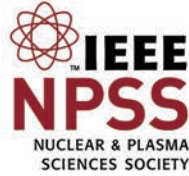


NSREC 2023

July 24-28, 2023

www.nsrec.com
www.ieee.org



NSREC 2023



skywater



SOUTHWEST RESEARCH INSTITUTE

As of Mar. 8, 2023

Chairman's Invitation



NSREC 2023



"It is my distinct honor to invite you to attend NSREC 2023 in the heart of America, Kansas City, Missouri. My Conference Committee and I are excited to host all of you with some Midwest hospitality while providing an outstanding conference and time to enjoy all of the social opportunities. Kansas City is known as the City of Fountains and home to professional sports, world class art, museums, music, and some of the best barbeque in America. The NSREC website will provide extensive links to all that Kansas City has to offer starting in September. Start planning your adventure now! On behalf of the many who make NSREC possible, I welcome you to NSREC 2023. Kansas City here we come!"

Keith Avery
NSREC 2023 General Chair
Air Force Research Laboratory

On behalf of the Institute of Electrical and Electronics Engineers (IEEE), its Nuclear and Plasma Sciences Society (NPSS), the Radiation Effects Steering Group (RESG) and the 2023 Nuclear and Space Radiation Effects Conference (NSREC) committee and volunteers, it is my sincere pleasure to invite you to attend the 60th NSREC to be held July 24-28, 2023. The conference will be in heart of America, Kansas City, Missouri at the Sheraton Crown Center.

Come enjoy learning, laughing and enjoying the community we call NSREC, where a lifetime of friendships renews and begins.

The conference begins Monday, July 24th, with a one-day Short Course titled *"Radiation Considerations for Board Level Computers"*. It is organized by **Ethan Cannon** of the The Boeing Company and consists of four sections taught by leading experts in their respective fields. The short course is designed to provide an overview of radiation effects in the computing system and testing at the system level. An extensive set of written notes will be provided.

The Technical Program will be held from Tuesday, July 25th to Friday, July 28th. **Jonny Pellish**, NASA Goddard Space Flight Center, is the Technical Program Chair. Jonny and his technical committee will select the outstanding contributed papers organized into 9 sessions of oral presentations and a poster session (**Jeff George**, Los Alamos National Laboratory – Poster Chair) that supports all sessions. In addition, the technical committee will select a set of quality presentations for the Radiation Effects Data Workshop (**Andrea Coronetti**, CNES – REDW Chair). Workshop posters will present radiation effects data on electronic and photonic devices and systems, and new simulation or test facilities. Finally, Jonny plans to invite three engaging guest speakers to give general interest presentations.

The Industrial Exhibit, organized by **Ken LaBel**, SSAI in support of NASA, opens Tuesday morning. We have a full slate of exhibitors demonstrating their latest developments in areas such as radiation-hardened and radiation-tolerant electronics, engineering services, facilities, modeling, and equipment. Attendees will be able to visit the booths during scheduled breaks and during lunch on both Tuesday and Wednesday. Attendees and their their guests, are invited to a reception in the exhibit halls on Tuesday evening. The exhibits will conclude at noon Wednesday with the exhibitor raffle.

Local Arrangements Chair, **Sarah Armstrong**, NAVSEA Crane, is organizing an outstanding social program for attendees and guests. The Conference Social, on Wednesday evening, is planned to offer all a fantastic evening of entertainment as well as a taste of Kansas City. Two or three companion tours are also being planned.

On behalf of my Conference Committee, which also includes Finance Chair **Nathan Nowlin** (Sandia National Laboratory), Publicity Chair **Teresa Farris** (Archon-LLC), Awards Chair **Julien Mekki** (CNES), Webmaster **Greg Allen** (NASA/JPL), Publicity **Adrian Ildefonso** (NRL), A/V **Carl Szabo** and **Martha O'Bryan** (NASA) and Meeting Planner **John Teehan** (IEEE MCE). I invite you to join us in Kansas City for an outstanding conference.

Kansas City welcomes you as only America's Midwest can with a warm welcome, great food and activities to suit everyone.

We look forward to seeing you in person this July!

Visit us on the web at:
www.nsrec.com

Short Course Program

RADIATION CONSIDERATIONS FOR BOARD-LEVEL COMPUTING SYSTEMS

**KANSAS CITY MARRIOTT
EXHIBIT HALL B
JULY 24, 2023**

- 8:00 AM **SHORT COURSE INTRODUCTION**
Dr. Ethan Cannon, *The Boeing Company*
- 8:10 AM **PART I – ADVANCEMENTS AND CHALLENGES WITH RADIATION- TOLERANT SPACEFLIGHT COMPUTERS**
Dr. Tyler Lovely, *US Air Force Research Laboratory*
- 9:40 AM **BREAK (Prefunction)**
- 10:10 AM **PART II – RADIATION EFFECTS IN FPGAS AND SOCS**
Dr. Nadia Rezzak and Dr. Pierre Maillard, *Microchip Technology and AMD, respectively*
- 11:40 AM **SHORT COURSE LUNCHEON
(Terrace and Atlanta Rooms)**
- 1:00 PM **PART III – RADIATION EFFECTS IN DATA LINKS**
Dr. Zachary Diggins, *Cyclo Technologies*
- 2:50 PM **BREAK (Prefunction)**
- 3:20 PM **PART IV – EXPERIMENTAL EVALUATION OF ARTIFICIAL NEURAL NETWORKS RELIABILITY: FROM GPUS TO LOW-POWER ACCELERATORS**
Prof. Paolo Rech, *UFGRS (Brazil) and University of Trento (Italy)*
- 4:50 PM **WRAP-UP**
- 5:00 PM **EXAM (only for students requesting CEU credit)**
- 5:30 PM **END OF SHORT COURSE**

The NSREC 2023 Short Course Notebook will be available for download at www.NSREC.com for all registered Short Course Attendees one week before NSREC conference.

Short Course

COURSE DESCRIPTION

A short course, “*Radiation Considerations for Board-Level Computing Systems*”, will be presented at the 2023 IEEE Nuclear and Space Radiation Effects Conference. The ultimate purpose of the radiation effects community is to enable successful system operation in radiation environments. System-level success stems from integrating an understanding of fundamental mechanisms, and sub-component and component-level responses to radiation, with system-level analysis. A spacecraft board-level computing system represents a commonly used exemplar comprised of multiple complex components.

The short course is organized into four sections, all featuring introductory material and advanced topics. The first section introduces spaceflight computing needs and challenges, considering various architectures beyond just traditional CPUs. The second topic covers FPGAs, which are widely used due to low development cost and schedule, and have increased in both capability and complexity to become bona fide Systems on Chip. The third section addresses data links, which are critical for communication between system components, including both electrical and optical connections. Finally, the last course covers artificial neural networks used for AI applications, addressing both GPUs and specialized accelerators. The topics covered should benefit people new to the field as well as experienced engineers and scientists, by providing up-to-date material and insights.

The short course is intended for radiation effects engineers, component specialists, system designers, and other technical and management personnel involved in developing reliable systems designed to operate in radiation environments. It provides a unique opportunity for IEEE NSREC attendees to benefit from the expertise of excellent instructors, along with a critical review of state-of-the-art knowledge in the field. Electronic copies of detailed course notes will be provided to each participant.

CONTINUING EDUCATION UNITS (CEUs)

Continuing Education Units (CEUs) will be available. For the interested attendees, an exam will be given at the end of the short course. The course is valued at 0.6 CEUs and is endorsed by the IEEE and by the International Association for Continuing Education and Training (IACET).

SHORT COURSE CHAIRMAN



*Ethan Cannon
The Boeing Company
Short Course Chair*

Ethan Cannon is Manager of the Advanced Microsystems Technology team in the Boeing Research & Technology—Solid-State Electronics Development organization, where his team develops revolutionary capabilities for Systems on Chip that meet current and future Military-Aerospace mission system needs. His research interests include extreme environments, high reliability applications, and hardware security. He has a Ph.D. in physics from the University of Illinois at Urbana-Champaign.

