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A Custom Bibliography From the
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October 2004

Scientific Data Collection/Analysis: 1994-2004

This custom bibliography from the NASA Scientific and Technical Information Program lists a sampling of records found in the NASA Aeronautics and Space Database. The scope of this topic includes technologies for lightweight, temperature-tolerant, radiation-hard sensors. This area of focus is one of the enabling technologies as defined by NASA's *Report of the President's Commission on Implementation of United States Space Exploration Policy*, published in June 2004.

OCTOBER 2004

20040084306 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Hubble Space Telescope Fine Guidance Sensor Post-Flight Bearing Inspection

Pellicciotti, J.; Loewenthal, S.; Jones, W., Jr.; Jumper, M.; 37th Aerospace Mechanisms Symposium; May 2004, 343-356; In English; No Copyright; Avail: CASI; A03, Hardcopy

Aerospace mechanism engineering success stories often, if not always, consist of overcoming developmental, test and flight anomalies. Many times it is these anomalies that stimulate technology growth and more reliable future systems. However, one must learn from these to achieve an ultimately successful mission. It is not often that a spacecraft engineer is able to inspect hardware that has flown in orbit for several years. However, in February 1997, the Fine Guidance Sensor-1 (FGS-1) was removed from the Hubble Space Telescope (HST) and returned to NASA Goddard Space Flight Center (GSFC) during the second Servicing Mission (SM2). At the time of removal, FGS-1 had nearly 7 years of service and the bearings in the Star Selector Servos (SSS) had accumulated approximately 25 million Coarse Track (CT) cycles. The main reason for its replacement was due to a bearing torque anomaly leading to stalling of the B Star Selector Servo (SSS-B) when reversing direction during a vehicle offset maneuver, referred to herein as a Reversal Bump (RB). The returned HST FGS SSS bearings were disassembled for post-service condition assessment to better understand the actual cause of the torque spikes, identify potential process/design improvements, and provide information for remedial on-orbit operation modifications. The methods and technology utilized for this inspection are not unique to this system and can be adapted to most investigations at varying stages of the mechanism life from development, through testing, to post flight evaluation. The systematic methods used for the HST Fine Guidance Sensor (FGS) SSS and specific findings are the subjects presented in this paper. The lessons learned include the importance of cleanliness and handling for precision instrument bearings and the potential effects from contamination. The paper describes in detail, the analytical techniques used for the SSS and their importance in this investigation. Inspection analytical data and photographs are included throughout the paper.

Author

Hubble Space Telescope; Guidance Sensors; Cameras; Bearings

20040074348 Missouri Univ., Rolla, MO, USA

Development of a Self-calibrating Dissolved Oxygen Microsensor Array for the Monitoring and Control of Plant Growth in a Space Environment

Kim, Chang-Soo; Brown, Christopher S.; Nagle, H. Troy; 2004; In English

Contract(s)/Grant(s): NAG9-1423; NRA-01-OBPR-01; No Copyright; Avail: CASI; A04, Hardcopy

Plant experiments in space will require active nutrient delivery concepts in which water and nutrients are replenished on a continuous basis for long-term growth. The goal of this study is to develop a novel microsensor array to provide information on the dissolved oxygen environment in the plant root zone for the optimum control of plant cultivation systems in the space environment. Control of water and oxygen is limited by the current state-of-the-art in sensor technology. Two capabilities of the new microsensor array were tested. First, a novel in situ self-diagnosis/self-calibration capability for the microsensor was explored by dynamically controlling the oxygen microenvironment in close proximity to an amperometric dissolved oxygen microsensors. A pair of integrated electrochemical actuator electrodes provided the microenvironments based on water electrolysis. Miniaturized thin film dissolved oxygen microsensors on a flexible polyimide (Kapton(Registered Trademark)? substrate were fabricated and their performances were tested. Secondly, measurements of dissolved oxygen in two representative plant growth systems were made, which had not been performed previously due to lack of proper sensing technology. The responses of the oxygen microsensor array on a flexible polymer substrate properly reflected the oxygen contents on the surface of a porous tube nutrient delivery system and within a particulate substrate system. Additionally, we demonstrated the feasibility of using a 4-point thin film microprobe for water contents measurements for both plant growth systems. mechanical flexibility, and self-diagnosis. The proposed technology is anticipated to provide a reliable sensor

feedback plant growth nutrient delivery systems in both terrestrial environment and the microgravity environment during long term space missions. The unique features of the sensor include small size and volume, multiple-point sensing,

Author

Aerospace Environments; Vegetation Growth; Plant Roots; Moisture Content; Microinstrumentation; Dissolved Gases; Calibrating; Sensors

20040071003 NASA Marshall Space Flight Center, Huntsville, AL, USA

Advanced Video Guidance Sensor (AVGS) Development Testing

Howard, Richard T.; Johnston, Albert S.; Bryan, Thomas C.; Book, Michael L.; 2004; In English, 12-16 Apr. 2004, Orlando, FL, USA; No Copyright; Avail: CASI; A03, Hardcopy

NASA's Marshall Space Flight Center was the driving force behind the development of the Advanced Video Guidance Sensor, an active sensor system that provides near-range sensor data as part of an automatic rendezvous and docking system. The sensor determines the relative positions and attitudes between the active sensor and the passive target at ranges up to 300 meters. The AVGS uses laser diodes to illuminate retro-reflectors in the target, a solid-state camera to detect the return from the target, and image capture electronics and a digital signal processor to convert the video information into the relative positions and attitudes. The AVGS will fly as part of the Demonstration of Autonomous Rendezvous Technologies (DART) in October, 2004. This development effort has required a great deal of testing of various sorts at every phase of development. Some of the test efforts included optical characterization of performance with the intended target, thermal vacuum testing, performance tests in long range vacuum facilities, EMI/EMC tests, and performance testing in dynamic situations. The sensor has been shown to track a target at ranges of up to 300 meters, both in vacuum and ambient conditions, to survive and operate during the thermal vacuum cycling specific to the DART mission, to handle EM1 well, and to perform well in dynamic situations.

Author

Guidance Sensors; Rendezvous Guidance; Digital Systems; Cameras; Thermal Cycling Tests; Signal Processing

20040058163

Fizeau interferometer for global astrometry in space

Loreggia, Davide; Gardiol, Daniele; Gai, Mario; Lattanzi, Mario G.; Busonero, Deborah; Applied Optics; February 01, 2004; ISSN 0003-6935; Volume 43, Issue no. 4, 721-728; In English; Copyright

We discuss the design and the performance of a Fizeau interferometer with a long focal length and a large field of view that is well suited for a global astrometry space mission. Our work focuses on the geometric optimization and minimization of aberration of such an astrometric interferometer, which is able to observe astronomical targets down to the visual magnitude (mag) mv = 20 mag, with an accuracy in the measurements of 10 micro-arcseconds at mv = 15 mag. We assume a mission profile similar to that of the Global Astrometric Interferometer for Astrophysics mission of the European Space Agency. In this framework, data acquisition is performed by an array of CCDs working in time-delay integration mode. Optical aberrations, particularly distortion and coma, play a crucial role in the efficiency of this technique. We present a design solution that meets the requirements for the best possible exploitation of the time-delay integration mode over a field of view of 0.7[deg] x 0.7[deg]. [copyright] 2004 Optical Society of America

Author (AIP)

Artificial Satellites; Astrometry; Field of View; Interferometers; Optics; Position (Location); Signal Processing; Space Missions; Telescopes

20040056794

Hardening CMOS Imagers: Radhard-by-design or Radhard-by-foundry

Pain, Bedabrata; Hancock, Bruce; Cunningham, Thomas J.; Seshadri, Suresh; Sun, Chao; Peddada, Pavani; Wrigley, Chris; Stirbl, Robert C.; Proceedings of SPIE - The International Society for Optical Engineering; 2004; ISSN 0277-786X; Volume 5167, p. 101-110; In English; Focal Plane Arrays for Space Telescopes, Aug. 4-6, 2003, San Diego, CA, USA; Copyright; Avail: Other Sources

A comparative study between radhard-by-design and radhard-by-foundry approaches for radiation hardening of CMOS imagers is presented. Main mechanisms for performance degradation in CMOS imagers in a radiation environment are identified, and key differences between the radiation effects in CMOS imagers and that in digital logic circuits are explained. Design methodologies for implementation of CMOS imagers operating in a radiation environment are presented. By summarizing the performance results obtained from imagers implemented in both radhard-by-design and radhard-by-foundry

approaches, the advantages and shortcomings of both approaches are identified. It is shown that neither approach presents an optimum solution. The paper concludes by discussing an alternate pathway to overcome these limitations and enable the next-generation high-performance radiation-hard CMOS images.
EI
CMOS; Digital Electronics; Imagery; Integrated Circuits; Logic Circuits; Measuring Instruments; Radiation Hardening

20040040125 NASA Goddard Space Flight Center, Greenbelt, MD, USA
On-Orbit Cross-Calibration of AM Satellite Remote Sensing Instruments using the Moon
Butler, James J.; Kieffer, Hugh H.; Barnes, Robert A.; Stone, Thomas C.; [2003]; In English; No Copyright; Avail: Other Sources; Abstract Only

