

17th HYPERVELOCITY IMPACT SYMPOSIUM



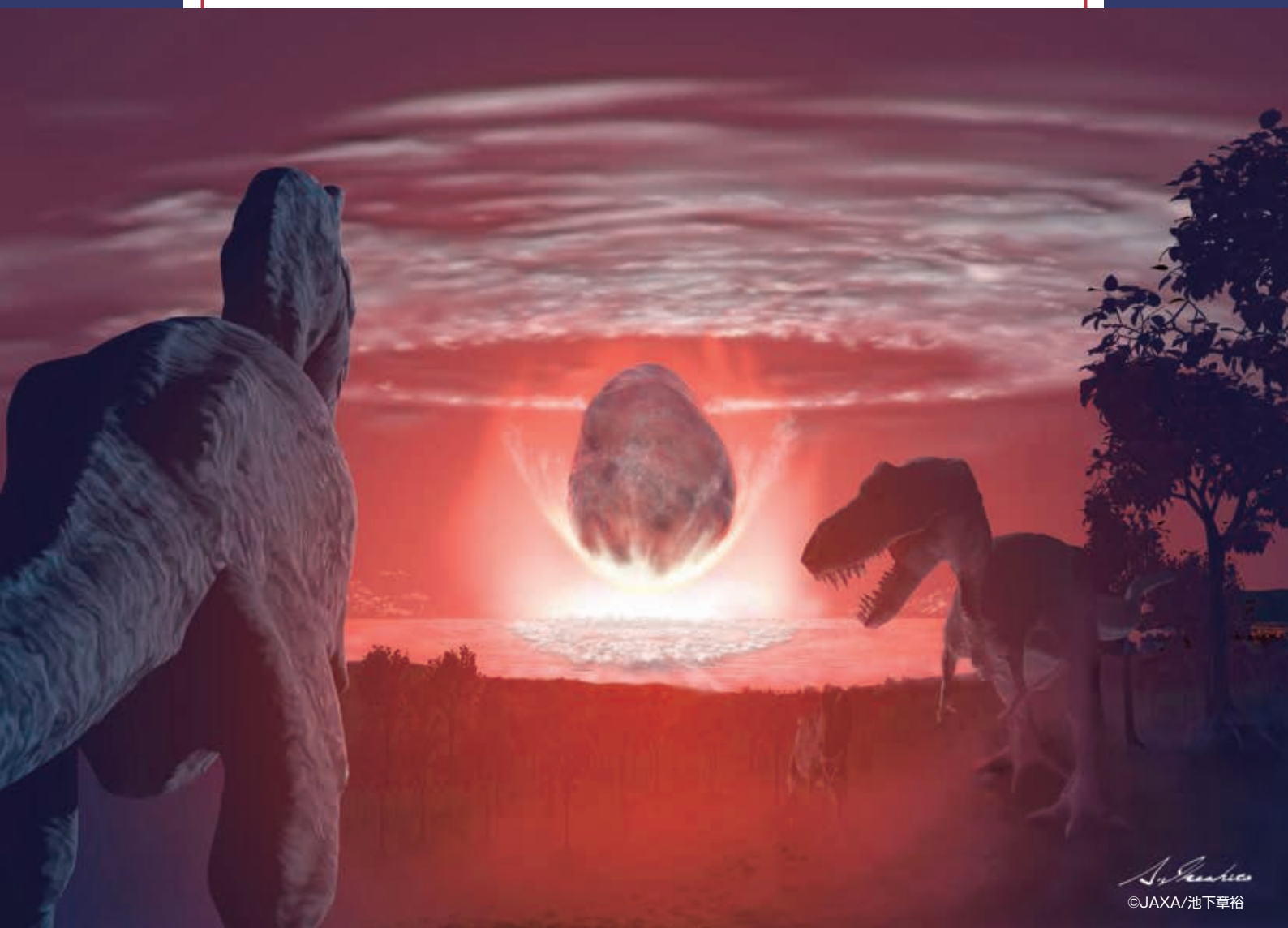
PROGRAM

2024

9.8^{SUN} – 9.13^{FRI}

Tsukuba, Japan 

Tsukuba International Congress Center
2-20-3 Takezono, Tsukuba City, Ibaraki Prefecture 305-0032



S. Saito
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Table of Contents

Welcome	2-3
Schedule at-a-Glance	4
Exhibitors	5
Organizing Committee	6
Symposium Schedule	
Sunday, September 8	7
Monday, September 9	7-8
Tuesday, September 10	9-11
Wednesday, September 11	12
Thursday, September 12	13-15
Friday, September 13	16
Keynote Sessions	
Session I	9
Session II	14

Exhibit Hours

Monday: 08:45 am – 05:45 pm
 Tuesday : 08:45 am – 05:45 pm
 Wednesday: 08:45 am – 12:30 pm
 Thursday: 08:45 am – 05:45 pm
 Friday: 08:45 am – 14:00 pm

President Welcome HVIS2024

On behalf of the Hypervelocity Impact Society, I'd like to welcome you to Tsukuba for the 2024 Hypervelocity Impact Symposium (HVIS 2024)! This is the 17th symposium held by the society to help advance science and technology on hypervelocity impact phenomena and related technical areas.

HVIS 2024 continues our long-standing international venue for the discussion, interchange, presentation, and recognition of technical contributions to the field of hypervelocity impact science. The technical quality of the papers continues to be very high with a diversity of topics ranging from Armor and Ballistic Technology to Equation of State to Spacecraft Debris and Shielding to Asteroid Impact and Planetary Defense. This year, a special session on Hypervelocity Phenomena related to Planetary Protection has been arranged to concentrate on another vital area of impact research. The local organizing committee, the Board of Directors, and the technical program chairs have worked hard to bring a high-quality, rewarding science forum to the beautiful Tsukuba City, Japan. Thank you to those of you who have submitted papers. I trust that you will enjoy the opportunity to listen to some great technical talks once again, interact with our poster presenters, and socialize with your colleagues.

Lastly, by attending the symposium, you are now a registered member of the society from now until the next symposium (HVIS 2026). Congratulations! Be sure to visit your Society website at <https://hvis.org> and please do not hesitate to let us know if you wish to volunteer on one of the many committees.



Angela M. Stickle,
PhD
President
Hypervelocity Impact
Society

Dr. Angela M. Stickle
President of the Hypervelocity Impact Society

Welcome to HVIS 2024

Welcome to the 2024 Hypervelocity Impact Symposium! This is the 17th symposium in the most recent series of symposia devoted to the study of hypervelocity impact phenomena and related technologies. The technical papers presented this week reaffirm the Society's commitment to providing a forum for the continued interaction of international scientists, engineers, and industrialists. Our objective this week is to facilitate the discussion and exchange of technical information related to hypervelocity impact phenomenology.

