

HI-AM ^{2nd} | 2019 Conference

HOLISTIC INNOVATION IN
ADDITIVE MANUFACTURING

PROGRAM SCHEDULE

JUNE 26 & 27
VANCOUVER, BC, CANADA

conference.nserc-hi-am.ca



Keynote Speakers at HI-AM 2019:



Prof. David Bourell
University of Texas
at Austin, TX



Prof. Milan Brandt
RMIT, Australia



Dr. Ali Bonakdar
Siemens Canada



Prof. Christoph Leyens
Fraunhofer
IWS, Germany



Dr. Hannes Gostner
EOS, Germany

HI-AM CONFERENCE 2019 PROGRAM SCHEDULE

DAY 1 – June 26, 2019

MORNING

8:00-8:30am	BREAKFAST	
8:30-8:40am	CONFERENCE OPENING James Olson, <i>Dean of the UBC Faculty of Applied Science</i> Ehsan Toyserkani, <i>HI-AM Director</i>	
8:40-9:20am	KEYNOTE: Metals for Additive Manufacturing David Bourell <i>Temple Foundation Professor, Director of Laboratory for Freeform Fabrication, The University of Texas at Austin</i>	
9:20-9:40am	SESSION 1: ADVANCES IN ADDITIVE MANUFACTURING I	Business Case for Additive Manufacturing in Serial Production Alexander Boehm <i>KSB, Germany</i>
9:40-10:00am		Low Cost, Medium-Speed Stereovision for Spatter Tracking in Powder Bed Fusion Eric MacDonald <i>Youngstown State University, United States</i>
10:00-10:20am		Efficient Parameter Development Strategy of Tool Steel Materials for Laser Additive Manufacturing Gregor Graf*, Manuela Leoni**, Tobias Muller, Jorg Fischer-Buhner, Daniel Beckers*, Sven Donisi*, Frederik Zanger**, Volker Schulze** <i>*Rosswag GmbH, Germany **Karlsruhe Institute of Technology, Germany</i>
10:20-10:40am	MORNING TEA AND POSTER VIEWING	
10:40-11:20am	KEYNOTE: Innovative Aerospace and Space Structures Made by Additive Manufacturing Christoph Leyens <i>Managing Director, Fraunhofer Institute of Materials and Beam Technology, Germany</i>	
11:20-11:40am	SESSION 2: ADVANCES IN ADDITIVE MANUFACTURING II	Optimisation of Process Parameters for In-situ Alloyed Titanium by Selective Laser Melting Igor Yadroitsev*, Ina Yadroitsev*, Pavel Krakhmalev**, Anton du Plessis†, Eric Newby*, Dean Kouprianoff* <i>*Central University of Technology, South Africa **Karlstun University, Sweden †Stellenbosch University, South Africa</i>
11:40am-12:00 pm		Novel Repair Strategy Using Additive Manufacturing to Address Severe Foreign Object Damage on Ti Alloy Fan Blades Priti Wanjara*, Javad Gholipour*, Kosuke Watanabe**, Koji Nezaki** <i>*National Research Council of Canada-Montreal **IHI Corporation, Japan</i>
12:00-12:20pm		Development of Metal Slurry Three-Dimensional Printing System Based on Maskless Projection Method Cho-Pei Jiang*, Shinn-Liang Chang** <i>*National Taipei University of Technology, Taiwan **National Formosa University, Taiwan</i>



