FY 2003 Scientific and Technical Reports, Articles, Papers, and Presentations

Compiled by
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December 2004
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National Aeronautics and Space Administration

Marshall Space Flight Center • MSFC, Alabama 35812

December 2004
In accordance with the NASA Space Act of 1958, the George C. Marshall Space Flight Center (MSFC) has provided for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

Since July 1, 1960, when MSFC was organized, the reporting of scientific and engineering information has been considered a prime responsibility of the Center. Our credo has been that “research and development work is valuable, but only if its results can be communicated and made understandable to others.”
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TM—2002–212049 October 2002

Basic mechanical properties; i.e., ultimate tensile strength, yield strength, percent elongation, and elastic modulus, were obtained for the aluminum-beryllium alloy, AlBeMet162, at cryogenic (–195.5 °C (–320 °F) and –252.8 °C (–423 °F)) temperatures. The material evaluated was purchased to the requirements of SAE–AMS7912, “Aluminum-Beryllium Alloy, Extrusions.”

TM—2003–212286 February 2003

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 a rotating body modifies the geometry of space-time, then nuclear spins could be used for detection. Thus, assuming a spinning body induces a 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; without shielding, a Faraday disc phenomenon was observed. Unexpected experimental measurements from the nonaxial Faraday disc configuration were recorded, and a theoretical model was derived to explain them.

TM—2003–212345 April 2003
Dwell Time and Surface Parameter Effects on Removal of Silicone Oil From D6ac Steel Using TCA. R.E. Boothe. Materials, Processes, and Manufacturing Department, Engineering Directorate.

This study was conducted to evaluate the impact of dwell time, surface roughness, and the surface activation state on 1,1,1-trichloroethane’s (TCA’s) effectiveness for removing silicone oil from D6ac steel. Silicone-contaminated test articles were washed with TCA solvent, and then the surfaces were analyzed for residue, using Fourier transform infrared spectroscopy. The predominant factor affecting the ability to remove the silicone oil was surface roughness.

TM—2003–212500 June 2003

A thermal interface material is one of the many tools often used as part of the thermal control scheme for space-based applications. Historically, at Marshall Space Flight Center, CHO-THERM 1671 has primarily been used for applications where an interface material was deemed necessary. However, numerous alternatives have come on the market in recent years. It was decided that a number of these materials should be tested against each other to see if there were better performing alternatives. The tests were done strictly to compare the
thermal performance of the materials relative to each other under repeatable conditions and do not take into consideration other design issues, such as off-gassing, electrical conduction, isolation, etc. The purpose of this Technical Memorandum is to detail the materials tested, test apparatus, procedures, and results of these tests. The results show that there are a number of better performing alternatives now available.

TM—2003–212501 June 2003

The goal of this effort was to develop a digital motor controller using field programmable gate arrays (FPGAs). This is a more rugged approach than a conventional microprocessor digital controller. FPGAs typically have higher radiation tolerance than both the microprocessor and memory required for a conventional digital controller. Furthermore, FPGAs can typically operate at higher speeds. (While speed is usually not an issue for motor controllers, it can be for other system controllers.) Other than motor power, only a 3.3-V digital power supply was used in the controller; no analog bias supplies were used. Since most of the circuit was implemented in the FPGA, no additional parts were needed other than the power transis tors to drive the motor. The benefits that FPGAs provide over conventional designs—lower power and fewer parts—allow for smaller packaging and reduced weight and cost.

TM—2003–212502 June 2003

This effort demonstrates that health management can be taken to the component level for electromechanical systems. The same techniques can be applied to take any health management system to the component level, based on the practicality of the implementation for that particular system. This effort allows various logic schemes to be implemented for the identification and management of failures. By taking health management to the component level, integrated vehicle health management systems can be enhanced by protecting box-level avionics from being shut down in order to isolate a failed computer.

TM—2003–212503 June 2003

In order to help identify contamination found on bonding surfaces, optical surfaces, or other items, the Materials Contamination Team of the Materials, Processes, and Manufacturing Department at Marshall Space Flight Center (MSFC) has initiated the development of an infrared database containing MSFC process materials and residues. Process materials analyzed to date using infrared spectroscopy for transferable and extractable contamination have included gloves, wiper cloths, solvents, bagging materials, etc. Significant findings included silicone contamination on several gloves and observations of extractables from the majority of materials tested.

TM—2003–212633 July 2003

To determine composite material properties’ effects from processing variables, a 3 factorial designed experiment with two replicates was conducted. The factors were cure method (oven versus autoclave), layup (hand versus tape-laying machine), and thickness (8 versus 52 ply). Four material systems were tested: AS4/3501–6, IM7/8551–7, IM7/F655 bismaleimide (BMI), and shear tests on IM7/F584. Material properties were $G_{12}$, $v_{12}$, $E_{1C}$, and $E_{2C}$. Since the samples were necessarily nonstandard, strengths, though recorded, cannot be considered valid. Void content was also compared.

Autoclave curing helped material properties for the low modulus fiber material but showed little benefit for higher stiffness fibers. The number of plies was very important for epoxy composites but not for the BMI. $E_1$ was generally unaffected by any factor.

Particularly high void content did correlate to reduced properties. Autoclave curing reduced void content over oven curing but a moderate amount of voids, <1 percent void content, did not correlate with material properties.

Oven cures and hand layups can produce high-quality parts. Part thickness of epoxy composites is important, though cure optimization may improve performance. Significant variations can be caused by processing and it is important that test coupons always reflect the layup and processes of the final part.


This Technical Memorandum lists the significant publications and presentations of the Science Directorate during the period January 1–December 31, 2002. Entries in the main part of the document are categorized according to NASA Reports (arranged by report number), Open Literature, and Presentations (arranged alphabetically by title). Most of the articles listed under Open Literature have appeared in refereed professional
journals, books, monographs, or conference proceedings. Although many published abstracts are eventually expanded into full papers for publication in scientific and technical journals, they are often sufficiently comprehensive to include the significant results of the research reported. Therefore, published abstracts are listed separately in a subsection under Open Literature. Questions or requests for additional information about the entries in the report should be directed to Dr. A.F. Whitaker (SD01, 256–544–2481) or one of the authors.