The presentations of the Distinguished Scientist Award recipient and the Society's Best Paper Award reinforce the Society's commitment to recognize and encourage excellence and quality in our fields of endeavor. The keynote session presentations are also indicative of the broad range of interests held by Society members. The excellent technical program and commercial exhibits of this symposium present an outstanding opportunity for everyone to be enriched by one another's expertise.

The presentations of the Distinguished Scientist Award recipient and the Society's Best Paper Award reinforce the society's commitment to recognize and encourage excellence and quality in our fields of endeavor.

Learn about and discuss the latest technical work in a wide variety of subject areas, network with your colleagues, make new friends, renew acquaintances, shop and compare the latest in impact-related equipment, software capabilities, and services offered by the companies in the Exhibit room – you are encouraged to take advantage of all this symposium has to offer. Also, please take a moment to visit with this year's cohort of Alex Charters Student Scholars. These fine young men and women are our future – please congratulate them on their selection this year and offer them your support and encouragement as future hypervelocity impact scientists and engineers.

We would like to take a moment to thank the following individuals and groups who volunteered their time and expertise to make this symposium a reality: the Hypervelocity Impact Society board of directors, Society committee chairs and committee members, the technical program chairs, the members of the HVIS 2024 technical program committee, Local organizing committee, Logistics team and conference staff. Without your hard work, this symposium would not have been possible. The Society thanks each of you for enriching our symposium with your presence and participation.

We are honored to host this symposium for the first time in Asia. We've had a lot of challenges, but we're really looking forward to finally seeing you. Enjoy your stay in Tsukuba City, Ibaraki Prefecture and Japan, and take your time to experience Japan food and Japan culture. I look forward to meeting and greeting many of you in person over the next few days.

Dr. Kumi Nitta
HVIS 2024 Symposium Chair



Kumi Nitta, PhD
HVIS 2024
Symposium Chair

HVIS 2024 is coordinated by the Hypervelocity Impact Society in conjunction with HVIS2024 Organizing Committee.

Official Support : JAXA

Schedule at-a-Glance

All technical sessions held in Convention Hall 300, TSUKUBA International Congress Center

Sunday, September 8

- 4:00 pm Registration
- Hotel Nikko Tsukuba
- 6:00 pm Welcome Reception
- Hotel Nikko Tsukuba 3rd floor "JUPITER"

Monday, September 9

- 8:45 am Registration
- TSUKUBA International Congress Center
- 9:30 am Opening Ceremonies
- Convention Hall 300
- 10:10 am Distinguished Scientist Keynote
- Convention Hall 300
- 11:00 am Break
- Conference Room 304
- 11:20 am **Technical Session 1:**
Analytical and Numerical Methodologies I
Session Chair: Stefano Signetti
- 12:20 pm Lunch - Main Hall Lobby
- 1:20 pm **Technical Session 2:**
Armor/Anti Armor and Ballistic Technology / High-velocity Penetration Mechanics and Target Response I
Session Chair: Casey Uhlig
- 3:00 pm Break - Conference Room 304
- 3:20 pm **Technical Session 3:**
Analytical and Numerical Methodologies II / Spacecraft/Meteoroid Debris Shielding and Failure Analyses I
Session Chair: Joshua Miller
- 5:00 pm Technical Sessions End
- 6:00 pm Conference Dinner
- Hotel Nikko Tsukuba 1st floor "SUBARU"

Tuesday, September 10

- 8:30 am Registration
- TSUKUBA International Congress Center
- 9:00 am **Keynote Session I** - Convention Hall 300
Speaker: Zoe Emerland

- 9:40 am **Exhibitor Briefings** - Convention Hall 300
- 11:20 am Break - Conference Room 304
- 11:40 am **Technical Session 4:**
Hypervelocity Phenomena Related to Planetary Protection / Asteroid Impact and Planetary Defense Technology I
Session Chair: Matthew Shaeffer
- 1:00 pm Lunch - Ristrante TSUMU
- 2:00 pm **Poster Session** - Foyer
- 3:30 pm Break
- 3:40 pm **Technical Session 5:**
Asteroid Impact and Planetary Defense Technology II
Session Chair: Angela Stickle
- 5:20 pm Technical Sessions End

Wednesday, September 11

- 8:30 am Registration
- TSUKUBA International Congress Center
- 9:00 am **Technical Session 6:**
Spacecraft/Meteoroid Debris Shielding and Failure Analyses II
Session Chair: Christopher Cline II
- 10:40 am Break
- Conference Room 304
- 11:00 am **Technical Session 7:**
High-velocity Penetration Mechanics and Target Response II
Session Chair: Justin Wilkerson
- 12:40 pm Technical Sessions End
Lunch (box lunches served)
- 1:30 pm Excursion - JAXA Tsukuba Space Center
- 6:30 pm Symposium Banquet
- Hotel Grand Shinonome 2nd floor "ARIAKE"

Thursday, September 12

- 8:30 am Registration
- TSUKUBA International Congress Center
- 9:00 am **Keynote Session II**
- Convention Hall 300
Speaker: Joshua Miller
- 9:40 am **Technical Session 8:**
High-velocity Launchers and Diagnostics
Session Chair: Yasuhiro Akahoshi

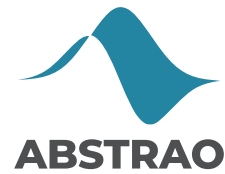
- 11:00 am Break - *Conference Room 304*
- 11:20 am **Technical Session 9:**
Fracture and Fragmentation I
Session Chair: David Price
- 12:40 pm Lunch - *Main Hall Lobby*
- 1:40 pm **Technical Session 10:**
Material Response (including EOS) /
Fracture and Fragmentation II
Session Chair: James Walker
- 3:20 pm Break - *Conference Room 304*
- 3:40 pm **Technical Session 11:**
Analytical and Numerical Methodologies III /
Spacecraft/Meteoroid Debris Shielding
and Failure Analyses III
Session Chair: William Schonberg
- 5:40 pm Technical Sessions End

Friday, September 13

- 8:30 am Registration
- *TSUKUBA International Congress Center*
- 9:00 am **Technical Session 12:**
High-velocity Penetration Mechanics
and Target Response III
Session Chair: Shannon Ryan
- 10:40 am Break - *Conference Room 304*
- 11:00 am **Technical Session 13:**
Spacecraft/Meteoroid Debris Shielding
and Failure Analyses IV
Session Chair: Masahiro Nishida
- 12:40 pm Technical Sessions End
- 12:50 pm HVIS Business Meeting (box lunches served)
- *Convention Hall 300*
- 1:50 pm Symposium Closes

Exhibitors

Stop by the Exhibit Hall (*Conference Room 304*) during the Symposium to visit with vendors about the latest in impact-related equipment, services and software capabilities.