On April 14,2003, three Earth remote sensing spacecraft were maneuvered enabling six satellite instruments operating in the visible through shortwave infrared wavelength region to view the Moon for purposes of on-orbit cross-calibration. These instruments included the Moderate Resolution Imaging Spectroradiometer (MODIS), the Multi-angle Imaging SpectroRadiometer (MISR), the Advanced Spaceborne Thermal Emission and Reflection (ASTER) radiometer on the Earth Observing System (EOS) Terra spacecraft, the Advanced Land Imager (ALI) and Hyperion instrument on Earth Observing-1 (EO-1) spacecraft, and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) on the SeaStar spacecraft. Observations of the Moon were compared using a spectral photometric mode for lunar irradiance developed by the Robotic Lunar Observatory (ROLO) project located at the USA Geological Survey in Flagstaff, Arizona. The ROLO model effectively accounts for variations in lunar irradiance corresponding to lunar phase and libration angles, allowing intercomparison of observations made by instruments on different spacecraft under different time and location conditions. The spacecraft maneuvers necessary to view the Moon are briefly described and results of using the lunar irradiance model in comparing the radiometric calibration scales of the six satellite instruments are presented here.
Author
Cross Correlation; Calibrating; Earth Observing System (EOS); Remote Sensing; Satellite Instruments; Satellite Observation; Sea-Viewing Wide Field-of-View Sensor; Moon

20040034054 Northrop Grumman Corp., Lanham, MD USA
Autonomous Telemetry Collection for Single-Processor Small Satellites
Speer, Dave; June 2003; In English, 11-14 Aug. 2003, Logan, UT, USA
Contract(s)/Grant(s): NAS5-99124
Report No.(s): SSC03-XI-6; No Copyright; Avail: CASI; A03, Hardcopy

For the Space Technology 5 mission, which is being developed under NASA's New Millennium Program, a single spacecraft processor will be required to do on-board real-time computations and operations associated with attitude control, up-link and down-link communications, science data processing, solid-state recorder management, power switching and battery charge management, experiment data collection, health and status data collection, etc. Much of the health and status information is in analog form, and each of the analog signals must be routed to the input of an analog-to-digital converter, converted to digital form, and then stored in memory. If the micro-operations of the analog data collection process are implemented in software, the processor may use up a lot of time either waiting for the analog signal to settle, waiting for the analog-to-digital conversion to complete, or servicing a large number of high frequency interrupts. In order to off-load a very busy processor, the collection and digitization of all analog spacecraft health and status data will be done autonomously by a field-programmable gate array that can configure the analog signal chain, control the analog-to-digital converter, and store the converted data in memory.
Author
Small Scientific Satellites; Autonomy; Telemetry; Airborne/Spaceborne Computers

20040031781 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Carrier Plus: A sensor payload for Living With a Star Space Environment Testbed (LWS/SET)
Marshall, Cheryl J.; Moss, Steven; Howard, Regan; LaBel, Kenneth A.; Grycewicz, Tom; Barth, Janet L.; Brewer, Dana; [2003]; In English; International Society for Optical Engineering; Copyright; Avail: CASI; A02, Hardcopy

The Defense Threat Reduction Agency (DTR4) and National Aeronautics and Space Administration (NASA) Goddard Space Flight Center are collaborating to develop the Carrier Plus sensor experiment platform as a capability of the Space Environments Testbed (SET). The Space Environment Testbed (SET) provides flight opportunities for technology experiments as part of NASA's Living With a Star (LWS) program. The Carrier Plus will provide new capability to characterize sensor

technologies such as state-of-the-art visible focal plane arrays (FPAs) in a natural space radiation environment. The technical objectives include on-orbit validation of recently developed FPA technologies and performance prediction methodologies, as well as characterization of the FPA radiation response to total ionizing dose damage, displacement damage and transients. It is expected that the sensor experiment will carry 4-6 FPAs and associated radiation correlative environment monitors (CEMs) for a 2006-2007 launch. Sensor technology candidates may include n- and p-charge coupled devices (CCDs), active pixel sensors (APS), and hybrid CMOS arrays. The presentation will describe the Carrier Plus goals and objectives, as well as provide details about the architecture and design. More information on the LWS program can be found at http://lws.gsfc.nasa.gov/. Business announcements for LWS/SET and program briefings are posted at http://lws-set.gsfc.nasa.gov
Author

Aerospace Environments; Prediction Analysis Techniques; Extraterrestrial Radiation; Focal Plane Devices; Performance Prediction; Payloads

20040031762 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Real-Time Attitude Independent Three Axis Magnetometer Calibration

Crassidis, John L.; Lai, Kok-Lam; Harman, Richard R.; [2003]; In English, 28-30 Oct. 2003, Greenbelt, MD, USA
Contract(s)/Grant(s): NAG5-12179; No Copyright; Avail: CASI; A03, Hardcopy

In this paper new real-time approaches for three-axis magnetometer sensor calibration are derived. These approaches rely on a conversion of the magnetometer-body and geomagnetic-reference vectors into an attitude independent observation by using scalar checking. The goal of the full calibration problem involves the determination of the magnetometer bias vector, scale factors and non-orthogonality corrections. Although the actual solution to this full calibration problem involves the minimization of a quartic loss function, the problem can be converted into a quadratic loss function by a centering approximation. This leads to a simple batch linear least squares solution. In this paper we develop alternative real-time algorithms based on both the extended Kalman filter and Unscented filter. With these real-time algorithms, a full magnetometer calibration can now be performed on-orbit during typical spacecraft mission-mode operations. Simulation results indicate that both algorithms provide accurate integer resolution in real time, but the Unscented filter is more robust to large initial condition errors than the extended Kalman filter. The algorithms are also tested using actual data from the Transition Region and Coronal Explorer (TRACE).
Author

Magnetometers; Calibrating; Real Time Operation; Scalars; Attitude (Inclination); Algorithms; Geomagnetism

20040027587 NASA Goddard Space Flight Center, Greenbelt, MD, USA

Testing of Gyroless Estimation Algorithms for the FUSE Spacecraft

Thienel, Julie; Harman, Rick; Oshman, Yaakov; [2003]; In English, 3-7 Aug. 2003, Big Sky, MT, USA; Copyright; Avail: CASI; A01, Hardcopy

The Far Ultraviolet Spectroscopic Explorer (FUSE) is equipped with two ring laser gyros on each of the spacecraft body axes. In May 2001 one gyro failed. It is anticipated that all of the remaining gyros will also fail based on intensity warnings. In addition to the gyro failure, two of four reaction wheels failed in late 2001. The spacecraft control now relies heavily on magnetic torque to perform the necessary science maneuvers and hold on target. The only sensor consistently available during slews is a magnetometer. This paper documents the testing and development of magnetometer-based gyroless attitude and rate estimation algorithms for FUSE. The results of two approaches are presented, one relies on a kinematic model for propagation, a method used in aircraft tracking, and the other is a pseudo-linear Kalman filter that utilizes Euler's equations in the propagation of the estimated rate. Both algorithms are tested using flight data collected over a few months before and after the reaction wheel failure. Finally, the question of closed-loop stability is addressed. The ability of the controller to meet the science slew requirements, without the gyros, is tested through simulations.
Author

Far UV Spectroscopic Explorer; Laser Gyroscopes; Ring Lasers; Magnetometers; Spacecraft Control; Feedback Control

20040020250

GEMS: A Revolutionary Concept for Planetary and Space Exploration

Manobianco, John; Bickford, James; George, Sean; Pister, Kristofer S. J.; Manobianco, Donna M.; AIP Conference Proceedings; February 04, 2004; ISSN 0094-243X; Volume 699, Issue no. 1, 1035-1043; In English; SPACE TECHNOLOGY and APPLICATIONS INTERNAT. FORUM-STAIF 2004: Conf.on Thermophys.in Microgravity; Commercial/Civil Next Gen.Space Transp.; 21st Symp.Space Nuclear Power & Propulsion; Human Space Explor.; Space Colonization; New Frontiers

& Future Concepts, 8-11 February 2004, Albuquerque, New Mexico, USA; Copyright

A novel observing system known as Global Environmental MEMS Sensors (GEMS) offers the potential to significantly improve the ability to take in situ measurements for a variety of space missions. The GEMS concept features devices with completely integrated sensing, power, and communications with characteristic dimensions of just millimeters. Thousands of these low-cost devices could potentially be deployed together from a spacecraft to enable distributed sensing in planetary and other space environments. The deployment of such probes is analyzed and discussed for various scenarios on Mars that would provide measurements with unprecedented spatial and temporal resolution. The extended coverage provided by the arrays would improve the ability to calibrate remote sensing data while also extending the areas traditionally measured by localized landers. The unique features of such a system could significantly improve the capabilities for planetary and space exploration in the near and far term. [copyright] 2004 American Institute of Physics

Author (AIP)

Cost Analysis; Cost Effectiveness; Data Links; Engineering; In Situ Measurement; Mars (Planet); Microelectromechanical Systems; Nanotechnology; Planetary Atmospheres; Remote Sensing; Space Exploration; Space Missions; Telecommunication

20040020219

Realistic Testing of the Safe Affordable Fission Engine (SAFE-100) Thermal Simulator Using Fiber Bragg Gratings

Stinson-Bagby, Kelly L.; Fielder, Robert S.; Van Dyke, Melissa K.; Wong, Wayne A.; AIP Conference Proceedings; February 04, 2004; ISSN 0094-243X; Volume 699, Issue no. 1, 749-756; In English; SPACE TECHNOLOGY and APPLICATIONS INTERNAT. FORUM-STAIF 2004: Conf.on Thermophys.in Microgravity; Commercial/Civil Next Gen.Space Transp.; 21st Symp.Space Nuclear Power & Propulsion; Human Space Explor.; Space Colonization; New Frontiers & Future Concepts, 8-11 February 2004, Albuquerque, New Mexico, USA; Copyright