12:20-1:00pm	LUNCH	
1:00-2:00pm	POSTER VIEWING	
2:00-2:40pm	KEYNOTE: Title TBA Hannes Gostner <i>Director Research and Development, EOS, Germany</i>	
2:40-3:00pm	SESSION 3: MATERIAL DEVELOPMENT	Effect of Powder Attributes on Microstructure and Mechanical Properties of 3D-printed Al10SiMg Alloy Using Laser Powder Bed Fusion Technique Vahid Fallah, Qingshan Dong, Mark Gallermeault <i>Queen's University, Canada</i>
3:00-3:20pm		Development of Modified A8 and S7 Tool Steel Powders for Additive Manufacturing by LPB-AM Denis Mutel, Carl Blais <i>Universite Laval, Canada</i>
3:20-3:40pm		Studying the Impact of Particle Morphology on Powder Spreading and Laser Powder Bed Fusion Characteristics to Maximize the Process Productivity Salah Eddin Brika*, Morgan Letenneurm*, Christopher Alex Dion**, Vladimir Brailovski* <i>*ETS Montreal, Canada **PyroGenesis Additive, Canada</i>
3:40-4:00pm		Selective Electron Beam Melting of Al-Cu-Mg Alloy: Processability and Characterization Mohammad Saleh Kenevisi, Feng Lin <i>Tsinghua University, China</i>
4:00-4:20pm		AFTERNOON TEA AND POSTER VIEWING
4:20-4:40pm	SESSION 5: PROCESS MONITORING AND CONTROL	In-line Melt Pool Monitoring of Laser Powder-bed Fusion Katayoon Taherkhani*, Zheng Ma*, Esmat Sheydaeian*, Ali Ghodsi*, Martin Otto**, Christopher Eischer**, Ehsan Toyserkani* <i>*University of Waterloo, Canada **EOS, Germany</i>
4:40-5:00pm		Modelling and Identification of Electron Beam Deflection System Scott Parks, Zekai Murat Kilic, Yusuf Altintas <i>The University of British Columbia, Canada</i>
5:00-5:20pm		Cost Effective Real-Time Thermal Dynamics Modeling in Laser Materials Processing Lucas Botelho, Amir Khajepour <i>University of Waterloo, Canada</i>
5:20-5:40pm		In-situ Sensing and Measurement for Quality Control in Metal Additive Manufacturing: Review and Future Directions Thomas Lehmann*, Tonya Wolfe**, Hani Henein*, Ahmed Qureshi* <i>*University of Alberta, Canada **InnoTech Alberta, Canada</i>
5:40-6:40pm	POSTER VIEWING	
5:40-6:40pm	SCIENTIFIC ADVISORY COMMITTEE MEETING	
6:40-9:00pm	CONFERENCE DINNER	
2:40-3:00pm	SESSION 4: ADVANCED PROCESS MODELING	Thermo-Mechanical Numerical Modelling of Selective Laser Melting for Prediction of Residual Stress Jean-Sebastien Cagnone, Jean-Philippe Marcotte, Marjan Molavi-Zarandi, Florin Ilinca, Kabanemi Kalonji Kabaa <i>National Research Council of Canada-Boucherville</i>
3:00-3:20pm		Topology Optimization of Support Structures for Laser Powder-bed Fusion Based on the Inherent Strain Method Zhidong Zhang*, Osezua Ibhadode*, Pouyan Rahnama*, Ali Bonakdar**, Ehsan Toyserkani* <i>*University of Waterloo, Canada **Siemens, Canada</i>
3:20-3:40pm		A Fast and Part-level Numerical Simulation of Temperature Field in Selective Laser Melting Process Zhibo Luo, Fiona Zhao <i>McGill University, Canada</i>
3:40-4:00pm		Fast-to-run Predictive Model for Thermal Fields During Additive Manufacturing Meet Upadhyay, Daan Maijer, Steve Cockcroft <i>The University of British Columbia, Canada</i>
4:20-4:40pm	SESSION 6: NOVEL AM PROCESSES AND PRODUCTS	Machine Learning Aided Optimization of Conformal Cooling Channel Zhenyang Gao, Fiona Zhao <i>McGill University, Canada</i>
4:40-5:00pm		Mechanical and Functional Performance of Porous Bone Replacement Implants Asma El Elmi*, David Melancon**, Meisam Asgari*, Liu Lu*, Damiano Pasini* <i>*McGill University, Canada **Harvard University, United States</i>
5:00-5:20pm		A Fast and Part-level Numerical Simulation of Temperature Field in Selective Laser Melting Process Zhibo Luo, Fiona Zhao <i>McGill University, Canada</i>
5:20-5:40pm		Surface Finishing of Titanium and Nickel-based Laser Powder Bed-fused Components: Abrasive Flow Machining Versus Electrochemical Polishing Neda Mohammadian*, Victor Urlea*, Clement Bouland*, Sylvain Turenne**, Vladimir Brailovski* <i>*ETS Montreal, Canada **Ecole Polytechnique de Montreal, Canada</i>



