Conference Schedule

Tuesday, April 12, 2016

Presentations are noted by corresponding paper number to the Abstracts listed on pages 18-39.

7:00 a.m. – 6:00 p.m.
Registration Desk Open
Grand A Foyer

7:00 a.m. – 8:00 a.m.
Continental Breakfast
Grand A Foyer

8:00 a.m. – 10:00 a.m.
Conference Grand Opening
Grand A

Welcome Remarks

Commercial Lunar Propellant – Opening a Gateway to the Solar System
Speaker: Tom Moser

Speaker details on page 6

Building an Energy Industry in Space for the Benefit of Humankind: The Off-World Consortium
Speaker: Jim Keravala

Speaker details on page 6

10:00 a.m. – 10:30 a.m.
Refreshment Break
Grand A Foyer

10:30 a.m. – 5:30 p.m.
Technical Sessions
See details on right

12:00 p.m. – 1:30 p.m.
Break for Lunch
Lunch on your own

3:00 p.m. – 3:30 p.m.
Refreshment Break
Grand A Foyer

3:30 p.m. – 9:30 p.m.
Dynamics and Controls Committee Meeting
Salon 7

6:00 p.m. – 8:00 p.m.
Conference Reception
3D-Printed Habitat Challenge Team Displays
Grand B Details on page 17

Symposium 1: Granular Materials in Space Exploration

Salon 13

Co-Chairs:
Juan Agui (NASA Glenn Research Center)
Phil Metzger (Univ. of Central Florida)

10:30 a.m. - 12:00 noon
Regolith Physical Properties I
Session Chair: Juan Agui (NASA Glenn Research Center)

1111 - Understanding Asteroid Regolith Properties Using Solar System Dust Bands

1112 - Tests on the Thermal Conductivity of Regolith Quasi-Analogues At Different Porosities

1113 - Detecting Loose Regolith in Lunar Craters Using Thermal Imaging

1:30 p.m. - 3:00 p.m.
Regolith Physical Properties II
Session Chair: Ashley Kehoe (Univ. of Central Florida)

1121 - Insights into Asteroid Surface Conditions from Spacecraft Observations, Meteorites, and Microgravity Experiments

1122 - Optical Extinction Measurements of Dust Density in the GMRO Regolith Test Bin

1123 - An Automated Tracking Method to Study Particle Motion in Microgravity

3:30 p.m. – 5:30 p.m.
Regolith Impacts and Gas Interactions
Session Chair: Jonathan Kollmer (North Carolina State Univ.)

1131 - Rocket Exhaust Blowing Soil in Near Vacuum Conditions is Faster than Predicted by Continuum Scaling Laws

1132 - Regolith Instability Caused by Gas Diffusion: A Case Study of the Asteroid Redirect Mission

1133 - A Combined Experimental and Numerical Approach to Understanding Impacts Involving Regolith on Planetary Surfaces

1134 - Low-Velocity Impacts Into Regolith Under Microgravity Conditions

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies

Salon 14

Co-Chairs:
Leslie Gertsch (Missouri Univ. of Science and Technology)
Kris Zacny (Honeybee Robotics)

10:30 a.m. - 12:00 noon
Drilling Techniques and Technologies I
Session Chair: Kris Zacny (Honeybee Robotics)

2111 - Push-and-Twist Drillstring Assemblies

2112 - Testing of Soft Regolith Dynamic Anchors for Celestial Exploration

2113 - Challenges in Auger-Based Sample Delivery for Planetary Missions: Contamination Paths, Mixing, And Dilution Of Drilled Samples

1:30 p.m. - 3:00 p.m.
Deep Planetary Drilling
Session Chair: Arwen Dave (NASA Ames Research Center)

2121 - Development of a Planetary Deep Drill

2122 - The Auto-Gopher - A Wireline Rotary-Percussive Deep Sampler

2123 - Testing of the Ultralight Mobile Drilling System (UMDS) for Deep Drilling and PACKMOON for Near Surface Sampling

3:30 p.m. – 5:30 p.m.
Prospecting on the Moon
Session Chair: Karol Seweryn (Space Research Centre)

2131 - Resource Prospector Instrumentation for Lunar Volatiles Prospecting, Sample Acquisition and Processing

2132 - Lunar Rover TRL-6 Drivetrain Development

2133 - Development and Testing of the Lunar Resource Prospector Drill (RPD)

2134 - Launch Lock Mechanism for a Resource Prospector Rover

Symposium 3: Advanced Materials and Designs

Salon 17

Co-Chairs:
Robert Goldberg ((NASA Glenn Research Center)
Pizhong Qiao (Washington State Univ.)