The motivation for the reported research was to support NASA space nuclear power initiatives through the development of advanced fiber optic sensors for space-based nuclear power applications. Distributed high temperature measurements were made with 20 FBG temperature sensors installed in the SAFE-100 thermal simulator at the NASA Marshal Space Flight Center. Experiments were performed at temperatures approaching 800[deg]C and 1150[deg]C for characterization studies of the SAFE-100 core. Temperature profiles were successfully generated for the core during temperature increases and decreases. Related tests in the SAFE-100 successfully provided strain measurement data. [copyright] 2004 American Institute of Physics

Author (AIP)

Bragg Gratings; Electric Generators; Fiber Optics; Nuclear Reactor Control; Nuclear Reactors; Reactor Safety; Simulation; Spacecraft Power Supplies; Temperature Measurement; Test Facilities; Thermal Analysis

20040020207

High Neutron Fluence Survivability Testing of Advanced Fiber Bragg Grating Sensors

Fielder, Robert S.; Klemer, Daniel; Stinson-Bagby, Kelly L.; AIP Conference Proceedings; February 04, 2004; ISSN 0094-243X; Volume 699, Issue no. 1, 650-657; In English; SPACE TECHNOLOGY and APPLICATIONS INTERNAT. FORUM-STAIF 2004: Conf.on Thermophys.in Microgravity; Commercial/Civil Next Gen.Space Transp.; 21st Symp.Space Nuclear Power & Propulsion; Human Space Explor.; Space Colonization; New Frontiers & Future Concepts, 8-11 February 2004, Albuquerque, New Mexico, USA

Contract(s)/Grant(s): NAS3-02173; Copyright

The motivation for the reported research was to support NASA space nuclear power initiatives through the development of advanced fiber optic sensors for space-based nuclear power applications. The purpose of the high-neutron fluence testing was to demonstrate the survivability of fiber Bragg grating (FBG) sensors in a fission reactor environment. 520 FBGs were installed in the Ford reactor at the University of Michigan. The reactor was operated for 1012 effective full power hours resulting in a maximum neutron fluence of approximately 5 x1019 n/cm2, and a maximum gamma dose of 2 x103 MGy gamma. This work is significant in that, to the knowledge of the authors, the exposure levels obtained are approximately 1000 times higher than for any previously published experiment. Four different fiber compositions were evaluated. An 87% survival rate was observed for fiber Bragg gratings located at the fuel centerline. Optical Frequency Domain Reflectometry (OFDR), originally developed at the NASA Langley Research Center, can be used to interrogate several thousand low-reflectivity FBG strain and/or temperature sensors along a single optical fiber. A key advantage of the OFDR sensor technology for space nuclear power is the extremely low mass of the sensor, which consists of only a silica fiber 125[mu]m in diameter. The sensors produced using this technology will fill applications in nuclear power for current reactor plants, emerging Generation-IV reactors, and for space nuclear power. The reported research was conducted by Luna Innovations and was funded through a

Small Business Innovative Research (SBIR) contract with the NASA Glenn Research Center. [copyright] 2004 American Institute of Physics
Author (AIP)
Bragg Gratings; Electric Generators; Environment Effects; Fiber Optics; Gamma Rays; Neutrons; Nuclear Reactor Control; Nuclear Reactors; Radiation Effects; Spacecraft Power Supplies

20040020199
Direct Estimation of Power Distribution in Reactors for Nuclear Thermal Space Propulsion
Aldemir, Tunc; Miller, Don W.; Burghelea, Andrei; AIP Conference Proceedings; February 04, 2004; ISSN 0094-243X; Volume 699, Issue no. 1, 582-589; In English; SPACE TECHNOLOGY and APPLICATIONS INTERNAT. FORUM-STAIF 2004: Conf.on Thermophys.in Microgravity; Commercial/Civil Next Gen.Space Transp.; 21st Symp.Space Nuclear Power & Propulsion; Human Space Explor.; Space Colonization; New Frontiers & Future Concepts, 8-11 February 2004, Albuquerque, New Mexico, USA; Copyright

A recently proposed constant temperature power sensor (CTPS) has the capability to directly measure the local power deposition rate in nuclear reactor cores proposed for space thermal propulsion. Such a capability reduces the uncertainties in the estimated power peaking factors and hence increases the reliability of the nuclear engine. The CTPS operation is sensitive to the changes in the local thermal conditions. A procedure is described for the automatic on-line calibration of the sensor through estimation of changes in thermal .conditions. [copyright] 2004 American Institute of Physics
Author (AIP)
Finite Difference Theory; Nuclear Propulsion; Nuclear Reactors; Power Reactors; Propulsion; Reactor Cores; Spacecraft; Temperature Distribution; Temperature Sensors

20040020154
Closed End Launch Tube (CELT)
Lueck, Dale E.; Immer, Christopher D.; AIP Conference Proceedings; February 04, 2004; ISSN 0094-243X; Volume 699, Issue no. 1, 189-196; In English; SPACE TECHNOLOGY and APPLICATIONS INTERNAT. FORUM-STAIF 2004: Conf.on Thermophys.in Microgravity; Commercial/Civil Next Gen.Space Transp.; 21st Symp.Space Nuclear Power & Propulsion; Human Space Explor.; Space Colonization; New Frontiers & Future Concepts, 8-11 February 2004, Albuquerque, New Mexico, USA; Copyright

A small-scale test apparatus has been built and tested for the CELT pneumatic launch assist concept presented at STAIF 2001. The 7.5 cm (3-inch) diameter x 305 M (1000 feet) long system accelerates and pneumatically brakes a 6.35 cm diameter projectile with variable weight (1.5 - 5 Kg). The acceleration and braking tube has been instrumented with optical sensors and pressure transducers at 14 stations to take data throughout the runs. Velocity and pressure profiles for runs with various accelerator pressures and projectile weights are given. This test apparatus can serve as an important experimental tool for verifying this concept. [copyright] 2004 American Institute of Physics
Author (AIP)
Budgeting; Pneumatics; Propulsion; Research Projects; Rocket Engines; Spacecraft

20040015247 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Offset of a Drag-Free Sensor from the Center of Gravity of Its Satellite
Starin, Scott R.; [2003]; In English, 24-26 Jun. 2003, College Park, MD, USA; No Copyright; Avail: Other Sources; Abstract Only

The drag-free satellite is one that encloses a proof mass, shielding it from atmospheric drag and solar radiation pressure (SRP). By sensing the location of the proof mass in the body and using thrusters to force the spacecraft to follow the proof mass in a closed-loop fashion, the effects of drag and SRP may be eliminated from the spacecraft orbit. Thus, several benefits may be gained, including improved ephemeris propagation and reduced operational costs. The package including the proof mass and the location sensing equipment may be considered as a single sensor; if generalized, such a sensor could be manufactured and used more easily in satellite designs, similar to how current missions use, for example, rate gyros and magnetometers. The flight heritage of the technology has been such that the proof mass sensor is a primary facet of the mission, allowing it to dominate design considerations. In particular, this paper discusses the effects that may be expected if a generalized drag-free sensor is placed some distance away from the spacecraft center of gravity. The proof mass will follow a given gravitational orbit, and a separation from the spacecraft center of gravity places the spacecraft itself in a different orbit from the proof mass, requiring additional fuel just to maintain function of the drag- free sensor. Conclusions include some

guiding principles for determining whether certain mission characteristics may restrict or preclude the use of drag-free sensors for that mission. These principles may be used both by mission planners considering drag-free missions and by hardware designers considering or pursuing the development of such generalized sensors.
Author
Drag Reduction; Feedback Control; Flat Surfaces; Magnetometers; Satellite Design; Shielding; Sensors

20040015132 NASA Ames Research Center, Moffett Field, CA, USA
Current Developments in Future Planetary Probe Sensors for TPS
Martinez, Ed; Venkatapathy, Ethiraj; Oishu, Tomo; [2003]; In English, 4-10 Oct. 2003, Lisbon, Portugal; Copyright; Avail: Other Sources; Abstract Only

In-situ Thermal Protection System (TPS) sensors are required to provide traceability of TPS performance and sizing tools. Traceability will lead to higher fidelity design tools, which in turn will lead to lower design safety margins, and decreased heatshield mass. Decreasing TPS mass will enable certain missions that are not otherwise feasible, and directly increase science payload. NASA Ames is currently developing two flight measurements as essential to advancing the state of TPS traceability for material modeling and aerothermal simulation: heat flux and surface recession (for ablators). The heat flux gage is applicable to both ablators and non-ablators and is therefore the more generalized sensor concept of the two with wider applicability to mission scenarios. This paper describes the development of a microsensor capable of surface and in-depth temperature and heat flux measurements for TPS materials appropriate to Titan, Neptune, and Mars aerocapture, and direct entry. The thermal sensor will be monolithic solid state devices composed of thick film platinum RTD on an alumina substrate. Choice of materials and critical dimensions are used to tailor gage response, determined during calibration activities, to specific (forebody vs. aftbody) heating environments. Current design has maximum operating temperature of 1500 K, and allowable constant heat flux of q=28.7 watts per square centimeter, and time constants between 0.05 and 0.2 seconds. The catalytic and radiative response of these heat flux gages can also be changed through the use of appropriate coatings. By using several co-located gages with various surface coatings, data can be obtained to isolate surface heat flux components due to radiation, catalycity and convection. Selectivity to radiative heat flux is a useful feature even for an in-depth gage, as radiative transport may be a significant heat transport mechanism for porous TPS materials in Titan aerocapture. This paper also reports on progress to adapt a previously flown surface recession sensor, based on the Jupiter probe Galileo Analog Resistance Ablation Detector (ARAD), to appropriate aerocapture conditions.
Author
Sensors; Thermal Protection; Space Probes; Microinstrumentation; Spacecraft Instruments

