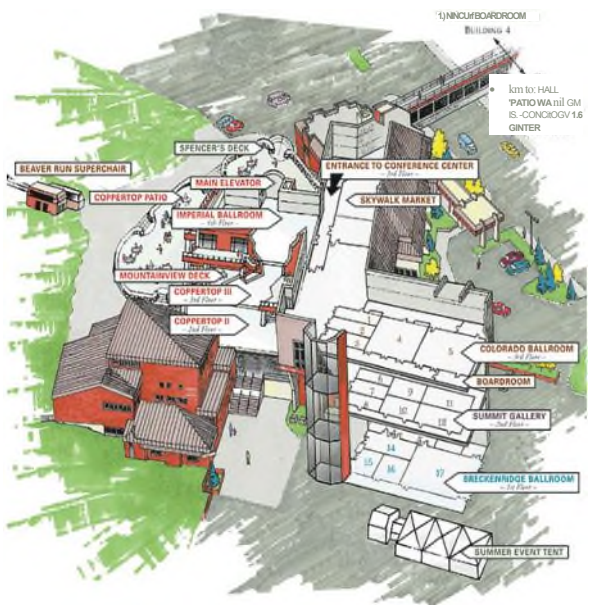# PROGRAM

41st ANNUAL AAS GUIDANCE & CONTROL CONFERENCE

February 1st to February 7th, 2018

Thursday, February 1st and
Friday, February 2nd

Check in **7AM**

Session **8AM**

Classified Session
Classified Advances in G&C and
Classified Recent Experiences

Pre-registration by Jan 18, 2018 is required and will be controlled (walk-ins will NOT be admitted). Attendees must register for the entire AAS conference to be eligible to attend classified sessions. Contact a local chairperson for more information.

Location of Classified Session:

The Aerospace Corporation
7250 Getting Heights
Colorado Springs, CO 80916

Traditional Conference Location

Beaver Run Conference Center
620 Village Rd
Breckenridge, Colorado 80424
(970) 453-6000

Room check-in at the Beaver Run Resort
front desk 4:00 p.m. daily.

Conference Registration

Friday 5:00 to 8:00 p.m.
Daily 6:30 to 10:00 a.m. and 4:00 to 6:00 p.m.

Registration Questions

Lis Garratt	303-931-7622
Amy Delay	303-731-9876
Carolyn O'Brien	720-277-5851

41th Annual AAS Guidance, Navigation & Control Conference Chairperson
Dr. Cheryl Walker
Lockheed Martin
303-977-2149
cheryl.a.walker@lmco.com

Wi-Fi Access

Select "**Beaver Run Meeting**" wireless network
Open a browser window
Enter voucher code: **AAS2018**

Preprint Paper Access (read-only)

Go to webpage: https://goo.gl/4SYSTE

Note: download the .zip file for all available pre-print papers

Conference Schedule Overview

Thursday, February 1nd

Badging and Breakfast	8–9 AM
Classified Session	9 AM–4:30 PM

Friday, February 2rd

Badging and Breakfast	8–9 AM
Classified Session	9 AM–12:30 PM
Conference Registration	5–8 PM
Welcome Reception	6–9 PM

Saturday, February 3rd

Morning Session	7–10 AM
AAS STEM SCAPE Event	10:30 AM–4 PM
NASA Astronaut for Children	4–5 PM
Technical Exhibits & Presentation of Student Awards	5–8 PM

Sunday, February 4th

Posters Focus Session	8:30–9 AM
Morning Sessions	7–10 AM
Beyond the Textbook Tutorial	11 AM–2 PM
Afternoon Sessions	2–4 PM
Super Bowl '18 in Imperial Ballroom	4:15 PM

Monday February 5th

Morning Sessions	7–10 AM
Beyond the Textbook Tutorial	1:30–3:30 PM
Afternoon Sessions	4–7 PM

Tuesday February 6th

Morning Sessions	7–10 AM
Beyond the Textbook Tutorials	
10:30 AM–12:30 PM and	1 PM–3 PM
Afternoon Sessions	4–7 PM

Wednesday, February 7th

Morning Session	7–10 AM

SATURDAY, February 3rd
7 AM Conference Opening

Session I   7–10 AM

Student Innovations in GN&C

This session embraces the wealth of research and innovative projects related to spacecraft GN&C being accomplished in the university setting. Papers in this session address hardware/software research as well as component, system or simulation advances. Papers submitted must have a student as the primary author and presenter. Papers will be adjudicated based on level of innovation, complexity of problem solved, perceived technical readiness level, applicability and fieldability to near-term systems, clarity of written and verbal delivery, number of completed years of schooling and adherence to delivery schedule. The session will be limited to 8 papers with the top 3 papers receiving awards.