8:00-8:30am		BREAKFAST	
8:30-9:10am		KEYNOTE: Additive Manufacturing Landscape in Australia Milan Brandt <i>Director Centre for Additive Manufacturing, Advanced Manufacturing Precinct, RMIT University, Australia</i>	
9:10-9:30am	SESSION 7: MATERIAL DEVELOPMENT	Fabrication of Rene 41 Parts with Laser Powder Bed Fusion Sila Atabay*, Kevin Plucknett**, Mathieu Brochu* <i>*McGill University, Canada **Dalhousie University, Canada</i>	SESSION 8: ADVANCED PROCESS MODELING, MONITORING AND CONTROL
9:30-9:50am		Particle Decoration: A Method for Developing New Material for Additive Manufacturing Ehsan Marzbanrad, Ehsan Toyserkani <i>University of Waterloo, Canada</i>	
9:50-10:10am		Electrostatic Atomisation of Metals Bilal Bharadia, Aziz Bogno, Hani Henein <i>University of Alberta, Canada</i>	
10:10-10:30am		Implementation of the Kitagawa-Takahashi Approach for Prediction of Fatigue Limit of Inconel 625 Components Containing Intentionally-seeded Defects Jean-Rene Poulin, Patrick Terriault, Vladimir Brailovski <i>ETS Montreal, Canada</i>	
10:30-10:50am		MORNING TEA AND POSTER VIEWING	
10:50-11:10am	SESSION 9: ADVANCED PROCESS MODELING	Microscale Interaction Between the Laser and Metal Powder in Powder-bed Additive Manufacturing: Conduction Mode Versus Keyhole Mode Hongze Wang, Yu Zou <i>University of Toronto, Canada</i>	SESSION 10: NOVEL AM PROCESSES AND PRODUCTS
11:10-11:30am		A Predictive System for Manufacturability Analysis of Laser Powder Bed Fusion Process Ying Zhang, Fiona Zhao <i>McGill University, Canada</i>	
11:30-11:50am		Thermal Fluid Modeling for Melt Pool Generation of Ti6Al4V Powder Bed In The Electron Beam Additive Manufacturing Eiko Nishimura, Steve Cockcroft, Daan Maijer, Farzaneh Farhang-Mehr <i>The University of British Columbia, Canada</i>	
11:50am-12:10pm		Normative Benchmark Design and Preliminary Geometric Quality Results for Selective Laser Melting Process Baltej Singh, Marc Secanell, Ahmed Qureshi <i>University of Alberta, Canada</i>	
12:10-12:30pm		Numerical Analysis of Melt Pool Geometry in Laser Powder-bed Fusion of Hastelloy X Shahriar Imani*, Adhitan Rani Kasinathan*, Zhidong Zhang*, Yahya Mahmoodkhani*, Usman Ali*, Ali Keshavarzkermani*, Ehsan Toyserkani*, Ali Bonakdar** <i>*University of Waterloo, Canada **Siemens, Canada</i>	
10:50-11:10am		Investigating Residual Stress Characteristics for Selected Direct Energy Deposition Process Settings: P420 Steel Single Bead Deposition on Mild Steel Jill Urbanic*, Navid Nazemi** <i>*University of Windsor, Canada **AMG Metal Inc., Canada</i>	
11:10-11:30am		Evaluation of Additive Manufacturing for Repair and Remanufacturing Purposes Fatih Sikan*, Priti Wanjara**, Javad Gholipour**, Mathieu Brochu* <i>*McGill University, Canada **National Research Council of Canada-Montreal</i>	
11:30-11:50am		Laser Powder Bed Fusion of AISi10Mg for Fabrication of an Aluminum Transmission Pump Housing Lisa Brock, Hamed Asgari, Mihaela Vlasea <i>University of Waterloo, Canada</i>	
11:50am-12:10pm		Direct Laser Deposition of Ti-5Al-5V-5Mo-3Cr Alloy Xinjin Cao*, Alexander Bois-Brochu**, Javad Gholipour* <i>*National Research Council of Canada **Centre de metallurgie du Quebec, Canada</i>	
12:10-12:30pm		E-beam Re-melting of Ti-6Al-4V EBM Parts for Enhanced Corrosion Resistance Mohammadali Shahsavari, Andaman Setavoraphan, William Sparling, Ralph Edinger, Rebecca Schaller <i>The University of British Columbia, Canada</i>	