10:30 a.m. - 12:00 noon

Composites in Aerospace Applications I

Session Chair: Wieslaw Binienda (Univ. of Akron)

3111 - Izod Impact Testing of Carbon Nanotube-Reinforced Woven Composites Enabled by the PopTube Approachs

3112 - Buckling of Doubly Curved and Imperfect Composite Shells Subjected to External Pressure

3113 - Analysis and Characterization of Damage Utilizing an Orthotropic Generalized Composite Material Model Suitable for Use in Impact Problems

1:30 p.m. - 3:00 p.m.

Advanced Materials Applications I

Session Chair: Robert Goldberg (NASA Glenn Research Center)

3121 - Three-Phase Statistically Equivalent Periodic Unit Cells for Protein-Bound Soil

3122 - Carbon Fiber-Based Structural Electric Capacitors: Coupled Mechanical-Electrical Behavior and Effect of Interlaminar Damage

3123 - Sensing Temperature and Stress Distributions on Rock Samples Under Mechanical Loading

3:30 p.m. – 5:30 p.m.

Design of Dams in Extreme Environments I

Session Chair: Pizhong Qiao (Washington State Univ.)

3131 - Analysis and Study on the Cause of the Dam Abutment Crack of CFRD

3132 - Prediction of the Ultimate Aseismatic Capacity of Zhen'an Concrete Face Rock-fill Dam At a Gradient Valley

3133 - Stability Analysis of Underground Openings in Discontinuous Rock Masses Using Multibody Finite Element Method

3134 - Simulation for Construction of Mass Concrete on Soft Foundation with Consideration of Consolidation Behavior

Symposium 4: Structures in Challenging Environments

Salon 18

Co-Chairs:
Ramesh B. Malla (Univ. of Connecticut)
Gangbing Song (Univ. of Houston)

9:00 a.m. – 10:30 a.m.

Aerospace and Related Structures

Session Chair: Ramesh Malla (Univ. of Connecticut)

4111 - Launch Pad in a Box

4112 - Airplane Off-Ground Advisory System (OGAS)

4113 - Modeling and Control of Cold Gas Propulsion for Spacecraft Attitude Control

1:30 p.m. - 3:00 p.m.

Structural Health Monitoring I

Session Chair: Gangbing Song (Univ. of Houston)

4121 - Detection of Bond Slip Failure in a Concrete-Encased Composite Structure Using Shear Mode Based Piezoceramic Transducers

4122 - Damage Identification of Shear Buildings Using Natural Frequency-Change Square Ratio Vector Based on Improved Restoring Force Technology

4123 - Detection of the Secondary Pouring Interface in Concrete Structure Using Piezoceramic Based Smart Aggregates

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies

Salon 18

3:30 p.m. – 5:30 p.m.

3D Printing for Planetary Construction

Session Chair: James Mantovani (NASA Kennedy Space Center)

2135 - Towards Mobile 3D Printing for Planetary Construction

2136 - NASA Centennial Challenge: Three Dimensional (3D) Printed Habitat

2137 - Autonomous Additive Construction on Mars

2138 - Automated Additive Construction (AAC) for Earth and Space Using In-situ Resources

Conference Schedule

Wednesday, April 13, 2016

Presentations are noted by corresponding paper number to the Abstracts listed on pages 18-39

7:00 a.m. – 12:30 p.m.
Registration Desk Open
Grand A Foyer

7:00 a.m. – 8:00 a.m.
Continental Breakfast
Grand A Foyer

8:00 a.m. – 9:00 a.m.
Plenary Session
Grand A

Announcements

The Exploration of Pluto
Speaker: Alan Stern

Speaker details on page 7

9:00 a.m. – 12:00 p.m.
Technical Sessions
(See schedule at right)

10:00 a.m. – 10:30 a.m.
Refreshment Break
Grand A Foyer

12:30 p.m. – 8:30 p.m.
Kennedy Space Center
Optional Tour
(See information below)

