

# 47<sup>th</sup> ANNUAL AAS GUIDANCE & CONTROL CONFERENCE

January 31 – February 5, 2025

Sponsored by the American Astronautical Society  
Rocky Mountain Section

**Please see our website: <http://aas-rocky-mountain-section.org/> to submit an abstract or to obtain additional information about the Conference**

**For additional questions, please contact the Conference Chairperson:**  
Graeme Ramsey, Lockheed Martin Space, [graeme.d.ramsey@lmco.com](mailto:graeme.d.ramsey@lmco.com)

**Paper and Poster Abstracts are due September 6, 2024  
(Submit through the AAS GN&C Conference [website](#))**

## TENTATIVE CONFERENCE AGENDA

### Registration

Room check-available at the Beaver Run Resort front lobby.

Conference registration 6:30 AM to 10:00 AM and 4:00 PM to 6:00 PM daily at the Conference Center.

Buffet Breakfast Daily from 6:00AM – 9:00AM (Saturday Feb. 1<sup>st</sup> – Wed. Feb. 5<sup>th</sup>)

### Thursday January 30, 2025

8:30 AM – 4:30 PM                      Classified Session (BAE Facility, Broomfield, CO)

### Friday January 31, 2025

8:30 AM – 12:30 PM                      Classified Session (BAE Facility, Broomfield, CO)  
6:00 PM – 9:00 PM                      Conference Opening Reception (Beaver Run Resort, Breckenridge, CO)

### Saturday February 1, 2025

7:00 AM – 10:00 AM                      Technical Sessions  
10:30 AM – 4:30 PM                      STEMscape Educational Event  
5:00 PM – 8:00 PM                      Technical Exhibits

### Sunday February 2, 2025

7:00 AM – 10:00 AM                      Technical Sessions  
11:00 AM – 3:30 PM                      Tutorial Session  
4:00 PM – 7:00 PM                      Technical Sessions  
7:30 PM – 9:30 PM                      Social Hour/Casino Night

### Monday February 3, 2025

7:00 AM – 10:00 AM                      Technical Sessions  
10:30 AM – 3:30 PM                      Tutorial Session  
4:00 PM – 6:00 PM                      Technical Sessions  
6:15 PM – 7:30 PM                      Industry Panel Discussion & Cocktail Hour

### Tuesday February 4, 2025

7:00 AM – 10:00 AM                      Technical Sessions  
10:30 AM – 3:30 PM                      Tutorial Session  
4:00 PM – 7:00 PM                      Technical Sessions

### Wednesday February 5, 2025

7:00 AM – 10:00 AM                      Technical Sessions

## **MAIN CONFERENCE SESSION INFORMATION**

### **Conference Registration and Welcome Reception**

**Friday January 31, 2025 from 6:00-9:00 PM**

**Beaver Run Conference Center, Breckenridge, CO**

The Conference Welcome Reception will be held in the Imperial Ballroom at the Beaver Run Resort in Breckenridge on Friday evening. This will be an opportunity to learn more details about the specifics of the planned program, meet new colleagues and renew connections with old friends. Early conference registration will be available from 6:00 PM to 9:00 PM in the Conference Center.

### **Conference Technical Session Topics**

**Saturday February 1 – Wednesday February 5, 2025**

**Beaver Run Conference Center, Breckenridge, CO**

**(Session Schedule To Be Announced)**

The conference sessions will be scheduled from Saturday, February 1<sup>st</sup> at 7:00 AM to Wednesday, February 5<sup>th</sup> at 10:00 AM. The final agenda will be available in the Fall of 2024. Tutorial sessions will be scheduled in between the technical sessions on Sunday, Monday and Tuesday. The following technical sessions are being planned for the 2025 conference.

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## **CLASSIFIED SESSION INFORMATION**

**Thursday January 30 – Friday January 31, 2025**

**BAE Space & Mission Systems, Broomfield, CO**

The classified sessions will be held at BAE Space & Mission Systems facility located in Broomfield, Colorado on January 30-31, 2025. All eligible conference participants may attend the classified presentations.

Attendees must be US-citizens and must possess the necessary clearances prior to registration.