Short Course Monday



Tyler M. Lovelly is the Principal Investigator for Space Computing within the Space Electronics Technology program at the U.S. Air Force Research Laboratory (AFRL), where his research focuses on advancing on-board computing capabilities for next-generation space systems. He has worked in the area of aerospace and defense electronics and computing for over 14 years. His previous experience includes serving as a research group leader at the NSF Center for Space, High-Performance, and Resilient Computing (SHREC), supporting AFRL as a contractor with the Universities Space Research Association, and working for United Space Alliance supporting the NASA Space Shuttle program. He holds a Ph.D. in Electrical and Computer Engineering (ECE) from the University of Florida, and a faculty title with the Department of ECE at the University of New Mexico.

ADVANCEMENTS AND CHALLENGES WITH RADIATION-TOLERANT SPACEFLIGHT COMPUTERS

Dr. Tyler M. Lovelly

U.S. Air Force Research Laboratory

On-board computing demands for space systems are continually increasing due to the need for real-time sensor and autonomous processing combined with limited communication bandwidth to ground stations. Although massive investments have been made by the electronics industry to advance the state-of-the-art in computing technologies, radiation-hardened technology requires longer lead times due to funding constraints, greater design complexity, and rigorous radiation testing and qualification requirements. Thus, the capabilities of radiation-hardened processors typically lag several technology generations behind commercial state-of-the-art technology. Due to changes in the spectrum of risk tolerance and a pivot from large and expensive long-duration missions to shorter-duration missions with more rapid technology refresh, increasing numbers of programs are considering and using small satellites, leading to high interest in leveraging commercial electronics. However, there exists little data quantifying the ability of commercial processors to operate reliably in a space radiation environment. Furthermore, it remains highly challenging to keep up with the broad, diverse, and rapidly changing landscape of available architectures such as CPUs, GPUs, FPGAs, SoCs, AI/ML accelerators, and others. During this module, **Dr. Tyler Lovelly**, *U.S. Air Force Research Laboratory*, will provide an overview of the spaceflight computing technology area including recent advancements and challenges in designing, manufacturing, evaluating, and deploying radiation-tolerant computers to support the next generation of space systems.

A top-level outline of the presentation is as follows:

- Introduction
- Spaceflight Computing
 - Missions and pervasive impacts
 - Motivations and constraints
 - Radiation considerations
- Spaceflight Processors
 - Applications and architectures
 - Radiation-hardened vs. commercial
 - Hybrid radiation-tolerant solutions
- Evaluation and Qualification
 - Performance metrics and benchmarking
 - Radiation qualification and spaceflight
 - Cyber security and trusted manufacturing
- Summary

Short Course Monday



Nadia Rezzak is the Senior Manager of Radiation Effects Technology and Development for the FPGA Business Unit at Microchip Technology, where she manages the radiation effects team and leads the development and validation of commercial and radiation tolerant FPGAs. She has over 10 years of experience with radiation effects and reliability and has over 30 conference presentations and journal publications. She received MS EE from Polytech Montpellier and MS and Ph.D. EE from Vanderbilt University.



Pierre Maillard joined AMD's Adaptive Embedded Computing Group (AECG) in 2013, where he is currently leading the Radiation Effects & RAS team. The team focuses on the architecture, development, and validation of commercial and rad. tolerant FPGA/ACAP solutions, for the Terrestrial (Telecom, Avionics, Automotive, Datacenter, etc.) and Space markets. He has over 20 presentations and publications in industry leading conferences and journals. He holds 13 issued patents in the field of radiation effects on electronics. He received his M.S. in Electrical Engineering (EE) from the universities of Montpellier II and M.S. and Ph.D. EE in from Vanderbilt University.

RADIATION EFFECTS IN FPGAS AND SOCS

Dr. Nadia Rezzak

Microchip Technology

Dr. Pierre Maillard

AMD

The ability to implement complex designs and evolving algorithms in reconfigurable devices makes Field Programmable Gate Arrays (FPGAs) attractive for many Terrestrial and Space applications, compared to fixed function Application Specific Integrated Circuits (ASICs).

Dr. Nadia Rezzak, *Microchip, Inc.* and **Dr. Pierre Maillard**, *AMD, Inc.*, will discuss Radiation Effects in FPGAs and SoCs. The first part of the course will address the basics of SRAM and non-volatile based FPGAs architecture and their evolution to modern/complex System On Chip (SoC) and Adaptive Compute Acceleration Platform (ACAP) devices. Then we will discuss Single Event Effects (SEE) and Total Ionizing Dose (TID) mechanisms, errors classification, test methodologies and representative results. The final section will focus on mitigation techniques and challenges to address requirements for Terrestrial (telecom, automotive, datacenters, avionics, etc.), Defense and Space markets.

A top-level outline of the presentation is as follows:

- A changing world –FPGAs and SoCs use cases in modern applications
 - Adapting to an electronic driven world
 - Why do FPGAs/SoC vendors care about radiation effects and testing for them?
- Introduction to FPGAs and SoCs
 - Basic FPGA fabric Architecture and configuration types
 - FPGA/SoC Architecture (Processors, NOC, AI Engines)
 - FPGA/SoC Design Flow
- Single Event Effect (SEE) and mitigation
 - SEE signature and classification
 - Example of SEE mitigation techniques
- Single Event Effect (SEE) and Total Ionizing Dose (TID) Testing
 - Testing Facilities and conditions
 - DUT preparation for wire-bonded and Flip-Chip package
 - SEE & TID test benches and results
- Next-gen development
 - Need for R&D/Innovation to adapt to new technologies and demands
 - Beam test methodologies adoption -laser testing
- Conclusion

Short Course Monday



Zachary Diggins is the founder of Cyclo Technologies, Inc., a company created in 2022 that provides cloud software and engineering consulting services supporting electronics design for radiation environments. Previously, he was the lead radiation effects engineer for SpaceX's Starlink satellite program, working 6 years on the project from pre-prototype through system deployment and activation. His interests include up-screening of commercial-of-the-shelf components and modeling system risk. He holds a Ph.D. from Vanderbilt University in Electrical Engineering, with a thesis focused on probabilistic modeling of radiation effects on systems.

RADIATION EFFECTS IN DATA LINKS

Dr. Zachary Diggins

Cyclo Technologies

Advances in sensor and networking payloads place ever increasing demands on data links. Additionally, reliable communication between different components on a spacecraft are critical for safe operation, while also potentially contributing to the spacecraft power and weight through harnessing and PCB requirements, making data links a critical design consideration. In this course, **Dr. Zachary Diggins**, *Cyclo Technologies*, will cover the radiation effects for the various data links on a single-board computer, from basic mechanisms through part selection considerations and testing strategies. Specifically, radiation effects in SerDes links for inter-chip communication will be reviewed, including clock generation and distribution considerations. Satellite bus communication protocols will be evaluated, including options for redundancy and wireless bus communication. A focused section will be included on optical communication technologies, including fiber based and inter-satellite data links, which have total-ionizing dose and displacement damage concerns. Finally, comparisons will be made to state-of-the-art terrestrial data center architectures.

A top-level outline of the presentation is as follows:

- Introduction
 - Elements of a Data Link
 - Industry Trends in Terrestrial Data Links
 - Industry Trends in Space Data Links
- Radiation Effects in Physical Layer of Data Links
 - ADC/DAC
 - PLL/Oscillators
 - SerDes
 - Photodiodes + Fiber
 - Wireless/RF Transceivers
- Radiation Effects on Protocol Layer of Data Links
 - Error Correction
 - Case Studies – SpaceWire/Time-Triggered Ethernet/PCIE
- Radiation Effects on Network Architecture Layer of Data Links
 - Fault Detection, Isolation, and Recovery
 - Point-to-Point/Bus/Mesh Topologies
- Environmental Considerations
 - Solar Flare Design Considerations
 - Lightly Shielded Peripherals and Space Facing Components
- Testing Strategies
 - Defining Pass/Fail Criteria
 - Benefits and Risks of System Level Testing
- Conclusions

Short Course Monday



Paolo Rech received his master and Ph.D. degrees from Padova University, Padova, Italy, in 2006 and 2009, respectively. He was then a Post Doc at LIRMM in Montpellier, France. Since 2022 Paolo is an associate professor at Università di Trento, in Italy and since 2012 he is an associate professor at UFRGS in Brazil. He is the 2019 Rosen Scholar Fellow at the Los Alamos National Laboratory, he received the 2020 impact in society award from the Rutherford Appleton Laboratory, UK. In 2020 Paolo was awarded the Marie Curie Fellowship at Politecnico di Torino, in Italy. His main research interests include the evaluation and mitigation of radiation-induced effects in autonomous vehicles for automotive applications and space exploration, in large-scale HPC centers, and quantum computers.

