IEEE Electric Ship Technologies (Virtual) Symposium
August 3-6, 2021: Main Program

http://ests21.mit.edu
Welcome Message

Welcome to the 2021 Electric Ship Technology Symposium. On behalf of the 2021 ESTS organizing committee, we would like to thank each and every one of you for attending this meeting where we will exchange ideas on the future of electric ship technologies. The Electric Ship Technology Symposium began in 2005, largely as a result of U.S. Navy interest in electric ships, an interest which has grown over the subsequent years. To this end, we particularly thank the U.S. Navy and the U.S. Office of Naval Research for their support of this technical area over the years. But of course, interest in electric ships is not limited to the U.S. Navy, or even the navies of the world; indeed, electric ship technology is of strong interest in many civilian maritime applications, and so the range of contributors to this technology is quite diverse. Thus, it is our goal that this conference welcomes all who are interested in electric ships to both learn and contribute new technical knowledge to this growing area.

We are offering tutorials the week before the official opening of the conference, and hope you will be able to take advantage of these. If you cannot attend, or happen to miss one of interest, this year we are recording the sessions and will make these recordings available online; please see https://ests21.mit.edu/ for a link to the tutorials. The tutorials are free and open to the public.

As we collectively participate in this year’s symposium, please be aware of the generous support provided by our platinum sponsor, Northrop Grumman, and our gold sponsor, Typhoon HIL. Please be sure to visit their booths during the conference as they are all important contributors to electric ship technology.

We also thank the IEEE Power and Energy Society and the IEEE Power Electronics Society for technical and financial sponsorship of this conference, without which the conference would have been impossible. The committee also thanks the IEEE Transportation Electrification Community for technical sponsorship, and for helping to advertise this event. Finally, we hope that each of you will find the conference to be enjoyable, stimulating, and enlightening.

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MIT Sea Grant College Program, Massachusetts Institute of Technology
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IEEE Transportation Electrification Community
Keynote Speaker

Rear Admiral Lorin Selby, Chief of Naval Research
United States Navy

Rear Adm. Lorin Selby is a native of Baltimore, Maryland and graduated from the University of Virginia with a Bachelor of Science in Nuclear Engineering and earned his commission through the Navy’s Reserve Officers Training Corps program. He also holds a Master of Science in Nuclear Engineering and a Nuclear Engineer degree from the Massachusetts Institute of Technology.

His shipboard tours include USS Puffer (SSN 652), USS Pogy (SSN 647) and USS Connecticut (SSN 22). From July 2004 to May 2007 he commanded USS Greeneville (SSN 772) in Pearl Harbor, Hawaii. During these assignments, Selby conducted several deployments to the Western Pacific, Northern Pacific, Northern Atlantic and Arctic Oceans.

Ashore, Selby’s staff assignments include duty as a company officer and instructor at the U.S. Naval Academy, service as the deputy director of the Navy’s liaison office to the U.S. House of Representatives and duty as the Submarine Platforms and Strategic Programs branch head in the Submarine Warfare Directorate on the Navy Staff. Following selection as an acquisition professional, he served as the program manager for both the Submarine Imaging and Electronic Warfare Systems Program Office (PMS 435) and the Advanced Undersea Systems Program Office (PMS 394).

As a flag officer, Selby served as commander, Naval Surface Warfare Centers (NSWC) from October 2014 to August 2016. In this position, he led more than 17,000 scientists, engineers, technicians and support personnel, both civilian and active duty, within eight NSWC divisions located across the country.

From June 2016 until May 2020, he served as the Navy’s chief engineer and the Naval Sea Systems Command (NAVSEA) Deputy Commander for Ship Design, Integration and Naval Engineering (SEA 05), where he led the engineering and scientific expertise, knowledge and technical authority necessary to design, build, maintain, repair, modernize, certify and dispose of the Navy’s ships, aircraft carriers, submarines and associated combat and weapons systems.

In May of 2020, he assumed command of the Office of Naval Research as the 26th Chief of Naval Research.

Selby is authorized to wear the Distinguished Service Medal, the Legion of Merit (three awards), Meritorious Service Medal (four awards), the Navy and Marine Corps Commendation Medal (six awards) and the Navy and Marine Corps Achievement Medal (three awards) in addition to various unit awards.
Keynote Speaker

Mr. Punter Pierluigi, Senior Vice President, Design and Engineering
Fincantieri Cruise Business Unit

Pierluigi Punter was born in Venice, Italy, and graduated from the University of Padua with a M.Sc. (Master of Science) Degree in Electrical Engineering.