20040010595 California Univ., San Diego, CA, USA
Space Instruments: General Considerations
Arnold, James R.; Space Science Reference Guide, 2nd Edition; [2003]; In English; Copyright; Avail: CASI; A01, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

A scientific instrument carried on a spacecraft must of course work well as a scientific instrument. The main requirement is that it be capable of doing a first-rate job, within the other limitations, in returning reliable, meaningful information for its intended purpose(s). This is especially true since missions are very infrequent, so that there may not be another opportunity for years or even decades to study the same questions. The first rule is to use the most reliable components available; their cost is usually considered negligible in the overall budget. These are usually at a minimum 'milspec' parts intended for military use, and hence, among other virtues, shock- and radiation-resistant. Critical parts are individually documented from birth. In reality this isn't always the best strategy -- there is some art here, especially when cost is a real constraint, as it will be more and more in the future. For example, current personal computers and laptops are much more rugged and reliable than the big mainframes of a decade ago. My own hand calculator has survived dropping on the floor many times. My four-year-old PC at home has had no service calls at all. So it may be that consumer devices and parts are in many cases more rugged than anything made in much smaller quantities. For critical functions, where disabling consequences are not extremely improbable, the second line of defense is redundancy. Of course this takes a bite out of scarce resources. It seems to be a rule of experience that electronic components have a life cycle much like humans. That is, there is a (relatively) high mortality soon after birth, followed by a long period of low risk, followed by old age and its inevitable close. Thus components and circuits for space use are normally 'burned in' by being run for an adequate period before being incorporated in the instrument, run again for ground testing, and flown. Third, function often depends on expendables, that is, materials that must be consumed to permit proper instrument function. For instruments, the most familiar examples are cryogens, solids or occasionally liquids that serve as heat sinks for instruments whose proper operation depends on low, steady temperature. An example is the immensely successful IRAS mission, the first to look broadly at the sky for interesting objects in the infrared. Successful operation of the

thermal sensors required a supply of solid helium at temperatures of only a few kelvins. Unforeseen heat leaks or even very short periods at higher temperature could have ended the mission prematurely. Other expendables include propellants for various purposes, although these aren't normally the experimenter's responsibility.
Author
Infrared Astronomy Satellite; Instruments; Radiation Tolerance; Life (Durability); Ground Tests; Central Processing Units

20040001292
A fast star sensor for balloon payloads
Nati, Federico; de Bernardis, Paolo; Iacoangeli, Armando; Masi, Silvia; Benoit, Alain; Yvon, Dominique; Review of Scientific Instruments; September 2003; ISSN 0034-6748; Volume 74, Issue no. 9, 4169-4175; In English; Copyright

We developed a system to reconstruct the attitude of balloon borne spinning experiments, where high accuracy (about 1(sup ')) and high rotation speed (up to tens of degrees per second) are required. It is based on a stellar sensor, and gathers together hardware simplicity, cheap components, high resolution, and sensitivity. It is composed of an optical mirror (diameter 40 cm), an array of 46 fast and sensitive photodiodes, and low noise readout electronics. It was designed for the Archeops experiment, a balloon borne millimetric telescope whose goal is to generate high resolution maps of large regions of the sky, to study the temperature anisotropies of the cosmic background radiation. [copyright] 2003 American Institute of Physics.
Author (AIP)
Attitude (Inclination); Balloons; High Speed; Optical Measuring Instruments; Optoelectronic Devices; Photodiodes; Readout; Telescopes

20030111818 NASA Ames Research Center, Moffett Field, CA, USA
Airborne Sun Photometer Measurements of Aerosol Optical Depth during SOLVE II: Comparison with SAGE III and POAM III Measurements
Russell, P.; Livingston, J.; Schmid, B.; Eilers, J.; Kolyer, R.; Redemann, J.; Yee, J.-H.; Trepte, C.; Thomason, L.; Zawodny, J., et al.; [2003]; In English; SOLVE II/Vintersol Joint Science Team Meeting, 21-24 Oct. 2003, Kissimmee, FL, USA
Contract(s)/Grant(s): WBS 21-621-60-02-10; Copyright; Avail: Other Sources; Abstract Only

The 14-channel NASA Ames Airborne Tracking Sunphotometer (AATS-14) was operated aboard the NASA DC-8 during the Second SAGE III Ozone Loss and Validation Experiment (SOLVE II) and obtained successful measurements during the sunlit segments of eight science flights. These included six flights out of Kiruna, Sweden, one flight out of NASA Dryden Flight Research Center (DFRC), and the Kiruna-DFRC return transit flight. Values of spectral aerosol optical depth (AOD), columnar ozone and columnar water vapor have been derived from the AATS-14 measurements. In this paper, we focus on AATS-14 AOD data. In particular, we compare AATS-14 AOD spectra with temporally and spatially near-coincident measurements by the Stratospheric Aerosol and Gas Experiment III (SAGE III) and the Polar Ozone and Aerosol Measurement III (POAM III) satellite sensors. We examine the effect on retrieved AOD of uncertainties in relative optical airmass (the ratio of AOD along the instrument-to-sun slant path to that along the vertical path) at large solar zenith angles. Airmass uncertainties result fiom uncertainties in requisite assumed vertical profiles of aerosol extinction due to inhomogeneity along the viewing path or simply to lack of available data. We also compare AATS-14 slant path solar transmission measurements with coincident measurements acquired from the DC-8 by the NASA Langley Research Center Gas and Aerosol Measurement Sensor (GAMS).
Author
Aerosols; Photometers; Optical Thickness; Airborne Equipment; Gas Analysis

20030111412 Remote Sensing Technology Center, Tokyo, Japan
Post-Launch Calibration of the Planet-B Extreme Ultraviolet Scanner
Shiomi, K.; Yamazaki, A.; Yoshikawa, I.; Takizawa, Y.; Nakamura, M.; Lunar and Planetary Science XXXIV; 2003; In English; Original contains color illustrations; Copyright; Avail: CASI; A01, Hardcopy; Available from CASI on CD-ROM only as part of the entire parent document

Extreme Ultraviolet scanner (XUV) onboard Planet-B was a newly developed telescope for measuring an amount of helium gas and ions, which emit resonantly scattered light, on Martian atmosphere and ionosphere. XUV observed moonlight at a distance of 80 Earth radii (R(sub g)) when Planet-B was in parking orbit around Earth. We study the validity of pre-launch laboratory calibration, such as sensor efficiency, line of sight (LOS), and field of view (FOV) of XUV, with analyzing observation data of the Moon.
Derived from text
Calibrating; Scanners; Extreme Ultraviolet Radiation; Mars Atmosphere

20030066758 California Univ., Berkeley, CA, USA

The Design and Implementation of Instruments for Low-Frequency Electromagnetic Sounding of the Martian Subsurface

Delory, G. T.; Grimm, R. E.; Sixth International Conference on Mars; 2003; In English; Original contains color illustrations
Contract(s)/Grant(s): NAG5-11781; Copyright; Avail: CASI; C01, CD-ROM; A01, Hardcopy; Available on CD-ROM as part of the entire parent document

Low-frequency electromagnetic soundings of the subsurface can identify liquid water at depths ranging from hundreds of meters to approx. 10 km in an environment such as Mars. Among the tools necessary to perform these soundings are low-frequency electric and magnetic field sensors capable of being deployed from a lander or rover such that horizontal and vertical components of the fields can be measured free of structural or electrical interference. Under a NASA Planetary Instrument Definition and Development Program (PIDDP), we are currently engaged in the prototype stages of low frequency sensor implementations that will enable this technique to be performed autonomously within the constraints of a lander platform. Once developed, this technique will represent both a complementary and alternative method to orbital radar sounding investigations, as the latter may not be able to identify subsurface water without significant ambiguities. Low frequency EM methods can play a crucial role as a ground truth measurement, performing deep soundings at sites identified as high priority areas by orbital radars. Alternatively, the penetration depth and conductivity discrimination of low-frequency methods may enable detection of subsurface water in areas that render radar methods ineffective. In either case, the sensitivity and depth of penetration inherent in low frequency EM exploration makes this tool a compelling candidate method to identify subsurface liquid water from a landed platform on Mars or other targets of interest.
Author

Spacecraft Instruments; Ground Water; Mars Surface; Sounding

20030066440 Nauchno-Proizvodstvennoe Obedinenie Prikladnoi Mekhaniki, Krasnoyarsk, Russia

Hall Effect Thruster Interactions Data From the Russian Express-A2 and Express-A3 Satellites, Part 2, Acquire TM Date for Type B Sensors for 'Express-A' Number 2 Satellite for the Period of March 12, 2000 to and Including June 15, 2000, Task 25