12:30-1:10pm	LUNCH	
1:00-2:00pm	POSTER VIEWING	
1:10-1:50pm	KEYNOTE: Title TBA Ali Bonakdar <i>Advanced Manufacturing Technology Lead, Siemens, Canada</i>	
1:50-2:10pm	Characterization of a New Hybrid Aluminum Composite Powder for Additive Manufacturing A.O.A. Ibadode*, Raphael Ebhojiaye** <i>*Federal University of Petroleum Resources Effurun, Nigeria *University of Benin, Nigeria</i>	Tool Path Related Process Planning Challenges for Direct Energy Deposition Systems Bob Hedrick*, Jill Urbanic** <i>*CAMufacturing Solutions Inc., Canada **University of Windsor, Canada</i>
2:10-2:30pm	Graphene Nanocellulose Composites for 3D Printed Electrodes Taylor Morrison, Hani Naguib <i>University of Toronto, Canada</i>	Selective Laser Melting of Graphene-reinforced Aluminum Matrix Composites for Electrical Batteries Mostafa Yakout, M. A. Elbestawi <i>McMaster University, Canada</i>
2:30-2:50pm	Application of Fast Cooling Calorimetry in AM An Fu*, Pierre Hudon*, Paul Bishop**, Mathieu Brochu* <i>*McGill University, Canada **Dalhousie University, Canada</i>	Influence of Operating Parameters During Plasma Transferred Arc Additive Manufacturing on Carbide Concentration of 70wt% Ni-WC Metal Matrix Composite Components Dylan Rose*, Tonya Wolfe**, Hani Henein*, Leijun Li* <i>*University of Alberta, Canada **InnoTech Alberta, Canada</i>
2:50-3:10pm	AFTERNOON TEA AND POSTER VIEWING	
3:10-3:30pm	Selective Laser Melting of Copper, Aluminum, and Copper-Aluminum Alloy Hao Kun Sun, Yu Zou, Gisele Azimi <i>University of Toronto, Canada</i>	Integration of Physically-based Analytical Model and Statistically-driven Empirical Model for Multi-objective Optimization of Laser Powder-bed Fusion Yuze Huang, Hamed Asgari, Mohammad Ansari, Behrad Khamesee, Ehsan Toyserkani <i>University of Waterloo, Canada</i>
3:30-3:50pm	Laser Powder Bed Processing of Aluminum Powders Containing Iron and Nickel Additions Greg Sweet*, Jon Hierlihy*, Ian Donaldson**, Mathieu Brochu†, Paul Bishop* <i>*Dalhousie University, Canada **GKN, Canada †McGill University, Canada</i>	Progress in Applying Fused Filament Fabrication to Metal Matrix Composites (MMC) Nancy Bhardwaj*, Hani Henein*, Tonya Wolfe** <i>*University of Alberta, Canada **InnoTech Alberta, Canada</i>
3:50-4:00pm	CLOSING REMARKS AND AWARDS Andrew Szeri, <i>UBC VP Academic and Provost</i>	
4:00-5:00pm	BOARD OF DIRECTORS MEETING	

SESSION 11: MATERIAL DEVELOPMENT

SESSION 12: ADVANCED PROCESS MODELING AND NOVEL AM PROCESSES

Poster Presentation Gallery



THEME 1 - MATERIAL DEVELOPMENT

Innovative Surface Finishing Methods for Reducing Internal and External Surface Roughness of Metal Additive Manufacturing Parts

Haniyeh Fayazfar, Mihaela Vlasea, Ehsan Toyserkani
University of Waterloo, Canada

The Contribution of Moisture from Cellulosic Filters in LPBF AM

Aniruddha Das, Mathieu Brochu
McGill University, Canada

Laser DED Cladding of H13 Tool Steel and Elemental Equivalents

Owen Craig, Kevin Plucknett
Dalhousie University, Canada

A Novel Binder Jetting Process to Fabricate Functionally Graded Nanocomposites for Hygroscopic Sensing and Actuation

Xuechen Shen, Hani Naguib
University of Toronto, Canada

Mechanical Properties of Additively Manufactured Tessellated Metamaterial Design Configurations

Anastasia Wickeler, Hani Naguib
University of Toronto, Canada

Improving Surface Finish of Low-cost Irregular Powders in Laser Powder-bed Fusion

Seung Ho Jeong, Allan Rogalsky, Adrian Gerlich, Mary Wells
University of Waterloo, Canada

Reactive Sintering for Post-processing of Binder-jet Additive Manufactured Metal Matrix Composites