National Chairpersons
David Geller, Utah State University
david.geller@usu.edu

Lt. Col. Michael Sobers, United States Air Force Academy
michael.sobers@usafa.edu

Local Chairpersons
Ian Gravseth, Ball Aerospace
igravseth@ball.com

David Chart, Lockheed Martin
david.a.chart@lmco.com

18-018 **Optimizing Satellite Orbital Geometries for Geolocation using RF Localization**
D. Lujan (Missouri University of Science and Technology), E. Clark, T. Lovell (Air Force Research Laboratory)

AAS STEM-SCAPE Event
10:30 AM–4 PM

In 2018, we will be hosting annual STEM event for one hundred high school students of diverse background from across the Denver metropolitan area. The event, called AAS STEM-SCAPE for "Student Career Arcs to Professional Engineers," will trace the elements of a successful career journey in aerospace including High School and University education, initial employment and ultimately a rewarding profession. The keynote speaker will be followed by a STEM career panel. The event concludes with a short design project that will be co-led with student volunteers from the University of Colorado.

Local Chairpersons
Michael Drews, Lockheed Martin
michael.e.drews@lmco.com

Meredith Stephens, Ball Aerospace
mstephen@ball.com

Special Event for Children of Conference Attendees and the Beaver Run Employees at 4 PM

NASA Astronaut, Richard Hieb

This presentation will inspire our next generation of engineers by offering kids the opportunity to interact with an astronaut. Mission specialist on STS-39 and STS-49, payload commander on STS-65

Session II   **5–8 PM**

Technical Exhibits

The Technical Exhibits Session is a unique opportunity to observe displays and demonstrations of state-of-the-art hardware, design and analysis tools, and services applicable to advancement of guidance, navigation, and control technology. The latest commercial tools for GN&C simulations, analysis, and graphical displays are demonstrated in a hands-on, interactive environment, including lessons learned and undocumented features. Associated papers not presented in other sessions are also provided and can be discussed with the author. Come enjoy an excellent complimentary buffet and interact with the technical representatives and authors. This session takes place in a social setting and family members are welcome!

Local Chairpersons
Jim Russell, Lockheed Martin
james.f.russell@lmco.com

Thomas Segal, Metropolitan State University of Denver
tsegal1@msudenver.edu

Exhibitors:
AAC Microtec
Adcole Maryland Aerospace
Airbus
GmbH
Ball Aerospace
BEI
Blue Canyon Technologies
Cayuga
EADS Sodern
Honeywell
Jena-Optronik GmbH
Jet Propulsion Laboratory
Lockheed Martin
Mathworks
NewSpace Systems
Northrop Grumman
Sierra Nevada Corporation
Utah State University Space Dynamics
Laboratory

SUNDAY, FEBRUARY 4th

Poster Focus Session   **8:30–9 AM**

The Poster Focus Session offers a unique forum for authors and interested parties to discuss relevant topics. Authors are required to accompany their posters during the Poster Focus Session. Posters do not require an accompanying written paper. However, authors who wish to have their work published in the proceedings can submit a written paper along with the poster.

In addition to the Poster Focus Session, posters will be available for viewing every day in the main conference room.

Local Chairpersons
Reuben Rohrschneider, Ball Aerospace
Company
rrohrsch@ball.com

Entry, Descent, and Landing Guidance with Direct Force Control Using Aerodynamic Shape Morphing
R. Lugo, R. Powell (AMA), A. Slagle, A. Korzun, A.Cianciolo (NASA)

Vision based tracking controller for an on-orbit meteor observer
R. T. Nallapu, A. Ravindran, J. Thangavelautham (University of Arizona)

A Micro-Newton Impulse-Bit Hydrazine Thruster Design, Test and Mission Applications
J.M. Parker (NASA/JPL), J. Blandino (Worcester Polytechnic Institute), D. Skulsky, J.R. Lewis (NASA/JPL)

Spacecraft Attitude Control Using Circulating Liquid Metals
J. Thangavelautham, R. T. Nallapu (University of Arizona)

Reaction Wheel Energy Storage in a Small Satellite
M. Duntz, F. Fogle, L. Sauter (United States Air Force Academy)

On-Orbit Satellite Servicing Using Multiple Tethered Robots
H. Kalita (University of Arizona)

Dither Gyro Scale Factor Calibration the GOES-16 Flight Experience
A. Reth (Chesapeake Aerospace)

Dual Morning Sessions

Session III   7–8:30 / 9–10:30 AM

Advanced Propulsion

The development of advanced propulsion technologies is critical for enabling spacecraft platforms ranging from CubeSats to ambitious human and robotic space exploration missions. Innovative developments in chemical, electric, nuclear, and propellantless propulsion will provide higher performance and greater operability, enabling new approaches ranging from launch to interstellar travel. This session will highlight advanced propulsion technologies matured by NASA, DOD, industry, and academia.