Photron



Organizing Committee

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Kumi Nitta, *JAXA*

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Nobuaki Kawai, *National Defense Academy*

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Joshua Miller, *The University of Texas at El Paso*

Joel Williamsen, *Institute for Defense Analyses*

Justin Moreno, *Johns Hopkins University*

Justin Wilkerson, *Texas A&M University*

Lorenzo Olivieri, *University of Padova*

Michael Hopson, *NSWC Dahlgren Division*

Patrick King, *Johns Hopkins Applied Physics Laboratory*

Scott Alexander, *Sandia National Laboratories*

Shannon Ryan, *Deakin University*

William Schonberg, *Missouri S&T*

Symposium Schedule

Sunday Evening, September 8, 2024

4:00 pm – 6:00 pm

Registration
- *Hotel Nikko Tsukuba*

6:00 pm

Welcome Reception
- *Hotel Nikko Tsukuba 3rd floor "JUPITER"*

Monday Morning, September 9, 2024 | Convention Hall 300

8:45 am

Registration

10:10 am – 11:00 am

Distinguished Scientist
Keynote Address

11:20 am – 12:20 pm

Technical Session 1:
Analytical and Numerical
Methodologies I

12:20 pm – 1:20 pm

Lunch - *Main Hall Lobby*

9:30 am – 10:10 am

Opening Ceremonies

11:00 am – 11:20 am

Break
- *Conference Room 304*

Technical Session 1 | 11:20 am – 12:20 pm

Analytical and Numerical Methodologies I

Session Chair: Stefano Signetti

052 - Overset Mesh Method for Arbitrary Lagrangian Eulerian Contact on Unstructured General Polyhedral Meshes

Nathan Vaughn-Kukura, Miles Buechler, Mack Kenamond, Mikhail Shashkov

100 - Collisionless Electrostatic Particle-in-Cell Simulation of Rapid Target Charging Along an Unbiased Surface due to Hypervelocity Impact Plasmas

Nancy Diallo, Raymond Lau, Nicolas Lee, Sigrid Elschot

083-2 - Fragmentation Prediction of a Steel Cylinder Using an Advanced Meshless Numerical Method Coupled with a Comprehensive Fracture Model Embedding Tensile and Shear Failure Modes

F. Nozères, R. Boulanger, Y. Quirion, A. Collé, J. Limido, P. Bailly, H. Couque

Symposium Schedule

Monday Afternoon, September 9, 2024 | Convention Hall 300

1:20 pm – 3:00 pm

Technical Session 2:

Armor/Anti Armor and Ballistic Technology / High-velocity Penetration Mechanics and Target Response I

3:20 pm – 5:00 pm

Technical Session 3:

Analytical and Numerical Methodologies II / Spacecraft/Meteoroid Debris Shielding and Failure Analyses I

5:00 pm

Technical Sessions End

6:00 pm

Conference Dinner
- *Hotel Nikko Tsukuba 1st floor "SUBARU"*

3:00 pm – 3:20 pm

Break - *Conference Room 304*

Technical Session 2 | 1:20 pm – 3:00 pm

Armor/Anti Armor and Ballistic Technology / High-velocity Penetration Mechanics and Target Response I

Session Chair: Casey Uhlig

031 - Impact Initiation of a Semi-confined High Explosive Target by Hypervelocity Debris

Filip Gökstorp, Olof Andersson, Urban Widing, Patrik Lundberg

065 - Shaped Charge Jets Interaction with Passive and Reactive Armor: A Complete Multi-Scale Approach

David Lebaillif, Yann Quirion, Solenn Le Mouroux

028 - Modeling and Analysis of a 66mm Shaped Charge

Kevin T. Miers, Nicholas R. Peterson, W. Lee Perry, Levi A. Lystrom, Justin C. Sweitzer, Stanley E. DeFisher

049 - Shaped Charge Penetration Experiments

Frances G. Daykin, David W. Price, Alexander Harding, Ernest J. Harris

068 - Extension of One-dimensional Penetration Model Considering Cylindrical Cavity Expansion with Johnson-Cook Hardening

Inhan Ga, Jeong Whan Yoon

Technical Session 3 | 3:20 pm – 5:00 pm

Analytical and Numerical Methodologies II / Spacecraft/Meteoroid Debris Shielding and Failure Analyses I

Session Chair: Joshua Miller

037 - Lethal Debris Creation Following Catastrophic and Sub-catastrophic Untracked Orbital Debris Impacts on Smallsats

Peter Mancini, Joel Williamsen, James Heagy, Bob Stellingwerf

078 - Look Out for The Little Ones: On the Long-term Impact of Debris Size Distribution on Breakup

Cameron J. Liang, Angelo Signoracci, Paul Fanto, Johnathon Ahlers

014 - Mars Sample Return Earth Entry System Uncertainty Analysis

Michael D. Squire, Victor Cabrera, Eric Christiansen, Alan Jenkin, Kevin Hoffman, Quincy McKown, Peter Parker, Glenn Peterson, Bruno Victorino Sarli, William Schonberg, Katie Steward, Brian Tulaba, Joel Williamsen

017 - Orion Artemis I as Flown MMOD Analysis

Kevin D. Deighton, Eric L. Christiansen, Dana M. Lear, James L. Hyde

011 - Tests and Simulations for an on-Orbit Micrometeoroid Detector

Sidney Chocron, Alexander J. Carpenter, Drew Hackney, Robert Enriquez-Vargas, James D. Walker, Michael A. Koets, Randy Rose, Robert Grimm

Symposium Schedule

Tuesday Morning, September 10, 2024 | Convention Hall 300

8:30 am
Registration

9:00 am – 9:40 am
Keynote Session I

9:40 am – 11:20 am
Exhibitor Briefings

11:20 am – 11:40 am
Break - Conference Room 304

Technical Session 4 | 11:40 am – 1:00 pm

Hypervelocity Phenomena Related to Planetary Protection / Asteroid Impact and Planetary Defense Technology I