Registration deadline (specific to the classified session) of January 23rd to allow processing time

Pre-registration is required and will be controlled (walk-ins will NOT be admitted). Questions on clearance requirements or steps on submitting an abstract should be directed to:

[aas\\_special\\_session@lists.aero.org](mailto:aas_special_session@lists.aero.org)

Location of Classified Session: BAE Space & Mission Systems, Broomfield, CO

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## Technical Exhibits

**THEME:** 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, and include lessons learned and undocumented features. Associated papers not presented in other sessions are also provided and can be discussed with the author. Come enjoy and excellent complimentary buffet and interact with the technical representatives and authors. This session takes place in a social setting and family members are welcome!

### Organizers

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## Advances in GN&C Hardware

**THEME:** Many programs depend on heritage, but the future is advanced by those willing to design and implement new and novel architectures, technologies, and algorithms to solve GN&C problems. This session is open to papers with topics 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.

### Organizers

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## Advances in Navigation

**THEME:** Advances in Position, Navigation, and Timing (PNT) seek to push the boundaries of spacecraft navigation and timing technology and address the shortcomings of current PNT systems. Proliferation of large-scale constellation deployments in Earth orbit and the need for maintaining a safe orbital environment for all operators require new PNT techniques and robust architectures to complement the existing ground based and GNSS systems. Lunar, interplanetary, and interstellar mission concepts require novel ways for collecting and processing observations from non-traditional sources. In this session, we explore novel and advanced ground-based, space-based, and autonomous spacecraft PNT approaches. Of particular interest are methods for inter-satellite navigation, lost-in-space scenarios, and new filtering techniques for processing radio and optical observations, pulsar observations, and other deep space signals of opportunity. With goals of expanded lunar exploration and long term habitation, new techniques, algorithms, and technology are needed to enable in-situ autonomous exploration in cislunar space. Additionally, with proposals and deployment of a lunar-centric time reference, there is a need to understand how this timing implementation will impact navigation design in terms of time transfers, stability characterization, and development of timing standards that enable an integrated PNT capability.

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## Advances in Propulsion

**THEME:** 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 and enabling subsystems matured by NASA, DOD, industry, and academia.

### Organizers

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## Advances in GN&C Software

**THEME:** Successful GN&C system performance is often dependent on innovative algorithms and software. This session is open to all development processes and systems ranging from vehicle code used to operate the spacecraft system, novel algorithms, 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.

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## Autonomy in GN&C

**THEME:** Satellite constellations are nothing new, but the sizes, scales, and configurations of modern Distributed Satellite Systems (DSS) are reaching unprecedented levels of scope and complexity. These configurations include constellations, swarms, and various fractionated architectures. Recent demonstrations of these DSS systems show that handling the planning, coordination and operations associated with large-scale constellations is a critical logistical problem that must be addressed for continued effective application of these systems. In addition to the logistical challenges, large and small multi-spacecraft systems must also work through autonomous operational complexities such as formation flying, fractionation, docking, structural assembly, tethering, station keeping for sparse aperture configurations and on-orbit servicing and reconfiguration. Some key system and subsystem challenges for autonomous operations include resource management, health management, task management and decision making, formation control, rendezvous management, expanded autonomous control, on-orbit calibration, station keeping, space traffic management, and human-interfaces. All these topics have a direct impact on GN&C and must be considered when architecting the GN&C system. All papers related to these topics are welcome.

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## **RPOD, Guidance/Targeting and Trajectory Design**

**THEME:** Autonomous rendezvous, proximity operations, and docking (RPOD) systems are key enablers to supporting objectives such as commercial servicing of existing spacecraft, orbital debris removal, on-orbit refueling, the next generation of space tugs and asteroid missions, or returning humans to the moon to establish a sustained presence. As many of our missions recently are going beyond low-earth orbit, the need to minimize propellant usage or time to rendezvous has generated new and exciting trajectories and guidance/targeting algorithms. This session explores aspects of enabling technologies for guidance and targeting, optimal trajectory design, control, and safety of flight to support this class of mission.

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## **RPOD, Relative Navigation and State Estimation**

**THEME:** Autonomous rendezvous, proximity operations, and docking (RPOD) systems are key enablers for many different types of spacecraft and missions including commercial servicing of existing spacecraft, orbital debris removal, on-orbit refueling, the next generation of space tugs and asteroid missions, or returning humans to the moon to establish a sustained presence. Some would say the heart of the GN&C system required for supporting these RPOD missions is the N: or relative navigation and state estimation. Many design challenges of spacecraft development, such as the need to minimize mass and volume, as well as computational footprint, has generated new, exciting, and innovative solutions to the relative navigation problem. This session explores aspects of enabling technologies for relative navigation, state estimation, and computer vision to support this class of mission.