National Chairperson
Jeff Sheehy, NASA STMD
jeffrey.sheehy@nasa.gov

Local Chairpersons
John Abrams, Analytical Mechanics Associates
j.abrams@ama-inc.com

Christopher McLean, Ball Aerospace
cmclean@ball.com

Nick Patzer, LASP
Nicholas.Patzer@lasp.colorado.edu

18-031	**Mission Design Implications of the Updated Electric Sail Thrust Model**
	A. Heaton (NASA)
18-032	**Solar Electric Propulsion Architectural Options for Future Applications on Ball Configurable Platforms**
	B. Deininger, R. Dissly, S. Enger, JC SotoMike, J. Weinberg O'Hara (Ball Aerospace)

18-033	**Hybrid Rocket Propulsion Technology Development for Low Temperature** Ashley Karp (JPL)
18-034	**Earth to Mars Abort Analysis for Human Mars Missions** R. Joyner, J. Horton, T. Kokan, D. Levack, F. Widman (Aerojet Rocketdyne)
18-035	**Fusion and Fission/Fusion Hybrid Propulsion Concepts for Rapid Exploration of the Solar System** J. Cassibry (University of Alabama, Huntsville)
18-036	**Magnetoshell Aerocapture for Manned Missions and Planetary Deep Space Orbiters** A. Pancotti (MSNW)
18-037	**Continuous Grid Inertial Electrostatic Confinement Fusion** R. Sedwick, A. Chap, N. Schilling (University of Maryland)

Session IV   7–8:30 / 9–10:30 AM

Small Satellite GN&C

Cubesats and smallsats range in mass from less than 1kg up to 180kg, and are gaining in popularity and utility. At the high end of this mass range, 100 to 180kg ESPA-class spacecraft are now trusted platforms for scientific and defense missions and offer pointing accuracy, pointing stability, and position knowledge that is compatible with Earth science missions. For cubesats, the GN&C capabilities are advancing quickly in an effort to support science and technology development missions. RPO and docking as well as significant on-board mission data processing capabilities.

This session is open to papers covering both hardware and software aspects of smallsat and cubesat GN&C. Papers on technology development for GN&C and mission GN&C experience are welcomed.

National Chairpersons
Scott Palo, University of Colorado
scott.palo@colorado.edu
Paul Mason, NASA GSFC
paul.a.mason@nasa.gov

Local Chairpersons
Jacob Griesbach, Ball Aerospace
jgriesba@ball.com
Jeffrey Parker, Advanced Space
parker@advanced-space.com

18-041	**GNC Implementations for Small Interplanetary and Lunar Spacecraft** M. Baumgart (Blue Canyon)
18-042	**Mobility and Science Operations on an Asteroid Using a Hopping Small Spacecraft on Stilts** H. Kalita (University of Arizona)
18-043	**Dynamic Programming Based Attitude Trajectories for Underactuated Control Systems** Vedant (University of Illinois)
18-044	**Sensor Fusion for Attitude Determination** Vedant (University of Illinois)
18-045	**Advanced GNC Techniques for Autonomous Rendezvous Proximity Operations and Docking of Small Satellites** Christopher W. T. Roscoe, Jason J. Westphal, Jason Crane, and Islam I. Hussein (Applied Defense Solutions)

18-047	**Verification of Attitude Determination and Control Capabilities for CubeSat-Class Spacecraft**
	M. Sorgenfrei (SGT/NASA Ames)
18-048	**Effects of Atmospheric Density Uncertainties on the Probability of Collision for Small Satellites**
	C. Bussy-Virat (University of Michigan)

TUTORIAL SESSION   **11 AM–1 PM**

Beyond the Textbook Tutorial: Hands-on Demonstration of Using the Basilisk Astrodynamics Framework

Speaker: Hanspeter Schaub, University of Colorado

Parallel Afternoon Sessions

Session V   2–4 PM
Entry Descent & Landing GN&C

Entry, descent, and landing technologies enable surface exploration of celestial bodies and safe return of payloads to Earth. Recent advances have improved landed mass capability at Mars and enabled the reuse of launch vehicle first stages. Ongoing work to further improve performance at government, industry, and university laboratories will enable more ambitious missions in the future. This session provides a venue for the discussion of advanced guidance and control technology for atmospheric entry vehicles and powered and unpowered descent and landing systems, including technologies for precision navigation and targeting, hazard avoidance, and safe landing.