Symposium 1: Granular Materials in Space Exploration
Salon 13

Co-Chairs:
Juan Agui (NASA Glenn Research Center)
Phil Metzger (Univ. Central Florida)

9:00 a.m. – 10:00 a.m.
Regolith Simulants
Session Chair: Andreas Becker (Technical Univ. Kaiserslautern)

1211 - **Results of the 2015 Workshop on Asteroid Simulants**

1212 - **Manufactured Porous Ambient Surface Simulants**

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies
Salon 13

10:30 a.m. – 12:00 p.m.
Space Robotics I
Session Chair: Jim Mantovani (NASA Kennedy Space Center)

2221 - **Effect of Angle of Attack on Slope Climbing Performance**

2222 - **Dust Tolerant Automated Umbilical (DTAU)**

2223 - **Concept for a Fully In-Situ Resource-Derived Habitat for Martian Environment**

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies
Salon 14

Co-Chairs:
Leslie Gertsch (Missouri Univ. of Science and Technology)
Kris Zacny (Honeybee Robotics)

9:00 a.m. – 10:00 a.m.
In Situ Resource Utilization (ISRU) - Volatiles I
Session Chair: Luther Beegle (Jet Propulsion Lab)

2211 - **Planetary Volatiles Extractor (PVEx) for In Situ Resource Utilization (ISRU)**

2212 - **Helium Implantation Into JSC-1A Lunar Regolith Simulant for Testing Volatile Extraction Technologies**

10:30 a.m. – 12:00 p.m.
In Situ Resource Utilization (ISRU) - Volatiles II
Session Chair: Paul van Susante (Michigan Technological Univ.)

2224 - **Some Strategic Considerations Related to the Potential Use of Water Resource Deposits on Mars by Future Human Explorers**

2225 - **Mars Atmospheric In Situ Resource Utilization Projects at the Kennedy Space Center**

2226 - **Analysis of Thermal/Water Propulsion for CubeSats That Refuel in Space**

NASA Kennedy Space Center Tour and Reception

Wednesday, April 13, 2016 | 12:30 p.m. - 8:30 p.m.

Spend an afternoon touring the Kennedy Space Center (KSC) Visitor Complex. The tour includes IMAX NASA space movies, a walk under the actual Space Shuttle orbiter *Atlantis*, and visits to all the indoor exhibits. At the evening buffet reception, we will have two presentations by NASA KSC management explaining the progress being made toward flying humans to Mars.

SPACE SHUTTLE ATLANTIS EXHIBIT — IMAX® THEATER — SHUTTLE LAUNCH EXPERIENCE® — EYES ON THE UNIVERSE

Symposium 3: Advanced Materials and Designs
Salon 17

Co-Chairs:
Robert Goldberg (NASA Glenn Research Center)
Pizhong Qiao (Washington State Univ.)

9:00 a.m. – 10:00 a.m.

Composites in Aerospace Application II
Session Chair: Robert Goldberg (NASA Glenn Research Center)

3212 - Axisymmetric Thermo-Mechanical Behavior of a Novel Functionally Graded Material Panel

10:30 a.m. – 12:00 p.m.

Composites in Aerospace Applications III
Session Chair: Pizhong Qiao (Washington State Univ.)

3221 - A Numerical Model to Study the Effect of Alumina Tri-Hydrate on Mechanical Properties of Fiber Reinforced Polymers

3222 - Strain Effect on the Performance of Solar Cells

3223 - The Effects of UV Aging on the Cracking of Titanium Oxide Layer on Poly (Ethylene Terephthalate) Substrate

Symposium 4: Structures in Challenging Environments
Salon 18

Co-Chairs:
Ramesh B. Malla (Univ. of Connecticut)
Gangbing Song (Univ. of Houston)

9:00 a.m. – 10:00 a.m.

Dynamics and Controls in Educational Technology
Session Chair: John Koppelman (Boeing Commercial Airlines)

4211 - Develop a Remote PID Motor Control Experiment for Engineering Technology Education - A Case Study

4212 - Develop a Collaborative and Cooperative Remote Experiment

10:30 a.m. – 12:00 p.m.

Structural Health Monitoring II
Session Chair: Baoxin Qi (Shenyang Jianzhu Univ.)