**TM—2003–212636**

June 2003


Manufacturing polymer hardware during space flight is currently outside the state of the art. A process called fused deposition modeling (FDM) can make this approach a reality by producing net-shaped components of polymer materials directly from a CAE model. FDM is a rapid prototyping process developed by Stratasys, Inc., which deposits a fine line of semimolten polymer onto a substrate while moving via computer control to form the cross-sectional shape of the part it is building. The build platen is then lowered and the process is repeated, building a component directly layer by layer. This method enables direct net-shaped production of polymer components directly from a computer file. The layered manufacturing process allows for the manufacture of complex shapes and internal cavities otherwise impossible to machine. This task demonstrated the benefits of the FDM technique to quickly and inexpensively produce replacement components or repair broken hardware in a Space Shuttle or Space Station environment.

The intent of the task was to develop and fabricate an FDM system that was lightweight, compact, and required minimum power consumption to fabricate ABS plastic hardware in microgravity. The final product of the shortened task turned out to be a ground-based breadboard device, demonstrating miniaturization capability of the system.

**TM—2003–212690**

August 2003


The primary objective of this research was to determine the processes and feasibility of using commercial off-the-shelf PC104 hardware for flight applications. This would lead to a faster, better, and cheaper approach to low-budget programs as opposed to the design, procurement, and fabrication of space flight hardware. This effort will provide experimental evaluation with results of flight environmental testing. Also, a method and/or suggestion used to bring test hardware up to flight standards will be given. Several microgravity programs, such as the Equiaxed Dendritic Solidification Experiment, Self-Diffusion in Liquid Elements, and various other programs, are interested in PC104 environmental testing to establish the limits of this technology.

**TM—2003–212692**

August 2003


The objective of this investigation was to examine the relationship between irradiation level (proton dose), microstructure, and stress levels in chemical vapor-deposited diamond and polysilicon films using cross-sectioned specimens. However, the emphasis was placed on the diamond specimen because diamond holds much promise for use in advanced technologies. The use of protons allows not only the study of the charged particle that may cause the most microstructural damage in Earth-orbit microelectromechanical systems (MEMS) devices, but also allows the study of relatively deeply buried damage inside the diamond material. Using protons allows these studies without having to resort to megaelectronvolt implant energies that may create extensive damage due to the high energy that is needed for the implantation process. Since MEMS devices operating in space will not have an opportunity to reverse radiation damage via annealing, only nonannealed specimens were investigated. The following three high spatial resolution techniques were used to examine these relationships: (1) Scanning electron microscopy, (2) micro-Raman spectroscopy, and (3) micro x-ray diffraction.

A simple power law model consisting of a single spectral index, $\alpha_1$, is believed to be an adequate description of the galactic cosmic-ray (GCR) proton flux at energies below $10^{13}$ eV, with a transition at the knee energy, $E_k$, to a steeper spectral index $\alpha_2 > \alpha_1$ above $E_k$. The maximum likelihood (ML) procedure was developed for estimating the single parameter $\alpha_1$ of a simple power law energy spectrum and generalized to estimate the three spectral parameters of the broken power law energy spectrum from simulated detector responses and real cosmic-ray data. The statistical properties of the ML estimator were investigated and shown to have the three desirable properties: (P1) consistency (asymptotically unbiased), (P2) efficiency (asymptotically attains the Cramer-Rao minimum variance bound), and (P3) asymptotically normally distributed, under a wide range of potential detector response functions. Attainment of these properties necessarily implies that the ML estimation procedure provides the best unbiased estimator possible.

While simulation studies can easily determine if a given estimation procedure provides an unbiased estimate of the spectra information, and whether or not the estimator is approximately normally distributed, attainment of the Cramer-Rao bound (CRB) can only be ascertained by calculating the CRB for an assumed energy spectrum-detector response function combination, which can be quite formidable in practice. However, the effort in calculating the CRB is very worthwhile because it provides the necessary means to compare the efficiency of competing estimation techniques and, furthermore, provides a stopping rule in the search for the best unbiased estimator. Consequently, the CRB for both the simple and broken power law energy spectra are derived herein and the conditions under which they are attained in practice are investigated.

The ML technique is then extended to estimate spectra information from an arbitrary number of astrophysics data sets produced by vastly different science instruments. This theory and its successful implementation will facilitate the interpretation of spectral information from multiple astrophysics missions and thereby permit the derivation of superior spectral parameter estimates based on the combination of data sets.


Marshall Space Flight Center has developed world-class space environmental effects testing facilities to simulate the space environment. The combined environmental effects test system exposes temperature-controlled samples to simultaneous protons, high- and low-energy electrons, vacuum ultraviolet (VUV) radiation, and near-ultraviolet (NUV) radiation. Separate chambers for studying the effects of NUV and VUV at elevated temperatures are also available. The Atomic Oxygen Beam Facility exposes samples to atomic oxygen of 5 eV energy to simulate low-Earth orbit (LEO). The LEO space plasma simulators are used to study current collection to biased spacecraft surfaces, arcing from insulators and electrical conductivity of materials. Plasma propulsion techniques are analyzed using the Marshall magnetic mirror system. The micro light gas gun simulates micrometeoroid and space debris impacts.

Candidate materials and hardware for spacecraft can be evaluated for durability in the space environment with a variety of analytical techniques. Mass, solar absorptance, infrared emittance, transmission, reflectance, bidirectional reflectance distribution function, and surface morphology characterization can be performed. The data from the space environmental effects testing facilities, combined with analytical results from flight experiments, enable the Environmental Effects Group to determine optimum materials for use on spacecraft.
MHD accelerator. The heat-sink and higher expansion ratios are expected to greatly improve scaling, improved seeding techniques, higher magnetic fields, constraint on expansion with the available magnet. Increased interaction; i.e., low flow velocity, due to an inherent physical spray prior to ignition by electrical spark. The driver exhausted to atmospheric pressure and seeded with a CsOH/methanol reaction: I. Performance Analysis and Design. R.J. Litchford, J.E. Jones, C.C. Dobson, J.W. Cole, B.R. Thompson,* D.H. Plemmons,** and M.W. Turner.*** Advanced Space Transportation Program Office, Space Transportation Directorate, *TMET, **Plemmons Consulting, and ***The University of Alabama in Huntsville.