Dunning, John, Technical Monitor; Sitnikova, N.; Volkov, D.; Maximov, I.; Petrusevich, V.; Allen, D.; June 2003; In English
Contract(s)/Grant(s): NAS3-99151; NAS3-99204; WBS 22-800-91-01
Report No.(s): NASA/CR-2003-212005/PT2; E-13691-2/PT2; NAS 1.15:212005/PT2; No Copyright; Avail: CASI; A08, Hardcopy

This 12-part report documents the data obtained from various sensor measurements taken aboard the Russian Express-A2 and Express-A3 spacecraft in Geosynchronous Earth Orbit (GEO). These GEO communications satellites, which were designed and built by NPO Prikladnoy Mekhaniki (NPO PM) of Zheleznogorsk, Russia, utilize Hall thruster propulsion systems for north-south and east-west stationkeeping and as of June 2002, were still operating at 80 E. and 11 W., respectively. Express-A2 was launched on March 12, 2000, while Express-A3 was launched on June 24, 2000. The diagnostic equipment from which these data were taken includes electric field strength sensors, ion current and energy sensors, and pressure sensors. The diagnostics and the Hall thruster propulsion systems are described in detail along with lists of tabular data from those diagnostics and propulsion system and other satellite systems. Space Power, Inc., now part of Pratt & Whitney's Chemical Systems Division, under contract NAS3 99151 to the NASA Glenn Research Center, obtained these data over several periods from March 12, 2000, through September 30, 2001. Each of the 12 individual reports describe, in detail, the propulsion systems as well as the diagnostic sensors utilized. Finally, parts 11 and 12 include the requirements to which NPO PM prepared and delivered these data.
Author

Hall Thrusters; Communication Satellites; Geosynchronous Orbits; Propulsion System Configurations

20030066367 Instituto Nacional de Pesquisas Espacias, Sao Jose dos Campos, Brazil

A Study of an Active Precession Control System (SCAP) for Sounding Rockets

Guilherme, Michel Silas; 2003; In Portuguese; CD-ROM contains full text document in PDF format and color illustrations. PDF also has blank pages.
Report No.(s): INPE-9780-TDI/862; Copyright; Avail: CASI; C01, CD-ROM; A08, Hardcopy

During the flight of a spacecraft there will be various sources of perturbations, where the most expressive are jet misalignment, dynamic unbalance, stages separation, that induce a precession motion, in spite of the spin stabilization. This motion, whose amplitude is proportional to the magnitude of the perturbation, can become catastrophic, ultimately leading to mission abort. To ensure that the precession motion remains within prescribed limits a control law proportional to the angular

velocities in the body frame was proposed. A control system of one and two axes was studied. On the one axis control system the strategy of misalignment between sensor and actuators was studied. This strategy implies in reducing the number of sensors and actuators of the control system. It was observed that the angle is sensible to the spin and disturbance orientation. Finally, a control system with an on-off actuator was studied. It shown to be very satisfactory, in respect to the amplitude of the precession motion and control torque, and present advantages in comparison with the control system with proportional actuator.
Author
Active Control; Sounding Rockets; Precession

20030032246 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Investigation of Space Interferometer Control Using Imaging Sensor Output Feedback
Cheng, Victore H. L.; Leitner, Jesse A.; January 28, 2003; In English, 11-13 Aug. 2003, Austin, TX, USA; Copyright; Avail: CASI; A03, Hardcopy

Numerous space interferometry missions are planned for the next decade to verify different enabling technologies towards very-long-baseline interferometry to achieve high-resolution imaging and high-precision measurements. These objectives will require coordinated formations of spacecraft separately carrying optical elements comprising the interferometer. High-precision sensing and control of the spacecraft and the interferometer-component payloads are necessary to deliver sub-wavelength accuracy to achieve the scientific objectives. For these missions, the primary scientific product of interferometer measurements may be the only source of data available at the precision required to maintain the spacecraft and interferometer-component formation. A concept is studied for detecting the interferometer's optical configuration errors based on information extracted from the interferometer sensor output. It enables precision control of the optical components, and, in cases of space interferometers requiring formation flight of spacecraft that comprise the elements of a distributed instrument, it enables the control of the formation flying vehicles because independent navigation or ranging sensors cannot deliver the high-precision metrology over the entire required geometry. Since the concept can act on the quality of the interferometer output directly, it can detect errors outside the capability of traditional metrology instruments, and provide the means needed to augment the traditional instrumentation to enable enhanced performance. Specific analyses performed in this study include the application of signal-processing and image-processing techniques to solve the problems of interferometer aperture baseline control, interferometer pointing, and orientation of multiple interferometer aperture pairs.
Author
Interferometers; Feedback Control; Interferometry; Metrology; Spacecraft Instruments; Optical Equipment; Control Systems Design; Error Analysis

20030025345 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Instructions for Plastic Encapsulated Microcircuit(PEM) Selection, Screening and Qualification.
King, Terry; Teverovsky, Alexander; Leidecker, Henning; August 2002; In English; Original contains black and white illustrations; No Copyright; Avail: CASI; A03, Hardcopy

The use of Plastic Encapsulated Microcircuits (PEMs) is permitted on NASA Goddard Space Flight Center (GSFC) spaceflight applications, provided each use is thoroughly evaluated for thermal, mechanical, and radiation implications of the specific application and found to meet mission requirements. PEMs shall be selected for their functional advantage and availability, not for cost saving; the steps necessary to ensure reliability usually negate any initial apparent cost advantage. A PEM shall not be substituted for a form, fit and functional equivalent, high reliability, hermetic device in spaceflight applications. Due to the rapid change in wafer-level designs typical of commercial parts and the unknown traceability between packaging lots and wafer lots, lot specific testing is required for PEMs, unless specifically excepted by the Mission Assurance Requirements (MAR) for the project. Lot specific qualification, screening, radiation hardness assurance analysis and/or testing, shall be consistent with the required reliability level as defined in the MAR. Developers proposing to use PEMs shall address the following items in their Performance Assurance Implementation Plan: source selection (manufacturers and distributors), storage conditions for all stages of use, packing, shipping and handling, electrostatic discharge (ESD), screening and qualification testing, derating, radiation hardness assurance, test house selection and control, data collection and retention.
Author
Encapsulated Microcircuits; Microelectronics; Wafers; Materials Selection; Mechanical Properties; Quality Control; Education

20030020849 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Precision Pointing for the Laser Interferometry Space Antenna Mission
Hyde, T. Tupper; Maghami, P. G.; [2003]; In English, 5-9 Feb. 2003, Colorado, USA
Report No.(s): AAS-03-066; No Copyright; Avail: CASI; A03, Hardcopy

The Laser Interferometer Space Antenna (LISA) mission is a planned NASA-ESA gravitational wave detector consisting of three spacecraft in heliocentric orbit. Lasers are used to measure distance fluctuations between proof masses aboard each spacecraft to the picometer level over a 5 million kilometer separation. Each spacecraft and its two laser transmit/receive telescopes must be held stable in pointing to less than 8 nanoradians per root Hertz in the frequency band 0.1-100 mHz. The pointing error is sensed in the received beam and the spacecraft attitude is controlled with a set of micro-Newton thrusters. Requirements, sensors, actuators, control design, and simulations are described.
Author

LISA (Observatory); Pointing Control Systems; Gravitational Waves; Laser Interferometry; Position Errors; Time Domain Analysis; Sensors; Spacecraft Control

20030020794 NASA Goddard Space Flight Center, Greenbelt, MD, USA
Overview of Terra
King, Michael D.; [2002]; In English, 25-30 Aug. 2002, L'Aquilla, Italy; No Copyright; Avail: Other Sources; Abstract Only

The Earth Observing System (EOS) is a space-based observing system comprised of a series of satellite sensors by which scientists can monitor the Earth, a Data and Information System (EOSDIS) enabling researchers worldwide to access the satellite data, and an interdisciplinary science research program to interpret the satellite data. During the last couple of years, seven EOS science missions were launched, representing observations of (i) total solar irradiance, (ii) Earth radiation budget, (iii) land cover & land use change, (iv) ocean processes (vector wind, sea surface temperature, ocean topography, and ocean color), (v) atmospheric processes (aerosol and cloud properties, water vapor, and temperature and moisture profiles), (v) tropospheric chemistry, (vi) sea ice concentration, and (viii) precipitation. In succeeding years many more satellites will be launched that will contribute immeasurably to our understanding of the Earth's environment. In this lecture I will describe how scientists are using NASA's Earth science data to examine land use and natural hazards, environmental air quality, including dust storms over the world's deserts, cloud and radiation properties, sea surface temperature, and tropospheric chemistry. This lecture will describe the Terra satellite, launched in December 1999 and still operating, and each of the five sensors onboard the spacecraft. This overview will highlight the goals and objectives of this mission, and describe the contributions and unique datasets provided by each sensor. This lecture will form the background for an extensive weeklong course on Terra and all the algorithms that have been developed and implemented to process the data from this spacecraft. This lecture will include a description of the Terra orbit, launch, data communication with the spacecraft, and data processing and archival of the data.
Author

Earth Observing System (EOS); Satellite Instruments; Terra Spacecraft; General Overviews; Earth Sciences