Session Chair: Matthew Shaeffer

056 - Development of an Experimental System for Hypervelocity Impact Sterilization Tests

Takashi Ozawa, Satoshi Nomura, Shinya Iwabuchi, Junko Arikawa, Kumi Nitta, Akira Nakamura, Akihiko Yamagishi, Kazuhisa Fujita, Shuto Tanaka, Haruna Sugahara

094 - Experiments and Biological Assays on Microorganisms Subjected to Impact Stresses

Lily Zhao, Cesar A. Perez-Fernandez, Jocelyne DiRuggiero, K. T. Ramesh

024 - Effects of Surface Topography on the Crater Formation Process of Rubble-Pile Asteroids

Yusaku Yokota, Masahiko Arakawa, Minami Yasui, Kei Shirai, Sunao Hasegawa

074 - Dynamic Weakening due to Localized Thermal Softening with Application to the Formation of Hypervelocity Impact Craters

David A. Crawford

11:40 am – 1:00 pm
Technical Session 4:
Hypervelocity Phenomena Related to Planetary Protection / Asteroid Impact and Planetary Defense Technology I

1:00 pm – 2:20 pm
Lunch - *Ristrante TSUMU*



Keynote Session I

Tuesday, September 10, 2024
9:00 am – 9:40 am

Speaker: Zoe Emerland

Presentation Title:
LGG Experiments to Evaluate the Probability of an Unsterilised Particle from Mars being Returned from Phobos by the MMX Sample-Return Mission

Author: Zoe Emerland

Speaker Bio: Dr Zoe Emerland recently completed her PhD entitled “An experimental and numerical assessment of ejected martian biosignatures impacting Phobos” in 2023 at the Open University. Now she is a Project Officer within the HyperVelocity Impact & Space and Planetary Environments Laboratories at the Open University. Dr Emerland's PhD was motivated by the works of Professor Manish Patel et al., as a part of the European Space Agency “Sterilization limits for sample return planetary protection measures” (SterLim) study, which aimed to evaluate the probability of collecting unsterilized martian material from the surface of Phobos, ahead of JAXA's Martian Moons eXploration (MMX) mission. The team including partners at Public Health England, Fluid Gravity Engineering Ltd, Thales Alenia Space UK and Kallisto Consultancy, spent three years experimentally and numerically estimating the proportion of a sample returned from Phobos that could contain viable organisms originating from Mars. Hypervelocity impact experiments using the Open University's All-Axis Two-stage Light Gas Gun were crucial to this study. This work had major implications for the Planetary Protection status of Phobos and ultimately contributed to its declaration as unrestricted Earth-return.



Prof. Manish Patel

Symposium Schedule

Tuesday Afternoon, September 10, 2024 | Convention Hall 300

2:00 pm – 3:30 pm
Poster Session – Foyer

3:30 pm – 3:40 pm
Break

3:40 pm – 5:20 pm
Technical Session 5
Asteroid Impact and Planetary
Defense Technology II

5:20 pm
Technical Sessions End

Technical Session 5 | 3:40 pm – 5:20 pm

Asteroid Impact and Planetary Defense Technology II

Session Chair: Angela Stickle

092 - Ejection Angles during Hypervelocity Impacts on Flat and Spherical Targets Investigated with Hydrocode Simulations

Kenji Kurosaki, Kosuke Kurosawa, Masahiko Arakawa

114 - Momentum Enhancement Resulting from Hypervelocity Impact into a Basalt Boulder

Minh T. Lê, Justin Moreno, K.T. Ramesh

099 - Momentum Enhancement from Impacts into Crushed Basalt at 2 and 5.5 km/s, Motivated by DART

James D. Walker, Sidney Chocron, Donald J. Grosch, Daniel D. Durda, Simone Marchi, Matthew V. Grimm, Christopher Sorini

032 - Hypervelocity Impact of Three L-type Ordinary Chondrites: A Test of the Variation of β and Q^*D with Target Porosity and Strength

G. J. Flynn, M. Strait, H. Willman, A. Rolling, T. Pytel, H. Wheeler-Cooney, R. J. Macke, D. D. Durda

072 - Asteroid Deflection: Do Repeated Impacts in the Same Location Increase Total Momentum Transfer?

Alexander Westra, Jason Damazo, Dominic Martinez, Kevin Housen, Leslie Lamberson

Poster Session | 2:00 pm – 3:30 pm | Foyer

Analytical and Numerical Methodologies

083-1 - High-performance Computational Modeling of Hypervelocity Impacts Using a Meshless Gamma-SPH Scheme

Gautier Dakin, Anthony Collé, Jérôme Limido

107 - Application of Limit State Function Method to Statistical Analysis of Ballistic Penetration

Shinsuke Sakai, Tomohisa Kumagai

Asteroid Impact and Planetary Defense Technology

035 - Study of the Scale Size Effect on Momentum Enhancement in Hypervelocity Impact for Rock Target

Taishi Satou, Yasuhiro Akahoshi, Takao Koura, Koudai Tanaka

041 - Spatial and Shape Distributions of Ejecta from Hypervelocity Impact between Rocky Projectile and Metal Target

Koske Matsubara, Yukari Yamaguchi, Akiko M. Nakamura, Sunao Hasegawa

054 - Cross-sectional Observation of Craters Formed by High-velocity Impacts under Low-gravity

Masato Kiuchi, Takaya Okamoto, Yuuya Nagaashi, Yukari Yamaguchi, Sunao Hasegawa, Akiko M. Nakamura

Fracture and Fragmentation

071 - Hypervelocity Impact Damage Formation in Multilayered Transparent Target

Nobuaki Kawai, Sunao Hasegawa

Symposium Schedule

Tuesday Afternoon, September 10, 2024 | Convention Hall 300

Poster Session | 2:00 pm – 3:30 pm | Foyer

High-velocity Launchers and Diagnostics

- 038 - Hugoniot Measurement of BK-7 Windows by Using Aluminum Impactors Launched by Explosive**
Hee Jung Lee, Sang Mok Jung, Sung Hyun Baek
- 058 - Digital Image Correlation on an Isentropic Compression Experiment Using a High Pulsed Power Driver**
Thibaut Paccou, Gaël Leblanc, Camille Chauvin
- 080 - Increase of the Muzzle Velocity of a Railgun Beyond 2500 m/s**
Bernhard Reck, Farid Alouahabi, Quentin Hassler, David Bluntzer