He started his career in Fincantieri in 1990 as an electrical engineer in the Technical Department and was directly involved in designing power and electrical propulsion systems for cruise ships. He covered different roles inside Fincantieri, among others Head of the Electrical Design Department, Proposal Engineer, Ships Commissioning Manager, Deputy Director of Fincantieri Marghera Shipyard, Project manager for cruise ships (Queen Victoria, Eurodam, Costa Luminosa and Regent Seven Seas Explorer).

He is currently Head of the Design and Engineering Department of Fincantieri Cruise Business Unit, with a workforce of about 1,000 engineers. The Department includes all the technical branches of the cruise basic and detail design including hull, electrical, mechanical, air conditioning and interior design (cabins and public areas) as well as comfort design of the hotel areas.

He took part in the activities of working groups involved in the reorganization process.

He was a member of national and international electrical technical committees, including IEC for electrical installation on board ships, and is member of the Italian Classification Society (RINA) technical committee.

He is a member of the Fincantieri Research and Innovation Committee.
TUTORIAL PROGRAM

Tuesday, July 27

10:00 am  Tutorial Session I  
**Electrical Power and Propulsion Preliminary and Contract Design Process**  
*Norbert Doerry, NAVSEA, United States*  
*John Amy, NSWC Philadelphia, United States*

12:30 pm  Tutorial Session II  
**PESNet 3.0: A Next Generation Communication and Control Network for High-frequency Modular Power Converters**  
*Jun Wang, University of Nebraska-Lincoln/Virginia Tech*

Wednesday, July 28

10:00 am  Tutorial Session III  
**High Temperature Superconducting Technology for Electric Ships**  
*Sastry Pamidi, FAMU-FSU College of Engineering*

12:30 pm  Tutorial Session IV  
**Electric Power Load Analysis (EPLA)**  
*John Amy, Naval Surface Warfare Center Philadelphia Division*  
*Norbert Doerry, Naval Surface Warfare Center Carderock Division*

Thursday, July 29

10:00 am  Tutorial Session V  
**Supporting Technology Development In-Service Operation of Shipboard Power Systems with Fit-For-Purpose Modeling and Simulation**  
*Graham Dudgeon, MathWorks, Inc*

12:30 pm  Tutorial Session VI  
**Control Hardware in the Loop Fundamentals**  
*Matt Baker, Typhoon HIL*  
*Jim Turso, Huntington Ingalls Industries*

Friday, July 30

10:00 am  Tutorial Session VII  
**Green Electrification of Ships and Ports**  
*John Prousalidis, National Technical University of Athens*

12:30 pm  Tutorial Session VIII  
**Model Predictive Control for Ship Power Systems**  
*Greg Sinsley, US Naval Academy*
MAIN PROGRAM

Tuesday, August 03

10:00 am  Opening Remarks and Keynote Address
Mr. Punter Pierluigi
Senior Vice President, Design and Engineering
Fincantieri Cruise Business Unit

10:30 am  Technical Session A1L-A
Electric Propulsion and Power Generation
Co-chairs: Dwight Alexander, Northrup Grumman; Zareh Soghomonian, FRDA, LLC

Stabilization of Generator Frequency Under Pulsed Load Condition Using Regenerative Propeller Braking
Ronald Matthews, Lee Rashkin, Steven Glover, Norbert Doerry

Endurance Life of Nanostructured Insulation Material for High Torque Density Propulsion Motors
Hiep Nguyen, Yifei Wang, Joanne Ronzello, Jack Chapman, Yang Cao

Assessing the Implementation of Power Take off (PTO) System Onboard Liquified Natural Gas (LNG) Carriers
Apostolos Souflis-Rigas, John Prousalidis, George Dimopoulos

11:00 am  Technical Session A2L-B
Real-Time Simulation of Shipboard Subsystems
Co-chairs: Harish Suryanarayana, ABB; Ali Davoudi, University of Texas Arlington

The Role of Sensitivity Analysis in Stress Testing Real Time Models of Power Systems Controllers
Behshad Mohebali, Karl Schoder, Mark Stanovich, Michael Mischa Steurer, Gordon Erlebacher

A General Common-Bus Architecture for Multiple-Interface Power Hardware-in-the-Loop Studies
Thiago Szymanski, James Langston, Michael Mischa Steurer