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## **Entry, Descent & Landing GN&C**

**THEME:** Entry, descent, and landing technologies enable surface exploration of celestial bodies and the safe return of payloads to Earth. Recent advances in powered flight guidance and in atmospheric entry systems have improved landed mass capability to the Moon and Mars, and has made the reuse of launch vehicle first stages commonplace on Earth. Continued advancements through the collaboration of government, industry, and academia will enable even more ambitious capabilities and missions in the future. This session provides a venue for discussing advanced entry vehicles, as well as guidance, navigation and control technologies for powered and unpowered descent and landing systems. Topics include precision navigation and targeting, novel guidance and control methodologies, hazard avoidance, and controlled landings.

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## **New Space and Cislunar Exploration**

**THEME:** In recent years, the exploration and habitation of the Moon and other extraterrestrial bodies has become increasingly popularized in the government, academic, and commercial aerospace communities. The exploration, development, and settlement of these bodies requires substantially more innovation in GN&C technologies beyond what is currently used in Earth's orbit. The challenges in this domain often require technological advances from a diverse set of sub-fields such as space flight GN&C, landing, autonomous surface operations, human-machine interfaces, and many others. This session focuses on such innovation, describing the challenges and solutions developed within the community.

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## **Image Processing for Spaceborne Navigation**

**THEME:** Image Processing (IP) is a critical step in many GN&C and ADCS algorithms, including attitude determination from star cameras and optical navigation from imaging sensors. Applications occur in various mission phases including interplanetary cruise, planetary orbit, proximity operations, descent and landing, and surface operations. An image from a visible, IR, LIDAR, or similar sensor can offer a wealth of information about a space vehicle's navigation state, but this information must be distilled into measurements that can be ingested by a navigation algorithm. Therefore, the success of algorithms which rely on image data depends on how effectively these algorithms perform IP---defined here as the process of extracting the salient pieces of information from an image in the presence of noise, clutter, and other real-world issues. This session is dedicated to papers that explore the relationship between IP algorithms and the broader problem of GN&C. Topics include IP algorithms; feedback/ feedforward between IP and GN&C; uncertainty quantification of IP outputs, processing of IP outputs to improve navigation, hosting platforms/architectures between CPUs, FPGAs, GPUs, and other processing units; IP techniques base on AI and ML; challenges with on-board real-time IP; on-board rendering; testing, verification, and validation of IP algorithms; and lessons learned from past experiences.

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## Recent Experiences

**THEME:** 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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## Small Body Exploration

**THEME:** Recent years have witnessed a remarkable surge in the landscape of planetary exploration missions to asteroids, comets, and other small solar system objects, with several new endeavors currently underway. This surge has driven significant advancements and innovations in the practical application of optical navigation, sensors, modeling, and autonomy that are essential to accomplish demanding mission objectives. From intricate task of characterizing a small body post-arrival to complexities of operating in a micro-gravity environment, and in some cases executing surface navigation, these tasks are at the core of such missions. This session solicits contributions showcasing GN&C experiences, successes, lessons learned, and future challenges associated with the exploration of asteroids, comets, and other small bodies.

### Organizers

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## Small Satellite GN&C

**THEME:** In recent years, small satellites including NanoSats and CubeSats have seen greater use for a range of applications in government, commercial, and educational sectors. At the high end of this mass range, ESPA-class spacecraft are now trusted platforms for scientific and defense missions. These missions require advanced technology insertion (GN&C, on-board processing) while advancing manufacturing practices to achieve higher production rates. Some key challenges related to increasing production volume include: supply-chain management, automated production and testing, and design for manufacturing approaches. This session is open to papers covering advanced technology insertion on small sats (e.g. propulsion, optical communications, proximity operations, drag sails, etc), advanced manufacturing practices (e.g. best practices for satellite production, automation and design for manufacturing) and operation practices (autonomous mission or conops). Papers on practical mission experience in these areas are welcomed.

### Organizers

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## Student Innovations in GN&C

**THEME:** 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 field-ability 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 monetary awards.