National Chairpersons
Zach Putnam, University of Illinois
zputnam@illinois.edu
Michelle Munk, NASA
michelle.m.munk@nasa.gov

Local Chairpersons
Reuben Rohrschneider, Ball Aerospace
rrohrsch@ball.com
Michael Osborne, Lockheed Martin
michael.l.osborne@lmco.com

18-051 **COBALT: A Terrestrial Flight Test of Landing Navigation using Lander Vision System with Navigation**
S. Collins, C. Seubert (NASA JPL)

18-052 **Aerocapture System Options for Delivery of Small Satellites to Mars**
J. Williams, G. Falcone, Z.R. Putnam (University of Illinois)

18-053 **Entry, Descent, and Landing Performance for a Mid-Lift-to-Drag Ratio Vehicle at Mars**
B. Johnson, E. Braden, R. Sostaric, C. Cerimele (NASA JSC), P. Lu (SDSU)

18-054 **Fuel-Optimal and Apollo Powered Descent Guidance Compared for High-Mass Mars Mission**
P. Lu (SDSU)

18-055 **Paper Withdrawn**

Parallel Afternoon Sessions

Session VI   2–4 PM

GN&C Challenges of Asteroid Deflection

In recent years, the detection of small bodies threatening the Earth and the characterization of asteroids for the purpose of resource utilization have received much attention. Threat mitigation efforts include actively perturbing the trajectory, while utilization efforts might include redirecting these small bodies to locations which facilitate access. The success of these endeavors depends directly on the ability to guide, navigate and control the robotic systems needed to meet that challenge. This session will highlight the Guidance, Navigation and Control challenges of deflecting and redirecting small bodies such as comets and asteroids.

National Chairpersons
Dr. Paul Chodas, NASA-Jet Propulsion Laboratory
Paul.w.chodas@jpl.nasa.gov

Local Chairpersons
Daniel Kubitschek, University of Colorado/Boulder LASP
daniel.kubitschek@lasp.colorado.edu

Charlie Schira, PlanetiQ
charlie.schira@planetiq.com

18-061   **Dynamics and Control of a Tethered Enhanced Gravity Tractor Performing Asteroid Deflection**
H. Shen (Analytical Mechanics Associates, Inc.), C. Roithmayr, Y. Li (NASA-Langley)

18-062 **Osiris-REx Navigation performance during First Leg of OUTBOUND Cruise**
P. Antreasian, J. Leonard, J. McAdams, B. Page, D. Wibben, K. Williams (KinetX), M. Moreau (NASA-GSFC)

18-063 **Small-body Maneuvering Autonomous Real-Time Navigation (SMART Nav): guiding a spacecraft to Didymos**
M. Chen, J. Atchison, D. Carrelli, P. Ericksen, Z. Fletcher, S. Jenkins, S. Jensenius, N. Mehta, T. Miller, D. O'Shaughnessy (JHU-APL)

18-064 **The RVS3000 and RVS3000-3D LIDAR Sensors - Test Results and Development Outlook**
F. M. Kolb, S. Dochow, C. Heilmann, B. Linhart, C. Schmitt, M. Schwarz, M. Windmueller (Jena-Optronik GmbH)

18-065 **OSIRIS-REx Guidance, Navigation and Control Preparation for Bennu Proximity Operations**
R. Olds, T. Schlapkohl (Lockheed Martin)

Super Bowl '18

4:15 in the Imperial Ballroom

Family Members of conference attendees are welcome!

Sandwiches and appetizers will be served

Parallel Morning Sessions

Session VII　　　　　　**7–10 AM**

Advances in GN&C Algorithms

Successful GN&C system performance is often dependent on innovative software.
This session is open to all development processes and systems ranging from vehicle code used to operate the spacecraft system, ground software used for perations/analysis, or simulations/frameworks used to test, validate or develop GN&C systems. The intent is to include current best practices as well as challenges in future software development such as the inclusion of complex systems like artificial intelligence, machine learning, vision processing, and iterative numerical solvers.