A Reconfigurable Megawatt-Scale Power Hardware-in-the-Loop Simulation System for Virtual Motors
Lu Wang, Yanjun Shi, Dionne Soto, James Langston, Matthew Bosworth, John Hauer, Michael Mischa Steurer
Shipboard Zonal Load Center Modeling and Characterization on Real-Time Simulation Platform
Md Multan Biswas, Tyler Deese, James Langston, Harsha Ravindra, Karl Schoder, Michael Mischa Steurer, Herbert Ginn, Christian Schegan

11:30 pm Technical Session A3L-C
Dielectric Challenges 1
Co-chairs: Mona Ghassemi, Virginia Tech; Mike Mazzola, University of North Carolina Charlotte

On the Likelihood of Partial Discharge Inception in Laminated Busbars from Electrified Ships
Gian Carlo Montanari, Riddhi Ghosh, Paolo Seri, Paul Defriese, Jesse Schmeller

Electret: A Remedy for Partial Discharge and Surface Flashover in Shipboard Power Applications
Farhina Haque, Omar Faruqe, Chanyeop Park

Surface Flashover Characteristics of Solid Dielectrics in Shipboard Atmospheric Conditions
Omar Faruqe, Farhina Haque, Han Berdiyev, Chanyeop Park

Characterizing the Surface Charge Distribution and Its Impact on the DC Surface Flashover Voltage of Insulators
Ning Guo, Minuk Lee, Jeong Ho Choi, Tushar Damle, Lukas Graber

12:00 pm Technical Session A4L-D
Power System Control and Stability
Co-chairs: Fletcher Fleming, DRS Technologies; David Wetz, University of Texas at Arlington

Active Damping Poles Repositioning for DC Shipboard Microgrids Control
Andrea Alessia Tavagnutti, Daniele Bosich, Giorgio Sulligoi

Modeling and Stability Analysis of Radial and Zonal Architectures of a Bipolar DC Ferry Ship
Sachin Yadav, Nils van der Blij, Pavol Bauer

Satish Vedula, Mehrzad Mohammadi Bijaieh, Ellis Oti Boateng, Olugbenga Moses Anubi

Low-Bandwidth Modular Mathematical Modeling of DC Microgrid Systems for Control Development with Application to Shipboard Power Systems
Mehrzad Mohammadi Bijaieh, Satish Vedula, Olugbenga Moses Anubi
Technical Session B1L-E
Model-Based Systems Engineering 1
Co-chairs: Terry Ericsen, Ericsen Innovations, LLC; Mohamad Zahzah, Ultra EMS

Naval Smart Grid Preliminary Integration Onboard Electric Ships
Andrea Vicenzutti, Giorgio Sulligoi, Vittorio Bucci, Serena Bertagna, Michele Cataneo, Paolo Borghese

Early Stage Modeling of Naval DC Power System for Digital Twin Development Miles
Leonard-Albert, Davis Hobbs, Jack Hannum, Enrico Santi, Kristen Booth

Concept Design Methodology to Enable Naval Smart Grid Onboard Electric Ships
Giorgio Sulligoi, Giorgio Trincas, Andrea Vicenzutti, Luca Braidotti, Michele Cataneo

Subdivision Blocks and Component Placement in Early-Stage Ship Design
Marisa Hoosen, Julie Chalfant

Wednesday, August 04

10:00 am Opening Remarks and Plenary Session 1
High-Density Machines
Chair: Michael Mazzola, UNC Charlotte

11:30 am Technical Session B2L-A
Model-Based Systems Engineering 2
Co-chairs: Terry Ericsen, Ericsen Innovations, LLC; Mohamad Zahzah, Ultra EMS

Integrating Electrical and Operational Load Models for Control Evaluation
Mark Stanovich, Greg Sinsley, Harsha Ravindra, Daniel F. Opila, John Stevens, Michael Mischa Steurer

Evolution of Operability-Based Performance Metrics for Assessment of Mission Performance
Musharrat Sabah, Isuje Ojo, Aaron Cramer

Reduced Order Model of a Four Zone Medium Voltage DC Electric Ship
Wayne Weaver, Rush Robinett III, David Wilson, Steven Glover

On Estimating the Port Power Demands for Cold Ironing Applications
Fabio D’Agostino, Giacomo Piero Schiapparelli, Stefanos Dallas, Dimosthenis Spathis, Vassilis Georgiou, John Prousalidis
12:00 am Technical Session B2L-B
Modeling & Analysis of Shipboard Subsystems
**Co-chairs:** Harish Suryanarayana, ABB; Ali Davoudi, University of Texas Arlington