20030006874
New Experiments with Spinning Metallic Discs
Mazuruk, Konstantin; Grugel, Richard N.; AIP Conference Proceedings; January 28, 2003; ISSN 0094-243X; Volume 654, Issue no. 1, 947-951; In English; SPACE TECHNOLOGY and APPLICATIONS INT.FORUM-STAIF 2003: Conf.on Thermophysics in Microgravity; Commercial/Civil Next Generation Space Transportation; Human Space Exploration, 2-5 February 2003, Albuquerque, New Mexico, USA; Copyright

A number of recent advanced theories related to torsion properties of the space-time matrix predict the existence of an interaction between classically spinning objects. Indeed, some experimental data suggest that spinning magnetic bodies discernibly interact with Earth's natural fields. If there are interactions between rotating bodies then nuclear spins could be used for detection. Thus, assuming a spinning body induces a hypothetical torsion field, a sensor based on the giant magnetoresistance effect would detect local changes. Experimentally, spinning a brass wheel shielded from Earth's magnetic field showed no measurable change in signals; with no shielding a Faraday disc phenomenon was observed. Unexpected experimental measurements from the non-axial Faraday disc configuration were recorded and a theoretical model was derived to explain them. [copyright] 2003 American Institute of Physics
Author (AIP)

Magnetic Fields; Magnetoresistivity; Nuclear Spin; Rotating Bodies; Torsion

20030006848

Application of Electrometer Technology to Materials Evaluation for Future Planetary Spaceports

Calle, C. I.; Buhler, C. R.; Mantovani, J. G.; Groop, E. E.; Nowicki, A. W.; AIP Conference Proceedings; January 28, 2003; ISSN 0094-243X; Volume 654, Issue no. 1, 751-756; In English; SPACE TECHNOLOGY and APPLICATIONS INT.FORUM-STAIF 2003: Conf.on Thermophysics in Microgravity; Commercial/Civil Next Generation Space Transportation; Human Space Exploration, 2-5 February 2003, Albuquerque, New Mexico, USA; Copyright

Future spaceports on dusty and dry planetary environments, such as the Martian or lunar environments, may be hindered by the build-up of electrostatic charge that may generate unwanted electrostatic potentials. In an effort to evaluate suitable materials for these environments, an electrometer sensor technology was developed. This technology and its associated environmental simulators have made possible the characterization of the electrostatic response of possible spaceport materials exposed to planetary regolith simulants. A ‘triboelectric series’ ranking of these materials according to their electrostatic response has been developed. Some material candidates with low electrostatic response when in contact with the regolith simulants have been identified. Candidate materials for future planetary spaceports can be characterized with this technology. [copyright] 2003 American Institute of Physics

Author (AIP)

Electrometers; Electrostatic Charge; Electrostatics; Lunar Environment; Mars Environment; Materials Tests; Planetary Environments; Planets

20030006796

The Successful Development of an Automated Rendezvous and Capture (AR&C) System for the National Aeronautics and Space Administration

Roe, Fred D.; Howard, Richard T.; AIP Conference Proceedings; January 28, 2003; ISSN 0094-243X; Volume 654, Issue no. 1, 313-319; In English; SPACE TECHNOLOGY and APPLICATIONS INT.FORUM-STAIF 2003: Conf.on Thermophysics in Microgravity; Commercial/Civil Next Generation Space Transportation; Human Space Exploration, 2-5 February 2003, Albuquerque, New Mexico, USA; Copyright

During the 1990’s, the Marshall Space Flight Center (MSFC) conducted pioneering research in the development of an automated rendezvous and capture/docking (AR&C) system for U.S. space vehicles. Development and demonstration of a rendezvous sensor was identified early in the AR&C Program as the critical enabling technology that allows automated proximity operations and docking. A first generation rendezvous sensor, the Video Guidance Sensor (VGS), was developed and successfully flown on STS-87 and STS-95, proving the concept of a video- based sensor. A ground demonstration of the entire system and software was successfully tested. Advances in both video and signal processing technologies and the lessons learned from the two successful flight experiments provided a baseline for the development, by the MSFC, of a new generation of video based rendezvous sensor. The Advanced Video Guidance Sensor (AGS) has greatly increased performance and additional capability for longer-range operation with a new target designed as a direct replacement for existing ISS hemispherical reflectors. [copyright] 2003 American Institute of Physics

Author (AIP)

Ground Support Equipment; Ground Support Systems; NASA Programs; Navigation; Orbital Rendezvous; Research Projects; Spacecraft; Spacecraft Docking

20020061278 NASA Goddard Space Flight Center, Greenbelt, MD USA

An Assessment of the Ability of Potential Satellite Instruments to Resolve Spatial and Temporal Variability of Atmospheric CO2

Andrews, A.; Bhartia, Pawan, Technical Monitor; [2002]; In English, 19 May - 1 Jun. 2002, Boulder, CO, USA; No Copyright; Avail: Other Sources; Abstract Only

Sufficiently precise satellite observations with adequate spatial and temporal resolution would substantially increase our knowledge of the atmospheric CO2 distribution and would undoubtedly lead to reduced uncertainty in estimates of the global carbon budget. An overview of possible strategies for measuring CO2 from space will be presented, including IR and nearby measurements, active sensors and broad band and narrow band passive sensors. The ability of potential satellite instruments with a variety of orbits, horizontal resolution and vertical weighting functions to capture the variation in atmospheric CO2 mixing ratios will be illustrated using a combination of surface data, aircraft data and model results.

Author

Atmospheric Composition; Satellite Instruments; Temporal Distribution; Meteorological Parameters; Carbon Dioxide; Spatial Distribution

20020060752 NASA Goddard Space Flight Center, Greenbelt, MD USA, Computer Sciences Corp., Beltsville, MD USA
New Attitude Sensor Alignment Calibration Algorithms
Hashmall, Joseph A.; Sedlak, Joseph E.; Harman, Richard, Technical Monitor; [2002]; In English; World Space Congress, 10-19 Oct. 2002, Houston, TX, USA
Contract(s)/Grant(s): GS-35F-4381-G; NASA Order S-43411-G; No Copyright; Avail: Other Sources; Abstract Only

Accurate spacecraft attitudes may only be obtained if the primary attitude sensors are well calibrated. Launch shock, relaxation of gravitational stresses and similar effects often produce large enough alignment shifts so that on-orbit alignment calibration is necessary if attitude accuracy requirements are to be met. A variety of attitude sensor alignment algorithms have been developed to meet the need for on-orbit calibration. Two new algorithms are presented here: ALICAL and ALIQUEST. Each of these has advantages in particular circumstances. ALICAL is an attitude independent algorithm that uses near simultaneous measurements from two or more sensors to produce accurate sensor alignments. For each set of simultaneous observations the attitude is overdetermined. The information content of the extra degrees of freedom can be combined over numerous sets to provide the sensor alignments. ALIQUEST is an attitude dependent algorithm that combines sensor and attitude data into a loss function that has the same mathematical form as the Wahba problem. Alignments can then be determined using any of the algorithms (such as the QUEST quaternion estimator) that have been developed to solve the Wahba problem for attitude. Results from the use of these methods on active missions are presented.
Author
Algorithms; Attitude (Inclination); Attitude Indicators; Calibrating; Spacecraft Instruments

20020060733 NASA Goddard Space Flight Center, Greenbelt, MD USA, Computer Sciences Corp., Greenbelt, MD USA
Fine Sun Sensor Field of View Calibration
Sedlak, Joseph E.; Hashmall, J.; Harman, Richard, Technical Monitor; [2002]; In English; COSPAR International Astronautical Congress Joint Session Astrodynamics Symposium, 10-19 Oct. 2002, Houston, TX, USA
Contract(s)/Grant(s): GS-35F-4381G; NASA Order S-43411-G; No Copyright; Avail: Other Sources; Abstract Only

The fine Sun sensor (FSS) used on many spacecraft consists of two independent single-axis sensors, nominally mounted perpendicularly, that detect Sun angle across a typical field of view of +/- 32 degrees. The nonlinear function that maps the measured counts into an observed angle is called the transfer function. The FSS transfer function provided by the manufacturer consists of nine parameters for each of the two sensitive axes. An improved transfer function has been previously reported that achieves a significant accuracy improvement across the entire field of view. This new function expands the parameter set to 12 coefficients per axis and includes cross terms combining counts from both axes. To make best use of the FSS for spacecraft attitude determination, it must be calibrated after launch. We are interested in simplifying the postlaunch calibration procedure for estimating improvements to the 24 parameters in the transfer function. This paper discusses how to recombine the terms of the transfer function to reduce their redundancy without decreasing its accuracy and then presents an attitude dependent procedure for estimating the parameters. The end result is a calibration algorithm that is easier to use and does not sacrifice accuracy. Results of calibration using on-orbit data are presented.
Author
Algorithms; Calibrating; Solar Sensors; Transfer Functions

20020051128 NASA Kennedy Space Center, Cocoa Beach, FL USA, DYNACS Engineering Co., Inc., Cocoa Beach, FL USA
Sensor Applications at NASA KSC
Perotti, Jose M.; Eckhoff, Anthony; Voska, N., Technical Monitor; [2002]; In English; IEEE Sensors 2002, 11-14 Jun. 2002, Orlando, FL, USA
Contract(s)/Grant(s): NAS10-98001
Report No.(s): KSC-2002-066; No Copyright; Avail: CASI; A03, Hardcopy