High-velocity Penetration Mechanics and Target Response

- 040 - Hypervelocity Impact Testing and Simulation at the University of Padova**
S. Lopresti, L. Olivieri, C. Giacomuzzo, A. Francesconi
- 046 - Hypervelocity Impact Experiments on Polycarbonate Targets: Cratering Efficiency and Crater Shape**
Yukari Yamaguchi, Koske Matsubara, Akiko M. Nakamura
- 048 - Modelling the Three Phases of Shaped Charge Function**
David W. Price, Frances G. Daykin, Ernest J. Harris
- 055 - Ricochet Angle at Hypervelocity Impact**
Filip Gökstorp, Olof Andersson, Ulf Gustavsson, Patrik Lundberg
- 091 - Perforation Hole Diameter and Ejecta from Aluminum Alloy 6061-T6 Sheets Processed by High-pressure Sliding**
Shimpei Nanri, Xinyi Guo, Masahiro Nishida, Yoichi Takizawa, Manabu Yumoto, Zenji Horita

Material Response (including EOS)

- 047 - Shock Wave Propagation in Unidirectional CFRP at Different Orientations**
Suman Shah, Paul J Hazell, Hongxu Wang, Juan P. Escobedo

Spacecraft/Meteoroid Debris Shielding and Failure Analyses

- 008 - pyBLOSSUM: An Open-source Python Repository for Assessing the Ballistic Limit of Spacecraft Structures under Space Debris Impact**
Shannon Ryan
- 084 - Micrometeoroid and Orbital Debris (MMOD) Testing, Ballistic Limit Equation Definition and Risk Assessment of the Exploration Extravehicular Mobility Unit (XEMU)**
Kevin D. Hoffman, Brian K. Tulaba Jr., James L. Hyde, Eric L. Christiansen
- 088 - Study of Damage Modes that Cause Titanium Alloy Tanks to Fracture due to Debris Impact Based on Rupture Limit Equation**
Sayaka Suzuki, Masumi Higashide, Kumi Nitta
- 090 - Establishment of Ejecta Evaluation during Hypervelocity Impact of Large Structures in Geostationary Orbit**
Yuma Kitaguro, Miyu Inoue, Yasuhiro Akahoshi, Takao Koura, Satomi Kawamoto, Taku Izumiyama

Hypervelocity Phenomena Related to Planetary Protection

- 061 - Development of the Light-gas Gun for Hypervelocity Impact Sterilization Tests with a Rifling Barrel**
Satoshi Nomura, Takashi Ozawa, Shinya Iwabuchi, Akira Nakamura, Shuto Tanaka, Kumi Nitta, Kazuhisa Fujita, Akihiko Yamagishi
- 097 - Microbial Setups for Hypervelocity Impact Sterilization Tests**
Shinya Iwabuchi, Kotone Miyajima, Junko Arikawa, Takashi Ozawa, Akihiko Yamagishi, Satoshi Nomura, Kumi Nitta, Kazuhisa Fujita, Akira Nakamura

Symposium Schedule

Wednesday, September 11, 2024 | Convention Hall 300

8:30 am
Registration

9:00 am – 10:40 am
Technical Session 6:
Spacecraft/Meteoroid Debris
Shielding and Failure Analyses II

10:40 am – 11:00 am
Break - Conference Room 304

11:00 am – 12:40 pm
Technical Session 7:
High-velocity Penetration
Mechanics and Target Response II

12:40 pm
Technical Sessions End
Lunch (box lunches served)

1:30 pm
Excursion
- JAXA Tsukuba Space Center

6:30 pm
Symposium Banquet
- Hotel Grand Shinonome
2nd floor "ARIAKE"

Technical Session 6 | 9:00 am – 10:40 am

Spacecraft/Meteoroid Debris Shielding and Failure Analyses II

Session Chair: Christopher Cline II

013 - Smooth Particle Hydrodynamic Code Predictions for Meteoroid Damage to Thermal Protection Systems Shielded by Composite Structures

Brooke Corbett, Joel Williamsen, Robert Stellingwerf, Michael Squire

007 - Extending the Applicability of Thermal Protection System Ballistic Limit Equations Beyond the Testable Regime

William P. Schonberg, Michael D. Squire

009 - General Ballistic Limit Equations for Whipple Shields against Low- and High-density Meteoroid Surrogates

Joshua E. Miller, Bruce Alan Davis, Kevin D. Deighton

026 - Physics-informed Machine Learning for Predicting the Ballistic Limit of Whipple Shields

Shannon Ryan, Hung Le, Julian Berk, AV Arun Kumar, Svetha Venkatesh

045 - The Application of Artificial Intelligence and Deep Learning to Visually Identify Micrometeoroid and Orbital Debris Impacts

Cameron M. Collins, Dana M. Lear, Kenton R. Fisher

Technical Session 7 | 11:00 am – 12:40 pm

High-velocity Penetration Mechanics and Target Response II

Session Chair: Justin Wilkerson

089 - Ballistic Limit Velocity and Impact Energy Absorption from Microns to Millimeters

Jacob A. Rogers, Kailu Xaio, Paul T. Mead, Charles U. Pittman, Jr., Edwin L. Thomas, Justin W. Wilkerson, Thomas E. Lacy Jr

027 - Evaluation of Debris Impact on AO-resistant Film

Yugo Kimoto, Yuko Kubo, Kaori Umeda, Sunao Hasegawa

033 - Laser Simulation of Hypervelocity Impact into Porous Graphite

Bertrand Aubert, David Hébert, Jean-Luc Rullier, Emilien Lescoute, Laurent Videau, Laurent Berthe

036 - Laser-driven Cratering into Porous Graphite: Experimental Investigation on Ejecta Distribution

Baptiste Reynier, Benjamin Jodar, Theo Geral, Emilien Lescoute, Corentin Le Bras, Lorenzo Taddei, Jean-Marc Chevalier, David Hebert, Michel Arrigoni

018 - Momentum Transfer During Laser-driven Cratering Experiments

David Hébert, Corentin Le Bras, Baptiste Reynier, Bertrand Aubert, Jean-Marc Chevalier, Emilien Lescoute, Guillaume Boutoux, Benjamin Jodar, Théo Géral, Didier Loison, Laurent Videau, Lorenzo Taddei, Michel Arrigoni, Laurent Berthe