National Chairpersons
Mark Jackson, Blue Origin
MJackson@blueorigin.com

Local Chairpersons
Scott Piggott, University of Colorado
scott.piggott@lasp.colorado.edu
Tomas Ryan, Ball Aerospace
tryan@ball.com

18-071　　**Closed Loop Pointing of the Remote Sensing Mast of the Mars 202 Rover**
P. Brugarolas, Z. Rahman, J. Casoliva, G. Griffin, A. Johnson, Y. Cheng (JPL)

18-072　　**Comparing Coarse Sun Sensor Based Sequential Sun-heading Filters**
T. Teil, S. Piggott, H. Schaub (University of Colorado)

18-073	**An innovative Control Law for MICROCARB Microsatellite**
	F. Genin, F. Viaud (CNES)
18-074	**Complete Solution to the Lambert Problem with Perturbations and Target State Uncertainties**
	B. Thompson, D. Brown (Odyssey Space Research), R. Cobb
18-075	**Recovering Time and State for Autonomous Navigation Systems in Deep Space**
	A. Dahir, D. Kubitschek, S. Palot (University of Colorado)
18-076	**Phase-Plane Control Algorithm with Adaptive Minimum-impulse Bit Integral Control**
	J. Aldrich, A. San Martin (JPL)
18-077	**In-flight Redundant Gyro Calibration Using Unscented Kalman Filter**
	L. Dahl (Ball Aerospace)
18-078	**Reinforcement Learning Techniques for Autonomous Aerobraking**
	A. Harris, H. Schaub (University of Colorado)

Future of Crewed Exploration
Introduction from Mike Hawes
VP at Lockheed Martin
Orion Program Manager
7–7:15 AM

Session VIII   **7:15–10 AM**

GN&C Advances to Enable New Frontiers in Crewed Spaceflight

NASA and its commercial and international partners strive to bring astronauts to new Lunar, asteroid and Martian destinations, increasingly new and innovative GN&C technologies will be required to transport and deliver crews and return them safely to the Earth.

Many new approaches are already in the final stages of development on the Orion and Space Launch System (SLS) programs, and yet further advances will be necessary to take the next steps to reach Mars in the coming decades. This session explores key advancements in automation, guidance, navigation and Fault Detection/Isolation (FDI) technologies which will ultimately enable human exploration onto lunar bases and beyond.

National Chairpersons
Tim Straube, NASA
timothy.m.straube@nasa.gov

Mike Hawes, Lockheed Martin
michael.w.hawes@lmco.com

Local Chairpersons
Ellis King, Draper
eking@draper.com

Jastesh Sud, Lockheed Martin
jastesh.sud@lmco.com

18-081	**RAON: Revolution in Autonomous Orbital Navigation** R. Bhatia, D. Geller (Utah State University)
18-082	**Exploring the Limits of High Altitude GPS for Future Lunar Missions** B. Ashman, J. Parker (NASA Goddard), F. Bauer (The Aerospace Corp), M. Esswein (Virginia Polytechnic Institute)
18-083	**Deep Space Autonomous Navigation Options for Future NASA Crewed Missions** S. Steffes, G. Barton, S. Bhatt, M. Fritz, E. King (Charles Stark Draper Laboratory, Inc), C. D'Souza, D. Woffinden (NASA/JSC)

18-084 **Orion's Powered Flight Guidance Burn Options for near term Exploration Missions**
T. Fill (Charles Stark Draper Laboratory, Inc), J. Goodman (Odyssey Space Research), S. Robinson (NASA/JSC)

18-085 **Orion EM-1 FDIR Architecture**
H. Mamich (Lockheed Martin)

18-086 **In-Flight Flight Software Reconfiguration for Orbit Burns**
D. Dionne (Charles Stark Draper Laboratory, Inc)

18-087 **Orion Burn Automation Response to Failures**
R. Odegard (Charles Stark Draper Laboratory, Inc), K. Pohlkamp, C. Barrett, D. Dannemiller (NASA Johnson), J. Sud (Lockheed Martin)

18-088 **A Generic Approach for Optimal BangOff-Bang Spacecraft Maneuvers**
E. Taheris, J. Junkins (Texas A&M University)

TUTORIAL SESSION 10:30 AM–3:30 PM

Beyond the Textbook: Program to Optimize Simulated Trajectories II (POST2) Introductory Tutorial (Rafael Lugo, AMA). Tutorial participation is limited to US-persons as defined by ITAR. Signups will be at the registration desk on check-in

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Parallel Afternoon Sessions

Session IX **4–7 PM**

Advances in GN&C Software
Successful GN&C system performance is often dependent on innovative software.

This session is open to all development processes and systems ranging from vehicle code used to operate the spacecraft system, ground software used for operations/analysis, or simulations/frameworks used to test, validate or develop GN&C systems. The intent is to include current best practices as well as challenges in future software development such as the inclusion of complex systems like artificial intelligence, machine learning, vision processing, and iterative numerical solvers.