EXPERIMENTAL EVALUATION OF ARTIFICIAL NEURAL NETWORKS RELIABILITY: FROM GPUS TO LOW-POWER ACCELERATORS

Dr. Paolo Rech

University of Trento, UFRGS

Artificial Neural Networks are among the greatest advancements in computer science and engineering and are today used to classify or detect objects in a frame and to enable autonomous vehicles. Since neural networks are heavily used in safety-critical applications, such as automotive and aerospace, their reliability must be paramount. However, the reliability evaluation of neural networks systems is extremely challenging due to the complexity of the software, which is composed of hundreds of layers, and of the underlying hardware, typically a powerful parallel device.

In this course, **Dr. Paolo Rech**, *UFRGS (Brazil)* and *University of Trento (Italy)*, will review fundamental concepts of Artificial Intelligence, Artificial Neural Networks, and parallel computing devices. Then, the course will detail the experimental setup required to have a deep and accurate reliability evaluation of an Artificial Neural Networks system. In particular, the guidelines for a successful neutron or heavy ion test of Graphics Processing Units (GPUs) and low-power accelerators, such as Tensor Processing Unit (TPU) or Systolic Arrays, will be provided. Specific attention will be given to the choice of the software, the neural network configuration, the input dataset, and to the experimental results analysis.

A top-level outline of the presentation is as follows:

- Introduction and motivation
- Hardware and Software for Artificial Neural Networks executions
 - Graphics Processing Units
 - Low-Power Accelerators
 - FPGAs and ASICs
- Experimental setup
 - Host vs device under test
 - Choose the software and the inputs
 - Choose the facility
 - What to log, what to look for
- Data gathering and analysis
 - Understand radiation errors in ANNs
 - Differentiating between tolerable and critical errors
- Conclusions and future perspectives

Technical Program

TECHNICAL INFORMATION



"On behalf of the Technical Program Committee, I invite you to attend the 2023 NSREC Technical Program. Rapid advancements in microelectronics, significant new investments on the horizon, and ever-expanding mission scope make events like NSREC more important than ever. Students and seasoned professionals alike will benefit from broad topic coverage and robust technical debates. The chairpersons for these eleven sessions will assemble an exceptional program covering the latest developments in nuclear and space radiation effects. I look forward to working with all the session chairs, reviewers, and authors who will contribute to an outstanding technical program."

*Jonny Pellish, NASA,
Technical Program Chair*

The NSREC technical program consists of contributed oral and poster papers, a data workshop, and invited talks. The oral presentations will be 12 minutes in duration with an additional three minutes for questions. The technical sessions and their chairpersons are:

- **Basic Mechanisms**
Chair: Ani Khachatryan, U.S. Naval Research Laboratory
- **Dosimetry and Facilities**
Chair: Richard Sharp, Radtest Ltd.
- **Hardening by Design**
Chair: Paula Chen, AMD, Inc.
- **Hardness Assurance: Piece Parts to Systems and Testing Approaches**
Chair: Courtney Matzkind, Missile Defense Agency
- **Photonic Devices and Integrated Circuits**
Chair: George Tzintzarov, The Aerospace Corporation
- **Radiation Effects in Devices and Integrated Circuits**
Chair: Rudy Ferraro, CERN
- **Single-Event Effects: Devices and Integrated Circuits**
Chair: Françoise Bezerra, CNES
- **Single-Event Effects: Mechanisms and Modeling**
Chair: Jason Osheroff, NASA Goddard Space Flight Center
- **Space and Terrestrial Environments**
Chair: Scott Messenger, Northrop Grumman Corporation
- **Poster Session**
Chair: Jeff George, Los Alamos National Laboratory
- **Radiation Effects Data Workshop**
Chair: Andrea Coronetti, CERN

POSTER SESSION

Those papers that can be presented more effectively in a visual format with group discussion will be displayed in the Poster Session in the New York, San Francisco, and Chicago Ballrooms. The formal Poster Session will be held on Wednesday from 1:30 – 4:30 PM and the authors will be available at that time to discuss their work. The Poster Session is chaired by Jeff George from Los Alamos National Laboratory.

RADIATION EFFECTS DATA WORKSHOP

Workshop papers provide piece part radiation response data and radiation test facilities technical information. The intent of the workshop is to provide data and facilities information to support design and radiation testing activities. Workshop papers can be viewed Tuesday through Friday in the the New York, San Francisco, and Chicago Ballrooms. Authors will be available on Thursday to discuss their work from 1:30 – 4:30 PM. A workshop record will be provided to all registered conference attendees. The Data Workshop chair is Andrea Coronetti from CERN.

Technical Program

INVITED SPEAKERS

There will be three invited speakers

- **Keeping Negro Leagues Baseball Alive**
Speaker info to come
- **Boulevard Brewing Company - Fermentation Science and Beer**
Speaker info to come
- **Kansas City National Security Campus - History**
Speaker info to come

LATE-NEWS PAPERS

A limited number of late-news papers will be accepted and included in the Poster Session and the Radiation Effects Data Workshop. The submission window for these newsworthy papers will be open from April 14, 2023 through May 12, 2023. Detailed instructions for submitting late-news summary will be available on the NSREC website at www.nsrec.com.

Session Chairs



*Ani Khachatryan,
U.S. Naval Research Laboratory
Basic Mechanisms of Radiation
Effects*



*Richard Sharp,
Radtest Ltd.
Dosimetry*



*Courtney Matzkind,
Missile Defense Agency
Hardness Assurance—Piece
Parts to Systems and Testing
Approaches*



*Paula Chen,
AMD, Inc.
Hardening by Design*



*Rudy Ferraro,
CERN
Radiation Effects in Devices
and Integrated Circuits*



*George Tzintzarov,
The Aerospace Corporation
Photonic Devices and
Integrated Circuits*



*Jason Osheroff, NASA Goddard
Space Flight Center
Single-Event Effects:
Mechanisms and Modeling*



*Françoise Bezerra,
CNES
Single-Event Effects: Devices
and Integrated Circuits*



*Scott Messenger,
Northrop Grumman Corporation
Space and Terrestrial
Environments*

RESG NEWS



IEEE

The purposes of the Radiation Effects Committee (REC) of the IEEE Nuclear and Plasma Sciences Society are to advance the theory and application of radiation effects and its allied sciences, to disseminate information pertaining to those fields, and to maintain high scientific and technical standards among its members.



*Robert Reed
Chair*

The Committee aids in promoting close cooperation and the exchange of technical information among its members. This is done by running conferences for the presentation and discussion of original contributions, assisting in the publication of technical papers on radiation effects in the IEEE Transactions on Nuclear Science, coordinating development of radiation effects measurement definitions and standards within IEEE and other standards organizations, providing a sounding board for radiation effects specialists, providing for the continued professional development and needs of its members, and providing liaisons between IEEE and other technical organizations in the areas of radiation effects.

Each year, the REC provides a forum for the technical exchange of information by holding the Nuclear and Space Radiation Effects Conference (NSREC). The NSREC is an international forum for presentation of research papers on nuclear and space radiation effects. This includes effects on electronic and photonic materials, devices, circuits, sensors, and systems, as well as semiconductor processing technology and design techniques for producing radiation-tolerant (hardened) devices and integrated circuits. Papers presented at the NSREC are submitted for possible publication in the January issue of the IEEE Transactions on Nuclear Science.



*Kay Chesnut,
Raytheon Technologies
Executive Vice-Chair*

NSREC 2023 will be held in Kansas City, Missouri, July 24-28, 2023, at the Sheraton Kansas City Hotel at Crown Center. Keith Avery, Air Force Research Laboratory is the Conference Chair. Supporters of the 2023 NSREC include Analog Devices, Boeing, EMPC, EPC Space, Frontgrade, Honeywell, IR HiRel Products (an Infineon Technologies Company), Jet Propulsion Laboratory, L3Harris Technologies, Radiation Test Solutions, Renesas, Skywater Technology, Southwest Research Institute, and The Aerospace Corporation. We thank our supporters for their significant and continuing commitments to the conference and welcome other organizations to consider becoming supporters of the IEEE NSREC.

NSREC 2024 will be held in Ottawa, Ontario, Canada, July 24-28, 2024, at the Shaw Center. Heather Quinn, Los Alamos National Laboratory, is the Conference Chair. Dolores Black, Sandia National Laboratories, is the Conference Chair for NSREC 2025 in Nashville, Tennessee. Philippe Paillet was selected as the 2026 NSREC Conference Chair.