The selection and qualification of commercial off-the-shelf products (COTS) transducers is desired whenever possible. In reality, qualified transducers are modified COTS to comply with KSC and program requirements. These requirements are dictated by the different NASA programs and the Kennedy Space Center (KSC). In some instances, there are no available commercial products that will meet the specific requirements of the application. The KSC Transducers Laboratory then develops these products. When fully developed, these products become certified GSE equipment and the potential for commercialization is assessed and pursued.
Derived from text
Commercial Off-the-Shelf Products; Commercialization; Transducers

20020049424 NASA Kennedy Space Center, Cocoa Beach, FL USA, DYNACS Engineering Co., Inc., Cocoa Beach, FL USA

Latest Development in Advanced Sensors at Kennedy Space Center (KSC)

Perotti, Jose M.; Eckhoff, Anthony J.; Voska, N., Technical Monitor; [2002]; In English; IEEE Sensors 2002, 12-14 Jun. 2002, Orlando, FL, USA

Contract(s)/Grant(s): NAS10-98001; No Copyright; Avail: CASI; A02, Hardcopy

Inexpensive space transportation system must be developed in order to make spaceflight more affordable. To achieve this goal, there is a need to develop inexpensive smart sensors to allow autonomous checking of the health of the vehicle and associated ground support equipment, warn technicians or operators of an impending problem and facilitate rapid vehicle pre-launch operations. The Transducers and Data Acquisition group at Kennedy Space Center has initiated an effort to study, research, develop and prototype inexpensive smart sensors to accomplish these goals. Several technological challenges are being investigated and integrated in this project multi-discipline sensors; self-calibration, health self-diagnosis capabilities embedded in sensors; advanced data acquisition systems with failure prediction algorithms and failure correction (self-healing) capabilities.

Author

Data Acquisition; Diagnosis; Failure Analysis; Ground Support Equipment; Health; Low Cost; Transducers

20020012004 Analex Corp., Brook Park, OH USA

The Electromagnetic Compatibility (EMC) Design Challenge for Scientific Spacecraft Powered by a Stirling Power Converter

Sargent, Noel B.; November 2001; In English, 29 July - 2 August, 2001, Savannah, GA, USA

Contract(s)/Grant(s): NAS3-00145; RTOP 896-30-00

Report No.(s): NASA/CR-2001-210945; E-12799; IECEC2001-CT-37; NAS 1.26:210945; No Copyright; Avail: CASI; A03, Hardcopy

A 55 We free-piston Stirling Technology Demonstration Convertor (TDC) has been tested as part of an evaluation to determine its feasibility as a means for significantly reducing the amount of radioactive material required compared to Radioisotope Thermoelectric Generators (RTGs) to support long-term space science missions. Measurements were made to quantify the low frequency magnetic and electric fields radiated from the Stirling's 80 Hertz (Hz) linear alternator and control electronics in order to determine the magnitude of reduction that will be required to protect sensitive field sensors aboard some science missions. One identified 'Solar Probe' mission requires a 100 dB reduction in the low frequency magnetic field over typical military standard design limits, to protect its plasma wave sensor. This paper discusses the electromagnetic interference (EMI) control options relative to the physical design impacts for this power system, composed of 3 basic electrical elements. They are (1) the Stirling Power Convertor with its linear alternator, (2) the power switching and control electronics to convert the 90 V, 80 Hz alternator output to DC for the use of the spacecraft, and (3) the interconnecting wiring including any instrumentation to monitor and control items 1 and 2.

Author

Electromagnetic Compatibility; Electromagnetic Interference; Linear Alternators; Power Converters; Stirling Engines; Nuclear Electric Power Generation; Stirling Cycle

20010110016 Louisiana Tech Univ., Ruston, LA USA

Thermal Analysis Of The NASA Integrated Vehicle Health Monitoring Experiment Technology For X-Vehicles (NITEX)

Hegab, Hisham E.; 2000 Research Reports: NASA/ASEE Summer Faculty Fellowship Program; October 2001, 85-94; In English; No Copyright; Avail: CASI; A02, Hardcopy

The purpose of this project was to perform a thermal analysis for the NASA Integrated Vehicle Health Monitoring (IVHM) Technology Experiment for X-vehicles (NITEX). This electronics package monitors vehicle sensor information in flight and downlinks vehicle health summary information via telemetry. The experiment will be tested on the X-34 in an unpressurized compartment, in the vicinity of one of the vehicle's liquid oxygen tanks. The transient temperature profile for the electronics package has been determined using finite element analysis for possible mission profiles that will most likely expose the package to the most extreme hot and cold environmental conditions. From the analyses, it was determined that temperature limits for the electronics would be exceeded for the worst case cold environment mission profile. The finite element model used for the analyses was modified to examine the use of insulation to address this problem. Recommendations

for insulating the experiment for the cold environment are presented, and were analyzed to determine their effect on a nominal mission profile.
Author
Thermal Analysis; X-34 Reusable Launch Vehicle; Health; Insulation; Temperature Profiles

20010084999 Computer Sciences Corp., Lanham, MD USA
On-Orbit Performance of Autonomous Star Trackers
Airapetian, V.; Sedlak, J.; Hashmall, J.; 2001 Flight Mechanics Symposium; June 2001, 545-557; In English
Contract(s)/Grant(s): GS-35F-4381G; NASA Order S-43411-G; No Copyright; Avail: CASI; A03, Hardcopy

This paper presents the results of a performance study of the autonomous star trackers (ASTs) on the IMAGE and the EO-1 spacecraft. IMAGE is a spinning spacecraft without gyros or redundant precision attitude sensors, so the statistical properties of the AST are estimated simply by comparing the output observed quaternions with a rigid rotator model with constant angular momentum. The initial conditions are determined by a least-squares fit to minimize the AST residuals. An additional fit is used to remove the remaining systematic error and to obtain the inherent sensor noise. Gyro rate data are available for the EO-1 mission, so the AST noise statistics are obtained from the residuals after solving for an epoch attitude and gyro bias also using a least-squares method.
Author
Star Trackers; Autonomy; Spacecraft Performance

20010084979 NASA Goddard Space Flight Center, Greenbelt, MD USA
Triana Safehold: A New Gyroless, Sun-Pointing Attitude Controller
Chen, J.; Morgenstern, Wendy; Garrick, Joseph; 2001 Flight Mechanics Symposium; June 2001, 271-283; In English; No Copyright; Avail: CASI; A03, Hardcopy

Triana is a single-string spacecraft to be placed in a halo orbit about the sun-earth Ll Lagrangian point. The Attitude Control Subsystem (ACS) hardware includes four reaction wheels, ten thrusters, six coarse sun sensors, a star tracker, and a three-axis Inertial Measuring Unit (IMU). The ACS Safehold design features a gyroless sun-pointing control scheme using only sun sensors and wheels. With this minimum hardware approach, Safehold increases mission reliability in the event of a gyroscope anomaly. In place of the gyroscope rate measurements, Triana Safehold uses wheel tachometers to help provide a scaled estimation of the spacecraft body rate about the sun vector. Since Triana nominally performs momentum management every three months, its accumulated system momentum can reach a significant fraction of the wheel capacity. It is therefore a requirement for Safehold to maintain a sun-pointing attitude even when the spacecraft system momentum is reasonably large. The tachometer sun-line rate estimation enables the controller to bring the spacecraft close to its desired sun-pointing attitude even with reasonably high system momentum and wheel drags. This paper presents the design rationale behind this gyroless controller, stability analysis, and some time-domain simulation results showing performances with various initial conditions. Finally, suggestions for future improvements are briefly discussed.
Author
Satellite Orientation; Attitude Control; Control Systems Design; Controllers; Pointing Control Systems

20010073024 NASA Ames Research Center, Moffett Field, CA USA
Remote Diagnosis of the International Space Station Utilizing Telemetry Data
Deb, Somnath; Ghoshal, Sudipto; Malepati, Venkat; Domagala, Chuck; Patterson-Hine, Ann; Alena, Richard; Norvig, Peter, Technical Monitor; [2000]; In English
Contract(s)/Grant(s): NAS2-99049; No Copyright; Avail: CASI; A01, Hardcopy

Modern systems such as fly-by-wire aircraft, nuclear power plants, manufacturing facilities, battlefields, etc., are all examples of highly connected network enabled systems. Many of these systems are also mission critical and need to be monitored round the clock. Such systems typically consist of embedded sensors in networked subsystems that can transmit data to central (or remote) monitoring stations. Moreover, many legacy are safety systems were originally not designed for real-time onboard diagnosis, but a critical and would benefit from such a solution. Embedding additional software or hardware in such systems is often considered too intrusive and introduces flight safety and validation concerns. Such systems can be equipped to transmit the sensor data to a remote-processing center for continuous health monitoring. At Qualtech Systems, we are developing a Remote Diagnosis Server (RDS) that can support multiple simultaneous diagnostic sessions from a variety of remote subsystems.
Derived from text
Telemetry; Remote Sensing; Systems Health Monitoring

20010018271 National Space Development Agency, Tsukuba, Japan

Microgravity Measurement Systems in JEM

Ikeda, Toshitami; Murakami, Keiji; Nineteenth International Microgravity Measurements Group Meeting; October 2000, 91-131; In English

Report No.(s): Paper-4; No Copyright; Avail: CASI; A03, Hardcopy

National Space Development Agency of Japan (NASDA) has been developing a microgravity measurement apparatus (MMA) to be installed in the Japanese Experiment Module (JEM). We can measure microgravity accelerations for each rack position by using MMA. We have the following five experiment equipment on which we need to measure accelerations in the JEM-PM (Pressurized Module) for the first generation a) Gradient Heating Furnace, b) Cell Biology Experiment Facility, c) Advanced Furnace for Microgravity Experiment with X-ray Radiography, d) Fluid Physics Experiment Facility, and e) Solution/Protein Crystal Growth Facility. The MMA will be launched on flight 1J/A in 2003. JEM vehicle side has a microgravity measurement equipment (MME) for JEM-EF (Exposed Facility). MME consists of three tri-axial acceleration sensors (MME-S) and a data handling unit (MME-D). Measurement data are used for comparison with structural analysis results of JEM-EF and for reflection to the analysis model and method. And the data are also provided for EF payload users. The MME is planned to be launch on flight 2J/A with JEM-EF.