The production of onboard electrical power by pulse detonation engines is problematic in that they generate no shaft power; however, pulse detonation-driven magnetohydrodynamic (MHD) electrical power generation represents one intriguing possibility for attaining self-sustained engine operation and generating large quantities of burst power for onboard electrical systems. To examine this possibility further, a simple heat-sink apparatus was developed for experimentally investigating pulse detonation-driven MHD generator concepts. The hydrogen-oxygen-fired driver was a 90-cm-long stainless steel tube having a 4.5-cm-square internal cross section and a short Schelkin spiral near the head-end to promote rapid formation of a detonation wave. The tube was intermittently filled to atmospheric pressure and seeded with a CsOH/methanol spray prior to ignition by electrical spark. The driver exhausted through an aluminum nozzle having an area contraction ratio of $A_1/A_2=1/10$ and an area expansion ratio of $A_3/A_4=3.2$ (as limited by available magnet bore size). The nozzle exhausted through a 24-electrode segmented Faraday channel (30.5-cm active length), which was inserted into a 0.6-T permanent magnet assembly. Initial experiments verified proper drive operation with and without the nozzle attachment, and head-end pressure and time-resolved thrust measurements were acquired. The exhaust jet from the nozzle was interrogated using a polychromatic microwave interferometer yielding an electron number density on the order of $10^{12} \text{ cm}^{-3}$ at the generator entrance. In this case, MHD power generation experiments suffered from severe near-electrode voltage drops and low MHD interaction; i.e., low flow velocity, due to an inherent physical constraint on expansion with the available magnet. Increased scaling, improved seeding techniques, higher magnetic fields, and higher expansion ratios are expected to greatly improve performance.

Fillets are one of the most common design features in structures. Proper finite element modeling of these fillets can frequently be problematic though. If the ratio of the fillet radius to the wall thickness is relatively large, the fillet cannot be ignored because it contributes significantly to structural stiffness, and although the most appropriate element for modeling the structure in general may be the plate element, geometric representation of the fillets requires the use of solid elements. This problem is the motivation for the development of a method that uses “bridge” plate elements connecting the tangent points of the fillet to accurately represent its stiffness and mass. The methodology equates the rotational deflection at the tangent point, derived from the proposed bridge system, with an analytical solution of the fillet itself to generate a pseudo Young’s Modulus and thickness for use in the bridge plates. The method was tested on a typical filleted structure, with the bridge method yielding modal analysis results as accurate as a high-fidelity solid model when compared to modal test but with a 90-percent reduction in number of degrees of freedom. This capability could prove extremely useful in design, dynamic, deflection, and preliminary stress analysis, and optimization.
Magnetic flux compression reaction chambers offer considerable promise for controlling the plasma flow associated with various micronuclear/chemical pulse propulsion and power schemes, primarily because they avoid thermalization with wall structures and permit multicycle operation modes. The major physical effects of concern are the diffusion of magnetic flux into the rapidly expanding plasma cloud and the development of Rayleigh-Taylor instabilities at the plasma surface, both of which can severely degrade reactor efficiency and lead to plasma-wall impact. A physical parameter of critical importance to these underlying magnetohydrodynamic (MHD) processes is the magnetic Reynolds number \( R_m \), the value of which depends upon the product of plasma electrical conductivity and velocity. Efficient flux compression requires \( R_m \gg 1 \), and a thorough understanding of MHD phenomena at high magnetic Reynolds numbers is essential to the reliable design and operation of practical reactors. As a means of improving this understanding, a simplified laboratory experiment has been constructed in which the plasma jet ejected from an ablative pulse plasma gun is used to investigate plasma armature interaction with magnetic fields. As a prelude to intensive study, exploratory experiments were carried out to quantify the magnetic Reynolds number characteristics of the plasma jet source. Jet velocity was deduced from time-of-flight measurements using optical probes, and electrical conductivity was measured using an inductive probing technique. Using air at 27-inHg vacuum, measured velocities approached 4.5 km/s and measured conductivities were in the range of 30 to 40 kS/m.

TP—2003–212342 March 2003
Flightweight Carbon Nanotube Magnet Technology.

Virtually all plasma-based systems for advanced airborne/spaceborne propulsion and power depend upon the future availability of lightweight magnet technology. Unfortunately, current technology for resistive and superconducting magnets yields system weights that tend to counteract the performance advantages normally associated with advanced plasma-based concepts. The ongoing nanotechnology revolution and the continuing development of carbon nanotubes (CNT), however, may ultimately relieve this limitation in the near future. Projections based on recent research indicate that CNTs may achieve current densities at least three orders of magnitude larger than known superconductors and mechanical strength two orders of magnitude larger than steel. In fact, some published work suggests that CNTs are superconductors. Such attributes imply a dramatic increase in magnet performance-to-weight ratio and offer real hope for the construction of true flightweight magnets. This Technical Publication reviews the technology status of CNTs with respect to potential magnet applications and discusses potential techniques for using CNT wires and ropes as a winding material and as an integral component of the containment structure. The technology shortfalls are identified and a research and technology strategy is described that addresses the following major issues: (1) Investigation and verification of mechanical and electrical properties, (2) development of tools for manipulation and fabrication on the nanoscale, (3) continuum/molecular dynamics analysis of nanotube behavior when exposed to practical bending and twisting loads, and (4) exploration of innovative magnet fabrication techniques that exploit the natural attributes of CNTs.

TP—2003–212634 July 2003

The Materials Contamination Team of the Environmental Effects Group, Materials, Processes, and Manufacturing Department, has been recognized for its contribution to space flight, including space transportation, space science, and flight projects, such as the reusable solid rocket motor, Chandra X-Ray Observatory, and the International Space Station. The Materials Contamination Team’s realm of responsibility encompasses all phases of hardware development including design, manufacturing, assembly, test, transportation, launchsite processing, on-orbit exposure, return, and refurbishment, if required. Contamination is a concern in the Space Shuttle with sensitive bondlines and reactive fluid (liquid oxygen) compatibility as well as for sensitive optics, particularly spacecraft, such as the Hubble Space Telescope and Chandra X-Ray Observatory.

The Materials Contamination Team has a variety of facilities and instrumentation capable of contaminant detection, identification, and monitoring. The team addresses material applications dealing with environments, including production facilities, clean rooms, and on-orbit exposure. The team of engineers and technicians also develops and evaluates new surface cleanliness inspection technologies. Databases are maintained by the team for process materials as well as outgassing and optical compatibility test results for specific environments.
February 2003

The 2002 Microgravity Materials Science Conference was held June 25–26, 2002, at the Von Braun Center, Huntsville, Alabama. Organized by the Microgravity Materials Science Discipline Working Group, sponsored by the Physical Sciences Research Division, NASA Headquarters, and hosted by NASA Marshall Space Flight Center and member institutions under the COoperative Research in Biology and Materials Science (CORBAMS) agreement, the conference provided a forum to review the current research and activities in materials science, discuss the envisioned long-term goals, highlight new crosscutting research areas of particular interest to the Physical Sciences Research Division, and inform the materials science community of research opportunities in reduced gravity. An abstracts book was published and distributed at the conference to the approximately 240 people attending, who represented industry, academia, and other NASA Centers. The proceedings on this CD-ROM are comprised of the research reports submitted by the Principal Investigators in the Microgravity Materials Science program.