National Chairperson
Mark Jackson, Blue Origin
MJackson@blueorigin.com

Local Chairpersons
Scott Piggott, University of Colorado
scott.piggott@lasp.colorado.edu
Tomas Ryan, Ball Aerospace
tryan@ball.com

18-091 **Modular Software Architecture for Fully-Coupled Spacecraft Simulations**
C. Allard, M. Ramos, P. Kenneally, H. Schaub, S. Piggott (University of Colorado)

18-092 **A performance Analysis of On-orbit Numerical Propagators**
S. Shuster, D. Geller (Utah State University) T. Smith (Space Dynamics Lab)

18-093 **Flexible Basilisk Astrodynamics Visualization Software Using the Unity Rendering Engine**
H. Schaub, J. Wood, M. Cols Margenet, P. Kenneally (University of Colorado)

18-094 **Software Simulator for Heterogeneous Spacecraft and Mission Components**
M. Cols-Margenet, P. Kenneally, H. Schaub, S. Piggott (University of Colorado)

18-095 **Optimal Multi-Variable Multi-Constraint Spacecraft GN&C Performance Requirement Derivation**
D. Woffinden (JSC), S. Bhatt, D. Kirkpatrick

18-096   **Fast Spacecraft Solar Radiation Pressure Modeling by Ray-Tracing on Graphic Processing Unit**
P. Kenneally, H. Schaub (University of Colorado)

18-097   **Spacecraft articulation Characterization Using Monocular Computer Vision**
D. Curtis, R. Cobb (AFIT)

18-098   **New Methodology for Wind Modeling for Launcher Application**
M. Ganet-Schoeller (Ariane Group), V. Feuillard

Session X   4–7 PM
Advances in GN&C Hardware

Many programs depend on heritage, but the future is advanced by those willing to design and implement new and novel architectures and technologies to solve the GN&C problems. This session is open to papers with topics concerning GN&C hardware ranging from theoretical formulations to innovative systems and intelligent sensors that will advance the state of the art, reduce the cost of applications, and speed the convergence to hardware, numerical, or design trade solutions.

18-101   **A new domestic source for high performance star trackers : The Ball CT-2020**
E. Tchilian, T. Ebben, K. Miller (Ball Aerospace)

18-102   **High Performance Reaction Wheels**
E. Stromswold, J. Krebs, B. Sullivan, S. Fox (Cayuga Astronautics)

18-103   **Attitude Control System Complexity Reduction via Tailored Viscoelastic Damping Co-Designs**
Lin, D. Herber, Vedant, Y. H. Lee, A. Ghosh, R. Ewoldt, J. T. Allison (University of Illinois at Urbana-Champaign)

18-104 **Hydra Star Tracker for JUICE mission**
B. Gelin, G. Montay, Y. Henriquel, J. F. Bouvry (SODERN), P. Regnier (Airbus Defence & Space), D. Gherardi (ESA)

18-105 **Rate Measurement Unit for Attitude Determination and Control Subsystem**
J. Beitia (InnaLabs), S. Kowaltschek (ESA)

18-106 **BCT Advancing GN&C Hardware with the RW4 & RW8**
M. Carton, B. Peters, C. Messick, S. Steg, M. Baumgart, D. Hegel, S. Schneider (Blue Canyon Technologies)

18-107 **ASTRO-XP High Accuracy Star Tracker**
U. Schmidt, B. Pradarutti (Jena-Optronik)

18-108 **Atom Interferometry: Lockheed Martin Systems Development**
V. Benischek, H. Rice, L. Sczaniecki (Lockheed Martin)

TUESDAY, FEBRUARY 6th

Parallel Morning Sessions

Science Weather Enabled Introduction from Mike Gazarik, VP of Engineering at Ball Aerospace 7–7:30 AM

Session XI 7:30–10 AM

Science Weather Enabled

This session looks at the scientific results that GN&C has helped deliver. From exoplanet detections to Martian habitability to studying on our own planet, G&C engineering has played a significant role in enabling some of the most exciting scientific discoveries of our generation. These findings not only add to the body of scientific knowledge of our world and worlds beyond, they light the public's imagination and inspire tomorrow's scientists and engineers.