4221 - Structural Health Monitoring of Plate-Like Structures Using Compressive/Shear Modes of Piezoelectric Transducers

4222 - Design and Application of Structural Health Monitoring System for Dalian Gymnasium

4223 - Study of Dynamic and Static Response of an Old Truss Railroad Bridge

Reception Speakers

Karen Thompson
Center Chief Technologist
Kennedy Space Center
Research & Technology Development at NASA KSC

Tom Engler
Deputy Director, Center Planning and Development
Transforming Kennedy Space Center into a 21st Century Spaceport

— ROCKET GARDEN — JOURNEY TO MARS: EXPLORERS WANTED

Kennedy Space Center Tour Schedule
12:30 p.m. – 8:30 p.m.

12:30 p.m. - 1:00 p.m.
Load Buses & Depart from Rosen Centre Hotel

1:00 p.m. - 2:00 p.m
Travel to KSC

2:00 p.m - 6:00 p.m
Tour KSC Visitor Complex

6:00 p.m - 7:00 p.m
Buffet Reception

7:00 p.m - 7:30 p.m
Load Buses & Depart

7:30 p.m - 8:30 p.m
Return to Rosen Centre Hotel

Conference Schedule

Thursday, April 14, 2016

Presentations are noted by corresponding paper number to the Abstracts listed on pages 18-39.

7:00 a.m. – 6:30 p.m.
Registration Desk Open
Grand A Foyer

7:00 a.m. – 8:00 a.m.
Continental Breakfast
Grand A Foyer

8:00 a.m. – 9:00 a.m.
Plenary Session
Grand A

Announcements

Drilling on the Martian Surface with the Mars Science Laboratory
Speaker: Luther Beegle

Speaker details on page 7

9:00 a.m. – 5:30 p.m.
Technical Sessions
See details on right

10:00 a.m. - 10:30 a.m.
Refreshment Break
Grand A Foyer

12:00 p.m. – 1:30 p.m.
Awards Luncheon
Grand B

3:00 p.m. – 3:30 p.m.
Refreshment Break
Grand A Foyer

5:30 p.m. – 11:30 p.m.
Regolith Operations, Mobility and Robotics Committee Meeting
Salon 17

Advanced Materials and Structures Committee Meeting
Salon 18

Symposium 1: Granular Materials in Space Exploration

Salon 13

Co-Chairs:
Juan Agui (NASA Glenn Research Center)
Phil Metzger (Univ. of Central Florida)

9:00 a.m. – 10:00 a.m.
Regolith Modeling I and Characterization
Session Chair: Phillip Metzger (Univ. of Central Florida)

1311 - **Simulating the Surface Morphology of a Carbonaceous Chondrite Asteroid**

1312 - **Axial-Torsional Interface Shear Studies Using GRC-3 Lunar Simulant and Textured Penetrometer Sleeves**

10:30 a.m. – 12:00 p.m.
Regolith Modeling
Session Chair: Elizabeth Carey (JPL, California Institute of Technology)

1321 - **Particle Flow Physics Modeling for Extreme Environments**

1322 - **Soil Modeling for InSight's HP³-Mole: From Highly Accurate Particle-Based Towards Fast Empirical Models**

1323 - **Modelling the Flow Behavior of Granular Media Through the Dosing Station of a Spacecraft Under Low Gravitational Environments**

1:30 p.m. – 3:00 p.m.
Mechanism-Regolith Interactions I
Session Chair: Jason Schuler (NASA Kennedy Space Center)

1331 - **Design of an Excavation Robot: Regolith Advanced Surface Systems Operations Robot (RASSOR) 2.0**

1332 - **Ultrasonic Penetration of Granular Materials in Varying Gravity**

1333 - **Characterization of Cohesive Mars Analog Soils Before and After Drilling**

3:30 p.m. – 5:30 p.m.
Mechanisms - Regolith Interactions II
Session Chair: Joseph Antony (Univ. of Leeds)

1341 - **Digging on Asteroids: a Laboratory Model of Granular Dynamics in Microgravity**

1342 - **Low Force Penetration of Icy Regolith**

1343 - **Modeling Dynamics of Counter-Rotating Bucket Drum Excavation for In-Situ Resource Utilization (ISRU) in Low-Gravity Environments**