Symposium Schedule

Thursday Morning, September 12, 2024 | Convention Hall 300

8:30 am
Registration

9:00 am – 9:40 am
Keynote Session II

9:40 am – 11:00 am
Technical Session 8:
High-velocity Launchers and
Diagnostics

11:00 am – 11:20 am
Break - Conference Room 304

11:20 am – 12:40 pm
Technical Session 9:
Fracture and Fragmentation I

12:40 pm – 1:40 pm
Lunch - Main Hall Lobby

Technical Session 8 | 9:40 am – 11:00 am

High-velocity Launchers and Diagnostics

Session Chair: Yasuhiro Akahoshi

050 - Dynamic Tensile Extrusion of 0.25 and 0.30 Caliber Hypervelocity Projectiles
W. Casey Uhlig, Matthew Coppinger, Brian Wilmer, Paul Berning

042 - Erosion from Hypervelocity Impacts with Simultaneously Launched Particles
Justin Moreno, Matthew Shaeffer, Samuel Slingluff, Yo-Rhin Rhim, David Brown, K.T. Ramesh

101 - A Comprehensive Optimization Study for Increasing Output Velocity and Minimizing Erosion in Small Caliber Two-stage Gas Guns
Daniel Rodriguez, Marcus Sandy, Paola Rodriguez, Jacob Golson, Darren Cone, Dax L. Rios

104 - A Laser Driven Gun for the Launch of Sub Millimetre Projectiles
Rhys Edwards, Stephen Rothman

Technical Session 9 | 11:20 am – 12:40 pm

Fracture and Fragmentation I

Session Chair: David Price

010 - In-situ Imaging of Spall Fracture
Jacob M. Diamond, Justin Moreno, Lily Zhao, K.T. Ramesh

093 - Crack Propagation Process by Stress Waves in Pre-cracked Glass Plate Subjected to Hypervelocity Impact of Debris
Mikio Nagano, Nobuaki Kawai, Sunao Hasegawa, Satoshi Yoshida, Eiichi Sato

067 - Pellet Shattering Process for the ITER Disruption Mitigation System – Part I: Development of a Discrete Element Code for Modeling the Dynamic Fragmentation of Cryogenic Materials
Stefano Signetti, Pascal Matura, Jose Luis Sandoval Murillo, Nathanaël Durr, Markus Büttner, Er kai Watson, Stefan Moser, Dilara Gebhardt, Stefan Jachmich, Michael Lehnen, Uron Kruezi

063 - Pellet Shattering Process for the ITER Disruption Mitigation System – Part II: Synthetic-diagnostics-based Fragment Tracking, Calibration, and Validation of Simulation Models
Pascal Matura, Stefano Signetti, Stefan Moser, Dilara Gebhardt, Er kai Watson, Alexander Schindler-Tyka, José Luis Sandoval Murillo, Nathanaël Durr, Markus Büttner, Stefan Jachmich, Michael Lehnen, Uron Kruezi

Symposium Schedule

Thursday Morning, September 12, 2024 | Convention Hall 300



Keynote Session II

Thursday, September 12, 2024

9:00 am – 9:40 am

Speaker: Joshua Miller

Presentation Title:

**Measurements of the Failure of
Composite Overwrapped Pressure Vessels by Direct Impact**

Author: Joshua Miller

Speaker Bio: Dr. Joshua Miller is a scientist and engineer with the University of Texas at El Paso. Dr. Miller received his Ph.D. in Mechanical Engineering from the University of Rochester with an emphasis in high-energy density physics while researching at the Omega Laser Facility. Starting as a systems analyst at Lockheed Martin, Dr. Miller specialized in assessing solid particle natural environments for Orion and other deep space robotic missions. For the past 12 years, Dr. Miller has been in the Hypervelocity Impact Technology (HVIT) group in the Astromaterials Research and Exploration Sciences Division at the NASA Johnson Space Center, providing direct support to system designers of the International Space Station, the Artemis program, the Gateway project, various other NASA robotic spacecraft as well as in support to the environment offices of the Orbital Debris Program Office and Meteoroid Engineering Office. Dr. Miller will be presenting on the coordinated effort between HVIT, the National Engineering Safety Center and the White Sands Remote Hypervelocity Test Laboratory to quantify thresholds of failure from hypervelocity impacts of energized composite overwrapped pressure vessels.

Symposium Schedule

Thursday Afternoon, September 12, 2024 | Convention Hall 300

1:40 pm – 3:20 pm

Technical Session 10:

Material Response (including EOS) /
Fracture and Fragmentation II

3:20 pm – 3:40 pm

Break - Conference Room 304

3:40 pm – 5:40 pm

Technical Session 11:

Analytical and Numerical
Methodologies III /
Spacecraft/Meteoroid Debris
Shielding and Failure Analyses III

5:40 pm

Technical Sessions End

Technical Session 10 | 1:40 pm – 3:20 pm

Material Response (including EOS) / Fracture and Fragmentation II

Session Chair: James Walker

**073 - Development of Back-face Coatings for the
Characterization of Non-reflective and Opaque
Materials by Laser Shocks**

Solenn Le Mouroux, David Lebaillif, Laurent Berthe,
Philippe Viot, Jérémie Girardot

**113 - Validation of Hypervelocity Impact Induced Damage
and Fragmentation Models for Silicon Carbide**

Joseph Morton, Leslie Lamberson

**043-1 - Computational Analysis of Thermal Hypervelocity
Impact Experiments**

Michael Hopson, Lauren Edgerton

**043-3 - Fracture Calculations Using Measurement based
Statistical Strength and Non-local Failure**

Michael Hopson, Christine Scott, Andrew Stershic,
Scott Alexander

**015 - Using Plate-impact-driven Ring Expansion Tests
(PIDRET) to Assess Analytical Models**

Gabriel Seisson, Fanny Gant, Patrice Longère, Skander El Maï,
Jean-Luc Zinszner

Technical Session 11 | 3:40 pm – 5:40 pm

Analytical and Numerical Methodologies III / Spacecraft/Meteoroid Debris Shielding and Failure Analyses III

Session Chair: William Schonberg

**075 - Fragment Impact Debris Morphology as a Function
of Impact Conditions**

Eugene Hertel, Matthew Garcia, Jeffrey Cole

**079 - Shape Effect of Non-Spherical Projectiles on CFRP
Spacecraft Structures**

Erkai Watson, Robin Putzar, Nathanaël Durr,
Kush Kumar Sharma, José Luis Sandoval Murillo,
Martin Schimmerohm

**034 - Creation of Lethal Debris from Meteoroid and
Orbital Debris Impacts on LEO Solar Array Materials**

Hannah Yi, Joel Williamsen, Robert Stellingwerf, Daniel Pechkis

**106 - On the Effect of Projectile Material on Damage
Induced to Single and Multi-plate Target**

Hakim Abdulhamid, Jérôme Mespoulet, Paul Deconinck

**025 - Preliminary Experimental Investigation of
Multi-Shock Shield Performance against Meteoritic
and Other Lithic Projectiles**