Derived from text

Microgravity; Acceleration Measurement; Spacecraft Modules; Systems Engineering

20010018269 NASA Glenn Research Center, Cleveland, OH USA

Microgravity Acceleration Measurement System (MAMS) Flight Configuration Verification and Status

Wagar, William; Nineteenth International Microgravity Measurements Group Meeting; October 2000, 27-69; In English

Report No.(s): Paper-2; No Copyright; Avail: CASI; A03, Hardcopy

The Microgravity Acceleration Measurement System (MAMS) is a precision spaceflight instrument designed to measure and characterize the microgravity environment existing in the US Lab Module of the International Space Station. Both vibratory and quasi-steady triaxial acceleration data are acquired and provided to an Ethernet data link. The MAMS Double Mid-Deck Locker (DMDL) EXPRESS Rack payload meets all the ISS IDD and ICD interface requirements as discussed in the paper which also presents flight configuration illustrations. The overall MAMS sensor and data acquisition performance and verification data are presented in addition to a discussion of the Command and Data Handling features implemented via the ISS, downlink and the GRC Telescience Center displays.

Derived from text

Microgravity; Acceleration Measurement; Space Flight; Flight Instruments; International Space Station

20000086664 NASA Goddard Space Flight Center, Greenbelt, MD USA

Analytic Steady-State Accuracy of a Spacecraft Attitude Estimator

Markley, F. Landis; [2000]; In English; No Copyright; Avail: CASI; A03, Hardcopy

This paper extends Farrenkopf's analysis of a single-axis spacecraft attitude estimator using gyro and angle sensor data to include the angle output white noise of a rate-integrating gyro. Analytic expressions are derived for the steady-state pre-update and post-update angle and drift bias variances and for the state update equations. It is shown that only part of the state update resulting from the angle sensor measurement is propagated to future times.

Author

Steady State; Accuracy; Attitude (Inclination); Estimating; Statistical Analysis

20000063380 NASA Glenn Research Center, Cleveland, OH USA

Quasi-Steady Acceleration Direction Indicator in Three Dimensions

DeLombard, Richard; Nelson, Emily S.; Jules, Kenol; May 2000; In English; 38th, 10-13 Jan. 2000, Reno, NV, USA

Contract(s)/Grant(s): RTOP 398-95-0G

Report No.(s): NASA/TM-2000-209931; E-12175; NAS 1.15:209931; AIAA Paper 2000-0570; No Copyright; Avail: CASI; A03, Hardcopy

Many materials processing and fluids physics experiments conducted in a microgravity environment require knowledge of the orientation of the low-frequency acceleration vector. This need becomes especially acute for space experiments such as directional solidification of a molten semiconductor, which is extremely sensitive to orientation and may involve tens of hours of operations of a materials furnace. These low-frequency acceleration data have been measured for many Shuttle missions with the Orbital Acceleration Research Experiment. Previous attempts at using fluid chambers for acceleration

measurements have met with limited success due to pointing and vehicle attitude complications. An acceleration direction indicator is described, which is comprised of two orthogonal short cylinders of fluid, each with a small bubble. The motion and the position of the bubble within the chamber will indicate the direction of the acceleration experienced at the sensor location. The direction of the acceleration vector may then be calculated from these data. The frequency response of such an instrument may be tailored for particular experiments with the proper selection of fluid and gas parameters, surface type, and geometry. A three-dimensional system for sensing and displaying the low-frequency acceleration direction via an innovative technique described in this paper has advantages in terms of size, mass, and power compared with electronic instrumentation systems.
Author
Accelerometers; Semiconductors (Materials); Low Frequencies; Directional Solidification (Crystals); Attitude (Inclination); Microgravity

20000056918 Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA
Results from the Space Shuttle STS-95 Electronic Nose Experiment
Ryan, M. A.; Buehler, M. G.; Homer, M. L.; Mannatt, K. S.; Lau, B.; Jackson, S.; Zhou, H.; [2000]; In English; No Copyright; Avail: CASI; A02, Hardcopy

A miniature electronic nose in which the sensing media are insulating polymers loaded with carbon black as a conductive medium has been designed and built at the Jet Propulsion Laboratory. The ENose has a volume of 1700 cc, weighs 1.4 kg including the operating computer, and uses 1.5 W average power (3 W peak power). This ENose was used in a demonstration experiment aboard STS-95 (October, 1998), in which the ENose was operated continuously for six days and recorded the sensors' response to the air in the middeck. The ENose was designed to detect ten common contaminants in space shuttle crew quarters air. The experiment was controlled by collecting air samples daily and analyzing them using standard analytical techniques after the flight. Changes in humidity were detected and quantified, neither the ENose nor the air samples detected any of the contaminants on the target list. The device is microgravity insensitive.
Author
Noise (Sound); Miniaturization; Design Analysis; Fabrication; Spaceborne Experiments; Electron Counters

20000031723 NASA Goddard Space Flight Center, Greenbelt, MD USA
MEMS Rate Sensors for Space
Gambino, Joel; [2000]; In English; 23rd, 2-6 Feb. 2000, Breckenridge, CO, USA
Report No.(s): AAS-00-062; No Copyright; Avail: CASI; A02, Hardcopy

Micromachined Electro Mechanical System (MEMS) Rate Sensors are an enabling technology for Nanosatellites. The recent award of a Nanosatellite program to the Goddard Space Flight Center (GSFC) underscores the urgency of the development of these systems for space use. The Guidance Navigation and Control Center (GNCC) at the GSFC is involved in several efforts to develop this technology. The GNCC seeks to improve the performance of these sensors and develop flight ready systems for spacecraft use by partnering with industry leaders in MEMS Rate Sensor development. This paper introduces Microgyros and discusses the efforts in progress at the GNCC to improve the performance of these units and develop MEMS Rate Sensors for space use.
Author
Microelectromechanical Systems; Sensors; Rates (Per Time); Nanosatellites; Space Flight; Inertial Guidance

20000020680 NASA Ames Research Center, Moffett Field, CA USA
Bion-11 Spaceflight Mission
Skidmore, M.; Proceedings of the First Biennial Space Biomedical Investigators' Workshop; 1999, 586; In English; No Copyright; Avail: CASI; A01, Hardcopy

The Sensors 2000! Program, in support of the Space Life Sciences Payloads Office at NASA Ames Research Center developed a suite of bioinstrumentation hardware for use on the Joint US/Russian Bion I I Biosatellite Mission (December 24, 1996 - January 7, 1997). This spaceflight included 20 separate experiments that were organized into a complimentary and interrelated whole, and performed by teams of US, Russian, and French investigators. Over 40 separate parameters were recorded in-flight on both analog and digital recording media for later analysis. These parameters included; Electromyogram (7 ch), Electrogastrogram, Electrooculogram (2 ch), ECG/EKG, Electroencephlogram (2 ch), single fiber firing of Neurovestibular afferent nerves (7 ch), Tendon Force, Head Motion Velocity (pitch & yaw), P02 (in vivo & ambient), temperature (deep body, skin, & ambient), and multiple animal and spacecraft performance parameters for a total of 45

channels of recorded data. Building on the close cooperation of previous missions, US and Russian engineers jointly developed, integrated, and tested the physiologic instrumentation and data recording system. For the first time US developed hardware replaced elements of the Russian systems resulting in a US/Russian hybrid instrumentation and data system that functioned flawlessly during the 14 day mission.

Author

Aerospace Engineering; Ambient Temperature; Bioinstrumentation; Biosatellites; Data Recording; Electrocardiography; Electromyography; Spacecraft Performance

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Development of the Scientific Measuring Instrument LINDA, a Part of the Payload on the Swedish Micro-Satellite Astrid-2

Jacksen, A.; Apr. 1998; ISSN 0284-1738; In English

Report No.(s): PB99-174146; IRF-TR-046; No Copyright; Avail: CASI; A06, Hardcopy

This document is an engineering diploma work that describes the development for a measurement instrument, LINDA (especially the development of the software). LINDA is one of four scientific measurement instruments that represent the payload on the Swedish micro-satellite Astrid-2. When the software of LINDA was developed, the main work was (from the requirement specification made by the scientists) to design and implement the algorithms of the three measure modes: (Normal mode, Survey mode and Sweep mode). Because the data rate in the telemetry channel, which is used when data are sent from the satellite to ground, is just a fraction of the one that is generated by the probes, a number of compression algorithms have been developed. Furthermore, a number of command functions have been developed that are used to change the behavior of LINDA measurement modes, and control the hardware.

NTIS

Measuring Instruments; Payloads; Satellite Instruments; Software Engineering

Subject Terms

Corporate Sources

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