April 2003


This document contains the proceedings of the 35th annual NASA Aerospace Battery Workshop, hosted by the Marshall Space Flight Center, November 19–21, 2002. The workshop was attended by scientists and engineers from various agencies of the U.S. Government, aerospace contractors, and battery manufacturers, as well as international participation in like kind.

The subjects covered included nickel-hydrogen, lithium-ion, nickel-metal hydride, lithium-sulfur, lithium-iron disulfide, and silver-zinc technologies.
A detector array charge collection model has been developed for use as an engineering tool to aid in the design of optical sensor missions for operation in the space radiation environment. This model is an enhancement of the prototype array charge collection model that was developed for the NGST program. The primary enhancements were accounting for drift-assisted diffusion by Monte Carlo modeling techniques and implementing the modeling approaches in a windows-based code. The modeling is concerned with integrated charge collection within discrete pixels in the focal plane array (FPA), with high-fidelity spatial resolution. It is applicable to all detector geometries, including monolithic charged-coupled devices (CCDs), active pixel sensors (APS), and hybrid FPA geometries based on a detector array bump-bonded to a readout integrated circuit (ROIC).

A model has been developed capable of calculating the electrostatic return of spacecraft-emitted molecules that are ionized and attracted back to the spacecraft by the spacecraft electric potential on its surfaces. The return of ionized contaminant molecules to charged spacecraft surfaces is very important to all altitudes. It is especially important at geosynchronous and interplanetary environments, since it may be the only mechanism by which contaminants can degrade a surface. This model is applicable to all altitudes and spacecraft geometries. In addition, results of the model will be completed to cover a wide range of potential space systems.

An experiment on the Microelectronics and Photonics Test Bed (MPTB) was testing field programmable gate arrays using spot shields to extend the life of some of the devices being tested. It was expected that the unshielded parts would fail from a total ionizing dose (TID) and yet the opposite occurred. The data show that the devices failing from the TID effects are those with the spot shields attached. This effort is to determine the mechanism by which the environment is interacting with the high-Z material to enhance the TID in these field programmable gate arrays.
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Using the Chandra Project to Communicate With Underdeveloped Constituencies—Abstract Only. For presentation at the Meeting on Communicating Astronomy to the Public, Washington, DC, October 1–3, 2003.

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GUZIK, T.G. Louisiana State University
For presentation at the 28th International Cosmic Ray Conference, Tsukuba, Japan, July 31–August 7, 2003.

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Nuclear Electric Propulsion for Outer Space Missions—Abstract Only. For presentation at the Society of Women Engineers Conference, Birmingham, AL, October 9–11, 2003.

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WEISSKOPF, M.C. SD50  SMITH, S. Jacobs Sverdrup
Chandra X-Ray Observatory Observations of the Globular

BEMPORAD, A. SD50  BLAKESLEE, R.J. SD60
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ROMOLI, M. SD50  PINTO, O. INPE
SUSS, S.T. SD50  ATHAYDE, A. INMET
Preliminary Analysis of a CME Observed by SOHO and
Ulysses Experiments—Abstract Only. For publication in

BEMPORAD, A. SD50  WEIDMAN, C.D. University of Arizona
POLETTO, G. SD50  The Rondonia Lightning Detection Network: Network
SUSS, S.T. SD50  Description Science Objectives, Data Processing/Archival
KO, Y. SD50  Methodology, and Results—Abstract Only. For presenta-
PARENTI, S. SD50  tion at the International Conference on Atmospheric Elec-
ROMOLI, M. SD50
ZURBUCHEN, T. SD50
Temporal Evolution of a Streamer Complex: Coronal and
In Situ Plasma Parameters—Abstract Only. For publication

BERNHARDSDOTTERT, E. SD46  BLAKESLEE, R.J. SD60
GARRIOTT, O. SD46  CROSKEY, C.L. Penn State University
PUSEY, M.L. SD46  DESCH, M.D. Goddard Space Flight Center
NG, J.D. SD46  FARRELL, W.M. Goddard Space Flight Center
Two Strategies for Microbial Production of an Industrial
Enzyme-Alpha-Amylase—Abstract Only. For presentation
at Student Research Day, The University of Alabama in
Huntsville, Huntsville, AL, April 11, 2003.

BEST, S. FD41  BLEVINS, J.A. TD40
NICHOLS, K.F. FD41  GOSTOWSKI, R. TD40
BRADFORD, R.N. FD41  CHIANESE, S. Penn State University
Utilization of Internet Protocol-Based Voice Systems
in Remote Payload Operations—Viewgraphs Only. For
presentation at the Ground System Architectures Work-
shop, Manhattan Beach, CA, March 4–6, 2003.

BJORKMAN, G. Lockheed Martin  BLEVINS, J.A. TD40
CANTRELL, M. Lockheed Martin  RODGERS, S.L. TD40
CARTER, R.R. ED33  Propulsion Research at the Propulsion Research Center of
the NASA Marshall Space Flight Center—Abstract Only.
For presentation at the 54th International Astronautical


BOCCIPPIO, D.J. Objective Classification of Radar Profile Types, and Their Relationship to Lightning Occurrence—Abstract Only. For presentation at the American Geophysical Union Fall Meeting, San Francisco, CA, December 8–12, 2003.


BUECHLER, D.E. UAH
MACH, D.M. UAH
BLAKESLEE, R.J. SD60


CALVIGNAC, J. Northrop Grumman
DANG, L. Northrop Grumman
TRAMEL, T.L. TD07
PASEUR, L. TD07


CAMPBELL, J.W. FD02
PHIPPS, C. FD02
SMALLEY, L. UAH
REILY, J.C. UAH
BOCCIO, D. City University of NY


CAMPBELL, J.W. FD02
SMALLEY, L. UAH
BOCCIO, D. City University of NY


CARMER, D.L. Stanford University
BEL, R.F. Stanford University
INAN, U.S. Stanford University
BENSON, R.F. Goddard Space Flight Center
REINISCH, B.W. University of Massachusetts
GALLAGHER, D.L. SD50


CARMER, P.K. SD46
SEBILLE, L. SD46
BOLES, W. Middle Tennessee State University
CHADWELL, M. University of South Alabama
SCHWARZ, L. UAH


CARRASQUILLO, R. FD21


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O’CONNOR, E. Hamilton Sundstrand
SNOWDON, D. Hamilton Sundstrand


CASAS, J. SD10
NALL, M. SD10

Enabling Sustainable Exploration Through the Commercial Development of Space—Abstract Only. For presentation at the 54th International Astronautical Congress, Bremen, Germany, September 29–October 3, 2003.