1344 - **Filter Media Tests Under Simulated Martian Atmospheric Conditions**

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies

Salon 14

Co-Chairs:
Leslie Gertsch (Missouri Univ. of Science and Technology)
Kris Zacny (Honeybee Robotics)

9:00 a.m. – 10:00 a.m.
Drilling Techniques and Technologies II
Session Chair: Yosi Bar Cohen (Jet Propulsion Lab)

2313 - **Icebreaker-3 Drill Integration and Testing at Two Mars-Analog Sites**

2314 - **Autonomous Structural Health Monitoring Techniques for the Icebreaker Drill**

10:30 a.m. – 12:00 p.m.
Electro-Mining and Regolith Transfer
Session Chair: Arwen Dave (NASA Ames Research Center)

2321- **An Electromagnetic Asteroid Regolith Excavator - Preliminary Results**

2322 - **Martian Atmospheric Dust Mitigation for ISRU Intakes Via Electrostatic Precipitation**

2323 - **Electrodynamic Dust Shield for Space Applications**

1:30 p.m. – 3:00 p.m.
Surface Construction with Regolith
Session Chair: Leslie Gertsch (Missouri Univ. of Science and Technology)

2331 - **An Introduction to AIT Requirements for Lunar Systems and Structures**

2332 - **ATHLETE as a Mobile ISRU and Regolith Construction Platform**

2333 - **A Carbonaceous Chondrite Based Simulant of Phobos**

3:30 p.m. – 5:30 p.m.
Asteroids and Planetary In Situ Resource Utilization
Session Chair: Chris Dreyer (Colorado School of Mines)

2341 - **Regolith Extraction, Storage and Transfer Under Micro-Gravity**

2342 - **Free-Flying Robotic System for Interplanetary Prospecting and In Situ Resource Utilization**

2343 - **Addressing Exploration and ISRU Safety Challenges for Volatile Rich Asteroids**

2344 - **LIRA LIBS for Stand-off Planetary and Asteroid Resource Prospecting**

Symposium 3: Advanced Materials and Designs

Salon 17

Co-Chairs:
Robert Goldberg (NASA Glenn Research Center)
Pizhong Qiao (Washington State Univ.)

9:00 a.m. – 10:00 a.m.

Composites in Aerospace Applications IV

Session Chair: Chao Zhang (National Renewable Energy Lab)

3311 - Buckling and Post-Buckling Analysis of Restrained Composite Laminated Plates

3312 - Lamb Wave-Based Delamination Detection of Laminated Composite Plates by a Network of Hexagonal Sensor Arrays

10:30 a.m. – 12:00 p.m.

Advanced Materials Applications II

Session Chair: Pizhong Qiao (Washington State Univ.)

3321 - Permeability of Sulfur Based Lunar Concrete

3322 - Visual Simulation Approach on Rheology of Ordinary Concrete

3323 - Properties of Manufactured Sand Mortar Based on Compressible Packing Model

1:30 p.m. – 3:00 p.m.

Design of Dams in Extreme Environments II

Session Chair: Robert Goldberg (NASA Glenn Research Center)

3331 - Effect Mechanism of Cyclic Wave Loading on Geotube Dam with Seams

3332 - Engineering Properties of Polyurethane Bonded Aggregates Used as Cushion of Geomembrane Surface Barriers for High Rock-Fill Dam

3333 - 3D Geospatial Function Monitoring Model of Arc Dam Deformation Based on the Improvement of Temperature Component

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies

Salon 17

3:30 p.m. – 5:30 p.m.

Launch Pad Construction and Infrastructure

Session Chair: Laurent Sibille (ESC-EASI)

2345 - Basalt Materials and Technologies for Vertical Take Off, Vertical Landing (VTVL) Rocket Pads

2346 - Design, Test and Simulation of Lunar and Mars Landing Pad Soil Stabilization Built with In-Situ Rock Utilization

2347 - Planetary Basalt Field Project: Construction of a Lunar Launch/Landing Pad, PISCES and NASA Kennedy Space Center Project Update

2348 - The Role of Space Settlement Research in Development of Environmentally Sustainable Technology

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies

Salon 18

9:00 a.m. – 10:00 a.m.