**Hybrid Analytical and Data-Driven Modeling Techniques for Digital Twin Applications**
Andrew Wunderlich, Kristen Booth, Enrico Santi

**Averaged-Value Modeling and Modelability Analysis for an Operational Megawatt-Scale Medium-Voltage Modular Multilevel Converter**
Lu Wang, Yanjun Shi, Dionne Soto, James Langston, Matthew Bosworth, John Hauer, Michael Mischa Steurer

**Modeling of Sources and Power Electronic Converters Installed in a Medium Voltage AC/DC Testbed**
Zachary Bailey, Alexander Johnston, David Wetz, Gregory Turner, Christian Schegan, John Heinzel

**Optimization Design of Medium-Voltage Modular Converter with Terminal Transient Response Constraint**
Qian Li, Igor Cvetkovic, Dushan Boroyevich, Rolando Burgos

12:30 pm Technical Session B4L-C
Dielectric Challenges 2
**Co-chairs:** Mona Ghassemi, Virginia Tech; Mike Mazzola, University of North Carolina Charlotte

**Behaviour of Surface Electric Field in DC Ship Spacers Under Real Operation Conditions: Voltage Transients and Ripple, Temperature Gradient and Pollution**
Robin Ramin, Gian Carlo Montanari, Peter Cheetham, Michael Mischa Steurer

**Modeling and Measurement of Internal Partial Discharges in Voids Artificially Made Within 3D-Printed Polylactic Acid (PLA) Block**
Moein Borghei, Mona Ghassemi, Behzad Kordi, Derek Oliver

**Effects of 7-Level ANPC SiC Inverter on Motor Stator Insulation and Cable Insulation in an Electric Ship Propulsion Drive**
Arshiah Mirza, Ali Bazzi

**Discrimination of Single- and Multi-Source Corona Discharges Using Deep Residual Network**
Moein Borghei, Mona Ghassemi
Thursday, August 05

10:00 am  Opening Remarks and Keynote Speaker
**Rear Admiral Lorin Selby**
Chief of Naval Research
United States Navy

10:30 am  Technical Session C1L-A
EMI, EMC, and Common-Mode Behavior
**Co-chairs:** Rob Cuzner, University of Wisconsin Milwaukee; Aaron Brovont, PC Krause & Associates

**Common-Mode Capacitance of Bus-Bar-Based Common-Mode Inductors**
Harshita Singh, Scott Sudhoff, Robert Swanson

**Eliminating Common Mode Conducted Emissions in Three-Phase Four-Leg Inverters**
Alexander Julian, Giovanna Oriti, Arthur Krener

**Impact of Output Terminations on Conducted Emissions Evaluation of Interface Converters**
Andrew Lemmon, Aaron Brovont

11:00 am  Technical Session C2L-B
Power System Control and Risk Mitigation
**Co-chairs:** Fletcher Fleming, DRS Technologies; David Wetz, University of Texas at Arlington

**Advanced Load Shedding for Integrated Power and Energy Systems**
Bang Nguyen, Tuyen Vu, Colin Ogilvie, Harsha Ravindra, Mark Stanovich, Karl Schoder, Michael Mischa Steurer, Charalambos Konstantinou, Christian Schegan

**Redundant Actuators Without Direct Communication for Reactor Control Rod Positioning**
Arthur Devine, Daniel F. Opila

**A Low Latency Parallel Bus Interface for High-Speed Multi-FPGA RT-Simulations**
Michele Difronzo, Herbert Ginn, Andrea Benigni

**Evaluation of Communication Network Models for Shipboard Power Systems**
Juan Ospina, Charalambos Konstantinou, Mark Stanovich, Michael Mischa Steurer
11:30 pm  Technical Session C3L-C
Protection, Reconfiguration, Survivability
Co-chairs: Marie Lawson, Ingalls Industries – Newport News Shipbuilding; Ali Bazzi, University of Connecticut

Robust 5 kA, 1 kV Solid-State DC Circuit Breaker for Next Generation Marine Power Systems
Rostan Rodrigues, Yuzhi Zhang, Utkarsh Raheja, Pietro Cairoli, Luca Raciti, Antonello Antoniazzi

System Inductance for MVDC Circuit Breakers
Norbert Doerry, John Amy Jr.