National Chairperson
Bill Frazier, NASA/JPL
william.e.frazier@jpl.nasa.gov

Local Chairpersons
Heidi Hallowell, Ball Aerospace
hhallowe@ball.com

Tim Bevacqua, Lockheed Martin
timothy.bevacqua@lmco.com

18-111 **On-Orbit Verification of GMI Instrument Spin Balance Stability Performance to Enable Essential Weat**
G. Ashton, L. Ayari, M. Kubitschek, S. Johnston, D. Debevec, D. Newell (Ball Aerospace), J. Pellicciot (NASA GSFC)

18-112 **GOES-16 ABI On-Orbit INR Tuning and Performance**
D. Gall, V. Virgilio, R. Forkert, J. Van Naarden, P. Griffith (Harris Corporation)

18-113 **Imaging X-Ray Polarimetry Explorer Mission Attitude Determination and Control Concept**
J. Bladt, W. Deininger, W. Kalinowski, M. Boysen, K. Bygott, J. Ferguson, L. Guy, C. Pentz, H. Phan, J. Wedmore (Ball Aerospace)

18-114 **Optical Autocovariance Wind Lidar for Guidance, Navigation, and Control**
S. Tucker (Ball Aerospace)

18-115 **Preliminary Saturn Atmospheric Density Results from Cassini's Final Plunge**
D. Boone, M. Wong, J. Bellerose, D. Roth (JPL/Caltech)

18-116 **JPSS-1 - Building the Nation\'s Next-Generation Operational Polar-orbiting Weather Satellite**
S. Asbury (Ball Aerospace)

18-117 **Novel Spacecraft Recovery, Guidance, and Control to Enable Kepler Science Mission Continuation**
K. McCalmont-Everton, D. Putnam, D. Wiemer, K.A. Larson, C.A. Peterson, S.E. Ross
(Ball Aerospace)

Session XII 7–10 AM

Pioneers of GN&C and Astrodynamics
This session will offer reflections on the careers and contributions of scientists and engineers who pioneered notable technical solutions for our aerospace community.

National Chairperson
Neil Dennehy, Goddard Space Flight Center
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Local Chairperson
James McQuerry, Ball Aerospace (Retired)
mcquerrydj@comcast.net

18-121 **How Doc Draper Became the Father of Inertial Guidance**
Phil Hattis (Draper)
18-122 **Henry Hoffman: NASA's Satellite Doctor**
J. O'Donnell, C. Dennehy (GSFC)
18-123 **Astrodynamics Pioneer: Robert Farquhar**
K. Howell (Purdue)
18-124 **Brad Parkinson: Father of GPS**
F. Bauer (FBauer Aerospace Consulting Services)
18-125 **Pioneers of GN&C: L. S. Pontryagin**
M. Ross (NPS)
18-126 **Nguyen Xuan Vinh – A Life in Hypersonic Flight**
A. Wolf (JPL)
18-127 **Innovation Experiences From Vanguard, Explorer 1, Sidewinder, and NOTSNIK**
J. Goodman (Odyssey)

TUTORIAL SESSION   10:30 AM-12:30 PM

Beyond the Textbook: Nav Filter Best Practices

Speaker: Russell Carpenter (GSFC)   Chris D'Souza (NASA/JSC)

TUTORIAL SESSION   1–3 PM

Beyond the Textbook: Applying Missile Intercept GN&C Solutions to the Problem of Asteroid Deflection for Planetary Defense Speakers: Nahum Melamed, Damian Toohey (The Aerospace Corp.)

Parallel Afternoon Sessions

Session XIII   4–7 PM

Space Launch System (SLS) Navigation

NASA's Space Launch System (SLS) represents a new era in space exploration for the United States. With the ability to implement increasingly more powerful launch configurations for both crew and cargo, SLS will help transport human and robotic missions to the moon, Mars, and beyond. This session will explore the navigation solutions required for mission success of this next generation space vehicle and its missions.

National Chairpersons
Evan Anzalone, MSFC
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Local Chairpersons
Heidi Hallowell, Ball Aerospace
hhallowe@ball.com
John Reed, United Launch Alliance
john.g.reed@ulalaunch.com

18-131 **SLS Navigation Model-Based Design Approach**
T. E. Oliver, E. Anzalone, K. Geohagan (MSFC), W. Bernard, T. Park (MSFC/Dynamic Concepts)

18-132 **6DOF Testing of the LS Inertial Navigation Unit**
K. Geohagan (MSFC), W. Bernard (MSFC/Dynamic Concepts), T. E. Oliver, J. Leggett (MSFC), D. Strickland (MSFC/CRM Solutions, Inc.)