Christopher J. Cline II, Eric Christiansen, Robert McCandless,
Joshua Miller, Bruce Alan Davis, Jesus Resendez

**110 - The Emission of Nonthermal Electromagnetic
Radiation by Colliding Space Debris**

M. Akhavan-Tafti, N. O. Renno, D. Crawford, Y. Zhang,
R. Backhus, T. Atilaw

Symposium Schedule

Friday Morning, September 13, 2024 | Convention Hall 300

8:30 am
Registration

9:00 am – 10:40 am
Technical Session 12:
High-velocity Penetration
Mechanics and Target Response III

10:40 am – 11:00 am
Break - *Conference Room 304*

11:00 am - 12:40 pm
Technical Session 13:
Spacecraft/Meteoroid Debris
Shielding and Failure Analyses IV

12:40 pm
Technical Sessions End

12:50 pm – 1:50 pm
HVIS Business Meeting
(box lunches served)
- *Convention Hall 300*

1:50 pm
Symposium Closes

Technical Session 12 | 9:00 am – 10:40 am

High-velocity Penetration Mechanics and Target Response III

Session Chair: Shannon Ryan

087 - Polyethylene's Response to Hypervelocity Impacts at Critical Transition Temperatures

Jacob A. Rogers, Aniket Mote, Sidney Davis, Paul T. Mead, Charles U. Pittman, Jr., Edwin L. Thomas, Justin W. Wilkerson, Thomas E. Lacy Jr.

077 - Failure Modes of CFRP Panels under Hypervelocity Impact: the Effects of Strain Rate Between 1 km/s and 6 km/s

Jacob Lawrence, Jonathan Painter, Alexandra Iordachescu, Charles J. Footer, Ryan M. Seabright, Gareth Appleby-Thomas

057 - Effects of Electron Beam and Atomic Oxygen Irradiation on Hypervelocity Impact Fracture Behavior of Polyimide CFRP

Masahiro Nishida, Kyouko Ashida, Su Ziyi, Yuichi Ishida, Masumi Higashide

085 - Flash X-ray Investigation of Ejecta Developed during High-velocity Impact into Boron Carbide

Konrad Muly, Justin Moreno, K.T. Ramesh

069 - Probing the Evolution of Solid Microjets from Grooved Sn Sample Using X-ray Radiography: Evidence of Coalescence Edge Effects

J.-R. Burie, C. Aragoncillo de Mingo, J.-M. Chevalier, J. Aupepin, T. Lerévérend, B. Imbert, L. Youinou, H. Requardt, D. J. Foster, B. Lukic, A. Sollier

Technical Session 13 | 11:00 am - 12:40 pm

Spacecraft/Meteoroid Debris Shielding and Failure Analyses IV

Session Chair: Masahiro Nishida

019 - A Numerical Method of Mesoscopic Metallic Foam under Hypervelocity Impact

Qunyi Tang, Xiaowei Chen

066 - SPH Modeling of Ultra High Molecular Weight Polyethylene Plate in Hypervelocity Impact

Takaomi Chubachi, Takayuki Shimizu, Hiromichi Akiyama, Kanjuro Makihara

096 - Hypervelocity Impact on Whipple Shields with Varying Bumper Material at 7 km/s: An Experimental Study

Rannveig M. Færgestad, Bruce A. Davis, Christopher J. Cline, Eric Christiansen, Kevin A. Ford, Odd S. Hopperstad, Jens K. Holmen, Tore Børvik

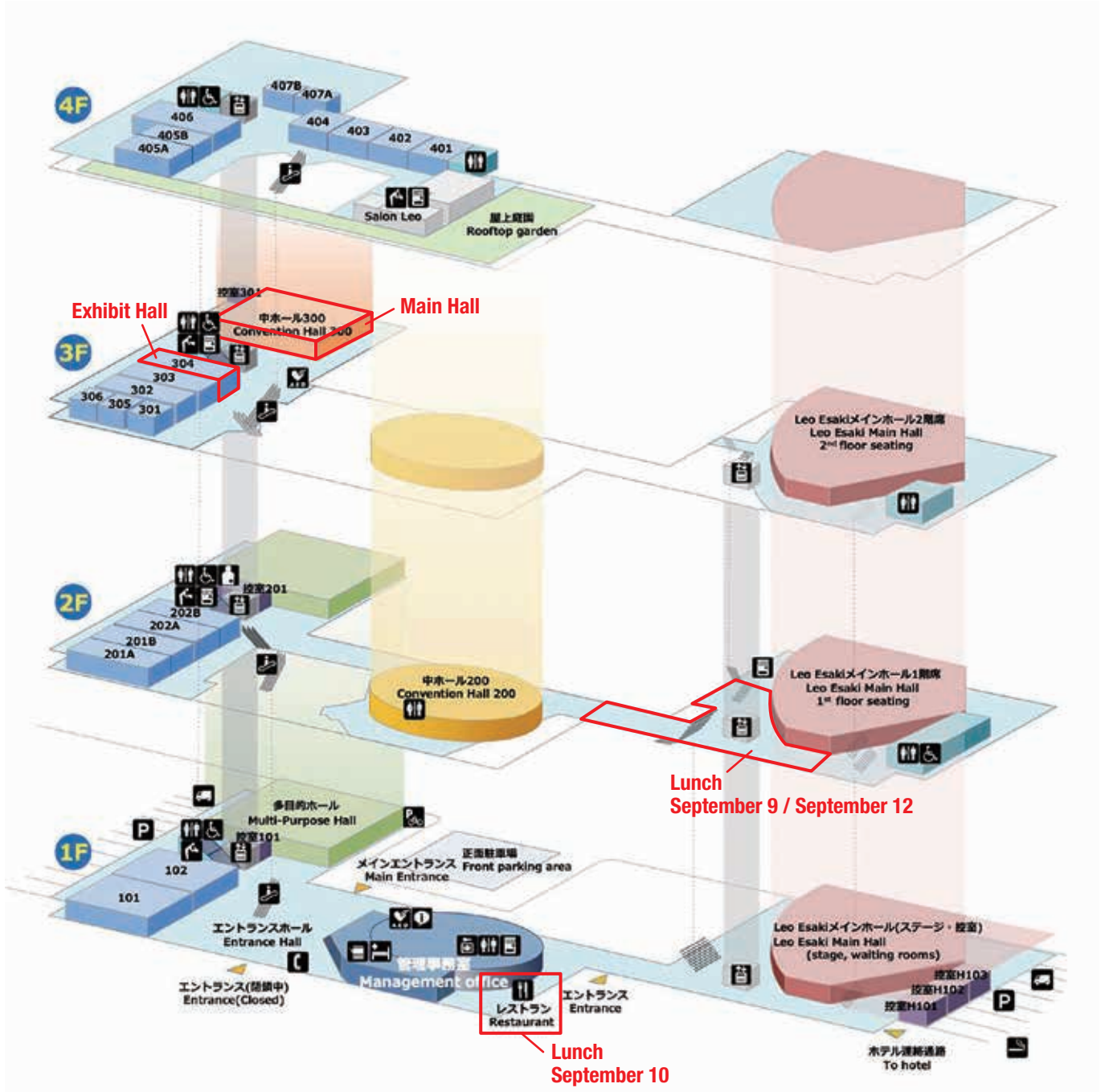
095 - Evaluation of the AFRP Durability against Debris Cloud Impacts within Multiple-layered Bumper Shield Structures