### Organizers

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## Using AI/ML in GN&C

**THEME:** As Guidance, Navigation and Control algorithms become increasingly autonomous, there is a natural progression towards incorporating Artificial Intelligence (AI) and Machine Learning (ML) technologies into the capabilities of today's autonomous systems. When combined with established systems and control theory, AI and ML algorithms can harness the wealth of information available from data obtained by sensors and cyberphysical systems over time. This session will highlight research and demonstrations focused on the theory and methods of learning, control, and computational intelligence for GN&C systems. Some example topics for this session include novel applications of AI systems in traditional GN&C systems, performance comparisons between classical GN&C methods and ones that leverage AI or ML, demonstrations of design and/or test of GN&C systems that utilize ML, and techniques and challenges for the verification and validation (V&V) of systems incorporating these technologies.

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## GN&C In Human Spaceflight

**THEME:** NASA along with its commercial and international partners are striving to bring astronauts and equipment to new Lunar, asteroid and Martian destinations. Increasingly new and innovative GN&C technologies required to transport and deliver crews and return them safely to the Earth are being developed and tested on robotic landers and other testbeds. After the successful 2022 Artemis I mission demonstrated the full capabilities of the Orion and Space Launch System (SLS) programs, excitement is building for the crewed Artemis II mission in 2026. New systems such as the Deep Space Gateway and two separate Lunar Landers are being developed as the next steps to establish a lunar base and eventually reach Mars in the coming decade. 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.

### **Organizers**

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## **Control, Mitigation, and Management of Liquid Propellant Dynamics**

**THEME:** Predicting, managing, and controlling space vehicle liquid propellant dynamics continues to present broad-reaching challenges in physics-based modeling, computational methods, control theory, and systems engineering. Emerging concepts in space access, including launch systems, planetary landers, and novel spacecraft are challenged to reduce traditional mass penalties like baffles and vanes while configurations evolve toward increasing propellant mass fractions. The use of cryogenics in high-performance designs adds further complications, as thermal management, propellant settling, and GN&C requirements intersect. This session explores advances in slosh modeling and slosh suppression in both microgravity and high-g flow regimes, particularly in the context of vehicle dynamics, test-based or semi-empirical methods, vehicle-CFD co-simulation, and novel techniques for sensing, estimation, and/or control of liquid motion. In addition, efforts to verify and validate dynamic models are of particular interest given the unique scaling challenges between ground test capability and the flight environment.

### **Organizers**

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## **Science Enabled By GN&C**

**THEME:** Across decades of space exploration and science investigations, guidance, navigation and control (GN&C) has been fundamentally important to the success of those endeavors and the associated popular interest demonstrated by national and international missions: From pointing and articulation of remote sensing platforms, to stunning images of never-before-seen worlds and small bodies; from targeting of impactors, landers and Earth return vehicles to the return of samples from far-away places; from atmospheric science to heliophysics and astrophysics investigations. This session solicits past, present, and future scientific investigations that are enabled by the GN&C engineers and the systems they design, integrate, test, and operate to advance our scientific knowledge and understanding.

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## Separation Dynamics

**THEME:** The separation and jettison of mass that is no longer needed is critical to optimize the payload mass to orbit of launch vehicles. Separation recontacts and failures are also a leading cause of launch vehicle failure. This session will involve discussion and analysis of launch vehicle and spacecraft multibody dynamics, equations of motion and trajectories to assess contact and clearance of during liftoff, separation, and jettison events; modeling ascent and in-space environments, errors, disturbances, GN&C algorithms, sensors, actuators, and mechanism; simulation and analysis of nominal, contingency, and failure scenarios during ascent and in-space flight separation and jettison events; algorithms and tools to analyze 6 DOF trajectories for separations and recontacts; requirement specifications for separation systems; reconstruction of flight trajectories and clearance events using imagery and navigation data.

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## Poster

**THEME:** Covering a wide variety of unique GN&C topics, this year's interactive Poster session falls on Sunday and Monday during the morning presentation sessions mid-point break. All Posters should be hosted by the author(s) during these two timespans and will include peoples' choice voting by conference attendees and subsequent awards to two winning Posters. Winners of the two categories, Presentation Quality and Material Interest, to be announced at the Monday night social event. Although the Posters will be on display for the full conference, conference attendees are highly encouraged to engage with poster hosts and cast their peoples' choice vote tokens specifically during the Sunday/Monday Poster session breaks.

### Organizers

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### **Note to Authors:**

**Abstracts are due by September 6, 2024**

We will continue to emphasize a 'paperless' method for collecting and distributing papers. Wireless service will be available at the conference.

Please submit paper and poster abstracts through the conference website, <http://aas-rocky-mountain-section.org/>

Additional conference details are also available on the website