18-133 **Sensor Data Quality and Angular Rate Down-Selection Algorithms on SLS EM-1**
T. Park (MSFC/Dynamic Concepts), A. Smith, T. E. Oliver (MSFC)

18-134 **Optimization of Second Fault Detection Thresholds to Maximize Mission POS**
E. Anzalone (MSFC)

18-135 **SLS Block 1-B and Exploration Upper Stage Navigation System Design**
T. E. Oliver (MSFC) / T. Park (MSFC/Dynamic Concepts), A. Smith, E. Anzalone, W. Bernard (MSFC/Dynamic Concepts), D. Strickland (MSFC/CRM Solutions, Inc.), K. Geohagan (MSFC), M. Green (MSFC/Jacobs Engineering), J. Leggett (MSFC)

18-136 **PEG Enhancement for EM1 and EM2+ Missions**
P. Von der Porten, N. Ahmad (MSFC), M. Hawkins (MSFC/Jacobs Engineering)

18-137 **Assessment and Verification of SLS Block 1-B Exploration Upper Stage State and Stage Disposal Performance**
S. Patrick, T. E. Oliver (MSFC)

Advances in RPOD

This session explores the state of the art technologies that enable rendezvous, proximity operations and docking with manmade or natural targets (cooperative or non-cooperative). Precise optical range sensors such as LIDARs that provide in-situ measurements coupled with modern algorithms are key to robust and optimal planning of autonomous operations.

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18-141　**Advanced State Estimation For Orion Orbital Rendezvous**
W. Pisano (Infinite Horizon Co), P. Good (LMSSC)

18-142　**Re-Evaluating Orion's Relative Navigation Filter Design for NASA's Future Exploration Missions**
D. Woffinden (NASA/JSC), K. Tuggle (U. Texas), C. D'Souza (NASA/JSC), R. Zanetti (U. Texas)

18-143　**Retro-Reflector Pattern Design and Identification for Orion Rendezvous, Proximity Operations, and Docking**
S. Robinson (NASA/JSC), C. Ertl (Rensselaer Polytechnic Institute), J. Christian (Rensselaer Polytechnic Institute)

18-144 Restore-L: Advanced In-Space Robotic Servicing Mission Enabled by a 3D Flash Lidar VNS
R. Rohrschneider, Lutgring (Ball Aerospace)

18-145 The Natural Feature Tracking and LIDAR Hybrid Approach for OSIRIS-REx Sample Collection
R. Olds (LMSSC), C. Miller (LMSSC), M. Skeen (LMSSC), D. Lorenz (NASA/GSFC), K. Berry (NASA/GSFC)

18-146 On a General Formulation of Relative Motion and Burn Targeting for Non-Circular Rendezvous
M. Wilkinson (SGT, Inc), D. Dannemiller (NASA/JSC)

18-147 Sampling-Based Receding Horizon Guidance for the Safe Inspection of a Tumbling Spacecraft
F. Capolupo (Airbus), S. Mast (TU Delft)

18-148 Optimal Maneuvers for Safe RPO Using Relative Orbital Elements and Sequential Convex Programming
N. Ortolano (Utah State), D. Geller (Utah State), A. Avery (Space Dynamics Lab)

WEDNESDAY, FEBRUARY 7th

Session XIV   **4–7 PM**

Recent Experiences

This session focuses on recent experiences in spaceflight GN&C, providing a forum to share insights gained through successes and failures. Discussions typically include GN&C experiences ranging from Earth orbiters to interplanetary spacecraft.

This session is a traditional part of the conference and has shown to be most interesting and informative.

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Brian Kirby, University of Colorado/LASP
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18-151 **Flying Cassini Through the Grand Finale Orbits: Prediction VS. Reality**
M. Vaquero, Y. Hahn, S. Hernandez, F. Laipert, P. Valerino, S. Wagner, M. Wong, D. Roth (NASA/JPL)

18-152 **Cassini Orbit Determination Operations through the final Titan flybys and the mission Grand Finale**
J. Bellerose, D. Roth, D. Boone, Z. Tarzi, K. Criddle, R. Ionasescu (JPL / Caltech)

18-153 **The Unexpected Root Cause Conclusions of Reaction Wheel Failures on Kepler and FUSE**
B. Bialke (Lochridge Farm LLC), E. Hansell (United Technologies Aerospace Systems)

18-154 **ESA's Recent Experience with Reaction Wheel Performance**
F. Liebold, R. Seiler, T. Haefner, D. Bojiloff, J. Demming (ESA/ESTEC)

NOTES

2018 Planning Committee

John Abrams	Analytical Mechanics
Lee Barker	Lockheed Martin
John Bendle	Lockheed Martin
Tim Bevacqua	Lockheed Martin
Jim Chapel	Lockheed Martin
David Chart	Lockheed Martin
Amy Delay	Lockheed Martin
Michael Drews	Lockheed Martin
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