Ryoya Sano, Yukihiro Ishibashi, Kai Ito, Shoya Iwata, Sunao Hasegawa, Penelope Wozniakiewicz, Luke Alesbrook, Gareth Appleby-Thomas, Kazuyoshi Arai, Hajime Yano

098 - Design Verification of Whipple Bumper Shields for Protecting Small Spacecraft from Hypervelocity Impacts during Fast Fly-bys to Dusty Objects

Hajime Yano, Kazuyoshi Arai, Yukihiro Ishibashi, Yasuyuki Miyazaki, Yasutaka Satoh, Ryoya Sano, Kai Ito, Shoya Iwata, Penelope Wozniakiewicz, Luke Alesbrook, Gareth Appleby-Thomas, Sunao Hasegawa, Ryu Funase

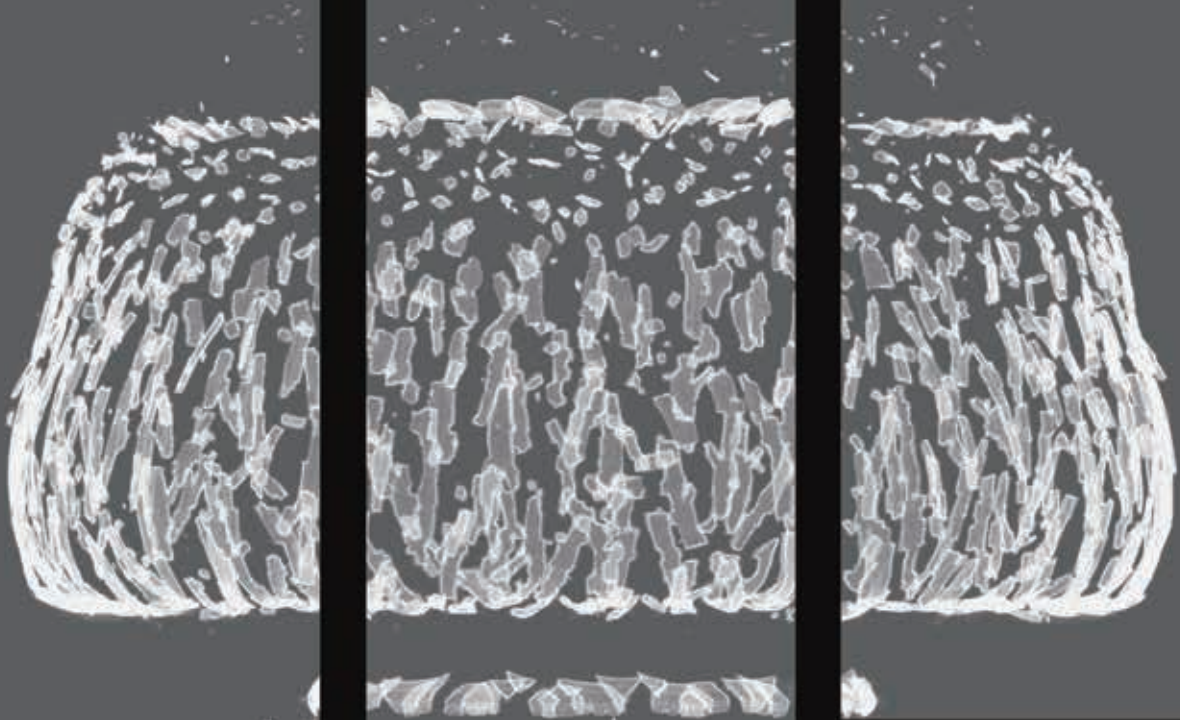
Venue Layout



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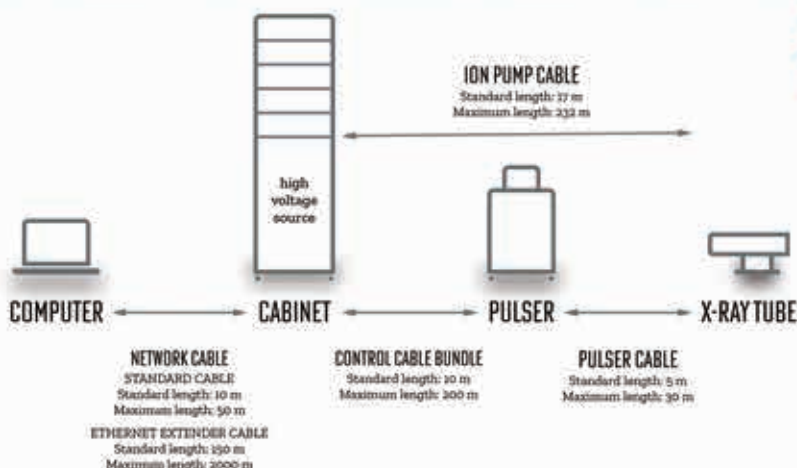
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人の目では見ることのできない、ミクロ領域で起こる事象の拡大観察ができる顕微鏡や、知覚できない波長の光を用いて映像での観察を可能にしたX線撮影装置や赤外線カメラの発明など、可視化技術により医学や工学は飛躍的に進歩を遂げてきました。わたしたちの目は20分の1秒より短い時間で起こる事象は捉えられません。このため、人の目では見えない瞬間に起こる事象を記録し、スロー再生によって可視化する高速度ビデオカメラが必要とされてきました。

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