CHAKRABARTI, S. TD40
MARTIN, J.J. TD40
PEARSON, J.B. TD40
LEWIS, R.A. R. Lewis Co.

CHANDLER, M.O.  SD50
AVANOV, L.A.  SD50

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MOORE, T.E.  SD50

CHANG, J.  Max Planck Institute
SCHEIDT, W.K.H.  Max Planck Institute
ADAMS, J.H.  SD50
AHN, H.S.  University of Maryland
BASHINDZHAGYAN, G.L.  Moscow State University
BATKOV, K.E.  Moscow State University
CHRISTL, M.J.  SD50
FAZLEY, A.R.  Southern University
GANEL, O.  University of Maryland
GUNASINGHA, R.M.  Southern University

CHAVERS, D.G.  TD40

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KOROTCHKINA, L.G.  SUNY at Buffalo
DOMINIAK, P.M.  SD46
SIDHU, S.  SUNY at Buffalo
PATEL, M.S.  SUNY at Buffalo
COE, M.J. Southampton University
HAIGH, N.J. Southampton University
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COLE, J.W. TD40

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ENGRLER, L. Morgan Research
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DORNEY, D.J. 
Design and Analysis of Turbomachinery for Space Applications—Presentation. For presentation at the Seminars at Wright-Patterson Air Force Base, OH, and at Wright State University, Dayton, OH, October 4, 2002.

DORNEY, D.J. 
GRIFFIN, L.W. 
HUBER, F.W. 
SONDAK, D.L. 

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GRIFFIN, L.W. 
HUBER, F.W. 
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DORNEY, S.M. 

DRAKE, B.G. 
COOKE, D.R. 
KOS, L.D. 
NASA Exploration Team (NExT) In-Space Transportation Overview—Presentation. For presentation at the 51st JANNAF Propulsion Meeting, Lake Buena Vista, FL, November 18–21, 2002.

DRESSLER, G.A. 
MATUZAK, L.W. 
STEPHENSON, D.D. 

DUKEMAN, G. 
Enhancements to an Atmospheric Ascent Guidance Algorithm—Final Paper. For presentation at the AIAA

DUMBACHER, D.L. UP01

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SEMMLER, C. Qualis Corporation

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STOWELL, B. Lockheed Martin
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ELAM, S.K. TD61
HOLMES, R. SD42
MCKECHNIE, T. Plasma Processes, Inc.
HICKMAN, R. Plasma Processes, Inc.
PICKENS, T. Plasma Processes, Inc.

ELSNER, R.F. SD50
GLADSTONE, R. Southwest Research Institute
WAITE, H. University of Michigan
LUGAZ, N. University of Michigan
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GRODENT, D. University of Liege

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EMRICH, W.J., JR. TD40

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SMITH, J.W. TD40
KOELFGEN, S.J. UAH
The Plasmoid Thruster Experiment (PTX)—Abstract and Charts. For presentation at the Advanced Space Propulsion Workshop, Huntsville, AL, April 15–17, 2003.

ESTES, M.G. USRA
QUATTROCHI, D.A. SD60
STASIKA, E. Intl. City/County Mgmt. Association

EVANS, J.P. Yale University
SMITH, R. Yale University
OGLESBY, R.J. SD60
Simulation of the Climate of Southwest Asia With a Regional Model—Abstract Only. For presentation at the American Geophysical Union Fall Meeting, San Francisco, CA, December 5–10, 2002.

EVANS, S.W. ED44

FALCONER, D.A. SD50
MOORE, R.L. SD50
GARY, G.A. SD50

FARRELL, W.M. Goddard Space Flight Center
GOLDBERG, R.A. Goddard Space Flight Center
BLAKESLEE, R.J. SD60
DESH, M.D. Goddard Space Flight Center
HOUER, J.G. Goddard Space Flight Center
MITCHELL, J.D. Penn State University
CROSKY, C.L. Penn State University
MACH, D.M. UAH
BAILEY, J.C. Raytheon

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Detection of High-Energy Cosmic Rays With the Advanced Thin Ionization Calorimeter, ATIC—Abstract Only. For

FAZLEY, A.R. Southern University
GUNASINGHA, R.M. Southern University
ADAMS, J.H. SD50
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AHN, H.S. University of Maryland
BASHINDZHAGYAN, G.L. Moscow State University
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WALKER, W.W. UAH
COLE, S.T. UAH
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LAYCOCK, R.L. UAH


FRAZIER, D.O. GLICKSMAN, M.E. Rensselaer Polytechnic Institute
MCNULTY, I. Argonne National Laboratory
RICHMOND, R.C. SD46
EHRET, C.F. General Chronobiomics


FINCKENOR, M.M. ED31
VAUGHN, J.A. ED31
WATTS, E.W. Qualis Corporation


FRIGO, S.P. Northern Arizona University
MCNULTY, I. Argonne National Laboratory
RICHMOND, R.C. SD46
EHRET, C.F. General Chronobiomics

Photoabsorption Study of Bacillus Megaterium, DNA, and Related Biological Materials in the Phosphorus K-Edge

GALLAGHER, D.L. SD50

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MONTGOMERY, E.E., IV TD05

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GOLDEN, B.L. Purdue University  
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GOLDSTEIN, J. Rice University  
SPASOJEVIC, M. STAR Laboratory  
REIFF, P. Rice University  
SANDEL, B.R. University of Arizona  
FORRESTER, T.T. University of Arizona  
GALLAGHER, D.L. SD50  
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GOODMAN, S.J. SD60  

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CHRISTIAN, H.J. SD60  
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HALL, J.M. Global Hydrology & Climate Center  
MCCAUL, E.W., JR. Global Hydrology & Climate Center  
BUECHLER, D.E. National Weather Service  
DARDEN, C. National Weather Service  
BURKS, J. National Weather Service  

GORTI, S. SD46  
FORSYTHE, E.L. USRA  
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Modeling Tetragonal Lysozyme Crystal Growth Rates—Abstract Only. For presentation at the American