Pablo Enrique, Norman Zhou, Ehsan Toyserkani
University of Waterloo, Canada

Characterization of Commercial Mo Powders and Their Laser Powder Bed Fusion Additive Manufacturing Behavior

Tejas Ramakrishnan, Eileen Ross Espiritu, Mathieu Brochu
McGill University, Canada

Elevated-temperature Tensile and Creep Properties of Laser Powder Bed-fused IN625 Components

Alena Kreitsberg*, Karine Inaekyan*, Sylvain Turenne**, Vladimir Brailovski*
*ETS Montreal, Canada | **Ecole Polytechnique de Montreal, Canada

Rapid Solidification of Al-Cu Eutectic

Daniela Diaz, Abdoul-Aziz Bogno, Jonas Valloton, Hani Henein
University of Alberta, Canada

Effect of Rapid Solidification on Microstructure and Properties of Al-Si alloys

Daniela Diaz, Hani Henein, Abdoul-Aziz Bogno
University of Alberta, Canada

Processing of Ti-64 by Laser Powder Fed Additive Manufacturing

Nick Gosse*, Ian Donaldson**, Kevin Plucknett*, Paul Bishop*
*Dalhousie University, Canada | **GKN, Canada

Binder Jet Printing of Low Cost Tool Steel Powders

Ryen Ley*, Ian Donaldson**, Paul Bishop*
*Dalhousie University, Canada | **GKN, Canada

Rapid Solidification of Al-Si-Sc Alloy

Akankshya Sahoo*, Abdoul-Aziz Bogno*, William Hearn**, Hani Henein*
*University of Alberta, Canada | **Chalmers University of Technology, Sweden

Correlating the Columnar Grain Structure with the Anisotropic Mechanical Response of Hastelloy X Produced by Laser Powder-bed Fusion

Ali Keshavarzkermani, Reza Esmaeilzadeh, Shahriar Imani, Hamid Jahed Motlagh, Norman Zhou, Ehsan Toyserkani
University of Waterloo, Canada

THEME 2 - ADVANCED PROCESS MODELING

Evaluation of Residual Stresses Induced in Laser Powder-bed Fusion Additive Manufacturing Process: Finite Element Simulation and Experimental Investigation

Marjan Molavi-Zarandi*, Ali Bonakdar**, Ramin Sedaghati†
*National Research Council of Canada-Boucherville
**Siemens, Canada | †Concordia University

Control of Density and Microstructure in Laser Powder Bed-fused Components Using a Combination of Melt Pool Modeling and Design of Experiment Approaches

Morgan Letenneur, Alena Kreitsberg, Vladimir Brailovski
ETS Montreal, Canada

Adaptive Trajectory Planning for Direct Energy Deposition Using Tri-Dexel Model

Farzaneh Kaji†, Vadim Kozhevnikov†, Ehsan Toyserkani*
*University of Waterloo, Canada | †Promation, Canada

Mechanics of Additively Built Porous Biomaterials

Ahmed Moussa*, Asma El Elmi*, David Melancon**, Damiano Pasini*
*McGill University, Canada | **Harvard University, United States

Topology Optimization of Structures Under Design-dependent Pressure Loads

Pouyan Rahnama, Osezua Ibadode, Zhidong Zhang, Ehsan Toyserkani
University of Waterloo, Canada

Design for Additive Manufacturing: Topology Optimization of a Mechanical Assembly

Osezua Ibadode, Pouyan Rahnama, Ehsan Toyserkani
University of Waterloo, Canada

Study on Fracture Mechanism of Ti-6Al-4V EBM Manufactured Under Different Loading Conditions Through a Hybrid Experimental-numerical Approach

Mohammad Shaterzadeh, Marcilio Alves
University of Sao Paulo, Brazil

Numerical Model of Al-33wt%Cu Eutectic Growth During Impulse Atomization

Jonas Valloton, Aziz Bogno, Hani Henein
University of Alberta, Canada

Residual Stress and Distortion in Electron Beam Additive Manufacturing of Ti-6Al-4V Build Plates

Pegah Pourabdollah, Farzaneh Farhang-Mehr, Steve Cockcroft, Daan Maijer
The University of British Columbia, Canada