Multiple Line-to-Ground Fault Characterization and Mitigation in MVDC Shipboard Electrical Systems
Jacob Gudex, Robert Cuzner

Deep Learning-Based Fault Detection, Classification, and Locating in Shipboard Power Systems
Soroush Senemmar, Jie Zhang

12:00 pm  Technical Session C4L-D
Energy Storage and Pulsating Loads
Co-chairs: Ben Ford, Hepburn & Sons; Stephen Kuznetsov, Raytheon

Using Power Hardware-in-the-Loop Simulation to Study Control of Energy Storage Within Limited-Inertia Power System
James Langston, Kazuki Watanabe, John Hauer, Karl Schoder, Mark Stanovich, Harsha Ravindra, Michael Mischa Steurer

Strategies for Preserving the Battery SOC in DC Shipboard Power Systems
Andrea Alessia Tavagnutti, Daniele Bosich, Giorgio Sulligoi

Battery Management System (BMS) Test Stand Utilizing a Hardware-in-the-Loop (HIL) Emulated Battery
Cole Tschritter, David Wetz, Gregory Turner, John Heinzel

The Optimal Control of an Electric Warship Driven by an Operational Vignette
Joseph Young, David Wilson, Marvin Cook

Priority-Based Management of Energy Resources During Power-Constrained Operation of Shipboard Power System
James Langston, Harsha Ravindra, Michael Mischa Steurer, Tom Fikse, Christian Schegan, Joseph Borraccini
Friday, August 06

10:00 am  Plenary Session II
Engineering Challenges of Autonomous Vessels

11:30 pm  Technical Session D1L-A
Electrical Power Conversion for DC Distribution
Co-chairs: Giorgio Sulligoi, University of Trieste; Patrick Lewis, Hepburn & Sons

Medium Voltage Ring-Bus Grid Design Employing Current-Fed, Three-Port Dual Active Bridge Converters with Average Power Flow Control
Zachary Smith, Brandon Grainger

Two-Phase Milli/Microchannel Cooling for SiC Power Module Using Dielectric Fluid Coolant
Bo Tian, Wei Chang, Enrico Santi, Chen Li, Tianyu Zhang, Lang Yuan

Design of a High-Frequency Transformer and 1.7 kV Switching-Cells for an Integrated Power Electronics Building Block (iPEBB)
Narayanan Rajagopal, Ravisekhar Raju, Taha Moaz, Christina Dimarino

Preliminary Investigation Into Liquid-Cooled PEBBs
Joushua Padilla, Julie Chalfant, Chryssostomos Chryssostomidis, Chathan Cooke

12:00 pm  Technical Session D2L-B
Electrical & Thermal Modeling of Converter Components
Co-chairs: Harish Suryanarayana, ABB; Ali Davoudi, University of Texas Arlington

Packaging of an 8-kV Silicon Carbide Diode Module with Double-Side Cooling and Sintered-Silver Joints
Zichen Zhang, Jiaxiang Zhang, Jiayu Xu, Khai Ngo, Guo-Quan Lu, Emily Cousineau, Paul Paret, Sreekant Narumanchi

Electrothermal Management Using In-Situ Junction Temperature Monitoring for Enhanced Reliability of SiC-Based Power Electronics
Dehao Qin, Gokhan Ozkan, Christopher Edrington, Zheyu Zhang

Empirical Procedure for Estimating Mutual Coupling in High-Performance Power Modules
Ali Shahabi, Andrew Lemmon, Brian Deboi, Troy Beechner, Robert Mayo

vemPEBB: Rapid PEBB Thermal Management Tool
Sam Yang, Juan Ordonez, Yue Xu, Igor Cvetkovic
Component Evaluation and PSpice Modeling for Charge Pump Based Cell Voltage Balancer Development
Mostafa Negm, Manuel Morales, William Lynch

12:30 pm Technical Session D3L-C
MVDC Power Distribution
Co-chairs: Mike Mazzola, University of North Carolina Charlotte; Mona Ghassemi, Virginia Tech

Coaxial Insulated Bus Pipe, a Low Magnetic Signature Solution for Medium Voltage Direct Current Shipboard Power Distribution
Terrence Northington, Patrick Lewis, Ehsan Alavi, Dustin Carver, Matthew Bosworth

Application of IEC-61800-5 Insulation Coordination to Shipboard Equipment Scaling Studies
Robert Cuzner, William Koebel

HTS Technology Driven Shipboard Power Distribution Architecture – Electrical
Peter Cheetham, Srikar Telikapalli, Taylor Stamm, Chul Kim, Sastry Pamidi

HTS Technology Driven Shipboard Power Distribution Architecture – Cryogenics
Srikar Telikapalli, Peter Cheetham, Chul Kim, Sastry Pamidi