GOSTOWSKI, R. TD40

GRANT, J. SD72
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SHARMA, A. Alabama A&M University

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OSEI, A. Oakwood College
SHARMA, A. Alabama A&M University

GRAY, P.A. ICRC
NEHLS, M.K. ED31
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GREINER, J. Astrophysikalisches Inst.
KLOSE, S. Thuringer Landesstern
SAVVATO, M. Astrophysikalisches Inst.
ZEH, A. Thuringer Landesstern
SCHWARTZ, R. Astrophysikalisches Inst.
HARTMAN, D.H. Clemson University
MASETTI, N. Istituto di Astrofisica
STECKLUM, B. Thuringer Landesstern
LAMER, G. Astrophysikalisches Inst.
KOUVEIOTOU, C. SD50

GRIFFIN, L.W. TD64
MSFC Turbomachinery Fluid Dynamics Roadmap—Presentation. For presentation at the MSFC Spring Workshop on Fluids, Birmingham, AL, April 22–24, 2003.

GRIFFIN, L.W. TD64
DORNEY, D.J. TD64
HUBER, F.W. Riverbend Desig Serv.

GRUBBS, R. MSFC
HDTV From the International Space Station—Charts Only. For presentation at the University of South Florida Seminar, Tampa, FL, March 28, 2003.
GRUGEL, R.N. SD46
ANILKUMAR, A.V. Vanderbilt University
LEE, C.P. SD46

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SPEEGLE, C.O. Raytheon ITSS
MARTIN, G. ERC, Inc.
GWALTNEY, D.A.  
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KING, K.  
FERGUSON, M.I. 

Jet Propulsion Laboratory

DUTTON, K. 
Madison Research Corporation


HAGYARD, M.J.  
PEVTSOV, A.A.  
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SMITH, J.E. 

National Solar Observatory 
Montana State University


HAGYARD, M.J.  
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BLEHM, Z.  
SMITH, J.E. 

Montana State University


HAKKILA, J.  
GIBLIN, T.W.  
ROIGER, R.J.  
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College of Charleston 
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Booz Allen Hamilton
Booz Allen Hamilton


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Virginia Polytechnic Institute 
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Virginia Polytechnic Institute 
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FIKES, J.C. FD02
HOWELL, J.T. FD02
MANKINS, J.C. NASA Headquarters

HISTAM, L.W. UAH
TAKAHASHI, Y. UAH
ZUCCARO, A. UAH
LAMB, D. UAH
PITALO, K. UAH
LOPADO, A. UAH
KEYS, A.S. SD72

HOLLADAY, J. SD50
HOLLADAY, J. FD23
CHO, F. Johnson Space Center

HOLMES, A.M. UAH
MONACO, L. Morgan Research
BARNES, C.L. USRA
SPEARING, S. Morgan Research
JENKINS, A. Morgan Research
JOHNSON, T. Micro Craft
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IRWIN, D. SD60
A Regional Monitoring and Visualization System for Decision Support and Disaster Management Applications for the Mesoamerican Biological Corridor and Beyond—Abstract Only. For presentation at the Central American Commission for Environment and Development Donors Conference, Paris, France, December 12, 2002.

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FYNO, J.P.U. University of Copenhagen
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JAMES, B. TD05
MUNK, M. TD05
MOON, S. Gray Research, Inc.

JAMES, B. TD15
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MOON, S. Gray Research, Inc.

JEDLOVEC, G. SD60
HAINES, S. UAH
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BRADSHAW, T. National Weather Service
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GILCHRIST, B.E. University of Michigan
LORENZINI, E.C. Harvard-Smithsonian
STONE, N. SRS Technologies
WRIGHT, K.H., JR. SD50
Propulsive Small Expendable Deployer System (ProSEDS) Experiment: Mission Overview and Status—Final Paper.

JOY, M. SD50
LAROQUE, S.J. SD50
BONAMENTE, M. SD50
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DAWSON, K.S. SD50

JUSTUS, C.G. Computer Sciences Corporation
DUVALL, A. Computer Sciences Corporation
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JUSTUS, C.G. Computer Sciences Corporation
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KEARNEY, M.W., III FD40

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KEPHART, R. UAH
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SNELL, E.H. SD46
VAN DER WOERD, M.J. SD46

KEYS, A.S. SD72
CROW, R.W. Sensing Strategies, Inc.
ASHLEY, P.R. U.S. Army Aviation

KHAZANOV, G.V. SD50

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DELAMERE, P.A. University of Colorado
KABIN, K. University of Alberta
LINDE, T.J. University of Chicago
KRIVORUTSKY, E. UAH

KHAZANOV, G.V. SD50
GAMAYUNOV, K.V. University of Alaska, Fairbanks
JORDANOVA, V.K. University of New Hampshire

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DELAMERE, P.A. SD50

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AVANOVA, N.A. SD50

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LIEMOHN, M.W. University of Michigan
NEWMAN, T.S. UAH
FOK, M.-C. Goddard Space Flight Center
RIDLEY, A.J. University of Michigan

KHAZANOV, G.V. SD50
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KOELBL, T.G. ED13
PONCHAK, D. GRC
LAMARCHE, T. Rannoch Corporation

KOELFGEN, S.J. UAH
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 MARTIN, A.K. TD40
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ET AL.

KOSHAK, W.J. SD60
Analytic Solution to the Problem of Aircraft Electric Field Mill Calibration—Abstract Only. For presentation at the American Geophysical Union Fall Meeting, San Francisco, CA, December 8–12, 2003.

KOSHAK, W.J. SD60

KOSHAK, W.J. SD60
SOLAKIEWICZ, R.J. Chicago State University
BLAKESLEE, R.J. SD60
GOODMAN, S.J. SD60
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HALL, J.M. SD60
BAILEY, J.C. SD60
KRIDER, E.P. SD60
BATEMAN, M.G. SD60
BOCCIPPIO, D.J. SD60

KOSHAK, W.J. SD60
SOLAKIEWICZ, R.J. SD60
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EICHLER, D. Ben-Gurion University
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GOGUS, E. USRA/Sabanci University
VAN DER KLIS, M. University of Amsterdam
TENNANT, A.F. SD50
WACHTER, S. SIRTFT Science Center/Caltech

KUNDROT, C.E. SD40

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LAMONTIA, M.A. Accudyne Systems, Inc.
GRUBER, M.B. Accudyne Systems, Inc.
FUNCK, S.B. Accudyne Systems, Inc.
WAIBEL, B.J. Accudyne Systems, Inc.
COPE, R.D. Accudyne Systems, Inc.
HULCHER, A.B. ED34

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BURKS, J. National Weather Service
JEDLOVEC, G. SD60
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DARDEN, C. National Weather Service
MEYER, P. SD60

KOUVELIOTOU, C. SD50
EICHLER, D. Ben-Gurion University
WOODS, P.M. USRA
LYUBARSKY, Y. USRA
PATEL, S.K. SD50
GOGUS, E. USRA/Sabanci University
VAN DER KLIS, M. University of Amsterdam
TENNANT, A.F. SD50
WACHTER, S. SIRTFT Science Center/Caltech

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LASZAR, J. TD62

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KASHALIKAR, U. Foster-Miller, Inc.
ROZENOYER, B. Foster-Miller, Inc.


