella, Jet Propulsion Laboratory
- 1135 - 1200 Low Temperature Rechargeable Li-ion Batteries for Mars Sample Return and Small Robotic Missions**
Marshall Smart, Jet Propulsion Laboratory
- 1200 - 1315 Networking Lunch - Provided Onsite**
Conference Center Lower Level, Room 106

Emerging and Advanced Deep Space Power Concepts

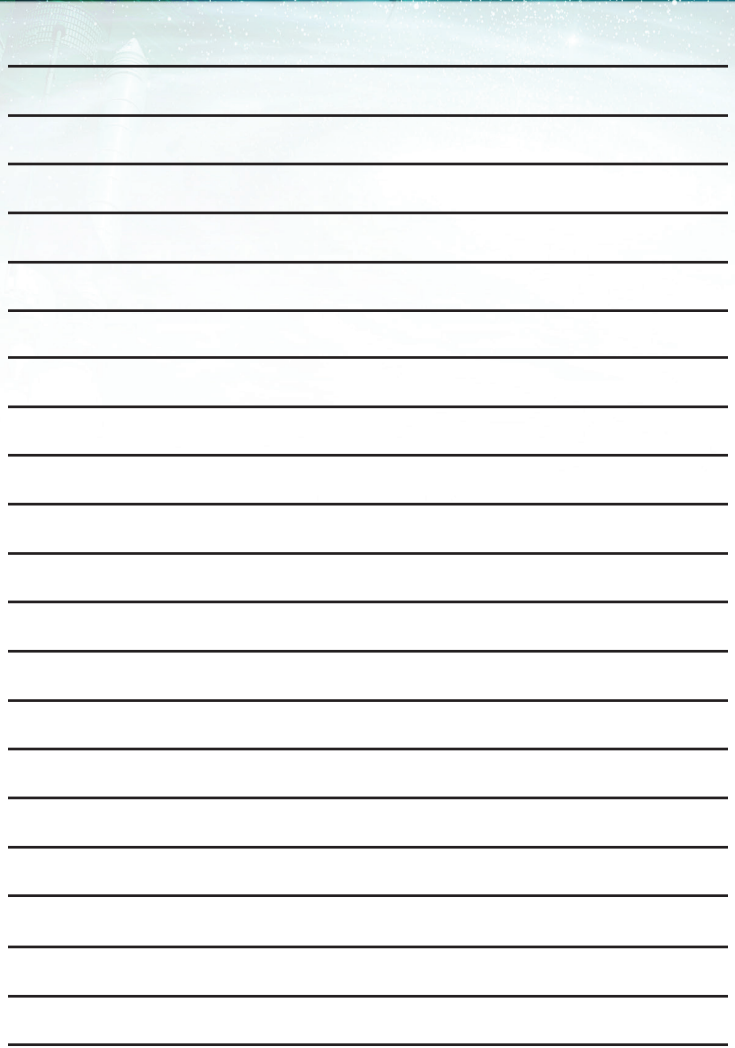
Session Chair: Erik Brandon, Jet Propulsion Laboratory
Conference Center Lower Level, Room 107

- 1315 - 1340 Dynamic Radioisotope Power Systems**
Salvatore Oriti, NASA Glenn Research Center

- 1340 - 1405 Chemical Heat Source Power Systems**
Alex Rattner, Penn State University
- 1405 - 1430 Fuel Cells for Mars and Beyond**
Thomas Valdez, Teledyne
- 1430 - 1455 Hybrid Power Storage & Conversion for Deep Space Applications**
Greg Semrau, Moog Aerospace
- 1455 - 1520 Development of the Point Focus Concentrator (PFC) Compact Telescoping Array (CTA)**
Mike McEachen, Northrop Grumman Innovation Systems
- 1520 - 1550 Break**
- 1550 - 1615 Overview of Systems Engineering Integrated with Technology Development Work to Inform Future RTG Designs**
Terry Hendricks and Jean-Pierre Fleurial, Jet Propulsion Laboratory
- 1615 - 1640 Power for Interstellar Encounter: Analysis of Ultra-Miniature Power Systems for an Interstellar Flyby Probe**
Geoffrey Landis, NASA Glenn Research Center
- 1640 - 1705 Directed Energy Propulsion for Interstellar Precursor Missions**
John Brophy, Jet Propulsion Laboratory
- 1705 - 1730 Power Beaming for Rover Systems**
Brett Kennedy, Jet Propulsion Laboratory
- 1730 Final Announcements and Conference Adjourn**



Notes



A whiteboard with horizontal lines for taking notes.

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