Meso-scale Thermal, Elastic and Plastic Strain Evolution in PB-EBAM

Asmita Chakraborty, Farzaneh Farhang-Mehr, Daan Maijer, Steve Cockcroft
The University of British Columbia, Canada

Residual Deformation and Stress Measurement

Farhad Rahimi, Farzaneh Farhang-Mehr, Daan Maijer, Steve Cockcroft
The University of British Columbia, Canada

Beam/Powder/Melt Pool Interaction; Experimental Validation

Arman Khobzi, Farzaneh Farhang-Mehr, Daan Maijer, Steve Cockcroft
The University of British Columbia, Canada

Poster Presentation Gallery



THEME 3 - PROCESS MONITORING AND CONTROL

Literature Survey of Laser Ultrasound Imaging Techniques Applicable to Defect Detection in Metal Additive Manufactured Parts

Alexander Martinez-Marchese, Ehsan Toyserkani
University of Waterloo, Canada

Assessment of Hydrogen Uptake and Capacity in SLM Austenitic Stainless Steel

Amin Imani, Rebecca Schaller
The University of British Columbia, Canada

Leveraging Keyhole Mode Melting Models in Laser Powder Bed Fusion

Sagar Patel, Mihaela Vlasea
University of Waterloo, Canada

Detection of Internal Defects and Surface Cracks in Additively Manufactured Conductive Parts by Eddy Current Technique

Heba Farag, Behrad Khamesee, Ehsan Toyserkani
University of Waterloo, Canada

Modelling of Powder Spreading to Optimize Compaction Consistency

Alexander Groen, Mihaela Vlasea, Kaan Erkorkmaz
University of Waterloo, Canada

Anisotropic Finite Element Modeling of an Aluminum Alloy Made by Additive Manufacturing

Henrique Ramos*, Rafael Santiago*, Marcilio Alves**, Peter Theobald†, Shwe Soe†
*Federal University of ABC, Brazil | **University of Sao Paulo, Brazil
†University of Cardiff, UK

Investigation of Binder Deposition and Infiltration Strategies for Binder Jetting

Marc Wang, Ken Nsiempba, Mihaela Vlasea
University of Waterloo, Canada

THEME 4 - NOVEL AM PROCESSES AND PRODUCTS

Design, Manufacture and Testing of Porous Materials with Ordered and Random Porosity: Application to Porous Medium Burners

Mykhailo Samoilenko, Patrice Seers, Patrick Terriault, Vladimir Brailovski
ETS Montreal, Canada

Patient-specific Endoprostheses for Limb Sparing in Dogs: Design, Manufacturing, in Vitro Study and Clinical Trial

Anatolie Timercan*, Bernard Seguin**, Yan Petit*, Bertrand Lussier†, Vladimir Brailovski*
*ETS Montreal, Canada | **Colorado State University, Colorado
†Universite de Montreal

Novel Strut Based Homogenization Method to Predict 3D Printed Lattice Structure Accuracy

Ken Nsiempba, Ehsan Toyserkani
University of Waterloo, Canada

Magnetic Levitation and Suspension Systems for Additive Manufacturing Techniques

Parichit Kumar, Behrad Khamesee, Ehsan Toyserkani
University of Waterloo, Canada

Laser Directed Energy Deposition of Metastable Beta Titanium Alloy: Influence of Process Parameters on Geometry of Single-Tracks

Mohammad Ansari, Ehsan Toyserkani
University of Waterloo, Canada

Processing Conditions of 17-4 PH using Plasma Transfer Arc Additive Manufacturing

Sandy El Moghazi*, Hani Hanein*, Tonya Wolfe**, Leijun Li*
*University of Alberta, Canada | **InnoTech Alberta, Canada

Nanoindentation Studies of Dual-phase Ti-6Al-2Zr-1Mo-1V Alloys Made by Additive Manufacturing

Zhiying Liu, Yu Zou
University of Toronto, Canada

Dip Coating of Tool Steel H13 with TiC-Ni3Al Cermet Suspensions, and Their Subsequent Laser Cladding

Zhila Russell, Kevin Plucknett
Dalhousie University, Canada

Print Pattern Impact on the Material Properties of Metal Big Area Additively Manufactured Multi-layered Steels

E. Tenuta*, A. Nycz**, M. Noakes**, S. Simunovic**, M.H.A. Piro*
*University of Ontario Institute of Technology, Canada | **Oak Ridge National Laboratory, United States