LAW, B.C. Mississippi State University
HUDSON, S.T. Mississippi State University
STEEL, W.G. Mississippi State University
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HUGHES, M.S. Stennis Space Center


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GARY, G.A. SD50
NEWMAN, T.S. UAH


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SPELBRING, C. Honeywell, Inc.
REEVES, D.R. Boeing
HOLT, J.M. ED25


LESLIE, F.W. SD46
RAMACHANDRAN, N. BAE Systems


LEVIN, G.V. Spherix, Inc.
MILLER, J.D. University of Southern California
STRAAT, P.A. Retired
HOOVER, R.B. SD50

LEHOCZKY, S.L. SD46

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ZHU, S. SD46
BAN, H. UAB
LI, C. UAB
SCRIPA, R.N. UAB
SU, C.-H. SD46
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FARRELL, W.M. Goddard Space Flight Center
GOLDBERG, R.A. Goddard Space Flight Center
DESCH, M.D. Goddard Space Flight Center
HOUSER, J.G. Goddard Space Flight Center
Preliminary Optical and Electric Field Pulse Statistics From Storm Overflights During the Altus Cumulus Electrification Study—Abstract Only. For presentation at the International Conference on Atmospheric Electricity, Versailles, France, June 9–13, 2003.

MACLEOD, T.C. SD22
HO, F.D. UAH

MAJUMDAR, A.K. ED25

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FLACHBART, R.H. ED25

MAJUMDAR, A.K. ED25
STEADMAN, T. Jacobs Sverdrup
Numerical Modeling of Thermofluid Transients During Chilldown of Cryogenic Transfer Lines—Abstract Only. For presentation at the 33rd International Conference

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MARKUSIC, T.E. TD40

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CHOUEIRI, E.Y. Princeton University

MARSHALL, H. SD50
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O’DELL, S.L. SD50
PLUCINSKY, P. SD50

MARSHALL, S. Rocky Mountain College
OGLESBY, R.J. SD60
DROBOT, S. University of Colorado
ANDERSON, M. University of Nebraska
Simulating Snow Over Sea Ice in Climate Models—Abstract Only. For presentation at the American Geophysical Union Fall Meeting, San Francisco, CA, December 8–12, 2002.

MARTIN, J.J. TD40
LEWIS, R.A. R. Lewis Company
FANT, W.E. Cortez III
Overview of the High-Performance Antiproton Trap (HiPAT) Experiment—Presentation. For presentation at the 17th International Conference on the Applications of Accelerators in Research and Industry, Denton, TX, November 12–16, 2002.

MARTIN, J.J. TD40
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MCDONALD, S. TD40

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STANOJEV, B. TD40


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HOOVER, R.B. SD50


MAXWELL, T.G. FD42

MAZURUK, K. SD46


MAZURUK, K. SD46
GRUGEL, R.N. SD46


MCCAUL, E.W., JR. USRA
BUECHLER, D.E. UAH
GOODMAN, S.J. SD60
CAMMARATA, M. National Weather Service


MCCAUL, E.W., JR. USRA
GOODMAN, S.J. SD60
BUECHLER, D.E. UAH
BLAKESLEE, R.J. SD60


MELENDEZ, M. University of Texas, El Paso
TANG, W. University of South Carolina
MCCLURE, J.C. University of Texas, El Paso
NUNES, A.C., JR. ED30
MURR, L.E. University of Texas, El Paso


MELEN, D.P. ED41
GARCIA, D. ED41
VAUGHAN, W.W. UAH


MELTON, T. FD32
ONKEN, J. FD32


MERKLE, C.L. UT Space Institute
SANKARAN, V. UT Space Institute
DORNEY, D.J. TD64
SONDAK, D.L. Boston University

the 41st AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 6–9, 2003.

**MIKELLIDES, I.G.** SAIC
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**REUTHER, J.** Ames Research Center
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**HATHAWAY, D.H.** SD50


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**MORRIS, C.I.** TD40


**MORRIS, C.I.** TD40


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**MURDOCH, K.** Hamilton Sundstrand
**PERRY, J.L.** FD21
**SMITH, F.** FD21


**NALL, M.** SD10

Commercial Research Results From the International Space Station—Abstract Only. For presentation at the 41st AIAA Aerospace Science Meeting and Exhibit, Reno, NV, January 6–9, 2003.

**NESMAN, T.E.** TD63

Shuttle Fuel Feedliner Cracking—Presentation. For presentation at the MSFC Fall Workshop on Fluids, Huntsville, AL, November 19–21, 2002.
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PHELPS, T.J.  
WHITE, D.C.  
Princeton University  
Pacific Northwest National Lab  
University of Tennessee  
Pacific Northwest National Lab  
Pacific Northwest National Lab  
Oak Ridge National Lab  
University of Tennessee  
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KOUVELIOTOU, C. SD50
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WOODS, P.M. SD50
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HOLLOWAY, J.P. University of Michigan

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SIMS, W.H. TD40

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CRAMBLITT, E.L. Boeing
Pikuta, E.V. PIKUTA, E.V. SD50
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Marsic, D. MARSIC, D. UAH
Whitman, W.B. WHITMAN, W.B. University of Georgia
Tang, J. TANG, J. American Type Culture
Krader, P. KRADER, P. American Type Culture

Platt, M.J. PLATT, M.J. Concepts NREC
Marsh, M. MARSH, M. TD61

Platt, M.J. PLATT, M.J. Concepts NREC
Yu, M.M. YU, M.M. Concepts NREC
Marsh, M. MARSH, M. TD61

Polsgrove, T. POLSGROVE, T. TD30
MSFC MXER Tether Study—Interim Report—Charts. For presentation at the Advanced Space Propulsion Workshop, Huntsville, AL, April 15–17, 2003.