Optical Mining of Asteroids

Session Chair: Laurent Sibille (ESC-EASI)

2315 - Optical Mining Subscale Testing

2316 - A Coordinated Research Program to Develop the Technology to Optical Mine Asteroids

Symposium 4: Structures in Challenging Environments

Salon 18

Co-Chairs:
Ramesh B. Malla (Univ. of Connecticut)
Gangbing Song (Univ. of Houston)

10:30 a.m. – 12:00 p.m.

Structural Health Monitoring III

Session Chair: Landolf Rhode-Barbarigos (Univ. of Miami)

4321 - Water Filled Crack Detection for Concrete Structures Using PZT Wave-Based Method

4322 - Spray Deposition Modeling of Carbon Nano-Inks for Structural Health Monitoring

4323 - Stress Wave Propagation Simulation for the Interface Debonding Detection of Concrete-Filled Steel Tubular with Spectral Element Method

1:30 p.m. – 3:00 p.m.

Structural Diagnosis and Control

Session Chair: Qian Feng (China Earthquake Admin.)

4331 - Concrete Mechanical Performance Detection Using NDT Technology

4332 - Fuzzy Control of Semi-Active Base-Isolated Structure Against Chi-Chi Earthquake

4333 - An Active Deployable Tensegrity-Ring Footbridge System

3:30 p.m. – 5:30 p.m.

Modeling and Analysis of Structures Under Extreme Loading

Session Chairs: Liang Ren (Dalian Univ. of Technology); Shi Yan (Shenyang Jianzhu Univ.)

4342 - Application of the Pounding Tuned Mass Damper to a Submerged Jumper Experiencing Horizontal and Vertical Vibrations

4343 - Effects of Fluid-Structure Interaction on Dynamic Response of High-Rise Intake Towers

4344 - Analysis of Anti-Blast Performance of Lightweight Steel Columns Subjected to Elevated Temperatures

Conference Schedule

Friday, April 15, 2016

Presentations are noted by corresponding paper number to the Abstracts listed on pages 18-39.

7:00 a.m. – 12:00 p.m.
Registration Desk Open
Grand A Foyer

7:00 a.m. – 8:00 a.m.
Continental Breakfast
Grand A Foyer

8:00 a.m. – 9:00 a.m.
Plenary Session
Grand A

Announcement

An Engineer-Astronaut Perspective on Planetary Exploration: Past, Present and Future
Speaker: Bonnie Dunbar

Speaker details on page 8

9:00 a.m. – 10:00 a.m.
Technical Sessions
See details on right

10:00 a.m. - 10:30 a.m.
Refreshment Break
Grand A Foyer

10:30 a.m. – 11:30 a.m.
Conference General Session
Grand A

Conference Closing Remarks
Robert P. Mueller, 2016 Conference Chair

2018 ASCE Earth and Space Conference Announcement
Robert Goldberg, 2018 Conference Chair

11:30 a.m.
Conference Adjourns

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies
Salon 13

9:00 a.m. – 10:00 a.m.
Space Robotics II
Session Chair: Paul Mackey (NASA Kennedy Space Center)

2411 - **The Ant and the Trap: Evolution of Ant-Inspired Obstacle Avoidance in a Multi-Agent Robotic System**

2412 - **Evolving Autonomous Charging Behavior in a Robot Swarm**

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies
Salon 14

9:00 a.m. – 10:00 a.m.
Space Technology and Manufacturing
Session Chair: Paul van Susante (Michigan Tech Univ.)

2413 - **Extraterrestrial Regolith Derived Atmospheric Entry Heat Shields**

2414 - **How to Build a Self-Replicating Machine on the Moon**

Symposium 3: Advanced Materials and Designs
Salon 17

9:00 a.m. – 10:00 a.m.
Design of Hydroelectric Structures in Extreme Environments
Session Chair: Pizhong Qiao (Washington State Univ.)

3411 - **Diagnosis of Abnormal Structural Vibration for Xiaoshunjiang Pumping Station**

3412 - **Stability Analysis of Rock Slope with Cracks Based on XFEM**

Symposium 2: Exploration and Utilization of Extra-Terrestrial Bodies
Salon 18

9:00 a.m. – 10:00 a.m.
Drilling Techniques and Technologies III
Session Chair: Dean Bergman (NASA Ames Research Center)

2415 - **Plasma Drill for Mars Exploration**

2416 - **Impact and Dynamic Analysis of an Ultrasonic Percussive Drill for Aerospace Applications**