Papers presented at the 2023 NSREC are eligible for publication in the January 2024 issue of the IEEE Transactions on Nuclear Science. Authors must upload their papers prior to the conference for consideration for publication in the January 2024 TNS Special Issue. Detailed instructions can be found at www.nsrec.com.

Keep visiting our web site for author information, paper submission details, exhibitor links, on-line registration, and the latest NSREC information.

RESG NEWS

EDITORS

Dan Fleetwood
Vice-Chair of Publications



All papers accepted for oral or poster presentation in the technical program will be eligible for publication in a special issue of the *IEEE Transactions on Nuclear Science* (January 2024), based on a separate submission of a complete paper. Each paper will be subject to the standard full peer review given all papers submitted to the *IEEE Transactions on Nuclear Science*. All papers must be submitted on IEEE ScholarOne. Instructions for submitting papers can be found at the Conference web site www.nsrec.com. The deadline for submission of papers is July 21, 2023. Data Workshop papers are published in a Workshop Record and are not candidates for publication in the *IEEE Transactions on Nuclear Science*. The process for the Workshop Record is managed by the Workshop Chair.

The review process for papers submitted to the *Transactions* is managed by a team of editors. To provide consistent review of papers, this editorial team manages the review process for all radiation effects papers submitted to the *Transactions* throughout the year. The editorial team consists of a senior editor and associate editors who are technically knowledgeable in one or more specializations and are experienced in the publication process. If you would like to serve as a reviewer for the NSREC special issue of the *Transactions* or for radiation effects papers submitted throughout the year, please contact one of the editors. The editors for the 2023 NSREC are:

Dan Fleetwood, Senior Editor, Vanderbilt University
Email: dan.fleetwood@vanderbilt.edu

Heather Quinn, Associate Editor, Los Alamos National Laboratory
Email: hquinn@lanl.gov

William Robinson, Associate Editor, Georgia Tech Research Institute
Email: William.Robinson@gtri.gatech.edu

Steven Moss, Associate Editor, The Aerospace Corporation, retired
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Jeffrey Black, Associate Editor, Sandia National Laboratories
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Federico Faccio, Associate Editor, CERN
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RESG NEWS / Awards

ARE YOU A MEMBER OF IEEE?

Now is the time to join the Institute of Electrical and Electronics Engineers (IEEE) and the Nuclear Plasma Sciences Society (NPSS). Why? First of all, you'll become a member of the largest professional engineering society in the world. About 60% of NSREC attendees are IEEE members. The cost of membership in the IEEE depends on your country and your career phase. IEEE members receive access to a broad range of benefits, including a terrific insurance program, on-line access to IEEE publications, and reduced rates at all IEEE sponsored conferences, including, of course, the IEEE NSREC and Short Course!

NPSS membership is \$35. NPSS members receive a free subscription to NPSS News, and free on-line electronic access via IEEE Xplore to the IEEE Transactions on Nuclear Science (TNS) and the NSREC Data Workshop Record. Now members can search and view digital copies of all IEEE TNS papers on-line all the way back to the first IEEE NSREC in 1964. NPSS members get to vote in our NSREC elections, held at the annual open meeting held during the conference. What are you waiting for? Apply for membership at <http://ieee-npss.org/why-join-npss-and-ieee/> or visit the IEEE registration desk at the conference.

NSREC PUBLICATIONS

NSREC has two publications each year:

- *IEEE Transactions on Nuclear Science*. This IEEE journal is the official archive of research papers presented at NSREC. Papers presented at the conference undergo an additional review before they are accepted for the January 2024 issue.
- *Radiation Effects Data Workshop Record*. Published each year in October, this IEEE proceedings has become the source for radiation test data on semiconductor components.

A complimentary copy of the 2023 *IEEE Radiation Effects Data Workshop Record* and the January 2023 special NSREC issue of the *IEEE Transactions on Nuclear Science* will be mailed to each NSREC technical session attendee if the attendee registered to be listed on the attendee list.

RADIATION EFFECTS COMMITTEE ANNUAL OPEN MEETING

You are invited to attend the IEEE Radiation Effects Committee's Annual Open Meeting on Thursday, July 27, 4:30 – 6:30 All conference attendees are encouraged to attend.

THURSDAY, JULY 27 4:30 PM – 6:30 PM

During the meeting we will discuss the 2023 conference and future IEEE Nuclear and Space Radiation Effects Conferences. A report on the nomination processes for the 2023 Junior Member-at-Large on the Radiation Effect Steering Group and the 2024 nominating committee will be presented. Voting instructions for IEEE NPSS members will be provided.

2022 OUTSTANDING PAPER AWARD

Radiation-Induced Faults Propagation in Quantum Bits and Quantum Circuits

D. Oliveira, E. Auden, and P. Rech

2022 MERITORIOUS PAPER AWARD

Fragmented High-Energy Heavy Ion Beams for Electronics Testing

R. Garcia Alia, K. Bilko, F. Cerutti, A. Coronetti, L. Esposito, S. Francesc, W. Andreas, F. Saïgne

Awards

2022 OUTSTANDING STUDENT PAPER AWARD

Scaling Trends for Single-Event Cross-Section for Conventional D-FF at Bulk FinFET Technology Nodes

Y. Xiong, N. Pieper, A. Feeley, B. Narasimham, D. Ball, B. Bhuvra

2022 OUTSTANDING DATA WORKSHOP PRESENTATION AWARD

A Heavy-Ion Single-Event Effects Test Facility at Michigan State University

S. Lidia, T. Glasmacher, S. Kim, G. Machicoane, P. Ostroumov, A. Stolz

2023 RADIATION EFFECTS AWARDS

The winners of the 2023 Radiation Effects and Radiation Effects Early Achievement Awards will be announced Tuesday, July 25 at the opening. The purpose of the Radiation Effects Award is to recognize individuals who have had a sustained history of outstanding and innovative technical and/or leadership contributions to the radiation effects community. The purpose of the Radiation Effects Early Achievement Award is to recognize an individual early in his or her career whose technical contributions and leadership have had a significant impact on the field of radiation effects.

2024 RADIATION EFFECTS AWARD

Nominations are currently being accepted for the 2024 IEEE Nuclear and Plasma Sciences Society (NPSS) Radiation Effects Award. The basis of the award is for individuals who have: (1) a substantial, long-term history of technical contributions that have had major impact on the radiation effects community. Examples include benchmark work that initiated major research and development activities or a major body of work that provided a solution to a widely recognized problem in radiation effects; and/or (2) a demonstrated long-term history of outstanding and innovative leadership contributions in support of the radiation effects community. Examples include initiation or development of innovative approaches for promoting cooperation and exchange of technical information or outstanding leadership in support of the professional development of the members of the radiation effects community.

Nominations are currently being accepted for the 2024 Radiation Effects Early Achievement Award. The basis of the award is for individuals whose technical contributions and leadership during the first ten years of the recipient's career that have had a major impact on the Radiation Effects Community. Examples include work that provides a solution to important technical problems in radiation effects or work that identifies significant new issues in the field. Other factors are cumulative research contributions over the first part of the career, internationally recognized leadership, and mentorship. It is the intent of the RESG to give special consideration for this award to members of the community who are IEEE/NPSS members.

Cash awards and plaques will be presented at the NSREC in Ottawa, Ontario, Canada in July 2024. Nomination forms are available electronically in PDF Format or in Microsoft Word format at <http://ieee-npss.org/technical-committees/radiationeffects/>. Forms should be sent to Michael Tostanoski, Member-at-Large, Radiation Test Solutions, at mtostanoski@radiationtestsolutions.com

Conference Information

CONFERENCE LOCATION

NSREC 2023 will be held in **Kansas City, Missouri**. Barbecue, fountains, and jazz define Kansas City—and have since the city's original renaissance in the early 1920s. Those traditions are as strong now as they've ever been thanks to free-flowing sauce, fountains, and musical notes, each a testament to the city's culture, history, and heart.



Photo courtesy of Sheraton Crown Center

With its heritage in KC's African American community, jazz first flourished in the 1920s and '30s on 12th & Vine and in what is now the 18th & Vine Historic Jazz District.