Porter, J.G. PORTER, J.G. SD50
West, E.A. WEST, E.A. SD50
Davis, J.M. DAVIS, J.M. SD50
Gary, G.A. GARY, G.A. SD50
Noble, M.W. NOBLE, M.W. SD50
Thomas, R.J. THOMAS, R.J. Goddard Space Flight Center
Rabin, D.M. RABIN, D.M. Goddard Space Flight Center
Uitenbroek, H. UITENBROEK, H. NSO

Prince, F.A. PRINCE, F.A. VS20

Pusey, M.L. PUSEY, M.L. SD46

Dowell, J. DOWELL, J. UAH
Gavira-Gallardo, J.A. GAVIRA-GALLARDO, J.A. UAH
Ng, J.D. NG, J.D. UAH

Van Der Woerd, M.J. VAN DER WOERD, M.J. USRA
Ferree, D.S. FERREE, D.S. USRA

Quinn, J.E. QUINN, J.E. TD51

Ramachandran, N. RAMACHANDRAN, N. USRA
Leslie, F.W. LESLIE, F.W. SD46

Ramachandran, N. RAMACHANDRAN, N. BAE/SD46
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RAMACHANDRAN, N. USRA
LESLIE, F.W. SD46

RAMACHANDRAN, N. BAE/SD46
MAJUMDAR, A.K. ED25
MCDANIELS, D.M. TD63
STEWART, E. ED25

RAMSEY, B.D. SD50
BASSO, S. Osservatorio Astronomico di Brera
BRUNI, R.J. Harvard-Smithsonian
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GHIIGO, M. Osservatorio Astronomico di Brera
GORENSTIEN, P. Harvard-Smithsonian
MAZZOLENI, F. Osservatorio Astronomico di Brera
O’DELL, S.L. SD50
SPEEGLE, C.O. Raytheon ITSS

RAMSEY, B.D. SD50
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RITCHIE, S. University of Alabama
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KUMMEROW, C.D. Colorado State University


ROBERTSON, T. NORLEY, G.D.


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ROCKER, M. WEST, J.S.


ROGERS, M. Luna Innovations, Inc.
STEVENSON, P. Luna Innovations, Inc.
SCRIBBEN, E. Virginia Polytechnic Institute
BAIRD, D. Virginia Polytechnic Institute
HULCHER, A.B. ED34


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DORNEY, D.J. TD64
DORNEY, S.M. TD64


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DORNEY, D.J. TD64

CFD-Based Design of Turbopump Inlet Duct for Reduced Dynamic Loads—Final Paper. For presentation at the Thermal and Fluids Analysis Workshop, Norfolk, VA, August 18–22, 2003.

RUF, J.H. TD64
HAGEMANN, G. Astrium, Germany
IMMICH, H. Astrium, Germany


RUF, J.H. TD64
MCDANIELS, D.M. TD64


RUSSELL, S.S. ED32
WALKER, J.L. ED32
LANSING, M.D. ED32

Leak Location and Classification in the Space Shuttle Main Engine Nozzle by Infrared Testing—Abstract Only.

For presentation at the ASNT Fall Conference and Quality Testing Show, Pittsburgh, PA, October 13–17, 2003.

SACKHEIM, R. DA01

In-Space Propulsion—Where We Stand and What’s Next—Final Paper. For presentation at the Tenth International Workshop on Combustion and Propulsion, Lerici, La Spezia, Italy, September 21–25, 2003.

SACKHEIM, R. DA01
CIKANEK, H.A. GRC
BEAURAIN, A. Snecma Moteurs
SOUCHIER, A. Snecma Moteurs
MORAVIE, M. Snecma Propulsion Solide


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DANIEL, C. UP10
KALIA, P. Raytheon ITSS


SALVAL, P.G. ED33


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SCHNELL, A.R. Tennessee Technological University
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<td>SIEJA, J.P.</td>
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<td>SONDAR, D.L.</td>
<td>Boston University</td>
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<td>SOZEN, M.</td>
<td>Embry-Riddle Aeronautical University</td>
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WHITE, S. TD40

ADAMS, R.B. TD40

THIO, Y.C.F. TD40

ALEXANDER, R. TD40

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PHILIPS, A. TD40

POLSGROVE, T. TD40

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SHAW, J.N. Auburn University
MASK, P.L. Auburn University
RICKMAN, D. SD60
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SULLIVAN, D.G. Auburn University
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ZUCCARO, A. UAH
ADAMS, J.H. SD50
CLINE, D. University of California


TAYLOR, J. Austin Peay State
RAKOZY, J. ED10
STEINCAMP, J. ED10
MATLOFF, G.L. Bangs/Matloff Aerospace


TAYLOR, T. Teledyne Brown Engineering
MOTON, T.T. Teledyne Brown Engineering
ROBINSON, D. Teledyne Brown Engineering
ANDING, R.C. Teledyne Brown Engineering


MONTGOMERY, E.E., IV TD05


THOMAS, D. VS01
SMITH, C. UP10


THOMAS, D. VS01
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OSBORNE, R. ERC, Inc.

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EARLY, J. Los Alamos National Laboratory
OSBORNE, R. ERC, Inc.
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COIMBRA, C. University of Hawaii
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VAIDYANATHAN, R. University of Florida
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Ion Velocity Distributions Within LLBL and Their Possible Implication to Multiple Reconnections—Abstract Only. For publication in Annales Geophysicae, 2003.

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VAIDYANATHAN, R. University of Florida
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WEFEL, J.P. Louisiana State University
ADAMS, J.H. SD50
AHN, H.S. University of Maryland
BASHINDZHAGYAN, G.L. Moscow State University
BATKOV, K.E. Moscow State University
CHRISTL, M.J. SD50
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FAZLEY, A.R. Southern University


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BECKER, W.E. Max Planck Institute
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SWARTZ, D.A. USRA


WEISSKOPF, M.C. SD50

WU, K. University College London
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SWARTZ, D.A. USRA


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Experience of Application of Silicon Matrix as a Charge Detector in the ATIC Experiment—Abstract Only. For presentation at the 28th International Cosmic Ray Conference, Tsukuba, Japan, July 31–August 7, 2003.


Experience of Application of Silicon Matrix as a Charge Detector in the ATIC Experiment—Abstract Only. For publication in Nuclear Instruments and Methods, 2003.
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B.A. Fowler
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