Today, those roots still run deep—the genre is as vibrant as ever, fueling more than 40 jazz and fine-dining venues every night of the week, including local icons the **Mutual Musicians Foundation**, **The Blue Room**, **The Phoenix** and the **Green Lady Lounge**.

Kansas City's barbecue craze can be traced back to Henry Perry, who in the early 1920s started barbecuing in an outdoor pit adjacent to his streetcar barn, serving slabs of food wrapped in newspaper.

His moment became a movement. Now, more than 100 different metro restaurants smoke everything from pork, beef, and chicken to jackfruit, mushrooms, and fish. There's even the KC BBQ Experience, and an entire mobile app dedicated to exploring the culinary scene. <https://www.visitkc.com/bbq/app>

Kansas City is home to more than 200 fountains—more than any other city in the world except Rome. From large and majestic to small and whimsical, discover waterworks dedicated to fallen firefighters, the city's children, women's leadership, and more.

The city's bubbly love affair began with a rather practical purpose; the Humane Society built the city's first fountains as water troughs for horses in the late 1800s. Now cherished works of public art, the fountains have become an attraction unto themselves—and a quintessential component of KC culture, found everywhere from Crown Center and Union Station to the Country Club Plaza.

The location for NSREC 2023 will be the **Sheraton Kansas City Hotel at Crown Center** in the Crown Center complex in Kansas City, Missouri.

Sheraton Kansas City Hotel at Crown Center, 2345 McGee Street, Kansas City, Missouri, USA. Website: <https://www.marriott.com/en-us/hotels/mcicr-sheraton-kansas-city-hotel-at-crown-center/overview/>

The **Sheraton Kansas City** will also be the Host Hotel, accommodating all of NSREC 2023's guests in comfort and style.

Conference Information

BREAKFASTS, LUNCHES AND BREAKS

The 2023 IEEE NSREC will provide breakfast and refreshments at breaks during the NSREC Short Course and Technical Sessions. Additionally, lunch will be included on Monday for the Short Course attendees. *These meals and refreshments are for registered conference attendees only. Please see the schedule for times and locations.*

The exhibitors will host breakfast and lunch on Tuesday, July 25th & Wednesday, July 26th, in **Exhibit Hall A**. There will also be an Exhibitor Reception in the evening on Tuesday, July 25th. *Breakfasts and lunches are for NSREC attendees and Exhibitor Booth Staff only. The Exhibitor reception is open to all NSREC attendees and their guests.*

BUSINESS CENTER

The Sheraton Kansas City at Crown Center has a small business center on-site with limited printing capabilities. If you require color printing or multiple copies, we recommend using the local FedEx Office located at 1111 Main St Suite 111 Kansas City, Missouri 64105

ROOMS FOR SIDE MEETINGS

A few “side meeting rooms” are available for use by any registered conference attendee at the Sheraton Crown Center on a first-come, first-served basis. *NSREC encourages side meetings to be scheduled at times other than during technical sessions.* Send an e-mail to j.teehan@ieee.org to make side meeting reservations before the conference. To make a side meeting room reservation during the conference, see the NSREC Registration staff in Van Horn A-C room in the Convention Center.

Notes: You must register for the conference before a side meeting room can be reserved! All audio/visual equipment and refreshments must be coordinated directly with the hotel and are the responsibility of the attendee hosting the meeting.

HEALTH AND WELLNESS PROTOCOLS/COVID-19 PREPAREDNESS:

IEEE NSREC will implement health and wellness protocols appropriate to the public health recommendations existing at the time of the conference. Compliance with the protocols adopted by IEEE NSREC may be mandatory for in-person attendance and participation at the conference. We will communicate any additional information regarding the specific health and safety measures, and any necessary consents by you, to attendees and exhibitors before the conference.

Conference Information

CHILD CARE REIMBURSEMENT

The 2023 Conference is offering child-care reimbursement of up to \$400 per family to assist conference attendees who incur additional childcare expenses by attending the conference. This program, funded by the NPSS AdCom, will also be carried out at other NPSS Conferences during 2023. Limited funds are available, and preference will be given to applicants in the early stages of their careers who are IEEE NPSS members. Up to five candidates will be selected.

Eligible applicants:

- Families where both parents are registered attendees at the conference
- Parent (registered attendee) who brings child(ren) to the conference
- Parent (registered attendee) who incurs additional expenses at his or her home location, *above normal child-care expenses*, while attending the conference.

Allowable expenses include:

- Babysitting or child-care expenses at the conference location while the parent(s) attend the conference
- Additional baby sitting or child-care expenses incurred in leaving a child home while parent(s) attend the conference
- Transportation expenses for a child-care provider to care for child(ren) during the conference. Reimbursement is only allowed for an adult or relative that does not share your home residence.

Expenses must be documented by receipts. An expense report, accompanied by receipts, must be received by **Nathan Nowlin nnowlin@sandia.gov by August 15, 2023**. If the report is not received by that date, no reimbursement will be made. All reimbursements will be made after the conference.

To apply, an attendee must register for the conference technical sessions, and then complete the application form to request reimbursement for child care. The application must be received no later than June 1, 2023 by **kay.c.chesnut@raytheon.com**. Applicants will be notified whether they qualify for these funds by June 15th 2023. Due to limited funding, it is possible that not all qualified applicants will be eligible for reimbursement. The application and expense form is available at **www.nsrec.com**.

Registration and Travel

CONFERENCE REGISTRATION

NSREC encourages Pre-Registration and offers a lower registration rate, "Early Registration," if the payment is received no later than Friday, June 16. After that date, the "Late Registration" rates apply.

Registrations can be submitted using the NSREC website link: www.nsrec.com. All Registrations must be completed online using the Registration Portal. Telephone registrations will not be accepted.

There are three acceptable forms of payment for registration and activity fees: 1) check made payable to "IEEE NSREC" in U.S. dollars and drawn on a U.S. bank, 2) Wire Transfer, or 3) MasterCard, VISA, Discover, and American Express credit card.

ON-SITE REGISTRATION LOCATION & TIMES IN KANSAS CITY

All conference registration will occur in the Sheraton Kansas City Hotel at Crown Center. If you *have not yet registered*, go to "On-Site Registration" in Van Horn A-C. If you *have already registered*, go to "Pre-Registration" in the Terrace on the second floor.

Registration hours are:

Sunday, July 23	5:00 PM – 8:00 PM
Monday, July 24	7:30 AM – 5:00 PM
Tuesday, July 25	7:30 AM – 5:00 PM
Wednesday, July 26	7:30 AM – 3:00 PM
Thursday, July 27	7:30 AM – 3:00 PM
Friday, July 28	7:30 AM – 10:00 AM

CONFERENCE CANCELLATION POLICY

A \$50 processing fee will be withheld from all refunds. Due to advance financial commitments, refunds of registration fees requested after June 17, 2023, cannot be guaranteed. Consideration of requests for refunds will be processed after the conference. To request a refund, you must notify NSREC at NSRECCreg@ieee.org

Registration and Travel

HOTEL ACCOMMODATIONS:

**Sheraton Kansas City Hotel at
Crown Center
2345 McGee Street
Kansas City, Missouri, USA**



Accommodations for the 2023 IEEE NSREC are available at the **Sheraton Kansas City Hotel at Crown Center**

Live like a Kansas City local at Sheraton Kansas City Hotel at Crown Center. With a central downtown location near the Crown Center, travelers are welcomed with sophisticated hotel accommodations. Relax effortlessly in contemporary rooms and suites smartly accessorized with Sheraton Signature beds, flat-screen TVs, large work areas and high-speed Wi-Fi. Indulge in classic American favorites at our hotel restaurant. Enjoy a direct connection to the shops, restaurants and entertainment of Crown Center and to Kansas City's historic Union Station. Explore popular attractions including Country Club Plaza, Legoland, the Convention Center and the vibrant Power & Light District. Get your heart pumping at the contemporary fitness center or make a splash in our outdoor pool. Discover a stylish haven amid some of the Kansas City's most famous attractions at Crown Center.



Photos courtesy of Sheraton Crown Center

Sheraton Kansas City room rates for a standard king or double-Queens are:

**NEGOTIATED GROUP RATE:
\$175.00 single/double per night**

**GOVERNMENT PER DIEM:
\$124.00 single/double* per night**

*For the government rate, guests must provide current government or military ID at check-in.

Room taxes currently at 18.1% will be added to all rates listed above.

NSREC 2023 hotel rates are available three days before and after the conference, based on availability.

Registration and Travel

HOTEL RESERVATIONS



Photo courtesy of Sheraton Crown Center

The preferred method to make reservations is by using the following weblinks:

Sheraton Kansas City Crown Center – Group rate

<https://www.marriott.com/event-reservations/reservation-link.mi?id=1673022800575&key=GRP&app=resvlink>

Sheraton Kansas City Crown Center – Government rate:

<https://www.marriott.com/event-reservations/reservation-link.mi?id=1673023058993&key=GRP&app=resvlink>

In any case, enter your arrival and departure dates and follow the prompts.

Room reservations require a credit card as a guarantee. The cut-off for IEEE NSREC reservations is at 5:00 PM Central Daylight Time (CDT) on **June 30, 2023**. Once the room block has been filled OR after the cut-off date (whichever comes first!), it is at the hotel's discretion as to whether they can book more rooms and at what room rate will be offered. Early reservations are strongly suggested!

Please be certain to notify the hotel of any change to your arrival or departure dates. When you check into the hotel, be sure to verify your departure date

AIRPORT AND TRANSPORTATION INFORMATION

Kansas City International Airport (code: **MCI**) is located approximately 35 miles from the Sheraton Kansas City at Crown Center. Traveling outside of normal commuting hours, the drive typically takes between 30-40 minutes. During heavy commuting times, the drive can take up to 60 minutes.

TAXI SERVICE & RIDESHARE

Airport to Hotel Transportation:

There is no scheduled shuttle service between the Hotel and the airport, but there are other options.

1) Taxi Service is available at the Kansas City International Airport. Courtesy phones for taxi service are located both inside and outside the terminal at each bag claim area and at other strategic locations outside the terminal exits. Make sure that you give the dispatcher your exact location.

Fares may be pro-rated (shared) when the originating passenger requests it and all other passengers agree.

Rates are \$2.50 plus \$2.10 per mile. Rates may vary due to traffic delays and waiting time.

2) There is a Super Shuttle Express service from the Kansas City International Airport to Downtown Kansas City. Details can be found on the Super Shuttle website: **<https://www.supershuttle.com/locations/kansascity-mci/>**

3) Uber Website: **<https://www.uber.com/>** - costs around \$30, depending on current driver availability and conditions

4) Lyft Website: **<https://www.lyft.com/>** - costs around \$30, depending on current driver availability and conditions

Registration and Travel

PARKING AND DRIVING DIRECTIONS

On-Site Parking: Daily: \$25

Valet: Daily: \$35

Kansas City International Airport to the Sheraton Kansas City Crown Center:

- Get on I-29 S/US-71 S in May Township from NW 120th St
- Use the left lane to merge onto NW 120th St
- Turn left onto L P Cookingham Dr
- Turn left onto NW 120th St
- Follow I-29 S to E 22nd St in Kaw Township. Take the 22nd St exit from U. S. Hwy 71 S
- Merge onto I-29 S/US-71 S
- Merge onto I-29 S/I-35 S/US-71 S
- Keep left to continue on U. S. Hwy 71
- Merge onto I-70 E/U. S. Hwy 71 S
- Use the middle 2 lanes to keep right at the fork and continue on U. S. Hwy 71 S
- Take the 22nd St exit toward The Paseo
- Continue on E 22nd St. Drive to McGee St
- Merge onto E 22nd St
- Turn left onto McGee St
- Destination will be on the left

GETTING AROUND TOWN

The NSREC optional tours are the easiest way to explore the area. Still, there is much to see and do within walking distance of the hotels. The city is quite safe, so feel free to experience it at your leisure. Kansas City offers a FREE Streetcar service that runs throughout downtown Kansas City. Details and Streetcar routes can be found here <https://kcstreetcar.org/>.

TIPS WHEN VISITING KANSAS CITY

Fun in the sun: On average, there may be only about 5 cloudy days in the entire month of July, so consider taking a hat, sunscreen, and sunglasses on any excursions.

Weather: July is a hot summer month in Kansas City, Missouri, with an average temperature fluctuating between 72°F (22.2°C) and 90.1°F (32.3°C).

Driving: Be patient in traffic and mindful of pedestrians. Obey all traffic rules and be alert, whether driving or walking. It is easy to navigate in the downtown Kansas City Area, but be mindful of the pedestrian traffic.

Restaurants & Tipping: Be aware that upscale restaurants might require reservations, especially during the busy dining hours of 6:00pm – 8:00pm. Most restaurants accept “casual” dress, although some are less “casual” than others. Standard tipping is 20 percent of the bill. Some restaurants add a “service charge” (gratuity) for groups of 6 or more, so check your bill to see if this has already been added.

Industrial Exhibits



Ken LaBel
Industrial Exhibits Chair
SSAI, Inc./NASA Goddard
Space Flight Ctr

The 2023 NSREC Industrial Exhibits will feature the leading worldwide suppliers of radiation hardened products, related materials, services, and research and development. This will be an excellent opportunity for key suppliers, technical engineers and managers to meet and discuss the needs and solutions for electronics used in space vehicles, military electronics, and applications requiring radiation tolerance in harsh environments.

The 2023 NSREC Industrial Exhibits will be held in Exhibit Hall A on Tuesday and Wednesday. Breakfast and conference breaks will be in the Exhibit Area on Tuesday and Wednesday, with an Exhibitor Lunch to be held on Tuesday and Wednesday. Breakfasts and lunches are for registered attendees only. NSREC badges must be worn at all times.

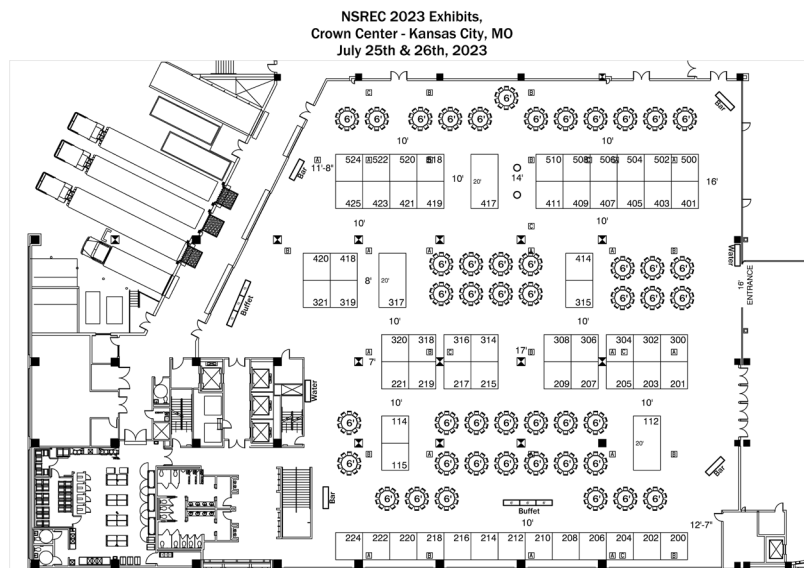
Tuesday evening, the exhibitors will host the Industrial Exhibits Reception featuring light hors d'oeuvres in the Exhibit Area. The Reception is open to all NSREC attendees and their guests.

NOTE: Children under 16 must be accompanied by an adult in the Exhibit Area.

For more information, or to get on the waiting list for a booth, contact:

Ken LaBel Phone: 1-240-988-3646
SSAI in support of NASA/GSFC Email: kenneth.a.label@nasa.gov

Or visit the 2023 NSREC Industrial Exhibits web site:
<https://www.nsrec.com/industrial-exhibits-2023/>



Industrial Exhibits

Please check our web site (www.nsrec.com) for a current listing of companies exhibiting at 2023 NSREC.

NSREC INDUSTRIAL EXHIBITS

CROWN CENTER

EXHIBIT HALL A

EXHIBIT HALL HOURS

TUESDAY, JULY 19

7:00 AM – 5:30 PM

10:00 AM - 10:30 AM

MORNING BREAK

1:50 PM - 2:30 PM

AFTERNOON BREAK

5:30 PM RECEPTION

WEDNESDAY, JULY 20

7:00 AM – 5:30 PM

10:10 AM - 10:40 AM

MORNING BREAK

12:00 PM - 1:30 PM

LUNCH

1:00 PM RAFFLES

(All of the exhibit events are for Registered Attendees; the Exhibit Reception is for Registered Attendees and Guests)

EXHIBITORS

Organization	Internet Site	Booth
3D PLUS USA, INC.	3d-plus.com	217
Air Force Research Laboratory – Space Vehicles Directorate	afri.af.mil/RV/	420
Alphacore Inc.	alphacoreinc.com/en	114
ALTER Technology	altertechnology-group.com/en/home/	321
AMD	https://www.xilinx.com/	222
Analog Devices, Inc.	analog.com	308
Apogee Semiconductor	apogeesemi.com/	209
Boeing	boeing.com/	411
Boeing LMTF	N/A	302
Brookhaven National Laboratory	bnl.gov/nsrl/	504
Checkpoint Technologies	checkpointtechnologies.com/	207
Crane Aerospace & Electronics	craneae.com	210
Crocker Nuclear Lab/UC Davis	cyclotron.crocker.ucdavis.edu/	522
Cyclo Technologies	cyclotechnologies.com/	319
Defense Microelectronics Activity (DMEA)	dmea.osd.mil	508
Electro Magnetic Applications, Inc. (EMA)	ema3d.com/	206
EMPC	empc.com	304
EPC Space	epc.space/	314
FASTRAD®	fastrad.net	520
Fifth Gait Technologies	5thgait.com/	500
Flex Logix Technologies, Inc.	flex-logix.com	216
Foss Therapy Services, Inc.	fosstherapy.com/	510
FRIB Single Event Effects Facility	frib.msu.edu/fsee	418
Frontgrade (formerly CAES Space Systems Division)	frontgrade.com	516/417
Honeywell International	honeywellmicroelectronics.com	524
IEEE Future Direction IEEE Low-Earth-Orbit (LEO) Satellites & Systems	cmte.ieee.org/futuredirections/projects/leo-satellites-systems/	220
imec	imeciclink.com	115
IR HiRel,		
an Infineon Technologies company	infineon.com/hirel	401/403
ISOCOM Limited	http://isocom.com/	306
Jeffrey Titus (Consultant)	jlt-rad-test.com	200
JL Shepherd and Associates	http://jlshepherd.com/	224
Lawrence Berkeley National Laboratory - 88-Inch Cyclotron	cyclotron.lbl.gov/	506
Magics Technologies NV	magics.tech	425
Microchip Technology Inc.	microchip.com/	421/423
Micropac	micropac.com	214
Micross Components	micross.com	320
NASA NEPP Program	nepp.nasa.gov/	315
Power Device Corporation / DDC	www.powerdevicecorp.com	502
PULSCAN	pulscan.com/	409
QuickLogic Corporation	quicklogic.com/	204
Radiation Test Solutions, Inc.	radiationtestsolutions.com	201/203
RADNEXT & PAC-G	radnext.web.cern.ch/	316
Renesas	renesas.com/us/en/products/space-harsh-environment	112/113
Robust Chip	robustchip.com	205
Sandia National Laboratories	sandia.gov	300
SkyWater Technology	skywatertech.com	215
STMicroelectronics, Inc.	st.com	317/416
Texas A&M University Cyclotron Institute	cyclotron.tamu.edu	518
Texas Instruments	ti.com/Space	221/219
Triad Semiconductor Inc	triadsemi.com	212
Trusted Semiconductor Solutions	trustedsemi.com	208
UNITES Systems a.s.	unites-systems.com	318
Vanderbilt University (ISDE)	http://www.isde.vanderbilt.edu/	202
Vicor	www.vicorpower.com/	419
VORAGO Technologies	voragotech.com	218
VPT, Inc	www.vptpower.com/	405/407
Zero-Error Systems (ZES) Pte Ltd	zero-errorsystems.com/	414

Local Activities

GENERAL INFORMATION

CROWN CENTER

Crown Center is the result of the vision of the late Joyce C. Hall, Hallmark Cards, Inc. founder, and his son, longtime Hallmark chairman, Donald J. Hall. In the early 1960s, the Halls looked out over the area surrounding their company's Kansas City headquarters and did not like what they saw: rutted parking lots, abandoned warehouses, the sorry remains of failed or failing businesses, and a limestone hill cluttered with signs and tarpaper shacks. They believed the industry leader in personal expression deserved a better setting for its home – and that the city which had given much to them deserved better than the blighted landscape stretched before them. They had two choices: follow the stream of businesses fleeing the city for the suburbs; or stay and make the city environment better. They chose to stay.

Crown Center Redevelopment Corporation, a Hallmark subsidiary, was formed to make the Halls' vision a reality. The Hall family sought the counsel of nationally known designers, urban planners and visionaries such as Walt Disney and James Rouse. They invested millions of dollars, and then were patient waiting for that investment to pay off, understanding that the returns on a project such as Crown Center would be realized only over the long term.

Today's Crown Center is the happy result.

Crown Center hosts shopping and dining experiences as well as attractions for all ages.

Crown Center Family Friendly Attractions:

SEA LIFE and **LEGOLAND** Kansas City – Crown Center is home to internationally recognized attractions. **SEA LIFE** is the world's largest family of aquariums and includes **SEA LIFE** Aquariums in North America. From its origins in 1979 in Oban, Scotland, **SEA LIFE** now provides immersive marine experiences in nearly 50 locations in 17 countries around the world. Their mission is to share a passion for the creatures of the oceans and to make guests fall in love with them. The **LEGOLAND** Discovery Center (LDC) attraction offers a fun, highly interactive and educational two to three-hour indoor experience ideal for families with children 3-10 years old. Based on the ever popular LEGO® brick, the LDC provides a range of interactive play areas including a 4D cinema; master classes from the LEGO® Master Model Builder; an exciting LEGO® laser ride; special party rooms for birthdays and other celebrations; as well as the MINILAND exhibit featuring iconic Kansas City buildings. Adults must be accompanied by a minor to visit **LEGOLAND**.

Kaleidoscope - Provided as a gift to the children and families of Kansas City by **Hallmark**, **Kaleidoscope** is a **FREE** center for artistic exploration and creativity for children of all ages to nourish their artistic spirit! It's a vivid, imaginative workshop where young artists use their imaginations to paint, discover, have fun, and feel good about their own special ideas! Guests use materials from Hallmark's manufacturing processes to dream up all kinds of colorful creations—some are cut into shapes, while others are left just as Hallmark sends them. Take your time to explore the whimsical space, make and create, then take home all your goodies to display your greatness!

Local Activities

Crown Center Dining:

Whether you feel like BBQ or a burger, pizza or tacos, there's something for every taste at Crown Center. From full service to fast casual, fast food to a quick snack, there is something for everyone. Try the closest BBQ restaurant to the conference hotel, **Burnt End BBQ!** Have a train deliver a burger right to your table at **Fritz's Railroad Restaurant**. Get creative with toppings at **SPIN! Pizza**. If it's fresh, locally inspired cuisine you are looking for, **Unforked** is for you. But make sure to save room for dessert with some of the best frozen custard around from **Sheridan's** or a delightful box of Kansas City Fudge® from **Chip's Chocolate Factory**. Wherever you decide to dine the options at Crown Center make your day made to order.

Crown Center Shopping:

When it comes to shopping in Kansas City, Crown Center isn't run of the mill. You'll love the unique finds at locally owned, one-of-a-kind stores. Whether you're looking for a cashmere sweater, a felt fedora, a fine pen, the ultimate Kansas City collectible, or a bag of world-famous popcorn, you'll find it here.

UNION STATION

Union Station Kansas City is a 104-year-old historical landmark and celebrated civic asset renovated and reopened to the public in 1999. Now 20 years later, Science City, a hands-on science center, has earned the distinction of Kansas City's "Favorite Attraction" and "Favorite Family-Friendly Attraction", while Union Station as a whole is recognized as KC's "Favorite Historic Attraction" and "Best of KC". The organization -- dedicated to preserving its historic monument and its stories, inspiring lifelong learning and creating lasting memories for our community -- is home to Kansas City's internationally-awarded Science City; the new Arvin Gottlieb Planetarium; the Regnier Extreme Screen Theatre; the popular Model Railroad Experience; City Stage featuring live theater, and a selection of unique shops and restaurants. Union Station is also home to prominent area civic organizations and businesses, and regularly hosts world-class traveling exhibitions.

Local Activities

KANSAS CITY ART & CULTURE

Fountains – Kansas City is the City of Fountains. Nowhere else but in Kansas City will you find...three men and a woman roaring through turbulent waters on the backs of powerful horses...cherubs and winged sea horses seemingly dancing through raindrops...abstract flames boldly rising above softly cascading waterfalls. And the J. C. Nichols Memorial Fountain is but one of hundreds of unique and majestic fountains that make their home in our City of Fountains.

KC Parks maintains 48 fountains with the city, ensuring that they work, stay beautiful and last forever. The City of Fountains Foundation recognizes the important role our fountains play as sources of beauty and celebration and dedicates its efforts to ensuring the continued development and maintenance of Kansas City's flowing treasures as well.

Explore all 48 KC Parks fountains online and be sure to visit them in person in July!

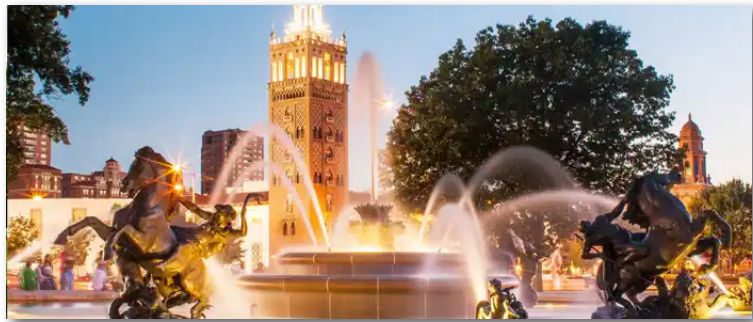


Photo courtesy VisitKC

MUSEUMS

THE NATIONAL WWI MUSEUM AND MEMORIAL

The National WWI Museum and Memorial is the only American museum solely dedicated to preserving the objects, history and personal experiences of a war whose impact still echoes in the world today. The National WWI Museum holds the most diverse collection of World War I objects and documents in the world and is the second-oldest public museum dedicated to preserving the objects, history and personal experiences of the war. The Museum takes visitors on an epic journey through a transformative period and shares deeply personal stories of courage, honor, patriotism, and sacrifice. Designated by Congress as America's official World War I Museum and located in downtown Kansas City, Mo., the National WWI Museum inspires thought, dialogue and learning to make the experiences of the Great War era meaningful and relevant for present and future generations.

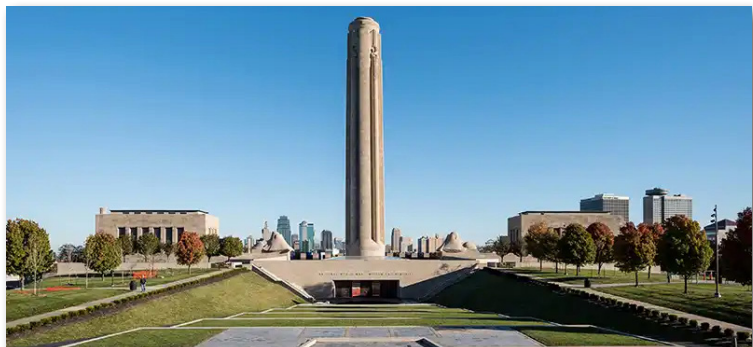


Photo courtesy VisitKC

Local Activities

THE NATIONAL MUSEUM OF TOYS AND MINIATURES.

The Midwest's largest collection of antique toys and the nation's largest collection of contemporary, fine-scale miniatures can be found at **The National Museum of Toys and Miniatures**. The museum, which is located just south of the Country Club Plaza, speaks to the art of play and imagination—and touts a collection featuring more than 72,000 objects from antique dolls and doll houses to dump trucks, ceramics, silver, erector sets, furniture, figurines and more.

THE NATIONAL ARCHIVES AT KANSAS CITY

Home to historical records dating from the 1820s to the 1990s, **The National Archives at Kansas City** is one of 15 facilities nationwide where the public has free access to Federal archival records. Visitors will find more than 50,000 cubic feet of documents—including the judgment from the landmark *Brown v. Board of Education* case—as well as selected military service indexes, architectural drawings, microfilmed materials, photographs and maps. The archives also feature a rotating exhibit gallery, workshops, lectures, programs and online genealogy subscription services.

COLLEGE BASKETBALL EXPERIENCE

Kansas City is home to the state-of-the-art College Basketball Experience (CBE). Sweating is almost inevitable as CBE's high-energy exhibits recreate the intensity of a college basketball game—from foul-line hecklers to a last-second buzzer beater. Each visitor's journey ends with a stop in the National Collegiate Basketball Hall of Fame, a quiet space devoted to the game's greats. Interactive kiosks offer a glimpse into each inductee's legacy.

THE MONEY MUSEUM

Located inside the Federal Reserve Bank, **The Money Museum** offers a free, one-hour tour encompassing the region's largest cash vault, interactive exhibits, a Truman Coin Collection and an area where guests can design their own digital currency. Walk-in or guided tour, **The Money Museum** is perfect for visitors of all ages. The most unique part? Every guest walks away with a free bag of money—shredded U.S. bills, that is.

MUSIC

Since the early 1900s, Kansas City has been synonymous with jazz. Today, those jazz roots still run deep and the genre is as vibrant here as ever, fueling more than 40 jazz venues on a regular basis.

The history of Kansas City jazz can be traced back to the blues, which began in the Mississippi Delta region near New Orleans, eventually migrating north. Once here, it melded with a sort of jump timber that soon became the distinctive sound the city still calls its own.

KC's jazz heyday in the 1920s and 1930s was found along 12th and 18th streets downtown, both part of the hub of the city's African-American community and where many great musicians got their start in jazz groups. As the Kansas City sound flourished, increasingly larger numbers of musicians flocked here to practice their craft in the numerous nightclubs, dance halls and vaudeville houses regularly featuring jazz music. They of course were followed by legions of fans which together helped create what is now the 18th & Vine Historic Jazz District.

Local Activities

EAT & DRINK

Barbecue in Kansas City is unique. For starters, the city invented and perfected a delicacy called the burnt end. Expect to find it on just about every barbecue menu in Kansas City, and expect to crave it long after you've left the region. Its composition: that crispy portion of the brisket not suitable for slicing, but delicious and full of flavor on its own. Pitmasters will chop it into cubes or chunks, and then submerge it into sauce, often times returning it to the smoker for even more smoking.

Kansas City is also a sauce town. Here, meat is often seasoned with a dry rub, then sauced. It's the sauce itself that defines so many of the restaurants in the region. Typically, the style is of a rounder, sweeter tone, as defined most notably by **Hillsdale Bank BBQ** and **Joe's Kansas City Bar-B-Que**. But the region's most famous sauces are both, atypically, more savory than sweet, and come from the region's two heavyweights, **Arthur Bryant's** and **Gates**.

In the not-so-distant past, the Kansas City beer scene relied mainly on just three brewing entities, **Boulevard Brewing Co.**, **75th Street Brewery** and **McCoy's Public House**. A small handful of beer-centric bars supported the cause, but over the course of the past few years, we've seen a sharp increase in businesses that cater to hop heads, helping to put Kansas City on the national beer map.

SHOPPING

Country Club Plaza - Kansas City's premier retail, dining and entertainment destination, offering 100+ shops and dozens of fine restaurants nestled within 15 blocks of old-world architecture. Plaza Shopping Shoppers will recognize fine stores like West Elm, The North Face and Tiffany & Co. Original Kansas City stores like Tivol and Made in KC Marketplace give local flavor to the Plaza's reputation. Pleasant surprises can be found along each block – from boutiques to delicious eateries, stylish salons and fine jewelry. Plaza Dining Contemporary American to Kansas City steaks, authentic Italian to cosmopolitan Mexican are all a part of the Plaza experience. The picturesque views of the Spanish influenced background entice Plaza visitors to dozens of outdoor dining venues.

Crossroads Arts District – Once-vacant warehouses now house carefully curated galleries in the Crossroads. It's here that visitors can truly take in the arts, both hanging in showrooms and spray-painted onto building exteriors –while restaurants, breweries, and speakeasies round out the neighborhood that the arts built.

Well Bottoms – Eclectic is just the beginning in this historic neighborhood where antique shoppers thrive and hipsters vibe. The West Bottoms touts an excellent selection of vintage and preowned stores, as well as atmospheric bars and restaurants; spend a few hours here and you'll see that it's on the cusp of something great.

Sources:

<https://www.visitkc.com>

<https://www.crowncenter.com>

Fountains Archives - KC Parks and Rec

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